

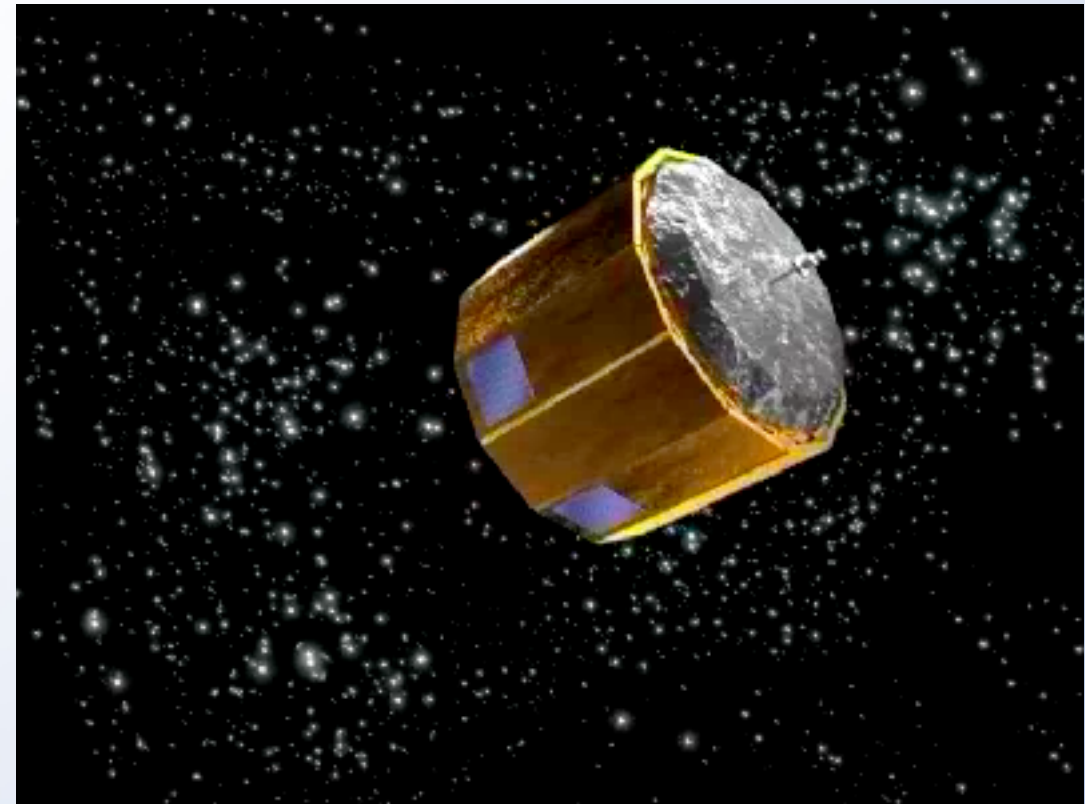


Gaia: Mission Concept, design and construction

Timo Prusti

Gaia Summary

- ESA mission building on the Hipparcos heritage
- Astrometry, Photometry and Spectroscopy
- Launch October 2013
- Satellite, including the payload, by industry (Astrium, Toulouse), operations by ESA and data processing by scientists (DPAC)
- Science Alerts early on
- First intermediate data release 22 months after launch



www.rssd.esa.int/Gaia



Science Topics

- Structure and dynamics of the Galaxy
- The star formation history of the Galaxy
- Stellar astrophysics
- Binaries and multiple stars
- Brown dwarfs and planetary systems
- Solar system
- Galaxies, Quasars and the Reference Frame
- Fundamental physics: General relativity

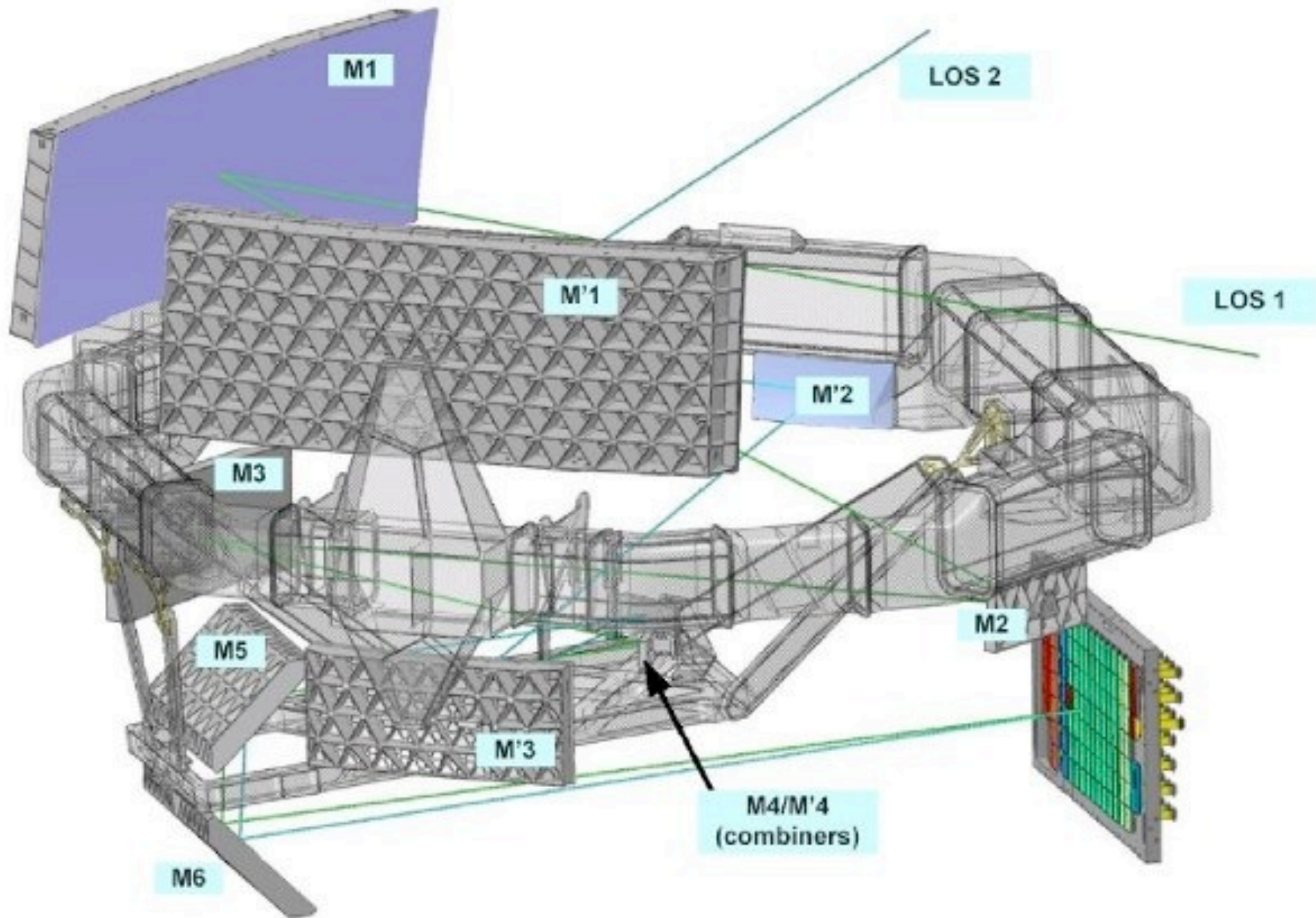


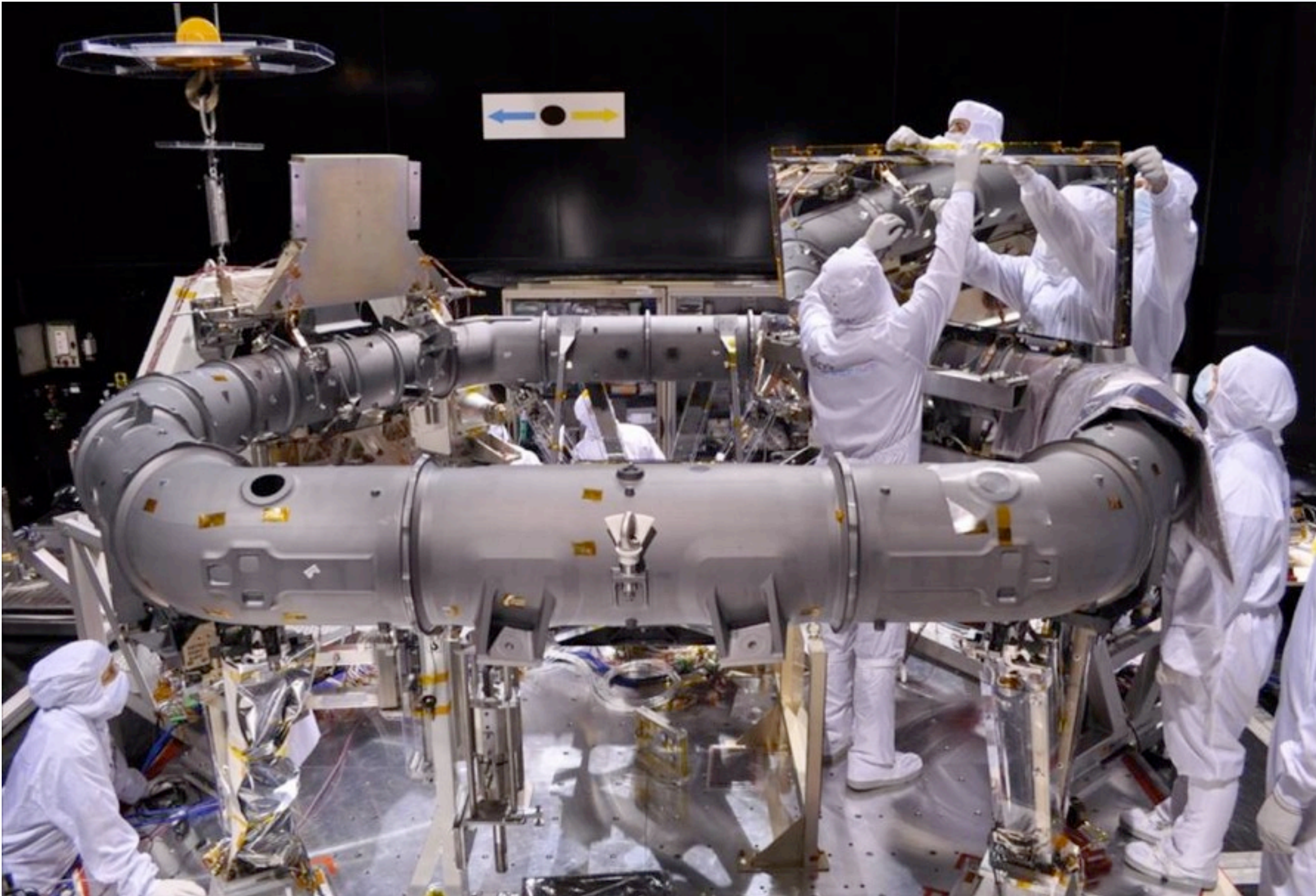
Gaia vs. Hipparcos

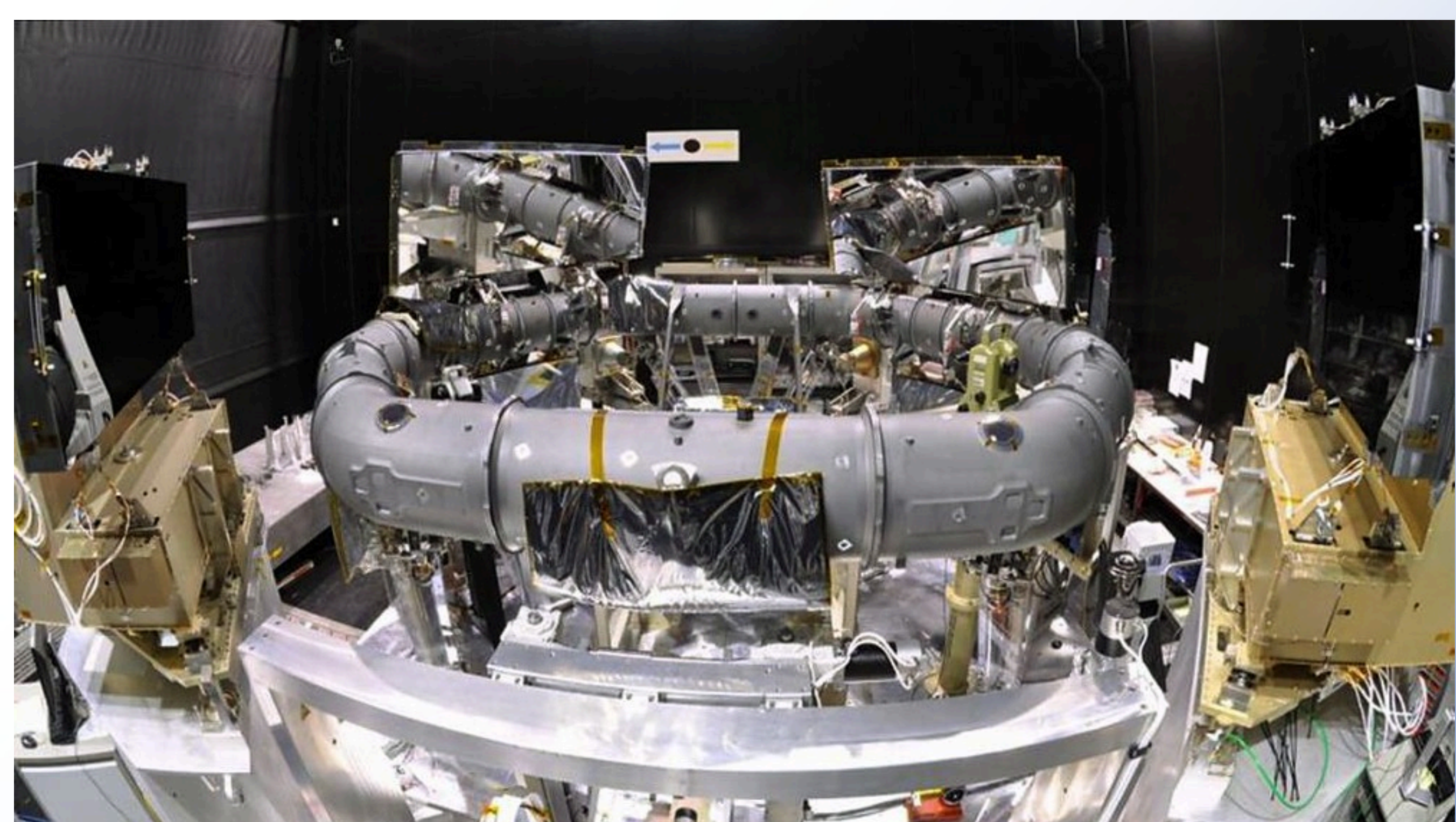
- Magnitude limits:
 - Hipparcos < 12 mag
 - Gaia 6 - 20 mag
- Number of objects: 120,000 => 10^9
- Accuracy: milliarcsec => μ arcsec
- Radial velocity: none => 150 million objects
- Pre-selected => Unbiased survey

