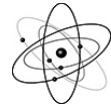


LHCb VELO: Performance and Radiation Damage in LHC Run I and Preparation for Run II

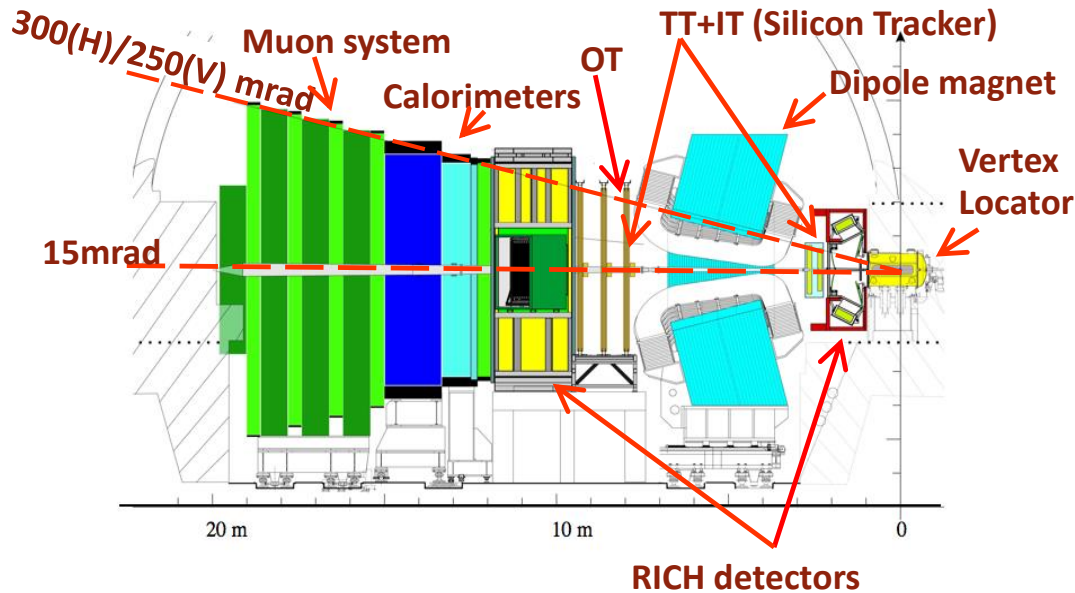


Tomasz Szumlak, Agnieszka Obłąkowska-Mucha, AGH UST Kraków
on behalf of the LHCb Collaboration



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The LHCb Spectrometer



- LHCb is dedicated for studying heavy flavour physics
- Single arm spectrometer geometry
- Fully instrumented in rapidity range $2 < \eta < 5$
- The most precise tracking system at LHC
- Full detector readout is performed at 1.1 MHz

Performance summary

- VELO (vertex locator)

$$\sigma_{IP} \sim 20 \mu\text{m}$$

for high p_T tracks

- Tracker

$$\frac{\delta p}{p} = 0.4 - 0.6\%$$

- HCAL

$$\frac{\sigma_E}{E} \sim \frac{70\%}{\sqrt{E\text{GeV}}} \oplus 9\%$$

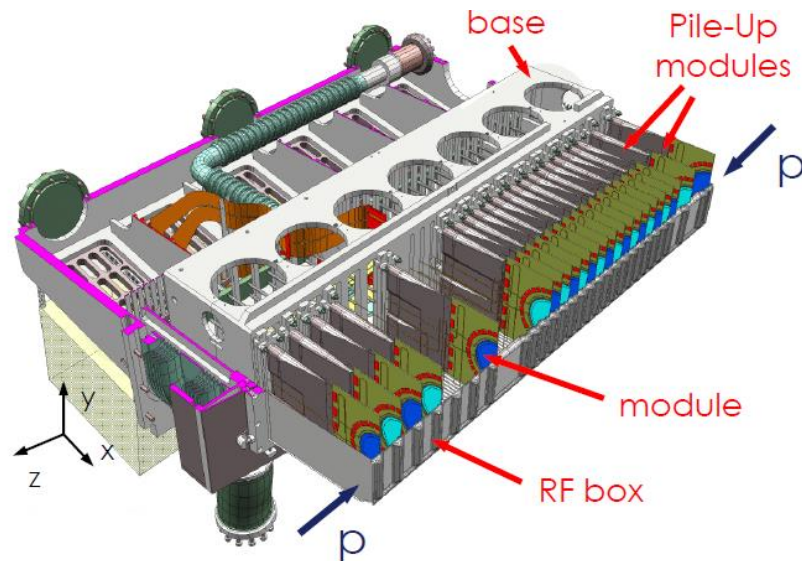
- ECAL

$$\frac{\sigma_E}{E} \sim \frac{10\%}{\sqrt{E\text{GeV}}} \oplus 1\%$$

- RICH

$$\varepsilon(K \rightarrow K) \sim 95\%$$

$$\pi \rightarrow K \text{ misID} \sim 5\%$$



- ❑ Silicon micro-strip vertex detector
- ❑ Two retractable detector halves
- ❑ One half comprises of 21 stations
- ❑ Each station has a R- and ϕ -type sensor
- ❑ Operates in secondary vacuum – separated from the LHC vacuum by 300 μm foil
- ❑ CO_2 cooling system – working point @ -30° sensors are kept @ -10°

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

Run I Performance

- ❑ Using the ADC distribution fit Landau
 - ⊗ Gauss function in order to retrieve MPV for signal and noise value
- ❑ Typical noise across the VELO $\sim 1.6 - 2$ ADC counts (depending on sensor position and type)
- ❑ Average signal to noise ratios measured for the VELO:

$$\left(\frac{S}{N}\right)_R \approx 19$$

$$\left(\frac{S}{N}\right)_\phi \approx 21$$

- ❑ Single hit resolution – linear dependence on strip pitch for a given projected angle range
 - the best resolution @LHC: $\sim 4 \mu m$
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Radiation damage

- ❑ Bulk current increases with delivered luminosity
- ❑ Typical increase amounts to roughly $\sim 1.9 \mu A / pb^{-1}$
- ❑ All silicon sensors operating at the same bias voltage of 150 V
- ❑ Good agreement with theory

Preparation for Run II

- ❑ Fully operational VELO replacement has been built in case of an accident with beam
- ❑ Need to define new procedures for CCE
- ❑ More aggressive approach to calibration scans – done on daily basis
- ❑ V_{ED} is not going to be uniform across sensors – careful monitoring needed
- ❑ Operation with different bias voltage for different sensors envisaged