

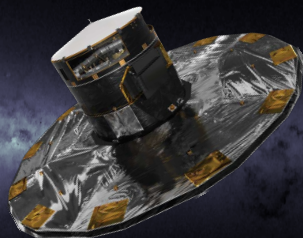
Gaia

aus der Sicht eines
"First Look Scientists"

Michael Biermann (ZAH-ARI)

MPIA AstroTechTalk, 16. September 2016

Gaia is an ESA Astrometry Space mission



December 2013

Gaia launch

July 2014

Start of nominal operations

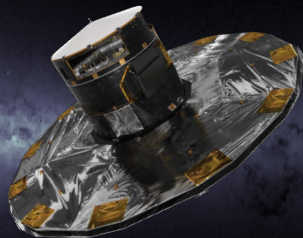
June 2019

End of nominal operations

mid 2022

final catalogue

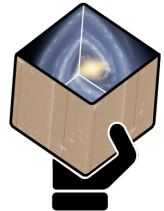
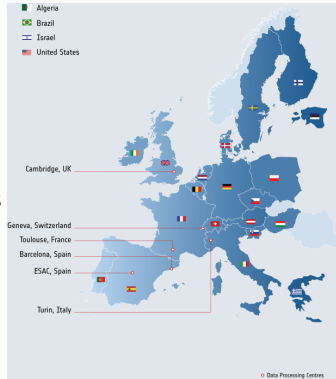
What Gaia is about



- Positions, parallaxes, proper motions, magnitudes, colours, ...
for > 1 billion stars ($20\text{--}25\ \mu\text{as}$ at $G = 15$, $300\ \mu\text{as}$ at $G = 20$)
- Spectroscopy for 10% of these stars

DPAC teamwork to deliver the promise of Gaia: DPAC = Data Processing and Analysis Consortium

- 10+ years of effort
- 450 scientists/engineers
- 160 institutes
- 24 countries and ESA
- 6 data processing centres



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α δ ϖ μ_{α^*} H_0 ...

Why having First Look Scientists?

- Astrometric space missions like Gaia have to simultaneously determine a tremendous number of (source, attitude, calibration, global) parameters.
- To reach the targeted level of precision, many months of observational data have to be incorporated in a global, coherent and interleaved data reduction.
- By no means neither the instrument nor the data health can be guaranteed by standard procedures.
- Since it is undesirable not to know the measurement precision and instrument stability until more than half a year of the mission has elapsed, one needs a Detailed First Look.

First Look

- is the in-depth assessment of scientific data health and quality within 1 day after reception of data,
- uses science data and satellite housekeeping data,
- assists Science Operations Center in solving any occurring problem.

Since Week 2, 2014:

131 FLS & PE Weekly Reports

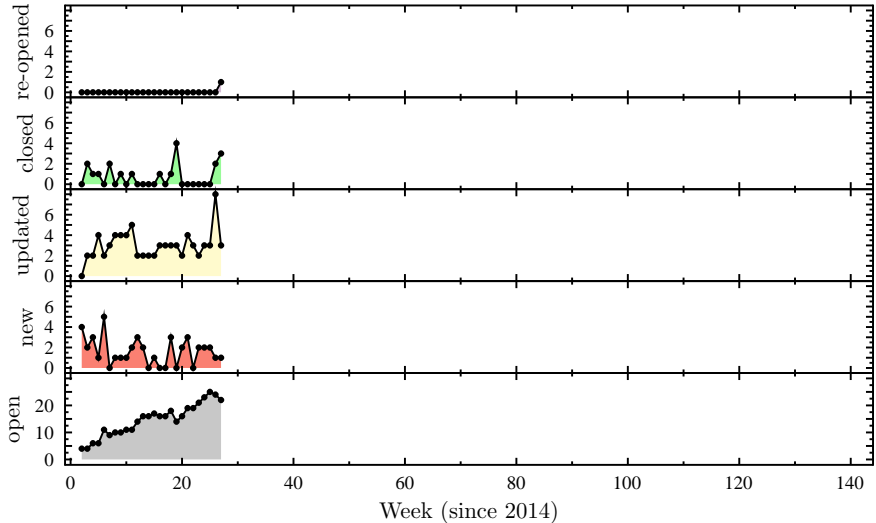
The sad fate of the First-Look Scientist(s):



If you are constantly watching out
for rain and hail,
you risk to miss all the sunny days.



