LHCb Run3

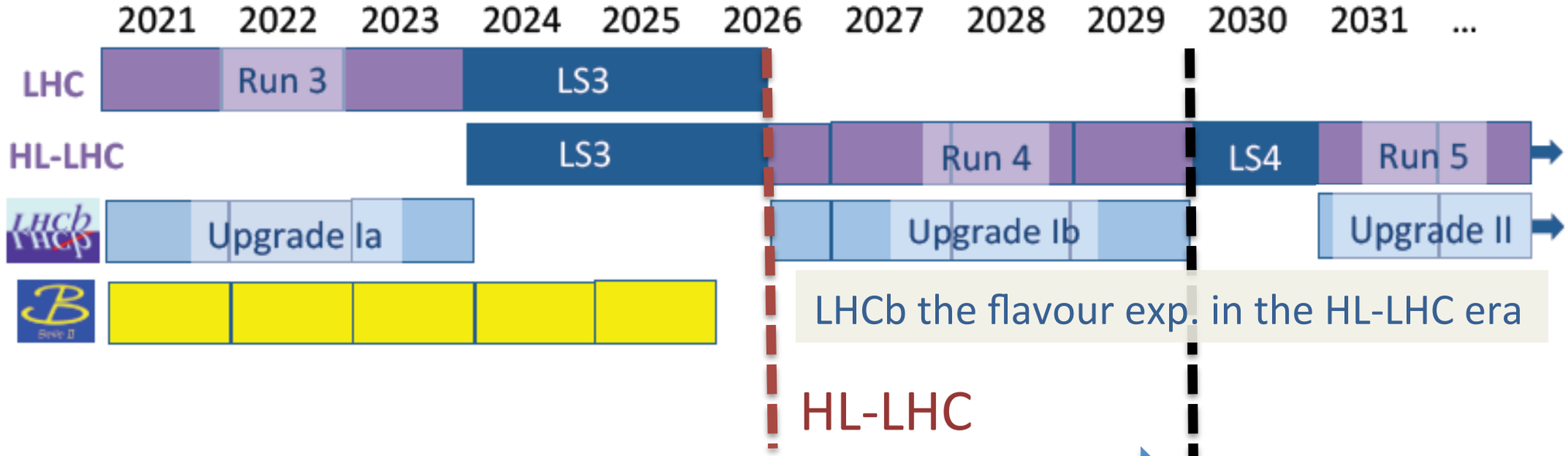
LHCb Upgrade

- **run 1 has been a great success for the LHC, LHCb, ... and the Standard Model**
  - but current measurement precision in the flavour sector still allows significant contributions from New Physics
- **precision of most LHCb results will still be limited by statistics after run 2**
  - leading systematic uncertainties will often decrease with available statistics
- **after run 2 would need > 10 years with current LHCb to double precision again**

LHCb upgrade after run 2
increase annual event yields by
- increasing instantaneous luminosity
- increasing trigger efficiencies

2010	run 1	0.037 fb^{-1} @ 7 TeV
2011		1 fb^{-1} @ 7 TeV
2012		2 fb^{-1} @ 8 TeV
2013	LS 1	minor maintenance work
2014		
2015	run 2	5 fb^{-1} @ 13 TeV
2016		
2017		
2018	LS 2	LHCb upgrade
2019		
2020	run 3	15 fb^{-1} @ 14 TeV
2021		
2022		
2023	LS 3	?
2024		
2025		
2026++	run 4	5 fb^{-1} / year @ 14 TeV

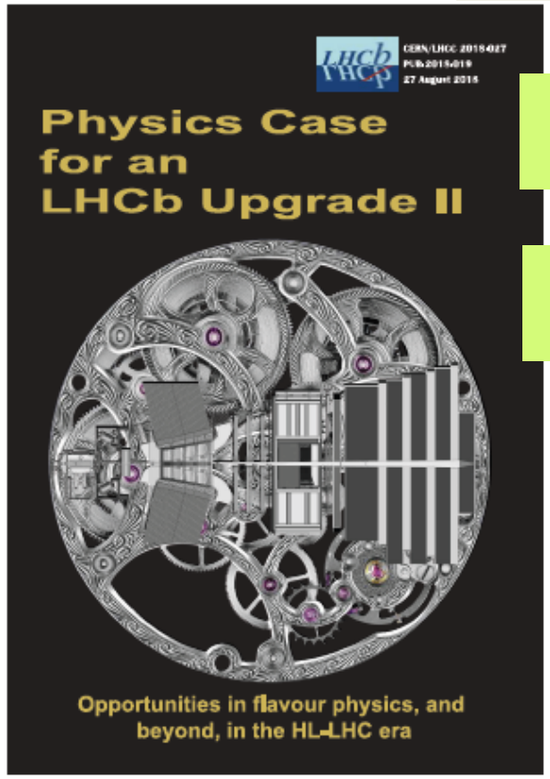
LHCb Calendar



LHCb the flavour exp. in the HL-LHC era

LHCb lumi limited to a max L= 2 x 10^{33} cm^{-2} s^{-1}
~5 interactions per bunch crossing

