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Kaon and Pion Identification Performances in Phase III data for TOP detector

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Abstract

We study the performances of the charged Kaon and Pion identification based on 2.64 fb^{-1} Phase III data from the Physics runs (Experiment#7 and 8) and compare with Phase III Monte Carlo events. The efficiency and the fake rates of kaon and pion identification are calculated using $D^{*+} \to D^0[K^-\pi^+]\pi^+$ decays for the TOP only binary PID criteria. The study is performed in the momentum and polar angle bins.

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1. DEFINITIONS

Information from each PID system is analysed independently to determine a likelihood for each charged particle hypothesis. These likelihoods may then be used to construct a combined likelihood ratio. Here in the plots presented, we study the TOP detector specific binary likelihood ratio defined as :

$$\mathcal{R}_{K/\pi} = \frac{\mathcal{L}_K}{\mathcal{L}_K + \mathcal{L}_\pi} \tag{1}$$

We report the PID performance of the charged kaon and pion separation using $D^{*+} \to D^0[K^-\pi^+]\pi^+$ decays. Slow pions can be used to tag D^0, which is finally used to identify the kaons and pions. So, with this information K/π PID efficiency and fake rate can be studied in data.

The kaon identification efficiency ϵ_K (ϵ_π) is defined as:

$$\epsilon_K(\epsilon_\pi) = \frac{\text{number of kaon (pion) tracks identified as kaon (pion)}}{\text{number of kaon (pion) tracks}} \tag{2}$$

while the pion mis-identification rate f is defined as:

$$f_\pi = \frac{\text{number of pion tracks identified as kaon}}{\text{number of pion tracks}} \tag{3}$$

2. DATA-SET

In this study, we use the data set (2.64 fb^{-1}) of `proc9` re-processing of `exp 7 runs [909 - 4120]` and `exp 8 runs [43 - 1022]` and `runs [1036 - 1554]`. The results are also compared with the official MC (12th campaign) generic sample (`mixed, charged, uubar, ddbar, ssbar, ccbar` and `taupair`) which are generated using early (single-layered PXD) Phase III geometry with nominal machine background.

