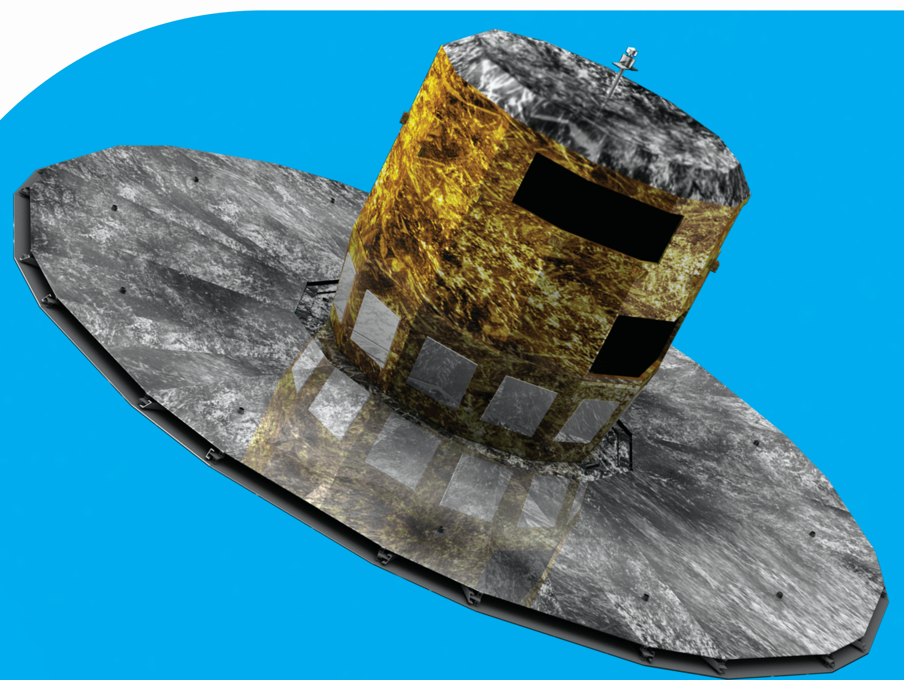
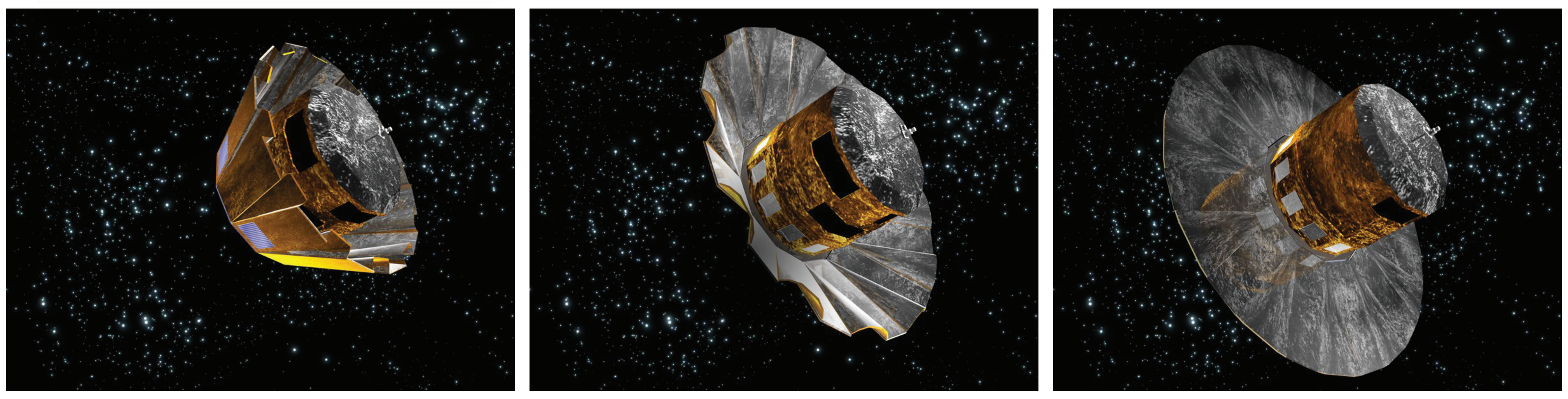


