

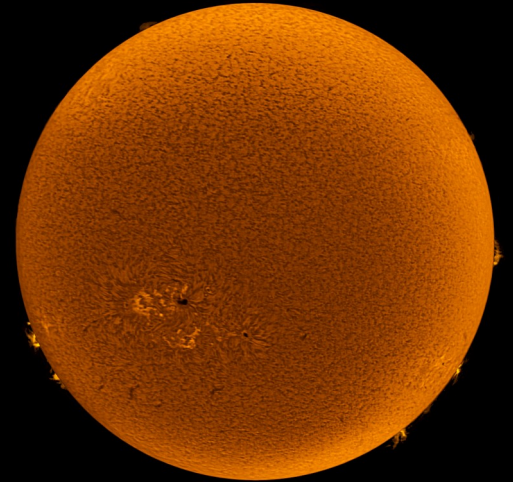
AAL / Eric Dondelinger



Amateur Astronomen
Lëtzebuerg

www.aal.lu

H-alpha solar pictures
using
the Coronado PST
and an
ASI 120MM Mini



Introduction

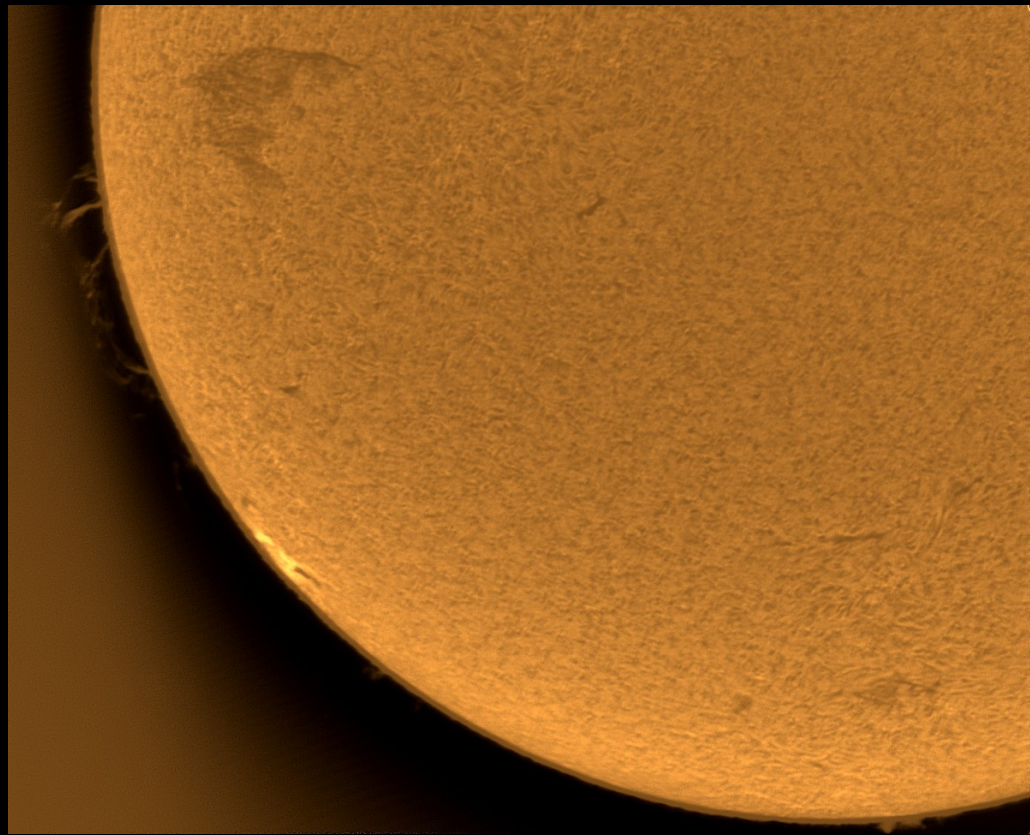
- Safe solar watching / imaging
 - Do not look into sun with remaining eye!
- White light
 - solar filter in front of telescope
 - Shows photosphere
- H-alpha
 - Shows chromosphere, 1 level above the photosphere
 - No simple, cheap way to it



2023-06-10

Contents

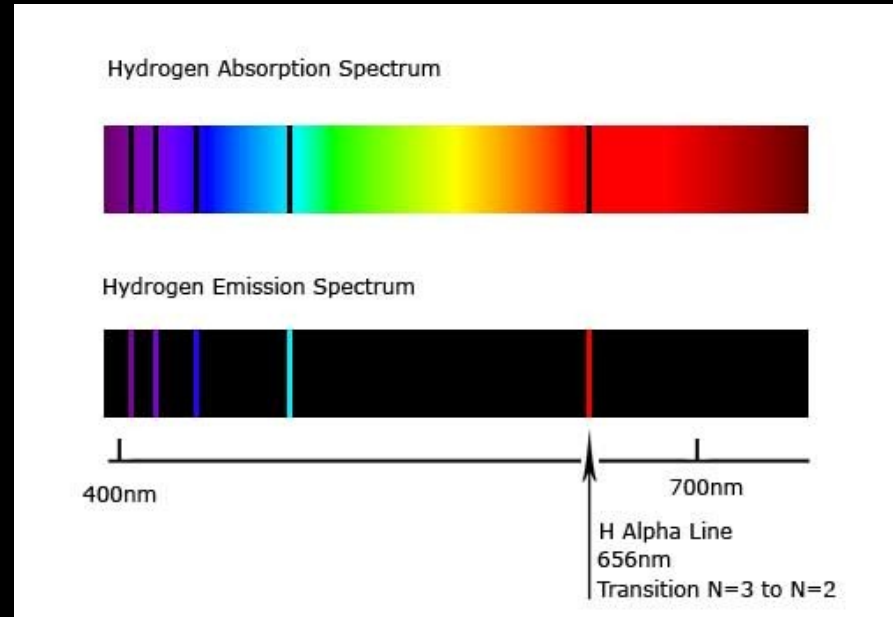
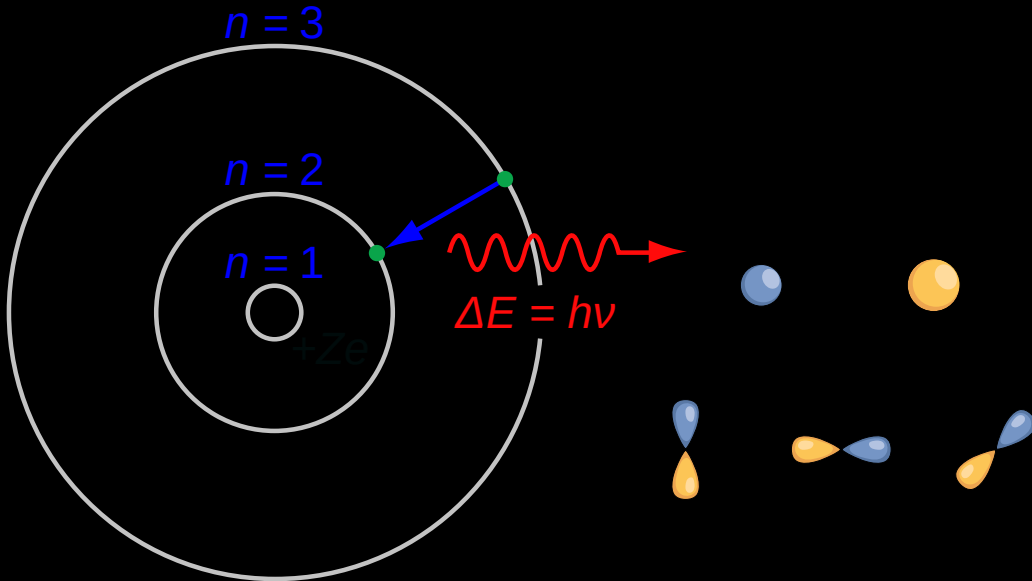
- What is h-alpha?
- Solar (H-alpha) Telescope
- Physical Setup
- Finding the Sun
- Capturing video (disc / rim, SharpCap)
- Generating flats
- Stacking the videos (AutoStakkert)
- Mosaic (fitswork or GIMP)
- Sharpening (Registax)
- Final processing (GIMP)



2021-08-21

h-alpha

- Excited hydrogen: electron on higher orbital (p)
- When electron falls back (to s), emits photon



Solar Telescope: Coronado PST



Coronado PST

Projection eyepiece

Eyepiece

Block Filter

T2 extension

ERF

Etalon

CORONADO

P.S.T.

