Backward EMC for $B \to \tau\nu_\tau$ Decay

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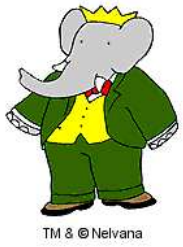
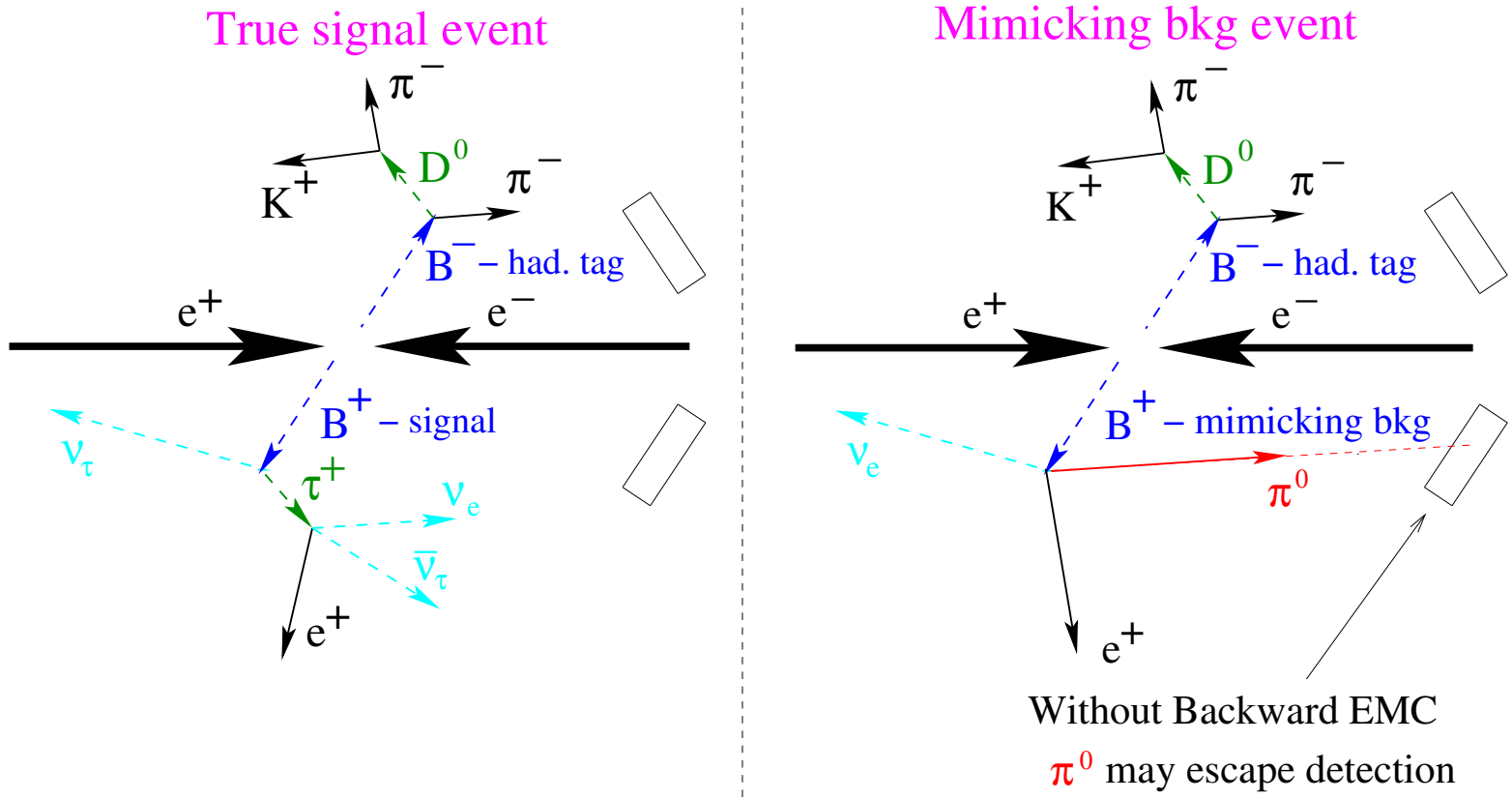
XIV SuperB General Meeting

http://www.hep.caltech.edu/~arakitin/tex/2010.Sep.29.SuperB/talk.pdf

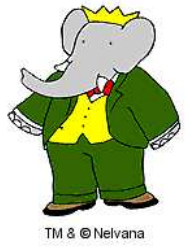
$B \to \tau\nu_\tau$ Event with Had. Tag





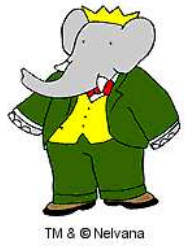
The purpose of Backward EMC is to better distinguish between signal and mimicking bkg by detecting (otherwise lost) decay products

Analysis Strategy

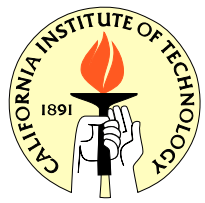


- Generate signal and mimicking background MC
  - FastSim V0.2.4, DG_4, MixSuperbBkg_NoPair
- Reconstruct B_{tag}
- Use the rest of the event to reconstruct τ
- Make sure that all the energy in the event is used up
  by requiring the E_{extra} to be small
  ☞ $E_{extra} = \sum E(\gamma) > E_{thr}$, $E_{thr} = 20, 30, 50, 70, 100$ MeV
- Obtain signal (S) and mimicking background (B) yields as well as ratios S/B and $S/\sqrt{S+B}$ as functions of the cut on E_{extra}
- Rescale these yields and ratios to 75 ab^{-1}
- Do this with and without Backward EMC and compare the results

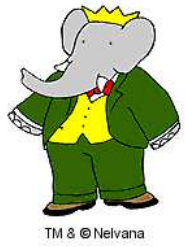
Used τ Decay Signatures



τ decay	BF from PDG
$\tau^+ \longrightarrow \mu^+ \nu_\mu \overline{\nu_\tau}$	17.36%
$\tau^+ \longrightarrow e^+ \nu_e \overline{\nu_\tau}$	17.85%
$\tau^+ \longrightarrow \pi^+ \overline{\nu_\tau}$	10.91%
$\tau^+ \longrightarrow \pi^+ \pi^0 \overline{\nu_\tau}$	25.51%
$\tau^+ \longrightarrow \pi^+ \pi^0 \pi^0 \overline{\nu_\tau}$	9.29%
$\tau^+ \longrightarrow \pi^+ \pi^- \pi^+ \overline{\nu_\tau}$	9.32%
Total	90.24%

