The Role of SuperB Backward EMC in Recoil Analyses

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http://www.slac.stanford.edu/~arakitin/tex/2009.May.25.GroupMtg/talk.pdf

Why Backward Calorimeter?

- Many interesting B-decays have neutrinos in final state
- Analysis of such decays is possible via reconstruction of *the other* B in the event (called *the tag* B)
- Such recoil analyses ($B \to (D)\tau\nu$, $B \to K/\pi\nu\nu$, $B \to \nu\nu(\gamma)$, $B \to \tau\tau$, $B \to \ell\nu(\gamma)$...) comprise a very important part of SuperB physics program
- Usually these analyses dominated by backgrounds, typically by similar decays with lost particles (e.g. $B \to \pi^0\tau\nu$ with lost π^0 decay products)
- It makes sense to try to catch as many decay products as possible
- Hence backward calorimeter

$B \to \tau\nu_\tau$ Decay

- Benchmark recoil analysis: $B \to \tau\nu_\tau$
- The tag B can decay either hadronically (fully-reconstructed hadronic tag) or semileptonically (only-neutrino-missing semileptonic tag)
- The recoil $B \to \tau\nu_\tau$, then either $\tau \to e\nu_e\nu_\tau$ or $\tau \to \mu\nu_\mu\nu_\tau$: 1-prong decay (other decays also possible but I do not consider them now)
- Signature: the reconstructed tag B + track + nothing else in the detector
- Background: here is a partial list of background processes:

  $B^+ \to \pi^0\ell\nu$ with lost π^0 photon(s)

  $B^+ \to \rho^0\ell\nu$ with lost ρ^0 pion(s)

  $B^+ \to D^0\ell\nu$ with lost D^0 decay product(s)

  $B^0 \to \pi^-\ell\nu$ with lost π^-

  $B^0 \to \rho^-\ell\nu$ with lost ρ^- pion(s)

  $B^0 \to D^-\ell\nu$ with lost D^- decay product(s)

  ...

Analysis Strategy

- Generate signal MC
- Reconstruct the tag B (First, I will concentrate on the simplest hadronic tag $B \to D^0(K\pi)\pi$)
- Make sure there is exactly one extra track
- Make sure there is no extra photons
  - Compute the difference E_{extra} between the total energy in the calorimeter and sum of energies associated with each track
  - Obtain B yield as a function of the cut on E_{extra}
- Repeat for different detector configurations: "SuperB with backward EMC" and "SuperB without backward EMC", to see the effect

Analysis Strategy

- Generate background MC
  - First I will concentrate on $B^+ \to \pi^0 \ell \nu$
- Apply the same tag B reconstruction procedure
- Apply the same requirement of exactly one extra track
- Apply the same requirement of no extra photons
  - Impose cut on E_{extra} and obtain B yield as a function of this cut
- Again, repeat for different detector configurations to see the effect

