

Digital Photography for Radio Amateurs

Presented by
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Digital Photography & Ham radio?

What does this:

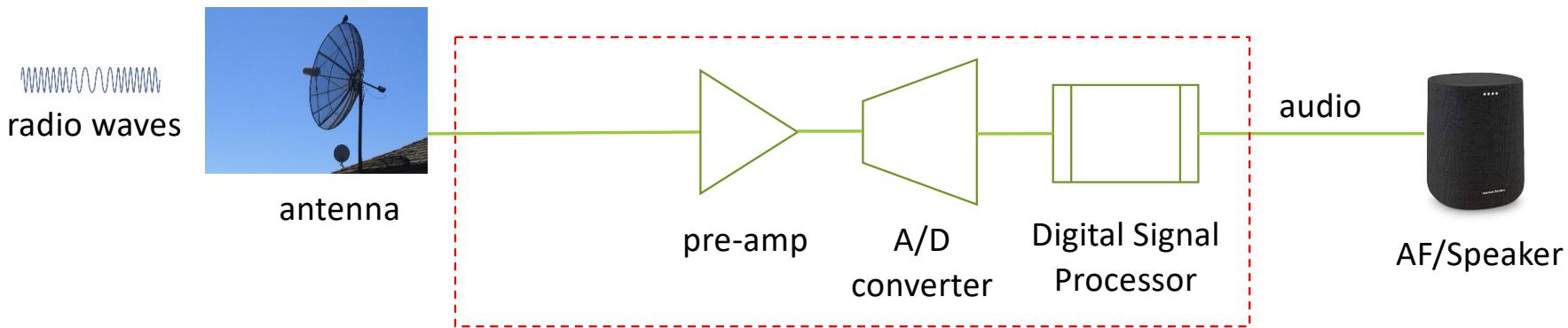


Have in common with this:

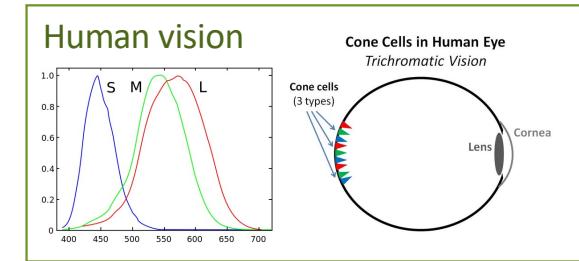
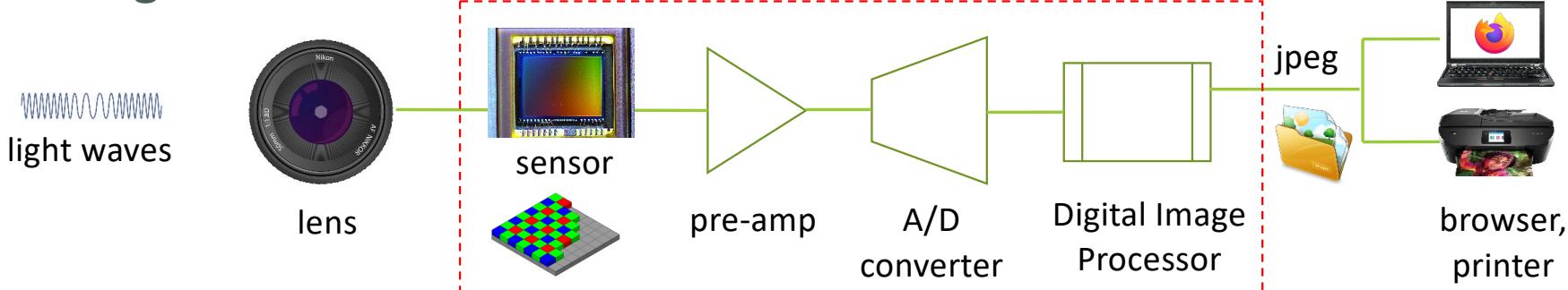


Signal Processing!!

- Digital (SDR) Radio:

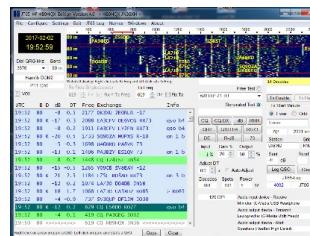


- Digital Camera:



How do Hams deal with weak signals?

