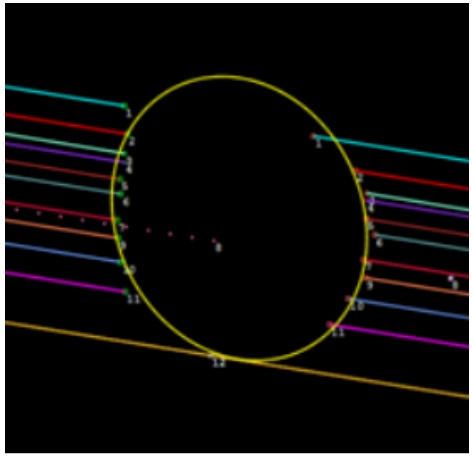
Getting Started in Occultation Science for Amateurs

North East Astronomy Forum
Pro-Am Workshop
Suffern, NY
2018 April 21

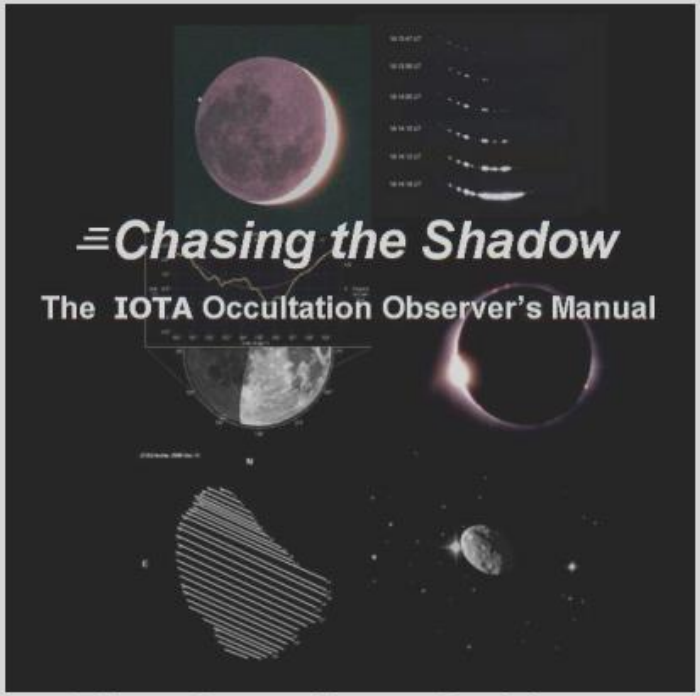


David Dunham
dunham@starpower.net
International Occultation Timing Association (IOTA)
http://occultations.org/

IOTA's Mission(s)

- **Provide predictions for occultations of stars by asteroids, planets, and the Moon**
- **Encourage and facilitate the observation and measurement of occultations and eclipses**
- **Provide software and information on observing equipment and techniques**
- **Report to our members and publish our observations**

IOTA Observing Manual



The Complete Guide to Observing Lunar, Grazing and Asteroid Occultations

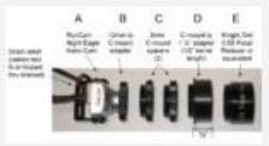
Published by the International Occultation Timing Association
Richard Nugent, Editor

Available at IOTA's main Web site, http://occultations.org

The observing tab there, directly http://occultations.org/observing/ has the latest information about recommended software and equipment.
Other tabs for joining, for our publications, and meetings ("community")

Occultation Observing Equipment

IOTA is offering several kits based on the RunCam Night Eagle 2 Astro edition video camera and and the adapters needed to use it with a telescope, to meet your various astronomy needs.



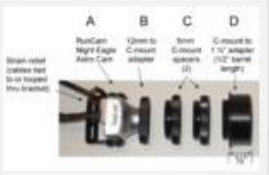
KIT 1 - RUNCAM NIGHT EAGLE ASTRO 2 WITH LENS, ALL ADAPTERS AND A 0.5X FOCAL REDUCER

This kit includes the camera with Astro firmware, W/A lens (not used with telescope), all power, video and OSD controller cables, all necessary adapters for telescopic use, and a 1 1/4 in. 0.5X focal reducer.

Domestic US shipping and handling will be added in shopping cart. For Canada, Mexico or Overseas shipping please add one of the extra shipping items at right.

$179.00

Add to Cart (appears below)



KIT 2 - RUNCAM NIGHT EAGLE ASTRO 2 WITH LENS AND ALL ADAPTERS (NO FOCAL REDUCER)

This kit is recommended only if you already have a 1.25 inch 0.5X focal reducer, as the focal reducer is highly recommended for all occultation observations.

Kit includes the camera with Astro firmware, W/A lens (not used with telescope), power, video and OSD controller cables and all necessary adapters to use it in a telescope, but no focal reducer.

Domestic US shipping and handling will be added in shopping cart. For Canada, Mexico or Overseas shipping please add one of the extra

KIT 3 - RUNCAM NIGHT EAGLE ASTRO 2 WITH WIDE ANGLE LENS (CAMERA, LENS AND CABLES ONLY)

This kit is recommended only if you intend to use the camera for something like all-sky or meteor recording.

Kit includes just the camera (with Astro firmware), power, video and OSD controller cables, and wide angle lens. If you wish to use it in a telescope, order Kit 1, or Kit 2 if you already have the focal reducer.

Domestic US shipping and handling will be added in shopping cart. For Canada, Mexico or Overseas shipping please add one of the extra shipping items at right.

Additional shipping - Canada and Mexico (Express)

ADDITIONAL SHIPPING - CANADA AND MEXICO (EXPRESS)

For addresses in Canada or Mexico only, please add just this item to your cart to cover additional shipping costs.

$25.00

Add to Cart (appears below)

Additional shipping - Overseas (Express)

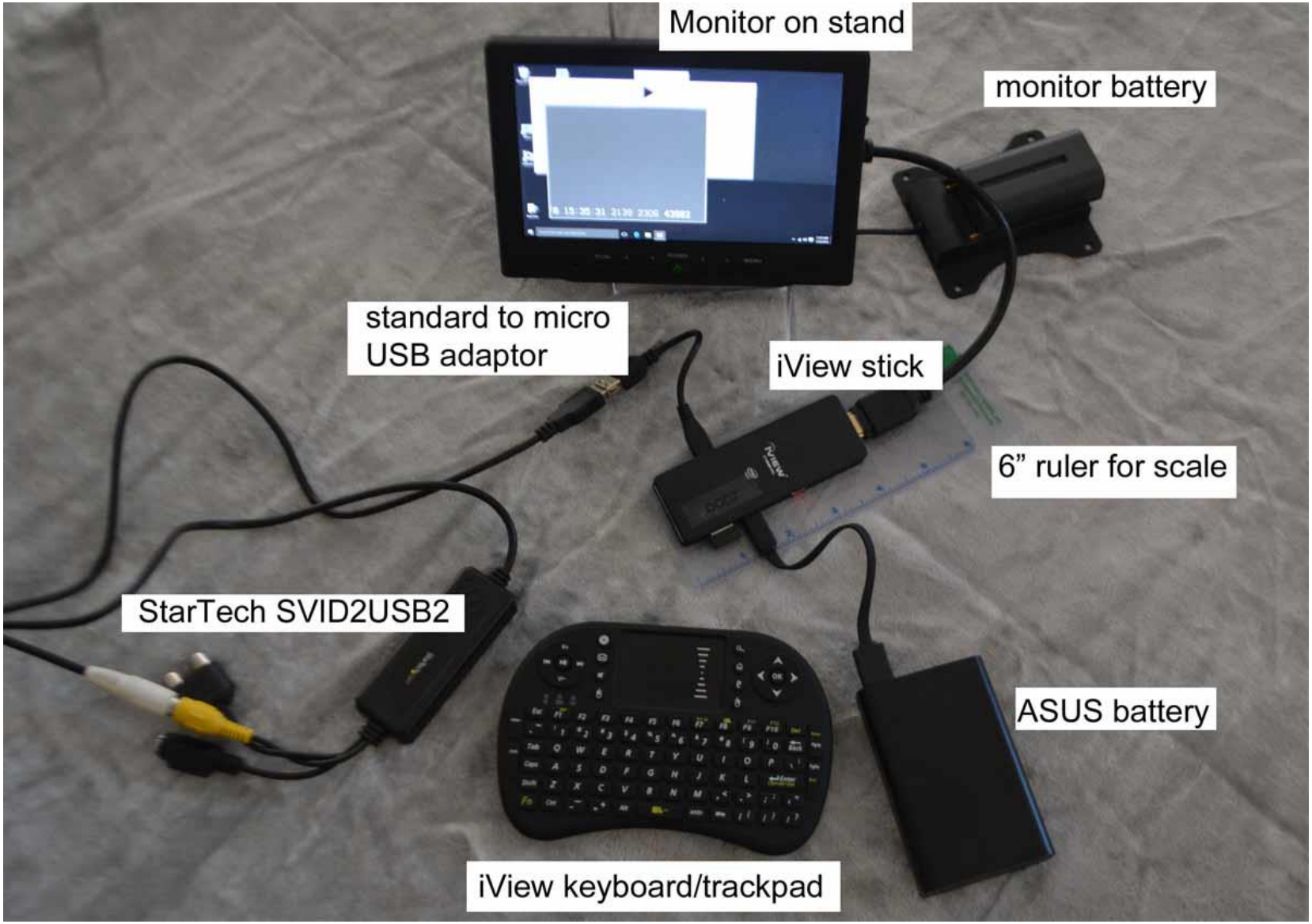
ADDITIONAL SHIPPING - OVERSEAS (EXPRESS)

For International orders other than in Canada or Mexico, please add just this item to your cart to cover additional shipping costs.

$40.00

Add to Cart (appears below)

Occ2 Recording System



GPS Video – IOTA VTI
Provides accurate (msec) timestamps on every video frame

Drift Scan Timing with an Astronomical CCD Camera

http://www.asteroidoccultation.com/observations/DriftScan/Index.htm

DRIFT-SCAN TIMING OF ASTEROID OCCULTATIONS

John Broughton (Updated 2014-11-13)

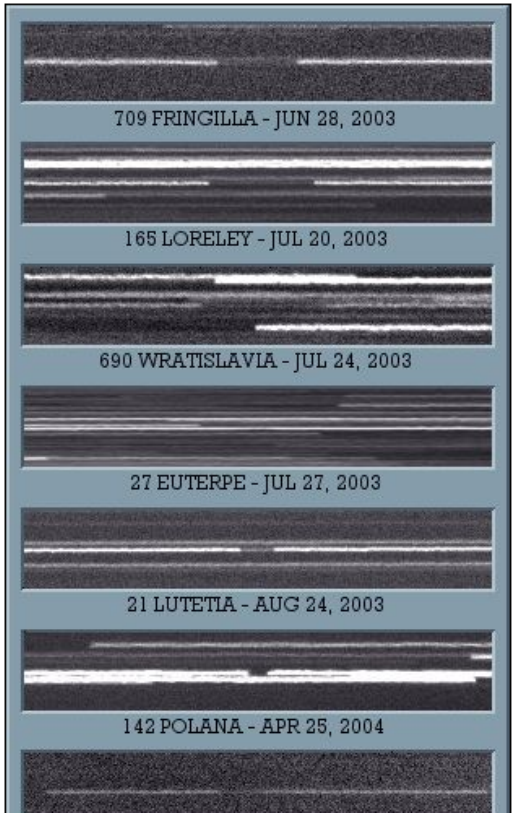
Occultations present the opportunity to remotely investigate shape and dimensions of planetary objects with orders of magnitude gain in resolution over direct imaging. I have in the past observed visually a spectacular Jupiter occultation of 2.6-magnitude Beta SCO and measured brief disappearances of a fifth magnitude star by ringlets of Saturn but until 2003 I had never observed the more common variety of occultation by an asteroid. Following on from the development of Dave Herald's Occult software, the turning point came with the advent of Steve Preston's updated predictions, the accuracy of which made viable a CCD imaging and timing technique I had under consideration many years earlier. The original inspiration was a trailed photograph of a Metis occultation taken by Paul Maley in 1979.

CCD

Due to their slow image transfer rate, most astronomical CCD cameras cannot record short-term variability on consecutive frames without missing out on most of the action; hence an occultation is best recorded on a single frame. One technique that has been particularly useful in recording rapid changes during lunar occultations is called TDI (time delay integration) where the CCD array is read out line by line to produce a trailed image. Not many cameras including my own have operating software supporting this electronic option but any integrating camera attached to a stationary telescope can take trailed images as a consequence of Earth's extremely regular rotation, which just happens to provide a rate of motion well suited to recording asteroid occultations.

With the advantage of noise reduction, a cooled CCD camera provides a substantial magnitude gain over non-integrating video cameras. From a moderately light-polluted location under otherwise favourable circumstances, sidereal-rate star trails as faint as magnitude 14 can be acquired with a telescope of 25cm aperture. A single image provides a convenient record for analysis, producing in most cases an unambiguously positive or negative result. Although cloud induced disappearances can mar an observation, they equally affect all nearby trails, making them easy to differentiate from the real thing.

Rigorous timing methods were devised and first employed for the Lutetia occultation of August 24, 2003. An accuracy of around .05 second can be expected for well-recorded events, leading to kilometre resolution in chord length and potentially an extremely precise celestial position for the asteroid. Lutetia incidentally has since been announced by ESA as the major asteroid flyby target of its currently enroute Rosetta comet rendezvous mission. Events previously considered unobservable may be within reach of observation; at right are the first 11 positive occultations recorded from my Reedy Creek, Gold Coast observatory in eastern Australia. The Euterpe event had a 0.3-magnitude drop, Echo occulted a star of magnitude 11.9 only 15 degrees from a full moon



Giant Aperture Not Required: You Only Need To See The Star - Not the Asteroid!

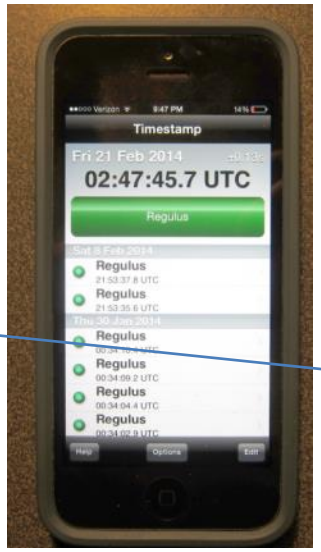
50mm objective
Down to magnitude 9.0

. . .

120mm objective
Down to magnitude 12.5

Visual timing

- Best: Smartphone timing app which syncs to UTC via NNTP



"Timestamp" by Emerald-Sequoia for iPhone

"Time The Sat" by satflare.com for Android

- Stopwatch

- Cellphone stopwatch app (elapsed time only)

- Count seconds to get E.T.
  - " 1 cig-a-rette 2 cig-a-rette "
- Any timing is better than no timing!

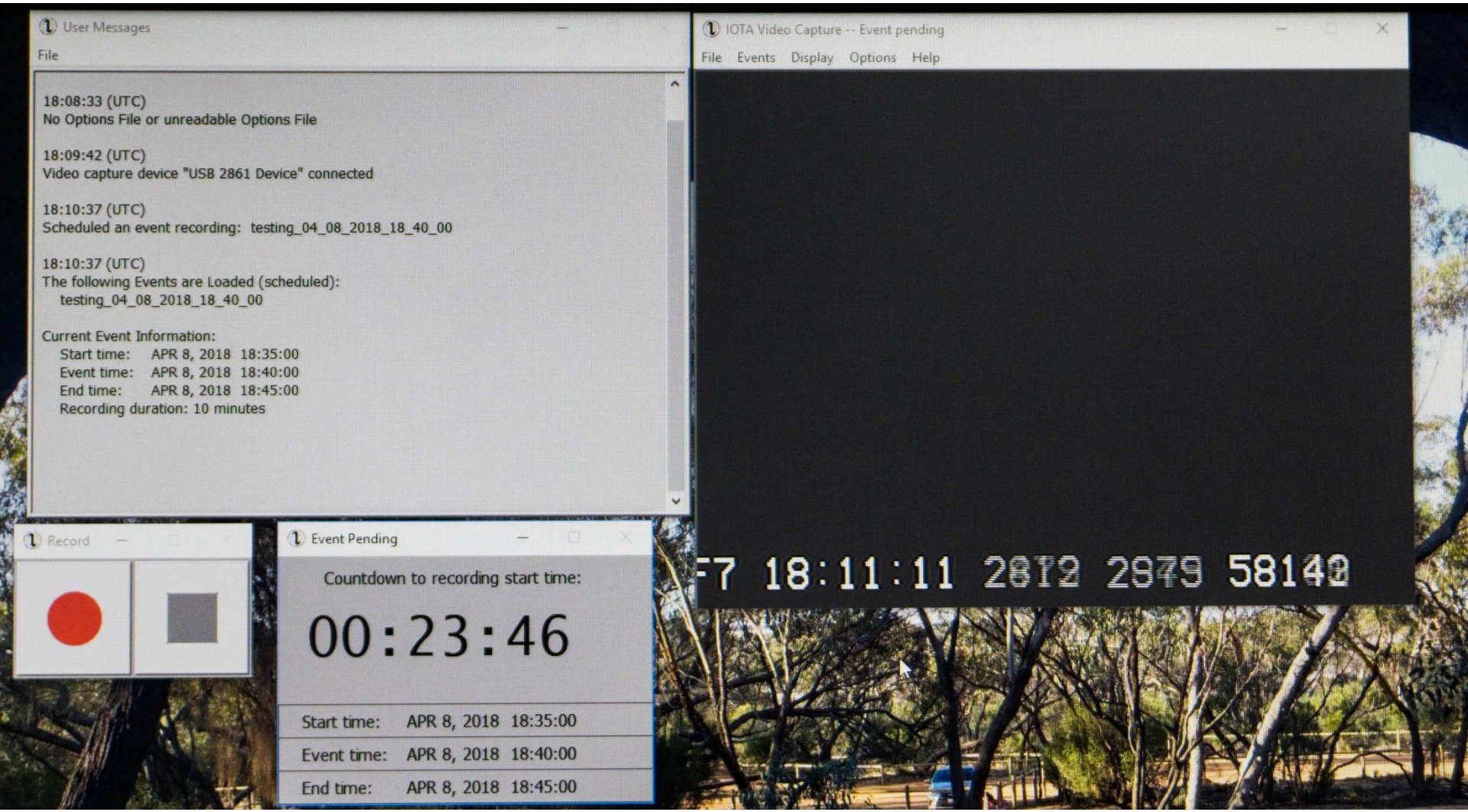
Better Visual Timing with Shortwave Radio (for WWV) and cassette audio tape recorder (now can use cell phone video, just for the audio recording)

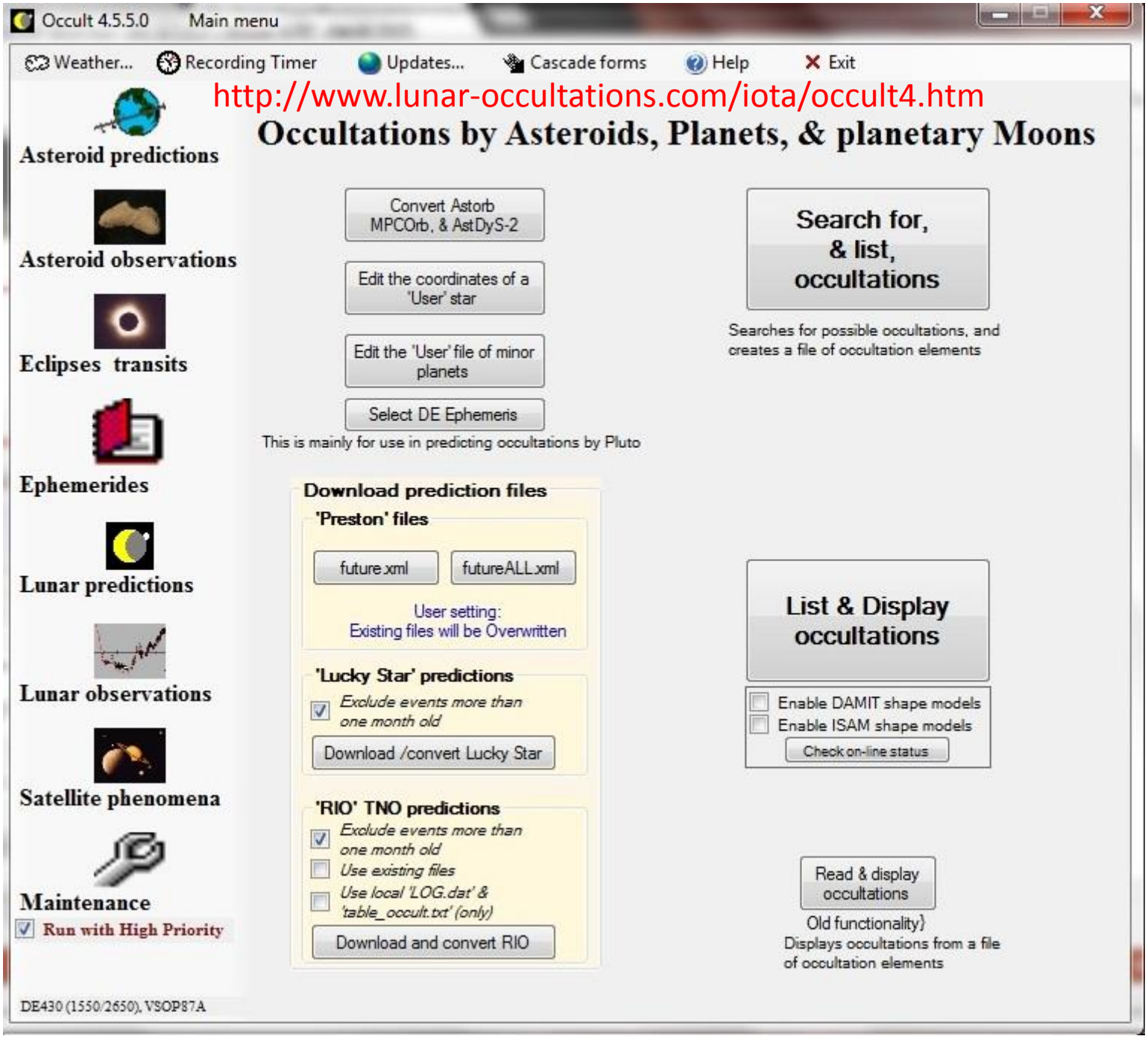
Software Tools

- IOTA Video Capture
  - Automates start and end of computer recordings
- Occult4
  - predictions, database of past observations
- Occult Watcher
  - Helps observers stay tuned to upcoming events
  - Helps coordinate observers on global scale
- Limovie
  - Photometry of standard video files of occultations
- Guide8 / Guide9

