NAROO-sat: issues, prospects and requirements

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Outline

- Artificial satellites
- Link with NAROO

50 years since the beginning of the space era

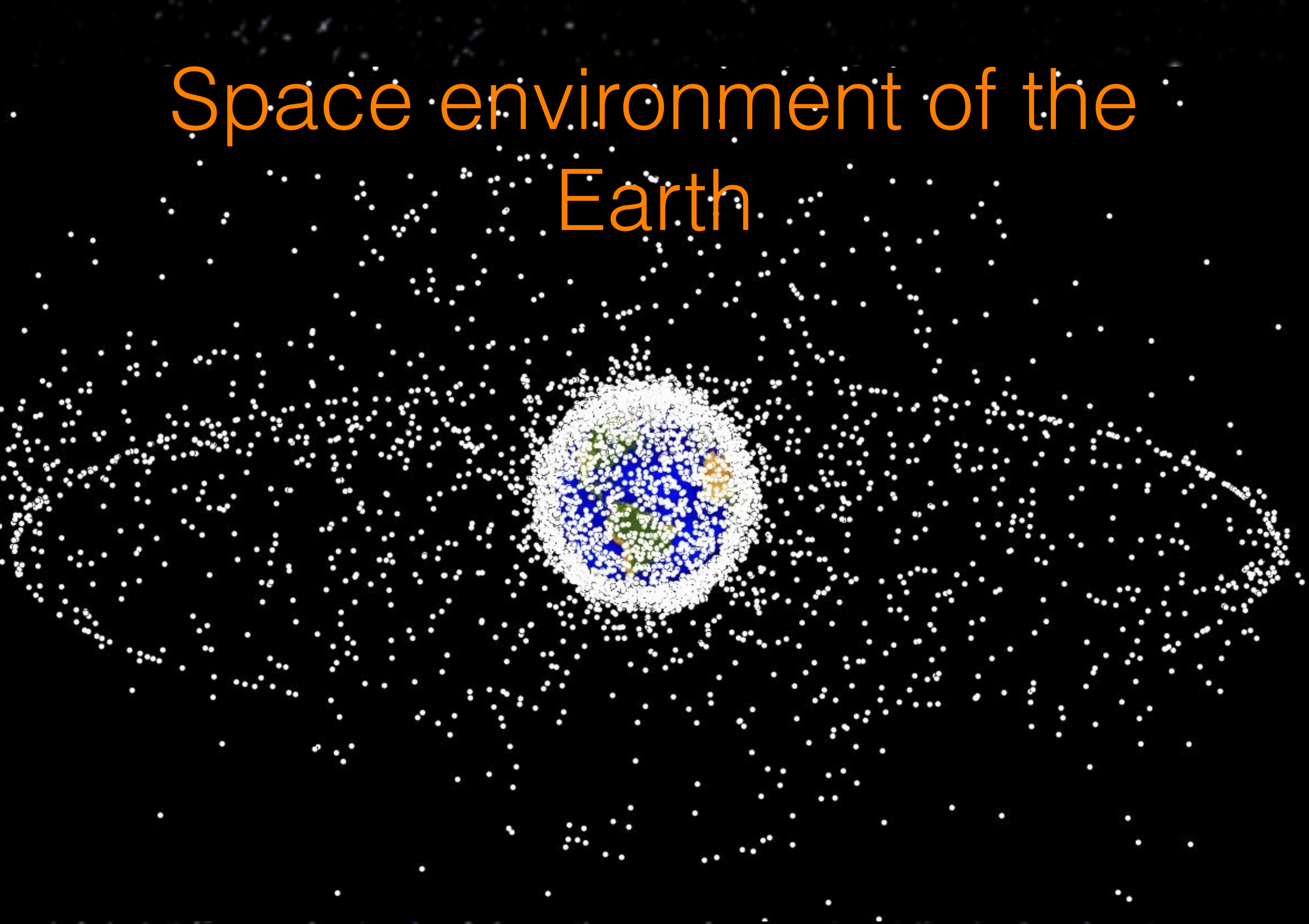
Geodetic Satellites

Altimétric Satellites

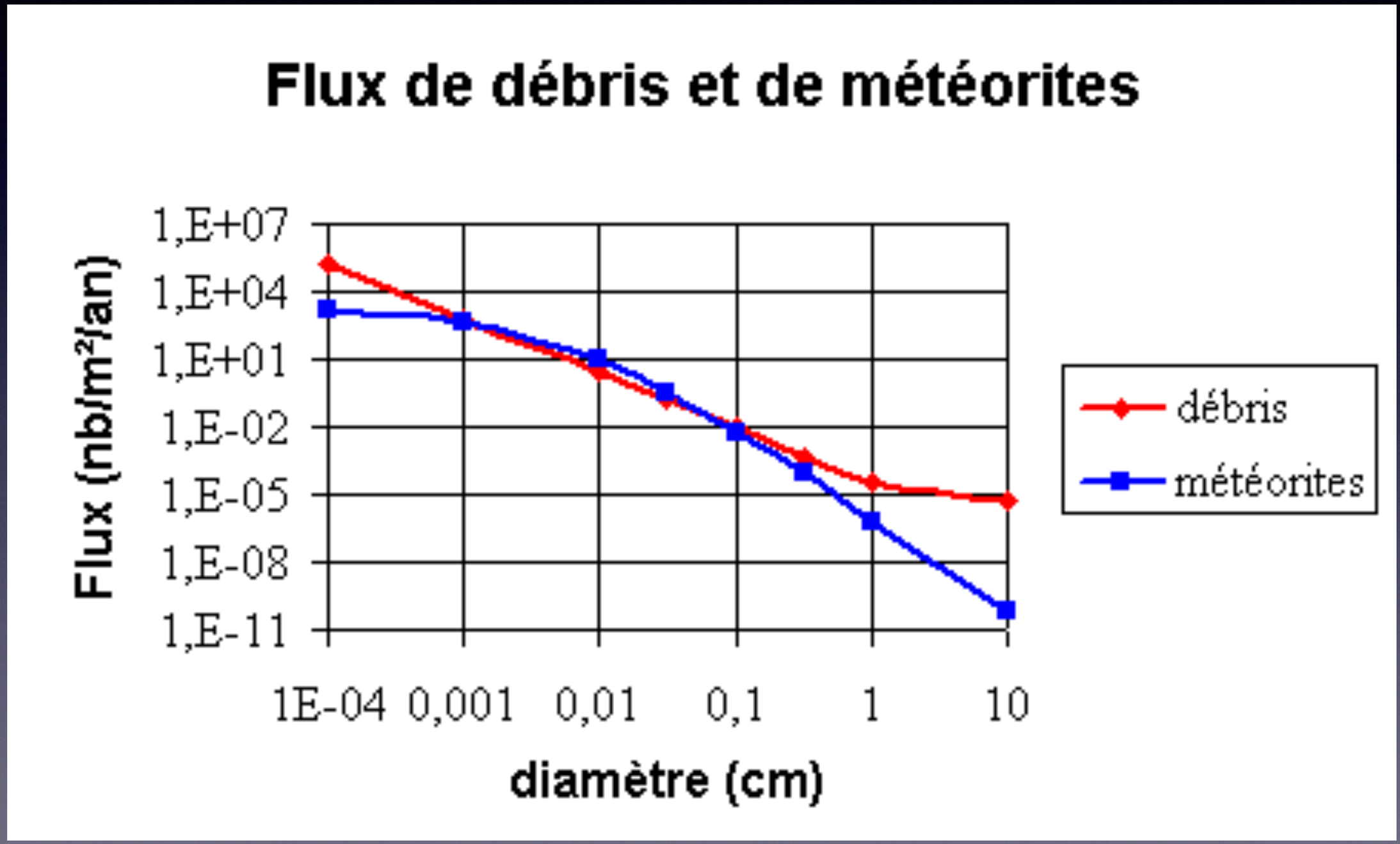
Télescope spatial Hubble

Gravity

Space environment of the Earth



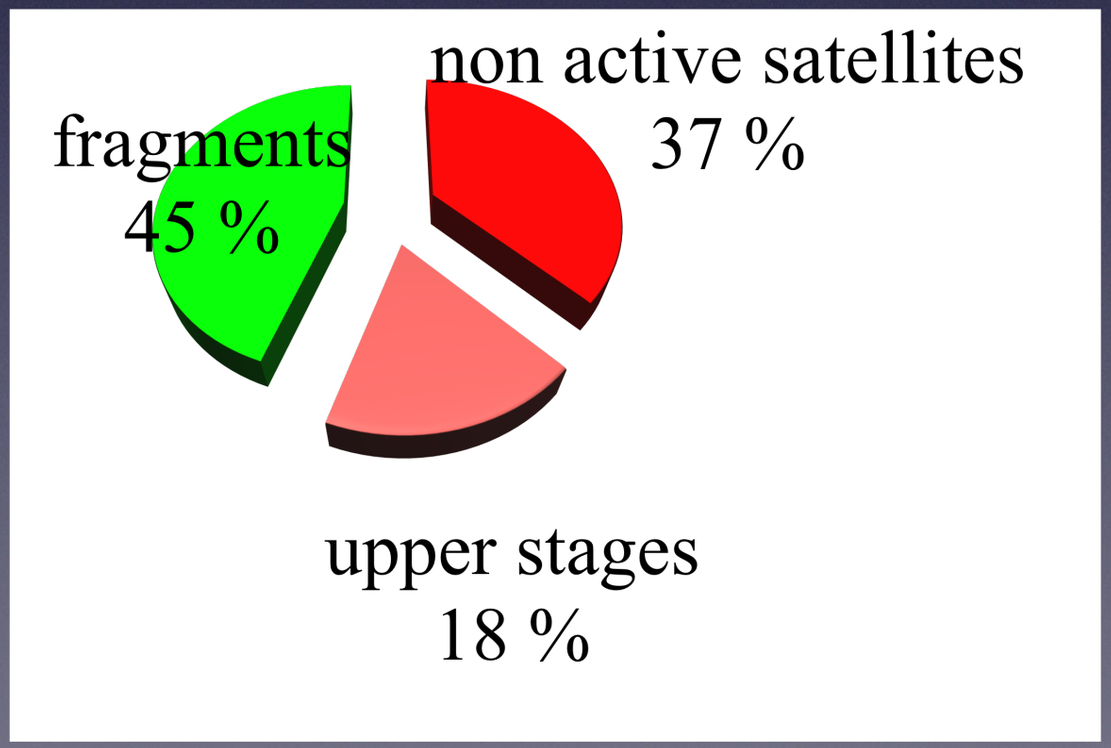
Meteors/ space debris



Number of objects

- Since 1957:
  - 25000 orbital objects
    - Atmosphere re-entry: 16000
    - Catalogued: 9000 (500 active)
  - 94% of space debris
- 100 launches / year, 200 new catalogued objects each year