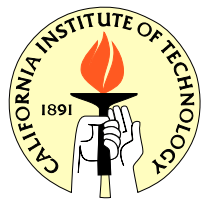


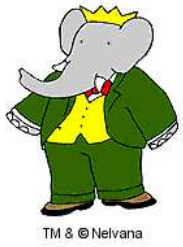
Analysis Outline



- Start with simplest hadronic tag $B_{tag} \to D^0\pi, D^0 \to K\pi$
  - Study simplest signal $B_{sig} \to \tau\nu, \tau \to \mu\nu\nu$
    - Compare with simplest muonic mimicking background $B_{sig} \to \pi^0\mu\nu$
    - Continue with generic muonic mimicking backgrounds $B_{sig} \to \mu\nu X$
    - Continue with generic electronic mimicking backgrounds $B_{sig} \to e\nu X$ (not very important)
    - Continue with generic tauonic mimicking backgrounds $B_{sig} \to \tau\nu X, \tau \to \mu\nu\nu$ (important)
  - Study each of the remaining signals individually (not shown)
  - Study combination of all 6 signals
    - Compare with generic (leptonic,hadronic,both) mimicking background
    - Compare with generic tauonic mimicking background

- Repeat studies for generic hadronic tag $B_{tag} \to DX$
- Repeat studies for simplest semileptonic tag $B_{tag} \to \mu\nu D^0, D^0 \to K\pi$
- Repeat studies for generic semileptonic tag $B_{tag} \to \nu\ell DX$



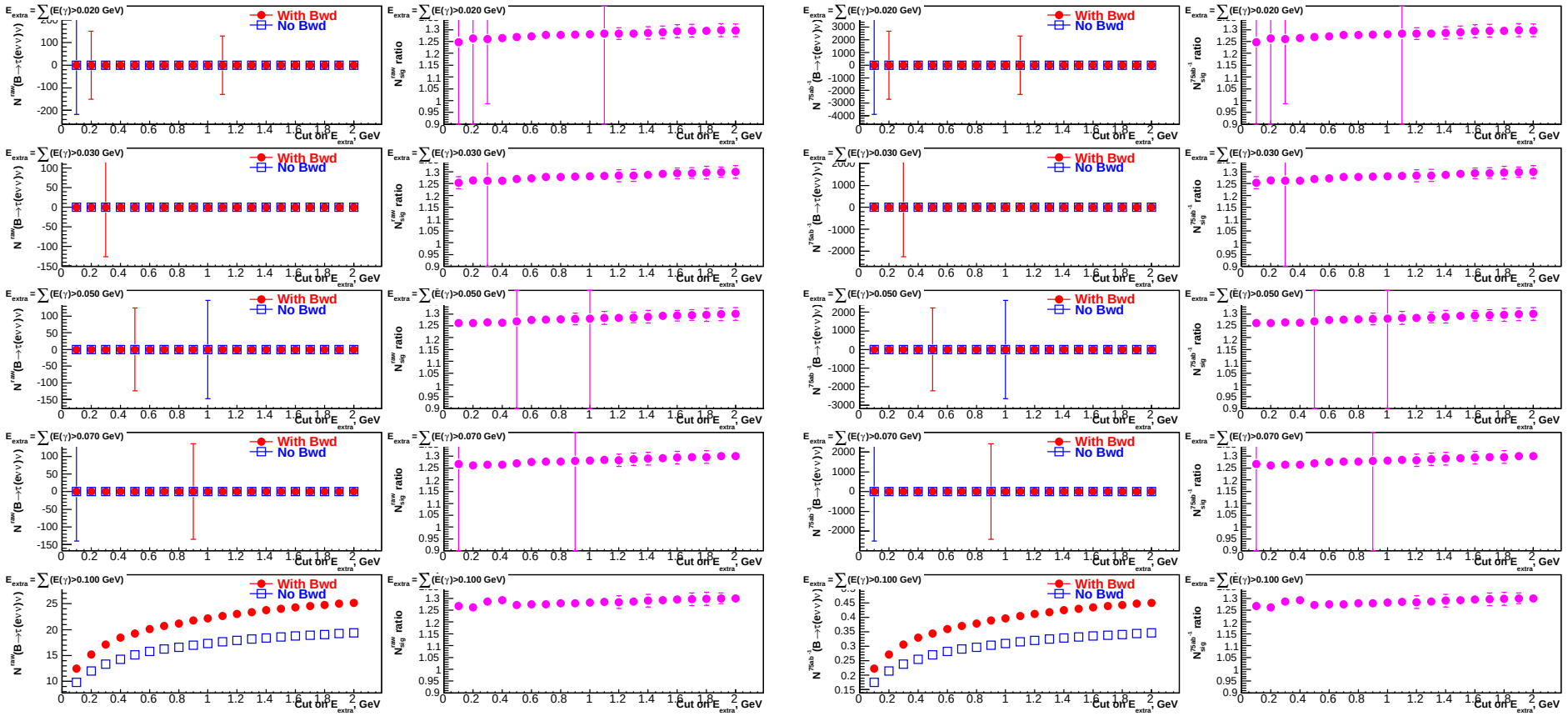


Simplest Hadronic Tag

$$B_{tag} \longrightarrow \pi D^0, D^0 \longrightarrow K\pi$$

Simplest Electronic Signal

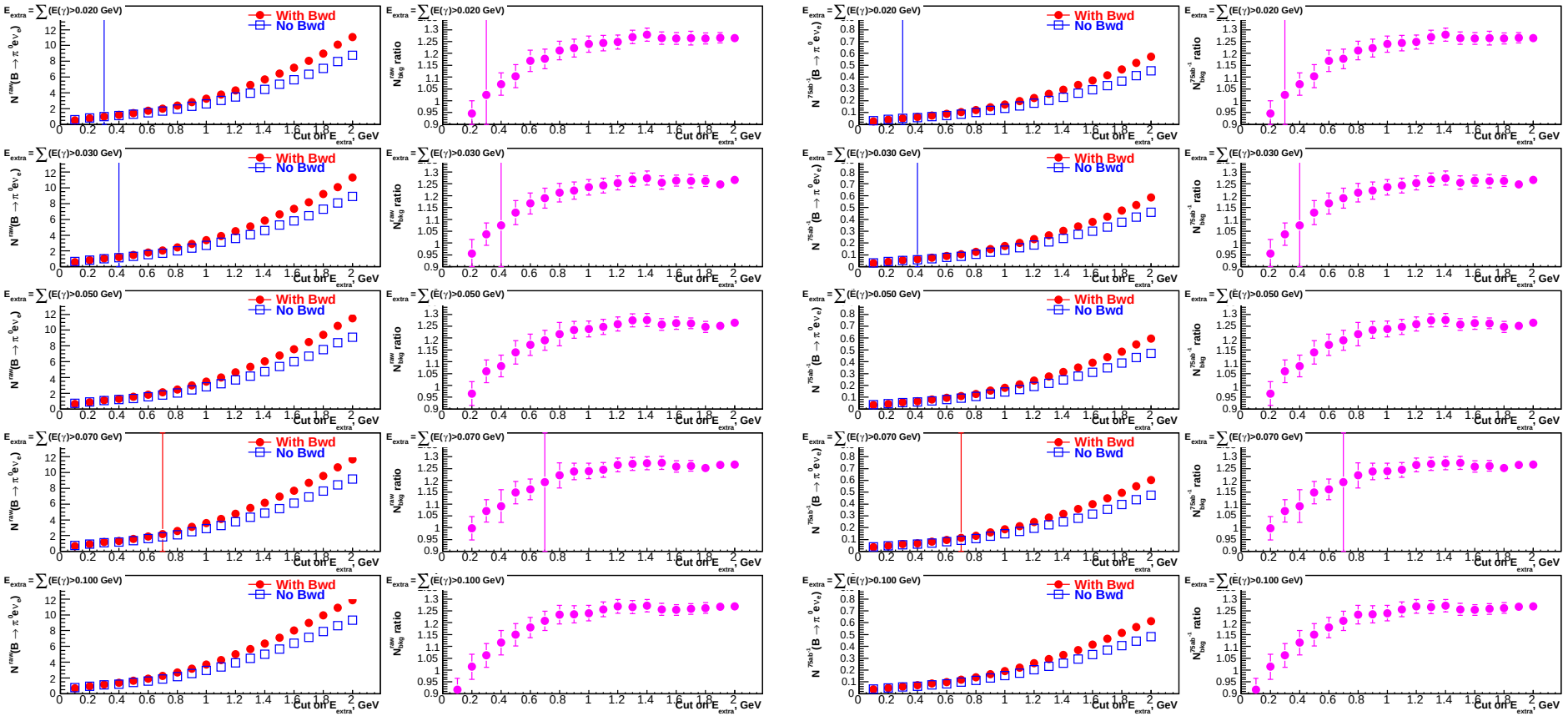
$$B_{sig} \rightarrow \tau\nu, \tau \rightarrow e\nu\nu$$