The many problems and oddities around Gaia



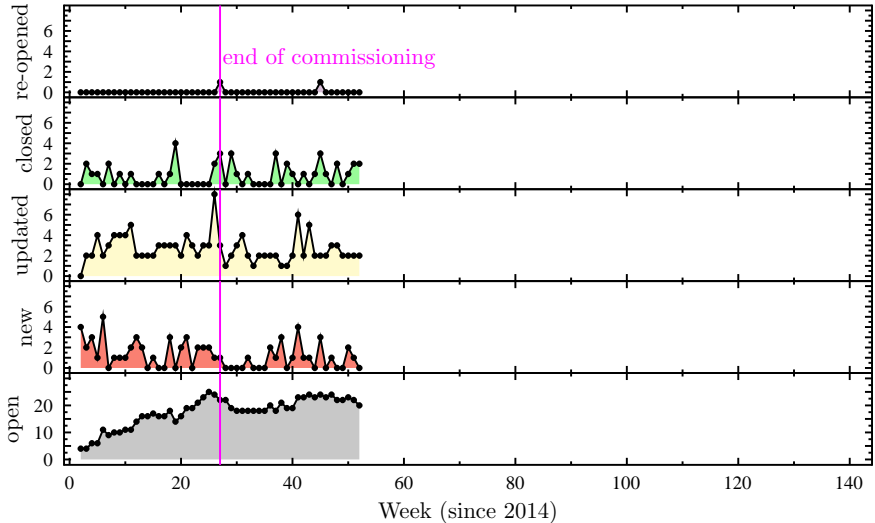


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The many problems and oddities around Gaia



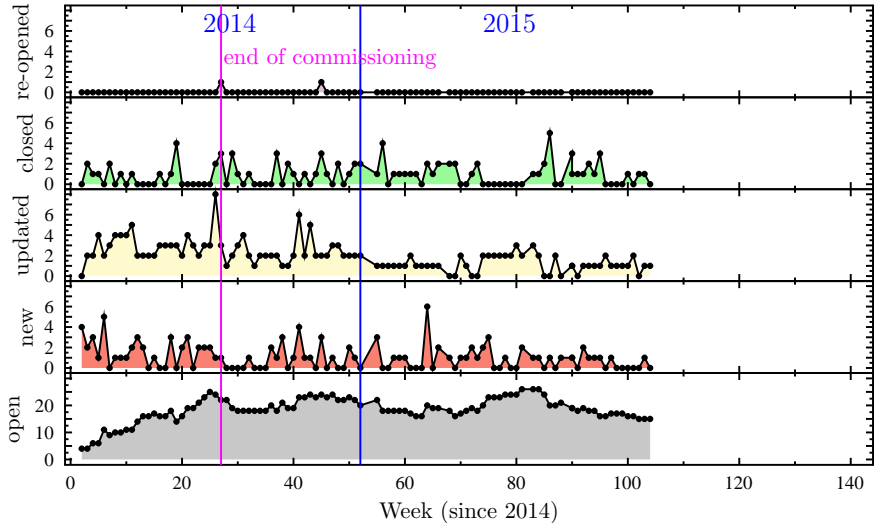


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The many problems and oddities around Gaia



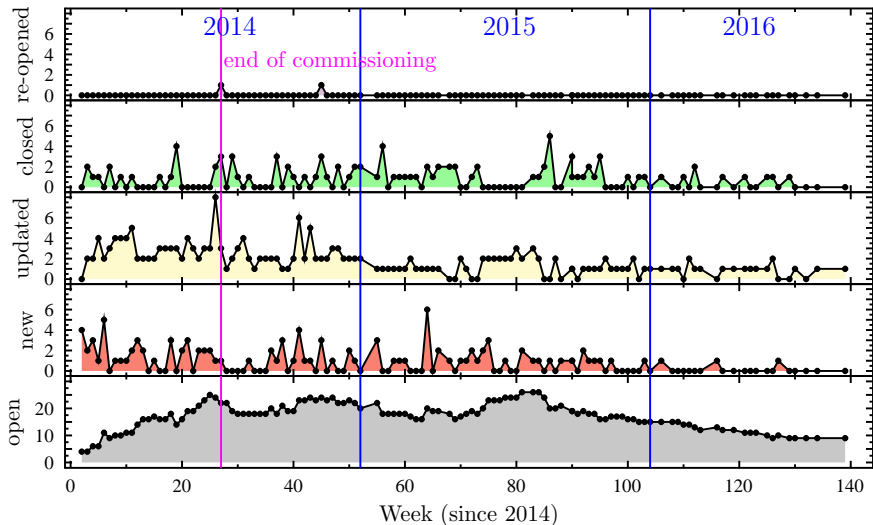


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The many problems and oddities around Gaia



Example I: Detection efficiency (ω Cen)



