

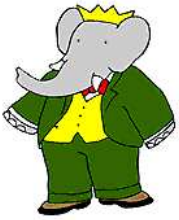
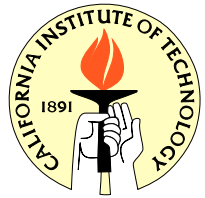
# Backward EMC for $B \rightarrow \tau \nu_\tau$ Decay

A. Rakitin

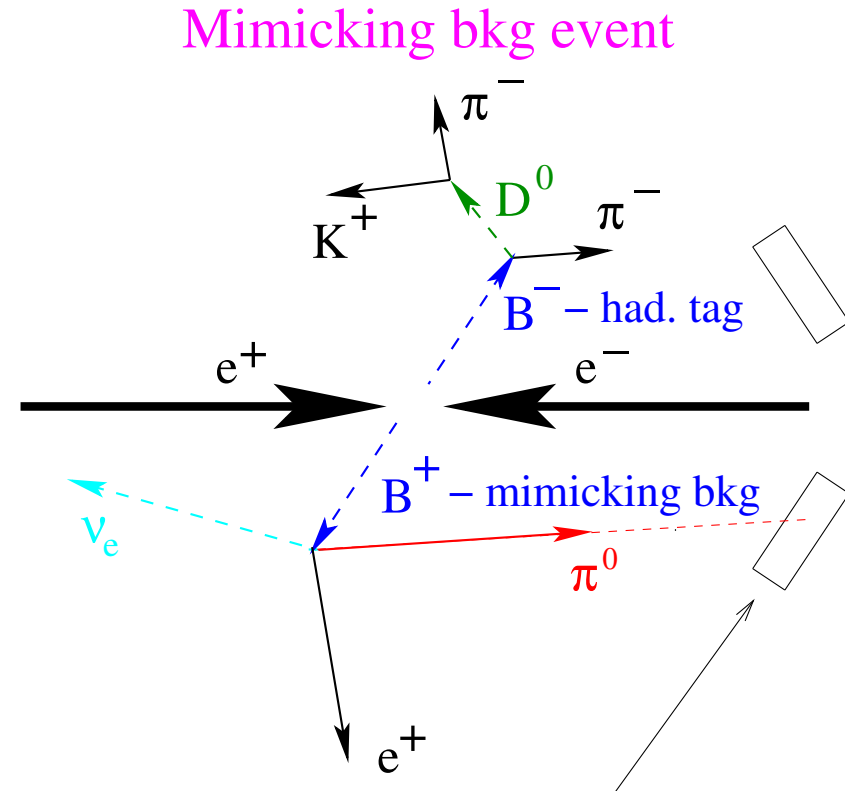
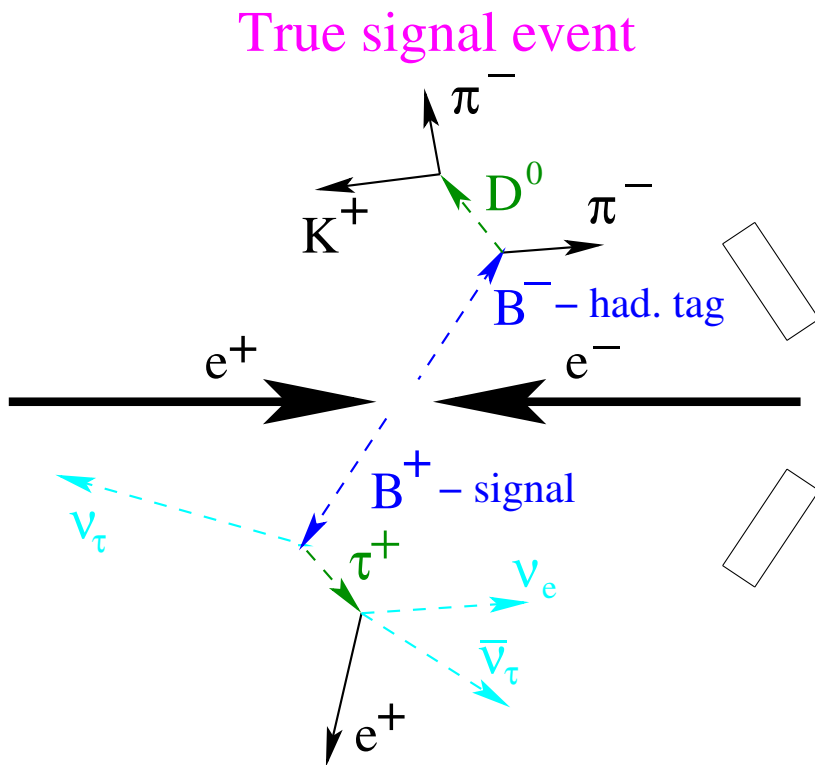
Caltech

December 14, 2010

XV SuperB General Meeting

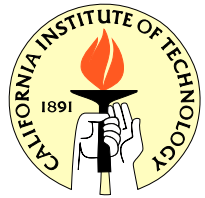


# $B \rightarrow \tau \nu_\tau$ Event

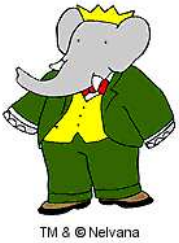


Without Backward EMC  
 $\pi^0$  may escape detection

The purpose of Backward EMC is to help better distinguish between signal and background by detecting (otherwise lost) photons

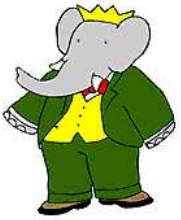
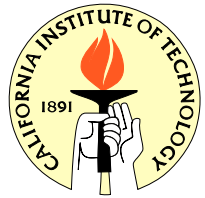


# Analysis strategy



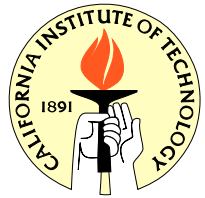
- Generate signal and background MC with FastSim V0.2.4
- Reconstruct  $B_{tag}$  (Hadronic and SL)
- Reconstruct  $B_{sig} \rightarrow \tau\nu_\tau$  ( $\tau$  decays to 5 modes) in both signal and background MC
- Obtain signal ( $S$ ) and background ( $B$ ) yields, as well as  $S/B$  ratio and  $S/\sqrt{S+B}$  at  $75 \text{ ab}^{-1}$  **without using Backward EMC info (reference values)**
- Calculate  $E_{extra}$  in Backward EMC for different thresholds: none, 30, 50, 70 MeV
- Obtain signal and background efficiencies, as well as  $S/B$  ratio and  $S/\sqrt{S+B}$  at  $75 \text{ ab}^{-1}$  **as functions of the cut on  $E_{extra}$**
- Compare to the references

Disclaimer: the results in this presentation are different from previously reported ones due to different definitions of  $E_{extra}$ . Now  $E_{extra}$  is calculated as a sum of the energy depositions in Backward EMC only, while previously it was calculated as a sum of energy depositions in the whole EMC.

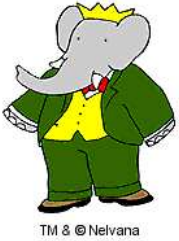


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# Hadronic Tag



# Used MC samples

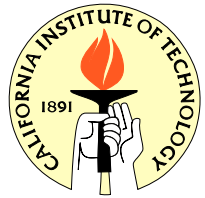


➔ For the signal MC I used two samples:

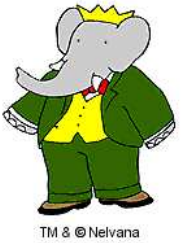
- Decay file `B+B-_taunu_DX.dec` with tag  $B$  decay modes containing exactly those  $D$  decays which are reconstructed by `PacHadRecoilUser` package (as a result, the generated combinatorial background is smaller than expected)
- Decay file `B+B-_taunu.dec` with tag  $B$  decaying generically

➔ For the background MC I also used two samples:

- $B_{sig} \rightarrow$  anything,  $B_{tag} \rightarrow$  DX (same tag  $B$  as first signal sample)
- [1/10<sup>th</sup> of ] `B+B-_Btag-HD_Cocktail` sample:  
 $B_{sig} \rightarrow$  anything,  $B_{tag} \rightarrow$  had. cocktail



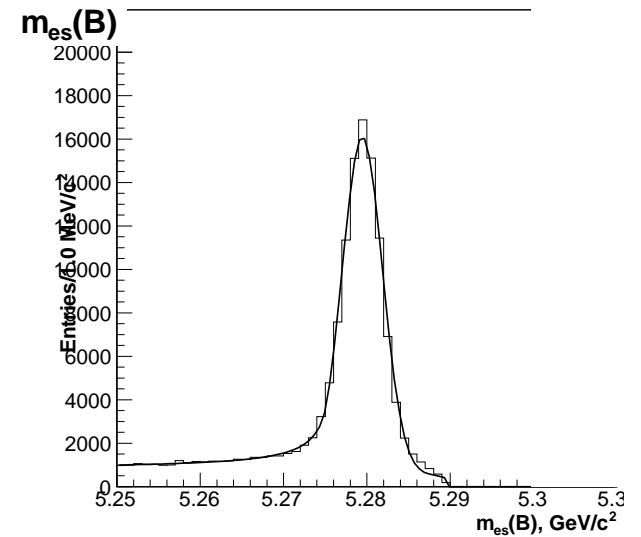
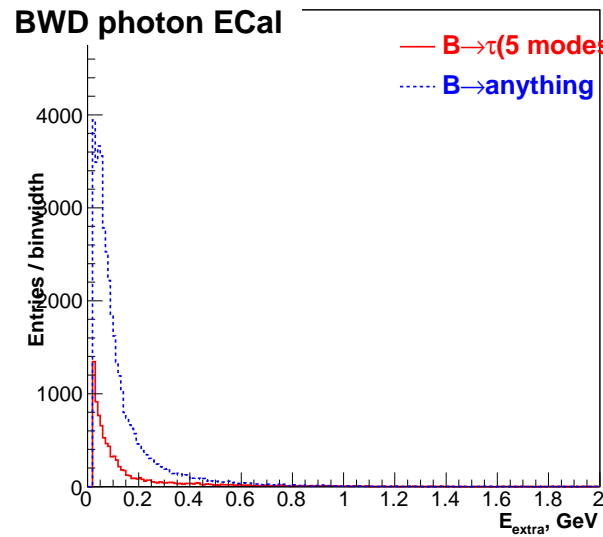
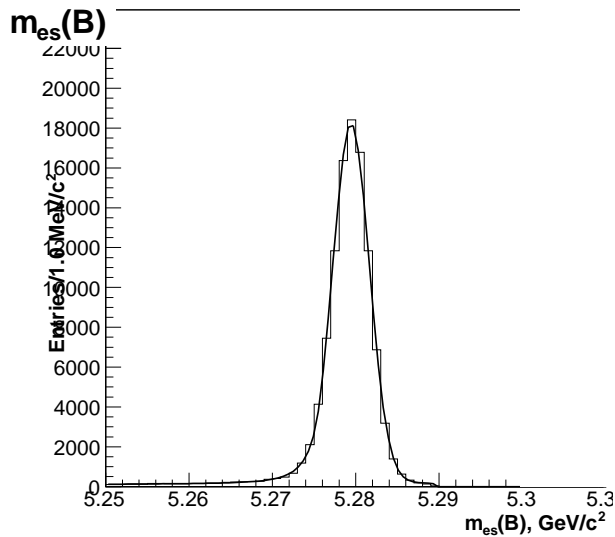
# $B_{tag} \rightarrow DX$ for sig and bkg



