BESIII Oxford Group Meeting

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Introduction

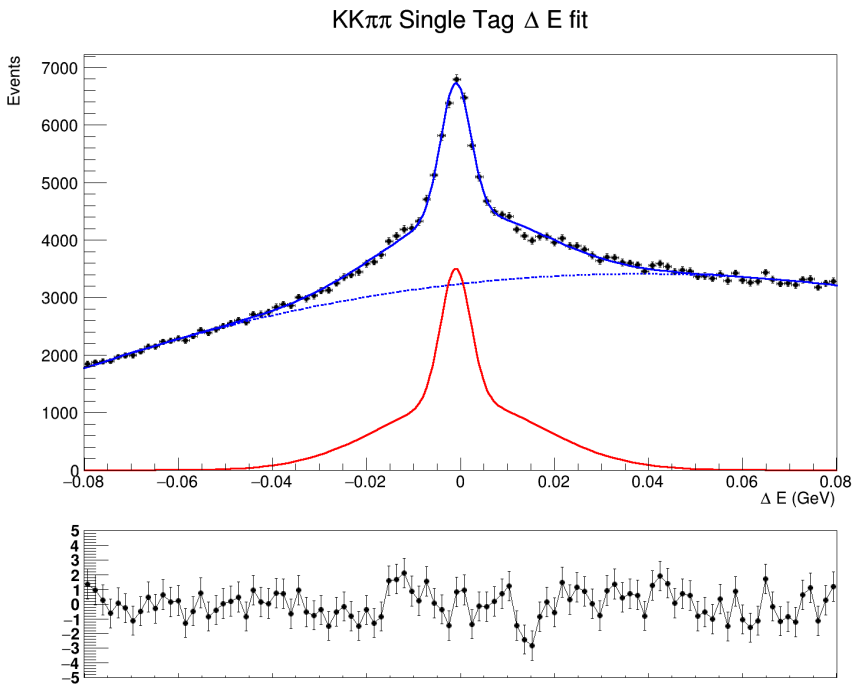
- $D \to K^+K^-\pi^+\pi^-$ analysis
- Previously: Fit to ΔE and m_{BC} to get $KK\pi\pi$ ST yield
  - Issue: Strange ΔE shape
- Current progress:
  - Found possible explanation for ΔE shape
  - Looked at $K_S KK$ background, found asymmetric veto range

MC samples

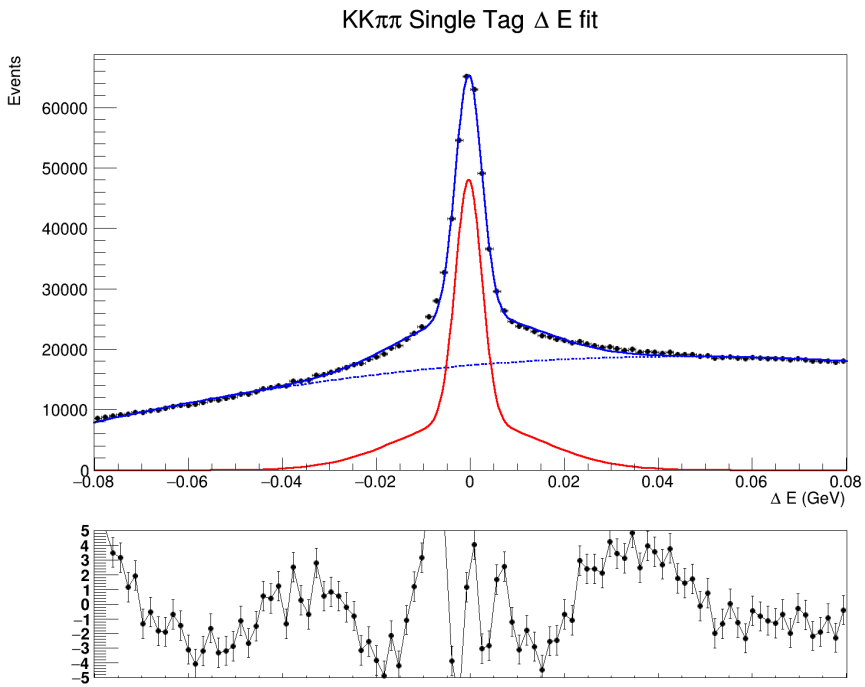
MC sample	Events (10^6)	Luminosity scale (2010/2011)
$D^0\bar{D}^0$	74	21.8/21.8
D^+D^-	29	10.9/10.8
$q\bar{q}$	122	7.8/7.3
$\psi(2S)\gamma$	34	10.8/10.1
$J/\psi\gamma$	22	10.8/10.1
$\tau\tau$	60	10.8/10.1
non-$D\bar{D}$	10	10.8/10.1

