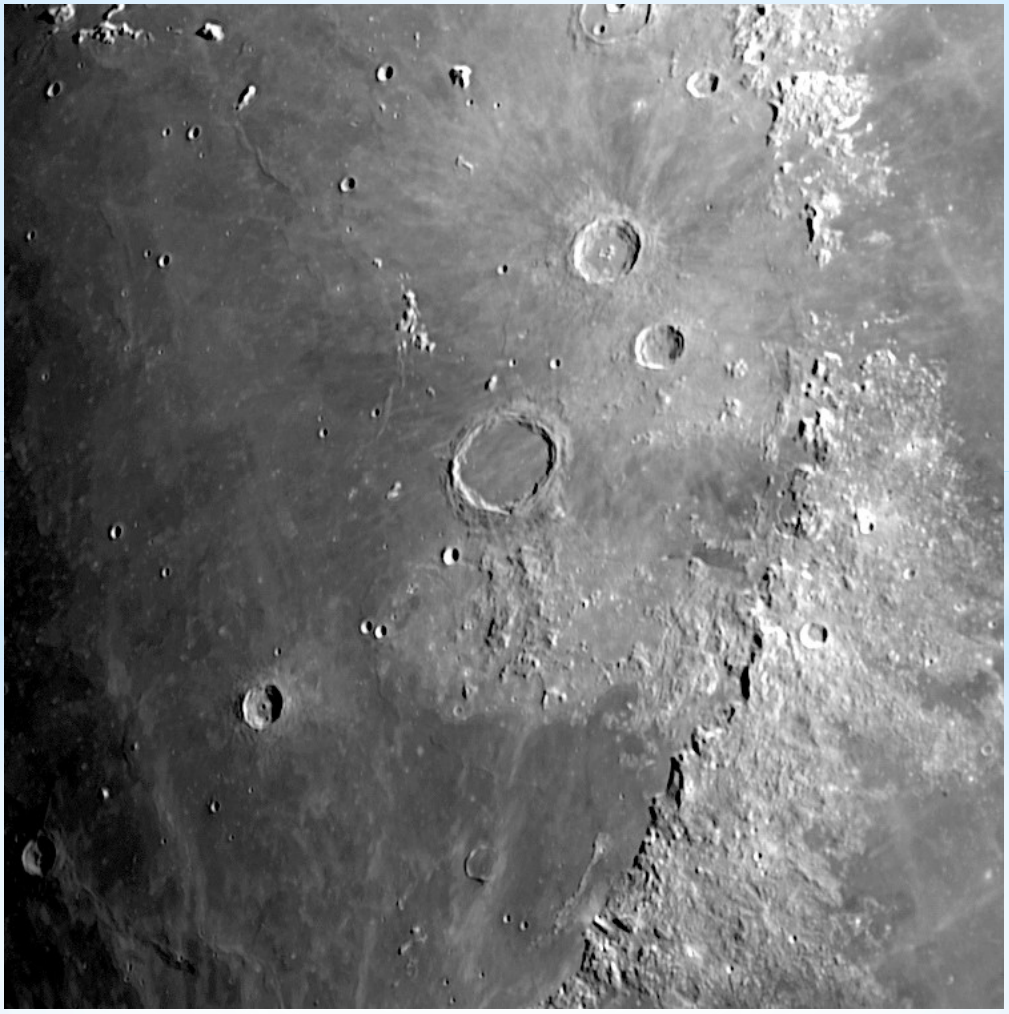
Imaging and Image Processing with a High Frame Rate Camera



Mick Jenkins and Daniel Coe
CAA June 2017

Imaging and Image Processing with a High Frame Rate Camera

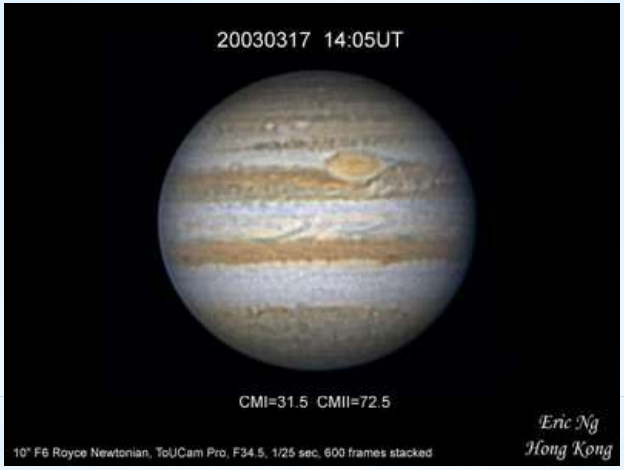
- History of webcams and high frame rate cameras
- Setting up your camera
- Camera filters
- Understanding Field of View (FOV)
- Camera Software
- Imaging
- Processing
- Creating a lunar mosaic

Mick Jenkins and Daniel Coe
CAA June 2017

History of Webcams

Philips Toucam Pro (2001)

Colour
640x480
CCD
30fps ? (10-15fps)



Philips Toucam Pro II (2003)

Colour
640x480
CCD (£65)
60fps ? (15fps)

History of Webcams

Meade LPI (2003)

- $150
- 640x480
- CMOS
- 3fps
- Meade software
- Ready to use

History of Webcams

Logitech Pro 4000 (2005)

640x480
CCD

15fps

Philips SPC900 (2007)

640x480
CCD

90fps ? (15-30fps)

USB2.0
VLounge Software

Sold in 2010

History of Webcams

Imaging Source Cameras (2010)

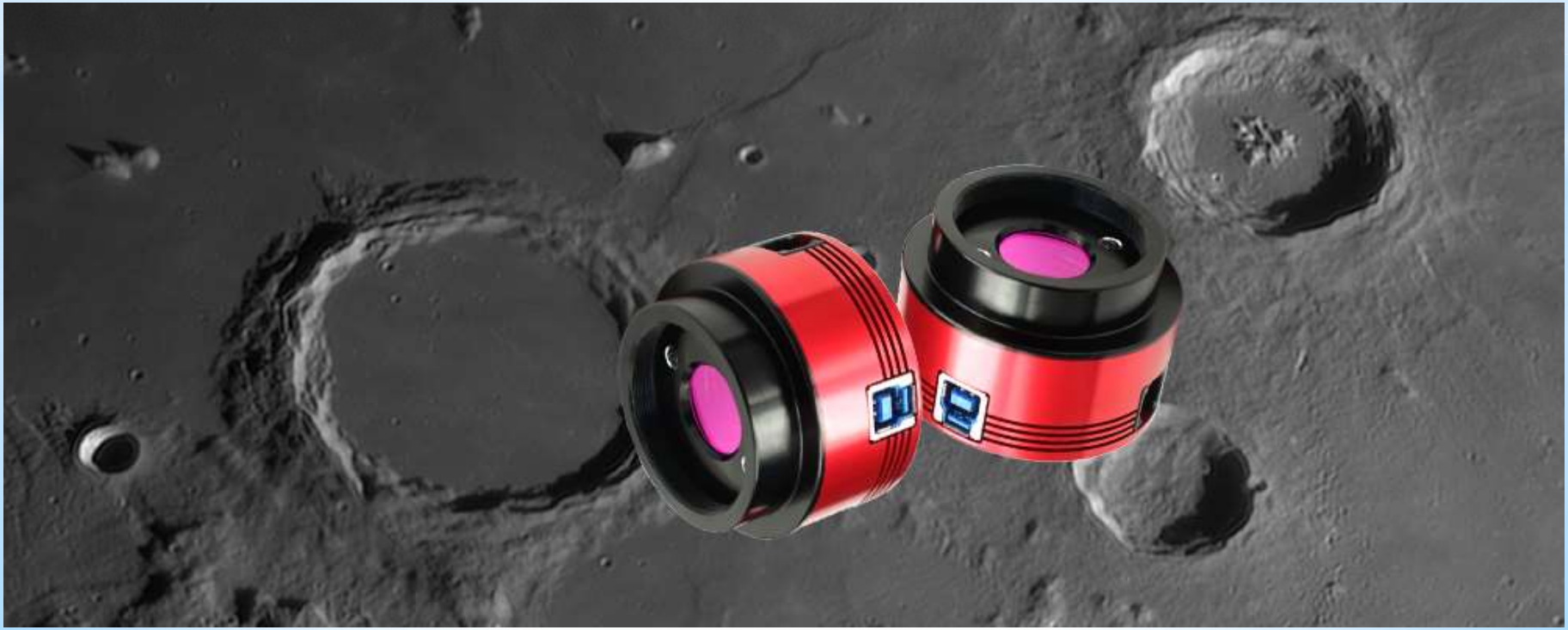
Popular model – DMK21
CCD - £300+
Mono or Colour?
60fps @ 640x480
Own IC Capture Software
Now Celestron Skyris

	Order Code	Type	IR Cut	Resolution	CCD	FPS	Sensor
	DMK 21AU04.AS	Monochrome	✖	640 x 480	CCD	60	Sony ICX098BL
	DMK 21AU618.AS	Monochrome	✖	640 x 480	CCD	60	Sony ICX618ALA
	DMK 31AU03.AS	Monochrome	✖	1024 x 768	CCD	30	Sony ICX204AL
	DMK 41AU02.AS	Monochrome	✖	1280 x 960	CCD	15	Sony ICX205AL
	DFK 21AU04.AS	Color	✔	640 x 480	CCD	60	Sony ICX098BQ
	DFK 21AU618.AS	Color	✔	640 x 480	CCD	60	Sony ICX618AQA
	DFK 31AU03.AS	Color	✔	1024 x 768	CCD	30	Sony ICX204AK
	DFK 41AU02.AS	Color	✔	1280 x 960	CCD	15	Sony ICX205AK
	DBK 21AU04.AS	Color	✖	640 x 480	CCD	60	Sony ICX098BQ
	DBK 21AU618.AS	Color	✖	640 x 480	CCD	60	Sony ICX618AQA
	DBK 31AU03.AS	Color	✖	1024 x 768	CCD	30	Sony ICX204AK
	DBK 41AU02.AS	Color	✖	1280 x 960	CCD	15	Sony ICX205AK

History of Webcams

ZWO Optical Cameras (2012)

Larger CMOS Sensors
ASI120 - 30fps @ 1280x960 / 113fps @ 640x480
USB2.0 and USB3.0
Include a fisheye lens
Massive range (mono/colour and cooled)
Now start at £140-£160

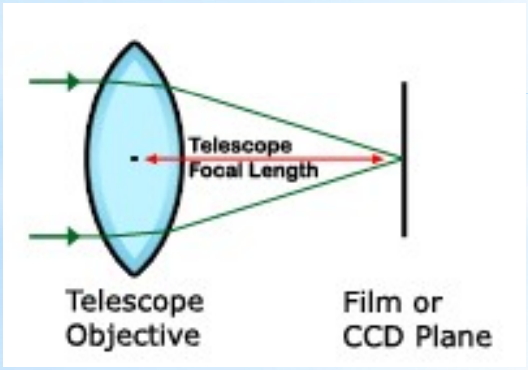


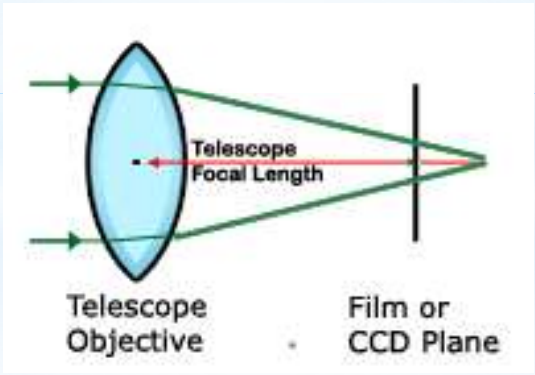
Setting up your Camera

Box contents:
- Camera
- USB lead
- 1.25” nosepiece
- Software CD

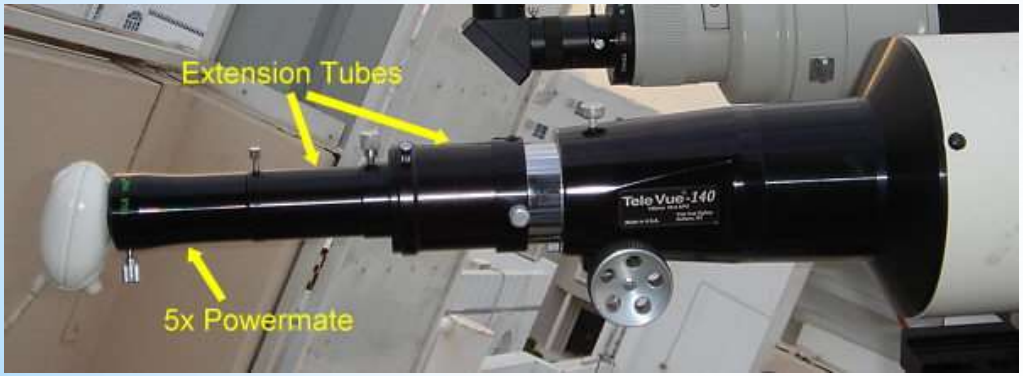
Setting up:
- Screw in 1.25” nosepiece or attach to focuser directly
- Install camera driver
- Attach USB cable to computer and camera
- Install capture software

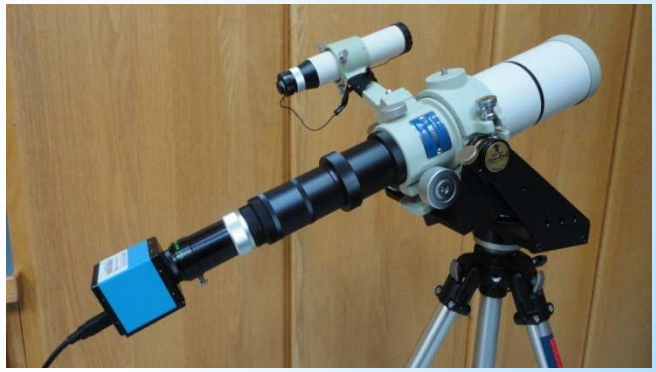
Focusing:





Can’t get focus?
Try a Diagonal
or Extension tube





Camera Filters

UV-IR-Cut filter are a must for improving image quality with CMOS and CCD cameras to produce better quality images, as these are quite sensitive to infrared (heat) radiation of light. They will also improve sharpness of the image as most of the optics are designed for the visible.

This Baader Planetarium Solar Continuum Filter Works in conjunction with a primary white light solar filter (or Herschel Wedge Prism) to show more granulation and sunspot detail

The Baader Planetarium Solar Continuum Filter boosts contrast, cuts down on atmospheric disturbances but transmits at 540nm.

Good for both visual work as well as imaging, and even makes a good star test filter.

