



Laboratoire de Physique des Hautes Energies

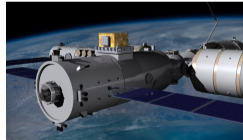
Swiss experimental contributions: EPFL

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Current activities in particle physics

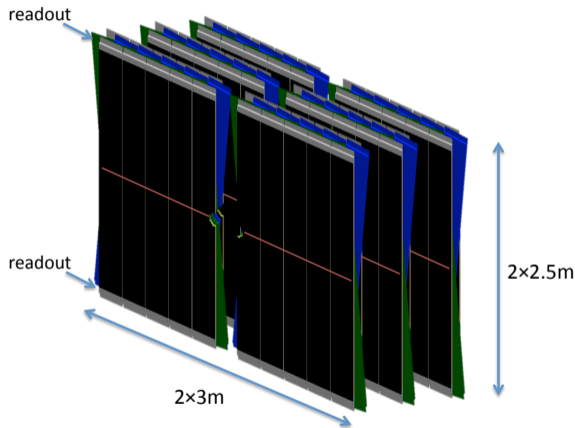
- 1 LHCb experiment: major involvement
 - design, construction and commissioning of SciFi tracker for upgrade
 - and of PLUME luminometer
 - physics analyses: exploring precision frontier and rare or forbidden in the SM processes
- 2 SND@LHC experiment: major contribution
 - target tracker construction and commissioning
 - DAQ development and coordination
 - physics case: neutrino measurement and dark matter searchers
- 3 SHiP experiment: contribution to the R&D activities and physics case
- 4 HERD (High Energy cosmic-Radiation Detection) experiment: Ambizione fellow
 - tracker R&D



Detector R&D: SciFi technology

- scintillating fibre technology developed for the LHCb Upgrade in LS2
- provides large area precise tracking with uniform detector
- composed of tightly packed $\varnothing 250 \mu\text{m}$ scintillating fibres
- read out by custom SiPM arrays with $250 \mu\text{m}$ channel width
- hit position resolution $70 \mu\text{m}$

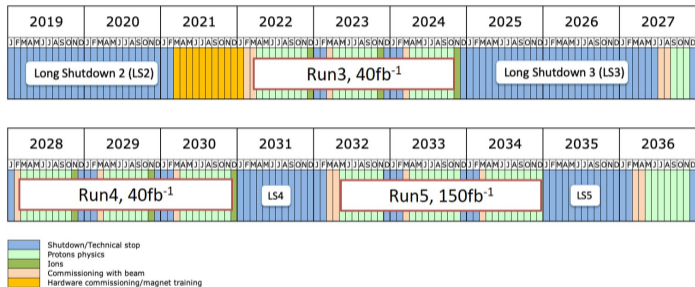
LHCb SciFi tracker layout



LHCb Tracker Upgrade Technical Design Report

Detector R&D: next targets

- LS3: LHCb Upgrade Ib – consolidation
- LS4: LHCb Upgrade II – redesign of many subsystems



Ultimate instantaneous luminosity goal: $1.5 \times 10^{34} \text{cm}^{-2} \text{s}^{-1}$

- $\times 10$ Run 3
- or $\times 100$ Run 1

SciFi R&D: new developments for LHCb

Challenges of increased (instantaneous) luminosity:

- higher occupancy in the central region \implies there can go for a Si tracker
- radiation damage to the fibres causes lower light yield and decreased hit efficiency

Ongoing R&D targets to mitigate this effect by:

- 1 improving light collection efficiency of SiPMs:
 - dedicated collaboration with industry
- 2 usage of cryo-cooling to decrease SiPM dark current rate
 - goes in the direction of direct DM searches approach
- 3 investigation of new rad. hard scintillating materials with higher light yield:
 - collaboration with the Institute of Chemistry at EPFL

These developments span over the course of $\sim 5-10$ years:

- ultimate goals are compatible with the FCC environment
- SciFi technology potentially can be considered for the FCC

