Contribution ID: **7** Type: **not specified**

Design and prototyping of support mechanics with integrated cooling for the Endcaps of the CMS Tracker Upgrade

Tuesday, 18 May 2021 16:30 (20 minutes)

The CMS Tracker upgrade, 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) capable of evacuating more than double the overall power of the present detector, at lower temperatures. The CMS Tracker Endcaps Double-Disk (TEDD) concept will be presented. The basic support structures of the TEDD, on which the silicon modules are directly mounted, are half-disks known as 'Dees'; the two Tracker Endcaps will contain 40 Dees. A Dee consists of lightweight foam layers sandwiched between carbon-fiber skins. Small-diameter (2.5mm) cooling pipes are embedded within the foam and are connected thermally to the silicon modules via inserts in the skins. A Dee has a diameter of 2.2 meters and its construction presents significant engineering challenges. Approximately 700 positioning inserts, which ensure the proper location of the silicon modules on both sides of the Dee, must be precisely glued within the structure. Cooling contacts to the pipes must be accurately placed in order to provide effective cooling for each of the ˜170 modules on the Dee. The Dee must conform to stringent stiffness and flatness specifications, while its mass must be reduced to a minimum. Full-size prototypes have been produced in collaboration with industry. Experience gained and problems encountered with these prototypes will be described. Results of tests of the mechanical precision and of the thermal contact between the cooling pipes and the modules will also be presented.

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