IOTA Video Capture

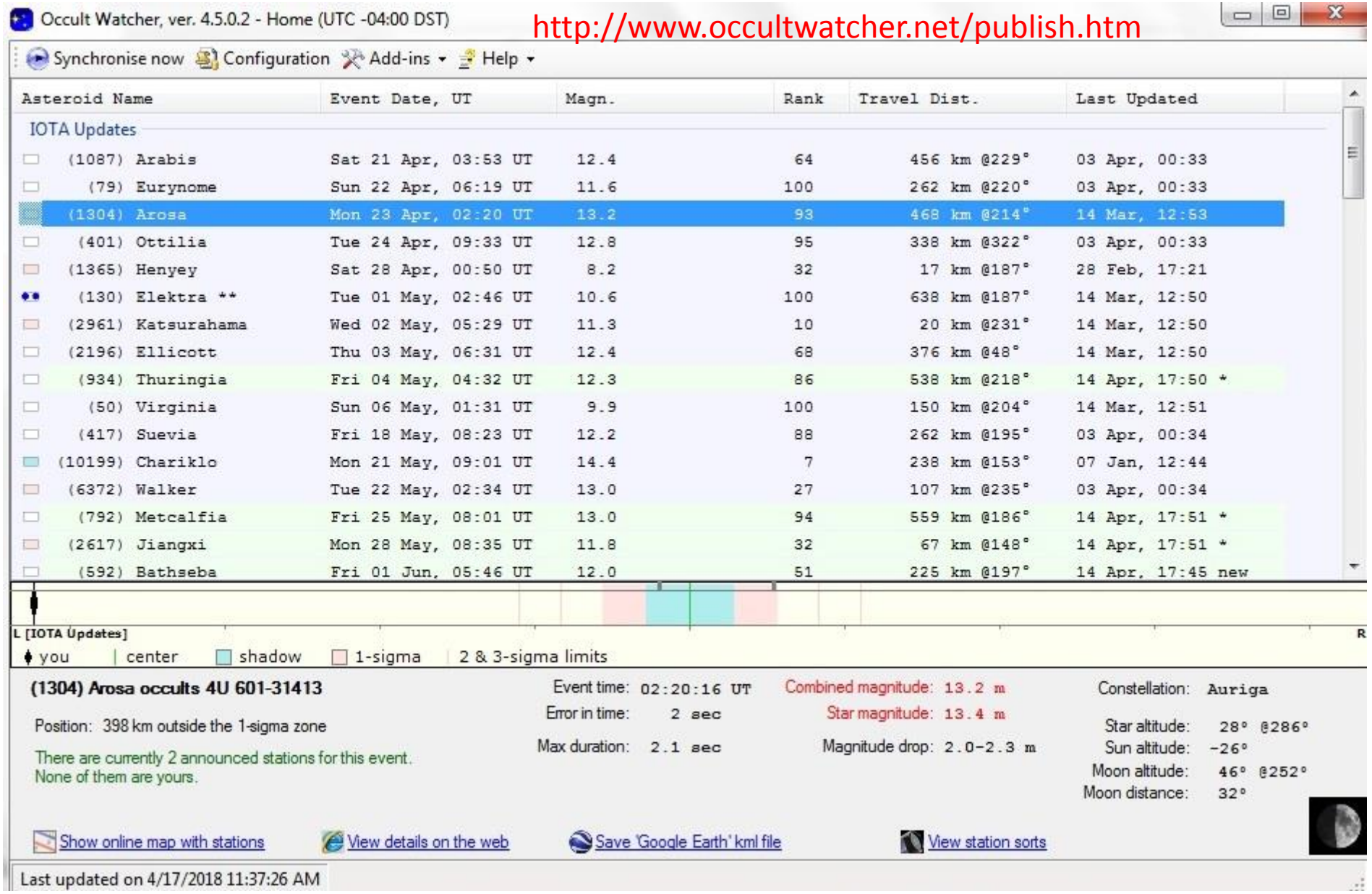
Link to download .zip file is at http://occultations.org/observing/software/





Occult 4 Main Menu

Occult Watcher (for asteroids & TNOs)



Paths within 550 km of Suffern, New York

Lunar Occultation Geometry

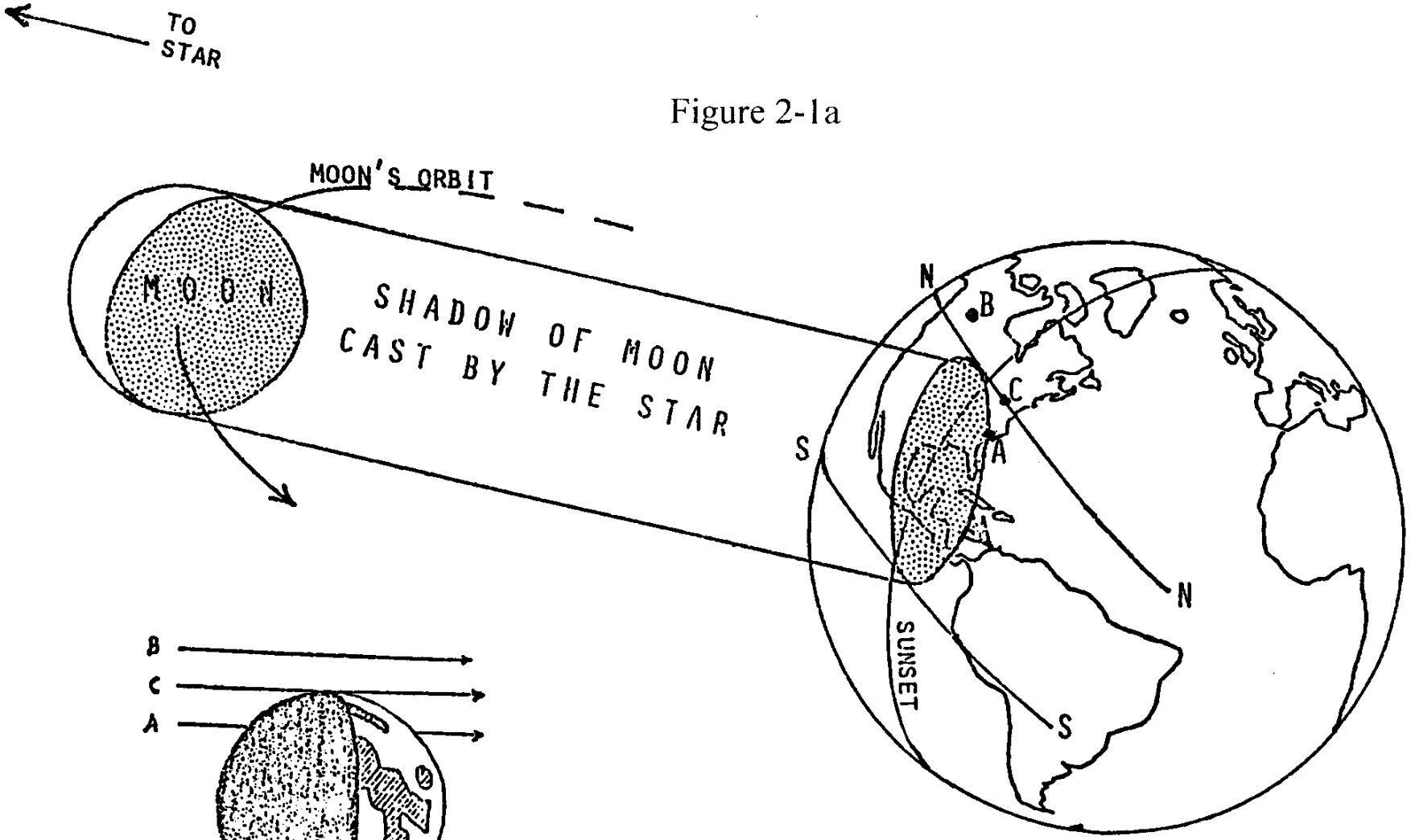


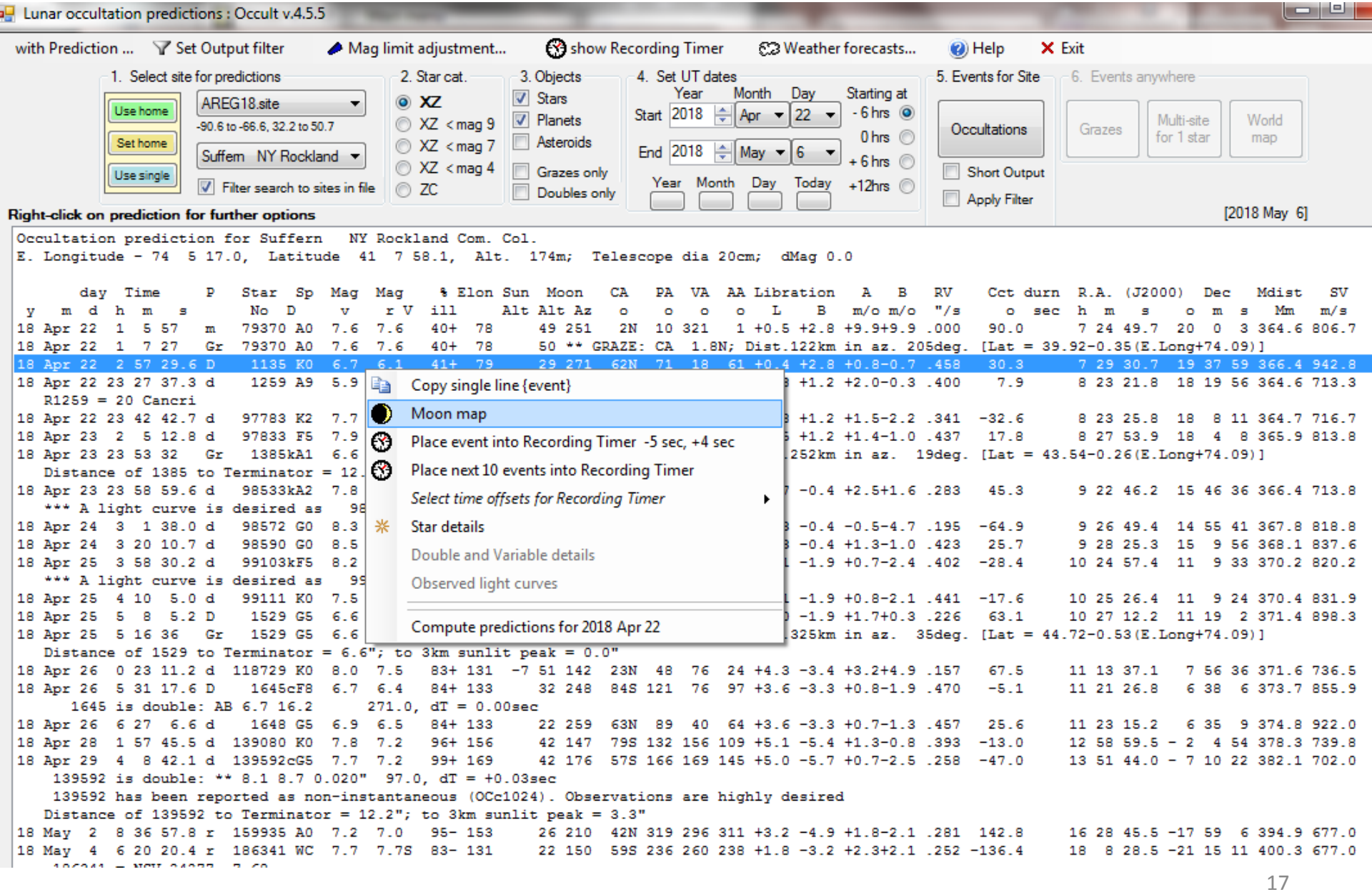
Figure 2-1b

B – Has no occultation (a miss)

C – Tangent path, a Grazing Occultation

A – Total Occultation

Occult 4 Total Occultation Predictions

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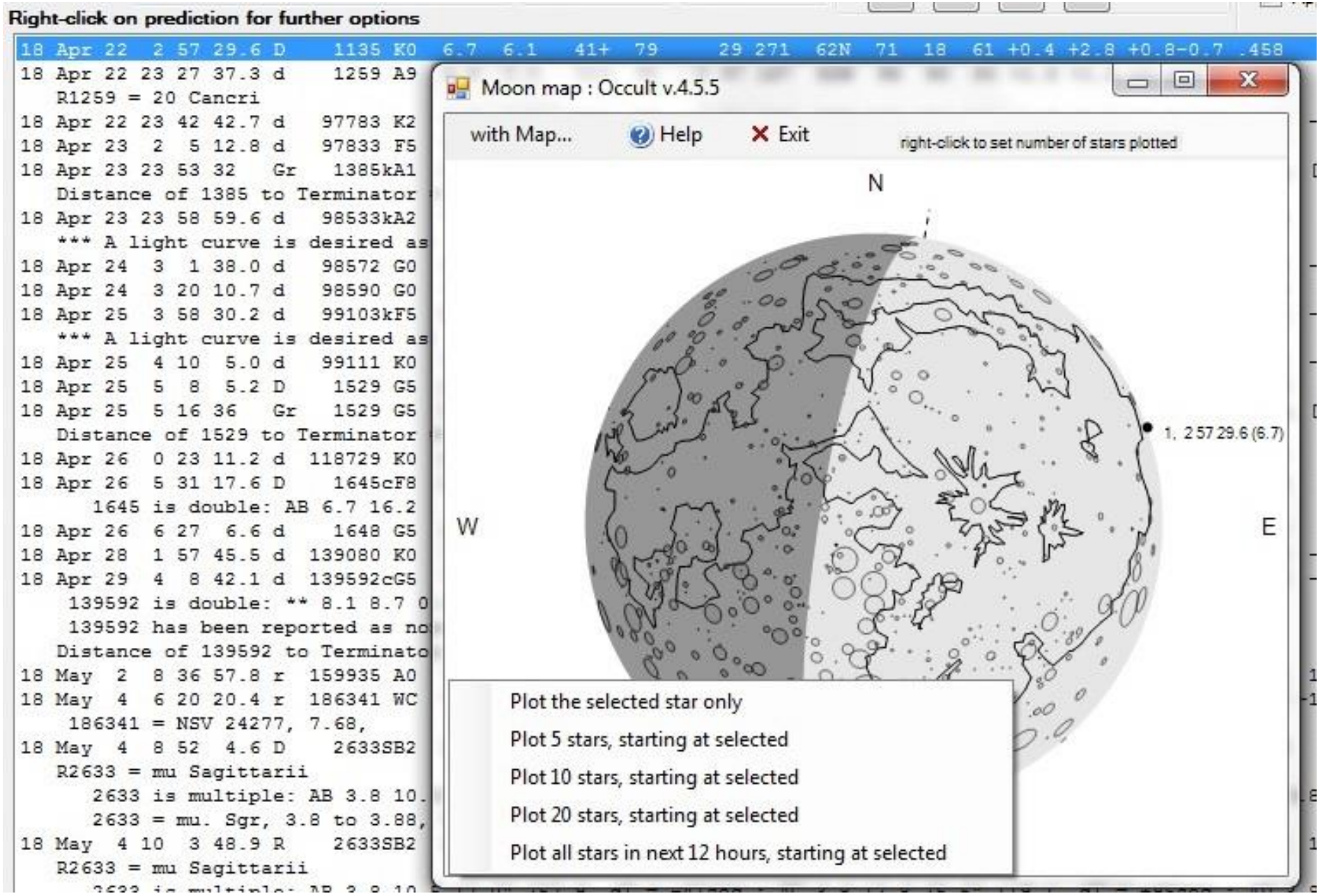
Occultation prediction for Suffern   NY Rockland Com. Col.
E. Longitude - 74  5 17.0,  Latitude  41  7 58.1,  Alt.  174m;  Telescope dia 20cm;  dMag 0.0

