Astrid Camera and other North American Occultation Developments in 2024

David Dunham, IOTA

Presented online 2024 Aug. 25

at the IOTA-East Asia Meeting

I am indebted to Bill Yeung, Mark Simpson, and Ted Blank for providing their presentations, which were used for significant parts of this presentation. I also acknowledge help from Steve Preston and Dave Herald, especially for the Occult predictions I showed, and from my wife, Joan, and the many observers who have recorded and reported the occultations I discuss.

Topics of this Presentation

1. New ASTRID (ASTro Imaging Device) for Occultations
2. Large Campaign for Occultation by Lucy binary Trojan target (617) Patroclus-Menoetius on 2024 August 11
3. 2024 Oct. 18 occultation by Patroclus/Menoetius in e. Asia

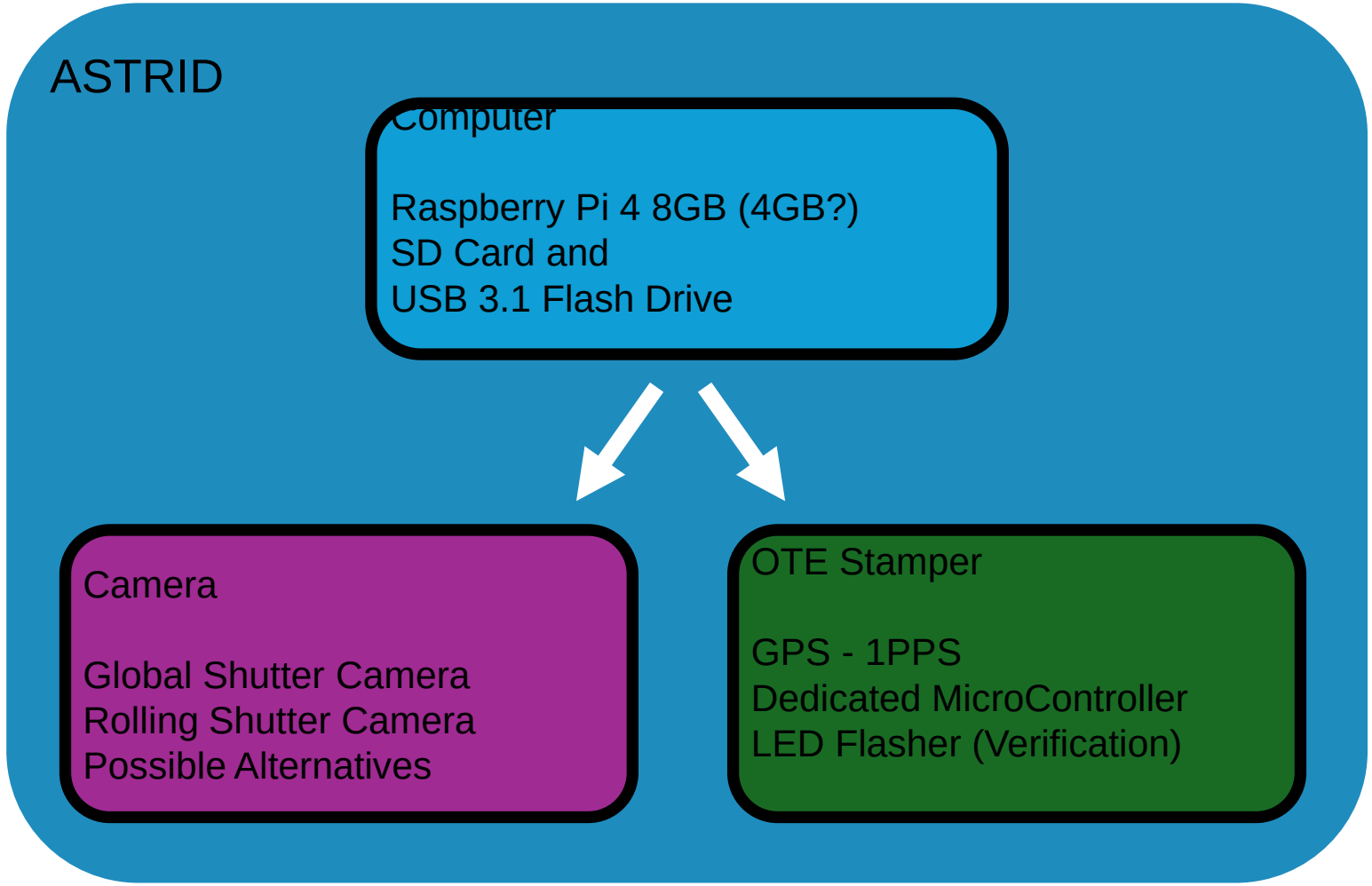
https://lucy.swri.edu/occ/predictions/20241018Patroclus/

4. Other occultations by the system before the 2033 Lucy flyby
5. 2025 Occultations by special main-belt asteroids in e. Asia

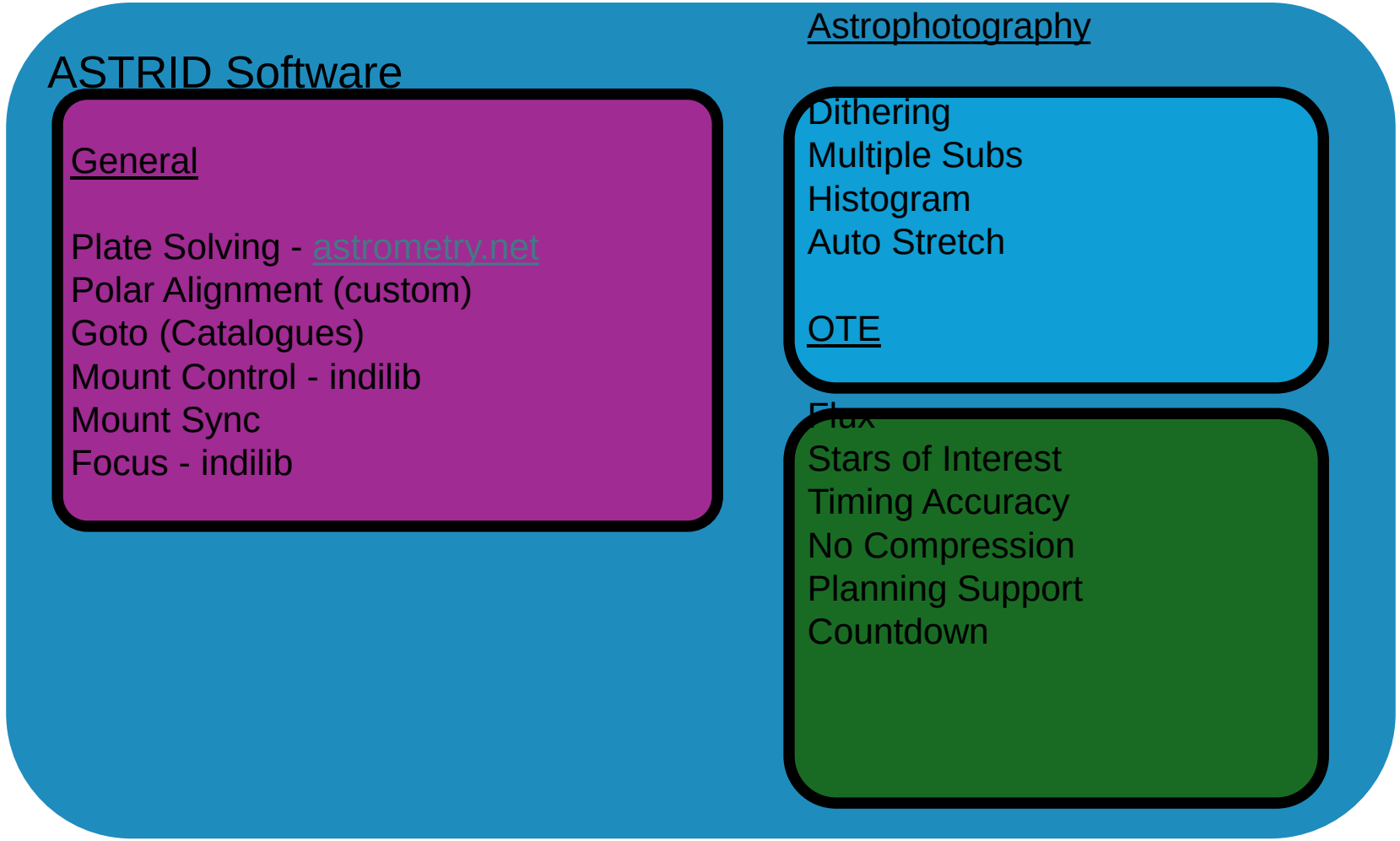
Mark Simpson, Calgary, Alberta, Canada, an occultation beginner story…

- 19th March 2023 - 17km diameter/path asteroid(785) 1991 PK8 occulted 4th-mag. 40 Leonis for 1.5s
- No Camera
- Zero experience
- Find equipment (cell phones for recording, etc., none ideal)
- Figure out the method
- Best practice older analog camera with GPS timestamp
- With the problems of analyzing observations with this poor equipment, these observations have not completed proper review to submit to Dave Herald
- There must be a better way, and the idea for ASTRID was born

Short Introduction to ASTRID (ASTROnomy Imaging Device)

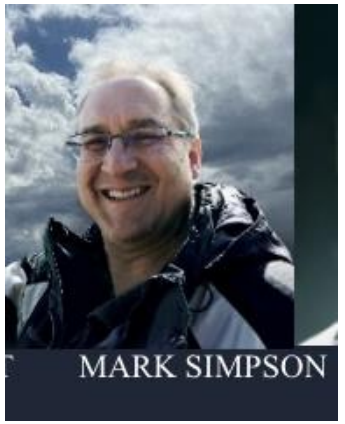


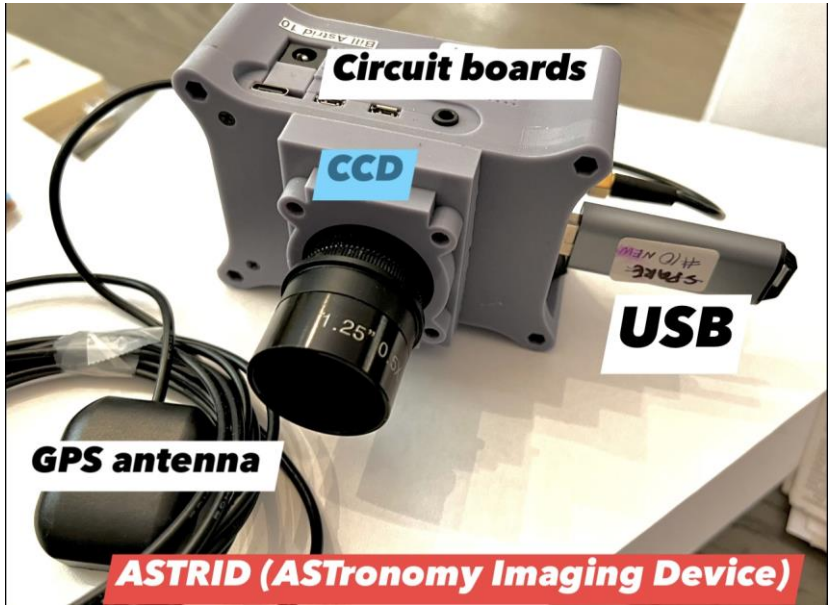
Software Overview



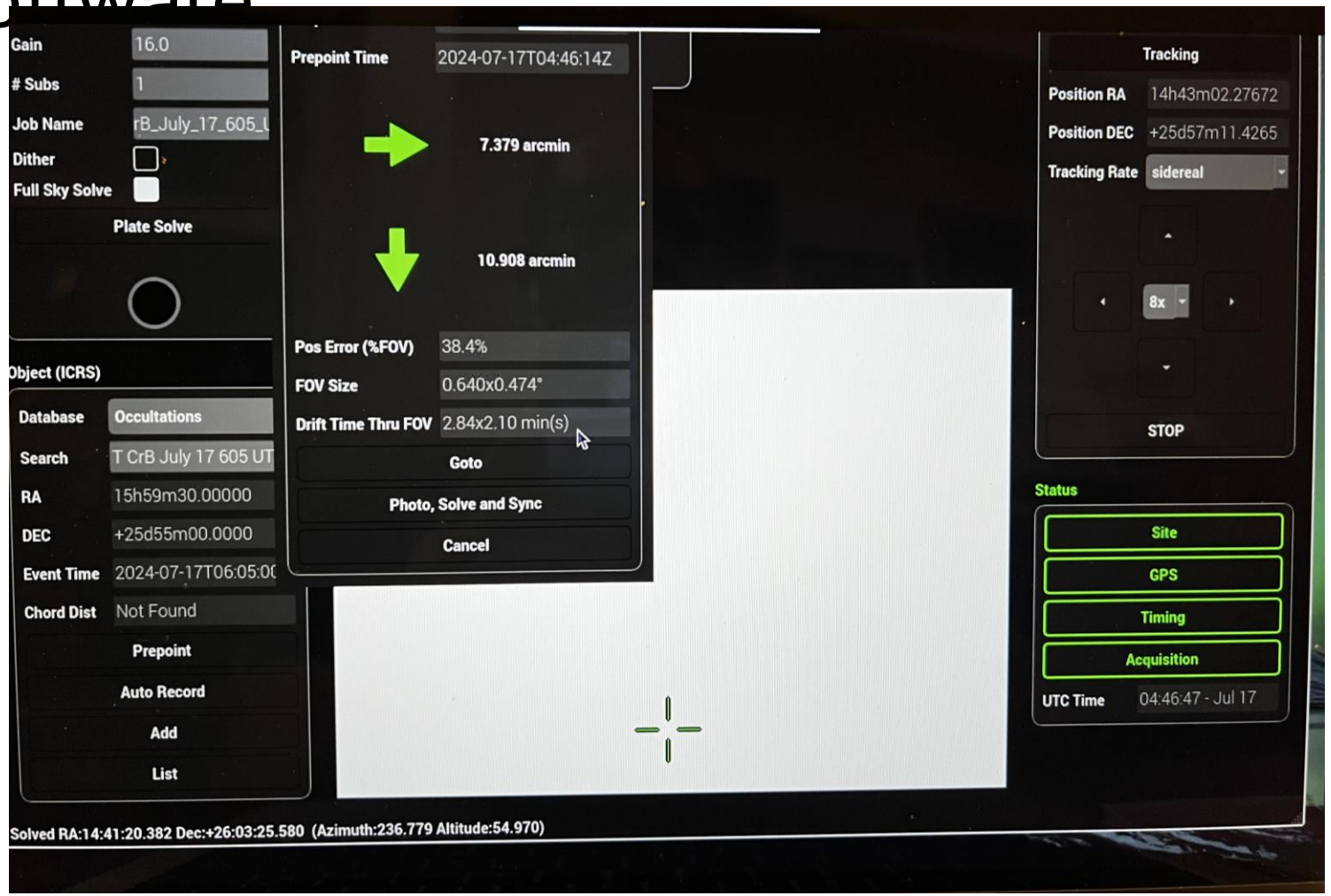
ASTRID (ASTROnomy Imaging Device) -- Hardware

