

GOcEcl2: Faint star predictions for larger apertures - UPDATE

Robert Purvinskis IOTA-ES

ESOP-40, 28 August 2021

Introduction

General comments & motivation

Star catalog evolution

Asteroids used

Stationary events search

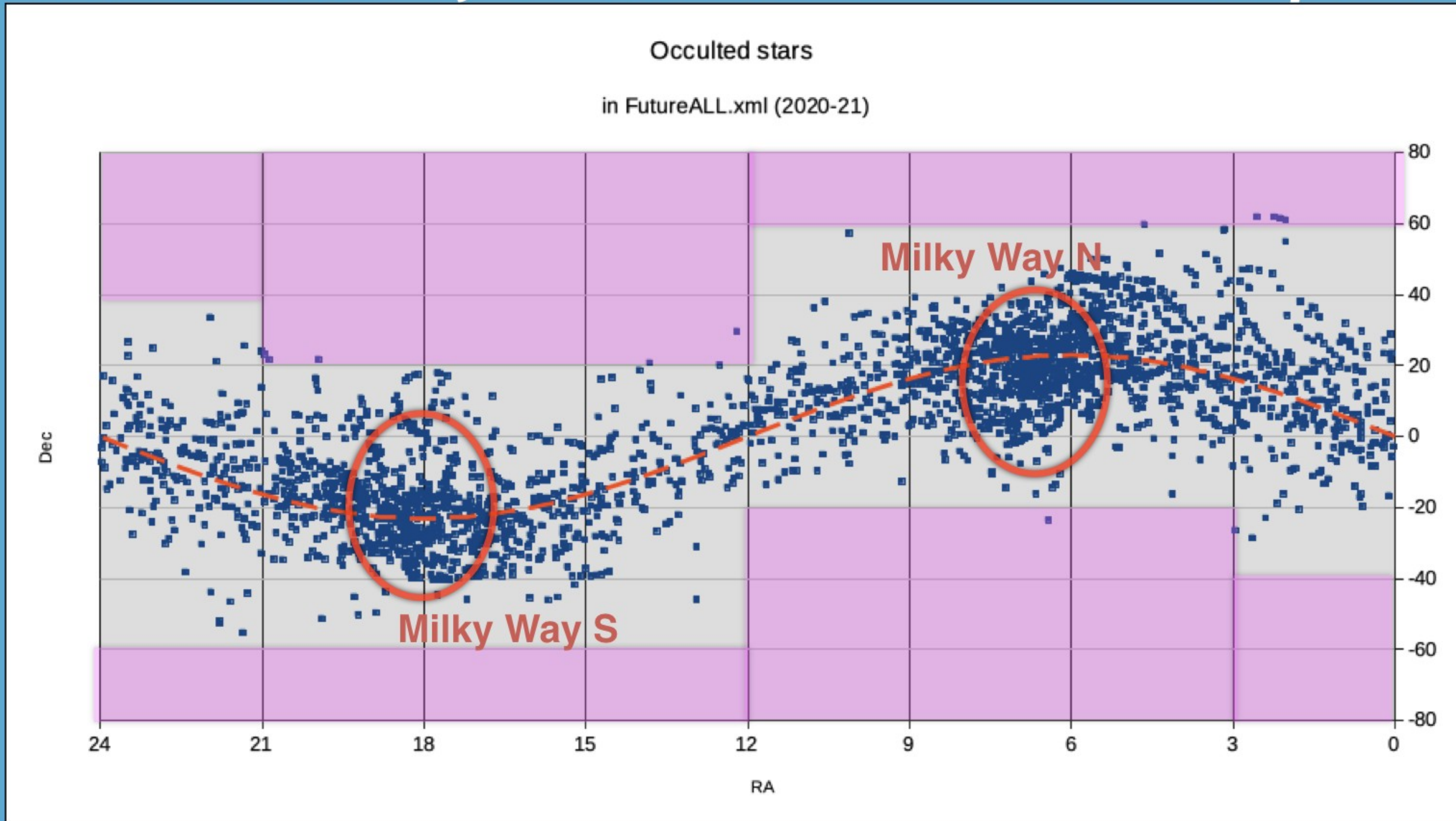
Statistics (including Milky Way fields)

Sample predictions

Star catalog

- DR2 has now been updated with EDR3. OCCULT modifications are still ongoing.
- Aim is to use fainter stars in the catalog, so a magnitude limit up to 16.5 - 17 has been used (depending on star density).
- Asteroids are not evenly distributed over the sky- most are in the main belt, near the ecliptic (+/- 25 deg)
- To avoid overlapping with other prediction feeds, a bright star limit of 14 is used.

Distribution of Predictions on the Ecliptic



Very few events happen in the pink areas

Asteroids used

- Focus is still on main belt asteroids between 7 and 50 km diameter.
- An easy way to remove small objects is to use a number limit between 150 000 - 200 000
- TNOs, NEOs and Trojans are specifically removed from the input Object file, which contains around 20 000 objects.

Stationary point events

- For objects near the stationary points, the events can be very slow.
- This allows to observe small objects ($> 3\text{km}$) with higher resolution, or also larger objects with shallower events
- Objects in low inclination orbits (e.g. Themis family) will produce the slowest events
- A directed search has shown some success. For a 100km object, events longer than 5 mins are possible.

17627 Humptydumpty occults G140741.6-114237 on 2020 Jun 25 from 3h 18m to 8h 40m UT

Star:
Mag V = 16.6; B = 17.9; R = 15.8
RA = 14 7 41.5894 (astrometric)
Dec = -11 42 36.950
[of Date: 14 8 47, -11 48 22]
Prediction of 2020 Jun 21.0

Max Duration = 23.6 secs
Mag Drop = 2.4 (2.7r)
Sun : Dist = 120°
Moon: Dist = 70°
illum = 18 %
E 0.034"x 0.034" in PA 90

Asteroid:
Mag = 18.9
Dia = 16km, 0.008
Parallax = 3.098"
Hourly dRA = 0.046s
dDec = -0.95"

Max. Duration 24 sec

Prediction from June 2020:

Faint star (mv =16.6)

Long duration event (up to 23 sec)