- Turn up the gain in the radio
- Increase antenna gain
- Collect signals over a longer period of time (e.g. JT65)

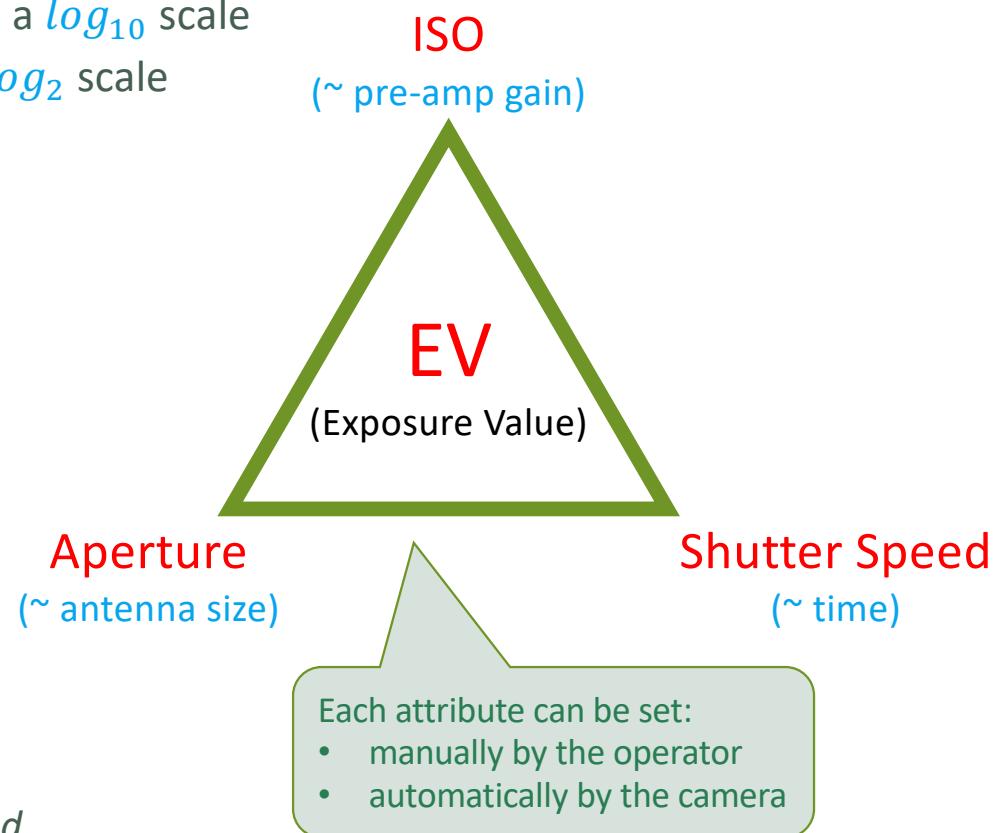


Photographic Equivalent: The Exposure Triangle

- For signal strength, hams use **S-meter/decibels**, a \log_{10} scale
- Photographers use **Exposure Value** or **Stops**, a \log_2 scale

	EV	Amount of light
...	-3	$\times 1/8$
-6dB	-2	$\times 1/4$
-3dB	-1	$\times 1/2$
0dB	0	$\times 1$
+3dB	+1	$\times 2$
+6dB	+2	$\times 4$
...	+3	$\times 8$

Each extra stop doubles the amount of light collected



ISO (turn up the gain)

- Can amplify analogue signal from sensor, or do it digitally in the DSP
- Each doubling of the ISO number adds 1 stop of exposure

ISO	EV
100	0
200	+1
400	+2
800	+3
...	
32000	+8.3

... and some cameras can even go beyond this range

- Increasing ISO increases noise
(same as increasing receiver gain in ham radio)

=> What to do?

Denoising



Image at 12800 ISO before denoising



After denoising, using darktable

Aperture – a bigger collector

- Like the pupil in your eye, you can control the size of the opening in your lens
- The **larger** the aperture *f/* number, the **smaller** the opening
- To add a slide, click New Slide on the Insert menu, or press CTRL+M.

