Plans of the International Occultation Timin Association (IOTA) for 2017 and Other "Eclipse" Opportunities

David & Joan Dunham, R. Nugent, D. Herald, S. Sofia, P. Maley, W. Warr
and many others

Solar Eclipse Conference 2014, Cloudcroft, NM, October 26, 2014

Columbia, MO, Aug. 21-22, 2014

Overview

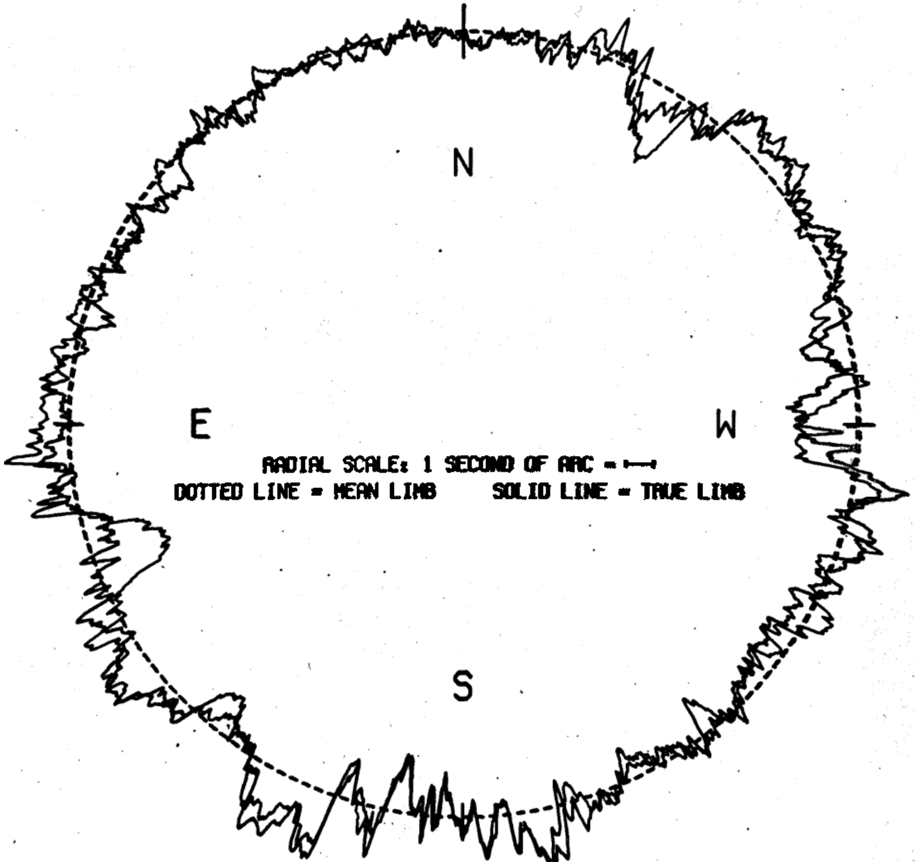
- IOTA’s long term solar radius measurement research
- Observations near central eclipse path edges since 1970
- Analysis of historical obs. back to 1715; look for more
- Re-analyze all obs. with accurate profile data- eg, LRO
- These large tasks manageable with some help from others in and outside of IOTA
- Plans for the 2017 eclipse
- Opportunities between eclipses & closer to home –
- Lunar grazing occultations (discover binary stars)
- Asteroidal occultations

Central Solar Eclipses from near the Path Edges, the Ultimate "Grazing Occultation"

- Interest in solar eclipses increased in the early 1980's when comparison of observations of the February 26, 1979 eclipse, well-observed in North America, showed that the solar radius was about 0.4″ smaller then than during eclipses observed in 1715 (Dunham et al., *Science*, **210**, pp. 1243-1243, 1980) and in 1925 (Sofia et al., *Nature*, **304**, pp. 522-526, 1983).
- Timings of the eclipse duration (2nd and 3rd contacts), and of other Baily's bead phenomena near the limits of total and annular eclipses, were found to give the best accuracy – see the next panel.
- Members of the International Occultation Timing Association (IOTA) and others began traveling to the edges of eclipse paths to time Baily's bead phenomena, first visually by viewing a projected image of the Sun but since 1983 mostly by video recording the eclipse to obtain a more complete record of the phenomena.
- Solar radius values determined from observations of nine eclipses were published in 1994 (Fiala, Dunham, and Sofia, *Solar Physics*, **152**, pp. 97-104).
- Since the edge of the Sun is not perfectly sharp but has a steep gradient, and different filters have been used in the observations, the consistency and accuracy of the results have been found to be poorer than the early estimates.

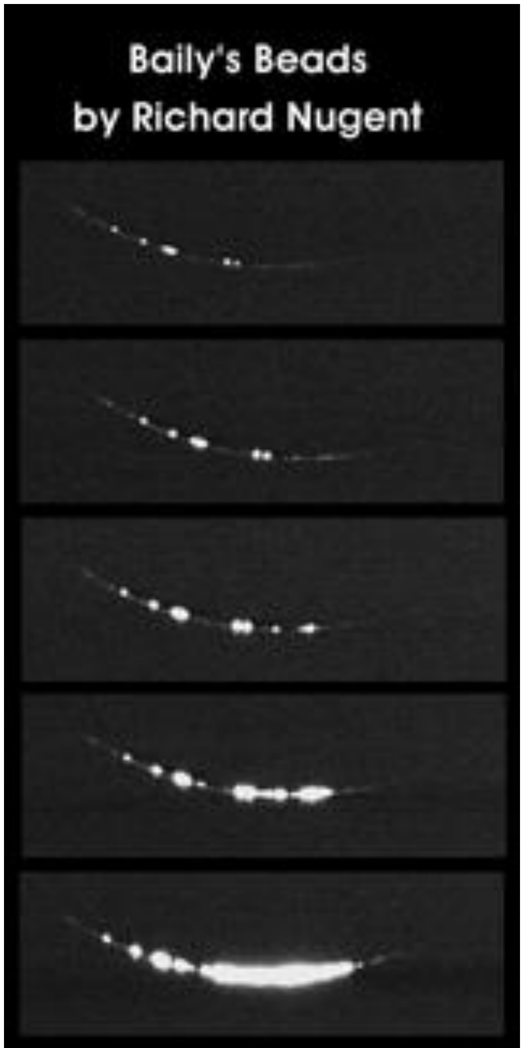
Why Observations near the Path Edges were better than those near the Center; Less Important now that very accurate lunar profiles are available from Kaguya and LRO

- The Moon is very close to the ecliptic (hence its name) during a solar eclipse, so the latitude libration is near zero.
- The longitude libration can have any value during an eclipse.
- Consequently, the same lunar features cause bead events near the lunar poles, while different ones cause them near the center.
- For observations near the eclipse path limits, this reduces the effect of the typical ±0.2″ error of the profile data from Watts' charts (U. S. Naval Obs. Pub. #17, 1963) that were used for the profiles to the right.
- Some of the polar profile has been refined by observations of lunar grazing occultations of stars observed by IOTA members since 1962.
- Central eclipse timings might be used now that Kaguya and the Lunar Reconnaissance Orbiter mapped the Moon accurately and comprehensively.



Two Lunar Profiles from Watts superimposed, both lat. Libration 0 but with long. librations +1.0° and –5.0°

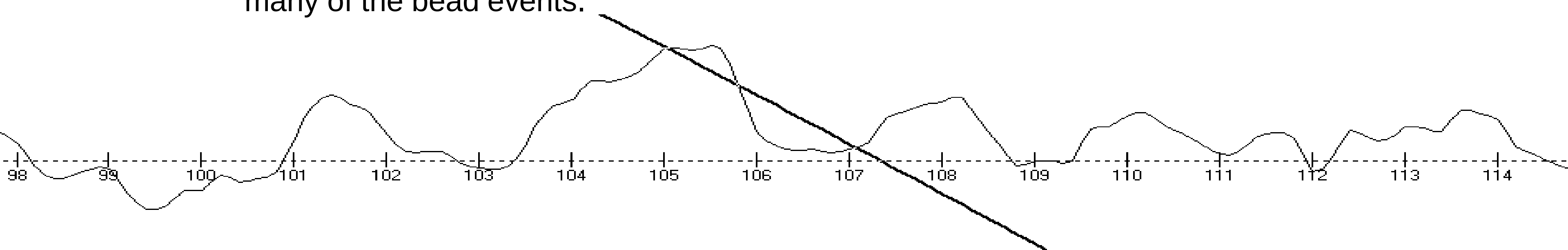
Video Recording of Baily's Beads, Curaçao, Feb. 26, 1998



- © Richard Nugent; recorded using a 4-inch Meade ETX and Thousand Oaks solar filter.
- 18:13:56 UT
- 18:14:00 UT
- 18:14:10 UT
- 18:14:12 UT
- 18:14:18 UT

Analyzing the Video Records
nearly all reduced with Watts profile data

- The digital tape clock times were calibrated with UTC using time signals or GPS time stamps.
- A video time inserter that triggers from WWV minute tones, designed and built by Peter Manly, with results improved with a VTACT unit designed and built by Tom Campbell, Jr., was used to insert UTC displays on VHS video tapes.
- The tapes were then advanced slowly a frame at a time to establish the UTC of the recorded Baily Bead phenomena to an accuracy of about 0.1 second.
- Using the Baily's Bead module of the WinOccult program by D. Herald, downloaded from the main IOTA Web site at http://www.lunar-occultations.com/iota, the lunar feature (angle measured from the projection of the Moon's axis of rotation, called "Watts angle" or WA) was identified for each timing using the program's profile display (example below). The display is calculated for the time of the observed bead event.
- The height of the Sun's limb (the diagonal line below) above the lunar mean limb (the horizontal dashed line) at the bottom of the lunar valley (for D and R events), and the height of the Moon's limb at that angle, were entered into a spread sheet (see next panel) that calculated their difference (residual).
- Solrad, Dunham's DOS FORTRAN program, was used to calculate corrections to the Moon's center relative to that of the Sun, and the solar radius, using the residuals from many of the bead events.



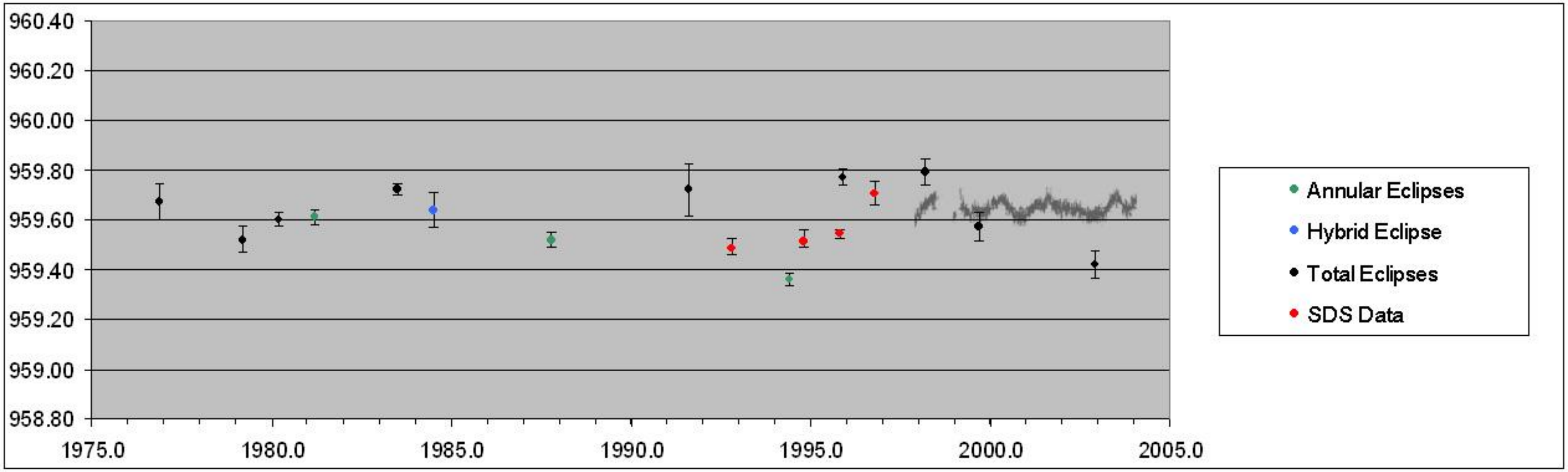
Solar Radius Determinations from Solar Eclipses

Year	Month	Day	Type	# Obs.	Method	ΔR⊙, "	σ, ±, "
1715	May	03	Total	3	visual	-0.5	0.2
1878	July	29	Total	12	visual	+0.55	0.15
1900	May	28	Total	8	visual	+0.12	0.09
1912	April	17	Hybrid	26	photoes	-0.29	0.22
1922	Sept.	21	Total	4	visual	+0.2	0.4
1925	Jan.	24	Total	11	visual	-0.21	0.17
1966	May	20	Hybrid	9	photoes	+0.03	0.05
1970	March	7	Total	4	visual & proj.	-0.05	0.12
1972	July	10	Total	14	visual & proj.	-0.02	0.61
1973	June	30	Total	7	visual & proj.	+0.4	0.2
1976	Oct.	23	Total	14	projection	-0.38	0.09
1979	Feb.	26	Total	21	visual & proj.	-0.05	0.08
1980	Feb.	16	Total	36	projection	-0.18	0.05
1981	Feb.	04	Annular	52	projection	-0.21	0.05
1983	June	11	Total	26	video & proj.	-0.10	0.08
1984	May	30	Hybrid	27	video	+0.13	0.07
1987	March	29	Hybrid	11	photoes	-0.19	0.08
1987	Sept.	23	Annular	44	video	+0.10	0.05
1988	March	18	Total	20	projection	-0.13	0.14
1991	July	11	Total	23	video	0.00	0.06
1994	May	10	Annular	75	video	-0.25	0.03
1995	Oct.	24	Total	25	video	+0.11	0.06
1998	Feb.	26	Total	44	video	+0.16	0.04
1999	Aug.	11	Total	19	video	-0.03	0.04
2002	Dec.	04	Total	13	video	-0.22	0.06
2005	Oct.	03	Annular	69	video	-0.06	0.03
2006	March	29	Total	105	video	+0.09	0.16

The radius correction, delta-R, is relative to the standard value at 1 A.U., 959.63 arc seconds. All have been reduced using David Herald's WinOccult program and analyzed with the Solrad programs. The Delta-R values are from 2-parameter solutions using bead events within 30° of the poles to use the better accuracy of the lunar polar profile as explained in a previous slide.

Solar Radius Determinations from Solar Eclipses Compared with SDS and SOHO Data

- The eclipse points with their formal solution error bars are plotted below.
- Four red dots are from the Solar Disk Sextant, from Sabatino Sofia.
- The gray curve is the “statistical thermal model correction” SOHO data from Fig. 13 of Kuhn, Bush, Emilio, and Scherrer, *Ap. J.*, **613**, p. 1249, 2004. Their “a priori thermal model correction” is about 0.2″ below the statistical thermal model data. SOHO was not designed to measure the solar radius; the application of large thermal effect corrections may have systematic errors.



Accuracy of the Video Observations of the Total Solar Eclipse of February 26, 1998

	3-Parameter solutions with all data								
N1	#	N2	#	S1	#	S2	#	DR	ERROR
DD	20	PR	51	RN	21	WW	25	-0.04	0.0355
DD	20	-	-	RN	21	-	-	0.24	0.0257
-	-	PR	51	RN	21	-	-	0.00	0.0337
DD	20	-	-	-	-	WW	25	-0.06	0.0452
-	-	PR	51	-	-	WW	25	-0.22	0.0291
	2-Parameter solutions with polar data								
N1	#	N2	#	S1	#	S2	#	DR	ERROR
DD	15	PR	18	RN	11	WW	04	0.16	0.0542
DD	15	-	-	RN	11	-	-	0.26	0.0360
-	-	PR	18	RN	11	-	-	0.20	0.0349
DD	15	-	-	-	-	WW	04	0.00	0.0494
-	-	PR	18	-	-	WW	04	-0.07	0.0418

The radius determinations were calculated in two stages, first a solution solving for corrections to the ecliptic longitude and latitude of the Moon's center relative to the Sun's center, and the solar radius. The longitude correction from this first solution was then fixed in a second solution that used only bead events within 30° of the poles and found corrections only to the latitude and radius. There were two video recordings made at each limit (N1, N2 and S1, S2) with observer's initials in the table followed by the number of bead timings. The first line in the two tables includes all observers; the results for different combinations of single observers at each limit follow. The first line of the 2nd (2-parameter) table was used in the table in panel 9**. Although the formal error for each result is rather small, the differences between results for different combinations of observers show that the true error is larger, about ±0.15″, apparently reflecting different levels of the Sun detected by different scope/filter/camera combinations.** A similar analysis of the 1878 eclipse showed larger errors for visual observations.

1715 eclipse, northern limit, Darrington, England

to the present astronomy department at Cambridge. For the town of Darrington, local telephone inquiry revealed that the old town was the western half of the present village, and being quite small, this was sufficient information. These locations were recovered from the Geodetic maps.