$m_{es}$  in signal sample

$E_{extra}$

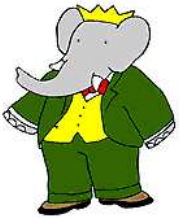
$m_{es}$  in bkg sample



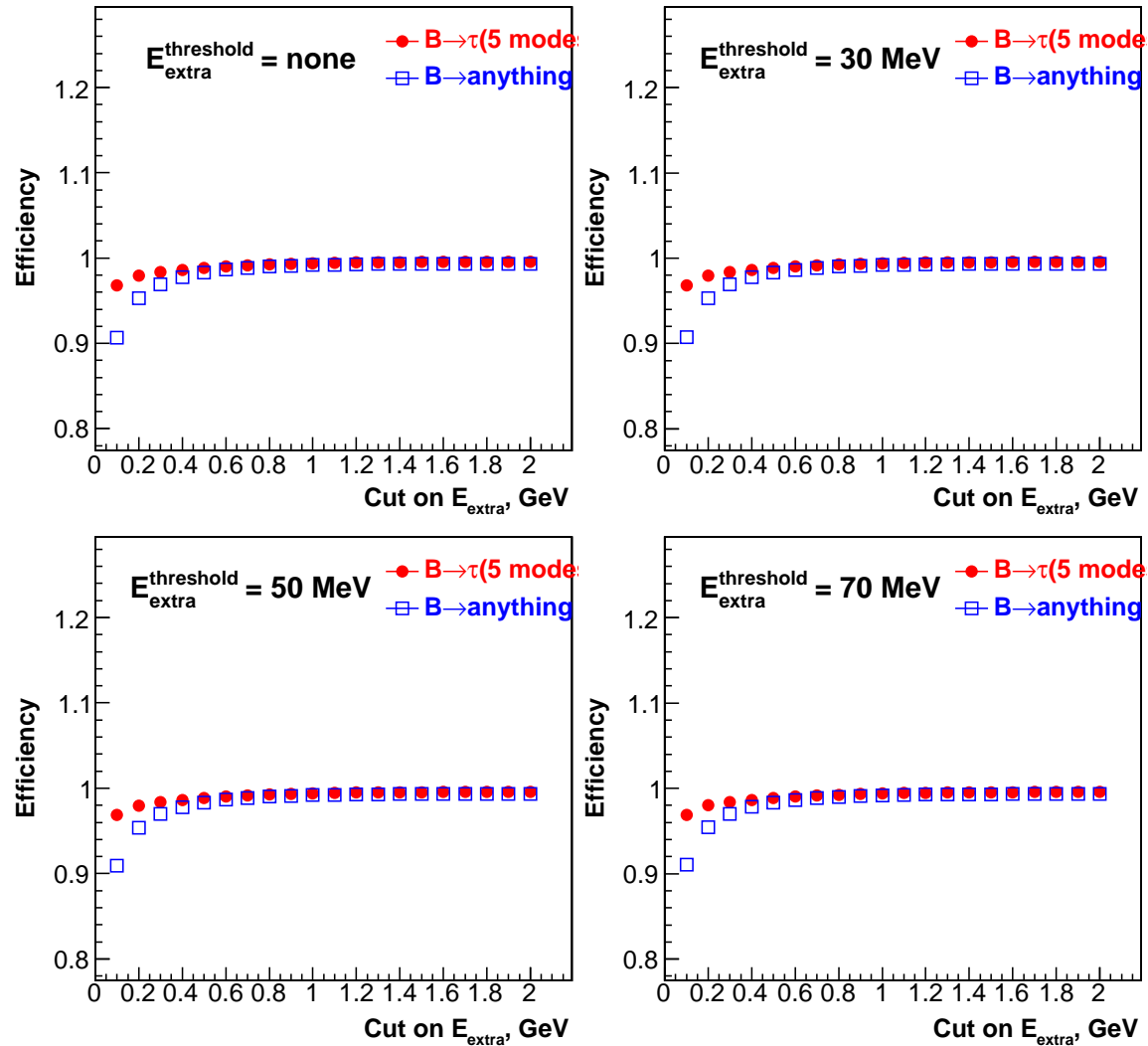
Let's cut on different values of  $E_{extra}$  in Backward EMC and fit for the peak yield for each cut with CB + Argus function



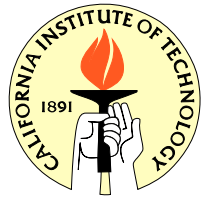
# $E_{extra}$ cut efficiency



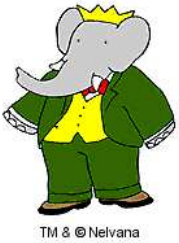
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Reduction in signal  $\sim 1\% - 2\%$ , reduction in bkg  $\sim 5\% - 10\%$

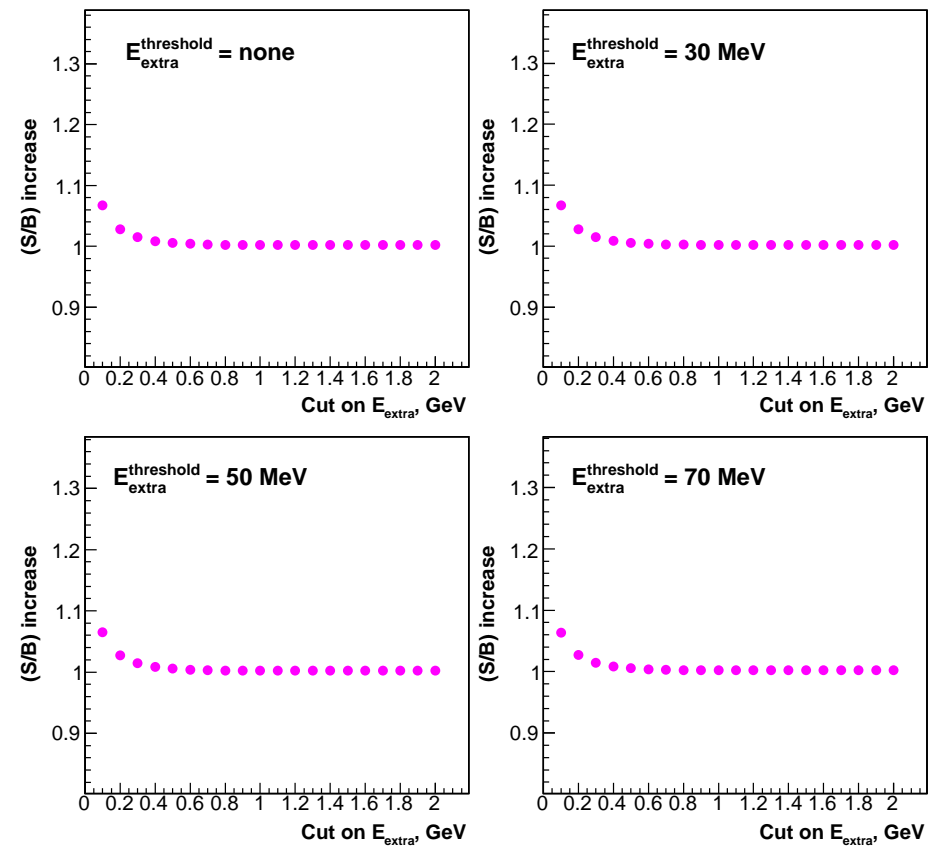
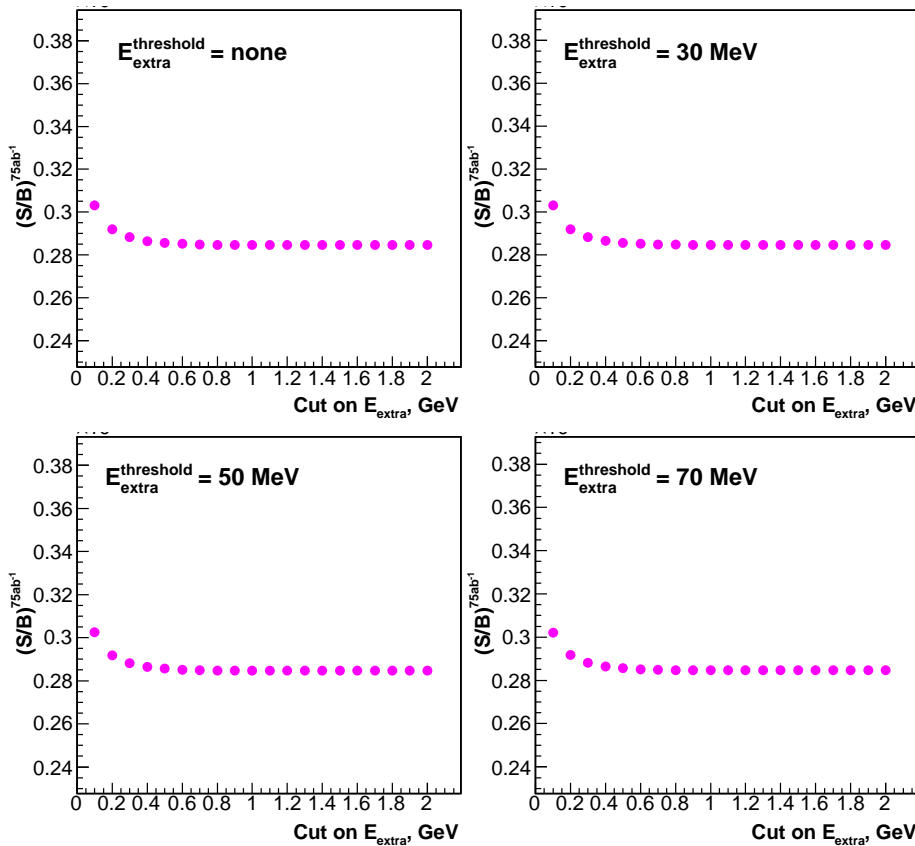