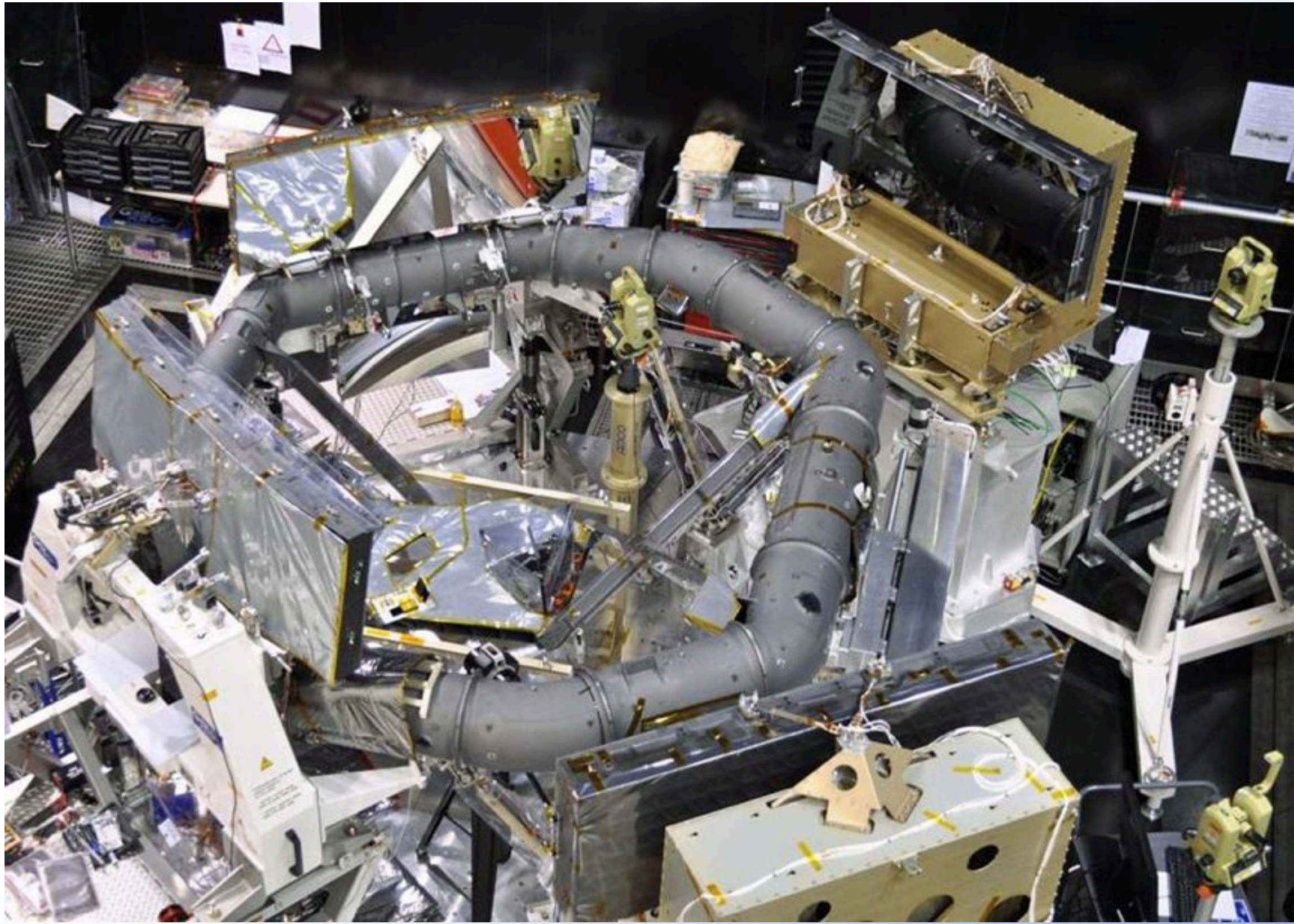


Payload and Telescope

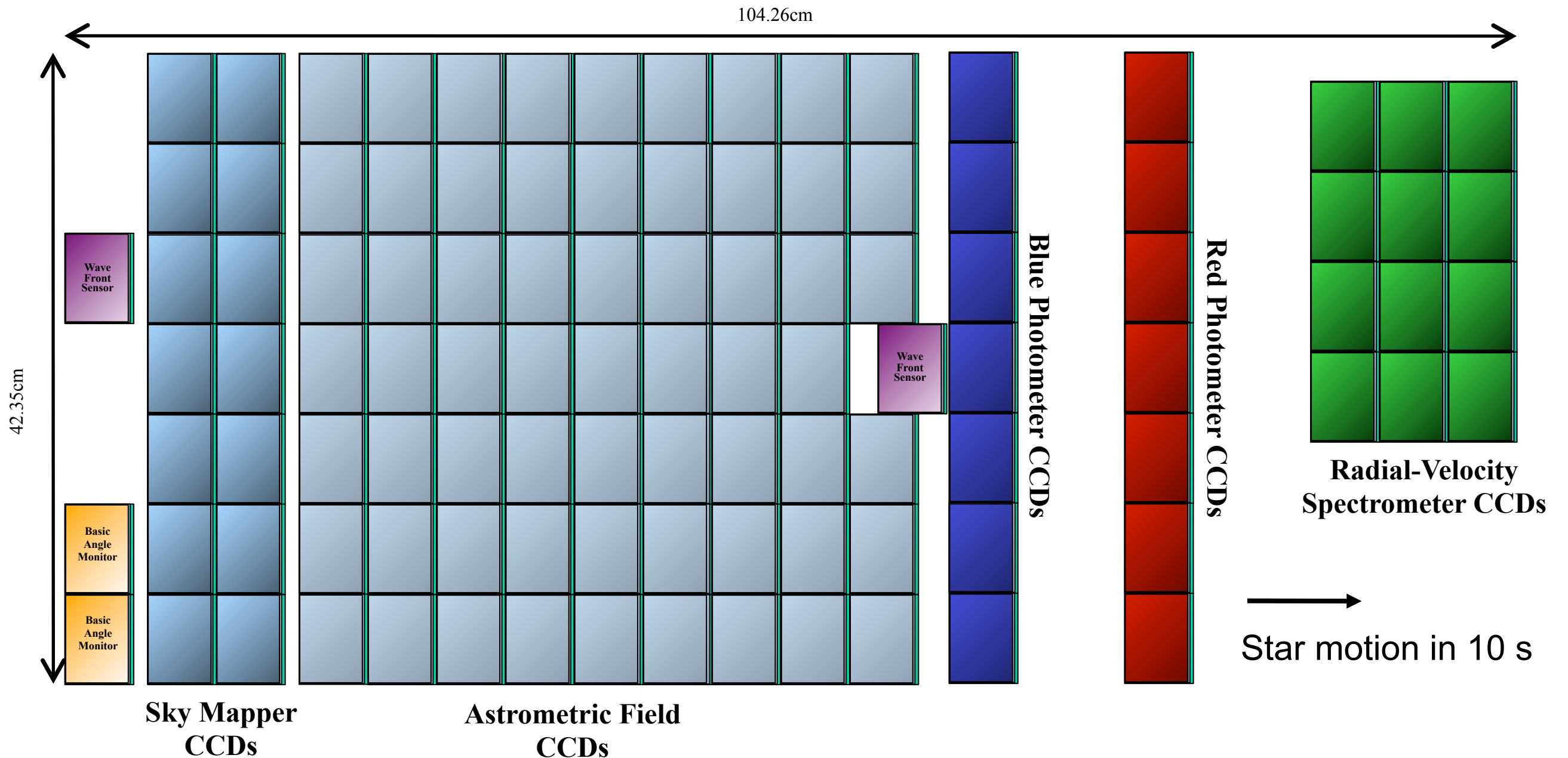








Focal Plane



Total field:

- active area: 0.75 deg²
- CCDs: 14 + 62 + 14 + 12 (+ 4)
- 4500 x 1966 pixels (TDI)
- pixel size = 10 μm x 30 μm
= 59 mas x 177 mas

Sky mapper:

- detects all objects to 20 mag
- rejects cosmic-ray events
- field-of-view discrimination

Astrometry:

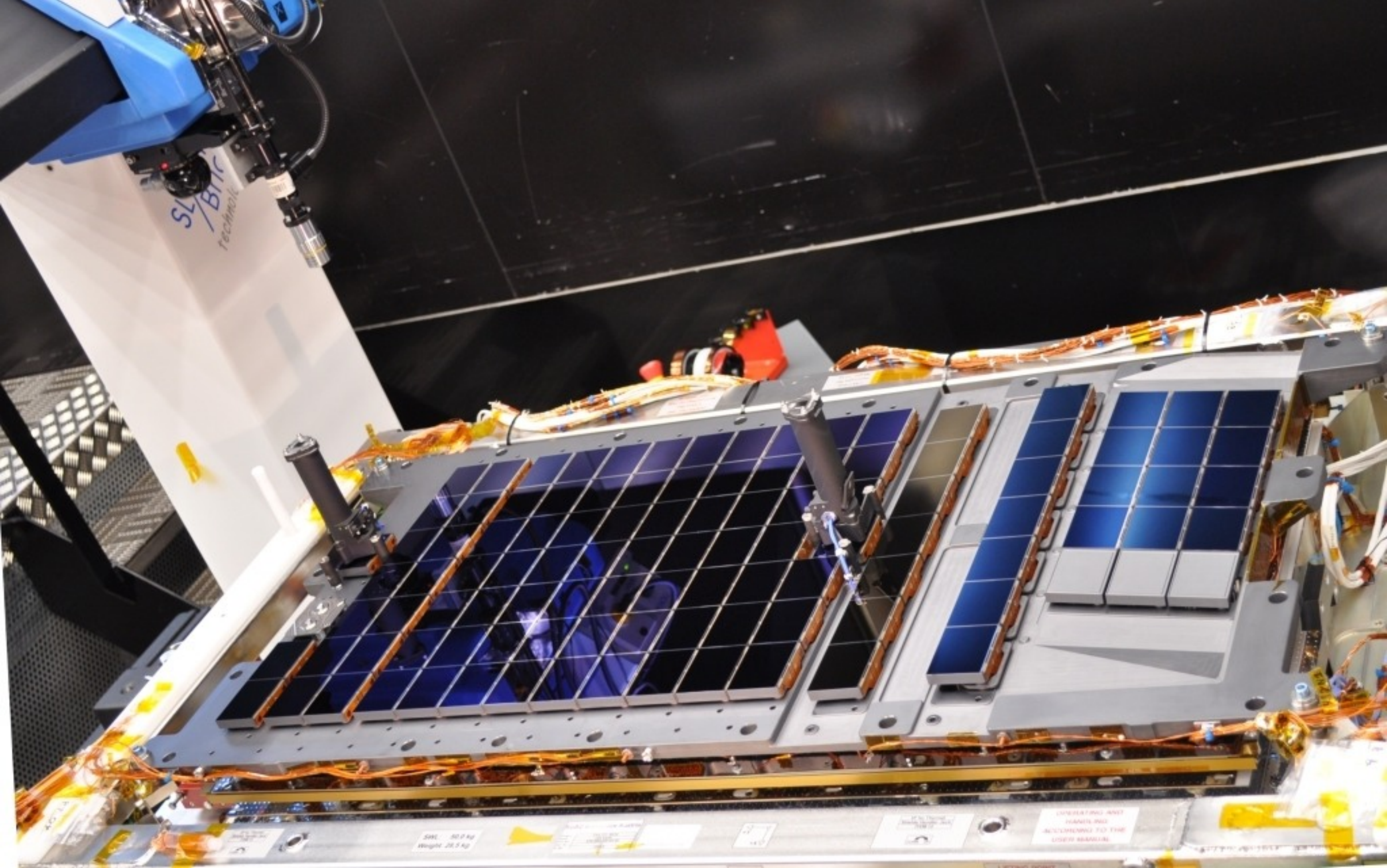
- total detection noise ~ 6 e⁻

Photometry:

- spectro-photometer
- blue and red CCDs

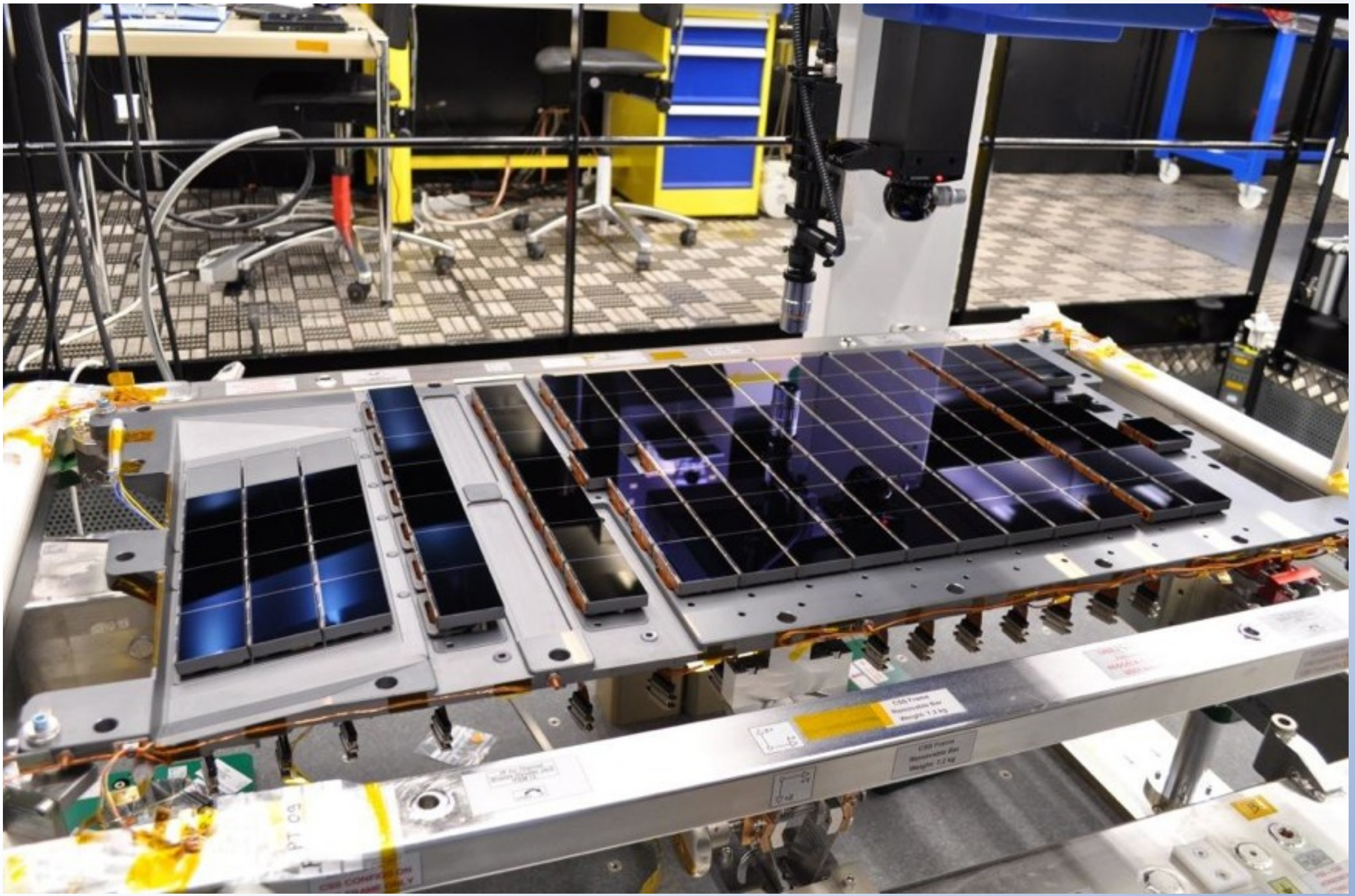
Spectroscopy:

- high-resolution spectra
- red CCDs

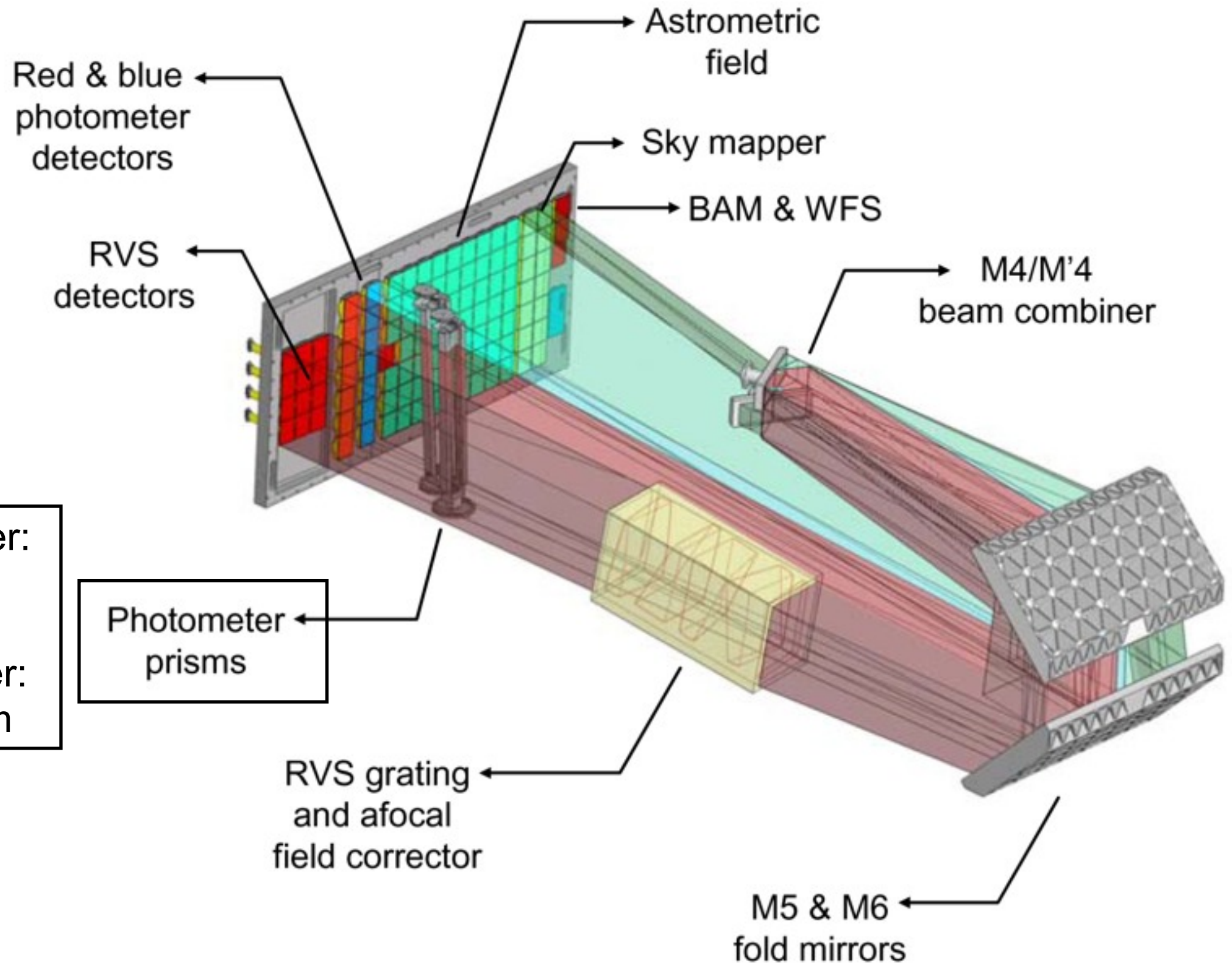


- Basic Angle Monitor (BAM)



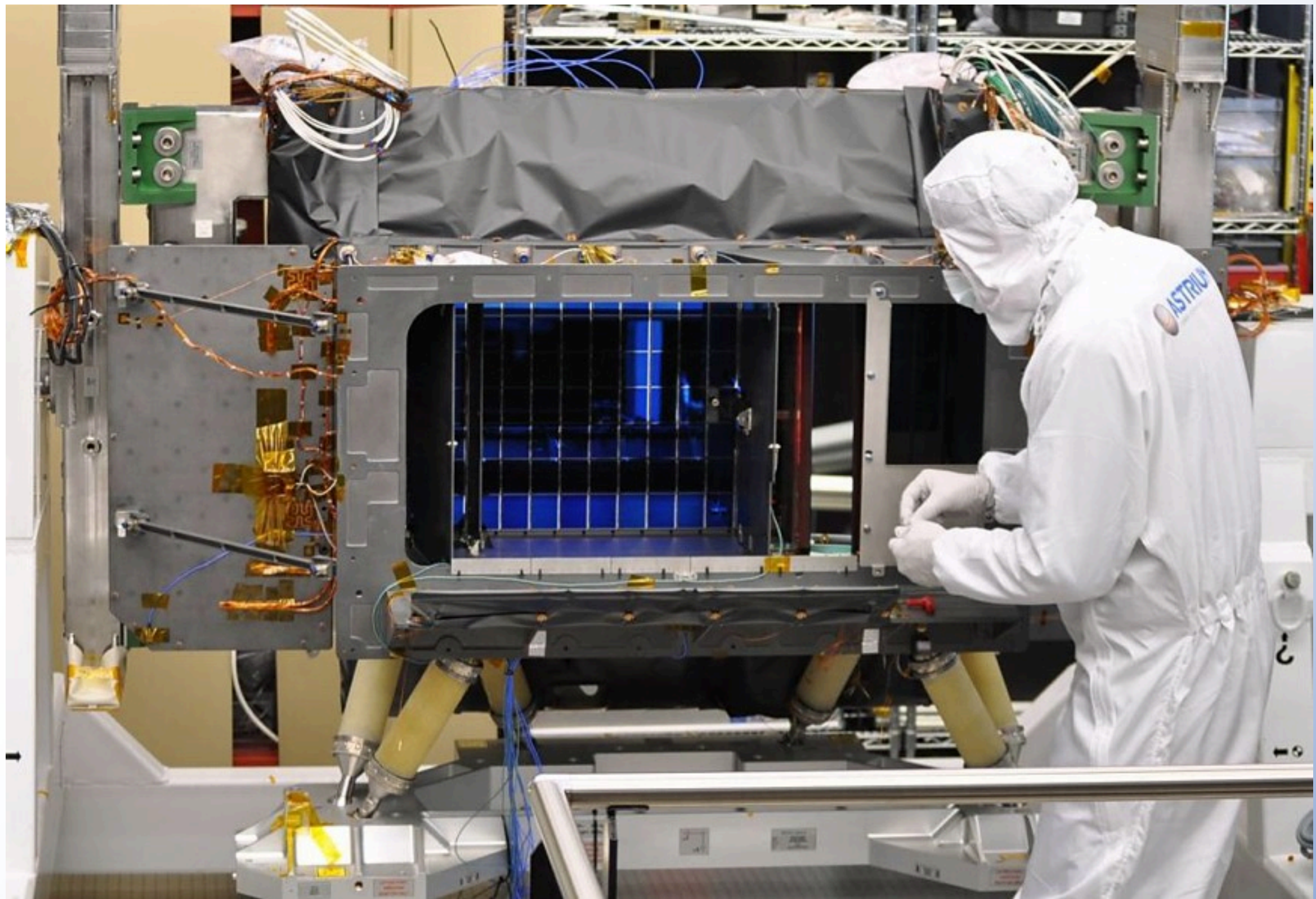


Photometry Measurement Concept



Blue photometer:
330 – 680 nm

Red photometer:
640 – 1000 nm



Radial-Velocity Measurement Concept

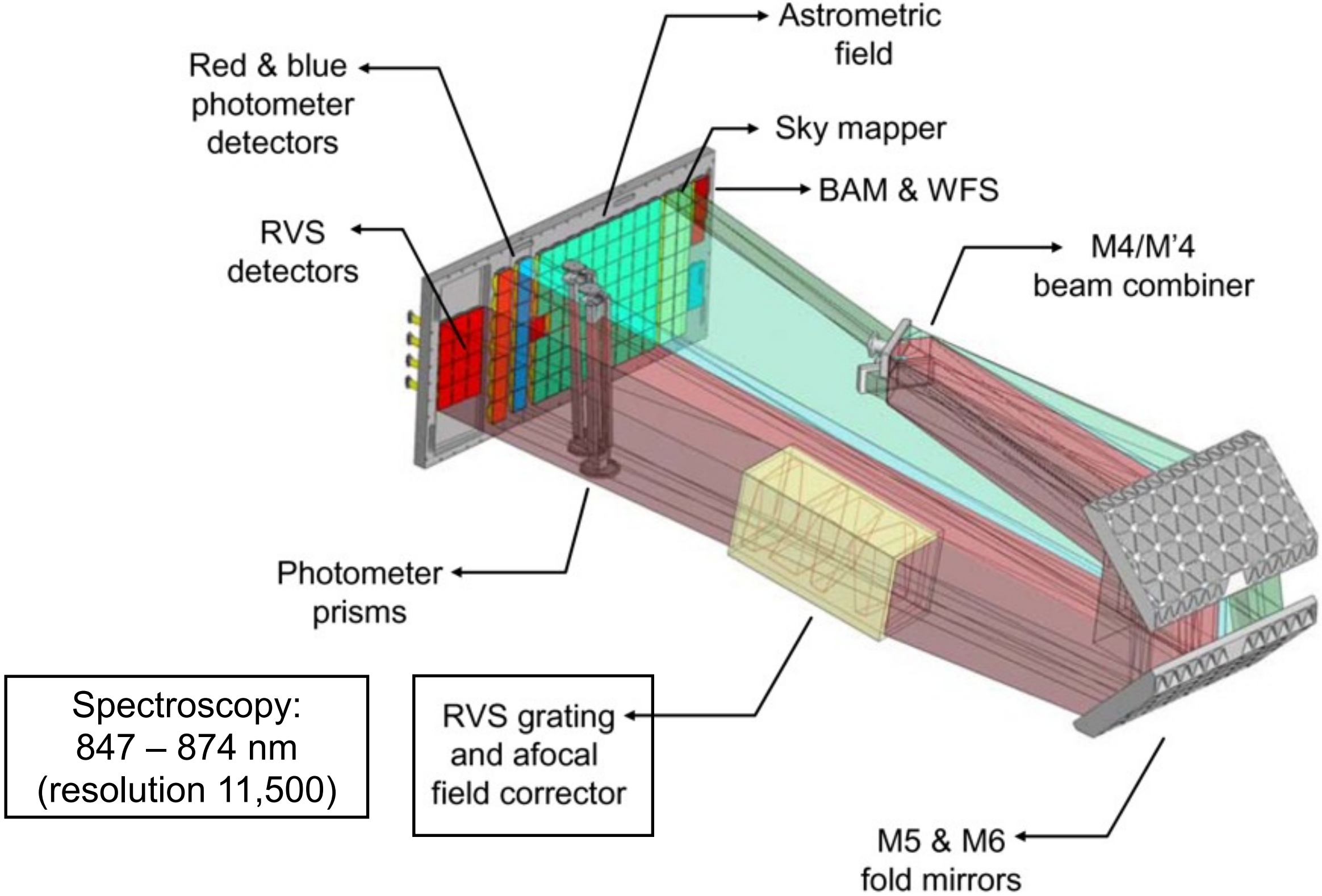
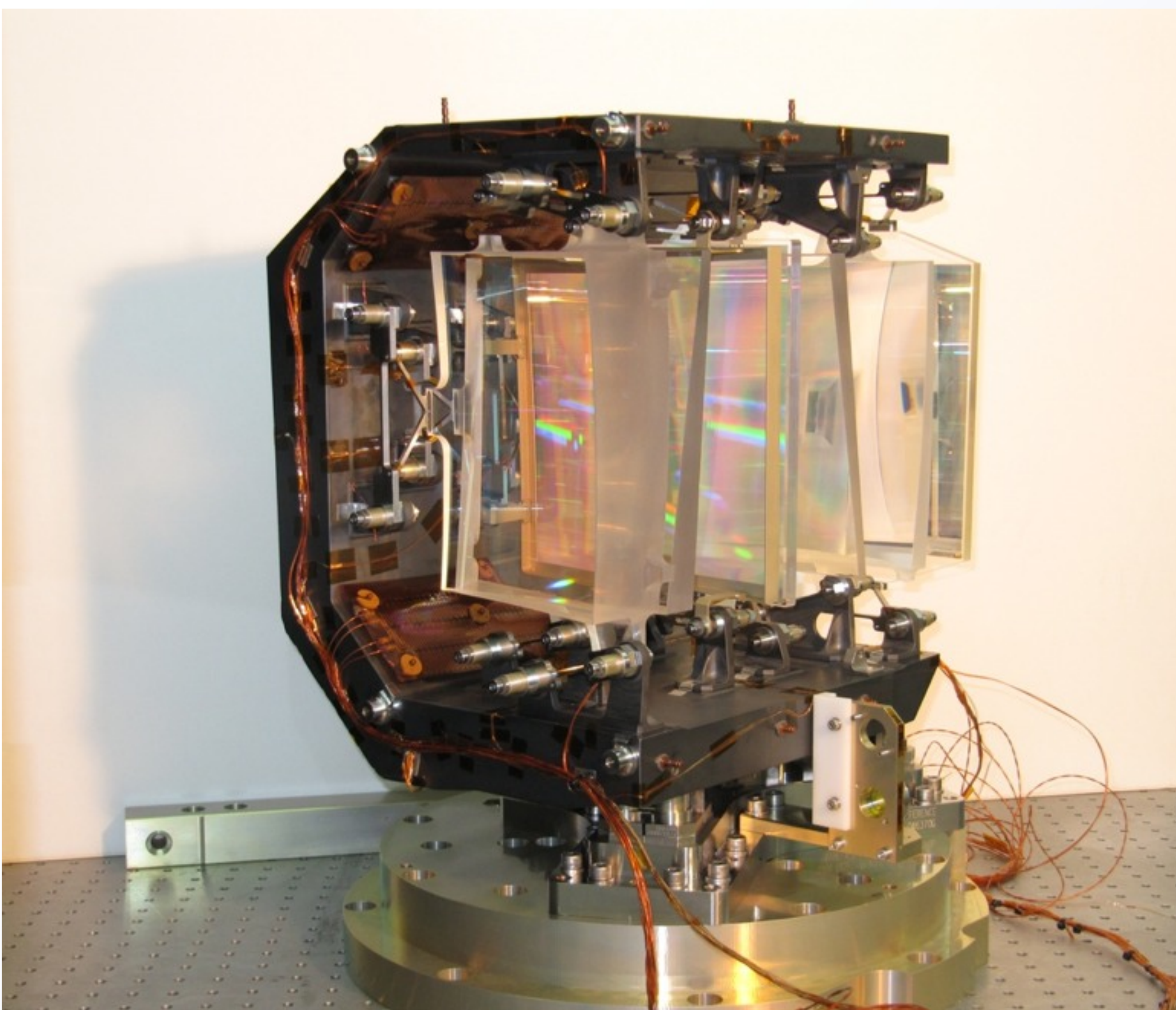
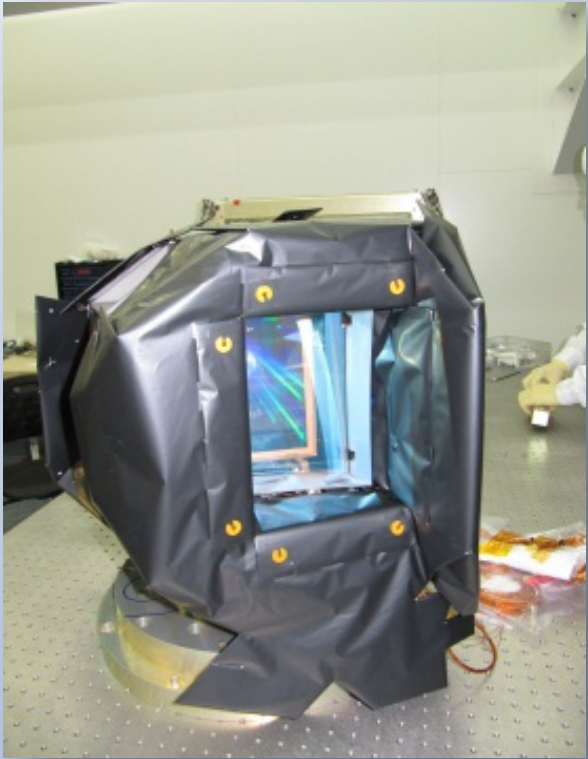
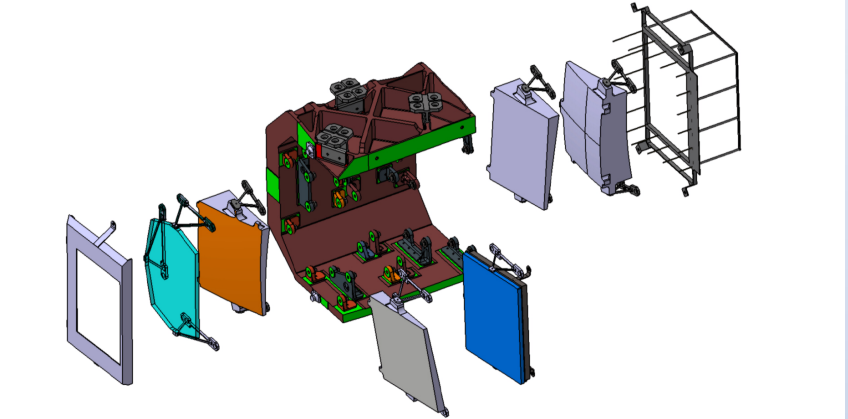
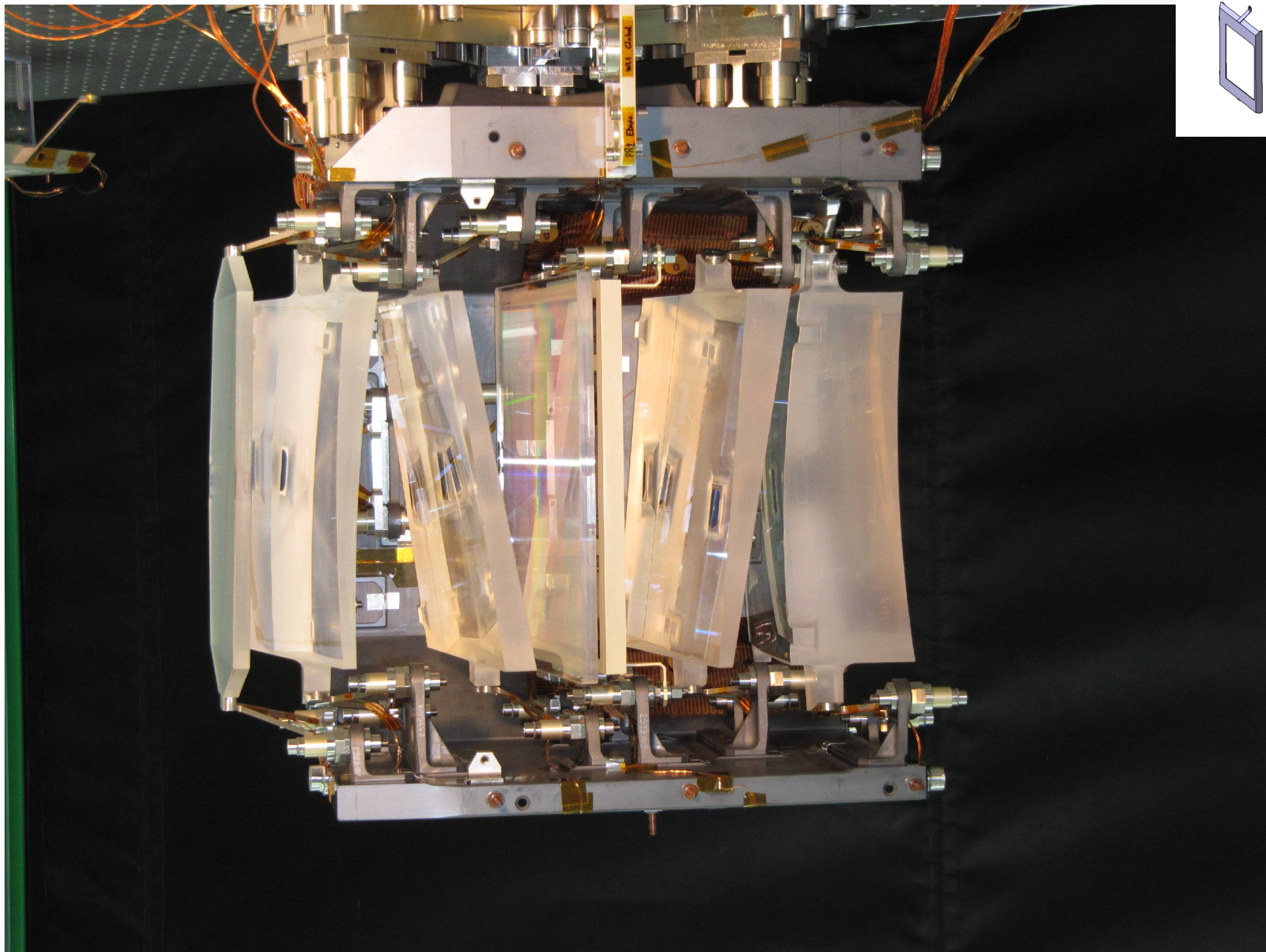
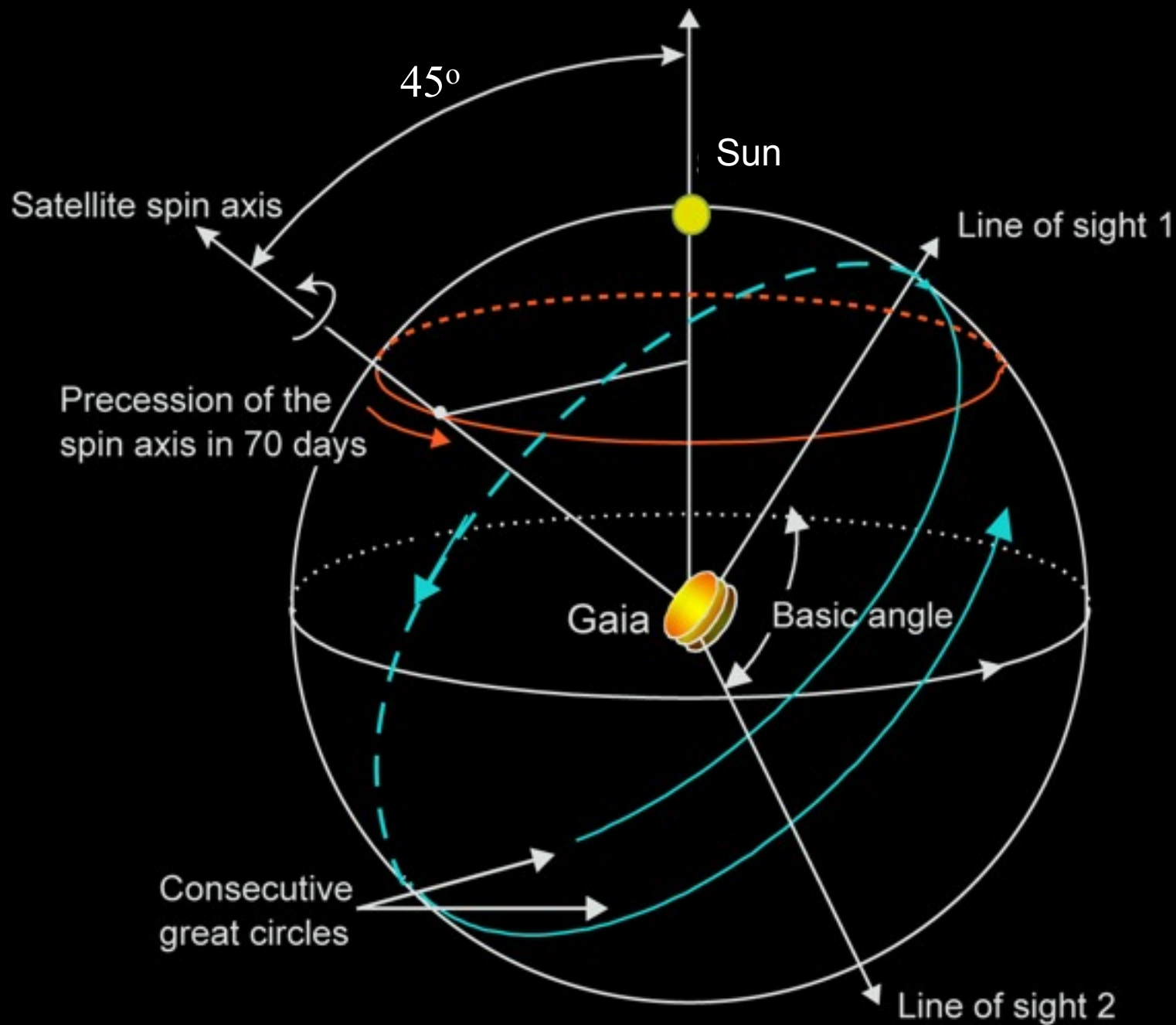


