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

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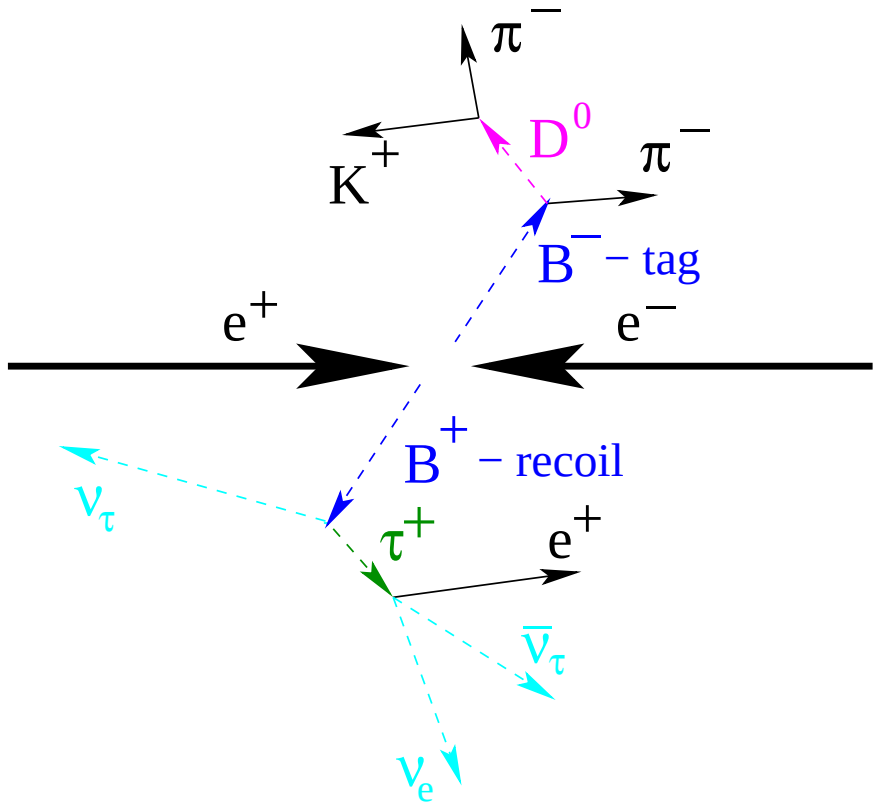
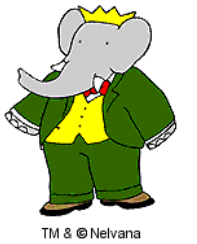
http://www.hep.caltech.edu/~arakitin/tex/2010.Mar.17.SuperB/talk.pdf

$B \to \tau\nu_\tau$ Event



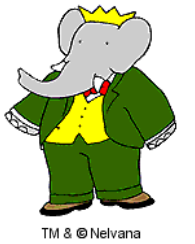
- So far we've investigated different decays of signal B with tag $B \to D^0\pi, D^0 \to K\pi$ – the cleanest mode, BF $= 0.5\%$
- This talk is devoted to other hadronic decays of tag B
  - November production – results never were presented
  - February production
- Also, I'll be talking about effect of Bhabha and timing window change on $B \to \tau\nu$ analysis

Analysis Strategy

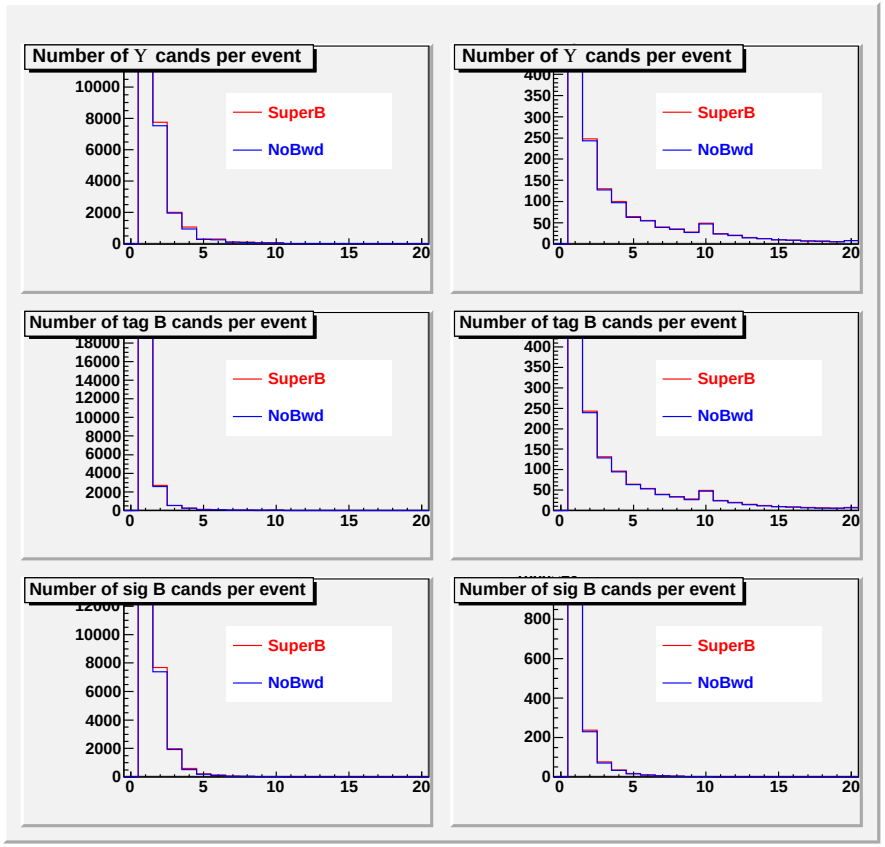


- Ntuples produced at CNAF contain multiple tag and signal B candidates
- Best tag B candidate: by smallest ΔE
- Best signal B candidate: hierarchically
  - if we have muon candidate – choose muon
  - if no muon – choose electron
  - if no electron – choose $\rho \to \pi\pi^0$
  - if no suitable π^0 – choose $a_1 \to 3\pi$
  - if no a_1 – choose π
  - if no π – skip the event

