

Study of $B^+ \rightarrow K^+ \tau^+ \tau^-$ using hadronic tagging

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September 16, 2022

SignalMC generator

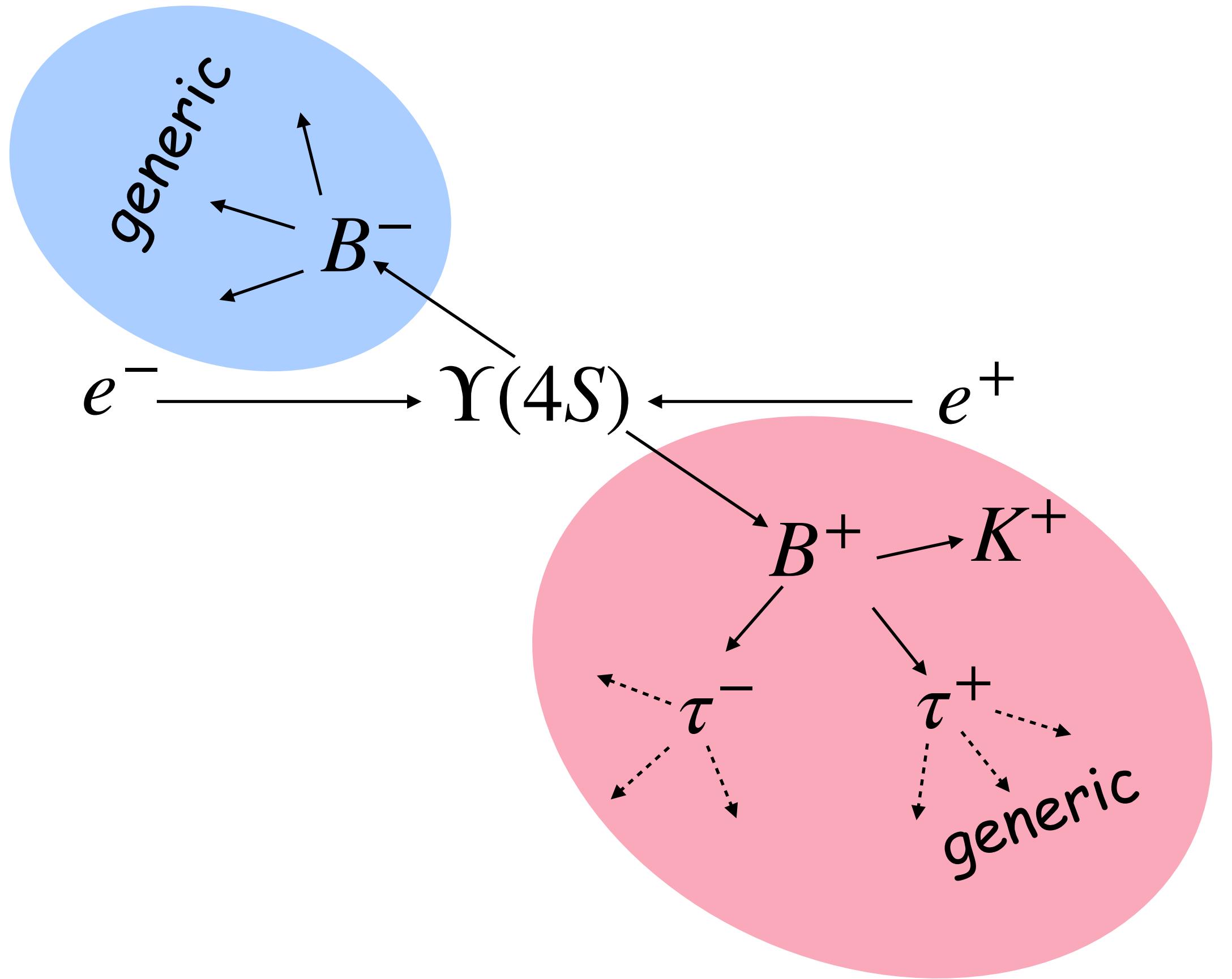
#simulated sample size: 50 million

generator model: BTOSLLBALL

release-06-00-10

globalTag: mc_production_MC15ri_a

bkg: early phase III (release-06-00-05), BGx1



later: only τ decays to
 $e^- \nu \nu, \mu^- \nu \nu, \pi^- \nu$

Reconstruction

B_{sig}^+ is composed of K^+ , h^+ , and h'^- :

