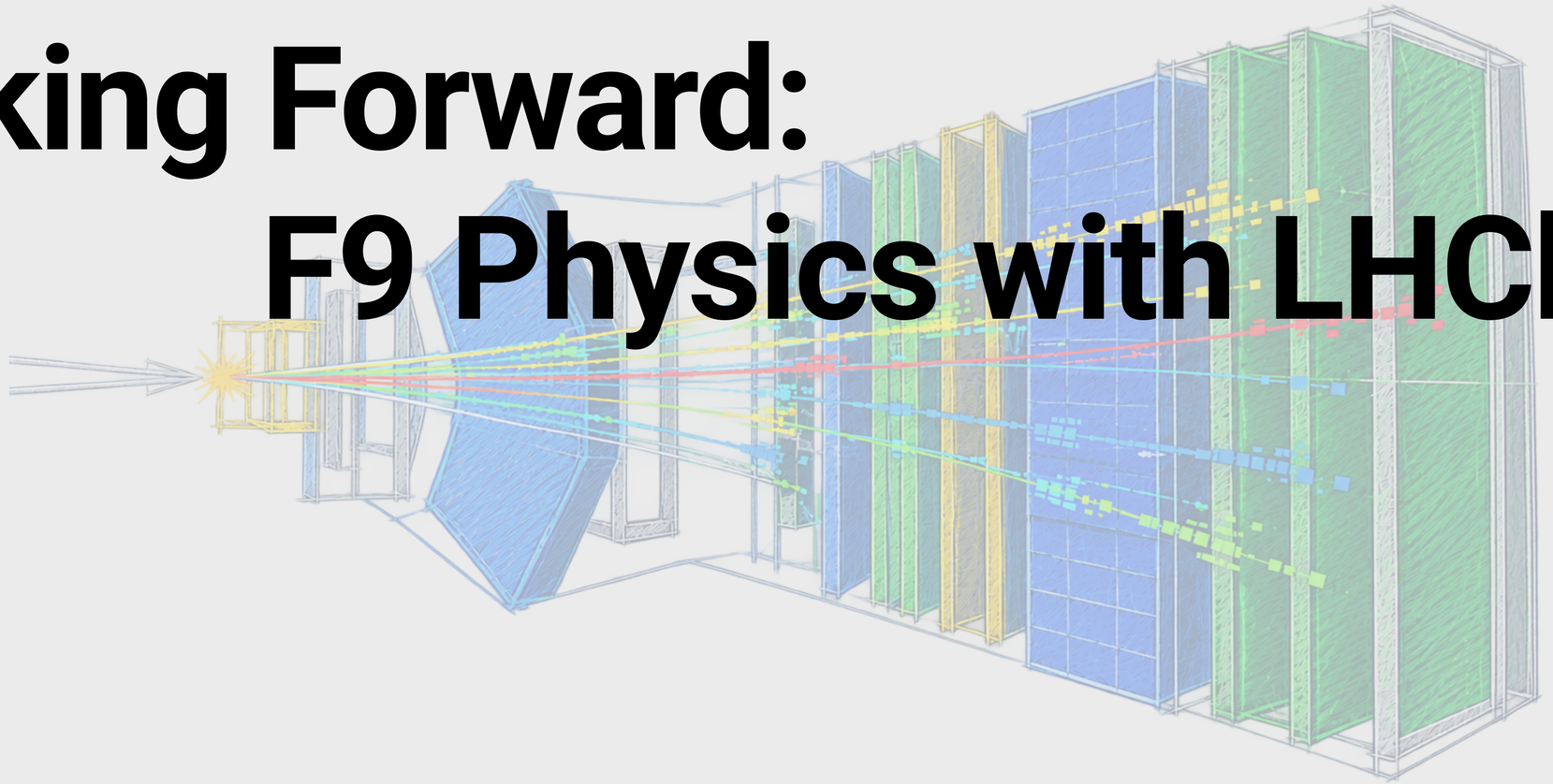
Institut
“Jožef Stefan”
Ljubljana, Slovenija

Looking Forward:
F9 Physics with LHCb



Blaž Leban, 28. 9. 2026

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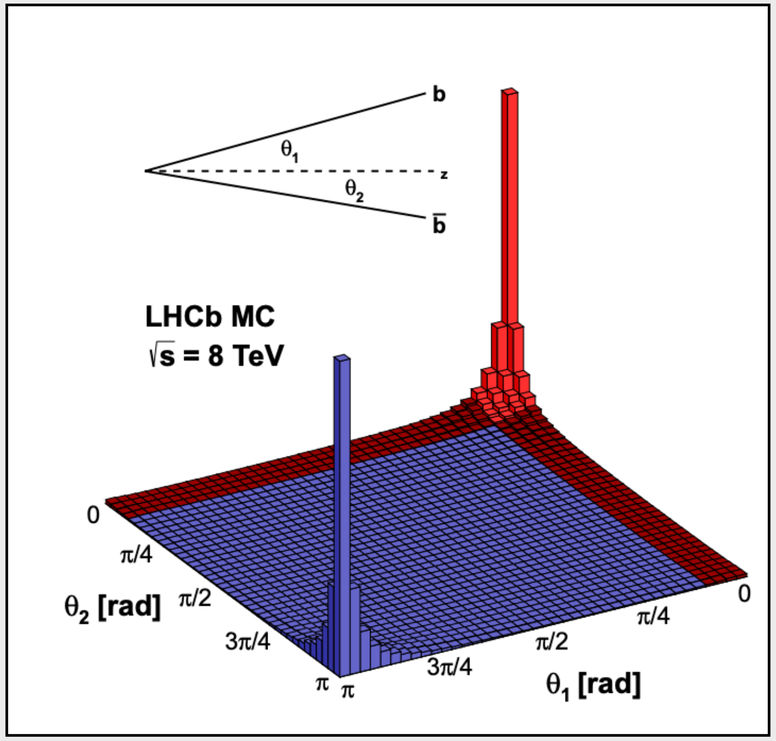
- LHCb experiment
- LHCb collaboration
- History of F9 involvement
- Short-term physics and computing plans
- Long-term plans

LHCb Experiment

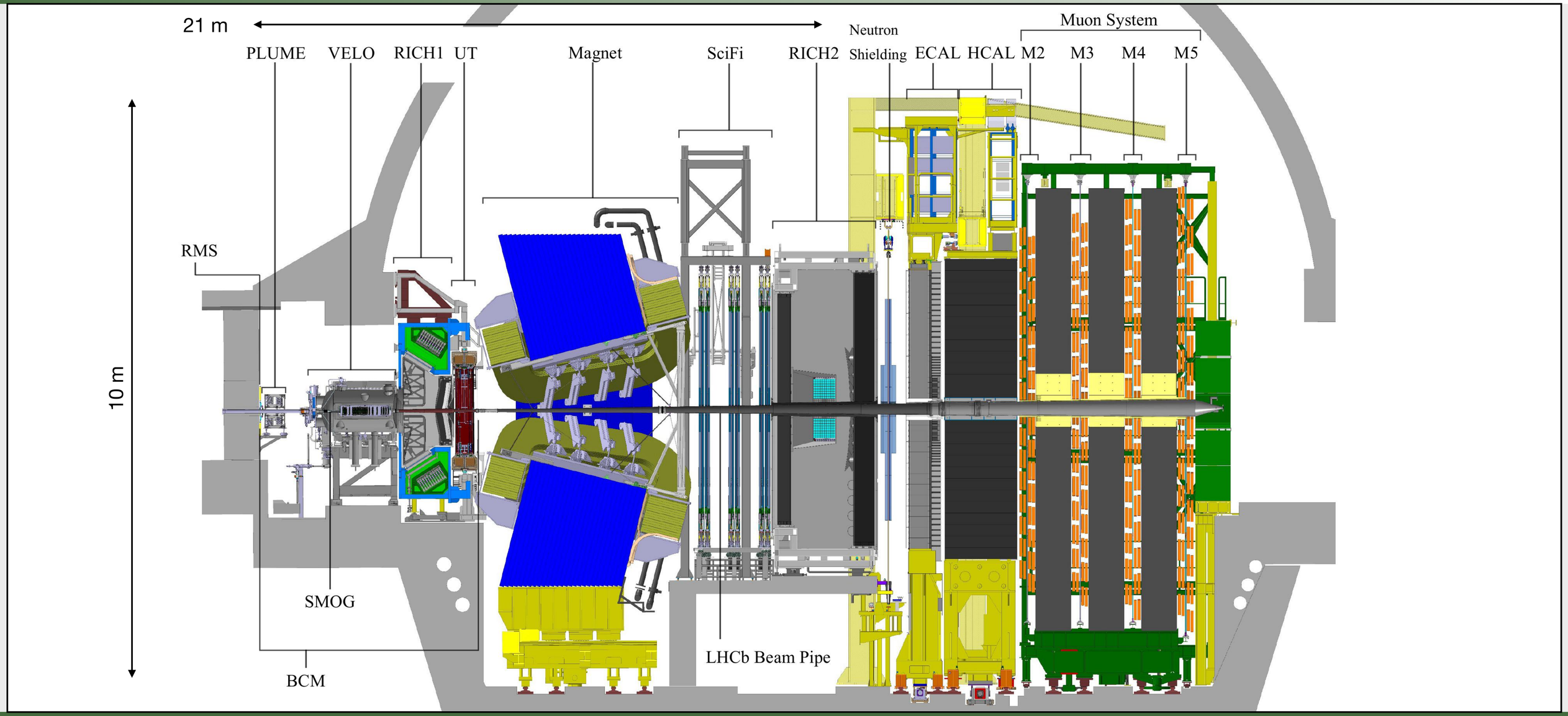
LHCb experiment basics

- LHCb is a **single-arm forward region spectrometer** located at the interaction point 8 of the LHC, covering the pseudorapidity range $2 < \eta < 5$, ie. $\theta \in [0.8°, 15.4°]$.
- The choice of detector geometry is justified by the fact that both b and $\bar{b}$ **hadrons are predominantly produced** in the same **forward or backward cone**.
  - *"If our collaboration had the budget of the ministry of defence we would probably have built two LHCb detectors, to catch both the forward and backward pairs."* [arXiv:2005.11226]
- **Excellent performance** of the detector allowed the **physics program to be extended** very rapidly to explore also charm, electroweak, and even heavy ion physics.

