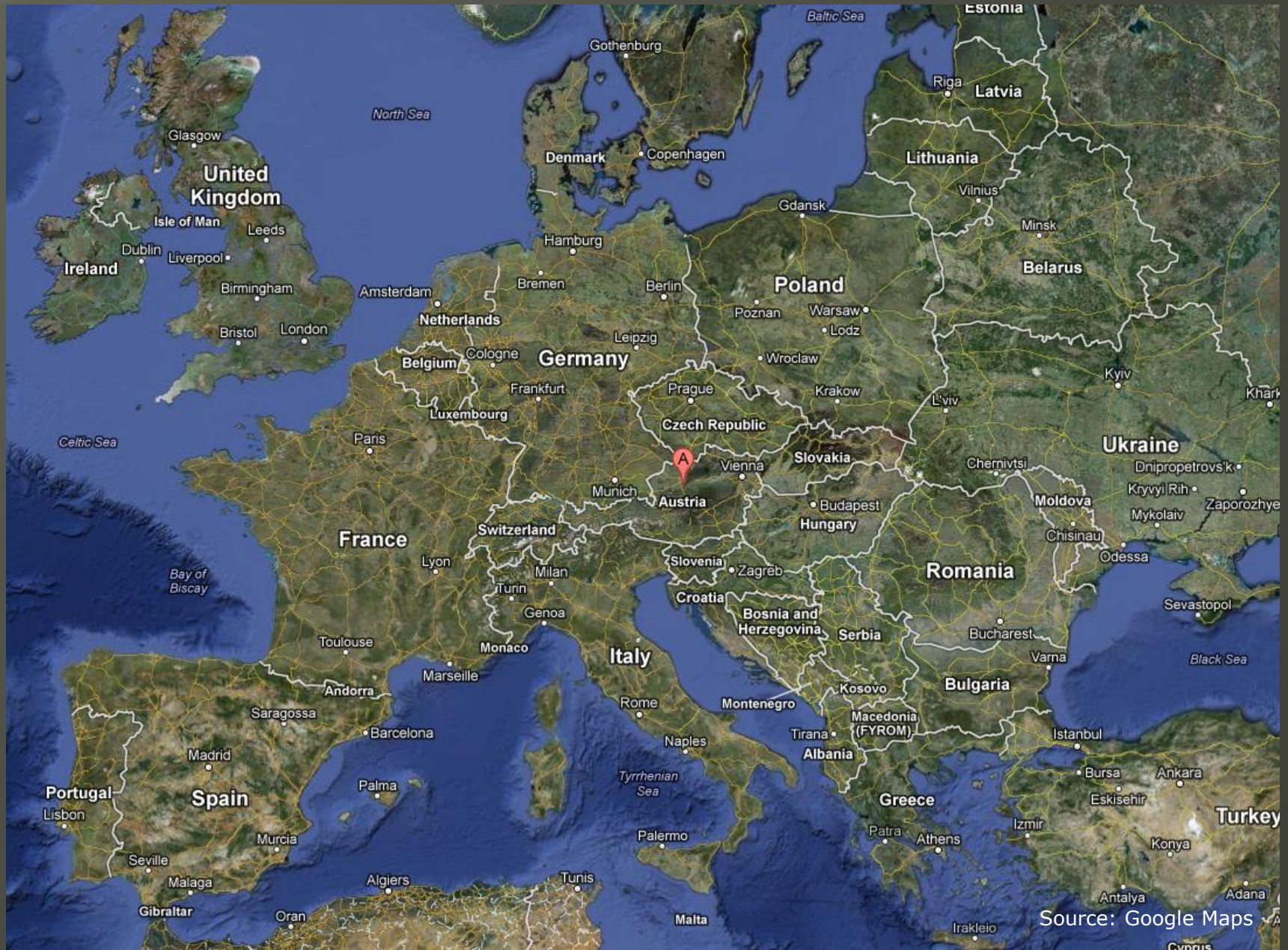
Wide Field
and
Long Focal Length
Imaging

Bernhard Hubl AIC 2012

Contents

- Location and equipment
- Image acquisition
- Calibration, registration and combine
- Image processing
- Examples

My observatory

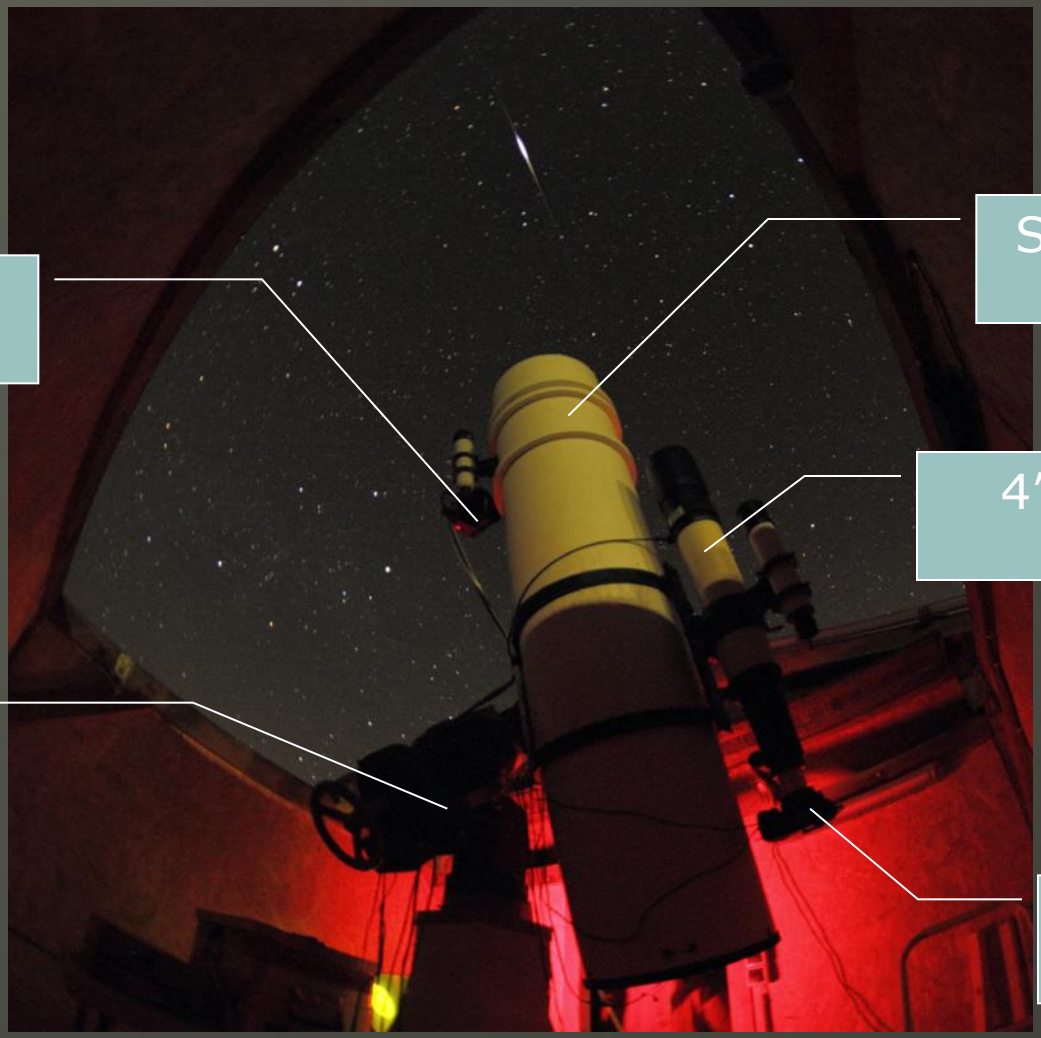


My observatory

My northern sky

Observatory

Observatory in action



Source: Herbert Raab

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Image Scale and Seeing

- Image Scale
  - 12” Newtonian + ST-2000XM: 1.3”/px
  - NP101 + DSLR: 2.2”/px (Bayer) -> 3-4”/px (effective)
- Seeing at my location
  - Typical: 2.4 – 3.2”
  - Excellent: 1.9 – 2.2”
  - Bad: 4 – 7”
- Conclusion:
  - Wide Field nearly always productive
  - Newtonian: Lum < 2.6” / RGB < 4.0”

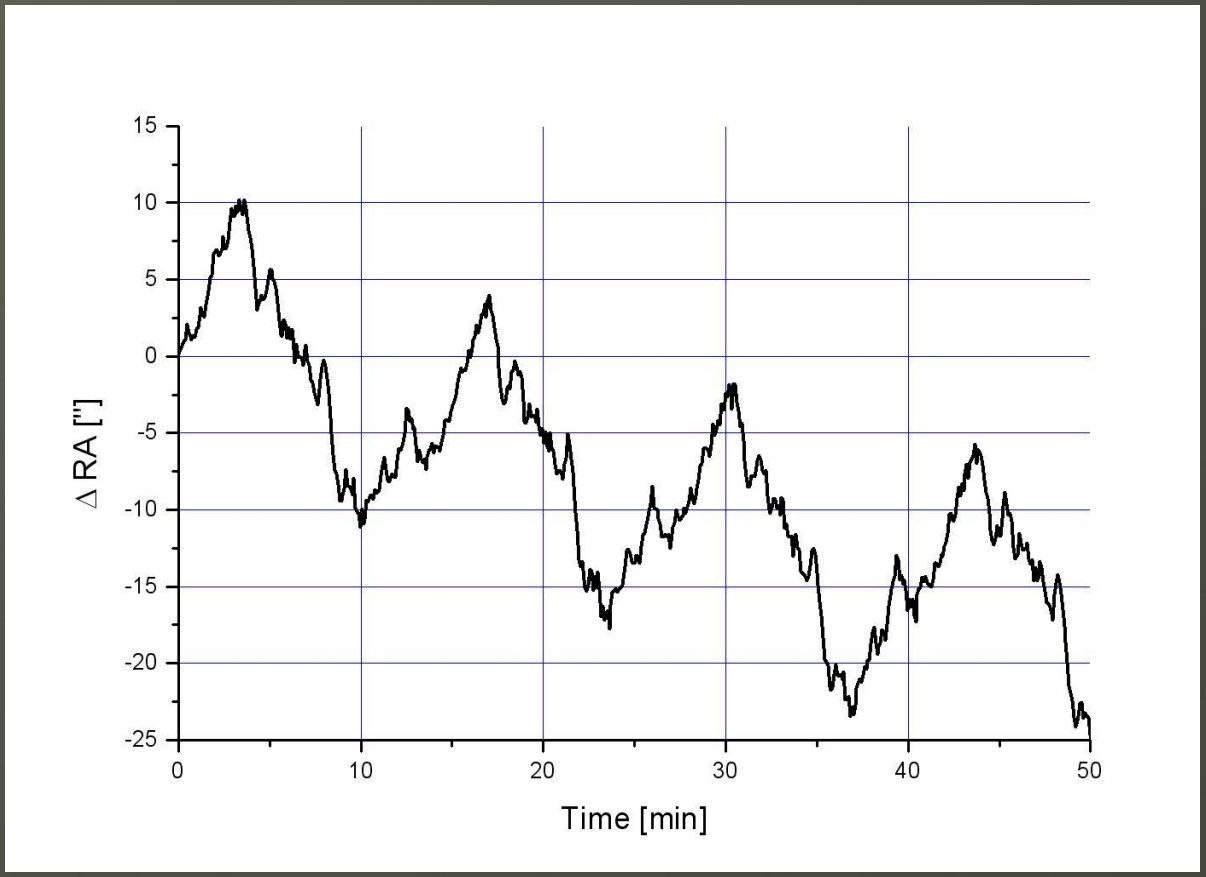
Tip #1 Introduce clear seeing limits

- In my case:
  - < 2.6” Lum
  - 2.6” – 4.0” RGB
  - 4.0” – 5.0” only wide field
  - > 5.0” go sleeping or go for a beer!
- Advantage:
  - No waste of nights with good seeing for RGB
  - Reproducibility

Mount

- Focal length -> guiding accuracy
  - 12” Newtonian: 1.3”/px
  - NP101 + DSLR: 2.2”/px (Bayer) -> 3-4”/px (effective)
- Do you need a perfect mount?

Periodic error of my mount



- typical ±10”
- Worst ±20”
- Period = 13.5 min

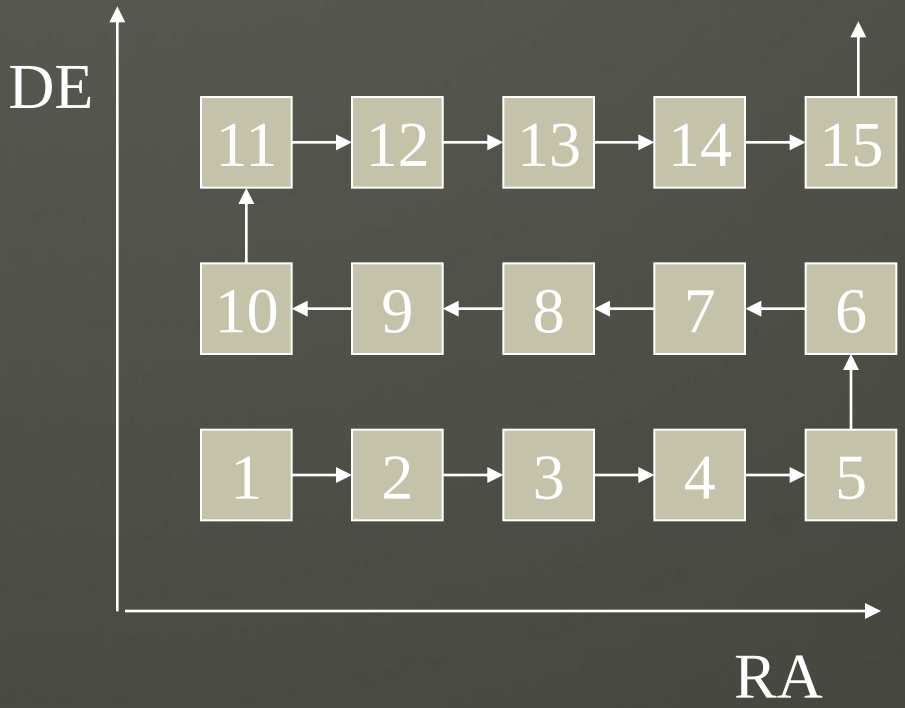
Tip #2 Analyze periodic error

- High value of PE is no problem
- No abrupt changes of track speed
- Long period

Backlash of my mount

Tip #3 Neutralize backlash

- Wind is critical!
- RA backlash
  - much more weight on the eastern side of the mount
- DE backlash
  - Misalignment of polar alignment -> continuous movement of guide star in declination
  - Snake dither: CCDSoft plugin Autodither by Paul Kanevsky



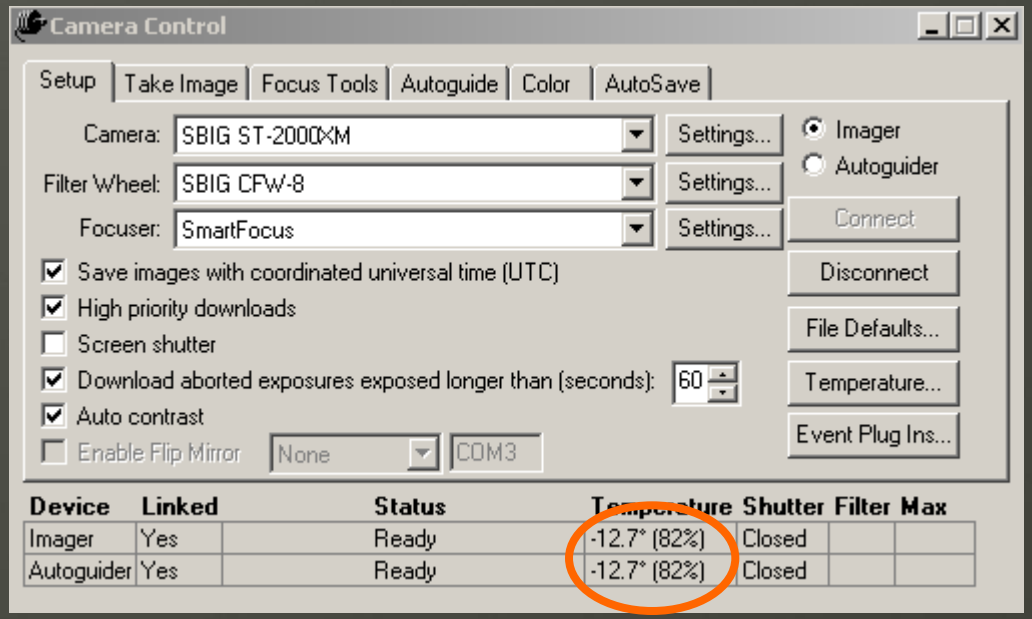
Demo

Focusing

- Ambient temperature declines up to 10°C during the night
- Refocusing interval: 20 min – 60 min
- Focusing during running exposures

Tip #4 Use the camera cooling for refocusing

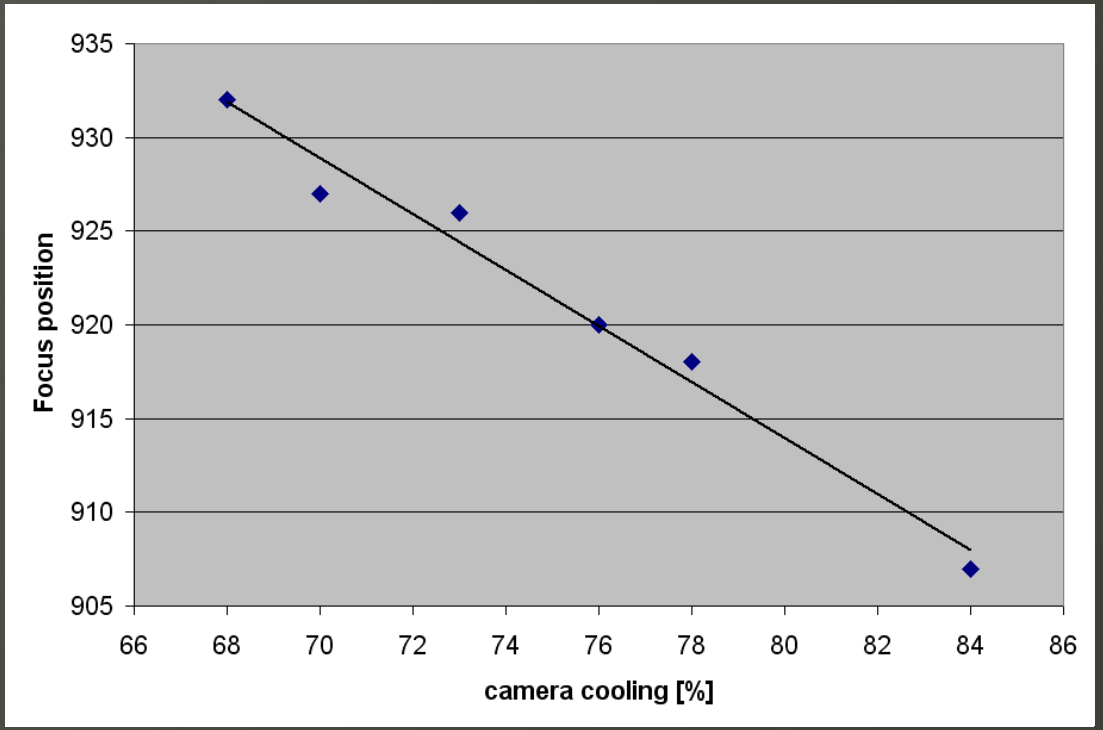
- Focuser
  - 2” JMI NGF with Smart Focus
  - No temperature compensation
  - No temperature measurement
- Idea: Use the percentage of the camera cooling as a detector for the temperature



Tip #4 Use the camera cooling for refocusing

- Invest one night for carefully focusing

time	camera cooling [%]	focus position
21:11	84	907
21:40	78	918
22:35	76	920
00:30	73	926
01:20	70	927
02:55	68	932

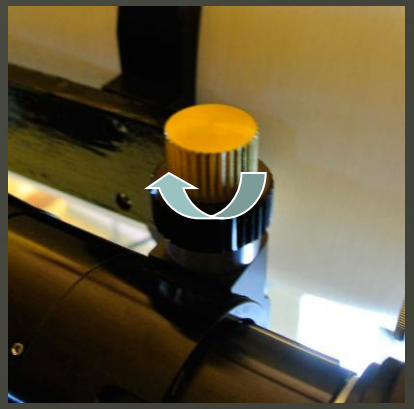


- Use Excel sheet focus.xls to calculate the focus position

Tip #5 Use the corners of the image for focusing

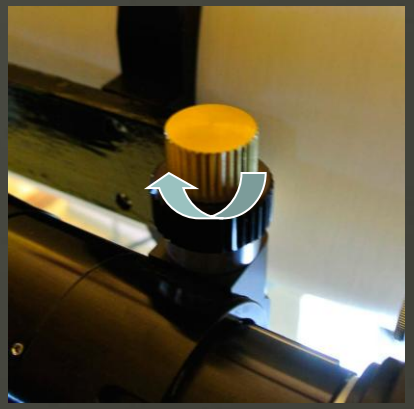
- Many refractors show the following behaviour:
  - Stars are elongated far away from the optical axis, when the telescope is not focused.
  - The direction of the star elongation gives us a hint in which direction the focus knob has to be moved to reach focus.
  - E.g. TeleVue NP101 + manual focuser