ORION Quick Guide

		#8 83%	#11 40%	#12 74%	#15 66%	#21 46%	#23A 75%	#25 14%	#29 6%	#30 27%	#32 13%	#38A 17%	#44A 14%	#46 2%	#47 9%	#56 33%	#57 33%	#58 24%	#64 25%	#80A 28%	#82A 73%
MERCURY	Planetary/sky contrast			●	●	●	●	●	●								●				
	Surface features			●				●	●												
VENUS	Planet/sky contrast						●	●	●												
	Clouds/atmospheric features											●		●	●			●			
	Reduce glare							●						●	●						
MOON	Lunar detail	●												●	●	●	●				
	Feature contrast			●	●															●	
	Reduce glare		●	●	●															●	
	Lunar transient phenomenon (LTP)							●					●								
	Areas of low contrast																				●
MARS	Atmospheric clouds			●	●							●								●	
	Surface plains and Maria	●			●	●	●	●	●												
	Darken Maria		●																		
	Desert regions			●																	
	Blue clearing													●	●						
	Dust storms					●		●				●				●					
	Polar ice caps			●	●			●	●						●	●		●		●	
	Melt lines																	●			
	Frost patches															●		●			
	Surface fogs															●					
	Limb hazes & terminator clouds												●		●			●			
	Ice fogs/polar hazes																		●		
	Red & blue features									●	●										
	Areas of low contrast																				●
JUPITER	Comet impact		●																		
	Belts	●			●	●	●	●	●			●				●				●	
	Cloud bands		●			●												●		●	
	Loops					●												●		●	
	Festoons			●		●												●		●	
	Ovals					●				●	●							●		●	
	Great Red Spot					●						●						●		●	
	Galilean Moon transits							●	●												
	Polar regions					●	●														
	Areas of low contrast																				●
SATURN	Clouds		●	●				●	●												
	Belts	●			●	●	●					●						●		●	
	Polar regions	●				●	●											●		●	
	Rings							●		●	●				●	●	●	●		●	
	Cassini Division		●		●																
	Areas of low contrast																				●
URANUS & NEPTUNE	Detail in large telescopes	●	●		●																
	Blue/green contrast			●						●	●						●				

MISCELLANEOUS *Reduce false color in achromats: #8, #11, #15, #80A Diagonal for terrestrial viewing: #8 Viewing planets in daytime: #8 Increase structure detail in galaxies: #82A*

Understanding Field of View (FOV)

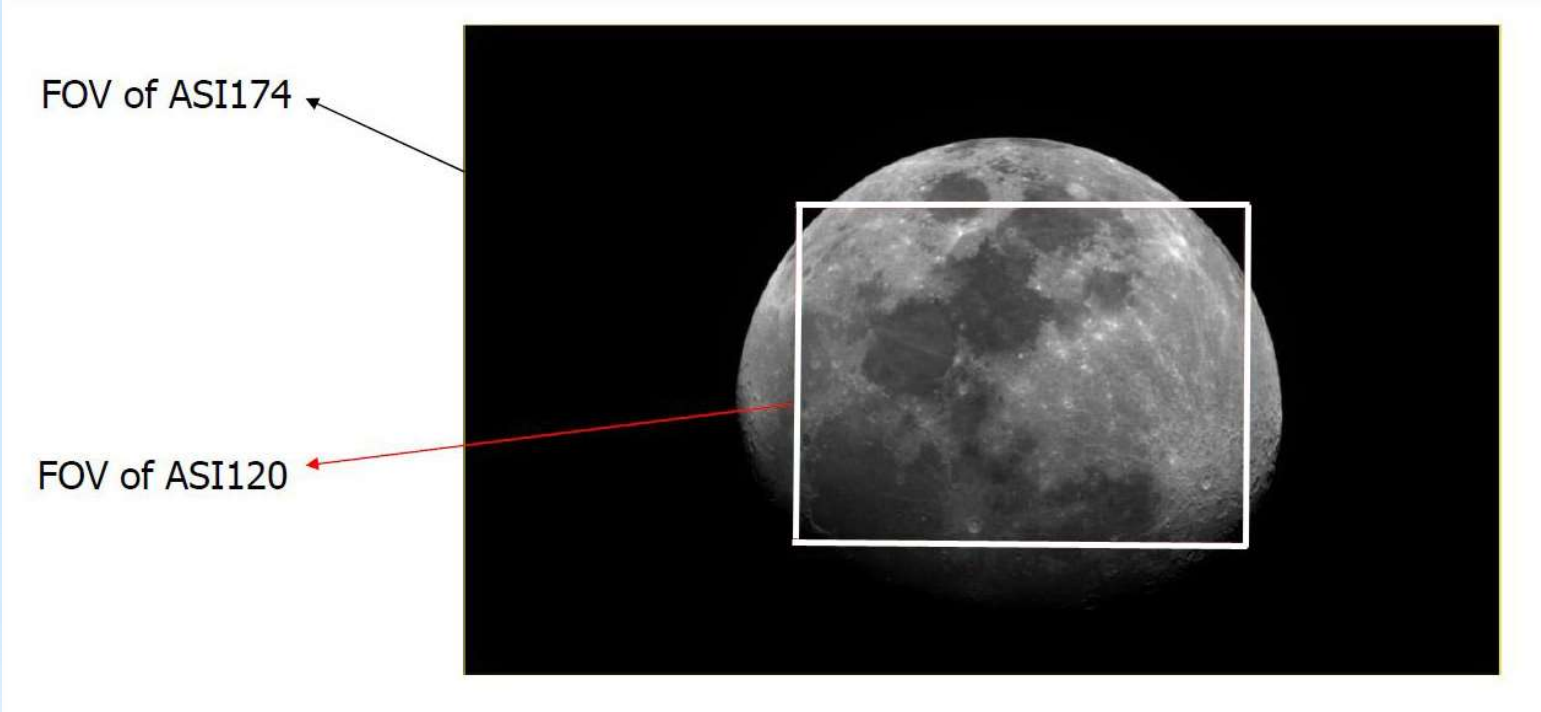


Image taken with a 600mm focal length scope, no Barlow lens added

NexImage Celestron Chip size is 640 x 480

ASI 120 Chip size is 1290 x 960 1.2 Mega pixels

ASI 174 Chip size is 1936 x 1216 2.3 Mega pixels

PowerMate Barlow X2 Barlow X3

Barlow's are powerful tools, the negative element defining them also limits their ability.

The PowerMate consists of a negative doublet plus a positive "pupil-correcting" doublet. This 4-element system provides the magnifying function of a Barlow without its limitations by restoring the field rays back to their original direction, as if the PowerMate were not there. The result is a pure magnification increase.

Camera Software

Basic Webcam's use DirectShow Video Capture by Microsoft.

Other manufacturers cameras come with recommended software which is available FREE on the internet such as:-

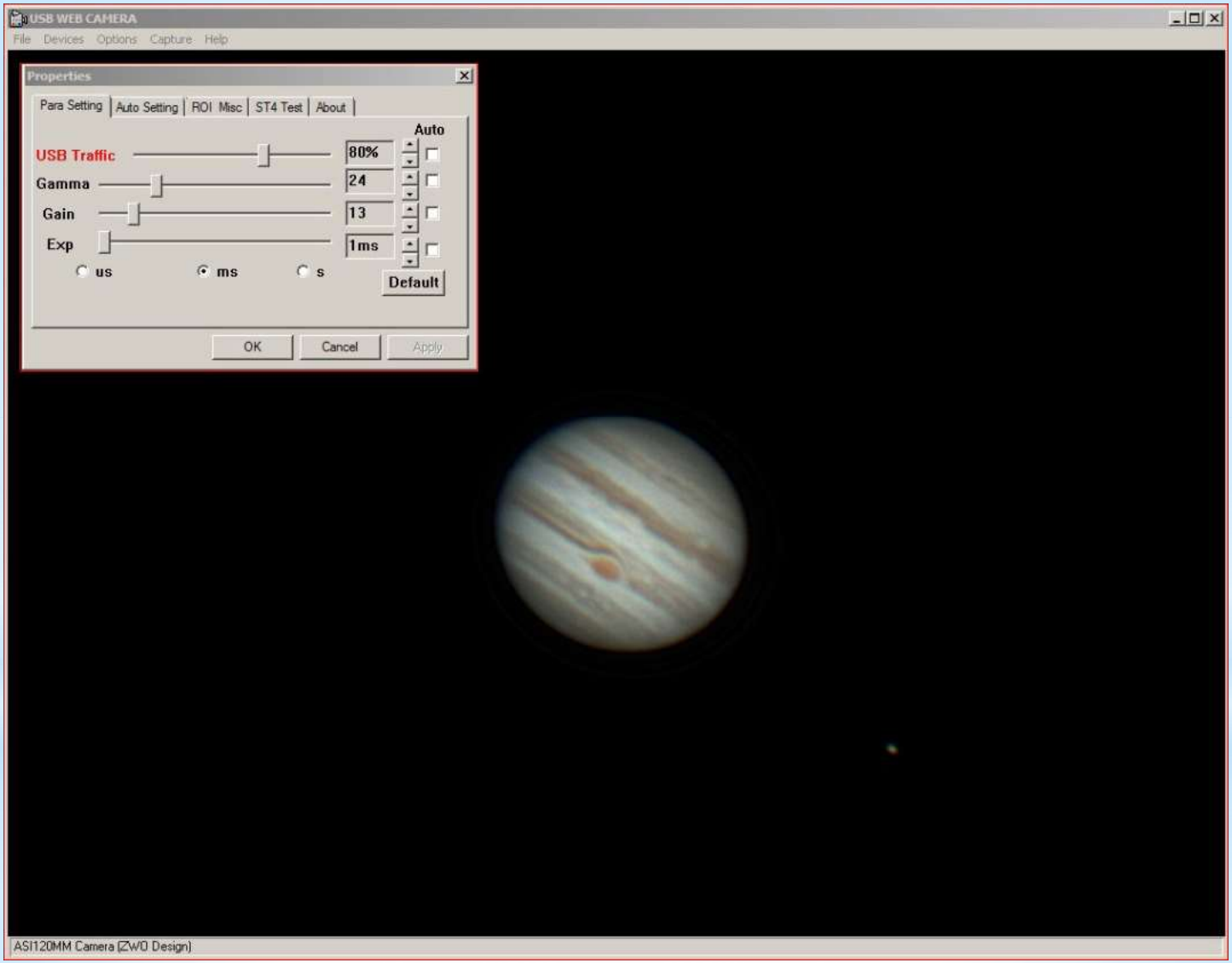
SharpCap Issue 3

Fire Capture v2.5

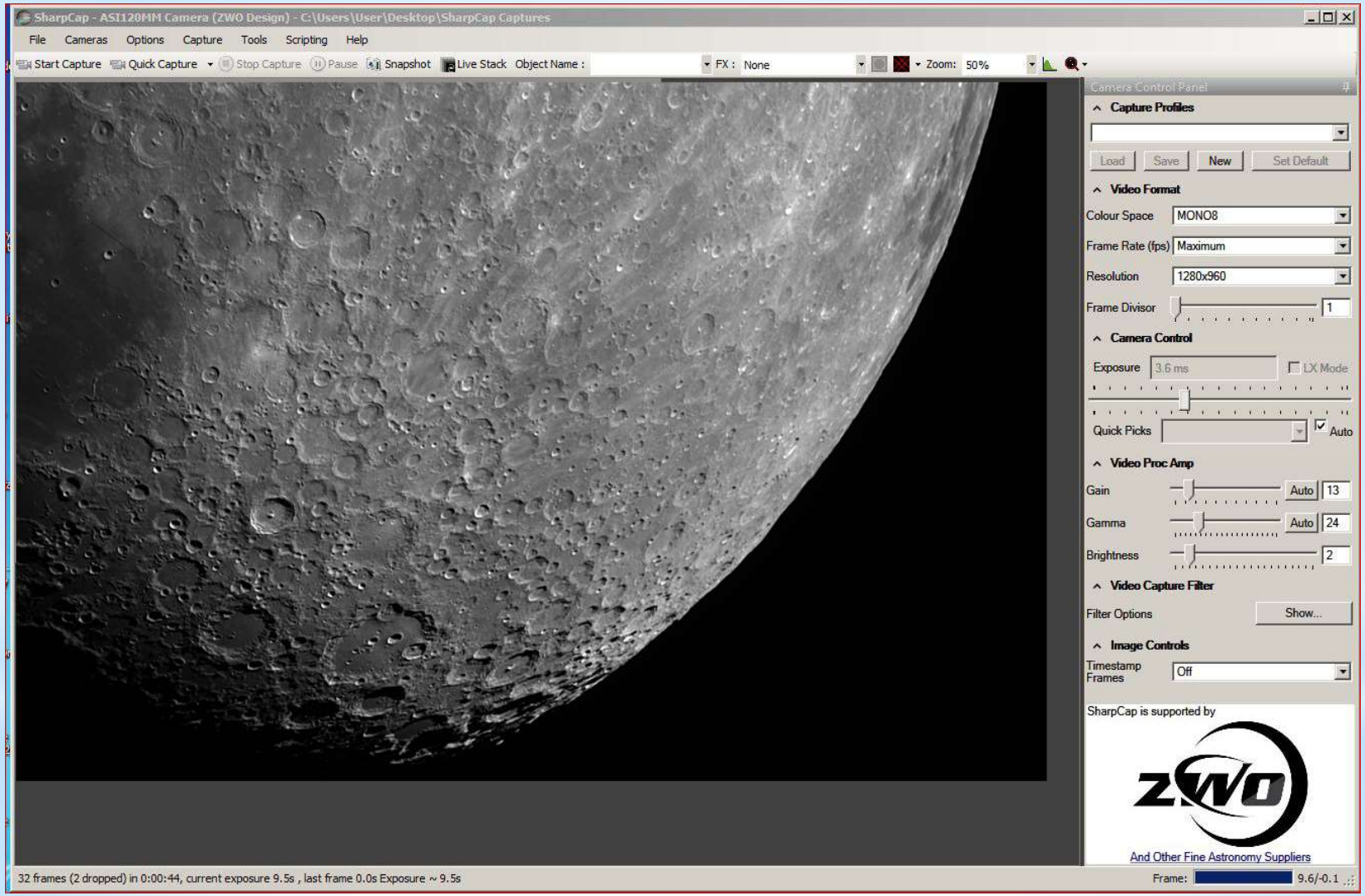
Some camera’s come with dedicated software designed by the manufacturer.