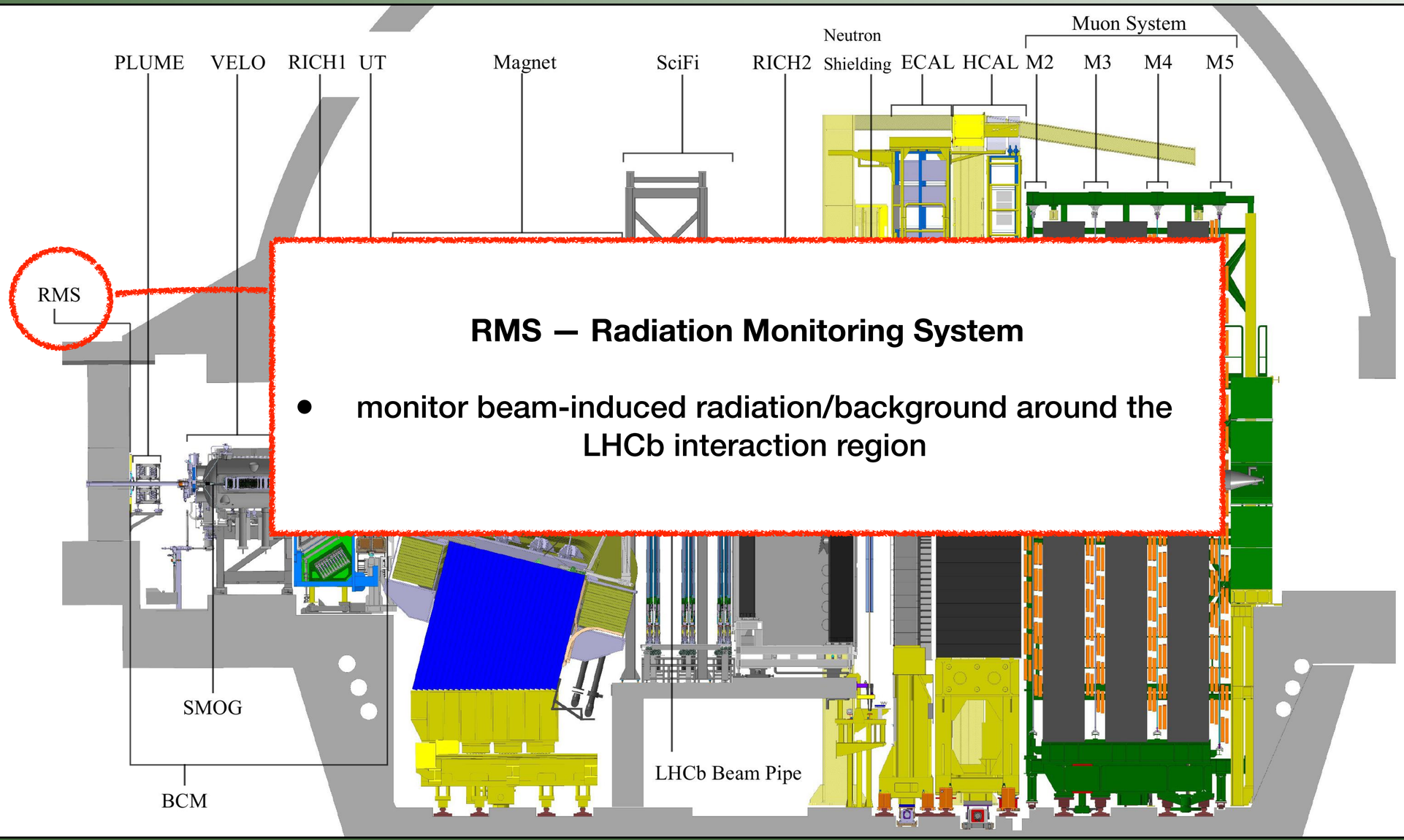


- LHCb acceptance

LHCb experiment layout



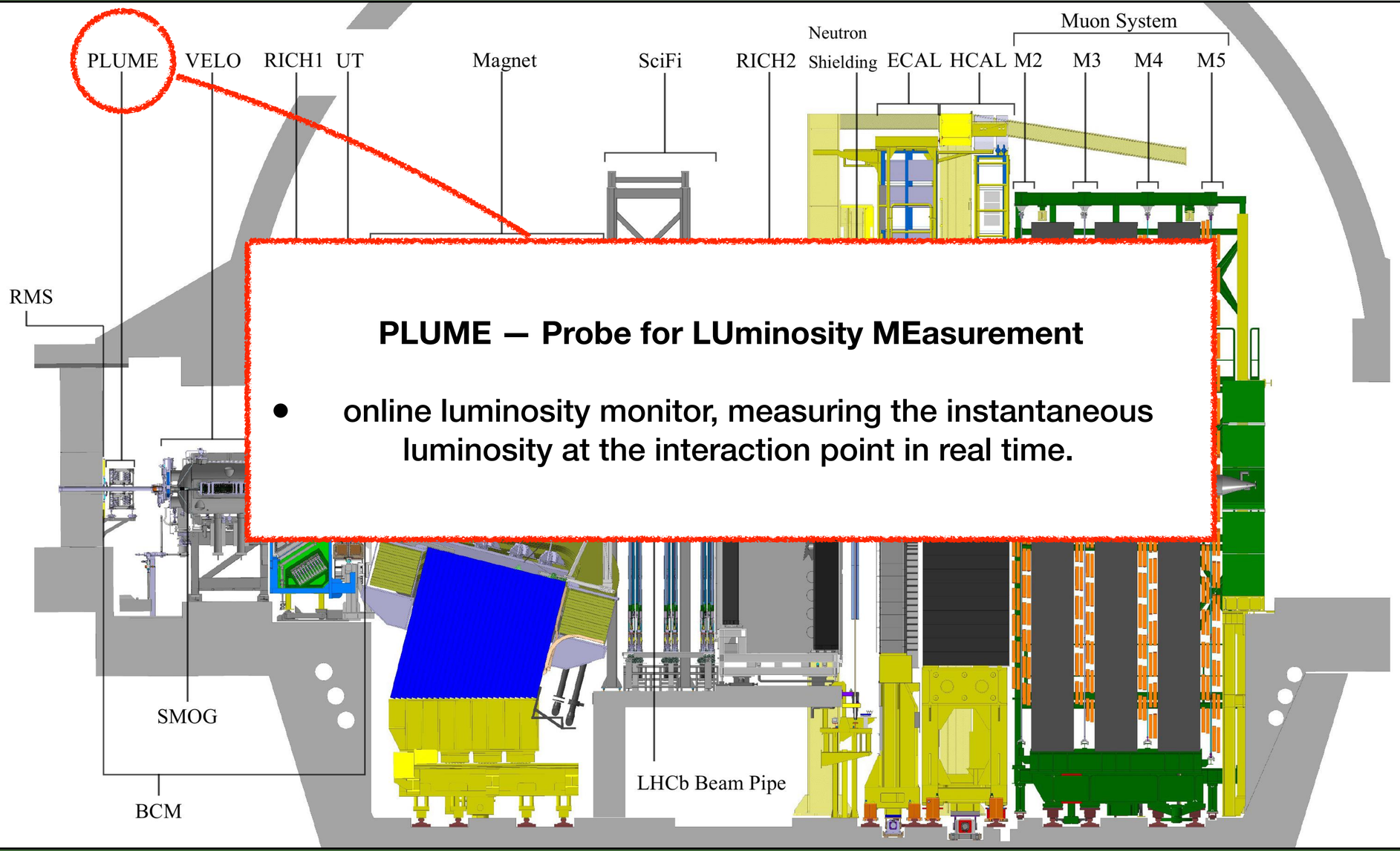
LHCb experiment layout



RMS — Radiation Monitoring System

- monitor beam-induced radiation/background around the LHCb interaction region

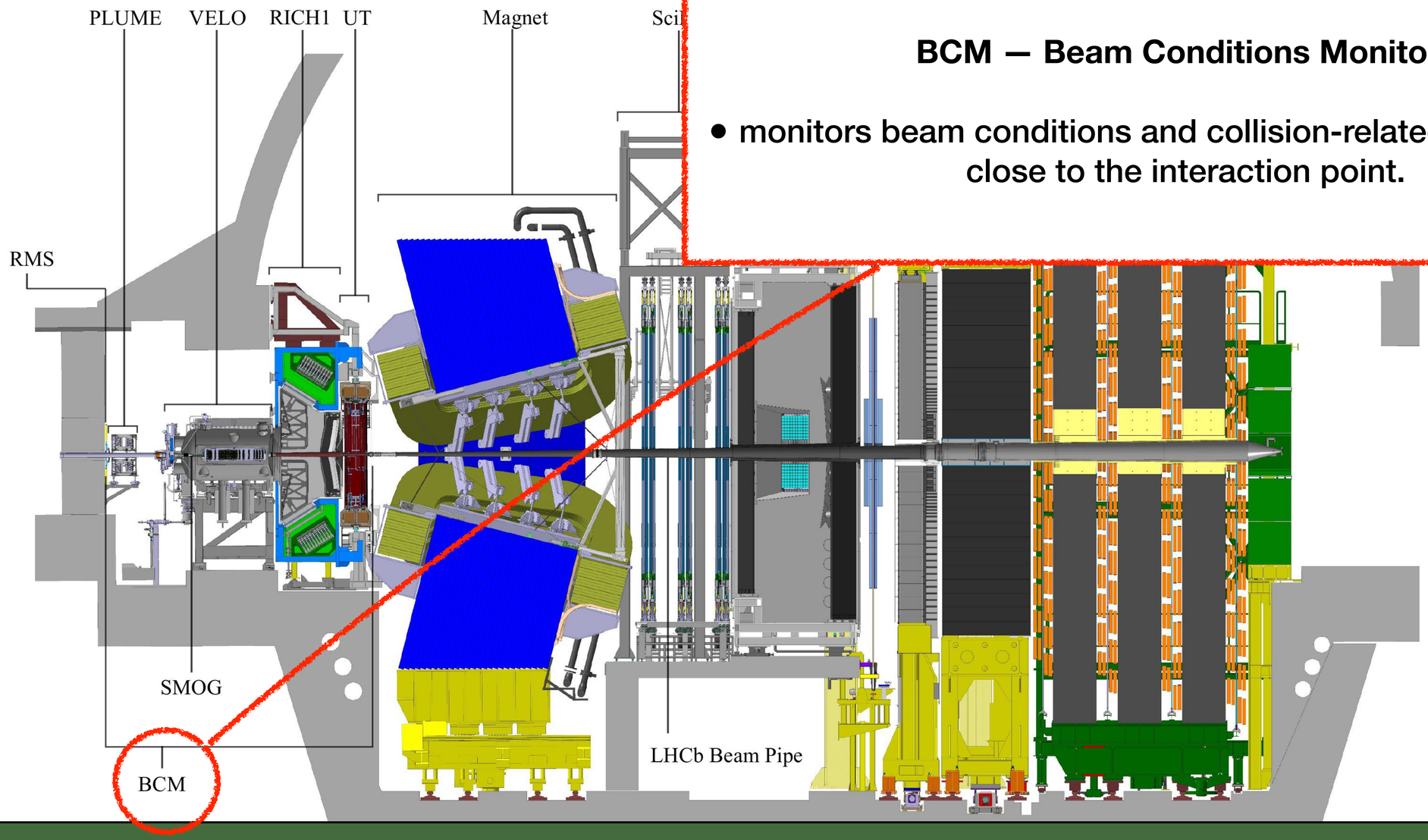
LHCb experiment layout



PLUME — Probe for LUminosity MEasurement

- online luminosity monitor, measuring the instantaneous luminosity at the interaction point in real time.

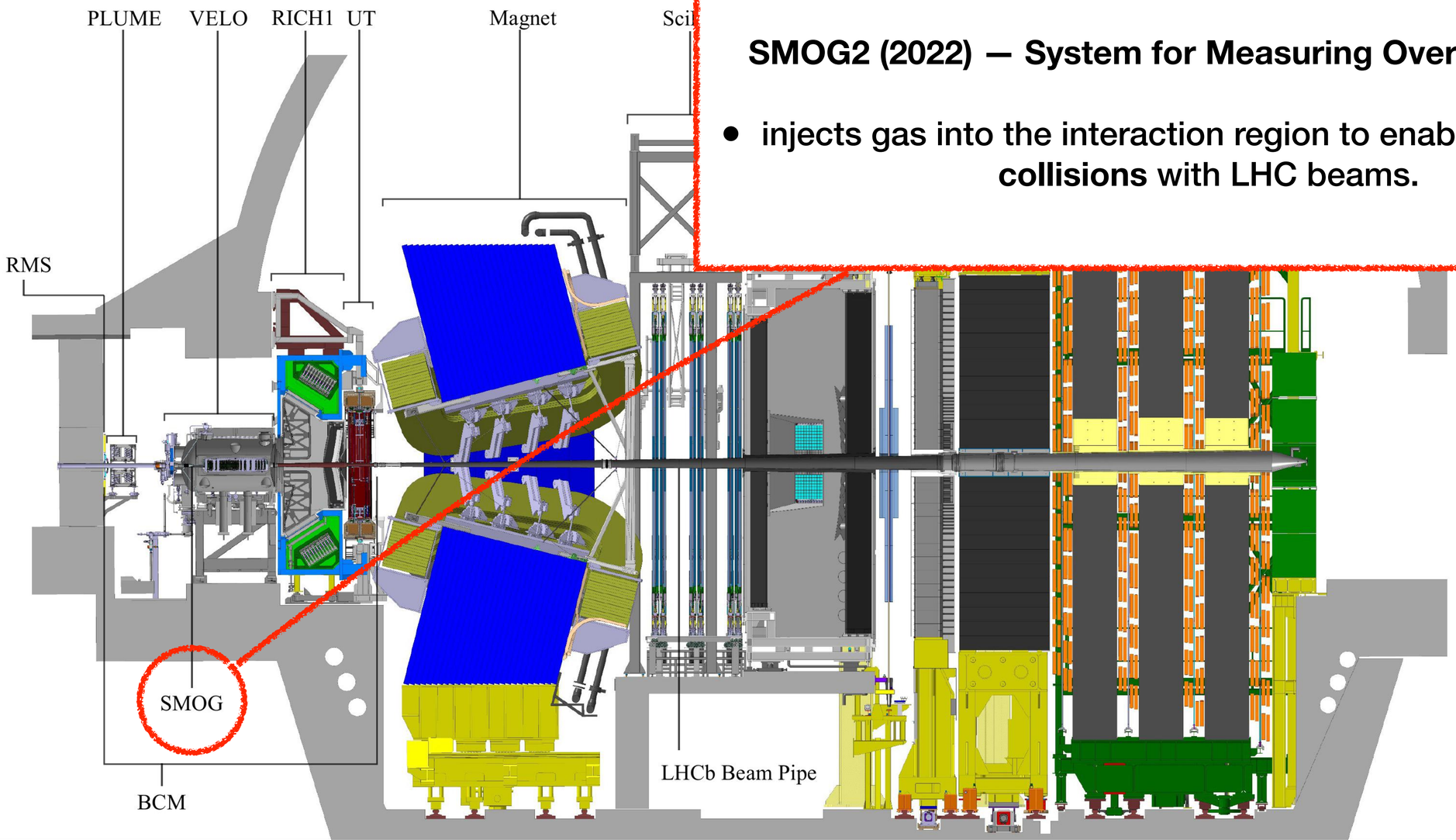
LHCb experiment layout



BCM — Beam Conditions Monitor

- monitors beam conditions and collision-related backgrounds close to the interaction point.

