Development of Next-Generation X-ray Instrumentation for Space and Planetary Science

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Project highlights:
- Work closely with space agencies including ESA, ISRO, and the UKSA, as well as the world leaders in space imaging technology, Teledyne e2v
- Contribute to and work on cutting-edge detector technology for future X-ray space instrumentation, particularly ESA’s THESEUS mission concept, enhancing the scientific return and fundamental understanding of the technology
- Hands-on laboratory training and experience of characterising novel detectors within a large multidisciplinary research group
- Potential for international travel to experimental facilities in Germany and the Netherlands, and further travel to international conferences and meetings to showcase research

Project description:
The Centre for Electronic Imaging (CEI) is a large multidisciplinary research group at the Open University specialising in the design, characterisation, radiation testing and optimisation of detectors for space and planetary science. It benefits from knowledge exchange with its industrial partner, Teledyne e2v – a world leader in space imaging technology. Our expertise spans from modelling radiation doses to detectors to, more recently, post-launch ground support for large space missions, including development of the software pipeline for ESA’s EUCLID space telescope. The CEI works with global space agencies including ESA, NASA, CSA, and ISRO, developing and testing detector technology that has now flown successfully on numerous missions.

Although CCD technology has dominated imagers for space and planetary science instruments thus far, CMOS image sensors (CIS) are fast becoming a preferred option due to
improvements in the technology – already ubiquitous in smartphone cameras – alongside their greater tolerance to certain radiation damage effects and lower power requirements. CIS technology was thus adopted for the JANUS camera on board ESA’s JUICE mission (launched April 2023), and later generations of CIS detectors have been developed in collaboration with Teledyne e2v.

More recently, a CIS prototype detector was developed within the CEI, utilising novel pixel design techniques to enable soft (i.e. low energy) X-ray detection for the proposed ESA THESEUS mission. The new detector, named CIS221-X, shows great promise in fulfilling the requirements of the soft X-ray imager (SXI) instrument on board THESEUS [1], but the technology must be developed further over the coming years. This includes the delivery of a significantly larger version, whilst refining the pixel design to further enhance the performance and hence science return of the instrument. Once designed, multiple detectors will be assembled into one of the largest focal planes ever made for X-ray astronomy.

The CIS221-X has also gained the attention of ISRO, the Indian Space Research Organisation [2], with which the CEI has a long-standing relationship having worked on X-ray detectors on board both their Chandrayaan-1 and Chandrayaan-2 missions. Their planned Auroral X-ray Imaging Spectrometer (AXIS) instrument aims to image and collect spectroscopic data on soft X-ray emission from aurorae at the Earth’s poles for the first time, adding to our understanding of the way in which solar energetic particles interact with the Earth’s upper atmosphere. A bilateral programme of work is expected to lead to the provision of CIS221-X for this instrument, requiring further testing and optimisation of operating parameters for the detector and associated flight electronics to meet science requirements.

The student would therefore have opportunities to collaborate closely with ISRO on the development of X-ray optimised CIS for AXIS and future X-ray instrumentation, and with ESA for the characterisation of a next-generation large-format CIS221-X detector for THESEUS. They are expected to perform laboratory characterisation work with the support of training within the group, and may pursue fundamental research into detector performance, and participate in experimental campaigns involving international travel to specialist test facilities.

References:
