
Those wonderful images!
How do you do it?
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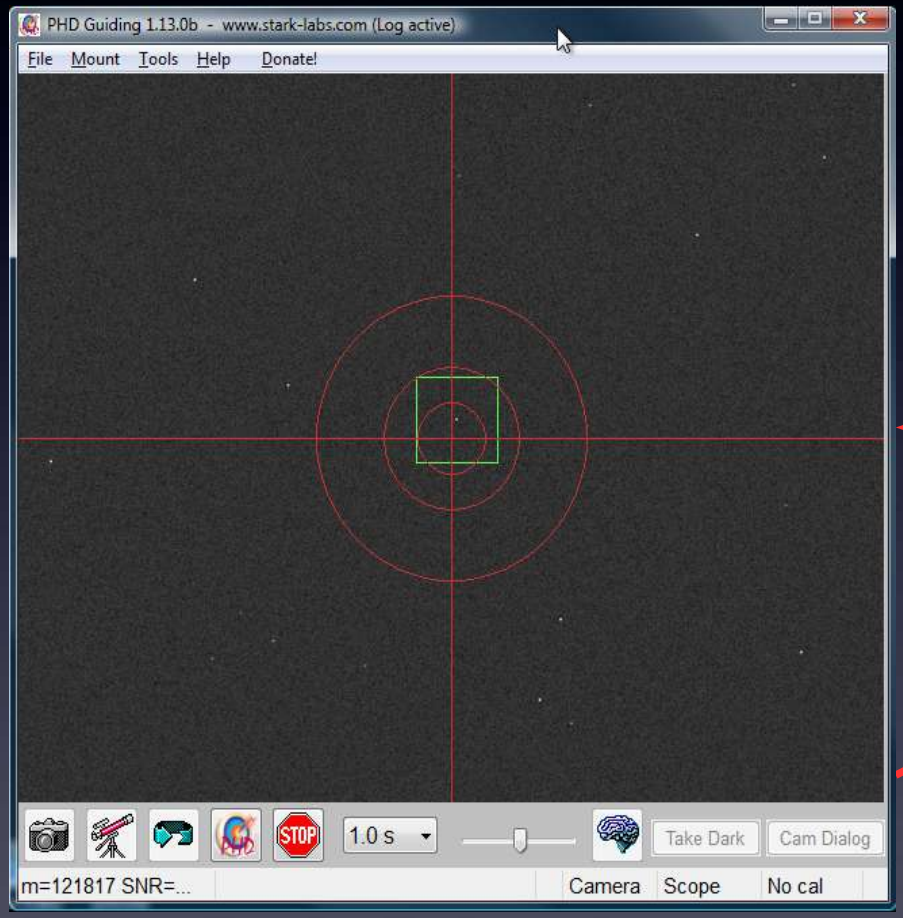
Where do you start?

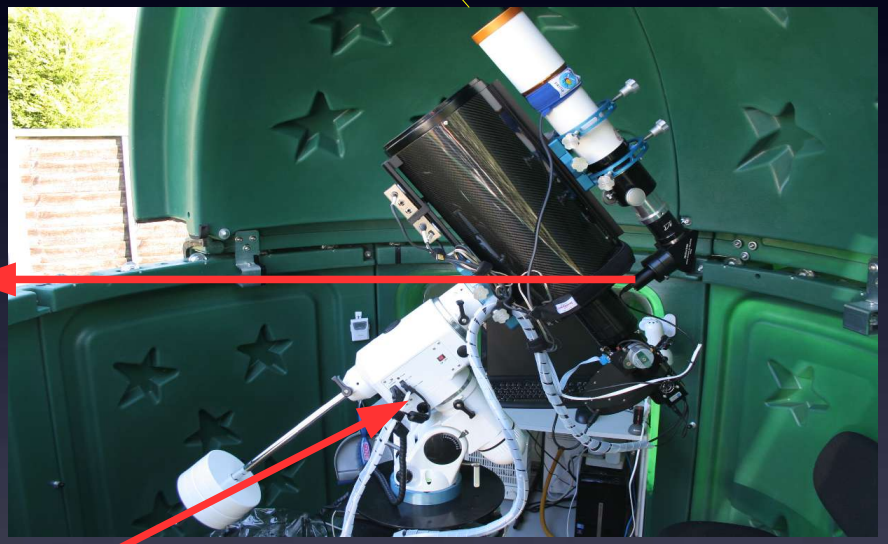
- I want to make images that look great!
- You have a book of Hubble Space Telescope pictures ;-)
- You have a telescope, goto mount and a camera.
- You have loads of spare time.....
- You can find your way around the constellations

First some basic terms?

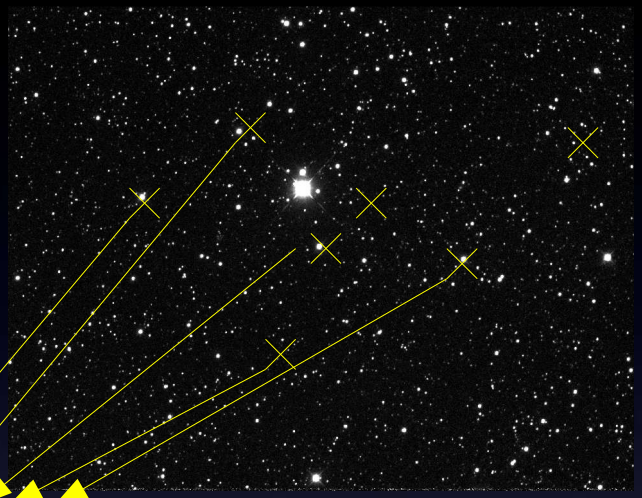
- Guiding – A system of camera,scope and software to make small corrections to the mount to keep it pointed at your star accurately.
- Solving or Plate Solving – comes from the days of looking at photo plates from the telescope and finding a star pattern you recognise in order to move the scope to the correct position. Many scope control programs like AstroArt5.0 have built in Solving to centre your image.
- Stacking or sometimes Preprocessing – aligning a group of images so the stars line up, then taking an average or median in order to reduce random noise and increase signal.

Guiding - Most mounts have tracking errors!





