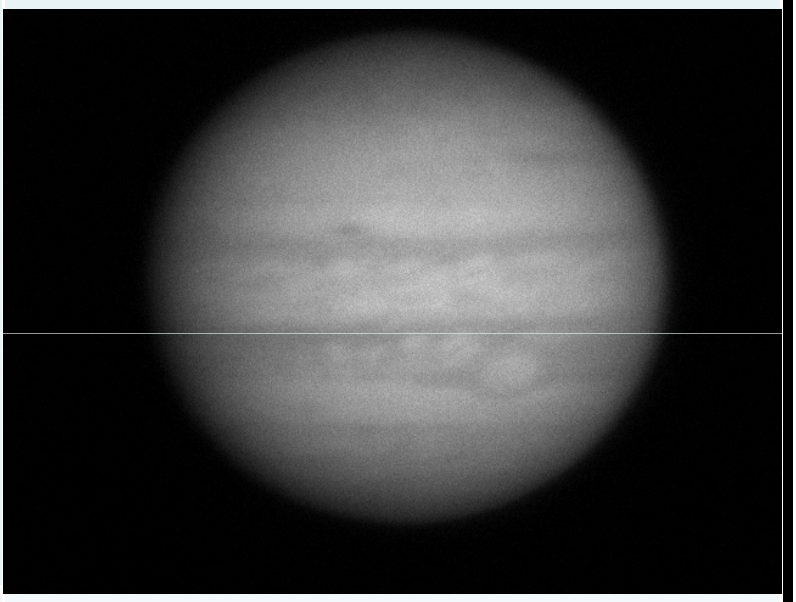
High Resolution Planetary Imaging

Fighting the Atmosphere

- Getting out of the Atmosphere
- Adaptive Optics
- Lucky Imaging

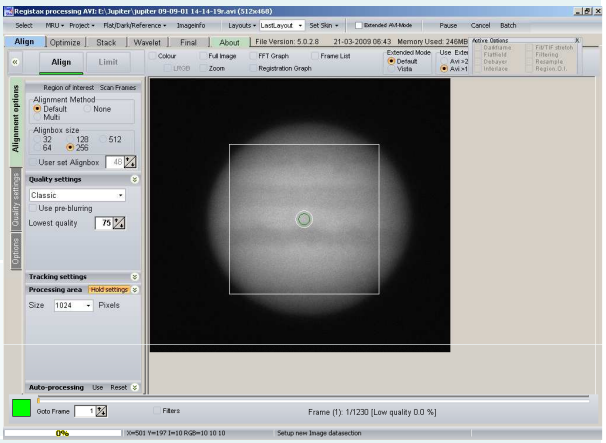
Feeling Lucky

Lucky Imaging is the process of capturing planets using a CCD video camera. A software to sort out the quality of the images. This takes allows one to take advantage of the fleeting good seeing.



Lucky Imaging

Development of inexpensive video capture devices. (ie, Philips Toucam, Imaging Source ZWO, PtGrey, Celestron)



The advances of computer hardware and interface.

The development of processing and control software. (ie Registax and Firecapture)

