



# *First results from stellar occultations in the “Gaia era”*

Gustavo Benedetti-Rossi



Roberto Vieira Martins



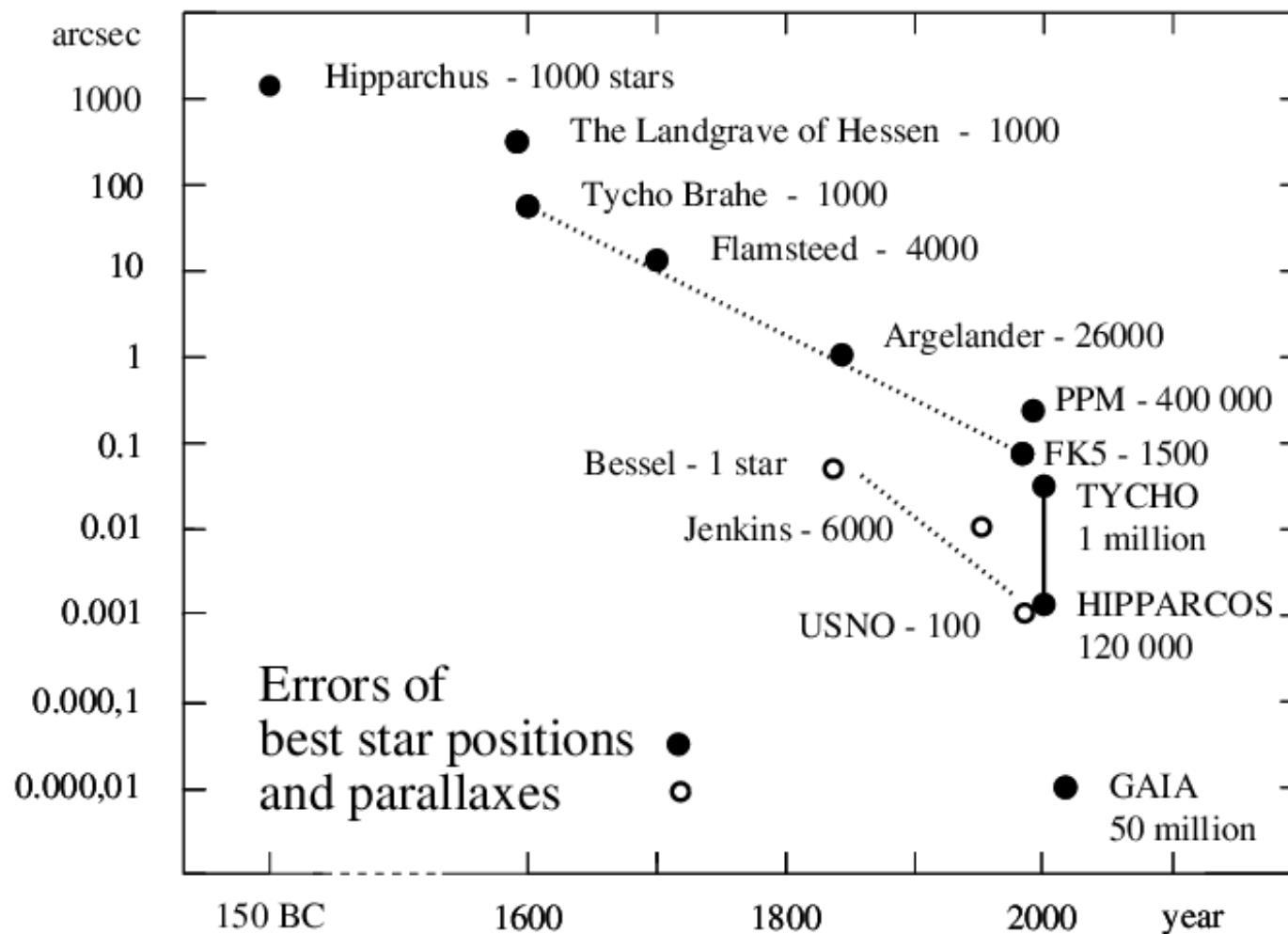
Bruno Sicardy



Jose Luis Ortiz

## “Gaia era”

- Gaia mission → position of  $\sim 10^9$  stars



## “Gaia era”

- Star positions → OK → Gaia DR1 October/2016
  - Not yet... → Proper Motion!
    - “Hybrid” catalogs (Ex: UCAC5, TGAS, ...)
  - DR2 → April 2018

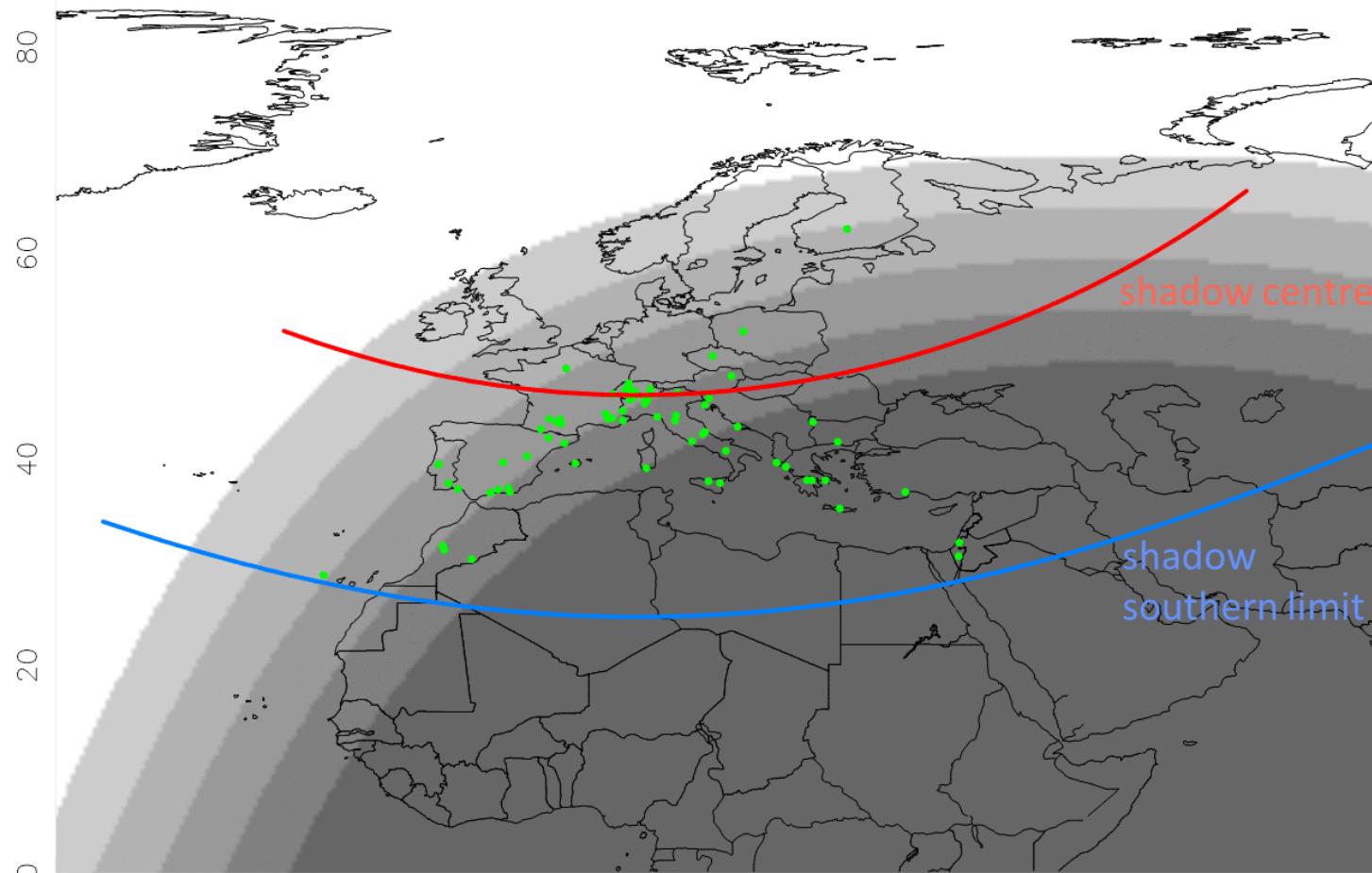
Uncertainties of 30-70 mas (ex: UCAC4) → 5-20 mas Gaia-DR1