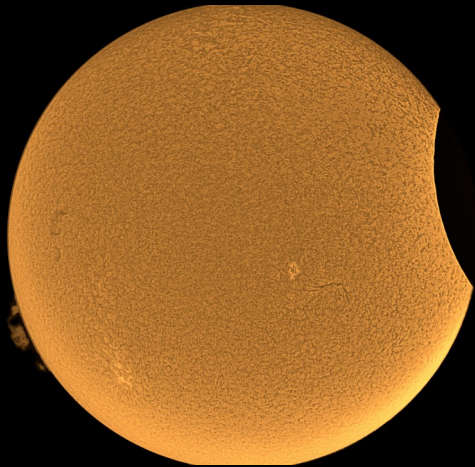
Pentaprism

Focuser box

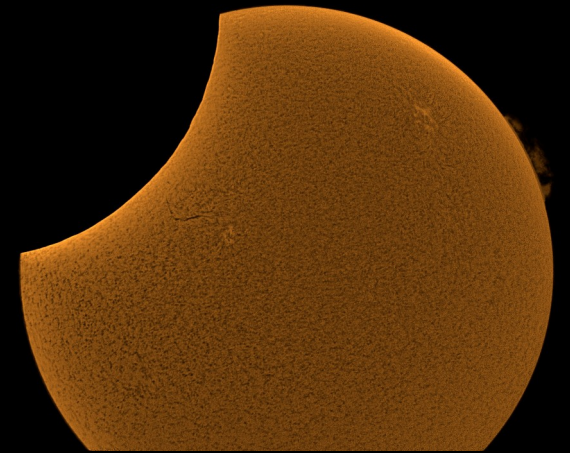
Lens tube

Important parts

- Energy rejection filter (ERF, rejects UV, IR)
- Etalon (band-pass mostly h-alpha)
- Blocking filter (blocks out-of-band wavelengths)



Partial eclipse
2021-06-10



Physical setup



- Mount Meade LXD75 (EQ, properly oriented to North to avoid drift!)
- Tripod head leftover
- Coronado PST
- Eyepiece
- Battery
- Laptop
- ASI 120MM Mini

Finding the Sun

- Use the shadow, Luke
- Solar finder integrated in the PST
- Put the bright spot slightly under the middle
- Mount: set lower speed
- Center the sun in the eyepiece



Capturing Video

- Replace the eyepiece by the ASI 120MM Mini, connect it to the laptop
- Avoid reflections on the laptop screen (sun shield, dark clothes) and turn the screen brightness up
- Start up SharpCap, activate the camera
- Slide the Camera far out to get into focus, fix it there.
- Fine focus using the PSTs focus screw at the back. Look at the rim or at sunspots.
- If necessary, adjust the etalon to maximize detail (i.e. protuberances)

Camera setup, focusing



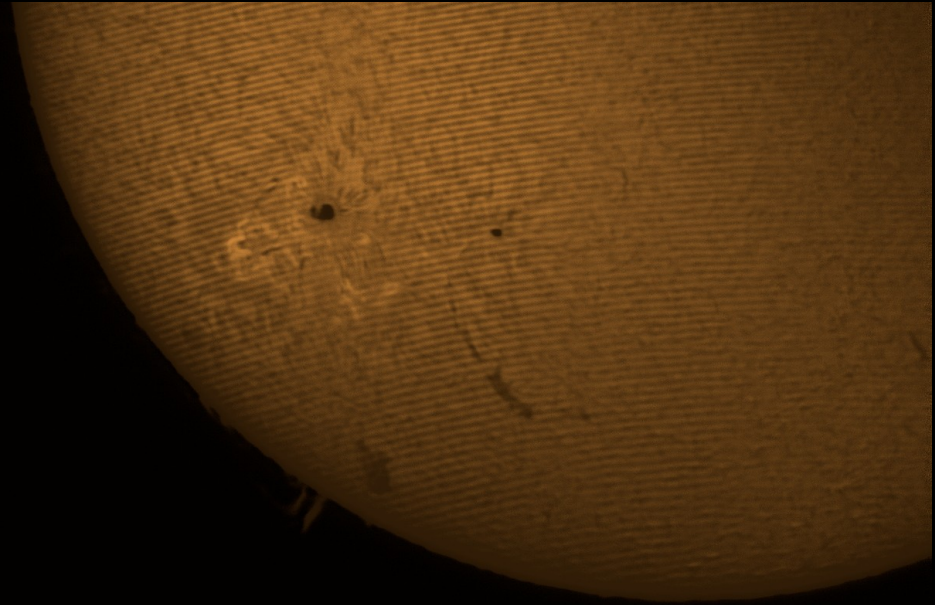
Useful settings

- Max resolution, MONO16, binning=1 (none)
- Surface: gain 50, exposure 1ms, brightness
- Rim: turn the exposure up to 4ms
- e.g. 500 frames per video for surface, rim
- e.g. 50 frames for flats
- PST + ASI120 will not show the entire sun, so try for 4 quarters of the sun (surface + flat + rim (+ flat)). 2 halves may suffice
- In my experience, it is more hassle than useful to use flats for the rim.

If you don't use flats...



2020-11-07



2020-11-26

you'll get
Newton rings

Flats

- The ASI120MM Mini produces newton rings when combined with the PST
- Generate flats to remove them on stacking
- Put clear plastic in front of the PST and capture some frames, e.g. 50



Stacking (AutoStakkert)

- Start with the flats: open video, generate master frame, save as TIF
- Settings for surface, with sharpening, e.g. 20% frames
- Open video for surface, load corresponding flat (under image calibration menu).
- Mark “interesting” region (ctrl-left click), analyse.
- Distribute anchors (automatic) via “place AP grid”
- Stack
- Unload flat before running next video

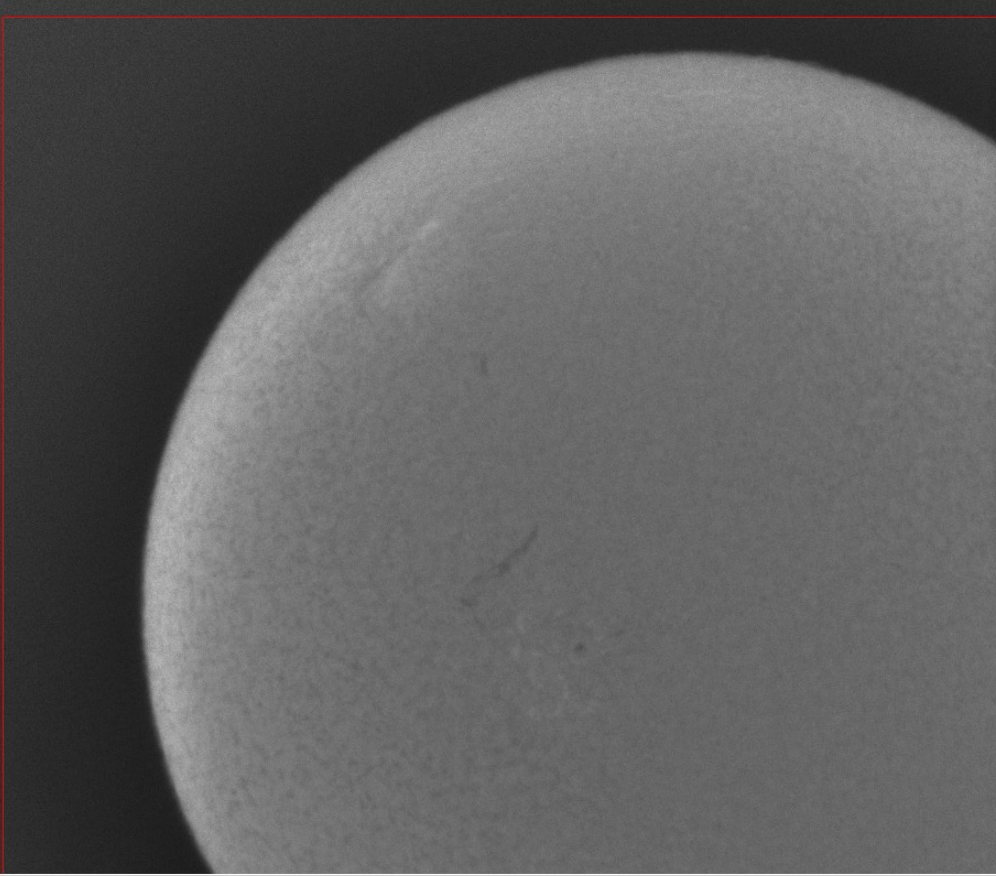
11_12_18.ser Done

Frames Scaling (FIT / SER) Auto Display Options Brightness 1 x Export Frame(s)

Image Size Width 1304 Height 968 Visualisation Draw AP's Range 16 bit(A) Does NOT alter data! As displayed here

offset: 11, 3 remember

Sr F# 143 [1/502] top 0.0 %
Q 100.0% 215.3 gray
Zoom 100%
Alignment Points 0 APs
 Manual Draw
Click in image to add an alignment point
AP Size 96 24 48 104 200
Auto AP
Min Bright 5
 Replace Multi-Scale



AutoStakker! 3.0.14 (x64) - free for non-commercial use © Emil Kraaikamp 2009-2017

File Memory Usage Color Advanced Image Calibration Help

1) Open Expand Limit Frames Cores 8 / 8 SSE2

Status Mem. usage 17.8 % (used 1529 available 7057 MB) buffering, fit Done!

Image Stabilization
 Surface Planet (COG)
 Improved Tracking
 Expand Cropped

Quality Estimator
 Laplace Δ
 Noise Robust 4 Normal range
 Local (AP) Global (Frame)

2) Analyse

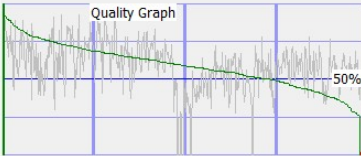
Reference Frame
 Double Stack Reference
 Auto size (quality based)
 Frames

Stack Options
 TIF PNG FIT
 Number of frames to stack: 0 0 0 0 #
 Frame percentage to stack: 20 0 0 0 %
 Sharpened Blend RAW in for 50 %
 RGB Align
 Save in Folders

Stack(name) Options
 Free field

Advanced Settings
 Drizzle Off 1.5 X 3.0 X
 Resample 2.0 X

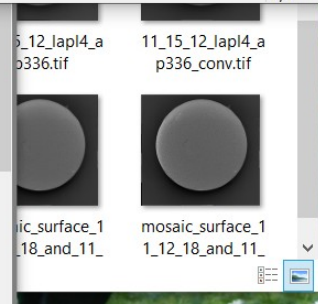
3) Stack

Quality Graph


Cancel...

