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VECTORS AND SUBMICRON PRECISION: REDUNDANCY AND 3D STACKING IN SILICON PIXEL DETECTORS

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It is traditional wisdom that a minimal number of silicon tracking planes must be used in the inner detectors, in order to avoid multiple scattering, large numbers of photon conversions and other disturbances upstream of the calorimeter. In this work it is shown that a silicon pixel detector with hundreds of successive, highly redundant measurement planes can provide extremely precise and detailed information. It is worth more study to determine trade-offs between gains in local precision and pattern recognition, and a degradation of the interaction products at the entrance of the calorimeter by the use of a 'redundant' device, with maybe some tens of layers. One obvious possibility is that such a redundant detector IS the entrance of the calorimeter. In the course of this work we observe also some interesting effects of secondary 'delta' electrons, which have a significant probablity to create corrupted position measurements along the trail. If these could be recognized and eliminated from the fitting procedure, an improved precision may result. At least one more point along the trails would be needed.
For the measurements two Medipix devices have been assembled closely together and results with this stack are described. With Medipix and Timepix detectors in the CERN H6 beam we illustrate a first voxelized detector system with full parallel readout, that can provide vector tracking with submicron precision, at very high densities of incident particles.

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Fig. 1 A frame (14x14 mm, 256x256 pixels) showing 3 beam muons and a vertical trail in the two back-to-back silicon pixel matrices. The horizontal GeV beam particles enter at the right, cross the central contact plane (a thin Cu foil) and exit from the left sensor. The top muon seems to generate an energetic secondary particle, probably a ˜MeV electron. By chance, a vertically incident cosmic ray muon has been recorded as well during the exposure time.

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