(personal journey title)
..or maybe
(some sort of beginners guide to astrophotography)

Tony Gomez

July 15, 2020

What Astrophotography is Really About and Things to Consider so You Don't make Costly Mistakes

(with hints of being a beginner guide and a little bit of my journey)

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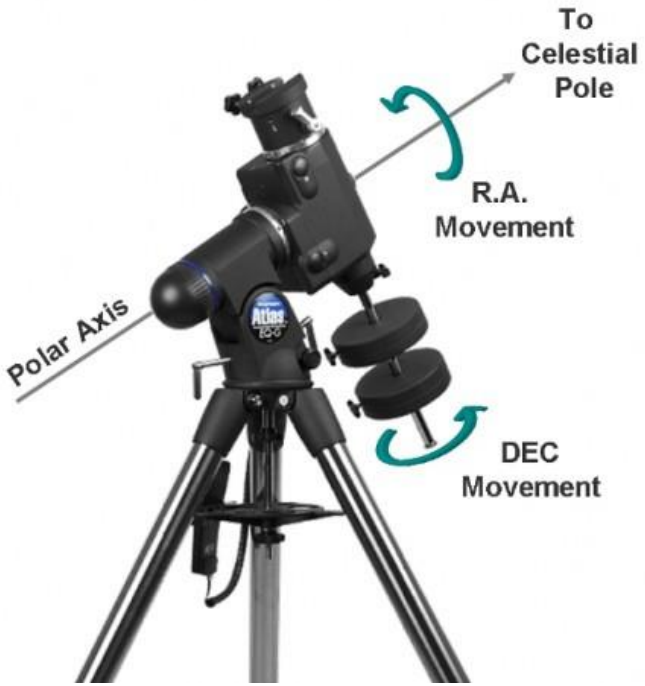
Minimal Equipment for AP

- Mount
- Camera
- Telescope/Camera Lens
- Computer
- Processing software

AP appropriate mounts

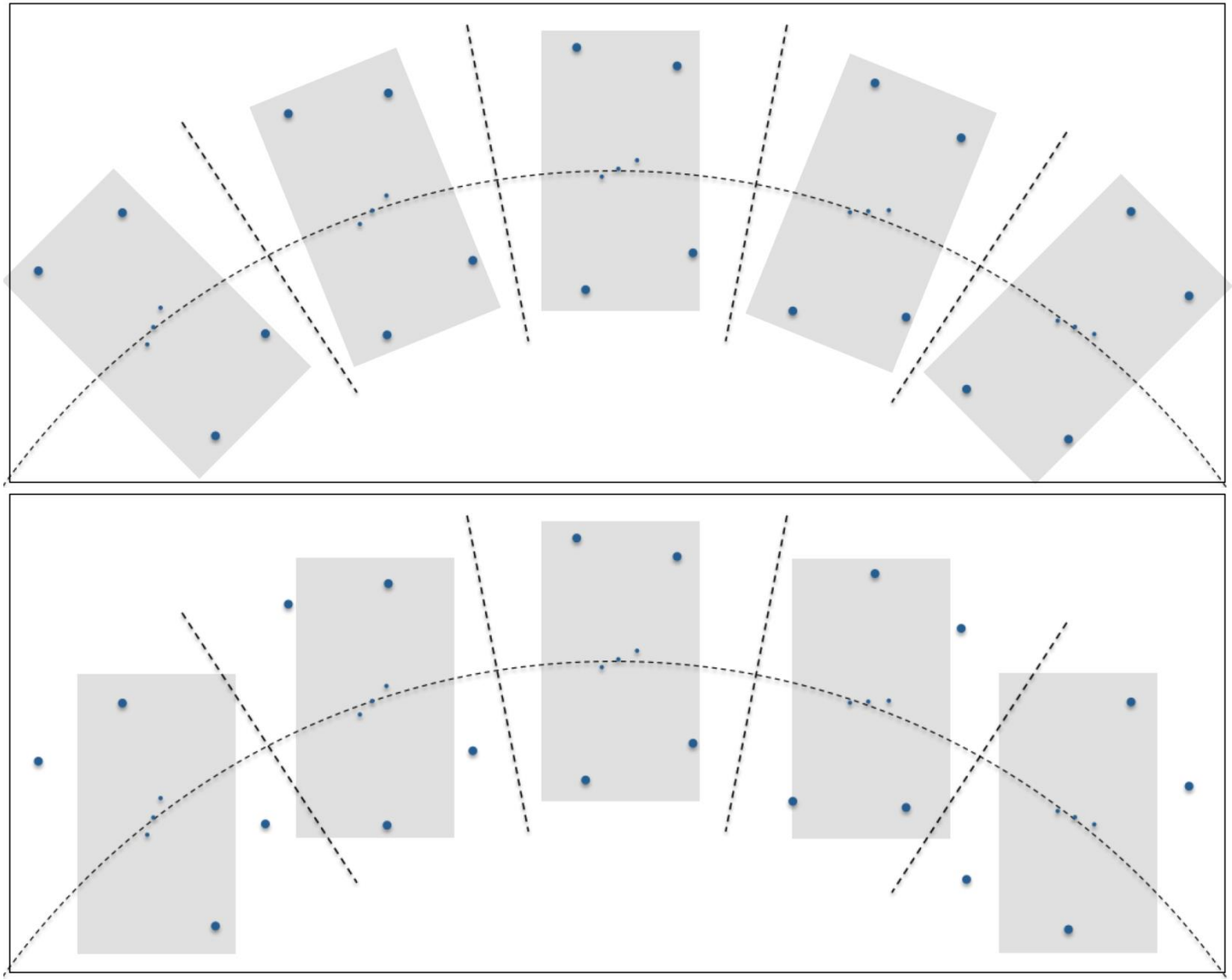
If you are on a very tight budget



Get a GEM if you can afford one

Not great but will work

Field rotation

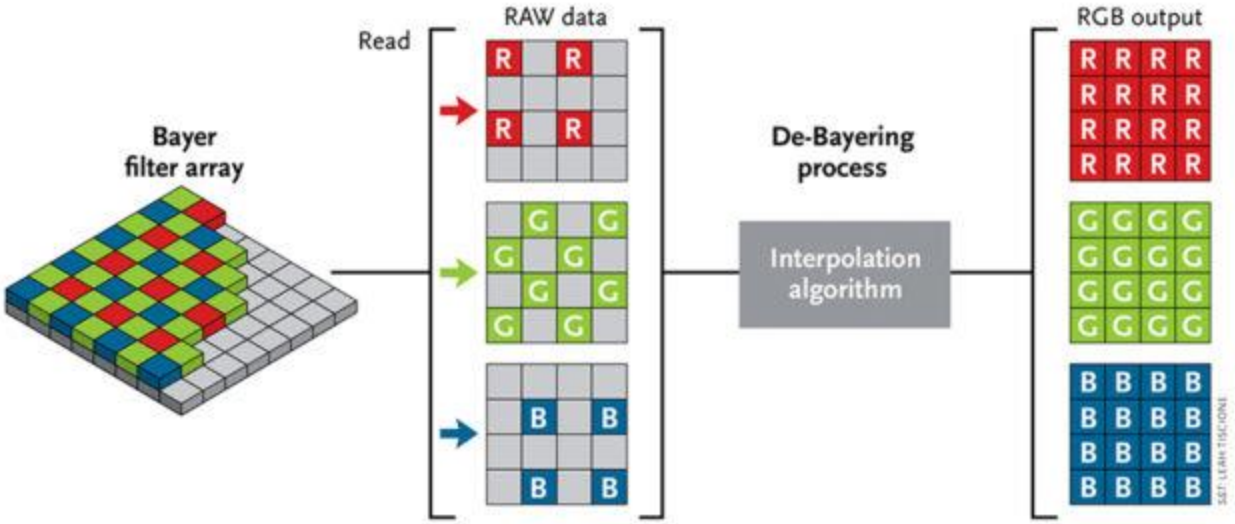


Cameras

+ you might have one already
+wide field
-noisier
-difficult to calibrate
-IR cut-off filter