Presence of Backward EMC increases signal yield by about 25%

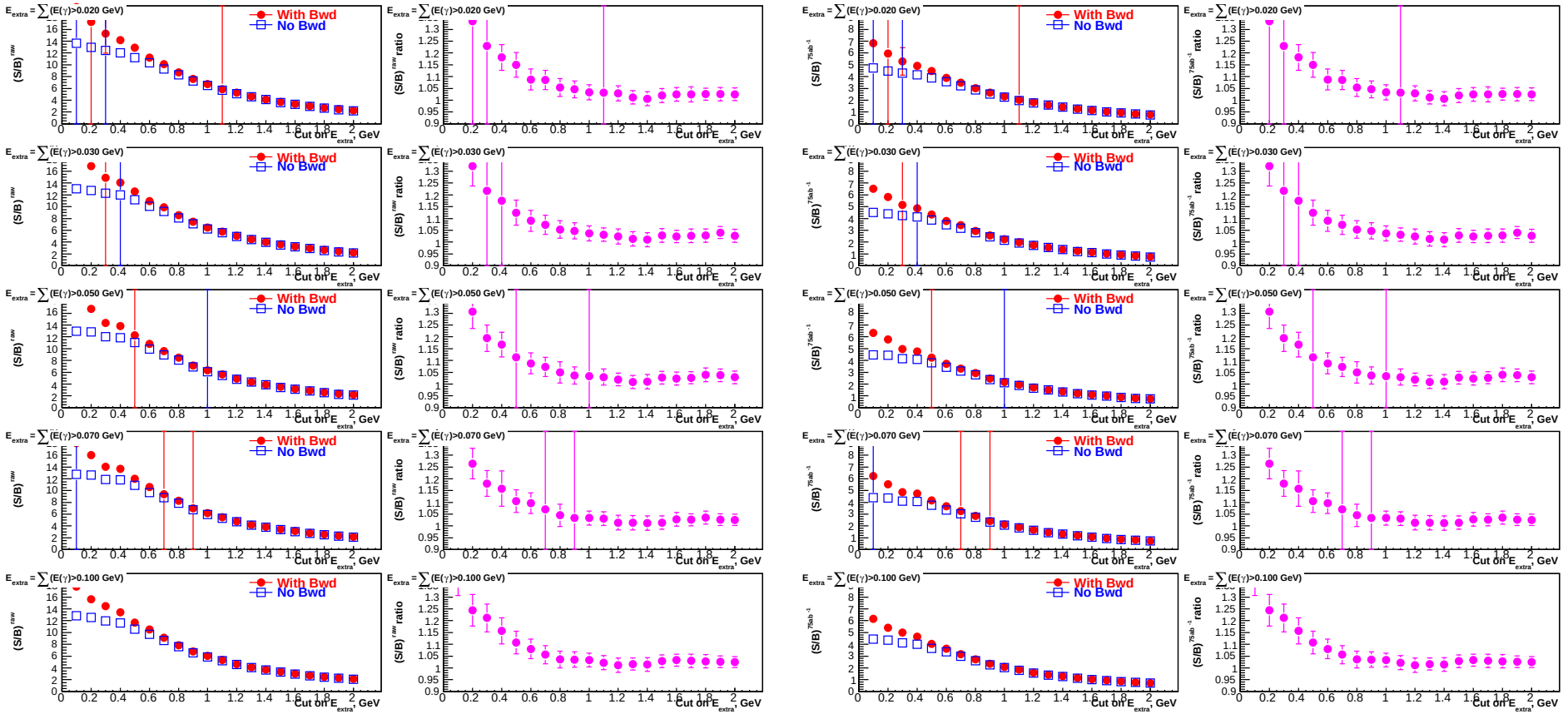
Simplest Electronic Mimicking Bkg

$$B_{sig} \rightarrow \pi^0 e \nu$$



Presence of Backward EMC decreases bkg yield by up to 20%

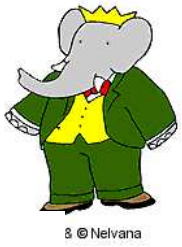
S/B Ratio

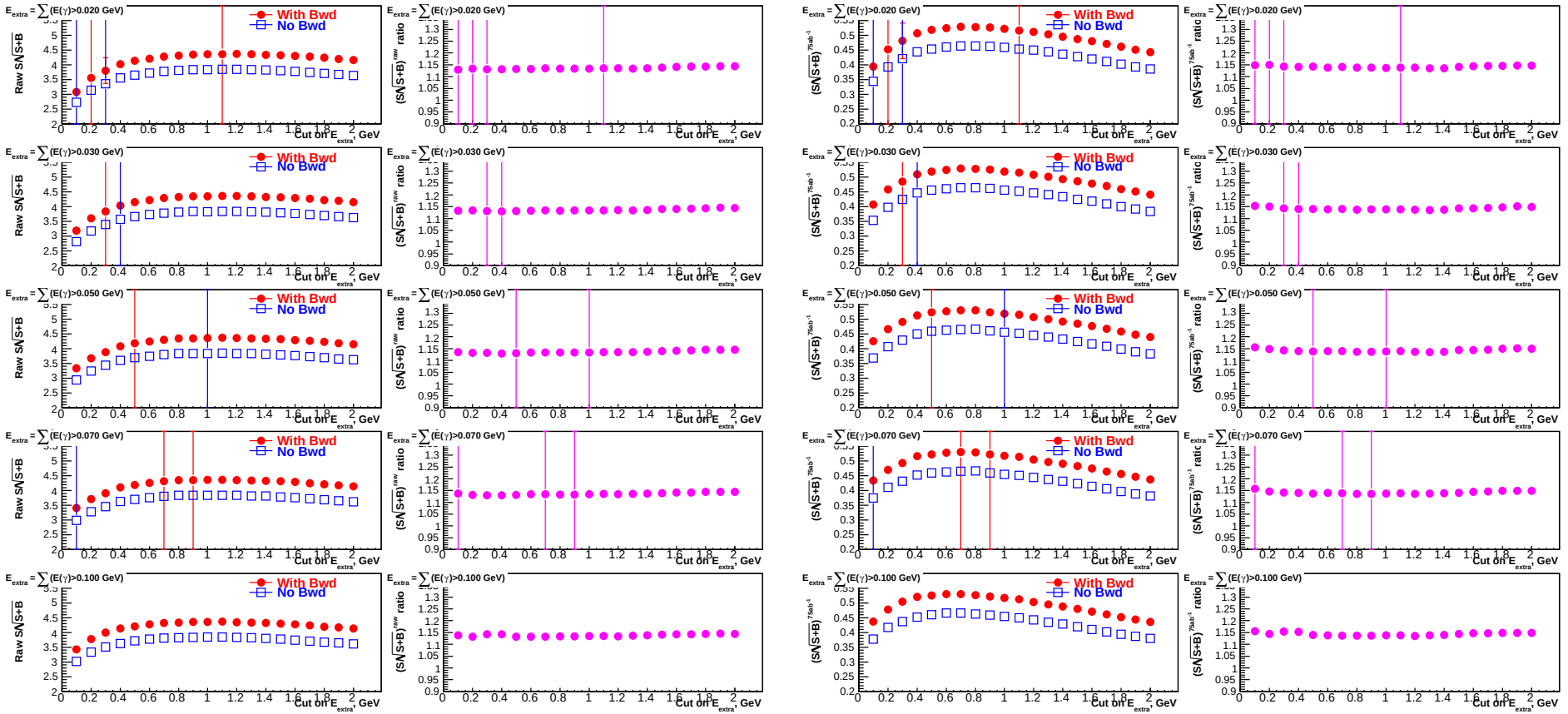


Presence of Backward EMC increases S/B ratio by about 20-25%

(let me remind that this is the simplest case)