Solving – You can never get perfect alignment!



Star location?
How many stars?
FOV?
Max error?

Pattern Matching software

Sync

Correction sent To scope to get Star centred.

Star database

What do you need?
A very short summary!

- Telescope - Many options – discussed in previous evenings
  - For deep sky objects field of View is important – Skywatcher 80mm low cost option.
- Stable Mount with guiding capability eg EQ6Pro
  - Mount must have a guiding interface and quite good tracking.
- Guide scope or purchased system – can use a webcam for guiding
  - Guiding software Freeware - PHD)
  - Can be a very low cost Skywatcher 60mm and web cam.
- Camera – DSLR or Specialist astroimaging camera.
- PC with loads of memory and a good graphics card – quad core.
- A lot of time and methodical approach!
- Image processing tools... Mostly available as freeware ;-)

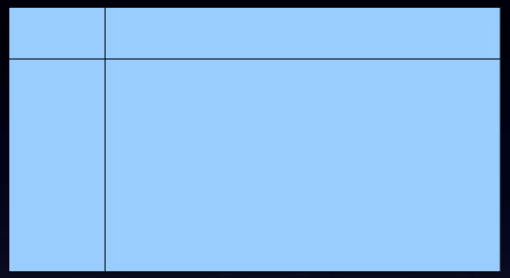
- Finally – Being realistic – a roll off roof shed or observatory dome.

You will get very tired of dragging out heavy kit to find the clouds roll in.

Things to know before you start

**The Field of View (FOV) of your system

- How many degrees x and y



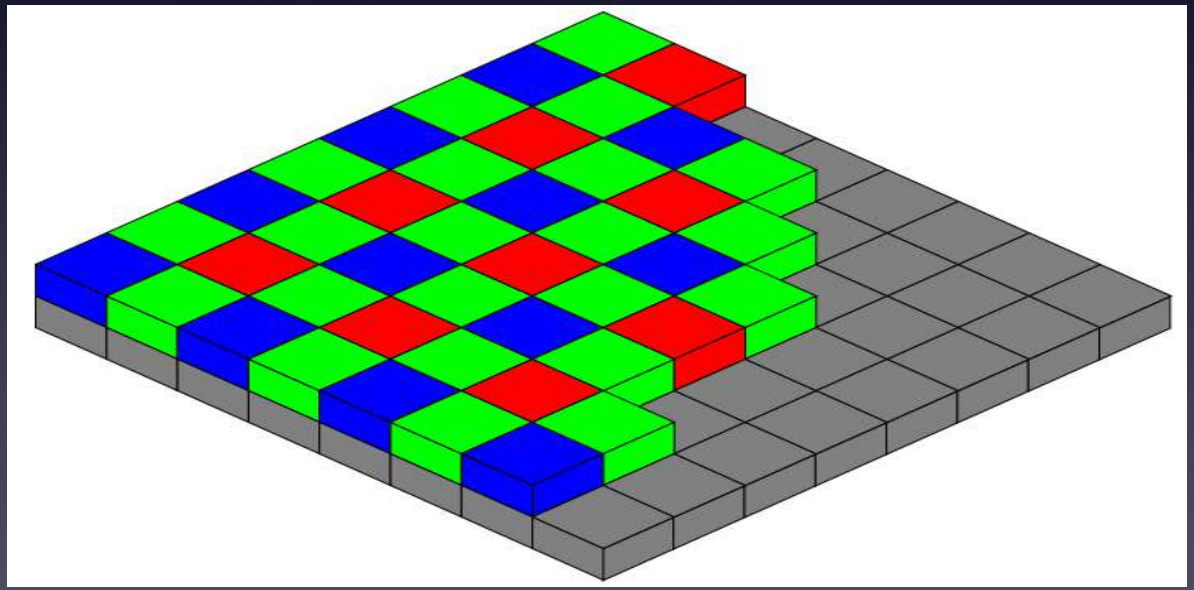
- Resolution – how many pixels x and y
- What sort of objects match your system capability? (without too much pasting together!)

- Andromeda galaxy is an example:
  - It is about 1.5 degrees across and about 1 degree high.
  - If you have a system with a FOV of 0.5 degrees that would take a while to stitch together.
- Does the object have significant colour? Nebulocity?

** Critical issues

There is no perfect imaging setup

- Specialised cameras of all formats and sizes are available
- SLR Cameras can be used but are slightly more difficult to use. Focus, image noise, IR filters.
- Monochrome cameras are better resolution than the equivalent CCD chip colour camera.
    - Why?
    - A colour dot matrix is printed over the individual pixels. Called a Bayer Matrix.

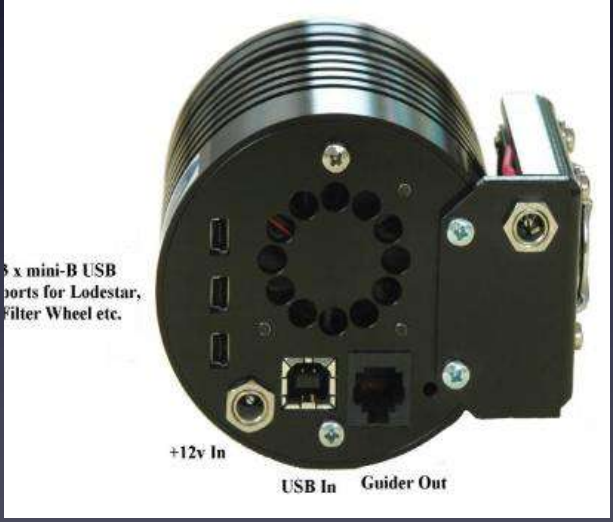


So what is a good combination for Orion?

- SLR – Assuming you can focus ok.
  - You will need long exposures of between 100sec – 300sec so use “Bulb”
  - You will need a FOV of about 0.5 degrees
  - If possible use the camera “Noise Reduction”
    - Or cover the lens and take an image or two with exactly the same exposure time (called a Dark)
  - Use Mirror Lock Up – Prevents that big mirror clunk!
  - Use a shutter release extension lead to stop vibration
  - Example Canon 450 (I still find focus an issue).

