Space Radiation Effects on Sub-micrometer Pixel and High-Resolution Advanced Image Sensors

PARTENAIRES

Top-Tier Global High-Tech Partner

Key words: CMOS Image Sensors, Space Radiation Effects, Semiconductor Defects, Space Instrumentation, Multiscale Multiphysics Modeling, Semiconductor Device Physics, Emerging Technologies

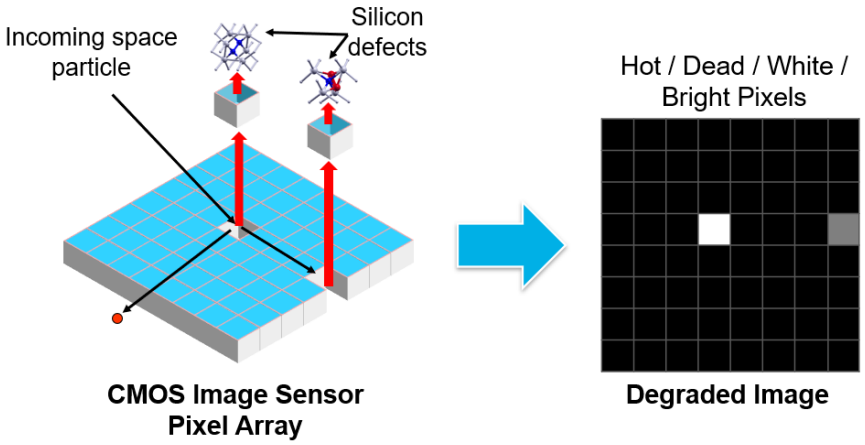
Department: Physics, Electronics, Signal and Space Instrumentation (DEOS), Integrated Image Sensors Research Team

ISAE-SUPAERO offers a PhD position in collaboration with a premium international consumer electronics maker. The project focuses on understanding and modeling space radiation effects on emerging CMOS image sensor technologies for next-generation space instrumentation.

Context:

Space instruments operate in environments where electronic devices are exposed to energetic particles from the Sun, planetary radiation belts, and cosmic rays. When these particles interact with semiconductor materials such as silicon, they can displace atoms from the crystal lattice, creating defects that alter the electrical properties of the device. In CMOS image sensors, these defects may generate excess dark current or noise. With the continuous scaling of pixel dimensions toward the sub-micrometer range, the region affected by a radiation event can extend over several pixels, potentially impacting the performance of high-resolution imaging systems. Understanding and modeling these effects is therefore essential for the design of robust image sensors for future space missions.

This PhD will experimentally study and model these physical effects to predict the performance of next-generation imaging technologies in harsh space environments.



Schematic illustration of radiation effects on a CMOS image sensor pixel array.

PhD Objectives and Work Plan:

The research will combine experimental and modeling approaches to address critical challenges in advanced image sensor technologies:

1. **Literature review and state-of-the-art survey** of radiation effects on CMOS image sensors and related devices.
2. **Experimental irradiation studies** of emerging image sensor technologies provided by the partner's R&D teams.
3. **Analysis and interpretation** of the physical phenomena underlying radiation-induced effects on submicrometer pixels.
4. **Identification of key design and technological parameters** that influence sensor performance under radiation.
5. **Development of predictive models** accounting for these parameters, enabling estimation of image sensor behavior in given radiative environments.

The PhD candidate will work in close collaboration with the partner, including **regular interactions and joint discussions**, and is expected to **produce multiple publications** in high-impact journals and conferences.

Career Opportunities:
This PhD offers exposure to **cutting-edge space instrumentation, radiation effects, and semiconductor industry research**, opening numerous career paths in both academic and industrial environments.

What We Offer:

- Collaboration with a **top-tier global high-tech partner**.
- Hands-on experience with **emerging imaging technologies**.
- Opportunities to **publish in leading journals and conferences**.
- Exposure to **industrial and space instrumentation career paths**.

More detailed background information:

- 2021 IEEE Nuclear and Space Radiation Effects Conference Short Course Part III: Hardening Techniques for Image Sensors https://filesender.renater.fr/?s=download&token=20de03b9-ea67-4c9e-ad20-c7117c2372dc
    - Section 1 (Introduction) gives an introduction to the CMOS Image Sensor technology
    - Section 3.1 (Displacement Damage in CIS) gives an overview of the most relevant space radiation effect for this PhD
- Recent publication related to the PhD topic: https://doi.org/10.1109/TNS.2025.3648295

REQUIRED PROFILE:
We are looking for students holding a **Master's degree or an engineering diploma** in:

- Applied Physics
- Electrical Engineering
- Aerospace Engineering

Desired skills and knowledge areas include (but are not limited to):

- Semiconductor device physics
- Solid-state physics
- Image sensors and instrumentation
- Solid-state detectors
- Micro/nanoelectronics
- Analog/digital electronics for sensors
- Experimental methods in radiation testing

EXPERIENCE: no requirement
COMPENSATION: 2600€ / AN
DURATION: 36 MOIS
RYTHM: Full time
LOCATION: ISAE-SUPAERO, Toulouse, France and potential stays/visits in US/Asia

RESPONSIBLE OF THE SUBJECT:
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APPLICATION PROCESS: Send CV and cover letter to vincent.goiffon@isae-supaero.fr **with [PHD application] in the subject line.**

APPLICATION DEADLINE: Review of applications will begin immediately and continue until the position is filled.