Object diameter 16 km

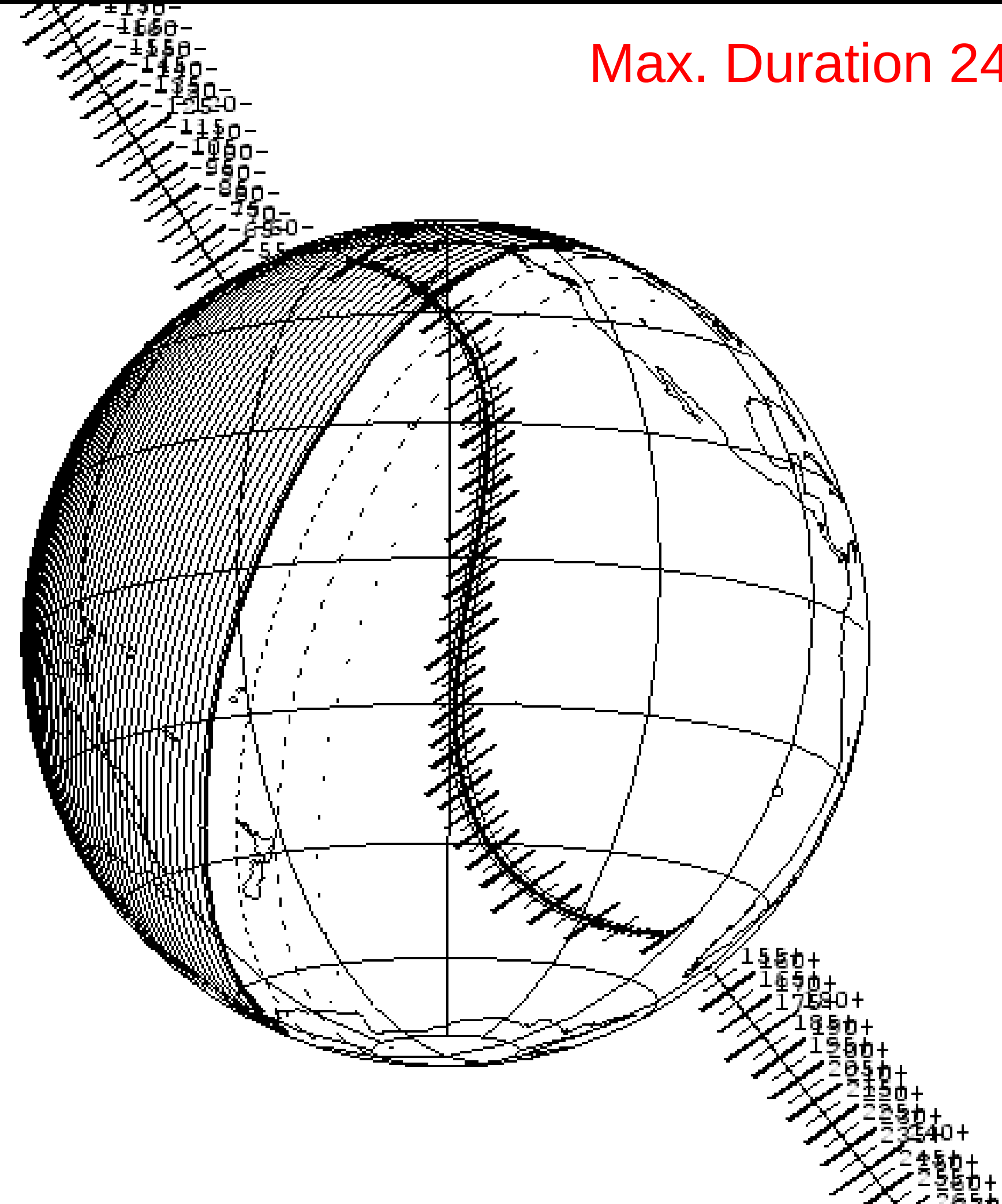
Path duration: over 5 hours → real time updates?

(Note that Earth's terminator moves during event – beware of plotting these!)

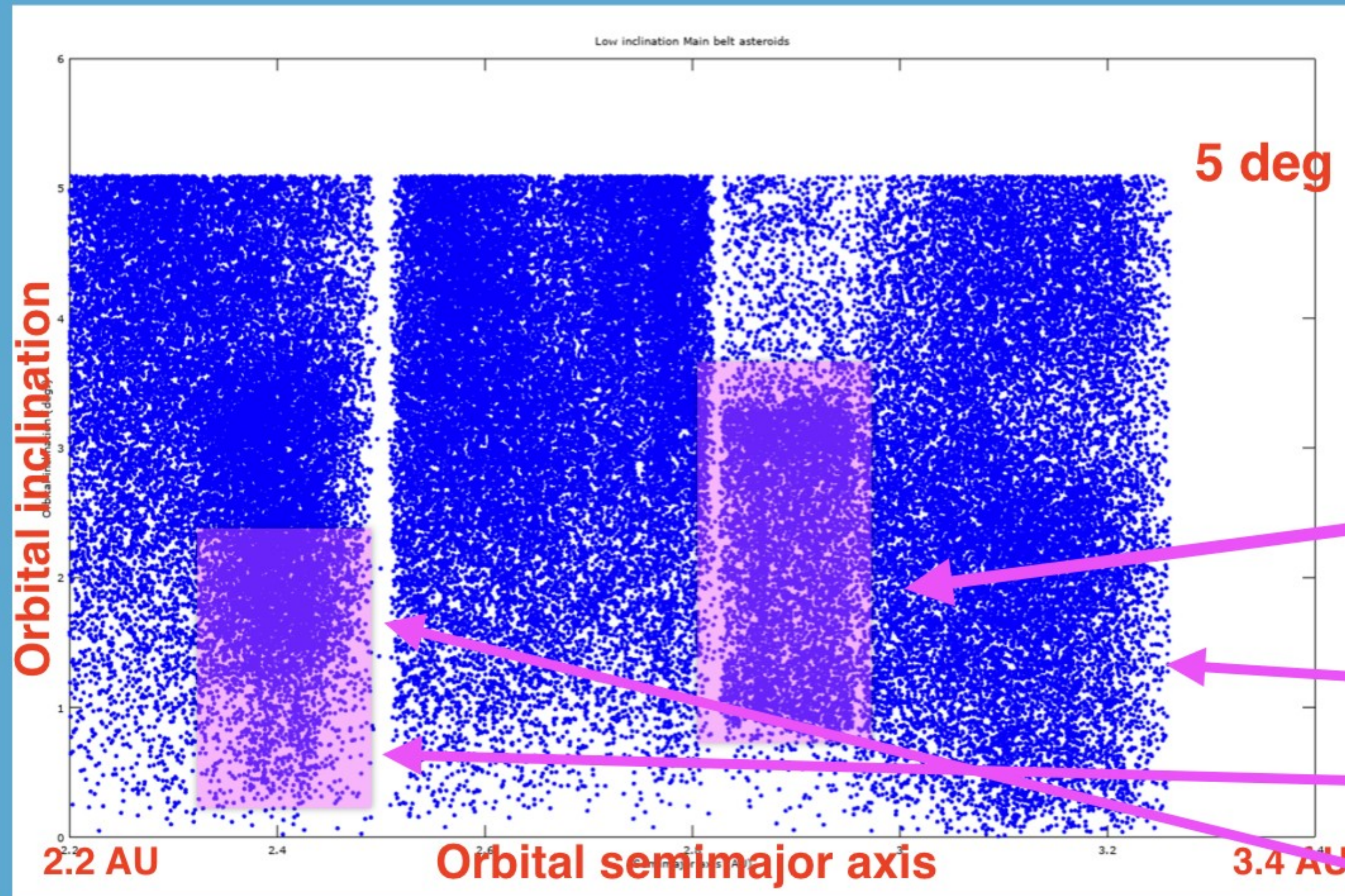
NB: March 2021:

An event of the low-inclination object (13320)

Jessicamiles attempted by Oliver Klös



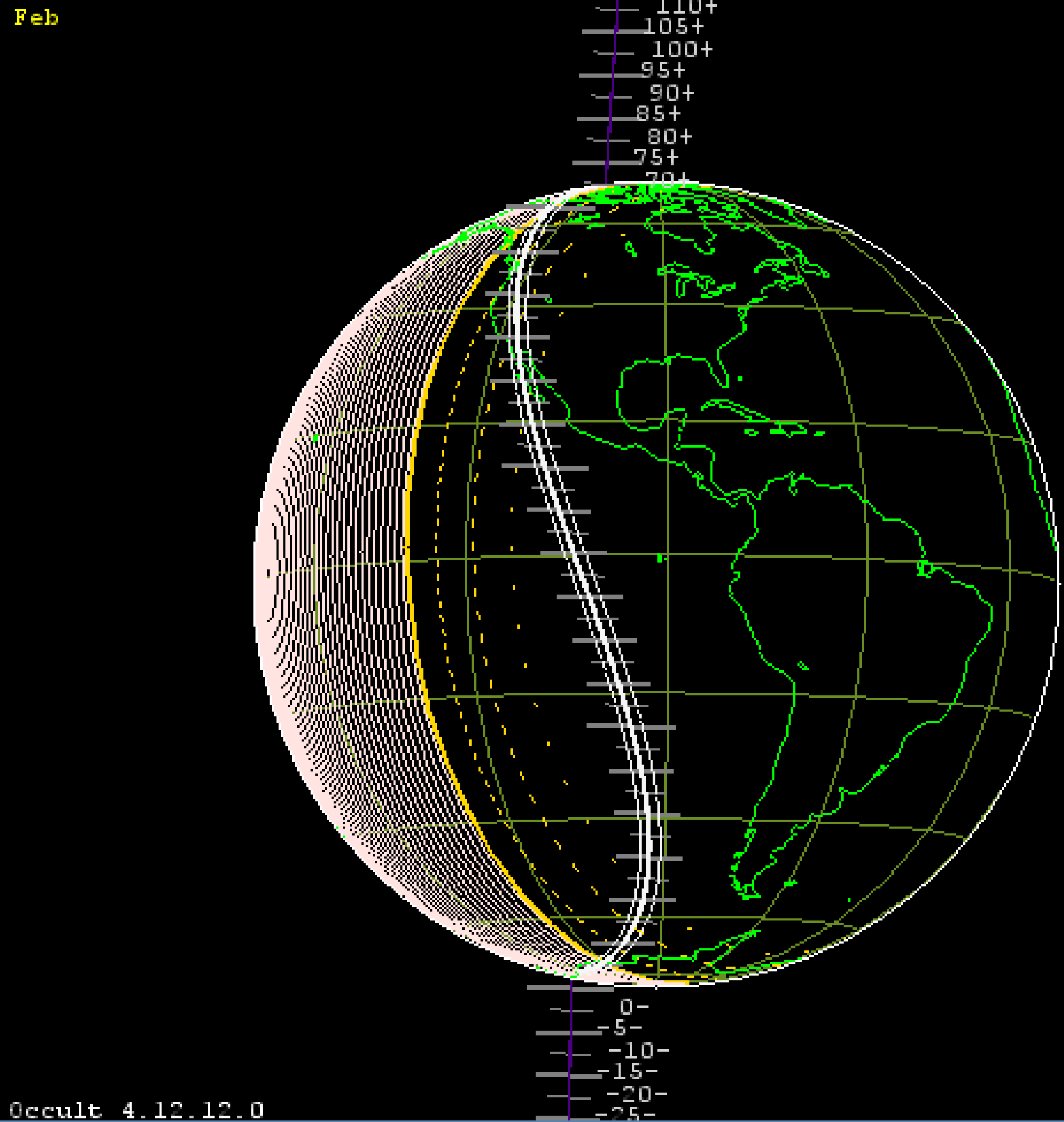
'Stationary' event families



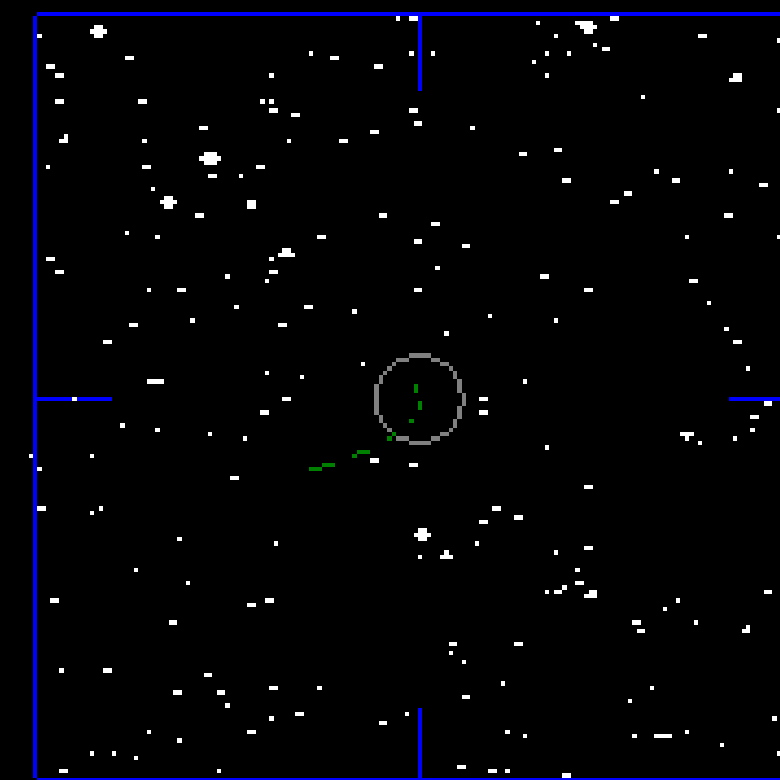
- Some particular asteroid families should be examined carefully for potential long-duration events of small objects (cf. Humptydumpty, Jessicamiles)
- Koronis /Karin family (5949 objects)
- Themis family (4782 objects)
- Massalia family (6424 objects)
- Nysa family

87672 2000 RN100 occults G205408.6-041129 on 2021 Sep 28 from 1h 3m to 4h 5m

Star: (Dia < 0.1 mas)	Max Duration = 6.8 secs	Asteroid:
Mv 14.2; Mb 14.6; Mr 13.6	Mag Drop = 4.3 (4.4r)	Mag = 18.4
RA = 20 54 8.6326 (astrometric)	Sun : Dist = 128°	Dia = 7.8 ±0.8km, 6 mas
Dec = - 4 11 29.456	Moon: Dist = 128°	Parallax = 5.131"
[of Date: 20 55 17, - 4 6 29]	: illum = 59 %	Hourly dRA = 0.011s
Prediction of 2021 Aug 24.0	Error 94.0x94.0 mas in PA 90°	dDec = 3.33"
Reliable 1.2 (good),		MPCorb2021, Star+PeakEphemUncert



