Status of the Gaia Mission

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La Mission Gaia

- Mission spatiale de l'Agence Spatiale Européenne
- Lancement le 19 décembre 2013
- **Objectif : Etudier le contenu, l'histoire et l'évolution de la Voie Lactée**
- **Méthodes :**
  - **position, distance et mouvement des étoiles**
  - **éclat et composition de leur lumière**
- Observation de 1 milliard d'étoiles
  - mesure des distances par la méthode géométrique → 0" 000 01
  - vitesses radiales, couleurs, composition chimique

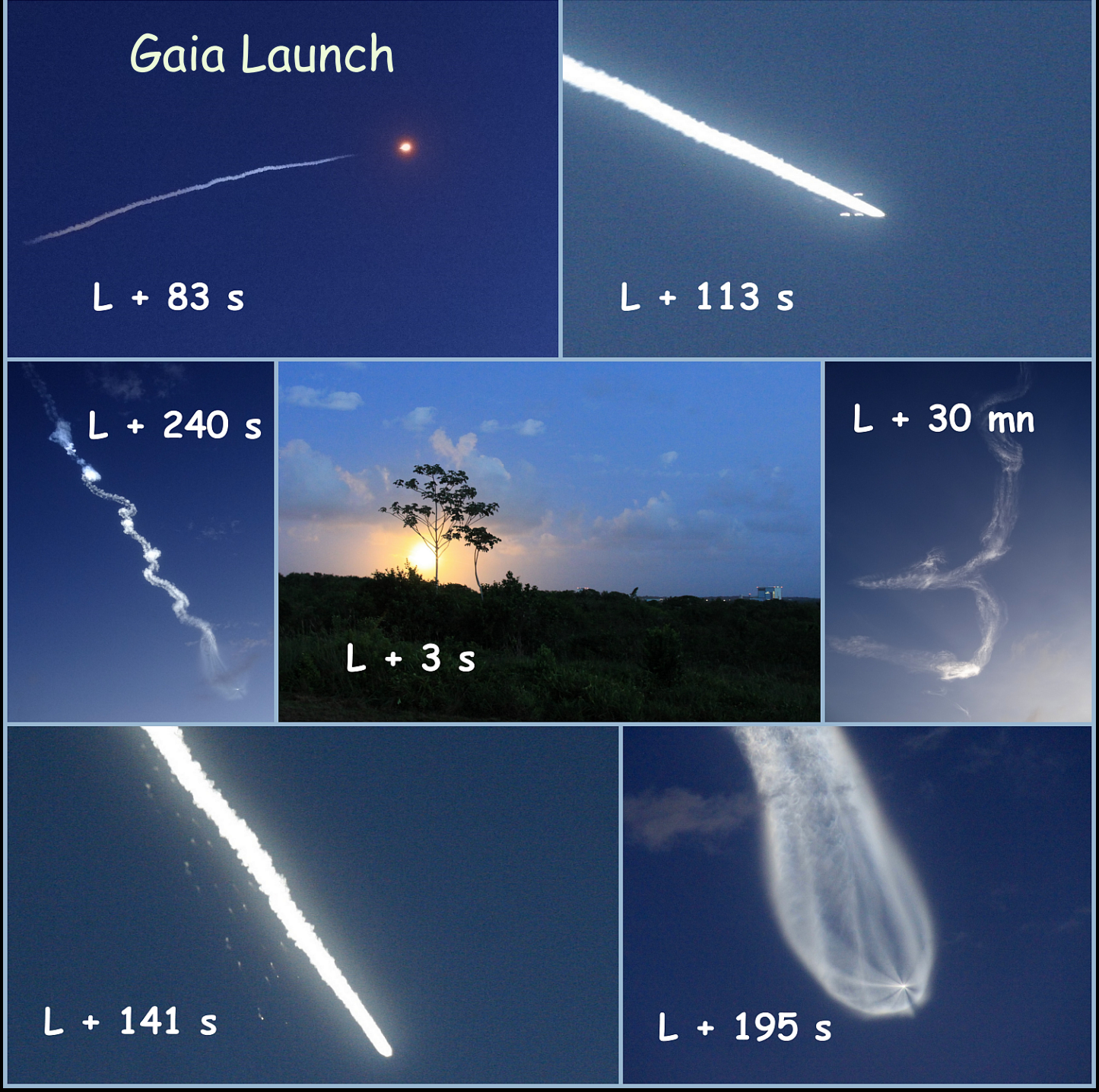


10 μas ~ 1 pièce de monnaie sur la Lune !