6.11

Figure 6.2

Halley's Critical Observations

Observer	Place	Lat	Lon	$2C_{obs}$	$3C_{obs}$	ΔT†
Halley	Royal Society	51.516	359.892	9^m03^s	12^m26^s	-10.5§
Rev. Pound	Wanstead Essex	51.573	0.037	9 28	12 48	-11.3
Prof. Cotes	Cambridge U.	52.205	0.119	—	14 37	-13.6
	Mean of the above timed contacts					ΔT_t = -11.8 ±
	Darrington	53.664	358.736	"Point like Mars"		
	Bocton Kent	51.288	0.938	"Point like Star"		
	Cranbrook Kent	51.101	0.529	"Duration instant"		
	Geometric determination from the above					ΔT_g = - 8.8 ±

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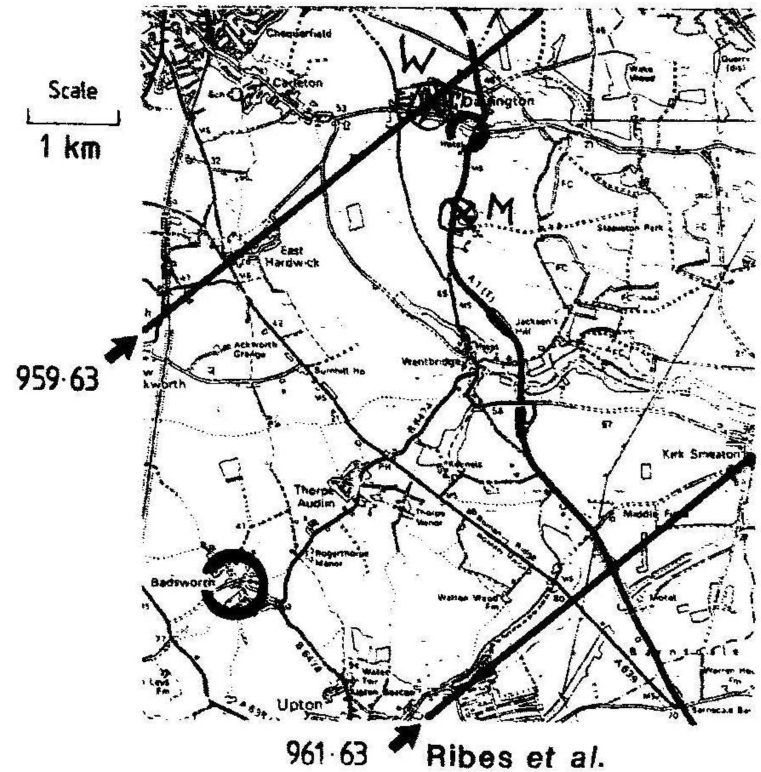


Fig. 4 The calculated northern limits of the path of totality of the 1715 eclipse in relation to Darrington and Badsworth. The limits have the same significance as in Fig. 3.

1715 eclipse, southern limit, Bocton, England

Golf Course, and shows clearly on the Geodetic Survey Map.

The observation attributed to Bocton, Kent, was transmitted to Halley by a fellow society secretary who passed through the village returning to Canterbury from Norton Court where he had presumably gone to be within the belt of totality. It is stated that the townspeople agreed that the eclipse had been not quite complete, "*a single point like a star remaining.*" The Bocton of 1715 was on the pilgrim's way to Canterbury, the same one noted in Chaucer, and at the location of the present Boughton Church Farm which appears on the Geodetic Map. I am indebted to the Reverend Schofield the vicar of Boughton Street for this crucial information.

The observation attributed to Cranbrook in Kent was transmitted to Halley by Mr. William Tempest, but w

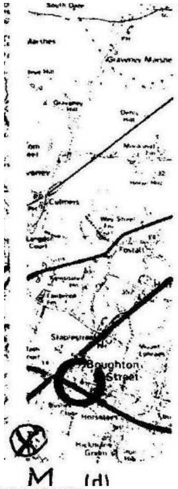
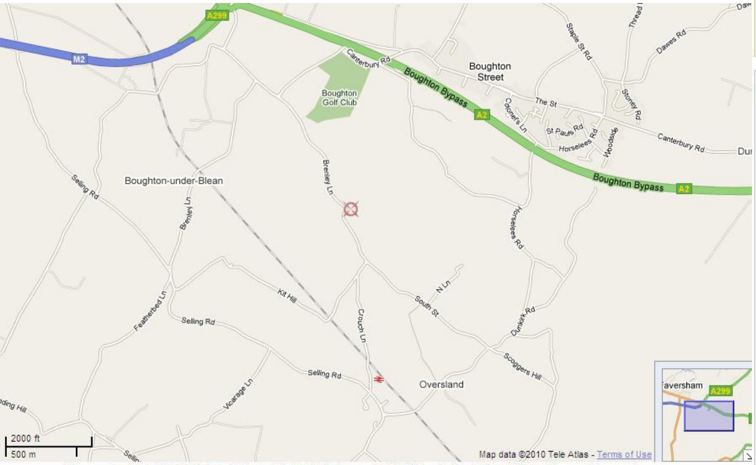
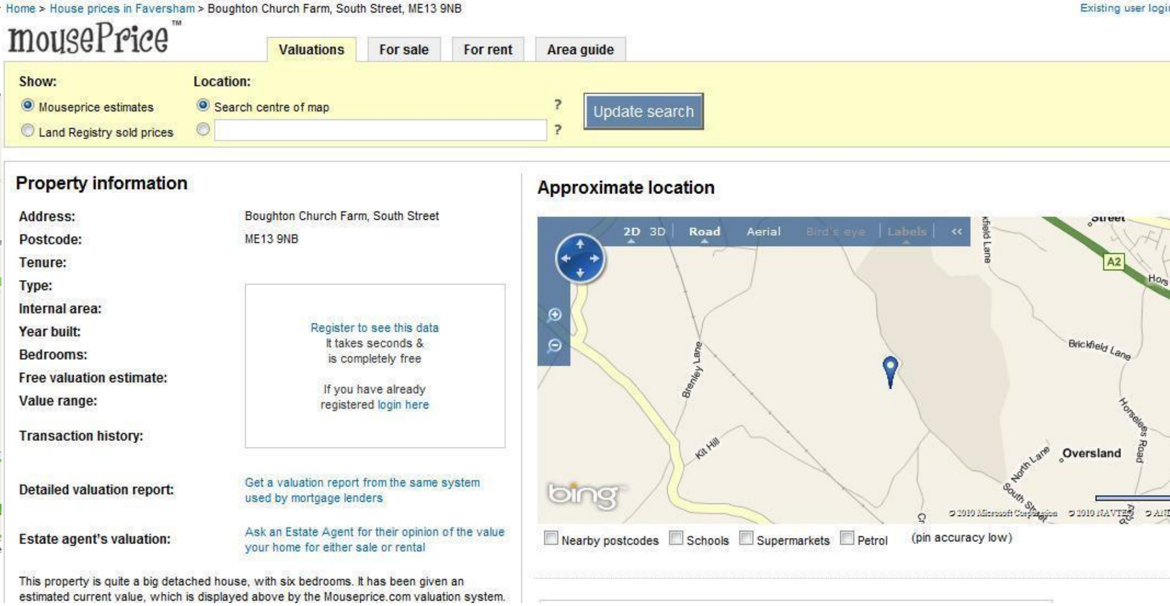
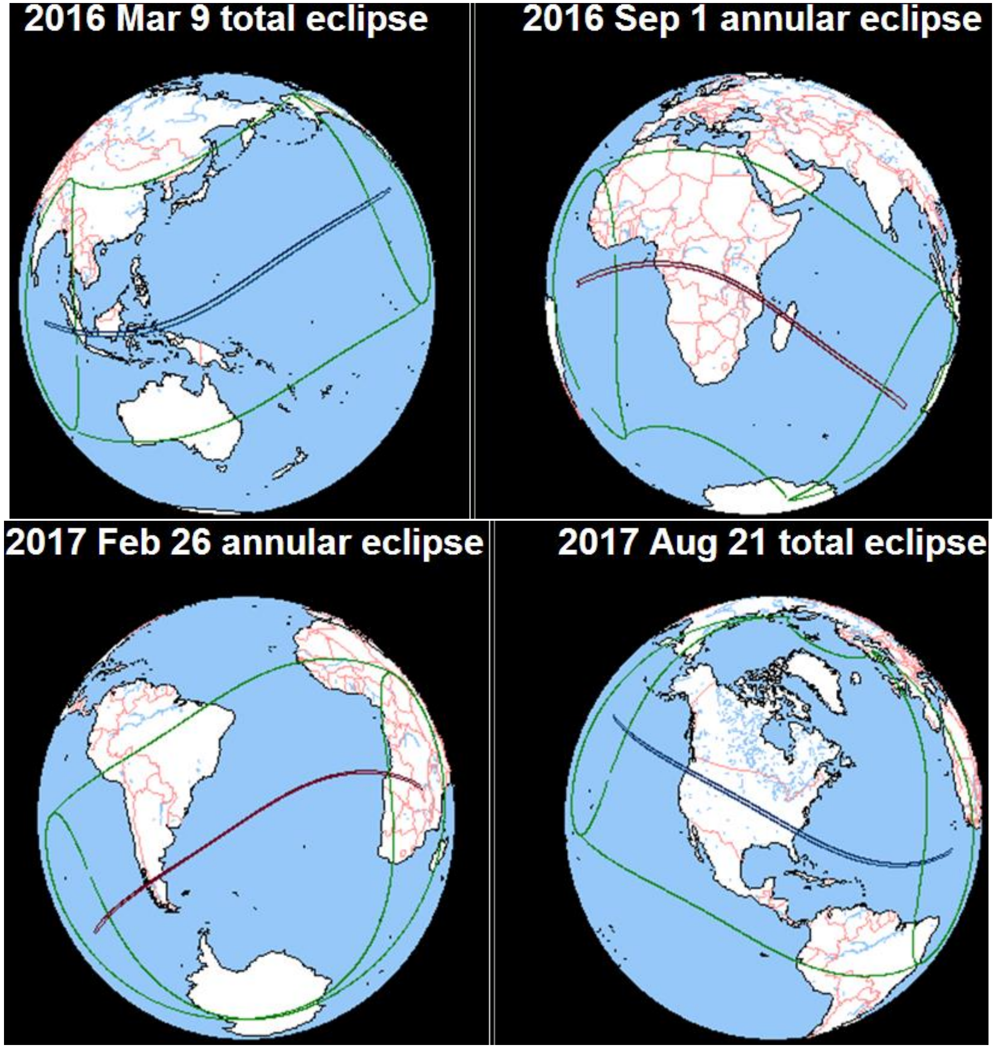


Fig. 3 The calculated southern limits of the path of totality of the 1715 eclipse in relation to Lewes (*a*), Wadhurst (*b*), Cranbrook (*c*) and Bocton (Boughton Street) (*d*). The limit using the current value of the Sun's semi-diameter is labelled 959.63 arc s. The limit using the early eighteenth century result of Ribes *et al.*[1] is labelled 961.63.



(Map center is at (WGS84 datum) Lat = 51.288171, Lon = 0.938043, which is 1812.504 Km from path center.)



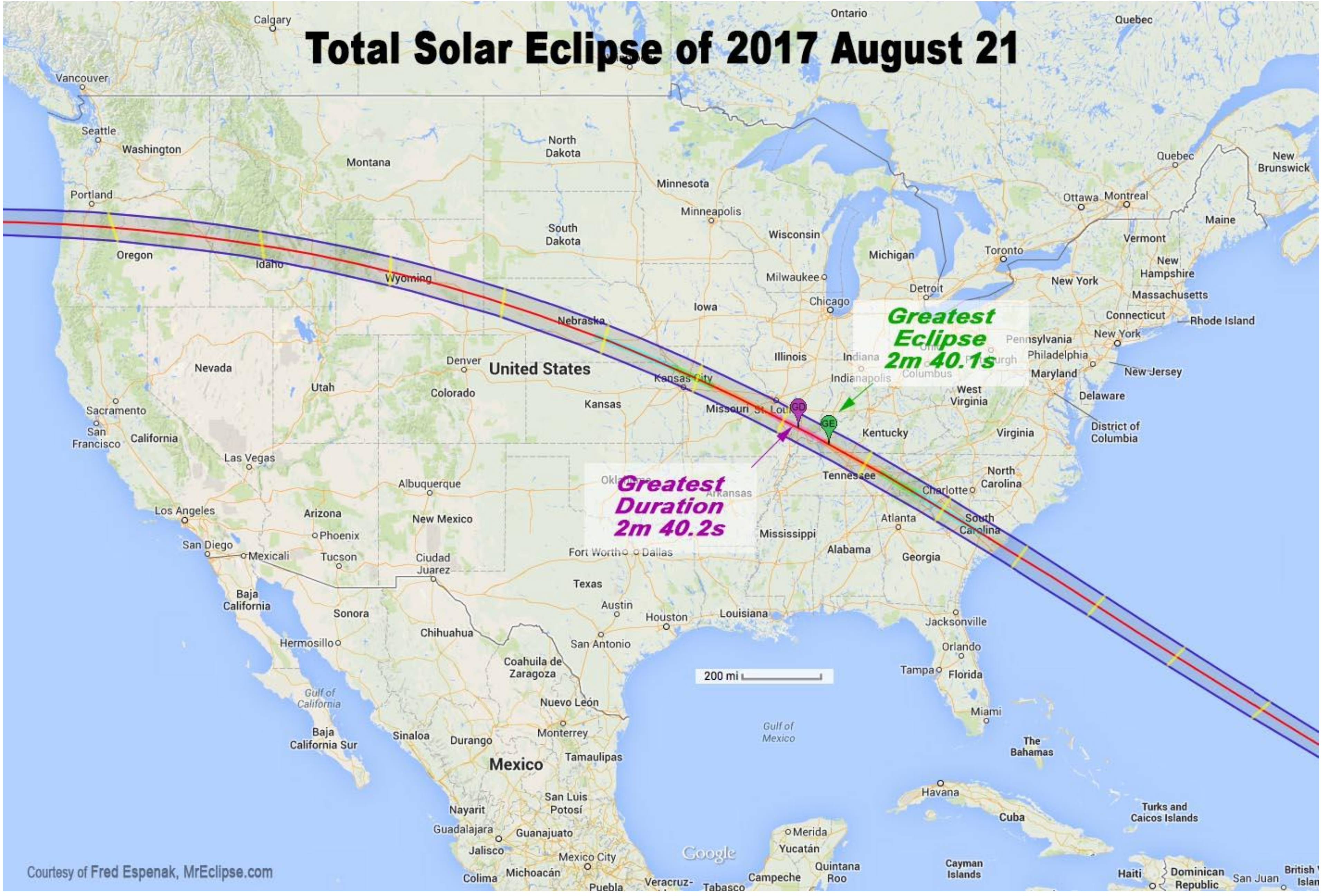


Central eclipses before Aug. 2017 are either in remote, difficult to access regions, or in regions with quite poor weather prospects.

IOTA plans to observe the Aug. 2017 eclipse from locations near the limits, for the best comparison with previous eclipse edge observations.

But some IOTA observers will prefer to observe near the center, and with Kaguya and LRO profiles available, they can make useful observations for our purposes there. Some of them would likely be willing to run other non-IOTA experiments.

Although capable, IOTA is too small to provide much help with a large campaign for the 2017 eclipse. Organizations such as the Astronomical League, with much greater access to those who live in or near the eclipse path, can help more.



Unique opportunity to deploy greater resources than usual

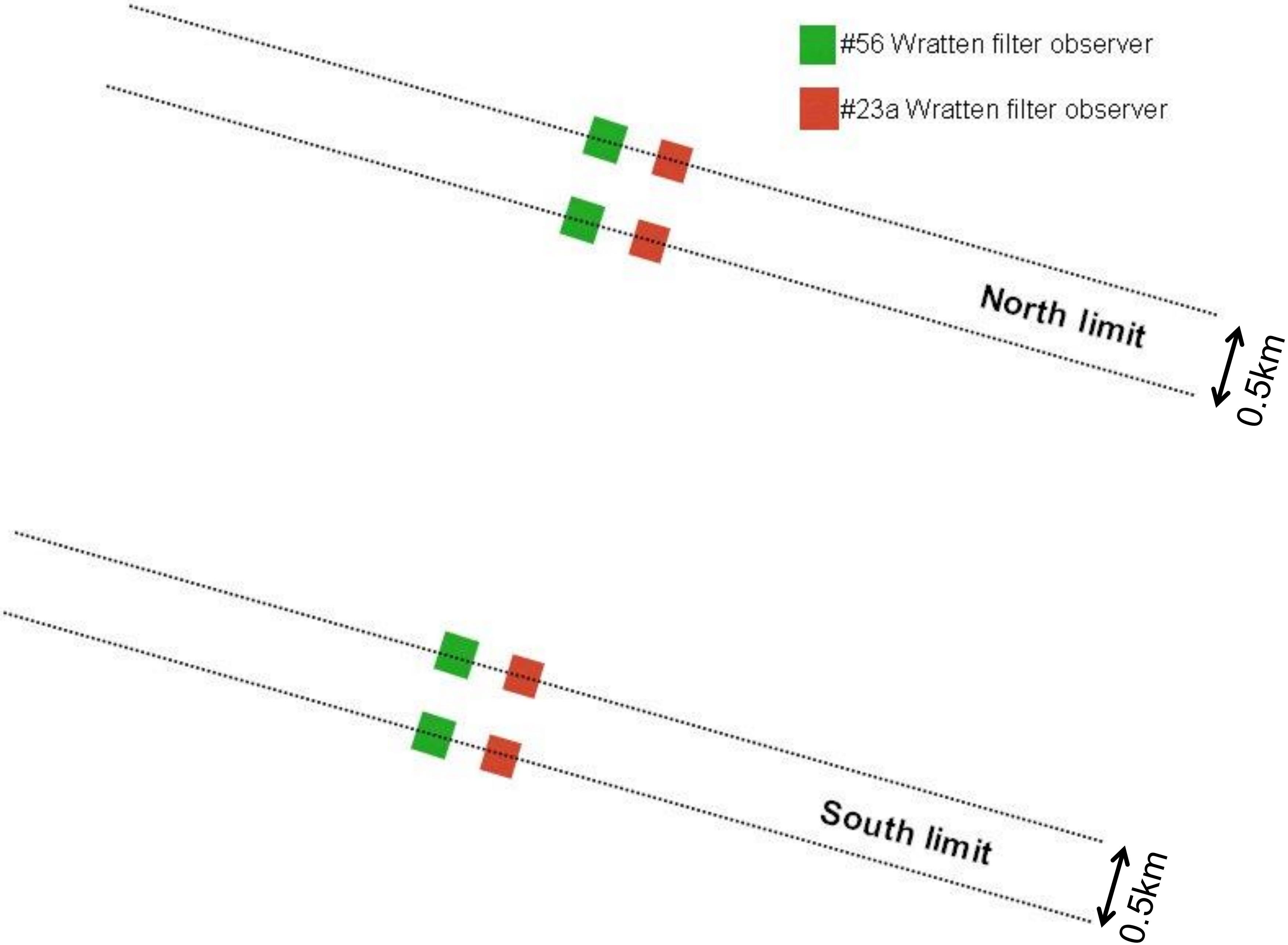
Primary goals for this eclipse

- Continuation for IOTA's long term solar radius measurement research
- Standardization of video equipment
- Standardization of solar filters
- Co-located use of previous techniques (visual, telescopic projected image, filtered telescopic video)
- Organize observations by closely-spaced local observers in towns on the limits, like in NYC in 1925
- 2nd use of narrow band filters (1st was for the May 20, 2012 annular eclipse)
- Desired Results: calibrate with Picard satellite data and with methods used at previous central eclipses

