

## darktable 2.6

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# Preface

User manual version and applicable darktable version are listed below:

	version	date
user manual	2.6.0	December 2018
darktable	2.6	December 2018

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# Chapter 1. Overview

darktable is an open source photography workflow application and raw developer, a virtual lighttable and darkroom for photographers.

It manages your digital negatives in a database, lets you view them through a zoomable lighttable and enables you to develop raw images and enhance them.

## General Features

- darktable runs on GNU/Linux / GTK3, Mac OS X / macports and Solaris 11 / GTK3.
- Fully non-destructive editing.
- All darktable core functions operate on 4x32-bit floating point pixel buffers for high accuracy processing, preventing banding and color breaks.
- darktable makes heavy use of *Streaming SIMD Extensions 2 (SSE2)* instructions of the CPU to speed up processing. In fact, darktable requires either an SSE2-capable x86 processor or an ARM64 processor.
- GPU acceleration via OpenCL (runtime detection and enabling).
- Most image processing is done in CIE Lab color space, which is much larger than the gamut of modern displays, printers or even human vision.
- Full color managed display with softproofing and gamut-check. Built-in ICC profile support for export: sRGB, Adobe RGB, XYZ and linear RGB.
- A collect module allows you to execute flexible database queries, search your images by tags, image rating (stars), color labels and many more. Filtering and sorting your collections within the base query or simple tagging by related tags are useful tools in your every-day photo workflow.
- Import a variety of standard, raw and high dynamic range image formats (e.g. JPEG, CR2, DNG, OpenEXR, PFM, ...).
- darktable has a zero-latency fullscreen, zoomable user interface through multi-level software caches.
- Tethered shooting.
- The powerful export system supports Google+ webalbum, flickr upload, disk storage, 1:1 copy, email attachments and can generate a simple html-based web gallery. darktable allows you to export to low dynamic range (JPEG, JPEG2000, PNG, TIFF, PDF), 16-bit (PPM, TIFF), or linear high dynamic range (PFM, EXR) images.
- darktable uses both XMP sidecar files as well as its fast database for saving metadata and processing settings. All Exif data is read and written using libexiv2.
- darktable comes with more than 60 image operation modules which cover everything from basic operations, tonal value changes, color manipulation, correction of common image defects to artistic effects.
- Many darktable modules can be combined with blending operators for even more development options.

- A powerful mask feature gives you fine control on module's effect to different parts of an image. You can at your choice draw a mask using various shapes or define a parametric mask based on pixel values.
- Most modules can exist as multiple instances. Together with the mask feature, you can let an operation have different effects on different parts of the image.
- darktable introduces a highly efficient, yet simple "single-click" denoiser that always just works™. It's designed as a module where the denoising performance only depends on camera and ISO setting. A database of profiles contains parameters for well above 200 popular camera models.
- darktable comes with a versatile scripting interface for functionality enhancement using Lua as a scripting language.
- Images containing geo coordinates can be displayed on a map with various map sources at your choice. Geo coordinates can be assigned to images by manually placing them on the map, or by automatically applying GPX track data.
- darktable has a built-in slideshow feature that lets you display your collection of images fullscreen.
- A versatile print module lets you send your image to a connected printer with full color management support.

## 1.1. Program invocation

darktable comes with two main binaries: the standard GUI variant which is started by calling `darktable` and a command line interface variant which is started by calling `darktable-cli`. Additionally darktable is shipped with some further binaries for special purposes.

### 1.1.1. darktable binary

This binary starts darktable with its GUI and full functionality; it is the standard way of using darktable.

darktable is called with the following command line parameters:

```
darktable [-d {all,cache,camctl,camsupport,control,dev,
              fswatch,input,lighttable,lua,masks,memory,nan,
              opengl,perf,pwstorage,print,sql}]
          [<input file>|<image folder>]
          [--version]
          [--disable-opengl]
          [--library <library file>]
          [--datadir <data directory>]
          [--moduledir <module directory>]
          [--tmpdir <tmp directory>]
          [--configdir <user config directory>]
          [--cachedir <user cache directory>]
          [--localedir <locale directory>]
          [--luacmd <lua command>]
          [--noiseprofiles <noiseprofiles json file>]
          [--conf <key>=<value>]
```

All parameters are optional; in most cases users will start darktable without any additional parameters in which case darktable uses suitable defaults.

**-d**

This option enables debug output to the terminal. There are several subsystems of darktable and debugging of each of them can be activated separately. You can use this option multiple times if you want debugging output of more than one subsystem.

**<input file>|<image folder>**

You may optionally supply the filename of an image or the name of a folder containing image files. If a filename is given darktable starts in darkroom view with that file opened. If a folder is given darktable starts in lighttable view with the content of that folder as the current collection.

**--version**

This option causes darktable to print its version number, a copyright notice, some other useful information, and then terminate.

**--disable-opengl**

This option prevents darktable from initializing the OpenGL subsystem. Use this option in case darktable crashes at startup due to a defective OpenGL implementation.

--library <library file>

darktable keeps image information in an sqlite database for fast access. The default location of that database file is "\$HOME/.config/darktable/library.db". You may give an alternative location, e.g. if you want to do some experiments without compromising your original library.db. If the database file does not exist, darktable creates it for you. You may also give ":memory:" as a library file in which case the database is kept in system memory – all changes are discarded when darktable terminates.

Whenever darktable starts, it will lock the library to the current user. It does this by writing the current process identifier (PID) into a lock file "<library file>.lock" next to the library specified. If darktable finds an existing lock file for the library, it will terminate immediately.

--datadir <data directory>

This option defines the directory where darktable finds its runtime data. The default place depends on your installation. Typical places are "/opt/darktable/share/darktable/" and "/usr/share/darktable/".

--moduledir <module directory>

darktable has a modular structure and organizes its modules as shared libraries for loading at runtime. With this option you tell darktable where to look for its shared libraries. The default place depends on your installation; typical places are "/opt/darktable/lib64/darktable/" and "/usr/lib64/darktable/".

--tmpdir <tmp directory>

The place where darktable stores its temporary files. If this option is not supplied darktable uses the system default.

--configdir <config directory>

This option defines the directory where darktable stores the user specific configuration. The default place is "\$HOME/.config/darktable/".

--cachedir <cache directory>

darktable keeps a cache of image thumbnails for fast image preview and of precompiled OpenCL binaries for fast startup. By default the cache is located in "\$HOME/.cache/darktable/". There may exist multiple thumbnail caches in parallel – one for each library file.

--localedir <locale directory>

The place where darktable finds its language specific text strings. The default place depends on your installation. Typical places are "/opt/darktable/share/locale/" and "/usr/share/locale/".

--luacmd <lua command>

A string containing lua commands to execute after lua initialization. These commands will be run after your "luarc" file.

If lua is not compiled in, this option will be accepted but won't do anything.

`--noiseprofiles <noiseprofiles json file>`

The json file that contains the camera specific noise profiles. The default location depends on your installation. Typical places are `"/opt/darktable/share/darktable/noiseprofile.json"` and `"/usr/share/darktable/noiseprofile.json"`.

`--conf <key>=<value>`

darktable supports a rich set of configuration parameters which the user defines in "darktable.rc" – darktable's configuration file in the user config directory. You may temporarily overwrite individual settings on the command line with this option – however, these settings will not be stored in "darktable.rc".

### 1.1.2. darktable-cli binary

This binary starts the command line interface variant of darktable which allows exporting images.

This variant does not open any display, so it will work in pure console mode without using any X11, wayland, etc. – this mode is useful for servers running background jobs.

darktable-cli is called with the following command line parameters:

```
darktable-cli <input file>|<image folder>
               [<xmp file>]
               <output file>
               [--width <max width>]
               [--height <max height>]
               [--bpp <bpp>]
               [--hq <0|1|true|false>]
               [--upscale <0|1|true|false>]
               [--style <style name>]
               [--style-overwrite]
               [--verbose]
               [--core <darktable options>]
```

The user needs to supply an input filename and an output filename. All other parameters are optional.

**<input file>**

The name of the input file to export or the name of an folder containing input images which are to be exported.

**<xmp file>**

The optional name of an XMP sidecar file containing the history stack data to be applied during export. If this option is not given darktable will search for an XMP file that belongs to the given input file(s).

**<output file>**

The name of the output file. darktable derives the export file format from the file extension. You can also use all the variables available in darktable's export module in the output filename (see Section 2.3.12, "Export selected"). For obvious reasons this is mandatory if you use the program on an image folder containing multiple images.

`--width <max width>`

This optional parameter allows to limit the width of the exported image to that number of pixels.

`--height <max height>`

This optional parameter allows to limit the height of the exported image to that number of pixels.

`--bpp <bpp>`

An optional parameter to define the bit depth of the exported image; allowed values depend on the file format. Currently this option is not yet functional. If you need to define the bit depth you need to use the following workaround:

```
--core  
--conf plugins/imageio/format/<FORMAT>/bpp=<VALUE>
```

where `<FORMAT>` is the name of the selected output format.

`--hq <0|1|true|false>`

A flag that defines whether to use high quality resampling during export (see Section 8.2, "Core options"). Defaults to true.

`--upscale <0|1|true|false>`

A flag that defines whether allow upscaling during export. Defaults to false.

`--style <style name>`

Specify the name of a style to be applied during export. If a style is specified, the path to the darktable configuration directory must also be specified (i.e. `--core --configdir ~/.config/darktable`). Defaults to no style specified.

`--style-overwrite`

The specified style overwrites the history stack instead of being appended to it.

`--verbose`

Enables verbose output.

`--core <darktable options>`

All command line parameters following "`--core`" are passed to the darktable core and handled as standard parameters. See Section 1.1.1, "darktable binary" for a detailed description.

### 1.1.3. darktable-generate-cache binary

This binary updates darktable's thumbnail cache. You can start this program to generate all missing thumbnails in the background when your computer is idle.

`darktable-generate-cache` is called with the following command line parameters:

```
darktable-generate-cache  
    [-h, --help]
```

```
[--version]
[--min-mip <0-7>] [-m, --max-mip <0 - 7>]
[--min-imgid <N>] [--max-imgid <N>]
[--core <darktable options>]
```

All parameters are optional. If started without parameters `darktable-generate-cache` uses reasonable defaults.

`-h, --help`

    Gives usage information and terminates.

`--version`

    Gives copyright and version information and terminates.

`--min-mip <0 - 7>, -m, --max-mip <0 - 7>`

    darktable can handle and store thumbnails with up to eight different resolution steps for each image. These parameters define which maximum resolution should be generated and default to a range of 0-2. There is normally no need to generate all possible resolutions here; missing ones will be automatically generated by darktable the moment they are needed. When asked to generate multiple resolutions at once, the lower-resolution images are quickly downsampled from the highest-resolution image.

`--min-imgid <N>, --max-imgid <N>`

    Specifies the range of internal image IDs from the database to work on. If no range is given, `darktable-generate-cache` will process all images from the entire collection.

`--core <darktable options>`

    All command line parameters following “`--core`” are passed to the darktable core and handled as standard parameters. See Section 1.1.1, “darktable binary” for a detailed description.

#### 1.1.4. `darktable-chart` binary

This binary is a dedicated utility to create styles out of pairs of images such as RAW+JPEG with in-camera processing. Details about its usage can be found in Section 10.3, “Using `darktable-chart`”.

`darktable-chart` either starts a GUI or is used as a command-line program.

```
darktable-chart
    [--help]
    [<input Lab pfm file>]
    [<cht file>]
    [<reference cgats/it8 or Lab pfm file>]
```

All parameters are optional, however, if you want to supply the second file name you also need to supply the first one etc. Starting `darktable-chart` this way opens a special GUI (details can be found in Section 10.3, “Using `darktable-chart`”).

`--help`

    Gives usage information and terminates.

<input Lab pfm file>

Opens the utility with the given file as source image. The input file needs to be in Lab Portable Float Map format.

<cht file>

Specifies a chart file describing the layout of the used color reference chart.

<reference cgats/it8 or Lab pfm file>

Specifies the reference values, either as measured values according to the CGATS standard, or as a reference image in Lab Portable Float Map format.

Alternatively `darktable-chart` can be used as a command line program to generate darktable style files out of previously saved CSV files.

```
darktable-chart
    --csv
    <csv file>
    <number patches>
    <output dtstyle file>
```

All parameters are mandatory.

<csv file>

A CSV file previously saved from within `darktable-chart`.

<number patches>

The number of color patches to be used in the *color look up table* settings of the created style.

<output dtstyle file>

The name of the style file to be created.

### 1.1.5. `darktable-cltest` binary

This binary checks if there is a usable OpenCL environment on your system that darktable can use. It emits some debug output that is equivalent to calling "`darktable -d opencl`" and then terminates.

`darktable-cltest` is called without command line parameters:

```
darktable-cltest
```

### 1.1.6. `darktable-cmstest` binary

This binary investigates if the color management subsystem of your computer is correctly configured and it displays some useful information about the installed monitor profile(s).

`darktable-cmstest` is called without command line parameters:

```
darktable-cmstest
```



## 1.2. User interface

This section describes the layout of the user interface.



### 1.2.1. Views

darktable consists of several views or modes. There are five available views as described in this section. You can switch between views by clicking the view name at the top of the right panel – the active view is highlighted – or by using one of the key accelerators:

<i>l</i>	switches to lighttable
<i>d</i>	switches to darkroom
<i>t</i>	switches to camera tethering
<i>m</i>	switches to map
<i>s</i>	switches to slideshow
<i>p</i>	switches to print

#### 1.2.1.1. Lighttable

The lighttable view is where images and film rolls are managed. It's also where you rate images, add tags and colorlabels, and export images among other actions (see Chapter 2, *Lighttable*).

#### 1.2.1.2. Darkroom

In the darkroom view you develop a single image using the available modules (see Chapter 3, *Darkroom*).

#### 1.2.1.3. Tethering

This view is for shooting with the camera connected to the computer and remotely capturing images that will be downloaded and shown on computer screen (see Chapter 4, *Tethering*).

#### 1.2.1.4. Map

This view shows images with geo-tag data on a map and allows manually geo-tagging new images (see Chapter 5, *Map*).


#### 1.2.1.5. Slideshow

This view shows images as a slideshow, processing them on-the-fly (see Chapter 6, *Slideshow*).

#### 1.2.1.6. Print

This view allows you to send images to your printer (see Chapter 7, *Print*).

## 1.2.2. Screen layout

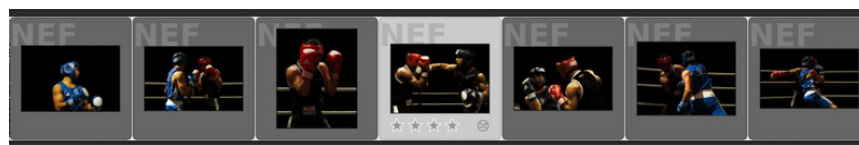
The general screen layout of all views is similar. There is a center area which contains most of the relevant information of that view. Then there are panels left, right, top and bottom to the center area. The left panel typically has an informational purpose. The right panel offers functions to modify an image. The top and bottom panel give access to several settings and shortcuts. Each of the panels can be collapsed or expanded by pressing a triangle like , located close to the panel.

By pressing the *TAB* key all panels get collapsed, allowing the center area to occupy all available space. Pressing *TAB* again brings you back to the previous view.


Fullscreen view can be toggled by pressing *F11*.

## 1.2.3. Filmstrip

The filmstrip along the bottom shows the same images as lighttable, with respect to filters and sort order. It is turned on/off with key accelerator *ctrl-f*. You can navigate along the filmstrip by scrolling with the mouse wheel and change the height of the filmstrip panel by dragging its top. The filmstrip allows you to interact with images while you are not in lighttable mode. For example, you can, while developing an image in darkroom mode, switch to another image to develop, by double clicking the thumbnail in the filmstrip. You can also rate the images as you do in lighttable, copy/paste history stack, etc.




## 1.2.4. Preferences

A button  located in the upper panel allows you to define various parameters which control darktable's behavior.

The options are fairly self-explanatory. If you need more information, hover the mouse cursor over the text label or entry box, to display a popup tool-tip. All configuration parameters are explained in Chapter 8, *Preferences and settings*.

## 1.2.5. Contextual help

A button  located in the upper panel allows you to open the online usermanual for various elements of darktable. Click on this button, then click on the element for which you want help. The related usermanual entry will open in your web browser.

## 1.3. darktable basic workflow

This section describes a typical darktable workflow which novice users may take as a starting point. We describe how to get an image into darktable, the basic steps of a raw development workflow and how to export the final result.

### 1.3.1. Importing images

To begin with darktable, you first need to import images. The import module is in the left panel of the lighttable view (Section 2.3.1, "Import"). You can either import from the filesystem or, if darktable supports your camera model, directly from camera.

#### 1.3.1.1. Importing images from filesystem

When importing from disk, you can import either a single image or a folder. darktable will analyse its content, detect images that are already imported and only import new images.

#### 1.3.1.2. Importing from camera

Connect your camera to your system. If your distribution tries to automount it, select the option to abort the mount operation. Otherwise the camera will be locked and not accessible from within darktable. If you don't see your camera in the import module, hit the "scan for devices" button. Your camera will then appear in the same module with additional choices: *import* and *tethering*.

## 1.3.2. Basic development steps

### 1.3.2.1. Introduction

This section will guide you through the basics of developing an image in the darkroom view.

To begin, open an image in darkroom mode by double clicking an image thumbnail on the lighttable. The darkroom mode is where the actual adjustments for an image are made, where an arsenal of modules are at hand to help you reach your goal.

Each change made on a module while developing an image is turned into a *history stack* item. The history is stored in a database and in an XMP sidecar file for the specific image.

All changes are stored automatically when you switch images or go from one darktable view to another. You can safely leave darkroom mode or quit darktable at any time and come back later to continue your work. That said darktable does not need a "save" button and it does not have one.

On the left panel in darkroom mode is the *history stack*, showing changes starting from bottom, and building up with each change made to the image. You can select a point in this history to show how the image looked at that point, for comparison of changes. The stack can be compressed: it will be optimized and redundant changes will be discarded. When you think you are done and are happy with what you have done, just compress the history stack.

darktable ships with a number of modules, arranged into groups. These module groups are accessed via toggle buttons in the right panel, just under the histogram. There are also two special module groups named "active" and "favorites", which only show modules enabled in the history for the current image, and modules selected as a favorite, respectively.

Marking a module as a favorite is done in the *more modules* dialog (Section 3.3.9, “More modules”), at the bottom of the right panel, by clicking a module until a star is displayed in front of the icon.

### 1.3.2.2. White balance

The *white balance* module controls the white balance or color temperature of the image. It's always enabled and reads its default values from camera metadata embedded in the image. The most common change is fine-tuning the white balance, which is done using the “temperature” slider. Moving this slider left will make the color balance cooler, and moving it right will make it warmer.

### 1.3.2.3. Exposure correction

The *exposure* module is probably the most basic module of them all. Exposure is fine-tuned either by using the slider, or by dragging with the mouse in the *histogram*. You can also boost the black level to enhance contrast; but be careful: use small amounts, like steps of 0.005. There is also an auto-correct feature.

### 1.3.2.4. Noise reduction

The best starting point for noise reduction is *profiled denoise*. This module offers an almost “single-click” solution to fight noise. From a user perspective the effect only depends on camera type and ISO value, both derived from Exif data. All other settings are taken from a database of noise profiles that the darktable team has collected – now covering well above 200 popular camera models. In addition you have several other options in darktable to reduce noise. There is *raw denoise*, *denoising based on bilateral filter*, *denoising based on non-local means*, and *equalizer*, which is based on wavelets. If your camera is not yet supported by *profiled denoise*, *denoising based on non-local means* is probably the most convenient, as it allows you to treat color and luminance noise separately.

### 1.3.2.5. Fixing spots

Sometimes you will need to remove spots caused by sensor dirt. The *spot removal* module and the *retouch* module are at hand and can also correct other disturbing elements like skin blemishes. If your camera has stuck pixels or tends to produce hot pixels at high ISO values or longer exposure times, have a look at the *hot pixels* module for automatic correction.

### 1.3.2.6. Geometrical corrections

Quite frequently you want to only show part of the captured scene in your image, e.g. to take away some disturbing feature close to the frame. In other cases, the horizon in the image may need levelling, or there are perspective distortions. All this can be corrected with full manual control in the *crop and rotate* module. For a fully automatic correction of perspective distortions you may alternatively visit the *perspective correction* module. If you need to correct typical camera lens flaws like cushion distortion, transversal chromatic aberrations or vignetting, there is a *lens correction* module.

### 1.3.2.7. Bringing back detail

Digital raw images often contain more information than you can see at first sight. Especially in the shadows of an image, there are lots of hidden details. The *shadows and highlights* module helps bring these details back into visible tonal values. Structural details in fully blown-out highlights, by nature of the digital sensor, can not be recovered. However, you can correct unfavorable color casts in these areas with the

*highlight reconstruction* module. Additionally the *color reconstruction* module is able to fill overexposed areas with suitable colors based on their surroundings.

### 1.3.2.8. Adjusting tonal values

Almost every workflow is likely to include adjusting the image's tonal range. darktable offers several alternative modules to take care of that. The most basic one is the *contrast brightness saturation* module. In the *tone curve* module, tonal values are adjusted by constructing a gradient curve. The *levels* module offers a concise interface, with three markers in a histogram. In addition, there is a *zone system* module which allows control over tonal values by zones, inspired by the work of Ansel Adams.

### 1.3.2.9. Enhancing local contrast

Local contrast enhancement can emphasize detail and clarity in your image. Carefully used, it can give your photograph the right pop. darktable offers several modules for this task. The *local contrast* module is easy to handle, with just a few parameters. A much more versatile, but also more complex, technique is offered by the *equalizer* module. Have a look at its presets, to get a feeling for how it works. Equalizer is darktable's "Swiss Army Knife" for many adjustments where spatial dimension plays a role.

### 1.3.2.10. Color adjustments

darktable offers many modules for adjusting colors in an image. A very straightforward technique is implemented in the *color correction* module. Use it to give an image an overall tint or to adjust overall color saturation. The *color zones* module offers a much finer control to adjust saturation, or lightness, and even hue, in user defined zones. darktable's *tone curve* module – in addition to the classical adjustment of tonal values – gives you fine control over the colors in an image. Finally, if you intend to convert an image into black & white, a good starting point, with an easy to use and intuitive user interface, is offered by the *monochrome* module. Alternatively, you might consider using darktable's *channel mixer*.

### 1.3.2.11. Sharpening

If you start your workflow from a raw image, you will need to have your final output sharpened. The *sharpen* module can do this with the classical USM (unsharp mask) approach, available in most image processing software. Another very versatile way to enhance edges in an image is offered by the *highpass* module, in combination with darktable's rich set of blending operators.

### 1.3.2.12. Artistic effects

darktable comes with a rich set of artistic effect modules. To name just a few: with the *watermark* module you add an individual watermark to your image. The *grain* module simulates the typical noise of classical analogue footage. Use the *color mapping* module to transfer the look and feel of one color image onto another. darktable's *low light* module allows to simulate human vision to make lowlight pictures look closer to reality. The *graduated density* filter adds a neutral or colored gradient to your image for exposure and color correction.

## 1.3.3. Exporting images

Changes to an image are not saved as in a regular image editor. darktable is a non-destructive editor, which means all changes are stored in a database, and the original image is untouched. Therefore, you need to export images to bake the processing options into an output file that can be distributed outside of darktable.

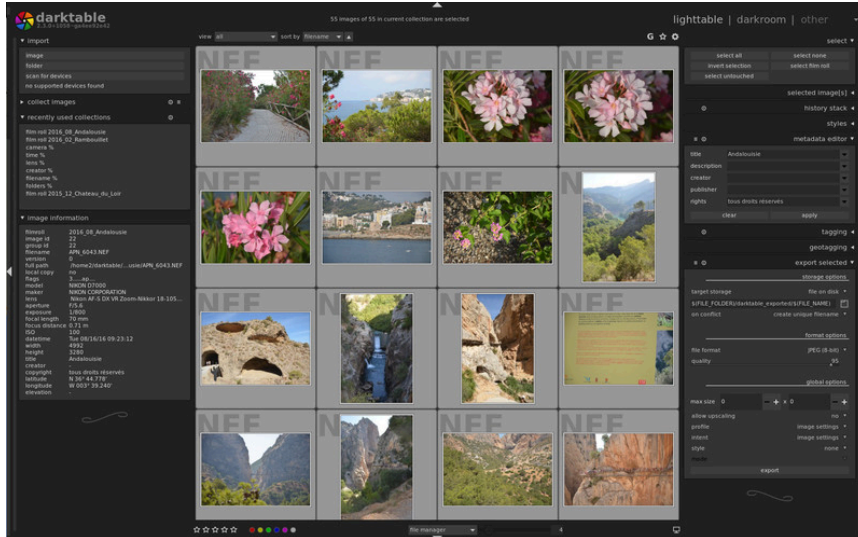
Images are exported from the lighttable view, using the *export selected* dialog in the right panel (Section 2.3.12, "Export selected"). In general, export means: save my developed raw image as a JPEG.

The export is modularized into *storage* and *format*. darktable ships with several storage modules such as *save on disk*, various webalbums, a LaTeX photo book template and more. Format modules are the actual image formats such as JPEG, PNG, TIFF, OpenEXR and more.


Select images on the lighttable, choose the target storage and format, and set the maximum width and height image restraints. This means that none of the images will be bigger than any of the width/height restraints and hit the export button. Leave the width and height restraints at zero if you want the original resolution.

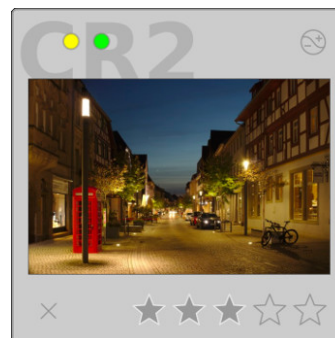
# Chapter 2. Lighttable

The lighttable is where you manage all your images, ratings, export and much more.





## 2.1. Overview


In the central view, your images are shown as thumbnails, surrounded by a frame. When the mouse is over an image, its rating and color labels are shown in the frame, along with an indicator  of whether the image has already been altered in darkroom. Also, when the mouse hovers over an image frame, image information (EXIF data, metadata) is shown in the *image information* panel at the bottom left.



While the mouse is over an image frame, there are a number of actions you can perform. Here is a table of keyboard shortcuts and assigned actions.

<i>0 – 5</i>	set the rating of the image; if an image has 1 star and you hit the <i>1</i> key, the image will be unrated. Pressing <i>r</i> rejects the image.
<i>F1 – F5</i>	set a color label
<i>ctrl-c</i>	copy the history stack
<i>ctrl-v</i>	paste the copied history stack
<i>d</i>	open in darkroom view for developing
<i>z</i>	fully zoom into the image while the key is pressed
<i>ctrl-z</i>	fully zoom into the image and show areas in focus

The overlay button  located in the upper panel activates the permanent display of star ratings and image-changed indicator  on all thumbnails. By default these overlays are only visible on the thumbnail under the mouse cursor. An overlay button is also available in the other views where it affects the filmstrip accordingly (see Section 1.2.3, “Filmstrip” and Section 3.3.10.7, “Filmstrip”).

Pressing the  button on the right side of the bottom panel lets you define the color profile of your monitor. You can either set this to “system display profile” (default) and let darktable enquire the system's display profile, or alternatively set it to one of the ICC profiles located in `$DARKTABLE/share/darktable/color/out` and `$HOME/.config/darktable/color/out`. `$DARKTABLE` is used here to represent your chosen darktable installation directory and `$HOME` your home directory. For more details on color management see Section 3.2.6, “Color management”.

In the center of the bottom panel you have an option to choose between zoomable lighttable view or filemanager view of the thumbnails. In zoomable lighttable view, scroll with your mouse wheel to zoom in and out. Moving the mouse while *pressing the left mouse button* allows you to navigate through your collection. In filemanager view, you can change the number of images in each row, using the slider next to the filemanager option, or by using *ctrl-(mouse wheel)*. Use your mouse wheel to navigate through your collection.

In both modes you can navigate left/right/up/down through your collection using *←/→/↑/↓*. Pressing *g* in filemanager mode goes to the top, *shift-g* to the bottom, *PageUp* brings you one page up and *PageDown* one page down.

You can select the image under the pointer by *left-clicking* on its thumbnail or by pressing *return*. A range of images is selected by *clicking* on the first one and then *shift-clicking* on



the last one. Images are added or removed from your selection by *ctrl-clicking* on their thumbnails or pressing *space*.

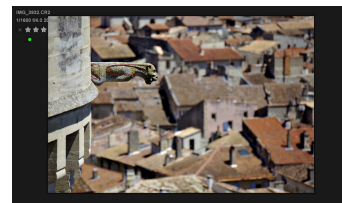
To locate where you are in a collection, there are indicators at the extreme borders of the window: left/right for your position when you are in filemanager mode, left/right and top/bottom for your vertical and your horizontal position, respectively, when you are in the zoomable lighttable view.

While holding down the *z* key a fully zoomed preview of the image under the mouse cursor is displayed. You can use this feature for a quick inspection of image quality while rating and selecting images.

Holding down the *ctrl-z* key fully zooms into the image and additionally activates an analysis for sharp regions, detecting those parts of the image that are in focus. Areas of high sharpness are indicated by a red border – the higher the color intensity the better the sharpness. In case that no area of *high* sharpness is detected darktable indicates areas of *moderate* sharpness with a blue border. For this tool to work the input image needs to hold an embedded JPEG thumbnail which is the case for most raw files.

Sometimes pressing *z* or *ctrl-z* may not reveal an immediate effect – in that case please click into the center area and press the corresponding key again.

Fully zoomed-in image view while holding down the *ctrl-z* key with indication of the sharp areas in focus. Sharpness detection is based on an embedded JPEG thumbnail of the original raw file independent of any processing steps within darktable.



## 2.2. Lighttable concepts

This section explains some of the underlying concepts on how darktable organizes images in the lighttable.

### 2.2.1. Film rolls

The basic element for organizing images in darktable is called a film roll – a kind of virtual folder. Whenever you import images from disk, the images are organized in a film roll whose name is derived from the name of the disk folder. Re-importing a disk folder will add any new images to the existing film roll; images already present in the film roll are not touched.

It is important to note that importing images in darktable does not involve a physical copy step. Importing a folder into darktable is therefore *not* a backup operation of that folder.

### 2.2.2. Collections

darktable offers a versatile feature to organize your images according to various user defined selection criteria. A set of images which is defined by a specific combination of selection criteria is called a collection. The most basic kind of collection is a film roll – covering all the images which have been imported from a specific folder on disk.

You can easily construct other kinds of collections based on various image attributes like Exif data, filename, tags etc. Multiple criteria can be logically combined to narrow or extend your collection (see Section 2.3.2, “Collect images”).

darktable keeps a list of the most recently used collections for quick access (see Section 2.3.3, “Recently used collections”).

### 2.2.3. Thumbnails

Each image of the current collection is represented by a thumbnail in the lighttable view. darktable keeps a cache of the last recently used thumbnails in a file on disk and loads it into memory at startup. The size of this cache can be adjusted in the core preferences dialog (see Section 8.2, “Core options”).

#### 2.2.3.1. Thumbnail creation

Thumbnails get created whenever darktable imports an image for the first time, after an image has been modified in the darkroom, or when revisiting an “old” image whose thumbnail is no longer available.

When darktable imports an image for the first time, there are two possible sources from where to take a thumbnail. darktable can either try to extract an embedded thumbnail out of the input image – most raw files contain these kind of thumbnails generated by the camera – or process the image by itself using default settings. You can define how darktable gets its thumbnails in the GUI preferences dialog (see Section 8.1, “GUI options”).

Extracting an embedded thumbnail from the input image has the advantage of being very fast. However, those thumbnails have been generated by the raw converter of the camera and do not represent darktable's “view” of that image. You will notice the difference as soon as you open the image in the darkroom mode, after which darktable replaces the embedded thumbnail with its own one.

After importing a new film roll darktable generates thumbnails for new images as they are needed. In the case of a larger set of new images this slows down navigation in the lighttable view as with each move new thumbnails might need to be produced. Alternatively you may terminate darktable and start the `darktable-generate-cache` binary. This program will generate all missing thumbnails in one go. For more details see Section 1.1.3, “`darktable-generate-cache` binary”.

As the thumbnail cache file has a pre-defined maximum size it will eventually get filled up. Then if new thumbnails are added, old ones need to be dropped. However, darktable will keep all thumbnails on disk if the corresponding disk backend option is activated in the core preferences dialog (see Section 8.2, “Core options”). Access to the thumbnails in this secondary cache is slower than to the ones in the primary cache, but still much faster than reprocessing thumbnails from scratch. The size of the secondary cache is only limited by disk space.

Thumbnails never get dropped from the secondary cache. In case you want to clean it up you can do so manually by deleting all images recursively in folder `$HOME/.cache/darktable/mipmaps-xyz.d` where `xyz` denotes an alphanumeric identifier of the cache. Afterwards you let darktable re-generate thumbnails as needed, or you generate all thumbnails in one go with `darktable-generate-cache`.

If you don't activate the disk backend and select a too small cache size you might observe adverse effects. Continuous regeneration of thumbnails whenever you move in your collection, flickering of thumbnail images, or even darktable becoming unresponsive are typical symptoms. A good choice of the cache size is 512MB or higher. Please mind that the inherent limits of *32-bit systems* will force you to go for a much lower cache size (see Section 10.1, “darktable and memory” for more details on these limitations).

Starting with darktable 2.0 thumbnails are fully color managed if the corresponding option is activated in the core preferences dialog (see Section 8.2, “Core options”). Colors are rendered accurately on screen as long as your system is properly set up to hand over the right monitor profile to darktable. For more information on color management see Section 3.2.6, “Color management”.

### 2.2.3.2. Skulls

If for some reason darktable is not able to generate a thumbnail, it displays a skull. Don't panic!



There are three main reasons for this to happen.


One possible cause is that the input image has been renamed or physically deleted from disk. darktable remembers all images ever imported, as long as they have not been removed from your database. In case darktable wants to create a thumbnail but is not able to open the input file, a skull is displayed instead. Users are advised to remove images from the database (see Section 2.3.6, “Selected image(s)”) *before* physically removing them from disk. Alternatively you may occasionally run the script `purge_non_existing_images.sh` from darktable's toolset to clean-up your database.

Another possible cause is sometimes darktable encounters an input image having an extension that seems valid for darktable but which has a file format that darktable does not support yet. darktable tries to process the image but is not able to get the job done.

The third possible cause for getting skulls is memory shortage: If darktable runs out of memory while generating a thumbnail, it will warn you and display a skull – this can happen if darktable is run with suboptimal settings, especially on a 32-bit system. Please consult Section 10.1, “darktable and memory” for more information.

## 2.2.4. Star ratings and color labels

Star ratings and color labels help you to sort and rank images according to your own criteria. An image’s star rating and its color labels are displayed in the thumbnail.

You can give a rating from zero to five stars to an image. The quality criteria which lead to a rating are fully up to you. Whenever you import images, each image receives a default rating which you can define in “GUI options” (see Section 8.1, “GUI options”). You can later revise the rating at any time. You can also mark an image as “rejected” by pressing the  icon or typing the *r* key. This will remove all stars. You can reverse the rejection by applying a new star rating.

There are several ways to change a rating. While hovering the cursor over an image thumbnail, you can press a number key *0–5* for the number of stars, or type *r* to “reject” an image; this is probably the fastest way when rating your images on first inspection of a film roll.

You can also directly click on the stars displayed in the thumbnails; click the *x* to reject, click the fifth star to get a rating of five stars, etc. Clicking either the *x* or the first star for a second time resets the image rating to unranked, or zero stars. The latter behavior can be changed in the “GUI options” dialog (see Section 8.1, “GUI options”).



To rate one or more images at once, select those images (see Section 2.3.5, “Select”) and then press the key for your rating, or click the desired star rating in the *bottom panel* of the lighttable view.



Color labels are another way to sort images, and can be used as an alternative to star ratings or work alongside star ratings. Each image can carry any combination of one or more color labels in red, yellow, green, blue, and purple.

You can set the color labels for a single image by hovering your cursor over the thumbnail and pressing the function keys *F1–F5*, which correspond with the labels in the order given above.

To toggle the color labels of one or more images, select the desired images (see Section 2.3.5, “Select”) and then press the corresponding color button in the bottom panel. To remove all labels from the selected images, press the grey button.



## 2.2.5. Filtering and sort order

The filtering and sort order of images in the lighttable view are controlled in the top panel.



With filtering you limit the number of displayed images in your current collection (see also Section 2.3.2, "Collect images"). Filtering is mainly based on the star ratings of your images. A typical filtering rule will show all images that have a rating at or above the given number of stars (from one to five). The comparison operator is not restricted to "≥". By clicking on the operator field you toggle between "≥", ">", "≠", "<", "≤", and "=".

Alternatively you can make darktable display "all" images, only the "unstarred" ones, only the "rejected" images and all but the rejected ones.

Images in the lighttable view can be displayed in different sort orders, depending on "filename", "time" (when the photo was taken), "rating" (i.e. stars), "id" (an internal ordering number of darktable), "color labels", "groups", "full path", "title", "description", "aspect ratio" or "custom order" (user can drag & drop images, only available in the lighttable's file manager mode). You can sort in reversed order by toggling the triangle button to the right of the "sort by" combobox.

## 2.2.6. Image grouping

Grouping images helps improve structure and clarity of your image collection when displayed in lighttable view.

You can combine images into a group by selecting them, and clicking the "group" button in the *selected image(s)* panel (Section 2.3.6, "Selected image(s)"), or by typing *ctrl-g*. Likewise, you can remove selected images from a group by clicking the "ungroup" button, or typing *shift-ctrl-g*. Images generated by duplicating an existing one, are automatically grouped. If you import images from the file system or camera, images with the same base name, but different extensions (eg. IMG\_1234.CR2 and IMG\_1234.JPG), will form a group.

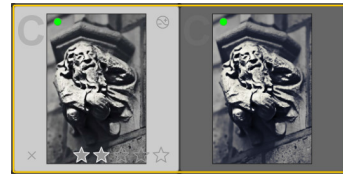
Images which are members of a group are labeled with a "G" symbol in their thumbnails.



The group button **G** in the top panel of the lightroom view toggles grouping mode on and off. If grouping is off, each image is displayed as an individual thumb. If grouping is on, images of a group are collapsed, which means they are represented by a single thumbnail. This thumbnail you see is called the group head. If you press the "G" symbol in the group's thumbnail, only this group gets expanded; if you then expand another group, the first

group collapses. To collapse an expanded group again, just click on the “G” symbol of its group head.

An expanded group in the filemanager mode of lighttable view is indicated by an orange frame which appears as soon as your mouse pointer hovers over one of the images.



You can define which image constitutes the group head, while in an expanded view of a group, clicking on the “G” symbol of the desired image. That symbol is shown only if grouping mode is enabled, so to change the group head, you need to first enable group mode, then expand the group you want to change and then click the “G” symbol on the desired image.

If you collapse an image group and then enter darkroom mode (e.g., by double-clicking on the thumbnail), the *group head* will be opened for developing.

Image groups are a convenient way to protect an existing history stack against unintentional changes. Suppose you have just finalized an image and want to protect its current version: all you need to do is select the image, click “duplicate” in the *selected images* panel, and make sure that grouping is switched on and that the group is collapsed. Now, whenever you open the image group again in darkroom, only the group head will be altered. The underlying duplicate remains unchanged.

Please note that “duplicating images” here only generates a copy of your history stack, stored in another small XMP file. There is still only one raw file, so you don’t waste a lot of disk space.

## 2.2.7. Sidecar files

darktable is a non-destructive image editor. This means that darktable opens images read-only. Any newly added metadata, tags, and parameters of image operations (the “history stack”) are stored in separate *.xmp* files, so-called sidecars, allowing you to store information about the images as well as the full editing history without touching the original raw files. When you import an image into darktable for the first time, an XMP file with default settings is generated automatically.

For a given source image, multiple editing versions, called duplicates, can co-exist, sharing the same input (raw) data but each having their own metadata, tags and history stack. Each duplicate is represented by a separate XMP sidecar file with a filename constructed in the form “<basename>\_<nn>.<extension>.xmp”, where *nn* represents the (minimum two-digit) version number of that edit. Information for the initial edit – the “duplicate” with version number zero – is stored in the sidecar file “<basename>.<extension>.xmp”. The version number of a duplicate is displayed in the image information panel in each of darktable’s views (see an example in Section 2.3.4, “Image information”).

Sidecar files automatically synchronize with your work without the need to press a “save” button. When backing up your data, make sure you also keep the XMP files, as these are needed to fully reconstruct your work in case of a disaster.

In addition to the sidecar files, darktable keeps all image-related data in its database for fast access. An image can only be viewed and edited from within darktable if its data is loaded in that database. This automatically happens when you first import an image or at any later time by re-importing it (see Section 2.3.1, “Import”). In the latter case the

database gets updated with data that darktable finds in the sidecar files belonging to that image.

Once an image has been imported into darktable the database entries take precedence over the XMP file. Subsequent changes to the XMP file by any other software are not visible to darktable – any changes get overwritten the next time darktable synchronizes the file. This behavior can be changed in the preferences dialog (see Section 8.2, “Core options”). On request darktable looks for updated XMP files at startup and offers a choice whether to update the database or overwrite the XMP file.

### 2.2.8. Importing sidecar files generated by other applications

When importing an image, darktable automatically checks if this is accompanied by a sidecar file. Other than the formats “<basename>.<extension>.xmp” and “<basename>\_nn.<extension>.xmp” darktable also checks for the presence of a file in the form “<basename>.xmp”. darktable's own sidecar files are always stored in the first format – the latter one would only be read – not overwritten.

At present, darktable is able to deal with the following metadata of Lightroom generated sidecar files during the import phase:

- tags and hierarchical tags
- color labels
- ratings
- GPS information

In addition, darktable has been designed to help migrate some image operations from specific other applications. The aim is not to make darktable a drop-in replacement for any other software; it's just meant to help you recover part of the work you have invested into your image in case you migrate to darktable. It is very important to understand that this import process will never give identical results. The underlying development engines are very different from application to application, and additionally depend a lot on the specific image. In some cases, it will probably be close, and in some cases, the development will need manual adjustment in darktable.

The migration happens automatically when entering the darkroom view, provided that a corresponding XMP sidecar is found.

At present, darktable is able to deal with the following development steps from Lightroom-generated XMP files (with the corresponding darktable module in parentheses):

- crop and rotate (*crop and rotate*)
- black level (*exposure*)
- exposure (*exposure*)
- vignette (*vignette*)
- clarity (*local contrast*)
- tone curve (*tone curve*)
- HSL (*color zones*)

- split toning (*split toning*)
- grain (*grain*)
- spot removal (*spot removal*)

## 2.2.9. Local copies

Many users have huge image collections which they store on extra hard drives in their desktop computer, or on an external storage medium like a RAID NAS, etc. So it is a common use case to develop some images while travelling using a notebook and then later synchronize them to the original storage medium. But copying images manually from the main storage to the notebook and back is cumbersome and prone to errors.

The “local copies” feature of darktable has been designed to directly support those use cases. You can create local copies of selected pictures on your computer’s local drive. This local copy is always used when present, giving access to the picture if the external storage is no longer connected, and having the advantage of being faster than a slow external drive. At a later point, when connected again with your main storage medium, you can synchronize the XMP sidecar files, deleting the local copy of your input image. These operations can be found in the *selected images* panel (see Section 2.3.6, “Selected image(s)”).

For safety reasons, if local copies exist and the external storage is available, the local XMP sidecars are automatically synchronized at start up.

The local copies are stored into the `$HOME/.cache/darktable` directory and named “img-`<SIGNATURE>.<EXT>`”, where:

<i>SIGNATURE</i>	is a hash signature (MD5) of the full pathname
<i>EXT</i>	is the original filename extension

A local copy is identified in the lighttable view with a white marker on the right of the thumbnail. In addition all local copies carry the `darktable/local-copy` tag for selecting them easily.

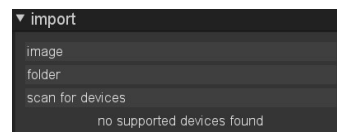




## 2.3. Lighttable panels

### 2.3.1. Import

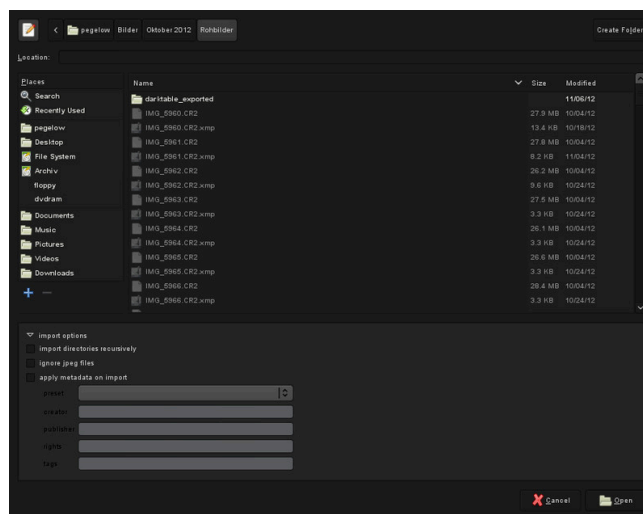
This panel is for importing images into film rolls. You can either import a complete folder, by pressing “folder”, or a single image with “image”. You can also cause darktable to search for connected cameras by pressing “scan for devices”. If a supported camera is connected you can import directly from that camera or control the camera from within darktable in tethering mode.



Imported images are organized as film rolls (see Section 2.2.1, “Film rolls”). All film rolls are accessible through the *collect images* module (see Section 2.3.2, “Collect images”). If you set the selection attribute to “film roll” you get a list of available film rolls, which can be filtered using the editbox to quickly find the one of interest. Double-click on a film roll in the list and it will open in the lighttable. You can also click the items in *recently used collections* (see Section 2.3.3, “Recently used collections”) to open the latest ones you have worked with.

#### 2.3.1.1. Import from filesystem

You can import either a single image, or a folder. The imported image(s) will show up in a film roll with the name of the filesystem folder.



Clicking on “image” or “folder” opens a file selector dialog. Navigate through the filesystem, and select the item to import. On the lower part of the dialog, are some further import options.

As the name implies, checking “import directories recursively” will import images in the currently selected directory, and all subdirectories. It is not recommended, and wastes resources, to do this on an exhaustive list of images. darktable would generate thumbnails for all of them, but in the end only keep the recent ones in its cache. It is better to import images in smaller chunks, making logical film rolls.

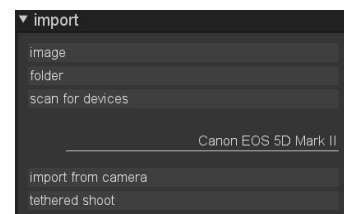
Checking “ignore JPEG files” is a good choice if there are JPEG images in the same folder that you do not want to process; eg. if the camera stores RAW+JPEG, you often only want to work on the raws, leaving the JPEG images alone.

You can also apply some metadata during import; see Section 2.3.10, “Metadata editor” for more details.

Importing a folder does not mean that darktable copies your images into another folder. It just means that the images are visible in lighttable and thus can be developed. If you delete an image or a folder from disk after having imported them, darktable cannot access them anymore. Importing an image or folder in darktable is not a backup of your filesystem! Moreover, darktable does not watch for changes in the filesystem. Thus, if you add an image to a folder, after having imported that folder in darktable, the new image will not be shown until explicitly imported.

### 2.3.1.2. Importing from a connected camera

When a camera is detected, it will show up in the device panel after pressing “scan for devices”. If you hover your mouse over the camera tab label, a tooltip will pop up with information about the camera, such as model, firmware version, and more. Depending on the camera's support, buttons with actions will be available such as “import from camera” and “tethered shoot”.



#### Import from camera

This will bring up an import dialog, showing the images on camera that can be selected for import into a film roll in darktable.

You define the base directory for storing imported images and the naming pattern of sub directories and individual images in the preferences dialog (see Section 8.3, “Session options”).

#### Tethered shoot

Tethering is used to integrate darktable with your camera. While you take images with your camera, they are automatically imported into darktable, so you can review the result of the shoot. You can also setup remote capture jobs, controlling the number of images and time between captures, along with camera settings such as exposure time, aperture and more.

If supported by your camera, tethering will take you into the capture view for tethered shooting. Read more about tethering in Chapter 4, *Tethering*.

### 2.3.1.3. Supported file formats

darktable is focused on managing and developing camera raw files. It supports a huge number of file formats from various camera manufacturers. In addition darktable can read specific *low dynamic range* and *high dynamic range* images – mainly for data exchange between darktable and other software.

In order for darktable to consider a file for import, it must have one of the following extensions (case independent): 3FR, ARI, ARW, BAY, BMQ, CAP, CINE, CR2, CRW, CS1, DC2, DCR, DNG, GPR, ERF, FFF, EXR, IA, IIQ, JPEG, JPG, K25, KC2, KDC, MDC, MEF, MOS, MRW, NEF, NRW, ORF, PEF, PFM, PNG, PXN, QTK, RAF, RAW, RDC, RW1, RW2, SR2, SRF, SRW, STI, TIF, TIFF, X3F.

If darktable was compiled with JPEG2000 support, these extensions are also recognized: J2C, J2K, JP2, JPC.

If darktable was compiled with GraphicsMagick support, the following extensions are recognized in addition to the standard ones: BMP, DCM, GIF, JNG, JPC, JP2, MIFF, MNG, PBM, PGM, PNM, PPM.

## Camera raw files

darktable reads raw files using the open source library RawSpeed [<https://github.com/darktable-org/rawspeed>], originally developed by Klaus Post and now maintained within the darktable project itself. The number of supported cameras and file formats is constantly increasing. It is beyond the scope of this manual to give an exhaustive list. Most modern camera models are supported, and new ones tend to get added very quickly. With the exception of Fujifilm X-Trans cameras, darktable does not decode images from cameras with non-Bayer sensors (e.g. Sigmas with the Foveon X3 sensor).

## LDR image files

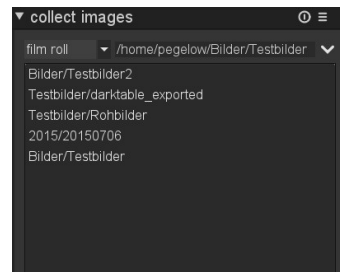
darktable natively reads “ordinary” images in JPEG, 8-bit/16-bit PNG and 8-bit/16-bit TIFF format. JPEG2000 is also supported if the required libraries are present at compile time. Similarly, if darktable was compiled with GraphicsMagick support, there are further import formats, like GIF, Dicom DCM, additional exotic TIFF formats, and some of Sun's “portable xyz-map” family.