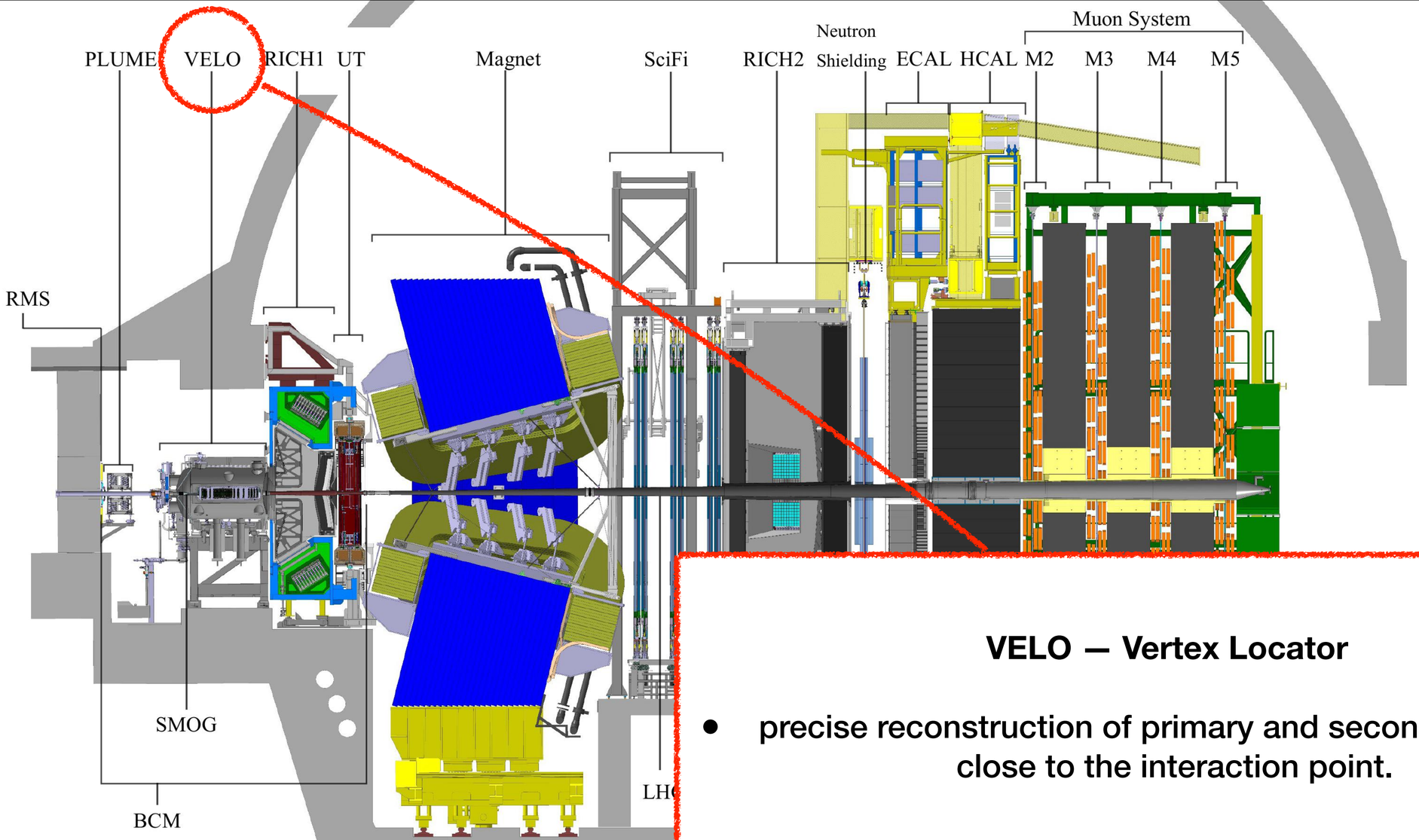
LHCb experiment layout



SMOG2 (2022) — System for Measuring Overlap with Gas

- injects gas into the interaction region to enable **fixed-target collisions** with LHC beams.

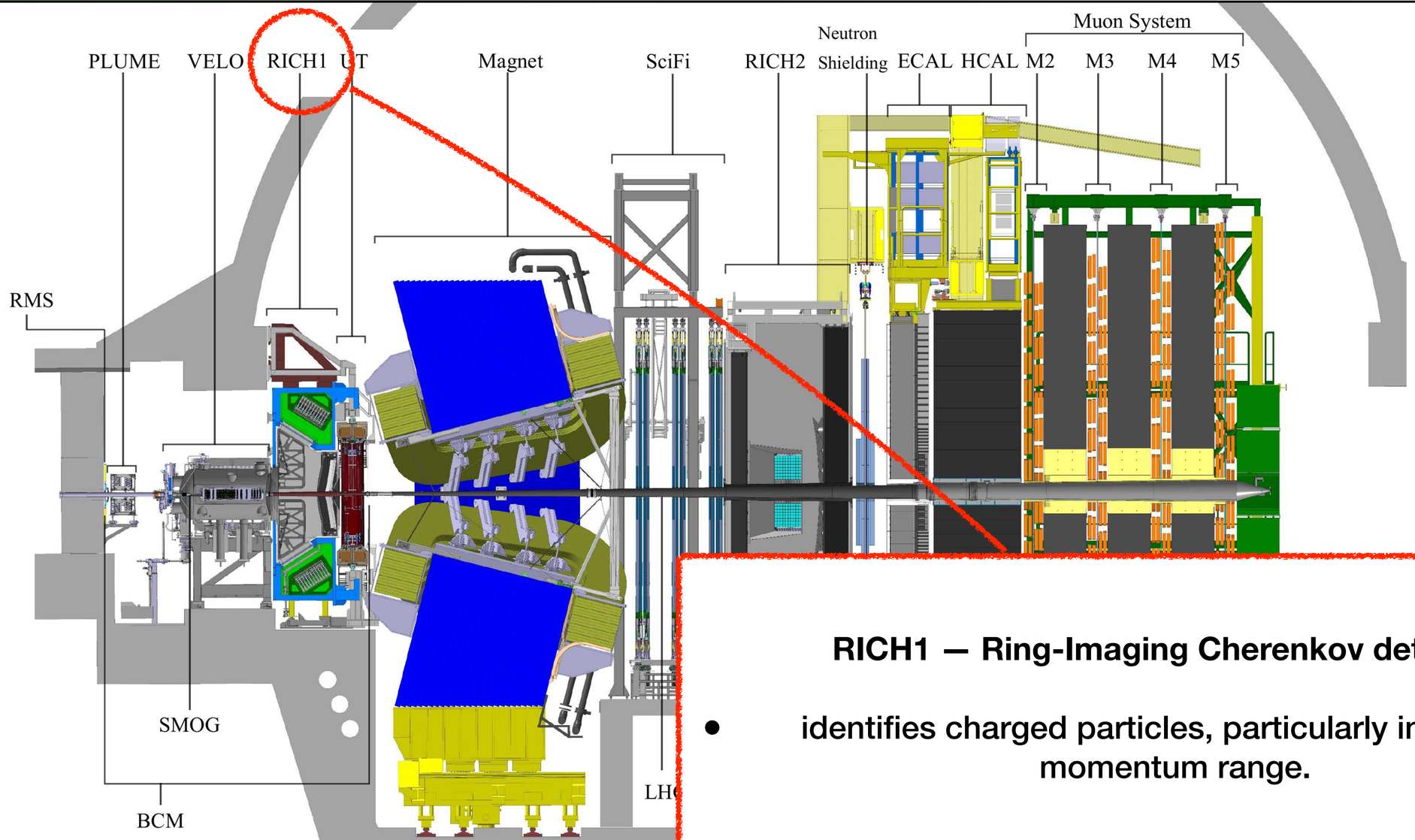
LHCb experiment layout



VELO — Vertex Locator

- precise reconstruction of primary and secondary vertices close to the interaction point.

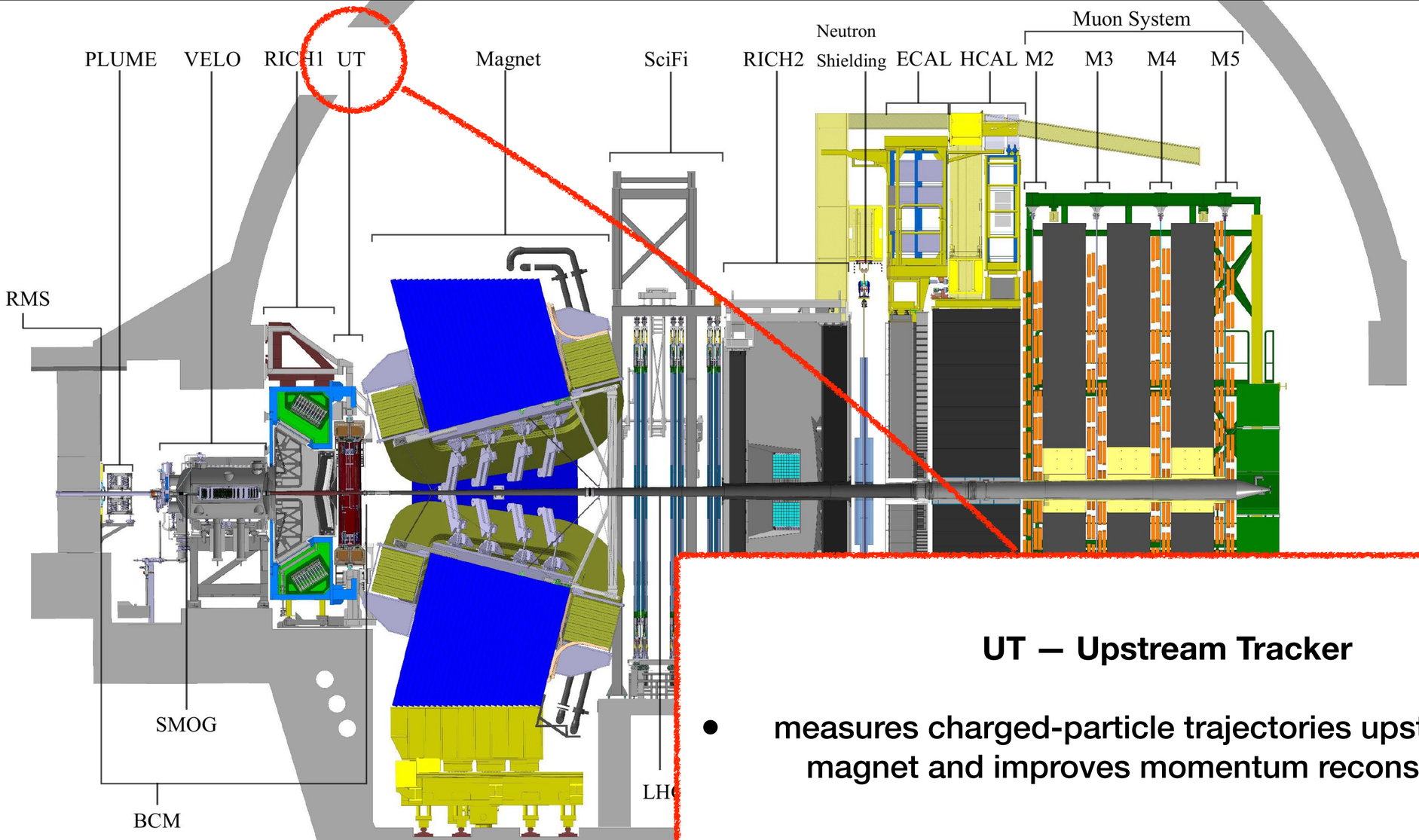
LHCb experiment layout



RICH1 — Ring-Imaging Cherenkov detector

- identifies charged particles, particularly in the lower momentum range.