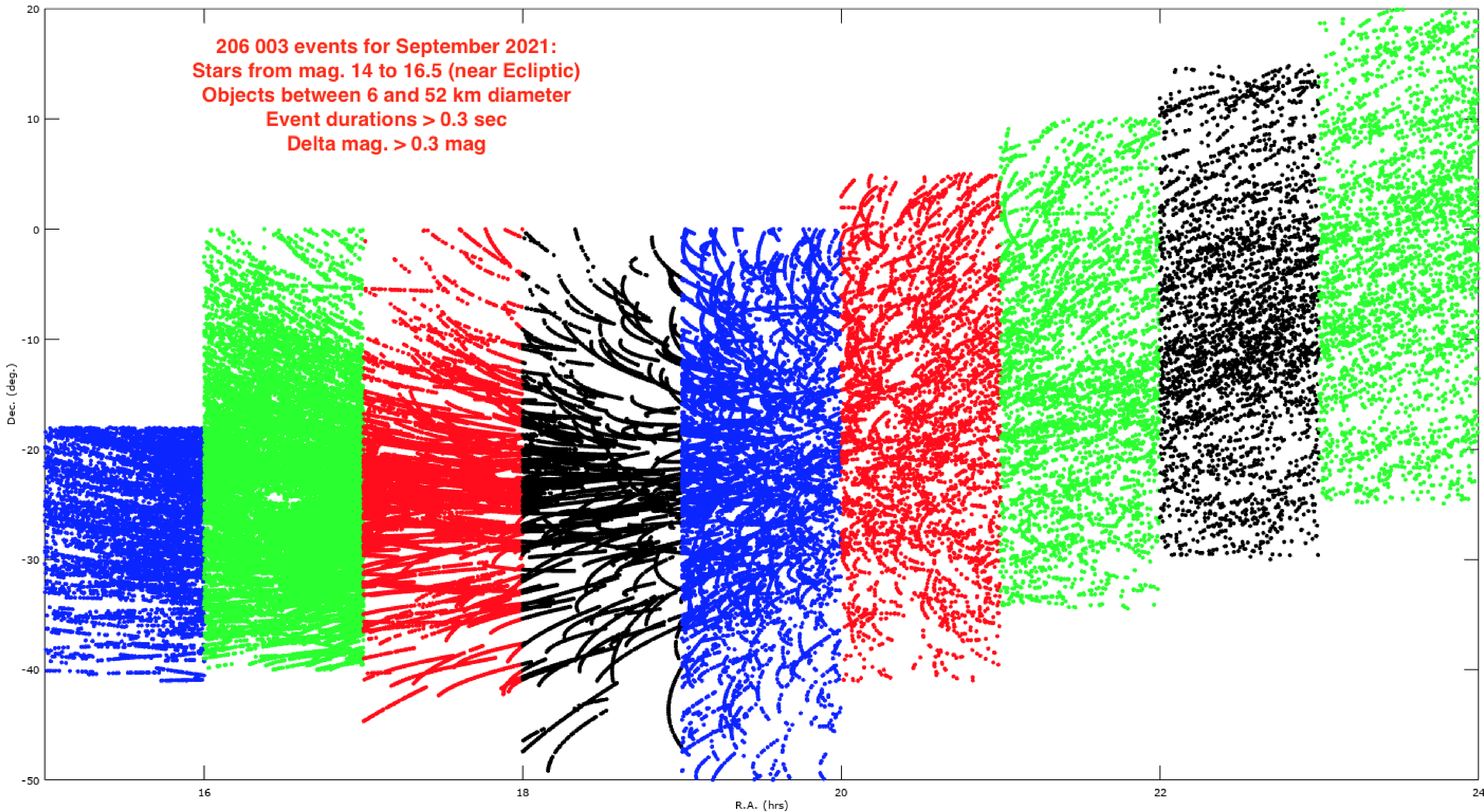
Max. Duration 6.8 sec
for 7.8 km diameter
object!



Occult 4.12.12.0

Some statistics

- Milky Way fields generate many multiple events for single objects: sometimes over 100 per object per month
- Certain times of the year will therefore generate many events.
- Events per field per month can vary by more than a factor of 4.



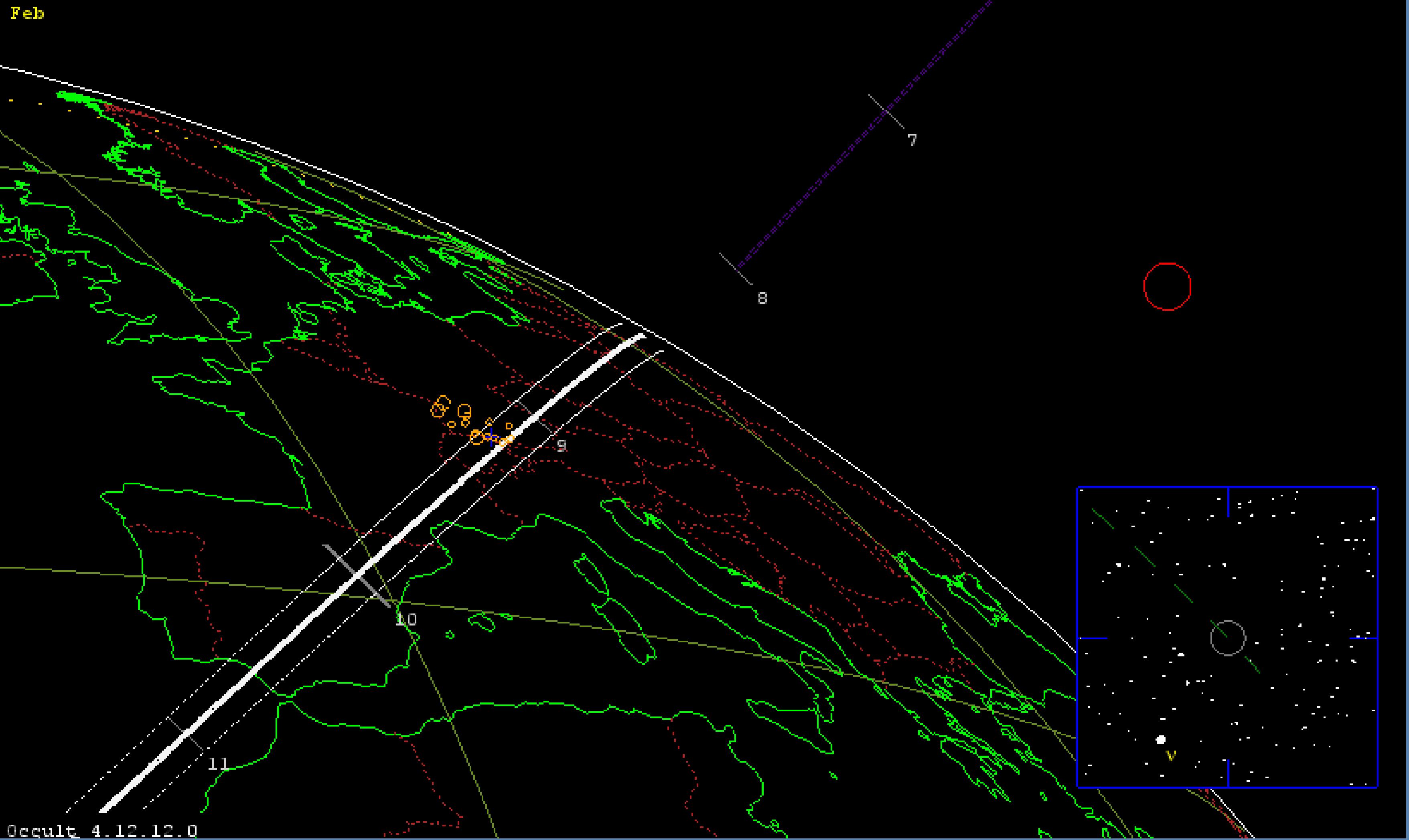
Where to find results?