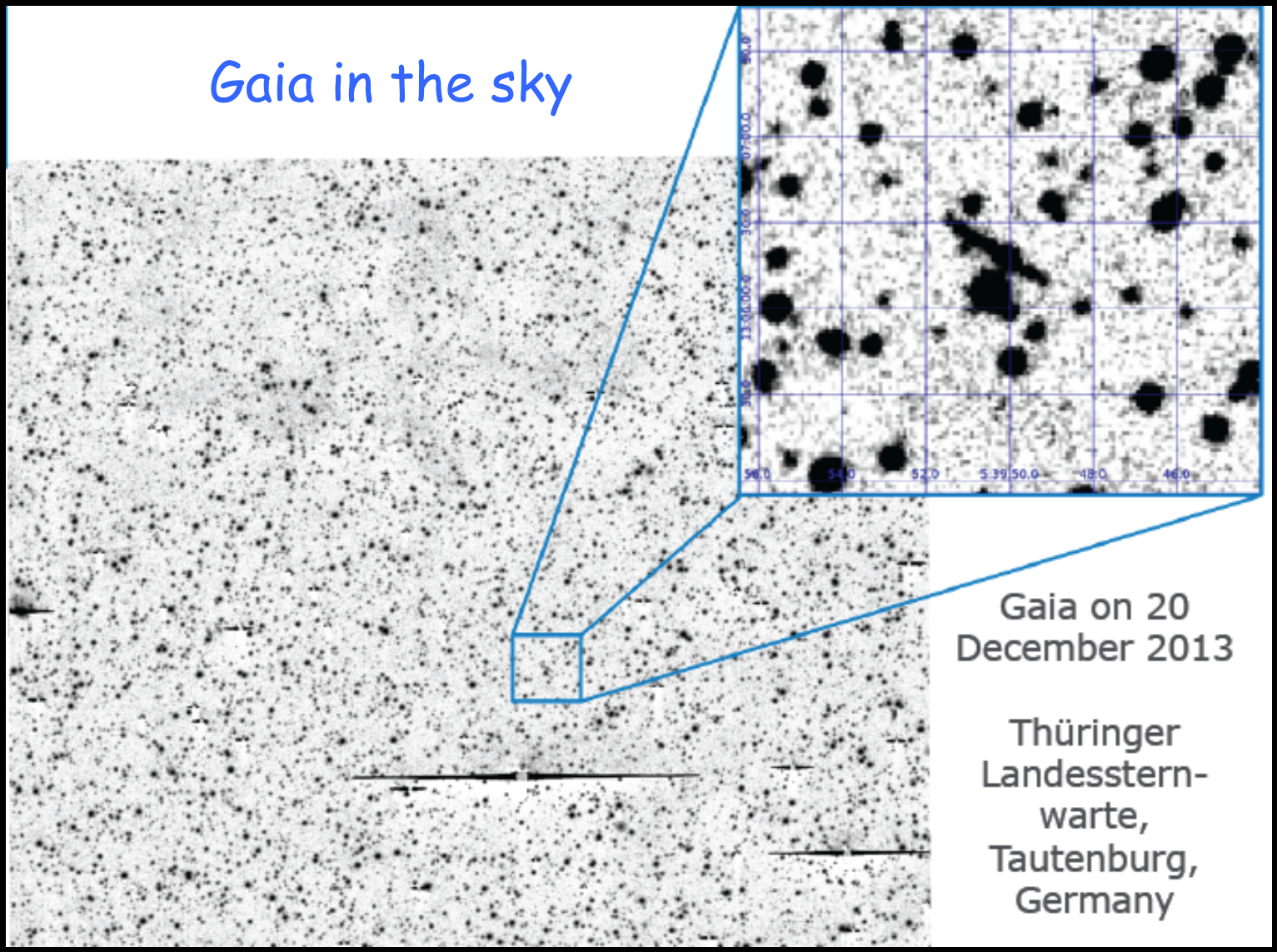
Launch and early phases




9 December 2013, 09:12:18 UTC


Gaia Launch
L + 83 s
L + 113 s
L + 240 s
L + 3 s
L + 30 mn
L + 141 s
L + 195 s

Gaia in the sky



Gaia on 20 December 2013

Thüringer Landesstern-warte, Tautenburg, Germany



Gaia on 23 January 2014 as seen with ESO’s VST

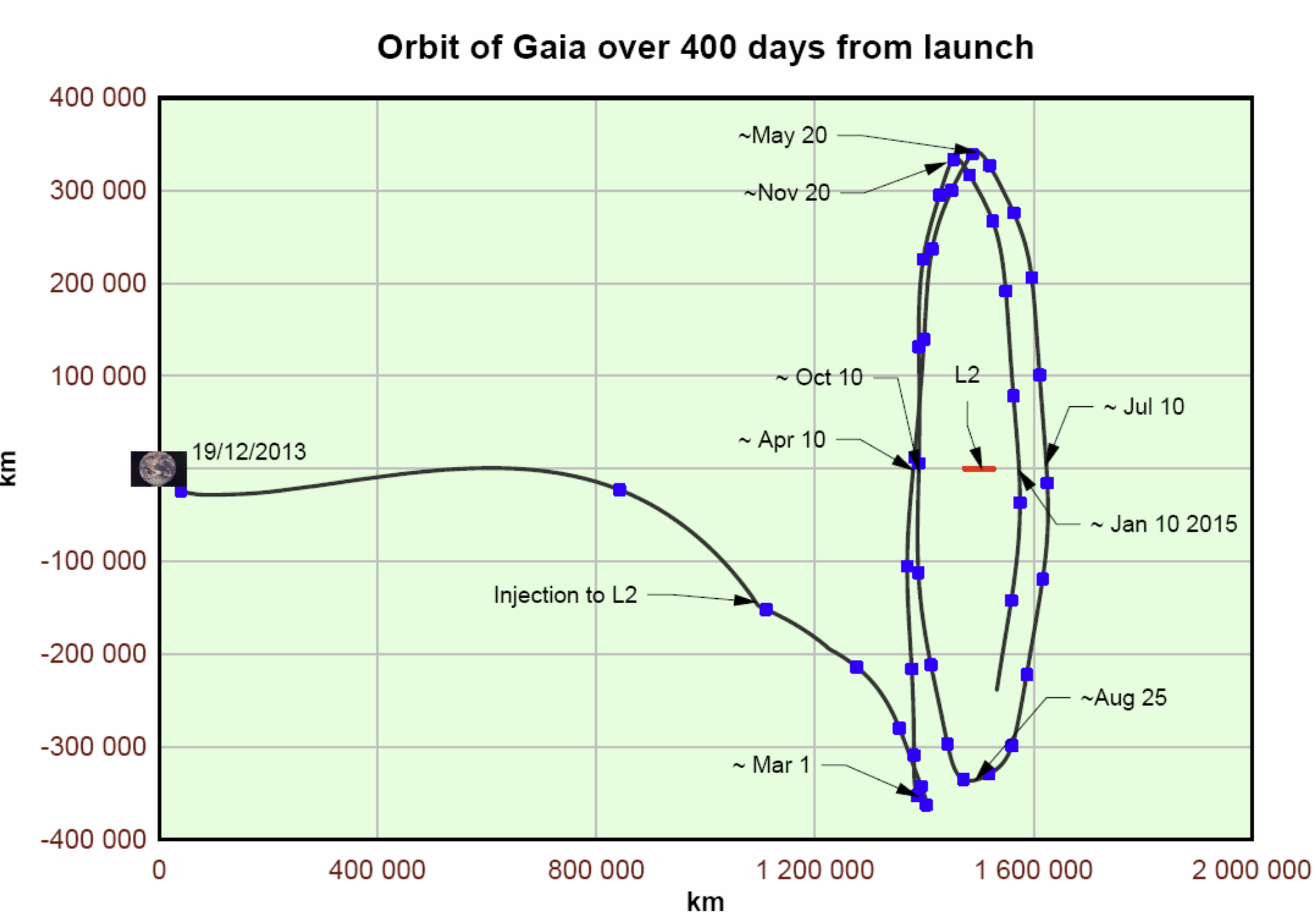
gaia European Space Agency

LEOP



- After launcher separation automatic sequence:
  - transmitter, gyroscopes, Payload module bipod release, CPS priming, thermal control configuration
- Acquisition of Sun pointing attitude
- Sunshield deployment completed at 10:38 UTC
- Start of Payload decontamination
- Star tracker switch-on and preparation for day-2 manoeuvre
- Day-2 trajectory correction

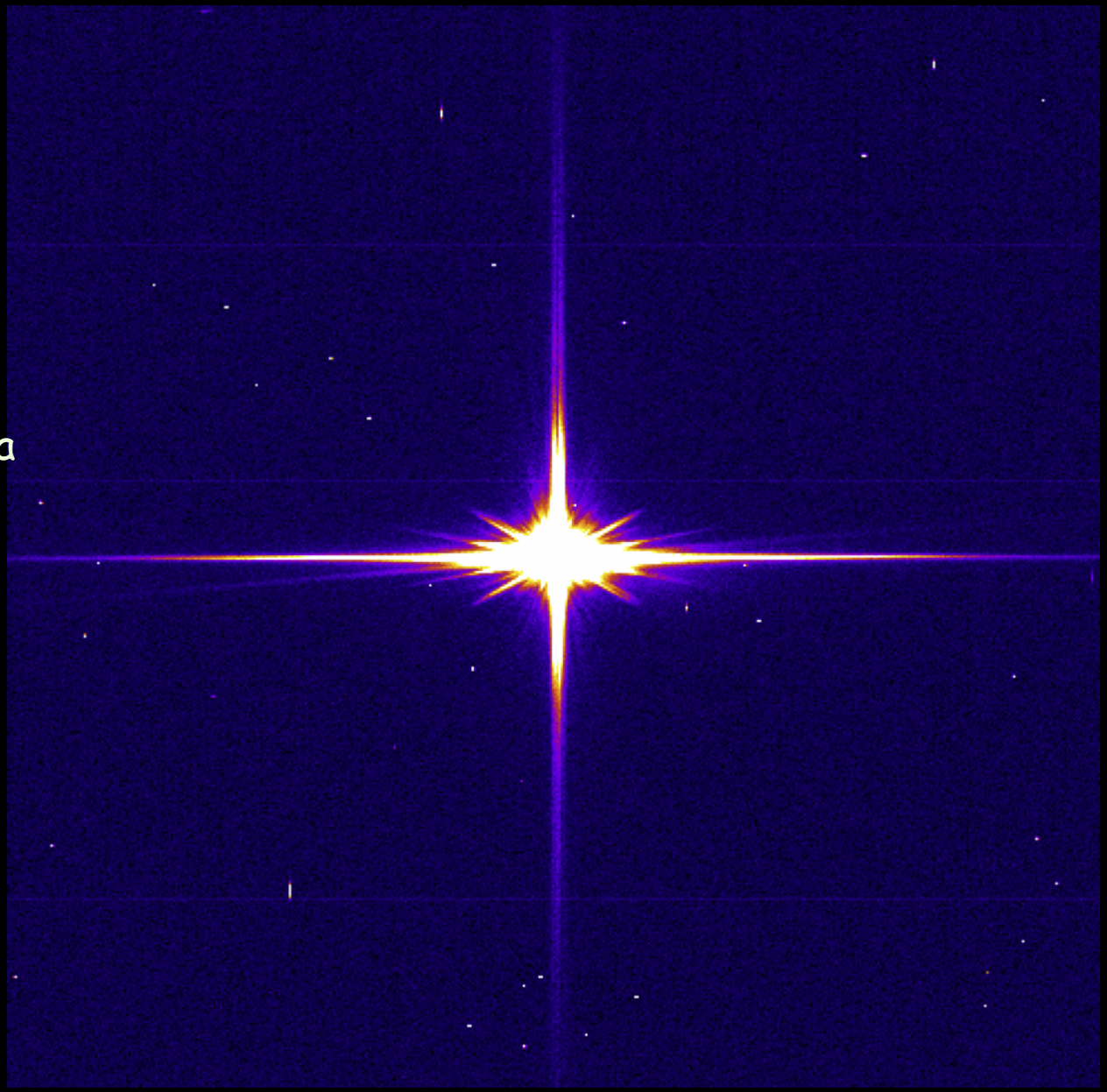
LEOP : Launch and Early Orbit Phase



Observatoire de la CÔTE d'AZUR

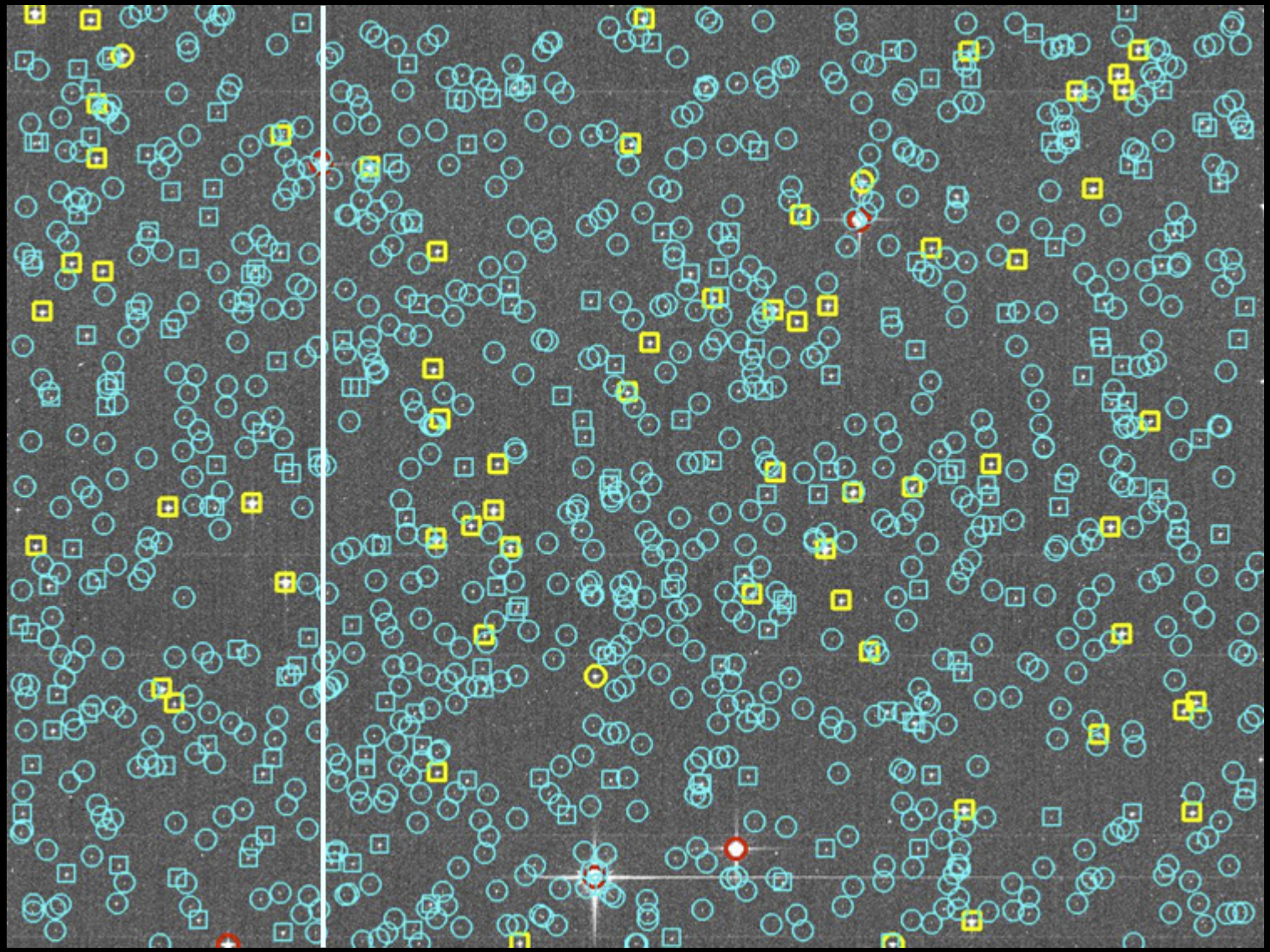
First light in January 2014

- alpha Aquarii, V ~ 3
- Exposure pof 2.85 s
- still bad focussing
- too bright a star for Gaia



credit : ESA/Gaia/DPAC/Airbus DS

On-board detection in real time 270" x 360"



