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ARCADIA FD-MAPS: simulation, characterization and perspectives for high resolution timing applications

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Monolithic Active Pixel Sensors (MAPS) are a promising technology that provides large sensitive areas at potentially low power consumption and low material budget. The ARCADIA project is developing Fully Depleted MAPS (FD-MAPS) with an innovative sensor design, that uses a backside bias to improve charge collection efficiency and timing over a wide range of operational and environmental conditions. The sensor design is based on a modified 110 nm CMOS process and incorporates a low-doped n-type silicon active volume with a p+ region at the bottom. The p-n junction sits on the bottom of the sensor, which results in the depletion region growing from the backside surface with increasing bias voltage. These FD-MAPS are thus operational at low front-side supply voltages while facilitating a fully depleted silicon bulk, which allows the electrode on the top to read out fast electron signals produced by drift.

The ARCADIA collaboration has produced a large set of prototypes in a first engineering run, with a main design consisting of a 512×512 pixel matrix with 25 μm pixel pitch and other smaller active sensor arrays. Test structures of pixel matrices with pixel pitches ranging from 10 to 50 μm and total thicknesses of 50 to 200 μm have been included, to ease the characterization of the sensors independently from integrated electronics.
We will give an overview of the status of the project including first results of the operation of the main demonstrator chip, and then focus on the characterization of the passive pixel matrices which include Capacitance-Voltage (CV) and Current-Voltage (IV), as well as Transient Current Technique (TCT) measurements with a red and an infrared laser. The results are supported by Technology Computer Aided Design (TCAD) simulations. An additional emphasis will be put on the design of pixels optimized for timing applications with sub-100 ps resolution.

Collaboration

ARCADIA

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