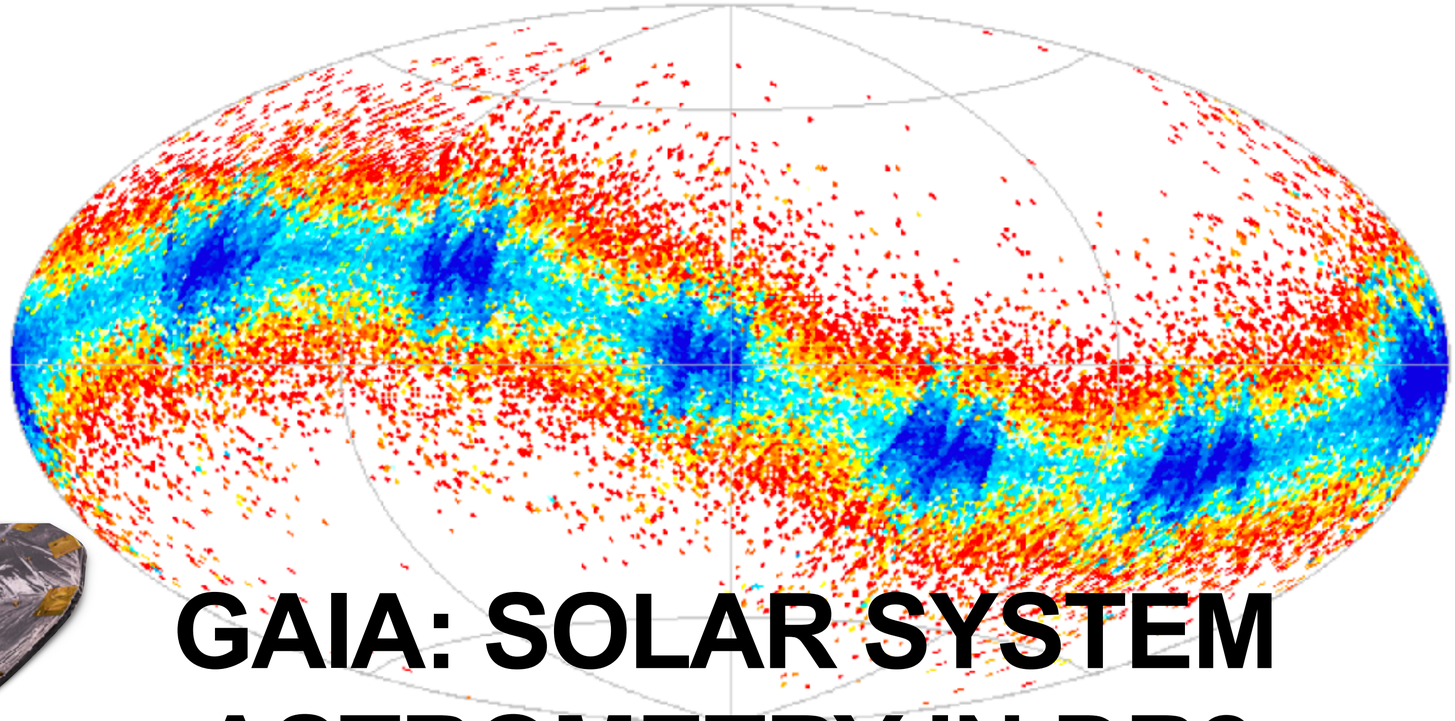

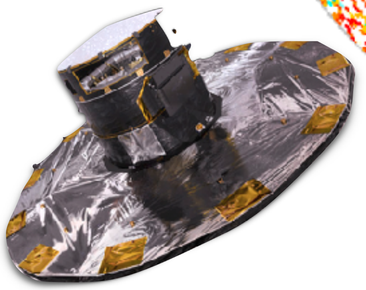

GAIA: SOLAR SYSTEM ASTROMETRY IN DR2

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[2]IMCCE, Observatoire de Paris, France

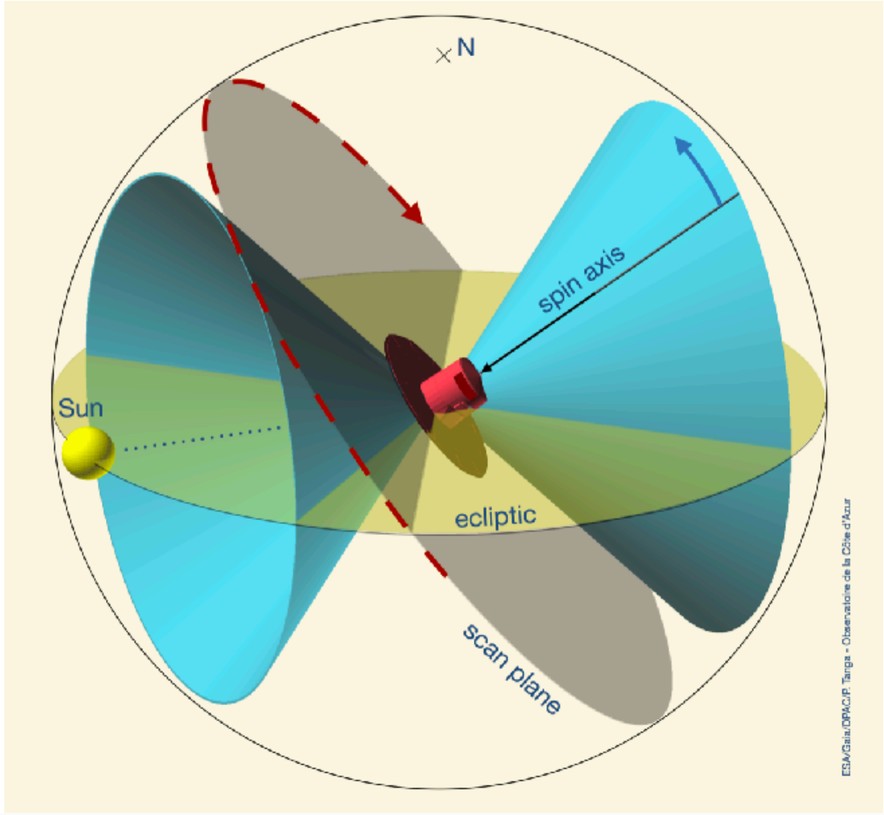
Gaia DPAC Data Processing & Analysis Consortium