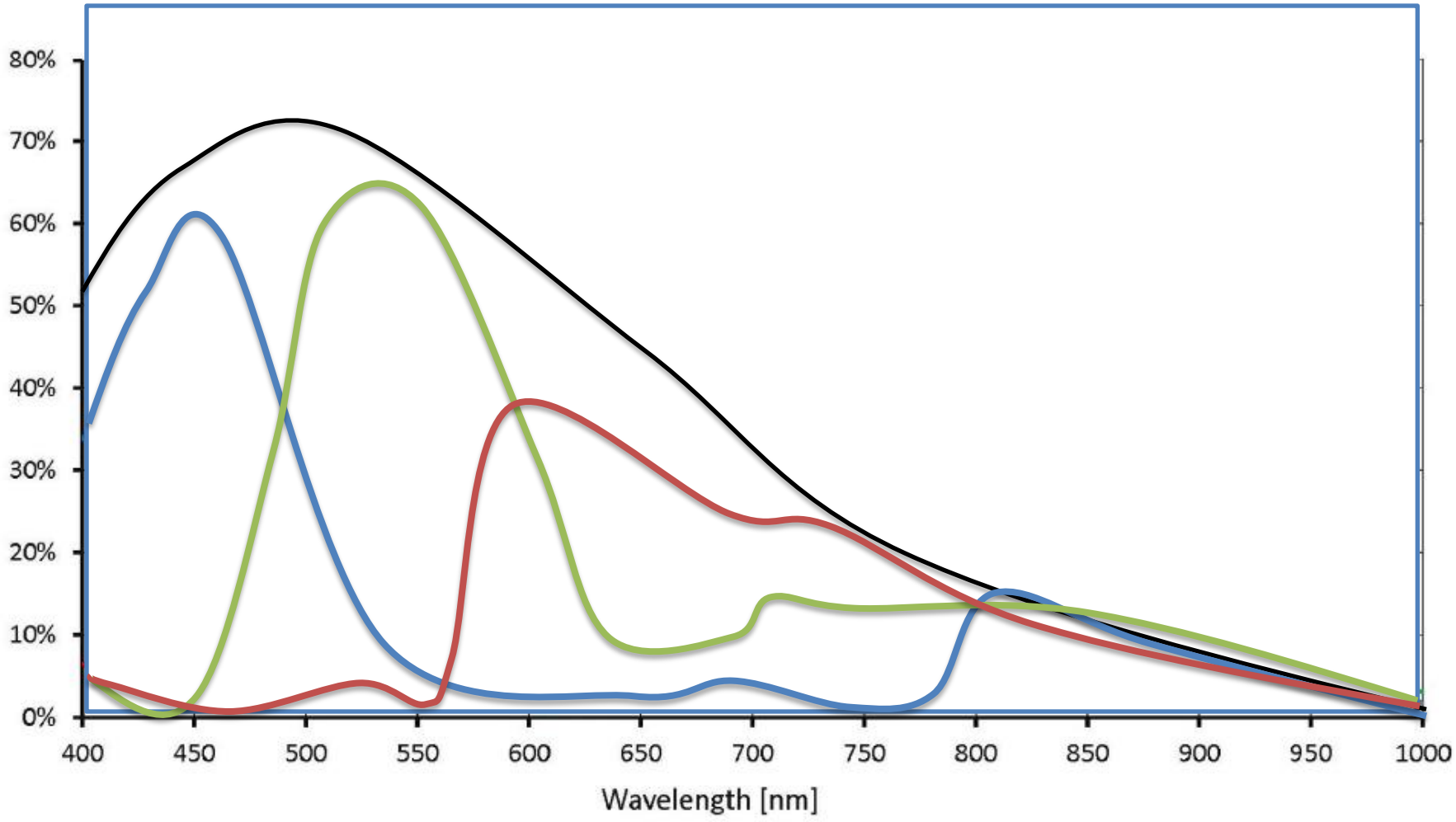
+cooling (low noise)
+easy to calibrate
+color and mono options
+easy computer control
-costs

Cameras-OSC (color)

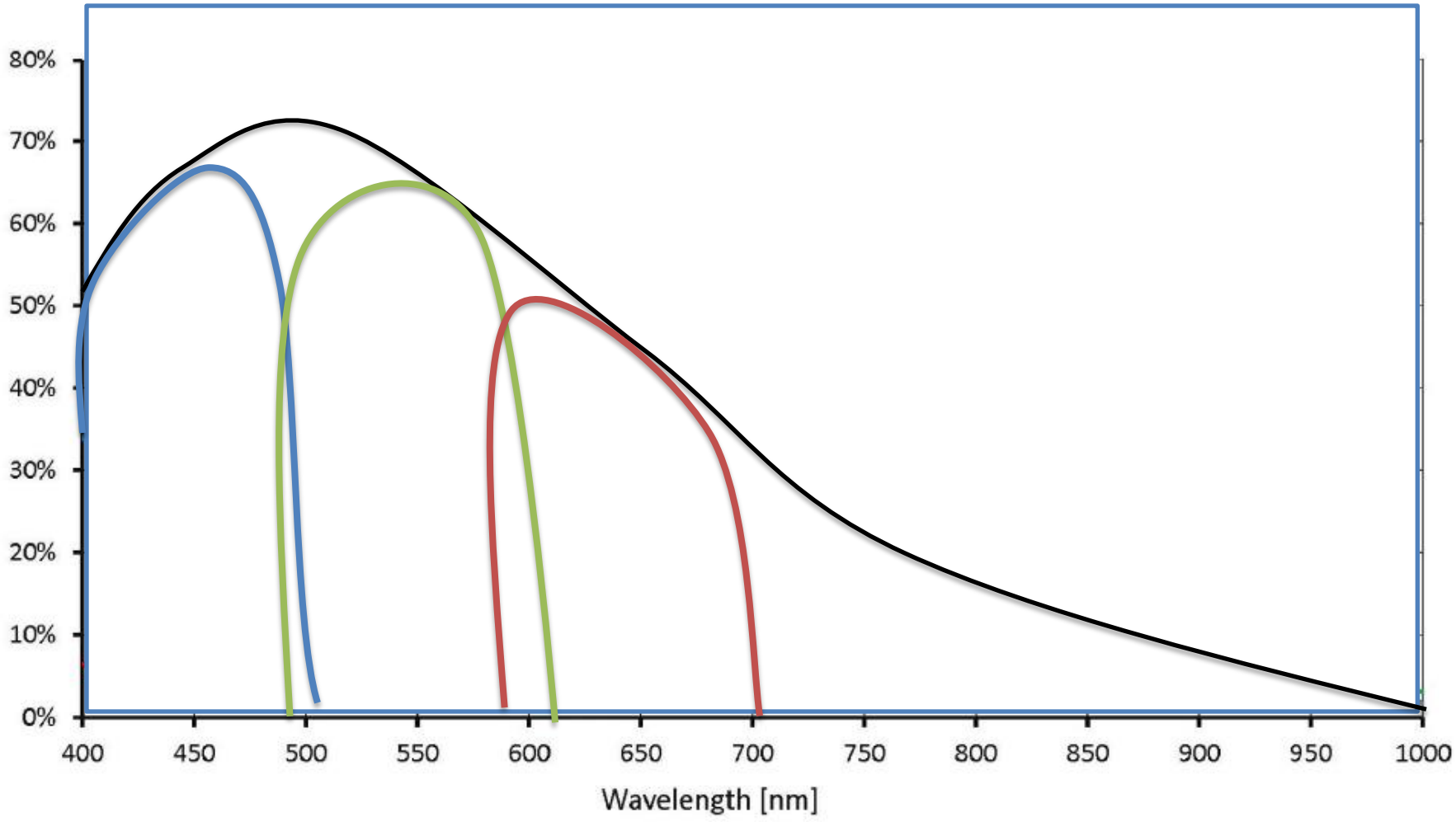


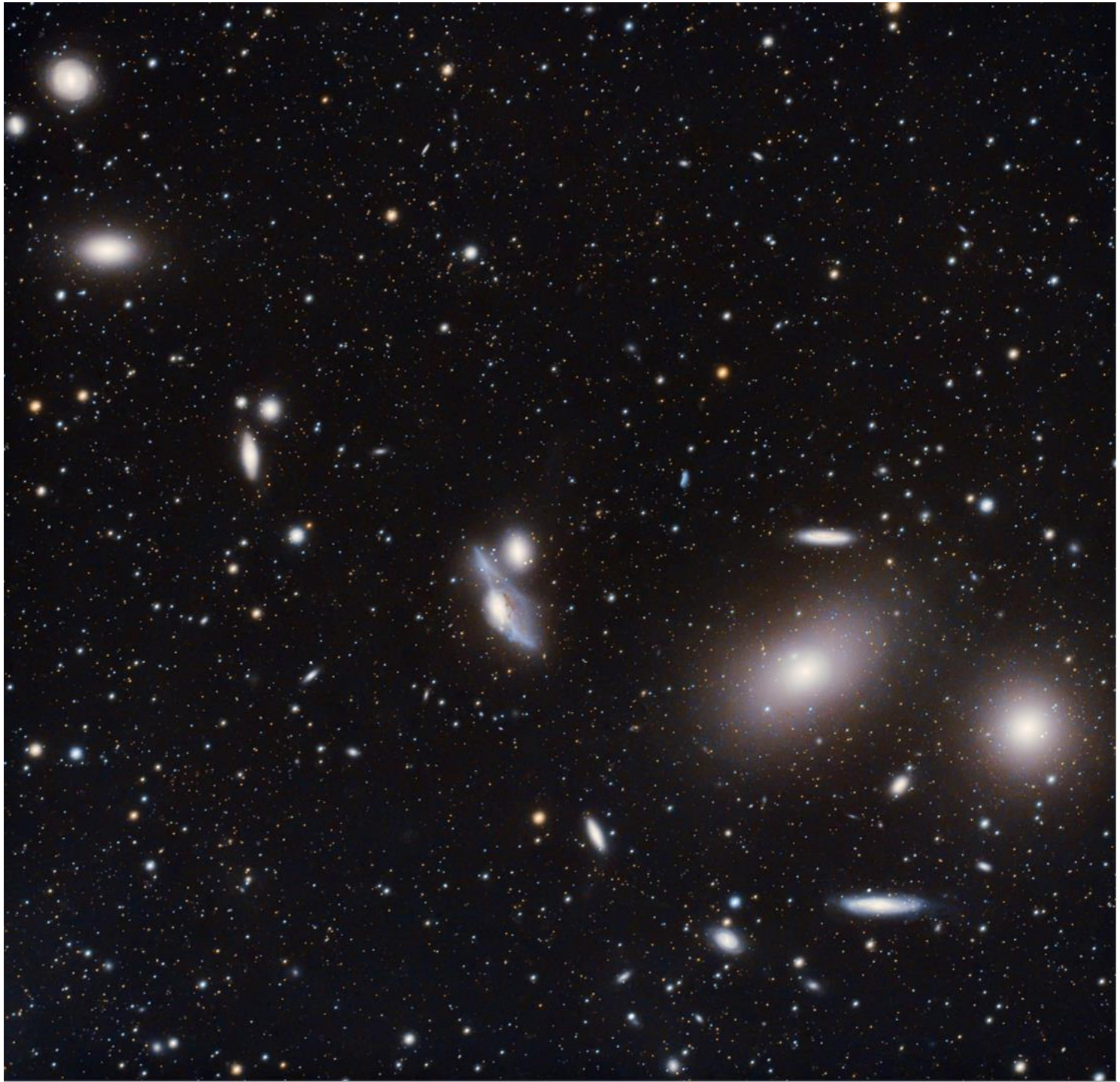
+ easy to use
+way cheaper to implement
-can't properly do narrowband
-inefficient