Finally, obtain the signal-to-noise ratios as functions of cut on E_{extra}

Analysis implementation

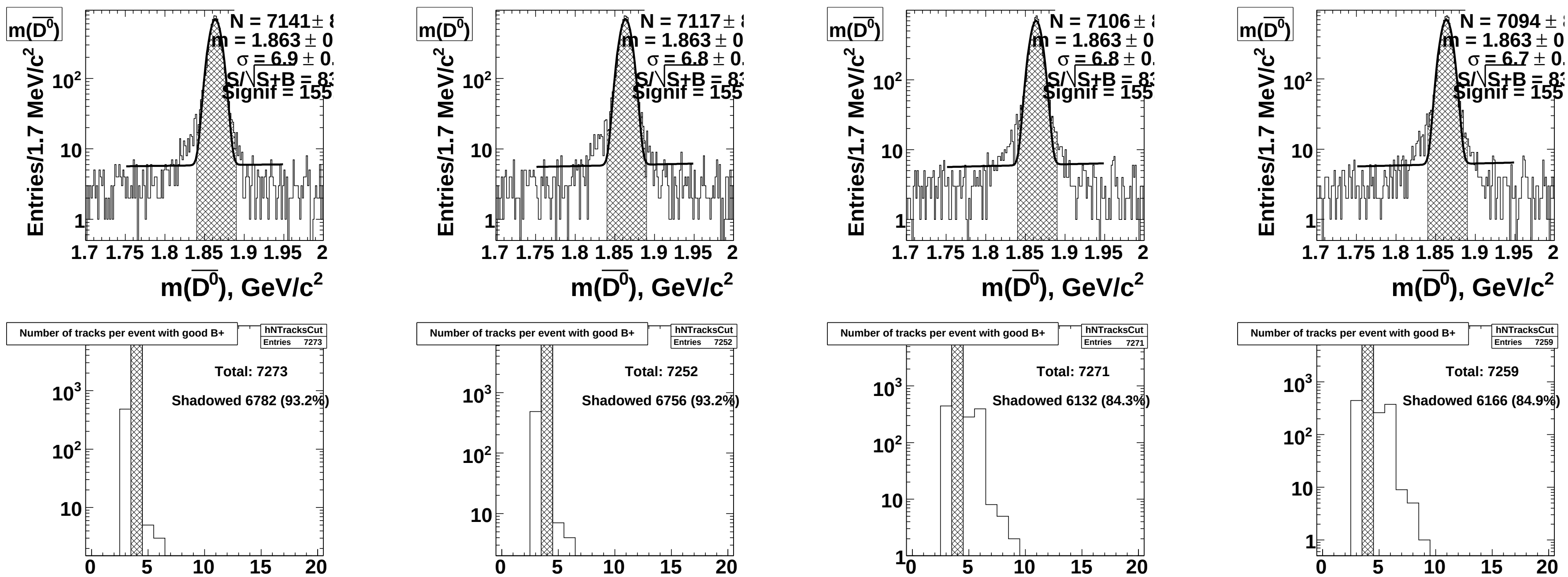
- Use FastSim v04
- Signal MC (10000 events):
  - $B^+ \rightarrow \overline{D^0}\pi, \overline{D^0} \rightarrow K^+\pi^-$
  - $B^- \rightarrow \tau^-\overline{\nu_\tau}$
    - ☞ $\tau^- \rightarrow e\overline{\nu_e}\nu_\tau$
    - ☞ $\tau^- \rightarrow \mu\overline{\nu_\mu}\nu_\tau$
    - ☞ $\tau^- \rightarrow \pi^-\nu_\tau$
- Background MC (10000 events):
  - $B^+ \rightarrow \overline{D^0}\pi, \overline{D^0} \rightarrow K^+\pi^-$
  - $B^- \rightarrow \ell^-\overline{\nu_\ell}, \ell = e, \mu, \tau$

  ☞ No constraints on τ decay
- Reconstruct B (use BtaTupleMaker, GoodTracksLoose) cut on $\overline{D^0}$ mass, require exactly 4 tracks