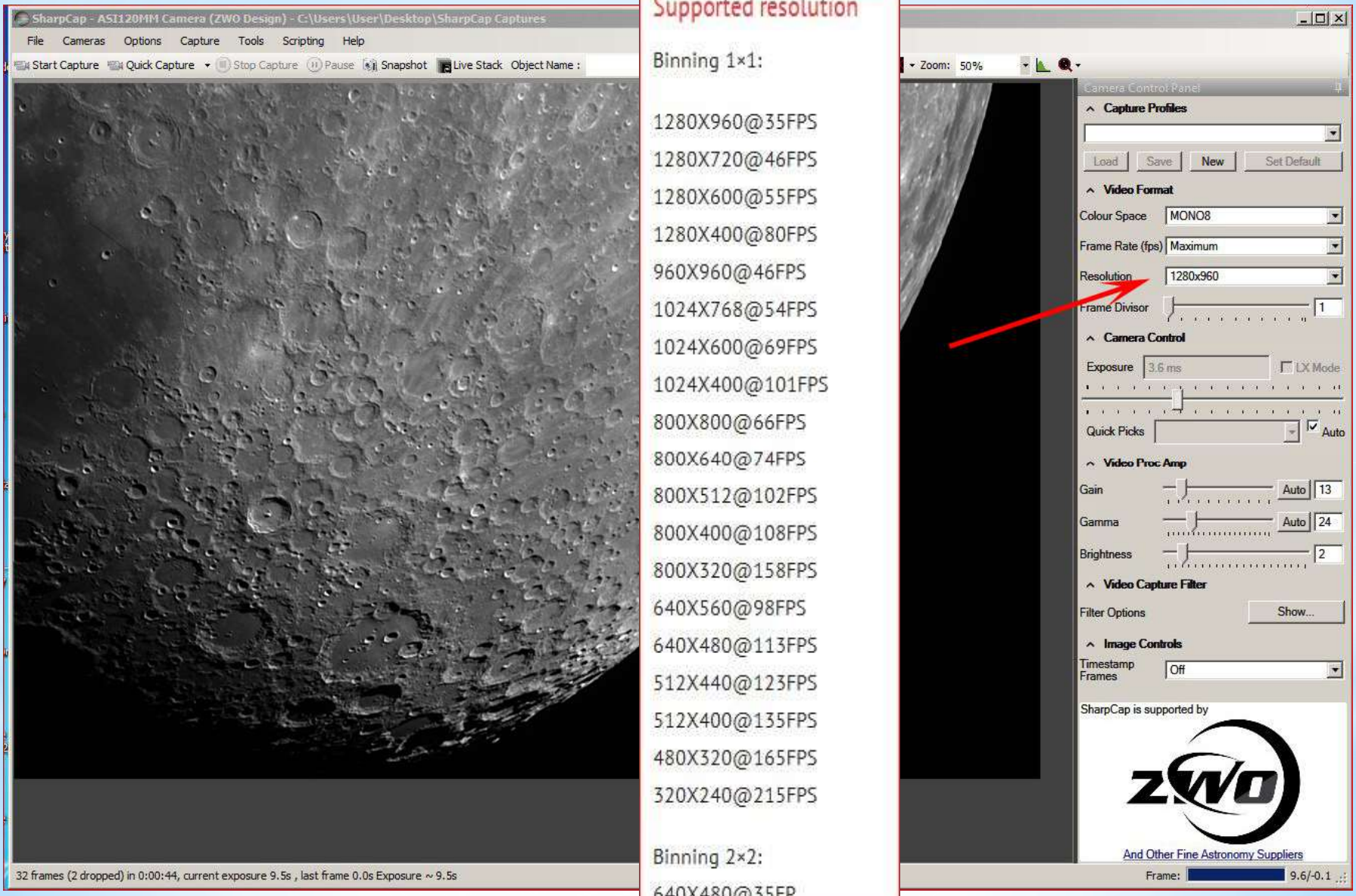
Basic WebCam
QHY 132 Colour Camera
ZWO ASI 120 Mono Camera
ZWO ASI 174 Mono Cooled Camera

DirectShow Video Capture by Microsoft



SharpCap V3 - Camera Software





Supported resolution

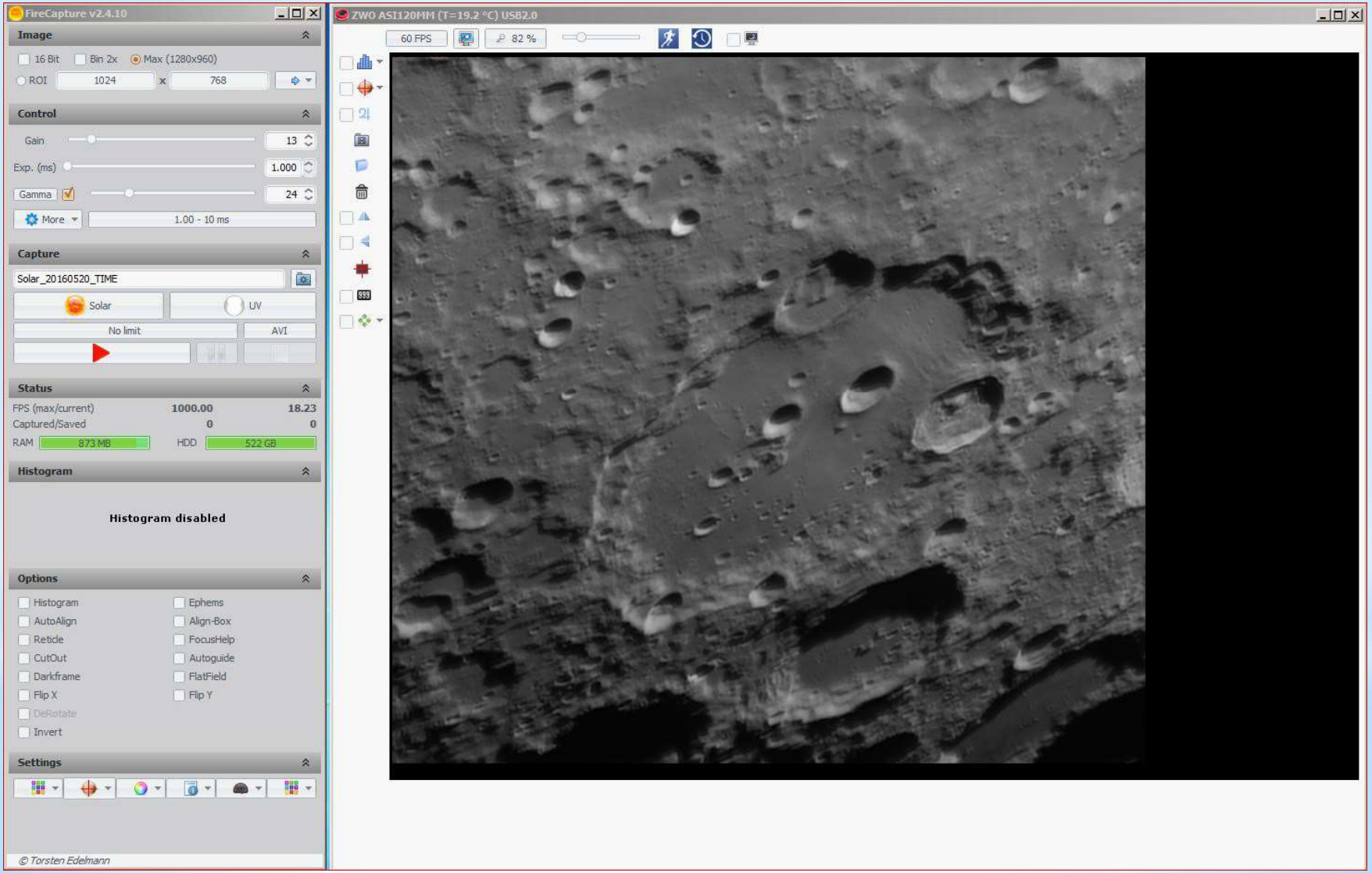
Binning 1×1:

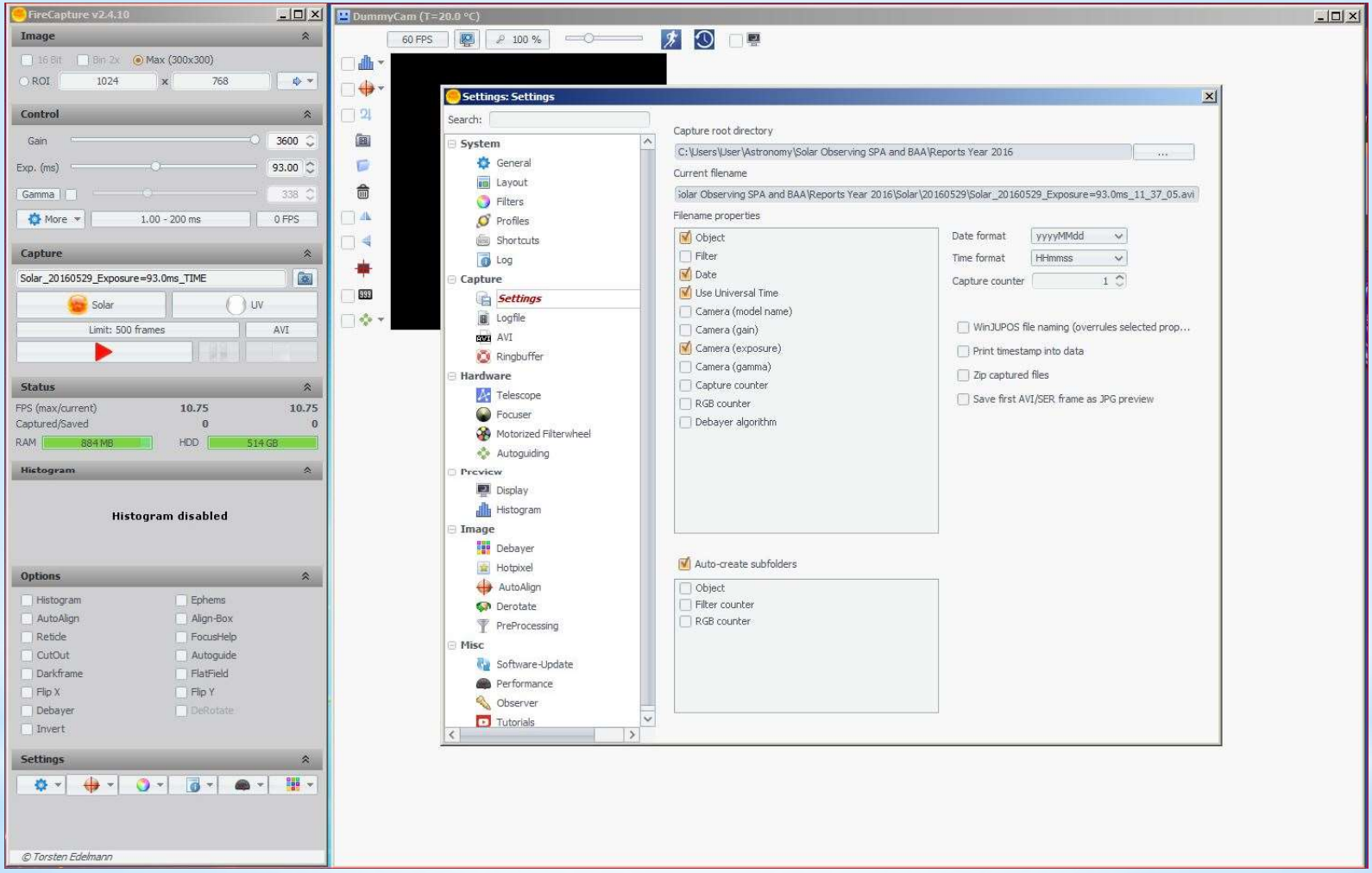
1280X960@35FPS
1280X720@46FPS
1280X600@55FPS
1280X400@80FPS
960X960@46FPS
1024X768@54FPS
1024X600@69FPS
1024X400@101FPS
800X800@66FPS
800X640@74FPS
800X512@102FPS
800X400@108FPS
800X320@158FPS
640X560@98FPS
640X480@113FPS
512X440@123FPS
512X400@135FPS
480X320@165FPS
320X240@215FPS

Binning 2×2:

640X480@35FP

FireCapture - Camera Software




FireCapture v2.4.10
Image
16 Bit
Bin 2x
Max (300x300)
ROI
1024
x
768
Control
Gain
3600
Exp. (ms)
93.00
Gamma
338
More
1.00 - 200 ms
0 FPS
Capture
Solar_20160529_Exposure=93.0ms_TIME
Solar
UV
Limit: 500 frames
AVI
Status
FPS (max/current)
10.75
10.75
Captured/Saved
0
0
RAM
884 MB
HDD
514 GB
Histogram
Histogram disabled
Options
Histogram
AutoAlign
Reticle
CutOut
Darkframe
Flip X
Debayer
Invert
Ephems
Align-Box
FocusHelp
Autoguide
FlatField
Flip Y
DeRotate
Settings
© Torsten Edelmann
DummyCam (T=20.0 °C)
60 FPS
100 %
Settings: Settings
Search:
System
General
Layout
Filters
Profiles
Shortcuts
Log
Capture
Settings
Logfile
AVI
Ringbuffer
Hardware
Telescope
Focuser
Motorized Filterwheel
Autoguiding
Preview
Display
Histogram
Image
Debayer
Hotpixel
AutoAlign
Derotate
PreProcessing
Misc
Software-Update
Performance
Observer
Tutorials
Capture root directory
C:\Users\User\Astronomy\Solar Observing SPA and BAA\Reports Year 2016
...
Current filename
Solar Observing SPA and BAA\Reports Year 2016\Solar\20160529\Solar_20160529_Exposure=93.0ms_11_37_05.avi
Filename properties
Object
Filter
Date
Use Universal Time
Camera (model name)
Camera (gain)
Camera (exposure)
Camera (gamma)
Capture counter
RGB counter
Debayer algorithm
Date format
yyyyMMdd
Time format
HHmmss
Capture counter
1
WinJUPOS file naming (overrules selected prop...
Print timestamp into data
Zip captured files
Save first AVI/SER frame as JPG preview
Auto-create subfolders
Object
Filter counter
RGB counter

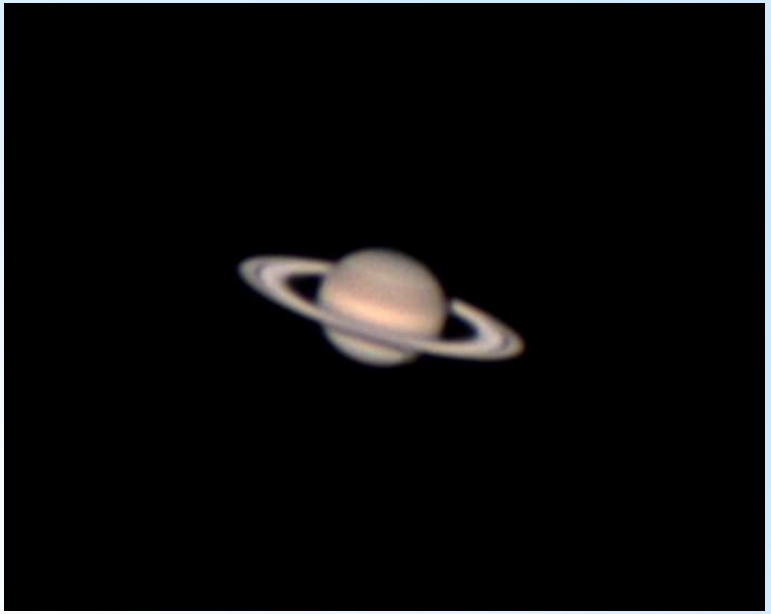
Imaging – Taking a Good Image

- Good Optics
- A Tracking mount for long exposures
- Filters selections for the target (UV/IR recommended)
- Camera setting – frames/second – image size – number of capture frames - file location
- Local weather conditions
- Position of object – low in the sky can cause poor images
- Cat and Mouse! Watch the image on the screen and wait until the image is stable then press record
- Take a number of AVIs files

Capturing and Using AVI files

Take a minimum of 10 AVI's at different settings this will improve your chances of achieving a good sharp image.