<i>f/</i> number	EV
1.4	0
2.0	+1
2.8	+2
4.0	+3
5.6	+4
8.0	+5



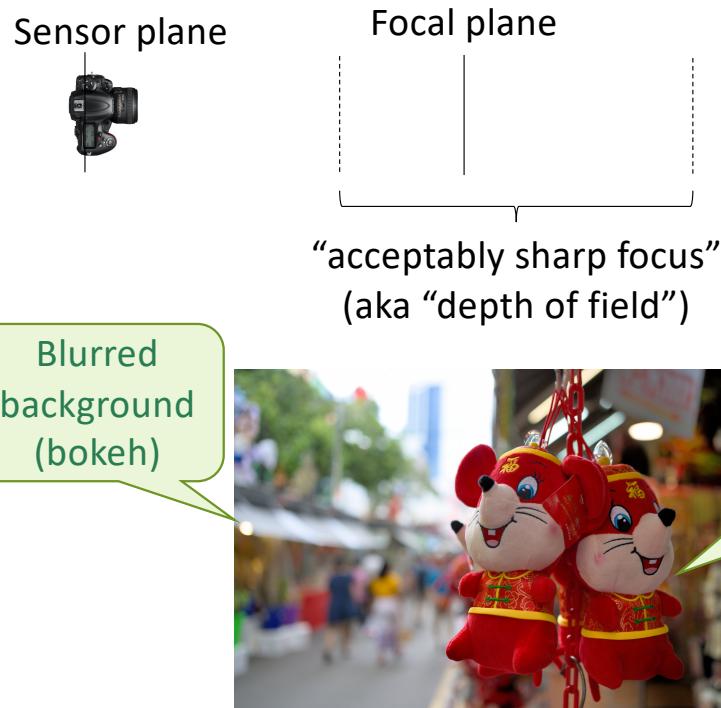
Why the weird numbers?

- Aperture depends on **diameter**
- Light collected depends on **area ($\propto diameter^2$)**

So, **doubling** the *f/* number decreases EV by **2 stops**

Aperture – Depth of Field

- Aperture side effect: how much of the image is in focus?



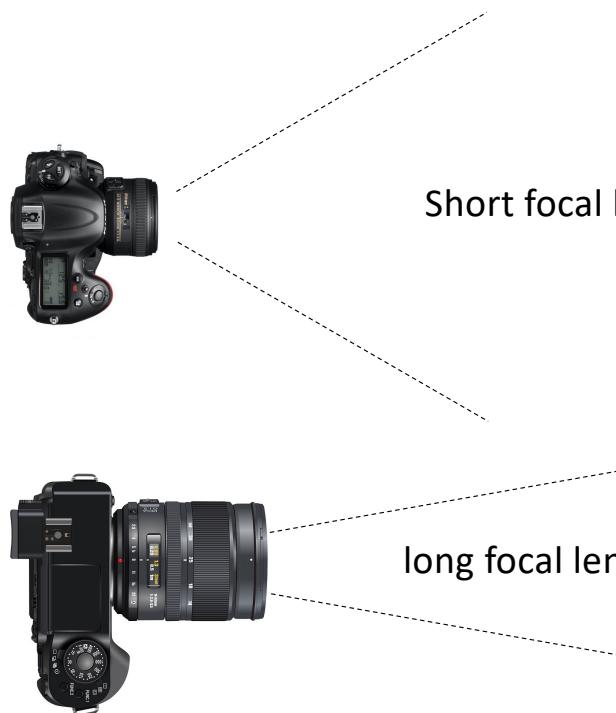
f/1.8 (wide open)



f/16 (closed down)

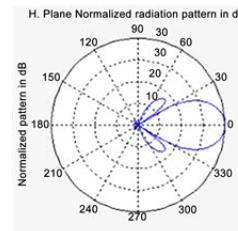


Focal Length (“beam width”)



Short focal length => wide angle of view

long focal length => narrow angle of view



- Can get closer to subject
- Background looks further away

- Must stand back from subject
- Background looks closer (aka “compression”)

Shutter Speed (Time)