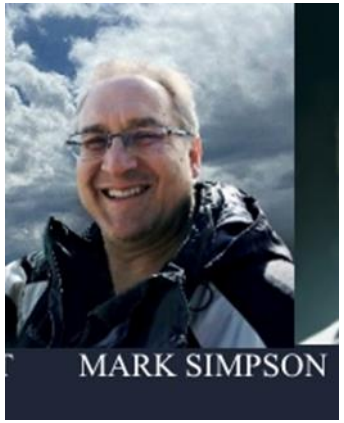
CCD is Pregius Gen 2 IMX296





ASTRID (ASTROnomy Imaging Device) -- Software

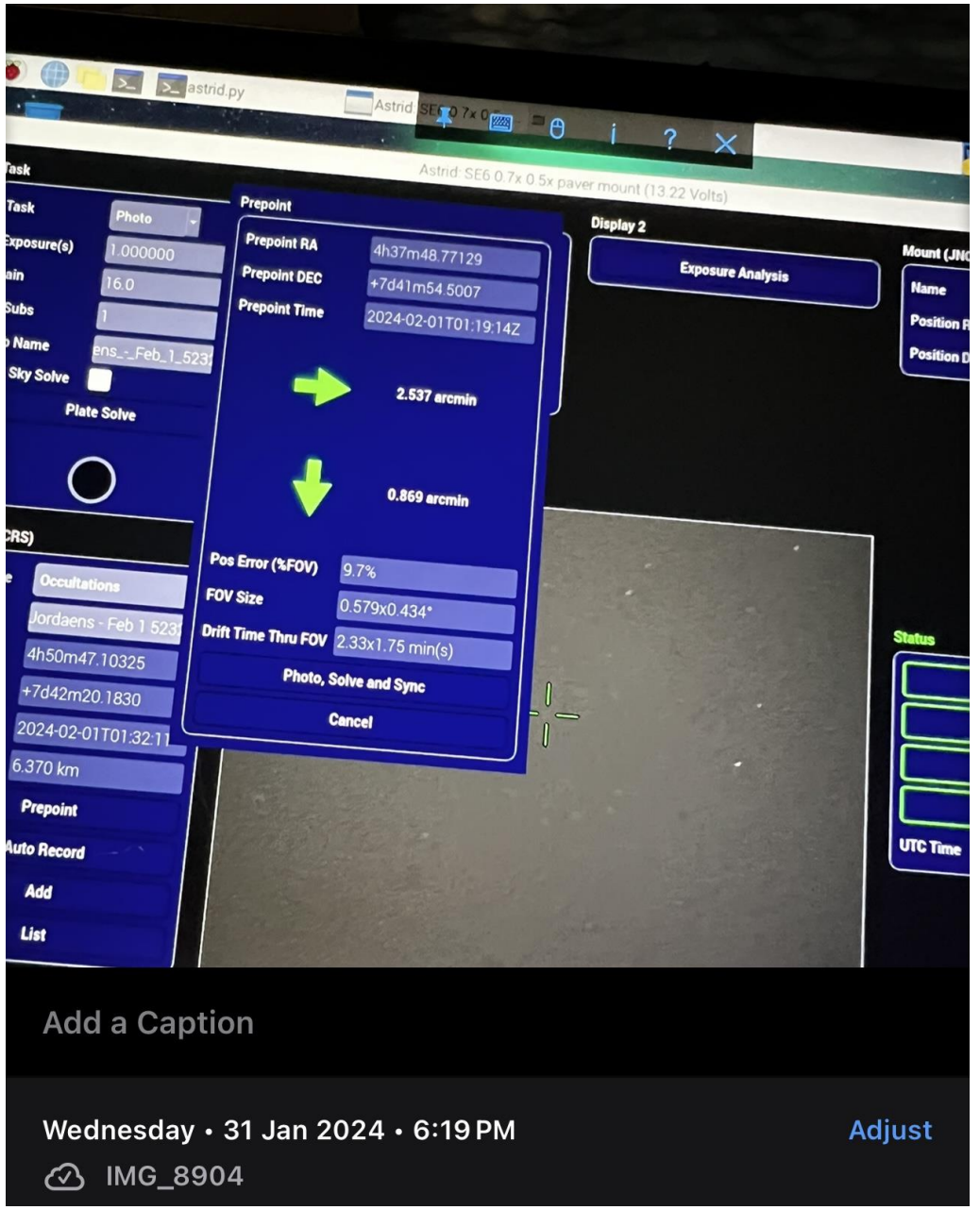




Prepoint

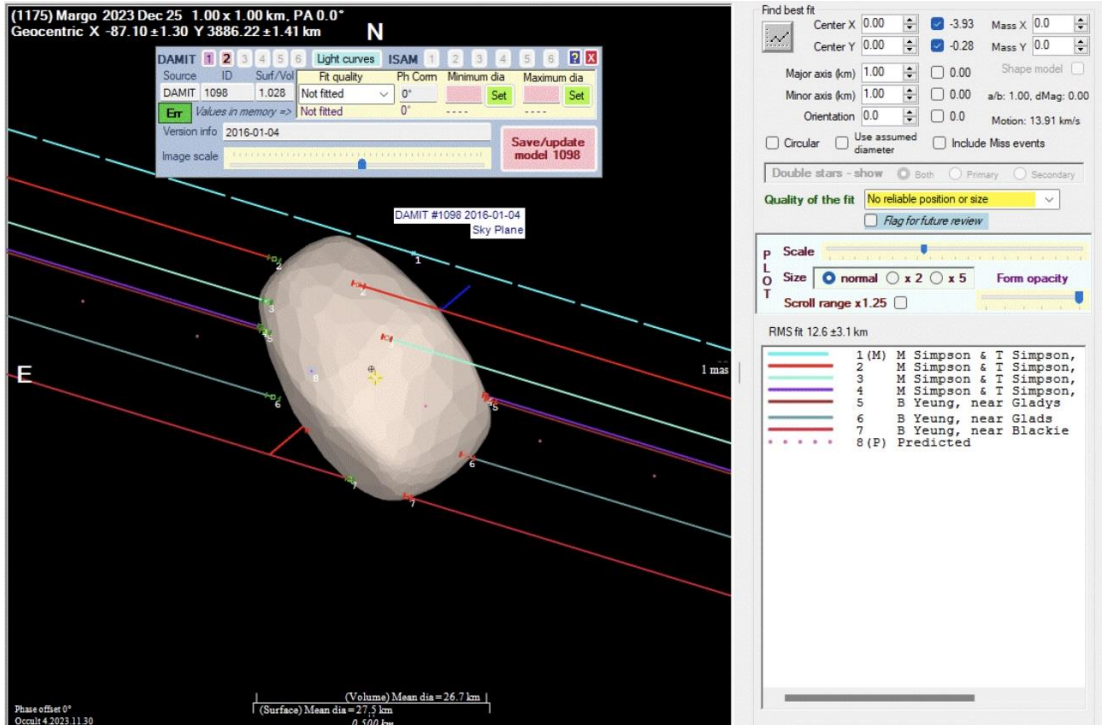

Prepoint


Polar aligned


astrid.py
Astrid:SE6 0.7x 0.5x paver mount (13.22 Volts)
Task
Photo
Exposure(s)
1.000000
16.0
Subs
1
Sky Solve
Plate Solve
Prepoint
Prepoint RA
4h37m48.77129
Prepoint DEC
+7d41m54.5007
Prepoint Time
2024-02-01T01:19:14Z
2.537 arcmin
0.869 arcmin
Pos Error (%FOV)
9.7%
FOV Size
0.579x0.434°
Drift Time Thru FOV
2.33x1.75 min(s)
Photo, Solve and Sync
Cancel
Display 2
Exposure Analysis
Occultations
4h50m47.10325
+7d42m20.1830
2024-02-01T01:32:11
6.370 km
Prepoint
Auto Record
Add
List
Status
UTC Time
Add a Caption
Wednesday • 31 Jan 2024 • 6:19 PM
Adjust
IMG_8904

