



# Midtjysk Astronomiforening

## Astrofotografering

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# Midtjysk Astronomiforening

## Program

Min interesse for rumfart, astronomi og fotografi

Visuel astronomi vs astrofotografering

Introduktion

Udstyr:

- Montering

- Teleskop

- Kamera

Opstilling

- Polar justering,

- Justering af teleskop

Fotografering:

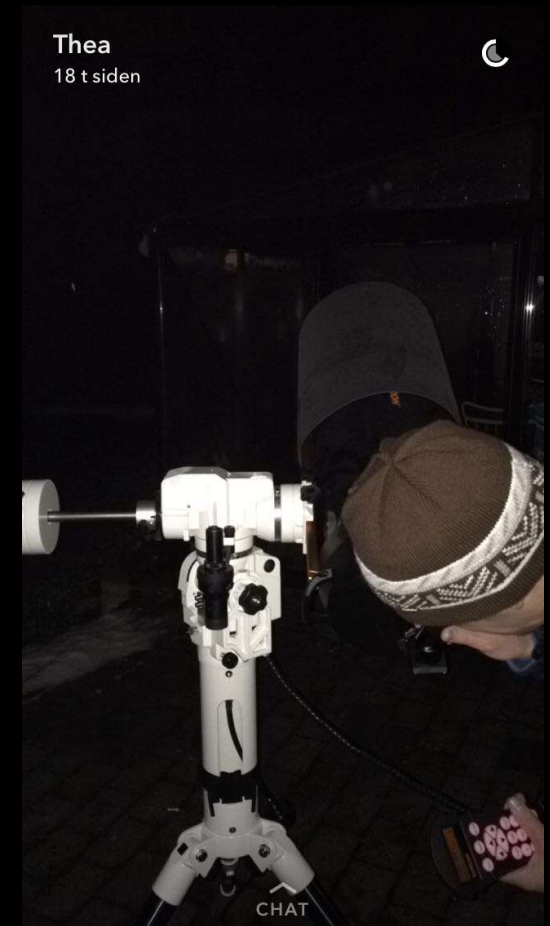
- En tur rundt på nattehimlen – kort eksponering

- Fotografering med lang eksponeringstid

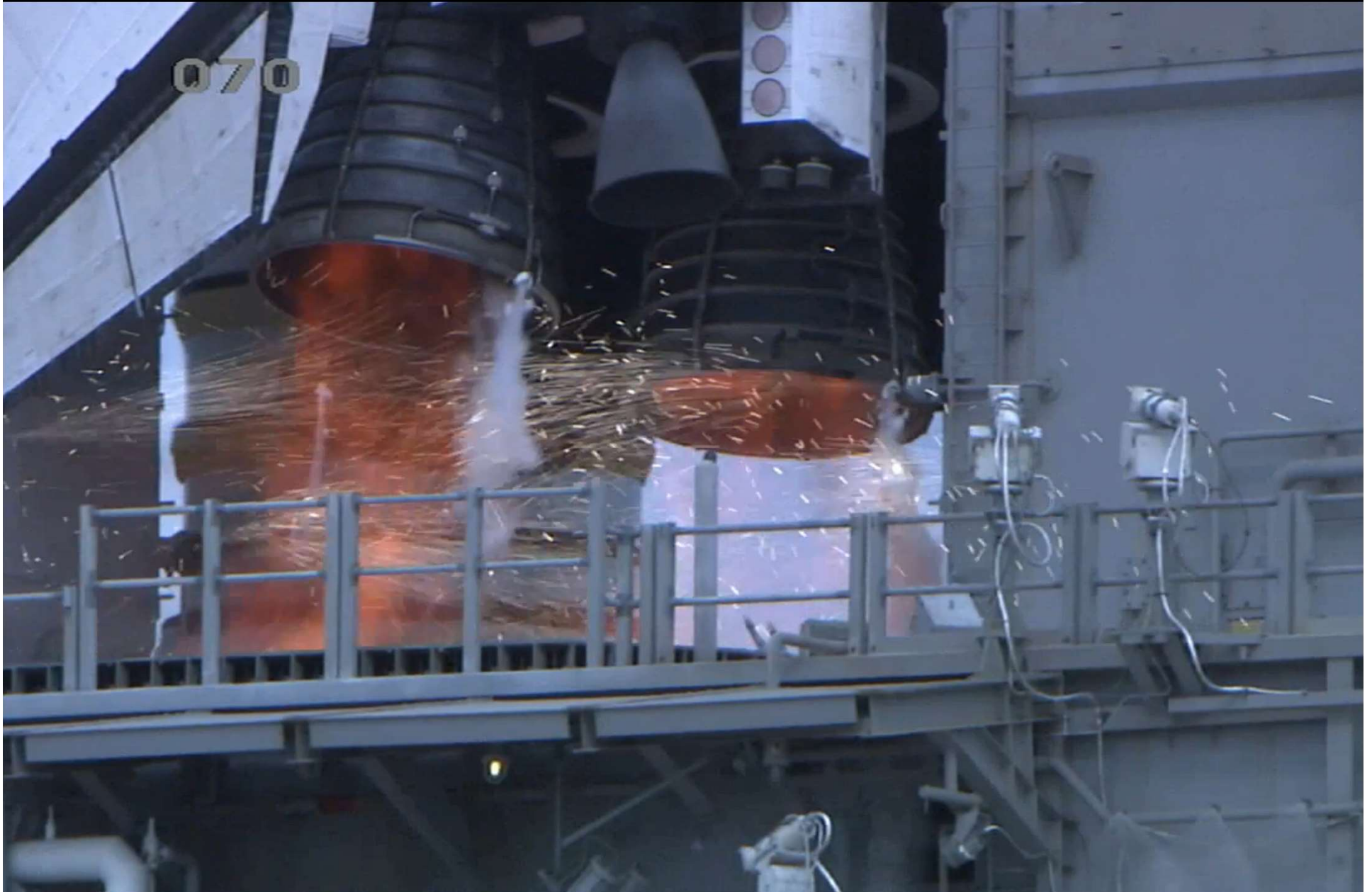
- Efterbehandling af billeder

Fotografering af solsystemets objekter

Lær mere om Astrofotografering



# Min interesse for rumfart og astronomi





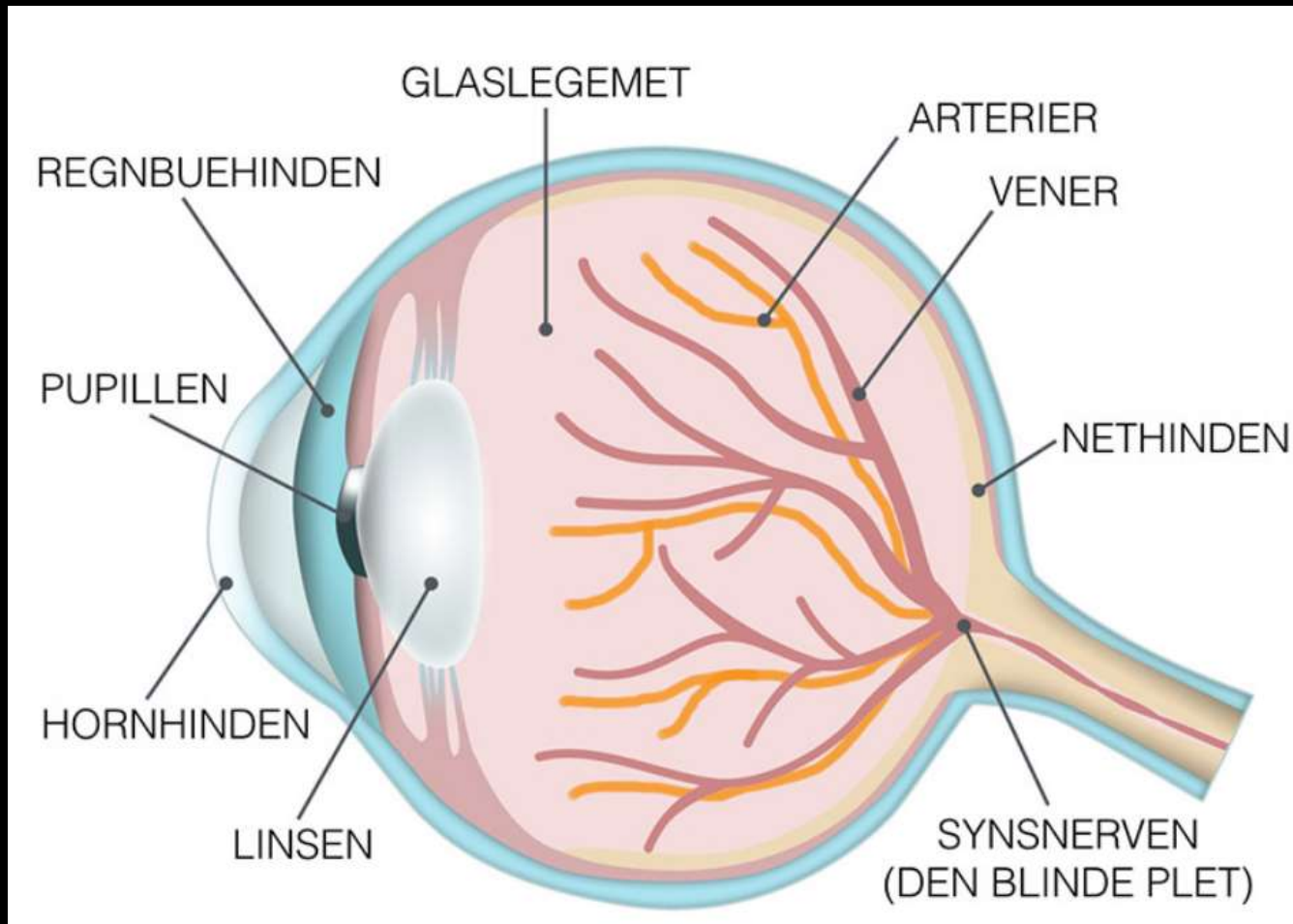




# Visuel astronomi vs astrofotografering



# Visuel astronomi vs astrofotografering

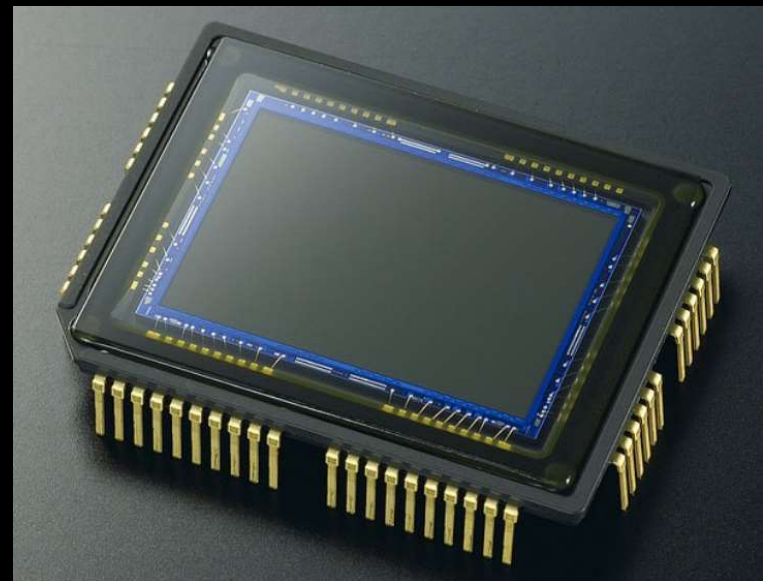


Øjet er det svageste led i visuel astronomi

# Visuel astronomi vs astrofotografering



CCD og CMOS teknologi gør det muligt at indsamle meget mere lys end øjet. Teknologien har udviklet sig hastigt siden år 2000.







