British Astronomical Association

Mercury & Venus Section Newsletter

Director: Dr Paul G. Abel

Messenger

No. 4, June 2020.

Figure 1 Venera 13 composite image of the dramatic landscape of Venus

Contents

From the Director

Dear Members,

I hope this newsletter finds you all safe and well and that you are all starting to adapt to the 'new normal' in these strange times! Since the last issue of Messenger in April, Venus has continued to dominate our evening skies. I am delighted to report that a total of 46 members have contributed their observations for the current elongation. In particular, I'd like to welcome the nine new members who joined the Section recently: Maurice Collins, Jon Culshaw, David Fisher, Murray Foster, Phil Masding, Trevor Smith, Brad Thomas, Peter Tickner and Craig Towell. Some of their observations can be found in *Observations from New Section Members*.

As I've stated in Messenger before, there is reasonable evidence to suppose that Venus is still a living world with active volcanoes present on the surface. The quest now is to try to image these volcanoes, and for earth based telescopes, the only way this can be done is by imaging the night side of the planet in the IR. This is an area of investigation that I am very keen for the Section to be involved with and I'm pleased to report that a number of members have obtained some good images of the night side.

I am pleased to report that Martin Lewis applied for, and successfully obtained a BA Ridley grant which allowed him to purchase a suitable IR filter to enable him to capture the night side of Venus. Martin has written a splendid article about his attempts to produce these images for Messenger, and I'm sure members who wish to engage in this work will find his article extremely useful.

Although inferior conjunction rapidly approaches, the planet will remain in the crescent stage into August, and so anyone who wishes to try and take IR images of the night side should continue to do so as the planet moves into the morning sky on 3rd June, and observers will have June and most of July to attempt this work. You will find a diary which describes important events in the upcoming Western Elongation of 2020-2021.

One of the aims of Messenger is to communicate observing ideas and techniques to Section Members, so if any of you have been experimenting with new techniques (perhaps new image processing, or new visual filters for example) and would like to share this with the rest of the Section then perhaps you might consider writing a short article for inclusion in Messenger. If anyone wishes to do so, please get in touch!

As Venus passes into the morning skies, I hope many of you will continue to follow the planet. It is a well-known fact that western elongations (i.e. morning elongations) are much less observed than evening ones, so perhaps we can use this time to change that! In the meantime I hope you all stay safe and well, and I wish you clear skies!

Best wishes,

Paul G. Abel
Director of Mercury & Venus Section

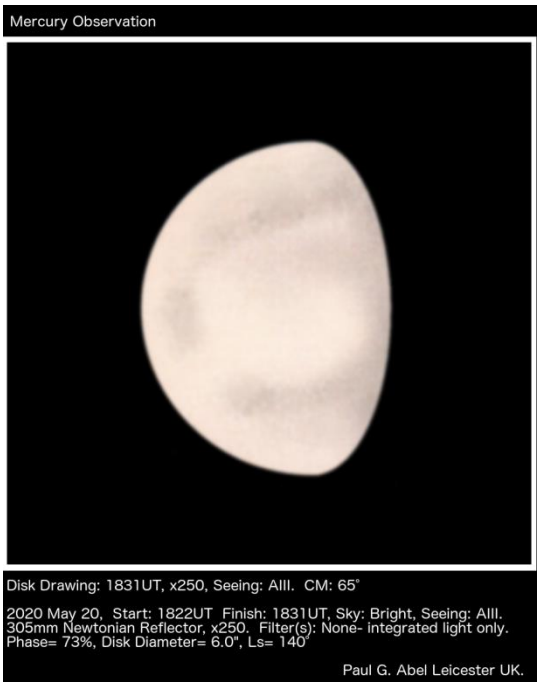
From the Mercury Coordinator

Over the last few weeks Mercury has been drawing steadily away from the Sun, and has been visible in the evenings after sunset. With all the current interest in Venus, particularly by observers attempting to record the crescent phases, the close proximity of Mercury has encouraged some to look for (and at) the smallest planet, including the Section director, Paul Abel, who sent in his "first-ever" disc drawing of Mercury a week ago, followed by a second one. Observing surface features on Mercury is tricky, but not impossible, so please follow Paul's example and give it a try before the planet becomes too faint to pick up.

The Section has received several images of the conjunction between Mercury and Venus on May 22nd taken with normal cameras, such as the one by Simon Kidd reproduced below, and these show the considerable contrast between the two planets, which were approximately one degree apart. Simon also captured a disc image on April 7th which shows a lot of detail. Niall MacNeill in Australia sent in some excellent images taken on April 13th, when the planet was in its gibbous phase before superior conjunction. Niall used a methane band filter for some of the images, and this gave excellent results, so anyone who has such a filter could perhaps try using it on Mercury. Chris Hooker attempted to image the planet in the near infra-red both before and after superior conjunction, but only the result from 7th May showed recognisable features.

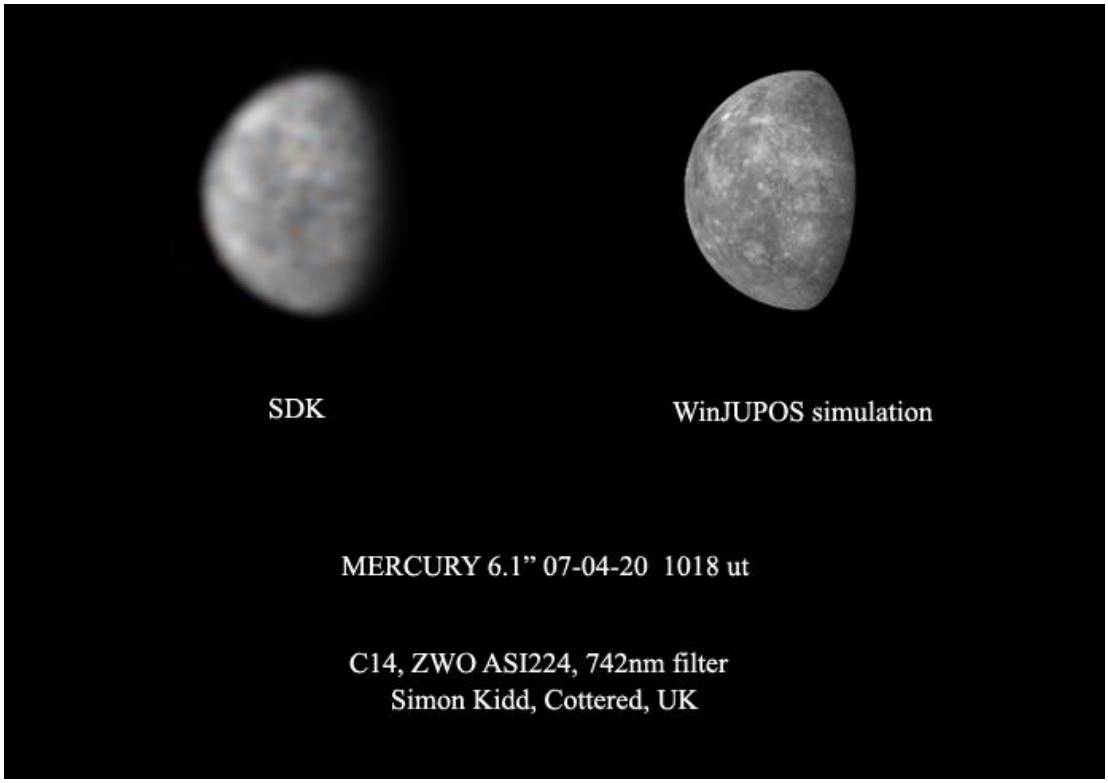
Mercury reaches greatest eastern elongation on June 4th, when it will be 24 degrees from the Sun, but by that time it will be a crescent with only 38% of the disc illuminated and a magnitude of 0.43, which will make it quite difficult to observe. Inferior conjunction occurs on July 1st, and the planet then reappears rapidly in the morning sky, moving towards its next western elongation of 20 degrees on July 22nd.

Here is Paul Abel's second observation, which shows some faint markings on the disc of Mercury:

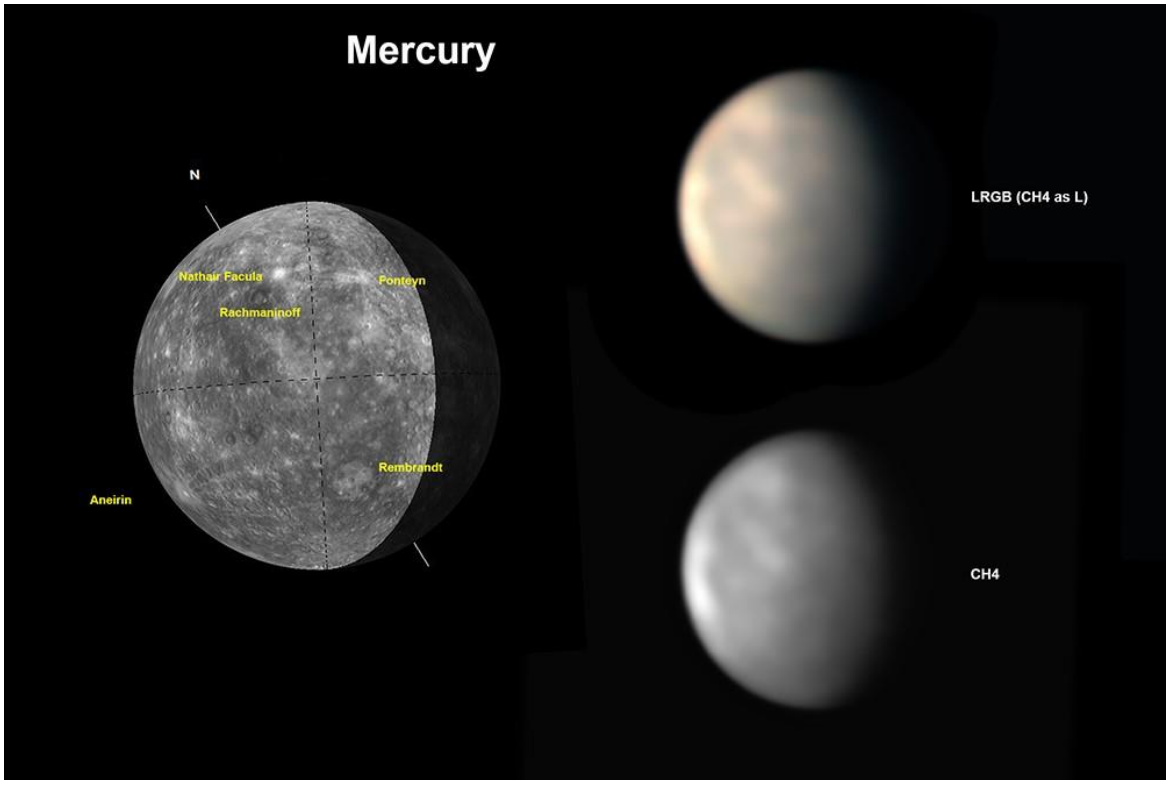


Mercury and Venus in conjunction, imaged by Simon Kidd. The planets are approximately 1 degree apart:

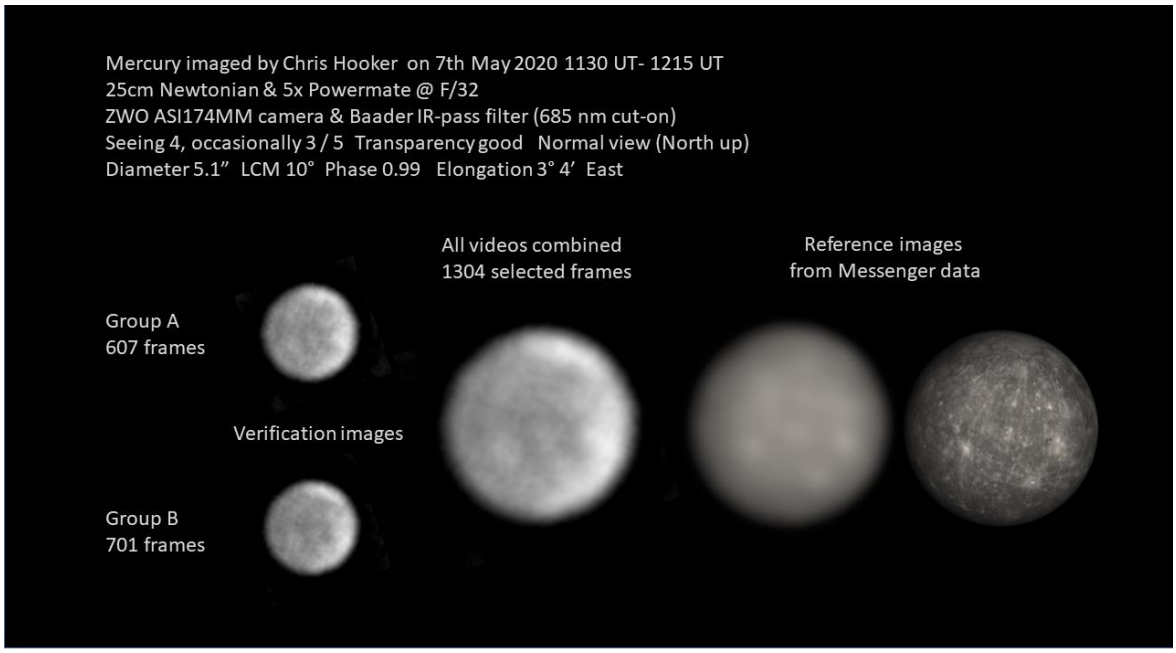
Mercury imaged by Simon Kidd on April 7th:



Mercury imaged by Niall MacNeill on April 13th. Celestron C14 Edge HD & 2.5x Powermate:

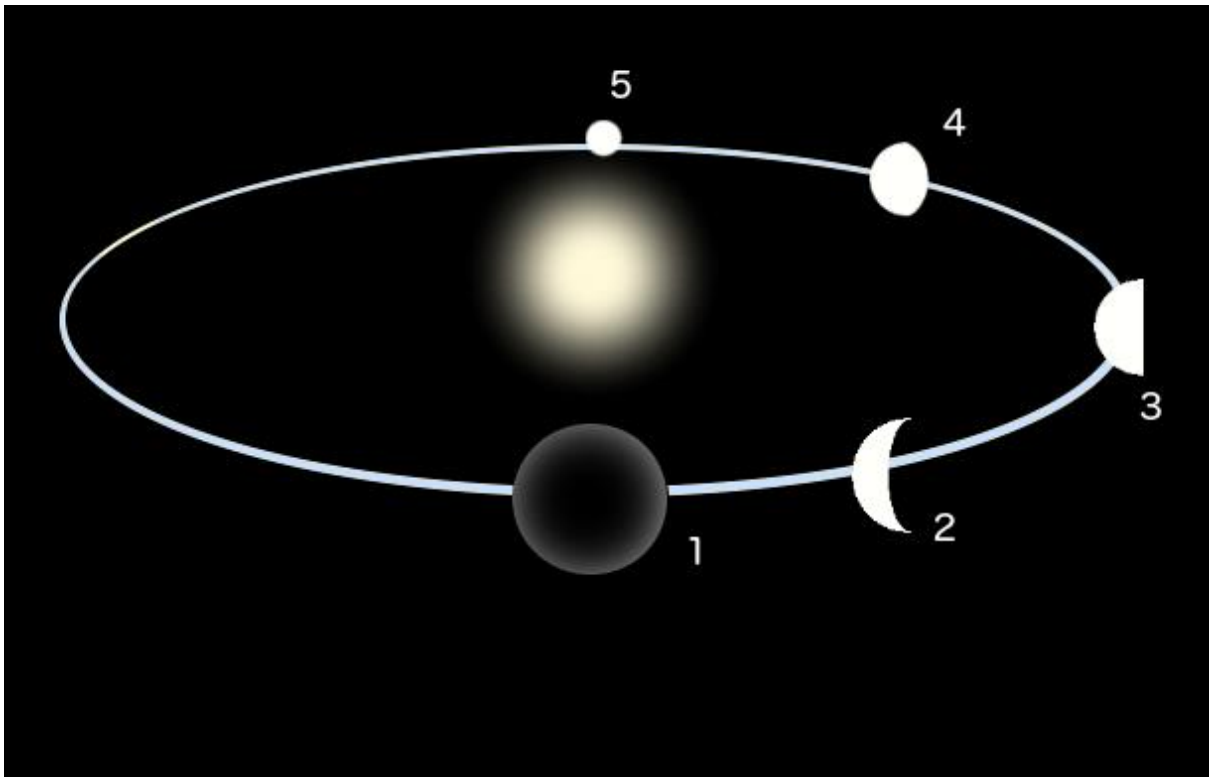


Mercury on May 7th, just after superior conjunction, imaged by Chris Hooker:



Chris Hooker
Mercury Coordinator

The Western Elongation of Venus 2020-2021



Diary of events:

Date	Event
03 June 2020	Position 1: Inferior conjunction, Western elongation 2020-2021 starts
03-June – 11 August 2020	Position2: Venus appears as a thin crescent, the phase will increase and the apparent diameter will decrease as Venus moves away from Earth.
12 August 2020	Position 3: Venus at theoritical dichotomy (50% illumination). Due to the Schroter effect however, actually dichotomy will occur shortly after this date. Observations will be required to determine the date of actual dichotomy.
13 August 2020	Venus at greatest western elongation (46° west of the Sun)
14 August 2020-25 March 2021	Position 4: During this time, Venus will now appear as a waxing gibbous, the disk size now getting quite small.
26 March 2021	Position 5: Superior conjunction, the end of the current western elongation and the next eastern elongation starts, Venus returns to the evening skies.

Imaging the Night side of Venus at 1000nm

Martin Lewis

Introduction

Richard McKim's excellent article in the Oct. 2017 BAA Journal (Vol. 127, No.5, p261) detailed the efforts of Australian amateurs, Anthony Wesley and Phil Miles, to image the night-side of Venus in infra-red during the morning apparition in Spring of 2017. This followed-on from previous observational work by several other amateurs who had recorded features on the unlit side of the planet, also imaging at wavelengths centred on 1000nm. Details of these attempts, stretching back to 2004, are given in another of Richard's recent BAA Journal articles (Vol. 129, No. 3, p149).

When imaging in this particular part of the infra-red spectrum, the planet's atmosphere is comparatively transparent. Surface topography is revealed as variations in the IR emission intensity — higher areas being cooler than lower lying regions. In 2017 Wesley and Miles also detected small brighter features, which, it was speculated, could be volcanic in origin. Inspired by their work and by the prospect of imaging the actual solid surface of Venus, I was keen to attempt something similar and briefly discussed the difficulties with Anthony at the BAA/RAS Juno meeting in May 2018.

In mid-April, towards the tail-end of the recent very favourable evening apparition of Venus, the challenge of imaging the night-side arose again during email exchanges with BAA Section Directors Paul Abel and David Arditti. After explaining that the main barrier was the high price of the dual filters needed to achieve the narrow bandpass at 1000nm, David suggested I apply for a BAA Ridley Grant to cover the cost. I applied, and the BAA Council were kind enough to rapidly approve a grant to cover the cost of a new lower-cost single-filter option — an Edmund Optics 1000nm filter with a 25nm bandpass (figure 1), together with most of the cost of the same FLIR camera that Wesley and Miles were using.

Anthony and Phil were extremely helpful in email exchanges and gave me some very useful pointers to get me up and running. With inferior conjunction looming, the pressure was on to get some results!

Figure 1. Edmunds Optics 1000nm filter with 25nm bandpass (Edmund Optics part number #87-823)

Preparations

Imaging the night-side of Venus is a tough challenge. The adjacent day-side is overwhelmingly bright, requiring clean optics and minimal glass between planet and chip to reduce glare and extraneous reflections. Furthermore, at these long wavelengths standard silicon-based sensors are very inefficient, making the night-side very dim. Low brightness means noise issues and pulling out detail would require careful attention to the many factors affecting it.

