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Design and construction of the Outer Tracker for the Phase-2 Upgrade

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The High Luminosity LHC (HL-LHC) is expected to deliver an integrated luminosity of 3000 - 4000 fb⁻¹ after 10 years of operation with peak instantaneous luminosity reaching about $5 - 7.5 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$. During Long Shutdown 3, several components of the CMS detector will undergo major changes, called Phase-2 upgrade, to be able to operate in the challenging environment of the HL-LHC. The current CMS silicon strip tracker has to be replaced with a new detector. The Phase-2 Outer Tracker (OT) will have higher radiation tolerance, higher granularity, and the capability to handle higher data rates compared to the current system. Another key feature of the OT will be to provide tracking information to the Level-1 (L1) 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 with two closely spaced sensors read out by 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 track finder. The modules come in two flavors: strip-strip (2S) and pixel-strip (PS), which contain different sensor configurations and multiple ASICs. In this contribution, the design of the CMS Phase-2 OT, the technological choices, and the quality assurance (QA) procedures used to ensure the functionality of the modules will be reported. The contribution will cover the first results with pre-production devices and the different aspects taken into account during the QA: from fulfilling the precision specification 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.

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