For the Planets I use a X2 Barlow or a 2.5 X PowerMate to get a good size image on the chip



Effects of Frames per second

Depending on the conditions and the object chosen the faster the frame rate the clearer and sharper the image.

Camera rates can vary from 15 to 200 frames/second with modern USB 3 camera's

Aim to take 1000 frames of video, if conditions are poor try 2000 at a faster frame rate

Image Processing

Registax 6

- Select video
- Set align points
- Align
- Limit the frames
- Stack the best frames
- Use wavelets to sharpen

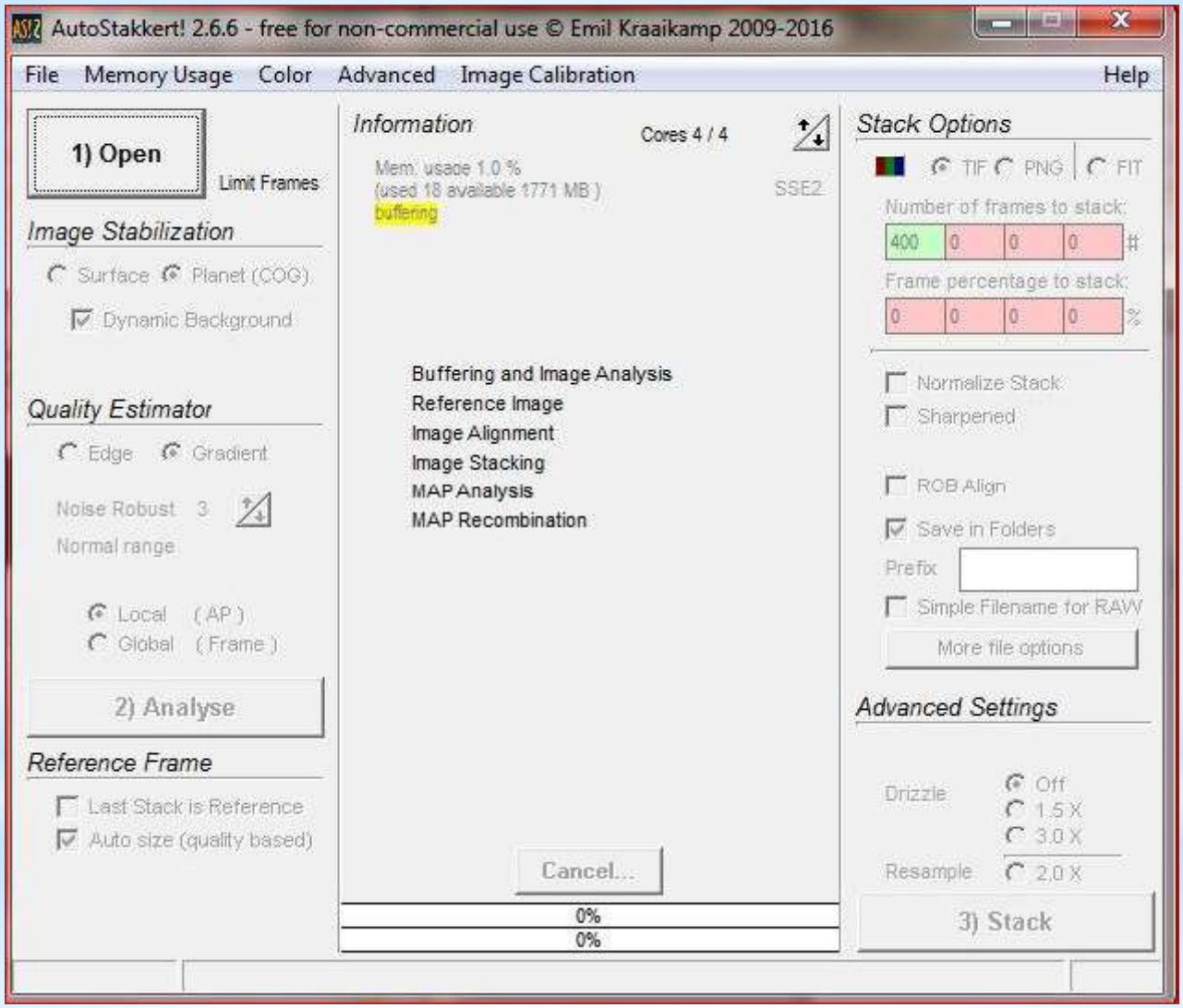
Move to image editing program to tweak brightness, contrast, sharpening etc.

Autostakkert

- ‘Open’ video
- Set Stack options
- Set stabilisation point
- Analyse
- Set alignment points
- Stack

Move to Registax for sharping the images using wavelet processing and then image editing program.