Figure courtesy EADS-Astrium



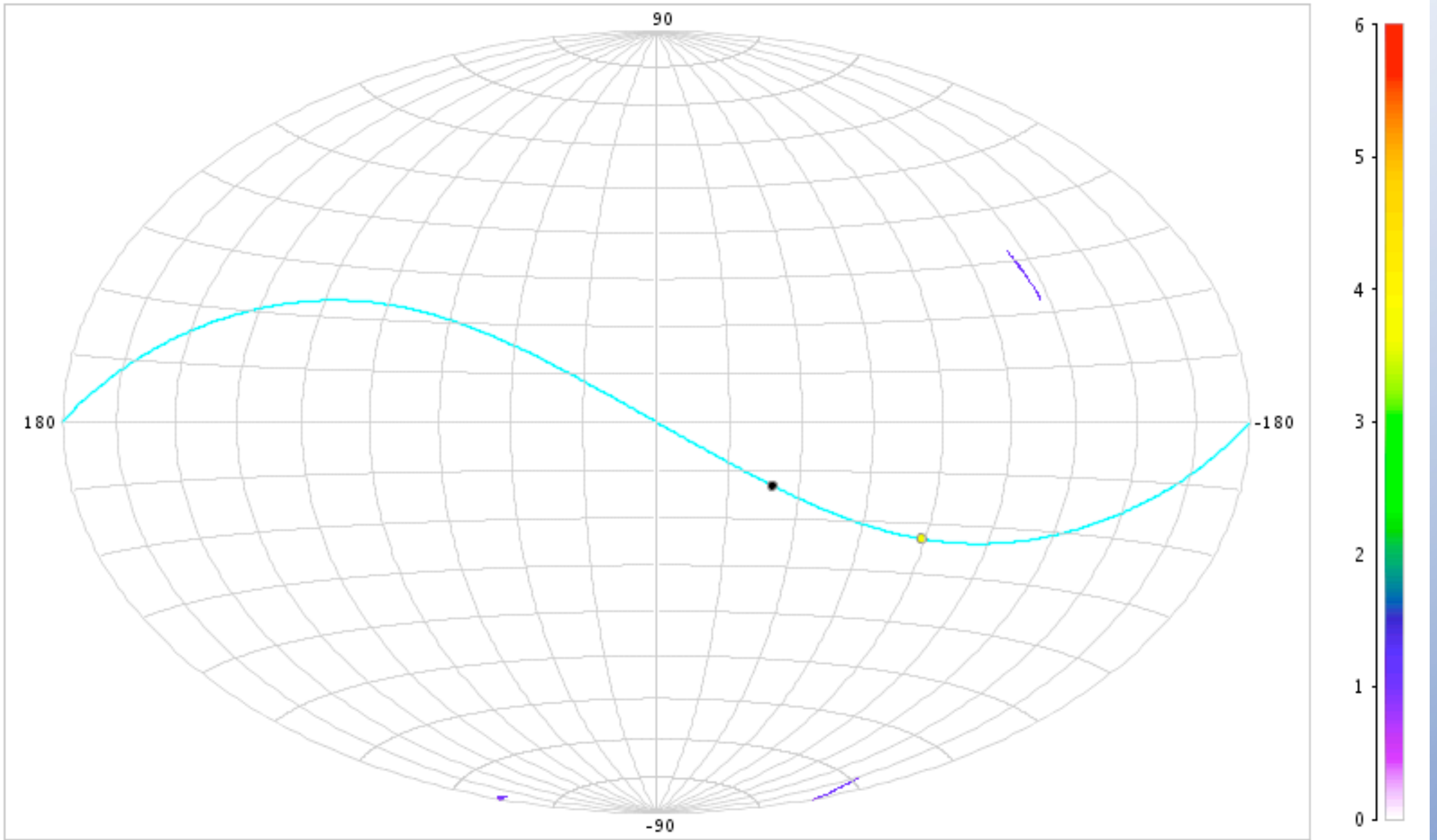


Sky-Scanning Principle

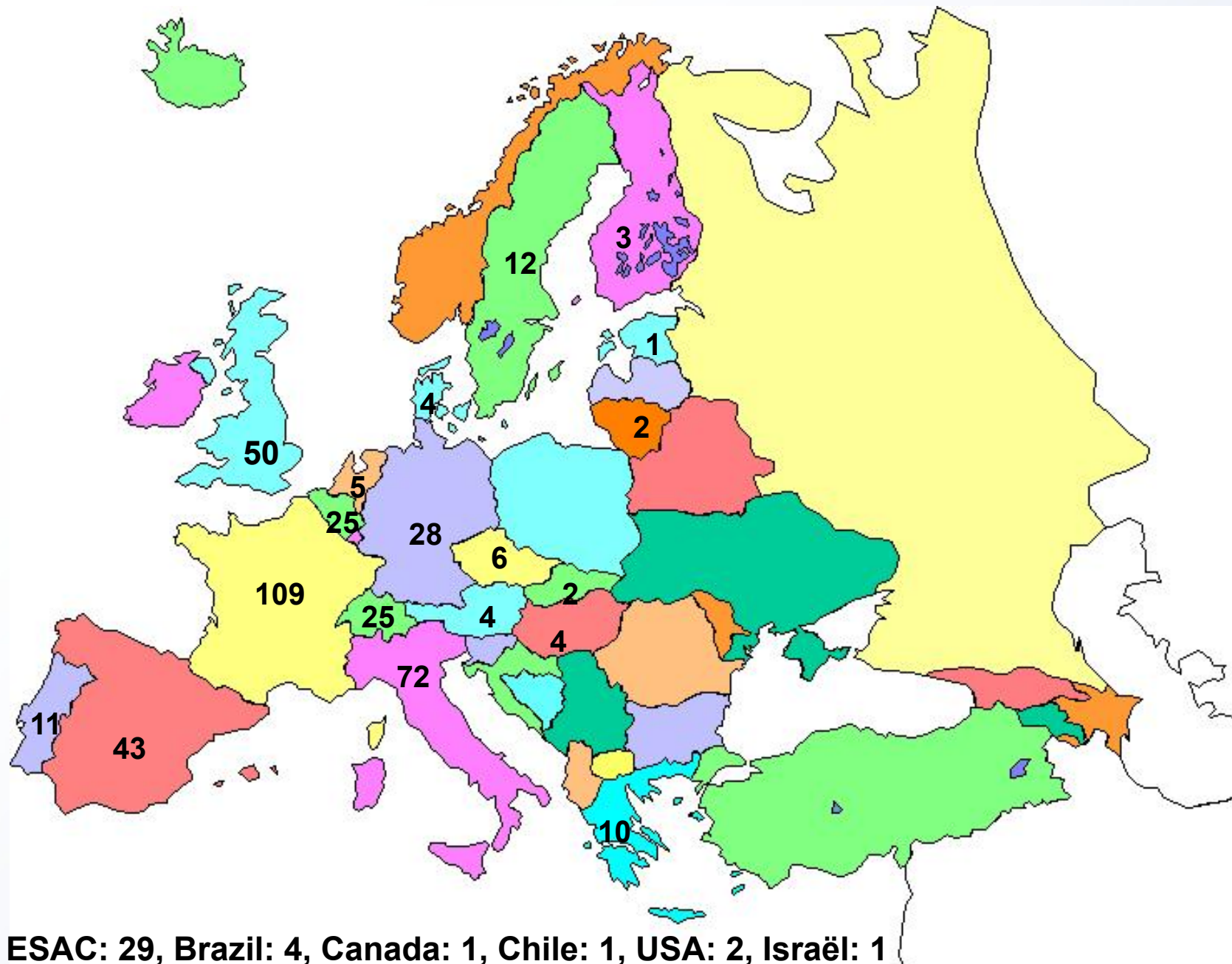


Spin axis	45° to Sun
Scan rate:	60 arcsec s ⁻¹
Spin period:	6 hours

NSL field transits in ICRS after: 0 years 000 days 00 hr 10 min



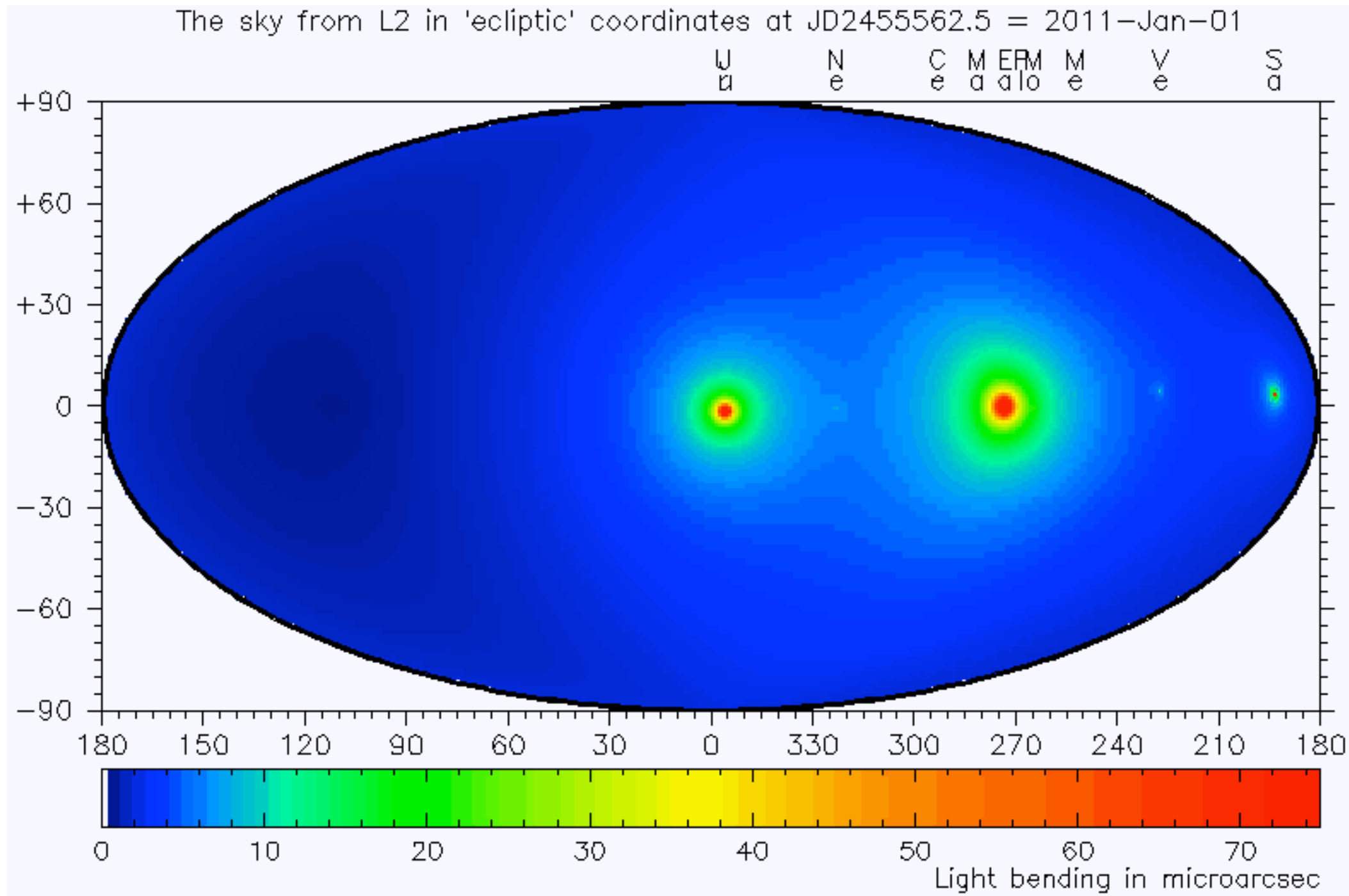
Data Processing



le
on is 40
400
e. 10
stars

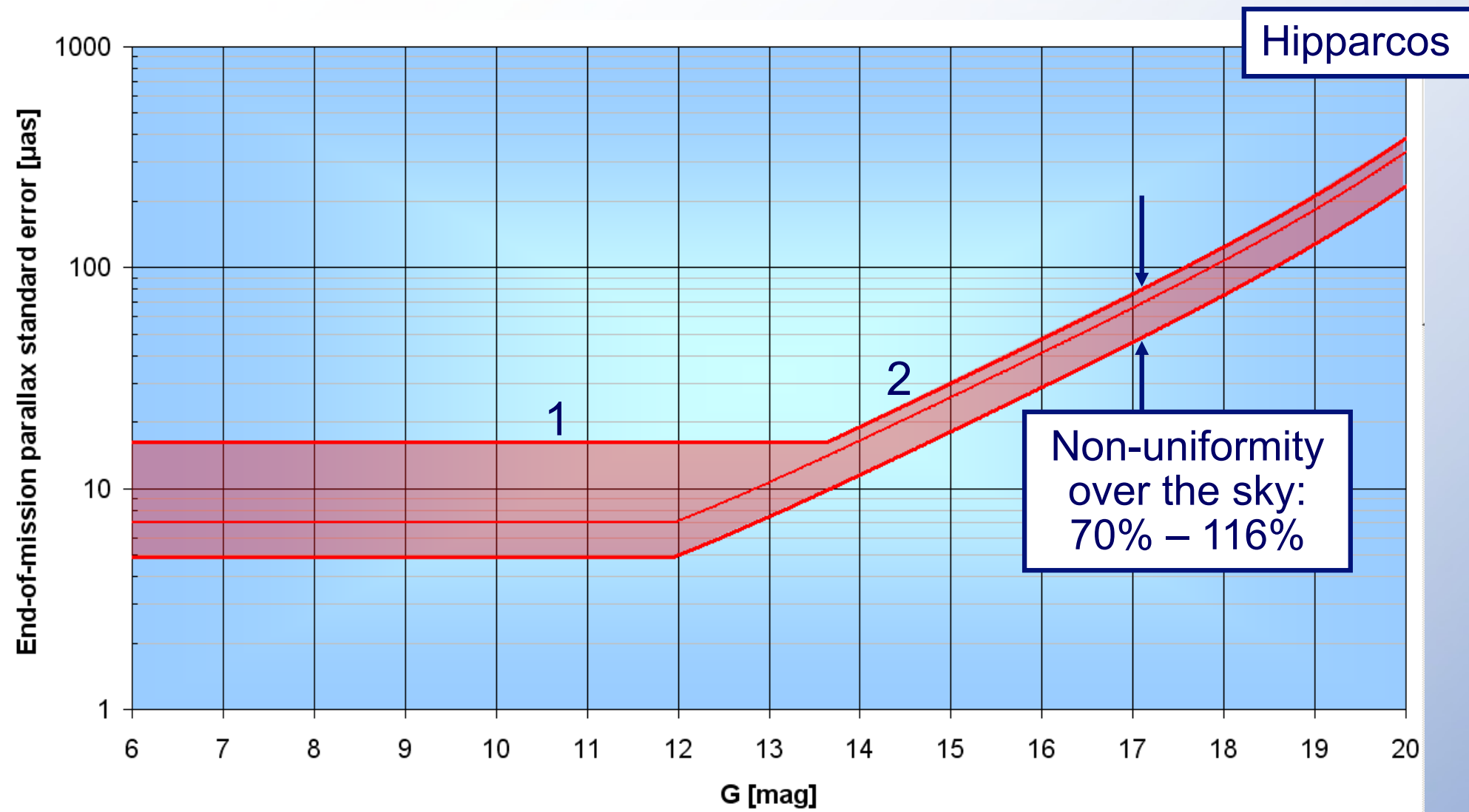


Light Bending in Solar System



Light bending in microarcsec, after subtraction of the much larger effect by the Sun