## HDR image files

darktable reads high dynamic range images in OpenEXR, RGBE and PFM format.

### 2.3.2. Collect images

The current view in lighttable is called a collection. The *collect images* panel lets you narrow down the list of visible images to just the ones you want to work with.



Information about all images imported into darktable are kept in a database, with various attributes describing each image. You define a collection by applying certain filtering rules to these attributes, creating a subset of images to display in the lighttable view.

The default collection is based on the film roll attribute – it displays all images of the last imported film roll or any other film roll chosen.

#### 2.3.2.1. Usage

##### image attributes

The left combobox lets you choose from the available attributes:

film roll	the film roll to which the image belongs
folders	the disk folder where the input image file is located
camera	the Exif data entry describing the camera make and model

tag	any tag that is attached to the image; if activated a hierarchical list of known tags is displayed for quick selection
date	the date when the photo was taken, in the format <i>YYYY:MM:DD</i>
time	the time (date <i>and</i> time of day) when the photo was taken, in the format <i>YYYY:MM:DD hh:mm:ss</i>
history	choose images whose history stacks have been altered or not altered
color label	any color label that is attached to the image: "red", "yellow", "green", "blue", "purple"
title	the title, as listed in the image's metadata "title" field
description	the description, as listed in the image's metadata "description" field
creator	the creator, as listed in the image's metadata "creator" field
publisher	the publisher, as listed in the image's metadata "publisher" field
rights	the copyrights statement, as written in the image's metadata "rights" field
lens	the Exif data entry describing the lens
focal length	the focal length value, as derived from Exif data
ISO	the ISO value, as derived from Exif data
aperture	the aperture value, as derived from Exif data
filename	the filename of the physical input image
geotagging	the geo location of the image

## search rules

In the text field to the right of the attribute, you write a pattern. The pattern is compared against all database entries with the selected attribute. This search detects a match if the images' attribute contains the pattern in its full text. You may use % as wildcard character. The collection gets limited to those images where the query matches. Leaving the text field empty matches all images for that attribute.

Attributes with numerical values as well as date and time attributes can be used in combination with comparative and range operators. Write <, <=, >, >=, <>, and = to select images with attributes less, less or equal, greater, greater or equal, not equal, or equal to the a given value, respectively. An expression in the form *[from;to]* selects a range of values.

The box below the search rule will list all matching database entries of the query you are currently working on. This list gets updated continuously as you type. You may also choose sorting criteria by scrolling through the list and double-clicking.

Clicking on the triangle button to the right of the text field opens a drop-down menu with options to finetune your current collection by adding further rules, or removing them:

### clear this rule

Removes this rule – or resets to default if this is the only rule defined.

### narrow down search

Adds a new rule which is combined with the previous rule(s) in a logical *AND* operation. An image is only part of the collection if it additionally fulfills the added rule.




### add more images

Adds a new rule which is combined with the previous rule(s) in a logical *OR* operation. Images that fulfill the new rule are added to the collection.

### exclude images

Adds a new rule which is combined with the previous rule(s) in a logical *EXCEPT* operation. Images which are selected by the new rule are exempted from the collection.

## combining rules

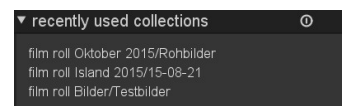
The logical operators defining the combination of rules are displayed to the right of the rule: *AND* by the  symbol, *OR* by the  symbol, and *EXCEPT* by the  symbol. Clicking on either symbol gives a choice to change the logical operation.

## updating folder path

While it is best to not touch imported files behind darktable's back, this module can help you recover from situations when you move imported folders after import. The collect images module has a feature that allows you to tell darktable about the new location of imported folders which have been moved. You set the combobox to *folders* to find the original folder name in the tree. The folder name will be displayed striked-out to emphasize that it is no longer there. Then you right-click on the folder name, select "search filmroll...", and then select the new location of the folder.

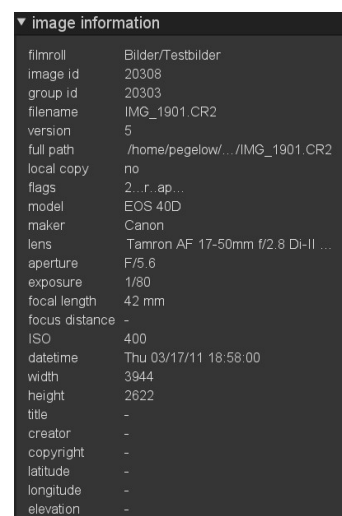
### 2.3.3. Recently used collections

This panel keeps track of the latest collections you have used, so you can jump to recently used collections without remembering what rules were specified in the collection.



### 2.3.4. Image information

This panel shows information embedded within an image's Exif data. When hovering with the mouse over thumbnails, darktable will update this view, displaying information of the image currently under the mouse cursor. This panel is also available in darkroom, tethering, map, and print view.



### 2.3.5. Select

This panel allows for a quick selection of images, according to some common criteria.



### 2.3.5.1. Usage

#### select all

Select all images in the current view (collection), with respect to the filters.

#### select none

De-select all images.

#### invert selection

Select all images that are not currently selected.

#### select film roll

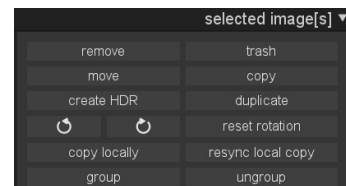
Select all images that are in the same film roll as the currently selected images.

#### select untouched

Select all images that have not yet been developed.

### 2.3.6. Selected image(s)

This panel provides some actions that operate on selected images.



### 2.3.6.1. Usage

#### remove

Remove the selected images from the darktable database. Those images will not be shown in lighttable anymore, but remain on the filesystem. As darktable stores XMP files with your development parameters on disk, you can later fully reconstruct your work by just re-importing the images.

When backing up your RAWs make sure to also save the XMP files!

#### delete/trash

Eliminate the selected images from the darktable database and remove the image files from their respective locations. Depending on the setting of config parameter "send files to trash when erasing images" (Section 8.1, "GUI options") this either irrevocably deletes the images from filesystem or puts them into your system's trash bin.

See also preference option “ask before erasing images from disk” (Section 8.1, “GUI options”). If this configuration option is not active, darktable will delete/trash the file(s) without further question.

When deleting an image with duplicates, darktable keeps the original input file on disk until the last of the duplicates gets deleted.

### **move**

Physically move selected images (parent file plus all accompanying XMP sidecar files) to another filesystem folder. darktable does not overwrite images in the target folder. If an input image with the given filename already exists in the target folder the source image is not moved but kept where it is.

### **copy**

Physically copy selected images (parent file plus accompanying XMP sidecar file) to another filesystem folder. If an image with the given name already exists in the target folder it does not get overwritten – instead a new duplicate with the given history stack is generated.

### **create hdr**

Create a high dynamic range image from the selected images, and store it as a new source file in DNG format. Images need to be properly aligned, which implies that they have been taken on a sturdy tripod. You can also generate HDRs with programs like *Luminance HDR* [<http://qtpfsgui.sourceforge.net/>], and later import them into darktable for further processing (see Section 2.3.1.3, “Supported file formats”). Note that darktable will only creates HDR images from raw files.

### **duplicate**

Create a virtual copy of selected images within darktable. It allows testing different developments for the same image, for example. Duplicate images share the same parent input file, but each have their own XMP sidecar file.

### **rotation**

Perform a counter-clockwise or clockwise rotation on selected images. The third button resets the image rotation to the value in the Exif data. This feature is directly linked to the orientation module (see Section 3.4.1.2, “Orientation”) – adjustments are converted into history stack items of that module.

### **copy locally**

This action will create local copies of the selected images into the local drive. These copies will then be used when the original images are not accessible (see Section 2.2.9, “Local copies”).

### **resync local copy**

This action will synchronize the XMP sidecars of the temporary local copy and the copy in external storage, if needed, and will remove the local copies. Note that if a local copy has been modified and the external storage is not accessible the local copy won't be deleted (see Section 2.2.9, “Local copies”).

### **group**

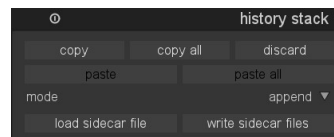
Create a new group from selected images (see Section 2.2.6, “Image grouping”).

### **ungroup**

Remove selected images from the group (see Section 2.2.6, “Image grouping”).

## **2.3.7. History stack**

This panel allows manipulating the history stack (development) of images. For each image, development is written in a sidecar file (.xmp), and is fully non-destructive.



### **2.3.7.1. Usage**

#### **copy**

Copy the history stack of the selected image. You will be prompted for which items are to be include. If more than one image is selected, the history stack is taken from the image that has been selected first.

#### **copy all**

Copy the complete history stack of the first selected image; all items will be included. If more than one image is selected, the history stack is taken from the image that has been selected first.

#### **discard**

Physically delete the history stack of the selected images. Beware, this action can not be undone!

#### **paste**

Paste a previously copied history stack onto all selected images. You will be prompted for which items to include. This button is greyed out, until a history stack is copied from another image.

#### **paste all**

Paste all previously copied items of a history stack onto all selected images. This button is greyed out, until a history stack is copied from another image.

#### **mode**

This setting defines how a new history stack behaves when pasted on an image that already has a history stack. In simple terms the “overwrite” mode deletes the previous history stack, whereas “append” will concatenate the two history stacks.

A copied history stack can have multiple entries of the same module either with the same name (see Section 3.3.3, “History stack”) or with different names (see Section 3.2.4, “Multiple instances”) and pasting behaves differently depending on the mode setting. On append mode, modules from the source image will be merged into the destination image in the following way: for each copied module of the source image, if there is a module in the destination image with the same name it will replace it. If there is not a such module, a new instance will be created. In both cases the instance is placed on top of the history stack. The “copy all”/“paste all” action with this mode will only copy the respective last instance of all modules with the same name to the source image.



In overwrite mode the behavior is the same except that the history of the destination image is deleted before the paste operation. The “copy all”/“paste all” action with this mode works differently; it will make an exact duplicate of the source image history to the destination image with all instances of all names of the modules.

*Note: if you use “overwrite” mode to paste history stack entries to the images that wasn't opened in darkroom previously, i.e. the automatic module presets weren't already applied to the image, next time you open said image in darkroom, the automatic presets will be applied to the image. So it may seem as if the “overwrite” mode did not actually override the existing history stack, but in fact it did override it, and the rest was added later.*

*Caution: only in “append” mode you keep the option to later reconstruct your existing history stack whereas in “overwrite” mode your previous edit gets irrevocably lost. Beware, the setting of this parameter remains effective when you quit darktable.*

## load sidecar file

Opens a dialog box to select an XMP file, thus loading a history stack that you can paste on images.

Files that were exported by darktable typically contain the full history stack if the file format supports embedded metadata (see Section 2.3.12, “Export selected” about this feature and its limitations). You can load an exported image as a sidecar file in the same way as you do with an XMP file. This feature allows you to recover all parameter settings in case you have accidentally lost or overwritten the XMP file. All you need is the source image, typically a raw, and the exported file.

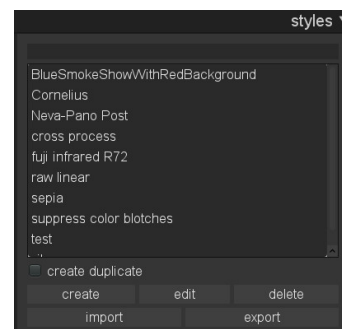
## write sidecar files

Write XMP sidecar files for all selected images. The filename is generated by appending “.xmp” to the name of the underlying input file.

By default darktable generates and updates sidecar files automatically whenever you work on an image and change the history stack. You can disable automatic sidecar file generation in the preferences dialog (see Section 8.2, “Core options”). However, this is not recommended.

## 2.3.8. Styles

This panel provides a powerful functionality in darktable: storing a history stack as a style, and applying it to other images. Styles are created within this panel or in the darkroom (see Section 3.3.3, “History stack”). They are managed within this lighttable panel, which allows you to create, apply, edit and delete styles.



### 2.3.8.1. Usage

This panel displays a list of all available styles. A search field above the list allows you to input a text string which is compared against the styles' names and descriptions, thus limiting the list to the matching ones.

Double clicking on a style name applies the style to all selected images.

### **create duplicate**

When applying a style to selected images, activating this box creates a duplicate of the image before applying the style. Disable this option if you want to try various styles without creating multiple duplicates; beware that in this case any existing history stack gets overwritten and cannot be recovered.

### **create**

This creates new styles out of the history stacks of the selected images. For each image a style creation window pops up. You need to supply a unique name for the new style and you can add an additional descriptive text. You have the option to de-select those history stack items which you want to not be part of the newly created style.

### **edit**

Styles are collections of history stack items. After pressing “edit”, you are prompted with a dialogue to include or exclude specific items from the stack. Check option “duplicate” if you want to create a new style, instead of overwriting the existing one; you need to provide a new unique style name in this case.

### **delete**

This deletes the selected style, without further question.

### **import**

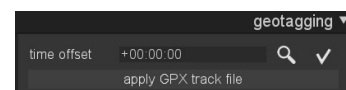
You can import a style which has been previously saved by darktable. darktable stores styles as XML files with the extension “.dtstyle”.

### **export**

This option saves a selected style to disk as a “.dtstyle” file. This allows publishing styles and sharing styles with other users.

## **2.3.9. Geotagging**

Use this panel to import and apply GPX track data on a selection of images. Alternatively, you can manually geotag images within the *Map* view (see Chapter 5, *Map*).



### **2.3.9.1. Usage**

A GPS receiver calculates its current position based on the information it receives from satellites and records them in a GPX file – together with the current date and time. The Exif data of the images also contains a time stamp defined by the camera settings. darktable takes the time stamp of the image, looks-up the position in the GPX file at that time, and stores the coordinates (latitude/longitude/elevation) in its database and the image's XMP sidecar file.

There may occur two problems. In contrast to GPS devices, most cameras don't record the accurate time. Secondly, the time stored in the Exif data doesn't contain a time zone.

Most people set their camera to local time, while the GPS devices store the time in UTC (Universal Time, Coordinated), i.e. Greenwich (London) time zone. If the time zones of camera and GPX file differs, than the related location will be wrong.

If your image already carries the UTC time stamp you can directly apply the GPX track without further adjustments.

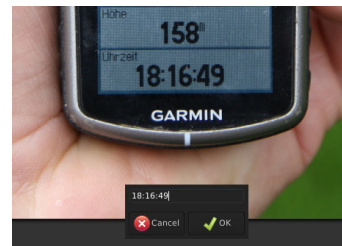
Otherwise we take two steps to correlate the time of camera and GPS tracker, first the offset, then the time zone.

To fix the drift of the camera time setting you can either enter it manually into the offset input field or let darktable calculate it. All you need is a picture taken of a reliable time source.



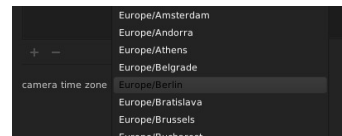
This can be any precise clock or even better the time displayed on your GPS device (normally it shows the local time, although it stores universal time).

When you have this image selected you can click on the (looking glass) button and darktable will present you an entry box. Just enter the time that is shown on the image. As a result you will get the difference between the time you entered and the one associated with the image in its Exif data.



Now you can select all the images you want to geotag and click the apply button (currently represented by a check mark). This will alter the time in darktable's internal database for these pictures – so you will also see the change in the image information module on the left.

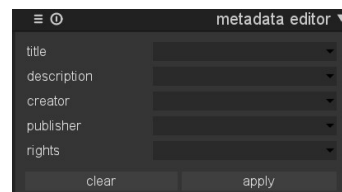
Now you can apply a GPX track. Click the corresponding button and navigate to the GPX file. Before confirming that dialog you should select the corresponding time zone for your camera in the drop-down-menu.



Should you ever make a mistake with the time zone selection you can just come back and reapply the GPX file with a different time zone.

## 2.3.10. Metadata editor

Edit metadata of an image, like *title*, *description*, *creator*, *publisher*, or *rights*. You can define your own presets if you want to apply specific settings frequently.



### 2.3.10.1. Usage

#### clear

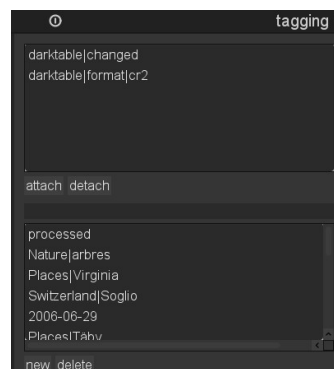
Delete existing metadata from the selected image(s).

## apply

Apply new settings, as defined in the fields above, to the selected image(s).

### 2.3.11. Tagging

This panel is for managing tags on images. Tags are stored in both sidecar files (.xmp) and within the darktable database for a faster access. The panel is divided into two parts: the upper part contains the tag(s) currently attached to the image under the cursor or the selected image(s) if the mouse is outside the lighttable. The lower part contains a list of all available tags in the database, which can be filtered in the text box above.



New tags get added to the list either by typing into the text box and pressing the “new” button, or if an automatically generated tag gets attached to an image, or on import of already tagged images. darktable sorts the list of tags by relevance and frequency of usage.

Hierarchical tags are supported and can be create using the pipe symbol “|”.

As you may notice there are automatically created tags like “darktable| exported” or “darktable|styles|your style”, which keep track of your actions and let you easily find already exported images or images with specific styles applied.

*Tip: ctrl-t opens a small text box at the bottom of the central view for quickly tagging your selected images by typing a tag phrase and hitting return.*

#### 2.3.11.1. Usage

##### attach

Attach the selected tag from the list below to all selected images.

##### detach

Detach the selected tag from all selected images. This also can be done by double clicking the specific tag.

##### new

Create a new tag for the list.


##### delete

Delete a tag from the list and from all images. A warning will be displayed on how many images have this tag attached. Take this warning seriously as there is no way to recover or later find the affected images.

### 2.3.12. Export selected

Workflow ends in this panel with the exporting of your developed images. You can export to a file on disk, email, various on-line storage places, a webalbum, or a book template. *Tip: you can use ctrl-e from within the darkroom mode to export.*



All settings in this panel can be saved for later reuse. Press the  button to manage your presets.

### 2.3.12.1. Usage

#### target storage

Where to store your selected images. Different back-ends are implemented, including file on disk, a LaTeX book template and various web albums. Depending on the selected target, you will be asked to give additional information, like filenames, or account name and password.

#### filename template

You can define filenames that darktable generates for export. Several pre-defined variables can be used as placeholders:

<code>\$(ROLL_NAME)</code>	roll of the input image
<code>\$(FILE_FOLDER)</code>	folder containing the input image
<code>\$(FILE_NAME)</code>	basename of the input image
<code>\$(FILE_EXTENSION)</code>	extension of the input image
<code>\$(ID)</code>	the image id
<code>\$(VERSION)</code>	the duplicate version (see Section 2.2.7, "Sidecar files")
<code>\$(SEQUENCE)</code>	a sequence number within export job
<code>\$(YEAR)</code>	year at date of export
<code>\$(MONTH)</code>	month at date of export
<code>\$(DAY)</code>	day at date of export
<code>\$(HOUR)</code>	hour at time of export
<code>\$(MINUTE)</code>	minute at time of export
<code>\$(SECOND)</code>	second at time of export
<code>\$(EXIF_YEAR)</code>	Exif year
<code>\$(EXIF_MONTH)</code>	Exif month


<code>\$(EXIF_DAY)</code>	Exif day
<code>\$(EXIF_HOUR)</code>	Exif hour
<code>\$(EXIF_MINUTE)</code>	Exif minute
<code>\$(EXIF_SECOND)</code>	Exif second
<code>\$(STARS)</code>	star rating
<code>\$(LABELS)</code>	colorlabels
<code>\$(MAKER)</code>	camera maker
<code>\$(MODEL)</code>	camera model
<code>\$(TITLE)</code>	title from metadata
<code>\$(CREATOR)</code>	creator from metadata
<code>\$(PUBLISHER)</code>	publisher from metadata
<code>\$(RIGHTS)</code>	rights from metadata
<code>\$(USERNAME)</code>	user name
<code>\$(PICTURES_FOLDER)</code>	pictures folder
<code>\$(HOME)</code>	home folder
<code>\$(DESKTOP)</code>	desktop folder

All of the variables support basic string substitution inspired by bash. The details differ however, for example all patterns are treated as simple string comparisons. There is no regex support. For example you can do the following: `$(ROLL_NAME/search/replace)`. This means if your roll name is e.g. `1970-01-01_RAW_Time-Begins` and you use `$(ROLL_NAME/RAW/JPG)` it will result in a roll name of: `1970-01-01_JPG_Time-Begins`

<code>\$(var-default)</code>	If <code>var</code> is empty, use default .
<code>\$(var+alt_value)</code>	If <code>var</code> is set, use <code>alt_value</code> , else use empty string.
<code>\$(var:offset)</code>	<code>var</code> starting from <code>offset</code> . If <code>offset</code> is less than zero it is counted from the back of the string.
<code>\$(var:offset:length)</code>	At most <code>length</code> characters of <code>var</code> , starting from <code>offset</code> . If <code>offset</code> is less than zero it is counted from the back of <code>var</code> . If <code>length</code> is less than zero it indicates the end of the result, counted from the back of <code>var</code> , and not an actual length.
<code>\$(var#pattern)</code>	Remove <code>pattern</code> from the start of <code>var</code> .
<code>\$(var%pattern)</code>	Remove <code>pattern</code> from the end of <code>var</code> .
<code>\$(var/pattern/replacement)</code>	Replace the first occurrence of <code>pattern</code> in <code>var</code> with <code>replacement</code> . If <code>replacement</code> is empty then <code>pattern</code> will be removed.
<code>\$(var//pattern/replacement)</code>	Replace all occurrences of <code>pattern</code> in <code>var</code> with <code>replacement</code> . If <code>replacement</code> is empty then <code>pattern</code> will be removed.
<code>\$(var/#pattern/replacement)</code>	If <code>var</code> starts with <code>pattern</code> then <code>pattern</code> is replaced with <code>replacement</code> .
<code>\$(var/%pattern/replacement)</code>	If <code>var</code> ends with <code>pattern</code> then <code>pattern</code> is replaced with <code>replacement</code> .

<code>\$(var^)</code>	Make the first character of <code>var</code> uppercase.
<code>\$(var^^)</code>	Make all characters of <code>var</code> uppercase.
<code>\$(var,)</code>	Make the first character of <code>var</code> lowercase.
<code>\$(var,,)</code>	Make all characters of <code>var</code> lowercase.

## output directory

Pressing button  opens a dialog to select the parent directory for export.

## on conflict

If this option is set to “create unique filename” darktable automatically chooses a unique new file name in case of naming conflicts with existing files. The alternative “overwrite” setting forces darktable to exactly adhere to the selected filename template, overwriting any existing files on conflict. This option gets reset to “create unique filename” after each export job in order to protect you from accidental data loss.

## file format

darktable can export to various file formats. Depending on the output format you can define additional parameters. For some formats you need to decide on the desired bit depth and the compression method, respectively.

For some export formats like JPEG you can define an output quality. Higher values will lead to larger file sizes. The default quality “95” is a good setting for very high quality exports, e.g. for archiving or printing purposes. If you need a good compromise between size and quality, e.g. for online image display or uploads, you should consider a value of “90” instead.

If the file format supports embedded metadata, like JPEG, JPEG2000 and TIFF, darktable will try to store the history stack as XMP tags within the output file. This information can later be used to reconstruct your parameters and settings that have produced the exported image (see Section 2.3.7, “History stack”).

*Caution: for various reasons embedding XMP tags into output files may fail without notice, eg. if certain size limits are exceeded. Users are therefore advised to not rely their backup strategy on this feature. To back up your data make sure to save your input (raw) file as well as all of darktable's XMP sidecar files.*

If you don't want to distribute history stack data with your images, there are various tools to delete embedded XMP tags. As an example you can use the program *exiftool* [<http://www.sno.phy.queensu.ca/~phil/exiftool/>] with:

```
Exiftool -XMP:all= image.jpg
```

## max size

Set the maximum width and height of the output images in pixels. Set both to a value of “0” to export with the original dimensions (after cropping). If the values exceed the original dimensions darktable will either export with the original dimensions or perform an upscaling step, depending on the setting of the following parameter.

*Caution: it's a frequent pitfall to accidentally put low values, like 1 or 10, in these fields, causing darktable to produce miniature output files. You might think darktable's output is broken, but in fact it only generated what you asked for.*

## allow upscaling

If set to “yes” darktable will perform an upscaling step in case the user defined maximum width and height exceed the original dimensions. If set to “no” the exported image's dimensions will not exceed the original ones (after cropping).

## profile

This defines the output color profile. Select “image settings” if you want the settings in the *output color profile* (see Section 3.4.3.3, “Output color profile”) module of the individual images to take precedence.

## intent

This option lets you define the intent, i.e. the way darktable will deal with out-of-gamut colors. See Section 3.2.6.3, “Rendering intent” for a more detailed description of the available options.


## style

This option lets you choose a style, i.e. a collection of history stack items, which darktable combines with the existing history stack to generate the output image. These history items are only added temporarily; the original history stack is not overwritten. You can use this feature to add processing steps and parameters that you want to be applied specifically to images before export, e.g. you may define a style that adds a stronger level of sharpening when you produce scaled-down JPEG files for the internet or add a certain level of exposure compensation to all of your output images. Learn more about styles in Section 2.3.8, “Styles”, and Section 3.3.3, “History stack”.

## mode

When applying a style during export this option defines whether the history stack items of that style replace the original history stack of the image or are appended to it. Technically speaking, in append mode history stack items of the style will constitute separate instances of the respective modules on top of any existing ones (see also Section 3.2.4, “Multiple instances”). As a consequence the original history stack will fully remain in effect with the new items being applied additionally. This way you can apply an overall adjustment (e.g. exposure) to a bunch of exported images while respecting the settings of each individual image.

## export

Pressing this button starts a background job to export all selected images. A bar at the bottom of the left side panel displays the progress. Furthermore a notification message pops up reporting the export progress. You may click on the pop-up to make it disappear. You may *abort* the export job by clicking on the  icon located close to the progress bar.



# Chapter 3. Darkroom

The darkroom view is where you develop your image.



### 3.1. Overview

Darkroom mode is for photographic development of the image that you selected from the lighttable. Numerous tools, named modules, are available for processing that image.

On the left hand side you have navigation, snapshot, history stack, color picker, tagging, image information and mask manager panels, described in Section 3.3, "Darkroom panels". In the right hand panel you can see the histogram and a list of modules available for working with the image. At the bottom of the right hand panel you can enable/disable the view of individual modules.

You can use *middle-click* to zoom 1:1. A double *middle-click* takes you to 2:1. Alternatively you can zoom in and out between 1:1 and fit-to-screen by mouse scrolling. Mouse scrolling while holding the control key pressed gives an extended zoom range between 2:1 and 1:10.

You normally export multiple images from the lighttable view but you can also export the current image directly from the darkroom by using the shortcut *ctrl-e*. Export parameters are then those currently selected in the lighttable.

## 3.2. Darkroom concepts

This section tries to explain some of the basic concepts on how darktable develops images in the darkroom.

The basic element of an image operation in darktable is called a module. darktable comes with a rich set of over 60 modules for all kind of image manipulations. In Section 3.4, “Modules” you will find a description for each of the available modules.

### 3.2.1. Pixelpipe, module order, and history stack

darktable processes images – from input to output – in a so called “pixelpipe”. Within the pixelpipe image processing consists of consecutive operations which are implemented as “modules”.

Modules are applied in a fixed order. This differentiates darktable, as a non-destructive image editor, from classical image manipulation programs like GIMP. As module order is fixed, you are free to activate, deactivate or change the parameters of a module at arbitrary points in time; the order of activation in your workflow does not have any impact on the outcome.

Users frequently ask why the module order is fixed and if there are plans to change that restriction. There are several reasons why darktable works in the way described:

- The sequence of modules has been selected with great care in order to give highest output quality. Changes to the sequence would generally worsen the result rather than improving it.
- Certain image processing steps just don't make sense if they are shifted in the pixelpipe. To mention just a few: highlight reconstruction needs to be done on raw data before demosaicing and the demosaic step needs to be performed before any input color profile can be applied.
- Most of darktable's modules are designed to work within a specific color model (see Section 3.2.6, “Color management” for more details). Full flexibility would require modules to support different parallel algorithms depending on the color space they are working in – this would drastically increase complexity.


That said, the fixed sequence of modules is not likely to change in the near future.

Whenever you activate or deactivate a module or go back to a module and change the parameters, this adds an item on top of the “history stack”.


For example, when working on a raw file, the history stack on the left panel might say that you first enabled *bilateral filtering*, then disabled *base curve*, then adjusted *white balance*. But at any time, the processing took the raw image, adjusted *white balance* on it, then *demosaic*, then *base curve* (if enabled), then *bilateral filtering* (if enabled), as shown bottom to top on the right panel.


The history stack records your workflow in the order in which you made changes to the pipeline. It allows you to go back to an earlier stage of development if needed. The history stack represents your personal workflow and is not to be confused with the sequence in which modules are applied in the pixelpipe (see above). For more details on the history stack see Section 3.3.3, “History stack”.

### 3.2.2. Interacting with modules


A module has an expander bar . Clicking on the name of the module expands the module's GUI with all parameters.

In its default setting darktable will only expand one GUI at a time. If you click the expander bar of another module, the previous GUI gets collapsed. If you want to see more than one GUI expanded, you may expand further modules with *shift-click* – all previously expanded GUIs remain opened. The expander bar behavior on *click* and *shift-click*, respectively, is controlled by a preference setting in GUI options (see Section 8.1, “GUI options”).

Expanding a module does *not* activate it. You need to click the  icon to turn a module on or off.

Icon  accesses the module's available presets or creates a new preset from your current settings (see Section 3.2.3, “Module presets”).

The  icon is used to reset the module parameters to their default values.

Many of darktable's modules can have multiple instances, each with different settings. Click on the  icon to generate new instances and control existing ones (see Section 3.2.4, “Multiple instances”).

The most frequently used control elements of modules are sliders, comboboxes and curves.

### 3.2.2.1. Sliders

Sliders offer five different ways of interaction, depending on the level of control you need.

#### 1. Left-click

Click anywhere in the slider area to set the value. You can also click and drag to change it. You don't have to aim for the small triangle or even the line, the whole height including the label works as the active area.

#### 2. Mouse wheel

Hover over any place on the slider with your mouse, then use your mouse wheel to adjust the value step by step.

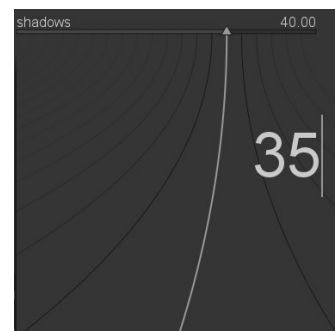
#### 3. Keyboard arrow keys

When the slider has keyboard focus you can hover over any place on the slider with your mouse, then use your keyboard's arrow keys ( $\leftarrow/\downarrow$  and  $\rightarrow/\uparrow$ ) to adjust the value stepwise. In order to give focus to the widget without changing the current value you can right-click, then right-click again.

#### 4. Right-click

When your mouse is over a slider right-click gives you a multi-functional pop-up below the slider for fine control with your mouse or numerical entry using the keyboard.

darktable's innovative input method: for both coarse and fine value adjustments in a single control element combined with keyboard input.



A bent line extending from the triangular marker moves as you move your mouse. The closer your mouse pointer is to the triangular marker the coarser the control; the further away from the triangular marker the finer is your control. Left-click with your mouse to accept the new value and go back to normal control.

Alternatively you can type in a new value using your keyboard and commit by hitting the enter key. You may even supply the new value in the form of an arithmetic expressions which darktable will calculate for you – the old value is referenced as “x”.

## 5. Double-click

You can double-click on a parameter label to reset its value to default.

Additionally, the mouse wheel and keyboard arrow keys support two input modifiers:

- You can hold down the *shift* key increasing the stepsize by a factor of 10. You can change this multiplier:

```
darkroom/ui/scale_rough_step_multiplier=10.0
```

- You can hold *ctrl* key decreasing the stepsize by a factor of 10. You can change this multiplier:

```
darkroom/ui/scale_precise_step_multiplier=0.1
```

### 3.2.2.2. Comboboxes

Clicking on a combobox will open a list of available options. Click on the item you want to select. Sometimes the selection list opens close to the bottom or top of the screen and only part of the items are visible; scroll with your mouse wheel to bring up the full list. Alternatively, you can also use the mouse wheel and keyboard arrow keys to select an option.

### 3.2.2.3. Curves

Some modules are controlled by adjusting curves. More detail is given later in this chapter when the respective modules are explained.

### 3.2.2.4. Undo/redo


During editing darktable records all changes made in the history (see Section 3.3.3, “History stack”). This includes modifications of any parameter in a module itself but also if a module instance is added or removed. Thanks to this recording it is possible to undo changes or redo them to recover a previous editing state. Note that this undo/redo facility is unlimited in the number of steps while editing an image but it is reset each time the darkroom is switched to a new image.

The default key shortcuts are:

- *Ctrl-z*: undo last history modification
- *Ctrl-y*: redo last undo (does nothing if undo has not been used yet)

Please note that changes to drawn masks (see Section 3.2.5.5, “Drawn mask”) are not recorded and thus cannot be undone.


## 3.2.3. Module presets

Presets are stored configurations for a module's parameters. Some modules already have internal pre-defined presets but you can also define your own. Both internal and user-defined presets are displayed by clicking the  icon with the currently activated preset shown in bold text.

The preset system also supports automatic preset selection based on image data such as focal length, ISO, camera model and other fields.

As a convenience, a preset can be applied to a new module instance by pressing the middle-click.

### 3.2.3.1. Creating a new preset

First configure the module's parameters then click the  icon and select "store new preset". The following dialog will be shown for configuring the preset:



The first two fields are used to name and describe the preset.

In the example above we have also checked the auto apply option. This brings up additional selection fields where you can define a filter used to decide if the preset should be automatically applied when opening other similar images in darkroom for the first time. The example dialog above sets up following rules: if lens name matches and aperture is greater or equal to f/8 and focal length is between 24 and 35mm the preset will be automatically applied. Also the second checkbox is clicked so this preset will only be shown in the preset list if the image matches the rule.

darktable finds this data in your image's Exif information. If you want a preset to be applied to all images from a specific camera leave all fields at default values except for the model field.

Tip: The *image information* panel for your image displays your model name, use this to ensure you have the correct spelling (see Section 2.3.4, "Image information").

### 3.2.3.2. Managing Presets

Both user created and pre-defined presets can be viewed and managed from within the presets menu (Section 8.5, "Presets") in the preferences dialog (see Chapter 8, *Preferences and settings*).

### 3.2.4. Multiple instances

Many of darktable's modules can be applied multiple times. Each instance of that module behaves like any other module, taking its input from the module below in the pixelpipe delivering its output to the module above.

### 3.2.4.1. Typical use cases

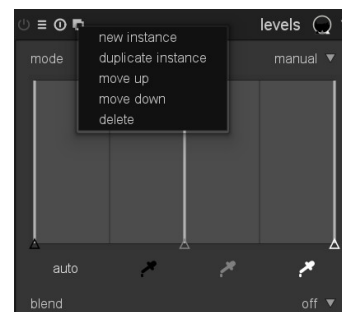
There are many occasions where it makes sense to have an operation act more than once in the pixelpipe. Here are a few use cases.

- Most of our modules are highly versatile and depending on parameters can deliver quite varying effects. For example the *fill light* module (Section 3.4.2.1, “Fill light”) allows local modification of lightness based on pixel values. You might want to do two lightness corrections in your image at the same time – one for dark tones and another one for lighter tones.
- You might want to apply a denoising module like *denoise (profile)* (Section 3.4.4.3, “Denoise – profiled”) with two different parameter sets. One to do luma denoising and another set of parameters to do chroma denoising. You could do so by generating two instances and use the first one only on luma by selecting blend mode “lightness” and use the second one just for chroma by selecting blend mode “color” (see Section 3.2.5.4, “Blending operators”).
- In an even more elaborate case you could have a module act on different parts of your image. As an example you might want to apply a certain gradation curve with module *tone curve* (Section 3.4.2.3, “Tone curve”) to your complete image and have a second curve being applied specifically to skin tones. All of the controls offered by *drawn masks* (Section 3.2.5.5, “Drawn mask”) and *parametric masks* (Section 3.2.5.6, “Parametric mask”) may be used to select those parts of an image where each of the module instances are applied.

Please be aware that of course each instance also adds to the workload of your pixelpipe. Generating too many instances – especially of the more demanding modules – will certainly cause some noticeable slow-down.

### 3.2.4.2. Managing instances

When clicking on the  icon a drop-down menu will appear.



Selecting “new instance” generates a new module instance above any existing ones. All parameters are set to default values. The new instance gets its own complete set of GUI controls and a number appended to the base module name for distinction.

Selecting “duplicate instance” behaves in a similar way. The only difference: the new instance will inherit all parameter settings from its parent.

darktable applies all modules in a defined order according to their type. Therefore all instances of a particular module will occur together in the pixelpipe. You can however decide on the relative order in which the different instances of a module are applied by selecting “move up” or “move down” to shift the position of the instance among its peers.

To delete an instance just press “delete” from the drop-down menu.

An instance can have any name without influencing the edits. To change the name use the “rename” option. See Section 2.3.7, “History stack” for more details on how the instance name impacts copying and pasting history stacks.

## 3.2.5. Blending

### 3.2.5.1. Overview

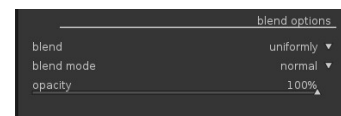
By default a module takes its input from the preceding module, performs its calculations and handles its output over to the next module in the pixelpipe. On demand you can activate an additional step where a module's output is reprocessed with its input before giving the result to the next module. This additional processing step is called blending. Input and output can be processed with different algorithms, called blending operators or blend modes.

Each blend mode is further controlled by a parameter called opacity, which can have a value between 0% and 100% and defines how input and output image contribute to the final result. Typically an opacity value of 0% gives as a result an image that is identical to the input image – the module remains without effect. An opacity value of 100% delivers the maximum effect of the module with the blend mode chosen.

The opacity value can be the same for all image pixels. In this case blending acts uniformly on the image. Alternatively you can make opacity values to vary between different image locations or pixel values. This is called a mask and gives fine control over what parts of an image are affected by a module and to what extent. At your choice you may activate a drawn mask or a parametric mask or a combination of both.

### 3.2.5.2. Usage

Modules with blending support exhibit an additional combobox “blend” at the bottom of their GUI.



#### blend

Blending is activated with this combobox. Depending on the value selected additional control elements will show up.

##### off

module's output is passed to the next module in pixelpipe without additional reprocessing. No further controls are displayed.

##### uniformly

reprocessing takes place with the chosen blend mode and opacity value – the same for all pixels. Additional controls to select blend mode and opacity value are displayed. The default blend mode is “normal” with an opacity of 100%.

##### drawn mask

reprocessing takes place with the chosen blend mode and opacity. Additional controls are displayed which allow you to draw a mask. If no mask elements are drawn all pixels have the same opacity, defined by the opacity slider. If you draw a mask element, e.g. a circle, the inner area of the circle will get maximum opacity, surrounded by a transition area or border with a gradual decay of opacity and the remaining image with an opacity of 0%. Different graphical shapes can be used. See Section 3.2.5.5, “Drawn mask” for further details.



### parametric mask

reprocessing takes place with the chosen blend mode and opacity. Additional controls are displayed which allow you to adjust the opacity on a per-pixel basis determined by pixel values. In previous versions of darktable this was called “conditional blending”. See Section 3.2.5.6, “Parametric mask” for further details.

### drawn and parametric mask

this option combines drawn and parametric masks and shows the full set of both controls. See Section 3.2.5.7, “Combining drawn and parametric masks” to learn how to best use this combination.

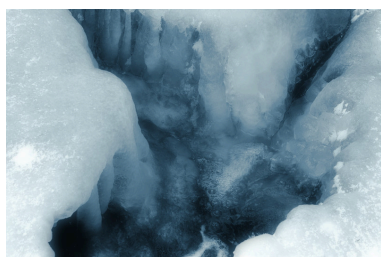
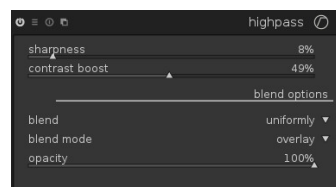
## 3.2.5.3. Examples

### Texturing an image

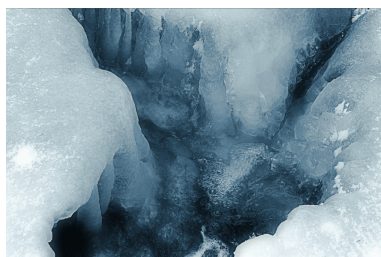
The watermark module supports SVG files with embedded images that can be used as a texture source. Blending operators then allow control of how that texture is expressed.

### Gritty details

When blending operators were introduced into darktable, a new module named *highpass* (see Section 3.4.5.7, “Highpass”) was added. It provides a highpass filter of the image to be implicitly used with blending. It is used to produce a gritty detailed image and is a method widely used in the workflow of other imaging software.



This is the original image, pretty heavily processed: first *monochrome*, then some blue *splittoning* but as you see it lacks pop in details and is a bit out of focus...



Here we applied the highpass filter with the values shown above. You can now see that the details are greatly boosted and we now have a really gritty detailed image.

## 3.2.5.4. Blending operators

There are several blend modes implemented and more might be added in future. For now all of the most commonly used ones are included and you will recognize a few of them from other imaging software. A good introduction on many common blend modes is given in the *GIMP Manual (Chapter 8.2, “Layer Modes”)* [<http://docs.gimp.org/2.8/en/gimp-concepts-layer-modes.html>]. Therefore we only discuss a few blend modes here in more detail.

## blend modes

### normal

This will probably be the most used blend mode. It just mixes input and output and, depending on the opacity value, it reduces the strength of a module's effect. Generally this is also the blend mode of choice if you want to apply a module's effect locally using masks.

### normal bounded

This blend mode acts similarly to blend mode "normal", except that input and output data are clamped to a particular min/max value range. Out-of-range values are effectively blocked and do not pass to the following modules. Sometimes this helps to prevent artifacts. However, in most cases (e.g. highly color saturated extreme highlights) it is better to let unbound values travel through the pixelpipe in order to properly deal with them at the right place (e.g. in module *output color profile*). Blend mode "normal" is most often the preferred choice.

### lightness

This blend mode mixes lightness from the input and output images. Color data (chroma and hue) are taken unaltered from the input image.

### chroma

This blend mode mixes chroma (saturation) from the input and output images. Lightness and hue are taken unaltered from the input image.

### hue

This blend mode mixes hue (color tint) from the input and output images. Lightness and chroma are taken unaltered from the input image. Caution: When modules drastically modify hue (e.g. when generating complementary colors) this blend mode can result in strong color noise.

### color

This blend mode mixes color (chroma and hue) from the input and output images. Lightness is taken unaltered from the input image. Caution: When modules drastically modify hue (e.g. when generating complementary colors) this blend mode can result in strong color noise.

### Lab lightness

Only available with modules that work in the Lab color space; this blend mode mixes lightness from the input and output images, while color data are taken unaltered from the input image. In contrast to blend mode "lightness" this blend mode does not involve any color space conversion and does not clamp any data. In some cases this is less prone to artifacts in comparison to "lightness".

### Lab color

Only available with modules that work in the Lab color space; this blend mode mixes Lab color channels a and b from the input and output images, while lightness data are taken unaltered from the input image. In contrast to blend mode "color" this blend mode does not involve any color space conversion and does not clamp any data. In some cases this is less prone to artifacts in comparison to "color".

### HSV lightness

Only available with modules that work in the RGB color space; this blend mode mixes lightness from the input and output images, while color data are taken only from the input image. In contrast to blend mode "lightness" this mode does not involve clamping.

### HSV color

Only available with modules that work in the RGB color space; this blend mode mixes color from the input and output images, while lightness data are taken only from the input image. In contrast to blend mode "color" this mode does not involve clamping.

### color adjustment

Some modules act predominantly on the tonal values of an image but also perform some color saturation adjustments, e.g. module *levels* and *tone curve*. The color adjustment blend mode takes the lightness only from output data and mixes colors from input and output enabling control of the module's color adjustments.

## 3.2.5.5. Drawn mask

Almost all darktable modules have the option to narrow down their effect by a drawn mask and thus allowing local adjustments.

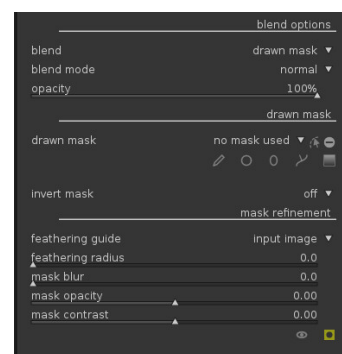
### Overview


With the drawn mask feature you can construct a mask by drawing directly on the image base. Different drawing operators, called shapes, are available and can be used alone or in combination. A flexible editing feature allows you to change single aspects of a shape, remove shapes or import shapes already defined in other modules.

Internally shapes are stored as vector graphics and rendered with the needed resolution during pixelpipe processing. Shapes are expressed in the coordinate system of the original image and transformed with all distorting modules. This way a shape will always work on the same image area regardless of warping or other modifications that may be applied.

### Usage

To draw a shape you need to click on one of the shape symbols. You will automatically be moved into the edit mode in which you generate a new instance of the selected shape and afterwards change its properties.




You leave edit mode by clicking on the  symbol. You can at any time go back to edit mode and do further adjustments by clicking the edit symbol again. In edit mode you can also remove a shape by right-clicking on it – the shape is removed from the current mask but it's still in the list of defined shapes.

Independent of the specific shape you can *scroll* to change the size of the shape, *shift+scroll* to change the feather of the shape and *ctrl+scroll* to change the opacity of the shape.

If you *ctrl-click* on the edit mode symbol you enter a restricted edit mode. Certain actions like dragging a complete shape or changing its size are blocked. Only finetuning changes like dragging a node are allowed.

Currently five shapes are implemented.

## brush

Clicking the  symbol adds a brush stroke.

Start drawing by *left-clicking* into the canvas and moving the mouse while keeping the button pressed. The brush stroke is finalized once you release the mouse button. Brush size, hardness and opacity can be changed by *scrolling*, *shift+scrolling*, and *ctrl+scrolling*, respectively, either before you start drawing or at any time during the operation. Likewise you can use keys *[ / ]* to decrease/increase brush size, *{ / }* to decrease/increase hardness, and *< / >* to decrease/increase opacity.

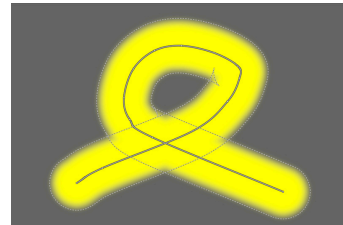
If you have a graphics tablet with pen pressure sensitivity, darktable can apply the recorded pen pressure to certain attributes of the brush stroke. See Section 8.1, “GUI options” for more details.

On lifting the tablet pen or releasing the left mouse button the drawn figure is converted into a number of connected nodes which define the shape. A configuration option (see Section 8.1, “GUI options”) controls how much smoothing is applied. A higher level of smoothing leads to less nodes – this eases subsequent editing at the expense of a lower initial accuracy.

Nodes and segments of a brush stroke can be modified individually. See the documentation on *path* below for more details.


Rendering a complex brush shape can consume a significant number of CPU cycles; consider to revert to the circle, ellipse or path shape if possible.

A brush stroke with controls and activated mask display.

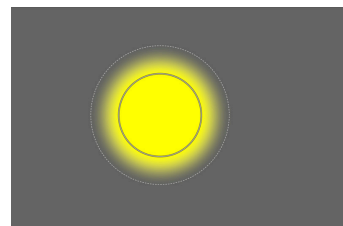


## circle


Clicking the  symbol adds a circle shape.

*Click* into the canvas to place the circle. *Left-click* and drag the circle to a different position if needed. Use the scroll wheel of your mouse while in the circle to change the diameter; *scroll* within the circle border to adjust the width of the gradual decay or *shift+scroll* anywhere in the shape for the same effect. With *ctrl+scroll* you can adjust the opacity of the circle – this is best observed with the mask displayed by pressing the  button.

A circle shape with controls and activated mask display.

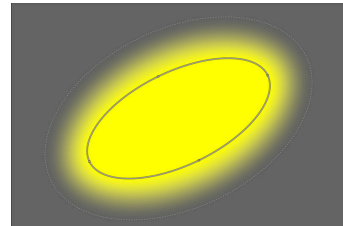


## ellipse


Clicking the  symbol adds an ellipse shape.

The general principle is the same as for the circle shape. In addition you get four nodes on the ellipse line. *Click* on the nodes to adjust the ellipse's eccentricity. *Ctrl-click* on them to rotate the ellipse or, alternatively, use *shift+ctrl+scroll*. *Shift-click* in the shape to toggle the gradual decay between equidistant and proportional mode.

An ellipse shape with controls and activated mask display.



## path

Clicking the  symbol adds a shape defined by a user defined closed path.

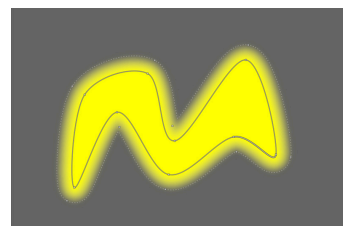
*Left-click* into the canvas to define path nodes; terminate the path by *right-clicking* after having set the last point. Per default nodes are connected by smooth lines. If you want a node to define a sharp corner, you can do so by creating it with *ctrl-click*.

In the edit mode you can convert existing nodes from smooth to sharp corners and vice versa by *ctrl-clicking* on them. You can insert additional nodes by *ctrl-clicking* on one of the line segments. Single nodes can be deleted by *right-clicking* on them; make sure that the mouse pointer is over the desired node and the node is highlighted, or else you might accidentally remove the whole path.


The size of the complete shape can be modified by *scrolling*—analogous to the circle shape. The same holds true for the width of the border, i.e. the area with a gradual opacity decay, which can be changed by *scrolling* when it is highlighted or by *shift+scroll* from anywhere within the shape. Single nodes as well as path segments can be moved by mouse *dragging*. If a node is selected by *clicking* on it, a further control point appears – you can move it around to modify the curvature of the line and reset to default by *right-clicking*. *Dragging* one of the control points on the border adjusts the border width just in that part of the shape.

Consider to finetune a path in the restricted edit mode (see above), which allows you to adjust single nodes and segments without the risk of accidentally shifting or resizing the whole shape.


A path shape with controls and activated mask display.



