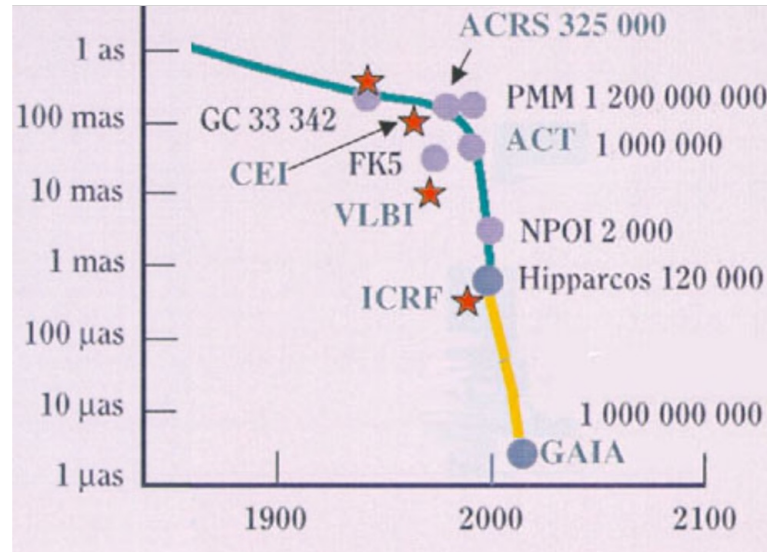


The NAROO program

Sub-micrometric digitization center

V. Robert (vincent.robert@obspm.fr)

J.-E. Arlot, J. Desmars, D. Hestroffer, V. Lainey, A.-C. Perlberg



Report

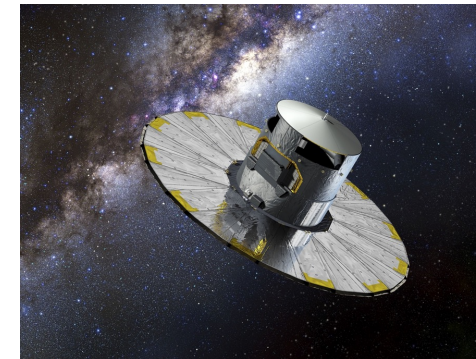
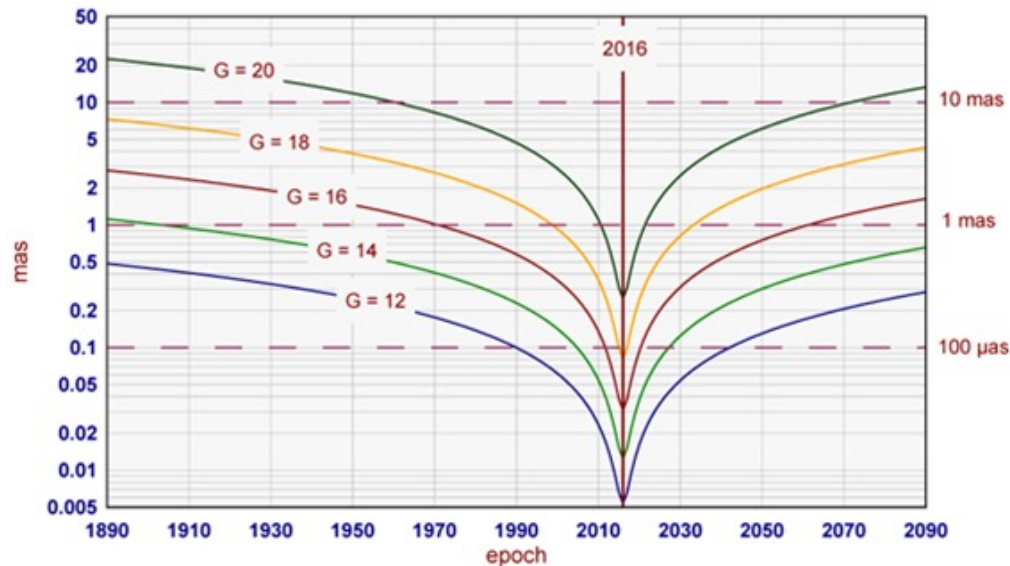
Most of the observations used in the adjustments have been reduced with references in the range 100-1000 mas in positioning accuracy: catalogs, proper motions, dynamics...

Value

Old observations are essential for the modelization of transitory phenomena and for the dynamics of moving objects !

Expanding the sampling with Gaia !

--- Arlot et al. 2017

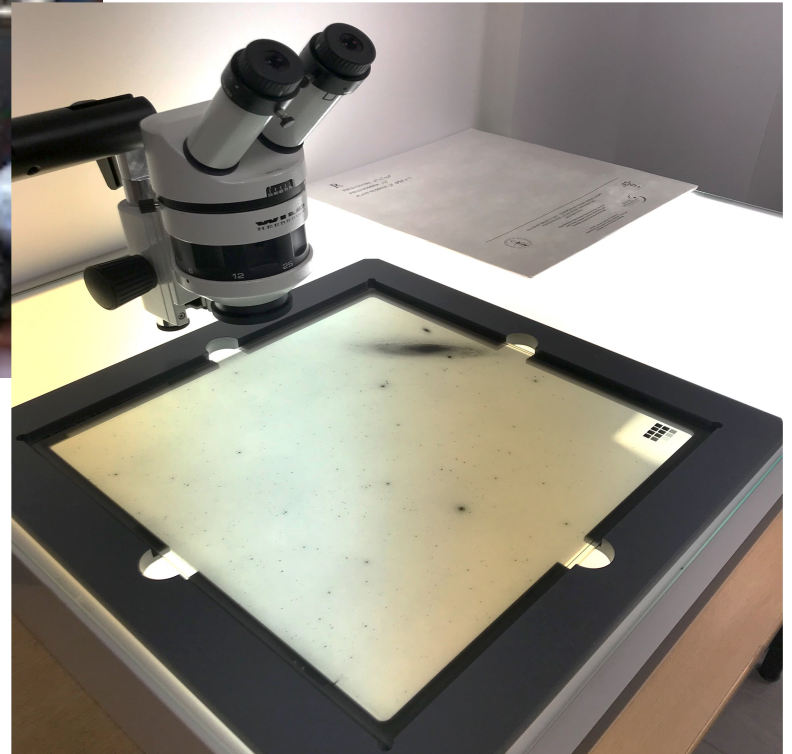


The challenge !

Re-reducing old observations allows us to decrease the mean accuracy from 1 arcsec to some tens of mas.



Kodak argentic films



Kodak photographic plate

A new definition:

An « old » observation was realized before Gaia (1880-2016) !

Why a new analysis ?

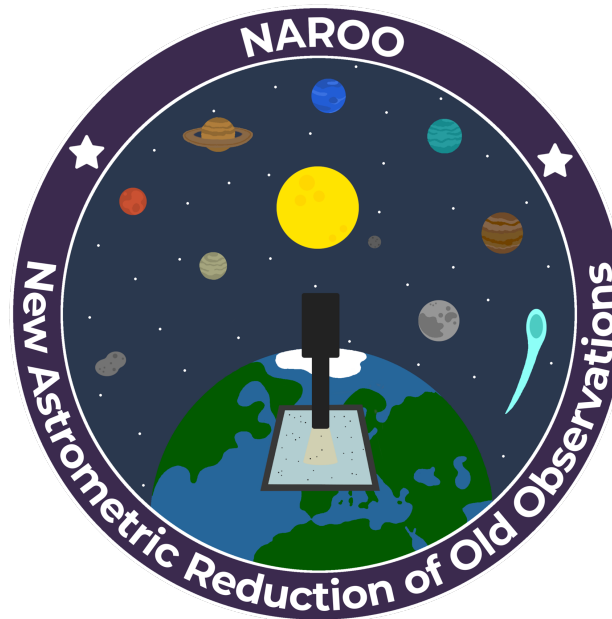
1. To improve the accuracy of old observations already reduced.
2. To analyze original observations.
3. To express all the data in the same reference system, eliminating biases.