Astrometry



1. $6 < G < 12$: bright-star regime (calibration errors, CCD saturation)
2. $12 < G < 20$: photon-noise regime, with sky-background noise and electronic noise setting in around $G \sim 20$ mag

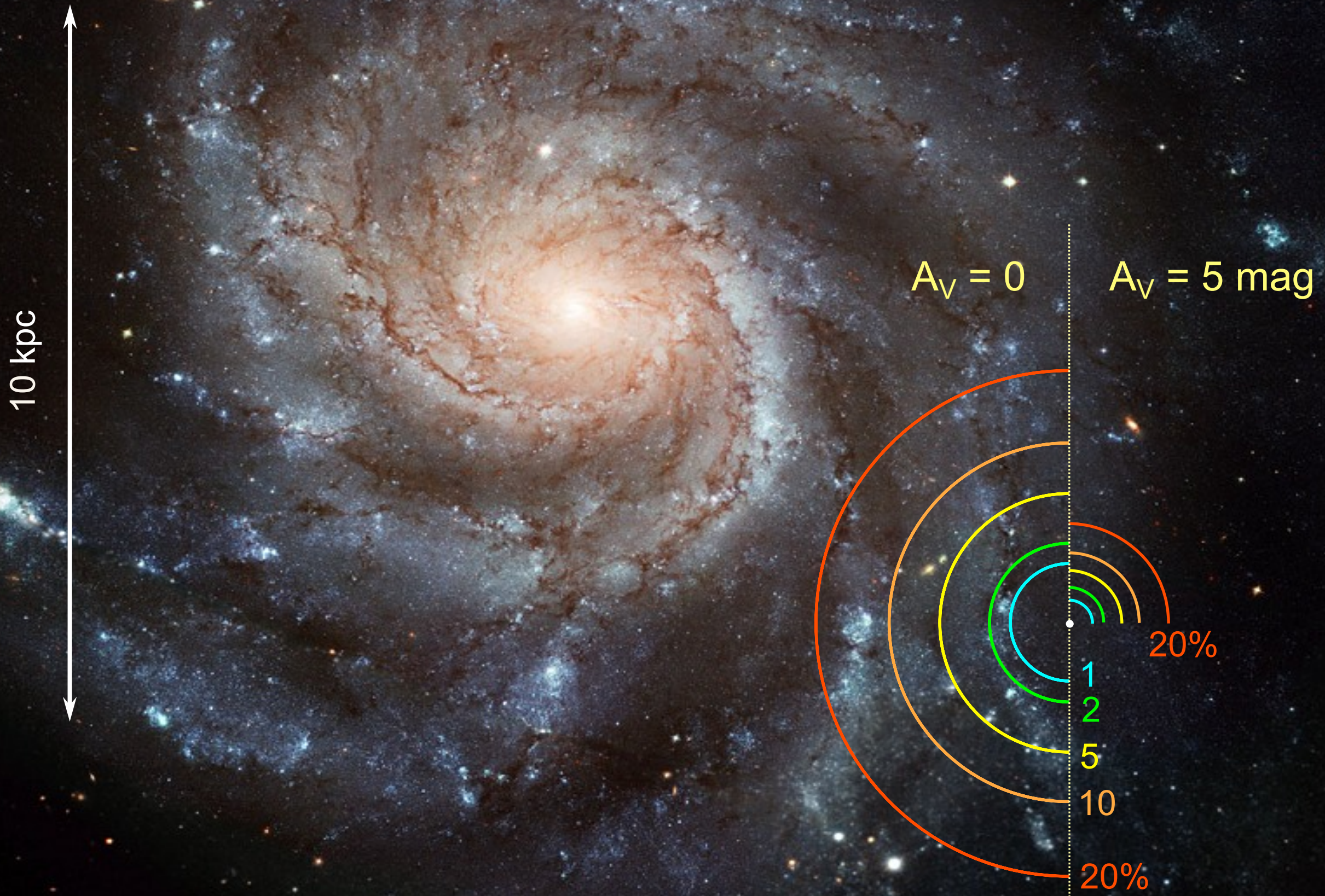


Parallax horizon for G0V stars (no extinction)

10 kpc



Parallax horizon for G0V stars



Parallax horizon for K5III stars

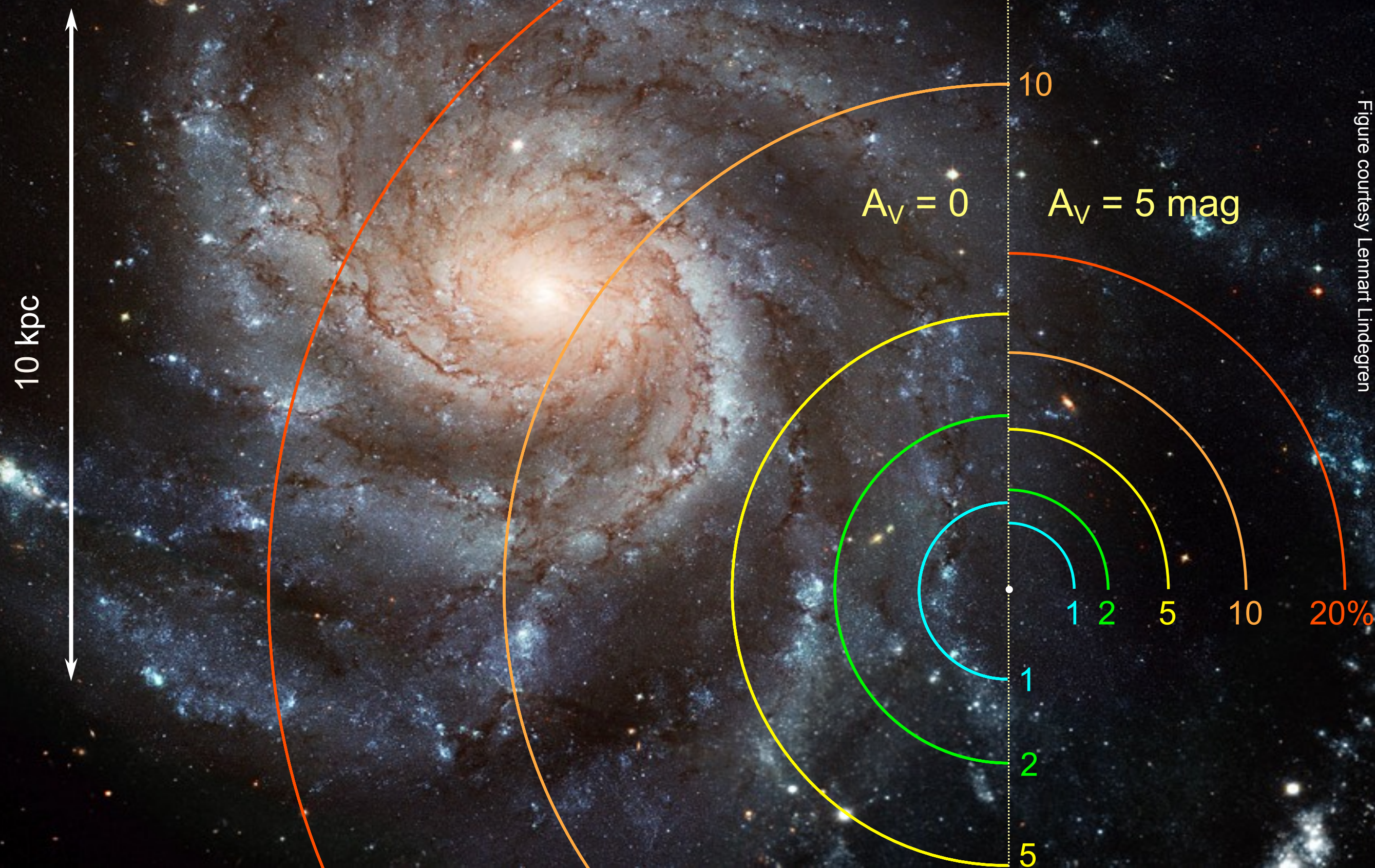
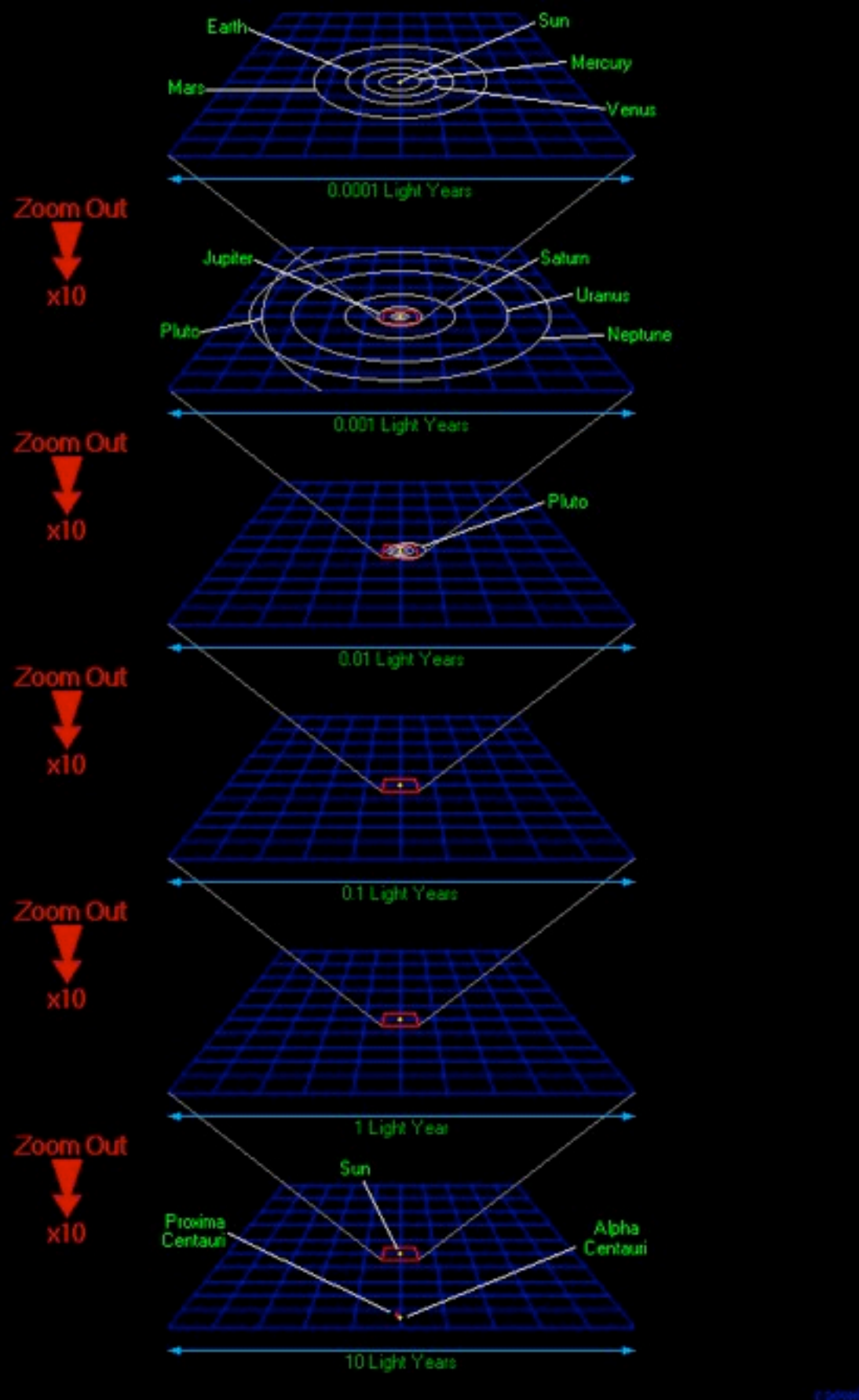


