Contribution ID: **205** Type: **Oral presentation**

Impact of X-ray induced radiation damage on FD-MAPS of the ARCADIA project

Thursday 1 July 2021 11:20 (20 minutes)

The ARCADIA collaboration is developing Fully-Depleted Monolithic Active Pixel Sensors (FD-MAPS) with an innovative sensor design in a 110nm CMOS process. This technology provides efficient charge collection and fast timing over a wide range of operational and environmental conditions [1]. The design targets very low power consumption, of the order of 20mWcm at 100MHzcm hit flux, to enable air-cooled operation.
In November 2020, the collaboration finalized the first design of a prototype with 1.31.3cm active area, consisting of 512512 pixels with 25m pitch. This prototype is currently being produced in a first engineering run together with additional test structures of pixel and strip arrays with different pitches and sensor geometries and will be available for testing in May 2021.
In this contribution, we will present the current status of the project and discuss the methodology, based on TCAD simulations, that has been used for the selection of the different pixel geometries included in the first engineering run. An emphasis will be set on the modelling of X-ray induced radiation damage at the Si-SiO interface and the impact on the in-pixel sensor capacitance. The so-called new Perugia model [2] has been used in the simulations to predict the sensor performance after total ionising doses of up to 10Mrad. Figure 1 shows the cross-section of the ARCADIA pixel with 25m pitch and 50m thickness in TCAD simulations at a backside bias voltage of -10V and a sensor bias voltage of 0.8V, with (b) and without (a) introduced surface damage. As visible in Figure 1; the effect of radiation damage at the Si-SiO interface changes the depletion region around the collection electrode, and gives rise to an accumulation of electrons in the gap between the p-, and n-wells. This accumulation originates from the introduced positive oxide charges in the SiO and effectively enlarges the collection nwell. The increase of the pixels'capacitance, in the given example from 1.9fF to 3.3fF at the depletion voltage of -7V, requires an optimisation of the gap and well sizes to minimise the capacitance after irradiation.
The simulated sensor characteristics will be related to characterisation results of active (MATISSE chip [3]) and passive pixel matrices produced in ARCADIA sensor technology.

[1] L. Pancheri et al.: FD-MAPS in 110-nm CMOS process with 100–300-µm active substrate, doi:10.1109/TED.2020.2985639
[2] A. Morozzi et al., TCAD advanced radiation damage modeling in silicon detectors, PoS(Vertex2019)050
[3] E. J. Olave et al., MATISSE: A Low power front-end electronics for MAPS characterization, PoS(TWEPP-17)016

The research activity presented in this article has been carried out in the framework of the ARCADIA experiment funded by the Istituto Nazionale di Fisica Nucleare (INFN), CSN5.

Authors: NEUBUSER, Coralie (Universita degli Studi di Trento and INFN (IT)); PANCHERI, Lucio (University of Trento and TIFPA-INFN); MATTIAZZO, Serena (Universita e INFN, Padova (IT))

Presenter: NEUBUSER, Coralie (Universita degli Studi di Trento and INFN (IT))

Session Classification: Oral presentations

Track Classification: Sensor Materials, Device Processing & Technologies