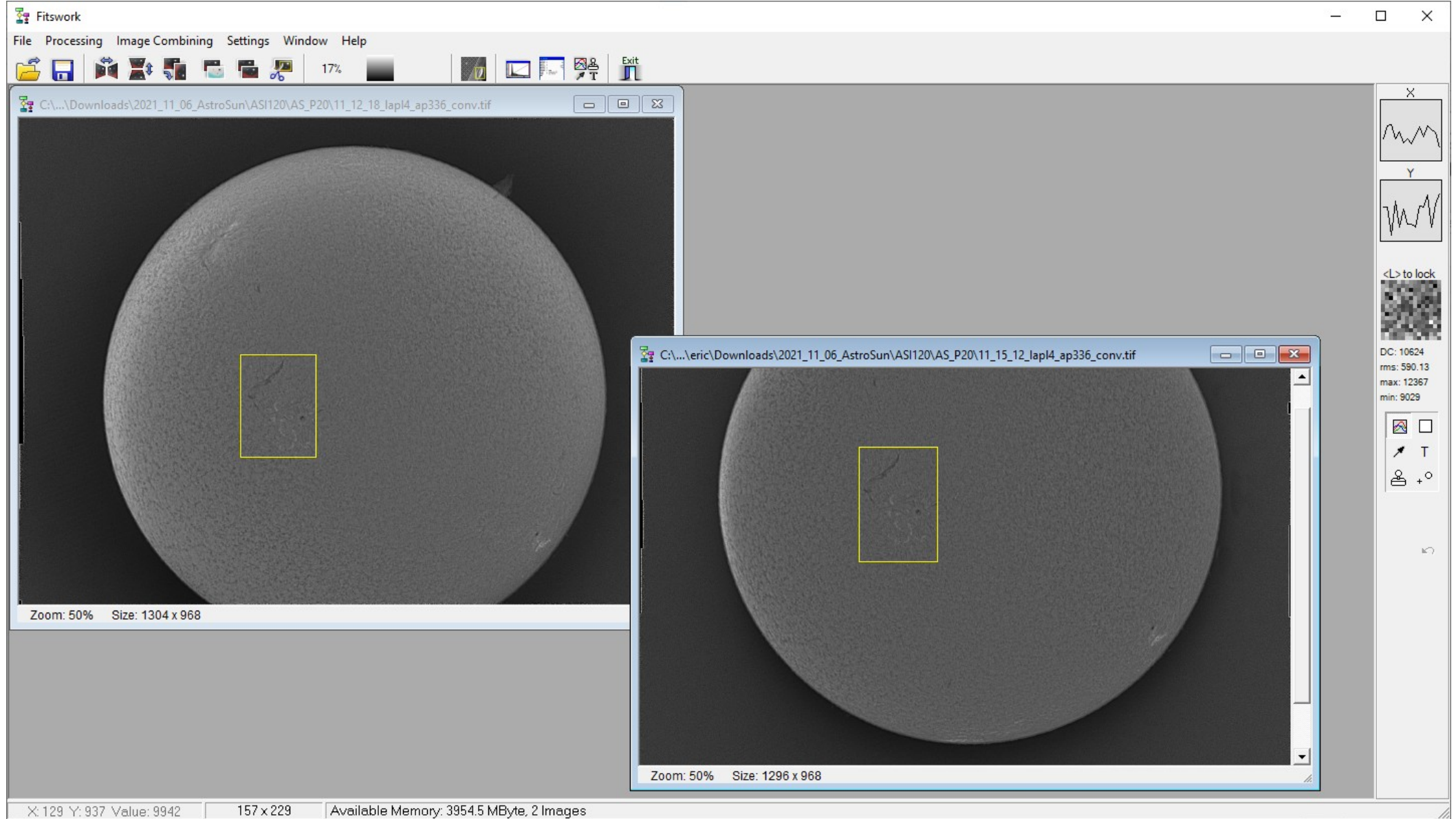
#F 502 16 bpp 11_12_18.ser Done 1/1

11_12_lapl4_a p336.tif
 11_15_12_lapl4_a p336_conv.tif
 ic_surface_1 18_and_11_
 mosaic_surface_1 1_12_18_and_11_



Mosaic in fitswork

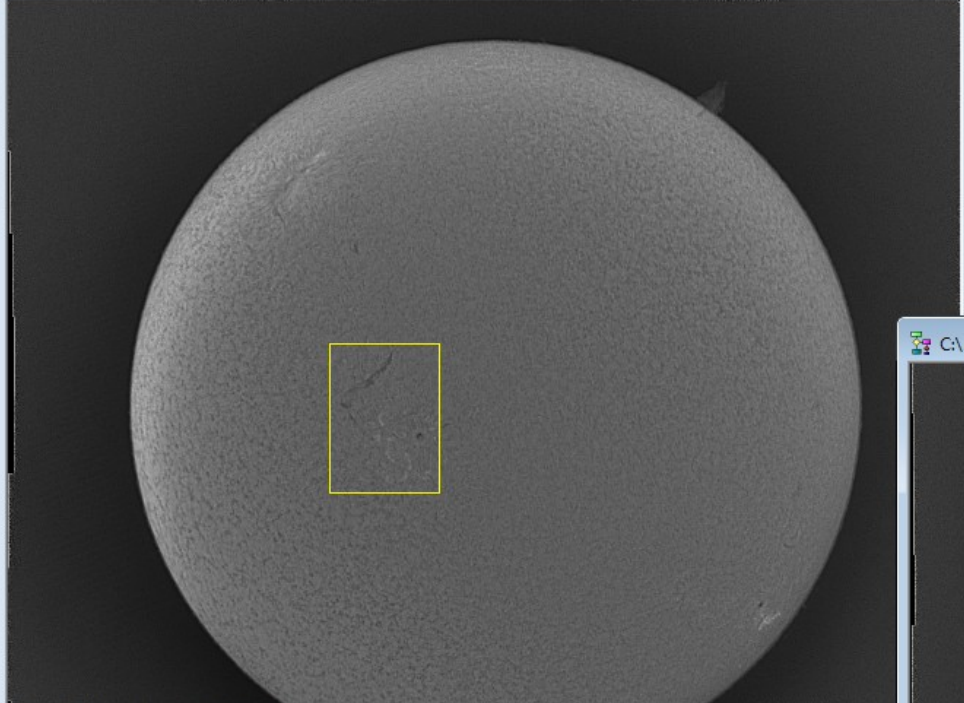
- Open the 2 pictures you want to stitch
- Mark common parts
- use Image Combining / Make Mosaic
- Accept “Should I adjust the Contrast?”
- If the result is not good, try from scratch, be more careful about marking the common parts



File Processing Image Combining Settings Window Help

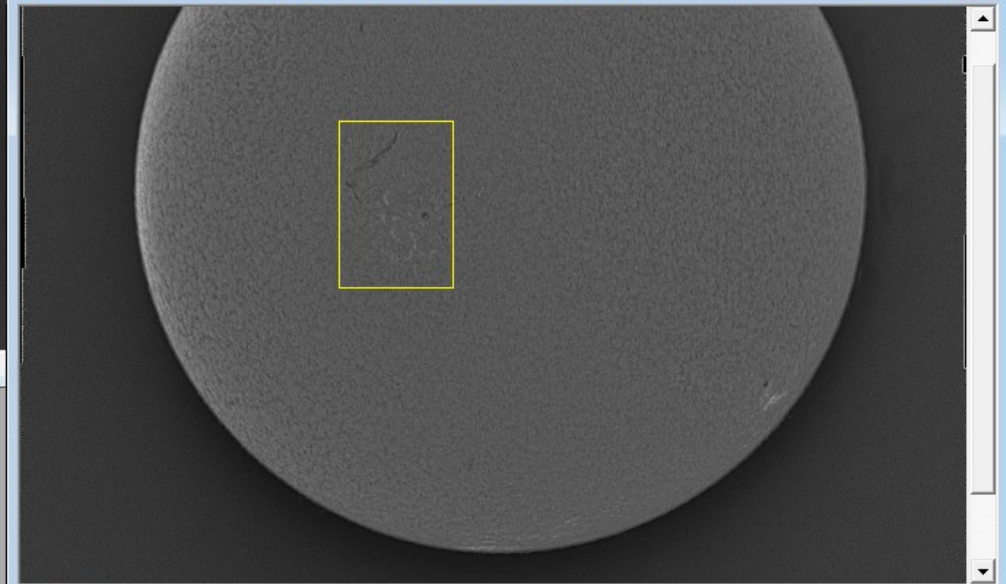


C:\...\Downloads\2021_11_06_AstroSun\ASI120\AS_P20\11_12_18_lapI4_ap336_conv.tif



Zoom: 50% Size: 1304 x 968

C:\...\eric\Downloads\2021_11_06_AstroSun\ASI120\AS_P20\11_15_12_lapI4_ap336_conv.tif