How to analyze photographic plates ?

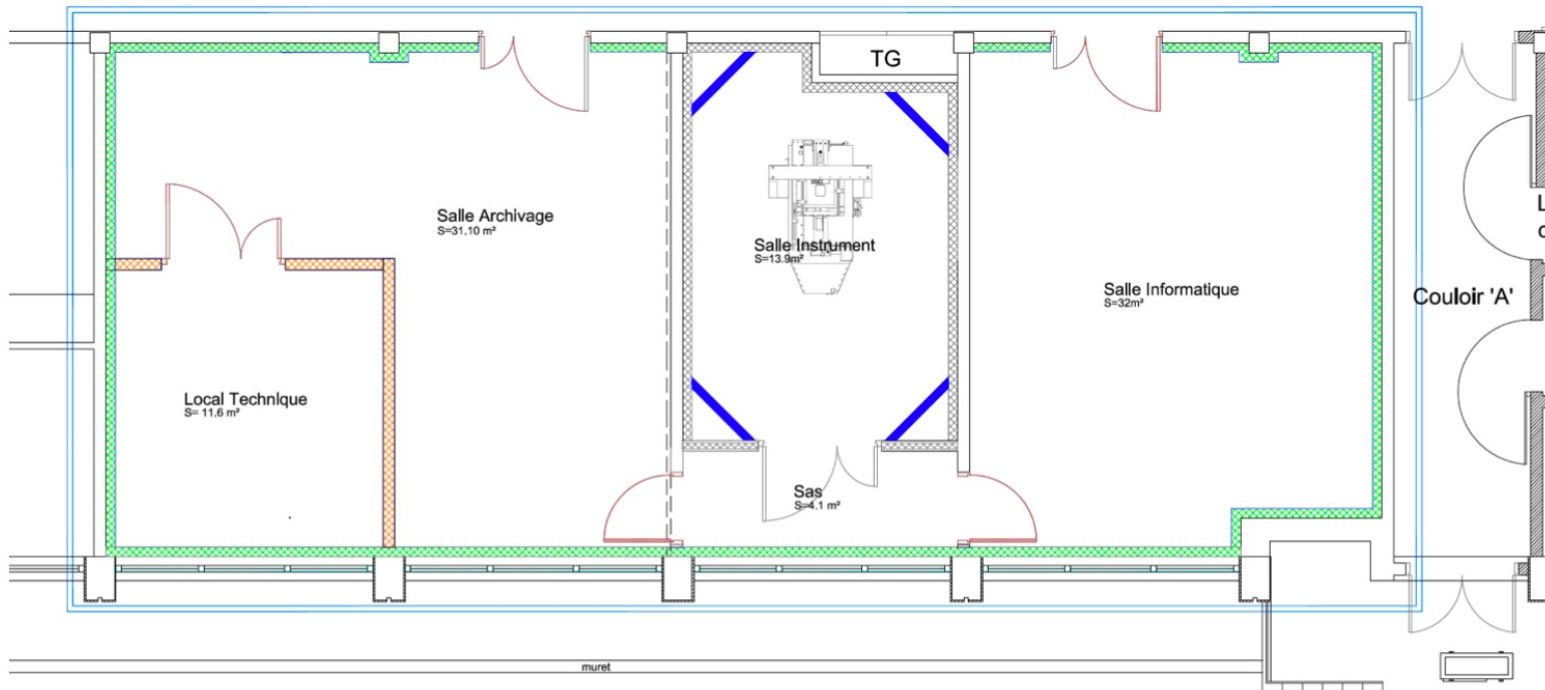
Either the measurements are still available (and accurate enough), or we digitize !
→ Role of the metadata (date, location, exposure time...).

By the end

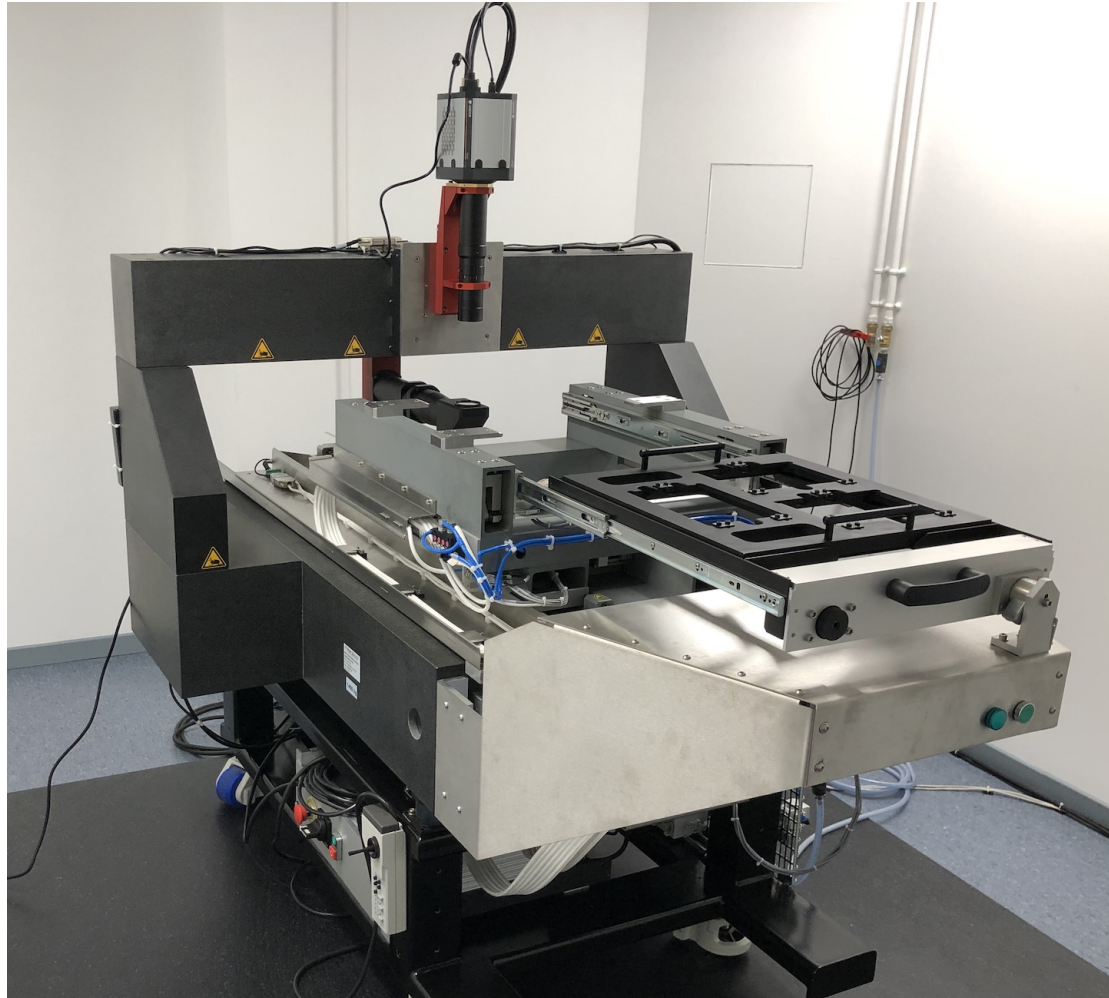
We have a **huge observational tank** (1890-1998) allowing a new analysis (improvement) and/or a first analysis (originality).