3. TOP ONLY BINARY LIKELIHOOD RATIOS

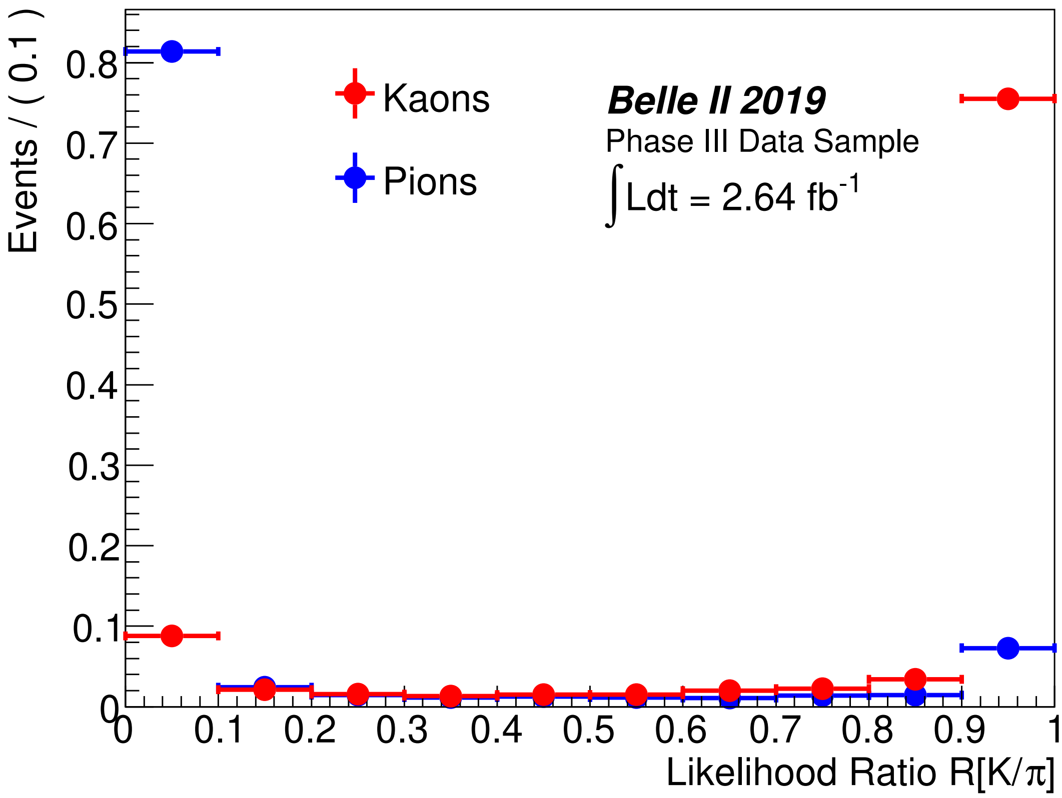

FIG. 1: $\mathcal{R}_{K/\pi}$ distribution from TOP only information. K and π tracks are tagged from the charge of the slow π (daughter of D^{*+}) in the decay $D^{*+} \to D^0[K^-\pi^+]\pi^+$.

4. TOP ONLY K-EFFICIENCIES AND π-FAKE RATES

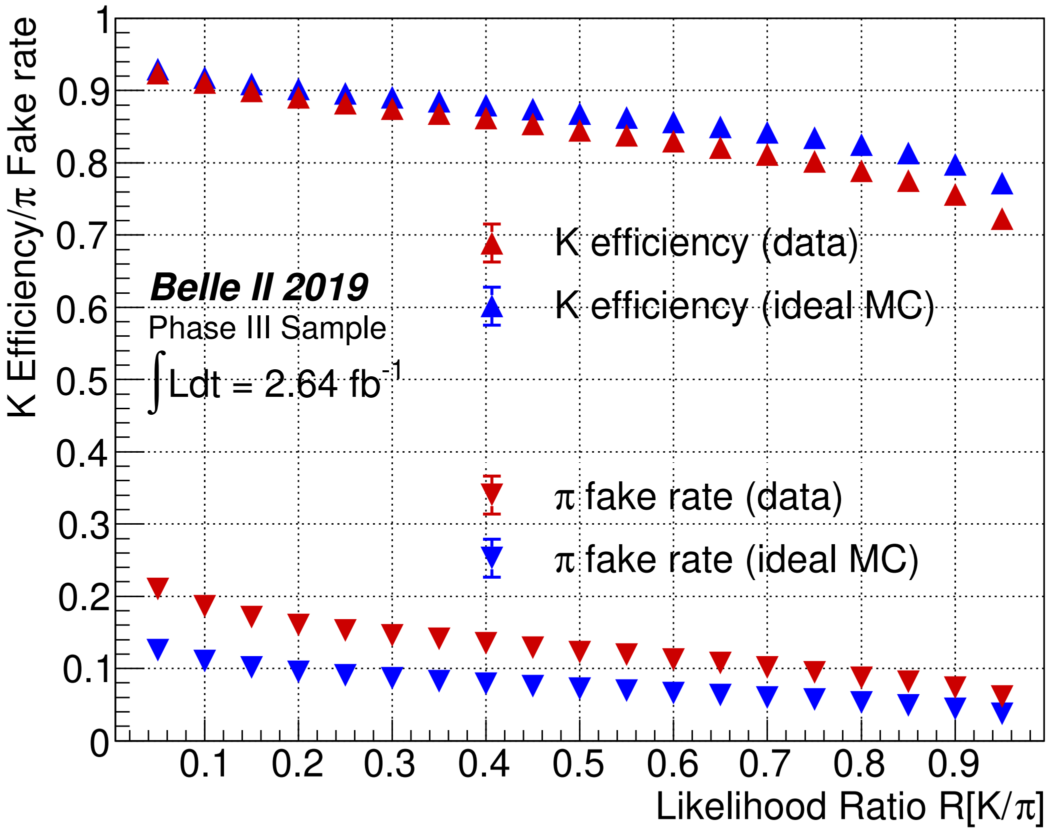

FIG. 2: TOP only K-efficiencies and π-fake rates are calculated for different PID criteria using the decay $D^{*+} \to D^0[K^-\pi^+]\pi^+$.

