Measurement of track reconstruction efficiency at LHCb

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on behalf of the LHCb collaboration
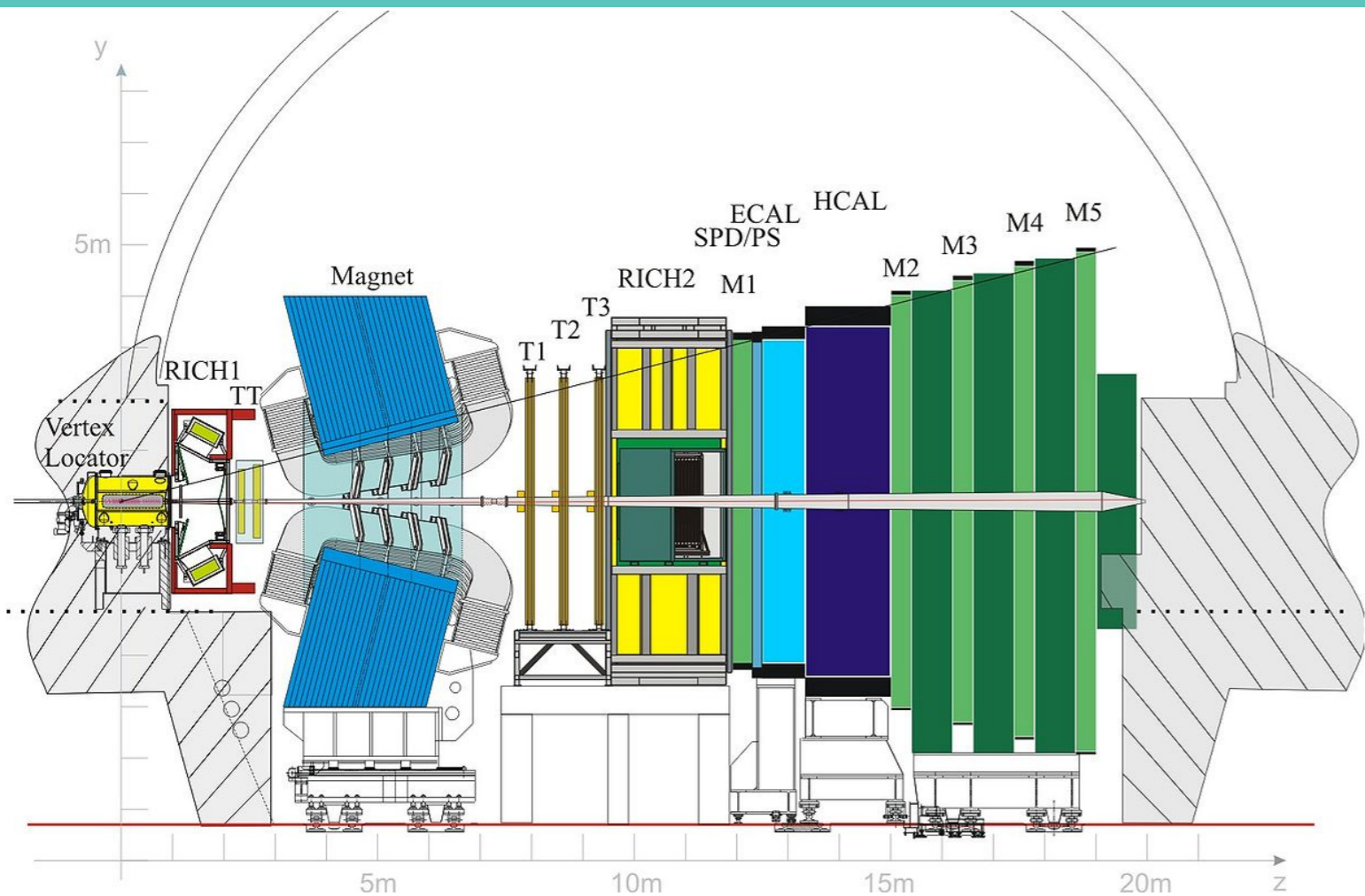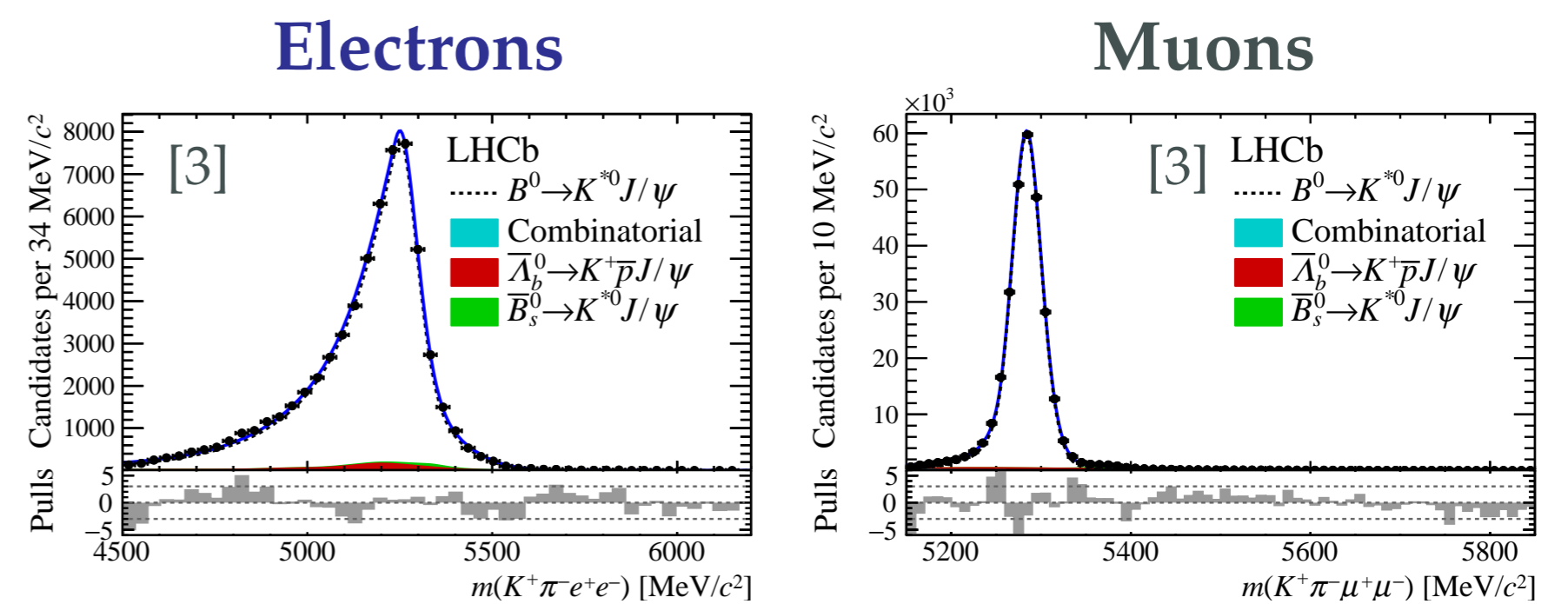[1] Nikhef National Institute for Subatomic Physics, The Netherlands

