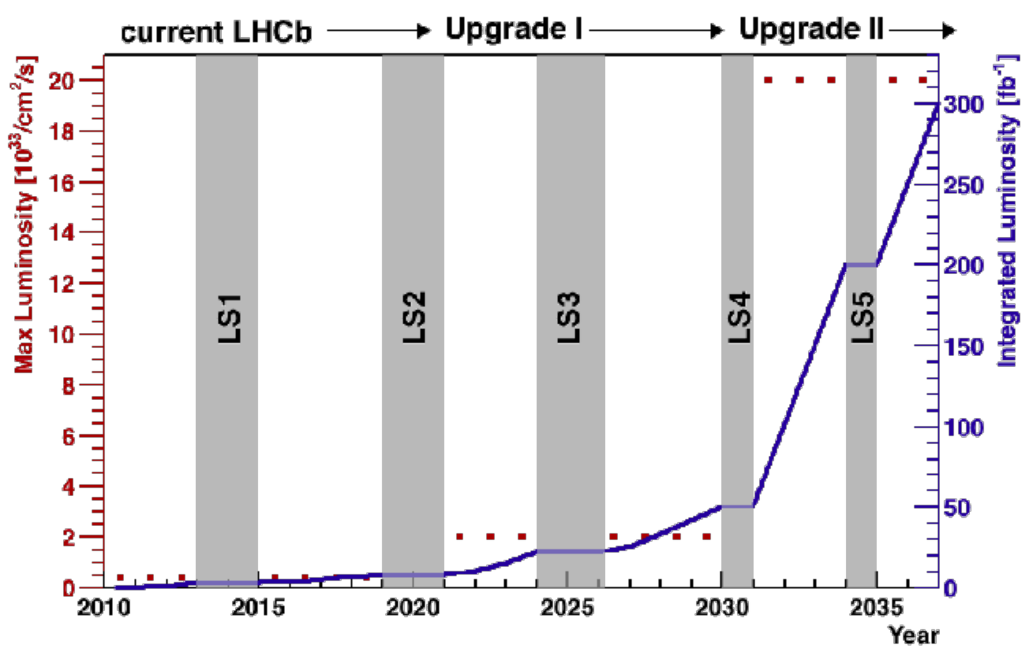
Future upgrades at LHCb

Vadym Denysenko (vadym.denysenko@cern.ch)
University of Zurich, Zurich, Switzerland
on behalf of the *LHCb* collaboration

Motivation



arXiv:1808.08865

The LHCb Collaboration is planning an Upgrade II, a flavour physics experiment for the high luminosity era. This will be installed in LS4 (2030) and targets an instantaneous luminosity of 1 to 2×10^{34} cm^{-2} s^{-1}, and an integrated luminosity of at least 300fb^{-1}. Modest consolidation of the current experiment are also planned for 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, 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;
- $R \equiv B(B^0 \to \mu^+ \mu^-)/B(B^0_s \to \mu^+ \mu^-)$ with an uncertainty of 20%;
- Lepton-universality tests in $b \to c\, l^- \bar{\nu}$ decays, exploiting the full range of b-hadrons.

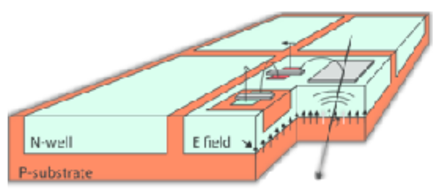
Tracking system

Two general design challenges:

- **Track segment matching**
- **Occupancy**

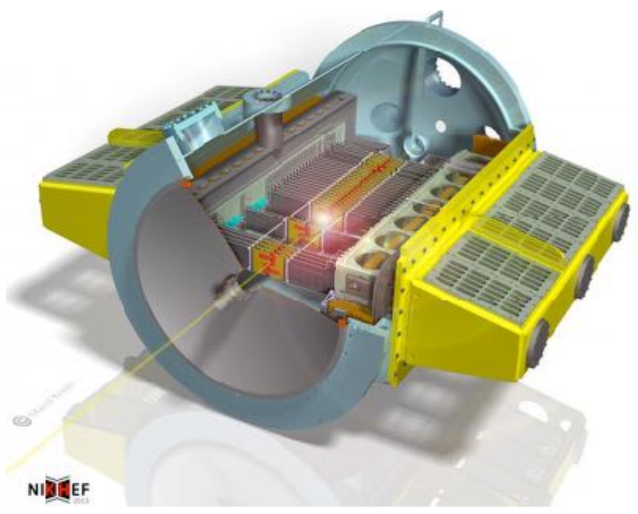
To meet this challenge it is foreseen to:

- **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**

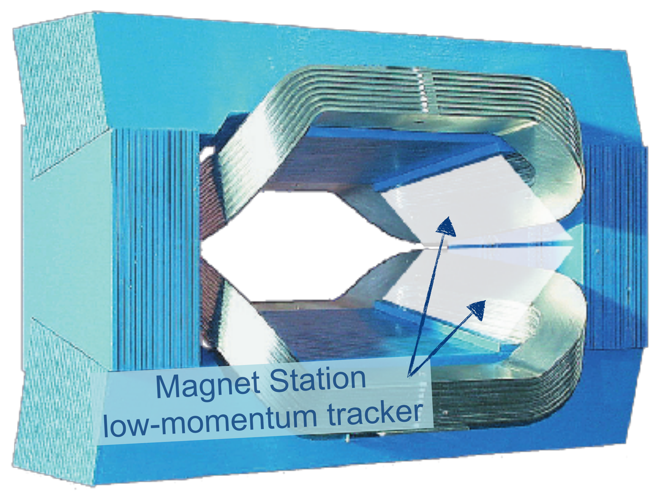
We should:

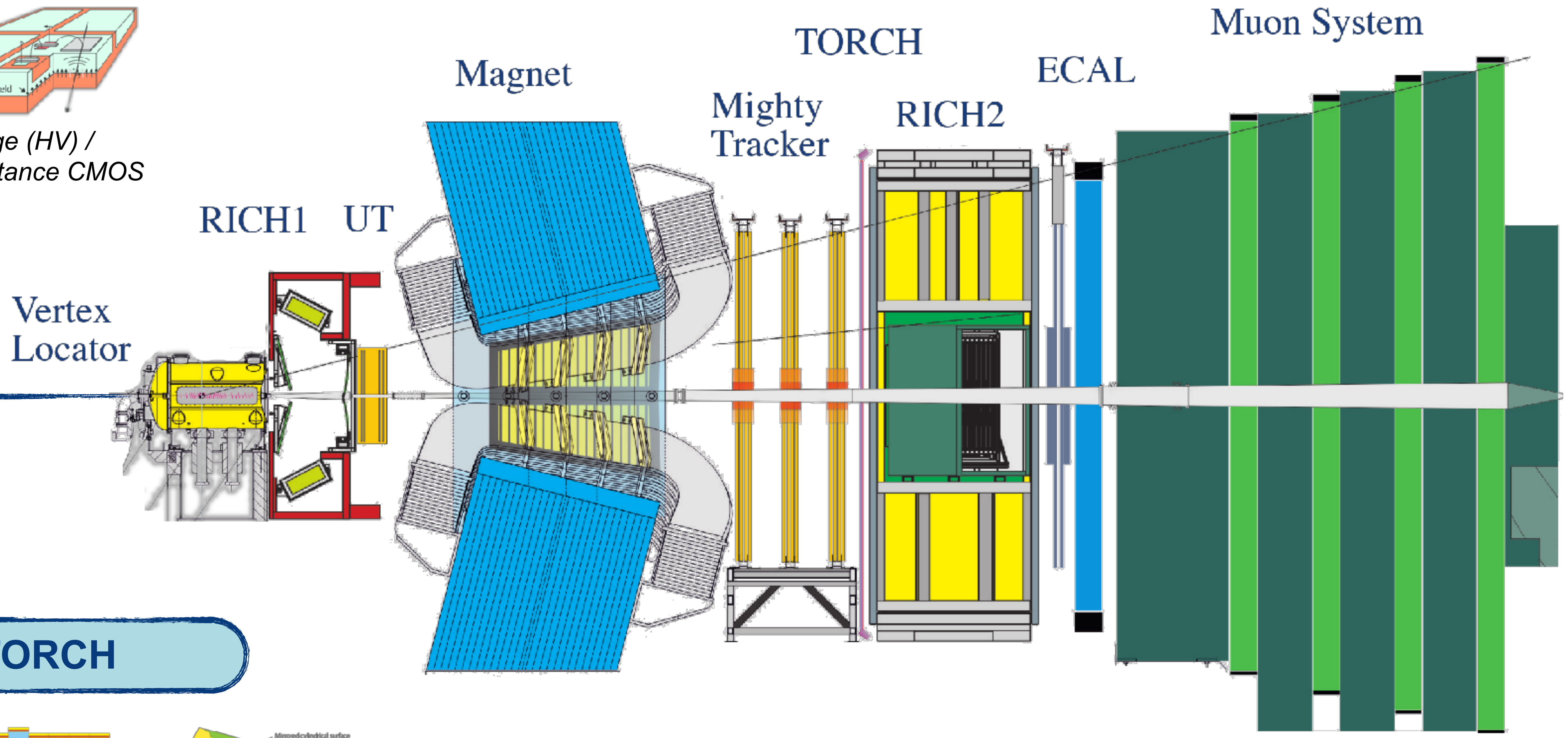
- **Reduce the pixel pitch size, sensor thickness**
- **Use detector with the timing resolution (e.g. LGAD)**
- **Remove the RF foil**
- **Use "hot-swap" mechanics**

