

CO₂ Cooling for the CMS Tracker at SLHC

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For a new CMS tracker at SLHC cooling of the silicon sensors and their electronics is a crucial issue. An evaporative CO₂ system is currently under investigation, which could provide more cooling power at a lower mass than the current mono-phase liquid system. Additionally CO₂ could allow lower operating temperatures, which is beneficial for the sensor performance and lifetime.

The recirculating CO₂ test system at RWTH Aachen University will be presented. First results of dryout (loss of cooling capability), temperature and pressure drop measurements and comparisons with theory will be shown.

Summary

As a consequence of the increasing luminosity at SLHC with respect to the LHC more particles are expected in the CMS tracker. This leads to the need for a higher read-out granularity and in general a higher functionality to preserve the good performance of the experiment. Therefore a new tracker has to be built.

An evaporative CO₂ system should fulfil the requirements of effective and low mass cooling. It is planned to employ it already in the phase-I upgrade of the pixel detector and later also in the phase-II upgrade of the whole tracker.

In Aachen we have built and commissioned a recirculating CO₂ test system. Our aim is to gain experience in working with this kind of system and to determine several important parameters such as the lowest operating temperature and the overall operating conditions for a stable system. With our set-up we can achieve a maximum cooling power of 500 W and cover a temperature range in the detector between -45°C and +20°C. We want to manage the continuous operation and precisely control temperature and flow. The maximum pressure in the system is 100 bar.

We performed dryout measurements at different saturation temperatures to determine which flow is needed to dissipate a certain heat load. Additionally we started to analyse the pressure and temperature drop over the pipe to investigate how accurate we can control the detector temperature. All measurements will be compared to theoretical models.

A main goal is to determine the optimal cooling pipe routing and thermal contacts between the cooling system and the sensors and electrical devices. With the knowledge gained by these measurements we would like to contribute to future module designs of the new strip tracker for phase-II.

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