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Tracking Efficiency Studies for LHCb in Run 3



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on behalf of the LHCb collaboration

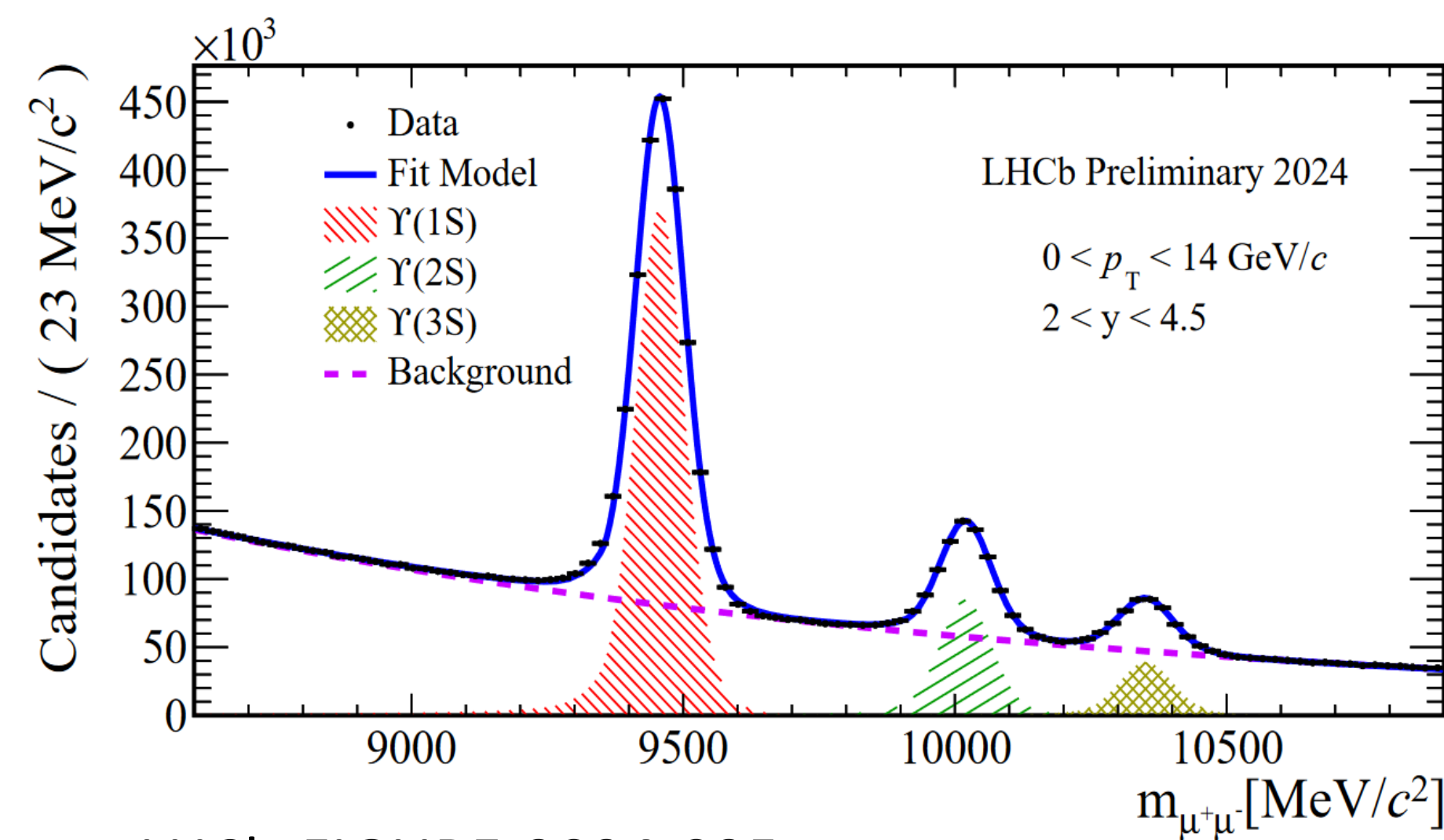
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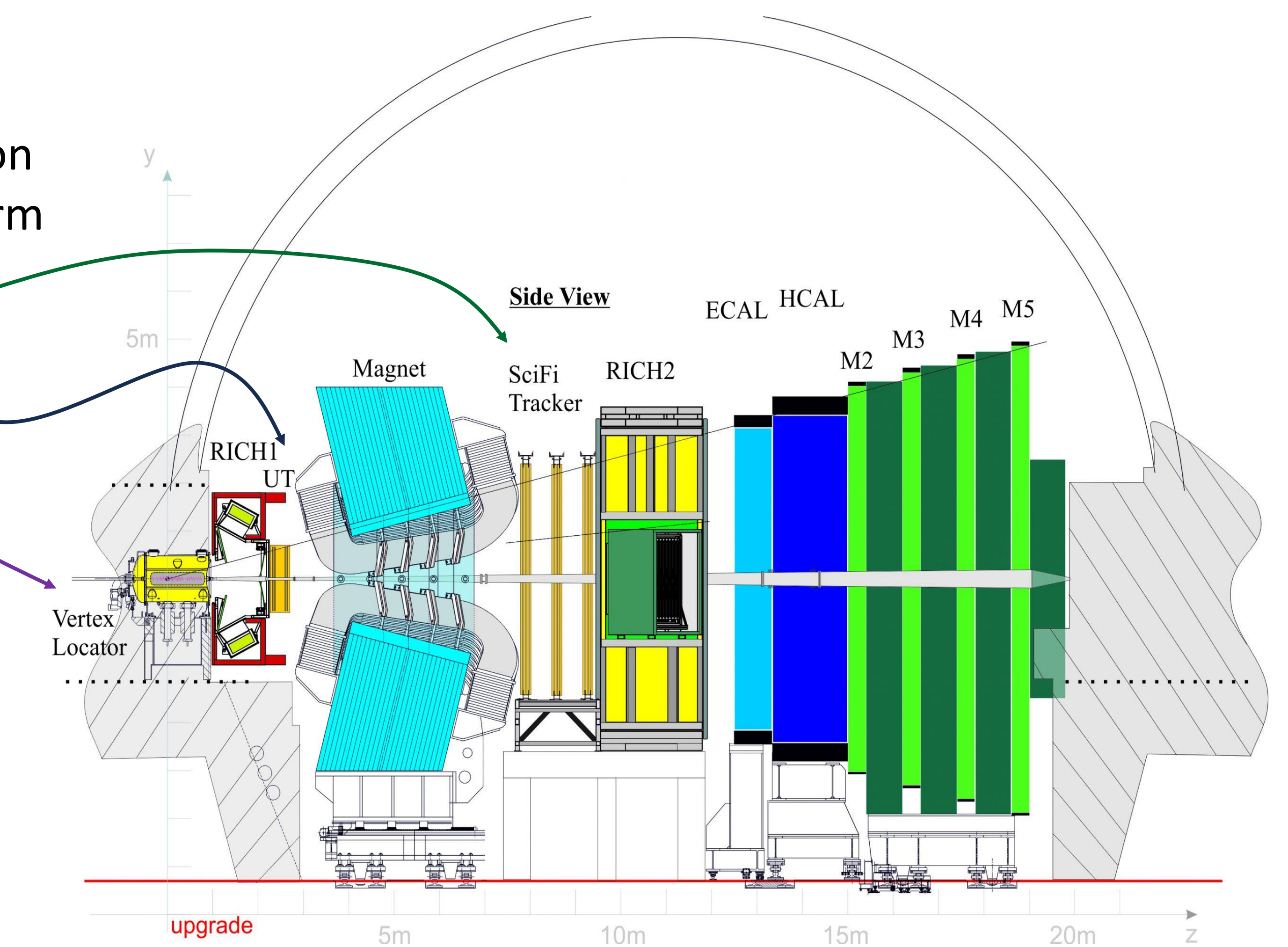