# $S/B$ ratio at $75 \text{ ab}^{-1}$



Absolute value

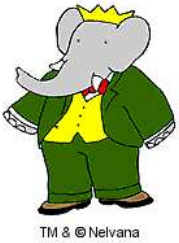
Relative increase



Cutting on  $E_{extra}$  increases  $S/B$  ratio at  $75 \text{ ab}^{-1}$  by  $\sim 5\% - 10\%$

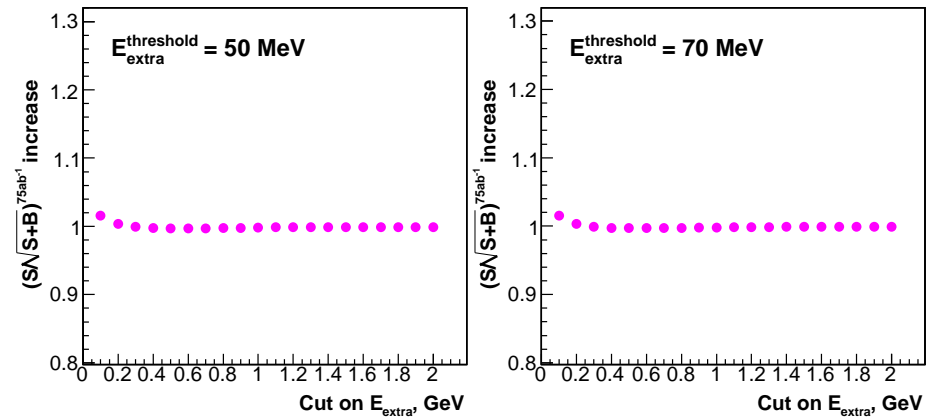
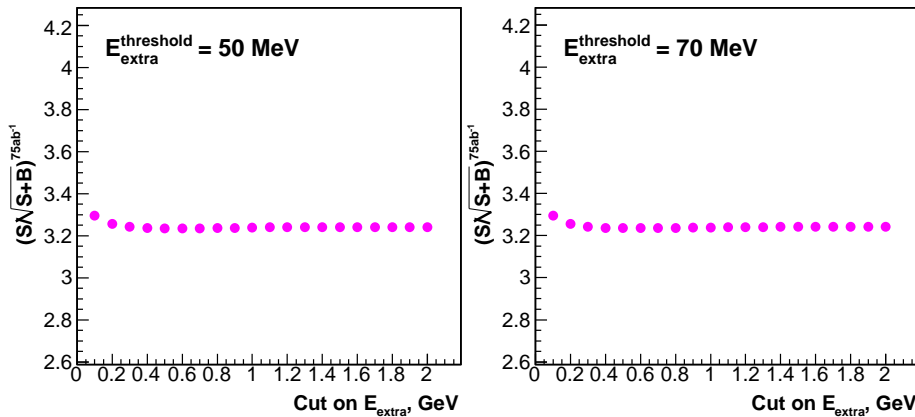
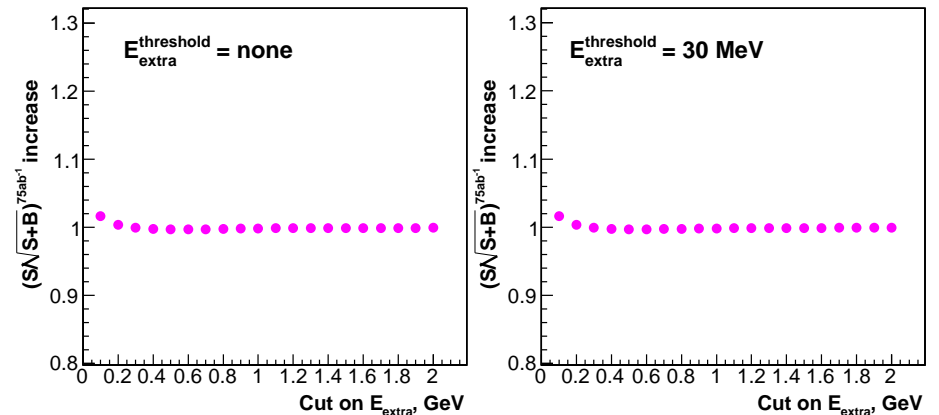
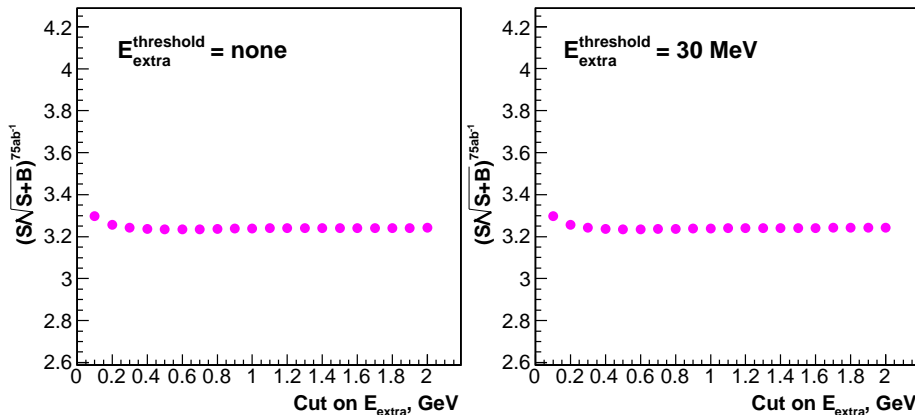


# $S/\sqrt{S+B}$ at $75 \text{ ab}^{-1}$

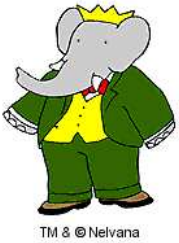
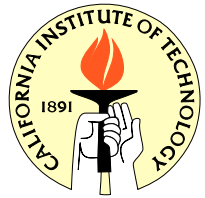


Absolute value

Relative increase



Cutting on  $E_{extra}$  increases  $S/\sqrt{S+B}$  ratio by  $\lesssim 1\%$

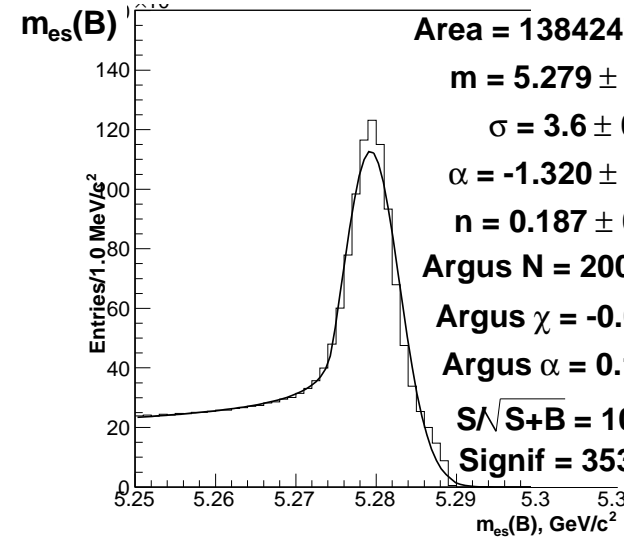
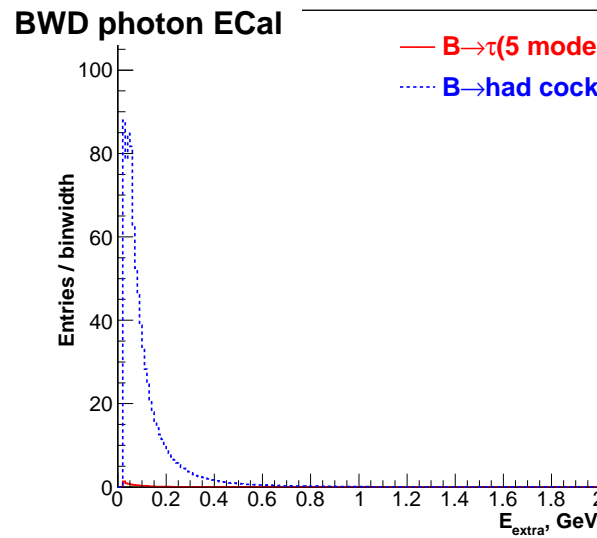
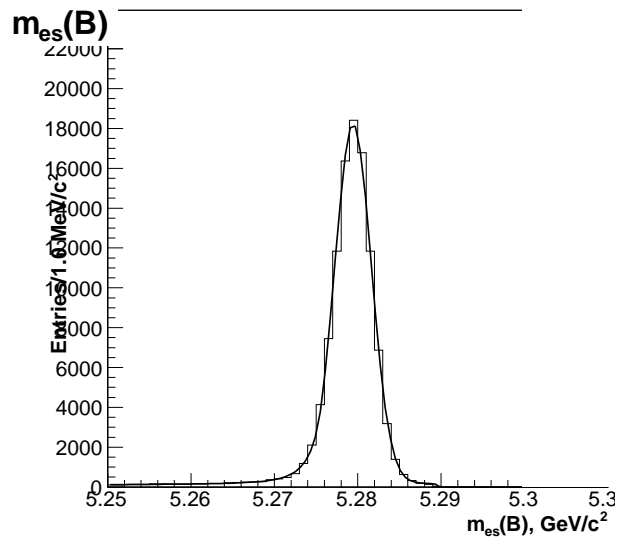


