BESIII Oxford Group Meeting

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Introduction

- $K_{S,L}KK$ double tag yields for $\delta_D^{K\pi}$ measurement
- Finalized K_LKK events tagged with $K\pi$, $K\pi\pi^0$, $K\pi\pi\pi$
- Peaking background subtraction
- K_SKK vs $Ke\nu$ yields a bit off...

Partially reconstructed double tags

- $K_S KK$ vs $Ke\nu$ and $K_L KK$ vs $K\pi$, $K\pi\pi^0$, $K\pi\pi\pi$
- More peaking backgrounds
- More sophisticated sideband subtraction (from $K_S KK$ MEMO):
- S: Signal region, L: Lower sideband, H: Upper sideband

$$Y_S = \frac{(N_S - N_S^P) - \delta(N_L - N_L^P) - \gamma(N_H - N_H^P)}{1 - \delta\alpha - \gamma\beta}$$

$$\delta, \gamma = \frac{\text{Flat background in S}}{\text{Flat background in L, H}}, \quad \alpha, \beta = \frac{\text{Signal in S}}{\text{Signal in L, H}}$$

- α, β, γ, δ shared between all bins
- α, β from signal MC, γ, δ from inclusive MC

Updated K_L reconstruction

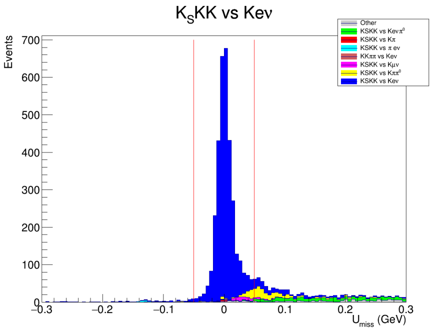
- Previously:
  - No additional good tracks
  - Either: Shower at $\cos(\alpha) > 0.98$ from K_L
  - Or: Shower energy $E_{\text{shower}} < 0.29\,\text{GeV}$
- New K_L selection (Study by Anita)
  - No additional tracks (good and bad)
  - Much less peaking background from $K_S \to \pi^+\pi^-$
  - Lower efficiency but higher purity
  - Matches MC much better

Peaking backgrounds

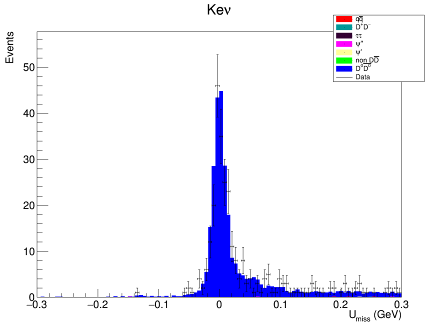
- $K_S KK$ backgrounds in $K_L KK$:
  - Get fraction of $K_L KK$ to $K_S KK$ from signal MC
  - Scale the corresponding double tag yield of $K_S KK$ in each bin
- Other peaking backgrounds in each bin fixed from inclusive MC
  - Correct outdated branching fractions

Mode	Branching fraction correction
$K_{S,L} KK$	1.44
$KK\pi\pi$	1.14
$K\pi\pi\pi$	1.03
$K_S K\pi$	0.68
$K\pi\pi^0$	1.04