G < 13

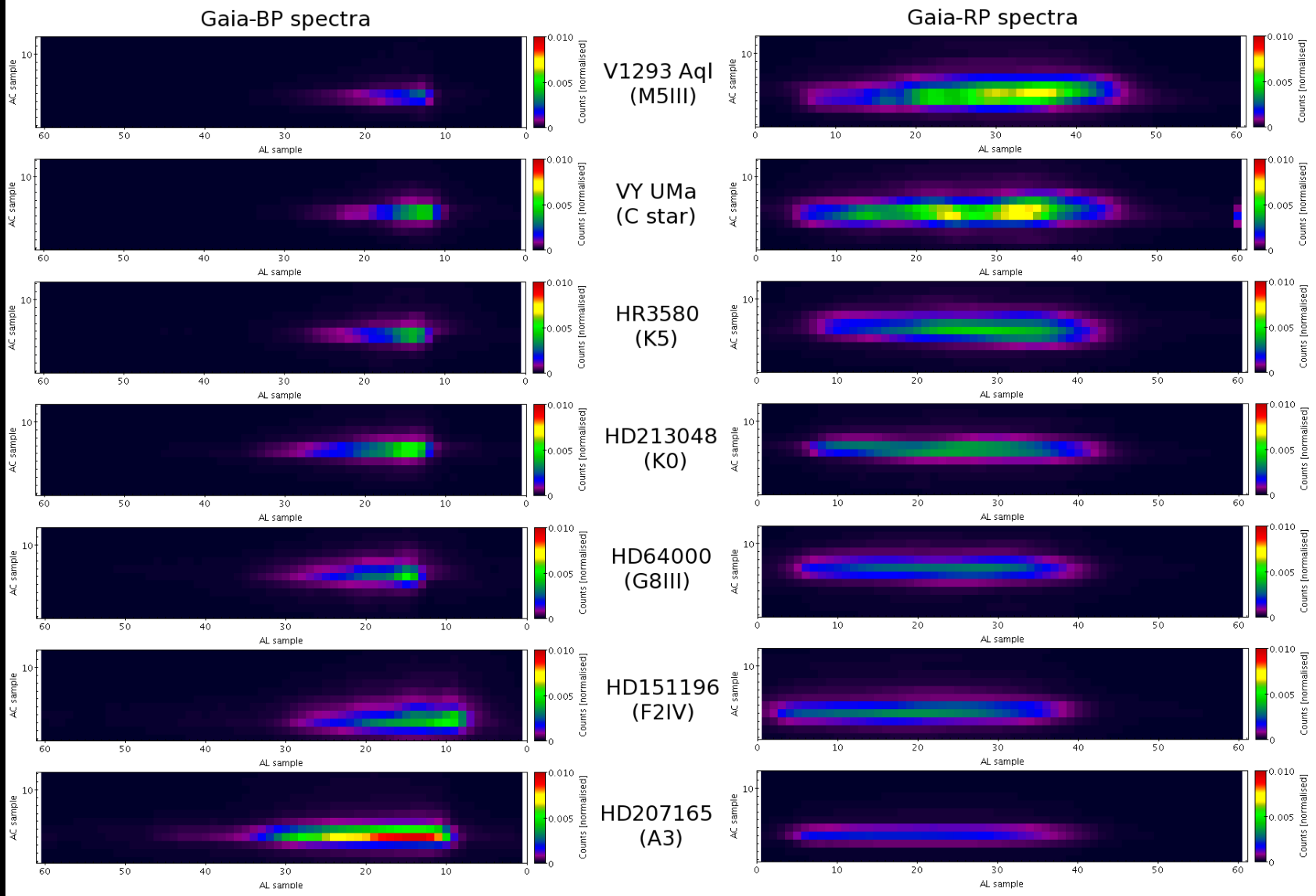
13< *G* < 16

16< *G* < 20

attitude

crédit : ESA/Gaia/DPAC/Airbus DS

First photometric data analysed in May 2014

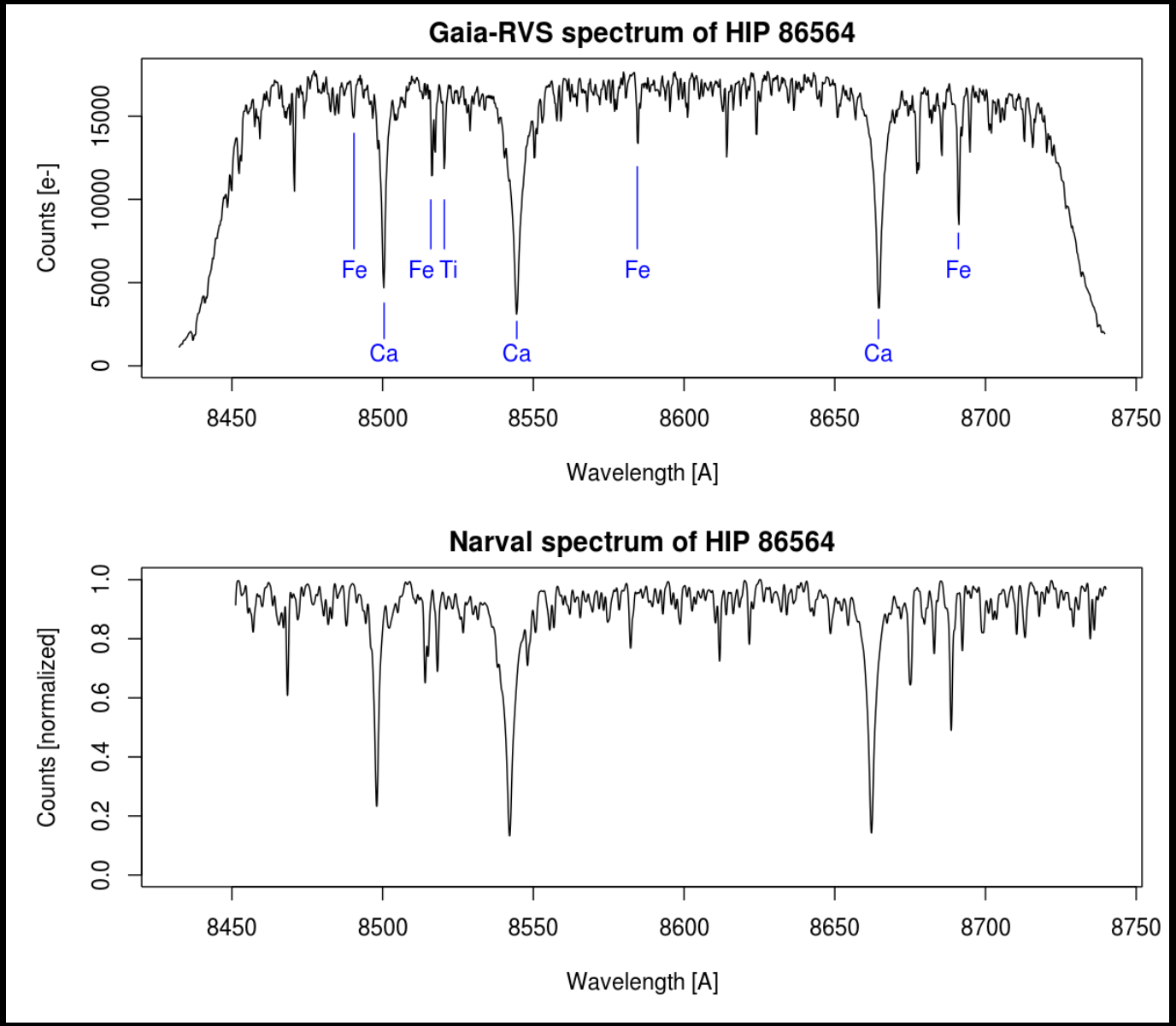


crédit : ESA/Gaia/DPAC/Airbus DS

Spectroscopic data
12 Avril 2014 - 09:50:44

V ~ 6.6

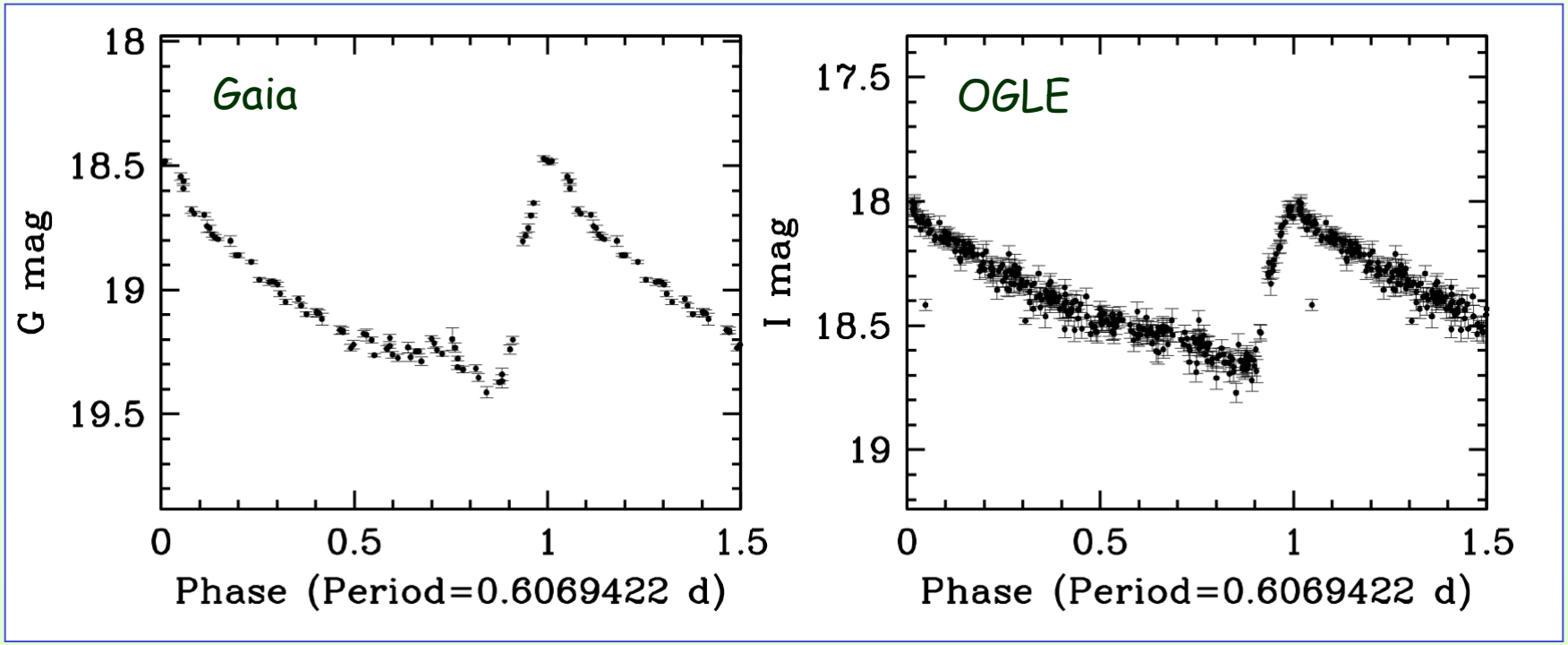
Type K5



crédit : ESA/Gaia/DPAC/Airbus DS

Variable Stars

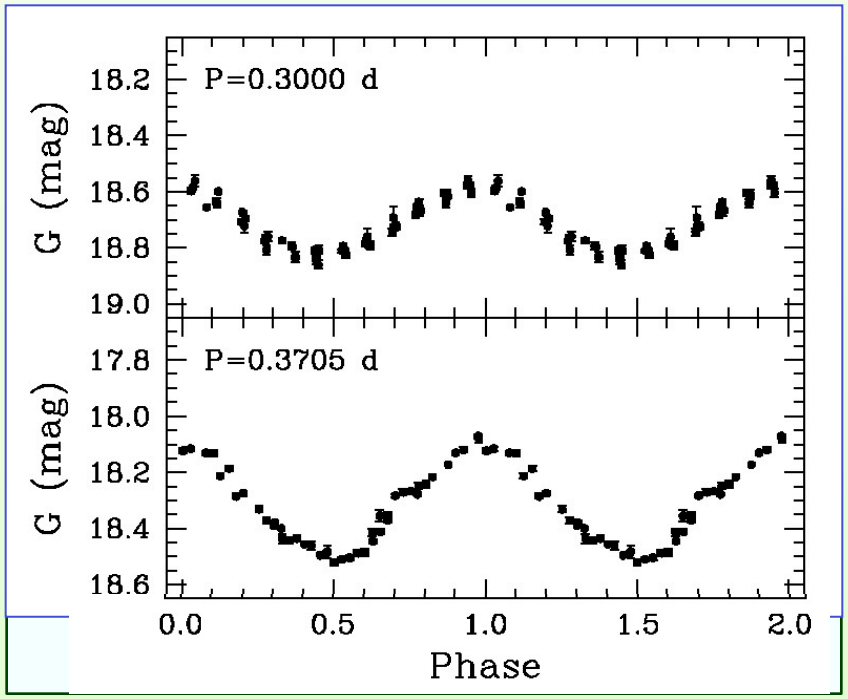
- Repeated observations from 25 July to 26 August 2014
- Analysis by the Variable Star group (CU7) of DPAC
- One measurement = one CCD crossing

