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Operation of the LHCb silicon tracking and vertexing systems in LHC Run-2

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The primary goal of the LHCb experiment at the LHC is to search for indirect evidence of new physics via measurements of CP violation and rare decays of beauty and charm hadrons. The LHCb detector is a single-arm forward spectrometer with precise silicon-strip detectors in the regions with highest particle occupancies. Around the interaction region, the VErtex LOcator (VELO) has active sensing elements as close as 8 mm from the LHC beams. The Silicon Tracker (ST) consists of a large-area detector located upstream of a dipole magnet, and three stations placed downstream of the magnet. Both detectors share the same front-end electronics, the Beetle chip.

The detectors performed very well throughout LHC Run-1 but new operating conditions for Run-2 pose new challenges.
In particular, the bunch separation has been reduced to 25 ns, which is the same order of magnitude as the shaping time of the front-end read-out amplifiers.
Signal spill-over from adjacent bunch crossings has to be considered in the reconstruction of clusters and tracks.
The centre-of-mass energy has also been increased leading to much higher particle multiplicities and increased radiation damage to the silicon sensors.

The non-uniform exposure of the LHCb sensors makes it an ideal laboratory to study radiation damage effects in silicon detectors.
The VELO sensors are exposed to fluences of the order of 5×10^{13} 1-MeV neq/cm^2 per fb^{-1} while the ST sensor are exposed to more moderate fluences of the order of 10^{12} 1 MeV neq/cm^2 per fb^{-1}.

Several different methods are used to monitor the radiation damage. In particular, regular High Voltage scans are taken which allow a precise measurement of the charge collection efficiency (CCE) as function of the voltage.
This analysis is used to determine the operational voltages, and allows to monitor any degradation in the detector performance.

The overall performance of the VELO and ST during Run-2 will be presented.
The results of the latest high voltage scans will be shown, and measurements of the effective depletion voltage will be compared with the expected values that are calculated using the Hamburg model. Several fits to the model will be shown that illustrate different annealing scenarios, related to maintenance activities of the cooling system that are evisaged in Run-2, and their impact on the operation of the detector during the remaining Run-2 data taking.

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