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The VELO Pixel Upgrade

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The LHCb Vertex Detector (VELO) will be upgraded in 2018 to a lightweight hybrid pixel detector capable of 40 MHz readout at a luminosity of 2x1033 cm-2 s-1 and operation in very close proximity to the LHC beams. The pattern recognition and track reconstruction precision is enhanced relative to the current VELO detector even at the high occupancy conditions of the upgrade, due to the pixel geometry and a closest approach to the LHC beams of just 5 mm. The pixel modules must withstand non-uniform irradiation levels reaching 8 x 1015 neq/cm2 at the regions closest to the beam, over the lifetime of the upgraded VELO. In order to achieve this, radiation hard technologies are employed for the sensors and electronics, and the sensors must be efficiently cooled. The pixel modules are mounted onto silicon plates which provide cooling via bi-phase CO2 circulating in microchannels etched within the silicon. The entire detector is split into two retractable halves, with the modules occupying a secondary vacuum volume separated from the primary vacuum by a thin, corrugated foil.

The detector contains 41 million 55 x 55 um square pixels, read out by the custom developed VeloPix front end ASIC. This ASIC, which is a development in common with the Medipix family of ASICs, most tolerate rates of over 900 Mhits/s and be capable of reading out every bunch crossing, leading to data rates of above 16 Gbits/s. The ASIC operates with a data driven readout and on-chip data packing into super pixels. The high speed signals are transmitted via electrical and optical links to the off detector electronics which incorporate FPGAs to time order and process the data for delivery into the software farm where the trigger is implemented.

The current status of R&D for the VELO upgrade, together with the prototyping results will be reviewed.

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