

GAIA: SOLAR SYSTEM ASTROMETRY IN DR2

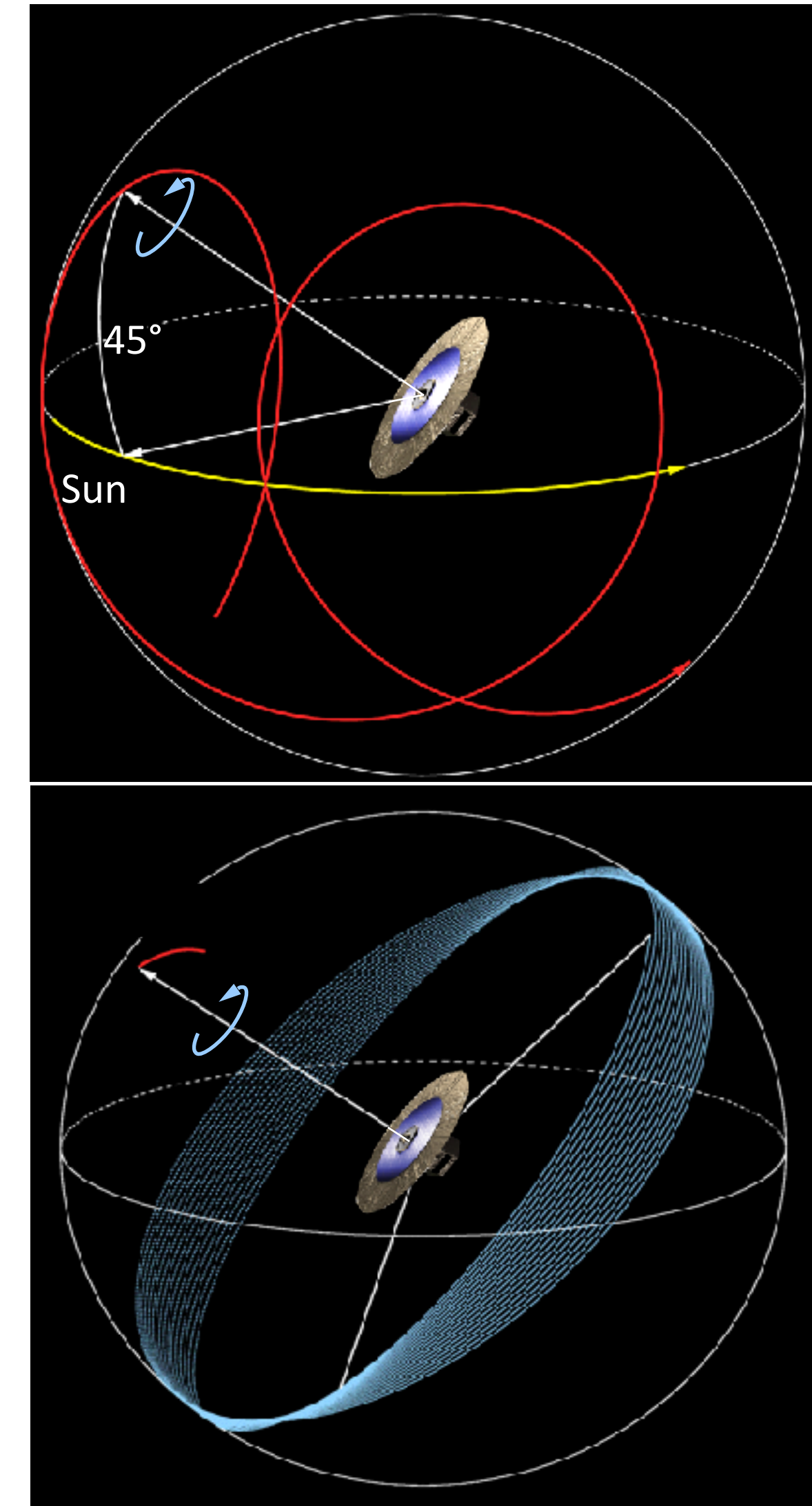
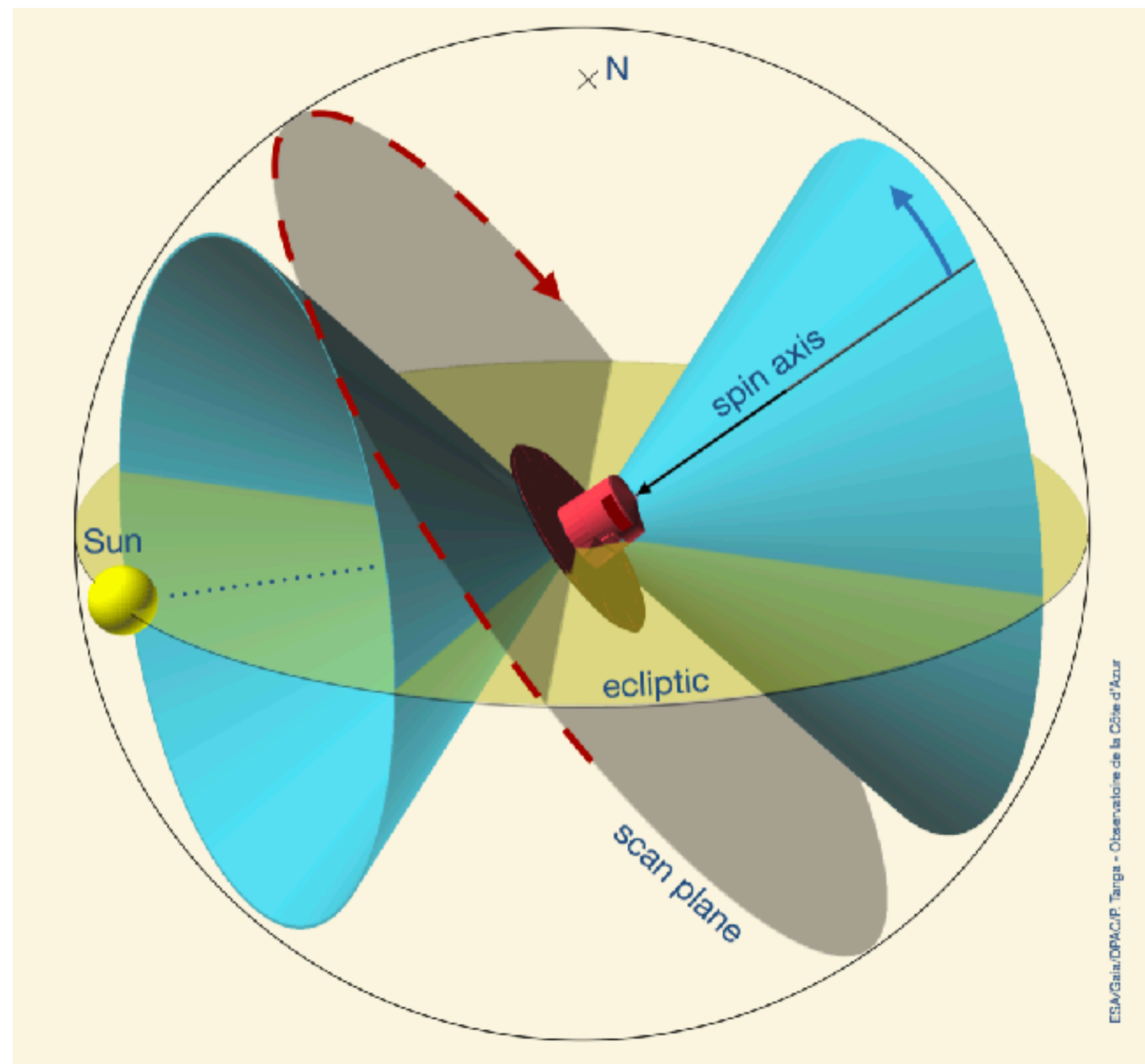
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²IMCCE, Observatoire de Paris, France