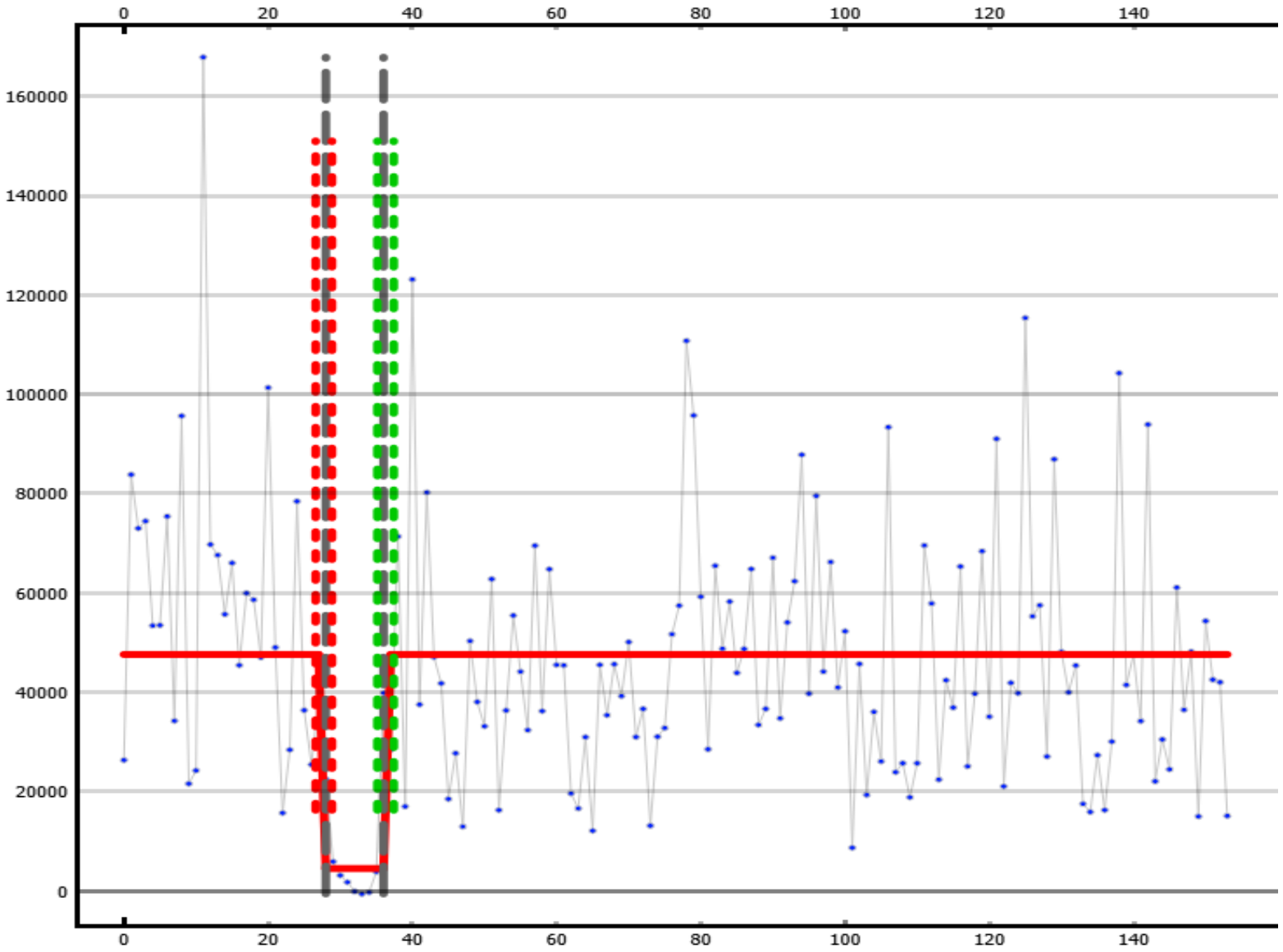
Dec 25, 2023 asteroid Margo occultation

First 7 chords observation near Calgary, Canada

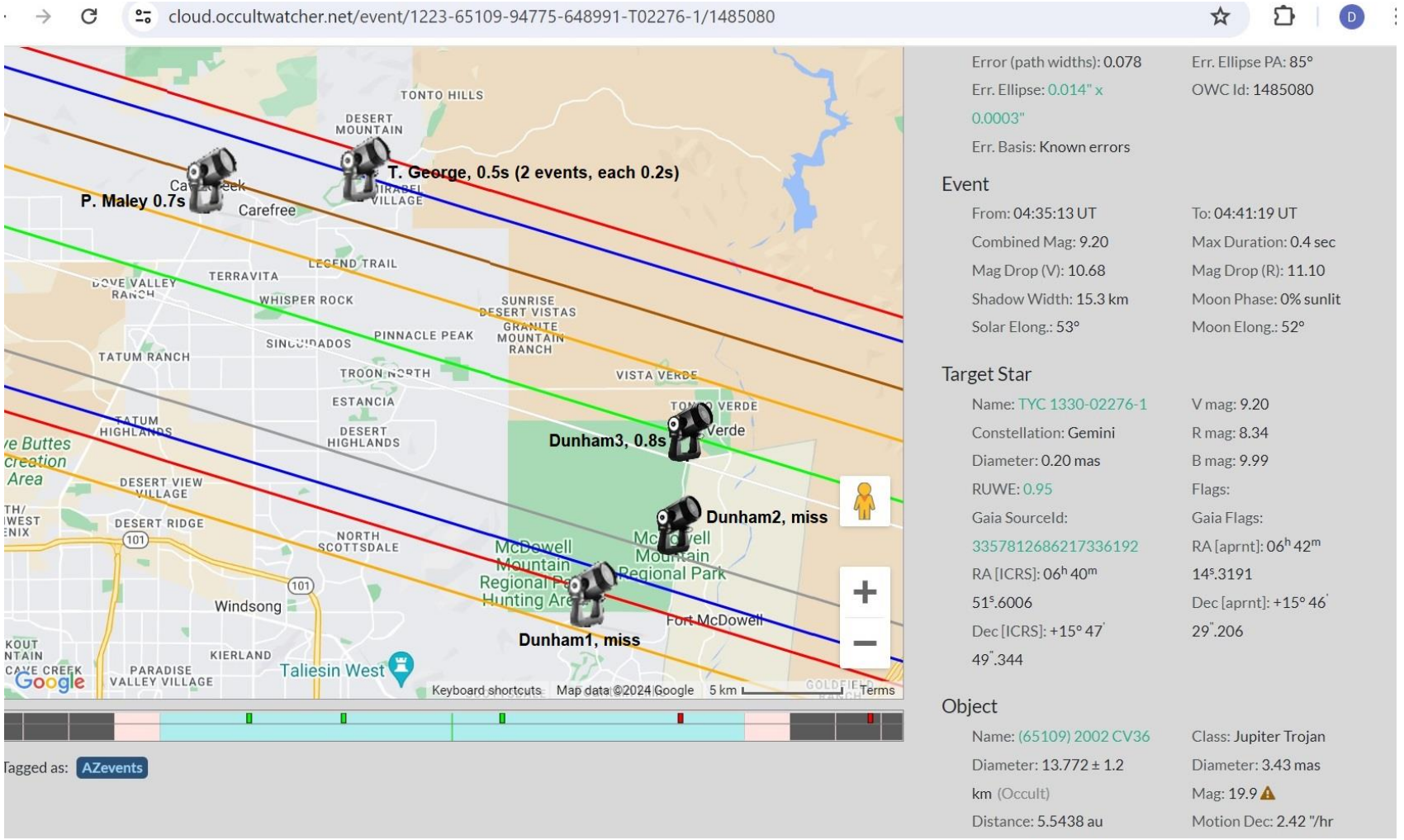


Bill Yeung’s set up now

2024 May 7th occultation by 2002 CV36, Dunham-3 with Astrid, 12cm scope, Rio Verde, AZ



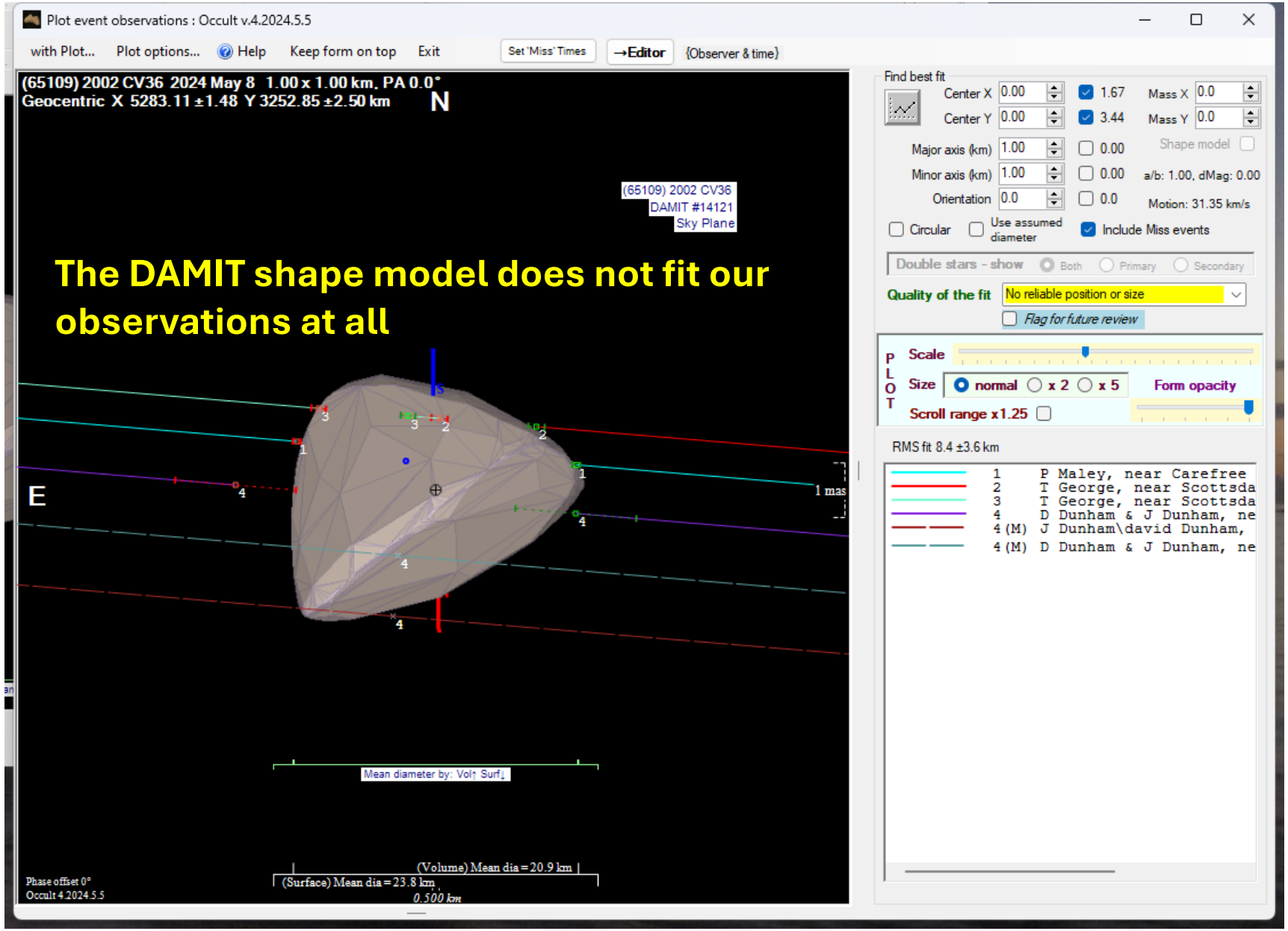
Occultation of 9.2mag star by small Trojan asteroid (65109) 2002 CV36, 2024 May 7, across N. Phoenix area



With the help of IOTA's new Astrid camera that uses plate solving to tell the observer how to adjust the scope to get to the altitude and azimuth of a predicted occultation, we ran 3 stations for this event (2 misses and one positive); P. Maley and T. George also recorded the occultation (both positive)

Occultation of 9.2mag star by small Trojan asteroid (65109) 2002 CV36, 2024 May 7/8, Sky Plane Plot by Tony George

/8



Information about Astrid

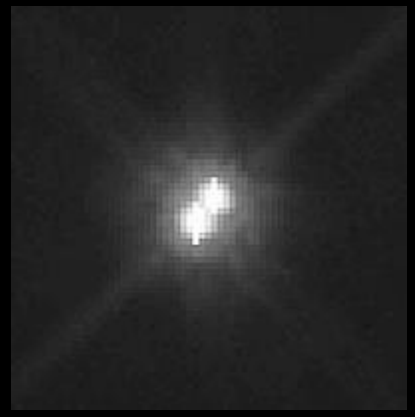
Details at https://github.com/ChasinSpin/astrid

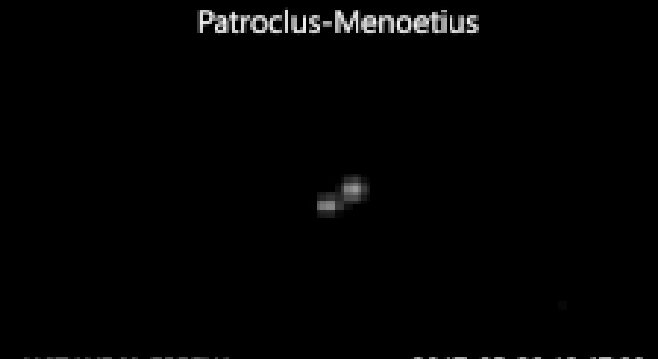
Youtube Videos about Astrid:
Introduction
https://www.youtube.com/playlist?list=PL4NoDf42dAJVYbvf5SUEgsVBWzvUSdJBl

Prepointing
https://www.youtube.com/watch?v=myGppMeeMI0

Orders being taken at the IOTA store:
https://occultations.org/astrid-details-and-ordering-page/

Mark Simpson email chasinspin@icloud.com





Chasing Shadows:

A Report on the August 7-11, 2024

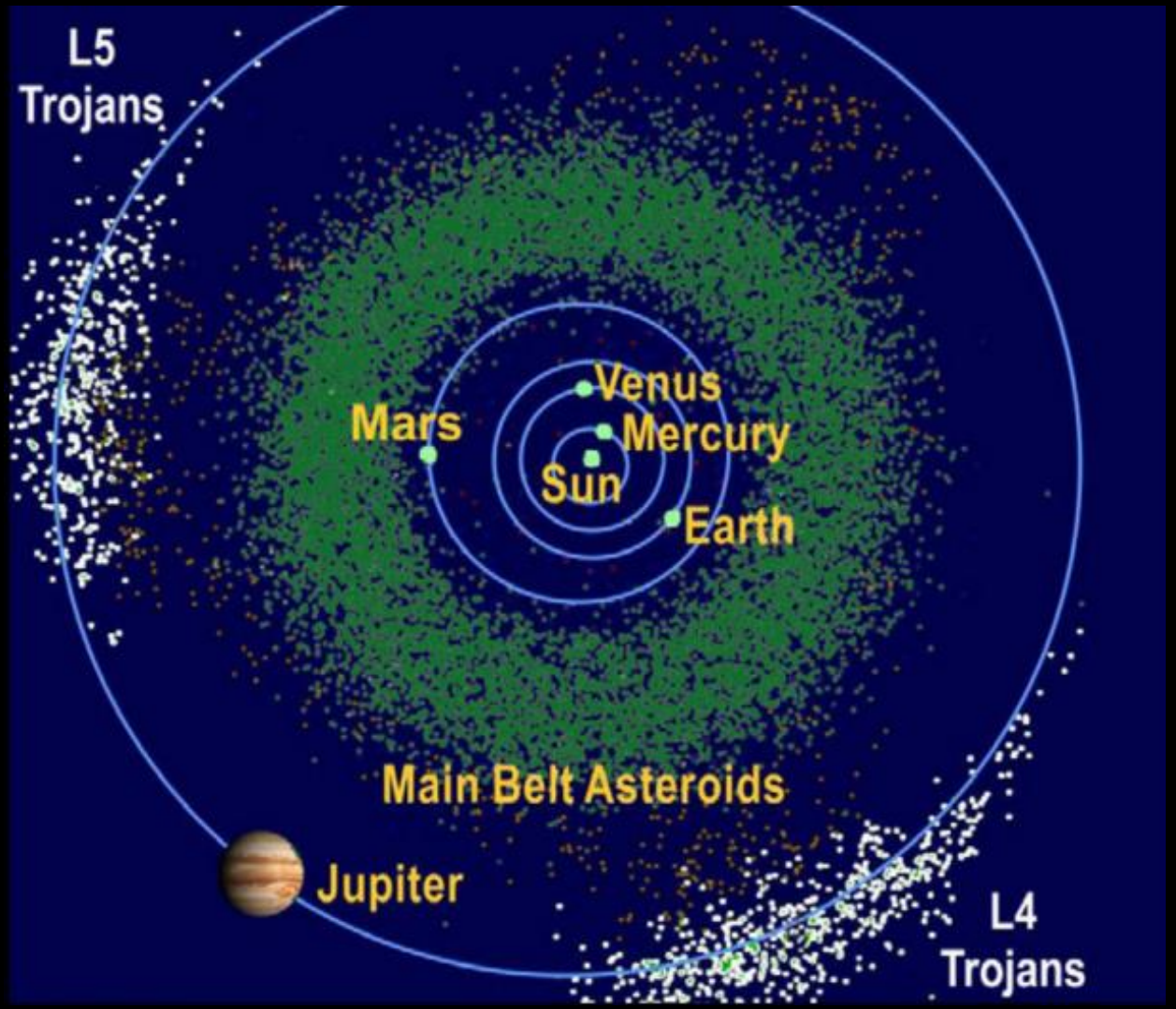
LUCY Mission

Occultation Campaign for Binary Trojan Asteroid

Patroclus / Menoetius

Ted Blank
East Valley Astronomy Club
August 16, 2024

Trojan Asteroids Share Jupiter's Orbit and Lucy Targets (r.)