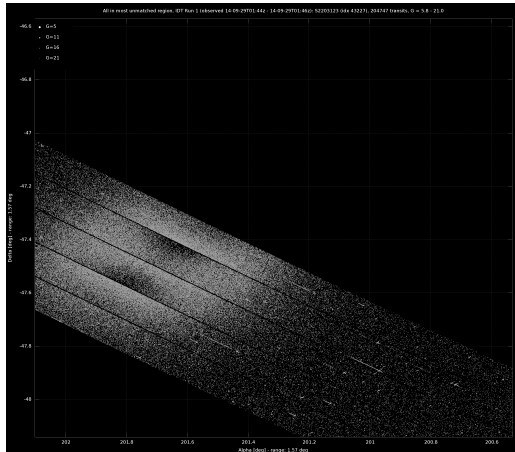


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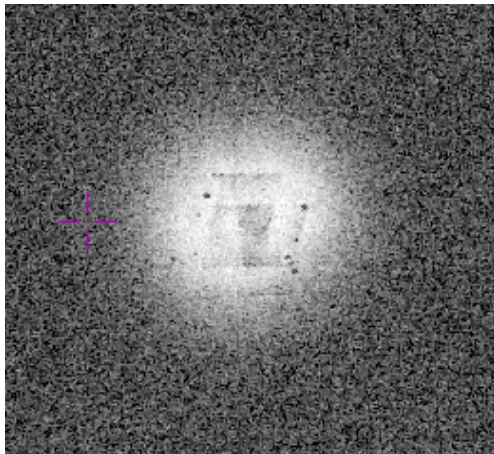


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Example I: Detection efficiency (ω Cen)

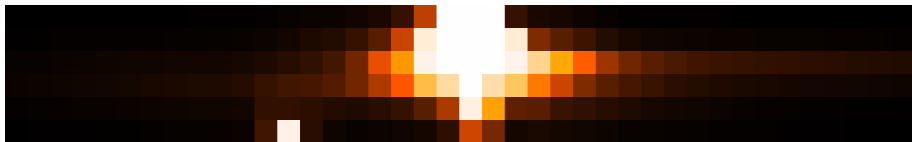


Example I: Detection efficiency (ω Cen)



Example II: Image centroid distributions

2D Gaia image (star brighter than $G = 13$)

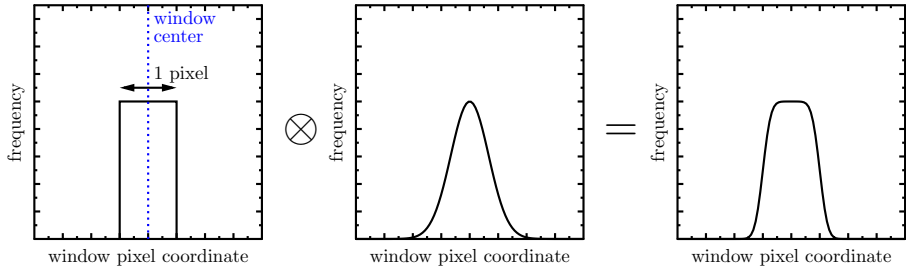


1D Gaia image (star fainter than $G = 13$)



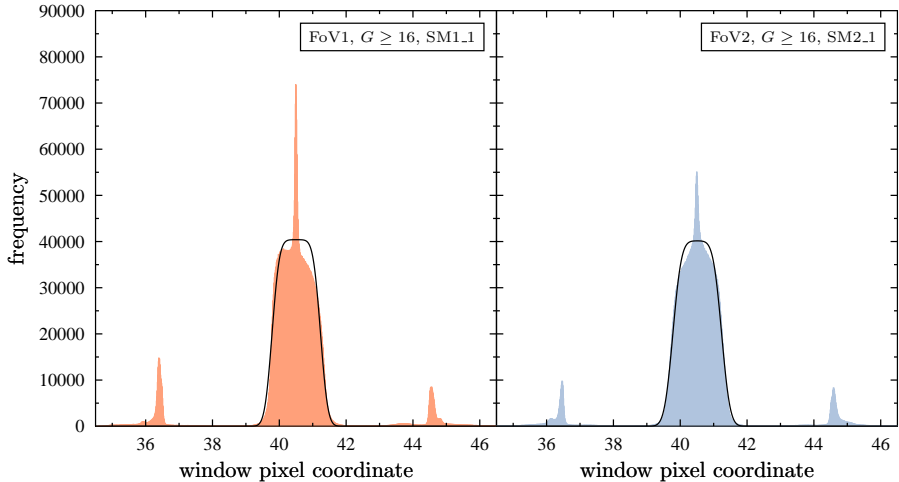
Example II: Image centroid distributions

What we expect:



And what we get ...

Example II: Image centroid distributions



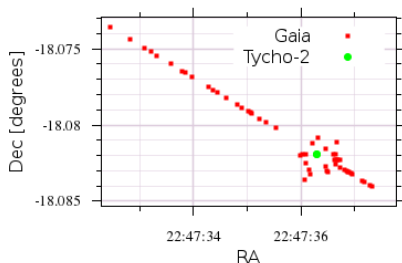
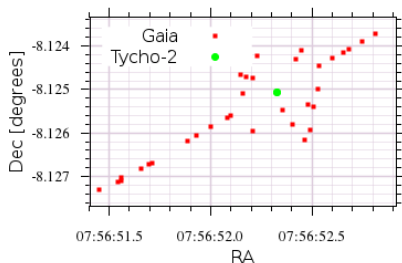
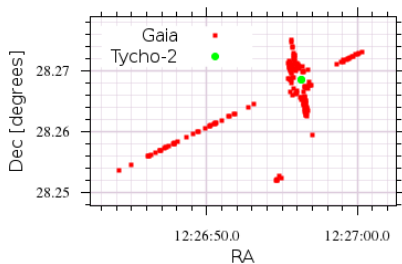
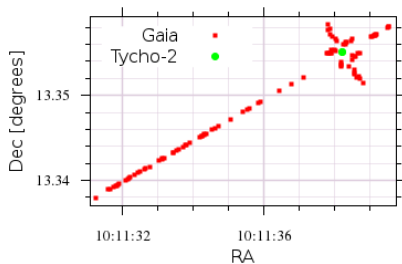