Spectral response-OSC

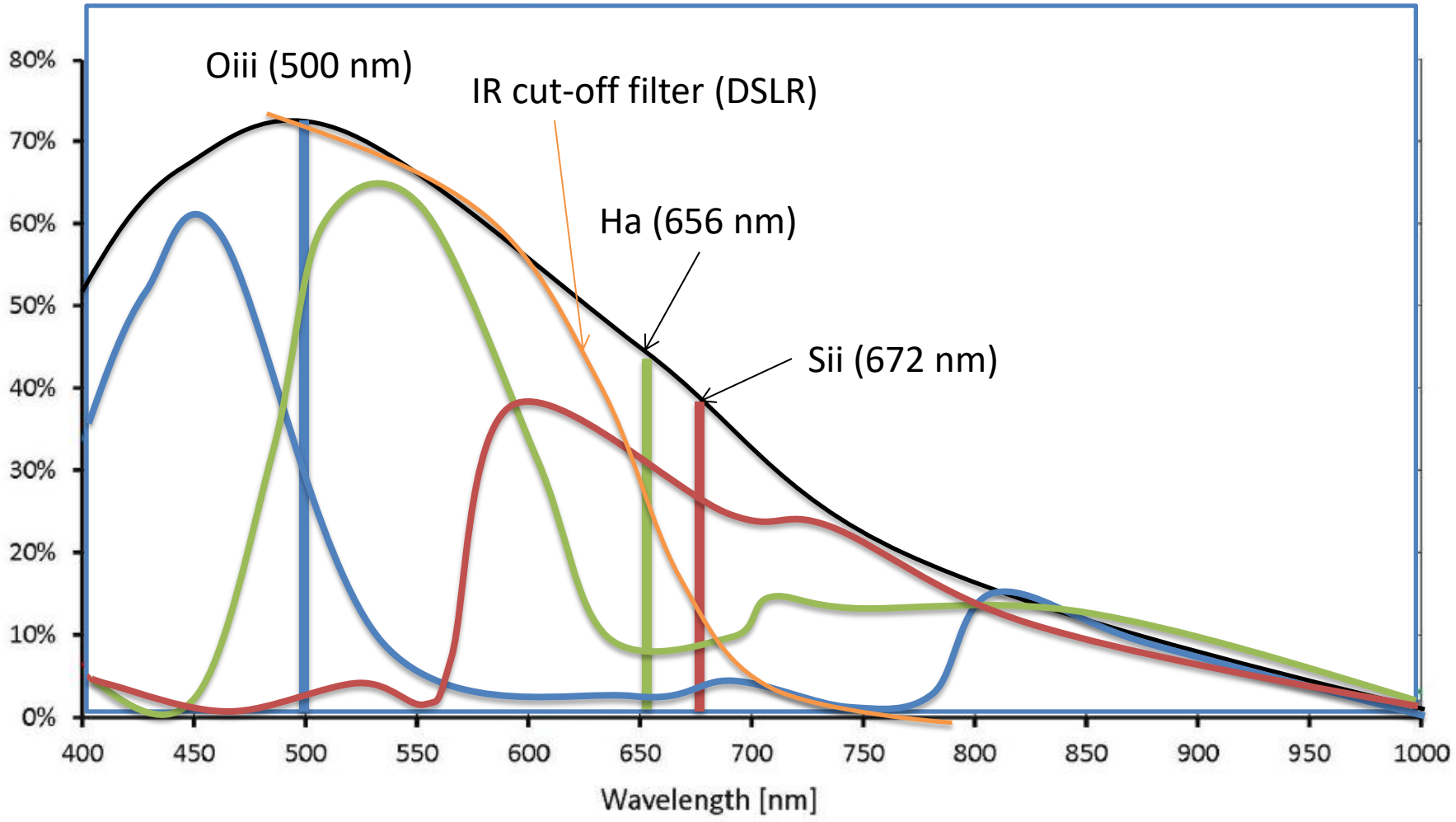


Spectral response-mono w/ RGB Filters

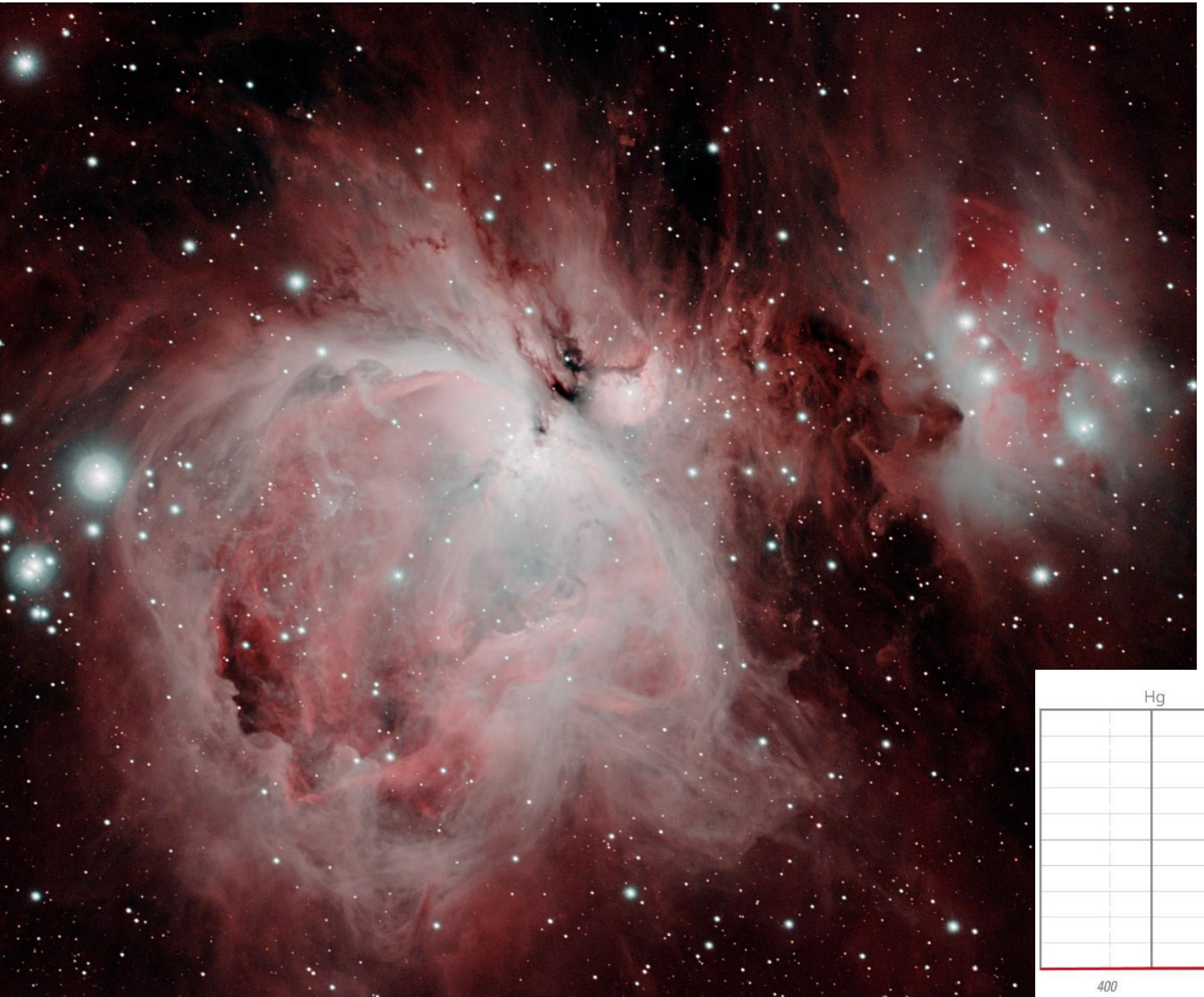




OSC-~~narrowband~~



OSC “narrowband”