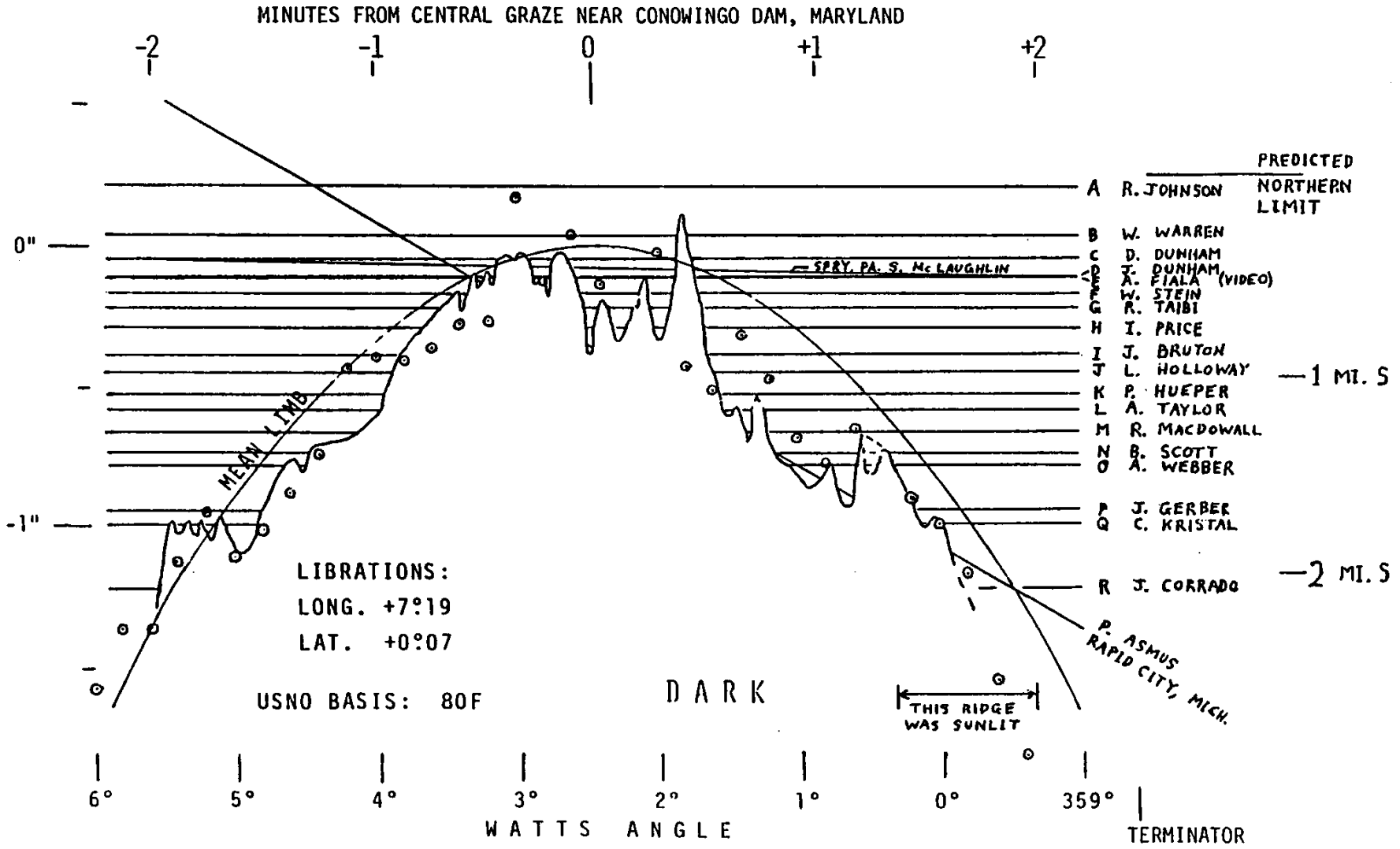
       day  Time     P   Star  Sp  Mag  Mag    % Elon Sun  Moon   CA   PA  VA  AA Libration    A   B   RV    Cct durn  R.A. (J2000)  Dec   Mdist   SV
 y   m  d  h  m   s        No  D    v    r V   ill     Alt Alt Az   o    o   o   o   L    B   m/o m/o  "/s      o  sec  h  m   s    o  m  s   Mm   m/s
18 Apr 22  1  5 57   m   79370 A0  7.6  7.6   40+  78      49 251   2N  10 321   1 +0.5 +2.8 +9.9+9.9 .000    90.0       7 24 49.7  20  0  3 364.6 806.7
18 Apr 22  1  7 27   Gr  79370 A0  7.6  7.6   40+  78      50 ** GRAZE: CA  1.8N; Dist.122km in az. 205deg. [Lat = 39.92-0.35(E.Long+74.09)]
18 Apr 22  2 57 29.6 D    1135 K0  6.7  6.1   41+  79      29 271  62N  71  18  61 +0.4 +2.8 +0.8-0.7 .458    30.3       7 29 30.7  19 37 59 366.4 942.8
18 Apr 22 23 27 37.3 d    1259 A9  5.9                                                +1.2 +2.0-0.3 .400     7.9       8 23 21.8  18 19 56 364.6 713.3
   R1259 = 20 Cancri
18 Apr 22 23 42 42.7 d   97783 K2  7.7                                                +1.2 +1.5-2.2 .341   -32.6       8 23 25.8  18  8 11 364.7 716.7
18 Apr 23  2  5 12.8 d   97833 F5  7.9                                                +1.2 +1.4-1.0 .437    17.8       8 27 53.9  18  4  8 365.9 813.8
18 Apr 23 23 53 32   Gr   1385kA1  6.6                                                .252km in az.  19deg. [Lat = 43.54-0.26(E.Long+74.09)]
   Distance of 1385 to Terminator = 12.
18 Apr 23 23 58 59.6 d   98533kA2  7.8                                                -0.4 +2.5+1.6 .283    45.3       9 22 46.2  15 46 36 366.4 713.8
   *** A light curve is desired as   98
18 Apr 24  3  1 38.0 d   98572 G0  8.3                                                -0.4 -0.5-4.7 .195   -64.9       9 26 49.4  14 55 41 367.8 818.8
18 Apr 24  3 20 10.7 d   98590 G0  8.5                                                -0.4 +1.3-1.0 .423    25.7       9 28 25.3  15  9 56 368.1 837.6
18 Apr 25  3 58 30.2 d   99103kF5  8.2                                                -1.9 +0.7-2.4 .402   -28.4      10 24 57.4  11  9 33 370.2 820.2
   *** A light curve is desired as   99
18 Apr 25  4 10  5.0 d   99111 K0  7.5                                                -1.9 +0.8-2.1 .441   -17.6      10 25 26.4  11  9 24 370.4 831.9
18 Apr 25  5  8  5.2 D    1529 G5  6.6                                                -1.9 +1.7+0.3 .226    63.1      10 27 12.2  11 19  2 371.4 898.3
18 Apr 25  5 16 36   Gr   1529 G5  6.6                                                .325km in az.  35deg. [Lat = 44.72-0.53(E.Long+74.09)]
   Distance of 1529 to Terminator = 6.6"; to 3km sunlit peak = 0.0"
18 Apr 26  0 23 11.2 d  118729 K0  8.0  7.5   83+ 131  -7 51 142  23N  48  76  24 +4.3 -3.4 +3.2+4.9 .157    67.5      11 13 37.1   7 56 36 371.6 736.5
18 Apr 26  5 31 17.6 D    1645cF8  6.7  6.4   84+ 133     32 248  84S 121  76  97 +3.6 -3.3 +0.8-1.9 .470    -5.1      11 21 26.8   6 38  6 373.7 855.9
      1645 is double: AB 6.7 16.2      271.0, dT = 0.00sec
18 Apr 26  6 27  6.6 d   1648 G5  6.9  6.5   84+ 133     22 259  63N  89  40  64 +3.6 -3.3 +0.7-1.3 .457    25.6      11 23 15.2   6 35  9 374.8 922.0
18 Apr 28  1 57 45.5 d  139080 K0  7.8  7.2   96+ 156     42 147  79S 132 156 109 +5.1 -5.4 +1.3-0.8 .393   -13.0      12 58 59.5 - 2  4 54 378.3 739.8
18 Apr 29  4  8 42.1 d  139592cG5  7.7  7.2   99+ 169     42 176  57S 166 169 145 +5.0 -5.7 +0.7-2.5 .258   -47.0      13 51 44.0 - 7 10 22 382.1 702.0
    139592 is double: ** 8.1 8.7 0.020"  97.0, dT = +0.03sec
    139592 has been reported as non-instantaneous (OCc1024). Observations are highly desired
   Distance of 139592 to Terminator = 12.2"; to 3km sunlit peak = 3.3"
