Pictured above is part of the team from the e2v wafer fabrication area that produced the initial batch of Gaia demonstrator CCDs. Inset: Two CCD91-72 CCDs on a silicon wafer. Each CCD comprises 4500×1966 pixels, each 10×30 μm^2 in size. Test structures are visible on either side of the CCDs. Images courtesy of e2v technologies.

Charge-Coupled-Device (CCD) detectors form the core of the Gaia payload. Their development and manufacture represents one of the key challenges for the programme. The design of the Gaia CCDs has been tailored to the needs of the mission. Compared with contemporary scientific space missions, Gaia's CCDs will need to be produced in unprecedented numbers. In order to meet this challenge, Gaia has enlisted the services of e2v technologies, the world's leading scientific CCD manufacturer.

Gaia features a focal-plane assembly of nearly 0.4 m^2. This FPA will be populated with 106 back-illuminated devices, each with an active area of 45×59 mm^2 corresponding to 4500 TDI lines and 1966 pixel columns. All CCDs will be operated in time-delayed integration (TDI) mode with a TDI period 982.8 μs. Stars will thus cross a CCD in 4.4s. All CCDs will be individually packaged and each CCD will be driven by a dedicated proximity electronics module mounted below it and connected to it via a thermally isolating flex circuit.

All of the Gaia CCDs are large area, back-illuminated, full frame devices. They all have a 4-phase electrode structure in the image section and a 2-phase structure in the readout register, leading to a single, high-performance, two-stage, buffered output node. A noise performance better than 10 electrons RMS is expected. The CCDs will be operated at –115°C, selected to minimise dark current and charge-trapping effects.

Gaia will observe objects over a very wide range of apparent magnitude and the CCDs must therefore be capable of handling a wide dynamic signal range. In order to observe all objects as efficiently as possible, the CCD quantum efficiency has been optimized, while keeping acceptable modulation-transfer-function performance. A number of features have been incorporated in the CCD design in order to cope with bright stars. These include a large full-well capacity (> 190,000 electrons), an anti-blooming drain, and 12 TDI gates which effectively reduce the integration time for bright objects. The CCDs also feature a summing well, a suplementary buried channel, and a charge-injection structure.

The pixel size of the CCDs has been specified in order to correctly sample the point spread functions of the astrometric instrument in the along- and across-scan directions. The resulting pixel dimensions are 10 × 30 μm^2. Whilst the QE of the main-field astrometric CCDs has been chosen to give good overall response in the centre of the band, ithe photometric and spectroscopic CCDs require a response biased towards the red or blue ends of the band. This is achieved in part by selecting appropriate surface passivation processes and anti-reflection coatings. However, for the red-enhanced CCDs, it is also necessary to fabricate thicker devices on high-resistivity silicon.