Zoom to the center of the image



Move focus from extrafocal to intrafocal position

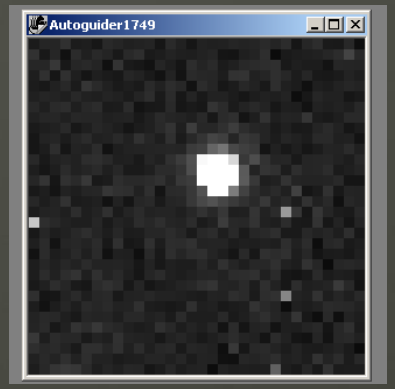
Zoom to the top right corner

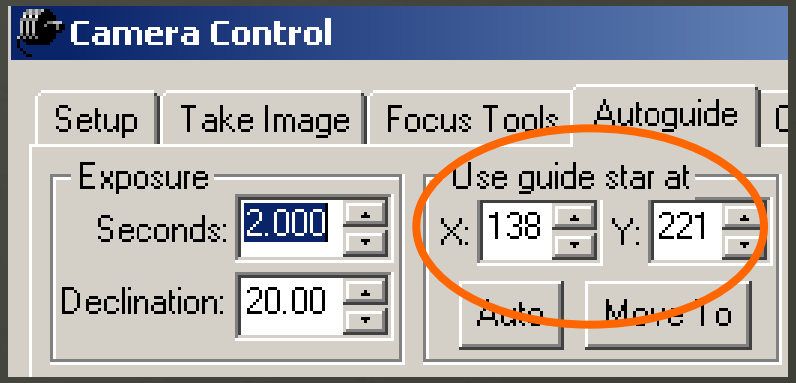


Move focus from extrafocal to intrafocal position

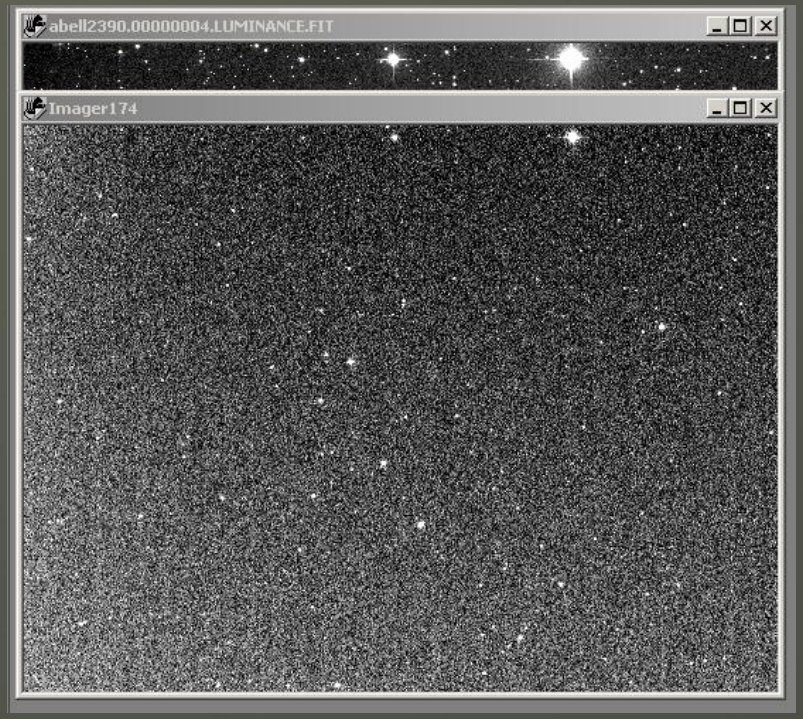
Tip #6 Use guide star position to reproduce framing

- Problem:
  - Many nights are necessary for a deep image
  - Reproducibility of framing is very important for cameras with few pixels (e.g. 1600x1200px of ST-2000XM)
- Solution:
  - Camera and telescope build a unit (no rotation)
  - Note exact position of guide star in first night
  - Following nights:

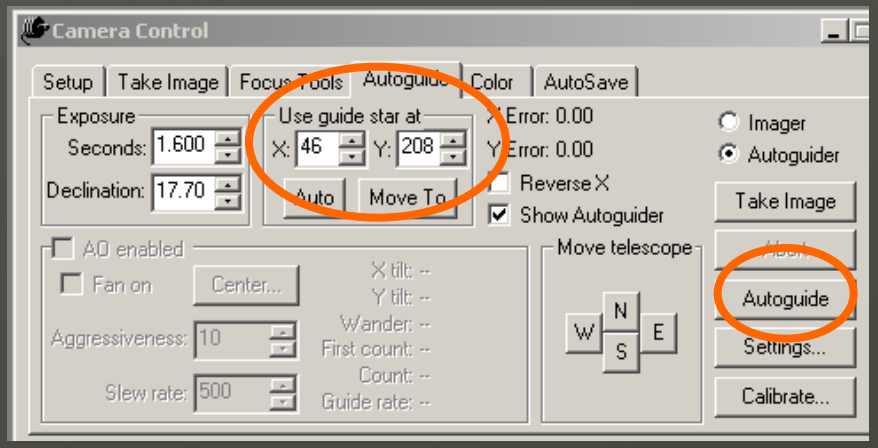


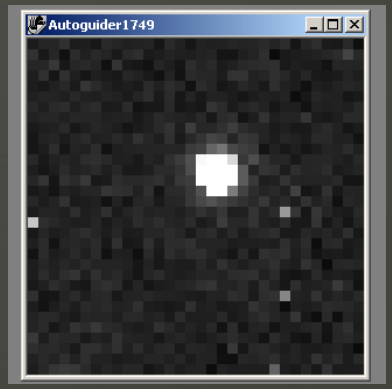


Tip #6 Use guide star position to reproduce framing



- Frame visually by comparison with existing exposures
- Enter the guide star coordinates in the Autoguide tab of CCDSoft
- Start Autoguide
- CCDSoft does sub-pixel accurate framing for you!





Do you always have a sky like this?

- If yes, then forget the following 3 slides!

- Do you want to double the number of clear nights at your location?
- Why do you not use two telescopes simultaneously?
- It’s easier than you think!

Tip #7 Use two telescopes simultaneously

- Why?
  - Double your output (unstable weather)
  - The environment around an object can be interesting
  - Nights with very bad seeing can be used
- How?
  - Guiding with the main telescope (long focal length)
  - Second telescope with much shorter focal length
  - DSLR or OSC for second telescope
  - Maximize exposure time for second telescope
  - Synchronize the exposure and delay times

Tip #7 Synchronize the exposure times

- Measure times for
  - Lum cycle of main camera (no change of filters)
  - RGB cycle of main camera (change of filters)
- How?
  - Measure total time for 10 cycles
  - Better accuracy
  - Delay.xls

Examples

- Bad Seeing


Ruprecht 173 – NP101 + ST-8300C

Examples

- Bad Seeing

- Interesting environment


GM 3-10
LDN810 – 12“Newt + ST-2000XM


Sh 2-92
LDN 810
LDN 803
LDN 808
LDN 807
LDN 804
PS Vul
LDN 806
Sh 2-90


Sh 2-92
LDN 810
GN 19.43.3.01

Examples

- Bad Seeing

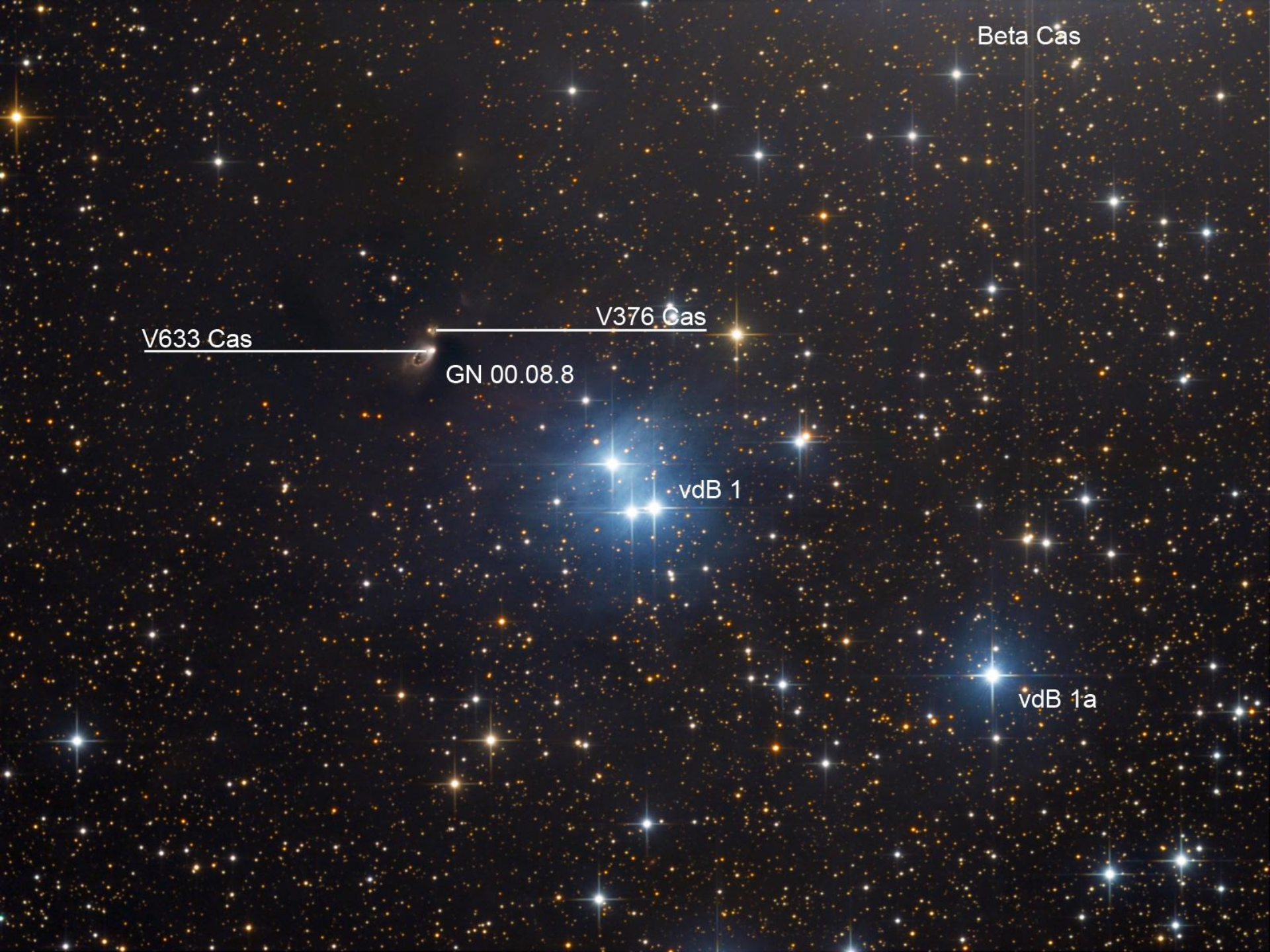
- Interesting environment

IC 10 – 12“ Newt + ST-2000XM

IC 10 – NP101 + ST-8300C


IC 10
Beta Cas
vdB 1


vdB 1 – 12“ Newt + ST-2000XM


Beta Cas
V376 Cas
V633 Cas
GN 00.08.8
vdB 1
vdB 1a

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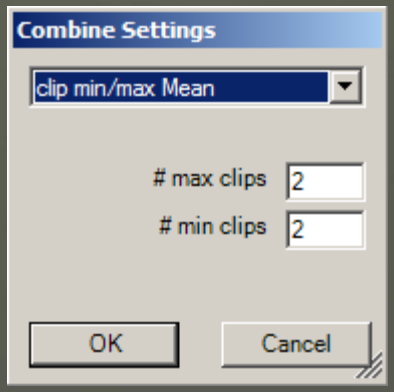
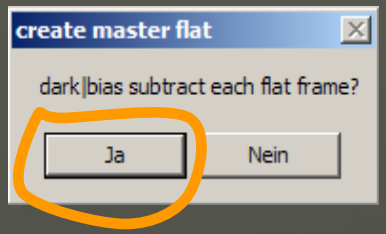
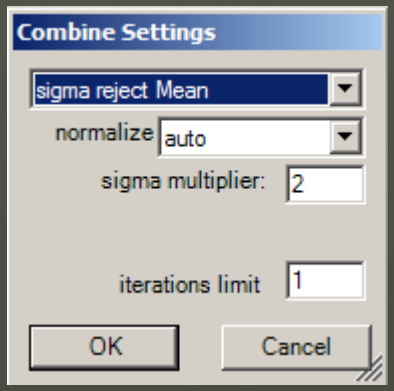
Calibration, registration and combine