Gaia is observing asteroids

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

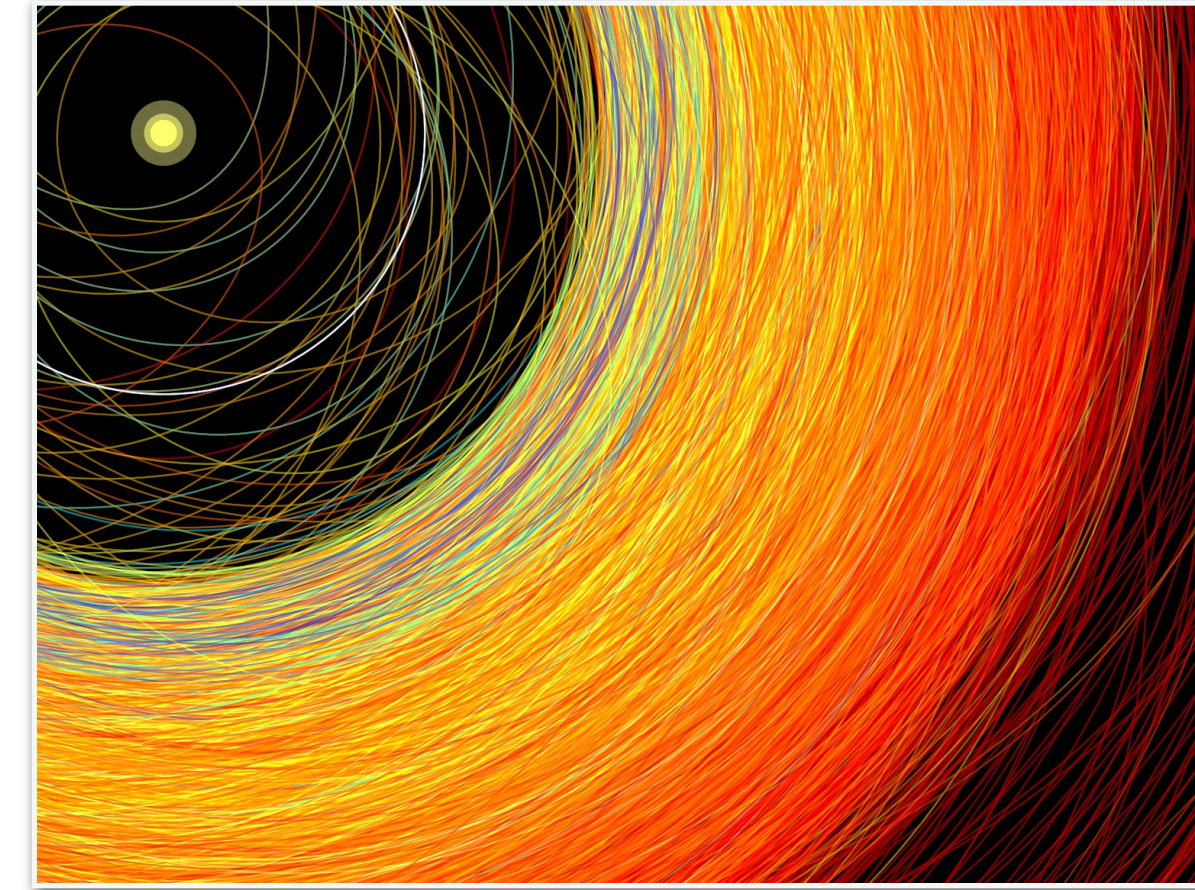


Gaia DR2 - Solar System

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

> 10 FOV transits over the 22 months of DR2

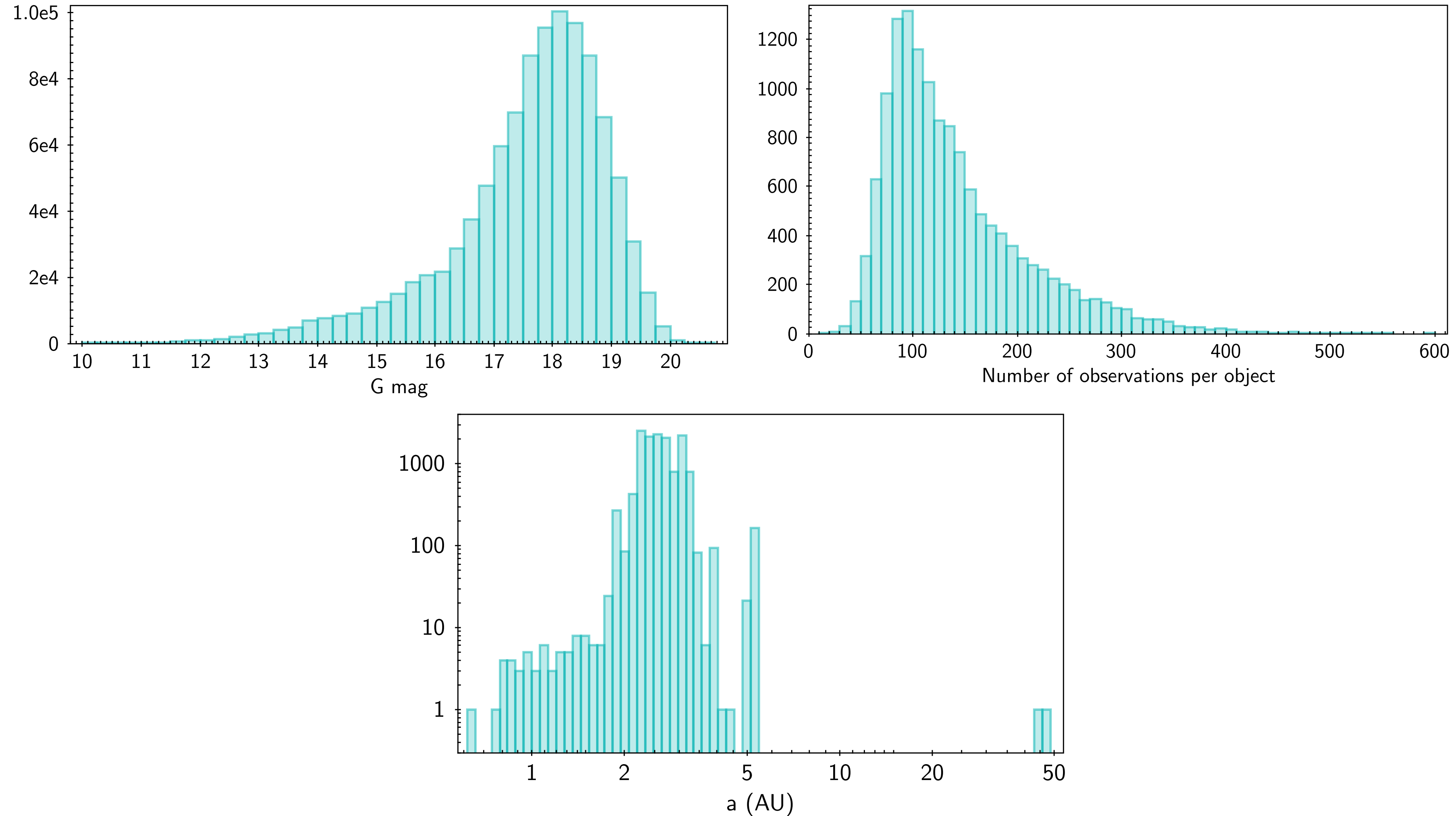
August 5, 2014 - May 23, 2016



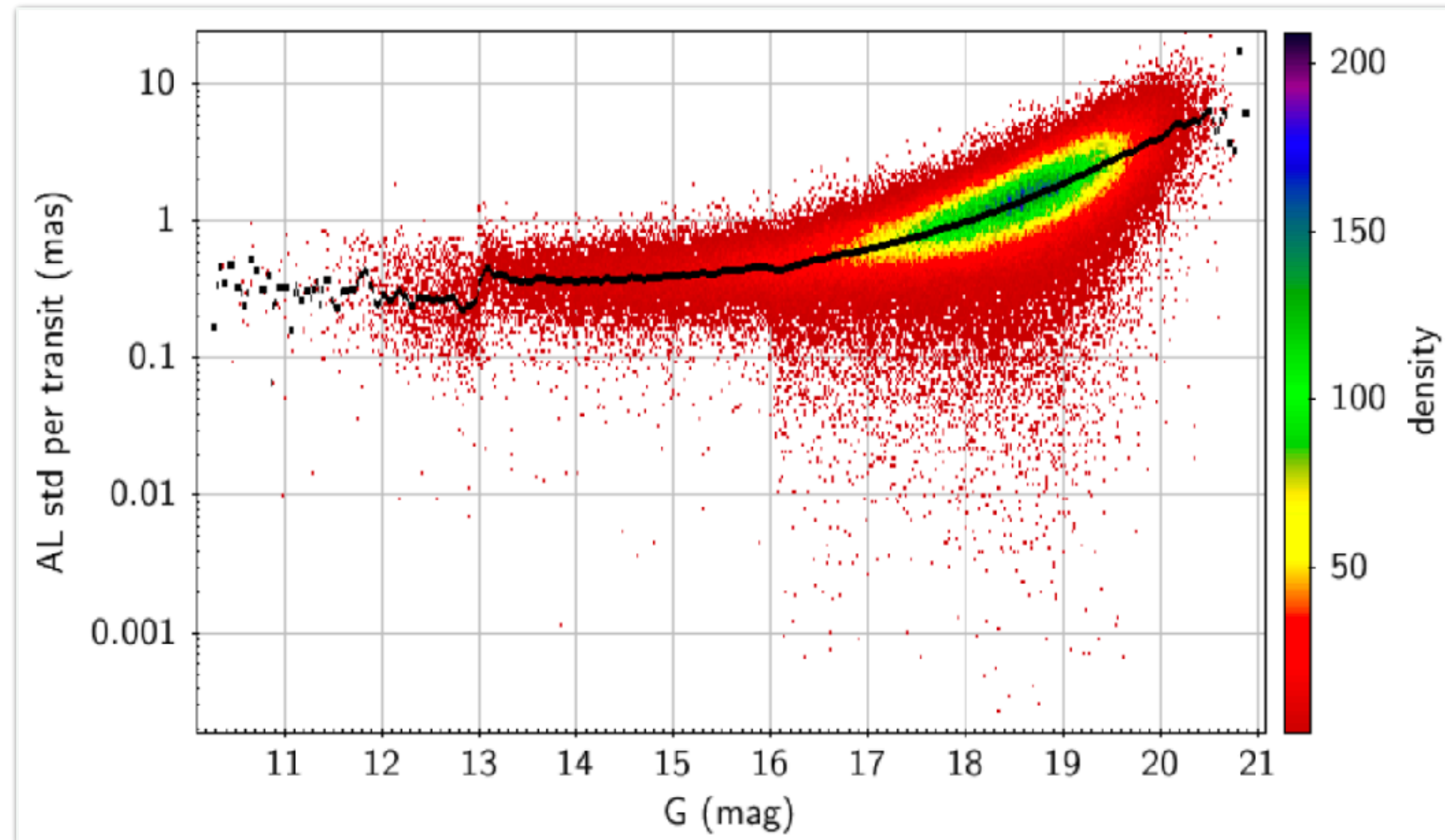
Objects	14 099
Epoch astrometry	1 997 702 CCD positions
	287 904 transits (52% : photometry)
Typ. accuracy	<1 mas (along scan)