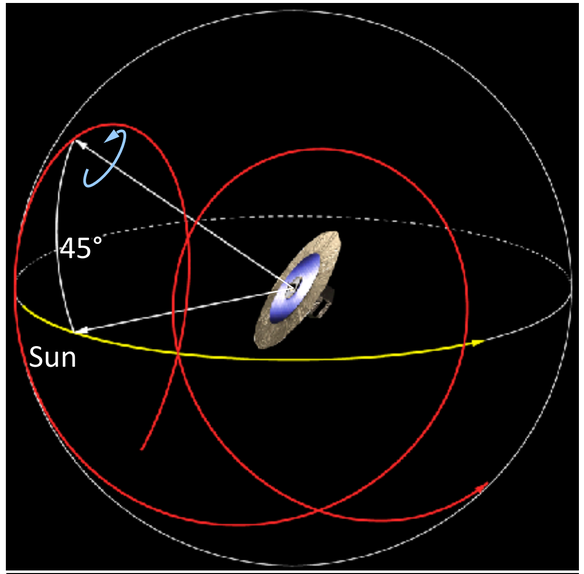
IAU 30 GA

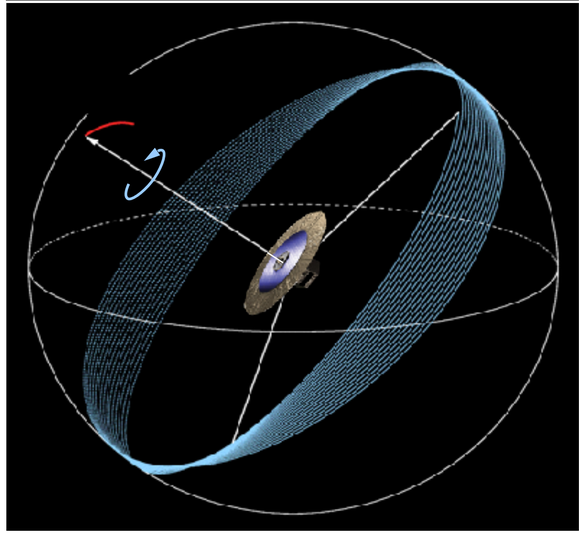
Observatoire de la CÔTE d'AZUR

Gaia is observing asteroids

- Scanning the sky since July 2014 (operational phase)
- Solar elongations 45° to 135°
- Limiting magnitude V~20.5
- 100.000 asteroid observations (CCD level) / day



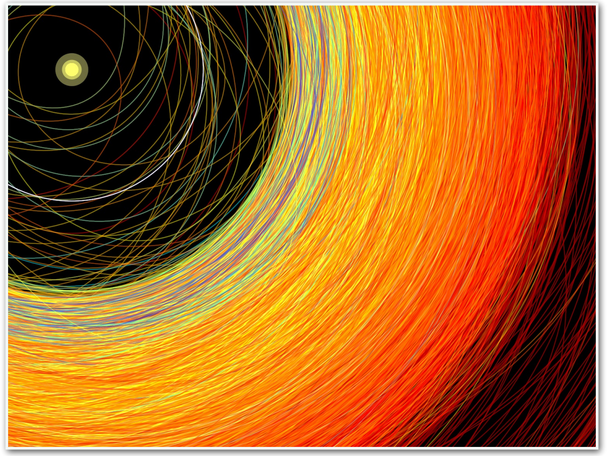




Gaia DR2 - Solar System

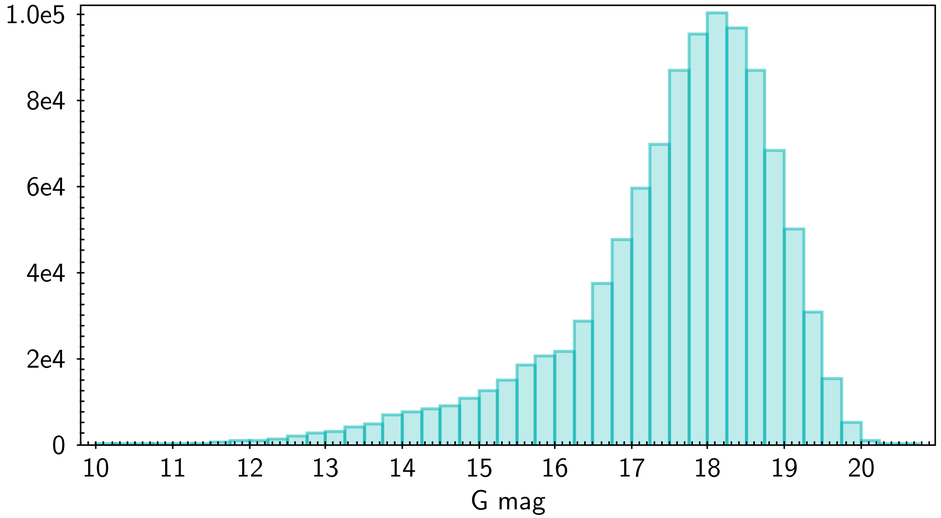
On the base of a pre-selected list of *known* objects

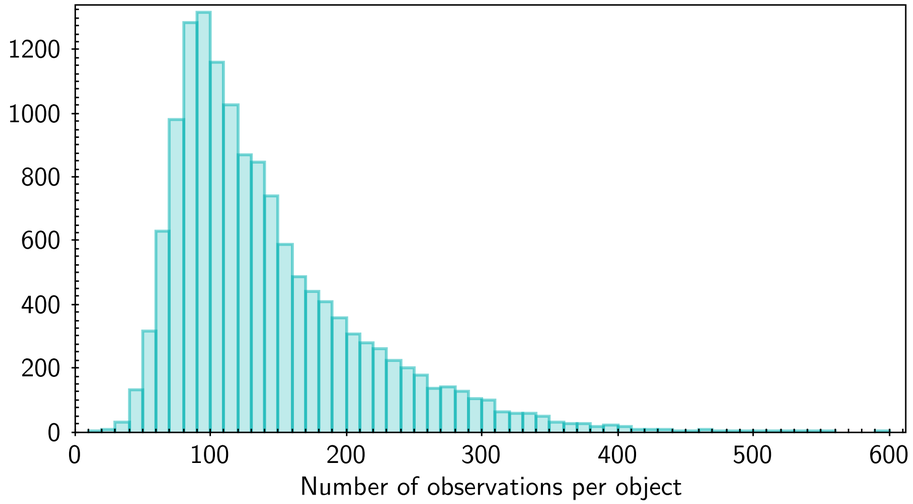
> 10 FOV transits over the 22 months of DR2
August 5, 2014 - May 23, 2016

