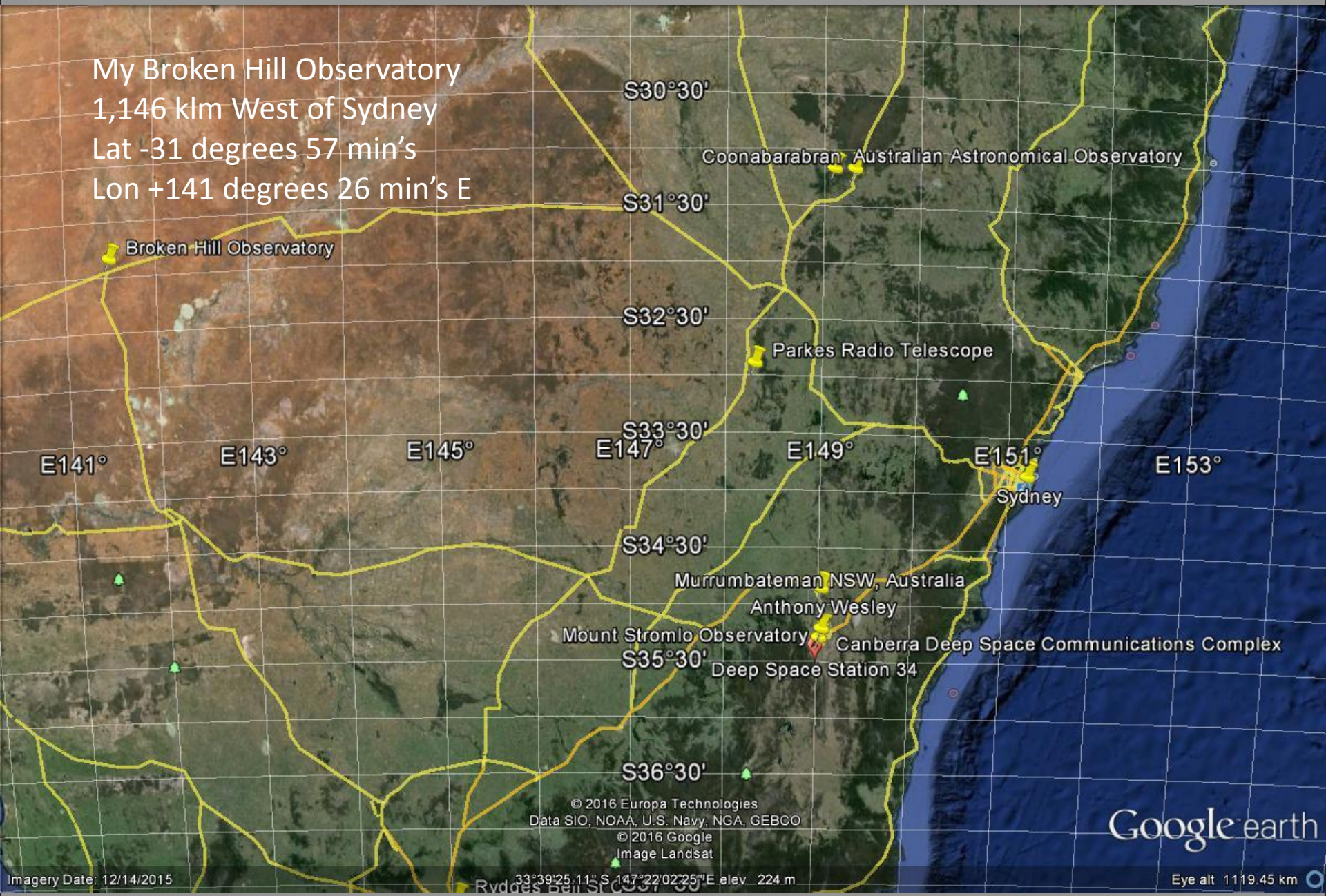
JUNO
Workshop
May 12th-13th 2016

Trevor Barry

Grad Cert Sc

Broken Hill Observatory

NSW Australia


My Broken Hill Observatory
1,146 klm West of Sydney
Lat -31 degrees 57 min's
Lon +141 degrees 26 min's E
S30°30'
Coonabarabran Australian Astronomical Observatory
S31°30'
Broken Hill Observatory
S32°30'
Parkes Radio Telescope
S33°30'
E141°
E143°
E145°
E147°
E149°
E151°
E153°
Sydney
S34°30'
Murrumbateman NSW, Australia
Anthony Wesley
Mount Stromlo Observatory
Canberra Deep Space Communications Complex
S35°30'
Deep Space Station 34
S36°30'
© 2016 Europa Technologies
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2016 Google
Image Landsat
Imagery Date: 12/14/2015
33°39'25.11" S 147°22'02.25" E elev 224 m
Eye alt 1119.45 km
Google earth

Age 64 years, retired 2002.
Mechanical & Electrical Engineering background, 34 years on the Broken Hill Mines.

Enrolled in Graduate Certificate of Science in Astronomy semester 1 2003 with Swinburne University.

Graduated Swinburne University Melbourne March 2005 with Grad Cert Sc
Received faculty Award for Excellence September 2005.

30 years active amateur astronomer.

2008 accompanied Swinburne research team, headed by Professor Duncan Forbes to Hawaii, had two nights observing with Keck II. Swinburne being the only Australian University with a time allocation on the Keck's and following our two nights with Keck II was invited to join Caltech Professor Chuck Steidel for a third night on Keck I.

The South Celestial Pole over the slot of my observatory.

I designed and built the Broken Hill Observatory in 1988, originally a single storey rotating dome but then built the current two storey version in 1996.

Downstairs in my observatory


PLANETS
OF THE SOLAR SYSTEM

MOON

Saturn Northern hemisphere's atmosphere and polar hexagon in 2013

M. Delcroix[1], P. Yanamandra-Fisher[1], G. Fischer[2], L.N. Fletcher[3], K.M. Sayanagi[4], T. Barry[5]

(EPSC2013-1067 AM1.P167)

[1] Space Science Institute (jdelcroix@ssi.edu), [2] University of Central Arkansas, [3] University of Oxford, [4] Hampton University, [5] Cahill Observatory, New South Wales, Australia

Abstract

In 2010, two years after the dramatic events of the Great White Spot (GWS), which occurred in the northern hemisphere (N 25), amateur astronomers continued to follow the evolution of the "GWS zone" centered around 41° planetographic on Saturn. A particular dark oval, created by the GWS. They should also recover a very rare Saturn Electrostatic Discharge (SED) storm and watch the hexagon at least until surviving Saturn's north pole with a spot at its edge.