SciFi R&D: lateral developments

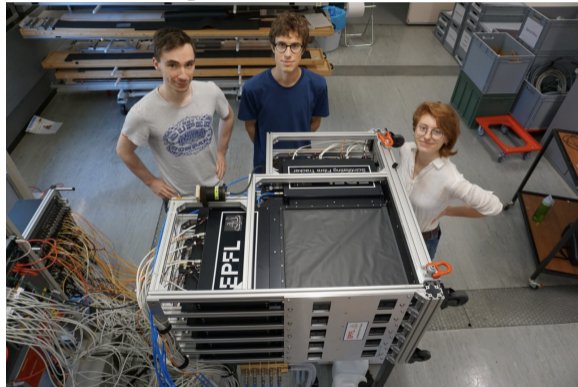
SciFi is used in other applications:

- SND@LHC (low-exposure neutrino-detection experiment)
- beam-gas monitoring system
- medical applications (external collaboration)

Allow for R&D in other directions:

- timing information from SciFi (as of now ~ 250 ps resolution)
- calorimetry application: EM and hadron shower identification and energy measurement
- “real-life” test ground for new scintillating materials

SND@LHC target tracker assembled



Physics analyses

Test standard model boundaries at LHCb through:

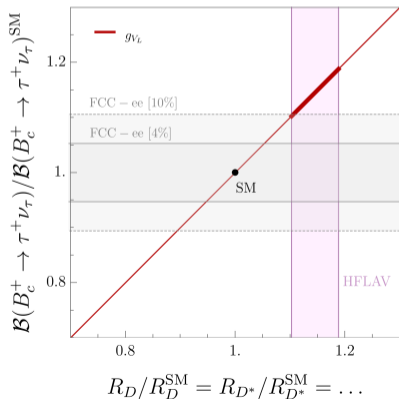
- 1 precision measurements:
 - measurements in charm sector
- 2 rare processes studies:
 - investigating radiative b decays
 - lepton flavor universality tests
- 3 searches of BSM effects:
 - lepton flavor violating processes
 - long-lived particles searches

Upcoming SND@LHC will allow to:

- 1 measure high-energy neutrinos and explore related quantities ([SND@LHC TP](#))
- 2 search for feebly interacting particles ([arXiv:2104.09688](#))

FCC studies

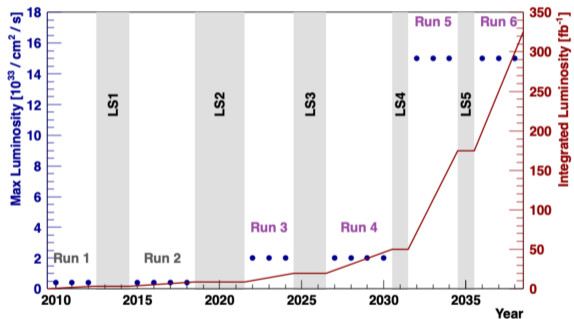
- no dedicated FCC physics or detector studies (yet)
- but LPHE members pursue avenues they are interested in
- e.g. studies of the $B_c^+ \rightarrow \tau^+ \nu_\tau$ at FCC-ee by Donal Hill *et al* ([arXiv:2105.13330](https://arxiv.org/abs/2105.13330)):
 - a powerful probe of the $b \rightarrow c l \nu$ structure exhibiting now tensions with the SM



Current $R_{D^{()}}$ measurements (magenta) wrt
FCC-ee $B_c^+ \rightarrow \tau^+ \nu_\tau$ projection for LQ model*

Summary

- currently, strong commitment to the LHCb exploitation and future upgrades (in LS3 and LS4)
- active R&D and construction goes up to 2030, with the data-taking till the end of HL-LHC



LHCb luminosity profile

- physics interests are diverse and can be greatly shaped by near-term results in flavor sector
- FCC activities will have to be established in the midterm future