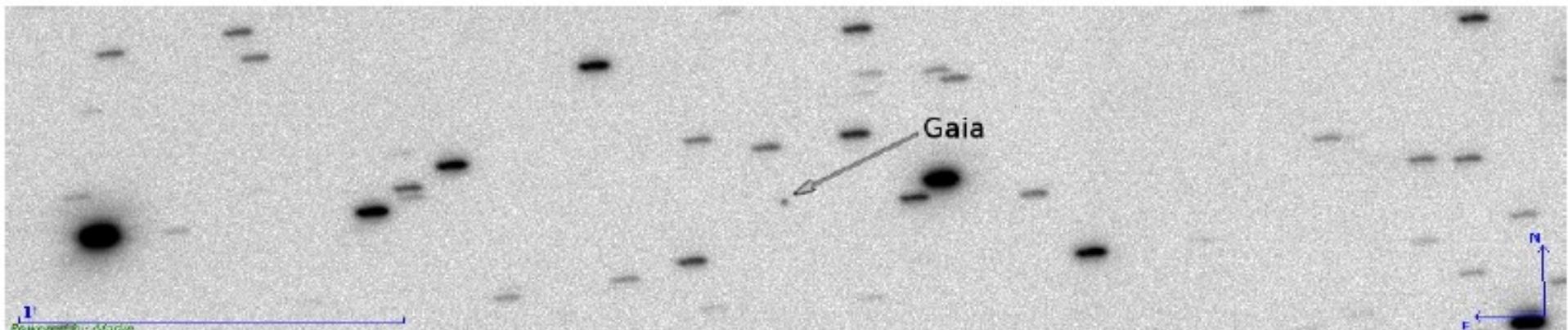


GBOT asteroids detection and reduction experiment

<http://gbot.obspm.fr/asteroids>



Sébastien Bouquillon behalf on Gaia-GBOT team



The Gaia tracking

To achieve its aim in terms of astrometric precision, the standard procedure for satellite tracking (i.e. by a single ranging and communications station) will not be sufficient either for correcting the relativistic aberration effects or for precisely measuring the parallaxes of solar system objects.

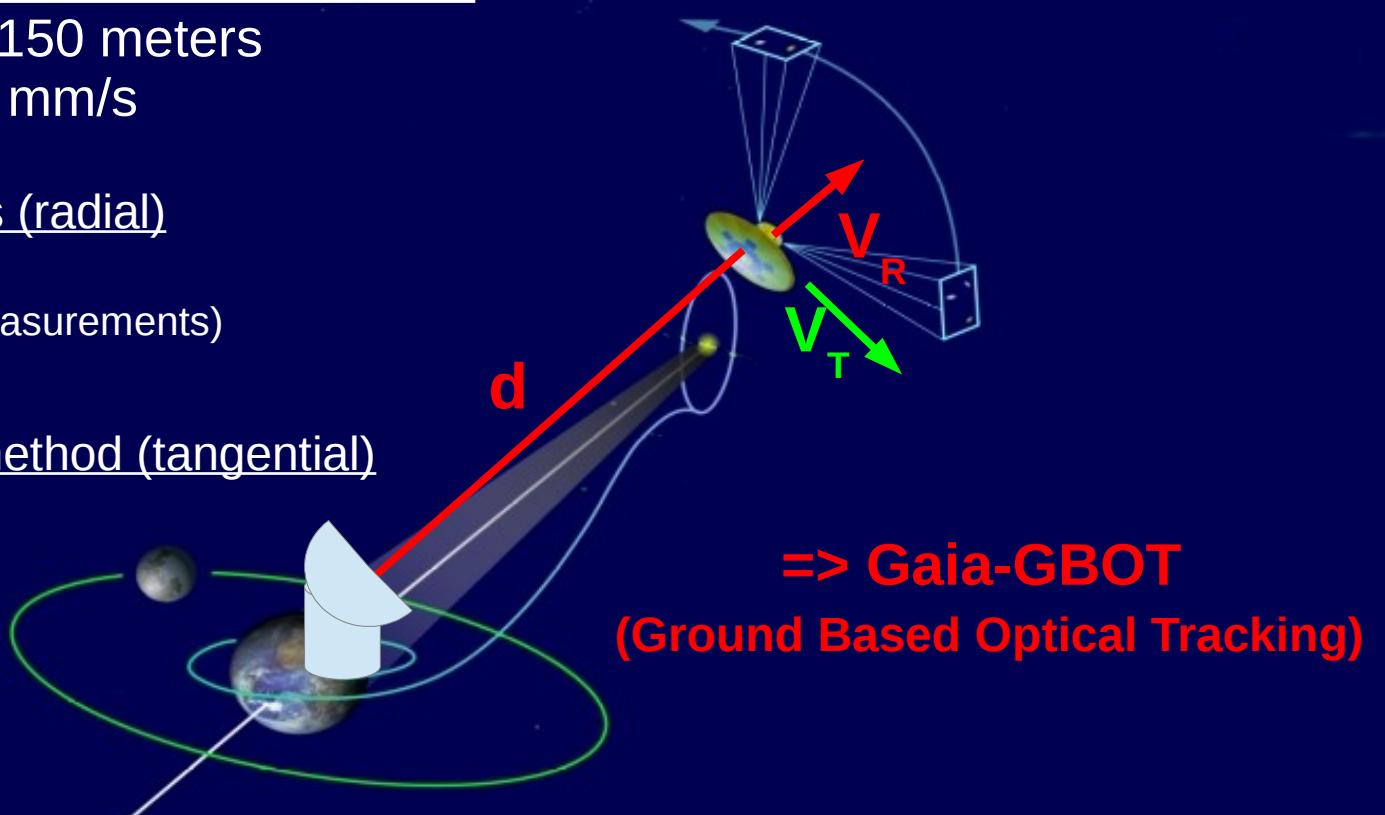
Requirements for the precision of Gaia Orbit

- Positional precision < 150 meters
- Speed precision < 2.5 mm/s

Standard tracking methods (radial)

- ★ Range (by radio telemetry)
- ★ Range rate (by Doppler measurements)
=> Not enough

Complementary tracking method (tangential)

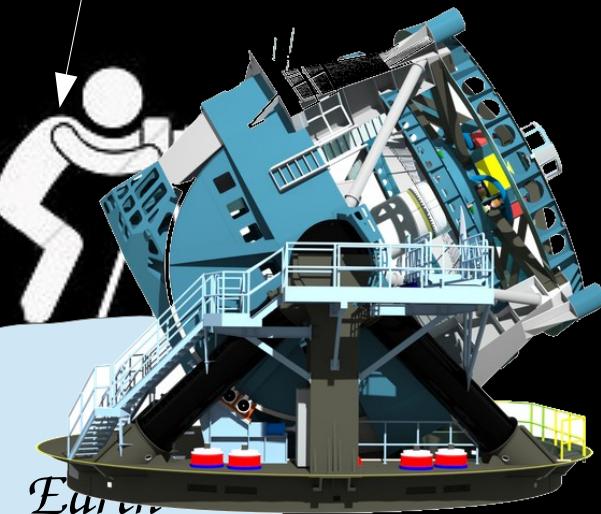


What GBOT do every night around midnight (local time)
during the whole Gaia mission

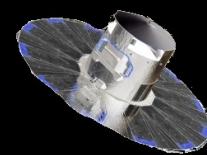


The dream of the GBOT team is ...

« GBOT » Observer



Eur



Gaia

Stars

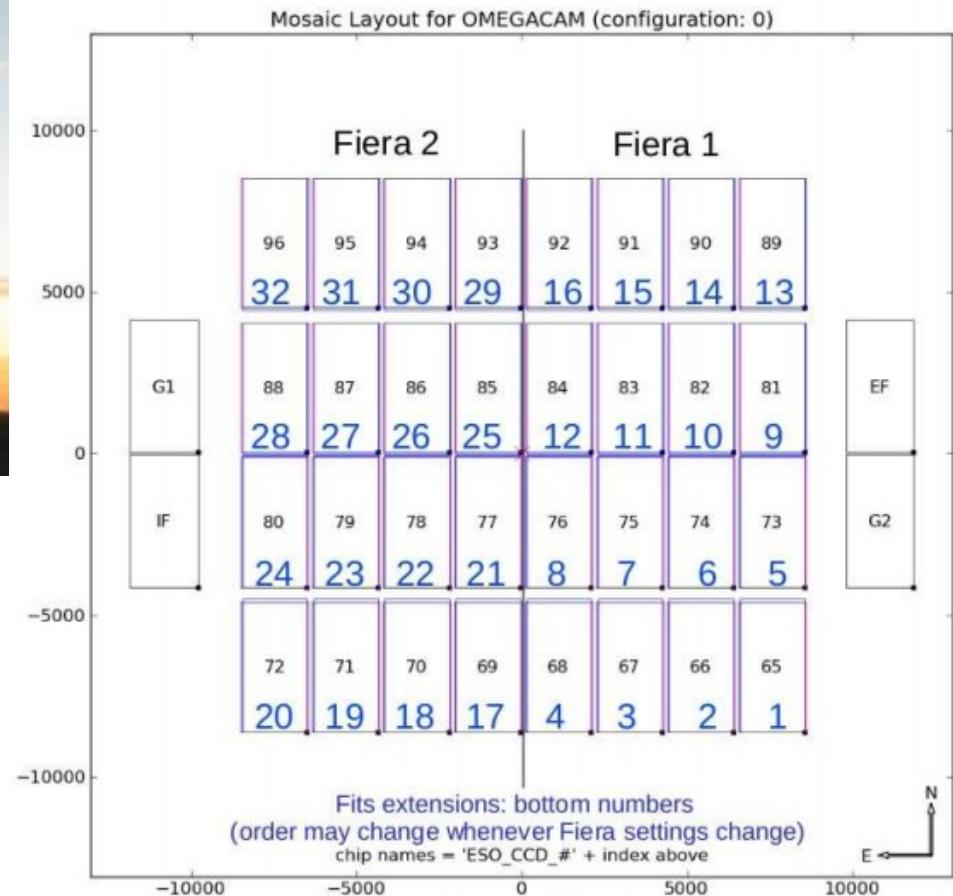


Main telescope and instrument used by GBOT

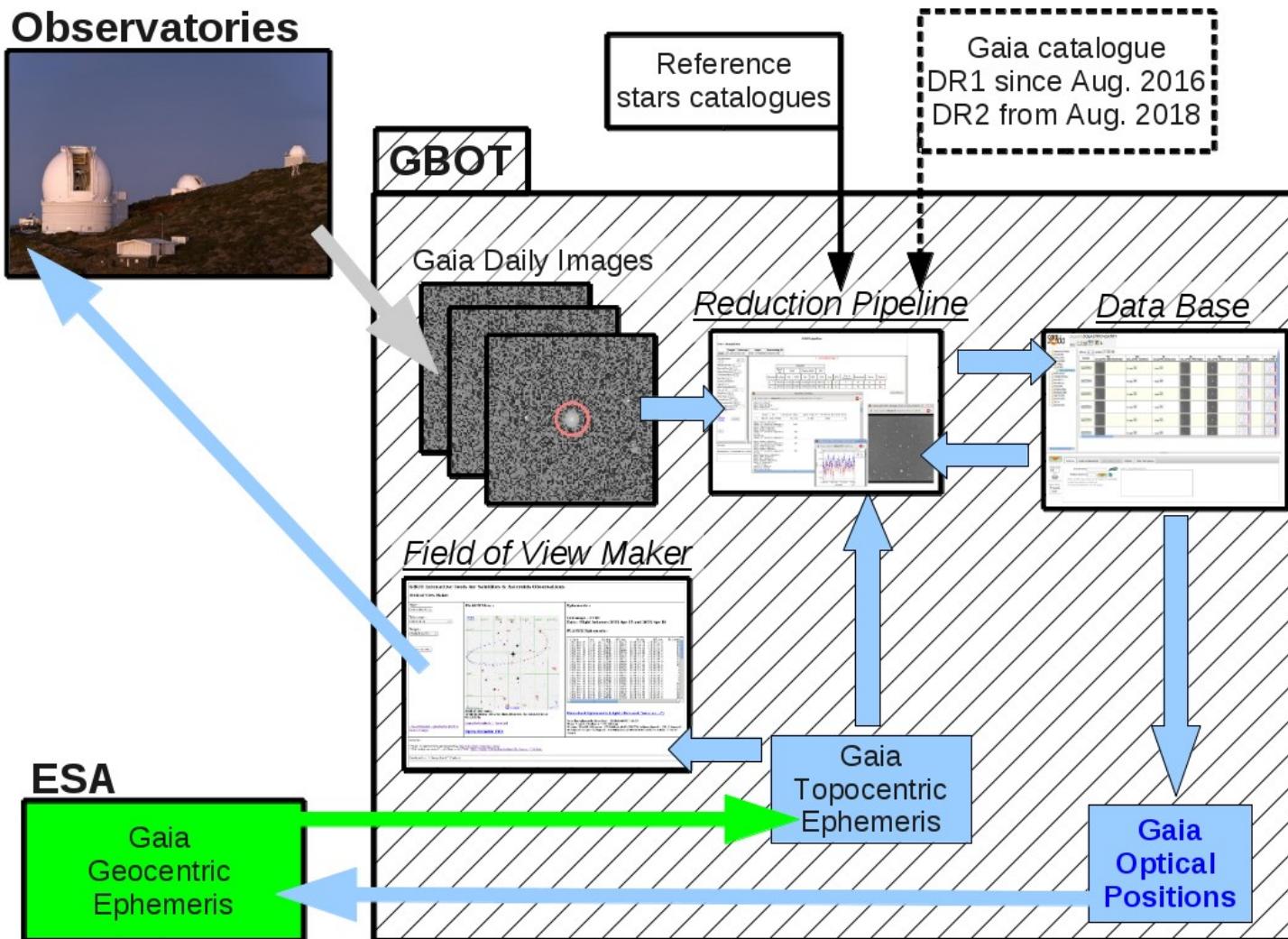


**VLT Survey Telescope
(Paranal, 2.6m)**

OMEGACAM
(32 CCD / $1^\circ \times 1^\circ$ / 16kx16k)
pixel size 0.21"



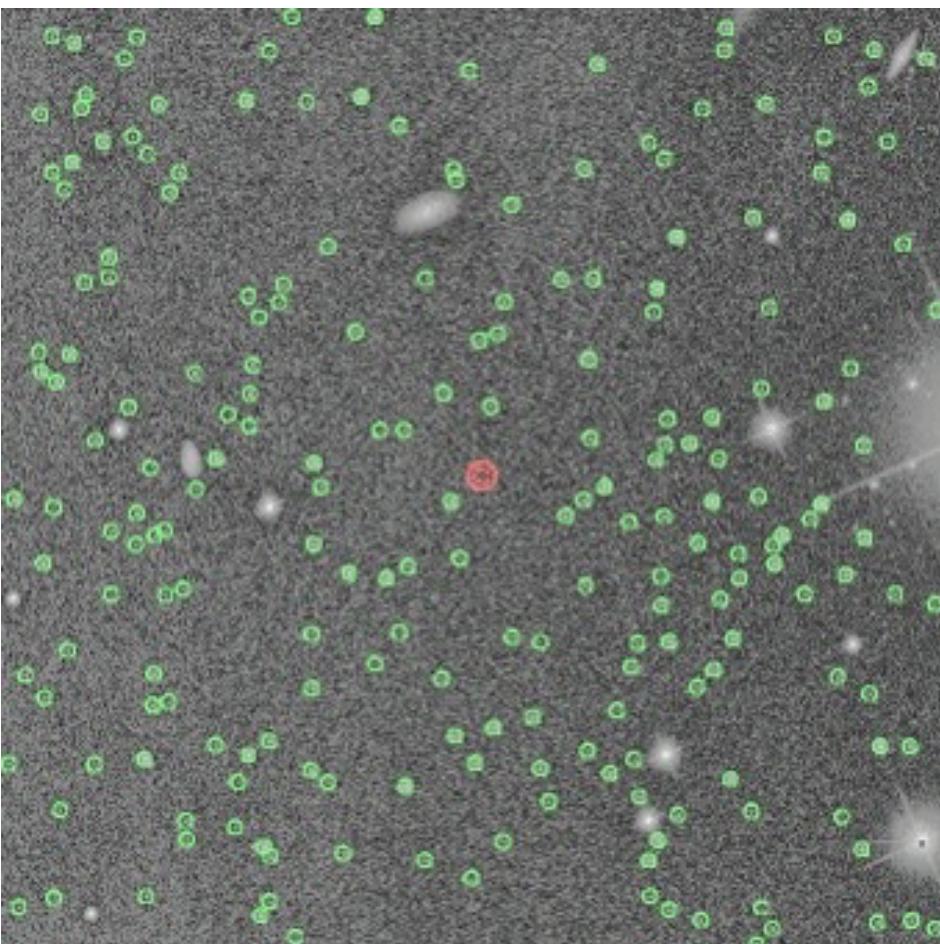
Overview of GBOT activities



What GBOT team do every day during the whole Gaia mission

The requirement for the **absolute accuracy** on the satellite position determination is **20 mas**.

