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## Performance and Design Validation of CMS Phase-2 Pixel Modules

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In view of the High Luminosity LHC, the current CMS Tracker detector will have to be replaced during Long Shutdown 3 to survive the higher radiation environment and to withstand an increased data rate. To prepare for the so called CMS Phase II upgrade, multiple studies were carried out to characterize the pixel module design and their performance. For this purpose, different aspects were put together to build a module Quality Control (QC) procedure and novel techniques became part of the module design validation process for the full-size prototype chip (CROCv1). Based on the outcome of the results collected on CROCv1 prototype modules and according to the module selection criteria the community agreed on, some changes were introduced in the module design to optimize the performance. This led to the production of the definitive chip (CROCv2) which will be installed in the final CMS detector.

This study presents the quality control test flow performed, both for the 1x2 and 2x2 design, on a big sample of CROCv1 prototypes together with the results that validated this module design. In particular, the validation process includes measurements of the readout chip powering, data transmission tests and open bump bonds identification. Thermal stress tests were instead performed only on a subset of pixel modules to ensure the integrity of the sensor and to provide quick feedback on the quality of the bump bond connectivity after harsh temperature cycles. Moreover, this work contains the latest design validation results on the first production CROCv2 modules which confirm that, even after some minor design changes, the definitive module design still fulfils the requirements.

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