D mass and number of tracks

Signal MC | Background MC

with bwd EMC | no bwd EMC | with bwd EMC | no bwd EMC

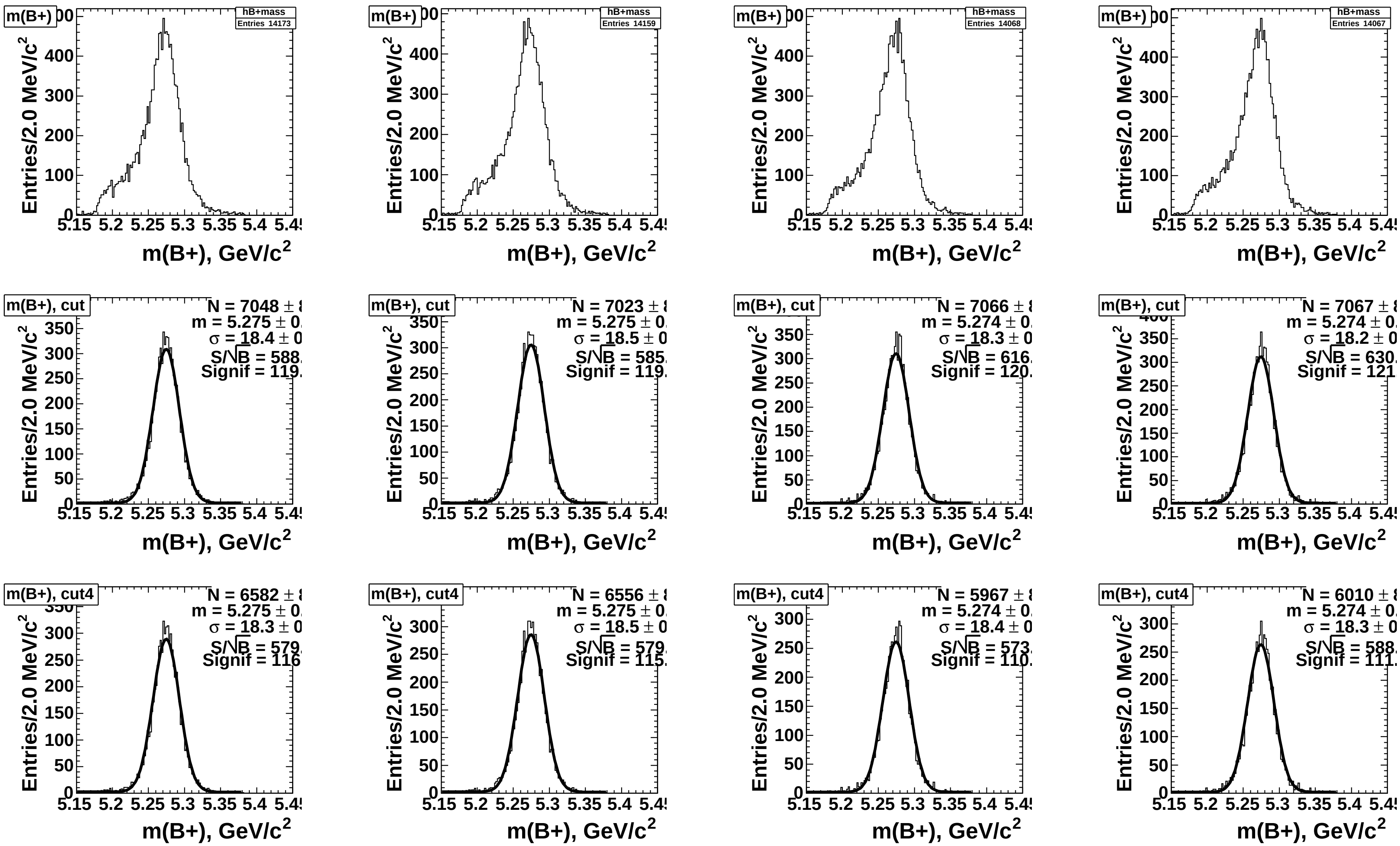


- Cut: $1.84 < m(D) < 1.89$ GeV$/c^2$