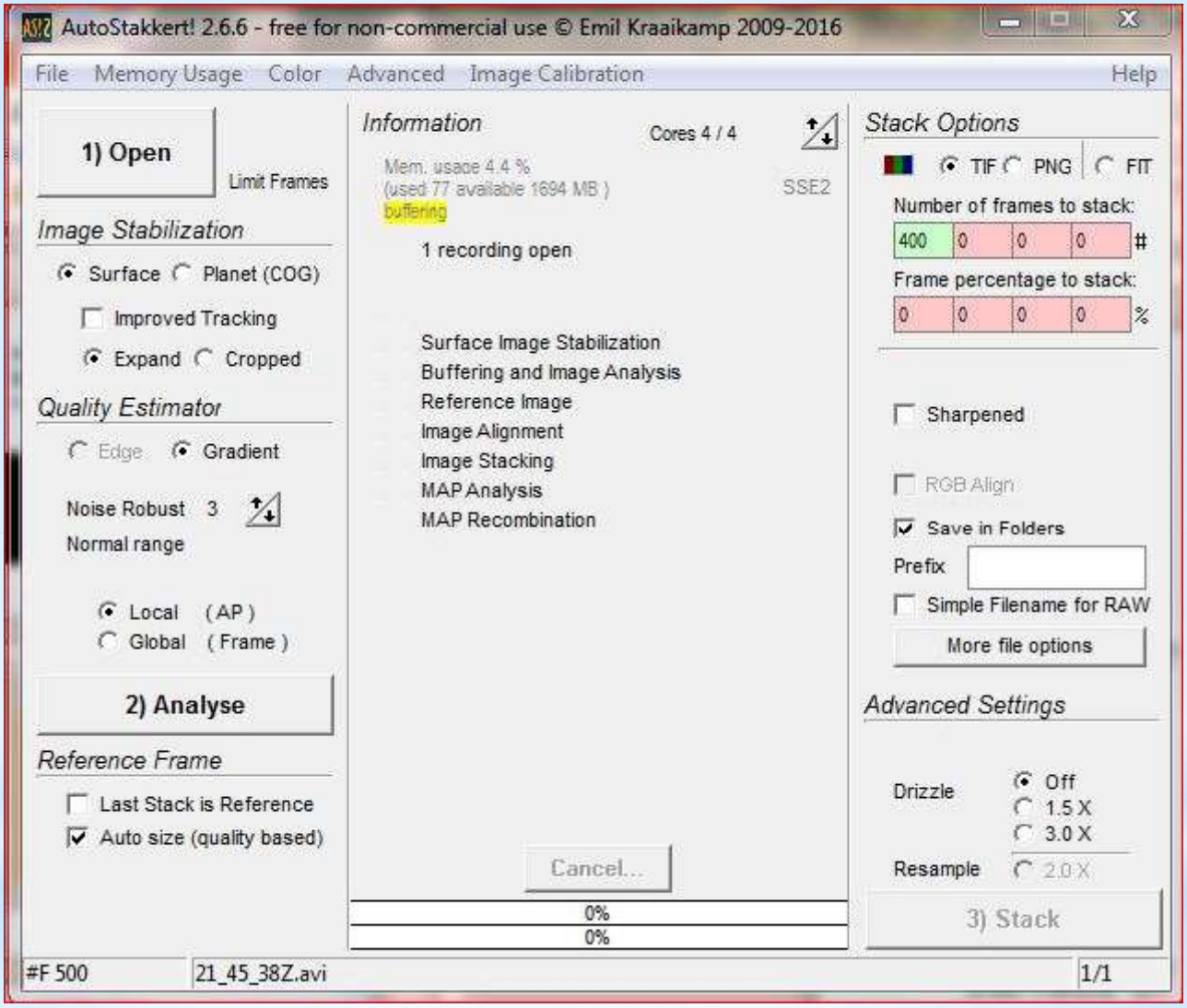
Image Processing with AutoStakkert



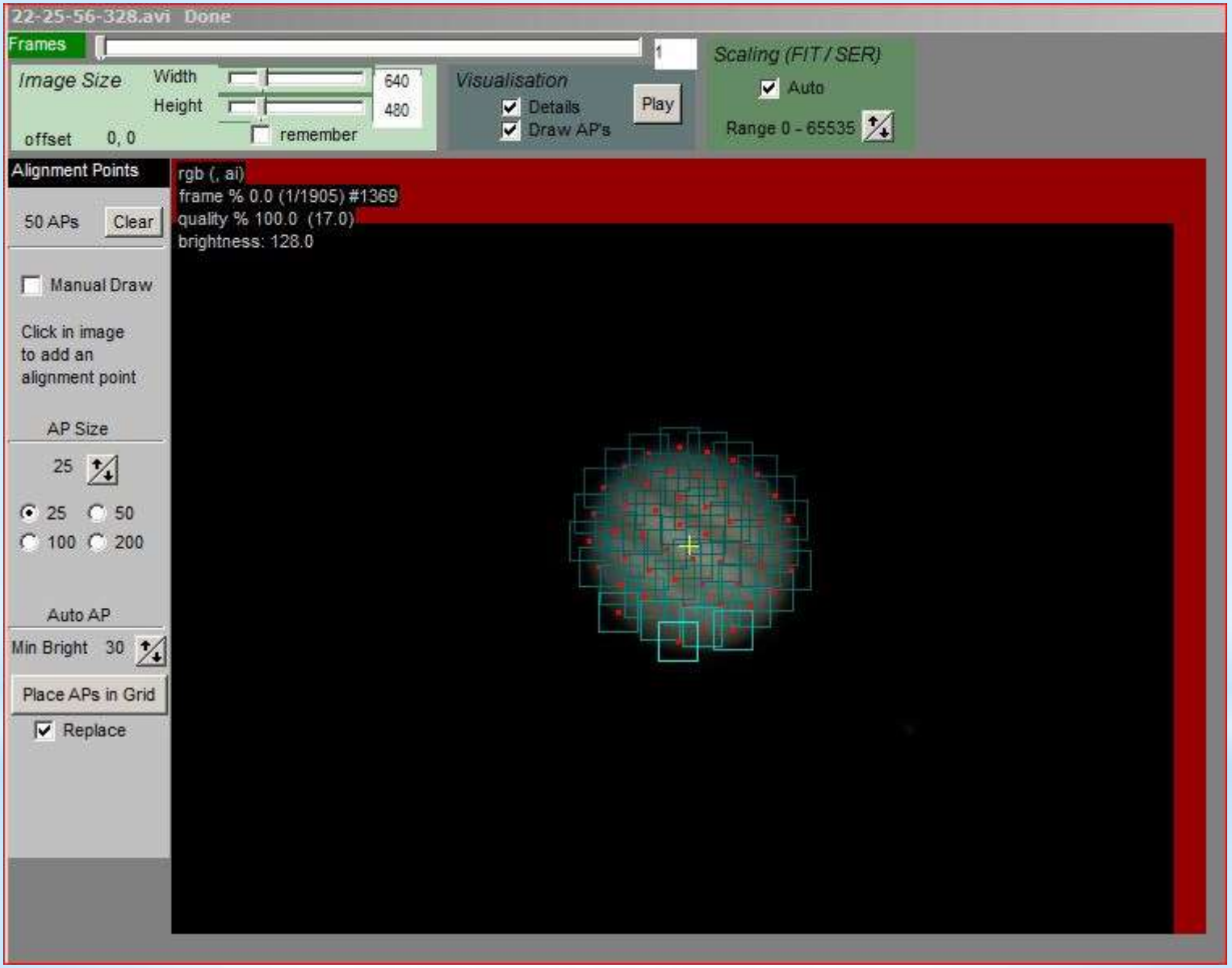
Select the AVI File

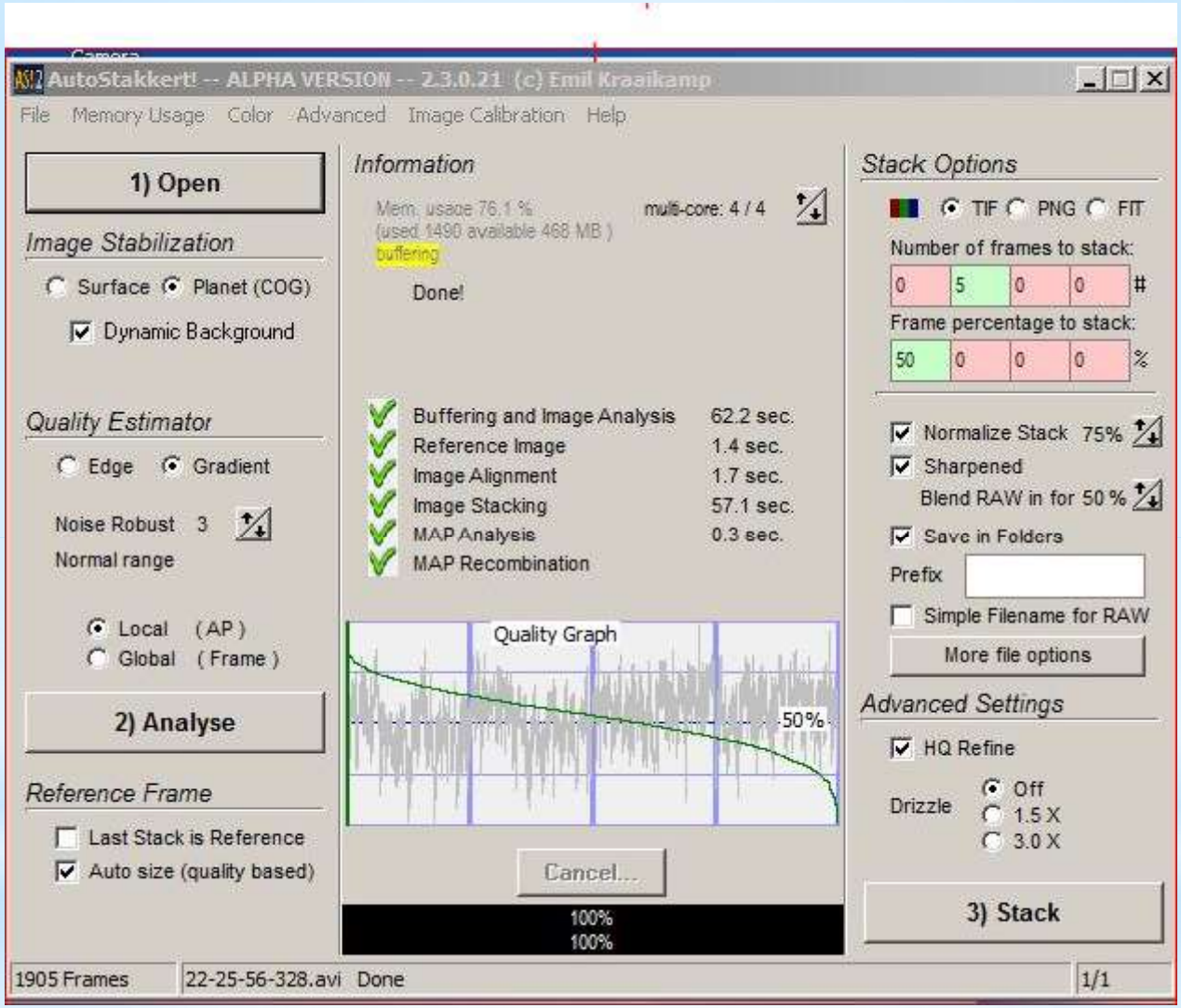
Select Surface or Planets

Press Analyse



AutoStakkert second window showing alignment points and image



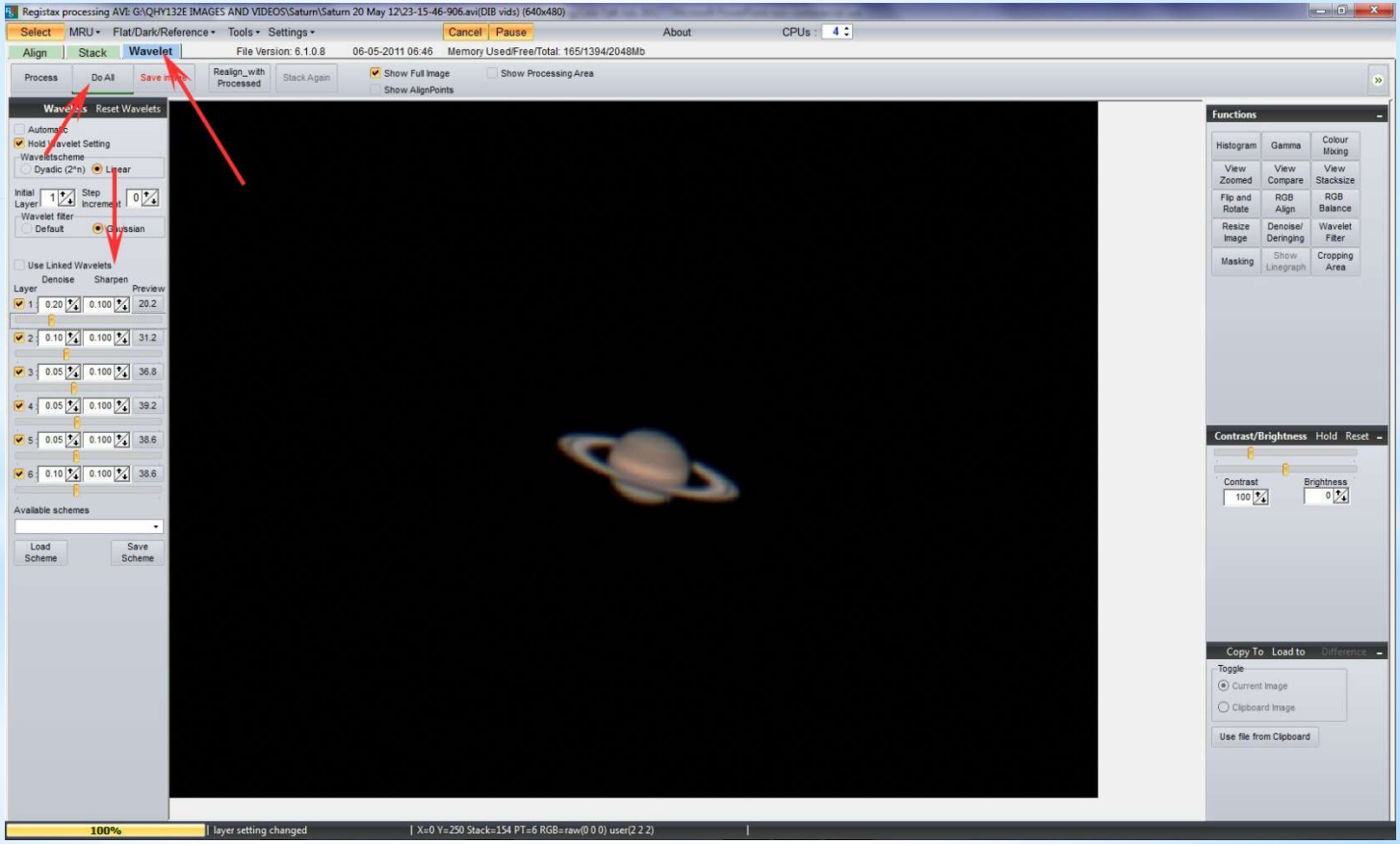

AutoStakkert! -- ALPHA VERSION -- 2.3.0.21 (c) Emil Kraaikamp
File Memory Usage Color Advanced Image Calibration Help
1) Open
Image Stabilization
Surface Planet (COG)
Dynamic Background
Quality Estimator
Edge Gradient
Noise Robust 3
Normal range
Local (AP)
Global (Frame)
2) Analyse
Reference Frame
Last Stack is Reference
Auto size (quality based)
Information
Mem. usage 76.1 %
(used 1490 available 468 MB)
buffering
multi-core: 4 / 4
Done!
Buffering and Image Analysis 62.2 sec.
Reference Image 1.4 sec.
Image Alignment 1.7 sec.
Image Stacking 57.1 sec.
MAP Analysis 0.3 sec.
MAP Recombination
Quality Graph
50%
Cancel...
100%
100%
Stack Options
TIF PNG FIT
Number of frames to stack:
0 5 0 0 #
Frame percentage to stack:
50 0 0 0 %
Normalize Stack 75%
Sharpened
Blend RAW in for 50 %
Save in Folders
Prefix
Simple Filename for RAW
More file options
Advanced Settings
HQ Refine
Drizzle Off 1.5 X 3.0 X
3) Stack
1905 Frames
22-25-56-328.avi Done
1/1

Wavelets - Sharpening the Image

In the Wavelet screen move the 6 sliders - starting from the bottom or the top watch the image carefully to see the improvement in the image sharpness.

Do not over do this or artefacts will start appearing.

Only part of the image is processed so after each adjustment click the **Do All** Button.



Demonstrations

AVI file of the Moon

SharpCap

AutoStakkert processing

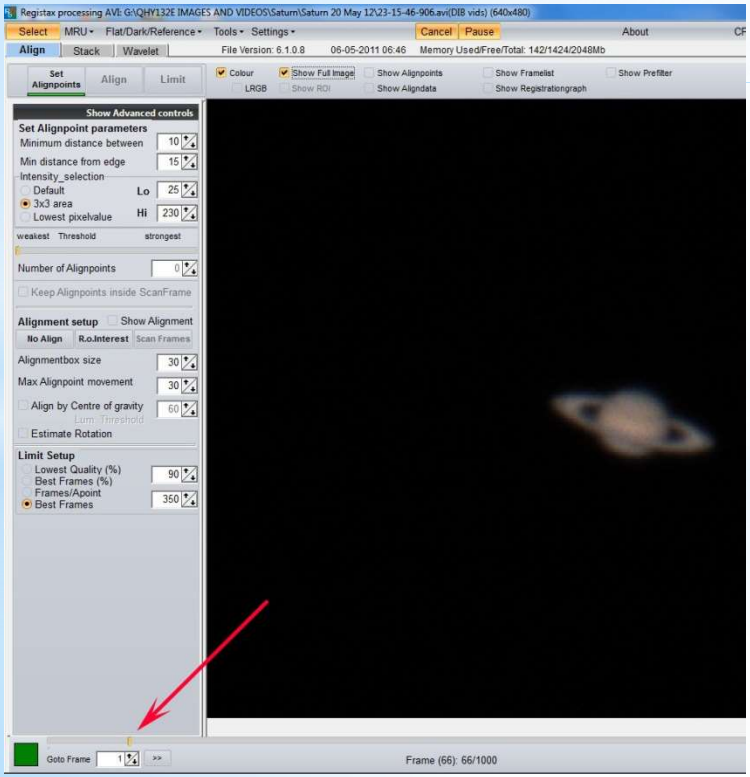
RegiStax Sharpening

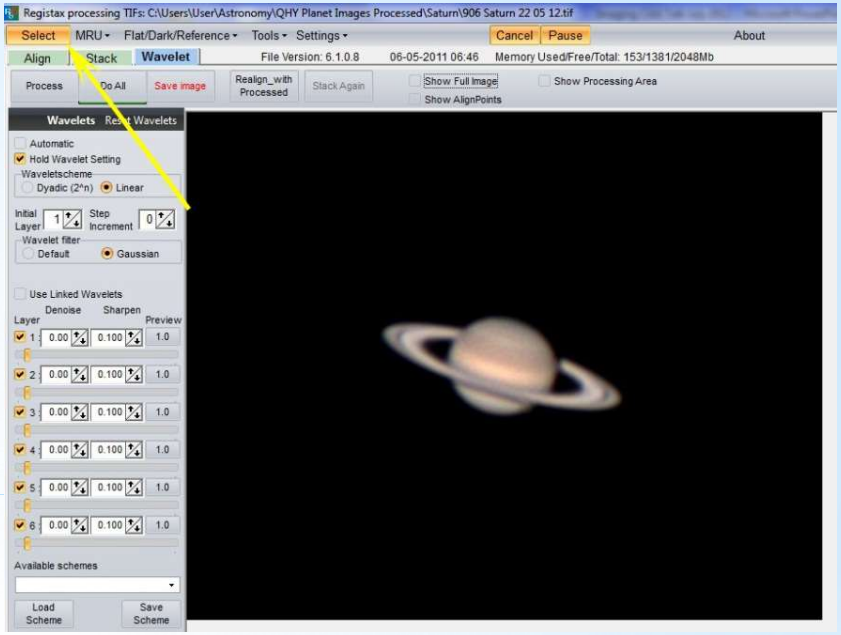
Image Processing with Registax

Stacking in RegiStax 6

RegiStax 6 is the brain child of Cor Berrevoets

The Software is available free on the internet





Choose the best AVI file and load it into RegiStax

Next move the slider to find the sharpest video frame - this is used as the master frame to which all the frames are stacked.

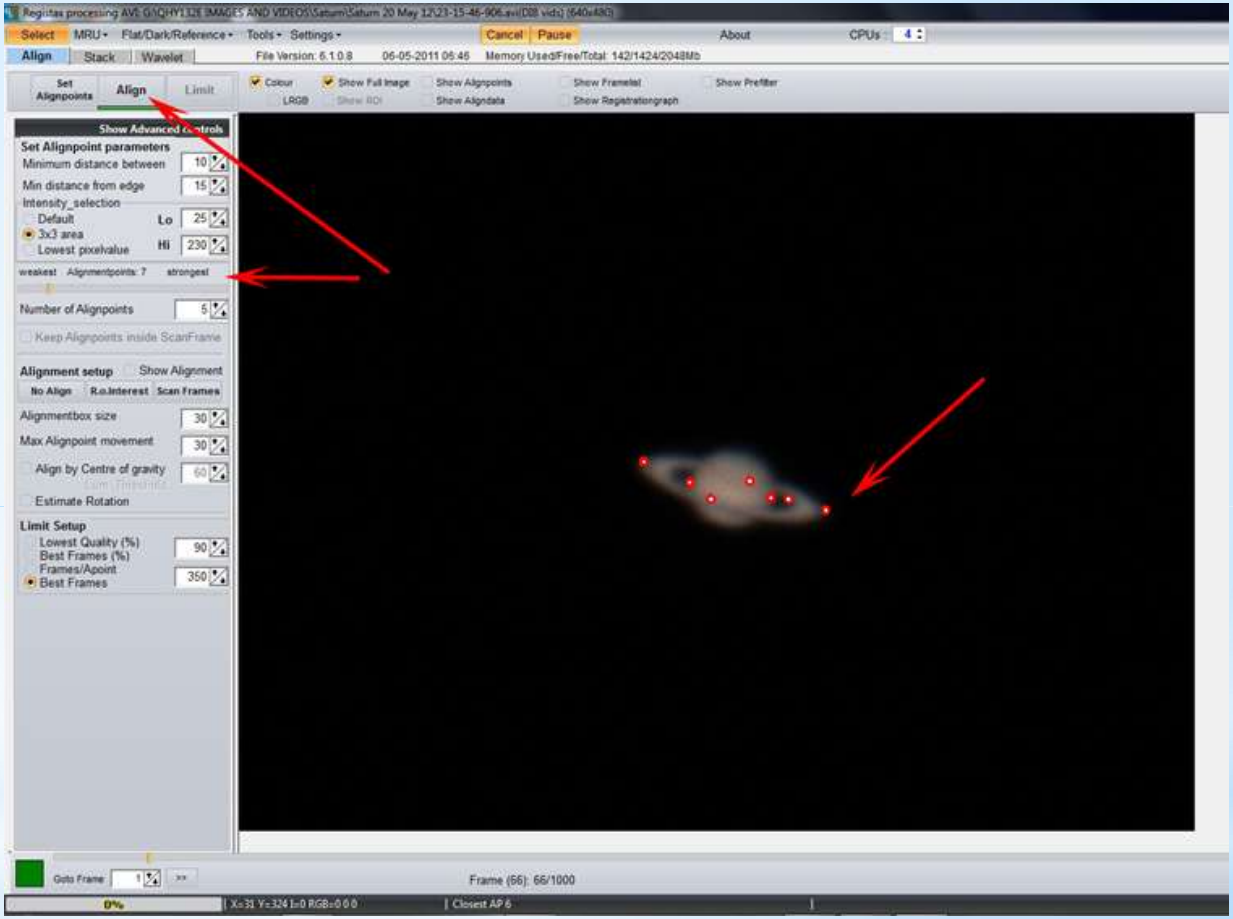
Alignment

Select the alignment points by clicking the **Align** button

The software chooses the Alignment points for you -To reduce the numbers move the Alignment Point slider