IOTA Standardization Attempted for the May 2012 Annular Eclipse

Equipment Specifications

- Telescope aperture: 75mm – 100mm
- Field of View – 15′ - 20′
- Solar filter – Baader brand – in sheets
- Narrow band filters – Wratten #23, #56
- Attempt to observe in Picard wavelengths
- Video camera: PC164C(EX-2), Watec 902H



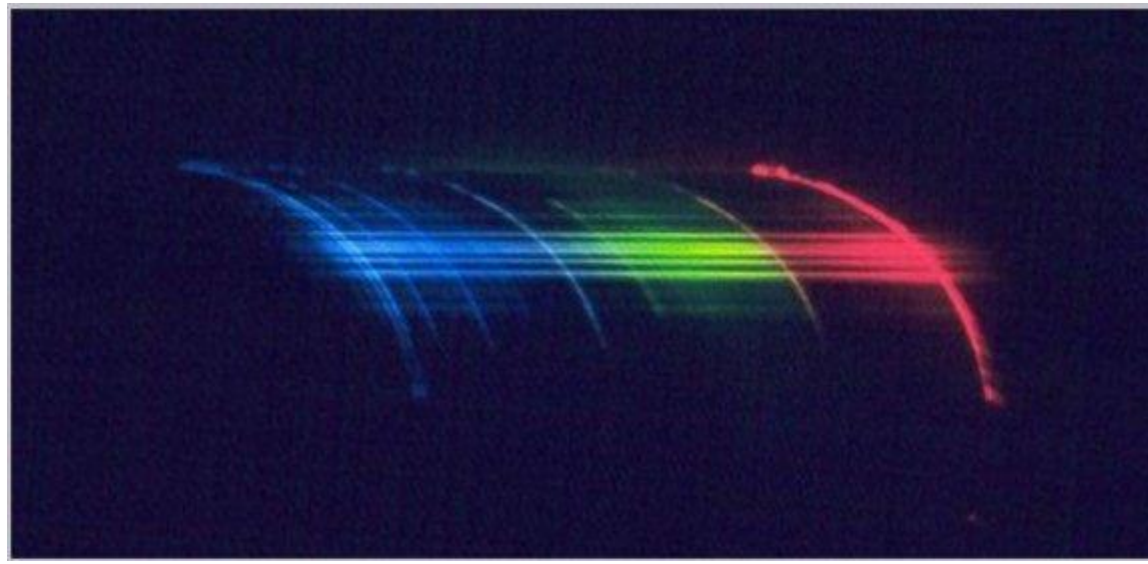
#56 Wratten filter observer
#23a Wratten filter observer
North limit
0.5km
South limit
0.5km

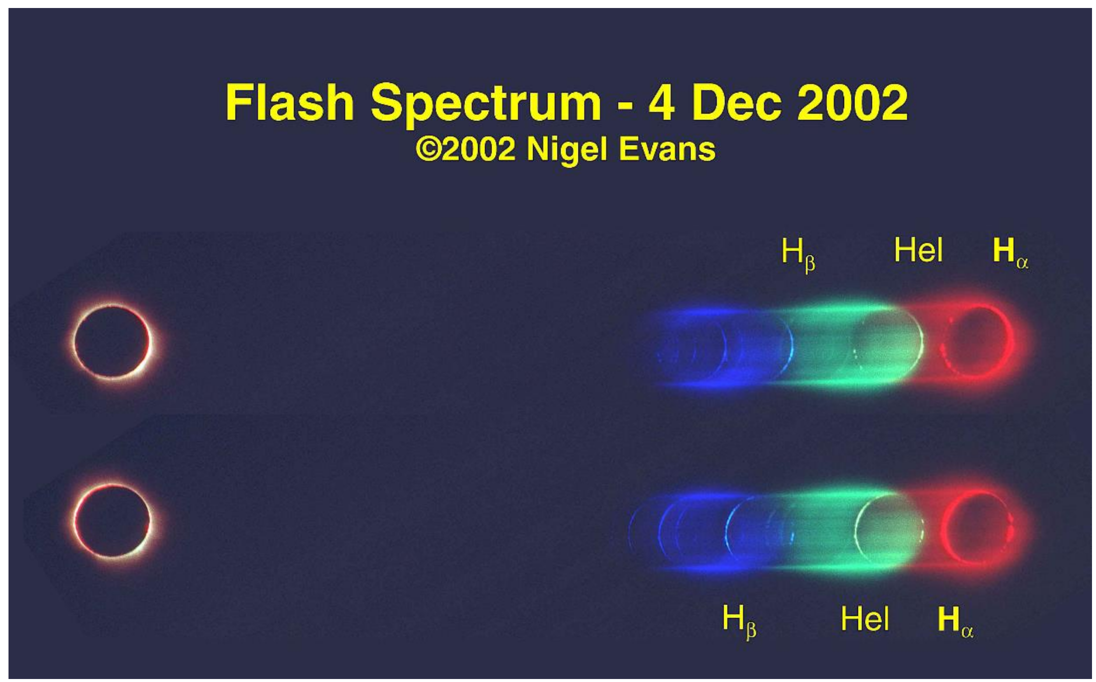
Ted Swift, S. Limit of May 2012 Annular Eclipse

15 sec interval

Unfortunately, clouds prevented observation near the northern limit.

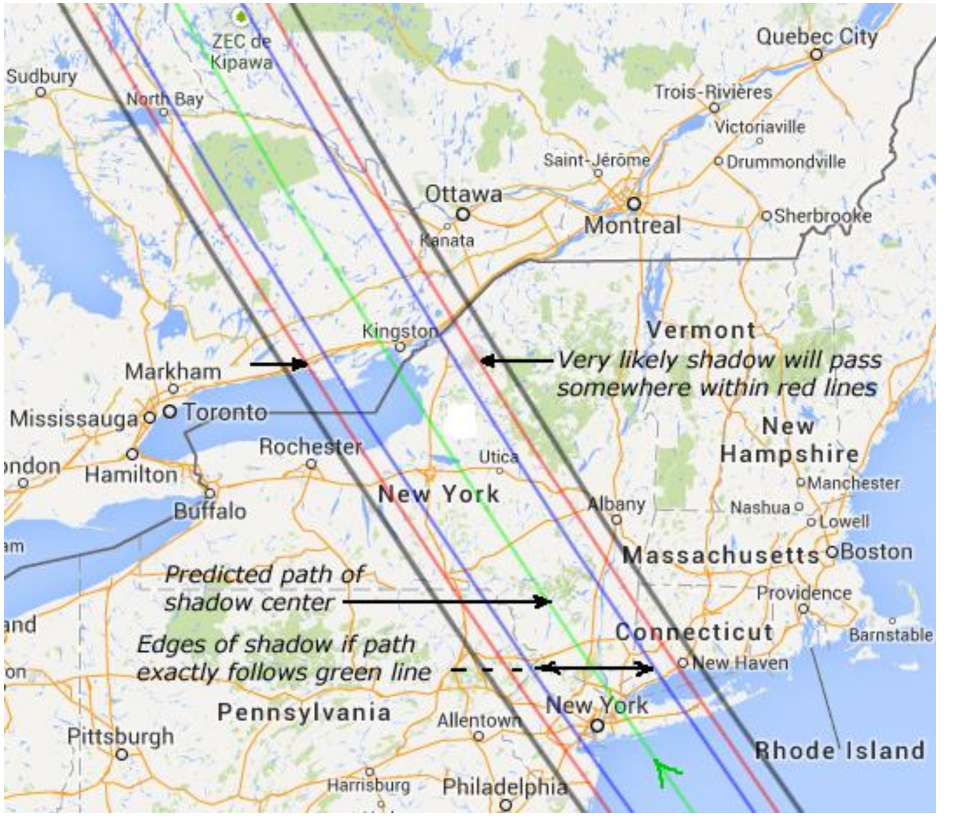
Recording the flash spectrum in a series of images at the contacts promises good results, enabling measurement of the solar edge intensity profile in different wavelengths. But comparison with the older direct obs. Is Important for use of historical eclipses.





January 24, 1925 Total Solar Eclipse – Boy Scouts and Con Ed workers found the southern limit by observing at one-block intervals across Manhattan. Similar efforts might be made at towns straddling the limits of the August 2017 TSE, a public outreach opportunity

Volunteer observers invited to time the March 20, 2014 Occultation of Regulus http://occultations.org/regulus2014/



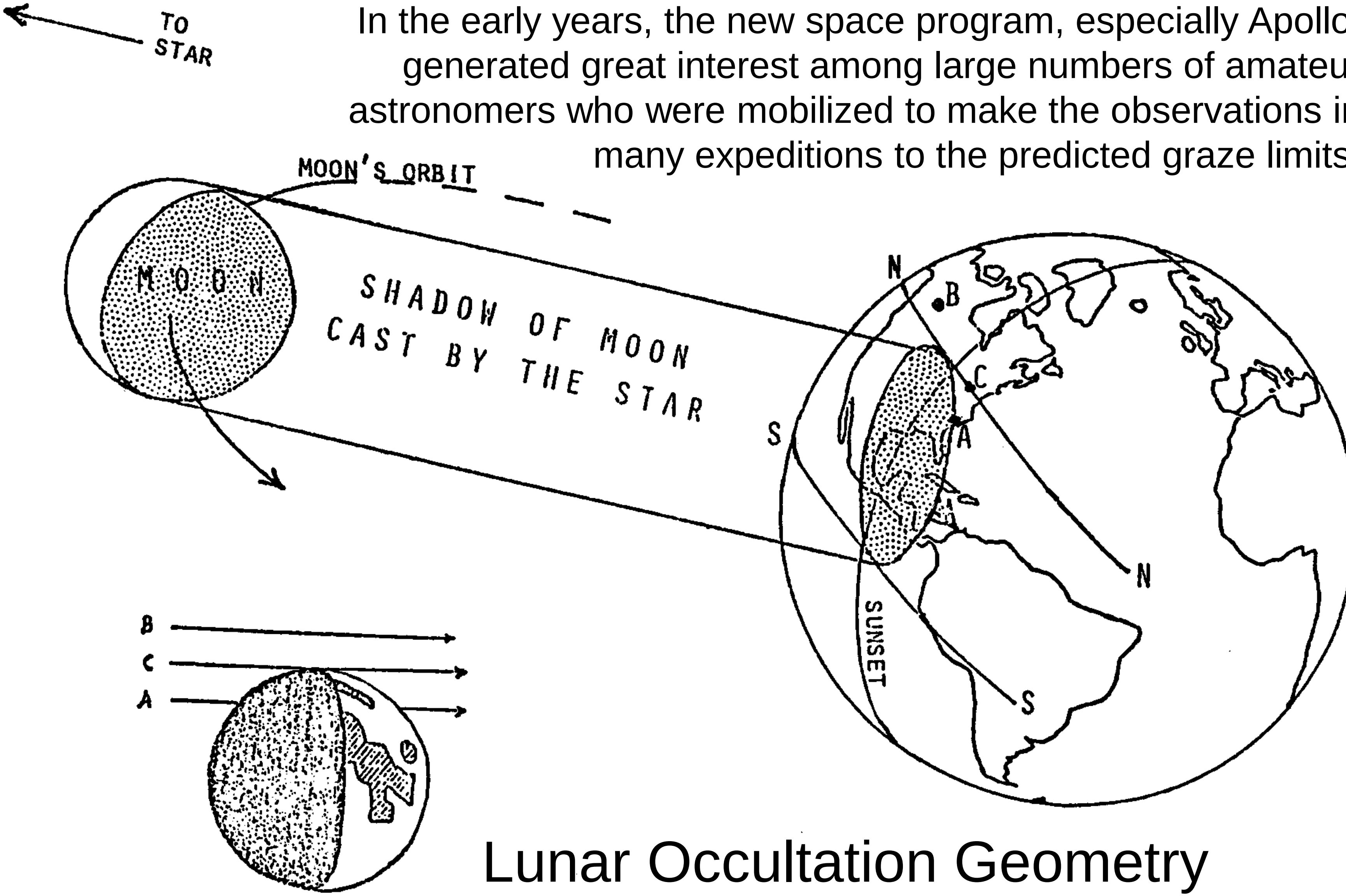
People were encouraged to observe using DSLR cameras, or visual timings using a new “Occultation 1.0” Android timing app (derived from an app that was developed for the transit of Venus in 2012; besides timing, it gets the observer’s position and automatically reports the observation).

Summary of Remaining Work

- Search publications and local university archives for past observations to analyze
- Work remains to be done, for example, on the rather well-observed US eclipses of 1806 and 1869
- The Internet facilitates connection with local historians who can often find information about past observations.
- Google Earth and other GIS tools make position determination much easier than using topo maps
- Re-analyze all obs. with accurate profile data- eg, LRO
- New observations with previous and modern techniques, especially at the 2017 eclipse, are needed to calibrate the earlier observations
- Anyone near a university or a central eclipse path, or even with just internet access, can help

IOTA's work initially concentrated on the prediction, observation, and analysis of lunar grazing occultations, 1962 - 1980

In the early years, the new space program, especially Apollo, generated great interest among large numbers of amateur astronomers who were mobilized to make the observations in many expeditions to the predicted graze limits.