**Sig:**  $B_{tag} \rightarrow DX$   
**Bkg:**  $B_{tag} \rightarrow \text{had. cocktail}$

$m_{es}$  in signal sample

$E_{extra}$

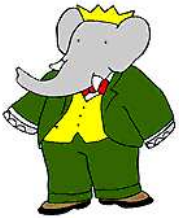
$m_{es}$  in bkg sample



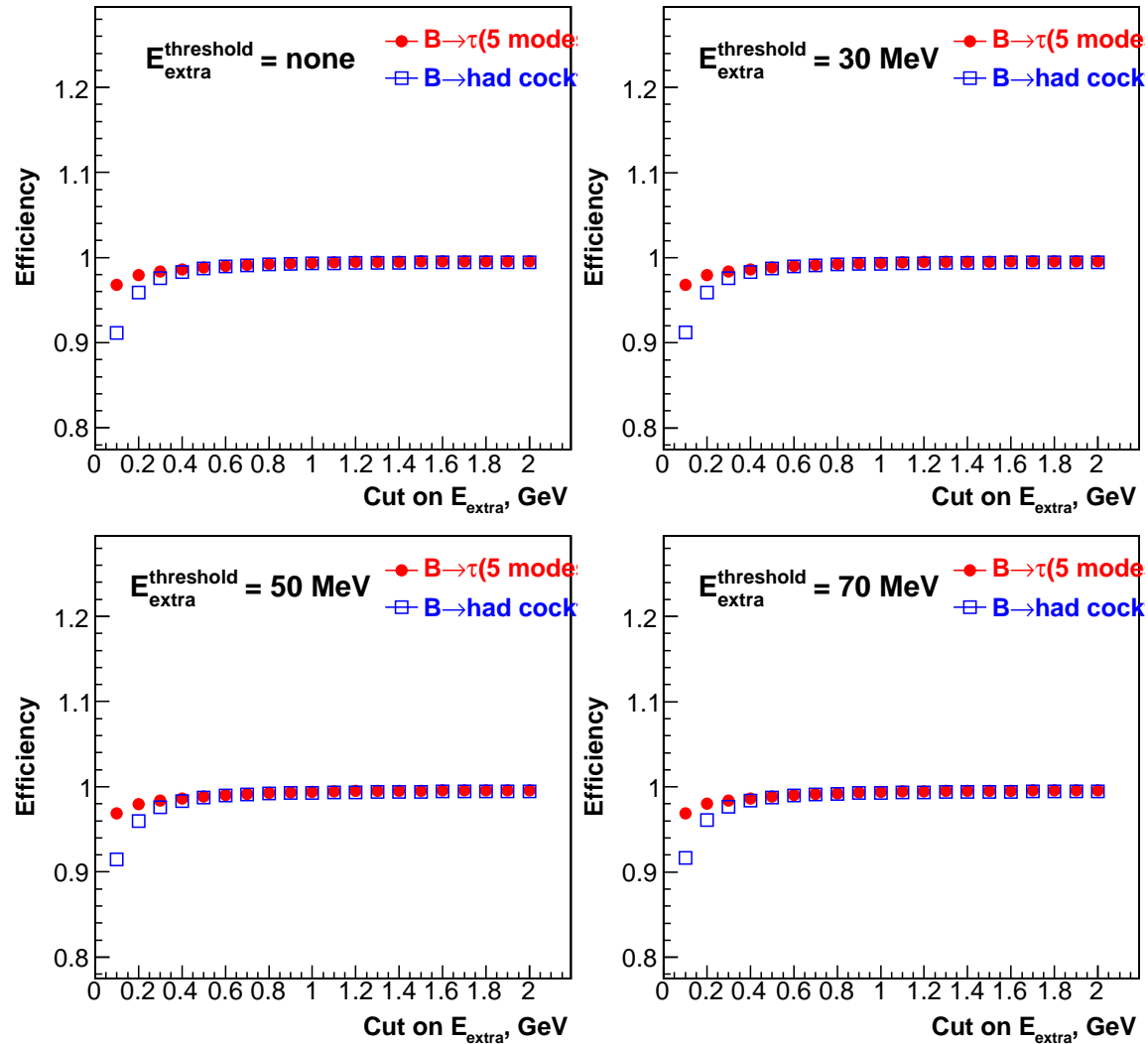
Again, cut on different values of  $E_{extra}$  in Backward EMC and fit for the peak yield for each cut with CB + Argus function



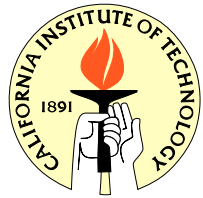
# $E_{extra}$ cut efficiency



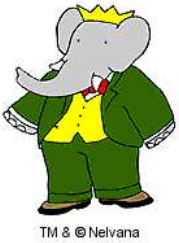
TM & © Nelvana



Again, reduction in signal  $\sim 1\%$ , reduction in bkg  $\sim 5\% - 10\%$

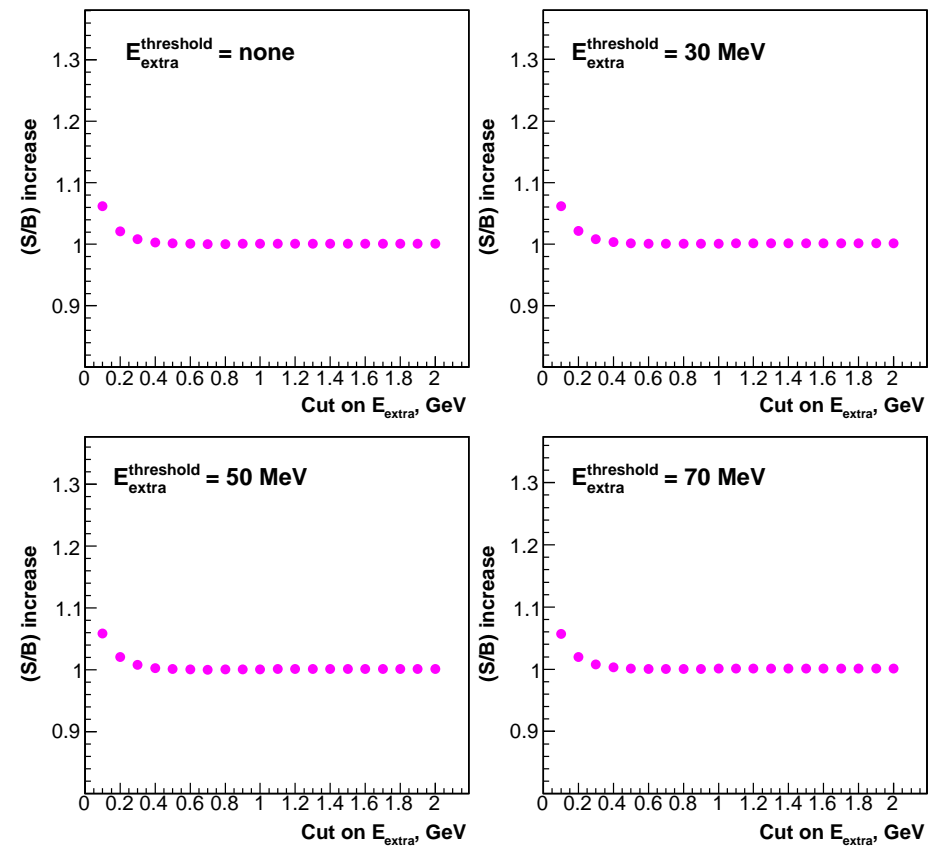
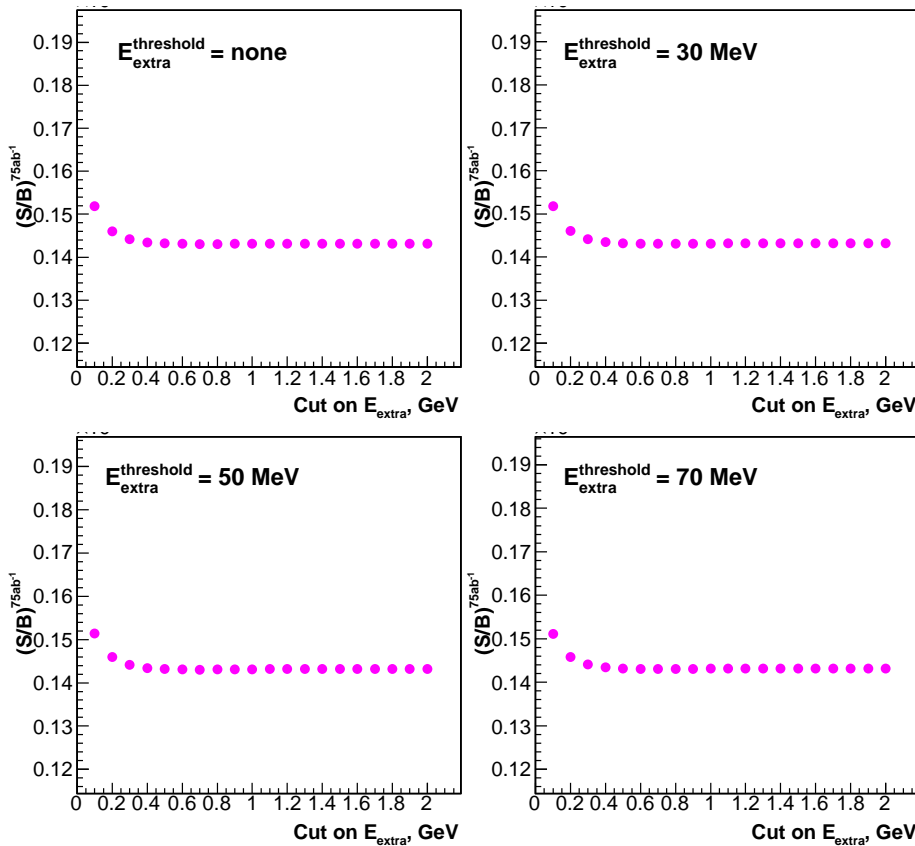