- Pay attention to log scale in all the plots above

B mass

Signal MC | Background MC

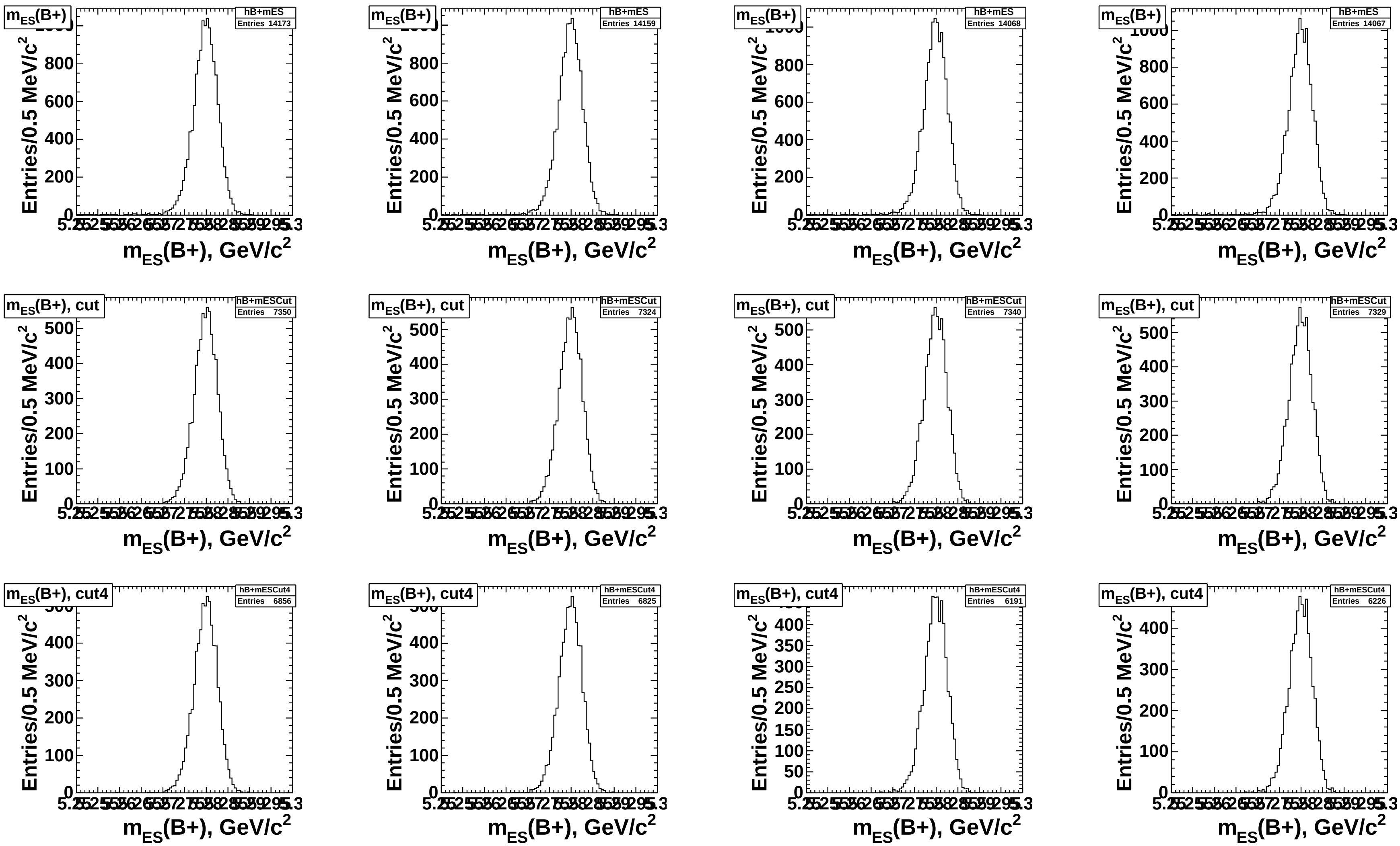
with bwd EMC | no bwd EMC | with bwd EMC | no bwd EMC



