



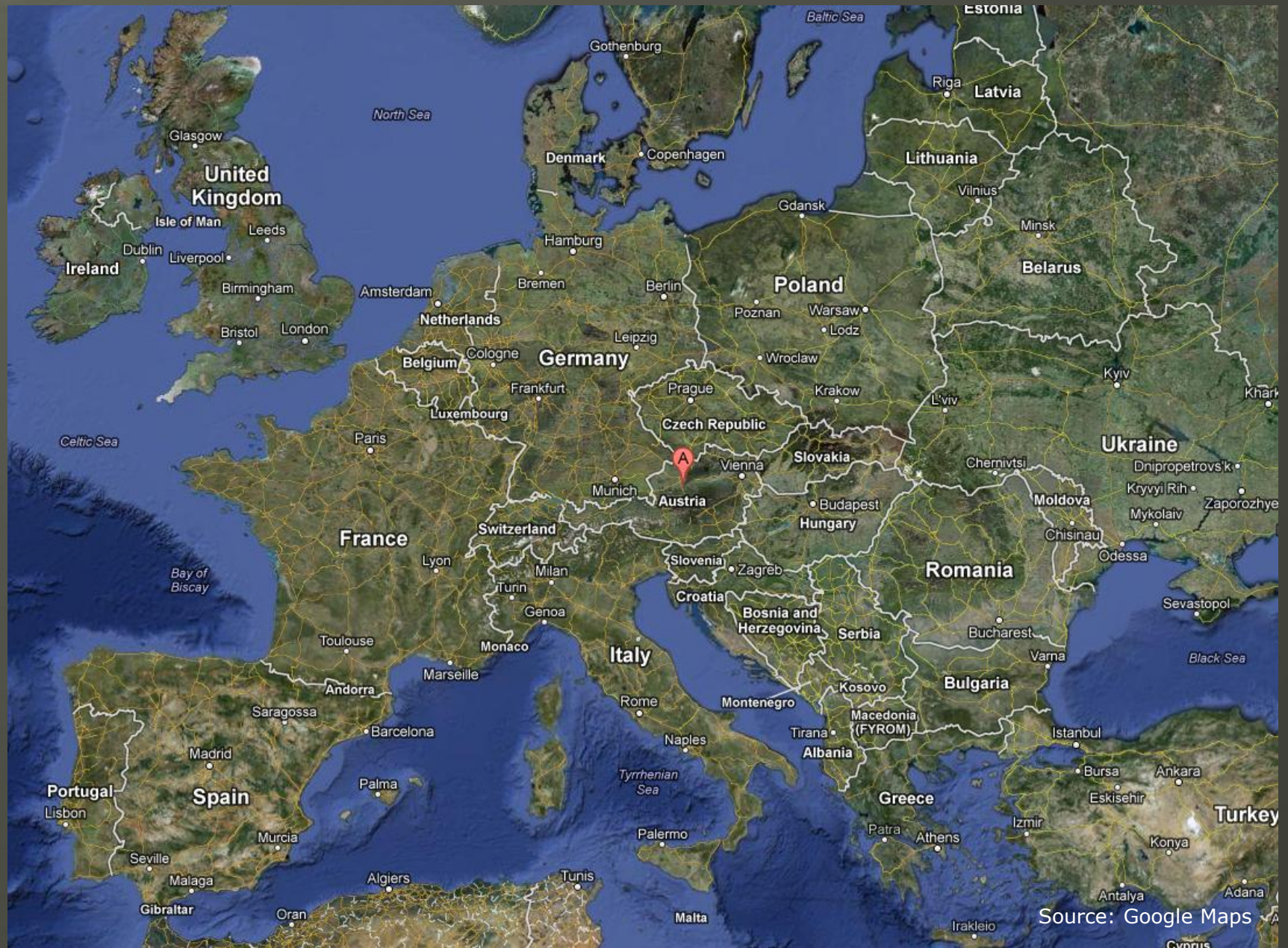
Wide Field and Long Focal Length Imaging



Contents

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

My observatory



My observatory



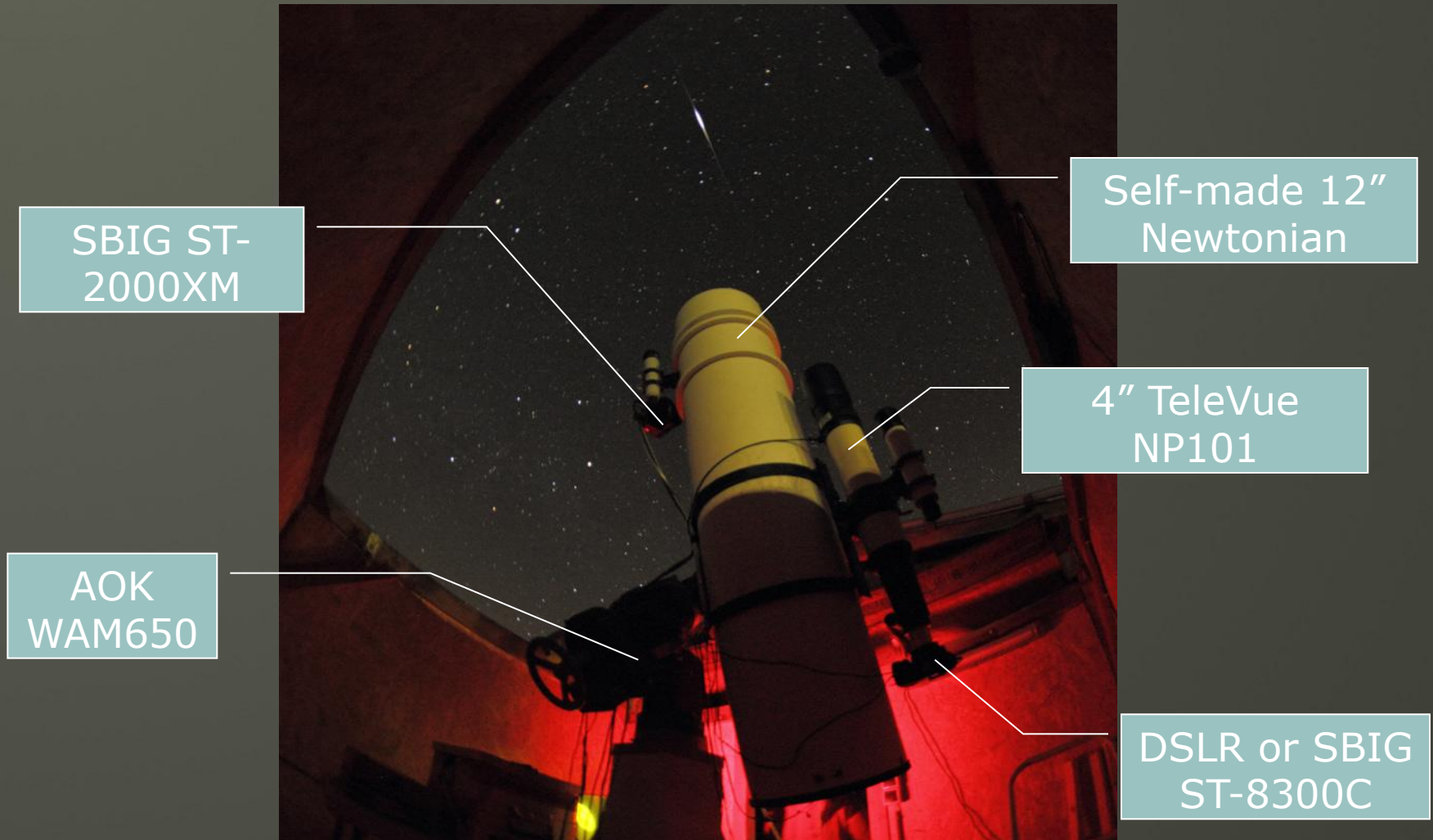
My northern sky



Observatory



Observatory in action





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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

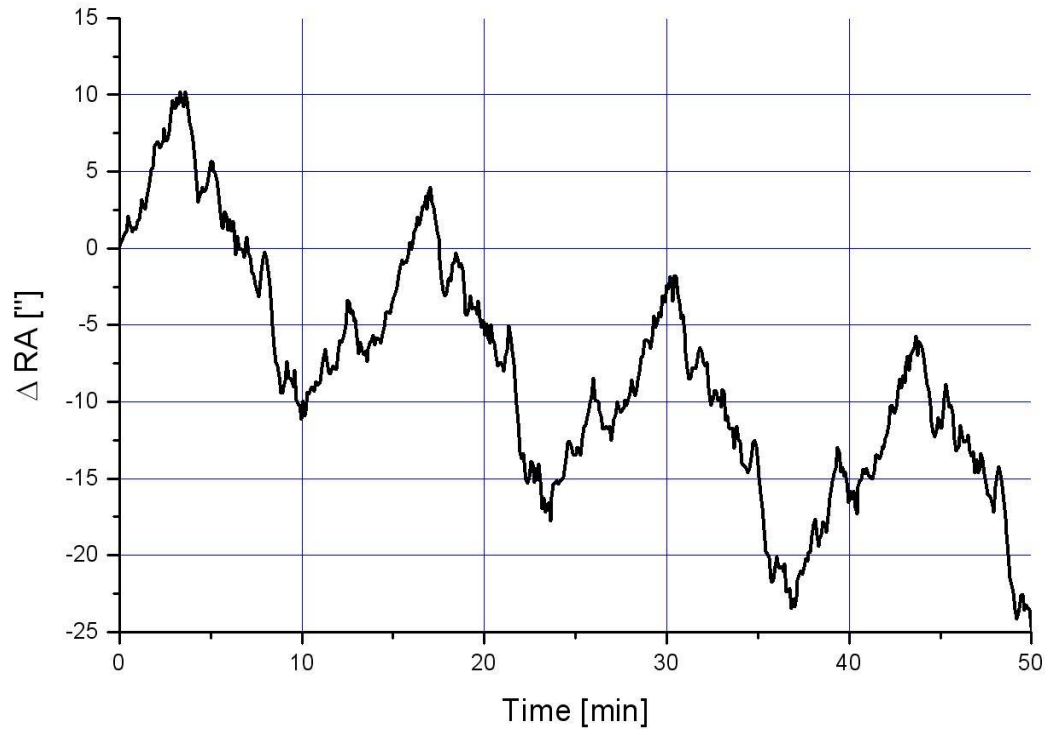
- ◆ In my case:
 - $< 2.6''$ Lum
 - $2.6'' - 4.0''$ RGB
 - $4.0'' - 5.0''$ only wide field
 - $> 5.0''$ go sleeping or go for a beer!
- ◆ Advantage:
 - No waste of nights with good seeing for RGB
 - Reproducibility



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 $\pm 10''$
- ◆ Worst $\pm 20''$
- ◆ Period = 13.5 min



