

Occultations observed by the Sabadell group during the last year

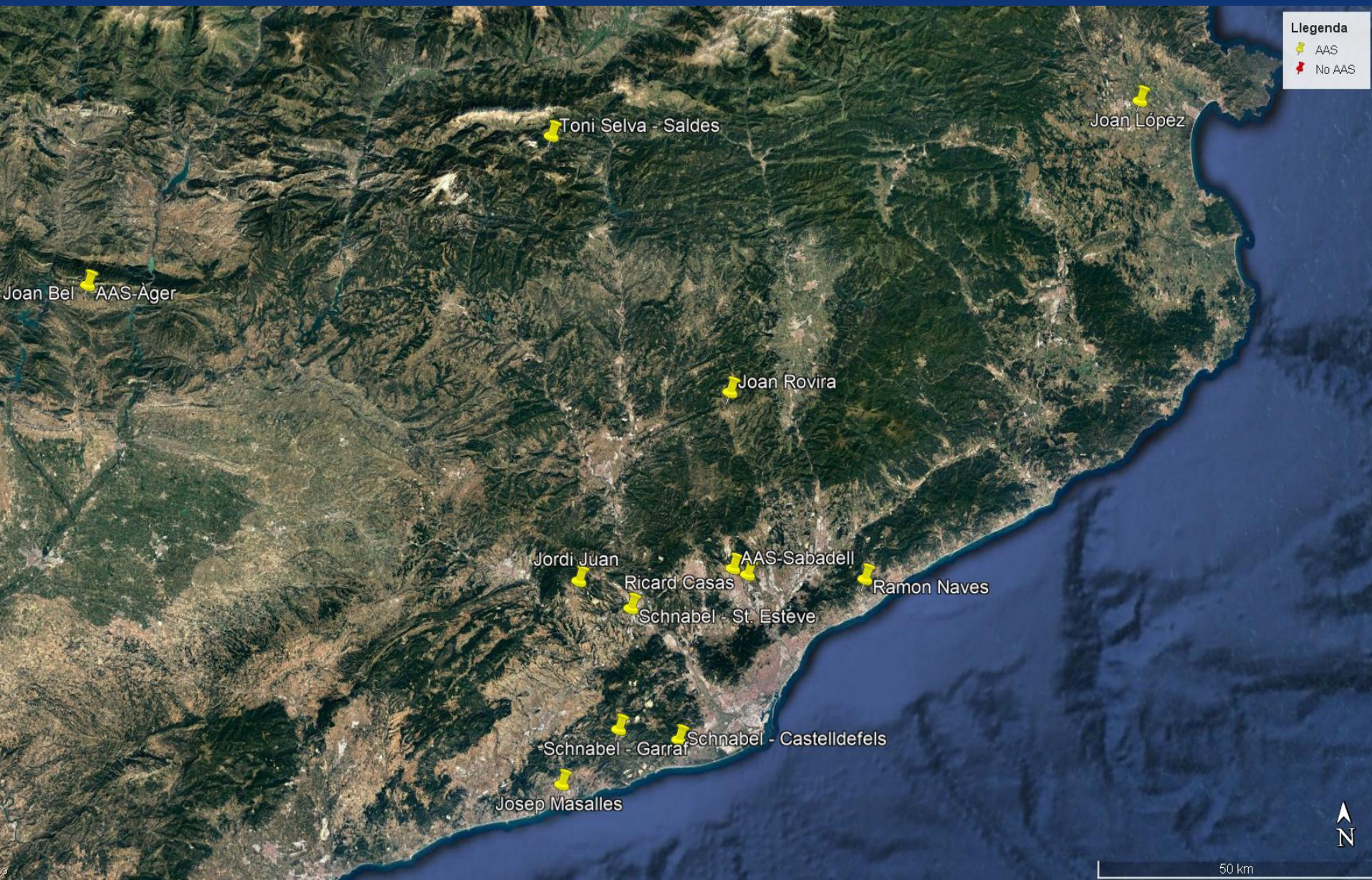
Antoni Selva & Carles Schnabel

IOTA/ES - AAS

ESOP XXXVIII

Paris • France

The Sabadell group



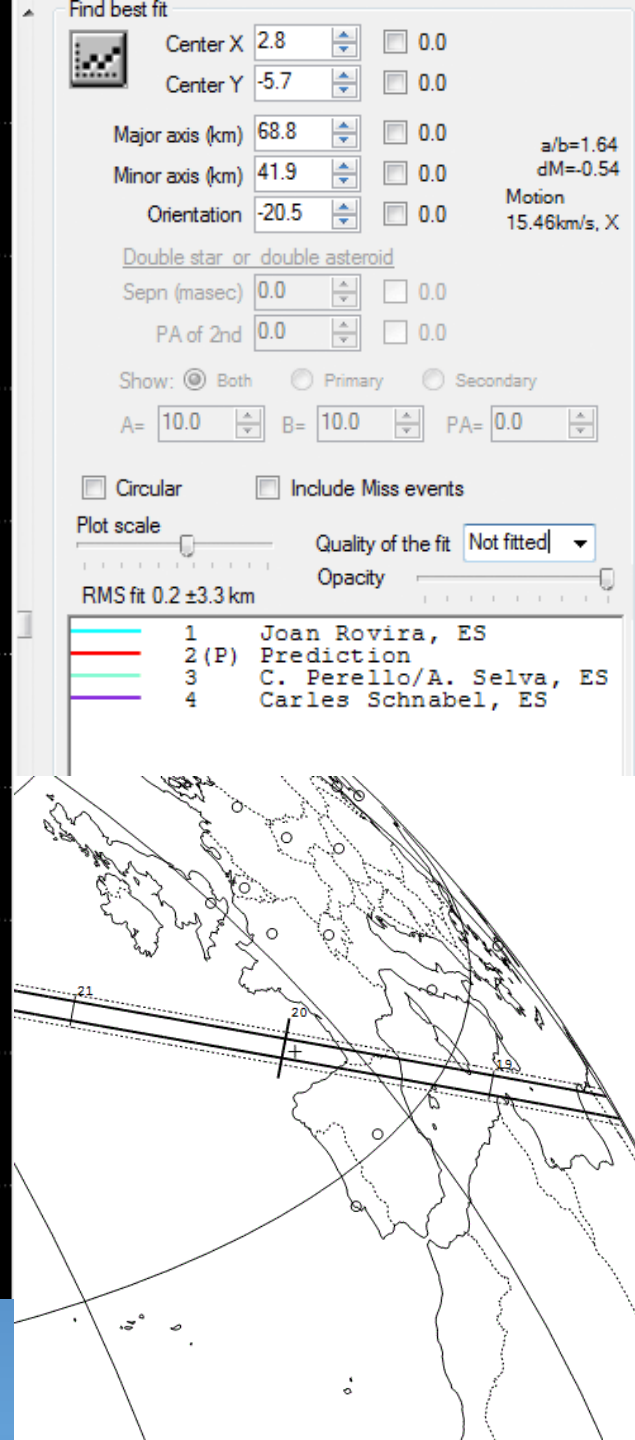
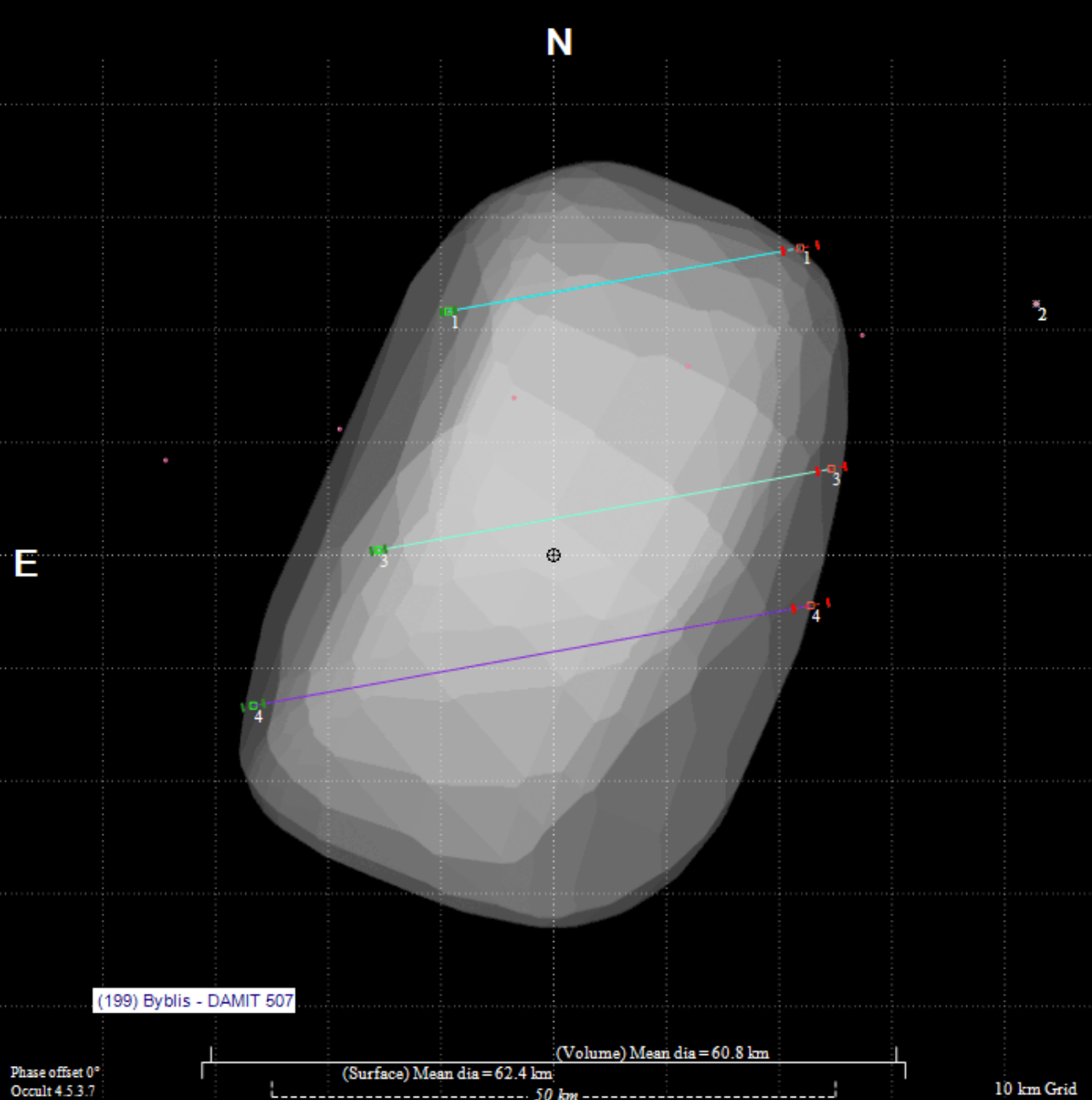
The Sabadell group +