- The amount of time the sensor is given to collect light is called “shutter speed”
- If you **double** the time the shutter is open, you **double** the amount of light (+1 EV)
- If the camera or the subject moves while the shutter is open, there will be “motion blur” (smearing)

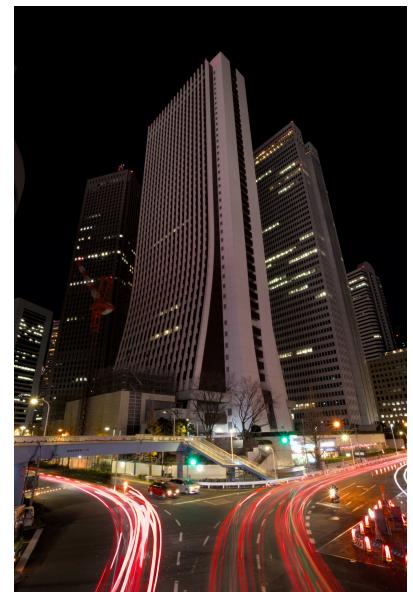
Reciprocal rule-of-thumb: for a clear hand-held shot:

Set shutter speed faster than $\frac{1}{\text{focal length}}$

e.g. for 50mm lens, set shutter speed to $1/50$ sec or faster



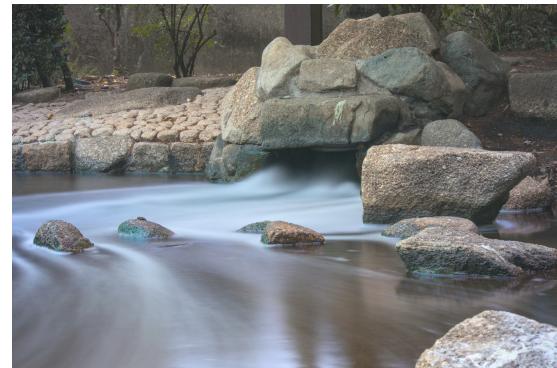
$1/1250$ sec



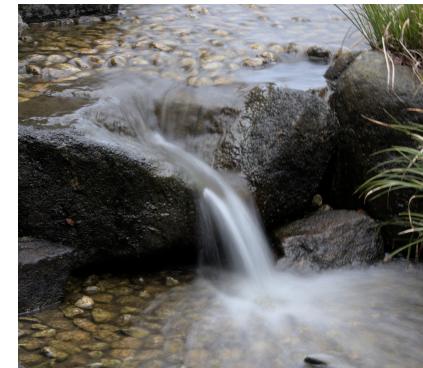
20 sec



$1/80$ sec

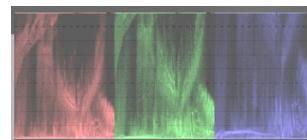
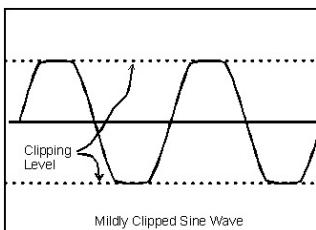


