$D \to K^+K^-\pi^+\pi^-$ strong phase analysis at BESIII

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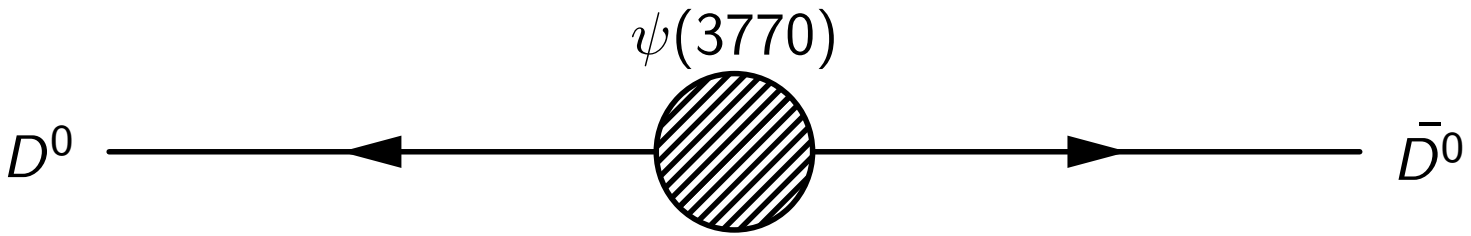
Recap of BESIII analysis

Analysis of $D^0 \to K^+K^-\pi^+\pi^-$

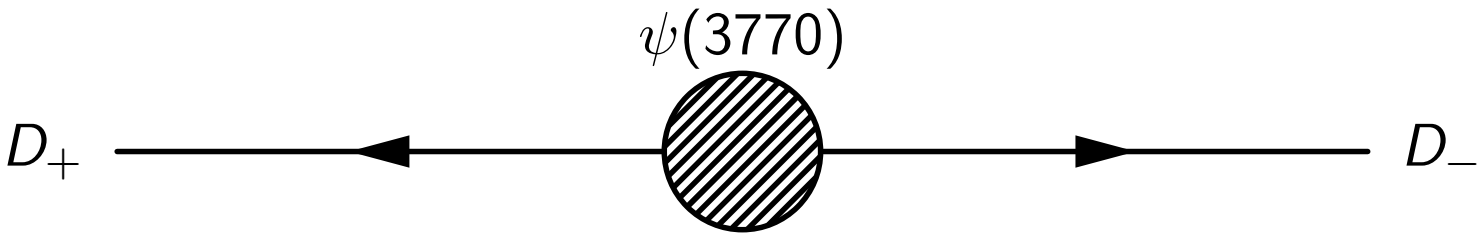
- Study D^0-$\bar{D}^0$ strong phase difference in bins of the 5D phase space
- Measurement of amplitude averaged strong phases c_i and s_i
- c_i and s_i are important inputs to the γ measurement at LHCb
  - LHCb result: $\gamma = (116^{+12}_{-14})^\circ$ with model dependent inputs
  - γ may change when updated with model independent c_i and s_i
- Measurement technique unique to charm factories: Study decays of quantum correlated $D\bar{D}$ pairs using a double tag method