Number of observed events

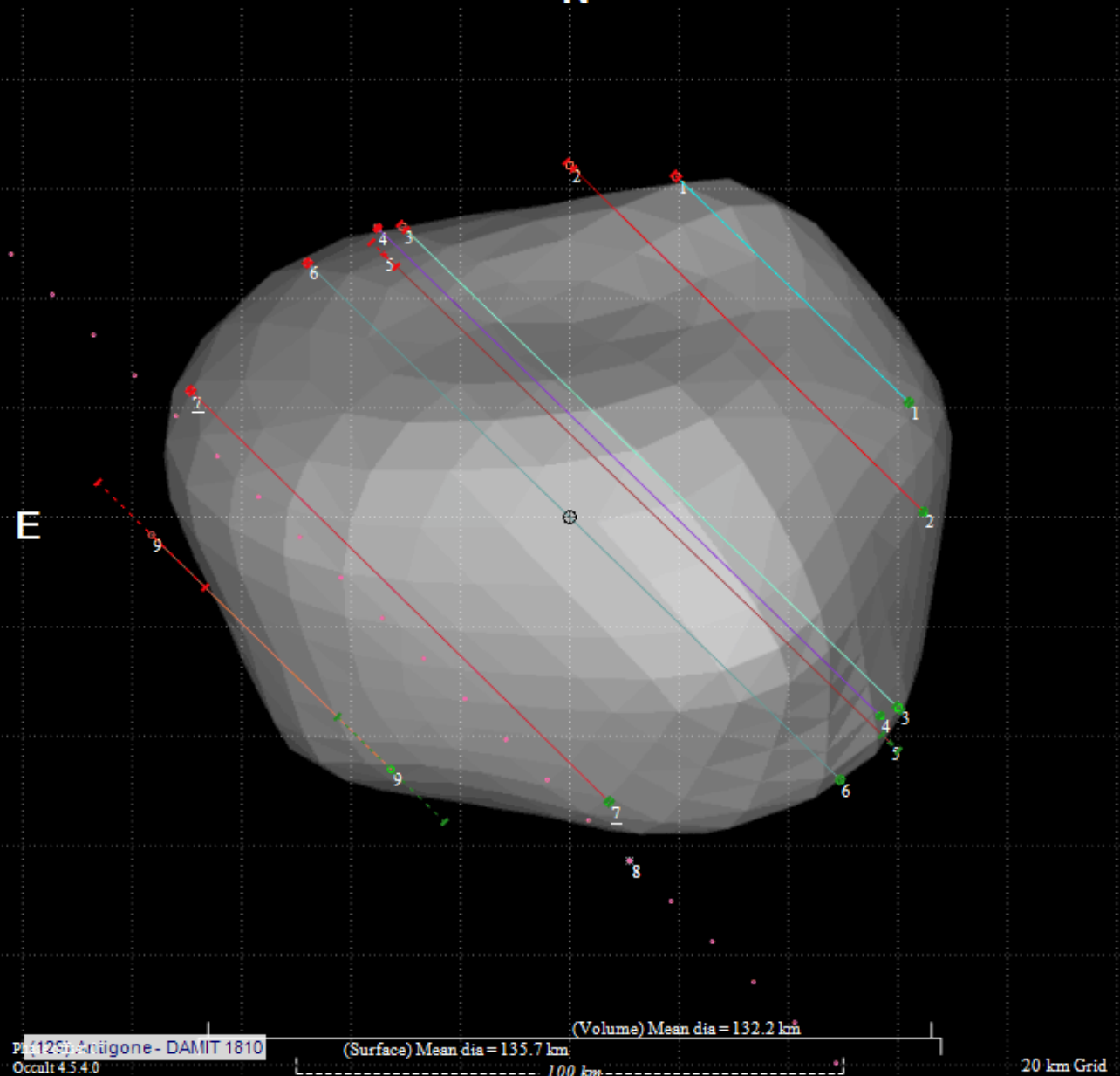
2018: 136 21(+) 15%

2019 (til Aug 25th) : 149 10(+) 8%



199 Byblis – 2018 01 02

(129) Antigone 2018 Feb 23 128.4 ± 5.2 x 128.4 km, PA 0.0°
 Geocentric X 1898.8 ± 1.8 Y 3840.9 ± 2.2 km



Find best fit

Center X 6.9 ☒ 0.0
 Center Y -6.5 ☒ 0.0

Major axis (km) 128.4 ☒ 0.1
 Minor axis (km) 128.4 ☐ 0.0
 Orientation 0.0 ☐ 0.0

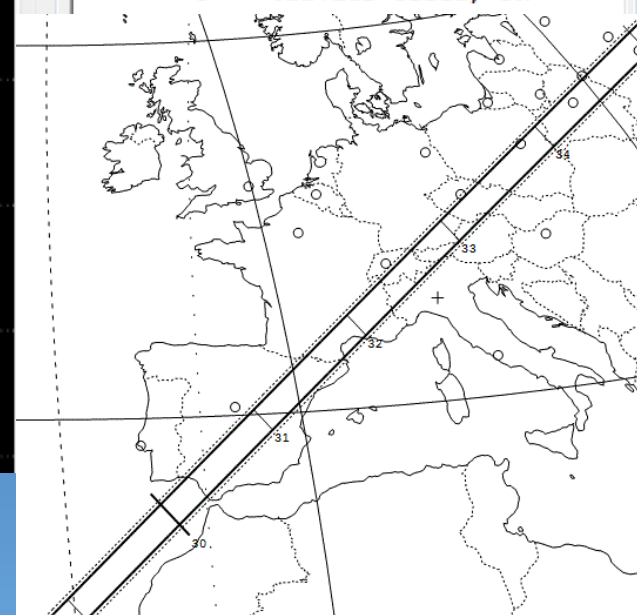
Double star or double asteroid
 Sepn (masec) 0.0 ☐ 0.0
 PA of 2nd 0.0 ☐ 0.0

Show: ☒ Both ☐ Primary ☐ Secondary
 A= 10.0 B= 10.0 PA= 0.0

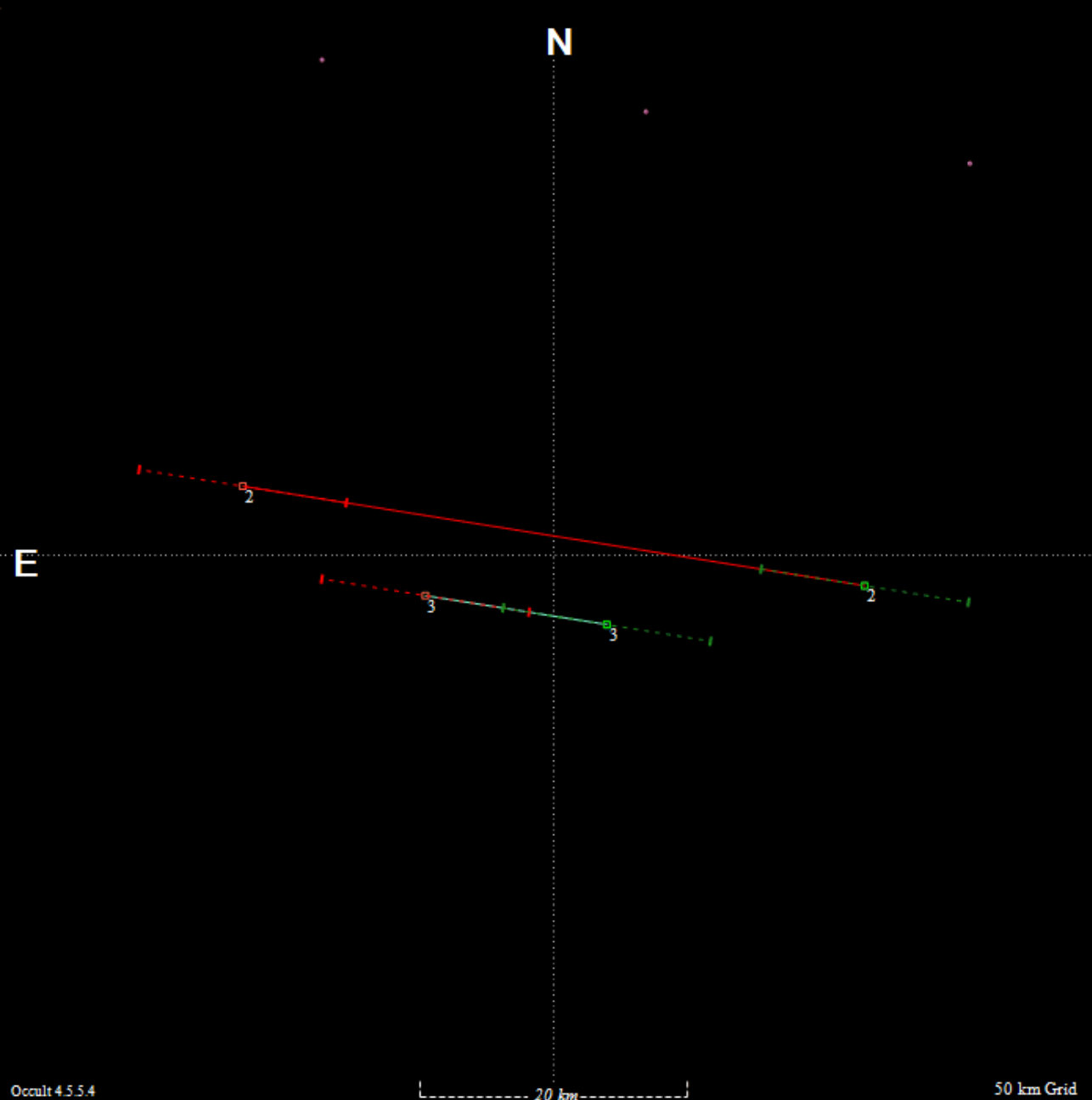
☒ Circular ☐ Include Miss events

Plot scale Quality of the fit Not fitted
 RMS fit 1.5 ± 4.8 km Opacity

1	Jiri Polak, CZ
2	P Andre/ML Faye/A Parou
3	Karel Halir, CZ
4	Michal Rottenborn, CZ
5	Wojciech Burzynski, PL
6	Jiri Kubanek, CZ
7	Oscar Canales, ES
8 (P)	Prediction
9	Olivier Gadal, FR