Tip #2 Analyze periodic error

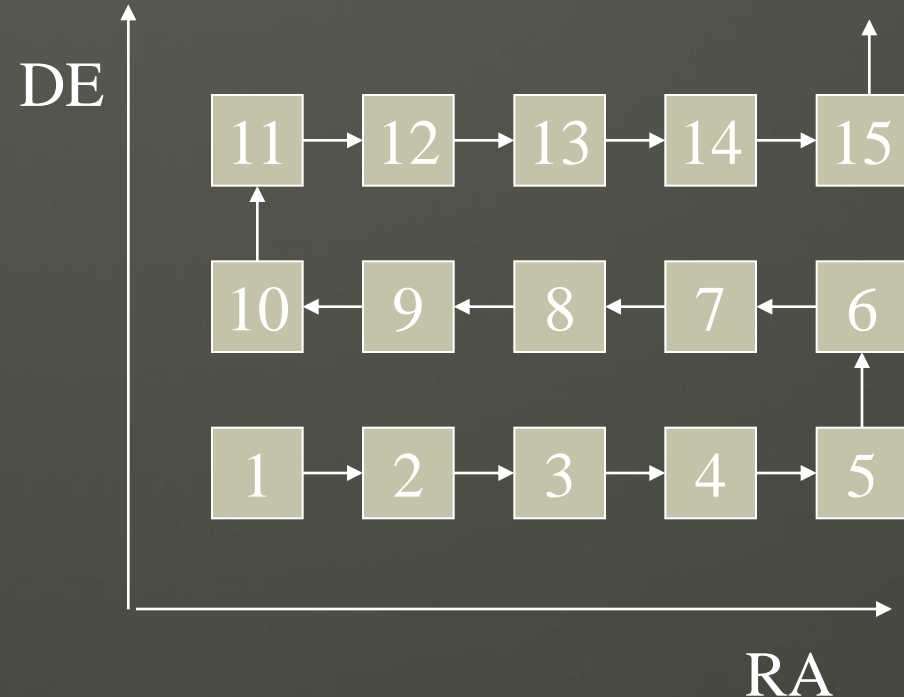
- ◆ High value of PE is no problem
- ◆ No abrupt changes of track speed
- ◆ Long period

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

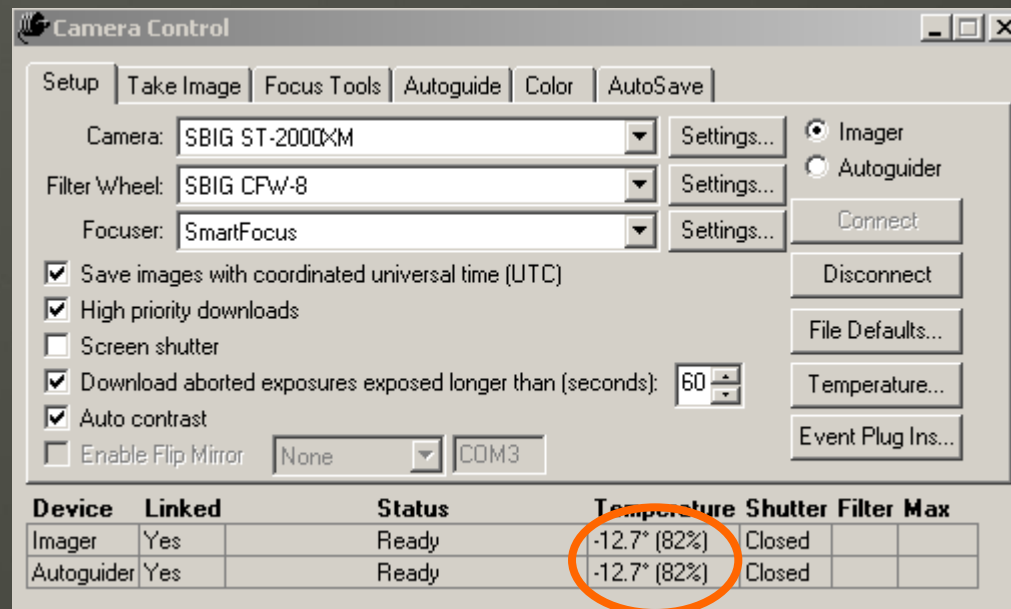
- ◆ Ambient temperature declines up to 10°C during the night
- ◆ Refocusing interval: 20 min – 60 min
- ◆ Focusing during running exposures

Tip #4 Use the camera cooling for refocusing

◆ Focuser

- 2" JMI NGF with Smart Focus
- No temperature compensation
- No temperature measurement

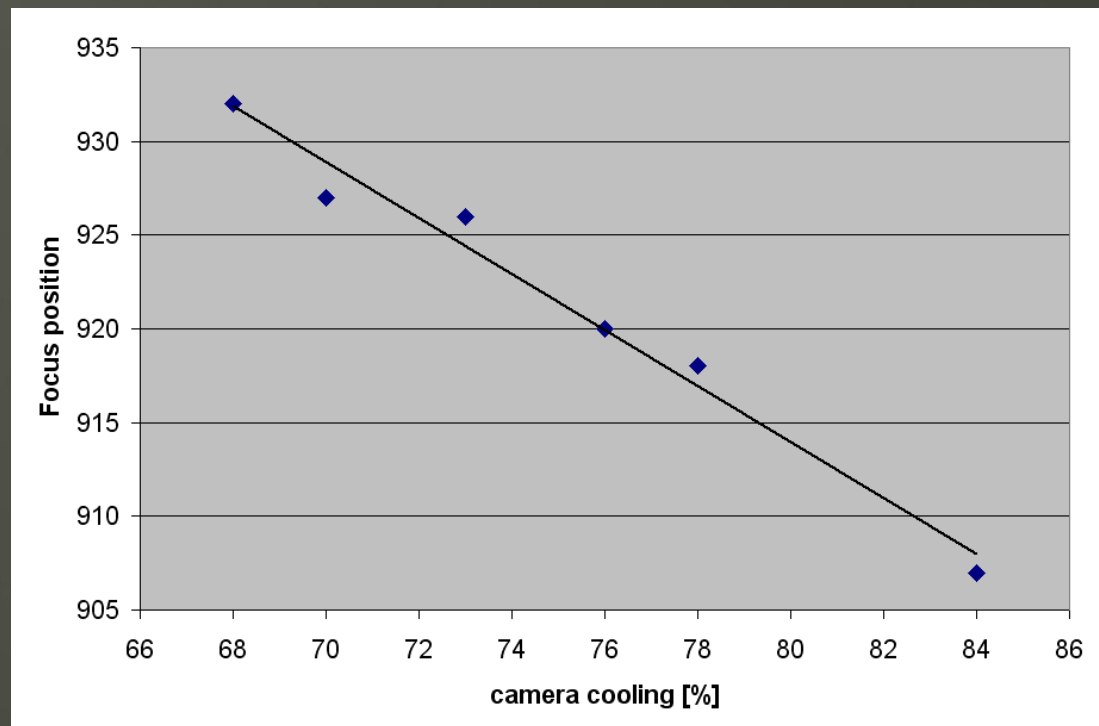
◆ Idea: Use the percentage of the camera cooling as a detector for the temperature



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

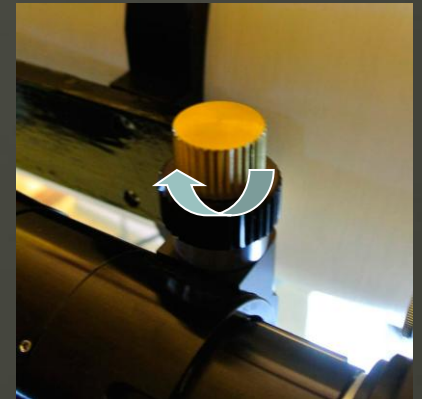


- ◆ Use Excel sheet [focus.xls](#) to calculate the focus position

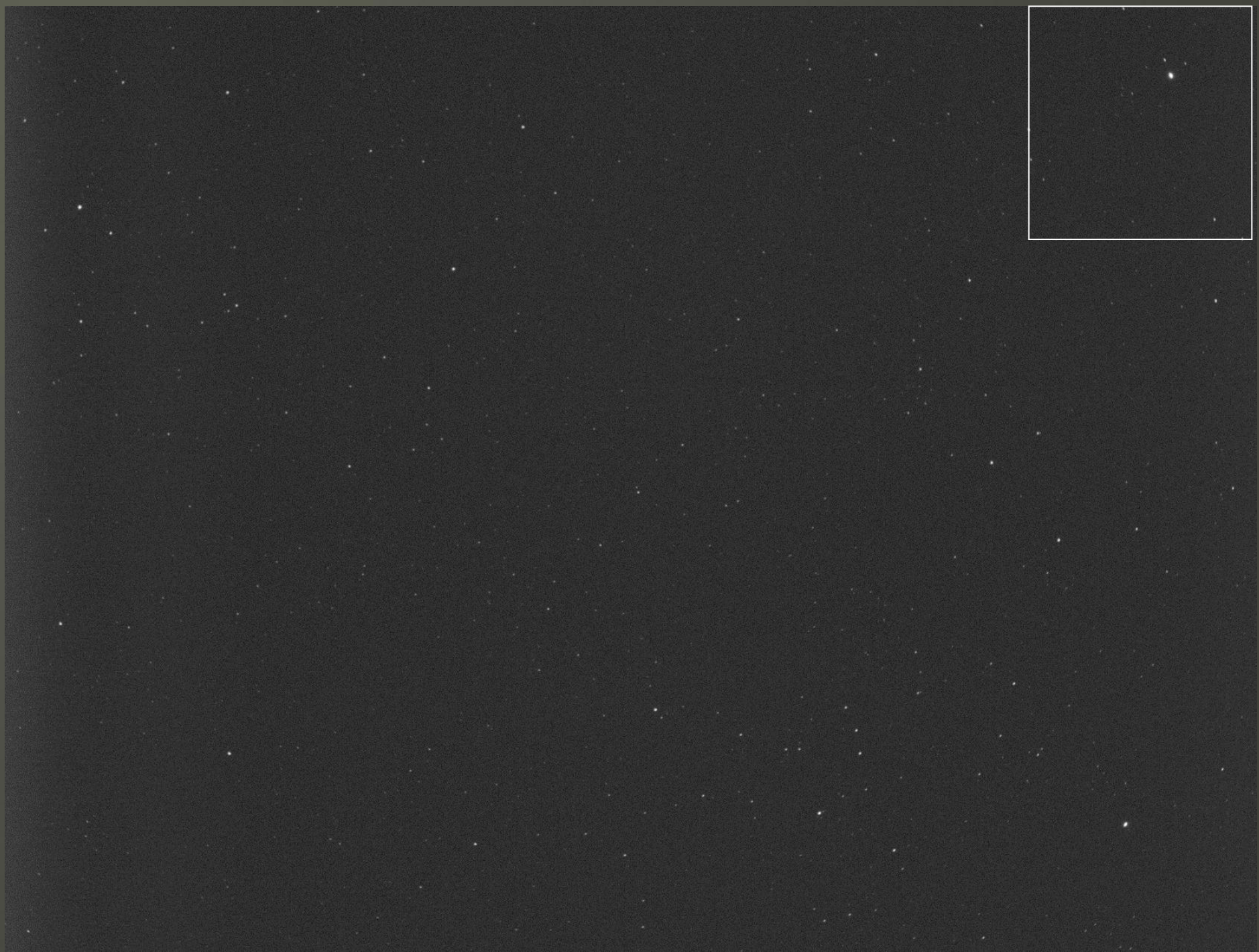
Tip #5 Use the corners of the image for focusing