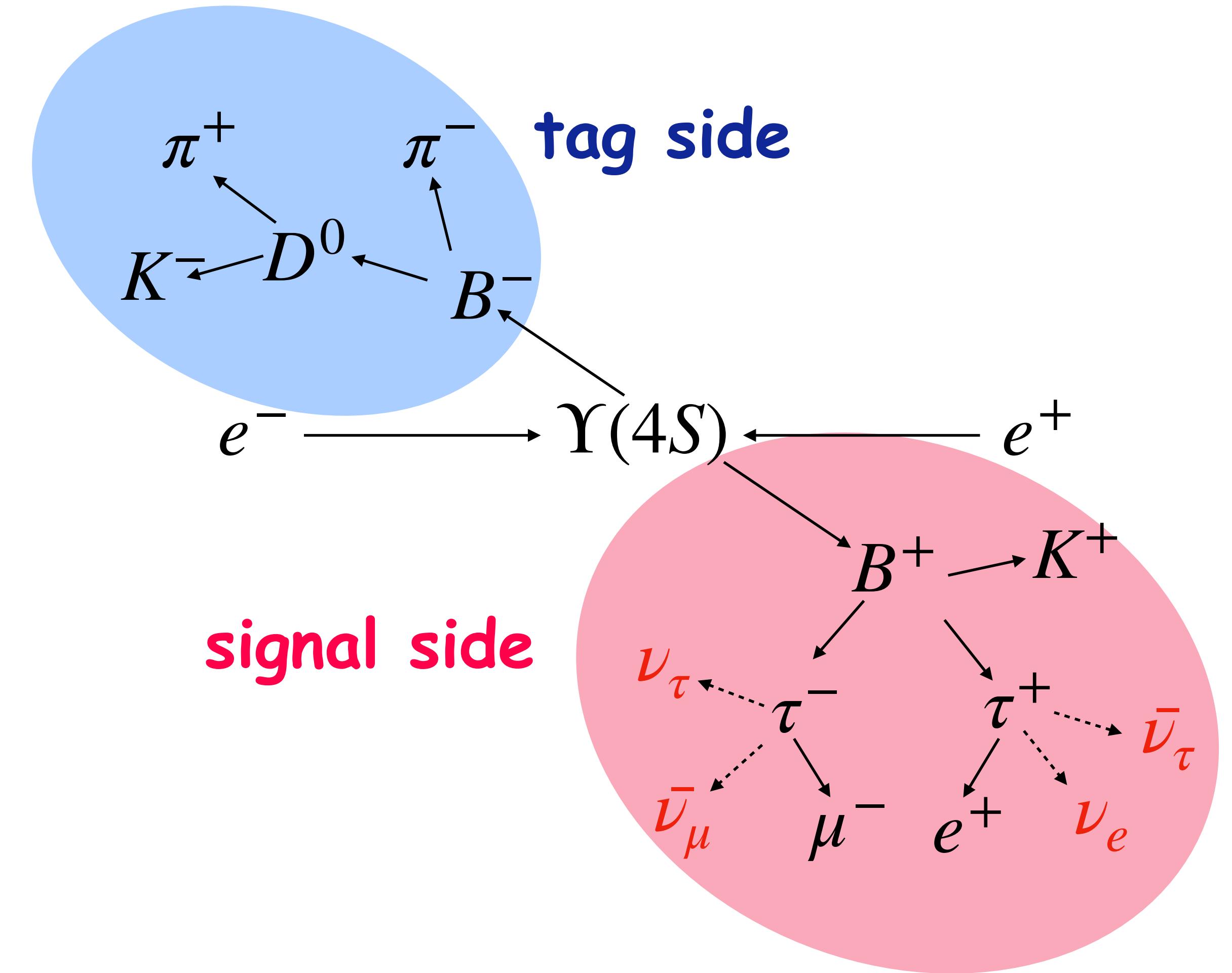
$K^+e^+e^-$, $K^+e^+\mu^-$, $K^+e^-\mu^+$

$K^+e^+\pi^-$, $K^+e^-\pi^+$, $K^+\mu^+\mu^-$

$K^+\mu^+\pi^-$, $K^+\mu^-\pi^+$, $K^+\pi^+\pi^-$

“tauSignalMissing” flag is built by combining:

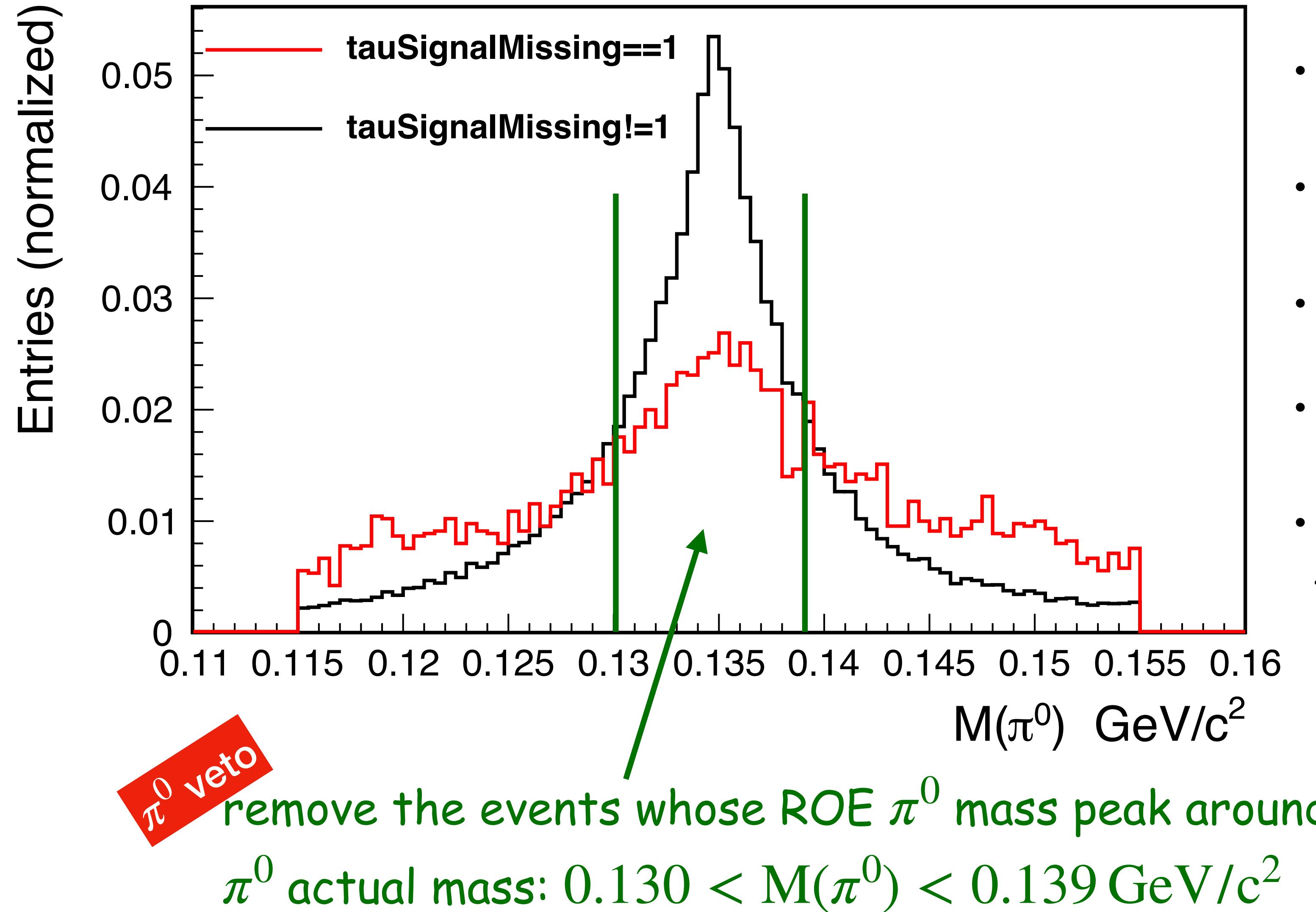
1. isSignalAcceptMissingNeutrino
2. matching mother, grandmother..., PDG codes