129 Antigone – 2018 02 23



Find best fit

Center X 3.2 ☐ 0.0

Center Y 4.0 ☐ 0.0

Major axis (km) 32.0 ☐ 0.0

Minor axis (km) 32.0 ☐ 0.0

Orientation 0.0 ☐ 0.0

Double star or double asteroid

Seprn (masec) 0.0 ☐ 0.0

PA of 2nd 0.0 ☐ 0.0

Show: ☒ Both ☐ Primary ☐ Secondary

A= 10.0 B= 10.0 PA= 0.0

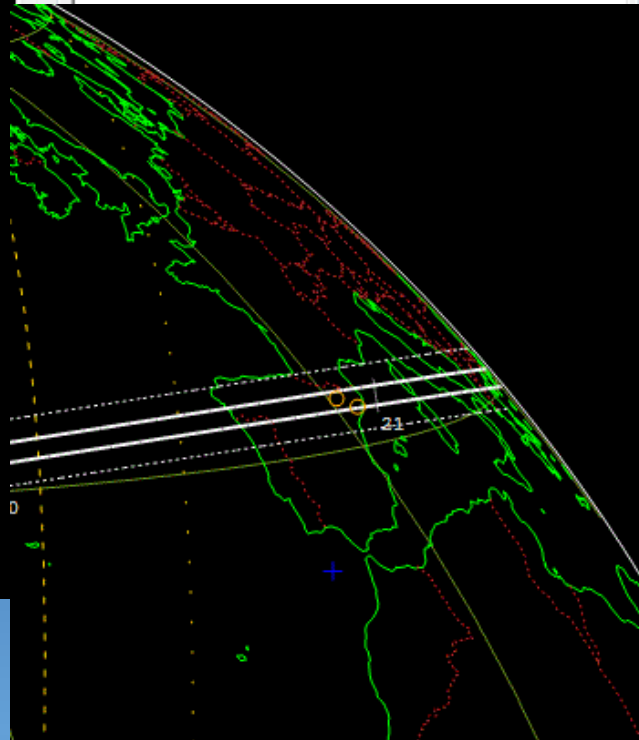
☒ Circular ☐ Include Miss events

Plot scale Quality of the fit Not fitted

RMS fit 1.8 ± 6.5 km Opacity

1 (P)	Prediction
2	Carlos Perello, ES
3	Carles Schnabel, ES

a/b=1.00
dM=0.00
Motion 24.23km/s, X



1031 Arctica – 2018 04 18

(52) Europa 2018 Jul 5 346.8 ± 11.9 x 299.3 ± 12.1 km. PA 31.5° ± 18.8°
Geocentric X 2294.3 ± 2.4 Y 5335.2 ± 4.6 km

N

E

(52) Europa - #2

52 Europa – 2018 07 05

Phase offset 0°
Occult 4.5 10.1

200 km

50 km Grid

Find best fit

Center X -5.4 0.0
Center Y -3.5 0.0

Major axis (km) 346.8 0.0
Minor axis (km) 299.3 0.0
Orientation 31.5 0.0

a/b=1.16
dM=-0.16
Motion 12.63km/s, X

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

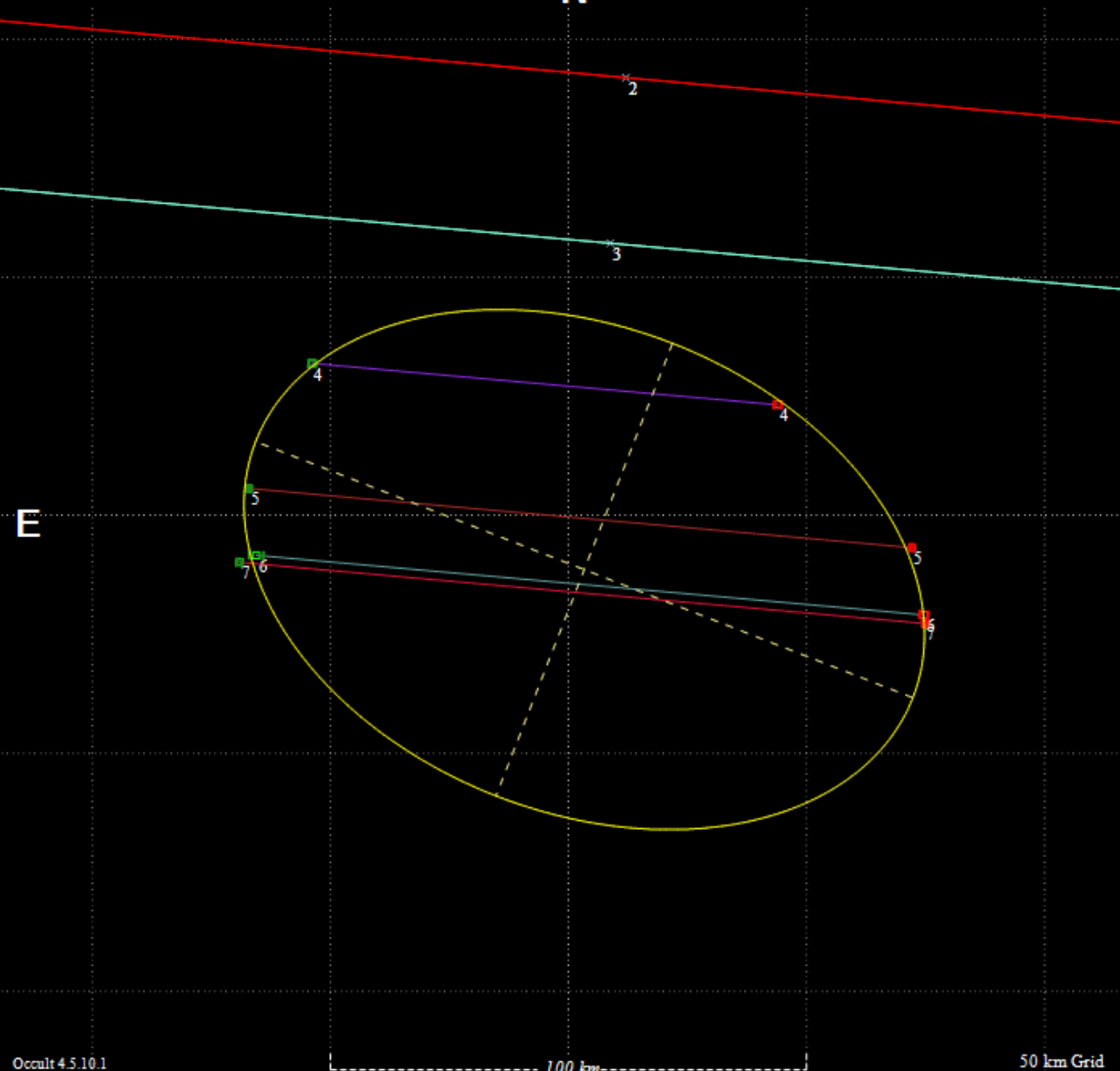
Show: ☒ Both ☐ Primary ☐ Secondary
A= 10.0 B= 10.0 PA= 0.0

☒ Circular ☐ Include Miss events
Plot scale Quality of the fit Not fitted
RMS fit -0.7 ± 7.4 km Opacity

1	Gerard Vaudescal, FR
2	Michel Boutet, FR
3 (P)	Prediction
4	C. Perello/A. Selva, ES
5	Emmanuel Arbouch, FR
6	Joan Rovira, ES
7	Jesus Delgado, ES
8	C. Perello/A. Selva, ES



(268) Adorea 2018 Jul 17 148.1 $\pm$ 2.1 x 102.0 $\pm$ 6.8 km. PA 68.7° $\pm$ 4.3°
 Geocentric X 2464.6 $\pm$ 0.6 Y 5401.2 $\pm$ 2.9 km



Find best fit

Center X 0.5 ☒ 0.0
 Center Y -46.0 ☒ 0.0

Major axis (km) 148.1 ☒ 0.0
 Minor axis (km) 102.0 ☒ 0.0
 Orientation 68.7 ☒ 0.0

a/b=1.45
 dM=0.40
 Motion 9.71km/s, X

Double star or double asteroid

Seprn (masec) 0.0 ☐ 0.0
 PA of 2nd 0.0 ☐ 0.0

Show: ☒ Both ☐ Primary ☐ Secondary

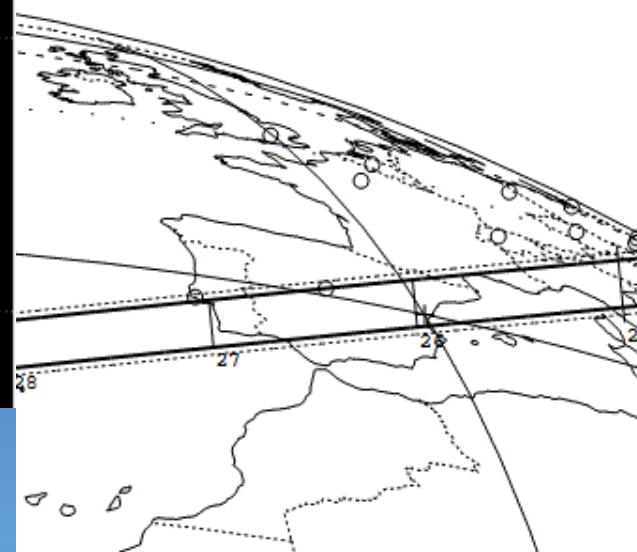
A= 10.0 B= 10.0 PA= 0.0

☐ Circular ☒ Include Miss events

Plot scale Quality of the fit Not fitted

RMS fit 0.0 $\pm$ 1.1 km Opacity

1 (P)	Prediction
2 (M)	Rui Goncalves, PT
3 (M)	Oscar Canales, ES
4	Patrick Sogorb, FR
5	Joan Rovira, ES
6	Carles Schnabel, ES
7	Antoni Selva, ES



268 Adorea – 2018 07 17

(97) Klotho 2018 Jul 26 $87.6 \pm 5.3 \times 87.6$ km. PA 0.0°
 Geocentric X 2466.8 ± 2.0 Y 4952.4 ± 2.2 km

E

N

Occult 4.5.10.1

50 km

50 km Grid

97 Klotho – 2018 07 26

Find best fit



Center X -1.0 ☒ 0.0

Center Y -3.2 ☒ 0.0

Major axis (km) 87.6 ☒ 0.0

Minor axis (km) 87.6 ☐ 0.0

Orientation 0.0 ☐ 0.0

a/b=1.00

dM=0.00

Motion

13.24km/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= 10.0 B= 10.0 PA= 0.0