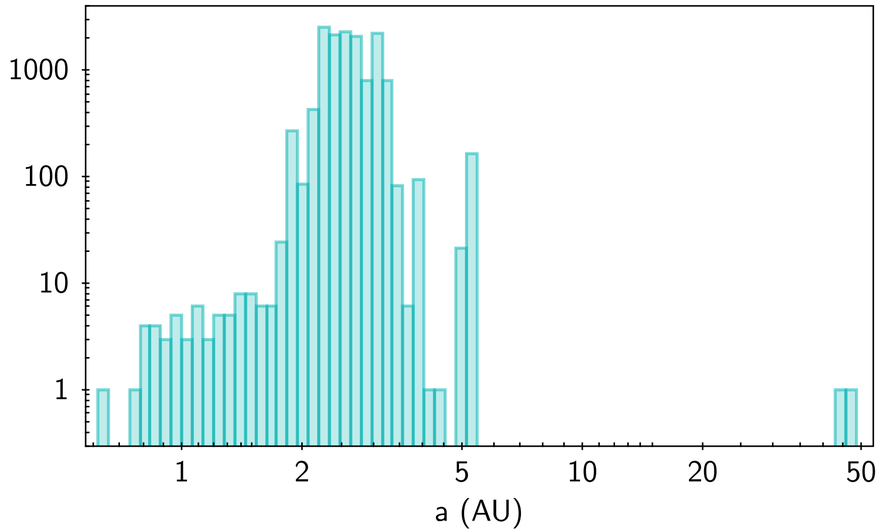


Objects	14 099
Epoch astrometry	1 997 702 CCD positions
	287 904 transits (52% : photometry)
Typ. accuracy	<1 mas (along scan)