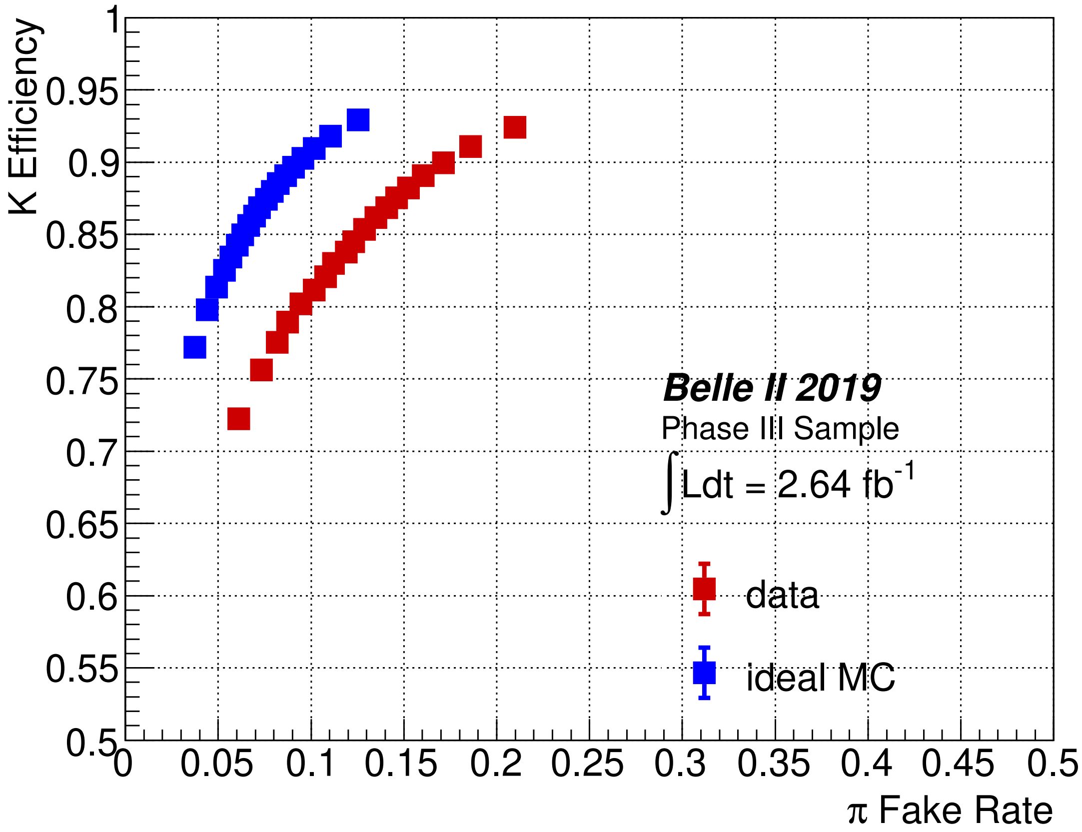

FIG. 3: TOP only K-efficiencies *vs.* π-fake rates for different PID criteria using the decay $D^{*+} \to D^0[K^-\pi^+]\pi^+$.

