

The LHCb VELO Upgrade

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The LHCb VELO (silicon Vertex Locator) will be upgraded in 2018, as part of the general upgrade of the LHCb experiment, which will transform the entire detector readout to a triggerless system operating at 40 MHz. The current L0 hardware trigger will be removed, and 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 above $2 \times 10^{33} \text{ cm}^{-2}\text{s}^{-1}$ and explore New Physics effects in the beauty and charm sector with unprecedented precision. The new vertex detector will have to cope with radiation levels of up to $10^{16} \text{ 1 MeV neutron equivalents / cm}^2$, more than an order of magnitude higher than those expected at the current experiment. At the same time, the sensors must approach the beam as closely as possible (7mm or below) without introducing dead material, hence the design of the sensor guard ring is crucial. New sensor designs have been launched for the 55×55 micron square pixel technology options with a number of manufacturers, and are being prototyped in lab and testbeam measurements. The lightweight radiation-hard assembly will integrate evaporative CO₂ cooling for which microchannel cooling is being considered as an alternative to diamond or TPG heat spreading planes. Technological challenges include the module design, the construction of a lightweight foil to separate the primary and secondary LHC vacuua, the use of high speed cables, and the metallisation and radiation qualification of the module. In order to cope with the huge data flow special techniques will be applied, with the major areas of R&D focussing on techniques for data compression in the chips, time ordering in the FPGAs, and the use of GPUs for pattern recognition and tracking. The current status of the LHCb VELO upgrade developments will be described, and the latest results from the mechanical prototyping and sensor tests in the testbeams will be shown.

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