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Status of the CMS Phase 1 Pixel Upgrade

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The silicon pixel detector is the innermost component of the CMS tracking system, providing high precision space point measurements of charged particle trajectories.

Before 2018 the instantaneous luminosity of the LHC is expected to reach $2 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$, which will significantly increase the number of interactions per bunch crossing.

The current pixel detector of CMS was not designed to work efficiently in such a high occupancy environment and will be degraded by substantial data-loss introduced by buffering in the analogue readout chip (ROC) and effects of radiation damage in the sensors, built up over the operational period.

To maintain a high tracking efficiency, CMS has planned to replace the current pixel system during „Phase 1” (2016/17) by a new lightweight detector, equipped with an additional 4th layer in the barrel, and one additional forward/backward disk. A new digital ROC has been designed, with increased buffers to minimize data-loss, and a digital readout protocol to increase the readout speed.

Prototypes of digital single-chip modules have been characterized in an electron test beam at DESY, before and after irradiation. Even after the expected 4th layer lifetime dose of 130kGy, the prototypes were measured to be ~99% efficient and the spacial resolution remained $\sim 7 \mu\text{m}$. Furthermore, energy calibrations using monochromatic X-rays were performed, and its dependence on irradiation and temperature were studied. This talk will give an overview of the upgraded detector with an emphasis on the status of the module production and testing of the 4th layer, which is being assembled and pretested by German institutes.

Summary

This talk will give an overview of the CMX pixel “Phase 1” upgrade with an emphasis on the status of the module production and testing of the 4th layer.

Author: Dr MATTIG, Stefan (Hamburg University (DE))

Presenter: Dr MATTIG, Stefan (Hamburg University (DE))

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