Data

Amateur data comes mostly from collectors with an aperture from 16 to 40 cm. Their image coverage is good during a number of years in opposition. The data comes from different sources (Pro-am Planetary Society, ALPO, Saturn (SPA) Awards, Astronomy Florida) imaging Saturn by "IR" wavelength from at around the world. From each of hundreds of 2012 as most of August 2013 have been studied. After collecting 177 images, based on quality, only one image per night was retained. Finally, 214 individual images were selected for this study. Also the polar hexagon images from Cassini ISS (Front Cam, 2010) were used to research the evolution of a dark wave in the hexagon shape and identify a storm feature, detected by [6][7][8], as part of the regular yearly cycle of storms in 2012 from professional telescopes (HST, Subaru) to image the hexagon and its surroundings.

The aim was to collect in order to observe the evolution of Saturn's northern hemisphere's atmosphere in 2013 and to measure the position of features, and derive their drift rates in longitude.

Figure 2: Tracking of the dark oval structure on 08/31 since the 2010 observation by Hubble and Cassini and tracked with a single Cassini ISS image (right) after years.

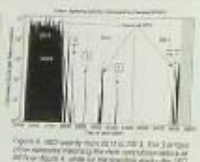
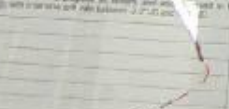


Figure 3: HST image from 2010-11-09 (left) and 2013-08-31 (right) showing the dark oval structure at 36°N on figure 2, while the hexagonal shape (the "GWS" remains invisible on ISS/Cassini). Should Cassi. see Jan. 2014, it will be close to opposition on the visible (left) again.

Dark oval in Northern hemisphere

Throughout the 2010 apparition, a dark spot was clearly visible at a planetographic latitude around 36° (see figure 2). It drifted at 3.4° in relative system III (System Day) between Sept. 2010 and Oct. 2011. Its drift rate then suddenly slowed down to 2.2° in 2012 and 2013. It is the dark oval originally observed by the 2010 HST observations (L2 detection) at 330, with a rotation drift rate between -2.2° and -3.4°.



White spot in the southern hemisphere

During the entire apparition, the zone where the southern jet had developed in 2010, and which is emerging slowly, also showed a very diffuse brighter zones, centered both on longitudes and 45° in relation to the aspect of early 2011 (cf. [3]). A bright, persistent white spot could be tracked in the HST images at 47° latitude, drifting at +0.5°/120 days thereof.

Polar hexagon observations

At the beginning of the 2013 opposition, a very spot was clearly visible at a planetographic latitude around 36° (see figure 2). It drifted at 3.4° in relative system III (System Day) between Sept. 2010 and Oct. 2011. Its drift rate then suddenly slowed down to 2.2° in 2012 and 2013. It is the dark oval originally observed by the 2010 HST observations (L2 detection) at 330, with a rotation drift rate between -2.2° and -3.4°.

Figure 1: North polar projection (see an image taken by Hans Barry on Apr. 26th 2013, a geometrical hexagon shape (red line) was then overlaid (blue) on Saturn's hexagon to match as closely as possible.

Figure 4: The hexagonal pattern observed from Earth (centre at north, on Saturn the North pole can reach 30° and is still lit) and Cassini (left) and Hubble (right) images.

Upstairs.
My very heavy German Equatorial Mount which I designed and built.

My 408mm F 4.5 Newtonian Reflector. I used a two piece aluminium tube construction pioneered by Anthony Wesley.

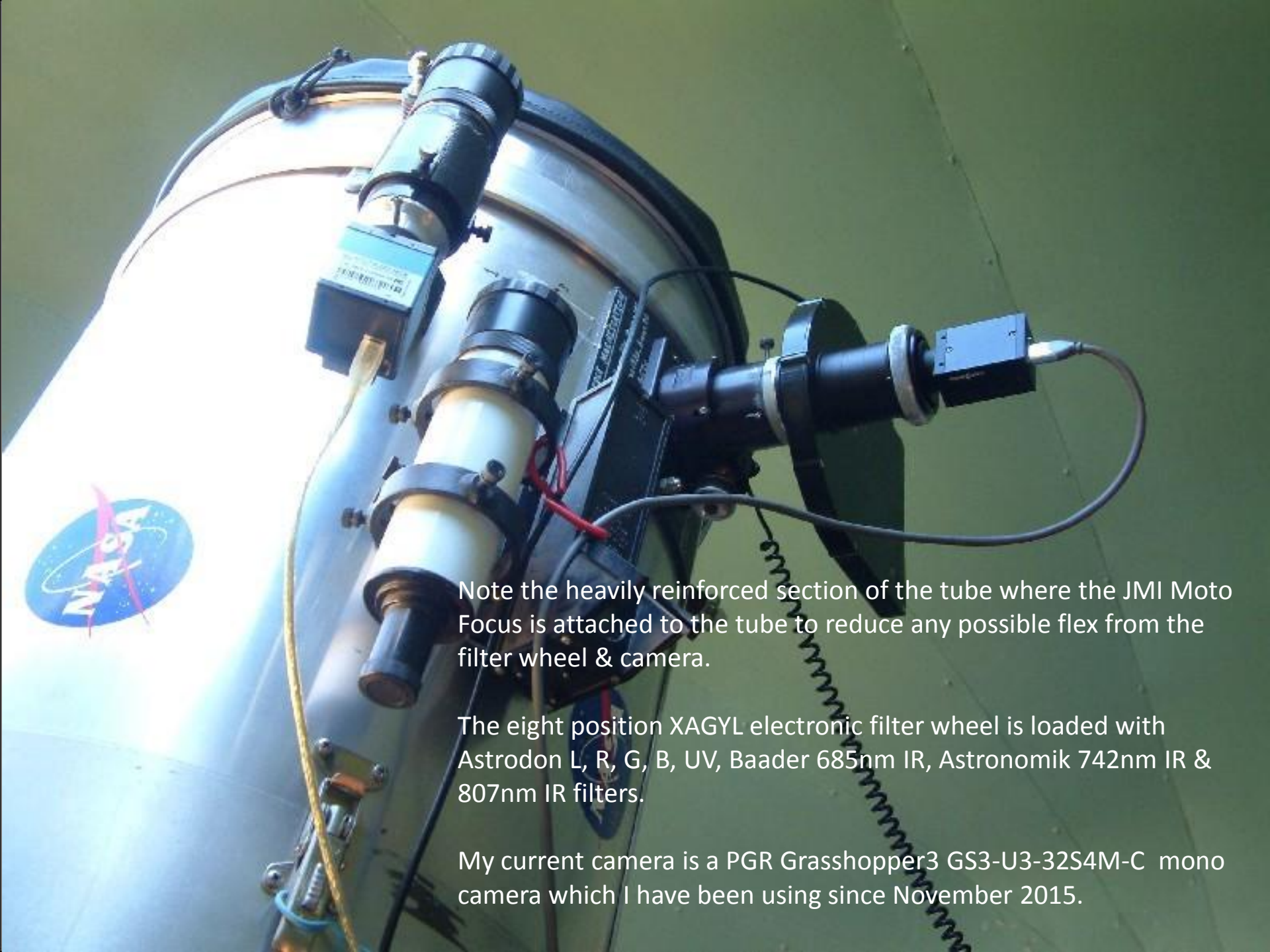
The aluminium follows the ambient temperature very closely, doesn't dew up or generate tube currents as a steel tube would.