Gaia DR2 - Solar System statistics



Gaia DR2 - Solar System - single transit astrometric performance

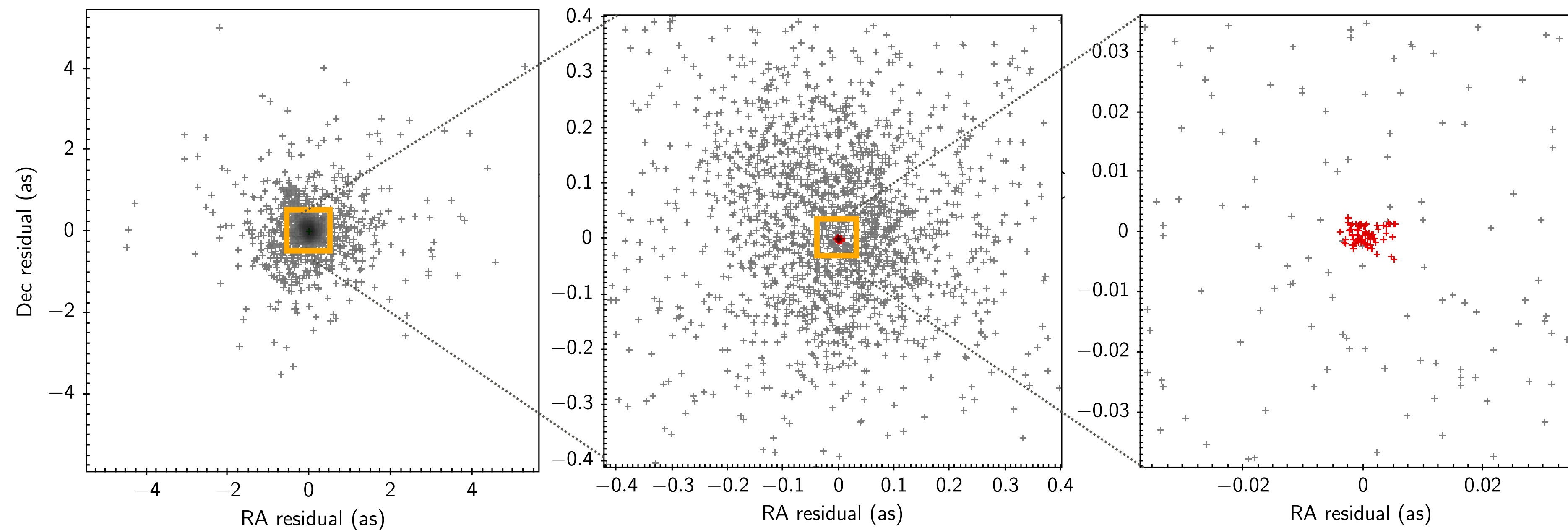


Residuals from the orbital fit of Gaia DR2 data only (along-scan direction)

Spoto et al. 2018

Asteroid (386) Siegena - residuals from orbital fit

Combining archive data (2776 obs.) to GDR2



factor 100 X improvement!



