LHCb Detector Upgrade

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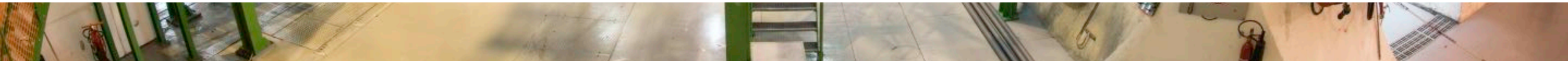
CHIPP Plenary, 10-11 June 2021, Spiez (CH)



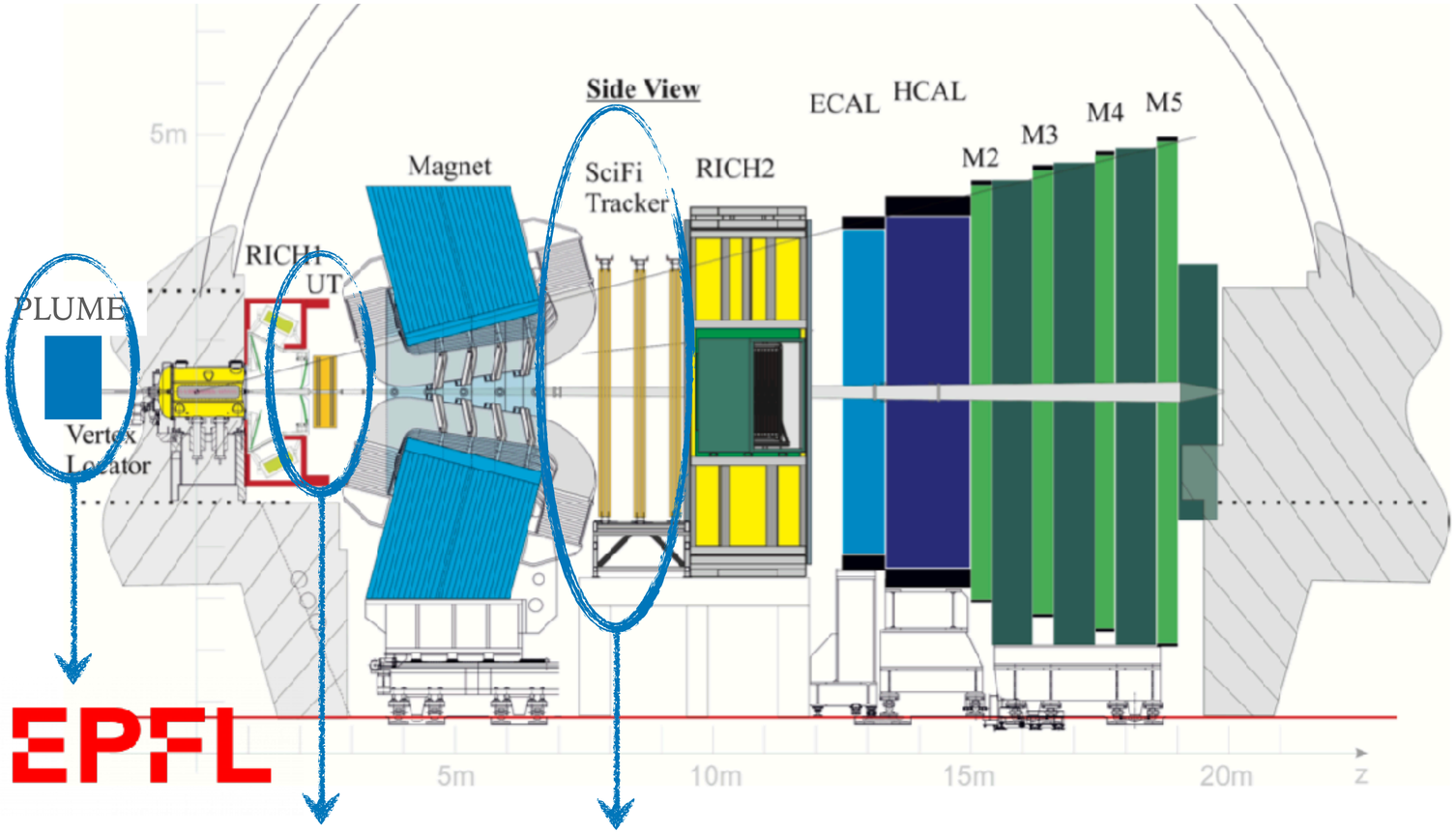
LHCb Upgrades

Run 2 Integrated luminosity ~6 fb-1	LS 2 Upgrade 1a	Run 3 Integrated luminosity ~ 40 fb^{-1}	LS 3 Upgrade 1b	Run 4 Integrated luminosity ~ 40 fb^{-1}
2015 - 2019	2019 - 2021	2022 - 2024	2025 - 2027	2028 - 2030

What happens during Long Shutdown 2?