Courtesy: Hal Levison

Main Asteroid Belt

(152830) Dinkinesh
Occured on Nov. 1, 2023
0 years 286 days ago

(52246) Donaldjohanson
April 20, 2025 in 0 248
Date ... Years Days

L_4-swarm

(3548) Eurybates
Aug. 12, 2027 in 2 362
Date ... Years Days

(15094) Polymele
Sept. 15, 2027 in 3 31
Date ... Years Days

(11351) Leucus
Apr. 18, 2028 in 3 247
Date ... Years Days

(21900) Orus
Nov. 11, 2028 in 4 88
Date ... Years Days

L_5-swarm

(617) Patroclus & Menoetius
Mar. 2, 2033 in 8 199
Date ... Years Days

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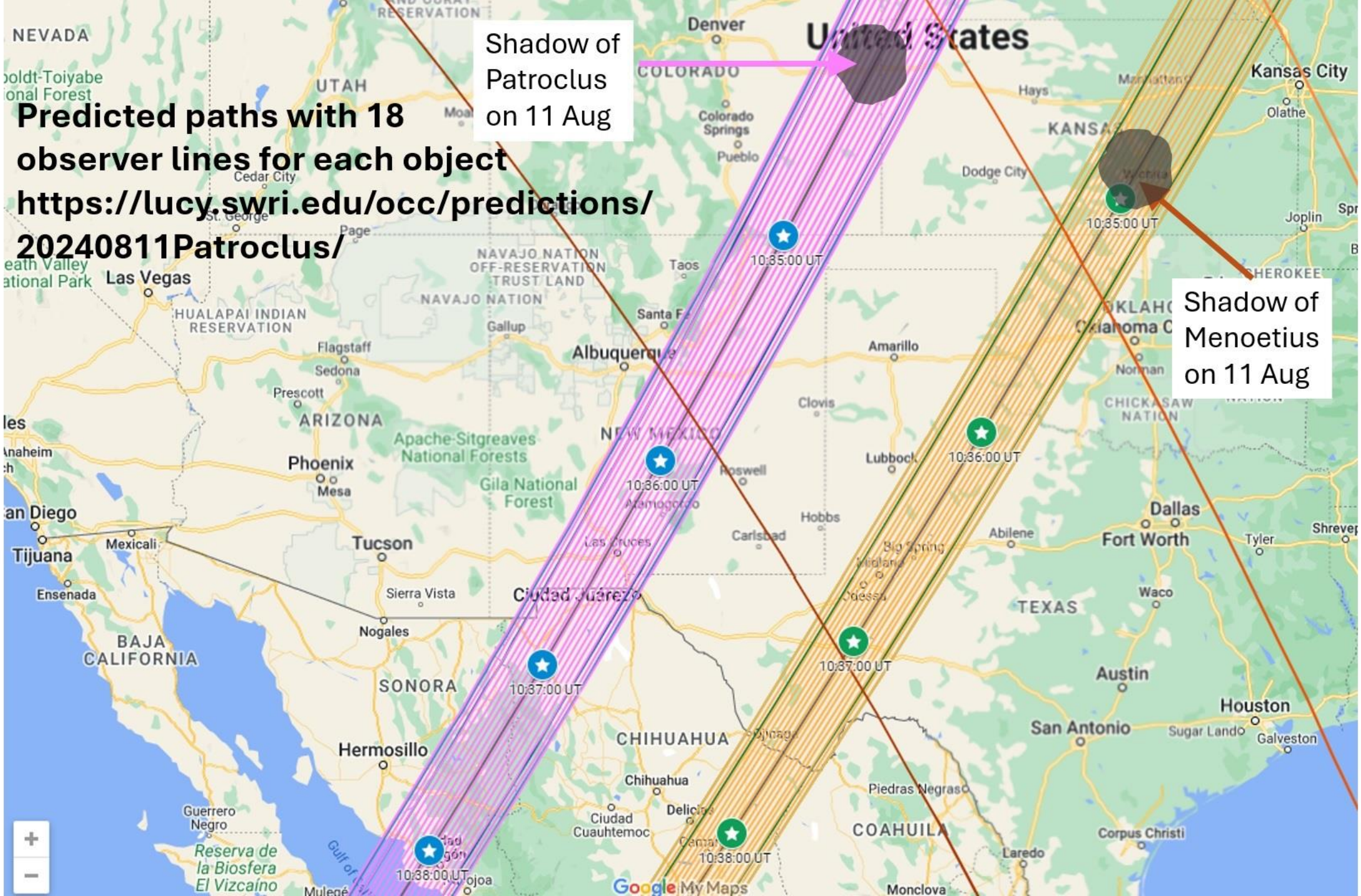
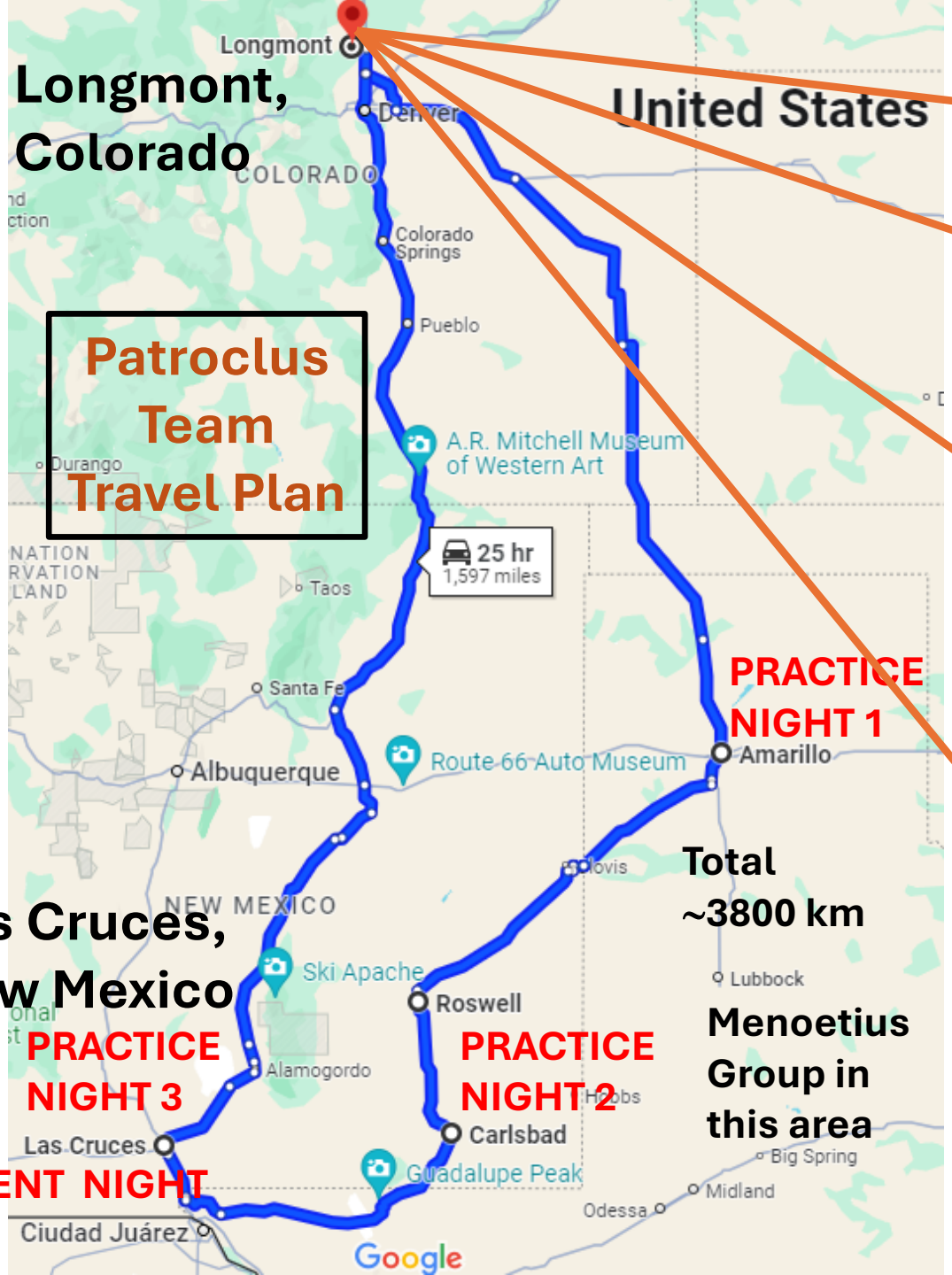
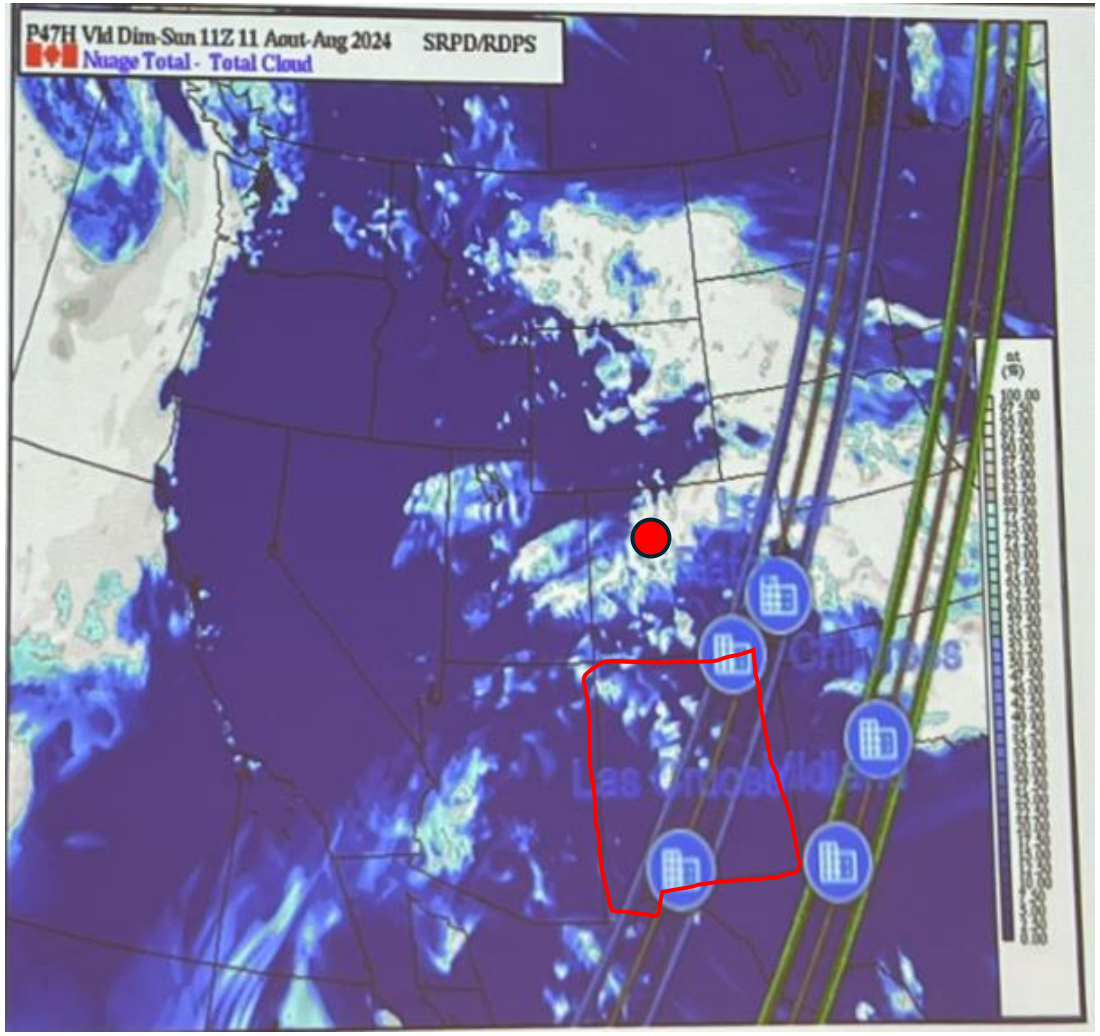

Predicted paths with 18 observer lines for each object
https://lucy.swri.edu/occ/predictions/20240811Patroclus/
Shadow of Patroclus on 11 Aug
Shadow of Menoetius on 11 Aug
10:35:00 UT
10:36:00 UT
10:37:00 UT
10:38:00 UT
Google My Maps



Occultation scopes & equipment are stored at “LUCY Occultation HeadQuarters” (LOHQ) in Longmont, CO

Why So Much Driving?



The Weather...