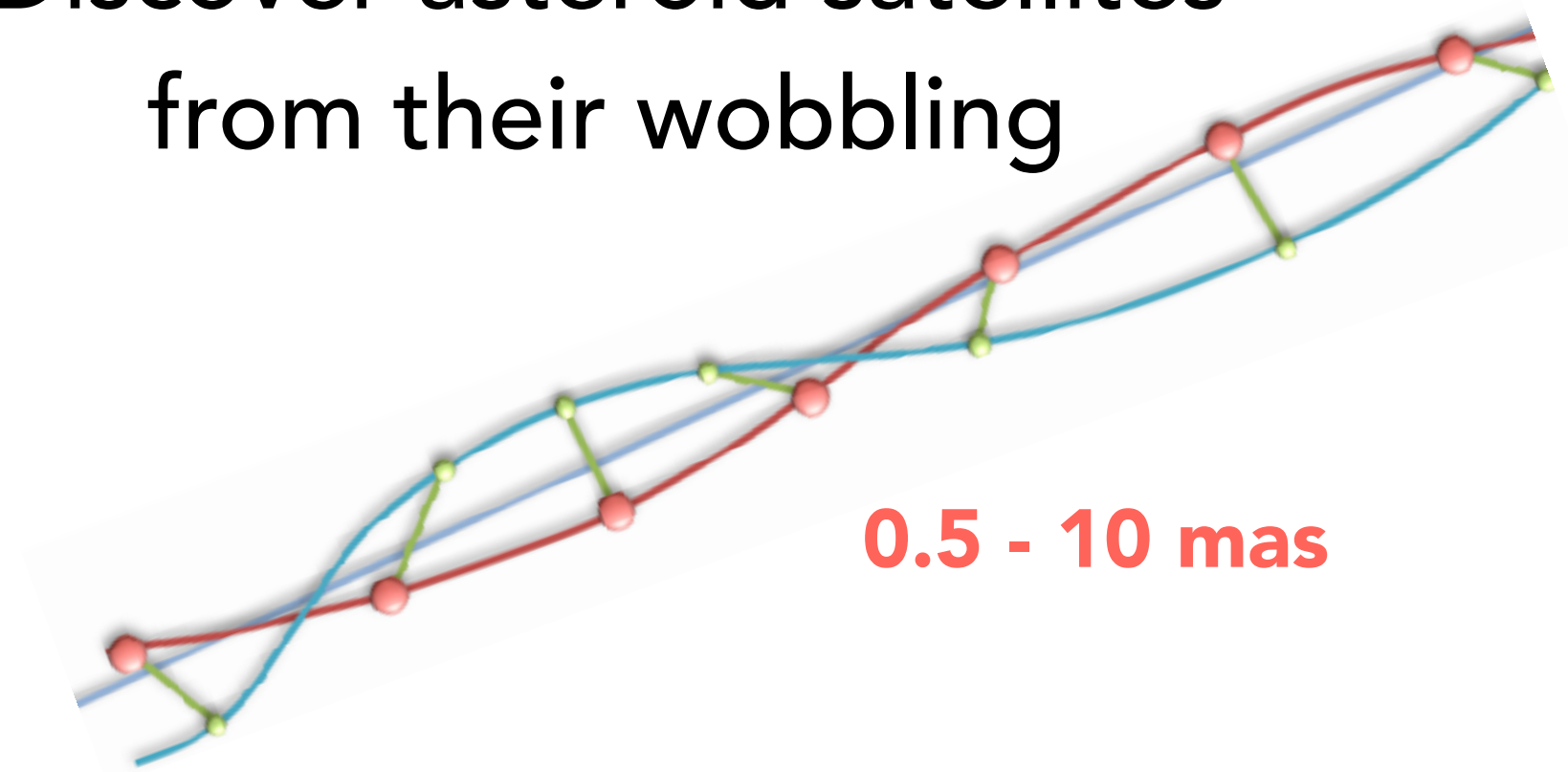
The situation, before Gaia

- **1.9×10^8** 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

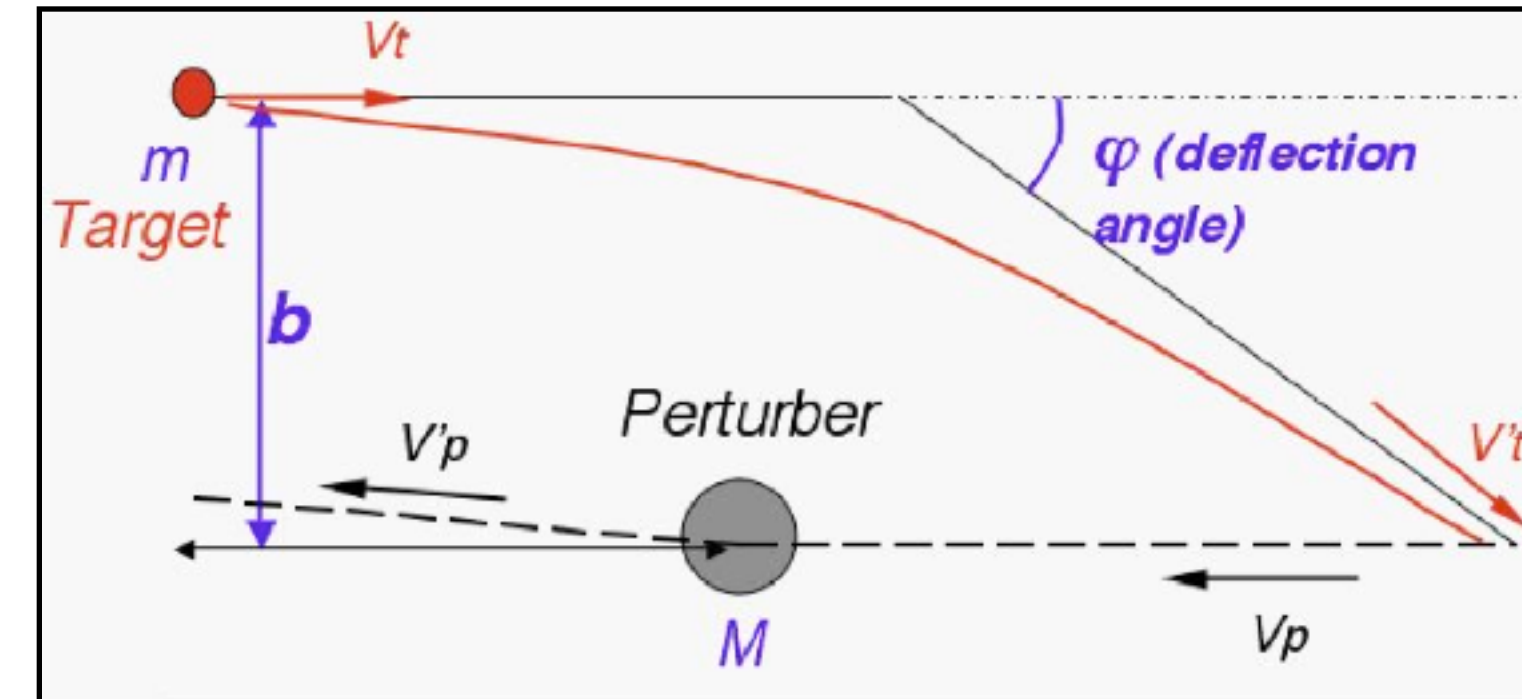


Some challenges for asteroid astrometry

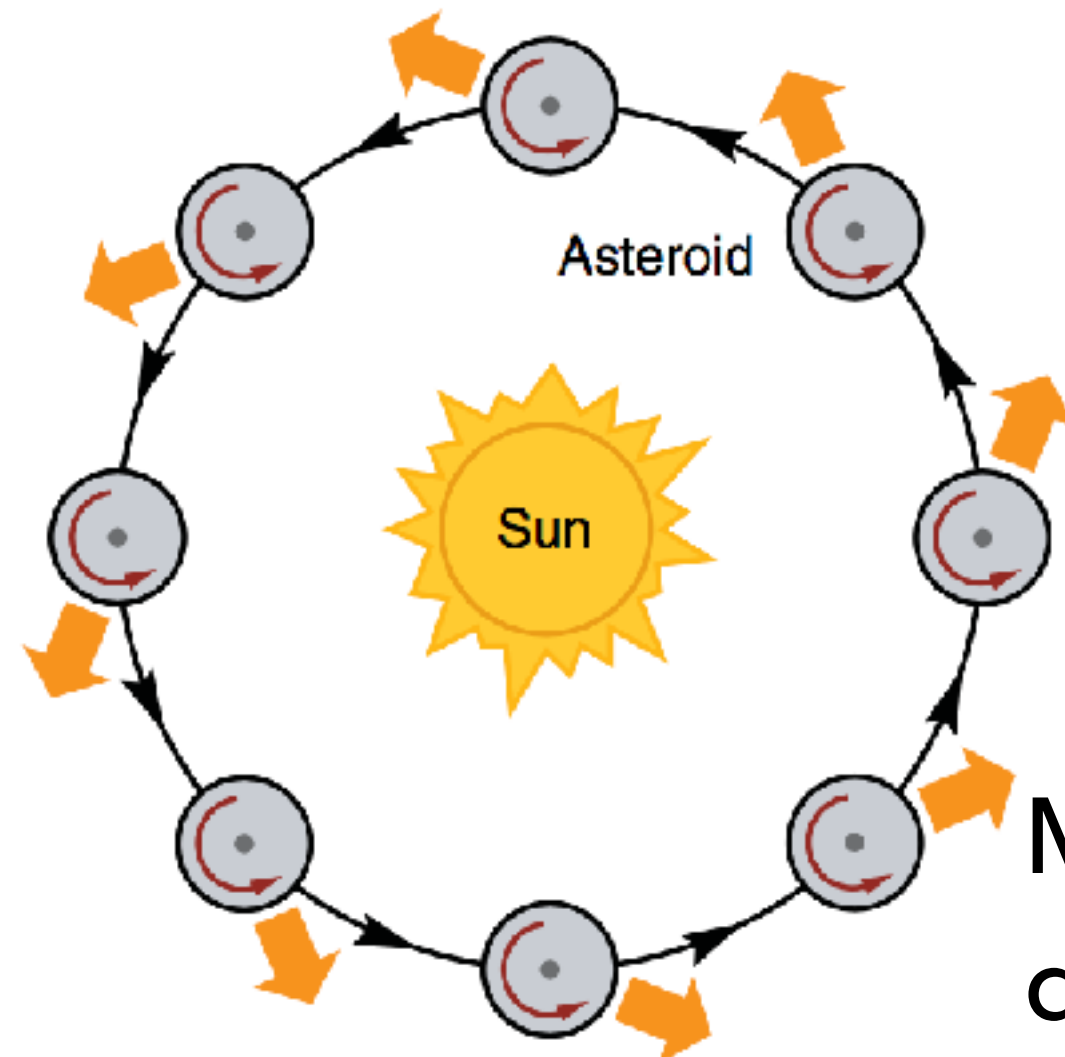
Discover asteroid satellites from their wobbling