- Go to full software trigger (removal of L0 trigger bottleneck and full detector readout at each bunch crossing)
  - ➡ Replace readout electronics of all detectors
- Prepare for five times higher luminosity w.r.t. Run 2
  - ➡ Replace all detectors that cannot stand luminosity $\mathscr{L} = 2 \times 10^{33} cm^{-2} s^{-1}$

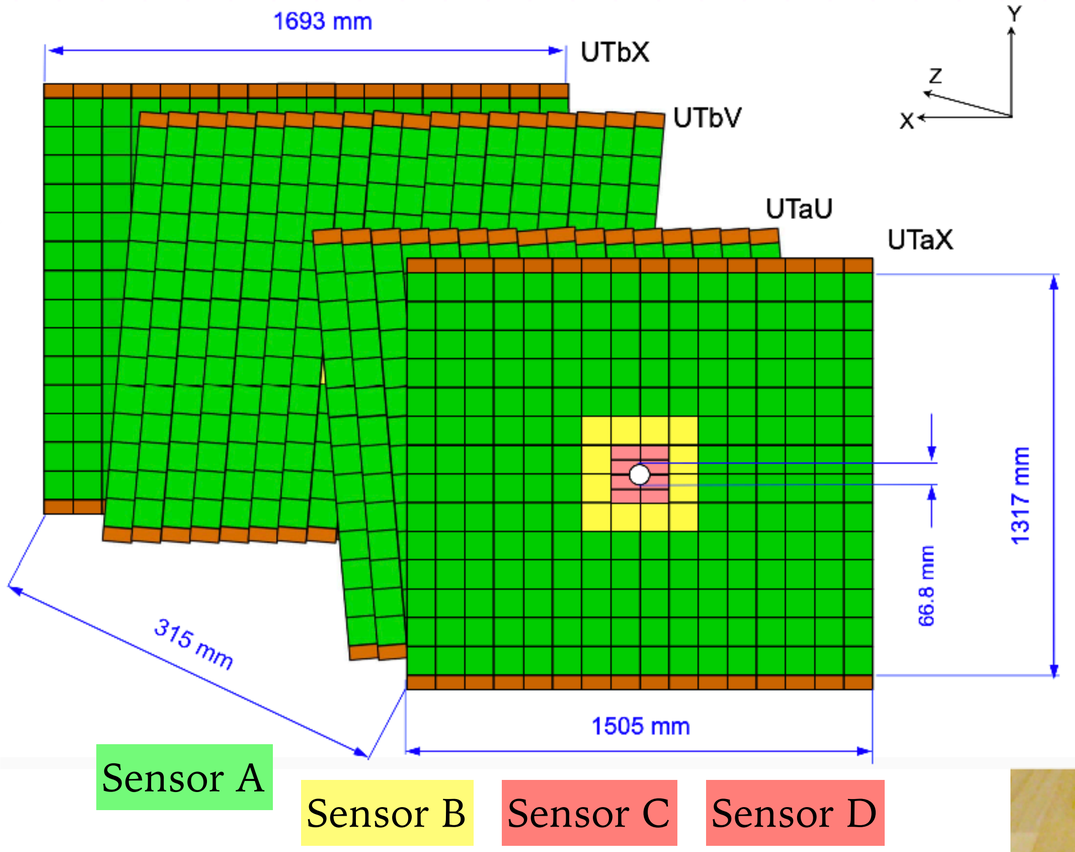
Upgrade 1a

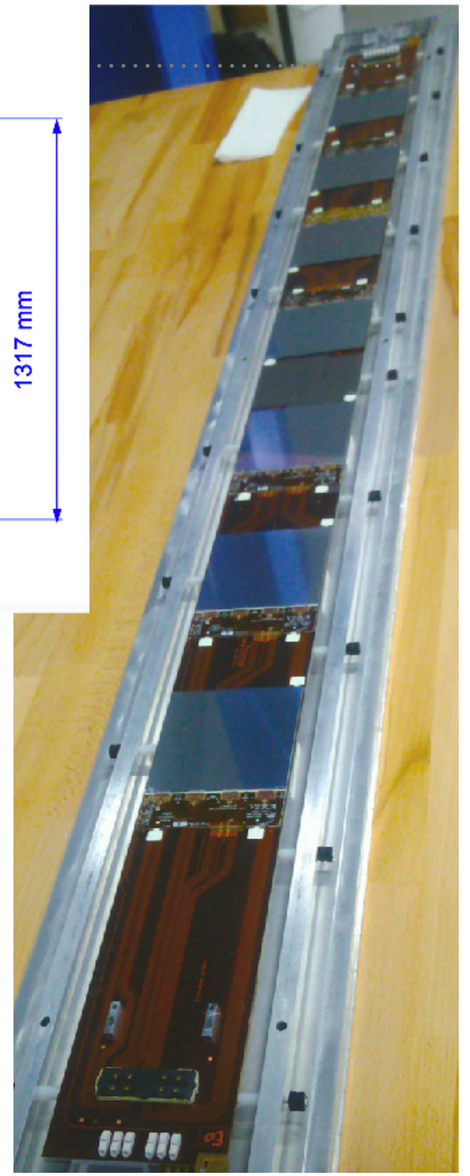


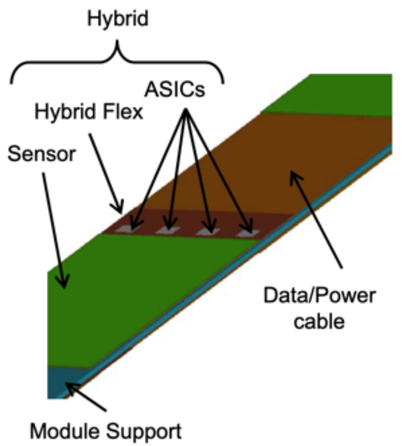
- RICH - Cherenkov detector for PID
  - New optics for RICH1
  - New **MaPMT** for both RICH1&2
- VELO - Vertex Locator
  - From **Si strips** to **Si pixel** detector
- New **U**pstream **T**racker (UT) replaces TT