LHCb

Single-arm forward spectrometer designed to study rare decays and CP violation of b and c hadrons produced in pp collisions at the LHC in the pseudorapidity range $2 < \eta < 5$.

Track reconstruction efficiency

Long tracks

Hits required in T stations and VELO (VErtex LOcator). The standard for analyses.

Downstream tracks

Hits required in TT and T stations. For long-lived particles like K_S^0 and Λ.

Efficiency measurements

Current/main method: tag-and-probe using displaced $J/\psi \to \mu^+\mu^-$ (from b-hadron decays) [1]. Three methods are used, probing each different efficiencies:

Long	**T-station**	**VELO**
Probe from TT and Muon hits. For long tracking efficiency. Main method.	Probe from VELO and Muon hits. For T-station efficiency.	Probe from downstream tracks, for VELO efficiency.

Combination of Long and VELO ⊕ T-station method used to get **long tracking efficiency**. For **muons** these tracking efficiencies are around **94%** a **97%**.
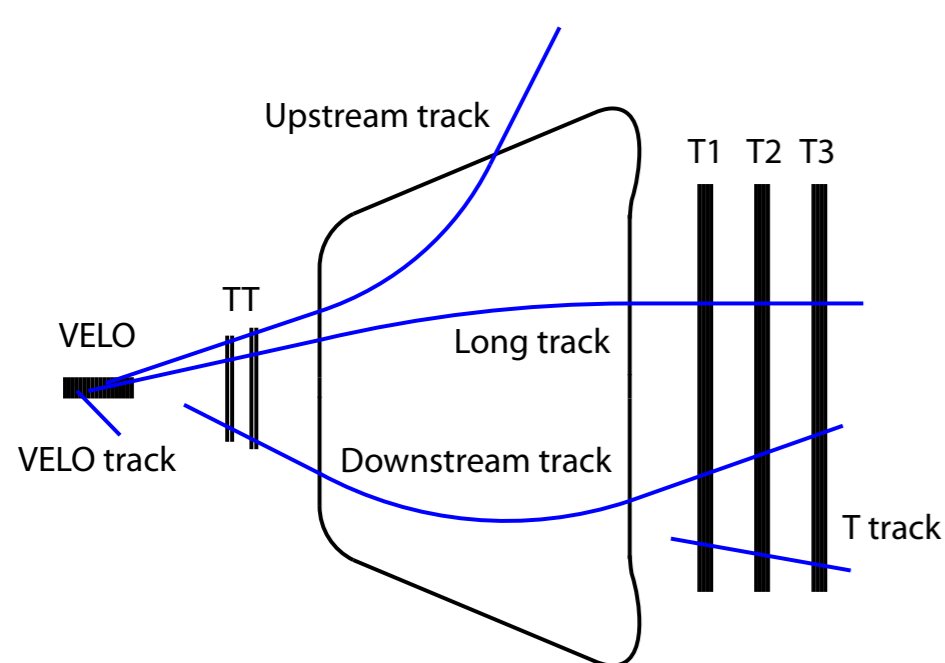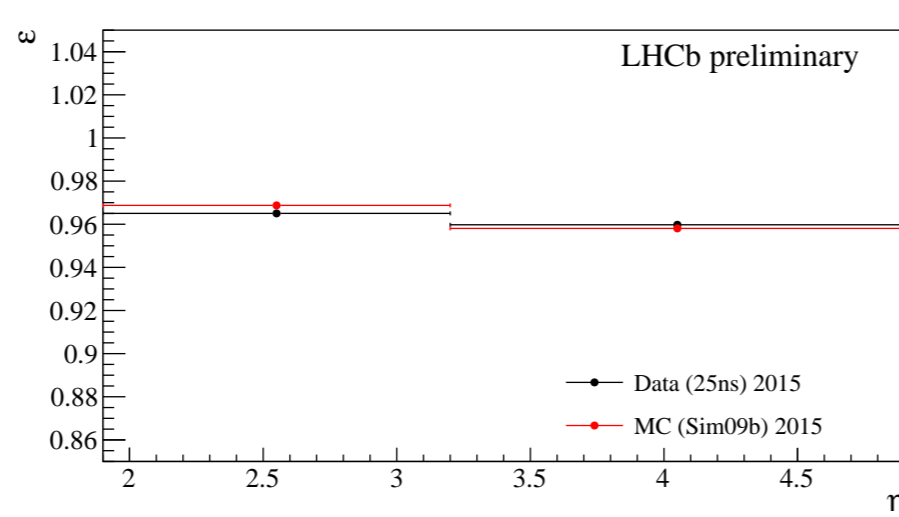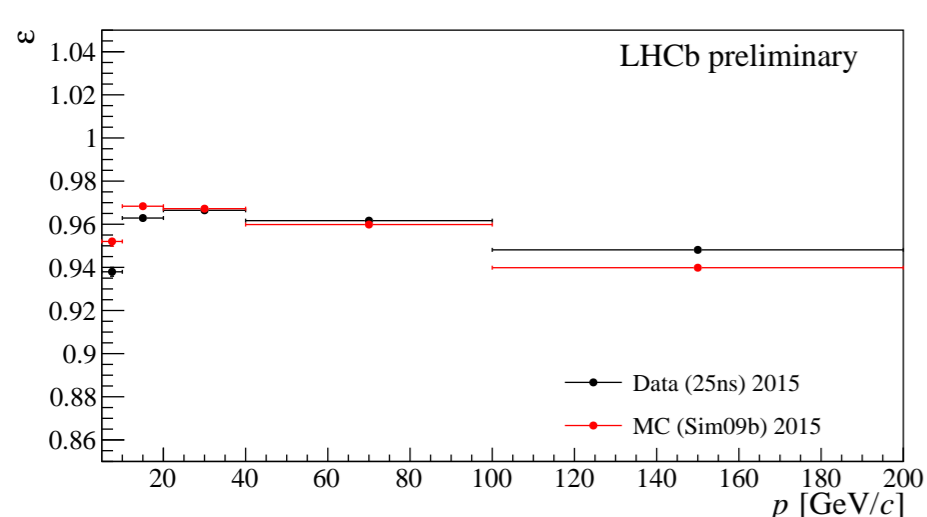