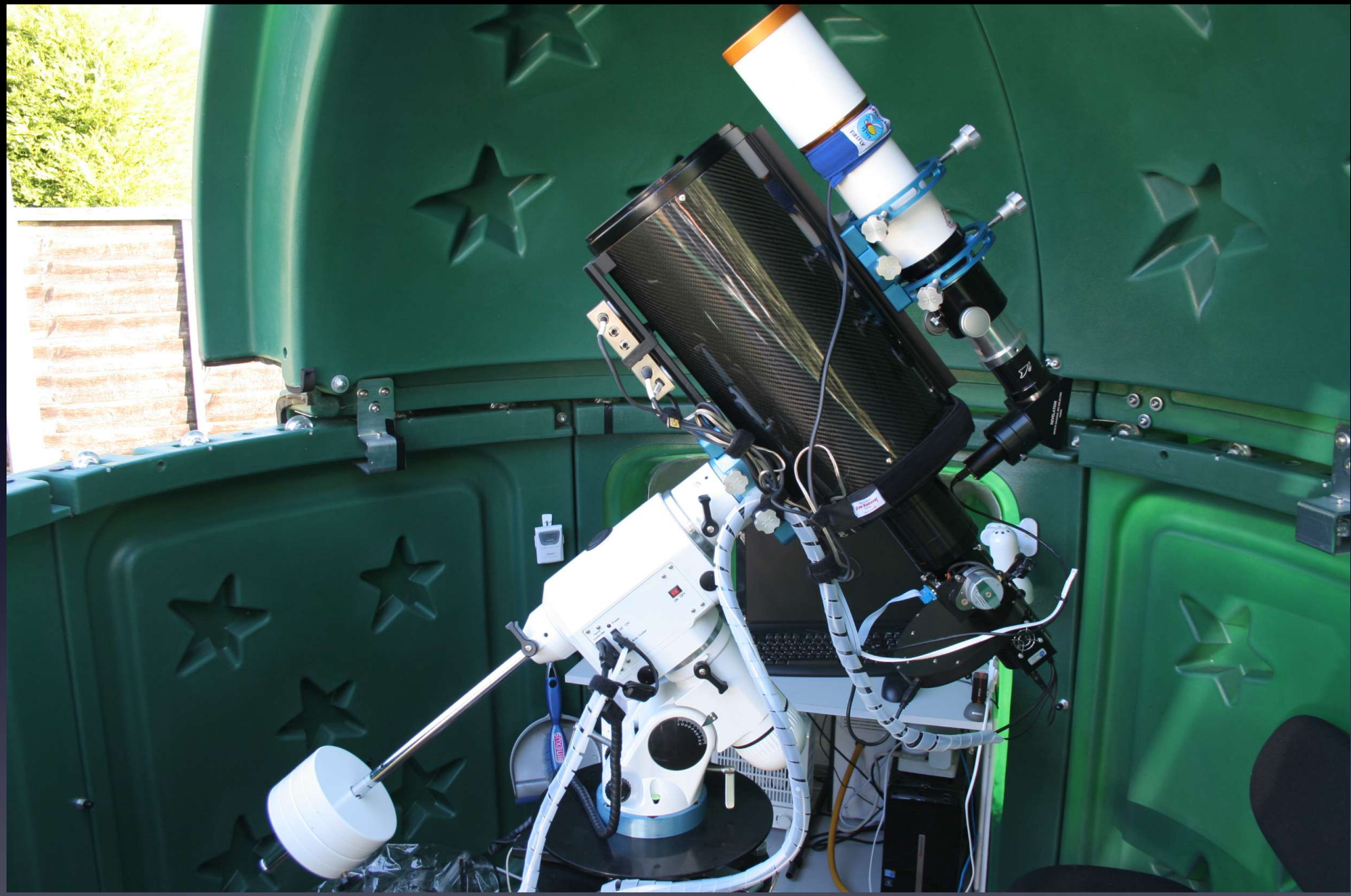
Specialist cameras

- A very reliable range:
  - ATIK
  - Starlight Xpress
  - Sbig
  - QSI



Specialist camera summary:

- All now have “set point cooling” to maintain say -15decC
- Typical format 6 X 6 uM Pixels at 3326 X 2504 pixels
- Each pixel can have a value between 0 and 64000**
- So an image area of 17.96 X 13.52
- Very low noise
- Expensive > £1000
- Some have an option for colour matrix but if not:
- Needs a filter system, although often packaged complete.
  (I would go for the mono with a LRGB filter set)