  - New **Si strip** detector
- New **SciFi** Tracker replaces IT and OT
  - Scintillating fibres + SiPM readout
- PLUME for luminosity monitoring
  - New detector to count particles with PMTs

Upstream Tracker

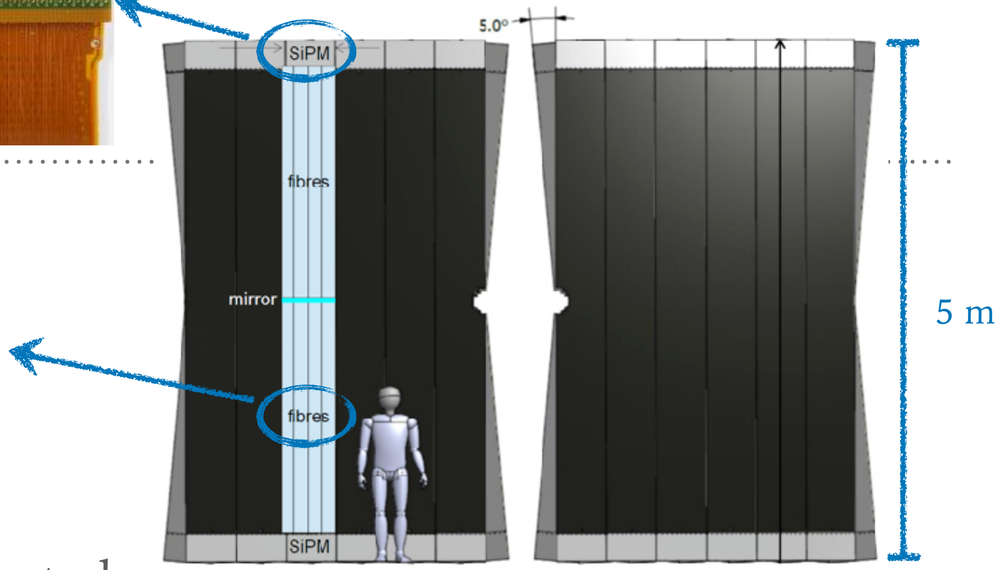
- Four planes of silicon strip detectors
  - Two inner ones rotated by ±5°
- Four sensor types
  - Different segmentations (strip pitch 95-190 μm) to cope with higher occupancy in inner regions
  - better radiation-hardness close to beampipe (usage of n-in-p type Si for sensor types B, C, D)
- Sensors are mounted on 1.6 m x 10 cm long staves
  - Space for 14/16 hybrid modules, data flex connectors and CO_2 cooling pipe



