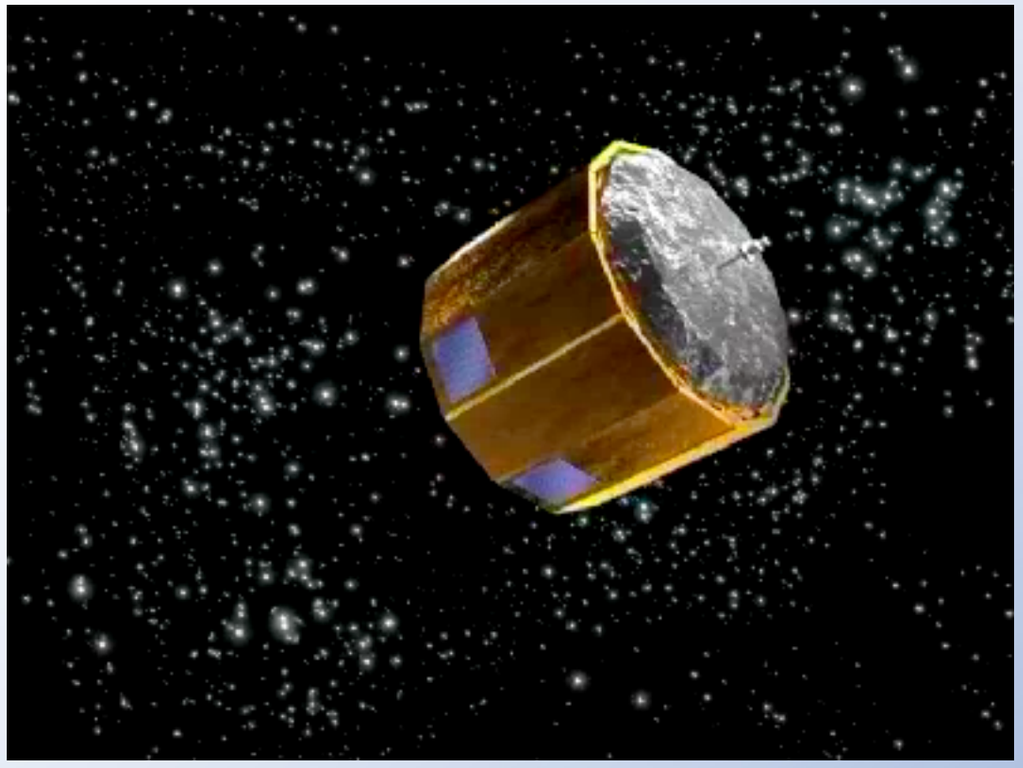
Gaia

Timo Prusti

Gaia Summary

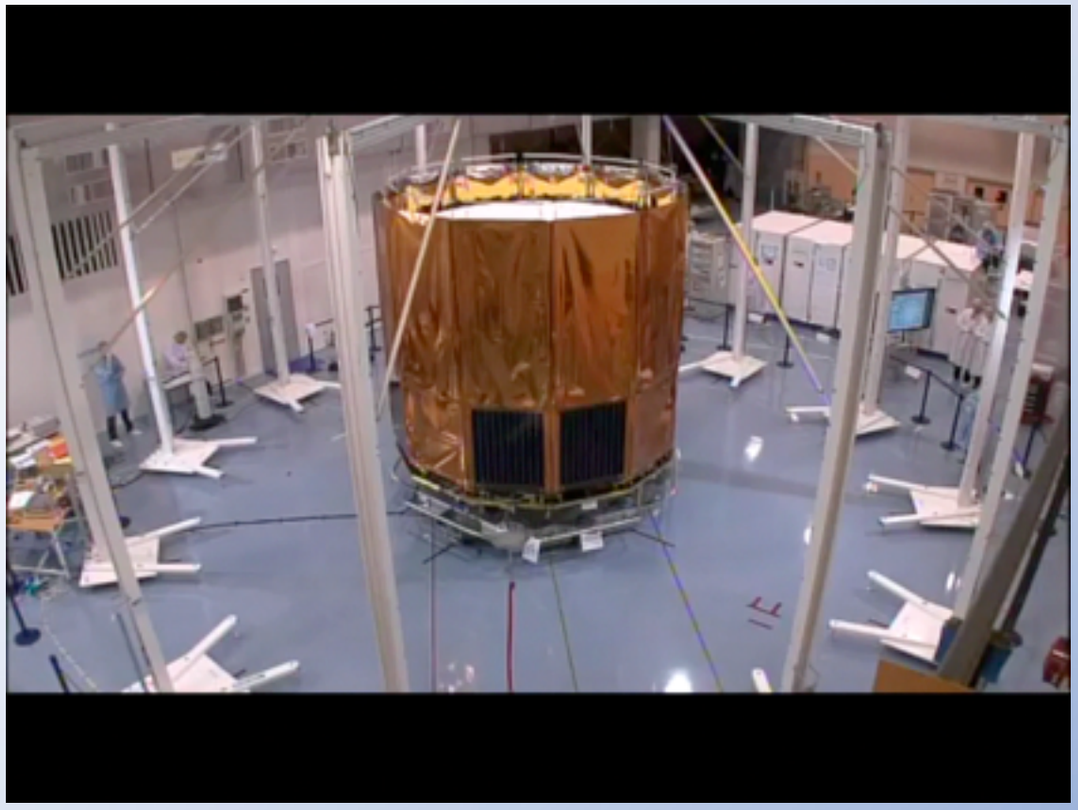
- ESA mission building on the Hipparcos heritage
- Astrometry, Photometry and Spectroscopy
- Satellite, including the payload, by industry (Astrium, Toulouse), operations by ESA and data processing by scientists (DPAC)
- Launch September 2013
- Science Alerts early on
- First intermediate data release 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 => μarcsec
- Radial velocity: none => 150 million objects
- Pre-selected => Unbiased survey

Payload and Telescope

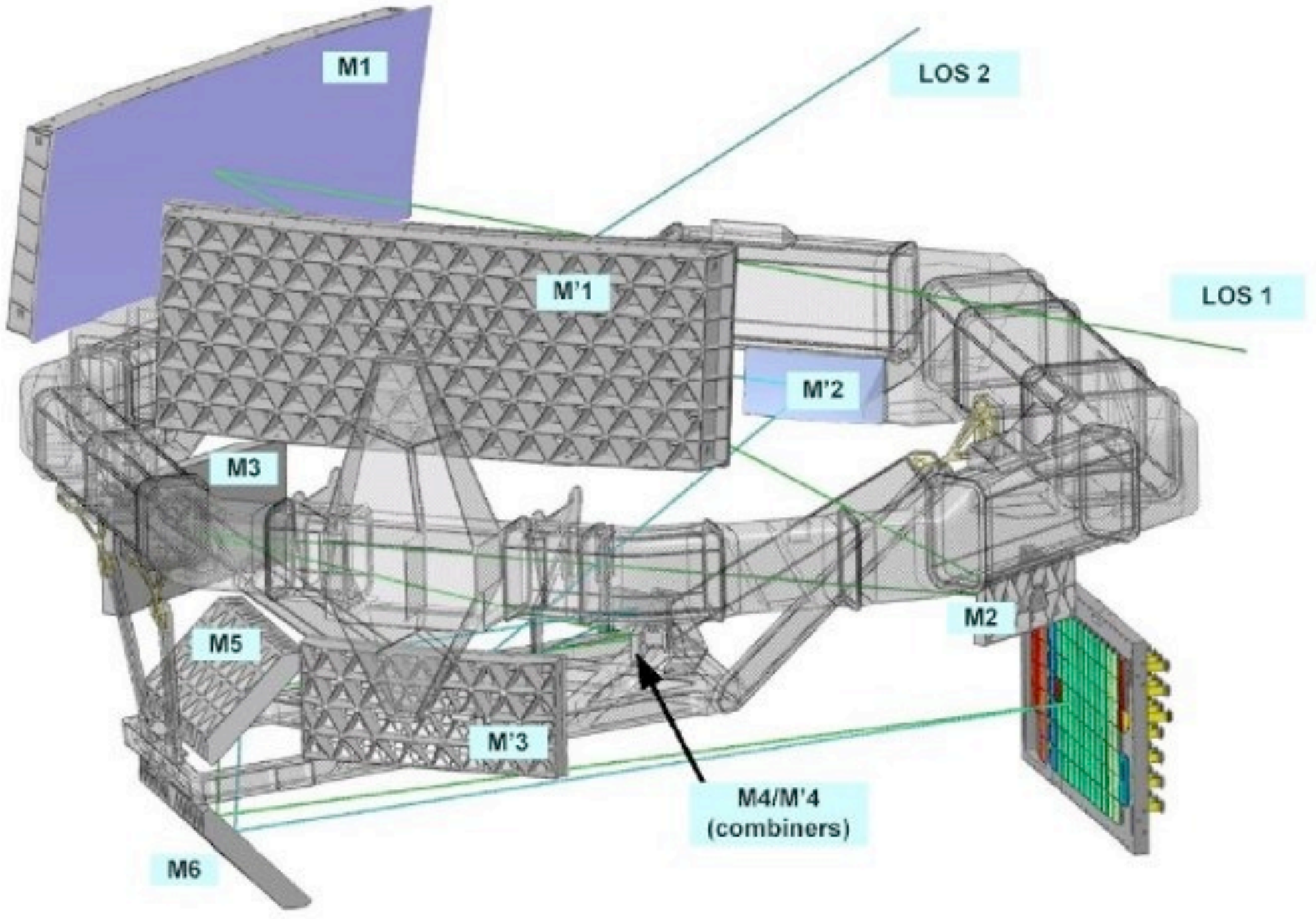
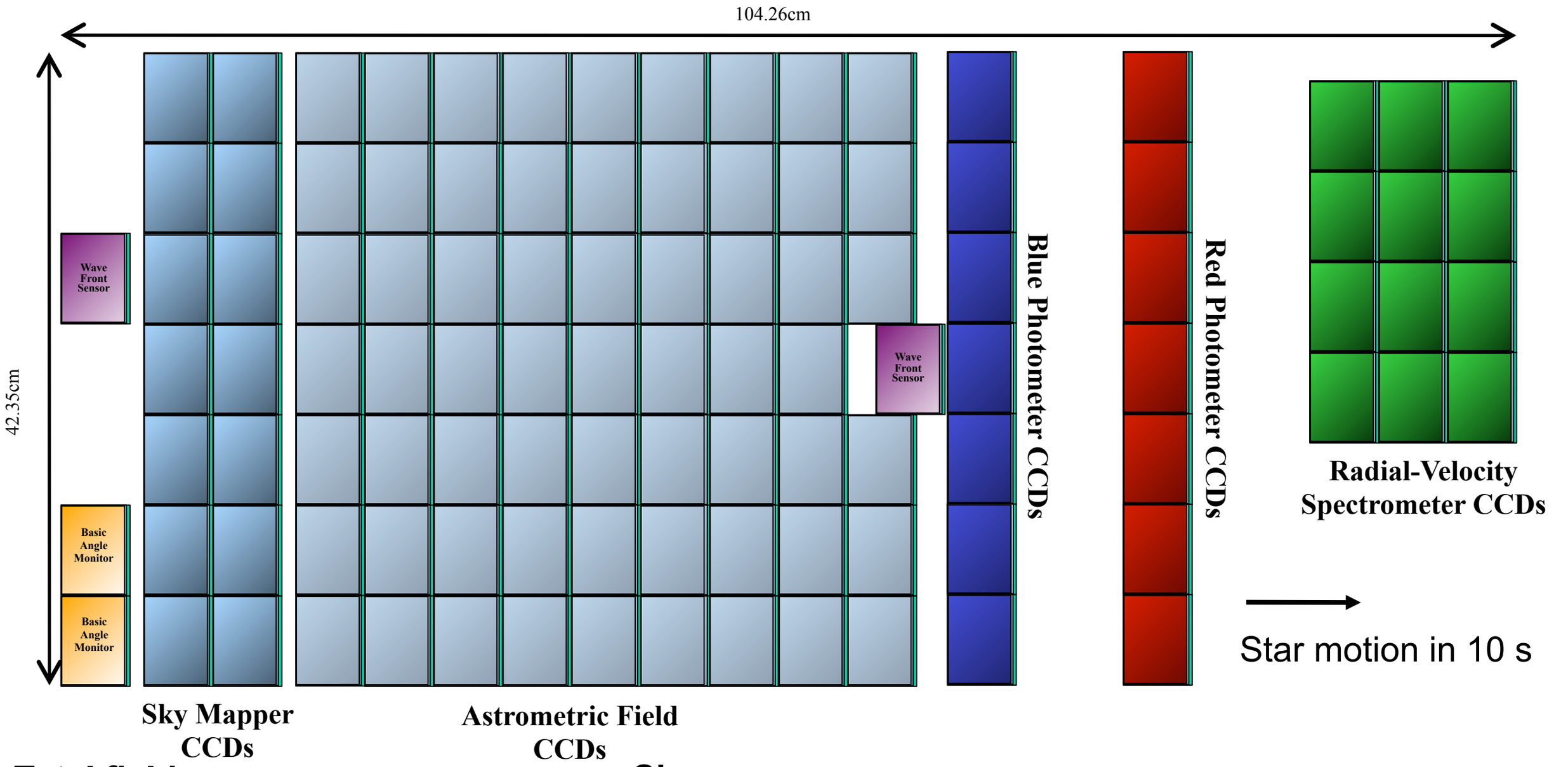


