

BESIII Oxford Group Meeting

Martin Tat

Oxford LHCb

11th March 2021



Introduction

- Double tagged $D \rightarrow K^+ K^- \pi^+ \pi^-$ events
- Previously: KK , $K\pi$, $K\pi\pi^0$, $K_S\pi^0$ tags
- Current progress: Have now implemented the following tags:
- CP tags:
 - KK , $\pi\pi$, $K_S\pi^0$, $K_S\pi^0\pi^0$, $\pi\pi\pi^0$, $K_S\eta$, $K_S\eta'(\pi\pi\eta)$, $K_S\eta'(\rho\gamma)$, $K_S(\eta,\omega)(\pi\pi\pi^0)$, $K_S\phi$
- CP conjugate tags:
 - $K_S\pi\pi$, $KK\pi\pi$
- Flavour tags:
 - $K\pi$, $K\pi\pi^0$
- Ran over full 2010 and 2011 MC $D^0\bar{D}^0$ sample (20x luminosity)

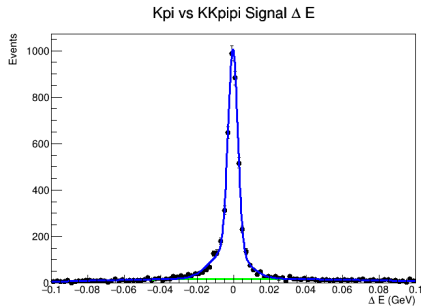
Selection procedure

- Standard cuts in the DTagTool package
- $\pi^0 \rightarrow \gamma\gamma$ with $0.110 \text{ GeV} < m(\gamma\gamma) < 0.155 \text{ GeV}$
- $\eta \rightarrow \gamma\gamma$ with $0.480 \text{ GeV} < m(\gamma\gamma) < 0.580 \text{ GeV}$
- $K_S \rightarrow \pi\pi$, flight significance cut at 2
- All $\pi\pi$ combinations have a flight significance cut at 2
- $\phi \rightarrow KK$, with $|m(KK) - m_{\text{PDG}}(\phi)| < 0.020 \text{ GeV}$
- $\eta' \rightarrow \pi\pi\eta$, with $0.940 \text{ GeV} < m(\pi\pi\eta) < 0.976 \text{ GeV}$
- $\eta' \rightarrow \pi\pi\gamma$, with $0.940 \text{ GeV} < m(\pi\pi\gamma) < 0.970 \text{ GeV}$
- $\eta \rightarrow \pi\pi\pi^0$, with $0.530 \text{ GeV} < m(\pi\pi\pi^0) < 0.565 \text{ GeV}$
- $\omega \rightarrow \pi\pi\pi^0$, with $0.750 \text{ GeV} < m(\pi\pi\pi^0) < 0.820 \text{ GeV}$

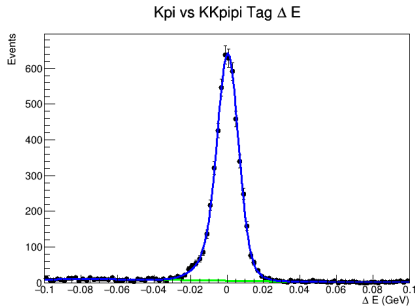
Cut on ΔE

- Fit double Gaussian and 2nd order polynomial to ΔE
- Cut at $(-3\sigma, +3\sigma)$ for modes without π^0
- Cut at $(-4\sigma, +3\sigma)$ for modes with π^0 (what about η ?)
- Fit both signal and tag side