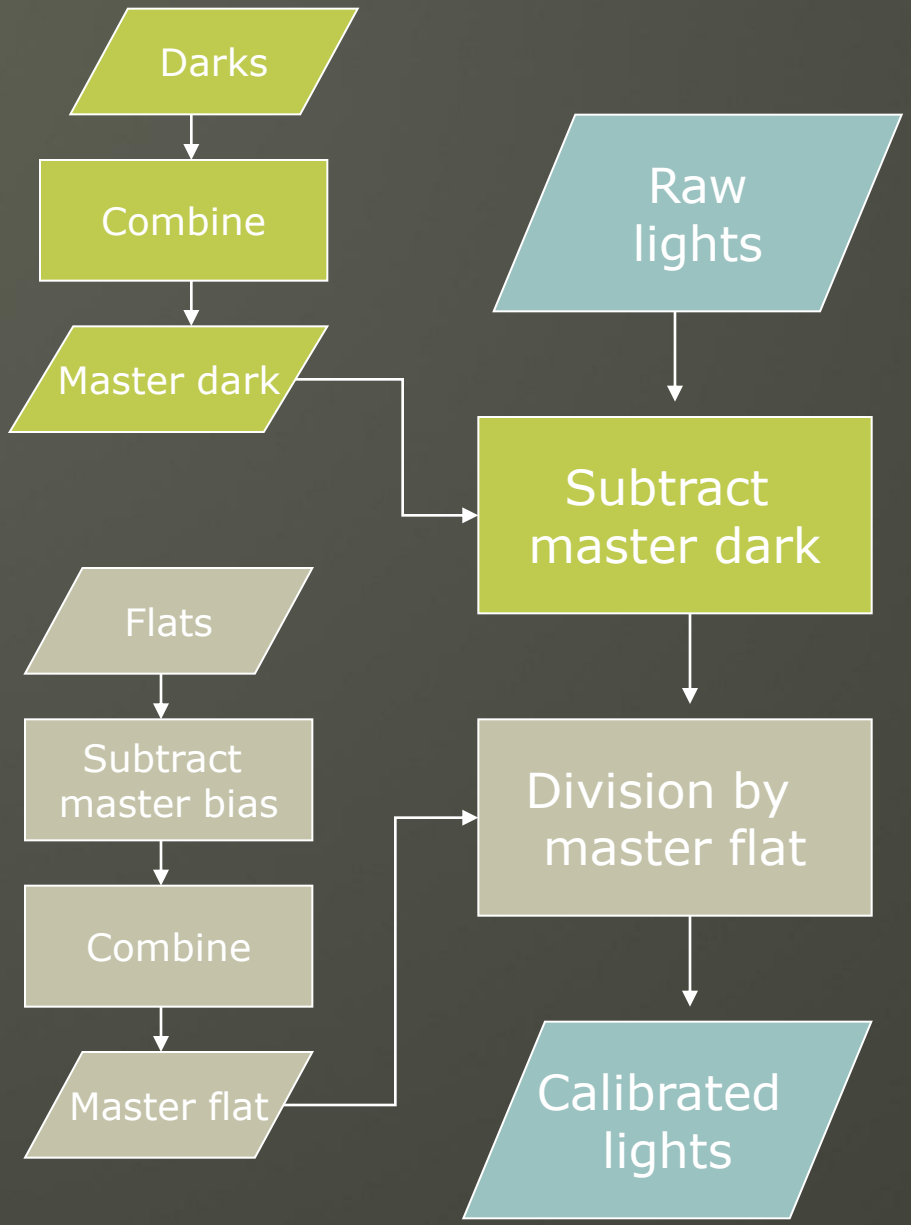
- Long focal length:
  - Mono camera -> CCDSTACK
- Wide field:
  - OSC -> CCDSTACK (very similar to mono workflow)
  - DSLR -> IRIS

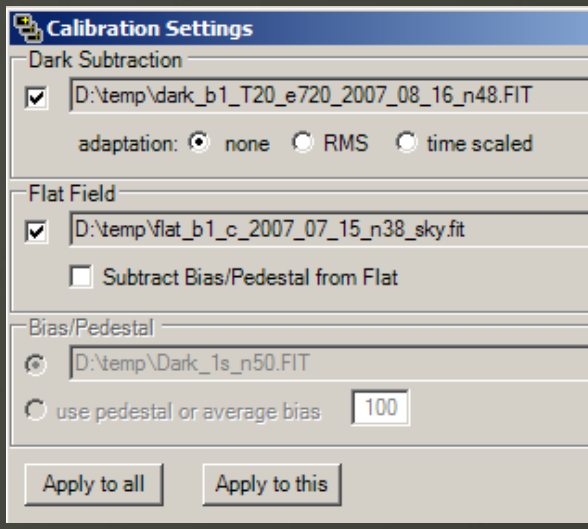
Calibration with CCDStack







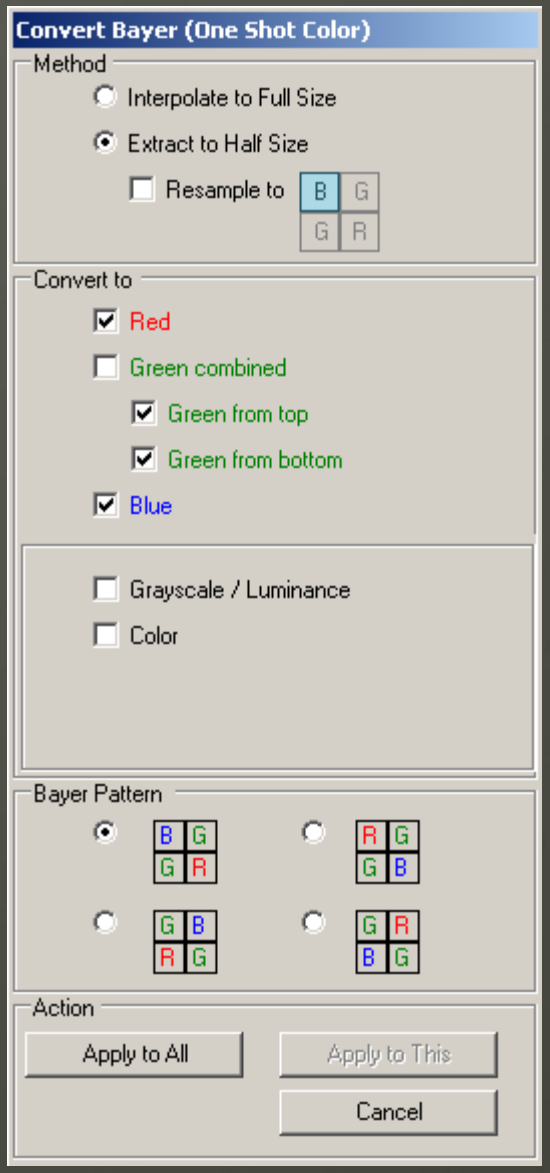




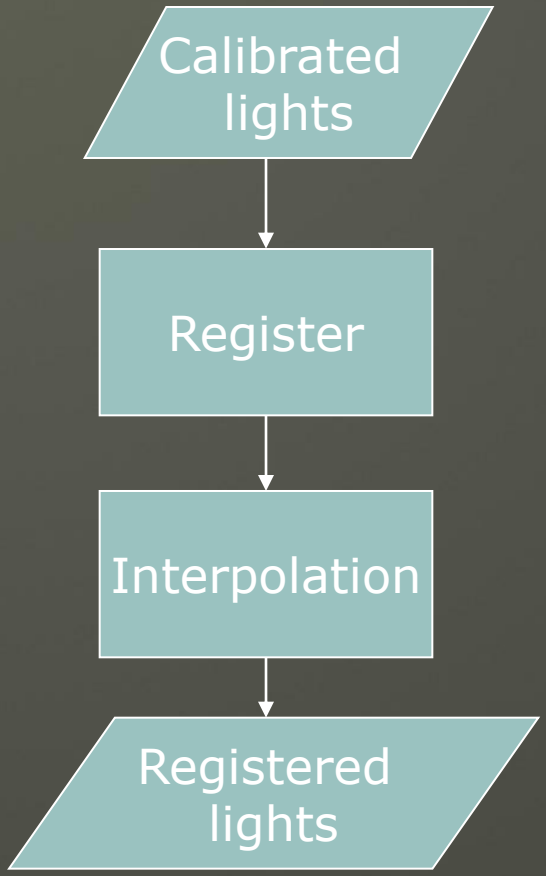
Tip #8 Keep your workflow simple

- What should I do, when I have to choose between two different ways of a processing step?
  - Compare the results critically
  - If the difference between the results is small, then always choose the simpler way.
  - Prefer steps which you understand entirely.
  - Include complex steps in your workflow only when the improvement is significant.
  - E.g. simple calibration with no hot / dark pixel removal