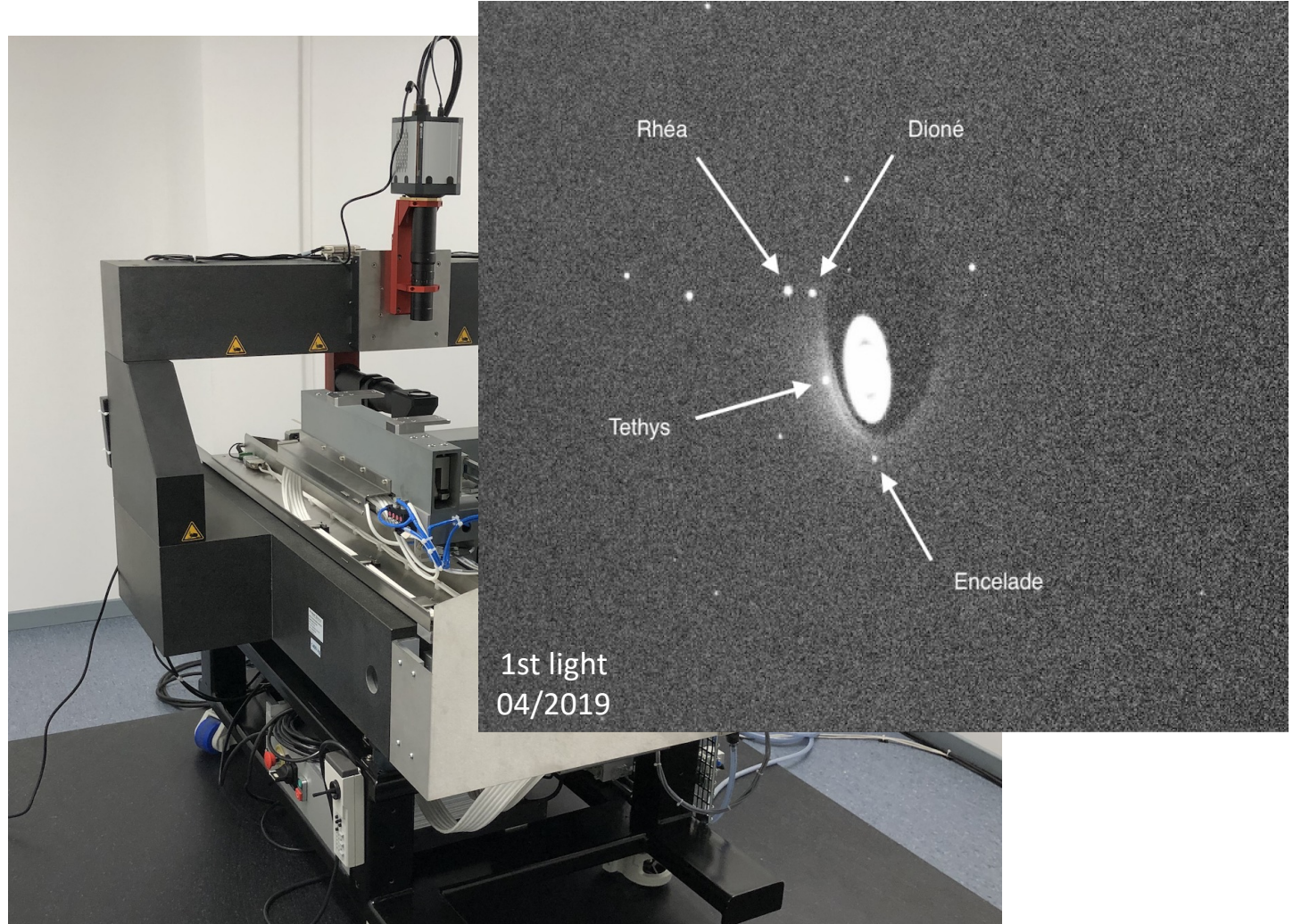


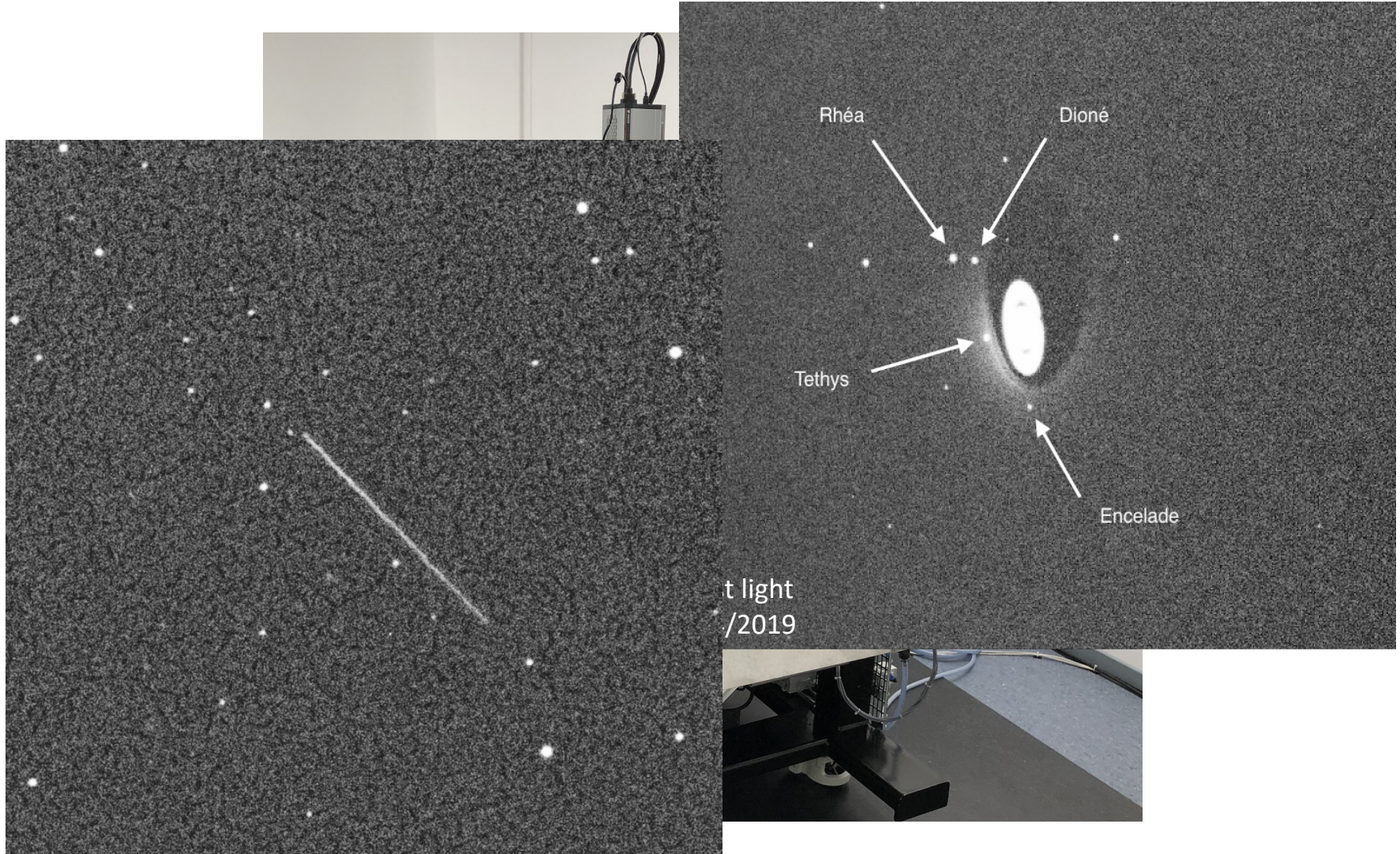
A unique digitization center dedicated to the sub-micrometric analysis of old astro-photographic plates, ***mainly for science purposes*** !