M81 spiral galakse (Bode's Galaxy)



M31 og M32 – Andromeda galaksen



M42 - Den Store Oriontåge





Jupiter

# Astrofotografering - introduktion



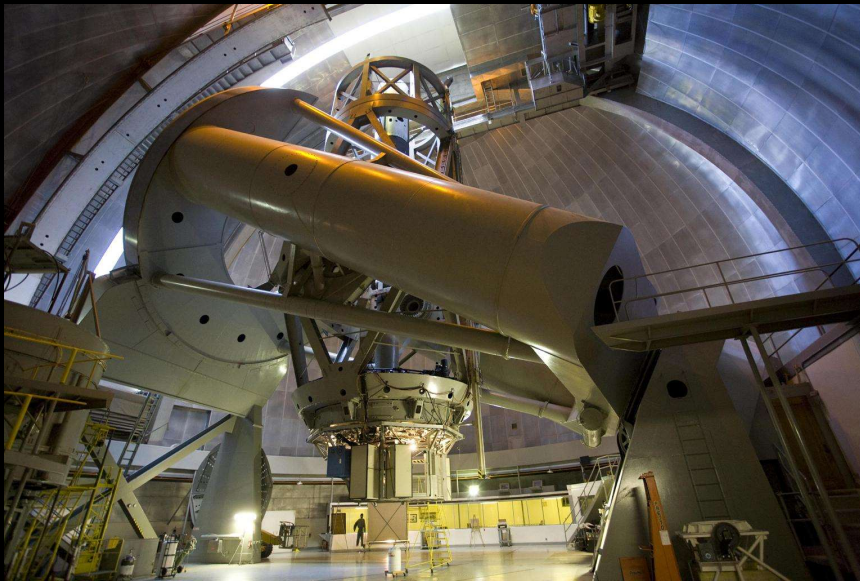


# Astrofotografering - introduktion





# Astrofotografering - introduktion





# Udstyr til astrofotografering



# Monteringen

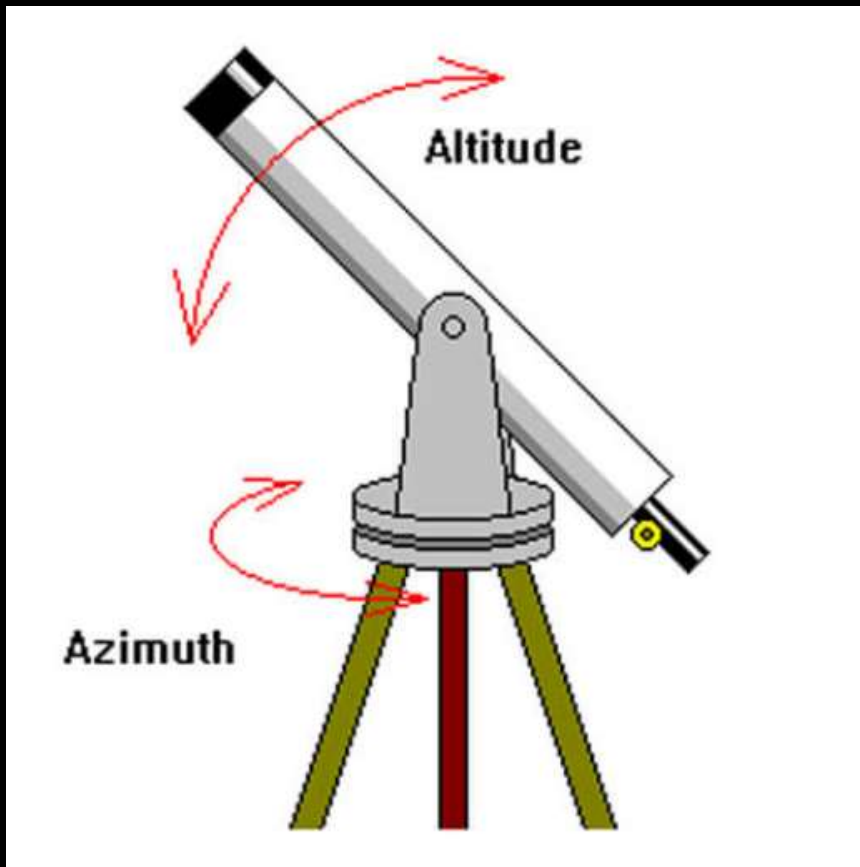




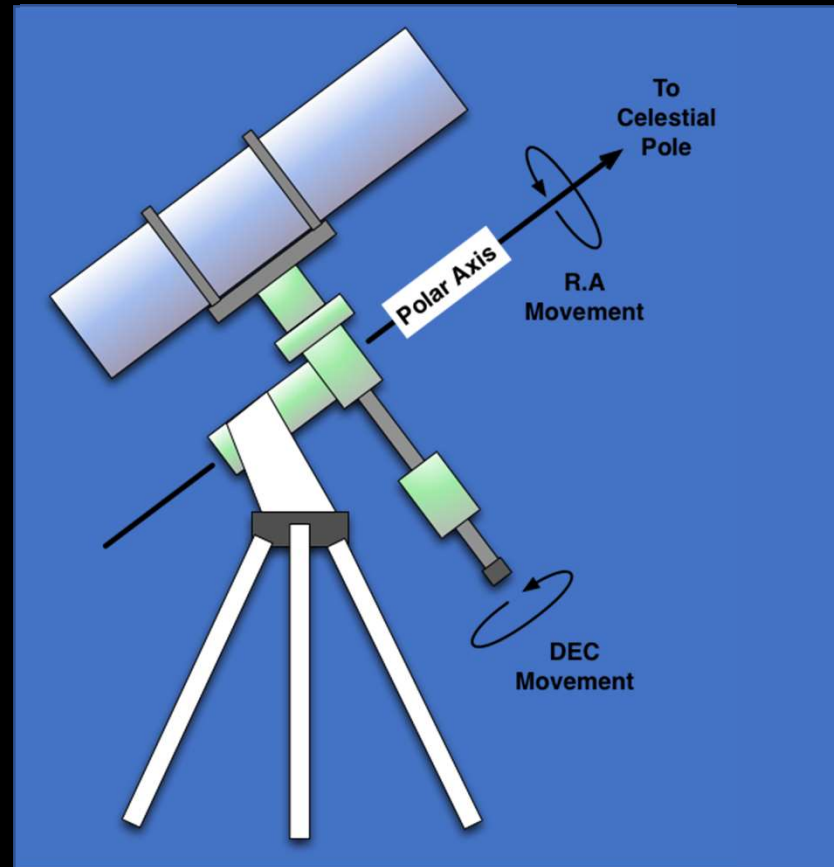
# Monteringen

Der findes 2 hovedtyper:

Type 1: Altitude-Azimuth  
eller blot Alt-Az



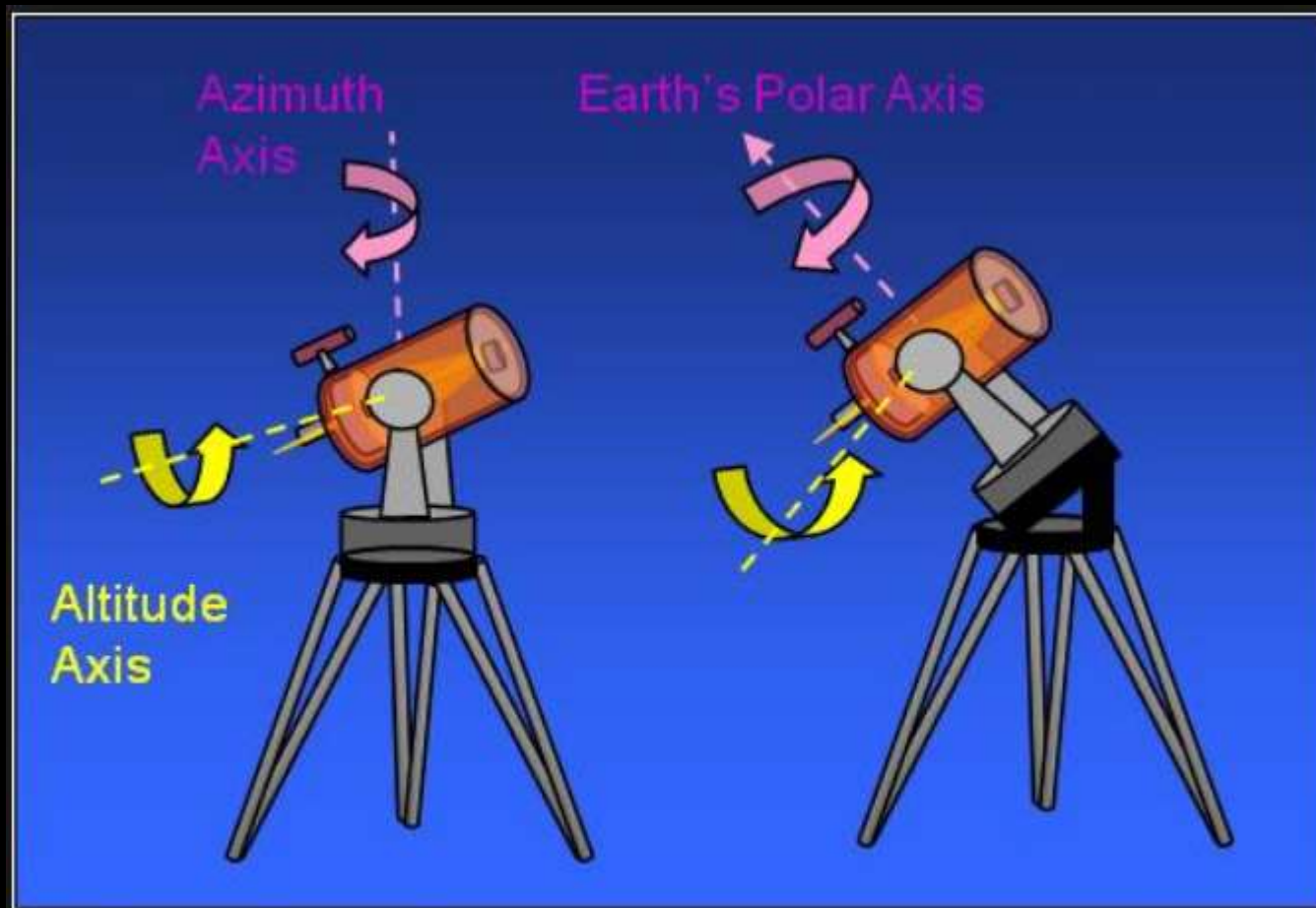
Type 2: Ækvatorial, betegnes typisk  
GEM (German Equatorial Mount)



# Monteringen

..og en variant af type 1:

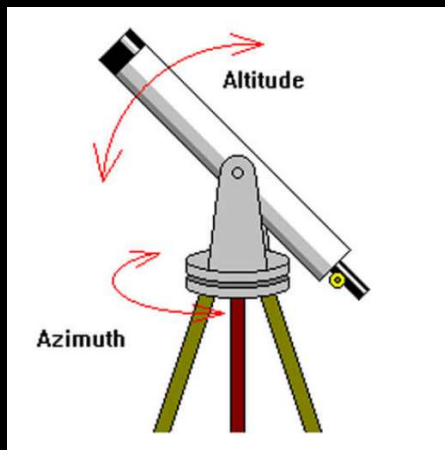
Type 3: Altitude-Azimuth med kile (wedge)



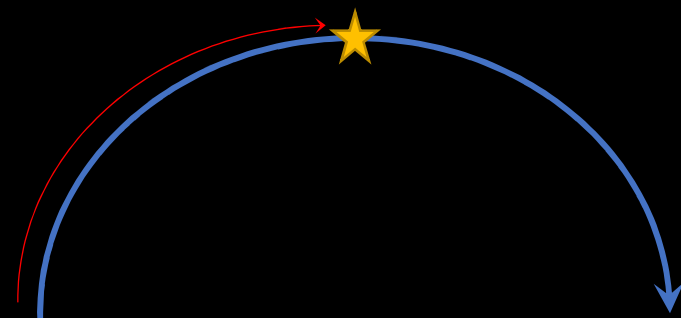
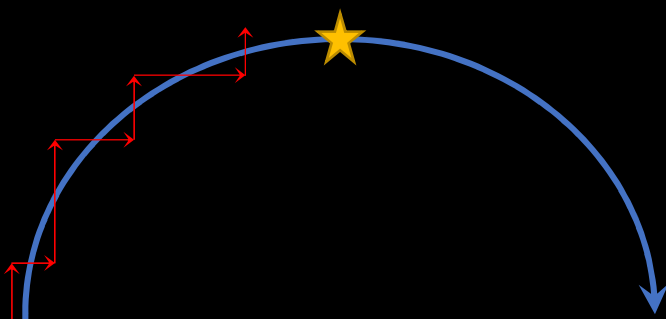
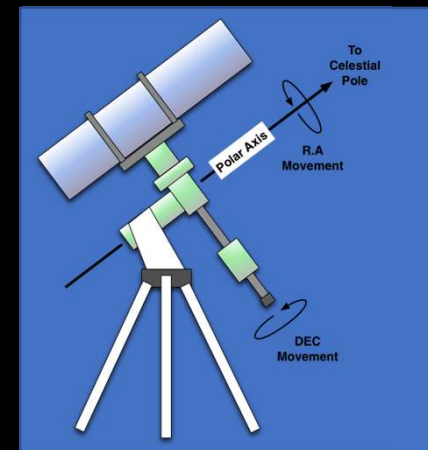
# Monteringen