## gradient

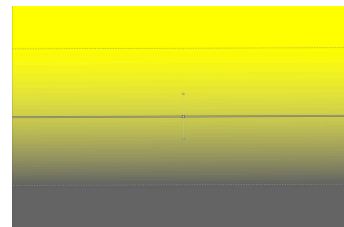
Clicking the  symbol adds a gradient to the mask. This does not generate a confined shape but produces a linear gradient extending the whole image.

Click into the canvas to define the position of the line where opacity is at 50%. The line has two anchor nodes which you can drag to change the rotation of the gradient.

Scrolling close to the center line changes the steepness of the gradient. Dotted lines indicate the distance beyond which the opacity is 100% and 0%, respectively. Between these dotted lines the opacity changes linearly. The gradient is best seen and modified when the mask is displayed by pressing the  button.



Depending on the module and the underlying image using a gradient shape might provoke banding artifacts. You should consider to activate the *dithering* module (see Section 3.4.4.14, “Dithering”)

A gradient with controls and activated mask display.



#### **drawn mask**

The number of shapes that are used in the current mask is displayed in the “drawn mask” field. Clicking on that field opens a dropdown box with all shapes that have already been defined in the context of the current image but are not yet used in the current mask. You can click on any of these items in order to add it to the current mask. The list also contains shapes once generated but no longer in use. This way you can even get back a deleted shape.

A polarity button ( and , respectively) allows the user to toggle between the normal and the inverted state of the drawn mask, i.e. the opacity values get inverted – 100% becomes 0% and vice versa. You need this feature when combining drawn and parametric masks (see Section 3.2.5.7, “Combining drawn and parametric masks”).

#### **invert mask**

When “drawn mask” is selected there is an additional combobox to invert the mask by switching mask inversion “on” or “off”.

#### **mask manager**

More functionality to control the interaction of multiple shapes within a mask can be found in the mask manager panel (see Section 3.3.6, “Mask manager”). Here you can give individual names to your shapes which will help you to keep track of your shapes. You can also select individual shapes for editing – a helpful feature if your masks happens to contain several shapes with overlapping control elements.

### **3.2.5.6. Parametric mask**

The parametric mask feature, formerly called “conditional blending”, offers fine-grained selective control over how individual pixels are blended. It does so by automatically

generating an intermediate blend mask from user defined parameters. These parameters are color coordinates not the geometrical coordinates used in drawn masks.

The parametric mask is a powerful tool with a certain level of complexity.

## Overview

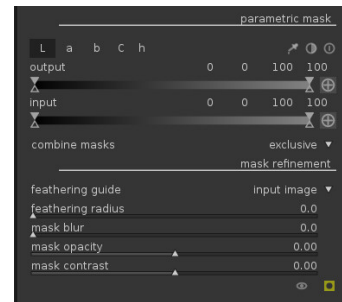
For each data channel of a module (Lab, RGB) and additionally for several virtual data channels (e.g. hue, saturation) users can construct a per-channel opacity function. Depending on the pixel's value for this data channel this function determines a blending factor between 0 and 1 (or 100%) for that pixel.

Each pixel of an image thus has different blending factors for each of its data channels (real and virtual). All blending factors are finally pixel-wise multiplied together with the value of the global opacity slider (see Section 3.2.5.4, "Blending operators") to form a blend mask for the image.

If for a given pixel the blend mask has a value of 0, the input of the module is left unchanged. If for a pixel the blend mask has its maximum value of 1 (or 100%), the module has full effect.

## Usage

When *parametric mask* is activated in combobox "blend" an additional set of tabbed controls is shown.



### Channel tabs

Each tab selects a data channel – real or virtual. Modules acting in Lab color space have data channels for L, a, b, C (chroma of LCh) and h (hue of LCh). Modules acting in RGB color space have data channels for g (gray), R, G, B, H (hue of HSL), S (saturation of HSL), and L (lightness of HSL). Consult for example Wikipedia's article on color spaces [[http://en.wikipedia.org/wiki/Color\\_space](http://en.wikipedia.org/wiki/Color_space)] for a deeper look.

Each tab provides two sliders for its data channels: one for the input data that the module receives and one for the output data that the module produces prior to blending.

You can inspect the image data corresponding to an individual color channel by holding down the *shift* key while entering the respective slider with the mouse cursor. The center image changes to display the selected color channel either in grayscale values or in false colors, depending on the corresponding preference setting in "GUI options" (see Section 8.1, "GUI options"). You may additionally hold down the *ctrl* key which lets you see the resulting mask overlaid to the image. When leaving the slider the image goes back to normal after a short delay.

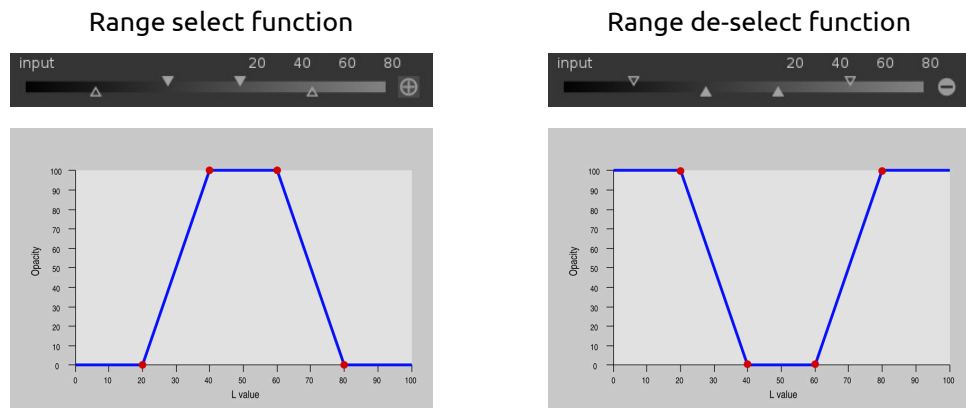
### Color channel sliders

With the color channel slider you construct a trapezoidal opacity function. For this purpose there are four markers per slider. Two triangles above the slider mark the range of values

where opacity is 1. Two triangles below the slider mark the range values where opacity is zero. Intermediate points between full and zero opacities are given a proportional opacity.

The filled triangles, or inside markers, indicate the closed (mostly narrower) edge of the trapezoidal function. The open triangles, or outside markers, indicate the open (mostly wider) edge of the trapezoidal function. The sequence of the markers always remains unchanged: they can touch but they can not switch position.

A polarity button (⊕ and ⊖, respectively) to the right of the slider switches between *range select* and *range de-select* function modes with visual confirmation provided by exchanging the upper and the lower triangle markers. These two types of trapezoidal functions are represented graphically in the following images.



A trapezoidal function that selects a narrow range of values for blending.

A trapezoidal function that de-selects a narrow range of values from blending.


In their default state all markers are at their extreme positions, maximum left and maximum right, respectively. In this state a *range select* function selects the whole range of values giving an “all at 100%” mask. Starting from there one can move the sliders inwards to gradually take out more and more parts of the image except of the remaining narrow range.


A *range de-select* function per default deselects the whole range of values, giving an “all-zero” mask as a starting point. Moving the sliders inwards gradually extends the mask more and more except of the remaining narrow range.

For more information on the polarity feature read Section 3.2.5.7, “Combining drawn and parametric masks”.


### Control buttons

Control buttons help you when designing a parametric mask.

With the color picker button  you can select a probe from your image. The corresponding values for the real and virtual data channels are then displayed within each color channel slider. You can switch between point and area sampling mode from within the global color picker panel (see Section 3.3.5, “Global color picker”).

With the invert button  you can toggle the polarities of all channels (including a potentially activated drawn mask) and change the method how channels are combined into the final mask. More on that topic can be found in Section 3.2.5.7, “Combining drawn and parametric masks”.



With the reset button  you can put all settings back to their default state.

### combine masks

When either a “parametric masks”, or the combination of “drawn and parametric mask” is active an additional combobox is shown that controls how the individual masks are combined to form the final mask. This option also allows to invert the final mask. Details on the combination of individual masks can be found in Section 3.2.5.7, “Combining drawn and parametric masks”.

## Example

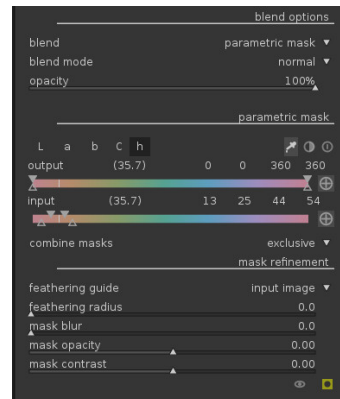
### Colorkey effect

To create a colorkey effect with this poppy blossom in red and the remainder of the image in monochrome, we could apply module *monochrome* to all parts of the image except for of the saturated red petals.



We choose the hue channel to control our mask as hue provides good separation between the petals and background.

These settings in hue channel construct a parametric blend mask that excludes the red petals. The small white bar in the gradient was obtained by using the color picker on one of the petals and the markers then closely centered on the indicated hue to increase the selectivity of our mask.



The resulting blend mask.



The final image after module *monochrome* is applied.



### 3.2.5.7. Combining drawn and parametric masks

This section describes how darktable combines individual masks to form the final mask of a module. Individual masks are the drawn mask and all the single channels of the parametric

mask. The topic is rather advanced – if you don't want to go through all the theoretical details just jump down where we describe two typical use cases.



## Overview

There are two main elements which control how individual masks are combined: the polarity setting of each individual mask, defined by the plus or minus buttons, and the setting in the “combine masks” combobox (see the section called “combine masks”).

Masks can be regarded as grayscale images which take up values between 0 and 1.0 (or from 0% to 100%) for each pixel.

A straightforward way to combine masks is by multiplying the individual pixel values. The final mask will have a pixel value of 0 whenever one of the individual masks is 0 at that pixel location. The final mask can only reach a maximum pixel value of 1.0 if each and every of the individual masks has a value of 1.0 at that location. We call this way of combination “exclusive”. Any individual mask can exclude a pixel by setting its value to zero, regardless of what the other individual masks do. Once a pixel is excluded (its value is 0) by any mask there is no way to include it again by any other individual mask.

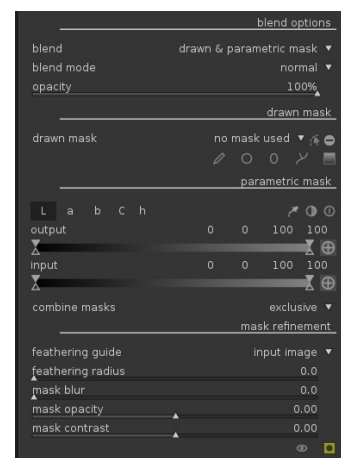
An alternative way to combine masks is the following: we first invert each individual mask – calculating 1.0 minus its value – then we multiply these inverted masks and as a last step invert the final mask again. Now if one of the non-inverted individual masks has a value of 1.0 at a pixel location the final will also be 1.0. The final mask can only reach a pixel value of 0 if all the individual masks have a value of 0. We call this way of combination “inclusive”. Any individual mask can include a pixel by setting its value to 1.0, regardless of what the other individual masks do. Once a pixel is included (its value is 1.0) by any mask there is no way to exclude it again by any other individual mask.

These two combination methods alone would still be rather limiting. We gain maximum flexibility by allowing an additional inversion step for each individual mask. This is governed by the polarity buttons  and  that you find close to the individual channels. Toggling the polarity button of a mask inverts its values, i.e. it recalculates the pixel values to 1.0 minus the original value.

Finally within the “combine masks” combobox you may once again invert the final result to fit your needs by selecting the *exclusive & inverted* or *inclusive & inverted* options.

## Usage

You will typically want to combine drawn and parametric masks to first select a certain region of your image – either by the drawn or the parametric mask – and use the other mask type to finetune your selection. Finetuning can either mean that you want to include further parts of the image, which are not included in the first place, or you want to exclude parts of the image that were previously included.



This gives two typical use cases:

### Inclusive mode

For this mode you set the “combine masks” combobox to *inclusive* and make sure that all polarity buttons of all the individual channels and of the drawn mask are set to negative (⊖). Your starting point is a mask where all pixels have a value of zero, i.e. no pixel is selected. You now adjust the parametric mask sliders to bring more and more pixels into the selection or you draw shapes on the canvas to select specific areas of your image.

### Exclusive mode

In the opposite case you set the “combine masks” combobox to *exclusive* and make sure that all polarity buttons are set to positive (⊕). Your starting point is a mask with all values at 1.0, i.e. all pixels selected. You now gradually change the parametric mask sliders to exclude parts of your image as needed or you directly draw shapes on the canvas to specifically exclude these areas.

For your convenience you find in the parametric masks GUI a  toggle button that inverts all channel polarities and toggles between inclusive and exclusive mode in the “combine masks” combobox.

For novice users it is recommended to stick to these two use cases. This implies that you should decide beforehand how you want to construct your mask. Advanced users will find their way to take advantage of the many possible combinations of polarities and mask combination modes.

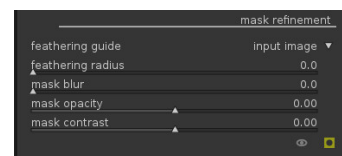
## 3.2.5.8. Mask refinement and additional controls

### Overview

When a “parametric masks”, a “drawn mask” or a combination of both is active several additional sliders are shown that allow for a meticulous refinement of the mask.

### Usage

When blending with a mask there are some additional options to deal with the final mask: you may feather the mask, blur the mask, adjust the mask's brightness and contrast, temporarily disable the mask, or display it as an overlay image. The latter option is particularly useful for examining the effect of the following controls.



### feathering guide

Mask feathering smoothens a drawn or parametric mask non-uniformly such that the mask's edges are adjusted automatically to match the edges of the image. This mask smoothing is guided either by the module's input image or by its output (before blending), depending on what is selected in the “feathering guide” combobox. The feathering is particularly sensitive to this choice for edge-modifying modules, i.e., modules for sharpening or blurring an image.

### feathering radius

The “feathering radius” slider adjusts the strength of the feathering effect. Feathering works best if the drawn and/or parametric mask's edges already match approximately some edges in the guiding image. The larger the “feathering radius” the better the feathering algorithm can align mask edges to more distant edges of the image. If this radius is too large, however, the feathered mask may overshoot. This means it cover

regions that the user actually wants to exclude. Feathering is turned off if the feathering radius is set to 0.

### mask blur

Blurring the mask creates a softer transition between blended and unblended parts of an image and avoids artifacts. The mask blur slider controls the radius of a gaussian blur applied to the final blend mask. The higher the radius, the stronger the blur – or set to 0 for an unblurred mask. Gaussian blur is always applied after feathering if both kinds of mask adjustment are activated. This order allows to smooth sharp edges or artefacts that may result by feathering.


### mask opacity

The strength of the module's effect is determined by the mask's local opacity. Feathering and blurring the mask may result in a mask with reduced opacity, which implies a reduced effect. Therefore, the “mask opacity” slider allows to readjust the mask opacity. If the opacity is decreased (negative slider values) least opaque parts are affected stronger than most opaque parts. Contrary, if the mask opacity is increased (positive slider values) most opaque parts are affected stronger than least opaque parts. As a consequence, completely opaque portions of the mask always remain opaque and completely transparent portions remain transparent. This is to ensure that regions which have been excluded from or included to a module's effect by setting the mask's opacity to 0% or 100% remain excluded or included even if the mask opacity is adjusted by this slider.


### mask contrast

This slider increases or decreases the mask contrast. This means it allows to modify the transition between opaque and transparent mask parts.

### temporarily switch off mask

Sometimes it is useful to visualize the module's effect without the mask taking action. You can do so by clicking on the  symbol, which will temporarily deactivate the mask – the selected blend mode and opacity remain in effect. Switch this button on and off to see if the mask is acting on the image as intended.

### display mask

Clicking on the  symbol will display the current mask as a yellow overlay over a black-and-white version of your image. Solid yellow indicates an opacity of 100%; a fully visible gray background image without yellow overlay indicates an opacity of 0%.

## Examples

### Feathering a drawn mask



It can be rather tedious to create a drawn mask by hand, which matches precisely a particular object or person in an image. In this example, we want to enhance the color contrast of the lion sculpture shown in the left image above without affecting the background. For this purpose, a rough selection of the sculpture is created by a drawn mask. See the second image above, where the “displays mask” feature is active. Note that the mask is rather fuzzy and it does not match precisely the lion sculpture. Adjusting the feathering radius, the mask opacity and the mask contrast leads to a well matching mask with little effort. In the third image above the feathering radius has been adjusted to 50, a blur radius of 5 was chosen to smooth the mask to some degree. The mask opacity and the mask contrast have been increased to 0.3 and 0.5, respectively, to further enhance the mask. The last image above shows the final result, where the color enhancement via the color contrast module (see Section 3.4.3.4, “Color contrast”) is restricted to the lion sculpture due to the mask.

Mask feathering works in this example particularly well because the sculpture in the original image is well separated from the blurry background. The distinct edge at the border of the sculpture guides the feathering mask adjustment to match the shape of the sculpture. Note that feathering can be applied to drawn masks as well as to parametric masks.

### 3.2.6. Color management

darktable employs a fully color managed workflow:

- Input color specifications are taken from embedded or user supplied ICC profiles or – in the case of raw files – from a library of camera specific color matrices.
- darktable automatically reads the display profile of your monitor (if properly configured) for an accurate color rendition on screen. Multi-screen setups are fully supported as long as a system service like *colord* is in place and properly set up to inform darktable about the correct monitor profile.
- Output files can be encoded in one of darktable’s built-in profiles, like sRGB [<http://en.wikipedia.org/wiki/SRGB>] or AdobeRGB (compatible) [<http://en.wikipedia.org/wiki/AdobeRGB>], or into any other output color space that the user supplies to darktable as an ICC profile.

#### 3.2.6.1. Display profile

In order for darktable to accurately render colors on screen it needs to find the correct display profile of your monitor. In general this requires your monitor to be properly calibrated and profiled, and it needs the profile to be correctly installed on your system. darktable queries your X display server’s *xatom* as well as the system service *colord* (if available) for the right profile. If needed you can enforce a specific method in the GUI preferences dialog (see Section 8.1, “GUI options”).

To investigate your display profile configuration you can call the `darktable-cmstest` binary which prints out useful information like profile name per monitor and tells you if the system is correctly configured (see Section 1.1.6, “darktable-cmstest binary”).

In rare cases you may need to manually select the display profile. This is possible from the softproof and gamut check option dialogs in the darkroom view (see Section 3.3.10.5, “Soft proof” and Section 3.3.10.6, “Gamut check”), and the display profile dialog in the lighttable view (see Section 2.1, “Overview”).

#### 3.2.6.2. Rendering method

A configuration parameter “always use LittleCMS 2 to apply output color profile” in darktable's *core options* (see Section 8.2, “Core options”) defines how colors are rendered.

darktable can render colors either with its internal algorithms or by using the external library *LittleCMS2* [<http://www.littlecms.com/>]. darktable's internal method is by an order of magnitude faster than the external one. The external option gives you a choice of the rendering intent and might offer a slightly higher accuracy in some cases.

Note that if the given ICC is LUT-based or contains both, a LUT and a matrix, darktable will use LittleCMS 2 to render the colors regardless of that configuration parameter's value.

### 3.2.6.3. Rendering intent

If rendering with LittleCMS2 is activated (see Section 3.2.6.2, “Rendering method”) you can define how out-of-gamut colors are handled when converting between color spaces. A selection box in the export panel (see Section 2.3.12, “Export selected”), the output color profile module (see Section 3.4.3.3, “Output color profile”), and the soft proof option (see Section 3.3.10.5, “Soft proof”) gives you a choice of the following rendering intents:

<i>perceptual</i>	Suited to pictures as it maintains the relative position of colors. This is usually the best choice.
<i>relative colorimetric</i>	Out-of-gamut colors are converted to colors having the same lightness, but different saturation. Other colors remain unmodified.
<i>saturation</i>	Saturation is kept but lightness is slightly changed.
<i>absolute colorimetric</i>	Keep the white point.

### 3.2.6.4. darktable's color spaces

darktable's input images are either RGB files (like JPEGs or TIFFs) or camera raws – both represent colors by a combination of red, green and blue. Most part of our modules act in the CIELAB color space [[http://en.wikipedia.org/wiki/Lab\\_color\\_space](http://en.wikipedia.org/wiki/Lab_color_space)] (often just called “Lab”) which describes color as a combination of lightness data (L) and a point in the a-b color plane. The final output of the image processing pipeline is once again in RGB, either shaped for the monitor display or the output file.

This process implies that the pixelpipe has two color conversion steps: *input color profile* and *output color profile*. In addition there is the *demosaic* step for raw images, where the colors of each pixel are reconstructed by interpolation.

Each module has a fixed position in the pixelpipe which tells you which color space the module lives in:

up to <i>demosaic</i>	Image is in raw data format with only latent colors. Each pixel carries lightness and color information for only one base color. Please mind that some of the modules in this part can also act on non-raw input images in RGB format with full information on all three color channels.
between <i>demosaic</i> and <i>input color profile</i>	Image is in RGB format within the color space of the specific camera or input file.
between <i>input color profile</i> and <i>output color profile</i>	Image is in Lab format. This is a very huge universal color space which covers all colors visible to the human eye (and even more). As darktable processes

images in 4x32-bit floating point buffers, we can handle the Lab color space without risking banding or tonal breaks.

after *output color profile* Image is in RGB format as defined by the selected display or output ICC profile.

### 3.2.6.5. Unbounded colors

Theoretically the individual components of color data are confined to certain minimum and maximum levels. As an example the intensity of an individual red, green or blue color channel in RGB can be anything in the range between 0% and 100% (or between 0.0 and 1.0). Likewise the L channel in Lab can be anything between 0 (pure black) and 100 (pure white).

In practice sometimes the image processing steps in darktable's modules can lead to values which lie outside of these confined ranges. In fact even the well established color matrices, which convert from camera RGB to Lab, may sometimes produce pixels with negative L values.

Pixels with these kind of values are said to have "unbounded colors". One could *clamp* (i.e. confine) those values to the allowed range at every processing step. However, it has been found that it is much preferred and less prone to artifacts to not clamp in-between unbounded colors, but treat them just like any other color data.

In darktable there is no technical requirement for clamping; due to the fact that we are using floating point arithmetics for all processing steps, unbounded values can be passed along like any other value until the final color conversion module makes sure that they are transferred into the most reasonable color within the selected output color space. Therefore darktable avoids clamping as far as the underlying algorithms allow.

### 3.2.6.6. Possible color artifacts

That said there are some infrequent situations which still can lead to problematic results unless the user takes some action. Some modules in Lab color space, like *levels* and *monochrome*, need to rely on the fact that the L channels carries all lightness information and the a and b channels purely represent chroma and hue. Unbounded colors with negative L values are especially problematic to these modules and can lead to black pixel artifacts.

It has been found that highly saturated blue light sources in the image frame are hot candidates for pixels with negative L values. If you are engaged in stage photography you should pay close attention to image areas like that.

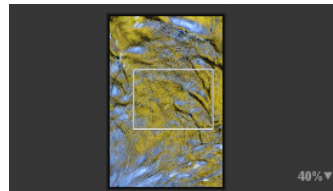
In order to mitigate that issue the *input color profile* module (see Section 3.4.3.11, "Input color profile") has a *gamut clipping* option. It is off by default but can be activated in case you observe artifacts. Depending on the settings, colors get confined to one of the offered RGB gamuts. In effect black pixel artifacts are prevented at the costs of losing some color dynamics. See Section 3.4.3.11, "Input color profile" for an example.

### 3.3. Darkroom panels

This section contains documentation for panels that are specific to the darkroom view.

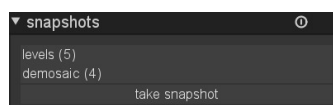
#### 3.3.1. Navigation

On the top left hand side the navigation panel displays a full preview of your image with a rectangle showing the currently visible zoom area in the central panel. Drag the rectangle around to pan the zoomed-in view. The current zoom scale is displayed to the right of the preview image. Click on that figure for a quick access to some common zoom levels.



#### 3.3.2. Snapshots

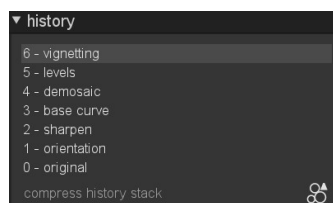
You can take snapshots of images as you process them. A snapshot is stored as a bitmap of the current center view and is kept as long as you stay in the darkroom. A snapshot can then be selected and overlaid in the current center view to help you with a side by side comparison (left: snapshot, right: active) when you are tuning parameters of a module. This can also be combined with history (see Section 3.3.3, “History stack”) to compare the snapshot against different stages of development.



You can control the split view by moving the splitline back and forth. If you hover with the mouse over the splitline, a small rotation icon will appear on the center of the line. Click it to change between vertical and horizontal split view.

#### 3.3.3. History stack


The history stack lists every change of state (activate/de-activated) for all modules. Here you can *select* a point in the stack to return to a point in the development history. If you then activate a new module or change a module parameter, all modules above the selected point will be discarded.



*Caution: activating any module action using key accelerators will discard all modules above the currently selected one. It is easy to lose all development work on an image this way!*

In darktable 2.0 it is safe to quit the program, leave the darkroom mode, or switch to another image while having selected some earlier state in the history stack panel. The history stack remains unchanged. When returning to the image you will find the history stack panel in the state where you left it.

Hitting “compress history stack” generates the shortest history stack that produces the current image, i.e. suppressing all obsolete stack items. This also will discard all modules above the currently selected one.

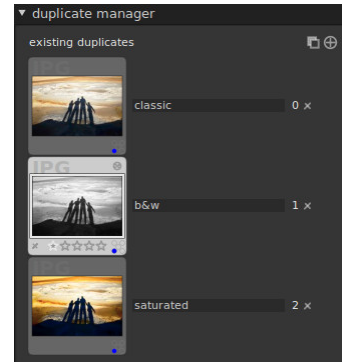
The button to the right  lets you create a new style for applying your history stack to other images. Use the first line of the popup dialog window to name your style and the second to add a searchable description. You are prompted for which of the current history stack modules to include in the style.




Once created styles are then managed and applied to other images through lighttable's *styles* panel (see Section 2.3.8, “Styles”).

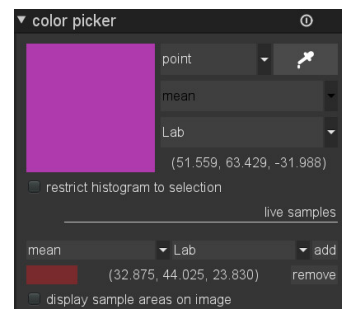
### 3.3.4. Duplicate manager

The duplicate manager lists all versions (see duplicate Section 2.3.6, “Selected image(s)”) of your image with their preview thumbnails. Single click on a thumbnail to temporarily show the related version inside the center view. Double click to completely switch to this version. Top-right buttons let you create new duplicates. Either a 'virgin' version, or an exact duplicate of the current image. For your convenience, you can also set a name to each versions.



### 3.3.5. Global color picker

Using the global color picker you can take color samples from your image, display their values in multiple ways and compare colors from different locations. The color picker is activated by pressing the  icon. There are multiple parameters for controlling how the color picker works, whose settings remain in effect until you leave the darkroom mode.



Besides the global color picker described here there are also local color pickers in some of the modules (eg. *tone curve*). Global and local color pickers are different. The global color picker works in monitor color space and takes samples after the complete pixelpipe has been processed. The local color pickers run in the color space of the individual module, which is usually Lab; they reflect the input and output data of that specific module within pixelpipe.

The global color picker can be run in point or area mode. When in point mode only a small spot under your cursor is taken as a sample. In area mode you can draw a rectangle and darktable samples the area within that rectangle. The combobox to switch between point and area mode can also be used to toggle the mode of local color pickers.

If samples are taken in area mode, darktable will calculate mean, min and max color channel values. A combobox allows you to select which of those are displayed. For obvious statistical reasons mean, min and max are identical for the single sample of point mode.

A color swatch representing the sampled point or area is displayed. Numerical values are shown as well. As said before global color picker works in monitor RGB color space. You can also let darktable translate these numerical values into Lab color space. Beware that Lab values are approximated here; depending on monitor color profile there can be some deviations from the real values.

When the checkbox “restrict histogram to selection” is ticked, only the values of your selected area or point are taken into account by the main histogram at the top of the right

hand panel (see Section 3.3.7, “Histogram”). This is a way to show which tonal values are present in a specific area.

The sampled colors in either area or point mode can be “stored” as live samples by pressing the “add” button. darktable will then show a color swatch and numerical values for each stored sample. You can once again select which numerical value (mean, min, max) is to be displayed and if this is to be done in RGB or Lab color space.

Newly created live samples are not locked. If you change your image the changes will be reflected in your live samples. Use this if you want see how changing parameters effects different parts of an image. Clicking on a live sample's color swatch locks it and a lock symbol is displayed. Further image changes will then no longer affect the sample. You can for example take two live samples from the same location and lock just one of them to provide a before and after sample comparison.

Live sample locations are indicated in your image if you check option “display sample areas on image”.

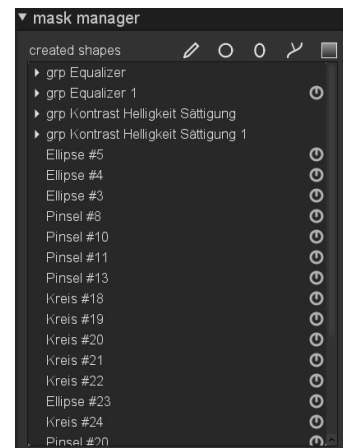
### 3.3.6. Mask manager


#### 3.3.6.1. Overview

The masks manager panel is the central place where you manage all masks and shapes within the context of the current image. Here you create, delete and change shapes or give them unique names. You can add shapes to and remove shapes from a mask, and you define how multiple shapes interact within a mask.

#### 3.3.6.2. Usage

In the top line of the masks manager panel you find buttons to create new shapes. They are the same as in the *drawn mask* GUI (see Section 3.2.5.5, “Drawn mask” for more details).



The lines below list all masks used and all individual shapes defined. The masks are noted with a headline in the form “grp levels” indicating the module in which they are used. The list of masks is followed by a list of all individual shapes which have been generated in the context of the given image. If a shape is in use by any of the masks it is marked by the  symbol to the right of the shape name.

#### 3.3.6.3. Shapes

By default shapes receive an automatically generated name, consisting of the shape type (“brush”, “circle”, “ellipse”, “path”, “gradient”) and a number that is incremented automatically. You can replace these automatically generated names by more meaningful ones. Double-clicking on the existing shape name prompts you for a new one. Giving a

meaningful name is a good habit, especially if you are going to use the same selection in different masks. A name like “house front” makes it easier to get the right shape, rather than something like “path #32”.

Clicking on the shape name shows the selected shape in the center canvas with all its controls. This is a convenient way to edit the properties of a specific shape. Especially if there are so many shapes within a mask that their controls overlap and make it difficult to hit the right target.

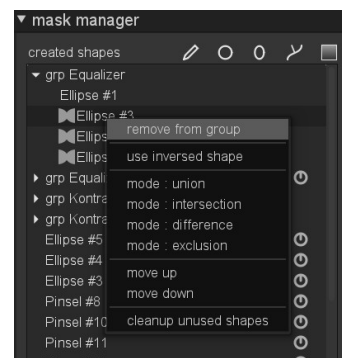
Right-clicking on a shape name gives you a drop-down menu with the options to remove the current shape or to remove all shapes currently not in use.

All shapes ever defined for the current image are kept in the list unless you remove them explicitly. If you have worked a lot with shapes on one image, this list can get quite long. All settings – with all defined shapes – are part of the XMP tags of an image and are included in exported files. If the list of shapes is very long the needed space to store all shapes might exceed the given limits of certain file formats, like JPEG. In that case storing the XMP tags might fail during export. This is normally not a problem – however, you can no longer rely on the exported file to contain your full history stack (see Section 2.3.12, “Export selected”).

### 3.3.6.4. Masks

Clicking on the name of a mask expands a list showing the individual shapes which constitute that mask.

Right-clicking on the shape name opens a drop-down menu. Here you define the way that the individual shapes interact to form the mask. You can also remove shapes from that mask.



Masks are constructed by adding the shapes in the order that they are listed from top to bottom. Each shape adds to the mask by using at your choice one out of four logical set operators.

As order matters when combining shapes you may move each shape up or down if needed.

Each shape before being added can be inverted and is then depicted by the  symbol.


### 3.3.6.5. Set operators

We use as an example a combination of a gradient followed by a path to demonstrate the effect of the set operator which we apply to the path shape. As a convention we say that a pixel is “selected” in a mask or shape if it has a value higher than zero.






## union

This is the default set operator. It is depicted by the  symbol left to the shape name. The shape adds to the existing mask in such a way that the resulting mask contains the pixels that are either selected in the existing mask or in the added shape. In overlapping areas the maximum value is taken.




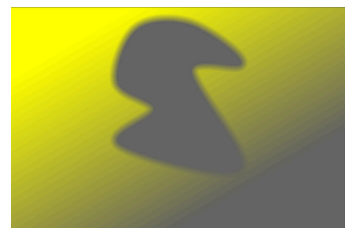
## intersection

This set operator is depicted by the  symbol left to the shape name. The shape adds to the existing mask in such a way that the resulting mask contains only pixels that are selected in both, the existing mask and the added shape. In overlapping areas the minimum value is used. In the given example we use this operator to “imprint” the path with a gradient.




## difference

This set operator is depicted by the  symbol. In the non-overlapping area the existing mask is unchanged. In the resulting mask pixels get selected only if they are selected in the existing mask but *not* in the added shape. This set operator can be chosen if you want to “cut out” a region from within an existing selection.



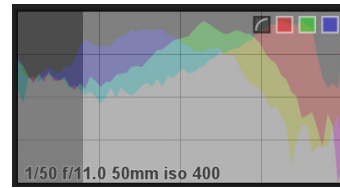
## exclusion

This set operator is depicted by the  symbol. The resulting mask has all pixels selected that are either selected in the existing mask and not in the added shape or vice versa. This is equivalent to an “exclusive or”.



### 3.3.7. Histogram

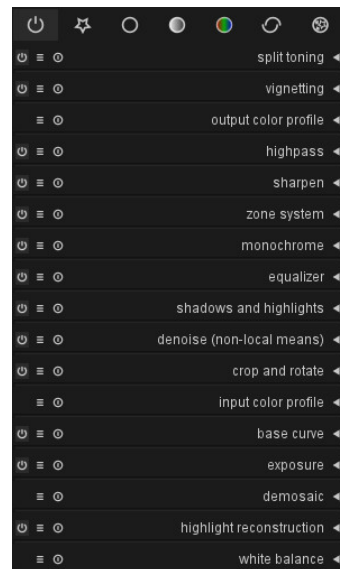
This shows a histogram of the developed image's light levels. In its default state curves for all three RGB color channels are displayed. You can toggle the colored squares to enable or disable specific color channels. A curve button is also provided to toggle between linear view, logarithmic view and waveform view.








The histogram is directly linked to the *exposure* module described in Section 3.4.1.5, "Exposure", and you can operate some of the exposure module's controls from the histogram. You can left-click towards the right hand side of the histogram and then drag right to increase or drag left to decrease the exposure. In a similar manner you can control the black level by clicking and dragging in the left hand side. Double-clicking in the histogram resets the exposure module's parameters to their defaults.



### 3.3.8. Module groups

The module groups button bar gives you quick access to darktable's processing modules.



Here follows a description of the module groups available:

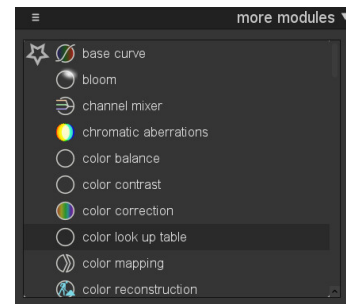
	Active	Modules you have activated and are using on the current image.
	Favorites	Modules you have marked as favorites using <i>more modules</i> (see Section 3.3.9, "More modules").
	Basic	Modules that are frequently used, such as exposure, temperature etc. (see Section 3.4.1, "Basic group").
	Tone	Modules for working with the image's tonal values, e.g. levels, tonemap etc. (see Section 3.4.2, "Tone group").
	Color	Modules for processing colors, such as color correction, vibrance etc. (see Section 3.4.3, "Color group").

	Correction	Modules making corrections to the image, e.g. denoise, CA correction etc. (see Section 3.4.4, "Correction group").
	Effect	Modules with a more artistic output, such as vignetting, softening etc. (see Section 3.4.5, "Effect group").

Clicking on one of the group symbols will show the modules in that group. If you once again click on the symbol, grouping will be de-activated and all non-hidden modules will be shown in one long list. This list shows the sequence in which modules are applied from bottom to top. As a general principle darktable applies modules in a pre-defined sequence.

### 3.3.9. More modules

More modules at the bottom of the right panel is used to show the less frequently used modules. By default only standard modules are shown to the user but you can use this function to make the extra modules visible, or alternatively to hide away modules you don't typically use.




Each module is shown with a small icon next to its name. Left-click with your mouse to toggle the status between visible, hidden and favorite. Favorite modules are indicated by a star in front of the icon and in addition to appearing in their normal module group will also be visible in the module group *favorites*. This is a good way to get fast access to modules that you use very frequently. Visible modules are indicated in the list by a light grey background whilst hidden modules have a dark grey background and do not display any of their controls.

Hiding or un-hiding modules is not meant to be part of your daily workflow, you should only occasionally need to review the modules you typically use. However, you may store various settings at your choice as presets for later reuse.


### 3.3.10. Bottom panel

The bottom panel provides quick access to apply presets and styles to your image and allows to activate over/underexposure warning as well as softproofing and gamut check. You can also activate a filmstrip for quick navigation within the current collection.


#### 3.3.10.1. Quick access to favorite presets

Clicking the  icon opens a combobox that gives you quick access to your favorite module's presets. Click on the preset name to apply it to the image.

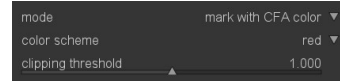
#### 3.3.10.2. Quick access to styles

Clicking the  icon opens a combobox with your styles. Hovering with the mouse over a style name opens a tooltip showing the involved modules. Click on a style name to apply that style to the image.

#### 3.3.10.3. Raw overexposed warning

Clicking the  icon warns you about areas of your raw input image with clipped color channels. Clipped color channels imply an overexposed image with loss of information in the affected areas. You may use the *highlight reconstruction* module or the *color reconstruction* module in order to reconstruct those areas (see Section 3.4.1.9, “Highlight reconstruction” and Section 3.4.1.7, “Color reconstruction”).

Right-clicking on the icon opens a dialog with configuration parameters.



#### mode

The default “mark with CFA color” mode displays a pattern of the respective primary colors (red, green, and blue) to indicate which color channels are found to be clipped. In the “mark with solid color” mode clipped areas are marked with a user defined solid color (see below) independent of the affected color channels. In the “false color” mode clipped color channels are set to zero in the affected areas.


#### color scheme

Selects the solid color for the “mark with solid color” mode.

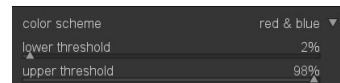
#### clipping threshold

This slider sets the threshold of what values are considered to be overexposed. You can leave it at its default value 1.0 (white level) in most cases.

### 3.3.10.4. Over/underexposed warning

By clicking the  icon an over/underexposed warning is toggled on or off. Pixels outside the dynamic range, close to pure white or close to pure black, are prominently displayed in a signal color. You can also activate the over/underexposure warning with the keyboard shortcut “o”.

Right-clicking on the icon opens a dialog with configuration parameters.



#### color scheme

In the default color scheme underexposed pixels are shown in blue and overexposed pixels in red. These colors are easy to identify in most cases. In some cases you may want to change the color scheme to “black & white” or “purple & green”, eg. if you experience overexposed highlights in red blossoms.


#### lower threshold

Sets the threshold for underexposure warning, expressed as a percentage of the maximal brightness.

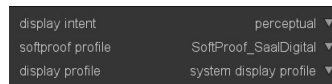
#### upper threshold

Sets the threshold for overexposure warning, expressed as a percentage of the maximal brightness.

### 3.3.10.5. Soft proof

Clicking the  icon activates the soft proof display mode of your image. Soft proof allows you to preview your image rendered using a printer profile so as to see how colors will end up on the final print. You can also activate soft proof with the keyboard shortcut “ctrl-s”. An information message “soft proof” on the bottom left of your image tells you that you are in soft proof display mode.

Right-clicking on the icon opens a dialog with configuration parameters.



### display intent

Sets the rendering intent for your display – only available if rendering with LittleCMS2 is activated. See Section 3.2.6.3, “Rendering intent” for available options.


### softproof profile

Sets the color profile for soft proofing. darktable searches for available profiles in `$DARKTABLE/share/darktable/color/out` and `$HOME/.config/darktable/color/out`. `$DARKTABLE` is used here to represent your chosen darktable installation directory and `$HOME` your home directory. Typically these profiles are supplied by your printer or generated during printer profiling.

### display profile

Sets the color profile for the display. The option “system display profile” is the preferred setting when working with a calibrated display; the profile is taken either from your system's color manager or from your X display server. In *GUI options* (see Section 8.1, “GUI options”) you can specify which method to use. For more information see Section 3.2.6.1, “Display profile”.

## 3.3.10.6. Gamut check

Clicking the  icon activates the gamut check display mode of your image. Gamut check highlights in cyan all pixels out of gamut with respect to the selected softproof profile. You can also activate gamut check with the keyboard shortcut “ctrl-g”. An information message “gamut check” on the bottom left of your image tells you that you are in gamut check display mode. Gamut check and soft proof are mutually exclusive modes.

Right-clicking on the icon opens a dialog with configuration parameters – they are the same as for the soft proof option (see Section 3.3.10.5, “Soft proof”).

## 3.3.10.7. Filmstrip

The optional filmstrip can be used to quickly switch between images while remaining in the darkroom view. The images viewed are the same as the ones in the lighttable view.

The filmstrip can be switched on and off using the shortcut *ctrl-f*. You can change the height of the filmstrip panel by dragging its top.

You can scroll with your mouse to quickly navigate through the images. You can change the photo being processed by double clicking on another picture. You can also use space bar to process the next photo and use backspace key to process the previous photo.

The picture currently processed is selected and highlighted; with a single click you can select any other picture from the filmstrip without changing the picture currently processed. With the *ctrl-a* shortcut you select all the pictures of the filmstrip. With



the shortcut *ctrl-shift-a* you unselect all images, and with *ctrl-i* you reverse the current selection.

The following shortcuts are available to act on the selected picture(s):

<i>F1 – F5</i>	toggle color label (red, yellow, green, blue, purple)
<i>0 – 5</i>	set/change image rating
<i>r</i>	reject image
<i>ctrl-d</i>	duplicate image
<i>ctrl-c</i>	copy the full history stack
<i>ctrl-v</i>	paste all of the copied history stack
<i>alt-ctrl-c</i>	selectively copy the history stack
<i>alt-ctrl-v</i>	selectively paste from the copied history stack



## 3.4. Modules

Modules are organized into five functional groups: basic, tone, color, correction and effect. You either view all modules in one long list or instead click on a group to just display modules belonging to that group.

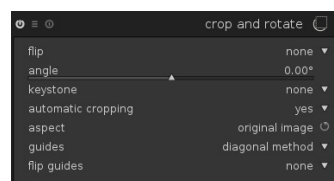
### 3.4.1. Basic group

The basic group of modules contains the modules for basic development. These are ones you probably will use most often, such as exposure, white balance etc.

#### 3.4.1.1. Crop and rotate

##### Overview

This module is used to crop, rotate and correct perspective distortions of your image. You can overlay your image with various helpful guidelines that assist you using the tools.



Some of the tools of this module, namely adjustment of angle and corrections of perspective distortion, will require the original image data to be interpolated. For best sharpness results set "lanczos3" as pixel interpolator in *core options* (see Section 8.2, "Core options").

##### Usage

Whenever the user interface of this module is in focus, you will see the full uncropped image overlaid with handles and guiding lines.

First off, select what aspect ratio you want and size the crop boundaries by dragging border and corner handles. Use the button right of the aspect box, to swap between portrait and landscape mode. You can move around the crop rectangle by holding down left mouse button and move around. When you are done and want to execute the crop, just give focus to another module or double-click into the image base. You can at any time change your crop area by just revisiting this module.

##### flip

This tool is used to flip the image on the horizontal, vertical or both axis.

##### angle

This tool corrects the rotation angle helping you level an image. You can either set a numerical value or use your mouse directly on the image. To use your mouse, right-click, hold it down and draw a line along a suited horizontal or vertical feature; as soon as you release the mouse button the image is rotated so the line you drew matches the horizontal/vertical axis.

##### keystone

This tool is used to correct perspective distortions in your image. Useful for example when you shoot a high building from ground with a short focal length, aiming upwards with your camera. The combobox lets you select the type of correction you want to use :

*vertical* if you want to limit the correction to vertical lines

*horizontal*            limit the correction to horizontal lines  
*free*                    if you want to correct horizontal and vertical lines

Depending on the selected correction type you will see two or four straight adjustment lines overlaid to your image. Two red circles on every line let you modify the line positions with your mouse. Each line additionally carries a “symmetry” button. If activated (and highlighted in red) all movements of the affected line will be mirrored by the opposite line.



In order to correct perspective distortions, you need to find suitable horizontal and/or vertical features in your image and align the adjustment lines with them. When done, press the “OK” button, which is located close to the center of your image. The image will be corrected immediately. You can at any time come back and refine your corrections by selecting “correction applied” in combobox keystone.

### **automatic cropping**

Use this options to avoid black edges on the image borders. Useful when you rotate the image.

### **aspect**

Here you can change what aspect ratio you want to have on the result, thus constraining the proportion of width and height of the crop rectangle to the aspect ratio of your choice. Many common numerical ratios are pre-defined. A few special aspect ratios deserve explanation:

*free*                    free forming the rectangle without any ratio restrictions  
*image*                this option constrains the ratio to be equal to image ratio  
*golden cut*        this option constrains the ratio to be equal the golden number  
*square*                this option constrains the ratio to be 1

You can also select any other ratio after opening the combobox and typing it in the form of “x:y”. If you want a certain aspect ratio to be added to the pre-defined ones you can do so by including a line of the form

```
plugins/darkroom/clipping/extra_aspect_ratios/foo=x:y
```

into darktable's configuration file `$HOME/.config/darktable/darktable/darktable.rc`. Here “foo” defines the name of the new aspect ratio and “x” and “y” the corresponding numerical values.

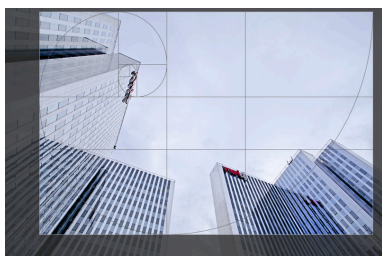
### **guides**

Many self-explaining guides are available to help you compose your image.

### **guides flip**

In case the chosen guidelines are not symmetrical relative to the image frame, you can flip them on the horizontal, vertical or both axis.

## Examples



A cropped image in center view when module crop and rotate is in focus. The cropped area is visible as well as some guiding lines.

### 3.4.1.2. Orientation

#### Overview

This module allows the user to modify the orientation of an image. By default it is active for all images and receives its standard settings from the camera's orientation flag stored in the Exif data.



#### Usage

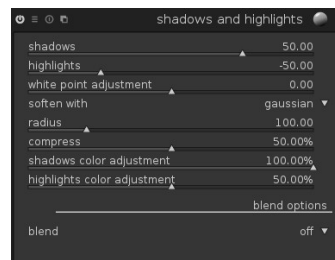
##### rotate

Clicking on one of the buttons causes a counter-clockwise or clockwise rotation in steps of 90 degrees.

### 3.4.1.3. Shadows and Highlights

#### Overview

The shadows and highlights module allows adjustment to the tonal range of darker parts of an image (shadows) and lighter parts (highlights); it can bring back details in shadows and highlights by enhancing local contrast.



#### Usage

##### shadows

This slider controls the effect on shadows; positive values will lighten up shadows while negative values will darken them.

##### highlights

This slider controls the effect on highlights; negative values will darken highlights while positive values will lighten them up.

##### white point adjustment

By default the algorithm of this modules leaves black point and white point untouched. In some cases an image might contain tonal variations beyond the white point, i.e. above a luminance value of 100. A negative shift in the white point adjustment slider allows to bring these values down into the proper range so that further details in the highlights get visible.

### **soften with**

This combobox chooses the underlying blurring filter, gaussian or bilateral. Try bilateral filter if you experience halos with gaussian blur.

### **radius**

This slider controls the radius of the involved blurring filter. Higher values give softer transitions between shadows and highlights but might introduce halos. Lower values will reduce the size of halos but may lead to an artificial look. As said, bilateral filter is much less prone to halo artifacts.

### **compress**

This slider controls how strong the effect extends to midtones; high values reduce the effect to the extreme shadows and highlights; low values cause strong adjustments also to midtones. You normally only need to touch this parameter if you want to limit the effects to the extreme shadows and highlights; increase the value in this case. At 100% this module has no visible effect any longer as only absolute black and absolute white are affected.

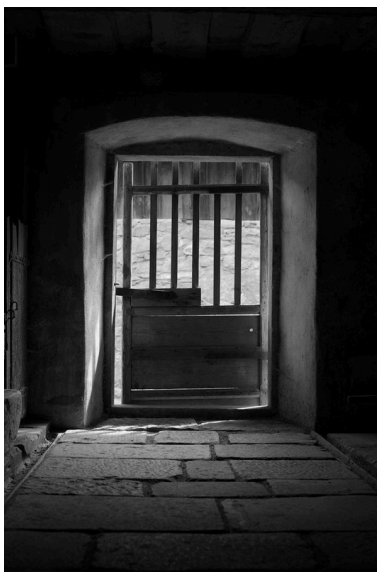
### **shadows color adjustment**

This slider controls the color saturation adjustment made to shadows; high values cause saturation enhancements on lightened shadows; low values cause desaturation on lightened shadows. It is normally safe to leave this at its default of 100%. This gives a natural saturation boost on shadows – similar to the one you would also expect in nature if shadows would receive more light.

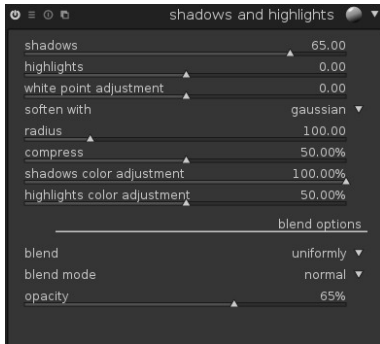
### **highlights color adjustment**

This slider controls the color saturation adjustment made to highlights; high values cause saturation enhancements on darkened highlights; low values cause desaturation on darkened highlights. Often highlights do not contain enough color information to give convincing colors when darkened. You might need to play a bit with this parameter in order to find the best fitting value depending on your specific image; but be aware that sometimes results still might not be fully satisfying.