Figure courtesy Alex Short

Focal Plane



Total field:

- active area: 0.75 deg^2
- 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

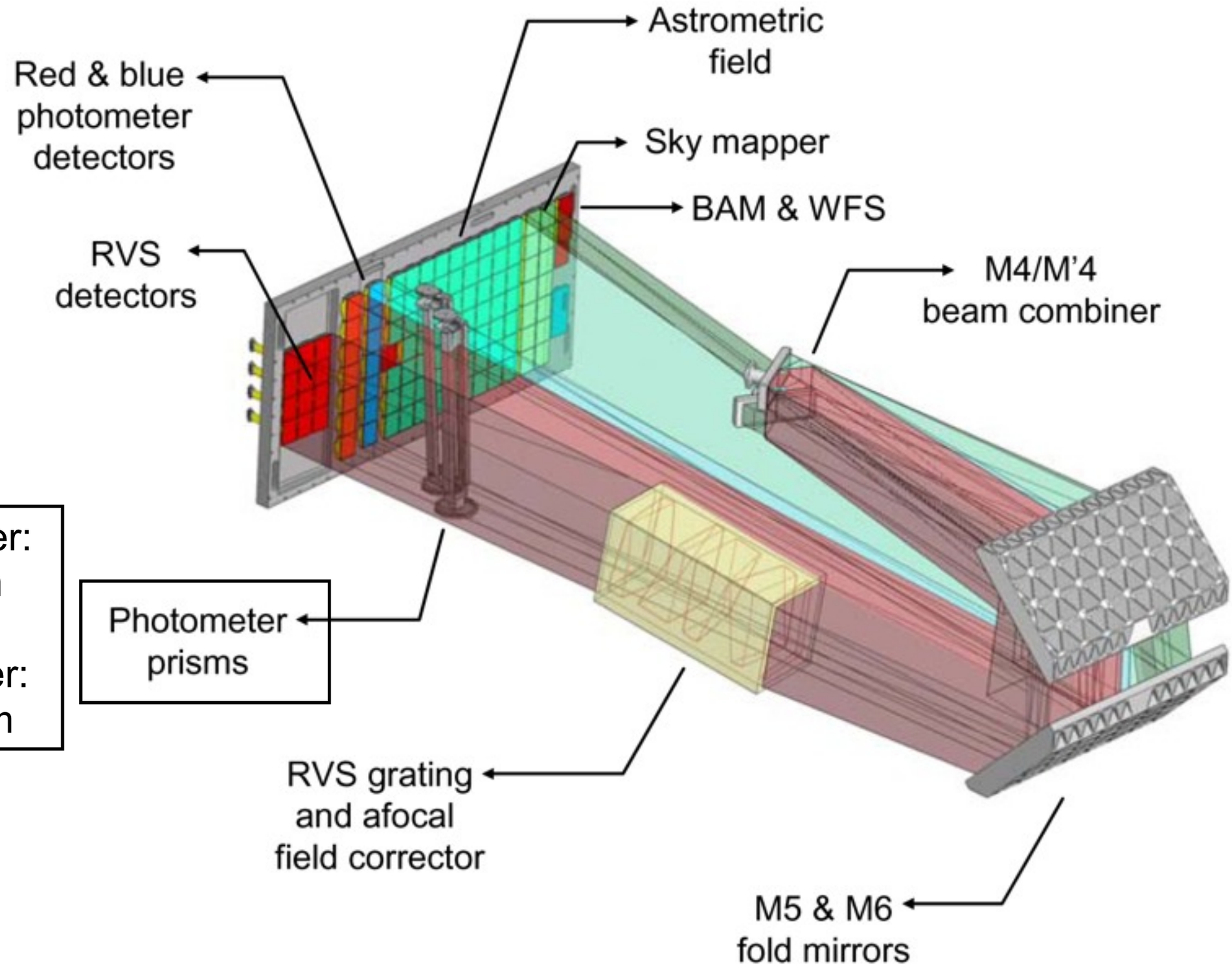
Spectroscopy:

- high-resolution spectra
- red CCDs

esa

Gaia

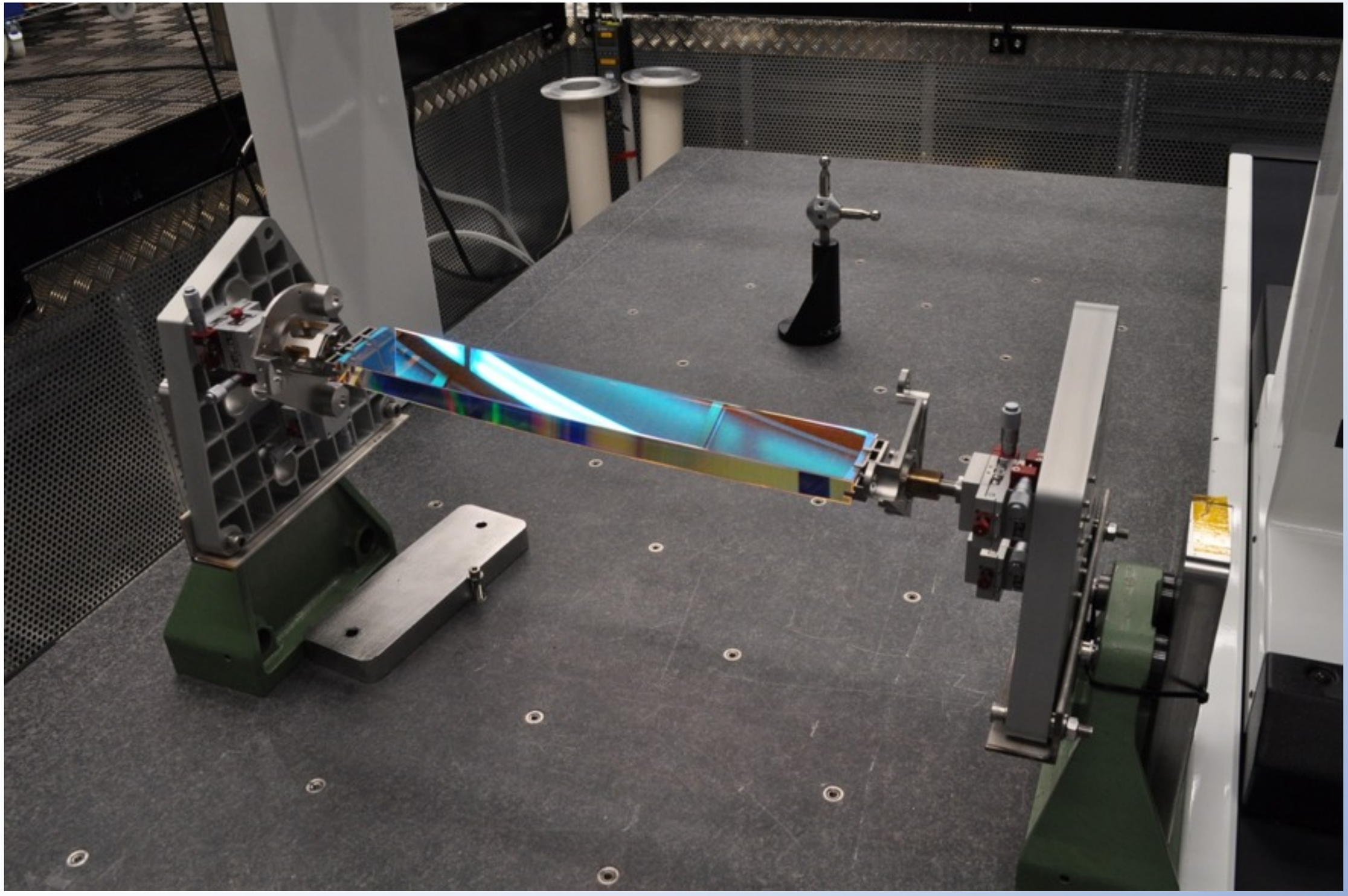
Photometry Measurement Concept

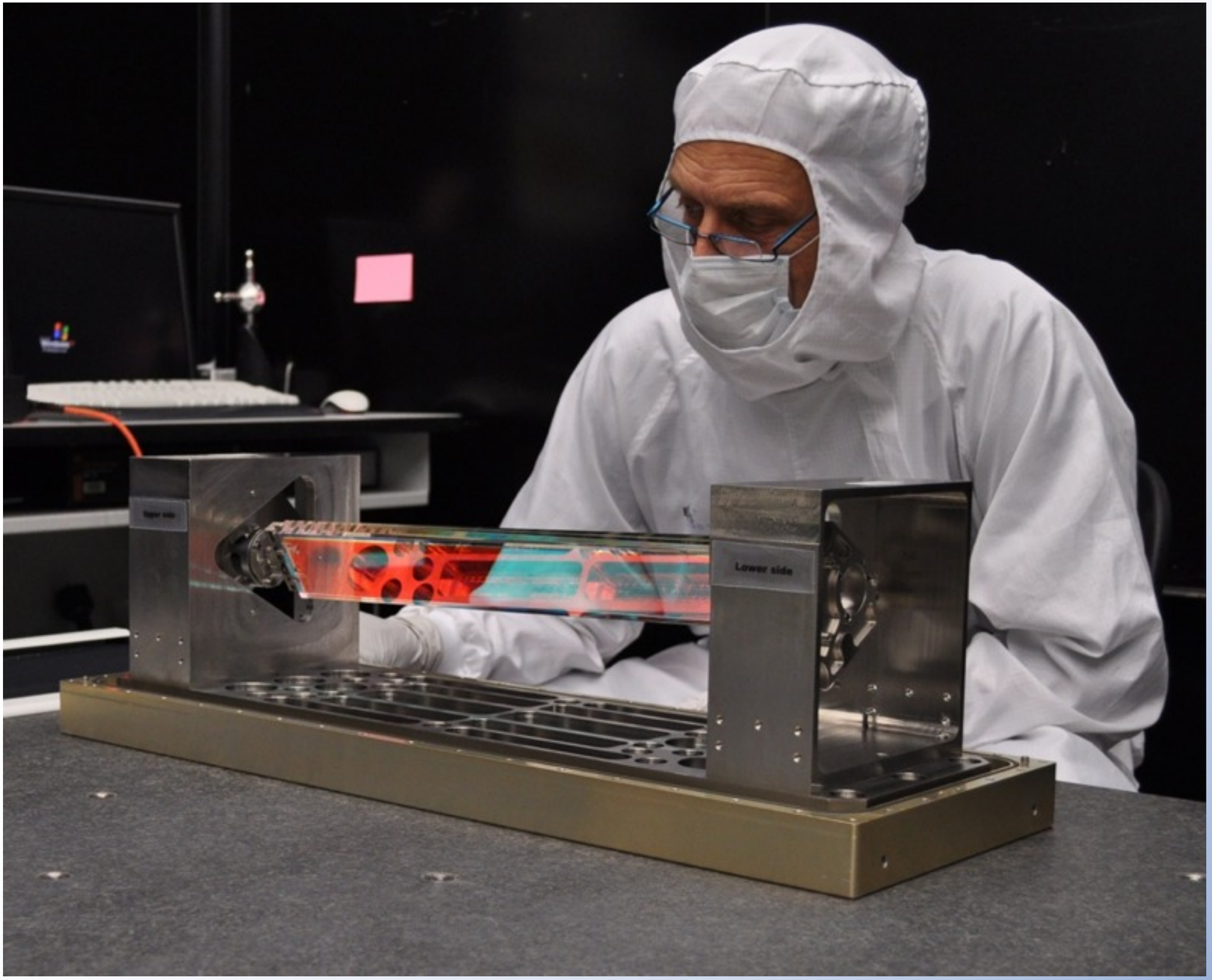


Blue photometer:
330 – 680 nm

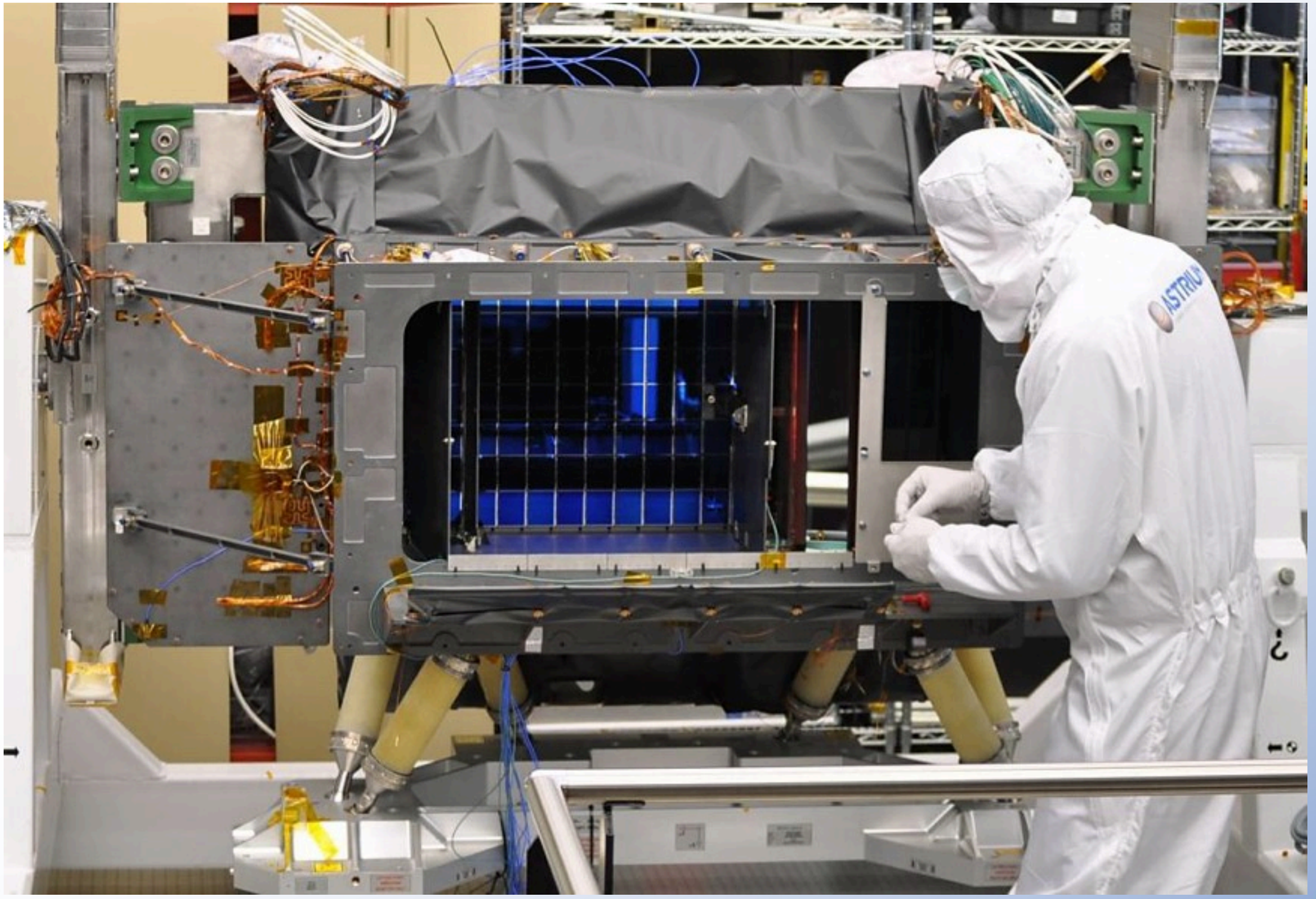
Red photometer:
640 – 1000 nm

Figure courtesy EADS-Astrium





esa



Radial-Velocity Measurement Concept

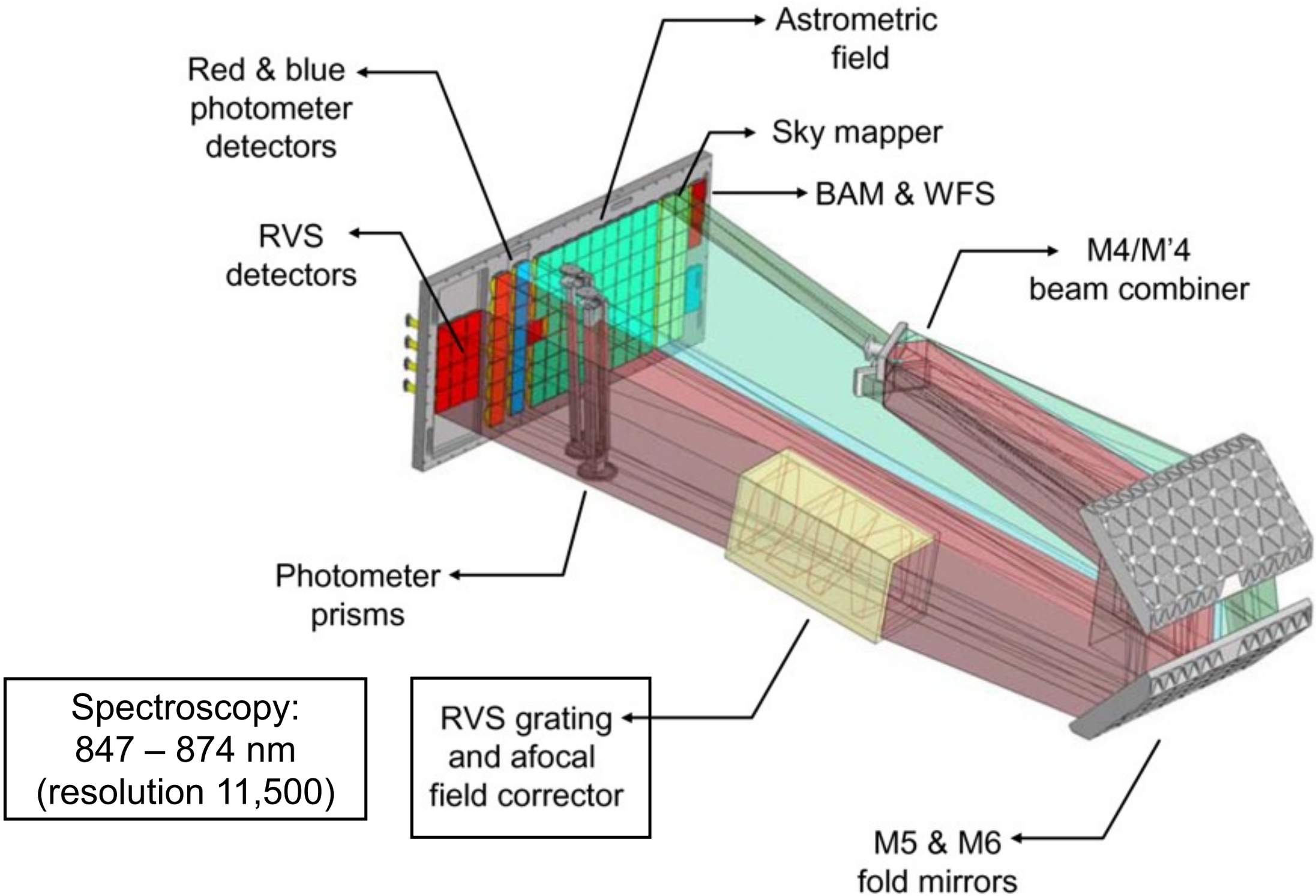
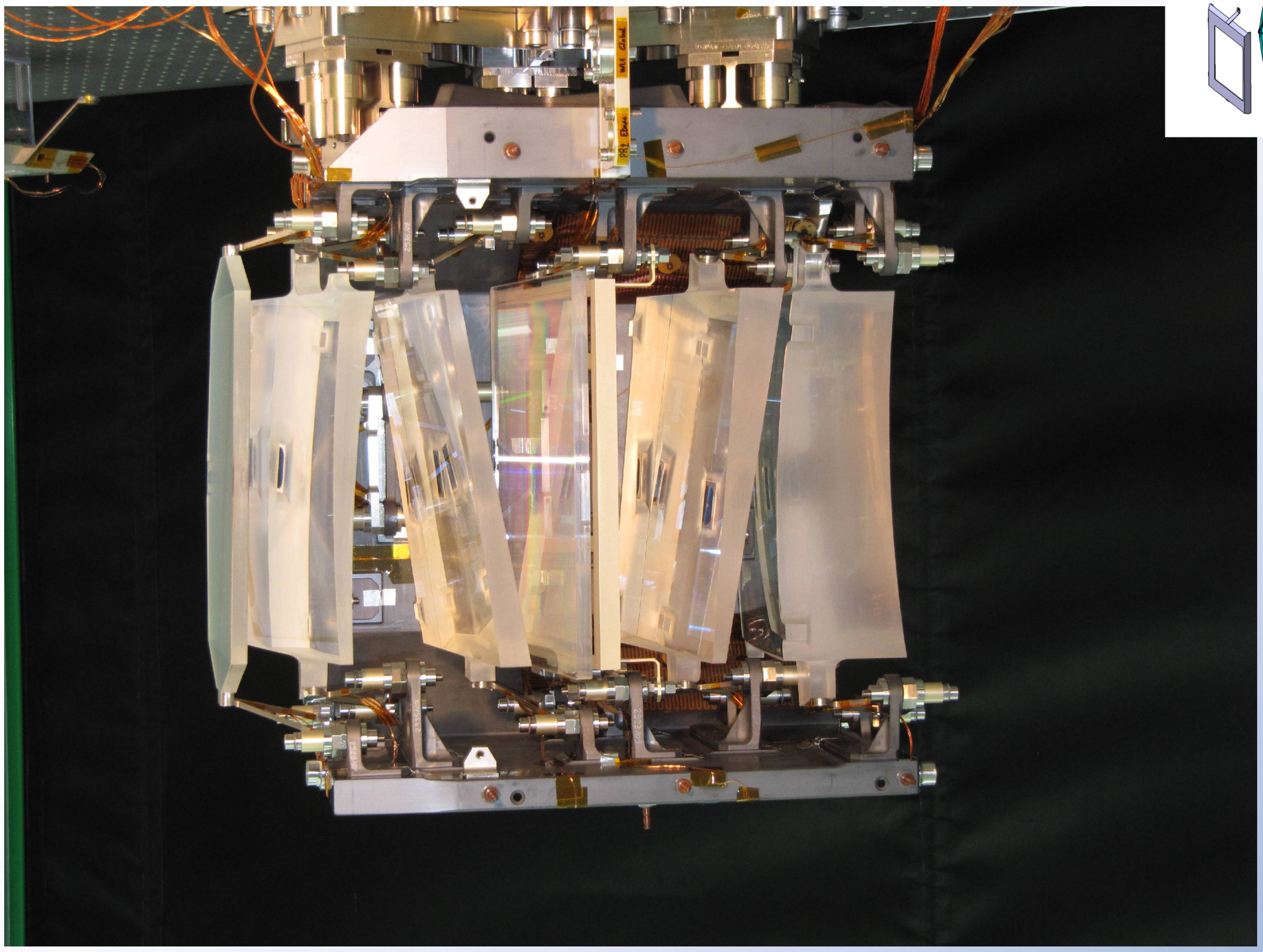
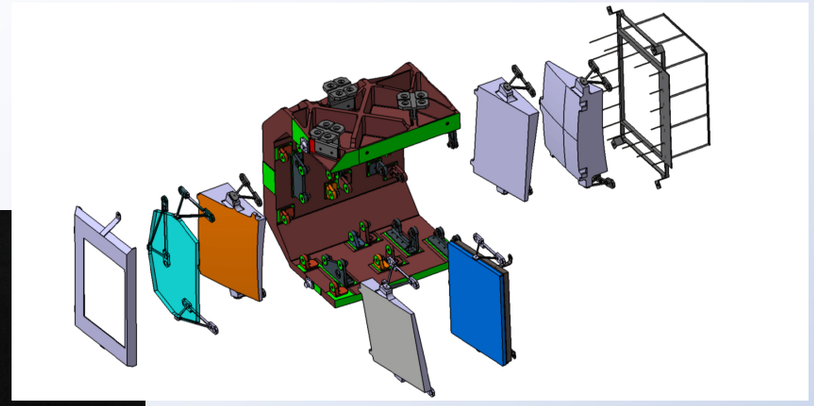
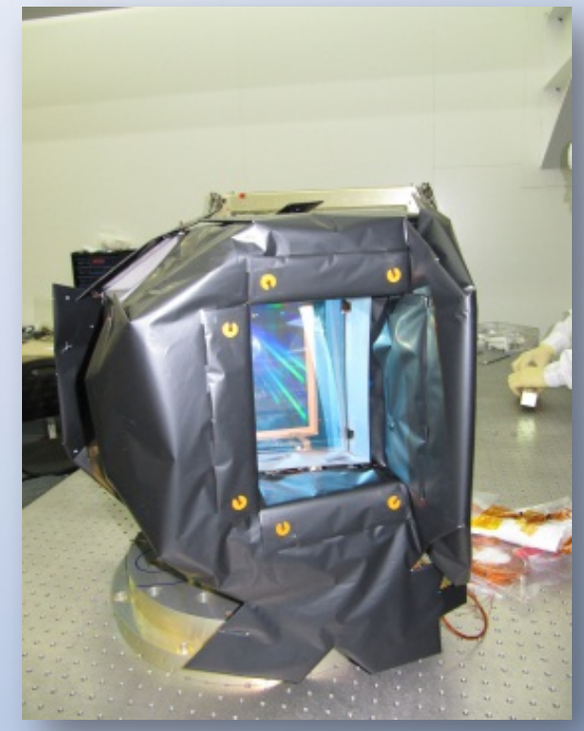