- Prediction sets have been generated roughly each 1 - 2 months (irregular, NOT a 'feed' provided as a service).
- .XML files available for users on SOTAS website for download into OCCULT <http://occultations.ch/agenda.html>
- No geographic sorting but a subset for Switzerland and Southern Germany is also available
- Still looking at integration into OCW. Main issue is applicability and the large number of events (10000 / month).

Thanks for your attention!

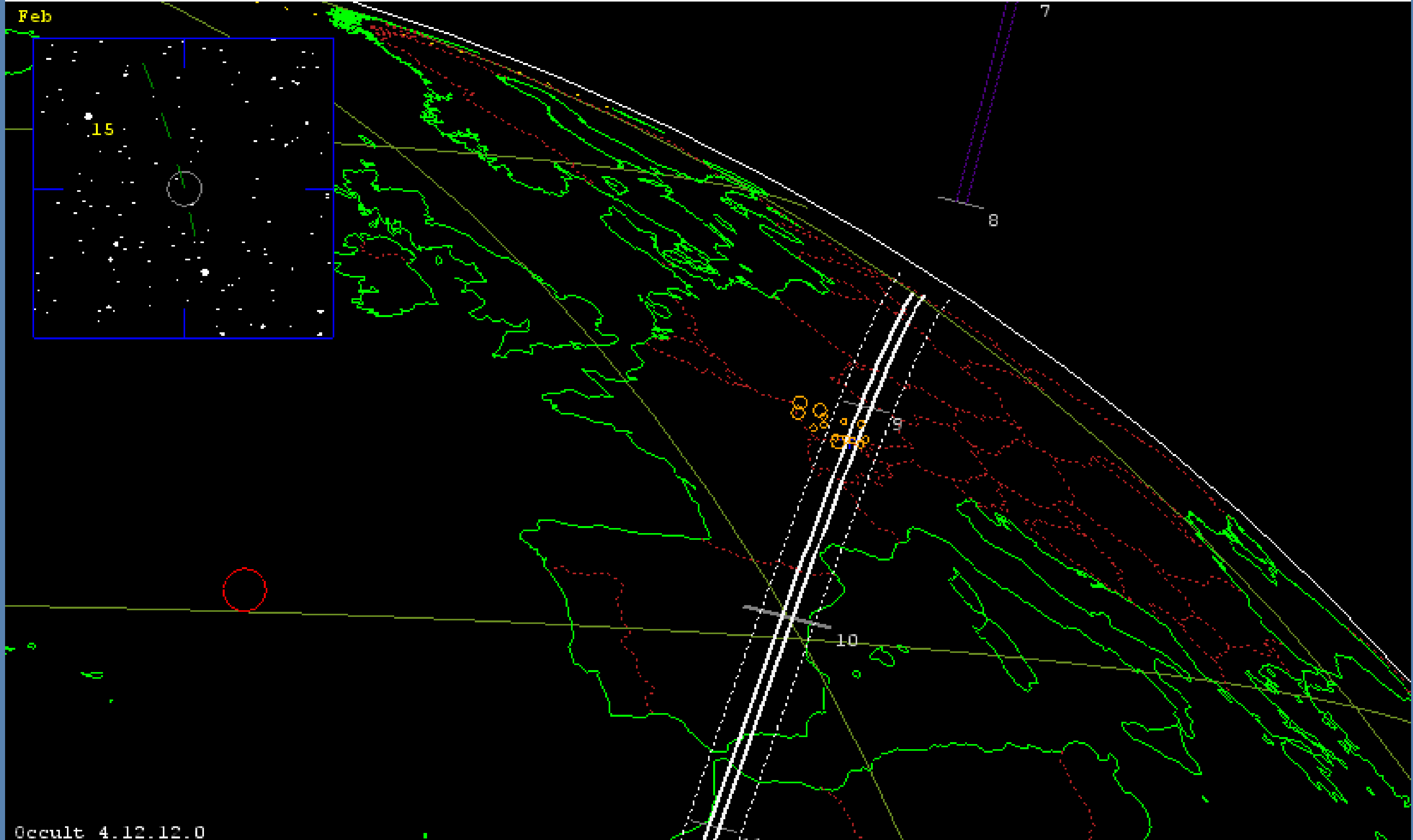
50712 2000 EV134 occults G210748.4-104148 on 2021 Sep 10 from 0h 8m to 0h 30m

Star: (Dia < 0.1 mas)	Max Duration = 0.77 secs	Asteroid:
Mv 14.5; Mb 15.0; Mr 13.8	Mag Drop = 4.3 (4.5r)	Mag = 18.8
RA = 21 7 48.4305 (astrometric)	Sun : Dist = 148°	Dia = 7.4 ±0.6km, 5 mas
Dec = -10 41 47.645	Moon: Dist = 109°	Parallax = 4.492"
[of Date: 21 8 59, -10 36 31]	: illum = 11 %	Hourly dRA = -1.136s
Prediction of 2021 Aug 24.0	Error 44.0x44.0 mas in PA 90°	dDec = -17.69"
Reliable 1.0 (good),		MPCorb2021, Star+PeakEphemUncert