In preparation for imaging, a custom baffled tube was made for the front of the camera, allowing the sensor to only 'see' the secondary mirror of my 444mm Newtonian, reducing extraneous light as much as possible (figure 2). In addition, the IR filter just came in a plain 25mm aluminium ring and I had to modify an old colour-filter cell to be able to hold it in the baffled tube. My lathe was also put to service to modify a 1.25" to 2" ultra-low-profile adaptor to allow me to do prime focus imaging at f4.4, maximising the number of photons per pixel.

Figure 2. Custom baffled tube on front of camera with 1000nm filter half way down

Camera Issues

My first attempts at 1000nm imaging were encouraging, but the brightness of the dayside crescent, combined with the long exposures needed, caused issues with my ASI290MM digital video imaging camera. This has comparatively good IR sensitivity, but even with the front window removed, it suffered badly from multiple internal reflections of the dayside crescent, as seen in figure 3. It was going to be a major issue in getting meaningful results with this particular camera!

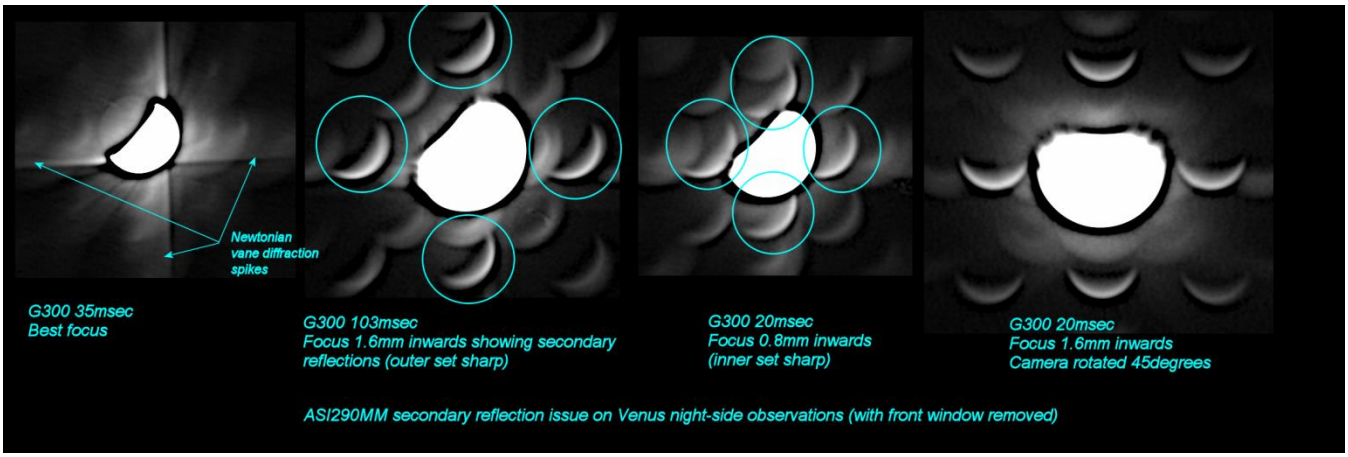


Figure 3. Internal reflections in ASI290MM back-illuminated camera. (I have since learned that the ASI178 also has a back-illuminated rolling shutter Sony chip and suffers from the same issue)

I needed a low-risk way forward and fortunately the BAA allowed me to put use the balance of the Ridley grant to cover most of cost of a new camera. I knew the same one used by Anthony Wesley would not suffer from these issue and so hurriedly purchased a FLIR Chameleon CS3 having an IMX265 chip with 3.45um pixels.

This camera gave much cleaner images than the ASI290MM, but was less sensitive than expected at 1000nm. For a few nights I did some tests alongside a ASI174MM camera I already owned. I had originally dismissed the idea of using this ASI camera, due to its lower sensitivity and its larger 5.86um pixels. I was already dramatically under-sampling at f4.4 with the 3.45um pixel camera and thought that using even larger pixels would just lose too much resolution. Side-by-side comparisons, however, seen in figure 4, showed the ASI174MM to work very well. It gave nice clean images and the large pixels gathered 2.9x the photons of the CS3 — reducing pixel shot noise by 1.7x. As the darker features on Venus are quite large, the under-sampling has been much less of an issue than had originally thought, especially if I use the 2x resize in Autostakkert3! after stacking. Since the session on the 2nd May, all runs were exclusively with the ASI174MM camera operating at prime focus.

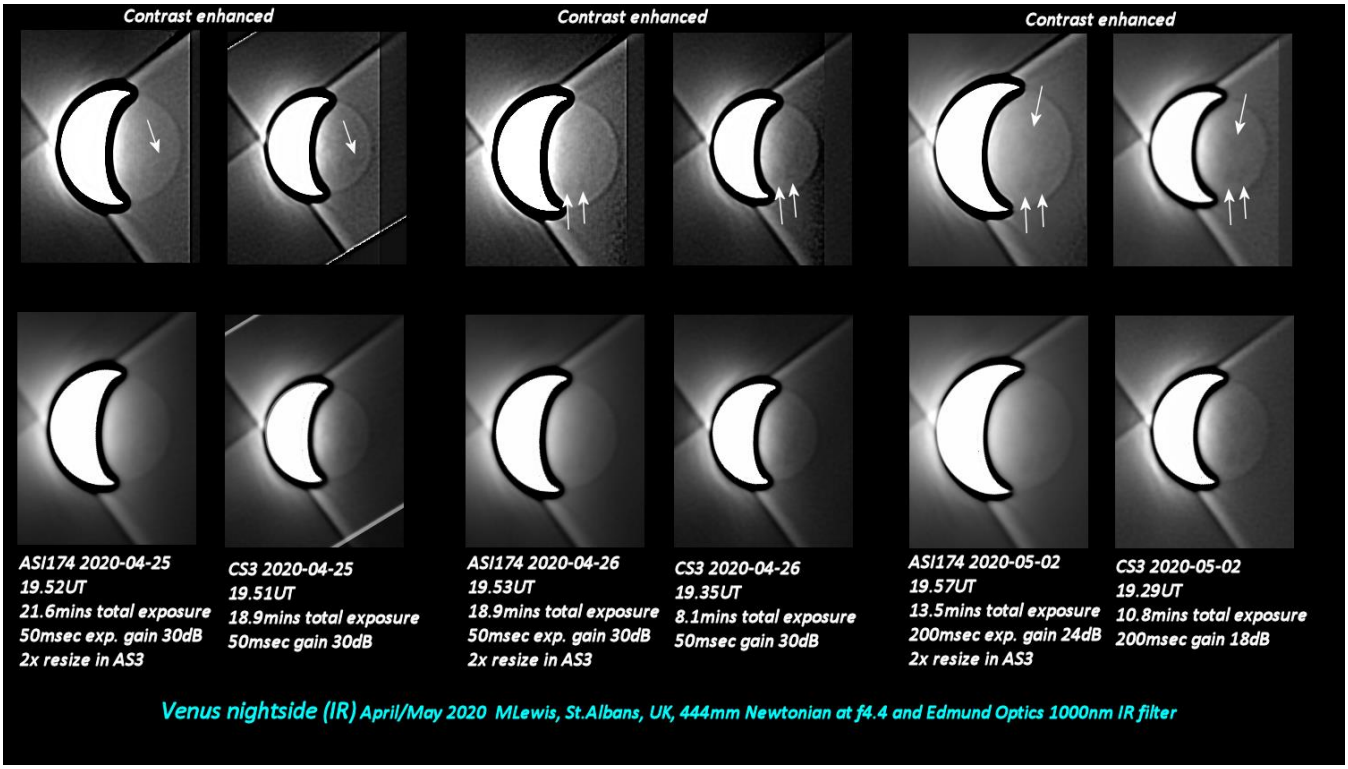


Figure 4. Comparing the ASI174 and CS3 on multiple nights. Arrowed, slightly darker features match between cameras and so are very likely real

Imaging Time Window

With the excellent weather we have had over the last few months there has been much opportunity to image Venus with the 1000nm filter. After some initial experimentation my first proper imaging session was on 25th April, about 6 weeks before inferior conjunction.

As you approach inferior conjunction some things improve — Venus gets larger and the ratio of the area of the night-side to that of the day-side gets better. It gets lower in the sky though, making the seeing more difficult, and you also have to image it closer to sunset, so the sky is brighter. This increased sky brightness causes major issues and means that the optimum time to do this sort of imaging is actually well before Venus is a thin crescent.

As is often the case in planetary imaging, one of the key obstacles to getting good results, is noise. If the task was to image the night-side in properly dark skies it would be bad enough — with the dimness of the night-side requiring several minutes of accumulated exposure for the darker features to appear out of the shot-noise-affected disc. Having to image in the brighter skies closer to inferior conjunction, however, causes further difficulties. The night-side gets swamped by sky brightness and, if you try and subtract this off, you are left with the high levels of residual shot noise from the sky. This can drown out the subtleties of the night-side disc detail — unless you have lots of data. The lower altitude of Venus later on, however, means session times are reduced and you can't gather as much data…… eventually you are defeated by the noise issues!

The tail-end of my imaging period was towards the middle of May and I was able to extend the date of my last imaging run by elevating my telescope and its equatorial platform on concrete building

blocks to able to see over fence-height bushes (figure 5). In addition, unprompted, a neighbour cut down some conifers at just the right time that were blocking my view WNW of me! My last imaging session was 20th May — much closer to inferior conjunction than I had hoped for and with Venus at 52" across and at an elongation of 21° from the Sun.

Figure 5. Radical steps taken to extend the Venus imaging window!

Results

I had ten proper 1000nm imaging sessions with my best single session being 5th May (figure 6). That evening skies were steady and highly transparent and Venus was decently high up in the western sky at around sunset.