Figure courtesy EADS-Astrium

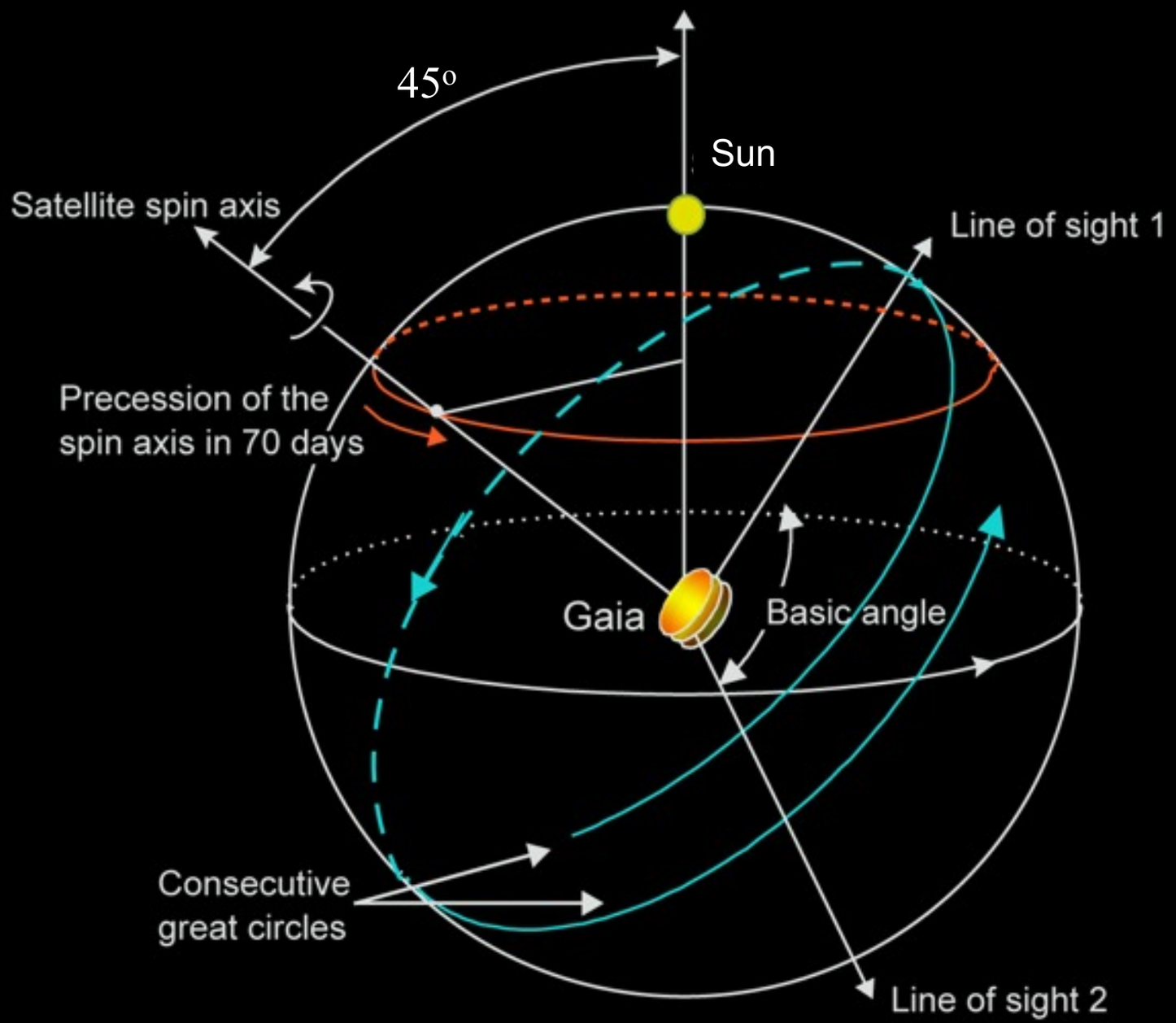







Gaia

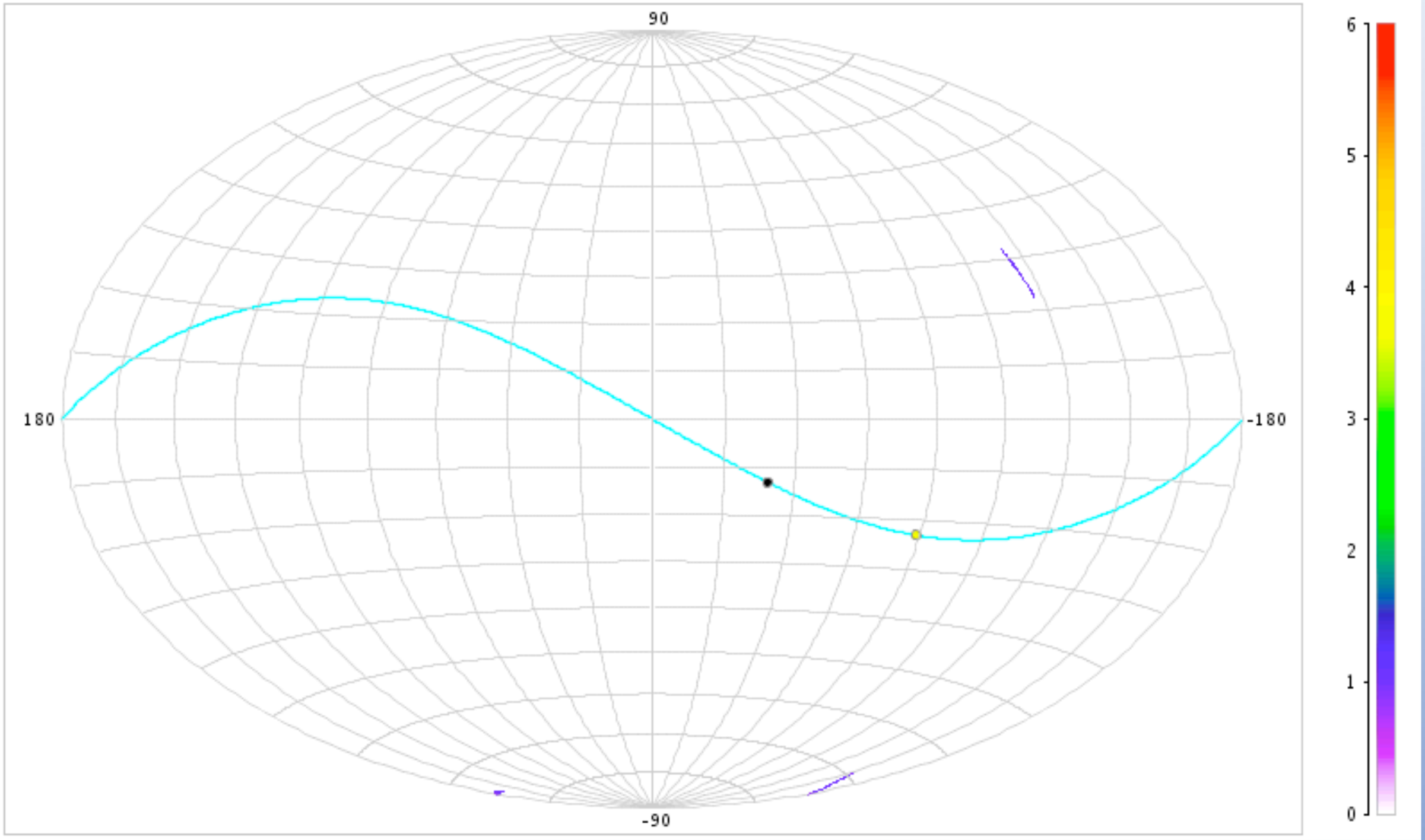
Sky-Scanning Principle



Spin axis	45^{o} to Sun
Scan rate:	60 arcsec s^{-1}
Spin period:	6 hours

Figure courtesy Karen O'Flaherty

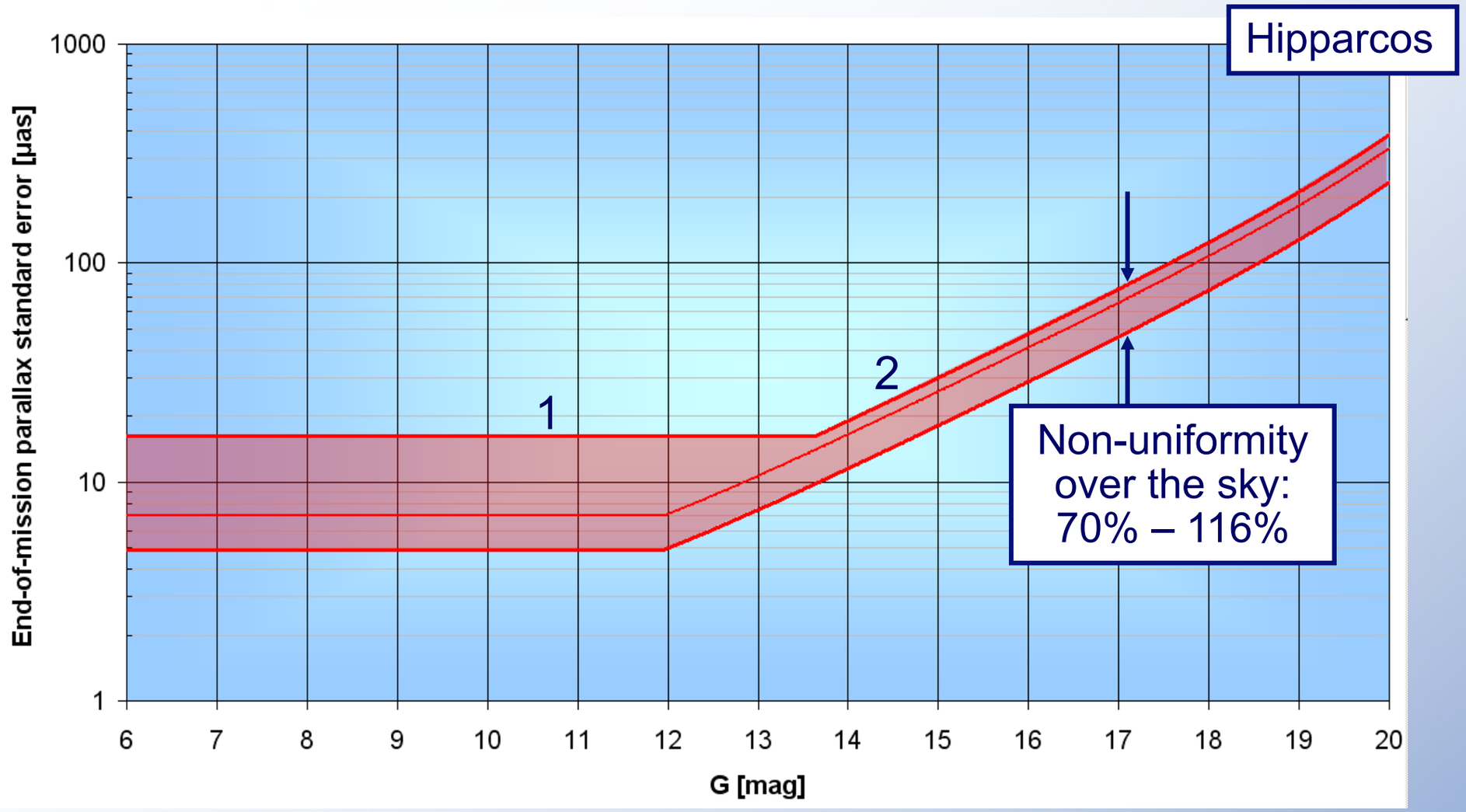
NSL field transits in ICRS after: 0 years 000 days 00 hr 10 min



esa

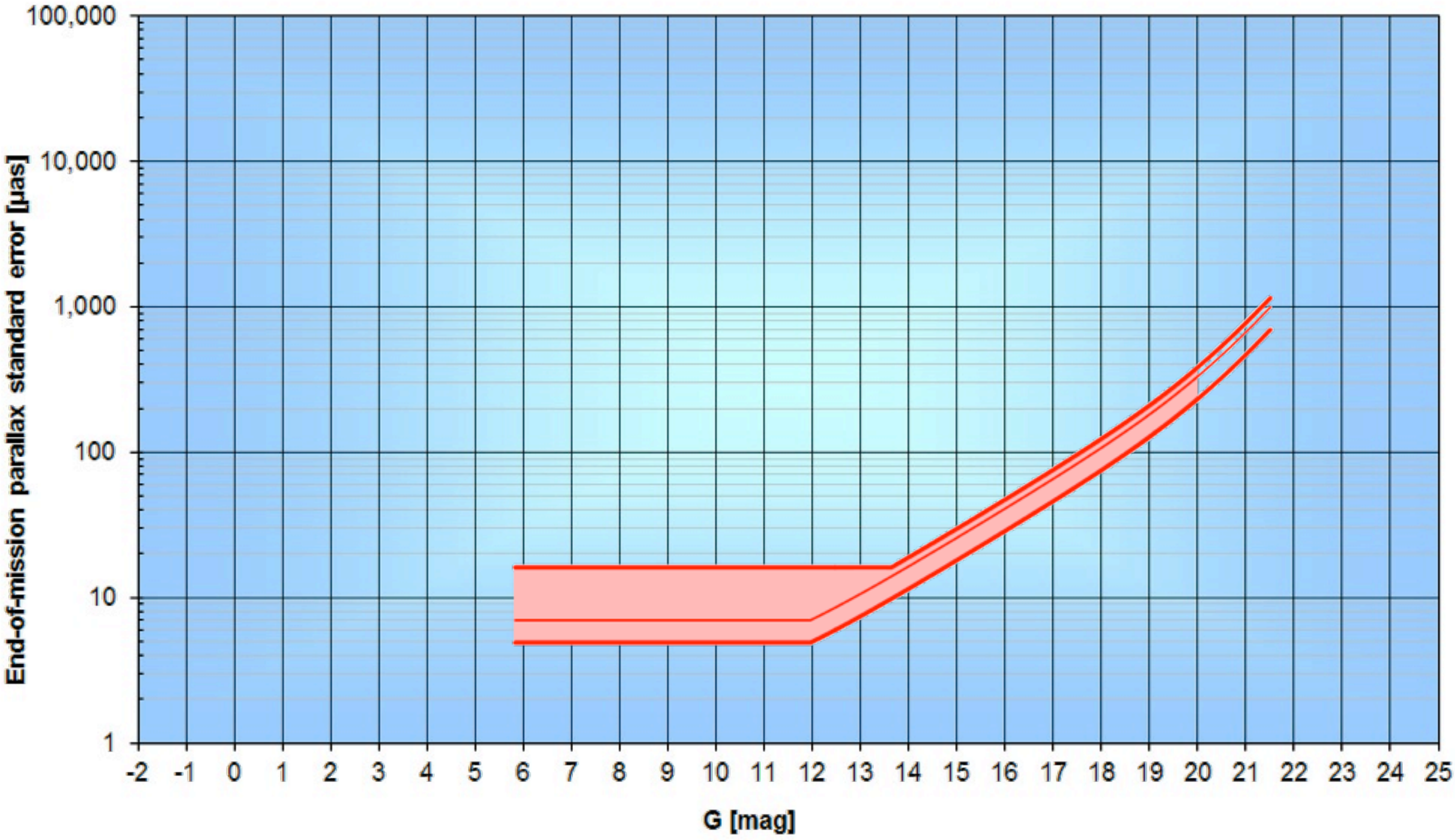
Gaia

Astrometry

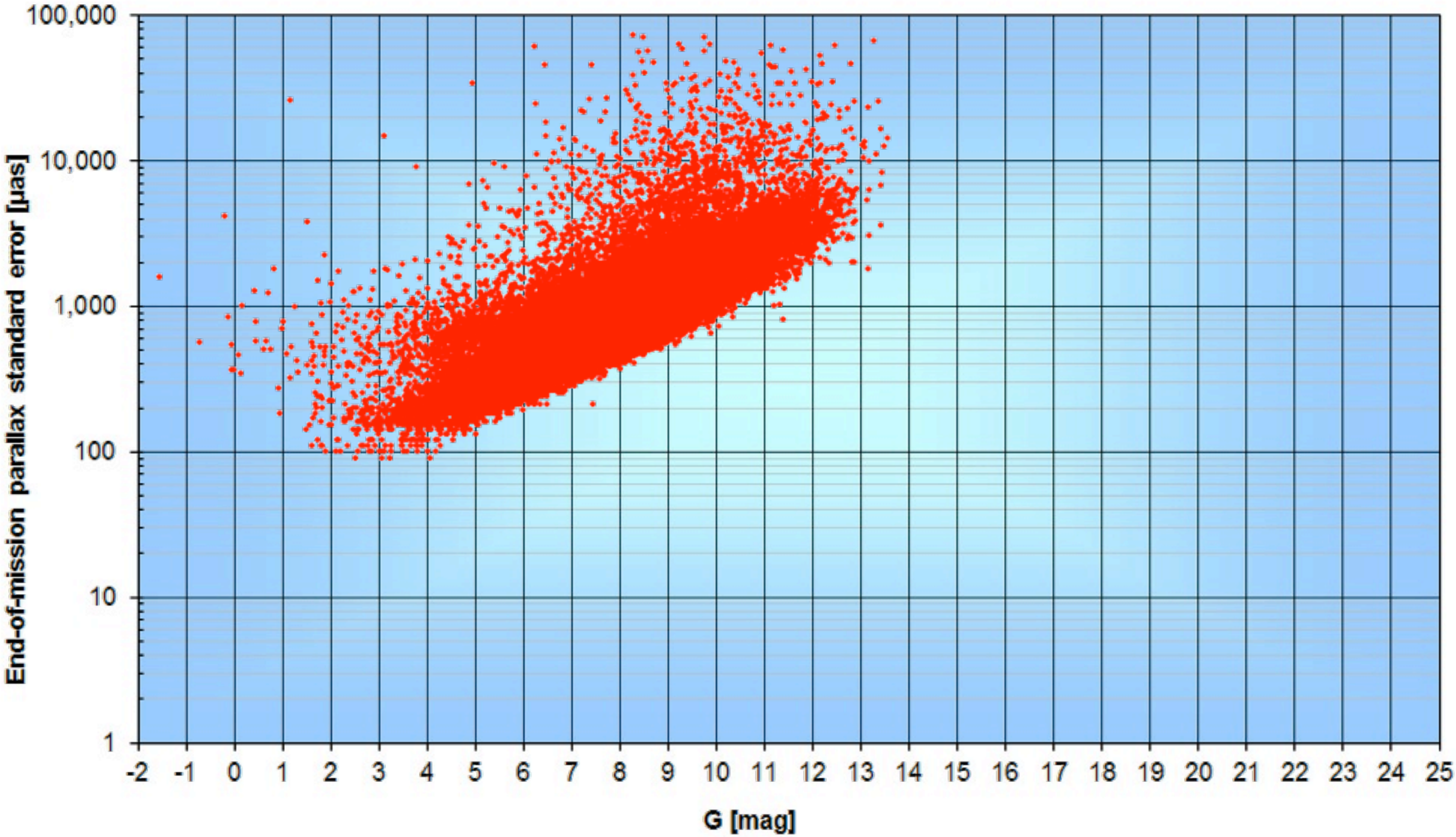


1. 6 < G < 12: bright-star regime (calibration errors, CCD saturation)
2. 12 < G < 20: photon-noise regime, with sky-background noise and electronic noise setting in around G ~ 20 mag