Laptop:

Sharpcap
ASCOM

Platesolving drives the scope to the target

CAMERA: QHY174M-GPS
(cooled to 0C)
FOCUSER: Celestron
BATTERY: Celestron
OPTICS:

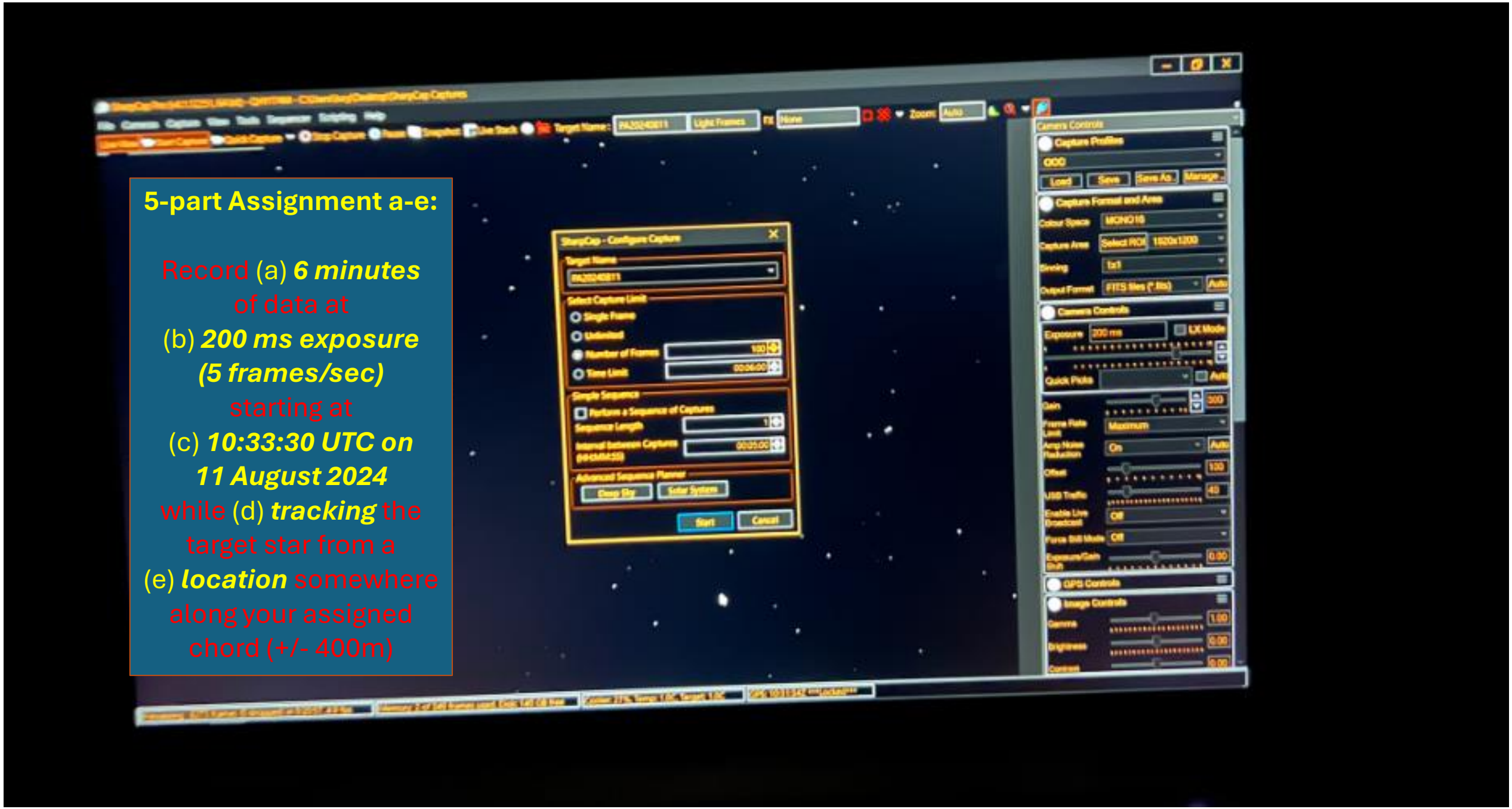
Hyperstar: Starizona

Celestron CPC11

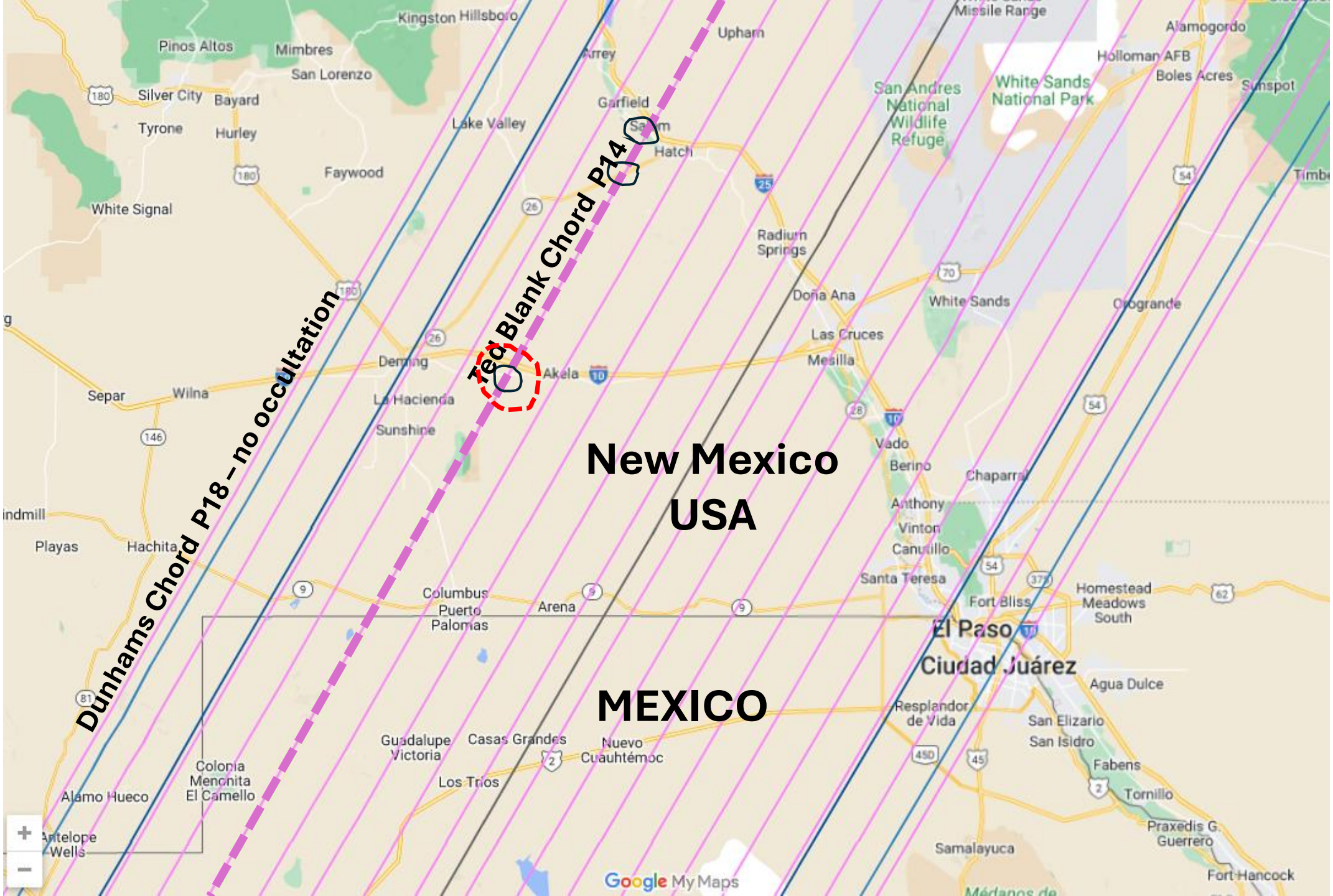
Result:

11” aperture at f/2


T56


5-part Assignment a-e:
Record (a) 6 minutes of data at (b) 200 ms exposure (5 frames/sec) starting at (c) 10:33:30 UTC on 11 August 2024 while (d) tracking the target star from a (e) location somewhere along your assigned chord (+/- 400m)

Day 3: Patroclus Team All-Hands Meeting / Weather Briefing


Dunhams Chord P18 – no occultation
Ted Blank Chord P14
New Mexico
USA
MEXICO
El Paso
Ciudad Juárez
Las Cruces
Mesilla
Deming
Akela
Columbus
Puerto Palomas
Arena
Hatch
Garfield
Lake Valley
Upham
Radium Springs
Doña Ana
White Sands
Orogrande
Alamogordo
Holloman AFB
White Sands National Park
San Andres National Wildlife Refuge
Missile Range
Boles Acres
Sunspot
Pinos Altos
Mimbres
San Lorenzo
Silver City
Bayard
Tyrone
Hurley
Faywood
White Signal
Kingston
Hillsboro
Separ
Wilna
La Hacienda
Sunshine
Playas
Hachita
Windmill
Vado
Berino
Chaparral
Anthony
Vinton
Canutillo
Santa Teresa
Fort Bliss
Homestead Meadows South
Agua Dulce
Resplandor de Vida
San Elizario
San Isidro
Fabens
Tornillo
Praxedis G. Guerrero
Samalayuca
Fort Hancock
Guadalupe Victoria
Casas Grandes
Nuevo Cuauhtémoc
Los Trios
Colonia Menonita El Camello
Alamo Hueco
Antelope Wells
Google My Maps

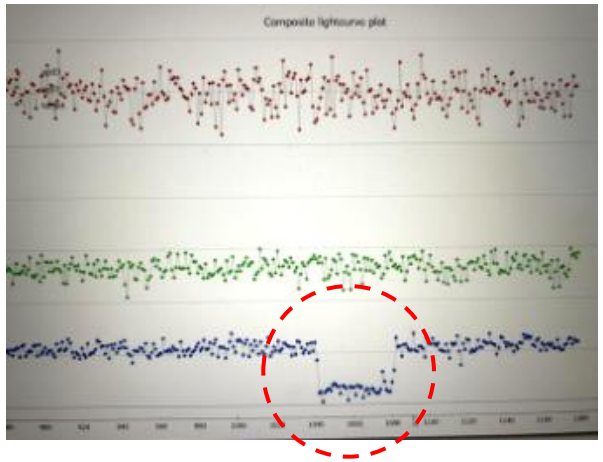

Akela
15205 NM-549
Deming, New Mexico
Google Street View
Apr 2023
See more dates
lazyko ranch
549
549
Google

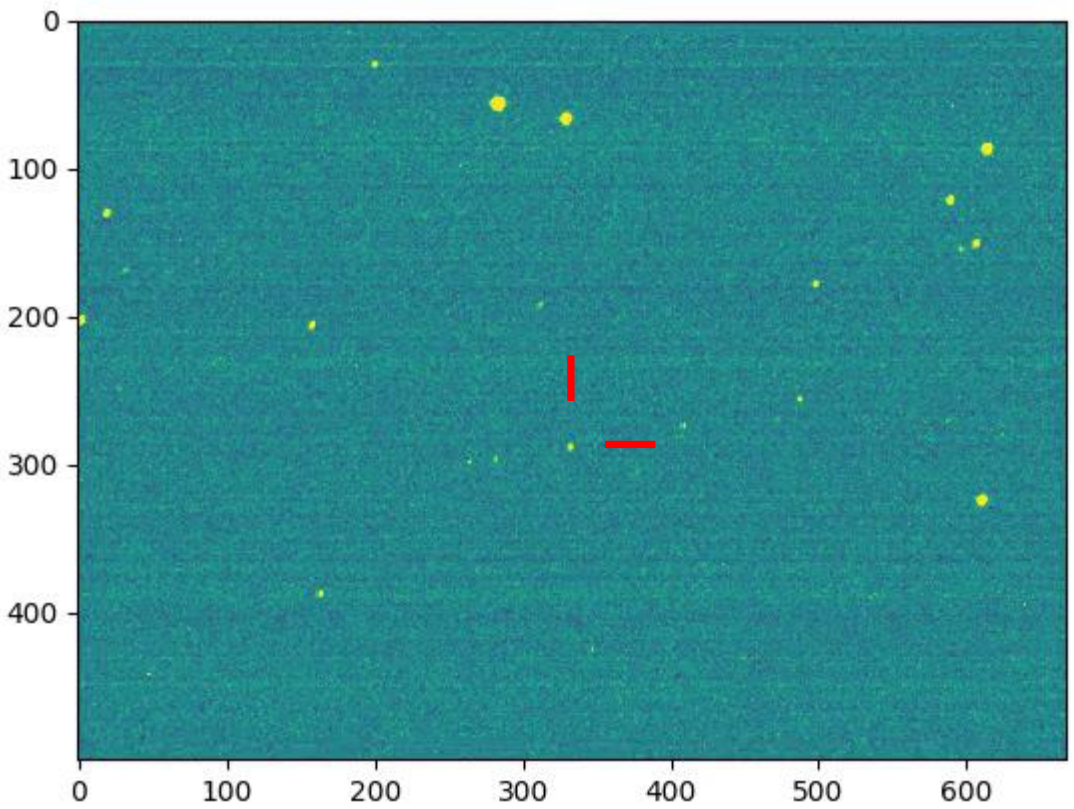
Event Night

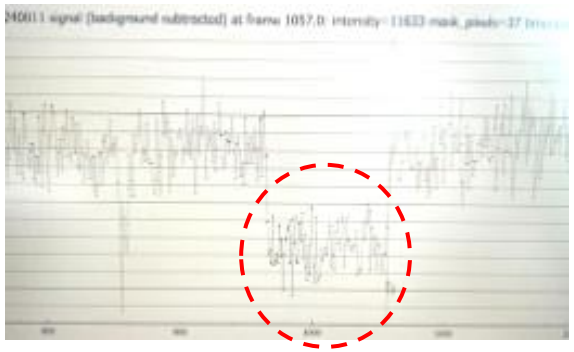
Setup

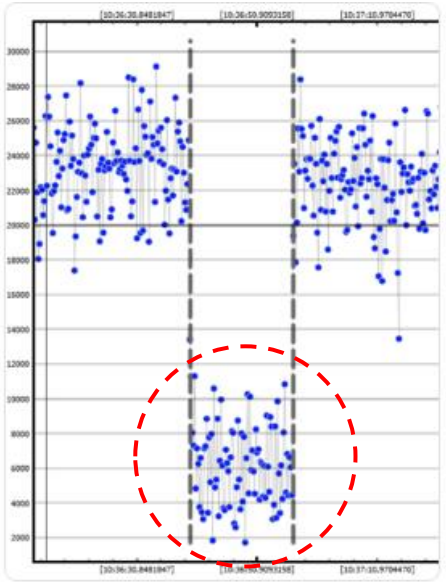
T – 1 hour and waiting

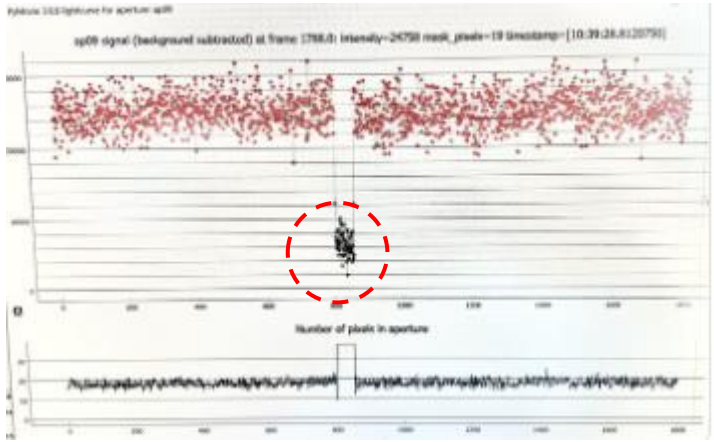
Maximum Expected Occultation: ~20 seconds