☒ Circular

☐ Include Miss events

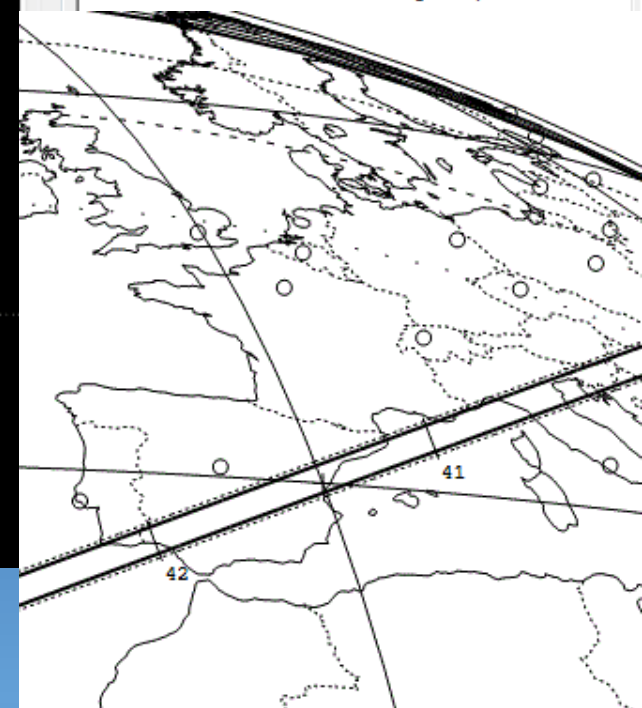
Plot scale

Quality of the fit Not fitted

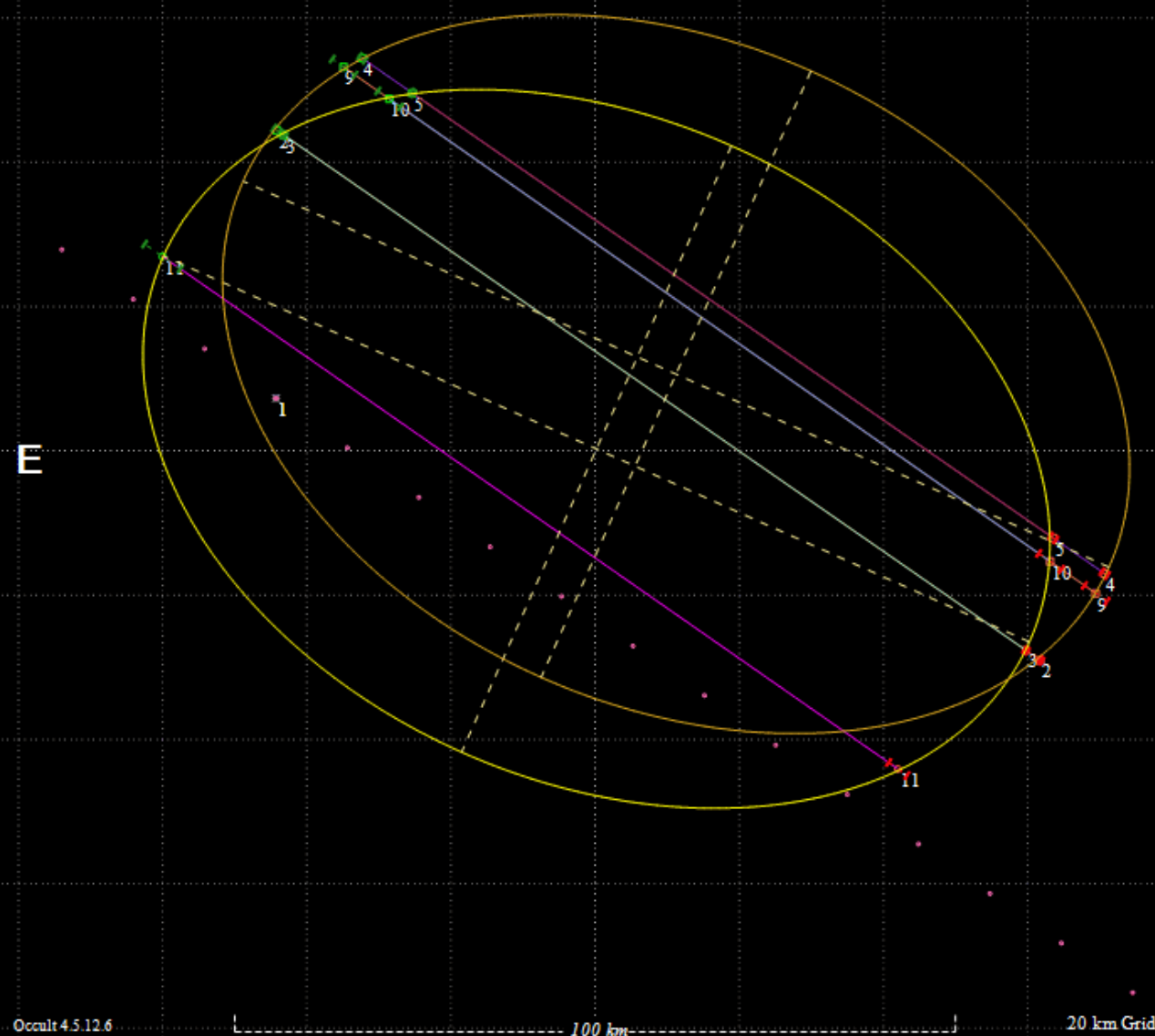
RMS fit 1.4 ± 4.2 km

Opacity

- | | |
|-------|-------------------------|
| 1 | Matthieu Conjat, FR |
| 2 | C. Perello/A. Selva, ES |
| 3 (P) | Prediction |
| 4 | Pietro Baruffetti, IT |
| 5 | Jesus Delgado, ES |



(476) Hedwig 2018 Nov 13 $131.5 \pm 0.2 \times 92.0 \pm 1.3$ km, PA $66.0^\circ \pm 0.7^\circ$
 Geocentric X -3094.1 ± 0.2 Y 1848.3 ± 0.2 km
 Double : Sep $0.0118 \pm 0.0004''$, PA $133.2^\circ \pm 0.5^\circ$



Find best fit

Center X ☐ 0.0
 Center Y ☐ 0.0

Major axis (km) ☐ 0.0
 Minor axis (km) ☐ 0.0
 Orientation ☐ 0.0

a/b=1.43
 dM=-0.39
 Motion 9.90km/s, X

Double star
 Sepn (masec) ☐ 0.0
 PA of 2nd ☐ 0.0

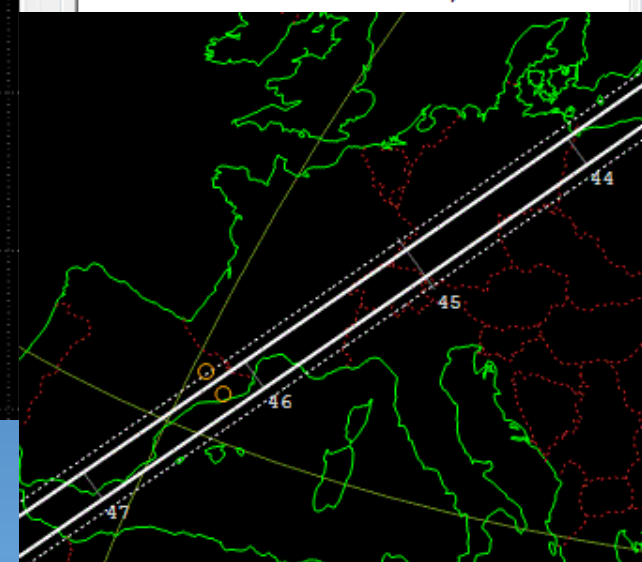
Show: ☒ Both ☐ Primary ☐ Secondary

A= B= PA=

☐ Circular ☐ Include Miss events

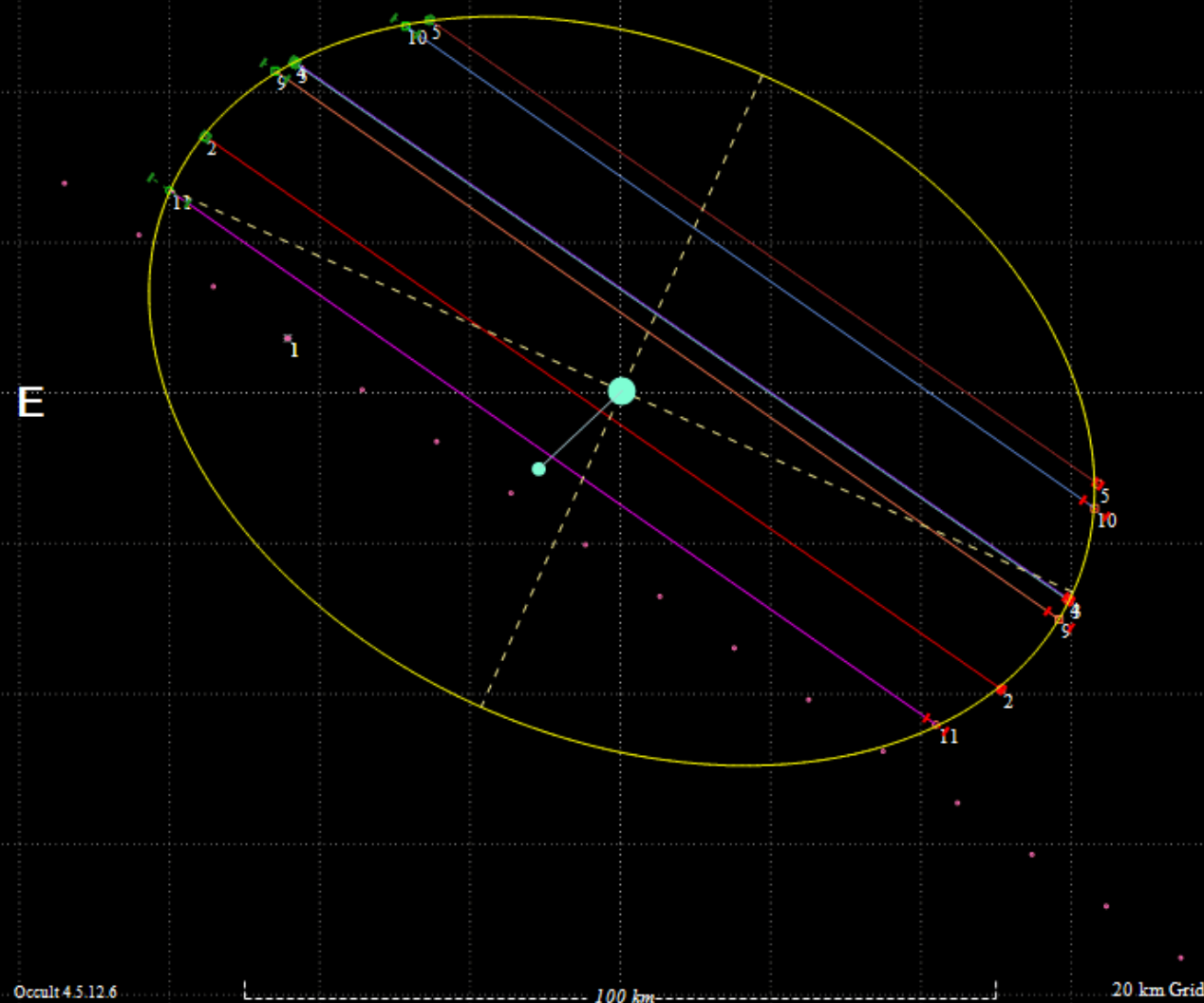
Plot scale Quality of the fit
 RMS fit 0.0 ± 0.2 km Opacity