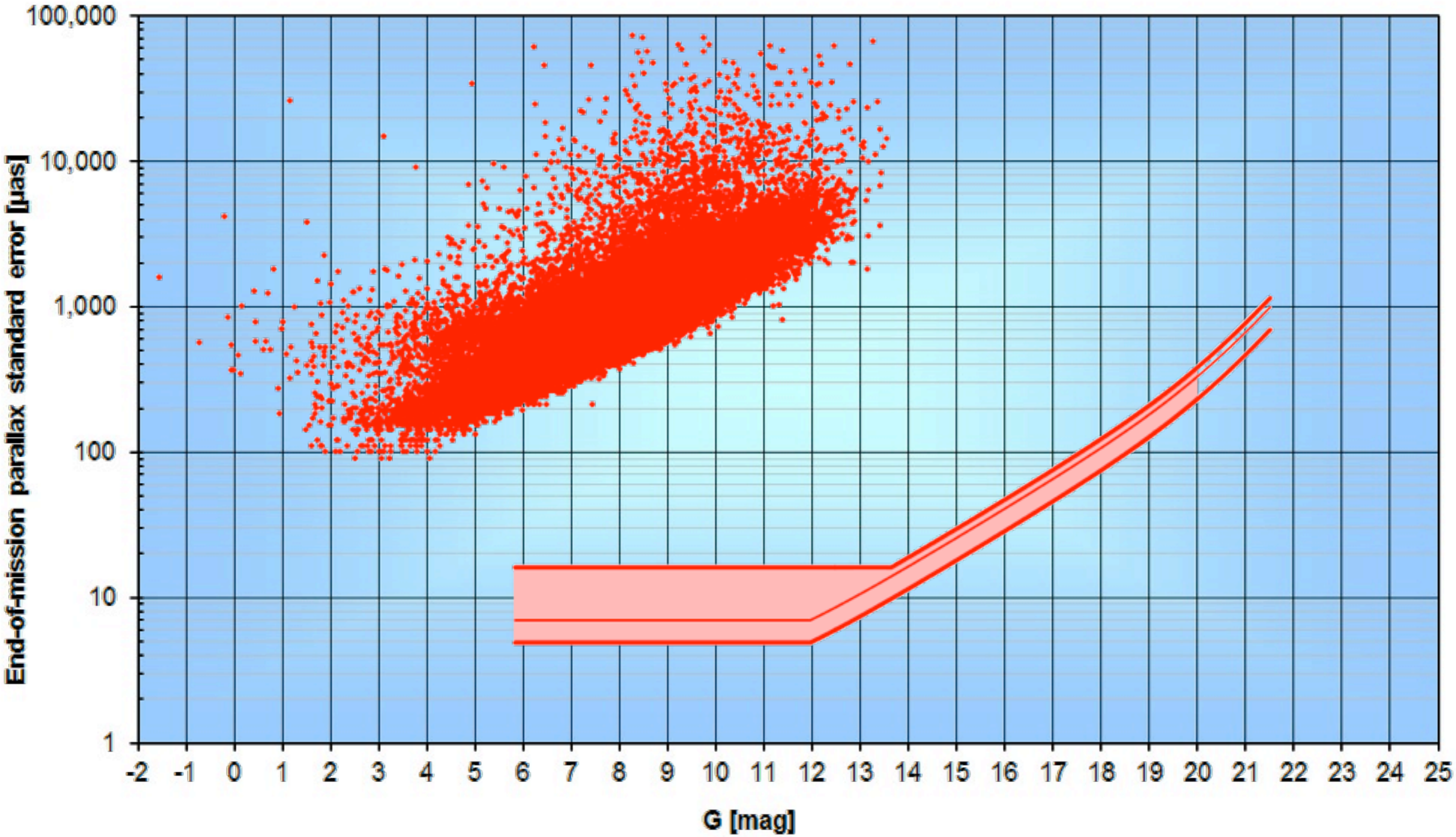
Gaia


100,000
10,000
1,000
100
10
1
End-of-mission parallax standard error [μas]
-2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
G [mag]

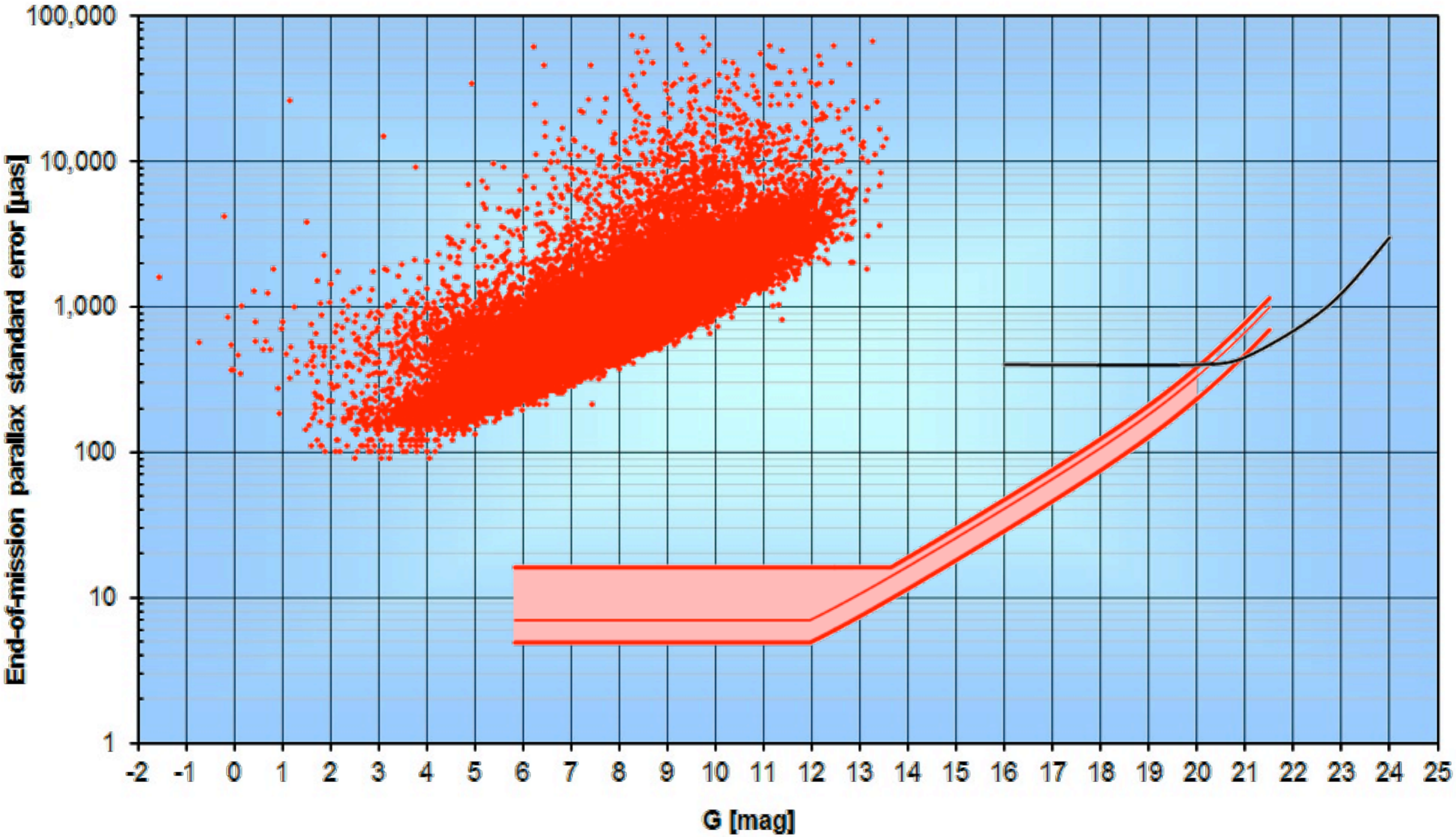
Hipparcos


100,000
10,000
1,000
100
10
1
End-of-mission parallax standard error [μas]
-2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
G [mag]