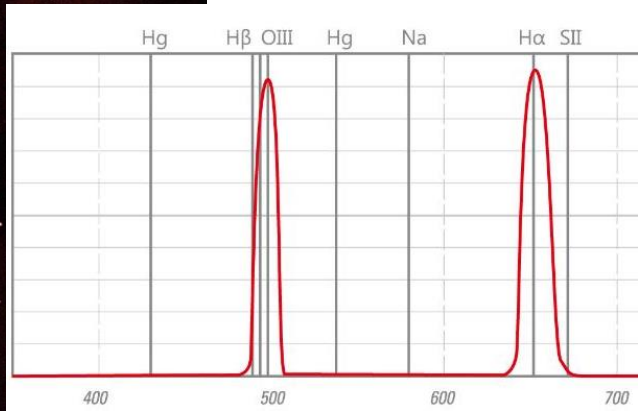


Oii → G and B
Ha →R

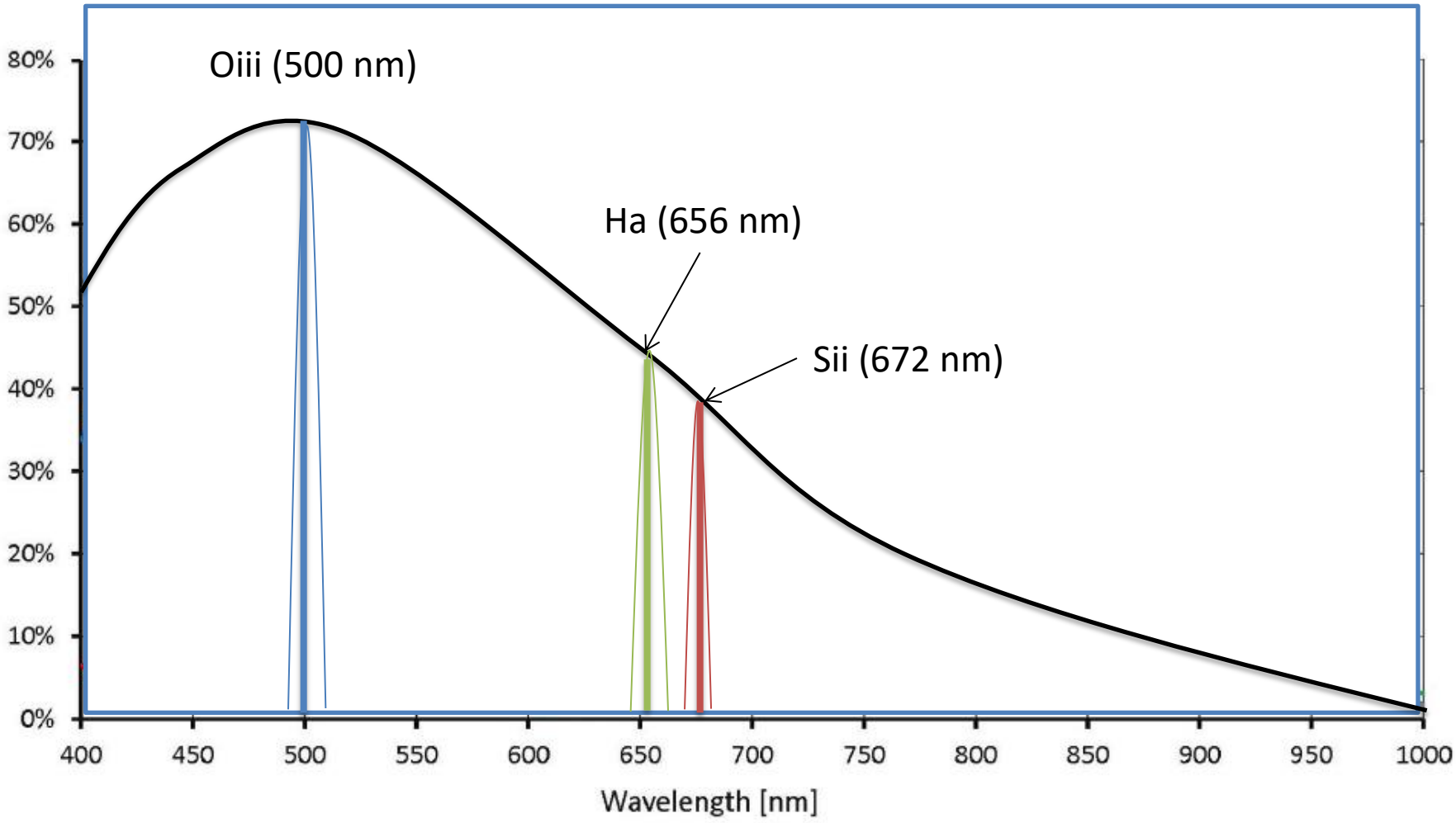
“duoband”

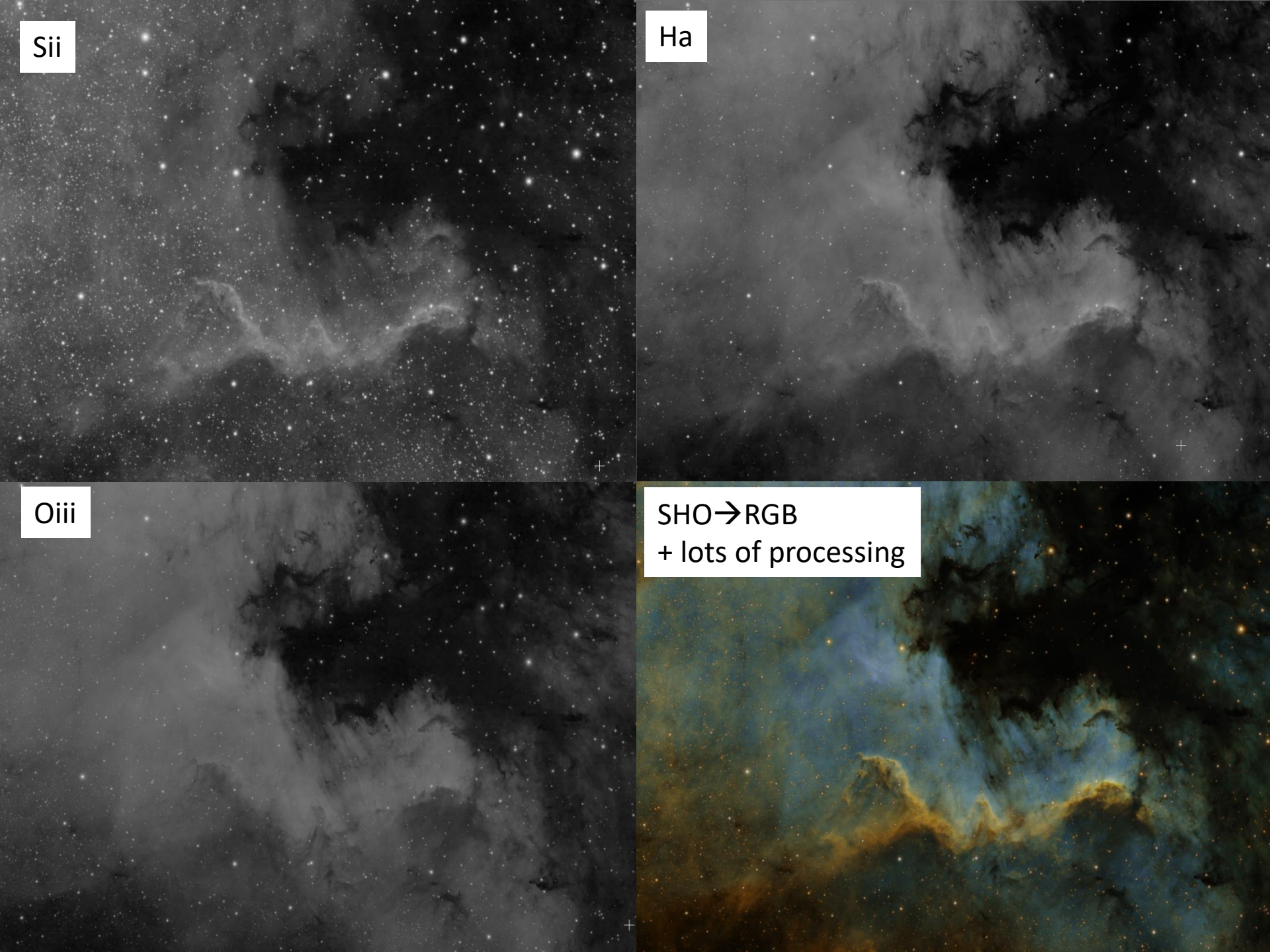
improves S/N

Better imaging with moonlight



Narrowband


Oiii (500 nm)
Ha (656 nm)
Sii (672 nm)
80%
70%
60%
50%
40%
30%
20%
10%
0%
400
450
500
550
600
650
700
750
800
850
900
950
1000
Wavelength [nm]


Sii
Ha
Oiii
SHO→RGB
+ lots of processing

“Entry” Optics (wide field)