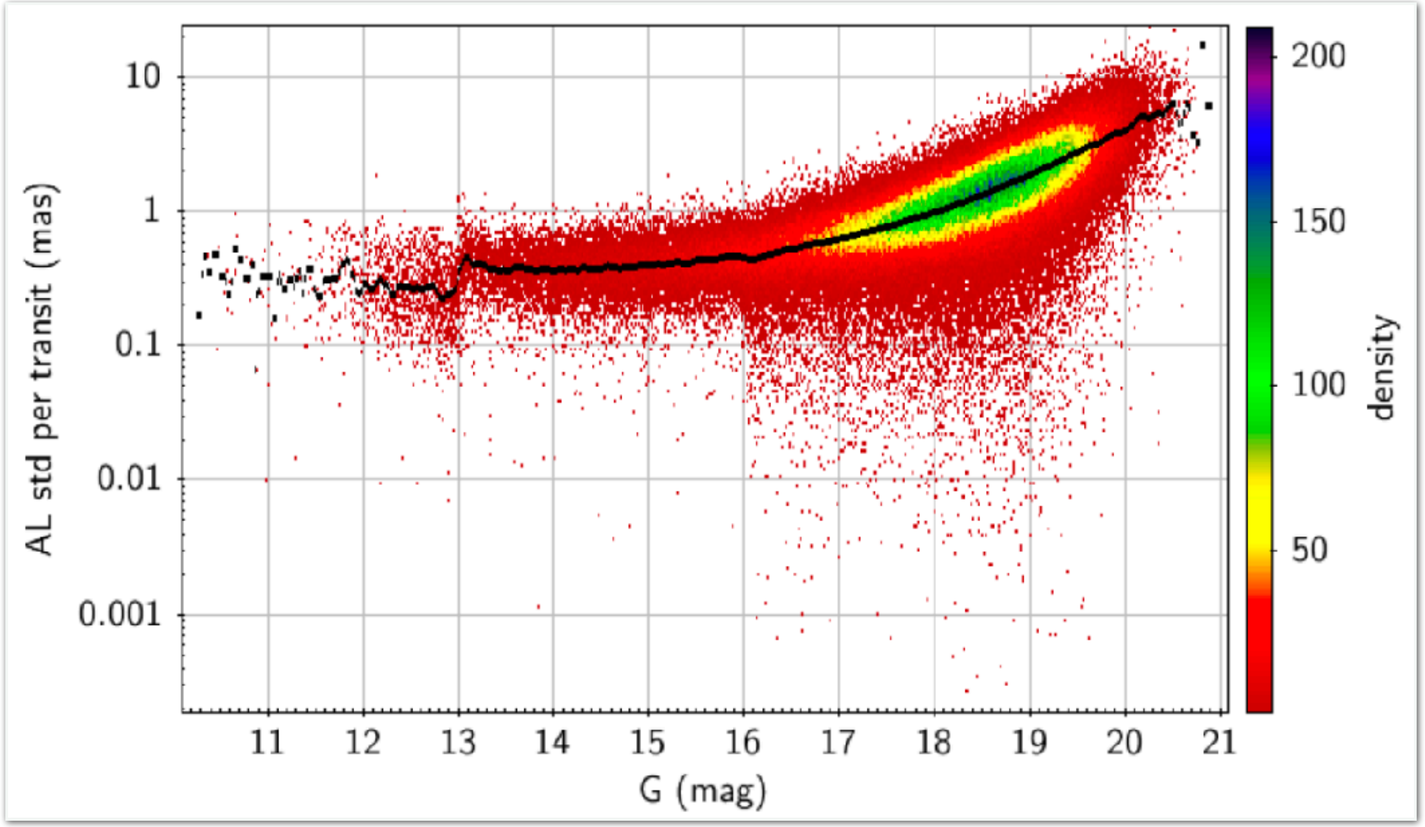
Gaia DR2 - Solar System statistics







Gaia DR2 - Solar System - single transit astrometric performance

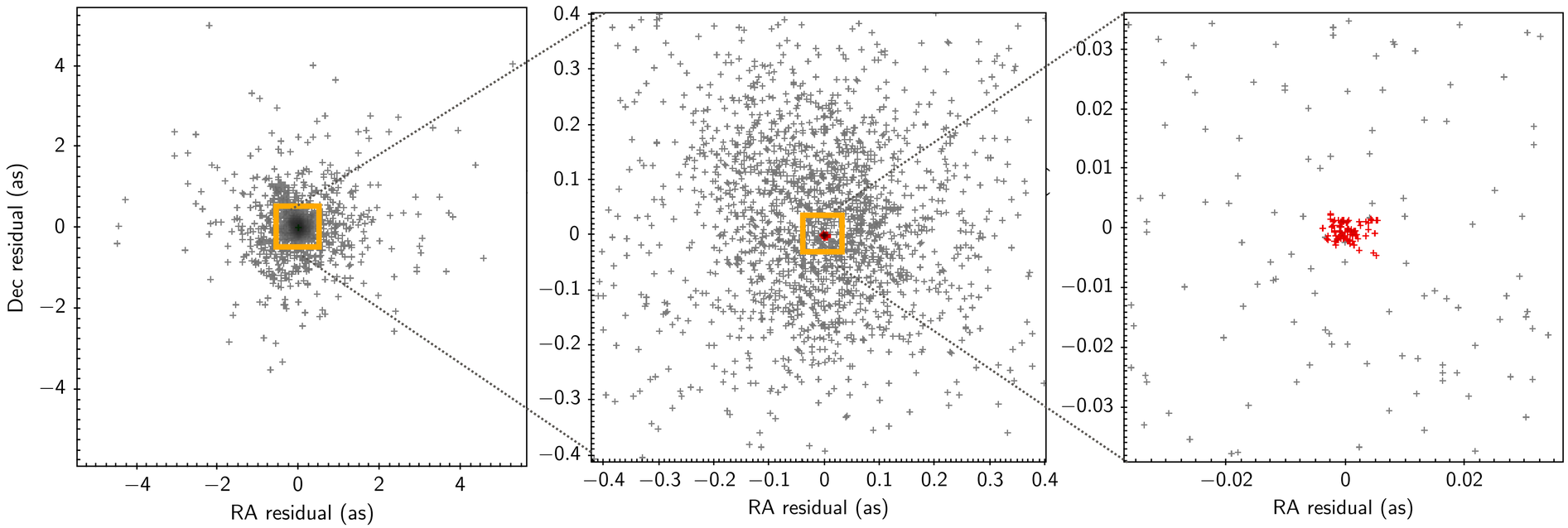


Residuals from the orbital fit of Gaia DR2 data only (along-scan direction)

Spoto et al. 2018

Asteroid (386) Siegena - residuals from orbital fit

Combining archive data (2776 obs.) to GDR2



factor 100 X improvement!

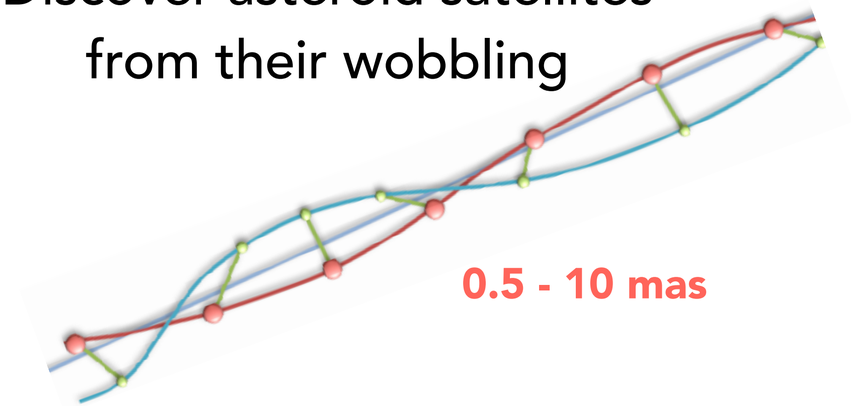
The situation, before Gaia

- **1.9 x 10^8** measurements in the archives of the Minor Planet Center
  - mostly CCD imaging
  - average accuracy: 0.4 as