SUMMARY

Choosing the Right Equipment

Imaging Workflow

a. Preparation

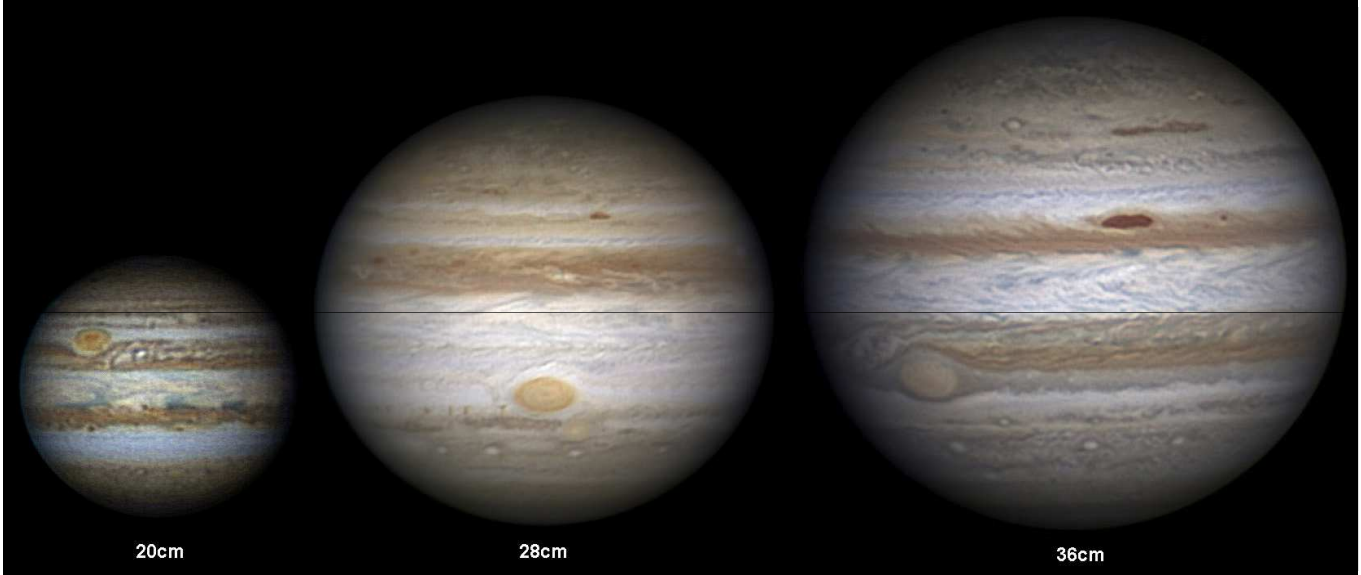
b. Image Capture

c. Image Processing

d. Post Processing

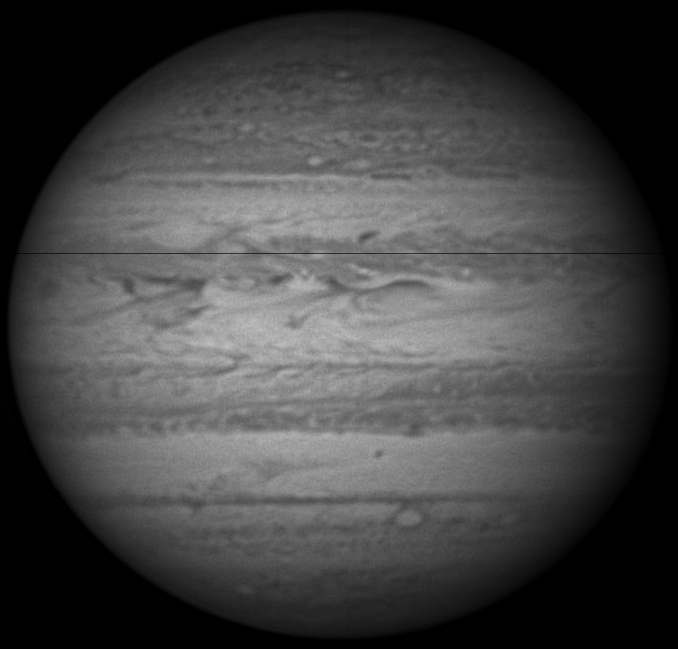
e. Archiving

The Telescope: Aperture Rules!

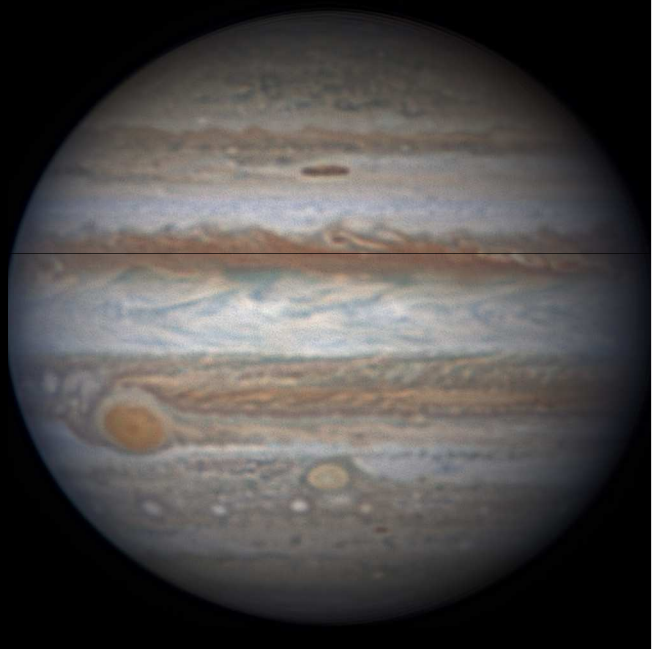


The bigger the aperture, the higher the resolution.

Imaging with Large Telescopes



Jupiter: Thailand National Observatory (IR720)
2014-12-10 21:50UT (4 min) 2.4m f/10
NARIT, Dr. Saran Poshyachinda, Christopher Go
Doi Inthanon, Thailand



Jupiter: GRS and Oval BA
2014-12-11 22:46UT (9 min)
I: 92 II: 180 III: 77 S: 8/10 T: 5/5
NARIT, Saran Poshyachinda, Christopher Go, Thanakrit Santikunaporn
Thailand National Observatory (Doi Inthanon)

The Camera

High Speed Machine Vision Industrial Camera

Can do high frame rate with no compression. Low noise circuit. Flexible imaging capabilities.

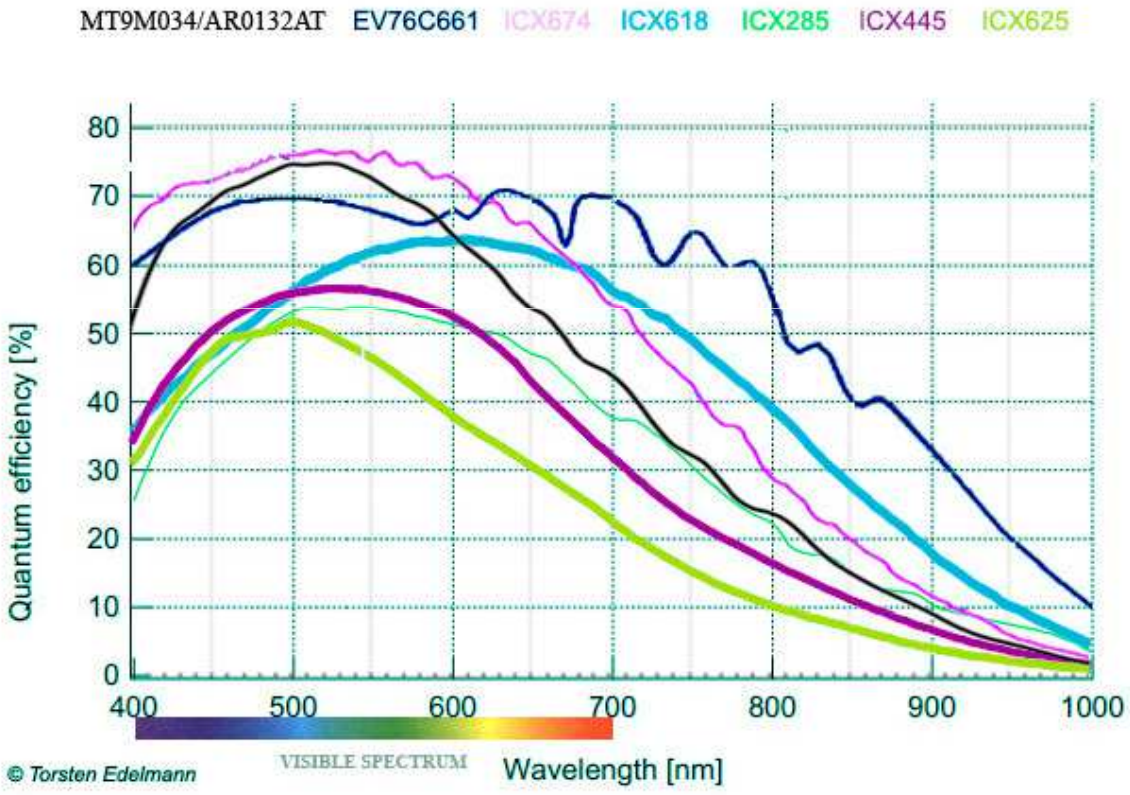
Available from the following companies:

1. Celestron International
2. Point Grey Research
3. ZWO Optical

Monochrome or Color

Color CCD	Monochrome CCD
Pro: Simple to Setup and Fast Processing. Very inexpensive setup.	Pro: Very Sensitive CCD, better image quality, no problem with Atmospheric Dispersion.
Cons: Less sensitive CCD due to Bayer Layers. Needs to compensate for Atmospheric Dispersion.	Cons: Expensive and Complicated Setup.

CCD is DEAD! Long Live CMOS!



Some Useful Accessories

Barlow	Increases the image scale of the object imaged
Motorized Filter Wheels	Allows vibration free changing of filters.
Filters:	
RGB Filters	To make colored image from monochrome camera.
UV, IR and Methane Band Filters	Special Filters to reveal atmospheric details on gas planets.
Flip Mirror	Time saver in centering an object to the CCD camera.
Motorized Focuser	Allows vibration free and fine focusing
Vibration Suppression Pads	Reduces high frequency vibration when imaging on hard surfaces

Preparations before Imaging

Location, Location, Location
• Best place to do planetary imaging is at the area close to the equator (where planets are higher), and close to the sea.
• Stay away from heat sources (ie., air conditioning system, chimneys, hot asphalt, etc.)
• The three most important thing in getting quality planetary image are: seeing, seeing and seeing!

COOL YOUR OTA

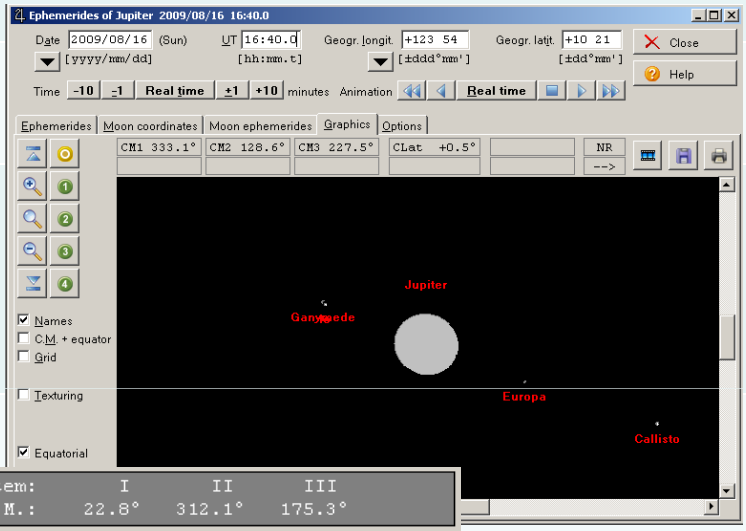
It is very important that the telescope is at ambient temperature. Tube currents KILL seeing!

Plan your imaging with WinJupos

Use the Ephemerides function of Winjupos.

Check which side of the planet will be visible in your planned observing time.

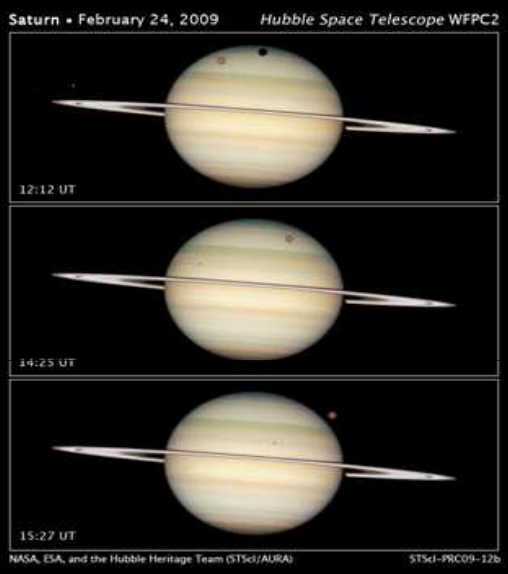
Check the position of the moons of the planets to check for transits or eclipses.

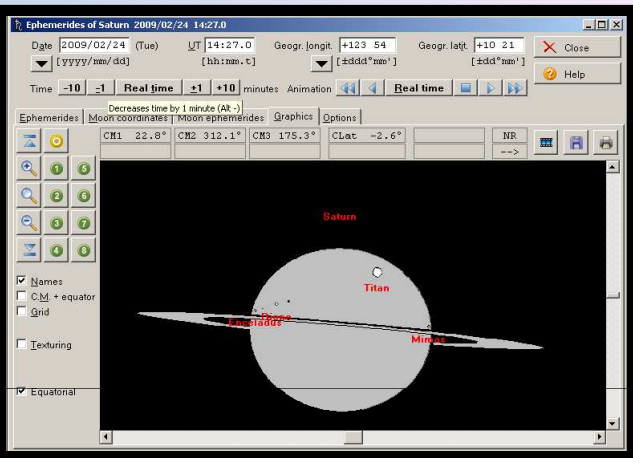


System:	I	II	III
C.M.:	22.8°	312.1°	175.3°
11h -	261.4	195.3	58.8
12h -	296.6	229.2	92.5
13h -	331.8	263.0	126.3
14h -	7.0	296.8	160.1
15h +	42.2	330.7	193.9
16h +	77.4	4.5	227.7
17h +	112.5	38.3	261.5

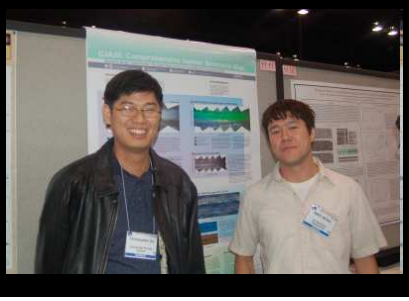
If you do not plan, you might miss exciting events!!