Each night, 10 consecutive images taken with VST (exp time =60 s in filter r)



- Gaia Mag (r) = 21.5
- Mean Gaia Speed = 1.2 “/min
- Centroiding: *Bouquillon et al. (2017, A&A, 606)*
- Calibration: Gaia catalogue (DR1, DR2)

Results for positioning Gaia *with PPMXL*

Image VST (*CCD n° 12*) 22/07/2014

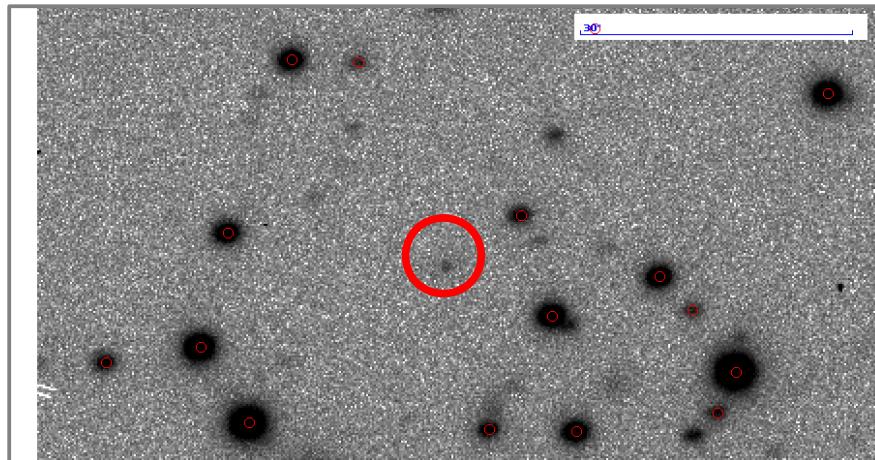
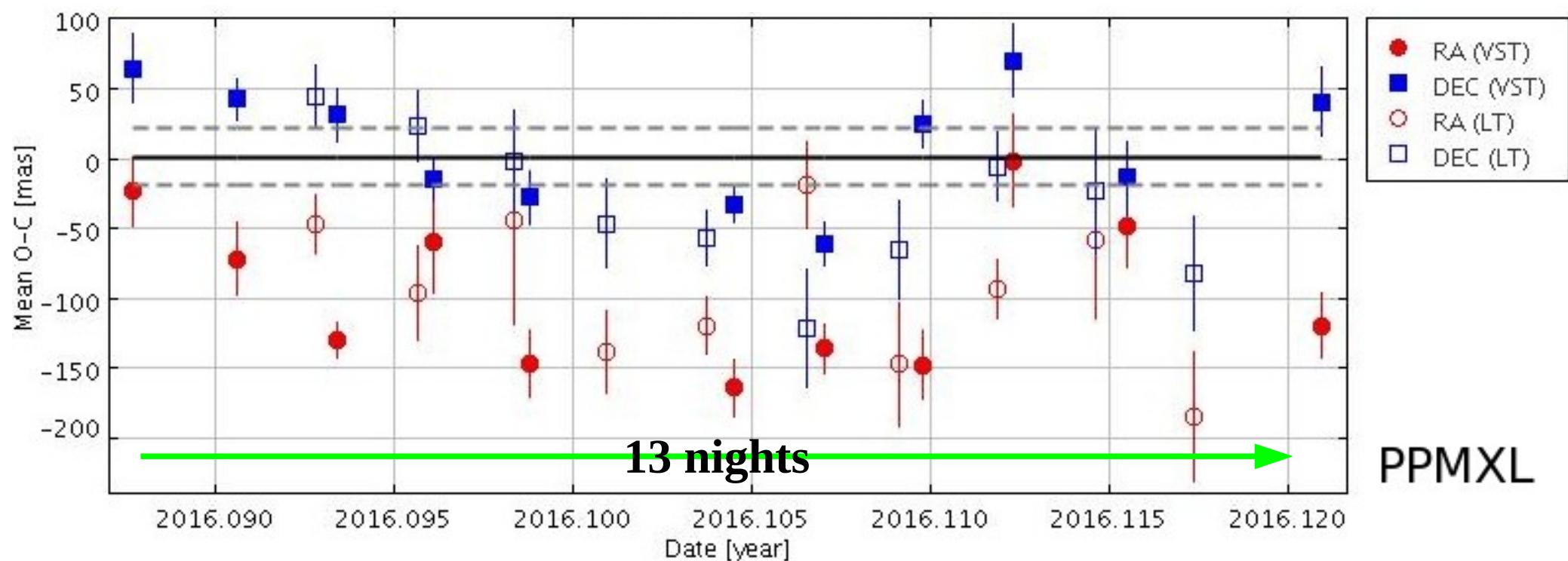
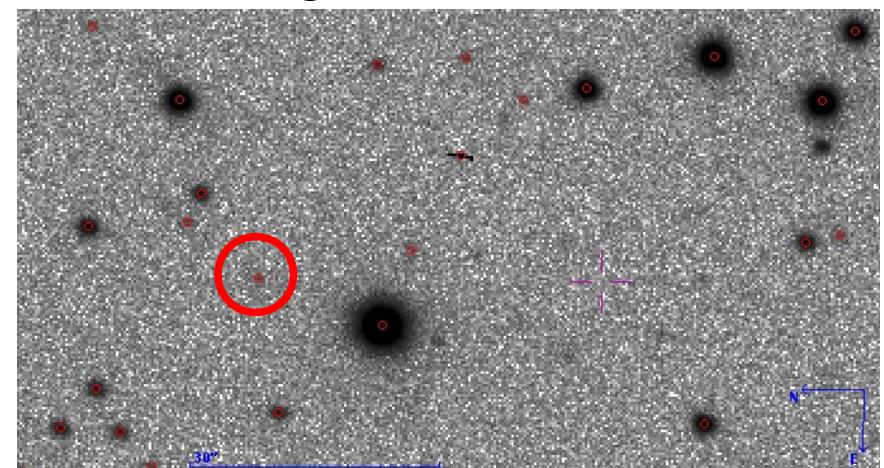


Image LT 22/07/2014



Results for positioning Gaia *with Gaia DR1*

Image VST (*CCD n° 12*) 22/07/2014

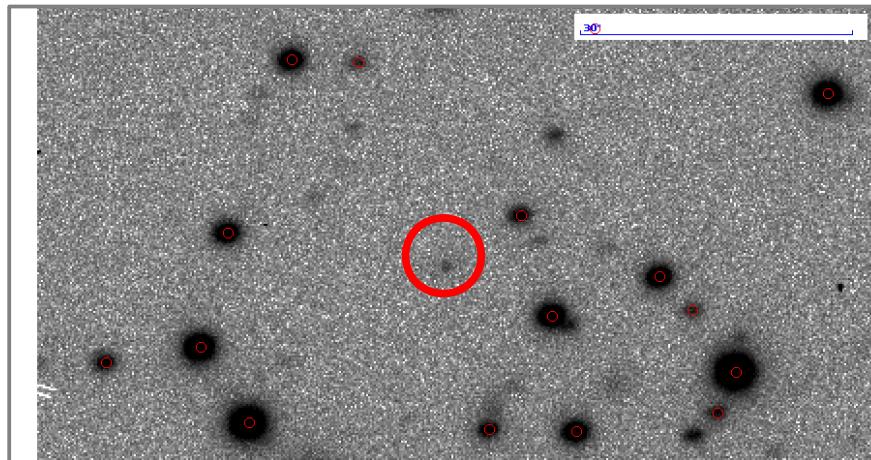
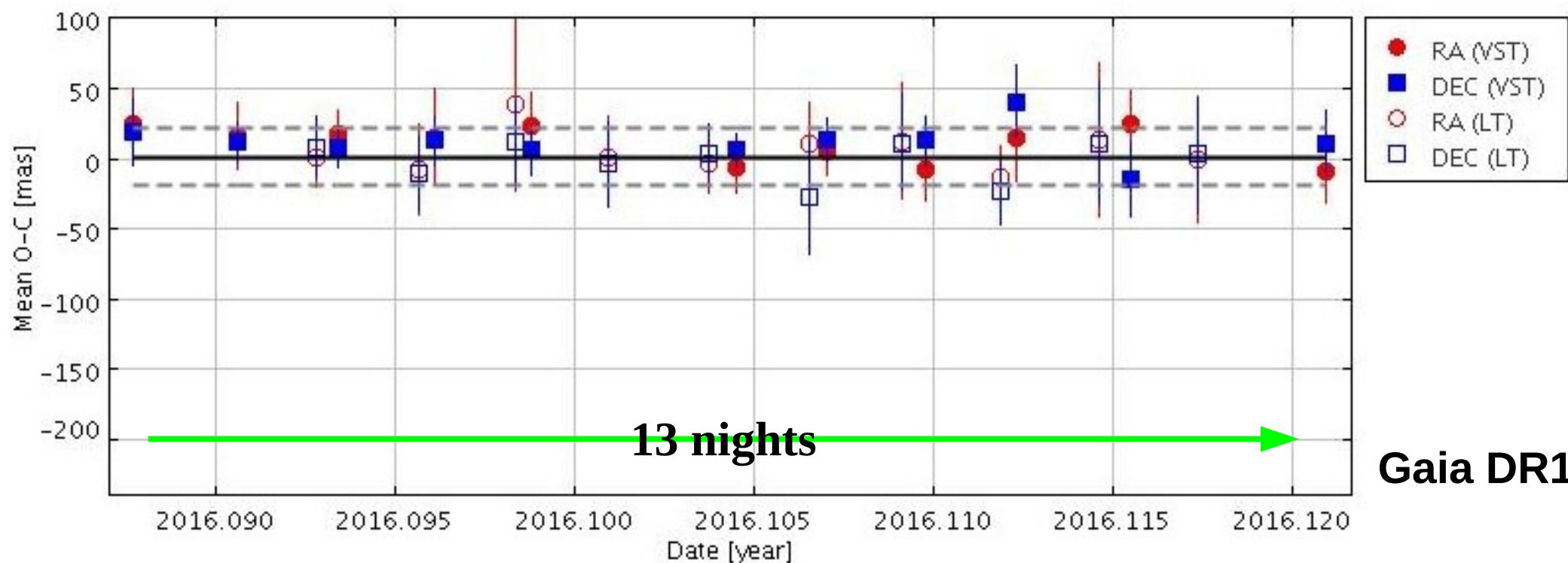
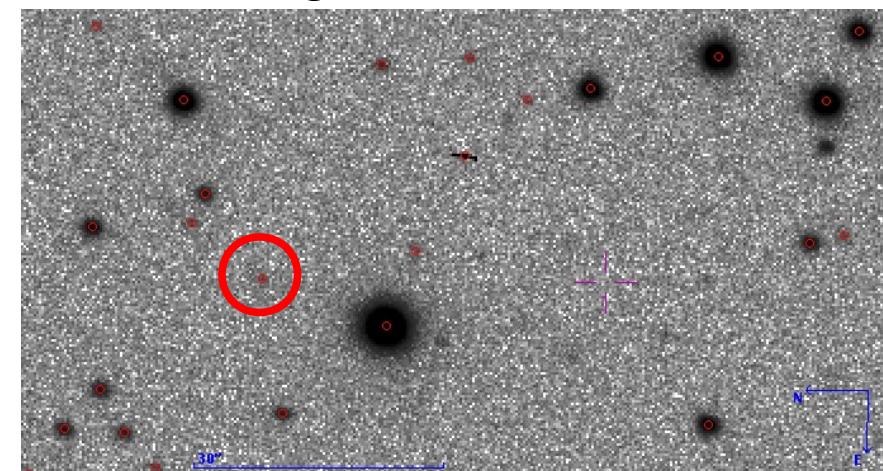