Credit: ESA - C. Carreau

The Gaia Spacecraft and Instruments



The Gaia spacecraft, with sunshield deploying

Credit: ESA - C. Carreau

Spacecraft

With a launch mass of about two tonnes, the Gaia spacecraft comprises a **payload module** and a **service module**. The service module comprises all mechanical, structural and thermal elements supporting the instrument and the spacecraft electronics, and includes the micro-propulsion system, deployable sunshield, payload thermal tent and solar arrays. The service module also offers support functions to the Gaia payload and spacecraft for pointing, electrical power control and distribution, central data management and radio communications with the Earth.

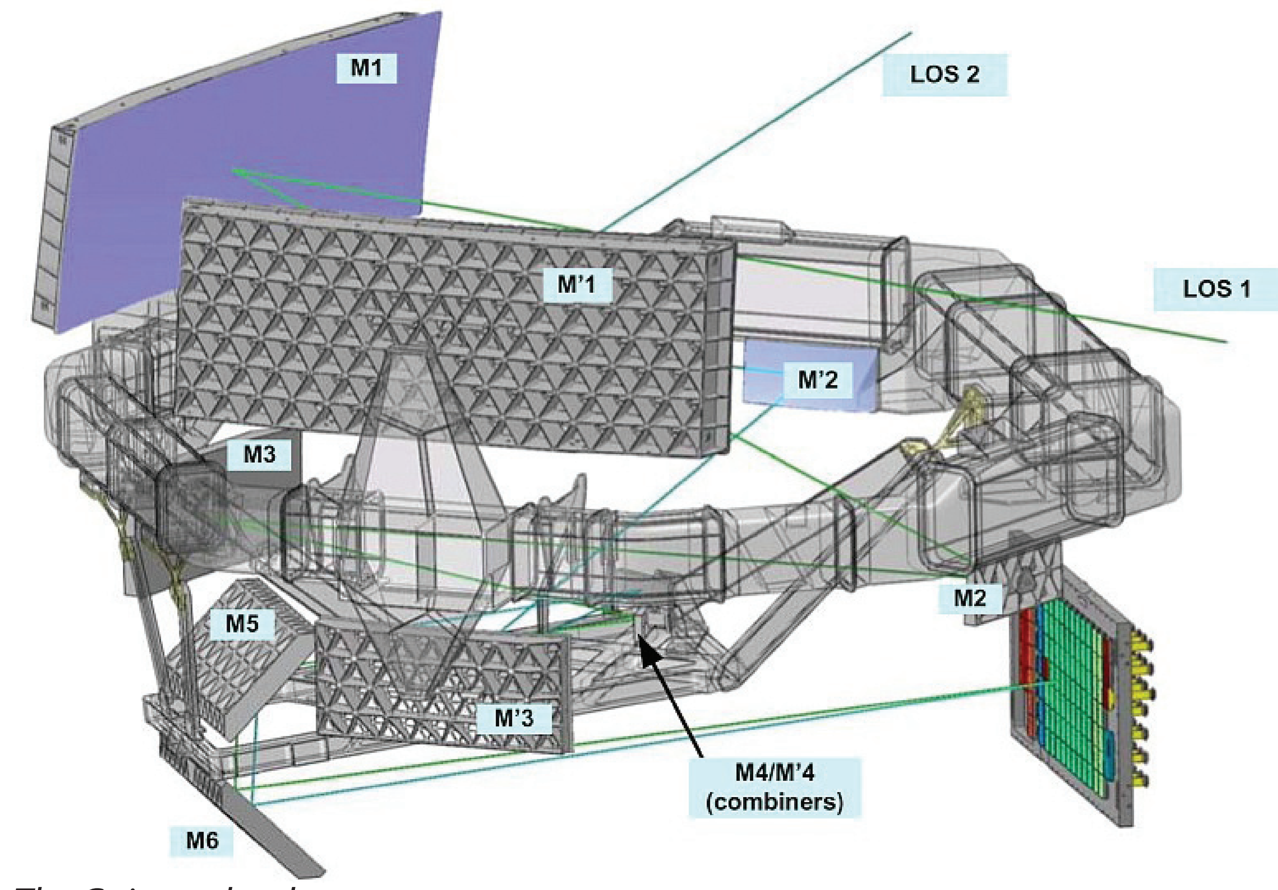
The mechanical service module is optimised so as to guarantee the stability of the basic angle, necessary to meet science requirements. It includes a flat, deployable sunshield which prevents Sun illumination of the spacecraft - and specifically the payload module - during the mission.

