Development of Curved Silicon Detectors for Space Imaging Applications

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Description:
CCDs have been a disruptive technology for many imaging applications, and most notably in space science in the examples of NASAs Hubble Space Telescope and ESAs Gaia missions. However for a typical imaging camera system, the image sensors represent only ~10% of the system value, with optics, electronics, etc. dominating the value. One of the key challenges is to maintain image quality across the image field, where the quality (point spread function, PSF) degrades off-axis, requiring e.g. complex multiple lens systems to correct for off-axis aberrations.

The use of curved sensors could lead to greatly simplified optics designs and thereby yield advantages for the entire system (in terms of cost, mass and complexity). However, today's imaging sensors fabricated on crystalline silicon are manufactured extremely flat, on silicon wafers. Using thinning technology present in many of e2v's back-illuminated imagers, it is possible to form the thin silicon sensors onto curved substrates, with 1-D curving being relatively easy, however, 2D curving of crystalline silicon could be extremely challenging, leading to lattice defects, reliability issues and even device fractures.

The CEI has developed techniques to evaluate space radiation damage which can identify individual crystalline defects created by proton interactions. This innovative technique could be applied to explore stresses and crystalline defects introduced in curved imaging detectors, and be a tool to assist in the production of defect-free image sensors. These new image sensors could be revolutionary for both optical imaging applications, and even X-ray diffraction experiments, e.g. at synchrotrons, where for example in diffraction stations, the X-ray beams diverge from a single point, and a spherically-curved detector would introduce fewer image artefacts.

The student would work with Teledyne-e2v who would be responsible for provision of both 1D and 2D imaging detector samples. We envisage that the student would also have an opportunity to work with the Technology Directorate at ESA/ESTEC, which would add further value to the work programme. The key outputs of the programme of study would be the generation of novel 2D curved silicon image sensors (possibly both CCDs and new CMOS sensors), with detailed characterisation of the silicon lattice defects, and any associated problems with the technical approach, plus hopefully some demonstrations of the applicability of the new technology to applications e.g. astronomy, other imaging applications or XRD.

Qualifications required:
Suitable for graduates with a physics (or related) undergraduate degree.