Or you can use Centre of Gravity setting

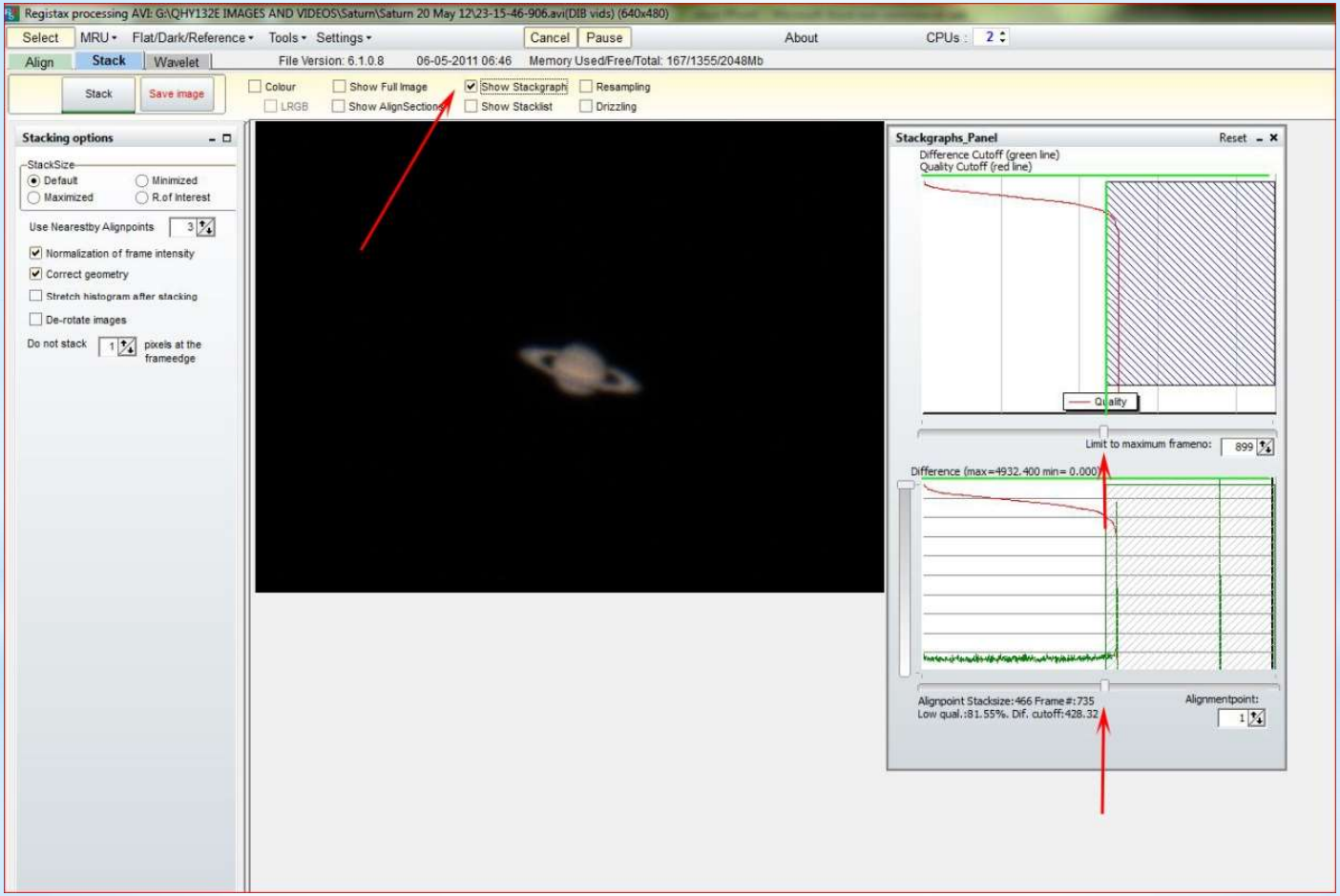
Not too many points because this will slow the program down.



Stackgraph

Tick the Stackgraph box. Then move the slider to improve the quality and registration this will set the number of frames used in the final image.

Then click the Limit tab.



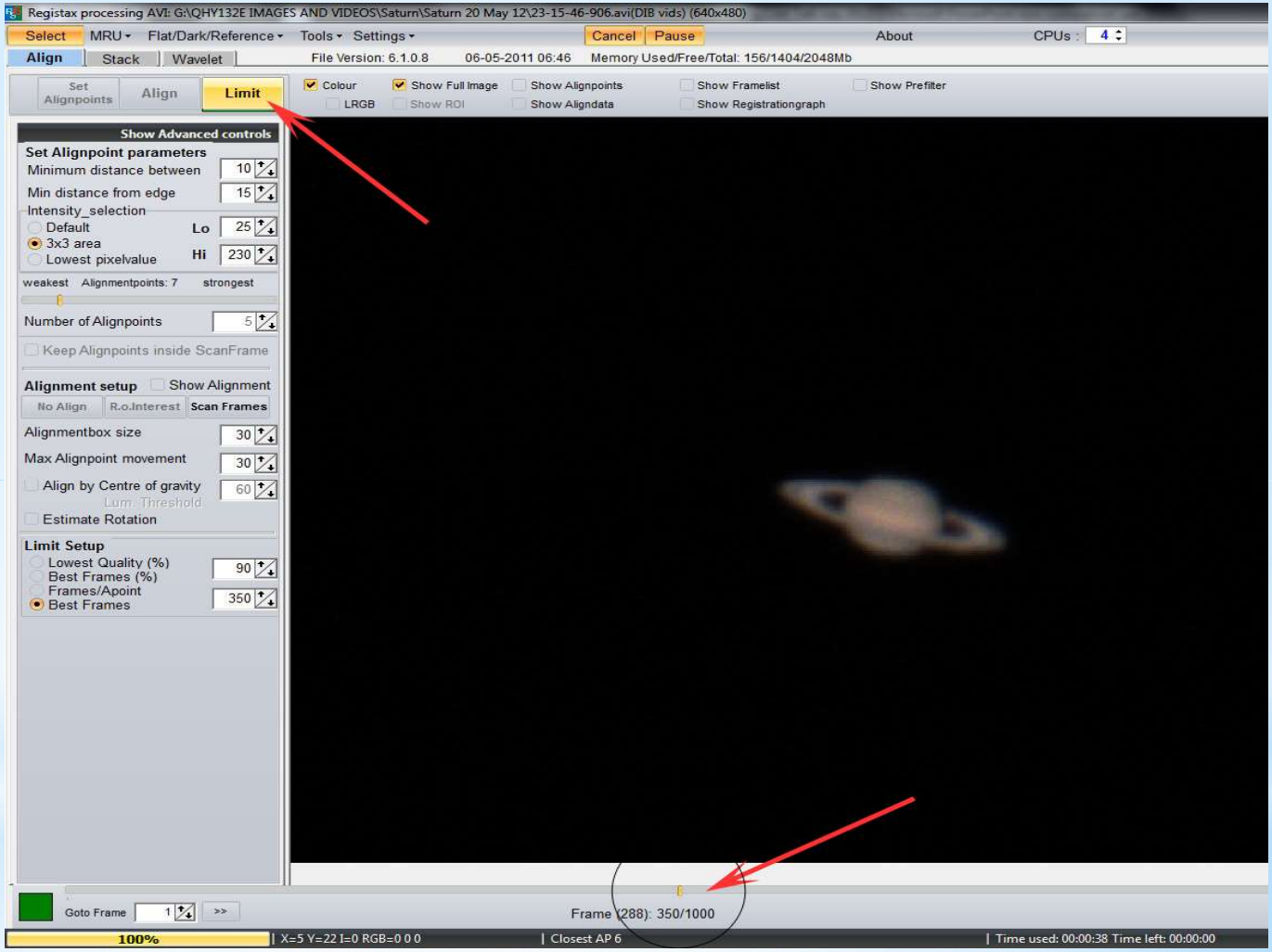
Limiting Numbers

Next starting from the far right hand side move the slider and watch the image.

Until the image looks reasonable, aim to finish with 60% of the frames

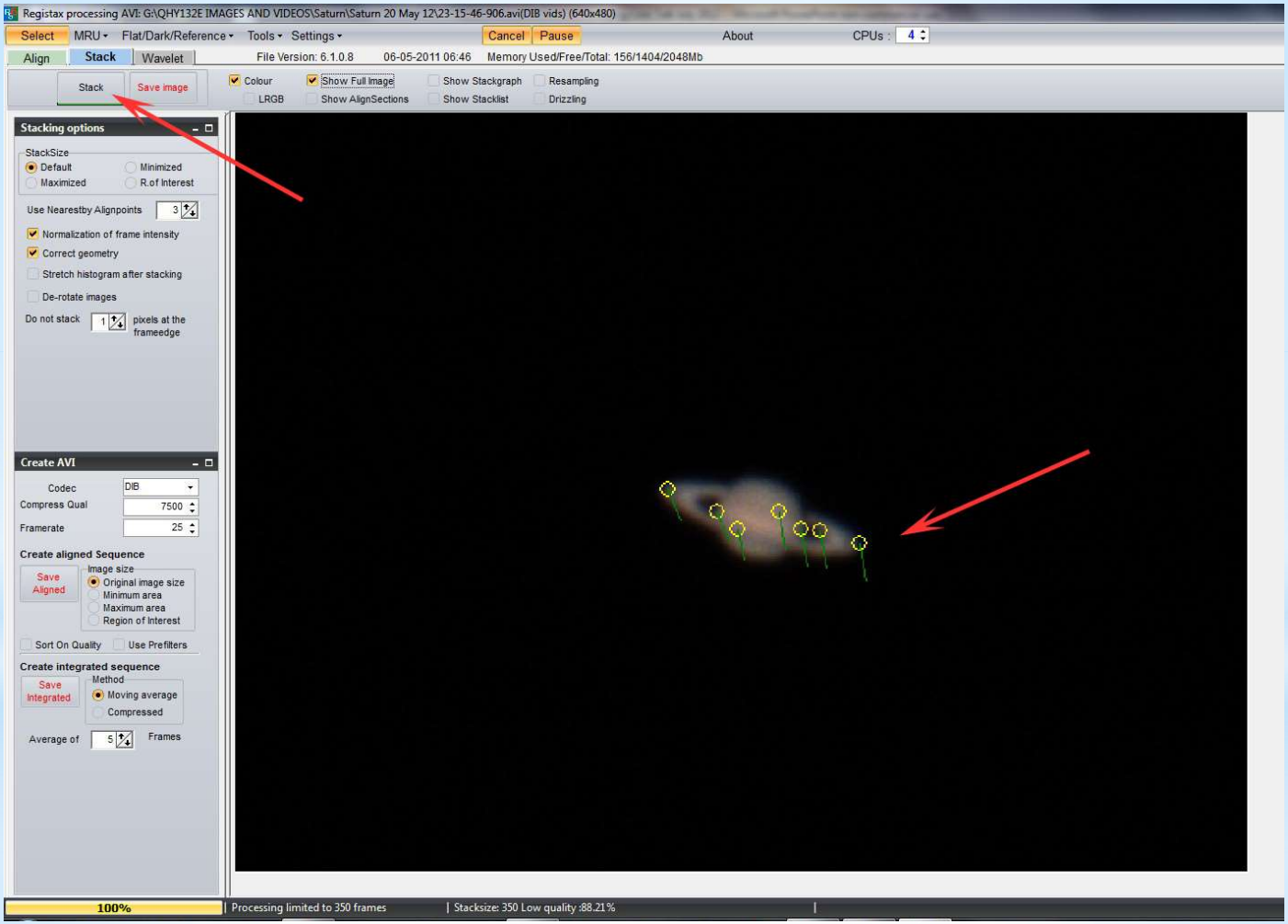
Then press the **Limit** button.

300 frames will give a good image.