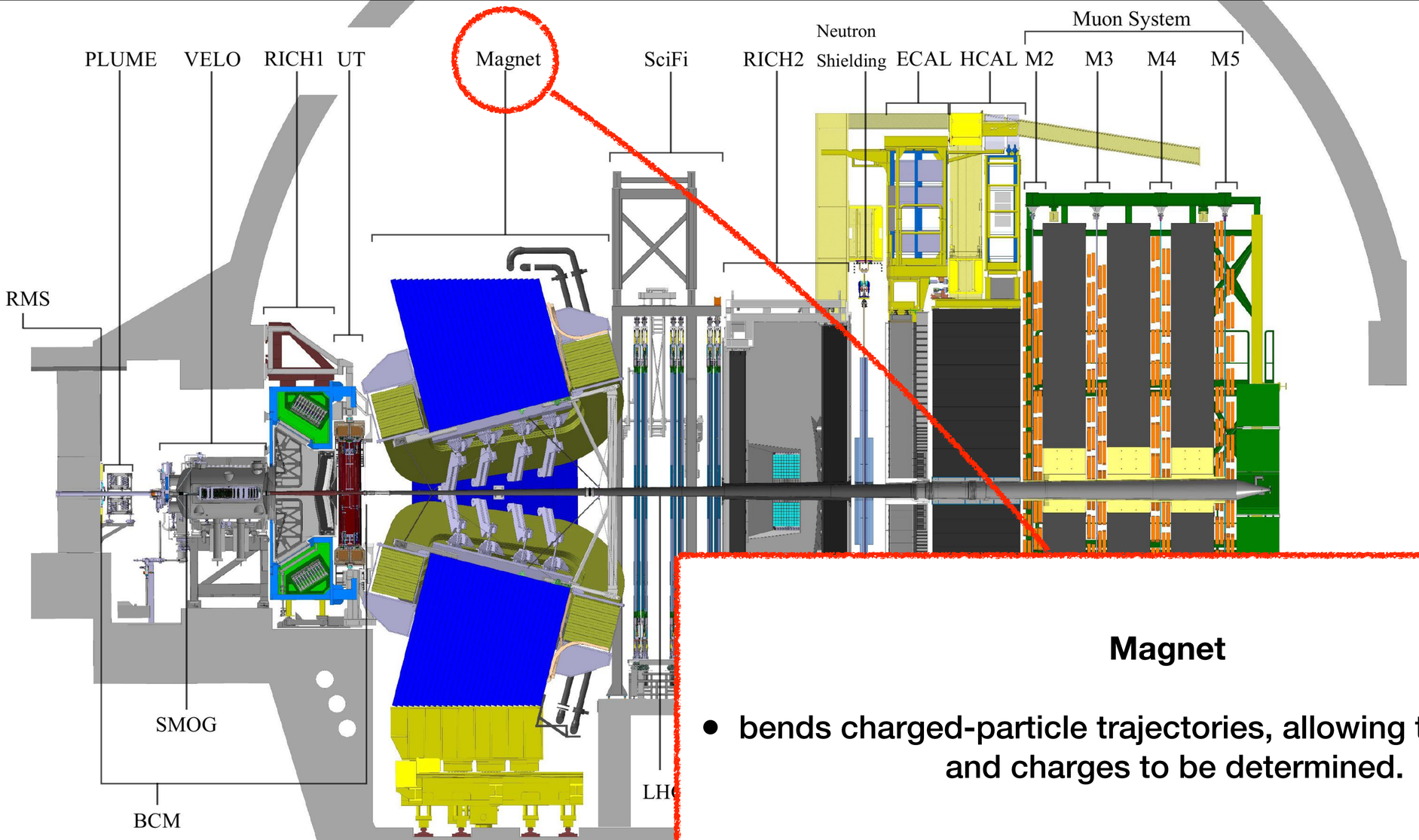
LHCb experiment layout



UT — Upstream Tracker

- measures charged-particle trajectories upstream of the magnet and improves momentum reconstruction.

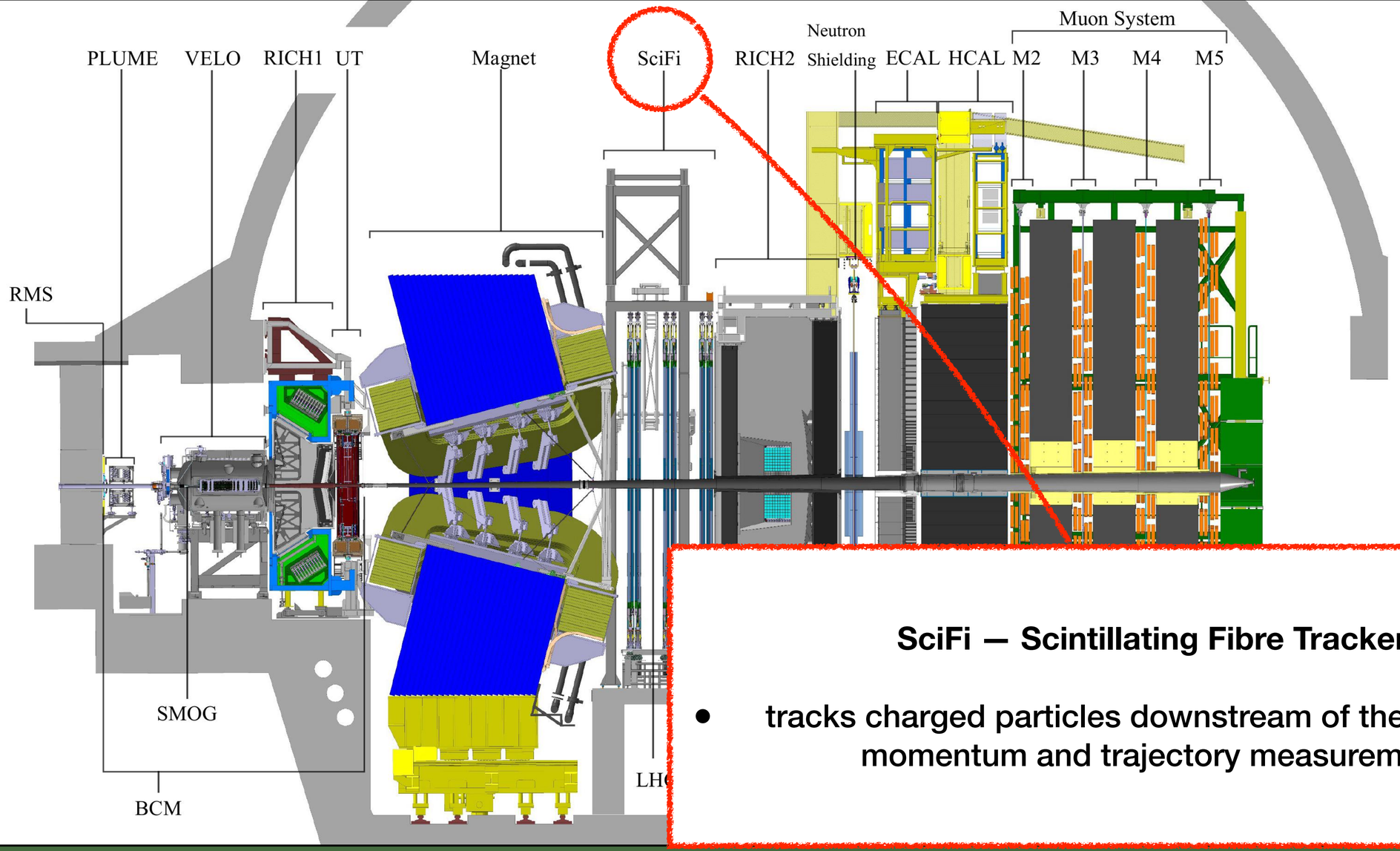
LHCb experiment layout



Magnet

- bends charged-particle trajectories, allowing their momenta and charges to be determined.

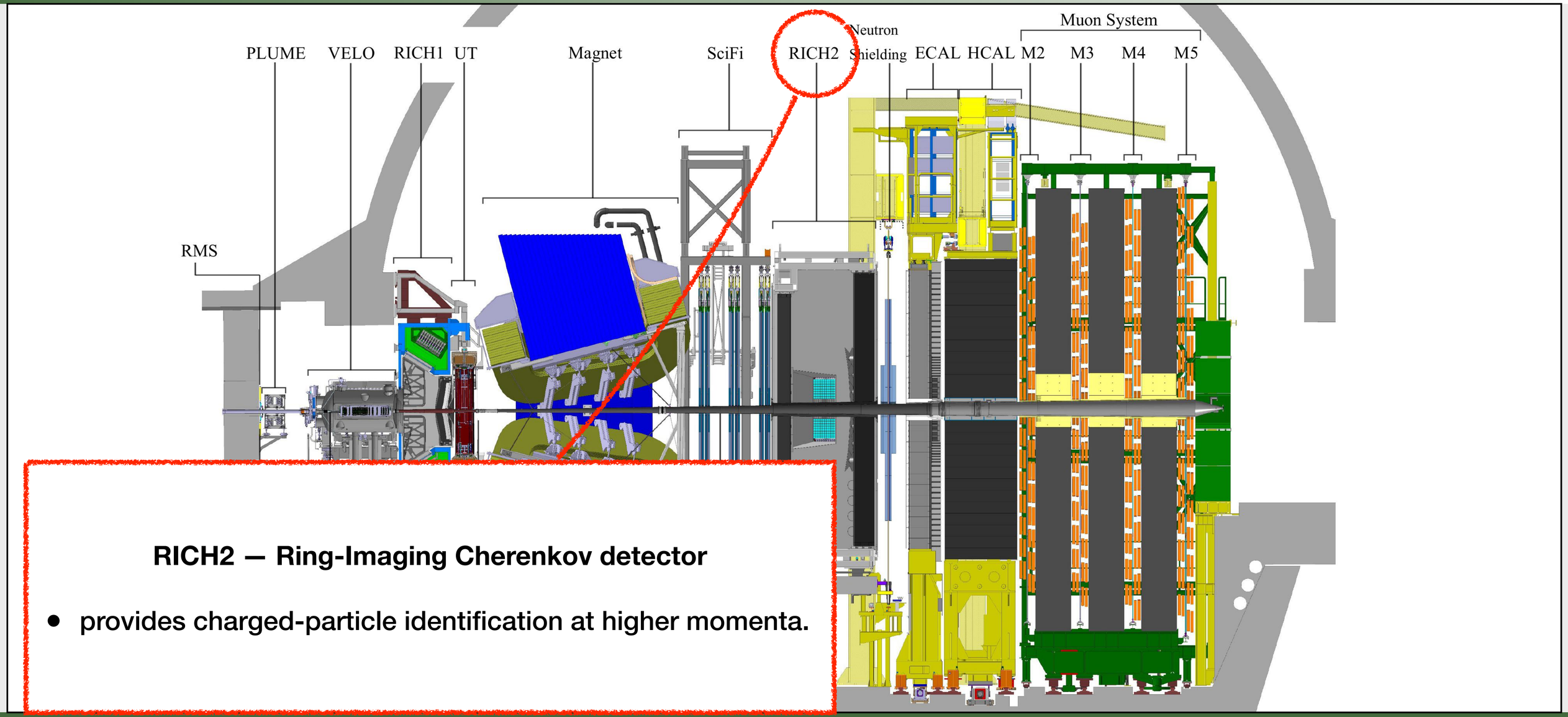
LHCb experiment layout



SciFi — Scintillating Fibre Tracker

- tracks charged particles downstream of the magnet for momentum and trajectory measurement.