Planning the image

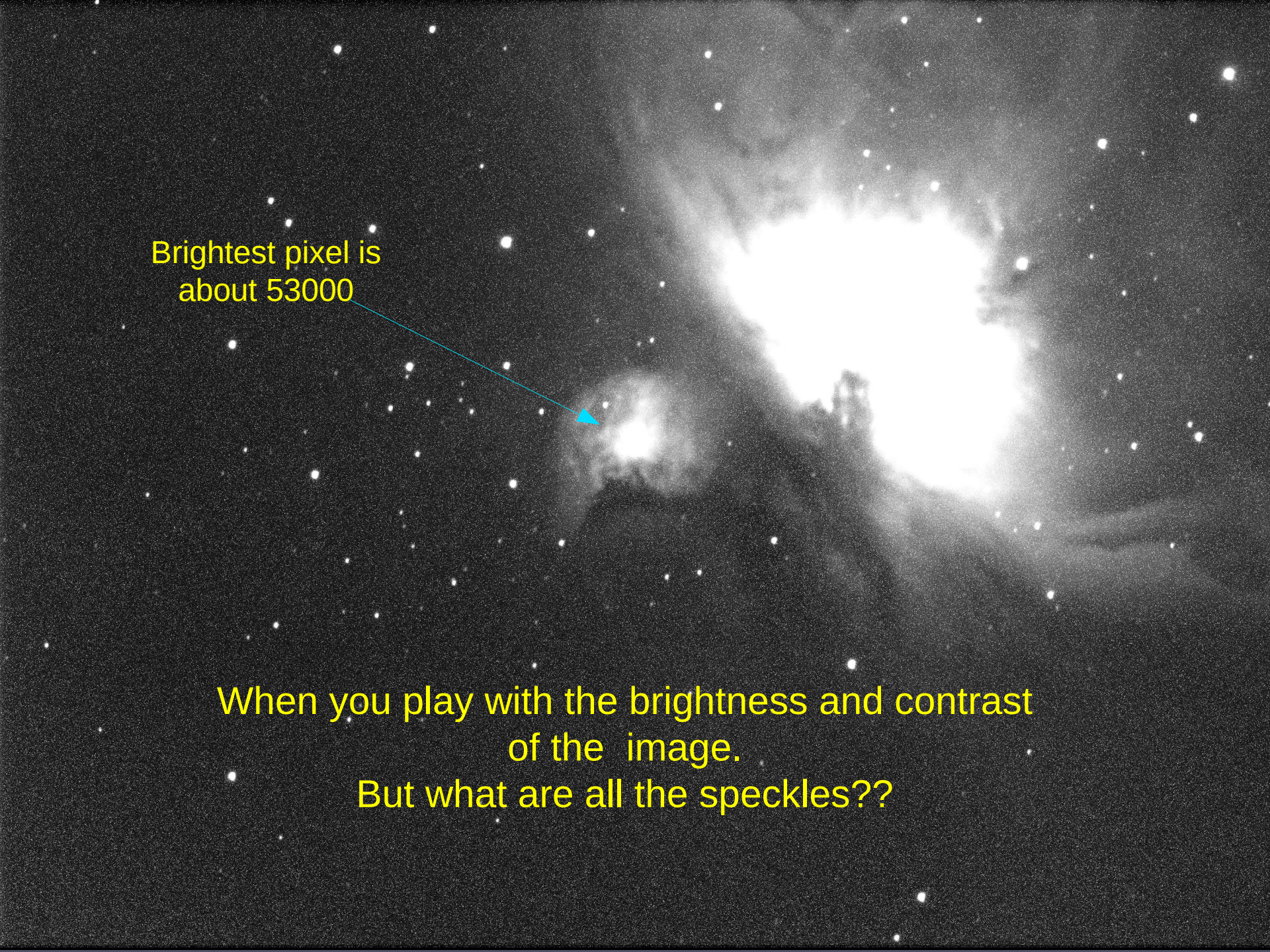
- Establish an object that matches your FOV
- Know where it is in the sky for a period of a couple of hours after the sky is dark. It should be higher than 30 degrees to avoid atmospheric effects. Use planetarium software like Stellarium (It can drive the scope).

- Know where the moon is and its brightness.

- Check the sky for thin cloud close to the time.

- Go out and take a few images at different exposures. Then examine them to find the best exposure. Probably about 100sec and 200sec.

Your first look at a 200sec image:



When you play with the brightness and contrast of the image.
But what are all the speckles??

Let me tell you about noise!

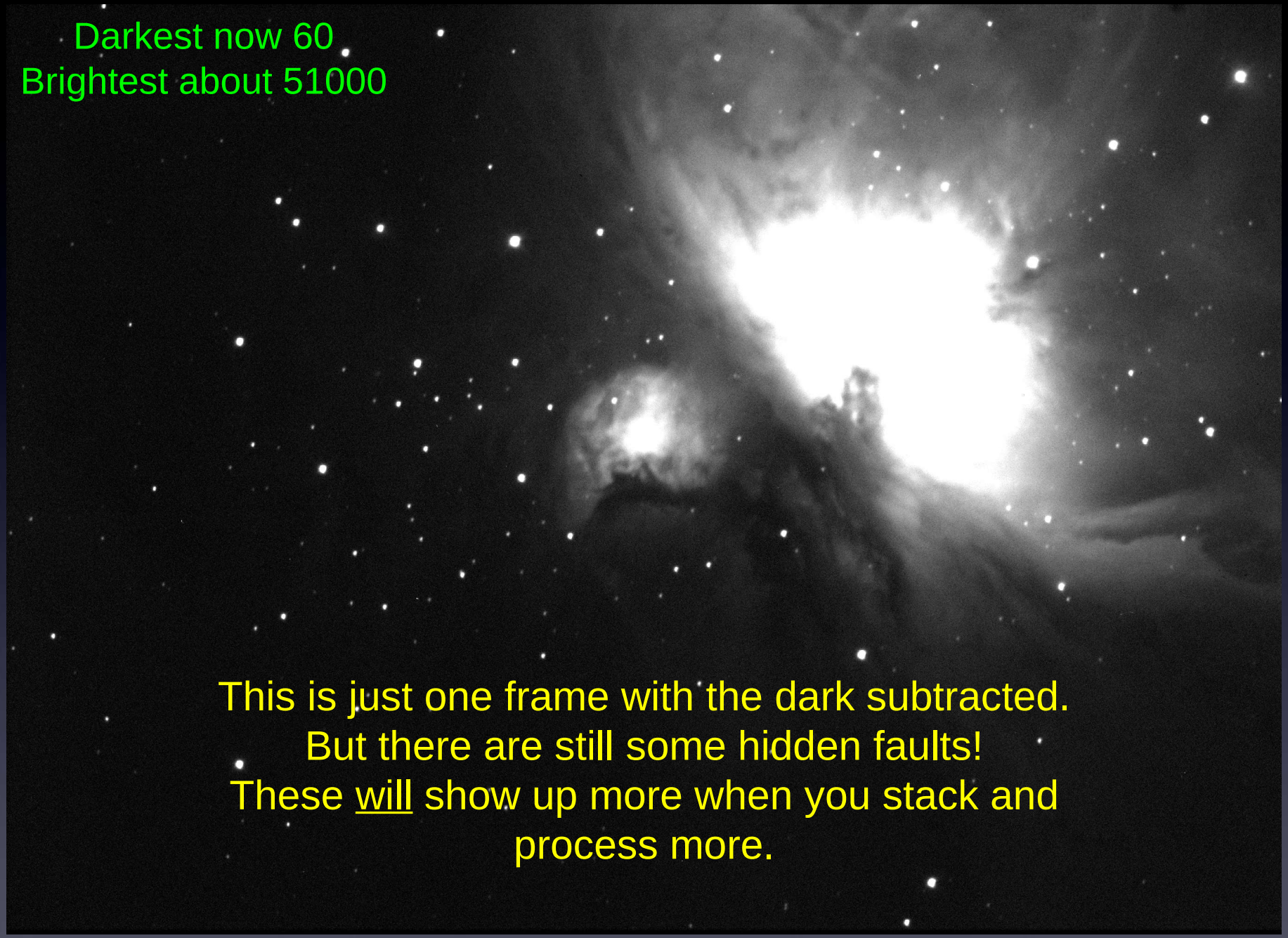
Sources!