I used the Ray Trace program NEWT to design the scope which is optimized for planetary imaging, the scope is fully baffled.

My primary mirror was cast by Newport Glass in California and finished by Master Mirror maker, Mark Suchting in Sydney Australia.

My secondary mirror is a 1/30 wave secondary from Antares Optics Rochester New York.

Note the 8 x 50 finder scope which I have modified, attaching a DMK21AU04 as a wide field low power finder, beside that is a normal 8 x 50 finder scope along with a Telrad.



Note the heavily reinforced section of the tube where the JMI Moto Focus is attached to the tube to reduce any possible flex from the filter wheel & camera.

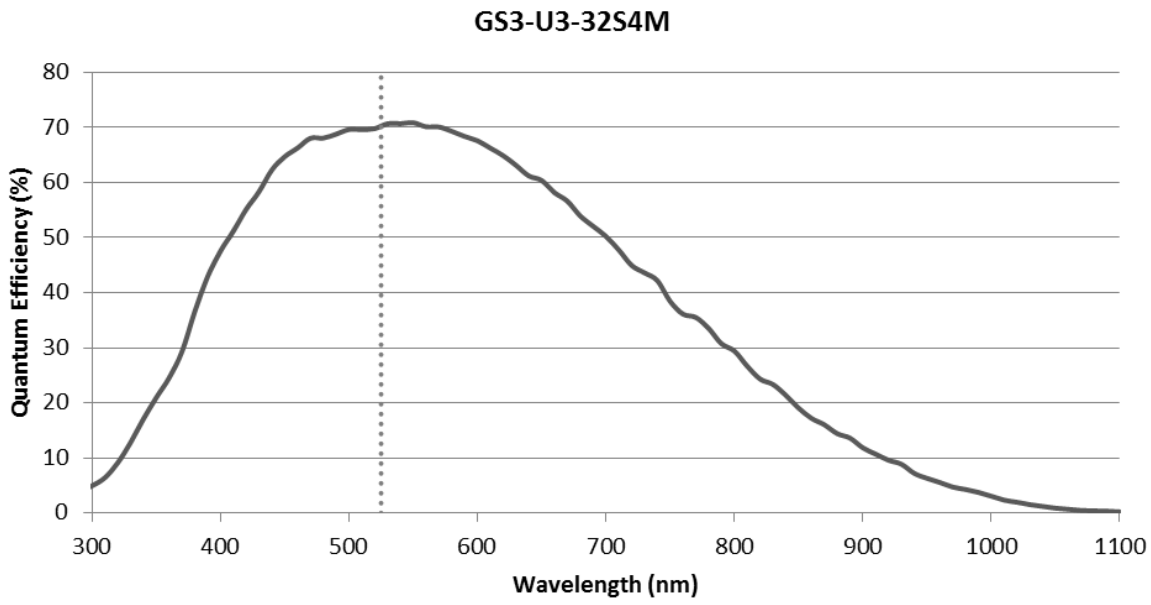
The eight position XAGYL electronic filter wheel is loaded with Astrodon L, R, G, B, UV, Baader 685nm IR, Astronomik 742nm IR & 807nm IR filters.

My current camera is a PGR Grasshopper3 GS3-U3-32S4M-C mono camera which I have been using since November 2015.

GS3-U3-32S4M-C Imaging Performance

Measurement	Video Mode 0	Video Mode 7
Pixel Clock (MHz)	37.13	37.13
ADC (Bits)	10-bit	12-bit
Quantum Efficiency (% at 525 nm)	70	76
Temporal Dark Noise (Read Noise) (e-)	5.11	2.37
Signal to Noise Ratio Maximum (dB)	40.09	40.15
Signal to Noise Ratio Maximum (Bits)	6.66	6.67
Absolute Sensitivity Threshold (γ)	8.00	4.03
Saturation Capacity (Well Depth) (e-)	10208	10361
Dynamic Range (dB)	65.20	71.15
Dynamic Range (Bits)	10.83	11.82
Gain (e-/ADU)	0.17	0.17

Revised 8/



Note the very low Read Noise & high sensitivity of this sensor, I run the camera in Video Mode 7. Particularly note the extended sensitivity into the IR.

Credit Point Grey Research for the imaging performance data and performance curve.

My Peltier cooler for controlling the temperature of my primary mirror. The outline of the cold plate can be seen through the translucent Perspex barrier.

Three internal fans circulate air from the cold plate over the rear of the primary.

The external heat sink can be seen also with three fans, forcing air through the heat sink fins which is expelled out either end of the heat sink. I aim to keep the primary within 1 degree C of ambient.

Digital thermometers, from the left, the temp of the back of the primary mirror, the temp of the side of the primary mirror, the ambient temp in the observatory.

My computer hutch.

The laptop on top is mounted in a cardboard box which acts as a light shield it runs the capture software for the DMK on the finder scope.

The desktop mounted in the lower section of the hutch runs the Grasshopper and XAGYL filter wheel.

I use the latest FireCapture v2.5.02 Beta x64 capture software.

The hutch is on castors which allows me to move around as the position of the scope changes through the night.