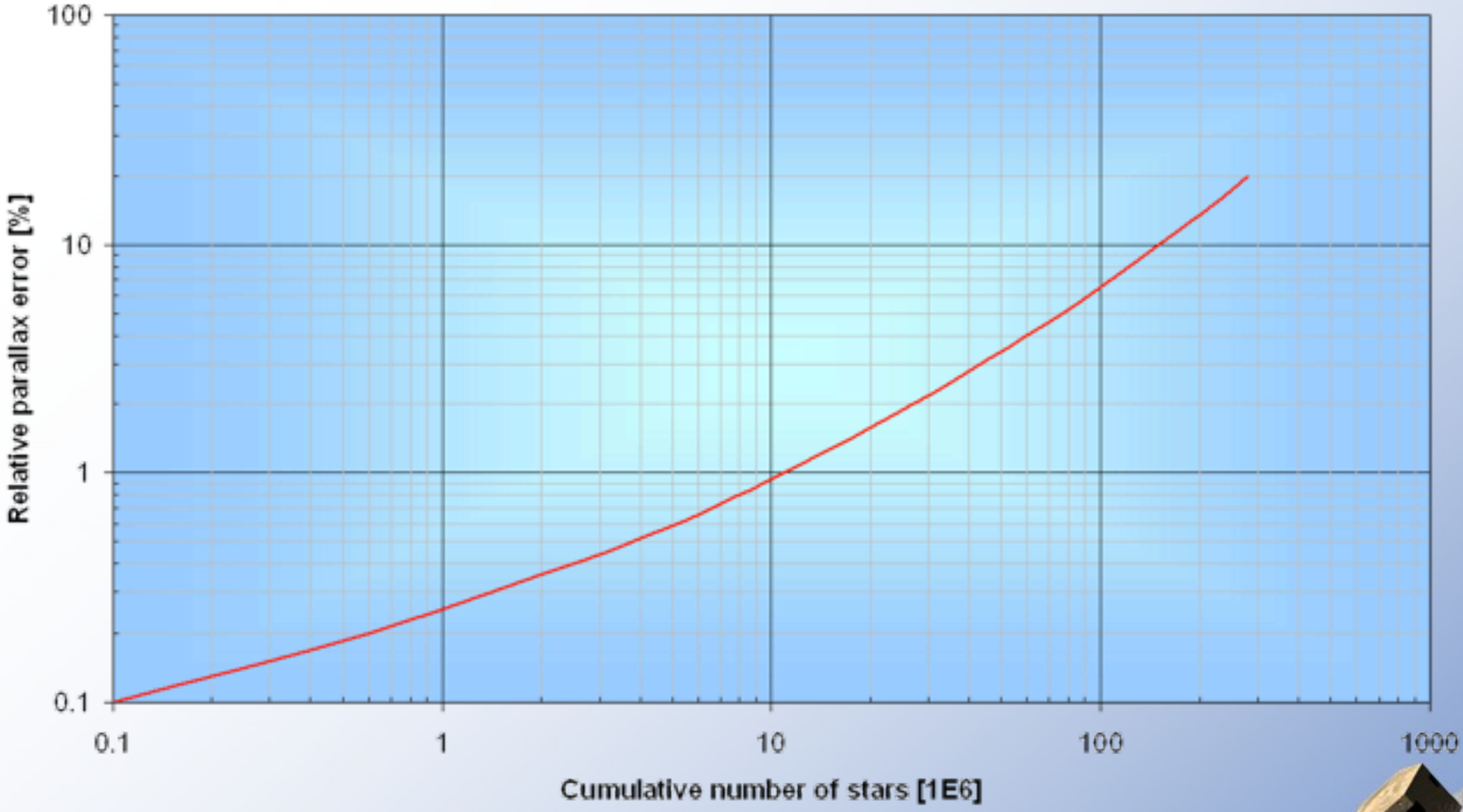
Gaia & Hipparcos



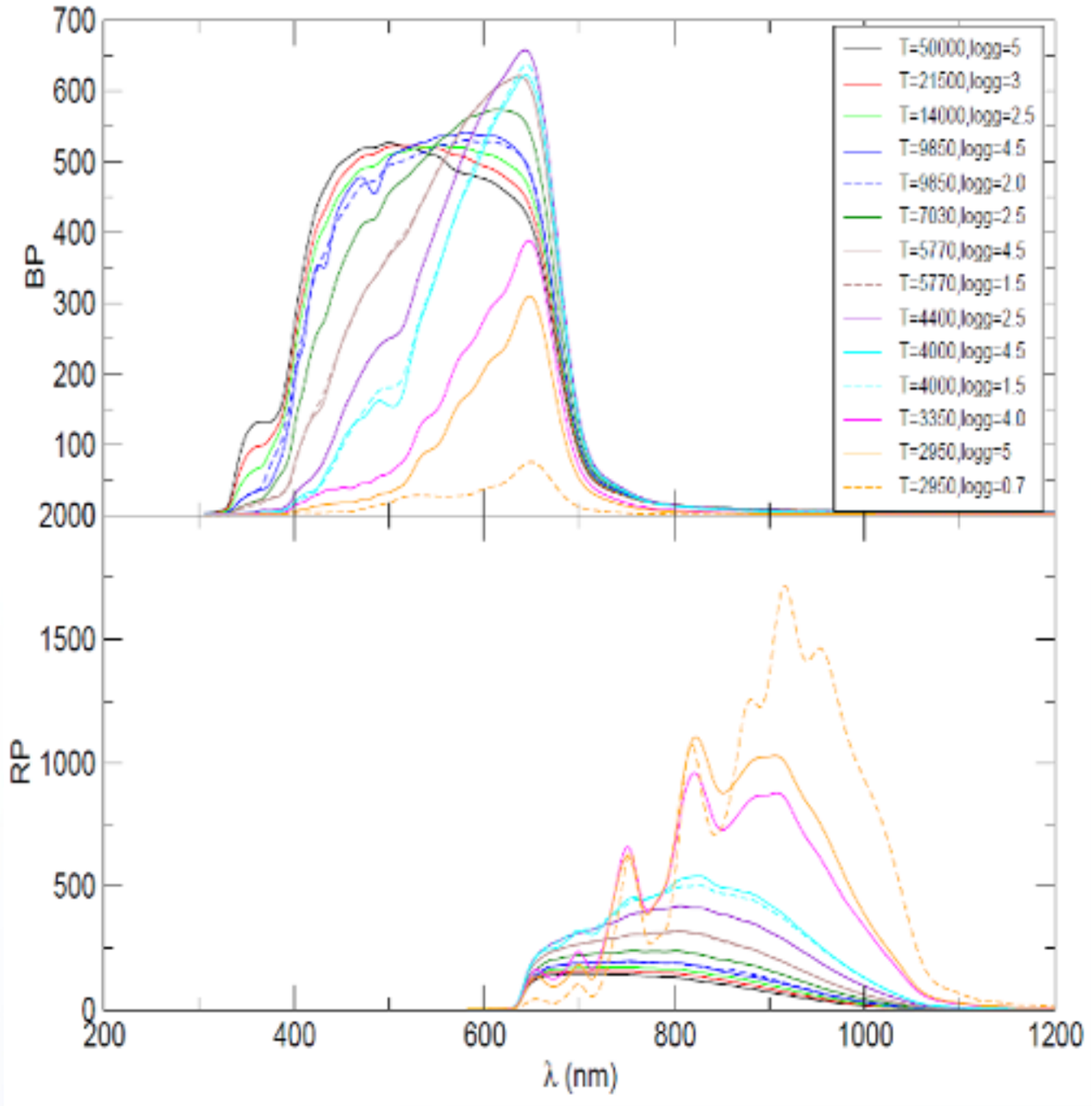
Gaia, Hipparcos & LSST



Parallax statistics

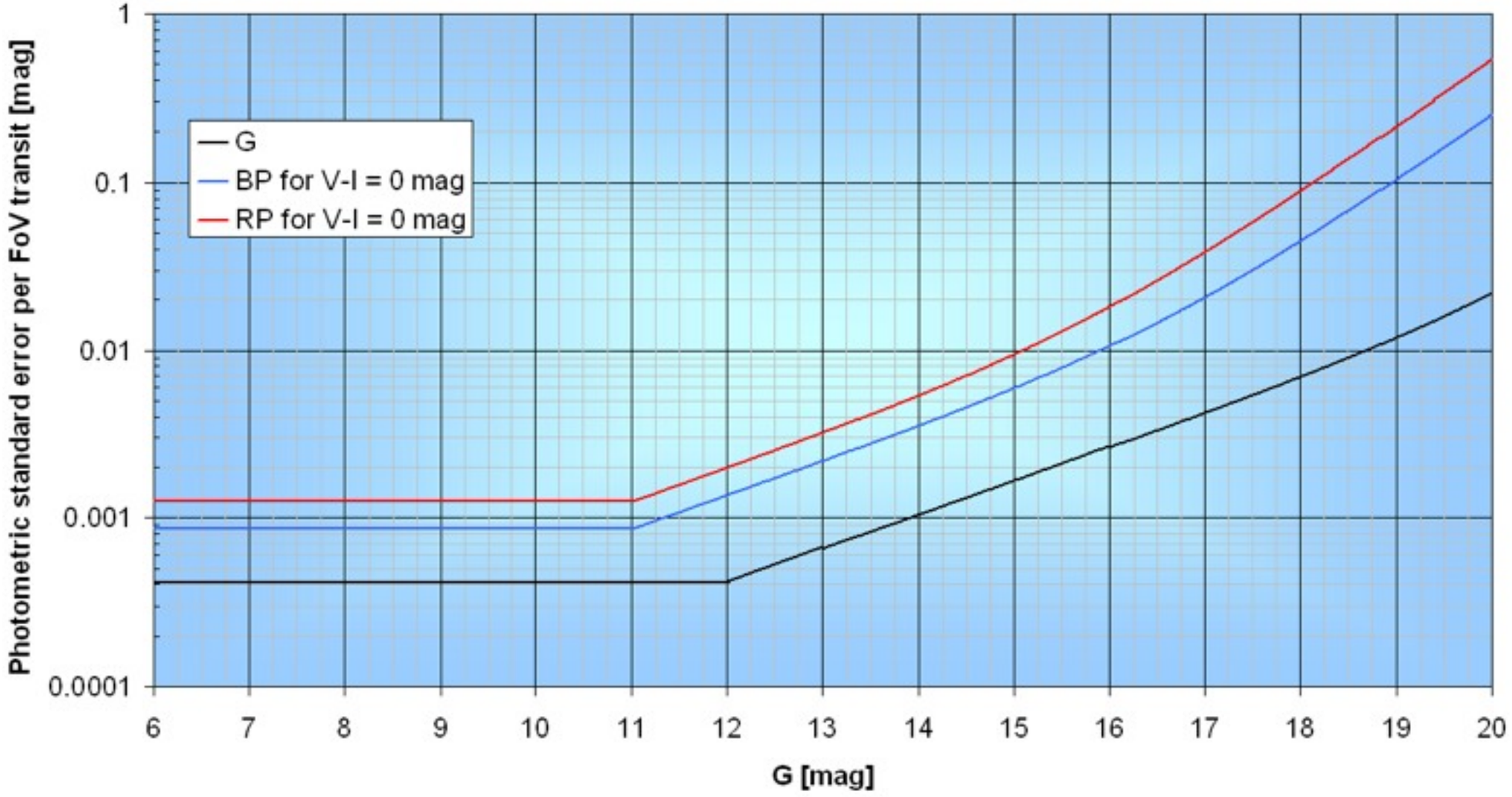


Spectro-photometry

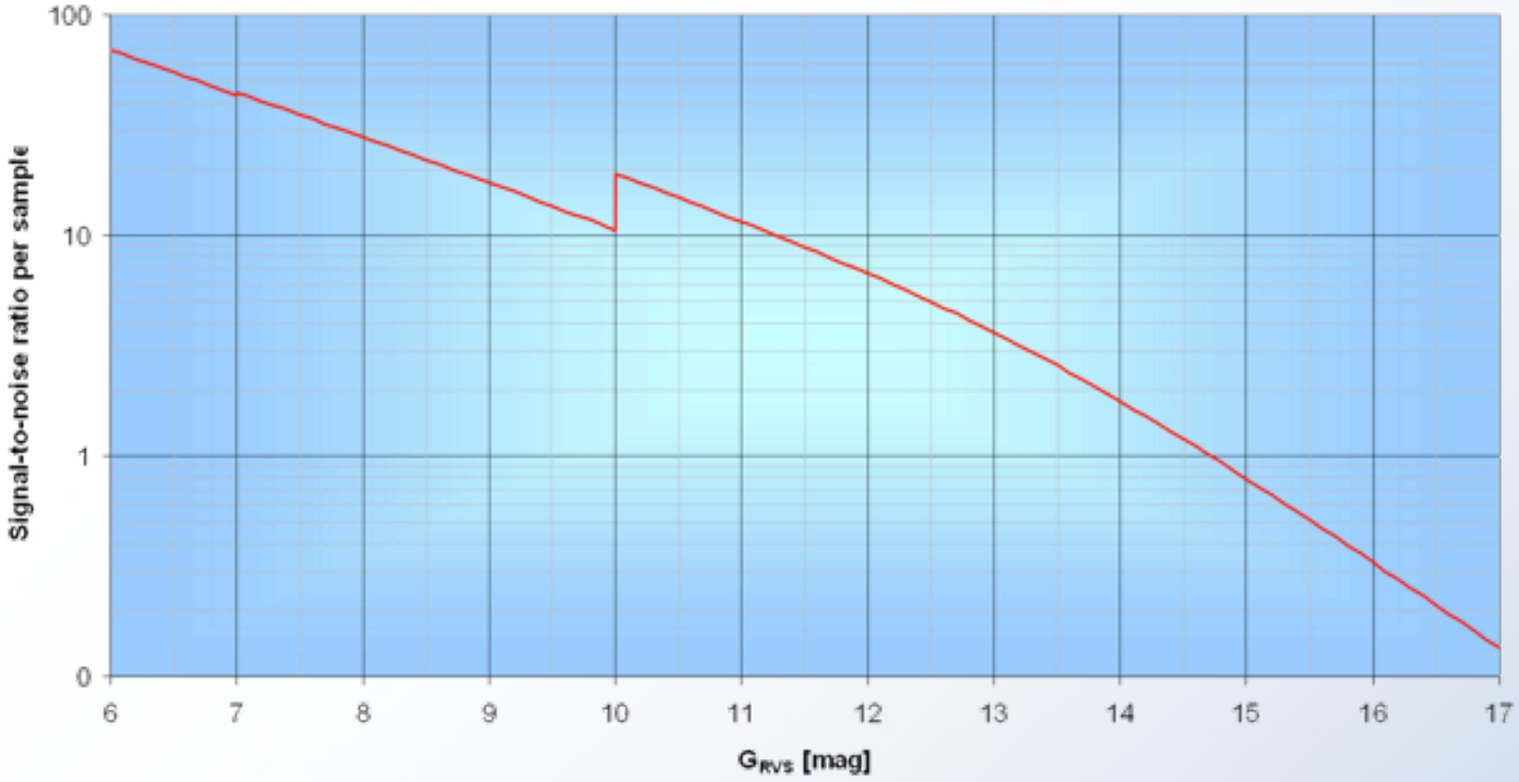


- Illustrative spectra for G=15 mag stars (Jordi et al. 2010)
- Goals at G=15 mag e.g. extinction within 0.1mag, surface gravity 0.2dex, metallicity 0.2dex and effective temperature within 200K (Bailer-Jones 2010)