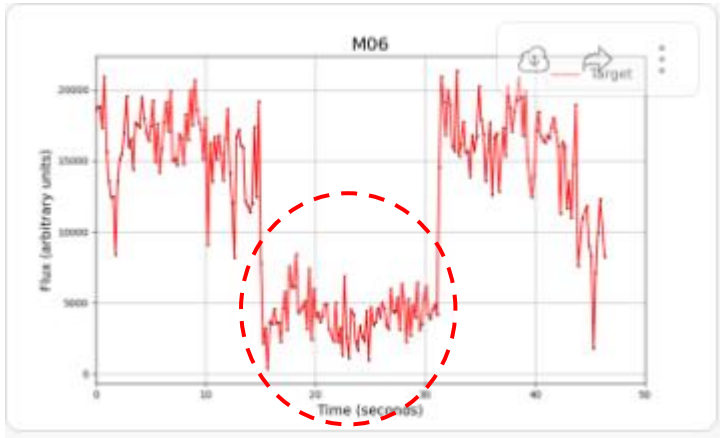




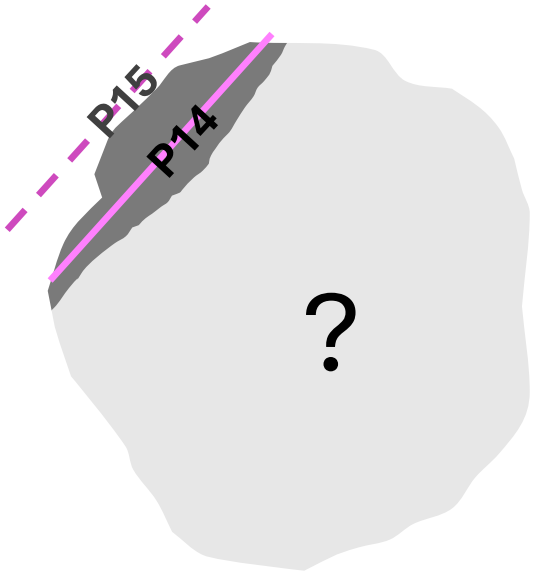






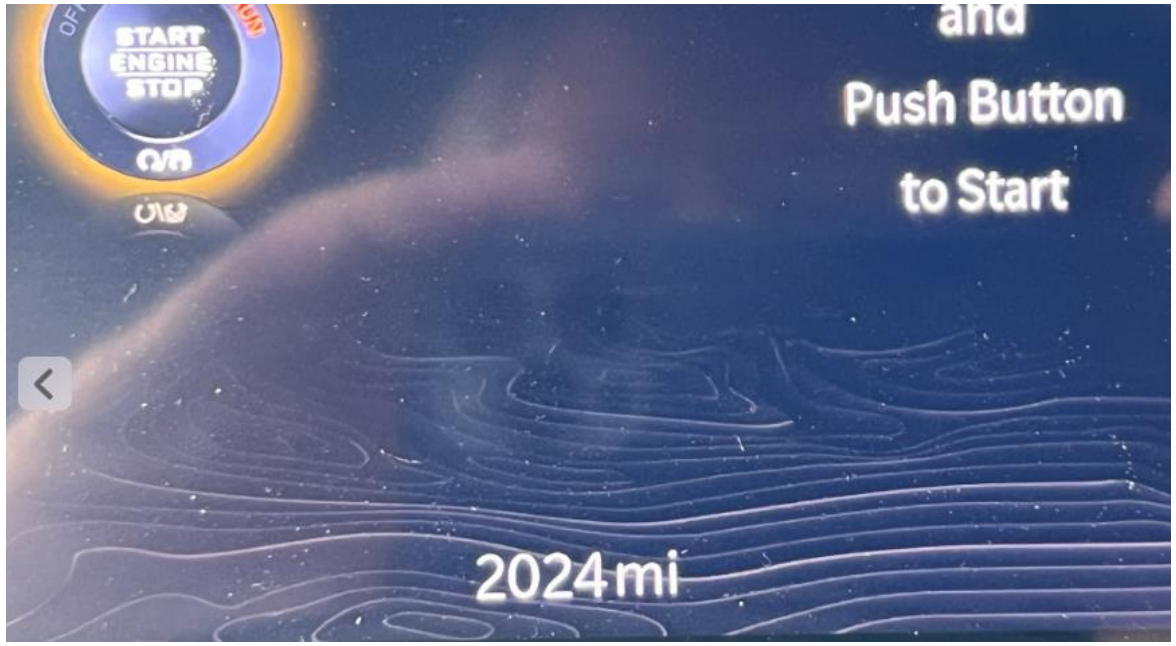


Happy P14 Team:
Ted Blank (IOTA)
Adam Schroeder (UVa)
Nick Velasquez (UVa)



P14: positive
P15: negative (miss)

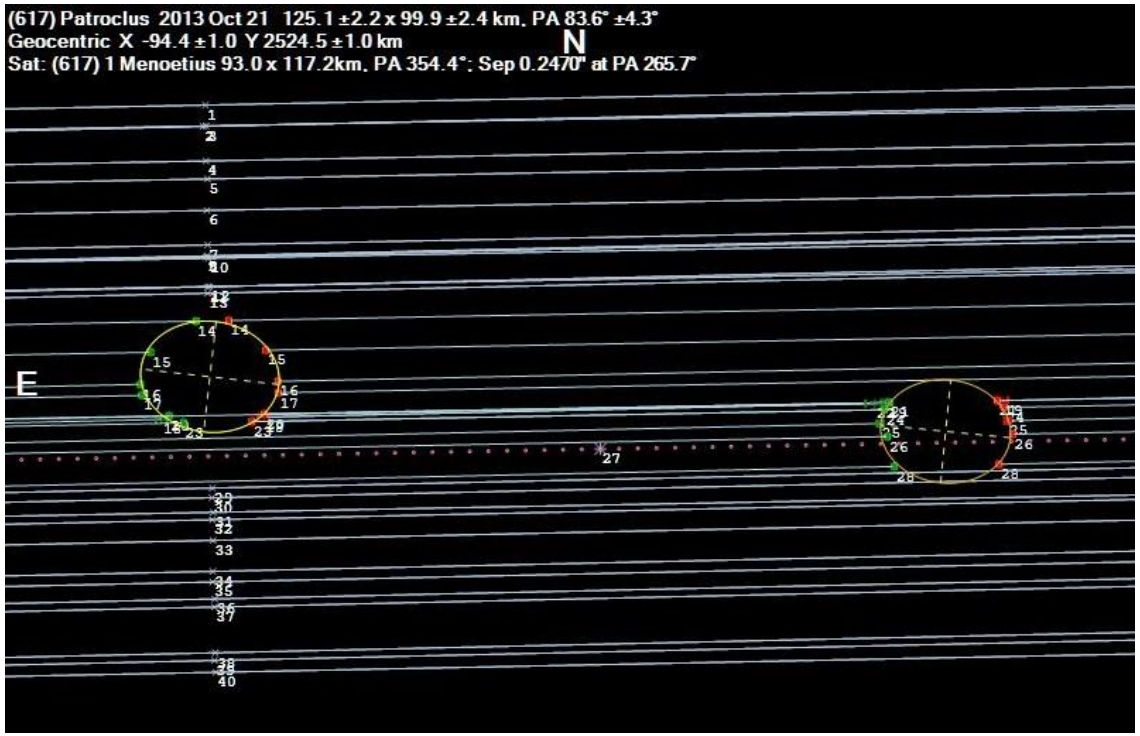
P: 11 positives
M: 13 positives



Earlier Results (2015)

Buie, et. al. Size and Shape from Stellar Occultation Observations of the Double Jupiter Trojan Patroclus and Menoetius.

The Astronomical Journal, Volume 149, Issue 3, article id. 113, 11 pp. (2015).



By KuriwaObs - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=80788471

Authors:

Buie, Marc W. ;
Olkin, Catherine B. ;
Merline, William J. ;
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Levison, Harold F. ;
Timerson, Brad ;
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Abramson, Katherine J. ;
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Conard, Steve J. ;
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Dunham, David W. ;
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Liu, Yanzhe ;
Maley, Paul D.
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Preston, Steve ;
Royer, Ronald ;
Scheck, Andrew E. ;
Sherrod, Clay ;
Sherrod, Lowell ;
Swift, Theodore J. ;
Taylor, Lawrence W., III ;
Venable, Roger

Field Observers

Topics of this Presentation

1. New ASTRID (ASTro Imaging Device) for Occultations
2. Large Campaign for Occultation by Lucy binary Trojan target (617) Patroclus-Menoetius on 2024 August 11
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https://lucy.swri.edu/occ/predictions/20241018Patroclus/

4. Other occultations by the system before the 2033 Lucy flyby
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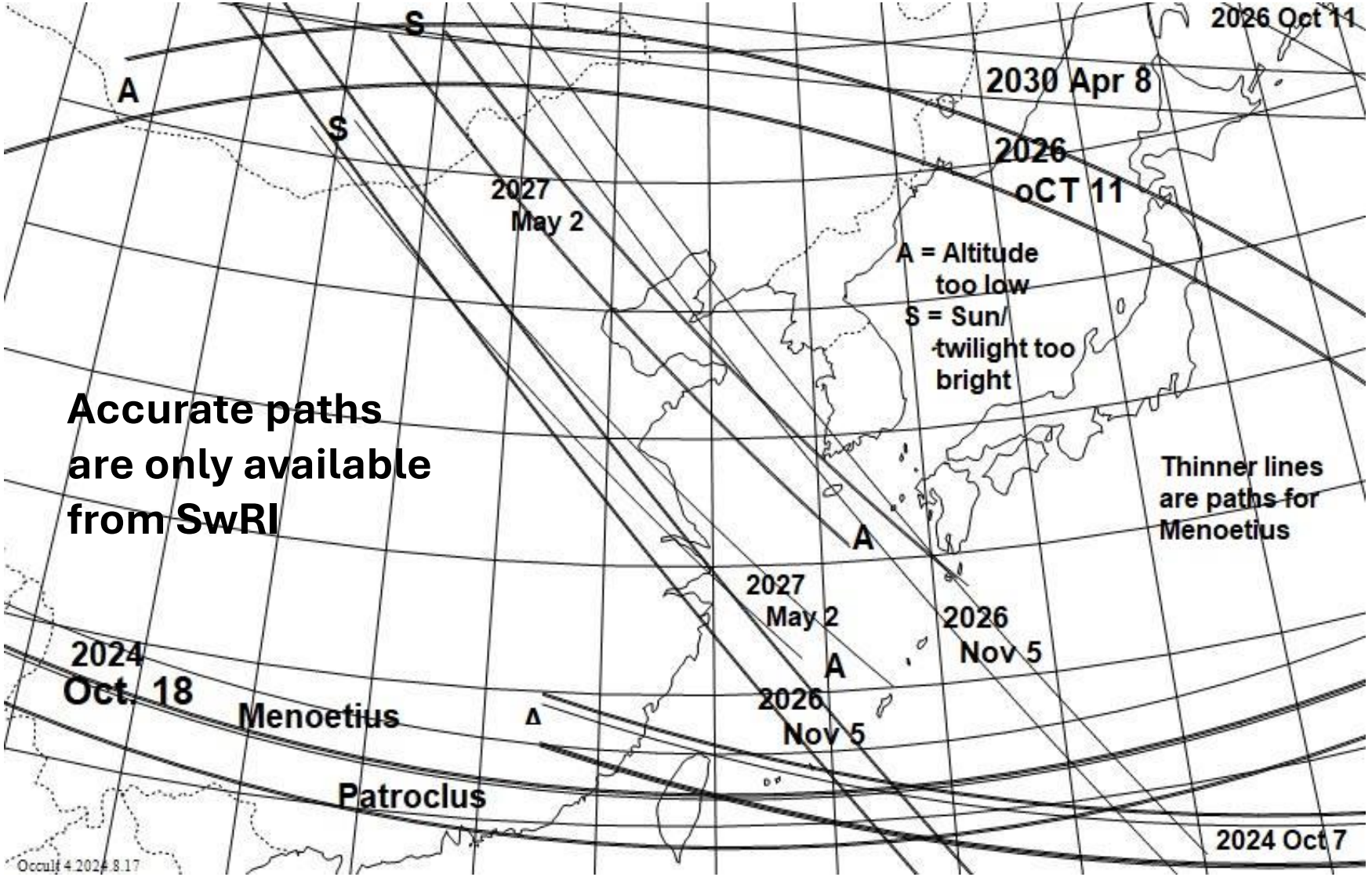
Patroclus Occs, 2024-2033, East Asia