18 May  2  8 36 57.8 r  159935 A0  7.2  7.0   95- 153     26 210  42N 319 296 311 +3.2 -4.9 +1.8-2.1 .281   142.8      16 28 45.5 -17 59  6 394.9 677.0
18 May  4  6 20 20.4 r  186341 WC  7.7  7.7S  83- 131     22 150  59S 236 260 238 +1.8 -3.2 +2.3+2.1 .252 -136.4      18  8 28.5 -21 15 11 400.3 677.0
```

Occult 4 Moonview for 2018 Apr. 22 ZC 1135 Occ'n



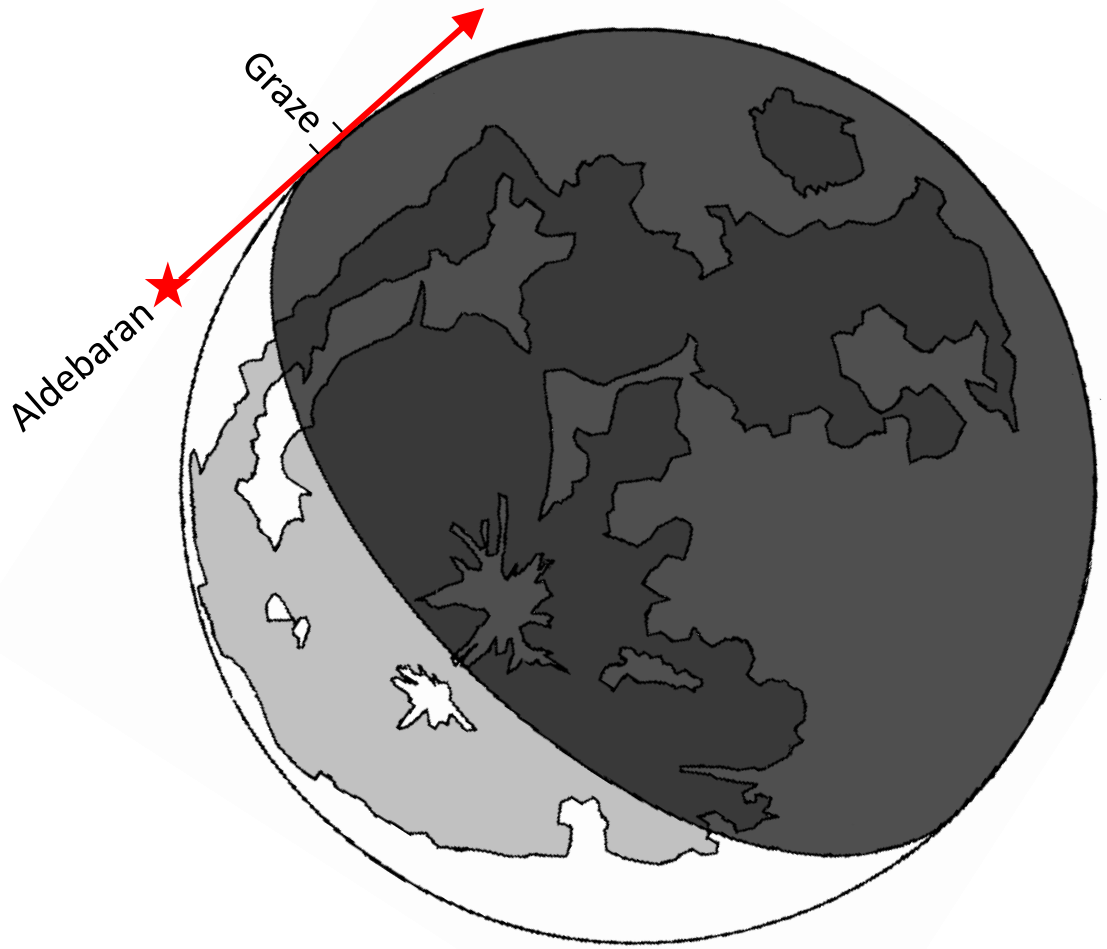
Lunar Profile from Graze of delta Cancri – 1981 May 9-10

Alan Fiala, USNO, obtained the first video recording of multiple events during this graze, with 7 D's and 7 R's



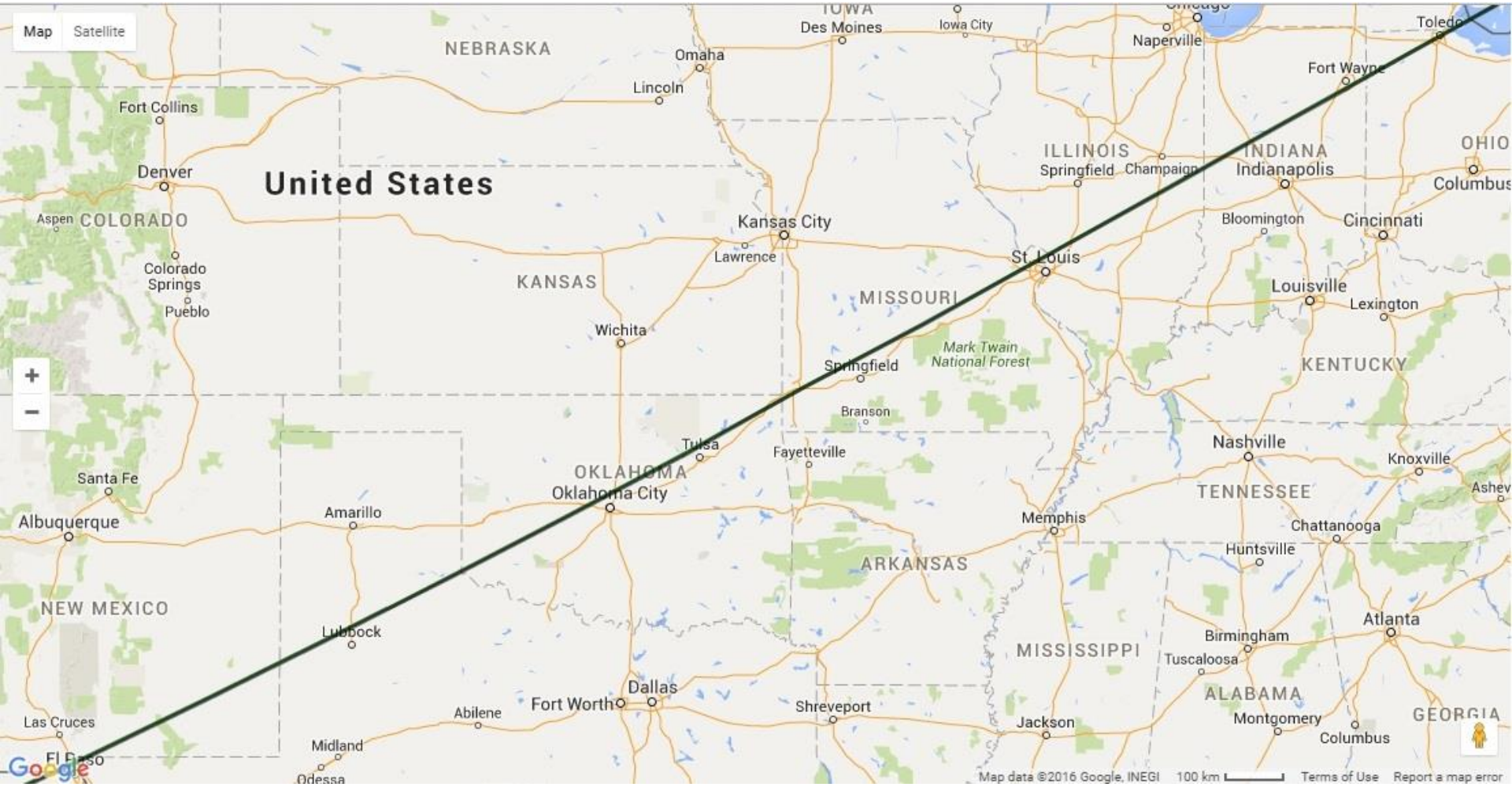
Circled dots are Watts' predicted limb corrections

View of Moon for the Aldebaran Graze, July 29, 2016



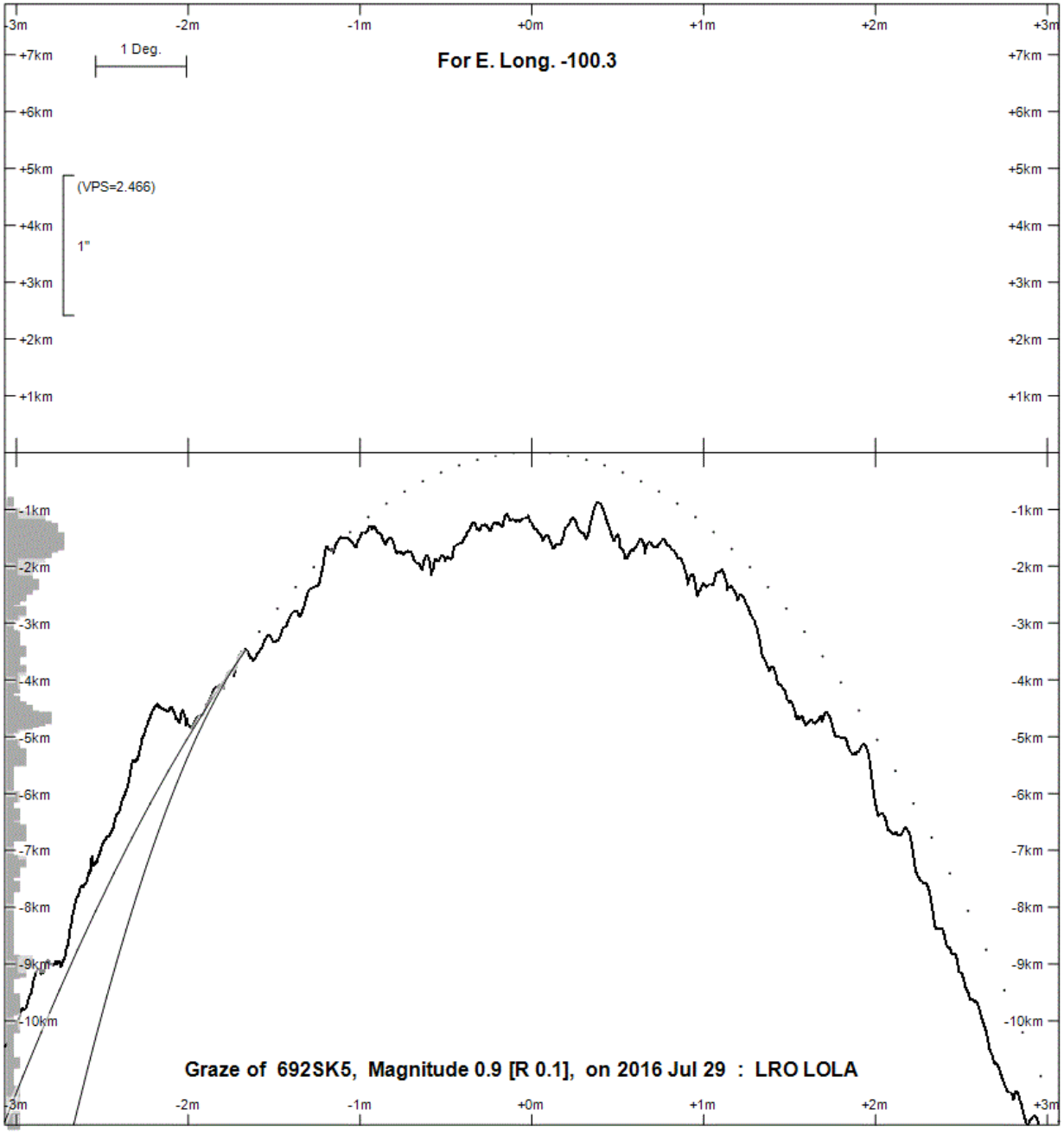
This is the view of the 23% sunlit waning crescent Moon as seen from Oklahoma, but the view will be virtually the same for other locations along the graze path across North America. The orange star will appear to approach the Moon from the sunlit side, passing very close to the northern cusp, where binoculars will probably be needed to see the star a few minutes before the graze. The star will become easier to see, even with the naked eye (where strong twilight or daylight doesn't interfere), as it moves onto the dark side during the graze. The dark side of the Moon is faintly illuminated by "Earthshine", and the darker "maria" (lava-filled "seas") can be seen with binoculars.

2017 July 29 Aldebaran path across USA



Northern-limit graze

Occult 4.2.0.6

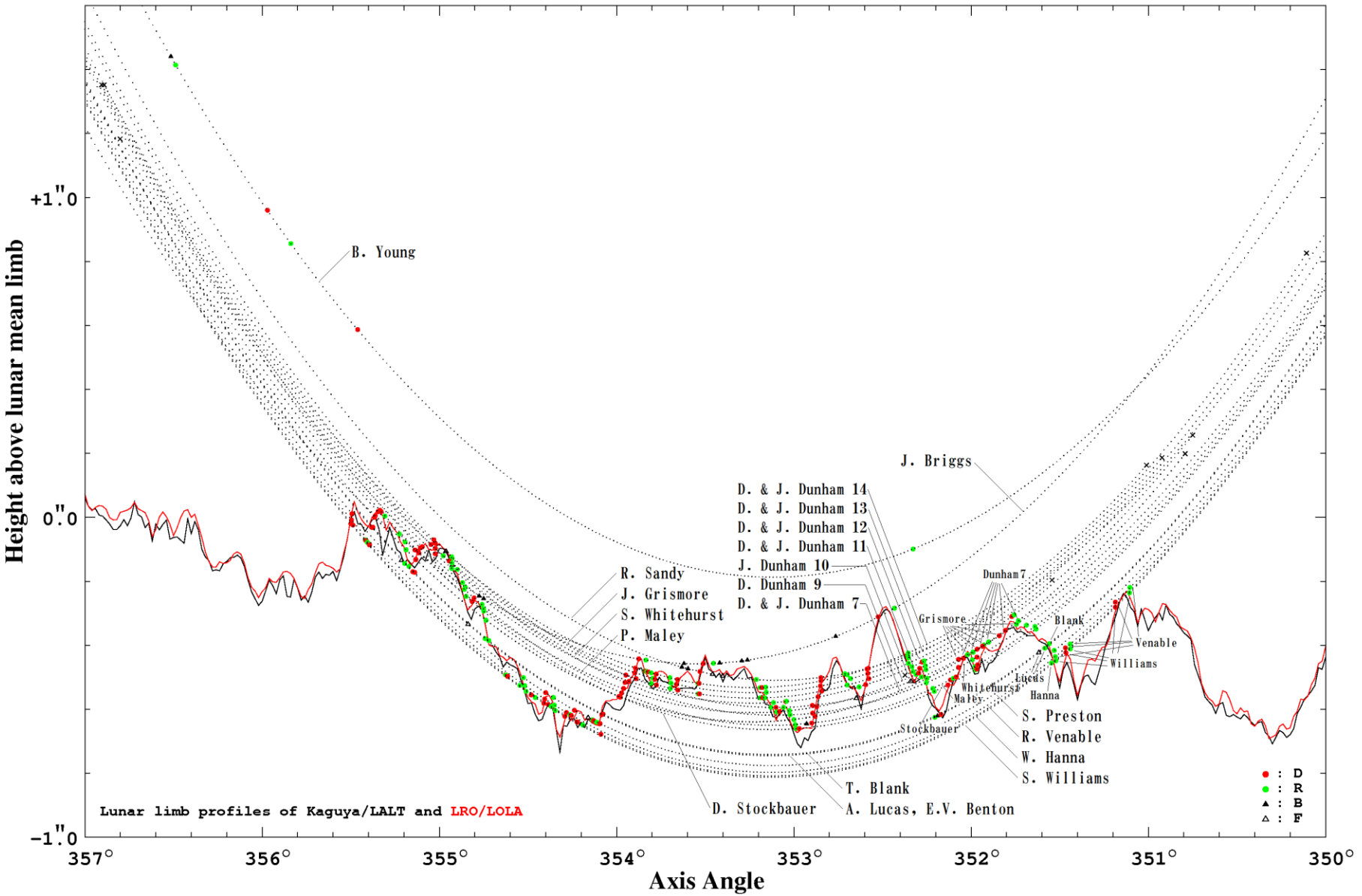


2017 July 29 Aldebaran Graze Predicted Profile

Carey, TX

To set gray offset line A (in km perpendicular to GREEN line), edit this box 1.23 then Click Here

To set gray offset line B (in km perpendicular to GREEN line), edit this box 1.89 then Click Here

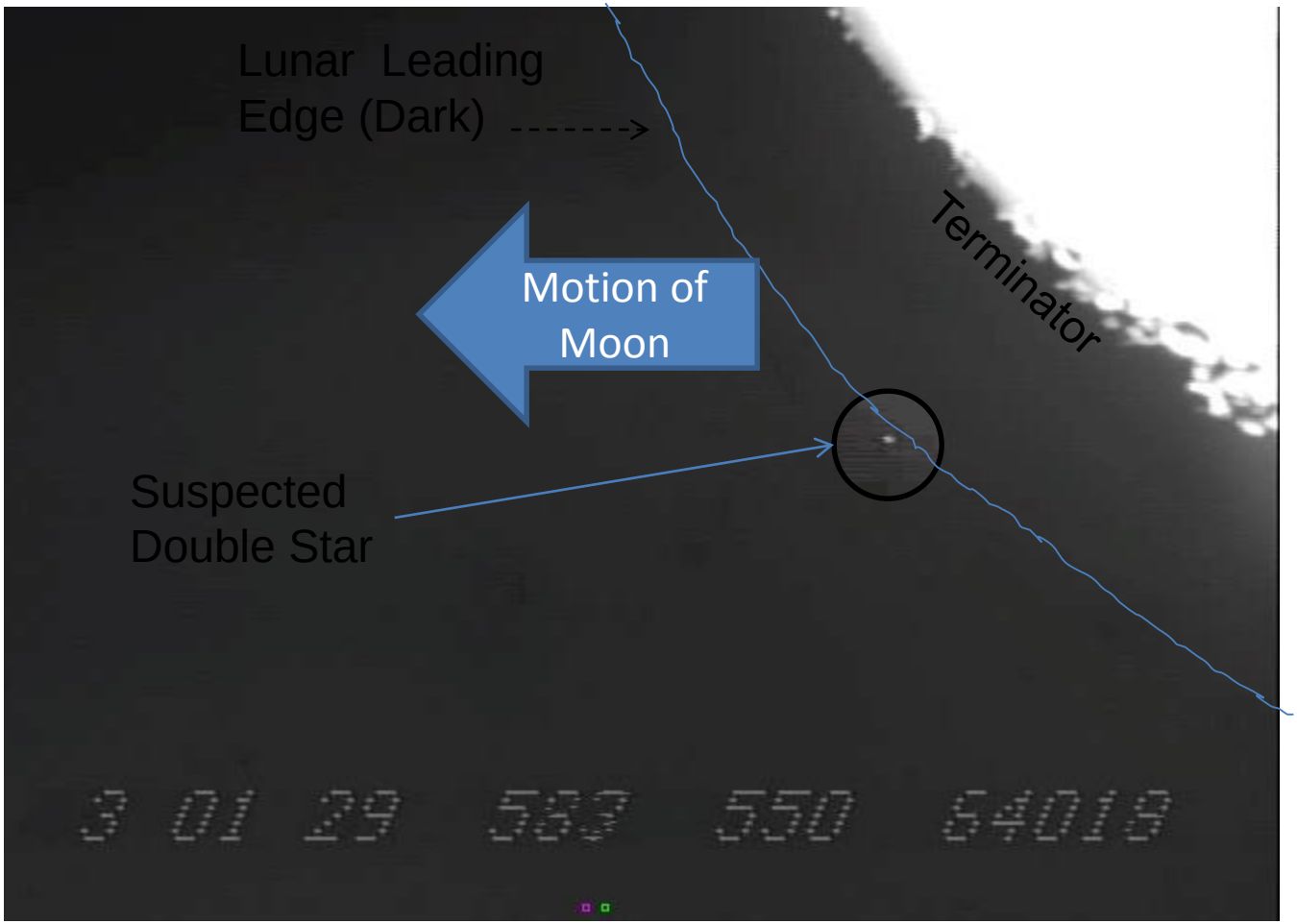

Graze of ZC 692 on 20160729
Basis = 99G
Libration 2.9 7.27 (deg)
Height above lunar mean limb
+1".0
0".0
-1".0
357°
356°
355°
354°
353°
352°
351°
350°
Axis Angle
B. Young
J. Briggs
D. & J. Dunham 14
D. & J. Dunham 13
D. & J. Dunham 12
D. & J. Dunham 11
J. Dunham 10
D. Dunham 9
D. & J. Dunham 7
R. Sandy
J. Grismore
S. Whitehurst
P. Maley
Dunham 7
Grismore
Blank
Venable
Williams
Lucas
Whitehurst
Maley
Hanna
Stockbauer
S. Preston
R. Venable
W. Hanna
S. Williams
T. Blank
D. Stockbauer
A. Lucas, E.V. Benton
Lunar limb profiles of Kaguya/LALT and LRO/LOLA
: D
: R
: B
: F

Spectacular Grazing Occultation of Aldebaran by the first quarter Moon
2017 March 4, graze 4 deg. from the north cusp on the dark side

Ten observers braved bitter conditions to set up six video stations across the graze zone.

https://vimeo.com/209854850

Discovery of New Double Stars



LIMOVIE Analysis

Discovery of Close Double Stars from Recordings of Lunar Occultations

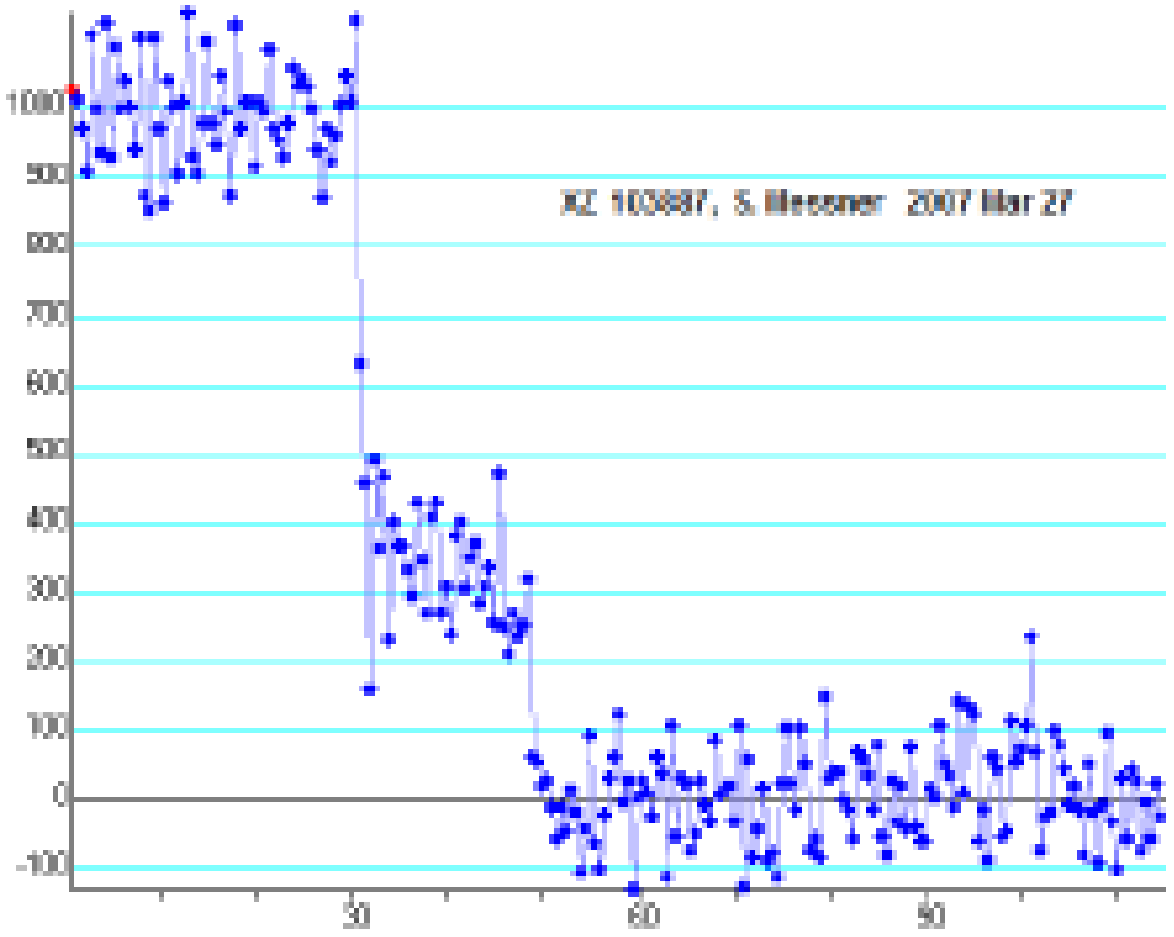
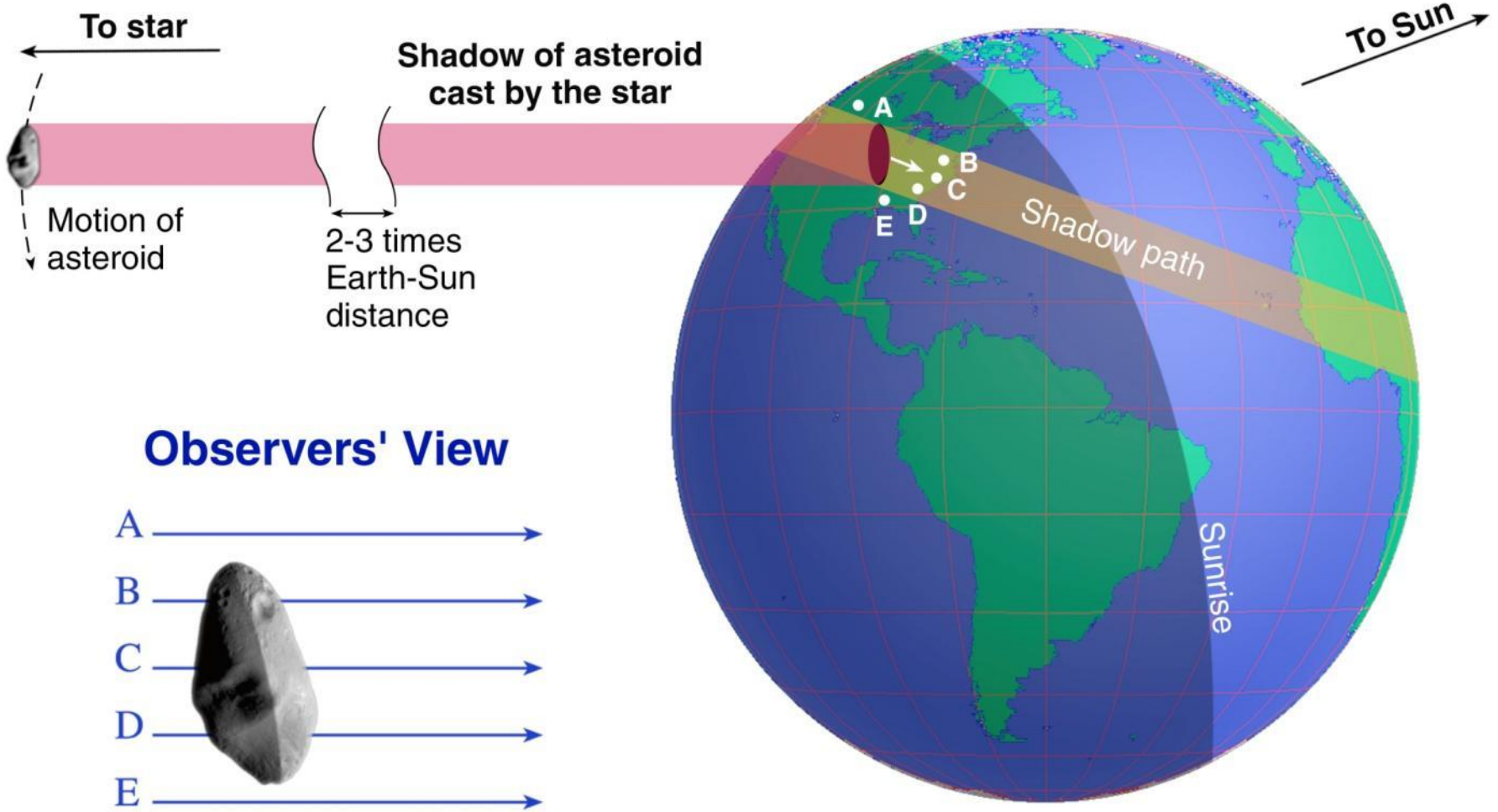


Figure 15: Light curve for occultation of XZ 103887 obtained by S. Messner, 2007 March 27. The step lasts 0.63 second with measures taken each video field.

Light curve generated with Limovie

Similar light curves can be generated with Tangra that can also make them from a series of FITS files

Geometry of an Asteroid Occultation



Observers' View

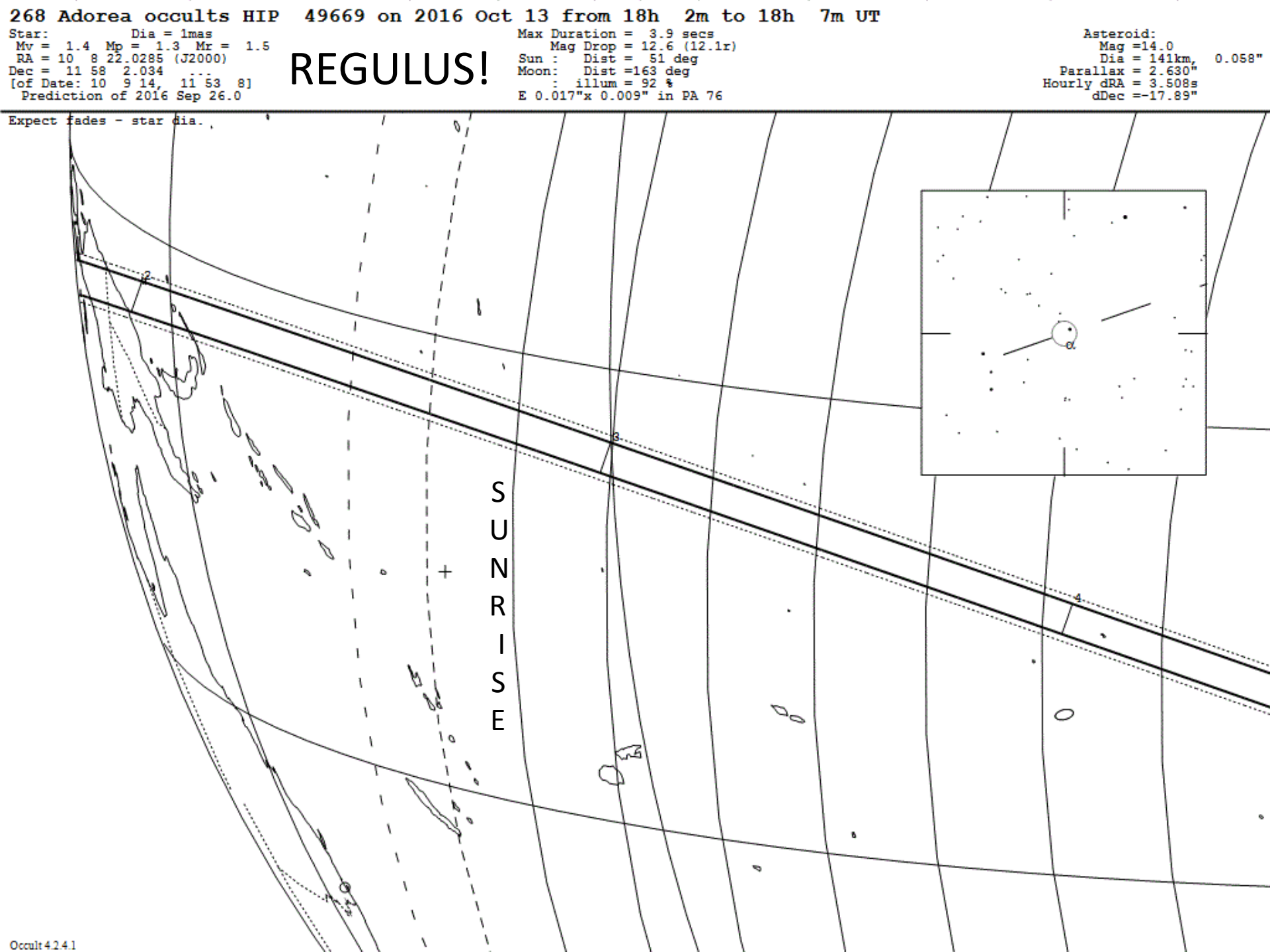
A, E: Negative observations
B, C, D: Positive observations

01-0417-5

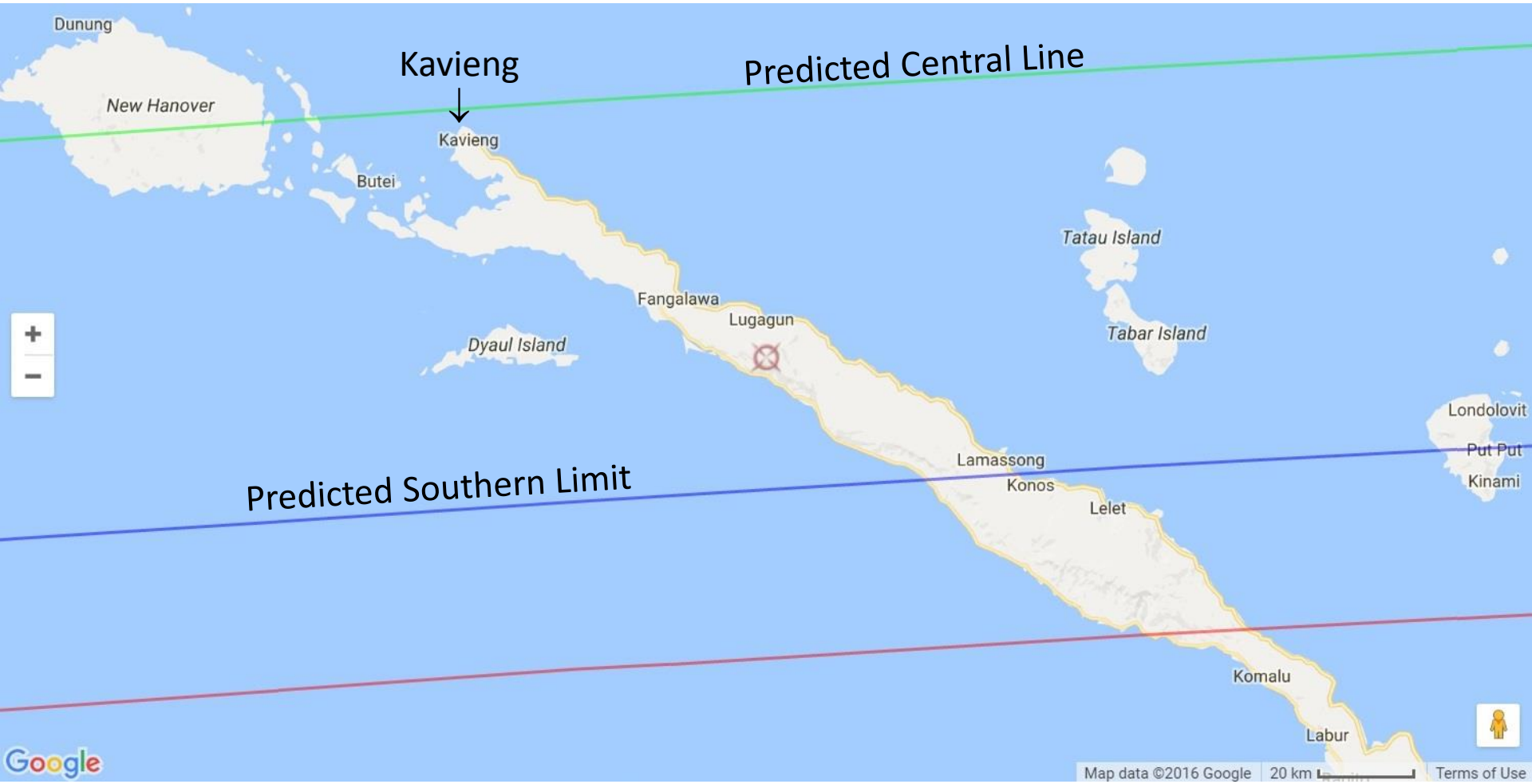
The 10-inch ‘Suitcase’ Telescope

The camera is at prime focus, so the images are reversed (one reflection); it is normally used for pre-pointed occultations of faint stars by asteroids.

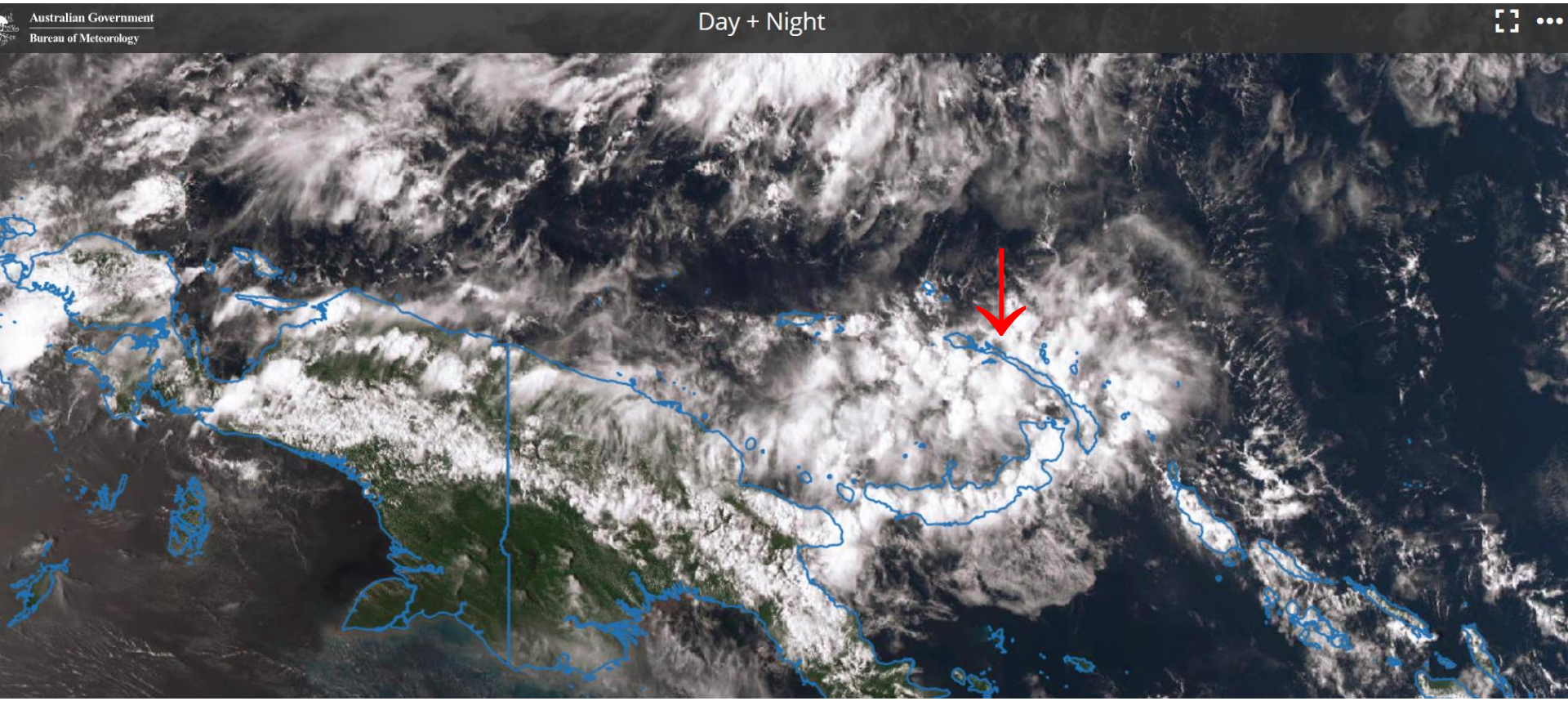
Components of John Broughton's 25cm "Suitcase Telescope"


268 Adorea occults HIP 49669 on 2016 Oct 13 from 18h 2m to 18h 7m UT
Star: Dia = 1mas
Mv = 1.4 Mp = 1.3 Mr = 1.5