Rokinon/Samyan 135mm F2

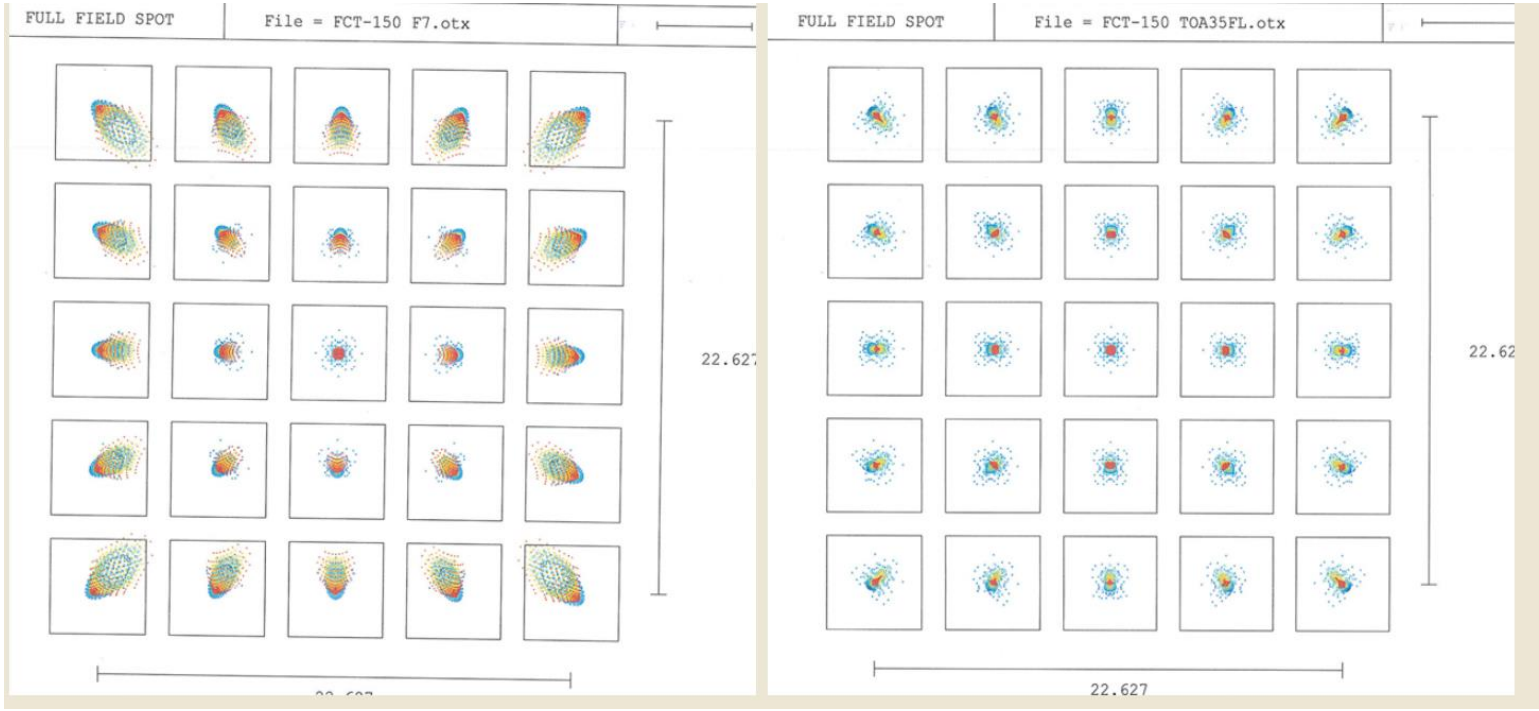
RASA 8 F2.2

William Optics ZenithStar Z61

Orion 10” F3.9 Astrograph

“Other” telescopes

Field Flatteners/Coma Correctors (+Reducers)



- Makes stars in focus all the way out to the edge
- Often matched to telescope
- Spacing is critical
- Flatteners have different reduction factors
- Required (imo) for serious AP*

Image Scale (pairing camera with telescope)

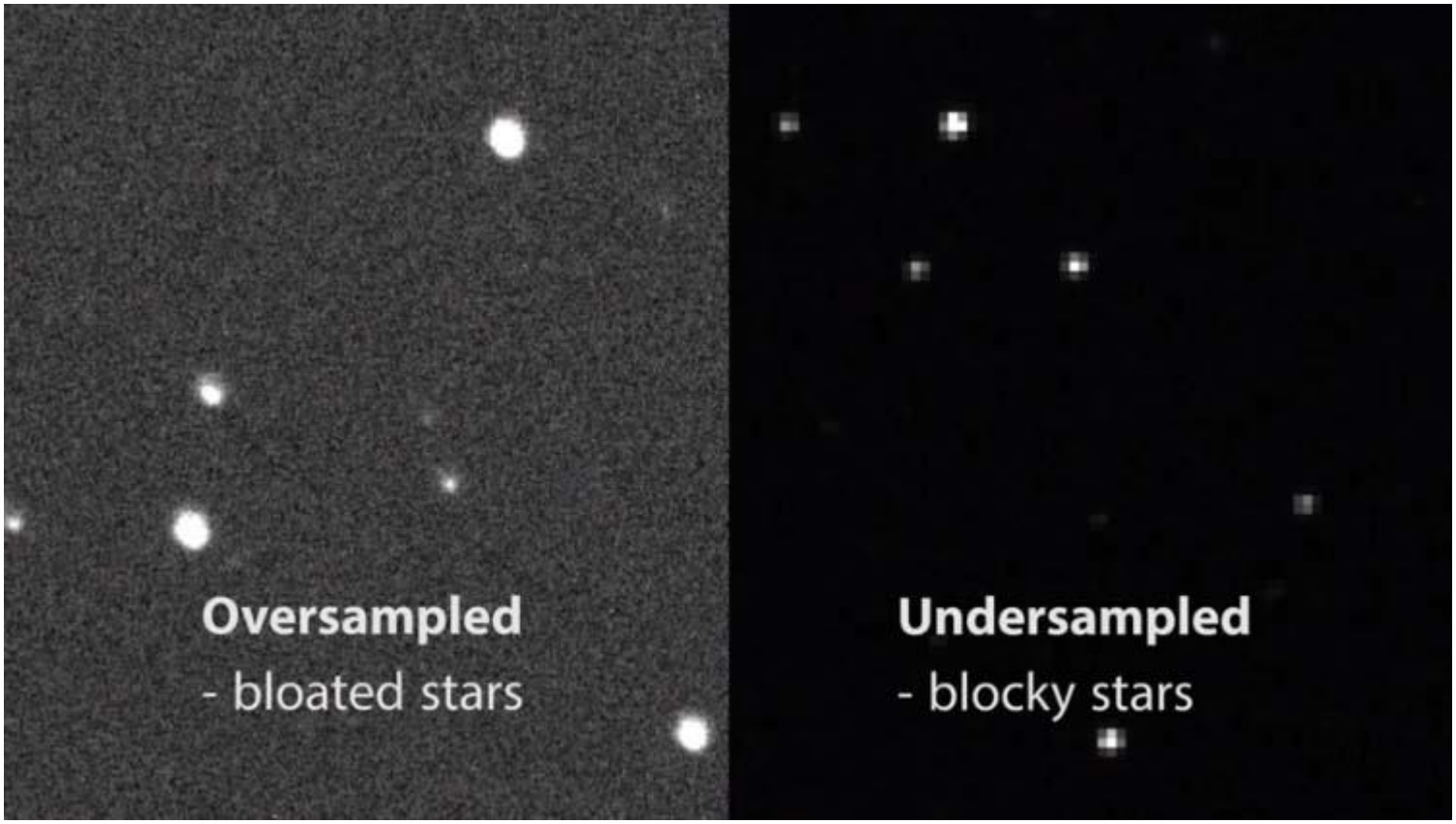


Image Scale (pairing camera with telescope)