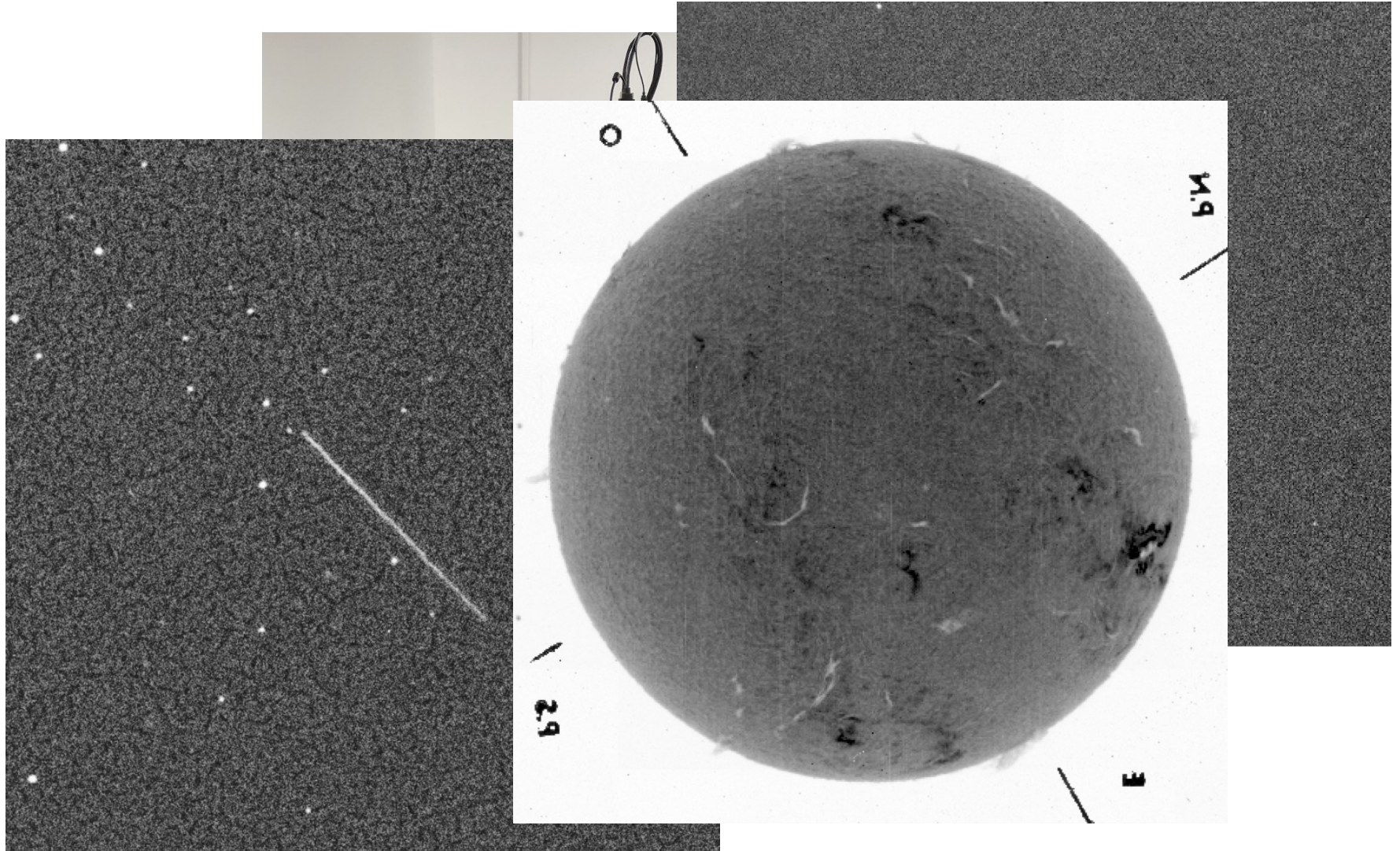


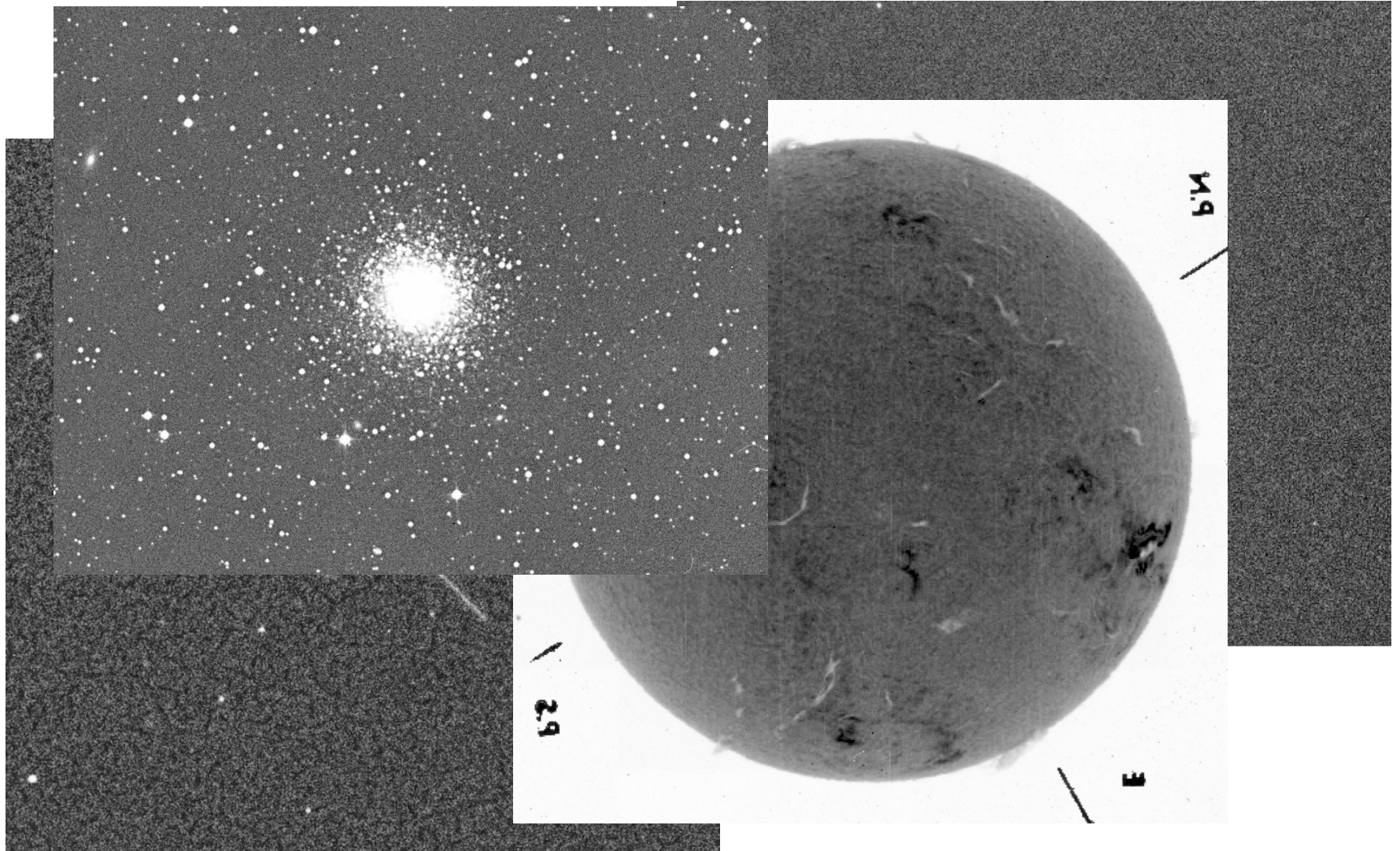
- 100 m², Paris Observatory, Meudon site.
- Computing, archive, and machine rooms.
- ISO-5 regulated clean room with $20^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$ and $50\% \text{ RH} \pm 10\% \text{ RH}$.