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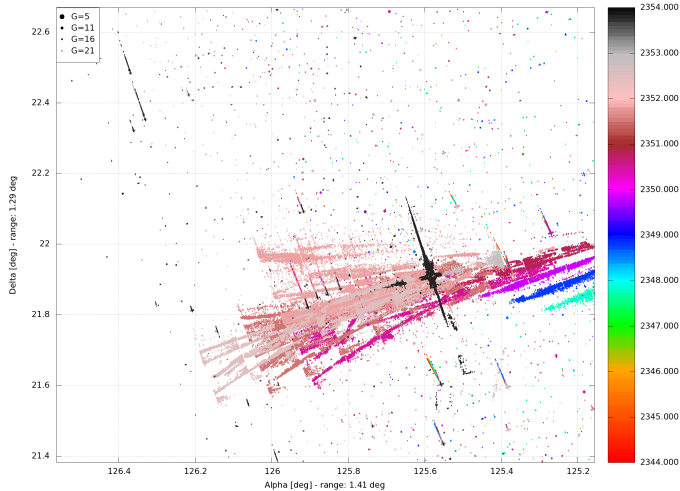
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Example II: Image centroid distributions

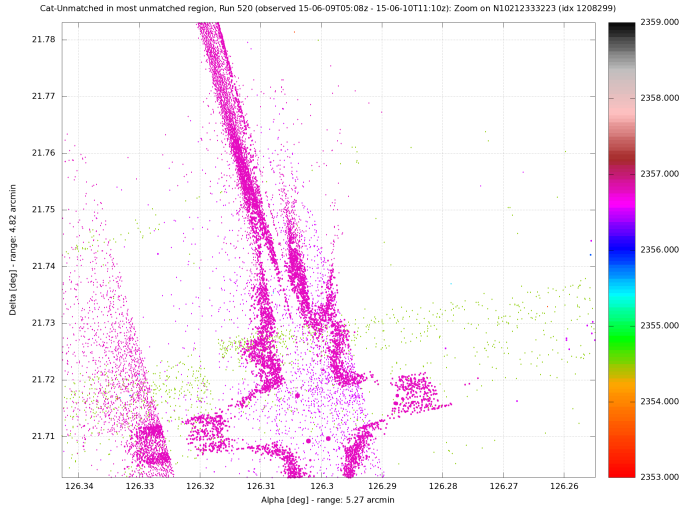


Example II: Add-on – Spurious detections

Unmatched in most unmatched region, Run 519 (observed 15-06-06T23:06z - 15-06-09T06:56z): HEALPix N1023011 (idx 4805), 172868 transits, $G = 5.0 - 20.2$

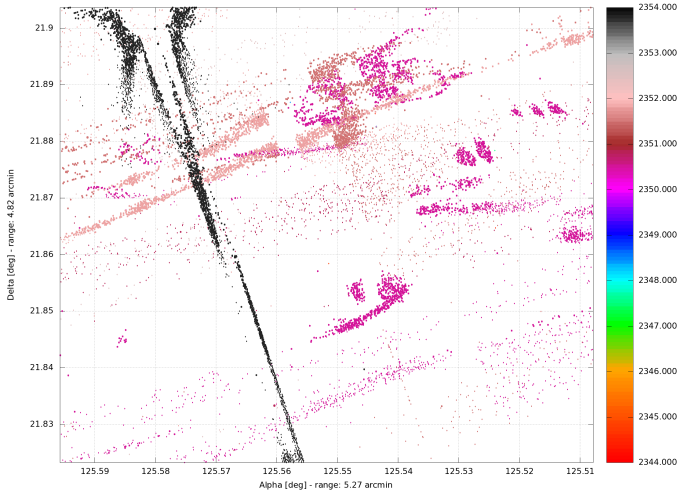


Example II: Add-on – Spurious detections



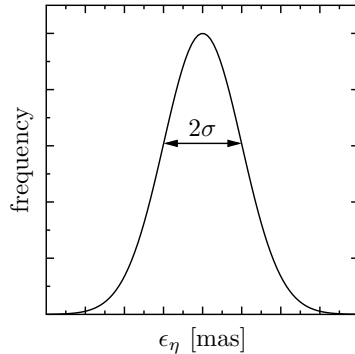
Example II: Add-on – Spurious detections

Cat-Unmatched in most unmatched region, Run 519 (observed 15-06-06T23:06z - 15-06-09T06:56z): Zoom on N10230112012 (idx 1230214)