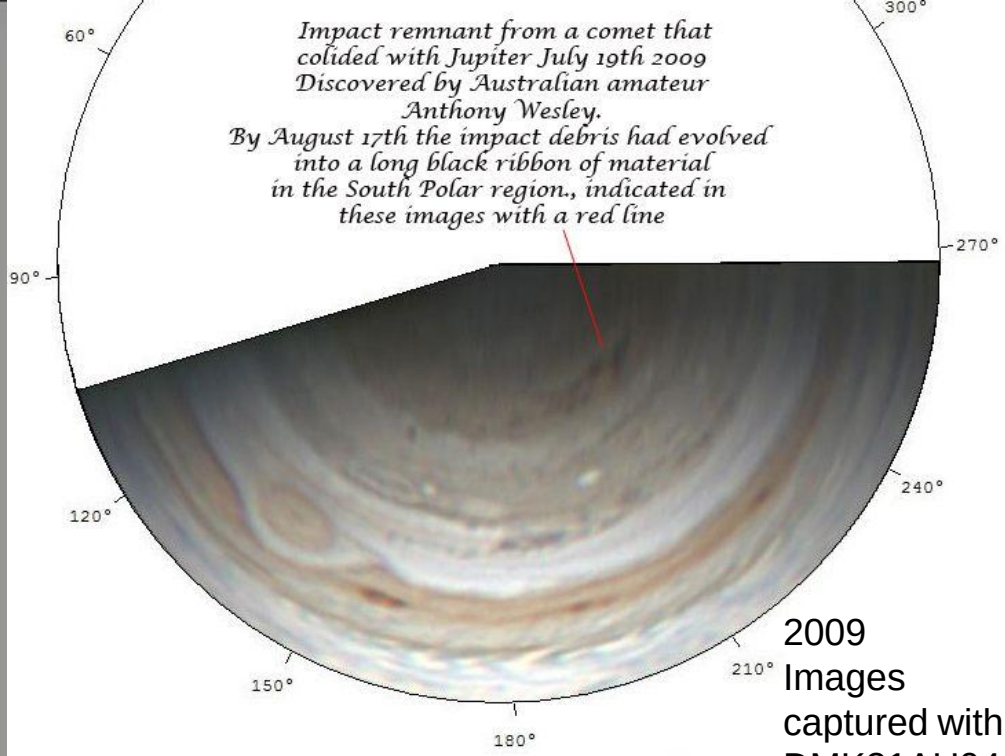
My prime interest is Saturn, tracking SED's related storms along with other atmospheric features for Cassini RPWS Dr Georg Fischer, Cassini ISS Dr Kunio Sayanagi and Professor Agustin Sanchez-Lavega. I run spreadsheets on the features I track and create drift charts from them. I use my spreadsheet data to create ephemerides using WinJUPOS. I have also been involved with other researchers regarding Saturn including Dr Leigh Fletcher, Dr Padma Yanamandra-Fisher and Marc Delcroix. That said I also contribute a significant amount of Jupiter data to JUPOS, PVOL, ALPO Japan & the BAA.

My location is good for astronomy with a high percentage of clear nights and generally low relative humidity. The local topography is typical of the Australian outback, flat in all directions. The high pressure systems that cross our continent often pass directly over Broken Hill which generally delivers good conditions for imaging, witnessed by the sheer volume of data that I produce. When I have been asked to provide time dependant data I have generally delivered it.

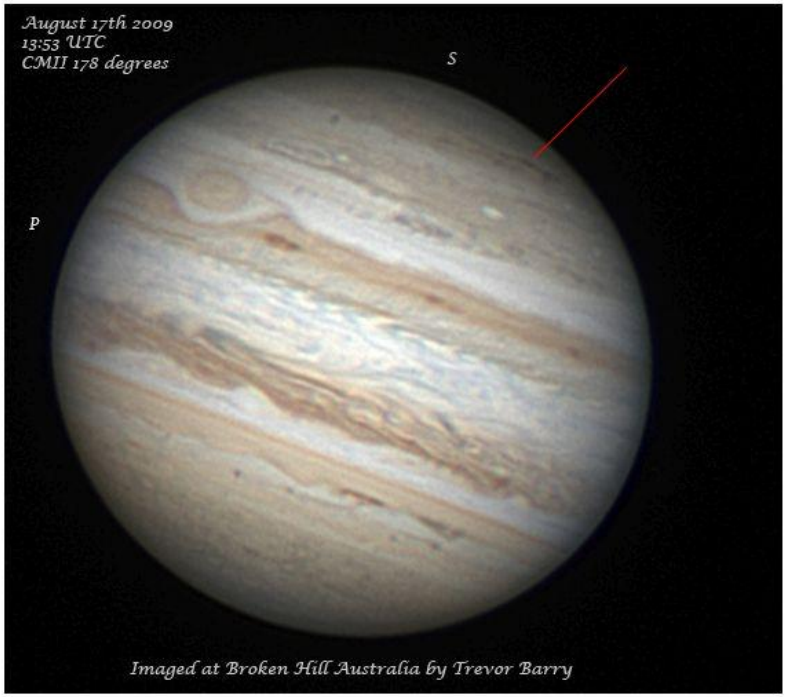
I have contributed data to JUPOS since July 2009 and as at February 5th 2016, my JUPOS measurer Michel Jacquesson has made 13,119 records of measurement from my data. I started contributing Saturn & Jupiter images to PVOL in 2008 and to March 16th 2016, have contributed 3,298 data sets.

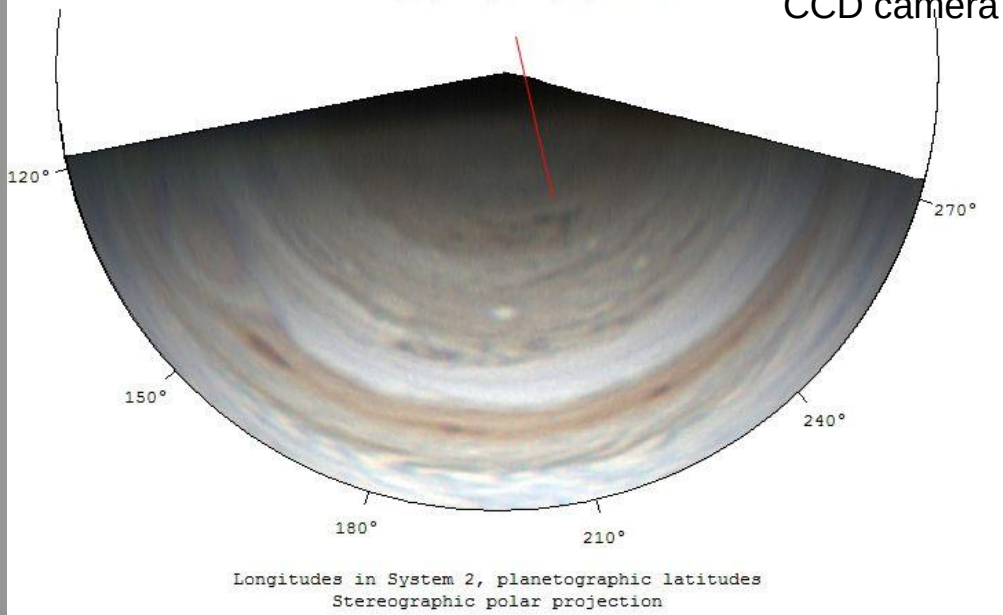
As this workshop is focused on the JUNO mission I have included a sample of my archived Jupiter data year by year from 2009. I should add that I participated in the Beta testing of the Mission JUNO website and continue to contribute data to it.

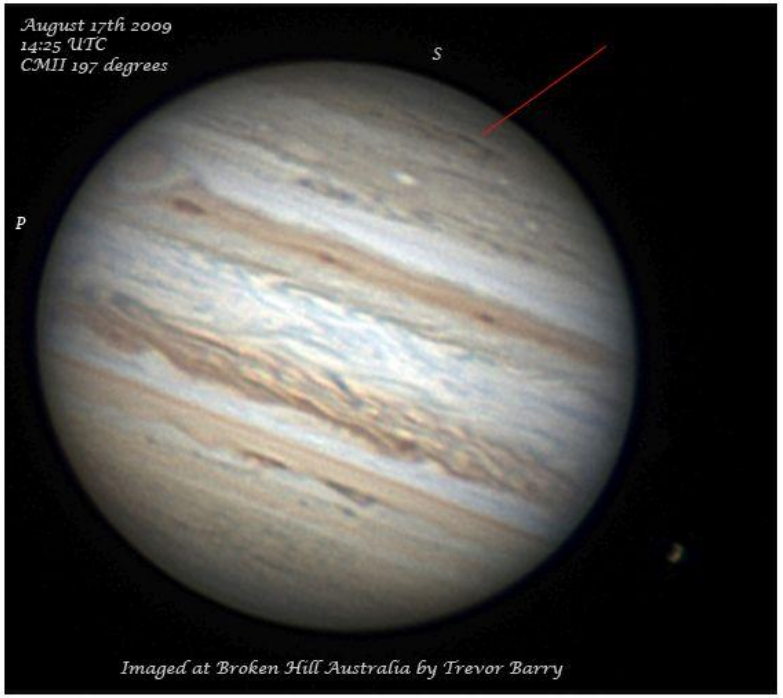
From my Broken Hill Observatory Jupiter will rise to an altitude of 52 degrees at 2016 opposition, 64 degrees at 2017 opposition and 74 degrees at 2018 opposition although the JUNO mission is set to conclude in February 2018.



2009 Images captured with DMK21AU04 CCD camera



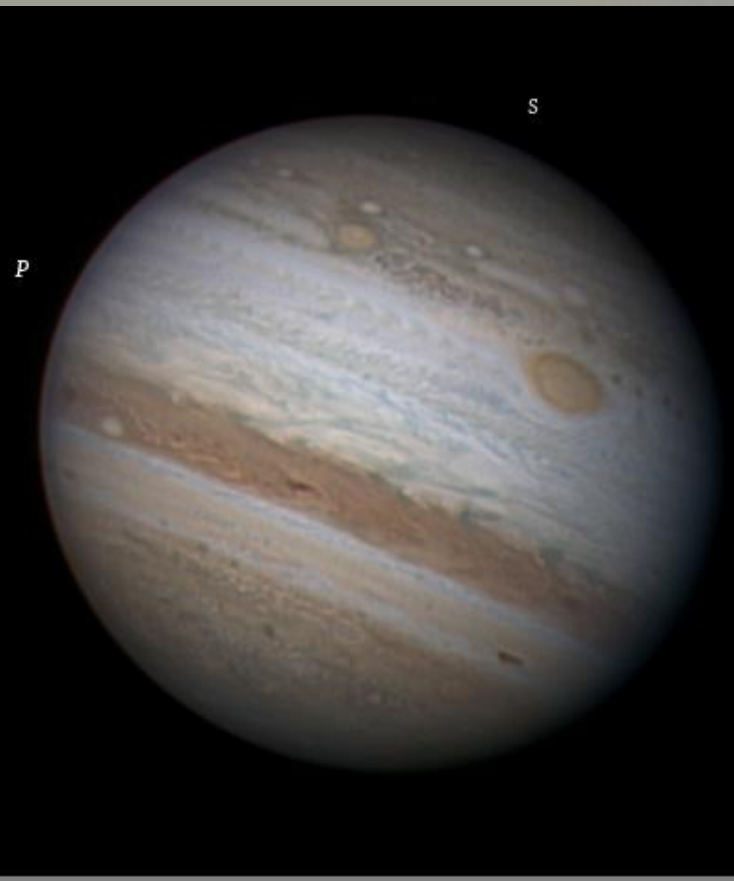




2010 and the fading of the SEB

November 18th 2010, 10:59 UTC, CMI 207 degrees, CMII 102.2 degrees
Dia 44.6 arc sec's, Alt 60 degrees 44 min's, seeing 8 to 8.5/10

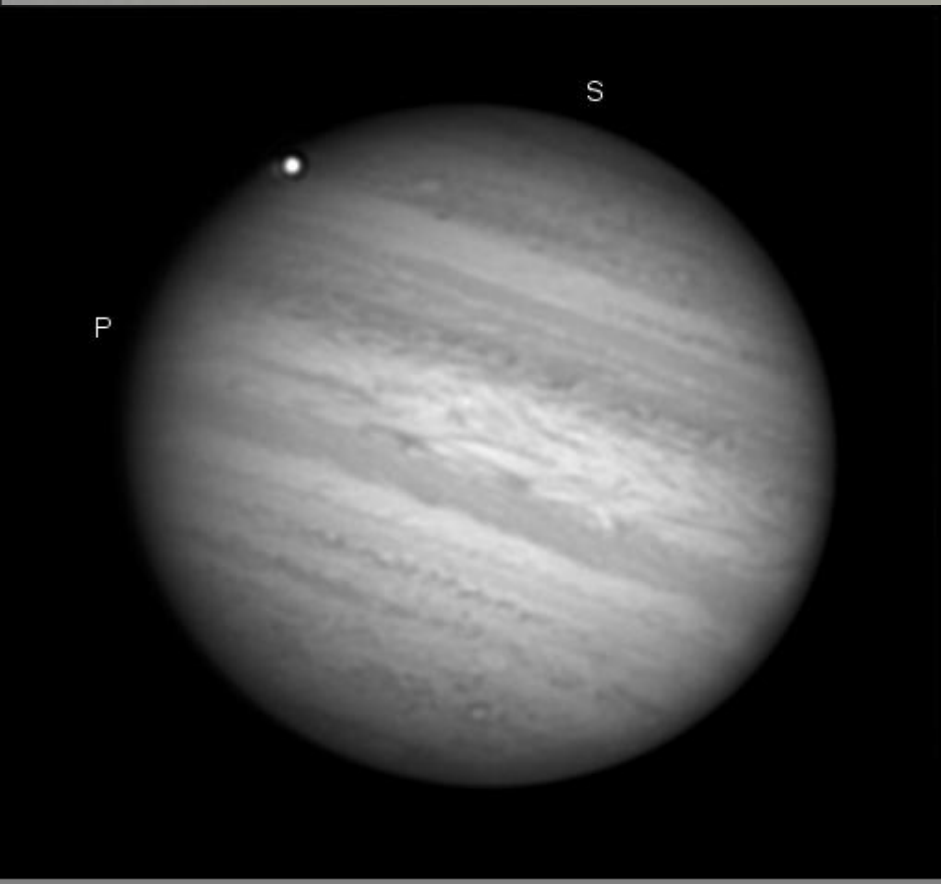
RGB 16" F 4.5 Newt working at F 23.7 PGR Flea3
Imaged at Broken Hill Australia by Trevor Barry