# $S/B$ ratio at $75 \text{ ab}^{-1}$



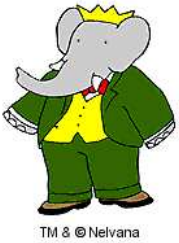
Absolute value

Relative increase



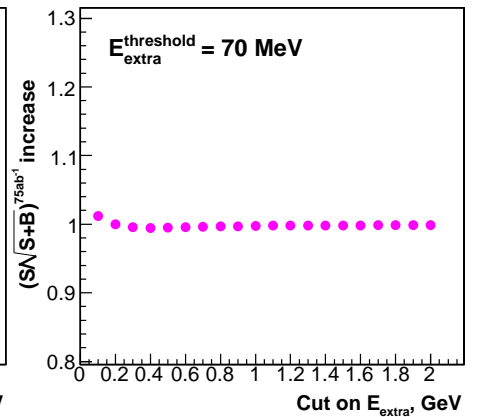
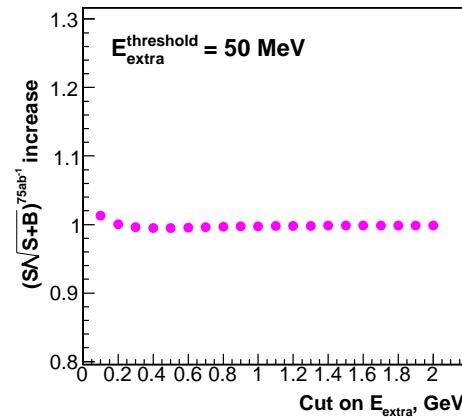
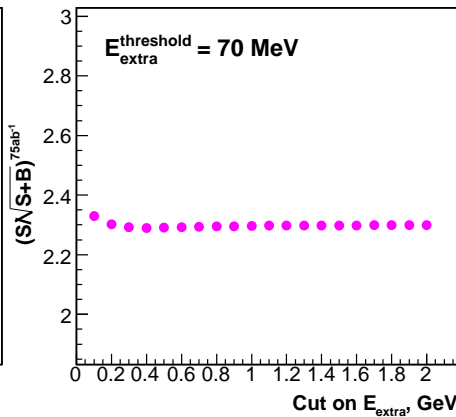
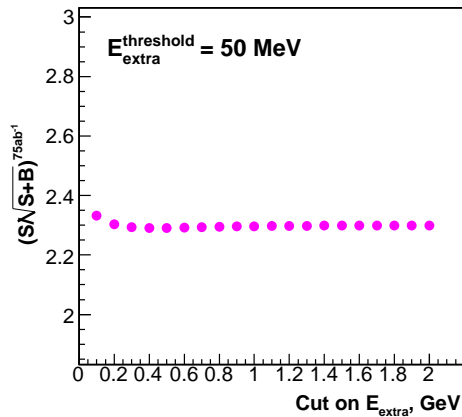
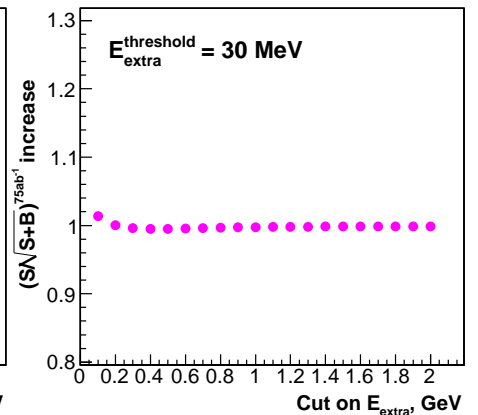
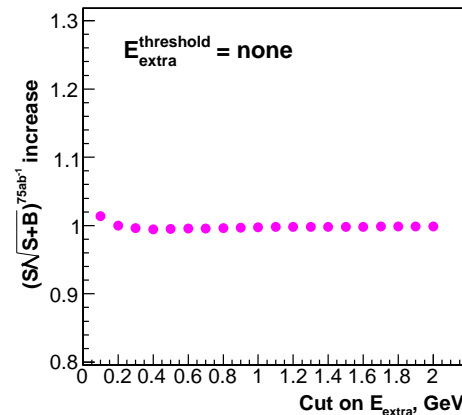
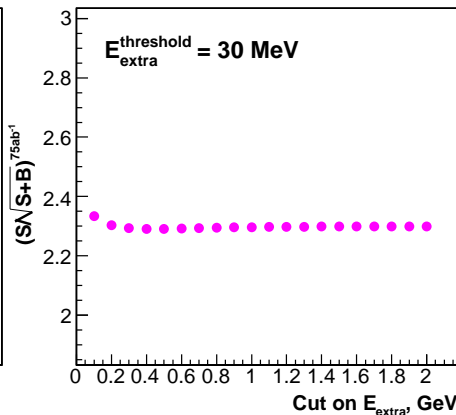
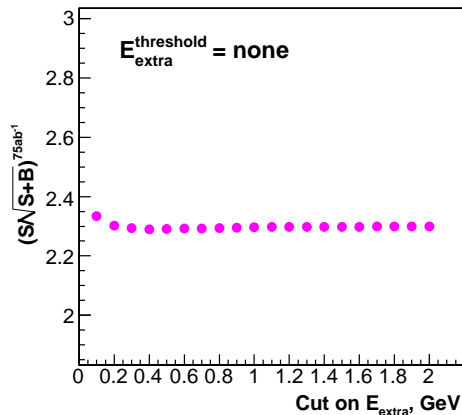
Cutting on  $E_{extra}$  increases  $S/B$  ratio at  $75 \text{ ab}^{-1}$  by  $\sim 5\% - 10\%$

# $S/\sqrt{S+B}$ at $75 \text{ ab}^{-1}$

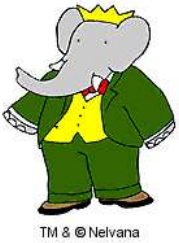
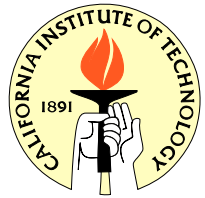


Absolute value

Relative increase



Cutting on  $E_{\text{extra}}$  increases  $S/\sqrt{S+B}$  ratio by  $\lesssim 1\%$

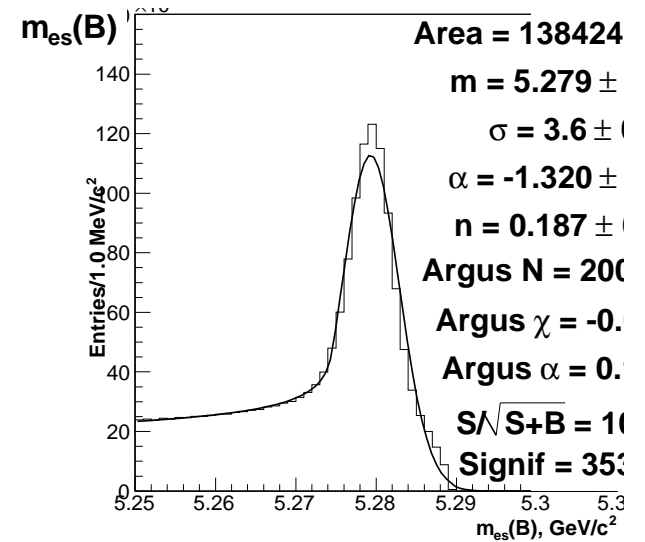
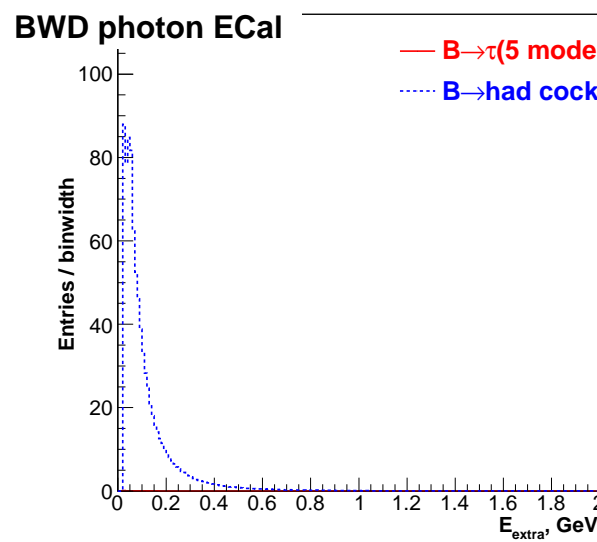
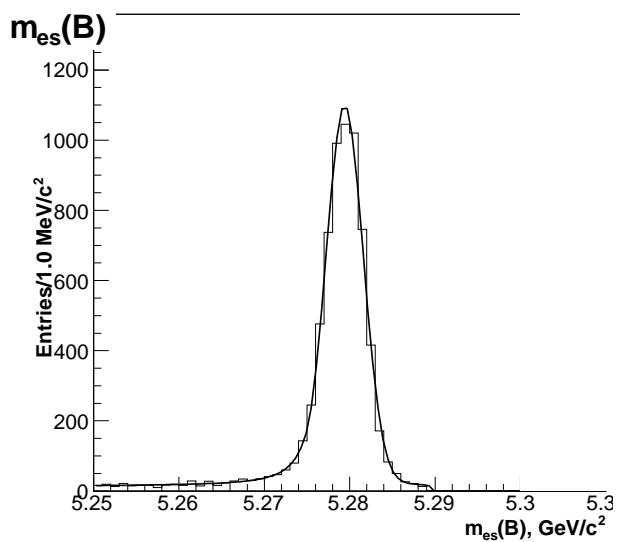