- ◆ 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

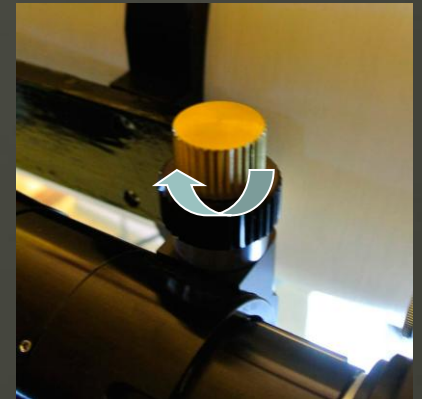
Zoom to the center of the image



Move focus from extrafocal to intrafocal position



Zoom to the top right corner



Move focus from extrafocal to intrafocal position

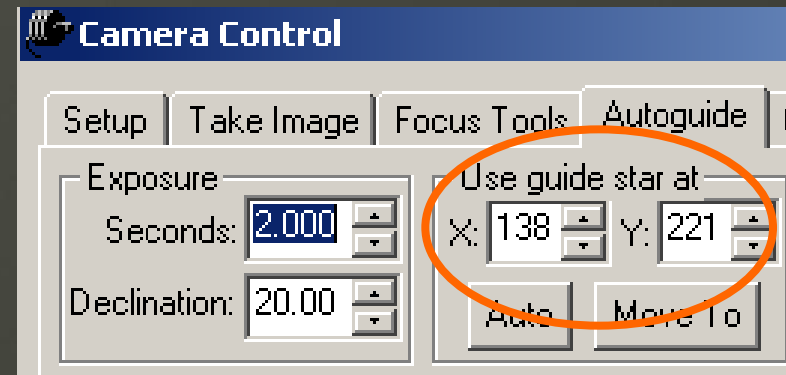
Tip #6 Use guide star position to reproduce framing

◆ Problem:

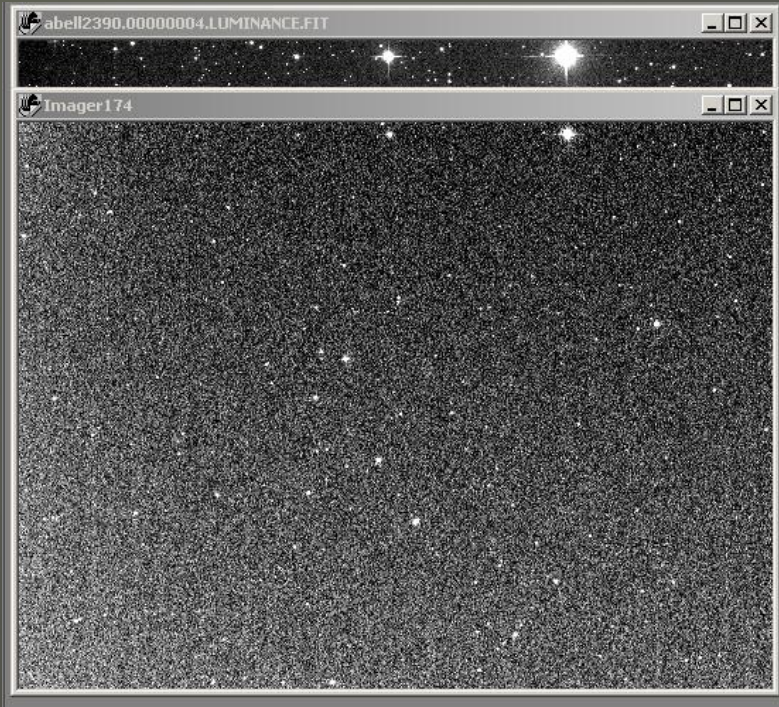
- Many nights are necessary for a deep image
- Reproducibility of framing is very important for cameras with few pixels (e.g. 1600x1200px of ST-2000XM)

◆ Solution:

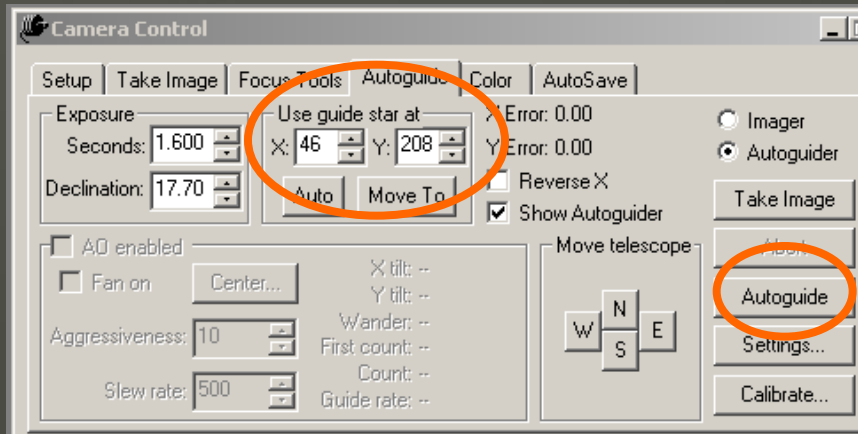
- Camera and telescope build a unit (no rotation)
- Note exact position of guide star in first night
- Following nights:



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





Examples

- ◆ Bad Seeing

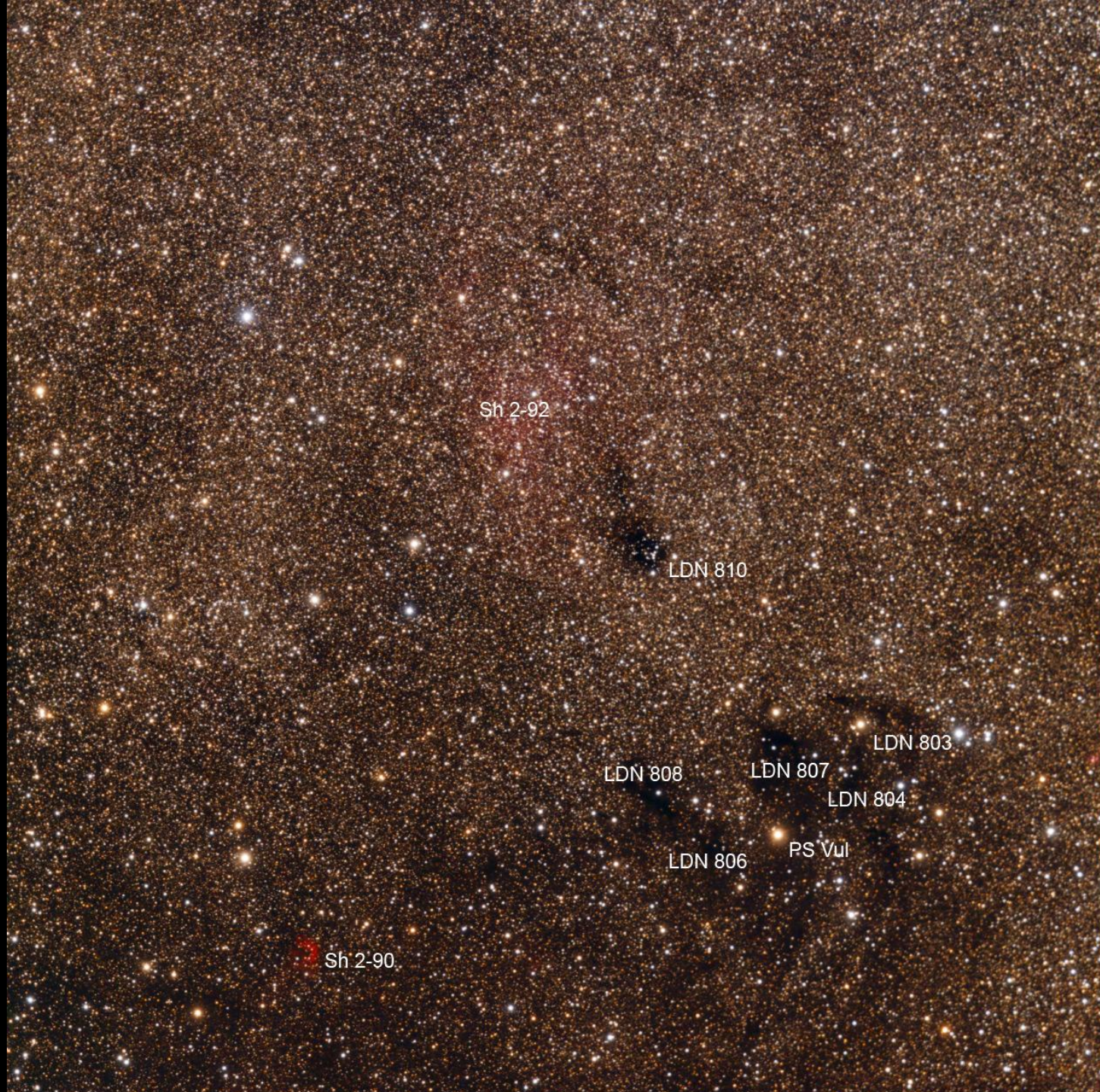


- ◆ Interesting environment





GM 3-10



Sh 2-92

LDN 810

LDN 808

LDN 807

LDN 803

LDN 804

LDN 806

PS Vul

Sh 2-90

Sh 2-92

LDN 810

GN 19.43 3.01

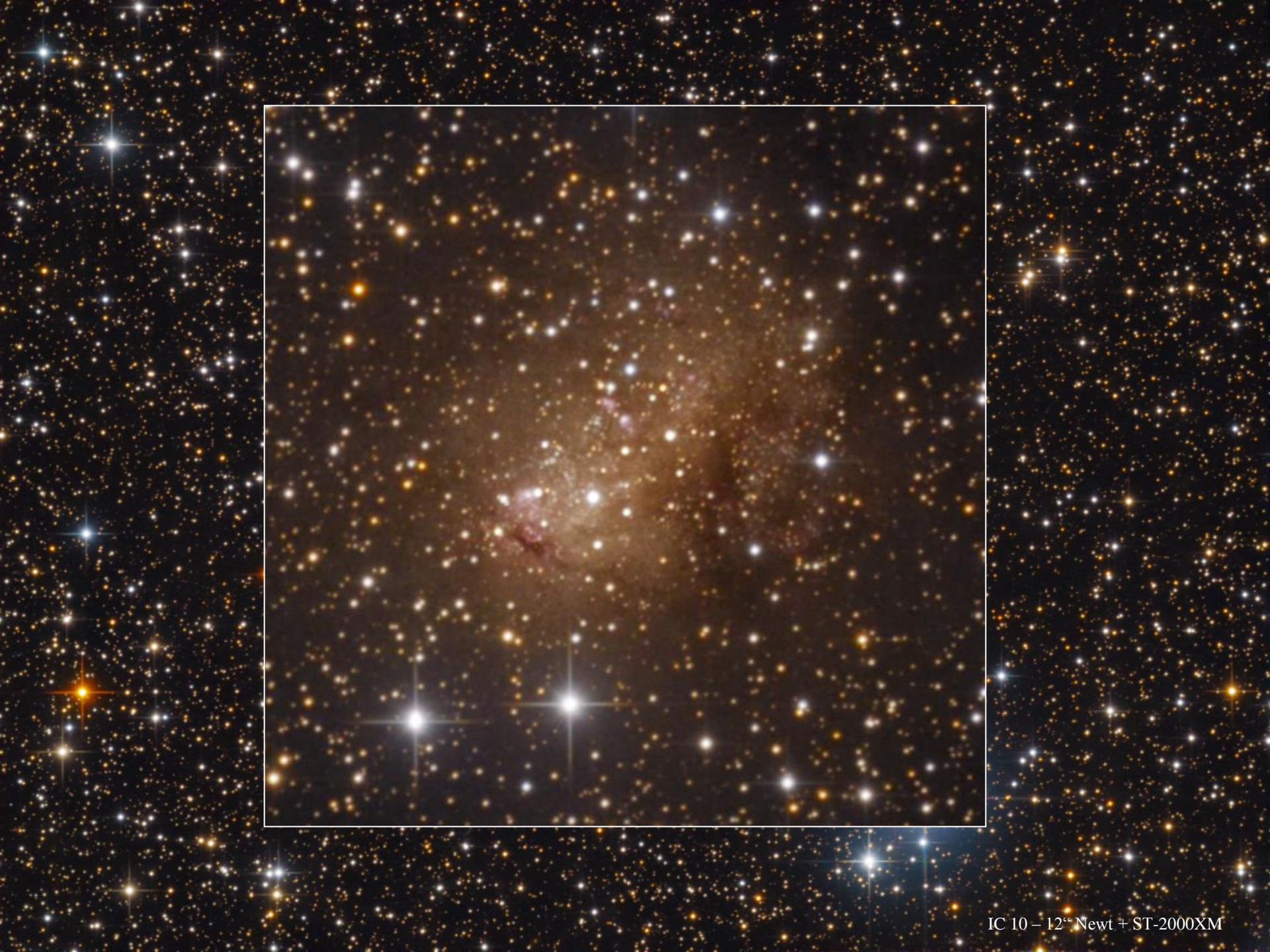
Examples

- ◆ Bad Seeing



- ◆ Interesting environment







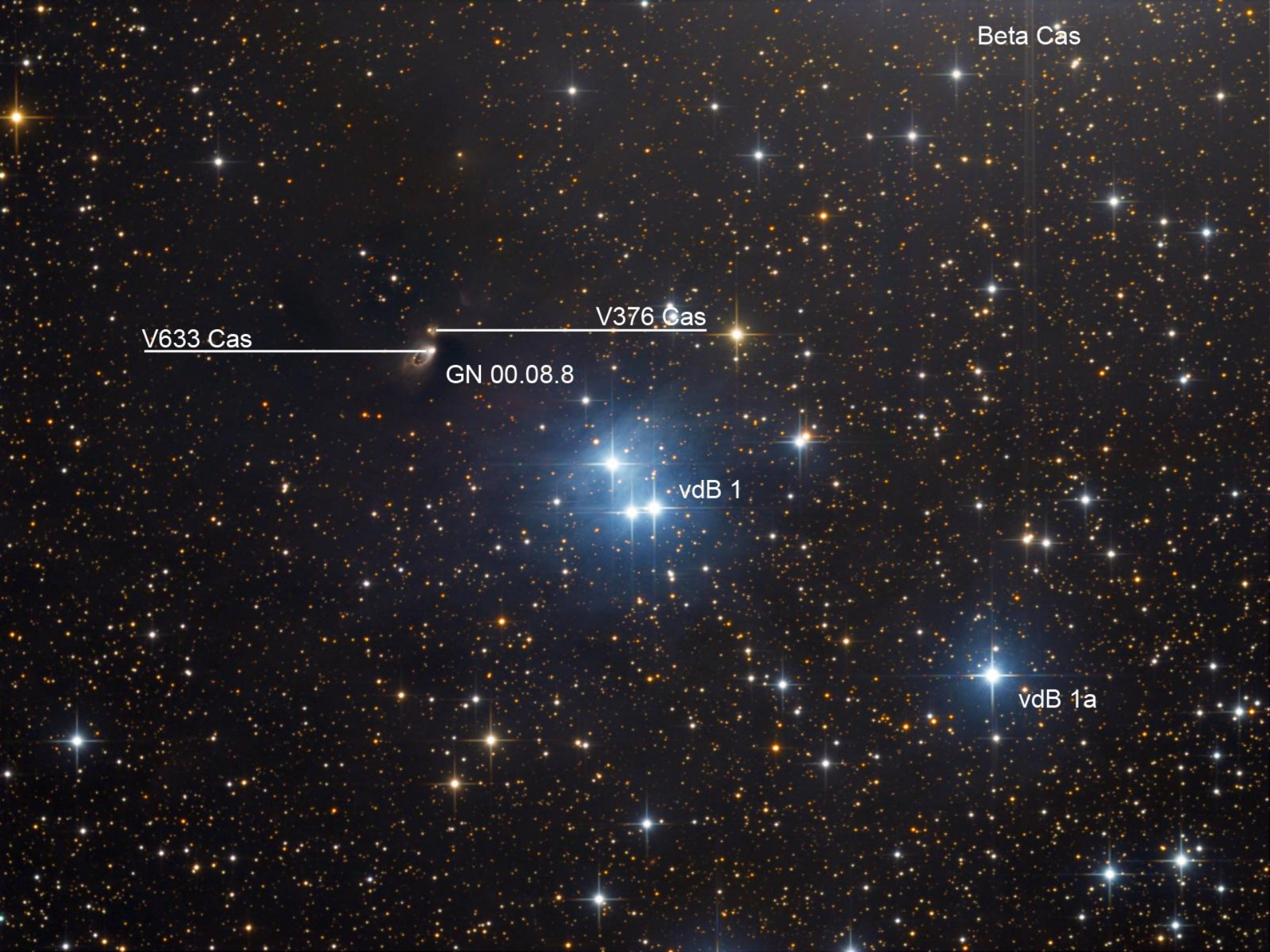
IC 10

Beta Cas

vdB 1







Beta Cas

V633 Cas

V376 Cas

GN 00.08.8

vdB 1

vdB 1a



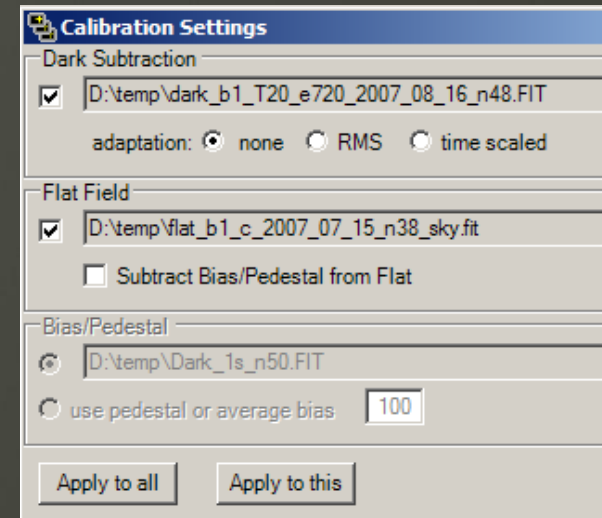
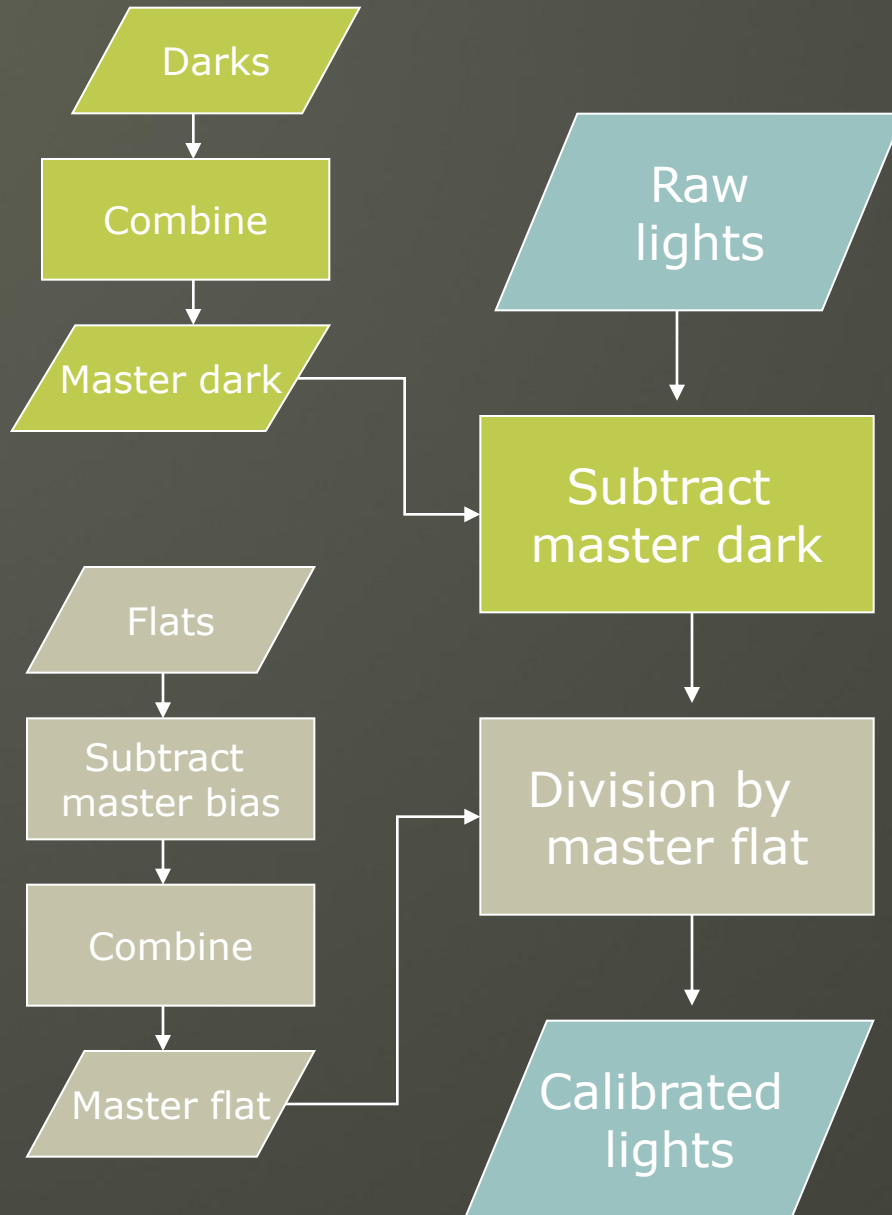
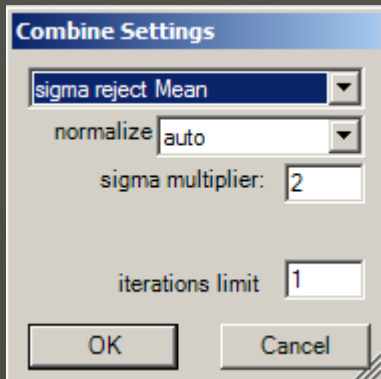
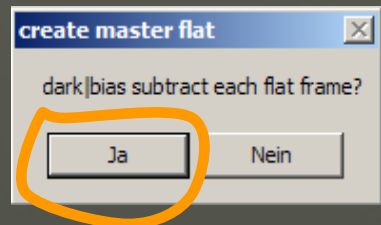
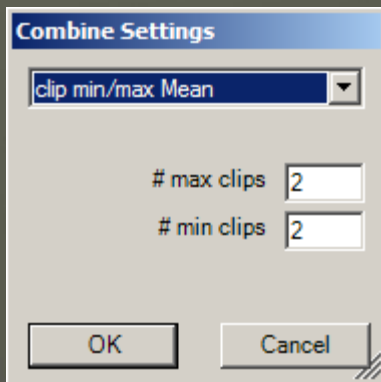
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Calibration, registration and combine