- Noise comes from many sources
- So called hot pixels – pixels that either don't work or are more sensitive.
- Noise that originates from the heat of the atoms in the chip
- **Noise can come from cosmic rays going through the detector.
- Noise generated while reading the pixel matrix.

You can take an image of the noise (except **) and subtract it!

- Cover the telescope lens or tube.
- Take a few images at the same exposure and the same temperature.
- This is what your get:


Darkest pixel about 1100
Brightest is about 2600


Darkest now 60
Brightest about 51000
This is just one frame with the dark subtracted.
But there are still some hidden faults!
These will show up more when you stack and process more.

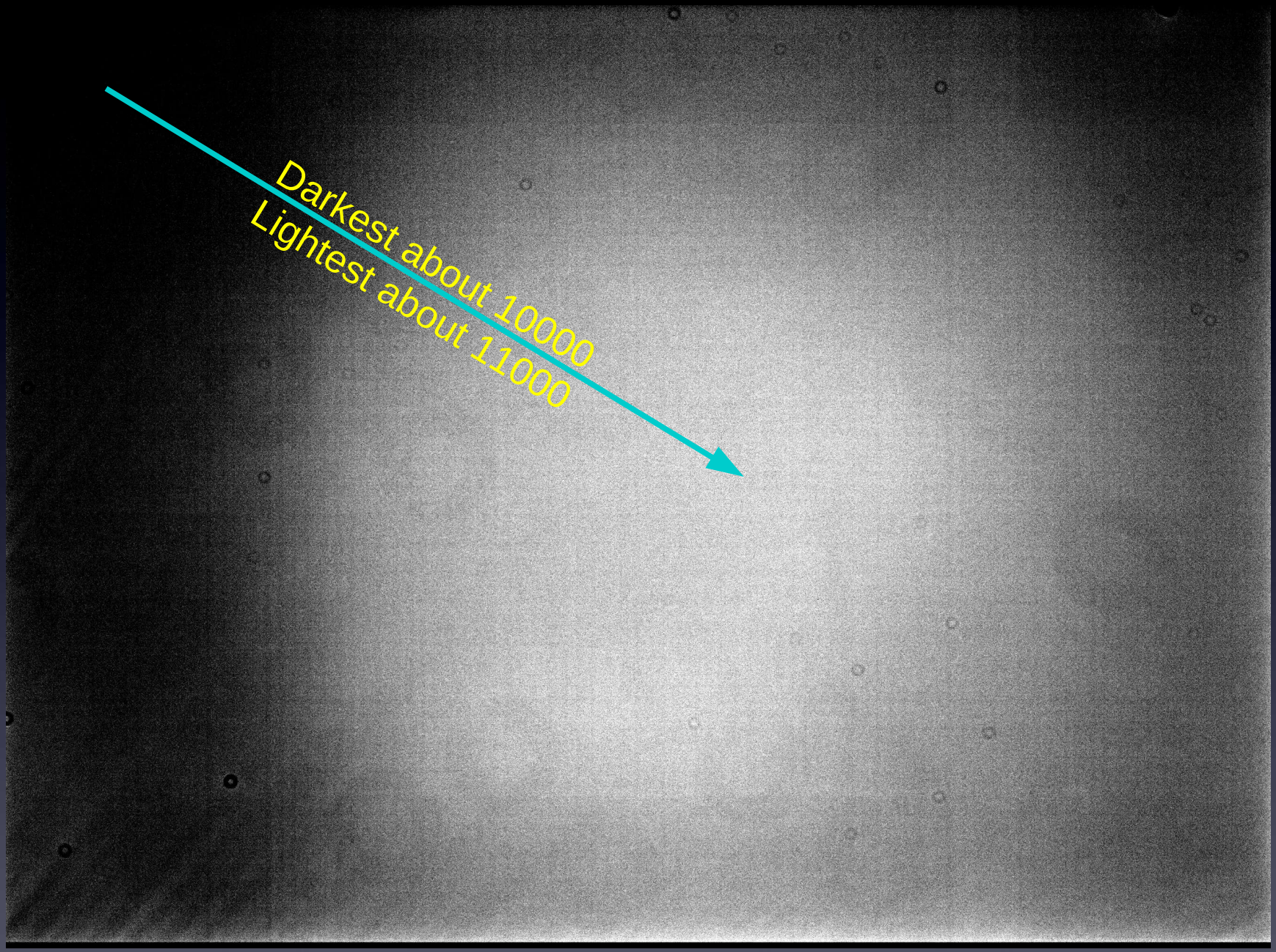
What other faults you say!

Sources!

- Dust on any of the glass elements filters or mirrors
- Even very small dust particles on the camera chip.
- Slight non linearity of the light intensity from edge to centre of image caused by lenses or mirror.