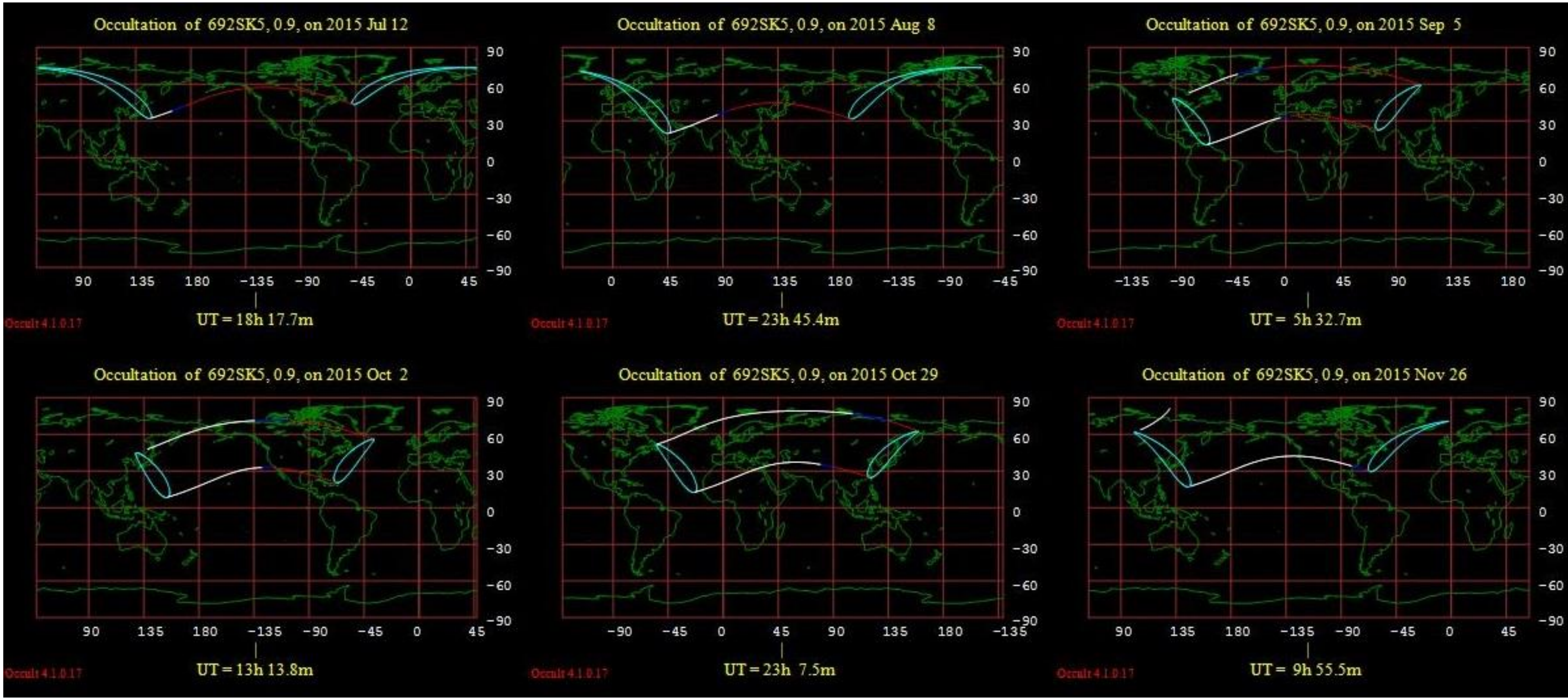


Lunar Occultation Geometry

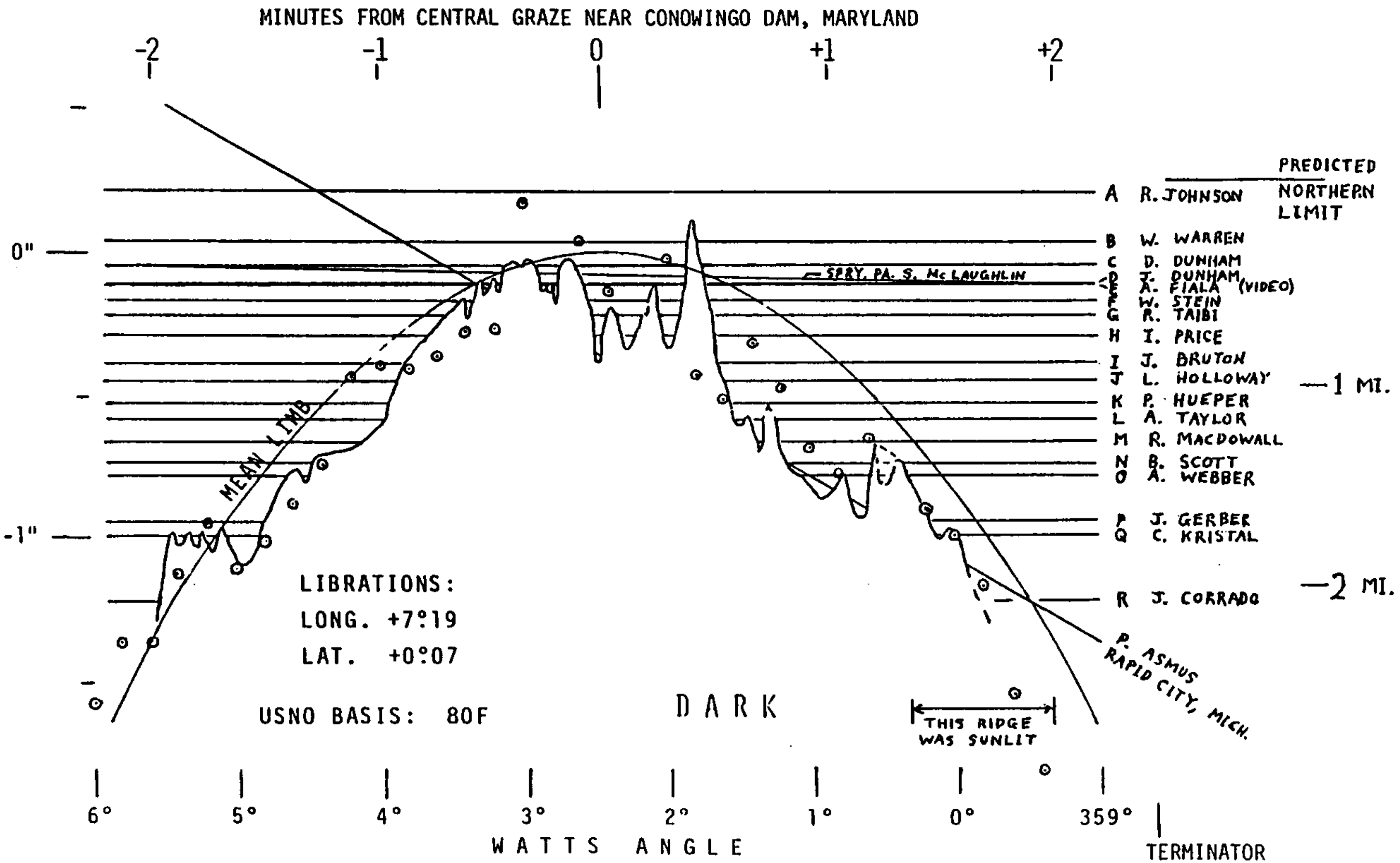
Video of 1990 April Aldebaran Grazing Occultation from Poland

A series of Aldebaran occultations will occur 2015 – 2017
(some will provide public outreach opportunities)

Some 2015-16 Aldebaran Occultations

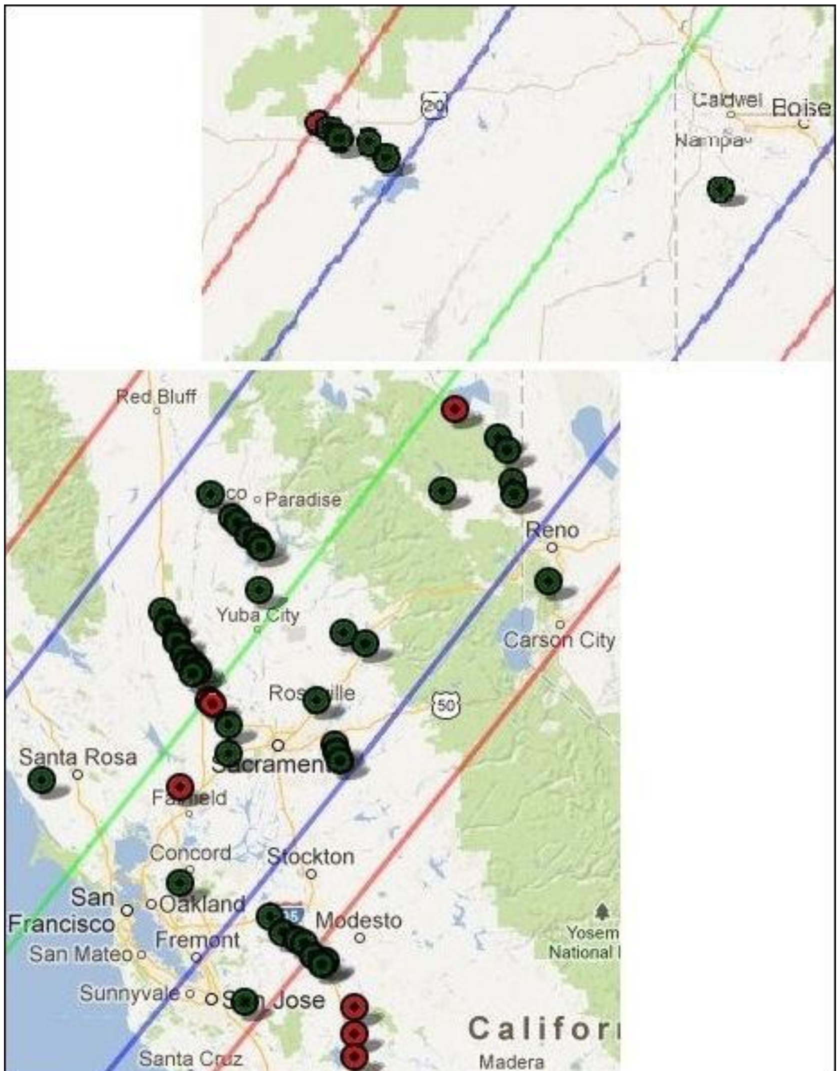


Lunar Profile from Graze of delta Cancri – May 9-10, 1981



The observations were mainly used for lunar profile and astrometric purposes, before better space-based Kaguya (2002) and HIPPARCOS (1997) data became available. Now, the main value is for resolving and measuring close double stars.

Occultation of LQ Aquarii by binary asteroid (90) Antiope, 2011 July 19

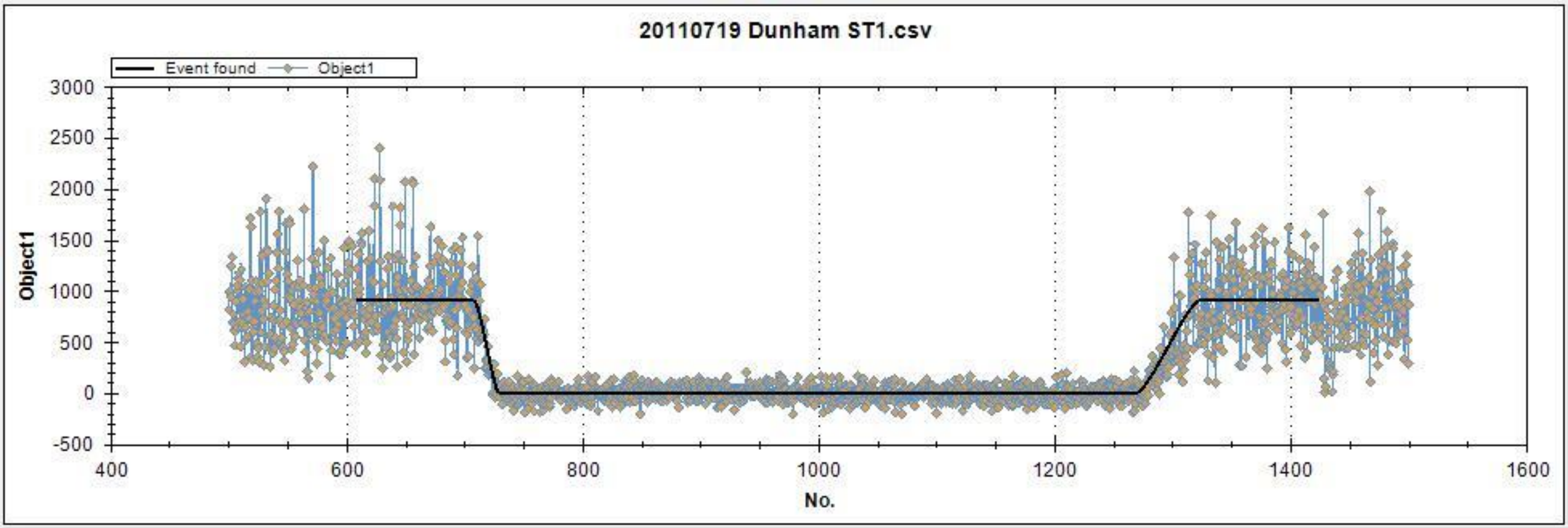


IOTA's emphasis shifted to asteroidal occultations around 1980.
IOTA's membership has decreased since the early years of mainly visual observation. Besides the general "graying" of amateur astronomy, many amateurs are reluctant to obtain the specialized video equipment that is advantageous for the asteroidal events. Nevertheless, impressive observations are being obtained by fewer observers, several now deploying <u>multiple</u> video stations at locations across the predicted paths using "Occult Watcher" software that allows planning to prevent duplicate chords.


Multi-Station Occultation
Observing with Galileo Sized
Optical Systems
Scott Degenhardt, IOTA
Galileo's Legacy 2009
Waianae, Hawaii

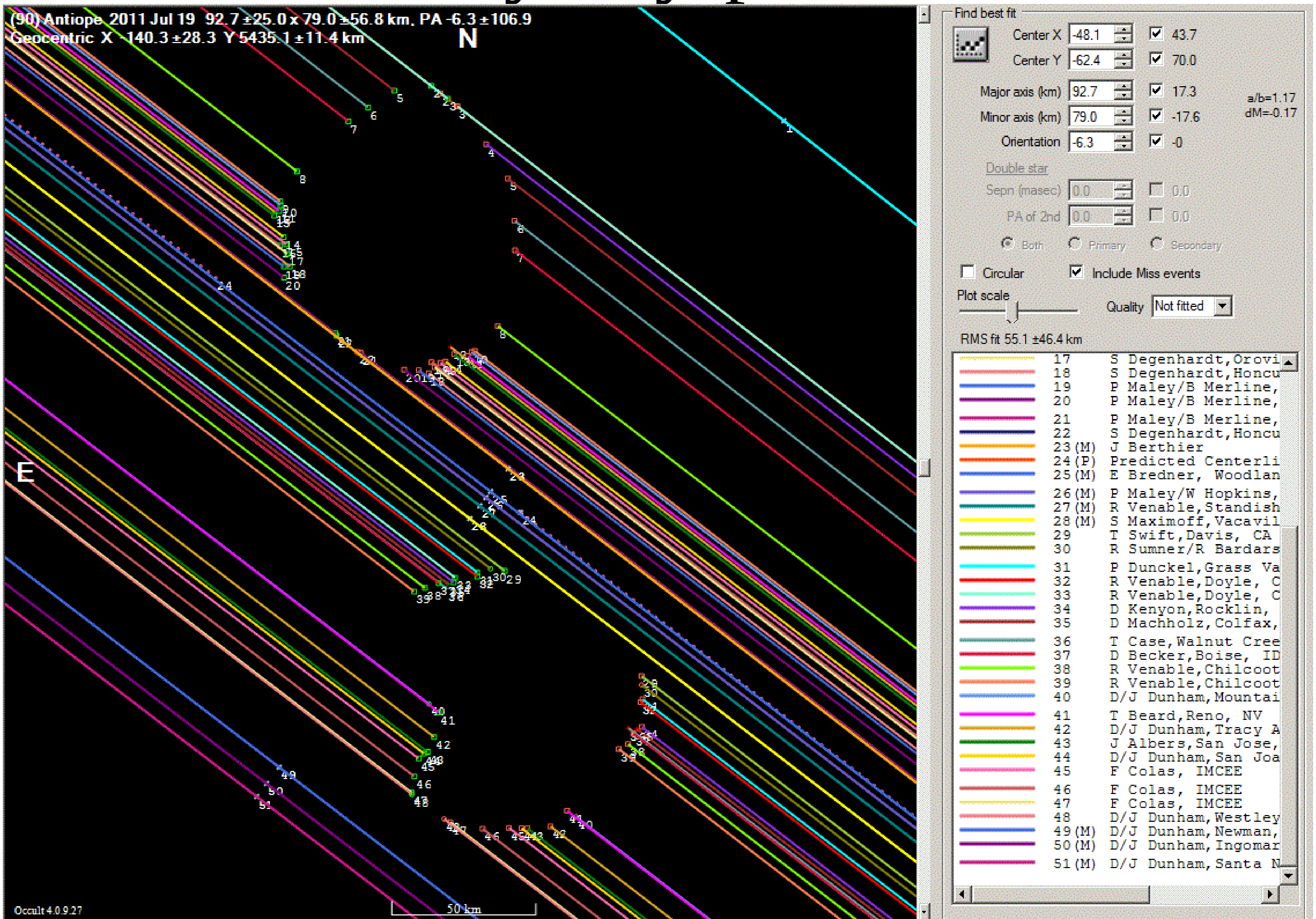
Setting up a “mighty mini” (using 50mm binocular optics) at my station #5 in Newman, Calif., for the 2011 Antiope occultation

Light curve of the occultation at Dunham Station #1 west of Tracy, Calif.



The angular diameter of the red giant star caused the disappearance and reappearance to be gradual over several tenths of a second, with different durations at the two events due to different slopes of the asteroid’s surface

Preliminary Sky-plane Profile



RECON
Research and Education Cooperative Occultation Network

Marc Buie, Southwest Research Institute
John Keller, Cal Poly

http://tnoRECON.net/

Community Observation Teams

- Take responsibility for 11-inch telescope and camera over duration of project
- Send one representative to 4-5 day weekend training session, Reno – March, 2013
- Participate in coordinated observations
  - 4 observations between April-September 2013
  - 6 observations between October 2013 – August 2014
- Download and transfer data files from observations to SwRI for analysis
- Discuss, inform, and/or involve additional members of their community in this citizen science research effort

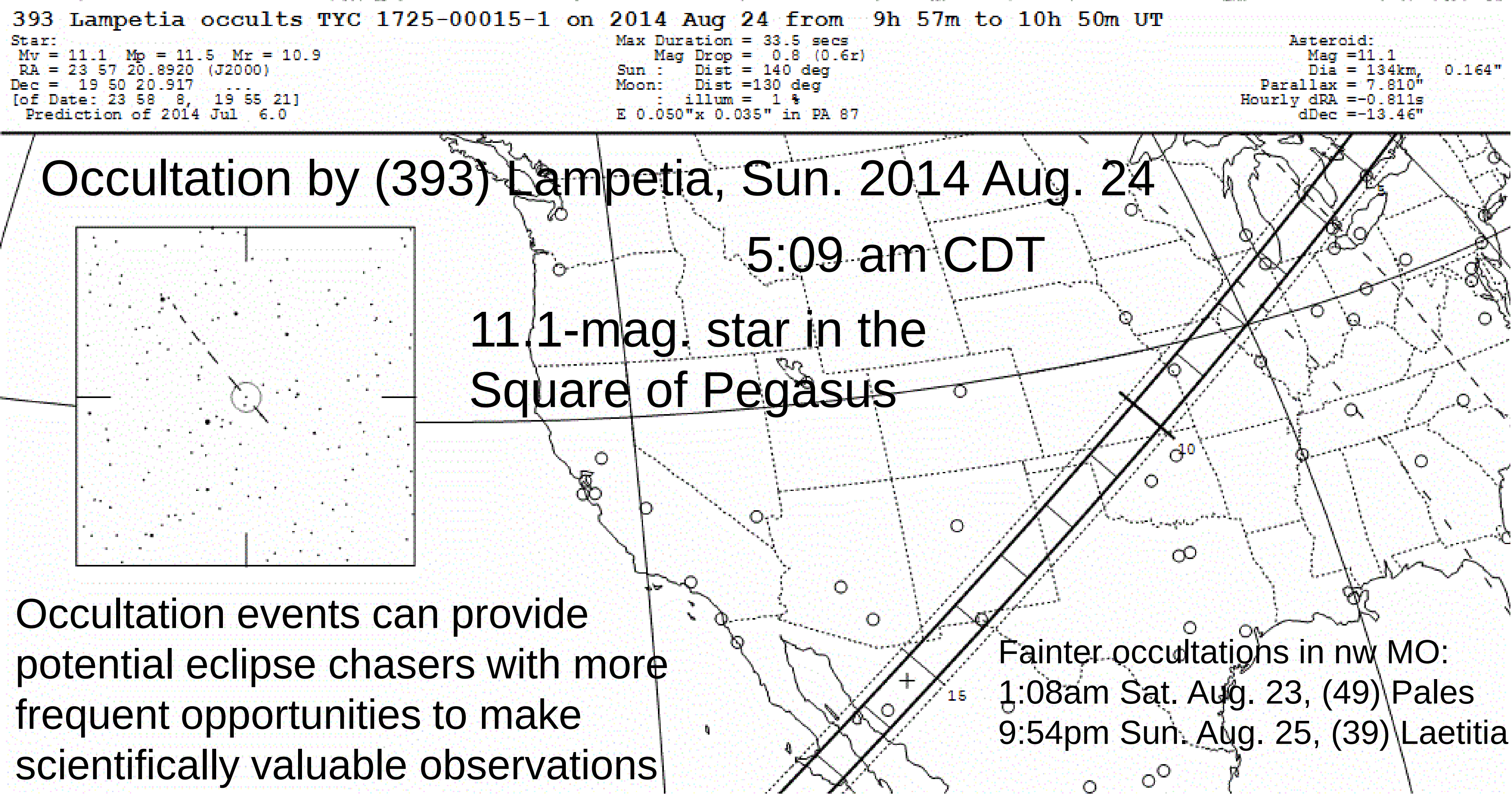
Tonopah, Nevada

Ted Sauvagean
Christie Eason
Teralyn Balckburn
Clair Blackburn
Marc Buie

Full Network

- Notional sites targeted
- Good spacing in most locations
- Red curve shows track from a 100 km object
- Gray curve shows track from a 500 km object