..selections are in backup

π^0 in ROE of $\Upsilon(4S)$

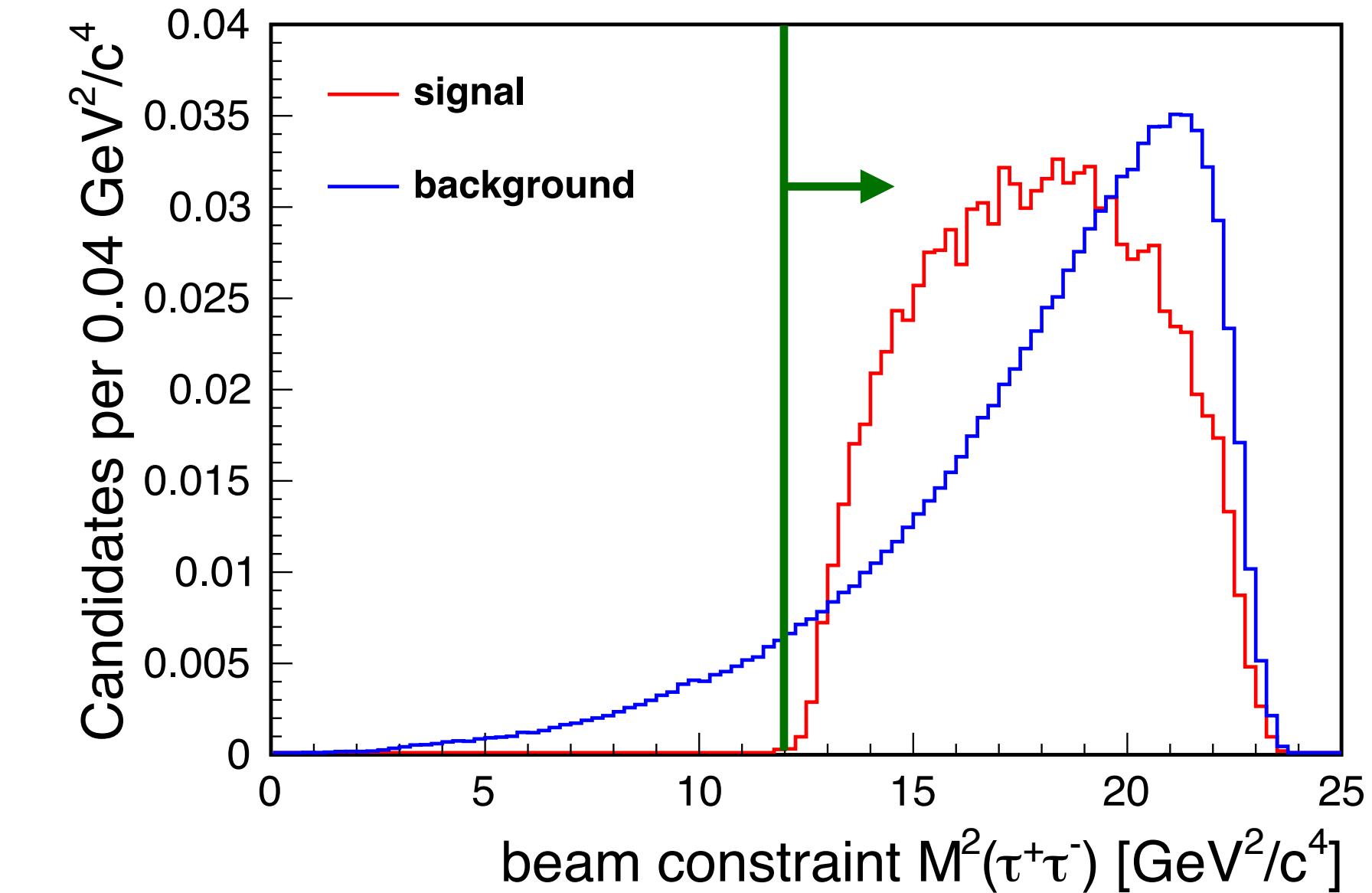
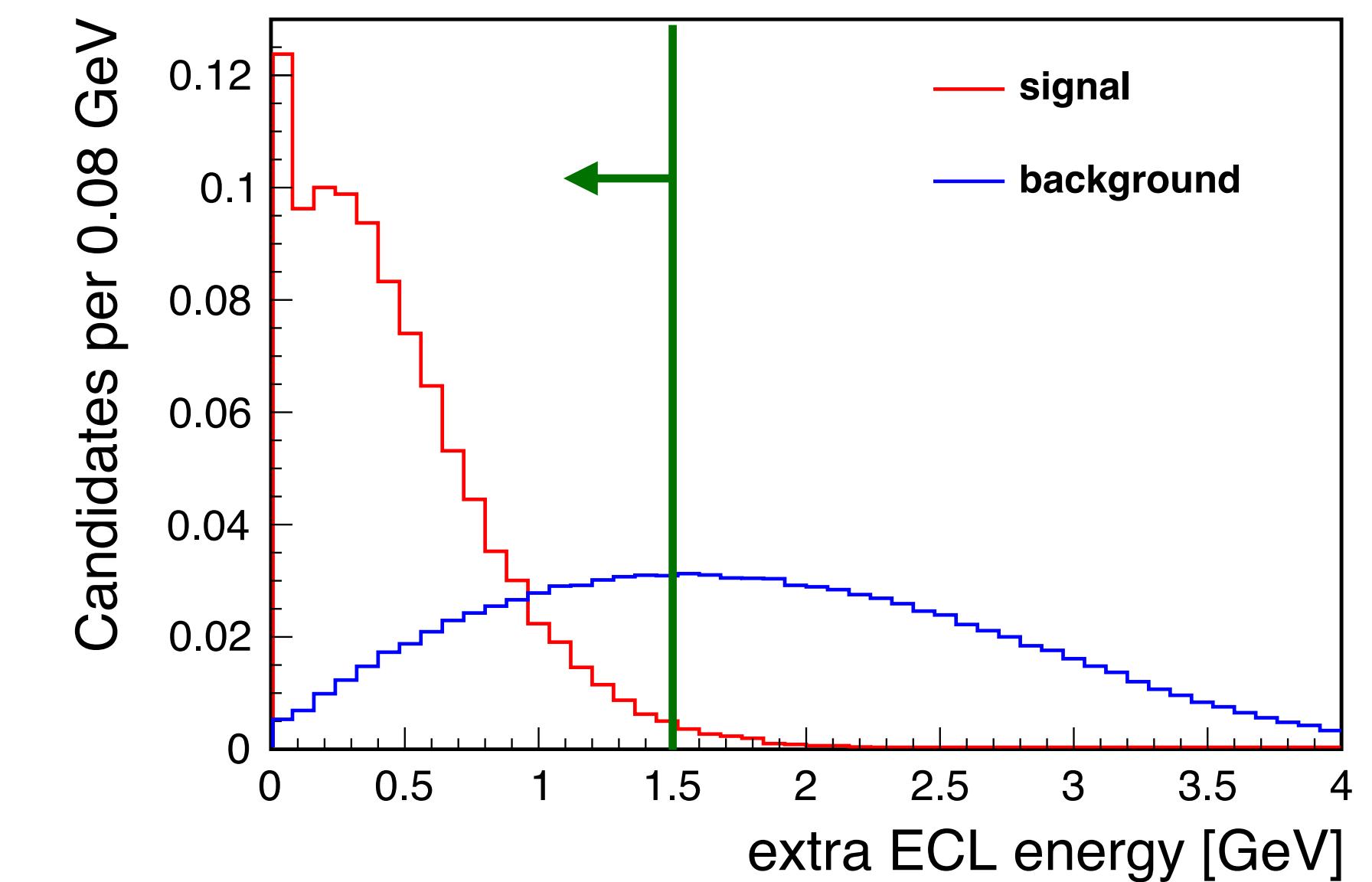
signalMC



- π^0 is built from ROE photons
- Cut on photons: $E > 60 \text{ MeV}$
- Cut on π^0 : $115 < M < 155 \text{ MeV}/c^2$
- Apply mass constraint
- Select one π^0 per event that has the nearest mass to the PDG mass

Simon's additional pre-cuts

- K PID cut: $\mathcal{R}_K \equiv \frac{\mathcal{L}_K}{\mathcal{L}_K + \mathcal{L}_\pi} > 0.6$
- Beam constraint $M^2(\tau^+\tau^-)$ ($q_K^2 > 12 \text{ GeV}^2/c^4$)
- Extra ECL cluster energy, $E_{\text{ECL}} < 1.5 \text{ GeV}$



Signal efficiency

$$\text{Signal eff.}(\epsilon) = \frac{\# \text{ signal events}}{\# \text{ generated events}}$$

$$\# \text{ generated events} = 50 \times 10^6$$

- without π^0 veto:

$$\# \text{ signal events} = 62362$$

$$\# \text{ signal eff.} = 1.25 \times 10^{-3}$$

- applying π^0 veto:

$$\# \text{ signal events} = 55164$$

$$\# \text{ signal eff.} = 1.10 \times 10^{-3}$$

12 % decrease in signal events

need to check the same in background

(under construction!)