	Number	Number(%)	Mass(%)
>10 cm	~10 000	0,02%	99,93%
1-10 cm	~200 000	0,31%	0,035%
0,1-1 cm	~35 000 000	99,67%	0,035%
Total	~35 000 000	100%	4 800 000kg



Courtesy of M. Laas-Bourez

Optical observations of debris

Loop of catalog maintenance

Specific requests

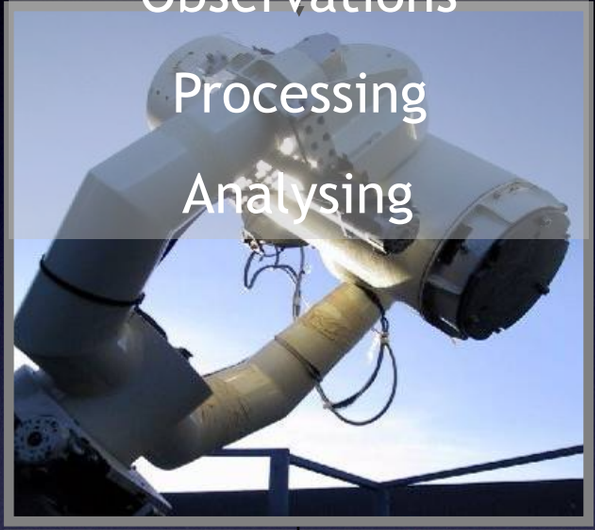
Requests/Planning

TAROT

Observations

Processing

Analysing



Measurements

Object tracking loop during the night

Identification

Yes

Matching

Orbit determination

Catalog

No

Pointing computation

Orbit determination/extrapolation

Artificial satellites detection on astronomical images

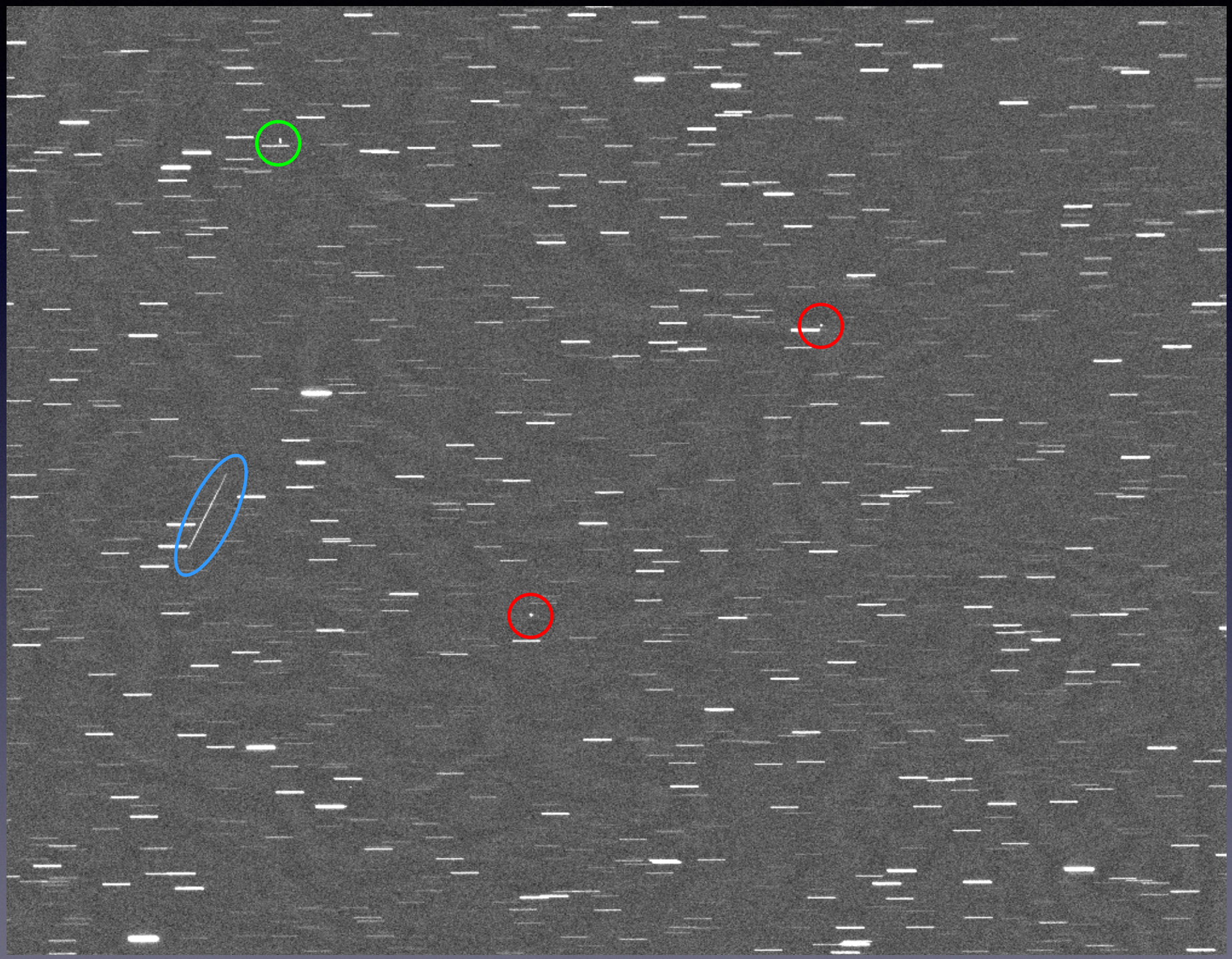
VARIOUS OBSERVATIONAL CONDITIONS (TAROT)