The 2009 Quad Transit at Saturn





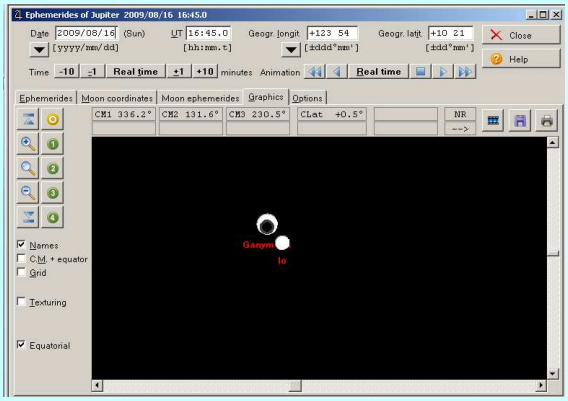
HST Imaging with Mike Wong and the Hubble Heritage Team.



Ganymede/Io Eclipse!

A very rare Solar Eclipse on Jupiter's moon Ganymede by volcanic Io!

This image sequence was taken using a Celestron C11 telescope with a DMK21F04 Camera.



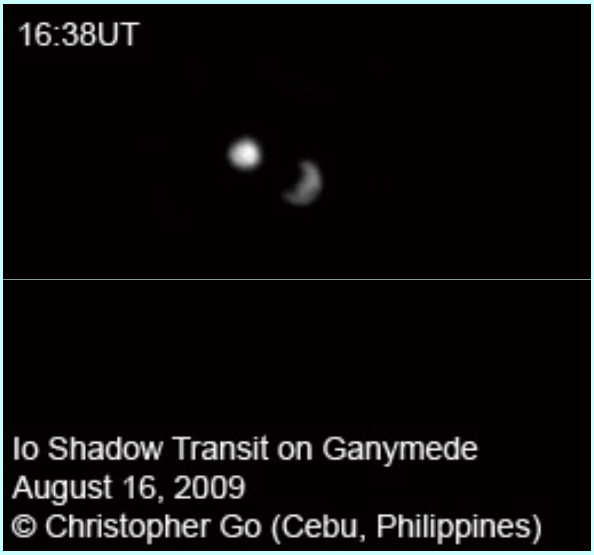
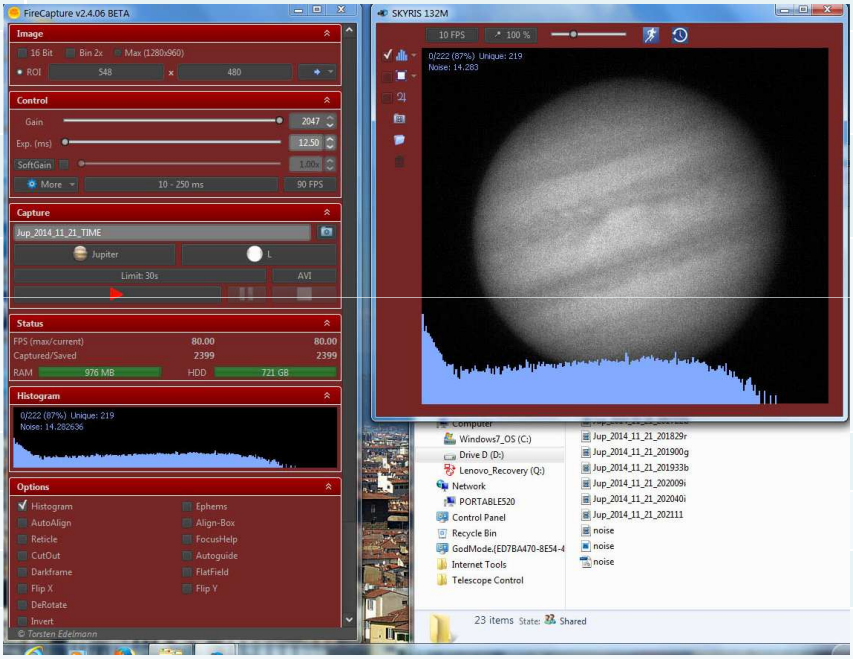


IMAGE CAPTURE

FireCapture

- Currently, one of the best capture software.
- It supports a variety of cameras.
- Feature rich. It as autoguide function and allows control of filter wheel.
- It's Free!!



Capture Secrets

Find the sweet spot of your imaging system. Have a capture routine for each target object.

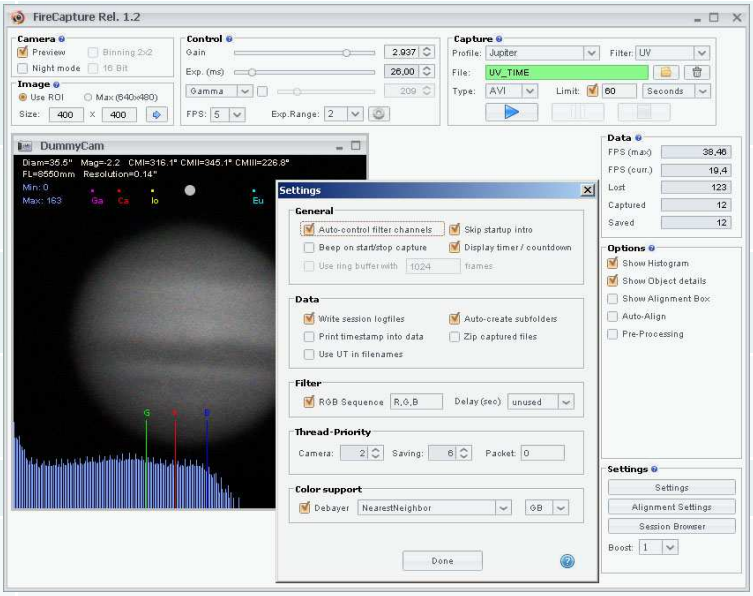
Make sure your filename includes the UT date and time.

