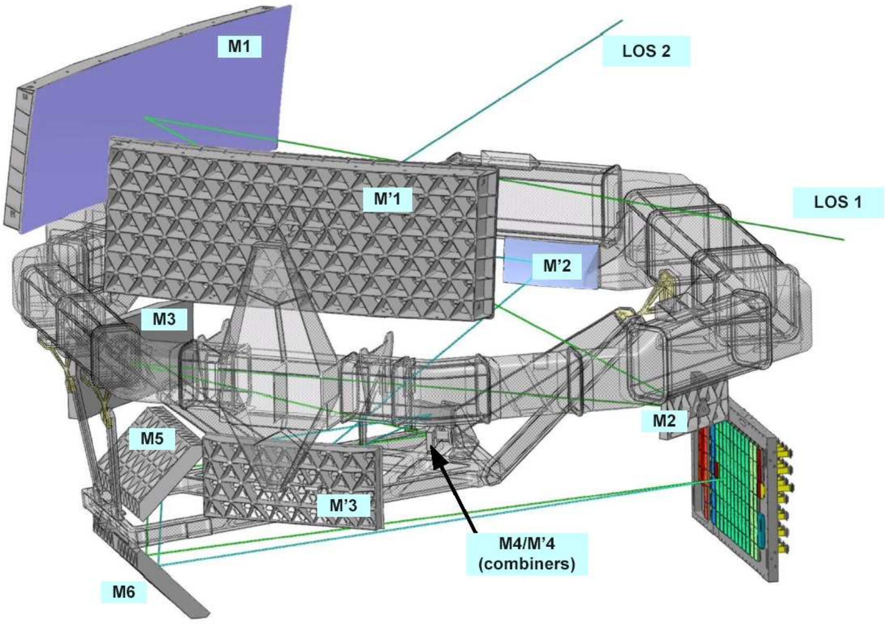

The optical path of both telescopes is composed of six reflectors (M1–M6), two of which are common (M5–M6). The entrance pupil of each telescope is 1.45 m $\times$ 0.5 m^2 and the focal length is 35 m. The payload module features a common focal plane shared by both telescopes. Figure courtesy of EADS-Astrium.

A number of important properties of the Gaia payload are reflected in the adopted optical design:

(a) The optical configuration reflects a six-mirror anastigmatic design. The two telescopes have rectangular entrance pupils (1.45 $\times$ 0.5 m^2) and large focal lengths (35 m). A CCD pixel size of 10 μm in the along-scan direction has been selected. With the 35 m focal length, corresponding to a plate scale of 170 μm arcsec^{-1}, this allows a 6-pixel sampling of the diffraction image along scan.

(b) To ensure the thermal and mechanical stability of the payload, the mirrors – like the optical bench (torus) on which they are mounted – are made of Silicon-Carbide (SiC).

(c) The optical system is compact, with an optical-bench diameter of about 3 m, and is housed within a mechanical structure adapted to the Soyuz-Fregat launcher fairing.

(d) The field of view of both telescopes is unvignetted and covers 0.45 deg^2 per telescope. The across-scan height of 0.7° is sufficient to avoid gaps in the sky coverage resulting from the slow yet continuous precession of the spin axis.

(e) The optical design allows high-quality imaging, both in terms of wave-front errors (WFEs) and (optical) distortion. The total, effective RMS WFE over the astrometric field of view, including optical design, manufacturing and integration, alignment, and cool-down, is $\sim$50 nm. The total, effective RMS distortion over the astrometric field of view, including payload optical design, manufacturing and integration, and in-orbit WFE compensation, is 1.8 μm (0.18 pixel) over a single CCD transit. The latter value is acceptable in terms of causing only limited along-scan blurring of star images during a CCD crossing.

(f) Although the optical design is fully reflective, based on mirrors only, diffraction effects with residual aberrations induce systematic chromatic shifts of the diffraction images and thus of the measured star positions. This effect, usually neglected in optical systems, was relevant for Hipparcos and is also critical for Gaia. The overall system design is such that these systematic chromatic displacements, which can amount to 500 μas or more, will need to be calibrated as part of the on-ground data analysis using the colour information provided by the photometry on each observed object.