RA = 10 8 22.0285 (J2000)
Dec = 11 58 2.034 ...
[of Date: 10 9 14, 11 53 8]
Prediction of 2016 Sep 26.0
REGULUS!
Max Duration = 3.9 secs
Mag Drop = 12.6 (12.1r)
Sun : Dist = 51 deg
Moon: Dist =163 deg
: illum = 92 %
E 0.017"x 0.009" in PA 76
Asteroid:
Mag =14.0
Dia = 141km, 0.058"
Parallax = 2.630"
Hourly dRA = 3.508s
dDec =-17.89"
Expect fades - star dia.
SUNRISE
Occult 4.2.4.1

Path of the Regulus/Adorea occultation over New Ireland



Weather Concerns – this is in the Tropics, Lat. -2°

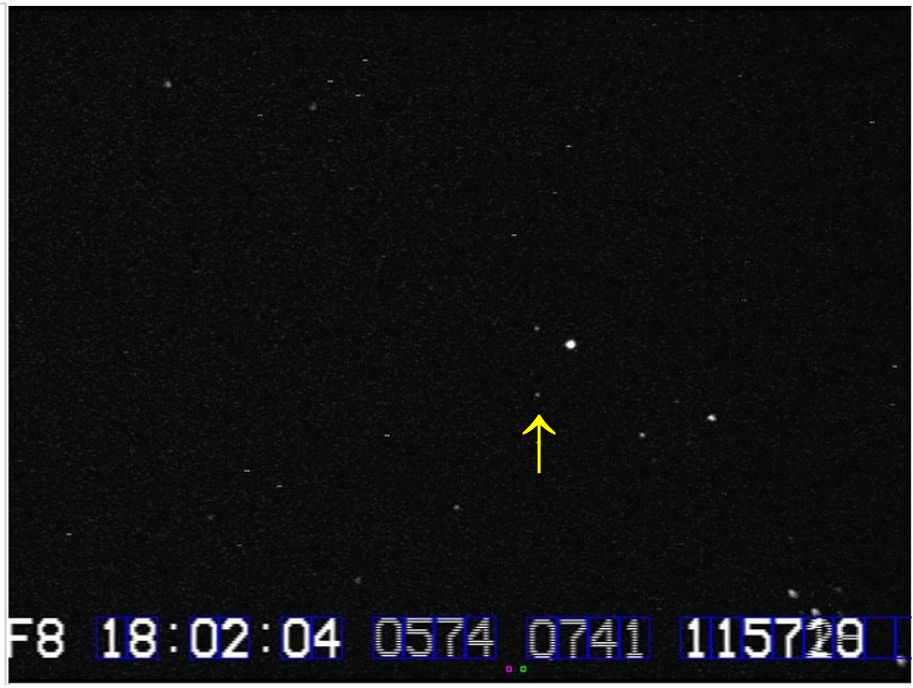


Right under the Intertropical Convergence in October. The first night we arrived, it was overcast with rain all night. But the locals said they often saw stars late at night. On the night of the event, it was overcast all evening, but the midnight IR image showed clouds thinner, and at 1:30am, we saw many stars. We left the motel for our sites.

During the 3s occultation, we recorded Regulus' companion that was Discovered spectroscopically in 2005.

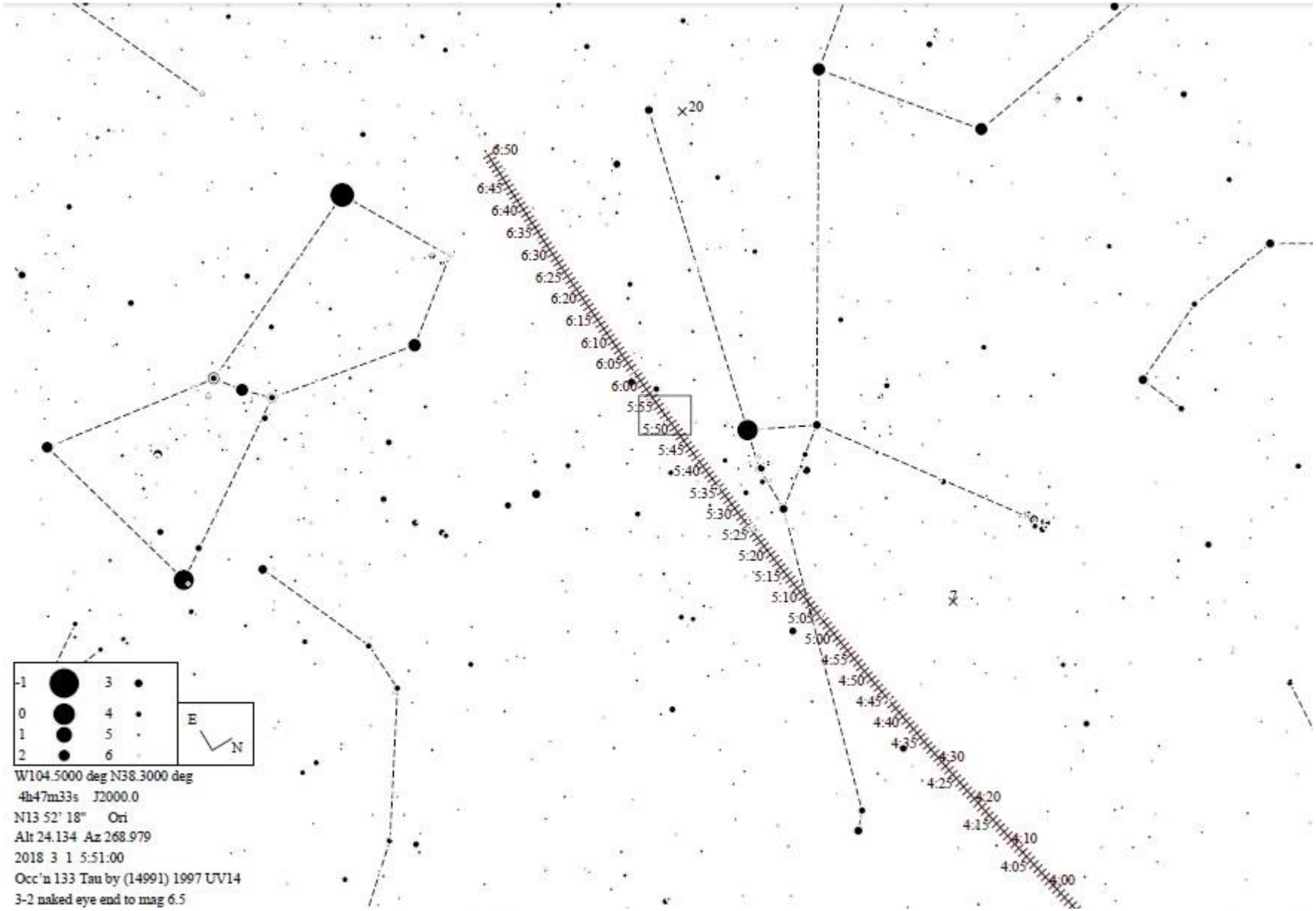
Before the occultation

During the occultation

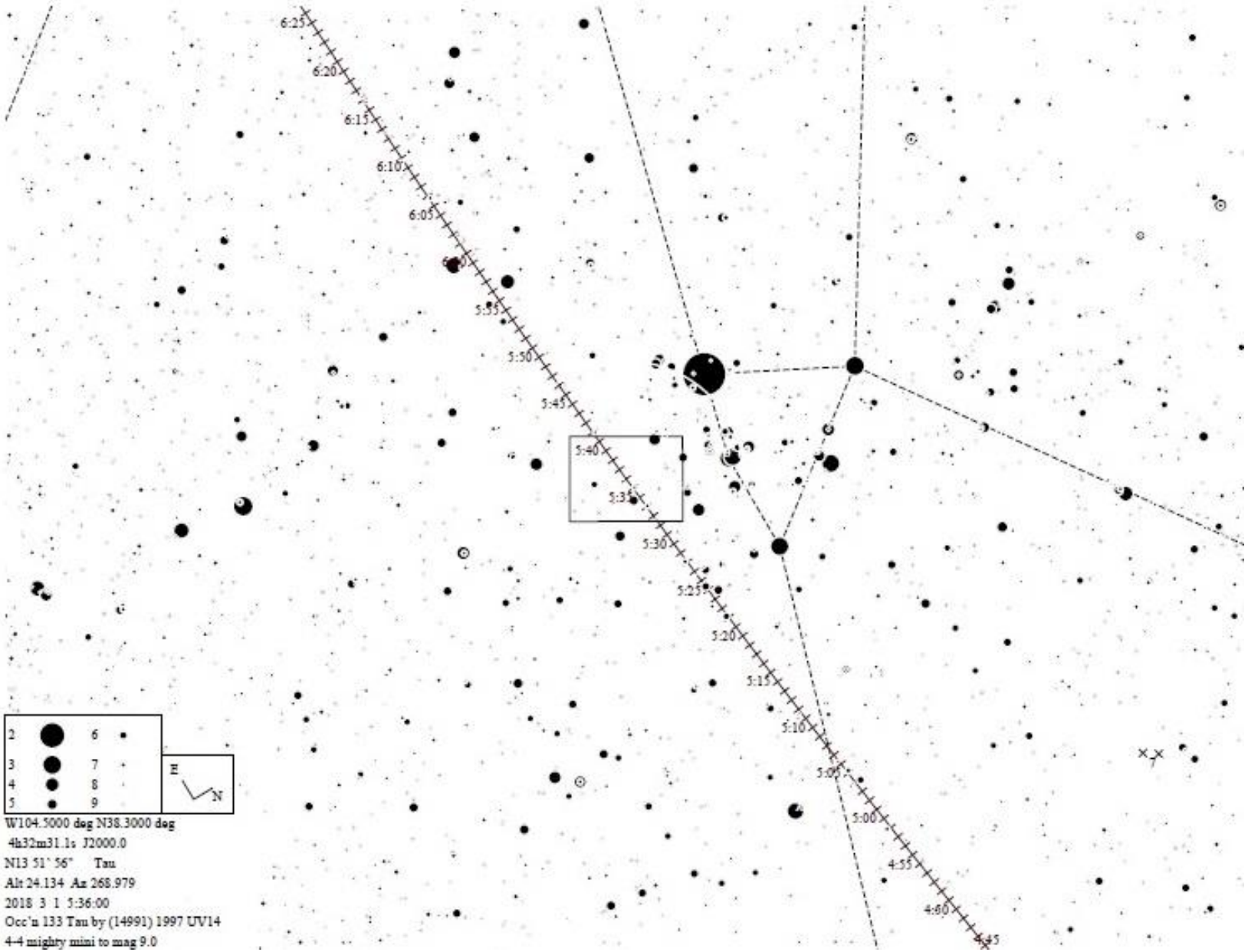


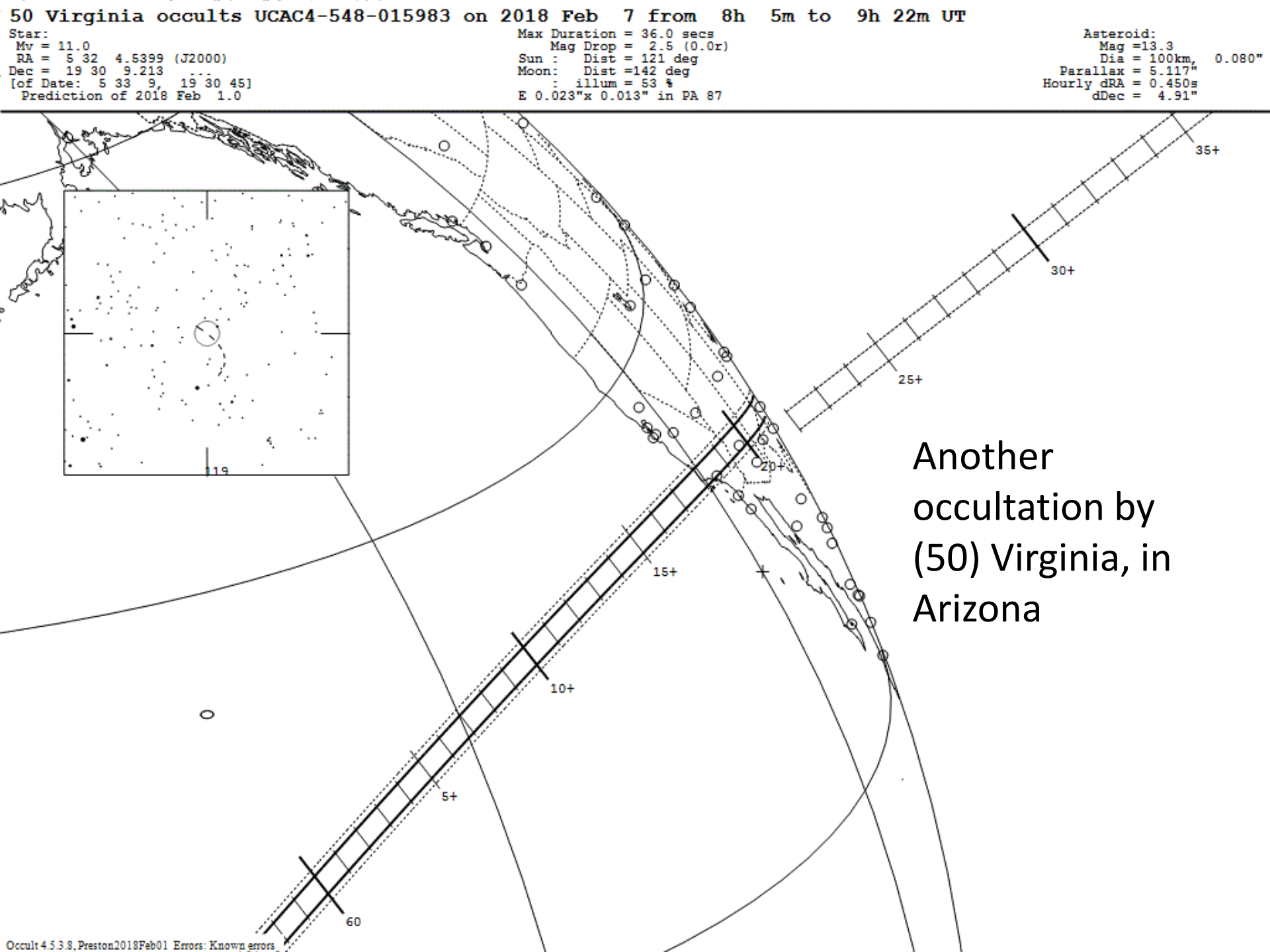
This was the first ever view of Regulus' close companion, which was 12th magnitude, consistent with its being a white dwarf, as the discoverers had speculated. Adorea was only mag. 14, too faint to be recorded with our 10-in. scope. Note Regulus' distant 8th-mag. visual companion above the star. The earlier clouds prevented pre-pointing 4 "mighty mini's" that we had with us. During the trip, we also recorded an occultation by asteroid Lumen from the Glass House Mountains area of Queensland, attended the American Astronomical Society's Division of Planetary Sciences conference in Pasadena, Calif., and visited our son in Ann Arbor, Michigan.

Example 1 of Guide8 Pre-Point Chart



Example 2 of Guide8 Pre-Point Chart

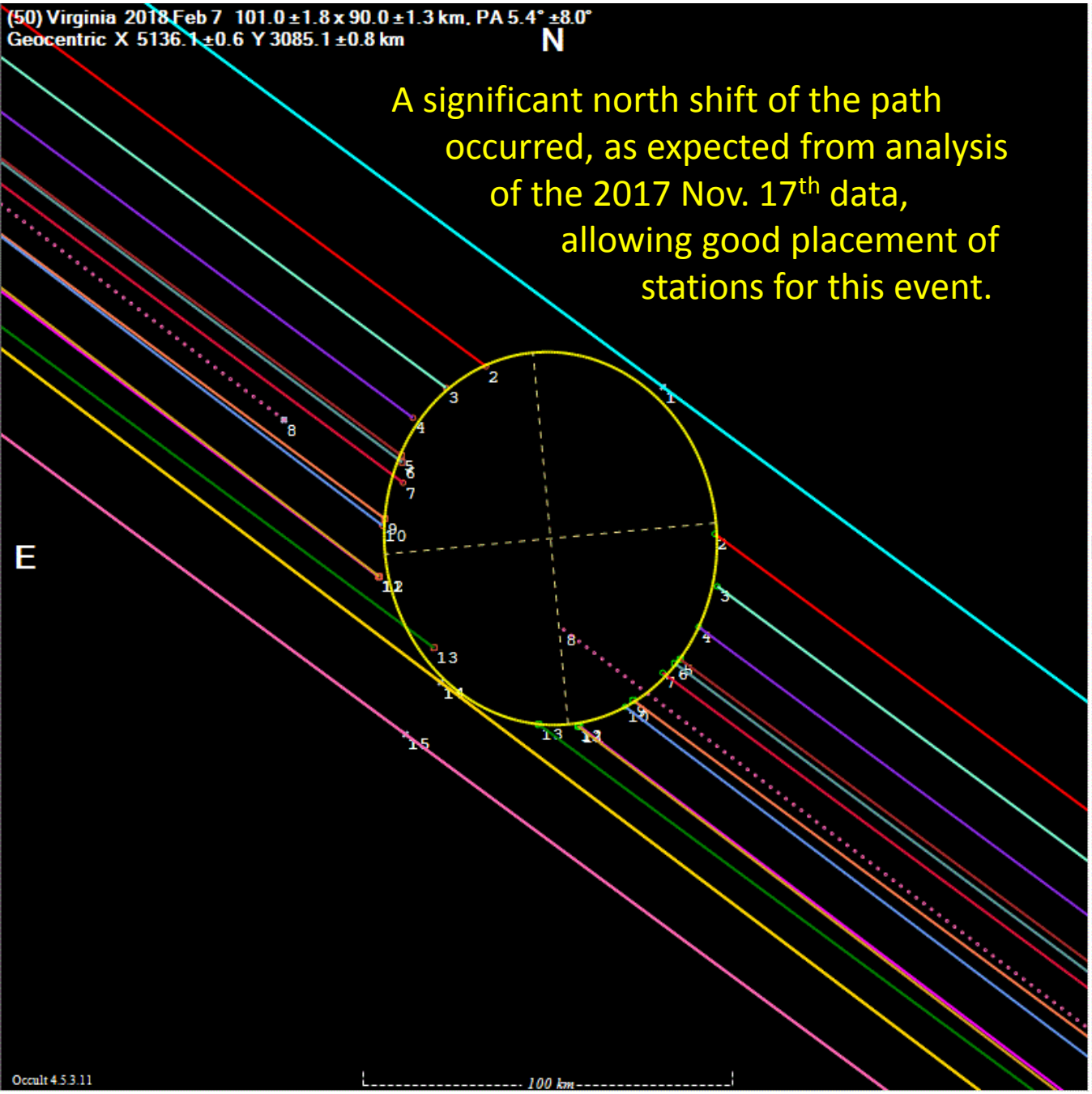




Another occultation by (50) Virginia, in Arizona

2018 Feb. 7 (50) Virginia Observers in Central AZ

There were 3 more positives and 1 negative in s. Calif. as well. While setting up our 1st station, we noticed a bright “fuzzy” star that moved; it was the injection burn by the upper stage for Elon Musk’s roadster.



Find best fit

Center X 0.7 0.0
Center Y 3.2 0.0
Major axis (km) 101.0 0.0
Minor axis (km) 90.0 0.0
Orientation 5.4 0.0

a/b=1.12
dM=-0.13
Motion
2.10km/s, X

Double star or double asteroid
Sepn (masec) 0.0 0.0
PA of 2nd 0.0 0.0

Show: Both Primary Secondary
A= 0.0 B= 0.0 PA= 0.0

Circular Include Miss events

Plot scale

Quality of the fit Not fitted

Opacity

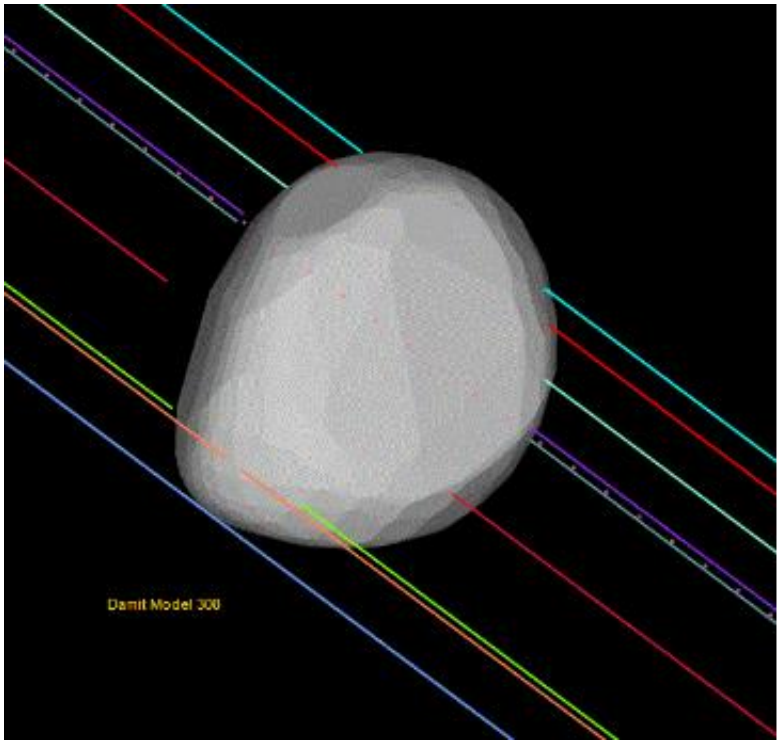
RMS fit 0.0 ±1.5 km

1	(M)	D Dunham/J Dunham,Sp
2		D Dunham/J Dunham,Bu
3		D Dunham/J Dunham,Bl
4		D Dunham/J Dunham,Ne
5		P Maley,Carefree, AZ
6		R Reaves,Parker, AZ
7		D Dunham/J Dunham,Pe
8	(P)	Predicted Centerline
9		T Blank,Fountain Hil
10		W Owen,Wrightwood, C
11		R Jones,Running Spri
12		C McPartlin,Santa Ba
13		J Gout,Scottsdale, A
14	(M)	G Lyzenga, Altadena,
15	(M)	M Collins,Chandler,

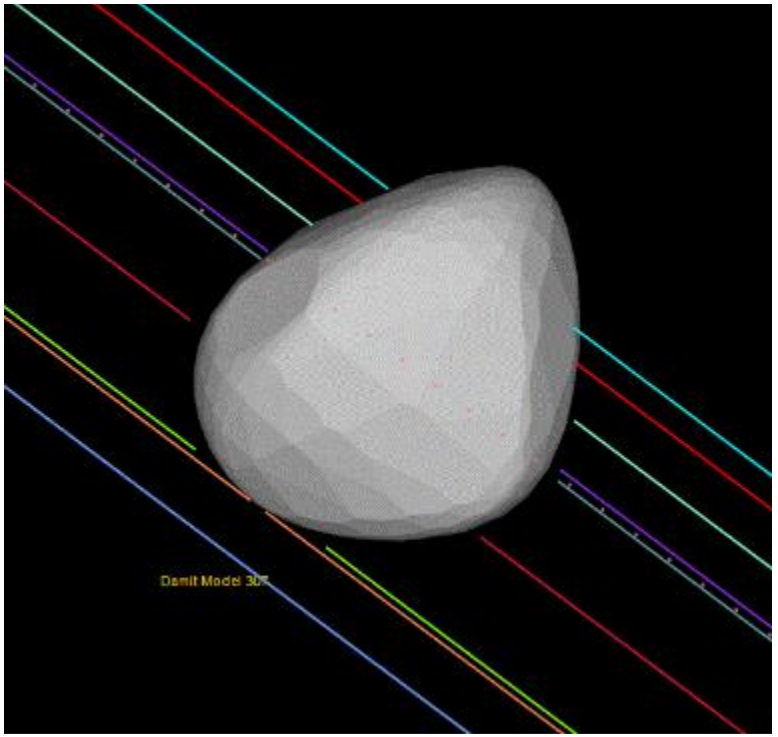
Average size 95 km, near the predicted 100 km & > the 60 km size from the 2017 Nov. 17 event

January, 2008 Occultation of (13) Egeria
When Multiple Lightcurve Models Exist, Occultation Data Can Help Distinguish Which Is The Better Fit

Model 1



Model 2



HIP 46249 Duplicity Discovery from Asteroidal Occultation by (160) Una

Tony George, Umatilla, OR, USA (triastro@oregontrail.net)
Brad Timerson, IOTA North American Coordinator
International Occultation Timing Association (IOTA)
Tom Beard, Reno, NV
Ted Blank, Hampton, NH
Ron Dantowitz, Boston, MA
Jack Davis, Dayton, NV
Dennis di Cicco, Sudbury, MA
David W. Dunham, Greenbelt, MD
