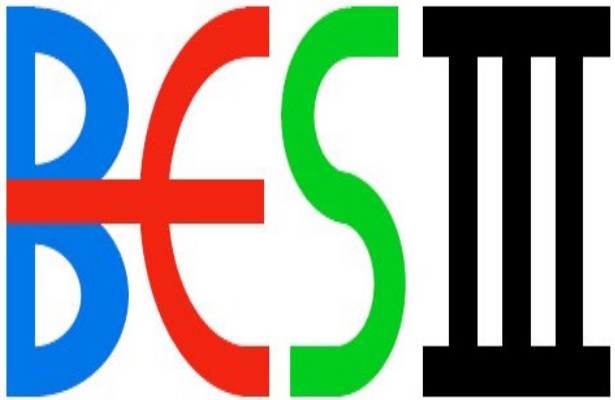
BESIII Oxford Group Meeting

Martin Tat

Oxford LHCb

17th February 2022

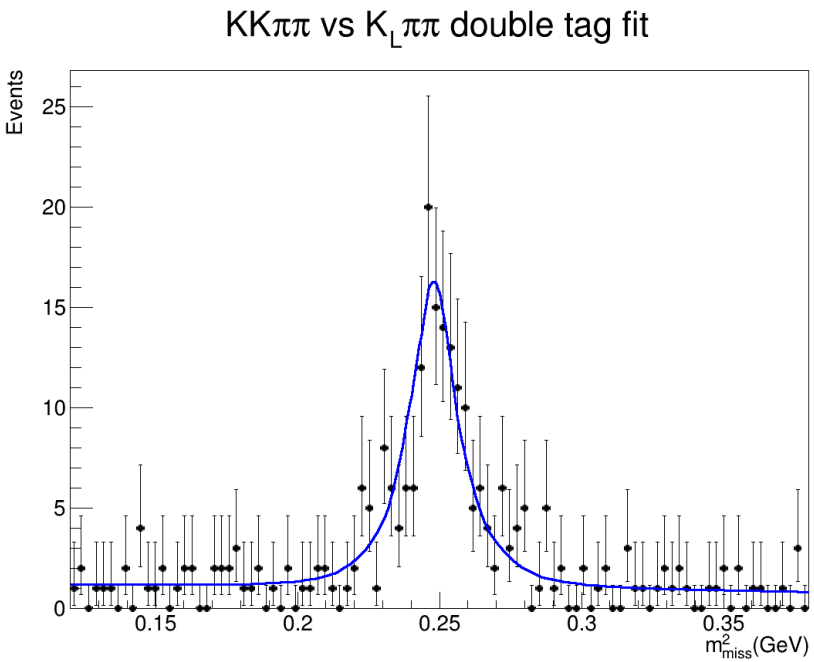


Outline

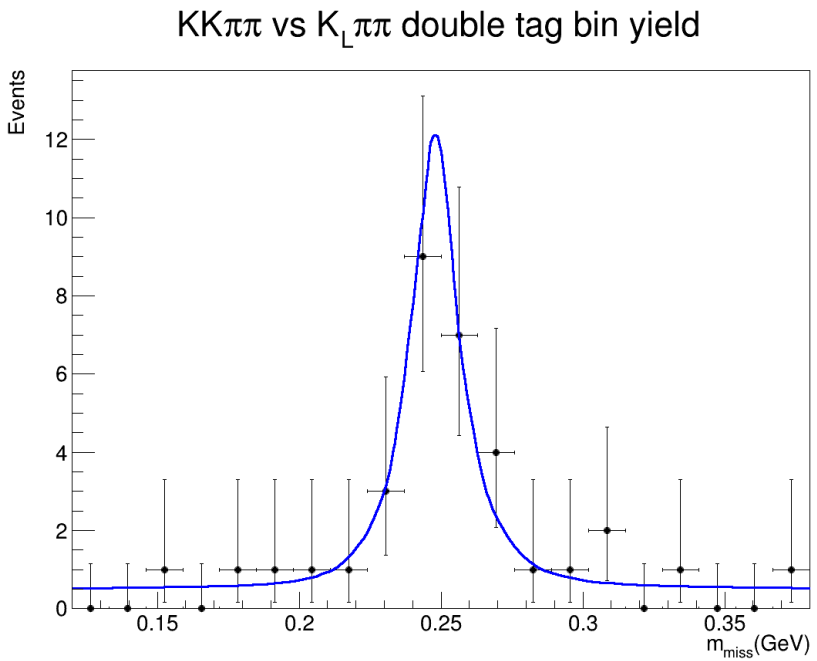
1. $K_L\pi\pi$ partially reconstructed tag
2. Partially reconstructed $KK\pi\pi$ vs $K_S\pi\pi$
3. Quantum correlation correction of K_SKK background