OSC: Debayer with CCDStack



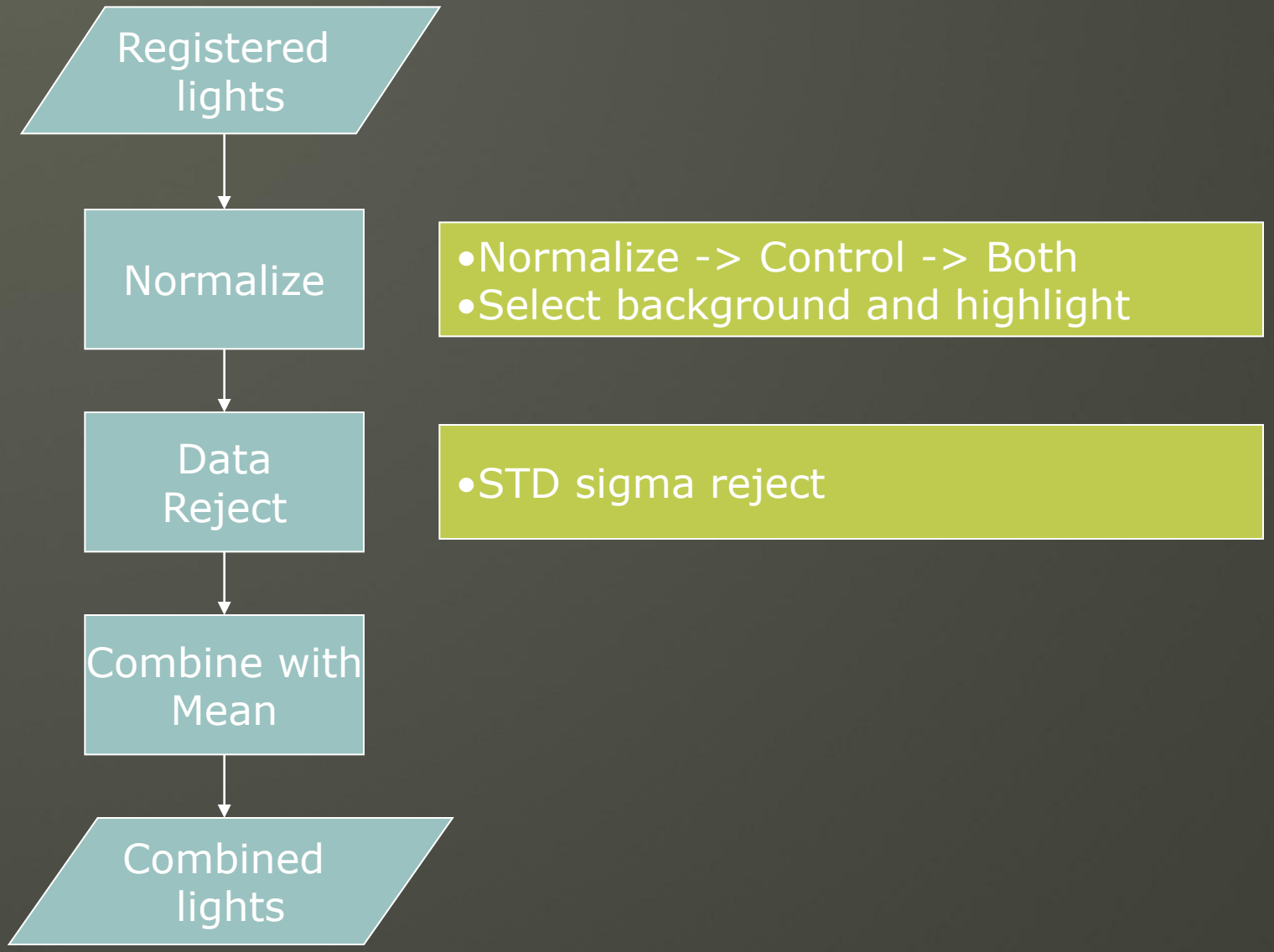
Registration with CCDStack



- Same lum base image for all frames
- CCDIS plugin

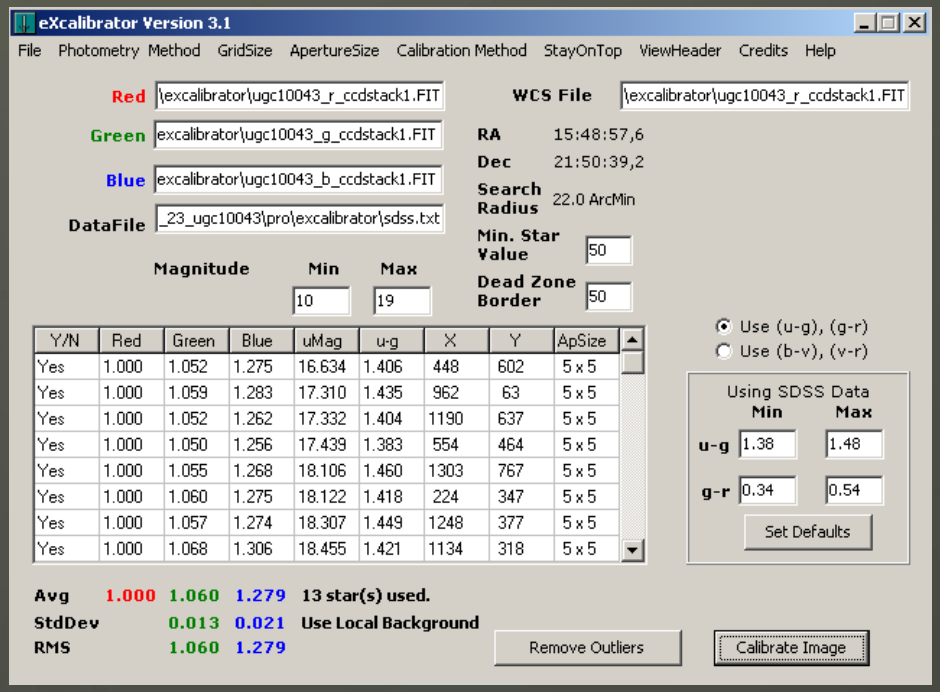
- Cosine for Lum
- Bicubic B-spline for RGB

Combine with CCDStack

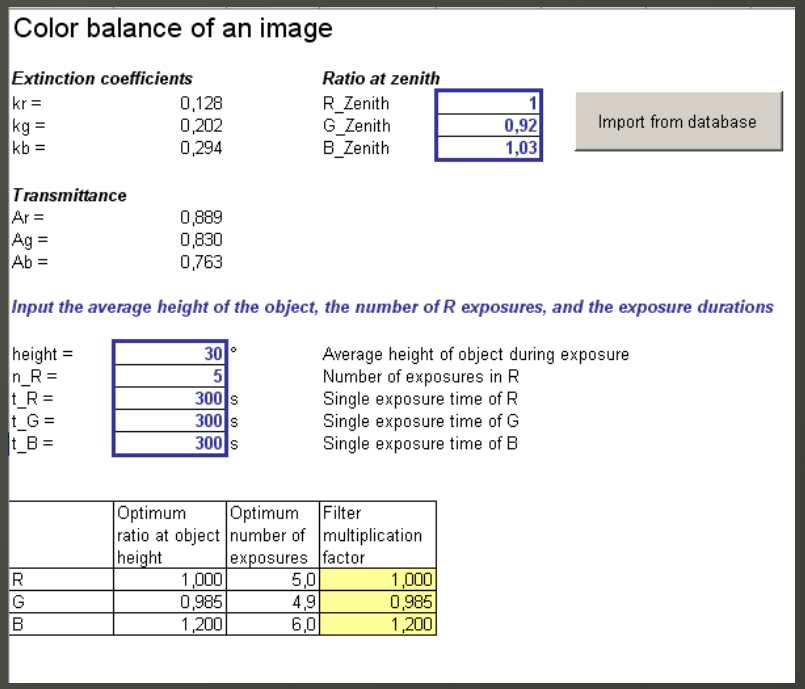


RGB weights

- eXcalibrator by Bob Franke



- G2_Calculator.xls



Tiff export with CCDStack 1.4

- DDP with similar settings for Lum and RGB
- Autoscale is a good start
- Reduce Gamma and Background a little bit
- Save as 16 bit TIFF scaled
- Compare Lum and RGB in Photoshop

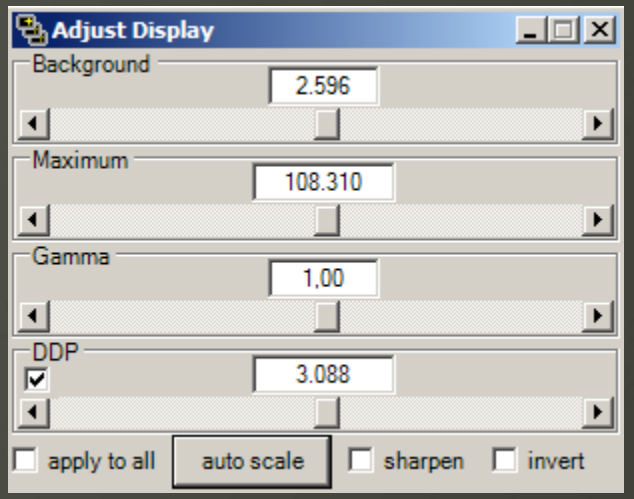


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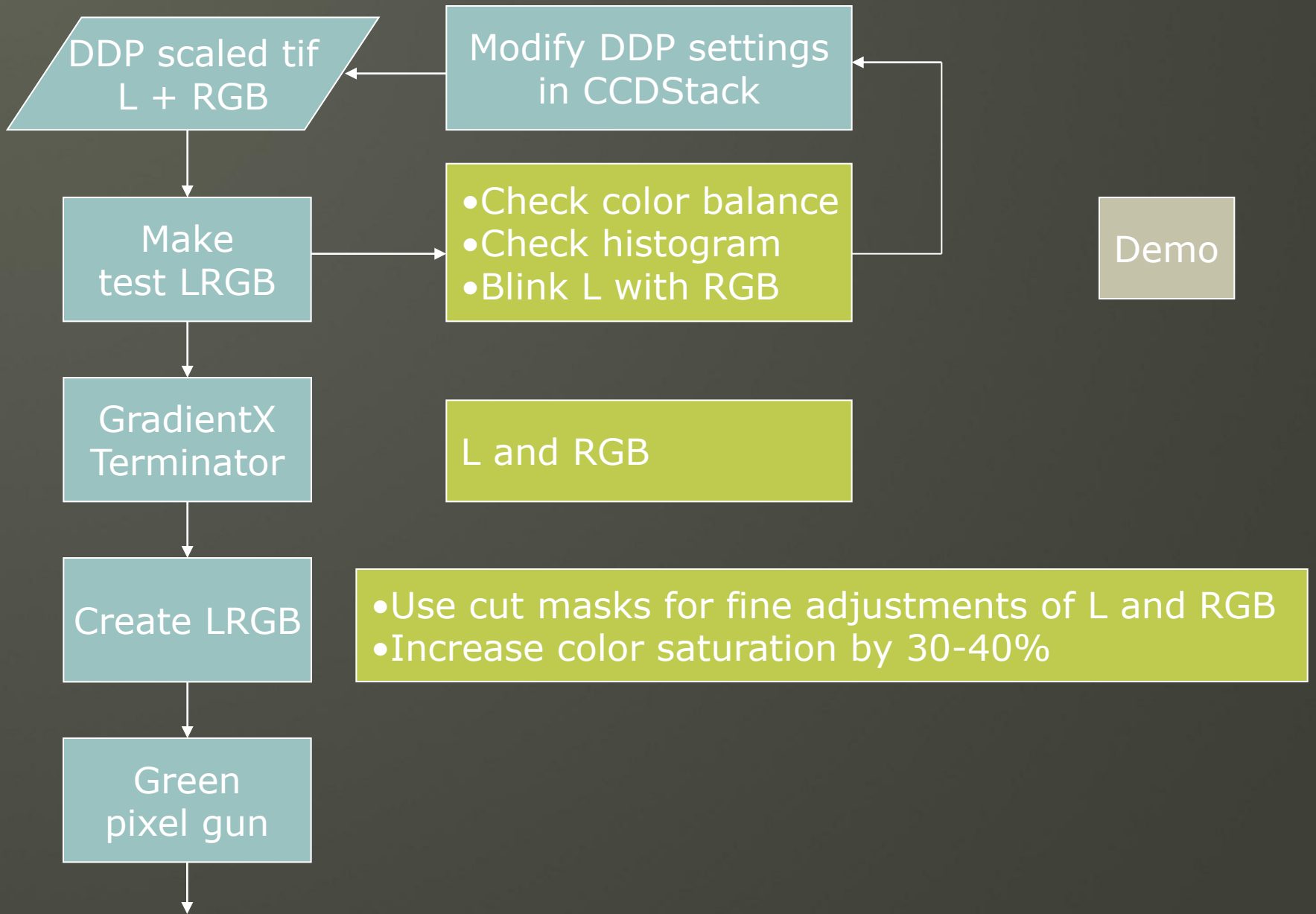
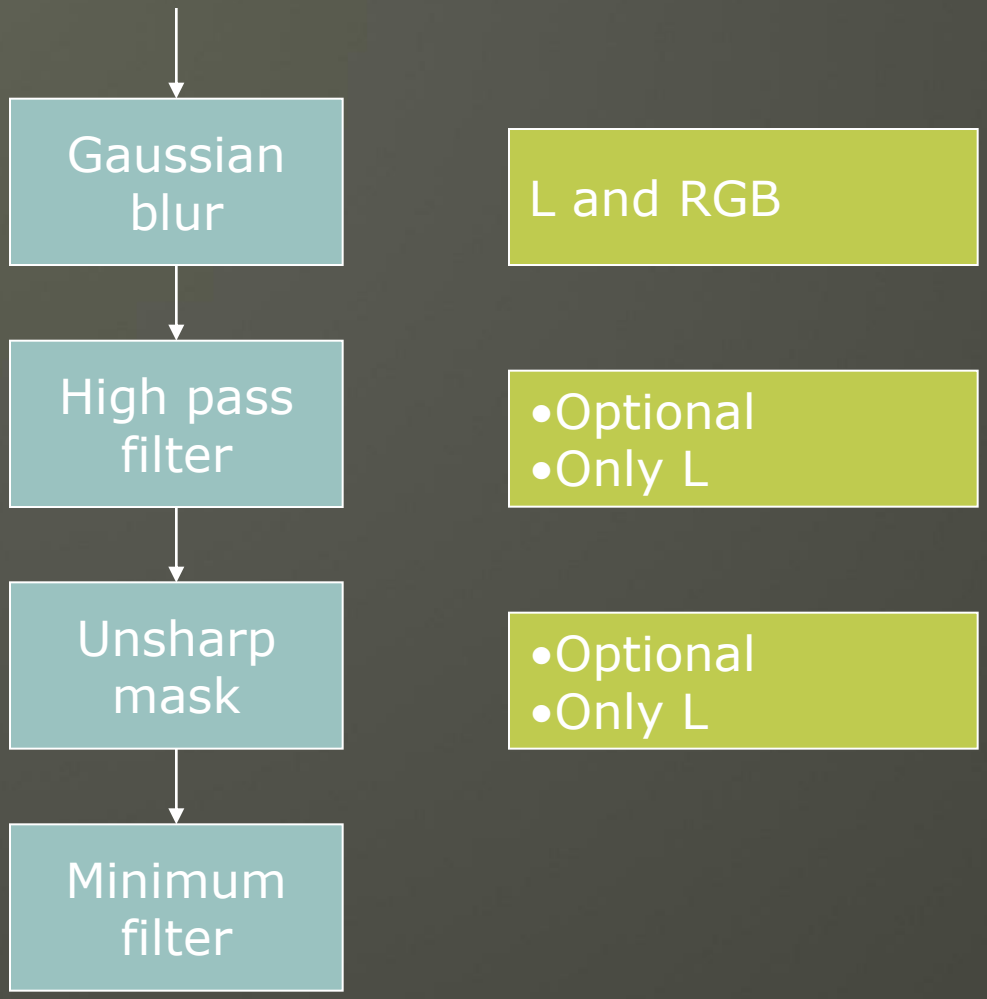
Image Processing