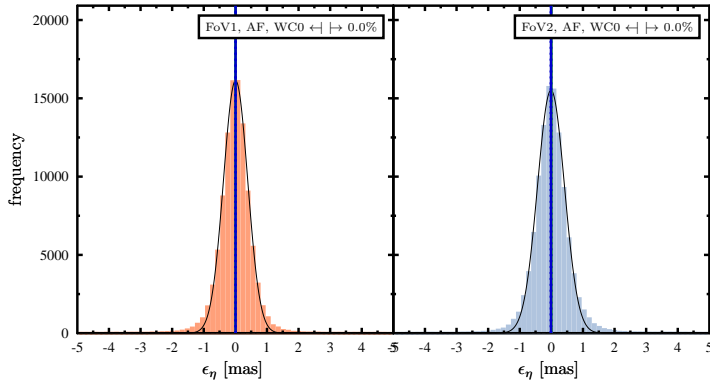
Example III: Astrometric along-scan scatter

Measure for the astrometric accuracy
 = astrometric along-scan scatter
 = width σ of a Gaussian fit
 to the astrometric residuals



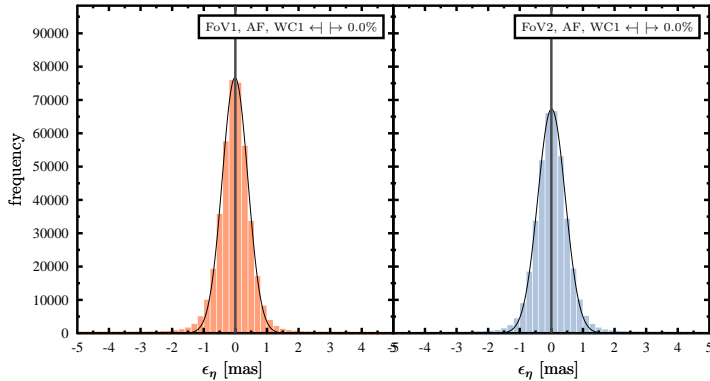
↪ target at $G = 15.8$ mag:
 330 μas for a single CCD transit.