Bevægelsen af teleskopet

Type 1: Alt-Az bevægelse



Type 2: Ækvatorial bevægelse

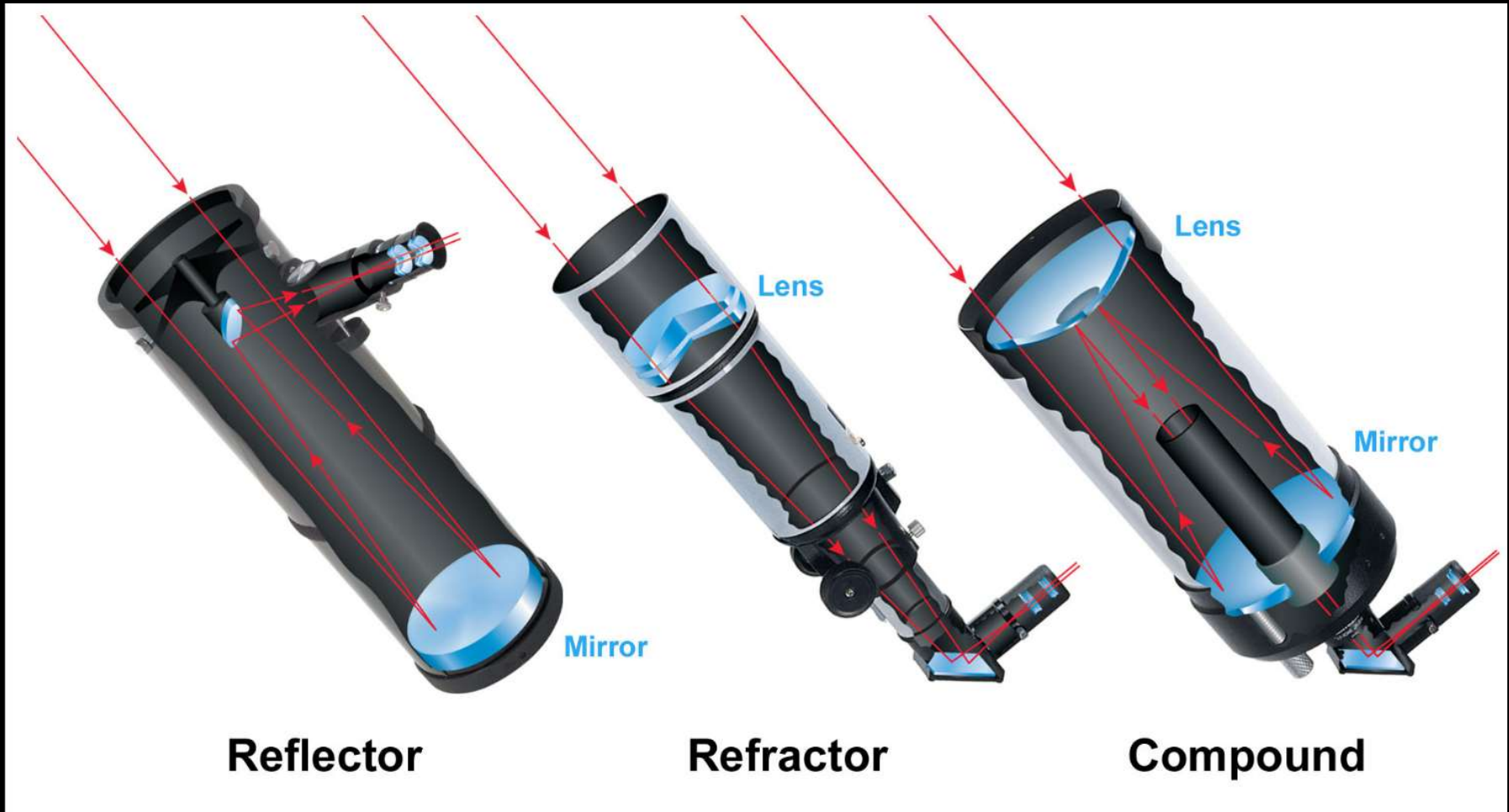




# Teleskopet



# Teleskopet



De tre hovedtyper:

Reflektor: Newton – spejlteleskopet

Refraktor: Linser (Galileo)

Katadioptrisk: Linser og spejle, f.eks. Schmidt-Cassegrain eller Maksutov

# Newton - teleskopet





# Refraktor - linseteleskopet



# Katadioptrisk – spejl- og linseteleskopet



# Kameraet

Thea

18 t siden from Camera Roll



CHAT



# Kameraet

2 forskellige veje:



DLSR  
Spejlrefleks kamera  
Evt. modificeret til  
astrofotografering



Dedikeret CCD eller CMOS kamera  
Farve  
eller  
Monokrom med farvefiltre

# Opstilling til astrofotografering

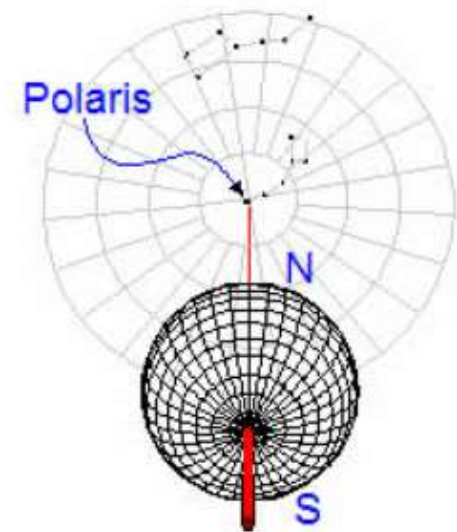
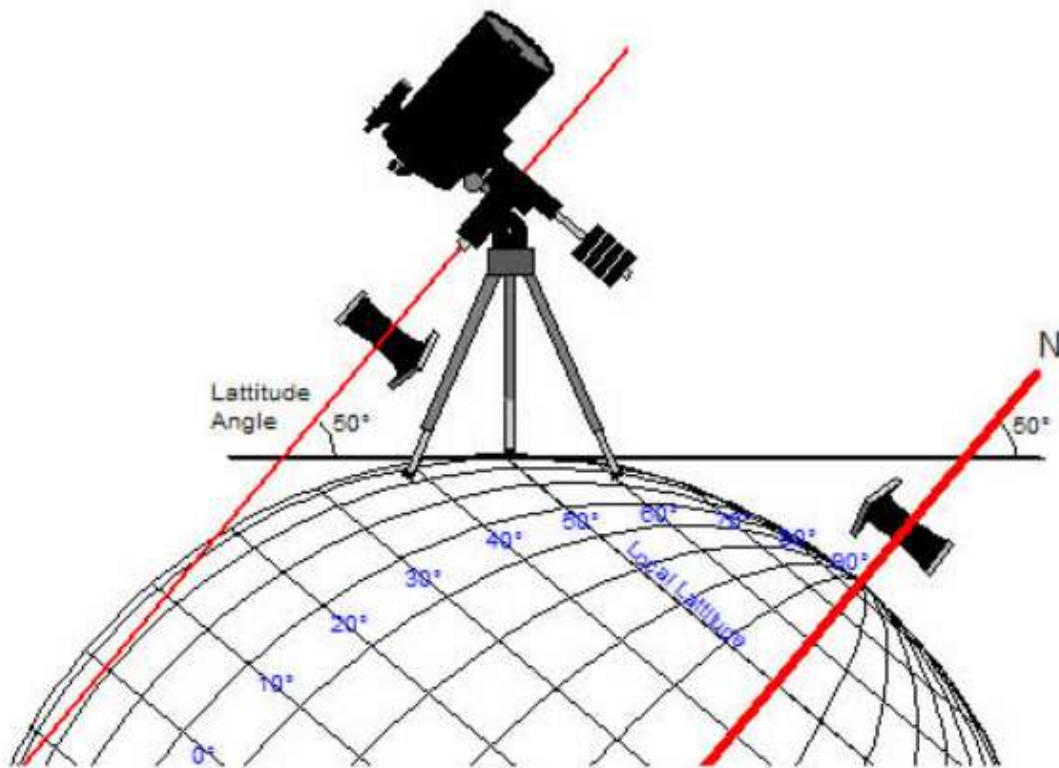