- **~2000** radar ranging measurements
  - equivalent accuracy : 10-50 mag

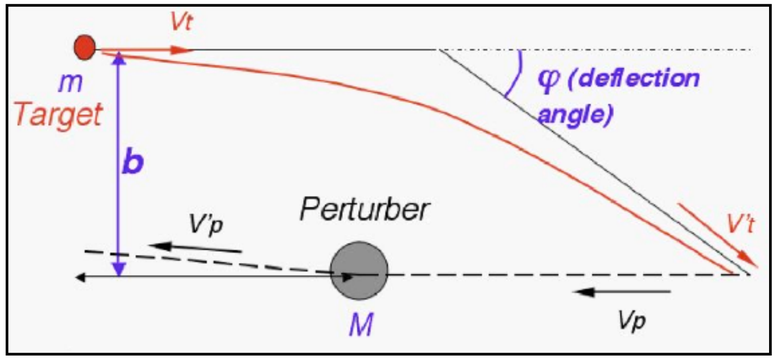
Some challenges for asteroid astrometry

Discover asteroid satellites from their wobbling

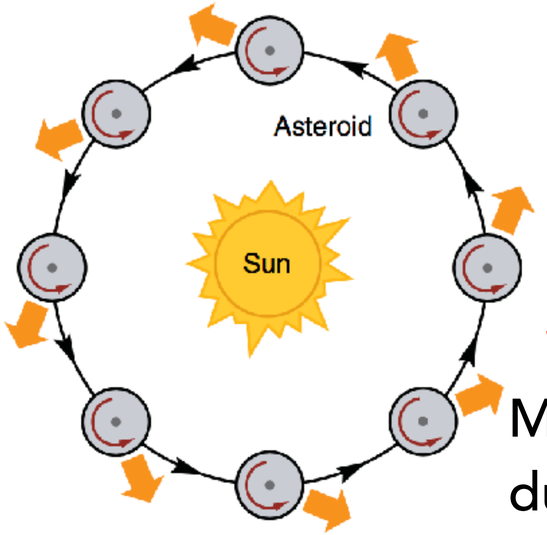


0.5 - 10 mas

New / precise asteroid masses



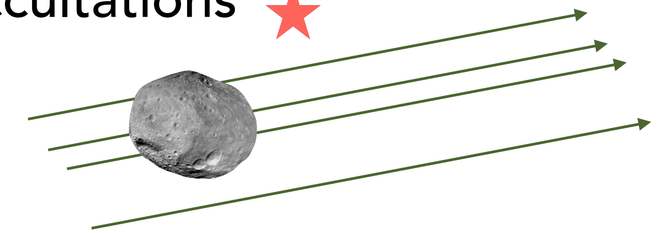
1000s encounters/year **> 10 mas**



~a few mas

Measure the orbital drift due to *Yarkovsky force*

Improve predictions of stellar occultations



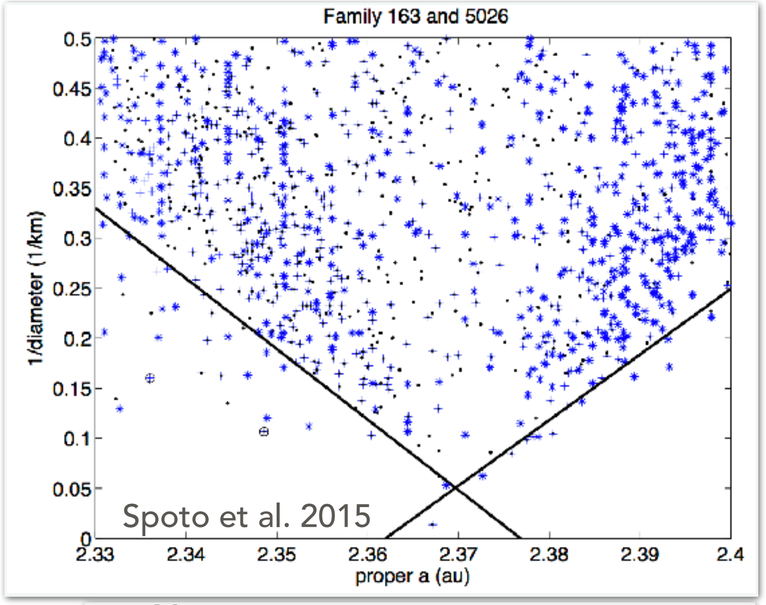
Yarkovsky effect: why we care

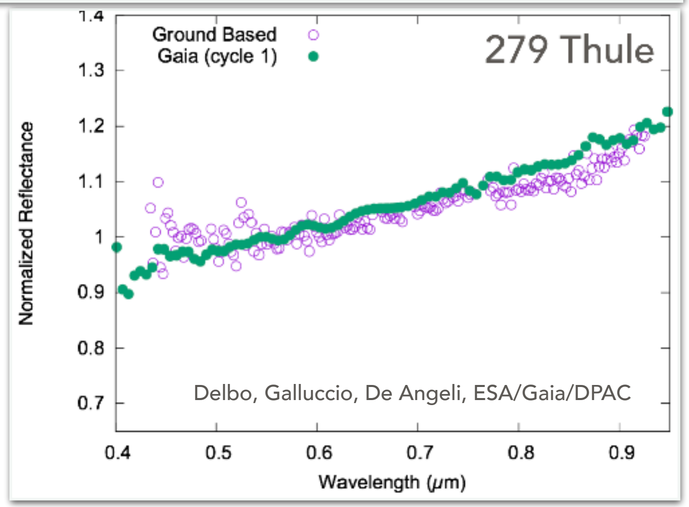
- Yarkovsky applications:
  - NEO and meteorite transport
  - physical properties (spin, density…)
  - family dispersion, ages

- The challenge: measure a few, apply to many

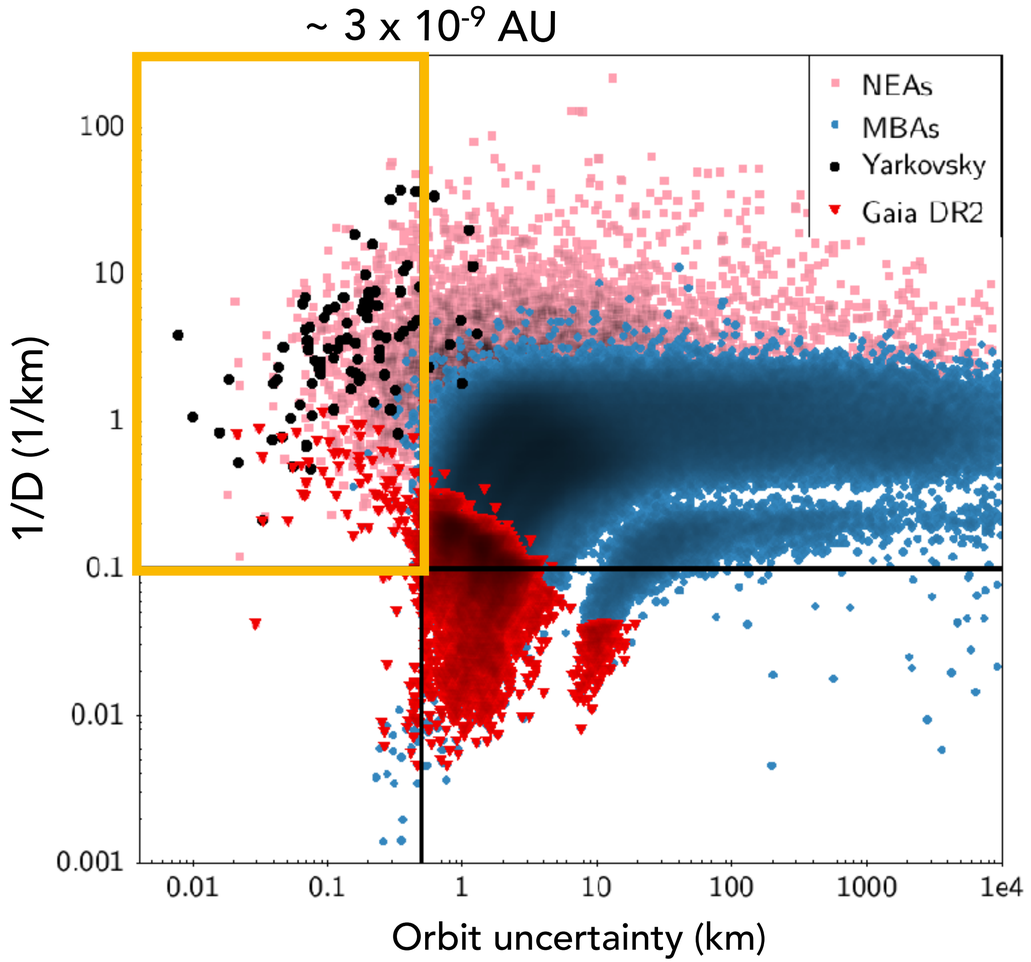
—> connection to spectro- photometry by Gaia:
  - low-res spectra: taxonomy in the visible
  - *mmag* photometry: shape determinations

- Large sample by end of mission: ~ 350 000





Yarkovsky and Gaia ?