5. TOP ONLY K-EFFICIENCY AND π-FAKE RATE IN MOMENTUM/POLAR ANGLE BINS

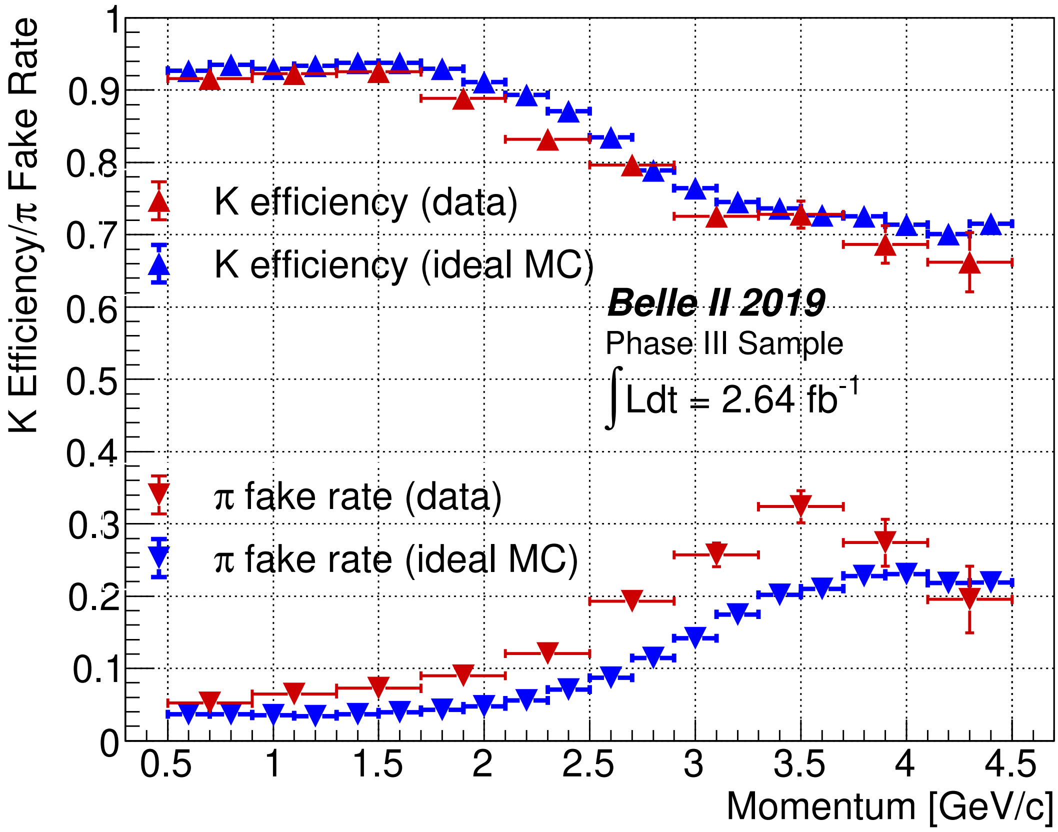

FIG. 4: Kaon efficiency and pion fake rate for the TOP only PID criterion $\mathcal{R}_{K/\pi} > 0.5$ using the decay $D^{*+} \to D^0[K^-\pi^+]\pi^+$ in the bins of momentum of the tracks.

