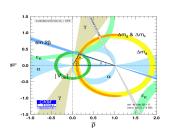
γ analysis update in $B^\pm o (K^+K^-\pi^+\pi^-)_D K^\pm$ decays

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28th June 2021





Summary of last time

- γ from $B^{\pm} \rightarrow DK^{\pm}$, $D \rightarrow K^{+}K^{-}\pi^{+}\pi^{-}$, arXiv:hep-ph/0611272
- Model independent measurement with BESIII strong phase input
- ullet Expected precision from signal-only study: $\Delta \gamma = 12^\circ$
- B candidate selection with BDT
- Inital mass fits

Summary of analysis procedure

- Currently only Run 2
- Perform global fit to fix yields and shapes
- **3** Separate B^{\pm} candidates by charge and into bins
- **1** Extract x_{\pm} and y_{\pm} with a simultaneous fit
- **5** Interpret x_{\pm} and y_{\pm} in terms of γ

CP observables

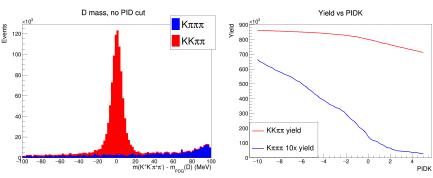
$$\begin{split} x_{\pm} &= r_B^{DK} \cos \left(\delta_B^{DK} \pm \gamma\right), \quad y_{\pm} = r_B^{DK} \sin \left(\delta_B^{DK} \pm \gamma\right) \\ x_{\xi}^{D\pi} &= \text{Re}(\xi^{D\pi}), \quad y_{\xi}^{D\pi} = \text{Im}(\xi^{D\pi}), \quad \xi^{D\pi} = \frac{r_B^{D\pi}}{r_B^{DK}} e^{i(\delta_B^{D\pi} - \delta_B^{DK})} \end{split}$$

Outline

- Backgrounds
 - Mis-ID from $D \to K\pi\pi\pi$
 - Charmless backgrounds
- ② Global mass fit
- Toy studies
 - Standard fits with 4 and 8 bins
 - Biases in CP observables
 - Systematics from c_i, s_i
- Summary and future work

Mis-ID from $D \rightarrow K\pi\pi\pi$

- Mis-ID of D daughter $\pi \to K$
- Peaks a much higher D mass
- Much higher branching ratio
- ullet Similar background from $D o \pi\pi\pi\pi$ is negligible



 $B^{\pm} \to (K^{+}K^{-}\pi^{+}\pi^{-})_{D}K^{\pm}$

(a) D invariant mass for $KK\pi\pi$ and $K\pi\pi\pi$

(b) Yield of $KK\pi\pi$ and $K\pi\pi\pi$ vs PIDK

Charmless backgrounds

- Background from $B^{\pm} \to KK\pi\pi h^{\pm}$
- Flight significance (FS) cut at 2
- Look in the lower D mass sideband $m(D) = [1770 \,\mathrm{MeV}, 1820 \,\mathrm{MeV}]$
- Upper sideband contaminated with $K\pi\pi\pi$
- \bullet Train a separate BDT without $\chi^2_{\rm DTF}$ to preserve D sidebands
- Overlap between samples without FS cut: 0.0%
- Overlap between samples with FS cut: 0.0%

Total charmless background yield

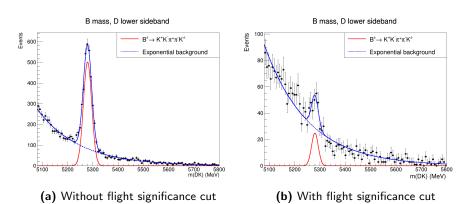


Figure 2: Charmless background in the D sideband

Charmless backgrounds by charge

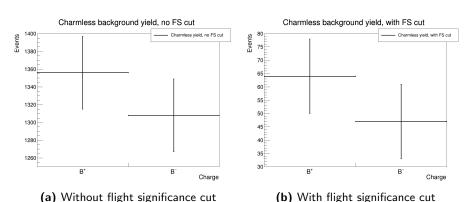


Figure 3: Charmless background split by charge

Charmless backgrounds by bins

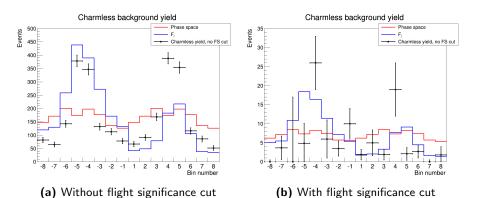
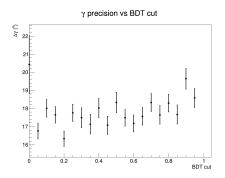


Figure 4: Charmless background split by bins

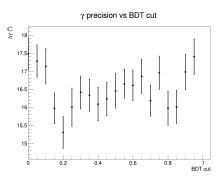
BDT cut optimization

- Current BDT cut: 0.75
- ullet Minimize statistical γ error
- Procedure:
 - Perform global fit to fix signal and background yields and PDF shapes
 - Generate 1000 toy datasets using the global fit parameters
 - lacksquare Fit for γ
 - lacktriangledown Extract expected γ precision from γ distribution of toy datasets