NSF recently funded RECON to expand to this full border-to-border network, including across the 2017 eclipse path



Occultation by (393) Lampetia, Sun. 2014 Aug. 24

5:09 am CDT

11.1-mag. star in the Square of Pegasus

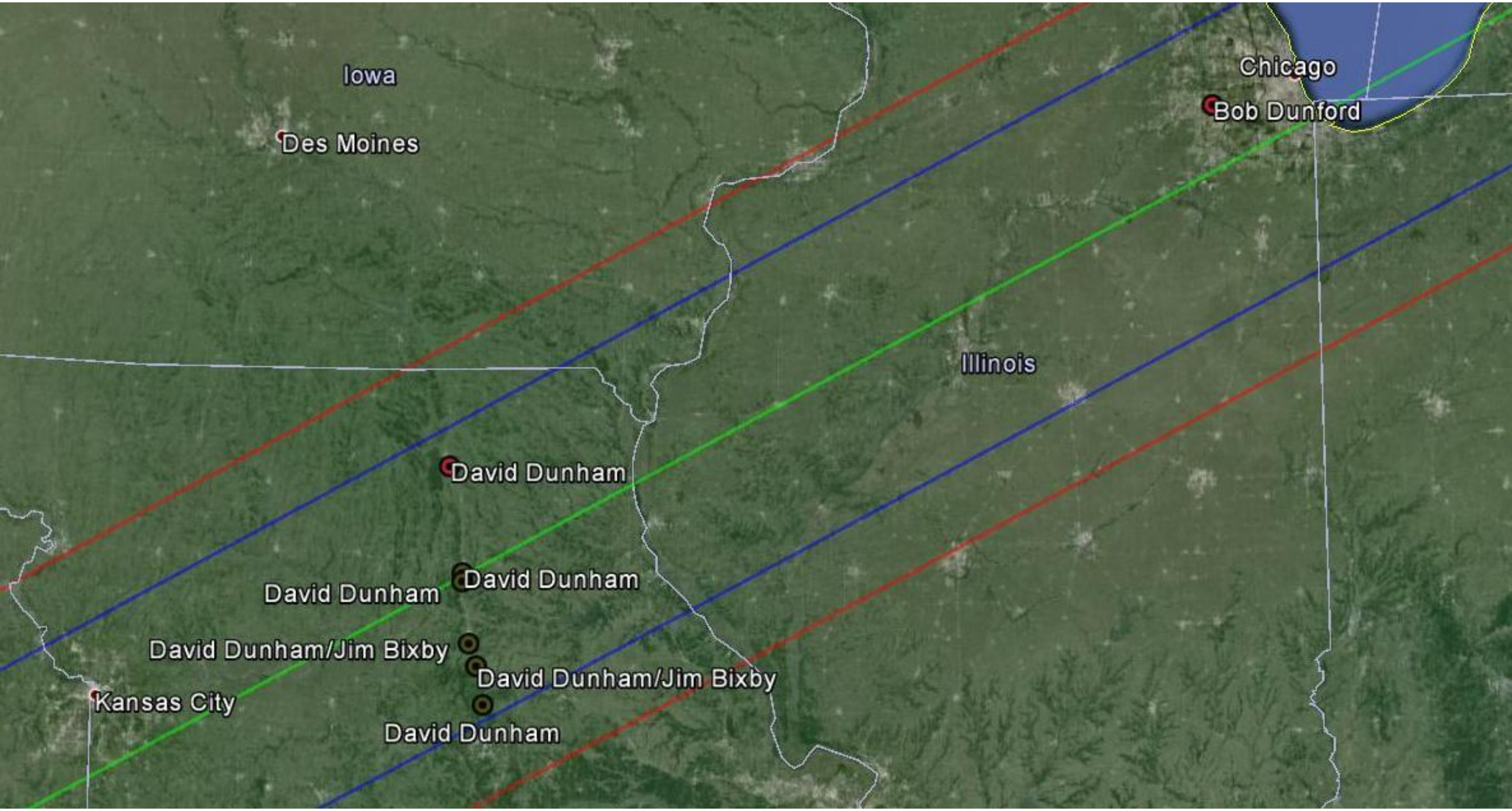
Occultation events can provide potential eclipse chasers with more frequent opportunities to make scientifically valuable observations

Fainter occultations in nw MO:
1:08am Sat. Aug. 23, (49) Pales
9:54pm Sun. Aug. 25, (39) Laetitia

while teaching the discipline that is needed for time-critical events like solar eclipses. One such opportunity will occur at 5:09 am Sunday morning with the asteroid 393 Lampetia (see above and http://www.asteroidoccultation.com & scroll to Aug. 24); Columbia is just south of the predicted southern limit, but with path uncertainties, an event could occur here. I brought equipment to run up to 8 remote video stations in the path north of Columbia, weather permitting.

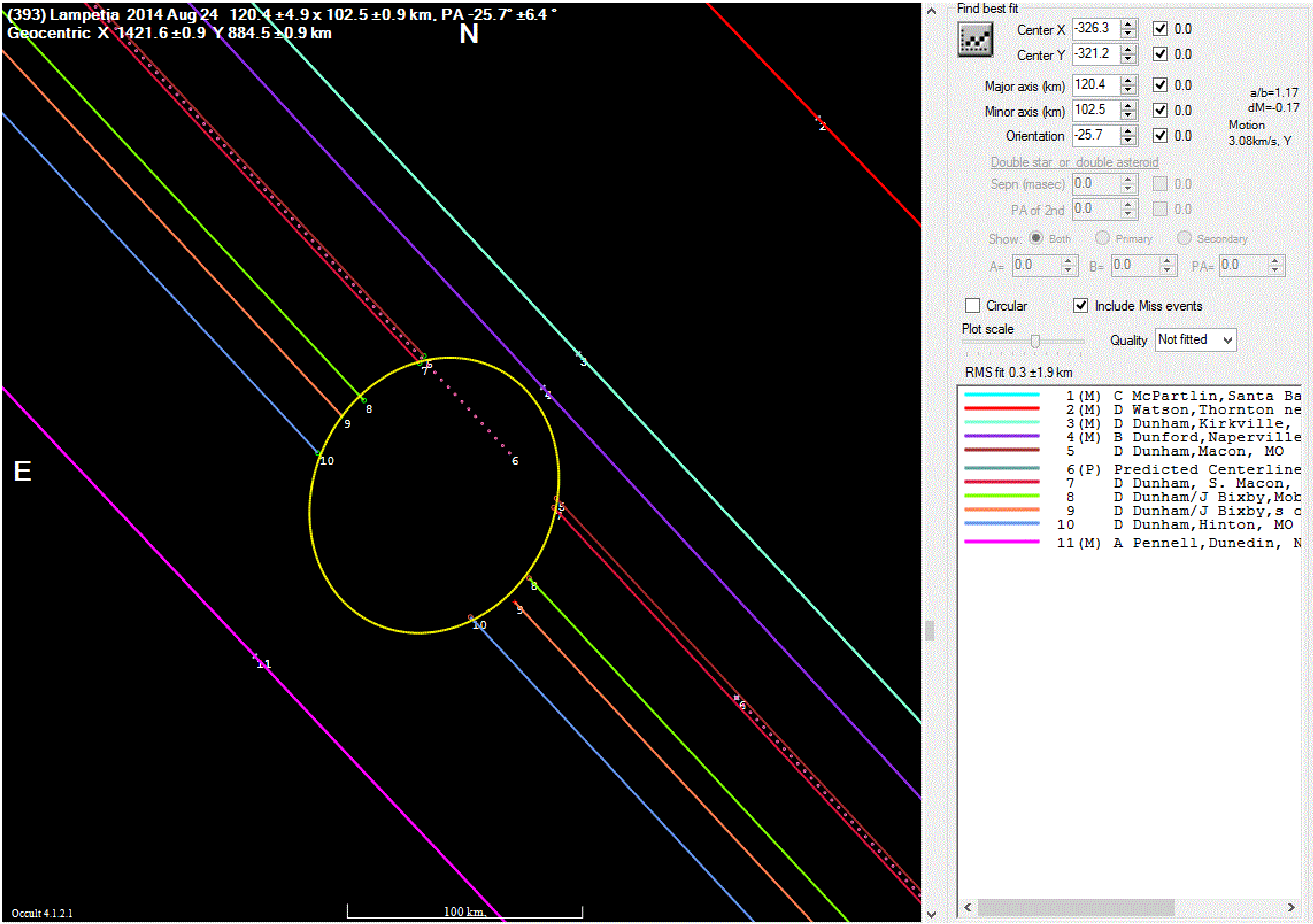
Some of the telescopes that we brought to MO

All Midwestern stations for the2014 Aug. 24th Lampetia occultation



Predicted lines: Green, center; Blue, limits; Red, 1-sigma limits.
Green dots, my 5 positive observations; red dots, negatives

2014 August 24th Lampetia Occultation Sky-plane Plot

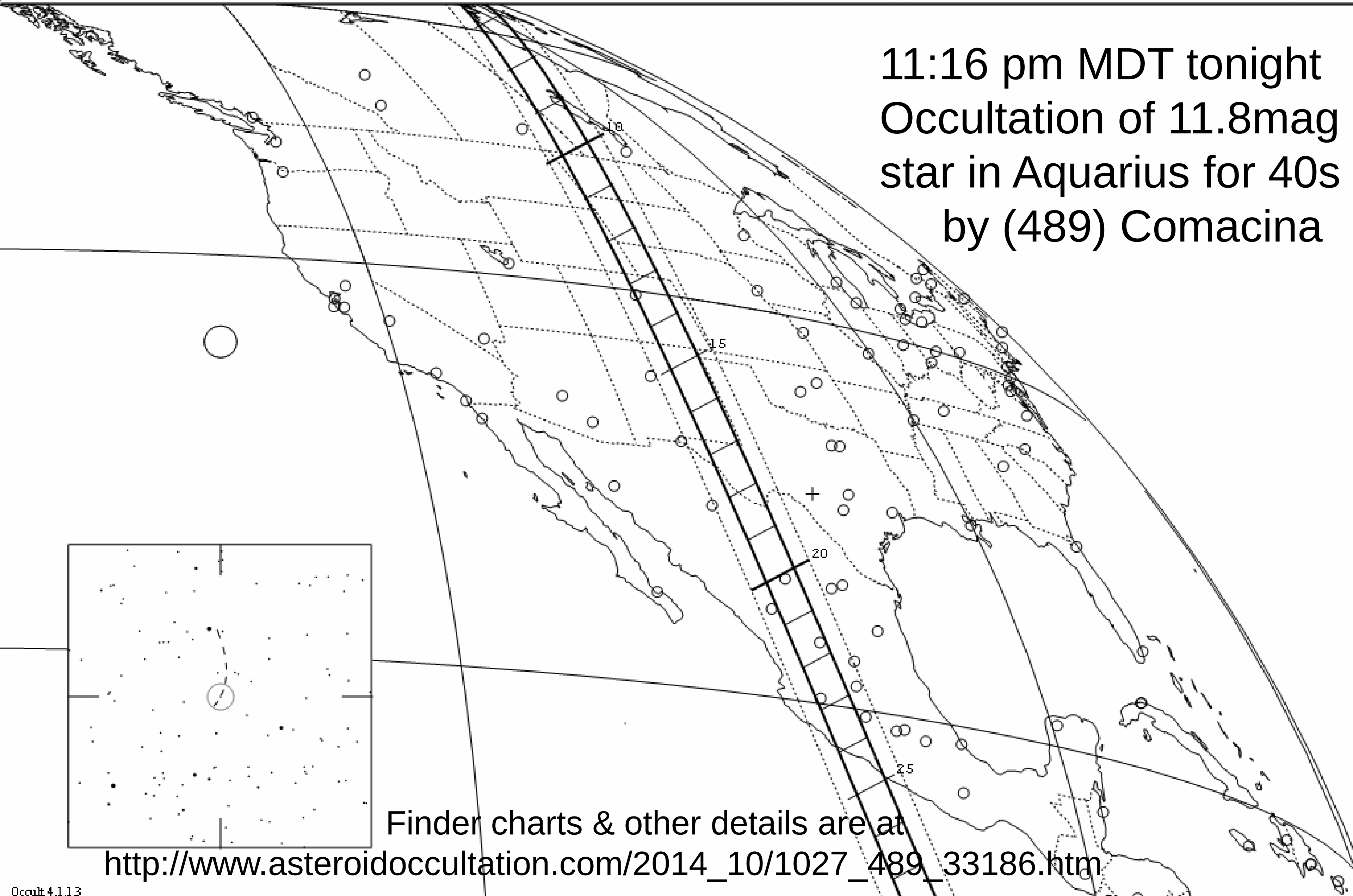


489 Comacina occults TYC 5807-00670-1 on 2014 Oct 27 from 5h 6m to 5h 50m UT

Star:
Mv = 11.8 Mp = 12.5 Mr = 11.4
RA = 22 23 49.2180 (J2000)
Dec = -10 38 38.520 ...
[of Date: 22 24 37, -10 33 59]
Prediction of 2014 Oct 5.0

Max Duration = 39.5 secs
Mag Drop = 2.2 (2.2r)
Sun : Dist = 120 deg
Moon: Dist = 80 deg
: illum = 12 %
E 0.035"x 0.034" in PA 89

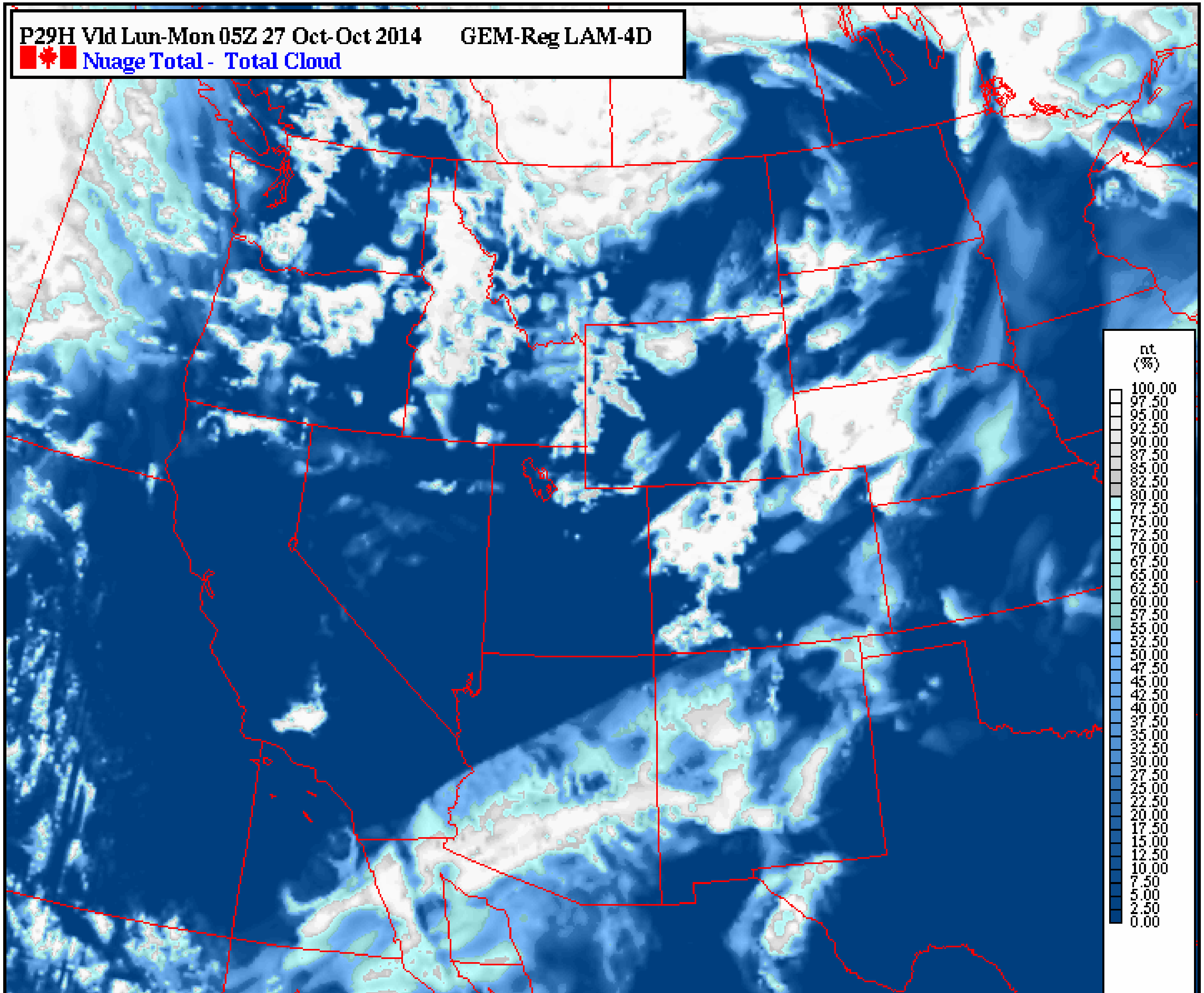
Asteroid:
Mag =13.9
Dia = 135km, 0.070"
Parallax = 3.288"
Hourly dRA = 0.203s
dDec = -5.57"