L= 10-20 x 10^{33} cm^{-2} s^{-1}
25-50 int. per BXing



PHYSICS CASE
[LHCB-PUB-2018-009]

HL-LHC machine study
CERN-ACC-NOTE-2018-0038

LHCC asked to address

Expression of Interest 2017
[CERN-LHCC-2017-003]

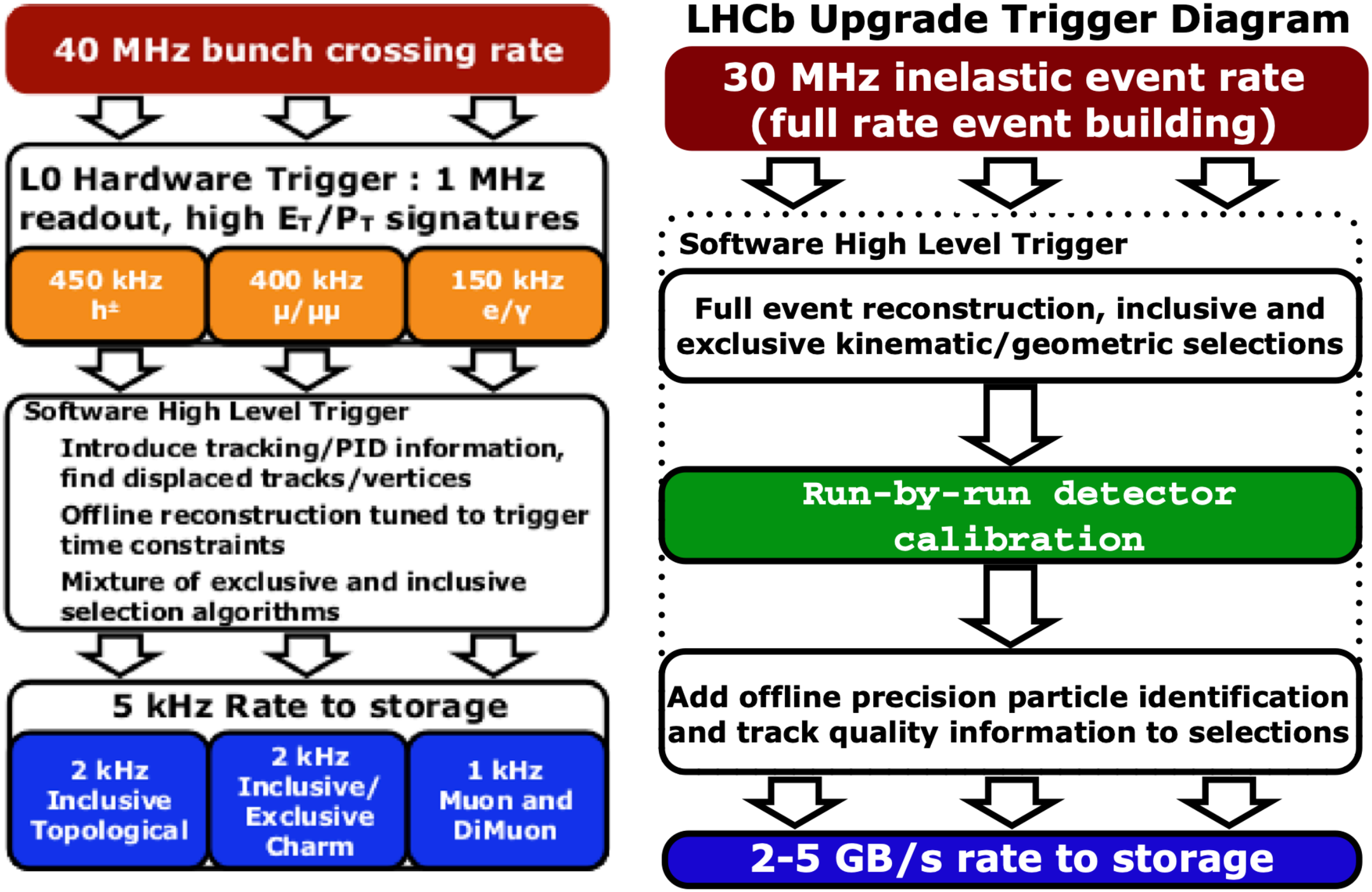
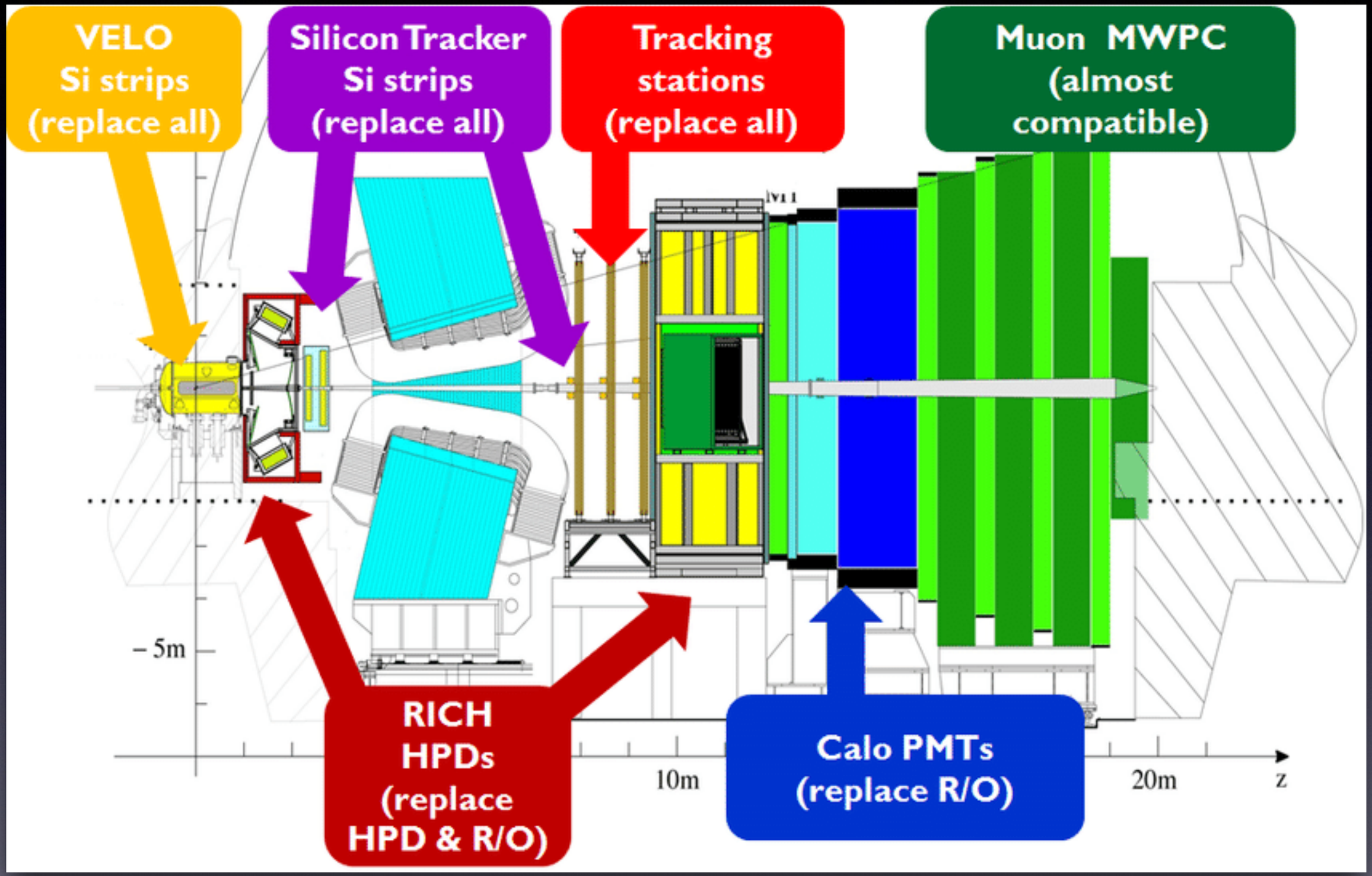
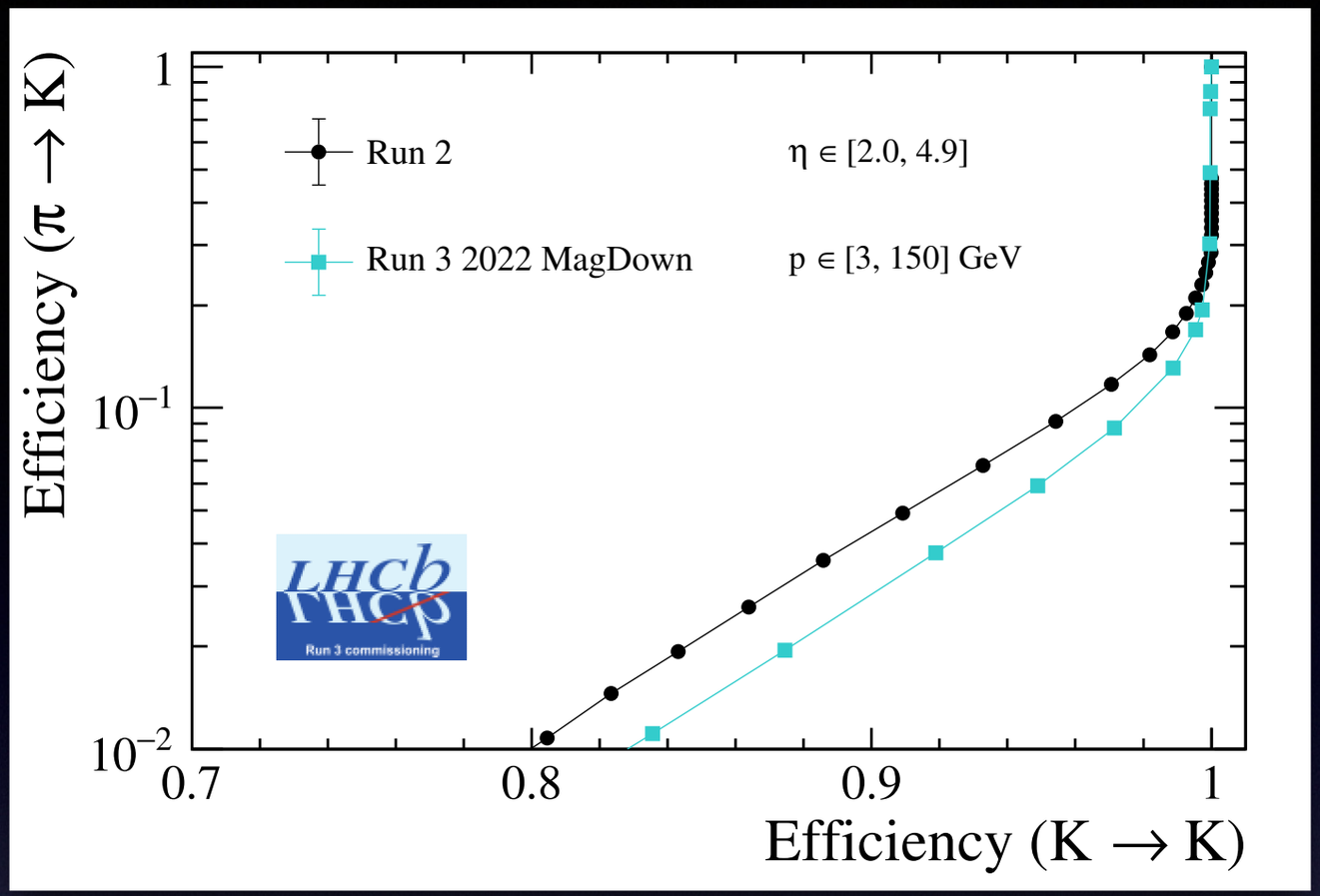


