13th International "Hiroshima" Symposium on the Development and Application of Semiconductor Tracking Detectors (HSTD13), Vancouver, Canada

Contribution ID: **35** Type: **Poster**

First Test Beam Results of Irradiated Single and Quad Modules Equipped with HPK Planar Pixel Sensors and CROC Readout Chips for the CMS Phase 2 Upgrade

The upcoming High-Luminosity running phase of the LHC will require a complete replacement of the current tracking system in the CMS experiment. With the planned integrated luminosity of about 4000 fbˆ-1 to be delivered to the experiments, the innermost layers of the CMS Inner Tracker (IT) will face particle fluences of up to approximately 2 x 10ˆ16 cmˆ-2 (1 MeV neutron equivalent).

Through an extensive R&D program involving multiple vendors, several pixel sensor options have been thoroughly evaluated, considering different pixel pitches and sensor cell designs. Recently, the final choices have been made. All layers, except the innermost layer of the barrel section of the IT, will be equipped with planar n+-p sensors featuring an active thickness of 150 μm and pixel pitches of 25 x 100 μm².

During the initial phase of the sensor qualification campaign, the sensors were coupled with demonstrator chips (RD53A), and the modules were exposed to fluences of up to φ_eq = 2 x 10ˆ16 cmˆ-2, undergoing comprehensive testing at both CERN and DESY test beam facilities. This year, single chip assemblies, along with the first full modules incorporating the final, full-size prototype readout chip (CROC) irradiated up to φ_eq = 1 x 10ˆ16 cmˆ-2, have become available and were subjected to testing at DESY in July.

During this presentation, an overview of the preliminary test beam results obtained will be provided. The studies will cover hit efficiency, spatial resolution, and noise hit occupancy for both non-irradiated samples and irradiated assemblies. The preliminary findings are in line with previous results obtained with RD53A assemblies. The measurements described in this contribution paved the way for the submission of the final readout chip CROC_v2 and kickoff batches for planar production sensors for the Inner Tracker that have been launched recently.

Submission declaration

Original and unplublished

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Track Classification: Pixel sensors for tracking