

# CMS INNER TRACKER UPGRADE AND TEPX ELECTRICAL TESTING AT VILNIUS

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The Large Hadron Collider (LHC) at CERN will enter the High-Luminosity LHC (HL-LHC) [1] era to enable more precise measurements and improve sensitivity to rare processes. This upgrade will expose the CMS experiment to extreme conditions, including peak luminosities of  $7.5 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$ , an integrated luminosity of  $300 \text{ fb}^{-1}$  per year, and about 200 proton-proton collisions per bunch crossing.

This work presents an overview of the CMS Inner Tracker (IT) upgrade [2], with a focus on the Tracker Endcap Pixel detector (TEPX), and highlights the ongoing electrical testing activities performed at the Vilnius test site.

To withstand radiation levels up to a 1 MeV neutron equivalent fluence of  $2.6 \times 10^{16} \text{ cm}^{-2}$  and a total ionizing dose of 13 MGy, while operating at hit rates reaching  $3.2 \text{ GHz/cm}^2$ , the upgraded IT will use thin, highly granular silicon sensors with pixel sizes of  $25 \times 100 \mu\text{m}^2$  and fast, radiation-hard 65 nm CMOS readout electronics developed by the RD53 collaboration [3]. TEPX will be installed in the far forward region, where its innermost ring on the last disk extends beyond  $|\eta| = 4$ , enabling precision tracking and luminosity monitoring.

The upgraded TEPX system is designed to sustain HL-LHC operating conditions while functioning as a high-precision luminosity monitor. The Vilnius test site contributes through wire-bonding of bare modules and module-level electrical qualification, ensuring proper operation of the production chain under the required performance constraints.

The CMS IT upgrade, particularly the TEPX detector, is crucial for maintaining tracking and luminosity performance in the forward region of CMS at the HL-LHC. The wire-bonding and electrical testing activities at Vilnius support detector integration and validation, helping to ensure readiness for future operation.

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[1] C. Y. R. Monographs, "CERN Yellow Reports: Monographs, Vol. 10 (2020): High-Luminosity Large Hadron Collider (HL-LHC): Technical design report," CERN Document Server (European Organization for Nuclear Research), Dec. 2020, doi: 10.23731/cyrm-2020-0010.  
[2] "The phase-2 upgrade of the CMS tracker," CERN Document Server, Jun. 2017, doi: 10.17181/CERN.QZ28.FLHW.  
[3] M. Garcia-Sciveres, "RD53C Chip Manual," CERN Document Server, Feb. 27, 2024. <https://cds.cern.ch/record/2890222>