Contribution ID: **13** Type: **Oral**

Design of a module providing trigger information from the CMS Tracker at SLHC

Wednesday 23 September 2009 15:25 (25 minutes)

The CMS experiment is planning a major upgrade of its tracking system to adapt to an expected increase in luminosity of the LHC accelerator to 1035 cm-2.s-1. The CMS Tracker will then have to cope with several hundred interactions per bunch crossing and fluxes of thousands of charged particles emerging from collisions. CMS requires tracker data to contribute to the first level trigger, which must maintain the present 100kHz rate for compatibility with existing sub-detector systems while increasing the trigger decision latency by only a few µs. It must be achieved if possible without significantly compromising the tracking performance which is very sensitive to the material budget. A key part of a system to achieve this will be the design of a suitable module to generate trigger primitives.
A module which might allow to provide suitable track trigger primitives is described and implications for the system are discussed.

Summary

The CMS experiment is planning a major upgrade of its tracking system for the SLHC, to adapt to the expected increase in luminosity of the LHC machine to 1035 cm-2.s-1. The CMS Tracker will then have to cope with several hundred interactions per bunch crossing and fluxes of thousands of charged particles emerging from the 40MHz collisions.
CMS has identified a requirement to provide tracker data to contribute to the first level trigger, which must maintain the present 100kHz maximum rate for compatibility with existing sub-detector systems while increasing the trigger decision latency by only a few µs. This must be achieved if possible without significantly compromising the performance for tracking, which is expected to be very sensitive to the material budget, in a much more demanding environment than LHC. It is therefore important that the overall tracker system be designed to provide trigger information with as low power as possible, and a system architecture must be developed which can achieve this.
One possible solution is based on so-called "stacked tracker modules"using closely spaced sensor layers. Such layers would be situated at intermediate radius within the tracker volume to ensure complete coverage of the maximum range of pseudorapidity. The sensors would be coarsely pixellated units, with typical dimensions of 2.5mm x 100µm so that a typical stacked layer would contain ˜40million elements. The pattern of hits in each layer is compared to identify high pT track candidates. Simulations have been carried out which support the basic concept and allow to define suitable modules which could implement the required features. Spacings of 1-2mm between the layers should allow to reject low transverse momentum tracks, with a typical threshold of a few GeV/c and efficiency close to 100% for momenta above threshold
A basic readout architecture is proposed and the electronic implications are described, including an outline design of the readout ASIC, the combinatorial logic, and other components as well possible means to construct suitable modules using accessible manufacturing technologies, which should use advanced but inexpensive interconnection techniques to achieve adequate density. In this scheme, the power consumption is strongly influenced by the means by which data from the two layers within a stacked module are brought into coincidence, and it is essential to minimise the data traffic within the module. The largest contribution to the total power budget comes from data transmission from the tracker to the off-detector system where the first level trigger processing is carried out, so it is essential to deploy the tracker data in a very economical way.
Estimates of likely power consumption will be given, as well as data rates and link bandwidth requirements, and possible implications for the implementation of the trigger. These results will determine what type of system is affordable, both in terms of power consumption and financial cost.

Author: Prof. HALL, Geoff (Imperial College London)

Presenter: Prof. HALL, Geoff (Imperial College London)

Session Classification: Parallel session A4 - Trigger

Track Classification: Trigger