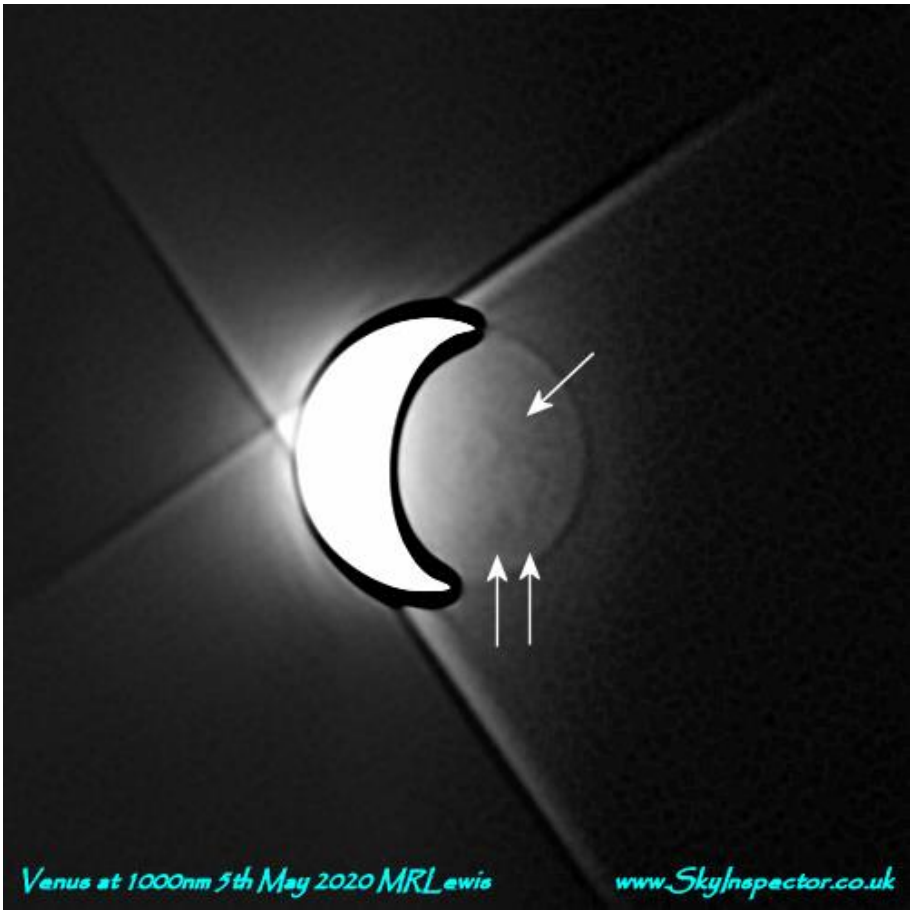


Figure 6. Venus from 5th May. 18.9mins of accumulated exposure with 200msec frames at gain 24dB.Surface features arrowed.

Recent improvements to Winjupos, requested by Anthony Wesley, have meant that this program can now derotate images of Venus taken on different nights, to a common time. This is a major advance for 1000nm Venus imaging and allows images to be combined from separate sessions to further reduce noise and improve the signal to noise ratio. I created several derotation sets from my runs. The best result combined data from 2nd, 5th, 6th and 9th May (see figure 7).

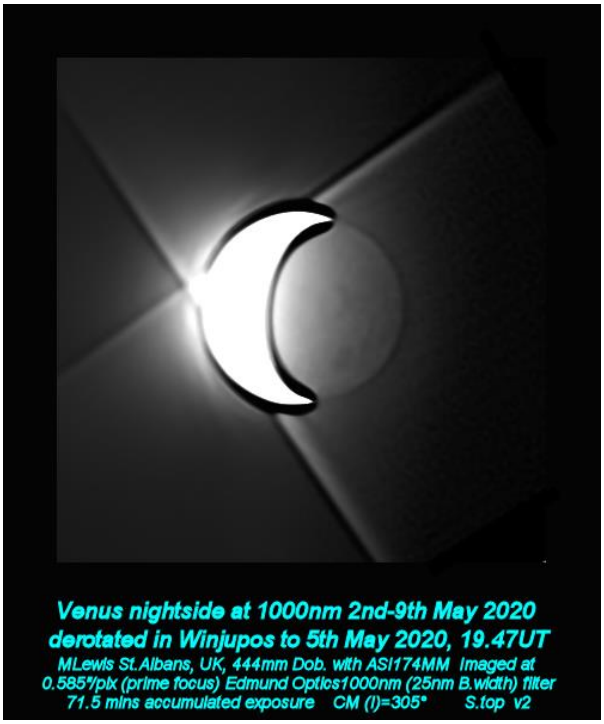


Figure 7. Derotated combination from 2nd, 5th, 6th, 9th May showing darker (higher/cooler) surface features

A later set with Venus larger and the crescent thinner, but with the planet not so well-placed, combined data from 9th, 13th and 14th May and is shown in figure 8.

Figure 8. Derotated combination from 9th, 13th, 14th May

My third derotated combination was a late working of my earliest data and combined data from the CS3 and ASI174MM camera to create a view derotated to 25th April (figure 9). This is based on 91.5mins of accumulated exposure data!

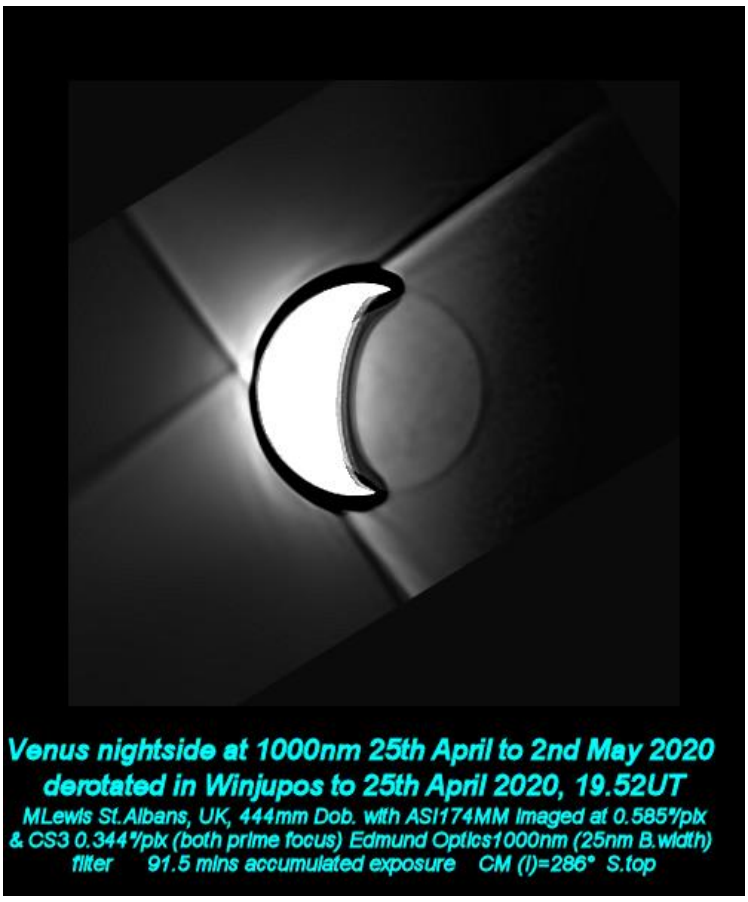


Figure 9. Derotated combination from 25th and 26th April and 2nd May

Winjupos has a further useful function, allowing you to unwrap the planet's surface and project it onto a 2-D rectangular map. I was able to do this for the data shown in figure 7, 8 and 9 and compare it with a Magellan probe altimetry map, matching the two maps in longitude. You can see a good agreement between the two in figure 10 and I was able to identify known four darker features regularly seen at inferior conjunction[1]; these are the elevated regions of Phoebe Regio, Beta Regio, Asteria Regio and Ulfrun Regio.

[1] Amazingly Venus shows the same face to Earth at every inferior conjunction and superior conjunction — something I did not know before embarking on this imaging challenge.

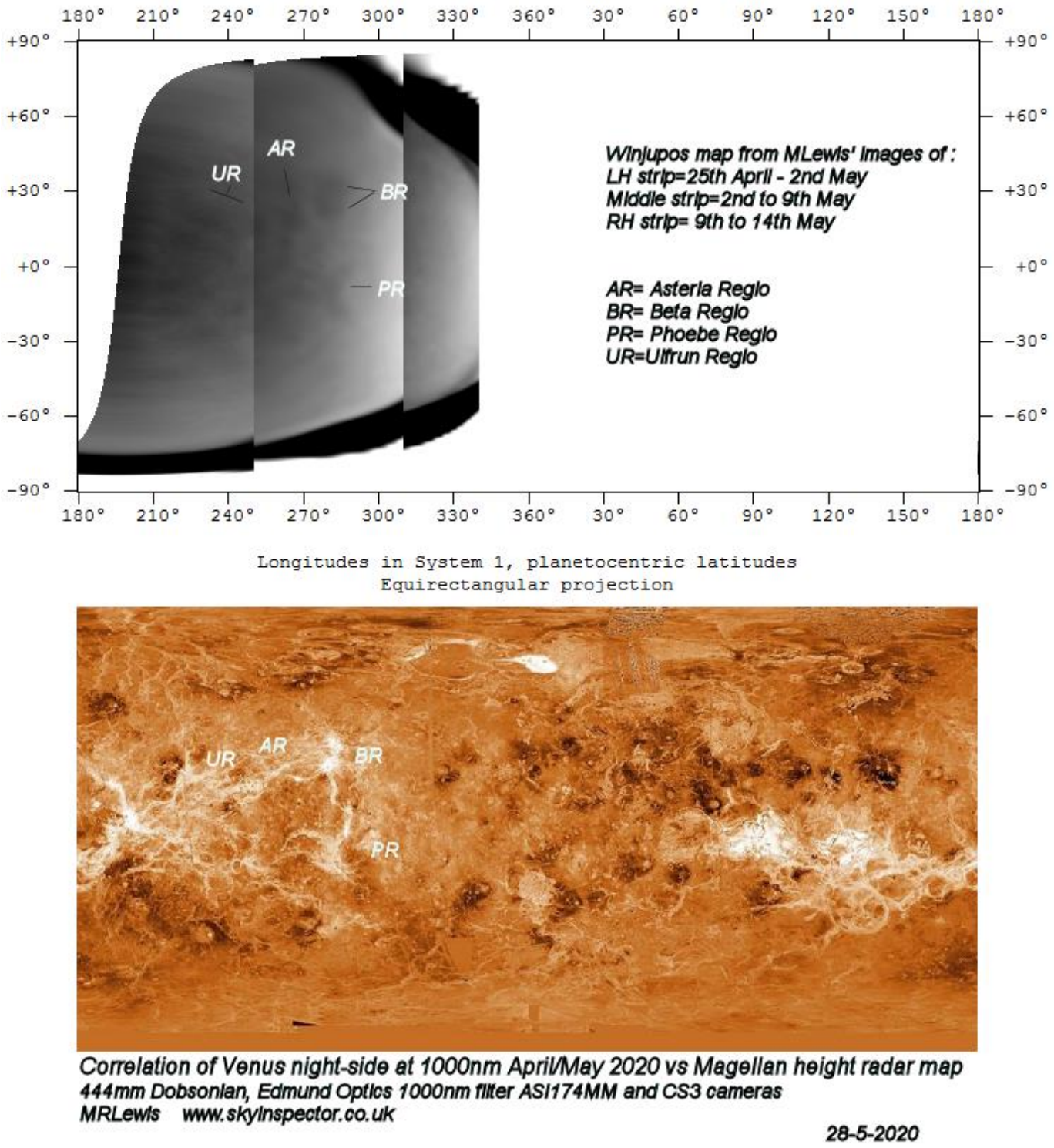


Figure 10. Correlation between Winjupos map created from Winjupos derotated data and Magellan altimetry map with both matched to the same longitude. Several dark patches from the 1000nm imaging match known elevated features on Venus

