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Towards 6D Tracking: using fast-timing to determine track position, time, and angles

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Current and future particle trackers are beginning to incorporate timing measurements as part of the readout electronics. The ATLAS HGTD and CMS MTD timing detectors for the HL-LHC are already capable of sub-50 picosecond-level resolution, and tracking detectors for future colliders such as the muon or 10 TeV hadron colliders will require similar or better levels of time resolution with pixel pitches in the tens of microns.

In this talk we show, using device-level simulations, that if an LGAD-based particle tracker can achieve O(10ps) hit time resolution with a pixel pitch in the tens of microns, we can use the timing information of neighboring pixels to calculate the angle at which the track crosses the detector. This would enable the determination of the angle of a particle track without needing a double-layer, just by using timing information. Furthermore, we show that when fast-timing information is used for track-hit clustering, it is important to be aware of the angle of the track, because it can change timing information by hundreds of picoseconds.

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