The LHCb detector and its tracking system

- LHCb experiment is general purpose experiment in the forward direction
→ dedicated especially to precision measurements in the beauty and charm
- started data taking with the upgraded detector in 2022
- entirely new reconstruction software & tracking system: Velo+UT+SciFi
→ amazing momentum resolution ($\Delta p/p \sim 0.5\%$ above 1 GeV)
- resulting magnificent mass resolution



LHCb-FIGURE-2024-025

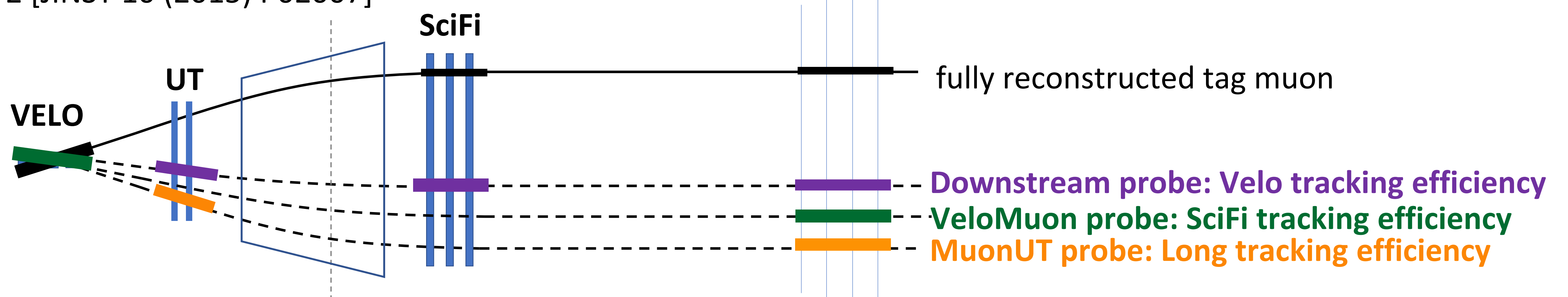


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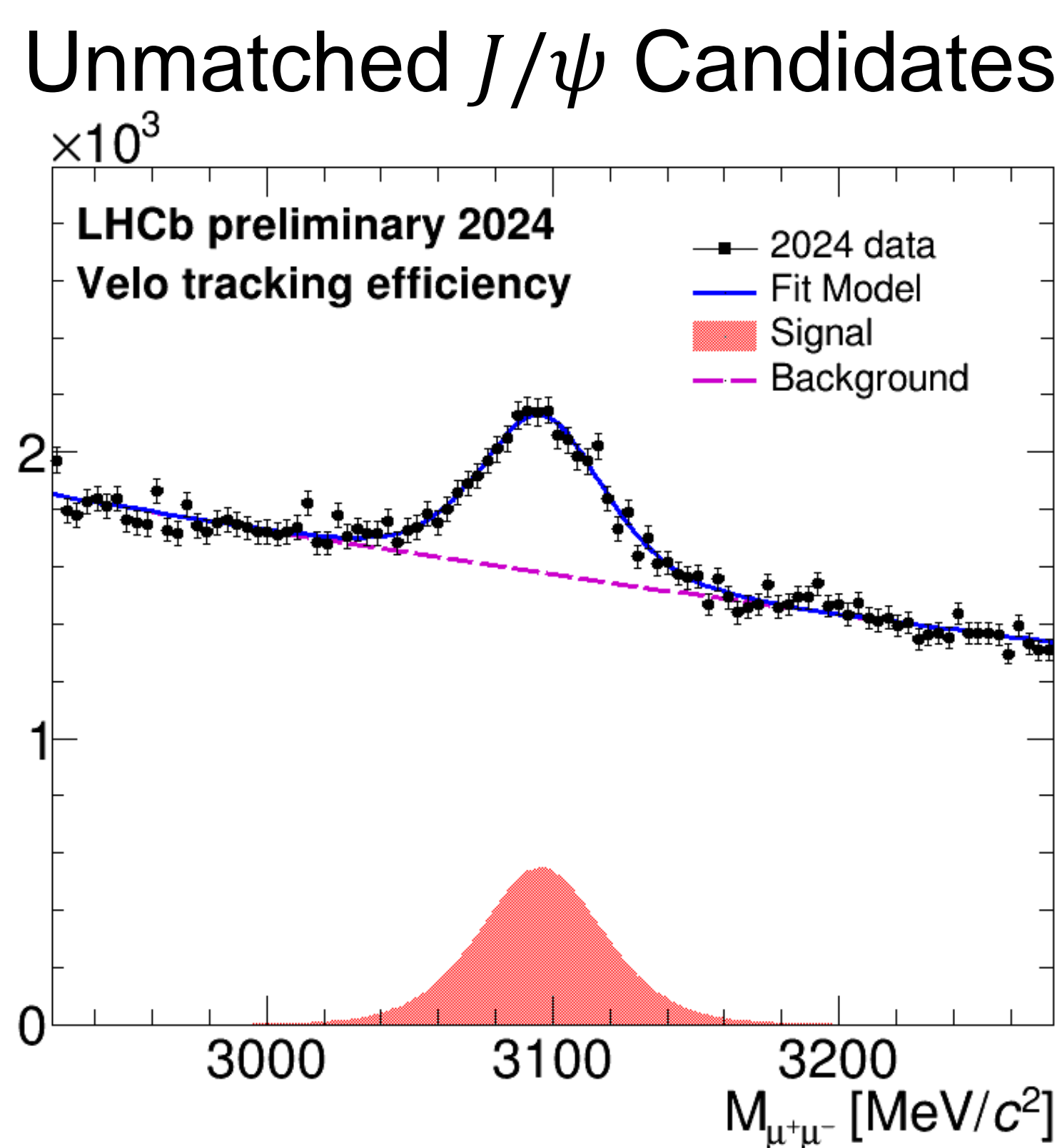
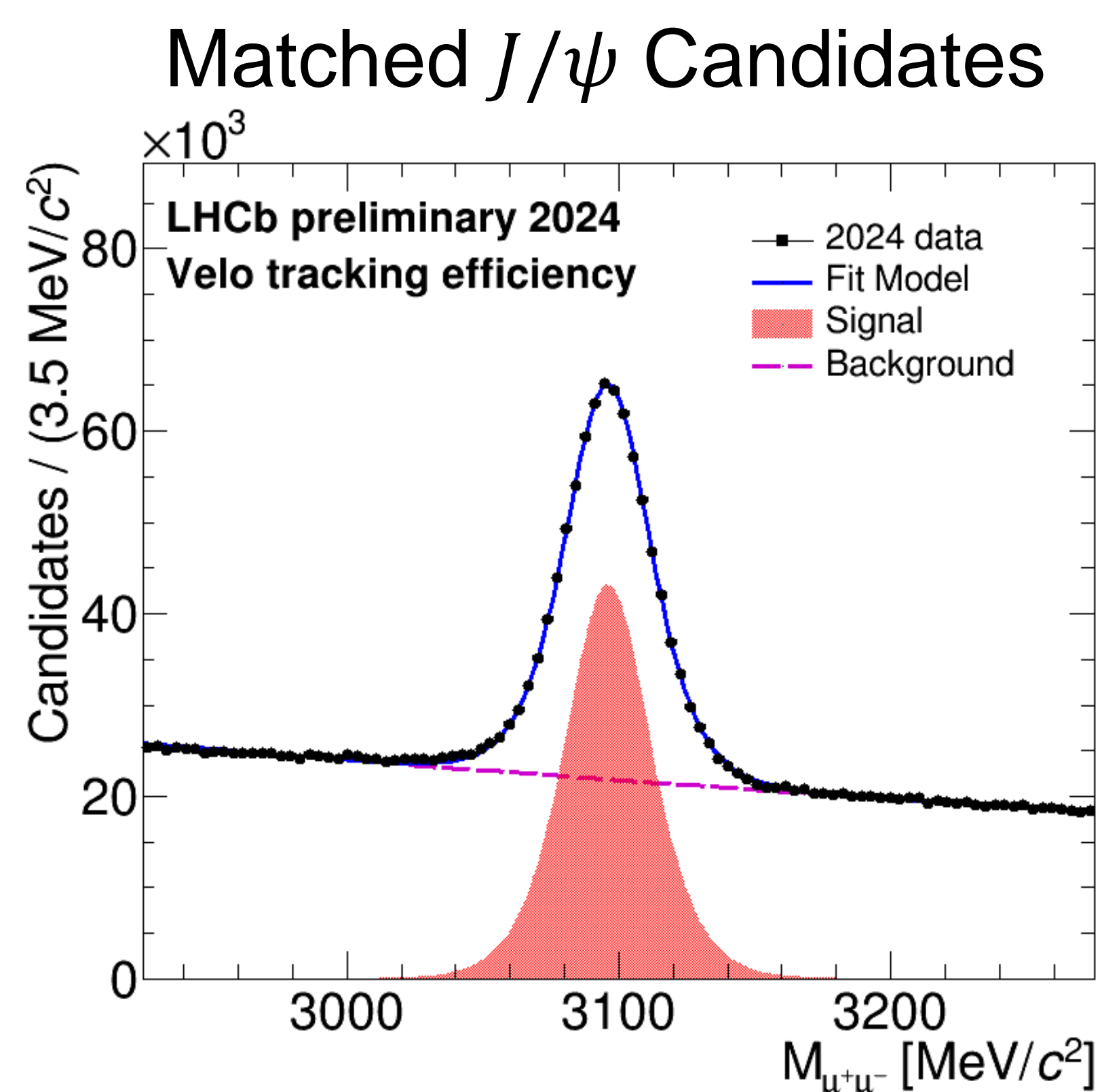
Track reconstruction efficiency measurement