- Did not run over ee and $\mu\mu$ MC

Previous ΔE fit in data vs MC



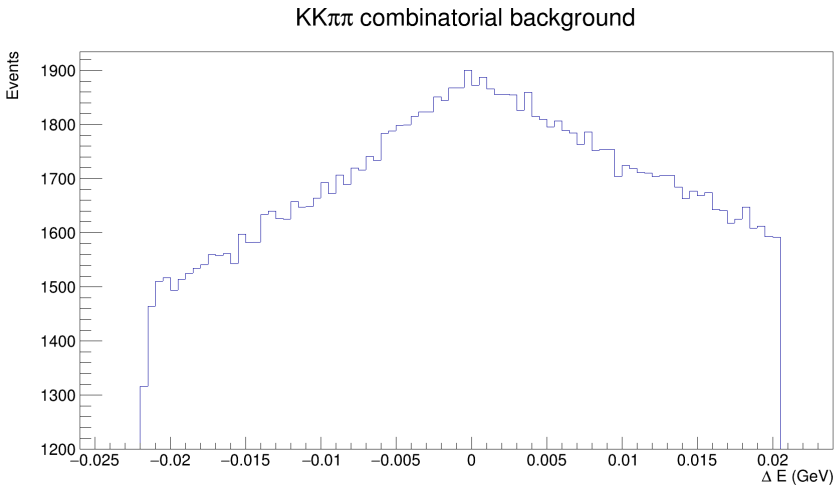
(a) ΔE, data



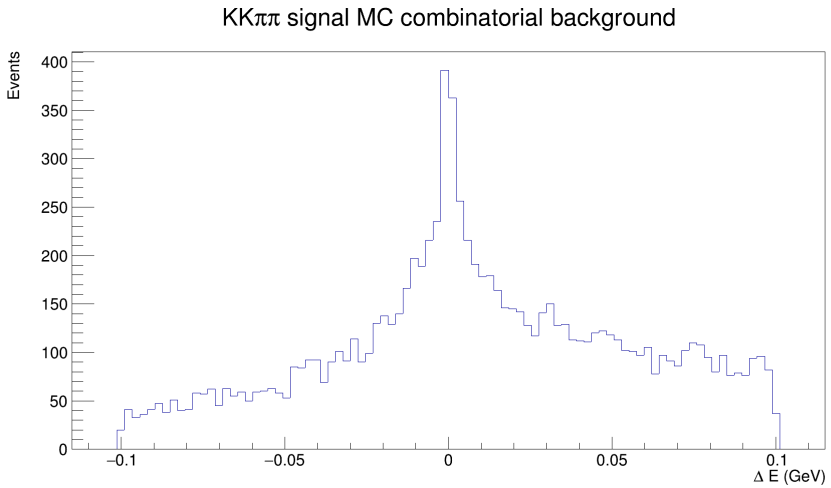
(b) ΔE, MC

Problem: Why is there a broad + narrow peak?

Broad peak from combinatorial background



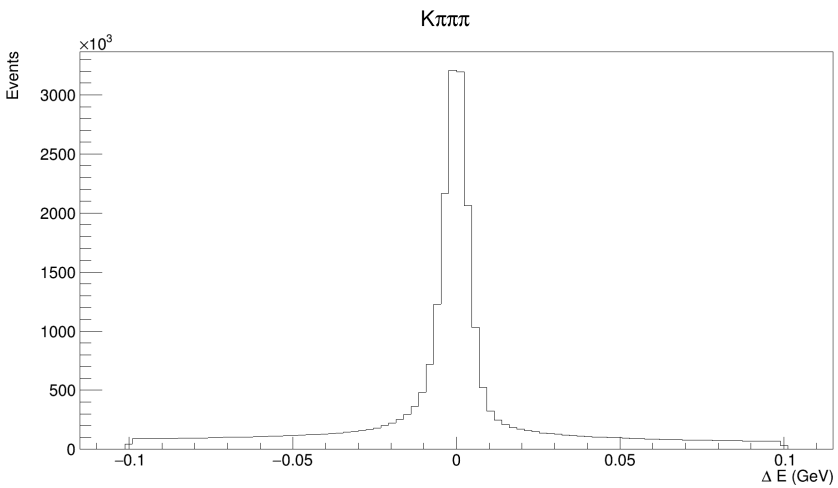
(a) ΔE, inclusive MC combinatorial background