Figure courtesy Lennart Lindegren

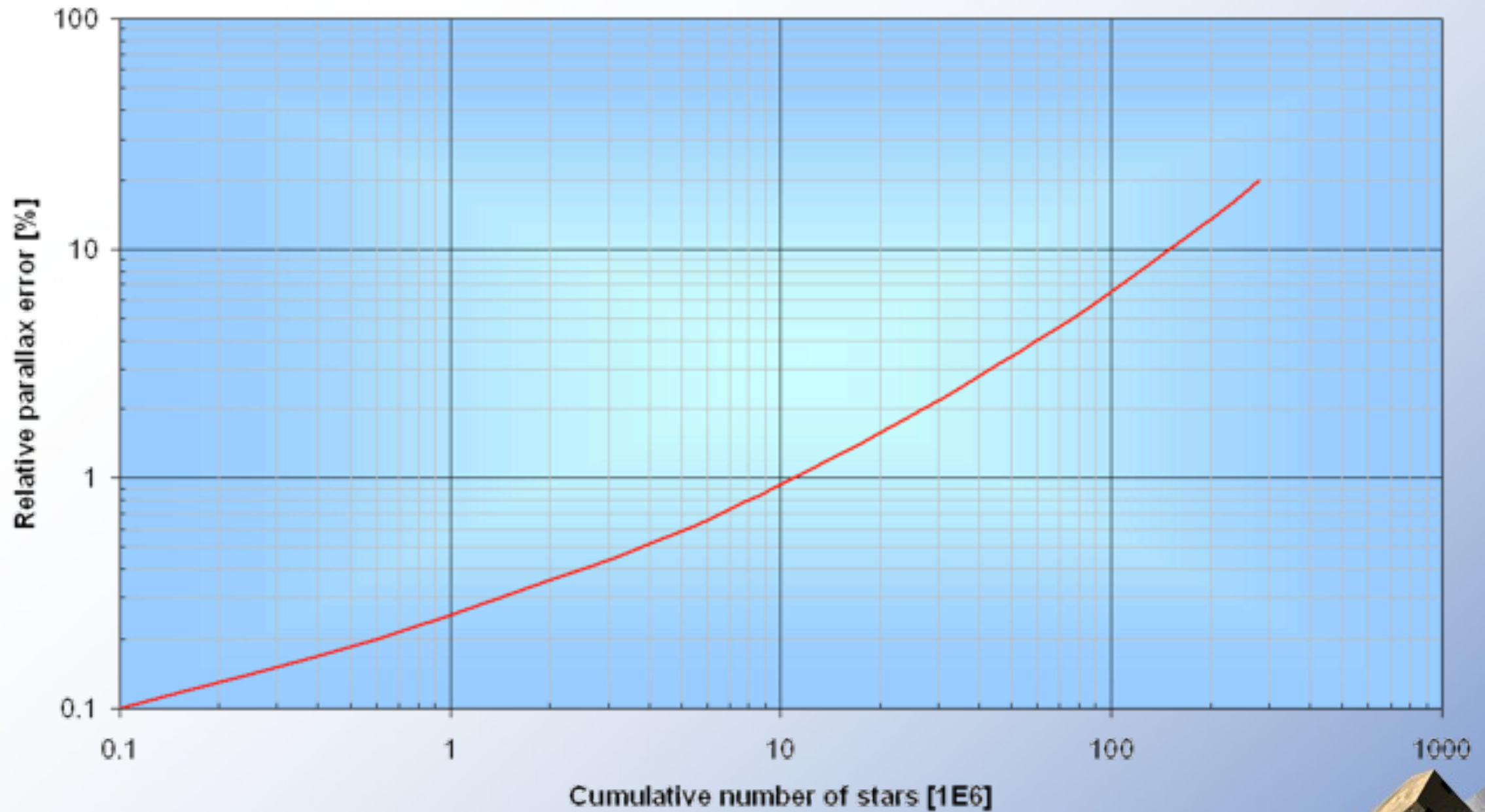
Parallax



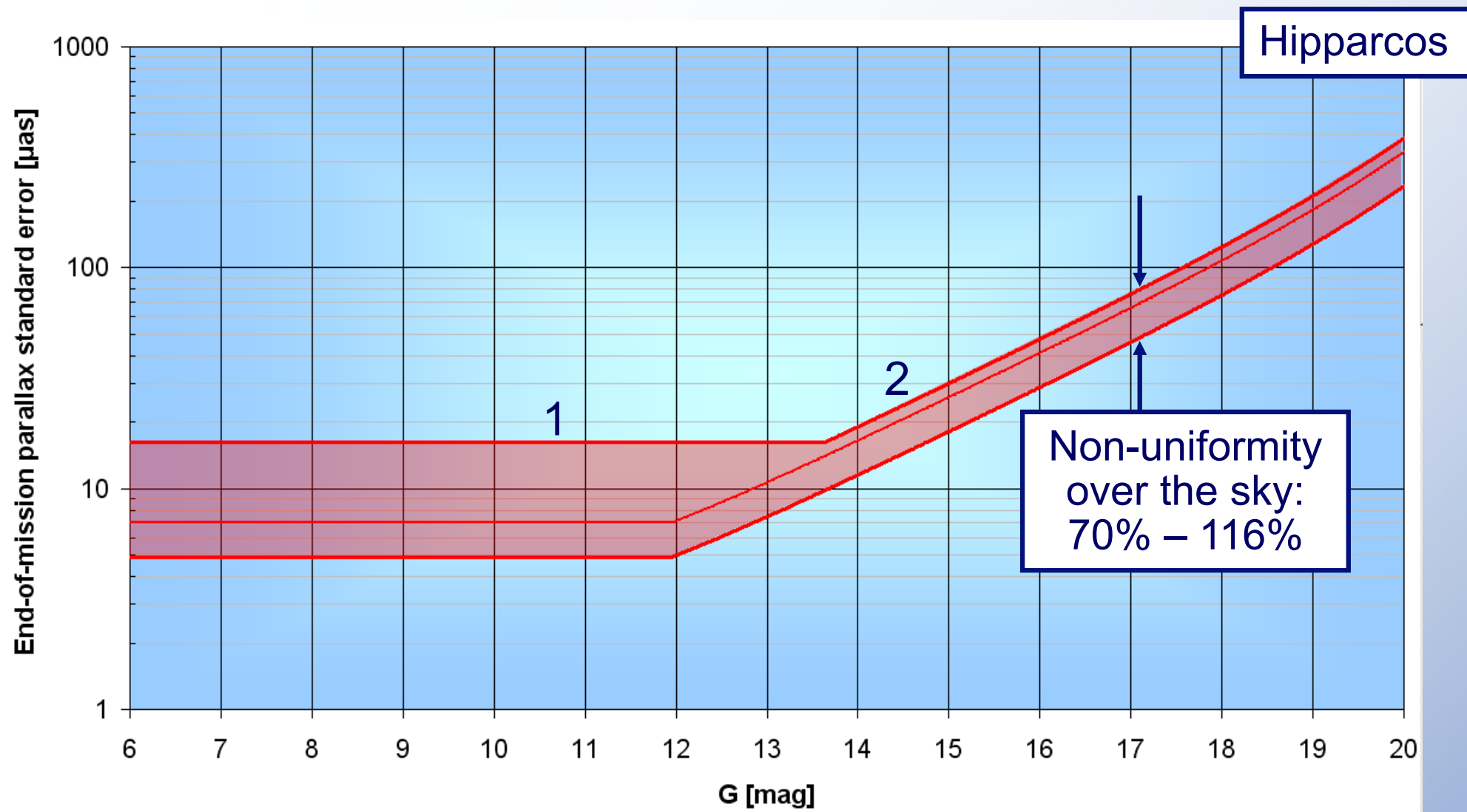
- Closest star 1.30 pc (4.24 light years) parallax 769 mas
- Gaia: $1.30xxx \pm 0.00001$ pc
- Parallax known to 1% for 719 stars
- Gaia $> 10^7$