→ Possible to achieve ~1 mas (ou less!) with Gaia-DR2

# “Gaia era” and the occultations

- Gaia “DR0”: Pluto stellar occultations on Sep/2016

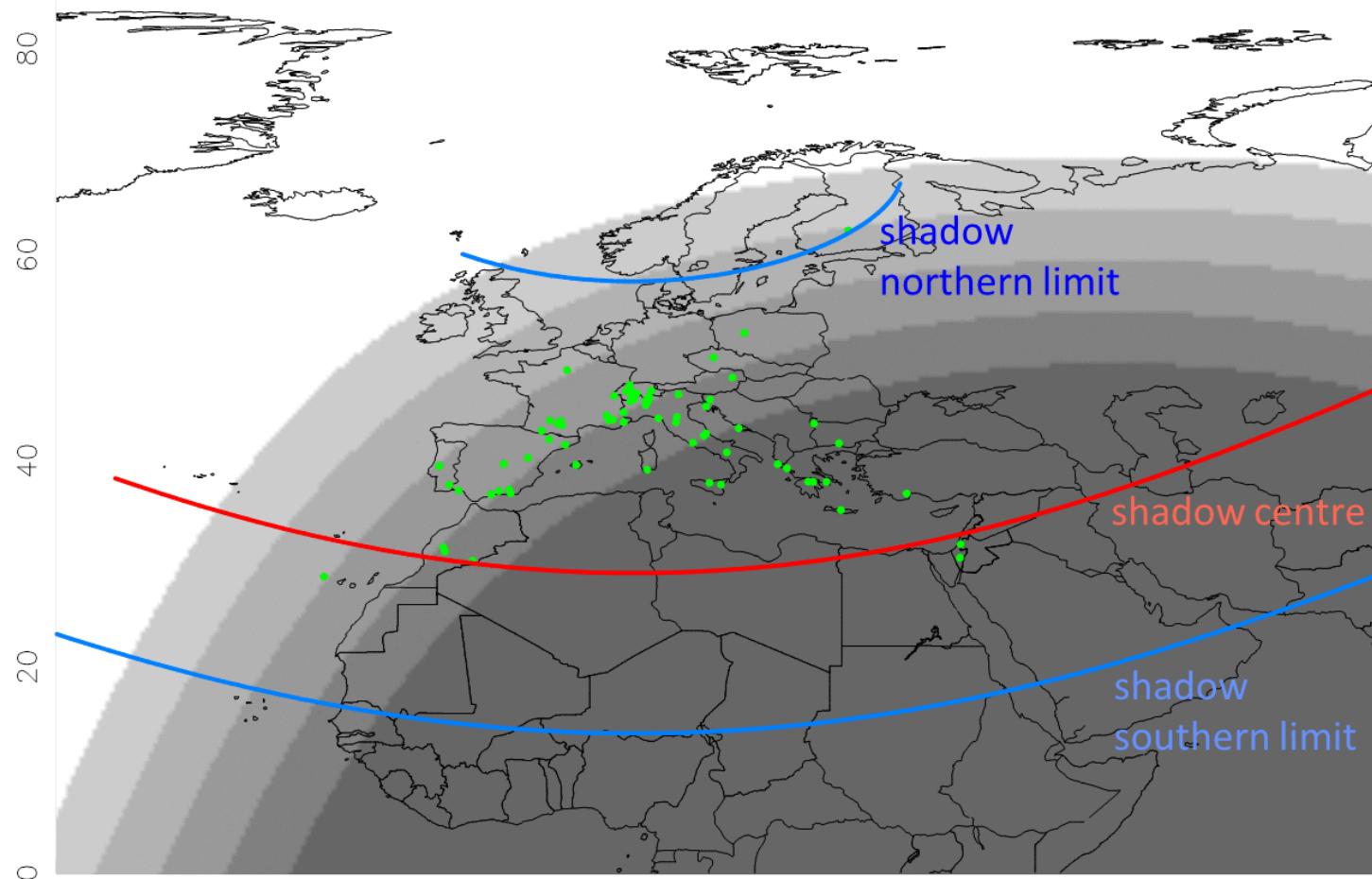
Fig.1



## “Gaia era” and the occultations

- Gaia “DR0”: Pluto stellar occultations on Sep/2016

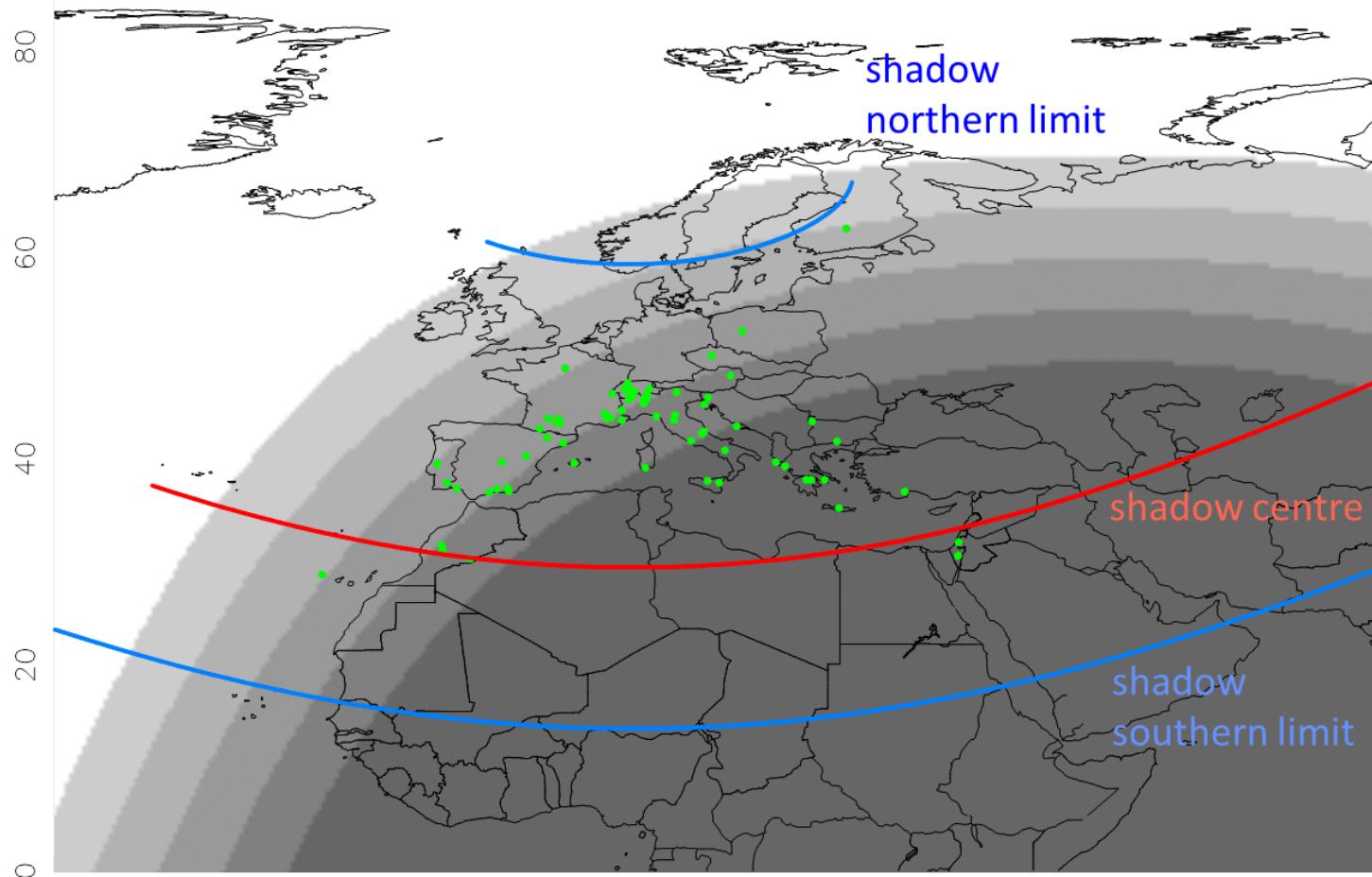
Fig.2



## “Gaia era” and the occultations

- Gaia “DR0”: Pluto stellar occultations on Sep/2016