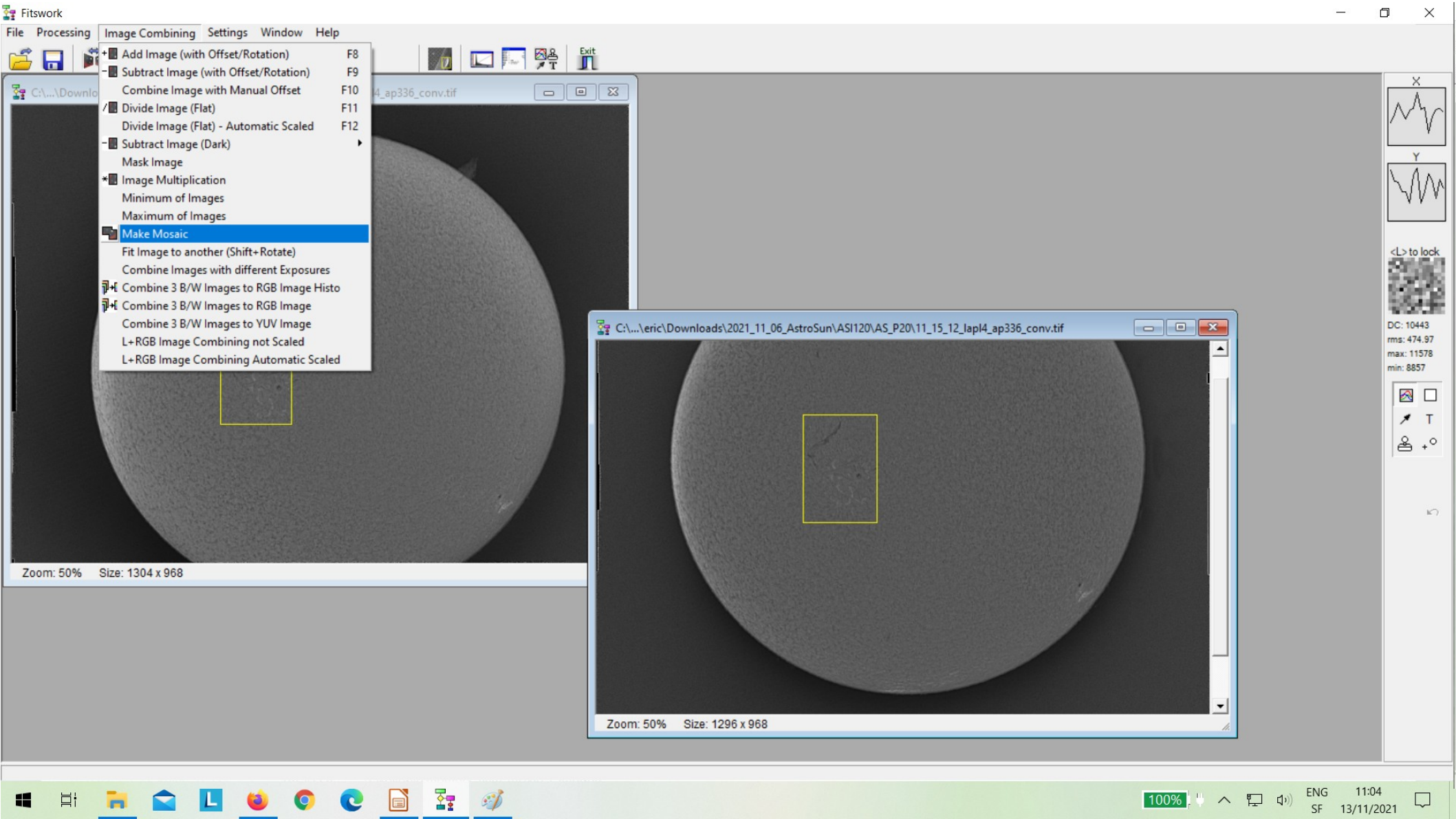


Zoom: 50% Size: 1296 x 968

X
Y
<L> to lock

DC: 10624
rms: 590.13
max: 12367
min: 9029

X: 129 Y: 937 Value: 9942 157 x 229 Available Memory: 3954.5 MByte, 2 Images



- + Add Image (with Offset/Rotation) F8
- Subtract Image (with Offset/Rotation) F9
- Combine Image with Manual Offset F10
- / Divide Image (Flat) F11
- Divide Image (Flat) - Automatic Scaled F12
- Subtract Image (Dark)
- Mask Image
- * Image Multiplication
- Minimum of Images
- Maximum of Images
- Make Mosaic**
- Fit Image to another (Shift+ Rotate)
- Combine Images with different Exposures
- Combine 3 B/W Images to RGB Image Histo
- Combine 3 B/W Images to RGB Image
- Combine 3 B/W Images to YUV Image
- L+RGB Image Combining not Scaled
- L+RGB Image Combining Automatic Scaled

Zoom: 50% Size: 1304 x 968

C:\...eric\Downloads\2021_11_06_AstroSun\ASI120\AS_P20\11_15_12_lap4_ap336_conv.tif

Zoom: 50% Size: 1296 x 968

X

Y

<L> to lock

DC: 10443
rms: 474.97
max: 11578
min: 8857

Sharpening (Registax)

- Optional: results are not good with the 120MM, but may be for other cameras
- Open your mosaic file, registax goes straight to wavelets
- Set values for the wavelet layers
- “do all”, after that is done “save image”
- Possible alternatives: ImPPG, AstroSurface

Process Do All Save image Realign_with Processed Stack Again

Show Full Image Show Processing Area

Show AlignPoints

Wavelets Reset Wavelets

Automatic

Hold Wavelet Setting

Waveletscheme

Dyadic (2^n) Linear

Initial Layer: 1 Step Increment: 0

Wavelet filter

Default Gaussian

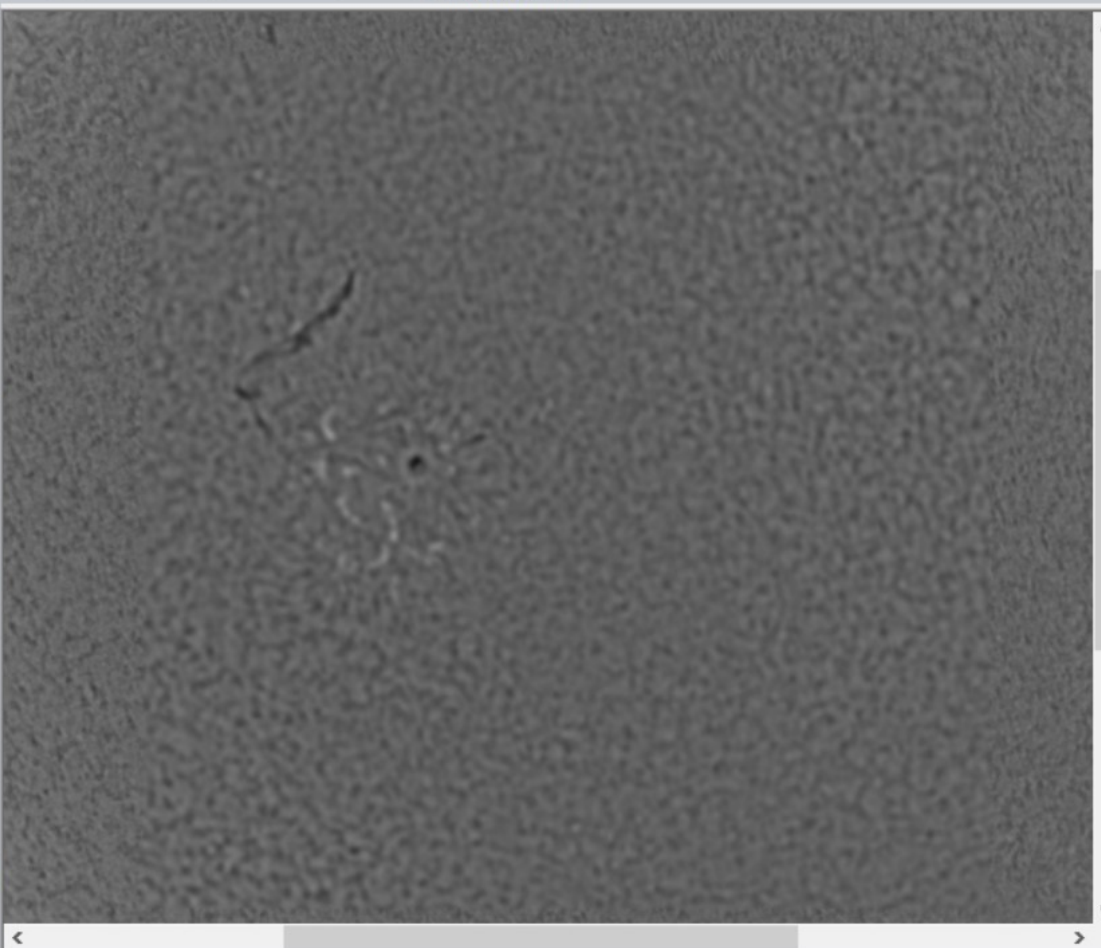
Use Linked Wavelets

Layer	Denoise	Sharpen	Preview
<input checked="" type="checkbox"/> 1	0,00	0,100	1.0
<input checked="" type="checkbox"/> 2	0,50	0,100	80,4
<input checked="" type="checkbox"/> 3	0,40	0,100	70,5
<input checked="" type="checkbox"/> 4	0,30	0,100	60,7
<input checked="" type="checkbox"/> 5	0,20	0,100	50,3
<input checked="" type="checkbox"/> 6	0,10	0,100	40,4

Available schemes

05_80.nrw

Load Scheme Save Scheme



Functions

Histogram	Gamma	Colour Mixing
View Zoomed	View Compare	View Stacksize
Flip and Rotate	RGB Align	RGB Balance
Resize Image	Denoise/Deringing	Wavelet Filter
Masking	Show Linegraph	Cropping Area

