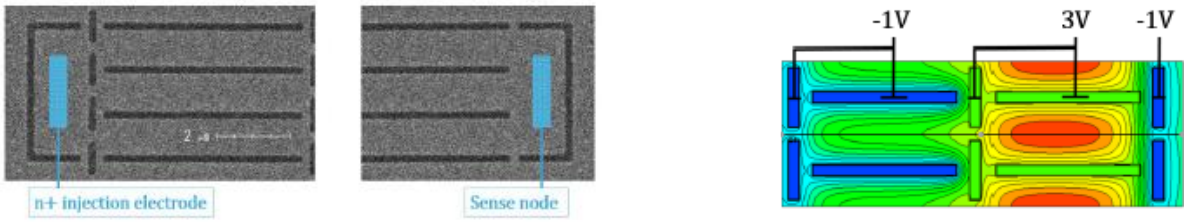
POSTDOCTORAL POSITION

Characterization of avalanche effects and radiation robustness evaluation of charge transfer devices for imagers dedicated to space applications

The considerable progress of CMOS imaging technologies obtained in recent years, in terms of both improved photo-detection performance and noise reduction, allow to consider these technologies for very demanding applications, such as space applications, where CCD sensors were, up until now, the best candidates.

Pléiades Satelite for Earth observation and very high resolution imaging : satellite and high resolution instrument focal plane (https://pleiades.cnes.fr)

In low-light level applications, the noise may have the same order of magnitude than the photogenerated charge, which can produce an unusable image. One of the solutions to improve the signal to noise ratio is to increase the signal using the multiplication of the photogenerated charge inside the imager.
Charge multiplication using impact ionization is used since the 80s in CCD image sensors (EMCCD) [1], and can be implanted in CMOS imagers thanks to the use to charge transfer registers [2]. Dedicated structures, allowing both collection and charge transfer in the silicon volume, have been developed, thanks to a partnership between ST Microelectronics, Thalès Alenia Space and CNES [3][4].



SEM planar views of the input and output stages (left) and planar cross-section of a 2D TCAD simulation of the electrostatic potential distribution (right) [3].

Thanks to the knowledge of physical mechanisms leading to avalanche multiplication, to TCAD simulations and measurements performed on existing charge transfer structures, some new architecture of column registers allowing the targeted multiplication gain have been designed, are currently being manufactured and will have to be fully characterized, including an evaluation of the robustness to radiative environment.

ISAE SUPAERO - Institut Supérieur de l'Aéronautique et de l'Espace
10, avenue Edouard-Belin - BP 54032 - 31055 Toulouse CEDEX 4 - FRANCE
Tél : 33 (0)5 61 33 80 80 - Télécopie : 33 (0)5 61 33 83 30 - Site internet : www.isae-supaero.fr

MISSION: As a part of the CIMI research team, inside the ISAE-Supaero Department of Electronics, Optronics and Signal processing, the main tasks of the candidate, in addition to understand and analyze the mechanisms implied in charge transfer devices, are to :

- Characterize new charge transfer structures in order to check that the avalanche regime can be obtained and measure associated electro-optical performances (dark current, noise…).
- Participate to the development to the irradiation campaign and take charge of the associated measurements.
- Improve and optimize characterization setup and simulation methodologies dedicated to charge transfer devices developed within the CIMI research team.

DURATION: 12 months

CANDIDAT'S PROFILE: The candidate must have a strong knowledge and skills in semiconductor physics, electronics and micro/nanoelectronics. The candidate will have to be familiar with semiconductor characterization devices and should demonstrate a taste for the experiments.
Good autonomy, work in a small team, for organization and communication skills are essentials.
The candidate must be an EU citizen.

Candidates should send a resume (cover letter, CV and a publication list and/or their PhD) via email to the contact persons.

Contact : Olivier MARCELOT
olivier.marcelot@isae-supaero.fr, 05 61 33 89 65
Magali ESTRIBEAU
magali.estribeau@isae-supaero.fr, 05 61 33 89 64

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[2]. R. Shimizu, M. Arimoto, H. Nakashima, K. Misawa, T. Ohno, Y. Nose, K. Watanabe, T. Ohyama, "A Charge-Multiplication CMOS Image Sensor Suitable for Low-Light-Level Imaging," Solid-State Circuits, IEEE Journal of , vol.44, no.12, pp.3603-3608, Dec. 200
[3]. P. Touron, F. Roy, P. Magnan, O. Marcelot, S. Demiguel and C. Virmontois, "Capacitive Trench-Based Charge Transfer Device," in *IEEE Electron Device Letters*, vol. 41, no. 9, pp. 1388-1391, Sept. 2020, doi: 10.1109/LED.2020.3014431.
[4]. A. Salih Alj *et al.*, "Capacitive Deep Trench Isolation-Based CCD-on-CMOS Image Sensor Sensitivity to Total Ionizing Dose," in *IEEE Transactions on Nuclear Science*, vol. 70, no. 8, pp. 2018-2026, Aug. 2023, doi: 10.1109/TNS.2023.3283264.