*It is not the actual signal efficiency as τ decays generically in MC generator

Summary

so far..

- Reconstructed $B^+ \rightarrow K^+\tau^+\tau^-$
- Applied all Simon's pre-selection

next..

- Check the pre-selections on K 's PID, q_K^2 , E_{ECL} in generic MC
- Look at the background reduction after π^0 veto
- Start background study and suppression

Backup

Selection

Charged tracks (e, μ, K, π) cuts:

- transverse distance from IP, $dr < 0.5$
- distance in beam direction from IP, $|dz| < 2$
- polar angle is within *CDC* acceptance
(*thetaInCDCAcceptance*)

Continuum suppression:

- event sphericity > 0.2
- $\cos TBTO < 0.9$

Reconstruct FEI hadronic B_{tag} :

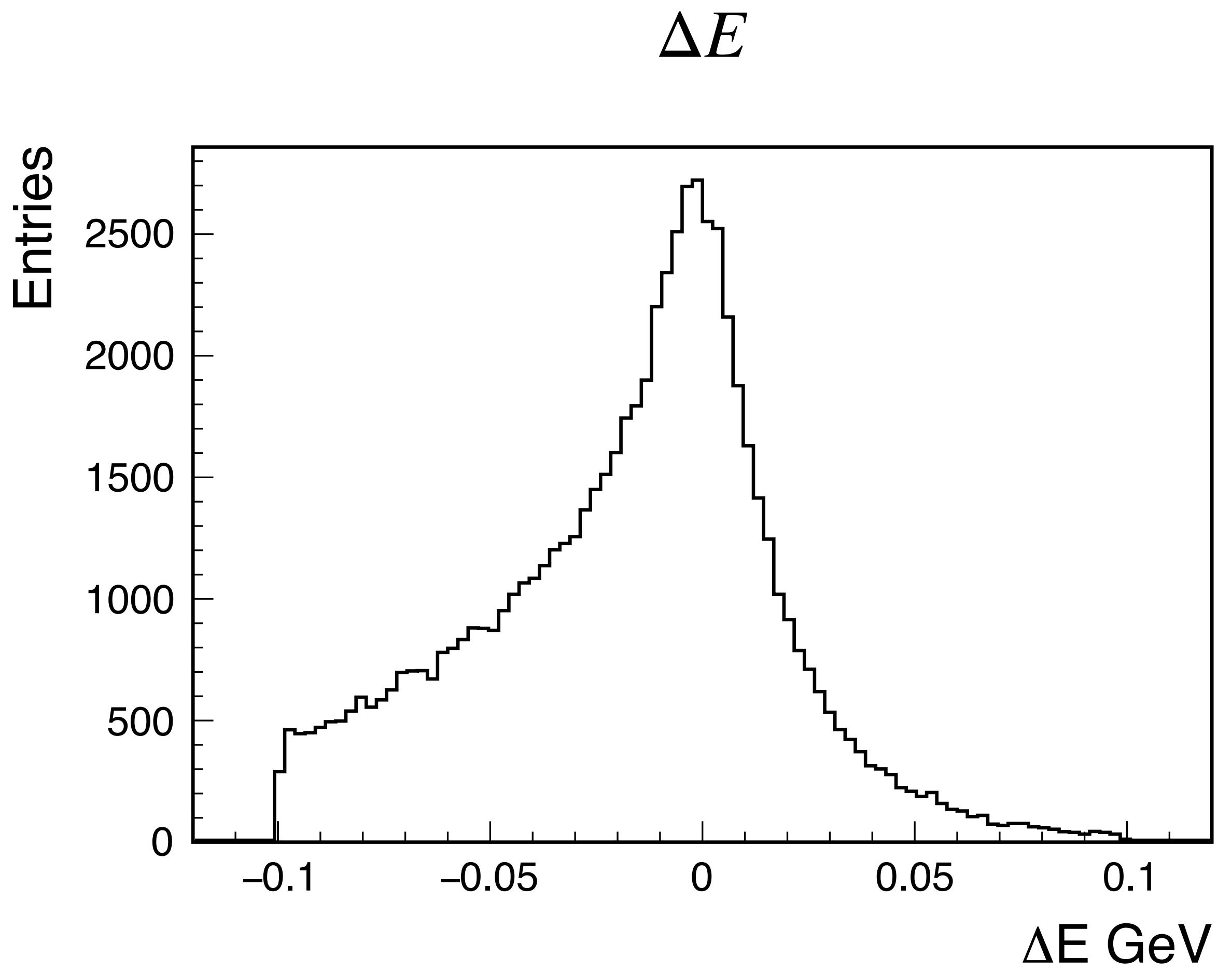
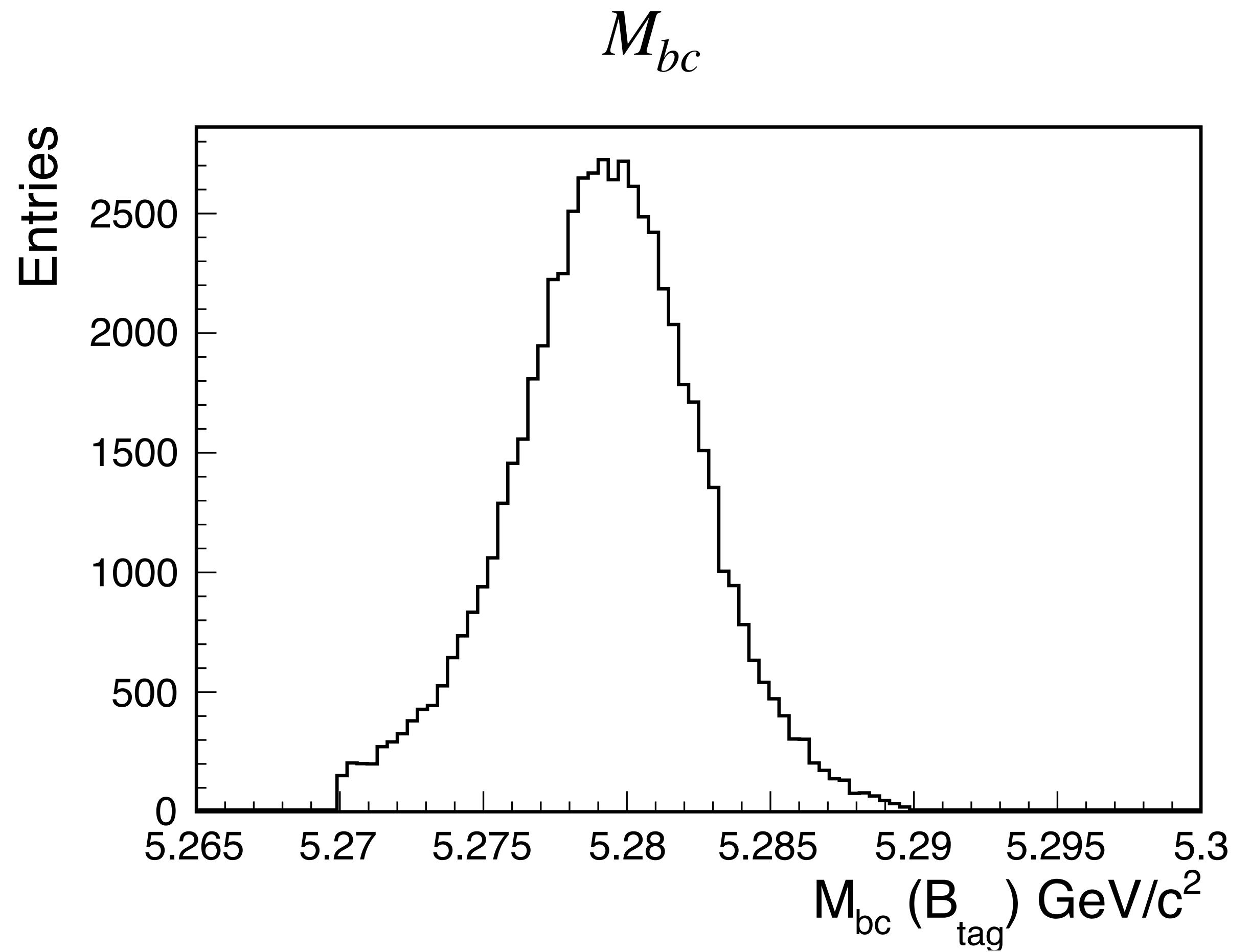
- weight file prefix -
'FEIv4_2021_MC14_release_05_01_12'
- most probable B_{tag} candidates is accepted
- $M_{bc} > 5.27$
- $|\Delta E| < 0.1$
- FEI signal probability > 0.001
- ROE of B_{tag} has 3 charged tracks