New / precise asteroid masses



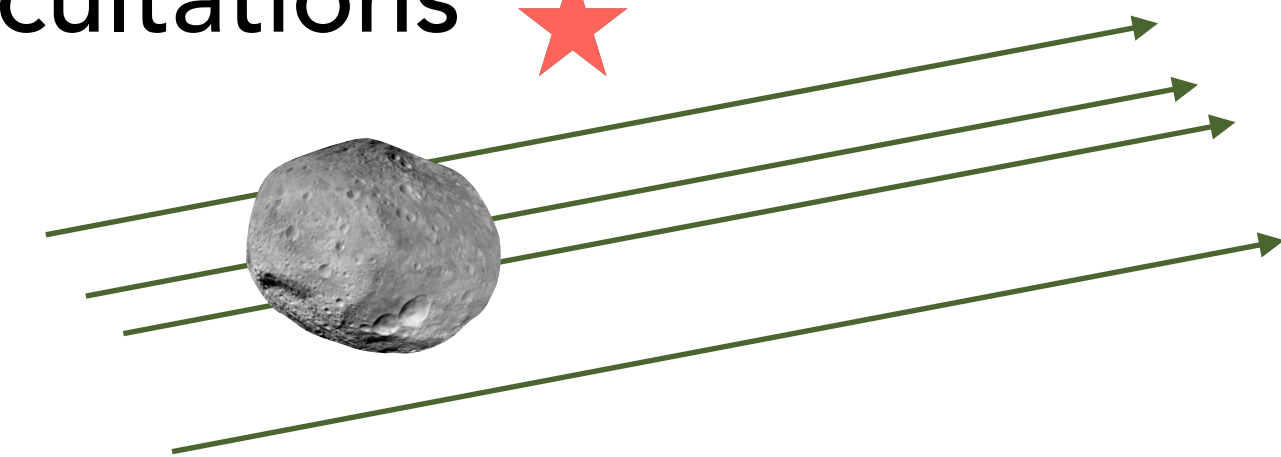
1000s encounters/year > 10 mas



~a few mas

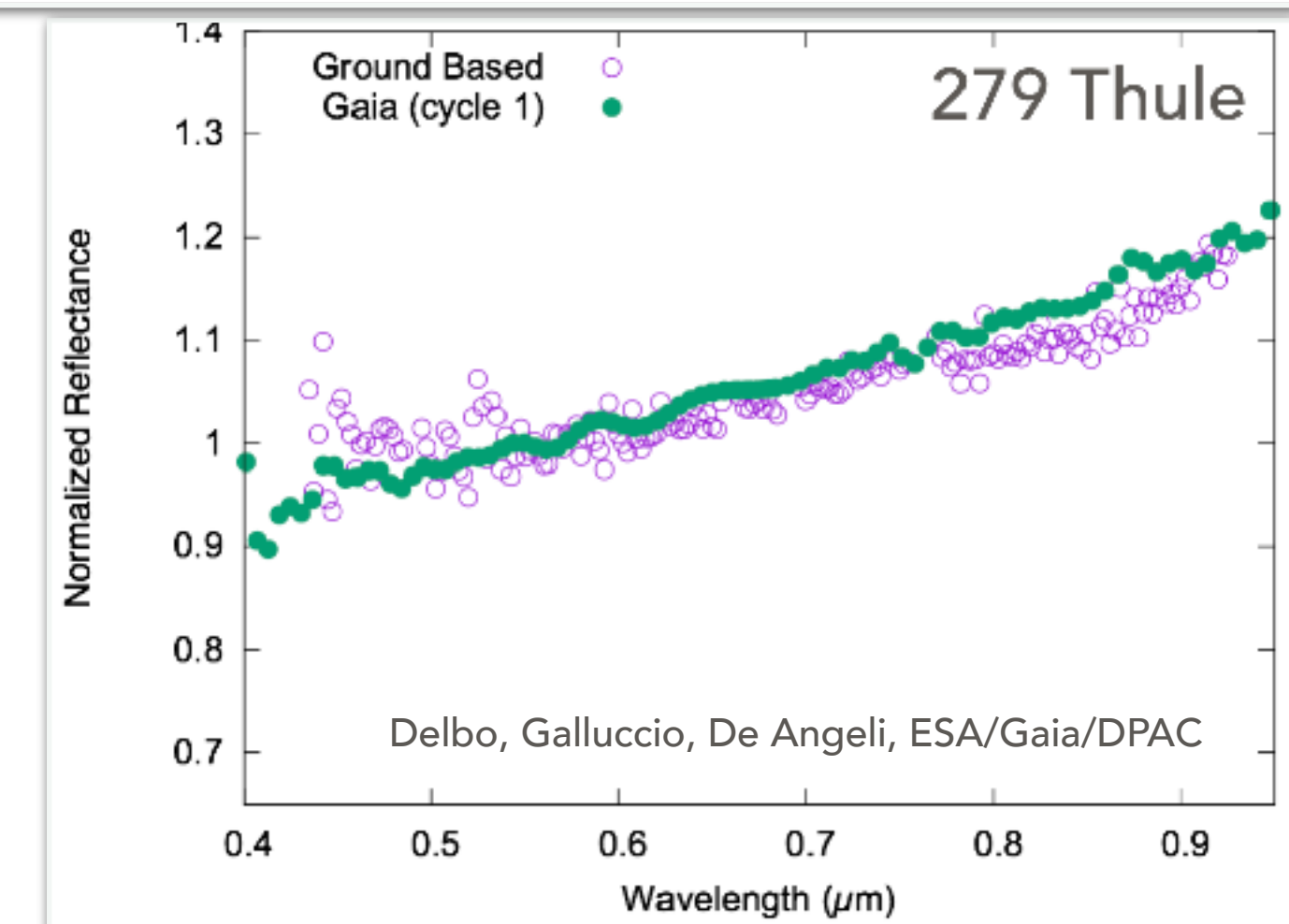
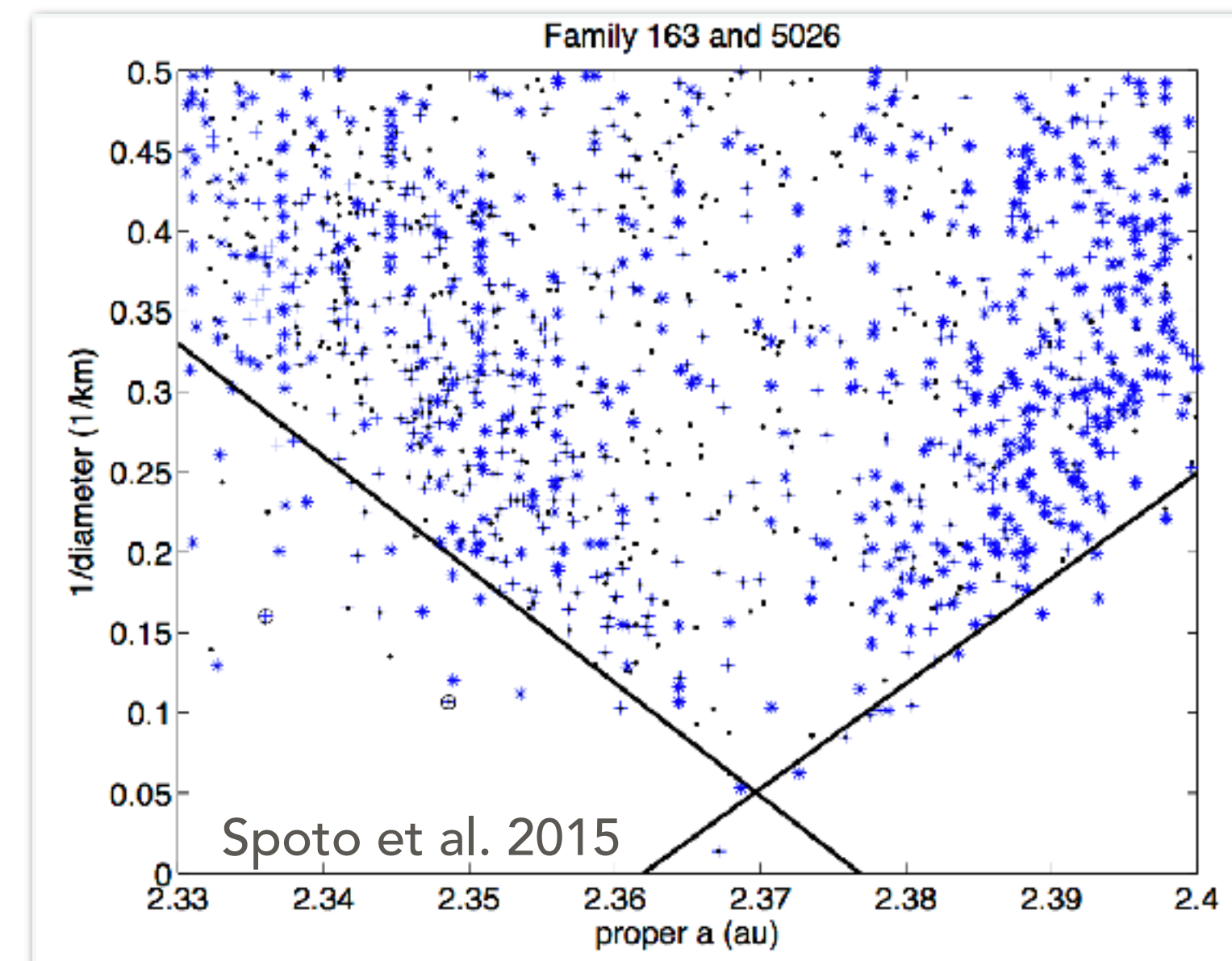
Measure the orbital drift due to *Yarkovsky force*