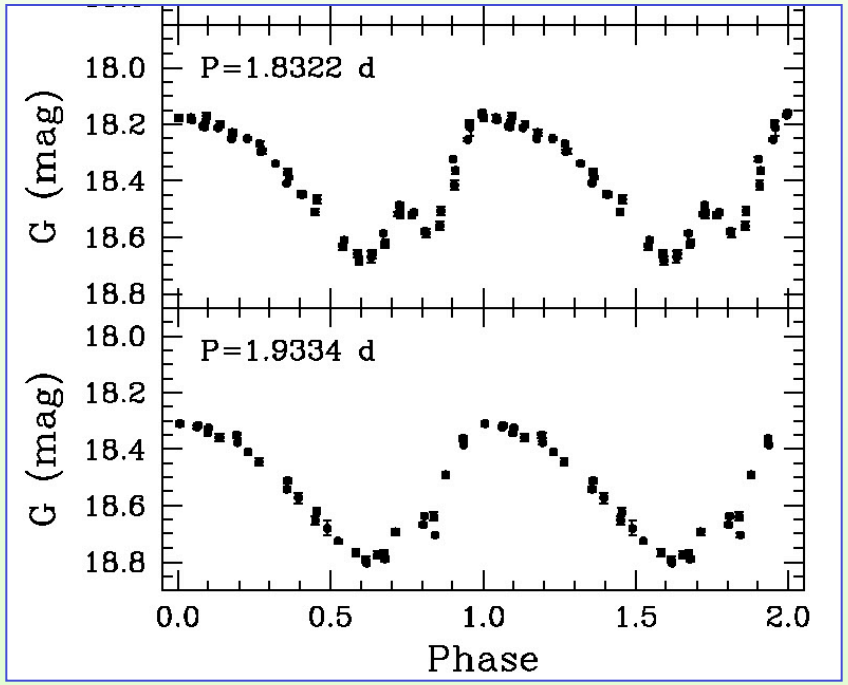


Credit : CU7 team

Cepheids in LMC

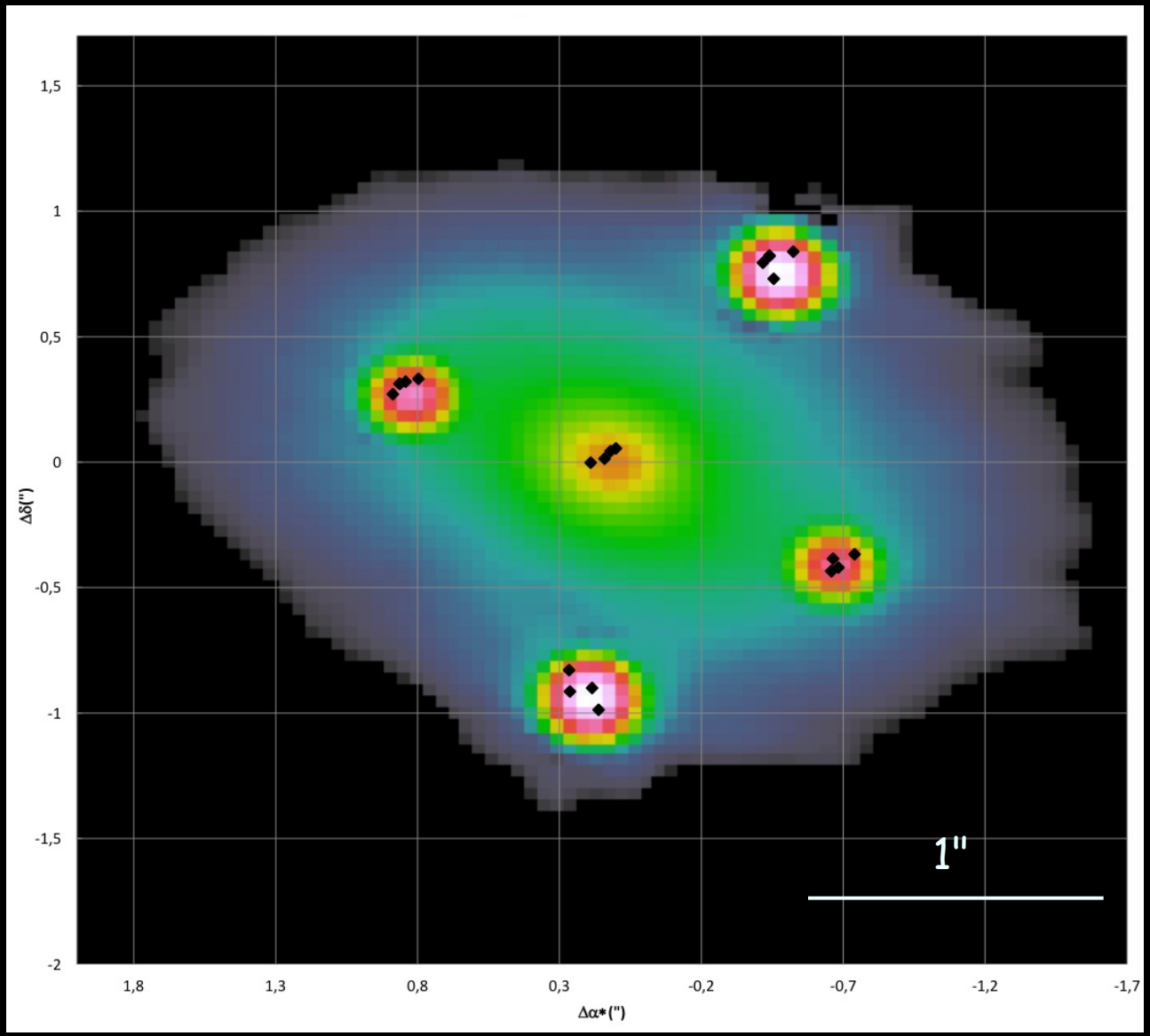
- Repeated observations during Ecliptic Pole scanning
  - Time coverage of 32 days
  - Median uncertainty of individual measurement 10-15 mmag
- Photometric reduction with CU5 PhotPipe
- Variability analysis with CU7 pipeline





Credit : G. Clementini et al., CU5 & CU7 team

The Einstein Cross seen with Gaia



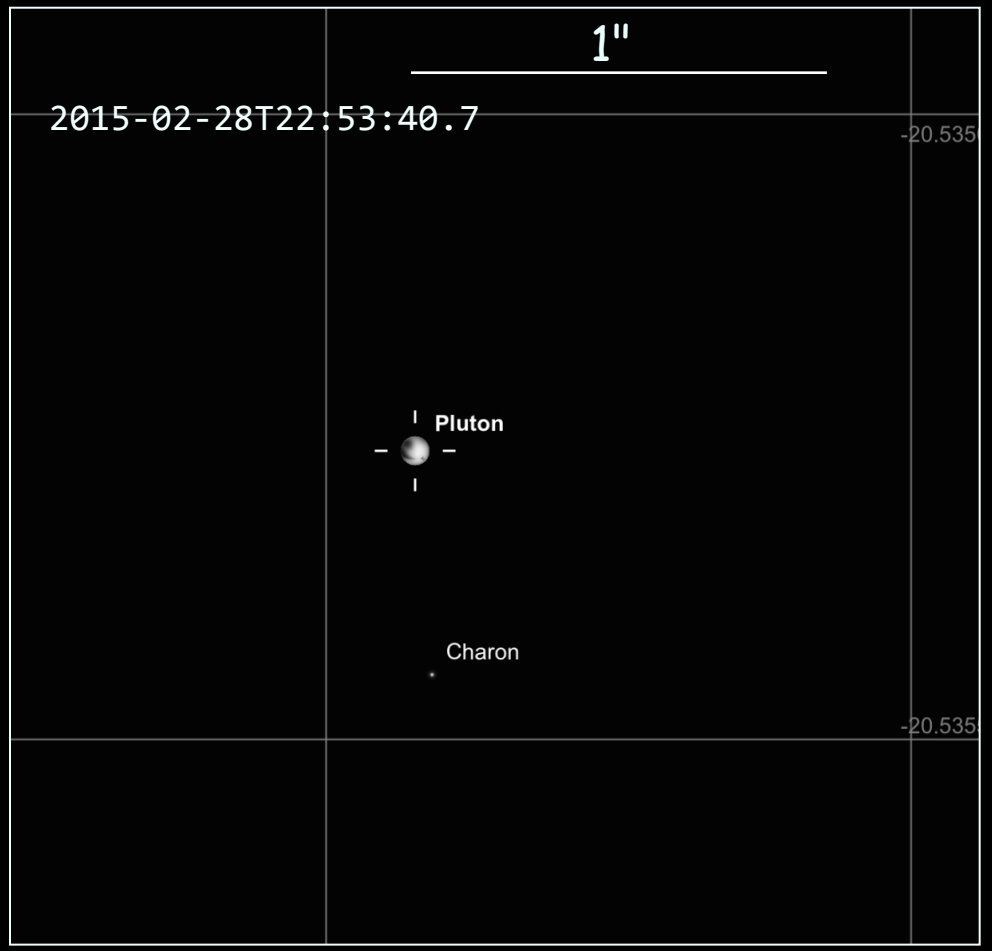
Ch. Ducourant, F. Mignard et al.

Spatial resolution in detection

Pluto	G	α	δ	Δα*	Δδ	ρ (")
2015-02-28T22:53:40.7	14.41	285.809849	-20.535768	0.1364	0.0535	0.1465
2015-02-28T22:53:40.7	16.50	285.809805	-20.535966	-0.0103	-0.6609	0.6610

… not a contaminant,

but Pluto and Charon !