~2 deg FOV

2 GEO

1 GTO

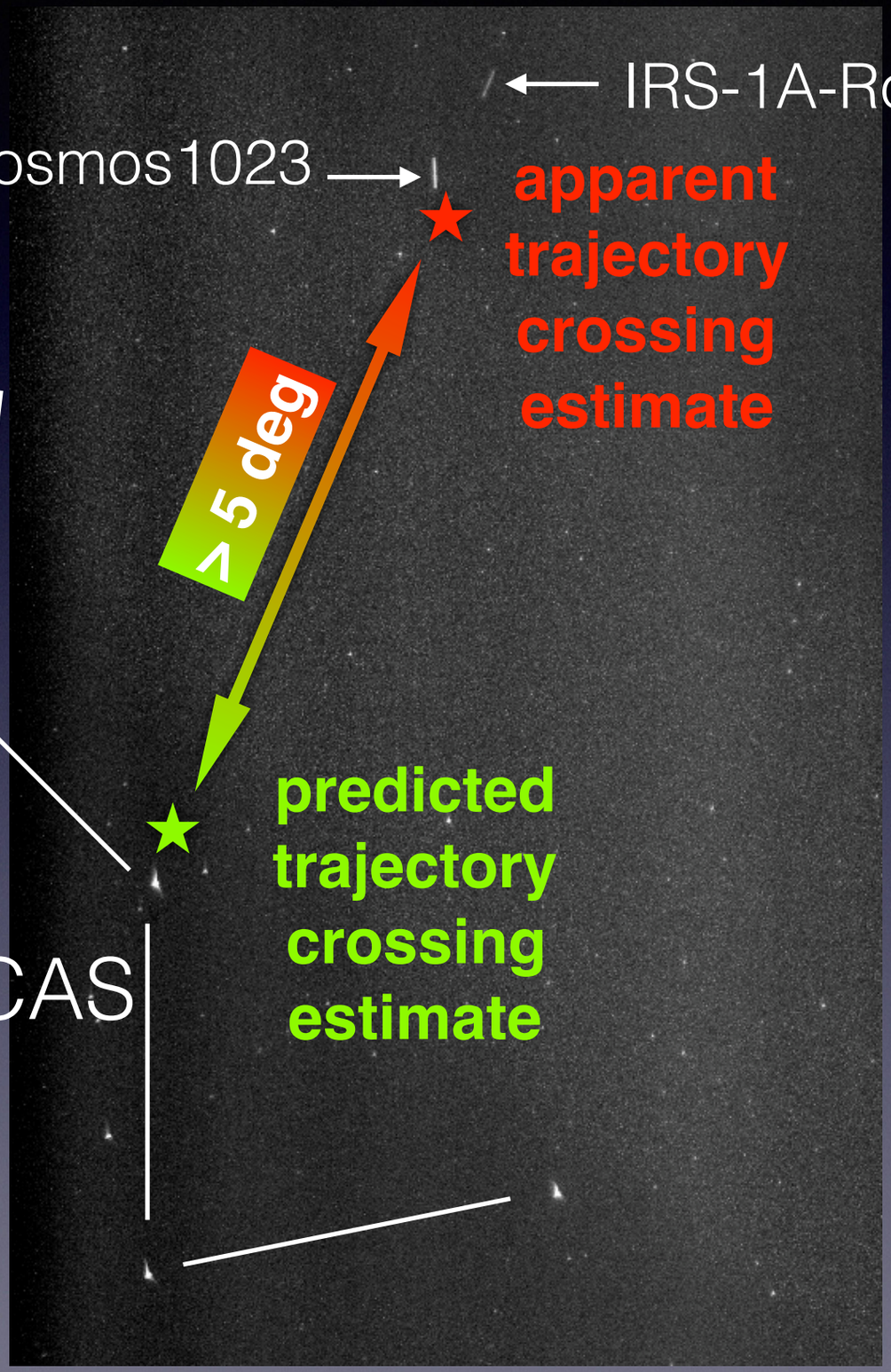
1 MEO

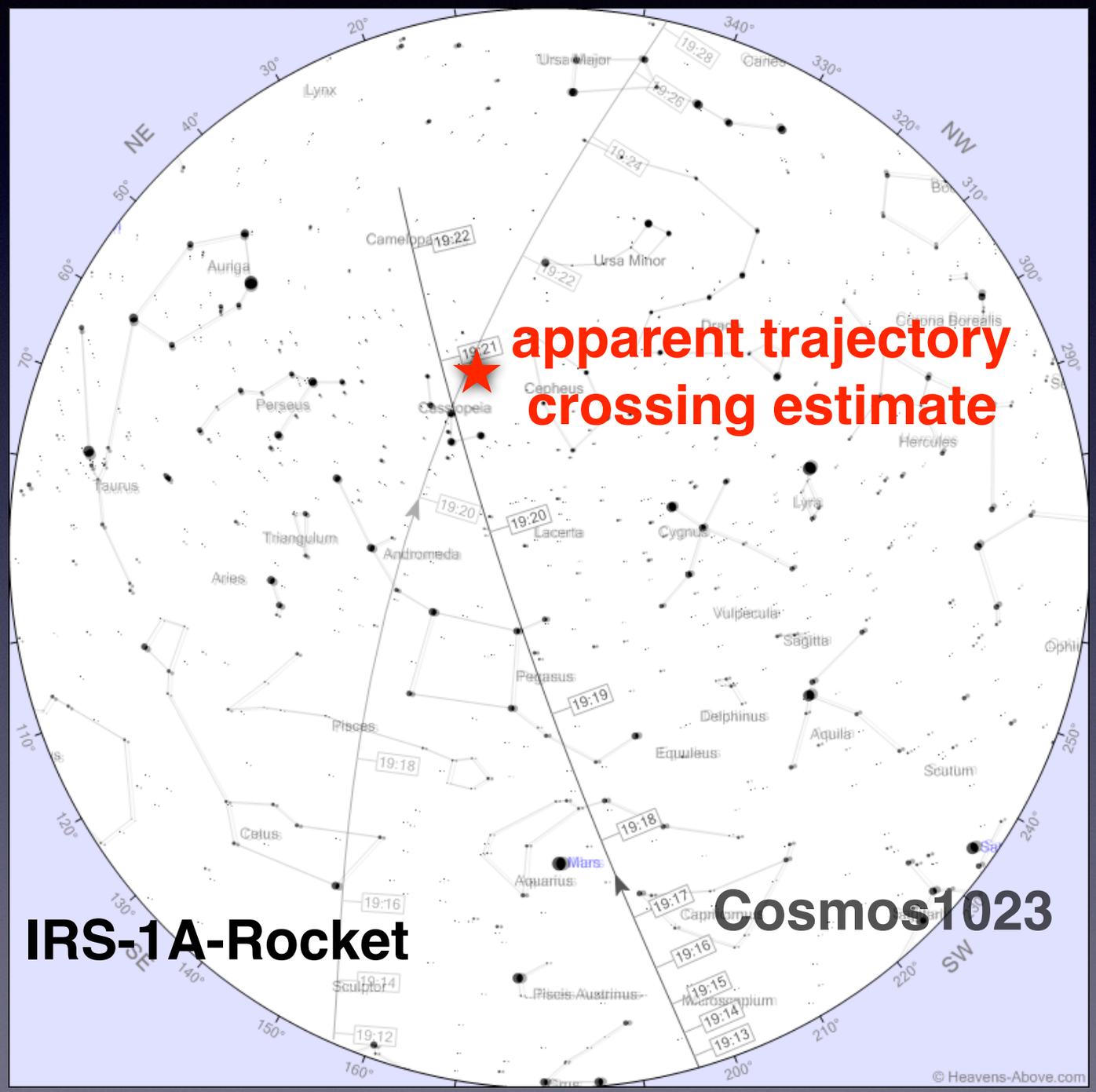


Courtesy of M. Laas-Bourez