$S/\sqrt{S+B}$ Ratio

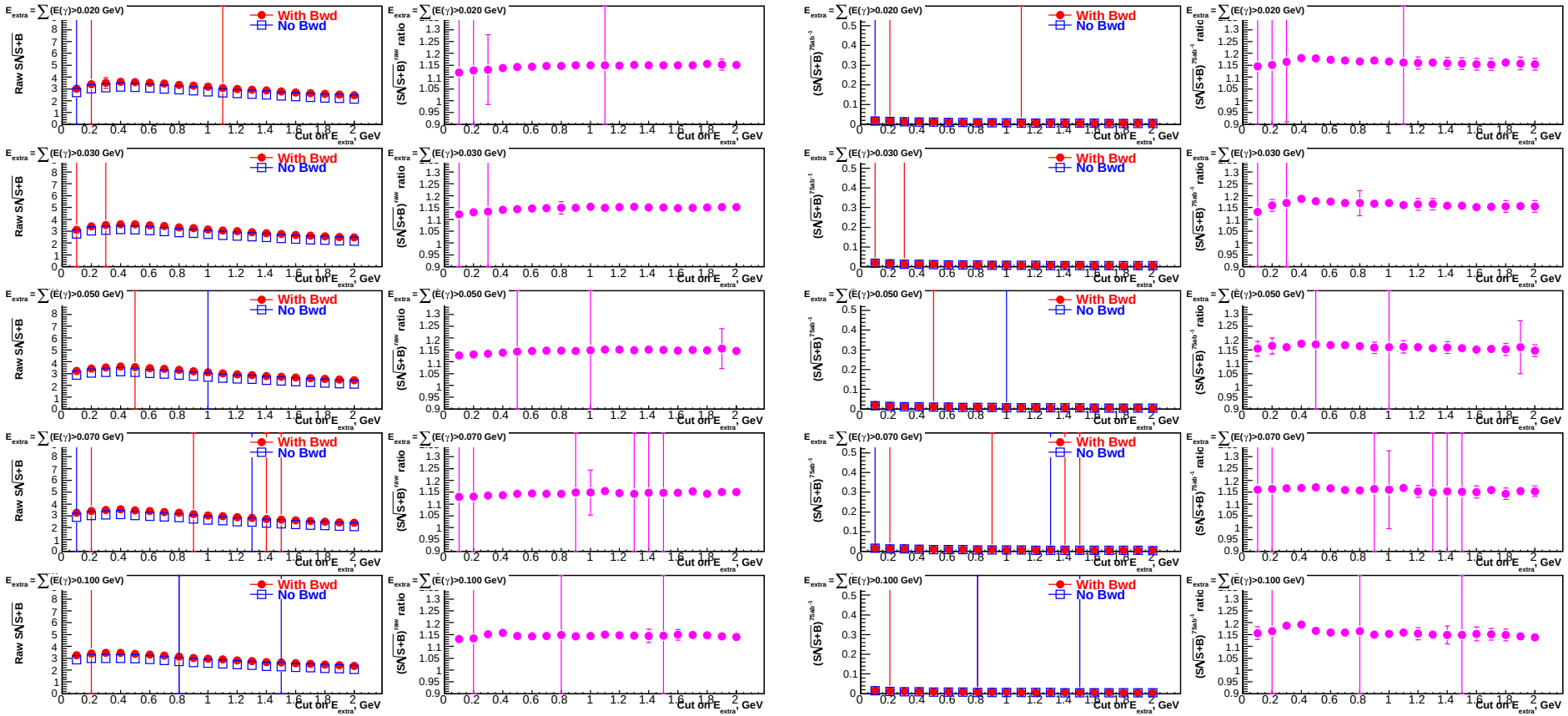




Presence of Backward EMC increases $S/\sqrt{S+B}$ ratio by 15%

Generic Electronic Mimicking Bkg

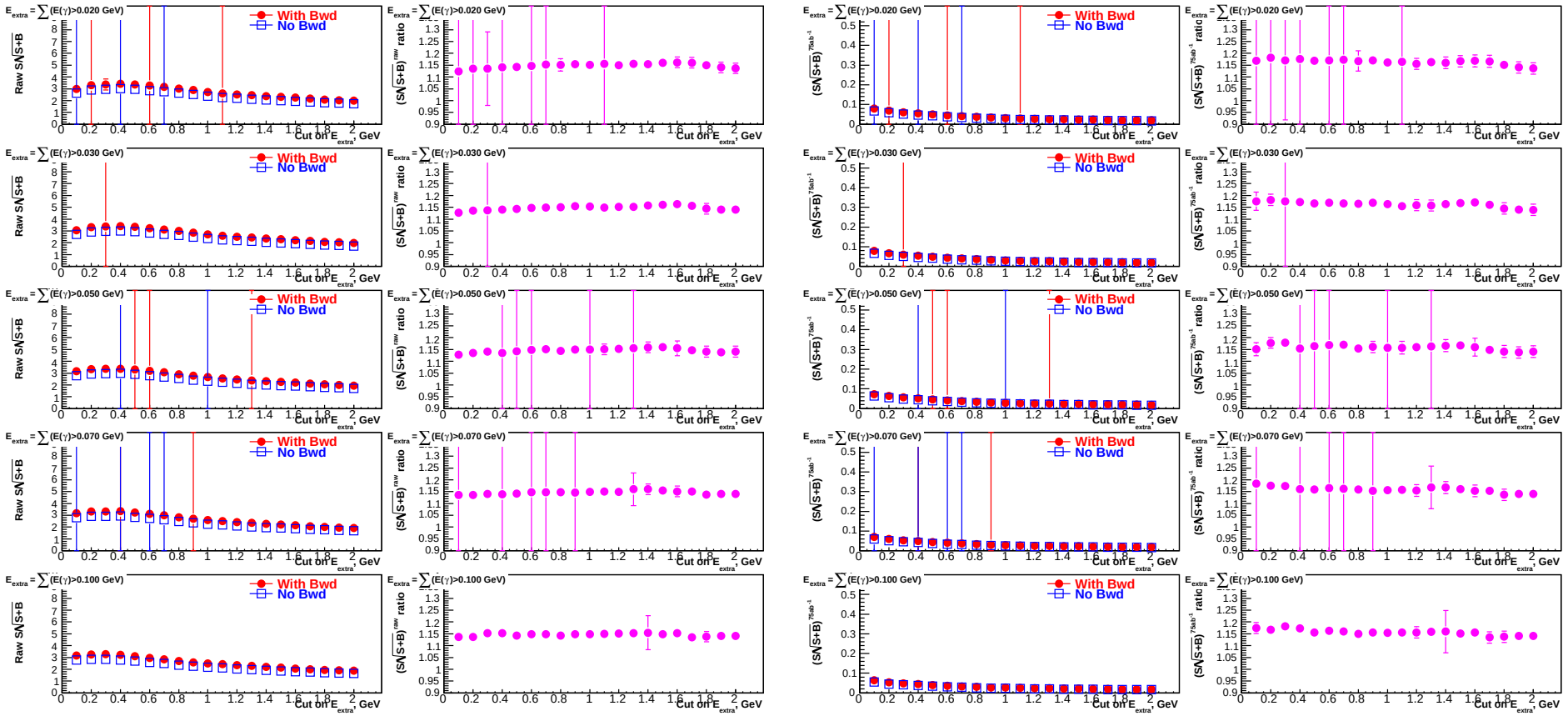
$$B_{sig} \rightarrow e\nu X$$



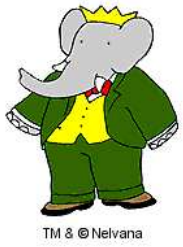
Presence of Backward EMC increases $S/\sqrt{S+B}$ ratio by about 15%

Generic Tauonic Mimicking Bkg

$$B_{sig} \to \tau\nu X, \tau \to e\nu\nu$$

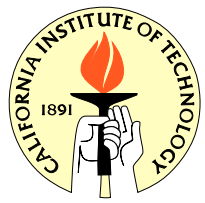


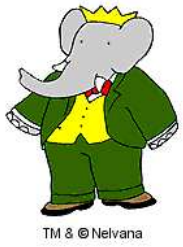
Presence of Backward EMC increases $S/\sqrt{S+B}$ ratio by about 17%



Generic Hadronic Tag

Unfortunately, the jobs are still running... Hope to show something on DGWG Meeting