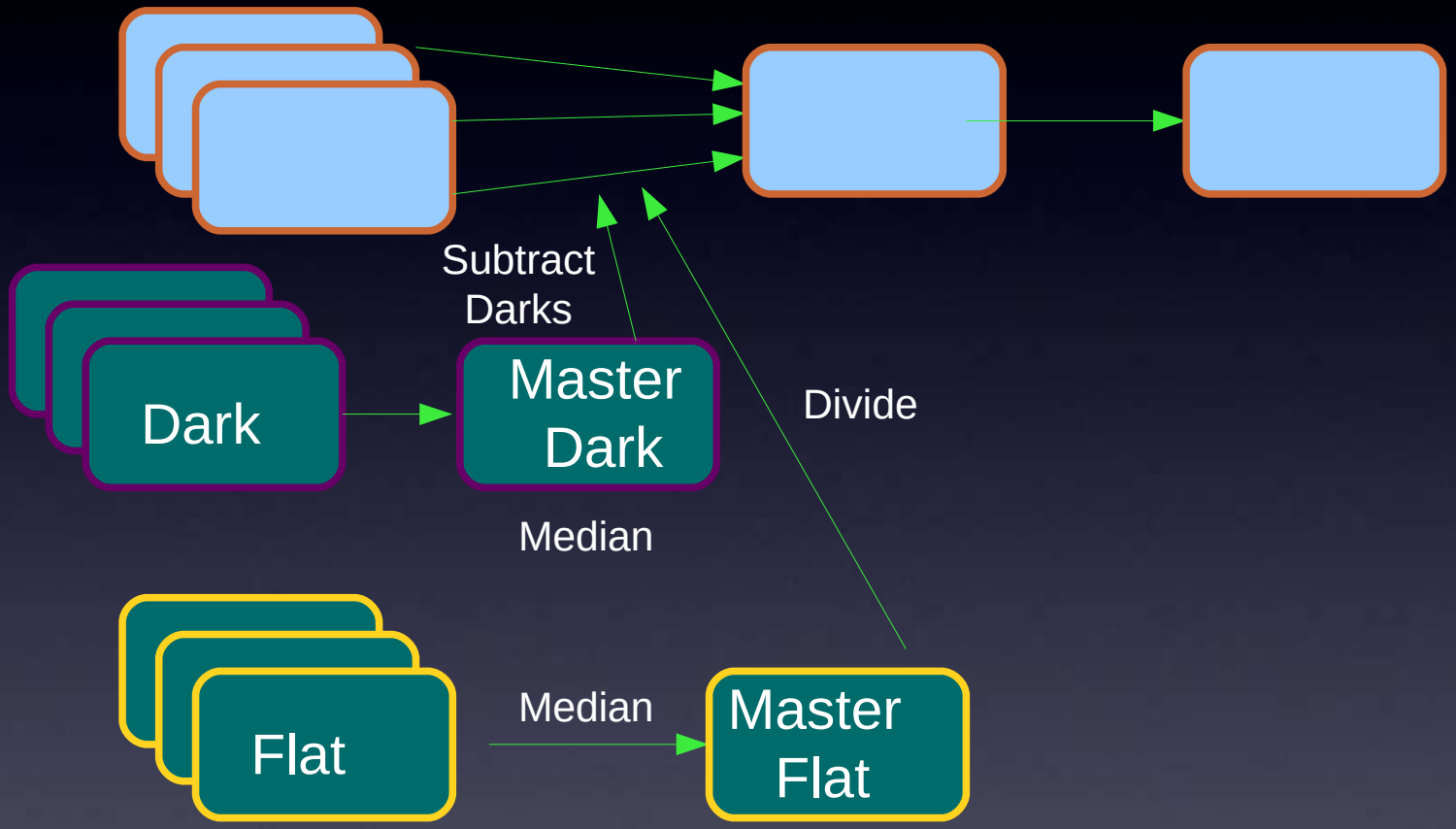
You can take an image of the dust and non linearity and divide the original image by the flat, pixel by pixel !

- Point the telescope at the sky at dusk (a nice flat bit!!)
- Take a few images at different exposures.
- One set for each filter (if you are using filters)
- Typically a second or two. Not really very critical as long as the image is not saturated.
- This is what you get:

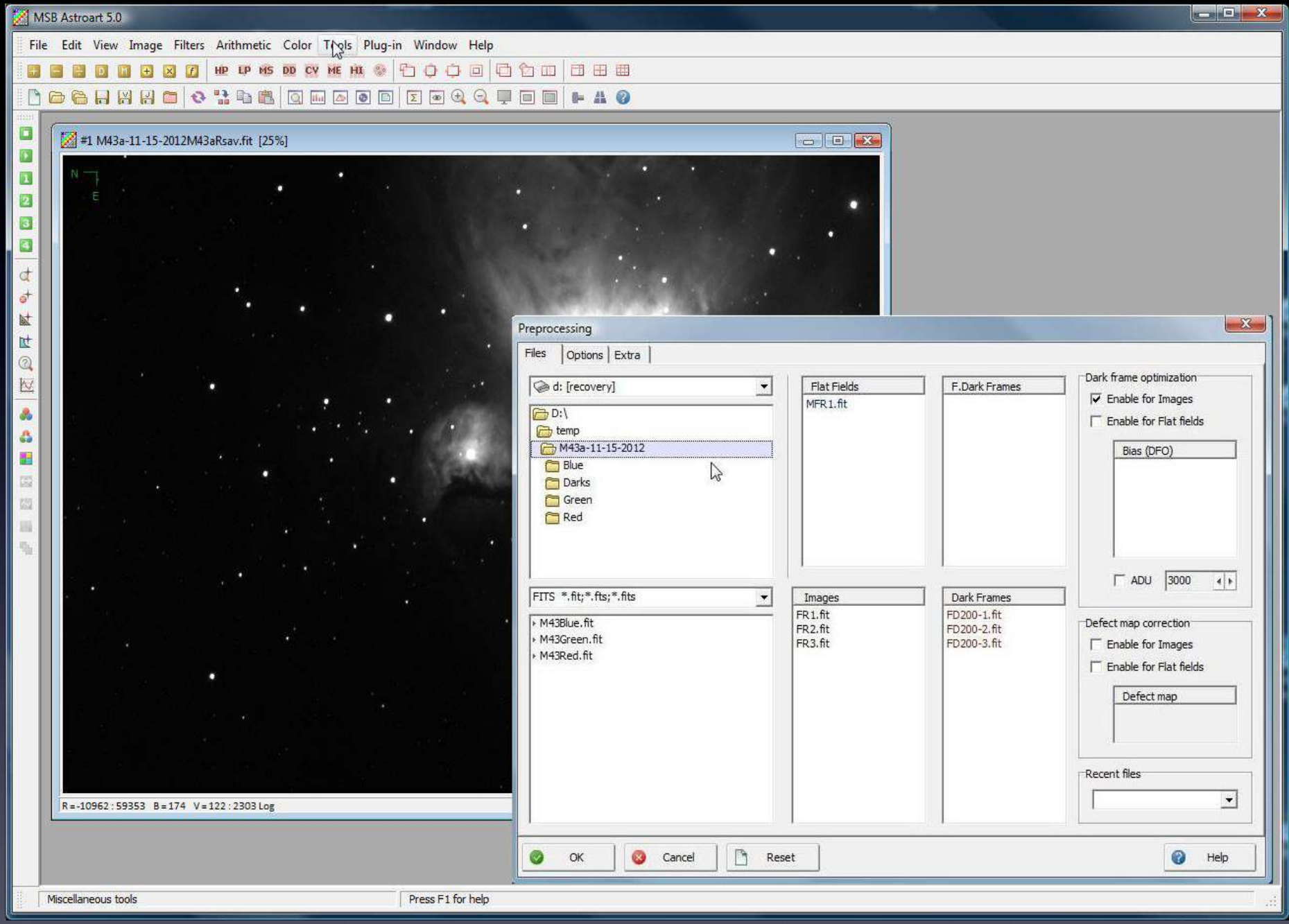

Darkest about 10000
Lightest about 11000

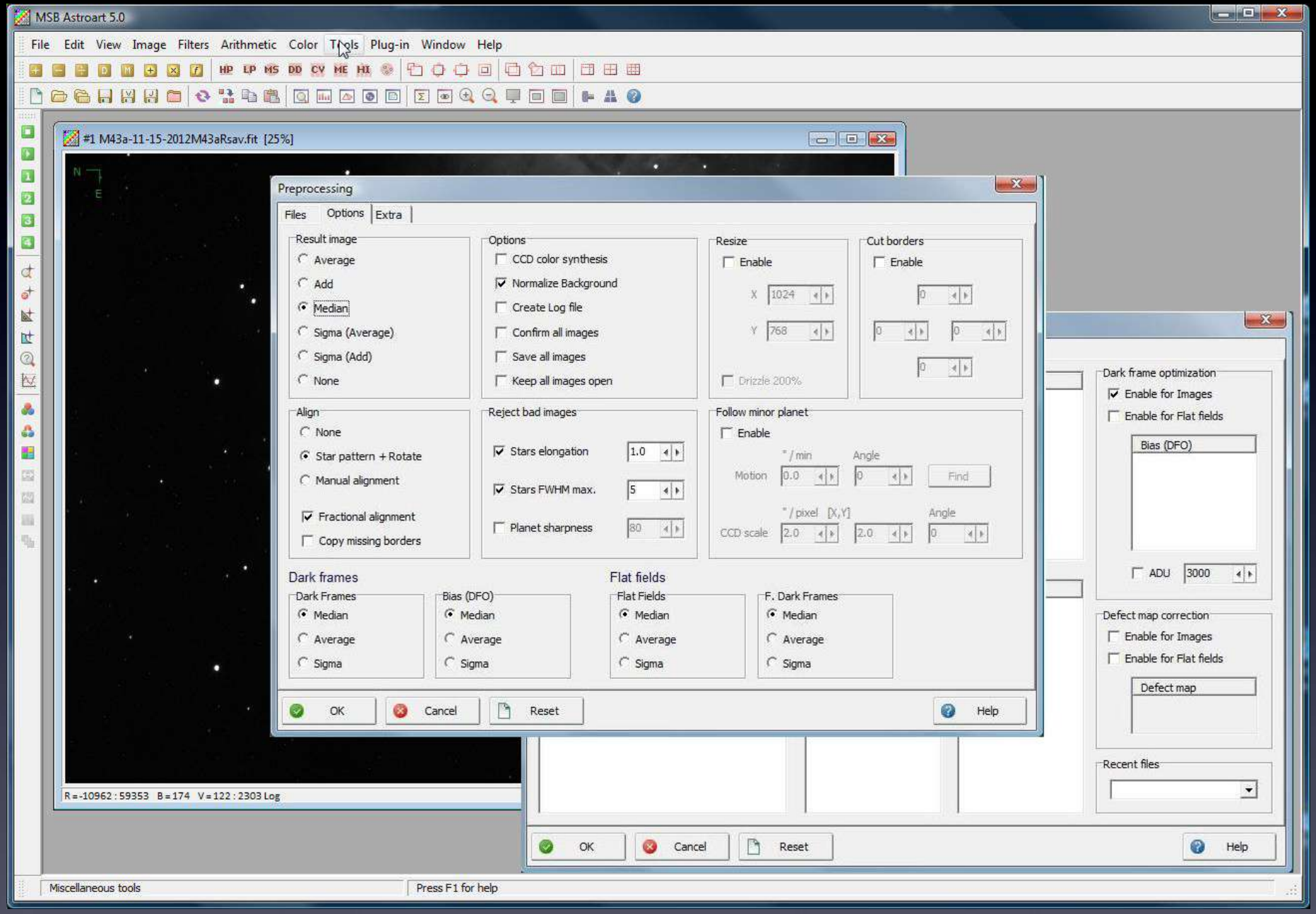
It is easiest to let a software package process all these frames!

