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Module Quality Assurance for the CMS Outer Tracker Phase-2 Upgrade

The High Luminosity Large Hadron Collider (HL-LHC) necessitates a complete replacement of the current Compact Muon Solenoid (CMS) silicon tracker due to harsh conditions. The Phase-2 Outer Tracker (OT) is designed with high radiation tolerance, increased granularity, and enhanced data rate handling. It will provide tracking data to the Level-1 trigger, maintaining sustainable trigger rates without compromising physics potential. Featuring modules with two closely spaced sensors read by custom front-end ASICs, it generates "stubs," allowing tracking at 40 MHz. This contribution will describe the quality assurance procedures and the calibrations used to ensure the functionality of the modules.

Summary (500 words)

To cope with the harsh conditions at the High Luminosity Large Hadron Collider (HL-LHC), the current Compact Muon Solenoid (CMS) silicon tracker has to be fully replaced.
The new Phase-2 Outer Tracker (OT) will have high radiation tolerance, higher granularity, and the capability to handle higher data rates. Another key feature of the OT will be to provide tracking information to the Level-1 trigger, allowing trigger rates to be kept at a sustainable level without sacrificing physics potential. For this, the OT will be made out of modules that have two closely spaced sensors read out by custom front-end ASICs, which can correlate hits in the two sensors creating short track segments called "stubs". The stubs will be used for tracking in the L1 trigger stage.
The modules come in two different flavors: strip-strip (2S) and pixel-strip (PS), which contain different sensor configurations and multiple ASICs.
More than 13,000 modules will be assembled in several production centers in Europe, the US, and Asia, starting in 2024.
This contribution will describe the quality assurance (QA) procedures and the calibrations used to ensure the functionality of the modules. Several aspects must be taken into account during QA: from meeting the mechanical specifications of the module assembly procedure to ensuring the proper communication between the different ASICs on the module.
The module noise performance is also checked and the full module functionality is verified at different temperatures.
In this contribution test results from the first produced modules with the final design will be shown.

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Track Classification: Production, Testing and Reliability