Fig.3



## “Gaia era” and the occultations

- Object positions → Still a lot to do...

- Few observations
- Recently discovered ( < 20 years )
- Faint (typical apparent magnitude ~19 )

► NIMA:  
<http://josselin.desmars.free.fr/tno/>

# “Gaia era” and the occultations

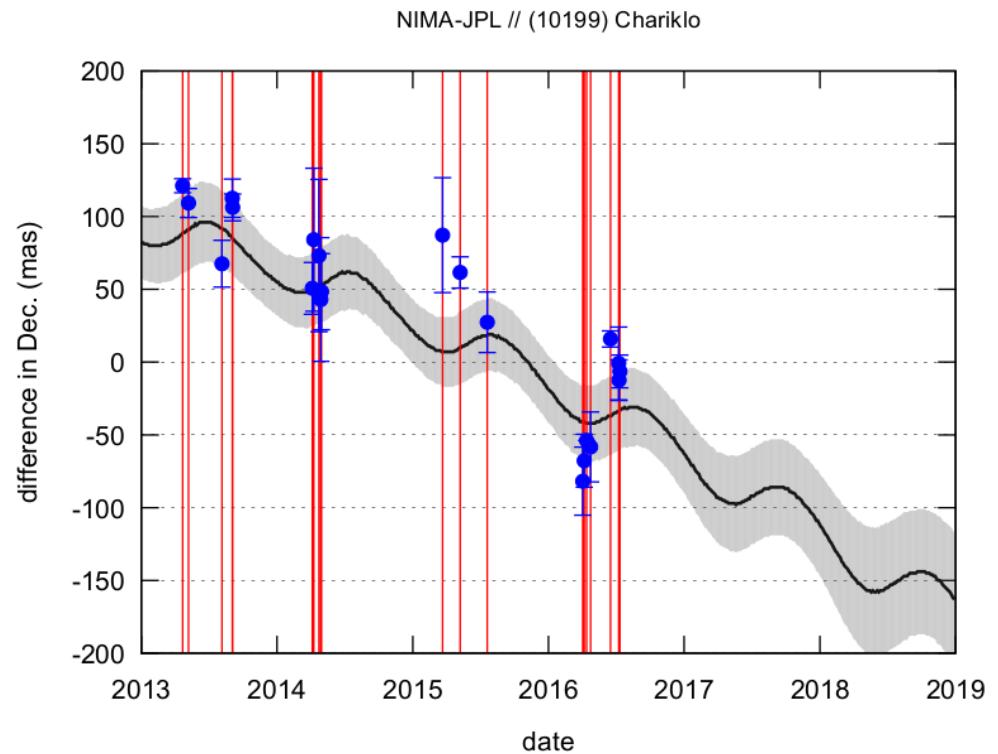
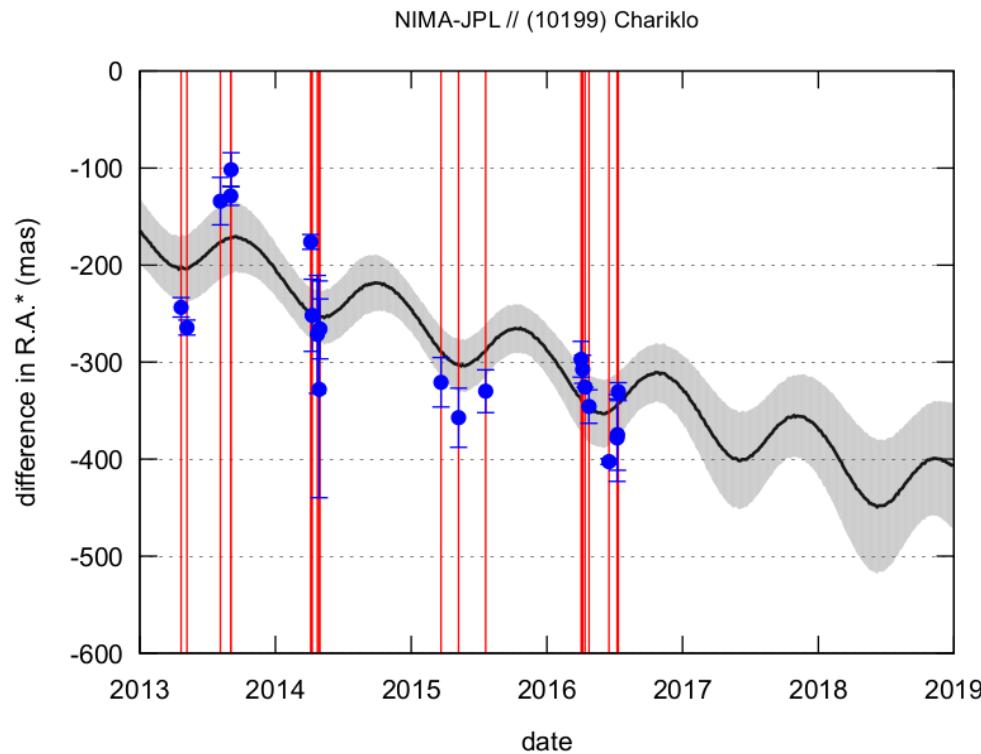
- NIMA