- ◆ 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

Convert Bayer (One Shot Color)

Method

☐ Interpolate to Full Size

☒ Extract to Half Size

☐ Resample to

B	G
G	R

Convert to

☒ Red

☐ Green combined

☒ Green from top

☒ Green from bottom

☒ Blue

☐ Grayscale / Luminance

☐ Color

Bayer Pattern

☒

B	G
G	R

☐

R	G
G	B

☐

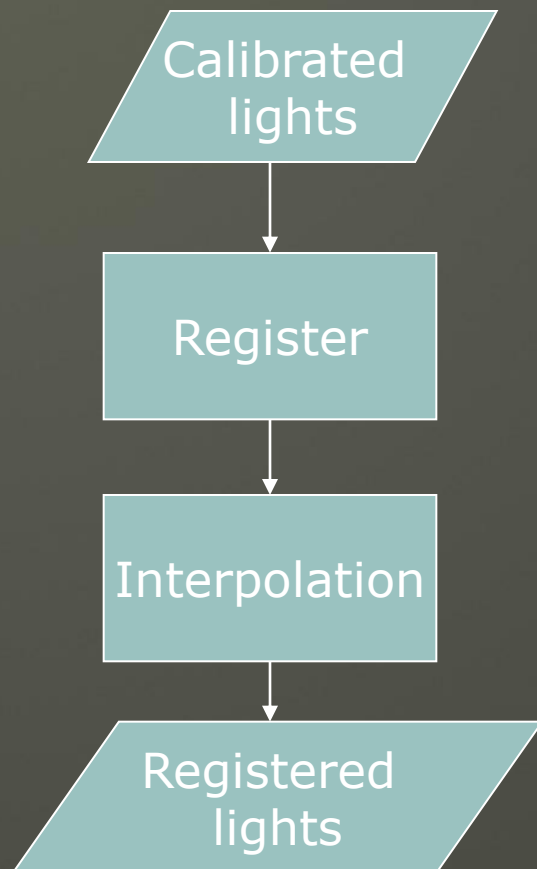
G	B
R	G

☐

G	R
B	G

Action

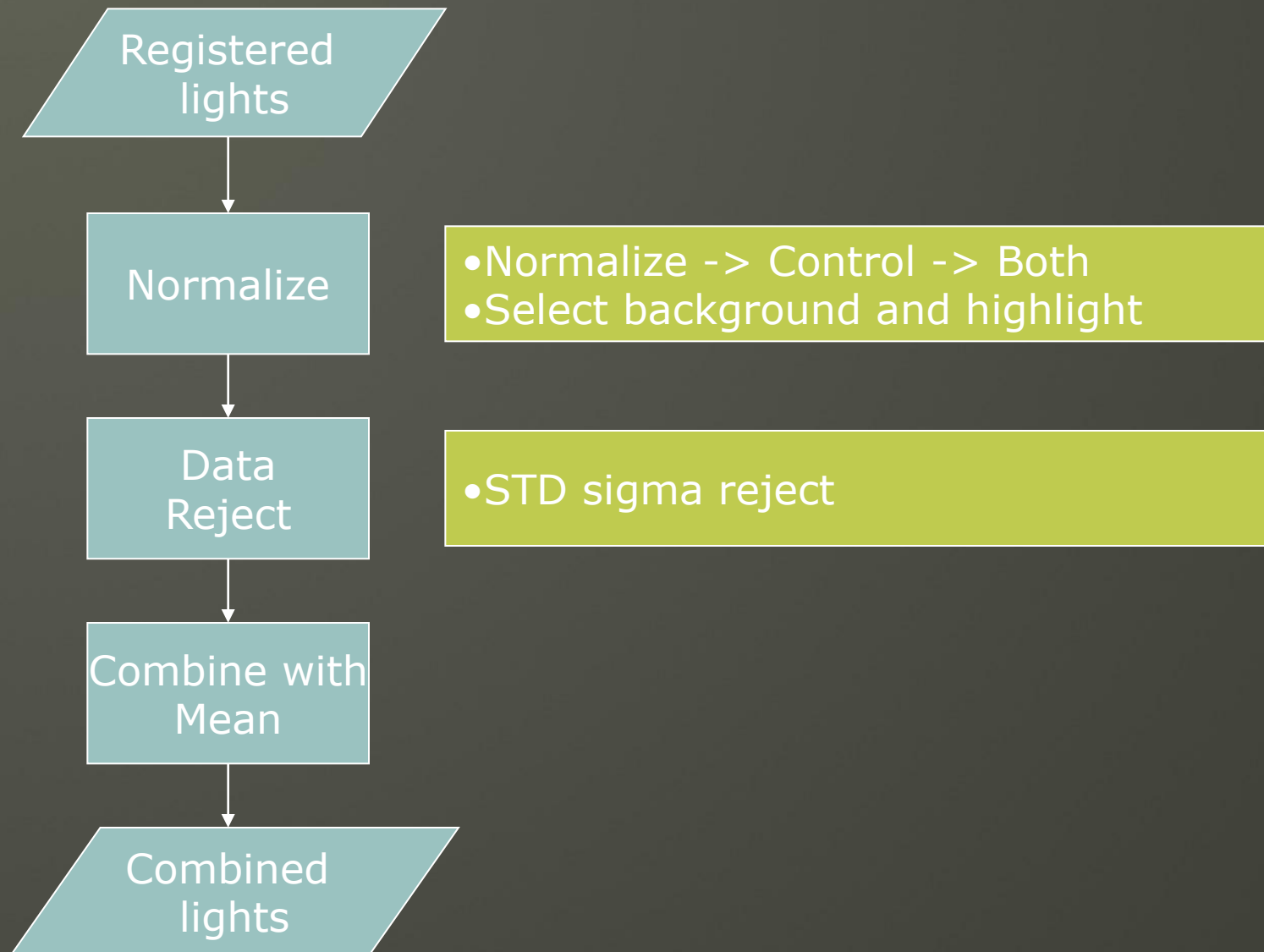
Registration with CCDStack



- 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

eXcalibrator Version 3.1

File Photometry Method GridSize ApertureSize Calibration Method StayOnTop ViewHeader Credits Help

Red |excalibrator\ugc10043_r_ccdstack1.FIT| **WCS File** |excalibrator\ugc10043_r_ccdstack1.FIT|

Green |excalibrator\ugc10043_g_ccdstack1.FIT|

Blue |excalibrator\ugc10043_b_ccdstack1.FIT|

DataFile |_23_ugc10043\pro\excalibrator\sdss.txt|

Magnitude **Min** **Max**

10 19

RA 15:48:57,6 **Dec** 21:50:39,2 **Search Radius** 22.0 ArcMin

Min. Star Value 50 **Dead Zone Border** 50

☒ Use (u-g), (g-r) ☐ Use (b-v), (v-r)

Using SDSS Data

Min **Max**

u-g 1.38 1.48 **g-r** 0.34 0.54

Set Defaults

Y/N	Red	Green	Blue	uMag	u-g	X	Y	ApSize
Yes	1.000	1.052	1.275	16.634	1.406	448	602	5 x 5
Yes	1.000	1.059	1.283	17.310	1.435	962	63	5 x 5
Yes	1.000	1.052	1.262	17.332	1.404	1190	637	5 x 5
Yes	1.000	1.050	1.256	17.439	1.383	554	464	5 x 5
Yes	1.000	1.055	1.268	18.106	1.460	1303	767	5 x 5
Yes	1.000	1.060	1.275	18.122	1.418	224	347	5 x 5
Yes	1.000	1.057	1.274	18.307	1.449	1248	377	5 x 5
Yes	1.000	1.068	1.306	18.455	1.421	1134	318	5 x 5

Avg 1.000 1.060 1.279 13 star(s) used.

StdDev 0.013 0.021 Use Local Background

RMS 1.060 1.279

Remove Outliers Calibrate Image

◆ G2_Calculator.xls

Color balance of an image

Extinction coefficients

kr = 0,128
kg = 0,202
kb = 0,294

Ratio at zenith

R_Zenith 1
G_Zenith 0,92
B_Zenith 1,03

Import from database

Transmittance

Ar = 0,889
Ag = 0,830
Ab = 0,763

Input the average height of the object, the number of R exposures, and the exposure durations

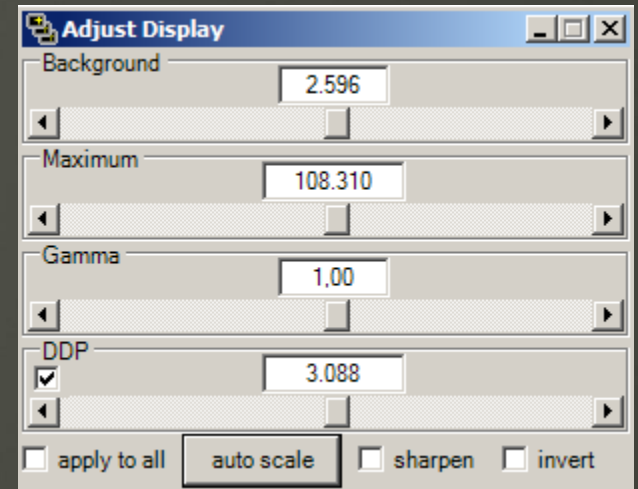
height = 30°
n_R = 5
t_R = 300 s
t_G = 300 s
t_B = 300 s

Average height of object during exposure
Number of exposures in R
Single exposure time of R
Single exposure time of G
Single exposure time of B

	Optimum ratio at object height	Optimum number of exposures	Filter multiplication factor
R	1,000	5,0	1,000
G	0,985	4,9	0,985
B	1,200	6,0	1,200