1 (P)	Prediction
2	C. Perello/A. Selva, ES
3	C. Perello/A. Selva, ES
4	Joan Rovira, ES
5	Joan Rovira, ES
6 (M)	Alberto Ossola, CH
7 (M)	Jiri Polak, CZ
8 (M)	Michal Rottenborn, CZ
9	Christian Weber, DE
10	Christian Weber, DE
11	Stefan Meister, CH



476 Hedwig – 2018 11 13

(476) Hedwig 2018 Nov 13 $131.5 \pm 0.2 \times 92.0 \pm 1.3$ km, PA $66.0^\circ \pm 0.7^\circ$
 Geocentric X -3094.1 ± 0.2 Y 1848.3 ± 0.2 km
 Double : Sep $0.0118 \pm 0.0004''$, PA $133.2^\circ \pm 0.5^\circ$



Find best fit

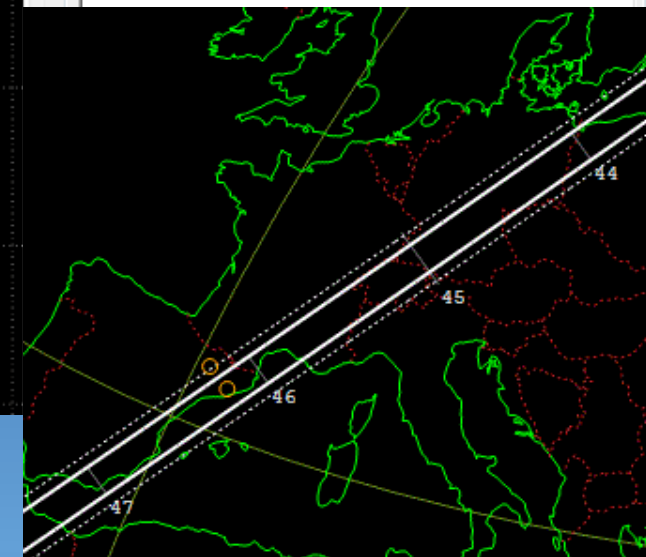
Center X	1.4	☒	0.0
Center Y	27.6	☒	0.0
Major axis (km)	131.5	☒	0.0
Minor axis (km)	92.0	☒	0.0
Orientation	66.0	☒	0.0
a/b=1.43 dM=-0.39			
Motion 9.90km/s, X			
<u>Double star</u>			
Sepn (masec)	11.8	☒	0.0
PA of 2nd	133.2	☒	0.0
Show:	☒ Both	☐ Primary	☐ Secondary
A=	10.0	B=	10.0
PA=	0.0		

☐ Circular ☐ Include Miss events

Plot scale Quality of the fit Not fitted

RMS fit 0.0 ± 0.2 km Opacity

- 1 (P) Prediction
- 2 C. Perello/A. Selva, ES
- 3 C. Perello/A. Selva, ES
- 4 Joan Rovira, ES
- 5 Joan Rovira, ES
- 6 (M) Alberto Ossola, CH
- 7 (M) Jiri Polak, CZ
- 8 (M) Michal Rottenborn, CZ
- 9 Christian Weber, DE
- 10 Christian Weber, DE
- 11 Stefan Meister, CH



476 Hedwig – 2018 11 13

987 Wallia occults UCAC4 570-044505 on 23h Dec 30 from 23h 3m to 23h 18m UT

Star:
 Mag V = 14.2; B = 14.9; R = 13.8
 RA = 8 34 24.0690 (J2000)
 Dec = 23 52 10.615
 [of Date: 8 35 31, 23 48 7]
 Prediction of 2018 Dec 23.0

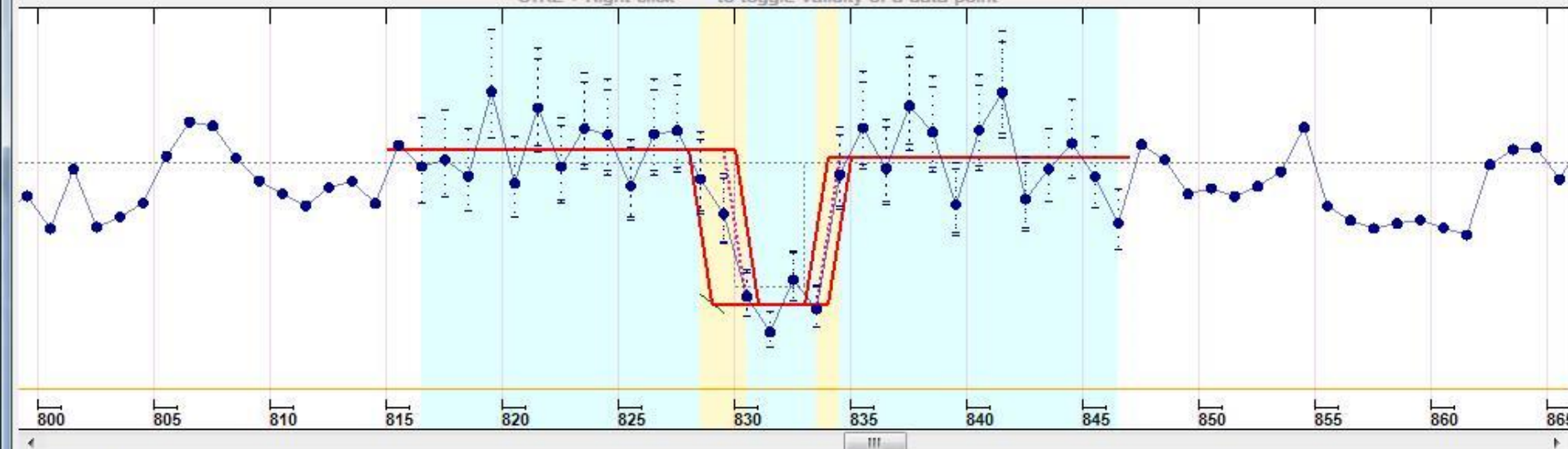
Max Duration = 3.7 secs
 Mag Drop = 1.2 (1.2r)
 Sun : Dist = 154°
 Moon: Dist = 83°
 : illum = 33 %
 E 0.023"x 0.024" in PA 90

Asteroid:
 Mag = 15.0
 Dia = 50km, 0.026"
 Parallax = 3.257"
 Hourly dRA = -1.798s
 dDec = 4.39"

AOTA v4.5.9.0 File being processed is 987.csv, measured with Tangra

File... Edit... Star diameter analysis... Light curve report ? Help ? Hints and Tips ✕ Exit

CTRL + Right-click - to toggle validity of a data point



Scale, Objects

Horizontal 15.0

1 5 10 15

Vertical 1.00

0 -point average

pts Target star

Comparison star 1

Comparison star 2

Comparison star 3

Background

1. Read, Integrity, Set time, Bin & normalise 2. (info) Fourier plot 3. Find events 4. Select event to analyse 5. Analyse event #1 6. Camera corrections & final times Event #1

Camera corrections

Video camera

WAT-910HX

Camera delay: 1.0 frames

Number of video frames integrated 0

Exposure delay: 0 frames

Video system

NTSC PAL Other Unknown (ADVS)

Set NTSC or PAL !!

Time difference from video stamp to start of exposure -0.040 secs

Final results ** Event #1

Time Source : Tangra Verify
 D at frame 830.0 +0.5/-1.5
 UTC of D 23 15 8.26 ± 0.16
 Transition 0 frames
 R at frame 834.0 +0.5/-0.5
 UTC of R 23 15 8.98 ± 0.08
 Transition 0 frames