## Special case: *electrons*

Electrons behave considerably different than muons, pions, kaons and protons

- Large amounts of bremsstrahlung in material causing momentum loss along trajectory

- **Affects mostly reconstruction after magnet/VELO**

Electrons 　　　　　　　**Muons**

Goal: developing dedicated electron reconstruction efficiency measurements. Electrons play a crucial role in *Lepton Flavour Universality* measurements, showing hints of new physics [2, 3].

New method

Tag-and-probe with **electron** probe a priori only consisting of a **VELO track** using $B^\pm \to J/\psi\,(\to e^+e^-)\,K^\pm$

- VELO reconstruction highly efficient ($\sim 98\%$)

- **Probing (main) efficiency (loss) after VELO.**

- Applicable also to muons ($J/\psi \to \mu^+\mu^-$), complementary to main method.
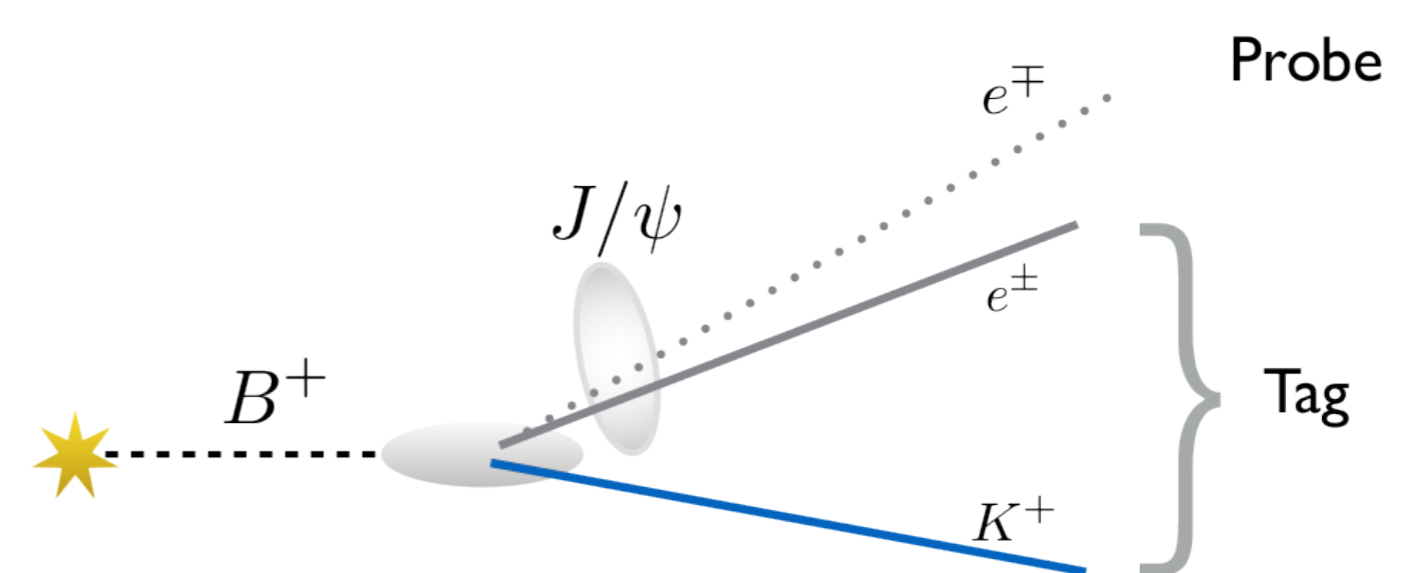
Kinematics