11:16 pm MDT tonight
Occultation of 11.8mag star in Aquarius for 40s by (489) Comacina

Finder charts & other details are at
http://www.asteroidoccultation.com/2014_10/1027_489_33186.htm

Weather forecast for Comacina Occ'n

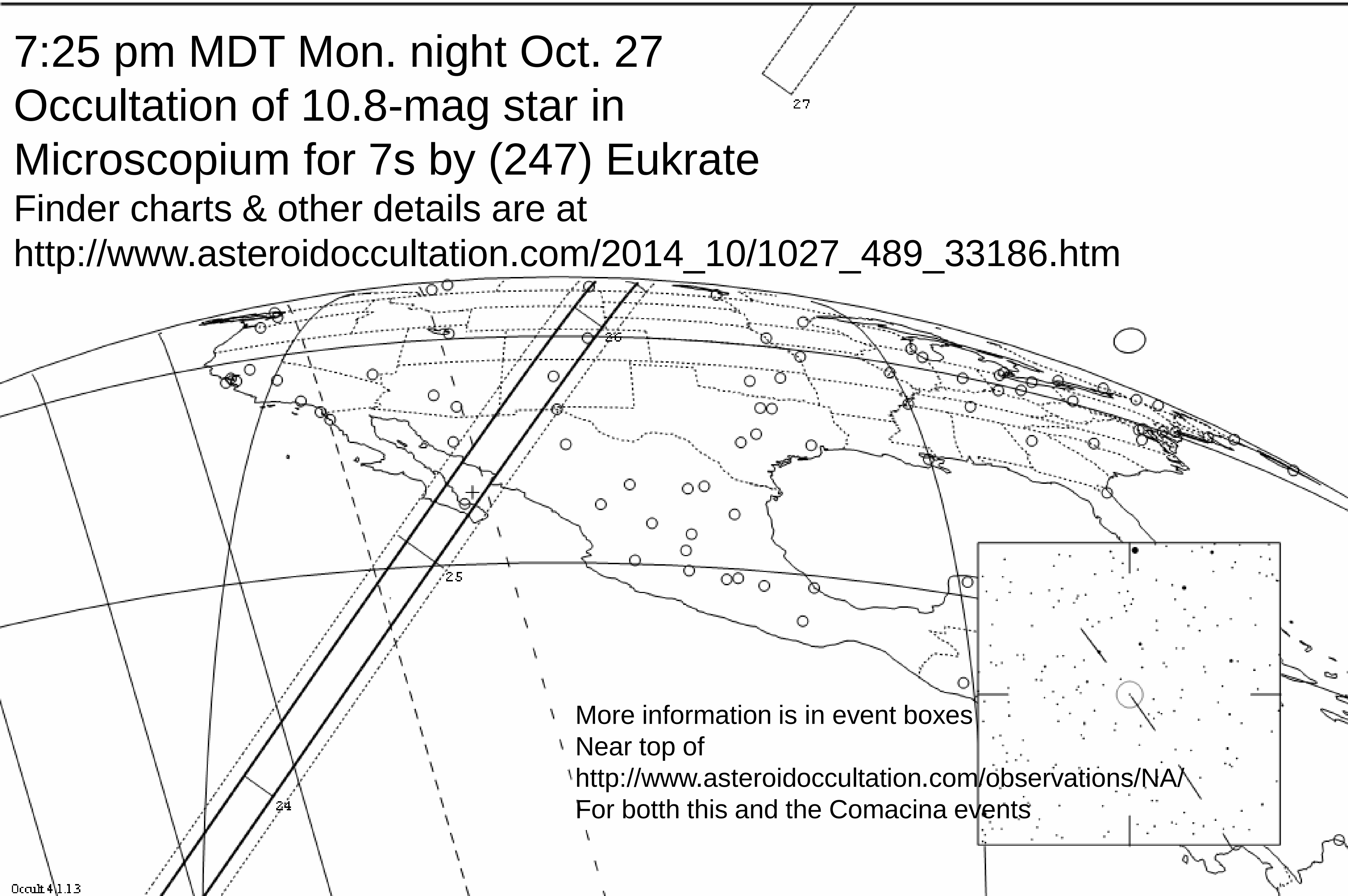


247 Eukrate occults TYC 7464-00898-1 on 2014 Oct 28 from 1h 17m to 1h 26m UT

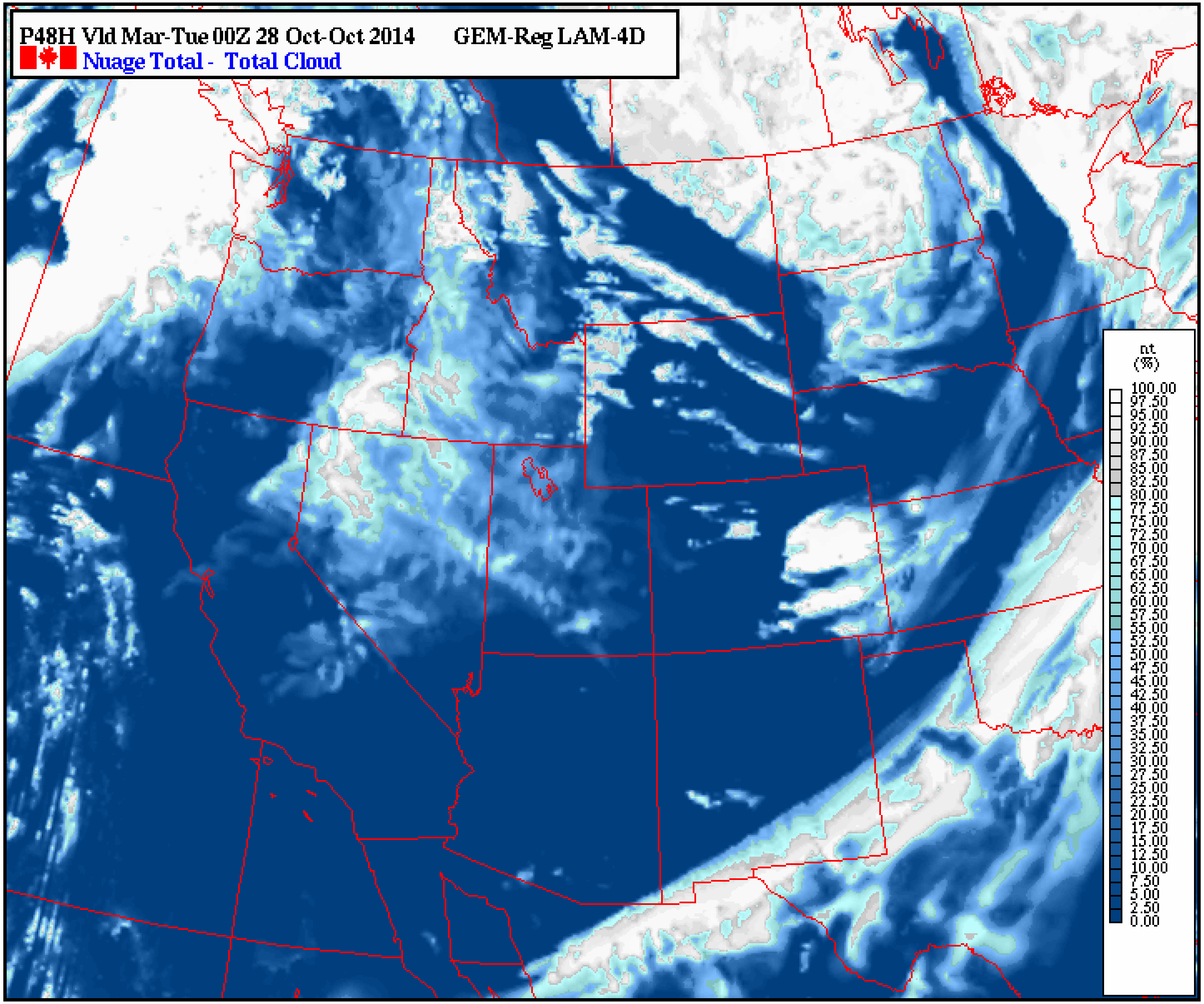
Star:		Asteroid:
Mv = 10.8 Mp = 12.0 Mr = 10.2	Max Duration = 7.4 secs	
RA = 20 40 29.9233 (J2000)	Mag Drop = 2.4 (2.6r)	Mag =13.1
Dec = -34 22 59.093 ...	Sun : Dist = 89 deg	Dia = 150km, 0.086"
[of Date: 20 41 26, -34 19 45]	Moon: Dist = 43 deg	Parallax = 3.657"
Prediction of 2014 Oct 5.0	: illum = 18 %	Hourly dRA = 1.962s
	E 0.038"x 0.029" in PA 80	dDec = 33.81"

7:25 pm MDT Mon. night Oct. 27
Occultation of 10.8-mag star in Microscopium for 7s by (247) Eukrate

Finder charts & other details are at
http://www.asteroidoccultation.com/2014_10/1027_489_33186.htm



Weather forecast for Eukrate Occ'n

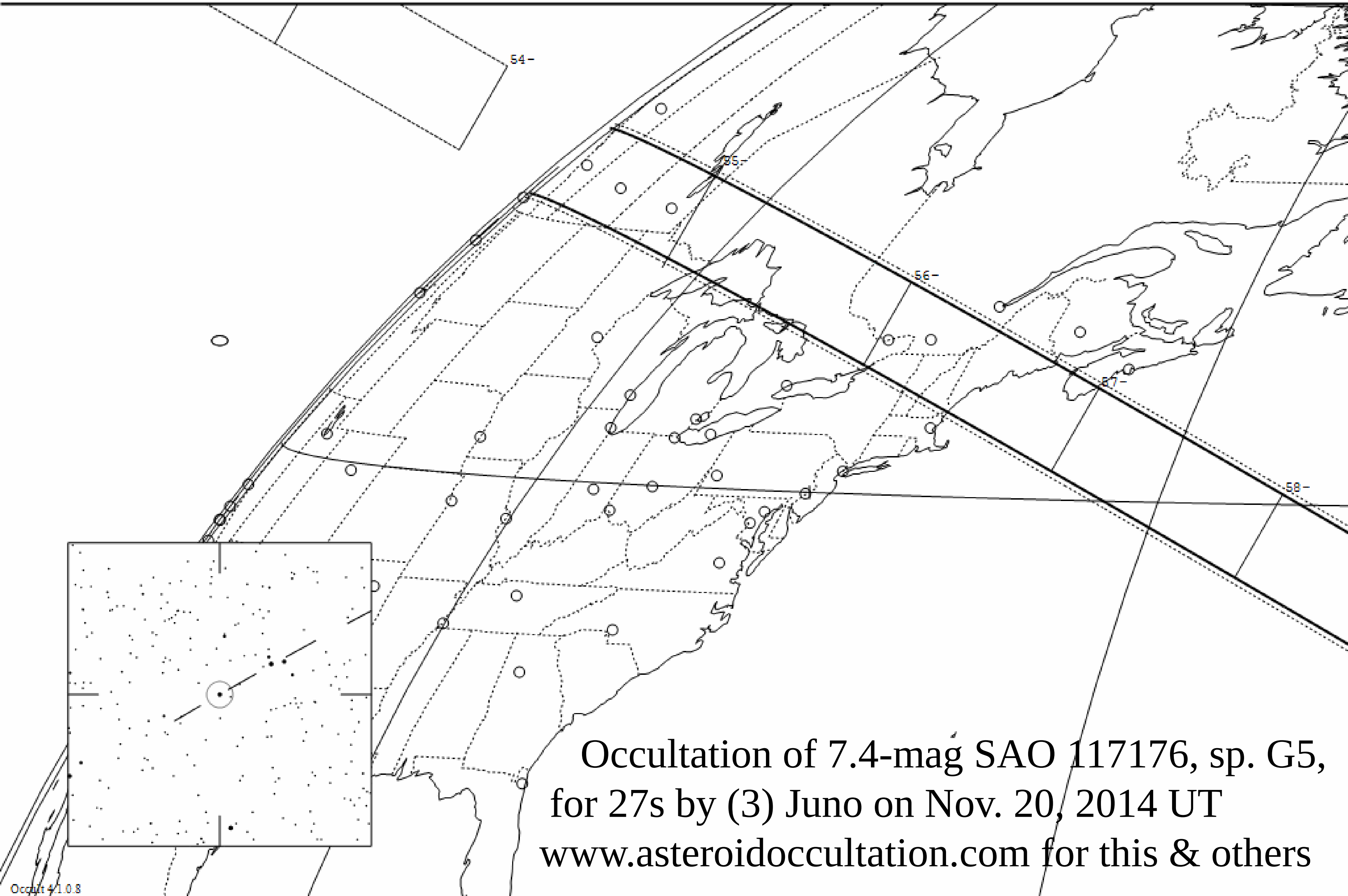


3 Juno occults HIP 43357 on 2014 Nov 20 from 6h 54m to 7h 13m UT

Star:
Mv = 7.4 Mp = 8.2 Mr = 7.0
RA = 8 49 54.3268 (J2000)
Dec = 2 21 44.317 ...
[of Date: 8 50 41, 2 18 18]
Prediction of 2013 May 10.0

Max Duration = 27.2 secs
Mag Drop = 1.9 (1.9r)
Sun : Dist = 103 deg
Moon: Dist = 77 deg
: illum = 5 %
E 0.020"x 0.012" in PA 90

Asteroid: (in ISAM)
Mag = 9.1
Dia = 290km, 0.238"
Parallax = 5.231"
Hourly dRA = 1.817s
dDec =-15.73"



Occultation of 7.4-mag SAO 117176, sp. G5,
for 27s by (3) Juno on Nov. 20, 2014 UT
www.asteroidoccultation.com for this & others