Mike Hill, Marlboro, MA
Aaron Sliski, Boston, MA
Red Sumner, Dayton, NV

Abstract: An occultation of HIP 46249 by the asteroid (160) Una on 2011 January 24 showed this star to be a double star. Both components of the double star were occulted as recorded by three observers. The separation of the two components is 0.0065 ± 0.0011 arcseconds at a position angle of 50.2 ± 12.2 degrees. The magnitude of the primary component is estimated to be 9.2 ± 0.1 V. The magnitude of the secondary component is estimated to be 10.6 ± 0.1 V.

HIP 46249 Duplicity Discovery from Asteroidal Occultation by (160) Una

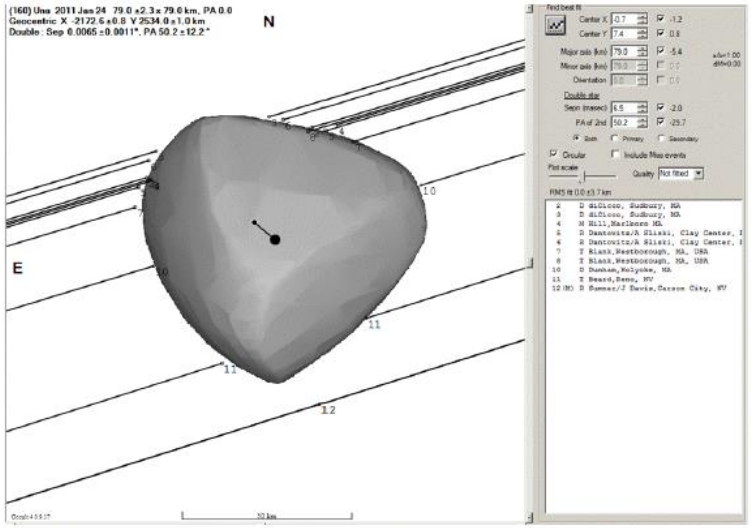


Figure 7: Occultation (160) Una occultation of HIP 46249 and DAMIT inversion model plot. Note that Chord 1 (a miss) was left off the plot to avoid conflict with other plot text. The direction of travel of the asteroid in the diagram is from upper right to lower left.

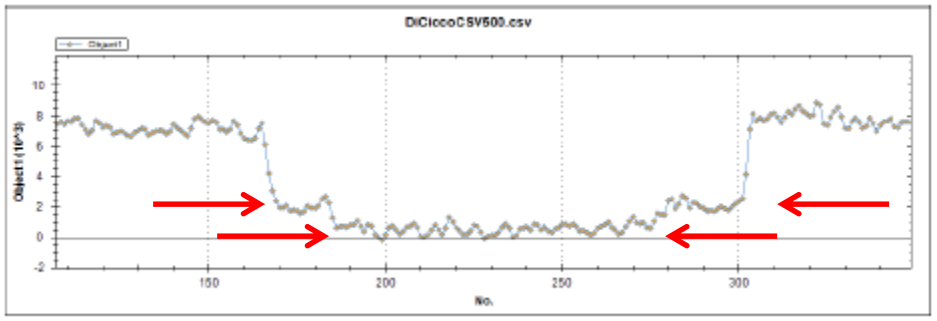
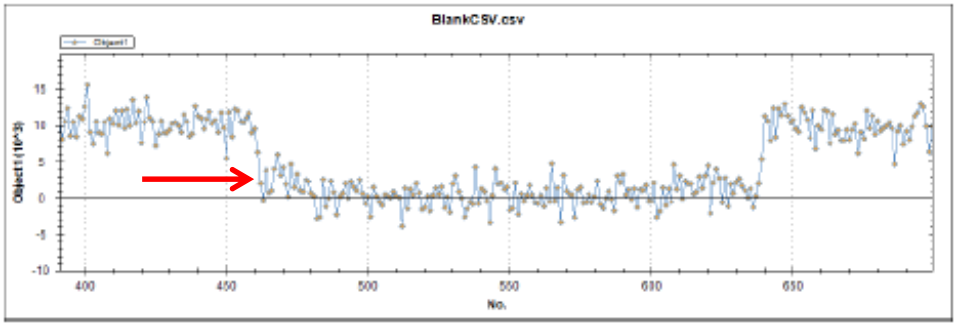
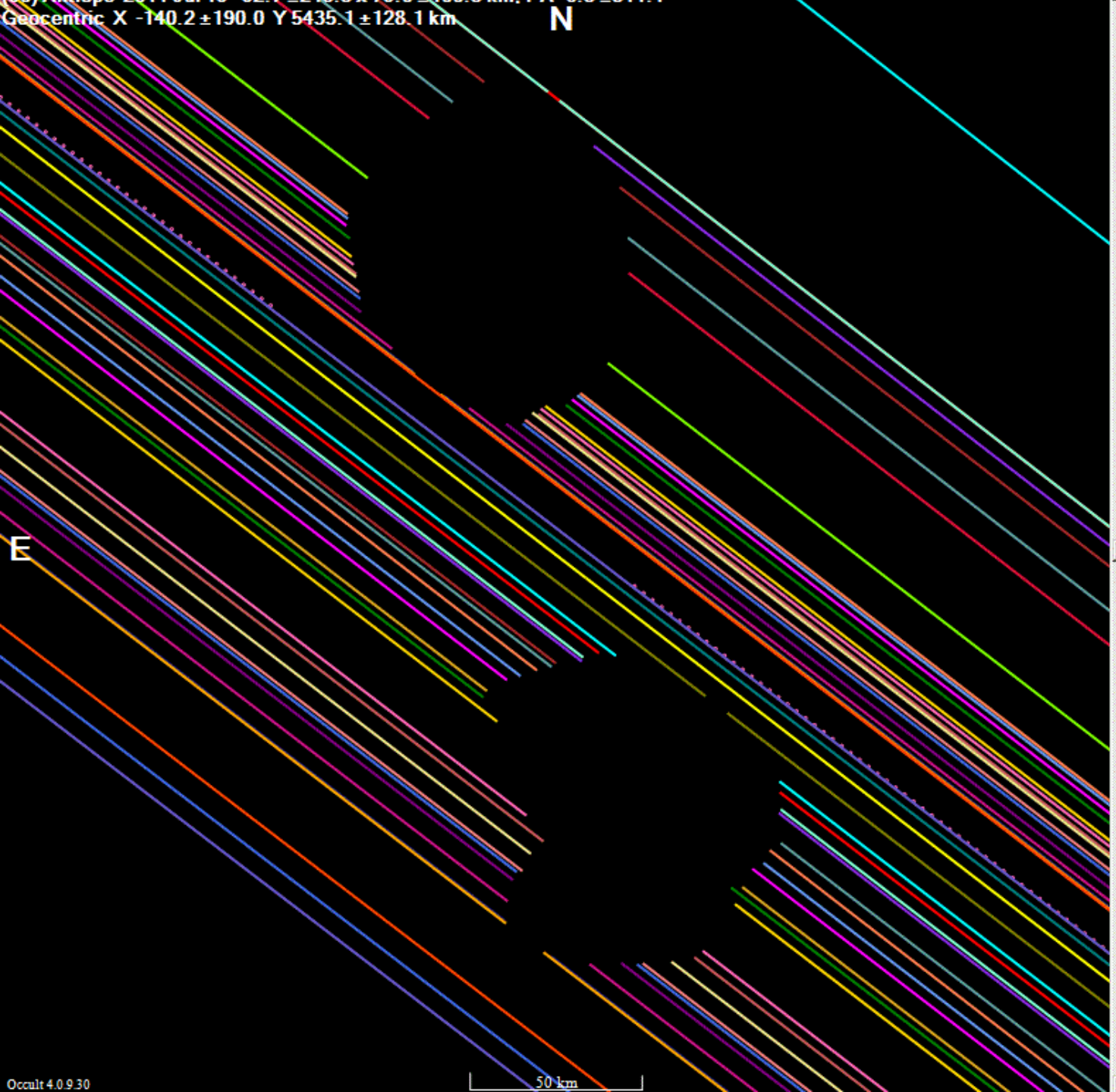


Figure 2: Di Cicco light curve showing distinct two-step event on D and R

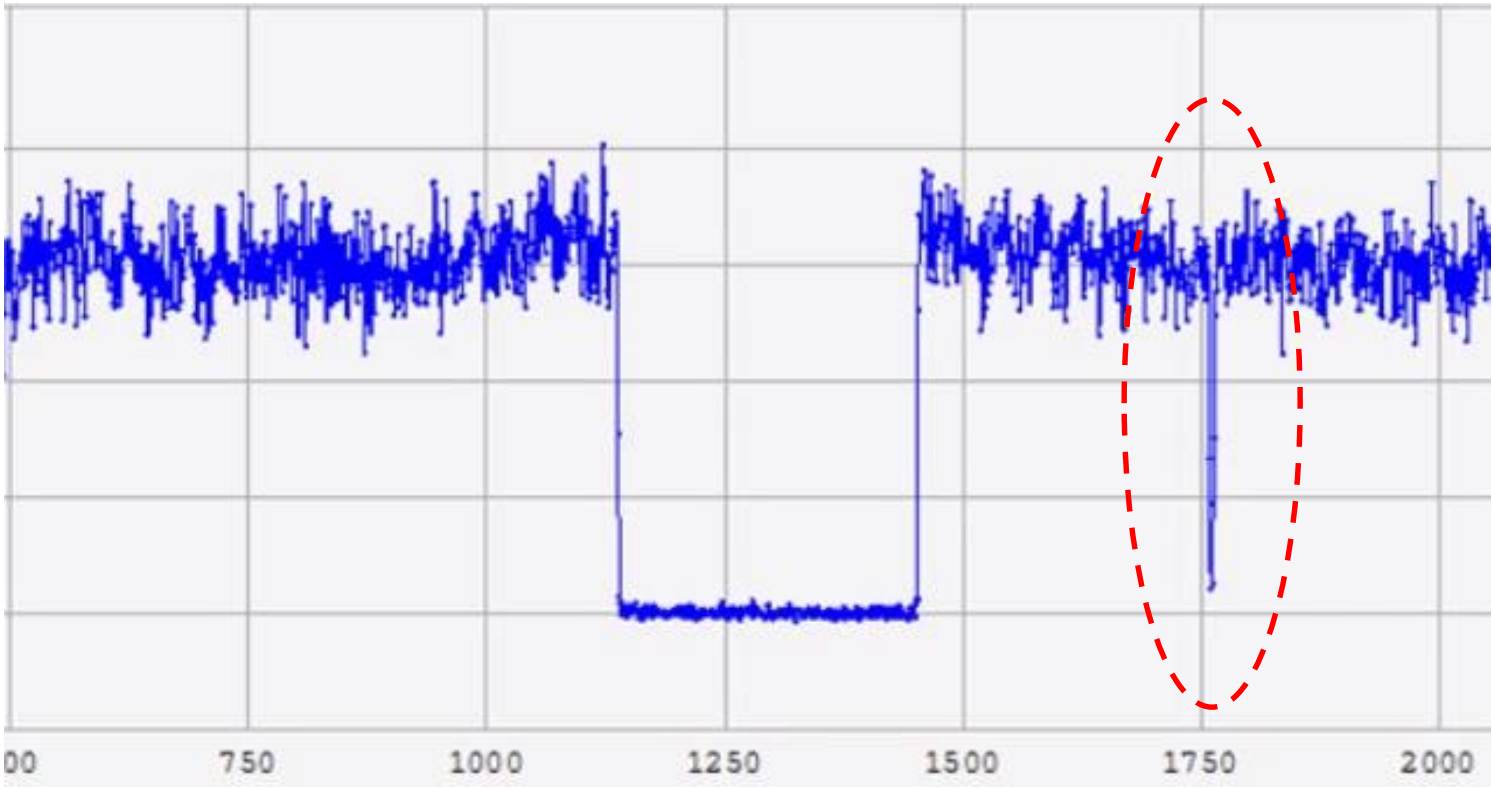




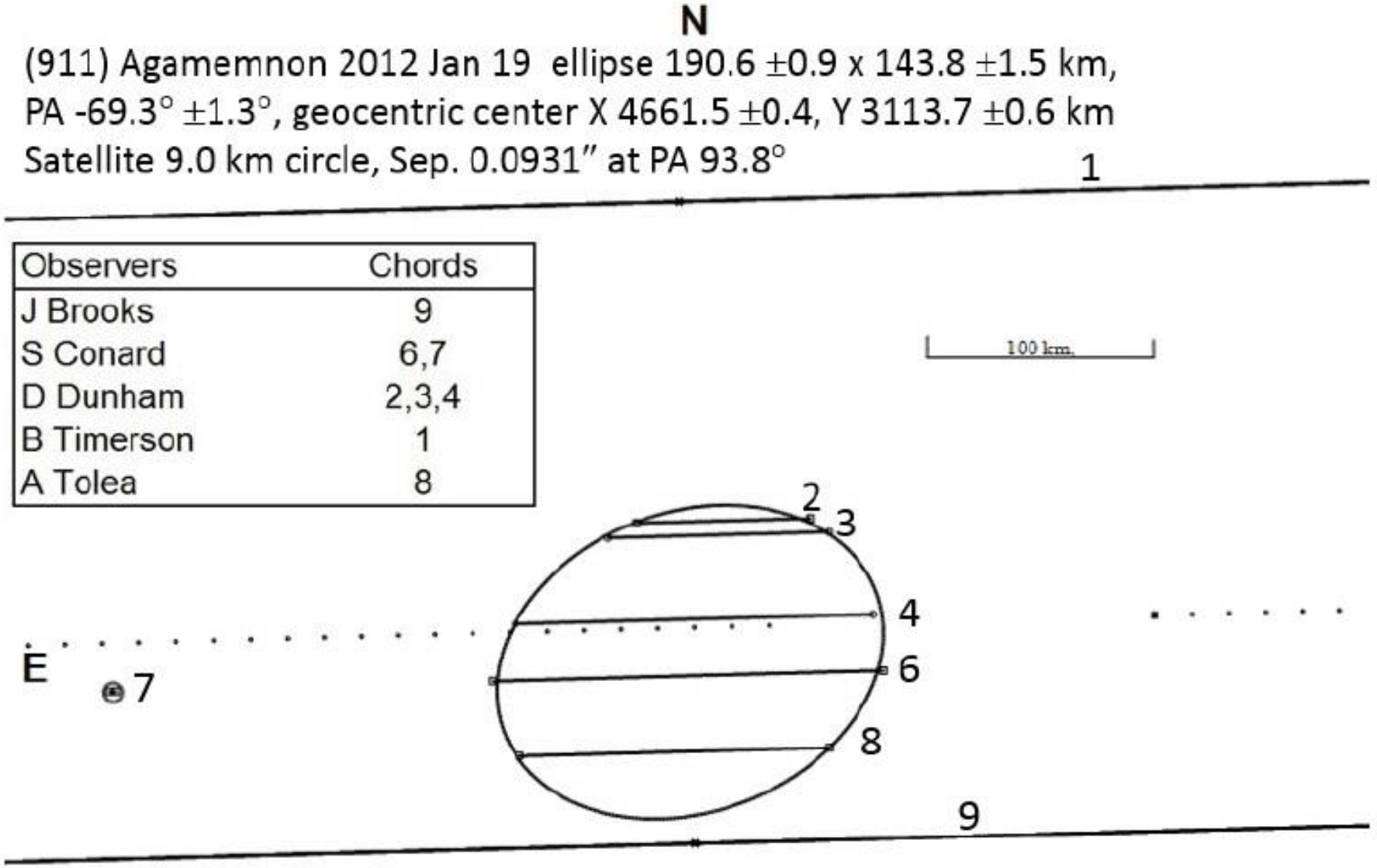
Center X -48.1 -487.
Center Y -62.4 146.4
Major axis (km) 92.7 100
Minor axis (km) 79.0 100
Orientation -6.3 -0
Double star
Sepn (masec) 0.0 0.0
PA of 2nd 0.0 0.0
Both Primary Secon
Circular Include Miss events
Plot scale Quality Not fitted
RMS fit 23.7 ±21.8 km

22	P Maley/B
23	S Degenhar
24 (M)	J Berthier
25 (P)	Predicted
26 (M)	E Bredner,
27 (M)	P Maley/W
28 (M)	R Venable,
29 (M)	S Maximoff
30	M Vincent,
31	T Swift,Da
32	R Sumner/P
33	P Dunckel,
34	R Venable,
35	R Venable,
36	D Kenyon,P
37	D Machholz
38	T Case,Wal
39	D Becker,P
40	R Venable,
41	R Venable,
42	F Vachier/
43	F Vachier/
44	Vachier/Co
45	D/J Dunhan
46	T Beard,Re
47	D/J Dunhan
48	J Albers,S
49	D/J Dunhan
50	F Colas, I
51	F Colas, I
52	F Colas, I
53	D/J Dunhan
54 (M)	D/J Dunhan
55 (M)	D/J Dunhan
56 (M)	D/J Dunhan

Identification of Satellites of Asteroids (Agamemnon, Steve Conard, Gamber, MD)

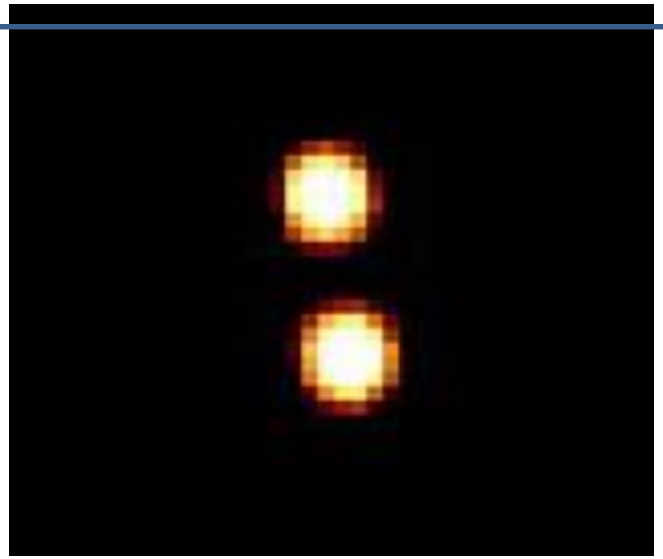


Sky Plane Plot for the Occultation of SAO 60804 by the Trojan asteroid (911) Agamemnon on 2012 Jan. 19



(90) Antiope

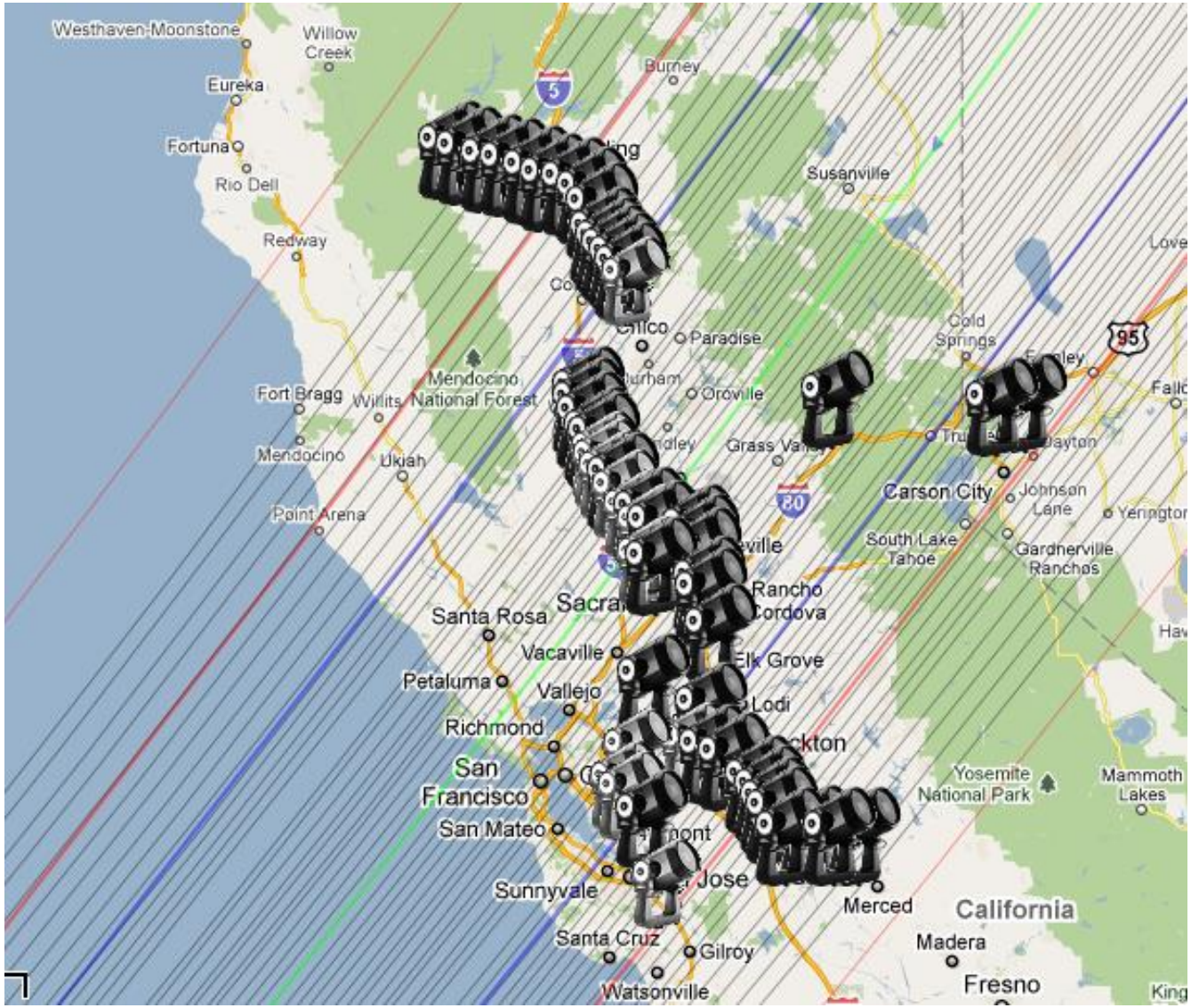
- Keck Observatory image from 2000
- Raw, unprocessed adaptive optics image
- Confirms asteroid's binary nature

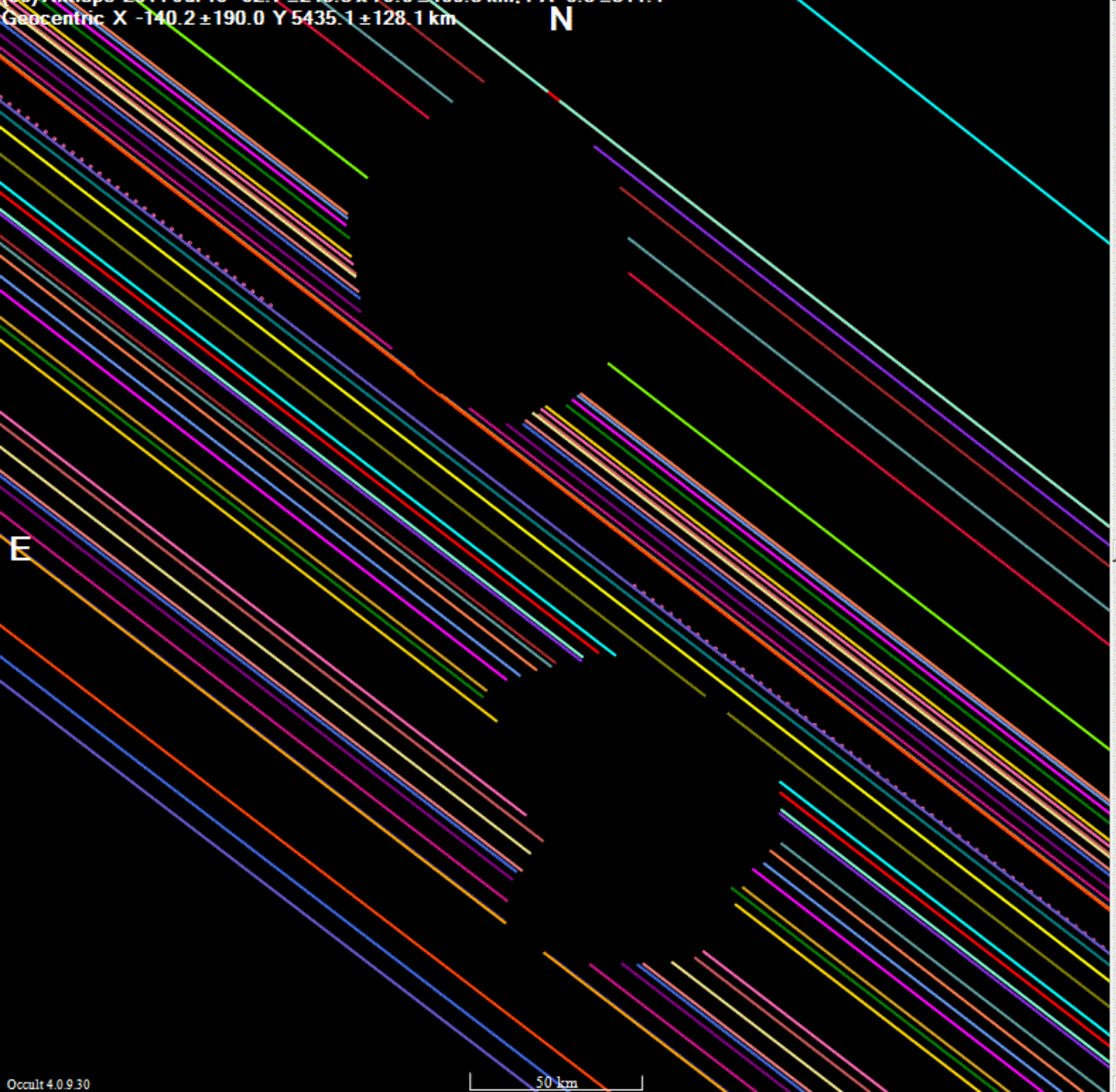


Binary asteroid 90 Antiope imaged in infrared by the Keck telescope with adaptive optics

IOTA Conference - July 16-18, 2011

Path Coverage for Antiope 2011





Center X -48.1 -487.
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Major axis (km) 92.7 100
Minor axis (km) 79.0 100
Orientation -6.3 -0
Double star
Sepn (masec) 0.0 0.0
PA of 2nd 0.0 0.0
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Plot scale Quality Not fitted
RMS fit 23.7 ±21.8 km

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31	T Swift,Da
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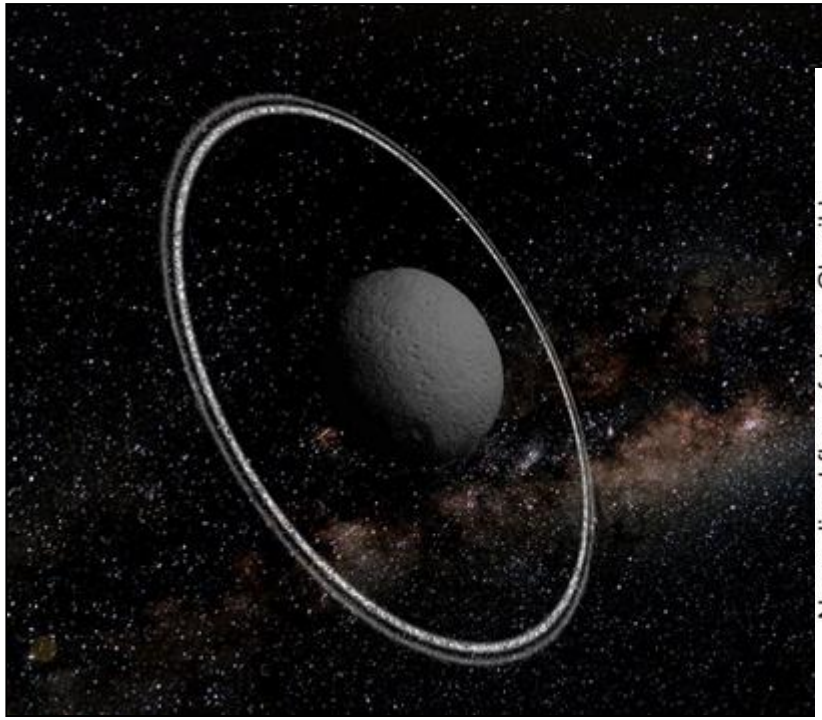
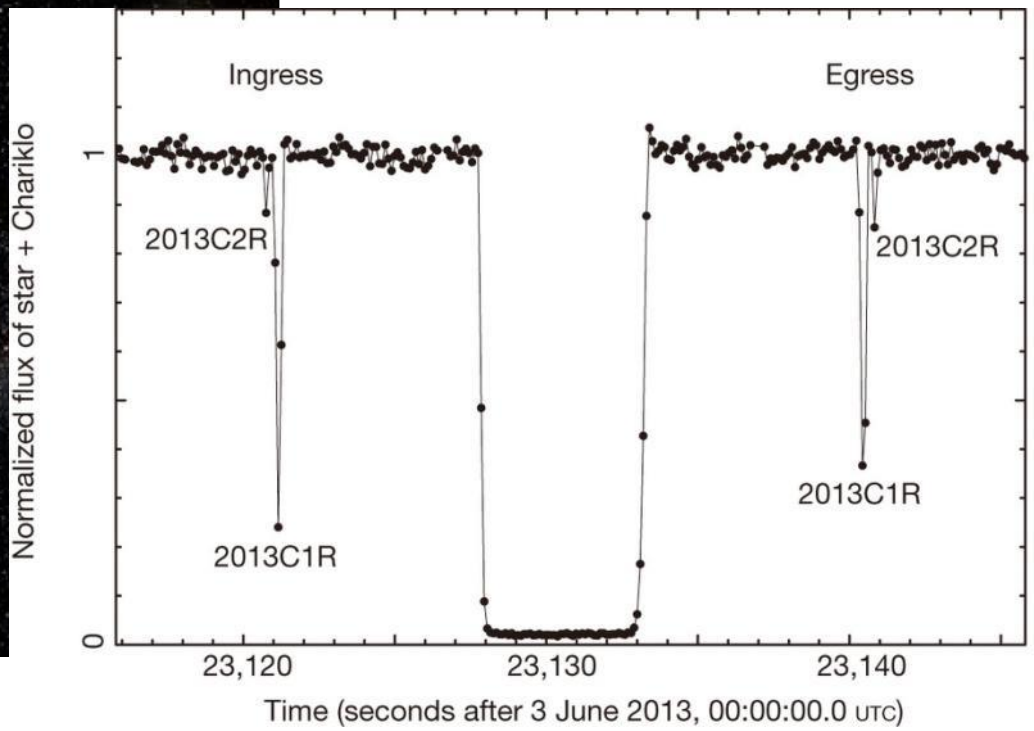
34	R Venable,
35	R Venable,
36	D Kenyon,P
37	D Machholz
38	T Case,Wal
39	D Becker,P
40	R Venable,
41	R Venable,
42	F Vachier/
43	F Vachier/
44	Vachier/Co
45	D/J Dunhan
46	T Beard,Re
47	D/J Dunhan
48	J Albers,S
49	D/J Dunhan
50	F Colas, I
51	F Colas, I
52	F Colas, I
53	D/J Dunhan
54 (M)	D/J Dunhan
55 (M)	D/J Dunhan
56 (M)	D/J Dunhan

Identification of Asteroid Rings! (10199) Chariklo



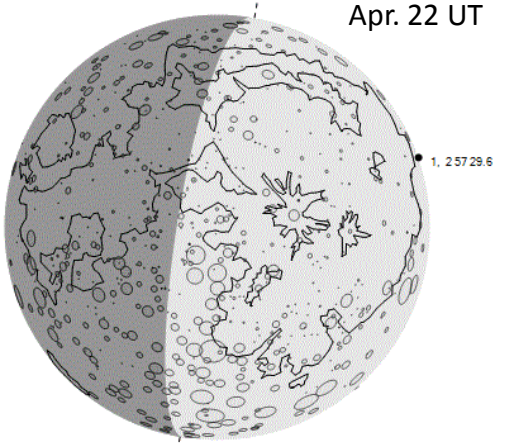


Total Lunar Occultations

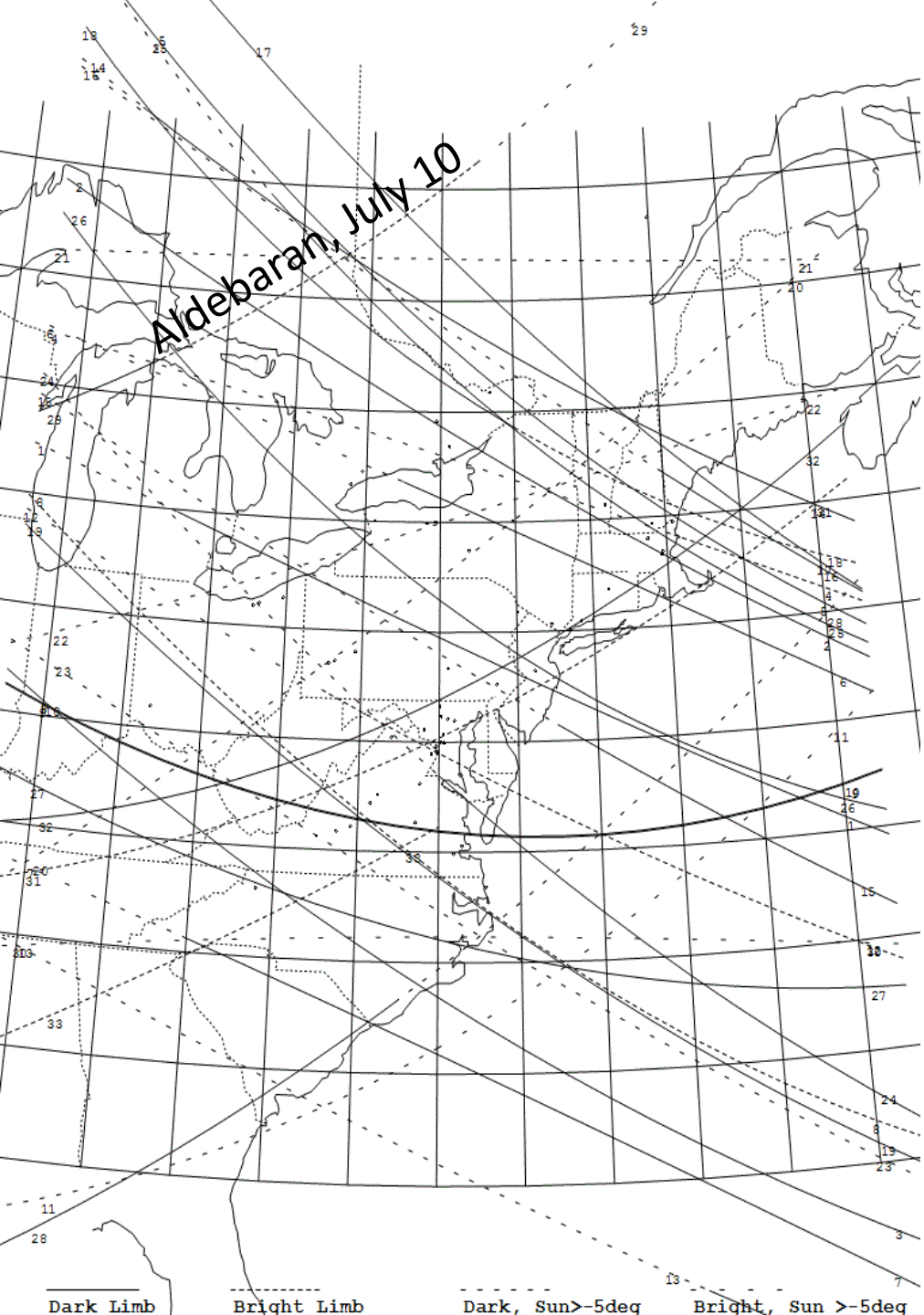
```
Occultation prediction for Suffern   NY Rockland Com. Col.
E. Longitude - 74  5 17.0,  Latitude  41  7 58.1,  Alt.  174m; Telescope dia 20cm

