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Status of the characterization and radiation-hardness of the LF-Monopix2 DMAPS prototype

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Depleted monolithic active pixel sensors ("DMAPS") use multi-well commercial CMOS processes to integrate sensor, front-end and read-out electronics in a single piece of silicon. These devices aim to meet the hit-rate and radiation-hardness requirements of tracker systems in particle collider experiments. In order to do so, they require a careful implementation of a fast readout and the use of large voltages in highly resistive substrates to collect charge mainly by drift.

LF-Monopix2 is the second prototype with dimensions at a reticle-size scale ($2\,\mathrm{cm}^2$) in a series of DMAPS fabricated in a $150\,\mathrm{nm}$ CMOS process. The device implements a fully functional column-drain readout architecture, while full front-end and readout circuitries are placed and isolated inside a charge collection node of a size comparable to the pixel area. It inherited and improved radiation-hard designs tested in its direct predecessor, while also reducing its pixel size by 40% and increasing its active column length to $1.7\,\mathrm{centimeters}$.

The sensor and front-end performance of the chip were characterized before and after proton irradiation up to a NIEL fluence of $2\times10^{15}\,\mathrm{n_{eq}/cm^2}$. This contribution presents an overview of key results from measurements of leakage current, depletion, noise, threshold tuning capabilities, timing and detection efficiencies in test beam campaigns. The overall performance of the device benefited from an improvement of its guard-ring layout, a reduction of the pixel capacitance and modifications to front-end parameters.

Author: CAICEDO SIERRA, Ivan Dario (University of Bonn (DE))

Co-authors: HABIB, Alexandre (Centre National de la Recherche Scientifique (FR)); ROZANOV, Alexandre (CPPM, Aix-Marseille Université, CNRS/IN2P3 (FR)); BESPIN, Christian (University of Bonn (DE)); HUEGGING, Fabian (University of Bonn (DE)); GUILLOUX, Fabrice (Université Paris-Saclay (FR)); KRUEGER, Hans (University of Bonn); DINGFELDER, Jochen Christian (University of Bonn (DE)); SCHALL, Lars Philip (University of Bonn); BARBERO, Marlon B. (CPPM, Aix-Marseille Université, CNRS/IN2P3 (FR)); WERMES, Norbert (University of Bonn (DE)); BREUGNON, Patrick (Centre National de la Recherche Scientifique (FR)); Mr PANGAUD, Patrick (CPPM, Aix Marseille Université, CNRS/IN2P3, Marseille, France); SCHWEMLING, Philippe (CEA/IRFU,Centre d'etude de Saclay Gif-sur-Yvette (FR)); BARRILLON, Pierre (Aix Marseille Univ, CNRS/IN2P3, CPPM, Marseille, France); RYMASZEWSKI, Piotr (University of Bonn (DE)); ZHANG, Sinuo (University of Bonn (DE)); WANG, Tianyang; HIRONO, Toko (University of Bonn (DE)); HEMPEREK, Tomasz (University of Bonn (DE)); DEGERLI, Yavuz (CEA Saclay)

Presenter: CAICEDO SIERRA, Ivan Dario (University of Bonn (DE))

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