# Jordens rotation



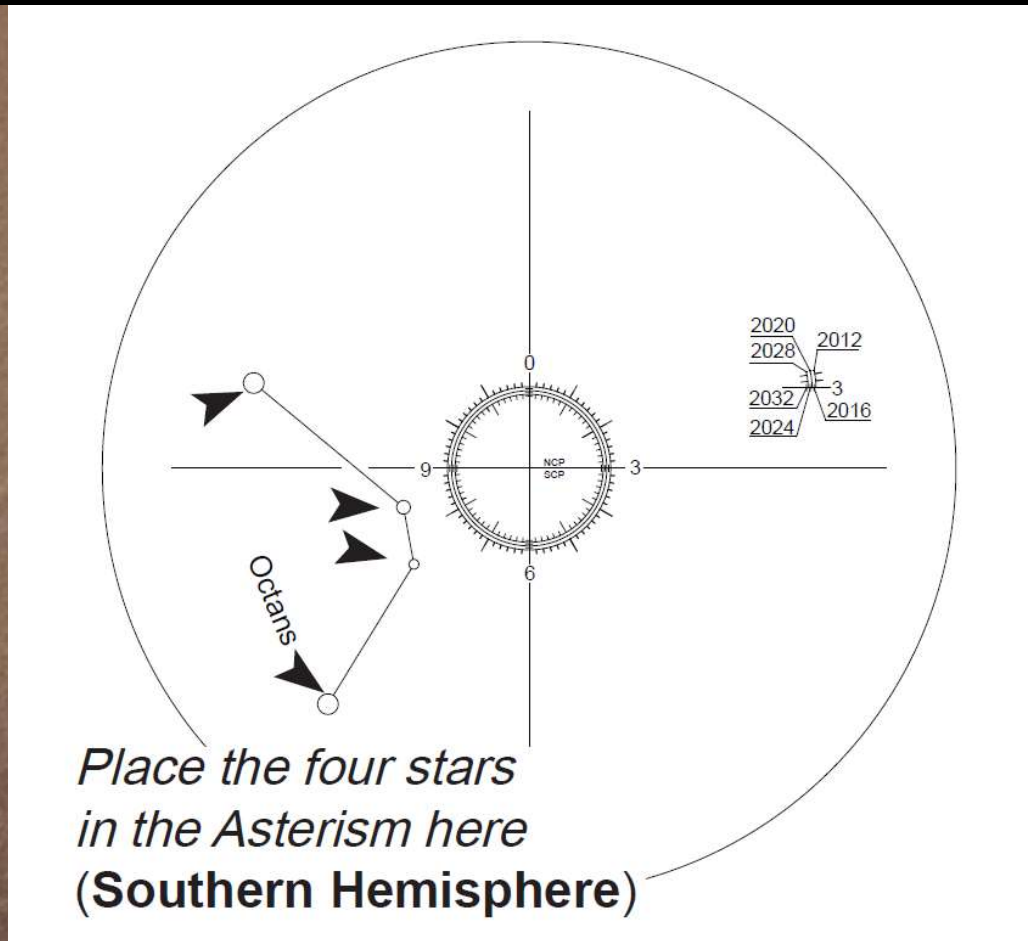


# Polar justering



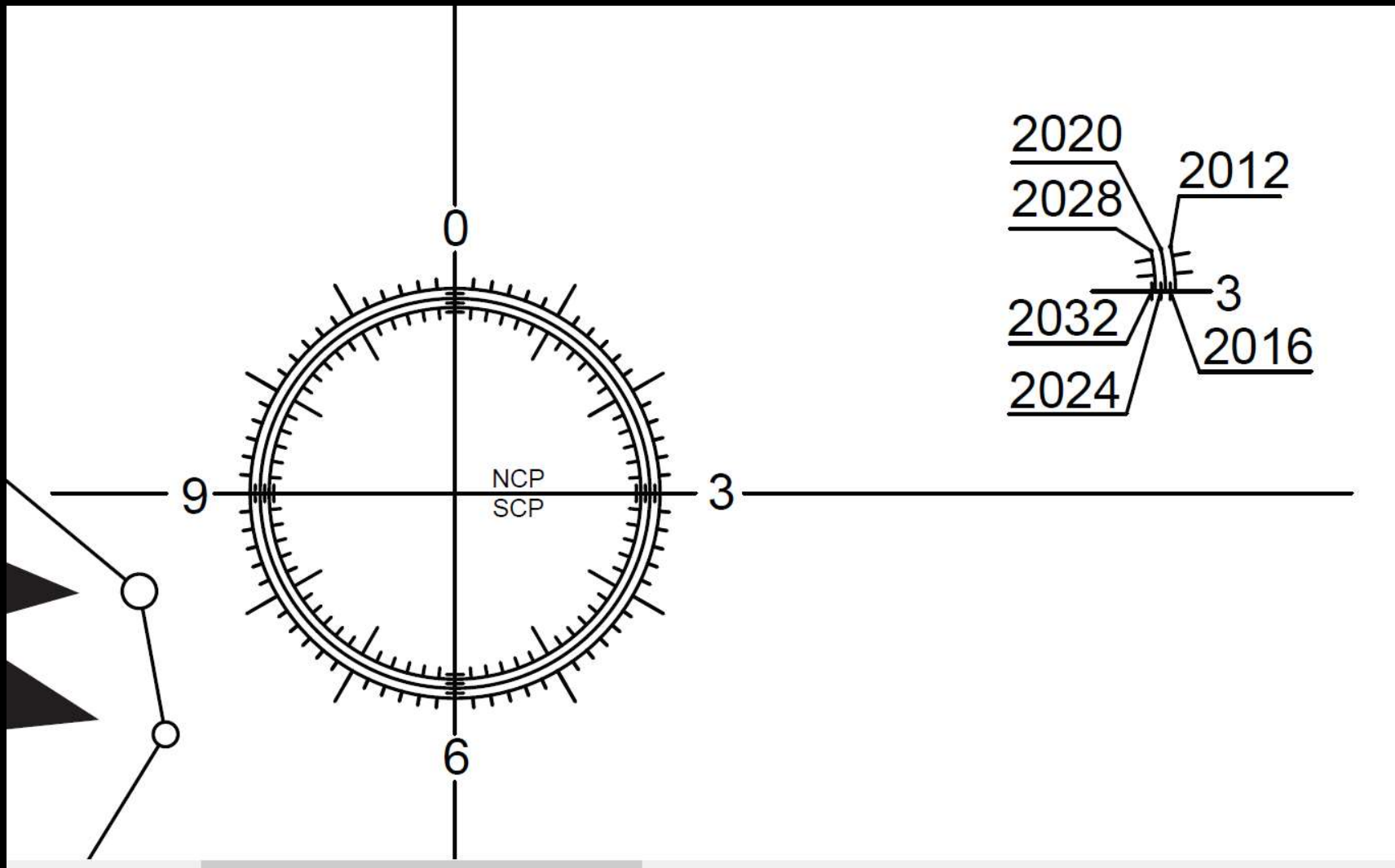
Monterings polare-akse (RA) skal være parallel med jorden akse og derfor pege mod nordstjernen Polaris

# Polar justering



En hjælpekikkert (Polar Scope) monteret parallelt med den polare akse hjælper med at kalibrere opstillingen

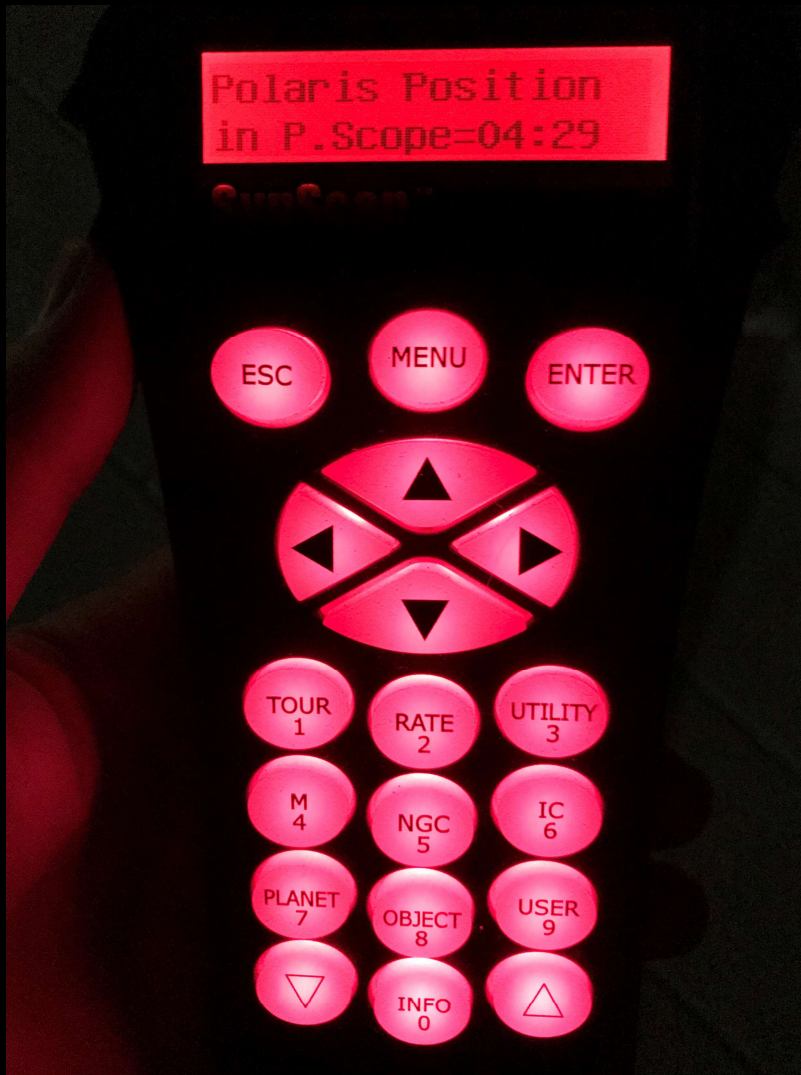
# Polar justering



I kikkerten kan man se et trådkors omkranset med kalibreringscirkler

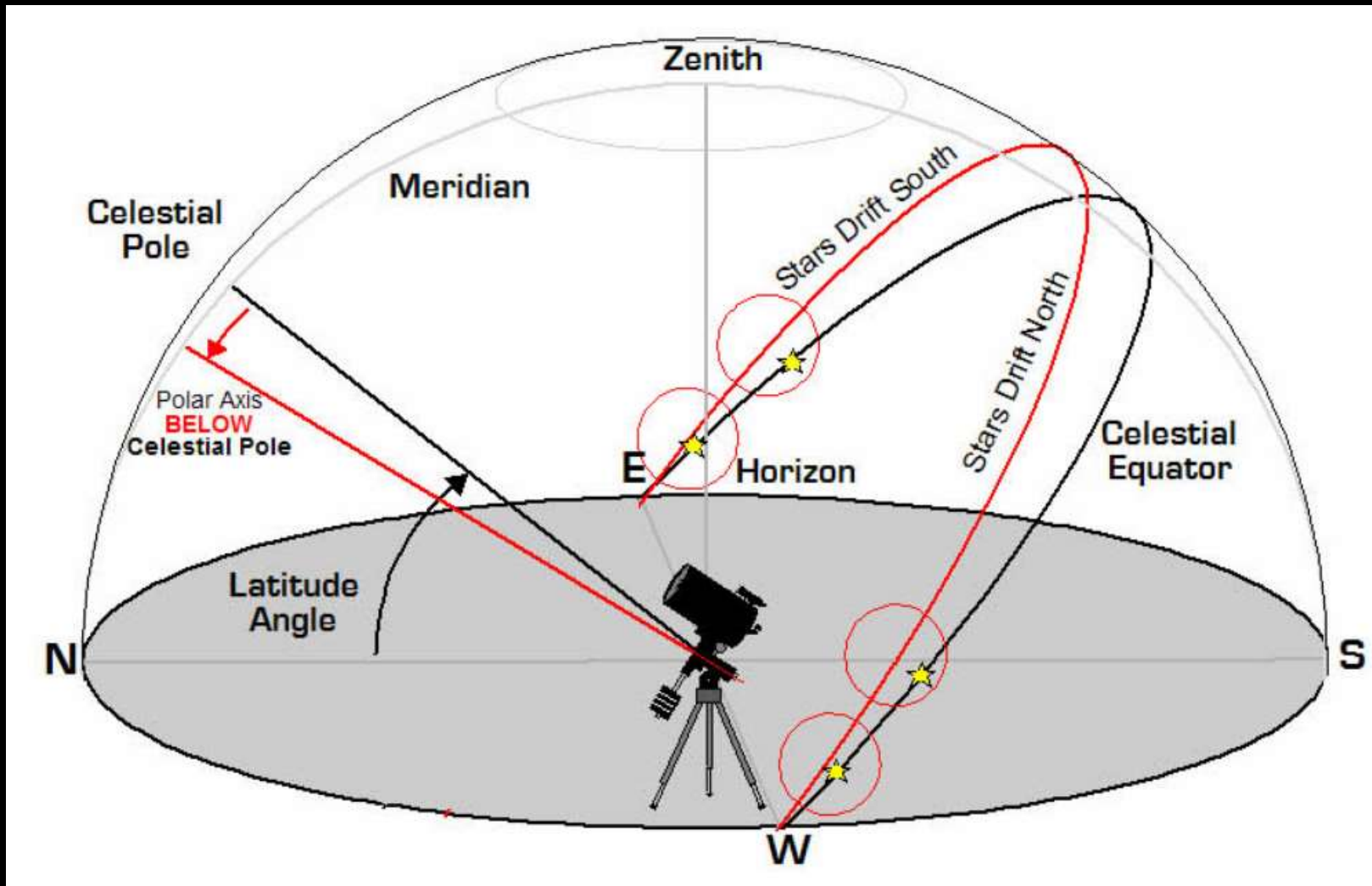


# Polar justering



Håndkontrollen fortæller, hvordan Polaris skal placeres i forhold til trådkorsets kalibreringscirkler. Billedet til højre er taget gennem kikkerten

# Polar justering



Her ses konsekvensen af upræcis justering – stjernerne "vandrer"

# Polar justering

Upræcis justering giver aflange stjerner ved eksponeringer på over 30 sek.



# Justering af hovedteleskopet



Teleskopet skal nu justeres så objekt-kataloget kan bruges.

Justeringen omfatter:

Bredde- og længdegrad

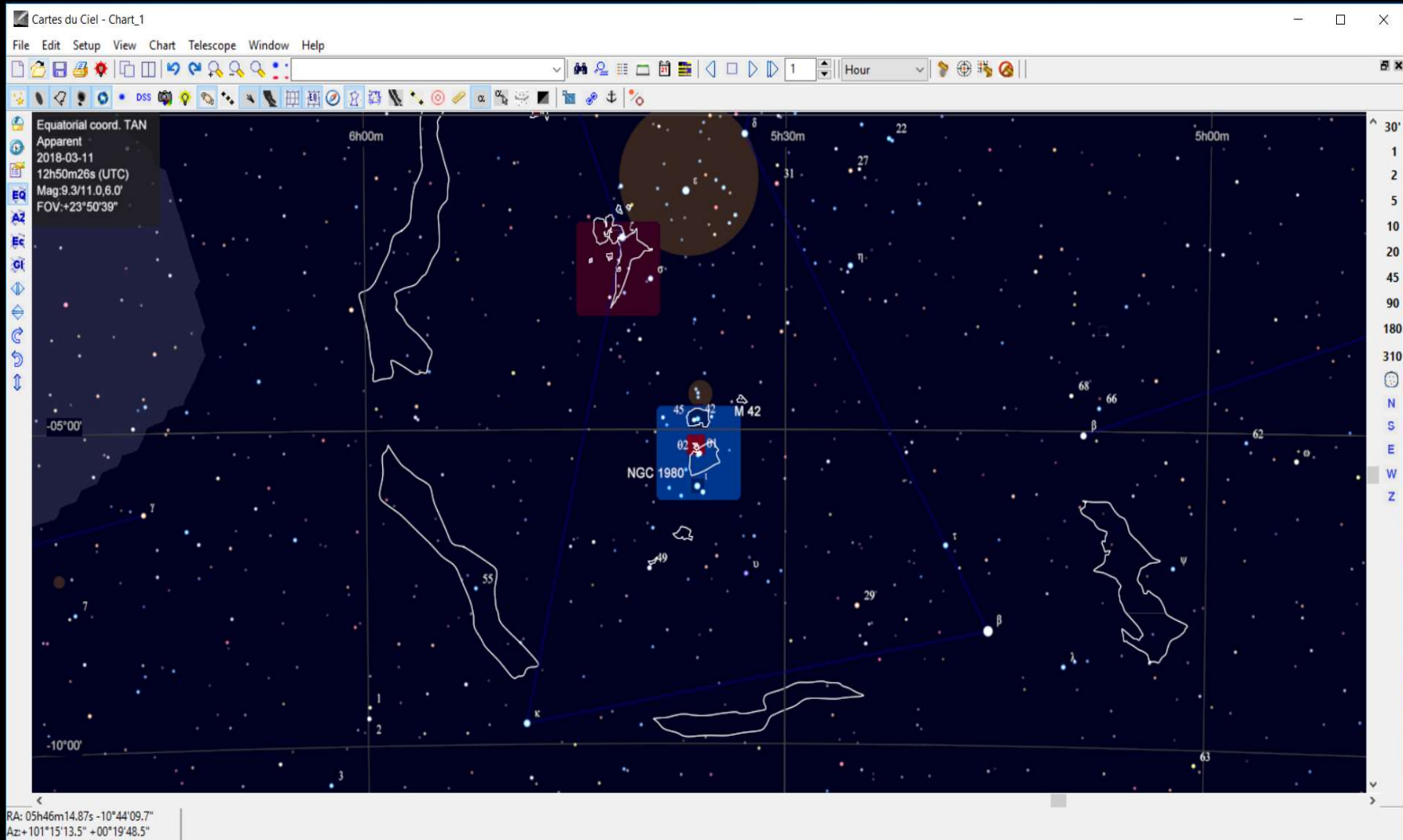
Tidspunkt

Udpegning af 1-3 stjerner.