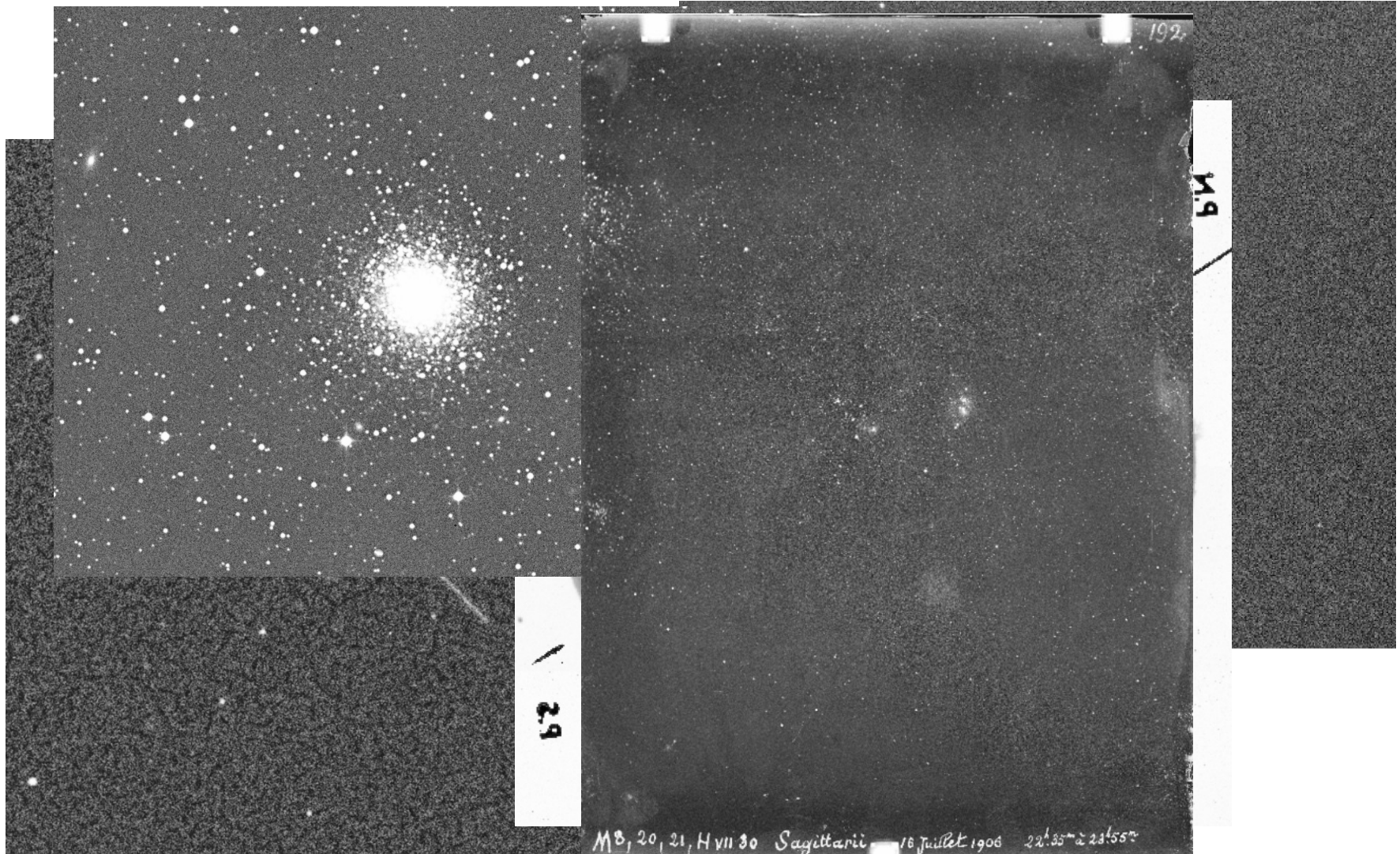


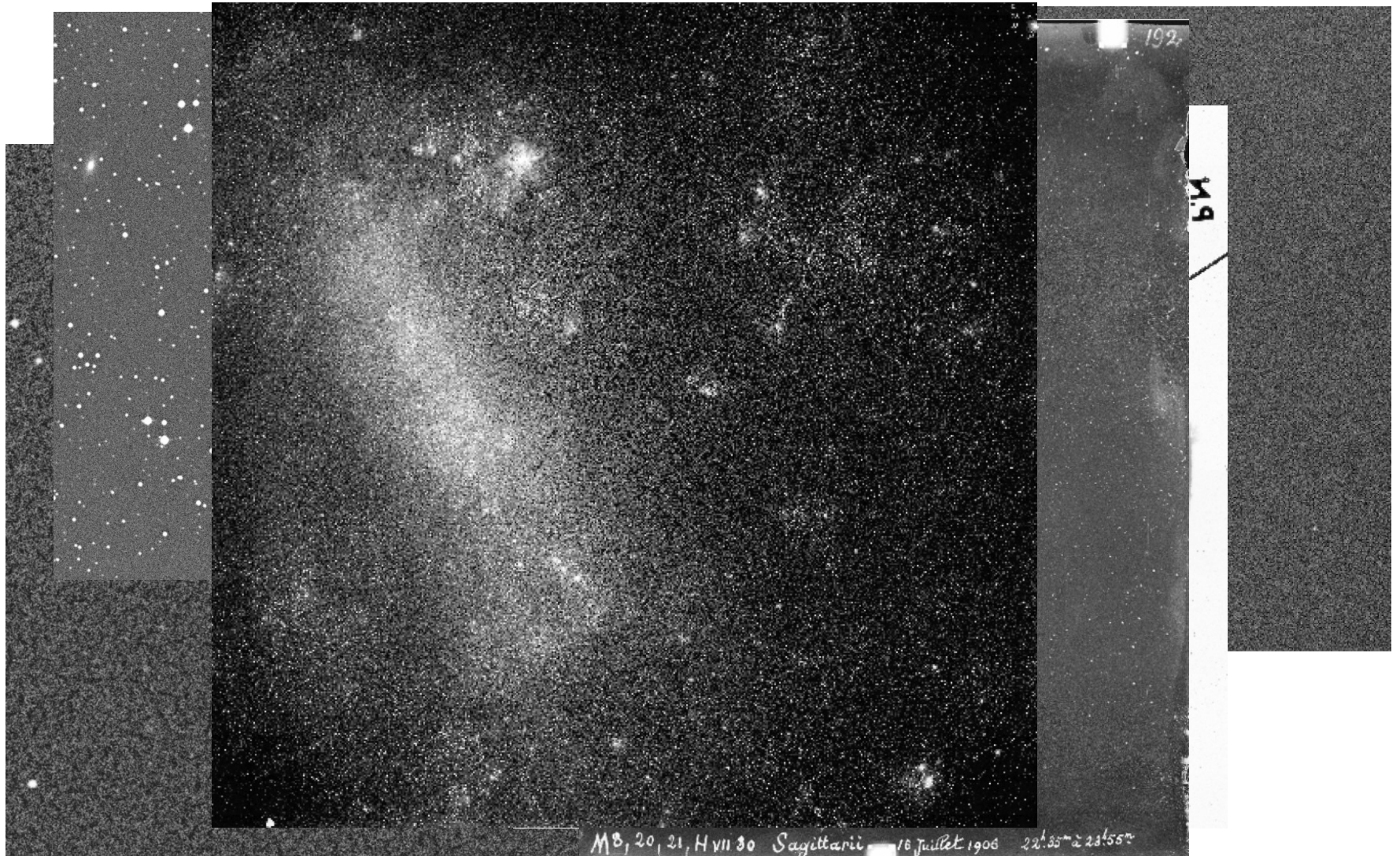












Machine

- Newport-Microcontrol XY-table 3 μm air-bearing system.
- Plates up to 35 cm x 35 cm.
- Orthogonality, tilts, flips constraints by Heidenhain 1nm encoders.
- Camera Andor sCMOS 6.5 μm .
- Newport stability 10 nm.
- Newport repeatability 40 nm.

Real data / Calibration

- Positioning stability below 15 nm.
- Positioning repeatability below 65 nm.
- Isotropic FOV with an error below 5 nm.
- Optical system with no tilt or distortion contributions (Instrument Pole).

Item	Maintenance	Call	Teaching	Discretionary
Quota	10 %	60 %	10 %	20 %

NAROO Call

- Public Call every 6 months --- Digitization/Use **free of charge** !
- 2022A Call with 4 submissions. 2022B Call with 5 submissions.
