



**Study of a new kinematic weighting algorithm for
the measurement of CP asymmetries in charm
decays**

LHCb Collaboration

Georgios Christou

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1 Introduction

We use a high statistics sample to calculate more accurately the weighting function which is given by

$$Q(\vec{p}_{D^*}, \vec{p}_{\pi_s}) \simeq \frac{\Gamma_{D^0}^{\pi\pi}(\vec{p}_{D^*} - \vec{p}_{\pi_s}) + \Gamma_{\bar{D}^0}^{\pi\pi}(\vec{p}_{D^*} - \vec{p}_{\pi_s})}{\Gamma_{D^0}^{KK}(\vec{p}_{D^*} - \vec{p}_{\pi_s}) + \Gamma_{\bar{D}^0}^{KK}(\vec{p}_{D^*} - \vec{p}_{\pi_s})} \quad (1)$$

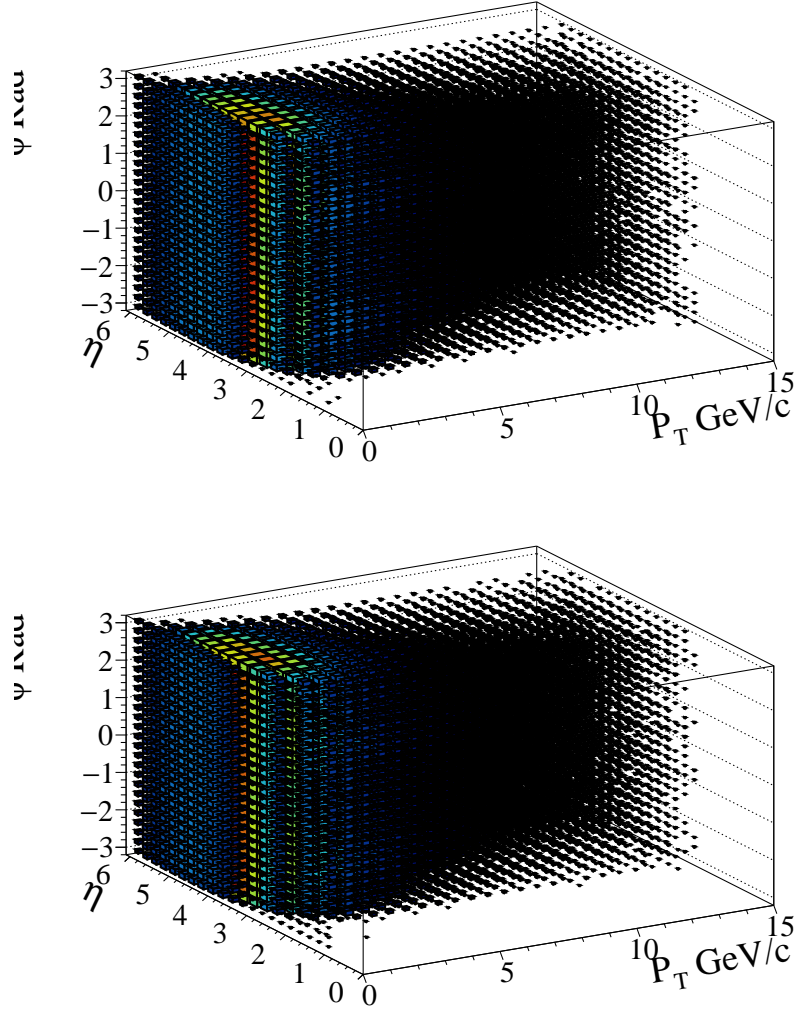


Figure 1: Normalized distributions for $D^0 \rightarrow K^- K^+$ (top) and $D^0 \rightarrow \pi^- \pi^+$ (bottom).

Using the weighting function Eq. 1 we assign weights to the low statistics $D^0 \rightarrow K^- K^+$ sample, thus, we equalize the kinematic distributions of D^0 .