Fig. 1. The LHCb trigger schemes for Run I (left) and Upgrade (right).

Upgrade 1 (Current)

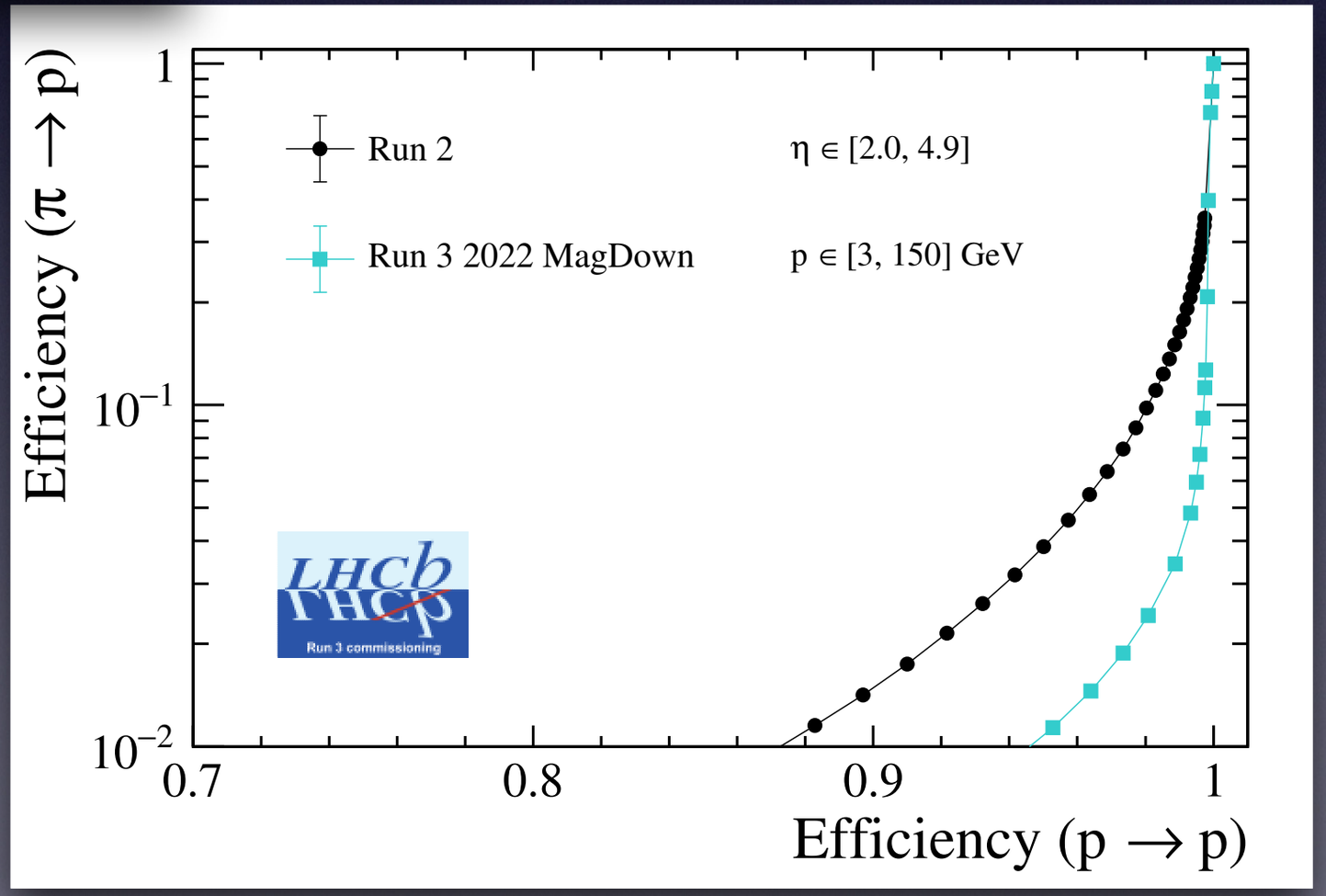


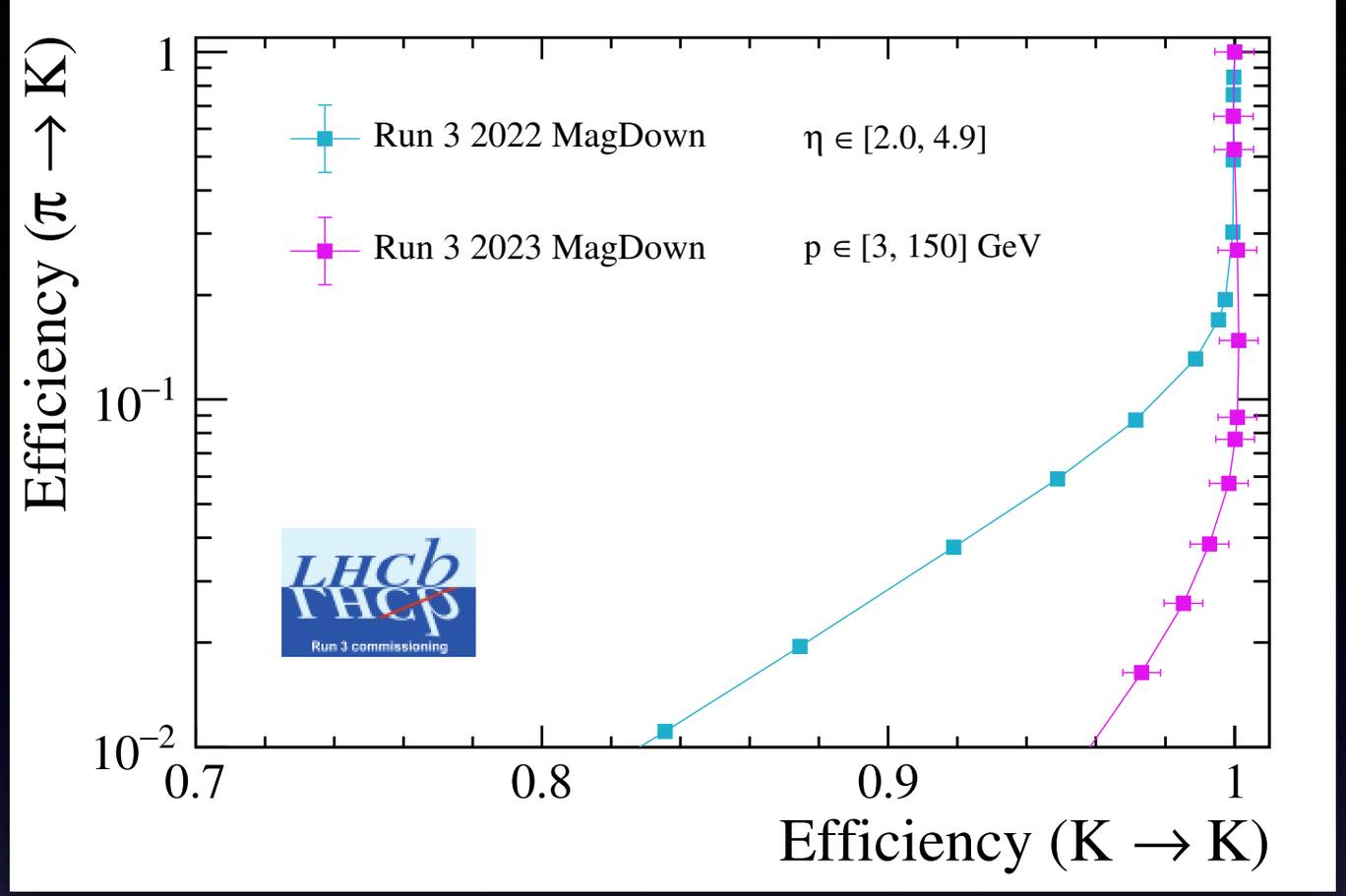


2022 Data RICH Performance

https://lbfence.cern.ch/alcm/public/figure/details/620

- Better performance in Run3, even though occupancies are higher
  - Run2 <#PVs> ~= 1.8
  - Run3 <#PVs> ~= 3.0

