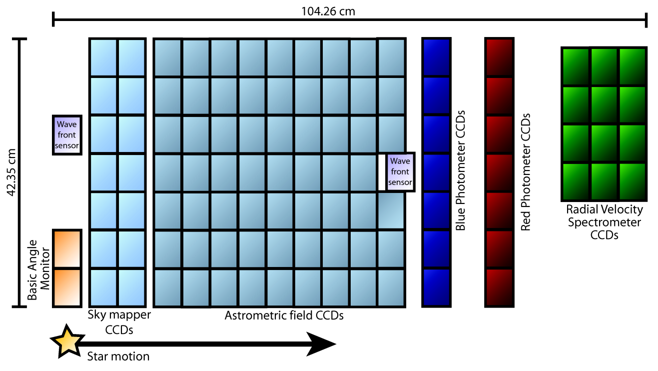

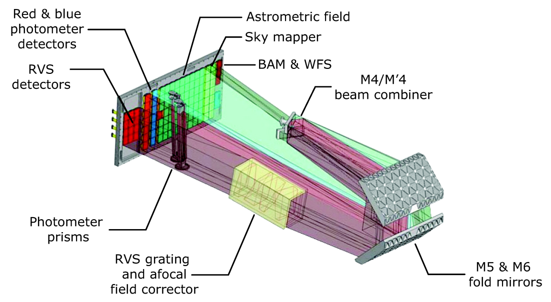

Left: the Gaia focal plane. Credit: ESA - A. Short. Right: the Gaia instruments. Credit: EADS Astrium.

Gaia has two telescopes with two associated viewing directions of size 0.7°× 0.7° (along scan × across scan) each. The two viewing angles are separated by a highly-stable 'basic angle' of 106.5°. The two field of views are combined into a single focal plane covered with CCD detectors. By measuring the instantaneous image centroids from the data sent to ground, Gaia measures the relative separations of the thousands of stars simultaneously present in the combined fields. 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 × 0.5 m^2 (along scan × across scan). The wide-angle measurements provide high rigidity of the resulting reference system.

The whole sky is systematically scanned such that observations extending over several years yield some 70 sets of relative measurements for each star. These permit a complete determination of each star's five basic astrometric parameters: two specifying the angular position, two specifying the proper motion and one - the parallax - specifying the star distance. A 5-year mission permits the determination of additional parameters, for example those relevant to orbital binaries, extra-solar planets and solar-system objects.

In practice, the *a posteriori* on-ground data processing is a highly complex task, linking all relative measurements and transforming the location (centroid) measurements in pixel coordinates to angular field coordinates through a geometrical calibration of the focal plane, and subsecuently to coordinates on the sky through calibrations of the instrument attitude and basic angle. Moreover, corrections for systematic chromatic shifts need to be made, as well as aberration corrections and corrections for general-relativistic light bending due to the Sun, the major planets, some of their moons and the most massive asteroids. Centroid shifts caused, under the influence of radiation damage, by stochastic charge trapping and de-trapping in CCDs also need to be understood and calibrated with high precision.

The astrometric field (AF) in the focal plane is sampled by an array of 62 CCDs, each read out in TDI (time-delayed integration) mode, synchronised to the scanning motion of the satellite. In practice, stars entering the combined field of view first pass across dedicated CCDs which act as a 'sky mapper' (SM) - each object is detected on board and information on its position and brightness is processed in real-time to define the windowed region read out by the following CCDs. Gaia's limiting magnitude is about 20-th magnitude and all objects brighter than this limit at the epoch of observation will be measured. Gaia's observations are thus not limited to stars but also cover quasars, near-Earth objects, asteroids, supernovae, etc.

Before stars leave the field of view, spectra are measured in three further sets of dedicated CCDs. The BP and RP CCDs - BP for Blue Photometer and RP for Red Photometer - record low-resolution prism spectra covering the wavelength intervals 330-680 and 640-1000 nm, respectively. These simultaneous semi-photometric measurements of the spectral energy distribution yield key astrophysical information, such as temperatures, gravities, metallicities and reddenings for each of the vast number of objects observed. In addition to the low-resolution photometric instrument, Gaia features a high-resolution integral-field spectrograph, the so-called Radial Velocity Spectrometer (RVS) instrument. The RVS provides the third component of the space velocity of each star (down to about 17-th magnitude).