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





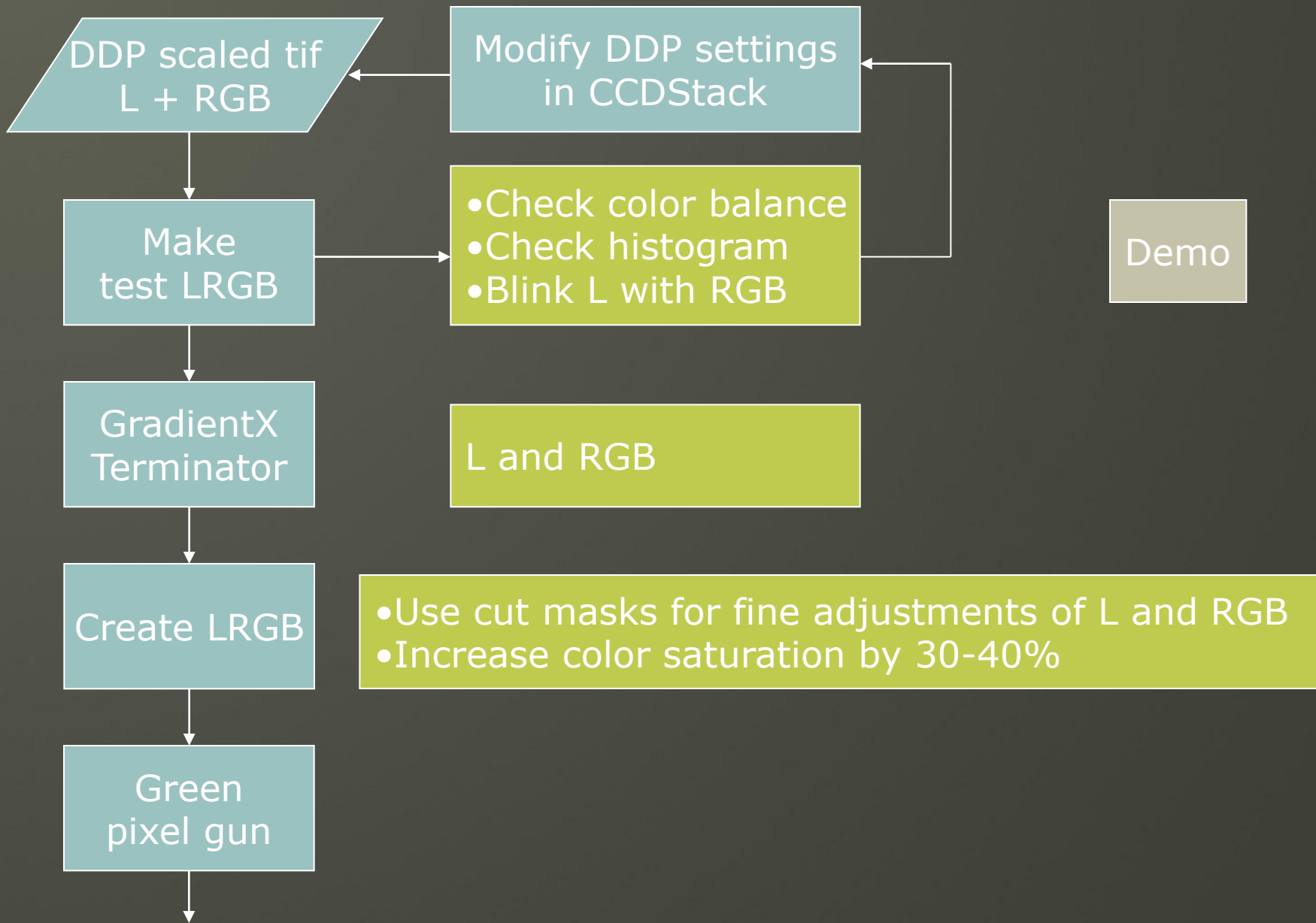
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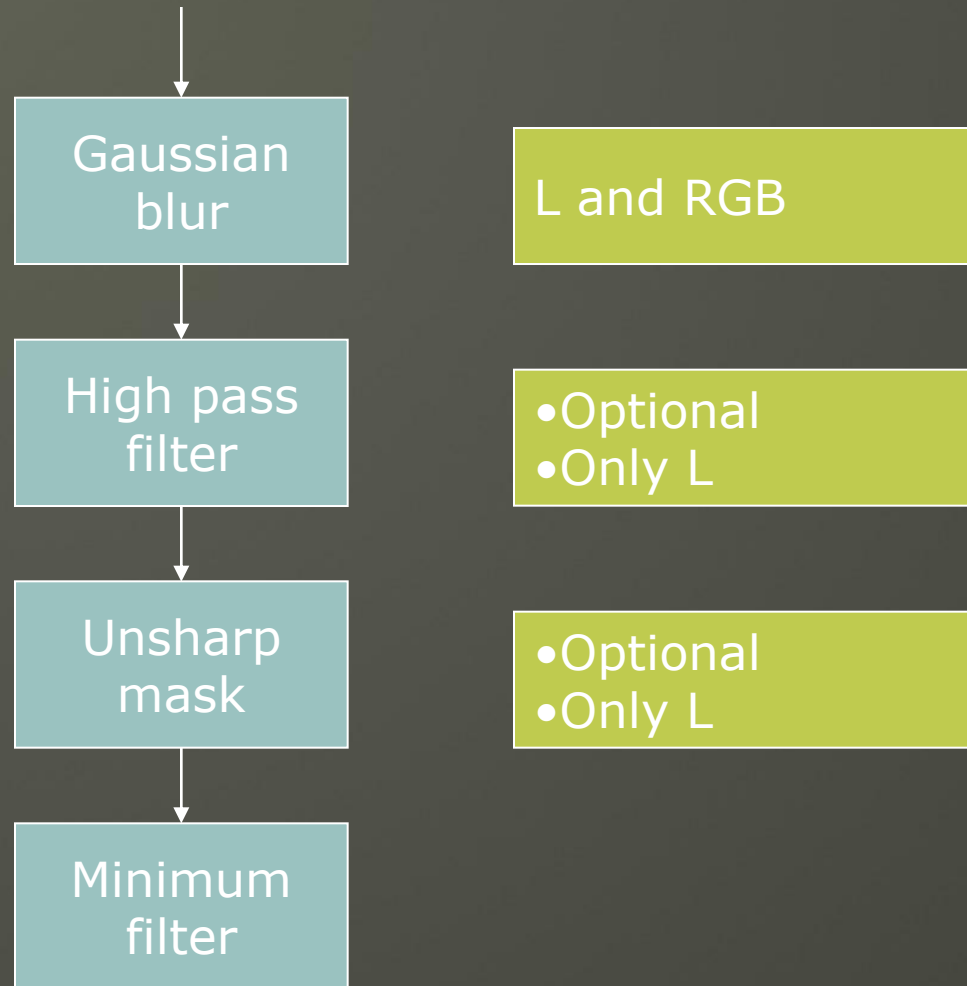
Image Processing