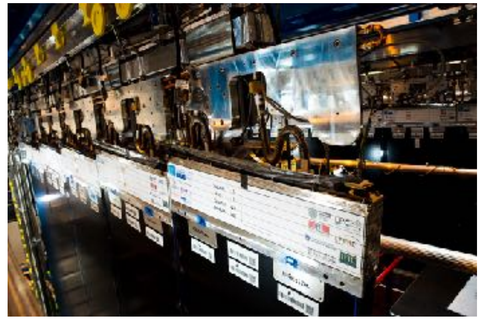


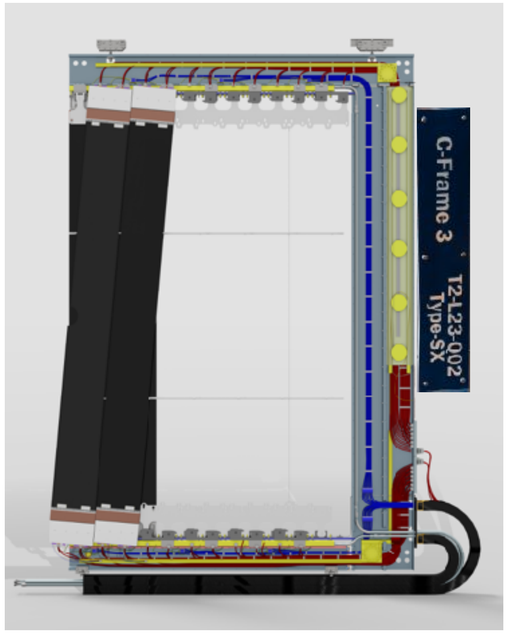


SciFi Tracker



- Consists of:
  - 11’000 km of scintillating fibres (SciFis) staggered to form 2.4 m long fibre mats
  - 12 detection layers cover total area of 340 m^2
  - Over 500k silicon photomultiplier channels (SiPMs) operated at – 40°C located outside the acceptance
  - No active elements in acceptance
- C-shaped frames carrying readout electronics, photodetectors and cooling, and the fibre modules





“And then we come to the tunnel…”

May 3, 2021

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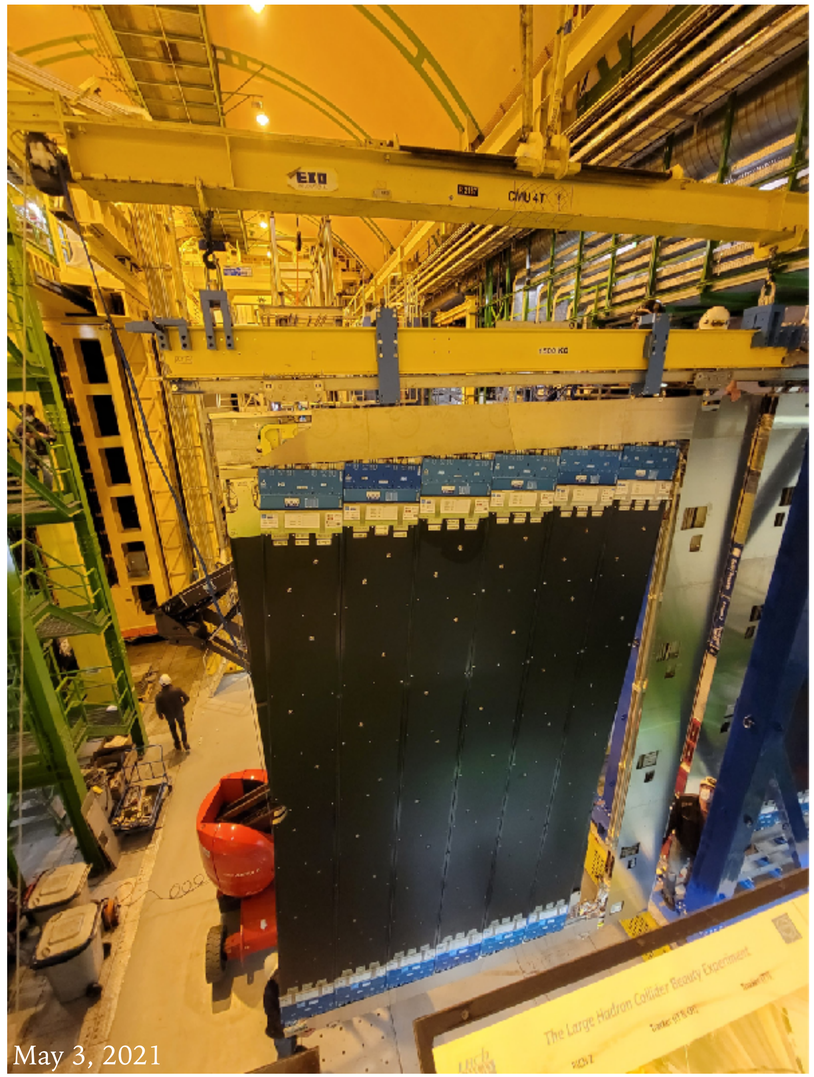