**Sig:**  $B_{tag} \rightarrow \text{anything}$   
**Bkg:**  $B_{tag} \rightarrow \text{had. cocktail}$

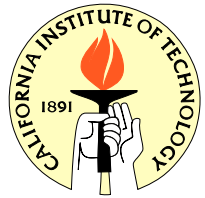
$m_{es}$  in signal sample

$E_{extra}$

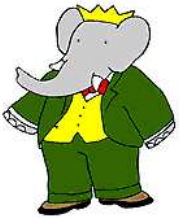
$m_{es}$  in bkg sample



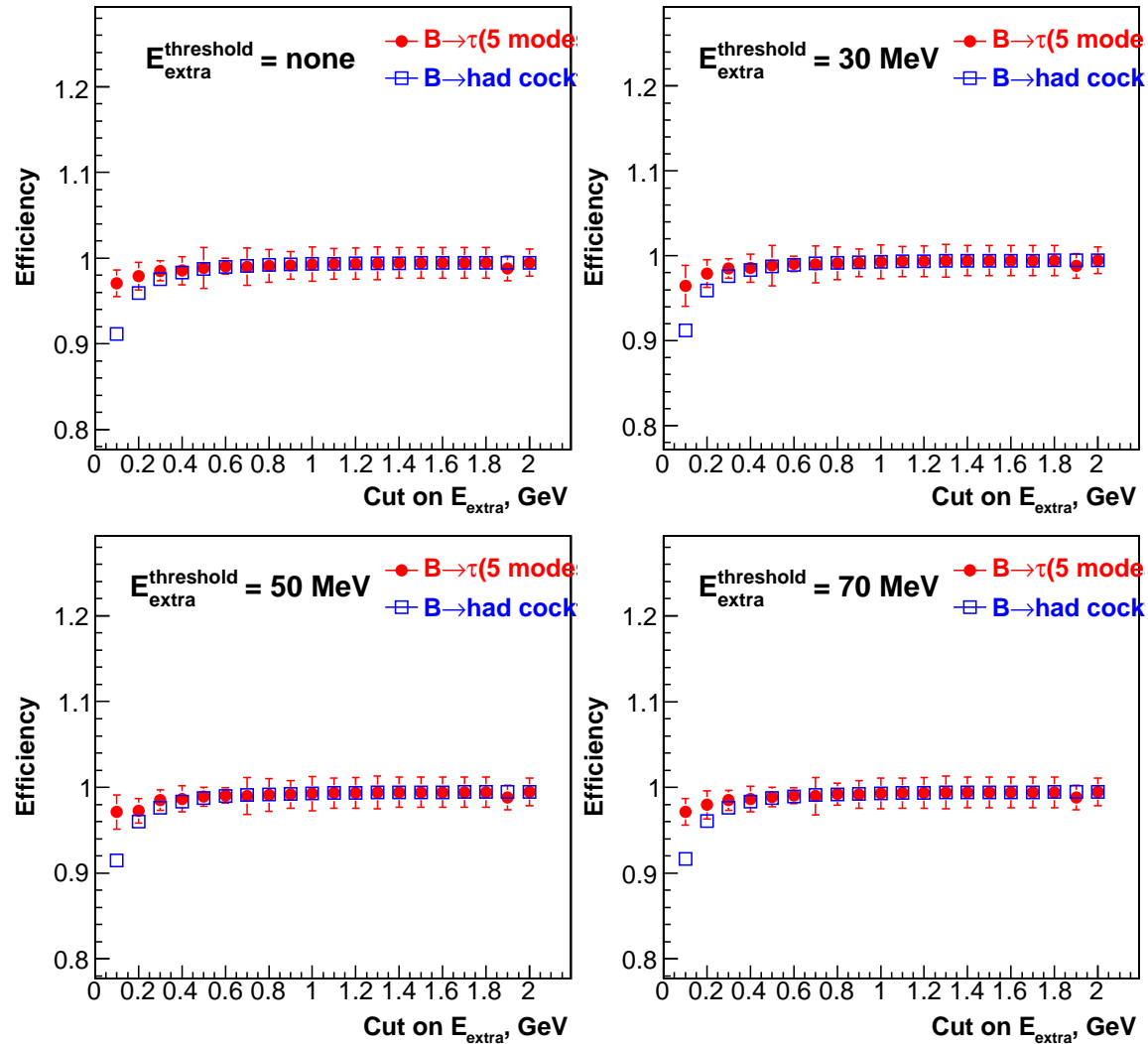
Again, cut on different values of  $E_{extra}$  in Backward EMC and fit for the peak yield for each cut with CB + Argus function



# $E_{extra}$ cut efficiency

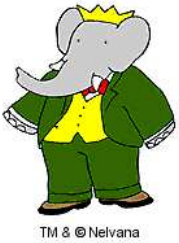


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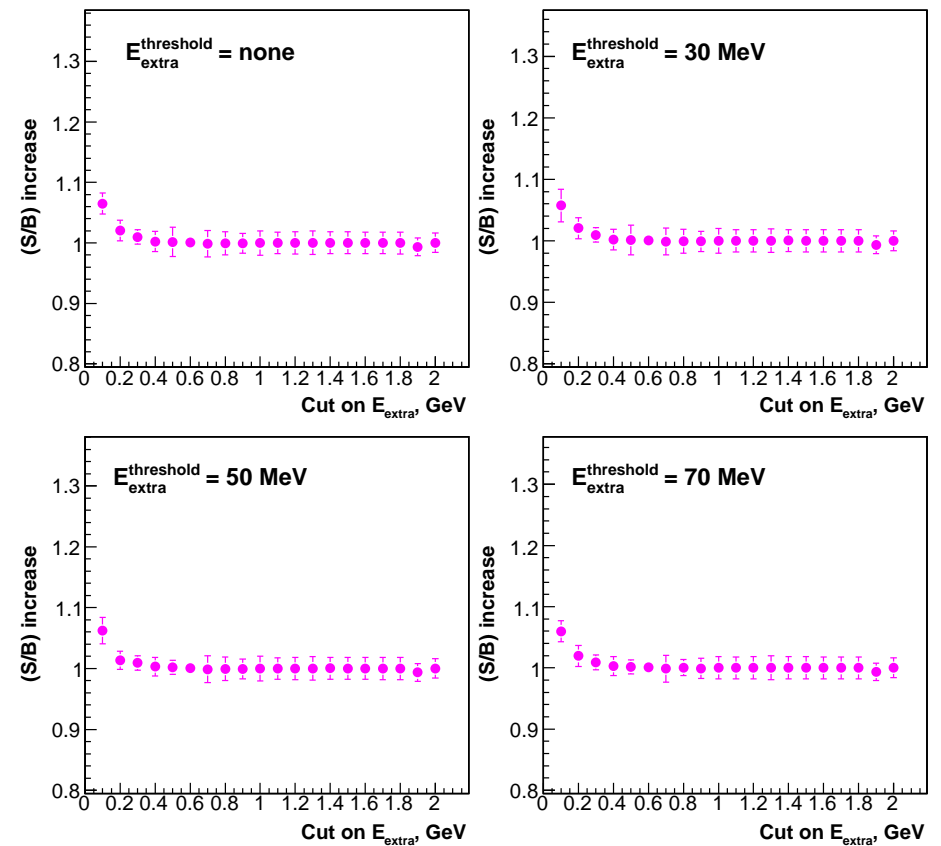
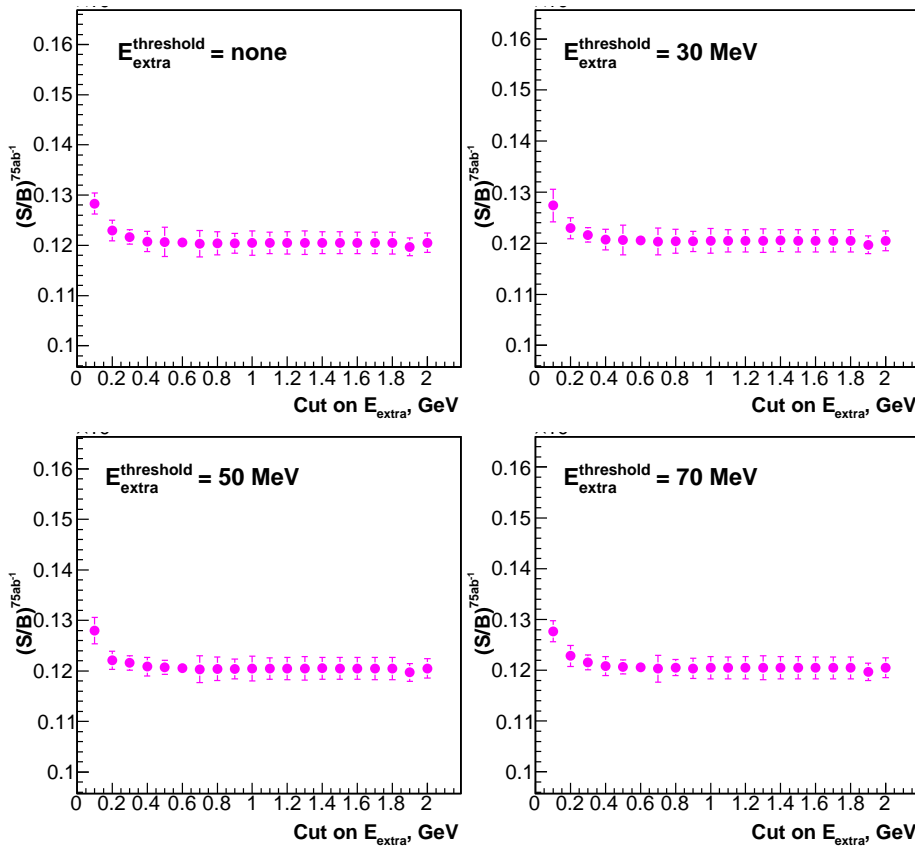
Reduction in signal  $\sim 1\%$ , reduction in bkg  $\sim 5\% - 10\%$

# $S/B$ ratio at $75 \text{ ab}^{-1}$



Absolute value

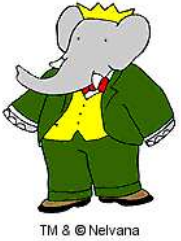
Relative increase



Cutting on  $E_{extra}$  increases  $S/B$  ratio at  $75 \text{ ab}^{-1}$  by  $\sim 5\% - 10\%$

