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Upgrade of the LHCb Vertex Locator

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The upgrade of the LHCb experiment, planned for 2018, will transform the entire readout to a trigger-less system operating at 40 MHz. All data reduction algorithms will be executed in a high-level software farm, with access to all event information. This will enable the detector to run at luminosities of $1-2 \times 10^{33}$ /cm²/s and probe physics beyond the Standard Model in the heavy sector with unprecedented precision.

The upgraded VELO must be low mass, radiation hard and vacuum compatible. It must be capable of fast pattern recognition and track reconstruction and will be required to drive data to the outside world at speeds of up to 3 Tbit/s. This challenge is being met with a new VELO design based on hybrid pixel detectors positioned to within 5 mm of the LHC colliding beams. The sensors have $55 \times 55 \mu\text{m}^2$ pixels and the VELOPix ASIC which is being developed for the readout is based on the Timepix/Medipix family of chips. The hottest ASIC will have to cope with pixel hit rates of up to 900 MHz.

The material budget will be optimised with the use of evaporative CO₂ coolant circulating in microchannels within a thin silicon substrate. Microchannel cooling brings many advantages: very efficient heat transfer with almost no temperature gradients across the module, no CTE mismatch with silicon components, and low material contribution. This is a breakthrough technology being developed for LHCb.

LHCb is also focussing effort on the construction of a lightweight foil to separate the primary and secondary LHC vacua, the development of high speed cables, and the metallisation and radiation qualification of the module.

The 40 MHz readout will also bring significant conceptual changes to the way in which the upgrade trigger is operated. Work is in progress to incorporate momentum and impact parameter information into the trigger at the earliest possible stage, using the fast pattern recognition capabilities of the upgraded detector.

The current status of the VELO upgrade will be described together with a presentation of recent test results.

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