- ◆ 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

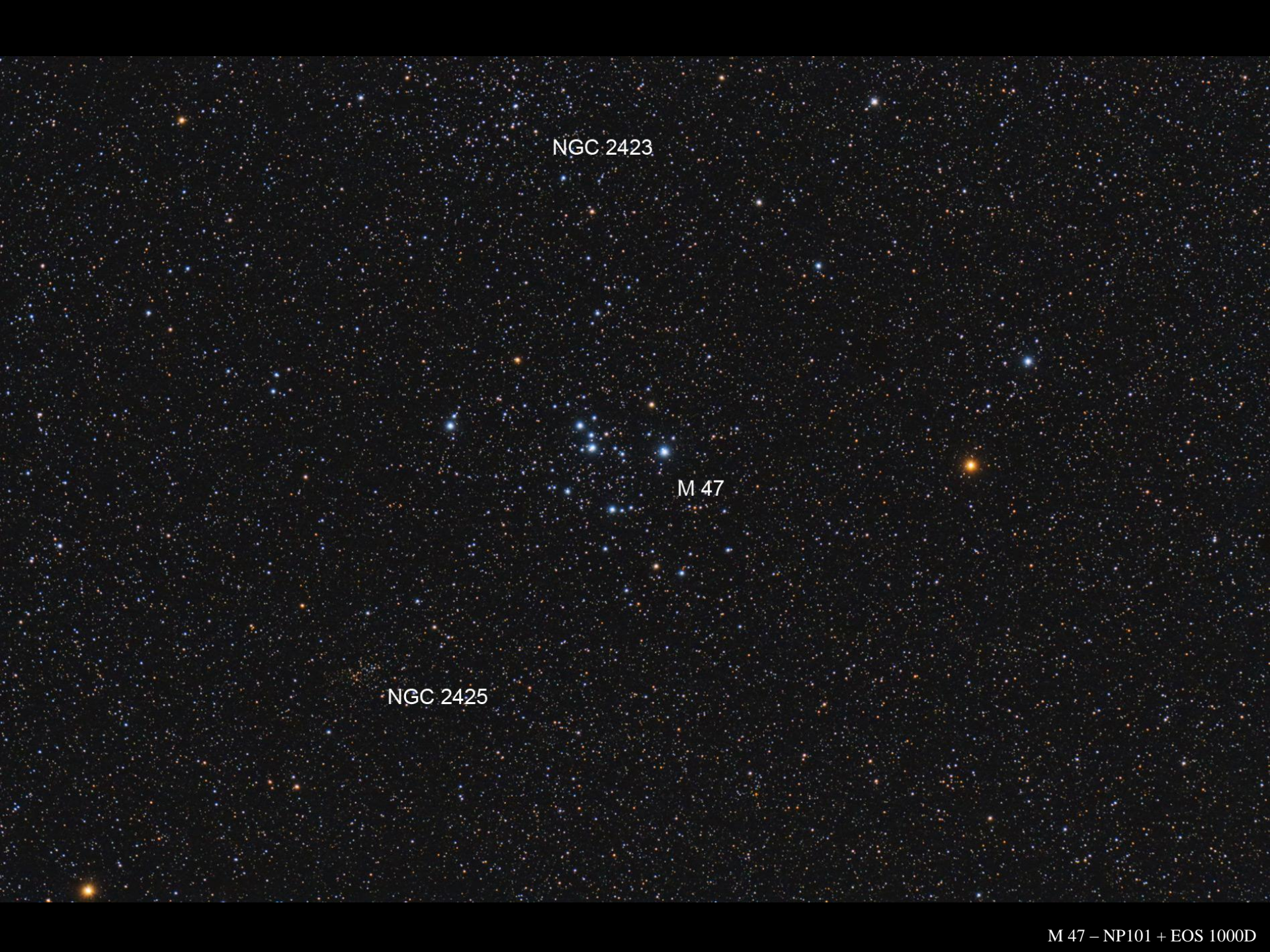




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NGC 2423

M 47

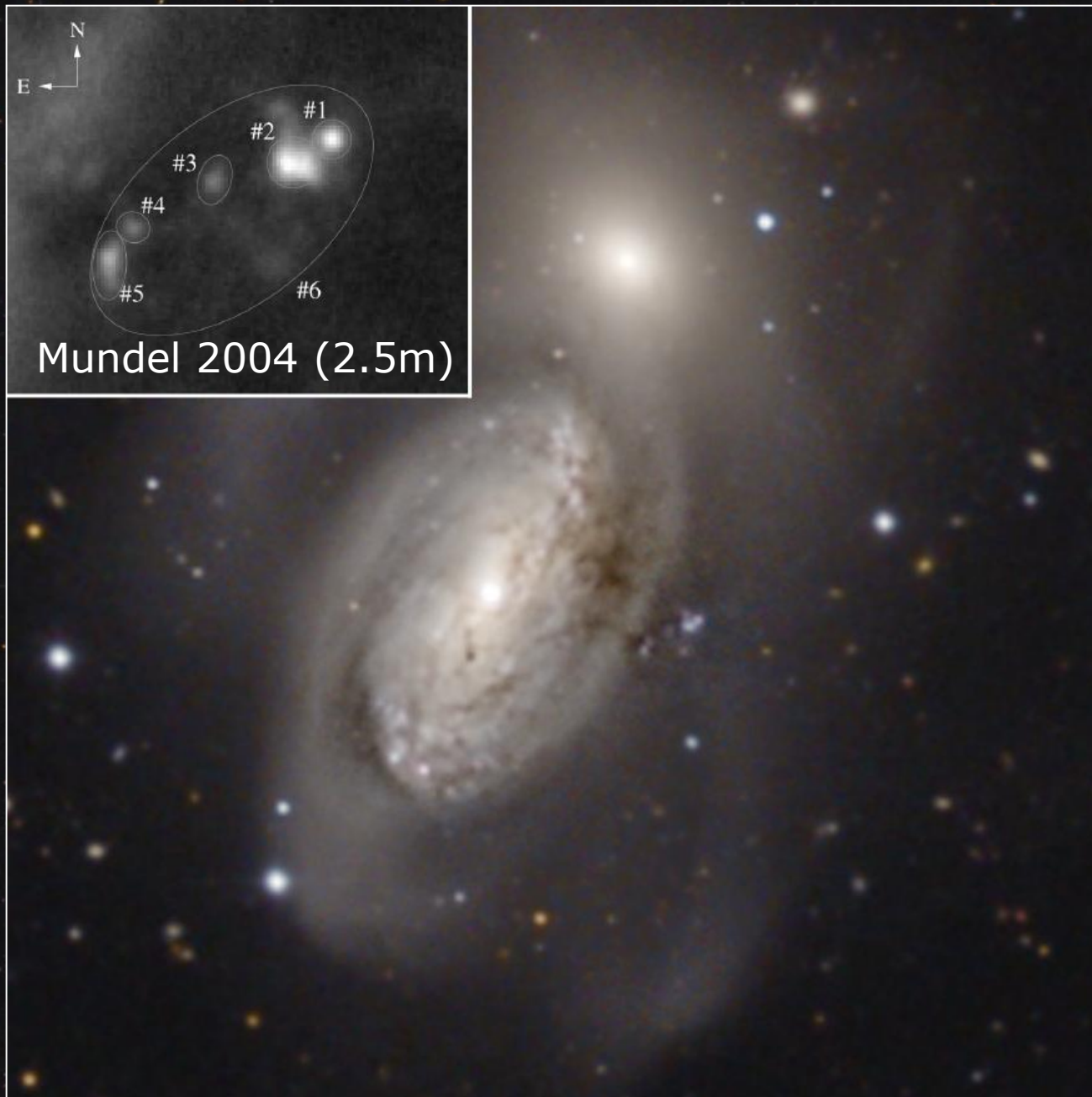
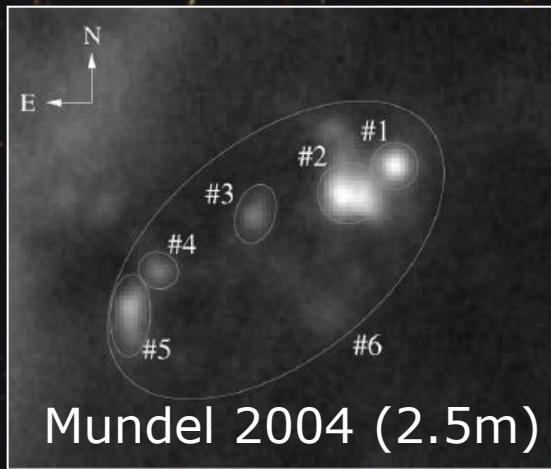
NGC 2425

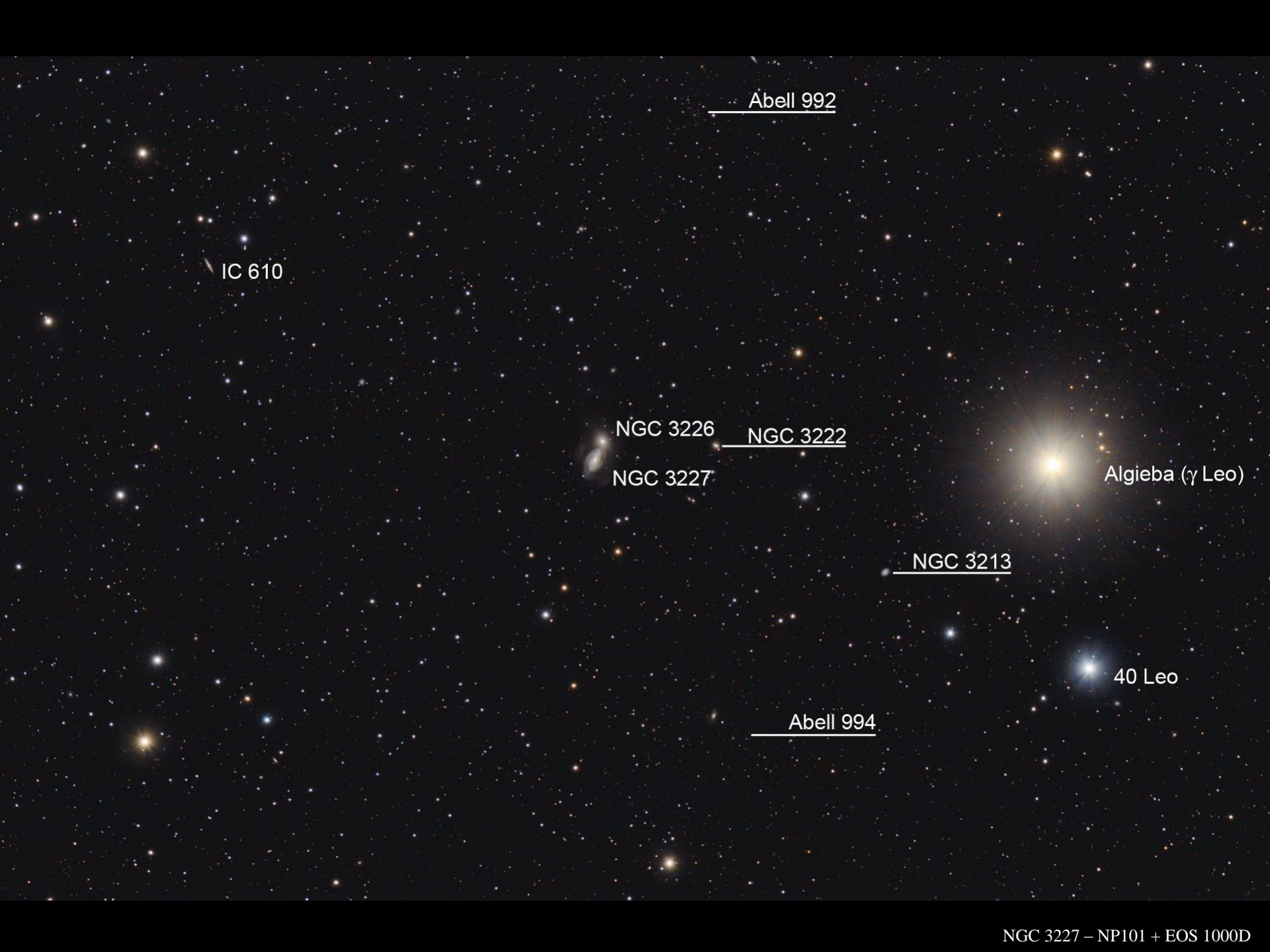












IC 610

Abell 992

NGC 3226

NGC 3222

NGC 3227

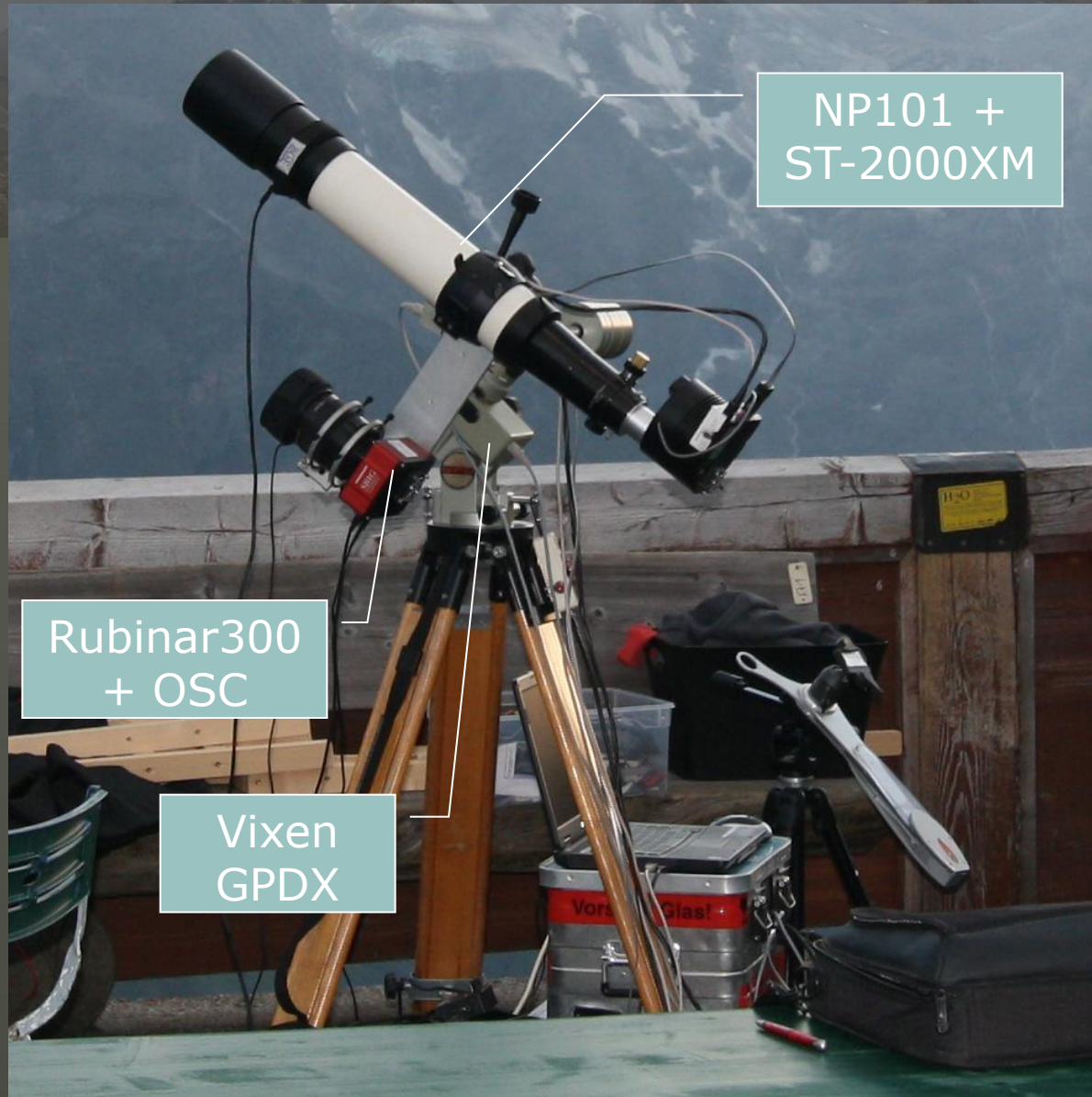
Algieba (γ Leo)