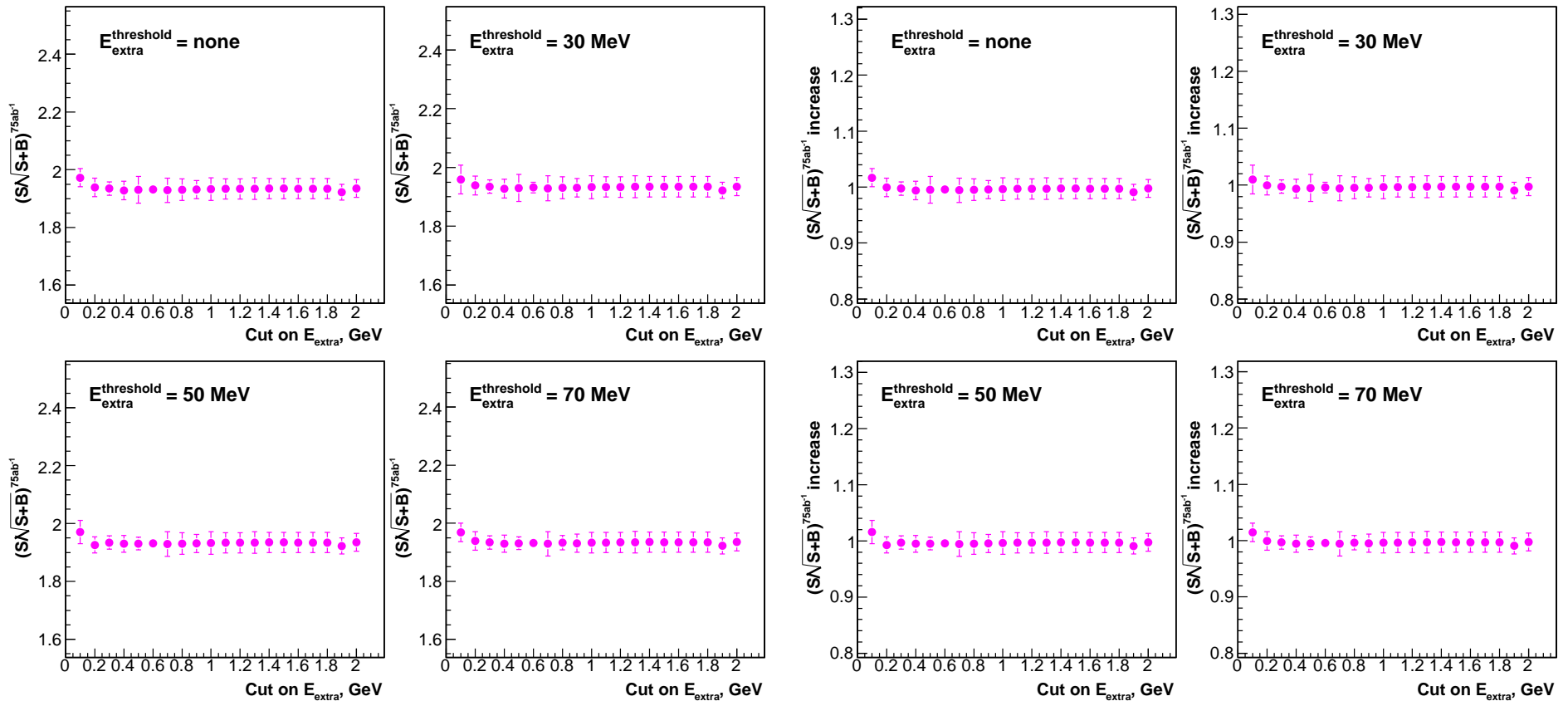


# $S/\sqrt{S+B}$ at $75 \text{ ab}^{-1}$

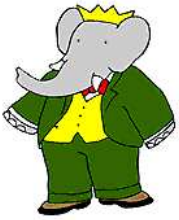
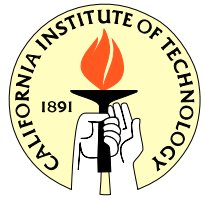


Absolute value

Relative increase

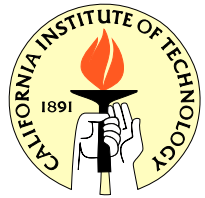


Cutting on  $E_{extra}$  increases  $S/\sqrt{S+B}$  ratio by  $\lesssim 1\% - 2\%$

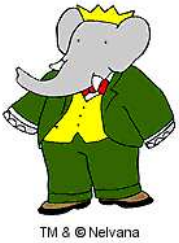


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# Semi-Muonic Tag



# Used MC samples



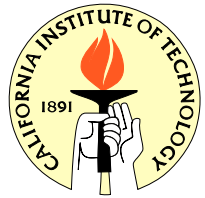
Unfortunately, I only did the simplest tag  $B_{tag} \rightarrow \mu D^0, D^0 \rightarrow K\pi$  so far:

➔ Signal MC:

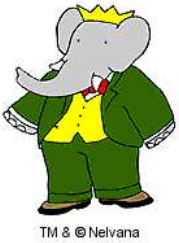
$$B_{sig} \rightarrow \tau\nu, B_{tag} \rightarrow \mu D^0, D^0 \rightarrow K\pi$$

➔ Background MC:

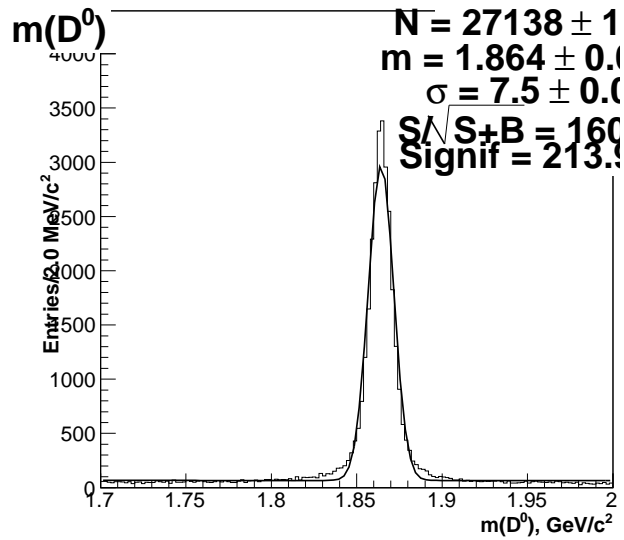
$$B_{sig} \rightarrow \text{anything}, B_{tag} \rightarrow \mu D^0, D^0 \rightarrow K\pi$$



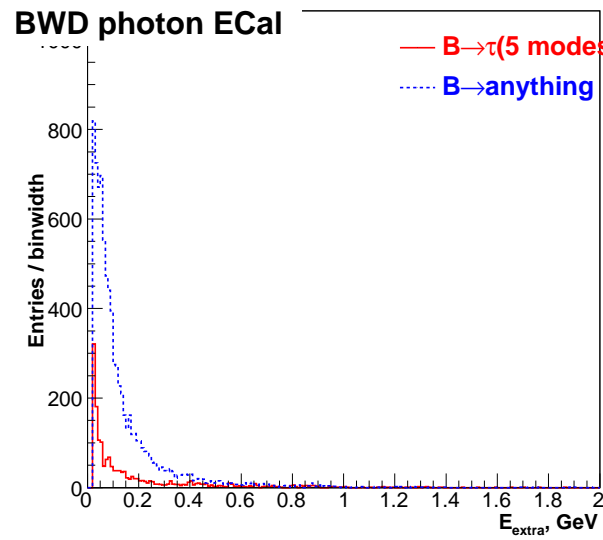
# $D^0$ mass



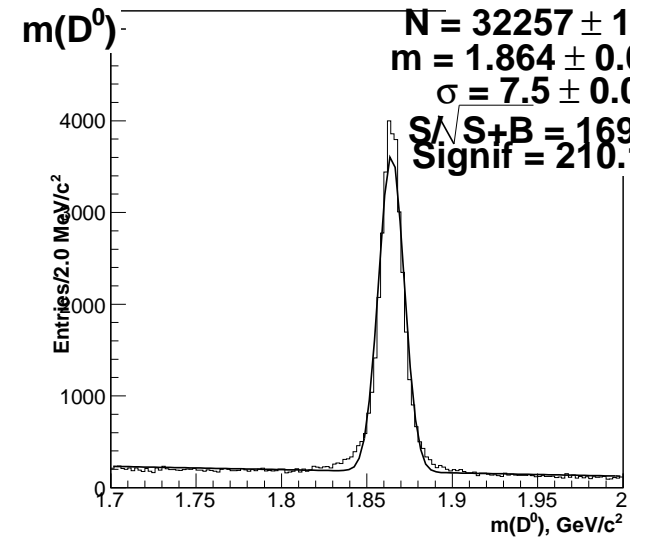
Signal sample



$E_{extra}$



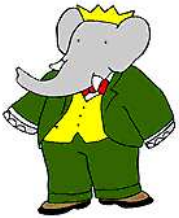
Bkg sample



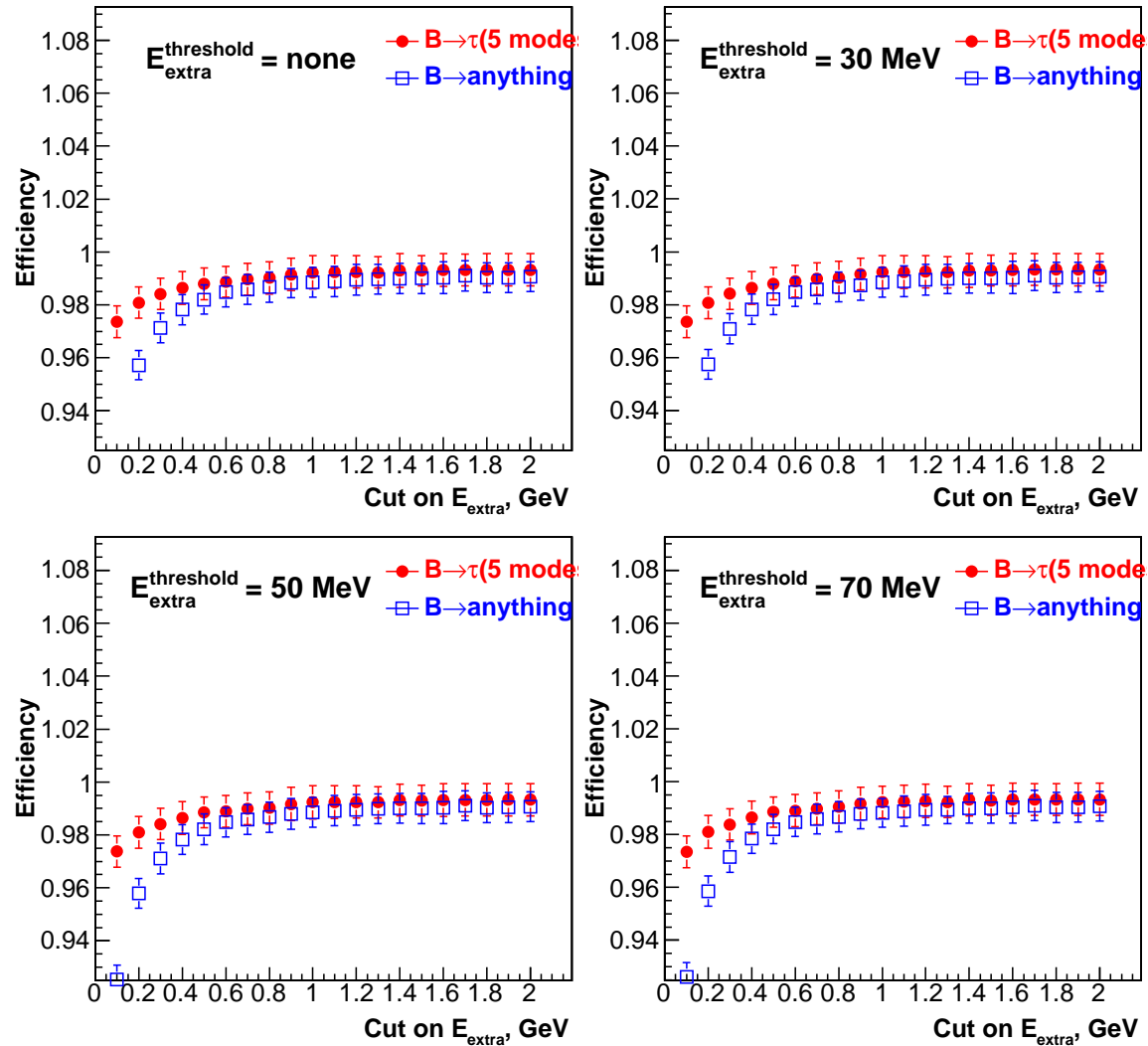
Let's again cut on different values of  $E_{extra}$  in Backward EMC and fit for the peak yield for each cut with Gaussian + linear bkg