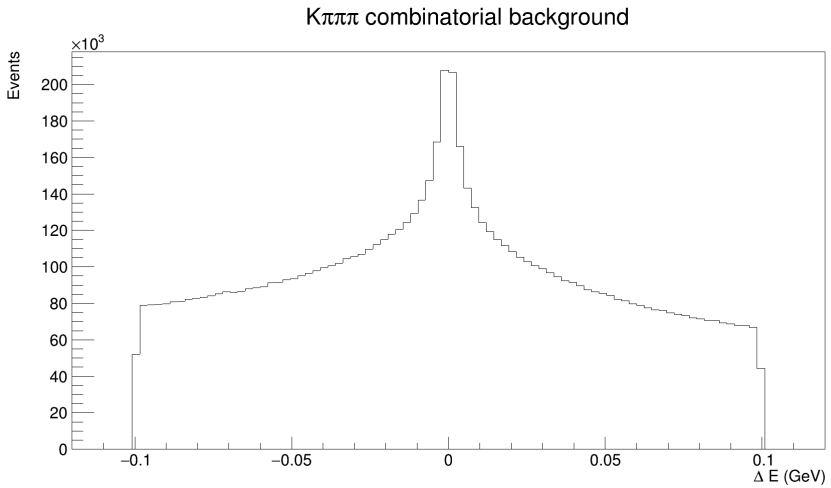
(b) ΔE, signal MC combinatorial background

- Sharp peak/kink near $\Delta E = 0$ in combinatorial background
- No particular component that causes this

Comparison with $K\pi\pi\pi$ combinatorial background



(a) ΔE from $K\pi\pi\pi$ single tag, inclusive $D^0\bar{D}^0$ MC



(b) ΔE from $K\pi\pi\pi$ combinatorial background, inclusive $D^0\bar{D}^0$ MC

- See a similar sharp peak/kink for $K\pi\pi\pi$
- Not noticeble under the large signal

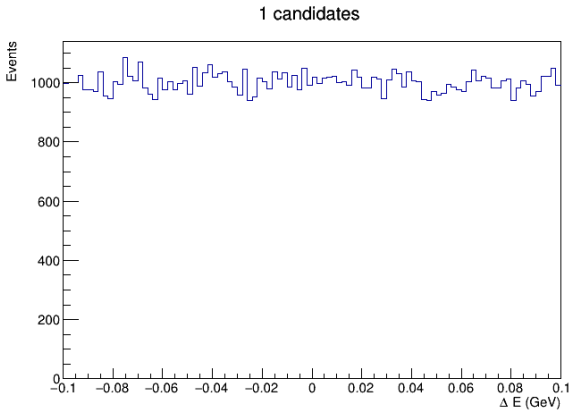
Possible explanation for ΔE shape

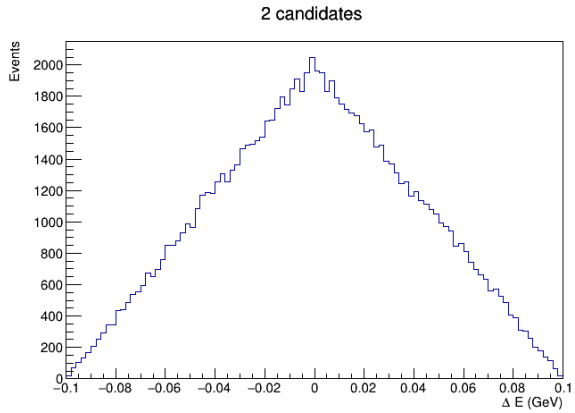
- Had a closer look at all single tag ΔE distributions:
  - Larger peak in modes with high track multiplicity
  - See a similar, but smaller peak in all 3-body modes
  - No peak for 2-body modes

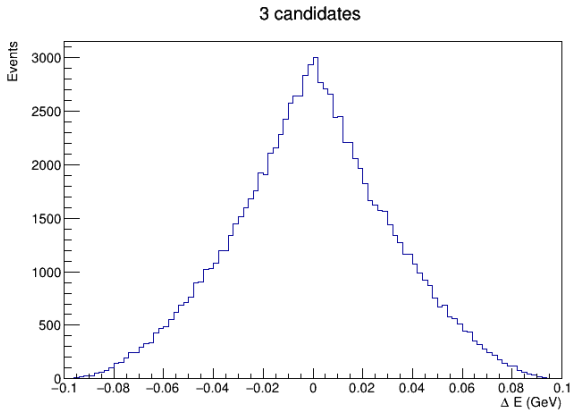
- Bias in ΔE because of selection:
  - DTagTool: For events with multiple candidates, pick candidates with smallest ΔE
  - For events with many track combinations, this will favour background near $\Delta E = 0$.