- Minimalist approach
- Natural looking image is main goal
- Workflow for wide field and long focal length imaging is very similar
- Differences in CCDStack
  - Debayer for wide field OSC
  - Deconvolution for lum of long focal length
- Differences in Photoshop
  - Pure RGB for wide field
  - LRGB for long focal length
  - OSC images need more color saturation

Photoshop CS2 Workflow I



Photoshop CS2 Workflow II



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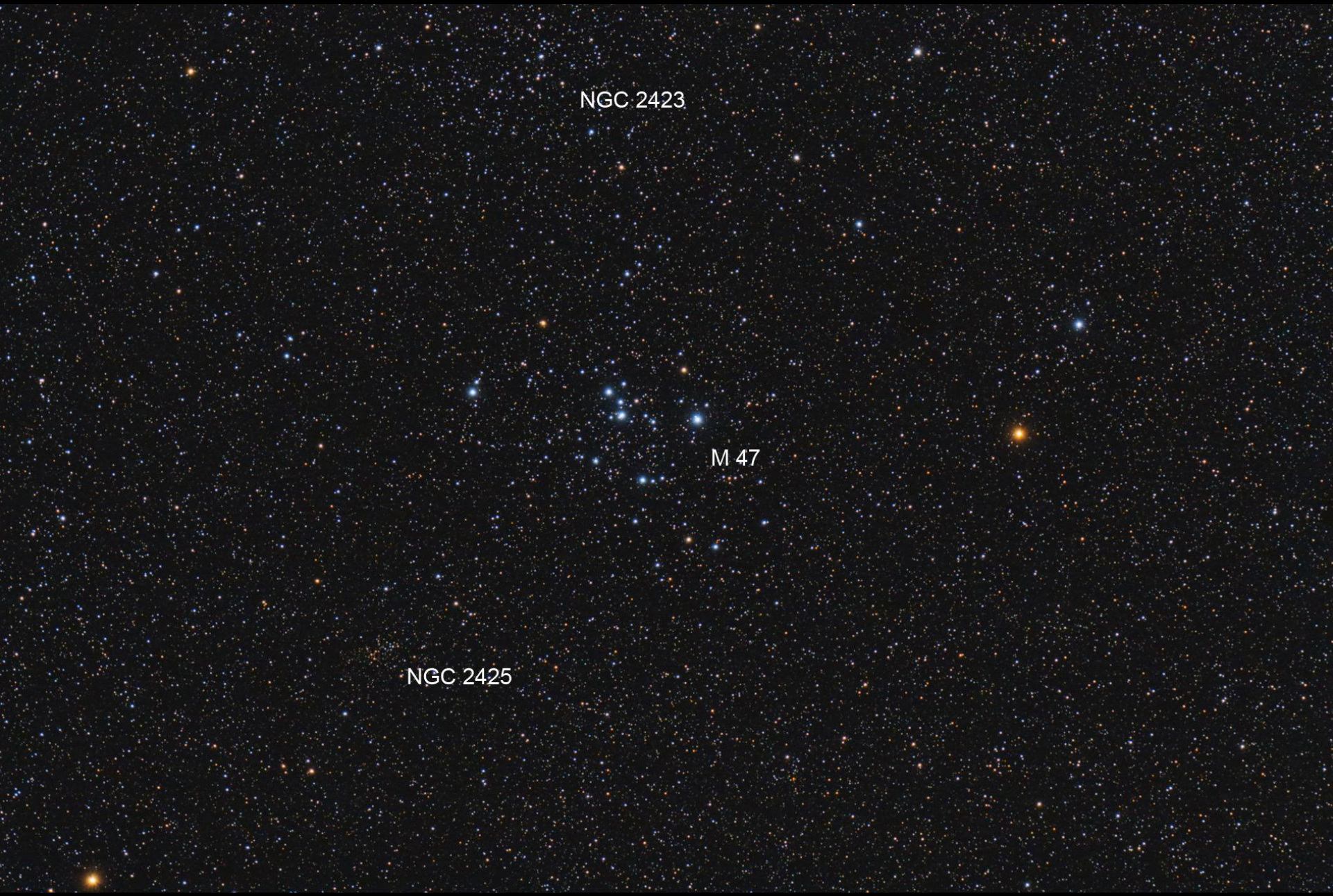
M 47 – 12“ Newt + ST-2000XM