May 3, 2021

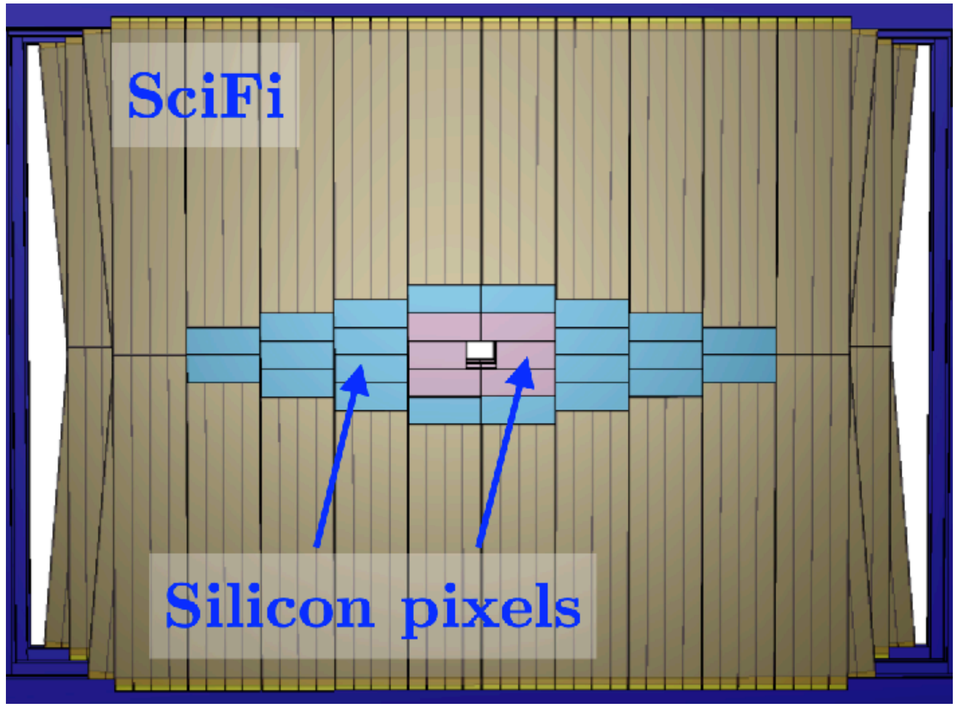
Future Upgrades with Swiss involvement

LS 3 Upgrade 1b	Run 4 Integrated luminosity ~ 40 fb^{-1}	LS 4 Upgrade 2	Run 5 Integrated luminosity ~ 300 fb^{-1}
2025 - 2027	2028 - 2030	2030 - 2031	2031 - 2034

- LS3: SciFi becomes Mighty Tracker
  - Replace inner fibre modules to accomodate inner Si pixel detector
  - Micro-lens-enhanced SiPM arrays to improve light yield of the SciFi (+20%)

Poster Session

- LS4:
  - Replace all SciFi modules (new scintillators)
  - Larger Si pixel detector
  - Cryogenic cooling for SiPMs



THANK YOU FOR YOUR ATTENTION!