Contrast/Brightness Hold Reset

Contrast: 100 Brightness: 0

Copy To Load to Difference

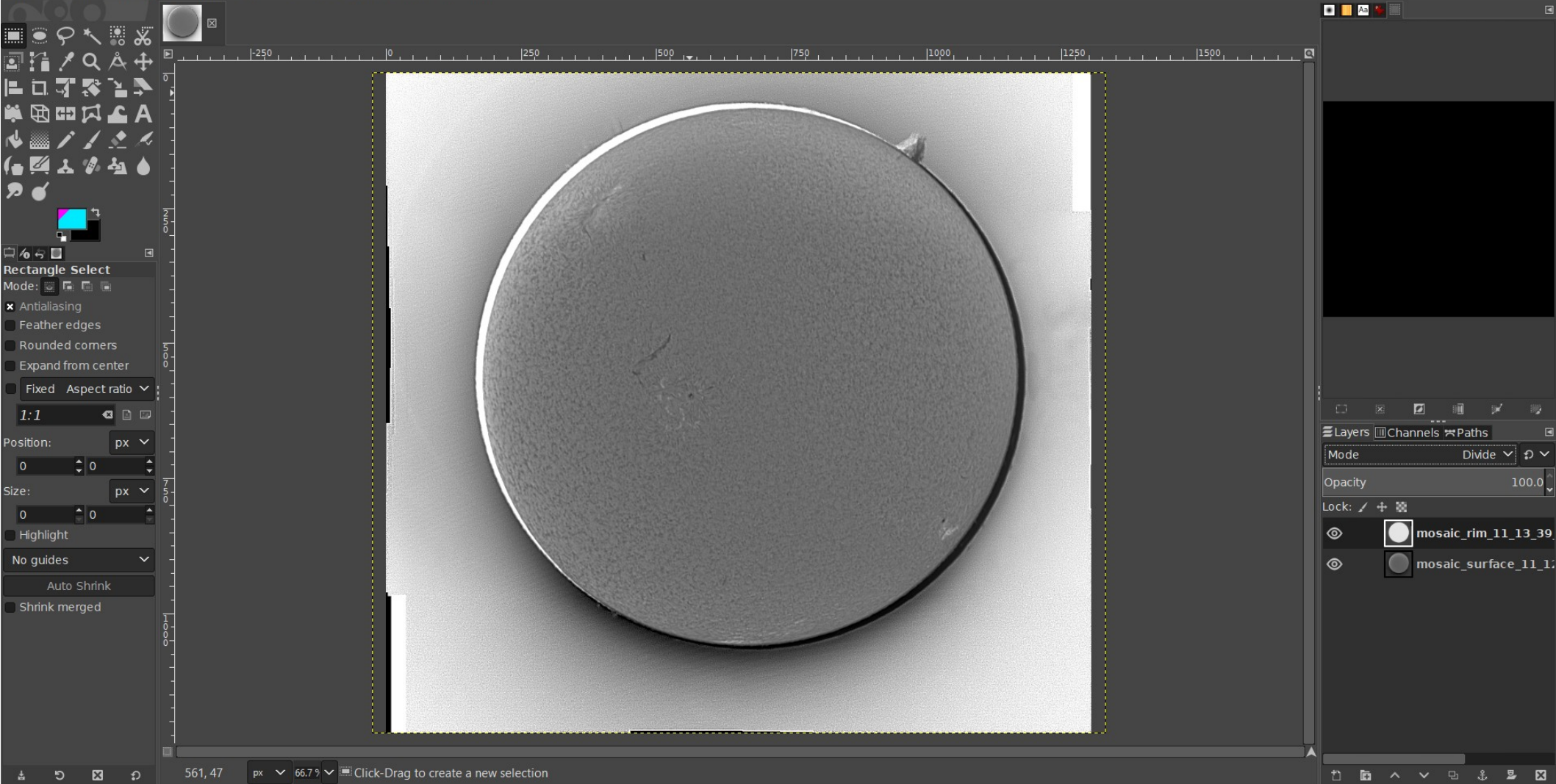
Toggle

Current Image

Clipboard Image

Final Processing (GIMP)

- Open e.g. your “surface” mosaic in GIMP
- Open as layer for the “rim” mosaic
- Set that layer e.g. to “divide”. You’ll see the disalignment between the layers. Move the layer so they align (mouse + fine-tuning via cursor keys)



Rectangle Select
Mode:

Antialiasing
 Feather edges
 Rounded corners
 Expand from center
 Fixed Aspect ratio
1:1

Position: px
0 0

Size: px
0 0

Highlight
No guides
Auto Shrink
 Shrink merged

Layers Channels Paths

Mode Divide

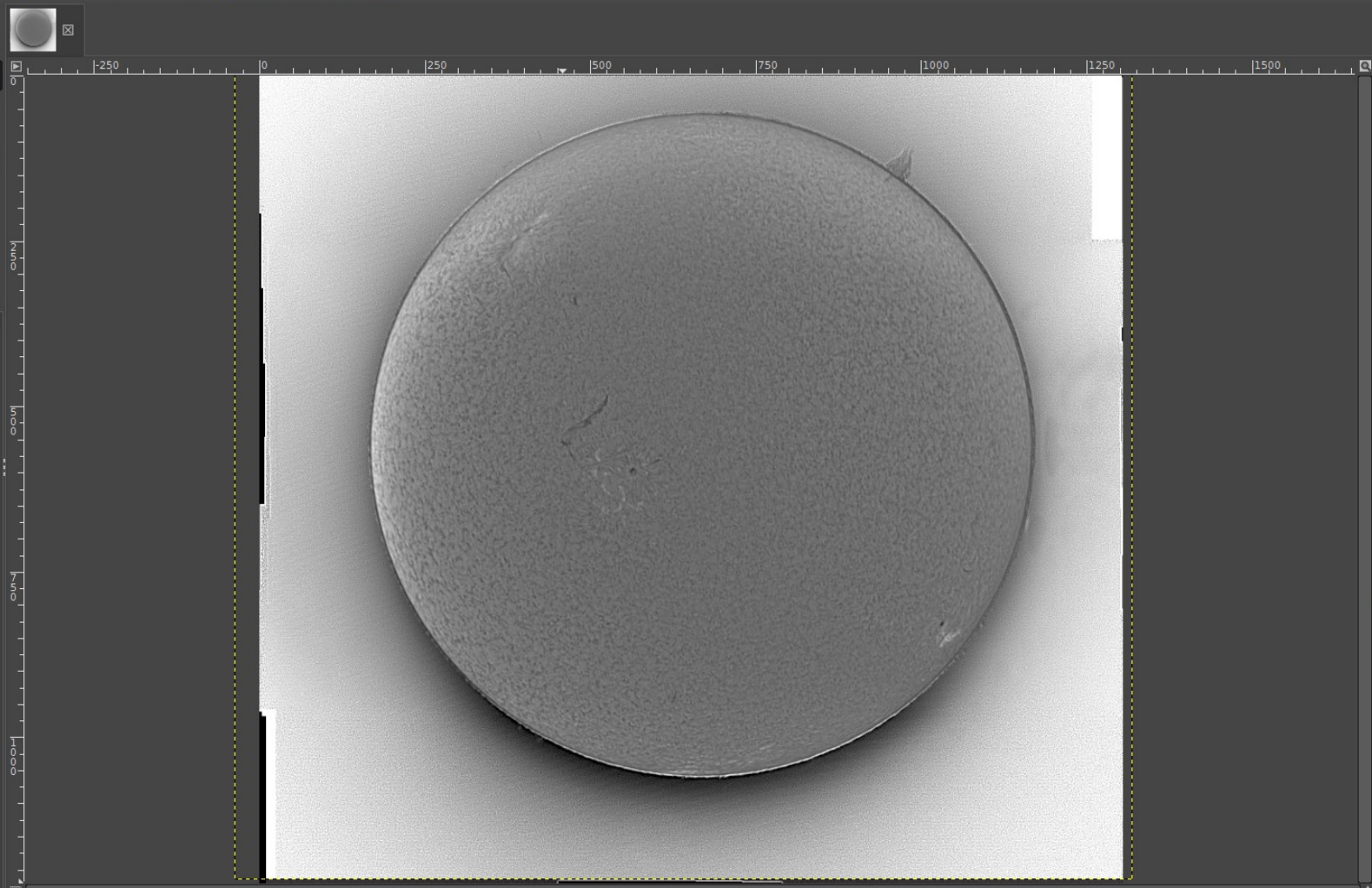
Opacity 100.0

Lock:

- mosaic_rim_11_13_39
- mosaic_surface_11_1...



Move
Move: [icon] [icon]
Tool Toggle (Shift)
● Pick a layer or guide
● Move the active layer



The Layers panel on the right side of the interface shows two layers. The top layer is named 'mosaic_rim_11_13_39' and is currently selected. The bottom layer is named 'mosaic_surface_11_12_18_and_11_15_12'. The panel also shows the Mode set to 'Divide' and Opacity set to 100.0.

Final processing (GIMP) (2)

- On rim layer, select the surface, cut out (only the rim remains)
- On surface layer, invert the selection, cut out (only the surface remains)
- For precise selection, zoom in, look only at the current layer
- Set the rim layer to “addition”
- Remove selection



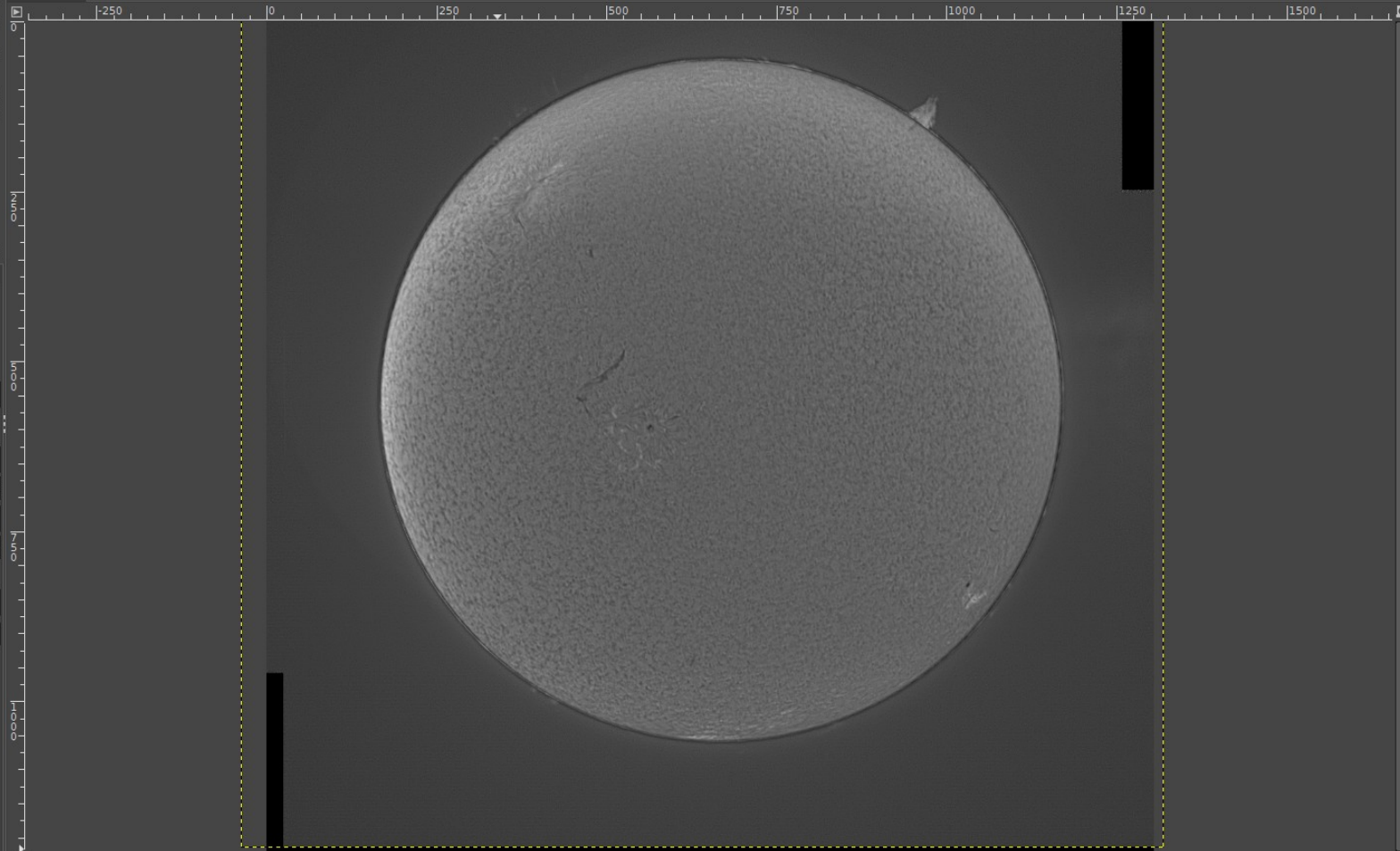
Ellipse Select
Mode:

Antialiasing
 Feather edges
 Expand from center
Fixed Aspect ratio ▼
1:1

Position: px ▼
166 56

Size: px ▼
1005 1003

Highlight
No guides ▼
Auto Shrink
 Shrink merged



Layers Channels Paths

Mode Addition ▼

Opacity 100.0 ▲ ▼

Lock:

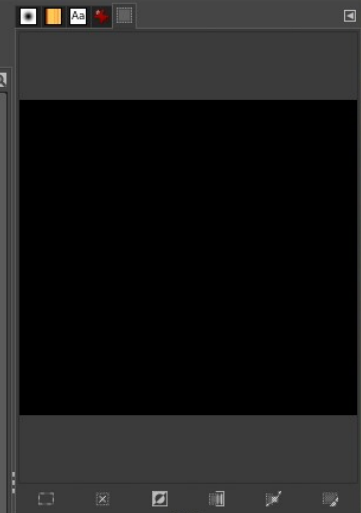
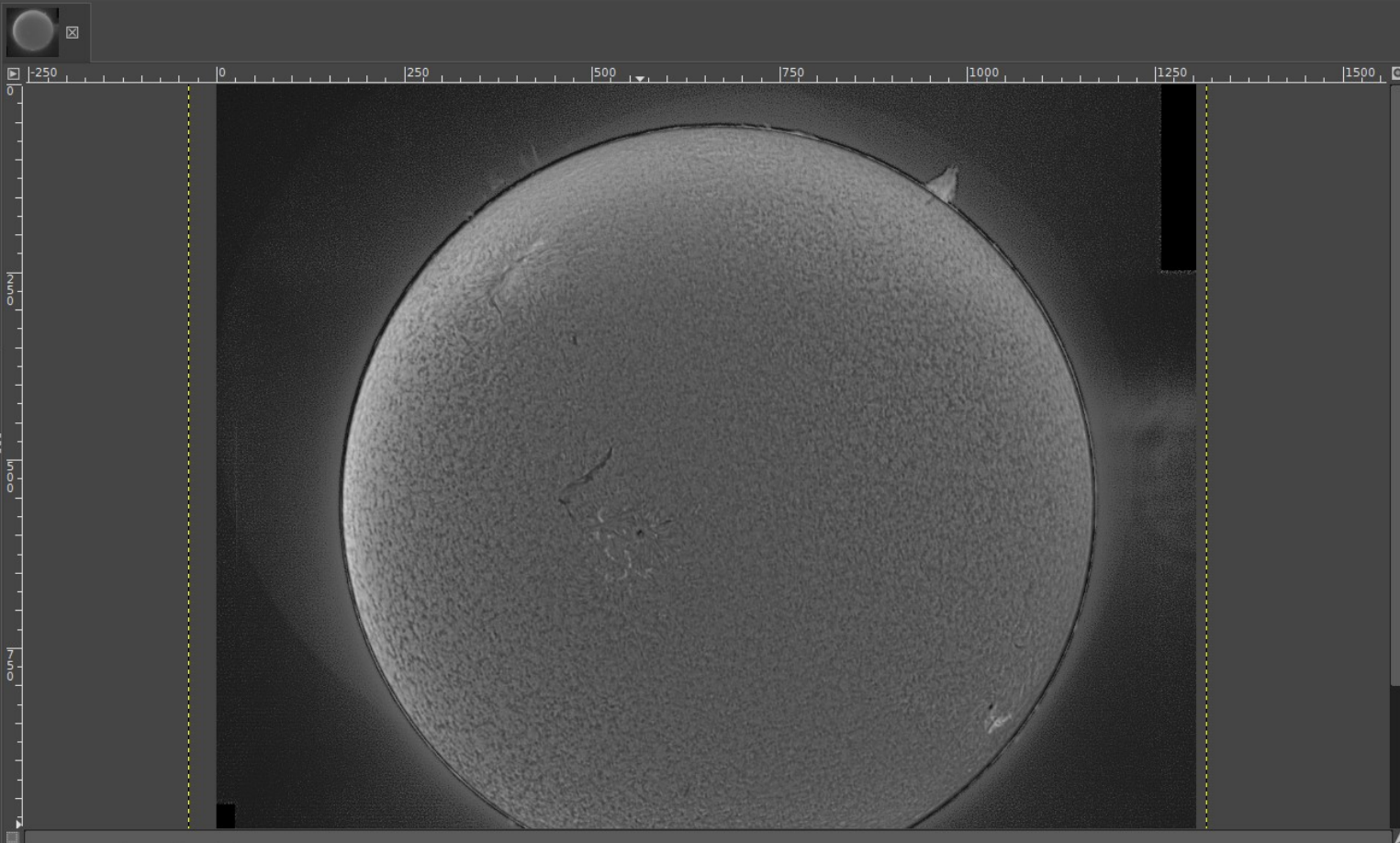
- mosaic_rim_11_13_39
- mosaic_surface_11_1...

Final processing (GIMP) (3)

- Select surface layer, use levels / curves to improve contrast and brightness
- Select rim layer, use levels / curves to stretch, make protuberances more visible



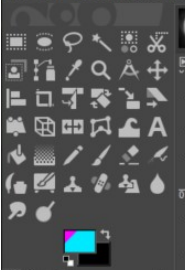
Curves
x Sample average
Radius 3



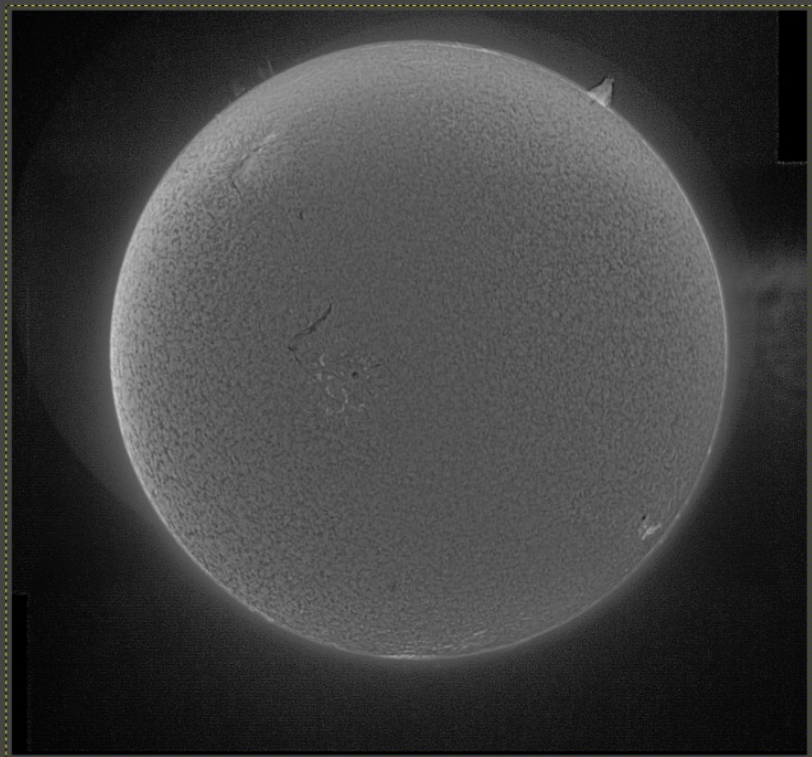
Layers Channels Paths
Mode Addition
Opacity 100.0
Lock: / +
mosaic_rim_11_13_39
mosaic_surface_11_12_18_and_11_15_12

Final processing (GIMP) (4)

- Especially on the rim, one sees some bright flaring besides the actual protuberances.
- Select a region around prominence and use curves to reduce the brightness around
- If you want to go all-out, draw black all around the actual protuberances (zoom in)
It's not always easy to distinguish a protuberance from noise!
- To remove the dark border between surface and rim, scale the surface layer to 101,5% (rim being brighter, the surface there seem slightly blown up)