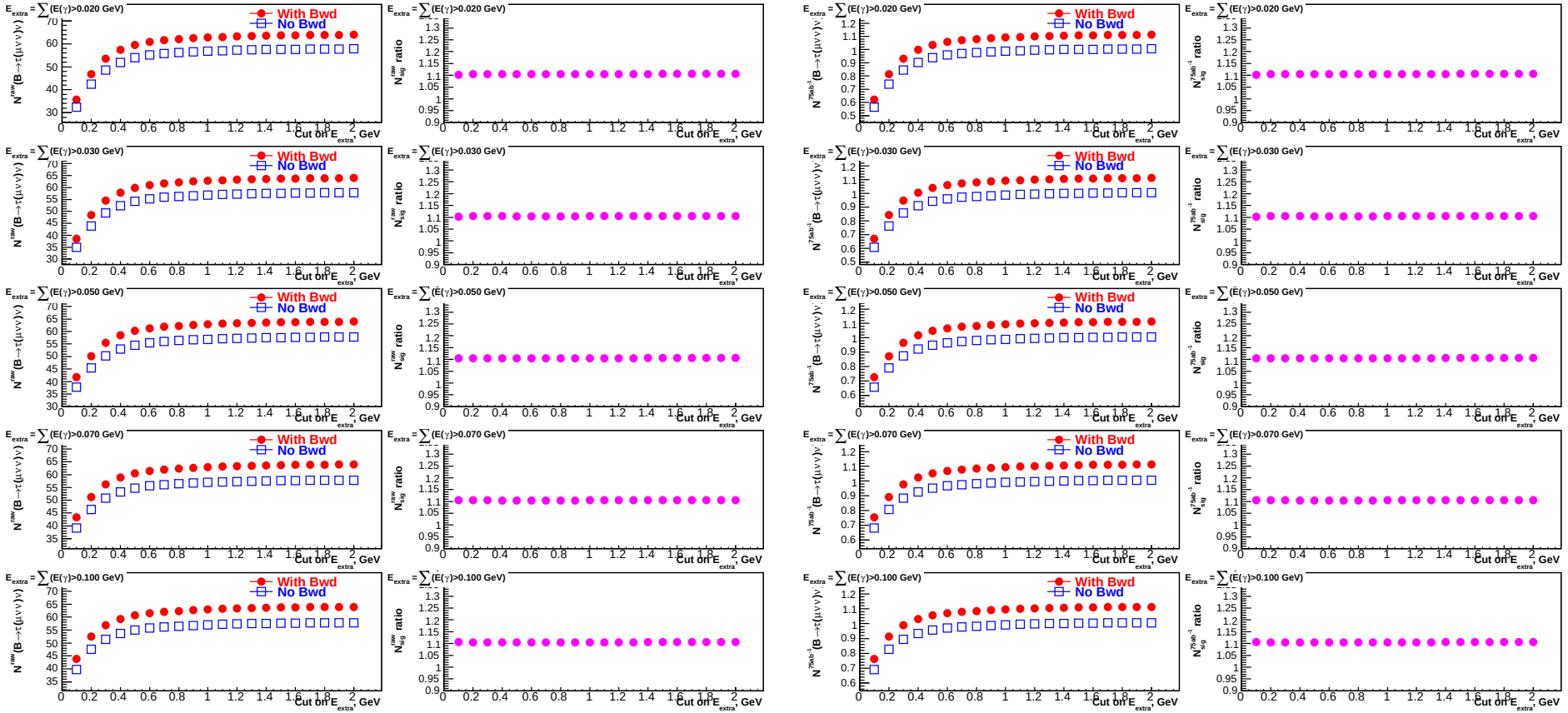


Simplest Semileptonic Tag

$$B_{tag} \rightarrow \mu D^0, D^0 \rightarrow K\pi$$

Simplest Muonic Signal

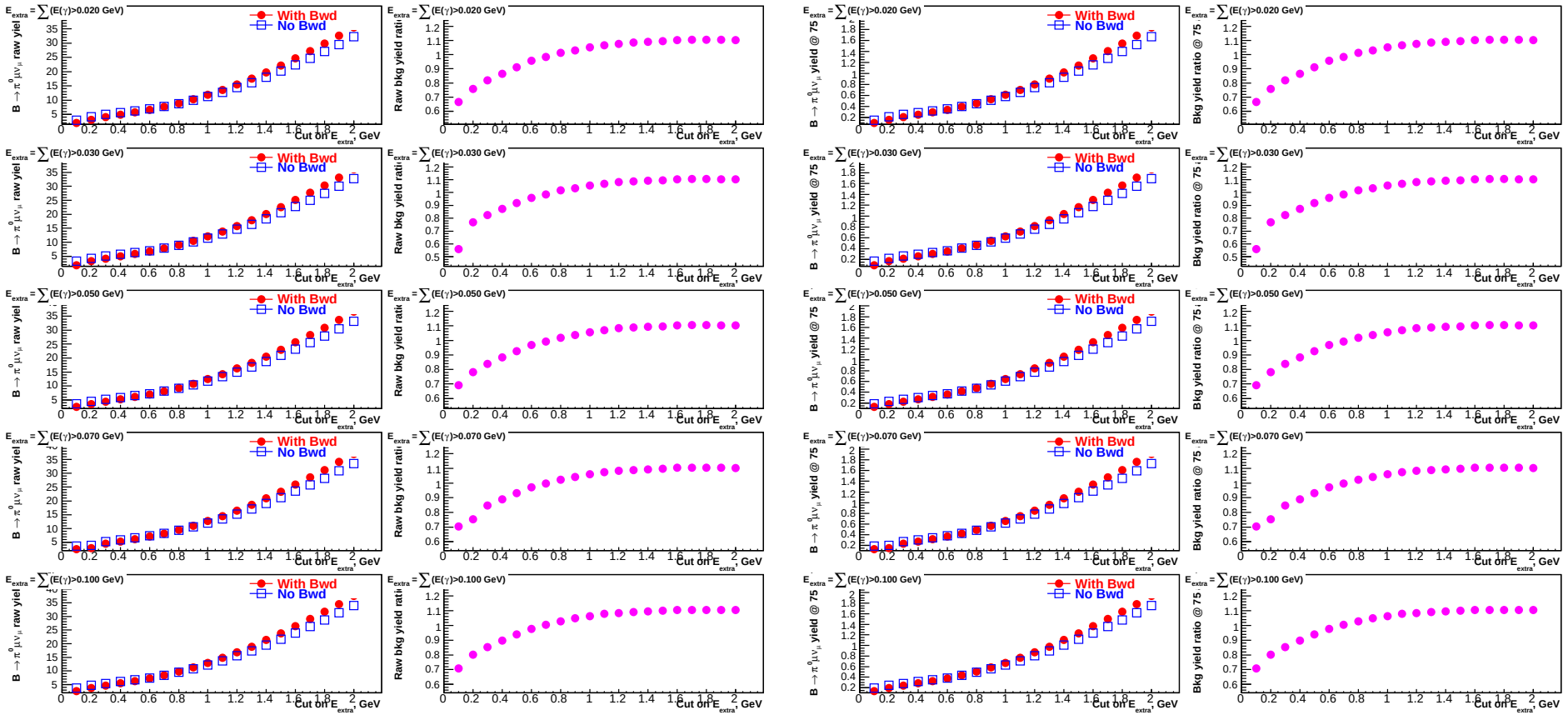
$$B_{sig} \to \tau\nu, \tau \to \mu\nu\nu$$



