

New kinematic weighting algorithm for CP asymmetries in charm decays

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LHCb Collaboration

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1 Introduction

- Asymmetries at the LHCb
- The weighting function

2 RapidSim

- Injecting detection asymmetry
- Weighting function



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We are interested in the following charm decays and the asymmetries that occur

$$D^{*\pm} \rightarrow D^0 \pi^\pm$$
$$D^0 \rightarrow K^- K^+ \text{ or } D^0 \rightarrow \pi^- \pi^+$$

At the LHCb we observe:

- CP asymmetries \rightarrow matter and antimatter differences
- Detection asymmetries \rightarrow detection of soft pions (π_s^\pm)



Asymmetries at the LHCb

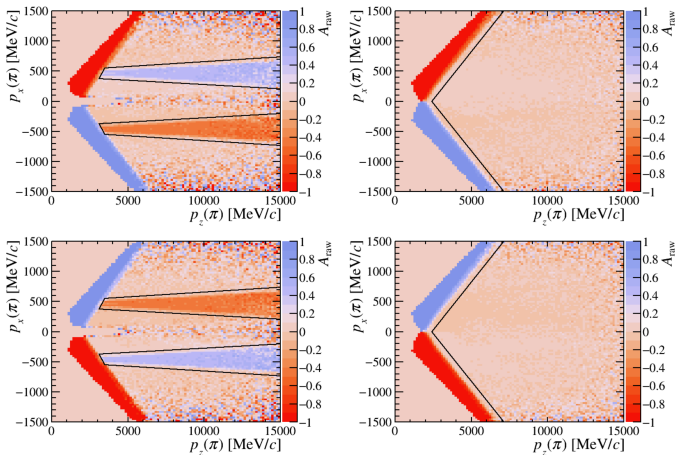


Figure: Asymmetries associated with certain kinematic regions of the soft pion. Credit: Federico Betti.

How do we calculate asymmetries?

- We can calculate the total number of positive and negative soft pions

$$A_{\text{total}} = \frac{N_+ - N_-}{N_+ + N_-}$$

- We can also estimate the total asymmetry

$$A_{\text{total}} = \frac{A_{CP} + A_D}{1 + A_{CP}A_D}$$

We are interested in $\Delta A_{\text{total}} = A_{\text{total}}^{KK} - A_{\text{total}}^{\pi\pi}$



The weighting function

- We introduce the weighting function

$$Q(\vec{p}_{D^*}, \vec{p}_{\pi_s}) \simeq \frac{\Gamma_{D^0}^{\pi\pi}(\vec{p}_{D^*} - \vec{p}_{\pi_s}) + \Gamma_{\bar{D}^0}^{\pi\pi}(\vec{p}_{D^*} - \vec{p}_{\pi_s})}{\Gamma_{D^0}^{KK}(\vec{p}_{D^*} - \vec{p}_{\pi_s}) + \Gamma_{\bar{D}^0}^{KK}(\vec{p}_{D^*} - \vec{p}_{\pi_s})}$$

- We equalize $D^0 \rightarrow K^- K^+$ and $D^0 \rightarrow \pi^- \pi^+$ kinematic distributions
- The detection asymmetries should cancel out and $\Delta A_{\text{total}} = \Delta A_{CP}$



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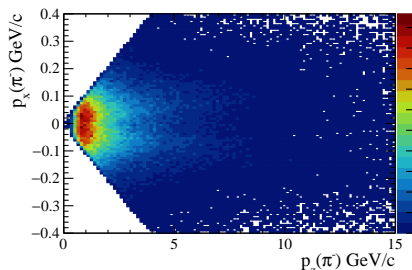
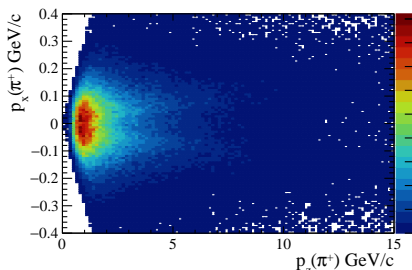
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Injecting detection asymmetry

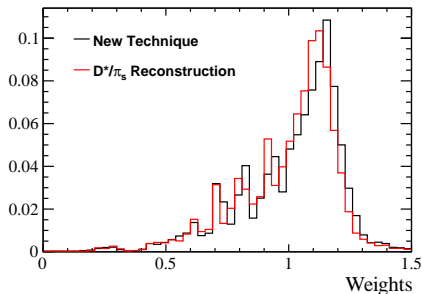
- We inject CP and detection asymmetries to the RapidSim data



- The π_s^+ sector is left unchanged
- The π_s^- sector has a detection asymmetry to simulate the LHCb plots

Weighting function

- We calculate the weighting function before and after the detection asymmetry



- Slight difference between the two
- How will the final results change?

Thank you for your attention!
Questions?