Use the fastest frame rate possible.

Don't be afraid to push gain to 100%.

Turn off Gamma!!

Spend time to focus the telescope.



Use Region of Interest (ROI) to reduce file size for faster processing.

Final Image Quality Depends on your capture quality. So be patient!

Jupiter

Keep histogram level around 80-90% on all channels.

Keep total integration time below 2 minutes.

Use focal length of around 30X of your aperture 5 micron pixel cameras and 20X the aperture for 3.75 micron cameras.

Saturn

Saturn has very low surface brightness.	Use Winjupos Derotation so that the final image will be smooth.
Use 50% histogram level for red and green and 30% for blue.	
Keep total integration time to around 3 minutes.	

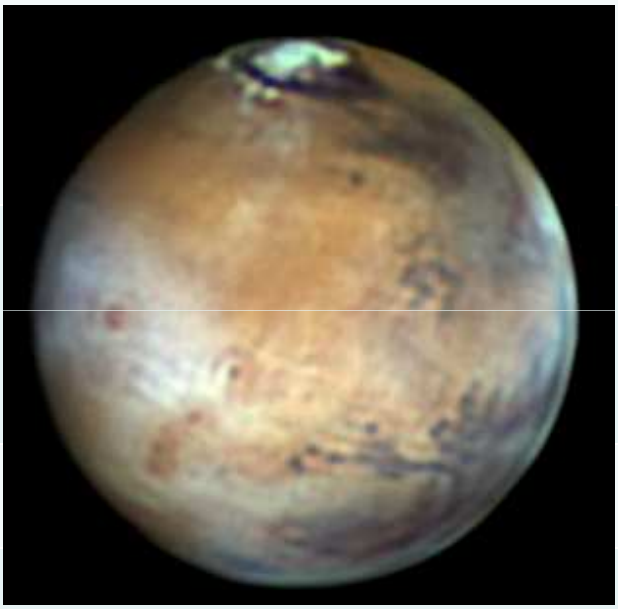
Mars

Use focal length around 50X the aperture for 5 micron pixel cameras and 30X the aperture for 3.75 micron cameras.

Keep histogram level of the Red Channel at around 80-90%. Keep Green at around 60-70% and Blue around 30-40%.

Total integration time can be as long as 4 minutes.

UV-IR should be blocked to get true colors. Make sure your blue channel has no IR leakage.



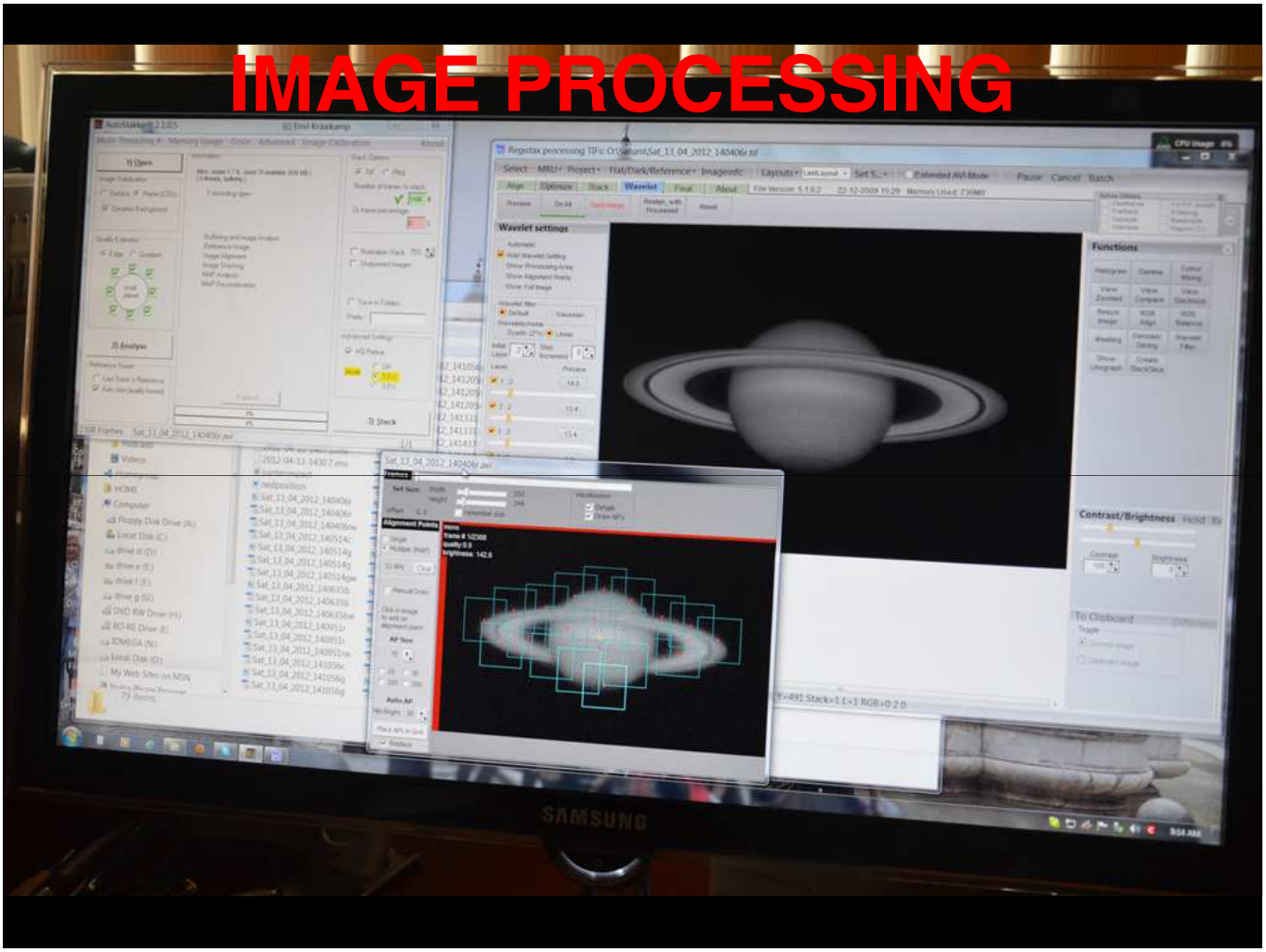
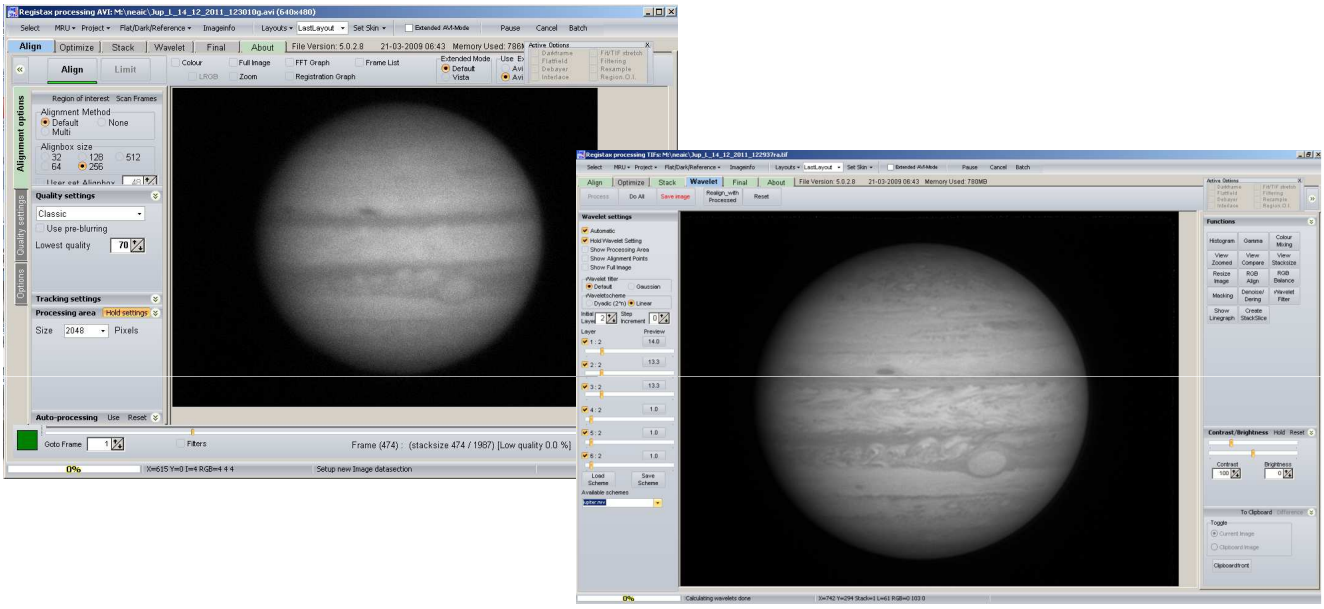