Presence of Backward EMC increases signal yield by about 10%

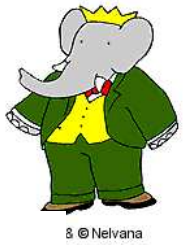
Simplest Muonic Mimicking Bkg

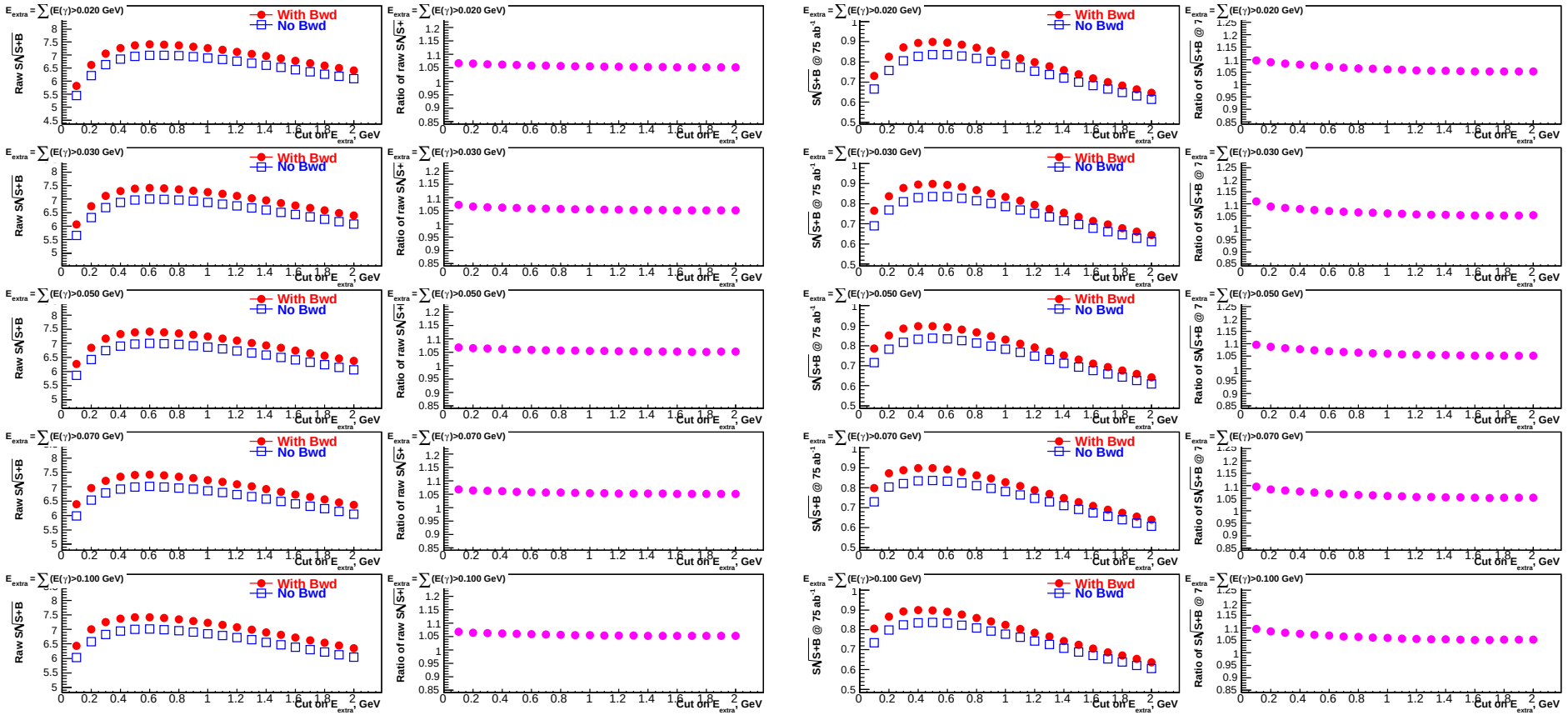
$$B_{sig} \to \pi^0 \mu \nu$$



Presence of Backward EMC decreases bkg yield by up to 30%

$S/\sqrt{S+B}$ Ratio

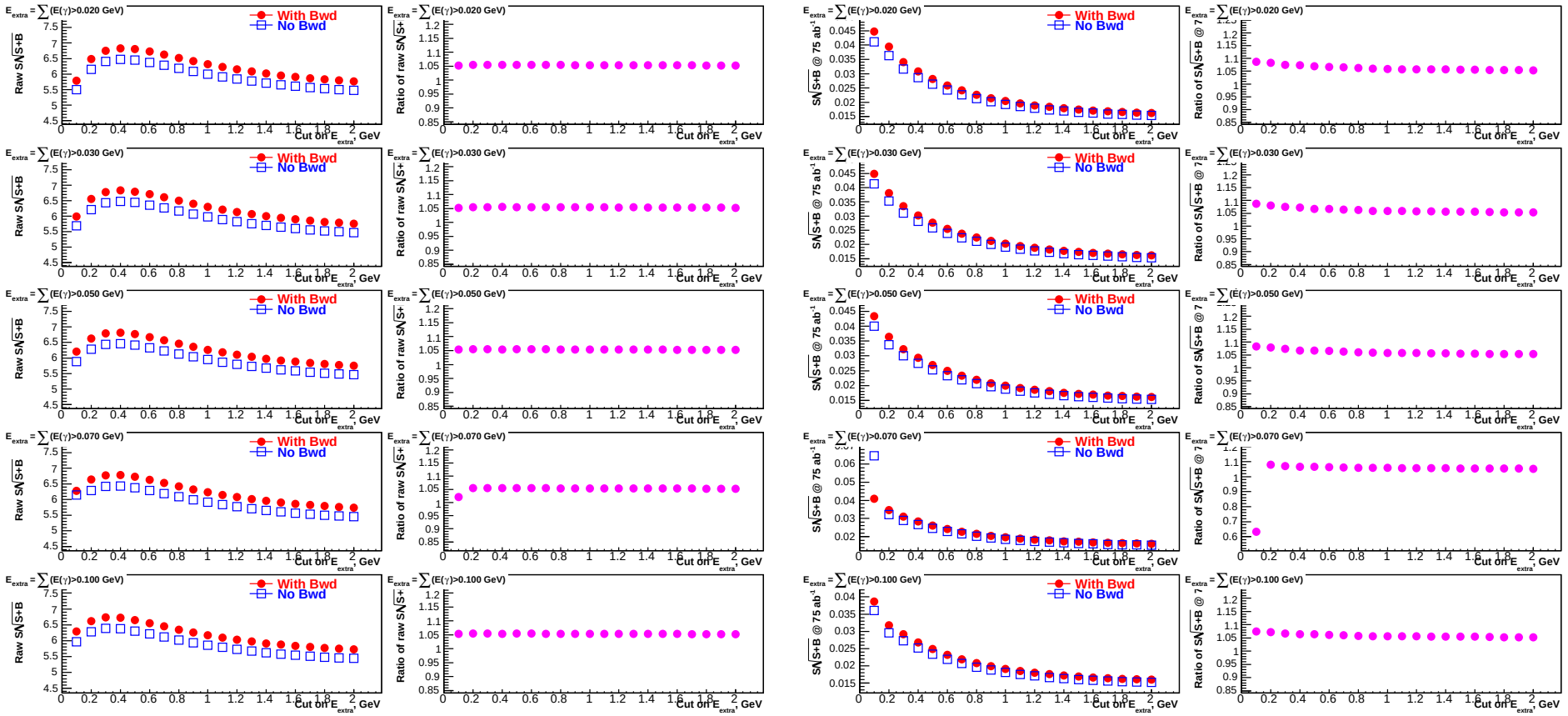




Presence of Backward EMC increases $S/\sqrt{S+B}$ ratio by about 10%

Generic Muonic Mimicking Bkg