## **Examples**



Original image exposed for the outer sunlit wall to avoid clipped highlights. As a consequence the interior of the barn has pitch black shadows.



Shadows get lightened; highlights are untouched; overall effect toned down a bit by *blend mode* "normal" and an opacity of 65%.

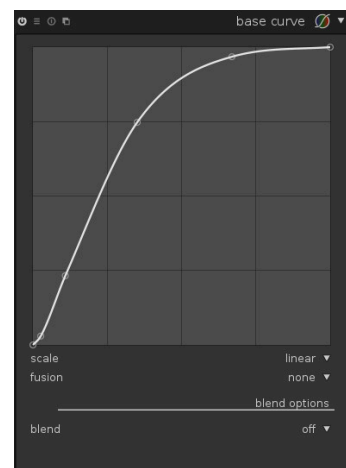


Resulting image.

### 3.4.1.4. Base curve

#### Overview

Camera sensors provide data in linear RGB format, the original image appears flat and dull. That's the reason why camera manufacturers apply their characteristic base curves to the raw data when they generate in-camera JPEG images with better colors and contrast.



#### Usage

darktable comes with base curve presets that mimic the curves of various manufacturers. These are automatically applied to raw images according to the manufacturer ID found

in Exif data. For several camera models darktable comes with base curves adapted for that specific model. A configuration option in the core preferences dialog (see Section 8.2, “Core options”) defines whether darktable by default should apply the per-camera base curve or the manufacturer one.

You can adjust an existing base curve or create a new one. The base curve is defined by two or more nodes. You can move any node to modify the curve. You can also create additional nodes by *clicking* on a curve segment between two nodes. With *ctrl-click* you generate a new node at the x-location of the mouse pointer and the corresponding y-location of the current curve – this adds a node without risking to accidentally modify the curve. In order to remove a node move it outside of the widget area.

Tip: If you intend to take full manual control of the tonal values with the *tone curve* module or the *zone system* module (see Section 3.4.2.3, “Tone curve” and Section 3.4.2.4, “Zone system”) it may be easier to leave the image in linear RGB. Disable the *base curve* module in this case.

#### scale

This combobox toggles between “linear” and “logarithmic” view. In the double logarithmic view more space is given to the lower values allowing a more fine-grained adjustment of the shadows.

#### fusion

This control triggers the *exposure fusion* [[https://en.wikipedia.org/wiki/Exposure\\_Fusion](https://en.wikipedia.org/wiki/Exposure_Fusion)] feature. You can choose to merge the image with one or two copies of itself after applying the current base curve and boosting its exposure by a selectable number of ev units. The resulting image is thus a combination of two or three different exposures of the original image. Use this to compress dynamic range for extremely underexposed images or for true HDR input. For best results, use the exposure module (see Section 3.4.1.5, “Exposure”) to apply a suitable adjustment for correctly exposed highlights.

#### exposure shift

This slider is only visible if the *exposure fusion* feature is activated. It allows you to set the exposure difference between the merged images in ev units (default 1).

#### exposure bias

This slider is only visible if the *exposure fusion* feature is activated. It allows you to choose how the multiple exposures are computed. With a bias of 1 (the default), the image is fused with overexposed copies of itself. With a bias of -1, it is fused with underexposed copies. A bias of 0 tries to preserve the overall lightness of the image by combining both over and under-exposed copies of the image.

### 3.4.1.5. Exposure

#### Overview

This module is used to tweak the exposure. It is directly linked to the histogram panel. If you correct exposure graphically, using the *histogram* (see Section 3.3.7, “Histogram”), you automatically



activate the exposure module. The histogram simply acts as a view for the exposure module.

You can activate multiple instances of this module each with different parameters acting on different parts of the image which you select by a drawn mask (see Section 3.2.4, “Multiple instances” and Section 3.2.5.5, “Drawn mask”). The histogram is always linked to the last instance in pixelpipe.

## Usage

This module is responsible for one of the most basic steps in each raw image development. An exposure adjustment value allows you – within certain limits – to correct for under- or overexposure. A shift by 1EV is equivalent to a change of exposure time by a factor of 2.

Positive exposure corrections will make the image brighter. As a side effect noise level gets higher. Depending on the basic noise level of your camera and the ISO value of your image, positive exposure compensations with up to 1EV or 2EV still give reasonable results.

Negative exposure corrections will make the image darker. Given the nature of digital images this can not correct for fully blown out highlights but allows to reconstruct data in case that only some of the RGB channels are clipped (see also Section 3.4.1.9, “Highlight reconstruction”).

A black level adjustment is a basic tool to increase contrast and pop of an image. The value defines at what threshold dark gray values are cut off to pure black. Use with care as the clipped values can not be recovered in other modules further down the pixelpipe. Please also have a look at the *tone curve* module (see Section 3.4.2.3, “Tone curve”) and the *levels* module (see Section 3.4.2.2, “Levels”) which can produce similar results with less side effects as they come later in pixelpipe.

The exposure module has two modes of operation.

In “manual” mode you directly define the value for exposure correction that you want to apply to your image.

In “automatic” mode darktable analyses the histogram of your image. You select a reference point within the histogram as a *percentile* and define a *target level* – darktable automatically calculates the exposure compensation that is needed to shift the selected position to that target value. The computed exposure compensation value is displayed in the module's GUI for your information.

The “automatic” mode has a black level adjustment that works as in manual mode.

Automatic adjustment is only available for raw images. A typical use case is deflickering of *time-lapse photographs* [[http://en.wikipedia.org/wiki/Time-lapse\\_photography](http://en.wikipedia.org/wiki/Time-lapse_photography)]. You apply an automatic exposure correction with the same set of parameters to all images of the series – differences in lighting get compensated so that the final video sequence does not show any flickering.

### mode

Defines the mode of operation. Defaults to “manual”.

### black


Adjust the black level in both “manual” and “automatic” mode.



### exposure

Adjust the exposure correction [EV] (only available in “manual” mode).

### clipping threshold

darktable can calculate correct black level and exposure values for your image based on the content of a rectangular area. The adjustment slider lets you define what percentage of bright values are to be clipped out in the calculation. Pressing the  icon starts the calculation and lets you draw a rectangular area of your choice using your mouse. This feature is only available in “manual” mode.

### percentile

Defines a location in the histogram for automatic exposure correction. A percentile of 50% denotes a position in the histogram where 50% of pixel values are below and 50% of pixel values are above. For more details see *percentile* [<http://en.wikipedia.org/wiki/Percentile>]. Only available in “automatic” mode.

### target level

Defines the target level for automatic exposure correction in terms of [EV] relative to the white point of the camera. The white point is camera specific and defines the highest lightness value that the camera sensor can detect. Only available in “automatic” mode.

## 3.4.1.6. Contrast Brightness Saturation

### Overview

This module offers a very basic tool for adjusting an image's contrast, brightness and saturation.



### Usage

The module has sliders for each of the three affected attributes. In their neutral position (zero) the image remains unchanged. Shifting sliders left to negative values reduces contrast, brightness and saturation, respectively. Shifting right to positive values leads to an increase.

Much more versatility for contrast and brightness adjustment is offered by the *tone curve*, *levels*, and *zone system* modules (see Section 3.4.2.3, “Tone curve”, Section 3.4.2.2, “Levels”, and Section 3.4.2.4, “Zone system”). Likewise you may adjust color saturation in a more detailed way with the *tone curve*, *color contrast*, and *color zones* modules (see Section 3.4.2.3, “Tone curve”, Section 3.4.3.4, “Color contrast”, and Section 3.4.3.8, “Color zones”).

### contrast

This slider adjusts the image's contrast.

### brightness

This slider adjusts the image's brightness.

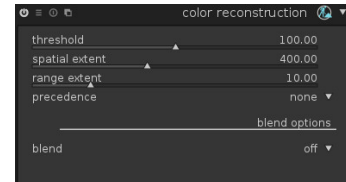
## saturation

This slider adjusts the color saturation.

### 3.4.1.7. Color reconstruction

#### Overview

The color reconstruction module is able to bring back color into blown out highlights.



#### Usage

Due to the nature of digital sensors, overexposed highlights are lacking valid color information. Most frequently they appear neutral white or exhibit some color cast – depending on which other image processing steps are involved. This module can “heal” overexposed highlights by replacing their colors with better fitting ones. The module acts on highlight pixels whose luminance values exceed a user defined threshold. Replacement colors are taken from the neighborhood. Both, the spatial distance and the luminance distance (*range*) are taken into account for color selection.

As a limitation of the underlying algorithm reconstructed colors may sometimes be displayed incorrectly if you zoom into the image in the darkroom view. If this happens you might observe a magenta shift in highlight areas close to high contrast edges, or you might see colorless highlight areas if you combine this module with the “reconstruct color” method of the “highlight reconstruction” module (see Section 3.4.1.9, “Highlight reconstruction”). These artifacts only influence image display – the final output remains unaffected. It is recommended that you finetune the parameters of this module while viewing the full, not zoomed-in image.

#### threshold

The color reconstruction module replaces the color of all target pixels characterized by luminance values above this threshold. Inversely, only pixels with luminance values below this threshold are taken as valid source pixels for replacement colors. Too high settings of this parameter will cause the module to have no effect on any pixels. Too low values will minimize the “pool” of replacement colors – if no suited ones are available the original colors are maintained. Therefore, this parameter exhibits a “sweet spot” characteristic with an optimum setting depending on the individual image.

#### spatial extent

Defines the spatial distance (x,y-coordinates) that source pixels may have from a target pixel in order for them to contribute to color replacement. Higher values cause ever more distant pixels to contribute; this increases the chance to find a replacement color but makes that color more undefined and less clear.

#### range extent

Defines the range distance (difference in luminance values) that source pixels may have from target pixels in order for them to contribute to color replacement. Higher values cause more pixels to contribute even if their luminance differs more strongly from the

target pixels; this again increases the chance to find a replacement color but at the same time increases the risk of unfitting colors creeping in.

### preference

This combobox defines if certain replacement colors shall take precedence over others. In its default setting "off" all pixels contribute equally. Setting it to "saturated colors" makes pixels contribute according to their chromaticity – the higher saturated a color the more it contributes. By selecting "hue" you get a choice of giving precedence to a specific hue.

### hue

This slider is visible if you set the preference combobox to "hue". It allows you to select a preferred hue of replacement colors. This only has an effect if the preferred hue is actually present within the selected spatial and range distance of the target pixels (see above). A typical use case is repairing highlights on human skin in situations where diverging colors are in close proximity (e.g. textiles or hair with a luminance close to skin). Setting a hue preference on skin tones avoids these other colors from creeping in.

## Examples



Original image with overexposed highlights on head, arm and shoulder of the statue.

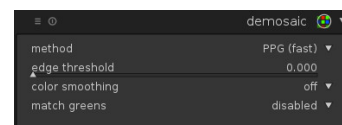


Color reconstruction with default settings of all module parameters.

### 3.4.1.8. Demosaic

#### Overview

This module allows you to control how the demosaic is processed.



#### Usage

Demosaic is an essential step of any raw image development process.

A detailed description would be beyond the scope of this manual. In a nutshell, the sensor cells of a digital camera are only able to record different levels of lightness, not different color. In order to get a color image, each cell is covered by a color filter, either in red, green or blue. Due to the color sensitivity of the human vision, there are two times more green cells than red or blue. Filters are arranged in a certain mosaic, called Bayer

pattern. Therefore each pixel of your image originally only has information about one color channel. Demosaic reconstructs the missing color channels by interpolation with data of the neighboring pixels. For further reading see the Wikipedia article on the Bayer filter [[http://en.wikipedia.org/wiki/Bayer\\_filter](http://en.wikipedia.org/wiki/Bayer_filter)].

As interpolation is prone to produce artifacts, various different demosaic algorithms have been developed in the past. Artifacts would typically be visible as moiré-like patterns when you strongly zoom into your image. Currently darktable supports PPG, AMAZE, and VNG4. All these algorithms produce high quality output with a low tendency to artifacts. AMAZE is reported to sometimes give slightly better results. However, as AMAZE is significantly slower, darktable uses PPG as a default. VNG4 produces the softest results of the three algorithms, but if you see "maze" artifacts, try VNG4 to eliminate them.

There are a few cameras whose sensors do not use a Bayer filter. Cameras with an "X-Trans" sensor have their own set of demosaicing algorithms. The default algorithm for X-Trans sensors is Markesteijn 1-pass, which produces fairly good results. For a bit better quality (at the cost of much slower processing), choose Markesteijn 3-pass. Though VNG demosaic is faster than Markesteijn 1-pass on certain computers, it is more prone to demosaicing artifacts.

Additionally, darktable supports a special demosaicing algorithm – passthrough (monochrome). It is not a general-purpose algorithm that is useful for all the images. It is only useful for cameras with the color filter array physically removed from the sensor, e.g. physically scratched off. Normally, demosaic reconstructs the missing color channels by interpolation with data of the neighboring pixels. But since the color filter array is not present, there is nothing to interpolate, so this algorithm simply sets all the color channels to the same value, which results in pixels being gray, thus producing a monochrome image. This method guarantees that there are no interpolation artifacts that would otherwise be present should one of the standard demosaicing algorithm be used.

Some further parameters of this module can activate additional averaging and smoothing steps. They might help to reduce remaining artifacts in special cases.

Demosaic is always applied when exporting images. Demosaic is done on monitor display only when zoom is greater than 50% or when the according preference setting "demosaicing for zoomed out darkroom mode" (see Section 8.2, "Core options") is set accordingly. Else color channels are taken from neighboring pixels without an expensive interpolation.

#### **method**

Set the demosaic method. darktable currently supports PPG, AMAZE, and VNG4 for Bayer sensors. For X-Trans sensors darktable supports VNG, Markesteijn 1-pass, and Markesteijn 3-pass.

#### **edge threshold**

Set the threshold for an additional median pass. Defaults to "0" which disables median filtering. This option is not shown for X-Trans sensors.

#### **color smoothing**

Activates a number of additional color smoothing passes. Defaults to "off".

#### **match greens**

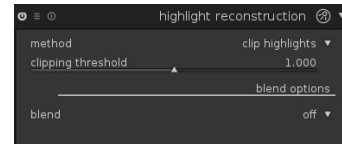
In some cameras the green filters have slightly varying properties. This parameter adds an additional equalization step to suppress artifacts. Available options are "disabled", "local

average”, “full average” and “full and local average”. This option is not shown for X-Trans sensors.

### 3.4.1.9. Highlight reconstruction

#### Overview

This module tries to reconstruct color information that is usually clipped because of incomplete information in some of the channels. If you do nothing, your clipped areas are often toned to the not clipped channel. For example, if your green and blue channels are clipped, then your image will appear red in the clipped areas.



#### Usage

You can choose between three methods for highlight reconstruction.

“Clip highlights” just clamps all the pixels to the white level. Effectively this converts all clipped highlights to neutral grey tones. This method is most useful in cases where clipped highlights occur in non-colored areas like clouds in the sky.

“Reconstruct in LCh” analyses each pixel having at least one channel clipped and transforms the information in LCh color space in an attempt to correct the clipped pixel using the values of the other (3 for Bayer or 8 for X-Trans) pixels in the affected sensor block. This method usually does a better job than “Clip highlights” as some details in the clipped areas are preserved. However it is incapable to reconstruct any color information – the reconstructed highlights will all be monochrome, but brighter and with more detail than with “Clip highlights”. This method works fairly well with a high-contrast base curve (such as most manufacturers apply to their JPEG), which renders highlights desaturated. This method is a good option on naturally desaturated objects such as clouds.

“Reconstruct color” uses an algorithm that transfers color information from the unclipped surroundings into the clipped highlights. This method works very well on areas with homogeneous colors and is especially useful on skin tones with smoothly fading highlights. It fails in certain cases where it produces maze-like artifacts at highlights behind high-contrast edges, such as fine, well-exposed structures in front of overexposed background (for instance ship masts or flags in front of the blown-out sky).

Tip: for highlight reconstruction to be effective you need to apply a negative EV correction in the exposure module (see Section 3.4.1.5, “Exposure”). If you want to avoid a general darkening of your image you can use darktable's mask feature in that module to limit the EV correction to only the highlights (see Section 3.2.5.5, “Drawn mask” and Section 3.2.5.6, “Parametric mask”).

#### method

Choose the method for highlight reconstruction.

#### clipping threshold

Manually adjust the clipping threshold against magenta highlights. The default is usually satisfactory without any need for additional adjustments.

### 3.4.1.10. White balance

## Overview

This module is used to set the white balance. You have three ways to interact with it: (a) Set up tint and temperature, (b) define the value of each channel, or (c) choose from predefined white balances.



## Usage

### tint

Alter the color tint of the image, from magenta (value < 1) to green (value > 1). The channel sliders will be updated when you adjust this parameter.

### temperature

Set the color temperature (in Kelvin). The channel sliders will be updated when you adjust this parameter. darktable derives the color temperature from the Exif data using some model assumptions. The value given is not meant to be authoritative. In the end only the updated channel values determine how the image is modified.

### red, green and blue channels

Set the channel values on a scale from 0 to 8.

### preset

Select a preset white balance.

*camera white balance (default)*

White balance reported by the camera.

*camera neutral*

Essentially sets temperature to 6502K. The actual math: it computes such white balance channel multipliers, so that pure white color in camera colorspace is converted into pure white color in sRGB D65. (pure white color here means having the same equal value for each channel = 1.0)

*spot white balance*

Select a square area in your image containing mostly grey pixels. The white balance is calculated based on the selected area.

*camera presets*

Camera specific white balance presets. Examples: direct sunlight, flash, cloudy, shade and a number of indoor lighting options.

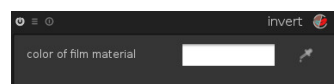
### finetune

Some cameras offer additional finetuning parameters if one of the camera presets is selected. Depending on camera white balance, can be adjusted in steps within a certain range. The adjustments are usually towards yellow (value < 1) or blue (value > 1).

### 3.4.1.11. Invert


## Overview

The main purpose of this module is to invert scanned negatives.



## Usage

### color of film material

The only control element of this module is a color selector which allows to adjust for different colors of your film material. Clicking on the colored field will open a color selector dialog which offers you a choice of commonly used colors, or allows to define a color in RGB color space. You can also activate a color picker by pressing  and take a color probe from your image – preferably from the unexposed border of your negative.

### 3.4.1.12. Raw black/white point

#### Overview

This module is activated automatically for raw images and makes sure that the camera specific black and white points are taken into account. Default settings are applied for all supported cameras. Changes to the defaults are normally not required.



## Usage

### black level 0 to 3

The camera specific black level of the four pixels in the RGG B Bayer pattern. Pixels with values lower than that level are considered to contain no valid data.

### white point

The camera specific white level. All pixels with values above are likely to be clipped and handled accordingly in the *highlight reconstruction* module (see Section 3.4.1.9, “Highlight reconstruction”). Pixels with values equal to the white level are considered to be white.

### 3.4.2. Tone group

This group contains modules that operate on the tonal values of an image, modulating brightness while leaving color values intact.

#### 3.4.2.1. Fill light

##### Overview

This module allows local modification of the exposure based on pixel lightness.




## Usage

Pushes exposure by increasing lightness with a Gaussian curve of a specified width, centered on a given lightness.

### exposure

Sets fill-light exposure in [EV].

### center

Sets the median lightness impacted by the fill-light. A color picker is activated by pressing . It shows the picked lightness value in the gradient bar, which helps find the desired center value. You can switch between point and area sampling mode from within the global color picker panel (see Section 3.3.5, "Global color picker").

### width

Sets the width of the Gaussian curve. This number is expressed in zones, with the whole dynamic range being 10 zones. As the Gaussian curve is symmetric, only even numbers can be entered.

## 3.4.2.2. Levels

### Overview

A tool for adjusting black, white, and mid-gray points. This module is especially useful if the histogram of an image does not span the whole horizontal range, from pure black to pure white.




### Usage

The levels tool offers two modes of operation: "manual" and "automatic".

In "manual" mode the levels tool shows a histogram of the image, and displays three bars with handles. Dragging the handles modifies the tones in the image. Those bars control the black, middle gray and white points in absolute values of image lightness (the L value from Lab).

You can move the black and white bars to match the left and right borders of the histogram, which will make the output image span the full available tonal range. A previously flat looking image will get more contrast and pop.

Moving the middle bar will modify the middle gray tones. Shifting it left will make the image look brighter, shifting it right will make it darker. This is often referred to as a change of image gamma.

There are three color pickers in black, gray, and white, available by pressing the respectively colored  icon. You can use them to sample the corresponding level directly from the image. You can switch between point and area sampling mode from within the global color picker panel (see Section 3.3.5, "Global color picker").

The "auto" button autoadjusts the black and white point and puts the gray point exactly in the mean between them.

In "automatic" mode the module automatically analyses the histogram of the image, detects the left and right histogram borders, and lets you define the black point, the gray



point and the white point in terms of *percentiles* [<http://en.wikipedia.org/wiki/Percentile>] relative to these borders.

Tip: Under certain conditions, especially highly saturated blue light sources in the frame, the levels module may produce black pixel artifacts. See the *gamut clipping* option (Section 3.4.3.11, “Input color profile”) on how to mitigate this issue.

#### mode

Set the mode of operation of this module. Defaults to “manual”.

#### black

Sets the black point in percentiles relative to the left border of the histogram (only “automatic” mode).

#### gray

Sets the gray point in percentiles relative to the left and right borders of the histogram *after* having applied the black point and white point corrections (only “automatic” mode).

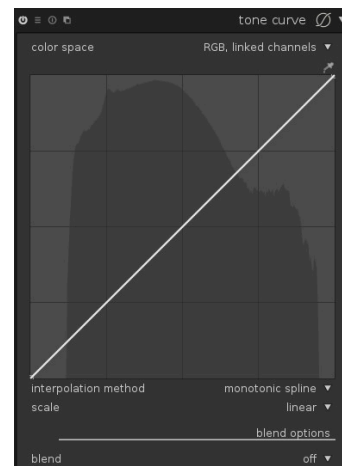
#### white

Sets the white point in percentiles relative to the right border of the histogram (only “automatic” mode).

### 3.4.2.3. Tone curve


#### Overview

This module is a classic digital photography tool. darktable's tone curve can work in three different color spaces: RGB, XYZ or Lab.



#### Usage

In its default state, curves will be straight lines, defined by few anchor nodes. You can move the nodes to modify the curve. You can generate new nodes by *clicking* on the curve. With *ctrl-click* you generate a new node at the x-location of the mouse pointer and the corresponding y-location of the current curve – this adds a node without risking to accidentally modify the curve. Up to 20 nodes per curve can be defined. To remove a node, move it out of the widget area.

A color picker is activated by pressing  and will show the picked values in the graph. You can switch between point and area sampling mode from within the global color picker

panel (see Section 3.3.5, “Global color picker”). Numerical Lab values of input and output (see below) at the selected spot or area are shown on top left of the widget.

### color spaces

Depending on the desired intent, you can apply the tone curve in three different color spaces:

- Lab, linked channels,
- Lab, separated channels,
- XYZ, linked channels,
- RGB, linked channels.

Lab is a perceptual color space that is designed to approximate the way human beings perceive colors and lightness, and representing the color information independently of the the lightness information. In “Lab, separated channels”, you get a fully independent control over the chrominance (a/b-channels) and the luminance (L-channel). In “Lab, linked channels”, only the luminance (L-channel) control is available. The color saturation correction will be automatically computed, for each pixel, from the contrast correction applied to the luminance channel. This works better in cases where a subtle contrast correction is applied, but gives increasingly inaccurate saturation correction as the contrast gets more dramatically enhanced.

XYZ is a linear technical color space designed to link the physiologic light response of human eyes to RGB spaces. As Lab, it separates the lightness from the color information, but it does so in a way that does not account for the role of the brain correction in human perception. The “XYZ, linked channels,” mode offers an alternative for “Lab, linked channels”. It works by applying the L-channel curve to all three channels in the XYZ color space. Look at blend mode “coloradjustment” if you want to tune the strength of automatic chroma scaling (see Section 3.2.5.4, “Blending operators”). This mode is known to produce a slight hue shift towards yellow.

RGB spaces are linear color spaces designed to capture and display images in additive synthesis. They are related to capture and display media and do not isolate color and lightness information. The “RGB, linked channels,” works in ProPhoto RGB and applies the L-channel curve to all three channels in the RGB color space. Adding contrast in RGB space is known to desaturate highlights and boost saturation in lowlights, but this has proven to be the most reliable way to edit contrast, and is the standard way to do it in most software. This mode makes the tone curve module behave the same way as the basecurve (see Section 3.4.1.4, “Base curve”), except the latter one works in camera RGB space.

Notice that the interface is controlled in Lab in all cases. This means that the middle gray coordinate is always 50% in the graph, no matter what color space is used. The same applies to the inset histogram displayed in the background of the curve. The controls are converted to the relevant color space before the corrections are applied – in RGB and XYZ, the middle-gray is therefore remapped from 50% to 18%.

### L-channel curve

The tone curve in L-channel works on Lightness. For a better overview a lightness histogram is displayed in the diagram. When working in “Lab, linked channels”, “RGB, linked channels” or “XYZ, linked channels”, the L-channel curve is the only one available.

The horizontal line represents the input image pixels' lightness. The vertical line represents the lightness of the output image pixels. A straight line does not change

anything. A point above the default diagonal increases the lightness, whereas a point under decreases it. Shifting the center of the curve upwards will lighten the image, shifting it downwards will darken the image. An S-like curve will enhance the contrast of the image.

### **a/b-channel curves**

The curves in the a and b channels work on color values and are available only in “Lab, separated channels” color space. The horizontal line represents the color channel value of the input image pixels. The vertical line represents the color channel value of the output image pixels. Positive a-values correspond to more magenta colors; negative a-values correspond to more greenish colors. Positive b-values correspond to more yellowish colors; negative b-values correspond to more blueish colors.

A straight line does not change anything. Shifting the center of the curve will give the image a color tint: shifting a-channel upwards gives a magenta tint; shifting b-channel upwards gives a yellow tint; shifting a-channel downwards gives a green tint; shifting b-channel downwards gives a blue tint.

Increasing/decreasing the steepness of the curves, without shifting its center, will increase/decrease the color saturation of the respective channel. With properly defined curves you can exert fine control on color saturation, depending on the input pixel's colors.

### **interpolation method**

The interpolation is the process by which a continuous curve is derived from a few punctual nodes. As this process is never perfect, several methods are offered that can alleviate the potential issues you may encounter with some nodes setups.

Arguably, the most visually pleasing method is the “cubic spline”. Since it gives smooth curves, the contrast in the image is better enhanced. However, this method is very sensitive to the nodes position, and can produce cusps and oscillations when the nodes are too close to each other, or when there are too many of them. This method works best when there are only 4 to 5 nodes, evenly spaced.

The “centripetal spline” is a method designed specifically to avoid cusps and oscillations, but as a drawback it will follow the nodes more loosely. It is very robust, no matter the number of nodes and their spacing, but will produce a more faded and dull contrast.

The “monotonic spline” is a method designed specifically to give a monotonic interpolation, meaning that there will be none of the oscillations the cubic spline may produce. This method is very suitable when you try to build an analytical function from a node interpolation (for example: exponential, logarithm, power, etc.). Such functions are provided as presets. It is a good trade-off between the two aforementioned methods.

### **scale**

The scale allows you to distort the graph display so that certain graphical properties emerge to help you draw meaningful curves. Notice that the scaling option only affects the curve display, not the actual parameters.

By default, the “linear” scale is used. This scale uses evenly spaced abscissa and ordinates axes.

The “log-log (x, y)” scale will compress the high values and dilate the low values, on both the abscissa and the axis of ordinates, so that the nodes in lowlights get more space on the graph and can be controlled more clearly.

The “semi-log (x)” is similar to the log-log scale, but the axis of ordinates is left linear and only the abscissa is logarithmically scaled. This is useful when you want to draw a purely exponential function: in semi-log (x) scale, exponential become identity lines.

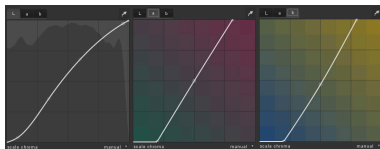
The “semi-log (y)” is similar to the log-log scale, but the abscissa axis is left linear and only the axis of ordinates is logarithmically scaled. This is useful when you want to draw a purely logarithmic function: in semi-log (y) scale, logarithms become identity lines.

When using non-linear scales, a “base of the logarithm” slider appears that lets you control the amount of compression/dilatation operated by the logarithmic scales. If you draw purely exponential or logarithmic functions from identity lines, setting this values defines the base of such functions.

## Examples



Original image



Tone curve settings. Please note how the center node of our b-curve was shifted down to negative values. This gives the image its blue tint.

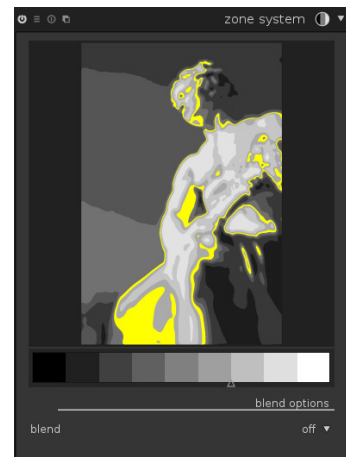


Resulting image

### 3.4.2.4. Zone system

#### Overview

This module is another way to change the lightness of your image, based on Ansel Adams' system. It allows modification of a zone's lightness taking into account the effect on the adjacent zones. It divides the lightness range into a user-defined number of zones.



## Usage

Following the concept of Ansel Adams the lightness (based on the L channel from Lab) is divided into a number of zones ranging from pure black to pure white. These zones are displayed in a zonebar. The number of zones can be changed by mouse-scrolling on that bar (defaults to 10 zones).

The zonebar is split horizontally with the upper part showing the zones of the module's output and the lower part the according zones of the module's input. In its default state both parts are fully aligned. While the output zones are static you can left click and drag a control point in the input zones to modify the zonemapping. Shifting a control point proportionally expands the zones on one side and compresses the zones on the other side. Any already existing control point stays in place, effectively preventing changes to the zones beyond. Use right click to remove a control point.

The preview shows the image broken down in zones. When hovering above a zone on the zonebar, that zone – either from input or output – is highlighted on the preview.

## Examples



The original image.



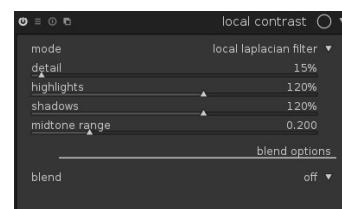
Here, the darker and lighter zones were compressed to increase contrast, then the upper parts of darker zones were expanded to increase their visual impact.



### 3.4.2.5. Local contrast

#### Overview

This module allows enhancing local contrast. It supports two modes of operation: the default one uses a local laplacian filter, the other one uses the unnormalized bilateral filter. Both work exclusively on the L channel from Lab.



#### Usage

Local contrast boosts details of your image, much like the *equalizer* does (see Section 3.4.4.2, "Equalizer"). However, it is easier to use as it does not require you to work on different frequency bands. The local laplacian filter has been designed to be very robust against unwanted halo effects and gradient reversals along edges.

#### mode

Choice of "local laplacian filter" or "unnormalised bilateral grid". The options for the bilateral grid are: coarseness, contrast, and detail. The local laplacian filter supports:

detail, highlights, shadows, and midtone range. The local laplacian mode supports shadow lifting and highlight compression, similar to the shadows and highlights module.

## Bilateral grid

### coarseness

Make the details you want to adjust finer or coarser.

### contrast

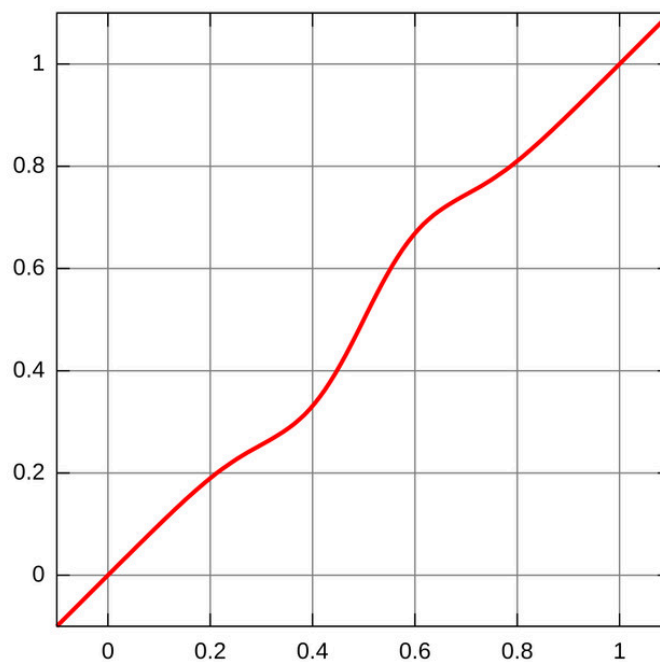
How strongly the algorithm distinguishes between brightness levels. Increasing the value results in a more contrasty look.

### detail

Add or remove detail. Higher values will increase local contrast.

## Local laplacian

To understand the parameters of the local laplacian filter, you can think of it as applying a curve to the image, similar to this picture:



It will then be applied to the image in a way that works locally and avoids halo artifacts.

### detail

Add or remove detail. Higher values will increase local contrast. This will insert an S shaped element in the center of the curve, to increase or decrease local contrast. For monochrome images it is often possible to push this parameter to extreme settings without ridiculous results or artifacts.

### highlights

This affects one end of the curve, effectively increasing or compressing contrast in the highlights. A low value will pull the highlights down.

## shadows

Similar to the highlights parameter, this affects the other far end of the curve, and will increase or decrease contrast in the shadows. A higher value gives more contrast in the shadows. A lower value will lift the shadows and can effectively simulate a fill light. Note that this is done via local manipulation of the image, however: this means that a completely dark image cannot be brightened this way, only dark things in front of bright things will be affected.

## midtone range

This controls the extent of the S shaped part of the contrast curve. A larger value will make the S wider, and thus classify more values to be midtone range and fewer values to belong to the highlights and shadows part. In more high dynamic range settings it can be useful to reduce this value to achieve stronger range compression by lowering the contrast in the highlights and the shadows. Note however that for really strong HDR scenarios this may work best in combination with a base curve which pre-compresses the range, maybe with an approximately logarithmic base curve. Also the exposure fusion feature in the base curve module may lead to more pleasing results at times, but is more prone to producing halo effects.

This setting can cause banding artifacts in the image if pushed to extreme values. This is due to the way darktable computes the fast approximation of the local laplacian filter.

## Example

Before



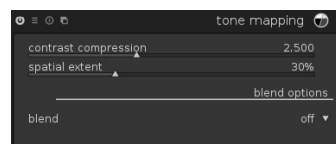
After, a little overdone to demonstrate the effect. Use this sparingly, to avoid a cheap, overprocessed look.



## 3.4.2.6. Tonemapping

### Overview

This module compresses the tonal range of HDR images, so they fit into the limits of a normal, low dynamic range image, using Durand's 2002 algorithm. darktable can import HDR images if they come in OpenEXR, RGBE or PFM format or as a DNG generated by darktable's HDR creation mechanism (see Section 2.3.6, "Selected image(s)").



### Usage

The underlying algorithm uses a bilateral filter to decompose an image into a coarse base layer and a detail layer. The contrast of the base layer is compressed, while the detail layer is preserved, then both layers are re-combined.

### contrast compression

Sets the contrast compression level of the base layer. A higher compression will make the image fit a lower dynamic range.

### spatial extent

Sets the spatial extent of the bilateral filter. Lower values cause the contrast compression to have stronger effects on image details.

## 3.4.2.7. Global tonemap

### Overview

This module implements another approach to compressing the tonal range of an HDR image into the limited tonal range of a typical LDR output file. It offers several implementations of global tonemap operators.



### Usage

Global tonemapping processes each pixel of an HDR image, without taking the local surrounding into account. This is generally faster than local tonemapping, as implemented in the *tonemapping* module but might lead to less convincing results with very high dynamic scenes. As an enhancement to the original operators, darktable can preserve detail of the input image, and transfer it back to the output image.

### operator

Reinhard, Filmic and Drago global tonemap operators are available for use. Depending on the selected operator, different parameters can be adjusted. Some operators are fully self-adjusting, and do not require specific controls.

### bias

Only offered for the *Drago* operator. This parameter influences the contrast of the output image. It is an essential parameter for adjusting the compression of high values and the visibility of details in dark areas. According to the original paper, a value of 0.85 is recommended as a starting point.

### target

Only offered for the *Drago* operator. This is a scale factor to adjust the global image brightness to the brightness of the intended display. It is measured in  $\text{cd/m}^2$ , and should match the according value of your output device. Higher values lead to a brighter image, while lower values lead to a darker image.

### detail

Offered as an addition to all operators. This parameter controls how much detail is preserved and transferred back into the output image after tonemapping.

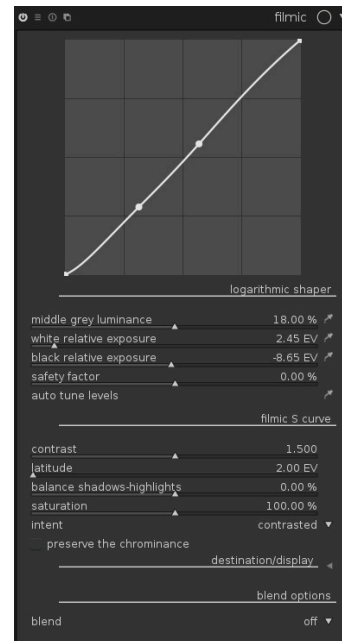
## 3.4.2.8. Filmic



## Overview

This module compresses the tonal range of an image by reproducing the tone and color response of classic film. Doing so, it will protect the colors and the contrast in mid-tones, recover the shadows, and compress bright highlights. It is very suitable in portrait photography, especially in back-lighting situations, but will need extra care when details need to be preserved in highlights (e.g. clouds).

The module is derived from the same named module in Blender 3D modeller by T. J. Sobotka. While it is primarily intended to recover high-dynamic range from raw sensor data, it can be used with any image in replacement of the base curve module. A full tutorial with examples and comments on the results can be found on *its developer's website* [<https://eng.aurelienpierre.com/2018/11/30/filmic-darktable-and-the-quest-of-the-hdr-tone-mapping/>].



## Prerequisites

In order to get the best out of filmic, images need some preparation:

- In-camera, expose the shot "to the right". This implies under exposing the shot so that the highlights are at the right of the histogram, just on the verge of clipping, but not clipped. It does not matter if the picture preview is very dark on your camera screen: as long as highlights are unclipped, filmic should be able to recover details from the raw data. Beware that clipped data are not recoverable. Some cameras have a clipping alert preview to help you diagnose this, and some even have an highlight-priority exposure mode.
- In darktable's exposure module, correct the black level and the exposure value to avoid any clipping. It is especially important to avoid negative pixels values (in black areas), because they will be clipped in filmic. For some cameras models (Canon, mainly), rawspeed, the raw decoding library of darktable, may set an exaggerated black level, resulting in crushed blacks and negative values. If so, brighten the blacks by setting a negative black level value in the exposure module.
- If you plan on using filmic's auto-tuners, use the white balance module first to correct any color casts and get neutral colors. In RGB color spaces, luminance and chrominance are linked, and filmic's luminance detection relies on accurate measures of both. If your picture is very noisy, add an initial step of denoising to help the black exposure readings, and use a high quality demosaicing.
- If you plan using filmic's chrominance preservation mode, avoid using any tone mapping module as well as the base curve module. These may produce unpredictable color shifts that would make the chrominance preservation useless. Neither of these modules is usually needed if you use filmic.

## Usage

There are 4 steps in the filmic process:

- Apply a logarithmic shaper to the RGB signal, to raise the midtones luminance in the same way human eyes and film respond to lightness. This is similar to what *unbreak input profile* does in its logarithmic mode.
- Apply an S-shaped parametric curve to enhance the contrast and remap the grey value to the middle grey of the display. This is similar to what the base curve or tone curve modules do.
- Apply a selective desaturation on extreme luminance values so that shadows degrade progressively toward pure black and highlights degrade progressively toward pure white.
- Apply an inverse gamma transfer function to linearize the output for the display gamma. Having a gamma correction applied on top of logarithmically encoded data would result in a double-up, with the luminance raised twice.

The sliders' ranges of filmic are limited to usual and safe values, but values are allowed out of these ranges by clicking on the sliders with the right button and inputting values on the keyboard. Filmic has no neutral parameters resulting in a no-operation: as soon as the module is enabled, the image is always at least slightly affected. The default parameters are tuned to have minimal impact on most pictures.

### **Middle-grey luminance**

The middle-grey luminance is the luminance in XYZ space of the scene referred 18% grey. Its color picker tool reads the average luminance over the drawn area. If you happen to have a grey card or a color chart (IT8 chart or colorchecker) shot in the scene lighting conditions, then the grey color picker tool can be used to quickly sample the luminance of the grey patch on the picture. In other situations, the color picker can be used to sample the average luminance of the subject.

This setting has an effect on the picture that is analogous to a lightness correction. Values close to 100% will not compress the highlights but will fail to recover shadows. Values close to 0% will recover greatly the shadows but will compress the highlights more harshly and result in local-contrast losses. The standard middle-grey value for linearly encoded camera RGB is 18%. Good values of grey are usually the average luminance of the whole picture or of the subject. Values much higher than 18% will make the filmic S curve difficult to control. In studio and indoors (low dynamic range scenes), proper grey values will be found between 15-18%. In high dynamic range scenes (landscapes, back-lit portraits), proper grey values will lie between 1.25 and 9%.

When modifying the middle-grey luminance, the white and black exposures are automatically slid accordingly, to preserve the dynamic range from clipping and to help you set find the right parameter faster. If you are not happy with the auto adjustment performed by the grey slider, you can correct again the white and black exposure parameters afterwards.

### **White relative exposure**

The white relative exposure is the number of stops (EV) between pure white and the middle grey. It is the right bound of the dynamic range. It should be adjusted to avoid highlight clipping. The white exposure color picker tool reads the maximum luminance in XYZ space over the drawn area, assumes it is pure white, and sets the white exposure parameter to remap the reading to 100% luminance.

When the grey is set at 18%, the white exposure will always be around 2.45EV. When the grey is set at 100%, the white exposure should be set at 0EV.

## Black relative exposure

The black relative exposure is the number of stops (EV) between pure black and the middle grey. It is the left bound of the dynamic range. The black exposure color-picker tool reads the minimum luminance in XYZ space over the drawn area, assumes it is pure black, and sets the black exposure parameter to remap the minimum reading to 0% luminance. The black color picker measurement is very sensitive to noise, and cannot identify if the minimum luminance is pure black (actual data) or just noise. It works better on low ISO pictures and with high quality demosaicing. When the color picker puts the black exposure at -16EV, it is a sign that the measure failed and you need to adjust it manually.

The black relative exposure allows you to choose how far you want to recover lowlights. On the contrary to the white exposure it will not be possible to completely avoid clipping blacks. When the black exposure is very low, the filmic S curve becomes very difficult to control and the final contrast is often faded. Every camera sensor has a maximum physical dynamic range for each ISO value (you can find them measured on *DXOMark* [<https://www.dxomark.com/>] or *DPreview* [<https://www.dpreview.com/>]), the software dynamic range in filmic (dynamic range = white exposure - black exposure) should generally not be greater than the physical dynamic range of the sensor (10-14EV in most cases). For better control of the filmic S curve, the black exposure should be kept close to the white exposure in absolute value (and ideally greater, in absolute value), so the dynamic range is almost centered in 0EV. Another guide to validate the black exposure value is the S curve should always go through the center of the graph display (it will not when challenging parameter are set). Notice that the dynamic range of the scene can be lower than the camera's one, especially indoors.

## Safety factor and auto-tune

The auto-tune color picker combines all three color pickers above, and will allow to set the grey, white and black exposures all at once, using the average of the drawn region as the grey estimation, the maximum as the white, and the minimum as the black. This gives good results in landscape photography but usually fails for portraits and indoor scenes.

When no true white and no true black are available on the scene, the maximum and minimum XYZ values read on the image are not valid assumptions anymore, so the safety factor will allow you to shrink or enlarge symmetrically the detected dynamic range and the current parameters. This works with all color pickers.

## Contrast

The filmic S curve is created from the user parameters, by computing the position of virtual nodes and interpolating them, similarly to the tone curve module (but here, the nodes cannot be moved manually). While this allow a quicker curve parametrization, not all the combinations of parameter deliver good curves, and the graph display will give a diagnostic interface. Good curves are either graceful S with a linear central portion and curved extremities, or lines following the diagonal of the graph.

The contrast parameter drives the slope of the central part of the curve. The larger the dynamic range is, the greater the contrast should be set, to avoid reversed branches that would invert the image contrast. Proper values of contrast lie between 1.4 (at 8EV dynamic range) and 1.7 (at 14EV dynamic range). This parameter will mostly affect mid-tones.

## Latitude

The latitude is the range between the 2 nodes enclosing the central linear portion of the curve. The bigger the latitude is, the more linearly the luminance is affected, which is desirable to preserve the chrominance. The latitude defines the range of luminances that is not desaturated in the third step of filmic processing. This parameter will mostly

affect extreme luminances. It is usually better to keep it as large as possible, and adjust the contrast to avoid clipping. Proper values lie between 25% and 50% of the dynamic range, and should be increased by 1EV each time the grey value is divided by 2.

### **Balance highlights/shadows**

By default, the latitude is distributed toward middle-grey accordingly to the dynamic range: when the dynamic range is centered in 0, it means the latitude is centered in 50%. In real life situations, the dynamic range is often decentered, with a bigger part allowed to shadows, and so will be the latitude. However, this can produce clipping in blacks. The balance parameter allows to slide the latitude along the slope, toward the shadows or toward the highlights. This way, the contrast will be preserved in mid-tones, but more room will be allowed to one extremity of the dynamic range so clipping will be avoided. This should usually be used to center the latitude at 50%, on the graph display.

### **Saturation**

The saturation parameter is a finetuning control that applies on top of the latitude parameter. By default, the picture is desaturated selectively in extreme luminances (near white and near black), and untouched in mid-tones. This is how film behaves and is also useful to avoid gamut clipping, because very bright and very saturated colours are usually out of the sRGB gamut.

The desaturation mask is a gaussian window which standard deviation is latitude  $\times$  saturation, and which is centered on the latitude. As the latitude affects the luminance and the saturation, you should set it first, leaving the saturation at 100%. Once you are happy with the luminance mapping, you can then finetune the saturation parameter to adjust the desaturation.

The saturation parameter sets at 100% means the desaturation window standard deviation is 100% of the latitude width. To desaturate more aggressively at extreme luminances, the saturation should be set lower than 100%. To almost disable the desaturation, saturation values can be set as high as 1000%, using right-click and inputting the values on the keyboard.

### **Intent**

The intent parameter controls the interpolation algorithm used to derive the curve from the position of the nodes. It is similar to the tone curve module, but the options are translated into common language. *Contrasted* uses a cubic spline interpolation that produce a smooth round curve and pleasing contrast, however it can be sensible to nodes in close proximity and produce cusps and oscillations in this setup. *Linear* uses a monotonic Hermite interpolation that ensures the monotonicity of the curve, but produces a flatter contrast at the extremities. *Faded* uses a Catmul-Rom centripetal interpolation, designed to avoid cusps at all cost, but produces even flatter contrast at the extremities, which can be used creatively to emulate old faded photographs. *Optimized* is an average between the *contrasted* and *linear* modes, providing a fair trade-off at the expense of being heavier on the CPU.

### **Preserve the chrominance**

The chrominance preservation mode is an advanced mode that cannot be used "as is" and needs extra-corrections. In regular mode, filmic applies its correction in ProPhotoRGB space, using the three RGB channels separately. This looks good most of the time, but can result in color hue shifts because no consistency between channels is ensured.

When using the chrominance preservation mode, the RGB ratios are saved before any correction in filmic. Only the maximum of the three RGB channels is used in the tone-

mapping, as an estimation of the luminance. At the end of the process, the RGB ratios are restored as before. This leads to marginally faster runtimes, and links the three RGB channels all along the process, to ensure the hue and the saturation are kept untouched, which is desirable when you performed precise color adjustments. However, this does not follow the eye response to luminance, so, keeping the saturation as is when pushing up the luminance will always look oversaturated. This is why, when using this mode, an extra desaturation should be performed, for example, using the output saturation in color balance module at 65 to 85%. In that case, color balance should be used to adjust the main saturation of the mid-tones, then an additional pass would fix the saturation of extreme luminances with the saturation parameter of filmic, set between 12 to 33%.

It is advised to perform all filmic settings in the regular RGB mode (unlinked channels), then enable the chrominance preservation last, and then adjust the saturation.

### **Black luminance**

The destination parameters set the target luminance values used to remap the tones through filmic. The default parameters will work 99% of the times, the remaining 1% being when you output in linear RGB space (REC709, REC2020) for media handling log-encoded data. These settings are then to be used with caution because darktable does not allow separate pipelines for display preview and for file output.

The black luminance parameter allows to set the ground-level black of the target medium. Set it greater than 0% if you want raised, faded blacks to achieve a retro look.

### **Middle-grey destination**

This is the middle-grey of the output medium, that is used as a target for the filmic S curve central node. On gamma corrected media, the actual grey is computed with the gamma correction ( $\text{middle-grey}^{(1/\text{gamma})}$ ), so a middle-grey parameter of 18% with a gamma of 2.2 gives an actual middle-grey target of 45.87%.

### **White luminance**

The white luminance parameter allows to set the ceiling level white of the target medium. Set it lower than 100% if you want dampened, muted whites to achieve a retro look.

### **Destination power factor**

The power of the output transfer function, often improperly called the gamma (only screen have a gamma), is the parameter used to raise or compress the mid-tones to account for the display non-linearities or to avoid quantization artifacts when encoding in 8 bits file formats. This is a common operation when applying ICC color profiles (except for linear RGB spaces, like REC 709 or REC 2020, which have a linear "gamma" of 1.0). However, at the output of filmic, the signal is logarithmically encoded, which is not something ICC color profiles know to handle. As a consequence, if we let them apply a gamma 1/2.2 on top, it will result in a double up, and the middle-grey will be remapped to 76% instead of 45% as it should.

To avoid double ups and washed pictures, filmic applies a "gamma" compression reverting the output ICC gamma correction, so the middle-grey is correctly remapped at the end. To remove this compression, set the destination power factor to 1.0 and the middle-grey destination to 45%.

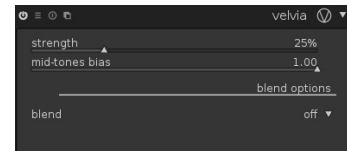
## **3.4.3. Color group**

Modules for working specifically on your image's color are found here in the color group.