Recap of BESIII analysis

- $\psi(3770) \to D^0 \bar{D}^0$ decay conserves $\mathcal{C} = -1$



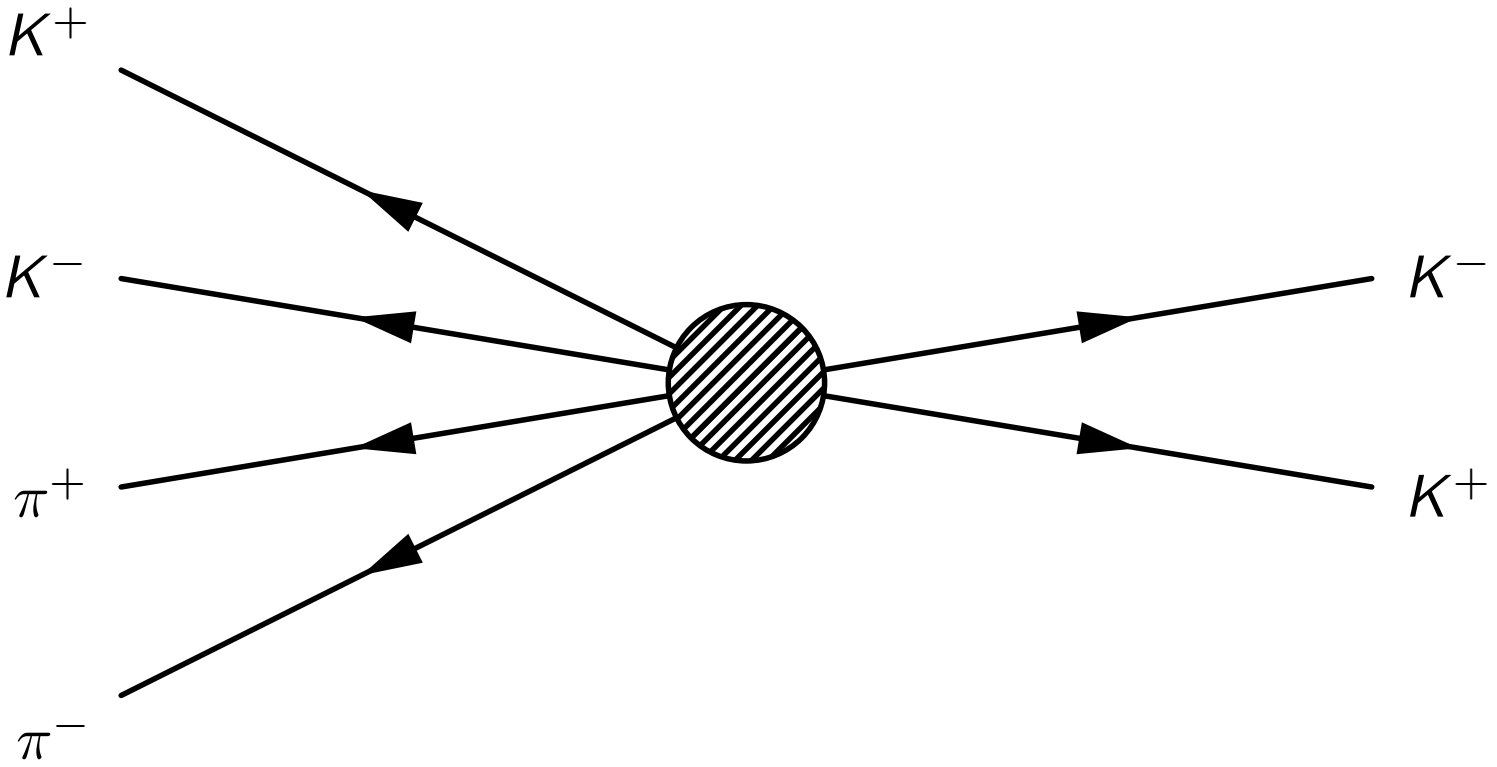
- But since they are quantum correlated, we must consider their CP eigenstates $D_\pm = (|D^0\rangle \pm |\bar{D}^0\rangle)/\sqrt{2}$
- Total wavefunction is $|D^0\rangle|\bar{D}^0\rangle - |\bar{D}^0\rangle|D^0\rangle = |D_+\rangle|D_-\rangle + |D_-\rangle|D_+\rangle$



The two D mesons do not communicate, but the $D \to KK\pi\pi$ decay is perfectly correlated with the tagged D