Solar System Object : (54) Alexandra

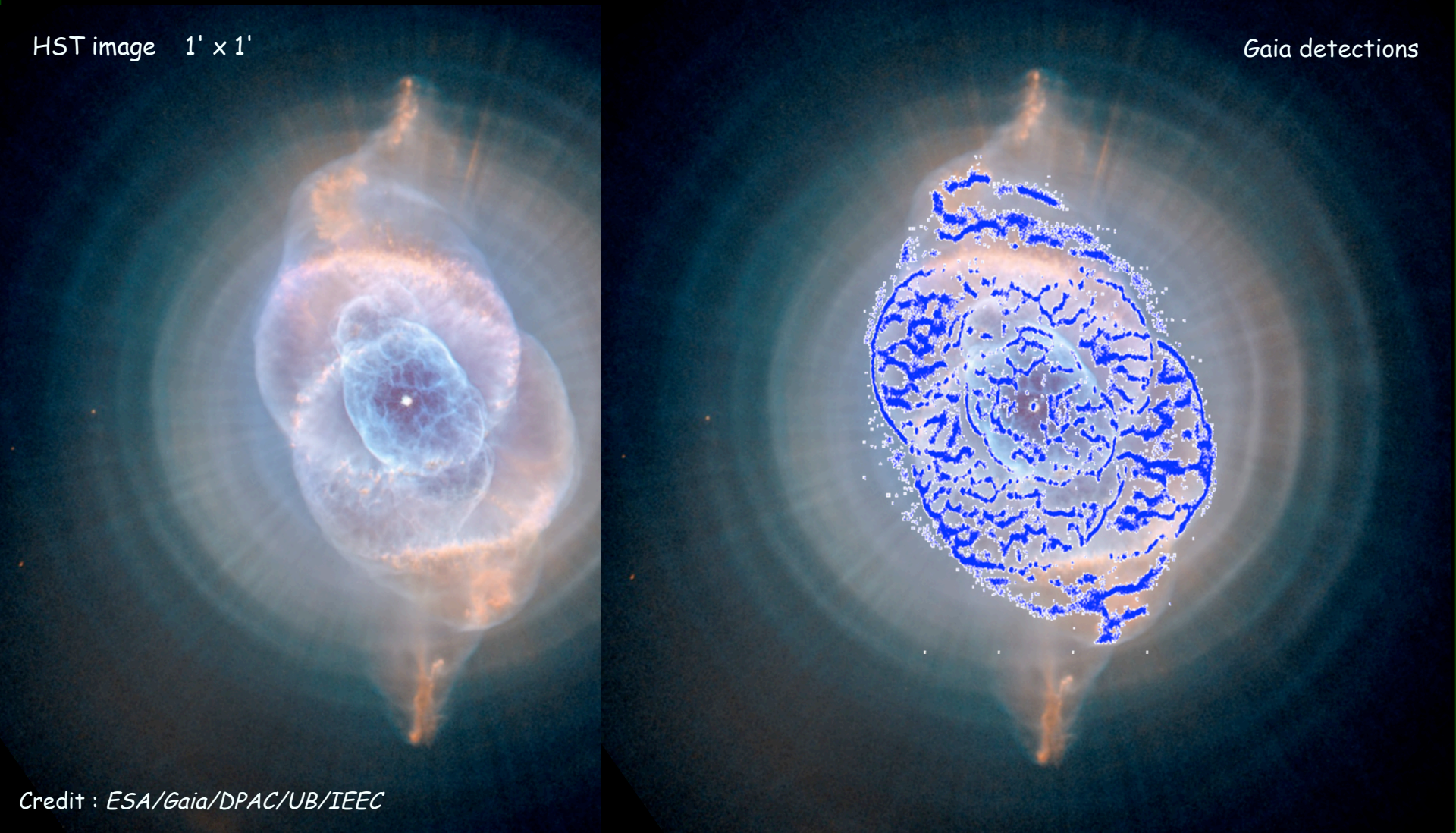




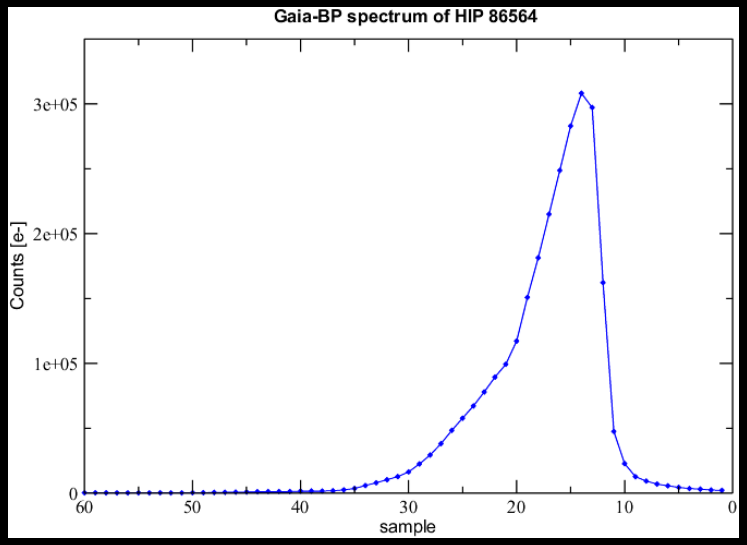
P. Tanga, F. Mignard et al.

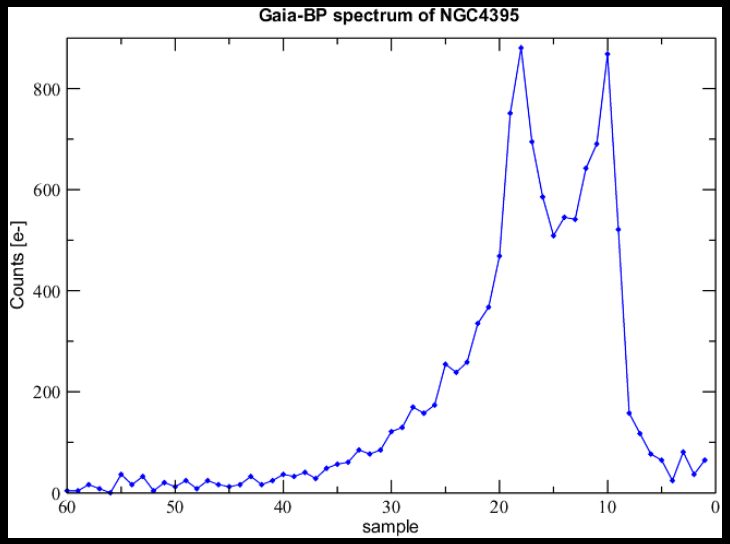
Extended sources

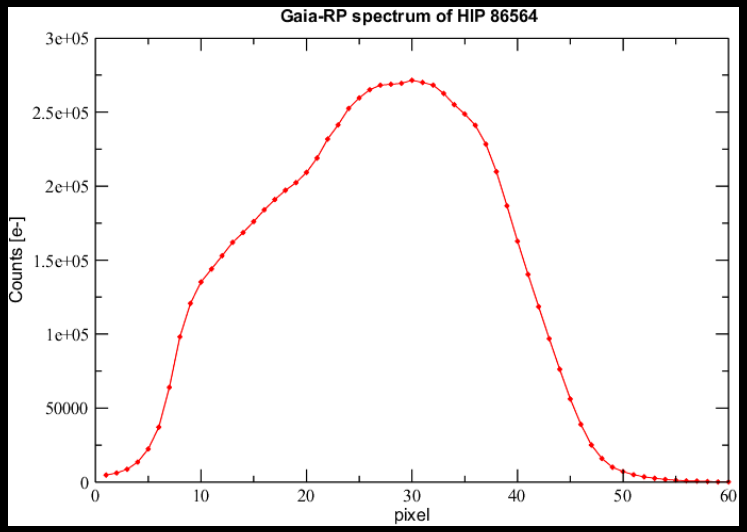
- The Cat's Eye Nebula near the North Ecliptic pole
  - 82,000 detections with Gaia ➔ imaging capabilities