$K_S KK$ vs $Ke\nu$



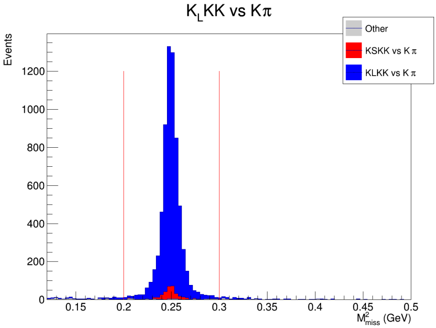
(a) $D^0\bar{D}^0$ peaking backgrounds



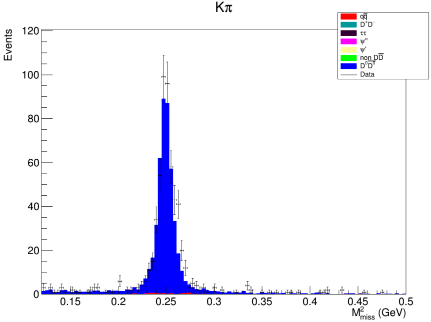
(b) Full inclusive MC

Figure 1: U_{miss} for $K_S KK$ vs $Ke\nu$

$K_L KK$ vs $K\pi$



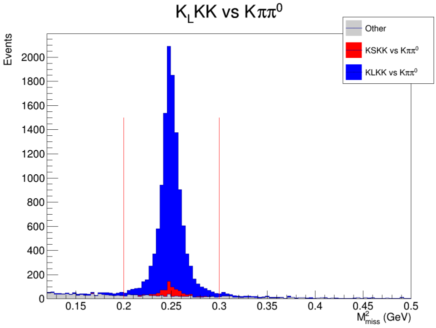
(a) $D^0\bar{D}^0$ peaking backgrounds



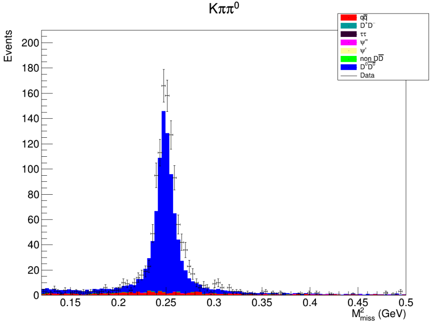
(b) Full inclusive MC

Figure 2: M^2_{miss} for $K_L KK$ vs $K\pi$

$K_L KK$ vs $K\pi\pi^0$

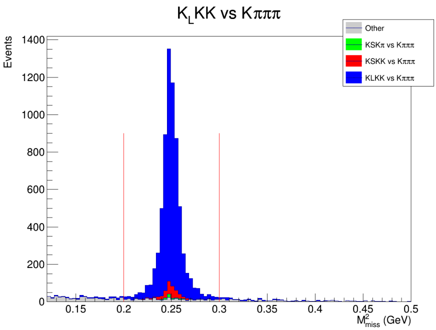


(a) $D^0\bar{D}^0$ peaking backgrounds

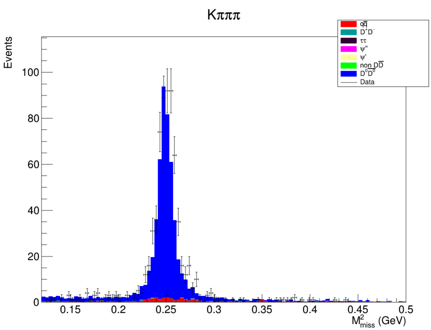


(b) Full inclusive MC

Figure 3: M^2_{miss} for $K_L KK$ vs $K\pi\pi^0$



(a) $D^0\bar{D}^0$ peaking backgrounds



(b) Full inclusive MC

Figure 4: M^2_{miss} for $K_L KK$ vs $K\pi\pi\pi$

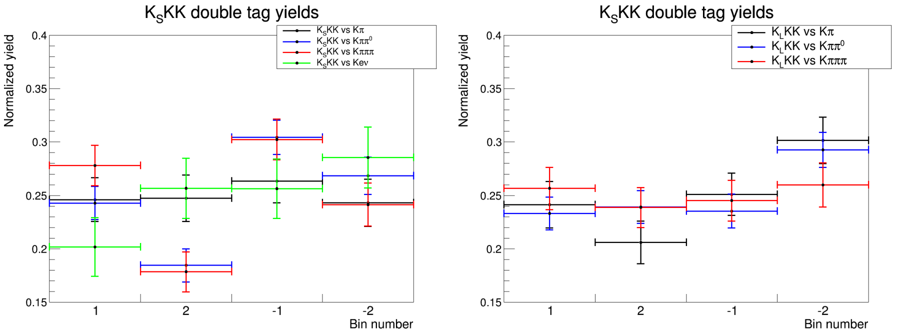
$K_S KK$ double tag yields

Bin	1	2	-1	-2
$K_S KK$ vs $K\pi$ raw yield	89	72	94	69
$K_S KK$ vs $K\pi$ corrected yield	642.5	646.1	688.2	634.5
$K_S KK$ vs $K\pi$ normalized yield	0.246	0.247	0.264	0.243
$K_S KK$ vs $K\pi\pi^0$ raw yield	156	101	201	140
$K_S KK$ vs $K\pi\pi^0$ corrected yield	2862.5	2175.1	3589.9	3165.1
$K_S KK$ vs $K\pi\pi^0$ normalized yield	0.243	0.184	0.304	0.268
$K_S KK$ vs $K\pi\pi\pi$ raw yield	117	68	135	88
$K_S KK$ vs $K\pi\pi\pi$ corrected yield	1696.8	1089.0	1846.6	1473.5
$K_S KK$ vs $K\pi\pi\pi$ normalized yield	0.278	0.178	0.302	0.241
$K_S KK$ vs $Ke\nu$ raw yield	49	46	63	50
$K_S KK$ vs $Ke\nu$ corrected yield	434.9	553.0	552.3	615.2
$K_S KK$ vs $Ke\nu$ normalized yield	0.202	0.257	0.256	0.285