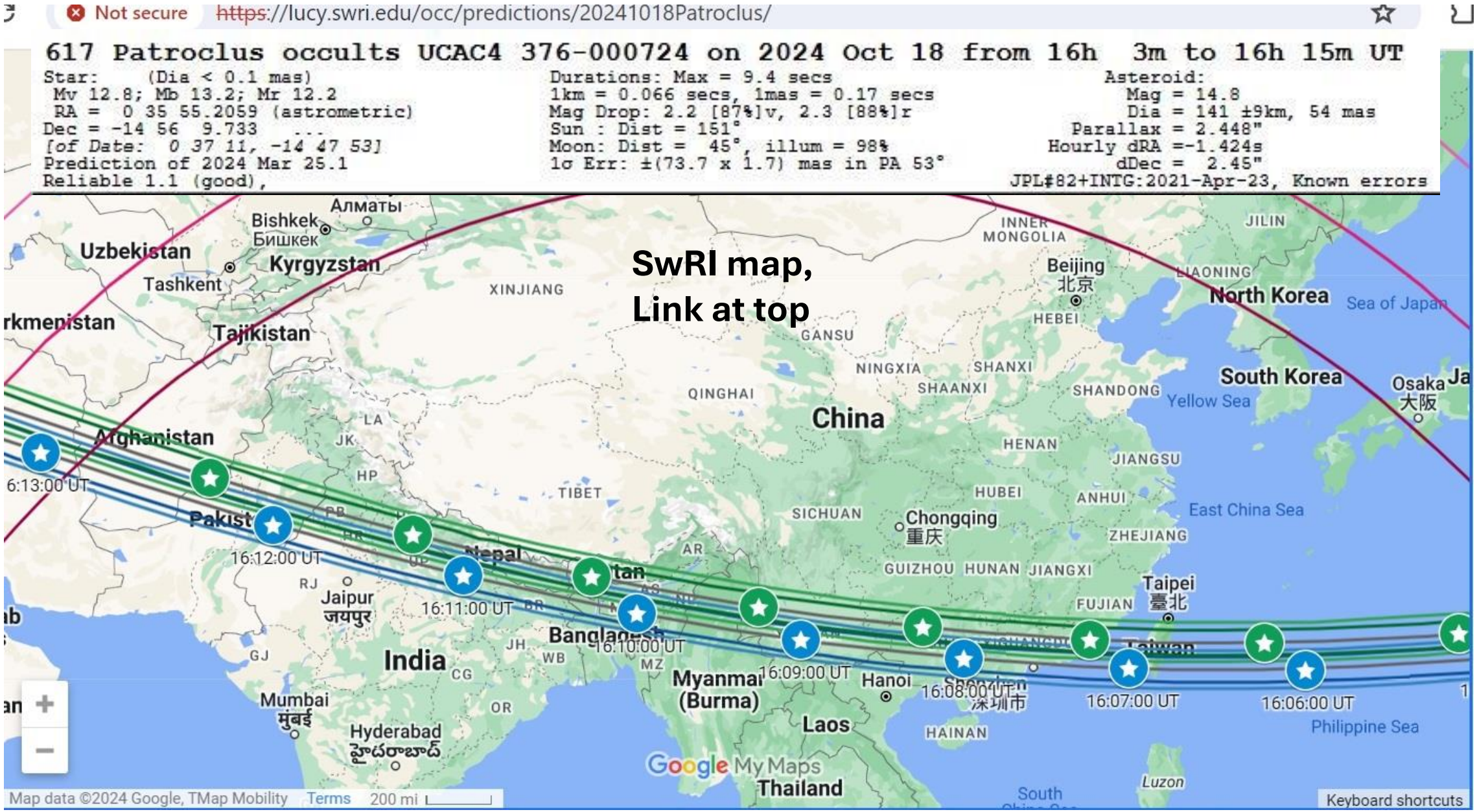


Patroclus Occs, 2024-2033, East Asia

Date			U.T.		Diameter		Durn	Star	Mag-Drop		Elon	%	Star	d	Rely	Planet		Min		Moon	
y	m	d	h	m	km	"	sec/m	mag	V	R *	o	Ill	No.		<1.4	No	Name	D	Error	Dist	ill
2024	Oct	7	11	18.5	141	0.055	8.8s	11.6	3.1	3.1	159		TYC 5271-01584-1		1.95	617	Patroclus	0.53	±0.04	115	19
2024	Oct	7	11	18.5	131	0.051	8.2s	11.6	3.1	3.1	159		TYC 5271-01584-1		1.95	617	Patroclus #1	0.53	±0.04	115	19
2024	Oct	7	11	17.9	116	0.045	7.2s	11.6	3.1	3.1	159		TYC 5271-01584-1		1.95	617	Menoetius #1	0.54	±0.04	115	19
2024	Oct	18	16	10.0	141	0.054	9.4s	12.8	2.2	2.3	151		UCAC4 376-000724		1.10	617	Patroclus	0.63	±0.04	45	98
2024	Oct	18	16	10.0	131	0.050	8.7s	12.8	2.2	2.3	151		UCAC4 376-000724		1.10	617	Patroclus #1	0.63	±0.04	45	98
2024	Oct	18	16	10.7	116	0.044	7.7s	12.8	2.2	2.3	151		UCAC4 376-000724		1.10	617	Menoetius #1	0.66	±0.04	45	98
2026	Aug	3	20	59.3	116	0.029	3.7s	12.0	4.1	4.3	52		UCAC4 610-017916		3.00	617	Menoetius #1	0.11	±0.06	66	74
2026	Aug	3	20	59.7	141	0.035	4.5s	12.0	4.1	4.3	52		UCAC4 610-017916		3.00	617	Patroclus	0.01	±0.06	66	74
2026	Aug	3	20	59.7	131	0.033	4.2s	12.0	4.1	4.3	52		UCAC4 610-017916		3.00	617	Patroclus #1	0.01	±0.06	66	74
2026	Oct	11	14	35.3	141	0.042	14.1s	12.2	3.6	4.0	111		UCAC4 633-028393		1.05	617	Patroclus	0.73	±0.05	123	1
2026	Oct	11	14	35.3	131	0.039	13.1s	12.2	3.6	4.0	111		UCAC4 633-028393		1.05	617	Patroclus #1	0.73	±0.05	123	1
2026	Oct	11	14	34.7	116	0.035	11.6s	12.2	3.6	4.0	111		UCAC4 633-028393		1.05	617	Menoetius #1	0.63	±0.05	123	1
2026	Nov	5	20	16.2	116	0.037	8.7s	11.0	4.6	4.3	135		TYC 2910-01401-1		0.95	617	Menoetius #1	0.26	±0.05	98	12
2026	Nov	5	20	15.9	141	0.045	10.6s	11.0	4.6	4.3	135		TYC 2910-01401-1		0.95	617	Patroclus	0.16	±0.05	98	12
2026	Nov	5	20	15.9	131	0.042	9.9s	11.0	4.6	4.3	135		TYC 2910-01401-1		0.95	617	Patroclus #1	0.16	±0.05	98	12
2027	May	2	13	5.2	141	0.033	4.2s	11.7	4.6	5.1	45		UCAC4 642-027814	s	1.30	617	Patroclus	0.51	±0.07	91	17
2027	May	2	13	5.2	131	0.031	3.9s	11.7	4.6	5.1	45		UCAC4 642-027814	s	1.30	617	Patroclus #1	0.51	±0.07	91	17
2027	May	2	13	5.4	116	0.027	3.5s	11.7	4.6	5.1	45		UCAC4 642-027814	s	1.30	617	Menoetius #1	0.46	±0.07	91	17
2030	Apr	8	16	8.6	141	0.038	8.7s	11.1	5.1	5.0	142		TYC 1982-01834-1		1.05	617	Patroclus	0.39	±0.06	85	27

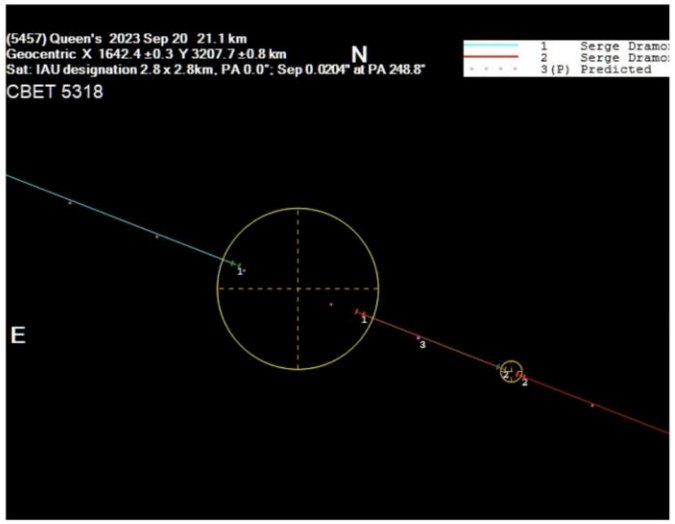
Generated from Occult4 to mag. 13.0 using input file World2024-2033PatroclusToMag14.xml with a link to download the file near the bottom of IOTA's Web page of Trojan asteroidal occultations at https://occultations.org/publications/rasc/2024/nam24Trojanoccs.htm .
SwRI predictions are needed for accurate paths,
can request from Brian Keeney, bkeeney@gmail.com

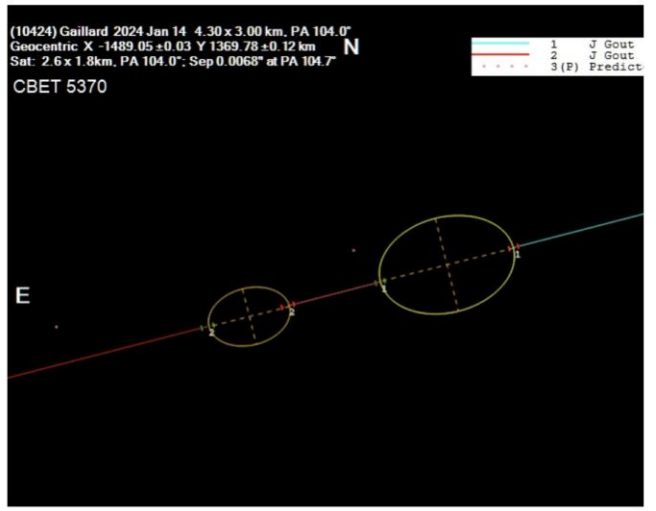
2024 October 18 (617) Patroclus Occ, s. Asia