ROE mask:

- $dr < 0.5, |dz| < 2, \text{thetaInCDCAcceptance}$
- $E > 0.06$ and $|\text{cluster time}| < 20$

Analysis global Tag: 'analysis_tools_light-2203-zeus'

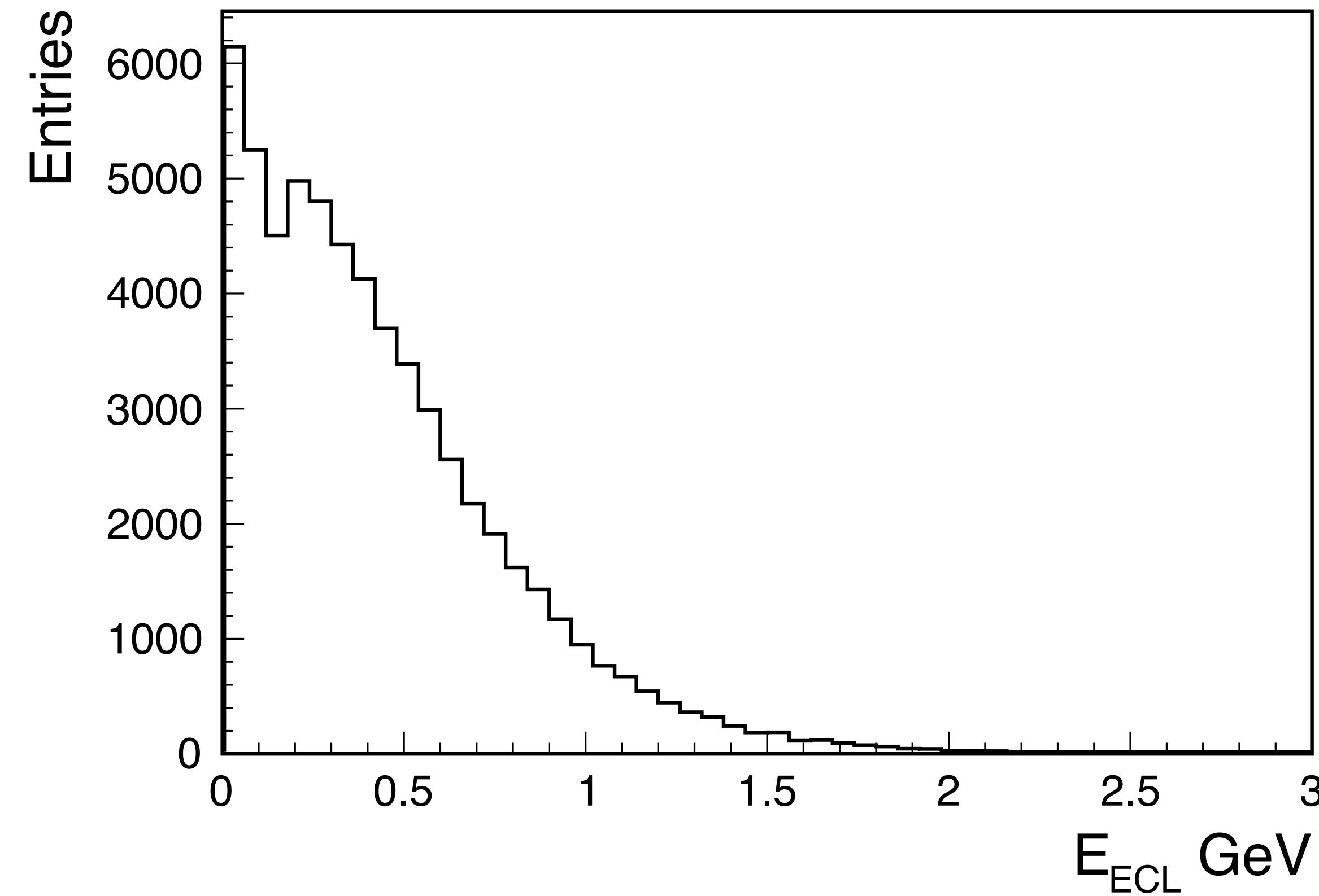
Tag side



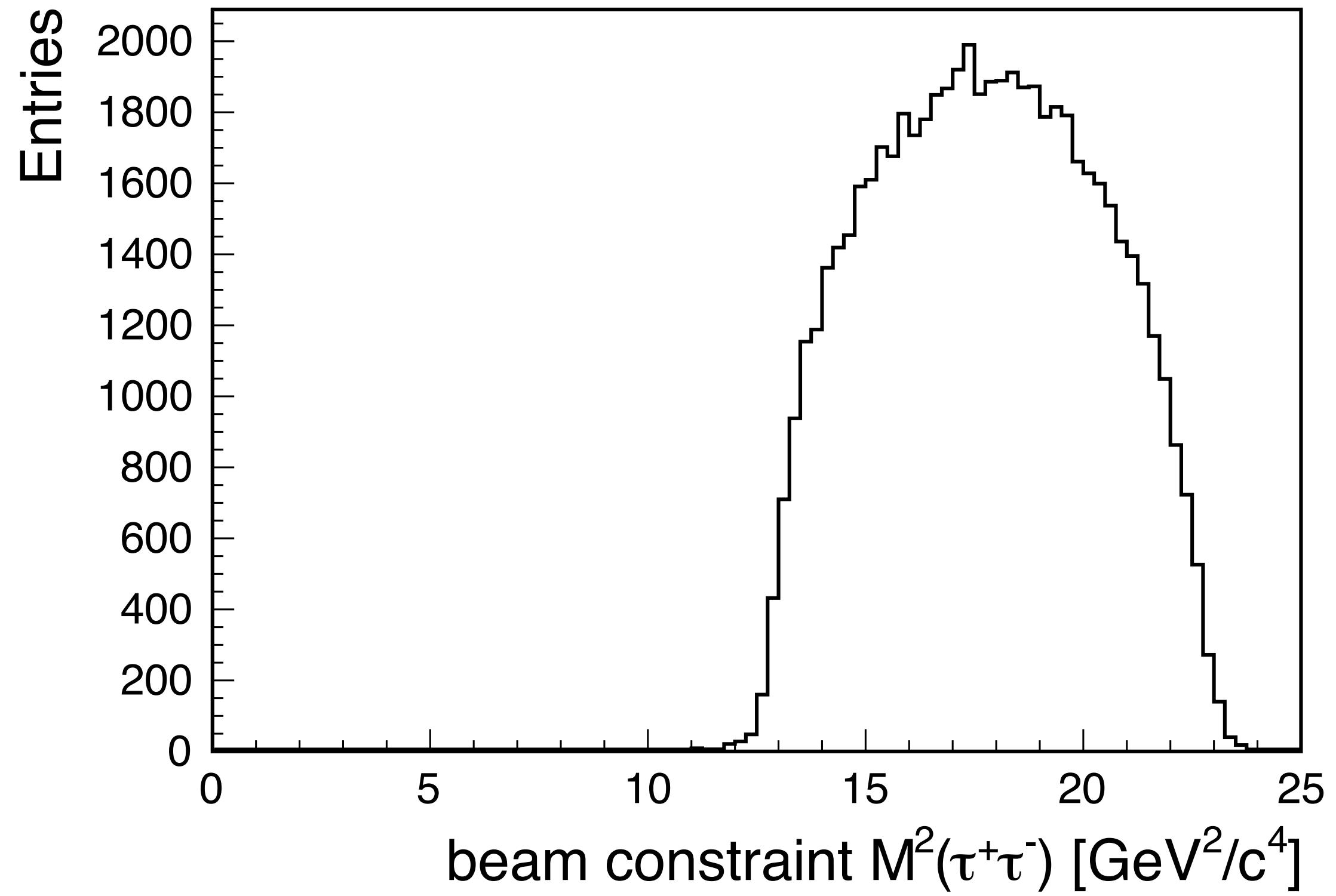
Extra ECL energy (E_{ECL})