$K_S KK$ double tag yields

Bin	1	2	-1	-2
$K_L KK$ vs $K\pi$ raw yield	148	102	144	130
$K_L KK$ vs $K\pi$ corrected yield	962.9	821.3	1001.5	1203.0
$K_L KK$ vs $K\pi$ normalized yield	0.241	0.206	0.251	0.302
$K_L KK$ vs $K\pi\pi^0$ raw yield	302	234	319	264
$K_L KK$ vs $K\pi\pi^0$ corrected yield	3558.7	3650.8	3593.9	4469.6
$K_L KK$ vs $K\pi\pi^0$ normalized yield	0.233	0.239	0.235	0.293
$K_L KK$ vs $K\pi\pi\pi$ raw yield	182	134	175	136
$K_L KK$ vs $K\pi\pi\pi$ corrected yield	2545.6	2368.8	2431.5	2577.0
$K_L KK$ vs $K\pi\pi\pi$ normalized yield	0.257	0.239	0.245	0.260

Normalized yields

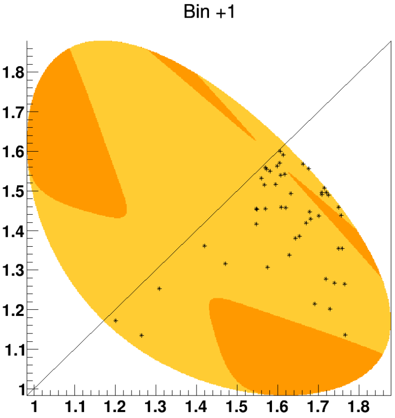


(a) $K_S KK$ **(b)** $K_L KK$

Figure 5: Double tag yields

- Errors:
  - Raw yields: Poisson ($\sqrt{N}$)
  - Peaking backgrounds: Poisson ($\sqrt{N}/21.8$)
  - Efficiencies: Binomial

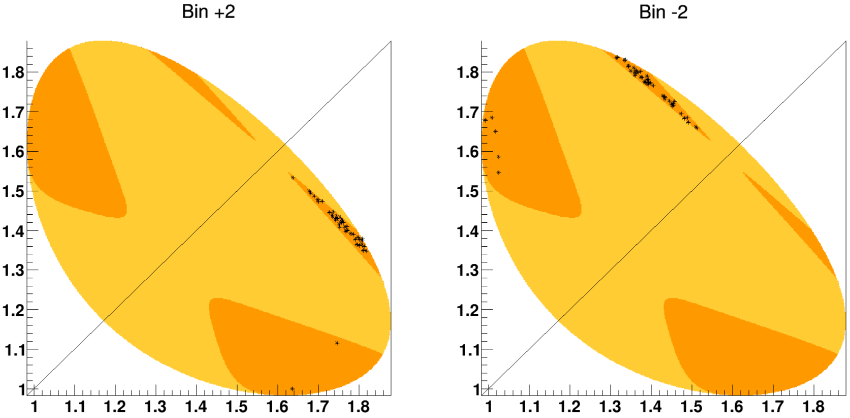
$Ke\nu$ Dalitz distributions



(a) Bin $+1$ **(b)** Bin -1

Figure 6: Dalitz distributions of $K_S KK$ vs $Ke\nu$

$Ke\nu$ Dalitz distributions



(a) Bin $+2$ **(b)** Bin -2

Figure 7: Dalitz distributions of $K_S KK$ vs $Ke\nu$

Next steps

- Flavour tag correction
- Amplitude model for $D \to K_{S,L} h^+ h^-$?

$$f_i = \frac{\int_i |f(m_+^2, m_-^2)|^2 dm_+^2 dm_-^2}{\int_i (|f(m_+^2, m_-^2)|^2 + (r_D^F)^2 |f(m_-^2, m_+^2)|^2 - 2 r_D^F R_F \mathcal{R}[e^{i\delta_D^F} f(m_+^2, m_-^2) f^*(m_-^2, m_+^2)]) dm_+^2 m_-^2}, \tag{20}$$

$$f_i' = \frac{\int_i |f'(m_+^2, m_-^2)|^2 dm_+^2 dm_-^2}{\int_i (|f'(m_+^2, m_-^2)|^2 + (r_D^F)^2 |f'(m_-^2, m_+^2)|^2 + 2 r_D^F R_F \mathcal{R}[e^{i\delta_D^F} f'(m_+^2, m_-^2) f'^*(m_-^2, m_)^2]) dm_+^2 m_-^2}, \tag{21}$$