NGC 3213

40 Leo

Abell 994

Astro trips

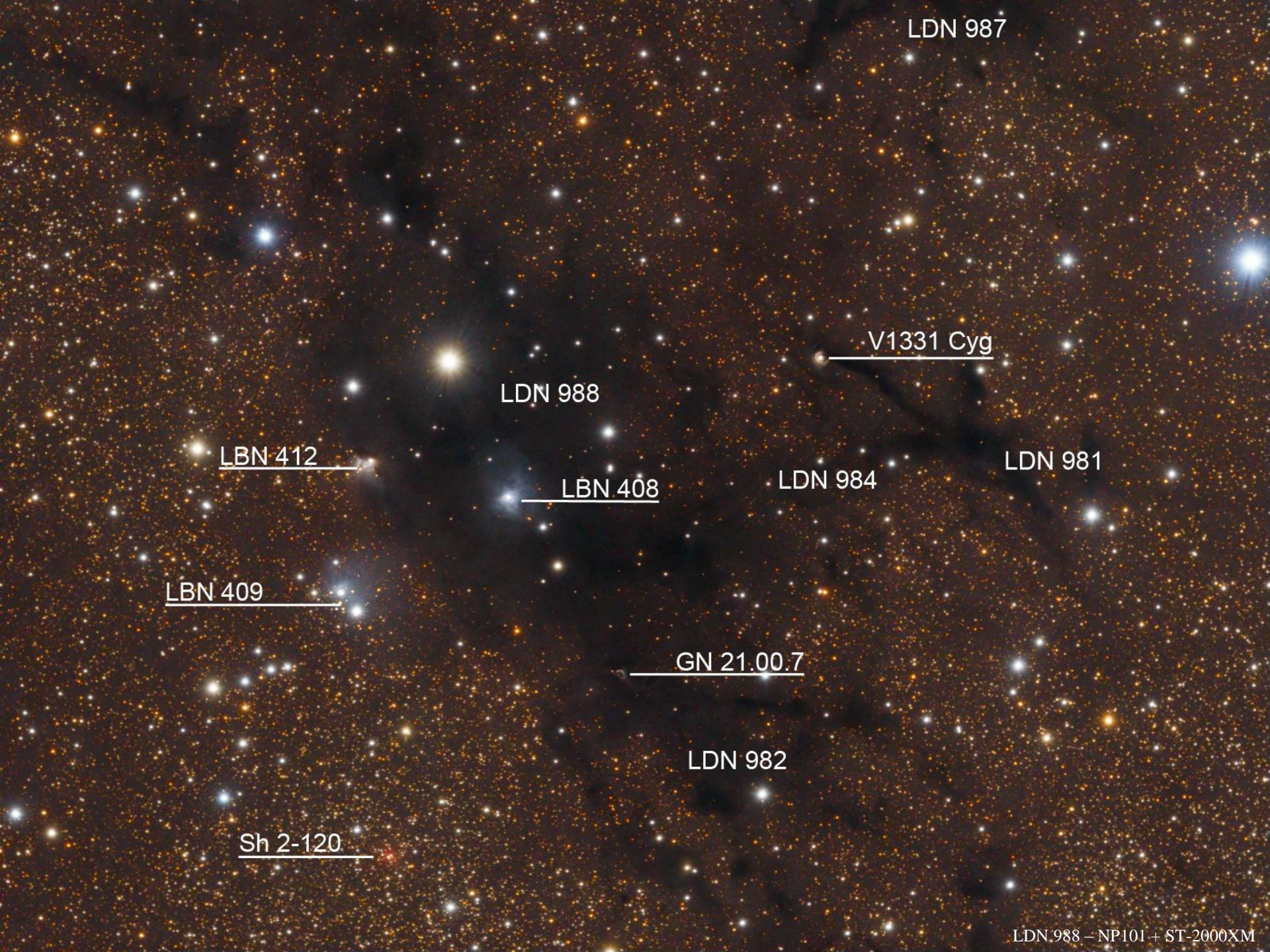


NP101 +
ST-2000XM

Rubinar300
+ OSC

Vixen
GPDx





LDN 987

V1331 Cyg

LDN 988

LBN 412

LBN 408

LDN 984

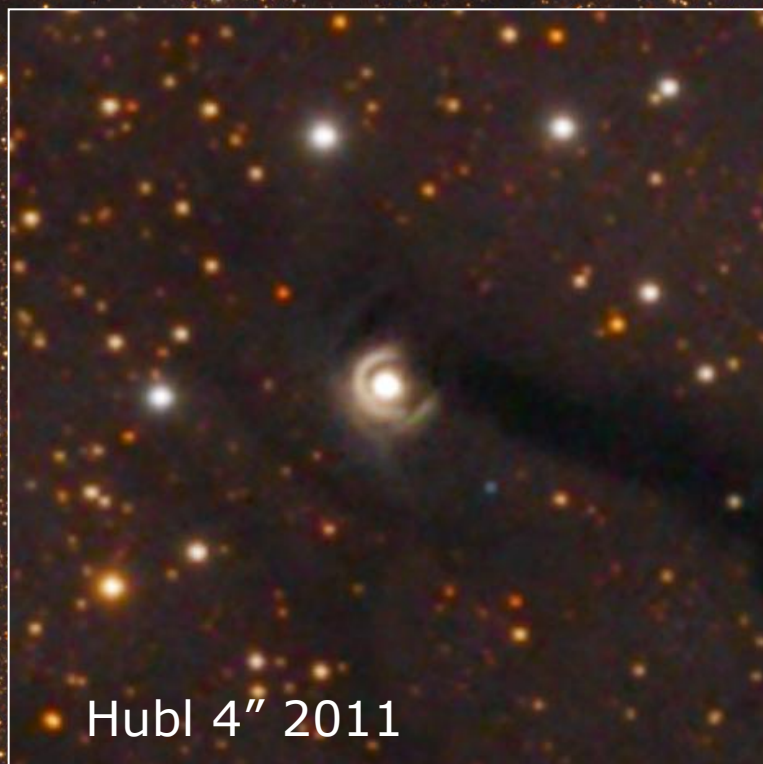
LDN 981

LBN 409

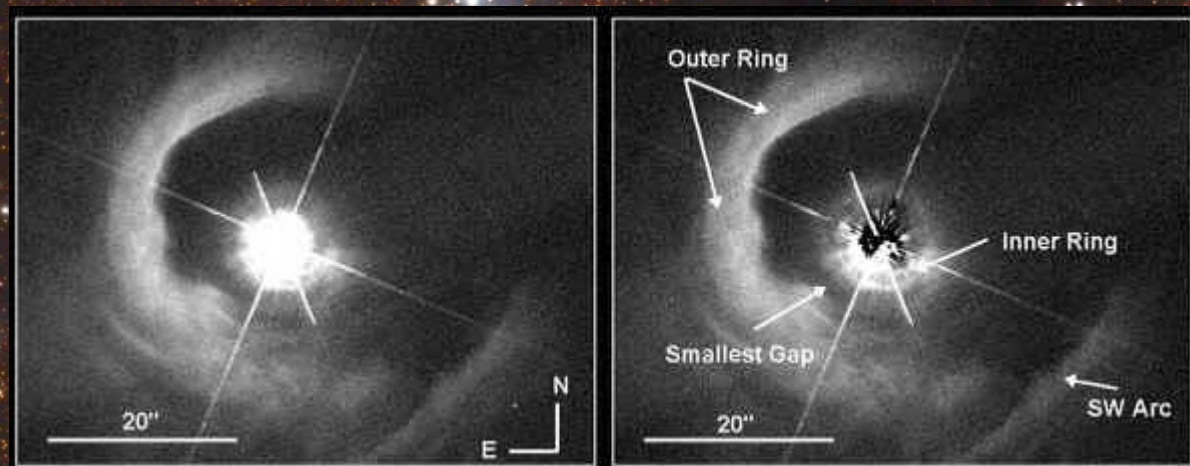
GN 21.00.7

LDN 982

Sh 2-120



Hubl 4'' 2011

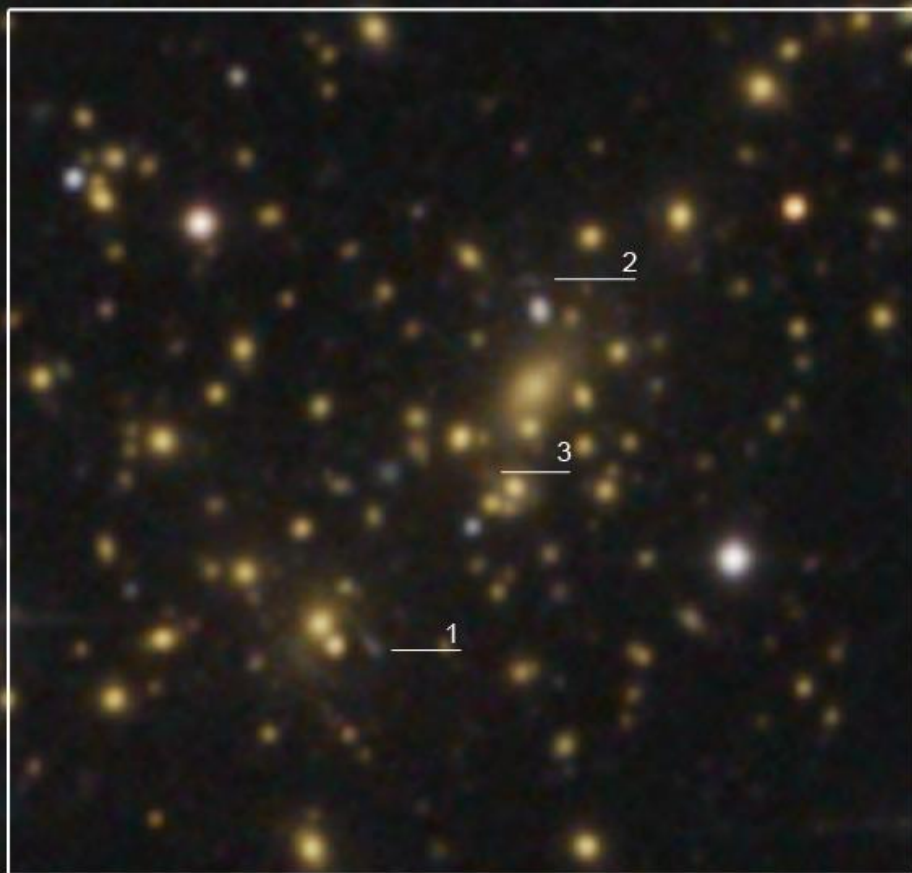


HST 2006





Depth?



Hubl, 12" f=1120mm



Hubble Space Telescope image

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



4" f/5.4, EOS1000D, 10h

12" f/3.8, ST2000XM, 12h

Last two tips



www.astronomie.at

The poster for the 'c.e.d.i.c.' (central european deepsky imaging conference) features a large, colorful inverted triangle with a rainbow gradient. Above the triangle is a horizontal rainbow bar, and below it is another horizontal rainbow bar. The text 'c.e.d.i.c.' is prominently displayed at the top, followed by 'central european deepsky imaging conference'. Below that, the dates and location are given: '1st - 3rd March 2013 - Ars Electronica Center Linz / Austria'. At the bottom, the opening event is announced: 'Opening: 1st of March 2013, 19.30h AEC/ Linz "DEEPSPACE"'. Logos for Adobe, Microsoft, and Linz are at the bottom left, and the website 'www.cedic.at' is at the bottom right.

c.e.d.i.c.
central european deepsky imaging conference
1st - 3rd March 2013 - Ars Electronica Center
Linz / Austria

Opening: 1st of March 2013, 19.30h AEC/ Linz
"DEEPSPACE"

Adobe Microsoft Linz
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