The LHCb Experiment

- Designed specifically for precision B physics measurements
- B vertex resolution of the order of 100 μm
- Cherenkov detectors for particle identification

B→DK Decays

- Interference between decays of D and $\bar{D}$ into common final states gives sensitivity to $\gamma$
- Decay rates and kinematical distributions differ between $B^+$ and $B^-$
- Two body D decays: final state is CP eigenstate such as $K^*\pi$ or $\pi\pi$ (GLW Method) or non-CP eigenstate such as $K\pi\pi$ (ADS Method)
- Four body D decays: non-CP final state of $K\pi\pi\pi$ (ADS)
- Non-CP final states involve doubly Cabibbo suppressed decays and allow for enhanced interference effects
- Three body D decays: Dalitz space of the final states of $K\pi\pi$ and $K_{L3}K$ is compared (GGSZ Method)
- These $B^\pm \rightarrow DK^\pm$ modes are kinematically similar to the decay $B^\pm \rightarrow D\pi^\pm$

Three Body Decays


- 1.0 fb$^{-1}$ of 2011 pp collision data
- Analysis is independent of model assumptions on the strong phase variation across Dalitz space
- Looks at $D \rightarrow K_{L3}^0\pi^+\pi^-$ and $D \rightarrow K^0\bar{K}^+\pi^-$
- Sensitivity to $\gamma$ in the parameters $x = r_B \cos(\delta_B + \gamma)$ and $y = r_B \sin(\delta_B + \gamma)$

Two Body Decays


- 1.0 fb$^{-1}$ of 2011 pp collision data
- Looks at decay modes $D \rightarrow K^+K^-$, $D \rightarrow \pi^+\pi^-$ and $D \rightarrow K\pi$
- Multivariate analysis event selection
- First observation of the suppressed mode $B^\pm \rightarrow D(K^{\mp}\pi^\mp)K^\pm$
- Observation of direct CP violation in $B^\pm \rightarrow DK^\pm$ at the level of 5.8σ significance

External Inputs

- Using quantum correlated decays, CLEO-c has performed measurements of D coherence factors for $K\pi\pi$ decays [2] and a direct measurement of the strong phase difference for three body decays involving $K_2$ [3].
- These measurements are used as inputs for several LHCb analyses
- Binning choice for Dalitz plot in three body analysis is motivated by a desire to improve the statistical significance of the analysis

Conclusions

- Combining observables from different $B^\pm \rightarrow DK^\pm$ decay modes, a measurement of $\gamma$ can be made with greater precision than any individual mode
- Two body, three body and four body $B^\pm \rightarrow DK^\pm$ analyses have all provided useful inputs to $\gamma$ measurement – each with only 1 fb$^{-1}$ of 2011 data!

Combined Gamma Measurement

Presented at CKM 2012
LHCb-CONF-2012-032

- Includes $B^\pm \rightarrow DK^\pm$ information from these three analyses
- Measurement is already of competitive precision to that of full-dataset B-factory results
- Best fit value of $\gamma = 71.1^\circ$
- At 68% CL $\gamma \in [55.4, 87.7]^\circ$

CKM Angle $\gamma$

- Angle $\gamma$ of the CKM Unitarity Triangle (UT) is the only one that can be measured directly at tree level
- Direct measurement of $\gamma$ constrains the apex of the UT. Deviations from unitarity are a signal of new physics
- The angle $\gamma$ appears as the weak phase between $b \rightarrow u$ and $b \rightarrow c$ quark transitions

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