Observations vs predictions

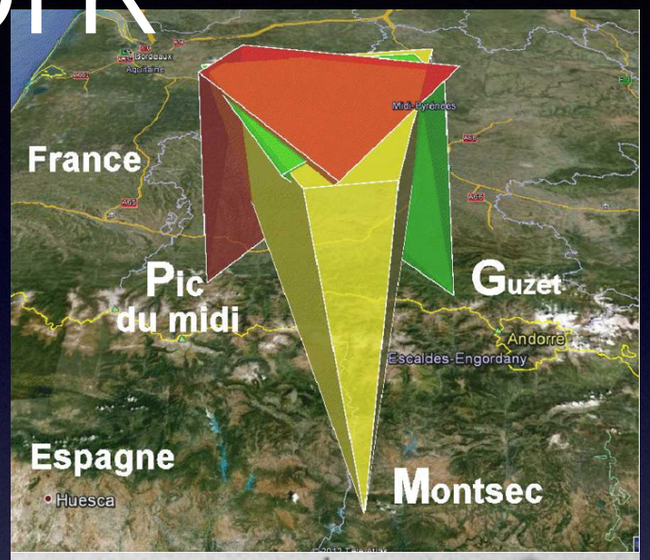
Observation from Montsec with CABERNET camera, 2018/11/25 18:21:09 UT