Efter justeringen kan man vælge mellem mange objekter og benytte Go-To funktionen til at finde og fastlåse teleskopet på et valgt objekt.

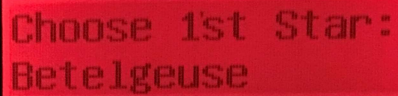
En anden mulighed er at bruge Stellarium, Cartes du Ciel eller andet PC Software i stedet for håndkontrolleren

# Justering af hovedteleskopet



Cartes du Ciel og ASCOM software kan kontrollere teleskopet fra PC'en

# Justering af hovedteleskopet



Choose 1st Star:  
Betelgeuse



I min opstilling kan jeg ikke se gennem et okular pga. kameraet

I stedet benytter jeg et mindre 60mm parallel monteret teleskop (Guidescope) monteret ovenpå hovedteleskopet til grov-justering.

Til finjustering benytter jeg software til kameraet (Backyard EOS)

Det lille teleskop har en meget vigtig funktion, som vi skal se senere.

Jeg vælger 1. stjerne Betelgeuse og teleskopet finder den på himlen.



# Justering af hovedteleskopet



Kamera monteret på teleskopet

# Justering af hovedteleskopet

BackyardEOS 3.1.8 - Premium Edition (100D-SL1)

20:55:58

Camera Information Center (100D-SL1)

1/4 1600

M Off

AS1

ASC0M Focuser

ASC0M Filter Wheel

1 2 3 4 5 6 7 8 9

Weather Center

Frame/Focus Center [Double image click to lock/unlock the zoom box.]

89%

Zoom Box Center

57,7 FWHM HFD StdDev Background Precision 17,0

Place a single star reasonably centered in the smaller zoom box image (bottom right).

Full Width Half Maximum is the width of a star's image at half its peak. Focus is achieved when you get the lowest value for the same star overtime, indicating a tighter star.

Shutter Duration ISO Pause

1/4 1600 0

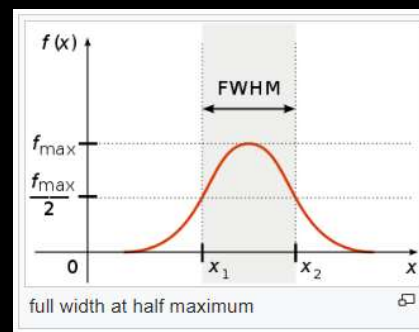
Snap Image Loop Live View

Betelgeuse kan ses, men er ikke i fokus

# Justering af hovedteleskopet



Her stiller jeg fokus assisteret af en funktion i programmet Backyard EOS, som kaldes FWHM



Jeg bliver ved indtil tallet er så lavt, som muligt



# Justering af hovedteleskopet

BackyardEOS 3.1.8 - Premium Edition (100D-SL1)

21:18:16

Camera Information Center

BULB 100

M Off +18c

RAW

ASCOM Focuser

ASCOM Filter Wheel

Dither Night Vision Setting

Weather Center

Image Center [LIGHT\_30s\_100iso\_+18c\_20180222-21h17m26s837ms.CR2]

18%

Histogram Center

Capture Plan Center

Frame Type Cable support Save To Mirror lock

LIGHT Camera USB PC 0

Target Name Filter Delay

Exposures	Shutter	Duration	ISO	Pause
1	1	BULB	30	100
2	0			
3	0			
4	0			
5	0			

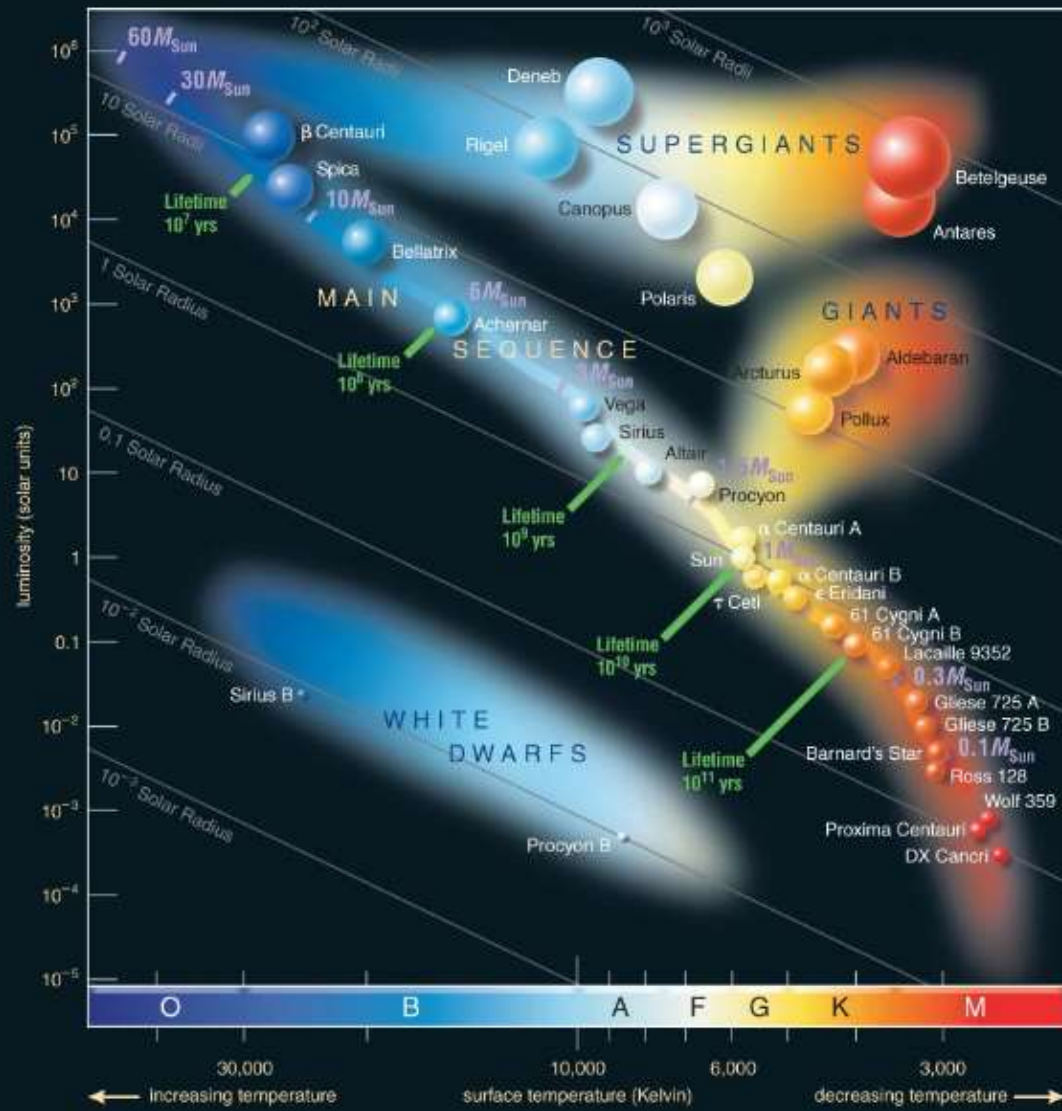
Load Save Save as... Reset

Start Capture Loop Preview Dual Camera

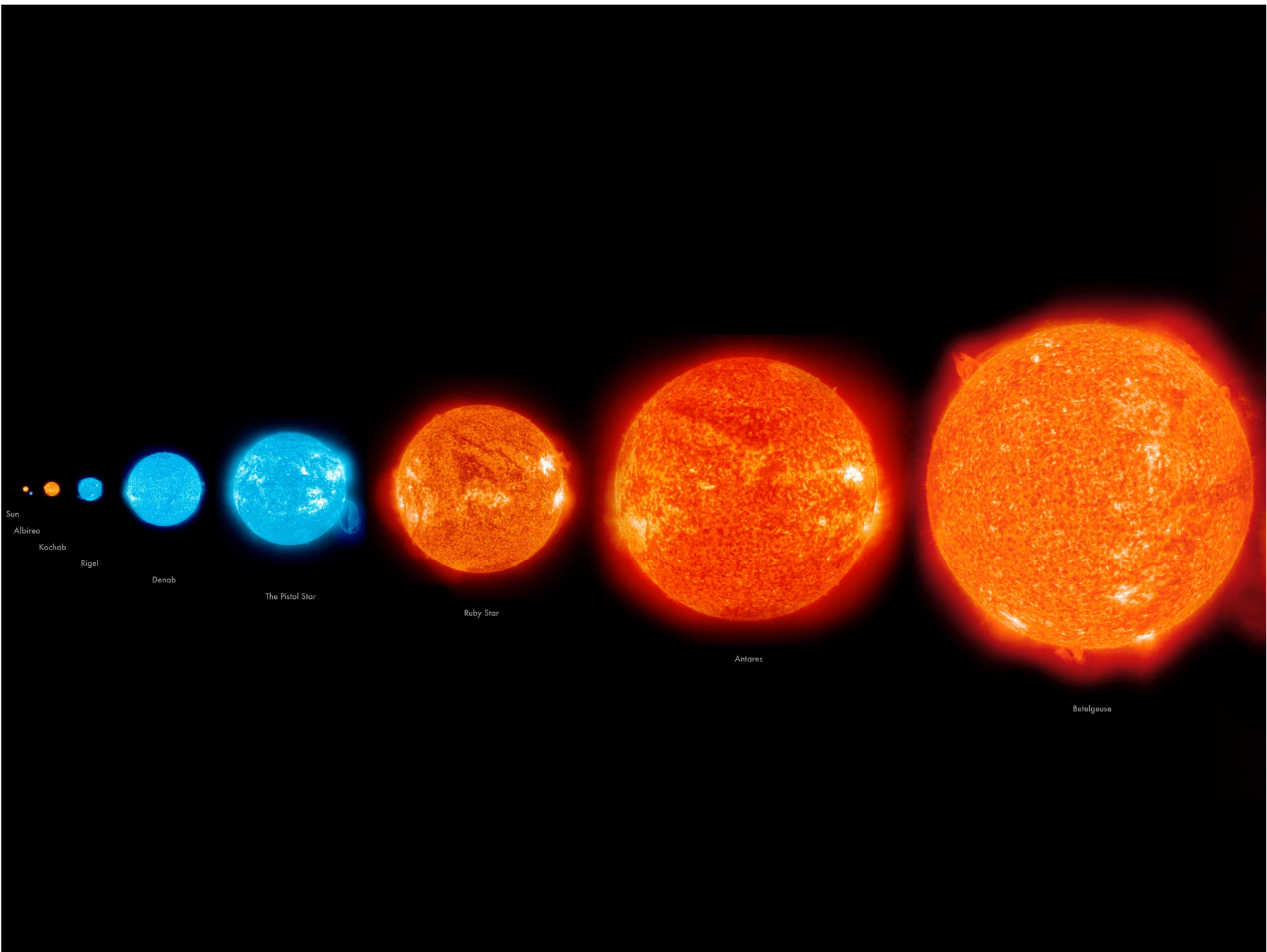
1 @ 21h04m56s 2 @ 21h13m56s 3 @ 21h16m34s 4 @ 21h17m04s 5 @ 21h18m01s

Nu er Betelgeuse placeret i centrum (Alignment) og er samtidig helt i fokus









Sun

Albireo

Kochab

Rigel

Denab

The Pistol Star

Ruby Star

Antares

Betelgeuse

# Justering af hovedteleskopet

Choose 2nd Star:  
Dubhe



Som 2. stjerne vælger jeg Dubhe

Efter justering er teleskopet klar til at finde over 40.000 objekter:

- Messier
- NGC
- IC
- SAO
- Caldwell
- Dobbelt stjerner
- Variable Stjerner
- Navngivne Stjerner
- Solsystemets planeter



# Opstilling



En tur rundt på nattehimlen





# En tur rundt på nattehimlen

BackyardEOS 3.1.8 - Premium Edition (100D-SL1)

