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ARCADIA: innovative low-power, large area MAPS for HEP and applied science

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Recent advancements in Monolithic Active Pixel Sensors (MAPS) demonstrated the ability to survive in radiation environments characterized by TID levels up to many thousands of Grays, that increases their appeal as sensors for high-energy physics detectors. The most recent example in such application is the new ALICE Inner Tracking System, entirely instrumented with CMOS MAPS, that covers an area of about 10 mˆ2.

However, the true potentiality of such devices have not yet been realized, especially in respect to the size of the active area, power consumption, and the timing capabilities (fast signal acquisition).
The ARCADIA experiment is developing MAPS characterized by an innovative sensor design, that uses a proprietary processing of the back side to improve the charge collection efficiency and timing over a wide range of operational (hit rate density) and environmental (radiation levels) conditions. Together with the innovative sensor design, ARCADIA is targeting very low power consumption levels, of the order of 20 mW cmˆ-2 at 100 MHz cmˆ-2 hit flux, to enable air-cooled operations of the sensors. Another key design parameter is the ability to further reduce the power regime of the sensor, down to 5 mW cmˆ-2 or better, for low hit density applications like the airborne and space ones. Maximizing the active area of the single sensor (10 cmˆ2 or bigger) simplifies and reduces the costs of detector construction, and even enables applications where no support material over the entire sensor area can be tolerated (e.g. medical scanners). ARCADIA has established innovative architectures to deal with "large"sensors, where the typical pixel column can reach many centimetres in length, with many thousands of pixels to read.

In this contribution, we will discuss the sensor design, characteristics, and testing results. Together with a detailed description of the chip characteristics and implementation, the highlight will be on the key features departing respect to the present state-of-the-art MAPS design. An overview of the synergies with other applications outside the HEP realm will also be given in order to illustrate how the next generation pixel sensors may come from fruitful collaboration with other fields in physics and science in general.

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