ΔE cut on $K\pi$ mode

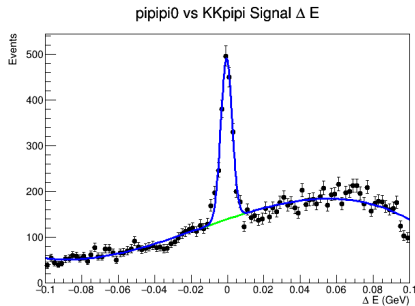


(a) ΔE , $KK\pi\pi$

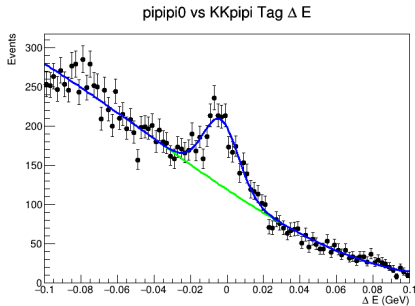


(b) ΔE , $K\pi$

ΔE cut on $\pi\pi\pi^0$ mode

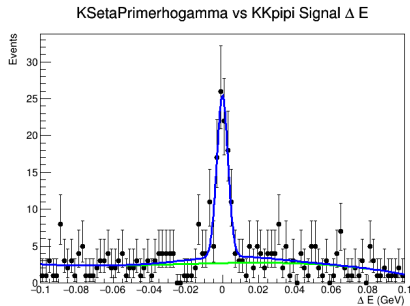


(a) $\Delta E, KK\pi\pi$

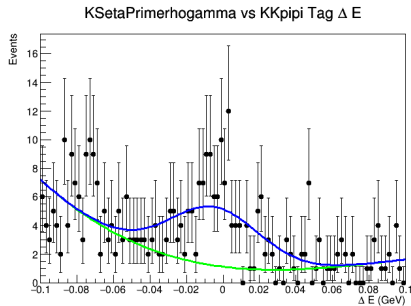


(b) $\Delta E, \pi\pi\pi^0$

ΔE cut on $K_S\eta'(\pi\pi\gamma)$ mode

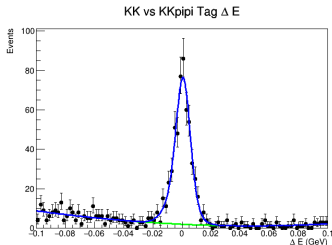


(a) $\Delta E, KK\pi\pi$

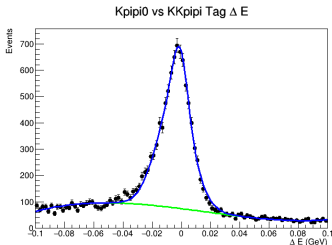


(b) $\Delta E, K_S\eta'(\pi\pi\gamma)$

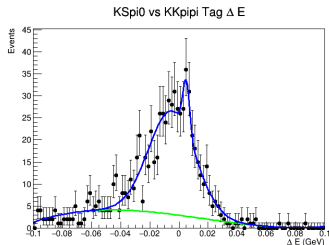
ΔE cut on other modes



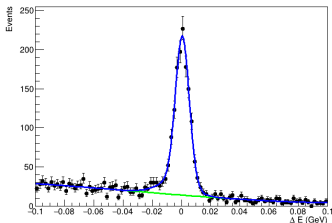
(a) ΔE , KK



(b) ΔE , $K\pi\pi^0$

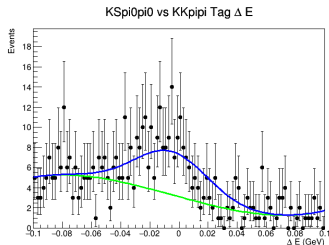


(c) ΔE , $K_S\pi^0$

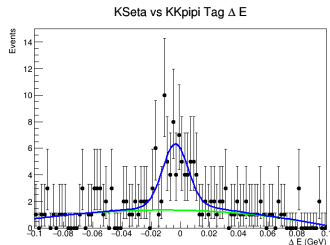


(d) ΔE , $K_S\pi\pi$

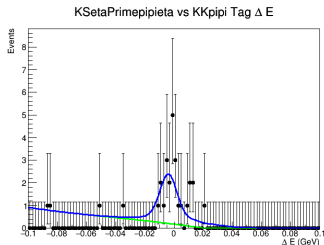
ΔE cut on other modes



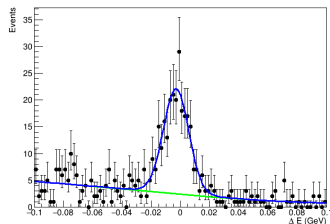
(a) $\Delta E, K_S \pi^0 \pi^0$



(b) $\Delta E, K_S \eta$

