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The ARCADIA Fully Depleted MAPS: laboratory characterization and particle tracking performance

The ARCADIA INFN collaboration developed a Fully Depleted Monolithic Active Pixel Sensor as a technology demonstrator, using the LFoundry 110nm CIS technology.
The whole high-resistivity substrate can be depleted, thanks to a custom backside process that allows a uniform electric field distribution inside the sensing volume. Several technology demonstrators have been developed with an overall active thickness of 50, 100 and 200
$upmu$m, which makes them suitable for both charged particles and X-rays detection.
The pixel array has an area of 1.3 $\times$ 1.3 cm^2, with a 25 μm pixel pitch.
The pixel output is digital, the readout architecture is event-driven and it can handle a rate up to 100 MHz/cm^2.
The chip design has been optimized for very low power consumption (10-30 mW/cm^2, depending on the event rate). These features make it suitable for experiments at future colliders, such as the FCC (Future Circular Collider), as well as space and medical applications.

The characterization of the ARCADIA Main Demonstrator (MD3) with 200 μm active thickness has been carried out with table-top experimental setups built at the Physics and Astronomy Department of the University of Padova, including both a ^{55}Fe reference radioactive source and truly monochromatic X-rays from fluorescence emission processes and at Fermilab with a narrow spot infrared laser setup.

During July 2024, the first test beam on the ARCADIA MD3 was performed with a 120 GeV proton beam at the Fermilab Test Beam Facility, using a custom-made telescope constituted by two ARCADIA tracking planes and one ARCADIA Device Under Test (DUT).

This contribution is an overview of the ARCADIA R\&D with main focus on the MD3 chip.
Thanks to the table-top setup, it is possible to obtain a calibration of the thresholds in the energy range of the fluorescence X-rays (4-8 keV) and a in-pixel map of the charge collection efficiency from the laser measurements. The testbeam results show a tracking efficiency above 99\% for the whole threshold scan range and a resolution around 5 μm.

Session

Sensors

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