Stacking the Frames

Next press the **Stack** Button and the software will stack the frames



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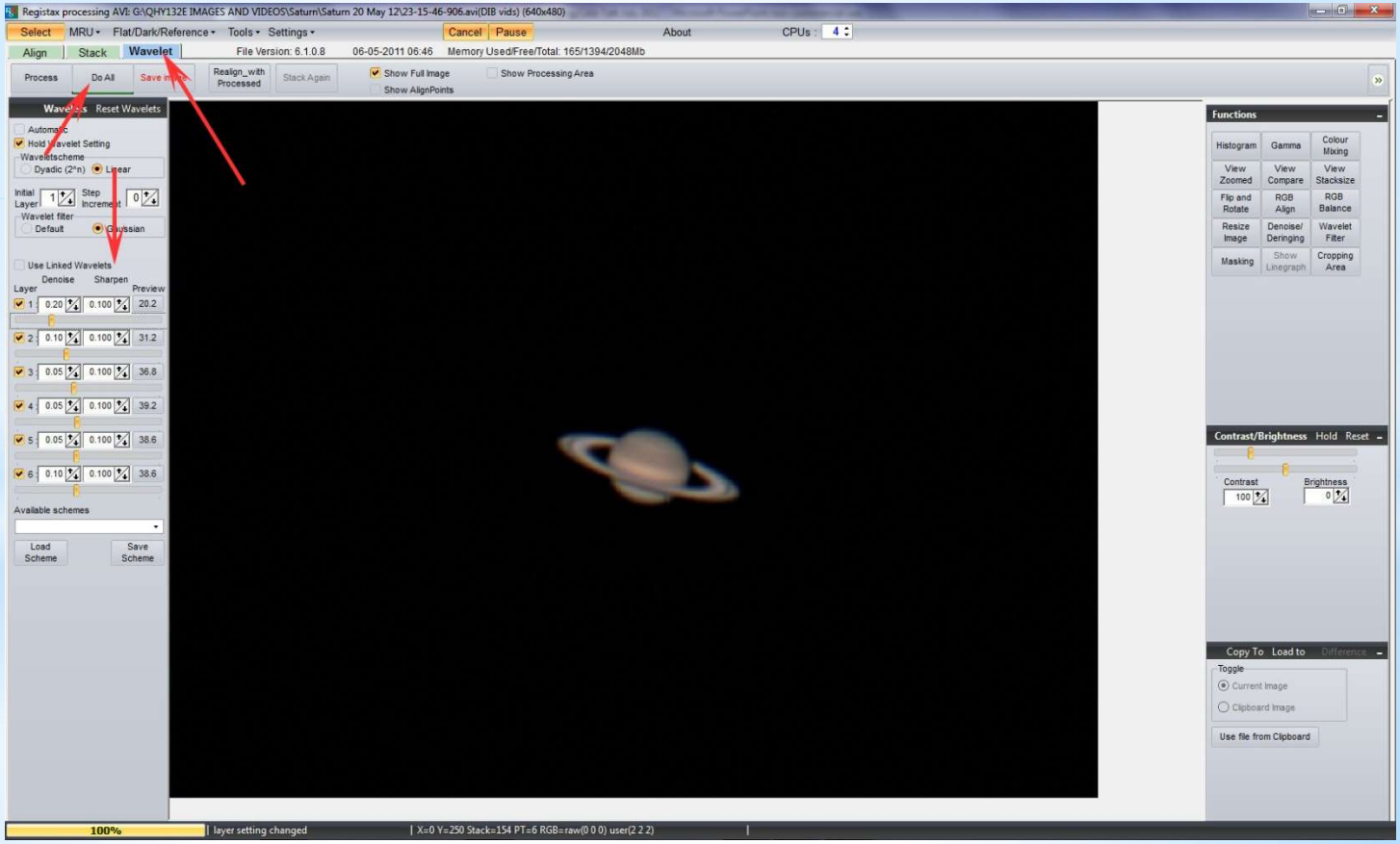
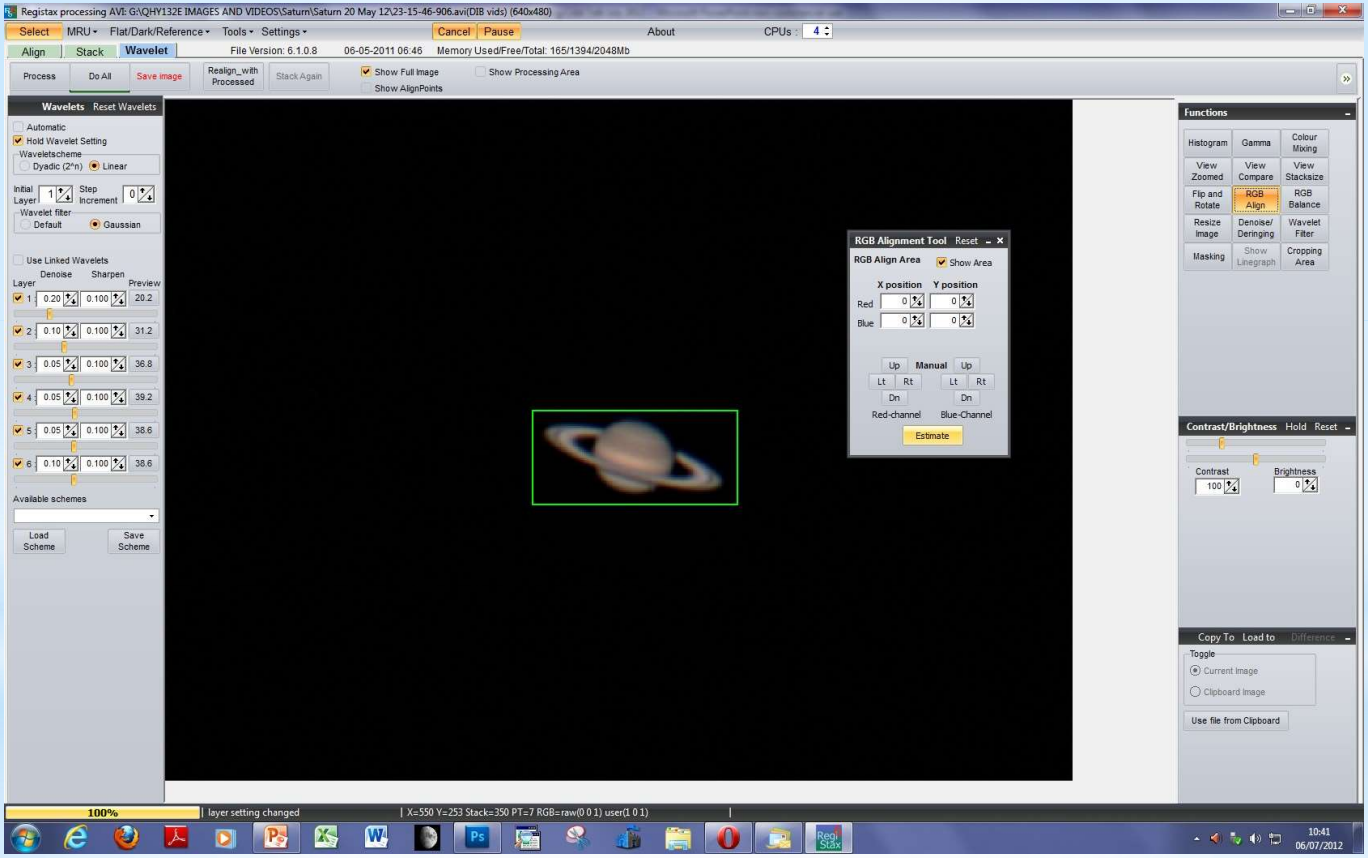


RGB Alignment

In some colour images fringing can some time be present, if so use the RGB Align function to correct the balance.

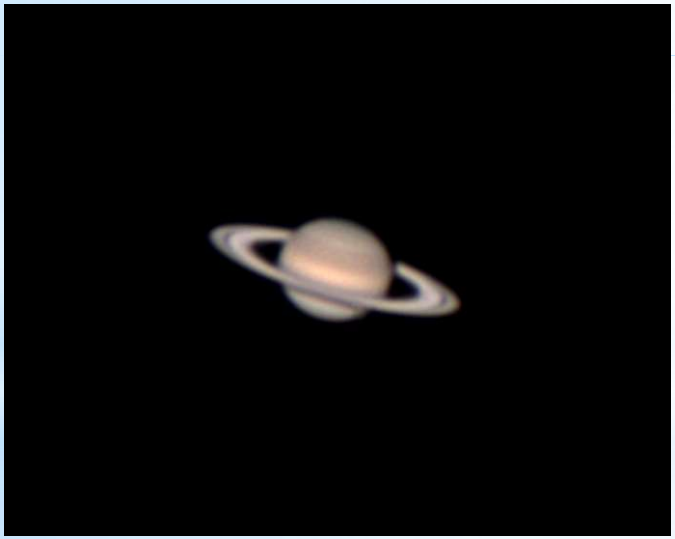
Draw a frame around the image and press Estimate



Other Processing Tweaks

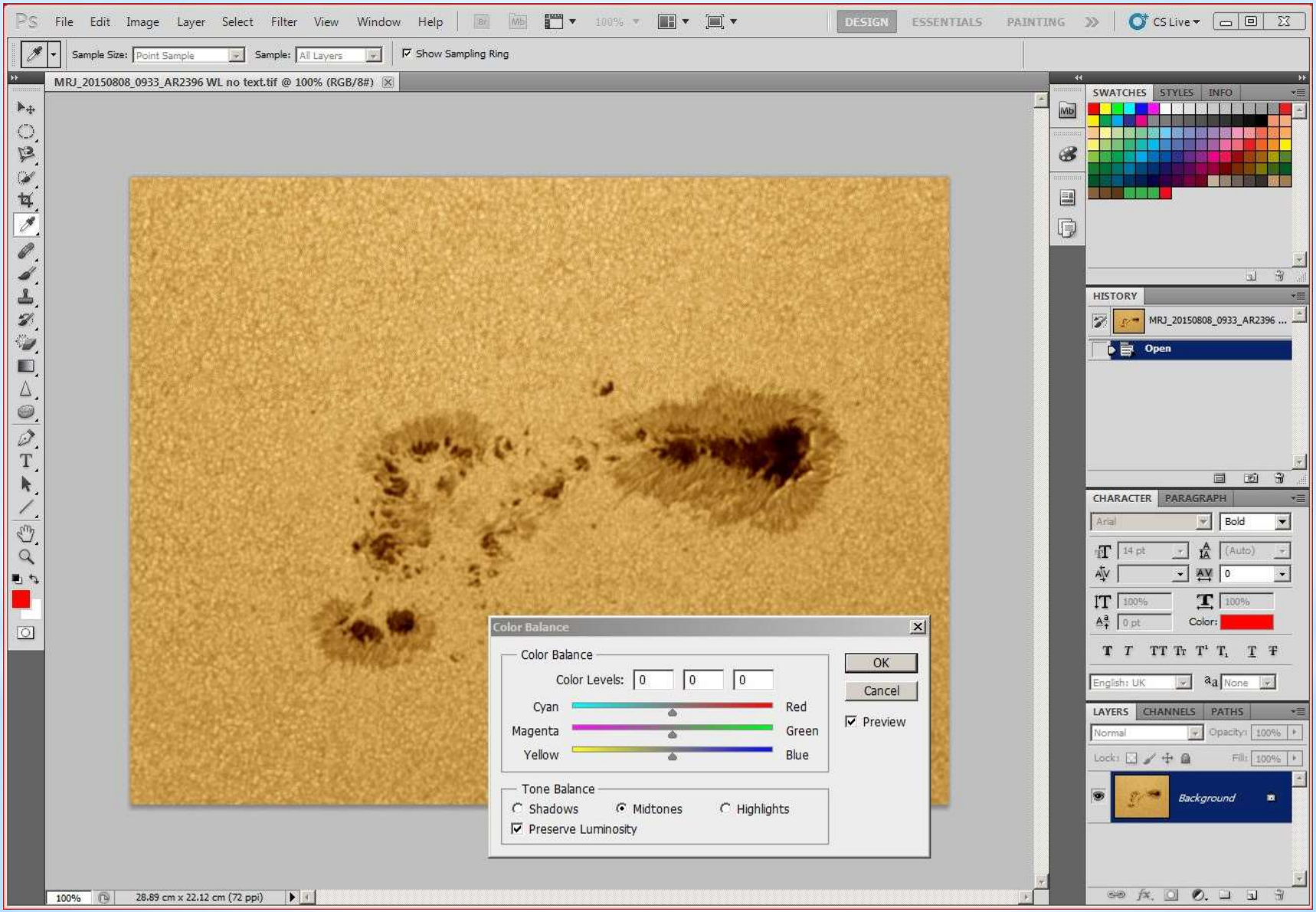
Its best to save the image as a Tiff file and do the rest of the processing in a Photographic software program such as Photoshop.

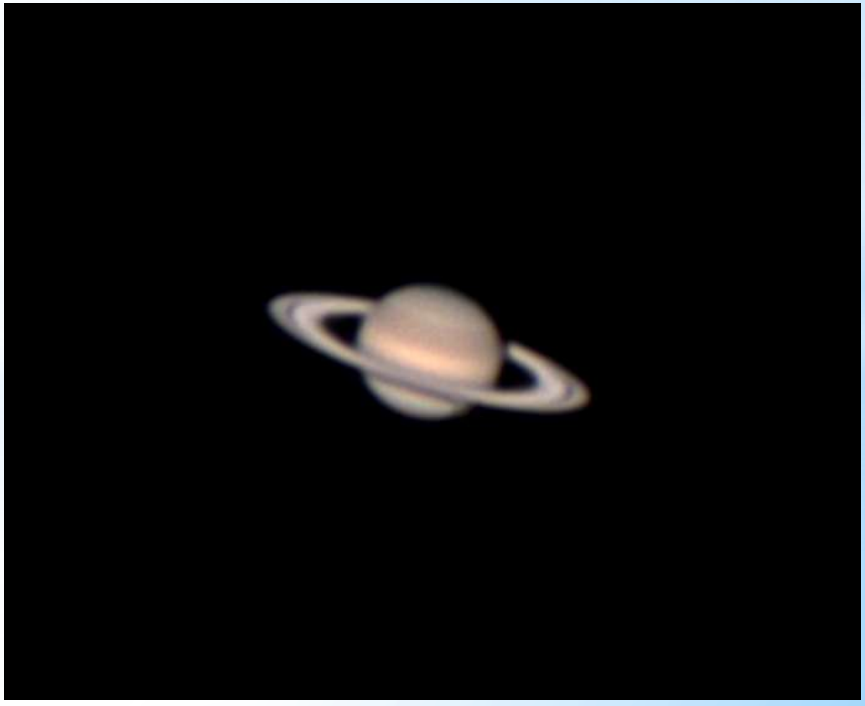
Some difficult images are best processed in the earlier Issue 5 version of RegiStax

