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Mechanical structure of the CMS TEDD detector: FEA dimensioning, mechanical tests on prototype and comparison to simulations

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The upgraded CMS Tracker, to be installed prior to the high luminosity phase of LHC operation (HL-LHC), will require novel approaches to overcome the challenges posed by the extreme radiation environment. In addition, the tracker must remain extremely lightweight and at the same time provide an efficient cooling system (evaporative CO2).

Tracker Endcaps Double-Disk (TEDD) of CMS Outer Tracker consists of two end caps of five double-disks each supporting the silicone detection modules (L1.5m and Ø2.4m). This highly integrated equipment provides 10 full planes of detection with more than 100% coverage thanks to over 13000 silicone sensors working at cryogenic temperature.
Mechanical structure that supports this assembly is particularly challenging because it must guarantee the accurate positioning of the sensors for precise reconstruction of particles trajectories for physics issues, but also very low -and controlled- deformations to allow adjusted insertion within Outer Tracker into the CMS Experiment.
Structure must also support half a ton of TEDD services (cooling, optical fibers and data wires) while remaining at the extreme periphery of the detector (between R1087mm and R1103mm) in order to stay mostly outside volume detection, with a lightweight framework to minimize particle interaction.
All these requires a massive use of CFRP (massive or sandwich) with major effort of carbon stacking definition.
Mechanical dimensioning performed with numerical simulations and FEA have oriented geometry adaptation and carbon plies optimization.

This contribution will present the studies leading to the final design of the TEDD global mechanical structure. After manufacturing a partial mock-up, metrology measurements, load tests and mechanical characterization have been performed on carbon parts, as well as on assemblies and inserts. We will describe these tests and their comparison to FEA in order to validate models and parameters used in numerical simulations.

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