BDT cut optimization



(a) γ precision vs BDT cut for 4 bins



(b) γ precision vs BDT cut for 8 bins

Global mass fit

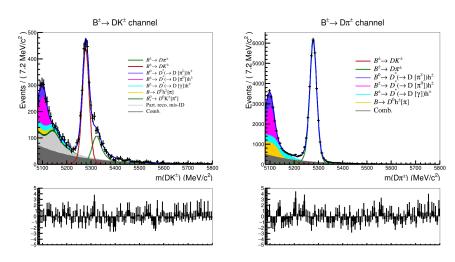
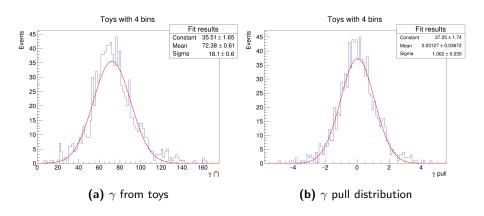
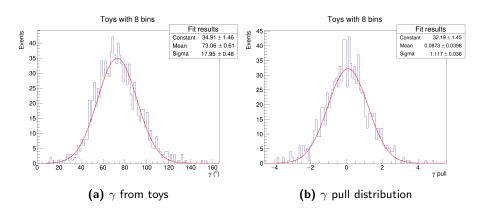


Figure 6: Global mass fit (left) B o DK and (right) $B o D\pi$

Standard toy studies with 4 bins



Standard toy studies with 8 bins



Biases in $B \rightarrow DK$ CP observables, 4 bins

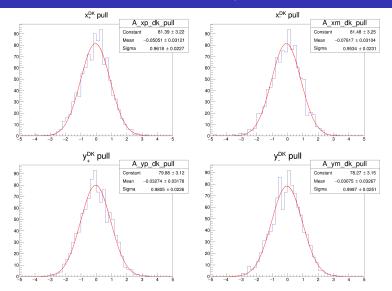


Figure 9: $B \rightarrow DK$ CP observable pull distributions

Biases in $B \rightarrow DK$ CP observables, 8 bins

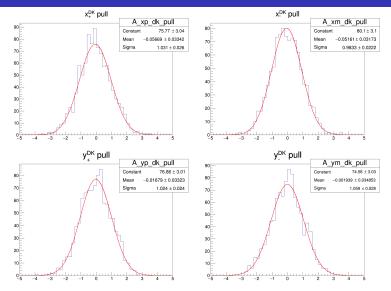


Figure 10: $B \rightarrow DK$ CP observable pull distributions

Biases in $B \to D\pi$ CP observables, 4 bins

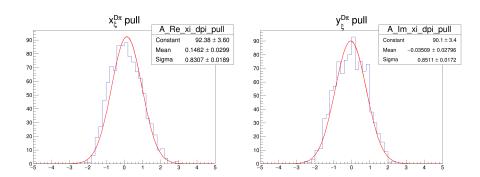


Figure 11: $B \rightarrow D\pi$ CP observable pull distributions

Biases in $B \to D\pi$ CP observables, 4 bins, 2x statistics

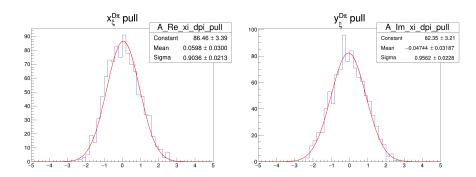


Figure 12: $B \rightarrow D\pi$ CP observable pull distributions

Biases in $B \to D\pi$ CP observables, 4 bins, 10x statistics

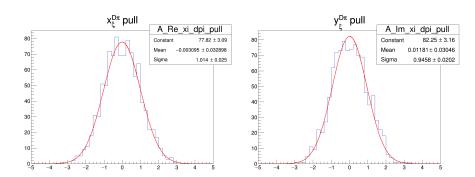


Figure 13: $B \rightarrow D\pi$ CP observable pull distributions

Biases in $B \to D\pi$ CP observables, 8 bins

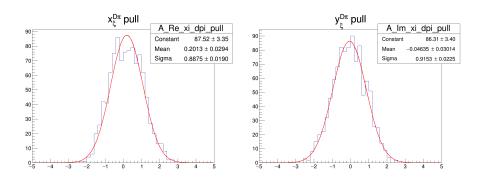


Figure 14: $B \rightarrow D\pi$ CP observable pull distributions

Biases in $B \to D\pi$ CP observables, 8 bins, 2x statistics

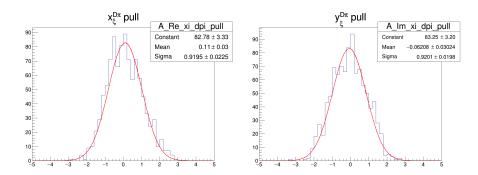


Figure 15: $B \rightarrow D\pi$ CP observable pull distributions

Biases in $B \to D\pi$ CP observables, 8 bins, 10x statistics

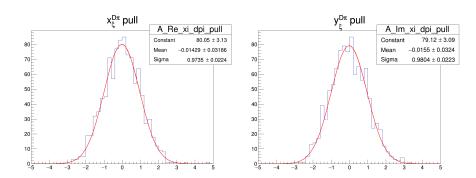


Figure 16: $B \rightarrow D\pi$ CP observable pull distributions

Systematics from c_i , s_i

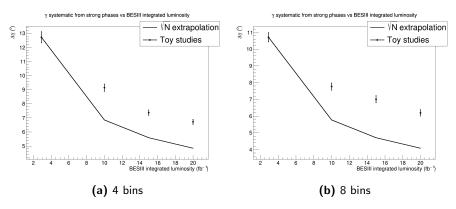


Figure 17: Systematic uncertainty from c_i and s_i with extrapolated BESIII statistics

Summary and future work

- Summary:
 - Global mass fit looks promising
 - 2 $D o K\pi\pi\pi$ and charmless backgrounds under control
 - 3 Toy studies show no suspicious behaviour
 - **4** Expected c_i and s_i systematics are not too large
- Next steps:
 - Study semileptonic backgrounds in RapidSim
 - Recalculate PID efficiencies with PIDCalib
 - Refit MC signal shapes
 - Rerun everything with Run 1 (finally!)