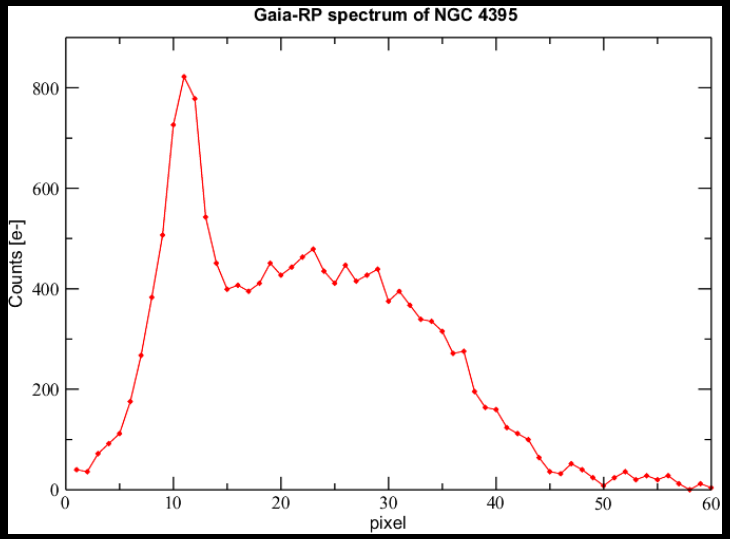


Star - Active Galaxy with Gaia







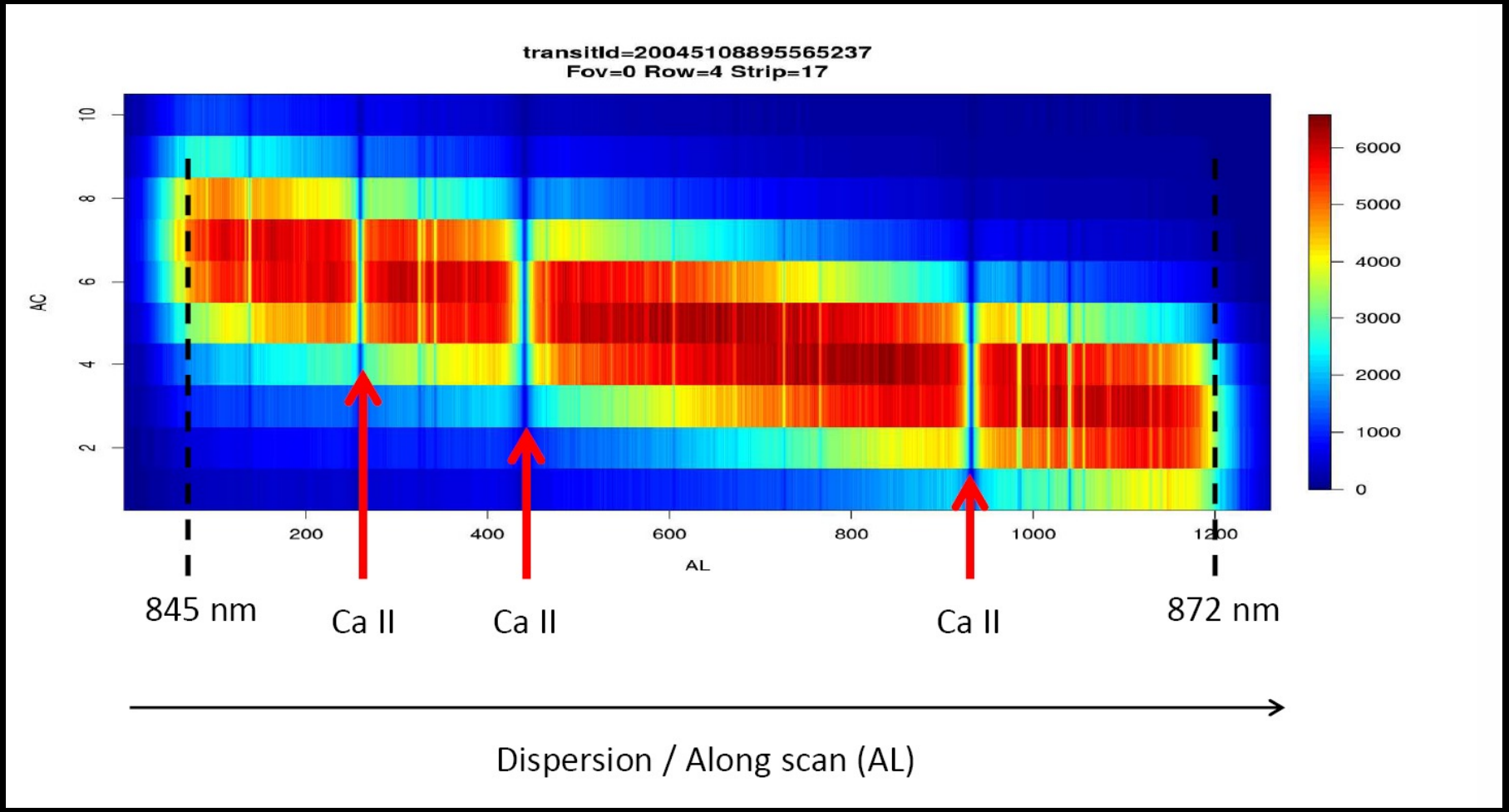


21/02/2014 23:49:03

25/04/2014 21:08:24

crédit : ESA/Gaia/DPAC/Airbus DS

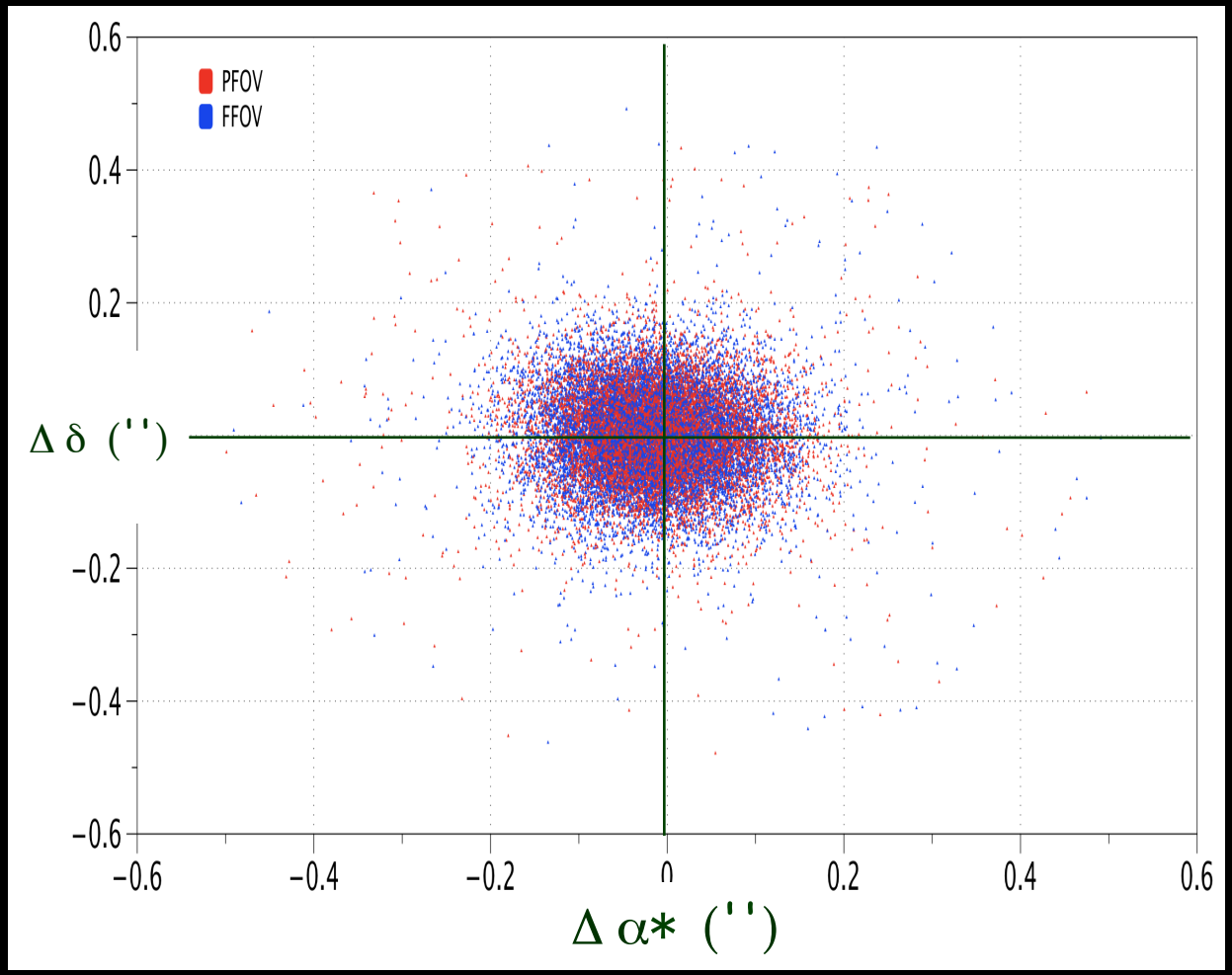
RVS Spectrum – 26 October 2014



crédit : D. Katz, O. Marchal

ICRF: Differences in position (arcsec)

- IDT only data
- No global attitude solution, no system adjustment



Attitude Control

- Example of automatic attitude control

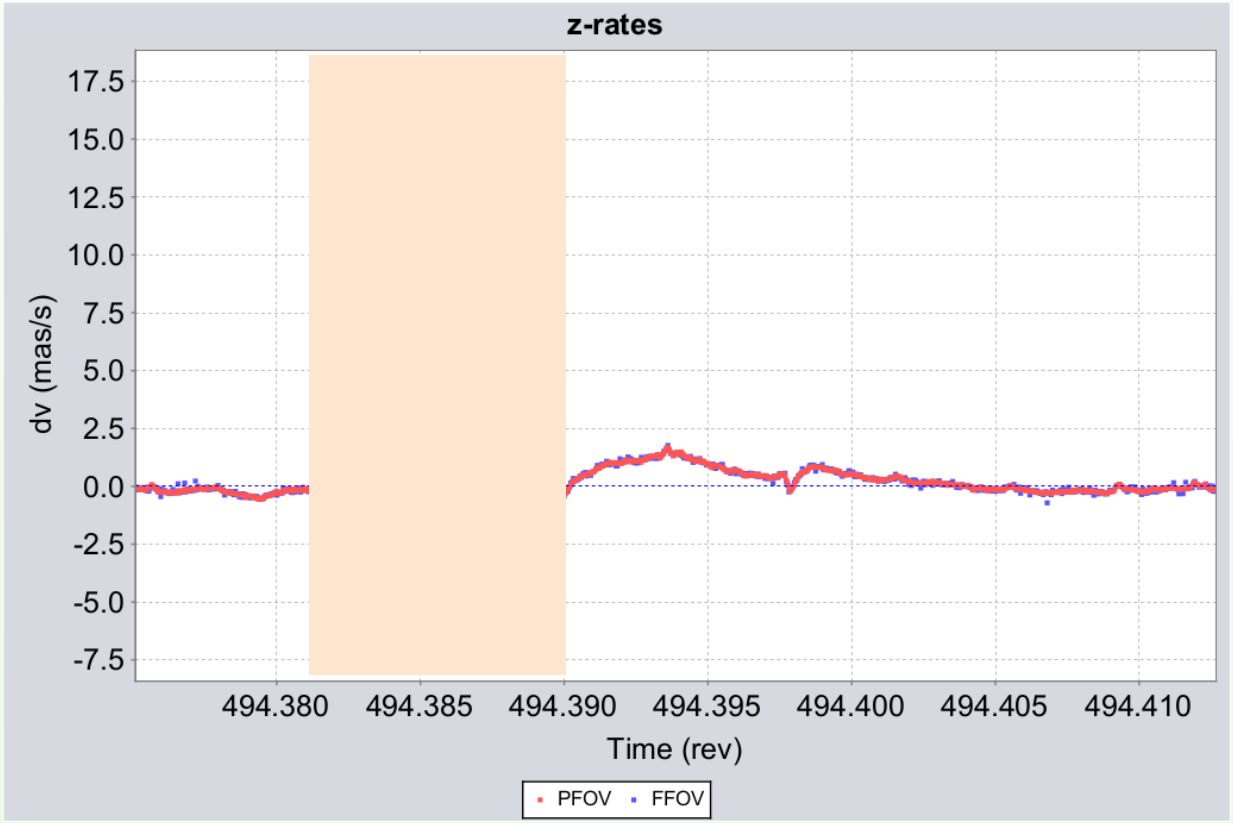


Figure by F. van Leeuwen

Data collected

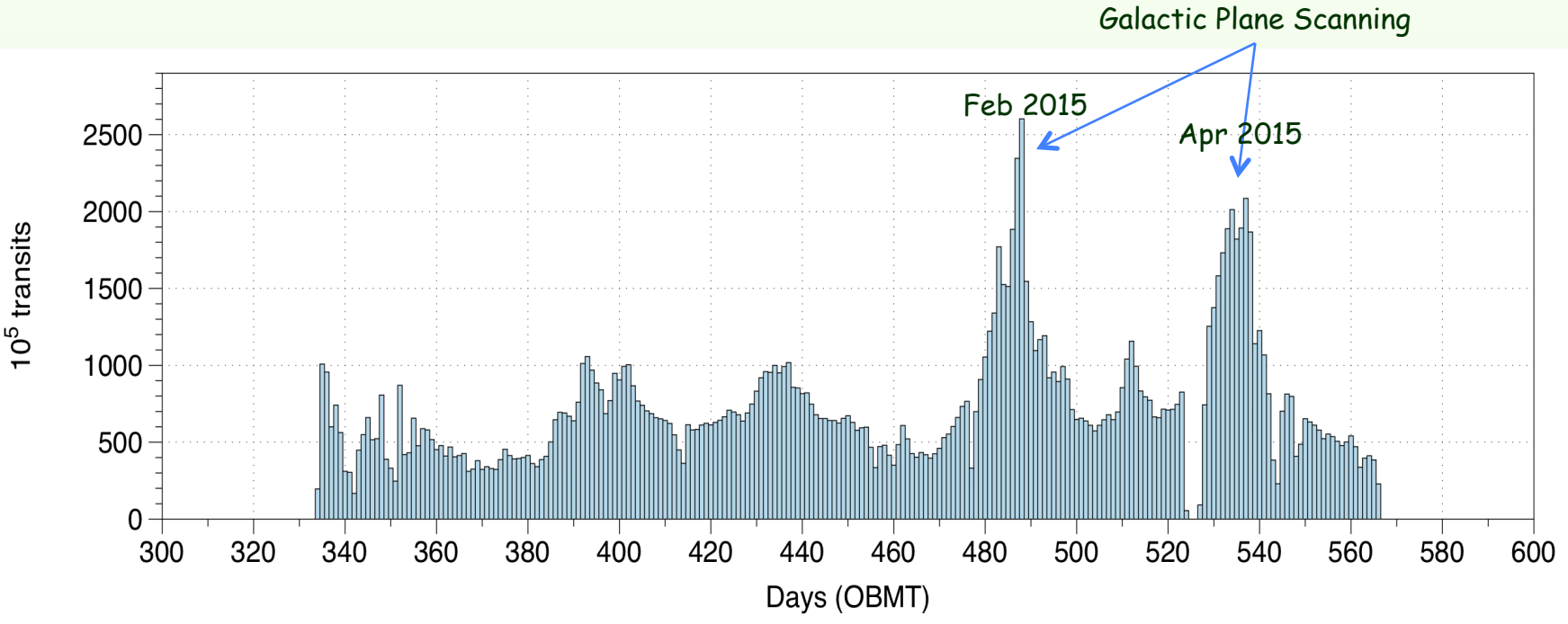
- Typically 30-40 millions sources per day