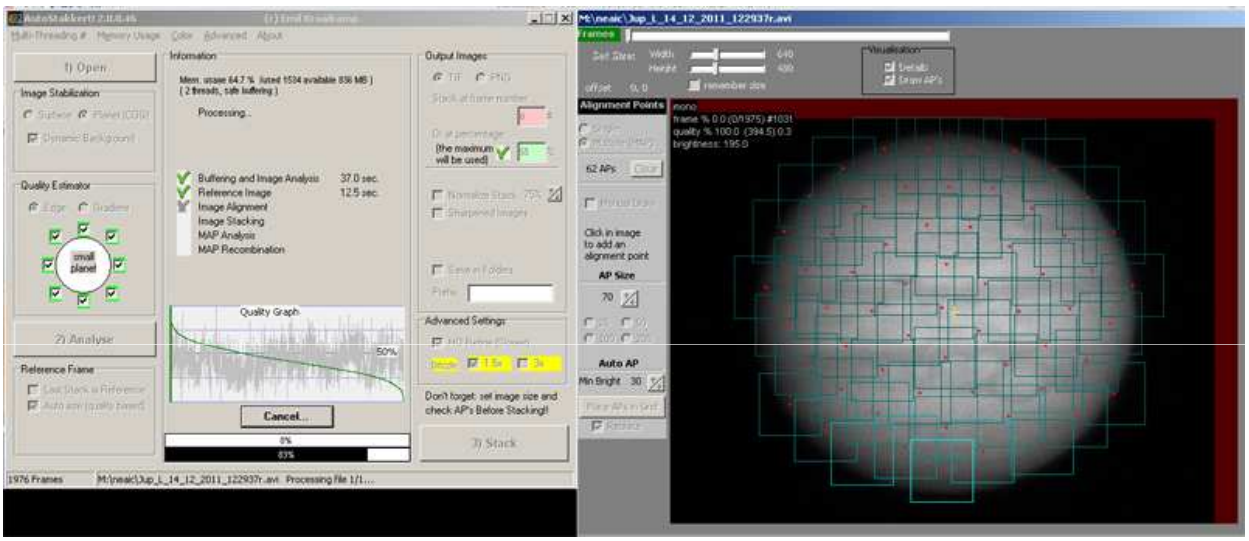
IMAGE PROCESSING
Wavelet settings
Functions
Contrast/Brightness
SAMSUNG

Registax



This is the software that revolutionized Planetary Imaging. This software has excellent controls and features. Allows the use of dark and flat correction. It has an excellent sharpening wavelet tool.

AutoStakkert!!



Pro: AutoStakkert is easier to use and better results vs Registax. Process the image faster and automatically aligns the image.