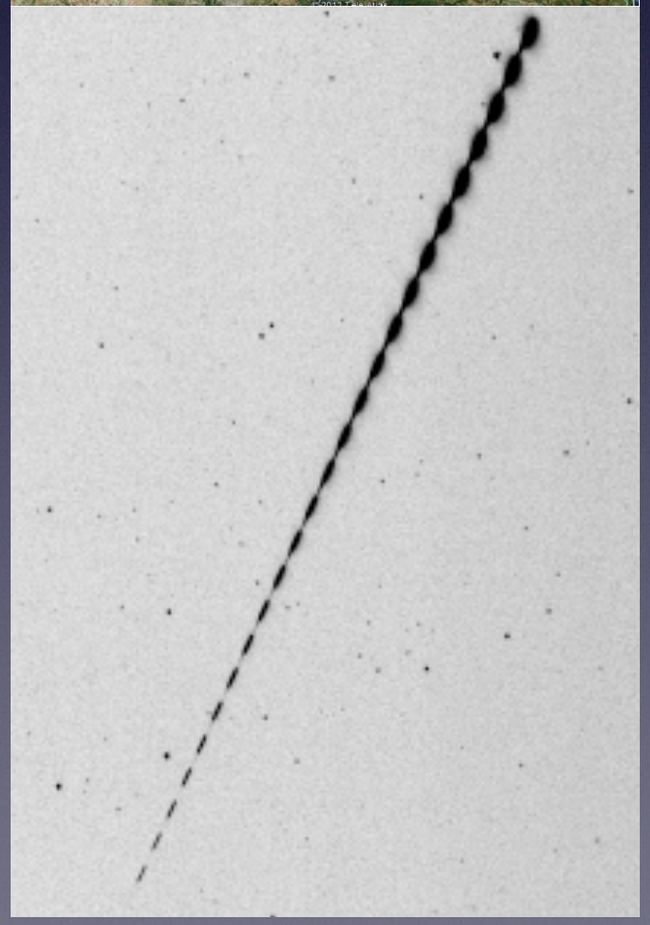




CAmera for **BE**tter **R**esolution **NET**work

3 stations
40x27 deg^2
1pixel=36”
100 Hz shutter





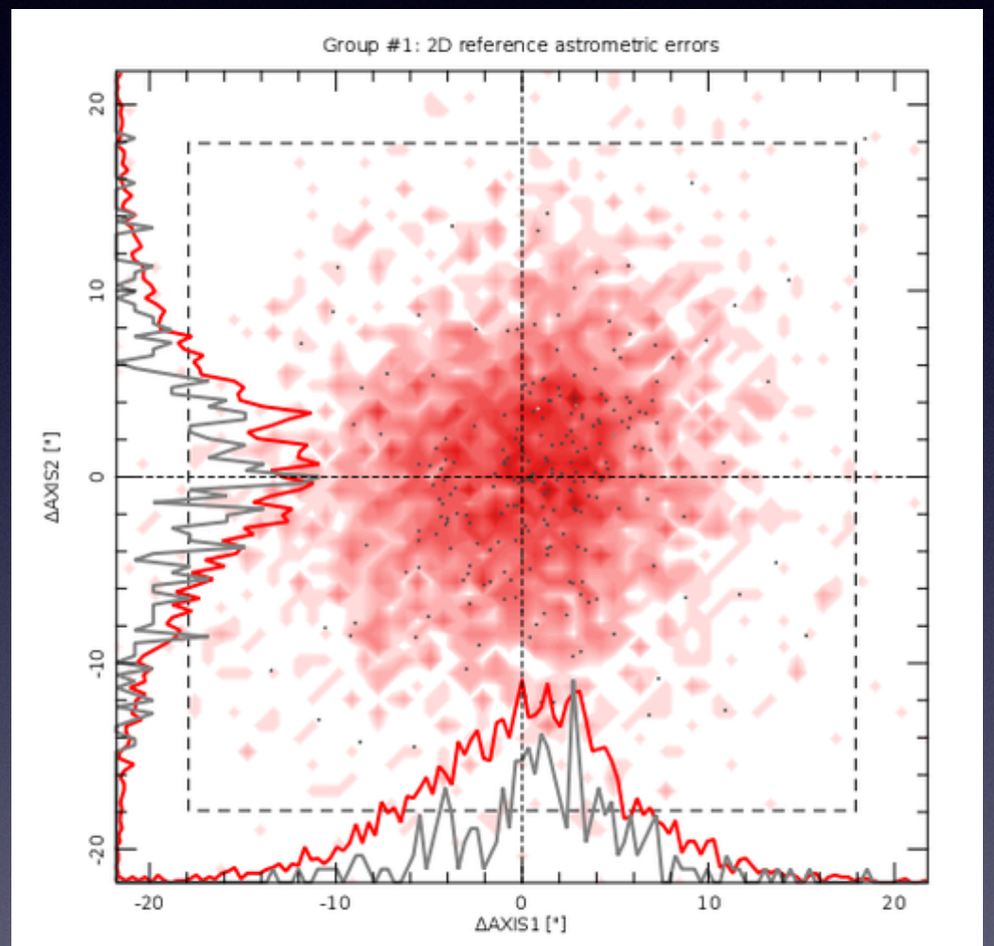
Technique: LH11000 camera

J. Vaubaillon, IMCCE

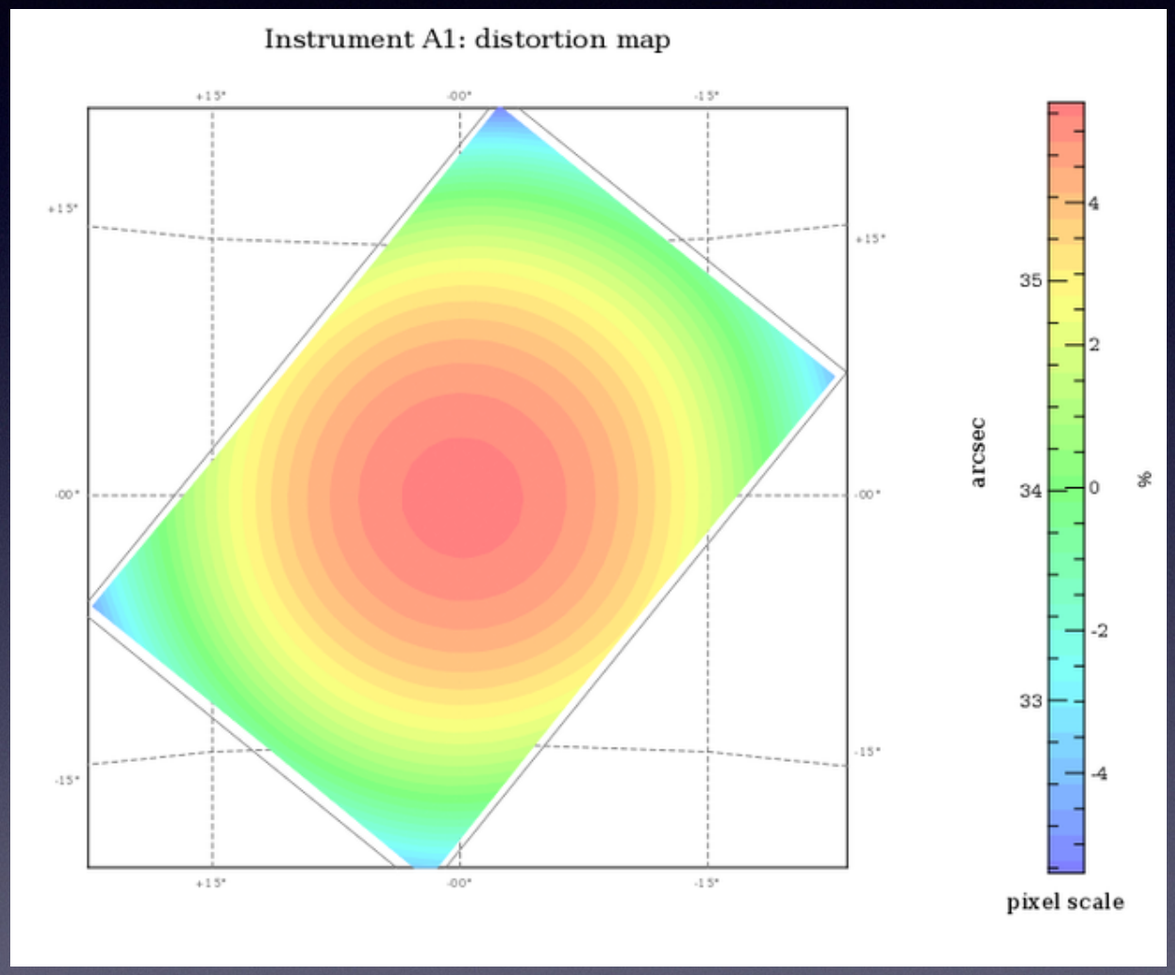
4000x2700 pixels
1s exp. time
100 Hz shutter