11569 Virgilsmith occults G211537.5-045952 on 2021 Sep 20 from 0h 8m to 0h 29m

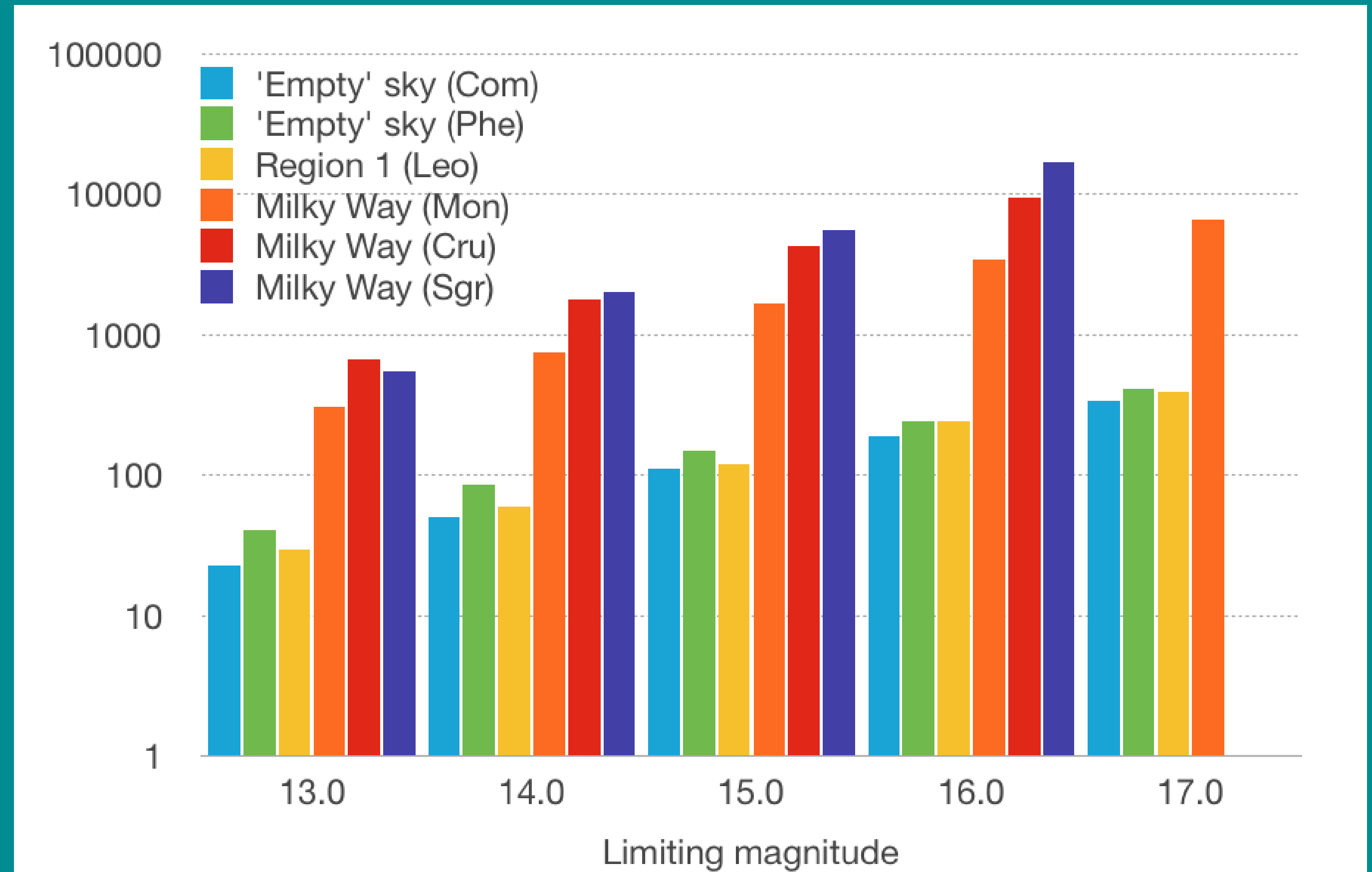
Star: (Dia < 0.1 mas)	Max Duration = 2.8 secs	Asteroid:
Mv 15.5; Mb 16.2; Mr 14.6	Mag Drop = 1.4 (1.7r)	Mag = 16.5
RA = 21 15 37.5253 (astrometric)	Sun : Dist = 141°	Dia = 27 ±2km, 20 mas
Dec = - 4 59 51.869	Moon: Dist = 30°	Parallax = 4.661"
[of Date: 21 16 46, - 4 54 24]	: illum = 99 %	Hourly dRA = -0.409s
Prediction of 2021 Aug 24.0	Error 41.0x41.0 mas in PA 90°	dDec = -24.44"
Reliable 1.0 (good),		MPCorb2021, Star+PeakEphemUncert