As well as the map of the darker features seen above I was also able to compile a gif animation showing the movement of the darker features over a 16-day period from 2nd to 19th May. This can be found at: http://www.skyinspector.co.uk/animations-and-video-clips .

Despite my best efforts, no bright spots were seen in any of my images that might indicate volcanic activity but I was imaging a different area of the planet to that imaged by Wesley and Miles back in 2017. I hope that they have more luck when they resume imaging that same area in the morning apparition in June/July. Despite the lack of any direct evidence of volcanism , I found imaging Venus at these wavelengths a very rewarding project with lots of new challenges that further stretched my understanding of the principles of planetary imaging. Things generally went much better than I could have imagined and I am thrilled to see the correlation with the altimetry map which shows that I did actually image real features on the solid surface of this cloud-shrouded planet.

Top Tips for Venus Night-side Imaging

16-bit imaging and Exposure Time

The signal from the real features you want to record are small changes on an already small signal and this is swimming in a sea of read noise and shot noise. Setting the camera to record at 16-bit resolution (actually 12-bit with 4-bits of null information tagged on) is needed give you the best chance of getting suitable grey-level discrimination of the night-side and capturing real signal variations.

Getting grey-level discrimination in the very dim data also requires exposure times to be unusually long for planetary recording — 200msec was the standard recommended by Wesley and Miles for this sort of image scale and all recordings from 2nd May onwards used this exposure time. Although tempting to use shorter exposures to reduce motion smearing caused by atmospheric movement, doing that and using 8-bit imaging may have recorded the cores of the very darkest features but would be unlikely to render much subtle detail and any smoothness in it.

Accumulated Exposure times

With night-side imaging, accumulated exposure times (the sum of all the frame durations) needs to run into tens of minutes to minimise shot noise and draw out the faint details in the dim target. Long accumulated exposure times are achieved by imaging for the whole of the possible capture period each evening and stacking almost all the data captured. There is no luxury of picking the sharpest frames as with normal planetary imaging and generally the best 95% of the frames were stacked. Further improvements in signal to noise are possible, as described previously, by combining sessions using the Winjupos derotate function.

For each session I generally produced one final image generated by combining all the images from each of the several 3-minute videos captured. This was done in Winjupos, again using the derotate function, although Venus's day is so long that during one session the planet is essentially non-rotating.

Choice of Gain

Gain is another critical parameter affecting results. Increasing the gain improves the grey-level discrimination and maximising the analog portion of the gain will help reduce the read noise to a minimum — important with all the stretching required to draw out the subtle detail. If sticking with long exposure times then you really can't use high gain when the sky is still bright, without the sky brightness and light from the daytime crescent swelling and engulfing the night-side. If you use lower gain though then the read noise can increase too much swamping the real detail! When the sky is bright then there is no option but to drop the exposure time as well so you don't have to drop the gain too much. A lower read noise camera would have helped as the ASI174MM is known to have a relatively high read noise level. When the sky brightness permitted it (ie. it was dark enough) I generally tried to use a gain of 240-300 in Firecapture if possible (24dB- 30dB) which minimises read noise as much as possible.

Image-scale

Surprisingly for such long exposures, it is possible to capture real surface features even in just reasonable seeing. Good seeing helps but it does not have to be superlative as the features are quite large. Minimising noise is the order of the day and that is best achieved with coarse image scales and short f-ratios. I recorded at prime focus (f4.4) giving an image scale for the ASI174MM of 0.58"/pixel — under-sampling by a factor of about 6x!

Stacking

I stacked frames in Autostakkert3! using a single alignment box round the whole of the planet and stacking the best 95% with 2x resample to give Registax wavelets a larger image to grapple with.

Registax Processing

Wavelet Processing in Registax was a little unusual with a gamma of 1.5 to bring up the night-side without blowing up the day-side and careful use of the high and low histogram settings to stretch the 16-bit data right out. Other settings used can be seen in figure 11.

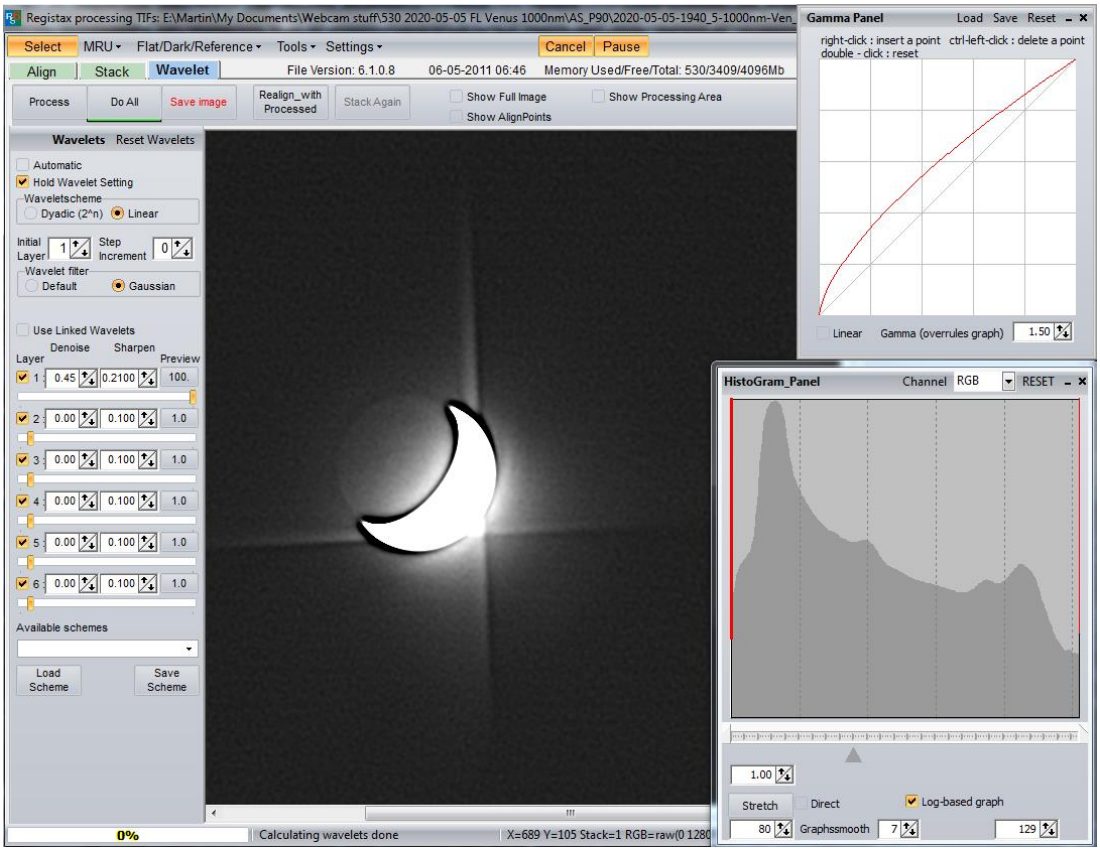


Figure 11. Registax wavelet settings

Image processing and dealing with the day-side glare

The biggest issue in doing any further processing of the Winjupos derotate output images was dealing with the big brightness gradient across the night-side caused by glare from the day-side. To help with this I used an adjustment layer in PaintShop Pro with a black to white gradient mask applied to it. In that way contrast and brightness could be applied in a progressive manner across the night-side to even it up a bit.

A Topaz Denoise plug-in helped reduce noise and detail was drawn out with the help of Astra Image Deconvolution plug-in.

Diffraction spikes

Imaging with a Newtonian telescope and imaging and processing to draw out faint details means that I was always going to see diffraction spikes from my secondary support vanes. Fortunately for me the crescent of Venus was orientated perfectly with respect to the vanes and the night-side sat in the open space between two spikes. I'm not sure what I would have done if the orientation of Venus was different — the vane positions are where they are and there was no possibility of changing their orientation with respect to the sky.

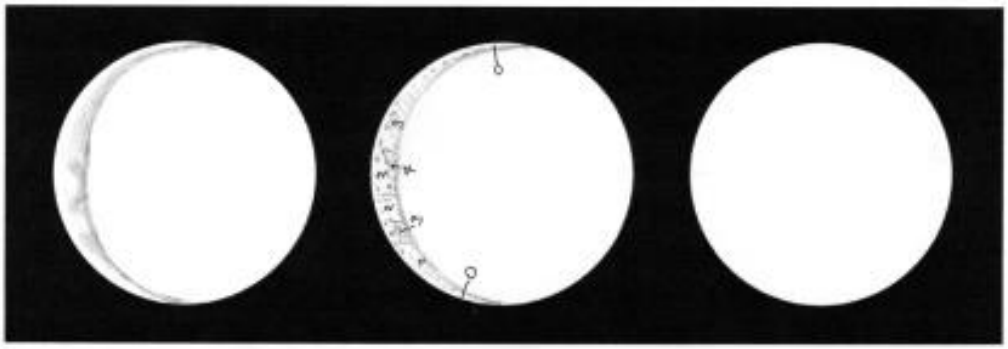
Observations from New Members

1. Maurice Collins, New Zealand:

2. Jon Culshaw, UK (2020-05-19, 2118UT, 150mm SCT):

3. David Fisher, UK:

BRITISH ASTRONOMICAL ASSOCIATION — VENUS VISUAL REPORT FORM



UT: 15 39	Mag'n: 153	X	UT:	Mag'n:	X	UT:	Mag'n:	X
Filter W:	Phase Est: 12	%	Filter W:	Phase Est:	%	Filter W:	Phase Est:	%

Date: 15th May 2020 — Start: 15 25 U.T. — Finish: 15 46 U.T.