21:58:21

Camera Information Center  
BULB 200  
M Off +7c  
RAW

ASCOP Focuser  
ASCOP Filter Wheel

Weather Center

Histogram Center

Capture Plan Center

Exposures	Shutter	Duration	ISO	Pause	
1	1	BULB	60	200	0
2	0				
3	0				
4	0				
5	0				

15 @ 21h58m10s

Start Capture Loop Preview Dual Camera

M31 – Andromeda Galaksen



# En tur rundt på nattehimlen

BackyardEOS 3.1.8 - Premium Edition (100D-SL1) 21:47:56

Camera Information Center  
BULB 200  
M Off +6c  
RAW

ASCAM Focuser  
ASCAM Filter Wheel

Weather Center

Image Center [LIGHT\_30s\_400iso\_+6c\_20180222-21h45m16s400ms.CR2]

18%

Histogram Center

Capture Plan Center

Exposures	Shutter	Duration	ISO	Pause
1	1	BULB	60	100
2	0			
3	0			
4	0			
5	0			

21h13m9s 3 @ 21h16m24s 4 @ 21h17m04s 5 @ 21h18m01s 6 @ 21h26m49s 7 @ 21h29m33s 8 @ 21h41m07s 9 @ 21h42m05s 10 @ 21h45m53s 11 @ 21h47m17s

Start Capture Loop Preview Dual Camera

M35 – Åben stjernehop i Tvillingerne





# En tur rundt på nattehimlen

BackyardEOS 3.1.8 - Premium Edition (100D-SL1) 21:42:38

**Camera Information Center**

**BULB** 100

**M** Off +6c

**RAW**

**ASCAM Focuser**

1 2 3 4 5 6 7 8 9

**ASCAM Filter Wheel**

1 2 3 4 5 6 7 8 9

**Weather Center**

Dither Night Vision Setting

21:41:27 Imaging session started.  
21:42:04 Imaging session completed successfully.  
21:42:04 LIGHT\_30s\_100iso\_+6c\_20180222-21h41m29s024ms.CR2  
[View log history...](#)

Image Center [LIGHT\_30s\_200iso\_+6c\_20180222-21h40m31s493ms.CR2]



**Histogram Center**

2 L RGB

Reset

**Capture Plan Center**

Frame Type	Cable support	Save To	Mirror lock
LIGHT	Camera USB	PC	0

Target Name: Filter: Delay: 0

Exposures	Shutter	Duration	ISO	Pause	
1	1	BULB	30	100	0
2	0				
3	0				
4	0				
5	0				

Load Save Save as... Reset

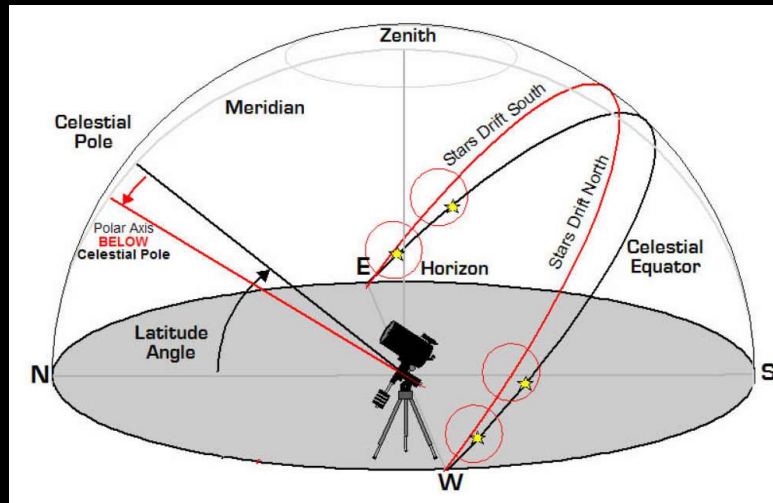
1 @ 21h04m56s 2 @ 21h13m56s 3 @ 21h16m34s 4 @ 21h17m04s 5 @ 21h18m01s 6 @ 21h38m49s 7 @ 21h39m33s 8 @ 21h42m07s 9 @ 21h42m05s

Start Capture Loop Preview Dual Camera

M42 – Orion tågen



# Fotografering med lang eksponeringstid



Uanset hvor præcist teleskopet er kalibreret vil man i praksis ikke kunne tage billeder med mere end 30-60sek. eksponeringstid

Nogle objekter kræver eksponeringstider på 4-5 min eller endnu længere.

Der er behov for at forbedre teleskopets præcision.

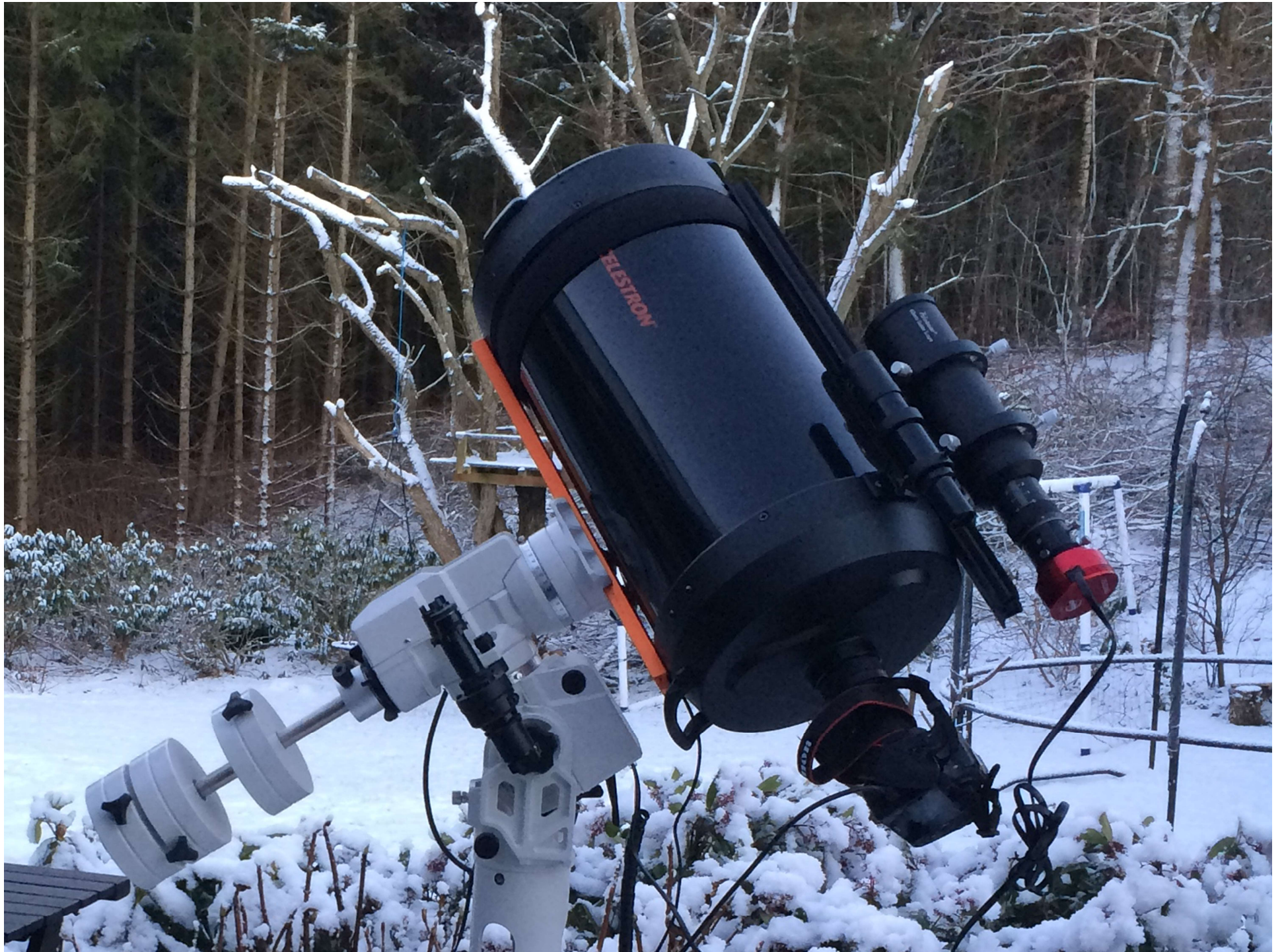


# Fotografering med lang eksponeringstid

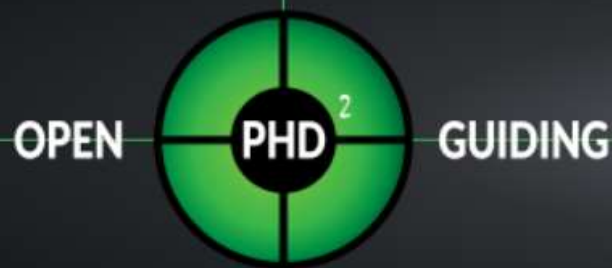


Guide scope









PHD2 is the enhanced, second generation version of the popular PHD guiding software from Stark Labs. Still available free of charge, PHD is now an open-source project, supported by an active community of developers and astro-imagers.

Download v2.6.4  
for Windows

Download v2.6.4  
for Mac OS X

Home Learn More News Changelog Download Documentation Getting Help About

## Open PHD Guiding – Official Website for PHD2

PHD2 is telescope guiding software that simplifies the process of tracking a guide star, letting you concentrate on other aspects of deep-sky imaging or spectroscopy.

### Latest News

#### PHD2 v2.6.4 Released

Head to [Downloads](#) for the installation files and release details.

#### PHD2 Best Practices

Bruce and Andy have compiled a list of best practices for PHD2. These aren't "must-do's", but they represent lessons learned from both personal experience and from analyzing hundreds of log files covering a wide range of equipment configurations.

Download PDF: [English](#) [Français](#)

#### PHD2\_Broker package available

Bruce has contributed a new PHD2\_Broker package that lets you use PHD2 with the latest CCD Autopilot automation package (v



# Guiding med PHD2

The screenshot displays the PHD2 Guiding 2.6.2 interface. The main window shows a blurry star field. On the right, the 'Star Profile' window displays a red line graph with a peak and a 'Mid row FWHM: -11.00' value. Below it, the 'Target' window shows a control panel with a 'Radius: 2.0' and a 'Reference Circle' option. The 'History' window at the bottom features a table with columns for RA, Dec, and GuideEast/Dec, and a control bar with 'RA: Agr 70', 'Hys 10', 'MnMo 0.21', 'DEC: Agr 00', 'MnMo 0.21', 'Scope: Mx RA 250C', 'Mx DEC 250C', and 'Auto'.

RA	Dec	GuideNorth	GuideEast
3"	3"		
2"	2"		
1"	1"		
-1"	-1"		
-2"	-2"		
-3"	-3"		

Her ser mit CMOS kamera gennem Guide-scope, men billedet er uskarpt

# Guiding med PHD2

The screenshot displays the PHD2 Guiding 2.6.2 interface. The main window shows a star field with a red circle highlighting a selected star. The interface includes several panels:

- Star Profile:** Shows a graph of the star's profile with a peak of 1.05 and a mid-row FWHM of 2.55. The HFD is 4.99 at 13.55".
- Target:** Shows a reference circle with a radius of 2.0 and a target position.
- History:** A table showing the guiding history with columns for RA, Dec, and GuideTime.
- Control Panel:** Includes settings for RA and Dec (Agn, Hys, MnMo), Scope (Mx RA, Mx DEC), and Auto.
- Status Bar:** Shows SNR 21.2, BPM, Cal, and a green indicator light.

RA	Dec	GuideTime
3"	3"	
2"	2"	
1"	1"	
-1"	-1"	
-2"	-2"	
-3"	-3"	

Så er der stillet skarpt og PHD2 har fundet en stjerne, som den kan fastholde (Tracking)



# Guiding med PHD2

The screenshot displays the PHD2 Guiding 2.6.2 interface. The main window shows a star field with a target star centered in a red circle. The Star Profile panel on the right shows a graph of the star's profile with a peak at 218 and a mid-row FWHM of 3.22. The HFD is displayed as 3.60. The Target panel shows a reference circle with a radius of 2.0. The History panel at the bottom shows a table of guiding data with columns for RA, Dec, and GuideNorth/GuideEast. The RMS Error is 0.00. The bottom status bar shows SNR 19.8 and BPM Cal.