Image LT 22/07/2014



Results for positioning Gaia *with Gaia DR1*

Image VST (*CCD n° 12*) 22/07/2014

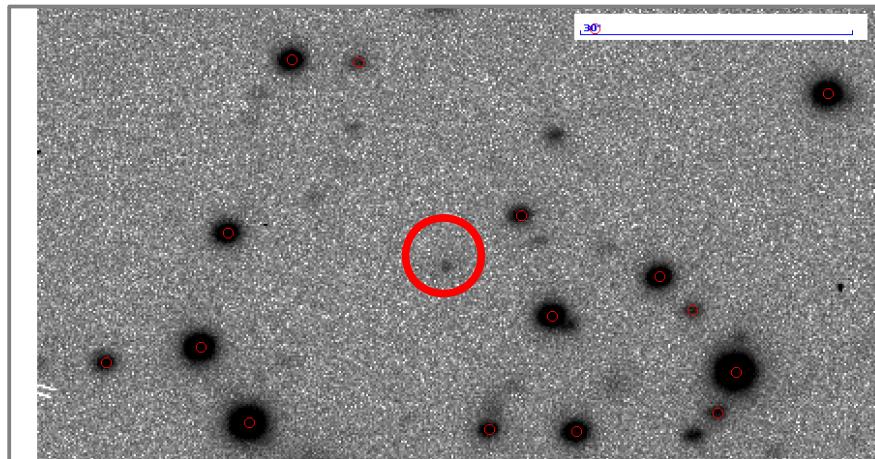
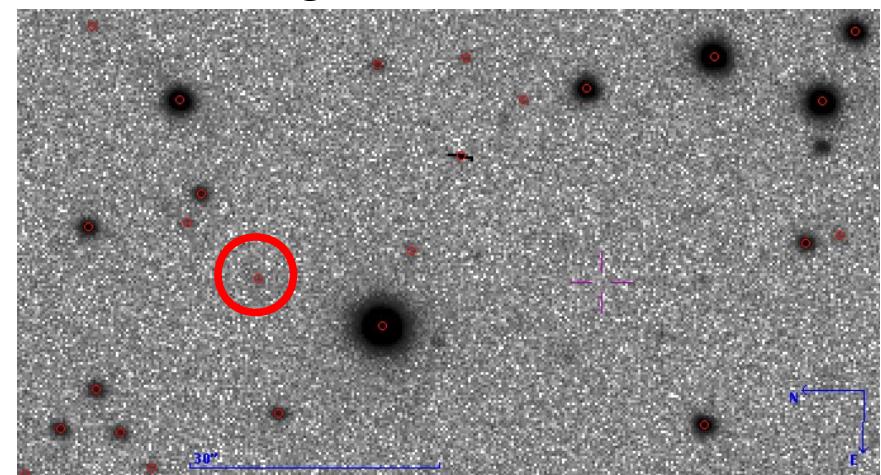
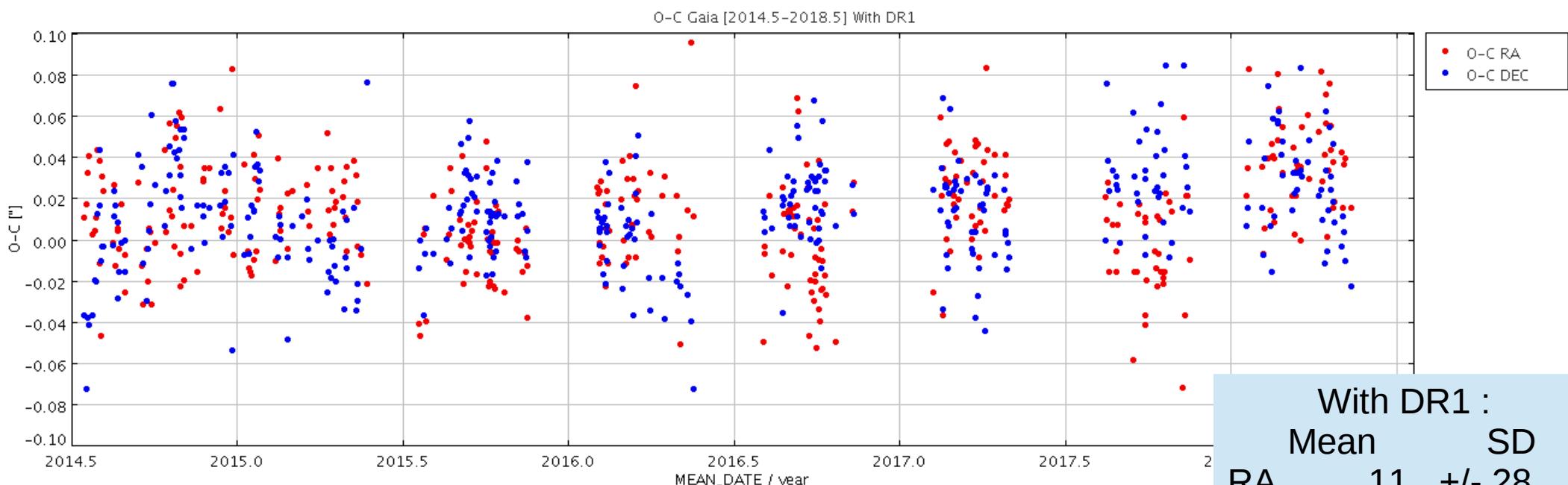


Image LT 22/07/2014



4 years



Results for positioning Gaia *with Gaia DR2*

Image VST (*CCD n° 12*) 22/07/2014

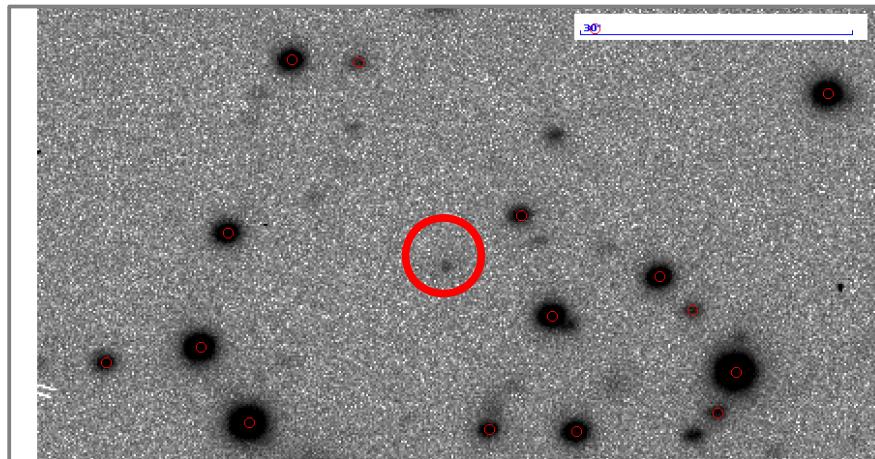
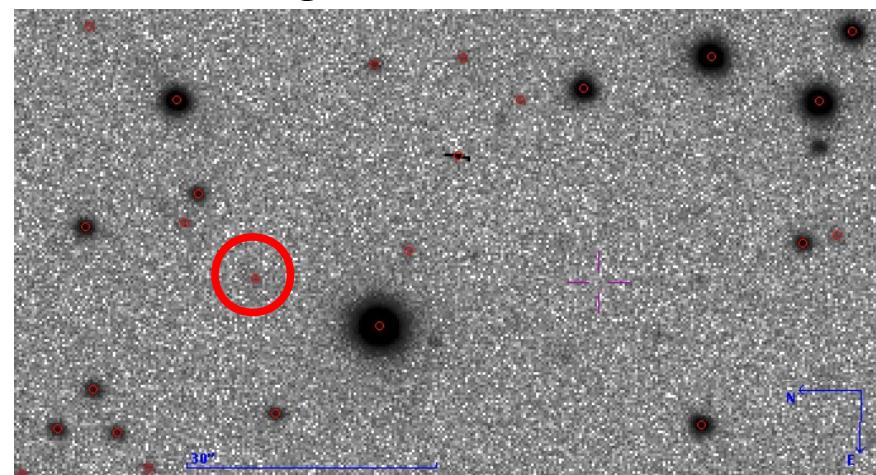
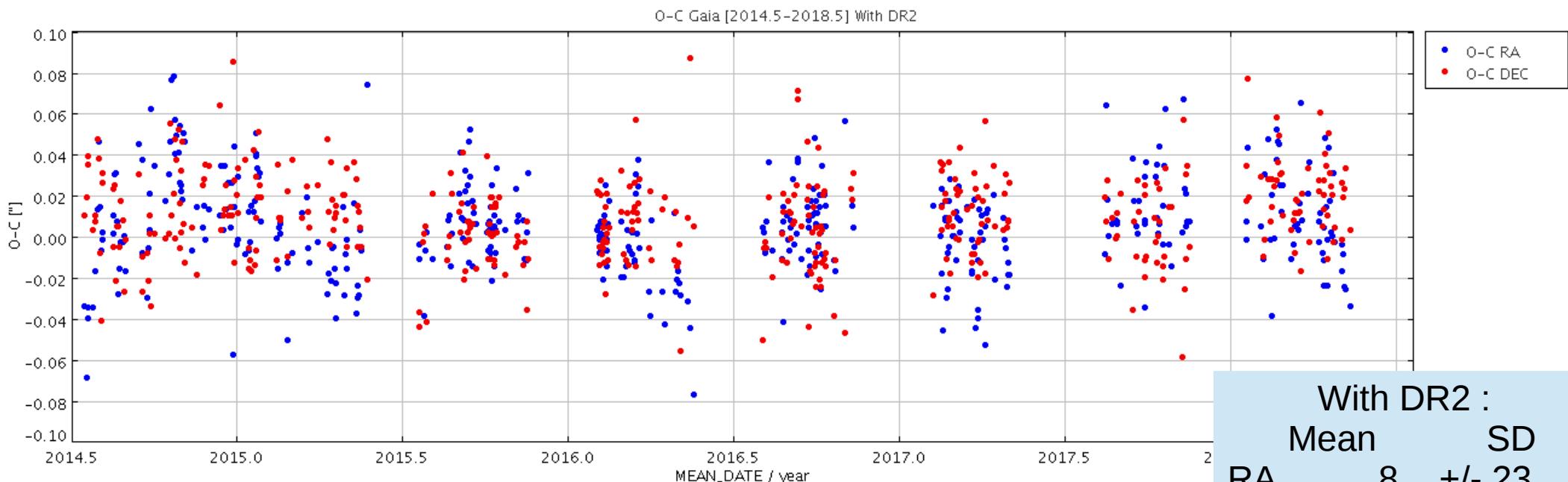


Image LT 22/07/2014



4 years



GBOT asteroids experiment

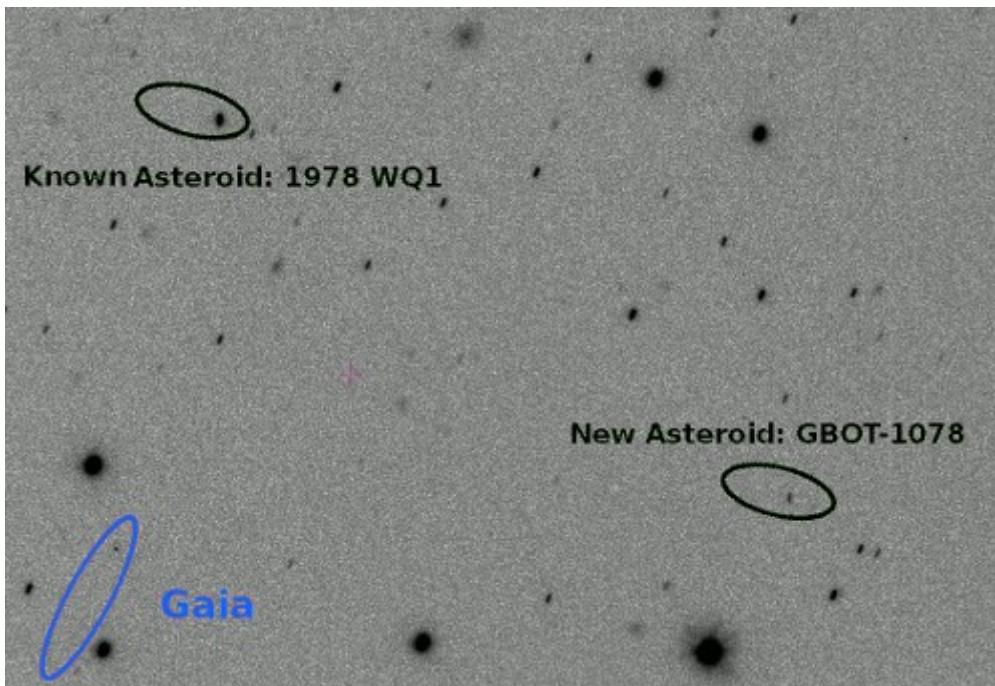
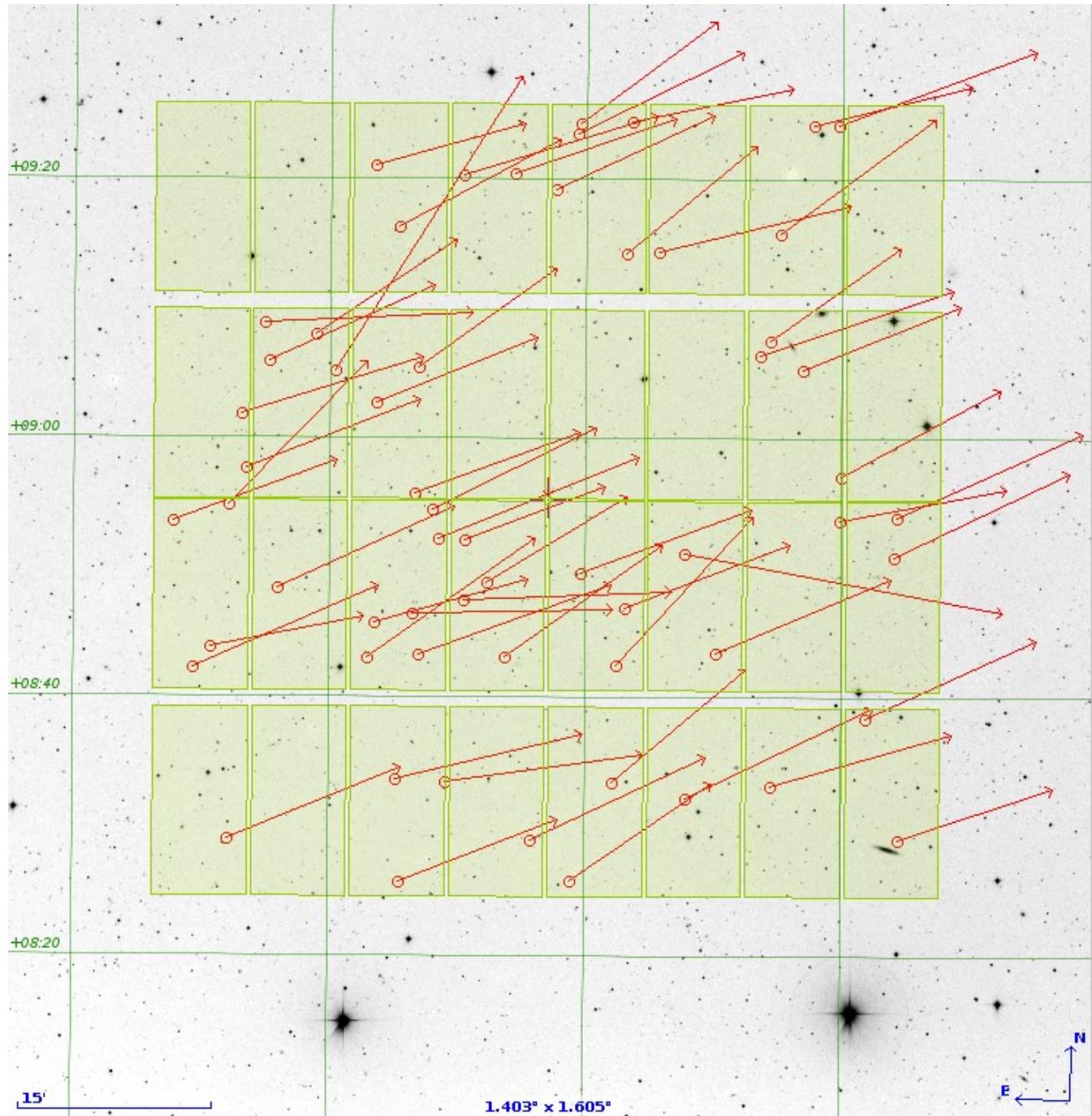