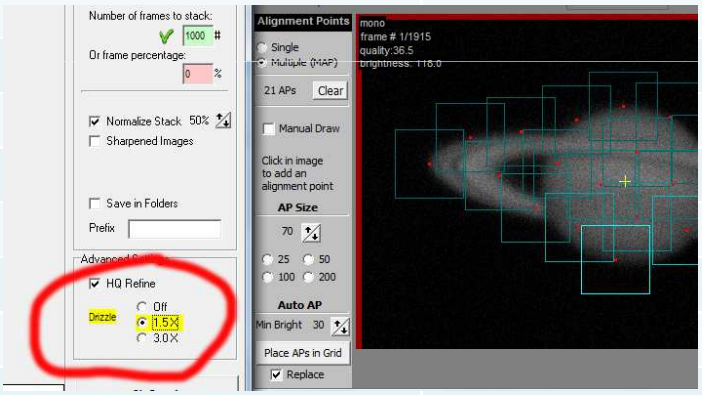
Con: Few controls. Not very intuitive to use.

Making Things Bigger

Resampling can be use to increase image size.

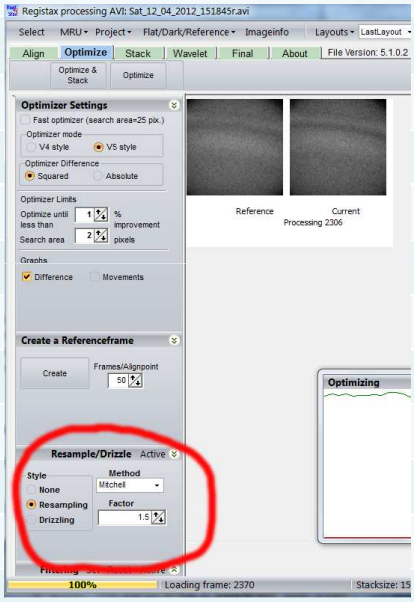
AutoStakkert

1.5X Drizzle



Registax

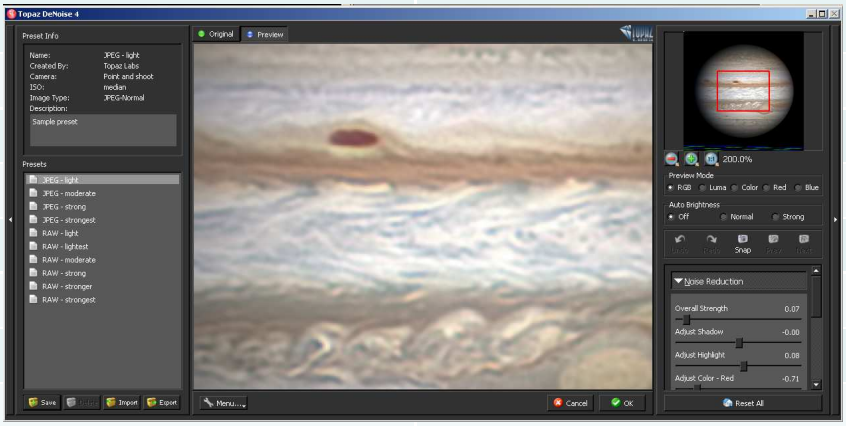
1.5X Mitchell



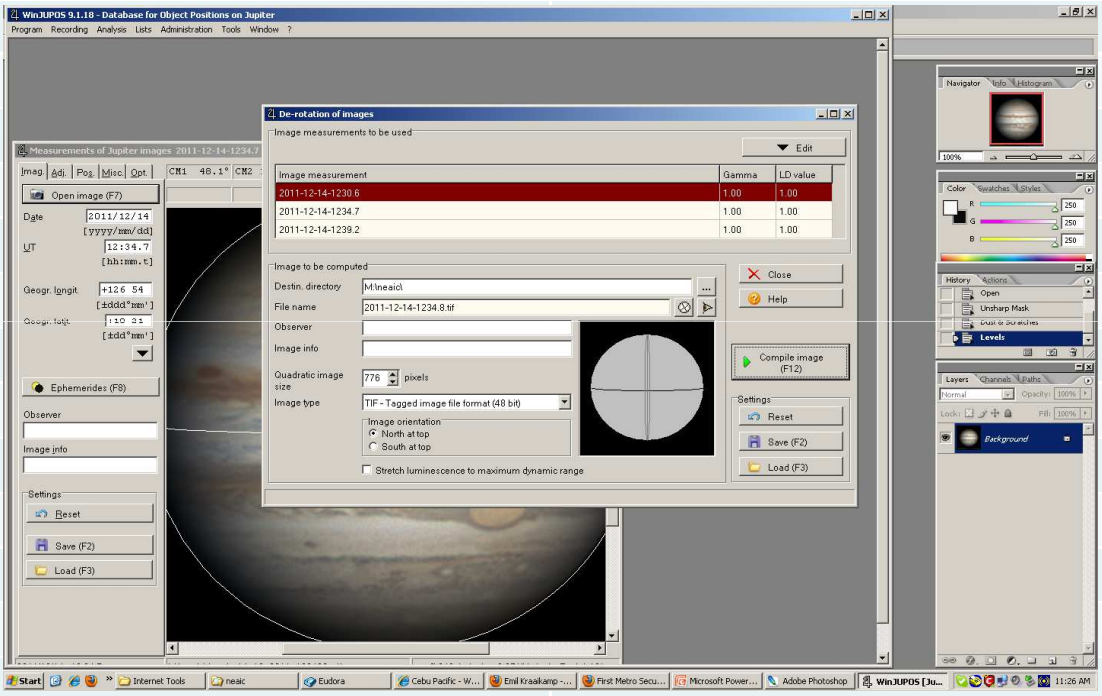
Sharpening vs Noise Reduction

Sharpening Tools	Noise Reduction Tools
Registax Wavelets	Despeckle Tool
Unsharp Masking	Dust and Scratches Tool
	Topaz Labs DeNoise Tool

Image Processing is an art form. Each person will have their own look.