30 sec

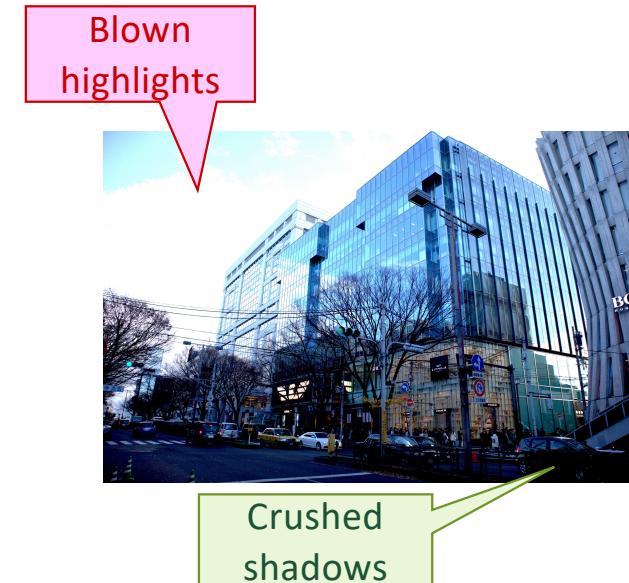
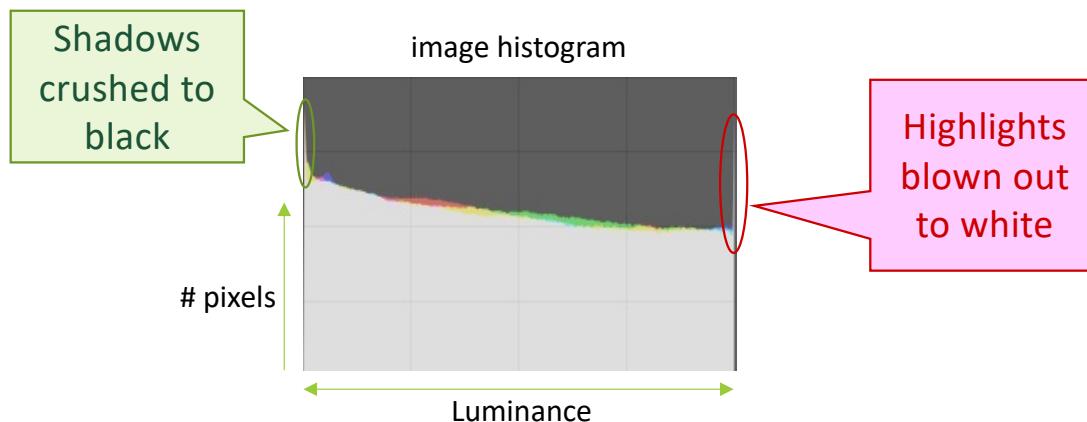


1 sec

Clipping



- Unless using full manual mode, camera will set the exposure so the average brightness will be “middle grey” (a bit like “AGC”)
- But what if regions in the image are too bright or too dark for the display to handle? => **clipping**

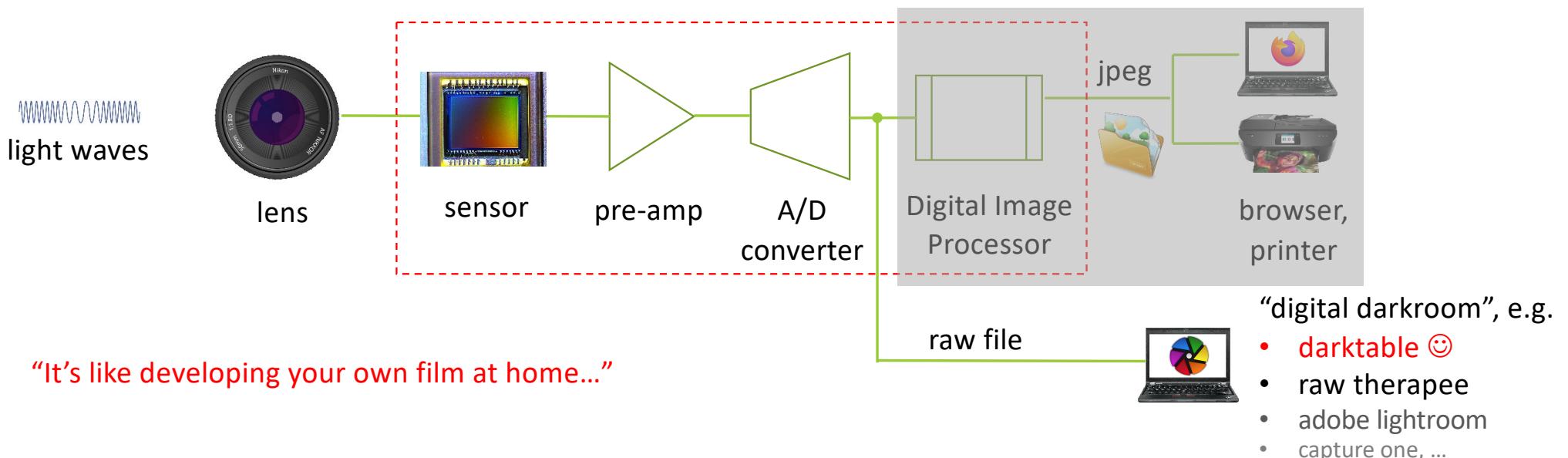


Clipped data is permanently lost. So, as rule-of-thumb:
Set exposure as high as possible (maximise SNR) **without** clipping highlights.

