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ARCADIA: sensor development and chip design of innovative low-power, large area MAPS

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The ARCADIA collaboration is developing Monolithic Active Pixel Sensors (MAPS) with 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 and environmental conditions. The sensor design targets very low power consumption, of the order of 20 mW cm^{-2} at 100 MHz cm^{-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 cm^{-2} or better, for low hit rates like e.g. at space applications. The MAPS architecture, initially embodied in a 512×512 pixel matrix, should enable the scalability of the sensor up to matrix sizes of 2048×2048 pixels. Maximising the active area of the single sensor (10 cm^2 or bigger) simplifies and reduces the costs of detector construction, and enables applications where no support material over the entire sensor area can be tolerated (e.g. medical scanners). The ARCADIA collaboration has established innovative architectures to deal with large pixel matrices, where the typical pixel column can reach many centimetres in length, with many thousands of pixels to read out.

In 2020 the ARCADIA collaboration has finalised a first design of a prototype of 1.3×1.3 cm^2 active area consisting of 512×512 pixels with 25 μm pitch. This prototype is currently being produced in a first engineering run with integrated digital electronics. Additional test structures of pixel and strip matrices with pitches ranging from 10 to 50 μm and total thicknesses of 50 to 200 μm will become available for detailed testing within first quarter of 2021.

In this contribution, we will present the current status of the project, the validation of the sensor concept by comparing measurements with TCAD simulation, and discuss the comprehensive simulation studies that lead to the design of the sensor test-structures which are currently in production.

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