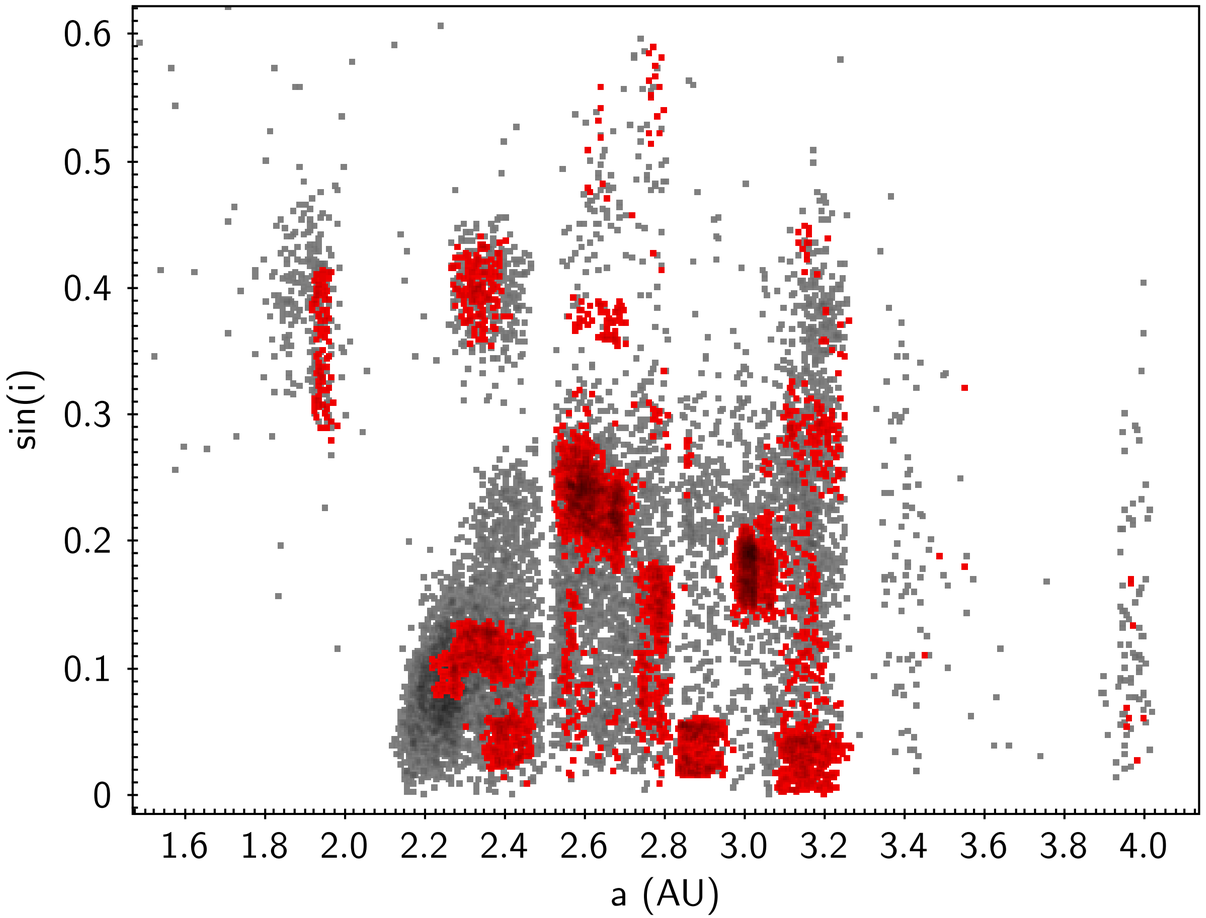
Pre-Gaia orbit quality (MPC data)

In DR2:

- 3 NEOs with measured Yarkovsky
- 5 NEOs with marginal detection
- about 20 good MB candidates

Asteroid family members in DR2

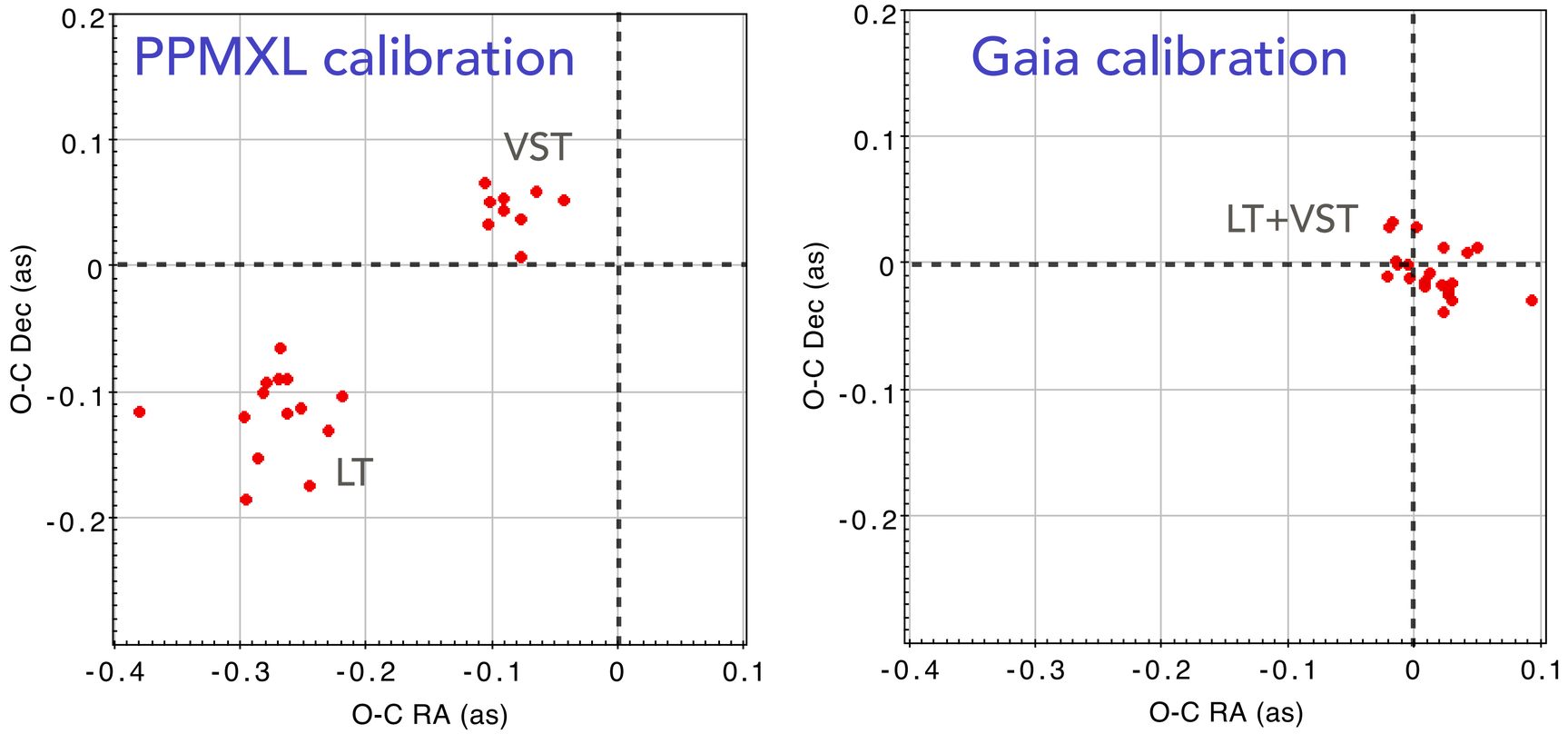
4676 family members in DR2 (from AstDys membership)



Joint exploitation Gaia + pre-Gaia astrometry: bias example

Asteroid (1132) Hollandia

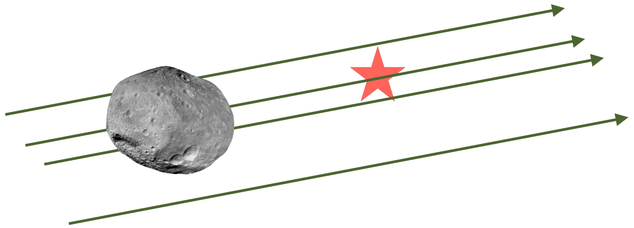
Liverpool Telescope + VST (8 hours apart) & MPC ground-based data (~1900 positions)



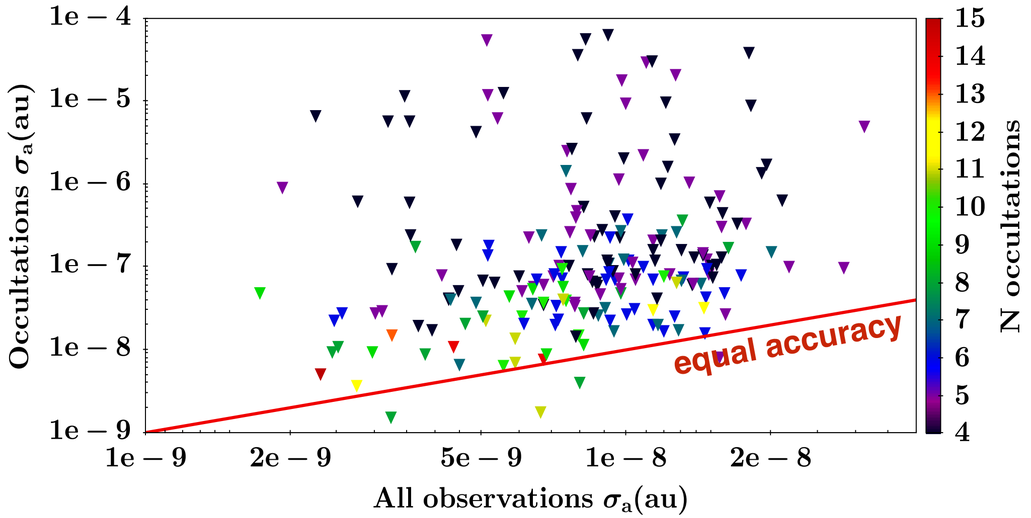
(credits: Gaia GBOT team)

The *occultation astrometry* with Gaia

- DR2 already successfully exploited
  - Triton (Octobre 3, 2017)
  - 2014 MU69 (V=27.5, 50 km KBO, ~1.4 mas)!!

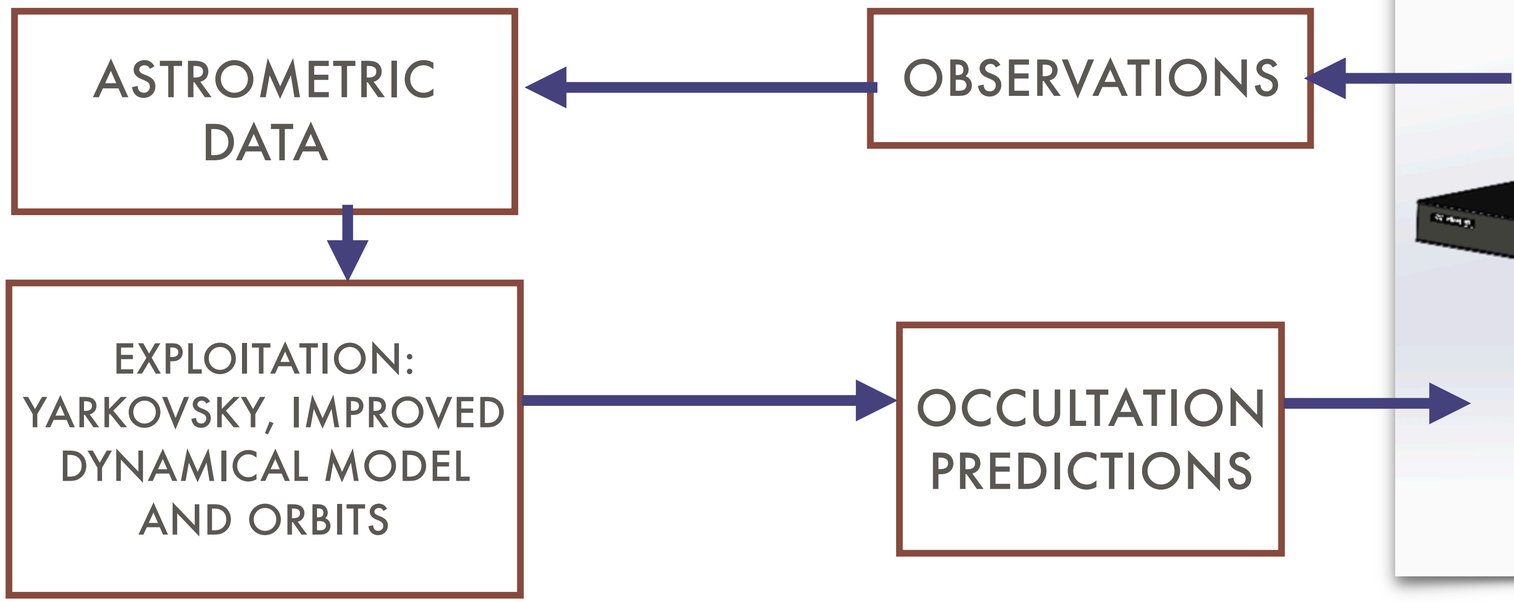


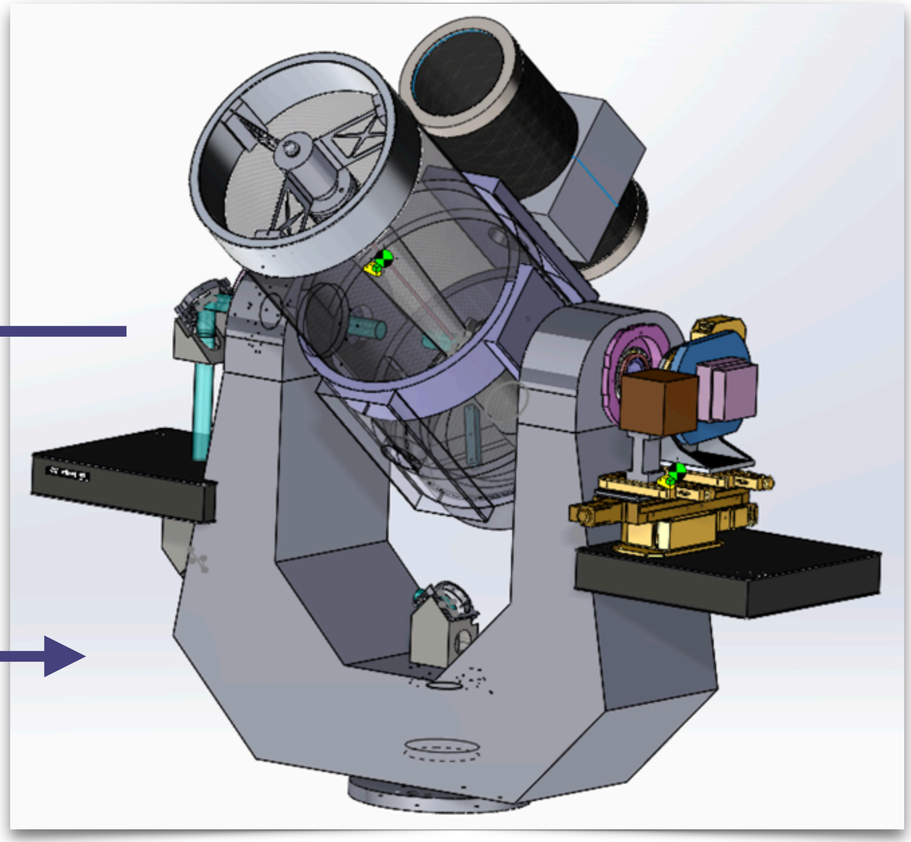
- Occultations: very accurate asteroid position at the level of the star astrometry
- …Beyond the duration of Gaia!