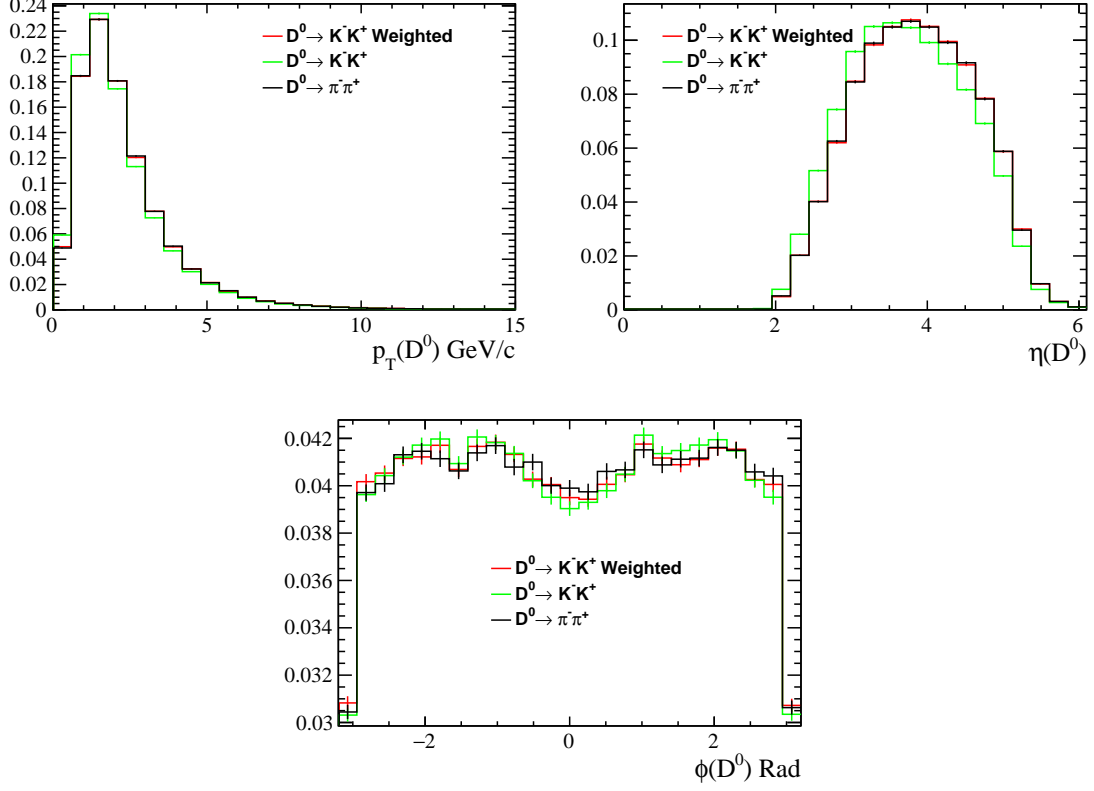


Figure 2: We present the kinematic distributions p_T , η and ϕ of D^0 for the two decay modes, before and after weighting.

We can compare how the total asymmetry is affected. The total asymmetry can be measured using

$$A_{\text{total}} = \frac{N^+ - N^-}{N^+ + N^-} \quad (2)$$

and the error can be estimated using the standard error propagation

$$\sigma A_{\text{total}}^2 = \left(\frac{\partial A_{\text{total}}}{\partial N^+} \sigma N^+ \right)^2 + \left(\frac{\partial A_{\text{total}}}{\partial N^-} \sigma N^- \right)^2 \quad (3)$$

For the weighted sample, $N^\pm = \sum_i w_i^\pm$ and $\sigma N^\pm = \sqrt{\sum_i w_i^\pm}$

	Weighted	Unweighted
A_{total}	0.1517 ± 0.0020	0.1647 ± 0.0020

Table 1: Total asymmetry for $D^0 \rightarrow K^- K^+$ sample with and without weights.

For the $D^0 \rightarrow \pi^- \pi^+$ sample the total calculated asymmetry is

$$A_{\text{total}} = 0.2446 \pm 0.0021 \quad (4)$$

Calculating the total asymmetry difference, we get

$$\Delta A_{\text{total}} = 0.0929 \pm 0.0029 \quad (5)$$

which deviates 2.4σ from the expected value.

Furthermore, we compare the kinematics of D^* and π_s to see whether or not the distributions are equalized after the weighting.