Parallax statistics



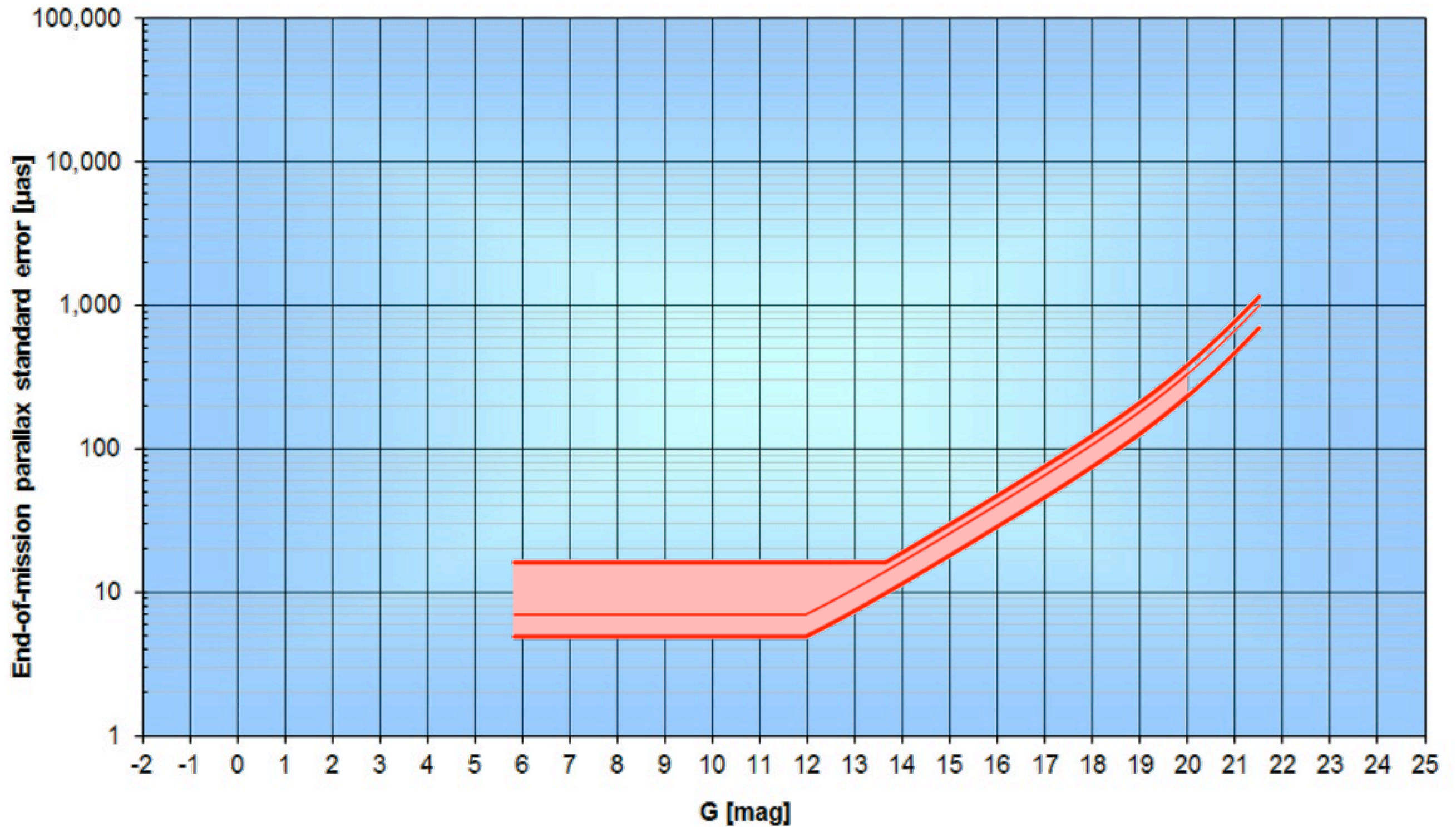
Astrometry



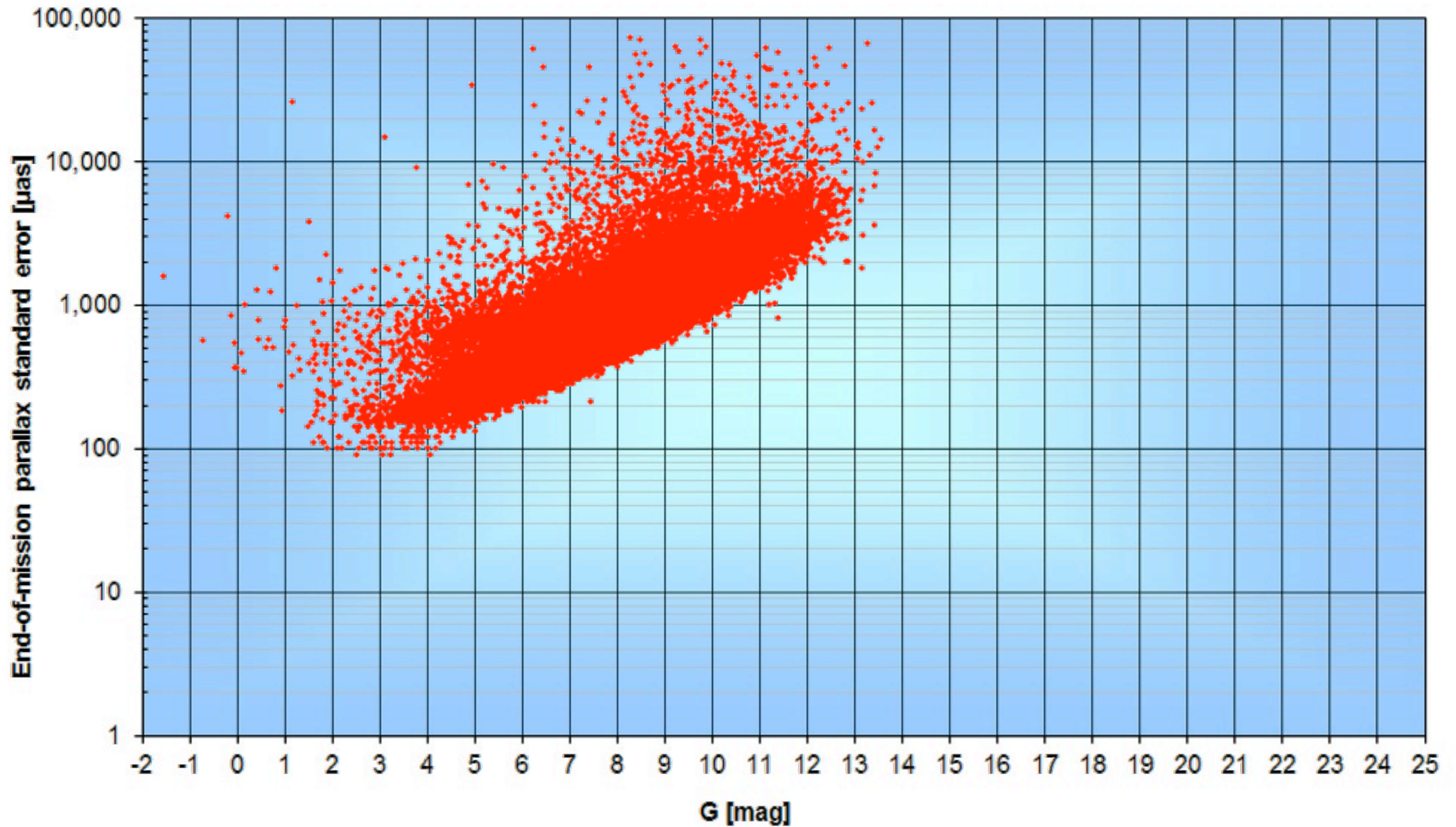
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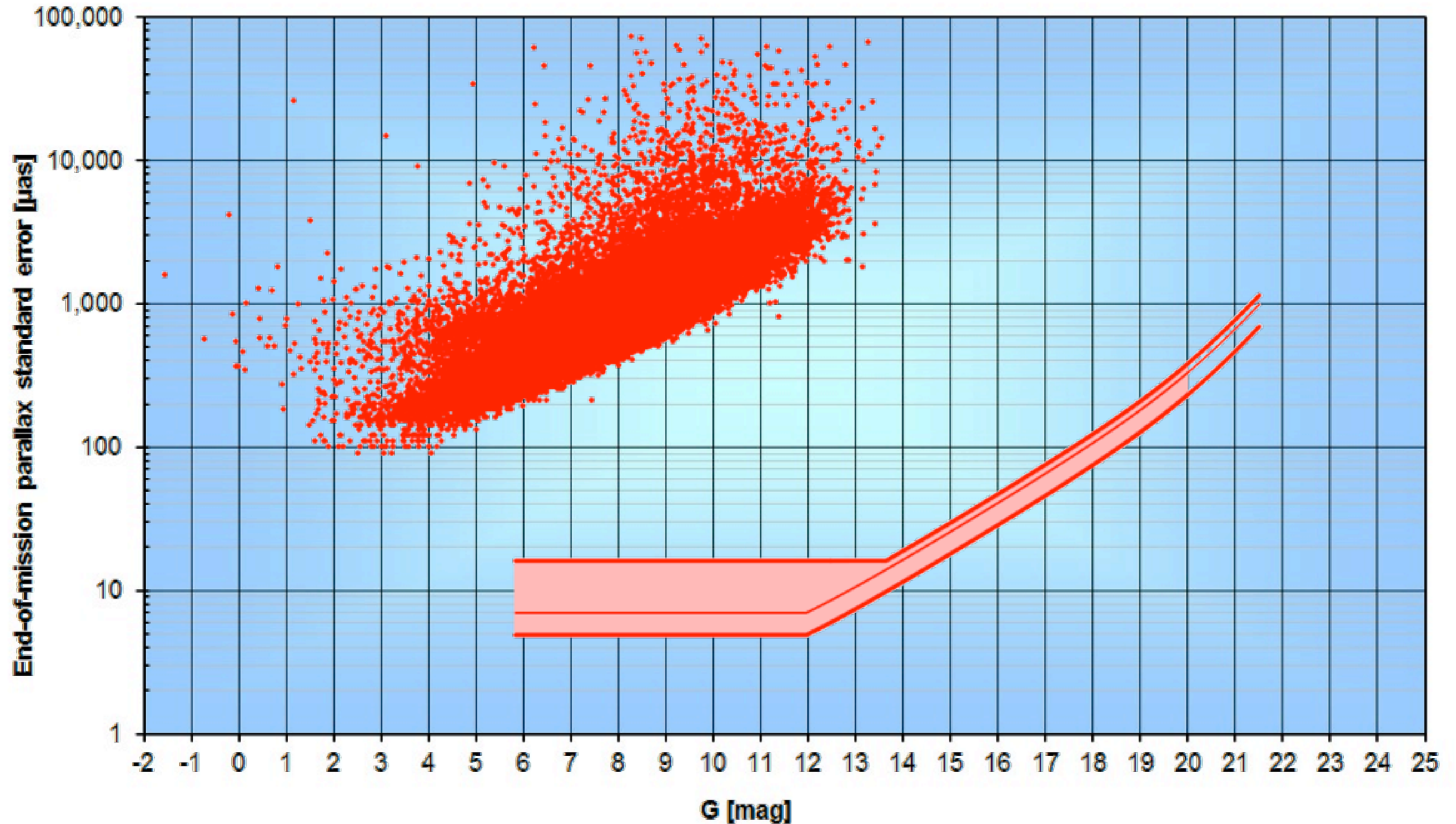
Gaia



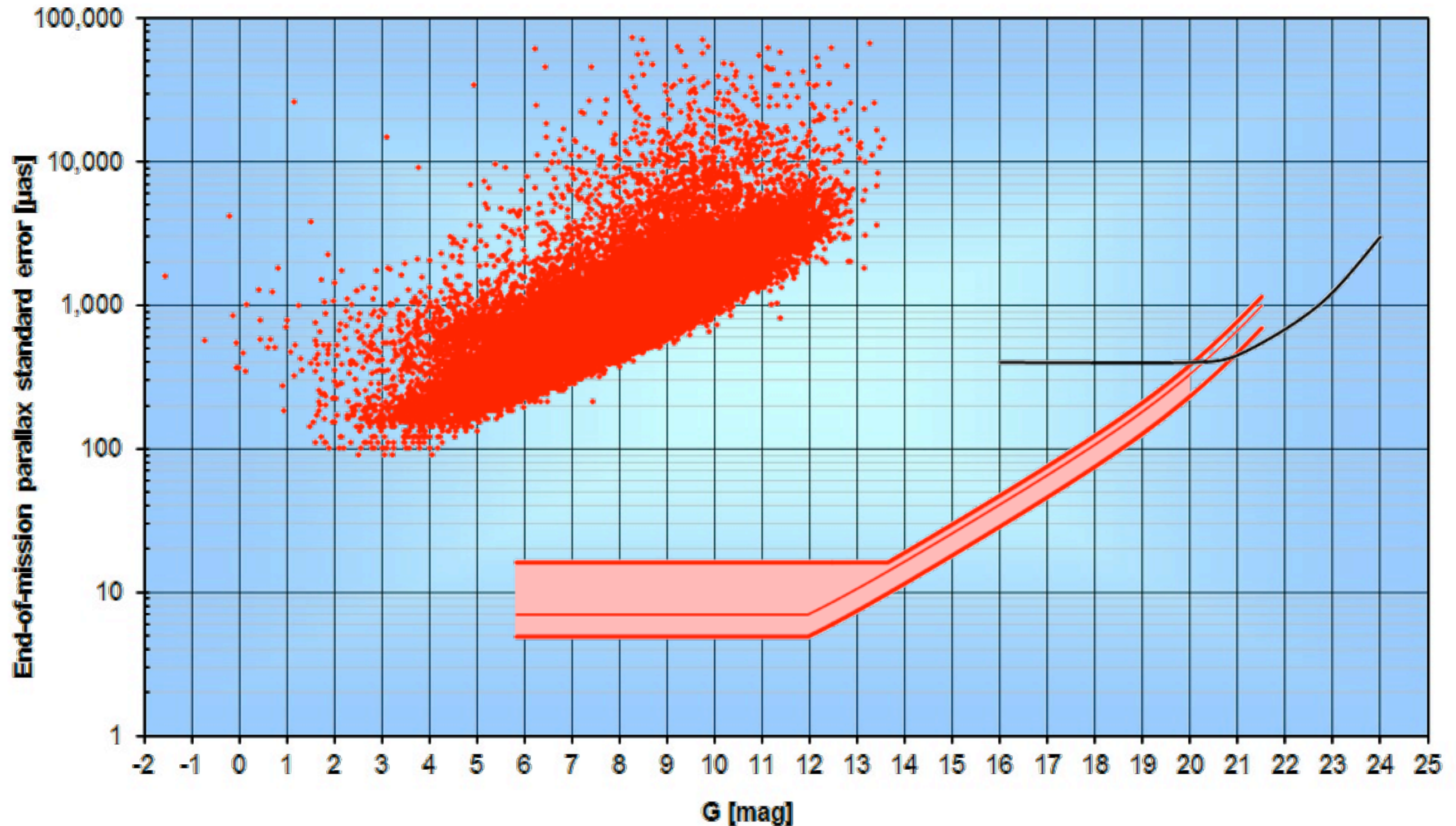
Hipparcos



Gaia & Hipparcos



Gaia, Hipparcos & LSST



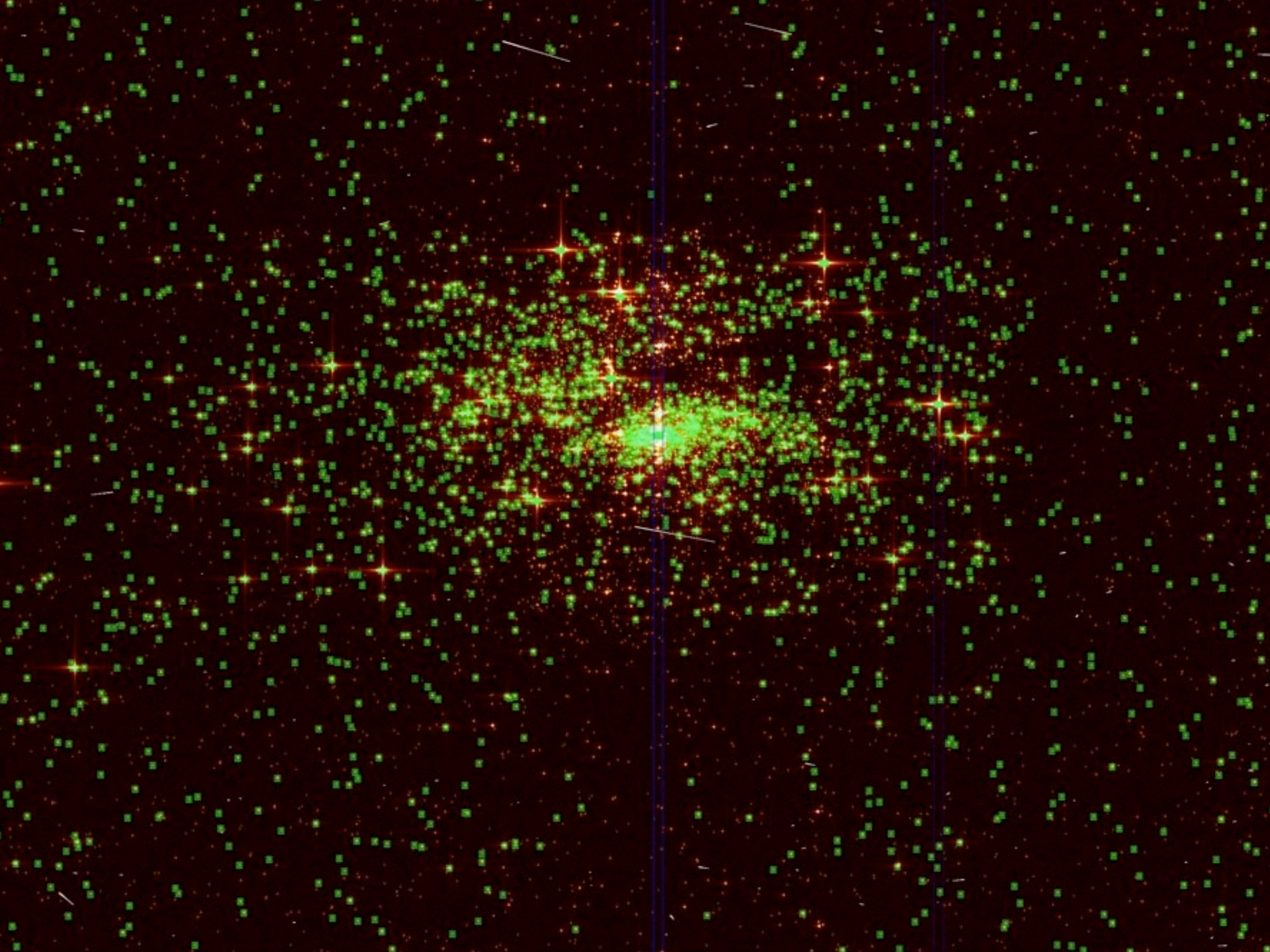


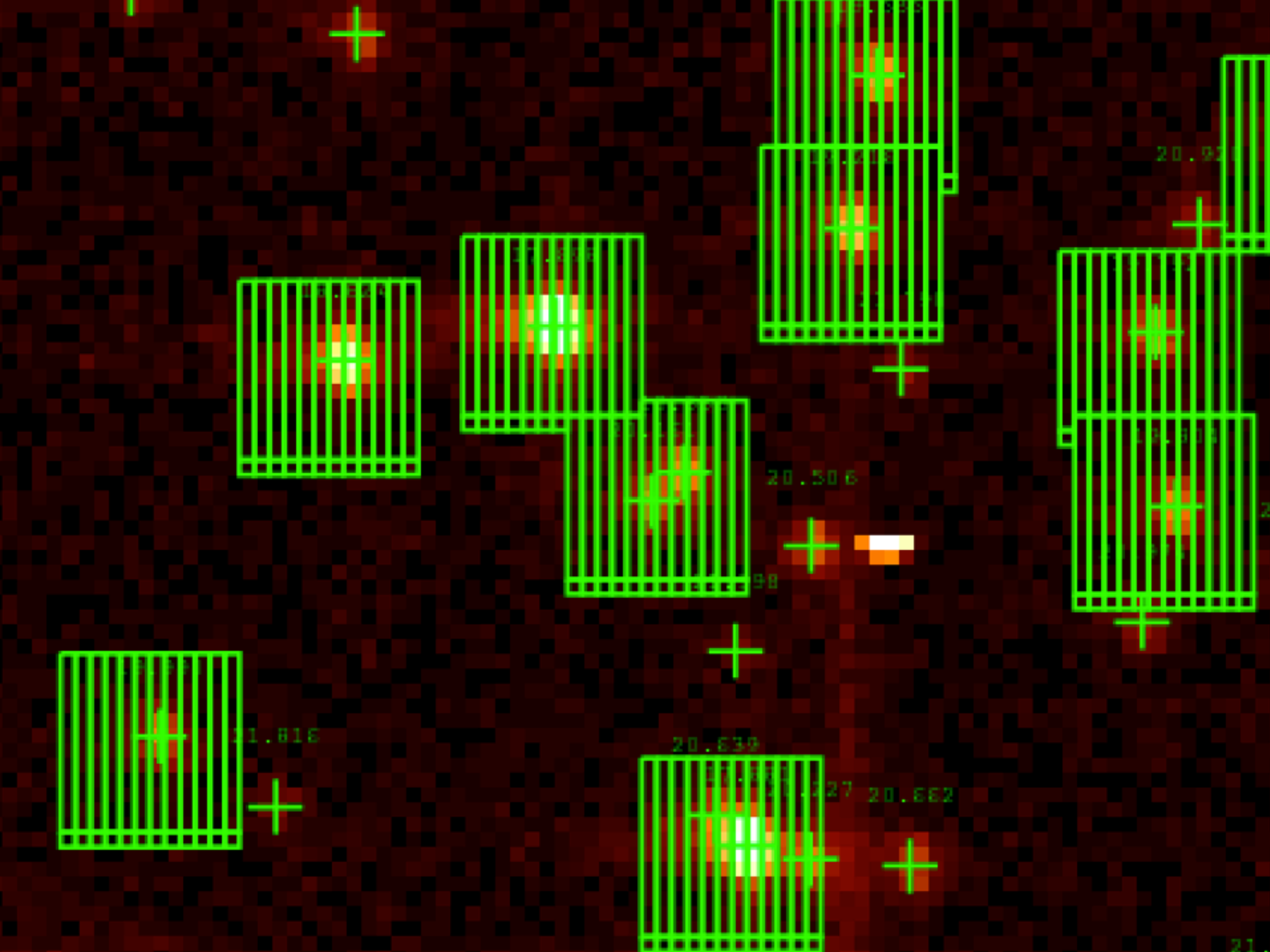
Star-Forming Region 30 Doradus
Hubble Space Telescope • WFC3/UVIS