# $E_{extra}$ cut efficiency



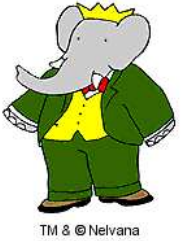
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Reduction in signal  $\sim 1\%$ , reduction in bkg  $\sim 5\%$

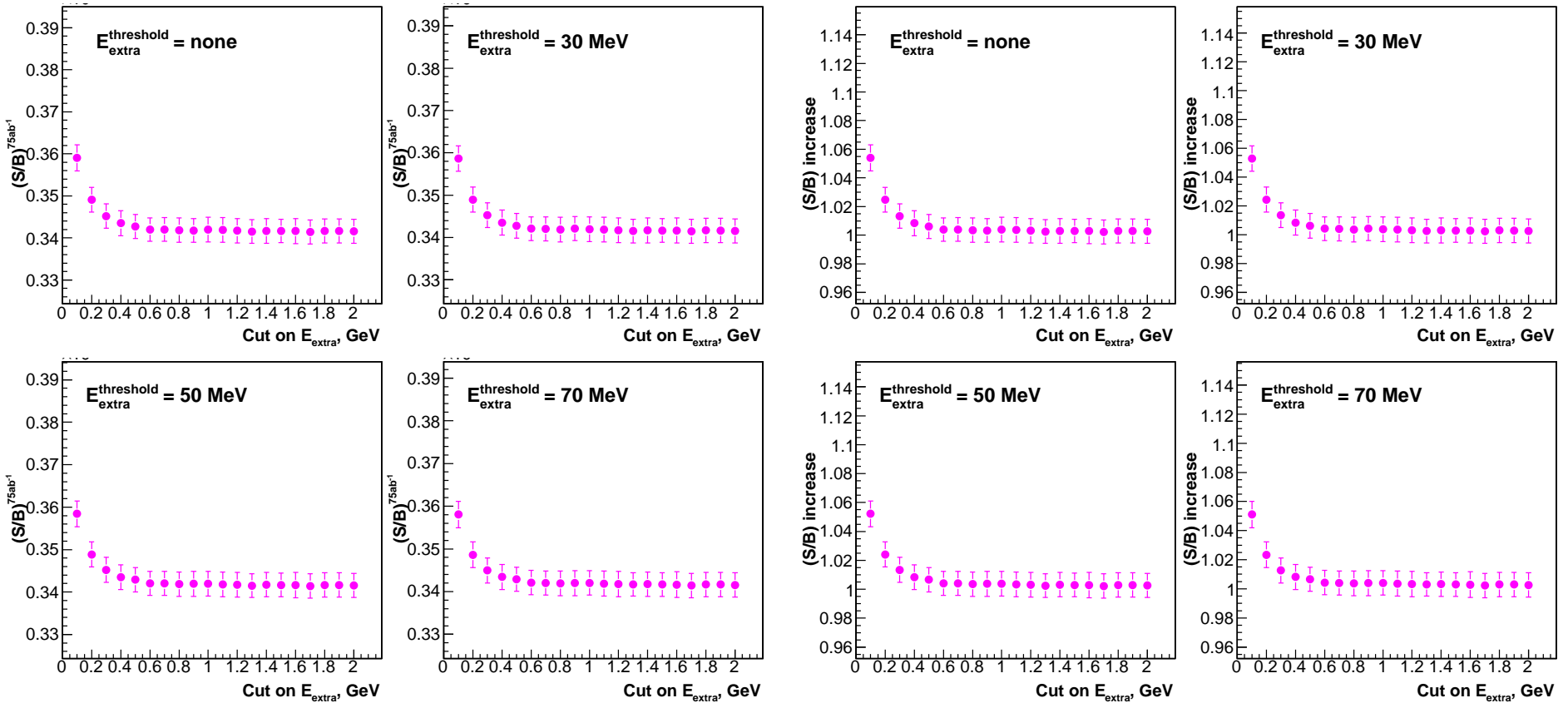


# $S/B$ ratio at $75 \text{ ab}^{-1}$



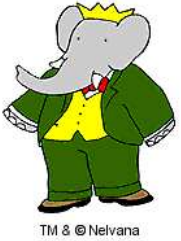
Absolute value

Relative increase



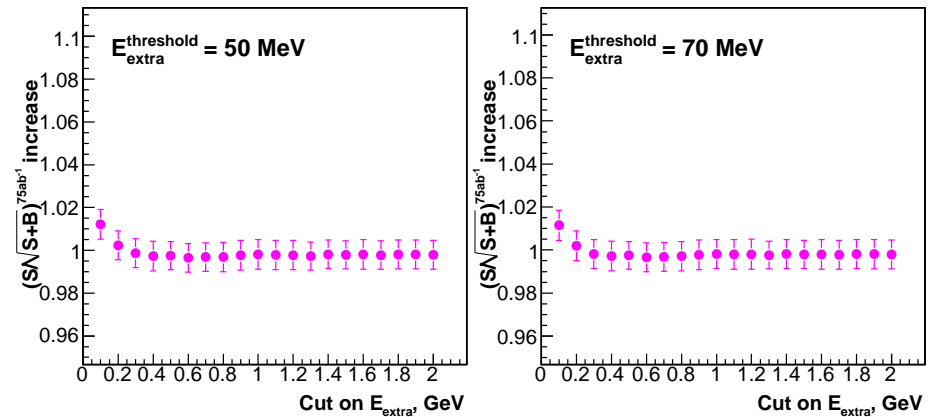
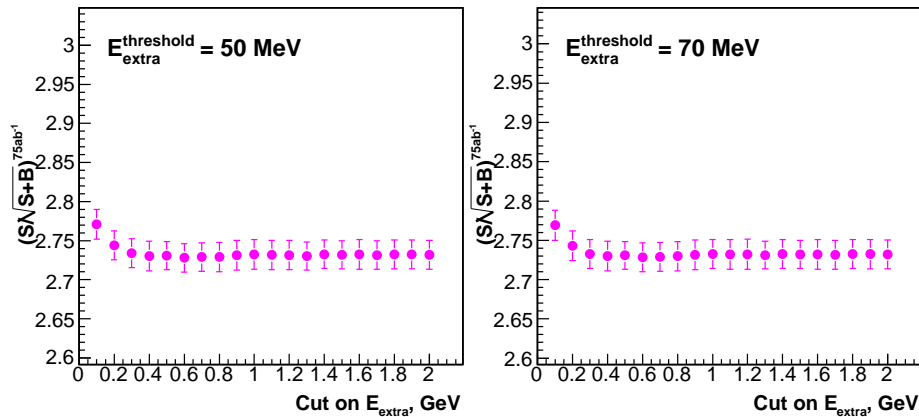
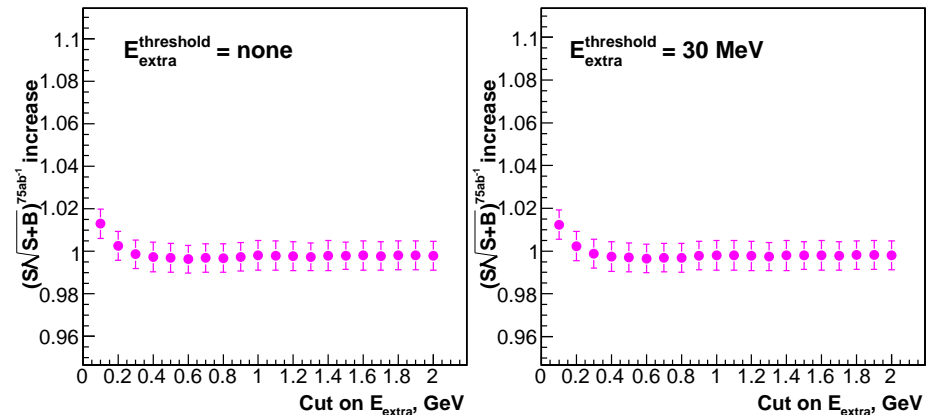
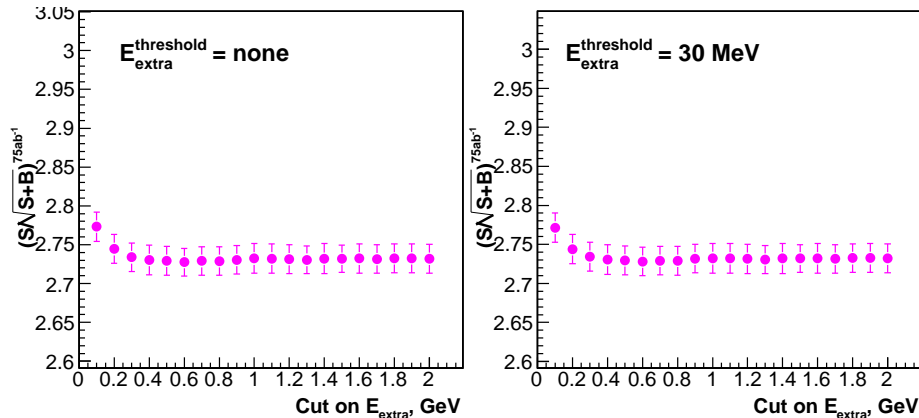
Cutting on  $E_{extra}$  increases  $S/B$  ratio at  $75 \text{ ab}^{-1}$  by  $\sim 3\%$

# $S/\sqrt{S+B}$ at $75 \text{ ab}^{-1}$

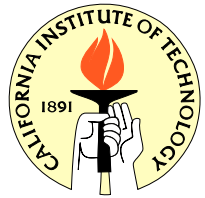


Absolute value

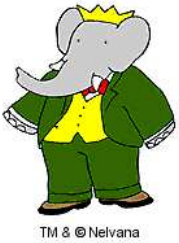
Relative increase



Cutting on  $E_{extra}$  increases  $S/\sqrt{S+B}$  ratio by  $\lesssim 1\%$



# Conclusion



Cutting on  $E_{extra}$  in Backward EMC improves:

- $S/B$  ratio at  $75 \text{ ab}^{-1}$  by about 5 - 10%
- $S/\sqrt{S+B}$  at  $75 \text{ ab}^{-1}$  by about 1 - 2%

for both hadronic and semi-muonic tag  $B_{tag} \rightarrow \mu D^0, D^0 \rightarrow K\pi$