Levels
x Sample average
Radius 3



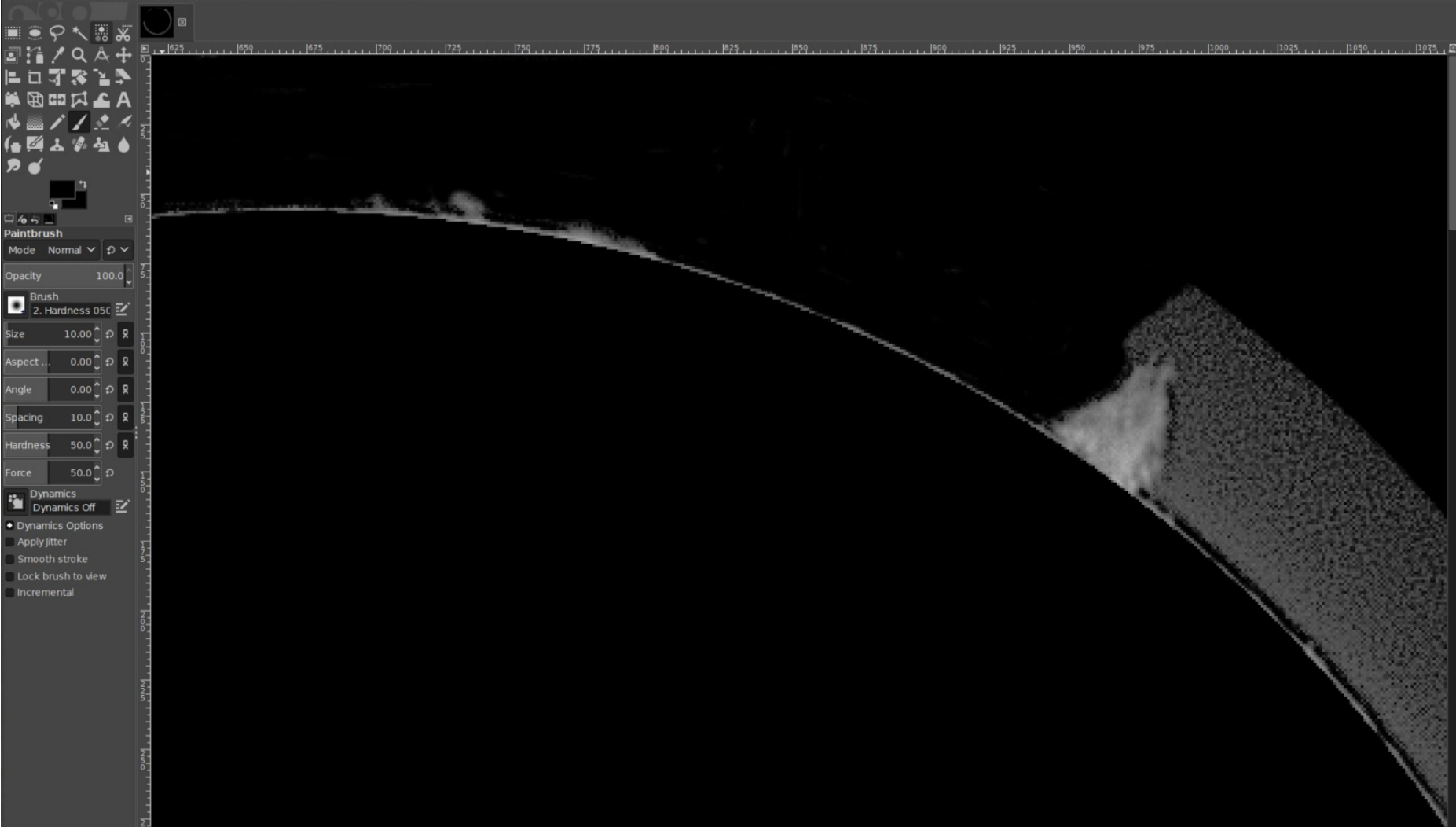
Layers Channels Paths

Mode Normal

Opacity 100.0

Lock: / +

- mosaic_rim_11_13_39
- mosaic_surface_11_1...



Paintbrush

Mode Normal

Opacity 100.0

Brush 2. Hardness 050

Size 10.00

Aspect... 0.00

Angle 0.00

Spacing 10.0

Hardness 50.0

Force 50.0

Dynamics Dynamics Off

Dynamics Options

- Apply jitter
- Smooth stroke
- Lock brush to view
- Incremental

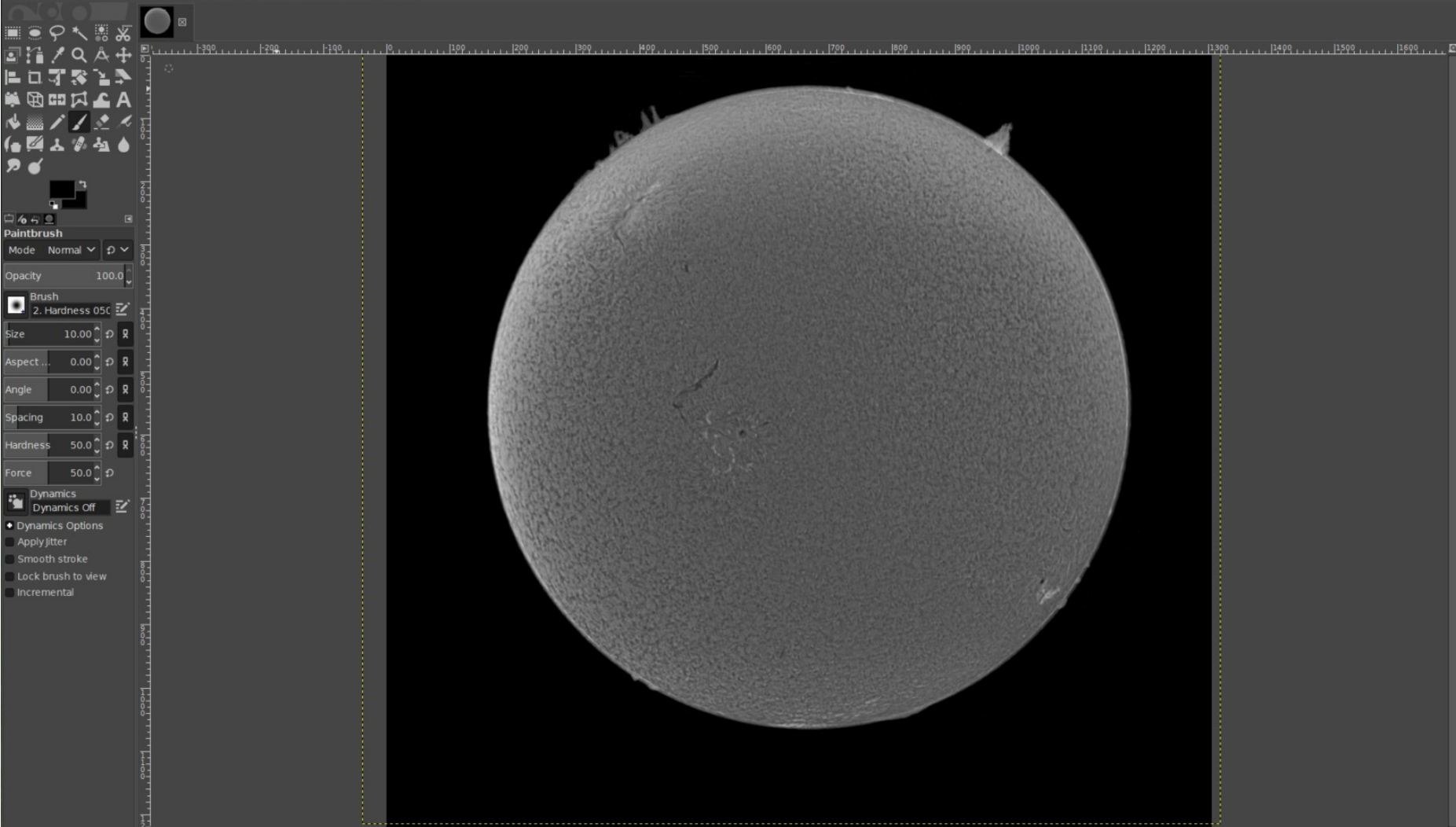
Layers Channels Paths

Mode Addition

Opacity 100.0

Lock: / +

- mosaic_rim_11_13_39
- mosaic_surface_11.1

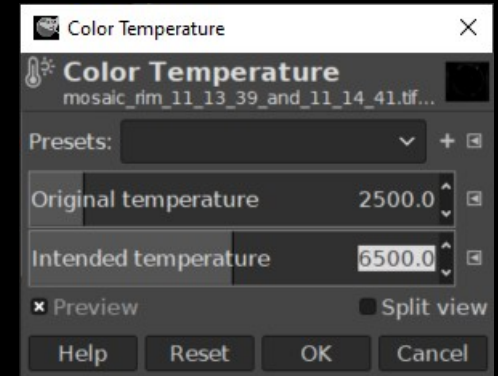


Paintbrush
Mode Normal
Opacity 100.0
Brush 2. Hardness 05C
Size 10.00
Aspect... 0.00
Angle 0.00
Spacing 10.0
Hardness 50.0
Force 50.0
Dynamics Dynamics Off
Dynamics Options
Apply jitter
Smooth stroke
Lock brush to view
Incremental

Layers Channels Paths
Mode Addition
Opacity 100.0
Lock: / +
mosaic_rim_11_13_39
mosaic_surface_11.1

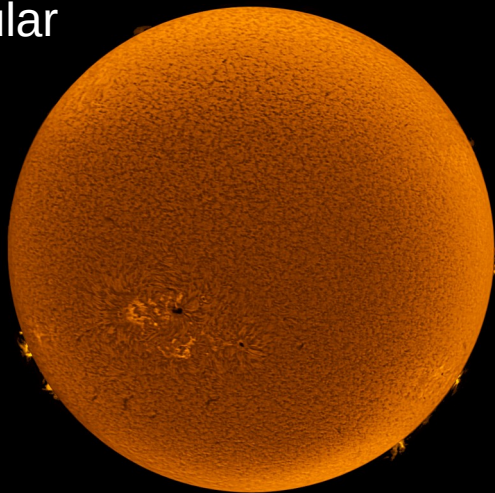
Final processing (GIMP) (5)

- Switch image mode from greyscale to RGB
- Use “color temperature” tool to color the sun to a yellow-reddish color, e.g. by setting the original temperature to 2500 (each layer)
- One may play with inverting the mono pic or setting color to negative