Backup slides

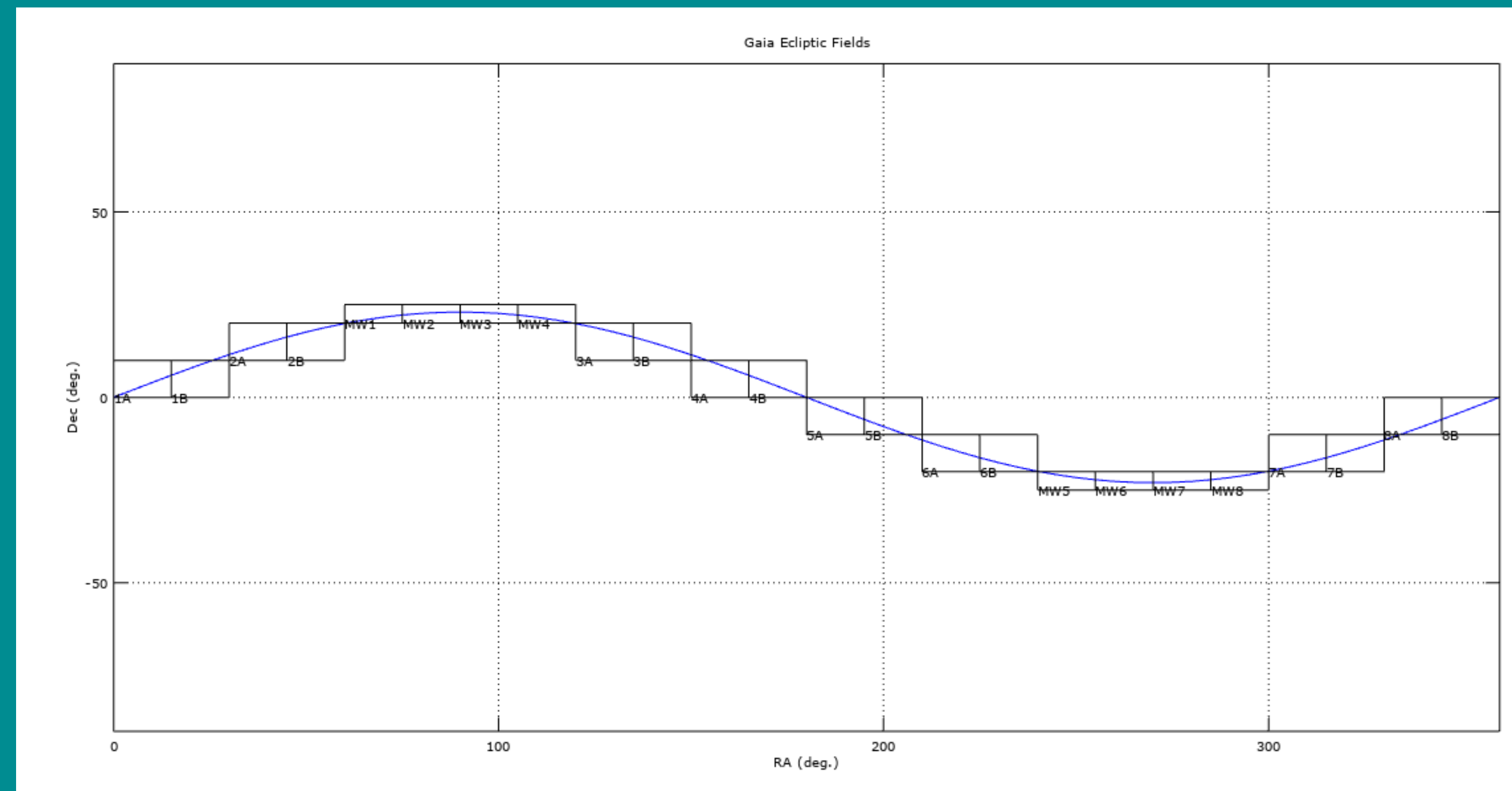
Star density

- Small areas of DR2 downloaded with ViZier
- This gives an idea of the variation in star density around the sky
- For prediction catalog, separate fields are used

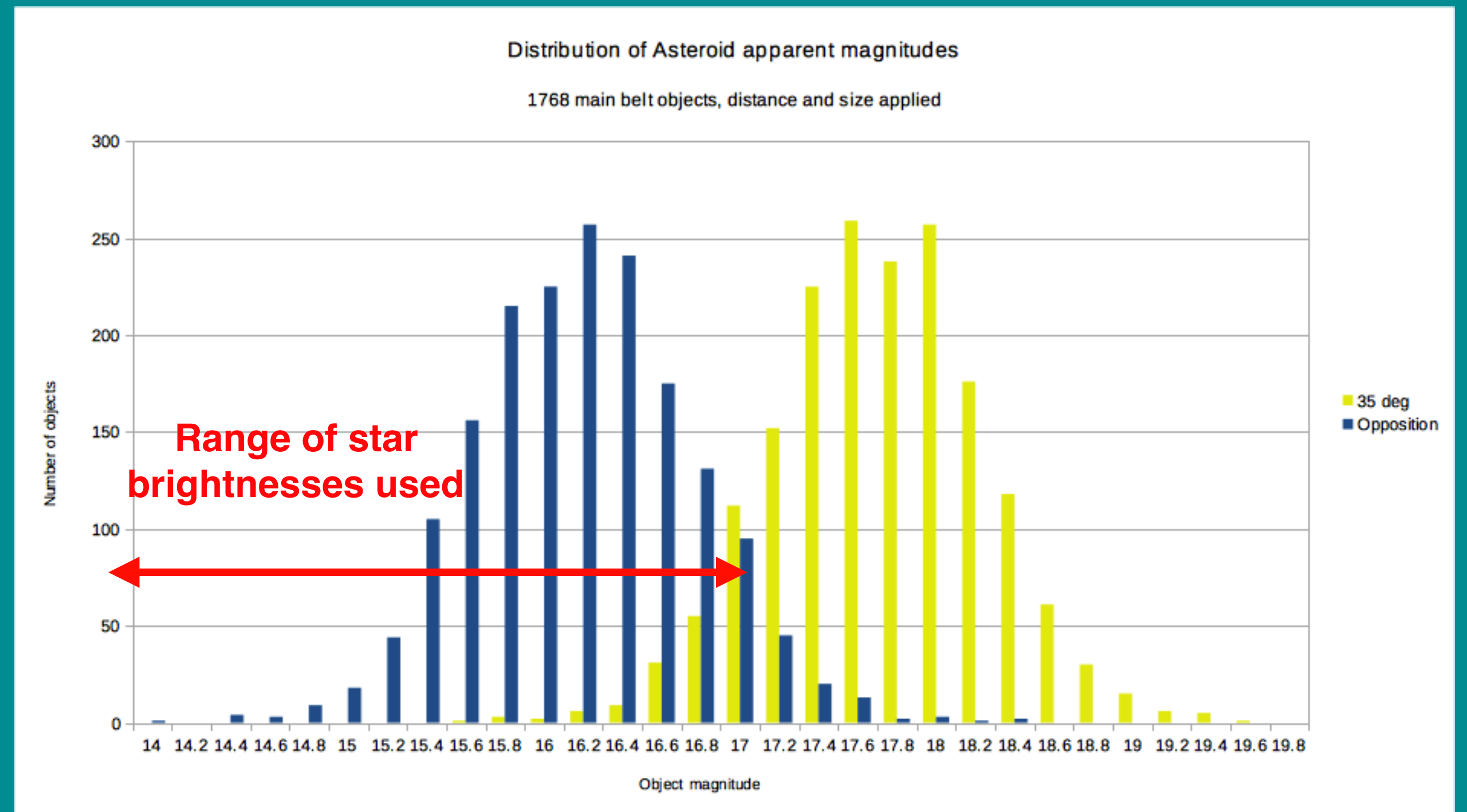
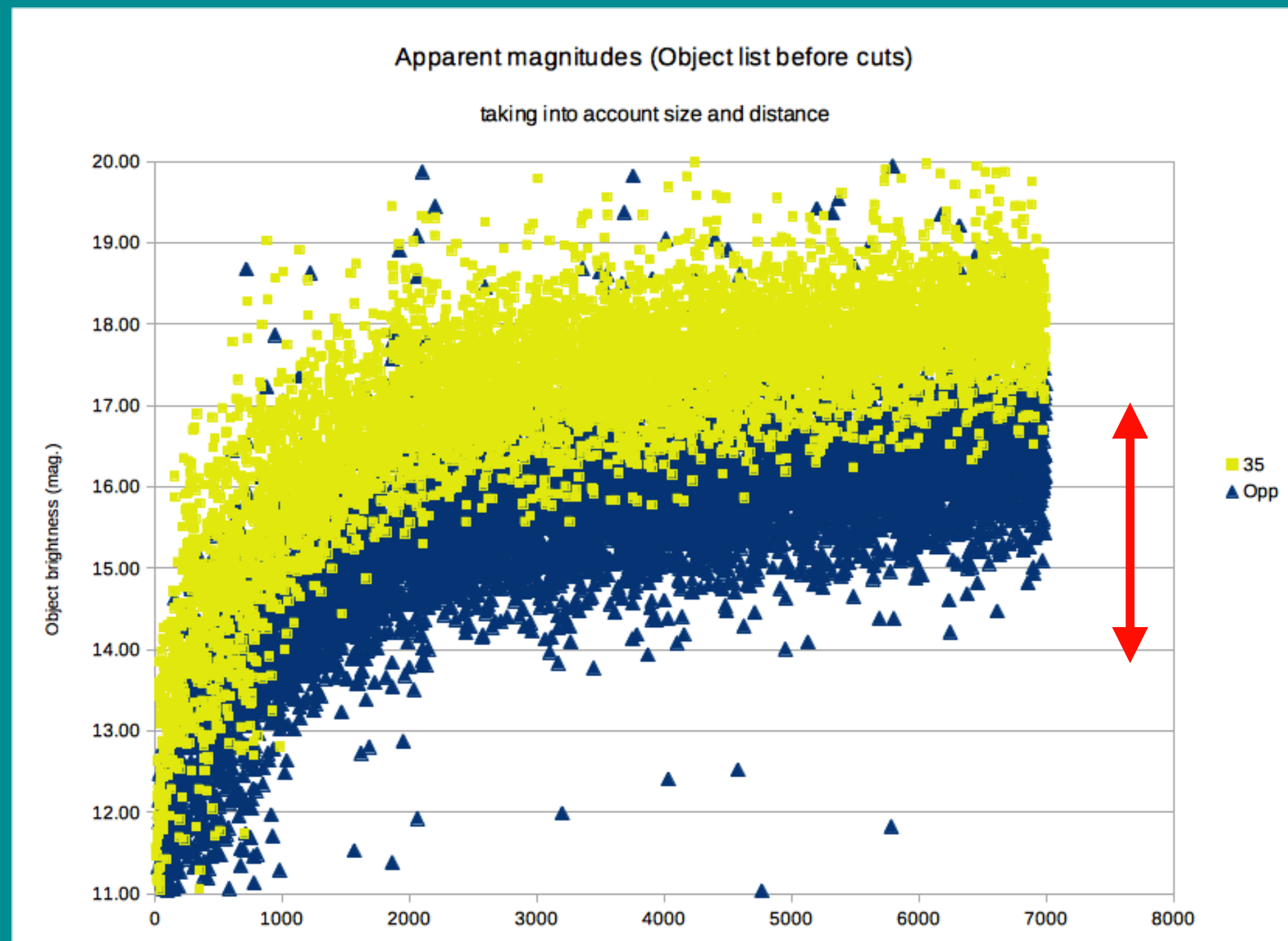