- Assignment by the NAROO SOC.

Communication

- Reference [Robert et al. 2021](#)
- PSL website <https://omekas.obspm.fr/s/naroo-project/>
- Mailing lists: internal and (inter)national.

#1 USNO Jupiter plates, 1967-1998

- 2500 observations
 - Galilean satellites and planet
- Robert et al. 2022 (upcoming #1)

#2 SAAO Saturn plates, 1926-1945

- 1200 observations
 - Main satellites and planet
- Robert et al. 2022 (upcoming #2)

#3 SAF Juvisy plates, 1903-1923

- 1500 observations Flammarion/Quénisset
 - Analysis of Gaia stars proper motions
- Robert et al. 2022 (upcoming #3)



#1 LESIA solar plates, 1945-1998

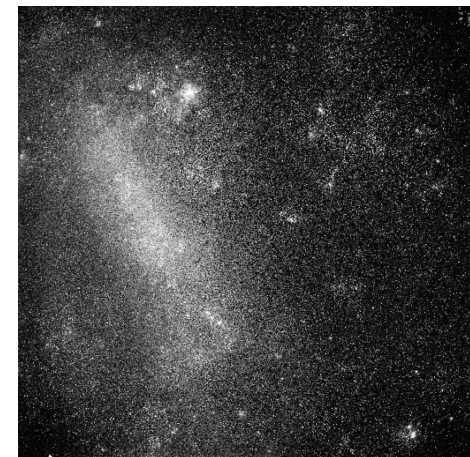
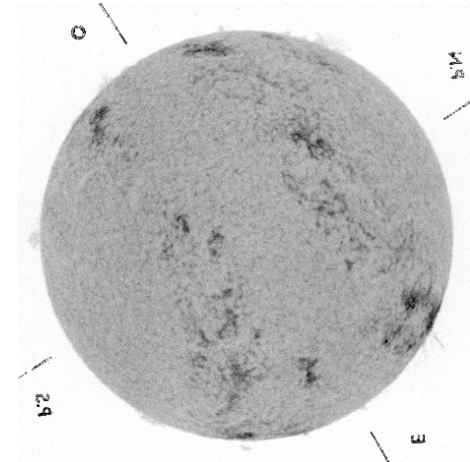
- 80000 observations
- Active regions
- Solar filaments

