CMOS Image Sensor for the THESEUS X-ray Space Telescope

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Description:

Proposed by the European Space Agency, the Transient High-Energy Sky and Early Universe Surveyor (THESEUS) is a space telescope mission tasked with studying the early Universe by imaging in the X-ray, gamma-ray and infrared wavelengths. Onboard THESEUS will be a soft X-ray imager working in the 300 eV to 6 keV energy range, which is planned to use an array of specialised CMOS image sensors (CIS) as active devices.

CIS are increasingly used in space applications due to their numerous advantages. Unlike Charge Coupled Devices (CCDs), CIS are largely immune to radiation-induced charge transfer inefficiency and can tolerate large doses of ionising radiation. In addition, CIS dissipate less power and integrate digitisation and other functions on-chip, significantly simplifying spacecraft electronics and reducing its mass.

The requirements for the soft X-ray imager dictate that the sensor is built on a relatively thick, fully depleted silicon substrate, and has large pixel size (e.g. 40 micrometres square) combined with very low readout noise and image lag. This poses several challenges to the sensor design due to the conflicting interplay between the requirements and the limitations of the available CMOS technologies. In particular, the solutions for achieving negligible image lag make full depletion more difficult, and can make the sense node too large, which increases the readout noise.

This studentship will be tasked with carrying out essential research towards overcoming the challenges in realising the soft X-ray imager for THESEUS in CMOS technology. The work will involve detailed device simulations, experimental characterisation of representative devices, and radiation damage studies for the space environment. Investigating new methods for minimising image lag in large pixels while simultaneously achieving high conversion gain and low noise will form a big part of the student's work. The sensor will use our patented method of obtaining full depletion in pinned photodiode CIS, which is needed to increase the quantum efficiency and minimise charge spread during collection. The combination of device characteristics is unprecedented for a monolithic CIS and the successful outcomes of the project could position this technology at the forefront of soft X-ray imaging.

Qualifications required: A first class or upper second class MSc degree in physics, electronics engineering or a related discipline.