Improve predictions of stellar occultations ★

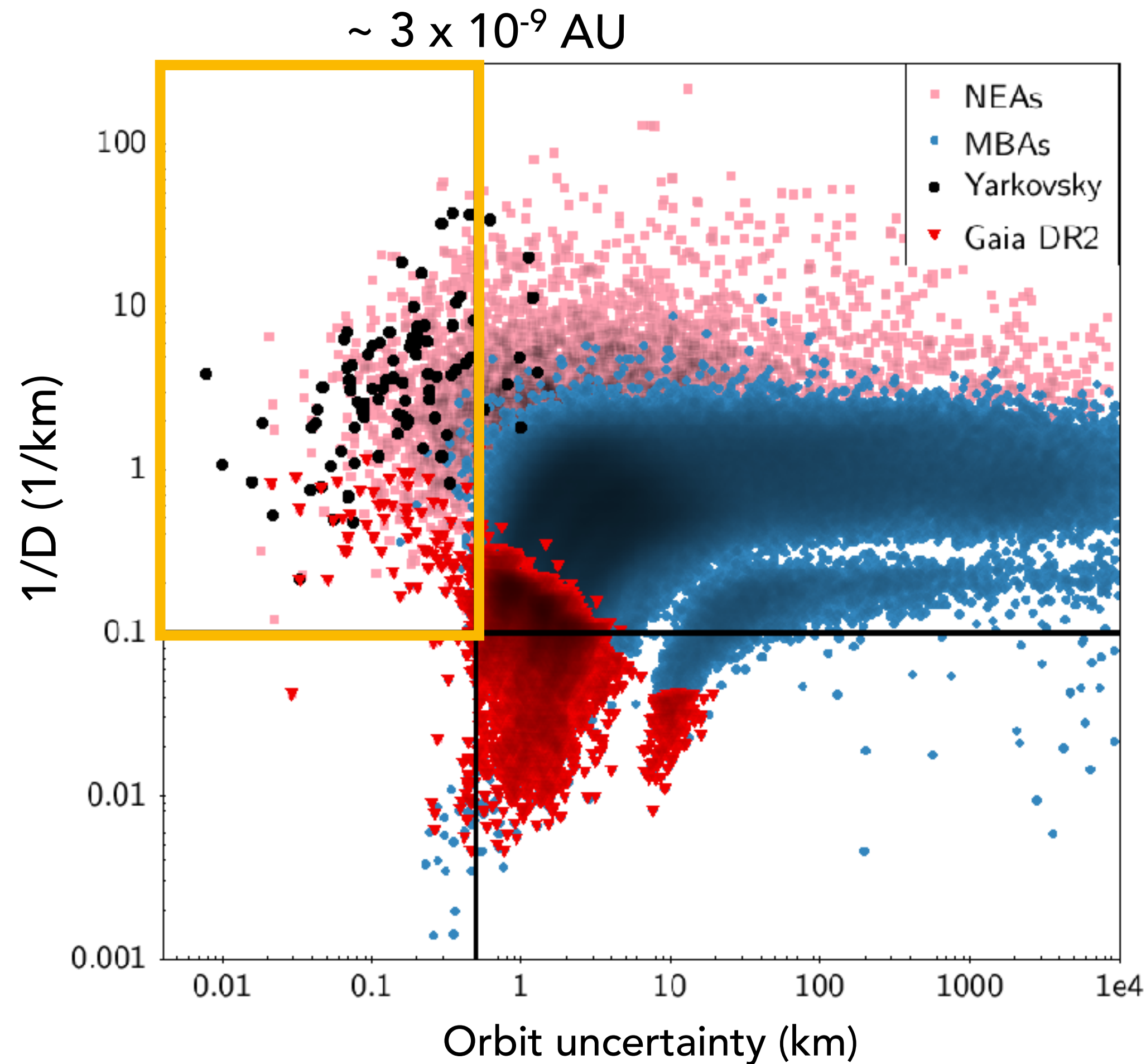


Yarkovsky effect: why we care

- 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)

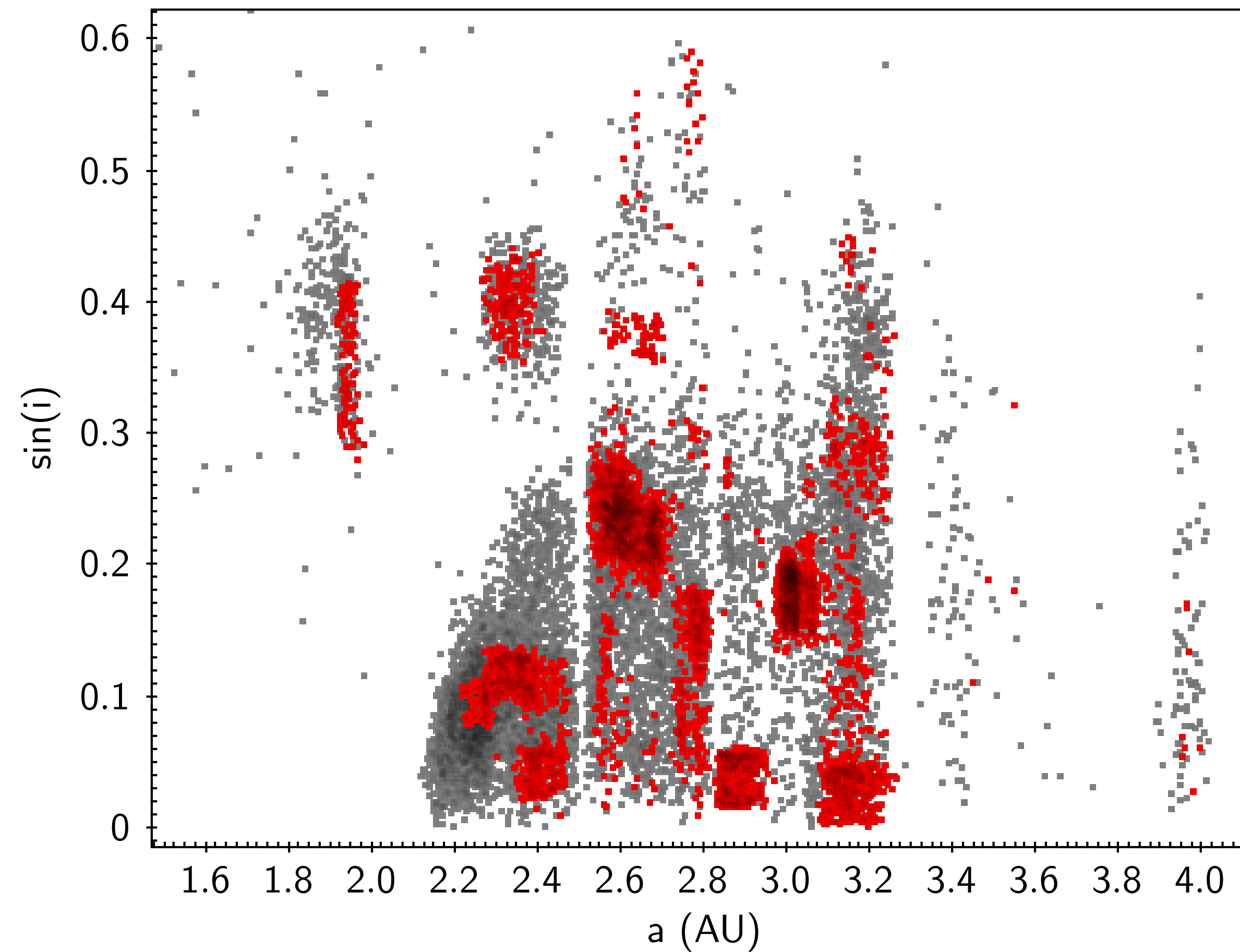
In DR2:

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



Asteroid family members in DR2

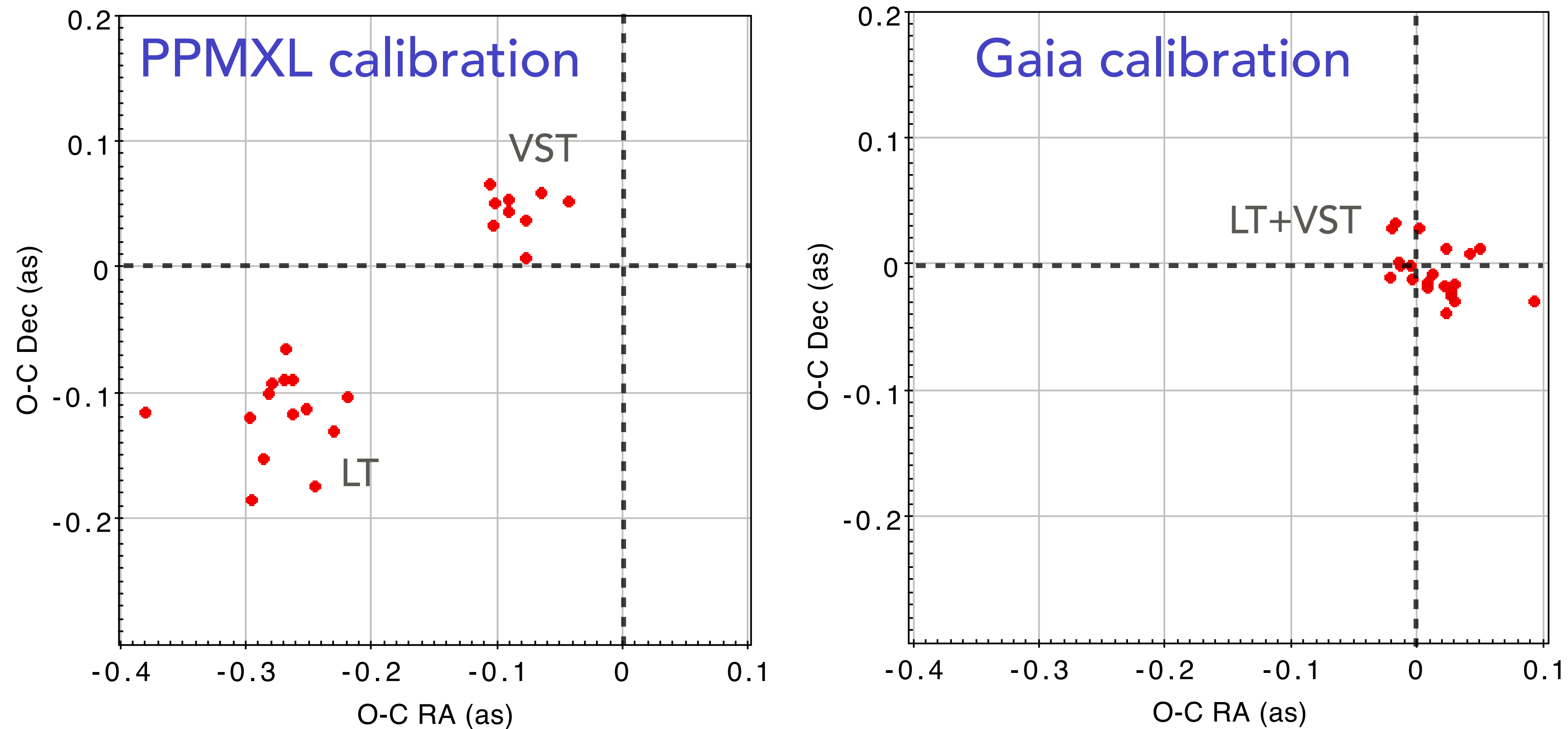
4676 family members in DR2 (from AstDys membership)



Joint exploitation Gaia + pre-Gaia astrometry: bias example

Asteroid (1132) Hollandia

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

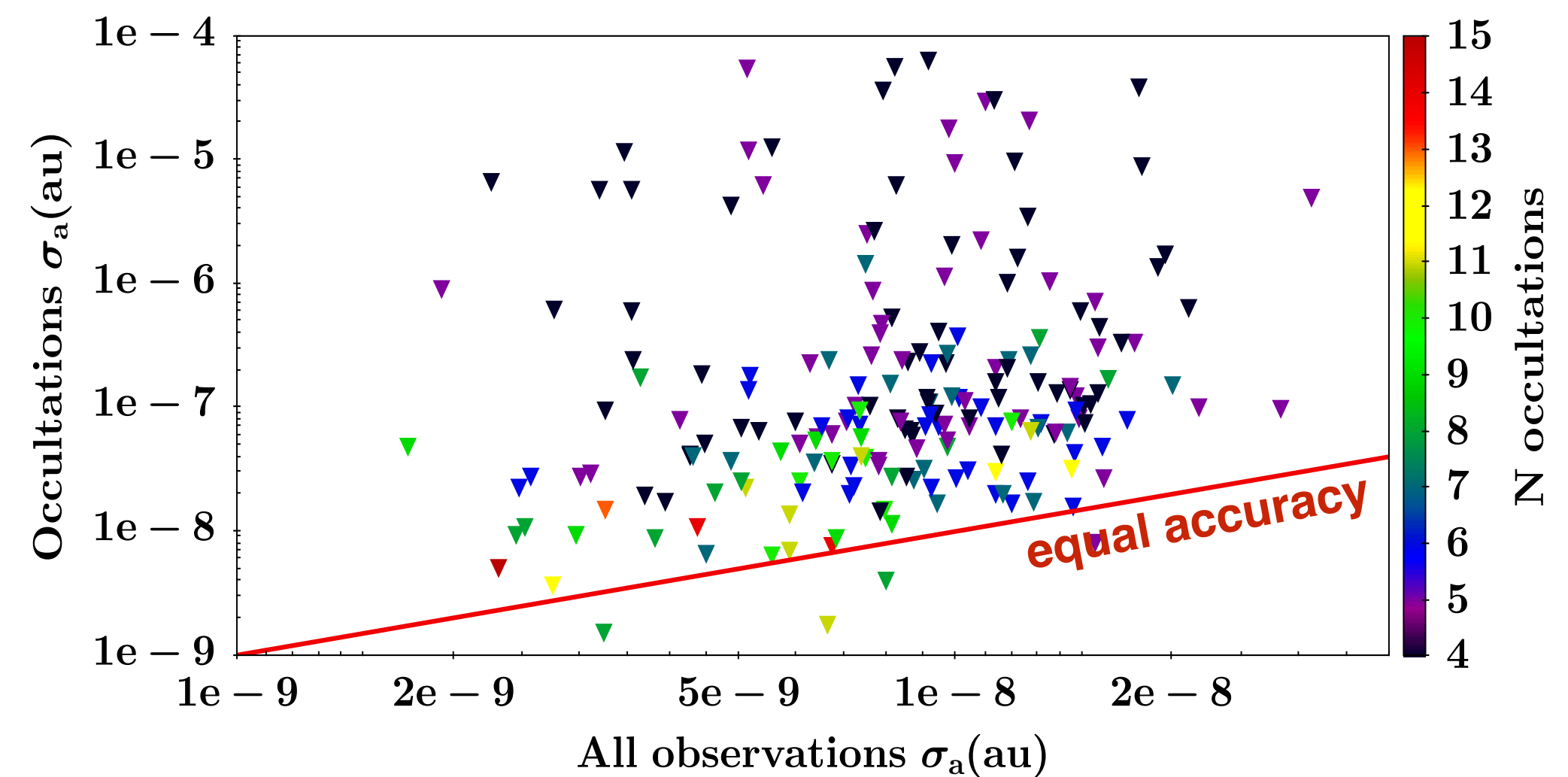
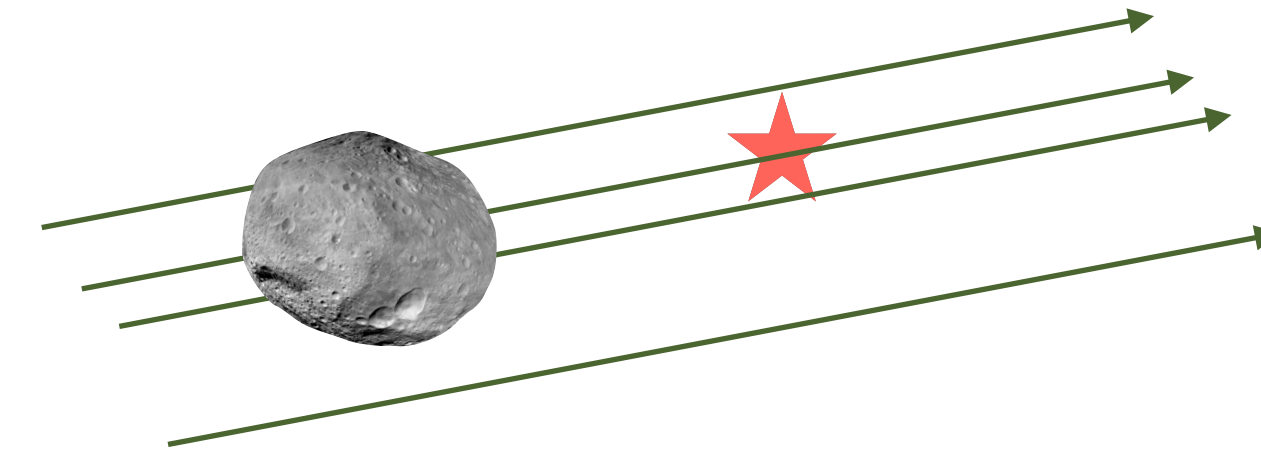


(credits: Gaia GBOT team)