#2 EROS program

- 250 Schmidt plates
- SMC and LMC
- Brown dwarfs

#3 Morehouse comet

- 50 observations
- Spectra and visible



#a NEO and TNO plates --- J. Desmars

- Available Schmidt archives, Paris

#b Star spectra --- C. Neiner

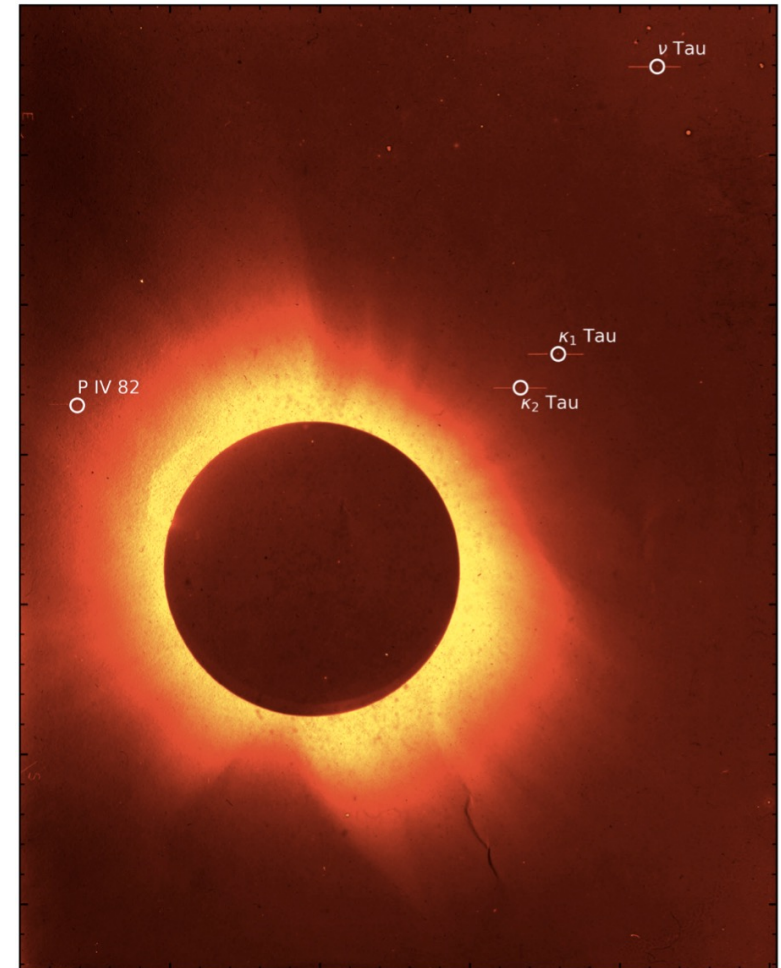
- Be stars, LESIA

#c General relativity --- C. Le Poncin-Lafitte

- Gravitational effects, SYRTE

#d Fundamental physics --- D. Valls-Gabaud

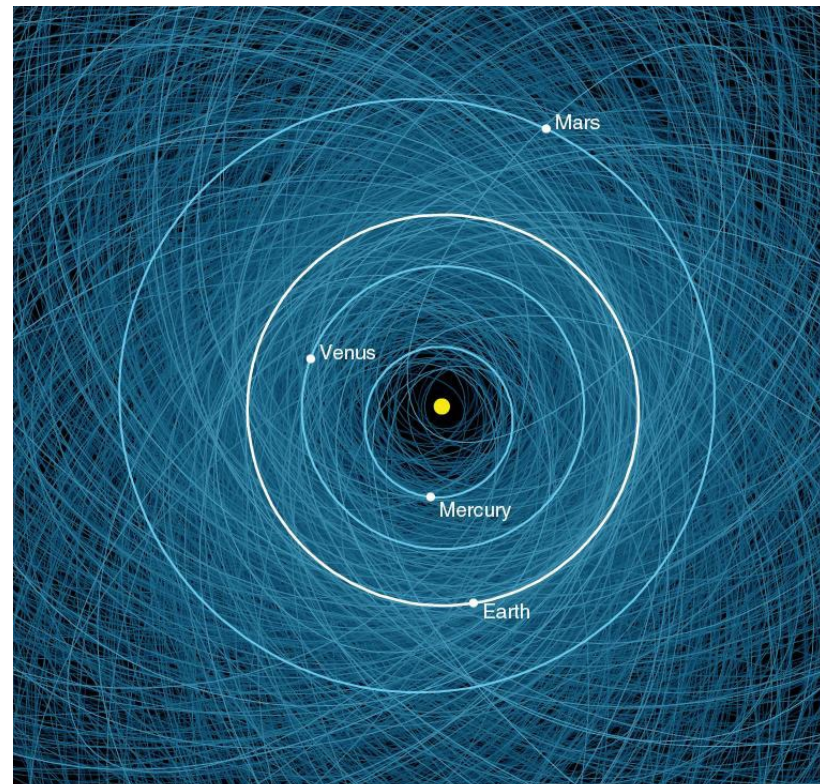
- 1919 Eddington, LERMA



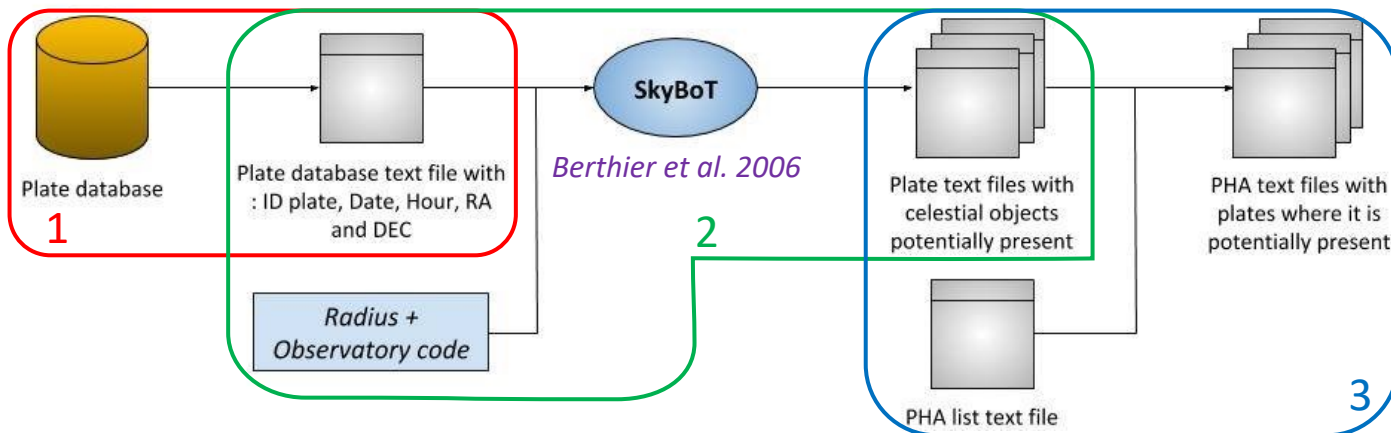
NAROO-AST / A.-C. Perlberg (upcoming 2022)