Transit level integrated photometry



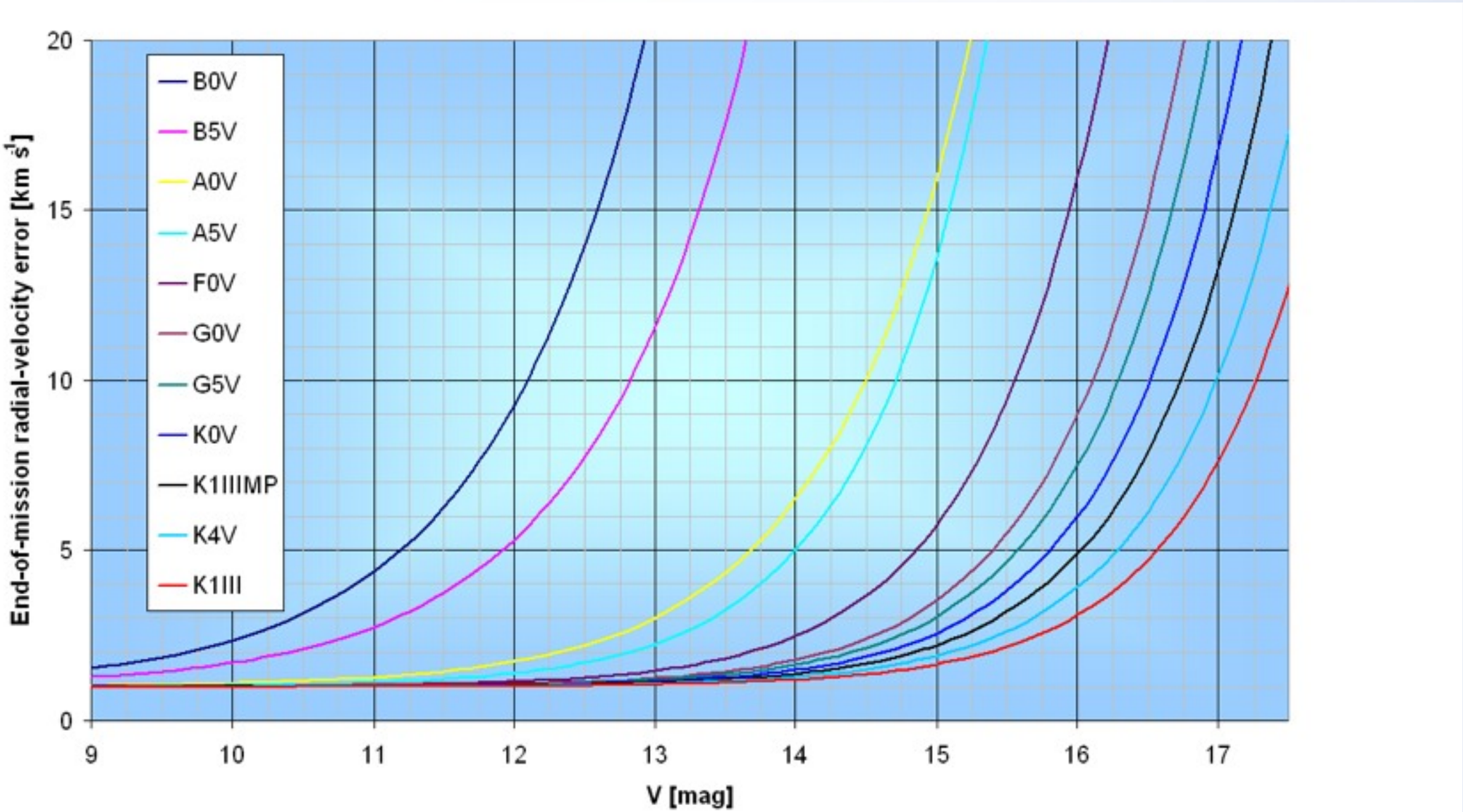
Spectroscopy



Single CCD S/N estimate

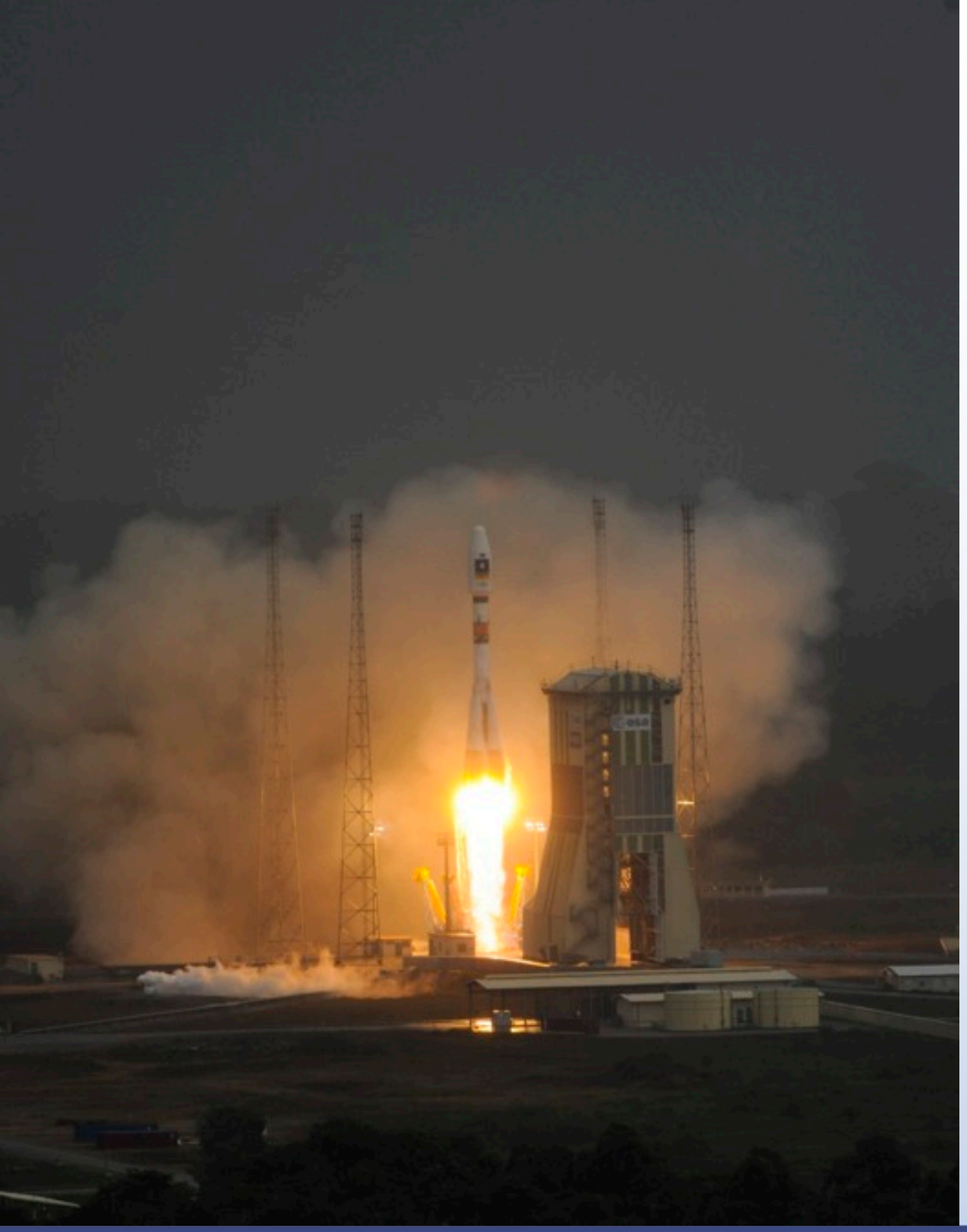
- Interstellar reddening, atmospheric parameters, and rotational velocities, for stars brighter than $G_{RVS} \approx 12$ mag (~5 million stars)
- provide element abundances for stars brighter than $G_{RVS} \approx 11$ mag (~2 million stars)

End-of-life Radial Velocity Errors

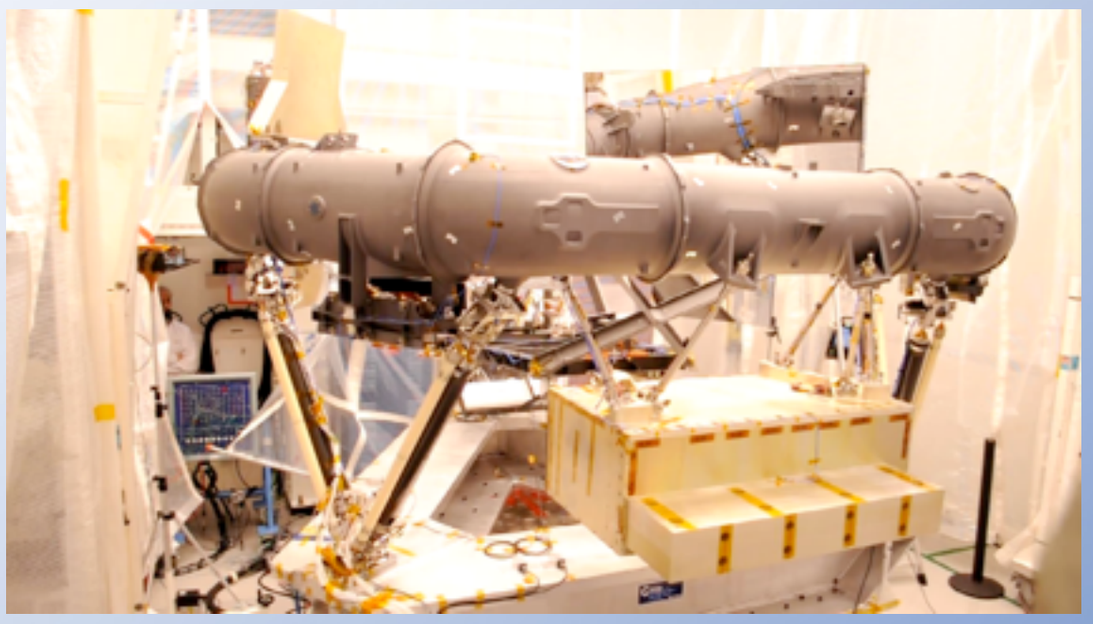


Intermediate Data Releases

- Data processing done by DPAC
- Science Alerts as soon as possible
- L+22m positions, G-magnitudes, proper motions to Hipparcos stars, ecliptic pole data
- L+28m + first 5 parameter astrometric results, bright star radial velocities, integrated BP/RP photometry
- L+40m + BP/RP data, some RVS spectra, astrophysical parameters, orbital solutions for short period binaries
- L+65m + variability, solar system objects



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



Schedule

- Service Module in Thermal Balance/Thermal Vacuum (TB/TV) tests finished and results under analysis; no major issues
- Payload Module TB/TV starting October
- Spacecraft level assembly starting January 2013 leading to launch in September
- Commissioning phase 4 months and data processing initialization during the following 2 months of ecliptic pole scanning
- Start of Science Alerts 2014
- First intermediate data release summer 2015
- First data release with five parameter astrometry late 2015/early 2016
- End of nominal operations and start of operations extension 2019
- "Final release" 2021