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A versatile and fast pixel matrix read-out architecture for MAPS

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Monolithic active pixel sensors are considered for vertex or tracking detectors of a large variety of particle physics experiments. Consequently, the design of pixel matrices faces a wide range of specifications. That impacts in particular the matrix read-out strategy, which is highly constrained in terms of power consumption, layout area, time-stramping ability, and hit rate. Asynchronous logic, an emerging ASIC design technique, seems promising in this respect, being naturally data-driven and power-sparing.
We have developed a pixel matrix read-out architecture based on the local interconnection of asynchronous N:1 arbiters with fixed priority. This architecture is not limited by global signals and can achieve high bandwidth with a fully column-parallel stream. Layouts of the required digital logic for a double column were completed in the 65 nm CMOS imaging process currently explored by the ALICE-ITS3 and CERN-EP R&D WP1.2 projects, for various combinations of pixel pitch (18 to 30 µm), column depth (512 to 1024 pixels) and arbiter size (2:1 to 1024:1).
This contribution presents the matrix read-out performances obtained from post-layout simulations, assuming either a continuous hit-rate or hit bursts clocked at 40 MHz, having in mind potential applications to HL-LHC experiments (ALICE3 or LHCb phase 2 upgrade), Belle II long term upgrade and a future high-energy leptonic collider like FCCee. Results explore the architecture benefits in terms of area, power consumption, and timing. Especially we address the feasibility of 18 µm pixel pitch with dissipation below 10 mW/cm2, the maximum hit-rate allowing to time-stamp hits within 25 ns with an efficiency of 99.9% and the evolution of the energy/hit/surface figure of merit with various configurations. Other aspects discussed include very small pitches (15µm or less), the possibility of integrating such readout in a stitched sensor and a discussion about radiation hardness.

Collaboration

Role of Submitter

I am the presenter

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