Name: David Fisher — Location: Sittingbourne, Kent

Seeing: (Antoniadi Scale I-V): III — Instrument: 216mm Newtonian

Sky: Very Bright (Bright) Fair Twilight Dark — Disk Diameter = 48.4 " — Theoretical Phase: 12 %

Illuminated Disk: Some shading along terminator, a fairly dark shading just off centre.

Unilluminated Disk:

Bright Limb Band: The preceding limb was bright.

[ ] Limb band not seen
[ ] Limb band visible & complete
[ ] Limb band visible & incomplete

Terminator:

[✓] Terminator geometrically regular
[ ] Terminator geometrically irregular

Cusp Regions: Cusps were bright, due to "suspected" cusp extension of 12° at the south cusp.

[ ] Neither cusp cap visible
[ ] North cusp cap only visible
[ ] South cusp cap only visible
[✓] Both cusp caps equally bright
[ ] North cusp cap brighter
[ ] South cusp cap brighter

Cusp Collars: [x] Neither visible [ ] Both visible [ ] North only visible [ ] South only visible

North Cusp Extension: ..... ° South Cusp Extension: Suspect 12 °

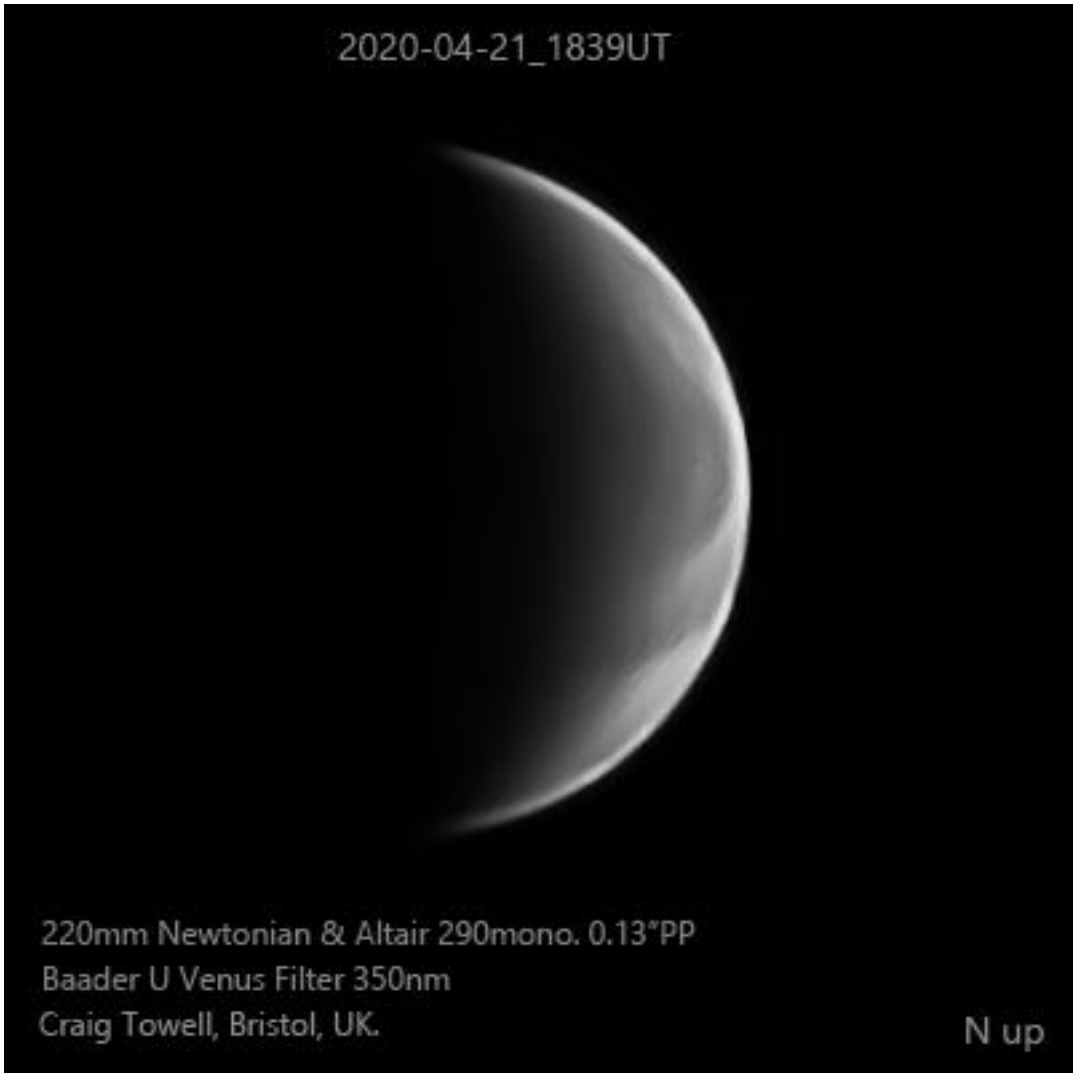
4. Murray Foster (2020-03-31, 1821UT, 152mm OG):

5. Phil Masding (2020-05-06, 1900UT):

6. Brad Thomas (2020-05-08, 2150UT):

7. Peter Tickner, UK:

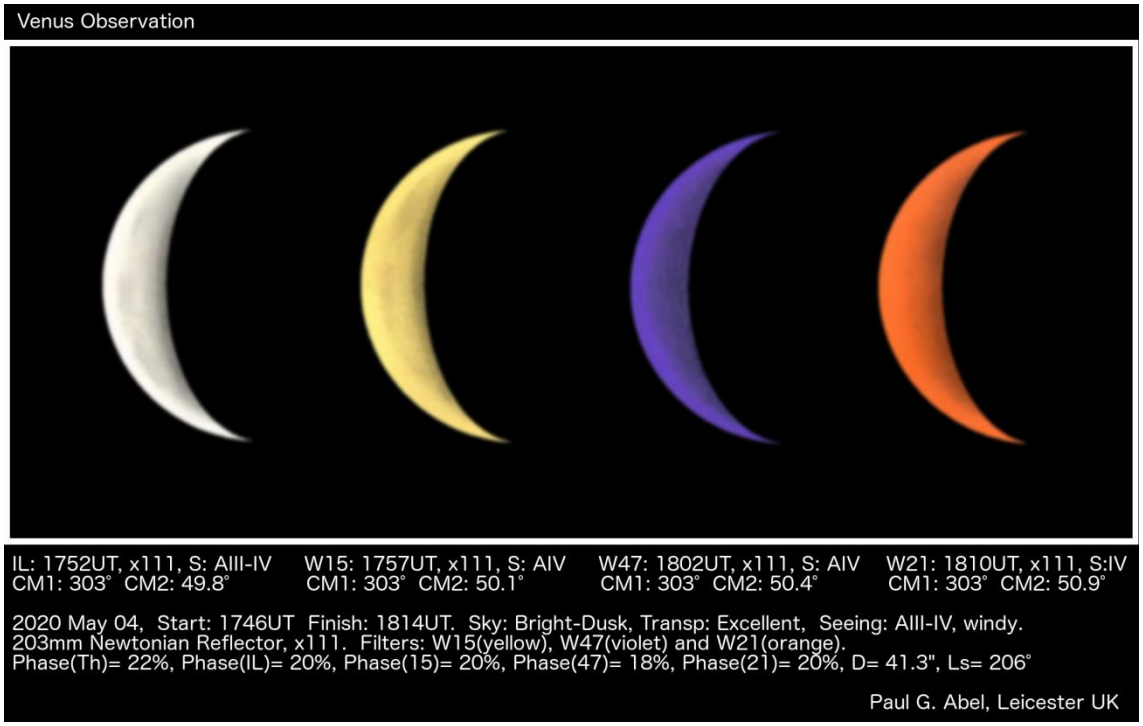
8. Craig Towell, UK:



Venus Observations

Visual Observations

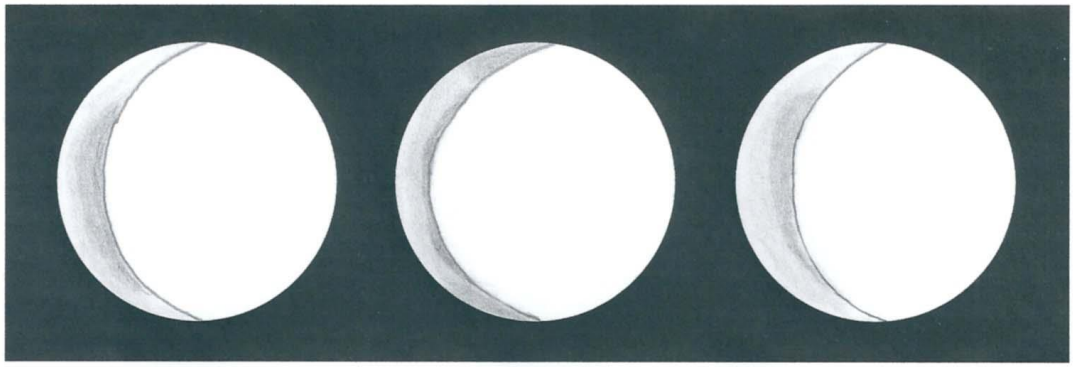
1. Paul G. Abel



2. Richard McKim, 76.2mm OG, x120:

3. Dave Basey, UK:

BRITISH ASTRONOMICAL ASSOCIATION — VENUS VISUAL REPORT FORM



UT: 1756 Mag'n: 225 X	UT: 1802 Mag'n: 225 X	UT: 1808 Mag'n: 225 X
Filter W: 15 Phase Est: 15 %	Filter W: 47 Phase Est: 12 %	Filter W: 25 Phase Est: 20 %

Date: 14/5/20 Start: 1756 U.T. Finish: 1814 U.T.