Payload

Inside the satellite, Gaia's instruments are mounted on a hexagonal optical bench. The payload features **two telescopes** sharing a **common focal plane**, each looking out through an aperture in the payload housing. The two viewing directions are each 1.7° by 0.6° in size, and separated by a **highly stable basic angle** of 106.5°.

Light from a celestial object enters the arrangement through one of the two apertures, striking the large primary mirror opposite (M1 and M'1 in the payload illustration). The light is reflected by the primary mirror and bounced by a series of further mirrors along a total focal length of 35 m, with the two light paths meeting at the M4/M'4 beam combiner before finally reaching the shared focal plane. At the focal plane is a large mosaic of sophisticated, **custom-built charge-coupled devices** (CCDs), light detectors of essentially the same kind as found in a digital camera. Containing 106 CCDs, the focal plane assembly comprises a total of **nearly one billion pixels** (a 'gigapixel'), compared to the few million of a typical digital camera.

As the spacecraft slowly rotates, the light from the celestial object (that is, the image of the object) passes across the focal plane. In this way, Gaia steadily scans the whole sky as the satellite spins and gradually precesses, with each part being observed around 70 times in the course of the operational lifetime.



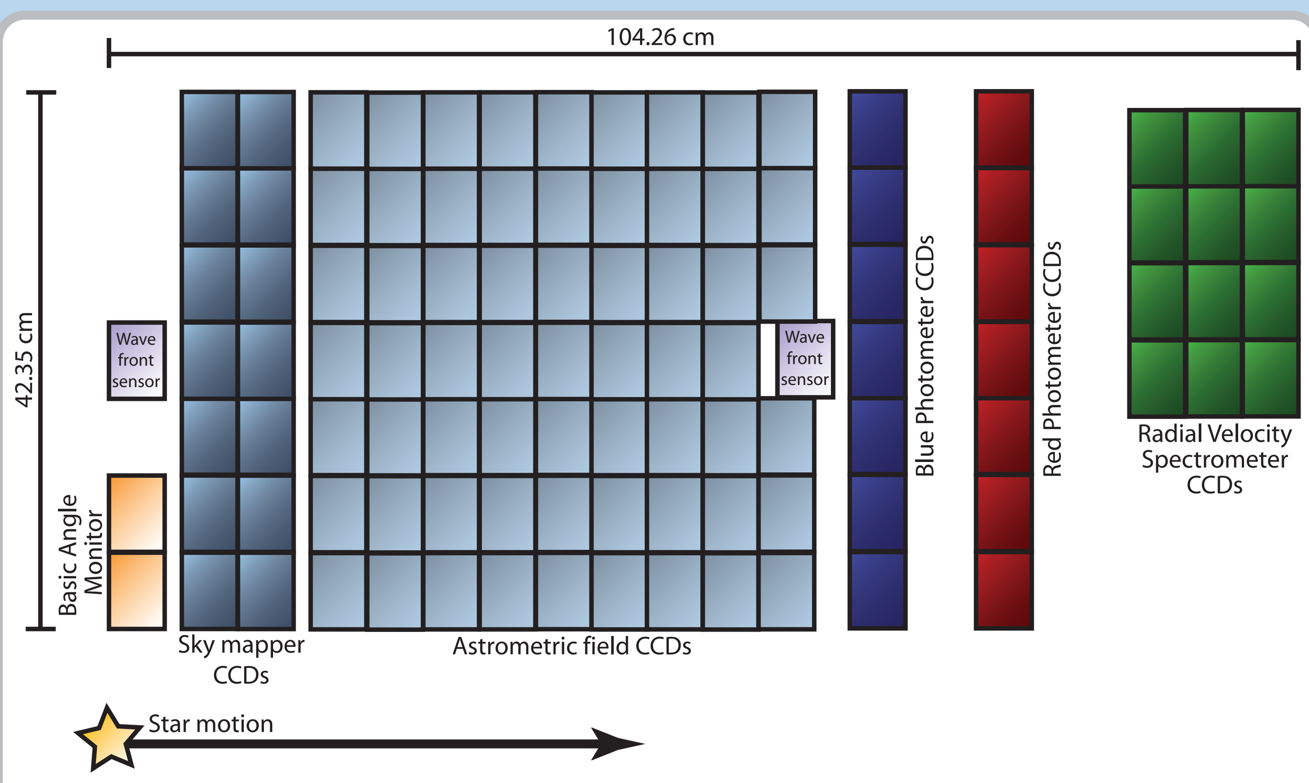
The Gaia payload

Credit: EADS Astrium

Astrometric Instrument

Gaia's astrometric measurements are made using the **global astrometry concept** successfully demonstrated by Hipparcos. Gaia measures the relative separations of the thousands of stars simultaneously present in the combined fields of view. The astrometric field in the focal plane is sampled by an array of 62 CCDs, each read out in time-delayed integration mode synchronized to the scanning motion of the satellite.

The spacecraft operates in a continuously scanning motion, such that a constant stream of **relative angular measurements** is built up as the fields of view sweep across the sky. High angular resolution (and hence high positional precision) in the scanning direction is provided by the primary mirror of each telescope, of dimension 1.45 x 0.5 m^2 (along scan x across scan). The wide-angle measurements provide the high rigidity of the resulting reference system.