m_{ES}

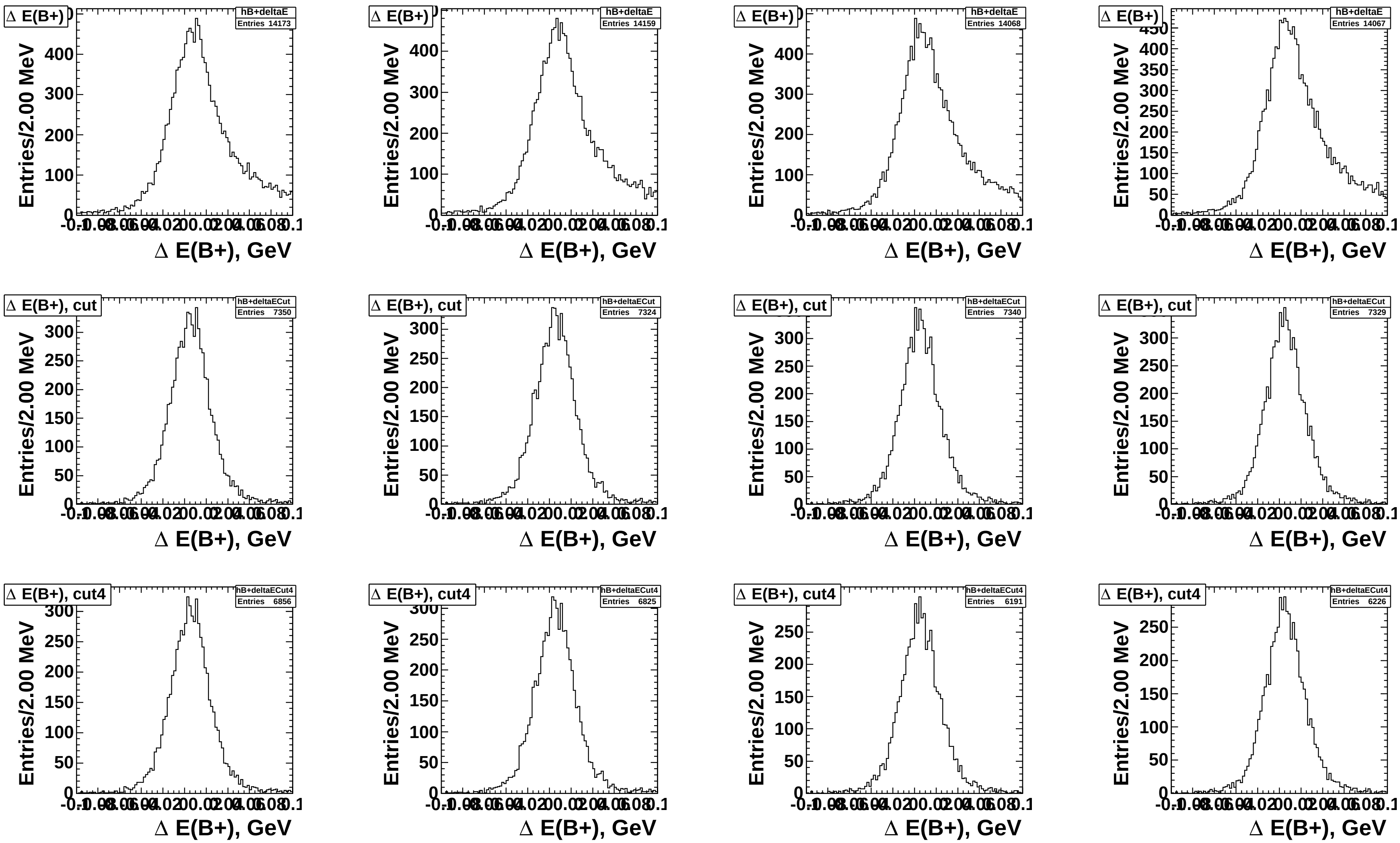
Signal MC | Background MC

with bwd EMC | no bwd EMC | with bwd EMC | no bwd EMC



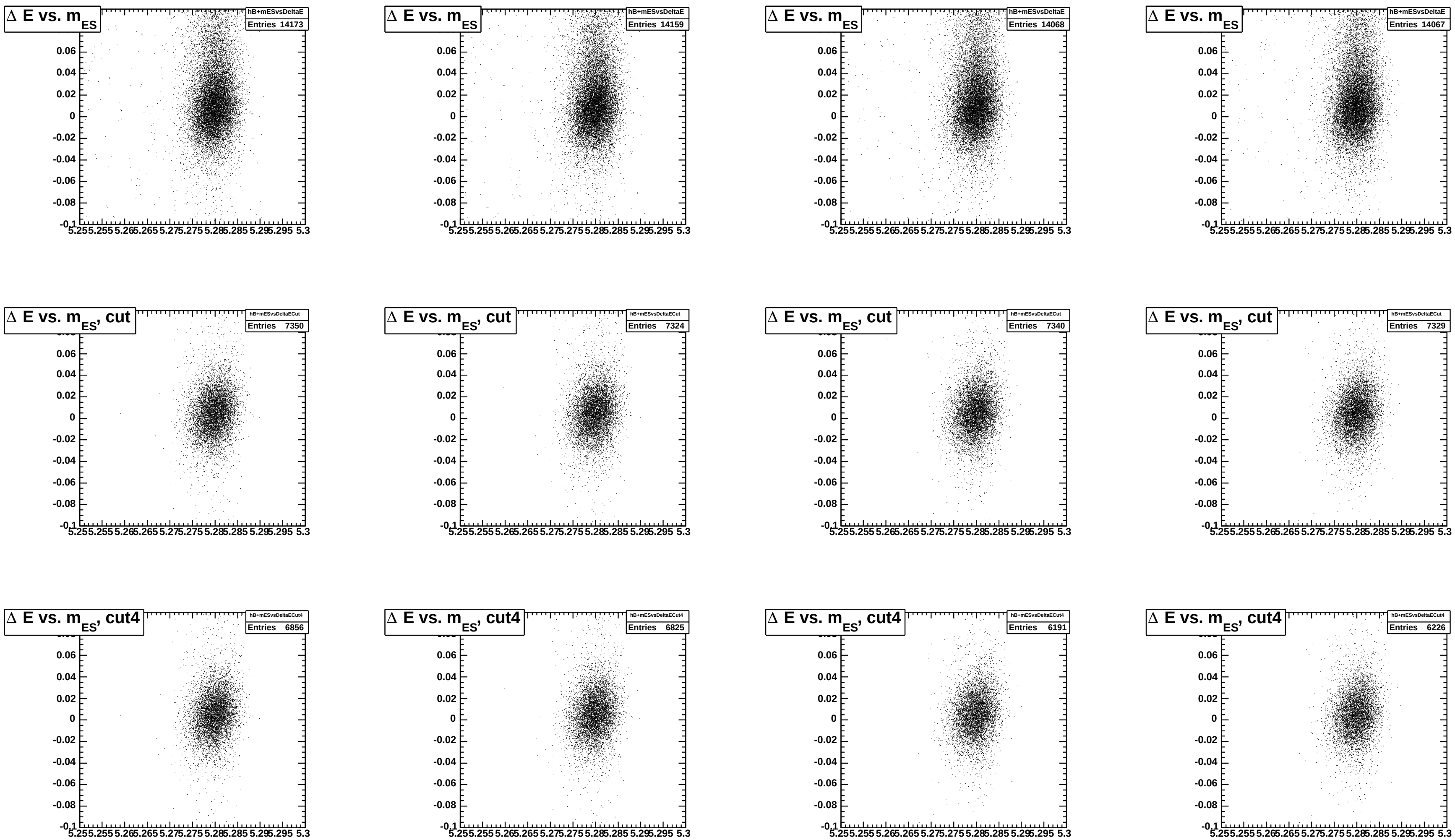
ΔE

Signal MC		Background MC	