- Estimated volume on May 15, 2015
  - 20 x 10^9 transits
  - 200 x 10^9 astrometric CCD images
  - 40 x 10^9 photmetric imagesimages
  - 2 x 10^9 RVS transits
  - 6 x 10^9 spectra

  - Science data > 15 TB (+40 GB/day)
  - IDT/FL DB > 100 TB

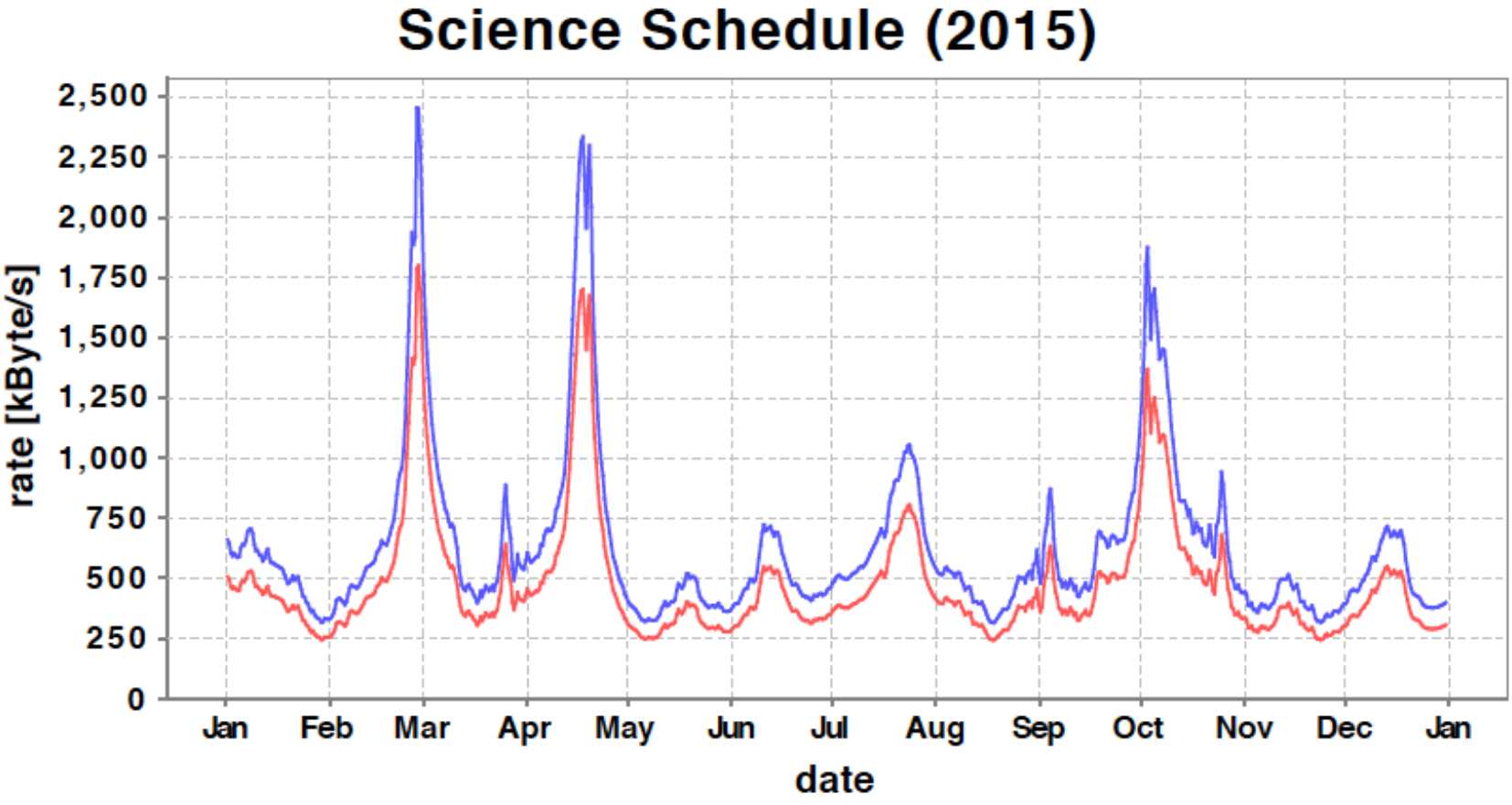
Overall statistics

- Time coverage from Sep 25, 2014 to 07 May, 2015
  - 17×10^9 transits in DetectionRecord



binsize = 1 day

Data flow in 2015



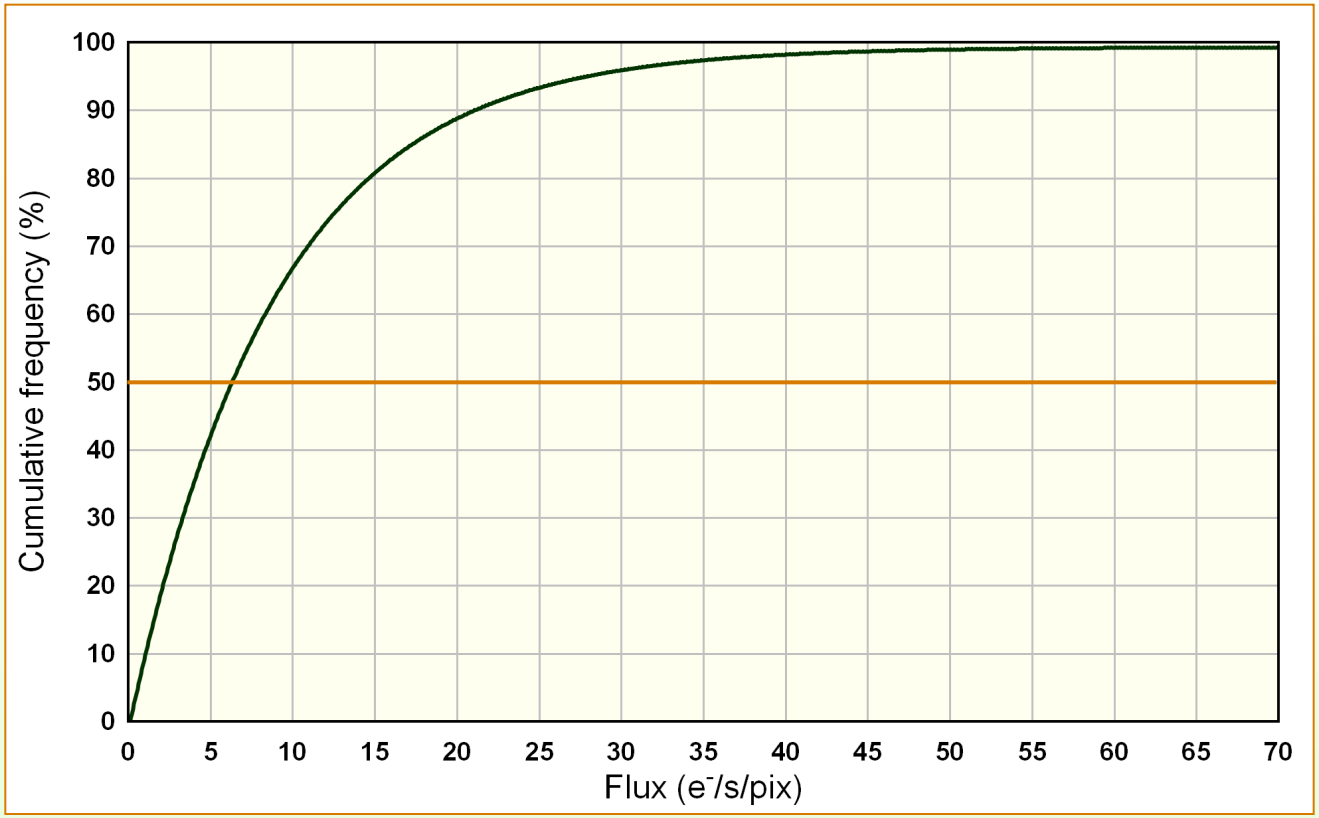
A Few problems



Unexpected Surprises

- Stray light both from astronomical sources and the Sun
  - Sun stray light paths not yet identified
  - Impacts faint sources especially in spectroscopy
- Transmission loss due to continuing contamination of mirrors by frost
  - Rate diminished, but water source not yet exhausted
- Basic Angle variation larger than expected
  - Basic Angle Monitor providing very precise measurements of the changes
- Too many on-board detections
  - Mapping observations to sources is heavily affected
  - Makes on—ground processing much harder