### 3.4.3.1. Velvia

#### Overview

The velvia module enhances image saturation. Its effect is tailored to increase saturation less on lower saturated pixels than on highly saturated pixels.



#### Usage

##### strength

This slider controls the strength of the effect.

##### mid-tones bias

Velvia can reduce its effect for mid-tones to avoid unnatural skin tones. The mid-tones bias slider controls this selectivity; reducing its value reduces mid-tone protection and makes the overall velvia effect stronger.

### 3.4.3.2. Channel mixer

#### Overview

This module is a powerful tool to manage channels. It accepts red, green and blue channels as an input. As output it provides red, green, blue, gray, hue, saturation and lightness channels.



#### Usage

First select your output channel and then set the amount each input channel feeds into that output channel. Among its many uses, this module can be used to see the RGB channels individually: use the gray destination and put the value 1 on the input channel you want to see and 0 on the others.

#### Examples



For skin tones the blue channel tends to represent detail, with red tending to also have smoother tones than green. Therefore tonal rendering is controlled by how we blend of the three input channels.



Here a monochrome portrait is produced by simply selecting the grey channel as output. A smooth skin tone is achieved by reducing the blue channels input and also emphasizing the red channels input relative to green. An RGB mix of 0.9, 0.3, -0.3 was used together with an 0.1 EV exposure increase to lighten the image.



In this example an RGB mix of 0.4, 0.75, -0.15 uses more green than red, bringing back some features. We still reduce the blue channel in the mix to de-emphasize unwanted skin texture.

#### Table of mixing values for some b/w films

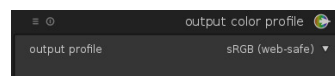
Classic black and white films have different characteristic color responses. Select gray as output mixing channel, and try out the values suggested below for your favorite film type.

Film Type	Red	Green	Blue
AGFA 200X	0.18	0.41	0.41
Agfapan 25	0.25	0.39	0.36
Agfapan 100	0.21	0.40	0.39
Agfapan 400	0.20	0.41	0.39
Ilford Delta 100	0.21	0.42	0.37
Ilford Delta 400	0.22	0.42	0.36
Ilford Delta 3200	0.31	0.36	0.33
Ilford FP4	0.28	0.41	0.31
Ilford HP5	0.23	0.37	0.40
Ilford Pan F	0.33	0.36	0.31
Ilford SFX	0.36	0.31	0.33
Ilford XP2 Super	0.21	0.42	0.37
Kodak T-Max 100	0.24	0.37	0.39
Kodak T-Max 400	0.27	0.36	0.37
Kodak Tri-X 400	0.25	0.35	0.40
Normal Contrast	0.43	0.33	0.30
High Contrast	0.40	0.34	0.60
Generic B/W	0.24	0.68	0.08

#### 3.4.3.3. Output color profile

## Overview

This module manages the output profiles for export as well as the rendering intent to be used when mapping between the different color spaces.



darktable comes with pre-defined profiles sRGB, AdobeRGB, XYZ and linear RGB but you can provide additional profiles by placing these in `$DARKTABLE/share/darktable/color/out` and `$HOME/.config/darktable/color/out`. `$DARKTABLE` is used here to represent your chosen darktable installation directory and `$HOME` your home directory.

## Usage

You can define the output color profile in two different places, either in this module, or in the export panel in lighttable mode (see Section 2.3.12, “Export selected”).

### output intent

Sets the rendering intent for output/export. For more details see Section 3.2.6.3, “Rendering intent”).

Only rendering with LittleCMS2 gives you a choice of rendering intent. The option is hidden, if darktable's internal rendering routines are used. Rendering with LittleCMS2 is activated in the preferences dialog (see Section 8.2, “Core options”).

### output profile

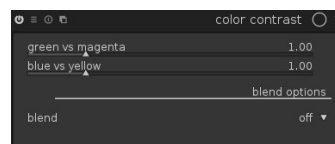
Sets the color profile for output/export, causing darktable to render colors with this profile. darktable embeds the profile data into the output file if supported by the file format – this allows other applications reading the file to correctly interpret its colors.

As not all applications, e.g. image viewers, are aware of color profiles, a general recommendation is to stick to sRGB as the default output profile. You should only deviate from sRGB if this is really required and if you know what you are doing.

## 3.4.3.4. Color contrast

### Overview

The color contrast module provides simplified control for changing the contrast or separation of colors between either green/magenta or blue/yellow axis.



### Usage

Higher values increase color contrast, lower values decrease it. The effect of this module's sliders are similar to applying a steepened or flattened a- or b-curve in module *tone curve* (see Section 3.4.2.3, “Tone curve”).



### green vs. magenta

Changes color contrast for green versus magenta.

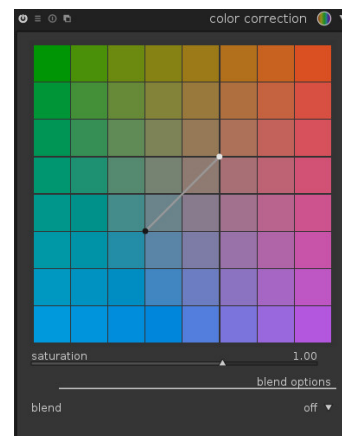
### blue vs. yellow

Changes color contrast for blue versus yellow.

## 3.4.3.5. Color correction

### Overview

This module can be used to modify the global saturation, give a tint to the image or to split tone it.



### Usage

#### color board

For split toning move the white dot to the desired highlight tint and then select a tint for shadows with the dark spot. For a simple global tint set both spots to the same color.

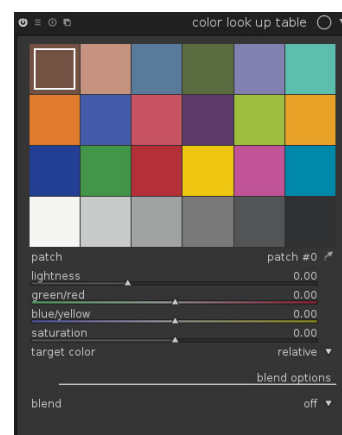
#### saturation

Use the saturation slider to correct the global saturation.

## 3.4.3.6. Color look up table

### Overview

This module implements a generic color look up table in Lab space. The input is a list of source and target points, the complete mapping will be interpolated using splines. The resulting luts are editable by hand and can be created using the `darktable-chart` utility to match given input (such as hald-cluts and RAW/JPEG with in-camera processing pairs). See Section 10.3, "Using `darktable-chart`" for details.



## Usage

### color board

When you select the module in darkroom mode, it should look something like the image above (configurations with more than 24 patches are shown in a 7x7 grid instead). By default, it will load the 24 patches of a color checker classic and initialise the mapping to identity (no change to the image).

The grid shows a list of colored patches. The colors of the patches are the source points. The target color of the selected patch is shown as offsets controlled by sliders in the GUI under the grid of patches. An outline is drawn around patches that have been altered, i.e. the source and target colors differ.

The selected patch is marked with a white square, and its number is displayed in the combo box below. Select a patch by left clicking on it, or using the combo box, or using the color picker.

### interaction

To modify the color mapping, you can change source as well as target colors.

The main use case is to change the target colors. You start with an appropriate palette of source colors (either from the presets menu or from a style you download). You can then change lightness (L), green-red (a), blue-yellow (b), or saturation (C) of the patches' target values via sliders.

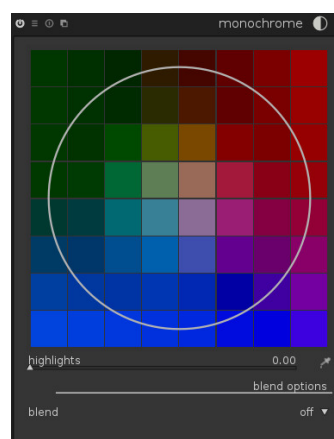
To change the source color of a patch you select a new color from your image by using the color picker, and shift-click on the patch you want to replace. You can switch between point and area sampling mode from within the global color picker panel (see Section 3.3.5, "Global color picker").

To reset a patch, double-click it. Right-click a patch to delete it. Shift-click on empty space to add a new patch (with the currently picked color as source color).


### 3.4.3.7. Monochrome

#### Overview

This module is a quick way to convert an image into black and white and provides a variable color filter for that conversion.



## Usage

A color picker is activated by pressing  and will automatically set the position and size of the filter. You can switch between point and area sampling mode from within the global color picker panel (see Section 3.3.5, "Global color picker").

The default central location of the filter has a neutral effect but dragging it to an alternate position applies a filter analogously to taking a b&w photograph through a conventional color filter.

As well as position you can change the filter size by scrolling with your mouse wheel. This makes the filter's range of hues more or less selective.

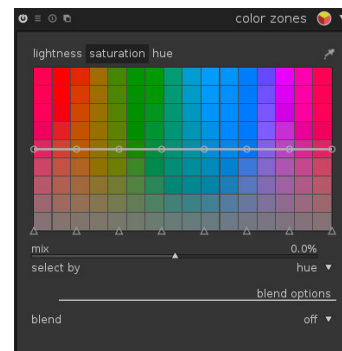
Tip: First reduce the filter size to concentrate its effect and move it across the hue pallet to find the best filter value for your desired image rendition. Then expand the filter to include more hues and thus more natural tonality.

Under certain conditions, especially highly saturated blue light sources in the frame, this module may produce black pixel artifacts. See the *gamut clipping* option (Section 3.4.3.11, "Input color profile") on how to mitigate this issue.

### 3.4.3.8. Color zones

#### Overview


This module selectively modifies the colors in your image. It is highly versatile and allows every transformation possible in the LCh colorspace.



#### Usage

The horizontal axis represents the range of values you can work on. The vertical axis shows the modifications you can apply by designing a curve. For both horizontal and vertical axes you can work on lightness, saturation or hue.

You can click on any of the eight nodes on the curve and drag to adjust it vertically. A circle indicates how strong adjacent nodes will be affected. Use the scroll wheel of your mouse to change the circle diameter. You can also use the eight controlpoints (triangles which define the vertical value of the nodes) at the bottom to adjust the curve.

A color picker is activated by pressing  and will show the picked values in the diagram. You can switch between point and area sampling mode from within the global color picker panel (see Section 3.3.5, "Global color picker").

#### tabbed controls

You can define curves for each of the three channels "lightness", "saturation", and "hue" individually.

#### select by

Defines the horizontal axis, i.e. the range of values you work on. You can choose between "lightness", "saturation", and "hue" (default). Changing this parameter resets any defined curve to a straight horizontal line.

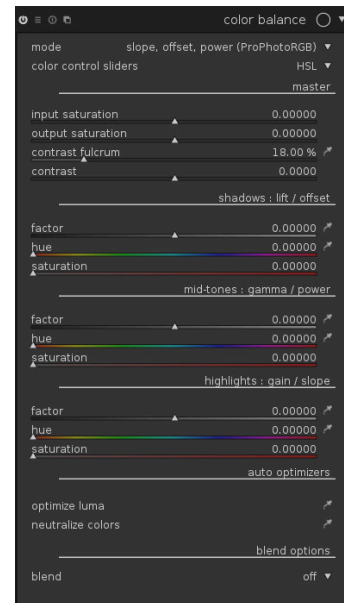
mix

Use this parameter to tune the strength of the overall effect.

### 3.4.3.9. Color balance

#### Overview

This module offers a versatile tool for adjusting an image's color balance.



#### Usage

For each of the three primary colors – red, green, and blue – there are three sliders “lift”, “gamma” and “gain” to control dark tones, mid tones and high tones, respectively. Changing these parameters adds offsets to the individual RGB channels and influences the color balance of the image.

Additional “factor” sliders act on all colors at once. Their effect is similar to the controls of the *levels* module (see Section 3.4.2.2, “Levels”).

The way to best envision the module's way of working is if you consider “lift”, “gamma” and “gain” as parameters influencing the properties of a tone curve which – in its original state – is a straight line going diagonally from bottom left to top right.

The lift parameter adjusts the left axis intercept of the line – this point can be shifted from its default location with zero abscissa to points with negative or positive ones. The gamma parameter modifies the line shape – the default shape is linear and can be turned into a convex curve with increased or into a concave curve with lowered gamma values. Finally, the gain parameter defines the steepness of the curve – by default the curve runs diagonally, higher values lead to a steeper curve and lower values to a flatter one.

Side note: although this module acts on RGB colors its location in pixelpipe puts it into the Lab color space. Accordingly the module converts from Lab to RGB, does its color adjustments, and then converts back to Lab.

#### lift

Adjusts the value of dark colors with individual sliders for each RGB color and with a “factor” slider acting on all three colors at once.

### gamma

Adjusts the mid tones with individual sliders for each RGB color and with a “factor” slider acting on all three colors at once.

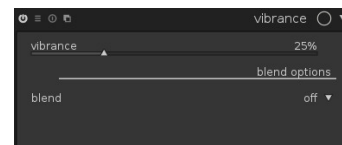
### gain

Adjusts the high tones with individual sliders for each RGB color and with a “factor” slider acting on all three colors at once.

## 3.4.3.10. Vibrance

### Overview

Vibrance is a widely used term in image processing but the mechanism and end result differ from program to program. Vibrance in darktable saturates and brings down the lightness of the most saturated pixels to make the colors more vivid.



### Usage

Vibrance only has one parameter which controls the amount applied.

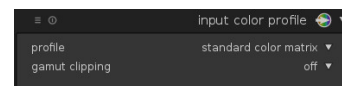
#### vibrance

The amount of vibrance to apply to the image.

## 3.4.3.11. Input color profile

### Overview

This module can be used to override darktable's automatic allocation of input color profile if there is an alternative that more closely matches your original image's color space.



### Usage

In this module you define the input color profile, i.e. how colors of your input image are to be interpreted. You also have an option to have colors confined to a certain gamut in order to mitigate some (infrequent) color artifacts.

#### profile

Choose the profile or color matrix to apply, darktable offers many widespread matrices along with an enhanced matrix for some camera models. The enhanced matrices were processed by the darktable team in order to provide a look closer to the manufacturer's.

You can also supply your own input ICC profiles and put them into `$DARKTABLE/share/darktable/color/in` or `$HOME/.config/darktable/color/in`. `$DARKTABLE` is used here to represent darktable's installation directory and `$HOME` your home directory. One common source of ICC profiles is the software that is shipped with your camera; it often contains profiles specific to your camera model. You may need to activate module *unbreak input profile* (see Section 3.4.3.12, “Unbreak input profile”) to use your extra profiles.

If your input image is a low dynamic range file like JPEG, or a raw in DNG format, it might already contain an embedded ICC profile which darktable will use as a default. You can

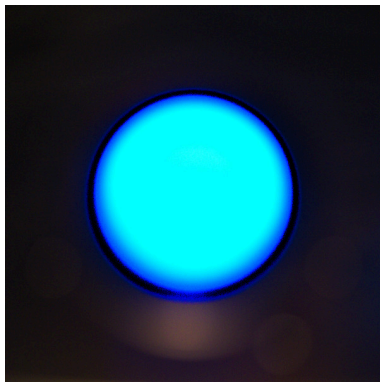
always overrule darktable and select a different profile. Select “embedded icc profile” to restore the default.

### gamut clipping

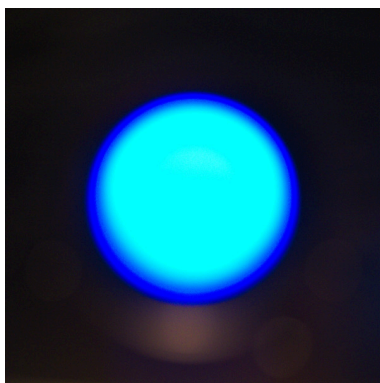
This combobox lets you activate a color clipping mechanism. In most cases you can leave it at its default “off” state. However, if your image shows some specific features like highly saturated blue light sources, gamut clipping might be useful to avoid black pixel artifacts. See Section 3.2.6.6, “Possible color artifacts” for more background information.

You can select from a list of RGB profiles. Input colors with a saturation that exceeds the permissible range of the selected profile get clipped to a maximum value. “linear Rec2020 RGB” and “Adobe RGB (compatible)” allow for a broader range of unclipped colors, while “sRGB” and “linear Rec709 RGB” produce a tighter clipping. You should select the profile that prevents artifacts while still maintaining highest color dynamics.

### Examples



Close-up of a blue light source (LED) with gamut clipping off. The activated levels module produces a ring of black pixel artifacts.

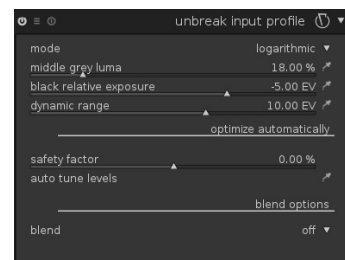


The same image and processing with gamut clipping set to “linear Rec2020 RGB”.

### 3.4.3.12. Unbreak input profile

#### Overview

This module adds a correction curve to image data, which is required if you have selected certain input profiles in module *input color profile*.



## Usage

If you decide in module *input color profile* to use an ICC profile from the camera manufacturer, a correction curve very frequently needs to be pre-applied to image data – or else the final output looks much too dark. This extra processing is not required if you use darktable's standard or enhanced color matrices. The correction curve is defined with a linear part extending from the shadows to some upper limit and a gamma curve covering mid-tones and highlights. For further reading please also have a look at darktable's neighbouring project UFRaw [<http://ufraw.sourceforge.net>].

### linear

Set the upper limit for the region counted as shadows and where no gamma correction is performed. Typically values between 0.0 and 0.1 are required by the profile.

### gamma

Set the gamma value to compensate your input profile. Often the required value is 0.45 (the reciprocal of 2.2 gamma used by some manufacturer's profile).

## 3.4.4. Correction group

The correction group contains the modules that will correct typical problems in a photo such as hotpixels, spot removal, noise, lens correction among others. This group also includes the basic sharpening tools.

### 3.4.4.1. Sharpen

#### Overview

This is a standard UnSharp Mask (USM) tool for sharpening the details of an image.



## Usage

This module works by enhancing the contrast around edges and thereby enhances the impression of sharpness of an image. In darktable this module is only applied to the L-channel in Lab color space.

### radius

USM applies a gaussian blur to your image as part of its algorithm. This controls the blur radius which in turn defines the spatial extent of edge enhancement. Too high values will lead to ugly over-sharpening.

### amount

This controls the strength of the sharpening.

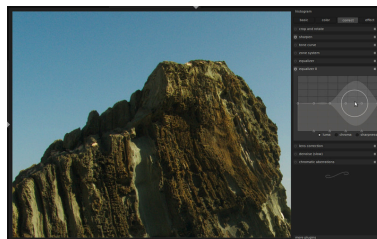
### threshold

Contrast differences below this threshold are excluded from sharpening. Use this to avoid amplification of noise.

### 3.4.4.2. Equalizer

#### Overview

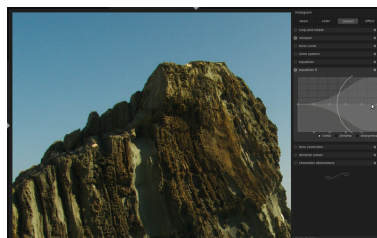
This versatile module can be used to achieve a variety of effects, such as: bloom, denoising, clarity, and local contrast enhancement. It works in the wavelet domain and parameters can be tuned for each frequency band separately.



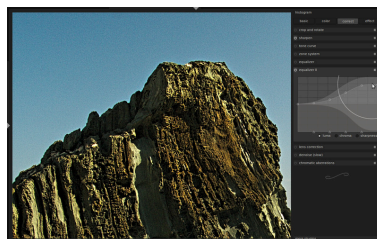
#### Usage

Each frequency band can be tweaked independently. In particular, you can adjust contrast boost and denoise threshold splines for both lightness and chromaticity ("luma" and "chroma"), as well as the acuteness ("edges") of the wavelet basis on each frequency scale.

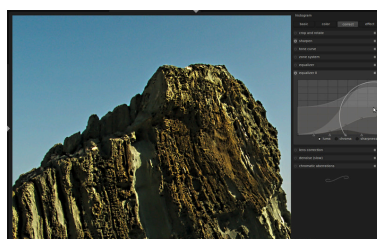
Each spline can be dragged with a proportional edit approach; use the mouse wheel to adjust the radius in which your changes will have an effect. The transparent area indicates where you would drag the spline with the current mouse position and radius. The small little triangles on the x-axis can be moved to alter the x-position of the spline nodes.



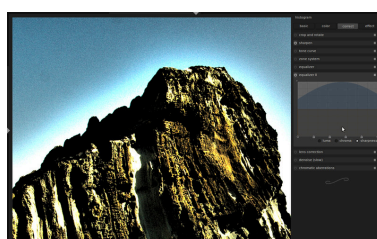
Drag the upper line (bright circles, here for the lightness channel) to affect local contrast. Pulling it up, as shown here, will result in a contrast boost for that frequency band. Higher frequencies, i.e. smaller details, are to the right of the grid. Pulling it down works, too.



The bottom spline (black circles) is used to perform denoising. It adjusts the wavelet shrinkage threshold for each frequency band. Pull it up to see the effect. In this example, the noise which has been amplified by local contrast enhancement is removed.



This screen shows the effect of the edge parameter. It is here pulled down to zero for all bands. This is effectively a regular à trous wavelet, without edge detection, and results in the characteristic halos around sharp edges in the image.





This image is the other extreme. The wavelet basis now oversharpens, which results in ugly gradient reversals near the ridge of the rock.



Note that the edge parameter only affects the wavelet basis, not the image directly. You will have to change some denoise/contrast boost parameters to see an effect following adjustments to the edge parameter.

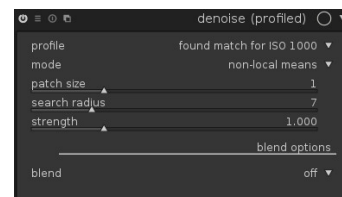
This module additionally has a “mix” slider below the spline GUI. Adjusting the slider will upscale or downscale the splines on the y-axis. The slider was added as a convenience tool to help you modify the strength of the effect. It is not a module parameter in itself; when you leave darkroom mode all changes will be consolidated into the spline curves.

Have a look at the presets where there are a broad variety of examples that will provide a good starting point to gain an intuitive understanding of the controls. Among others there is preset to enhance an image's “clarity”.

### 3.4.4.3. Denoise – profiled

#### Overview

This module offers an easy to use and – at the same time – highly efficient denoise operation. Under the hood it applies (your choice of) a non-local means or edge-aware wavelet denoise algorithm with parameters specifically profiled for certain camera models and ISO settings.



#### Usage

The darktable team, with the help of many users, has measured noise profiles for various cameras. Differentiated by ISO settings we evaluated how the noise statistics develop with brightness for the three color channels. Our set of profiles covers well above 200 popular camera models from all major manufacturers.

darktable stores noise profiles in an external json file. This file can be found in `$(DARKTABLE)/share/darktable/noiseprofile.json` where `$(DARKTABLE)` represents the darktable installation directory. The json format is quite straightforward and explained in depth in [json.org](http://json.org/) [http://json.org/]. You can replace the default noise profiles by your own ones and specify that file on the command line when starting darktable. For more details see Section 1.1.1, “darktable binary”. If you generate your own noise profiles don't forget to share your results with the darktable team!

#### profile

Based on Exif data of your raw file, darktable will automatically determine the camera model and ISO setting. If found in its database, the corresponding noise profile will be used. If your image has an intermediate ISO value, the statistical properties will be interpolated between the two closest datasets in the database, and this interpolated setting will show up as the first line in the combo box. You also have the option to manually

overwrite this selection to suit your personal preferences better. The top-most entry in the combo box brings you back to the profile darktable deems most suited.

### mode

This module can eliminate noise with two different core algorithms. “non-local means” can tackle efficiently luma (lightness) noise whereas it is less efficient with chroma (color noise). “wavelet” is particularly efficient at eliminating chroma (color) noise but can also give good results for luma noise. It also lets you adjust the force of the denoising depending on the noise coarseness. If needed you can apply two instances of this module (see Section 3.2.4, “Multiple instances”): one instance to tackle luma noise with blend mode “lightness” or “HSV lightness”, and another one to tackle chroma noise with blend mode “color” or “HSV color”. An example of the use of two instances with blending modes is available within the presets of this module. For more information on blend modes have a look at Section 3.2.5.4, “Blending operators”.

### patch size

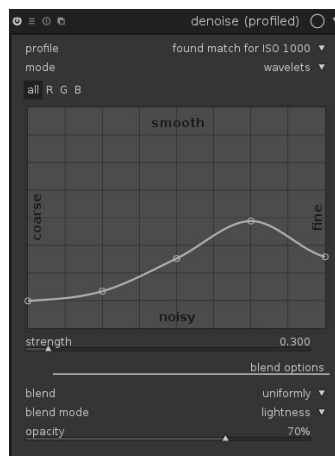
This slider is only available if mode “non-local means” is selected. It controls the size of the patches being matched when deciding which pixels to average (see also Section 3.4.4.4, “Denoise – non local means”). Setting this to higher values can give more sharpness, especially on strong edges, but may also give more artifacts. Processing time will stay about the same.

### search radius

This slider is only available if mode “non-local means” is selected. It controls the how far from a pixel the algorithm will try to find similar patches. The processing time is hugely impacted by this parameter: it depends on the square of the parameter. A lower value will make execution faster, a higher value will make it slower. Increasing the value can give better results for very noisy images when coarse grain noise is visible.

### coarse/fine curves

These curves are only available if mode “wavelet” is selected. The noise of an image is usually not only fine grain, but also more or less coarse grain. These curves allow to denoise more or less depending on the coarseness of the visible noise. The left of the curve will act on very coarse grain noise, while the right of the curve will act on very fine grain noise. Pushing up the curve will result in more smoothing, pulling it down will result in less smoothing. As an example, you can preserve very-fine grain noise by pulling down the rightmost point of the curve until the minimum value. As another example, if you are tackling chroma noise with a blend mode, you can push up the right part of the curve, as colors are not supposed to change a lot on fine grain scales: this will help especially if you see some isolated pixel left undenoised.



Considering R, G, and B curves, the best way to use them is to look at one of the channel using the channel mixer module in gray mode, denoise this particular channel, and then do the same for the other channels. This way, you can take into account the fact that some channel may be noisier than others into your denoising. Be aware that guessing which channel is noisy without actually seeing the channels individually is not straightforward

and can be counterintuitive: a pixel which is completely red may not be caused by noise on the R channel, but actually by noise on B and G channels.

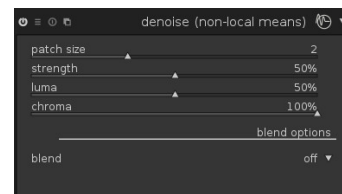
### strength

This parameter is here to fine-tune the strength of the denoise effect. The default value has been chosen to maximize the peak signal to noise ratio. It's mostly a matter of taste if you prefer a rather low noise level at the costs of a higher loss of detail, or if you accept more remaining noise in order to have finer structures better preserved within your image.

## 3.4.4.4. Denoise – non local means

### Overview

This is a denoise algorithm, which will work on chroma and/or luma.



### Usage

This module reduces noise in your image but preserves structures. This is accomplished by averaging each pixel with some surrounding pixels in the image. The weight of such a pixel in the averaging process depends on the similarity of its neighborhood with the neighborhood of the one pixel to be denoised. A patch with a certain size is used to measure that similarity. As denoising is a resource hungry process, it slows down pixelpipe processing significantly; consider activating this module late in your workflow.

### patch size

The radius of the patch for similarity evaluation.

### strength

The strength of the denoise. Higher values lead to a stronger effect.

### luma

Amount of denoise to apply to luma. Select carefully in order not to lose too much structure.

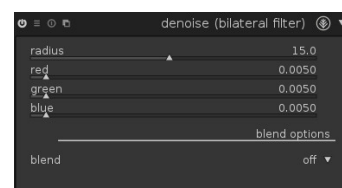
### chroma

Amount of denoise to apply to chroma. You can be much more aggressive with this parameter compared to luma.

## 3.4.4.5. Denoise – bilateral

### Overview

This module is used to denoise high ISO pictures. It is flagged as a slow module due to its high resource consumption, both in terms of CPU cycles and in terms of memory usage. Quite counter-intuitively, the greater the values for sliders, the lesser resources.



## Usage

This module reduces noise in your image but preserves sharp edges. This is accomplished by averaging pixels with their neighbors, taking into account not only the geometric distance but also the distance on the range scale, i.e. differences in the RGB values. As denoising is a resource hungry process, it slows down pixelpipe processing significantly; consider to activate this module late in your workflow. The module can be really effective if some RGB channel is more noisy than the 2 other channels. In such a case, use the channel mixer module to see the channels one by one, in order to set the blur intensities accordingly.

### radius

Set the spatial extent of the gaussian blur.

### red

Blur intensity for red channel.

### green

Blur intensity for green channel.

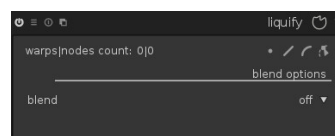
### blue

Blur intensity for blue channel.

## 3.4.4.6. Liquify

### Overview

The liquify module offers a versatile way of moving pixels around by applying free style distortions to parts of the image. There are three tools to help doing that: points, lines, and curves.

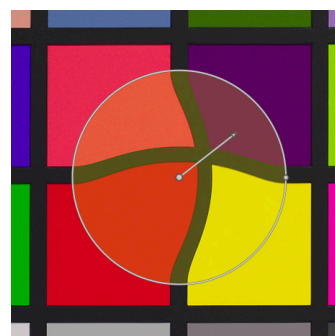


Each of liquify's tools is based on nodes. A point is given by a single node, a line or a curve consist of a set of nodes defining the path.

There is a limit of 100 nodes in a single liquify instance. For more distortions one can use multiple instances of the liquify module. However, take into account that the liquify module requires a lot of computing resources.

## Usage

The basic elements of all tools in liquify are nodes.



You can drag the central point of a node to move the node around. The radius describes the area of the applied effect: the distortion occurs only inside this radius. To change the radius drag the handle at the circumference. A strength vector starting from the center describes the direction of the distortion, and its strength is depicted by the length of the vector. You change the vector by dragging its arrowhead.

### warps and nodes count

This information field displays the number of warps (individual distortion object) and nodes currently used.

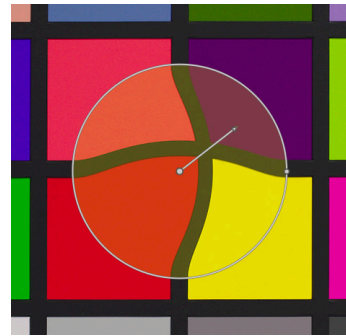
### point tool

Click the  icon to activate the point tool and left-click on the image to place it.

A point is formed by a single node. In a point the strength vector has three different modes which are toggled using ctrl-click over the arrowhead of the strength vector:

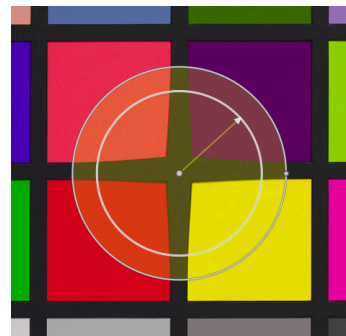
#### *linear*

The linear mode produces a linear distortion inside the circle. Starting from the opposite side of the strength vector and following the strength vector's direction. This is the default mode.



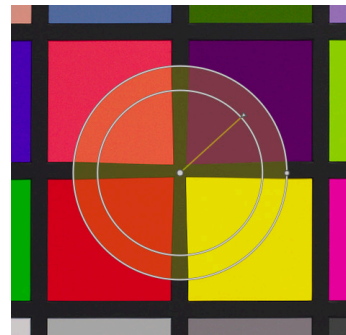
#### *radial growing*

In this mode the strength vector's effect is radial, starting with a strength of 0% in the center and growing when going away from the center. This mode is depicted by an additional circle with the arrow pointing outwards.



#### *radial shrinking*

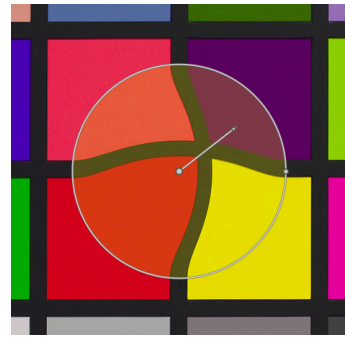
In this mode the strength vector's effect is radial, starting with a strength of 100% in the center and shrinking when going away from the center. This mode is depicted by an additional circle with the arrow pointing inwards.



Note that the strength by default varies linearly from 0% to 100% between the center and the radius of the control point. It is possible to modify the feathering effect by clicking on the center of the circle:

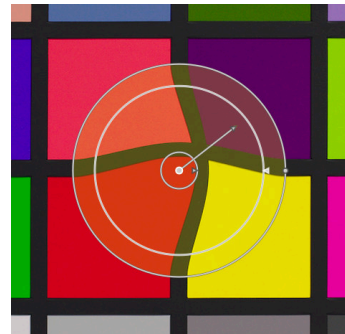
*default*

Linear from the center to the radius.




*feathered*

Two control circles are displayed and can be modified independently to feather the strength of the effect. Note that clicking again the center of the circle only hides the feathering controls but does not return to the default.



A point can be removed by right-clicking on the center.

### line tool

Click the  icon to activate the line tool and left-click on the image to place the first point, move and left-click to place another point and start forming the path. To end the line just right-click anywhere.

A line is a set of points. The points are linked together, the effect is interpolated by a set of strength vectors.




It is possible to add a control point on a line by ctrl-click on a segment. You may remove a control point from a line by ctrl-right-click on the node center.

A right-click on a segment will remove the shape completely.

A ctrl-alt-click on a segment will change it to a curve segment.

### curve tool

Click the  icon to activate the curve tool and left-click on the image to place the first point, move and left-click to place another point and start forming the path. To end the line just right-click anywhere.

A curve is a set of points. The points are linked together, the effect is interpolated as a bezier curve by a set of strength vectors.



It is possible to add a control point on a curve by ctrl-click on a segment. You may remove a control point from a curve by ctrl-right-click on the node center.


A right-click on a segment will remove the shape completely.

A ctrl-alt-click on a segment will change it to a line segment.

It is possible to change the way the points of the curve are linked together by using ctrl-click on the center. There are four modes which correspond to different ways of handling the steepness of the bezier curve by control handles:

<i>autosmooth</i>	This is the default mode in which the control handles are not displayed as they are automatically computed to always give a smooth curve.
<i>cusp</i>	Control handles can be moved independently. This mode is depicted by a triangle symbol in the node center.
<i>smooth</i>	Control handles are always giving a smooth curve. This mode is depicted by a diamond symbol in the node center.
<i>symmetrical</i>	Control handles are always moved together. This mode is depicted by a square symbol in the node center.

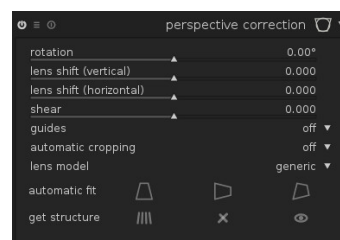
#### node edit tool

Clicking the  icon activates or deactivates the node edit tool displaying all defined distortion objects and their controls. Alternatively you can at any time right-click on the image for the same effect.

### 3.4.4.7. Perspective correction

#### Overview

This module is designed to automatically correct for converging lines, a form of perspective distortions frequently seen in architectural photographs. The underlying mechanism is inspired by Markus Hebel's *ShiftN* [<http://www.shiftn.de/>] program.




Perspective distortions are a natural effect when projecting a three dimensional scene onto a two dimensional plane and cause objects close to the viewer to appear larger

than objects further away. Converging lines are a special case of perspective distortions frequently seen in architectural photographs. Parallel lines when photographed at an angle get transformed into converging lines that meet at some vantage point within or outside the image frame.

This module is able to correct converging lines by warping the image in such a way that the lines in question become parallel to the image frame. Corrections can be applied in vertical and horizontal direction, either separately or in combination. In order to perform an automatic correction the module analyzes the image for suitable structural features consisting of line segments. Based on these line segments a fitting procedure is started that determines the best values of the module parameters.

## Usage

Clicking the “get structure” icon () causes darktable to analyze the image for structural elements. Line segments are detected and evaluated. Only lines that form a set of either vertical or horizontal lines are used for further processing steps. The line segments are displayed as overlays on the image base. A color code describes what type of line darktable has found:

<i>green</i>	lines that are selected as relevant vertical converging lines
<i>red</i>	lines that are vertical but are not part of the set of converging lines
<i>blue</i>	lines that are selected as relevant horizontal converging lines
<i>yellow</i>	lines that are horizontal but are not part of the set of converging lines
<i>grey</i>	other lines identified but not of interest to this module

Lines marked in red or yellow are regarded as outliers and are not taken into account for the automatic fitting step. This outlier elimination involves a statistical process with random sampling so that each time you press the “get structure” button the color pattern of the lines will look a bit different. You can manually change the status of line segments: left-clicking on a line selects it (turns the color to green or blue) while right-clicking deselects it (turns the color to red or yellow). Keeping the mouse button pressed allows for a sweeping action to select/deselect multiple lines in a row; the size of the select/deselect brush can be changed with the mouse wheel. Holding down the *shift* key and keeping the left or right mouse button pressed while dragging selects or deselects all lines in the chosen rectangular area.

Clicking one of the “automatic fit” icons (see below) starts an optimization process which finds the best suited parameters. The image and the overlaid lines are then displayed with perspective corrections applied.

### rotation

This parameter controls a rotation of the image around its center and can correct for a skewed horizon.

### lens shift (horizontal)

This parameter corrects converging lines horizontally.

### lens shift (vertical)

This parameter corrects converging lines vertically. In some cases you get a more naturally looking image if you correct vertical distortions not to their full extent but rather at an



80 to 90% level. If desired just reduce the value after having performed the automatic correction.

#### **shear**

This parameter shears the image along one of its diagonals and is needed when correcting vertical and horizontal perspective distortions simultaneously.

#### **guides**

If activated a number of guide lines is laid over the image to help you judge the quality of the correction.

#### **automatic cropping**

When activated the automatic cropping feature clips the image to get rid of any black corners. At your choice you can either clip to the “largest area” or to the largest rectangle maintaining the original aspect ratio (“original format”). In the latter case you can manually adjust the automatic cropping result: left click into to clip region and move it around. The size of the region gets modified automatically excluding any black corners.

#### **lens model**

This parameter controls how lens and camera specifics are taken into account. If set to “generic” a focal length of 28mm on a full-format camera is assumed. If set to “specific”, focal length and crop factor can be set manually.

#### **focal length**

The focal length of the lens used. The default value is taken from the Exif data of your image. This parameter is only effective and visible if the “specific” lens model has been selected.




#### **crop factor**

The crop factor of the camera used. You will typically need to set this value manually. This parameter is only effective and visible if the “specific” lens model has been selected.




#### **aspect adjust**

If the “specific” lens model has been selected this parameter allows for a free manual adjustment of the image's aspect ratio.

#### **automatic fit**

Clicking on one of the icons starts an automatic fitting of the module parameters based on the selected vertical and/or horizontal lines. You can choose to correct only vertical distortions (  ), only horizontal distortions (  ), or both types of distortions simultaneously (  ). *Ctrl-clicking* on either icon only fits rotation. *Shift-clicking* on either icon only fits vertical and/or horizontal lens shift.

#### **get structure**

Clicking on the  icon causes the image to be (re-)analyzed for suitable line segments. *Shift-clicking* applies a prior contrast enhancement step, *ctrl-clicking* applies an edge enhancement step. Both variations can be used alone or in combination if the default is not able to detect a sufficient number of lines. Clicking on the  icon discards all collected structural data. By clicking on the  icon you can switch the overlay display of line segments on and off.

## Examples



An input image with a skewed horizon and converging lines caused by directing the camera upwards.

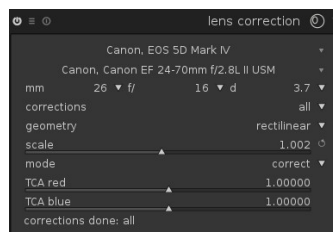


The image after having corrected for vertical and horizontal perspective distortions. Note the framing by the automatic cropping feature and the still visible overlay of structural lines.

### 3.4.4.8. Lens correction

#### Overview

This module is able to correct certain lens flaws, namely distortions, transversal chromatic aberrations (TCA) and vignetting. It relies on the external library lensfun [<http://lensfun.sourceforge.net/>], which comes with correction profiles for many (but not all) common cameras and lenses.



#### Usage

In order to perform lens corrections the module uses Exif data of your image to identify the specific camera/lens combination and collects the needed correction parameters from a profile in lensfun's database.

##### camera

The camera make and model as determined by Exif data. You can override this manually and select your camera from a hierarchical menu.

Only lenses with correction profiles matching the selected camera will be shown.

##### lens

The lens make and model as determined by Exif data. You can override this manually and select your lens from a hierarchical menu. This is mainly needed for pure mechanical lenses, but may also be needed for off-brand / third party lenses.

##### photometric parameters: focal length, aperture, focal distance

Corrections additionally depend on certain photometric parameters that are read from Exif data: focal length (needed for distortion, TCA, vignetting), aperture (needed for TCA, vignetting) and focal distance (needed for vignetting). Many cameras do not record focal distance in their Exif data; most likely you need to set this manually.

You can manually override all automatically selected parameters. Either take one of the predefined values from the pull-down menu; or – with the pull-down menu still open – just type in your own value.

If your system's lensfun library has no correction profile for the automatically identified camera/lens combination the controls for the three photometric parameters are not displayed, and you get a warning message instead. You may try to find the right profile yourself by searching for it in the menu. If you can't find your lens, check if it is in the list of currently supported lenses [<http://lensfun.sourceforge.net/lenslist/>], and refer to the lensfun-update-data tool [<http://lensfun.sourceforge.net/manual/lensfun-update-data.html>]. If there is no matching profile for your lens, please visit this lens calibration service [<https://www.darktable.org/2013/07/have-your-lens-calibrated/>] offered by Torsten Bronger, one of darktable's users. Alternatively you may go to lensfun's home page [<http://lensfun.sourceforge.net/>] and learn how to generate your own set of correction parameters. Don't forget to share your profile with the lensfun team!

### **corrections**

This combobox gives you a choice about which corrections (out of distortion, TCA and vignetting) darktable shall apply. Change this from its default "all", if your camera has already done some internal corrections (e.g. of vignetting), or if you plan to do certain corrections with a separate program.

### **geometry**

In addition to the correction of lens flaws, this module can change the projection type of your image. Set this combobox to the aimed projection type, like "rectilinear", "fish-eye", "panoramic", "equirectangular", "orthographic", "stereographic", "equisolid angle", "thoby fish-eye".

### **scale**

This slider allows you to adjust the scaling factor of your image. Pressing the auto scale button (right to the slider) will let darktable find the best fit to avoid black corners.

### **mode**

The default behavior of this module is to correct lens flaws. Switch this combobox to "distort" in order to simulate the behavior of a specific lens (inverted effect).

### **TCA red**

This slider allows to override the correction parameter for TCA. You can also use this slider to manually set the parameter in case the lens profile does not contain TCA correction. Look out for colored seams at features with high contrast edges and adjust this parameter and the following one to minimize those seams.

### **TCA blue**

This slider allows to override the correction parameter for TCA. You can also use this slider to manually set the parameter in case the lens profile does not contain TCA correction.

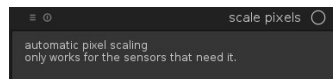
### **corrections done**

You will sometimes observe that for a given camera/lens combination only part of the possible corrections (distortion, TCA, vignetting) are supported by lensfun's profiles. This message box will tell you what corrections have actually been applied.

### 3.4.4.9. Scale pixels

#### Overview

Some cameras like the Nikon D1X have rectangular instead of the usual square sensor cells. Without correction this would lead to distorted images. This module applies the needed scaling.



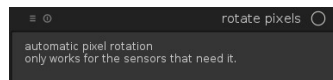
#### Usage

darktable detects images that need correction by their Exif data and automatically activates this module. For other images the module always remains disabled. The module has no parameters.

### 3.4.4.10. Rotate pixels

#### Overview

The sensors of some cameras like the Fujifilm FinePix S2Pro, F700, and E550 have a diagonally oriented Bayer pattern instead of the usual orthogonal layout. Without correction this would lead to a tilted image with black corners. This module applies the needed rotation.



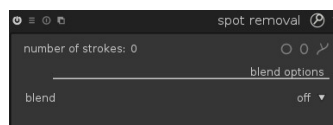
#### Usage

darktable detects images that need correction by their Exif data and automatically activates this module. For other images the module always remains disabled. The module has no parameters.

### 3.4.4.11. Spot removal

#### Overview

Spot removal allows you to correct an area in your image by using another area as model.



#### Usage

This module uses some of the shapes that are offered in drawn masks, namely circles, ellipses and path shapes. The user interface and the controls are the same as in drawn mask and explained in more detail in Section 3.2.5.5, "Drawn mask".

Select the desired shape by clicking the corresponding icon, then click on the canvas to choose the area to be healed, i.e. the target area. A cross is displayed where the source area will be positioned.

The source positioning has two modes: absolute or relative. To set the absolute mode, while creating a shape, *shift+ctrl+click* on the desired position. From now on, all new

shapes will have the source created at that position. To set the relative mode, still while creating a shape, *shift+click* on the desired position. The current shape will have the source created at that position and the subsequent ones will have the source created at the same relative position.

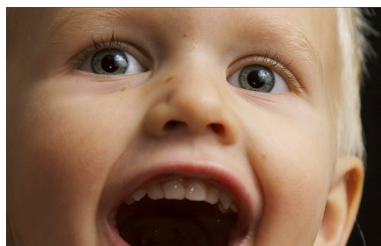
After creation source area and target area can be shifted independently until the result matches your expectations. An arrow helps to tell source from target area.

Use the shape specific controls to adjust its size, its border width, and other attributes.

Right-click on a shape to delete it.

Collapse the module to complete the changes.

## Examples



Let's use this portrait as example; we want to remove some dirt and unwanted catchlight from camera popup strobe.



I have marked all the spots that I want to remove from the image with circle shapes and appropriately selected source areas.

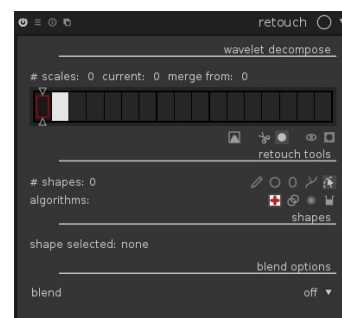


And here is the result image of the spotremoval.

### 3.4.4.12. Retouch

#### Overview

Retouch allows to heal, clone, fill and blur certain areas of the image. It can perform a wavelet decomposition which separates the image into different frequency scales, from fine to coarse, and apply retouch operations to each wavelet scale individually.



## Usage

For a basic use, with default parameters, add the shapes to the image like with the spot removal module (see Section 3.4.4.11, "Spot removal"). To use the wavelet decompose first select one of the scales as the current scale (see below) and then add the shapes.

The GUI is divided in three main sections: wavelet decompose, retouch tools and shapes.

### wavelet decompose section

The wavelet decompose toolbar controls the wavelet decompose algorithm. It has a central area divided in boxes and two sliders. The first box, scale zero, represents the original image, the second is the wavelet scale 1, and so on.

The bottom slider adjusts the number of scales, zero means no wavelet decompose is done. The maximum number of scales depends on the image size, but any number can be selected. If the image is not big enough for the selected number of scales the maximum number of scales for this image size is used and the rest of the scales are ignored.

The image is decomposed to the selected number of scales plus the residual image, so if 5 is selected as the number of scales, scale zero is the original image, scales 1 to 5 are the detail scales, and scale 6 is the residual image. As a visual aid, the original image is always represented by a black box, detail scales are light gray, residual image white and inactive scales dark gray.



The central area allows to select the current scale on which the user can then apply retouch tools by left clicking any of the boxes. The selected scale is marked by a red frame. Any scale can be selected as the current scale, even if it is greater than the number of scales. If a shape is added to a scale greater than the residual image it will be ignored, as the scale is not processed.

Only the shapes on the current scale are displayed, when the current scale is changed shapes will be displayed accordingly.

A green line on top of each box indicates that the scale has shapes associated with it.

Fine detail scales can only be seen at certain zoom level, a light gray line on top of each box will indicate that the scale is visible at current zoom level.

The top slider adjusts the *merge scale* feature. This setting allows to apply a common edit on multiple consecutive scales within a group starting from the highest scale (not including the residual image) down to the one selected by this slider. If the slider is set to 3 and the maximum scale is 5 then all edits that are added to scale 5 will be applied to scales 3 to 5. Edits added to scale 4 will be applied to scales 3 and 4, and edits added to scale 3 will be applied only to scale 3. *Merged scales* are represented by a green-yellow color. A value of zero means that the merge feature is not used.

The display wavelet scale button (  ) allow to view the current wavelet scale. The module's blend feature is temporary disabled when this option is set. If blending in the module is active and the option to display masks is active this option cannot be set. When this option is active a new section, "preview single scale", will be displayed, allowing to adjust the levels for the displayed image. This is purely a convenience feature so you can adjust wavelet scale display to your needs. It does not have an effect on the final output image. An auto levels button (  ) is also available; it works on the displayed image, so different results can be expected depending on the image displayed when zoomed in/out. Levels are only applied to detail scales, not the original or residual image.

The cut and paste buttons allow to move all the shapes from one scale to another. In order to do this first select the current scale, click the cut button (✂), select the destination scale and click paste (📄). This can be useful when there are edits on the residual image and one has to change the number of scales; since the residual image is changed, shapes need to be moved to the new one.

The switch off shapes button (🚫) temporarily disables the processing of all shapes for a simple before/after comparison.

The display masks button (👁) works similar to the one on the blend module, but it will display only the shapes on the current scale. This option and display mask on the blend module cannot be set at the same time.

### retouch tools section

The shapes toolbar allows to add new shapes to the image. Shapes creation/editing behaves like in the spot removal module. In addition, by Ctrl+click on any shape button, the *continuous add mode* is activated. Once a shape is added, darktable will remain in creation mode, allowing to add another shape of the same type. To change the shape type to be added Ctrl+click on a different shape button to continue on continuous add mode or plain click to add a single shape. To leave the continuous add mode right click on any clear area of the image.

The algorithms toolbar allows to select between heal (+), clone (🔄), fill (🎨) and blur (🌀) algorithms. Before actually creating a shape the algorithm must be selected – once a shape is created the algorithm cannot be changed.

Any combination of shape type and algorithm can be added to the image.

### shapes section

The shape selected field displays the selected shape (if any). To select a shape click on it, to deselect click on a free area on the image.