6. TOP ONLY K-EFFICIENCY AND π-FAKE RATE IN DIFFERENT SLOTS

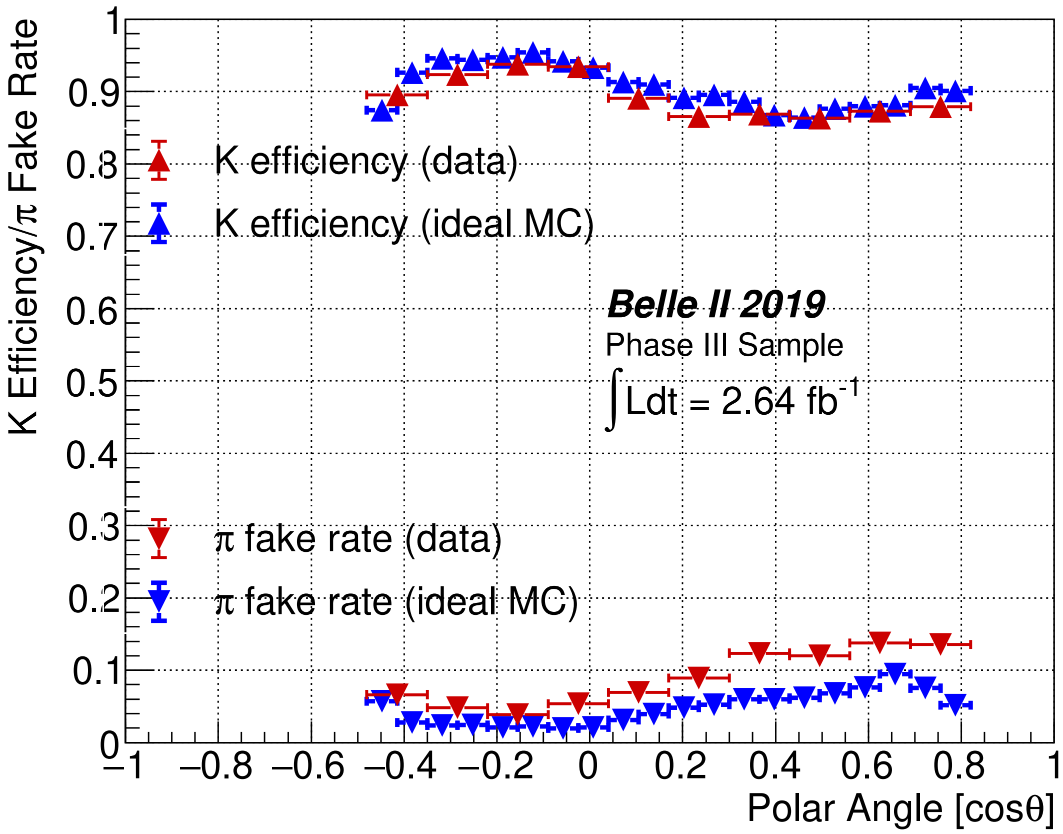

FIG. 5: Kaon efficiency and pion fake rate for the TOP only PID criterion $\mathcal{R}_{K/\pi} > 0.5$ using the decay $D^{*+} \to D^0[K^-\pi^+]\pi^+$ in the bins of polar angle of the tracks.

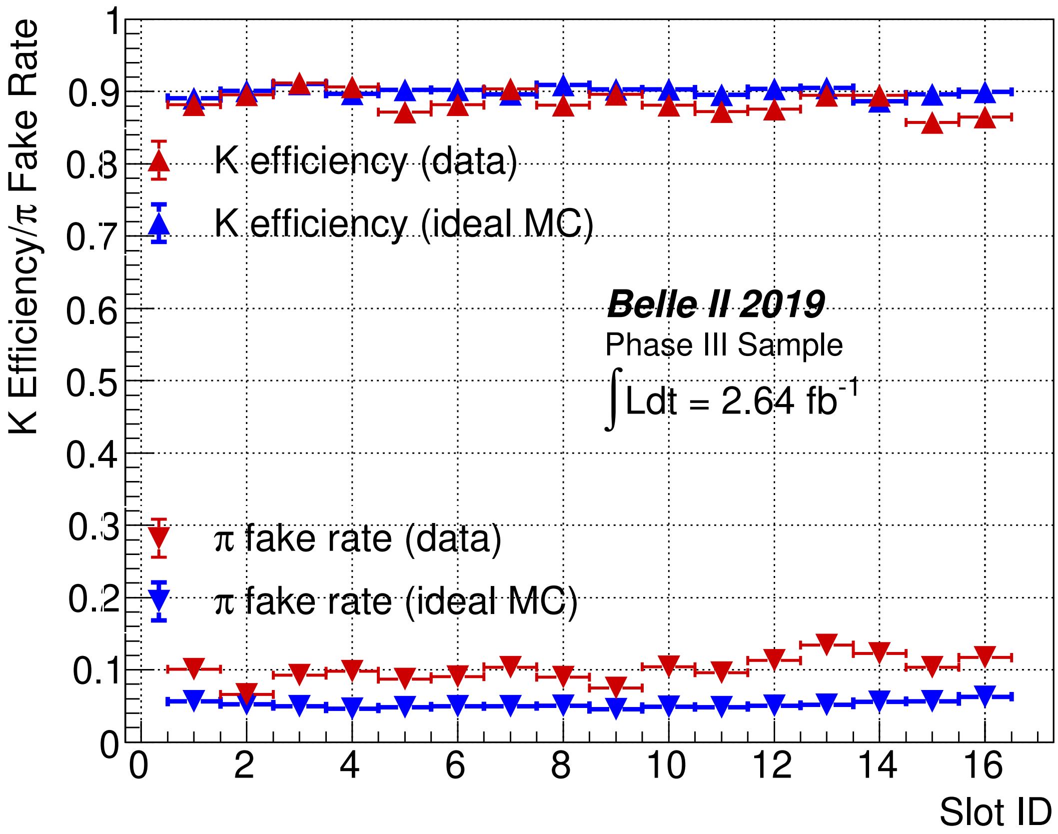

FIG. 6: Kaon efficiency and pion fake rate for the TOP only PID criterion $\mathcal{R}_{K/\pi} > 0.5$ using the decay $D^{*+} \to D^0[K^-\pi^+]\pi^+$ in the 16 TOP slots.