Example III: Astrometric along-scan scatter



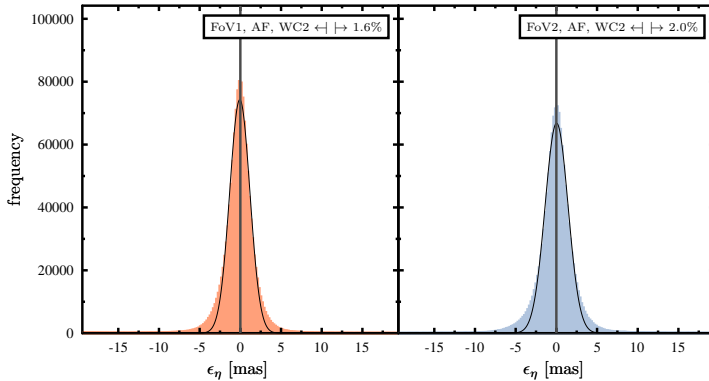
bright stars, $G < 13$

Example III: Astrometric along-scan scatter



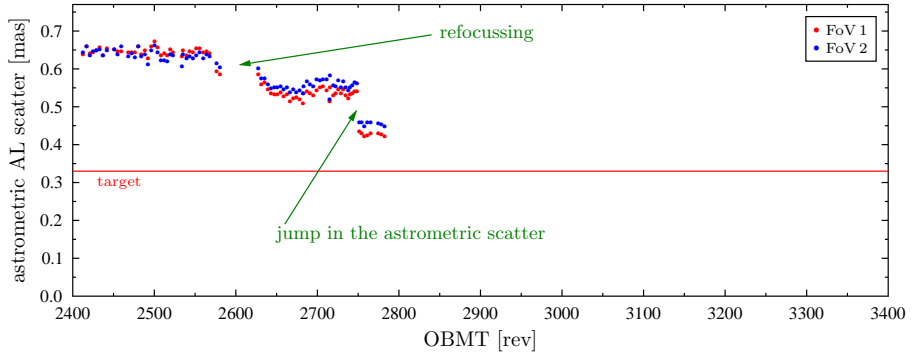
medium-bright stars, $13 < G < 16$

Example III: Astrometric along-scan scatter



faint stars, $G > 16$

Example III: Astrometric along-scan scatter



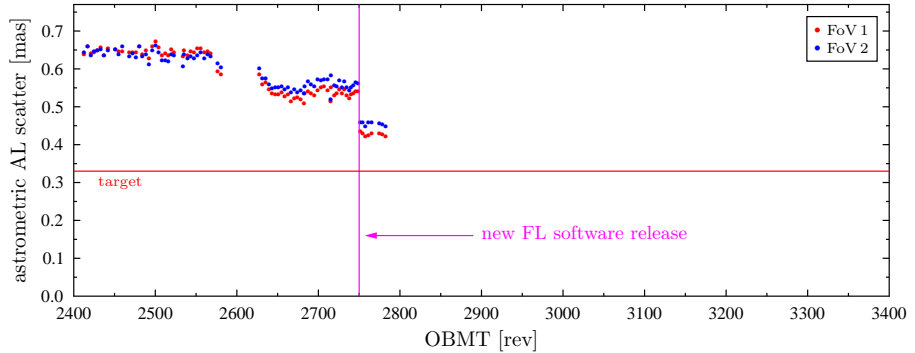


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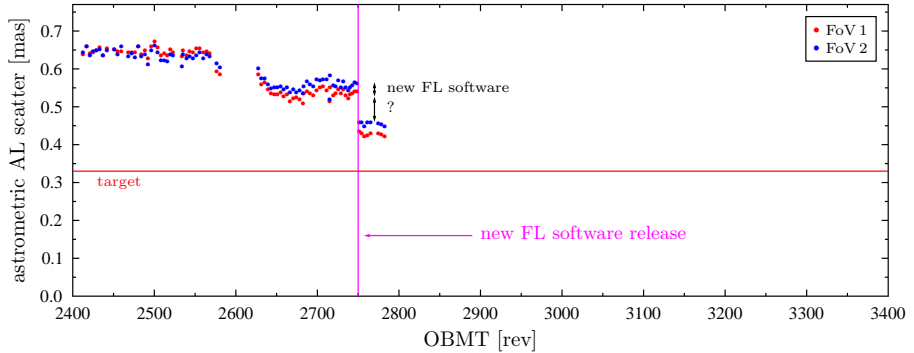


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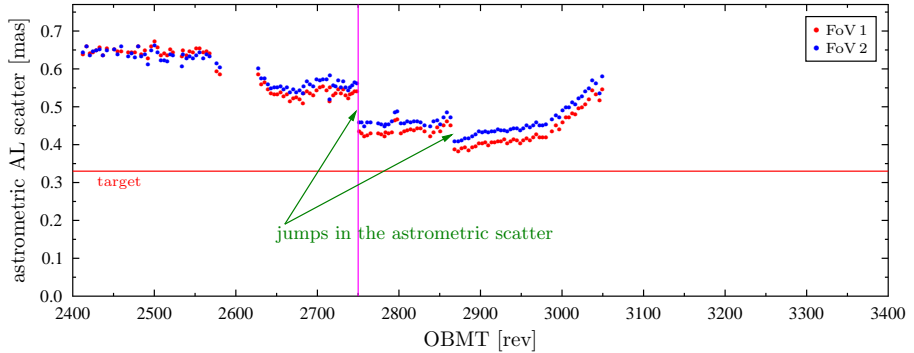
Example III: Astrometric along-scan scatter



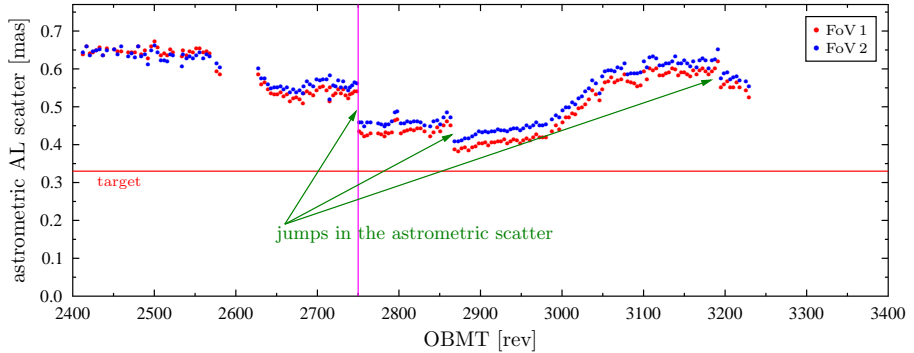
Example III: Astrometric along-scan scatter