Save AOTA images

Image format

jpeg

Save Tab 5 image for Event #1

Save Tab 4 image of plot analysis

4 events to analyse

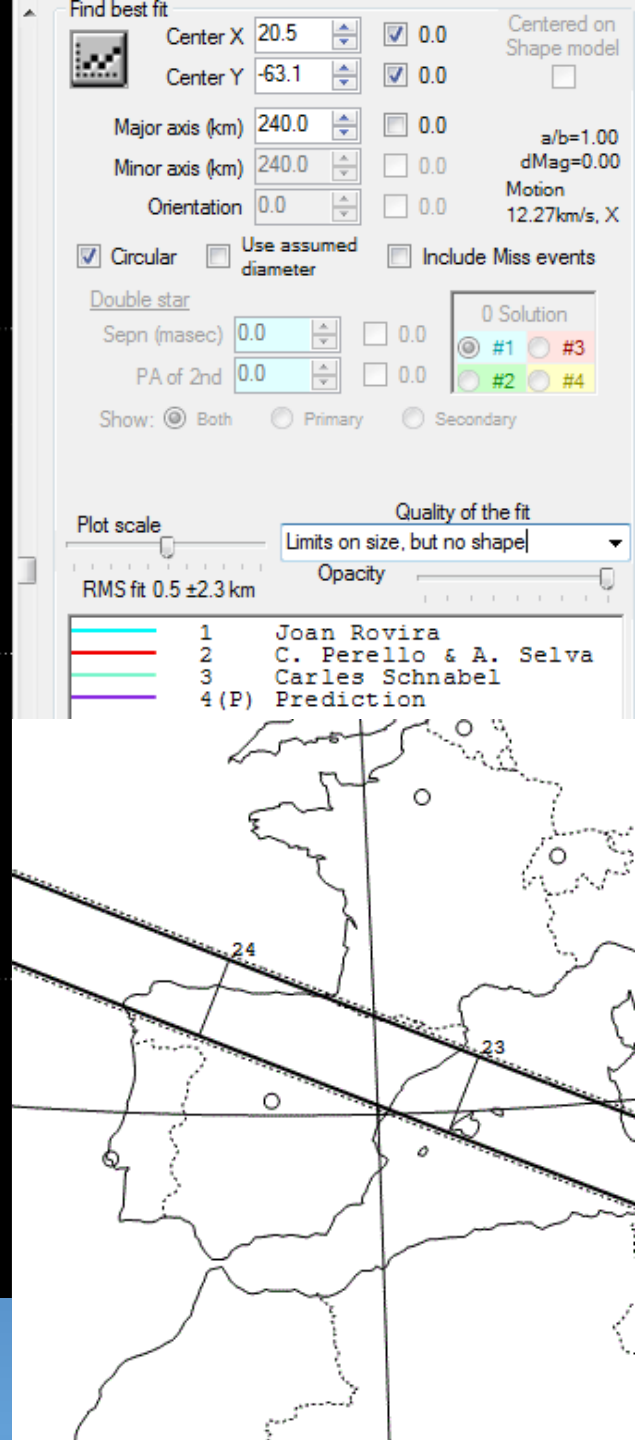
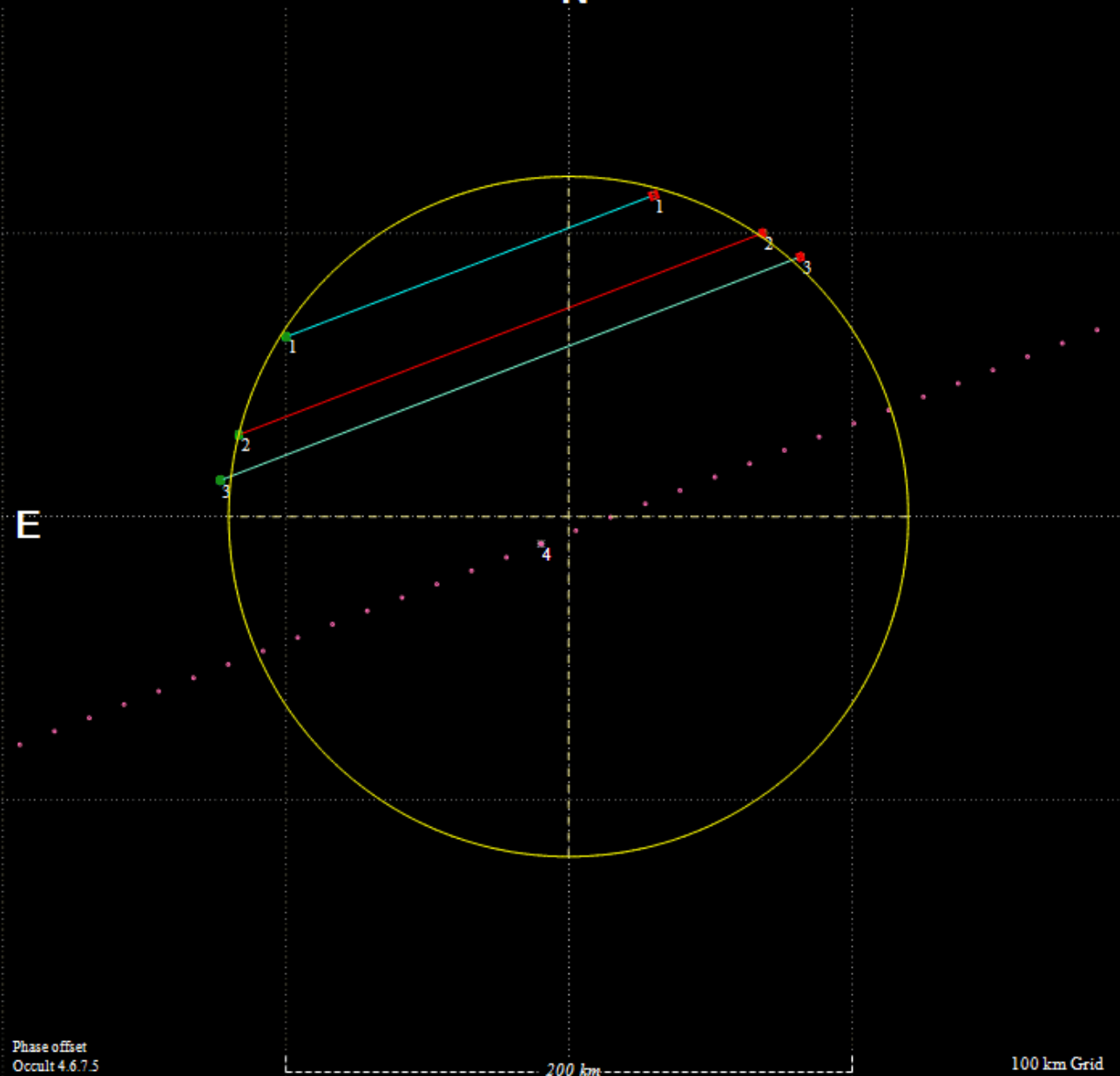
Set Event #1 as a non-event

View Report

Save Report

Light curve report

(451) Patientia 2019 Mar 18 240.0 x 240.0 km, PA 0.0°
 Geocentric X 426.1 ± 1.2 Y 1746.9 ± 1.5 km



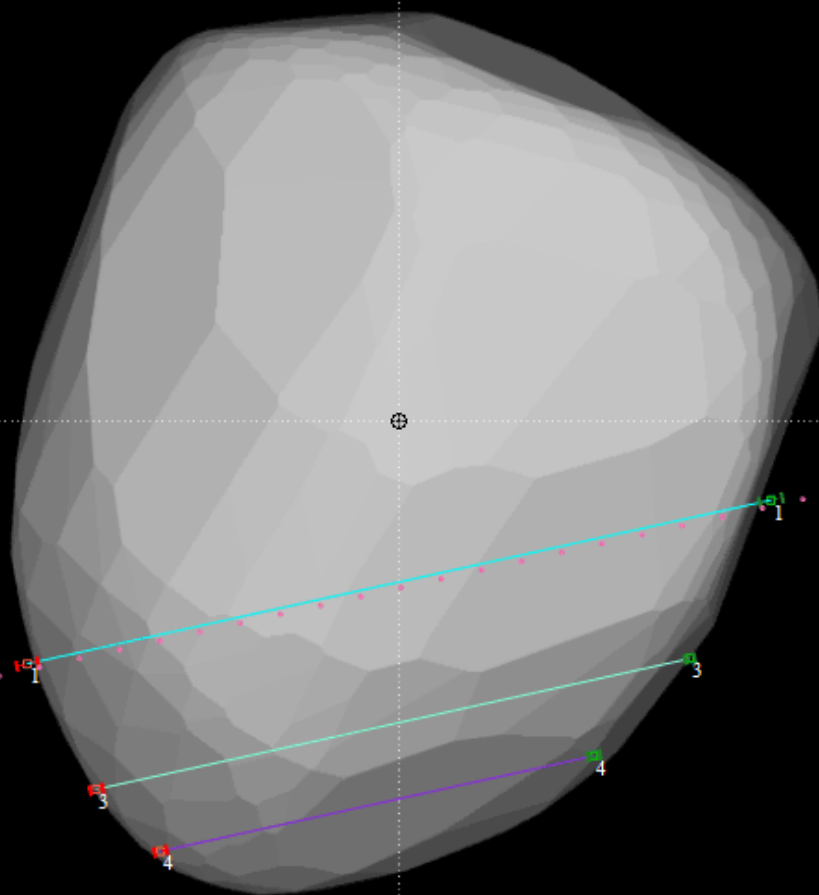
451 Patientia – 2019 03 18

(129) Antigone 2019 Apr 25 129.0 x 129.0 km. PA 0.0°
Geocentric X 3686.2 ± 1.7 Y 2903.3 ± 2.0 km

N

Sky Plane

E



DAMIT #159 v2011-03-28; Quality n/a

Phase offset 0°
Occult 4.6:7.5

(Surface) Mean dia = 134.9 km
(Volume) Mean dia = 132.0 km

100 km Grid

Find best fit

Center X -8.1 0.0 Centered on Shape model
Center Y 34.1 0.0

Major axis (km) 129.0 0.0 a/b=1.00
Minor axis (km) 129.0 0.0 dMag=0.00
Orientation 0.0 0.0 Motion 6.41km/s, X