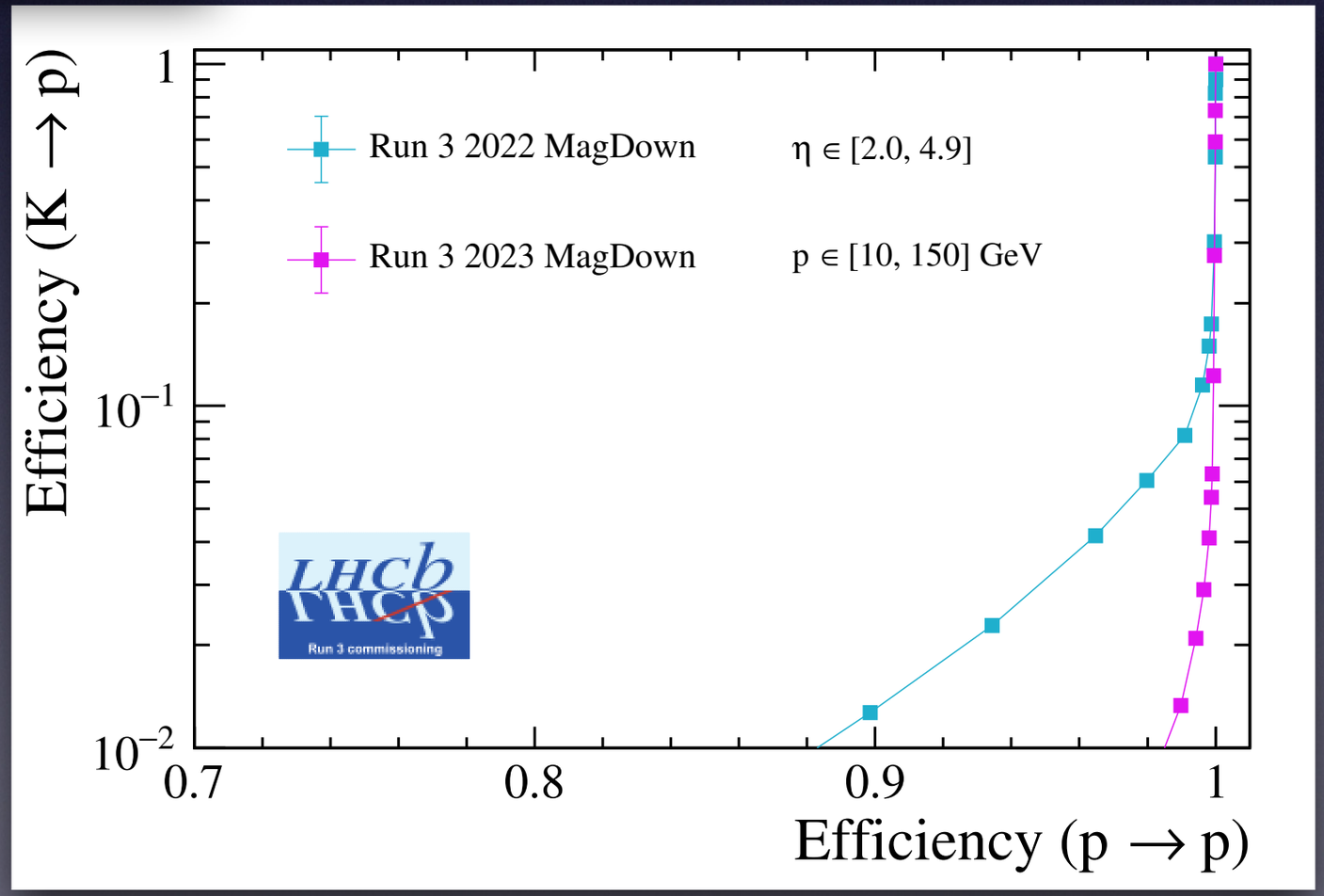




2023 Data RICH Performance

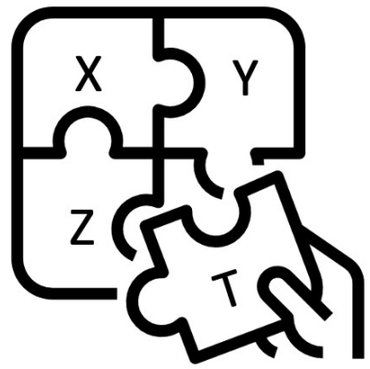
https://lbfence.cern.ch/alcm/public/figure/details/620

- Better performance in 2023
  - In part due to data taking conditions. Open Vertex Locator, slightly lower luminosity.
  - But also improved detector calibration and alignment.