PHD2 Guiding 2.6.2 - Lyngvad  
File Tools View Darks Bookmarks Help

Star Profile  
Peak 218  
Mid row FWHM: 3.22  
HFD: 3.60 9.77"

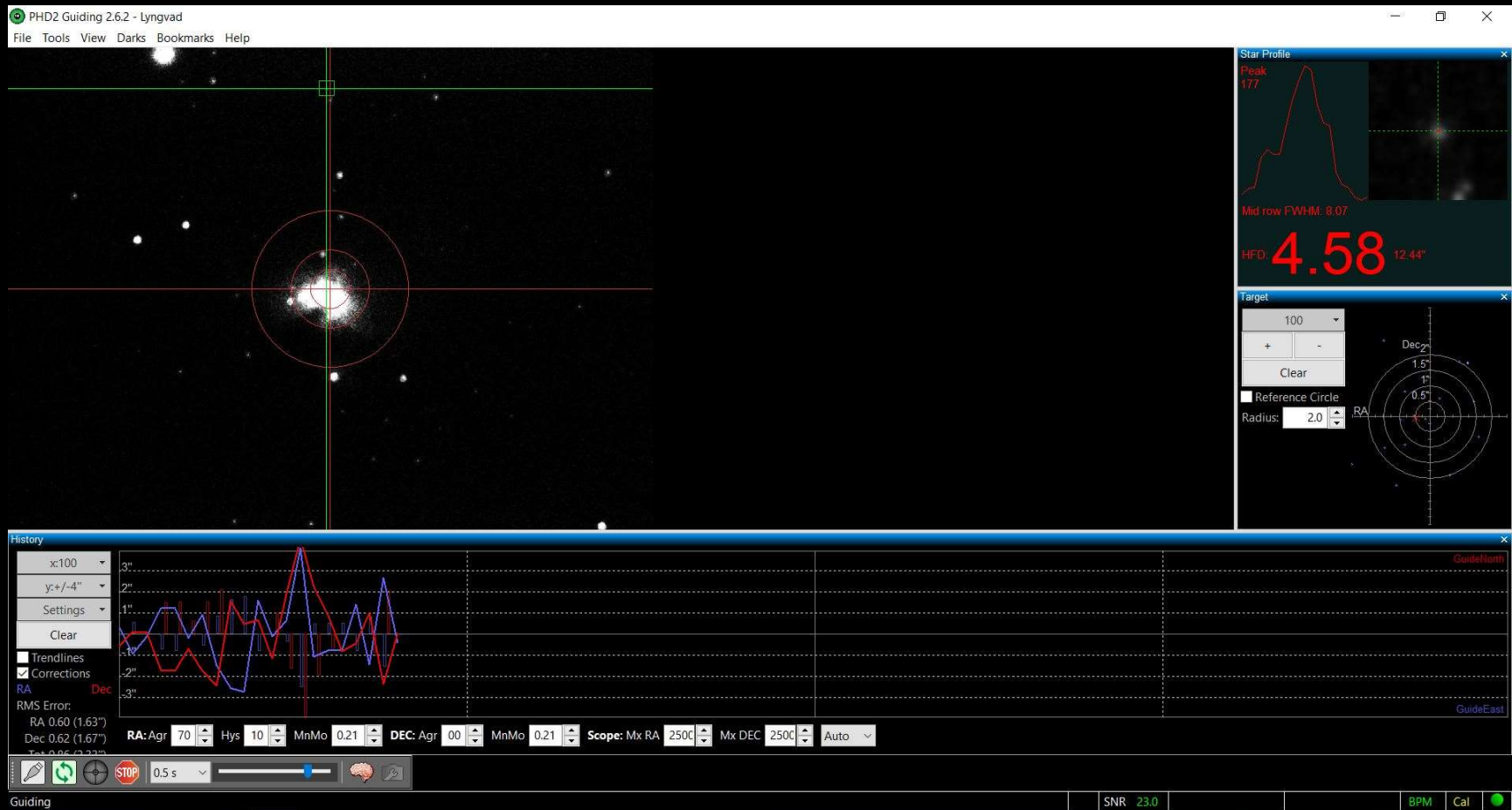
Target  
100  
+ -  
Clear  
Reference Circle  
Radius: 2.0

History  
x100  
y: +/- 4"  
Settings  
Clear  
Trendlines  
Corrections  
RA Dec  
RMS Error:  
RA 0.00  
Dec 0.00  
RA: Agr 70 Hys 10 MnMo 0.21 DEC: Agr 00 MnMo 0.21 Scope: Mx RA 2500 Mx DEC 2500 Auto  
0.5 s

West step 7, dist=11.0 | SNR 19.8 | BPM Cal

PHD2 kalibrerer ved at undersøge hvor meget stjerne vandrer over tid

# Guiding med PHD2



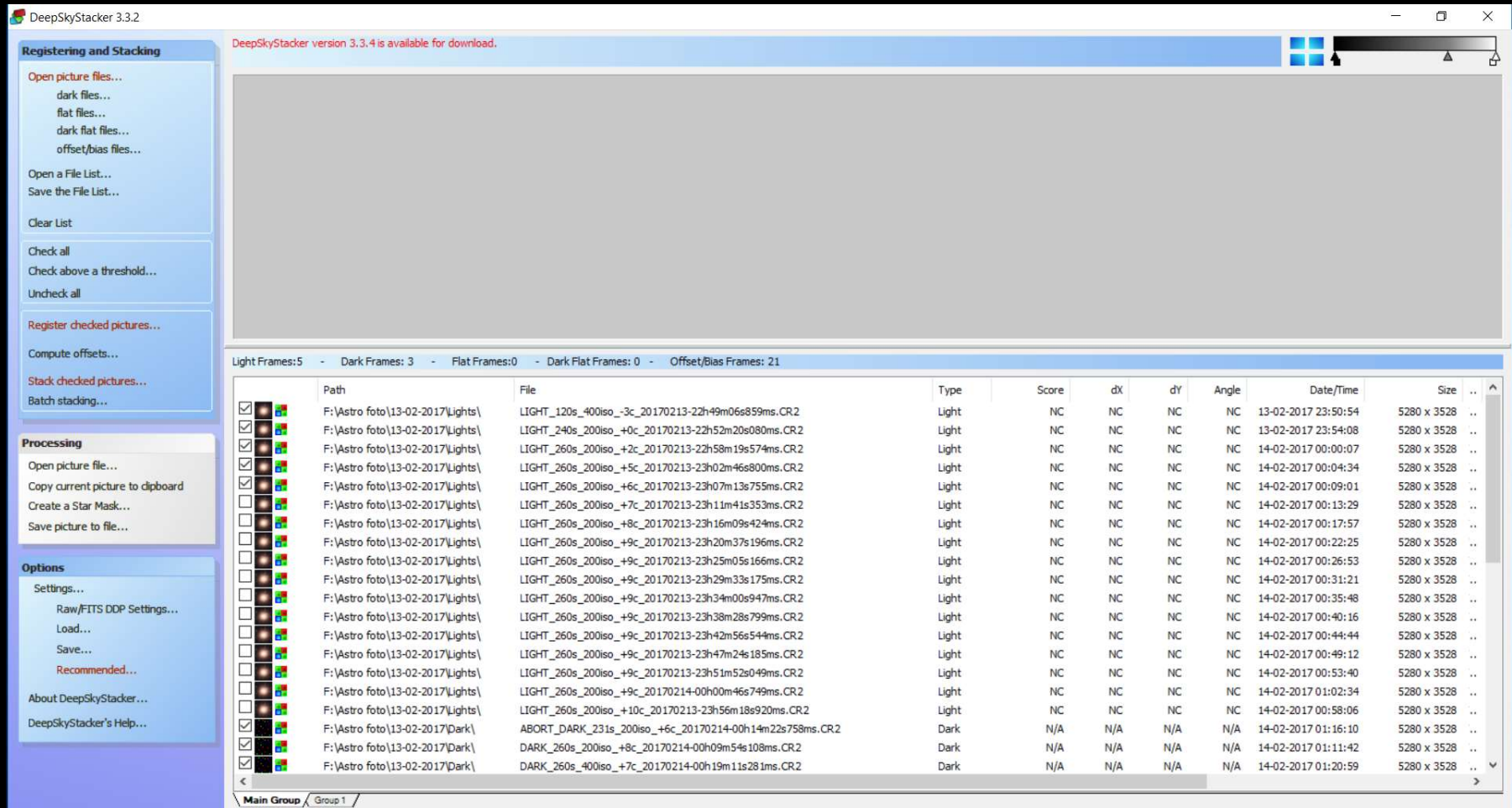
Kalibrering afsluttet og programmet fastholder nu stjernen  
PHD2 søger hele tiden for at finjustere teleskopets bevægelser

# Guiding med PHD2



Her ses en optagelse på 260 sek (>4 min) af M51a  
Spiralarmene træder kun svagt frem

# Efterbehandling af billeder



DeepSkyStacker 3.3.2

DeepSkyStacker version 3.3.4 is available for download.

Light Frames: 5 - Dark Frames: 3 - Flat Frames: 0 - Dark Flat Frames: 0 - Offset/Bias Frames: 21

	Path	File	Type	Score	dX	dY	Angle	Date/Time	Size	
<input checked="" type="checkbox"/>	F:\Astro foto\13-02-2017\Lights\	LIGHT_120s_400iso_-3c_20170213-22h49m06s859ms.CR2	Light	NC	NC	NC	NC	13-02-2017 23:50:54	5280 x 3528	..
<input checked="" type="checkbox"/>	F:\Astro foto\13-02-2017\Lights\	LIGHT_240s_200iso_+0c_20170213-22h52m20s080ms.CR2	Light	NC	NC	NC	NC	13-02-2017 23:54:08	5280 x 3528	..
<input checked="" type="checkbox"/>	F:\Astro foto\13-02-2017\Lights\	LIGHT_260s_200iso_+2c_20170213-22h58m19s574ms.CR2	Light	NC	NC	NC	NC	14-02-2017 00:00:07	5280 x 3528	..
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<input checked="" type="checkbox"/>	F:\Astro foto\13-02-2017\Lights\	LIGHT_260s_200iso_+6c_20170213-23h07m13s755ms.CR2	Light	NC	NC	NC	NC	14-02-2017 00:09:01	5280 x 3528	..
<input checked="" type="checkbox"/>	F:\Astro foto\13-02-2017\Lights\	LIGHT_260s_200iso_+7c_20170213-23h11m41s353ms.CR2	Light	NC	NC	NC	NC	14-02-2017 00:13:29	5280 x 3528	..
<input type="checkbox"/>	F:\Astro foto\13-02-2017\Lights\	LIGHT_260s_200iso_+8c_20170213-23h16m09s424ms.CR2	Light	NC	NC	NC	NC	14-02-2017 00:17:57	5280 x 3528	..
<input type="checkbox"/>	F:\Astro foto\13-02-2017\Lights\	LIGHT_260s_200iso_+9c_20170213-23h20m37s196ms.CR2	Light	NC	NC	NC	NC	14-02-2017 00:22:25	5280 x 3528	..
<input type="checkbox"/>	F:\Astro foto\13-02-2017\Lights\	LIGHT_260s_200iso_+9c_20170213-23h25m05s166ms.CR2	Light	NC	NC	NC	NC	14-02-2017 00:26:53	5280 x 3528	..
<input type="checkbox"/>	F:\Astro foto\13-02-2017\Lights\	LIGHT_260s_200iso_+9c_20170213-23h29m33s175ms.CR2	Light	NC	NC	NC	NC	14-02-2017 00:31:21	5280 x 3528	..
<input type="checkbox"/>	F:\Astro foto\13-02-2017\Lights\	LIGHT_260s_200iso_+9c_20170213-23h34m00s947ms.CR2	Light	NC	NC	NC	NC	14-02-2017 00:35:48	5280 x 3528	..
<input type="checkbox"/>	F:\Astro foto\13-02-2017\Lights\	LIGHT_260s_200iso_+9c_20170213-23h38m28s799ms.CR2	Light	NC	NC	NC	NC	14-02-2017 00:40:16	5280 x 3528	..
<input type="checkbox"/>	F:\Astro foto\13-02-2017\Lights\	LIGHT_260s_200iso_+9c_20170213-23h42m56s544ms.CR2	Light	NC	NC	NC	NC	14-02-2017 00:44:44	5280 x 3528	..
<input type="checkbox"/>	F:\Astro foto\13-02-2017\Lights\	LIGHT_260s_200iso_+9c_20170213-23h47m24s185ms.CR2	Light	NC	NC	NC	NC	14-02-2017 00:49:12	5280 x 3528	..
<input type="checkbox"/>	F:\Astro foto\13-02-2017\Lights\	LIGHT_260s_200iso_+9c_20170214-00h00m46s749ms.CR2	Light	NC	NC	NC	NC	14-02-2017 01:02:34	5280 x 3528	..
<input type="checkbox"/>	F:\Astro foto\13-02-2017\Lights\	LIGHT_260s_200iso_+10c_20170213-23h56m18s920ms.CR2	Light	NC	NC	NC	NC	14-02-2017 00:58:06	5280 x 3528	..
<input checked="" type="checkbox"/>	F:\Astro foto\13-02-2017\Dark\	ABORT_DARK_231s_200iso_+6c_20170214-00h14m22s758ms.CR2	Dark	N/A	N/A	N/A	N/A	14-02-2017 01:16:10	5280 x 3528	..
<input checked="" type="checkbox"/>	F:\Astro foto\13-02-2017\Dark\	DARK_260s_200iso_+8c_20170214-00h09m54s108ms.CR2	Dark	N/A	N/A	N/A	N/A	14-02-2017 01:11:42	5280 x 3528	..
<input checked="" type="checkbox"/>	F:\Astro foto\13-02-2017\Dark\	DARK_260s_400iso_+7c_20170214-00h19m11s281ms.CR2	Dark	N/A	N/A	N/A	N/A	14-02-2017 01:20:59	5280 x 3528	..

