A universal model for detector simulations for space applications

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Description:

The current and next generation of spaceborne instruments embarked upon ESA Science missions have moved observational astrophysics into an era of precision astronomy. Instruments are designed to maximize specific, high-precision science returns that push technical capabilities ever closer to their theoretical limits. In parallel, rapid advances in computational methods have unlocked the capability of relying on instrument simulations accounting for complex optical, mechanical, thermal, and other effects to achieve these high-precision science cases.

The implementation of detailed instrument modelling now spans all phases of a project: translating the high-level science requirements into a defined instrument concept, monitoring the compliance between science performance specifications and requirements during the design and construction phases, optimising science return through calibration, planning for science operations, and analysing astronomical data products.

One critical aspect of instrument simulation is the behaviour of the detectors. While many instruments use similar (and in some cases identical) detectors, most instrument teams have implemented the most important basic detector effects for their application into their instrument simulators independently.

ESA (SCI-FIV), in partnership with ESO, has over the last years developed a general detector simulation framework called Pyxel with the main objectives being:

- reusability: to avoid duplicated effort between projects and enabling best use of available manpower
- knowledge transfer: to enable cross-fertilisation between projects and provide a unique forum where detector models from experts around the world can be shared and directly used
- reliability: to make sure the detector models are validated, transparent, and results obtained in different context or at different epochs are reproducible

This open-source Python-based detector simulation framework allows scientists, engineers, and users to contribute models of various detector effects that can then be used and validated by all instrument teams using CCD, CMOS, or hybridized detectors in the optical and infrared.

This 3-year PhD project aims at probing the physics and fundamental understanding of the detectors for a variety of applications and using this new knowledge to develop exciting new capabilities for Pyxel in the context of the on-going detector developments taking place at OU CEI group as well as the past modelling knowledge acquired in the context of the SMILE, Euclid, JUICE, and Gaia missions.

The project will be undertaken in close collaboration with ESA and will include several trips to ESTEC in the Netherlands.

References:

1. D. Lucsanyi, T. Prod'homme, et al. "Pyxel: a novel and multi-purpose Python-based framework for imaging detector simulation", Proc. SPIE 10709, High Energy, Optical, and Infrared Detectors for Astronomy VIII, 107091A (16 July 2018); https://doi.org/10.1117/12.2314047
2. https://esa.gitlab.io/pyxel/

Qualifications required:

A first class or upper second-class MSc/BSc degree in Physics, Astronomy, Electronic Engineering, Computer Science or a related discipline. Knowledge of space science mission instrumentation, in particular visible and infra-red detection technologies, is considered a plus. Fluency in Python is considered a plus.