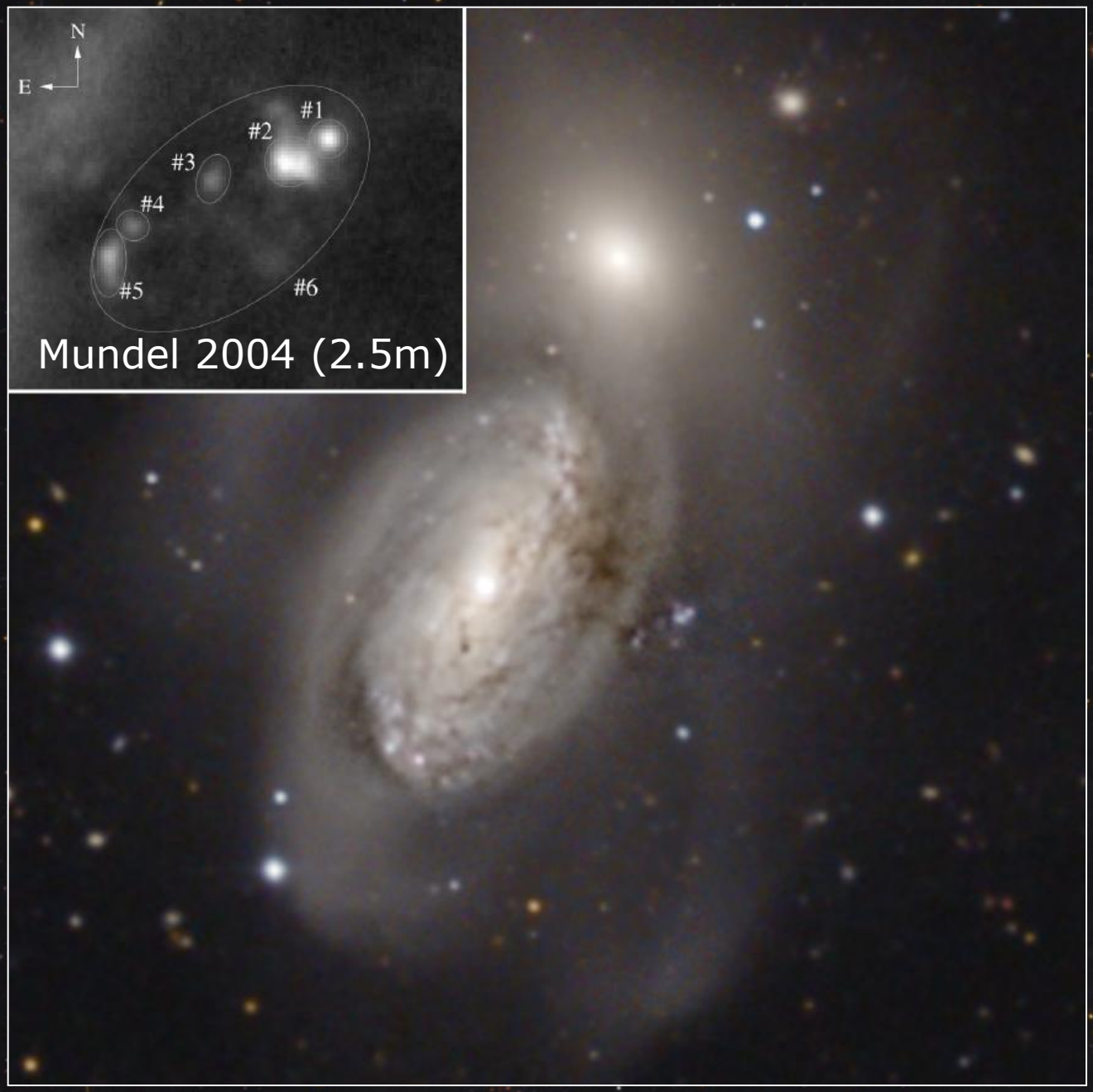
M 47 – NP101 + EOS 1000D

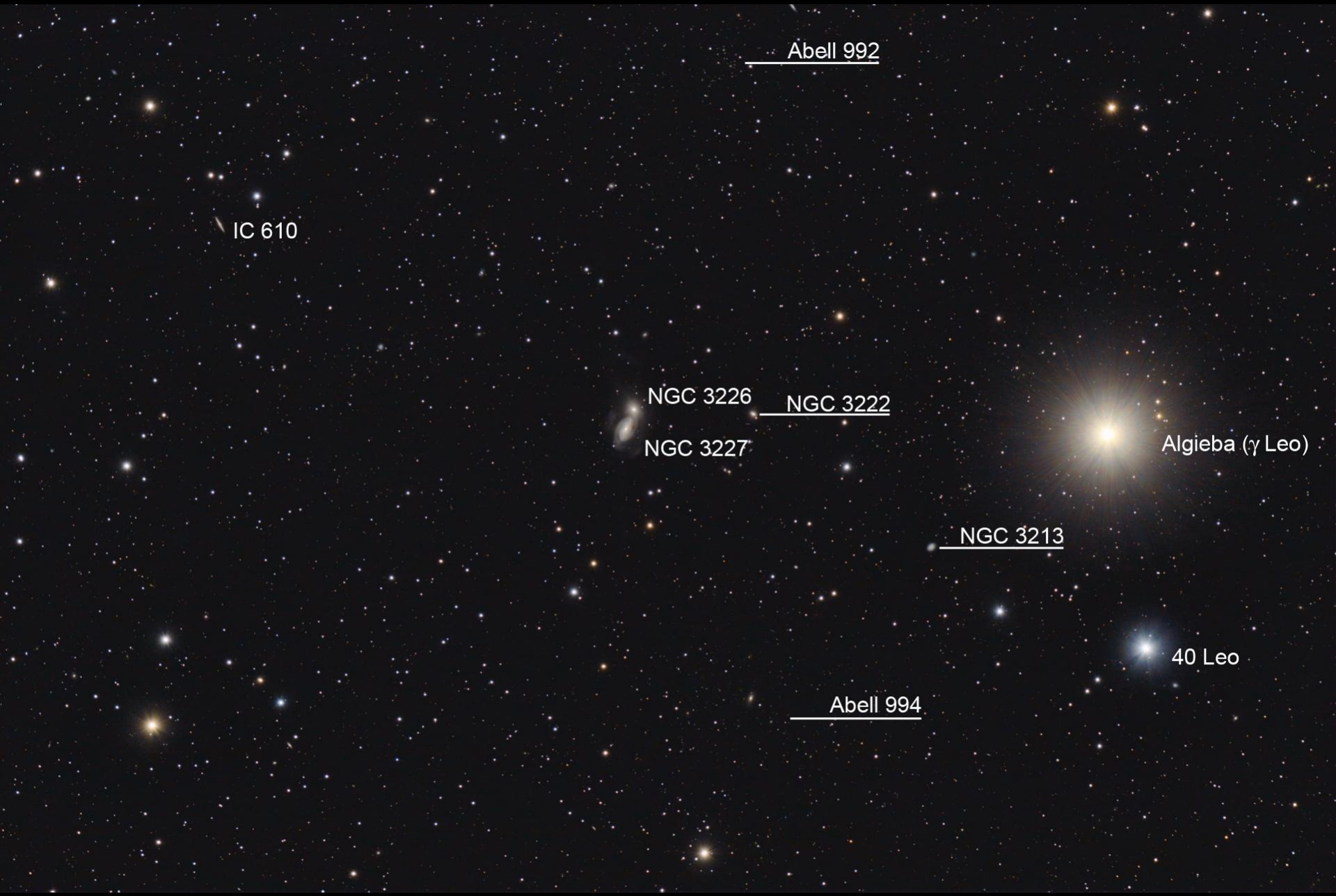

vdB 24 – 12“ Newt + ST-2000XM

vdB 24 – NP101 + EOS 1000D

NGC 2419– 12“ Newt + ST-2000XM

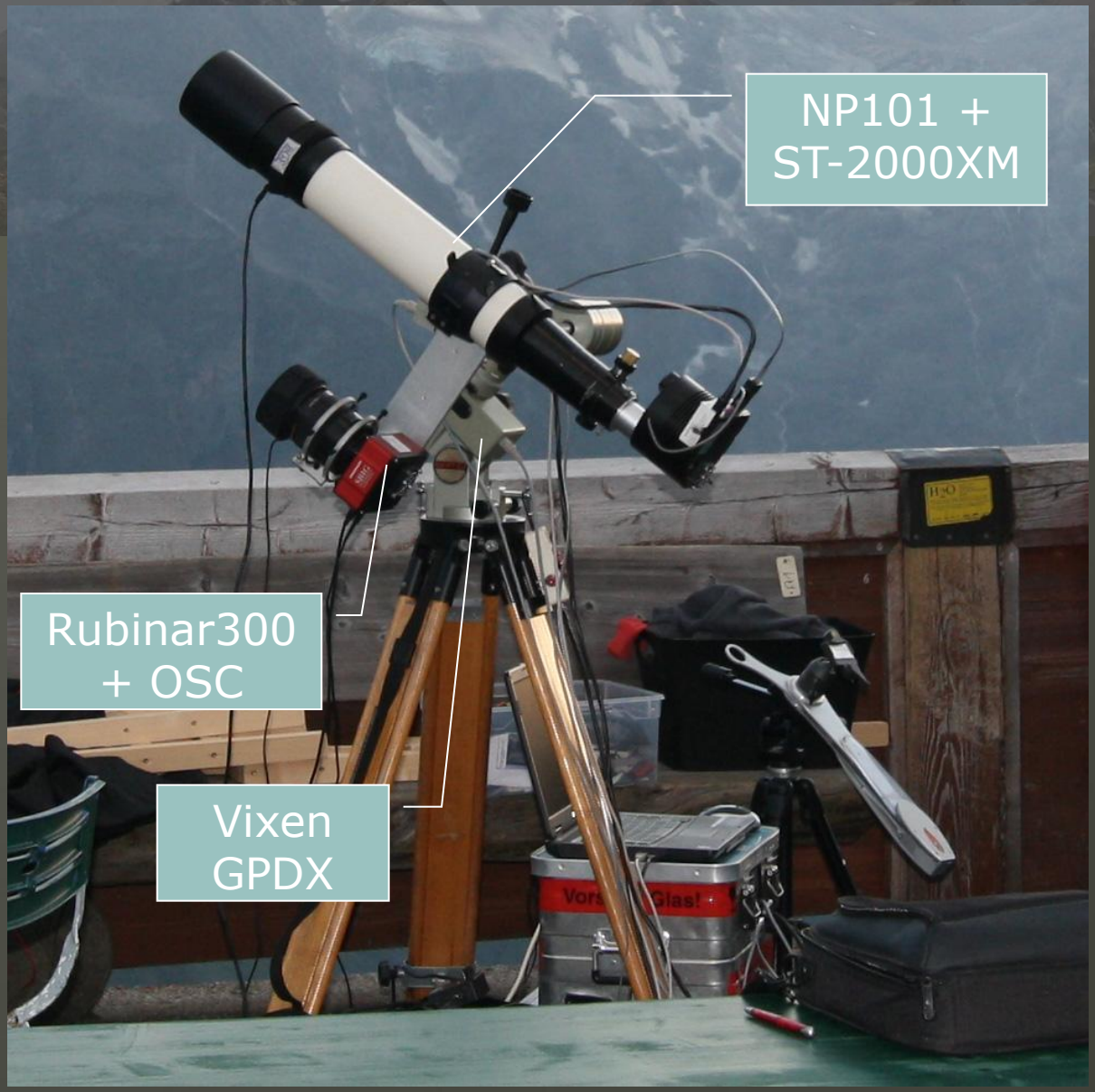

NGC 2419 – NP101 + ST-8300C


N
E
#1
#2
#3
#4
#5
#6
Mundel 2004 (2.5m)

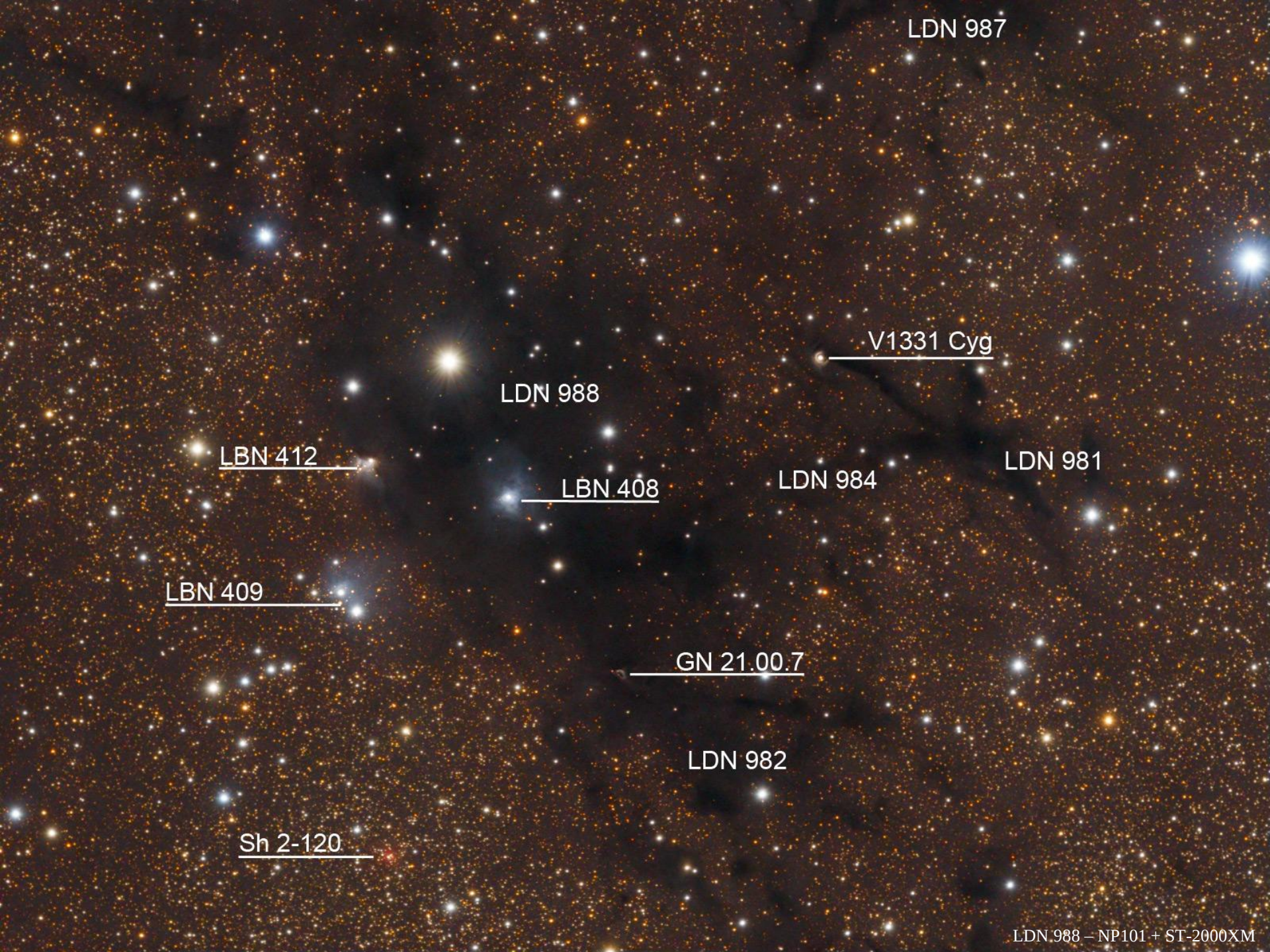


NGC 3227 – NP101 + EOS 1000D

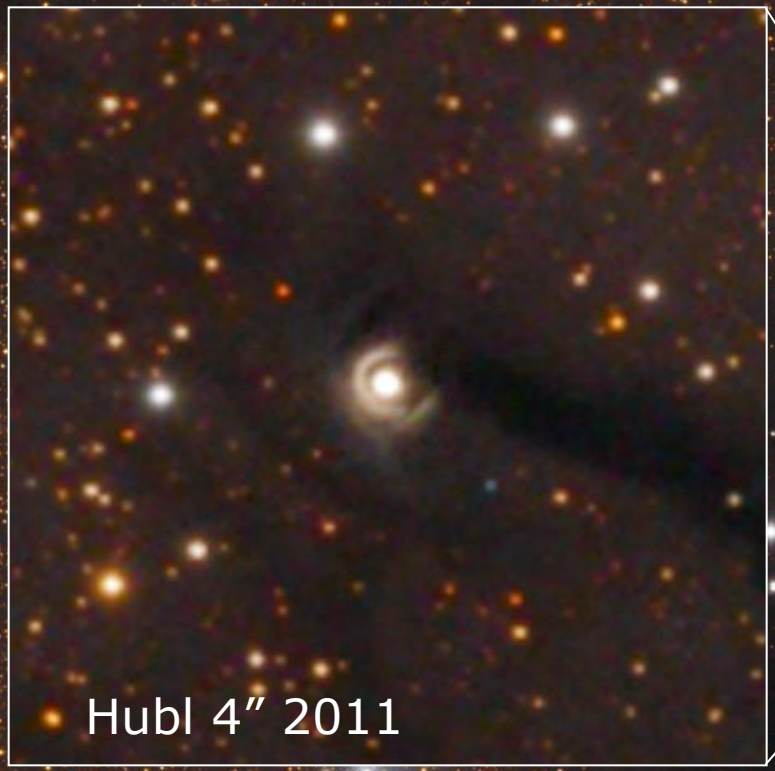
Astro trips

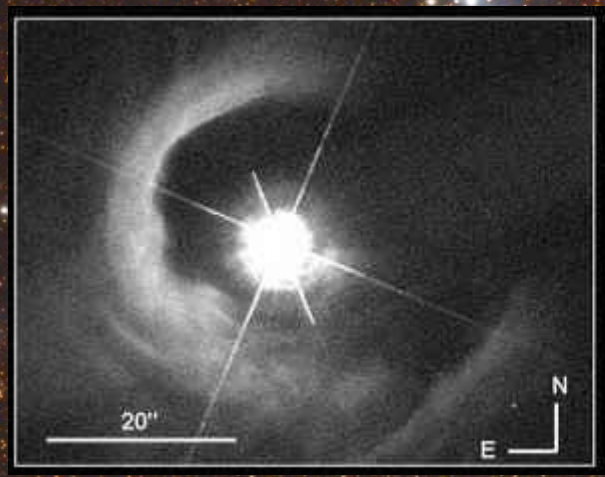


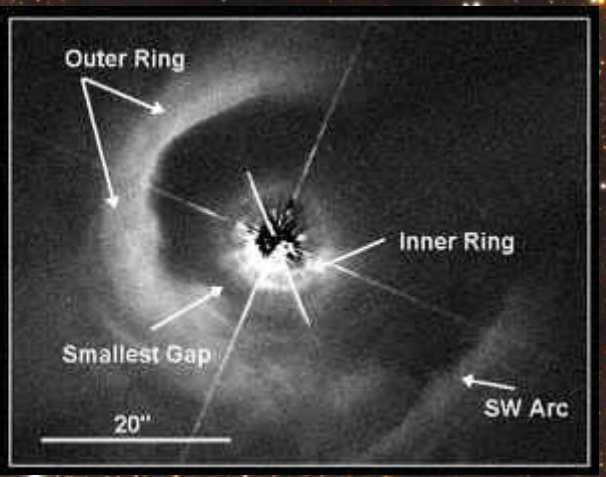

LDN 988 – NP101 + ST-2000XM



LDN 988 – NP101 + ST-2000XM

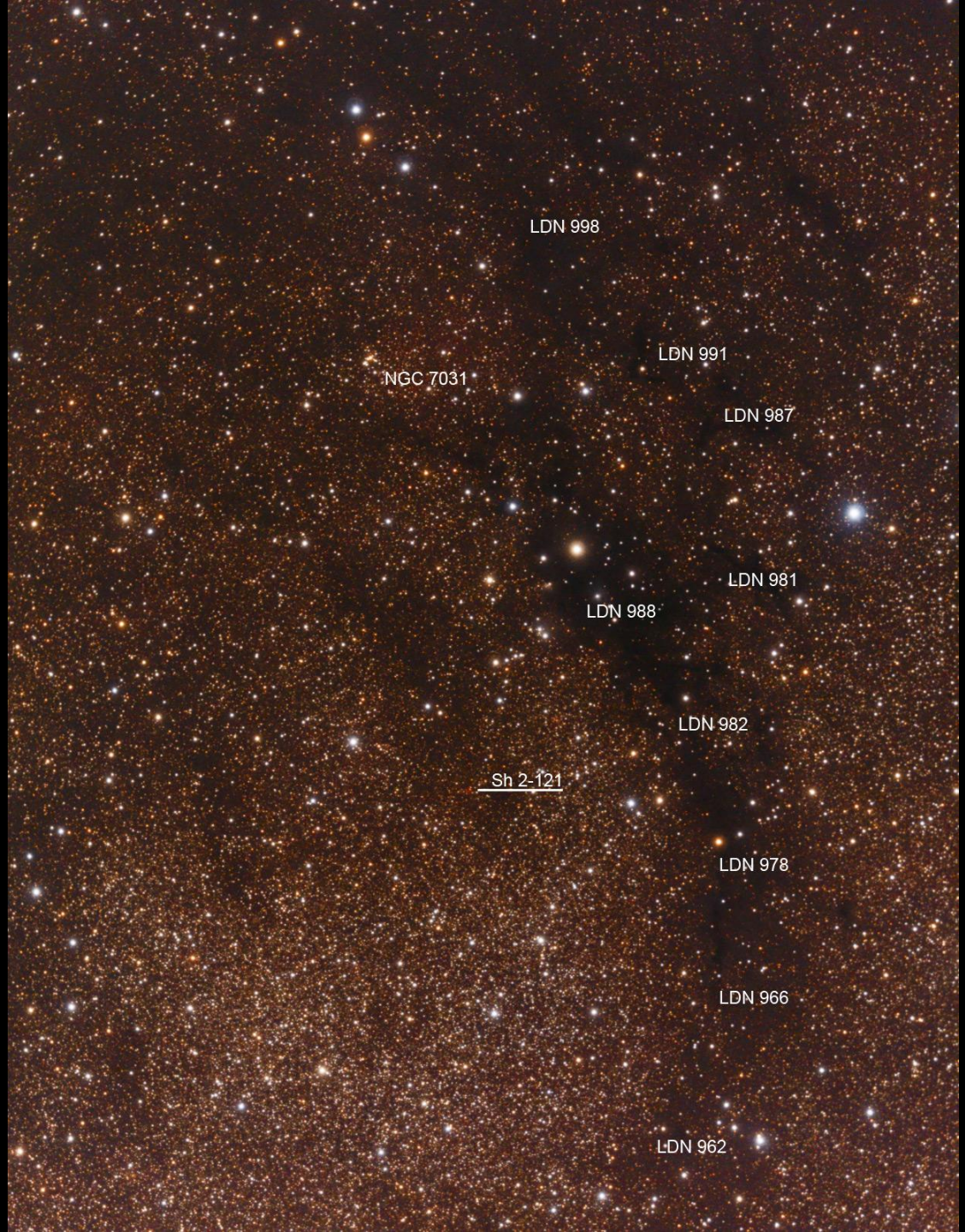






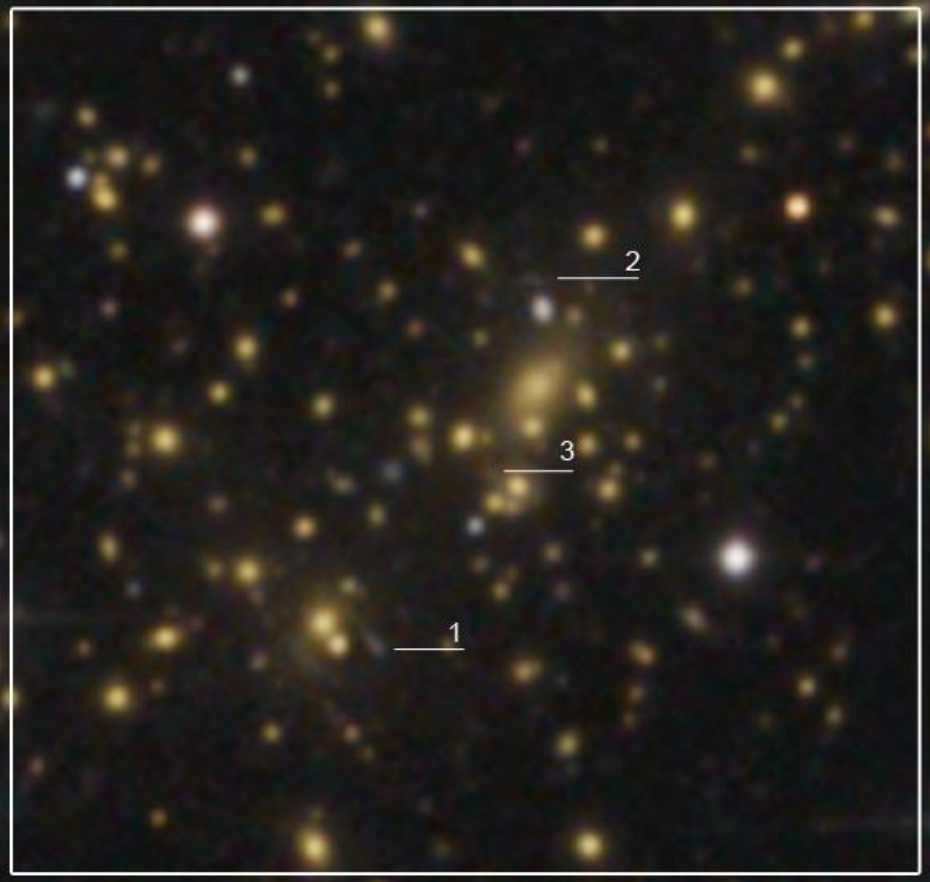
HST 2006

LDN 988 – NP101 + ST-2000XM



LDN 988 – Rubinar300 + ST-8300C

Depth?



Hubl, 12“ f=1120mm

Hubble Space Telescope image

Credit: NASA, ESA, and Johan Richard (Caltech, USA)

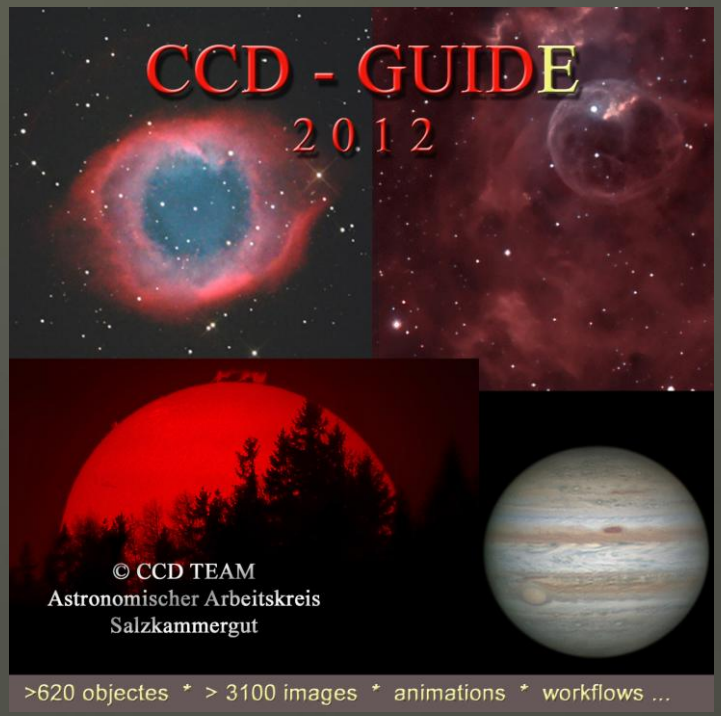
Abell 2218– 12“ Newt + ST-2000XM

4“ f/5.4, EOS1000D, 10h

12“ f/3.8, ST2000XM, 12h

Abell 2218 – NP101 + EOS 1000D

Last two tips



www.astronomie.at