Last 4 binary asteroids discovered by occultations

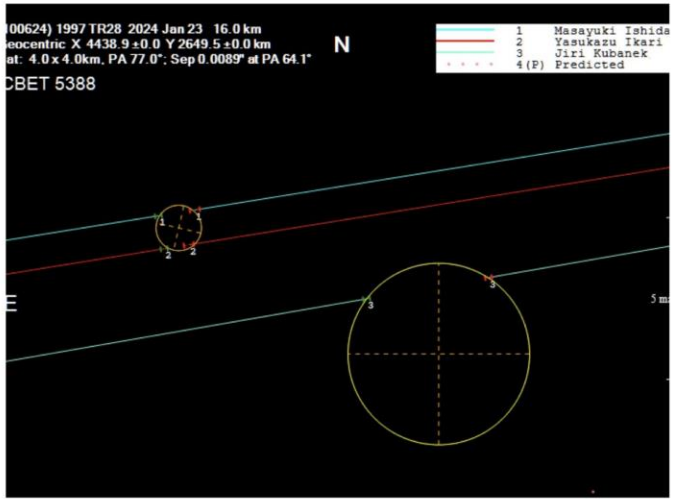
2023 Sep. 20, (5457) Queen's Europe

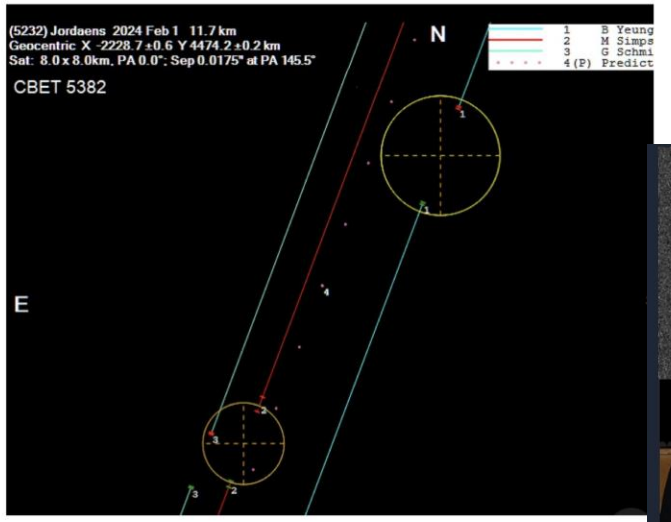


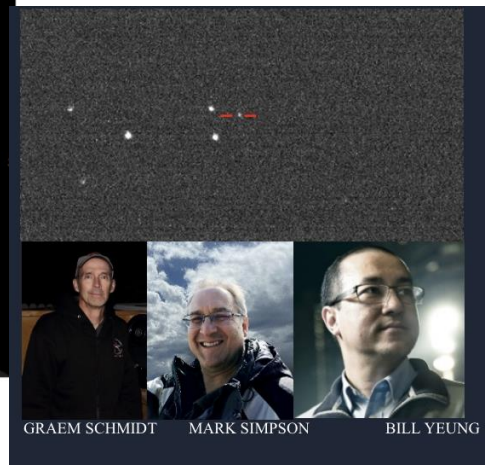


2024 Jan. 14, (10424) Gaillard, Mississippi

2024 Jan. 23, Trojan (100624) 1997 TR28 Europe and Japan







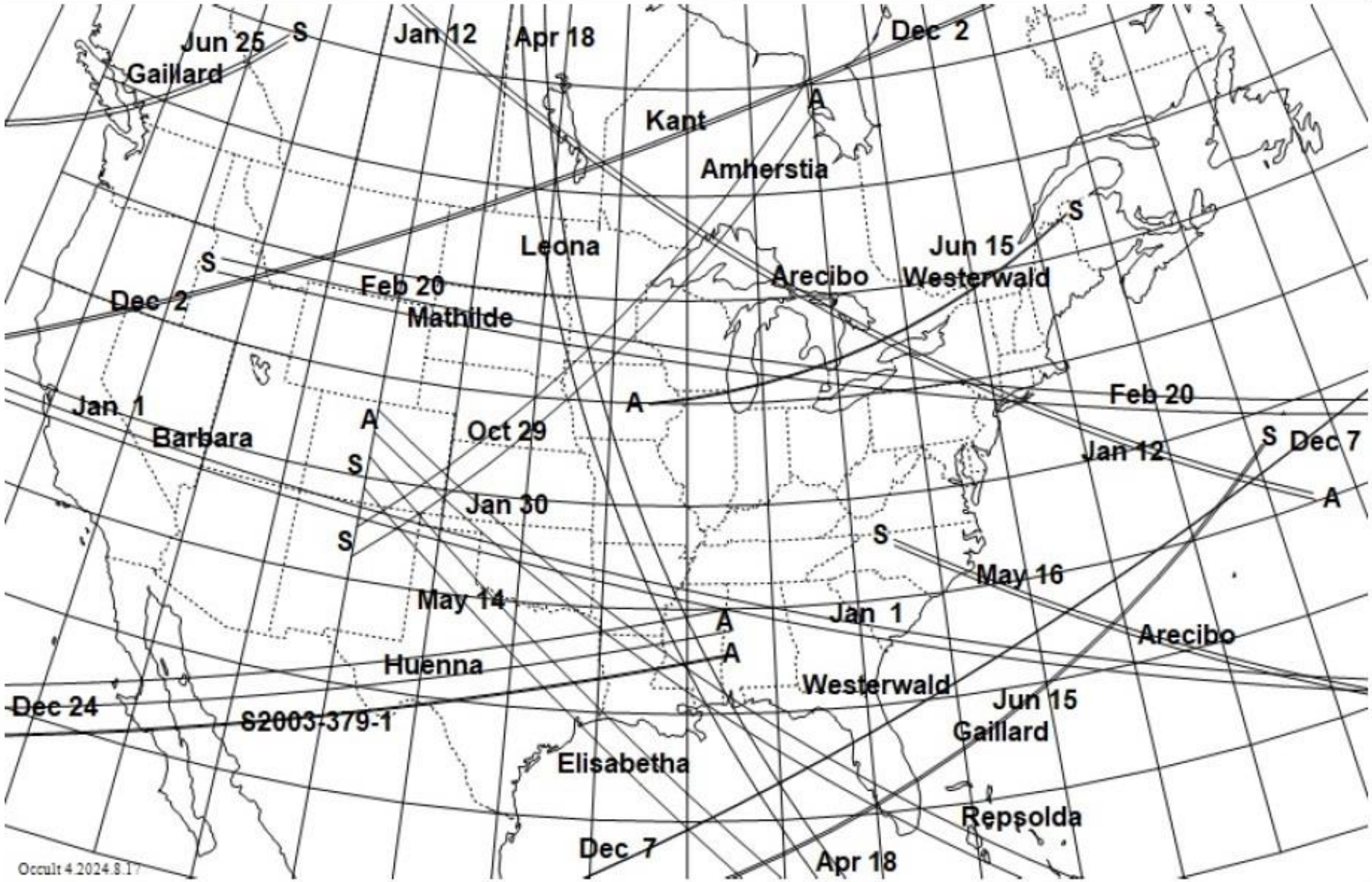
2024 Feb. 1, (5232) Jordaens, Alberta, Canada , ↑ and →

Occultations by Special Main-Belt Asteroids

1. IOTA is now predicting and encouraging observation of 71 special main-belt asteroids, including:
2. Binary objects discovered or suspected from past occultations, like the ones shown in the previous slide; there are several others
3. Targets of spacecraft missions (planned and past flybys)
4. The better asteroids that may have moons based on Gaia observations (Europe's Gaiamoons program)
5. Asteroids that likely have satellites from light-curve observations
6. Others with unusual occultation shapes or other characteristics
7. On Sep. 14, an occultation by binary (4337) Arecibo will occur in USA

Most of the 71 objects are described at
https://occultations.org/publications/rasc/2024/nam24MBspecialoccs.htm

2025 OCCULTATIONS BY SPECIAL MAIN-BELT ASTEROIDS

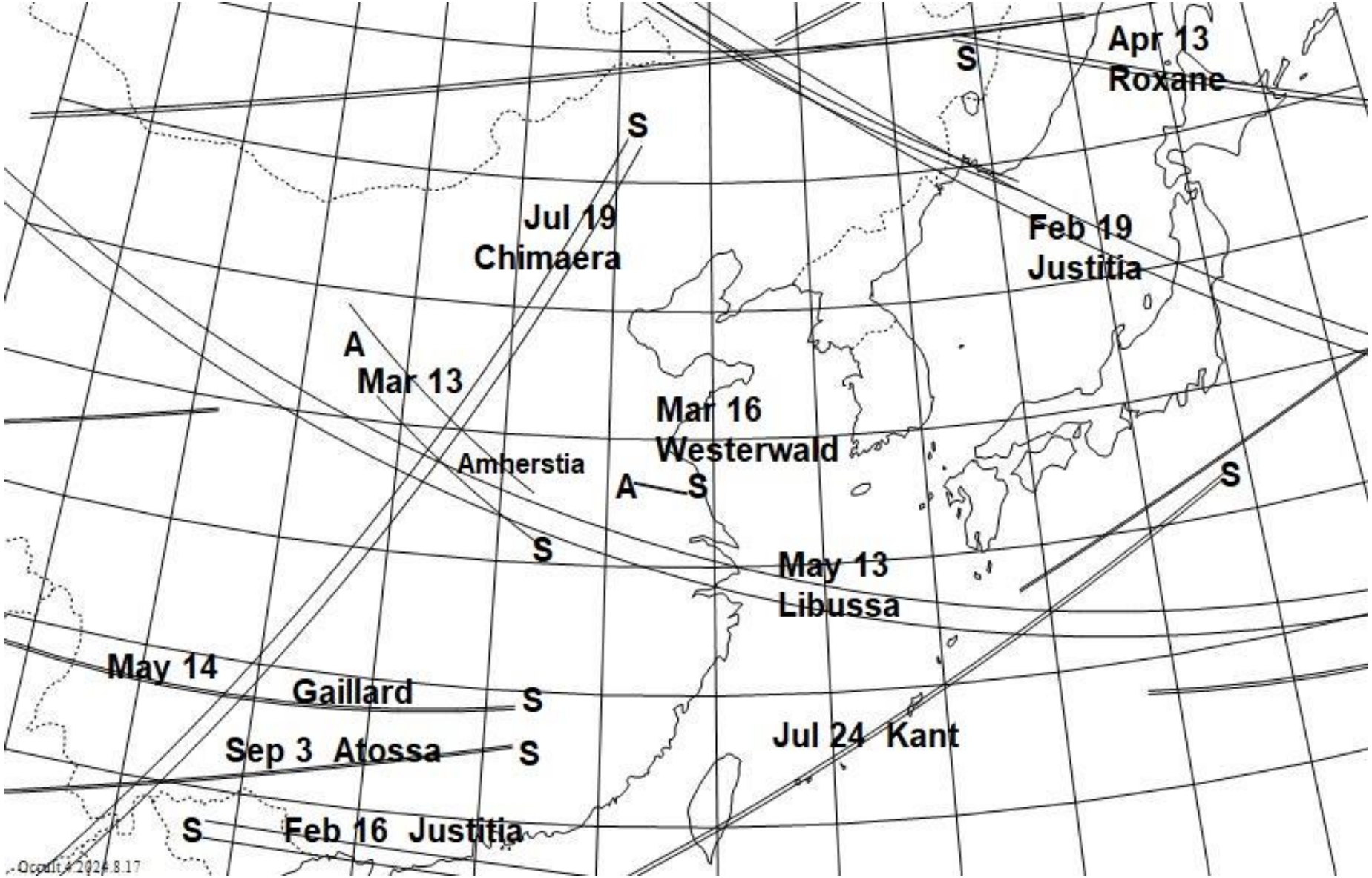


2025 OCCULTATIONS BY SPECIAL MAIN-BELT ASTEROIDS

Date	UT	Occulting Body	Star	Mag.	RA (2000) h m s	Dec ° ′ ″	ΔMag.	Dur. s	Path
Jan. 01	04:57	234 Barbara	TYC 0796-00572-1	10.6	08 28 59.2	08 23 40	2.7	3.7	SC-CA
Jan. 12	09:50	4337 Arecibo	UCAC4 578-036587	12.1	07 00 22.6	25 30 20	5.3	1.4	NY-SK
Jan. 30	10:57	906 Repsolda	SAO 184211	8.2	16 11 52.6	–22 32 43	7.1	2.3	CO-FL
Feb. 20	02:07	253 Mathilde	PPM 156225	9.5	09 49 27.9	07 51 43	5.4	3.6	NY-ID
Apr. 18	05:33	319 Leona	UCAC4 473-046221	9.1	10 50 55.2	04 29 58	7.1	9.4	MS-MB
May 14	02:57	412 Elisabetha	TYC 1964-00239-1	9.9	09 53 08.6	26 10 44	4.5	5.7	CO-TX
May 16	01:20	4337 Arecibo	UCAC4 569-040040	11.3	07 31 11.5	23 43 06	7.5	0.6	NC
Jun. 15	07:07	10253 Westerwald	PPM 207368	10.3	23 16 55.5	–05 06 02	10.0	0.2	IA-NB
Jun. 15	07:35	10424 Gaillard	UCAC4 341-199151	11.9	20 38 39.8	21 55 39	6.7	1.9	FL
Jun. 25	09:36	10424 Gaillard	TYC 6342-00379-1	10.4	20 33 49.5	–22 18 58	8.1	1.0	AB-BC
Oct. 29	01:01	516 Amherstia	PPM 270836	10.4	20 12 35.1	–21 14 53	2.9	3.0	NM-ON
Dec. 02	06:40	7083 Kant	SAO 93645	8.0	03 52 36.5	19 36 29	7.8	1.6	QC-CA
Dec. 07	01:50	10253 Westerwald	PPM 206928	9.4	22 55 11.0	–07 13 06	10.7	0.1	FL
Dec. 24	04:07	379 S2003-379-1	SAO 146655	8.7	23 21 5.1	–04 46 17	5.5	0.2	Baja-AL
Dec.[1]24	04:09	379 Huenna	SAO 146655	8.7	23 21 5.1	–04 46 17	5.5	3.5	Baja-MS

1

2025 special Main Belt occultations, East Asia



2025 special Main Belt occultations, East Asia

Date	U.T.	Diameter		Durn	Star	Mag-Drop		Elon	%	Star	d	Rely	Planet		Min		Moon	
m d	h m	km	"	sec/m	mag	V	R *	o	Ill	No.		<1.4	No	Name	D	Error	Dist	ill
Jan 13	21 35.9	18	0.011	1.26s	9.2	5.4	5.0	95		HIP 64151	s	1.10	317	Roxane	0.76	±0.00	85	100
Feb 10	9 33.2	6.9	0.004	0.98s	10.6	7.6	7.4	119		TYC 2913-02250-1	s	0.95	7165	Pendleton	0.37	±0.00	35	95
Feb 16	11 44.9	56	0.036	4.7s	9.6	5.0	4.4	151		TYC 1376-01160-1	s	0.90	269	Justitia	0.09	±0.00	73	86
Feb 19	15 21.8	56	0.036	5.1s	10.3	4.4	4.1	148		TYC 1380-01792-1	s	1.20	269	Justitia	0.58	±0.00	110	60
Mar 13	21 48.8	66	0.045	2.3s	10.8	1.9	1.8	73		UCAC4 274-183260	s	0.95	516	Amherstia	0.86	±0.00	111	100
Mar 16	21 27.6	2.16	0.001	0.06s	9.9	11.0	10.7	37		UCAC4 373-184296	s	0.95	10253	Westerwald	0.82	±0.00	114	94
Apr 13	10 53.5	18	0.017	1.62s	10.7	2.5	2.1	169		TYC 4952-00198-1	K	1.00	317	Roxane	0.45	±0.00	17	100
May 13	14 26.2	58	0.038	4.1s	10.9	2.4	2.5	178		UCAC4 350-075139		1.05	264	Libussa	0.73	±0.00	9	99
May 14	20 38.3	6.6	0.005	0.81s	11.2	8.1	8.0	109		TYC 6342-00824-1		1.10	10424	Gaillard	0.75	±0.00	47	96
Jul 19	19 42.4	44	0.028	2.1s	10.5	5.0	4.8	88		UCAC4 564-002772	s	1.15	623	Chimaera	0.55	±0.00	24	30
Jul 24	18 48.4	13	0.008	0.47s	11.2	6.7	6.6	74		UCAC4 557-005787		1.10	7083	Kant	0.39	±0.00	74	0
Aug 25	17 44.9	14	0.007	0.45s	11.3	5.6	5.6	54		UCAC4 548-030026	s	1.00	699	Hela	0.52	±0.00	84	6
Aug 28	21 47.9	8.0	0.005	0.25s	11.2	6.2	5.9	57		TYC 1341-00248-1	s	1.05	810	Atossa	0.30	±0.00	121	28
Sep 2	18 25.0	6.5	0.003	0.16s	10.2	8.1	7.3	43		TYC 1930-00944-1		1.15	5044	Shestaka	0.27	±0.00	162	73
Sep 3	16 18.0	42	0.021	1.89s	10.6	4.1	3.9	74		UCAC4 589-021121	s	0.95	550	Senta	0.15	±0.00	157	81
Sep 3	21 20.5	8.1	0.005	0.26s	10.7	6.6	6.4	60		UCAC4 554-031658	s	0.85	810	Atossa	0.11	±0.00	166	83
Sep 9	9 48.6	7.3	0.003	0.20s	9.2	9.0	8.4	46		UCAC4 410-058242	s	0.95	1800	Aguilar	0.75	±0.00	156	96
Sep 12	19 20.3	14	0.007	0.55s	10.3	6.5	5.9	66		TYC 1348-01030-1		1.05	699	Hela	0.35	±0.00	47	68

Generated from Occult4 Input file 2025MBspecialToMag16elongGT15.xml.
Westerwald is the first (small) flyby target of the United Emirates Main-Belt mission that plans to launch in March 2028. Chimaera and Justitia are the largest targets of the mission, while Justitia is the last (rendezvous) target and an unusual red object, likely originally a TNO or Centaur.
Gaillard was discovered to be binary from an occultation observed in January, and confirmed with rotational light-curve observations.