Flavour Physics at the High Luminosity LHC

LHCb Upgrade II

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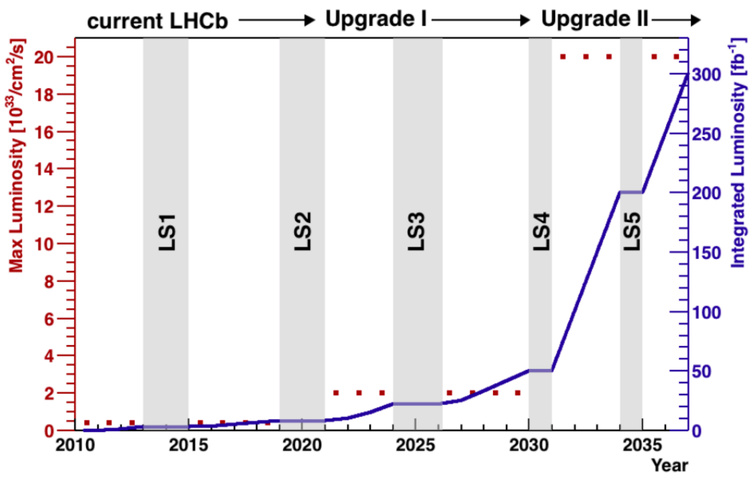
on behalf of the LHCb Collaboration



Motivation

The LHCb Collaboration is planning an Upgrade II, a flavour physics experiment for the high luminosity era. It will be installed in LS4 (2030) and targets an instantaneous luminosity of 1 to 2x10^{34} cm^{-2} s^{-1}, with an integrated luminosity of at least 300fb^{-1}. Modest consolidation of the current experiment will also be introduced in LS3 (2025).

LHCb Upgrade II will allow for a broad spectrum of important flavour-physics measurements such as:

- Semileptonic $b \to s l^+l^-$ and $b \to d l^+l^-$ transitions, of which many not accessible in the current experiment or Upgrade I;
- CP-violating phases γ and φ_s with a precision of 0.4° and 3 μrad;
- CP-violation studies in charm with 10^{-5} precision;
- $B(B^0 \to \mu^+\mu^-)/B(B^0_s \to \mu^+\mu^-)$ with an uncertainty of 20%;
- Lepton-universality tests in $b \to c\, l^-\nu$ decays, exploiting the full range of b-hadrons.

Tracking System

Two general design challenges:

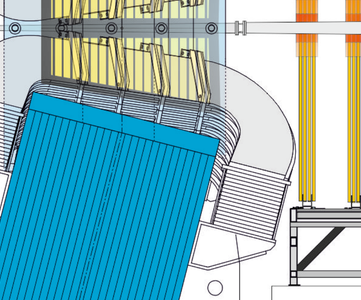
- Track segment matching
- Occupancy

To meet this challenge it is foreseen to:

- Increase the granularity
- Reduce the amount of material
- Exploit the use of precision timing

High Voltage (HV) /
High Resistance CMOS

Vertex Locator



To achieve performant operation:

- In a high pile-up environment
- Under high-radiation conditions

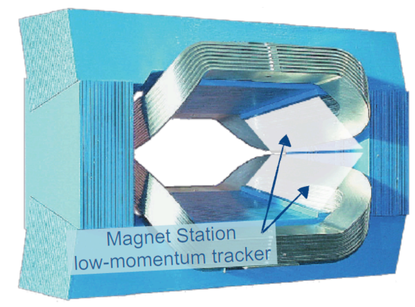
We should:

- Reduce the pixel pitch size, sensor thickness
- Use detector with the timing resolution (LGAD)
- Remove the RF foil
- Use "hot-swap" mechanics