Thought experiment to explain the peak

- Consider a uniform combinatorial background in ΔE
- Generate N random numbers between -0.1 and 0.1
- Pick number closest to $\Delta E = 0$
- Resulting ΔE distribution has a peak/kink at $\Delta E = 0$





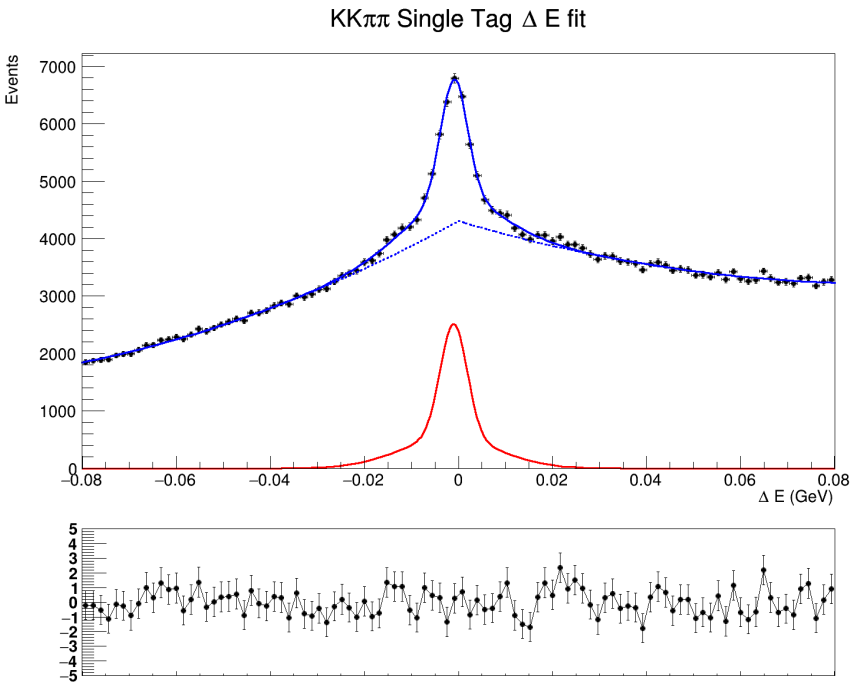


How to deal with this?

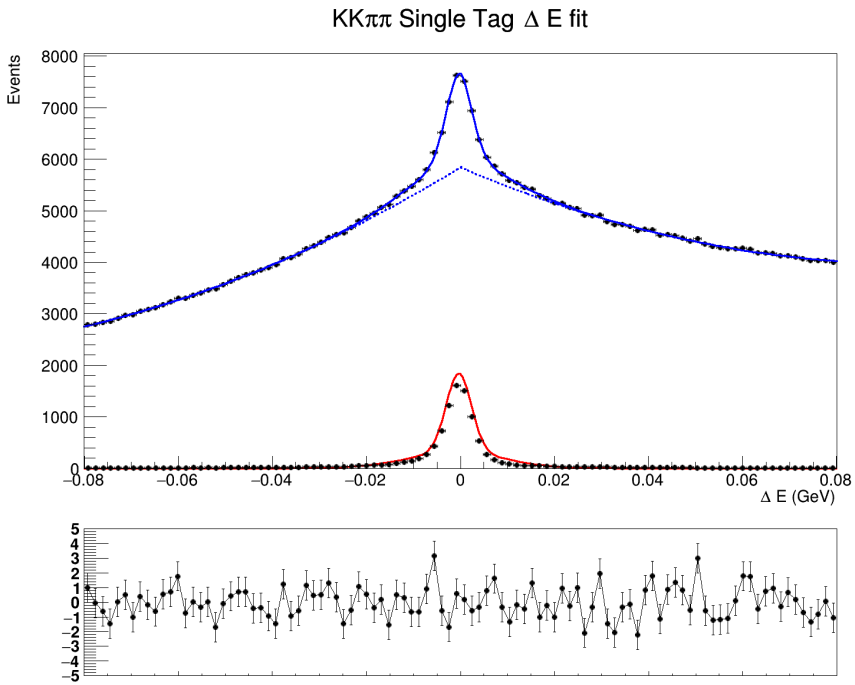
- Peak at ΔE seems to be caused by the selection itself, can't remove with cuts