☒ Circular ☒ Use assumed diameter ☐ Include Miss events

Double star
Sepn (masec) 0.0 0.0
PA of 2nd 0.0 0.0

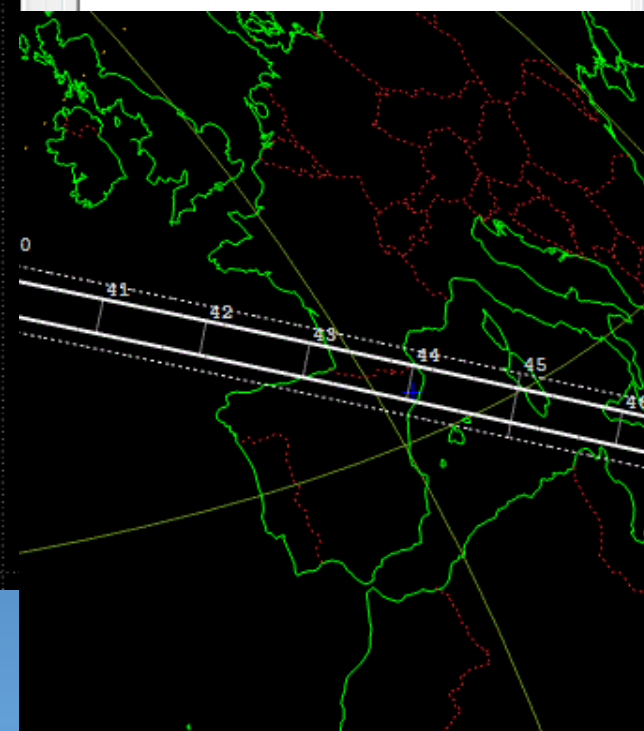
Show: ☒ Both ☐ Primary ☐ Secondary

Plot scale
RMS fit 0.0 ± 3.2 km

Quality of the fit
Limits on size, but no shape
Opacity

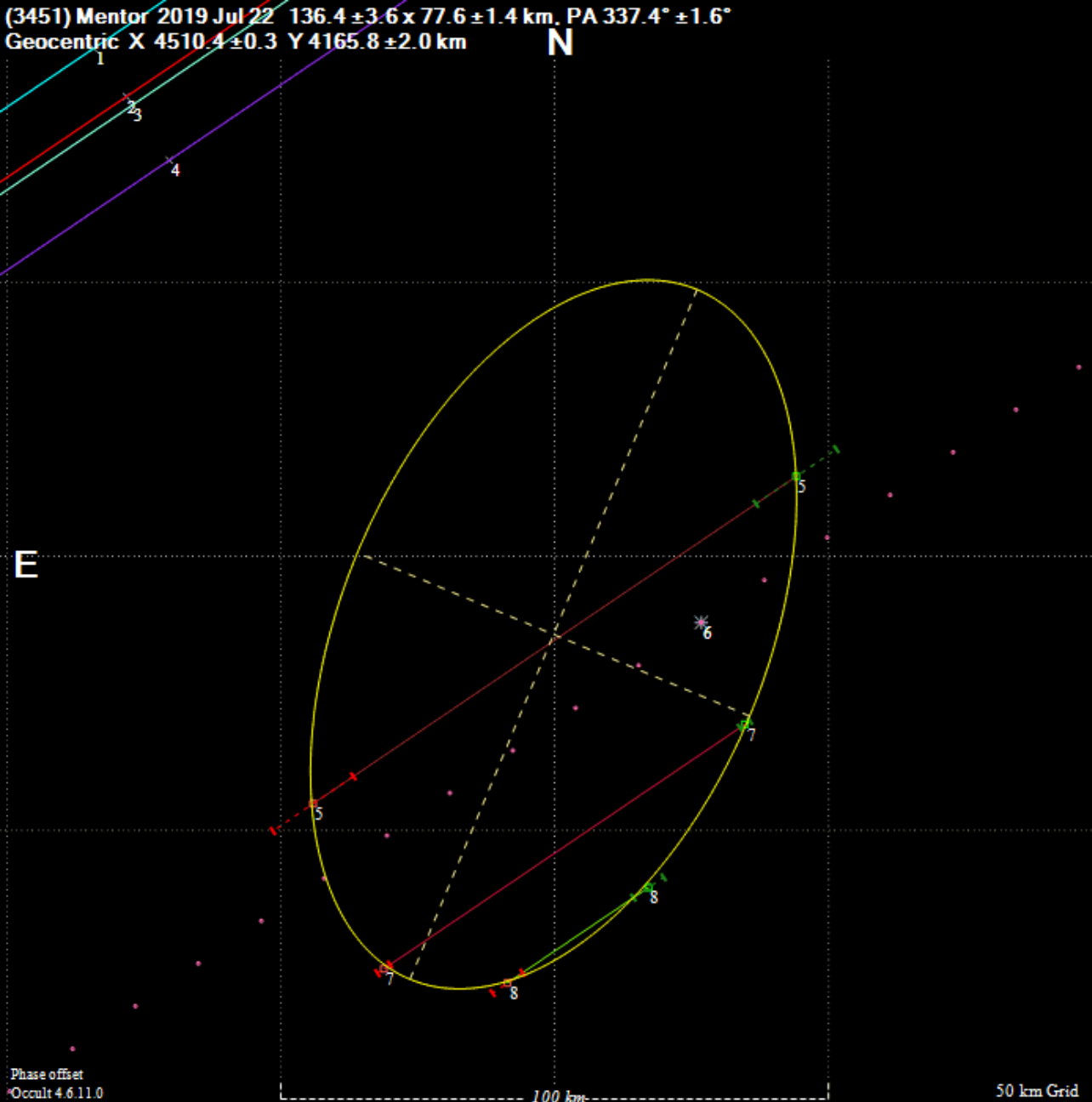
0 Solution
#1 #3
#2 #4

1 Joan Rovira
2 (P) Prediction
3 C. Perello & A. Selva
4 Carles Schnabel



129 Antigone – 2019 04 25

(3451) Mentor 2019 Jul 22 $136.4 \pm 3.6 \times 77.6 \pm 1.4$ km. PA $337.4^\circ \pm 1.6^\circ$
 Geocentric X 4510.4 ± 0.3 Y 4165.8 ± 2.0 km



Find best fit

Center X ☒ 0.0 Centered on Shape model ☐

Center Y ☒ 0.0

Major axis (km) ☒ 0.0 $a/b=1.76$

Minor axis (km) ☒ 0.0 $dMag=-0.61$

Orientation ☒ 0.0 Motion 11.49km/s, X

☐ Circular ☐ Use assumed diameter ☒ Include Miss events

Double star

Seprn (masec) ☐ 0.0

PA of 2nd ☐ 0.0

Show: ☒ Both ☐ Primary ☐ Secondary

0 Solution

☒ #1 ☐ #3

☐ #2 ☐ #4

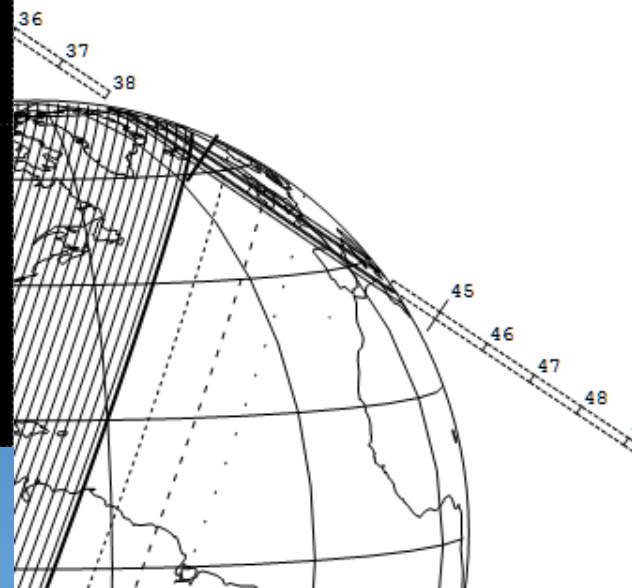
Plot scale

Quality of the fit

Limits on size, but no shape

Opacity

—	1 (M)	Alex Pratt
—	2 (M)	Adrian Jones
—	3 (M)	Tim Haymes
—	4 (M)	Peter Birtwhistle
—	5	Michel Boutet
—	6 (P)	Prediction
—	7	Joan Rovira
—	8	Carles Schnabel



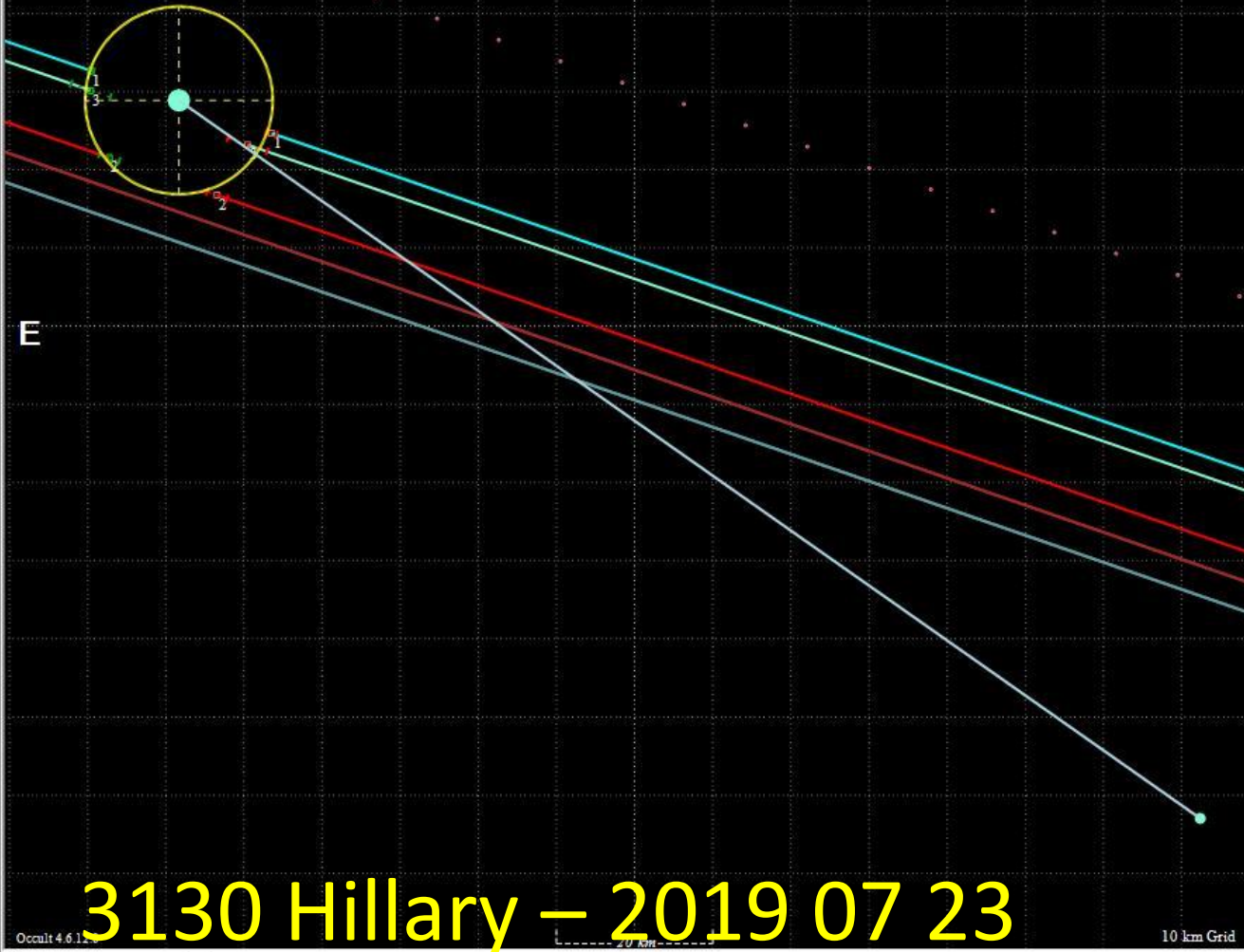
3451 Mentor – 2019 07 22

with Plot... Plot options... Help Keep form on top Exit Set Miss Times -Editor {Observer & time}

(3130) Hillary 2019 Jul 23 24.0 x 24.0 km, PA 0.0°
 Geocentric X 858.7 Y 5853.2 km
 Double : Sep 0.1938 ± 0.0006", PA 234.9° ± 0.3°

N

E



Find best fit

Center X -0.3

0.0

Centered on

Center Y 0.2

0.0

Shape model

Major axis (km) 24.0

0.0

a/b=1.00

Minor axis (km) 24.0

0.0

dMag=0.00

Orientation 0.0

0.0

Motion
7.86km/s, X☒ Circular☐ Use assumed diameter☒ Include Miss events

Double star

☒ 1/3 Plot scale

Sepn (msec) 193.8

☒ 0.0

PA of 2nd 234.9

☒ 0.0

2 solutions

☒ #1 ☐ #3☐ #2 ☐ #4Show: ☒ Both☐ Primary☐ Secondary

Set offsets

#1 (0.0,0.0)

#2 (0.0,0.0)

#3 (0.0,0.0)

#4 (0.0,0.0)