Strong-phases in quantum correlated $D^0\bar{D}^0$ decays

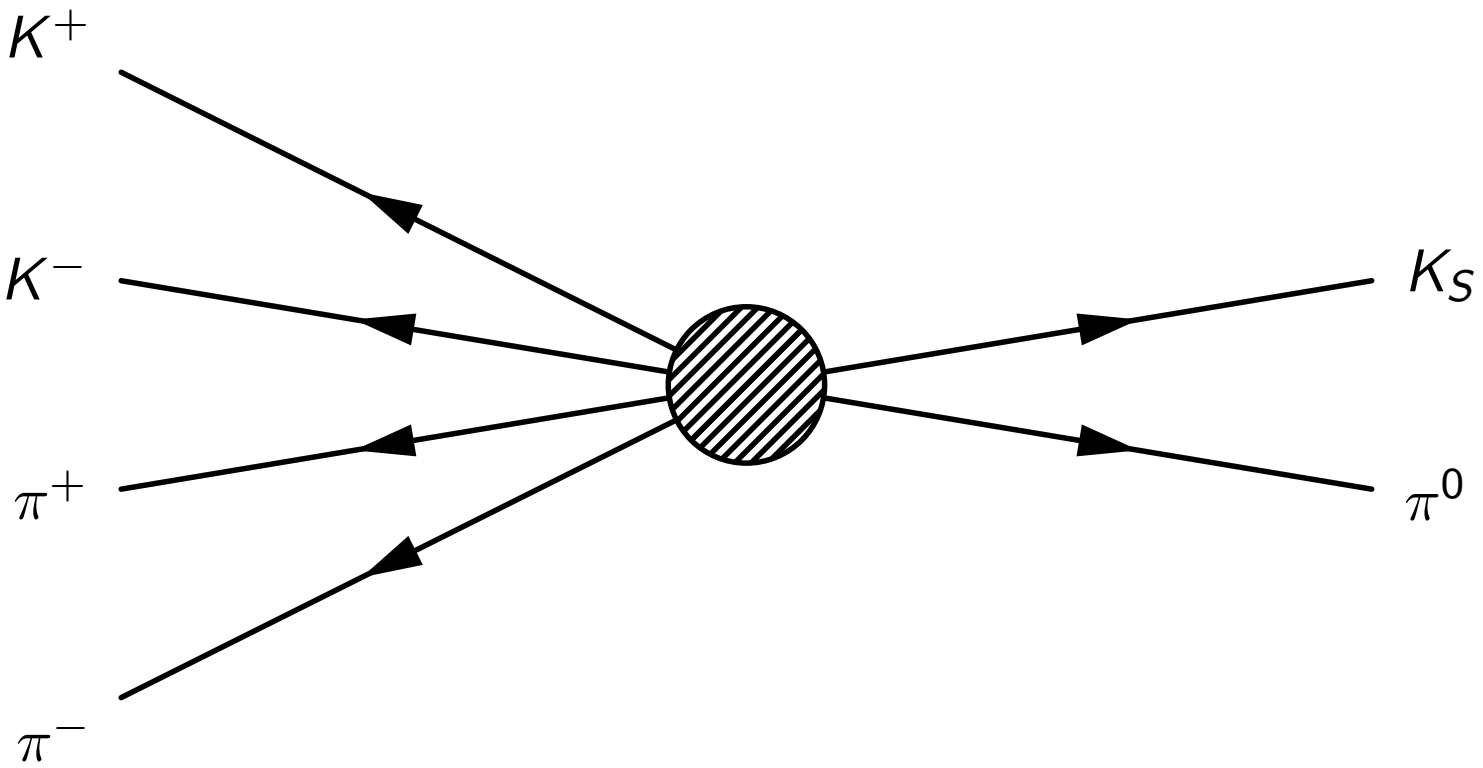
- Tag mode can be a CP even tag
  - KK, $\pi\pi$, $\pi\pi\pi^0$, $K_S\pi^0\pi^0$, $K_L\pi^0$, $K_L\omega$



$D \to K^+K^-$, which is CP even, forces $D \to K^+K^-\pi^+\pi^-$ to be CP odd

Strong-phase in quantum correlated $D^0\bar{D}^0$ decays

- Tag mode can be a CP odd tag
  - $K_S\pi^0$, $K_S\omega$, $K_S\eta$, $K_S\eta'$, $K_L\pi^0\pi^0$



$D \to K^0_S\pi^0$, which is CP odd, forces $D \to K^+K^-\pi^+\pi^-$ to be CP even

Fit yield of some CP tags

Do simultaneous double tag yield fit of CP tags

(a) $10.2^{+6.7}_{-3.9}$ **(b)** $14.4^{+4.8}_{-4.1}$

Figure 1: $KK\pi\pi$ vs KK

Summary and next steps

- BESIII measurement of c_i and s_i is progressing well
- A partially reconstructed $D \to KK\pi\pi$ method has been tested, but there were some challenges with large $D \to K\pi\pi\pi^0$ backgrounds
- The preliminary fit of c_i and s_i shows promising results
  - A method for direct DCS decay corrections is working well
  - Results of c_i agree with the F_+ measurement
  - s_i shows tensions with the LHCb model
- Next steps:
  1. Finish calculation of peaking backgrounds in each bin
  2. Reprocess all data and generate new MC once new data is available
  3. Add the rest of the tags
  4. Charm WG review

Thank you for listening!