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MAPS sensor for cosmic applications designed in 180 nm SOI CMOS technology

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The radiation tolerance is considered the main obstacle for space research with cosmonauts and in the colonization of the Solar system. The orbit radiation has a destructive effect for the electronic systems (unreliability, Single Event Upset (SEU), degradation of component properties), device mechanics (natural damage) and naturally to the living organism, including humans. The ionizing radiation properties in the universe are qualitatively different from the terrestrial radiation sources. Therefore, the cosmic dosimetry concerning the instrumentations and effects is very different from the terrestrial dosimetry.
Since the end of the Apollo mission, human-flight is conducted in the Low Earth Orbit (LEO), where Earth's magnetosphere considerably protects astronauts. Flights beyond the LEO boundary, which are planned for the next decade by space agencies and private companies, are complicated due to radiation damage. A compact device that allows for the measurement of not only regular dosimetric quantities, but also the determination of the type of ionizing radiation and the biologic effect of radiation, is highly demanded by space agencies. The other required property of the device is the detection of the fast neutrons from energy events of the Sun magnetosphere, which can be a precursor to the arrival of a cloud of charged particles from the solar eruption and provides early warnings to the cosmonauts.
The Monolithic Active Pixel Sensor (MAPS), which is a revolutionary ionizing radiation detector, significantly improves the detection of physical parameters and enables new types of the measurement of physical quantities. A unique type of the dosimetric MAPS sensor, Lightweight Orbital Radiation Detection System (LORDS), was developed using a 180 nm deep submicron Silicon On Insulator (SOI) CMOS commercial technology, Figure 1, [1]. The design of LORDS, as shown in Figure 2, as well as circuit simulation and experimental results of the previous prototypes, will be presented. The experimental and simulation results are of great importance for the further development of the dosimetric MAPS detector, designed in SOI technologies, for the cosmic applications.

[1] T. Benka, M. Havranek, M. Hejtmanek, J. Jakovenko, Z. Janoska, M. Marcisovska et al., 2018 Characterization of pixel sensor designed in 180 nm SOI CMOS technology JINST 13 C01025

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