

Digital Photography for Radio Amateurs

Presented by

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Digital Photography & Ham radio?

What does this:

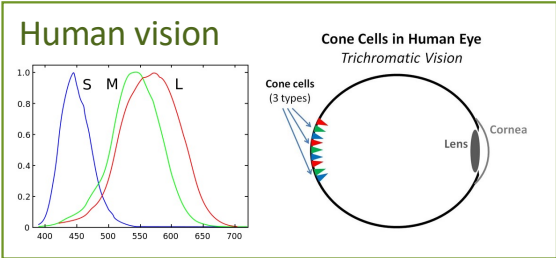
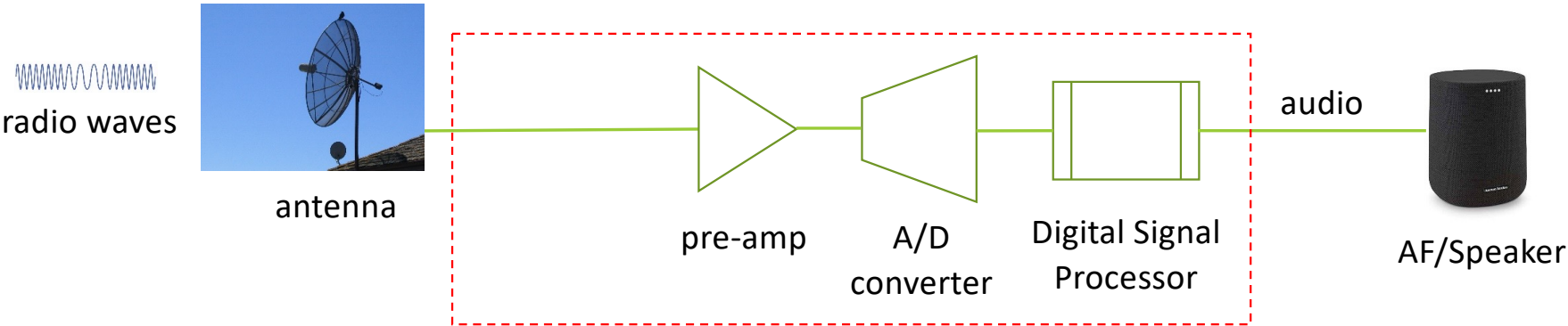


Have in common with this:

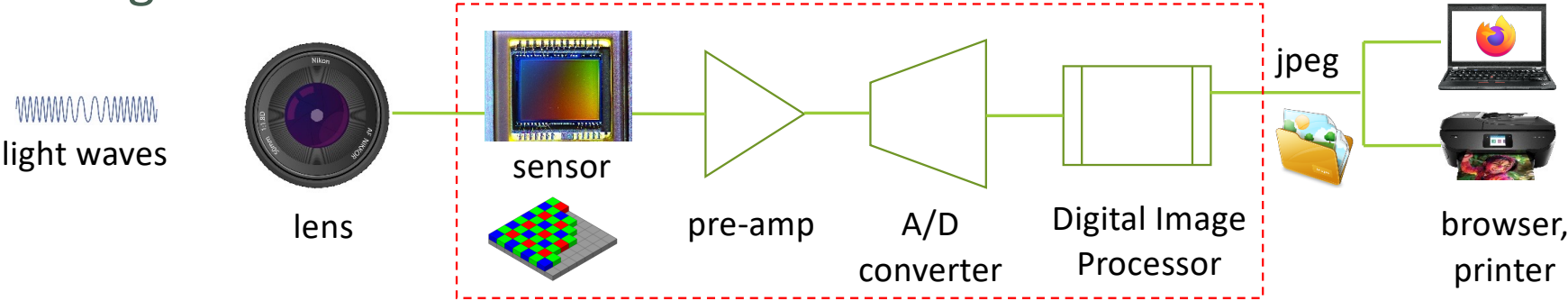


Signal Processing!!

- Digital (SDR) Radio:

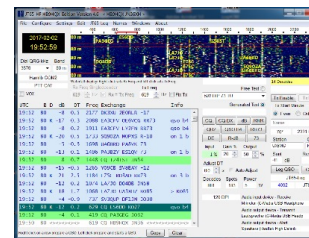


- Digital Camera:



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)

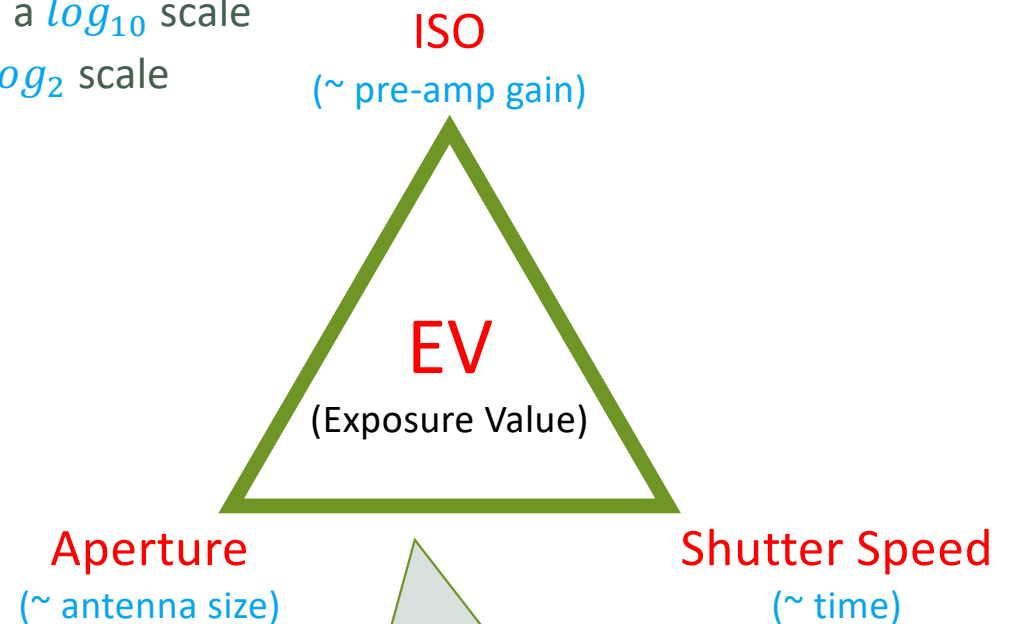


Photographic Equivalent: The Exposure Triangle

- 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



Each attribute can be set:

- manually by the operator
- automatically by the camera

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.

| $f/$ 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** ($\propto \text{diameter}^2$)

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

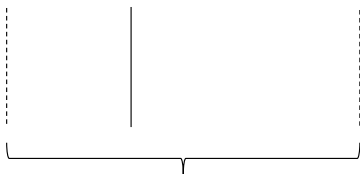
Aperture – Depth of Field

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

Sensor plane



Focal plane



“acceptably sharp focus”
(aka “depth of field”)

Blurred
background
(bokeh)

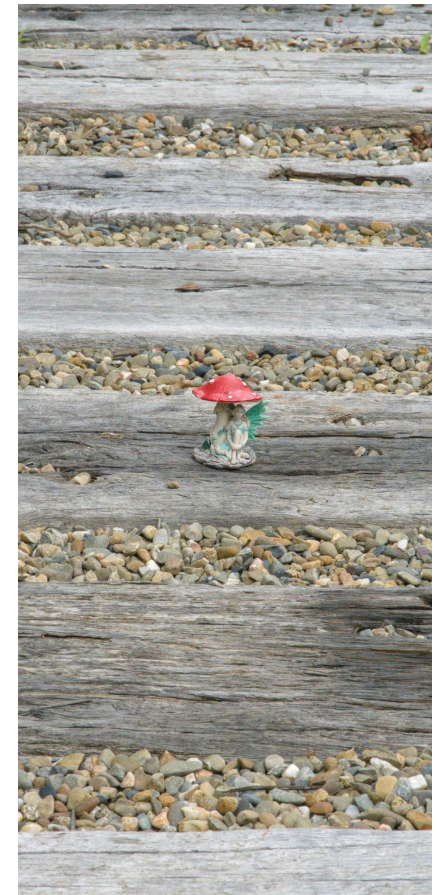


Subject in
focus, stands
out against
background

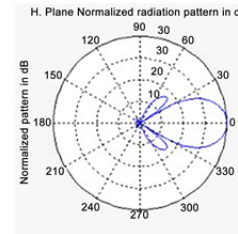
f/1.8 (wide open)



f/16 (closed down)



Focal Length (“beam width”)



