

R&D on CO₂ cooling using a silicon Microchannel substrate for the LHCb VELO

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LHCb is a flavour physics detector at the LHC, designed to detect decays of b- and c-hadrons for the study of CP violation and rare decays. At the end of Run-II the experiment will implement a major upgrade. The hardware trigger will be removed and the entire experiment will operate at 40 MHz. The Vertex Locator (VELO) is the silicon detector surrounding the interaction region, responsible for reconstructing the primary collision points and secondary decay vertices of long-lived particles. It will be replaced with a new light weight pixel detector equipped with electronics capable of providing 40 MHz readout.

The upgraded VELO modules will each host 4 silicon hybrid pixel tiles, each read out by 3 VeloPix ASICs with a total power consumption of up to 30 W. The tiles will be subjected to significant radiation damage and an efficient lightweight cooling solution is essential to control reverse annealing in the silicon sensors. The solution adopted is to mount the tiles on a cooling substrate composed of thin silicon plates with embedded micro-channels that allow the circulation of evaporative CO₂. This solution is highly efficient, has low and uniform mass, and is radiation hard. Specific R&D has resulted in a design which gives the correct pressure-flow performance and allows the attachment of the connector to the cooling substrate. The design has undergone robustness and stability tests guaranteeing that the system level performance will function correctly. The microchannels are currently in production and the cooling status will be described.

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