35 Leukothea occults TYC 2443-00047-1 on 2014 Dec 13 from 11h 14m to 11h 31m UT

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Star:                                           Max Duration =   8.9 secs                Asteroid:
 Mv =   9.3  Mp =  9.3  Mr =  9.3                  Mag Drop =   3.9 (3.5r)                 Mag =13.2
 RA =   6 43 34.6050 (J2000)                   Sun :    Dist = 159 deg                      Dia = 112km,   0.071"
Dec =  34 18 41.883    ...                     Moon:    Dist = 62 deg                   Parallax = 4.023"
[of Date:  6 44 36,   34 17 32]                    :  illum = 60 %                  Hourly dRA =-2.265s
  Prediction of 2013 Apr 20.0                  E 0.031"x 0.030" in PA 94                   dDec =  5.16"
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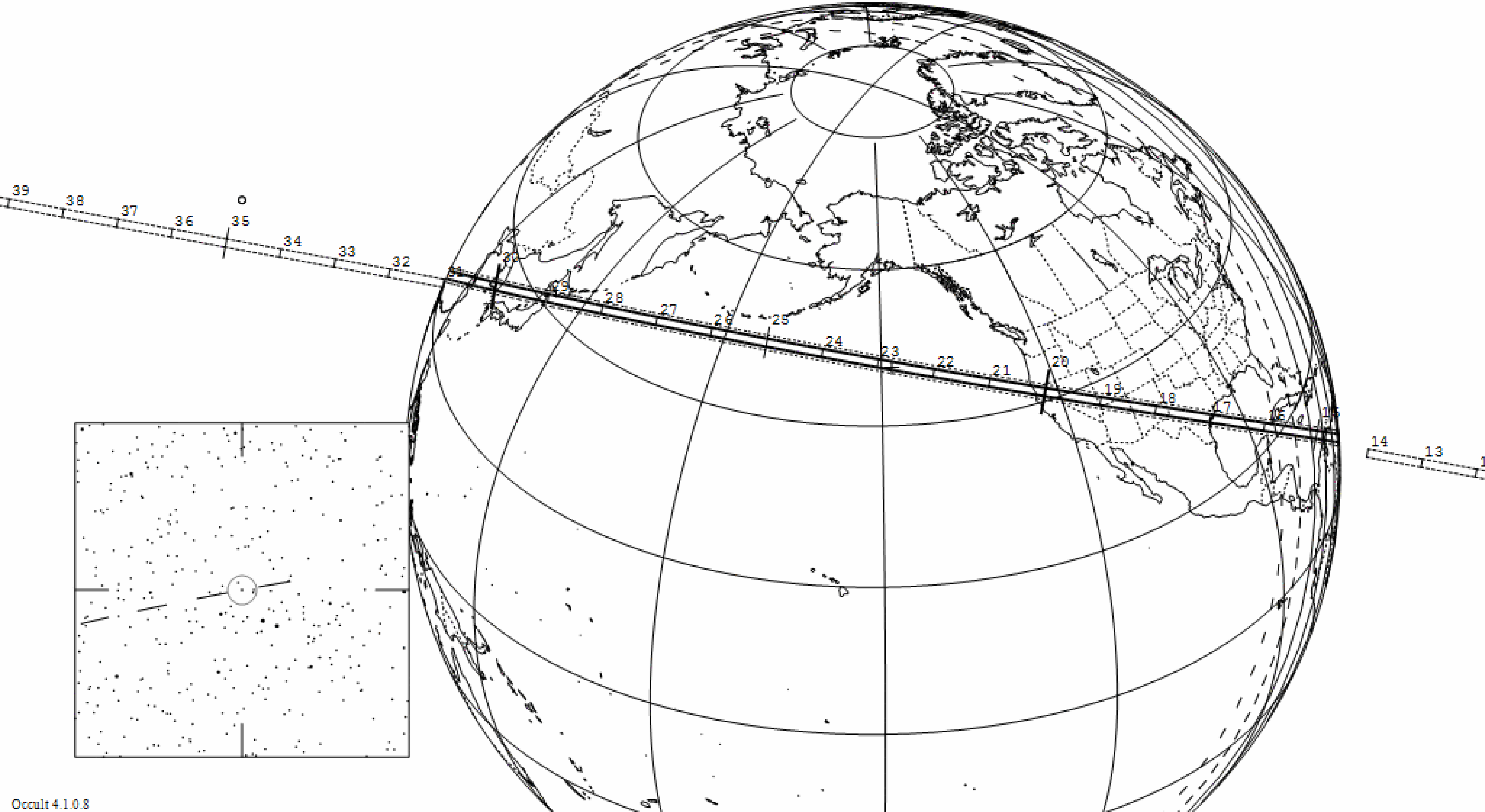
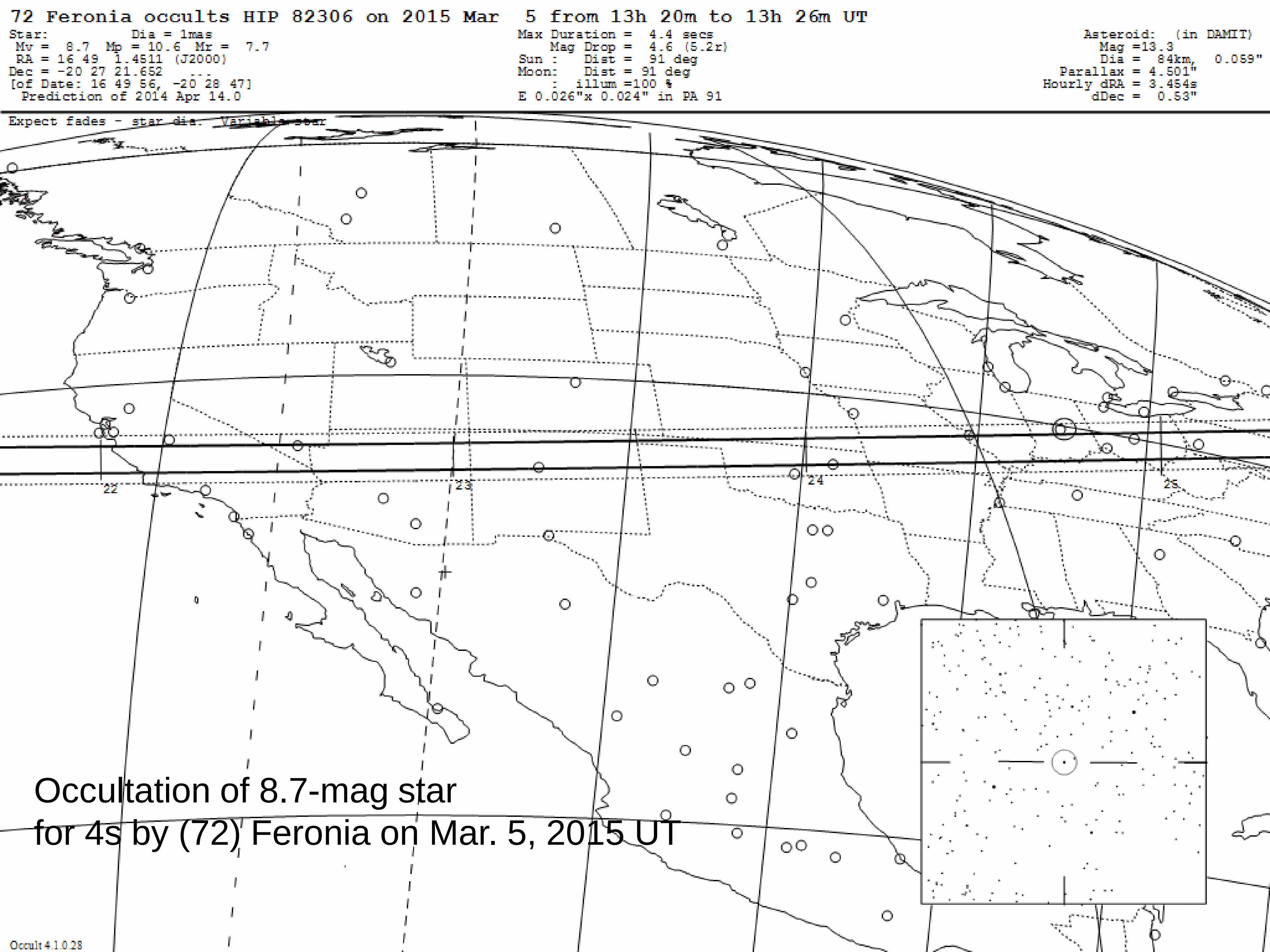
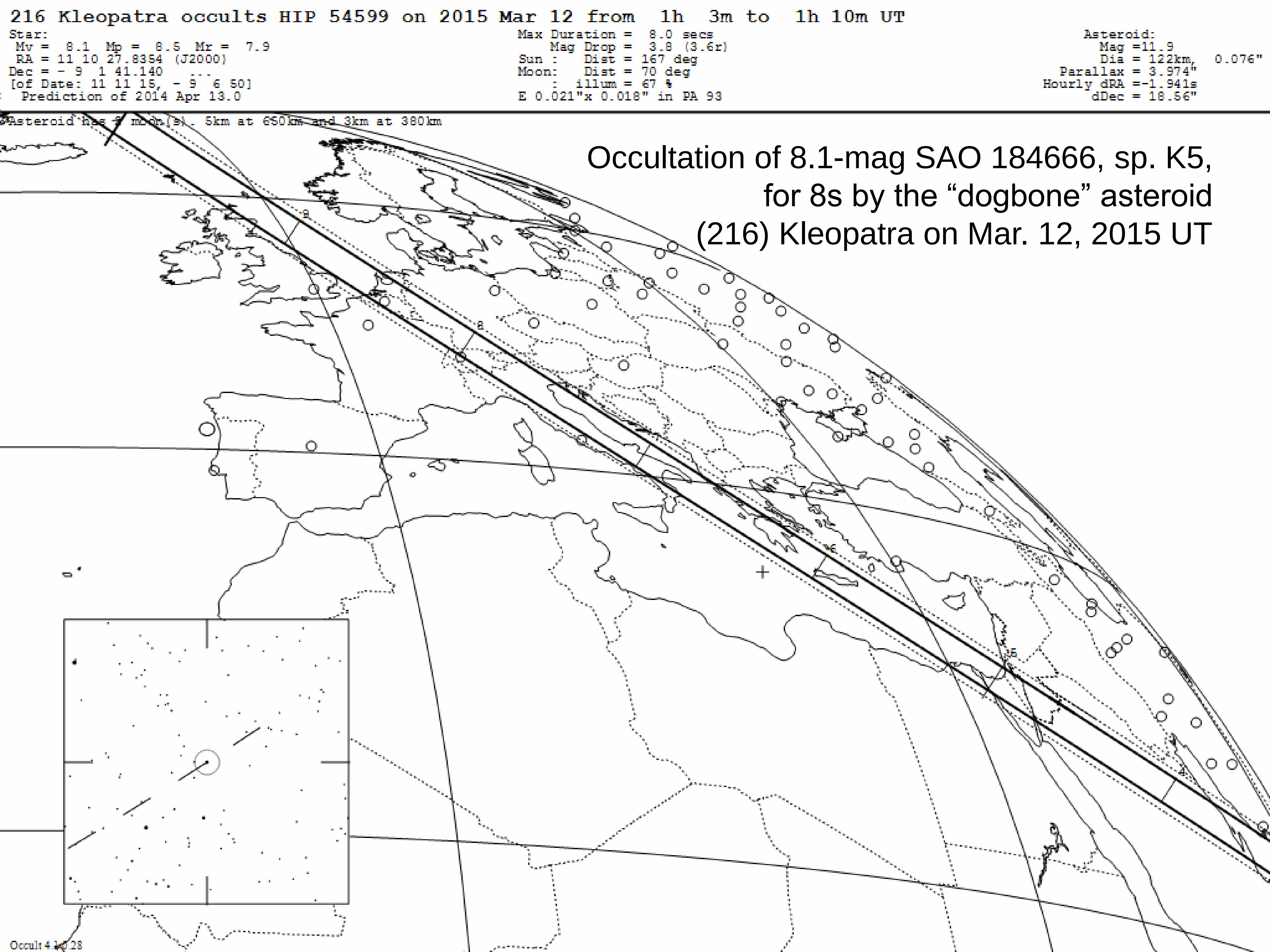
Occultation of 9.3-mag SAO 59412, sp. A5, for 9s by (35) Leukothea on Dec. 13, 2014 UT

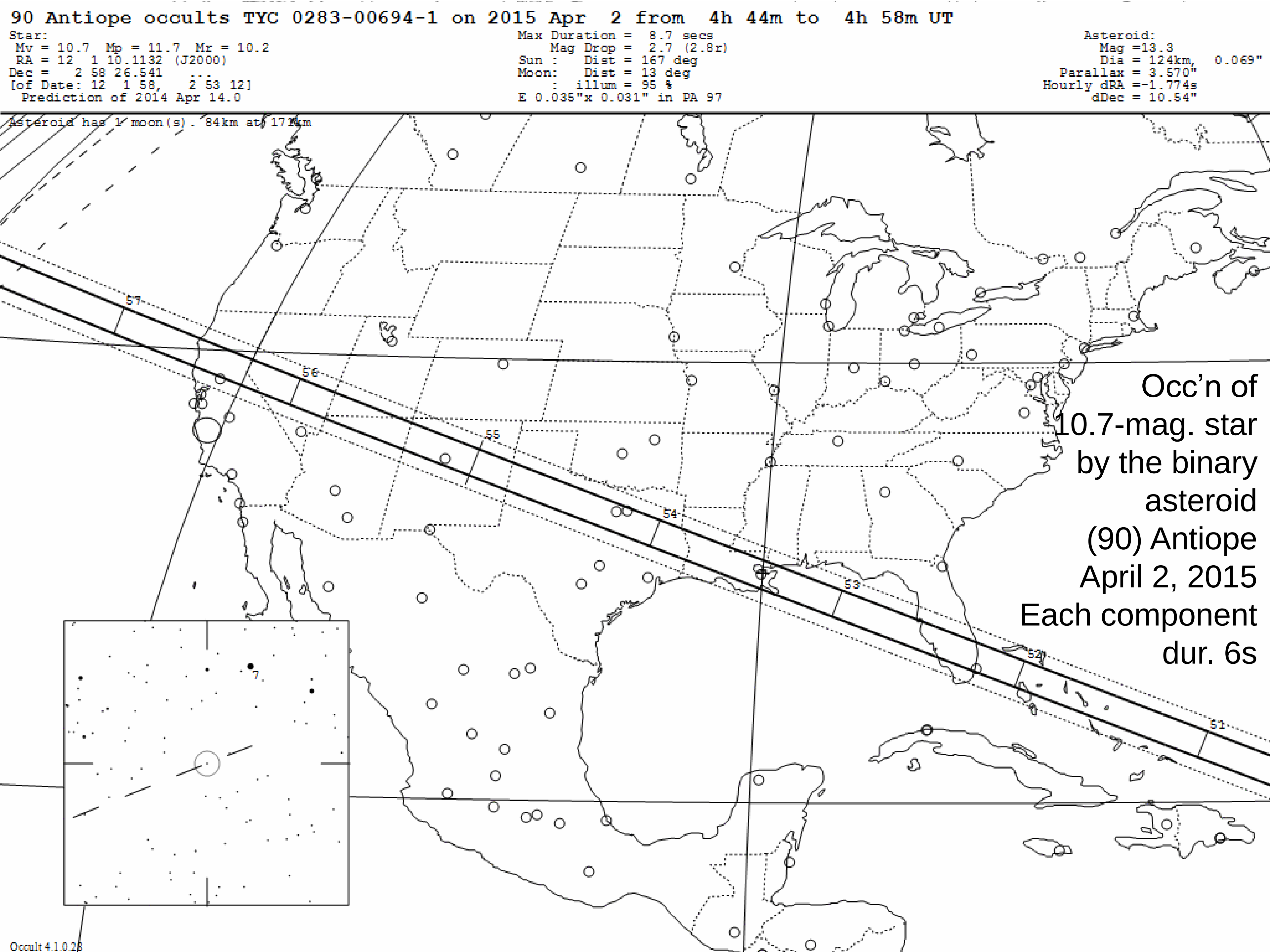


Occult 4.1.0.8



Occultation of 8.7-mag star
for 4s by (72) Feronia on Mar. 5, 2015 UT


216 Kleopatra occults HIP 54599 on 2015 Mar 12 from 1h 3m to 1h 10m UT
Star:
Mv = 8.1 Mp = 8.5 Mr = 7.9
RA = 11 10 27.8354 (J2000)
Dec = - 9 1 41.140 ...
[of Date: 11 11 15, - 9 6 50]
Prediction of 2014 Apr 13.0
Max Duration = 8.0 secs
Mag Drop = 3.8 (3.6r)
Sun : Dist = 167 deg
Moon: Dist = 70 deg
: illum = 67 %
E 0.021"x 0.018" in PA 93
Asteroid:
Mag =11.9
Dia = 122km, 0.076"
Parallax = 3.974"
Hourly dRA =-1.941s
dDec = 18.56"
5km at 650km and 3km at 380km
Occultation of 8.1-mag SAO 184666, sp. K5,
for 8s by the “dogbone” asteroid
(216) Kleopatra on Mar. 12, 2015 UT
Occult 4.1.0.28


90 Antiope occults TYC 0283-00694-1 on 2015 Apr 2 from 4h 44m to 4h 58m UT
Star:
Mv = 10.7 Mp = 11.7 Mr = 10.2
RA = 12 1 10.1132 (J2000)
Dec = 2 58 26.541 ...
[of Date: 12 1 58, 2 53 12]
Prediction of 2014 Apr 14.0
Max Duration = 8.7 secs
Mag Drop = 2.7 (2.8r)
Sun : Dist = 167 deg
Moon: Dist = 13 deg
: illum = 95 %
E 0.035"x 0.031" in PA 97
Asteroid:
Mag =13.3
Dia = 124km, 0.069"
Parallax = 3.570"
Hourly dRA =-1.774s
dDec = 10.54"
Asteroid has 1 moon(s). 84km at 171km
57
56
55
54
53
52
51
7
Occult 4.1.0.28
Occ'n of 10.7-mag. star by the binary asteroid (90) Antiope April 2, 2015 Each component dur. 6s

1669 Dagmar occults HIP 49669 on 2015 May 24 from 16h 40m to 16h 51m UT

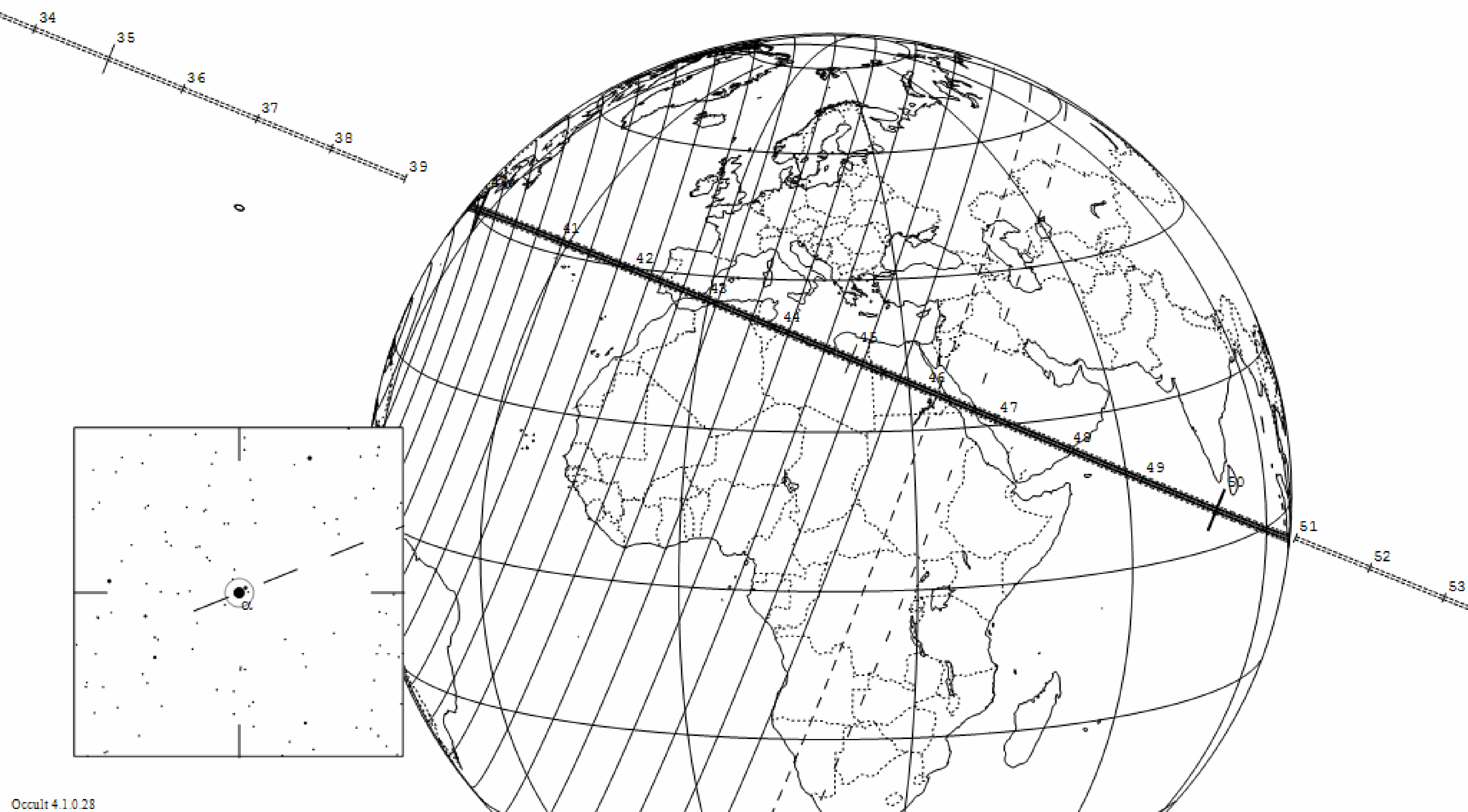
Star: Dia = 1mas
Mv = 1.4 Mp = 1.3 Mr = 1.5
RA = 10 8 22.0474 (J2000)
Dec = 11 58 2.052 ...
[of Date: 10 9 11, 11 53 25]
Prediction of 2014 Apr 10.0

