The LHCb Scintillating Fibre Tracker

Commissioning, Calibration and BCAM-Based 3D Monitoring

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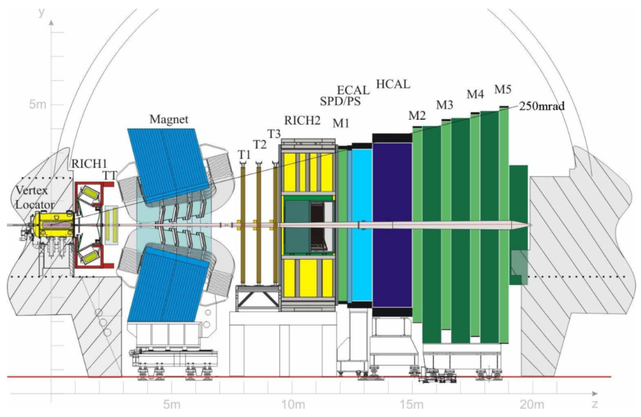
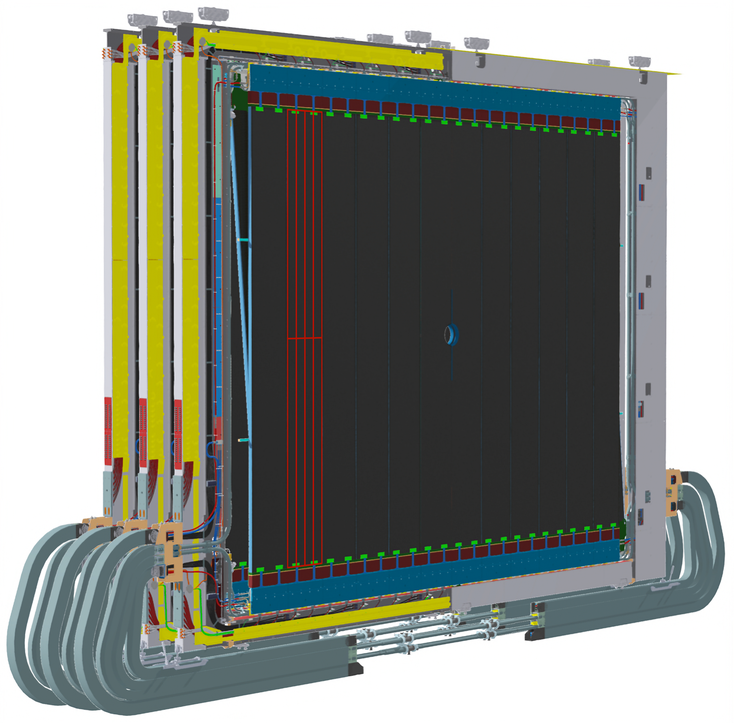
The LHCb Detector



- Single-arm forward spectrometer designed to reconstruct decays of beauty and charm hadrons
- Upgrade for LHC Run 3 to operate at five times higher luminosity
  - Trigger-less 40 MHz readout
  - New frontend & backend electronics

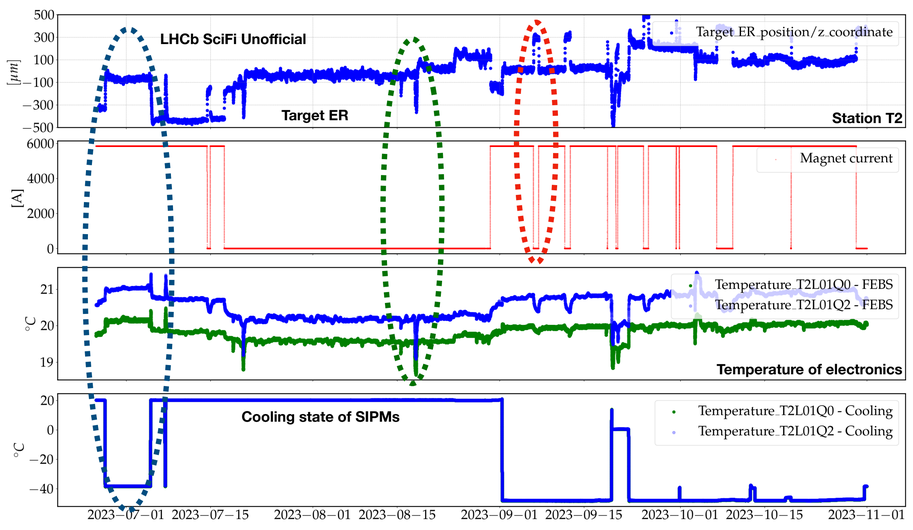
The LHCb Scintillating Fibre Tracker

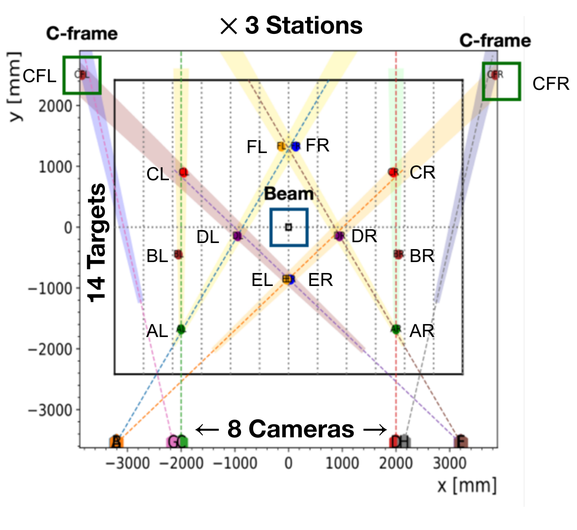


- Three stations with four layers each, covering a total active area of 340 m^2
- Eight 2.5 m long six-layer fibre mats per module
  - 250 µm diameter scintillating fibres
  - 11 000 km of fibre used throughout the detector
- Readout by silicon photomultiplier (SiPM) arrays
  - 524 288 readout channels in total
  - Cooled to −40 °C to mitigate radiation damage
- Signal processing with 40 MHz readout electronics
  - Custom ASIC (PACIFIC) for analogue processing & digitisation with three comparators per channel
  - Online zero-suppression & clustering on FPGAs