Robotic observations of asteroid occultations

- Extension to faint magnitudes and small asteroids
- Only method providing ~Gaia accuracy
- 50 cm robotic telescope at OCA, France

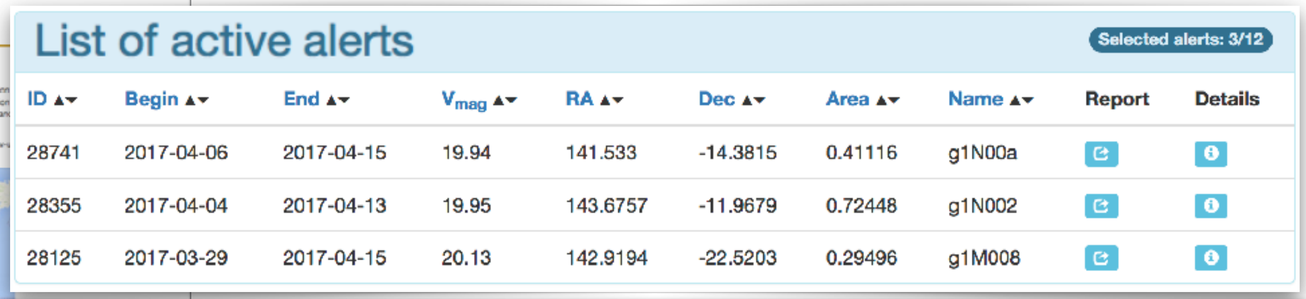


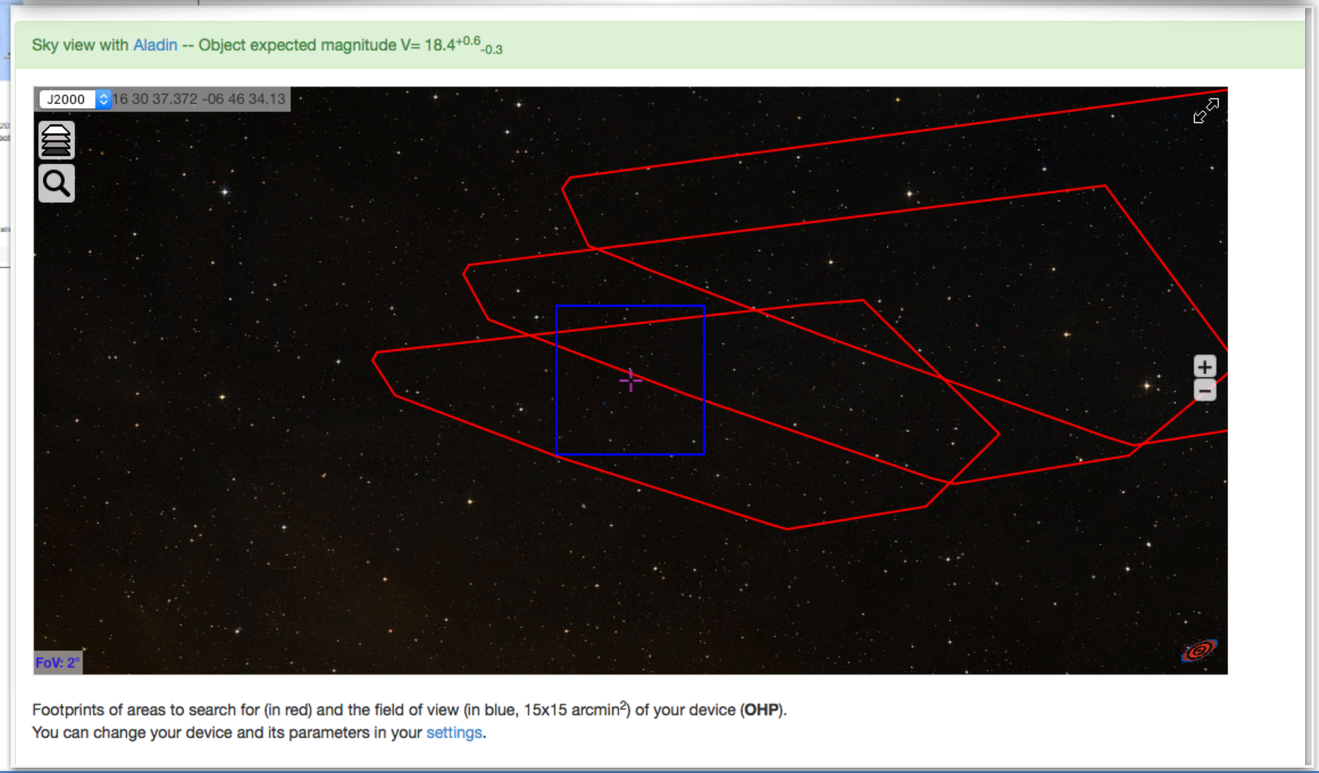


Conclusions

- Gaia DR2 asteroid data: the first sample, already useful to test subtle dynamical effects
  - Yarkovsky determination
  - general orbit improvement
  - application to stellar occultations
- Combination with other observations: it starts to work…
  - but weighting of the data is critical
  - accurate debiasing is required
  - a new method successfully implemented and tested
- Yarkovsky detection *in the Main Belt* is getting closer…

Diffusion of asteroid alerts





http://gaiafunsso.imcce.fr

B. Carry (OCA), W. Thuillot (IMCCE)

Register and contribute!