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Flow distribution capillary tube testing for the CMS silicon detector upgrades

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Abstract

At CERN, developments are ongoing around evaporative CO2 cooling technologies used for thermal management of new silicon particle detectors for the high luminosity upgrade. These new detectors are set to be installed in the new CMS and ATLAS experiments during long shutdown 3. The 2 Phase Accumulator Controlled Loop (2PACL) principle will be scaled up to a size larger than ever before, 300 to 550 kW respectively compared to the 1 to 15kW in previous systems. The scaling up of the 2PACL principle brings numerous challenges compared to smaller scale 2PACL systems.

One of the challenges is the flow distribution of the thousands of cooling loops. These loops will be fed with a fixed pressure drop of 10 bar. Flow restrictions at the inlet of the loops are needed to balance the resistance such that the designed flow is obtained.

In CMS and ATLAS these restrictions are made with capillaries, a total of ˜1800 in CMS and ˜1000 in ATLAS are needed. In order the define the proper capillary diameters and lengths two dedicated bottle-fed CO2 blow-system were developed and built at CERN to allow rapid measurements of these capillaries, ensuring that the characteristics are within the desired specifications of the detector system's needs.

The proposed talk will go into more detail on the theoretical prediction, physical manufacturing, measurements, and quality control of these capillaries used for the CMS phase-II cooling systems planned for the 2026 LHC High Luminosity Upgrades.

Keywords: Refrigeration, Carbon Dioxide, CMS, ATLAS, 2PACL, CERN, Blow-system

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