      day  Time      P   Star  Sp  Mag  Mag    % Elon Sun  Moon   CA   PA  VA  AA
 y   m  d  h  m   s        No  D    v    r V  ill     Alt Alt Az   o    o   o   o
18 Apr 22  2 57 29.6 D    1135 K0  6.7  6.1   41+  79      29 271  62N  71  18  61
18 Apr 22 23 27 37.3 d    1259 A9  5.9  5.9   51+  91   2  67 187  82N
   R1259 = 20 Cancri
18 Apr 22 23 42 42.7 d   97783 K2  7.7  6.9   51+  91  -1  66 196  57S
18 Apr 23  2  5 12.8 d   97833 F5  7.9  7.7   52+  92      48 249  75N
18 Apr 23 23 58 59.6 d   98533kA2  7.8  7.7   62+ 104  -3  65 173  46N
   *** A light curve is desired as   98533 is in the Kepler2 program
18 Apr 24  3  1 38.0 d   98572 G0  8.3  8.0   63+ 106      46 246  22S
18 Apr 24  3 20 10.7 d   98590 G0  8.5  8.2   64+ 106      43 250  68N
18 Apr 25  3 58 30.2 d   99103kF5  8.2  7.9   74+ 119      42 243  59S
   *** A light curve is desired as   99103 is in the Kepler2 program
18 Apr 25  4 10  5.0 d   99111 K0  7.5  7.0   74+ 119      41 246  70S
18 Apr 25  5  8  5.2 D    1529 G5  6.6  6.2   75+ 120      31 258  29N
18 Apr 26  0 23 11.2 d  118729 K0  8.0  7.5   83+ 131  -7  51 142  23N
18 Apr 26  5 31 17.6 D    1645cF8  6.7  6.4   84+ 133      32 248  84S
     1645 is double: AB 6.7 16.2       271.0, dT = 0.00sec
18 Apr 26  6 27  6.6 d    1648 G5  6.9  6.5   84+ 133      22 259  63N
18 Apr 28  1 57 45.5 d  139080 K0  7.8  7.2   96+ 156      42 147  79S 132 130 109
18 Apr 29  4  8 42.1 d  139592cG5  7.7  7.2   99+ 169      42 176  57S 166 169 145
    139592 is double: ** 8.1 8.7 0.020"  97.0, dT = +0.03sec
    139592 has been reported as non-instantaneous (OCc1024). Observations desired
   Distance of 139592 to Terminator = 12.2"; to 3km sunlit peak = 3.3"
18 May  2  8 36 57.8 r  159935 A0  7.2  7.0   95- 153      26 210  42N 319 296 311
18 May  4  6 20 20.4 r  186341 WC  7.7  7.7s  83- 131      22 150  59S 236 260 238
18 May  4  8 52  4.6 D    2633SB2  3.8* 3.7e  83- 131 -11  28 188 -56N  53  47  56
  2633 is multiple: AB 3.8 10.5 17.0" 257.9, dT = -62sec
  2633 = mu. Sgr, 3.8 to 3.88, V, Type EA+ACYG, Period 180.55 days, Phase 69 %
18 May  4 10  3 48.9 R    2633SB2  3.8* 3.7e  82- 130   1  24 206  48N 308 288 311
   R2633 = mu Sagittarii; see above for more about the star
18 May  5  5  2 43.5 R    2759 G8  3.5  2.9   76- 121       7 125  52N 302 343 309
   R2759 = xi 2 Sagittarii
18 May  5  9 10 19.6 r X163643p    8.0  7.7   75- 119  -7  28 180  33S 206 206 214
   *** A light curve is desired as X163643 is in the Kepler2 program
   X163643 is double: BA 8.1 7.9 1.3"   3.1, dT = +7sec
18 May  5  9 10 23.8 r    2778DF8  7.3*       75- 119  -7  28 180  33S 206 206 214
     2778 is double: AB 7.87 8.06 1.25" 183.1, dT = -7sec
18 May  5 12  5  4.5 d    2797SF2  2.9* 2.7s  74- 119  24  16 221 -55N  48  15  56
 2797 = Al Baldah = pi Sagittarii is triple: AB 3.6 3.6 0.10" 193.9, dT = -0.27sec
18 May  5 13  9 38.7 r    2797SF2  2.9* 2.7s  74- 118  36   7 234  60N 292 251 300
```

Moonview for 6.7-mag. ZC 1135, Apr. 22 UT



Times are UT; subtract 4h for EDT. Then, ZC 1135 will disappear at 10:57:29.6 pm EDT of Saturday, 2018 April 21



2018 Lunar Grazing Occultations, April 22 - July 31

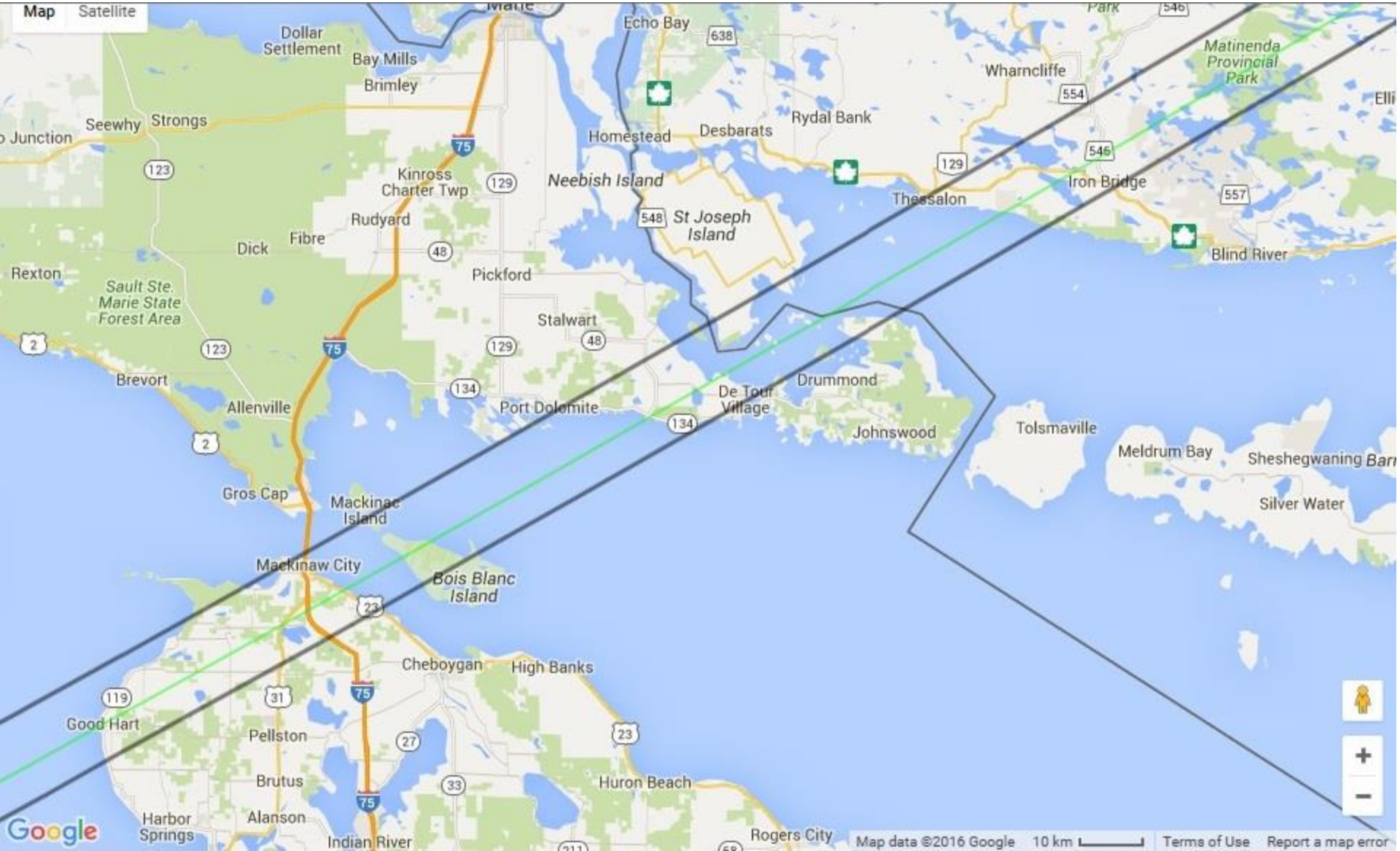
#	2018 Mth	Dy	U.T. Hr	Mn	Star Number	Mag	% ill	Cusp Ang.	Sun alt
1	Apr	22	1	3	79370	7.6	40+	1N	
2	Apr	22	2	20	96913	8.8	40+	2N	
3	Apr	23	4	25	1275	5.3	53+	3N	
4	Apr	23	23	48	1385	6.6	62+	0S	+2
5	Apr	25	5	12	1529	6.6	75+	1N	
6	Apr	26	0	33	118729	8.0	83+	0N	-6
7	Apr	26	0	42	1625	5.8	83+	2N	-12
8	May	1	6	8	2223	3.9	98-	-25N	
9	May	5	8	41	2778	7.3	75-	6S	
10	May	5	8	41x	163643	8.0	75-	6S	
11	May	10	11	6	3419	4.2	28-	-1S	+10
12	May	18	0	56	915	4.6	9+	-3S	-8
13	May	18	23	44	1077	4.0	16+	1N	+2
14	May	18	1	59	95239	8.8	9+	4S	-12
15	May	20	0	23	1227	7.6	26+	2N	-1
16	May	21	0	25	1361	7.6	37+	2N	+2
17	May	23	2	28	118637	8.1	60+	3N	
18	May	24	5	11	1733	5.4	72+	-0N	
19	May	30	3	52	2436	6.6	100-	38S	
20	Jun	4	11	46	3126	4.3	72-	5N	+22
21	Jun	10	18	50	364	4.3	13-	6S	+58
22	Jun	16	15	40	1275	5.3	12+	10S	+63
23	Jun	16	22	25	1310	3.9	14+	3N	+22
24	Jun	20	0	59	118979	8.5	45+	6N	-5
25	Jun	20	2	21	119004	8.5	46+	3N	-11
26	Jun	23	3	15	2035	7.2	77+	3N	
27	Jul	2	4	16	3190	2.9	86-	6S	
28	Jul	8	9	52	405	4.3	28-	7N	-3
29	Jul	10	8	41	692	0.9	11-	-1S	-5
30	Jul	11	16	35	894	4.4	3-	-5N	+74
31	Jul	25	5	45	2633	3.8	94+	-5N	
32	Jul	26	5	22	2779	3.8	98+	4S	
33	Jul	26	8	47	2797	2.9	98+	-8N	

Sun alt. given only if it is > -13 deg.

The Last Aldebaran Graze (until 2033)

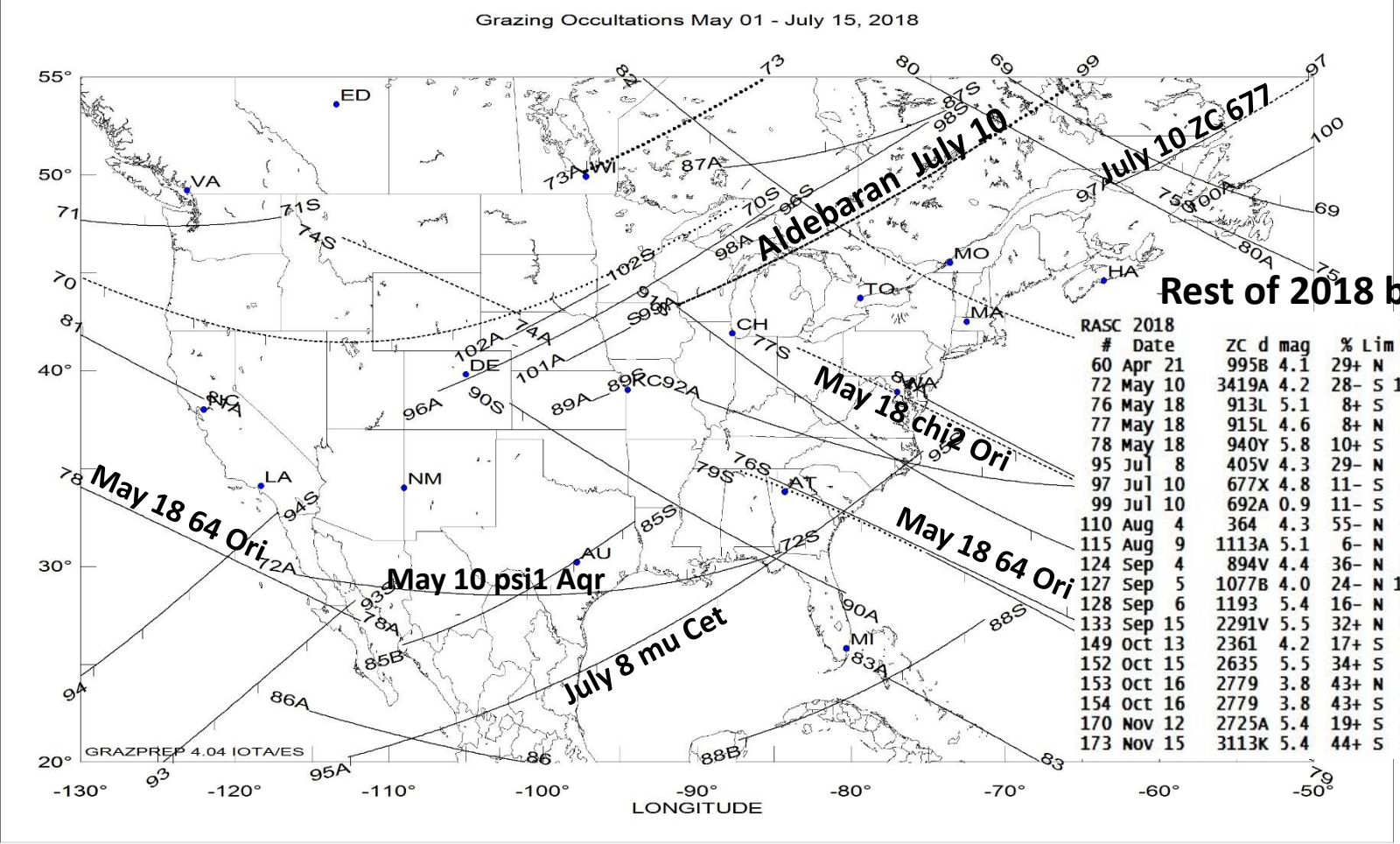
2018 July 10 UT, the s. limit starts at moonrise in n.e. Iowa, then crosses s. Wisc., n. Mich., and s. Ont., where twilight becomes strong. The graze will occur right at the thin southern cusp of the only 11% sunlit waning Moon. (Last of this series for us)

2018 July 10 Aldebaran Graze
Mackinaw City region & s.e. ON



Other Grazes in 2018

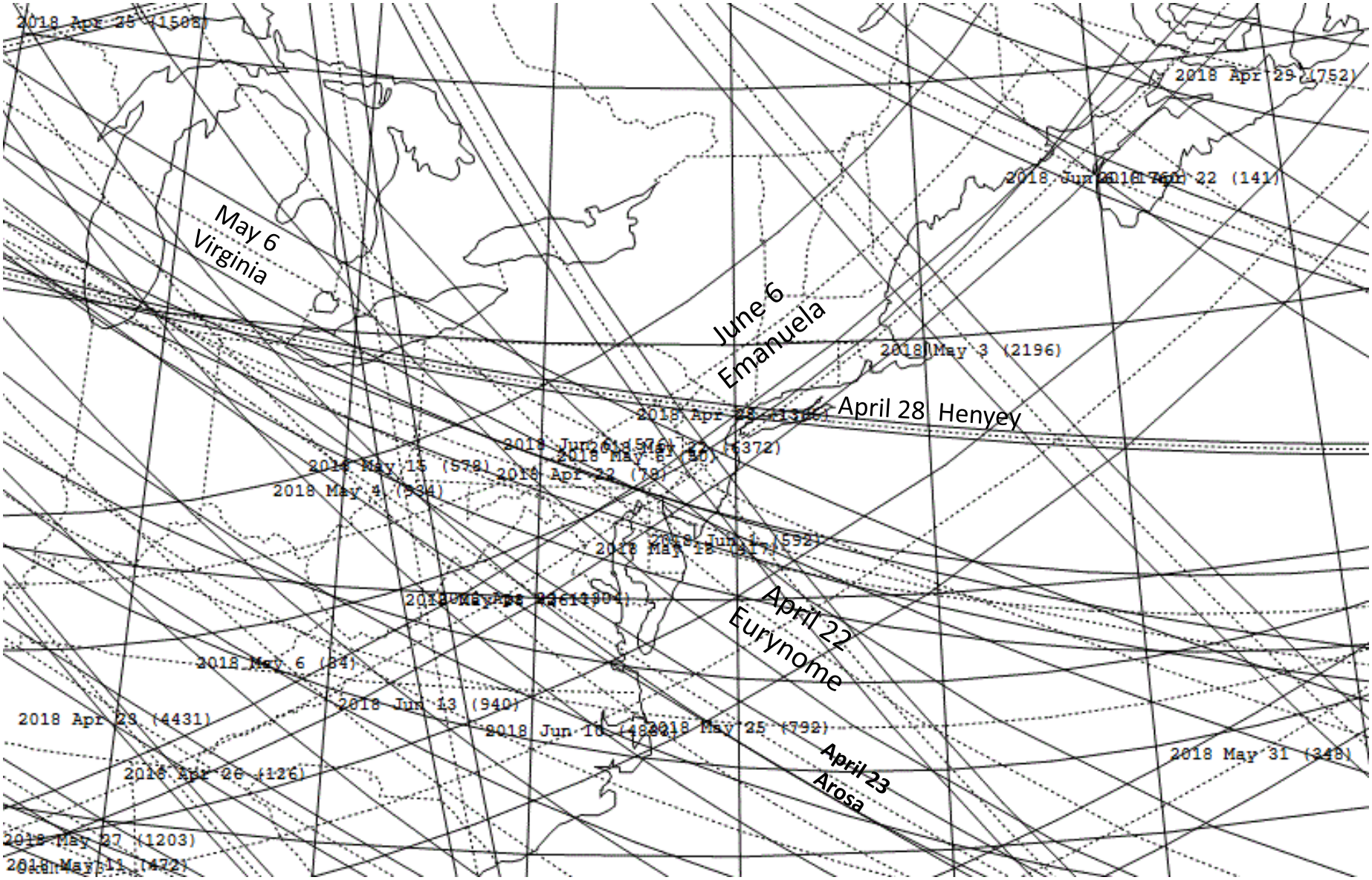
The 2017 February 18th graze of 3.9-mag. γ Librae shows that you don't need a 1st-mag. star to observe an interesting grazing occultation. A 6th or 7th-mag. star when the lunar profile lines up right can give an interesting show, that's useful to resolve (discover, or cast into doubt a past claim) close double stars. The map below is just one of 6 that are in the RASC Observer's Handbook for 2018, and are posted on IOTA's site at http://iota.jhuapl.edu/GRAZEMAP.HTM. The paths can be computed with Occult 4, and were sent in the annual files to IOTA members.



Rest of 2018 best grazes

RASC 2018 #	Date	ZC	d mag	% Lim	W.U.T. h	m	western Long	Lat	Star
60	Apr 21	995B	4.1	29+ N	2	54.4	-120	47	nu Gem
72	May 10	3419A	4.2	28- S	10	22.9	-116	30	psi1 Aqr
76	May 18	913L	5.1	8+ S	0	49.6	-85	35	64 Ori
77	May 18	915L	4.6	8+ N	0	51.5	-83	41	chi2 Ori
78	May 18	940Y	5.8	10+ S	4	8.5	-130	34	68 Ori
95	Jul 8	405V	4.3	29- N	9	10.4	-112	20	mu Cet
97	Jul 10	677X	4.8	11- S	6	34.9	-62	50	
99	Jul 10	692A	0.9	11- S	8	36.2	-91	43	Aldebaran
110	Aug 4	364	4.3	55- N	9	18.8	-130	46	xi2 Cet
115	Aug 9	1113A	5.1	6- N	9	57.6	-92	27	56 Gem
124	Sep 4	894V	4.4	36- N	8	48.8	-105	20	chi1 Ori
127	Sep 5	1077B	4.0	24- N	12	32.0	-130	44	zeta Gem
128	Sep 6	1193	5.4	16- N	8	2.3	-83	30	85 Gem
133	Sep 15	2291V	5.5	32+ N	4	20.6	-130	49	49 Lib
149	Oct 13	2361	4.2	17+ S	2	20.0	-121	20	chi Oph
152	Oct 15	2635	5.5	34+ S	3	45.3	-109	20	14 Sgr
153	Oct 16	2779	3.8	43+ N	1	45.0	-130	51	omicron Sgr
154	Oct 16	2779	3.8	43+ S	3	20.9	-79	20	omicron Sgr
170	Nov 12	2725A	5.4	19+ S	2	26.4	-130	36	28 Sgr
173	Nov 15	3113K	5.4	44+ S	2	44.9	-99	20	30 Cap

Asteroidal Occultation Paths, 2018 April 22 – June 15



Upcoming Asteroidal, Planetary, & TNO Occultations

Event Summary for Suffern, NY Longitude -74.09 Latitude 41.13 (events plotted on regional map)

2018 mon	dy	U.T. h	m	Diam km	Dura- tion	Star mag	Mag Drop	Solar Elong	Star Number	Planet No	Name	Alt o	Dist km	Moon % Elon	ill	R.A. (J2000) h	m	s	Dec. o	'	"
Apr	22	2	5.1	137	4.5s	12.1	1.7	65	UCAC4-587-030528	141	Lumen	32	832	15	41	6	30	12.679	27	16	59.74
Apr	22	6	19.4	73	6.9s	11.6	0.5	154	4U 433-57099	79	Eurynome	29	252	72	43	12	18	43.442	- 3	34	48.53
Apr	23	2	20.3	57	2.1s	13.2	2.2	61	4U 601-31413	1304	Arosa	28	458	32	52	6	17	27.869	30	8	22.30
Apr	23	3	36.8	29	2.1s	9.8	6.5	170	TYC 5550-00977-1	4431	Holeungholee	35	1097	78	53	13	22	19.606	-13	30	56.76
Apr	25	7	6.0	18	1.6s	10.0	5.3	149	TYC 4943-01010-1	1508	Kemi	17	950	28	76	12	11	11.785	- 3	58	40.41
Apr	26	1	29.6	45	1.3s	11.4	3.2	55	TYC 1868-00586-1	126	Velleda	30	969	76	83	6	1	9.419	25	55	14.39
Apr	28	0	50.8	15	1.6s	8.2	7.4	106	HIP 47158	1365	Henyey	55	17	50	95	9	36	33.613	7	7	20.45
Apr	29	8	39.2	61	7.0s	10.0	5.1	106	TYC 6311-00060-1	752	Sulamitis	24	915	82	99	19	38	28.218	-22	17	3.51
May	1	2	46.3	199	18.1s	10.6	2.2	135	TYC 0411-00597-1	130	Elektra	17	640	33	99	17	14	47.081	6	18	3.36
May	3	6	31.1	66	9.3s	12.4	3.4	134	2UCAC 26718814	2196	Ellicott	31	378	9	90	17	50	46.685	-14	10	34.53
May	4	4	32.4	63	5.6s	12.3	3.3	97	2UCAC 35575348	934	Thuringia	19	494	130	84	9	28	34.235	10	38	15.96
May	6	1	31.6	100	3.1s	9.9	4.9	59	TYC 1356-00370-1	50	Virginia	31	148	171	69	7	2	53.807	20	43	35.42
May	6	6	6.9	113	13.7s	10.9	1.2	157	TYC 4972-00102-1	34	Circe	32	769	93	67	13	30	52.221	- 5	6	4.95