November 18th 2010, 11:48 UTC, CMI 236.9 degrees, CMII 131.8 degrees
Dia 44.6 arc sec's, Alt 55 degrees 36 min's, seeing 8 to 8.5/10

RGB 16" F 4.5 Newt working at F 23.7 PGR Flea3
Imaged at Broken Hill Australia by Trevor Barry

2011

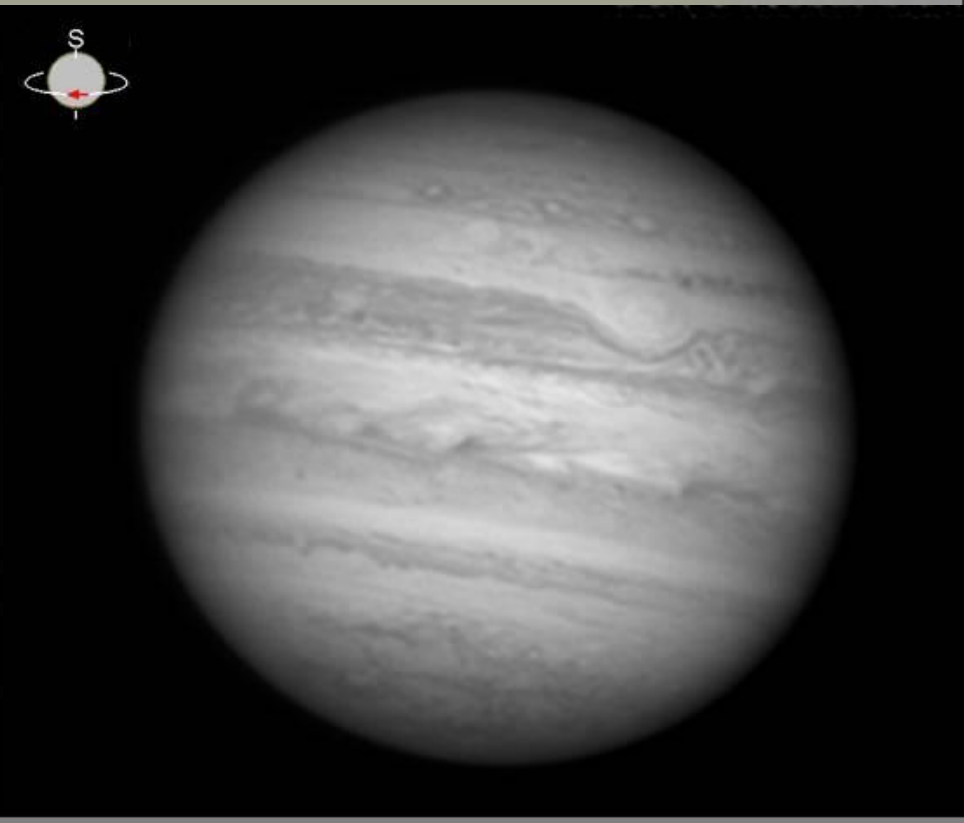


September 12th 2011, 17:17 UTC, CMI 286.8 degrees, CMII 66.2 degrees
Dia 46.3 arc sec's, Alt 44 degrees, seeing 5 to 6/10
807nm IR image with 16" F 4.5 Newt working at F23.7 PGR Flea3
Primary by Mark Suchting, 1/30th wave Antares Secondary
Imaged at Broken Hill Australia by Trevor Barry

September 12th 2011, 17:36 UTC, CMI 298.4 degrees, CMII 77.7 degrees
Dia 46.3 arc sec's, Alt 44 degrees, seeing 6/10
RGB image with 16" F 4.5 Newt working at F23.7 PGR Flea3
Primary by Mark Suchting, 1/30th wave Antares Secondary
Imaged at Broken Hill Australia by Trevor Barry