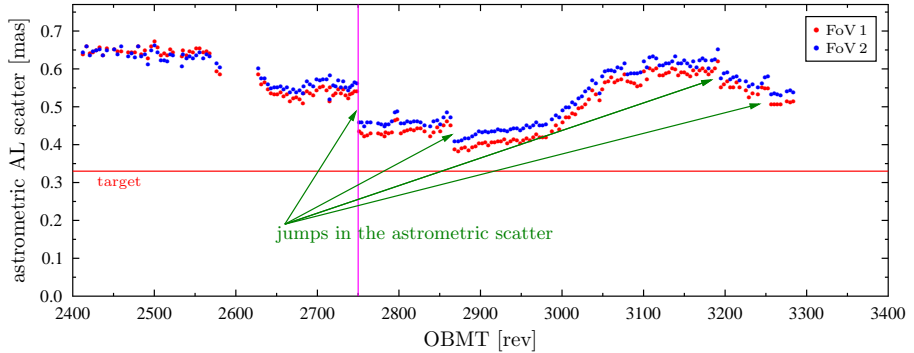
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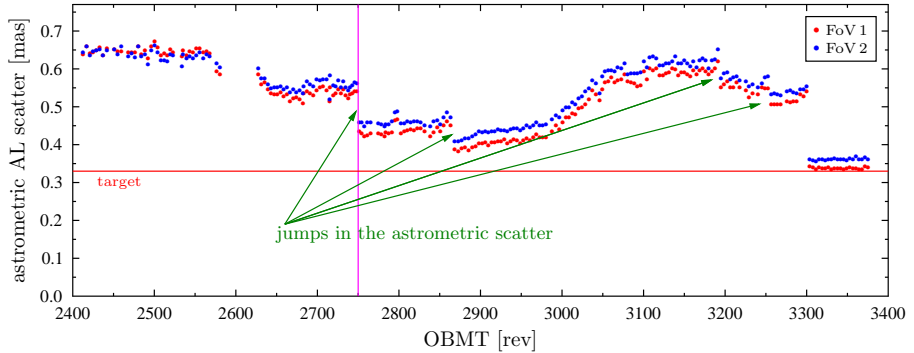
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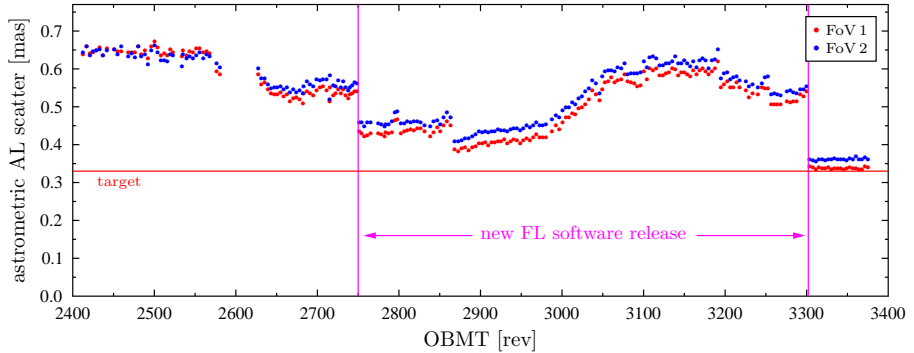
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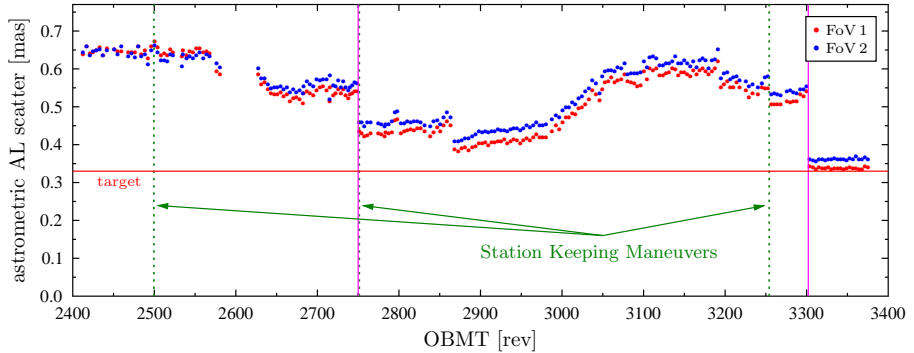
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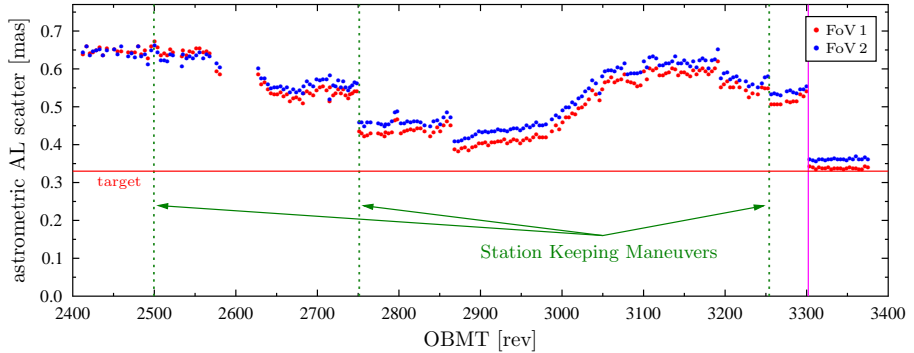
Example III: Astrometric along-scan scatter



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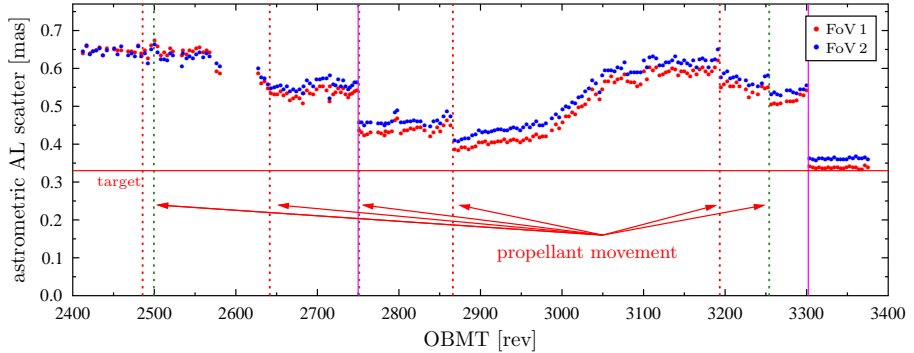




