PhD opportunity

Impact of circuit modelling and low energy particles on Single-Event Effect rate prediction

New applications in the industrial sectors of space, automotive, IoT, nuclear dismantling, civil applications, medical and accelerators among others require innovative radiation testing methodologies. As well, for coping with the industrial demand and market timelines, streamlined and coordinated testing becomes highly necessary.

This PhD thesis is part of the international RADNEXT EU project[1] that aims at increasing and optimizing the access of system developers to irradiation facilities in which representative conditions of their final application are reproduced, and that can serve as a satisfactory validation for the end-users. Such optimization will be based on a network of irradiation facilities with a common entry-point, in which users can define, prepare, carry out and analyze their irradiation campaigns. A key point of such improvement will be that of advancing in the harmonization and standardization of the system level testing methodology, so not to multiply efforts around the same common objective.

Along with the characterization under irradiation conditions, the usage of simulation tools is a crucial step for a successful development of test campaigns. Predictive and post-irradiation simulations provide means of better understanding the variety of mechanisms that undergoes at circuit and component level, allowing to maximize the outcome from an irradiation campaign. In this sense, this PhD thesis will develop and apply, in the framework of the RADNEXT project, tools and approaches for modelling radiation effects on electronics such as Single-Event Upset (SEU) and Single-Event Transient (SET). These require a multi-physics approach, at radiation-matter interaction, semiconductor physics and circuit level.

[1] https://radnext-network.web.cern.ch/

There are 4 main points to address in this PhD:

- **Impact of layout and input vector on SET cross section calculation**

The goal is to investigate the impact of the transistor design on the sensitivity of combinational circuits and to identify the most and the less sensitive to radiation. Additionally, the set of input stimuli will be studied to determine their different implications on the SET characterization of digital circuits.

- **Impact of low energy protons, muons and neutrons on SEU rate prediction**

As the electronics technologies shrink, they become more and more sensitive to low energy protons, muons (the two formers, mainly via direct ionization) and neutrons (which are, by the way, very abundant in the atmosphere). We then aim to evaluate, through the relevant radiation-matter interaction simulation tools, the contribution of protons, muons and neutrons in the 0.1-10 MeV energy range and determine if there is a trend with downscaling. To do so, we will perform calculations of Soft Error Rates (SER) for different technologies and evaluate the contribution of the 0.1-10 MeV energy range, and the related Radiation Hardness Assurance (RHA) implications.

- **Circuit level modelling**

While electrical models of circuits are necessary to evaluate the sensitivity of a device to radiation, they are generally not provided by the manufacturer. Therefore, the PhD student will investigate simplistic, but yet, realistic alternative models that can be used in the simulation studies and evaluate their accuracy. This has already been successfully investigated for SRAM circuits and we proposed to extend to other circuits such as combinational logic (NAND, NOR, Inverter and so on).

- **Experimental part**

In order to check the validity of previous simulations, a test chip will be designed with the circuits and technologies of interest. In view of the increasing demand for the qualification of commercial off-the-shelf (COTS) components, there will be also the possibility of irradiating commercially available components that are relevant to the proposed studies. The test chip and the COTS components will be irradiated at facilities available in the framework of the project.

Skills:

The candidate will be very interested in modelling and simulations. He/She will have skills in radiation matter interaction and electronics (combinational circuits, SRAM).

Knowing SPICE and FLUKA will be appreciated but not required.

Location:

The student will be mainly located in Montpellier (France) and will have a secondment in CERN for a period of 1 to 2 months (among 36 months)

How to apply?

Application deadline: 25 July, 2021.
Send CV and motivation letter by email to frederic.wrobel@umontpellier.fr