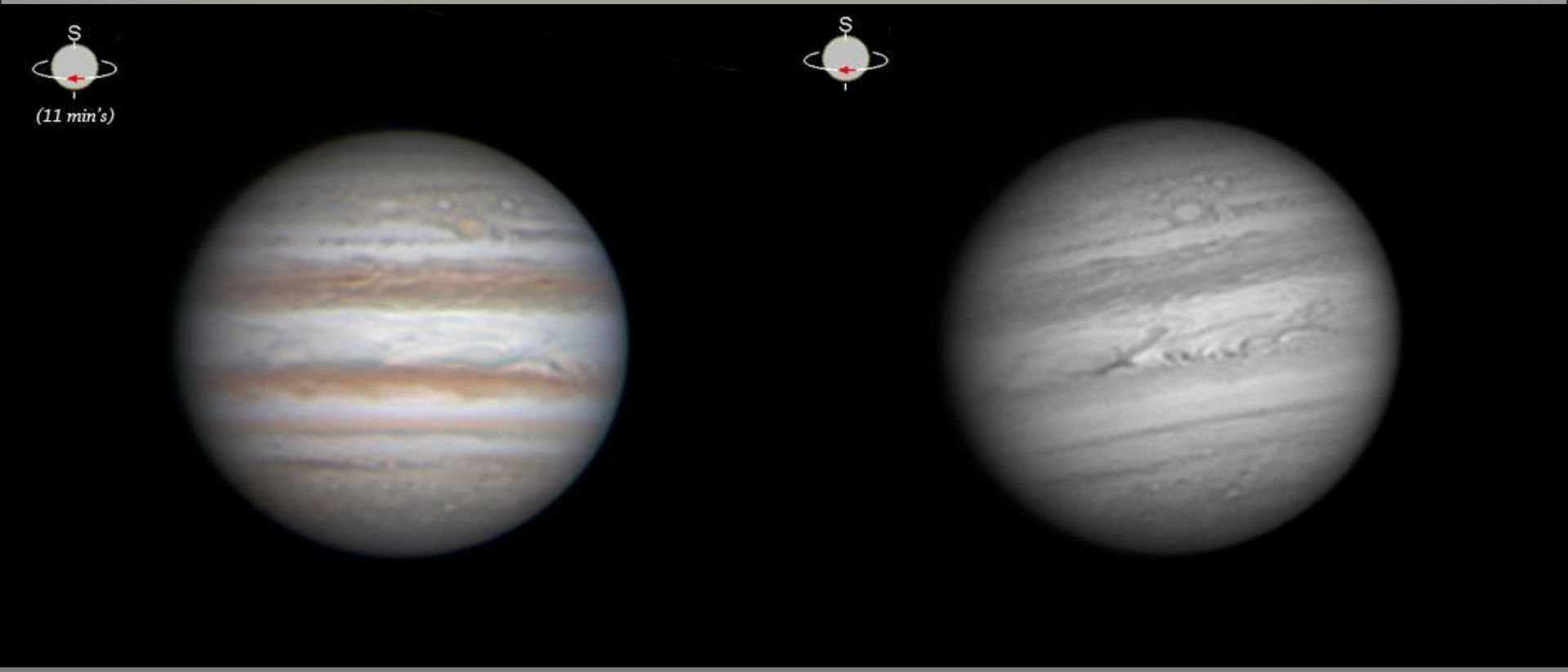
2012

December 5th 2012, 12:23 UTC, CMI 212.4 CMII 159.8
Dia 48.4", Alt 30 degrees, seeing 4 to 5/10
16" F4.5 Custom Newt working at F23.7 Mark Suchting Primary Antares 1/30th wave Secondary
RGB Image PGR Flea3 GigE Trevor Barry Broken Hill Australia



December 5th 2012, 12:31 UTC, CMI 217.3 CMII 164.6
Dia 48.4", Alt 31 degrees, seeing 4 to 5/10
16" F4.5 Custom Newt working at F23.7 Mark Suchting Primary Antares 1/30th wave Secondary
742nm IR Image PGR Flea3 GigE Trevor Barry Broken Hill Australia

2013



September 28th 2013, 19:41 UTC, CMI 172.9 CMII 12

Dia 37.4", Alt 30 degrees, seeing 5 to 6/10

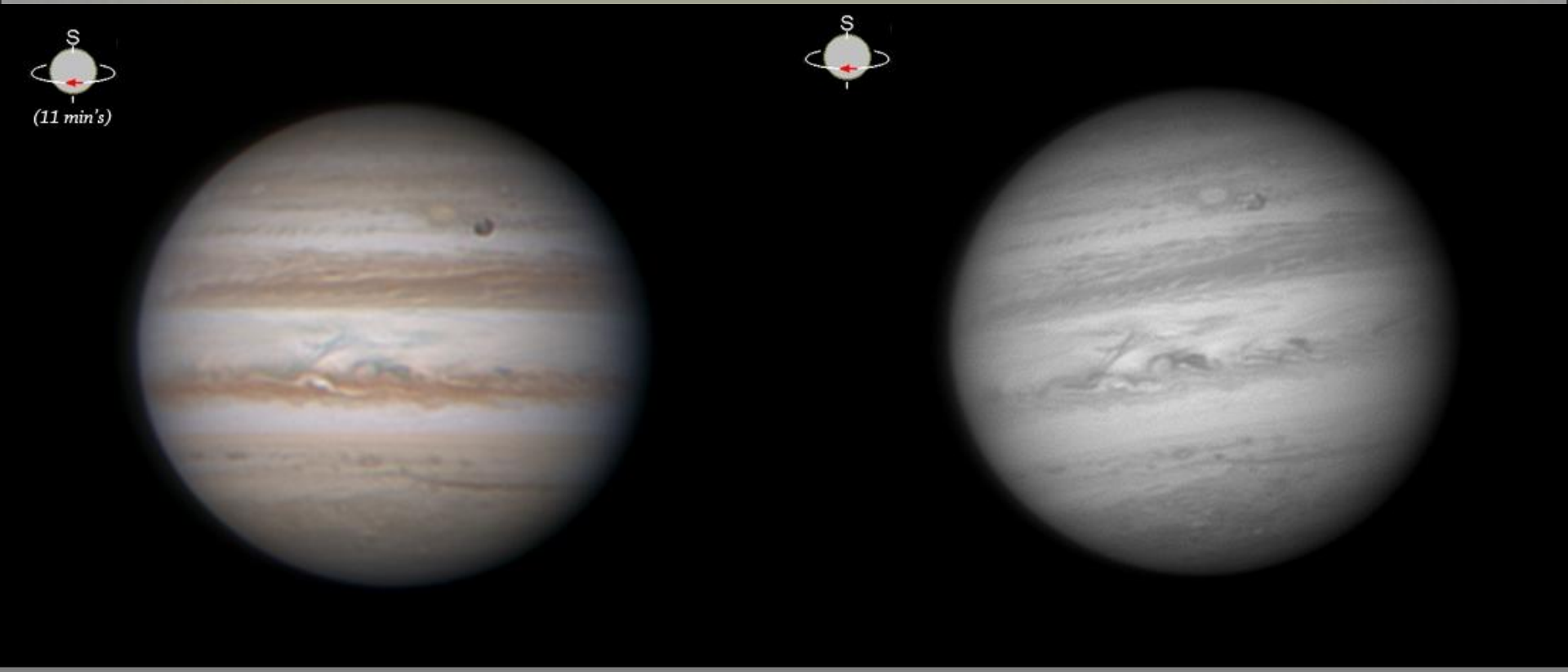
16" F4.5 Custom Newt working at F16.7 Mark Suchting Primary Antares 1/30th wave Secondary
RGB Image ZWO ASI120MM Trevor Barry Broken Hill Australia