with bwd EMC	no bwd EMC	with bwd EMC	no bwd EMC



m_{ES} vs ΔE

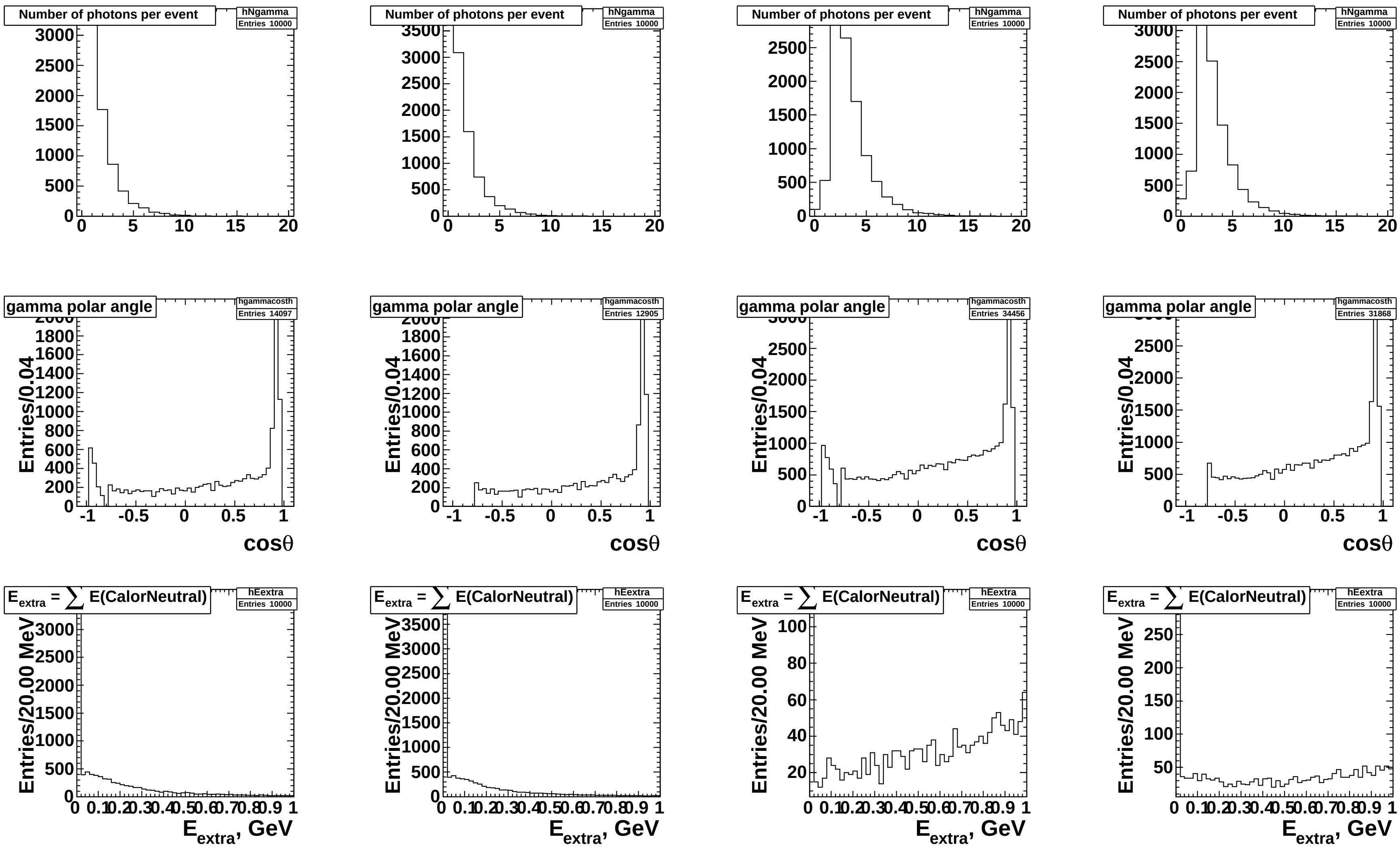
Signal MC | | Background MC |
with bwd EMC | no bwd EMC | with bwd EMC | no bwd EMC