Max Duration = 2.4 secs
Mag Drop = 15.0 (14.5r)
Sun : Dist = 87 deg
Moon: Dist = 9 deg
: illum = 40 %
E 0.033"x 0.017" in PA 110

Asteroid:
Mag =16.4
Dia = 43km, 0.022"
Parallax = 3.273"
Hourly dRA = 2.147s
dDec =-12.72"

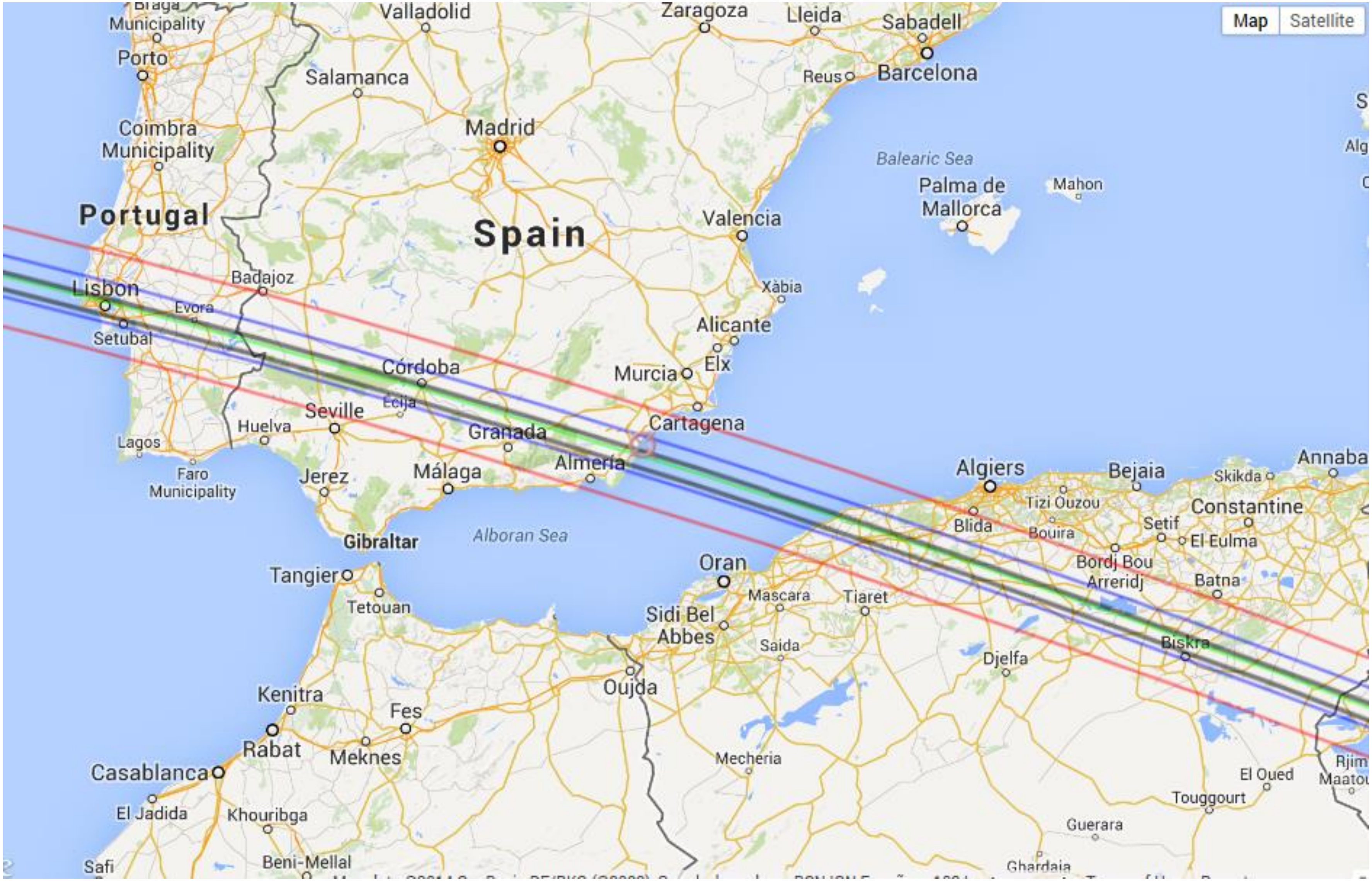
Expect fades - star dia.

Another asteroidal occultation of Regulus! By (1669) Dagmar May 24, 2015



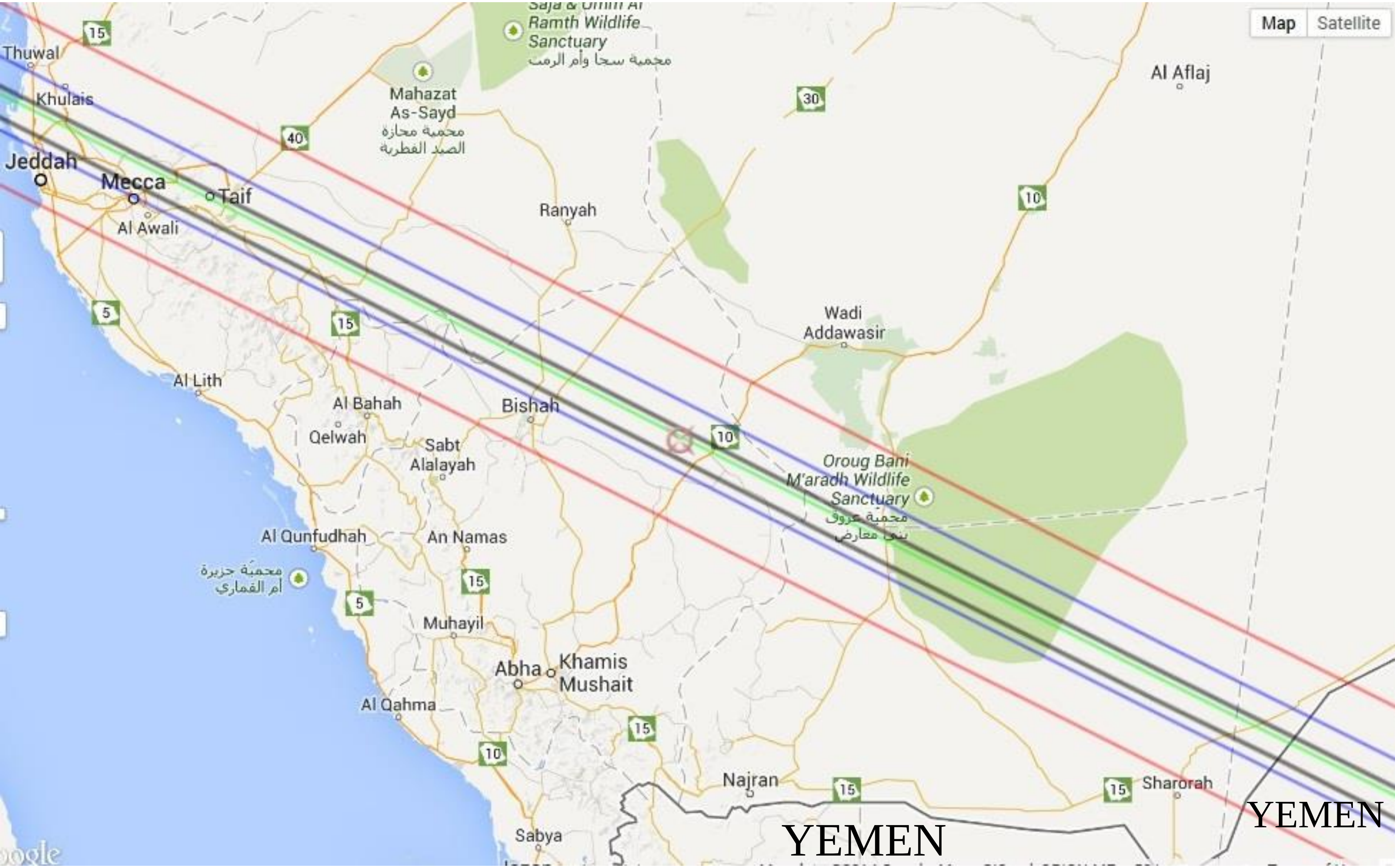
Occult 4.1.0.28

It will occur in the same parts of southern Spain and Portugal where the 2005 Rhodope Regulus Occultation occurred



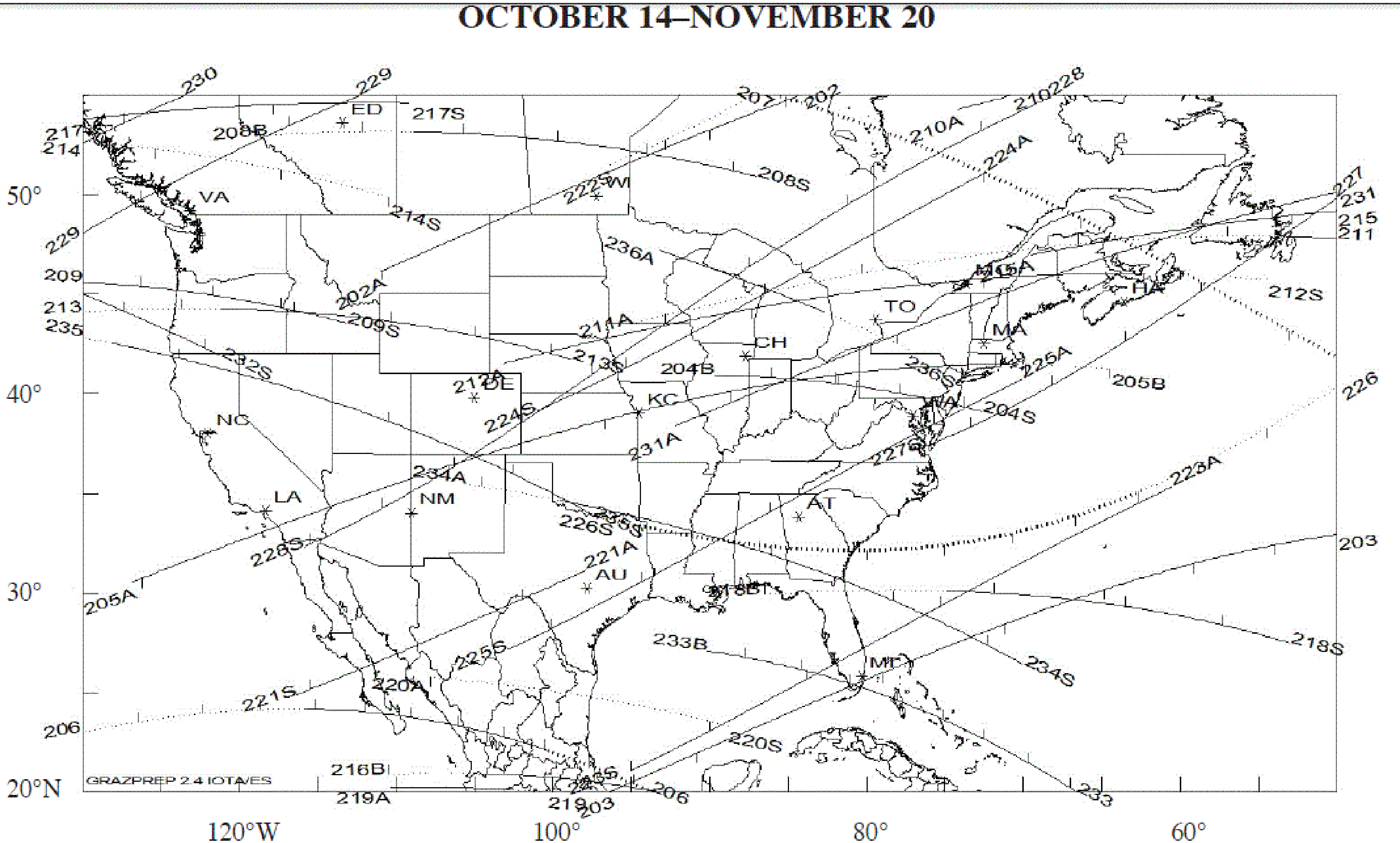
But the Sun alt. will be 31° and star alt. 53°, could pre-point in early am

The best place for this event is Saudi Arabia

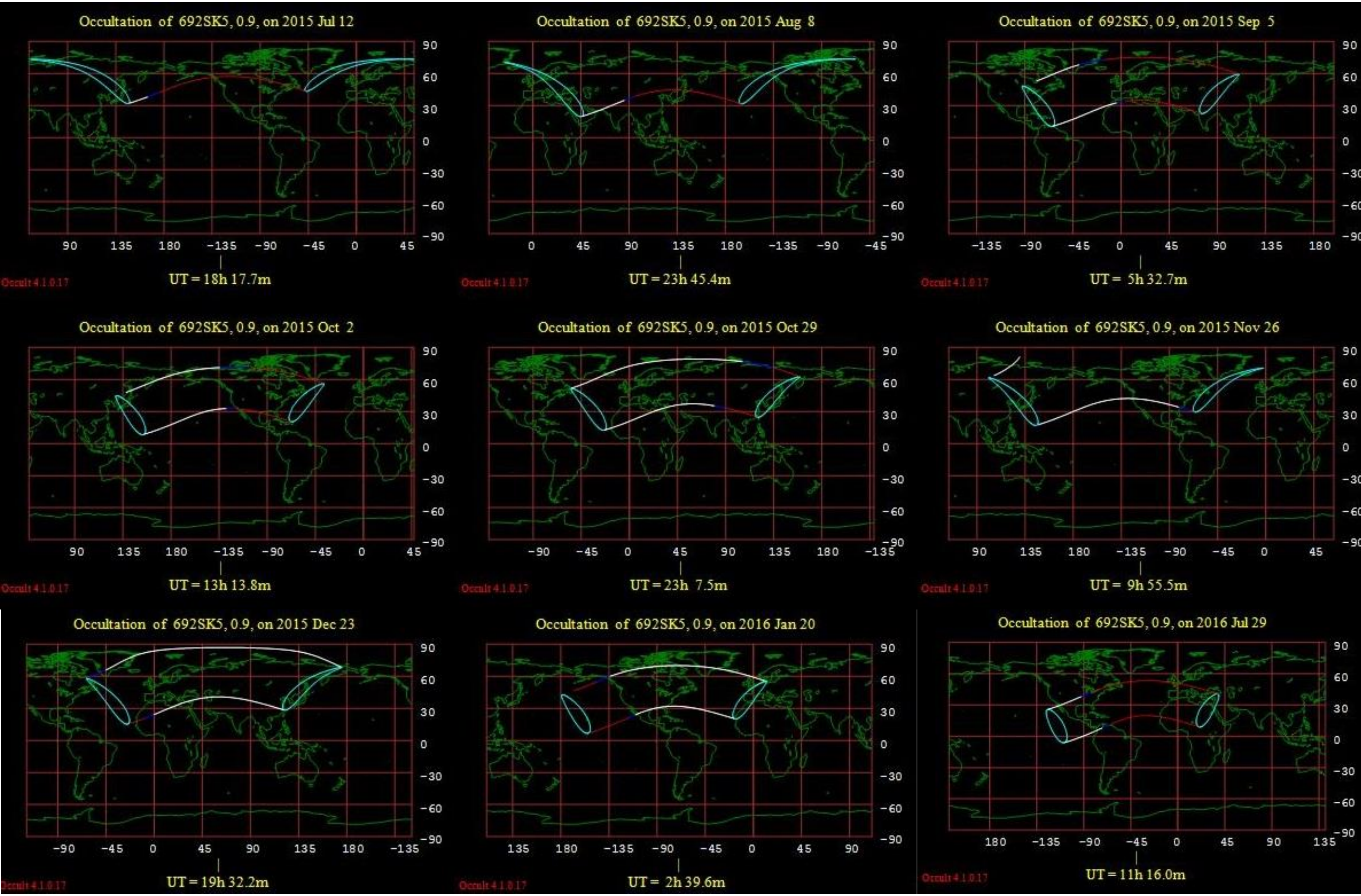


At Highway 10, the star alt. will be about 64° with Sun alt. -16°

2014 Lunar Grazing Occultation Paths to 7th Mag.



Lunar occultations of Aldebaran, 2015-2016



N. & s. limits: white, night; red, day; dark blue, twilight   Some of best ones; there are more to 2018

RASC Observer's Handbook and

http://www.occultations.org

After my talk, a video of the1994 May annular eclipse video by Ken Wilcox may be shown; it's on YouTube at https://www.youtube.com/watch?v=JIcQ0z_xQlo

This and many other eclipse and occultation YouTube videos are linked to from:

http://www.asteroidoccultation.com/observations/YouTubeVideos.htm

Listed on this web page are, in groups from top to bottom,

Lunar Occultation Videos; Asteroidal Occultation Videos; Jupiter/Saturn Satellite Events

Miscellaneous Events (most of them are solar eclipse videos made near the edges of total and annular solar eclipse paths)