γ analysis update in $B^{\pm} \to (K^{+}K^{-}\pi^{+}\pi^{-})_{D}K^{\pm}$ decays

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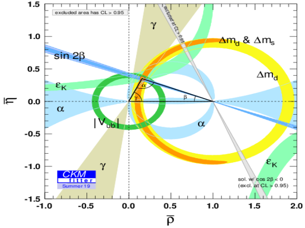


Outline

1. Summary of last time
2. Binning scheme

Summary of last time

- $B^\pm \to DK^\pm$, $D \to K^+K^-\pi^+\pi^-$, arXiv:hep-ph/0611272
- Model independent measurement with BESIII strong phase input
- Estimate 2000 B events from LHCb Run 1 and 2
  - Benchmark: $\sigma(\gamma) = 11^\circ$ from model dependent fit
  - LHCb amplitude model in AmpGen, arXiv:1811.08304
- Pull study to test and optimize binning scheme
  - Simulated 1000 experiments with 2000 events each
  - Strong phases from amplitude model using MC integration

Binning scheme

- Aim: Pick binning scheme to maximize $x_\pm$ and $y_\pm$ sensitivity

Event yield in bin i

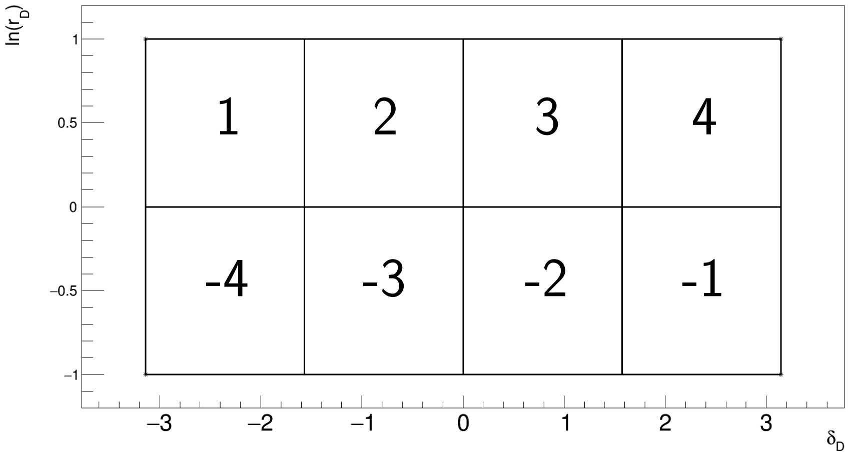
$$N_i^+ = h_{B^+}\left(\bar{K}_i + (x_+^2 + y_+^2)K_i + 2\sqrt{K_i\bar{K}_i}(x_+c_i - y_+s_i)\right)$$
$$N_{-i}^+ = h_{B^+}\left(K_i + (x_+^2 + y_+^2)\bar{K}_i + 2\sqrt{K_i\bar{K}_i}(x_+c_i + y_+s_i)\right)$$
$$x_\pm = r_B\cos(\delta_B \pm \gamma), \quad y_\pm = r_B\sin(\delta_B \pm \gamma)$$

- Previously: Rectangular parameterization of 5D phase space
- Better and simpler:
  - Generate C++ source code for amplitude model using AmpGen
  - Evaluate amplitude directly in analysis
  - Decide bin based on strong phase and amplitude ratio directly

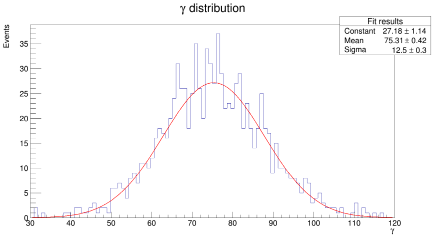
Strong phase and amplitude ratio

$$\mathcal{A}(D^0)/\mathcal{A}(\bar{D}^0) = r_D\exp(i\delta_D)$$

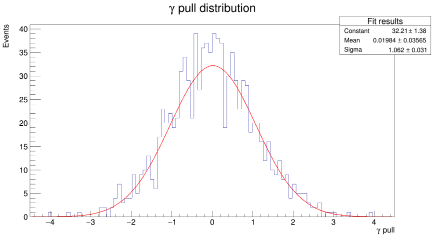
Naive ampltiude binning scheme



Pull study naive amplitude binning



(a) γ distribution



(b) γ pull

Achieved γ precision of $\sigma(\gamma) = 13^{\circ}$

Optimize bin widths

- Optimize $x_\pm$, $y_\pm$ sensitivity
- Vary bin edges, keep symmetric around $\delta_D = 0$

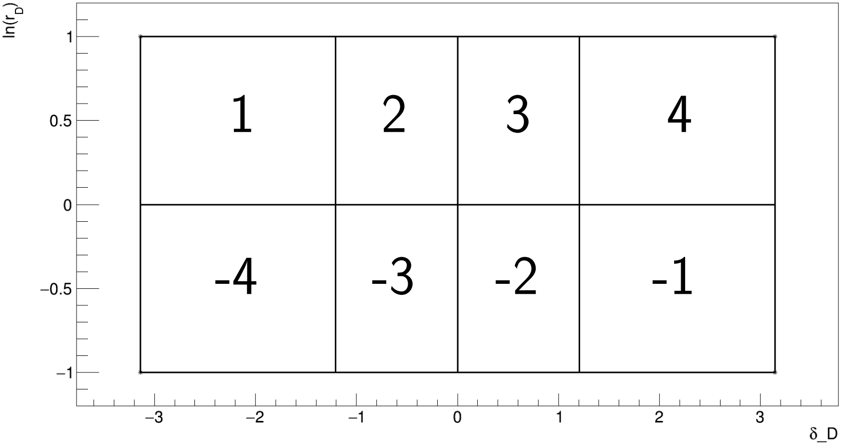
Binning Q value

$$Q^2 = 1 - \sum_i \frac{K_i \bar{K}_i (1 - c_i^2 - s_i^2)}{N_i} \Big/ \sum_i K_i$$

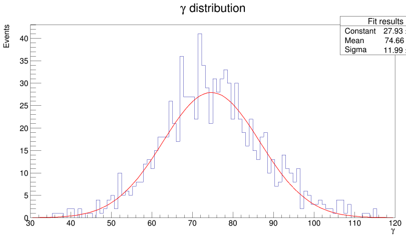
$$Q^2 \approx \sum_i N_i (c_i^2 + s_i^2) \Big/ \sum_i N_i$$

- Can achieve $Q \approx 0.90$ with 8 bins $\implies$ expect $\sigma(\gamma) = 12^\circ$

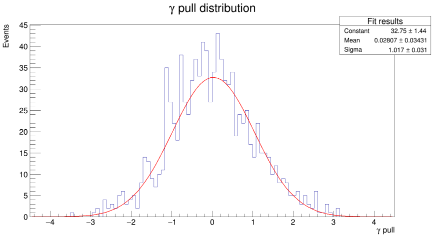
Variable widths binning scheme



Pull study with variable widths binning



(a) γ distribution



(b) γ pull

Achieved γ precision of $\sigma(\gamma) = 12^\circ$

Binning along r_D

- Further optmization by binning along r_D
- Claim: Can use **same** c_i and s_i in bin i and i'
- Can push $\sigma(\gamma)$ down by 0.5°-1°