Raw Processing

- Camera capture more information than is displayed
- Camera's processor makes compromises to produce JPEG and discards the extra data
- Camera raw files let us capture data directly off the sensor

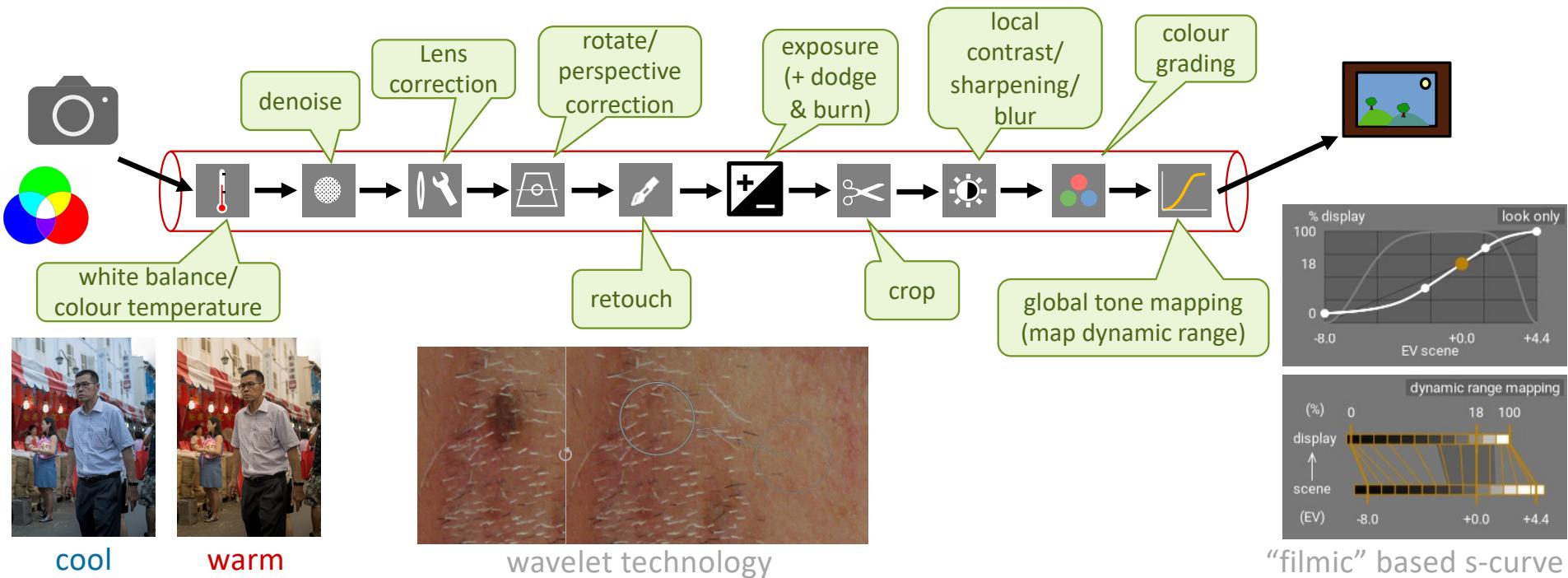
Medium	Max Dynamic Range
Camera Sensor	12-14EV
LCD Display	8-9EV
Paper Print	6-7EV





Darktable (open source)

- Non-destructive editor (raw file is never modified)
- Implements a “pixel pipeline” of processing modules
- List of modules & their settings are recorded in an “xmp” sidecar file



Conclusion

- Digital photography offers plenty of scope for learning and experimenting at all levels

Activity	Level	Learning
Use phone camera/ automatic mode	CB Radio Appliance operator	Learn about lighting and composition
Use camera in manual modes with JPEG	Ham Radio operator	Learn more advanced camera techniques
Shoot and develop RAW files	Ham Radio kit builder	Learn how image processing works using pre-defined modules
Contribute to open-source image processing software	Ham radio homebrewer	Delve into image processing algorithms in depth!

So, no matter your level, get out there, take some photos, and HAVE FUN!!