- MPC
- Offset (Observations)
- Non-published data
- Past occultations positions

→ Different weight for each kind of observation

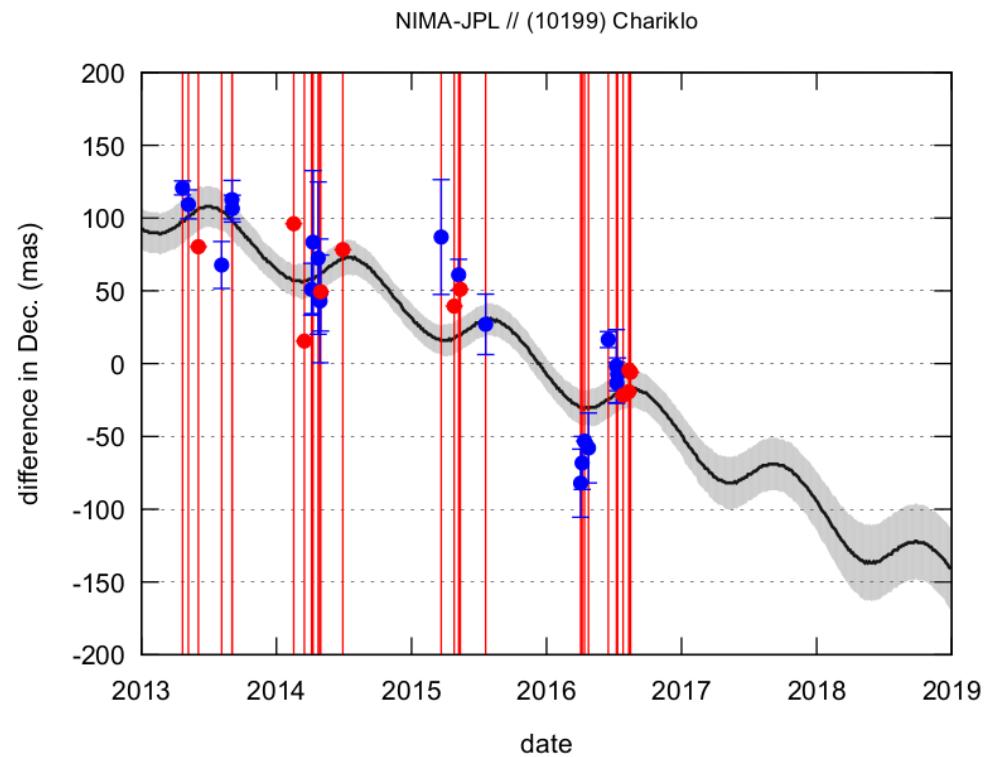
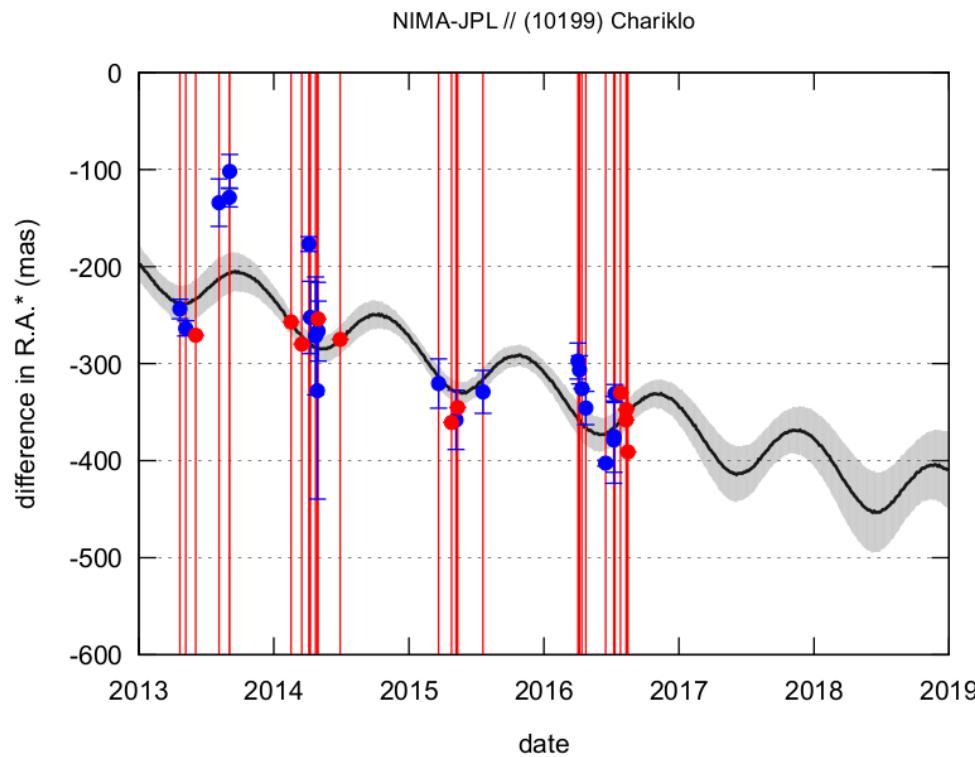
# “Gaia era” and the occultations

MPC (1988-2011) + Offset obs. (OPD, ESO, ...) using UCAC4



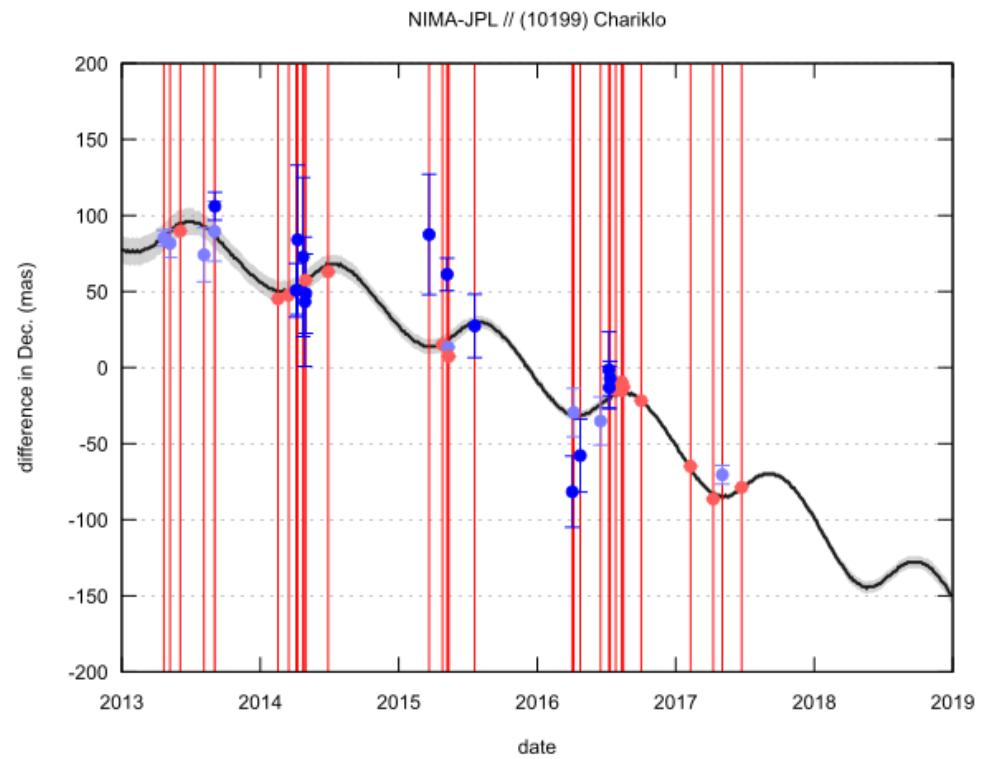
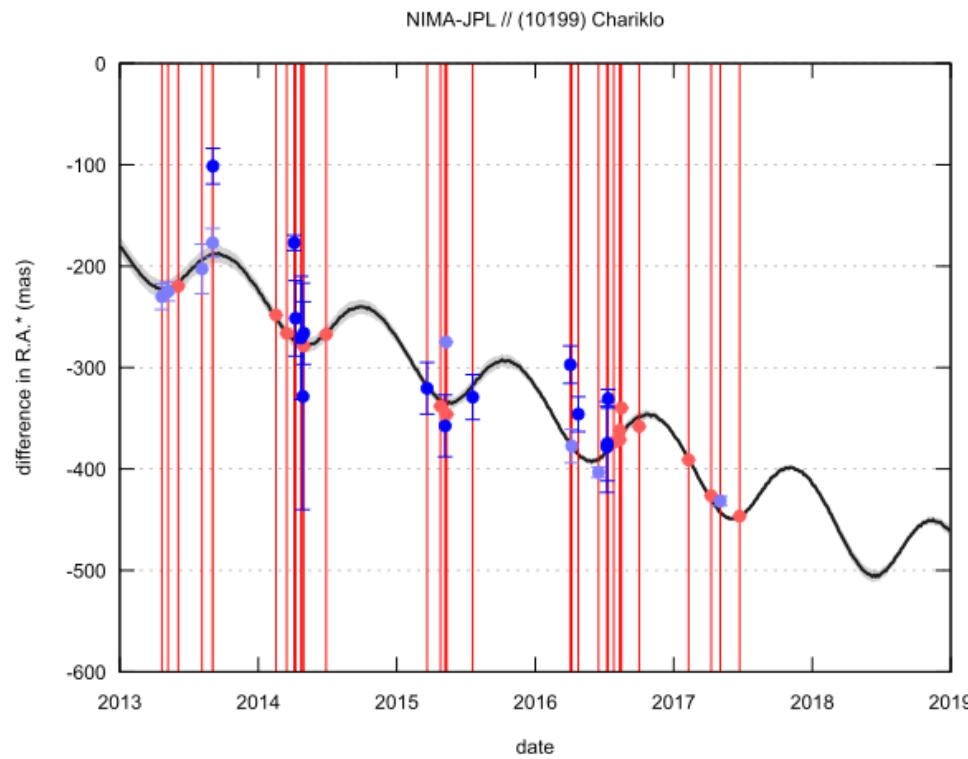
# “Gaia era” and the occultations