$K_L\pi\pi$ partially reconstructed tag

- Previously: Non-sensible Kalman kinematic fits
- Cause: A single mass constraint insufficient with missing momentum
- Solution: Fit whole $D^0\bar{D}^0$ decay tree



(a) Inclusive

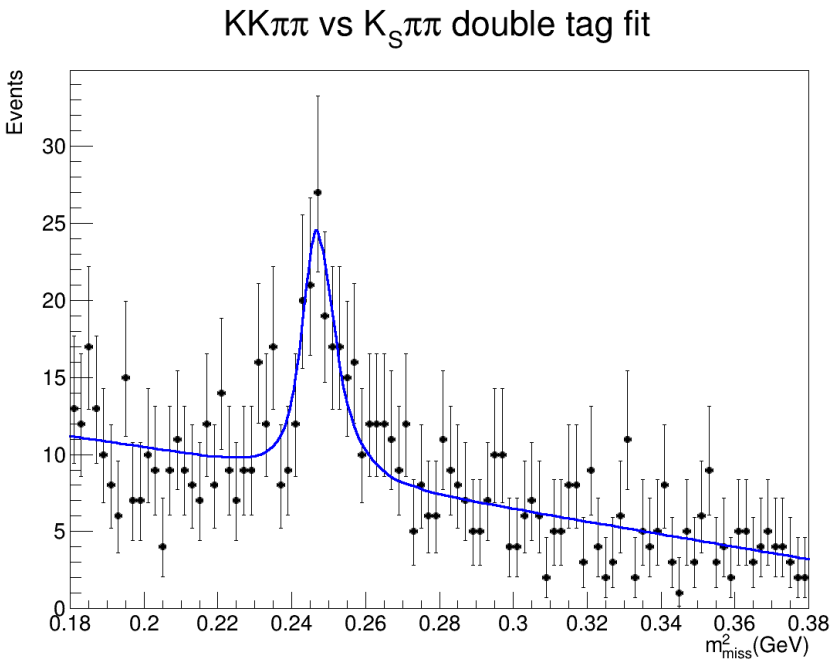


(b) $KK\pi\pi$ bin 1+2, $K_S\pi\pi$ bin 6+7+8

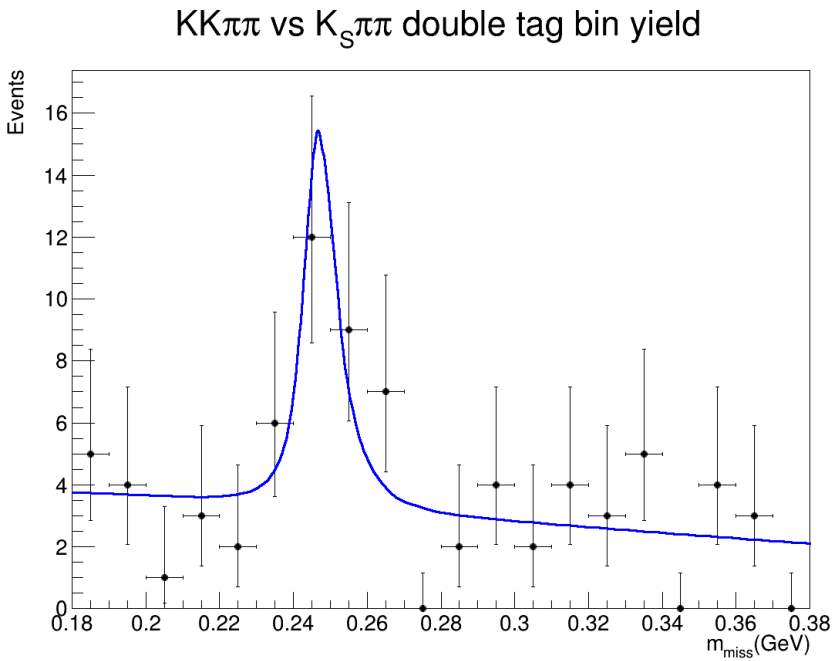
Figure 1: Signal shape from MC, background is 1st order polynomial

Partially reconstructed $KK\pi\pi$ vs $K_S\pi\pi$

- Reconstruct $K_S\pi\pi$ first
- Require exactly 3 charged tracks on the other side ($K\pi\pi$)
- Problem: Large, non-peaking background under signal!