October 3rd 2013, 19:01 UTC, CMI 217.9 CMII 19

Dia 37.9", Alt 28 degrees, seeing 5 to 6/10

16" F4.5 Custom Newt working at F16.7 Mark Suchting Primary Antares 1/30th wave Secondary
742nm IR Image ZWO ASI120MM Trevor Barry Broken Hill Australia

2014

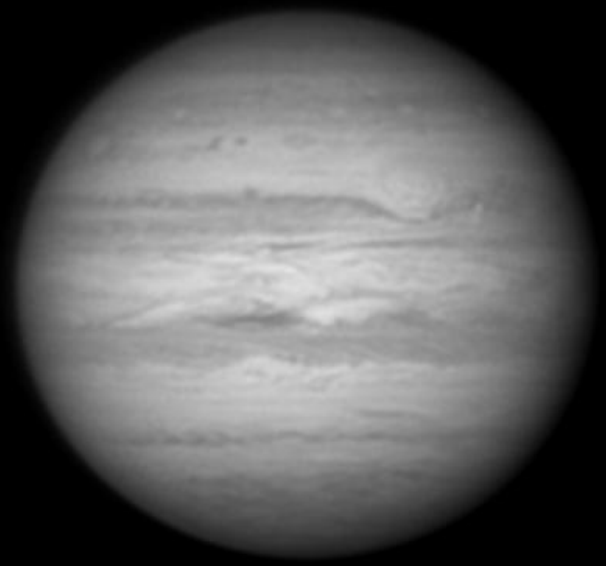


March 2nd 2014, 10:37 UTC, CMI 205.7 CMII 304.9
Dia 42.2", Alt 35 degrees, seeing 7/10
16" F4.5 Custom Newt working at F16.7 Mark Suchting Primary Antares 1/30th wave Secondary
RGB Image ZWO ASI120MM Trevor Barry Broken Hill Australia

March 2nd 2014, 10:45 UTC, CMI 210.5 CMII 309.7
Dia 42.2", Alt 35 degrees, seeing 7/10
16" F4.5 Custom Newt working at F16.7 Mark Suchting Primary Antares 1/30th wave Secondary
742nm IR Image ZWO ASI120MM Trevor Barry Broken Hill Australia

2015

(4 min's)



March 10th 2015, 11:38 UTC, CMI 67.2 CMII 200.1
Dia 43.6", Alt 39 degrees, seeing 5/10
16" F4.5 Custom Newt working at F16.7 Mark Suchting Primary Antares 1/30th wave Secondary
742nm IR Image ZWO ASI120MM-S Trevor Barry Broken Hill Australia

(12 min's)

March 10th 2015, 11:48 UTC, CMI 73.3 CMII 206.1
Dia 43.6", Alt 39 degrees, seeing 5/10
16" F4.5 Custom Newt working at F16.7 Mark Suchting Primary Antares 1/30th wave Secondary
RGB Image ZWO ASI120MM-S Trevor Barry Broken Hill Australia

(12.3 min's)

Contributions of data & Scientific Papers.

Media release from (CICLOPS) Cassini Imaging Central Laboratory for Operations 29th April 2008 acknowledging the contribution of amateurs, Marc Delcroix from France, Ralf Vandebergh from the Netherlands, Chris Go from the Philippines and Trevor Barry from Australia for tracking a great electrical storm on Saturn.
http://ciclops.org/view.php?id=4963&js=1

7th International Workshop on Planetary, Solar & Heliospheric Radio Emissions. Graz Austria, 15th - 17th September 2010. Overview of Saturn lightning observations G. Fischer etal. (Included as co-author)
http://www-pw.physics.uiowa.edu/~dag/publications/2011_OverviewOfSaturnLightningObservations_book.pdf

Peer Reviewed Journal "Science" 332, 1413 (2011) :DOI: 10.1126/science.1204774 Thermal Structure & Dynamics of Saturn's Northern Springtime Disturbance Leigh. N. Fletcher etal. (Included in acknowledgements as my data was presented in the paper side by side with the VLT data) associated media releases from JPL & ESO below.
http://www.jpl.nasa.gov/news/news.php?release=2011-150
http://www.eso.org/public/images/eso1116a/

Peer Reviewed Journal "Nature", 475,71-74 (07 July 2011) I doi:10. 1038/nature10203. Deep Winds Beneath Saturn's Upper Clouds from a seasonal long- lived planetary- scale storm. Sanchez-Lavega etal. (Included as co-author)
http://www.nature.com/nature/journal/v475/n7354/full/nature10203.html

(EPSC) European Planetary Science Congress Madrid 2012. Saturn's Northern Hemisphere Atmosphere after the 2010/2011 Great White Spot. M. Delcroix, G. Fischer and T. Barry. Abstract and Presentation. NOTE: The Presentation is 5.97Mb
http://www.astrosurf.com/delcroix/doc/EPSC2012/Delcroix%20M.%20et%20al.%202012-Saturn%20Northern%20hemisphere%27s%20atmosphere%20after%20the%202010%20GWS%20%28abstract%29-EPSC2012%20Madrid%20September%2027%202012.pdf

AGU Fall meeting, San Francisco December 2012) Thunderstorm and lightning observations during and after the GWS event on Saturn. Georg Fischer, Kunio M. Sayanagi, Donald A. Garnett, William S. Kurth, Ulyana A. Dyudina, Andrew P. Ingersoll, Marc Delcroix, Anthony Wesley and Trevor Barry.
http://www.astrosurf.com/delcroix/doc/Fischer%20G.%20et%20al.%202012-Thunderstorm%20and%20lightning%20observations%20during%20and%20after%20the%20Great%20White%20Spot%20event%20on%20Saturn%20abstract-AGU%202012%20San%20Franciso%20December%202012.ppt

(EPSC) European Planetary Science Congress University College London 2013. Saturn Northern Hemisphere's Atmosphere and Polar Hexagon in 2013. M. Delcroix, P. Yanamandra-Fisher, G. Fischer, L.N. Fletcher, K.M. Sayanagi, T. Barry.
http://www.astrosurf.com/delcroix/doc/Delcroix%20M.%20et%20al.%202013-Saturn%20Northern%20hemisphere%27s%20atmosphere%20and%20polar%20hexagon%20in%202013-EPSC2013-1067.pdf

AGU Geophysical Research Letters March 7th 2014 "The long-term steady motion of Saturn's hexagon and the stability of its enclosed jet stream under seasonal changes ." A. Sanchez-Lavega etal (Included as co-author)
Article first published online: 7 MAR 2014 | DOI: 10.1002/2013GL059078
http://onlinelibrary.wiley.com/doi/10.1002/2013GL059078/abstract

The End