MPC (1988-2011) + Offset obs. (OPD, ESO, ...) using UCAC4 + 11  
Occultations (2013-2016)



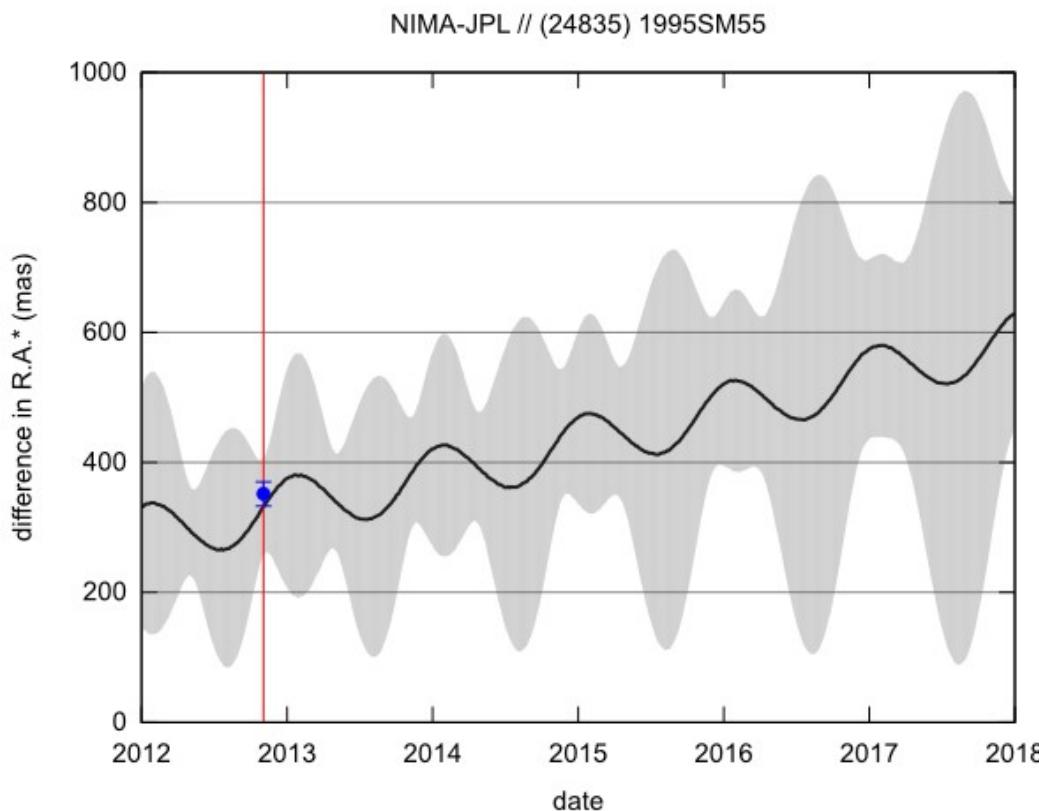
# “Gaia era” and the occultations

MPC (1988-2011) + Offset obs. (OPD, ESO, ...) using UCAC4 + 11  
 Occultations (2013-2017) + NIMA V13



Jul 23, 2017 Occultation → error on prediction of 1.5 mas (~15 km)!