- Instead, modify PDF shape
  - Before: $f(x) = 1 + ax + bx^2$
  - Change to: Two independent polynomials on either side
    - $f(x) = 1 + a_1 x + b_1 x^2, \quad \Delta E < 0$
    - $f(x) = 1 + a_2 x + b_2 x^2, \quad \Delta E > 0$

New ΔE fit in data vs MC

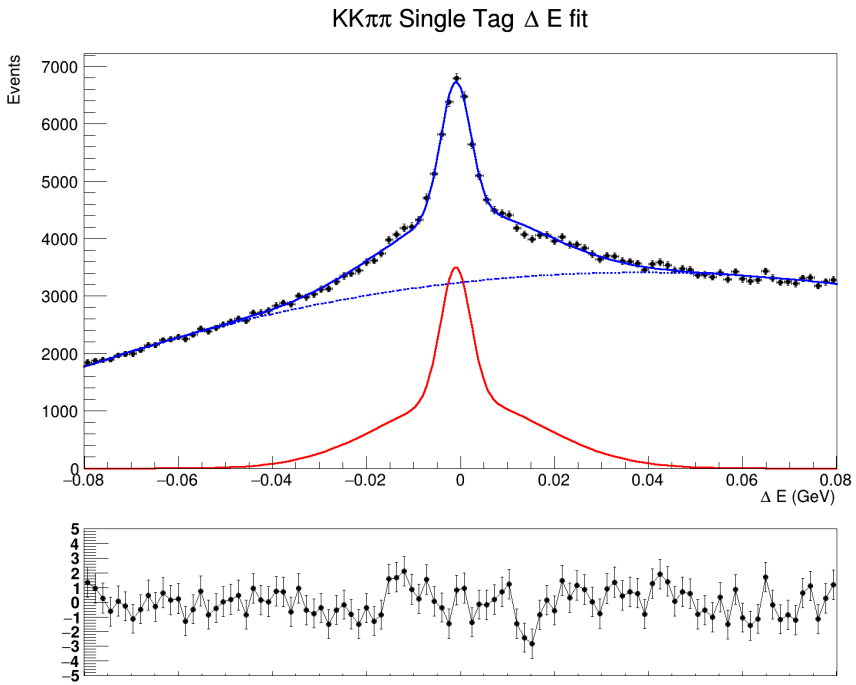


(a) ΔE, data

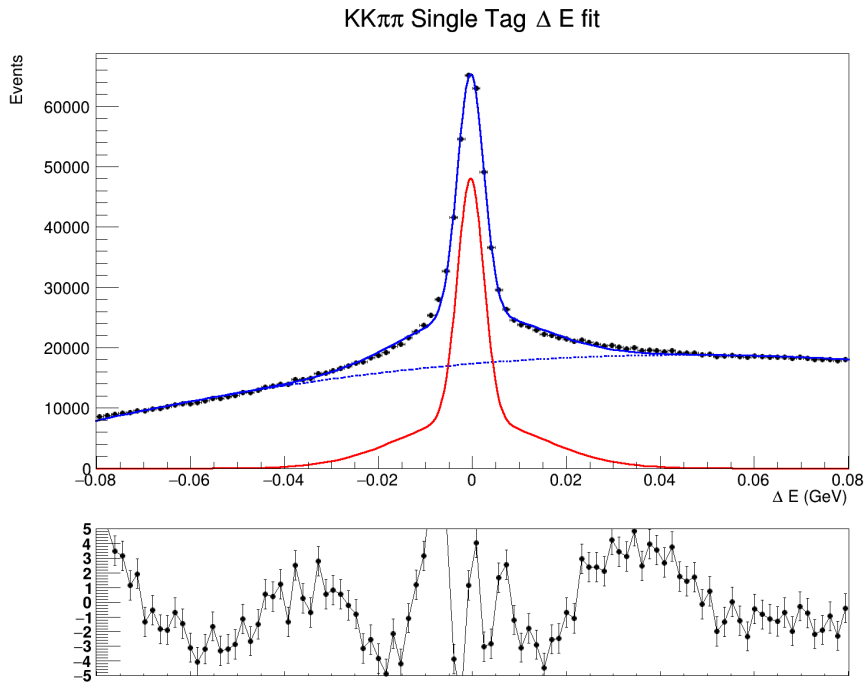


(b) ΔE, MC

Previous ΔE fit in data vs MC



(a) ΔE, data



(b) ΔE, MC

$K_S KK$ peaking background

- Generated a signal MC sample of $K_S KK$, reconstructed as $KK\pi\pi$
- Applied flight significance cut at 2
- Out of 200000 generated events, 6883 events made it through this selection (3%)