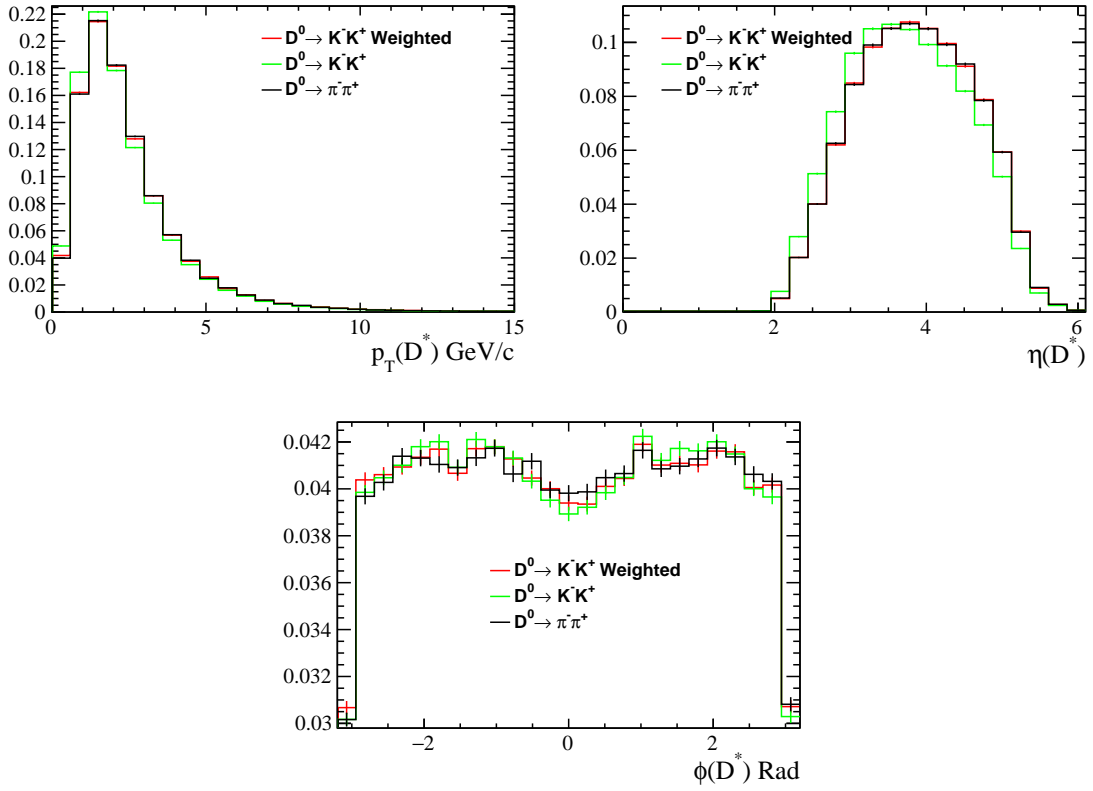


Figure 3: We present the kinematic distributions p_T , η and ϕ of D^* for the two decay modes, before and after weighting.

As we can see, the kinematics of $D^0 \rightarrow K^- K^+$ and $D^0 \rightarrow \pi^- \pi^+$ samples match after the weighting which is expected, thus we conclude that the weighting is done correctly.

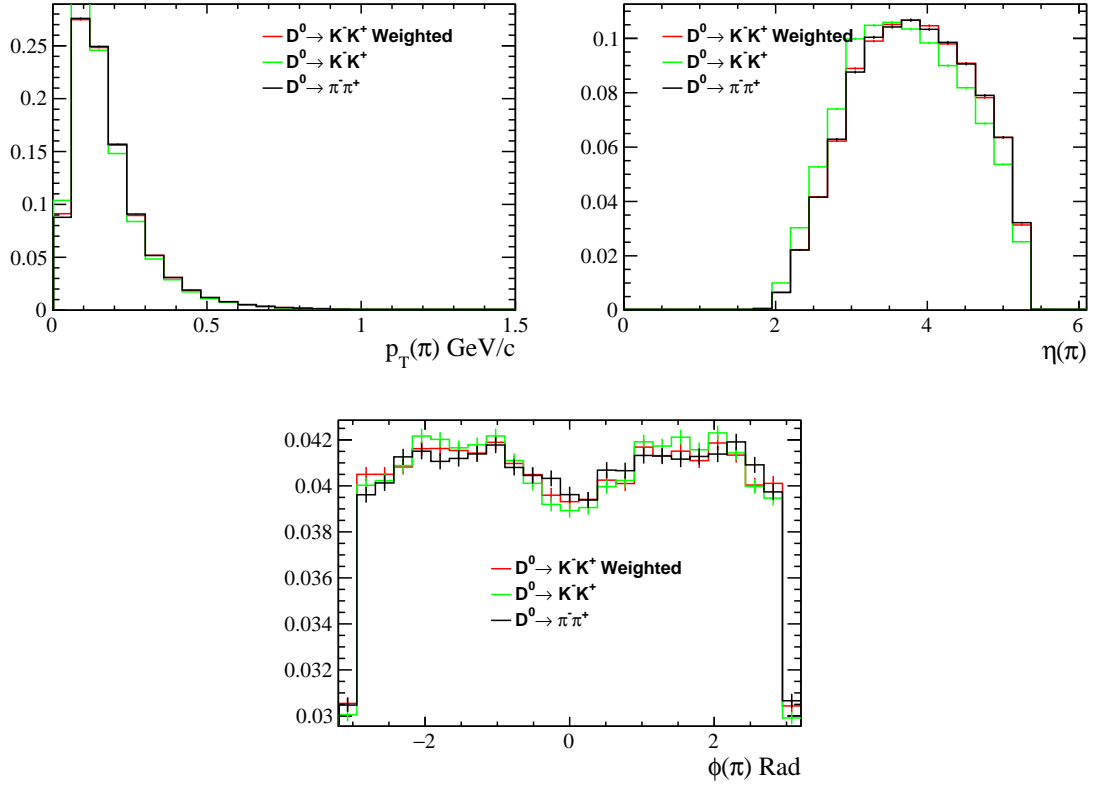


Figure 4: We present the kinematic distributions p_T , η and ϕ of π_s for the two decay modes, before and after weighting.