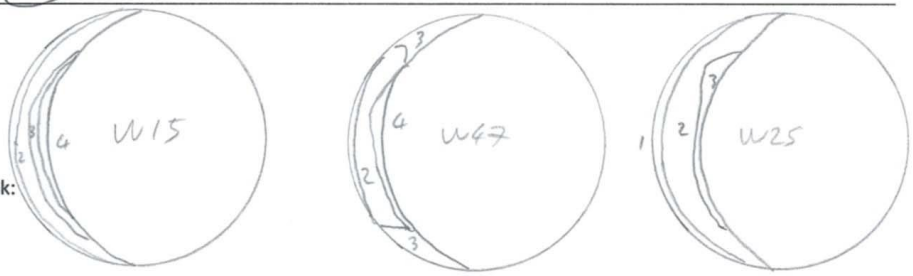
Name: DAVID BASEY Location: BRUNDALL, NORFOLK

Seeing: (Antoniadi Scale I-V): III Instrument: 350mm NEWTONIAN

Sky: Very Bright (Bright) Fair Twilight Dark Disk Diameter = 48.4" Theoretical Phase: 12 %

Illuminated Disk:

Unilluminated Disk:



Bright Limb Band:

[ ] Limb band not seen
[X] Limb band visible & complete
[ ] Limb band visible & incomplete

Terminator:

[X] Terminator geometrically regular
[ ] Terminator geometrically irregular

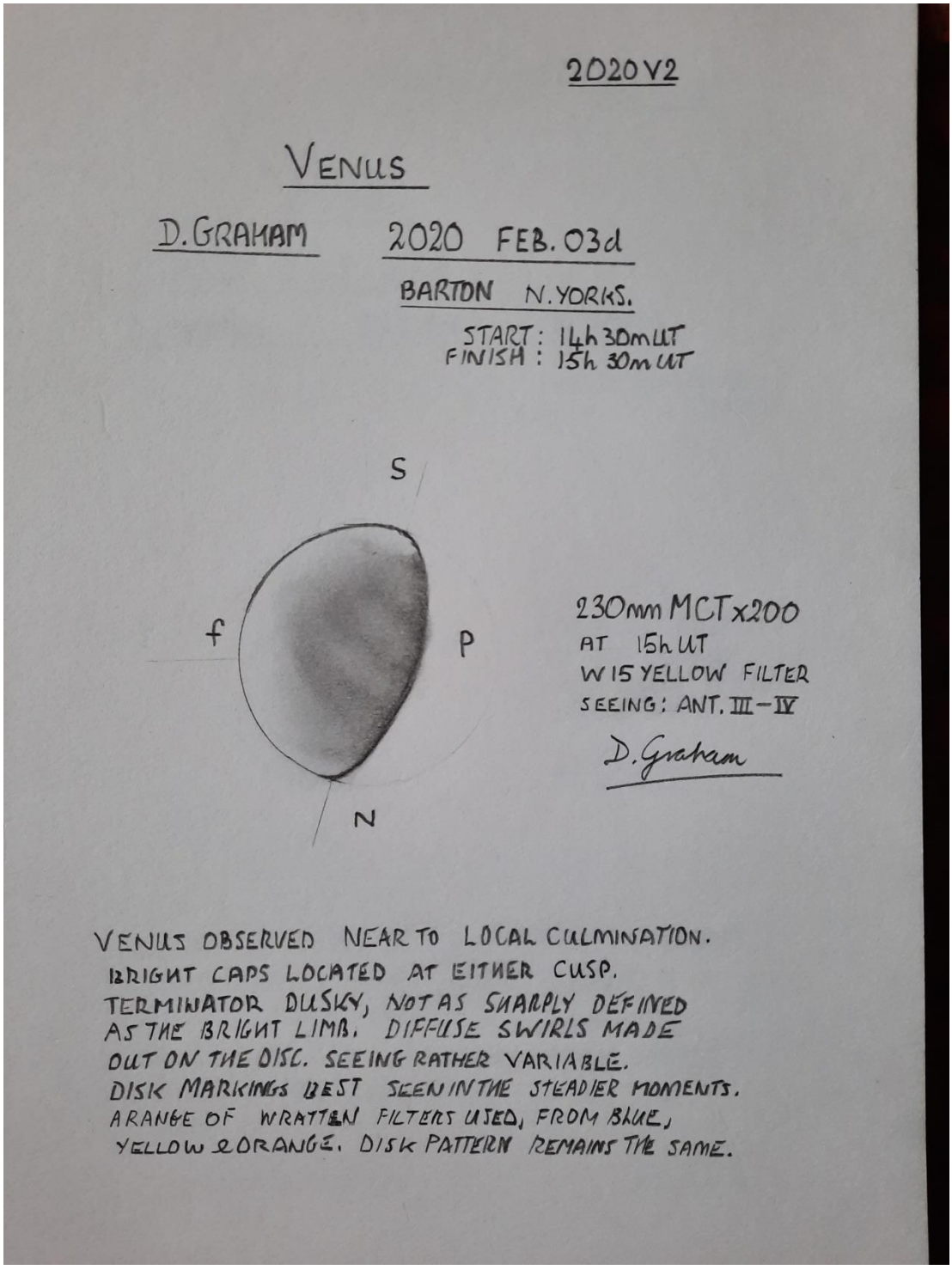
Cusp Regions:

[X] Neither cusp cap visible
[ ] North cusp cap only visible
[ ] South cusp cap only visible
[ ] Both cusp caps equally bright
[ ] North cusp cap brighter
[ ] South cusp cap brighter

Cusp Collars: [X] Neither visible [ ] Both visible [ ] North only visible [ ] South only visible

North Cusp Extension:.....° South Cusp Extension:.....°

4. David Graham, UK:



5. Alan W. Heath, UK:

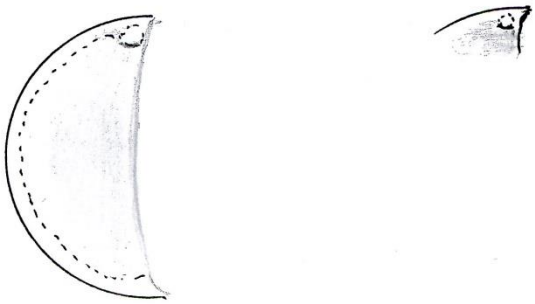
10

2020 March 26d 18·40 UT
X 200 Celestron-8 Seeing Fair S 3-4

PHASE	47	
TERMINATOR	int 3	Some minor irregularities suspected
DISC	int 1	some very vague shading suspected especially when using the apodizing screen
LIMB	bright cusp to cusp. Slight projection cusps	
CUSPS	Cusp Caps both N and S and the S Cusp best especially in Yellow (W15) ? dark border	

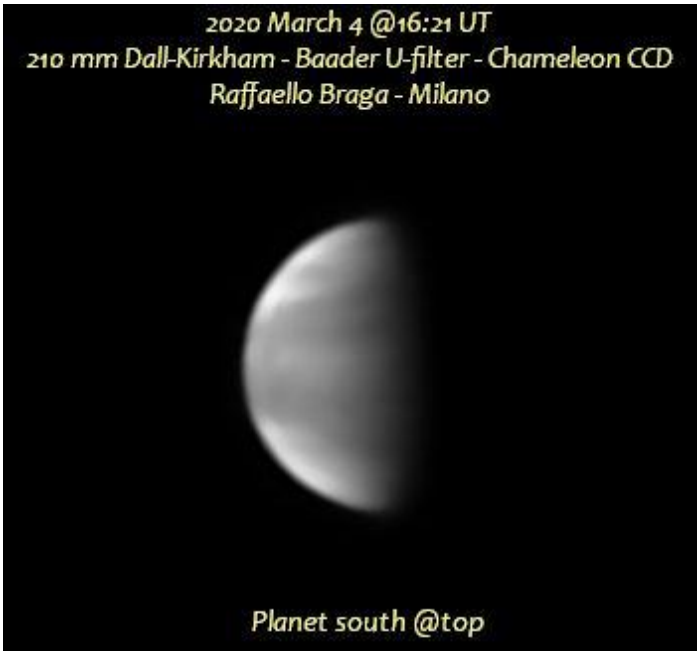
COLOUR FILTERS :
- RED (W25) similar to No Filter but the Cusp caps are weaker. Limb brightness very narrow
- YELLOW (W15) similar to No Filter but the S Cusp Cap very bright and a slightly darker border suspected
- BLUE (W44a) Limb brightness extends slightly further on to the disc. Disc int 1½

APODIZING SCREEN : Made from 1·5mm square mesh net curtain Image seems a little more stable. Screen placed over the end of the telescope. Used with Colour Filters also. I feel more certain about the vague shading on the Disc. No cusp caps seen with Blue (W44a) both with and without Screen