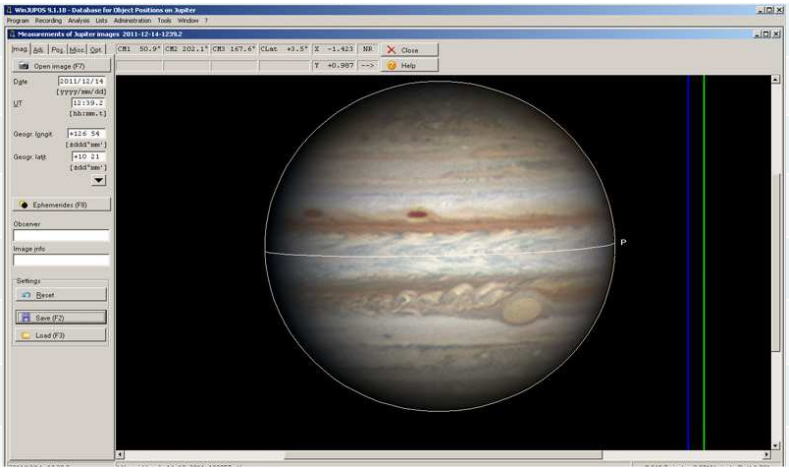
WinJupos DeRotation: The Next Revolution in Planetary Imaging



WinJupos DeRotation module allows imagers to go past the time limits set my the rotation of the planets.

1. Image Measurement

a. Capture multiple image sequence for a span of 15-20 min.	*-Use Page Up and Down to increase or decrease the size of the outline.*
b.Open Image in Image measurement window. Input the date and time the image was taken.	c. Press F11 to automatically adjust the outline.
d. The outline has to be adjusted by: *-Use the Arrow Keys to go move the outline.* *-N to rotate the outline clockwise and P to rate it counterclockwise.*	e. Save the measurement in .ims file. f. Repeat with all images.



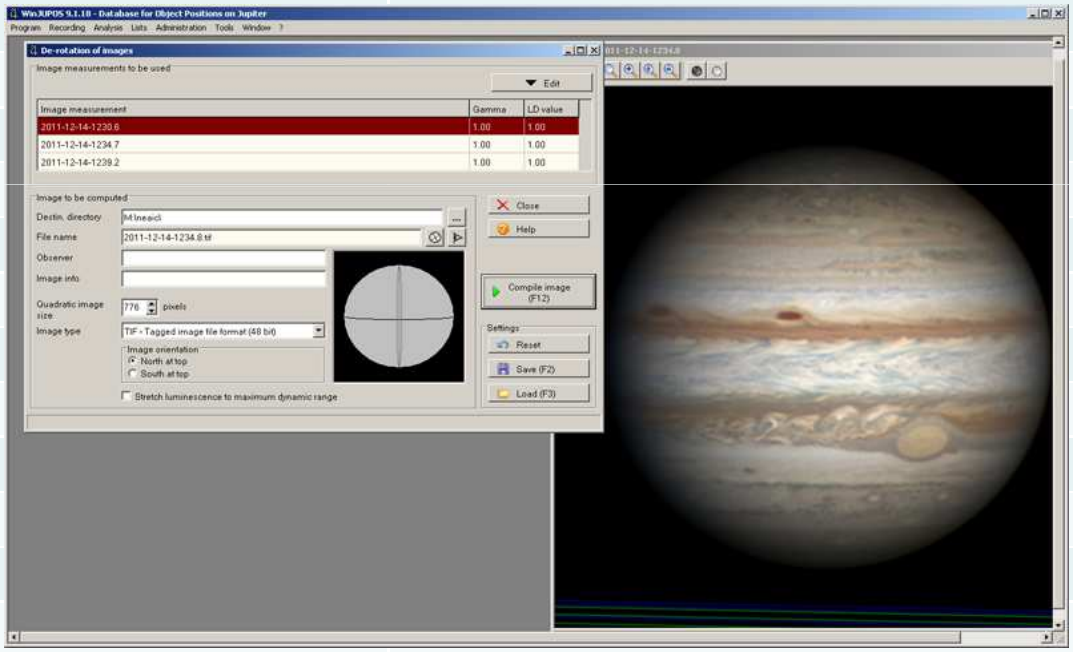
2. De-Rotation

a. The der-otation module can be found under the tools menu.

b. Press Edit and Add each of the IMAGE MEASUREMENT FILES you want to stack.

c. Choose the output file type and image orientation you want your final image to look.

d. Press COMPILE IMAGE.



Single vs Derotated

SINGLE IMAGE

10 IMAGE DEROTATED IMAGE

The Work Flow

Capture Workflow

1. For RGB: capture continues RGB sets. When seeing is good, capture 4 sets for amateur telescopes. For 1m and above, capture 15 sets of RGB.

2. For IR, CH4 and UV, capture 4 continuous capture for amateur telescopes and 15 for 1m and above.

Processing Sequence:

1. Process all captured data in Autostakkert.
2. Apply Registax Wavelets.
3. Combine RGB in Photoshop.
4. In Winjupos, do image measurement for each RGB file.
5. Derotate

The Final Image

1. North or South up?
2. Use UT time of the green channel if your are doing RGB.
3. Include Central Meridian info. This info can be obtained with WinJupos Ephemerides Tool.

For Jupiter and Saturn Include the THREE Central Meridian Info.

4. Include observer information Name and Location.
5. When using De-Rotation indicate your total capture time.

Post Processing/Archiving

Review all Jupiter and Saturn videos for possible impacts using the Jupiter Impact Detection Software.

Archive your data! Use compression to reduce data volume.

Burn compressed archives on Blue-Ray Discs or store on removable hard drives.

Software/Hardware Info

Capture Software	
FireCapture	http://firecapture.wonderplanets.de/
Stacking Software	
Registax	http://www.astronomie.be/registax/
AutoStakkert 2.0	http://www.autostakkert.com/
Winjupos	http://www.grischa-hahn.homepage.t-online.de/astro/winjupos/index.htm
Camera Companies	
Celestron	http://www.celestron.com/
Point Grey Research	http://www.ptgrey.com
ZWO Optical	http://www.zwoptical.com/Eng/cameras/