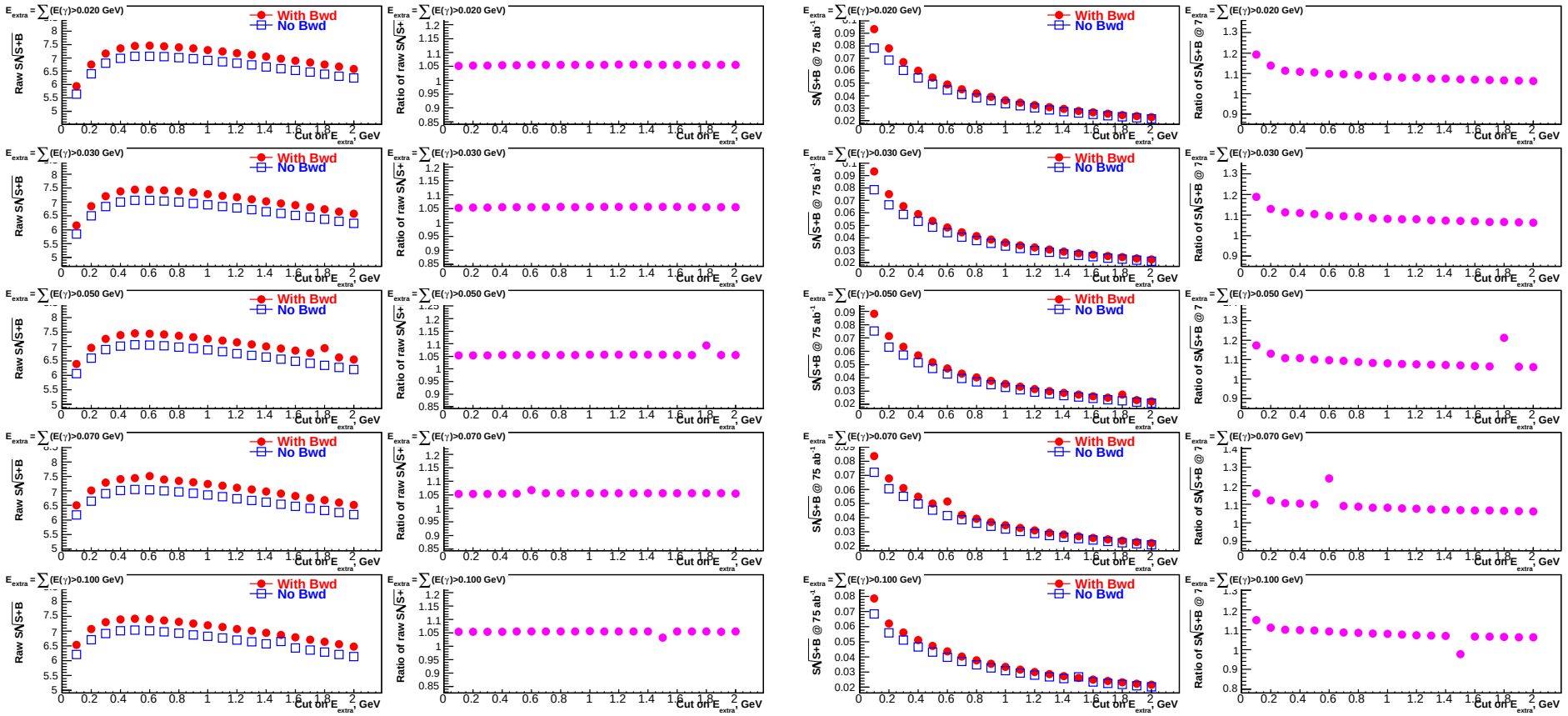
$$B_{sig} \rightarrow \mu\nu X$$



Presence of Backward EMC increases $S/\sqrt{S+B}$ ratio by about 10%

Generic Electronic Mimicking Bkg

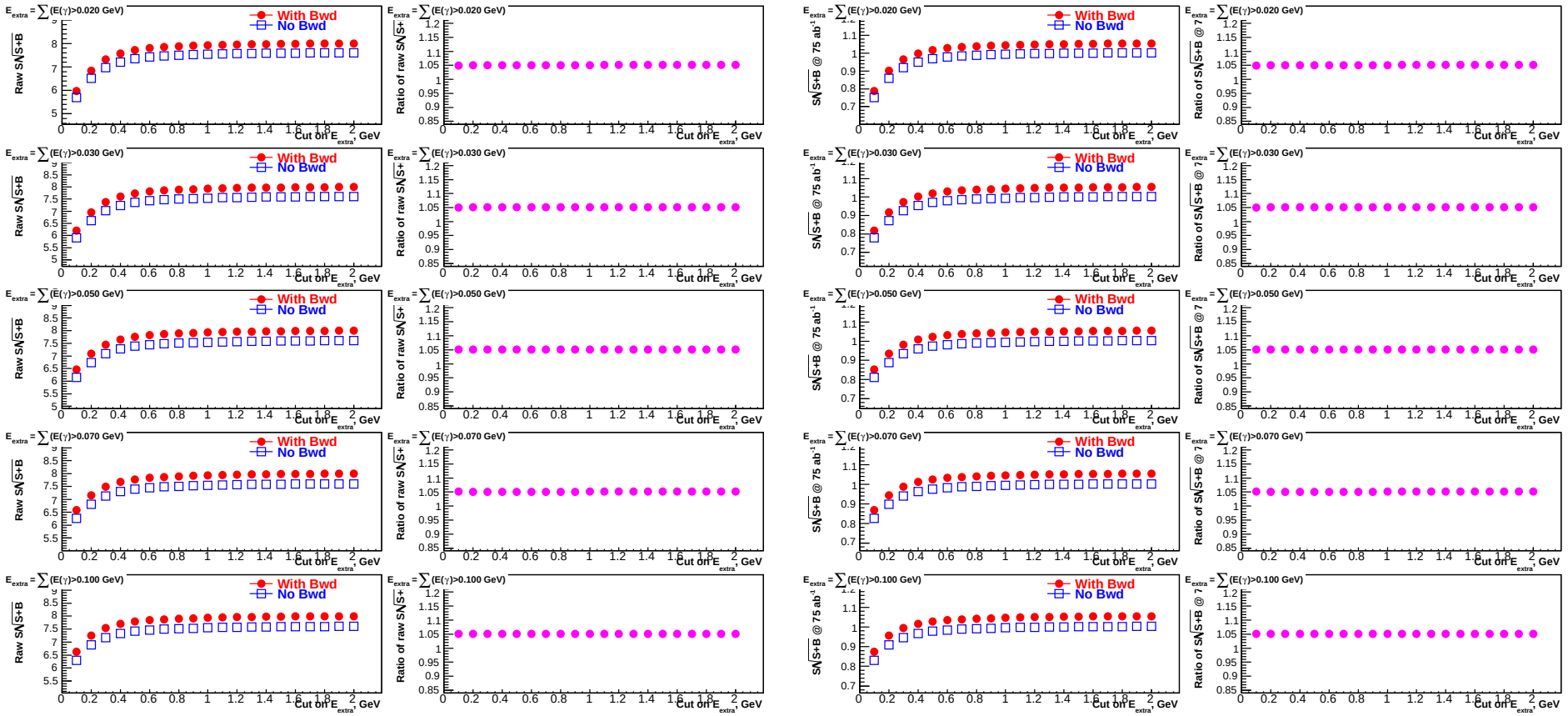
$$B_{sig} \rightarrow e\nu X$$



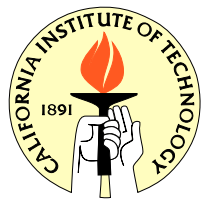
Presence of Backward EMC increases $S/\sqrt{S+B}$ ratio by about 5-10%

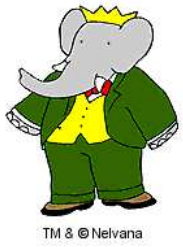
Generic Tauonic Mimicking Bkg

$$B_{sig} \rightarrow \tau\nu X, \tau \rightarrow \mu\nu\nu$$



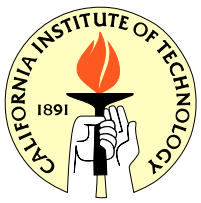
Presence of Backward EMC increases $S/\sqrt{S+B}$ ratio by about 5%



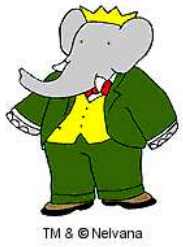


Generic Semileptonic Tag

Not completed yet, stay tuned...



Conclusion



The presence of Backward EMC improves $S/\sqrt{S+B}$ ratio by about 5-10% in the simplest cases.

More complicated cases are coming soon...