Astrometry

Goal: 1/10 pixel=3.6”



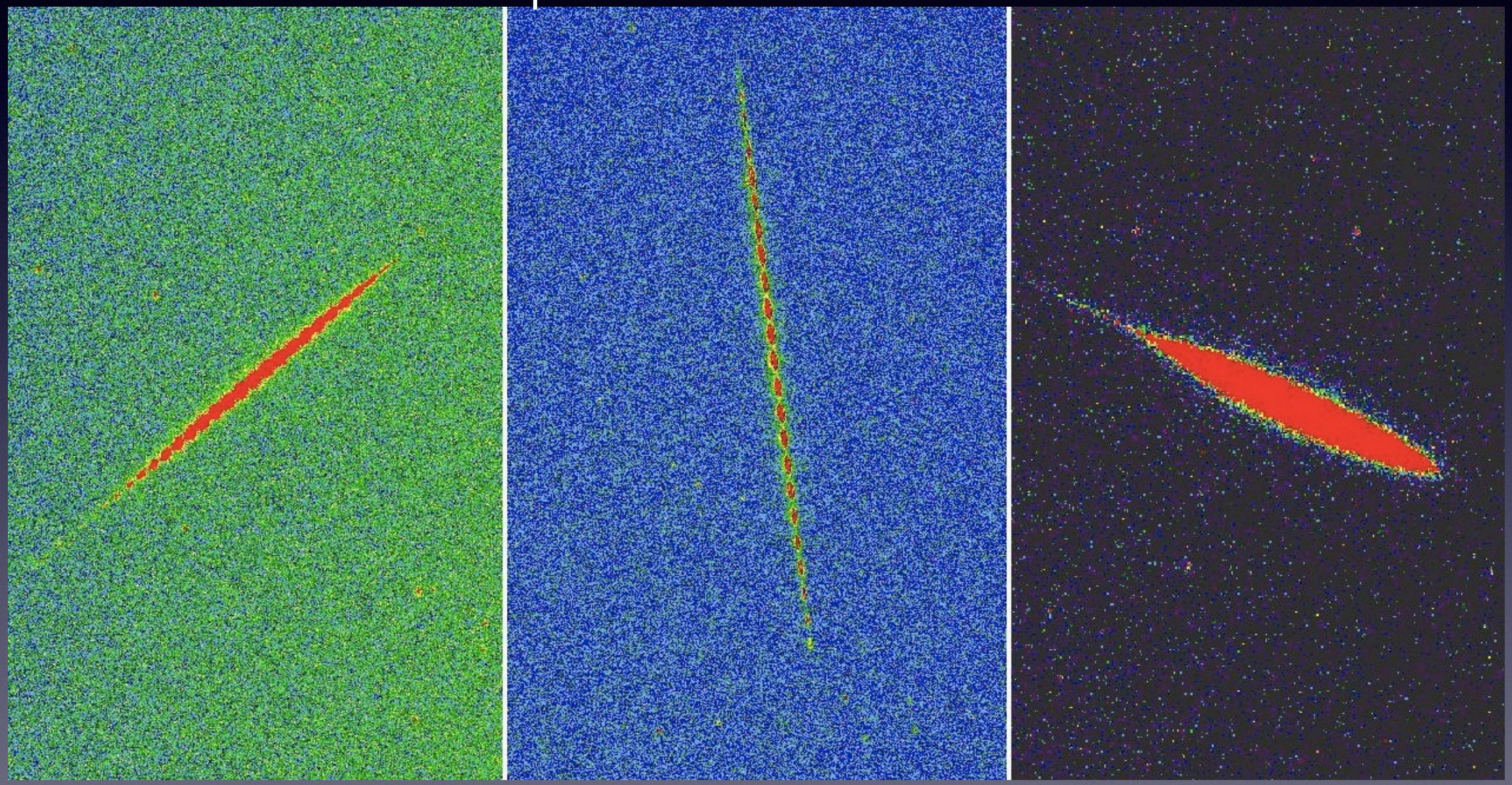
distortion map



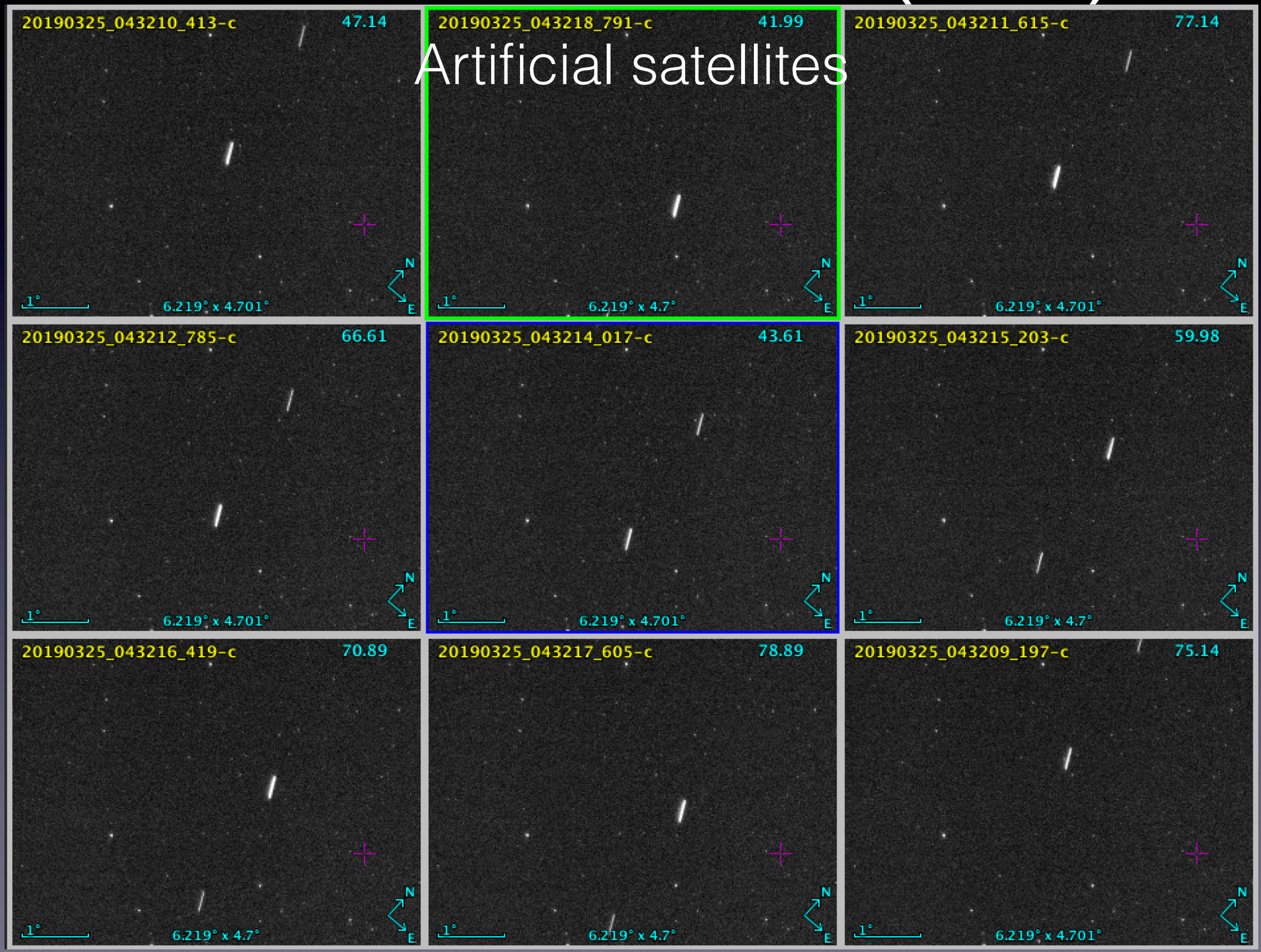
Extensive use of: SExtractor, PSFex & SCAMP
(E. Bertin, C. Marmo - IAP)

Observations (1/2)

Triple-station Meteor



Observations (2/2)



Artificial satellites

On-going work

- Detection of artificial satellites in CABERNET data
- Cross correlation, and identification
  - (quasi-) real time and data mining
- Towards a new generalized method (< DOCT-PODET)

NAROO-sat

- Observe artificial satellite in the past (>1957…)
- Improve our knowledge of artificial satellite:
  - dynamics
  - flux
  - space environment

Scientific objectives

- Individual objects
  - Dynamics up to 50 years
  - Correlation with catalogs (and improvement)
  - Predictability of unpredictable events: solar activity, resonance effects
- Dynamics of the population
  - Size of the population (regions, number of objects), evolution with time
  - Correlation / uncorrelation with existing catalogs
  - Probability of collisions
  - Statistics (to be improved with time)
- Space environment
  - Orbit decay
  - Reference frame issues

How to?

- Measure location (track) of satellite or meteor in “old” photographic plate
- Identify the object
- Link it to subsequent orbit
- do science : dynamics, statistics on number of objects

Conclusion

- Observation of meteors & artificial satellite on-going at IMCCE
- Need for “old” (>1957) photographic records: NAROO-sat