Plot scale

Quality of the fit

RMS fit -0.2 ± 0.8 km

Limits on size, but no shape

Opacity

1 C.Perello & A.Selva

2 Jiri Polak

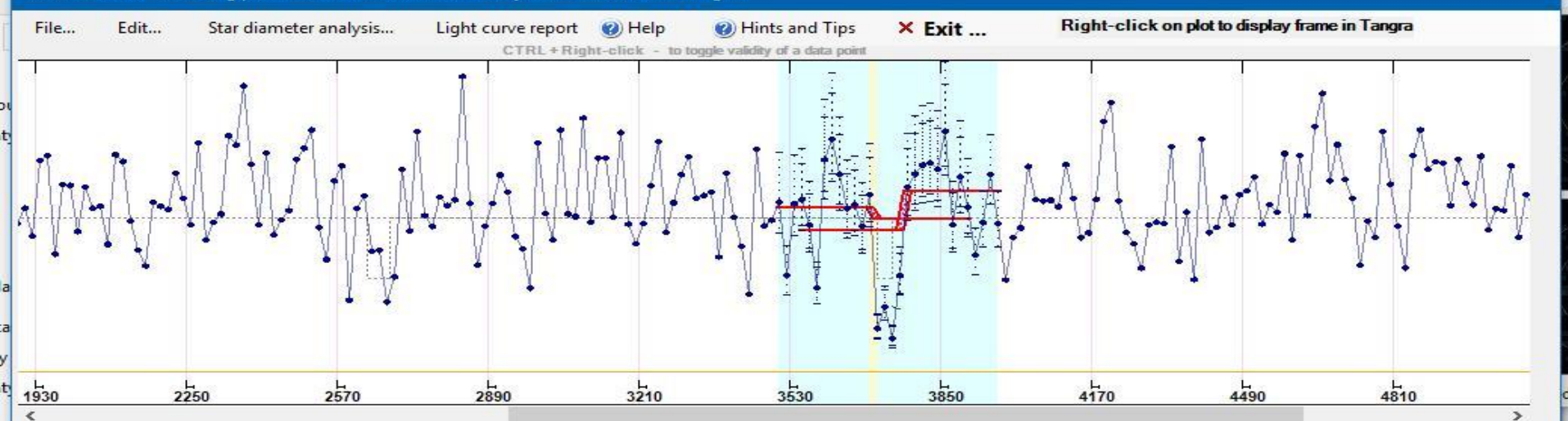
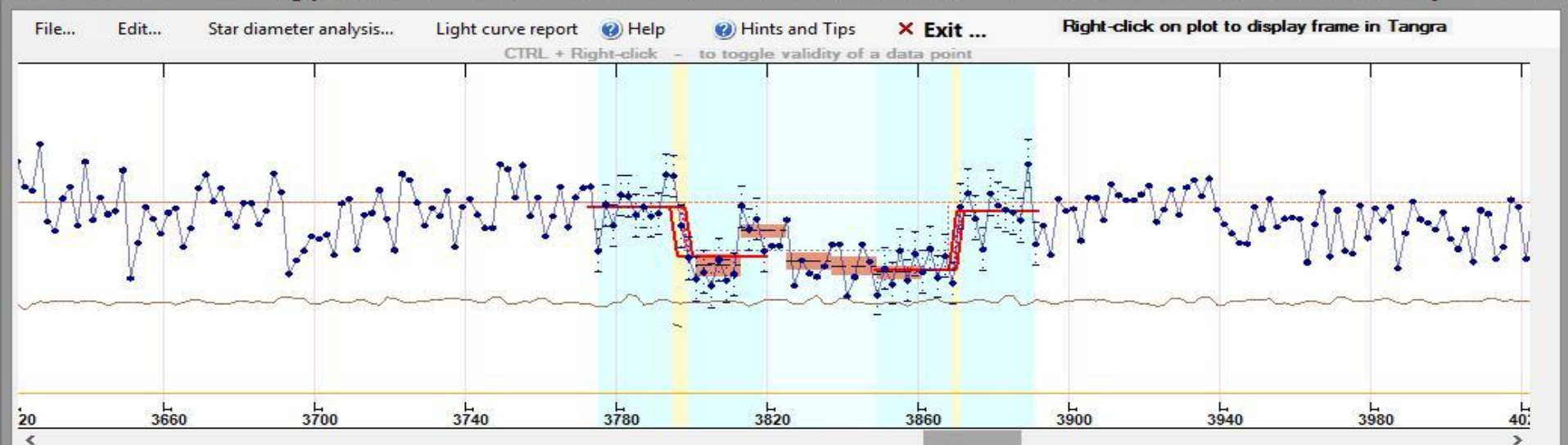
3 Tomas Janik

4 (P) Predicted

5 (m) Michal Rottenborn

6 (m) Bjoern Kattentidt

3130 Hillary – 2019 07 23



Scale. Objects

Horizontal 5.0

Vertical 1.00

0 - point average

Comparison star 1

Comparison star 2

Comparison star 3

Background

1. Read, Integrity, Set time, Bin & normalise 2. (info) Fourier plot 3. Find events 4. Select event to analyse 5. Analyse 6. Camera corrections & final times

Camera corrections

Video camera

WAT-120N+

Camera delay: 0.8 frames

Number of video frames integrated 16

Exposure delay: 16 frames

Video system

NTSC PAL Other (ADVS AAV, SER)

Time difference from video stamp to start of exposure -0.670 secs

Final results

Time Source: Tangra

D at frame 3706.0 +8.0/-8.0

UTC of D 23 39 19.31 ± 0.32

Transition 0 frames

R at frame 3770.0 +8.0/-8.0

UTC of R 23 39 21.87 ± 0.32

Transition 0 frames

Save AOTA images

Save Tab 5 image for Event # 1

Save Tab 4 image of plot analysis

0 events to analyse

Set Event # 0 as a non-event

View Report

Save Report

Light curve report

(754) Malabar 2019 Jul 28 124.0 x 59.0 km. PA 254.0°
Geocentric X -1144.3 ± 2.3 Y 3426.7 ± 2.0 km

N

E

Find best fit

Center X ☒ 0.0 Centered on Shape model
Center Y ☒ 0.0
Major axis (km) ☐ 0.0 a/b=2.10
Minor axis (km) ☐ 0.0 dMag=-0.81
Orientation ☐ 0.0 Motion 12.11km/s, X

☐ Circular ☐ Use assumed diameter ☐ Include Miss events

Double star

Sepn (masec) ☐ 0.0

PA of 2nd ☐ 0.0

Show: ☒ Both ☐ Primary ☐ Secondary

0 solutions

☒ #1 ☐ #3
☒ #2 ☐ #4

Plot scale

Quality of the fit

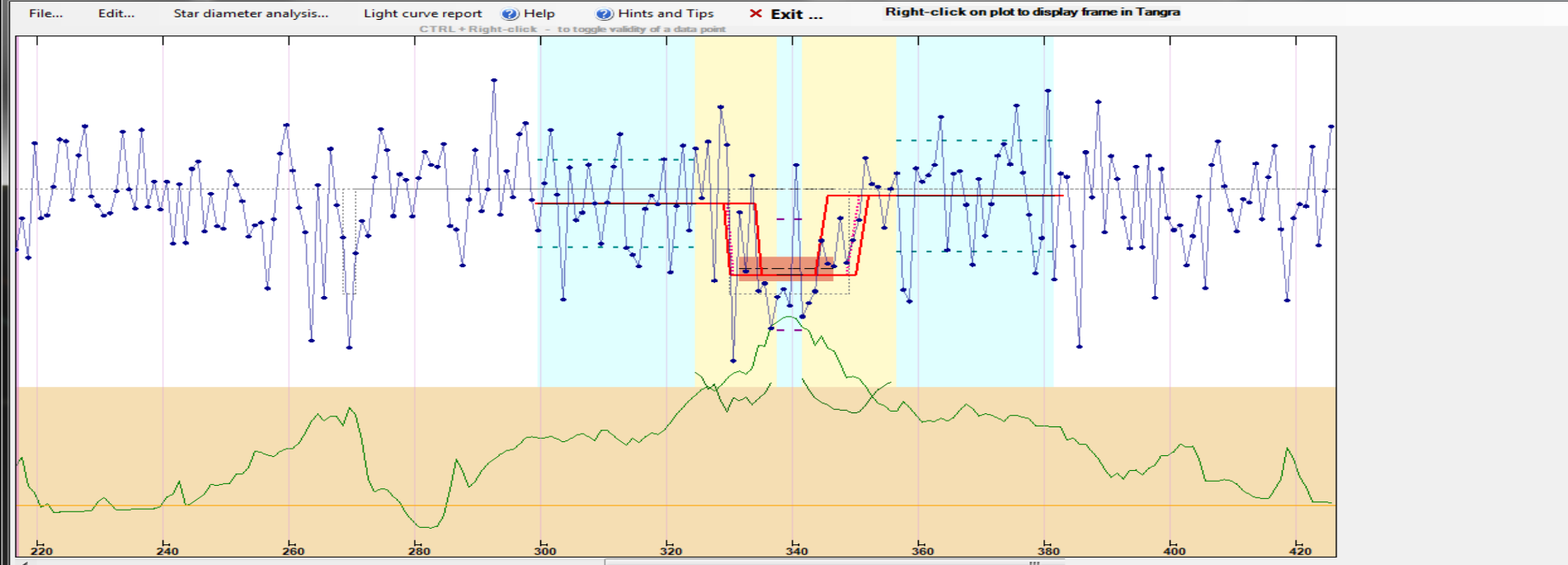
Astrometry only. No reliable size

RMS fit 0.6 ± 3.2 km

Opacity

1 (P) Predicted
2 Perello & Selva
3 Schnabel

754 Malabar – 2019 07 28



Scale, Objects
Horizontal 5.0
Vertical 1.00
0 - point average
☒ JTS Target star
Comparison star 1
Comparison star 2
Comparison star 3
Background

1. Read, Integrity, Set time, Bin & normalise 2. (info) Fourier plot 3. Find events 4. Select event to analyse 5. Analyse event #1 6. Camera corrections & final times Event #1

Camera corrections

Video camera

SER system

Camera delay: 0.0 frames

Video system

NTSC PAL Other (ADVS AAV, SER)

Non Camera corrections applied within Tangra from video stamp to start of exposure

Exposure delay: 0 frames

0.000 secs

Final results ** Event #1

Time Source: Tangra

D at frame 330.0 +4.5/-0.5

UTC of D 22 0 9.71 ± 0.88

Transition 0 frames

R at frame 349.5 +1.5/-5.0

UTC of R 22 0 16.22 ± 1.13

Transition 1 frames

Verify

Save AOTA images

Save Tab 5 image for Event #1

Save Tab 4 image of plot analysis

2 events to analyse

Set Event #1 as a non-event

View Report

Save Report

Light curve report

Thank you!
Merci beaucoup!