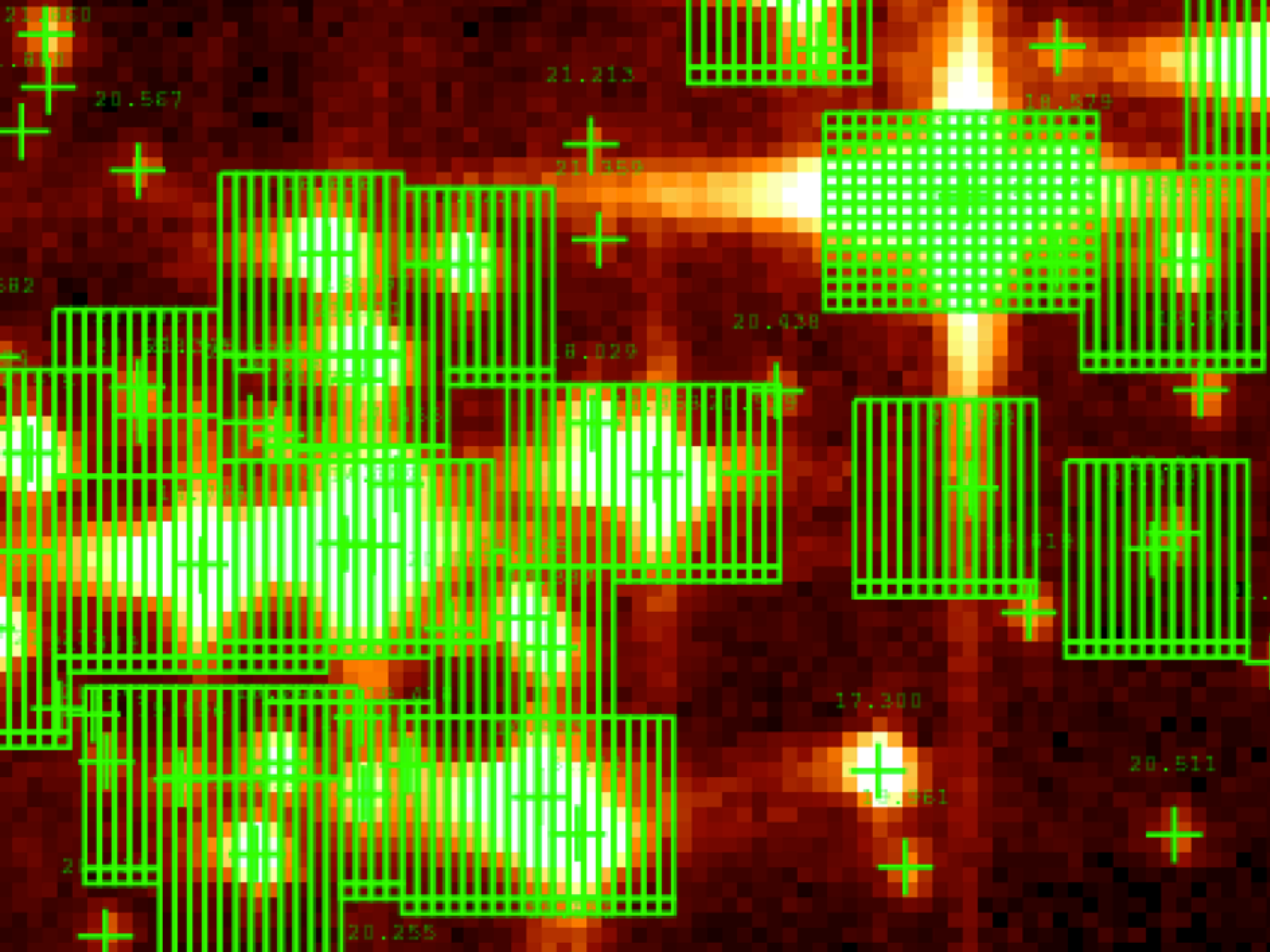
NASA, ESA, F. Paresce (INAF-IASF, Italy), and the WFC3 Science Oversight Committee

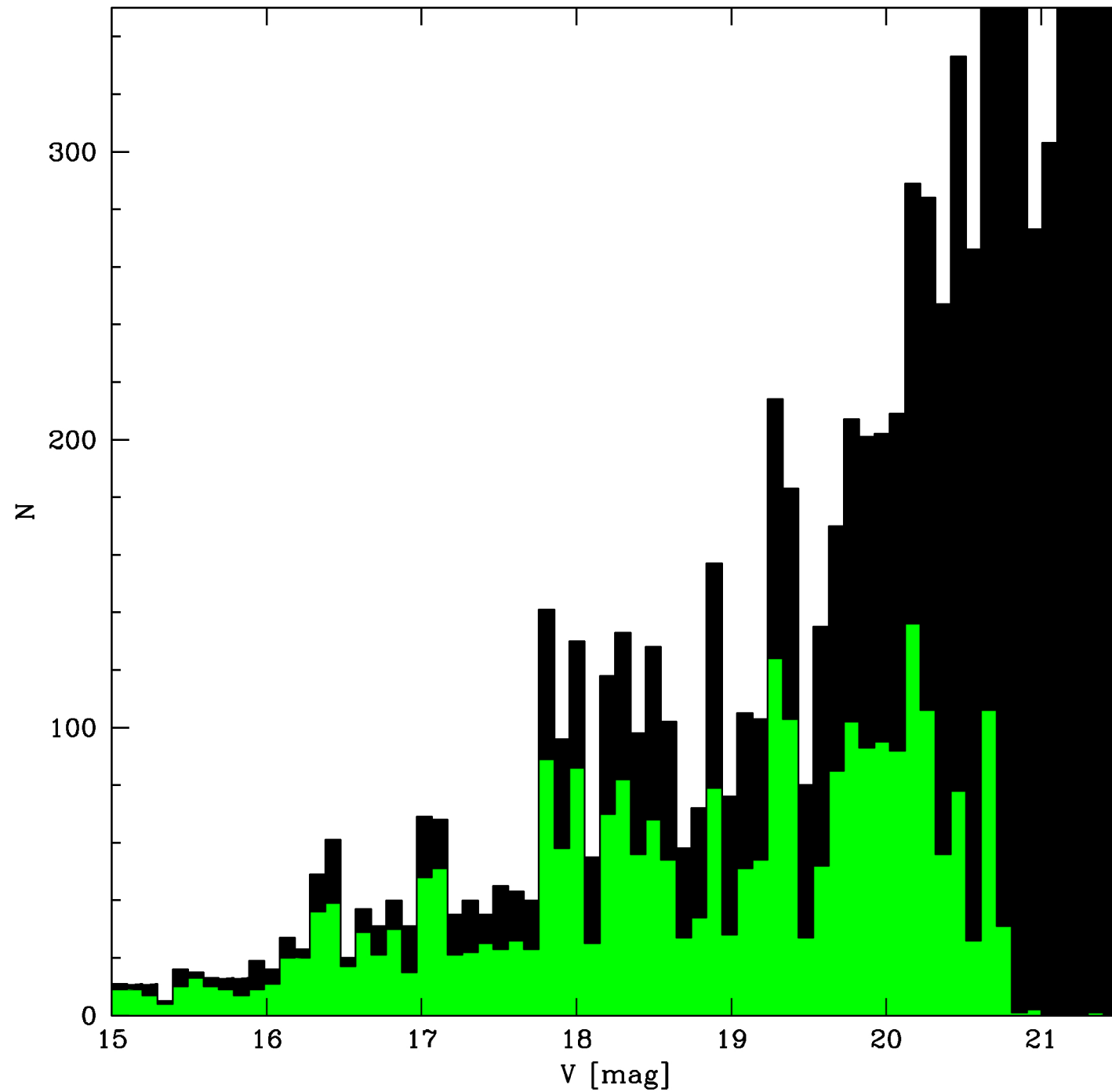
STScI-PRC09-32a











- HST (black) vs. one epoch of 4.4s of Gaia (green) observations on one CCD in R136

Figures courtesy of de Bruijne & de Marchi

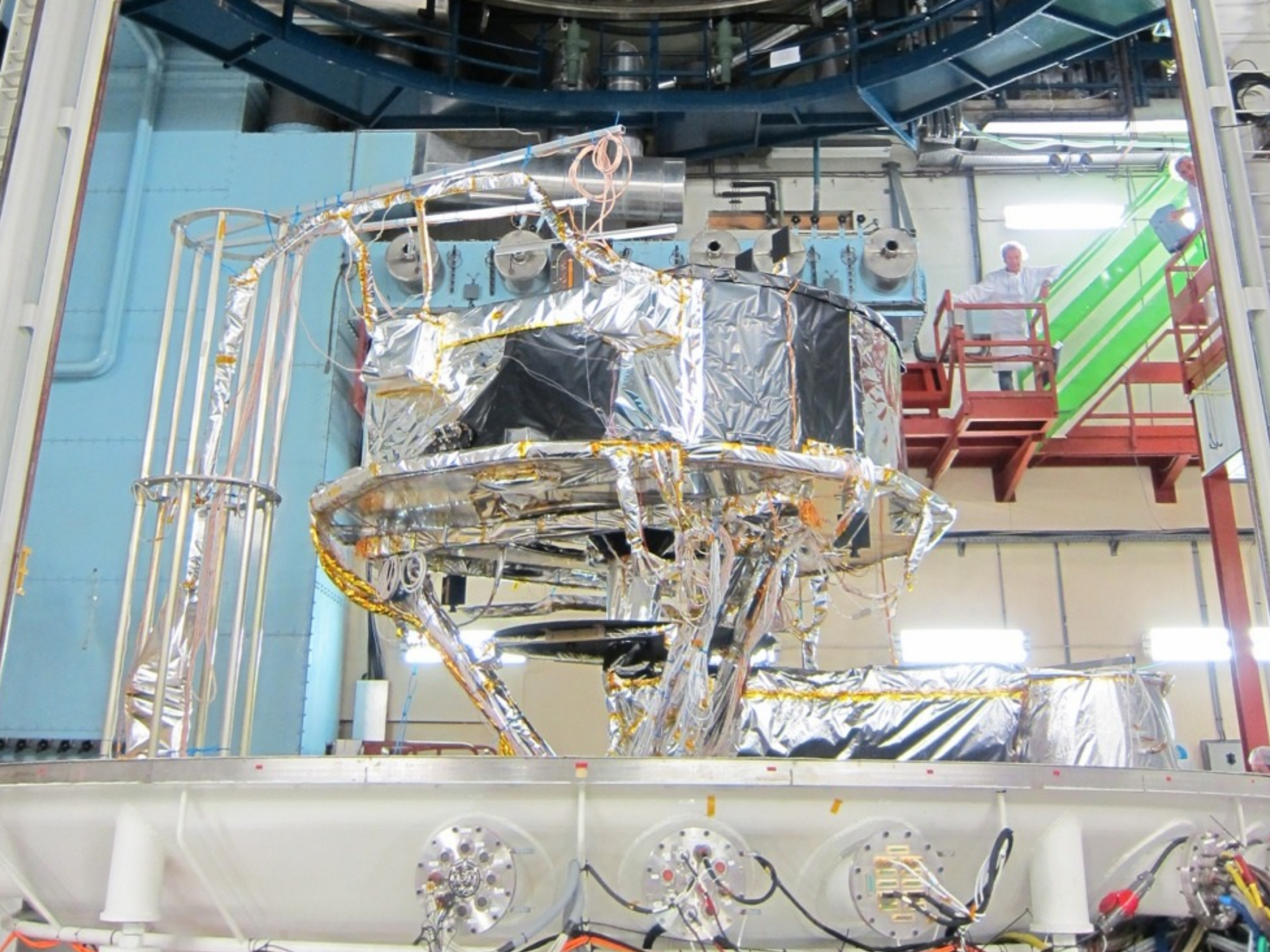


- Micro-thruster Assembly (MTA)

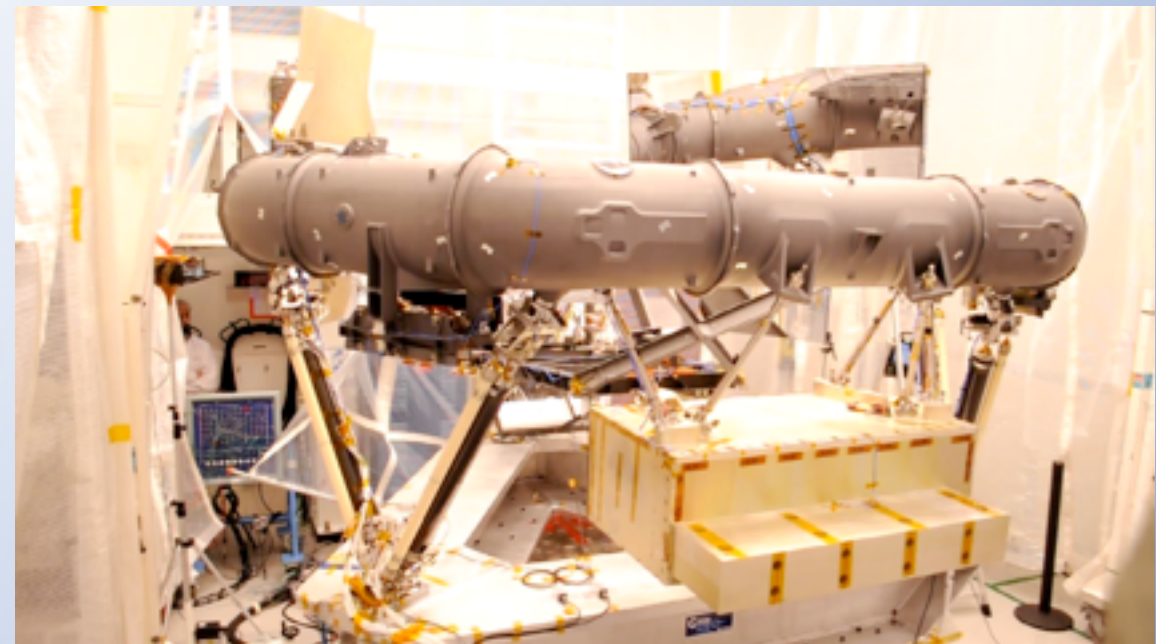


- Deployable Sunshield Assembly checked after testing, dismounted from the Service Module (SVM) and put into storage





- Galileo launch in October 2011 successful and with mechanical loads as anticipated
- Gaia launcher manufacturing started
- Soyuz rocket Sz-013



Schedule

- Service Module Thermal Balance/Thermal Vacuum (TB/TV) completed
- Payload Module TB/TV completed
- Spacecraft level assembly starting January 2013 leading to launch in October 2013
- Commissioning phase 4 months
- Start of Science Alerts 2014
- First intermediate data release summer 2015
- First data release with five parameter astrometry early 2016
- End of nominal operations and start of operations extension 2019
- “Final release” 2021



Promises of Gaia

- Orders of magnitude improvements
- Schedule stabilising: launch October 2013
- Science alerts early on and intermediate releases starting two years after launch
- Get ready for **the** promise of Gaia
...astronomy will change



Gaia

Unraveling the chemical and dynamical
history of our Galaxy