Main Group / Group 1

DeepSkyStacker samler mange enkeltbilleder til et billede. Programmet er Freeware og desværre ikke særlig stabilt



# Efterbehandling af billeder



Ved at tage  $> 50$  billeder og samle til et billede (Stacking) øges detaljegraden

# Efterbehandling af billeder



Software som Photoshop eller Gimp kan gøre billederne utroligt detaljerede, men det tager lang tid at lære!

# Fotografering af solsystemets objekter



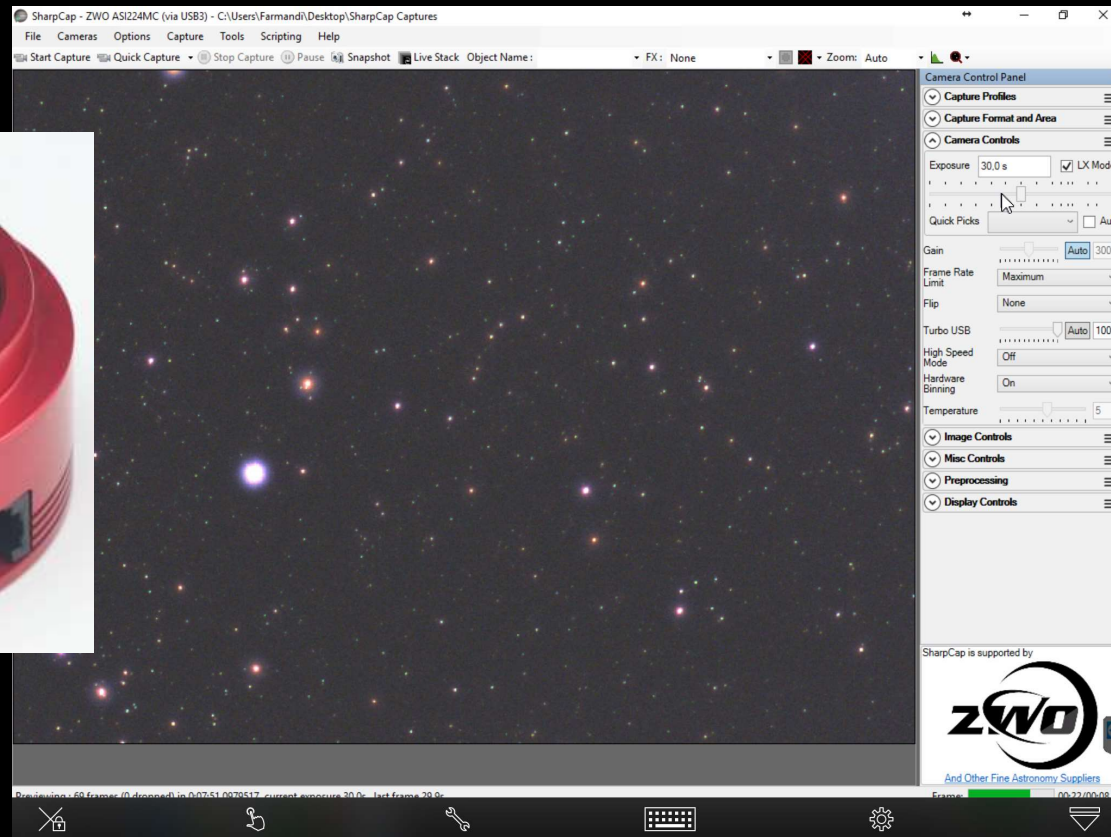


# Fotografering af solsystemets objekter





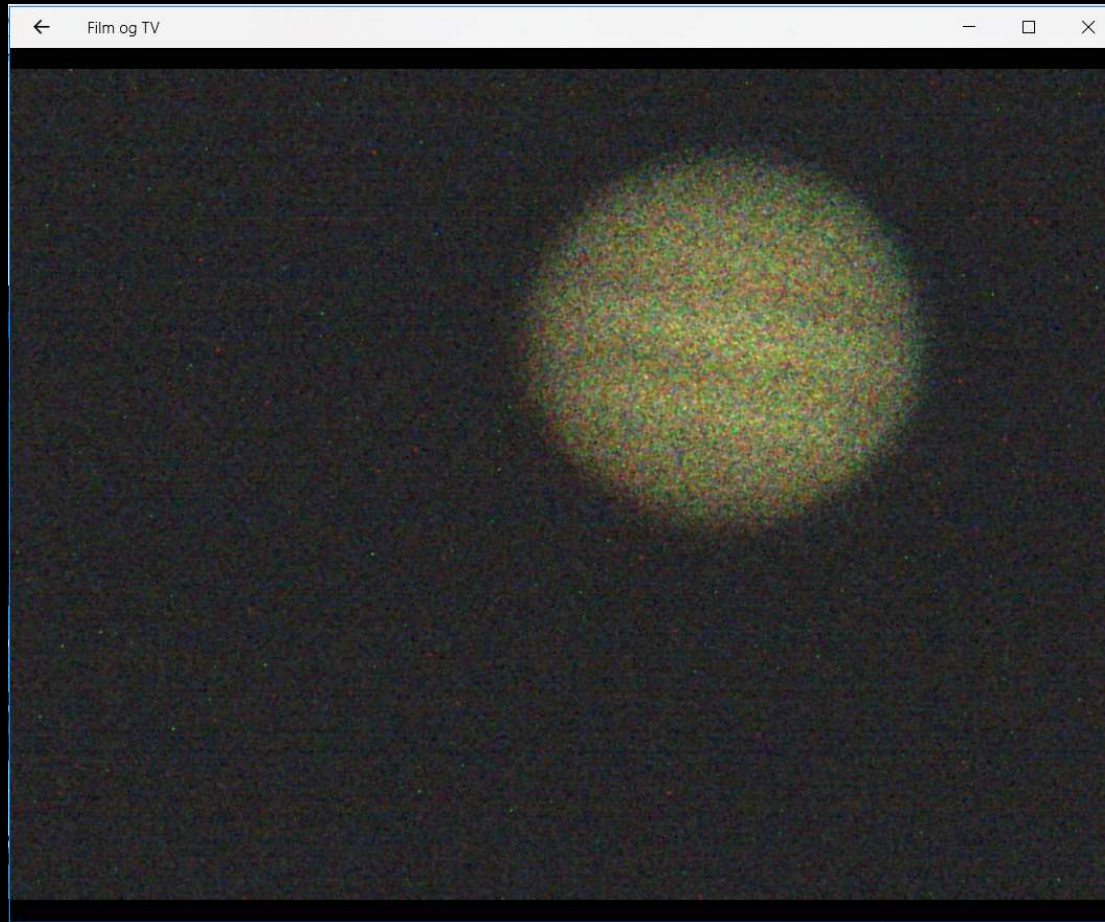
# Fotografering af solsystemets objekter



Et lille CMOS kamera er optimalt til fotografering af planeter, f.eks. dette fra ZWO

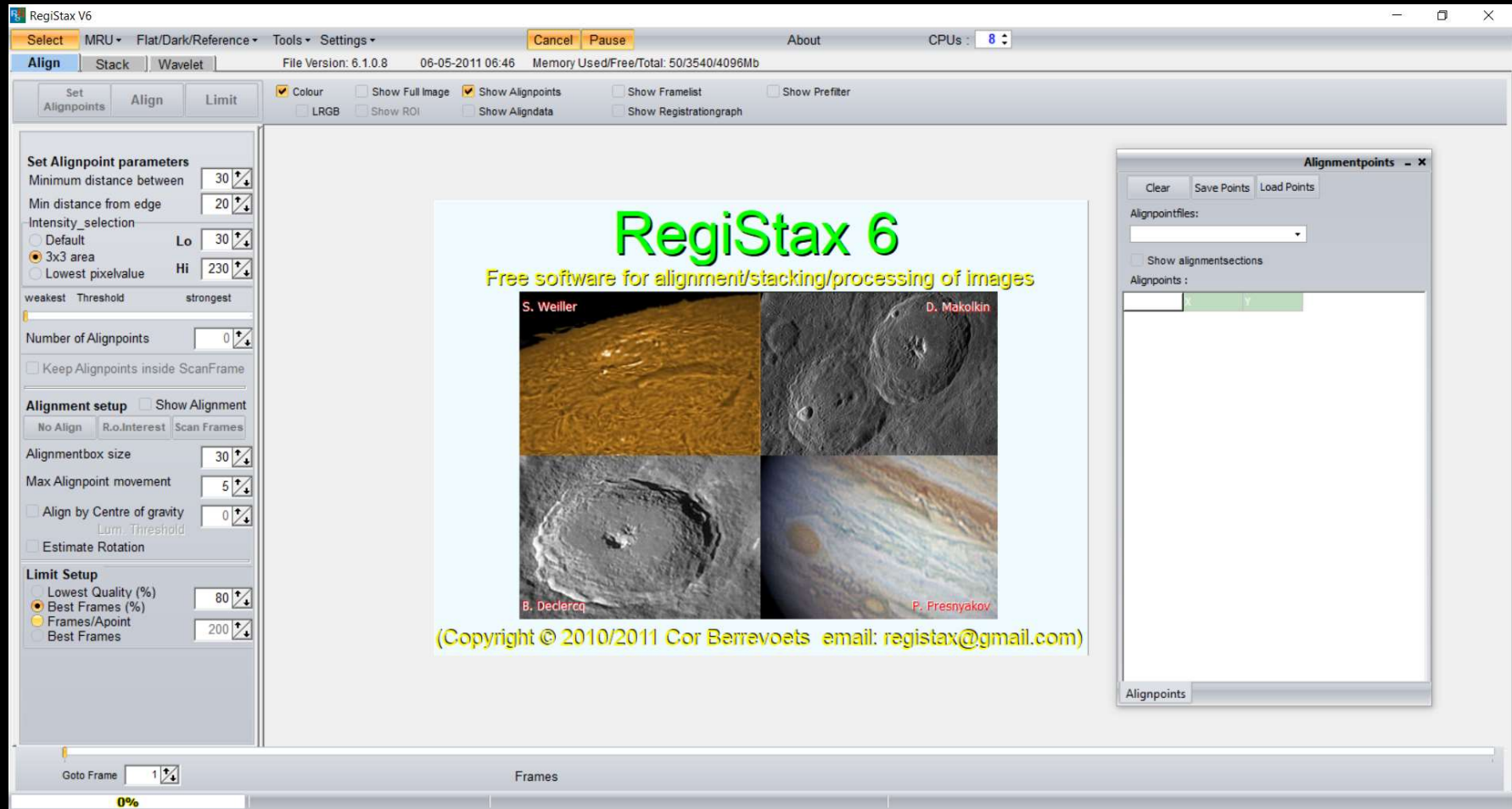
Det gratis program SharpCap bruges til kontrol af kameraet

# Fotografering af solsystemets objekter



Objektet filmes og de mange billeder, typisk flere tusinde samles til et billede (Lucky Shot)

# Fotografering af solsystemets objekter



Stacking og efterbehandling af billedet med foregår f.eks. med programmet RegiStax 6



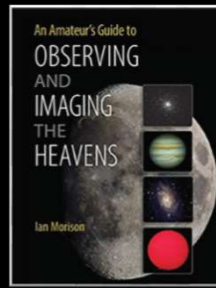
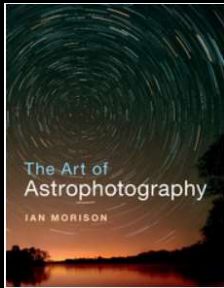
# PLANETARY IMAGING:



# INTRODUCTION



# Lær mere om astrofotografering?



## Litteratur:

Ian Morison  
Jesper Grønne



## Foreningerne:

Mest fokus på observatorieteknik

Google

You Tube

## On-line:

[astrobin.com](http://astrobin.com)

[amateurastrophotography.net](http://amateurastrophotography.net)

Youtube Kanaler:

Astrobackyard

Astronomy and Nature TV

The Astro Imaging Channel

Lonely Speck

Los Angeles Astronomical Society

SkyandTelescopeMedia



# Midtjysk Astronomiforening

Tak for opmærksomheden