So What Next ? Upgrade II …

Novel feature of the LHCb detector: fast timing

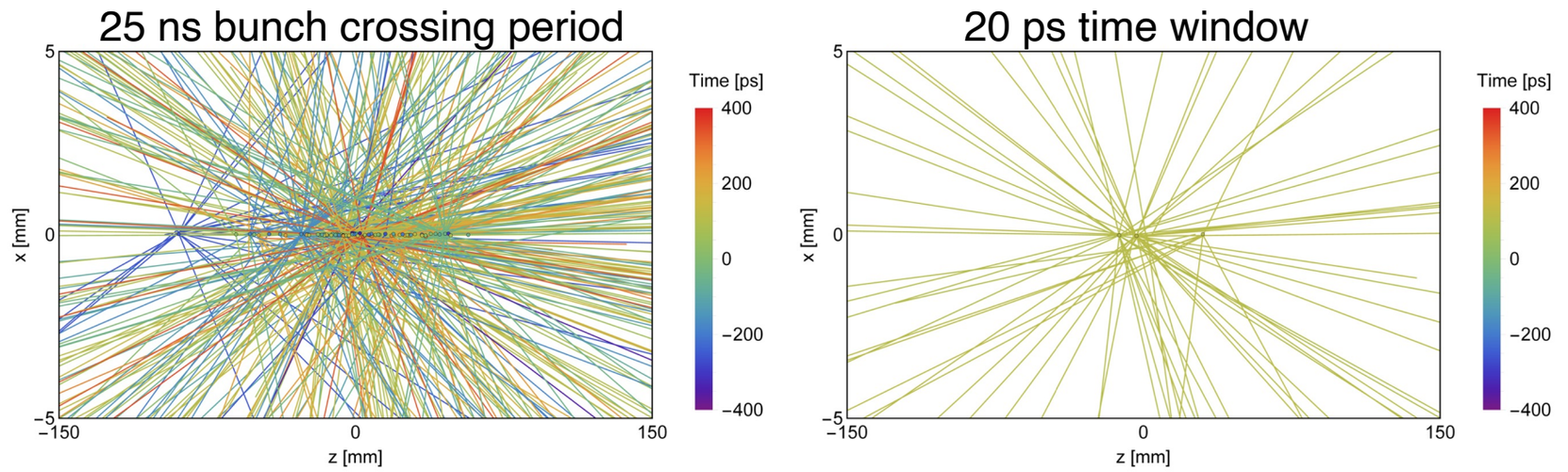


A new dimension will be added to the LHCb experiment.

Timing information with a **few tens of ps resolution** per particle will allow charged tracks and photons to be associated to the correct interaction vertex.

VELO, RICH, ECAL and TORCH will be fast timing detectors.

- Adds a new dimension to the **information exchange** between sub-detectors.
- Could all contribute to the same estimate of the **track time as it passes the detector**.
- Opens up **new avenues for data suppression** in front-end hardware and in software trigger.
- Sets challenging R&D requirements particularly for sensor technologies and front-end ASICs.