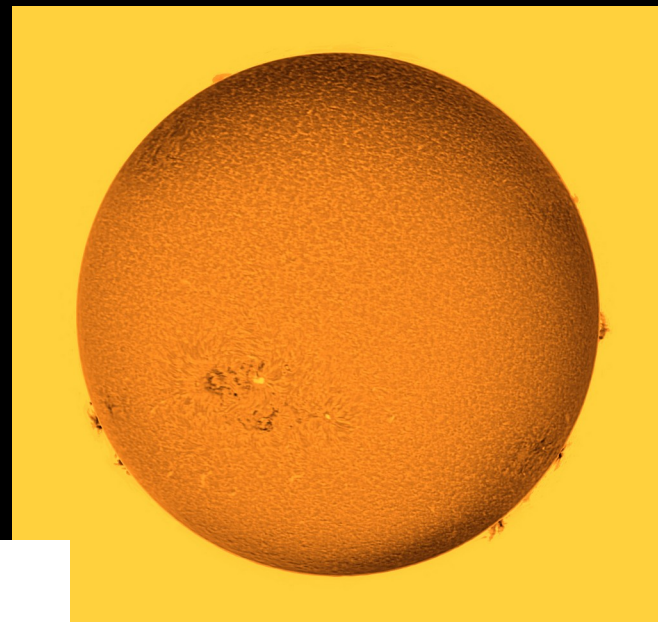
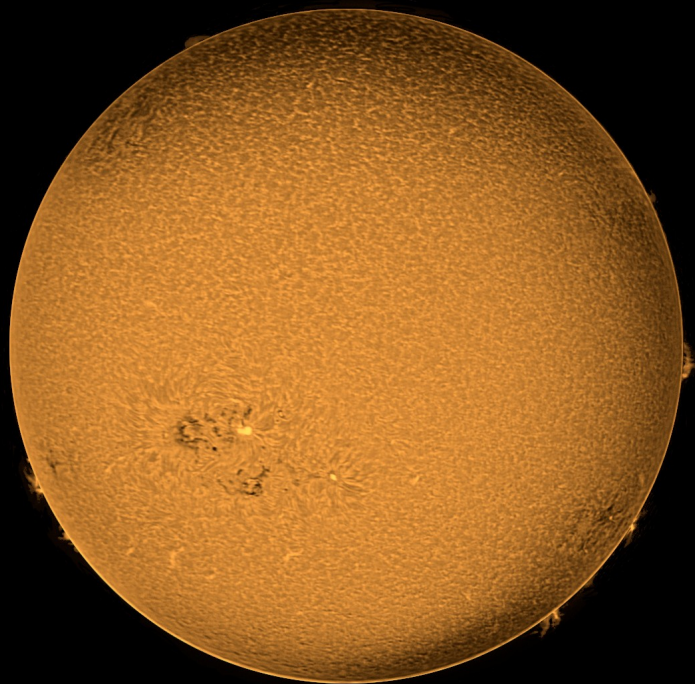


2020-11-28

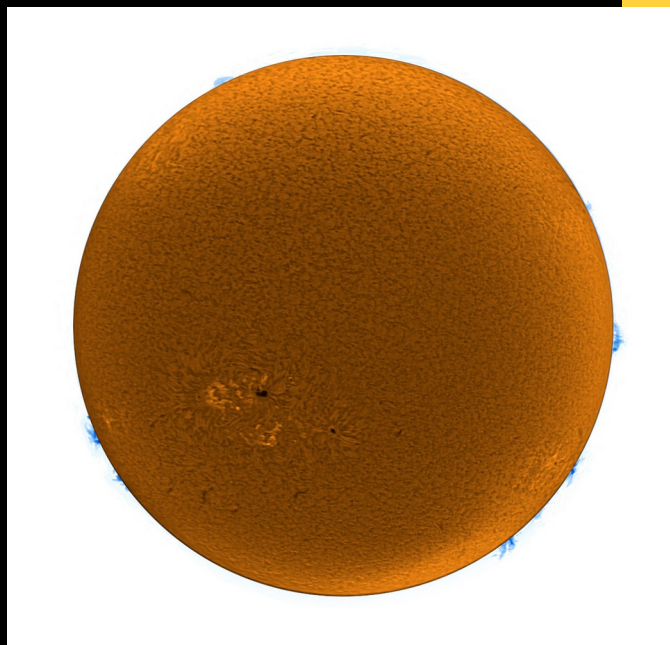
Regular



Surface inverted



Both disc + rim inverted

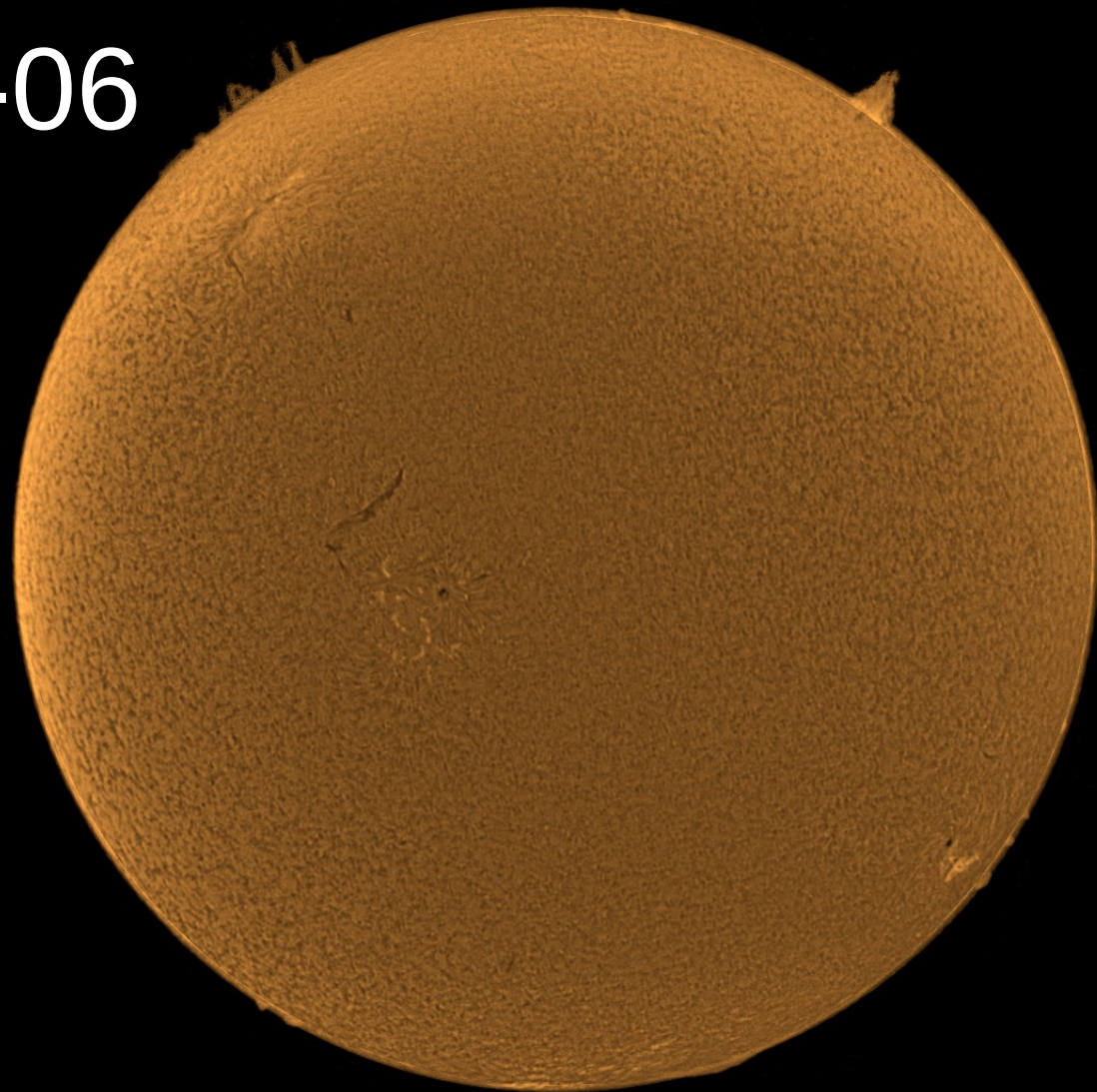


rim colored, negative

Final processing (GIMP) (6)

- Save the GIMP .xcf file in case you want to go over the final result again
- Flatten image
- Crop so as to center the Sun
- Optionally, add a text with data about the picture (date, (c) notice, equipment...)
- Export the final result (to PNG, JPG, ...)

2021-11-06



Remarks

- Use of a 2x barlow possible
- Same kind of processing can be done on white light surface pics of the sun (e.g. baader solar filter in front of a regular telescope – A4 size costs about 30 EUR), even if only sun spots can be seen there (no protuberances)
- I have successfully tested the ASI1600 on the PST, with full view of the entire sun. The data rate is enormous, much higher resolution. But details lost to field of view.
- ASI178MC works much like ASI120 via eyepiece projection, but only MONO8 and mosaic is much harder to do.

Upgrades / alternatives

- Some people adapt the PST filter(s) to a larger refractor “PST mods”
 - Take off the tube and lens, replace by a 2” adapter
 - Put it on the refractor (tube may need to be shortened)
 - ERF on the front of the refractor
- “eyepiece” filter, e.g. DayStar Quark
- Bigger Coronado or Lunt solar scopes, expensive

References

- SharpCap <https://www.sharpcap.co.uk/sharpcap/downloads>
- AutoStakkert <https://www.autostakkert.com/wp/download/>
- Fitswork <https://www.fitswork.de/software/>
- Registax <http://www.astronomie.be/registax/download.html>
- GIMP <https://www.gimp.org/downloads/>
- ImPPG <https://greatattractor.github.io/imppg/>
- AstroSurface <http://astrosurface.com/>

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- Atomic orbitals: nagwa.com
- h-alpha spectrum: astronomyknowhow.com
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