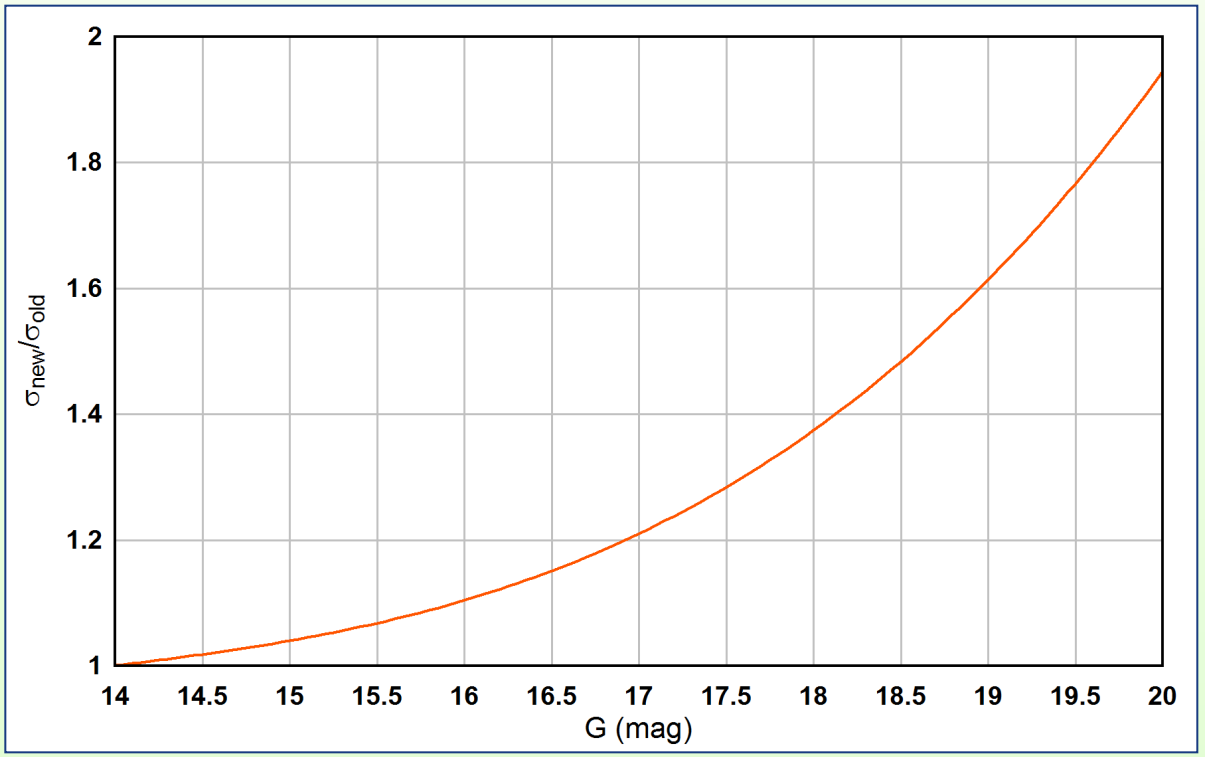
Gaia straylight : relevant figures



- Median straylight ~ 7e-/s/px
- G = 20 in AF field ➔ 180 e-/s
- faintest RVS stars ➔ < 1 e-/s/px
- Requirement ➔ 0.1 e-/s/px

Impact on performances

- Straylight coming from the Sun and the sky background
  - although this remains very small, it impacts the final accuracy
    - less for astrometry than photometry
    - less for photometry than for spectroscopy

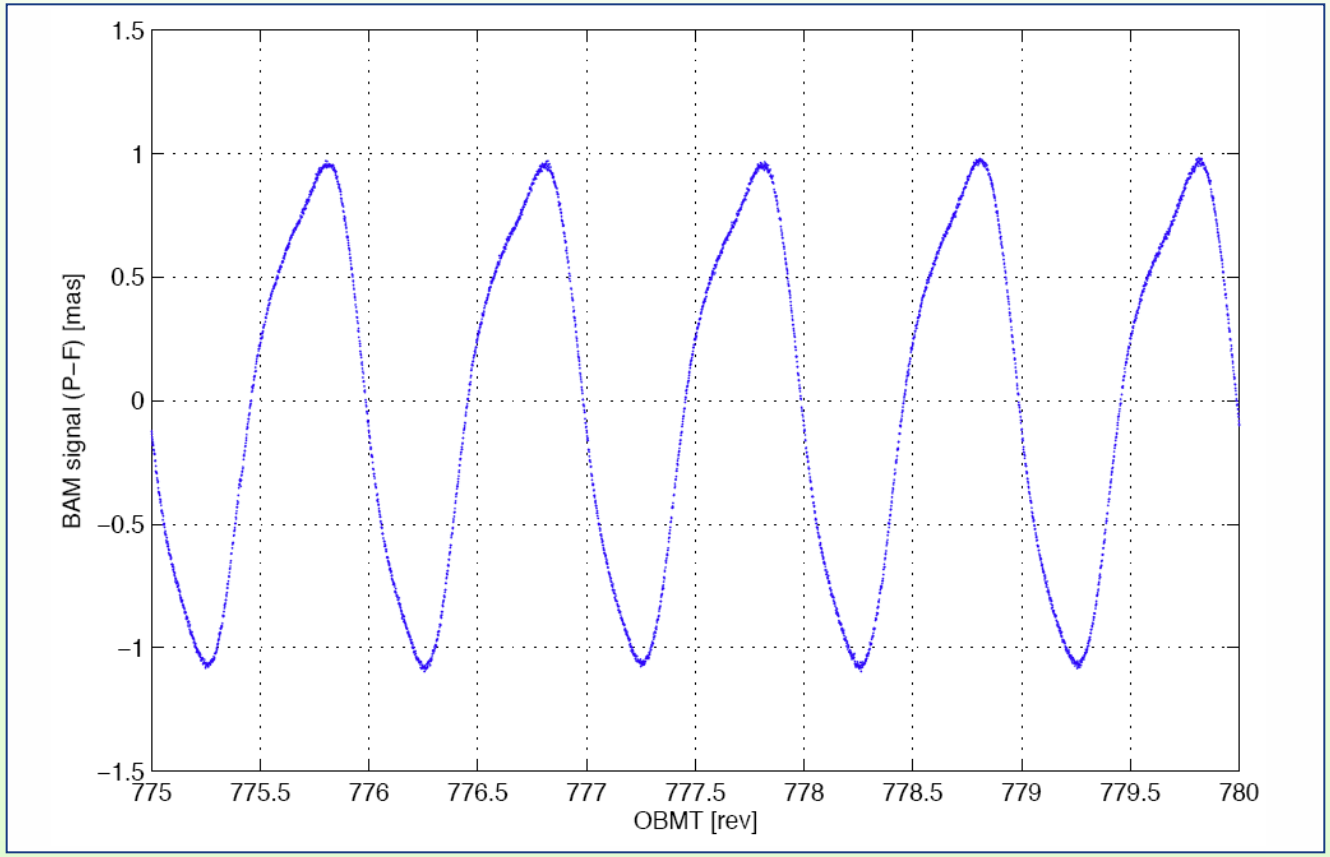


Degradation on astrometric accuracy

Basic Angle Variation

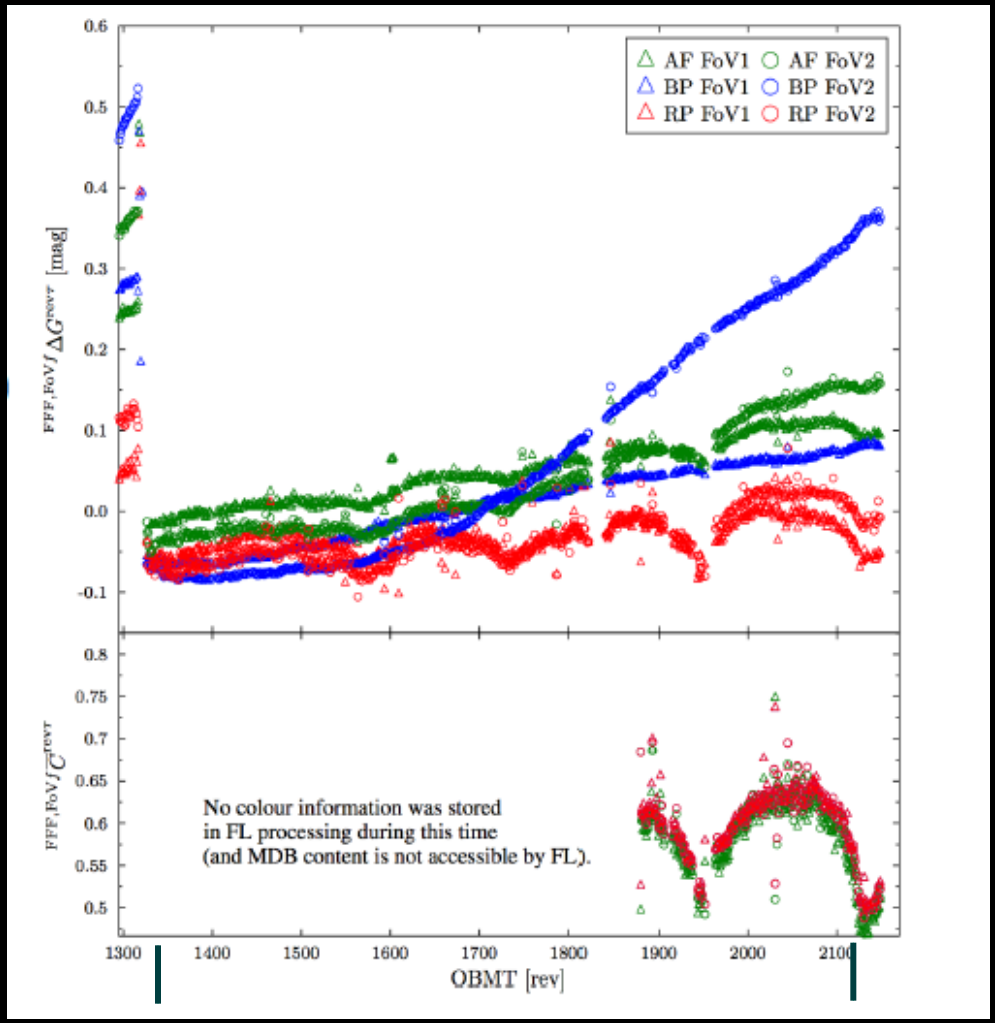
- Very regular oscillation with 1 mas amplitude
- Can be calibrated to 10 muas accuracy (1%)
- Root cause not found

1mas



Ice contaminant

- Ice deposits form on the optical surfaces
- This affects the overall transmission
- Periodic heating solve the problem
- The effects is less pronounced now than before
- New decomtamination : 3-4 June



Oct 2014

May 2015

Example of contaminated detections

1993-FK20	ρ (")
2014-10-24T19:10:35.20	3.7130
2014-10-24T19:10:35.21	0.1503
2014-10-24T19:10:35.23	0.5407
2014-10-24T19:10:35.23	0.7869
2014-10-24T19:10:35.25	1.1926
2014-10-24T19:10:35.28	2.6110
2014-10-24T19:10:35.28	2.8774
2014-10-24T19:10:35.30	3.1707



- There is a very bright star (V = 4.4) nearby, but not very close (~ 100 ")
- Many artefacts produced on-board and matched to a new source
- All about the same magnitude ~ 19.5 – 19.8
- From the AL velocity the 2nd is likely the planet

Data release Scenario

- Mid-2016
  - Positions + G magnitudes (all sky, single stars)
  - Includes more-often-scanned ecliptic-pole regions
  - Hundred Thousand Proper Motions (Hipparcos-Gaia, 50 μas/yr)
- Early 2017
  - Radial velocities for bright stars, two-band photometry, and full astrometry (α, δ, π, μα*, μδ) where available
- 2017/2018 (TBC)
  - Full astrometry, orbital solutions for short period binaries, (GBP – GRP), BP/RP spectrophotometry and astrophysical parameters, radial velocities, RVS spectra
- 2018/2019 (TBC)
  - Updates on previous release — including moresources, source classifications, multiple astrophysical parameters, variable-star solutions and epoch photometry, solar-system results
- 2022 (TBC) Everything

Conclusions

- Gaia is performing its mission largely as planned
- The detected problems are not significantly impairing the data collection
- The accuracy is slightly degraded but remains unchallenged
- The survey will go fainter than expected
  - *G* = 20.7 instead of *G* =20
- Sources brighter than *G*= 5.7 are observed
- Detections of extended sources (> 1") are successful
- Consumable level would allow a 10-year + mission
- Instrument is more complex than expected and impacts on the data processing speed



Merci de votre attention