The focal plane assembly

Credit: ESA - A. Short

Photometric and Spectroscopic Instruments

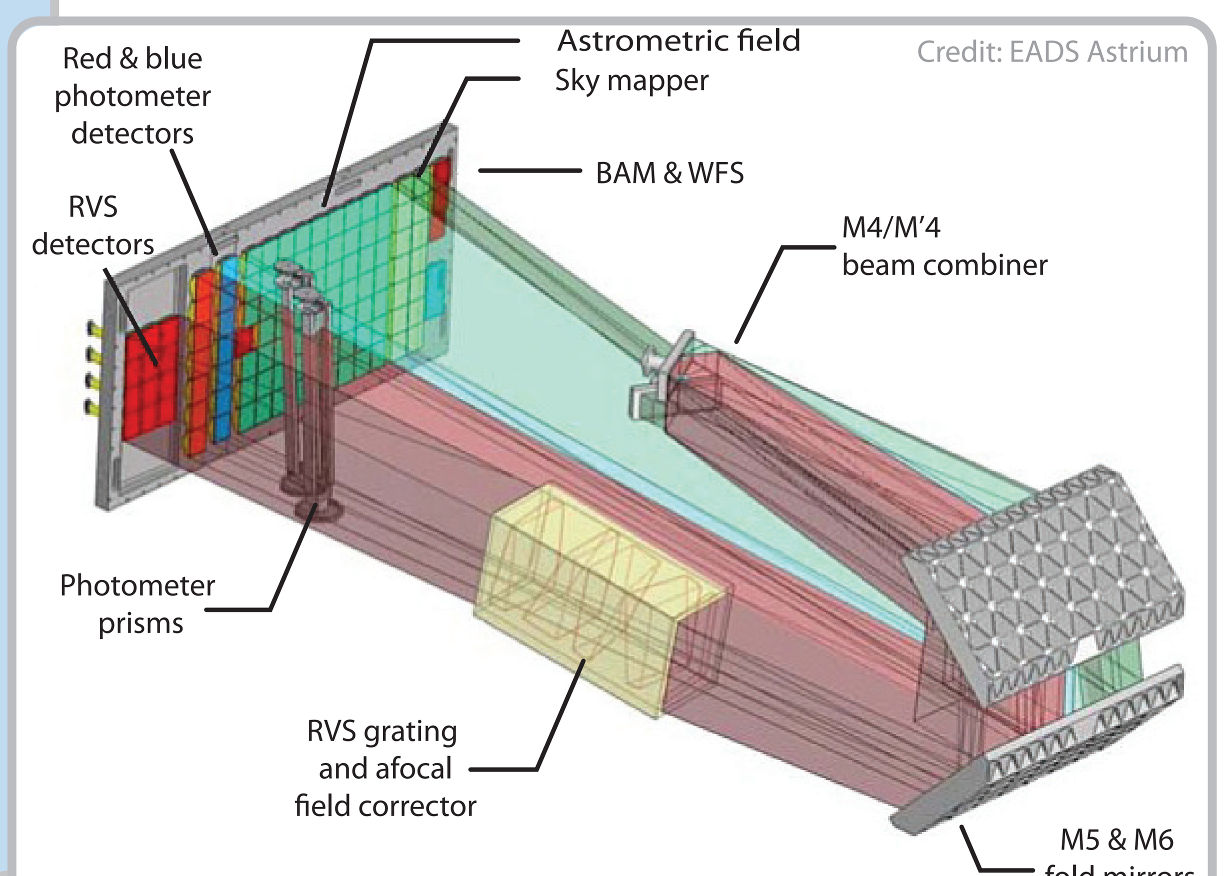
Gaia's **photometric instrument** consists of two low-resolution fused-silica prisms dispersing all the light entering the field of view. One disperser — called BP for Blue Photometer — operates in the wavelength range 330–680 nm; the other — called RP for Red Photometer — covers the wavelength range 640–1050 nm. The prisms are located between the last telescope mirror (M6) and the focal plane. These measurements of the spectral energy distribution yield key astrophysical information, such as temperatures, gravities, metallicities, and reddenings, for each of the vast number of stars observed.

In addition to the photometric instrument, Gaia features the **Radial Velocity Spectrometer (RVS) instrument**. The RVS provides the third component of the space velocity of each star down to about 17th magnitude. The instrument is a near-infrared (847–874 nm), medium-resolution ($\lambda/\Delta\lambda \sim 11000$), integral-field spectrograph dispersing all the light entering the field of view. The spectral dispersion of objects in the field of view is materialised by means of an optical module located between M6 and the focal plane. This module contains a grating plate and an afocal field corrector lens, composed of four fused-silica prisms.

The photometers and RVS are both **integrated with the astrometric instrument and telescopes**. As a result, the light from the two viewing directions is superimposed on the photometric and RVS CCDs. RVS and BP/RP use the (astrometric) sky mapper function for object detection and confirmation. Objects will be selected for RVS observation based on measurements made slightly earlier in the Red Photometer.

Prime Contractor

In May 2006, European satellite specialist EADS Astrium signed a contract to develop and build the Gaia satellite under the responsibility of the ESA Project Manager. The cutting-edge technology employed in the Gaia craft and instruments draws on Astrium's considerable expertise, particularly with silicon carbide telescopes, as used on the Herschel Space Observatory. Moreover, as the makers of Gaia's predecessor, Hipparcos, EADS Astrium bring much valuable experience to the project.



Credit: EADS Astrium

Gaia's instruments

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Gaia: Surveying the Galaxy