Mask opacity is displayed when a shape is selected. It displays/sets the opacity of the mask. Opacity is a property of the currently selected shape and won't be used as default value for newly added shapes.

Different properties will be displayed depending on the selected algorithm:

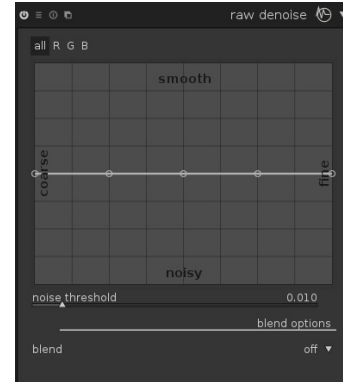
<i>fill algorithm</i>	fill mode
	Can be erase or color. Erase is used to delete details from a wavelet scale. Color allows to select a color to fill the area defined by the shape.
	brightness
	Adds the selected value to the color, allowing to make it brighter or darker. Works the same with both fill modes.
<i>blur algorithm</i>	blur type
	Can be gaussian or bilateral.
	blur radius
	Sets the blur radius.

The value set on each one of these properties is used as a default when a new shape is created.

### 3.4.4.13. Raw denoise

#### Overview

Raw denoise allows you to perform denoising on the data before it gets demosaiced. It is ported from *dcrw* [<http://www.cybercom.net/~dcoffin/dcrw/>].



#### Usage

##### noise threshold

Set the threshold for noise detection. Higher values lead to stronger noise removal and higher loss of image detail.

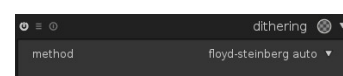
##### coarse/fine curves

The noise of an image is usually not only fine grain, but also more or less coarse grain. These curves allow to denoise more or less depending on the coarseness of the visible noise. The left of the curve will act on very coarse grain noise, while the right of the curve will act on very fine grain noise. Pushing up the curve will result in more smoothing, pulling it down will result in less smoothing. As an example, you can preserve very-fine grain noise by pulling down the rightmost point of the curve until the minimum value. As another example, if you are tackling chroma noise with a blend mode, you can push up the right part of the curve, as colors are not supposed to change a lot on fine grain scales: this will help especially if you see some isolated pixel left undenoised. Considering R, G, and B curves, the best way to use them is to look at one of the channel using the channel mixer module in gray mode, denoise this particular channel, and then do the same for the other channels. This way, you can take into account the fact that some channel may be noisier than others into your denoising. Be aware that guessing which channel is noisy without actually seeing the channels individually is not straightforward and can be counterintuitive: a pixel which is completely red may not be caused by noise on the R channel, but actually by noise on B and G channels.

### 3.4.4.14. Dithering

#### Overview

This module eliminates some of the typical banding artifacts which can occur, when darktable's internal 32-bit floating point data are transferred into a discrete 8-bit or 16-bit integer output format for display or file export.





Banding is a problem which can arise, when an image is downsampled into a lower bit-depth. Downsampling happens regularly, when darktable displays or exports the results of a pixelpipe. In order to avoid banding, you may activate this module. As dithering consumes significant resources this module is disabled by default.

Although banding is not an inherent problem of any of darktable's modules, some operations may provoke it as they produce a lightness gradient in the image. To mitigate possible artifacts you should consider to activate dithering when using the *vignette* and the *graduated density* module, respectively (see Section 3.4.5.4, "Vignetting" and Section 3.4.5.13, "Graduated Density"). This is especially relevant for images with extended homogeneous areas like cloudless sky. Also when using a *gradient mask* (see the section called "gradient") you should watch out for possible banding artifacts.

## Usage

Viewing from some distance an image dithered into a very low bit depth (like "floyd-steinberg 1-bit b&w") will give the impression of a homogeneous grayscale image. We try to mimic this impression in darktable when you look at zoomed-out images in the center view, in the navigation window and for thumbnails. This is accomplished by dithering those images into a higher number of grayscale levels. Note that as a consequence the histogram – which is derived from the navigation window – will show this increased number of levels and is no longer a full match of the output image.

### method

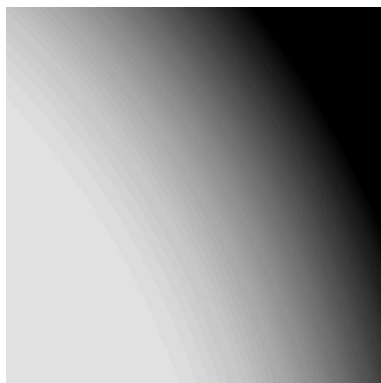
This combobox sets the dithering method. Floyd-Steinberg error diffusion – with some typical output bit depths – and random noise dithering are both supported. Floyd-Steinberg systematically distributes quantization errors over neighboring pixels, whereas random dithering just adds some level of randomness to break sharp tonal value bands. The default setting is "floyd-steinberg auto", which automatically adapts to the desired output format.

### damping

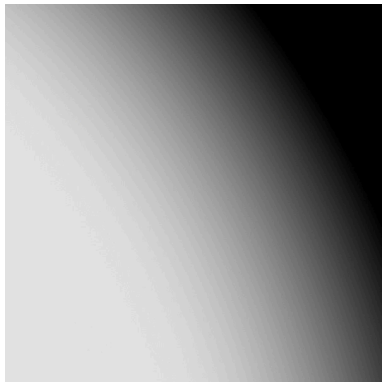
This slider is only displayed if you choose method "random". It controls the level of added random noise expressed as a damping factor in a  $10 \cdot \log_2$  basis. A value of -80 is a good fit for 8-bit output formats and -160 for 16-bit ones.

## Examples

The visibility of the following examples depends on the quality of your monitor or the print quality.



Banding artifact caused by vignetting (100% crop of a 8-bit PNG; effect heavily exaggerated by strong contrast enhancement).

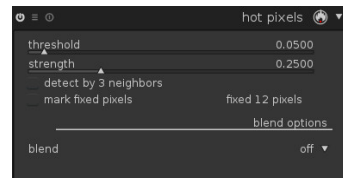


The same image area, processed as above but with activated Floyd-Steinberg dithering.

### 3.4.4.15. Hotpixels

#### Overview

This module is able to automatically detect and eliminate hotpixels. Hotpixels are pixels which failed to record light level correctly. Detected hotpixels are replaced by an average value of their neighbors.



#### Usage

You control the detection sensitivity with the threshold parameter and the level of elimination with the strength parameter.

##### threshold

The threshold of the detection, i.e. how strong a pixel's value needs to deviate from its neighbors to be regarded as a hotpixel.

##### strength

The strength of blending hotpixels with their surrounding.

##### detect by 3 neighbours

This will extend the detection of hotpixels, it will even regard a pixel as hot if a minimum of only three (instead of four) neighbor pixels deviate by more than the threshold level.

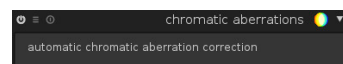
##### mark fixed pixels

This options will mark the pixels that have been corrected. It also displays the count of detected and fixed pixels.

### 3.4.4.16. Chromatic aberrations

#### Overview

This module allows you to correct chromatic aberrations.



## Usage

The module has no parameters. On activation it will automatically try to optimize away visible CA's.

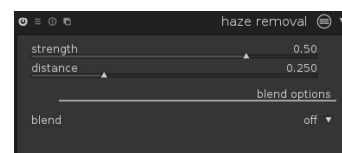
The underlying model assumes as input an uncropped photographic image. The module is likely to fail when you zoom into the image, as in that case it will only receive parts of your photograph as input in darktable's pixelpipe. As a consequence, chromatic aberrations do not get corrected properly in the center view. This limitation only applies to interactive work, not to file export.

This module currently only works for images recorded with a Bayer sensor (which is the sensor used in the majority of cameras).

### 3.4.4.17. Automatic haze removal

#### Overview

The haze removal module is designed to automatically reduce the effect of dust and haze in the air, which often reduces the color contrast in landscape photographs. In general, this module may be employed to give pictures a color boost specifically in low-contrast image regions.



The higher the haze density in the air and the longer the distance between the camera and the photographed object the less colorful the object appears in the image. Haze absorbs light approaching from the objects into the direction of the camera but it is also a source of diffusive background light. Thus the haze removal module estimates for each image region the amount of haze in the scene first and then removes the diffusive background light according to its local strength and recovers the original object light.

## Usage

The haze removal module has two controls that determine the amount of haze reduction and limit the distance up to which haze is removed. Setting both controls to unity maximizes the amount of haze removal but this is also likely to produce some artifacts. Removing the atmospheric light entirely may render the image flat and may result in an unnatural looking style. Optimal values are typically below unity and these are rather image dependent but also a matter of personal aesthetic preferences.

#### strength

The strength parameter controls the amount of haze removal. Setting it to unity, the module removes 100 percent of the detected haze between the camera and up to the specified distance; see below. Negative values for the strength increase the amount of haze in the image.

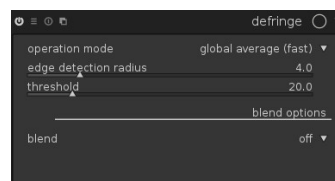
#### distance

This parameter limits the distance up to which haze is removed. For small values, haze removal is restricted to the foreground of the image. Haze is removed from the foreground to the far background if the distance parameter is set to unity. In case of a negative strength the distance control has no effect.

### 3.4.4.18. Defringe

## Overview

This module is designed to remove purple or any other color of fringing which often results from Longitudinal Chromatic Aberrations (LCA), also known as Axial Chromatic Aberrations.



## Usage

This module helps removing fringe via edge-detection. Where pixels are detected as a fringe, it rebuilds the color from lower-saturated neighboring pixels.

### operation mode

Set the operation mode for detecting fringes. "global average" is usually the fastest but might show slightly incorrect previews in high magnification. It might also protect the wrong regions of color too much or too little by comparison with local averaging. "local average" is slower because it computes local color references for every pixel, which might protect color better than global average and allows for rebuilding color where actually required. The "static" method does not use a color reference but directly uses the threshold as given by the user.

### edge detection radius

Set the spatial extent of the gaussian blur used for an edge detection. The algorithm uses the difference of gaussian-blurred and original image as an indicator for edges (a special case of the "difference of gaussians" edge detection). Try increasing this value if you either want a stronger detection of the fringes or the thickness of the fringe edges is too high.

### threshold

Sets the threshold over which the edge of a pixel is counted as a "fringe". The colors of the affected pixels will be rebuild from neighboring pixels. Try lowering this value if there is not enough fringe detected and try increasing this value if too many pixels are desaturated. You may additionally want to play around with the edge detection radius.

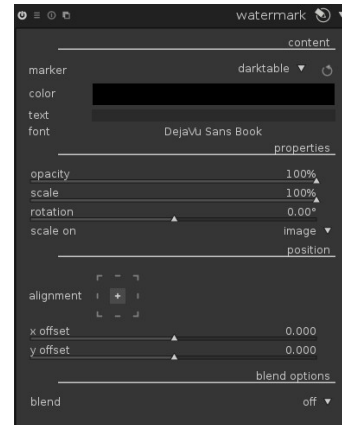
## 3.4.5. Effect group

In the effect group you will find modules with a more artistic touch.

### 3.4.5.1. Watermark

## Overview

The watermark module provides a way to render a vector-based overlay onto your image. Watermarks are standard SVG documents and can be designed using *Inkscape* [<http://www.inkscape.org>].



The SVG processor of darktable also substitutes strings within the SVG document, which gives the opportunity to include image dependent information in the watermark such as aperture, exposure time and other metadata.

User-designed watermarks are placed into the directory `$HOME/.config/darktable/watermarks`. Once in place, use the reload button at the right of the watermark file name to update the list of available watermarks to use.

Here follows a list of available variable strings that is supported for substitution within the svg document.

<code>\$(DARKTABLE.NAME)</code>	The application name
<code>\$(DARKTABLE.VERSION)</code>	The version of darktable
<code>\$(WATERMARK_TEXT)</code>	A short free text (max. 63 characters)
<code>\$(WATERMARK_COLOR)</code>	The color to use for <code>\$(WATERMARK_TEXT)</code>
<code>\$(WATERMARK_FONT_FAMILY)</code>	The font family to use for <code>\$(WATERMARK_TEXT)</code>
<code>\$(WATERMARK_FONT_STYLE)</code>	The font style (normal, oblique, italic)
<code>\$(WATERMARK_FONT_WEIGHT)</code>	The font weight (boldness)
<code>\$(IMAGE.ID)</code>	The unique image id within current library
<code>\$(IMAGE.FILENAME)</code>	The image filename
<code>\$(IMAGE.BASENAME)</code>	The image file basename
<code>\$(IMAGE.EXIF)</code>	The image Exif string
<code>\$(EXIF.DATE)</code>	The image date
<code>\$(EXIF.DATE.SECOND)</code>	Seconds from the image Exif data
<code>\$(EXIF.DATE.MINUTE)</code>	Minutes from the image Exif data
<code>\$(EXIF.DATE.HOUR)</code>	Hours from the image Exif data (24h)
<code>\$(EXIF.DATE.HOUR_AMPM)</code>	Hours from the image Exif data (12h, AM/PM)
<code>\$(EXIF.DATE.DAY)</code>	Day of month from the image Exif data (01 .. 31)
<code>\$(EXIF.DATE.MONTH)</code>	Month from the image Exif data (01 .. 12)

\$(EXIF.DATE.SHORT_MONTH)	Month from the image Exif data localized (Jan, Feb, .. Dec)
\$(EXIF.DATE.LONG_MONTH)	Month from the image Exif data localized (January, February, .. December)
\$(EXIF.DATE.SHORT_YEAR)	Abbreviated year from the image Exif data (2013 is "13")
\$(EXIF.DATE.LONG_YEAR)	Full year from the image Exif data
\$(DATE)	Current system date
\$(DATE.SECOND)	Current system time seconds
\$(DATE.MINUTE)	Current system time minutes
\$(DATE.HOUR)	Current system time hours (24h)
\$(DATE.HOUR_AMPM)	Current system time hours (12, AP/PM)
\$(DATE.DAY)	Current system time day of month (01 .. 31)
\$(DATE.MONTH)	Current system time month (01 .. 12)
\$(DATE.SHORT_MONTH)	Current system time month localized (Jan, Feb, .. Dec)
\$(DATE.LONG_MONTH)	Current system time month localized (January, February, .. December)
\$(DATE.SHORT_YEAR)	Current system time year (abbreviated)
\$(DATE.LONG_YEAR)	Current system time year
\$(EXIF.MAKER)	The maker of camera model
\$(EXIF.MODEL)	The camera model
\$(EXIF.LENS)	The specific lens used
\$(Xmp.dc.creator)	The creator string
\$(Xmp.dc.publisher)	The publisher string
\$(Xmp.dc.title)	The title of the image
\$(Xmp.dc.description)	The description of the image. This is the field to use when you're looking for the user-specified text that some cameras add at shoot time to exif field "User Comment" (also called "Exif.Photo.UserComment").
\$(Xmp.dc.rights)	The rights assigned to the image
\$(GPS.LATITUDE)	The image latitude coordinate (N/S 0 .. 90)
\$(GPS.LONGITUDE)	The image longitude coordinate (E/W 0 .. 180)
\$(GPS.ELEVATION)	The image elevation level (meters)
\$(GPS.LOCATION)	All three coordinates (latitude, longitude, elevation)

## Usage

### marker

Choose the watermark of interest. You can use the reload button next to the combobox to update the list with all newly added watermarks.

### text

A free text field with up to 63 characters which gets printed if the corresponding watermark references it. An example is supplied as `simple-text.svg`.

### text color

This field shows the text color. Clicking on the colored field will open a color selector dialog which offers you a choice of commonly used colors, or allows to define a color in RGB color space.

### text font

This field lets you select the text font. Clicking on the field opens a dialog box which shows the fonts available to your system. Fonts can be searched by name and a preview of each available font is shown next to the font name; you may specify your own sample text. The font defaults to "DejaVu Sans Book".

### opacity

Set the opacity of the watermark's rendering.

### scale

Scale the watermark pixel-independently.

### rotate

Set the rotation angle of the watermark.

### scale on

Defines the reference for the scale parameter. The default setting "image" scales the watermark relative to the horizontal image size. Alternatively you can scale the watermark relative to the "larger border" and "smaller border", respectively.

### alignment

Use these controls to align the watermark to any edge or center of the image.

### x offset

Pixel-independent offset relative to the choice of alignment on the x-axis.

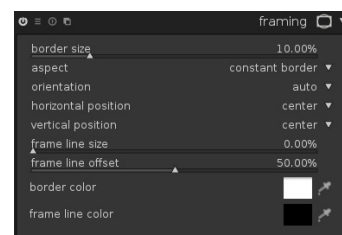
### y offset

Pixel-independent offset relative to the choice of alignment on the y-axis.

## 3.4.5.2. Framing

### Overview

This module is an artistic feature to generate a frame around your image. The frame consists of a border with a user defined color and a frame line inside that border, which has another user defined color. There are various options for you to control the geometry of your frame.



## Usage

### border size

This slider controls the size of the frame in percent of the underlying full image.

### aspect

With this combobox you can choose between different aspect ratios for the final output of this module, i.e. underlying image plus frame.

### orientation

If you select a non-square aspect ratio this combobox defines the orientation – portrait or landscape. Set to “auto” if you want darktable to select the most reasonable orientation based on the underlying image.

### horizontal position

Select from a set of pre-defined ratios where you want your underlying image be positioned on the horizontal axis. You can also right click and enter your own ratio as “x/y”.

### vertical position

Select from a set of pre-defined ratios where you want your underlying image be positioned on the vertical axis. You can also right click and enter your own ratio as “x/y”.

### frame line size


The percentage of the frame line size relative to the border size at its smallest part.

### frame line offset

Where the frame line is positioned relative to the underlying image. Select a value of 0 for a frame line touching the image, 100% for a frame line touching the outer border limits.


### border color

A color selector which allows to define a color for the border. Clicking on the colored field will open a color selector dialog which offers you a choice of commonly used colors, or allows to define a color in RGB color space.

You can also activate a color picker by pressing  and take a color probe from your image. You can switch between point and area sampling mode from within the global color picker panel (see Section 3.3.5, “Global color picker”).

### frame line color

A color selector which allows to define a color for the frame. Clicking on the colored field will open a color selector dialog which offers you a choice of commonly used colors, or allows to define a color in RGB color space.

You can also activate a color picker by pressing  and take a color probe from your image. You can switch between point and area sampling mode from within the global color picker panel (see Section 3.3.5, “Global color picker”).



## Examples

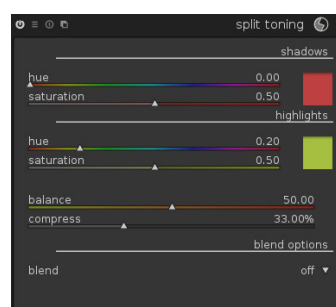


Example image with a user defined frame.

### 3.4.5.3. Splittoning

#### Overview

darktable's splittoning method creates a two color linear toning effect where the shadows and highlights are represented by two different colors. In the example image below you can see an original black and white image and one where a splittoning effect is applied with blue in shadows and a yellowish color in highlights.



Compared to traditional splittoning our module has more parameters to influence its behavior. We have parameter “balance”, which offsets the 50% gray level in your image – at your choice – more to the shadows or more to the highlights. Additionally, with parameter “compression” you can compress toning in the shadows and highlights and leave a gap in the mid-tones, which remain untouched by the effect.

The splittoning module does not convert images to black and white and has limited benefits on color images. So, if you want to do traditional splittoning, use the *monochrome* module (see Section 3.4.3.7, “Monochrome”) to make the image black and white before playing around with splittoning effect.

#### Usage

##### shadows and highlights color

These controls are used to set the color of the splittoning effect, you select the desired color and saturation for both shadows and highlights. Clicking on the colored squares will open a color selector dialog which offers you a choice of commonly used colors, or allows to define a color in RGB color space.

##### balance

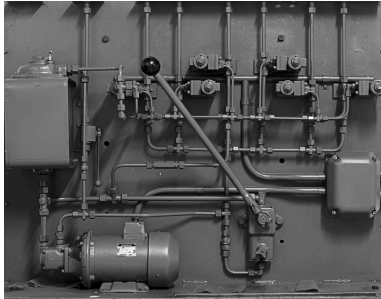
This parameter represents the ratio of toning between shadows and highlights. For a value of 50% half of the lightness range in image is used for shadows toning and the other half for highlights toning.

##### compression

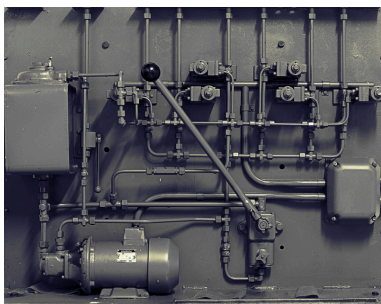
Compression is a percentage of total lightness range that is not affected by color toning. Default value is set to 33%; this is not the default behavior of an original splittoning which

would be 0% compression. The choice of 33% as a default is to invite you experimenting with these parameters and how it extends the original splittoning method.

## Examples



Original black and white image.

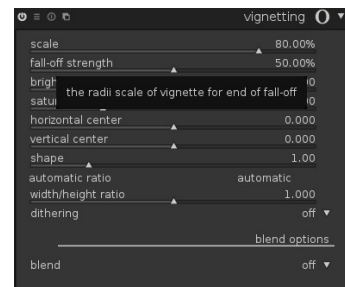


Splittoning with blue shadows and yellow highlights.

### 3.4.5.4. Vignetting

#### Overview

This module is an artistic feature which creates vignetting (modification of the brightness/saturation at the borders).



#### Usage

The vignetting module has an extensive set of parameters to precisely tune its effect. It also will display graphical controls within the image if the module is in focus. Give it a try to get a feeling of how it works. On-screen controls and parameter sliders will stay in sync.

This module is known to provoke banding artifacts under certain conditions; you should consider to activate the *dithering* module (see Section 3.4.4.14, "Dithering").

#### scale

Set the radius of the vignetting area.

#### fall-off strength

Sets the progressiveness of the fall-off. Higher values will cause a steeper transition.

**brightness**

Sets the intensity of brightening (positive values) or darkening (negative values).

**saturation**

Controls how strong colors become when desaturated or saturated in the darkened or brightened vignetting area.

**horizontal center**

Shifts the center of the vignetting area horizontally.

**vertical center**

Shifts the center of the vignetting area vertically.

**shape**

Influences the shape of the vignetting area. The default value of 1 causes a circular or elliptical area. Smaller values will shift the shape into a more square one; higher values turn it into a cross-like shape.

**automatic ratio**

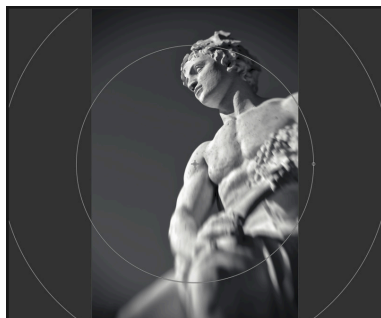
Click this button to automatically adjust the width/height ratio of the vignetting area to the aspect ratio of the underlying image. The vignetting area will typically become elliptical.

**width/height ratio**

Manually adjust the width/height ratio of the vignetting area.

**dithering**

With this combobox you can activate random noise dithering to overcome banding artifacts caused by vignette gradients. Select "8-bit output" to prevent banding on monitor display and for JPEGs. When set to "16-bit output", only a little dithering will be applied, just strong enough to compensate for banding on the fine grained 16-bit level. This feature is mostly obsoleted by our new module *dithering* (see Section 3.4.4.14, "Dithering").

**Examples**

An image with vignetting and with graphical vignetting controls displayed.

**3.4.5.5. Soften**

## Overview

This module is an artistic feature that creates a softened image, commonly known as the Orton effect.



## Usage

Michael Orton achieved his results on slide film by using two exposures of the same scene: one well exposed and one overexposed; he then used a darkroom technique to blend those into a final image where the overexposed image was blurred.

This module is almost a copy of Orton's analogue process into the digital domain. You can control brightness and blur with the provided parameters; we also add a control for saturation of the overexposed image for more play.

### size

Set the size of blur of the overexposed image in the process, the bigger the softer.

### saturation

Set the saturation of the overexposed image.

### brightness

Expressed in [EV], the brightness slider selects the increase in brightness.

### mix

Controls the mix of the overexposed image and the overall effect.

## Examples



This is the original image, use it as reference for the changes below...



In this image I used the default values, and added 0.33EV to brightness for a little more light in the soft layer.

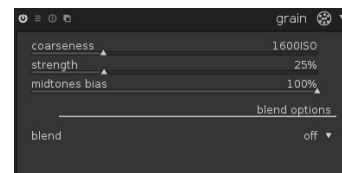


This version is the same as above but with 25% saturation.

### 3.4.5.6. Grain

#### Overview

This module is an artistic feature which simulates the grain of a film.



#### Usage

The grain is processed on the L channel from CIELAB.

##### coarseness

Set the grain size, which has been scaled to simulate an ISO number.

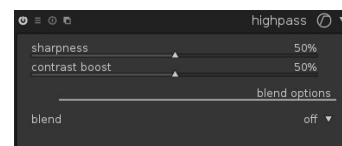
##### strength

Set the strength of the effect.

### 3.4.5.7. Highpass

#### Overview

Highpass acts as a high pass filter. The primary usage for this filter is in combination with a blending operator. Try out blend mode "soft light" to get highpass sharpening. Use the opacity slider to adjust the strength of the effect or use a *drawn mask* (see Section 3.2.5.5, "Drawn mask") or *parametric mask* (see Section 3.2.5.6, "Parametric mask") to limit the effect to only parts of your image.



#### Usage

##### sharpen

Set the sharpness. The higher, the more details.

##### contrast boost

Set the contrast boost.

### 3.4.5.8. Lowpass

#### Overview

A lowpass filter (eg. gaussian blur) with additional control of the outcome both of contrast and saturation. The primary usage for lowpass filter is in combination with a *blending operator* (see Section 3.2.5.4, "Blending operators"). Try out the preset named "local contrast mask" with an "overlay" blending operation.



#### Usage

This module offers enormous artistic potential, albeit, with results that are sometimes difficult to predict.

##### radius

Set the radius of the blur.

##### soften with

This combobox defines the blur algorithm; you can choose between "gaussian" blur (default) and "bilateral" filter. The latter leads to an edge preserving blur. "gaussian" will blur all image channels: L, a and b. "bilateral" will only blur L channel.

##### contrast

Changes the contrast. Negative values result in an inverted negative image. Higher absolute values increase contrast; lower absolute values reduce contrast. A value of zero leads to a neutral plane.

##### brightness

Changes the brightness. Negative values result in a darker image. Positive values increase the image's brightness.

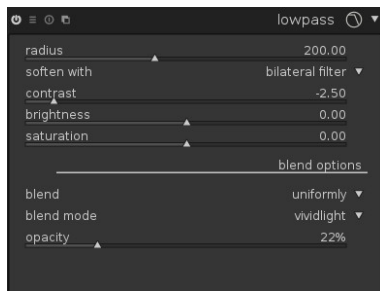
##### saturation

Changes the color saturation. Negative values result in complementary colors by inverting the a/b-channels. Higher absolute values increase color saturation; lower absolute values reduce color saturation. A value of zero leads to a desaturated black&white image.

#### Examples



The original image, already heavily processed. The boat is almost a silhouette.



Bilateral blur with high radius. Desaturated, inverted and with high contrast.



Intermediate result after lowpass filter ...



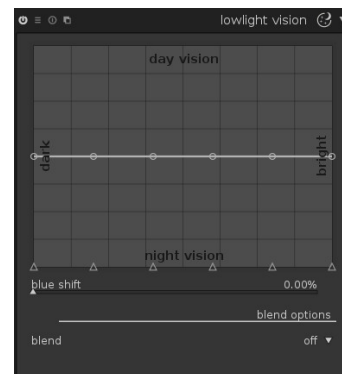
... and final image after this was applied with blend mode "vividlight".

### 3.4.5.9. Low light

#### Overview

The *low light* module allows one to simulate human lowlight vision, thus providing ability to make lowlight pictures look closer to reality. It can also be used to perform a day to night conversion.

The idea is to calculate a scotopic vision [[http://en.wikipedia.org/wiki/Scotopic\\_vision](http://en.wikipedia.org/wiki/Scotopic_vision)] image which is perceived by rods rather than than cones in the eye under low light. Scotopic lightness then is mixed with photopic value (regular color image pixel) using some blending function. Also this module is able to simulate the Purkinje effect [[http://en.wikipedia.org/wiki/Purkinje\\_effect](http://en.wikipedia.org/wiki/Purkinje_effect)] by adding some blueness to the dark parts of the image.



#### Usage

This module comes with several presets. Give them a try to get a better feeling how it works.

#### curve

The horizontal axis is about pixel lightness from dark (left) to bright (right). The vertical axis represents the kind of vision from night vision (bottom) to day vision (top)

## blue

Set the blue hint in shadows (Purkinje effect).

### Examples



Image 1. This is the original image.

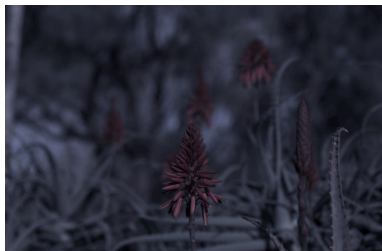


Image 1. With low light module on.

Image 2. This is the original image.

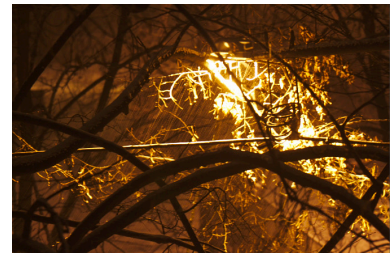
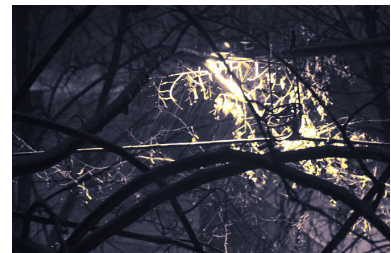


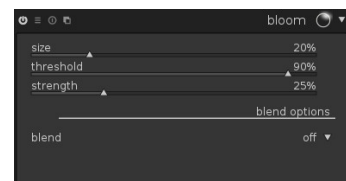
Image 2. With low light module on.



### 3.4.5.10. Bloom

#### Overview

This module takes highlights, blurs them and then blends (screen blend lightness) with the original to create a soft blooms over the image, hence the name of the effect. There are numerous ways to use this module depending on the image's actual scenery lighting.



#### Usage

Starting from the default settings change the strength value for a pleasant look, then change the size to control the spread of light.



**size**

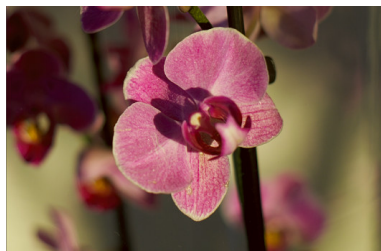
Represents the spatial extent of the bloom effect.

**threshold**

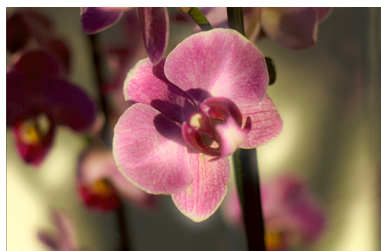
Set the threshold for the increase in brightness.

**strength**

Set the strength of overlightning for the effect.

**Examples**

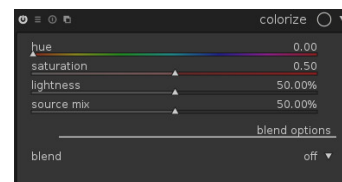
This is the original image, use it as reference for the changes below...



Here we have chosen to use a size of 10%, which is a rather small radius for the soft light spread. We boosted up the strength to 50% for a more exaggerated effect.

**3.4.5.11. Colorize****Overview**

This module is an artistic feature that adds a solid layer of color to your image.

**Usage**

Several parameters control the effect of this module. Much more versatility can be reached if you apply blending and masks. (see Section 3.2.5, "Blending").

**hue**

Selects the hue of the color layer.

**saturation**

Selects the color saturation of shadow tones.

**lightness**

Selects the lightness of the color layer.

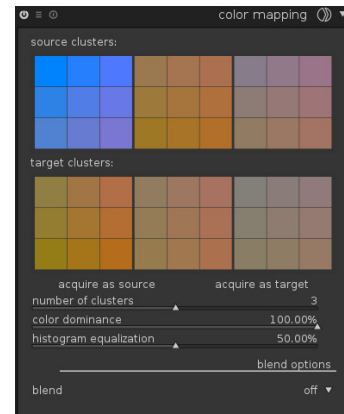
### source mix

This slider controls how the lightness of the input image is mixed in. If you set this to zero a uniformly colored plane will result.

## 3.4.5.12. Color mapping

### Overview


This module transfers the look and feel from one image onto another. It statistically analyses the color characteristics of a source image and a target image. The colors of the source image are then mapped to corresponding colors of the target image.



### Usage

To use this module two steps are required.

First you open the source image in darkroom mode and acquire its color characteristics by pressing the “acquire as source” button. A set of color clusters is generated and displayed in the “source clusters” area. Each cluster is represented by a set of color swatches with the mean value in the center surrounded by swatches indicating the color variance within that cluster. The clusters are sorted in ascending order by their weight, i.e. the number of pixels that contribute to the clusters.

Next you open your target image in darkroom mode. darktable has remembered the previously collected source clusters; if they are not yet displayed, press the  button. You now press the “acquire as target” button to generate a corresponding set of color clusters for your target image, which gets displayed in the “target clusters” area.

When both source and target clusters are collected an automatic color mapping is applied to the target image. In its default settings the overall effect is quite exaggerated. A set of sliders gives you control of the effect's strength. You can also use blending operator “normal” to tame the effect (see Section 3.2.5.4, “Blending operators”). As the *color mapping* module comes early in the pixelpipe, you can finetune the colors with modules like *tone curve* (see Section 3.4.2.3, “Tone curve”) or *color correction* (see Section 3.4.3.5, “Color correction”).

### acquire as source/target

Press these buttons to generate color clusters for the source and target image, respectively. The processing takes a few seconds during which the GUI remains unresponsive.

### number of clusters

Sets the number of color clusters to use. If you change this parameter all collected color clusters are reset and need to be acquired anew.

### color dominance

This parameter controls the mapping between source and target clusters. At the lowest value mapping is based on color proximity. This typically leads to very subtle effects on the target image. At the maximum value mapping is based on the relative weight of the color clusters – dominant colors of the source image are mapped to dominant colors of the target image. This typically leads to a very bold effect. In-between values incrementally shift between the extremes.

### histogram equalization

Besides mapping of color characteristics this module can modify the target image's contrast by matching its histogram with the histogram of the source image. This slider controls the extent of the effect.

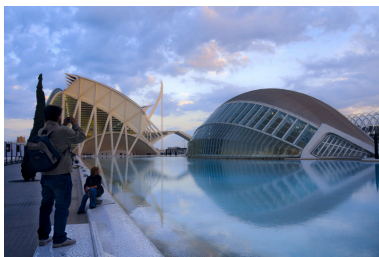
## Examples



The source image taken shortly after sunset under front lighting conditions.



The target image taken in the afternoon with a partly cloudy sky. Our goal is to transfer the evening atmosphere of the source image.

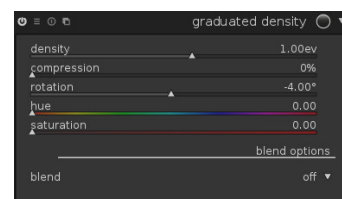


The target image with color mapping applied. A number of 2 clusters was used. "color dominance" is set to 100% for a bold but still credible effect. "histogram equalization" is set to 80%.

### 3.4.5.13. Graduated Density

#### Overview

This module aims at simulating a graduated density filter, in order to correct exposure and color in a progressive manner.



## Usage

The module uses a gradient to modify the exposure and the color cast of the image in a non-homogeneously manner.

This module is known to provoke banding artifacts under certain conditions; you should consider to activate the *dithering* module (see Section 3.4.4.14, "Dithering").

### density

Set the density of the filter in [ev]. A low value underexposes slightly whereas a high value creates a strong filter.

It is expressed as [ev] that is equivalent to *f-stops*. Lens filters are often referred as ND2, ND4, ND8 and so on. Each time you add an [ev] you double the ND. So ND2 is 1 ev, ND4 is 2 ev, and so on. You can also express it in optical density or transmittance. The table below sums up the different approach for the most common filters:

ND	[ev] or f-stop	absorbance	transmittance
ND2	-1	0.3	50%
ND4	-2	0.6	25%
ND8	-3	0.9	12.5%
ND400	-9	2.7	0.195%

### compression

Set progressiveness of the gradient. A low value creates a smooth transition, whereas a high value makes the transition abrupt.

### hue

Set the hue to add a color cast to the gradient.

### saturation

Set the saturation to add a color cast to the gradient.

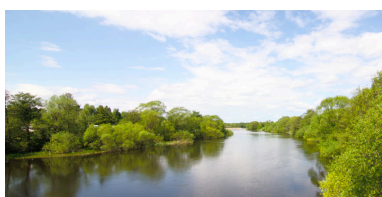
### position

You can set the position of the gradient directly on the image by moving the white line. For fine tuning, you can also use the rotation slider. Negative values turn clockwise.



## Examples

Here is an example that shows various options of darktable's graduated density filter:



This is the original image with a pretty overexposed sky, use it as reference for the changes below...



And now we have added a neutral ND8 filter which does a pretty good job on the image..



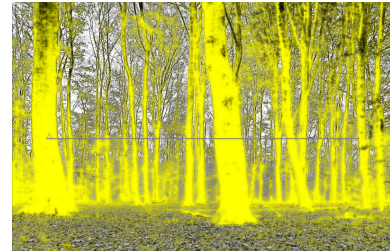
And at last, we added an orange colored filter rotating it -180 degrees, applying it on water/trees for a more artistic use of the filter.

darktable's graduated density filter is a powerful tool. Nevertheless, hardware filters have some advantages over a pure software solution. With a physical GND filter you can in fact reduce the dynamic range of your scene to make it better fit the limits of your camera sensor.

In this example a hardware GND filter (Hitech ND0.6, soft edge) helped to prevent over-exposure in the sky and tree tops, while at the same time getting a well exposed image of the ground. A rather disturbing element is the decay of brightness in the tree trunks from bottom to top.



darktable's graduated density filter together with the parametric mask feature (see Section 3.2.5.6, "Parametric mask") comes in handy. We can add a brightness gradient that is just inverted in relation to the hardware filter. As we only want to compensate the unnatural decay of brightness in the tree trunks, we combine the module with a suited blend mask.



The resulting image.



Tip: If you know you intend to use the graduated density filter before actually making a shot with your camera you might want to underexpose by one or two thirds of an f-stop to make sure detail remains in the highlights. When all detail has truly been blown out the graduated density filter cannot produce a pleasing results, this is a limitation that is inherent to digital postprocessing. For instructions on how to intentionally underexpose, please consult your camera's manual, look for "exposure compensation".

## 3.5. Examples

### 3.5.1. Converting to black and white

#### 3.5.1.1. Overview

Black and white conversion can be achieved in several ways with darktable. Indeed, darktable comes with a lot of modules, especially for color manipulation. In this manual, I will show you 4 ways to perform a black and white conversion.



#### 3.5.1.2. The obvious way: monochrome module

To perform the conversion, just activate the *monochrome* module (Section 3.4.3.7, “Monochrome”). You can then simulate a color filter, by dragging the circle above the colors you want to filter. Filter size can be modified via scrolling the mouse wheel.

#### 3.5.1.3. The simple way: color correction module

To perform such conversion we use the *color correction* module (Section 3.4.3.5, “Color correction”).

1. Activate the color correction module
2. Use the bottom slider to set saturation to zero

#### 3.5.1.4. The LAB way: color contrast module

To perform such conversion we use the *color contrast* module (Section 3.4.3.4, “Color contrast”).

1. Activate the color contrast module
2. Set both steepness sliders to zero

#### 3.5.1.5. The artistic way: color zones module

To perform the conversion we use the *color zone* module (Section 3.4.3.8, “Color zones”).

1. Activate the color zones module
2. By default, the active tabbed control is set to “saturation” whereas the “select by” combobox is set to “hue”. This means that color are selected according to their hue (horizontal scale) and you can change for each hue its “saturation” (vertical scale). You simply need to set all points to the minimum of the vertical scale to de-saturate every hue.
3. But now if you want, you can keep some hues a little bit saturated, so your image will be all black and white but some hue. A classical use for portrait is to keep red hue saturated in order to make the lips standing out.

You can also use one of the available presets that perform black and white conversion, keeping some hues saturated.

### 3.5.1.6. The sophisticated way: channel mixer module

To perform the conversion we use the *channel mixer* module (Section 3.4.3.2, “Channel mixer”).

1. Activate the channel mixer module
2. Select the gray output channel
3. Set the proportion of each color, the sum having to equal 1 if you want to keep your global lightness.

## 3.5.2. Cross-processing

### 3.5.2.1. Overview

Cross-processing is an analog processing technique where slide film (normally developed thanks to an E6 solution) is processed in chemicals used for processing print film (C41). The resulting images get skewed colors usually a cyan hue and increased contrast and saturation.



The standard way for doing digital cross-processing is to use a channel curve tool but darktable lacks this tool for the moment and another way to accommodate the effect is used.

### 3.5.2.2. Procedure

This procedure uses tone curve, channel mixer and splitting modules.

#### 1. Image preparation

Prepare the image for the cross process steps by adjusting the base settings such as exposure, whitebalance etc. for a correctly looking image.

#### 2. Boost contrast

Select the medium contrast curve preset for *tone curve* module (Section 3.4.2.3, “Tone curve”) to boost the overall contrast in the image. You might later return here to tune the curve for better result.

#### 3. Color cast

This step changes the color cast as the base for the effect using the *channel mixer* module (Section 3.4.3.2, “Channel mixer”). You might later again return to this and finetune the colorcast of the final result.

- a. Enable the channel mixer module
- b. Select the blue channel and set the blue color value to 0.8
- c. Select the red channel and change the blue color value to 0.1
- d. Select the green channel and change the blue color value to 0.1

#### 4. Splittoning

We use *splittoning* (Section 3.4.5.3, “Splittoning”) to add some more coloring to the result for cyan/blue shadows and yellow highlight.

- a. Enable the splittoning module
- b. Select a cyan/blue tone for shadows and set saturation around 50%
- c. Select a yellow/orange tone for highlights and set saturation around 70%
- d. Set compression to 10%
- e. Use the balance slider to tune the splittoning effect. This differs on every image due to it's exposure, motive etc.

### 3.5.3. Cyan toned image

#### 3.5.3.1. Overview

Cyan is a nice color touchup for black and white images, this example guides you through how to make this with darktable and how to control the tone. You can choose any tone of your like for this tutorial...



#### 3.5.3.2. Procedure

This procedure uses monochrome, channel mixer and splittoning modules.

##### 1. Image preparation

Prepare the image for the cyan toned steps by adjusting the base settings such as exposure, black level, contrast etc. for a correctly looking image.

##### 2. Black and white

Enable the *monochrome* module (Section 3.4.3.7, “Monochrome”) to make the image black and white.

##### 3. Add color tone

This step selects the base tone of the image using *channel mixer* (Section 3.4.3.2, “Channel mixer”), we are going for cyan tone but you can choose any tone that you like here.

- a. Enable the channel mixer module
- b. Select the red channel destination and set the red color value to 0.7
- c. Select the green channel destination and set the green color value to 1.15
- d. Select the blue channel destination and set the blue color value to 1.15

As you notice we mix blue and green color to get a cyan tone, we subtract 0.3 from the red channel and add them to blue and green.



#### 4. Splittoning

The result of the previous step does also add a color cast on highlights that we actually want to have white for a prettier result. We also want to add some blue color cast to the shadows in order to emphasis them. Module *splittoning* (Section 3.4.5.3, “Splittoning”) can accomplish this.

- a. Enable the splittoning module
- b. Select a blue/cyan tone for shadows and set saturation around 50%
- c. Set highlights saturation to zero, to remove saturation on highlights
- d. Set compression to zero
- e. Use the balance slider to tune the effect, our example uses a balance of 70/30

### 3.5.4. Removal of red-eye effect

#### 3.5.4.1. Overview

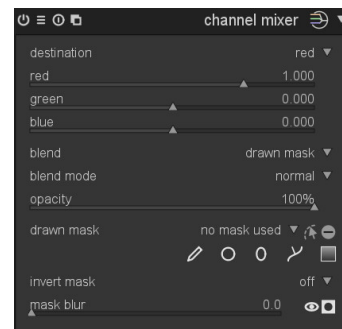
The red-eye effect in photography is the common appearance of red pupils in color photographs of eyes. It occurs when using a photographic flash very close to the camera lens (as with most cameras with built-in flash), in ambient low light.

We use the channel mixer module to reduce the red color of the pupil. To limit the processing to the pupils we have to apply two masks.



#### 3.5.4.2. Masking

1. Enable the channel mixer module (see Section 3.4.3.2, “Channel mixer”).



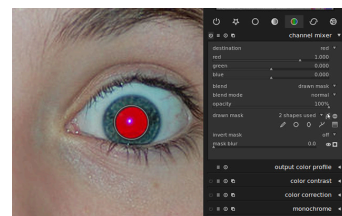
2. Activate blending

Modules with blending support exhibit an additional combobox “blend” at the bottom of their GUI. Blending is activated with this combobox. Set value to “drawn mask”. Additional controls are displayed which allow you to draw a mask.

3. Masking the pupil


Clicking the  symbol adds a circle shape.

Click into the canvas to place the circle. Left-click and drag the circle to the position of the first pupil. Use the scroll-wheel of your mouse while in the circle to change the diameter. Scroll within the circle border to minimize the width of the gradual decay.



Alternatively you can use an elliptical shape. See Section 3.2.5.5, “Drawn mask” for further details.

4. Repeat step 3.

Clicking the  symbol adds another circle shape.

Mark the second pupil.

### 3.5.4.3. Desaturation

1. Approach - Modifying the output channel "red".

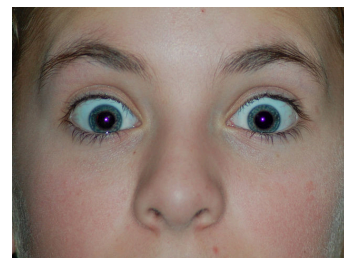
a. Set output channel "destination" to "red" (default)

b. Set red color value to 0.00

c. Set green color value to 0.50

d. Set blue color value to 0.50

You are free to experiment what gives you the most realistic pupil, but this is a good starting point. Another proposal is 0.10/0.60/0.30. The sum of the three values should be 1.



2. Approach - Modifying the output channel "gray".

a. Set output channel "destination" to "gray"

b. Set red color value to 0.24

c. Set green color value to 0.68

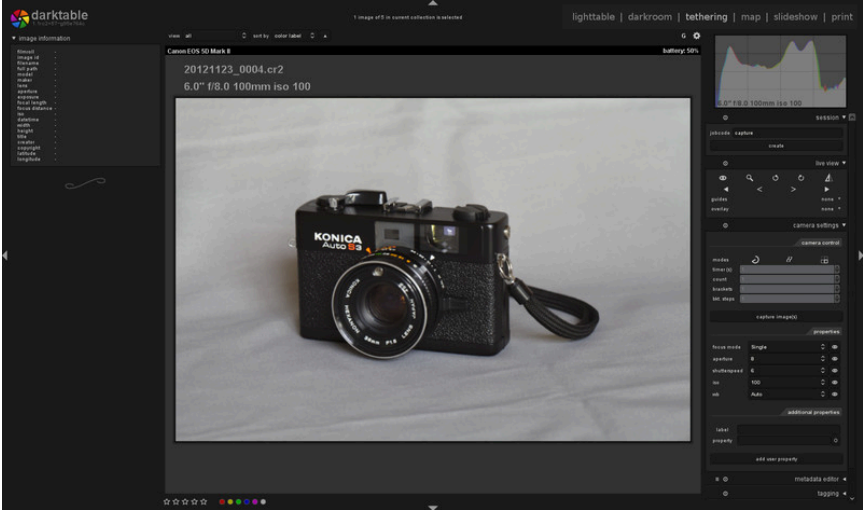
d. Set blue color value to 0.08

You are free to experiment what gives you the most realistic pupil, but this is a good starting point. The sum of the three values should be 1.



# Chapter 4. Tethering

The tethering view allows you to capture images directly into darktable from your connected camera.



## 4.1. Overview

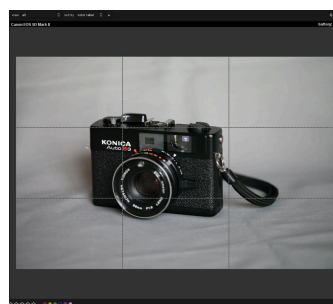
To use the tethering feature you need to connect your camera to your PC using a USB cable. Your computer might ask to mount or view the connected camera. Do not mount or view the camera. If that happens automatically, you will need to “unmount/eject” the camera. This is required to unlock the camera so darktable can lock it for usage.

After the USB cable is connected, look at the import panel in lighttable mode (see Section 2.3.1, “Import”). If your camera is not visible in this panel, click the “scan devices” button and it will appear with two functions: “import from camera” and “tethered shoot”. Click “tethered shoot” to enter the tethering mode.

darktable uses gphoto2 to interface with your camera. If you have problems finding the connected camera as described above, check the troubleshoot section in this chapter in order to verify your camera has tethering support.

### 4.1.1. Tethering

In the center view images are shown while you capture them. You can get an exposure by either using darktable's userinterface or manually triggering a capture on your camera. If you are using LiveView it will be shown in darktable's center view.



When entering tethering view, a film roll will be created using the same structure as defined when you import from the camera. Job code will be predefined as “capture”.

If you want to group your captures into different film rolls, you should use the session panel in right side. When entering a new name and pressing enter, a new film roll will be created and captured images will go into this new film roll.

darktable provides some nifty tools to setup a capture in the user interface. You can setup timelapse captures and brackets for HDR creations. The configuration is so dynamic that you can create sequential capture of brackets – go figure... For more information read the documentation about the capture panel and the examples in this chapter.

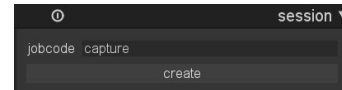
## 4.2. Tethering panels

This section contains documentation for panels that are specific to the tethering view.

### 4.2.1. Session

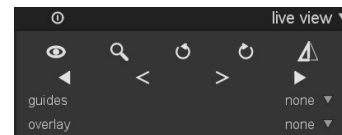
A session is a sequence of exposures taken in tethering mode and going into a single film roll. A new session equals a new film roll. A film roll is created with the same storage structure that is used when you import images from camera into darktable.