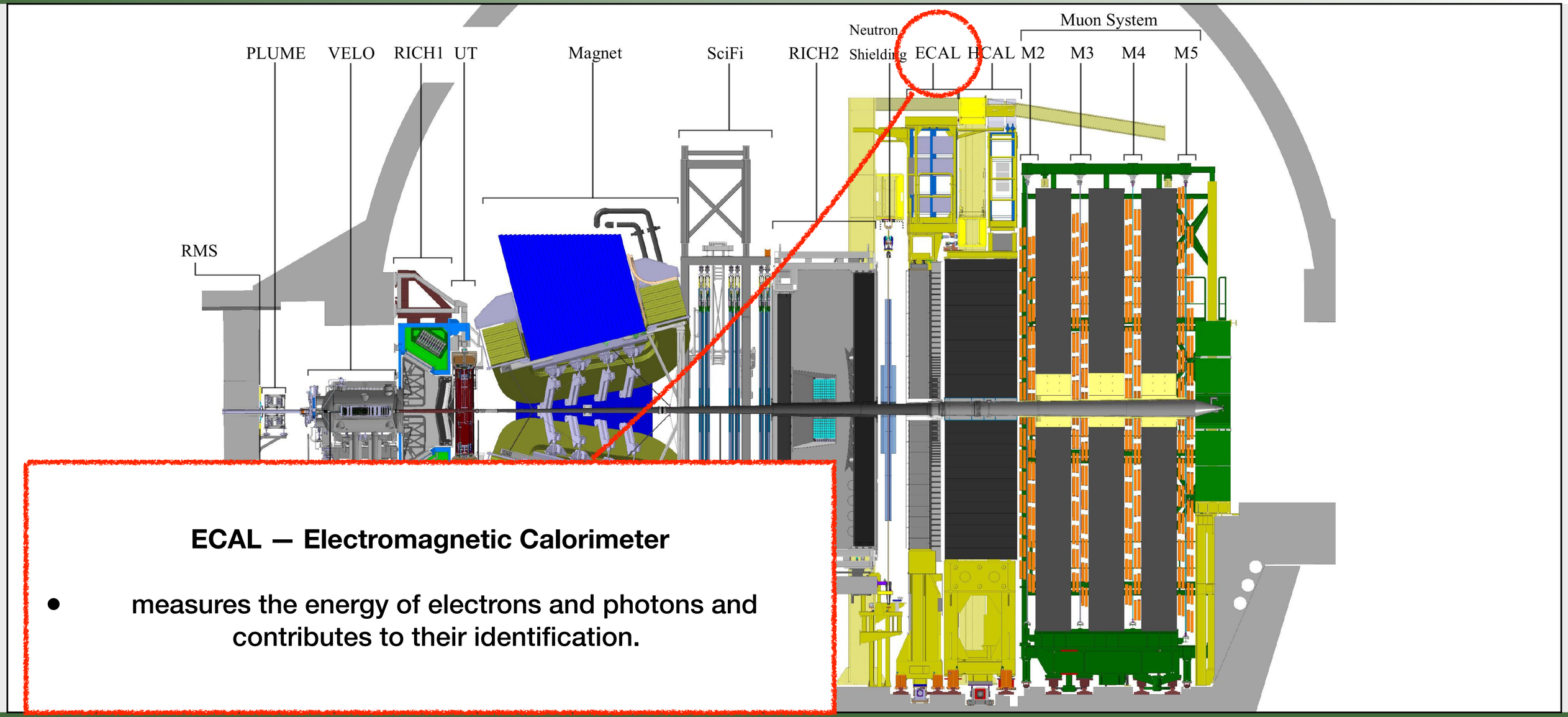
LHCb experiment layout



RICH2 — Ring-Imaging Cherenkov detector

- provides charged-particle identification at higher momenta.

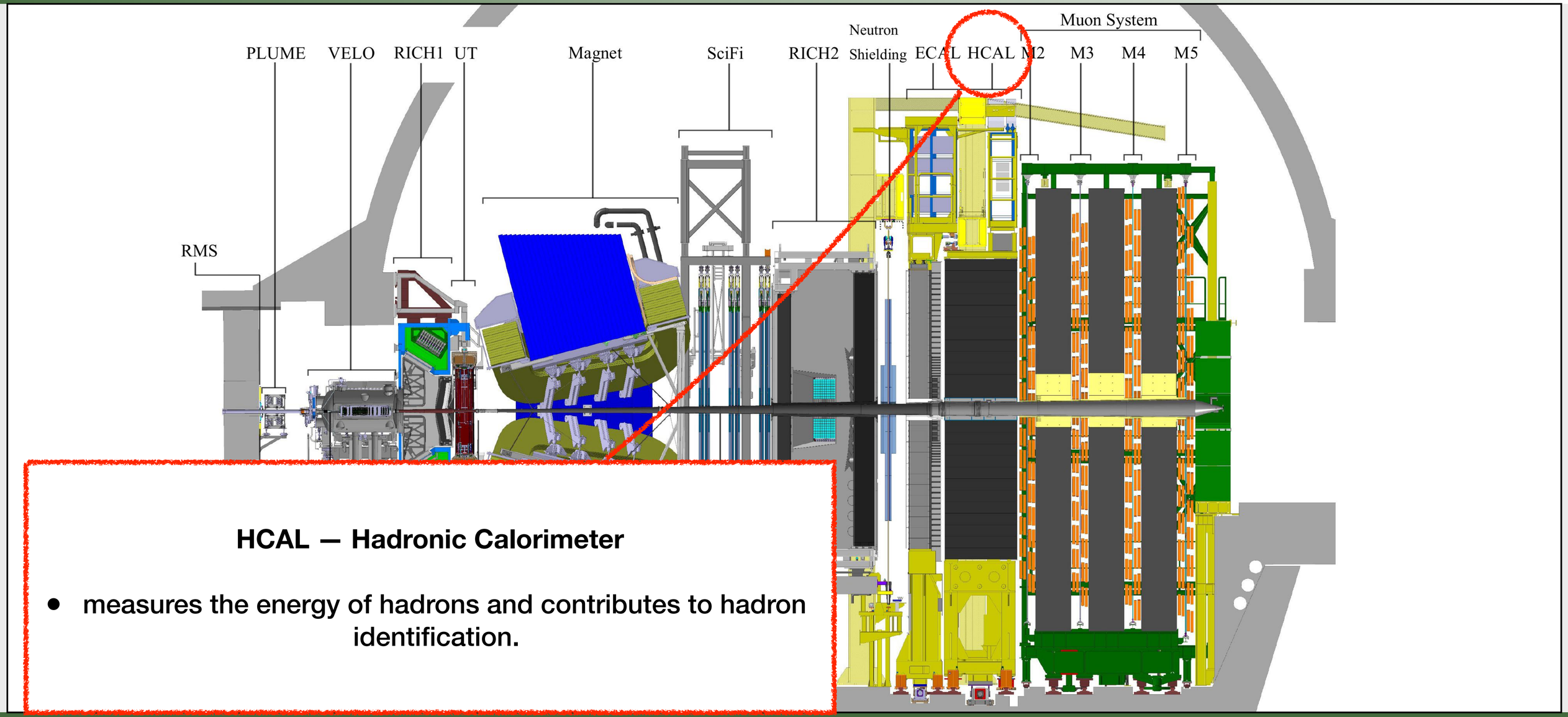
LHCb experiment layout



ECAL — Electromagnetic Calorimeter

- measures the energy of electrons and photons and contributes to their identification.

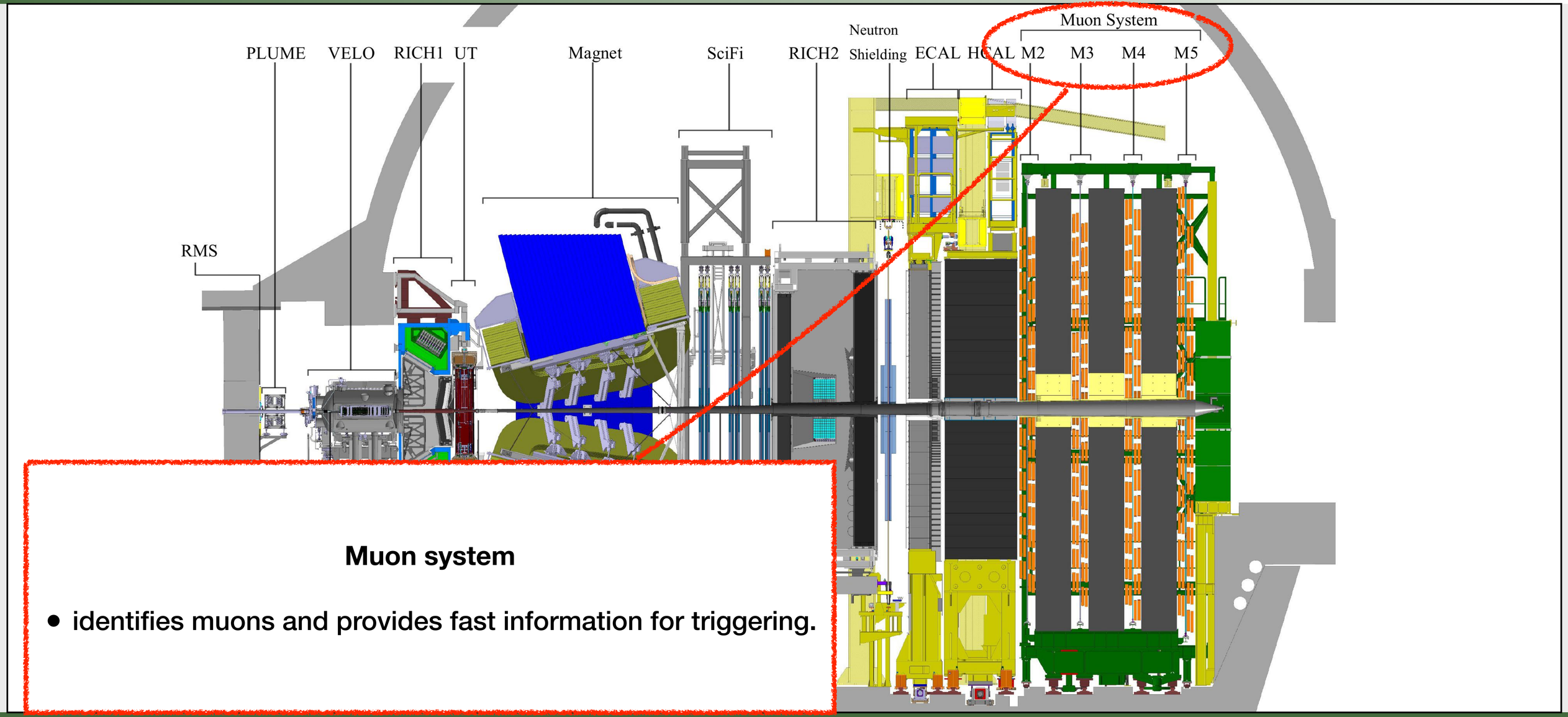
LHCb experiment layout



HCAL — Hadronic Calorimeter

- measures the energy of hadrons and contributes to hadron identification.