Probe momentum is inferred from J/ψ mass constraint. The $B^\pm$ mass after J/ψ mass constraint is used to discriminate between signal and background.
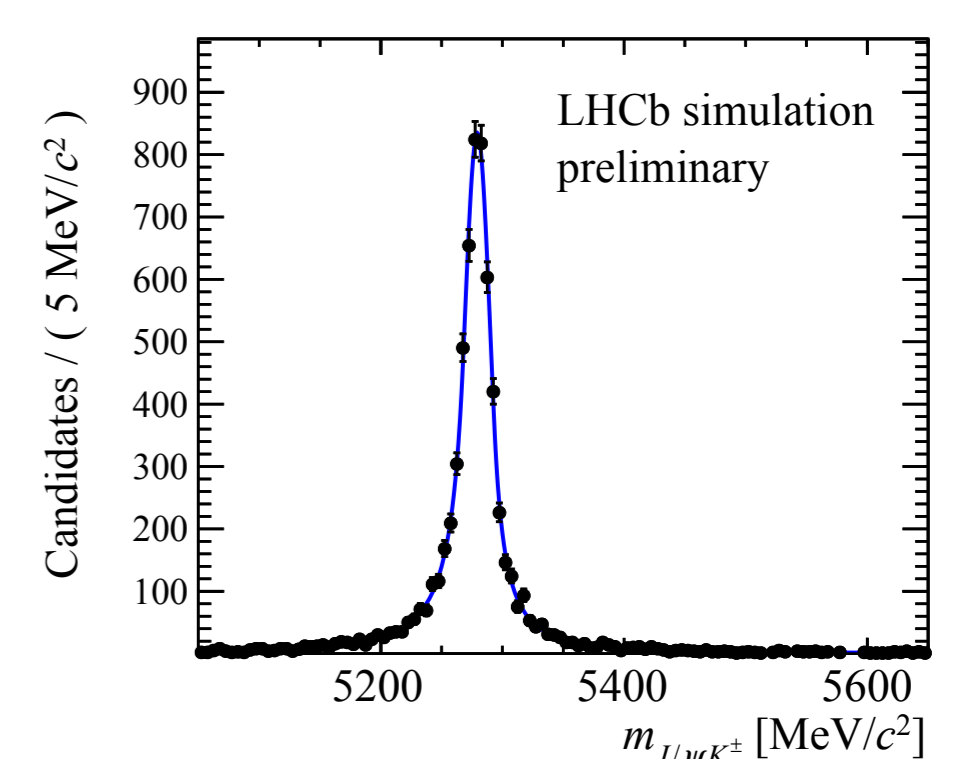
Trigger: *TurboCalib*

For selecting and saving the events used for the tracking efficiency calibration a specialised data stream is used online, possible due to the availability of the full reconstruction in the last trigger stage. This is done similar to how particle identification calibration samples are obtained [4].

References

[1] Aaij, R. and others; *Measurement of the track reconstruction efficiency at LHCb*; JINST 10 P02007 (2015); arXiv:1408.1251

[2] Aaij, R. and others; *Test of lepton universality with $B^+ \to K^+\ell^+\ell^-$ decays*; Phys. Rev. Lett. (2014) 113; arXiv:1406.6482

[3] Aaij, R. and others; *Test of lepton universality with $B^0 \to K^{*0}\ell^+\ell^-$ decays*; JHEP **08** (2017) 055; arXiv:1705.05802

[4] Aaij, R. and others; Selection and processing of calibration samples to measure the particle identification performance of the LHCb experiment in Run 2; arXiv:1803.00824