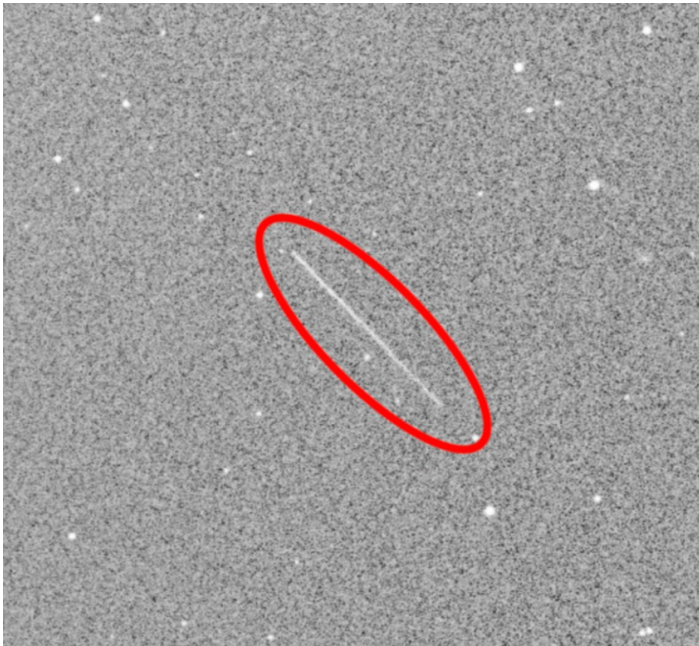
Precoveries of NEA / PHA

NAROO
+
Gaia
=
Improving
probabilities

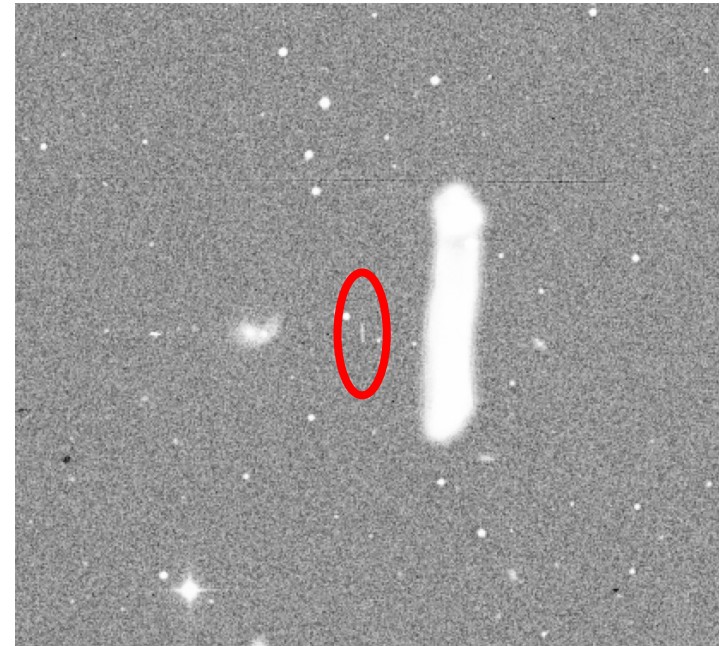


*Image NASA JPL Caltech
Orbits of PHAs*



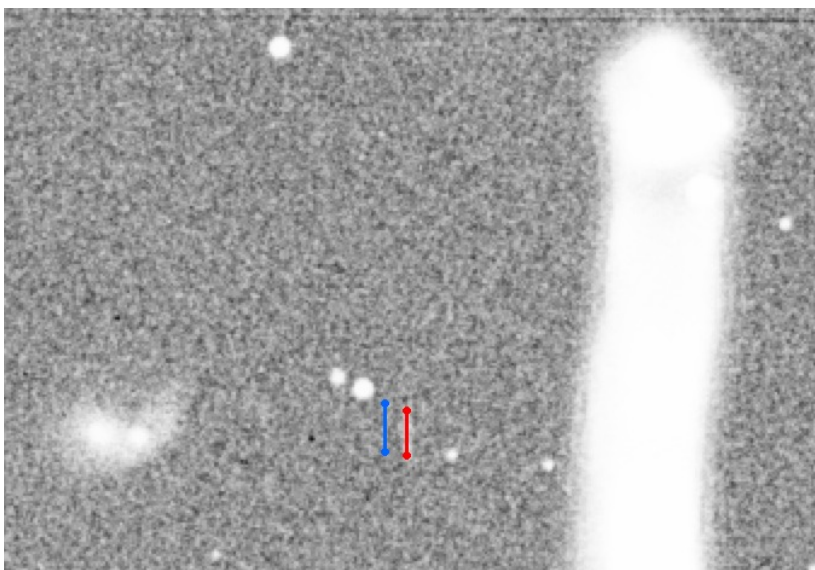


2006 SU49
OCA Caussols, 1982
→ 24 years before !

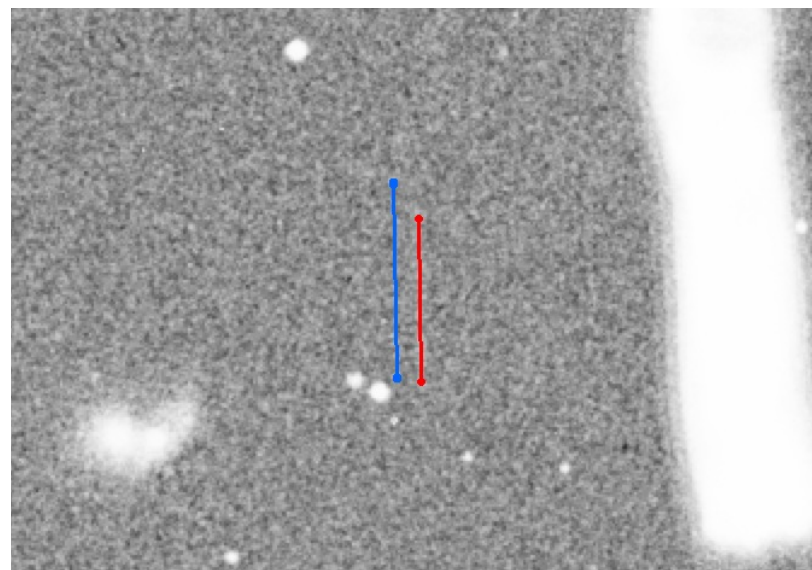


2014 WV363
POSSI, 1954
→ 60 years before !!!

Precoveries of 2014 WV363



03/10/1954 06:18:00 UT / POSSI R



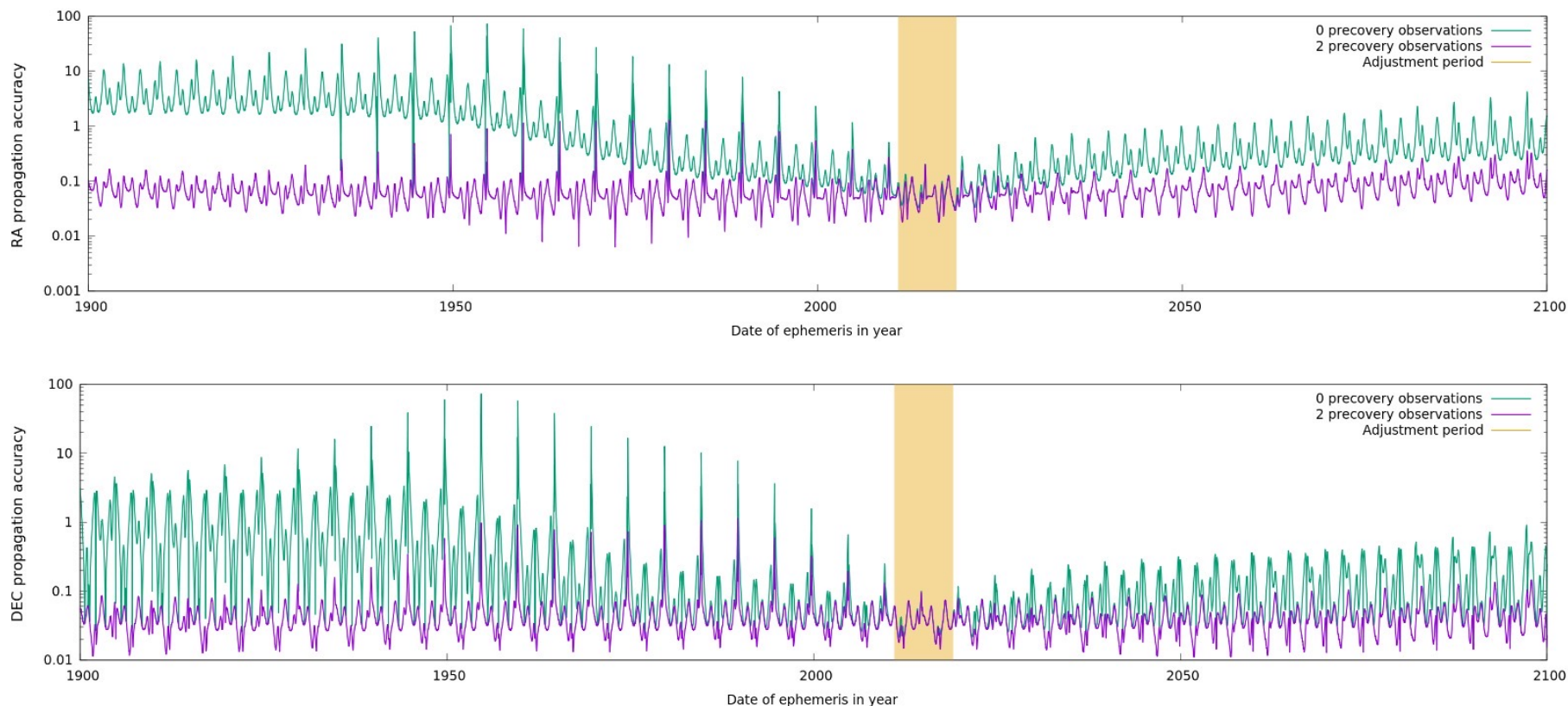
03/10/1954 06:32:00 UT / POSSI B

(O-C)s up to 10 arcsec in equatorial positions.

Discovery
24/11/2014

Observation period
30/01/2011 - 07/08/2019

Precoveries
Two en 1954



NAROO

The digitization and the analysis of astro-photographic plates consist in a huge challenge but contribute to many topics in Astronomy and Astrophysics.

Observatories

The contribution of the observatories in the archiving of the materials is essential if we want to use original data and to avoid losing them.

Collaborations and Call

- The NAROO website <https://omekas.obspm.fr/s/naroo-project/>
- The project contact naroo.infos@sympa.obspm.fr