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Radiation Hardness and Leakage Current Homogeneity of CMS HGCAL 8-Inch Silicon Sensors irradiated at RINSC

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The High-Luminosity LHC will challenge the detectors with a nearly 10-fold increase in integrated luminosity compared to the previous LHC runs combined, thus the CMS detector will be upgraded to face the higher levels of radiation and the larger amounts of data collected. The High-Granularity Calorimeter (HGCAL) will replace the current endcap calorimeters of the CMS detector. It will facilitate the use of particle-flow calorimetry with its unprecedented transverse and longitudinal readout/trigger segmentation, with more than 6M readout channels. The electromagnetic section as well as the high-radiation regions of the hadronic section of the HGCAL (fluences above 10¹⁴ n_{eq}/cm²) will be equipped with silicon pad sensors, covering a total area of 620 m². Fluences up to 10¹⁶ n_{eq}/cm² and doses up to 1.5 MGy are expected. The sensors are processed on novel 8-inch p-type wafers with an active thickness of 300 µm, 200 µm and 120 µm and cut into hexagonal shapes for optimal use of the wafer area and tiling. Each sensor contains several hundred individually read out cells of two sizes (around 0.5 cm² or 1.2 cm²). In order to investigate the radiation-induced bulk damage, the sensors have been irradiated with neutrons at RINSC (Rhode Island Nuclear Science Centre, US) to fluences between 6.5·10¹⁴ n_{eq}/cm² and 1.5·10¹⁶ n_{eq}/cm². We present electrical characterisation (IV) results from partial sensors cut from multi-geometry wafers with internal dicing lines on the HV potential within the active sensor area as well as from full sensors. The leakage current data is corrected for the pad volume to become sensitive to fluence and annealing inhomogeneities across the 8-inch sensor area. We investigate means to limit the annealing time of the sensors during irradiation, analyzing the influence of the irradiation container material and the impact of splitting high-fluence irradiations. Finally, we provide recommendations for future irradiation campaigns in the RINSC irradiation facility.

Type of presentation (in-person/online)

in-person presentation

Type of presentation (scientific results or project proposal)

Presentation on scientific results

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