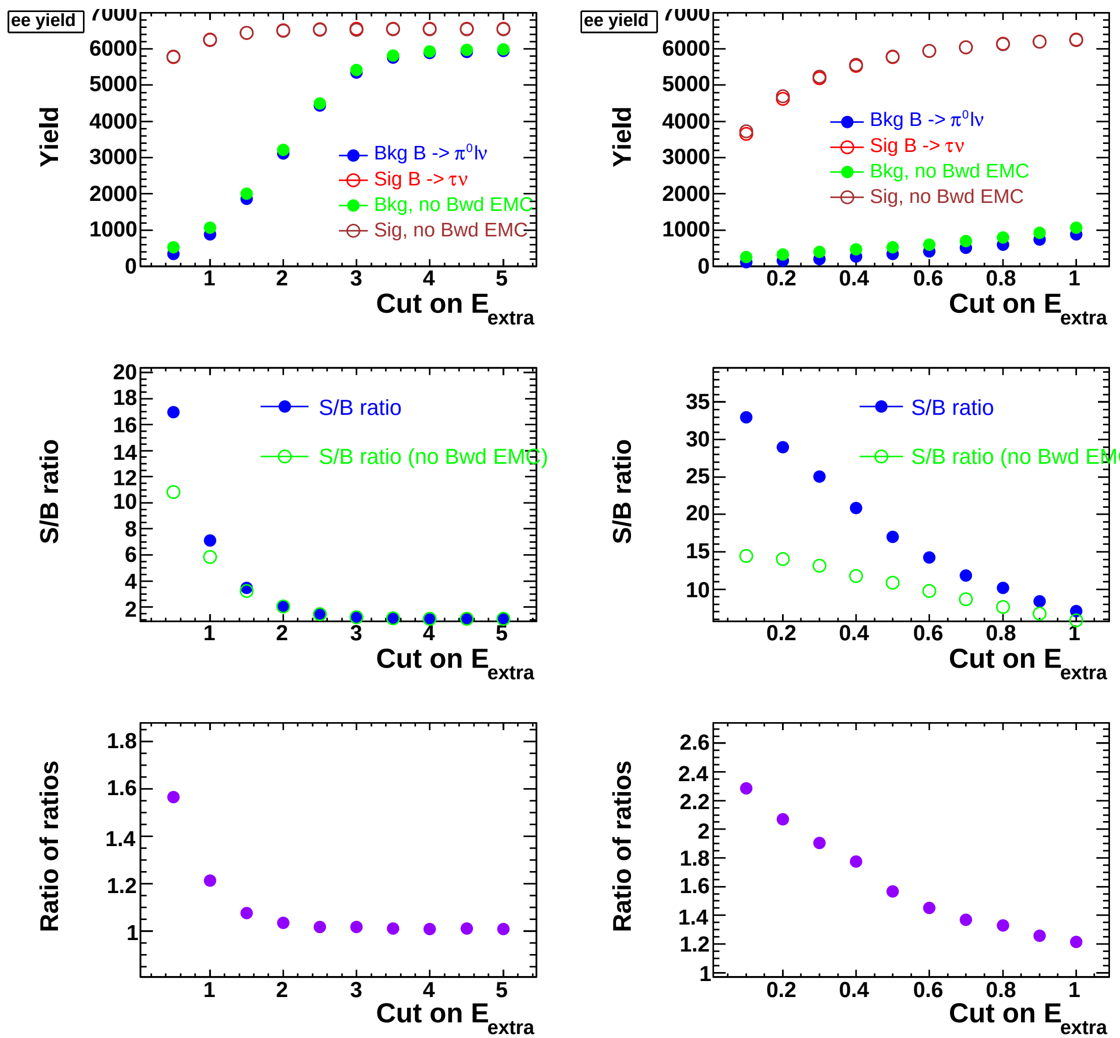
Photons

TM & © Nelvana

Signal MC		Background MC	
with bwd EMC	no bwd EMC	with bwd EMC	no bwd EMC

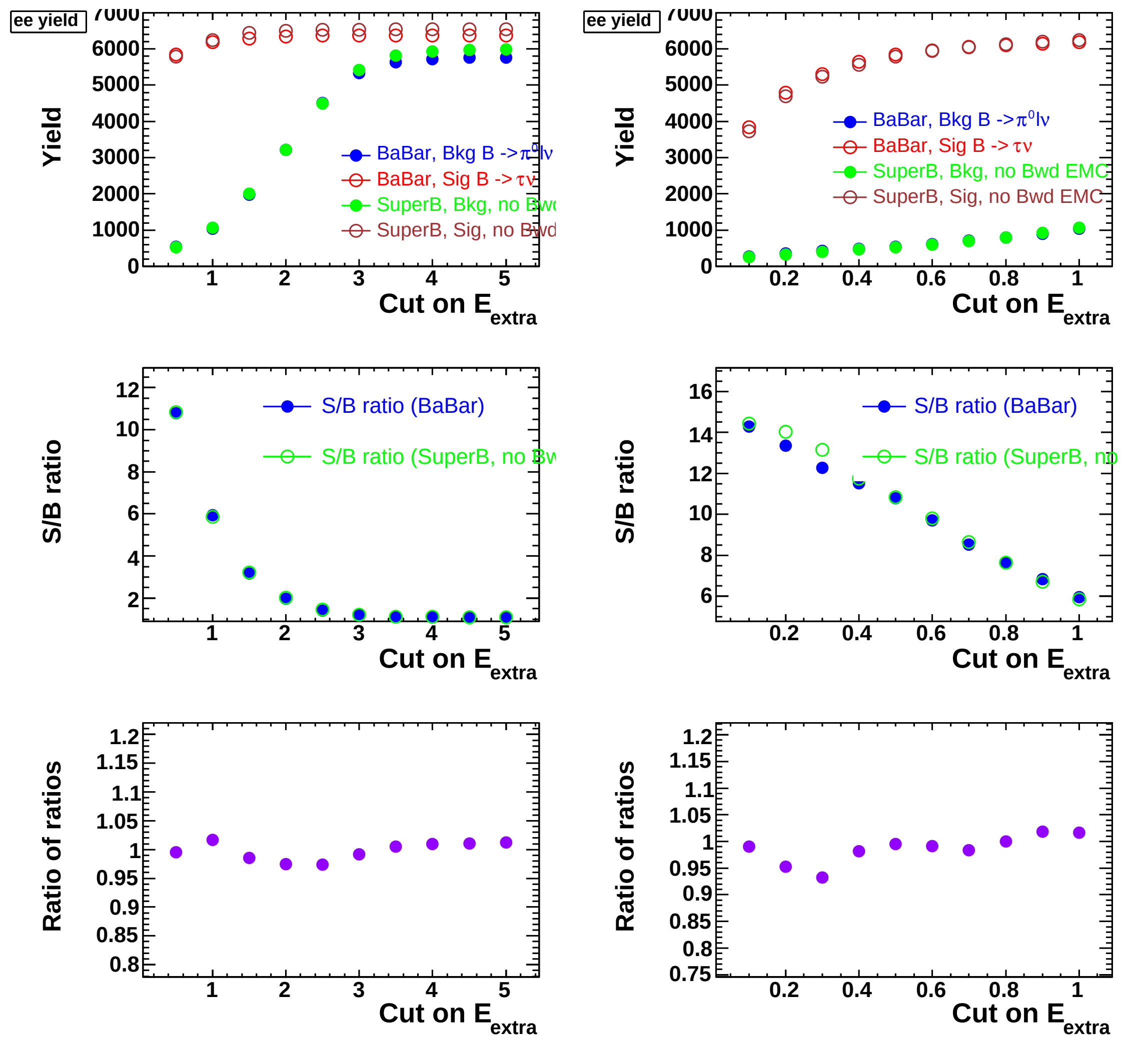


S/B ratio



We seem to work twice as better with the backward EMC than without (for given decay modes)

S/B ratio



Both SuperB and BaBar seem to work equally well without backward EMC