It's a bit awkward, but configuring this storage structure is done in the camera import dialog for now.



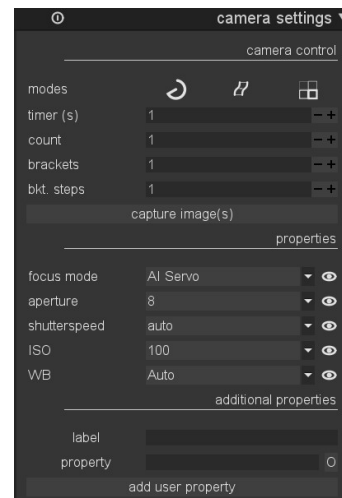
### 4.2.2. Live view

This panel gives you control of your camera's live view mode. Functionality such as focus setting, rotation, adding guides and overlays are supported.



### 4.2.3. Camera settings

The camera settings section allows you to set up a capture job. This can include sequence, bracket and delayed captures. You are also able to control other camera settings such as focus mode, aperture, shutter speed, ISO and white balance.



## 4.3. Examples

This section contains examples of typical usages of tethering.

### 4.3.1. Studio setup with screening

This is a pretty common use case. You have your studio and subject set up, the camera is connected to your computer and tethering view is active in darktable. You work at the camera and take images. Whenever you want, you can screen the image directly on your computer monitor instead of using the camera LCD for validation.

This workflow is efficient and effective, since you can immediately review your captures instead of waiting until after the shoot when everyone is gone. If you're shooting a model this is a pretty nice way to pre-view the captures with the client instead of fumbling around with your camera.

Working in the tethered mode can save you time and aggravation. Set a session name, shoot your images and they will save in the correct film roll for the session for easy on-site review.

### 4.3.2. Capturing a timelapse

A timelapse is a video clip composed of images taken in a time sequence. A typical example is to take a timelapse of cityscapes where you capture clouds and traffic etc.

To setup a timelapse capture, create a new session as described previously. Now decide if you want to shoot in manual or auto mode. Only use auto in situations where the ambient light will change significantly during the time of the shoot, eg. shooting a timelapse over 24 hours might give you easier control of light in that kind of captured sequence.

The camera settings panel is where you define delay and sequence. Sequence will give you the opportunity to choose how many images you want to capture and delay will set the time in seconds between captures.

To start the capture click the capture button in the same panel and watch the filmstrip fill up with images. The latest captured image is always displayed in center view.

## 4.4. Troubleshoot

### 4.4.1. Verify that your camera is supported

This troubleshooting guide will give you steps to verify your camera can be used with tethering. This is done using the gphoto2 commandline tools. This is what darktable uses to interface with your camera.

#### 1. Verify that camera is detected

The following command will verify a camera that is connected to the computer and detected by gphoto2. Find your camera port name to use it in the following tests below. Usually port "usb:" will be enough and therefore used in these examples.

```
env LANG=C gphoto2 --auto-detect
```

#### 2. Verify camera driver abilities

Execute the following command and verify that the *capture choices* ability supports "Image" and *configuration support* is "yes". darktable will check these two abilities and decide if "tethered shoot" button should be shown or not.

```
env LANG=C gphoto2 --port usb: --abilities
```

#### 3. Verify camera remote capture

This step will verify that your camera can be remotely controlled; that it can capture an image, download it to your computer and display it within darktable.

```
env LANG=C gphoto2 --port usb: --capture-image-and-download
```

#### 4. Verify camera tethered capture

And this last step tests if your camera supports events which darktable heavily relies on. Running this command will make the gphoto2 process wait for an image capture event which you must manually trigger on your camera. If successful, the image will be downloaded to your computer.

```
env LANG=C gphoto2 --port usb: --capture-tethered
```

### 4.4.2. So, now what?

If any of the steps above failed, there are problems with your specific camera and driver. Please report the issues to gphoto2 mailing list for further help. You can find the mailing list at [www.gphoto.org](http://www.gphoto.org) [<http://www.gphoto.org/maillinglists/>]. Add the following flags to the failed command above for better support and attach the log output to your mail:

```
--debug --debug-file gphoto2_debug.log
```

If you successfully went through all the tests above, your camera will most likely be supported by darktable. Even if successful, if you stumble upon a problem in darktable, please file a bug at redmine [<https://www.darktable.org/redmine>]. Please attach the log outputs from the steps above and the log file output generated after starting darktable with the following command.

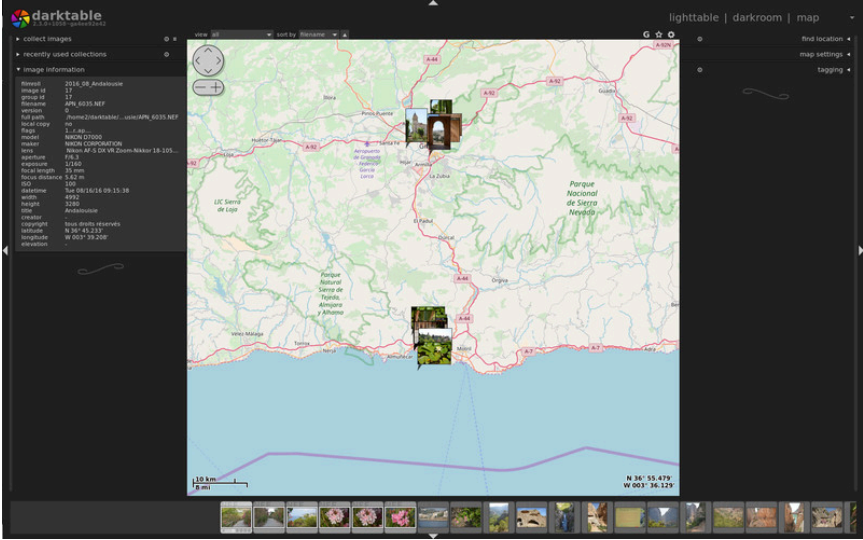
```
darktable -d camctl 2>1 >camctl.log
```





# Chapter 5. Map

The Map view is where you geotag your images.



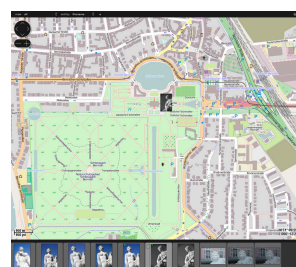
## 5.1. Overview

Map view will show you a world map with the currently open image, or film roll of images, pinned to their geotagged location. This requires that the image was geotagged by a camera with that feature. Some newer cameras, including smartphones, are already equipped with GPS receivers. Other cameras may need additional GPS hardware to do this.

Even if your camera doesn't support this feature, there is an alternative method. darktable can match the Exif time and date data in your image(s) to a separate GPX data tracking file created by a GPS tracker recording your movements. These can be handheld devices or a GPS tracker app on your smartphone. This is all done in the lighttable view (see Section 2.3.9, "Geotagging").

### 5.1.1. Center map view

In the center of the map view you will see a map.



Map data are taken from open map sources on the internet. New map data are only available if you are connected to the internet. darktable keeps a disk cache of previously loaded map data.

Your mouse will allow navigation in the map. Left-click will drag the map; using the scroll-wheel will zoom in or out.

There are on-screen controls and displays that assist you to find your way. A navigation area is located on top left of the map. Use it as an alternative to mouse-dragging and scrolling. The scale of your map is displayed on bottom left. On bottom right you see the geographical coordinates for the center of the map.

Images that already have geo location attributes in their metadata are displayed as small icons on the map.

In order to assign geo coordinates to an image, activate the film-strip on the lower panel (press *Ctrl-f*). You can simply assign a geo location to an image by dragging the image icon from the film-strip and position it onto the map. darktable will record the new geo location (longitude and latitude) as part of the image metadata. Exported images will include this data.

In order to remove geo coordinates from an image just drag it from the map and drop it onto the filmstrip.

Left and right to the central map there are panels for additional control.

### 5.1.2. Undo/redo

All image moves in the map view are recorded by darktable. It is then possible to undo or redo such changes to recover a previous state. Note that this undo/redo facility is unlimited while moving images but it is reset each time the map view is left.

The default key shortcuts are:

- *Ctrl-z*: undo last move
- *Ctrl-y*: redo last undo (does nothing if undo has not been used yet)

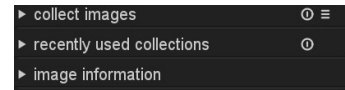
## 5.2. Map panels

This section contains documentation for panels that are specific to the map view.

### 5.2.1. Left panels

The panels on the left side we already know from lighttable mode (Section 2.3, “Lighttable panels”).

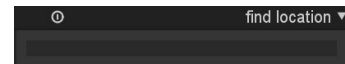
Choose your image selection rules with the *collect images* panel. Recently used collections can be chosen with their respective names in a separate panel. You can also get an overview of the information of the image under your mouse cursor in a panel labeled *image information*.



### 5.2.2. Find location

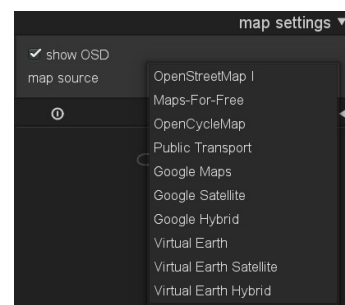
The *find location* module is used to search for a place on map. You need to be connected to the internet to use this feature.

To use, type in a place or address, press enter and a list of results will be shown. Click on one of the resulting items and the map will zoom to that location. Additionally, an outline covering that location, or a pin pointing at the location will be displayed. Now drag images from the film strip at the bottom of the screen to their location on the map. The GPS location will be embedded in the image.



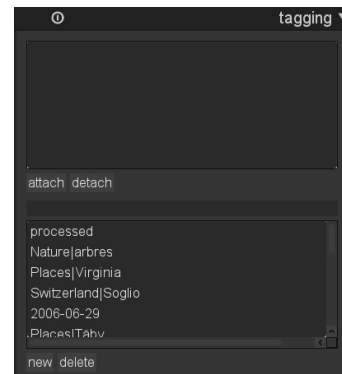
### 5.2.3. Map settings

In the *map settings* panel you can select your preferred map data from various providers. Some will provide different layers, such as satellite view etc., which you can toggle.



## 5.2.4. Tagging

The *tagging* panel allows you to attach or detach different tags to an image as well as creating or deleting a tag. It is divided into two parts. The upper part contains tags that are currently attached to the image. The lower part contains all available tags. You must select or mouse over an image for the data to be displayed. See Section 2.3.11, “Tagging” for more details.





# Chapter 6. Slideshow

The slideshow view starts a slideshow of your current collection.



## 6.1. Overview

Entering the slideshow view starts a slideshow of the images of the current collection with filtering rules and sort order applied. To learn more on how to define the collection, the filtering and the sort order see Section 2.3.2, “Collect images” and Section 2.2.5, “Filtering and sort order”.

The image display is optimized to take full advantage of your screen size. You should therefore put darktable into fullscreen mode which is toggled by pressing *F11*. You may press *TAB* in order to hide all remaining panels – namely the filtering option in the top panel.



## 6.2. Usage

The slideshow view is in an early stage of development with a basic set of features.

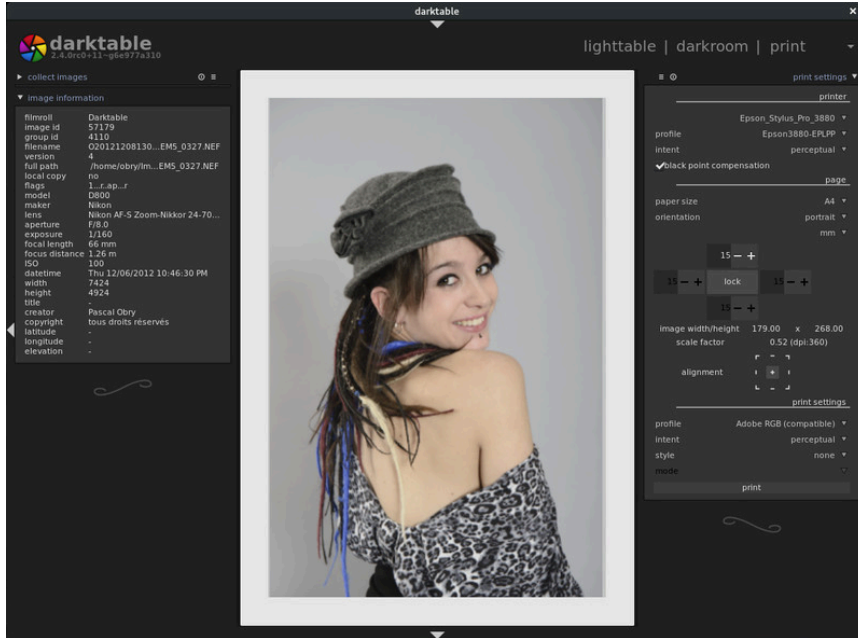
<i>left-click</i>	switch to the next image of the collection
<i>right-click</i>	switch to the previous image of the collection
<i>space</i>	start and stop auto-advance mode which automatically switches to the next images every five seconds and after the last image loops back to the beginning
<i>ESC</i>	leave slideshow mode and return to lighttable view

Depending on the complexity of the history stack and the power of your hardware, processing an image with high resolution can take a significant amount of time. darktable prefetches the next image in the background in order to minimize latencies. If you still experience long delays when switching between images or if you intend to quickly advance in your collection consider to disable the option "do high quality processing for slideshow" which gives a much higher processing speed at the expense of a possible slight loss in quality (see Section 8.1, "GUI options").



# Chapter 7. Print

The print view lets you output a selected image to your printer.



## 7.1. Overview

This view is about printing – or the joy of giving birth to a photograph which can be put on the wall. Because printing is not easy, there are many technical aspects to be taken into account.

After selecting an image in the lighttable view (see Section 2.1, “Overview”) one can enter the print module where there are several options for the print layout and for selecting which printer to use.

The central area displays the image layout on the paper (the white area). Some gray borders may be displayed around the image to represent the printable area (the page minus the borders) not filled by the image.

On the left side you find the *collect images* panel which is described in more detail in Section 2.3.2, “Collect images”. This panel lets you define which images are present in the filmstrip. Visibility of the filmstrip – located in the bottom panel – is toggled by pressing *ctrl-f* (see Section 1.2.3, “Filmstrip”). On the left side you also have an *image information* panel which displays useful Exif data of the image in the center area, or the filmstrip image under the pointer, respectively (see Section 2.3.4, “Image information”).

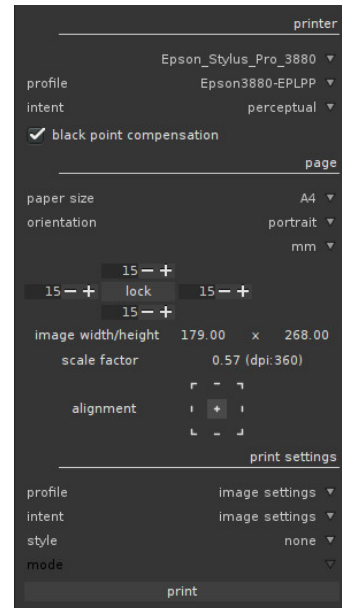
On the right panel the print settings module has many options to layout the image on the page, select the paper, options for exporting, etc. This module is described in depth in the section below.

This module supports the printer's ICC profile which is somewhat mandatory if you want to get a high quality print close to the image displayed on the screen.

It is important to note that ICC profiles provided by the paper and/or printer manufacturers cannot be used on GNU/Linux as they depend on the printer drivers. The darktable print module is using CUPS [<http://www.cups.org/>] and there is no ready-to-use ICC profiles for this driver.

## 7.2. Usage

The print module has many options. We describe the panel in this section.



### 7.2.1. Printer section

#### printer

This entry is to select one of the installed printers.

#### media

The media kind loaded on the printer (Plain Paper, Luster Photo Paper, etc.).

#### profile

The printer's ICC profile for the loaded paper. This is the profile specific to the printer and printer's paper. This profile is the last color space transformation done to the picture whose goal is to create a high quality print.

#### intent

The print rendering intent ("perceptual", "relative colorimetric", "saturation" or "absolute colorimetric"). See Section 3.2.6.3, "Rendering intent" for more information.

#### black point compensation

Whether to adjust the black point of the output profile which is often lighter than the input profile. This should be "on" when the above intent is set to "relative colorimetric".

### 7.2.2. Page section

#### paper size

The size of the paper on which to print.

#### orientation

Portrait or landscape (note that darktable chooses by default the best fit).

## **units**

The unit to use for setting the margins. “mm”, “cm”, and “inch” are available options.

## **margins**

It is possible to set each margin separately or all together by clicking on the middle “lock” button.

## **image width/height**

This information field displays the actual image width and height (given with the selected units) on the paper.

## **scale factor**

This information field displays the scaling of the image to fit on the paper. If this value is less than 1 the image is down-scaled otherwise it is up-scaled. This is an important factor to watch – a too large value (up-scale) may result in a low quality print. The corresponding dpi (dots per inch) is also displayed.

## **alignment**

This option allows you to select the alignment of the image on the paper.

### **7.2.3. Print settings**

#### **profile**

This allows you to select the export profile to use. This profile is the entry point used for the next transformation using the printer's ICC profile above. Usually it is better to prefer a large gamut like AdobeRGB rather than a smaller one as sRGB.

#### **intent**

This option sets the rendering intent to use when exporting the image. For more information see Section 3.2.6.3, “Rendering intent”.

#### **style**

Defines a style to apply when exporting the image and defaults to “none”. See the *export* panel (Section 2.3.12, “Export selected”) for a more detailed discussion of applying a style during export.


#### **mode**

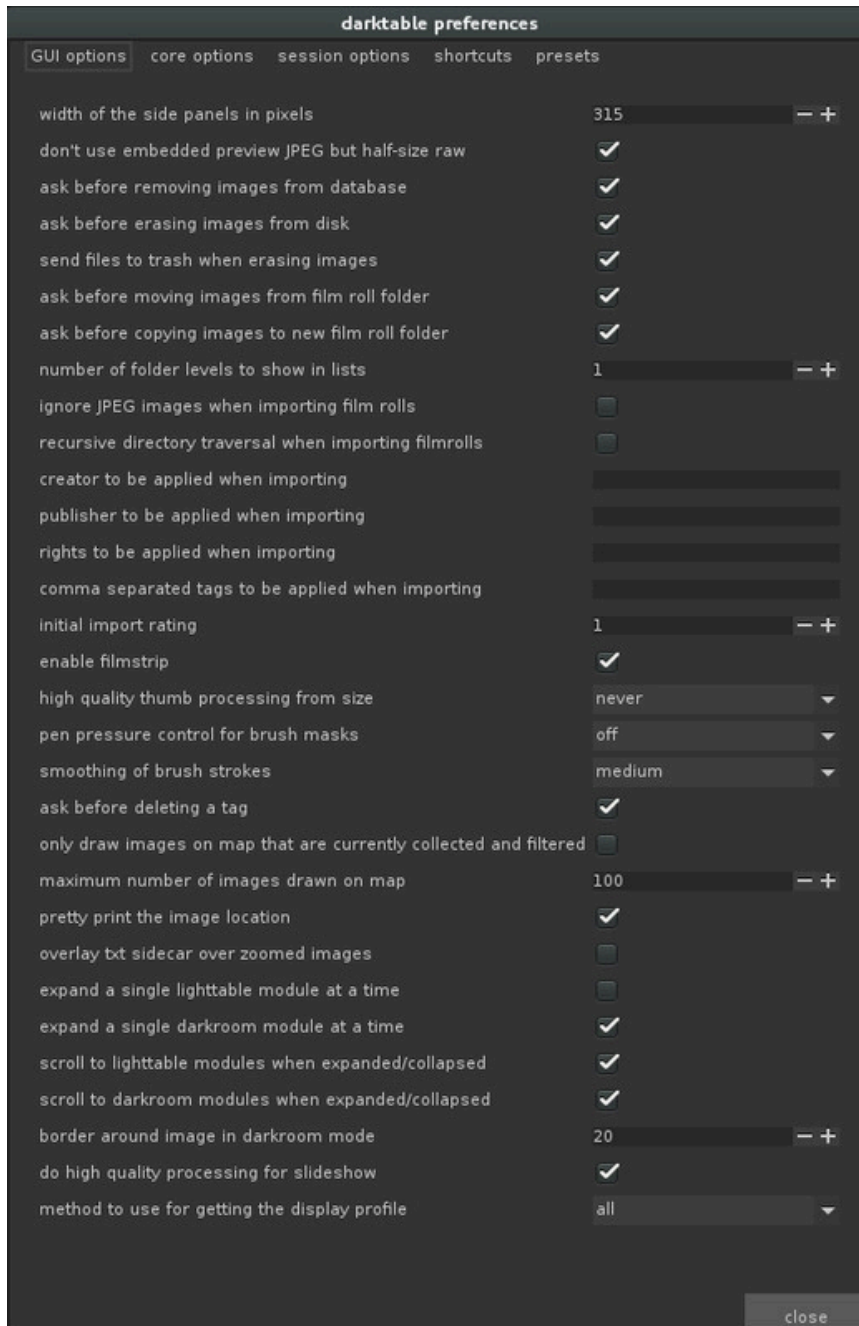
This selects whether the style is appended to the existing history stack or replacing it completely. See Section 2.3.12, “Export selected” for more details.

### **7.2.4. Print button**

At the bottom of the right panel you find the “print” button. When clicked the image is exported using the selected options and sent to the printer.

# Chapter 8. Preferences and settings

darktable comes with a number of settings that can be configured by users. You reach the configuration menu by clicking  at the top of the screen.



## 8.1. GUI options

These options control the look and feel of darktable.

### **width of the side panels in pixels**

This controls the size of side panels in pixels. Side panels are found left and right to the center view (default 350).

### **don't use embedded preview JPEG but half-size raw**

Check this option to not use the embedded JPEG from the raw file but process the raw data. This is slower. (default off).

### **ask before removing images from database**

Always ask the user before any image is removed from the database (default on).

### **ask before erasing images from disk**

Always ask the user before any image file is deleted (default on).

### **send files to trash when erasing images**

Instead of physically deleting images from disk put them into the system's trash bin (default on).

### **ask before moving images from film roll folder**

Always ask the user before any image file is moved (default on).

### **ask before copying images to new film roll folder**

Always ask the user before any image file is copied (default on).

### **number of folder levels to show in lists**

The number of folder levels to show in film roll names, starting from the right (default 1).

### **ignore JPEG images when importing film rolls**

When having RAW+JPEG images together in one directory it makes no sense to import both. With this flag one can ignore all JPEGs found (default off).

### **recursive directory traversal when importing film rolls**

Not only import images from the directory selected but recursively go through all subdirectories as well (default off).

### **creator to be applied when importing**

If provided, automatically add this string as a creator tag when importing images (default none).

### **publisher to be applied when importing**

If provided, automatically add this string as a publisher tag when importing images (default none).



### **rights to be applied when importing**

If provided, automatically add this string as a copyrights tag when importing images (default none).

### **comma separated tags to be applied when importing**

If you want to add further tags when importing images, you can give them as a comma separated list (default none).

### **initial import rating**

Initial star rating (from 0 to 5) for all images when importing a film roll (default 1).

### **enable filmstrip**

Enable the filmstrip in darkroom, tethering and geomapping modes (default on).

### **high quality thumb processing from size**

If the thumbnails size is greater than this value, it will be processed using the full quality rendering path which is better but slower (default 720p).

### **enable extended thumb overlay**

If enabled adds additional information to the thumbnail under the mouse cursor: image name, exposure time, aperture, focal length, ISO value (default off).

### **pen pressure control for brush masks**

Controls how the pressure reading of a graphics tablet impacts newly generated brush strokes (see Section 3.2.5.5, "Drawn mask"). You can control the brush width, its hardness and its opacity. "Absolute" control means that the pressure reading directly defines the attribute with a value between 0% and 100%. "Relative" means that the pressure reading adjusts the attribute between zero and the pre-defined default value (default off).

### **smoothing of brush strokes**

Sets the level for smoothing of brush strokes. Stronger smoothing leads to less nodes and easier editing at the expense of lower accuracy.

### **display of individual color channels**

Controls how individual color channels are displayed when activated in the parametric masks feature. You can choose between "false color" and "grey scale" (default false color).

### **ask before deleting a tag**

Always ask user before deleting a tag from an image (default on).

### **only draw images on map that are currently collected and filtered**

Use the current filter settings to select the geotagged images drawn in the map view. This limits the images drawn to those currently shown in the filmstrip and thus reduces the time needed (default off).

### **maximum number of images drawn on map**

The maximum number of geotagged images drawn on the map. Increasing this number can slow down the drawing of the map. Needs a restart if changed (default 100).

### **pretty print the image location**

Show a more readable representation of the geo location in the image information module (default on).

### **overlay txt sidecar over zoomed images**

When there is a text file next to an image it can be shown as an overlay over zoomed images on the lighttable. The text file has the same base name as the image file with file extension “.txt”. It either has to be there at import time or the crawler has to be enabled – see option “look for updated xmp files on startup” in Section 8.2, “Core options” (default off).

### **expand a single lighttable module at a time**

Controls how lighttable panels are expanded. If this option is enabled, expanding a panel by *clicking* collapses any currently expanded panel. If you want to expand a panel without collapsing the others you do so with *shift-click*. Disabling this option reverts the meaning of *click* and *shift-click* (default off).

### **expand a single darkroom module at a time**

Controls how darkroom modules are expanded. If this option is enabled, expanding a module by *clicking* collapses any currently expanded module. If you want to expand a module without collapsing the others you do so with *shift-click*. Disabling this option reverts the meaning of *click* and *shift-click* (default on).

### **scroll to lighttable modules when expanded/collapsed**

With this option enabled the lighttable side panels will scroll a module to the top when it is expanded or collapsed (default off).

### **scroll to darkroom modules when expanded/collapsed**

With this option enabled the darkroom side panel will scroll a module to the top when it is expanded or collapsed (default on).

### **border around image in darkroom mode**

Process the image in darkroom mode with a small border of the given number of pixels (default 20).

### **do high quality processing for slideshow**

Controls how images are processed for the slideshow view. If this option is enabled, the image will first be processed in full resolution, and downsampled at the very end. This can result in better quality sometimes, but will always be slower (default on).

### **rating an image one star twice will not zero out the rating**

Normally clicking a one star rating twice will set a zero star rating to that image. When checking this option a second click on a one star rating will keep that rating (default off).

### **method to use for getting the display profile**

This option allows to force a specific way of getting the current display profile for color management (see Section 3.2.6.2, “Rendering method”). In the default setting “all”

darktable will either query the X display server's `xatom` or the `colord` system service. You can set this option to `"xatom"` or `"colord"` to enforce a specific method if the alternative gives wrong results.

## 8.2. Core options

These options control some of the internals of darktable.

### memory in megabytes to use for thumbnail cache

In order to speed-up display of film rolls, darktable stores thumbnails in a cache file on disk (primary cache) and loads it into memory at startup. This value controls the cache size in megabytes. It needs a restart if changed (default 256MB).

### enable disk backend for thumbnail cache

If activated darktable stores all thumbnails on disk as a secondary cache, and thereby keeping thumbnails accessible in case they get dropped from the primary cache. This needs more disk space but speeds up lighttable view as it avoids reprocessing of thumbnails (default on).

### color manage cached thumbnails

If activated darktable generates thumbnails in a general color space (AdobeRGB) in order to render them independently of the individual monitor. Conversion to the monitor color space is done at display time. If this option is not activated thumbnails are directly stored in the specific monitor color space valid at generation time and are subsequently displayed without further corrections (default on).

### number of background threads

This controls how many parallel threads are used to create thumbnails during import. On 32bit systems it is strongly recommended to set this to 1. Needs a restart if changed (default 2).

### host memory limit (in MB) for tiling

In order to manage large images on systems with limited memory darktable does tile-wise processing. This variable controls the *maximum* amount of memory (in MB) a module may use during image processing. Lower values will force memory hungry modules to process an image with increasing number of tiles. Setting this to 0 will omit any limits. Values below 500 will be treated as 500. On a 32bit system you should set this to 500. Needs a restart if changed (default 1500).

### minimum amount of memory (in MB) for a single buffer in tiling

If set to a positive, non-zero value, this variable defines the *minimum* amount of memory (in MB) that darktable should take for a single tile. On a 32bit system you should set this to 8. 64bit systems can live with higher values. Needs a restart if changed (default 16).

### write sidcar file for each image

These redundant XMP files can later be re-imported into a different database, preserving your changes to the image. It's strongly recommended to have this option activated so you don't lose data in case of a database corruption. Backing up your raw file plus the accompanying XMP file will allow you to fully restore your work (default on).

### store xmp tags in compressed format

Entries in XMP tags can get rather large and may exceed the available space to store the history stack in output files on export. This option allows binary XMP tags to be

compressed in order to save space. Available options are “never”, “always”, and “only large entries” (default).

### **omit hierarchy in simple tag lists**

When exporting images the hierarchical tags are also added as a simple list of non-hierarchical ones to make them visible to some other programs. When this option is checked darktable will only include their last part and ignore the rest. So “foo|bar|baz” will only add “baz”.

### **activate OpenCL support**

darktable can use your GPU to speed up processing significantly. Interface OpenCL requires suitable hardware and matching OpenCL drivers on your system. If one of those is not found the option is greyed out. Can be switched on and off at any time and takes immediate effect (default on).

### **OpenCL scheduling profile**

Defines how preview and full pixelpipe tasks are scheduled on OpenCL enabled systems. “default”: the GPU processes the center view pixelpipe and the CPU processes the preview pipe; “multiple GPUs”: both pixelpipes are processed in parallel on two different GPUs; “very fast GPU”: both pixelpipes are processed sequentially on the GPU.

### **always use LittleCMS 2 to apply output color profile**

If this option is activated, darktable will use system library LittleCMS 2 instead of its own routines. This is significantly slower than the default but might give more accurate results in some cases (default off).

Note that if the given ICC is LUT-based or contains both, a LUT and a matrix, darktable will use LittleCMS 2 to render the colors regardless of this configuration parameter's value.

### **do high quality resampling during export**

The image will first be processed in full resolution, and downsampled at the very end. This can result in better quality sometimes, but will always be slower (default off).

### **demosaiing for zoomed out darkroom mode**

Interpolation when not viewing 1:1 in darkroom mode: “always bilinear (fast)” is fastest, but not as sharp. “at most ppg (reasonable)” is using ppg + interpolation modes specified below, “full (possibly slow)” will use exactly the settings for full-size export (default “at most ppg (reasonable)”).

### **pixel interpolator**

Pixel interpolator used in rotation, lens correction, up-and-down scaling; options are “bilinear”, “bicubic”, “lanczos2”, “lanczos3” (default).

### **password storage backend to use**

The storage backend for password storage. Options: “auto” (default), “none”, “libsecret”, “kwallet”.

### **look for updated xmp files on startup**

Check file modification times of all XMP files on startup to find out if any got updated in the meantime by some other software. If updated XMP files are found a menu opens

for the user to decide which of the XMP files to be reloaded – replacing darktable's database entries by the XMP file contents – and which of the XMP files to be overwritten by darktable's database. Activating this option also causes darktable to check for text sidecar files that have been added after import time – see option “overlay txt sidecar over zoomed images” in Section 8.1, “GUI options” (default off).

### **executable for playing audio files**

Defines an external program which is used in the lighttable view to play audio files that some cameras record to keep notes for images (default “aplay”).

### **auto-apply per camera basecurve presets**

Use the per-camera basecurve by default instead of the generic manufacturer one if there is one available. For more details see Section 3.4.1.4, “Base curve” (default off).

### 8.3. Session options

These options define a naming pattern to organize images on disk when importing from a connected camera (see Section 2.3.1, "Import") and when taking photos in the tethering view (see Chapter 4, *Tethering*).

The naming pattern consists of three parts: a base part defining the parent folder, a session part defining a sub directory which is specific to the individual import session, and a file name part defining the filename structure for each imported image.

Several pre-defined variables can be used in the pattern as placeholders:

<code>\$(HOME)</code>	the home folder as defined by the system
<code>\$(PICTURES_FOLDER)</code>	the pictures folder as defined by the system (usually "\$HOME/Pictures")
<code>\$(DESKTOP)</code>	the desktop folder as defined by the system (usually "\$HOME/Desktop")
<code>\$(USERNAME)</code>	your user account name on the system
<code>\$(FILE_NAME)</code>	basename of the imported image
<code>\$(FILE_EXTENSION)</code>	extension of the imported image
<code>\$(JOBCODE)</code>	unique identifier of the import job
<code>\$(SEQUENCE)</code>	a sequence number within the import job
<code>\$(ID)</code>	unique identification number of the image in darktable's database
<code>\$(YEAR)</code>	year at the date of import
<code>\$(MONTH)</code>	month at the date of import
<code>\$(DAY)</code>	day at the date of import
<code>\$(HOUR)</code>	hour at the time of import
<code>\$(MINUTE)</code>	minute at the time of import
<code>\$(SECOND)</code>	second at the time of import
<code>\$(EXIF_YEAR)</code>	year the photo was taken (from Exif data)
<code>\$(EXIF_MONTH)</code>	month the photo was taken (from Exif data)
<code>\$(EXIF_DAY)</code>	day the photo was taken (from Exif data)
<code>\$(EXIF_HOUR)</code>	hour the photo was taken (from Exif data)
<code>\$(EXIF_MINUTE)</code>	minute the photo was taken (from Exif data)
<code>\$(EXIF_SECOND)</code>	seconds the photo was taken (from Exif data)
<code>\$(EXIF_ISO)</code>	ISO value of the photo (from Exif data)

#### base directory naming pattern

The base directory part of the naming pattern (default "`$(PICTURES_FOLDER)/Darktable`").

#### sub directory naming pattern

The sub directory part of the naming pattern (default "`$(YEAR)$(MONTH)$(DAY)_$(JOBCODE)`").

**file naming pattern**

The file name part of the naming pattern (default "\$ (YEAR)\$ (MONTH)\$ (DAY)\_ \$(SEQUENCE).\$(FILE\_EXTENSION)").



## 8.4. Shortcuts

darktable has a large set of keyboard shortcuts that is user configurable through the preference dialog.

When you open the shortcuts menu you are presented with a hierarchical list of all actions that can receive a keyboard shortcut. Go to the action you want to change and double click. You are then prompted to press the new key combination to be mapped to the selected action. In order to remove an existing keyboard shortcut, click on the action and press backspace.

You can export your mappings to a file or import mappings from a file. Press “default” to reset all keyaccelerators to their default state.

Below is a table with the default keybindings for actions available in darktable.

global/quit	<Primary>q
global/lighttable view	l
global/darkroom view	d
global/tethering view	t
global/map view	m
global/slideshow view	s
global/print view	p
global/switch view	period
global/toggle header	<Primary>h
global/toggle side borders	Tab
global/toggle fullscreen	F11
global/leave fullscreen	Escape
global/zoom in	<Primary>KP_plus
global/zoom out	<Primary>KP_minus
image operations/clipping/commit	Return
image operations/flip/rotate 90 degrees CCW	bracketleft
image operations/flip/rotate 90 degrees CW	bracketright
modules/copy_history/copy all	<Primary>c
modules/copy_history/copy	<Primary><Shift>c
modules/copy_history/paste all	<Primary>v
modules/copy_history/paste	<Primary><Shift>v
modules/export/export	<Primary>e
modules/filmstrip/color blue	F4
modules/filmstrip/color green	F3
modules/filmstrip/color purple	F5
modules/filmstrip/color red	F1
modules/filmstrip/color yellow	F2
modules/filmstrip/copy history	<Primary>c
modules/filmstrip/copy history parts	<Primary><Shift>c
modules/filmstrip/duplicate image	<Primary>d

modules/filmstrip/invert selection	<Primary>i
modules/filmstrip/paste history	<Primary>v
modules/filmstrip/paste history parts	<Primary><Shift>v
modules/filmstrip/rate 0	0
modules/filmstrip/rate 1	1
modules/filmstrip/rate 2	2
modules/filmstrip/rate 3	3
modules/filmstrip/rate 4	4
modules/filmstrip/rate 5	5
modules/filmstrip/rate reject	r
modules/filmstrip/select all	<Primary>a
modules/filmstrip/select none	<Primary><Shift>a
modules/image/duplicate	<Primary>d
modules/image/group	<Primary>g
modules/image/remove from collection	Delete
modules/image/ungroup	<Primary><Shift>g
modules/import/import folder	<Primary><Shift>i
modules/lighttable_mode/invert selection	<Primary>i
modules/lighttable_mode/select all	<Primary>a
modules/lighttable_mode/select none	<Primary><Shift>a
modules/lighttable_mode/zoom in	<Alt>2
modules/lighttable_mode/zoom max	<Alt>1
modules/lighttable_mode/zoom min	<Alt>4
modules/lighttable_mode/zoom out	<Alt>3
modules/live_view/toggle live view	v
modules/metadata_view/jump to film roll	<Primary>j
modules/recentcollect/jump back to previous collection	<Primary>k
modules/tagging/tag	<Primary>t
views/darkroom/undo	<Primary>z
views/darkroom/redo	<Primary>y
views/darkroom/decrease brush hardness	braceleft
views/darkroom/decrease brush opacity	less
views/darkroom/decrease brush size	bracketleft
views/darkroom/export	<Primary>e
views/darkroom/full preview	z
views/darkroom/gamut check	<Primary>g
views/darkroom/image back	BackSpace
views/darkroom/image forward	space
views/darkroom/increase brush hardness	braceright
views/darkroom/increase brush opacity	greater
views/darkroom/increase brush size	bracketright

views/darkroom/overexposed	o
views/darkroom/softproof	<Primary>s
views/darkroom/toggle film strip	<Primary>f
views/darkroom/zoom close-up	<Alt>1
views/darkroom/zoom fill	<Alt>2
views/darkroom/zoom fit	<Alt>3
views/lighttable/color blue	F4
views/lighttable/color green	F3
views/lighttable/color purple	F5
views/lighttable/color red	F1
views/lighttable/color yellow	F2
views/lighttable/navigate down	<Shift>g
views/lighttable/navigate page down	Page_Down
views/lighttable/navigate page up	Page_Up
views/lighttable/navigate up	g
views/lighttable/preview with focus detection	<Primary>z
views/lighttable/preview	z
views/lighttable/rate 0	0
views/lighttable/rate 1	1
views/lighttable/rate 2	2
views/lighttable/rate 3	3
views/lighttable/rate 4	4
views/lighttable/rate 5	5
views/lighttable/rate reject	r
views/lighttable/realign images to grid	l
views/lighttable/scroll center	apostrophe
views/lighttable/scroll down	Down
views/lighttable/scroll left	Left
views/lighttable/scroll right	Right
views/lighttable/scroll up	Up
views/lighttable/select single image	Return
views/lighttable/select toggle image	space
views/map/undo	<Primary>z
views/map/redo	<Primary>y
views/map/toggle film strip	<Primary>f
views/map/undo	<Primary>z
views/print/toggle film strip	<Primary>f
views/slideshow/start and stop	space
views/tethering/toggle film strip	<Primary>f

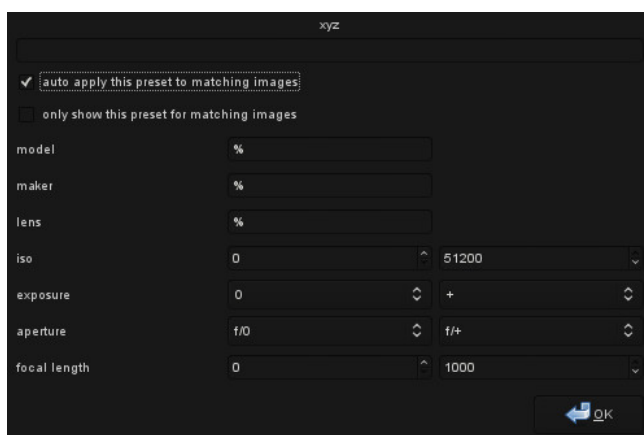
## 8.5. Presets

This menu gives you an overview of the presets that are defined for darktable's modules. In this dialog you can select whether a certain user defined preset shall be auto-applied to matching images.

darktable already comes with a set of pre-defined presets for several modules. In addition you can define your own presets from within each module in darkroom mode (see Section 3.2.3, "Module presets").

Pre-defined presets are shown with a lock symbol. Their auto-apply properties can not be changed.

Double clicking on a user-defined preset will open a menu.



### auto apply this preset to matching images

activate this checkbox to automatically apply the preset on newly imported images; a set of fields is displayed where you can define patterns to be matched against Exif data.

### only show this preset for matching images

activate this checkbox to hide the preset in darkroom mode if it does not match the defined patterns.

### model

a pattern to be matched against the Exif field that describes your camera model; use "%" as wildcard.

### maker

a pattern to be matched against the Exif field that describes the maker of your camera; use "%" as wildcard.

### lens

a pattern to be matched against the Exif field that describes your lens; use "%" as wildcard.

### iso

only apply the preset if the ISO value of your image lies within the given range.

**exposure**

only apply the preset if the exposure time of your image lies within the given range; set "+" as the upper value to match arbitrarily long exposures.

**aperture**

only apply the preset if the aperture of your image lies within the given range; set "f/0" as the lower value to match arbitrarily open apertures; set "f/+" as the upper value to match arbitrarily closed apertures.

**focal length**

only apply the preset if the focal length of your image lies within the given range (from 0 to 1000).



# Chapter 9. Scripting with Lua

darktable comes with a versatile scripting interface for functionality enhancement.

```
dt = require "darktable"
dt.register_storage("module_stitcher", "mosaic generator", nil,
function(storage, image_table)
    dt.print_error("Will try to stitch now")
    command = "gm convert "
    for _,v in pairs(image_table) do
        command = command..v.." "
    end
    command = command..".append -resize 15% "..dt.configuration.tmp_dir.."/tmp.png"
    dt.print_error("this is the command: "..command)
    os.execute(command)

    dt.print("Stitching saved to "..dt.configuration.tmp_dir.."/tmp.png")
end
```

## 9.1. Lua usage

Lua can be used to define actions which darktable will perform whenever a specified event is triggered. One example might be calling an external application during file export in order to apply additional processing steps outside of darktable.

darktable uses *Lua* [<http://www.lua.org/>], which is an independent project founded in 1993, providing a powerful, fast, lightweight, embeddable scripting language. Lua is widely used by many open source applications, in commercial programs, and for games programming.

darktable uses Lua version 5.2. Describing the principles and syntax of Lua is beyond the scope of this usermanual. For a detailed introduction see the Lua reference manual [<http://www.lua.org/manual/5.2/manual.html>].

### 9.1.1. Basic principles

At startup, darktable will automatically run two Lua scripts:

- a script called *luarc* in `$DARKTABLE/share/darktable`
- a script called *luarc* in the user's configuration directory

`$DARKTABLE` is used here to represent your system's darktable installation directory.

This is the only time darktable will run Lua scripts by itself. The script can register callbacks to perform actions on various darktable events. This callback mechanism is the primary way to trigger lua actions.

### 9.1.2. A simple lua example

Let's start with a simple example. We will print some code on the console. Create a file called *luarc* in darktable's configuration directory (usually `~/.config/darktable/`) and add the following line to it:

```
print("Hello World !")
```

Start darktable and you will see the sentence *Hello World!* printed on the console. Nothing fancy but it's a start...

At this point, there is nothing specific to darktable in the script. We simply use the standard `print` function to print a string. That's nice and all, but we can do better than that. To access the darktable API you first need to `require` it and save the returned object in a variable. Once this is done you can access the darktable API as subfields of the returned object. All of this is documented in darktable's Lua API reference manual (see Section 9.2, "Lua API").

```
local darktable = require "darktable"  
darktable.print_error("Hello World !")
```

Run the script ... and nothing happens. The function `darktable.print_error` is just like `print` but will only print the message if you have enabled lua traces with `-d lua` on the command line. This is the recommended way to do traces in a darktable lua script.

### 9.1.3. Printing labeled images

This first example showed us the very basics of lua and allowed us to check that everything is working properly. Let's do something a little bit more complex. Let's try to print the list of images that have a red label attached to them. But first of all, what is an image?



```

local darktable = require "darktable"
local debug = require "darktable.debug"
print(darktable.debug.dump(darktable.database[1]))

```

Running the code above will produce a lot of output. We will look at it in a moment, but first let's look at the code itself.

We know about requiring `darktable`. Here, we need to separately require `darktable.debug` which is an optional section of the API that provides helper functions to help debug lua scripts.

`darktable.database` is a table provided by the API that contains all images in the database (currently visible or not, duplicate or not...). Each entry in the database is an image object. Image objects are complex objects that allow you to manipulate your image in various ways (it is all documented in the `types_dt_lua_image_t` section of the API manual). To display our images, we use `darktable.debug.dump` which is a function that will take anything as its parameter and recursively dump its content. Since images are complex objects that indirectly reference other complex objects, the resulting output is huge. Below is a cut down example of the output.

```

toplevel (userdata,dt_lua_image_t) : /images/100.JPG
  publisher (string) : ""
  path (string) : "/images"
  move (function)
  exif_aperture (number) : 2.7999999523163
  rights (string) : ""
  make_group_leader (function)
  exif_crop (number) : 0
  duplicate_index (number) : 0
  is_raw (boolean) : false
  exif_iso (number) : 200
  is_ldr (boolean) : true
  rating (number) : 1
  description (string) : ""
  red (boolean) : false
  get_tags (function)
  duplicate (function)
  creator (string) : ""
  latitude (nil)
  blue (boolean) : false
  exif_datetime_taken (string) : "2014:04:27 14:10:27"
  exif_maker (string) : "Panasonic"
  drop_cache (function)
  title (string) : ""
  reset (function)
  create_style (function)
  apply_style (function)
  film (userdata,dt_lua_film_t) : /images
    1 (userdata,dt_lua_image_t): .toplevel
    [.....]
  exif_exposure (number) : 0.0062500000931323
  exif_lens (string) : ""

```

```

detach_tag (function): toplevel.film.2.detach_tag
exif_focal_length (number) : 4.5
get_group_members (function): toplevel.film.2.get_group_members
id (number) : 1
group_with (function): toplevel.film.2.group_with
delete (function): toplevel.film.2.delete
purple (boolean) : false
is_hdr (boolean) : false
exif_model (string) : "DMC-FZ200"
green (boolean) : false
yellow (boolean) : false
longitude (nil)
filename (string) : "100.JPG"
width (number) : 945
attach_tag (function): toplevel.film.2.attach_tag
exif_focus_distance (number) : 0
height (number) : 648
local_copy (boolean) : false
copy (function): toplevel.film.2.copy
group_leader (userdata,dt_lua_image_t): .toplevel

```

As we can see, an image has a large number of fields which provide all sort of information about it. We are interested in the red label. This field is a boolean, and the documentation tells us that it can be written. We now just need to find all images with that field and print them out.

```

darktable = require "darktable"
for _,v in ipairs(darktable.database) do
  if v.red then
    print(tostring(v))
  end
end
end

```

This code should be quite simple to understand at this point, but it contains a few interesting aspects about lua that are worth highlighting:

- `ipairs` is a standard lua function that will iterate through all numeric indices of a table. We use it here because `darktable.database` has non-numeric indices which are functions to manipulate the database itself (adding or deleting images, for example).
- Iterating through a table will return both the key and the value used. It is conventional in lua to use a variable named “\_” to store values that we don't care about.
- Note that we use the standard lua function `tostring` here and not the `darktable` specific `darktable.debug.dump`. The standard function will return a name for the object whereas the debug function will print the content. The debug function would be too verbose here. Once again, it is a great debug tool but should not be used for anything else.

### 9.1.4. Adding a simple shortcut

So far, all our scripts have done things during startup. This is of limited use and doesn't allow us to react to real user actions. To do more advanced things we need to register

a function that will be called on a given event. The most common event to react to is a keyboard shortcut.

```
darktable = require "darktable"

local function hello_shortcut(event, shortcut)
darktable.print("Hello, I just received '"..event..
    "' with parameter '"..shortcut.."")
end

darktable.register_event("shortcut",hello_shortcut,
    "A shortcut that print its parameters")
```

Now start darktable, go to preferences => shortcut => lua => A shortcut that print its parameters assign a shortcut and try it. You should have a nice message printed on the screen.

Let's look at the code in details. We first define a function with two parameters. These parameters are strings. The first one is the type of event that is triggered ( "shortcut" ) and the second one is what shortcut specifically ( "A shortcut that print its parameters" ). The function itself calls `darktable.print` that will print the message as an overlay in the main window.

Once that function is defined, we register it as a shortcut callback. To do that we call `darktable.register_event` which is a generic function for all types of events. We tell it that we are registering a shortcut event, then we give the callback to call and last, we give the string to use to describe the shortcut in the preference window.

Let's try a shortcut a little more interactive. This one will look at the images the user is currently interested in (selected or moused-over) and will increase their rating.

```
darktable = require "darktable"

darktable.register_event("shortcut",function(event,shortcut)
    local images = darktable.gui.action_images
    for _,v in pairs(images) do
        v.rating = v.rating + 1
    end
end,"Increase the rating of an image")
```

At this point, most of this code should be self explanatory. Just a couple of notes:

- Instead of declaring a function and referencing it, we declare it directly in the call to `darktable.register_event` this is strictly equivalent but slightly more compact.
- `image.rating` is a field of any image that gives its rating (between 0 and 5 stars, -1 means rejected).
- `darktable.gui.action_images` is a table containing all the images of interest. `darktable` will act on selected images if any image is selected, and on the image under the mouse if no image is selected. This function allows to easily follow darktable's UI logic in lua.

If you select an image and press your shortcut a couple of time, it will work correctly at first but when you have reached five stars, darktable will start showing the following error on the console:

```
LUA ERROR : rating too high : 6
stack traceback:
[C]: in ?
[C]: in function '__newindex'
./configdir/luarc:10: in function <./configdir/luarc:7>
    LUA ERROR : rating too high : 6
```

This is lua's way of reporting errors. We have attempted to set a rating of 6 to an image, but a rating can only go as high as 5. It would be trivial to add a check, but let's go the complicated way and catch the error instead.

```
darktable.register_event("shortcut",function(event,shortcut)
    local images = darktable.gui.action_images
    for _,v in pairs(images) do
        result,message = pcall(function()
            v.rating = v.rating + 1
        end)
        if not result then
            darktable.print_error("could not increase rating of image "..
                tostring(v).. " : "..message)
        end
    end
end,"Increase the rating of an image")
```

`pcall` will run its first argument and catch any exception thrown by it. If there is no exception it will return `true` plus any result returned by the function; if there is an exception it will return `false` and the error message of the exception. We simply test these results and print them on the console...

### 9.1.5. Exporting images with Lua

We have learned to use lua to adapt darktable to our particular workflow, let's look at how to use lua to easily export images. darktable can easily export images to quite a few online services but there are always more. If you are able to upload an image to a service via the command line then you can use lua to integrate it into darktable's user interface.

