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Process quality control strategy for the Phase-2 upgrade of the CMS outer tracker and calorimeter endcap

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The CERN Large Hadron Collider (LHC) will undergo a major upgrade between 2025 and 2027, to increase the collision rate by a factor of about 5 compared to the present. Some existing components of the CMS detector - most notably the Tracker and Endcap Calorimeter - will have to be replaced to cope with the conditions of the high luminosity (HL-LHC) era: instantaneous peak luminosity up to $7.5 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$ and integrated luminosity up to 3000 fb^{-1} by 2037. Over 50,000 new silicon sensors covering a total area of about 800 m^2 will constitute the CMS tracker and parts of the CMS calorimeter endcaps. The quality of the sensors and the production process must be monitored constantly during production time to facilitate stable operation under HL-LHC conditions. This presentation introduces the process quality control strategy for the sensor series production. Each manufacturing wafer contains at least two instances of a set of test structures designed to provide easy access to critical process parameters. These include parameters not directly accessible on the sensors (e.g. oxide charge concentration and interface trap density) and parameters requiring potentially destructive measurements (e.g. dielectric strength). The set is divided into test structures for initial evaluation of the most relevant process parameters and structures for in-depth analysis. All structures can be contacted using a 20-needle probe card and an automated positioning stage. With this system, the initial analysis of one wafer is possible in under 30 minutes. We present the finalized layout of the set that will be implemented in the production runs for the CMS outer tracker and calorimeter endcap and report on measurements illustrating the functionality of the included test structures.

Primary authors: HINGER, Viktoria (Austrian Academy of Sciences (AT)); ON BEHALF OF THE CMS COLLABORATION; COLLABORATION, CMS

Presenters: HINGER, Viktoria (Austrian Academy of Sciences (AT)); COLLABORATION, CMS

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