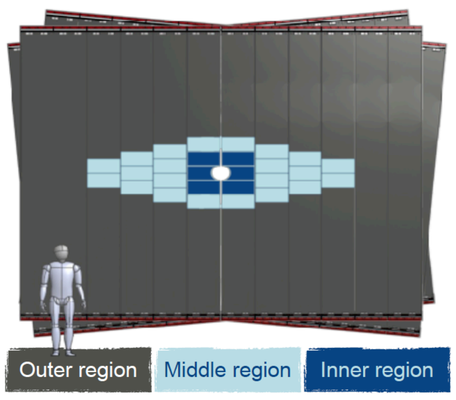
Magnet Station

Instrument internal surfaces:

- Detector from scintillating fibres
- Readout by SiPMs

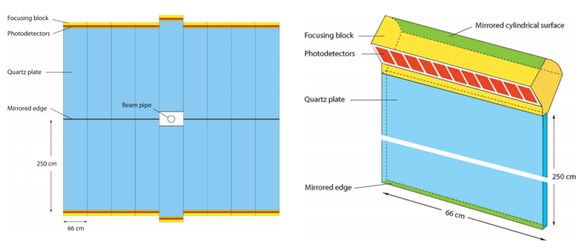


Mighty Tracker



The Outer region:
Vertical scintillating fibres
The Inner and Middle region:
Silicon detectors (HVCMOS)

TORCH



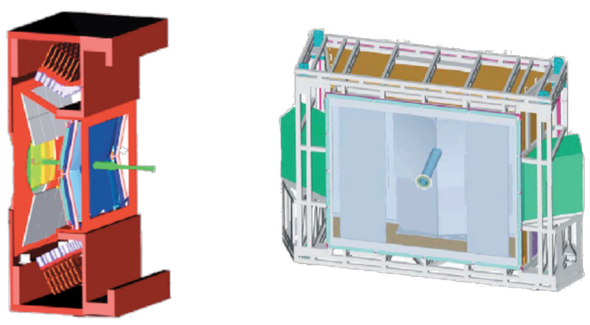
New time-of-flight system with
Micro-Channel Plate PMTs:

- Time resolution: 70 ps/photon
- Expected yield: ~30 photons/track

Significant improvement for:

- flavour tagging
- reconstruction of multi-body final states
- physics with baryons
- spectroscopy studies

RICH system

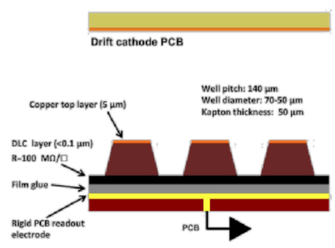


Will be installed new:

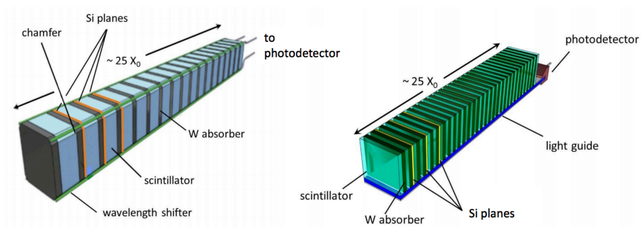
- SiPM-based technology photodetectors, pixel area of ~1mm^2
- Mirror with a thickness of around 1%X0

Muon system

- Additional iron shielding instead of Hadron Calorimeter
- New chamber technology (μ-RWELL) with their own customised frontend electronics in the hottest region



Calorimeters



New possible candidates for ECAL:

- Multi-doped GAGG:Ce crystal calorimeter with longitudinal segmentation (good radiation hardness, excellent energy resolution, very fast response)
- Shashlik or SpaCal (tungsten-alloy converter 25 X_0 in depth, crystal component for providing a fast-timing signal)

The Hadron Calorimeter will be removed

More Information

The LHCb experiment: http://lhcb-public.web.cern.ch/lhcb-public
Expression of Interest for a Phase-II LHCb Upgrade: Opportunities in flavour physics, and beyond, in the HL-LHC era: https://cds.cern.ch/record/2244311
Physics case for an LHCb Upgrade II: https://cds.cern.ch/record/2320509
This poster is based on Vadym Denysenko's design: https://cds.cern.ch/record/2663388