- using tag-and-probe method with $J/\psi \rightarrow \mu\mu$ decays by reconstructing one muon fully + one muon partially
- probe missing segment by matching partial track to the full track
- use complementary Downstream&VeloMuon and MuonUT methods to reduce systematic effects
- similar method as in Run 2 [JINST 10 (2015) P02007]

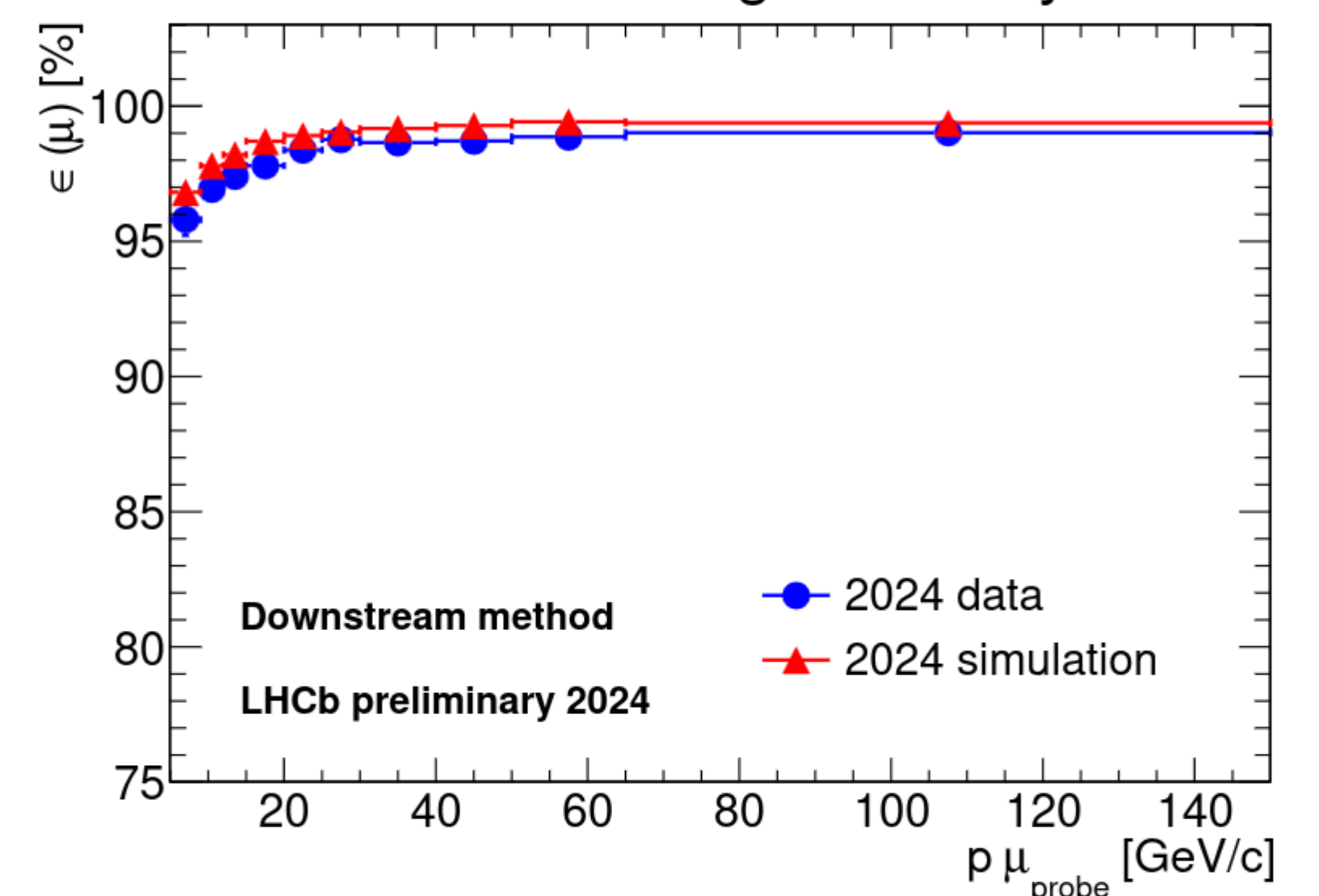
$$\epsilon_{\text{track reconstruction}} = \frac{N_{\text{matched}}}{N_{\text{matched}} + N_{\text{unmatched}}}$$



- reconstruction of invariant $\mu^+\mu^-$ mass with matched and unmatched probe tracks



momentum dependency in data and simulation:
Velo tracking efficiency



Effects of hadronic interactions on tracking efficiency

- source of largest systematic uncertainty for hadron tracking efficiency: uncertainty on material budget (hadronic interactions) & hadronic cross-sections
- using $D^{*+} \rightarrow (D^0 \rightarrow K\pi\pi\pi)\pi^+$ and $D^{*+} \rightarrow (D^0 \rightarrow K\pi)\pi^+$ decays to estimate effects of hadronic interaction with the detector material

$$R_{\pi\pi}^{\text{data/simulation}} = \frac{\epsilon_{K\pi\pi\pi}^{\text{data}} / \epsilon_{K\pi\pi\pi}^{\text{simulation}}}{\epsilon_{K\pi}^{\text{data}} / \epsilon_{K\pi}^{\text{simulation}}}$$

- correct ratio for different selection efficiencies between the two decay channels