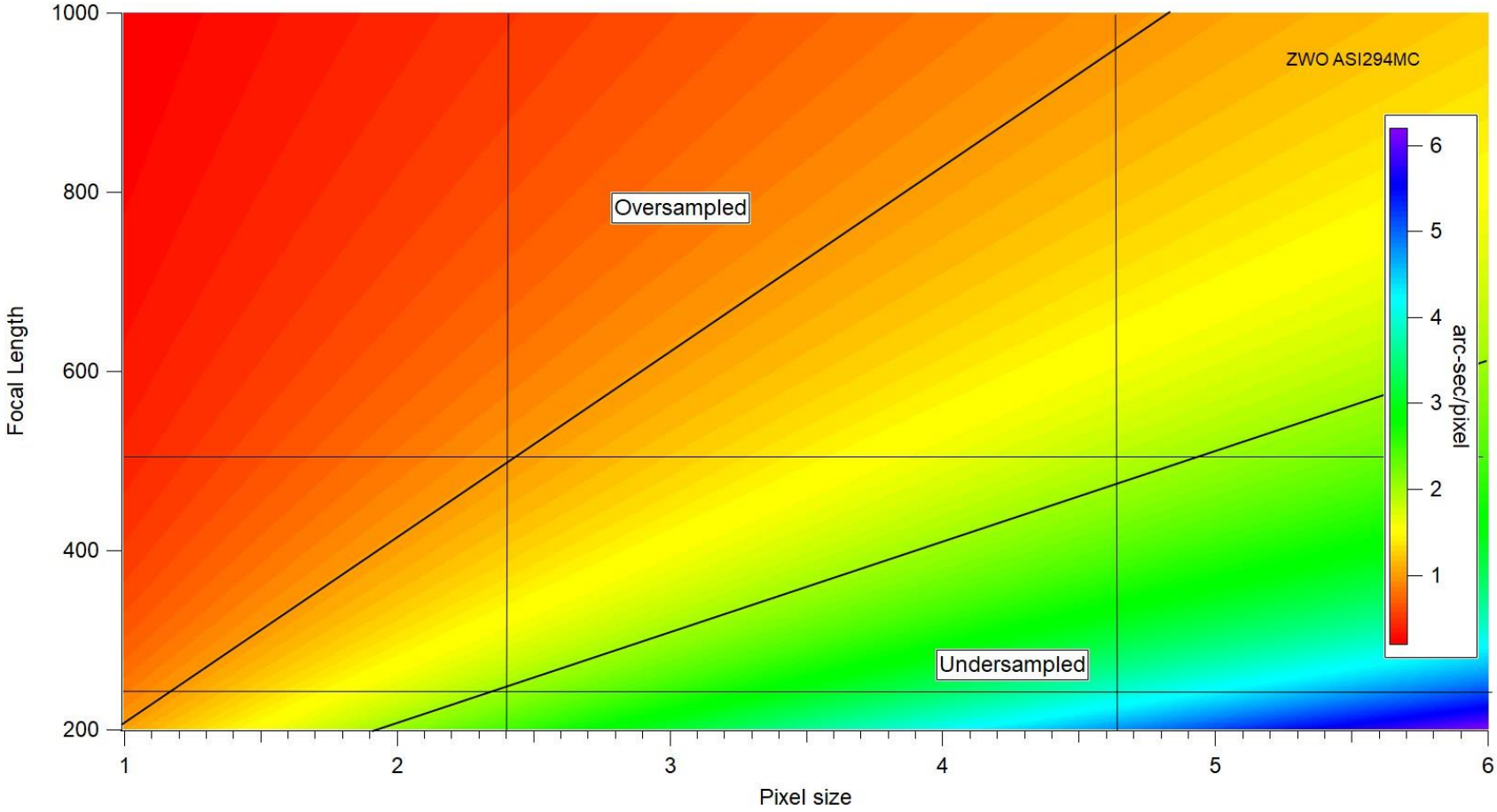
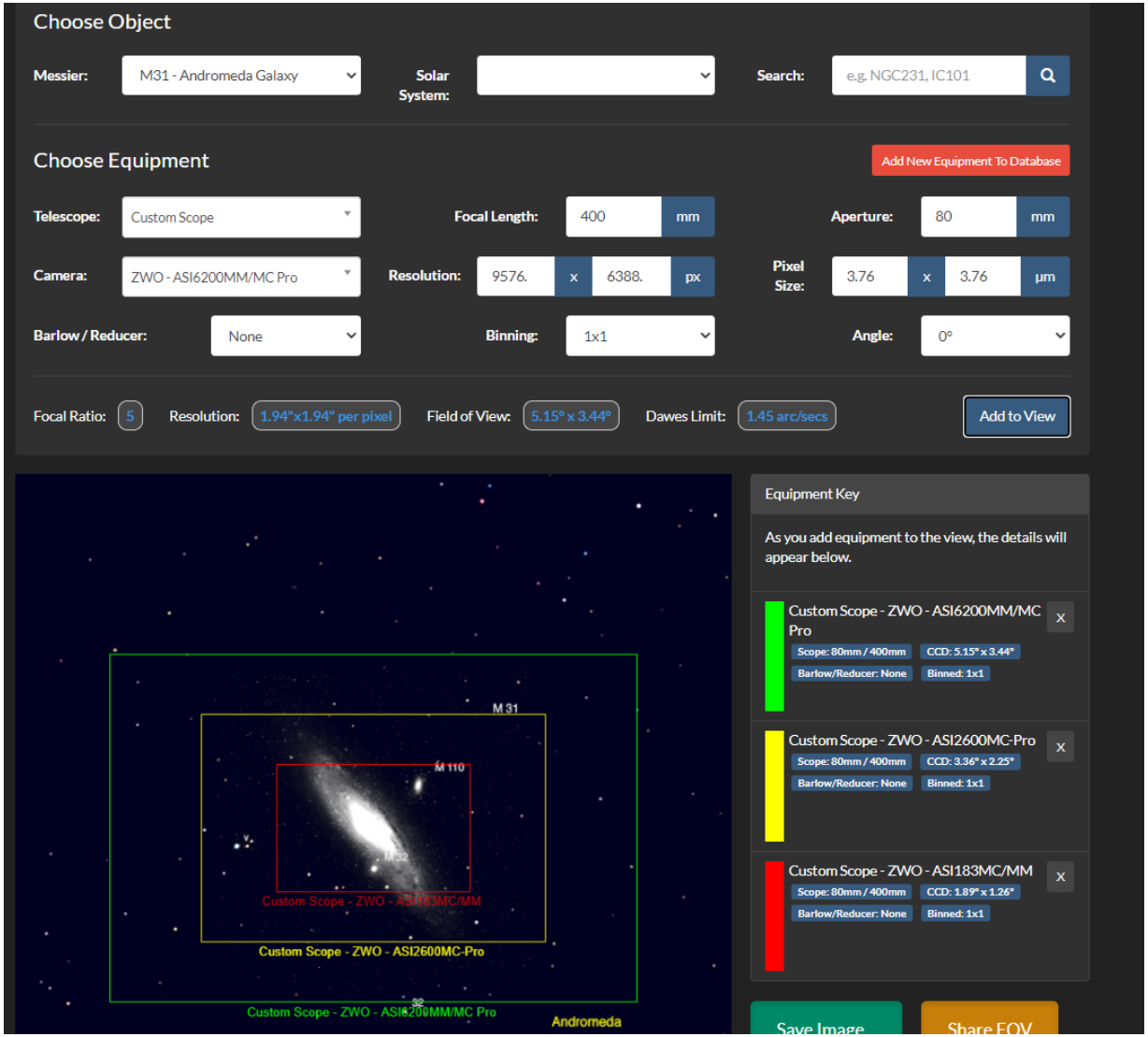


Image scale = 206 * pixel size(microns) / (focal length (mm))
generally want IS to be below 2 and above 1. Seeing and tracking dependent.

FOV



https://astronomy.tools/calculators/field_of_view/ (I mainly use Stellarium)

Extra equipment

- Polar alignment (important for good tracking!!!)
- Guiding solution
- Remote computer control
- Filters etc.
- Focusing
- Paid software
- Dew heater
- Flats panel
- Battery bank

Current rig

Typical session

1. Very rough polar alignment using phone app to locate Polaris during daytime
2. ASPA (Celestron feature) to get decent polar alignment
3. Drift align to get very good polar alignment
4. Fine focus using autofocus routine (used to manually focus with Bahtinov Mask)
5. Build imaging sequence in NINA
6. Slew to target and platesolve
7. Start integrations when dark (about 9:45 pm) till just before sunrise (4:45am)

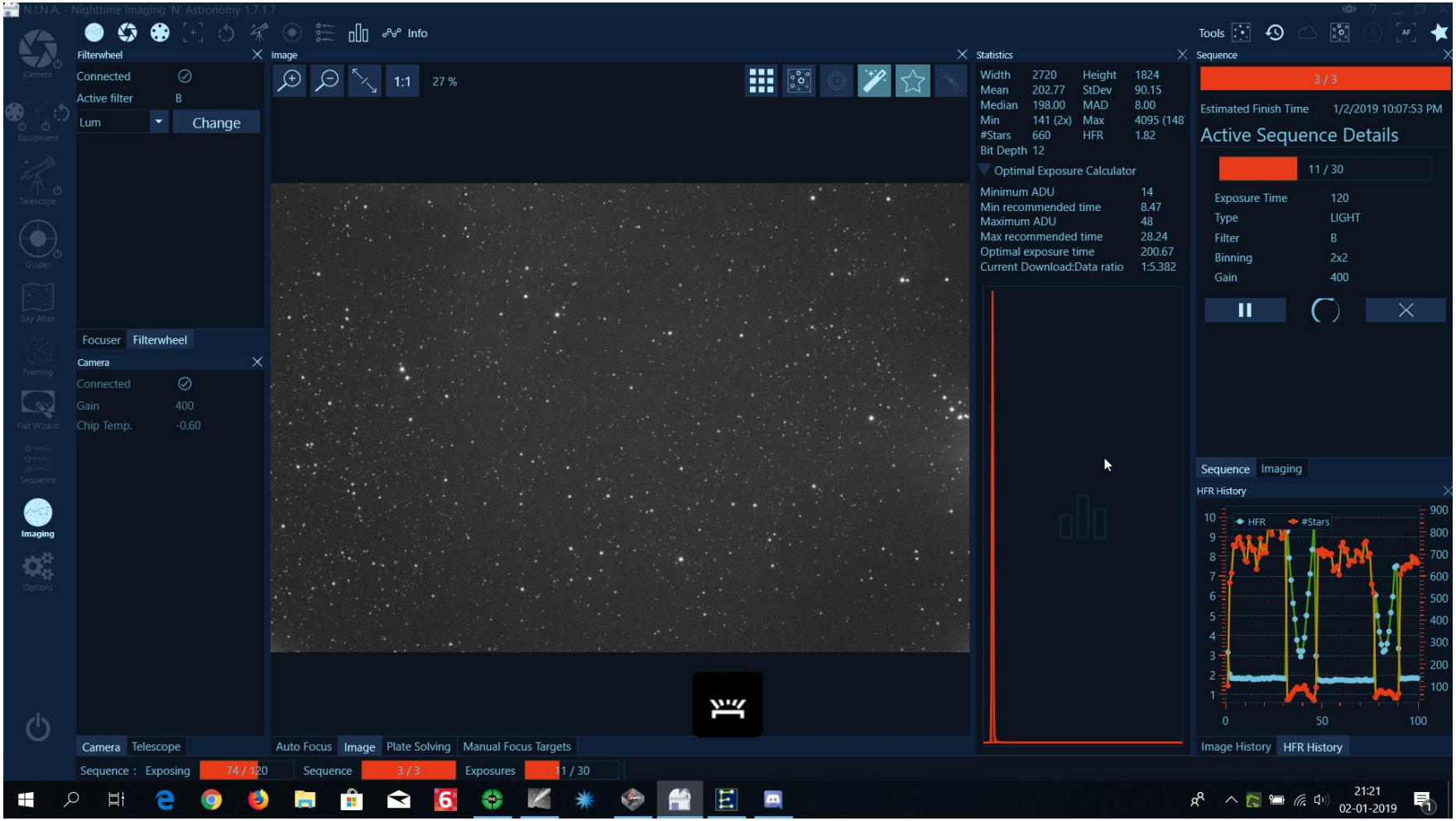
8. In morning, cover optics and remove everything off mount (monolithic setup)
9. Cover mount if weather is good to continue next day or break down fully.
10. Transfer data for processing