In this next example we will use lua to export via **scp**. A new storage will appear in darktable's UI which will export images to a remote target via ssh's copy mechanism.

```
darktable = require "darktable"
```

```

darktable.preferences.register("scp_export","export_path",
    "string","target SCP path",
    "Complete path to copy to. Can include user and hostname","")

darktable.register_storage("scp_export","Export via scp",
    function( storage, image, format, filename,
        number, total, high_quality, extra_data)
        if coroutine.yield("RUN_COMMAND","scp "..filename.." "..
            darktable.preferences.read("scp_export",
                "export_path","string")) then
            darktable.print_error("scp failed for "..tostring(image))
        end
    end)
end)

```

`darktable.preferences.register` will add a new preference to darktable's preference menu. `scp_export` and `export_path` allow us to uniquely identify our preference. These fields are reused when we read the value of the preference. The `string` field tells the lua engine that the preference is a string. It could also be an integer, a filename or any of the types detailed in API manual relating to `types_lua_pref_type`. We then have the label for the preference in the preference menu, the tooltip when hovering over the value and a default value.

`darktable.register_storage` is the call that actually registers a new storage. The first argument is a name for the storage, the second is the label that will be displayed in the UI and last is a function to call on each image. This function has a lot of parameters, but `filename` is the only one we use in this example. It contains the name of a temporary file where the image was exported by darktable's engine.

This code will work but it has a couple of limitations. This is just a simple example after all:

- We use preferences to configure the target path. It would be nicer to add an element to the export UI in darktable. We will detail how to do that in the next section
- We do not check the returned value of `scp`. That command might fail, in particular if the user has not correctly set the preference.
- This script can't read input from the user. The remote `scp` must use password-less copy. `Scp` can't be provided a password easily, so we will leave it that way
- There is no message displayed once the example is done, only the progressbar on the lower left side tells the user that the job is done.
- We use `coroutine.yield` to call an external program. The normal `os.execute` would block other lua codes from happening.

### 9.1.6. Building User Interface elements

Our previous example was a bit limited. In particular the use of a preference for the export path wasn't very nice. We can do better than that by adding elements to the user interface in the export dialog.

UI elements are created via the `darktable_new_widget` function. This function takes a type of widget as a parameter and returns a new object corresponding to that widget. You can then set various fields to that widget to set its parameters. You will then use that object as a parameter to various functions that will add it to the darktable UI. The following simple example adds a lib in the lighttable view with a simple label

```

local my_label = darktable.new_widget("label")
my_label.label = "Hello, world !"

```

```

dt.register_lib("test", "test", false, {
  [dt.gui.views.lighttable] = {"DT_UI_CONTAINER_PANEL_LEFT_CENTER", 20},
}, my_label)

```

There is a nice syntactic trick to make UI element code easier to read and write. You can call these objects as functions with a table of key values as an argument. This allows the following example to work. It creates a container widget with two sub-widgets. A label and a text entry field.

```

local my_widget = darktable.new_widget("box"){
  orientation = "horizontal",
  darktable.new_widget("label"){ label = "here => " },
  darktable.new_widget("entry"){ tooltip = "please enter text here" }
}

```

Now that we know that, let's improve our script a bit.

```

darktable = require "darktable"

local scp_path = darktable.new_widget("entry"){
  tooltip = "Complete path to copy to. Can include user and hostname",
  text = "",
  reset_callback = function(self) self.text = "" end
}

darktable.register_storage("scp_export", "Export via scp",
  function( storage, image, format, filename,
    number, total, high_quality, extra_data)
    if coroutine.yield("RUN_COMMAND", "scp "..filename.." "..
      scp_path.text
    ) then
      darktable.print_error("scp failed for "..tostring(image))
    end
  end,
  nil, --finalize
  nil, --supported
  nil, --initialize
  darktable.new_widget("box") {
    orientation = "horizontal",
    darktable.new_widget("label"){label = "target SCP PATH "},
    scp_path,
  })

```

### 9.1.7. Sharing scripts

So far, our lua code was in *luarc*. That's a good way to develop your script but not very practical for distribution. We need to make this into a proper lua module. To do that, we save the code in a separate file (**scp-storage.lua** in our case):

```

--[ [
SCP STORAGE
a simple storage to export images via scp

AUTHOR
J r my Rosen (jeremy.rosen@enst-bretagne.fr)

INSTALLATION
* copy this file in $CONFIGDIR/luarc/ where CONFIGDIR
is your darktable configuration directory
* add the following line in the file $CONFIGDIR/luarc
require "scp-storage"

USAGE
* select "Export via SCP" in the storage selection menu
* set the target directory
* export your images

LICENSE
GPLv2

]]
darktable = require "darktable"
darktable.configuration.check_version(...,{2,0,0})

local scp_path = darktable.new_widget("entry"){
  tooltip="Complete path to copy to. Can include user and hostname",
  text = "",
  reset_callback = function(self) self.text = "" end
}

darktable.register_storage("scp_export","Export via scp",
function( storage, image, format, filename,
  number, total, high_quality, extra_data)
  if coroutine.yield("RUN_COMMAND","scp "..filename.." "..
    scp_path.text
  ) then
    darktable.print_error("scp failed for "..tostring(image))
  end
end,
nil, --finalize
nil, --supported
nil, --initialize
darktable.new_widget("box") {
  orientation ="horizontal",
  darktable.new_widget("label"){label = "target SCP PATH "},
  scp_path,
})

darktable will look for scripts (following the normal lua rules) in the standard directories
plus $CONFIGDIR/luarc/?.lua . So our script can be called by simply adding require
"scp-storage" in the luarc file. A couple of extra notes...

```

- The function `darktable.configuration.check_version` will check compatibility for you. The `...` will turn into your script's name and `{2,0,0}` is the API version you have tested your script with. You can add multiple API versions if you update your script for multiple versions of darktable.
- Make sure to declare all your functions as `local` to not pollute the general namespace.
- Make sure you do not leave debug prints in your code. `darktable.print_error` in particular allows you to leave debug prints in your final code without disturbing the console.
- You are free to choose any license for your script but scripts that are uploaded on darktable's website need to be GPLv2.

Once you have filled all the fields, checked your code, you can upload it to our script page here [<https://darktable.org/redmine/projects/darktable/wiki/LuaScripts>].

### 9.1.8. Calling Lua from Dbus

It is possible to send a lua command to darktable via its Dbus interface. The method `org.darktable.service.Remote.Lua` takes a single string parameter which is interpreted as a lua command. The command will be executed in the current lua context and should return either `nil` or a string. The result will be passed back as the result of the Dbus method.

If the Lua call results in an error, the Dbus method call will return an error `org.darktable.Error.LuaError` with the lua error message as the message attached to the Dbus error.

### 9.1.9. Using darktable from a lua script

*Warning: This feature is very experimental. It is known that several elements don't work in library mode yet. Careful testing is highly recommended.*

The lua interface allows you to use darktable from any lua script. This will load darktable as a library and provide you with most of the lua API (darktable is configured headless, so the functions related to the user interface are not available).

As an example, the following program will print the list of all images in your library:

```
#!/usr/bin/env lua
package = require "package"
package.cpath=package.cpath..";./lib/darktable/lib?.so"

dt = require("darktable")(
  "--library", "./library.db",
  "--datadir", "./share/darktable",
  "--moduledir", "./lib/darktable",
  "--configdir", "./configdir",
  "--cachedir", "cachedir",
  "--g-fatal-warnings")

require("darktable.debug")

for k,v in ipairs(dt.database) do
  print(tostring(v))
end
```



Note the third line that points to the location of the `libdarktable.so` file.

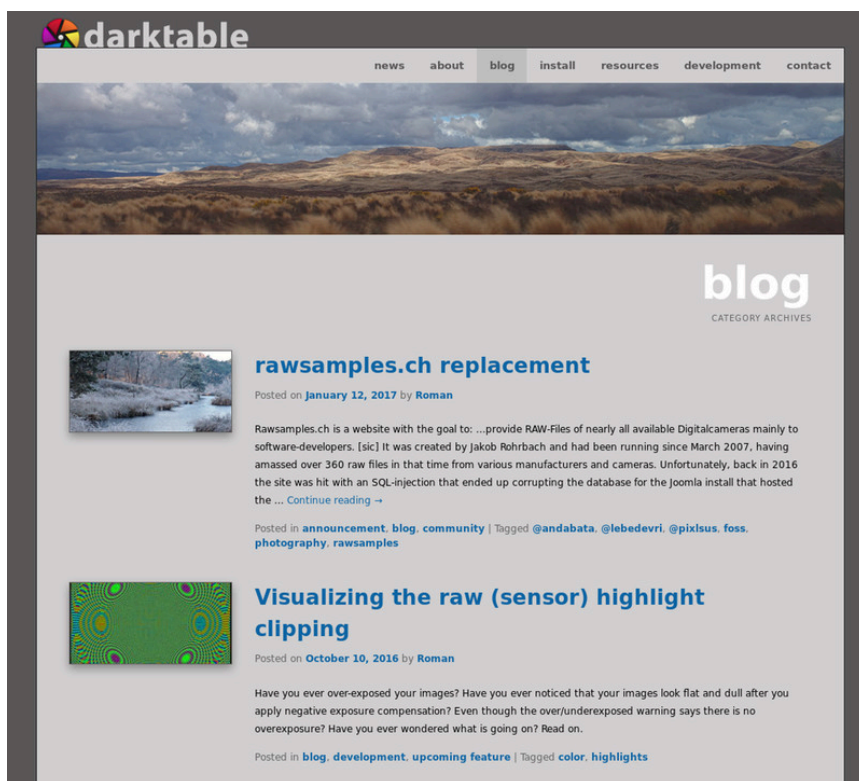
Also note that the call to `require` returns a function that can be called only once and allows you to set darktable's command line parameter. The `:memory:` parameter to `--library` is useful here if you don't want to work on your personal library.

## 9.2. Lua API

darktable's Lua API is documented in its own manual with a detailed description of all data structures and functions. You can download the API manual from darktable's webpage [<https://www.darktable.org/resources/>].

# Chapter 10. Special topics

This chapter touches several technical topics which might help you to get darktable running on specific hardware or optimize its performance. A lot of additional technical background information and many tips and tricks are also covered in an extensive blog section that you can find on our homepage [<https://www.darktable.org>].




The screenshot shows the darktable website's blog page. At the top left is the darktable logo. A navigation menu includes links for news, about, blog, install, resources, development, and contact. Below the menu is a large landscape photograph of a field under a cloudy sky. On the right side, the word "blog" is displayed in a large font, with "CATEGORY ARCHIVES" written in smaller text underneath. The main content area features two blog posts. The first post is titled "rawsamples.ch replacement" and is dated January 12, 2017, by Roman. It includes a small thumbnail image of a snowy landscape. The text of the post describes the website's goal and its history. The second post is titled "Visualizing the raw (sensor) highlight clipping" and is dated October 10, 2016, by Roman. It includes a thumbnail image showing a colorful, abstract pattern representing sensor highlight clipping. The text of the post asks if the reader has ever over-exposed their images and explains the effects of negative exposure compensation.

**darktable**

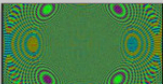
news about **blog** install resources development contact

**blog**  
CATEGORY ARCHIVES

 **rawsamples.ch replacement**  
Posted on **January 12, 2017** by **Roman**

Rawsamples.ch is a website with the goal to: ...provide RAW-Files of nearly all available Digitalcameras mainly to software-developers. [sic] It was created by Jakob Rohrbach and had been running since March 2007, having amassed over 360 raw files in that time from various manufacturers and cameras. Unfortunately, back in 2016 the site was hit with an SQL-injection that ended up corrupting the database for the Joomla install that hosted the ... [Continue reading →](#)

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 **Visualizing the raw (sensor) highlight clipping**  
Posted on **October 10, 2016** by **Roman**

Have you ever over-exposed your images? Have you ever noticed that your images look flat and dull after you apply negative exposure compensation? Even though the over/underexposed warning says there is no overexposure? Have you ever wondered what is going on? Read on.

Posted in [blog](#), [development](#), [upcoming feature](#) | Tagged [color](#), [highlights](#)

## 10.1. darktable and memory

darktable's memory requirements are high. A simple calculation makes this clear. If you have a 20MPix image, darktable for precision reasons will store this internally as a 4 x 32-bit floating point cell for each pixel. Each full image of this size will need about 300MB of memory. As we want to process the image, we will at least need two buffers for each module – one for input and one for output. If we have a more complex module, its algorithm might additionally require several intermediate buffers of the same size. Without further optimization, anything between 600MB and 3GB would be needed only to store and process image data. On top we have darktable's code segment, the code and data of all dynamically linked system libraries, and not to forget further buffers where darktable stores intermediate images for quick access during interactive work (mip map cache). All in all, darktable would like to see a minimum of about 4GB to run happily.

### 10.1.1. Total system memory

From what I said before, it is evident that your computer needs a sane memory setup to properly run darktable. We suggest that you have a least 4GB of physical RAM plus 4 to 8GB of additional swap space installed. The latter is required, so that your system can swap out temporarily unneeded data to disk in order to free physical RAM.

Theoretically, you could also run darktable with lower amounts of physical RAM and balance this with enough swap space. However, you should be prepared that your system could then heavily “thrash”, as it reads or writes data pages to and from the hard disk. We have positive reports that this functions well for several users, but it still might get extremely slow for others...

### 10.1.2. Available address space

Besides the total amount of system memory there is another limiting factor: the available address space of your hardware architecture. How much memory can be addressed by a process depends on the number of address bits your CPU offers. For a CPU with 32-bit address registers, this is  $2^{32}$  bytes, which makes a total of 4GB. This is the absolute upper limit of memory that can be used by a process and it constitutes a tight situation for darktable as we have seen above.

darktable's escape route is called tiling. Instead of processing an image in one big chunk, we split the image into smaller parts for every processing step (module). This will still require one full input and output buffer, but intermediate buffers can be made small enough to have everything fit into the hardware limits.

### 10.1.3. Memory fragmentation

Unfortunately this is not the full story yet. There is an effect called memory fragmentation, which can and will hit software that needs to do extensive memory management. If such a program allocates 5 times 300MB at a time and frees it again, that memory should normally be available for one big 1.5GB allocation afterwards. This however is often not the case. The system's memory allocator may no longer see this area as one contiguous 1.5GB block but as a row of 300MB areas. If there is no other free area of 1.5GB available, the allocation would fail. During a program run this mechanism will take away more and more of the larger memory blocks in favor of smaller ones. darktable 2.0 mip map cache allocates several small memory blocks per each thumbnail, so this problem is even bigger. For this reason, as of darktable 2.0, 32-bit support is soft-deprecated.

#### 10.1.4. Further limitations

As if this were not challenging enough, there are further things that might limit your access to memory. On some older boards you need to activate BIOS option “memory remapping” in order to have all physically installed memory enabled. In addition if you are on a 32-bit OS you will probably need a kernel version that has “Physical Address Extension” (PAE) enabled. This is often but not always the case for Linux. Many distributions deliver different kernels, some with and some without PAE activated; you need to choose the right one. To check if the system is setup correctly, use the command “free” in a terminal and examine the output. If the output reports less RAM than you have installed, you have an issue needing correction; for example you have 4GB on your board, but your kernel is only seeing 3GB or less. You need to consult your BIOS manual and the information about your Linux variant for further help.

#### 10.1.5. Setting up darktable on 32-bit systems

As we've seen 32-bit systems are difficult environments for darktable. Still some users are running darktable on them, if the basic requirements in terms of total system memory and the topics mentioned in the paragraphs above are addressed properly.

There are several adjustment parameters to get it running. If you install fresh, darktable will detect your system and set conservative values by default. However, if you upgrade darktable from an older version (e.g. coming from 0.9.3 and going to 1.0), chances are you have unfavorable settings in your preferences. The consequences might be darktable aborting due to allocation failures or – very typically – darktable not being able to properly import a new film roll. As a frequent symptom you get skulls displayed instead of thumbs for many of your pictures.

If this is the case, take a minute to optimize the preference settings in this case. You will find them under “core options” (Section 8.2, “Core options”) in darktable's preference dialog. You should also find these parameters as configuration variables in `$/HOME/.config/darktable/darktable.rc` and edit them there.

Here is a short explanation of the relevant parameters and their proposed settings:

number of background threads

This parameter defines the maximum number of threads that are allowed in parallel when importing film rolls or doing other background stuff. For obvious reasons on 32-bit systems you can only have one thread eating resources at a time. So you need set this parameter to 1; anything higher will kill you.

host memory limit (in MB) for tiling

This parameter tells darktable how much memory (in MB) it should assume is available to store image buffers during module operations. If an image can not be processed within these limits in one chunk, tiling will take over and process the image in several parts, one after the other. Set this to the lowest possible value of 500 as a starting point. You might experiment later whether you can increase it a bit in order to reduce the overhead of tiling.

minimum amount of memory (in MB) for a single buffer in tiling

This is a second parameter that controls tiling. It sets a lower limit for the size of intermediate image buffers in megabytes. The parameter is needed to avoid excessive tiling in some cases (for some modules). Set this parameter to a low value of 8. You might tentatively increase it to 16 later.

memory in megabytes to use for thumbnail cache

This controls how many thumbnails (or mip maps) can be stored in memory at a time. As a starting point set this to something like 256MB. Since darktable 2.0, the cache does allocate a few small buffers per each thumbnail in cache, thus causing significant memory fragmentation. As explained before, this poses a problem for 32-bit systems. For this reason, as of darktable 2.0, 32-bit support is soft-deprecated.

### 10.1.6. darktable on 64-bit systems

There's not much to be said here. Of course also 64-bit systems require a sufficient amount of main memory, so the 4GB plus swap recommendation holds true. On the other hand, 64-bit architectures do not suffer from the specific 32-bit limitations like small address space and fragmentation madness.

Most modern Intel or AMD 64-bit CPUs will have available address space in the range of several Terabytes. The word "modern" is relative in this context: all AMD and Intel CPUs introduced since 2003 and 2004, respectively, offer a 64-bit mode. Linux 64-bit has been available for many years.

All relevant Linux distributions give you the choice to install a 32-bit or a 64-bit version with no added costs. You can even run old 32-bit binaries on a 64-bit Linux. The only thing you need to do: invest some time into the migration. In the end we strongly recommend moving to a 64-bit version of Linux. There really is no reason not to upgrade to 64-bit.

On a 64-bit system you can safely leave the tiling related configuration parameters at their defaults: "host memory limit (in MB) for tiling" should have a value of 1500 and "minimum amount of memory (in MB) for a single buffer in tiling" should be set to 16. In case you are migrating from a 32-bit to a 64-bit system you will need to check these settings and manually change them if needed in darktable's preference dialog.

Typically there is no need to restrict oneself in the number of background threads on a 64-bit system. On a multi-processor system a number of two to eight threads can speed up thumbnail generation considerably versus only one thread. The reason is not so much taking maximum advantage of all your CPU cores – darktable's pixelpipe anyhow uses all of them in parallel – but hiding I/O latency.

One exception is worth to be mentioned. If you use darktable to process stitched panoramas, e.g. TIFFs as generated by Hugin, these images can reach considerable sizes. Each background thread needs to allocate enough memory to keep one full image plus intermediates and output in its buffers. This may quickly run even a well equipped 64-bit system out of memory. In that case lower the number of background threads to only one.

## 10.2. darktable and OpenCL

darktable can use GPU acceleration via OpenCL to improve performance.

### 10.2.1. The background

Processing high resolution images is a demanding task needing a modern computer. Both in terms of memory requirements and in terms of CPU power, getting the best out of a typical 15, 20 or 25 Megapixel image can quickly bring your computer to its limits.

darktable's requirements are no exception. Our decision to not compromise processing quality, has led to all calculations being done on 4 x 32bit floating point numbers. This is slower than "ordinary" 8 or 16bit integer algebra, but eliminates all problems of tonal breaks or loss of information.

A lot of hand optimization has been invested to make darktable as fast as possible. If you run a current version of darktable on a modern computer, you might not notice any "slowness". However, there are conditions and certain modules where you will feel (or hear from the howling of your CPU fan) how much your poor multi-core processor has to struggle.

That's where OpenCL comes in. OpenCL allows us to take advantage of the enormous power of modern graphics cards. Gamer's demand for high detailed 3D worlds in modern ego shooters has fostered GPU development. ATI, NVIDIA and Co had to put enormous processing power into their GPUs to meet these demands. The result is modern graphics cards with highly parallelized GPUs to quickly calculate surfaces and textures at high frame rates.

You are not a gamer and you don't take advantage of that power? Well, then you should at least use it in darktable! For the task of highly parallel floating point calculations modern GPUs are much faster than CPUs. That is especially true, when you want to do the same few processing steps over millions of items. Typical use case: processing of megapixel images.

### 10.2.2. How OpenCL works

As you can imagine, hardware architectures of GPUs can vary significantly. There are different manufacturers, and even different generations of GPUs from the same manufacturer may differ. At the same time GPU manufacturers don't normally disclose all hardware details of their products to the public. One of the known consequences is the need to use proprietary drivers under Linux, if you want to take full advantage of your graphics card.

Fortunately an industry consortium lead by The Khronos Group has developed an open, standardized interface called OpenCL. It allows the use of your GPU as a numerical processing device. OpenCL offers a C99-like programming language with a strong focus on parallel computing. An application that wants to use OpenCL will need OpenCL source code that it hands over to a hardware specific OpenCL compiler at run-time. This way the application can use OpenCL on different GPU architectures (even at the same time). All hardware "secrets" are hidden in this compiler and are normally not visible to the user (or the application). The compiled OpenCL code is loaded onto your GPU and – with certain API calls – it is ready to do calculations for you.

### 10.2.3. How to activate OpenCL in darktable

Using OpenCL in darktable requires that your PC is equipped with a suitable graphics card and that it has the required libraries in place. Namely modern graphics cards from NVIDIA

and AMD come with full OpenCL support. The OpenCL compiler is normally shipped as part of the proprietary graphics driver; it is used as a dynamic library called "libOpenCL.so". This library must be in a folder where it is found by your system's dynamic linker.

When darktable starts, it will first try to find and load libOpenCL.so and – on success – check if the available graphics card comes with OpenCL support. A sufficient amount of graphics memory (1GB+) needs to be available to take advantage of the GPU. If that is OK, darktable tries to setup its OpenCL environment: a processing context needs to be initialized, a calculation pipeline to be started, OpenCL source code files (extension is .cl) need to be read and compiled and the included routines (called OpenCL kernels) need to be prepared for darktable's modules. If all that is done, the preparation is finished.

Per default OpenCL support is activated in darktable if all the above steps were successful. If you want to de-activate it you can do so in "core options" (Section 8.2, "Core options") by unchecking "activate opencl support". This configuration parameter also tells you if OpenCL initialization failed: it is greyed out in that case.

You can at any time switch OpenCL support off and on; this will happen immediately. Depending on the type of modules you are using, you will notice the effect as a general speed-up during interactive work and during export. Most modules in darktable can take advantage of OpenCL but not all modules are demanding enough to make a noticeable difference. In order to feel a real difference, take modules like *shadows and highlights*, *sharpen*, *lowpass*, *highpass* or even more extreme *equalizer* and *profiled denoise*.

If you are interested in profiling figures, you can start darktable with command line parameters "-d opencl -d perf". After each run of the pixelpipe you will get a detailed allocation of processing time to each module plus an even more fine grained profile for all used OpenCL kernels.

Besides the speed-up you should not see any difference in the results between CPU and GPU processing. Except of rounding errors, the results are designed to be identical. If, for some reasons, darktable fails to properly finish a GPU calculation, it will normally notice and automatically (and transparently) fall back to CPU processing.

#### 10.2.4. Setting up OpenCL on your system

The huge diversity of systems and the marked differences between OpenCL vendors and driver versions makes it impossible to give an comprehensive overview of how to setup OpenCL. We only can give you an example, in this case for NVIDIA driver version 331.89 on Ubuntu 14.04. We hope that this will serve you as a first impression and will help to solve possible problems of your specific setup.

The principle OpenCL function flow is like this:

darktable -> libOpenCL.so -> libnvidia-opencl.so.1 -> kernel driver module(s) -> GPU

- darktable dynamically loads `libOpenCL.so`, a system library which must be accessible to the system's dynamic loader (`ld.so`).
- `libOpenCL.so` will read the vendor specific information file (`/etc/OpenCL/vendors/nvidia.icd`) to find the library which contains the vendor specific OpenCL implementation.
- The vendor specific OpenCL implementation comes as a library `libnvidia-opencl.so.1` (which in our case is a symbolic link to `libnvidia-opencl.so.331.89`).



- `libnvidia-opencl.so.1` needs to talk to the vendor specific kernel modules `nvidia` and `nvidia_uvm` via device special files `/dev/nvidia0`, `/dev/nvidiactl`, and `/dev/nvidia-uvm`.

At system startup the required device special files (`/dev/nvidia*`) need to be created. If this does not happen on your system by default, the easiest way to set them up and make sure all modules are loaded is installing the `nvidia-modprobe` package (which, at the time of this writing, is only available for “utopic”, but works well with “trusty” and “Mint 17”). You can grab it at this site [<http://packages.ubuntu.com/utopic/nvidia-modprobe>].

A user account which wants to make use of OpenCL from within darktable needs to have read-write access to NVIDIA's device special files. On some systems these files allow world read-write access by default, which avoids permission issues but might be debatable in terms of system security. Other systems restrict the access to a user group, e.g. “video”. In that case your user account has to be member of that group.

To summarise, the packages which needed to be installed in this specific case were:

- `nvidia-331` (331.89-0ubuntu1~xedgers14.04.2)
- `nvidia-331-dev` (331.89-0ubuntu1~xedgers14.04.2)
- `nvidia-331-uvm` (331.89-0ubuntu1~xedgers14.04.2)
- `nvidia-libopencl1-331` (331.89-0ubuntu1~xedgers14.04.2)
- `nvidia-modprobe` (340.24-1)
- `nvidia-opencl-dev:amd64` (5.5.22-3ubuntu1)
- `nvidia-opencl-icd-331` (331.89-0ubuntu1~xedgers14.04.2)
- `nvidia-settings` (340.24-0ubuntu1~xedgers14.04.1)
- `nvidia-settings-304` (340.24-0ubuntu1~xedgers14.04.1)
- `nvidia-libopencl1-331` (331.89-0ubuntu1~xedgers14.04.2)
- `nvidia-opencl-dev:amd64` (5.5.22-3ubuntu1)
- `nvidia-opencl-icd-331` (331.89-0ubuntu1~xedgers14.04.2)
- `opencl-headers` (1.2-2013.10.23-1)

The list of NVIDIA related kernel modules as reported by `lsmod` is:

```
nvidia
nvidia_uvm
```

The list of NVIDIA related device special files (`ls -l /dev/nvidia*`) should read like:

```
crw-rw-rw- 1 root root 195,  0 Jul 28 21:13 /dev/nvidia0
crw-rw-rw- 1 root root 195, 255 Jul 28 21:13 /dev/nvidiactl
crw-rw-rw- 1 root root 250,  0 Jul 28 21:13 /dev/nvidia-uvm
```

Beware that the major/minor numbers (e.g. 250/0 for `/dev/nvidia-uvm` in this example) may vary depending on your system.

## 10.2.5. Possible problems and solutions

darktable will detect OpenCL run-time problems automatically. It will then reprocess everything on CPU; only speed is affected, the final result should not be endangered.

There can be various reasons why OpenCL could fail during initialization phase. We depend on hardware requirements and on the presence of certain drivers and libraries. In addition all these have to fit in terms of maker model and revision number. If anything does not fit, e.g. your graphics driver (loaded as a kernel module) does not match the version of your libOpenCL.so, OpenCL support is likely not available.

In that case, the best thing to do is start darktable from a console with

```
darktable -d opengl
```

This will give additional debugging output about the initialization and use of OpenCL. First see if you find a line that starts with “[opengl\_init] FINALLY ...” This should tell you, if OpenCL support is available for you or not. If initialization failed, look at the messages above for anything that reads like “could not be detected” or “could not be created”. Check if there is a hint about where it failed.

Here are a few cases observed in the past:

- darktable might tell you that no OpenCL aware graphics card is detected or that the available memory on your GPU is too low and the device is discarded. In that case you might need to buy a new card, if you really want OpenCL support.
- darktable might find your libOpenCL.so but then tell you that it couldn't get a platform. NVIDIA drivers will often give error code -1001 in that case. This happens because libOpenCL.so is only a wrapper library. For the real work further libraries – specific to vendor, device and driver – need to be loaded. This failed for some reason. There is a structure of files in /etc/OpenCL on your system that libOpenCL.so consults to find these libraries. Check if you find something fishy in there and try to fix it. Often the needed libraries cannot be found by your system's dynamic loader. Giving full path names might help.
- darktable might also tell you that a context could not be created. This often indicates a version mismatch between (loaded) graphics driver and libOpenCL. Check if you have left-over kernel modules or graphics libraries of an older install and take appropriate action. In doubt, make a clean reinstall of your graphics driver. Sometimes, immediately after a driver update, the loaded kernel driver does not match the newly installed libraries: reboot your system in that case.
- darktable might crash in very rare cases directly during startup. This can happen if your OpenCL setup is completely broken or if driver/library contains a severe bug. If you can't fix it, you can still use darktable with option “--disable-opengl”, which will skip the entire OpenCL initialization step.
- darktable might fail to compile its OpenCL source files at run-time. In that case you will get a number of error messages looking like typical compiler errors. This could indicate an incompatibility between your OpenCL implementation and our interpretation of the standard. In that case visit us in IRC in #darktable on FreeNode or on the developers mailing list at darktable-dev@lists.darktable.org and report the problem. Chances are good that we can help you. Please also report if you see significant differences between CPU and GPU processing of an image!

There also exists a few on-CPU implementations of OpenCL. These come as drivers provided by INTEL or AMD. We observed that they do not give us any speed gain versus

our hand-optimized CPU code. Therefore we simply discard these devices by default. This behavior can be changed by setting the configuration variable `openccl_use_cpu_devices` to `TRUE`.

### 10.2.6. Setting up OpenCL for AMD/ATI devices

While NVIDIA devices and most modern AMD/ATI devices will most often run out of the box, there is more to do for older AMD/ATI graphics cards, namely those prior to the HD7xxx series. This starts with the fact that those devices will only report to darktable part of their total GPU memory. For a 1GB device this typically amounts to 512MB, a value which darktable in its standard configuration will refuse as not being sufficient for its tasks. Consequence: the device will not be used.

On the web you might find as a tip to set environment variable `GPU_MAX_HEAP_SIZE` to a value of 100 in this case. Indeed this will cause the AMD/ATI driver to report the full installed memory to darktable. However, there is a problem. On many (most?) cards this will cause buffers to be allocated on your computer (host) not on the video card! In this case all memory accesses will need to go through the slow PCIe bus. This will cost you a factor of 10x or more in performance and will render OpenCL useless for you, especially when exporting files.

Another environment variable which changes driver behavior is `GPU_MAX_ALLOC_PERCENT`. You could set this to 100 in order to allow memory allocations as high as 1GB on your AMD/ATI card. The problem is, this tends to cause darktable to crash sooner or later.

Our recommendation is to leave these settings untouched. Often your card will be recognized with 512MB memory and a maximum allocation size of 128MB. There are three configuration parameter which you set in file `$HOME/.config/darktable/darktable.rc` to get things running. Here are the details:

`openccl_memory_requirement`

Set this parameter to 500 so that darktable will accept your 512MB graphics memory as being sufficient in memory.

`openccl_memory_headroom`

This parameter controls how much graphics memory (out of the reported one) darktable should leave untouched for driver and display use. As for AMD/ATI devices we anyhow only can get half of the available RAM it's safe to set this to zero. So all of the 512MB can be used by darktable.

`openccl_avoid_atomics`

Atomic operations in OpenCL are a special way of data synchronization. They are only used in a few kernels. Unfortunately, some (most?) AMD/ATI devices are extremely slow in processing atomics. It's better to process the affected modules on CPU rather than accepting an ultra-slow GPU codepath. Set this parameter to `TRUE` if you experience slow processing of modules like *shadows and highlights*, *monochrome*, *local contrast*, or *global tonemap* or if you even get intermittent system freezes.

These recommendations do not apply to the more recent Radeon HD7xxx series with GCN architecture. Besides being very fast in terms of GPU computing they normally run out of the box. You only might consider to try some of the performance optimization options which are described in the following section.

## 10.2.7. OpenCL performance optimization

There are some configuration parameters in `$HOME/.config/darktable/darktable.rc` that help to finetune your system's OpenCL performance. Performance in this context mostly means the latency of darktable during interactive work, i.e. how long it takes to reprocess your pixelpipe. For a comfortable workflow it is essential to keep latency low.

In order to get profiling info you start darktable from a terminal with

```
darktable -d opengl -d perf
```

After each reprocessing of pixelpipe – caused by module parameter change, zooming, panning, etc. – you will get the total time and the time spent in each of our OpenCL kernels. The most reliable value is the total time spent in pixelpipe. Please note that the timings given for each individual module are unreliable when running the OpenCL pixelpipe asynchronously (see `opengl_async_pixelpipe` below).

To allow for a fast pixelpipe processing with OpenCL it is essential that we keep the GPU busy. Any interrupts or a stalled data flow will add to the total processing time. This is especially important for the small image buffers we need to handle during interactive work. They can be processed quickly by a fast GPU. However, even short-term stalls of the pixelpipe will easily become a bottleneck.

On the other hand darktable's performance during file exports is more or less only governed by the speed of our algorithms and the horse-power of your GPU. Short-term stalls will not have a noticeable effect on the total time of an export.

darktable comes with default settings that should deliver a decent GPU performance on most systems. However, if you want to fiddle around a bit by yourself and try to optimize things further, here is a description of the relevant configuration parameters.

`opengl_async_pixelpipe`

This boolean flag controls how often we block the OpenCL pixelpipe and get a status on success/failure of all the kernels that have been run. For optimum latency set this to `TRUE`, so darktable runs the pixelpipe asynchronously and tries to use as few interrupts as possible. If you experience OpenCL errors like failing kernels, set the parameter to `FALSE`. darktable will then interrupt after each module so you can more easily isolate the problem. Problems have been reported with some older ATI/AMD cards, like HD57xx, which can produce garbled output if this parameter is set to `TRUE`. If in doubt, leave it at its default `FALSE`.

`opengl_number_event_handles`

Event handles are used so we can monitor success/failure of kernels and profiling info even if the pixelpipe is run asynchronously. The number of event handles is a limited resource of your OpenCL driver. For sure we can recycle them, but there is a limited number that we can use at the same time. Unfortunately, there is no way to find out what the resource limits are; so we need to guess. Our default value of 25 is quite conservative. You might want to try if higher values like 100 give better OpenCL performance. If your driver runs out of free handles you would experience failing OpenCL kernels with error code `"-5 (CL_OUT_OF_RESOURCES)"` or even crashes or system freezes; reduce the number again in that case. A value of 0 will block darktable from using any event handles. This will prevent darktable from properly monitoring the success of your OpenCL kernels but saves some driver overhead. The consequence is that any failures will likely lead to garbled output without darktable taking notice;

only recommended if you know for sure that your system runs rock-solid. You can also set this parameter to -1, which means that darktable assumes no restriction in the number of event handles; this is not recommended.

#### `opencl_synch_cache`

This parameter, if set to TRUE, will force darktable to fetch image buffers from your GPU after each module and store them in its pixelpipe cache. This is a very resource consuming operation. It only makes sense if you have a rather slow GPU. In that case darktable might in fact save some time when module parameters have changed, as it can go back to some cached intermediate state and reprocess only part of the pixelpipe. In most cases this parameter should be set to FALSE (default).

#### `opencl_micro_nap`

In an ideal case you keep your GPU busy at 100% when reprocessing the pixelpipe. That's good. On the other hand your GPU is also needed to do regular GUI updates. It might happen that there is no sufficient time left for this task. Consequence would be a jerky reaction of your GUI on panning, zooming or when moving sliders. darktable can add small naps into its pixelpipe processing to have the GPU catch some breath and do GUI related stuff. Parameter `opencl_micro_nap` controls the duration of these naps in microseconds. You need to experiment in order to find an optimum value for your system. Values of 0, 100, 500 and 1000 are good starting points to try. Defaults to 1000.

#### `opencl_use_pinned_memory`

During tiling huge amounts of memory need to be transferred between host and device. On some devices (namely AMD) direct memory transfers to and from an arbitrary host memory region may give a huge performance penalty. This is especially noticeable when exporting large images. Setting this configuration parameter to TRUE tells darktable to use a special kind of intermediate buffer for host-device data transfers. On some devices this can speed up exporting of large files by a factor of 2 to 3. NVIDIA devices and drivers seem to have a more efficient memory transfer technique even for arbitrary memory regions. As they may not show any performance gain and even may produce garbled output, `opencl_use_pinned_memory` should be left at its default FALSE for those devices.

### 10.2.8. OpenCL scheduling profile

darktable can use the CPU and one or several OpenCL capable GPUs. Depending on the relative performance users can choose among certain scheduling profiles to optimize performance. This is done by the configuration parameter "OpenCL scheduling profile" in the "core options" dialog (Section 8.2, "Core options") which offers the following choices:

- |               |   |
|---------------|---|
| default       | If an OpenCL capable GPU is found darktable uses it for processing the center image view while the preview window (see Section 3.3.1, "Navigation") is processed on the CPU in parallel. This is the preferred setting for systems with a reasonably fast CPU and a moderately fast GPU. The exact allocation of devices to the various pixelpipe types can be finetuned with the "opencl_device_priority" configuration parameter (see below). |
| very fast GPU | With this scheduling profile darktable processes the center image view and the preview window on the GPU sequentially. This is the preferred setting for systems with a GPU that strongly outperforms the CPU.  |

multiple GPUs            This setting addresses systems with multiple GPUs whose relative performance does not differ significantly. Whenever a processing job is started darktable uses any currently idle GPU but not the CPU. Users of systems with a variety of GPUs will need better control on their relative priority. They should better select the “default” profile and finetune their system with the “`opengl_device_priority`” configuration parameter (see below).

On first start-up or after any detected change in the GPU configuration of your system darktable tries to identify the best suited profile for you. You can change it at any time in the “core options” dialog (Section 8.2, “Core options”) with immediate effect.

### 10.2.9. Multiple OpenCL devices – manual settings

The scheduling of OpenCL devices on most typical systems can be optimized using the “OpenCL scheduling profile” settings. However, if your system is equipped with a variety of GPUs you might want to set the relative device priority manually. To do so you need to select the “default” scheduling profile and do your settings in the “`opengl_device_priority`” configuration parameter.

It is important to understand how darktable uses OpenCL devices. Each processing sequence of an image – to convert an input to the final output using a certain history stack – is run in a so called pixelpipe. There are four different types of pixelpipe in darktable. One type is responsible to process the center image view (or full view) in darkroom mode, another pixelpipe processes the preview image (navigation window) top left in darkroom mode. Of each of these two pixelpipe there can be one at a time – with the full and the preview pixelpipe running in parallel. In addition there can be multiple parallel pixelpipes doing file exports and there can be multiple parallel pixelpipes generating thumbnails. If an OpenCL device is available darktable dynamically allocates it to one specific pixelpipe for one run and releases it afterwards.

The computational demand depends a lot on the pixelpipe type. Preview image and thumbnails have a low resolution and can be processed quickly; center image view is more demanding, let alone the pixelpipe doing a file export.

Configuration parameter “`opengl_device_priority`” holds a string with the following structure:

```
a,b,c.../k,l,m.../o,p,q.../x,y,z...
```

Each letter represents one specific OpenCL device. There are four fields in the parameter string separated by a slash, each representing one type of pixelpipe. “a,b,c...” defines the devices that are allowed to process the center image (full) pixelpipe. Likewise devices “k,l,m...” can process the preview pixelpipe, devices “o,p,q...” the export pixelpipes and finally devices “x,y,z...” the thumbnail pixelpipes. An empty field means that no OpenCL device may serve this type of pixelpipe.

darktable has an internal numbering system, where the first available OpenCL device will receive number “0”. All further devices are numbered consecutively. This number together with the device name is displayed when you start darktable with “`darktable -d opengl`”. You can specify a device either by number or by name (upper/lower case and whitespace do not matter). If you have more than one device – all with the same name – you need to use the device numbers in order to differentiate them.

A device specifier can be prefixed with an exclamation mark “!”, in which case the device is excluded from processing this pixelpipe. You can also give an asterisk “\*” as a wildcard, representing all devices not mentioned explicitly before in that group.

Sequence order within a group matters. darktable will read the list from left to right and whenever it tries to allocate an OpenCL device to a pixelpipe it will scan the devices in that order, taking the first free device it finds.

If a pixelpipe process is about to be started and if all GPUs in the corresponding group are busy, darktable automatically processes the image on the CPU by default. You can enforce GPU processing by prefixing the list of allowed GPUs with a plus sign "+". darktable will not use the CPU but rather suspend processing until the next allowed OpenCL device is available.

darktable's default setting for "opengl\_device\_priority" is:

```
*/!0,*/**/*
```

Any detected OpenCL device is allowed to process our center view image. The first OpenCL device (0) is not allowed to process the preview pixelpipe. As a consequence, if there is only one GPU owned by your system, preview pixelpipe will always be processed on CPU, keeping your single GPU exclusively for the more demanding center image view. This is a reasonable setting for most systems. No restrictions apply to export and thumbnail pixelpipes.

The default is a good choice if you have only one device. If you have several devices it forms a reasonable starting point. However, as your devices might have quite different levels of processing power, it makes sense to invest a few thoughts and optimize your priority list.

Here is an example. Let's assume we have a system with two devices, a fast Radeon HD7950 and an older and slower GeForce GTS450. darktable (started with "darktable -d opengl") will report the following devices:

```
[opengl_init] successfully initialized.
[opengl_init] here are the internal numbers and names of
                OpenCL devices available to darktable:
[opengl_init]          0          'GeForce GTS 450'
[opengl_init]          1          'Tahiti'
[opengl_init] FINALLY: opengl is AVAILABLE on this system.
```

So the GeForce GTS 450 is detected as the first device; the Radeon HD7950 ('Tahiti') as the second one. This order will normally not change unless the hardware or driver configuration is modified. But it's better to use device names rather than numbers to be on the safe side.

As the GTS450 is slower than the HD7950, an optimized opengl\_device\_priority could look like:

```
!GeForce GTS450,*/!Tahiti,*/Tahiti,*/Tahiti,*
```

The GTS450 is explicitly excluded from doing the center image pixelpipe; this is reserved to "all" other devices (i.e. the HD7950/Tahiti). Completely the opposite for our preview pixelpipe. Here the Tahiti is excluded, so that only the GTS450 will be allowed to do the work.

For file export and thumbnail generation we want all hands on deck. However, darktable should first look if device Tahiti is free, because it's faster. If that's not the case, all other devices – in fact only the GTS450 – are checked.

## 10.2.10. OpenCL still does not run for me!

As has been said before OpenCL systems come with a huge variety of setups: different GPU manufacturers, different GPU models, varying amounts of GPU memory, different

drivers, different distributions etc. Many of the potential problems will only appear with a very specific combination of those factors.

As we developers of darktable on our computers only have access to a small fraction of those variations, please understand that we might not be able to fix your specific problem. There is not much we can do, if there is no way for us to reproduce.

If nothing else helps, the best option might be to start darktable with

```
darktable --disable-opengl
```

In the end there is nothing in darktable which only runs on GPU. Don't let OpenCL discourage you; also darktable's CPU code is highly optimized for performance!



## 10.3. Using `darktable-chart`

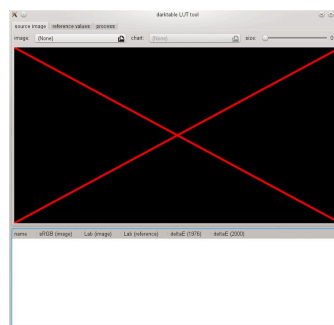
### 10.3.1. Overview

With `darktable-chart` we provide a tool for extracting luminance and color values out of images taken from color reference cards like IT8.7/1 charts. Its main purpose is to compare a source image (typically a largely unprocessed raw image) to a target image (typically a JPEG image created in-camera) and produce a darktable style that is able to convert luminance and color values of the source image to produce the target image. This style employs the *base curve* module, the *input color profile*, and the *color look up table* module for that purpose (see Section 3.4.1.4, “Base curve”, Section 3.4.3.11, “Input color profile”, and Section 3.4.3.6, “Color look up table”).

Some cameras are particularly advanced in offering various film simulation modes of your choice. With the help of `darktable-chart` and the underlying modules you can now create styles that replicate these film simulations from within darktable.

### 10.3.2. Usage

The tool is organized into three tabs in the upper part and a text output frame in the lower part.



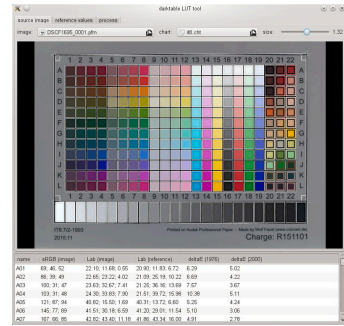
The first tab is used to define the source image, the second tab defines the reference (target) and the third tab contains the controls to generate the resulting darktable style.

### 10.3.3. Source image

In the “source image” tab you set your source image which requires two elements. The first element is an input file in Lab Portable Float Map format (extension *.pfm*). The source file represents the largely unmodified data as the camera sees them. Details on taking photos of a color reference card and producing a *.pfm* output file are described below. The second element is a chart file that contains a formal description of the underlying color reference card's layout (extension *.cht*). Chart files are usually shipped with your color reference card or can be downloaded.

In real life the photo taken from the color reference card will show some perspective distortions relative to the layout defined in the chart file. For that reason the layout is displayed as a grid over the image and can be modified.

You can move the corners of the grid using the mouse to reach best alignment of grid and image.



A rectangular frame is displayed for each patch and defines the area from which `darktable-chart` will actually sample the needed input data. It may be required to modify the size of these rectangles so that the sampling area is big enough but does not overlap with neighboring patches. Use the “size” slider in the upper right part of the GUI. Higher values lead to smaller sizes.

### 10.3.4. Reference values

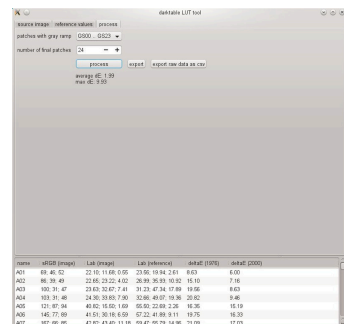
The “reference values” tab determines the target values to which the source image is to be modified by the resulting style. You can either supply reference values in the form of measured data of your color reference card (mode “cie/it8 file”), or you supply a photographic image (mode “color chart image”) much in the same way as described above. This second image must also be supplied in Lab Portable Float Map format. There is no need to supply the chart file again as `darktable-chart` takes the same one as defined under “source image”. You only need to again align the layout grid and the image and potentially adjust the “size” slider.

In a typical use case the second image will be based on a JPEG file produced in-camera. This way you can create a style to simulate the in-camera processing within darktable.

In the lower text output frame you see the color values extracted from the available data for each individual color patch. The first column gives the name of the patch, the second and third column show the corresponding color values of the source image in RGB and Lab format, respectively. The fourth column contains the Lab value coming from the reference (or from the chart file if no reference image has been given). Finally, the fifth and sixth columns display how strongly source and reference values deviate in terms of delta E values.

### 10.3.5. Process

If all required settings in “source image” and “reference values” are ready you can move to the “process” tab.



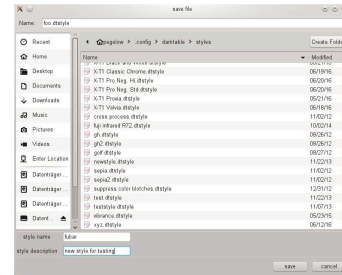
You first need to tell `darktable-chart` which of the patches represent the gray ramp. In the screenshot displayed further above the gray ramp is positioned in the lower part of the color reference chart, denoted as “GS00...GS23”.

The input “number of final patches” defines how many editable color patches the resulting style will use within the *color look up table* module (for more details see Section 3.4.3.6, “Color look up table”).

By clicking the “process” button you start the calculation.

The quality of the result in terms of average delta E and maximum delta E are displayed below the button. These data show how close the resulting style applied to the source image will be able to match the reference values – the lower the better.

Once you are happy with the result you can click on “export” and save the generated style.



You supply a style name and a style description under which the style will later appear in darktable. `darktable-chart` saves the style as a *.dstyle* file which can be imported into darktable (see Section 2.3.8, “Styles”) and shared with others.

The “export raw data as csv” button allows you to save the extracted raw data as a CSV file for debugging purposes or later usage. `darktable-chart` offers a command line option to produce a style with the desired number of final patches from a supplied CSV file (see Section 1.1.4, “darktable-chart binary”).

### 10.3.6. Making input images for `darktable-chart`

To start with, you need a suitable photo of your color reference card in RAW+JPEG format. It goes beyond the scope of this manual to explain the details of how to take this photo, but in a nutshell you need to make the shot on a sunny day around midday with the light source (sun) shining at an angle onto the card. You need to avoid any glare in the image. The neutral white color patch in the gray ramp (G00) should end up at the L value specified in the description of your card. Often this is L=92 and requires you to overexpose the shot by about 1/3 EV. Ideally you make several shots with slightly different exposures to later select the right one in darktable. Make sure that the chart fills up most of the frame. Take a lens with a “normal” focal length (e.g. 50mm equivalent) and stop down a bit to avoid vignetting.

You then open the raw file in darktable and disable most modules, especially *base curve*. Select the standard input matrix in the *input color profile* module and disable gamut clipping. Select “camera white balance” in the *white balance* module (see Section 3.4.1.4, “Base curve”, Section 3.4.3.11, “Input color profile”, and Section 3.4.1.10, “White balance”).

There is a special situation if your camera automatically applies some lens corrections, namely vignetting correction, to the resulting JPEG file. In this case you need to activate the *lens correction* module in darktable so that raw processing matches the JPEG in this respect (see Section 3.4.4.8, “Lens correction”).

To output your image you go to the “export” module in darktable (see Section 2.3.12, “Export selected”).

You need to select “Lab” as output color profile. This color space is not visible in the combobox by default. You first need to enable it by setting `allow_lab_output` to TRUE

in `$HOME/.config/darktable/darktable.rc`. Alternatively, you can start darktable with:

```
darktable --conf allow_lab_output=true
```

Then select “PFM (float)” as output format and press “export” to generate the source image file.

In a similar way you produce the corresponding reference (target) image from the JPEG. Also this time you need to disable all modules and export with “Lab” output color profile in “PFM (float)” format.

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