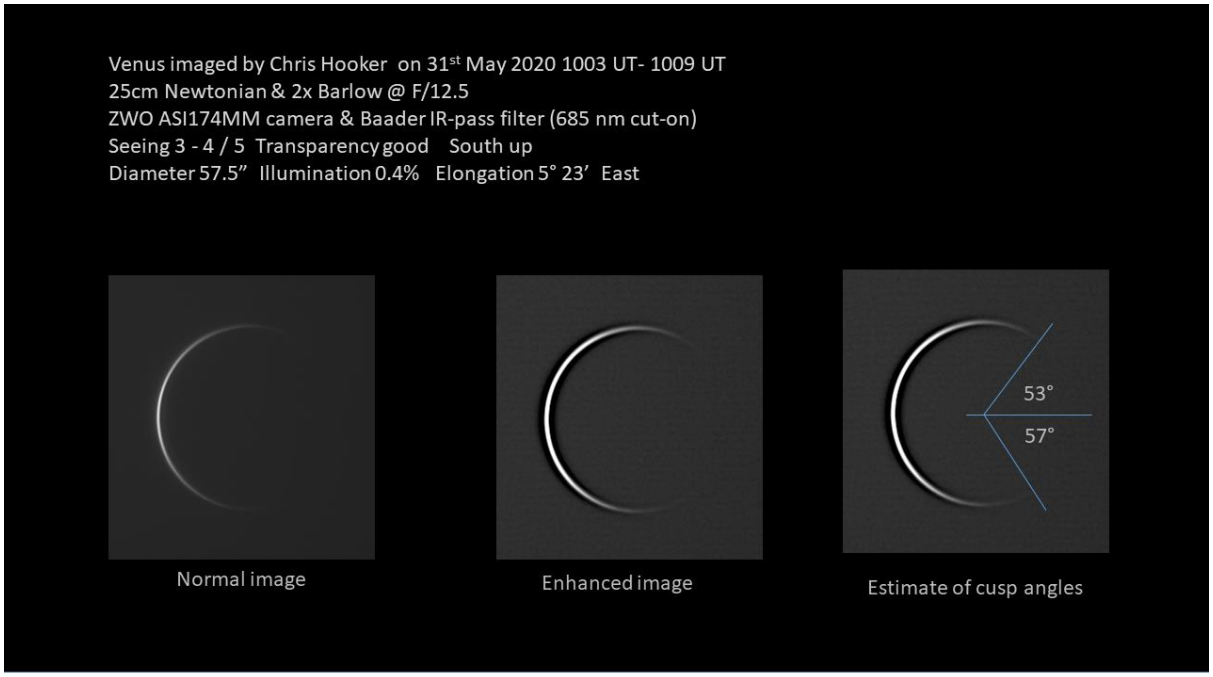
Images:

1. Raffaello Braga, Italy:



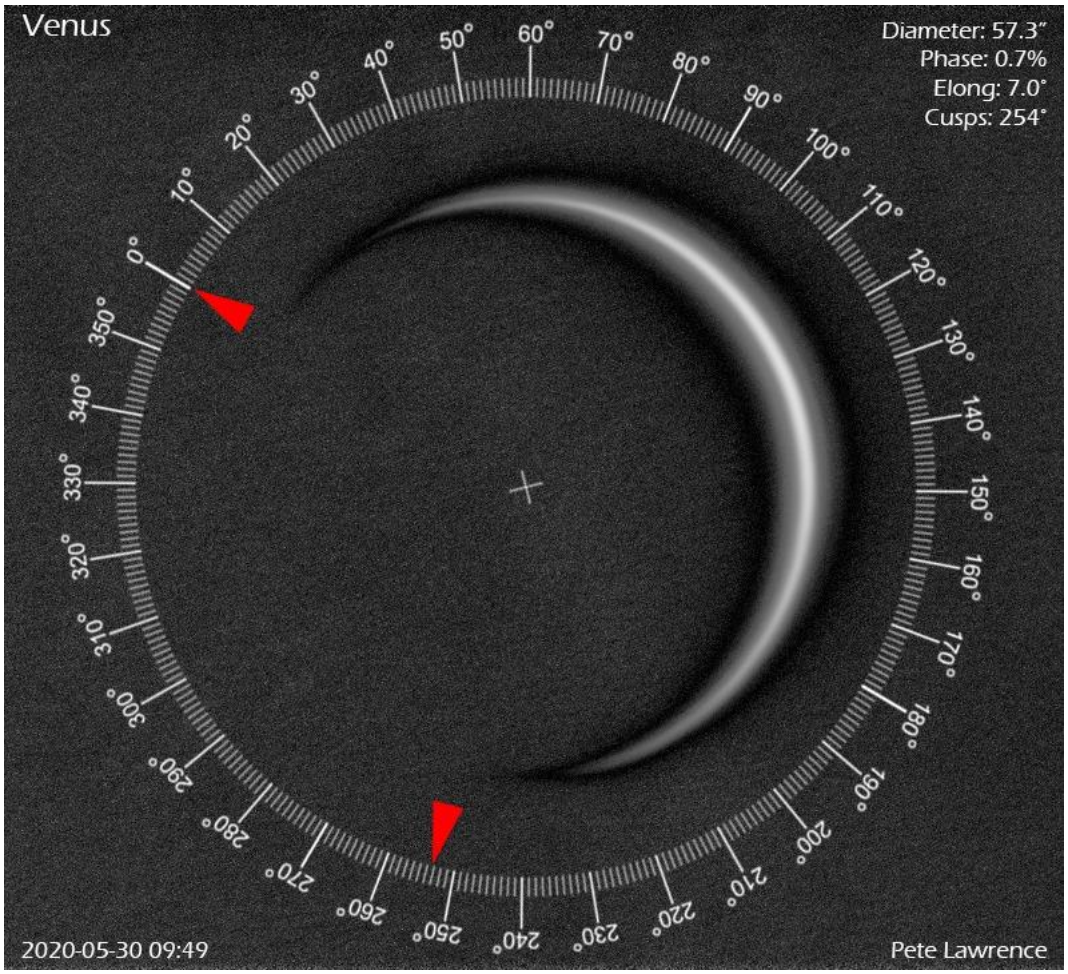
2. Mike Foulkes, UK:

3. Chris Hooker , UK:



4. Nick James, UK:

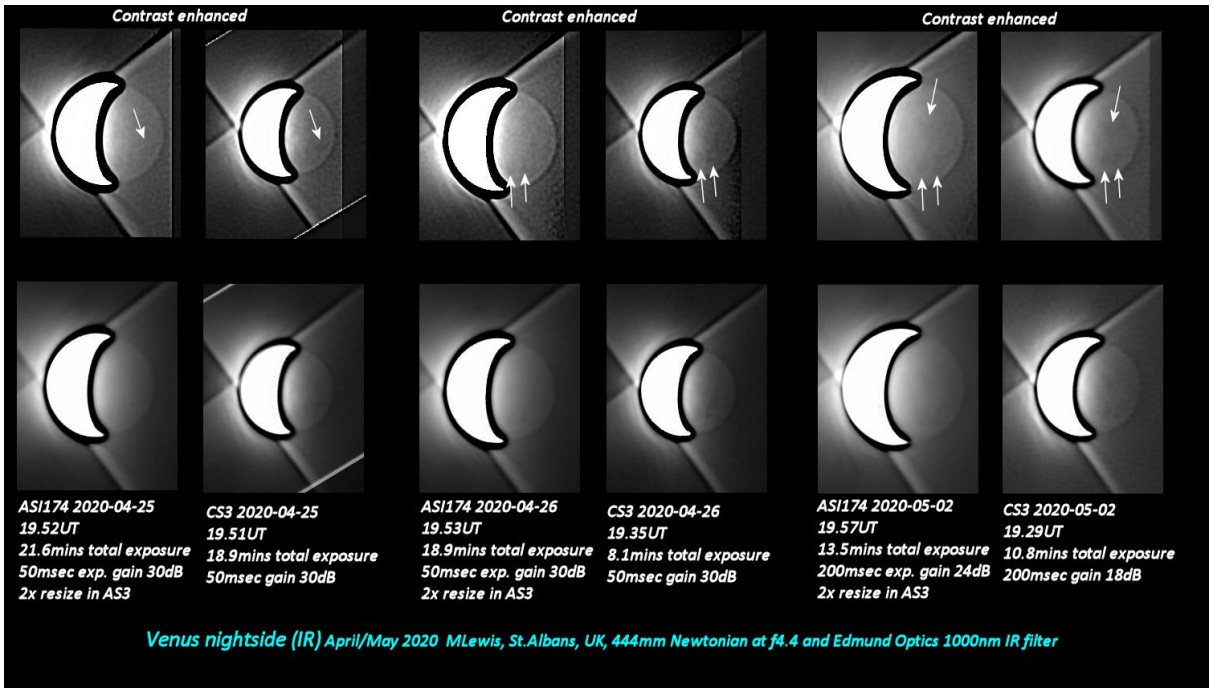
5. Pete Lawrence, UK:



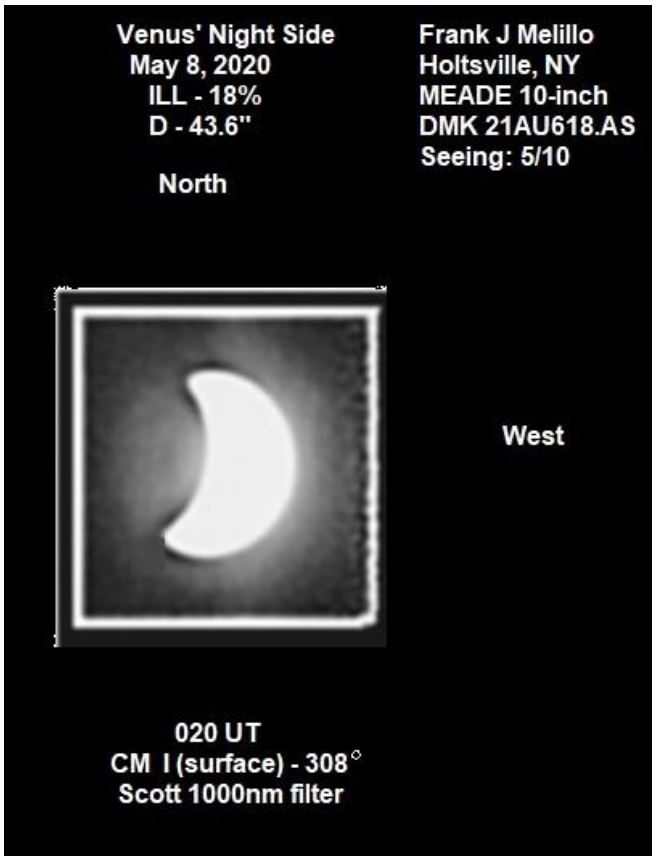
6. Bill Leatherbarrow, UK (2020 May 02, 1926UT, 305mm SCT, IR):

7. Raphaello Lena, Italy:

8. Martin Lewis, UK:



9. Frank Melillo, USA:



10. Geoffrey White, Malta (2020 May 20, 2052UT):