$K_S KK$ peaking background

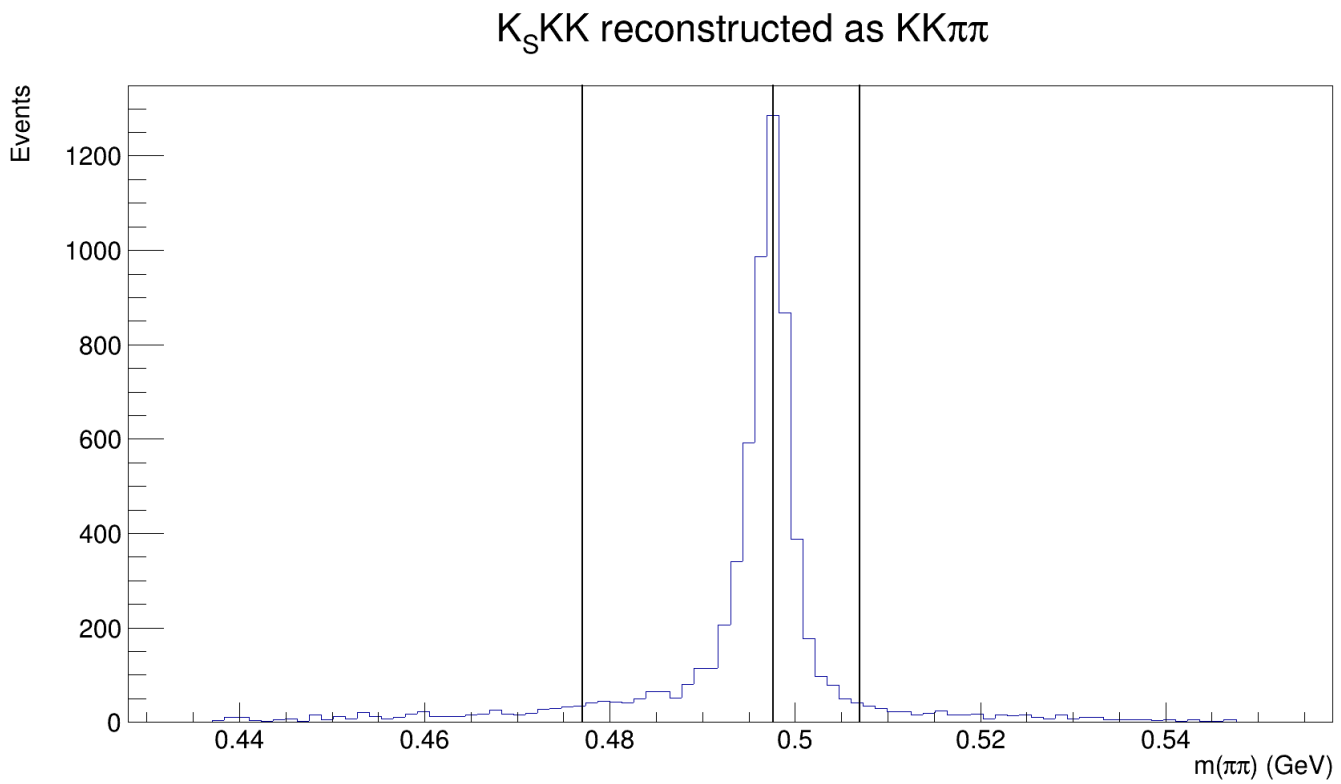


Figure 7: $\pi\pi$ invariant mass in $K_S KK$ peaking background

- A veto at 477 MeV $< m(\pi\pi) <$ 507 MeV removes 85% of the remaining background

