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Mitigation of the effects of thermal contraction of cooling pipes used in the ATLAS ITk Pixel Outer Barrel

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Temperature control is an integral part of tracking detector mechanics. Keeping the silicon modules at safe working temperatures is imperative for favourable detector performance. However, cold operation requires specific design solutions to accommodate the thermal contraction of the pipes used in the cooling circuit. In ATLAS ITk, titanium tubes are used to cool the pixel detector modules with two-phase CO₂. Long inlet capillaries and exhaust pipes have the potential to thermally contract a large amount and introduce unwanted stresses (and deformations) to the thin evaporators used in the local supports. In the Pixel Outer Barrel, expansion loops and clamps have been designed to compensate for these effects. Finite element simulations have been conducted to analyse the displacement and forces at work in different pipe shapes. The simulations take into account pipes cooling down from +22°C to -55°C, the internal pressure of the fluid and different clamping configurations. In addition, an experimental setup has been constructed to check the validity of the simulations. A “cold box” has been made to fit full-size pipes with the possibility of visual inspection and measurement during testing at various temperatures.

Author: Mr WŁODARCZYK, Szymon Dominik (CERN)

Co-authors: CATINACCIO, Andrea (CERN); BAULT, Christophe (CERN); ALVAREZ FEITO, Diego (CERN); TAVARES REGO, Ricardo (CERN)

Presenter: Mr WŁODARCZYK, Szymon Dominik (CERN)

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