Short focal length => wide angle of view



long focal length => narrow angle of view



18mm "wide"



50mm "normal"



120mm "telephoto"

- 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 $\frac{1}{50}$ sec or faster



$\frac{1}{1250}$ sec



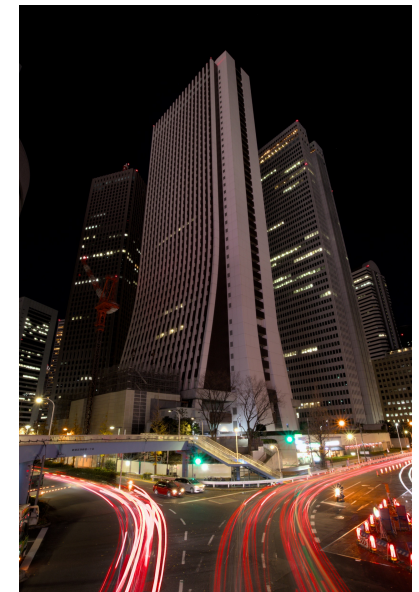
$\frac{1}{80}$ sec



30 sec

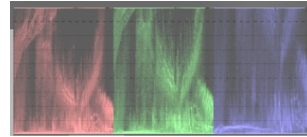
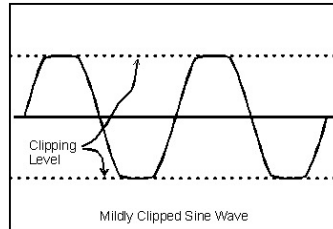


