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4D trackers (space + time information)

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As particle physics strives for increased precision and sensitivity in its measurements, the beam energy, power, and per-bunch luminosity of colliders increase and produce significantly more complex events primarily by way of overlapping collisions (pileup) that test the performance and robustness of our algorithms and analysis.

One avenue towards mitigating the effects of pileup in tracking detectors is to create sensors with finer and finer segmentation to accurately identify individual particles, and this has seen great success within the field. Next generation colliders, like the HL-LHC (200 pileup) and FCC (1000 pileup with 25ns bunches) where pileup events can occur multiple times per millimeter pose a significant challenge using spatial information alone, since events can overlap in space, and track distributions from near-by vertices can become confused. This leads to degradations in reconstruction performance and physics analysis. A clear way to mitigate these degradations is to use the time-at-closest-approach of tracks to more precisely connect tracks to their true vertex of origin, increasing the quality and amount of information in the event.

Recent advancements in silicon precision timing detectors indicate that finely pixellated, lightweight planar timing detectors with MIP sensitivity are coming within reach. I will discuss these devices, and demonstrate their uses in terms of mitigation of pileup in "timing layer" configurations, where there is one layer providing the time stamp. This initial discussion will be extended to true 4-dimensional trackers where each coordinate measurement is a point in spacetime, focusing on the algorithmic implications and next steps needed to achieve these devices.

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Track Classification: 4 : Intelligent tracking detectors