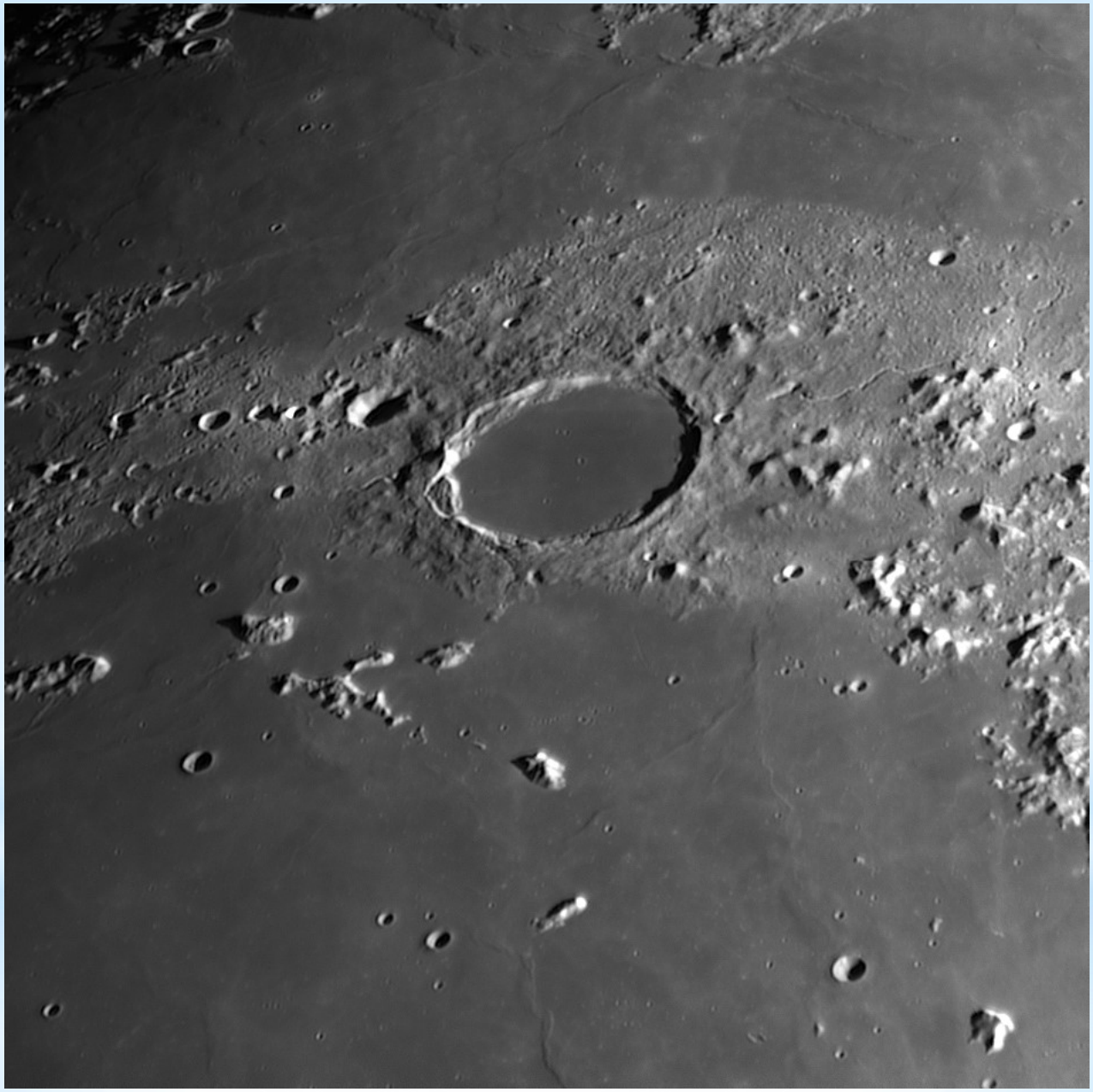


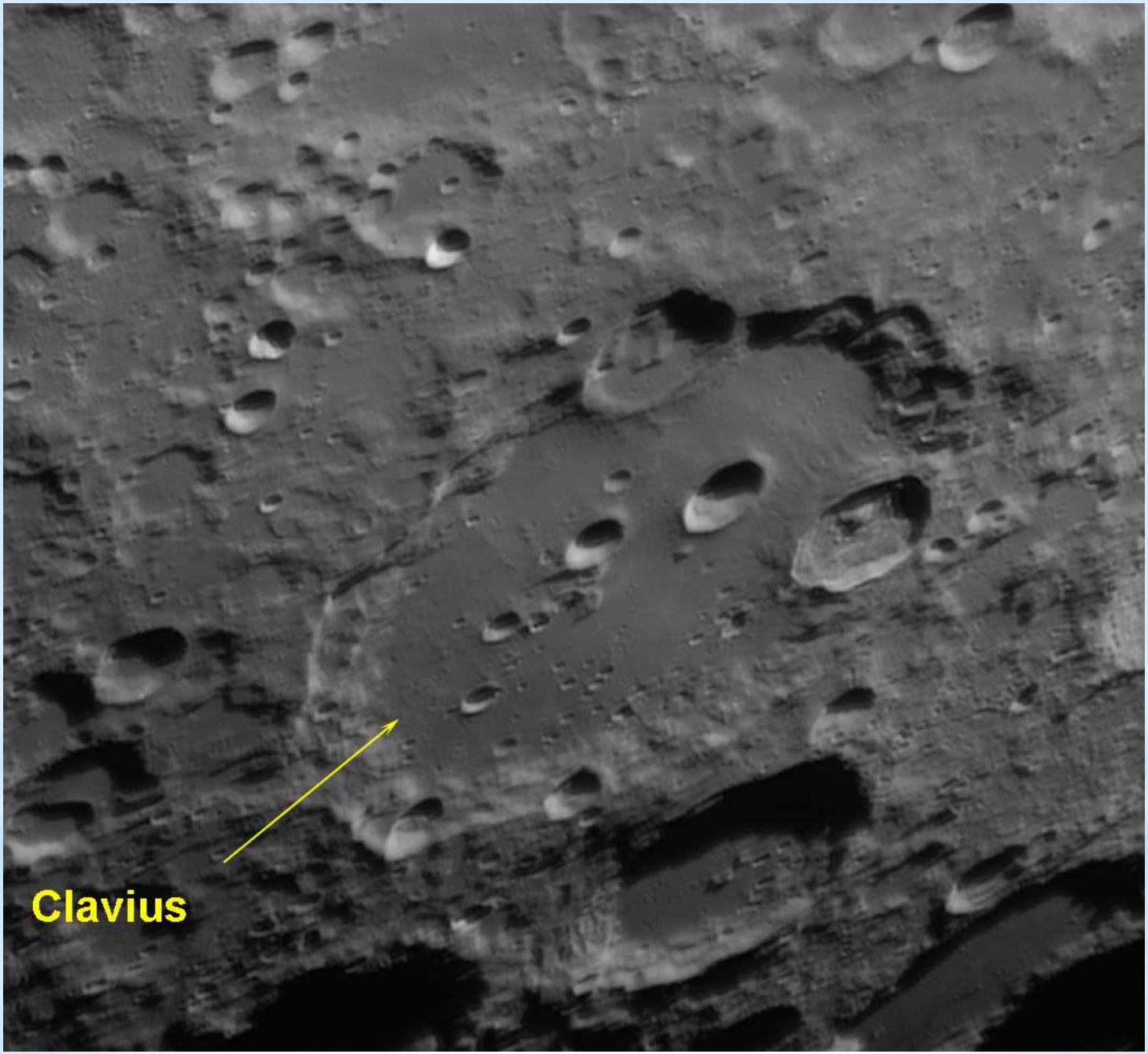
Finished Image

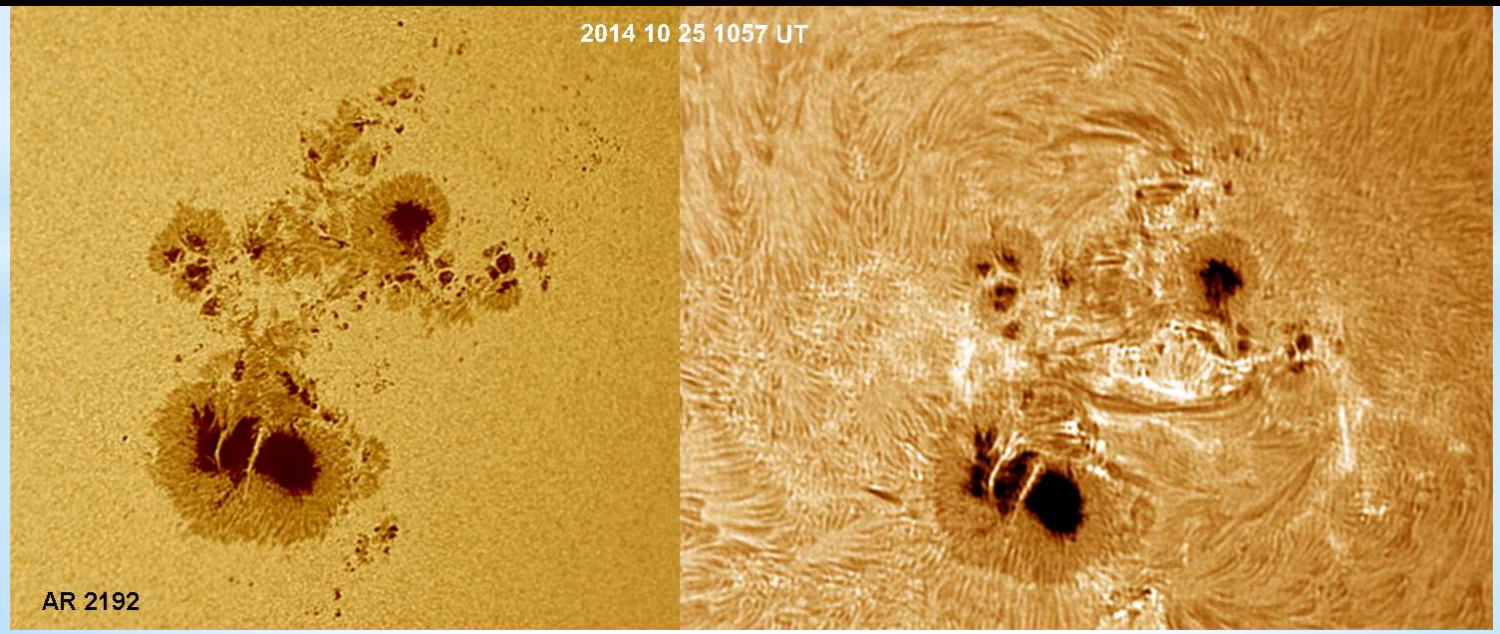
Photoshop - Final Processing








Clavius


2014 10 25 1057 UT
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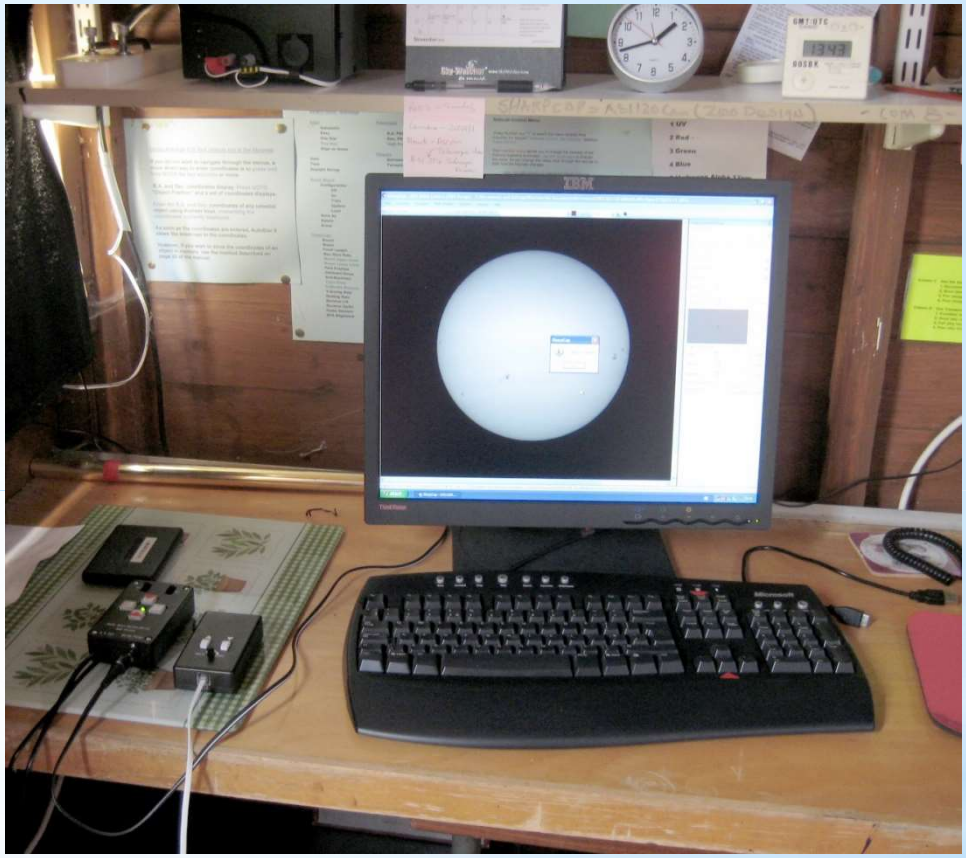
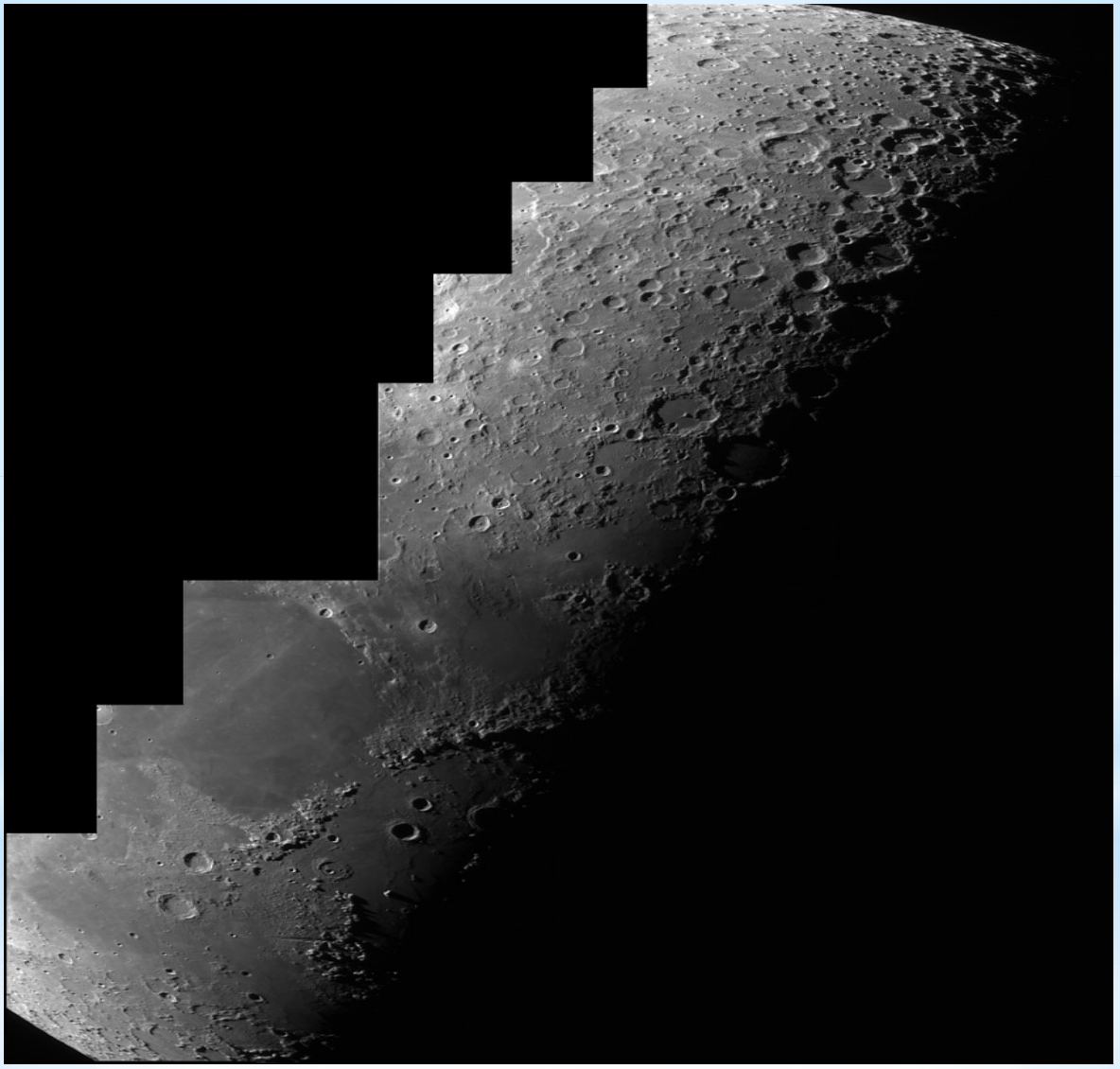

IBM

Creating a Lunar Mosaic



Creating a Lunar Mosaic

Most webcams have a small sensor size, so a small field of view.

To get the whole moon you may need to make a mosaic by taking several videos.

- Set your tracking mount to the Lunar Rate
- Keep settings the same throughout all videos
- Make sure you overlap your videos
- Process in Autostakkert and Registax – use same settings, including Wavelets
- You don't have to manually align the image frames.
  - Use Photomerge in Photoshop and Photoshop Elements (8+)
  - Microsoft ICE program (Free)