The CMS Phase-II Tracker Upgrade

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Upgrade Motivation

For the high luminosity LHC (HL-LHC), a major upgrade is planned for the CMS experiment. In Phase II, the layout will reach luminosities up to $5 	imes 10^{34}$ cm$^{-2}$ s$^{-1}$. To cope with the increased rates and occupancies, CMS will replace the current microstrip sensors and tracker electronics. The primary goal is to withstand the increased radiation corresponding to 3000 R$b^-$ integrated luminosity and upgrade the 1000 million per bunch crossing while being able to provide information to the first level trigger (L1) and maintain the excellent tracking performance.

Upgrade Requirements

- Radiation tolerance
- Increased granularity
- Improved track separation
- Reduced material in the tracking volume
- Robust pattern recognition
- Compatibility with the L1 trigger upgrade
- Increased tracking acceptance

The Phase-II Outer Tracker Detector

The outer tracker consists of two types of P$\tau$ modules, which are capable of detecting signals from particles below a certain P$\tau$ threshold. The PG (silicon) modules consist of two closely-spaced parallel silicon sensors, and the 2S (silicon) modules consist of two closely-spaced strip sensors. The scanned sensors in each module are read out in a common pipeline, which provides hits in the trigger that pass the P$\tau$ threshold, which are called hits.

The “stub” concept for high-P$\tau$ track selection

The first stage of track finding consists of a 4x4 array of parallel $d$-code and $d$-code planes, which can be implemented in different regions of the tracker. The P$\tau$ discrimination is highly dependent on the position of the module in the tracker volume. To keep uniform P$\tau$ thresholds across the entire tracker, each 4x4 module is divided into 16 submodules, and all submodules must be implemented in different regions of the tracker.

DESY-II Test Beam Setup and Measurements

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Events reconstruction

The CMS detector provides the read-out of beam without information about the charge deposition on each strip. Therefore, clusters are defined as groups of neighboring strips, each energy being assigned to the cluster.

Conclusions

- A test beam with mini 2S-module read out by CBC2 chip was performed with a position beam (2$\sigma$ or 4$\sigma$) successfully.
- A threshold scan per sensor and chip showed that at low thresholds (4$\sigma$-8$\sigma$), inefficiency of 90% is achieved.

Outlook

- A test beam with irradiated mini 2S-modules took place in June 2015. Data is currently being analyzed including Teledetection in order to perform precise tracking.
- A full 1T full module with 56 CBC2 will be tested at CERN in November 2015.
- A third version of the CBC2 is in development.

References


[http://www.desy.de]