(a) Inclusive

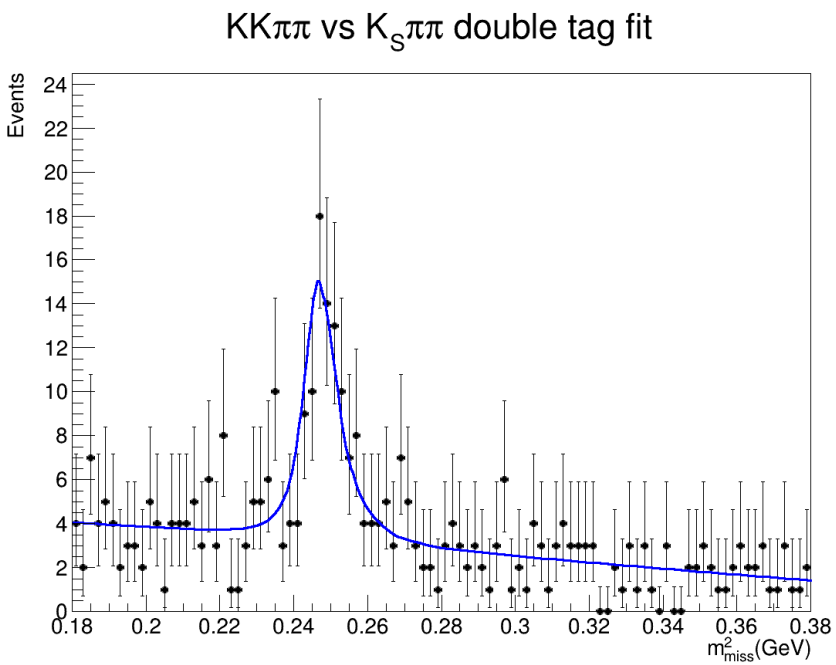


(b) $KK\pi\pi$ bin 1+2, $K_S\pi\pi$ bin 6+7+8

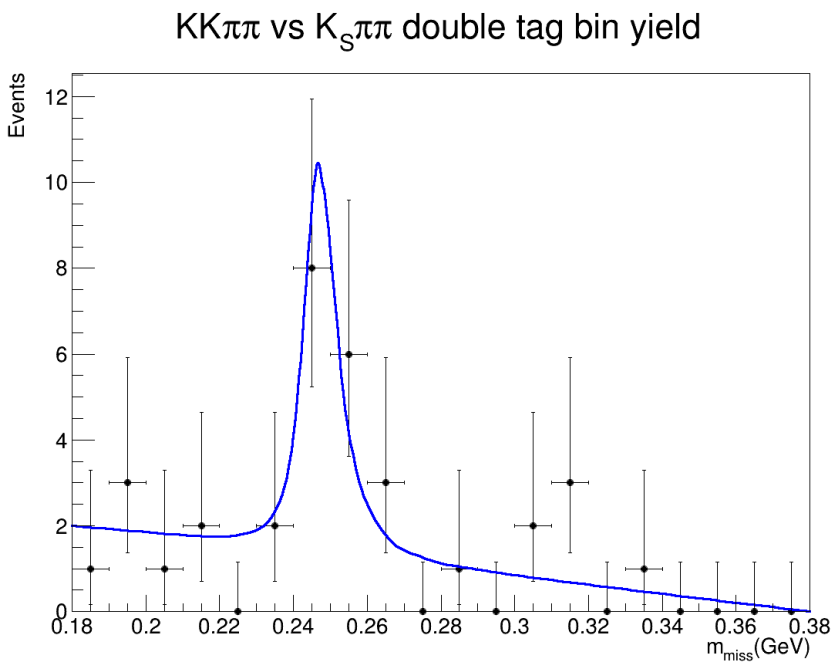
Figure 2: Signal shape from MC, background is 1st order polynomial