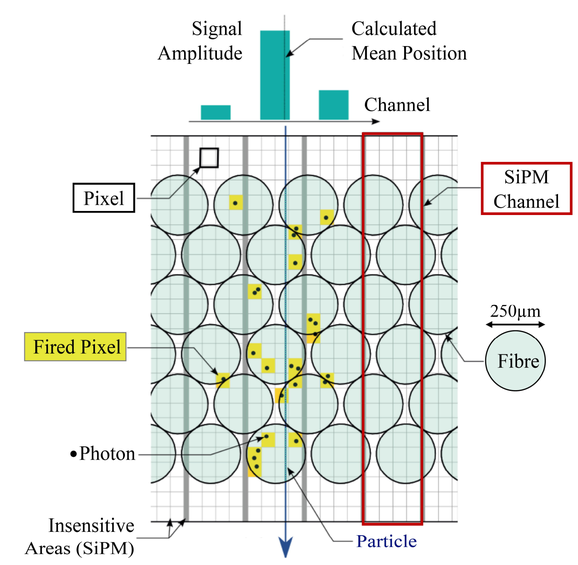
BCAM-Based 3D Monitoring

- Time dependent geometry monitoring of the detector with respect to external conditions (e.g magnet)
- Brandeis Cameras (BCAM) and refractive glass balls (n=2) used to obtain 3D positions from triangulation
- Intrinsic resolution better than 50 µm. After averaging → resolution below 10 µm





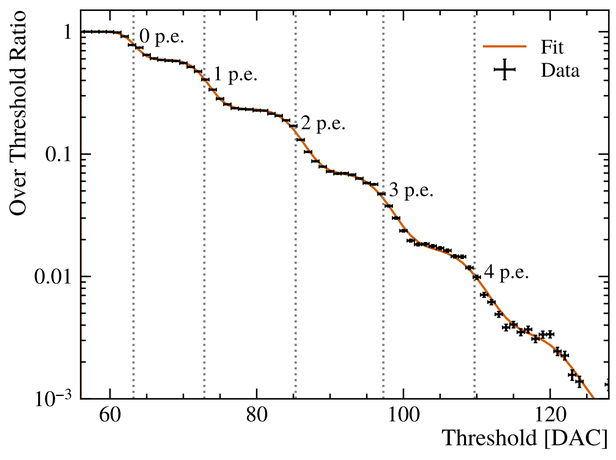
Working Principle

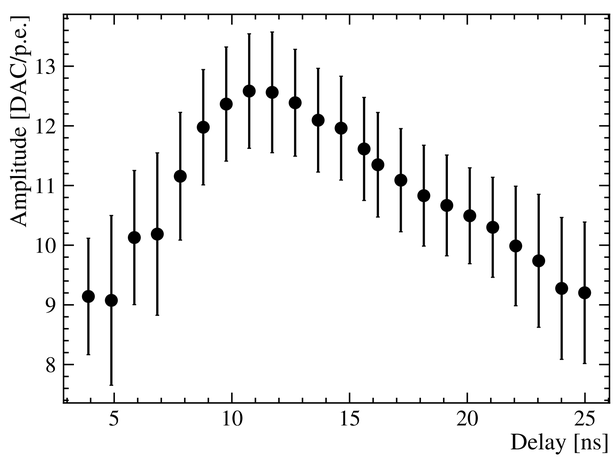


Schematic representation of a charged particle traversing one layer of the SciFi Tracker.

Threshold Calibration

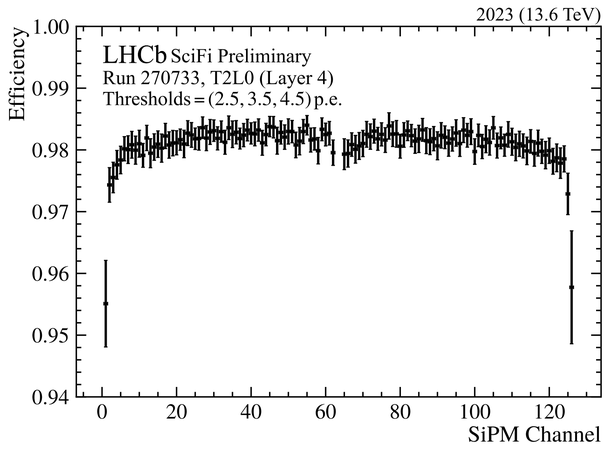
- PACIFIC comparator thresholds need to be calibrated with respect to the connected SiPM channel
- Convert the signal from digital values (DAC) to photo electrons (p.e.)
- Perform threshold scan with pulsed light for each channel and comparator





- Light injection needs to be in-phase with the integration window of the PACIFIC to maximise the amplitude
- Perform threshold scan with pulsed light for different delay settings of the light injection

Hit Efficiency



- Hit efficiency determined by excluding the layer under study from track reconstruction
- Preliminary hit efficiency of 98% with high threshold settings (2.5, 3.5, 4.5 p.e.)