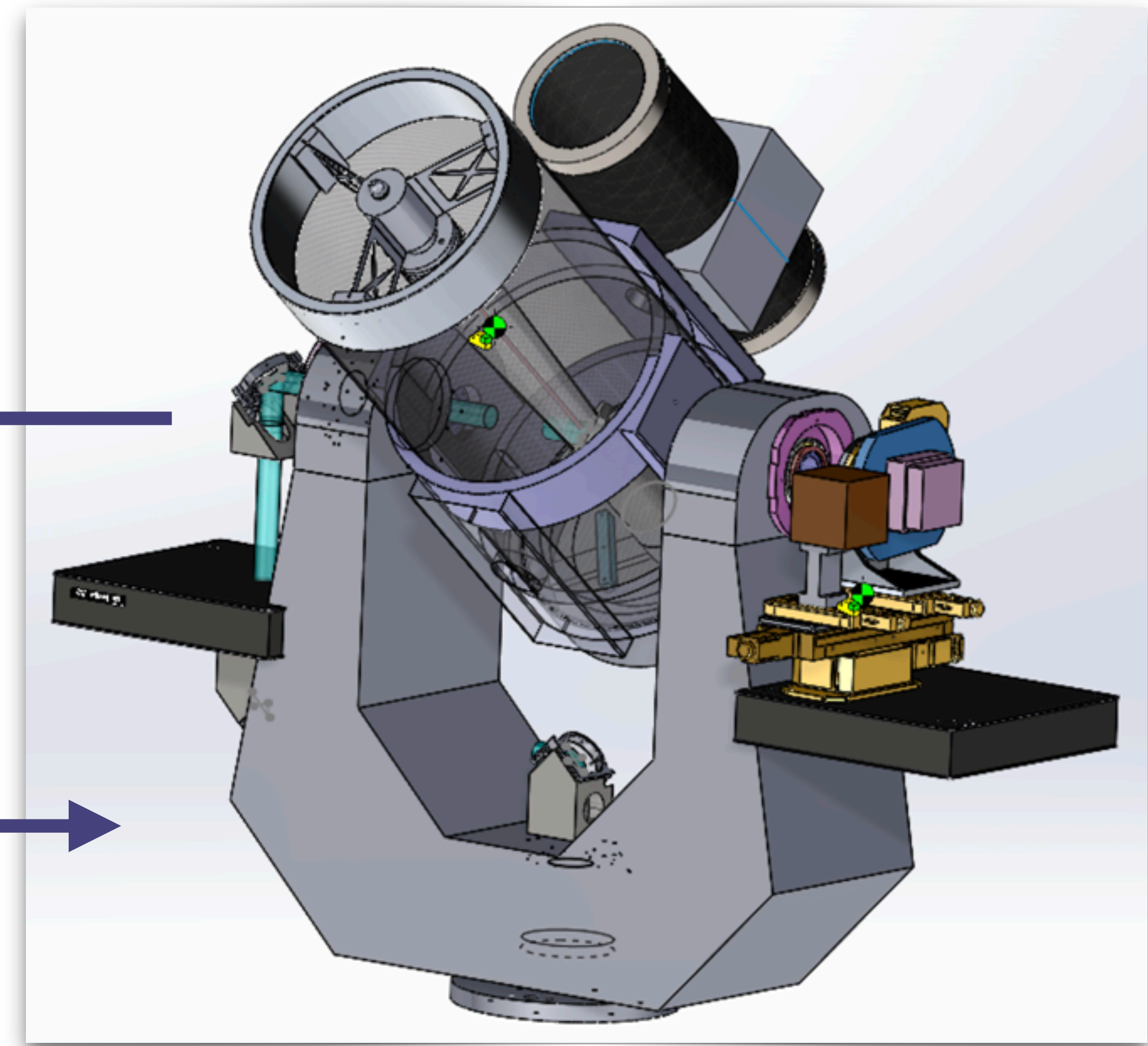
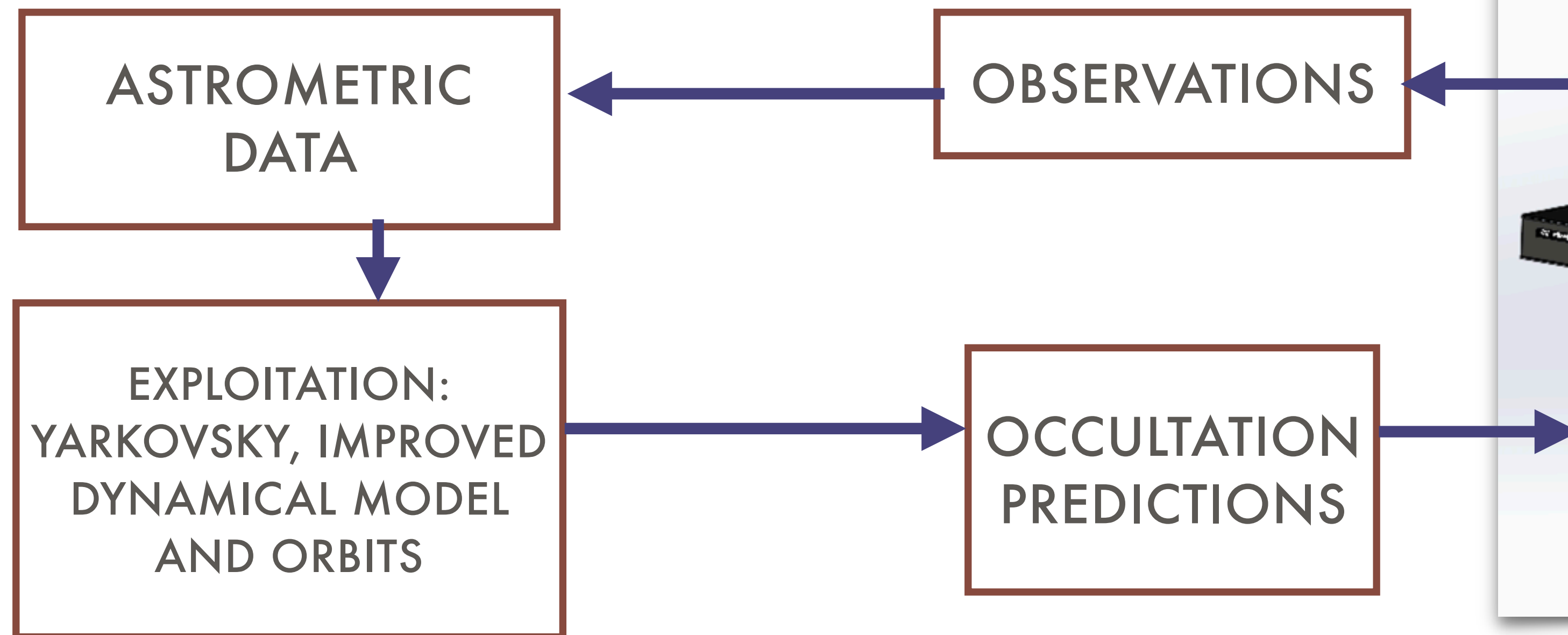
The *occultation astrometry* with Gaia

- 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

Gaia Follow-Up Network for Solar System Objects

Goal

The Gaia Follow-Up Network for Solar System Objects (Gaia-FUN-SSO) has been set up in the framework of a task (task 6) of the Consortium DPAC Gaia consortium. Its goal is to coordinate ground-based observations on alert triggered by the data processing system during the mission: detected moving objects or for the improvement of orbits of some critical targets. Gaia will scan the sky following a pre-defined scanning law and are required to avoid the loss of newly detected Solar System objects and to facilitate their subsequent identification by the probe.

These pages provide an access to the alerts, including the opportunities to help finding the targets, for the registered members of the Gaia Follow-Up Network (September 2015) consists in 95 observing sites, spread all over the world.



Workshops

Three Gaia-FUN-SSO workshops dedicated to the astrometric follow-up of the Solar System Objects have already been organized in 2010, 2011 and 2014. Discussions has been held about this network and the tasks to be accomplished, the capabilities of the observing sites and the preliminary observations.

- Proceedings of the 2010 workshop have been published and can be freely downloaded from the workshop web site.
- Proceedings of the 2011 workshop have been published. These proceedings and the talks are accessible on the workshop web site.
- Proceedings of the 2014 workshop have been published. These proceedings and the talks are accessible on the workshop web site.

Registration


To get a full access to these pages and to share data, you must be registered as active participant of this observing network. For this registration network needs to have a large geographical coverage: if you are interested, do not hesitate to contact us!

Please report bugs here in project "Gaia-FUN-SSO", or contact us at gaia-fun-ssn@imcce.fr.

List of active alerts Selected alerts: 3/12

ID ▲▼	Begin ▲▼	End ▲▼	V _{mag} ▲▼	RA ▲▼	Dec ▲▼	Area ▲▼	Name ▲▼	Report	Details
28741	2017-04-06	2017-04-15	19.94	141.533	-14.3815	0.41116	g1N00a		
28355	2017-04-04	2017-04-13	19.95	143.6757	-11.9679	0.72448	g1N002		
28125	2017-03-29	2017-04-15	20.13	142.9194	-22.5203	0.29496	g1M008		

Sky view with Aladin -- Object expected magnitude $V = 18.4^{+0.6}_{-0.3}$



J2000 16 30 37.372 -06 46 34.13

FoV: 2"

Footprints of areas to search for (in red) and the field of view (in blue, 15x15 arcmin²) of your device (OHP). You can change your device and its parameters in your [settings](#).

<http://gaiafunssn.imcce.fr>

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

Register and contribute!