Partially reconstructed $KK\pi\pi$ vs $K_S\pi\pi$

- Background mostly from $K\pi\pi\pi\pi^0$
- Veto any events with π^0



(a) Inclusive



(b) $KK\pi\pi$ bin 1+2, $K_S\pi\pi$ bin 6+7+8

Figure 3: Signal shape from MC, background is 1st order polynomial

Summary of $K^0\pi\pi$ yields and efficiencies

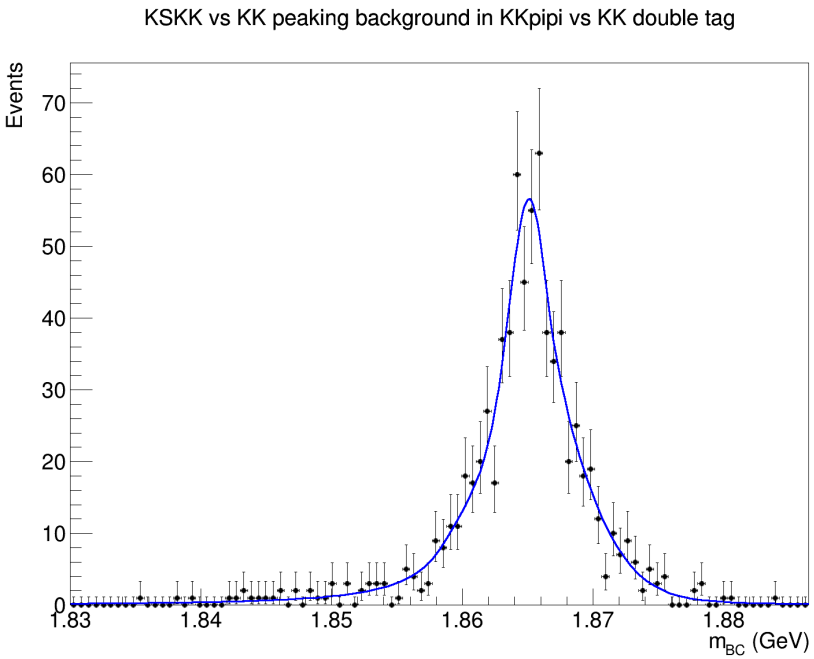
Mode	Inclusive yield	Double tag efficiency
$K_L\pi\pi$ (fully reconstructed)	158.7	6.93 ± 0.04
$K_S\pi\pi$ (fully reconstructed)	67.2	6.63 ± 0.04
$K_S\pi\pi$ (partially reconstructed)	85.9	6.50 ± 0.03
$K_S\pi\pi$ (part reco, no π^0 veto)	116.0	9.04 ± 0.04

Quantum correlation correction of $K_S KK$ background

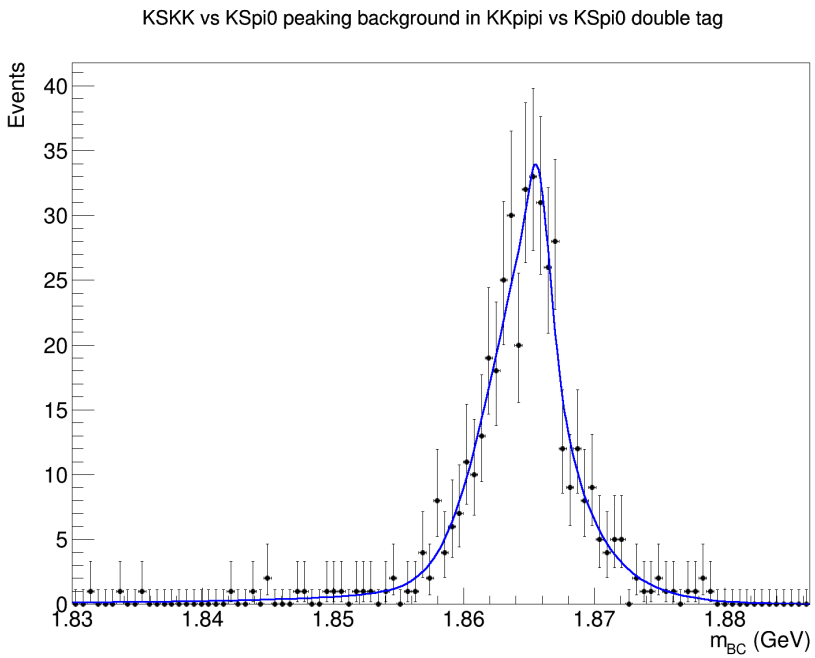
- $K_S KK \to KK\pi\pi$ is a background in all tags
- Must account for QC in CP tags
- $K_S KK$ $F_+ = 0.524 \pm 0.018$ from $F_+ = \frac{1}{2} + \sum_i \sqrt{K_i K_{-i}} c_i$
  - Similar constributions from $K_S \phi$ (odd) and $K_S a_0(980)^0$ (even)
- Strategy:
  1. Generate signal MC of $K_S KK$ vs CP tag
  2. Account for relative bin efficiency
  3. Calculate "effective" F_+
- Results:
  - KK tag (even): $F_+ = 0.726 \pm 0.030$
  - $K_S \pi^0$ tag (odd): $F_+ = 0.840 \pm 0.034$

Quantum correlation correction of $K_S KK$ background

- To first order $K_S KK$ background is independent of tag mode
- Use KK and $K_S\pi^0$ shape and "effective" F_+ for CP even and odd tags, respectively



(a) KK tag



(b) $K_S\pi^0$ tag

Figure 4: $K_S KK$ background shape for CP even and odd tags

Conclusion and next steps

- Conclusion:
  - $K_L\pi\pi$ tag works with sensible yields
  - Partially reconstructed $KK\pi\pi$ vs $K_S\pi\pi$ increases sensitivity to s_i
  - Quantum correlation of $K_SKK \to KK\pi\pi$ background is accounted for with "effective" F_+ in CP tags

- Next steps:
  1. Finalize treatment of peaking backgrounds in all CP tags
  2. Combine all single and double tag yields, after efficiency corrections, to fit $KK\pi\pi$ F_+
  3. Binned analysis of $K_S\pi\pi$ and $K_L\pi\pi$ in F_+ measurement