1 sec

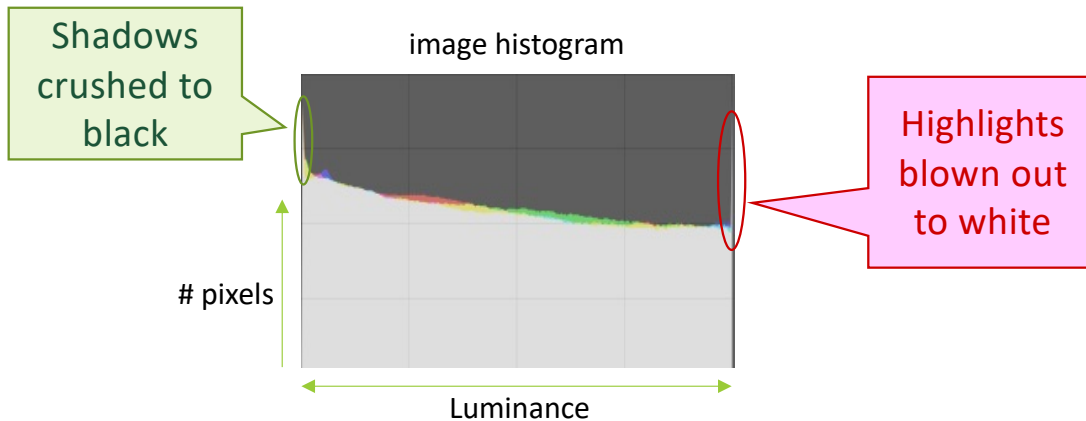


20 sec

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**



Blown highlights



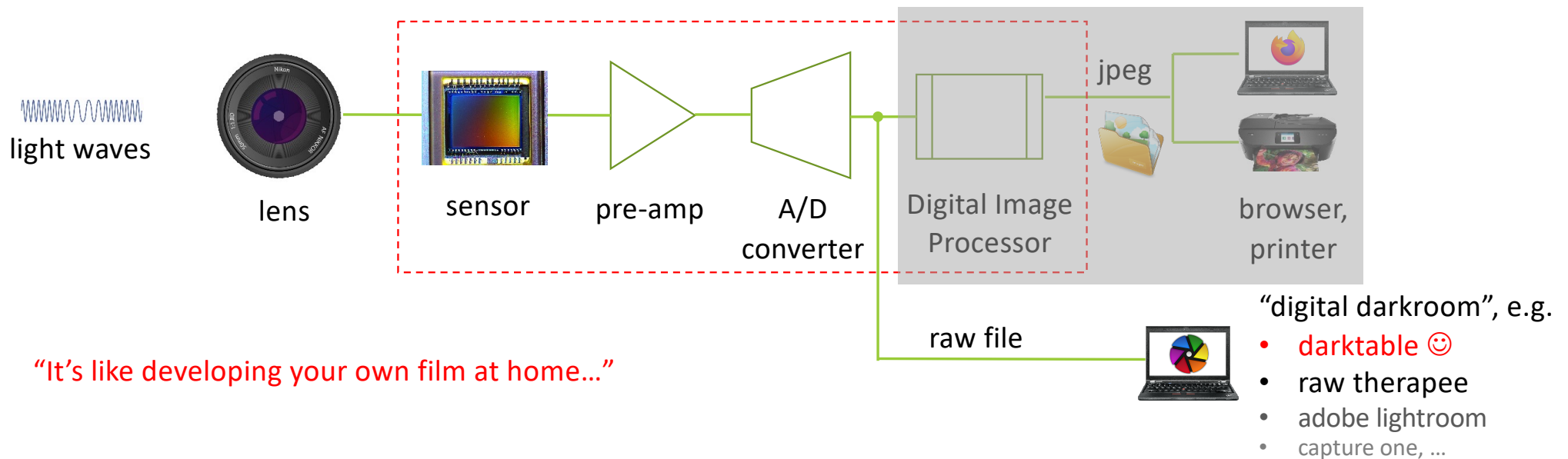
Crushed shadows

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 |

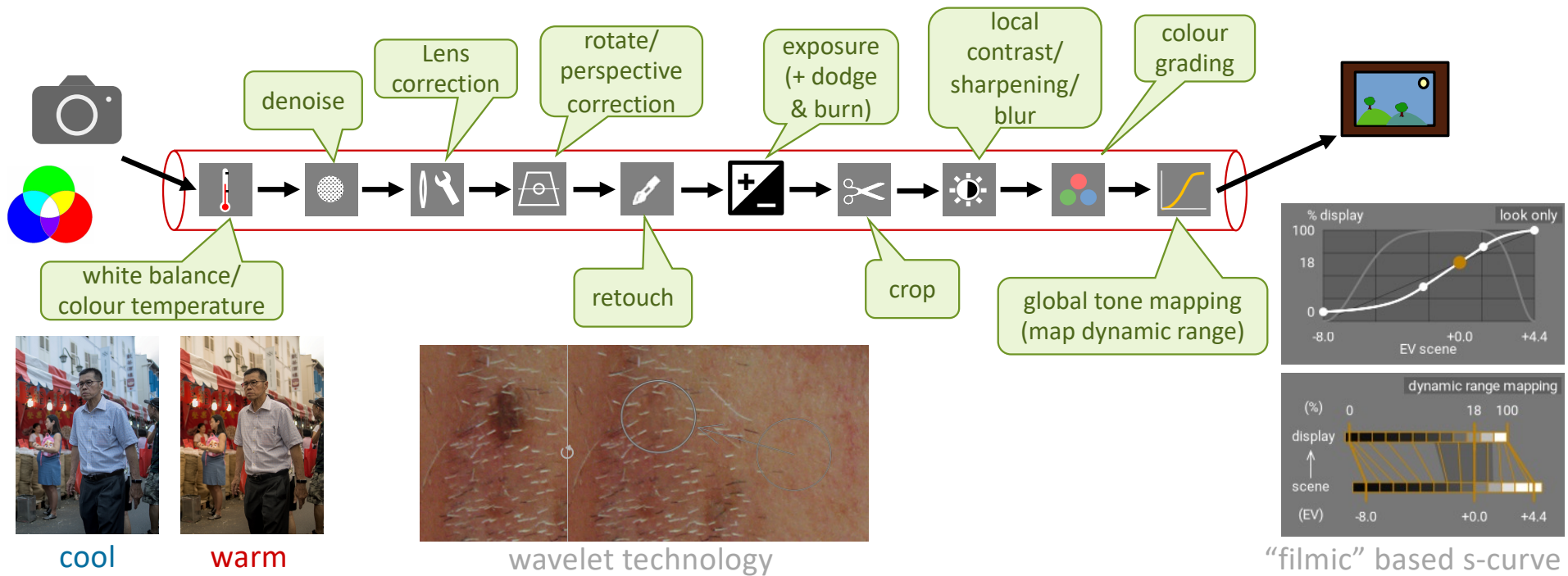


"digital darkroom", e.g.

- darktable 😊
- raw therapee
- adobe lightroom
- capture one, ...

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!!