Magnet Station

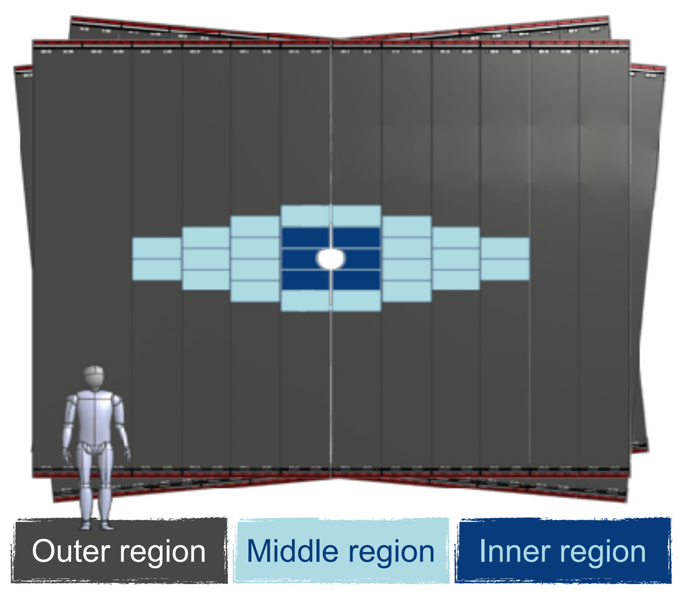
Instrument internal surfaces:

- **Extruded scintillator bars with WLS fibres or scintillating fibres**
- **Readout by SiPMs**





Mighty Tracker



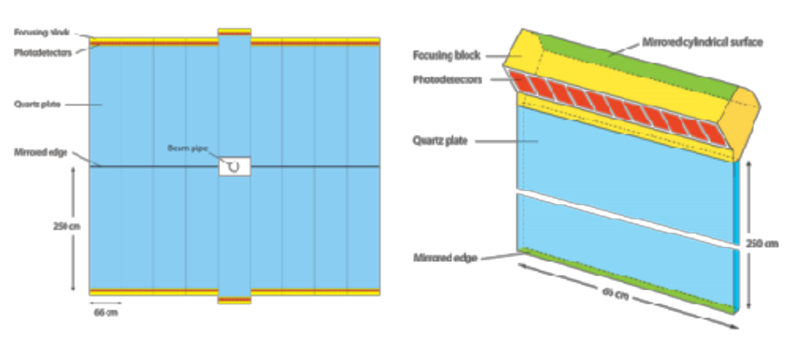
The Outer region:

Vertical scintillating fibres

The Inner and Middle region:

Silicon detectors (HVCMOS)

TORCH



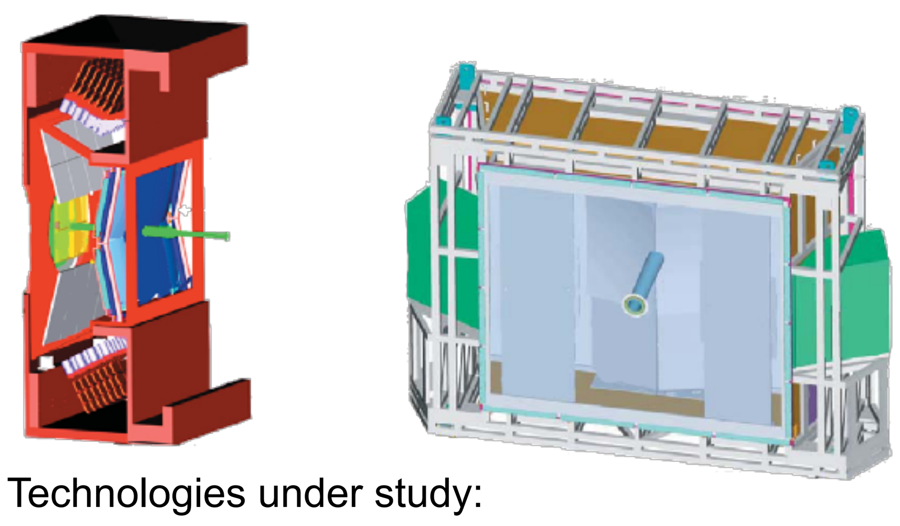
New time-of-flight system with Micro-Channel Plate PMTs:

- **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

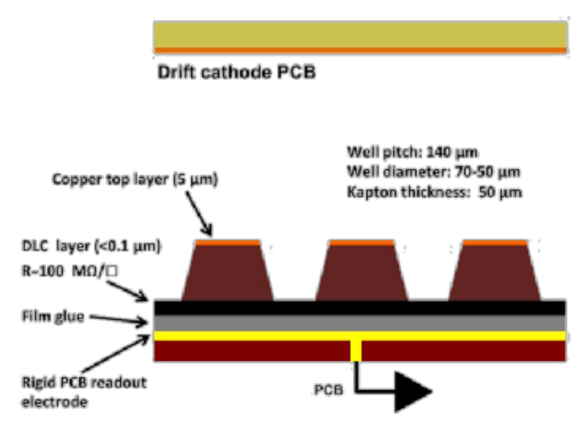


Technologies under study:

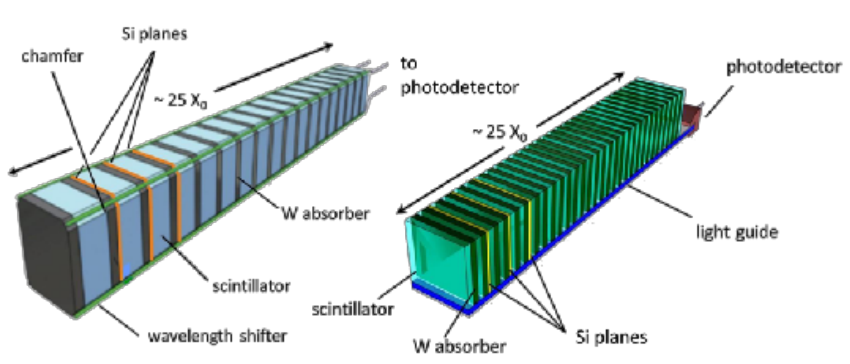
- **SiPM-based technology photodetectors, pixel area of ~1mm²**
- **Mirror with a thickness of around 1%X_0**

Muon system

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



Calorimetry



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

For 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, *CERN-LHCC-2017-003*

Physics case for an LHCb Upgrade II, *LHCb-PUB-2018-009*, arXive: *arXiv:1808.08865*