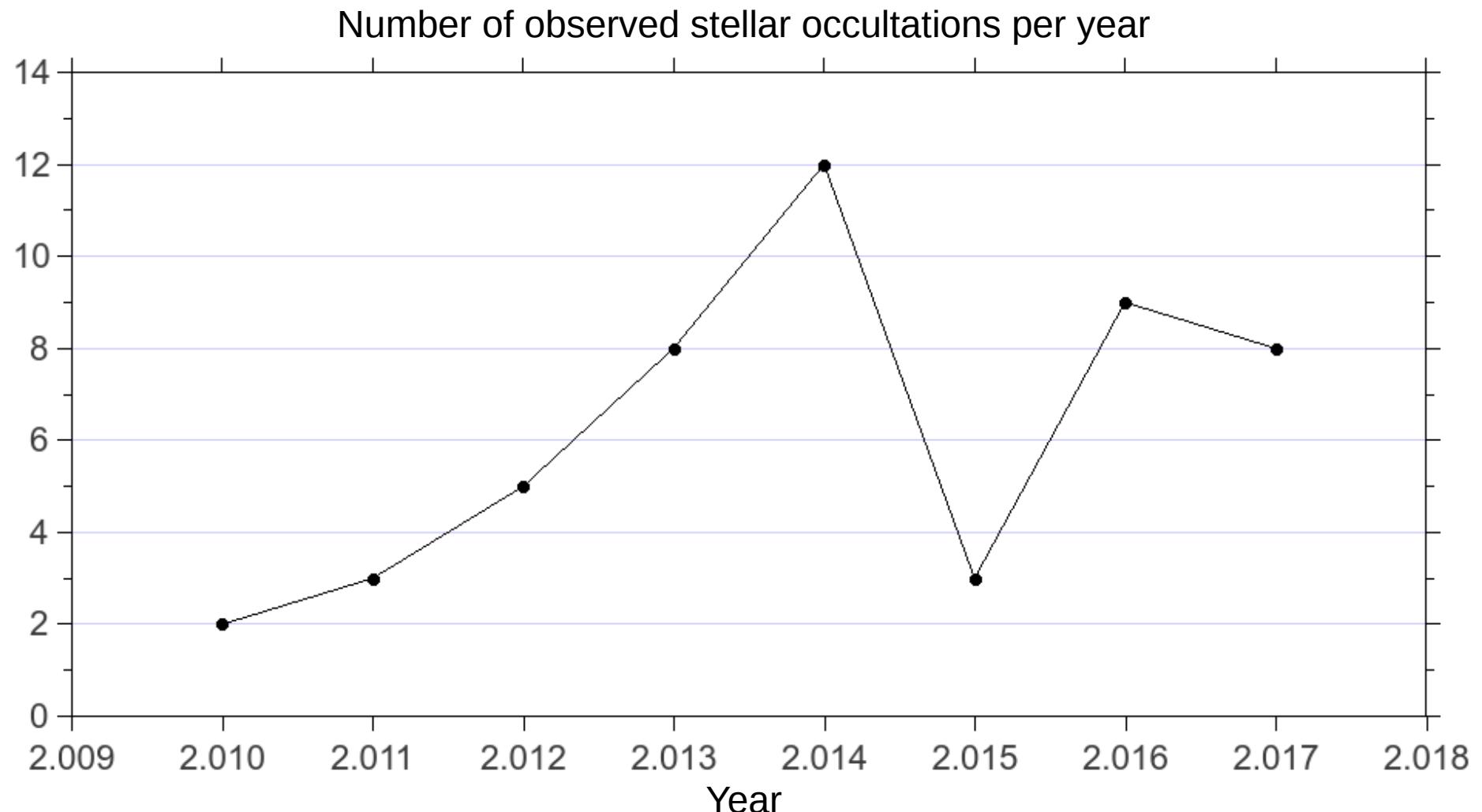
## “Gaia era” and the occultations



50 mas on ephemeris =

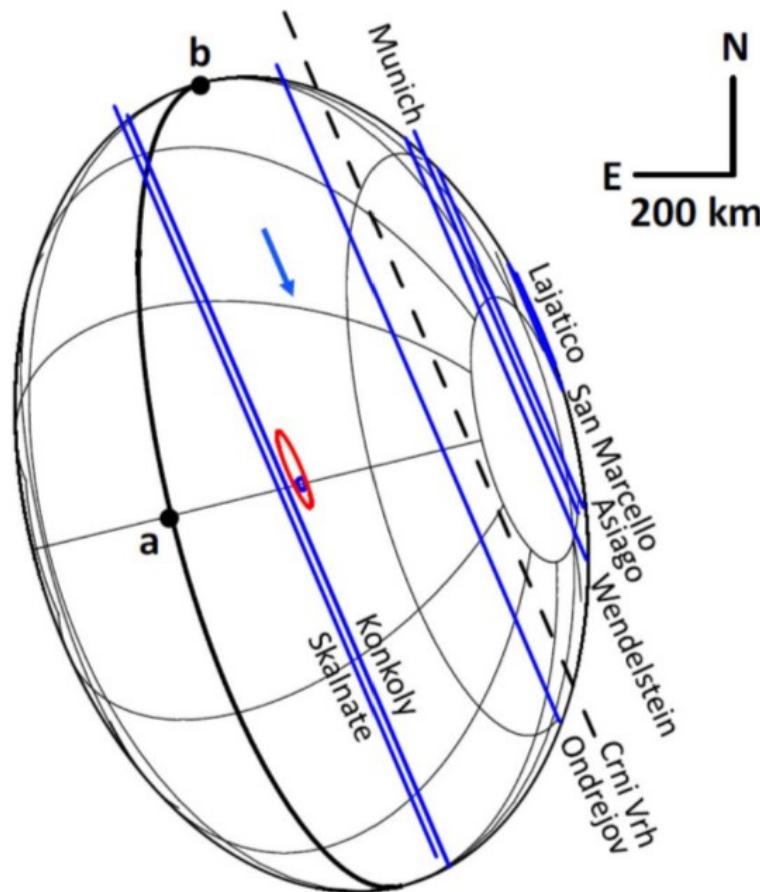
~1500 km error on the shadow position on Earth for an object at 45 au

## “Gaia era” and the occultations



# “Gaia era” and the occultations

- Haumea: 9 positive chords (11 telescopes)