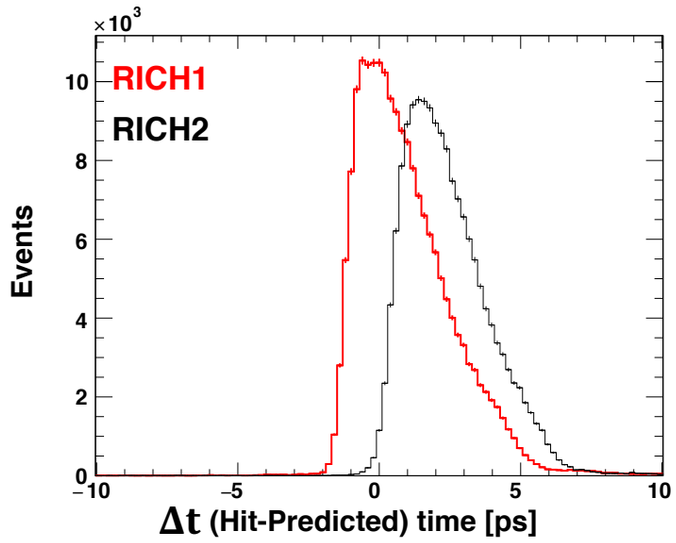


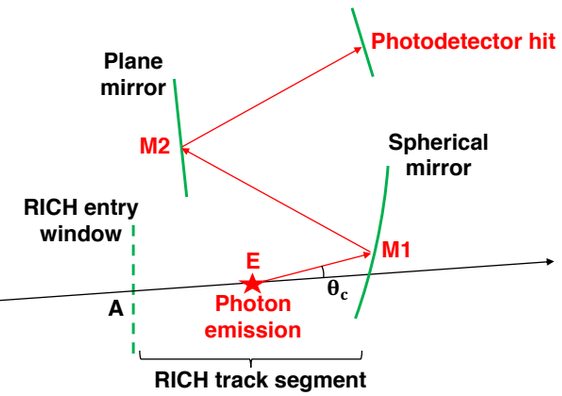
Doi:10.17863/CAM.45822

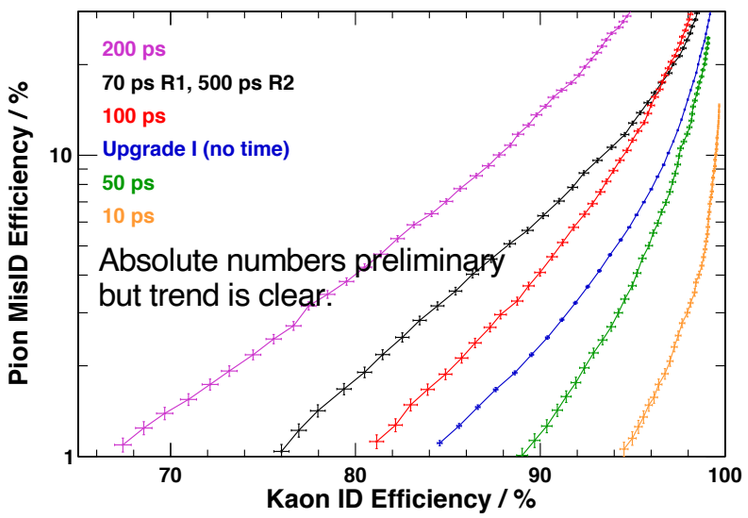
Fast timing in the RICH detectors

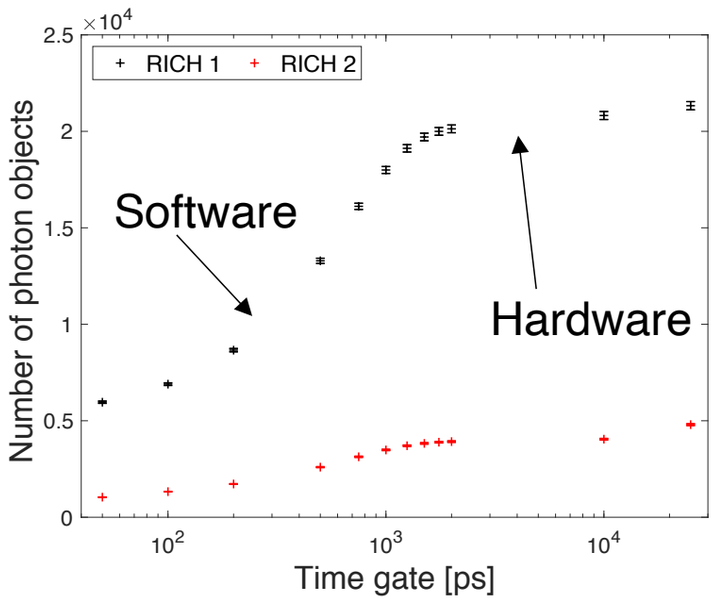
Owing to the prompt Cherenkov radiation and focusing mirror geometry, all photons from a given track arrive at approximately the same time at the photon detector plane.

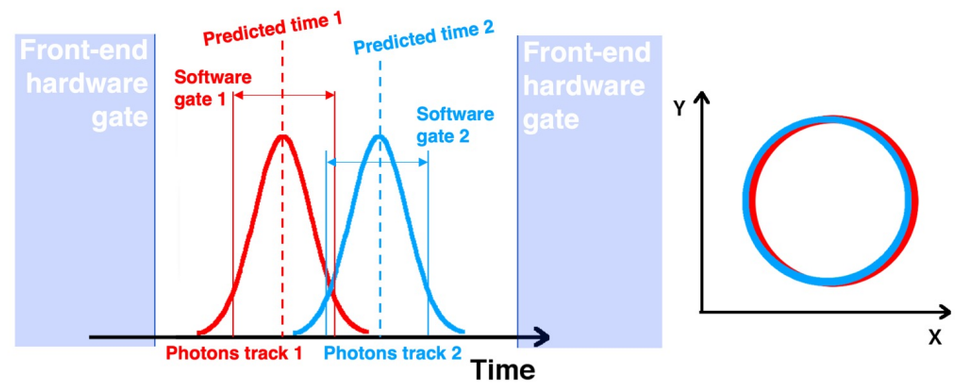
- Using **reconstructed parameters** in the RICH algorithms and the PV t-zero, can predict the detector hit times to within 10 ps.
- **Time gate around the predicted time** significantly reduces combinatorial background and helps to recover the Run 3 particle ID performance.
- **Faster detectors are better**, as in practice the photon detector resolution will dominate the width of the time gate.
  Aiming for a resolution better than 100 ps.









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