Ideally it should peak at zero

Energy left in ECL cluster after removing B_{tag} and B_{sig} related deposition



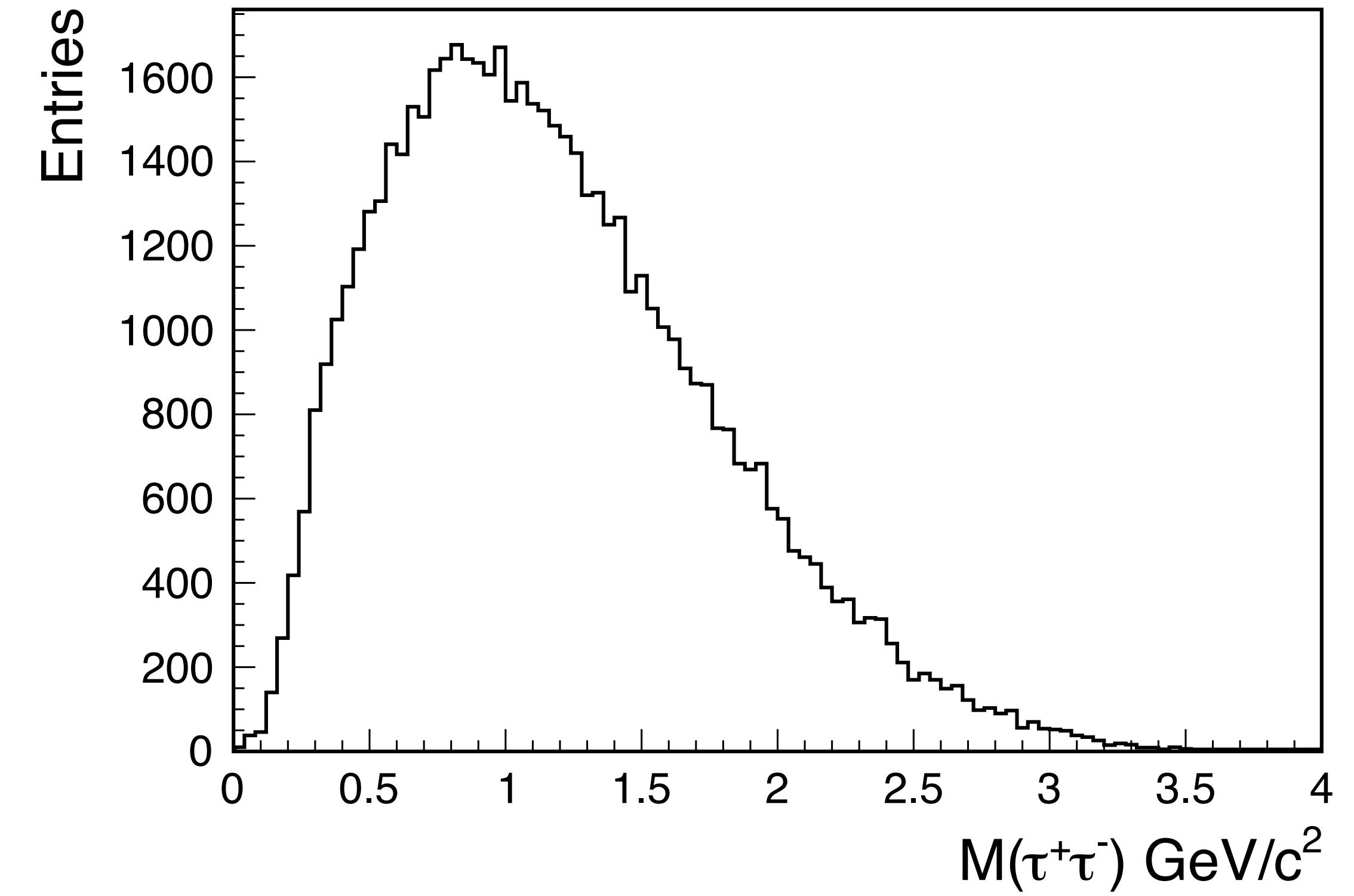
q_K^2 and $M(\tau^+\tau^-)$



beam constraint square mass of τ pair:

$$q_K^2 \equiv (p_{Y(4S)} - p_{B_{tag}} - p_K)^2$$

where $p_{Y(4S)}$ is the four momentum of beam



reconstructed invariant mass of τ pair

$$M(\tau\tau) \equiv \sqrt{(p_h + p_{h'})^2}$$