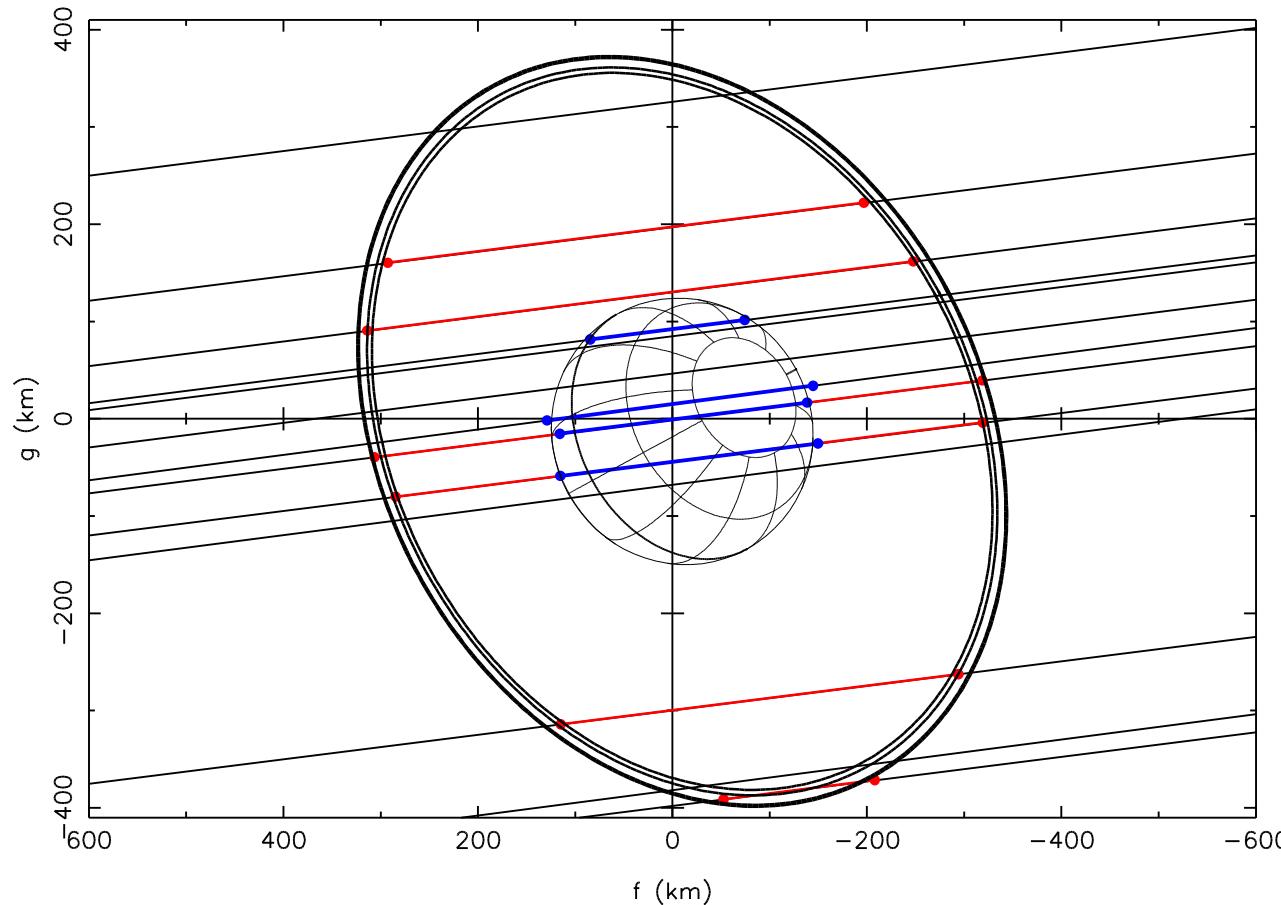


J. L. Ortiz  
Wed, 20 Sep, 14:45  
Room Venus

# “Gaia era” and the occultations

- Chariklo: 4 occultations – many chords

Chariklo July 23, 2017, ( $f_c = -10, g_c = -13$ ) km



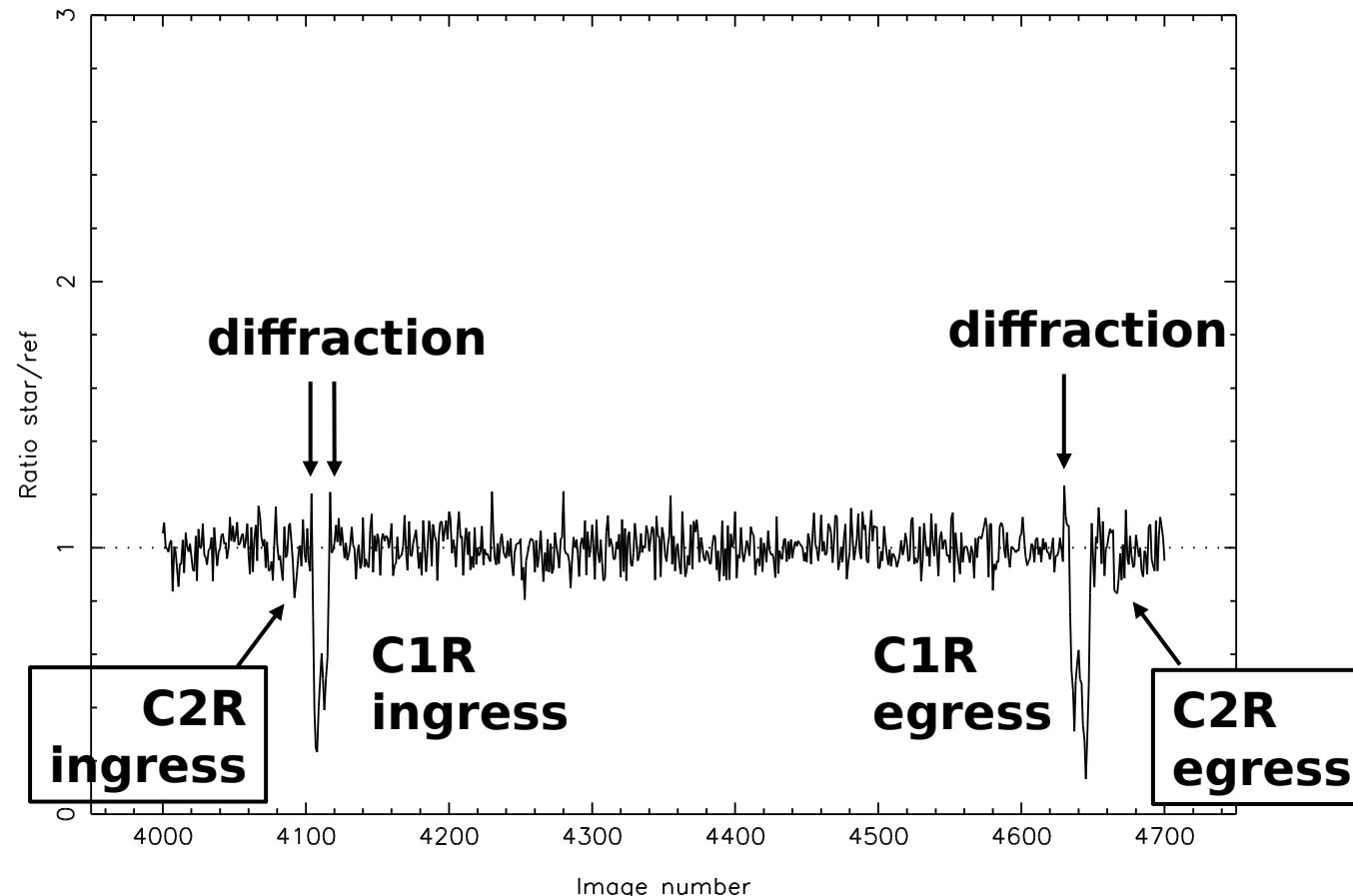
D. Bérard  
Thu, 21 Sep, P130  
Poster area

15

# “Gaia era” and the occultations

- Chariklo: 4 occultations – many chords

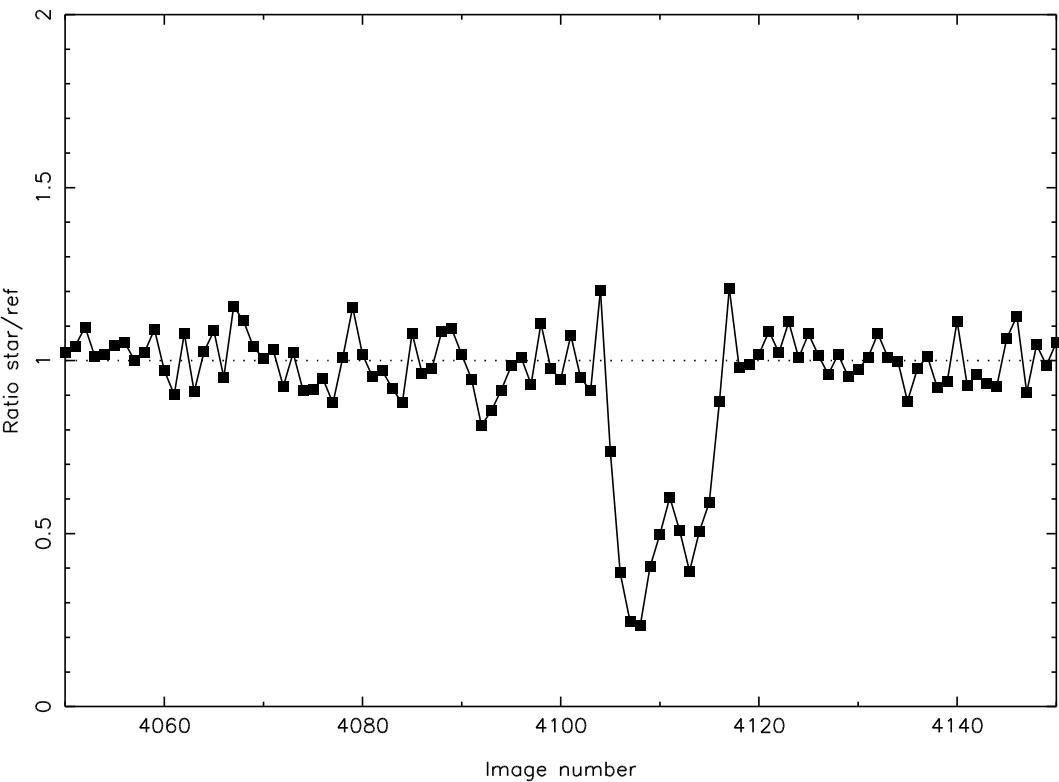
Chariklo 23 July 2017, Danish red DIT= 1/30 s