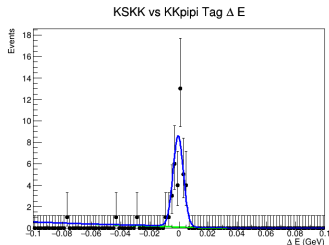


(c) $\Delta E, K_S \eta'(\pi\pi\eta)$

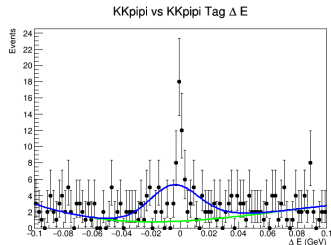


(d) $\Delta E, K_S(\eta, \omega)(\pi\pi\pi^0)$

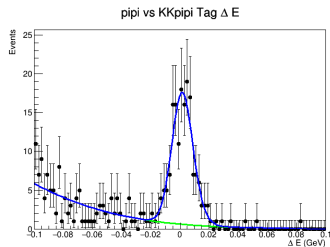
ΔE cut on other modes



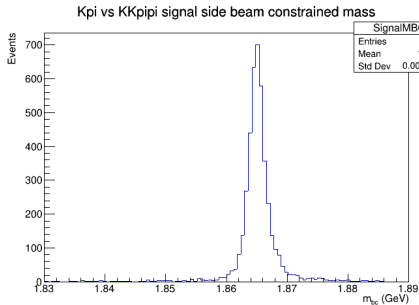
(a) ΔE , $K_S KK$



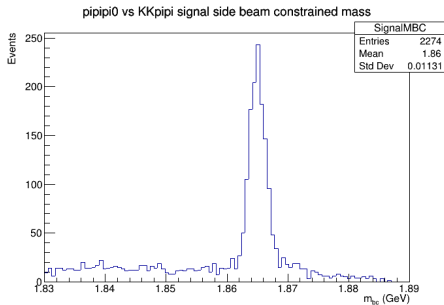
(b) ΔE , $KK\pi\pi$



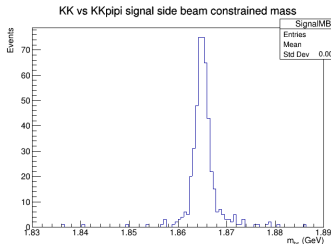
(c) ΔE , $\pi\pi$



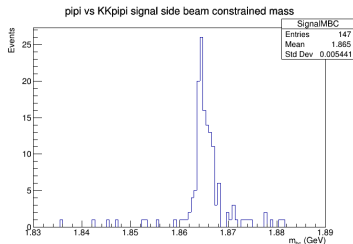
(a) $m_{BC}, K\pi$



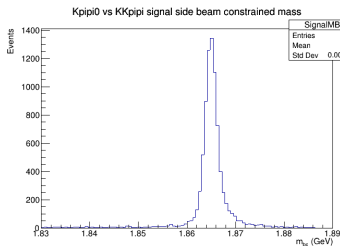
(b) $m_{BC}, \pi\pi\pi^0$



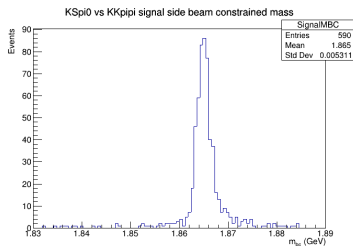
(a) m_{BC}, KK



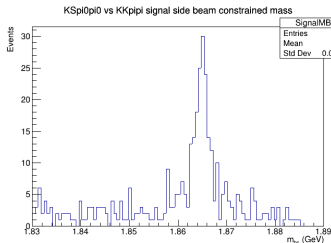
(b) $m_{BC}, \pi\pi$



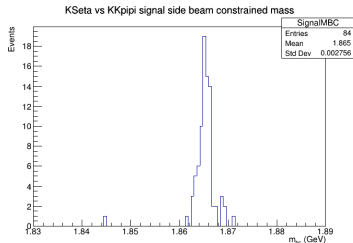
(c) $m_{BC}, K\pi\pi^0$



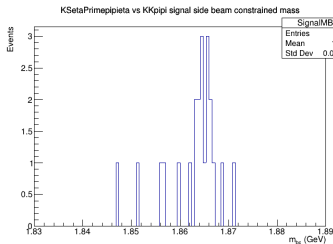
(d) $m_{BC}, K_S\pi^0$



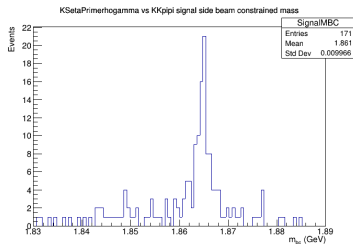
(a) $m_{BC}, KS\pi^0\pi^0$



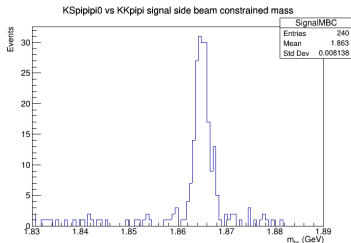
(b) $m_{BC}, KS\eta$



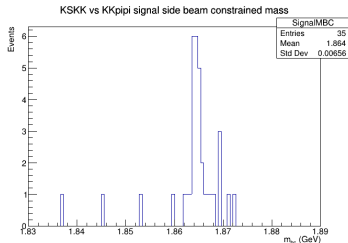