11-99. Processing

Computer control

- Need laptop, mini PC or Arduino based system to control sequence and capture/store
- A second remote PC means you can do everything (once set up) from the comfort of your warm/cool home.

N.I.N.A



I use NINA which is open source (free) and windows based. Also used Kstars (also open source and free) with Raspberry Pi.

Lots of other solutions like Voyager, Nebulosity, Maxim DL, SGP, Backyard EOS etc

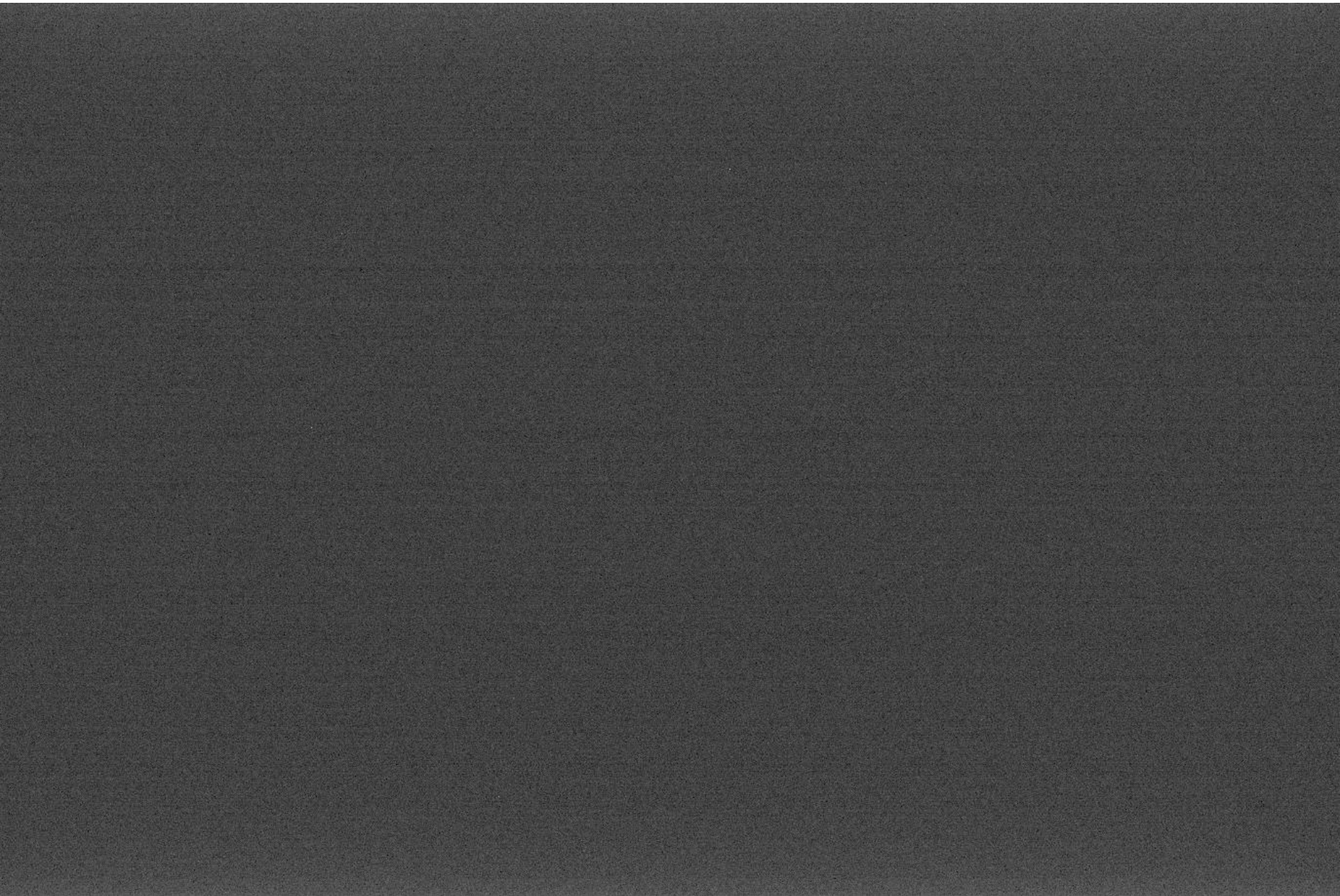
Now entering processing.
a.k.a. Is this photography anymore?