May	11	8	8.3	50	4.2s	10.7	2.4	155	TYC 0371-00418-1	472	Roma	41	1033	116	20	16	11	33.511	2	19	28.79
May	15	8	27.1	69	18.1s	11.8	1.2	131	2UCAC 19276129	578	Happelia	19	600	128	0	19	0	51.810	-30	25	45.77
May	18	8	23.1	62	6.2s	12.2	0.5	168	4U 381-74924	417	Suevia	23	250	149	11	16	22	46.720	-13	57	14.96
May	20	0	58.8	74	9.0s	11.6	2.4	138	2UCAC 26680624	640	Brambilla	33	1010	77	27	12	54	29.962	-14	11	16.60
May	22	2	34.3	38	1.3s	13.0	4.6	62	4U 616-44037	6372	Walker	30	105	31	49	8	30	26.389	33	5	28.55
May	25	8	1.3	64	5.6s	13.0	1.3	162	4U 323-111316	792	Metcalfia	19	483	68	82	17	22	31.956	-25	28	55.29
May	27	5	43.3	35	2.4s	11.9	4.6	169	TYC 6223-01445-1	1203	Nanna	30	1037	38	94	17	2	43.992	-18	41	36.22
May	28	8	35.5	50	3.2s	11.8	4.1	164	UCAC4-326-107960	2617	Jiangxi	15	66	30	98	17	27	26.829	-24	51	14.69
May	31	6	55.1	83	6.4s	12.0	1.9	168	2UCAC 23917584	348	May	27	871	7	97	17	24	40.857	-20	10	4.96
Jun	1	5	46.6	42	4.6s	12.0	2.8	144	2UCAC 28609348	592	Bathseba	35	219	12	94	18	58	44.332	- 9	29	54.08
Jun	6	6	7.2	34	3.6s	10.8	4.7	152	TYC 5705-00423-1	1760	Sandra	33	662	58	55	18	50	11.379	-14	49	16.90
Jun	6	8	34.0	77	8.6s	11.6	1.4	161	2UCAC 18032168	576	Emanuela	9	48	69	54	18	9	59.137	-32	34	19.44
Jun	10	4	38.6	87	4.8s	12.3	3.8	160	2UCAC 25617196	4833	Meges	28	363	113	17	18	32	37.750	-16	58	45.56
Jun	13	2	22.8	93	7.1s	12.1	2.1	173	2UCAC 22031696	940	Kordula	19	632	173	1	16	53	36.967	-24	15	15.16

The occultation probability at Suffern is 0% for all events
except for Apr 28 17%, May 18 1%, May 22 11%, May 28 17%, Jun 6 8h 69%, & Jun 13 10%.

Centaur, Saturn, and TNO Events, and some good later asteroidal occ'ns

2018 Date	Day	EDT	Star	Mag.	Asteroid	dmag	dur. s	Ap. "	Location
May 21	Mon	5:01	2UC20274656	14.4	Chariklo	4.4	20	12	USA except n.e.
Jul 5	Thu	1:47	PPM 733925	8.8	Saturn	0.0	100m	8	Americas
Jul 8	Sun	1:28	see note 1	14.8	Quaor	4.3	49	13	TNO, USA
Aug 15	Wed	1:29	see note 2	12.9	Pluto	1.6	123	11	e&swUSA,Mexico
Aug 27	Mon	5:10	TYC07560895	10.4	Corduba	4.1	2	5	nPA,seNY,sNEng
Sep 6	Thu	20:34	iota Aquarii	4.3	Zelima	9.3	4	1	seSC,seNC;seMA?
Sep 16	Sun	4:51	ZC 782	7.2	Sappho	4.6	5	2	sON,nNY,nNEng
Sep 21	Fri	3:56	4UC52232397	11.2	Kleopatra	1.0	5	6	eTX,LA,sAL,sGA
Oct 28	Sun	4:33	TYC07650506	11.1	Kleopatra	0.9	10	5	sON,c&seNY,CT

Event details at http://www.asteroidoccultation.com/ except for:
Note 1: http://lesia.obspm.fr/lucky-star/predictions/single.php?p=4127
Note 2: http://lesia.obspm.fr/lucky-star/predictions/single.php?p=3031

79 Eurynome occults 4U 433-57099 on 2018 Apr 22 from 6h 15m to 6h 26m UT

2:19 am EDT

Tonight! Occultation in
S. New Jersey & Delaware

Zavijava

Porrima

Star is in Virgo

1304 Arosa occults 4U 601-31413 on 2018 Apr 23 from 2h 14m to 2h 21m UT

Sun. 10:20pm EDT

Occult Watcher map
with planned stations in VA

The target star is 0.8°
north of 4.3-mag. κ Aurigae

AURIGA

El Nath

GEMINI

Mebsuta

50 Virginia occults TYC 1356-00370-1 on 2018 May 6 from 1h 27m to 1h 32m UT

A rather good
bright event at
9:31pm EDT,
Saturday
May 5

10199 Chariklo occults 2UCAC 20274656 on 2018 May 21 from 8h 55m to 9h 12m UT

Centaur Asteroid has 2 ring(s).

Chariklo is a large Centaur object with rings. Twilight will be too strong northeast of westernmost Virginia. Later astrometric updates could move the path, and hopefully reduce the path error; with the current time uncertainty, the star should be recorded for at least 40 minutes centered on the predicted closest approach time at your location.

Predictions computed with free Occult 4 program. More is at IOTA's site, http://www.occultations.org/ especially the Observing tab, and in the RASC Observer's Handbook. More asteroidal occ'n info. is at http://www.asteroidoccultation.com/observations/ . dunham@starpower.net

P6M00 Saturn occults TYC 6277-323-1 on 2018 Jul 5 from 5h 4m to 6h 31m UT

Star:
Mv = 8.8 Mp = 8.8 Mr = 8.8
RA = 18 21 47.3081 (J2000)
Dec = -22 29 56.686 ...
[of Date: 18 22 55, -22 29 14]
Prediction of 2017 Jul 29.0

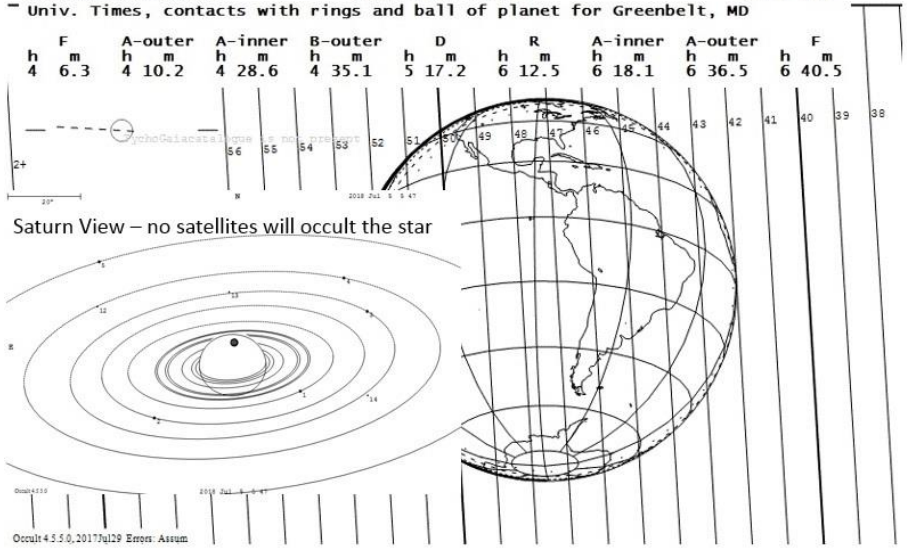
Max Duration =6036.1 secs
Mag Drop = 0.00 (0.00r)
Sun : Dist = 172 deg
Moon: Dist = 86 deg
: illum = 61 %
E 0.050"x 0.050" in PA 90

Star is PPM 733925

Asteroid:
Mag = 0.1
Dia =120000km, 18.268
Parallax = 0.971"
Hourly dRA =-0.785s
dDec = -0.65"

Univ. Times, contacts with rings and ball of planet for Greenbelt, MD

F	A-outer	A-inner	B-outer	D	R	A-inner	A-outer	F
h m	h m	h m	h m	h m	h m	h m	h m	h m
4 6.3	4 10.2	4 28.6	4 35.1	5 17.2	6 12.5	6 18.1	6 36.5	6 40.5

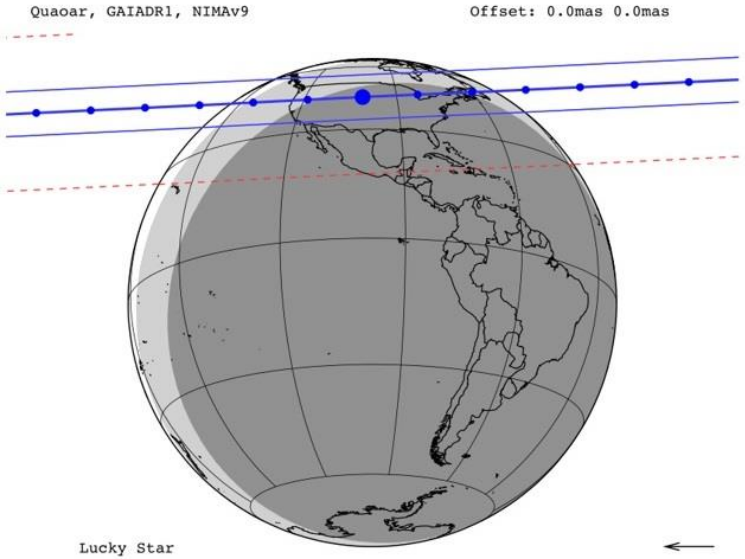


Saturn View – no satellites will occult the star

Occult 4.5.0, 2017jul29 Errors: Assum

Occultation of 14.8-mag. star by large TNO Quaor, 2018 July 8

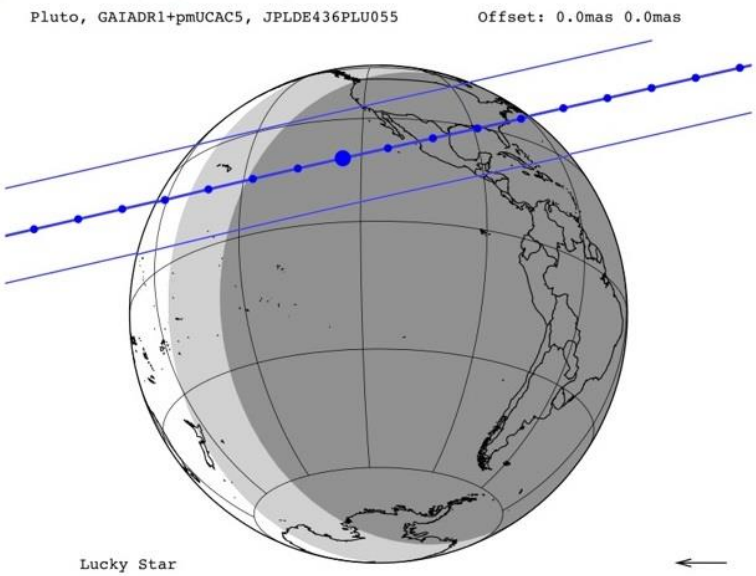
http://lesia.obspm.fr/lucky-star/predictions/single.php?p=4127



Occultation of 12.9-mag. star by Pluto, 2018 Aug. 15

http://lesia.obspm.fr/lucky-star/predictions/single.php?p=3031

Major IOTA campaign for this, the most valuable 2018 N. American occultatio



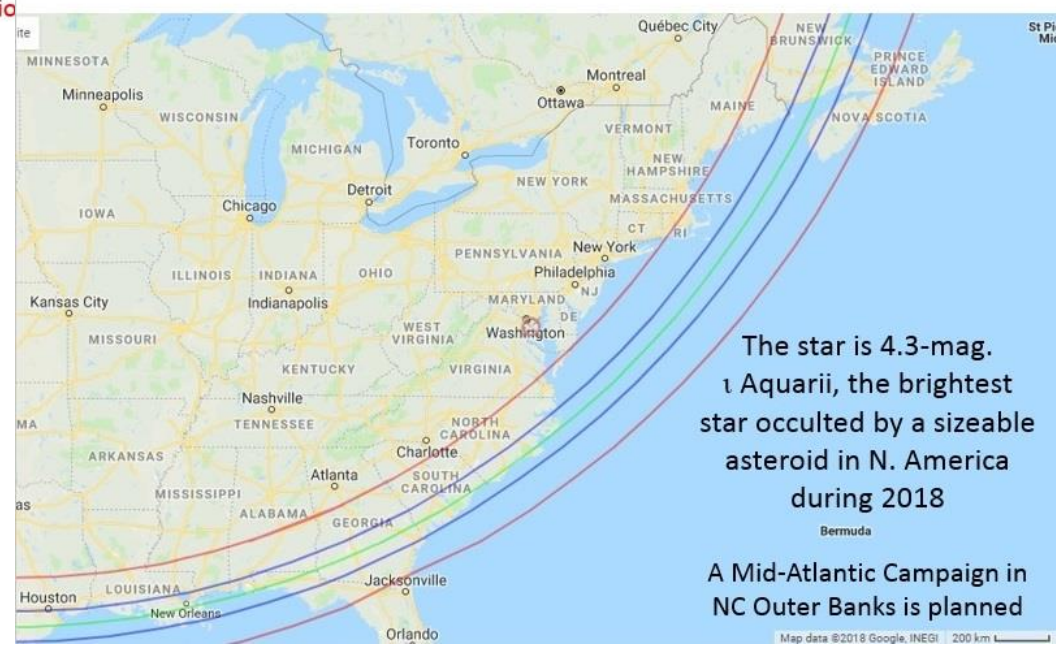
yyyy mm dd hh:mm:ss.s	RA_star_J2000	DE_star_J2000	C/A	P/A	vel	Delta	G*	J*
2018-08-15 05:32:34.2	19 22 10.4686	-21 58 49.020	0.172	347.11	-19.33	32.7670	12.9	11.9

633 Zelima occults HIP 109139 on 2018 Sep 7 from 0h 31m to 0h 38m UT

Star:
Mv = 4.3
RA = 22 7 26.2804 (J2000)
Dec = -13 52 11.894 ...
[of Date: 22 7 27, -13 46 38]
Prediction of 2017 May 21.0

Max Duration = 3.8 secs
Mag Drop = 9.3
Sun : Dist = 164 deg
Moon: Dist =158 deg
: illum = 11 %
E 0.047"x 0.026" in PA 81

Asteroid:
Mag =13.6
Dia = 40km, 0.031"
Parallax = 4.935"
Hourly dRA =-1.605s
dDec =-18.43"



The star is 4.3-mag. ι Aquarii, the brightest star occulted by a sizeable asteroid in N. America during 2018

A Mid-Atlantic Campaign in NC Outer Banks is planned

365 Corduba occults TYC 0756-00895-1 on 2018 Aug 27 from 9h 10m to 9h 15m UT

Star:
Mv = 10.4
RA = 6 58 55.4141 (J2000)
Dec = 12 18 36.267 ...
[of Date: 6 59 56, 12 17 0]
Prediction of 2017 May 21.0

Max Duration = 2.4 secs
Mag Drop = 4.1
Sun : Dist = 50 deg
Moon: Dist =119 deg
: illum = 99 %
E 0.018"x 0.011" in PA 86

Asteroid: (in DAMIT, ISAM)
Mag =14.5
Dia = 92km, 0.043"
Parallax = 2.948"
Hourly dRA = 4.177s
dDec =-12.54"

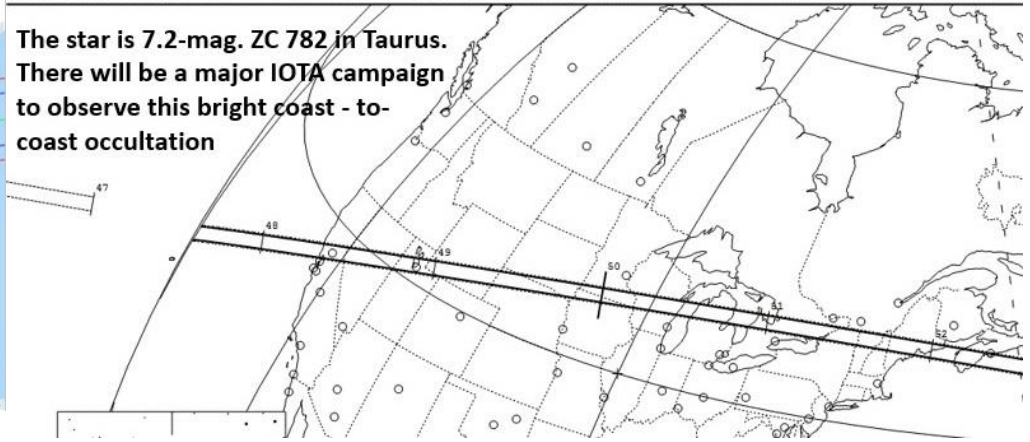
80 Sappho occults HIP 24403 on 2018 Sep 16 from 8h 48m to 9h 0m UT

Star:
Mv = 7.2
RA = 5 14 5.7611 (J2000)
Dec = 21 13 25.187 ...
[of Date: 5 15 12, 21 14 34]
Prediction of 2017 May 24.0

Max Duration = 5.0 secs
Mag Drop = 4.6
Sun : Dist = 94 deg
Moon: Dist =177 deg
: illum = 44 %
E 0.012"x 0.006" in PA 85

Asteroid: (in DAMIT, ISAM)
Mag =11.9
Dia = 79km, 0.068"
Parallax = 5.466"
Hourly dRA = 3.407s
dDec = -8.37"

The star is 7.2-mag. ZC 782 in Taurus. There will be a major IOTA campaign to observe this bright coast - to-coast occultation



216 Kleopatra occults UCAC4-522-032397 on 2018 Sep 21 from 7h 56m to 8h 4m UT

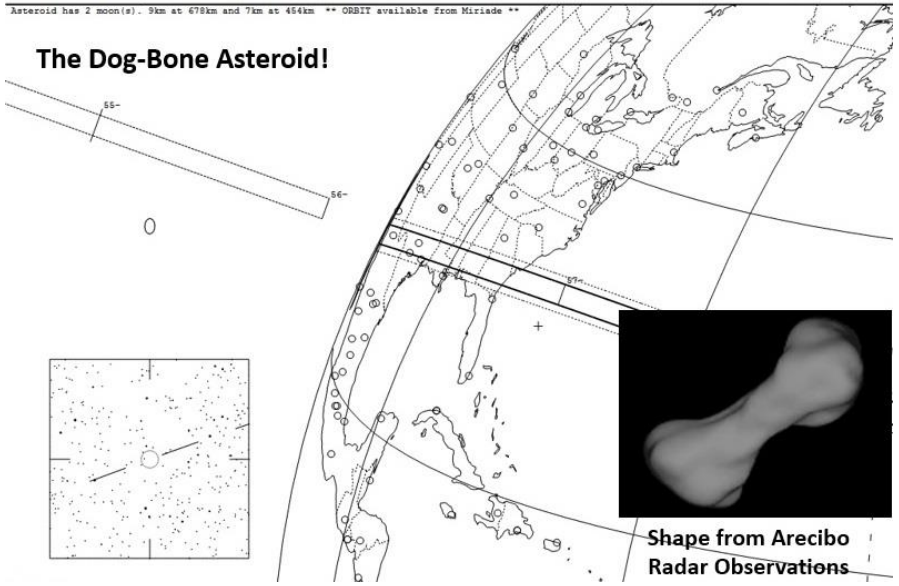
Star:
Mv = 11.2
RA = 6 50 45.8038 (J2000)
Dec = 14 21 39.028 ...
[of Date: 6 51 48, 14 20 16]
Prediction of 2017 May 24.0

Max Duration = 5.3 secs
Mag Drop = 1.0
Sun : Dist = 76 deg
Moon: Dist =145 deg
: illum = 87 %
E 0.030"x 0.020" in PA 2

Asteroid:
Mag =11.7
Dia = 138km, 0.086"
Parallax = 3.956"
Hourly dRA = 3.750s
dDec =-19.79"

Asteroid has 2 moon(s). 9km at 678km and 7km at 464km ** ORBIT available from Miriade **

The Dog-Bone Asteroid!



Shape from Arecibo Radar Observations

216 Kleopatra occults TYC 0765-00506-1 on 2018 Oct 28 from 8h 31m to 8h 46m UT

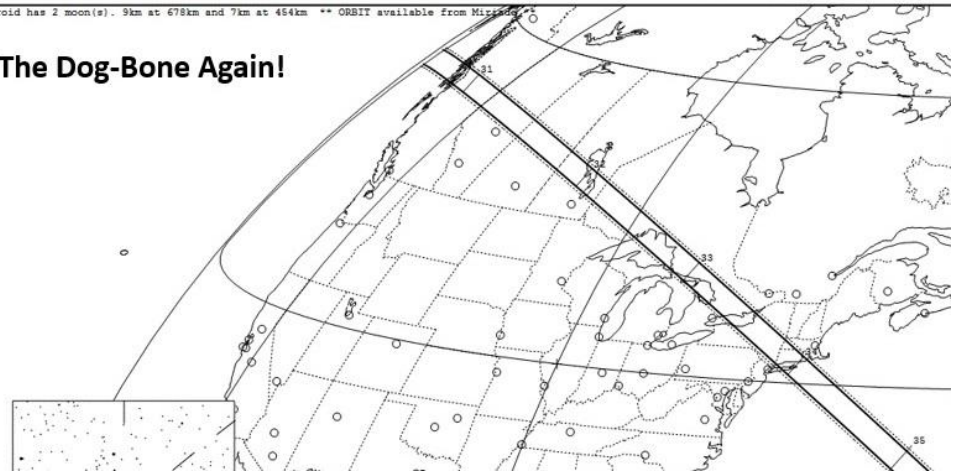
Star:
Mv = 11.1
RA = 7 32 57.0828 (J2000)
Dec = 8 48 11.086 ...
[of Date: 7 33 58, 8 45 44]
Prediction of 2017 May 24.0

Max Duration = 10.2 secs
Mag Drop = 0.9
Sun : Dist = 101 deg
Moon: Dist = 33 deg
: illum = 84 %
E 0.015"x 0.009" in PA 80

Asteroid:
Mag =11.4
Dia = 130km, 0.102"
Parallax = 4.705"
Hourly dRA = 1.794s
dDec =-24.00"

Asteroid has 2 moon(s). 9km at 678km and 7km at 464km ** ORBIT available from Miriade **

The Dog-Bone Again!



IOTA Booth at NEAF
Come See Us!

IOTAoccultations (Yahoo discussion group)

www.occultations.org

www.asteroidoccultation.com

www.occultwatcher.net

Thank you!