Image VST (ESO CCD #84) le 20 avril 2015

GBOT asteroids experiment

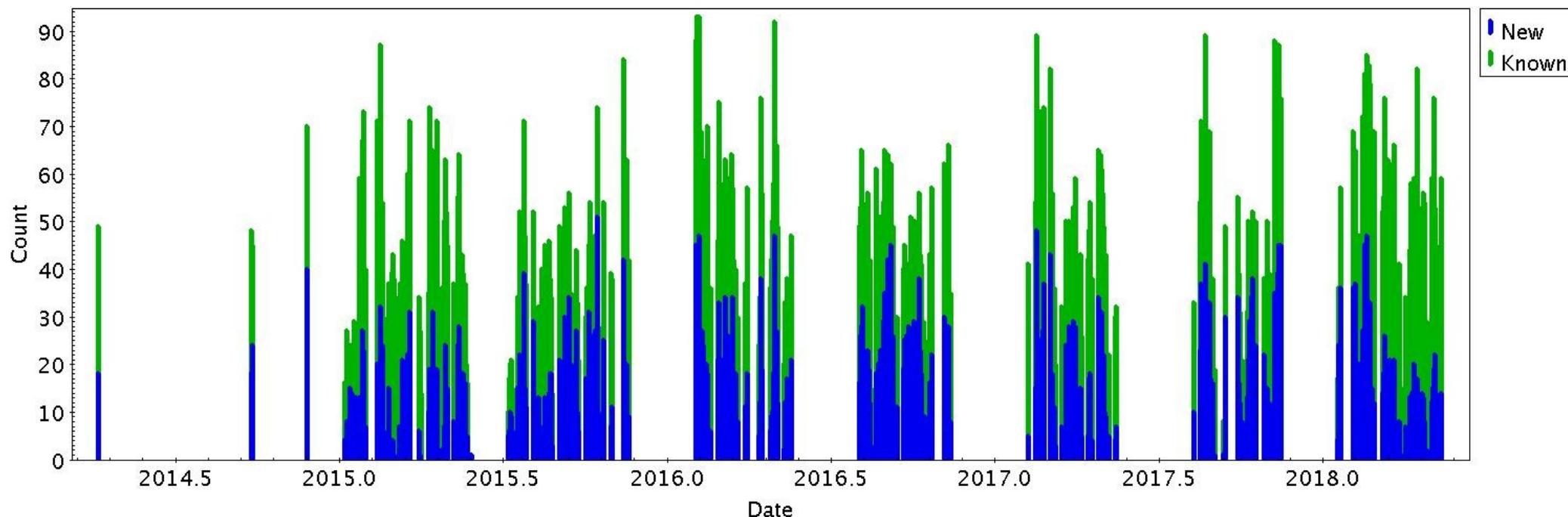


Typical night (18 March 2015)

- 60 asteroids detected
 - ◆ 33 known (in MPC DB)
 - ◆ 27 unknown

GBOT asteroids experiment

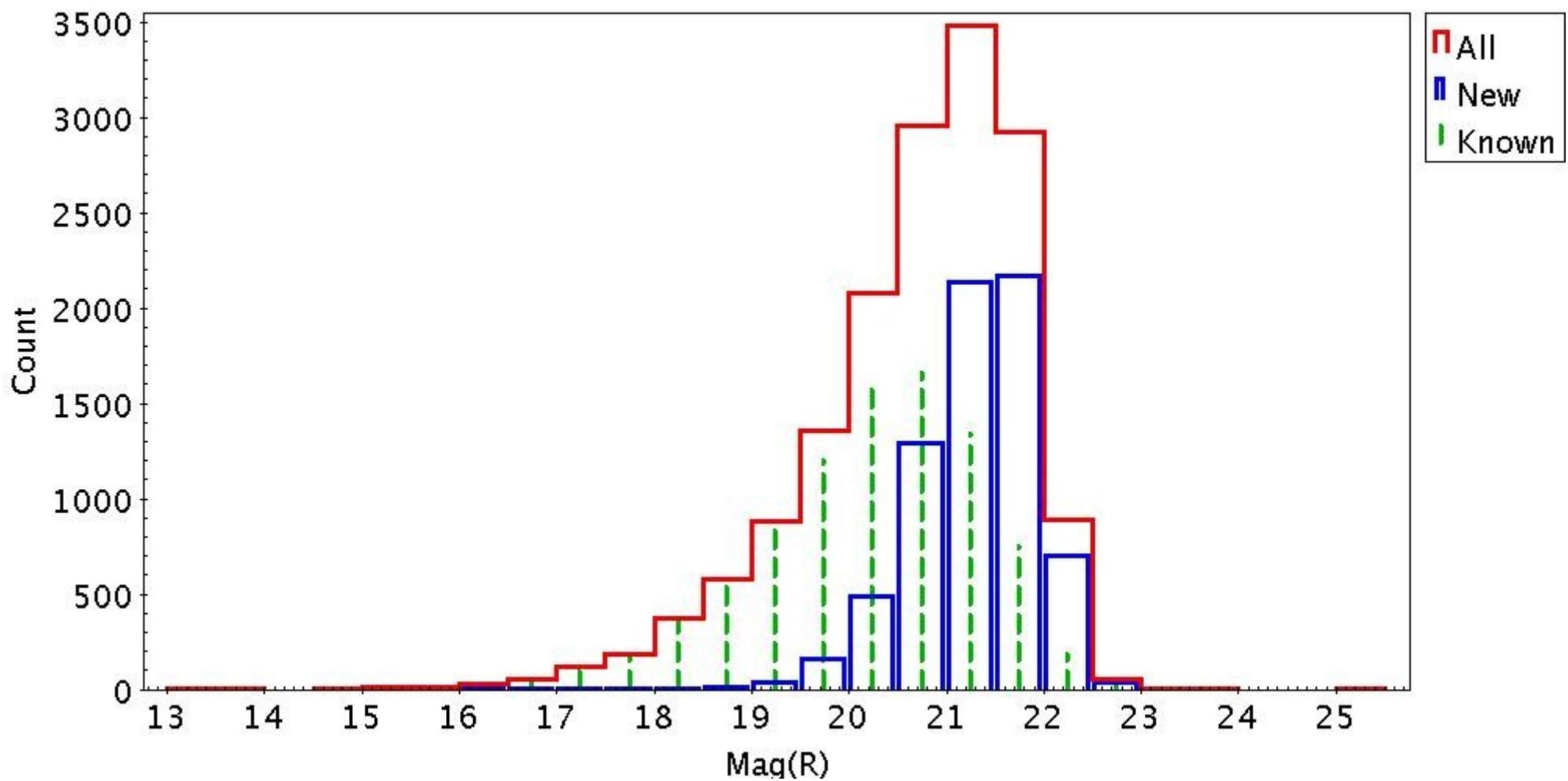
Asteroids detected by night



Asteroids detected in 4 years:	18 962
● Known:	10 017
● Unknown (<i>at the observation date</i>):	8 945
● Currently lost:	7 044 (79%)
● Identified (follow up, etc.):	1 901 (21%)

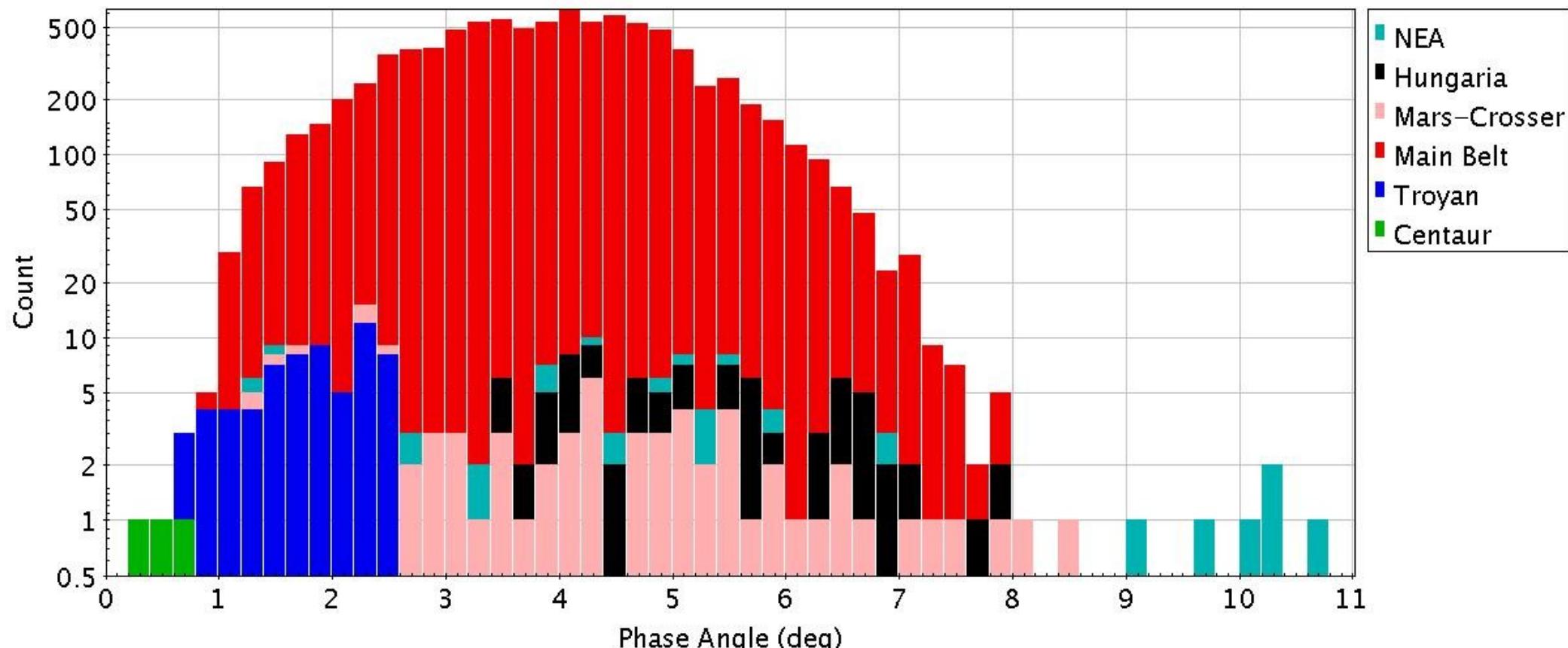
GBOT asteroids experiment

Asteroids magnitude



GBOT asteroids experiment

Asteroids phase angle

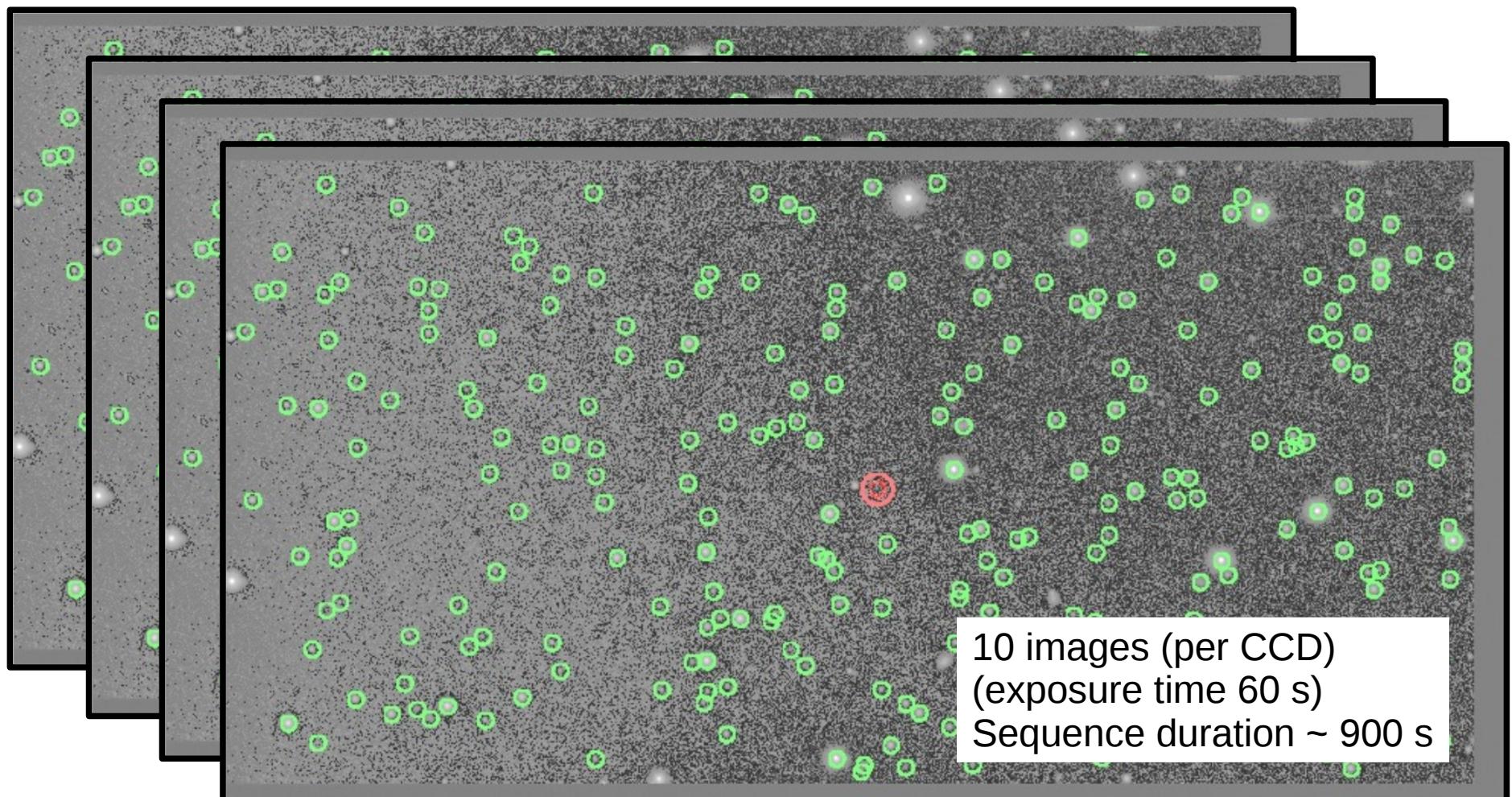


NEA - Amor	12
NEA - Apollo	9
Hungaria	49
Mars-Crosser	61
Main Belt	8752
Trojan	63
Centaur	3

GBOT asteroids detection method

Astro-photometric reduction of the 32 CCDs of the VST Mosaic:

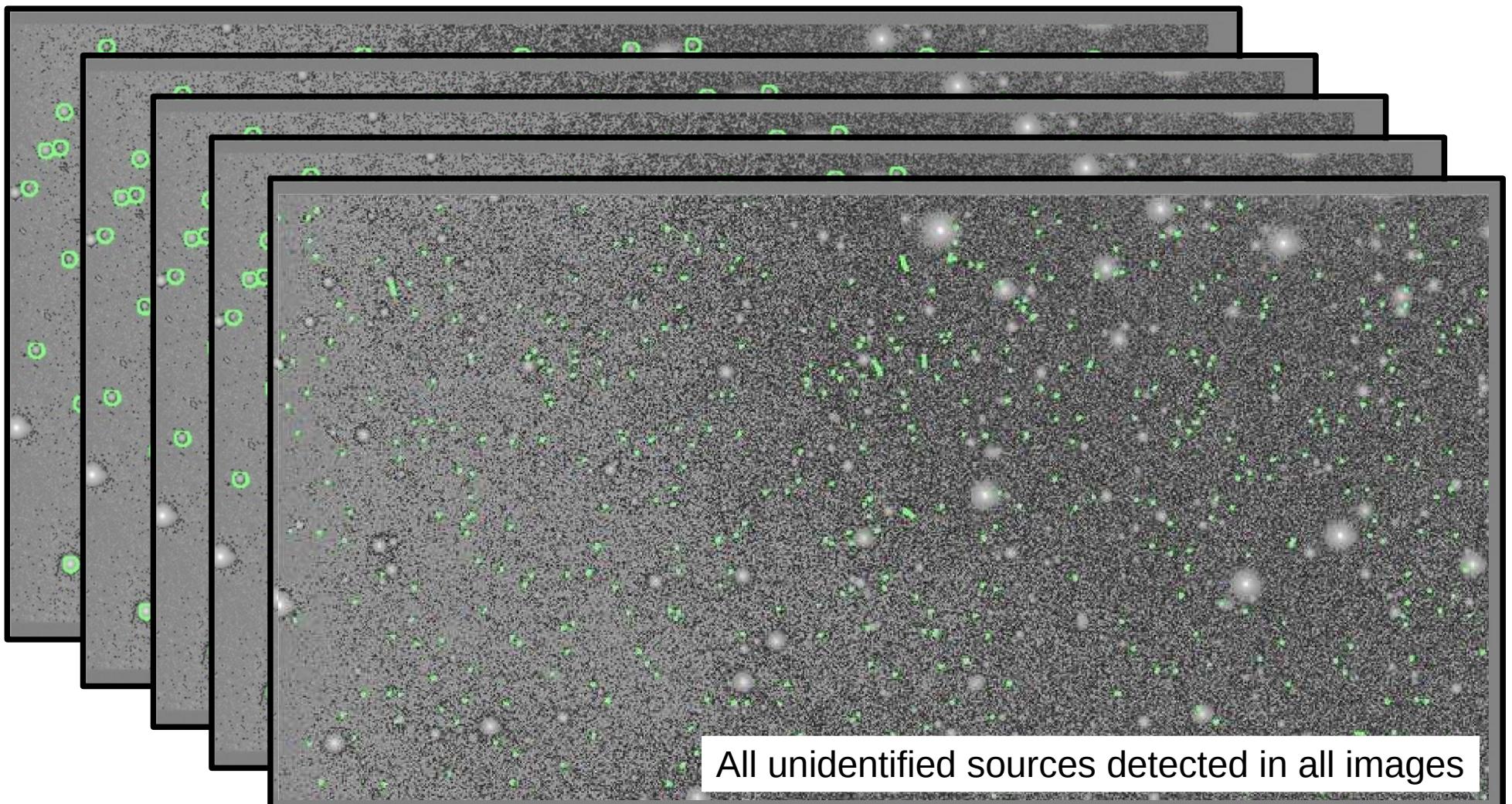
- with Gaia GBOT pipeline
- with Gaia DR2 (currently) as reference catalogue



