LHCb VELO: Performance and Radiation Damage in LHC Run I and Preparation for Run II
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on behalf of the LHCb Collaboration
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The LHCb Spectrometer

Performance during Run I

Signal and Noise

- Using the ADC distribution fit Landau + Gaussian function in order to retrieve MPV for signal and noise value
- Typical noise across the VELO ~ 1.6 – 2 ADC counts (depending on sensor position and type)
- Average signal to noise ratios measured for the VELO:

$$\frac{\sigma_s}{\sigma_n} = 19$$

$$\frac{\sigma_p}{\sigma_n} = 21$$

Performance of the LHCb VELO [JINST 3 2008 S08005]

Resolutions

- Single hit resolution – linear dependence on strip pitch for a given projected angle range - the best resolution @ LHC: ~ 4 μm
- Primary Vertex resolution ~ 69 (13) μm for (x,y) respectively for 25 tracks
- Impact Parameter resolution – critical for trigger performance – amounts to ~ 12 μm for high momentum tracks

Radiation damage

- Bulk current increases with delivered luminosity
- Typical increase amounts to roughly ~ 1.9 μA/pb−1
- All silicon sensors operating at the same bias voltage of 150 V
- Good agreement with theory

- Effective depletion voltage $V_{ED}$ decrease with fluence
- Minimum of $V_{ED}$ ~ 18 V observed at ~ $1.5 \times 10^{13} n_p cm^{-2}$
- Overall good agreement with the Hamborg Model – the apparent departure related to small electric field

Preparation for Run II

- Fully operational VELO replacement has been built - in case of accident or some unexpected radiation damage related problem
- Need to define new procedures for CCE
- More aggressive approach to calibration
- Need to define new procedures for CCE
- $V_{ED}$ is not going to be uniform across sensors – careful monitoring needed
- Operation with different bias voltage for different sensors envisaged

$V_{ED}$ well below 500 V!

We can operate the VELO successfully till the end of the Run II