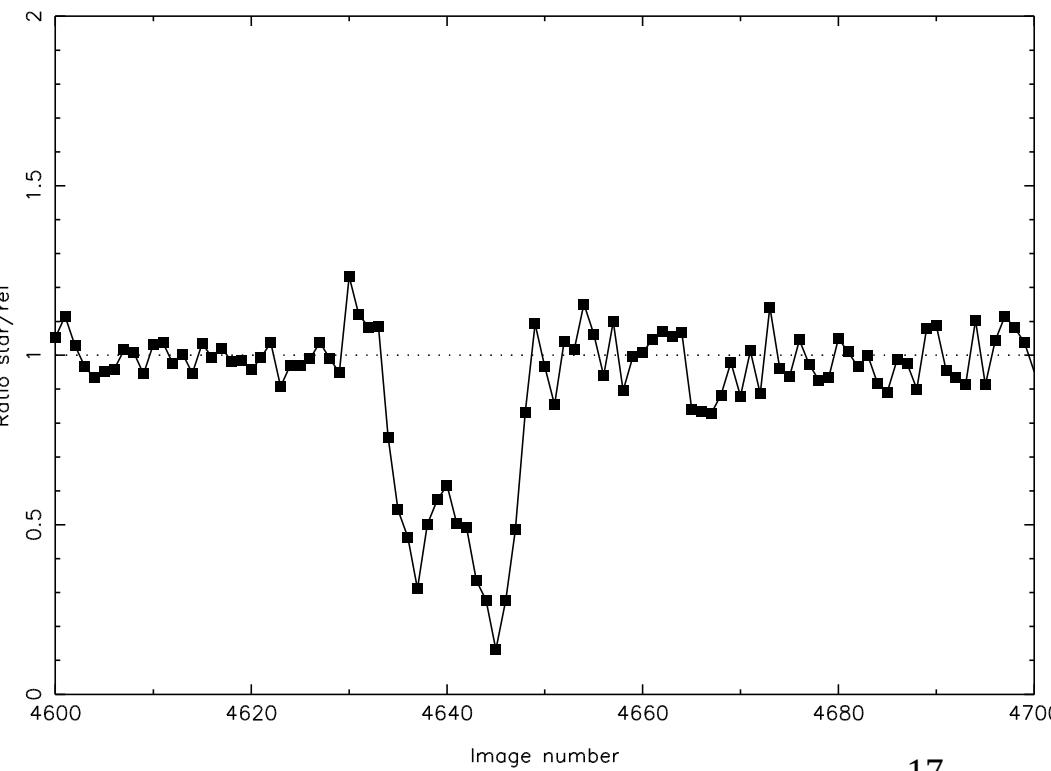
# “Gaia era” and the occultations

- Chariklo: 4 occultations – many chords

Chariklo 23 July 2017, Danish red DIT= 1/30 s



Chariklo 23 July 2017, Danish red DIT= 1/30 s



# Conclusions and Perspectives

- Prediction
  - Pre-Gaia: 30-40 mas
  - Gaia-DR1: ~10 mas → For Chariklo ~1mas
  - Gaia-DR2: <1 mas
  
  - Still need observation of the object to improve ephemerides
  - LSST → observation of ~40.000 TNOs (today ~2500)

# TNO

[Go to TNO Filter](#)

This page provides predictions of stellar occultations by TNOs and Centaurs, as part of the efforts led by the Observatório Nacional/MCTIC and the Laboratório Interinstitucional de e-Astronomia (P.I.s.: R. Vieira-Martins and L. da Costa, Brazil), the Paris Observatory (ERC "Lucky Star" project, P.I.: B. Sicardy, France), and the Instituto de Astrofísica de Andalucía (P.I.: J.-L. Ortiz, Spain). All objects considered here are those listed by the [Johnston's Archive](#), as last updated on 2016/SEP/05. Exception is made to Pluto and those objects that are presented as not having an MPC designation.

These maps are intended to provide a useful step to select those events on which a more careful work to refine their predictions is considered to be of interest. More accurate predictions to a smaller number of objects, as well as details on observational procedures and hints to observe an occultation event, can be obtained at the [Lucky Star page](#) by J. Desmars and at [F. Braga-Ribas' page](#).

Please, read the [ReadMe](#) file for details on the page and its contents.

**Please, if you plan to observe one of these occultation events, contact [Julio Camargo](#) or [F. Braga-Ribas](#)**

**Contacts:**

Website design and maintenance: [helpdesk](#)

**Maps and Tables:**

- They involve efforts from the three institutions mentioned above (Rio, Paris, and Granada teams). Emails can be sent to [Julio Camargo](#)

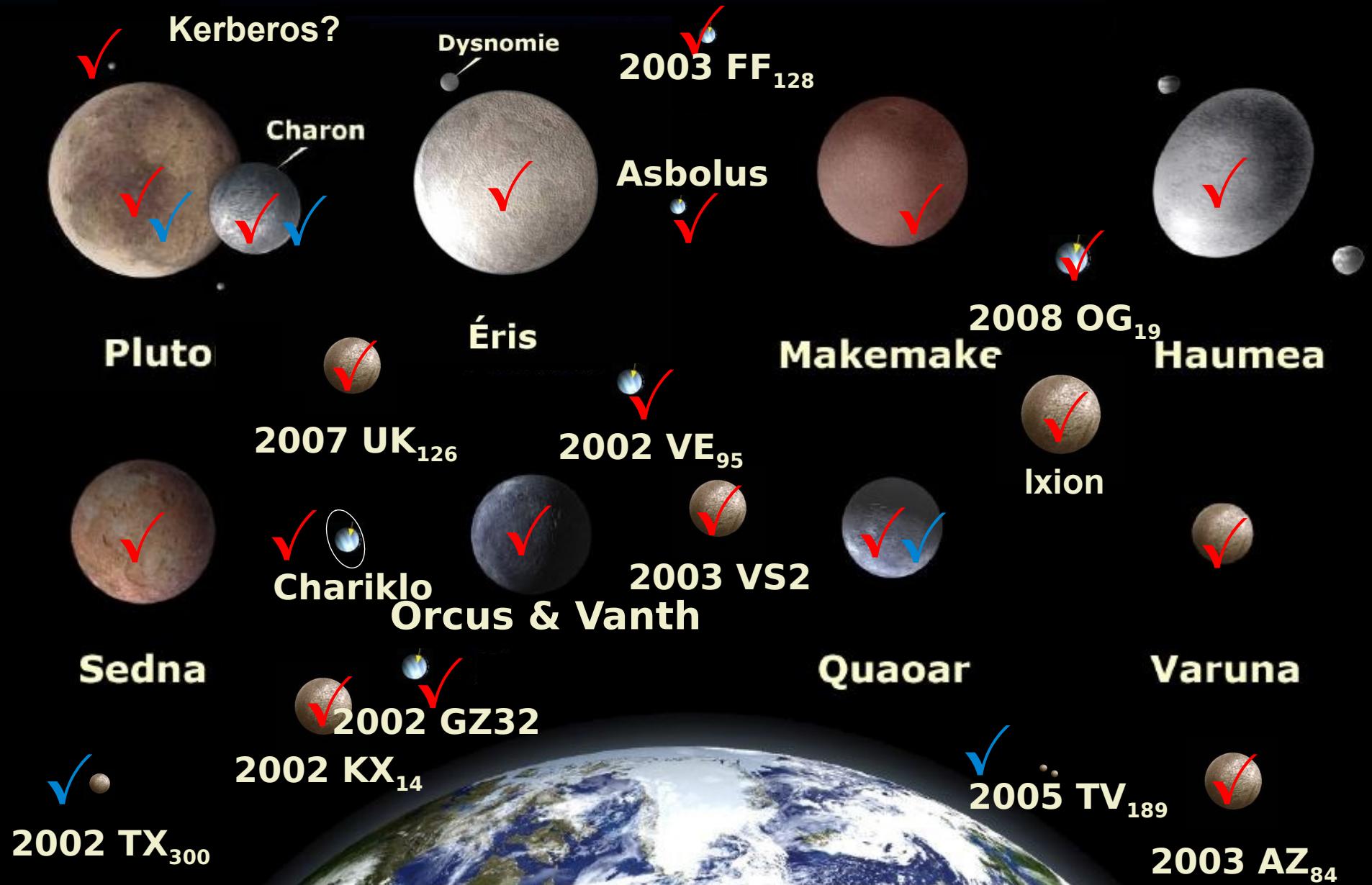
**Acknowledgements:**

- This work is funded by the LIneA, Observatório Nacional/MCTIC, and INCT do e-Universo.
- This work has made use of data from the European Space Agency (ESA) mission Gaia (<https://www.cosmos.esa.int/gaia>), processed by the Gaia Data Processing and Analysis Consortium (DPAC, <https://www.cosmos.esa.int/web/gaia/dpac/consortium>). Funding for the DPAC has been provided by national institutions, in particular the institutions participating in the Gaia Multilateral Agreement.
- This work has made use of the NAIF/SPICE softwares and scripts.

# Conclusions and Perspectives

- Observation and data reduction (**Pre-Gaia**)
  - Prediction of ~55 objects
  - Observation of occultations of ~25 objects
- Observation and data reduction (**Post-Gaia**)
  - Increase of observed events → bigger international collaboration
    - more data
    - more work
  - Development of pipelines (automatic programs and routines)

# Les plus grands objets transneptuniens connus



# Thank you!