GBOT asteroids detection method

Astro-photometric reduction of the 32 CCDs of the VST Mosaic:

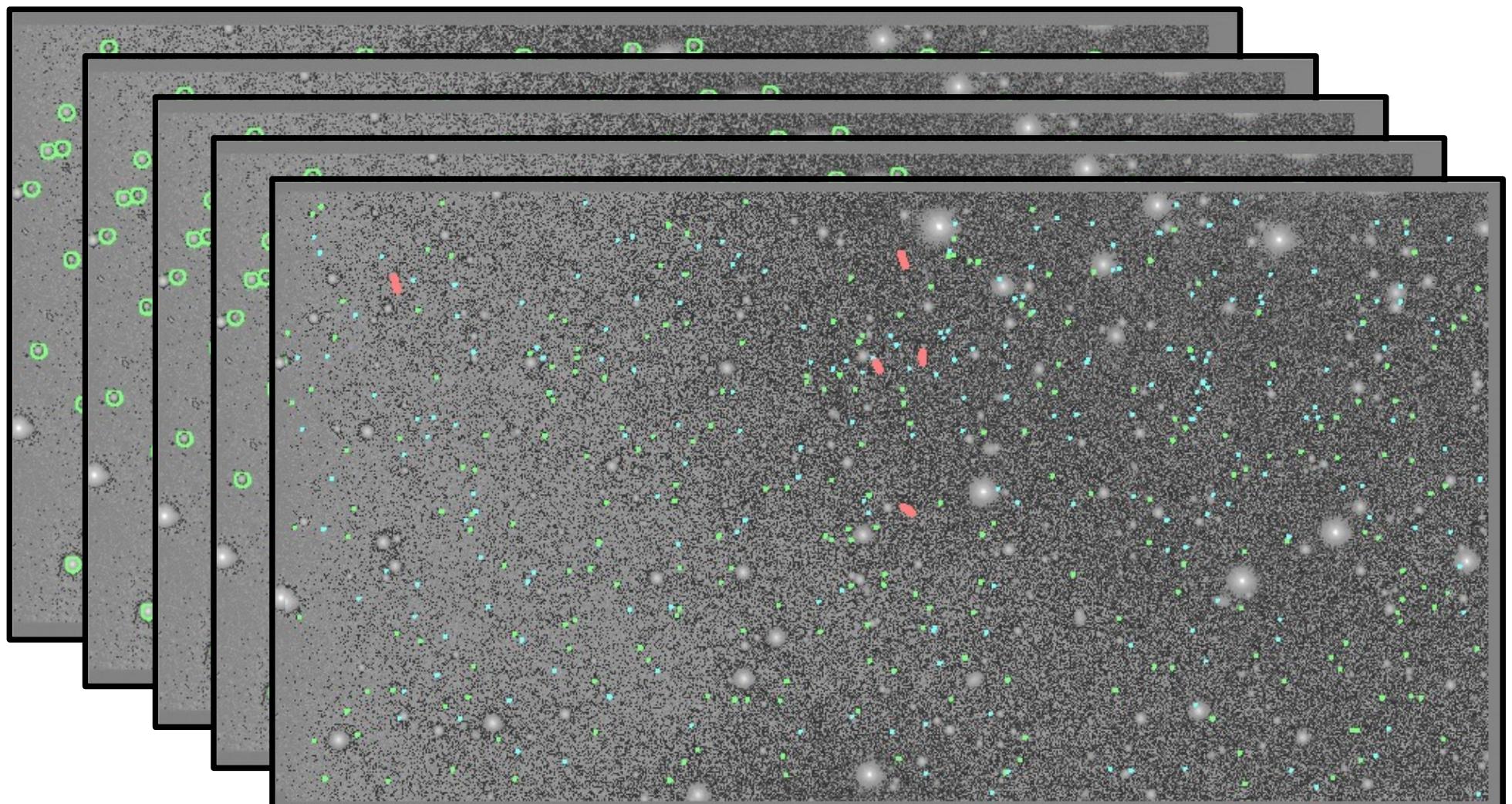
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- with Gaia DR2 (currently) as reference catalogue



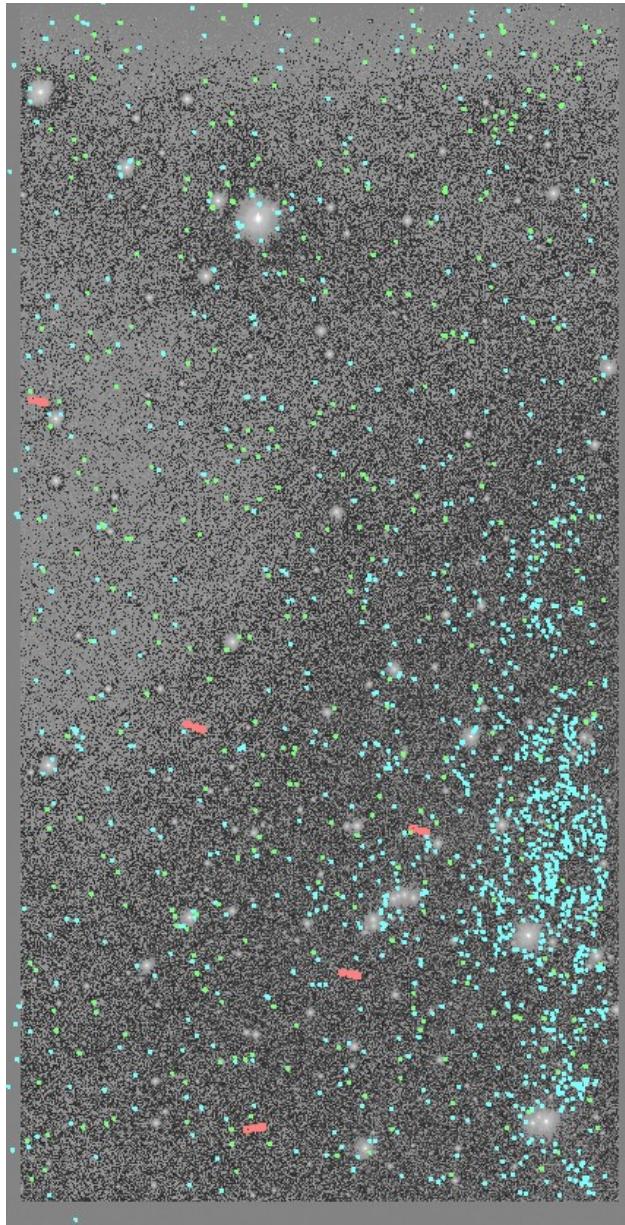
GBOT asteroids detection method

Astro-photometric reduction of the 32 CCDs of the VST Mosaic:

- with Gaia GBOT pipeline
- with Gaia DR2 (currently) as reference catalogue

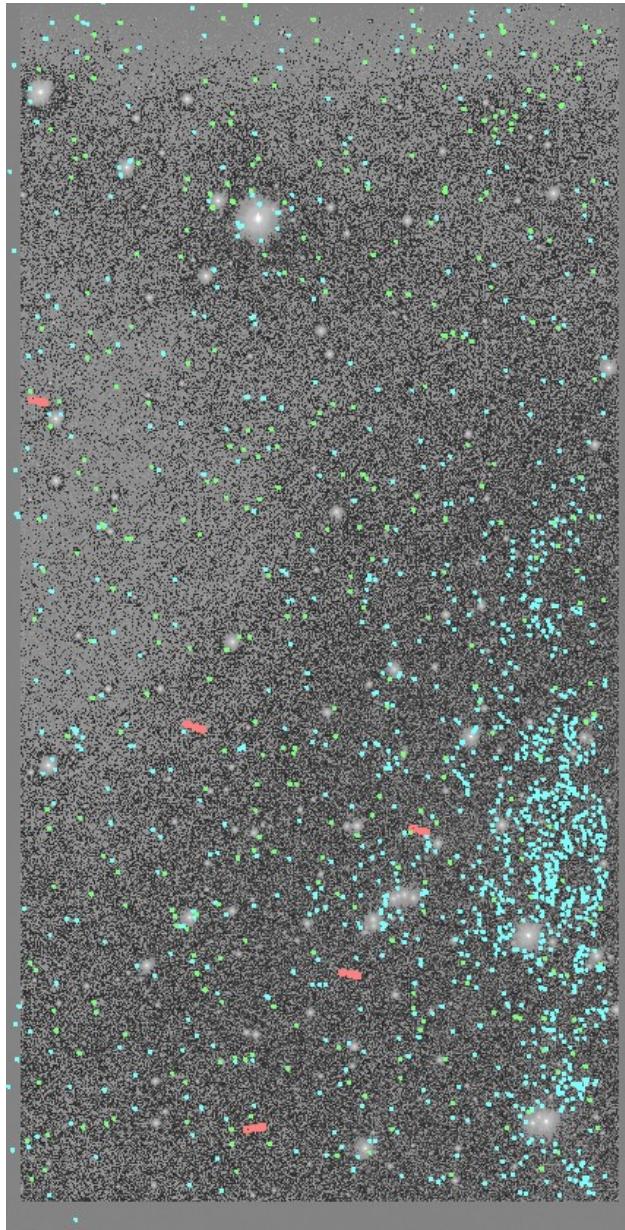


GBOT asteroids detection method

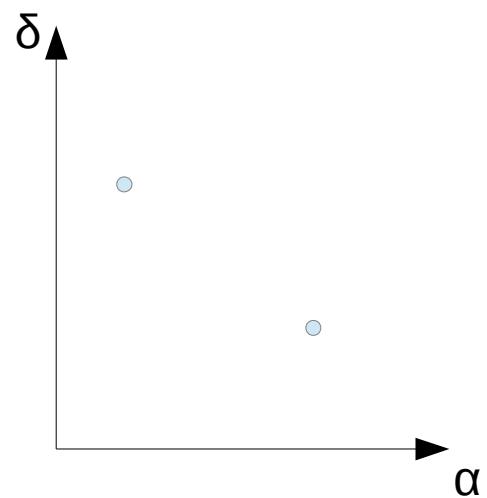


- Elimination of stationary sources (green points)

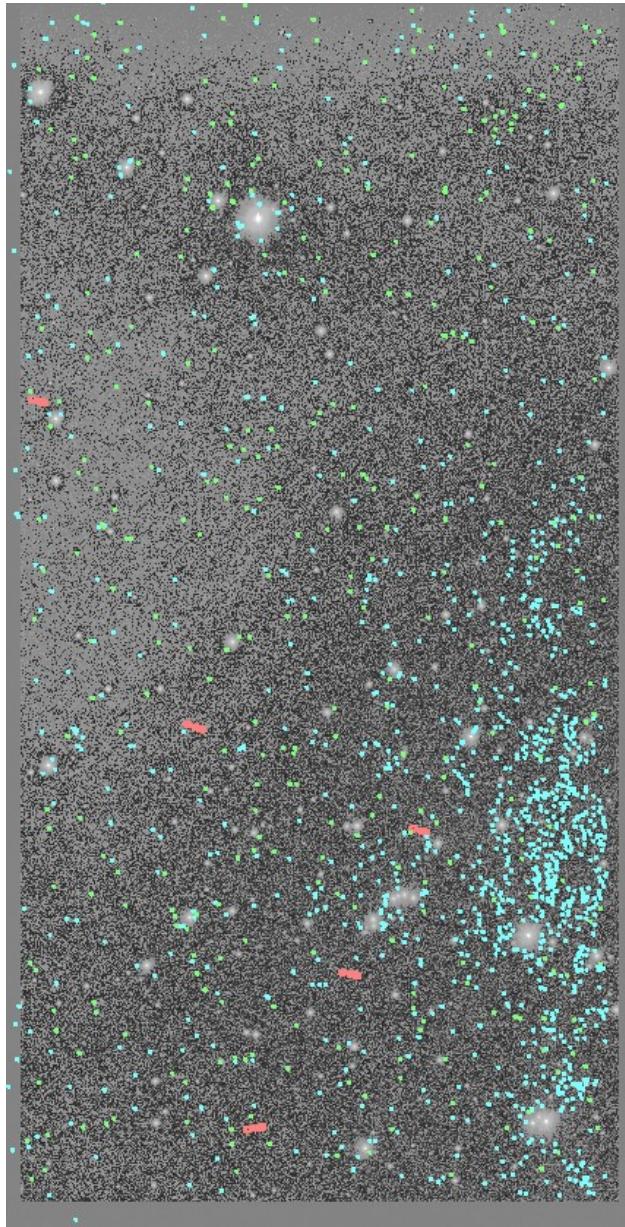
GBOT asteroids detection method



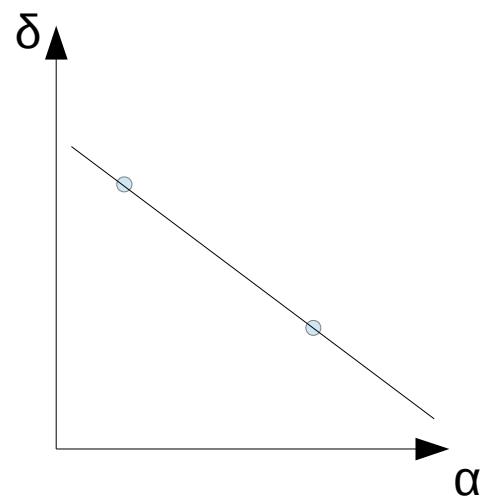
- Elimination of stationary sources (green points)
- For each pair of unidentified sources:



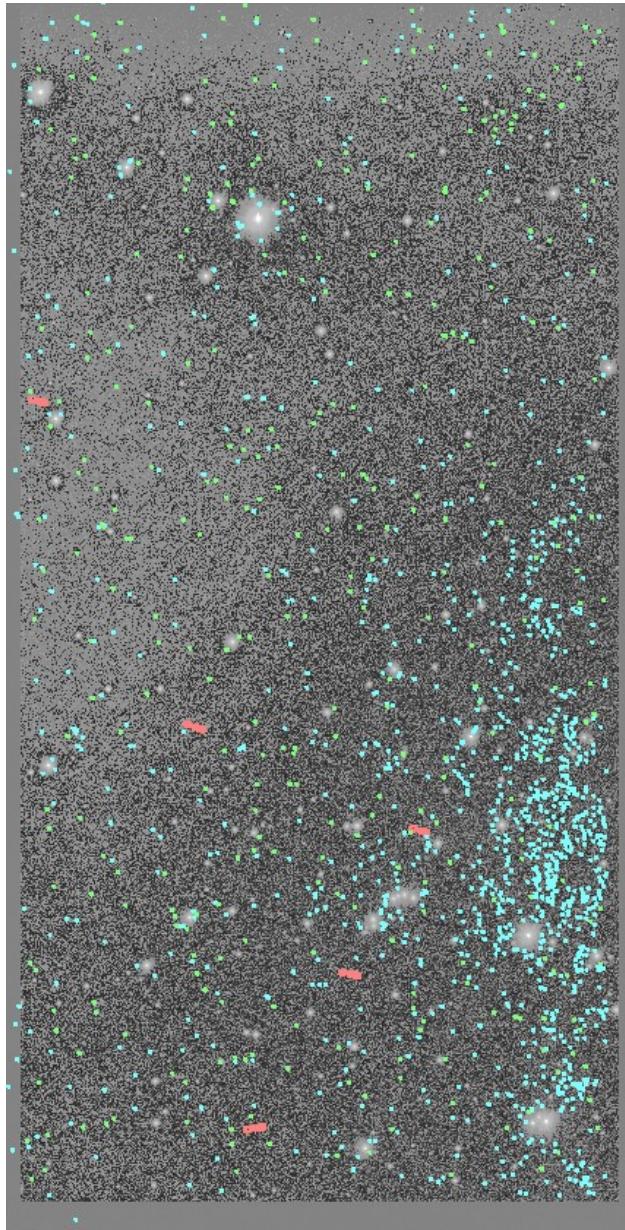
GBOT asteroids detection method



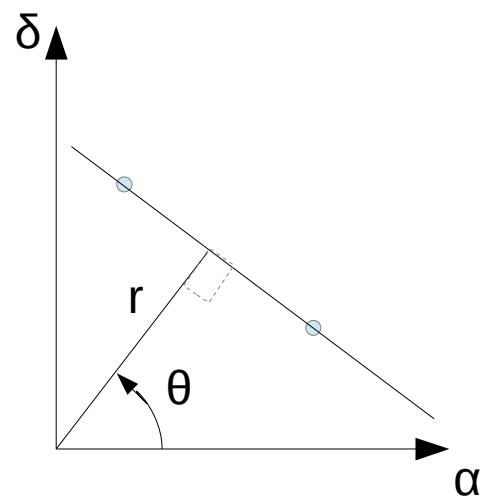
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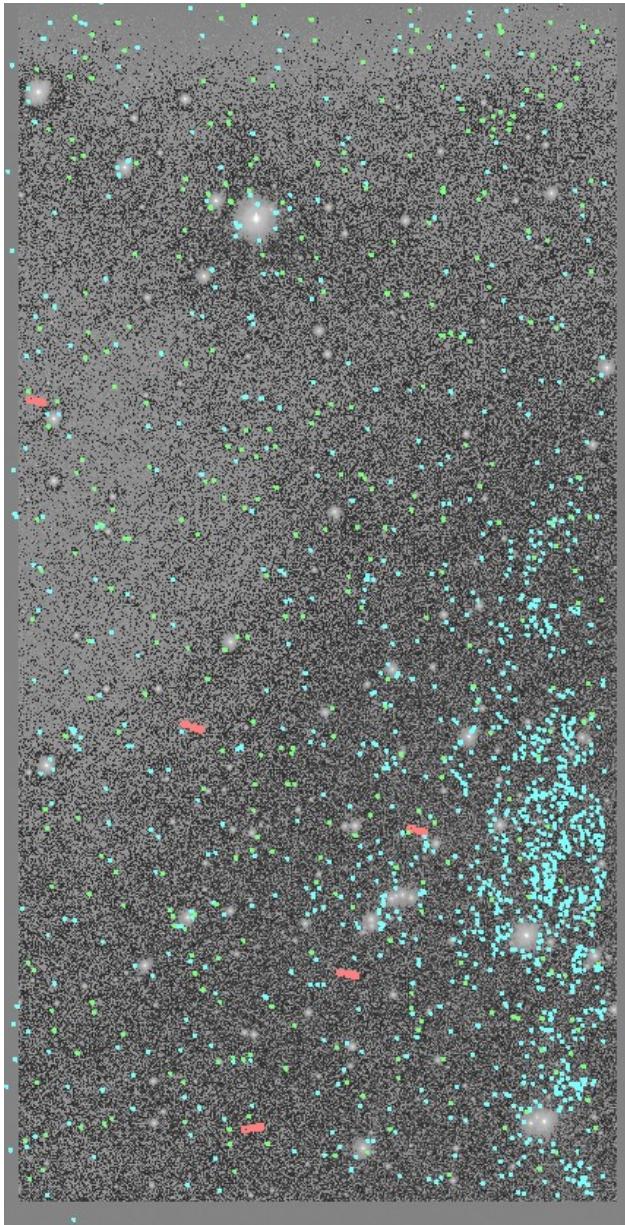
GBOT asteroids detection method



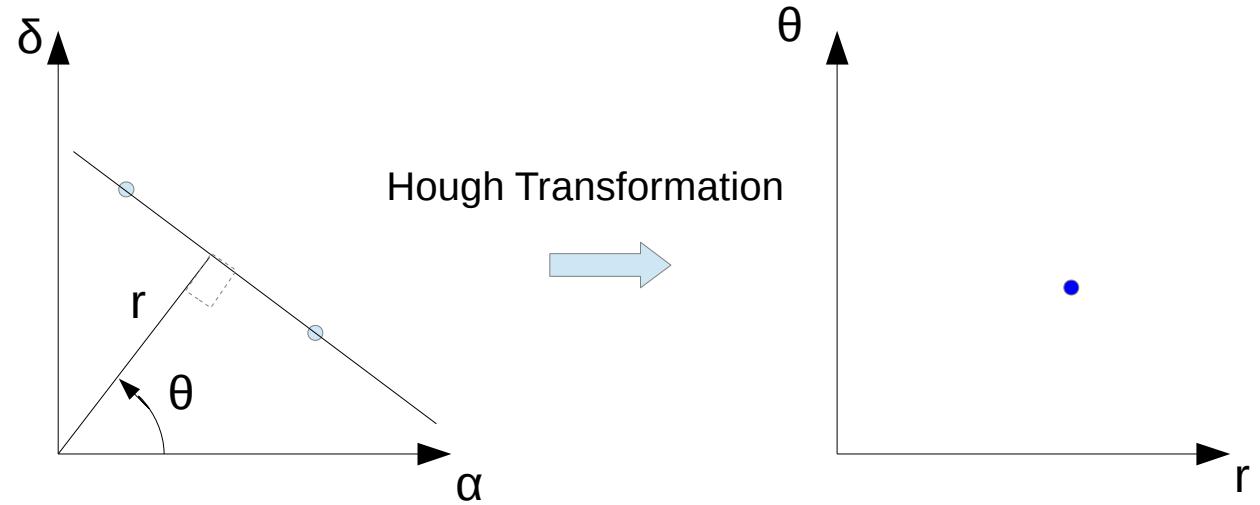
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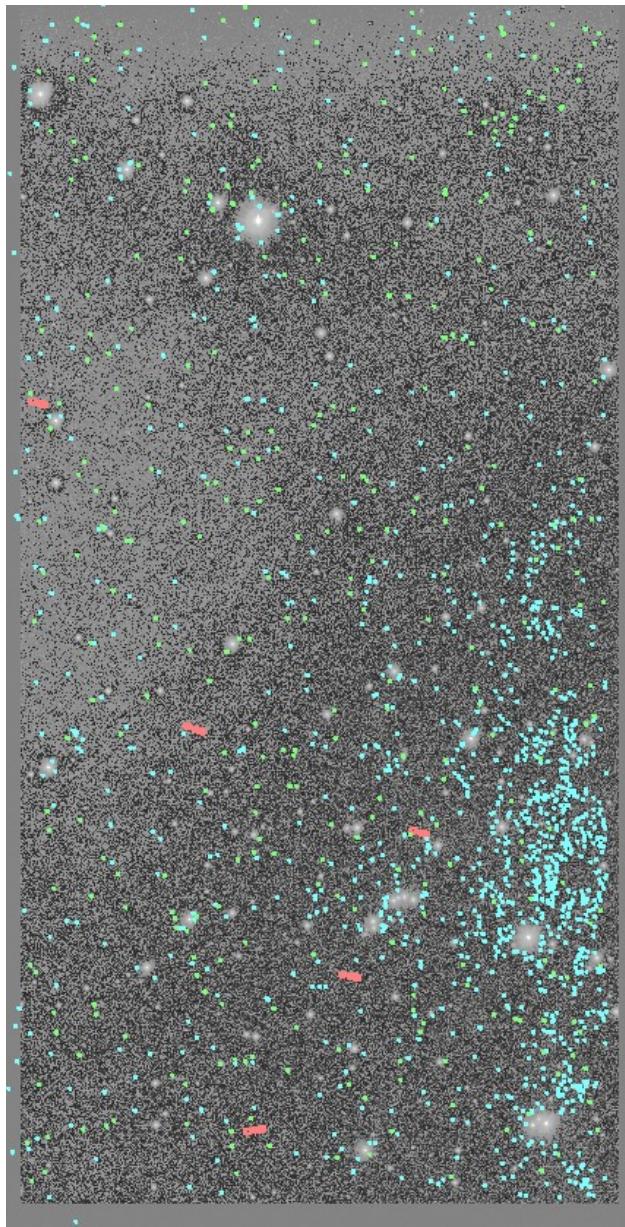
GBOT asteroids detection method



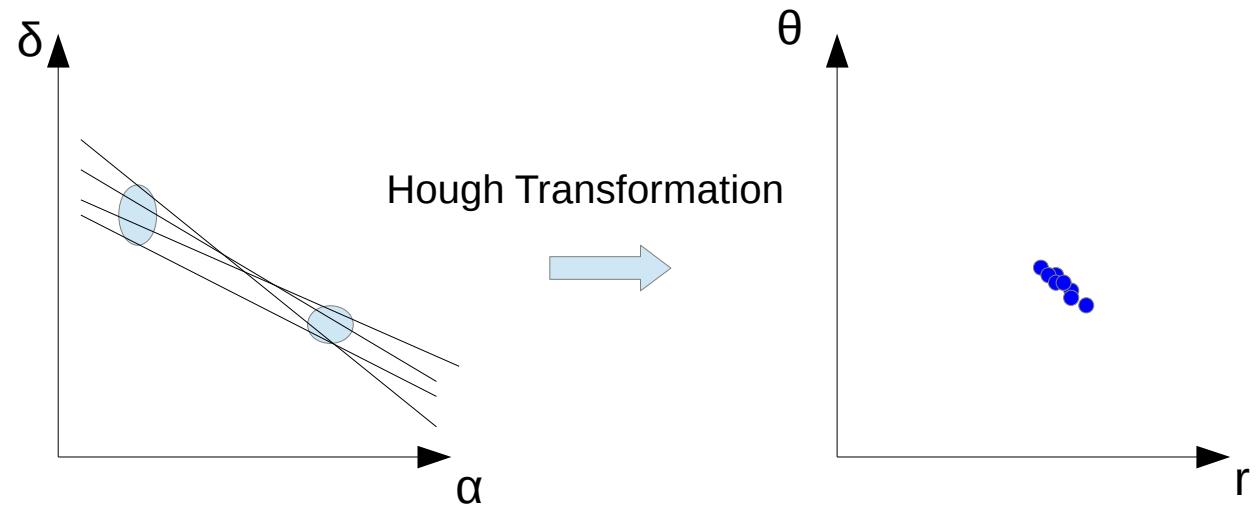
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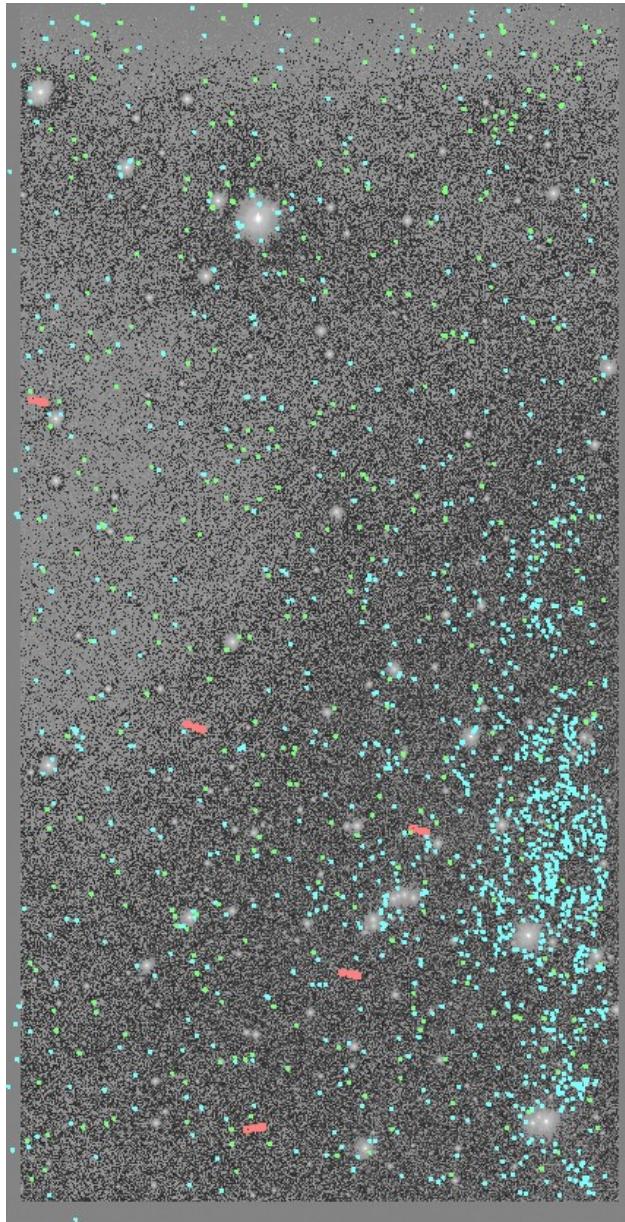
GBOT asteroids detection method



