Thermal Modelling Studies of the ATLAS ITk Strip Barrel Staves Using ANSYS

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Abstract

The Phase-II upgrade of the ATLAS Inner Tracker (ITk) is being developed to operate in the high-luminosity phase of the LHC, where increased occupancy, radiation levels, and power dissipation place stringent requirements on detector performance. The upgraded system employs a fully silicon-based tracker with enhanced granularity and a two-phase CO_2 cooling system to ensure stable operation under these conditions.

This work presents finite element thermal models of the ITk barrel strip staves in both short-strip and long-strip configurations, developed using ANSYS. The models are used to study the thermal behaviour of the staves under nominal operating conditions and to evaluate their response under conditions approaching thermal instability. The analysis focuses on temperature distribution along the End-of-Substructure (EoS) regions and the associated thermal margins, as well as the sensitivity of the system to small variations introduced during assembly and construction.

Comparison with earlier ABAQUS models shows good agreement, with temperature differences of 0.3 – 1 °C at module level, and maximum differences of 1.3 °C and 1.7 °C for the long-strip and short-strip staves, respectively. At stave level, the module sensor temperatures agree within 0.4 °C, while the largest deviations are observed in the EoS regions, supporting the validity of the ANSYS thermal model.