(c) $m_{BC}, KS\eta'(\pi\pi\eta)$



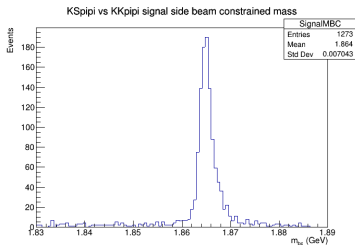
(d) $m_{BC}, KS\eta'(\pi\pi\gamma)$



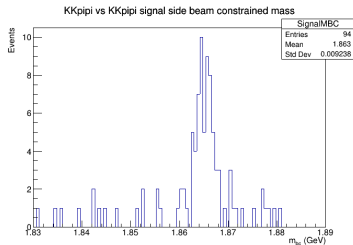
(a) $m_{BC}, K_S(\eta, \omega)(\pi\pi\pi^0)$



(b) $m_{BC}, K_S KK$



(c) $m_{BC}, K_S \pi\pi$



(d) $m_{BC}, KK\pi\pi$

Flat background estimate

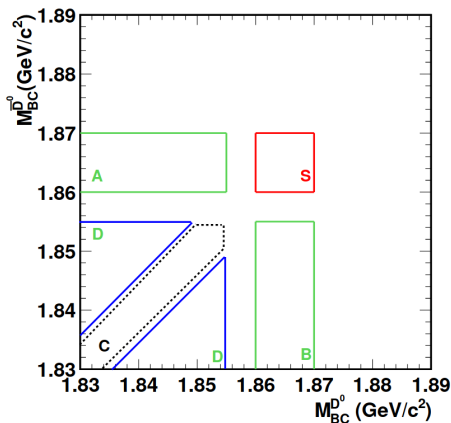


Figure 11: m_{BC} plane, BESIII $K_S^0 K^+ K^-$ MEMO

$$F = \frac{a_S}{a_D} D + \sum_{i=A,B,C} \frac{a_S}{a_i} \left(i - \frac{a_S}{a_i} D \right)$$

Flat background estimate

Tag mode	Yield	Background
$K\pi\pi^0$	6898	178.5
$K\pi\phi$	3855	32.8
$\pi\pi\pi^0$	1295	14.4
$K_S\pi\pi$	1043	7.3
K_π^0	481	4.8
KK	413	8.0
$K_S(\eta, \omega)(\pi\pi\pi^0)$	183	1.3
$K_S\pi^0\pi^0$	149	10.6
$\pi\pi$	122	2.6
$K_S\eta'(\pi\pi\gamma)$	79	5.0
$K_S\eta$	68	5.6
$KK\pi\pi$	52	6.1
$K_S\phi$	28	1.2
$K_S\eta'(\pi\pi\eta)$	15	0.8

Next steps

- Implement K_L tag modes
 - $K_L\pi^0$, $K_L\omega$, $K_L\pi^0\pi^0$
- Run over data