Star search fields

- ‘GOcEcl’ = “Gaia Occultations on the Ecliptic”
- Areas are 1h R.A. x 10 deg Dec
- Only stars from G mag. 14 - 17
- Total stars in all fields (not Milky Way): roughly 3 million



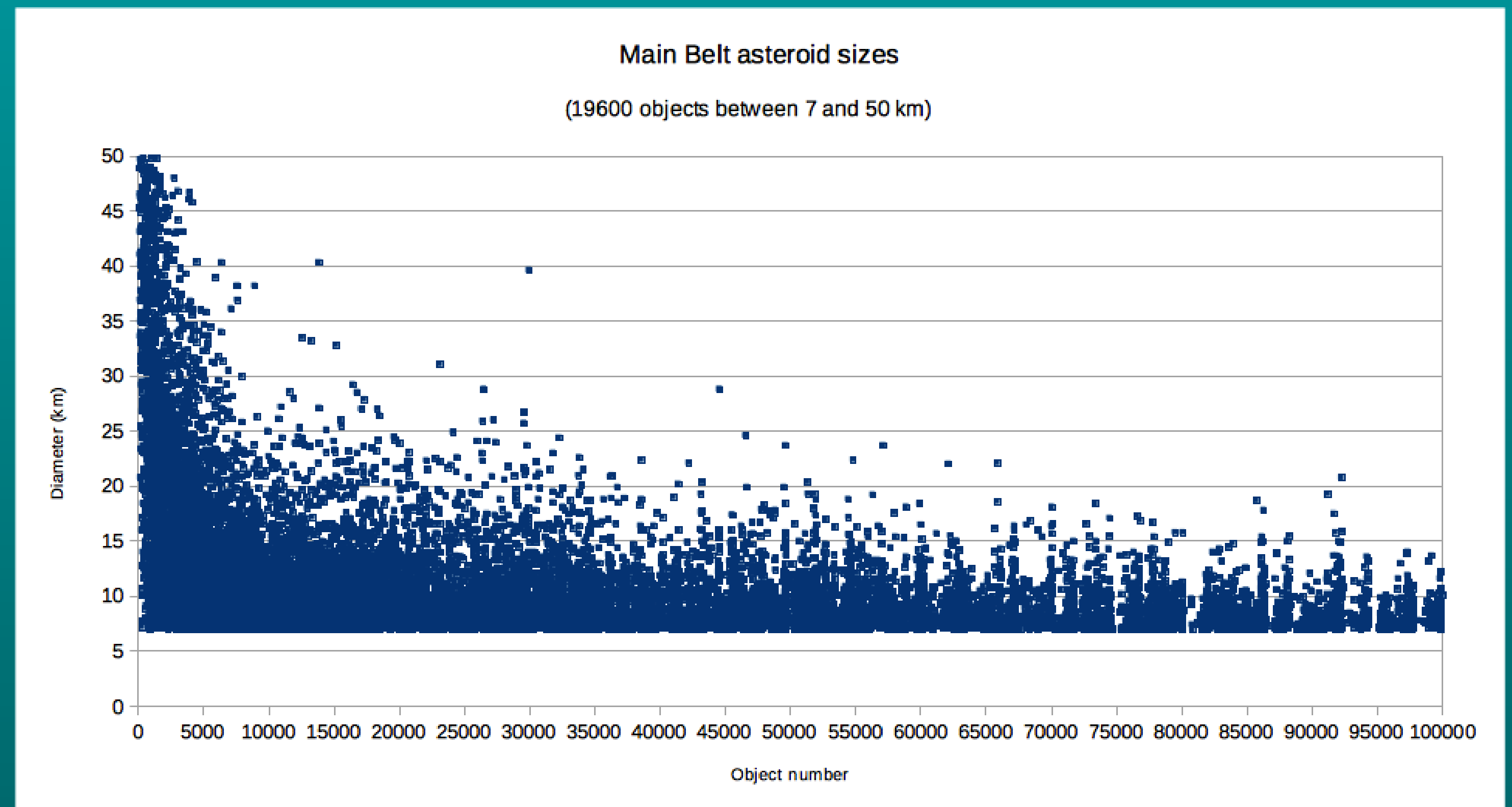
Asteroid brightness



- Sufficient brightness difference needed between star and asteroid
- Object number is a rough indicator of brightness
- Objects at opposition are 1 - 2 magnitudes brighter than 35 deg elong-> avoid this area

Asteroid sizes - selected se

- Object numbers are also a proxy for size (more small objects are discovered today)
- If interested in objects with diameter $> 5\text{km}$, high object numbers are not needed
- (This is Main Belt: TNOs not included)



Asteroid sizes - small objects

- Object numbers are also a proxy for size (more small objects discovered today)
- If interested in objects $> 5\text{km}$, high object numbers not needed
- (This is Main Belt: TNOs not included)