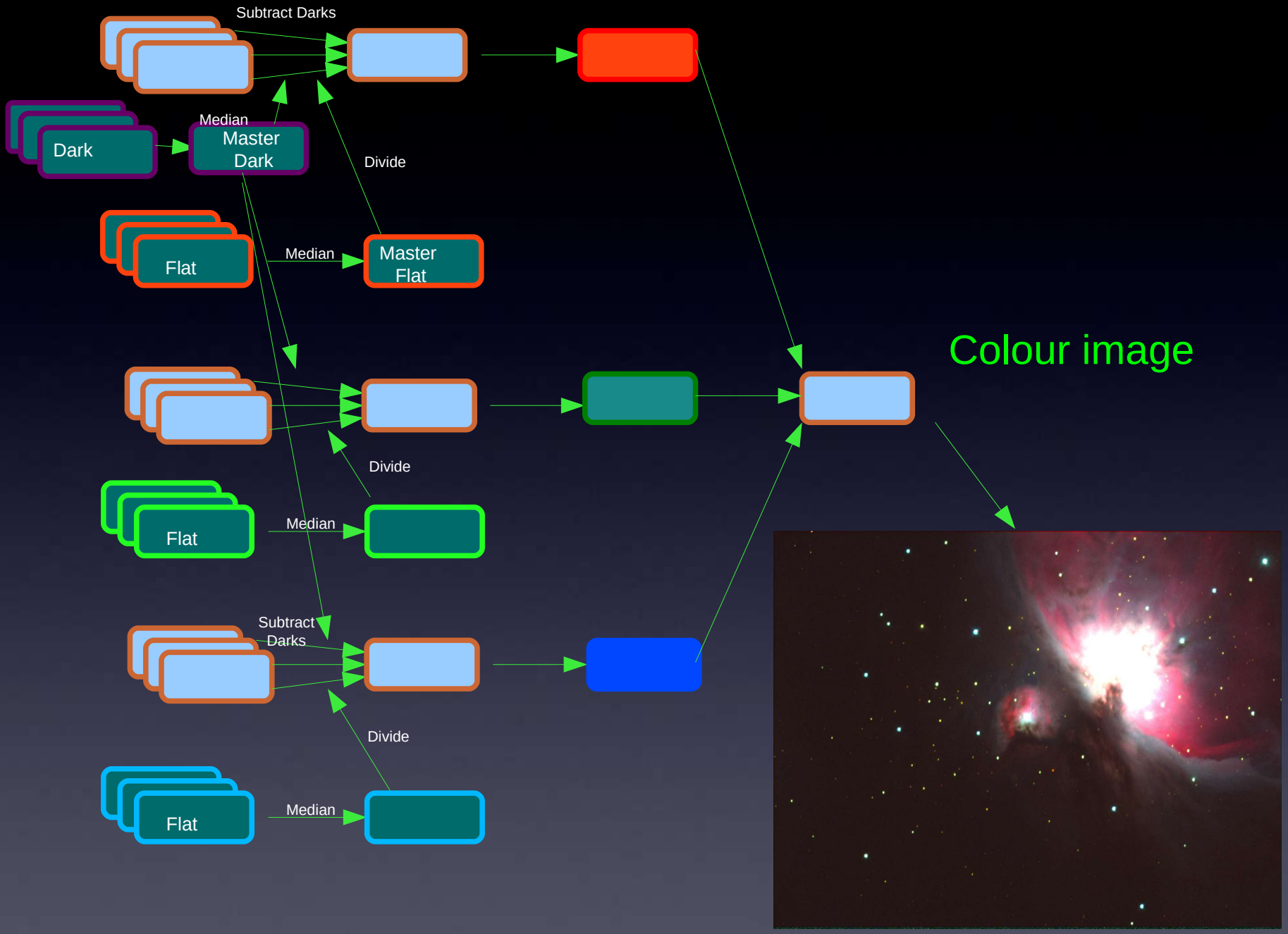
For each colour R G B!



Taking the median of 4 frames would reduce random noise by 50%


MSB Astroart 5.0
File Edit View Image Filters Arithmetic Color Tools Plug-in Window Help
#1 M43a-11-15-2012M43aRsav.fit [25%]
R=-10962 : 59353 B=174 V=122 : 2303 Log
Preprocessing
Files Options Extra
d: [recovery]
D:\
temp
M43a-11-15-2012
Blue
Darks
Green
Red
FITS *.fit;*.fts;*.fits
M43Blue.fit
M43Green.fit
M43Red.fit
Flat Fields
MFR1.fit
F.Dark Frames
Images
FR1.fit
FR2.fit
FR3.fit
Dark Frames
FD200-1.fit
FD200-2.fit
FD200-3.fit
Dark frame optimization
Enable for Images
Enable for Flat fields
Bias (DFO)
ADU
3000
Defect map correction
Enable for Images
Enable for Flat fields
Defect map
Recent files
OK
Cancel
Reset
Help
Miscellaneous tools
Press F1 for help


MSB Astroart 5.0
File Edit View Image Filters Arithmetic Color Tools Plug-in Window Help
#1 M43a-11-15-2012M43aRsav.fit [25%]
Preprocessing
Files Options Extra
Result image
Average
Add
Median
Sigma (Average)
Sigma (Add)
None
Options
CCD color synthesis
Normalize Background
Create Log file
Confirm all images
Save all images
Keep all images open
Resize
Enable
X 1024
Y 768
Drizzle 200%
Cut borders
Enable
Align
None
Star pattern + Rotate
Manual alignment
Fractional alignment
Copy missing borders
Reject bad images
Stars elongation 1.0
Stars FWHM max. 5
Planet sharpness 80
Follow minor planet
Enable
" / min
Angle
Motion 0.0
Find
" / pixel [X,Y]
CCD scale 2.0 2.0
Dark frames
Dark Frames
Median
Average
Sigma
Bias (DFO)
Median
Average
Sigma
Flat fields
Flat Fields
Median
Average
Sigma
F. Dark Frames
Median
Average
Sigma
OK
Cancel
Reset
Help
Dark frame optimization
Enable for Images
Enable for Flat fields
Bias (DFO)
ADU 3000
Defect map correction
Enable for Images
Enable for Flat fields
Defect map
Recent files
R = -10962 : 59353 B = 174 V = 122 : 2303 Log
Miscellaneous tools
Press F1 for help


Subtract Darks
Dark
Median
Master Dark
Divide
Flat
Median
Master Flat
Divide
Flat
Median
Subtract Darks
Divide
Flat
Median
Colour image


Core area needs shorter exposure time!

You may need more than one set of exposures

Why!

- The range of pixel values may not allow very dim and very bright in the same picture.

Solution is to take another set of images at shorter exposure say 100sec or shorter !

- The same process is used for the shorter exposure colour image.
- The result is:

Graphics processing is now needed to merge the two images

Expensive Photoshop will do this very well but I use Freeware! GIMP 2.6

- Ensure the two images are saved at the same scale.
- Load each as a layer
- Flip between layers to align them
- On the top image create a black layer mask
- Using a fine spray brush – spray white on the mask to make it transparent.

- I have video of the three stages in operation if you would like to see the tools in real operation?