Calibration-Raw single sub

Calibration-Darks

Calibration-Flats

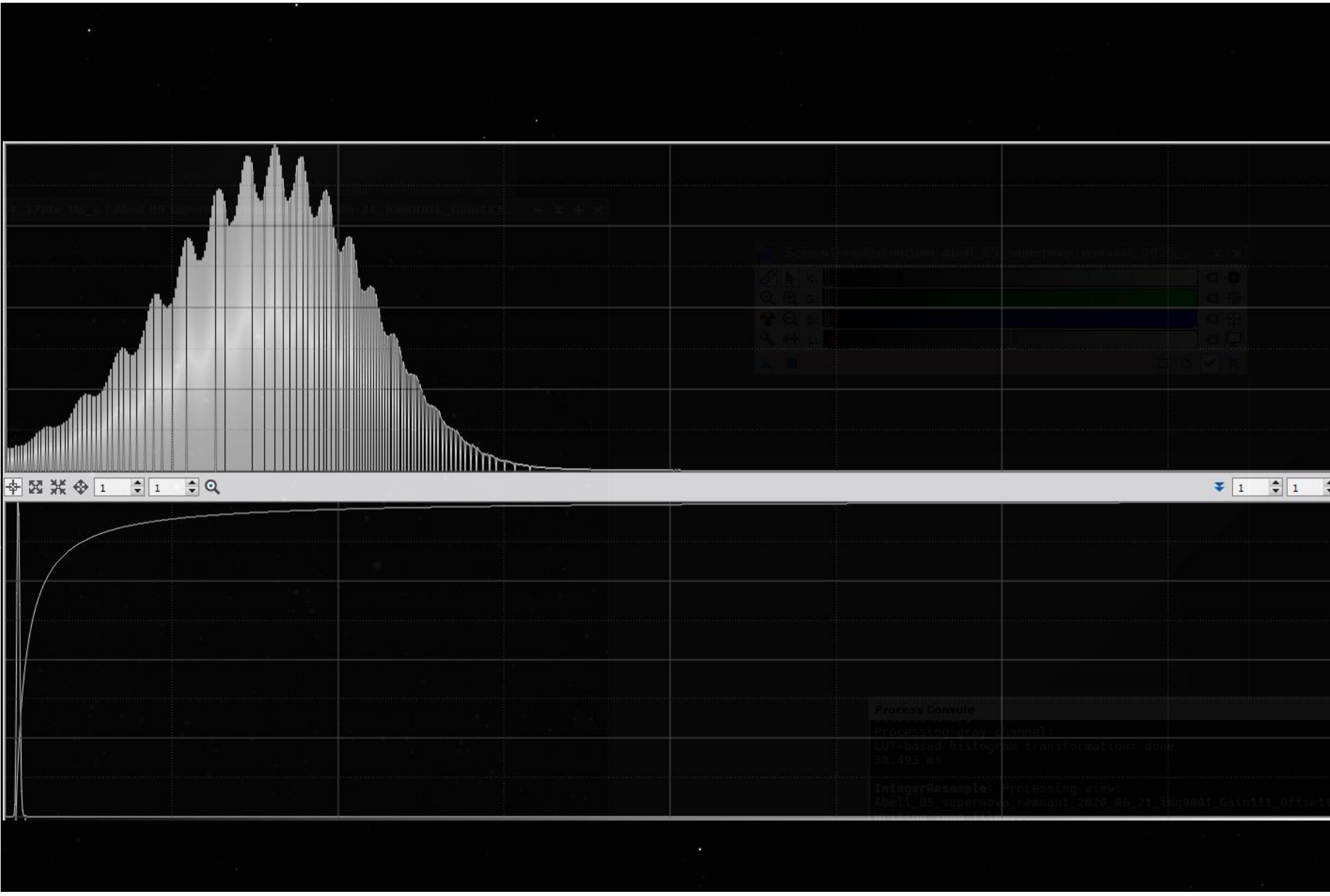
Calibration-Flat Darks



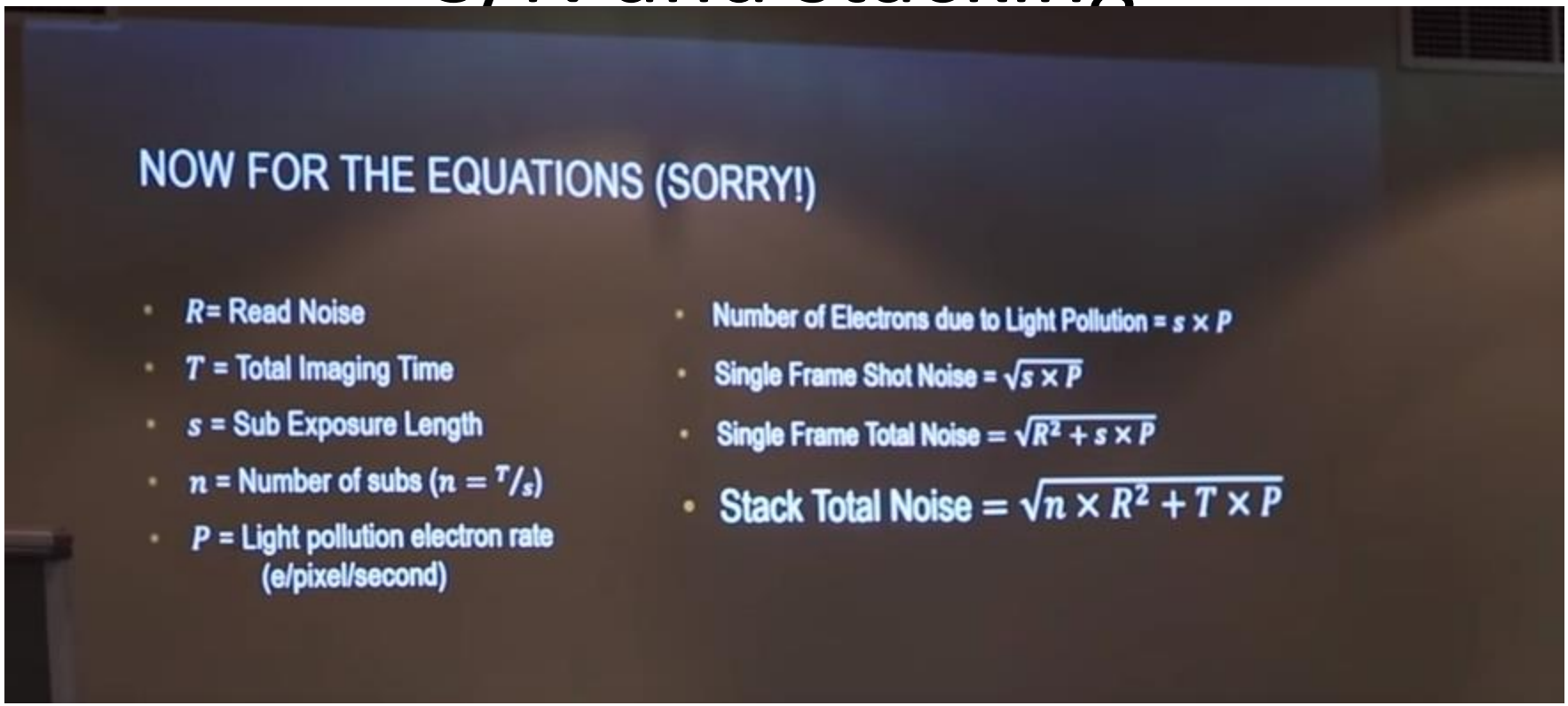
(Light-dark)/(Flat-FlatDark)*avg(Flat)

Stretching

Stretching



S/N and stacking



In short
Signal increases linearly with number of subs
Noise decreases with the squareroot of the number of subs.
So, more subs improve the S/N ratio

https://www.youtube.com/watch?v=3RH93UvP358

1 sub, 10 minutes

2 sub, 20 minutes

4 sub, 40 minutes

8 sub, 80 minutes

16 sub, 2.7 hours

32 sub, 5.3 hours

64 sub, 10.7 hours

128 subs, 21.3 hours

190 subs, 31.7 hrs (properly stretched)

Satellites, hot pixels, and planes

Processing cont.

If this talk were several hours longer, we could talk about

1. All the “knobs and dials” with calibrating
2. Noise reduction algorithms
3. Background extraction
4. Deconvolution
5. Ways to stretch
6. Masking
7. Combining SHO and RBG (and L to RGB)
8. Tone mapping
9. Curves transformations
10. Starless editing
11. Lots and lots more fine details

Software (that I use)

Stellarium-Sky Atlas

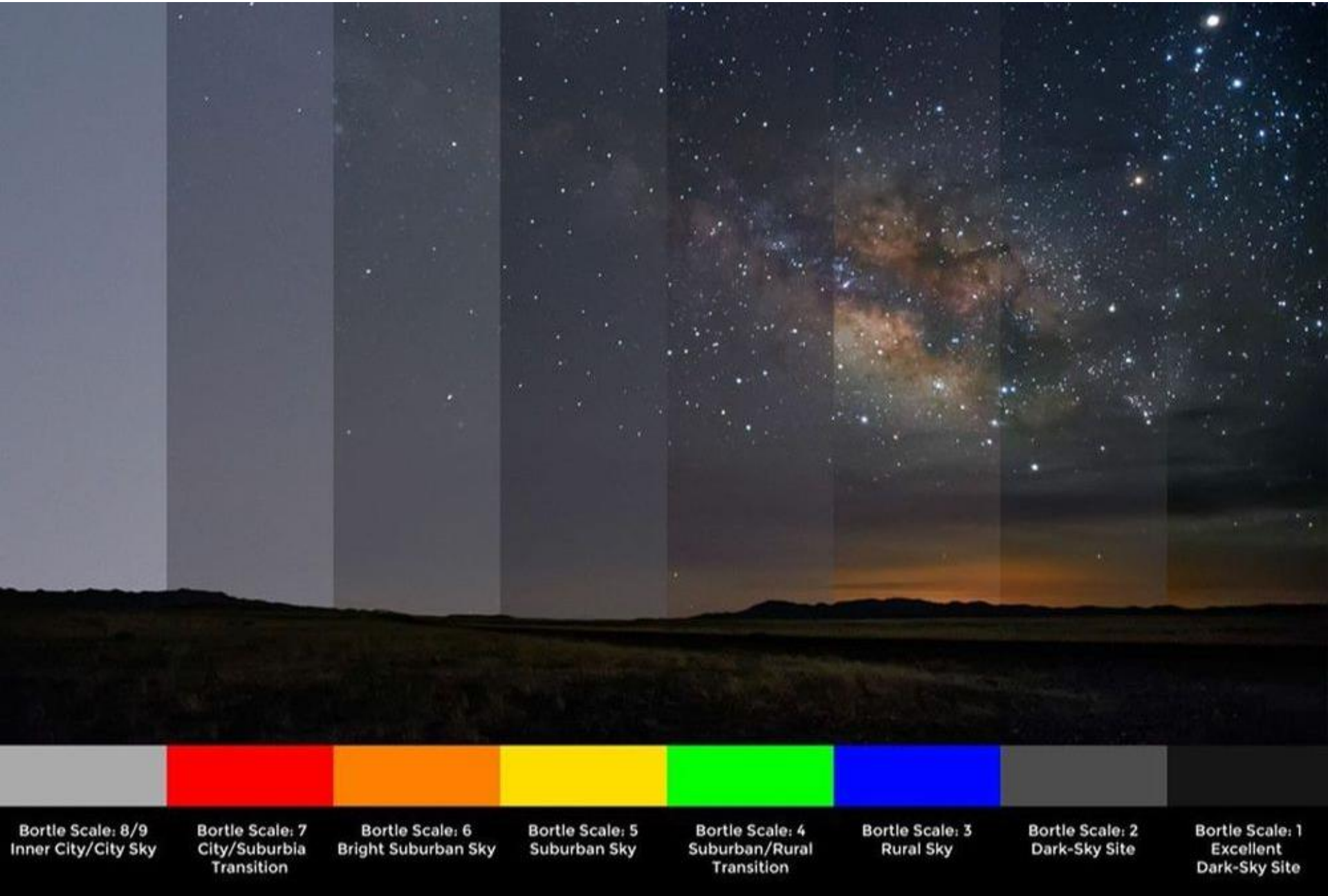
NINA or Kstars-instrument control

Deepsky stacker-…stacking/calibration

GIMP-(think free version of photoshop)

Pixinsight –stacking/calibration/processing

Bortle Scale



Light pollution

A couple more pictures? Sure!

Final thoughts

- AP is less about photography than it is about acquiring data and data processing
- You can’t buy your way into a good image
- AP can be insanely expensive, but it doesn’t have to be
- AP can be as simple or as complicated as you will let it be.
- Dark skies aren’t always required, but the sure save you a ton of time (especially with RGB imaging).
- “Why bother when there is Hubble?”