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Recent results on fast 3D-trench silicon sensors and related electronics

In the last three years the TimeSPOT Collaboration has developed innovative silicon pixels allowing to reach a time resolution better than 20 ps on minimum ionizing particles. Such new devices are 3D silicon pixels with trench-shaped electrodes. They achieve such an outstanding time resolution thanks to both a highly uniform electric field inside the pixel and electrons and holes drift velocities close to saturation.

Tests performed under particle beams at accelerator facilities and with radioactive sources in laboratory have routinely shown time resolutions of about 20 ps per hit on 55 μm pitch pixels.

In the last year accurate laboratory tests, both with a pulsed laser-based setup, able to precisely measure the sensor response throughout its active area, and with radioactive sources, emulating a test beam setup in the more controlled laboratory environment, have shown that these 3D pixel sensors intrinsically possess a time resolution close to 10 ps, and the available front-end electronics represents the real limit to their timing performance. A dedicated ASIC, developed in CMOS 28-nm technology and capable to readout a matrix of 1024 pixels of 55 μm pitch, has been produced and is presently under characterization in our laboratory. THE ASIC integrates a full readout chain and a high-resolution TDC per single pixel. First test results on such last developments will be presented at the workshop.

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