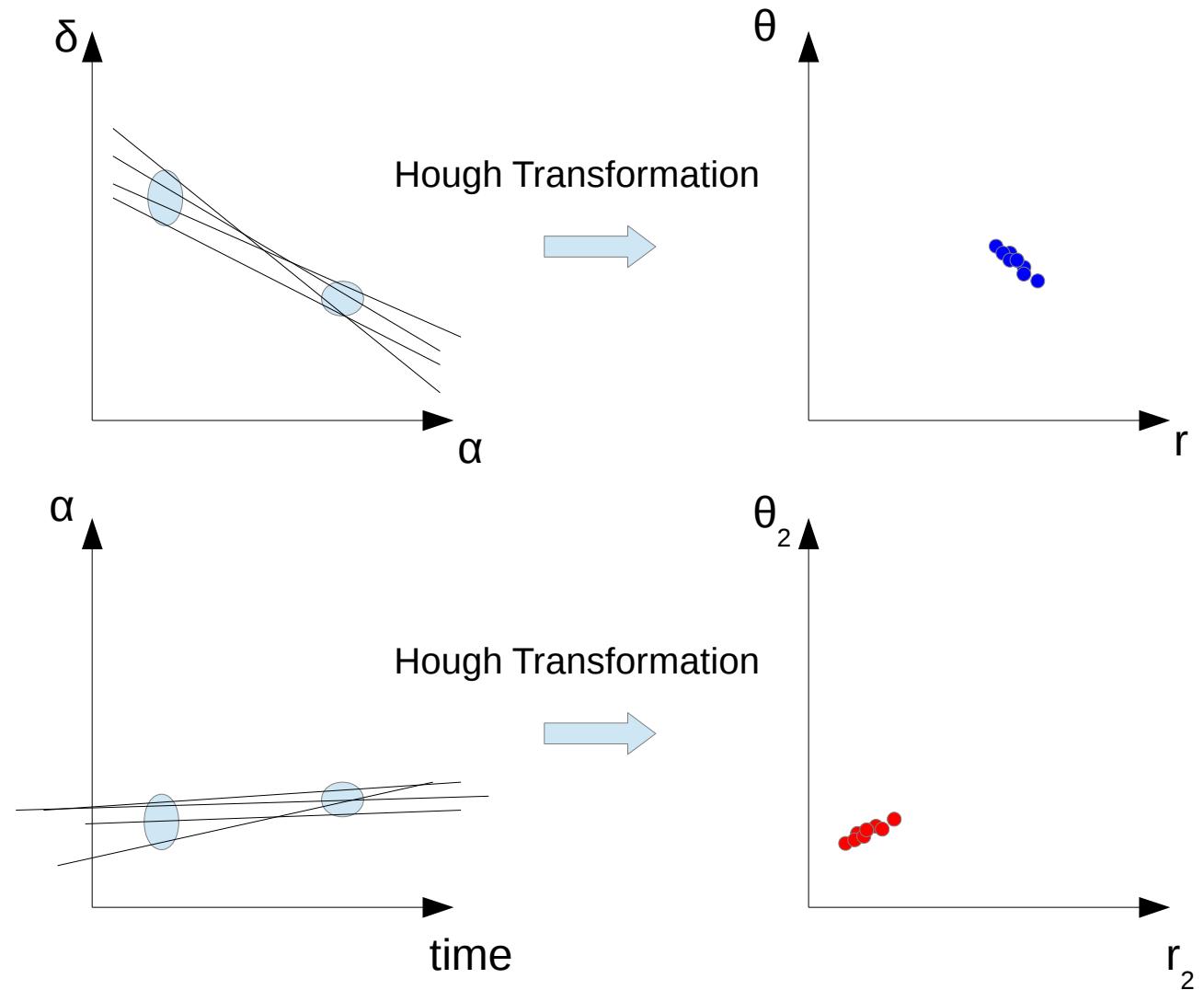
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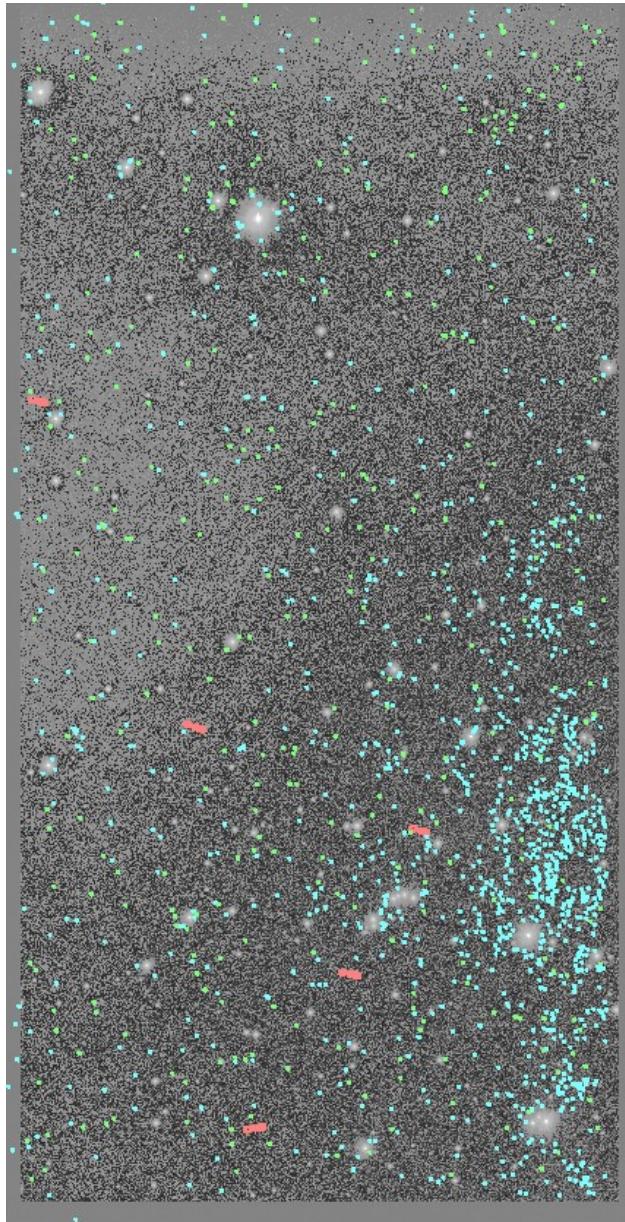
GBOT asteroids detection method



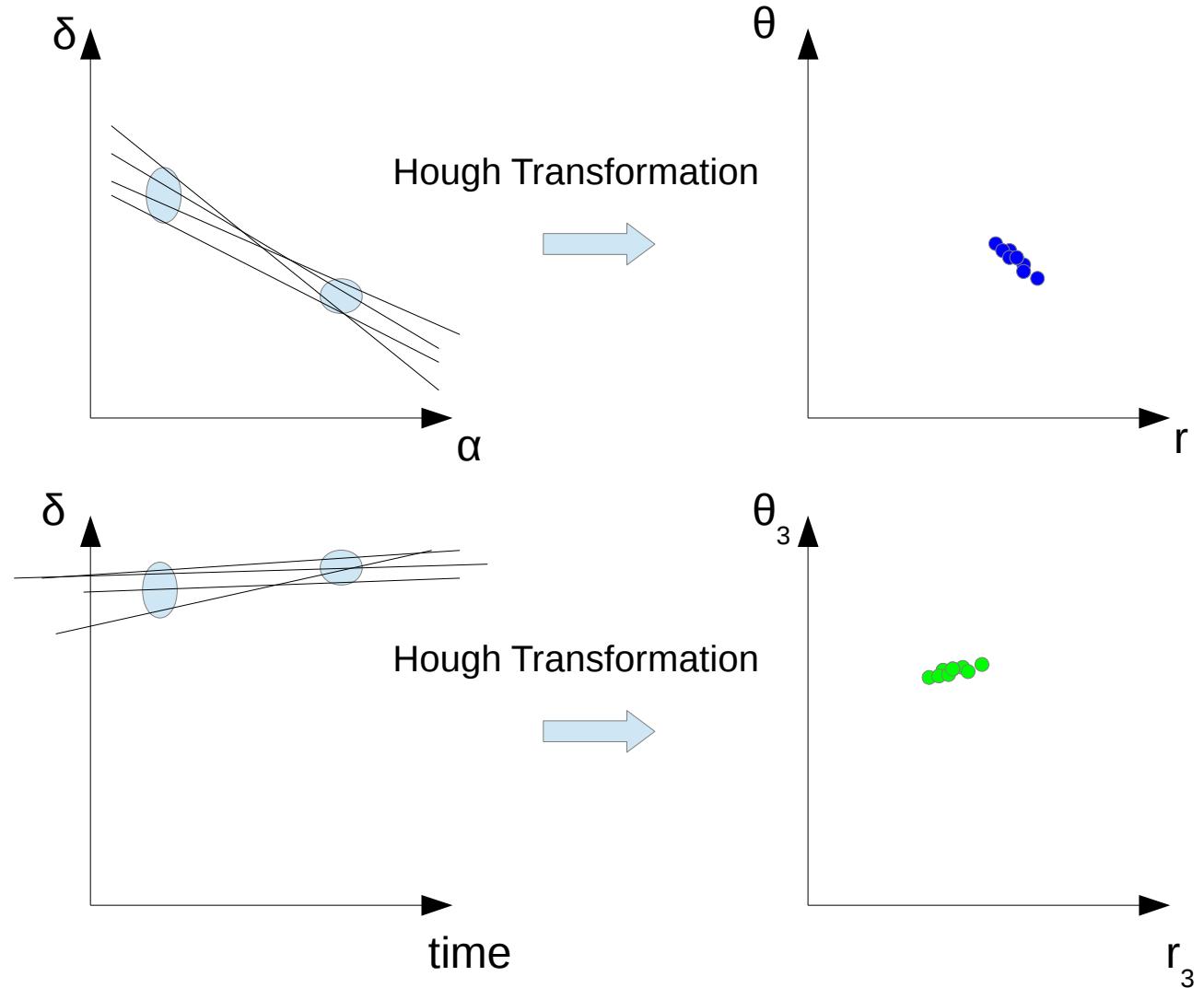
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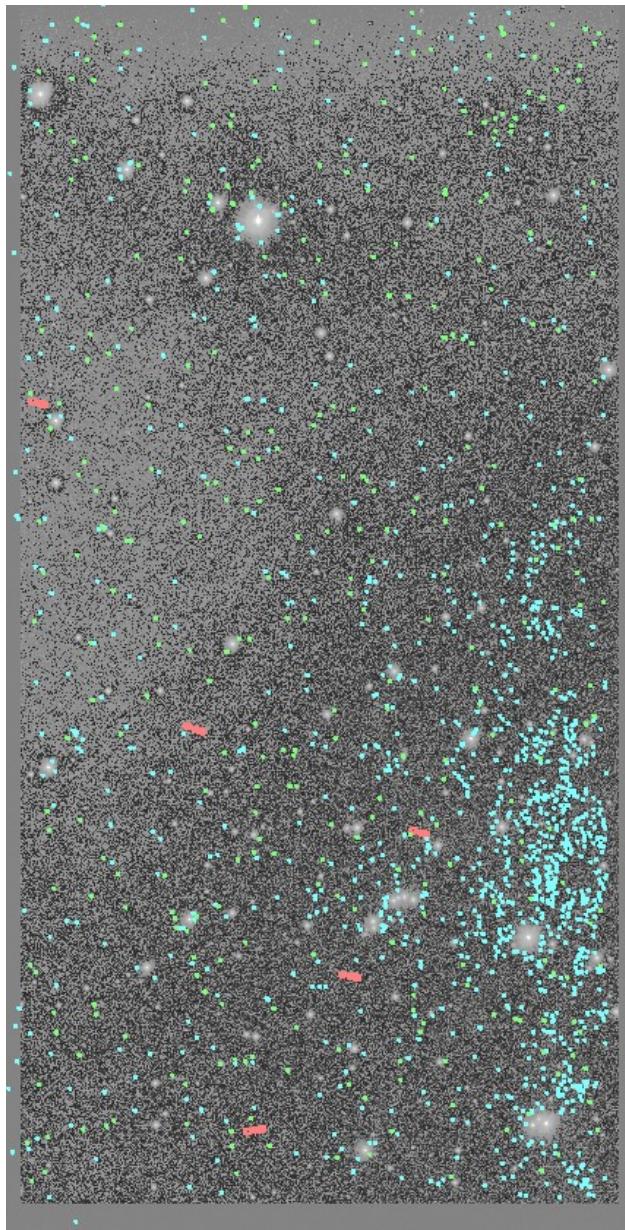
GBOT asteroids detection method



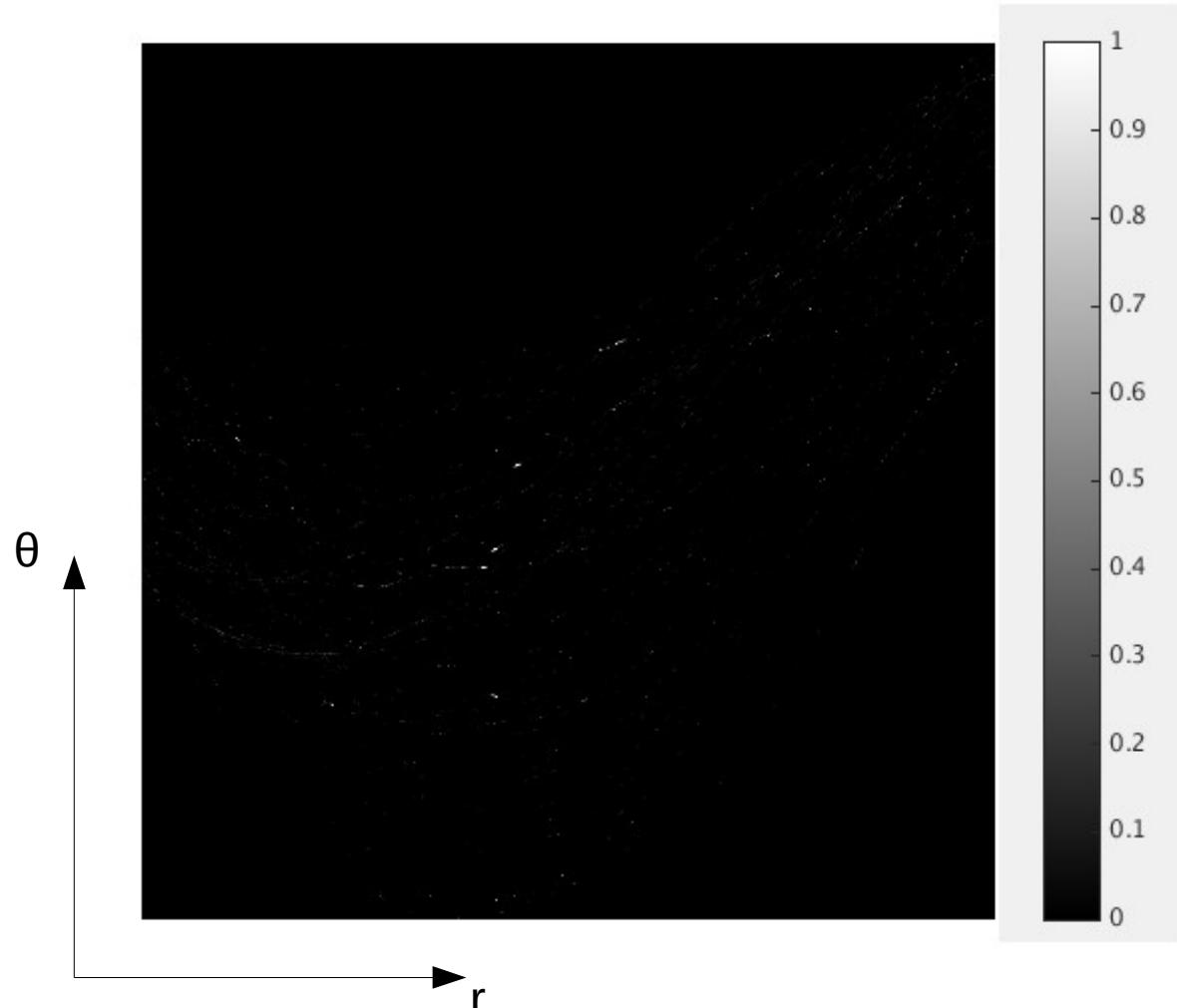
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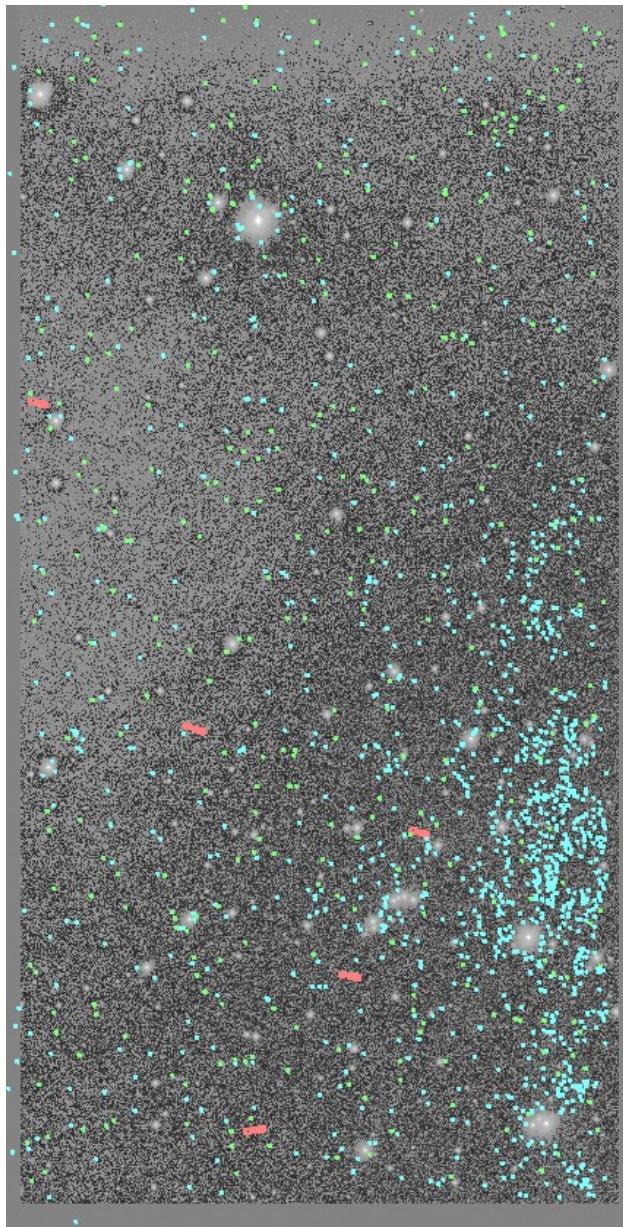
GBOT asteroids detection method