LHCb experiment layout

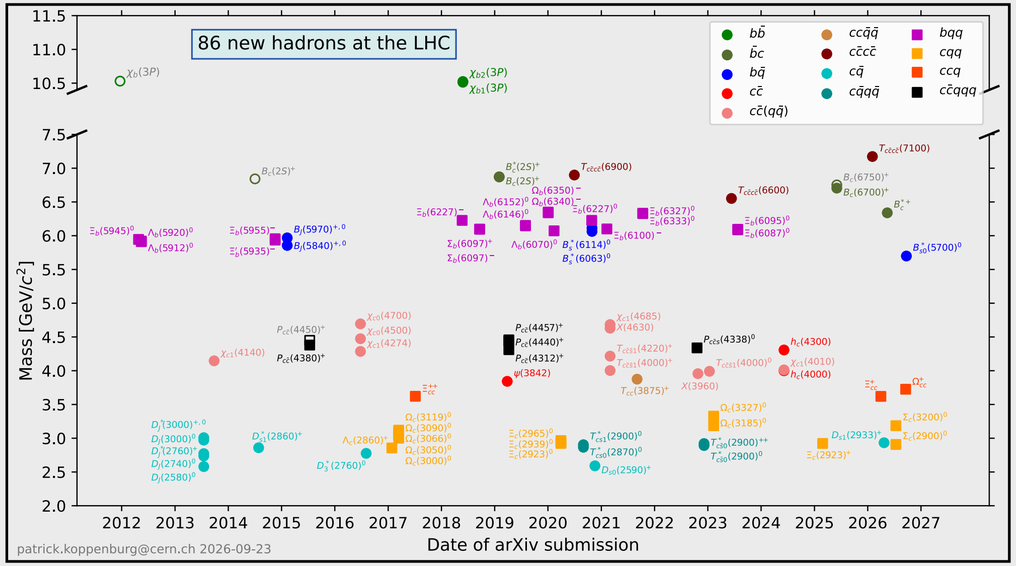


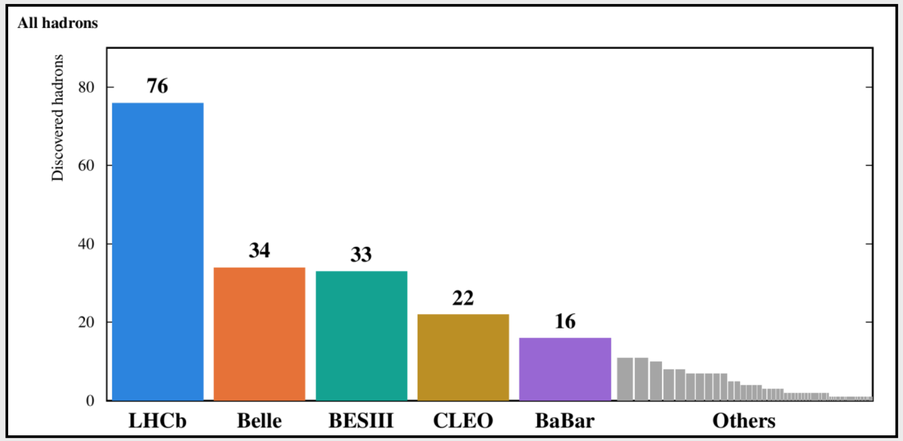
Muon system

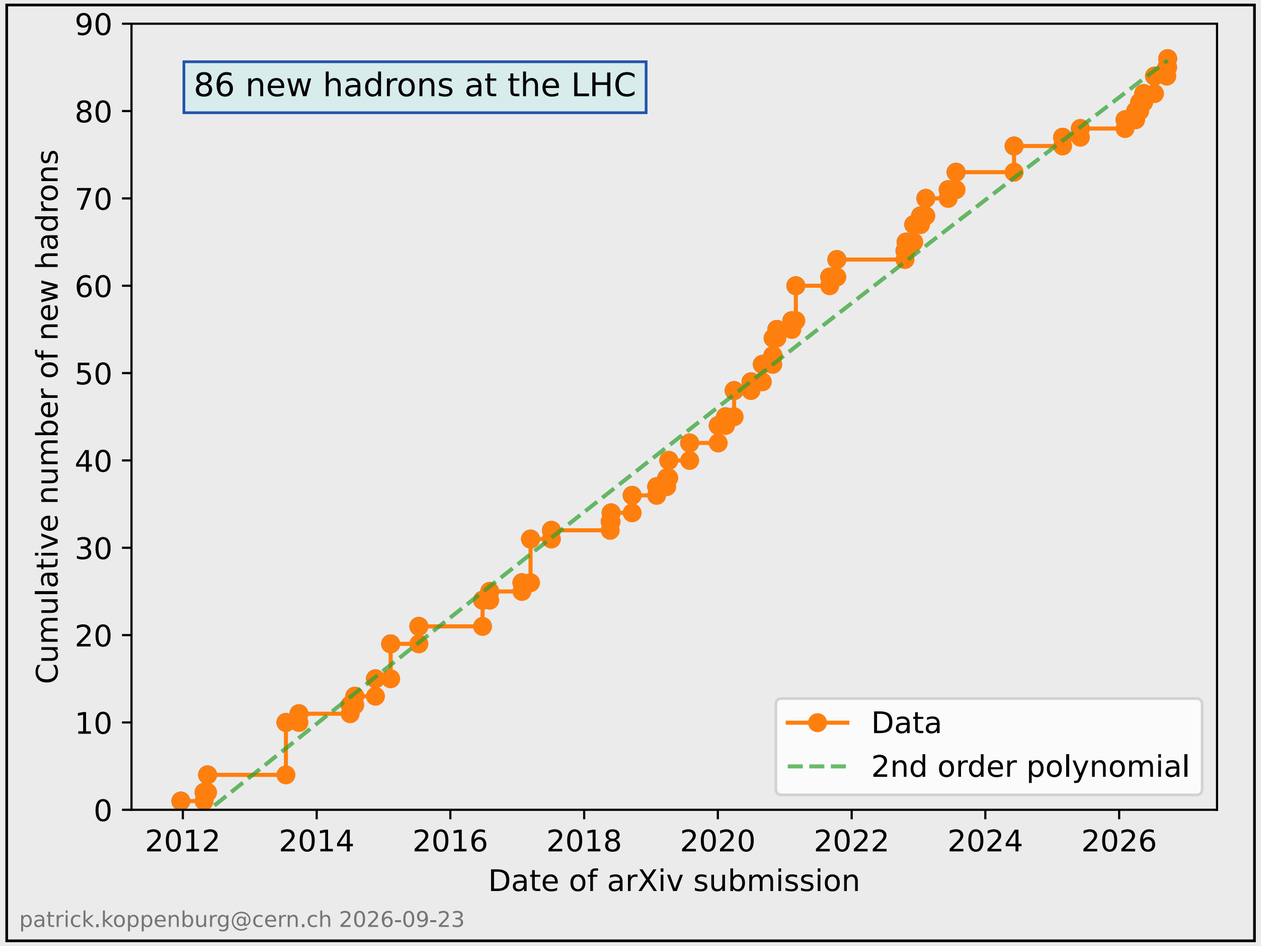
- identifies muons and provides fast information for triggering.

LHCb experiment success

- So far **86 hadrons** have been discovered at the LHC, of which **76 by LHCb**.





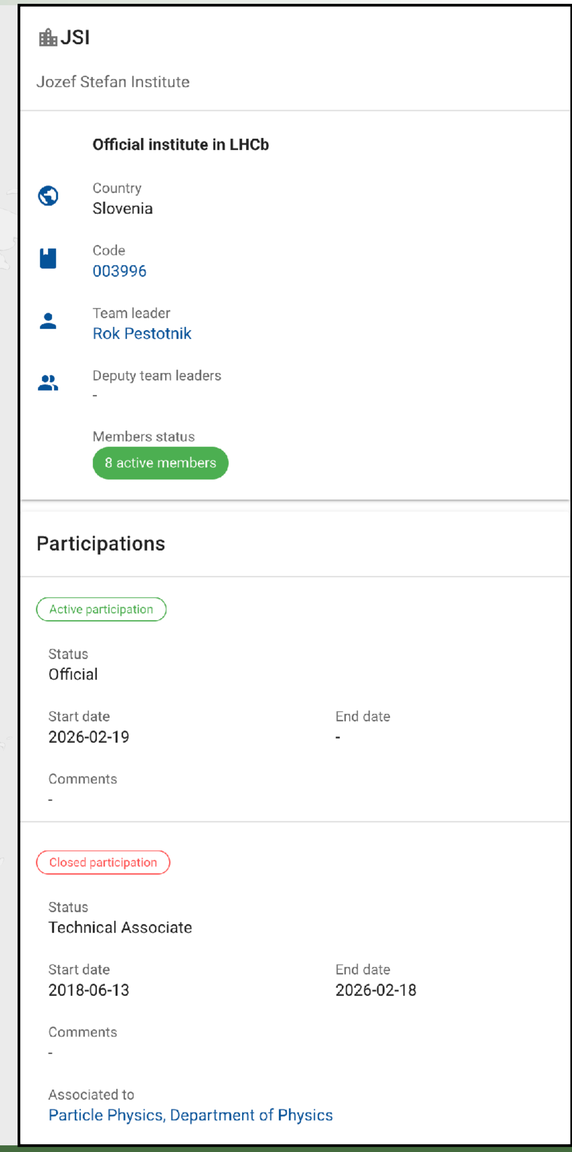


LHCb Collaboration

LHCb Collaboration

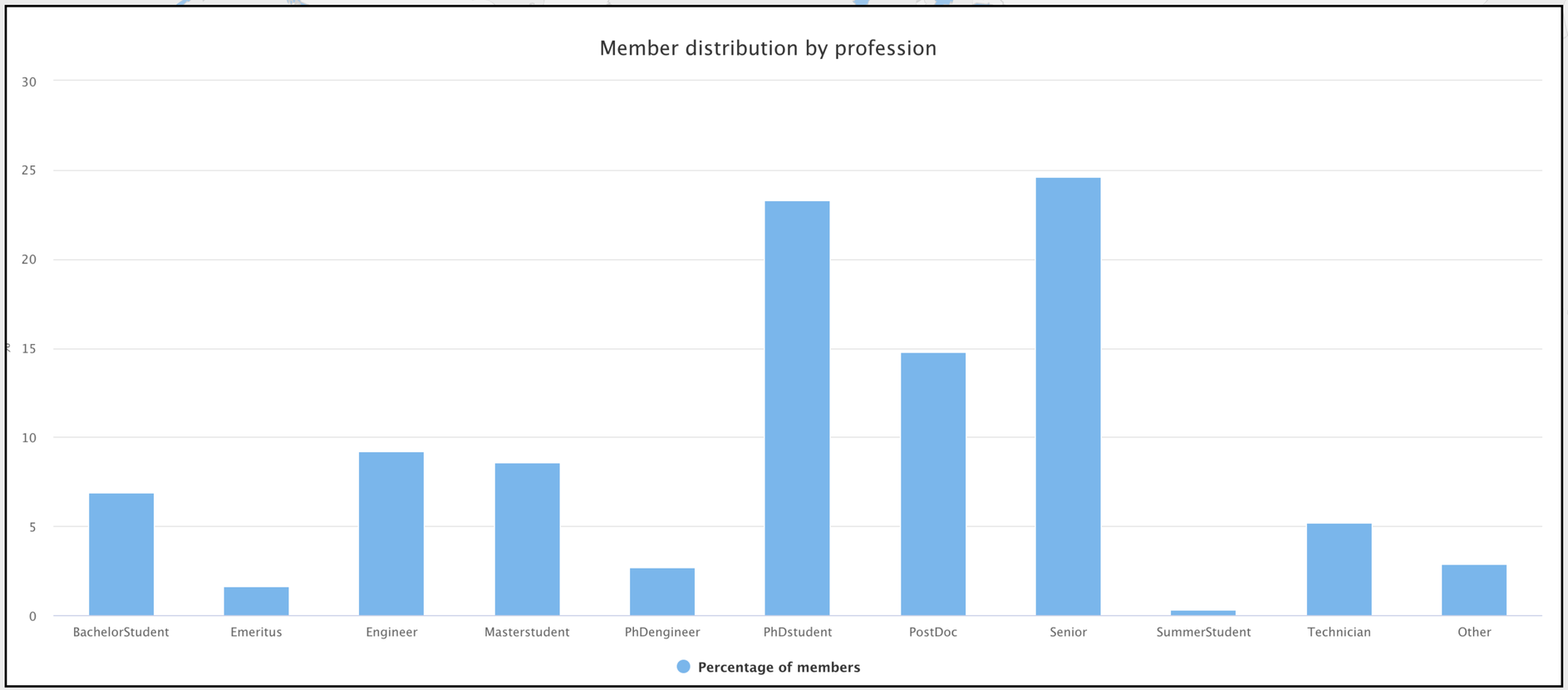
- **1995**: Letter of Intent
- **1998**: Experiment approved
- **2008**: First data
- **2019–22 (LS2)**: Upgrade I - over 90% of its active electronics, detector channels, and the data acquisition system replaced.
- **LS3**: Upgrade II for Run 5 and Run 6 era
- **1912 members** from 112 institutes in 28 countries
- **1201 authors** from 121 institutes

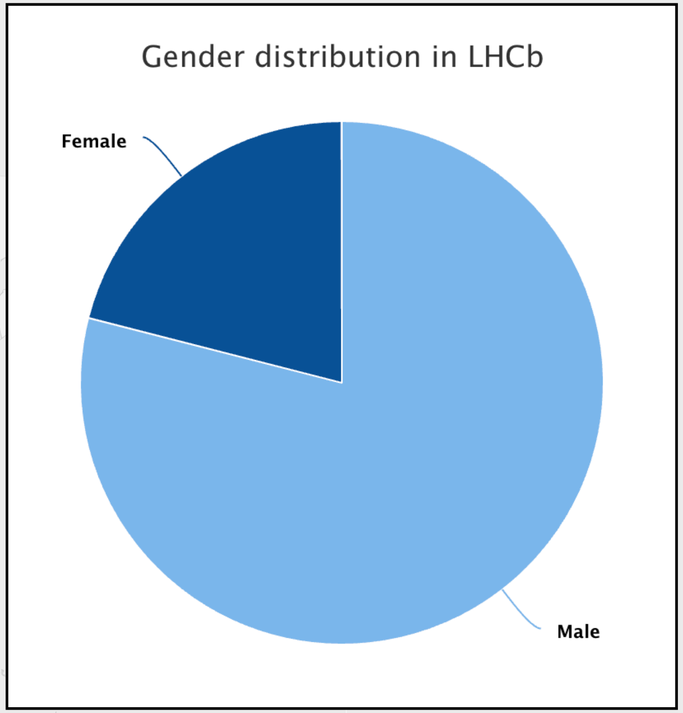
[48] **Jozef Stefan Institute, Ljubljana, Slovenia**
Team Leader: Rok Pestotnik
Members: Andrej Lozar , Andrej Seljak , Bla\v{z} Leban , Boris Gardinovacki , Frank Bernard Grijalva Iii , Kristof Spenko , Rok Dolenec , Rok Pestotnik



LHCb Collaboration

- **PhD students**: 23,3%
- **PostDocs**: 14,8%
- **Seniors**: 24,5%





Past, present, future...

Past F9 involvement

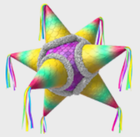
- 13. 6. 2018 - 18. 2. 2026: **Technical Associate** through the University of Oxford.
- Contributed to detector R&D:
  - RICH,
  - TORCH (withdrawn from Upgrade II).
- Since 2021 involvement in Beam tests.
- LS3 Enhancement:
  - Responsible for the design and production of the electronics backboard, quality assurance, and radiation hardness of the electronics.
- Upgrade II:
  - Evaluation of the photo sensor and mitigation strategies for the detectors.

JSI becoming a Full Member









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Professor Rok Pestotnik
Josef Stefan Institute
Experimental Particle Physics Department
Jamova 39
PO Box 3000
1001 Ljubljana
Slovenia

Geneva, 03rd of March 2026

Dear Professor Pestotnik,

It is our pleasure to inform you that the LHCb Collaboration Board decided to accept the application of your group at Josef Stefan Institute, in Ljubljana, Slovenia as a Full Member of the LHCb experiment in its meeting on 19th of February 2026.

The CB highly appreciates your significant involvement in RICH and TORCH efforts in the past and is looking forward to your future contributions to the RICH project and to the general operation of the experiment. The CB welcomes your huge expertise in flavor physics. It is excited about upcoming analysis efforts of your group but likes to remind you to carefully separate those from the Belle II involvement of parts of your institute.

These contributions must be formalised in the form of an addendum to the existing Memorandum of Understanding for operating the LHCb experiment, to be signed by your University or Funding Agency.

We are looking forward to a fruitful collaboration.

Yours Sincerely,

Vincenzo Vagnoni
Spokesperson of the LHCb Collaboration

Stephanie Hansmann-Menzemer
Chair of the LHCb Collaboration Board

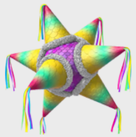
cc :
Gautier Hamel de Monchenault, CERN, Director for research and computing

home.cern



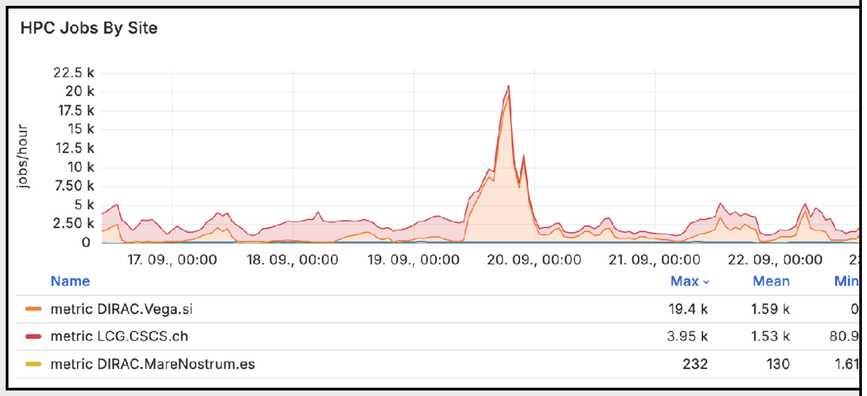


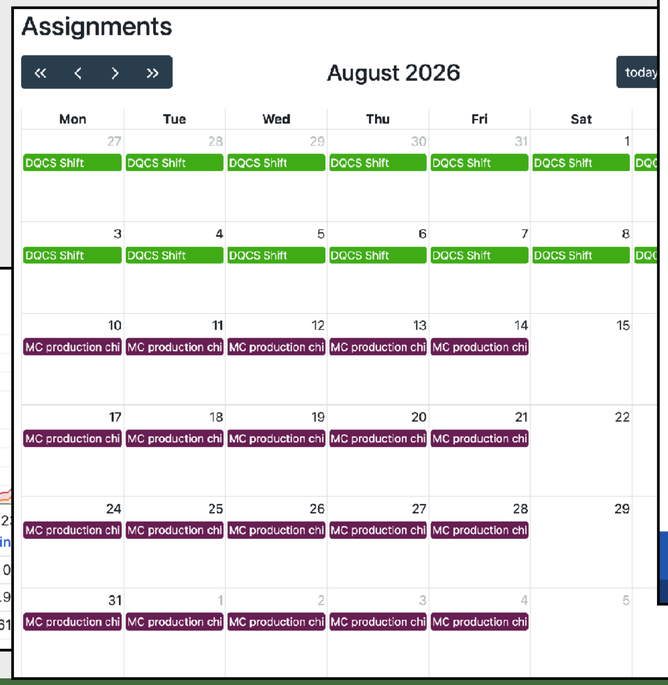


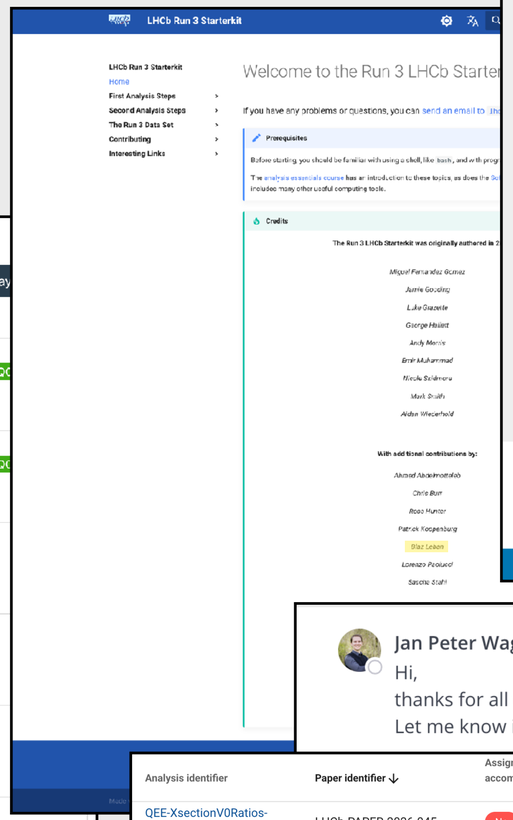


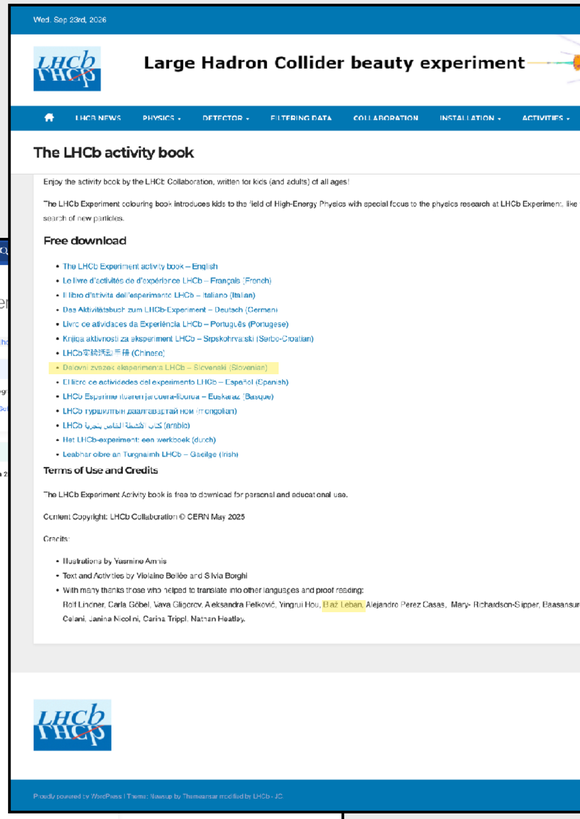
Current contributions

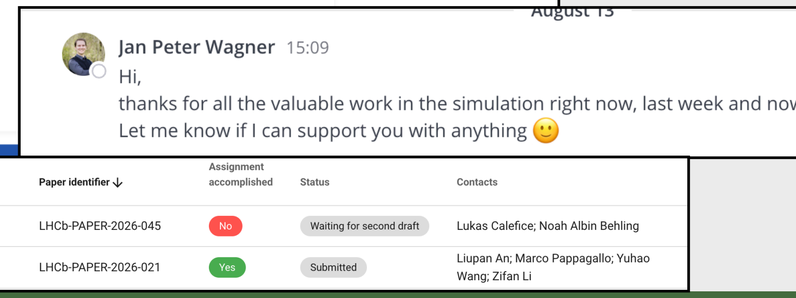
- Building visibility within the Collaboration:
  - Taking **shifts**, which helps getting to know LHCb software.
  - Improving **tutorials and documentation**.
  - Participating at **collaboration events**.
  - We are currently offering **opportunistic use of Vega HPC**. If no issues a few thousand jobs are running.









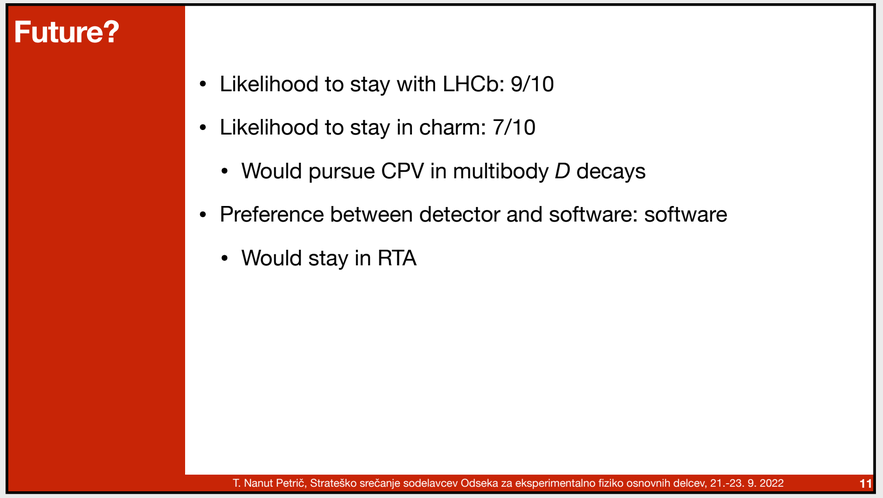


Short-term physics plans

- Based on our experience in BSM Exotic physics, we are **joining the QCD, Electroweak and Exotica (QEE) working group**.
- Due to the **restricted access** to physics content up until mid-summer, it was **challenging to identify** the most suitable **entry point**.
- Following discussions with the QEE WG coordinators (some of whom share similar past involvement in ATLAS), the recommendation was to begin with a relatively straightforward SM **measurement using Run 3 data**, e.g. measurement of diboson (WW, ZZ), or W/Z+jets cross-section. We are in contact with:
  - *Davide Zuliani (Padova)* about contributing to Run 3 +jets analysis and potentially start a Z+ HF jets analysis (which includes common ML flavour tagging studies).
  - *Hengne Li (SCNU)* about contributing to ZZ analyses, with $H \to ZZ^*$and electron channel feasibility study.
- This approach allows our group to **quickly integrate** into the WG operations and **build familiarity** with current software tools before progressing to more advanced and exotic BSM topics that better match our core expertise, while still providing **valuable contributions to the community**.

