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A level 1 tracking trigger for the super LHC

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Many of the previous tracking triggers have been based on table lookups using content addressable memories. An alternative method is being developed that uses pairs of closely separated silicon sensors to incrementally find particle tracks. This system avoids a complicated memory lookup so it is fast enough to work as a level 1 trigger. We describe the readout and data processing architecture necessary for this trigger system.

Summary

This design is based on silicon sensor tracker that consists of 3 "super layers"spaced at roughly 350, 550 and 1000 mm from the beam axis. Each super layer is comprised of 4 sensor layers arranged into two stacks of two sensors each. The 100 mm by 100 mm sensors in a stack are separated by roughly 1 mm and the two stacks are separated by 40 mm. The stack is constructed using 3D chip technology so that one chip can read out both sensor layers. The 1 mm separation and the 4 tesla field of CMS allows the chip to identify track candidates (called stubs) with pt > 2.5 GeV/c. The chip architecture is described in a separate submission to this conference.

Stubs from every stack are sent off the detector every 25 ns. Off detector hardware then matches the stubs in each super layer. Since the separation of the two stacks is only 40 mm and the number of stubs in a sensor is not too large, it is straightforward to match stubs to form track candidates (called tracklets). Extensive monte carlo simulation shows that projecting a tracklet to another super layer can be done with an accuracy of a few mm depending on particle momentum. Thus, the search window on another layer is small enough that a simple search algorithm is adequate to match tracklets into tracks.

All track matching is done in pairs of super layers and duplicates are eliminated at the final processing step. This means that a track that is missed in one or two sensors will still be found making the system quite robust to failures.

The challenge in this design is routing the information from a point in one super layer to a point that matches the track projection in the second super layer. We employ a multilevel routing method similar to that used in the internet to route the information to the correct location.

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