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MONOLITH - picosecond time stamping capabilities in fully monolithic highly granular silicon pixel detectors

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The MONOLITH H2020 ERC Advanced project aims at producing a monolithic silicon pixel ASIC with 50 μ m pixel pitch and picosecond-level time stamping. The two main ingredients of the project are fast and low-noise SiGe BiCMOS electronics and a novel sensor concept, the Picosecond Avalanche Detector (PicoAD). The PicoAD uses a patented multi-PN junction to engineer the electric field and produce a continuous gain layer deep in the sensor volume. The result is an ultra-fast current signal with low intrinsic jitter in a full fill factor and highly granular monolithic detector.

Testbeam measurements of the proof-of-concept PicoAD prototype, based on a 2019 ASIC design, shows full efficiency and time resolutions of 13ps at the center of the pixel and 25ps at the pixel edge, for an average of 17ps over the pixel surface.

A new monolithic prototype with improved SiGe BiCMOS electronics was produced in 2022 on a 350 Ω cm substrate. Although this ASIC does not have an internal gain layer, it provided 20ps time resolution in a testbeam with pions. This prototype was irradiated with 70MeV protons with the electronics on. Laboratory measurements with a ⁹⁰Sr source for a detector irradiated with 10¹⁶ n_{eq}/cm² show a time resolution of 50ps at a sensor bias voltage of 200V, and 40 ps at 325 V.

These results give confidence that SiGe BiCMOS processes could be considered as a candidate for the production of very high time resolution detectors for future colliders and other disciplines that involve very high radiation environments.

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