$KK\pi\pi$ single tag components

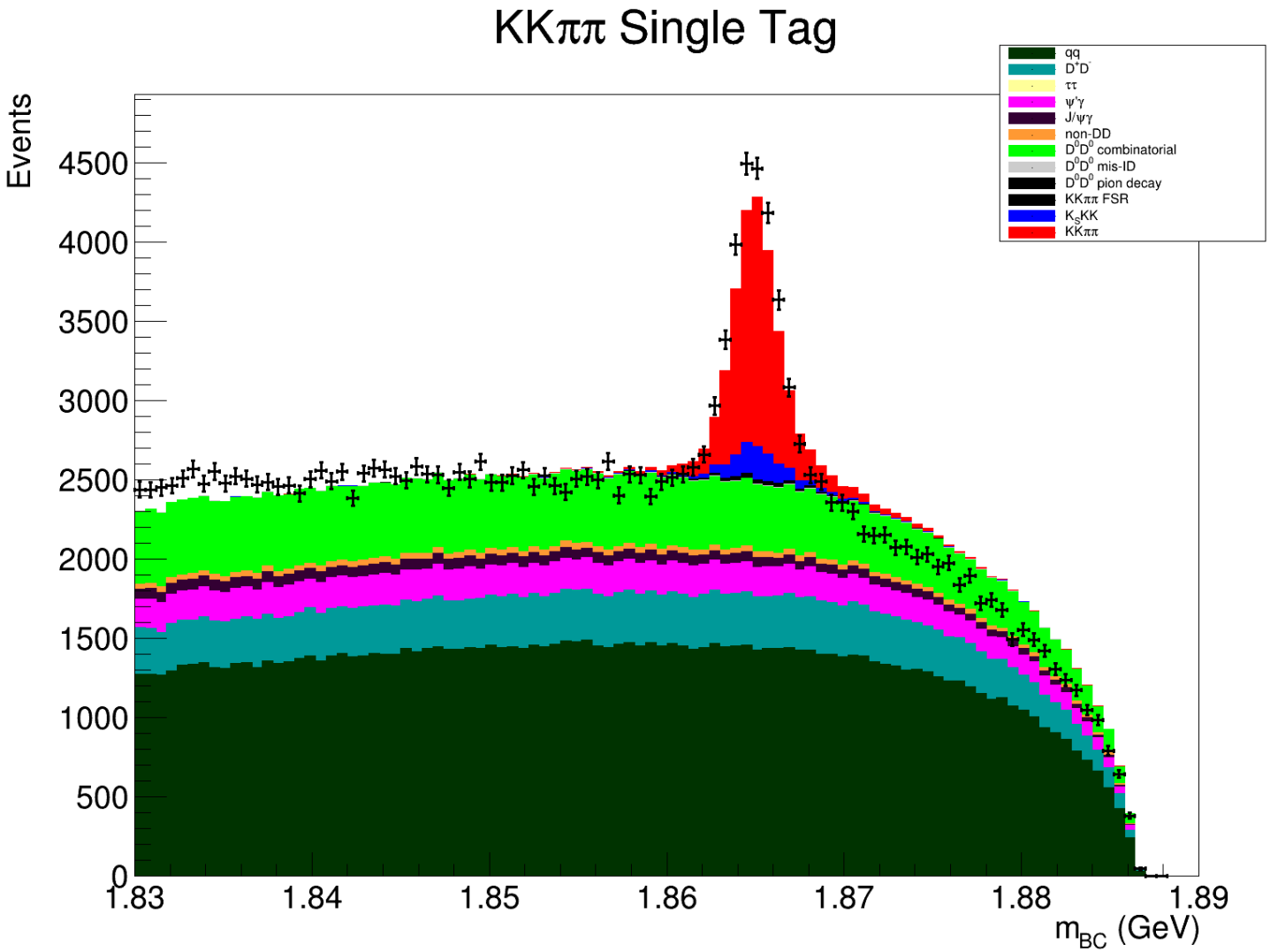


Figure 8: $KK\pi\pi$ single tag m_{BC} components

$KK\pi\pi$ single tag components

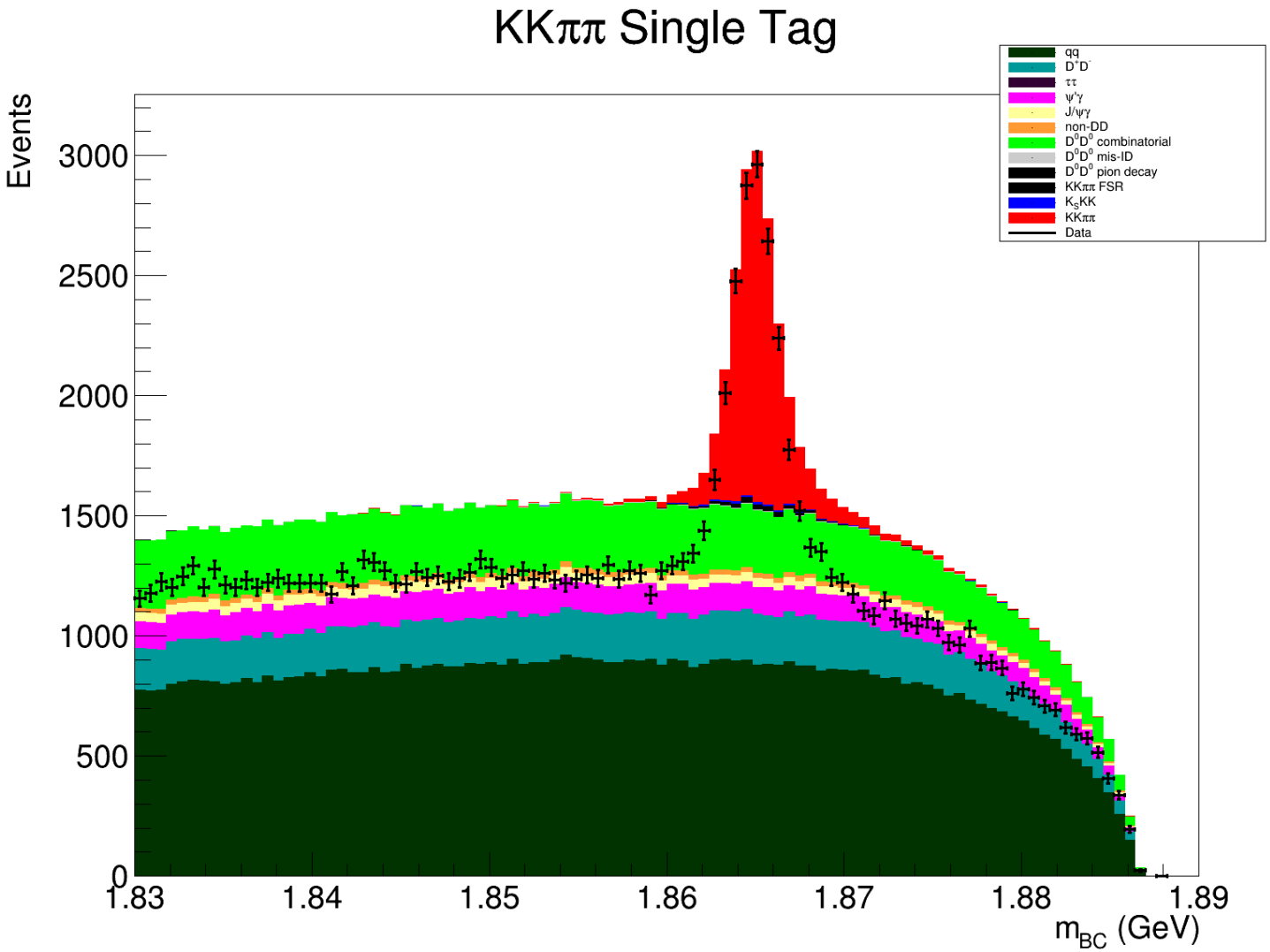


Figure 9: $KK\pi\pi$ single tag m_{BC} components

$KK\pi\pi$ single tag components

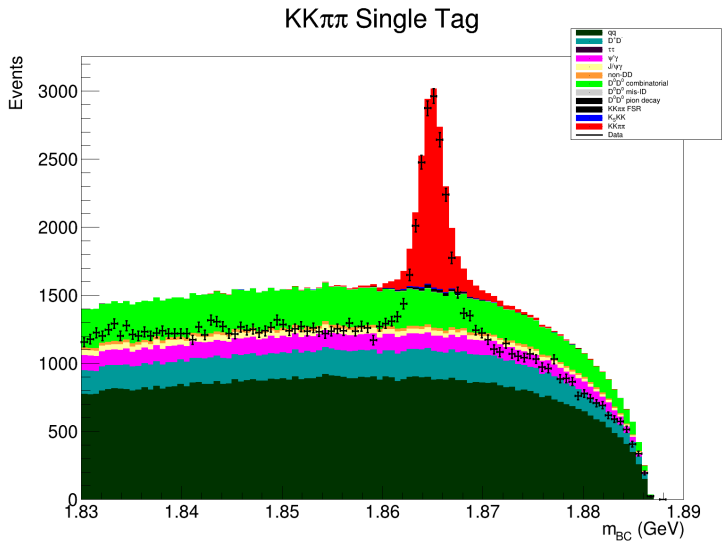


Figure 10: $KK\pi\pi$ single tag m_{BC} components

- $K_S KK$ background is very small
- Combinatorial background lower in data
- Signal larger in data, possibly because branching fraction is lower in decay card (15%)

Next steps

- Run same studies on other modes
- Start with DT yields, check with expectation from amplitude model