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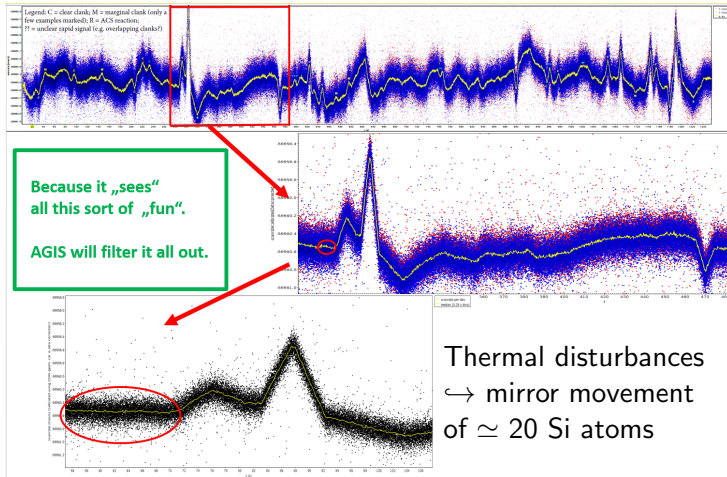
Example III: Astrometric along-scan scatter



Jumps in astrometric scatter are caused by sudden changes in Gaia's mass moment of inertia due to propellant movements.

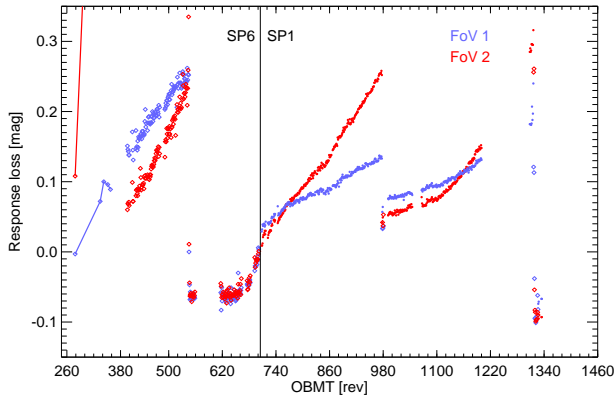
Example III: Add-on: micro-clanks

Why hasn't ODAS reached yet the target precision?

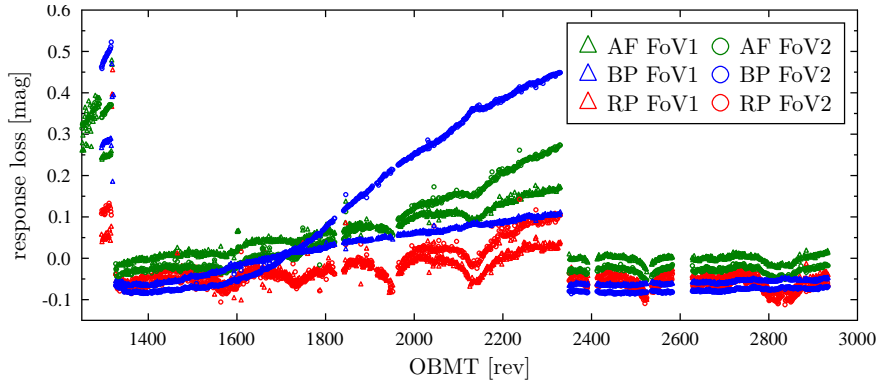


Example IV: Response loss

From the very beginning, Gaia suffered from ice contamination.



Example IV: Response loss



- By and large, Gaia is working well and producing tremendous quantities of unprecedented data.
- On Sep 14, we (DPAC) have released the first Gaia Data Release.
 - ▶ 2D positions, 2D proper motions and parallaxes of 2 million sources down to $G \simeq 12$ with accuracies of about 0.3 mas and 1 mas/yr.
 - ▶ 2D positions of 1.1 billion sources down to $G = 20.7$ with a positional accuracy of about 10 mas or better.
 - ▶ Mean G -band magnitudes for all sources.
 - ▶ Light curves of 3 194 variables (Cepheids, RR Lyrae) around the south ecliptic pole over 28 days with around 200 epochs.
 - ▶ Special A&A issue. 19 papers.
- There are already science papers out based on Gaia DR1.
- Gaia DR1 is just an appetiser!
20 times more (and three times more accurate) than Hipparcos, but only 0.2% of Gaia DR2 (Q4 2017).

Last but not least:

During this presentation Gaia has

- observed 0.7 million stars,
- collected 7 million astrometric measurements, and
- collected 275.000 spectra of 80.000 stars.

Thanks for your attention!