Next generation EOS wind speed LIDAR sensor: Hot Pixel Generation and Clock Induced Charge in Te2v EM CCDs

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Description:

Launched in August 2018, Aeolus is the first satellite that is able to acquire profiles of the Earth's wind at a global scale. Near-real time observations from the mission are helping to dramatically improve the accuracy of weather and climate prediction, advancing our understanding of climate variability and tropical dynamics. In recent months, with the current global pandemic bringing a sharp decline in weather-related measurements, data from Aeolus has proved even more important to provide accurate forecasting across Europe. The Aeolus mission, the fifth in the family of ESA's Earth Explorer missions addressing key scientific challenges using breakthrough technology, is collecting these vital data using laser technology.

Traditional methods used to gather this type of data involve deploying weather balloons, cloud tracking, and monitoring temperature and surface winds. Instead, the Aeolus satellite employs a very powerful laser in an instrument known as ALADIN. Teledyne e2v, in collaboration with Airbus Defence & Space and ESA, developed an innovative new detector that simultaneously measures the distance of a returned ultraviolet laser pulse to resolve the altitude of aerosols in the atmosphere, and the Doppler shift that equates to the wind speed at each altitude. Teledyne e2v's detector consists of a 16 x 16 pixel CCD with a novel storage region that accumulates the signal from several successive laser pulses.

The returned signal is typically extremely weak, however the detector has the capability to add together a number of returned pulses to improve the accuracy of the measurements. Aeolus is the first satellite of its kind to utilize this type of technology in space, but the sensors are experiencing some unexpected effects from the radiation environment in orbit that must be better understood, both for the benefit of Aeolus and to enable the development of a new generation of detectors.

The Centre for Electronic Imaging (CEI) at the Open University has been involved in studying the nuances of radiation damage in Charge-Coupled Devices (CCDs) for over a decade as part of a long-running collaboration with Teledyne e2v. Most recently, detailed study of Clock-Induced Charge (CIC) by a CEI PhD student was undertaken on detectors towards the WFIRST Coronagraph (now named the Nancy Grace Roman Space Telescope). Coupled to the generation of CIC, the generation mechanisms and properties of hot pixels has become somewhat of a "hot" topic in recent studies.

In this PhD studentship, working with scientists from Airbus Toulouse and ESA, the successful candidate would aim to:

- Develop a fundamental understanding of hot pixel generation and anomalies in specific Teledyne e2v devices.
- Analyse the impact of hot pixels in flight.

- Further develop the understanding of CIC generation in Teledyne e2v CCDs.
- Consider possible ways of reducing the generation rate of hot pixels and generation of CIC and ways to mitigate the impact.
- Collaborate with scientists from Airbus Toulouse and ESA, using their new research findings to the benefit of the Aeolus mission.
- Feed their results into Teledyne e2v's design processes for the next generation of sensors for future missions.

By working in collaboration with the CCD manufacturers, Teledyne e2v, Airbus Toulouse and ESA, the student would gain a rounded training and understanding of detector development and research in industry and in academia, with support provided by both academic and industrial supervisors.

This studentship will be hosted by the Centre for Electronic Imaging (CEI) at the Open University. There may also be opportunity during the period of the studentship to spend periods of time at both Airbus Toulouse and at ESA's ESTEC research centre in the Netherlands. Previous industry-sponsored studentships with the CEI and Te2v related to novel device development have had great and proven success and provided exceptional scientific return, with major impacts on ESA's Euclid VIS, JUICE JANUS, Athena WFI and SMILE SXI, alongside new device development programmes at Te2v. All have moved directly into employment following completion.

Te2v is a global leader in specialised components and subsystems for innovative solutions in medical, science, aerospace, defence and industrial applications. Based in Chelmsford, UK, Te2v has been trusted to design and deliver CCD and CMOS imaging sensors and sub-systems for over 150 space missions by the world's largest space agencies, including ESA, NASA and JAXA.

References:

1. Bush, Nathan L. (2018). The Impact of Radiation Damage on Electron Multiplying CCD Technology for the WFIRST Coronagraph. PhD thesis The Open University.

Qualifications required: 2.1 Masters in Physics or related subject.