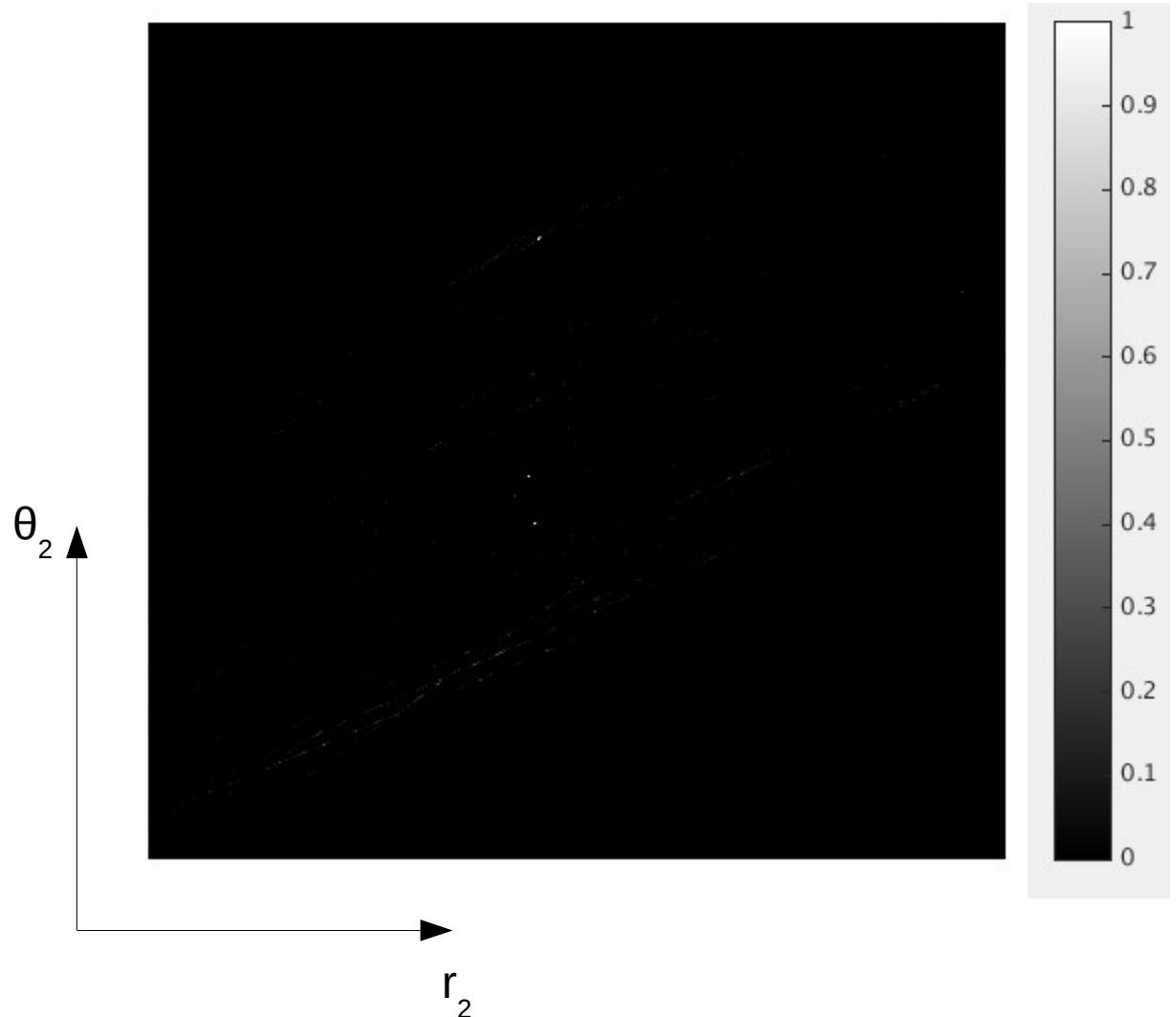
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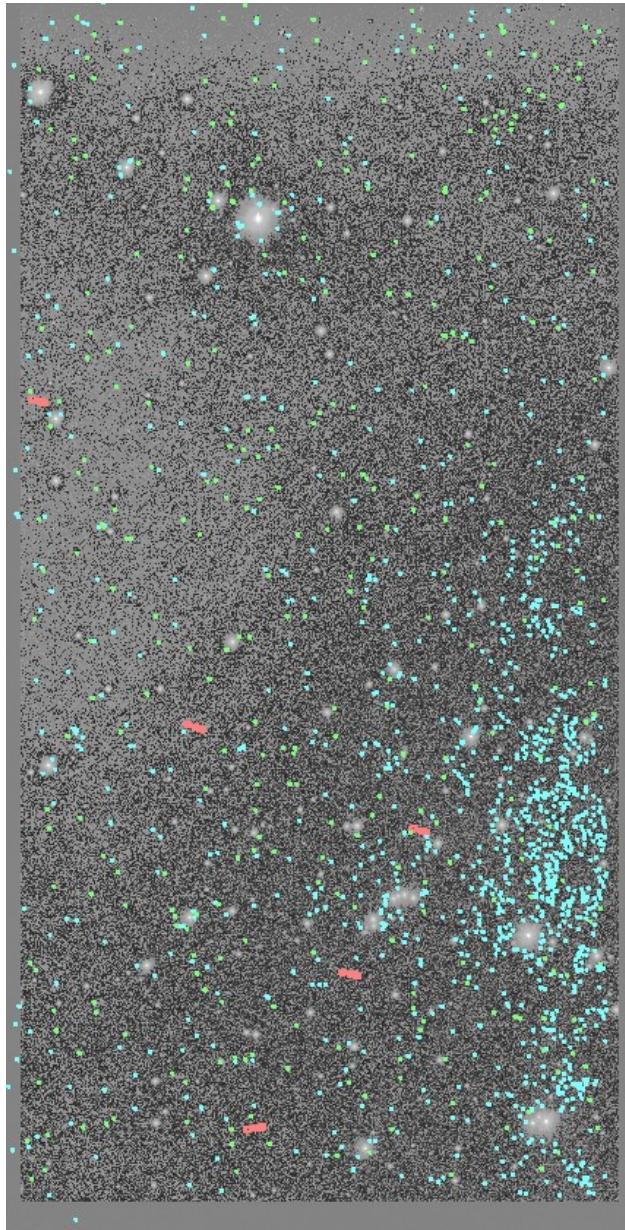
GBOT asteroids detection method



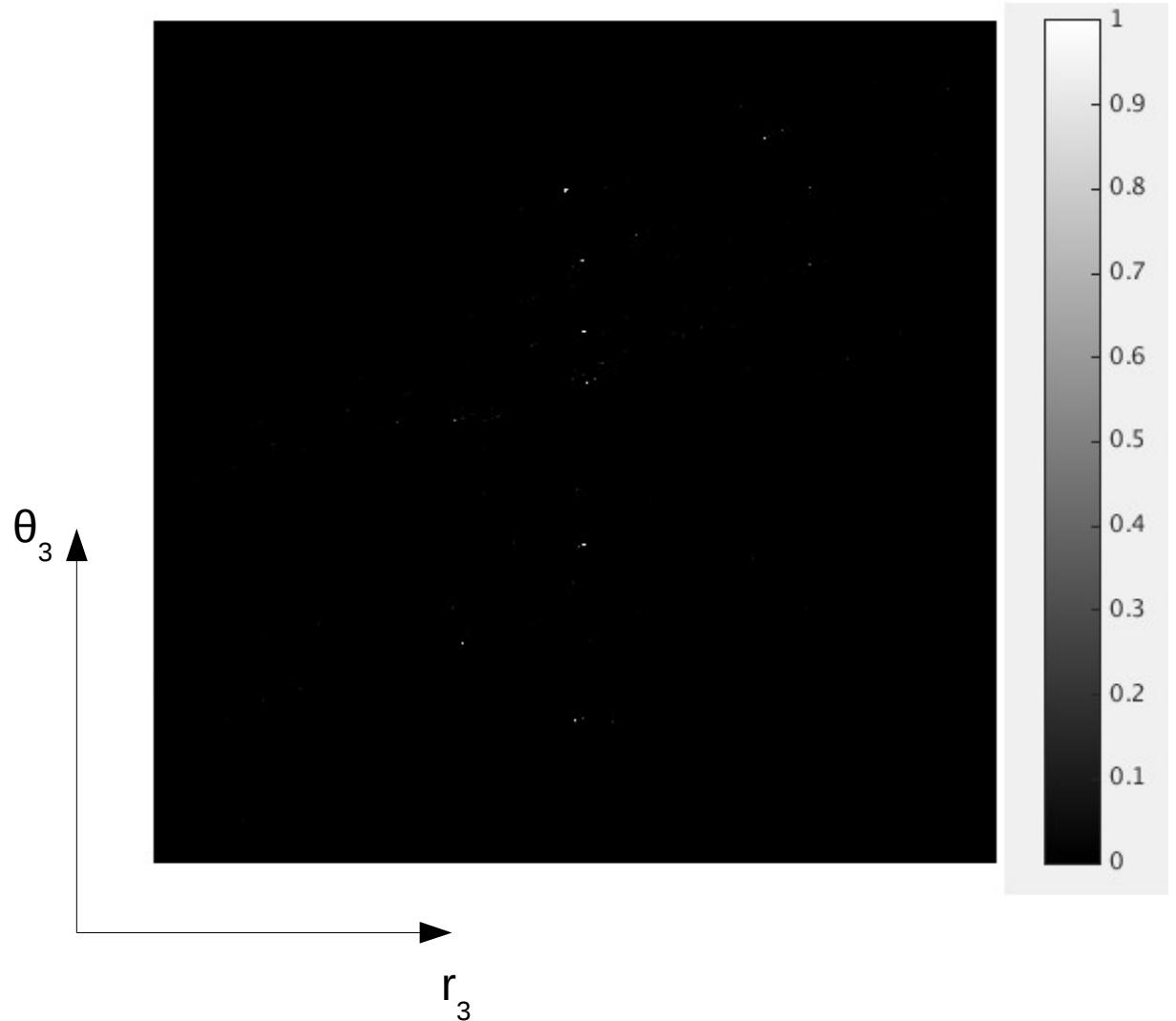
- Elimination of stationary sources (green points)
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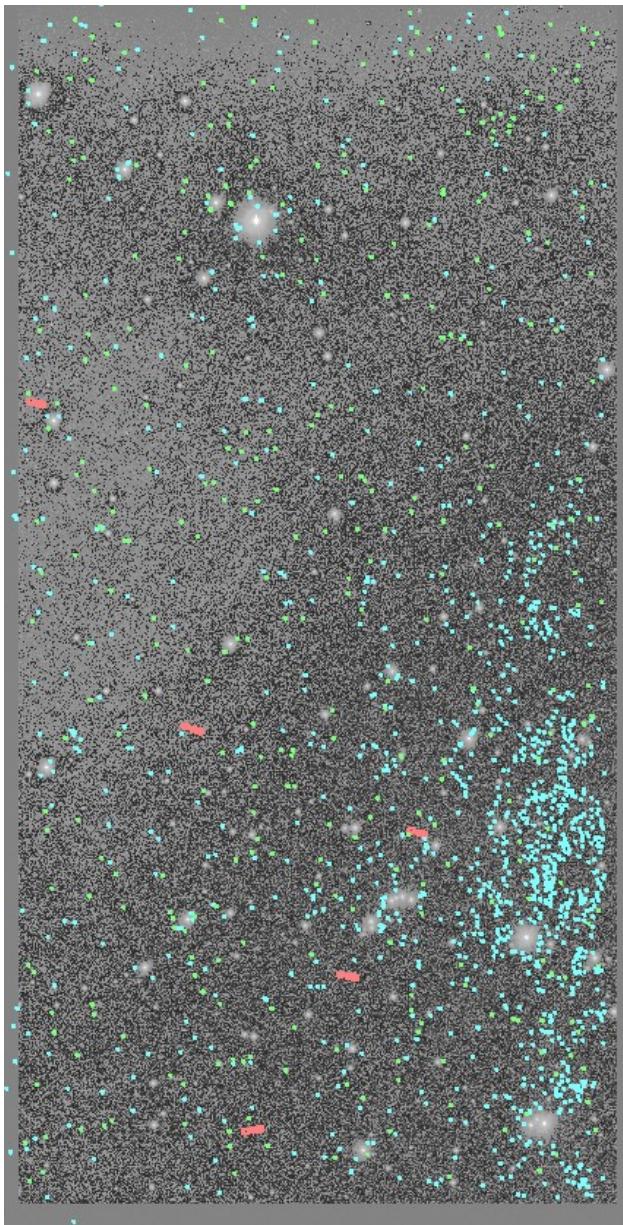
GBOT asteroids detection method



- Elimination of stationary sources (green points)
- For each pair of unidentified sources:



GBOT asteroids detection method



Current Problems

- Overlap with faint stars not identified in available catalogue
- False detection of moving object in noisy area

Detection threshold above background at 3σ

(instead of the current threshold at 1σ)

= > missing detection of real moving faint object

Human check => time consuming

- 25% of object missing

Detection threshold above background at 3σ

= > missing detection of real moving faint object

Remove the detected moving object and repeat the detection process