Long-term physics plans

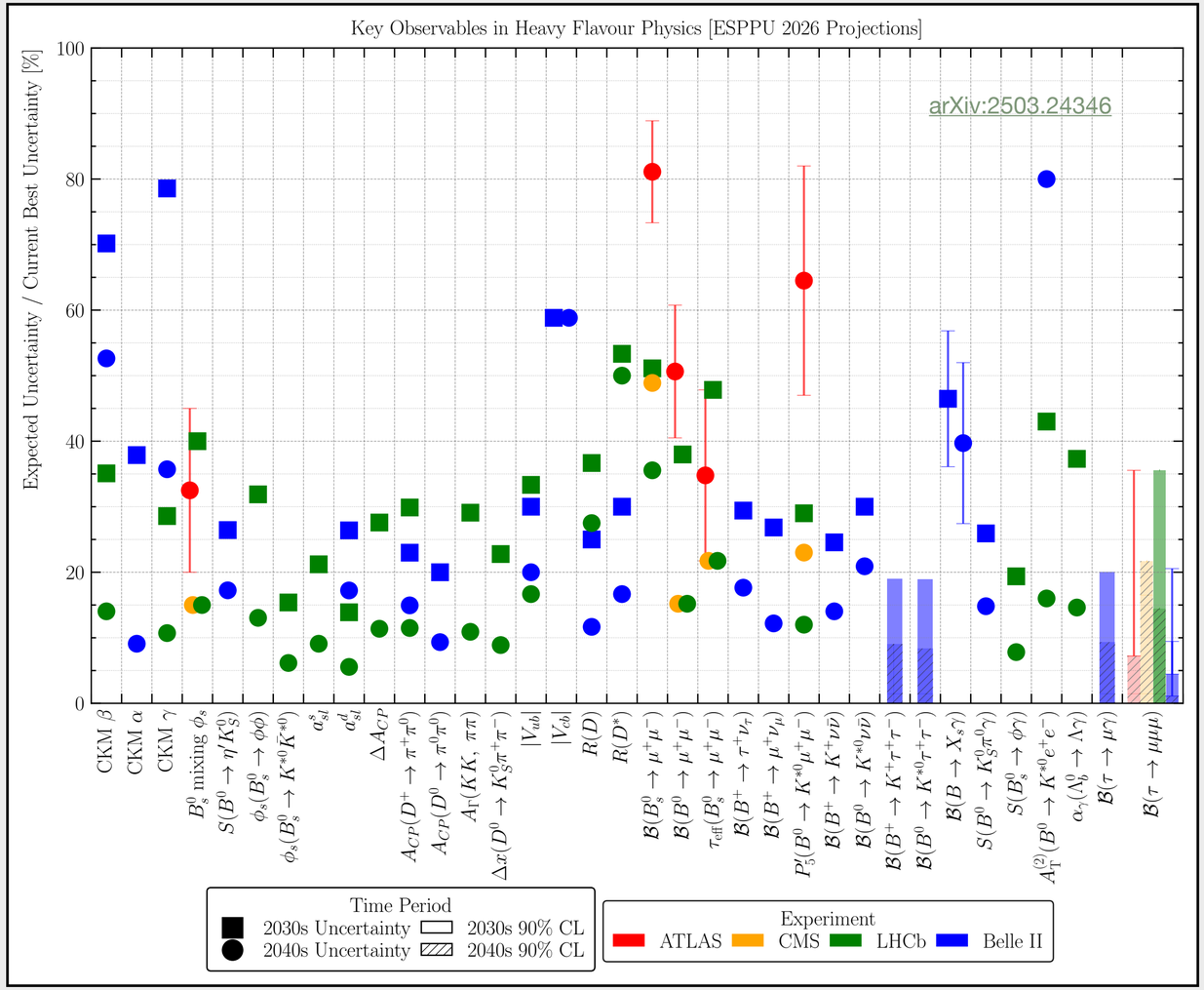
- Depending on **person power** and **interests**, a progression towards flavour physics would open a larger field of physics opportunities:
  - Possible collaboration with flavour-physics theory colleagues from F1 department, who expressed interest in us joining the LHCb experiment before.
  - Will need to be careful to stay orthogonal to Belle II physics at F9, to avoid potential overlap or conflict of interests (we are currently even working in the same offices 🤫).
  - We will need a good strategy to bring more people (back) to be able to be broad.
- Personally, I definitely want to stay within the Simulation Project.
- If LHCb gets pledged allocation at Vega somebody (me) will need to take care of the maintenance.



Projections in HF physics

- LHCb Upgrade II ● will give the best precision to the broadest range of key observables.
- Belle II ● has unique capability for modes with multiple neutrals or missing particles.
- ATLAS ● and CMS ● will be competitive for modes with multiple muons.

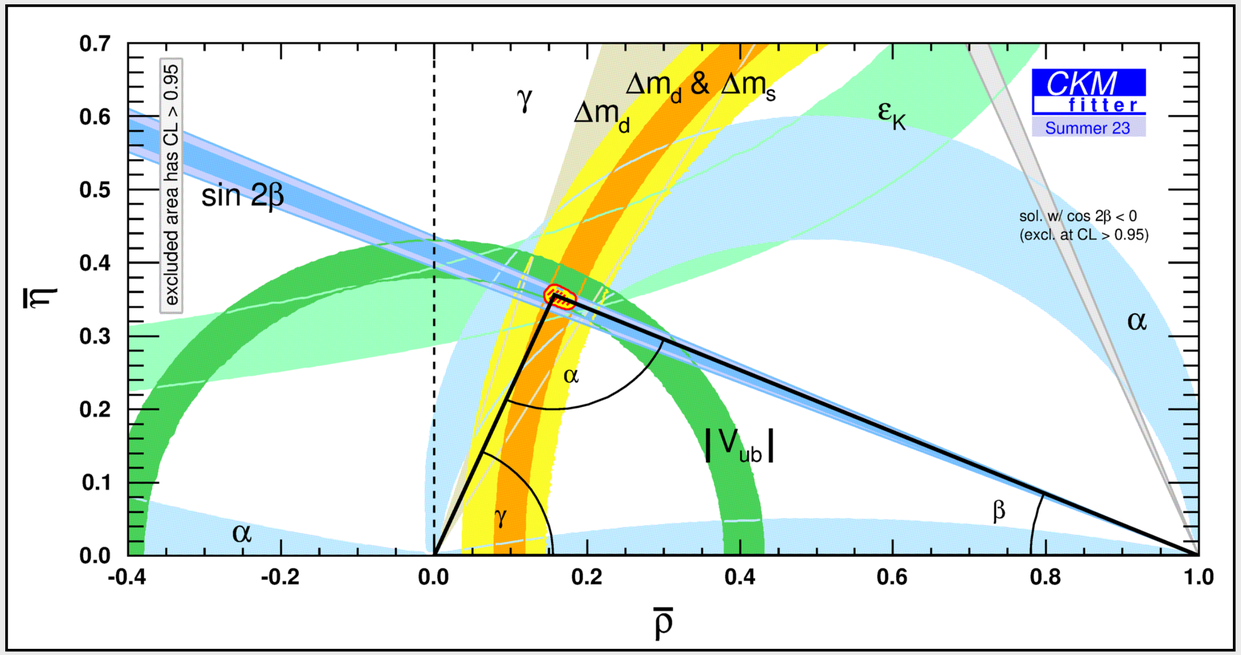
NOTE: LHCb Upgrade II physics programme also includes spectroscopy, heavy ion physics, EW precision measurements, dark sector searches …



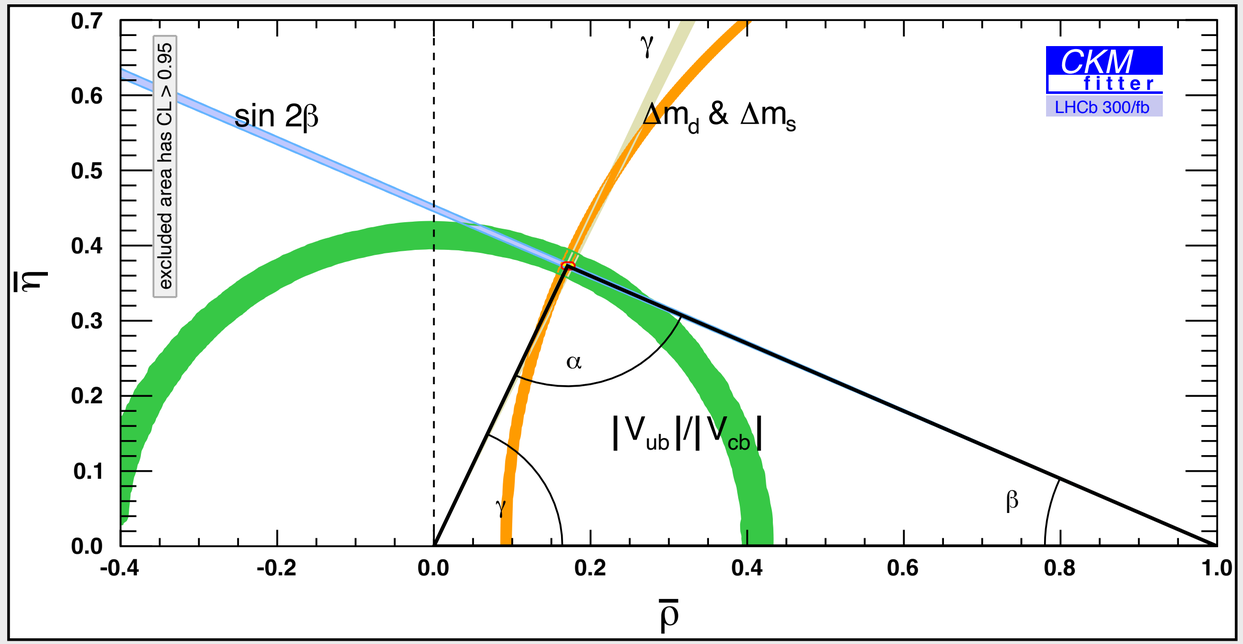
Evolution in unitary triangle

- The latest data from LHCb give a measurement of γ with a precision better than 3°.
- With LHCb Upgrade II the precision of the “direct” determination will be improved down to ~0.35°.

LHCB-TDR-026



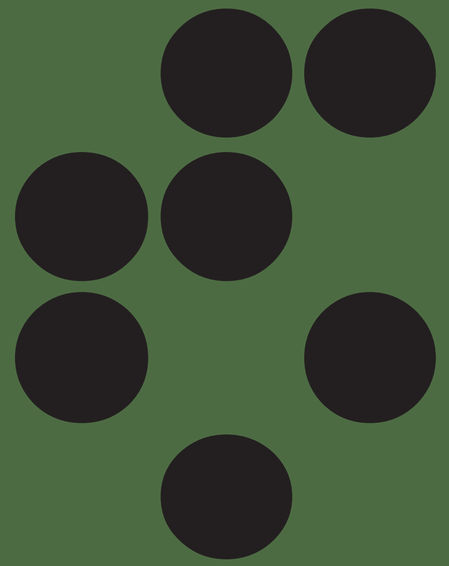
Global inputs as of 2023.



LHCb Upgrade II measurements with
300 fb^{-1} and improved lattice QCD calculations.

Conclusions

- F9 has recently become a Full Member of another major (LHC) collaboration.
- Valuable work has been done before by our colleagues, making the transition to Full Member smooth and straightforward.
- We are keen to expand our visibility and contributions:
  - Need new Master and PhD students, PostDocs.
  - Need experience in flavour physics analyses.



IJS