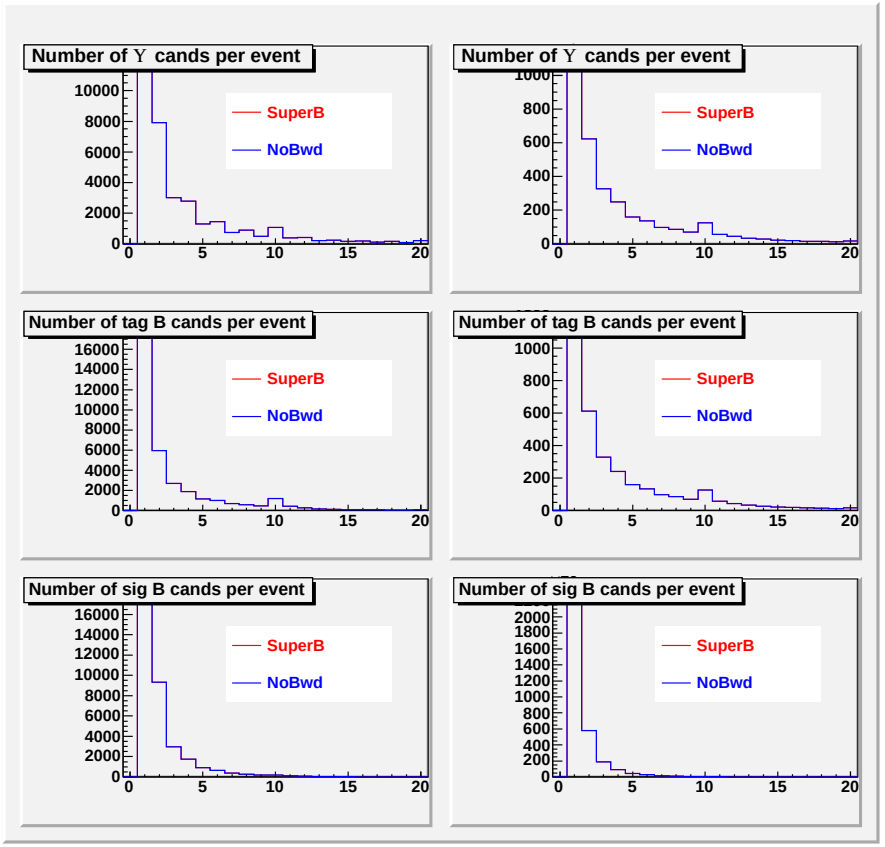
Number of Candidates



November

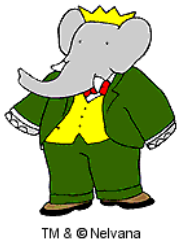


February

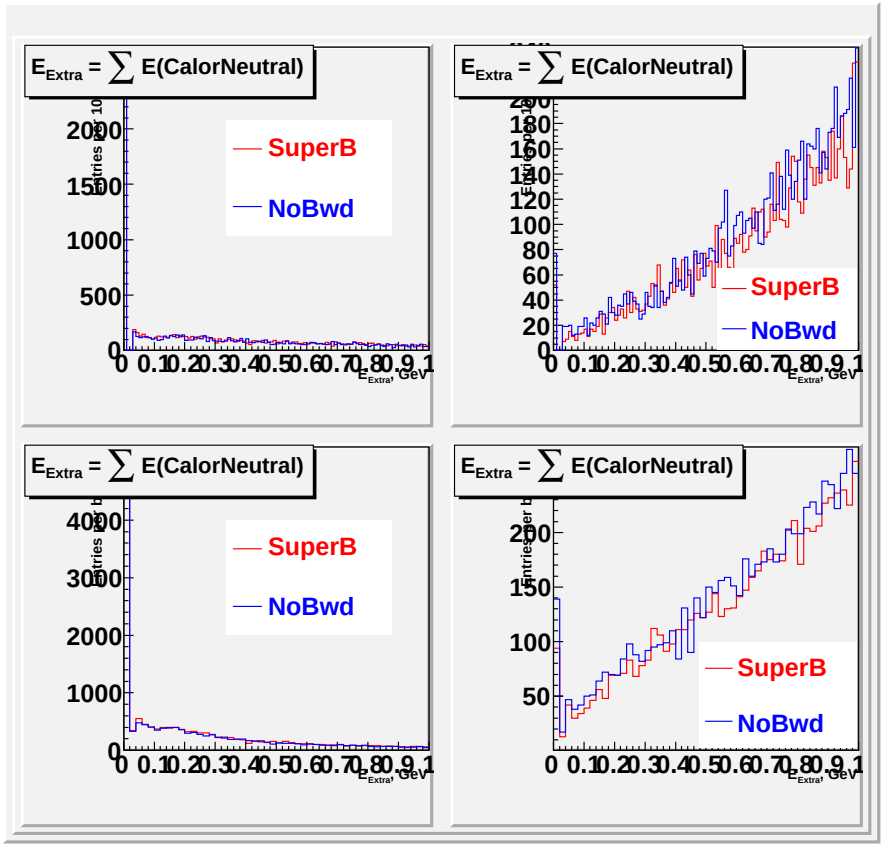


Strange feature at N=10...

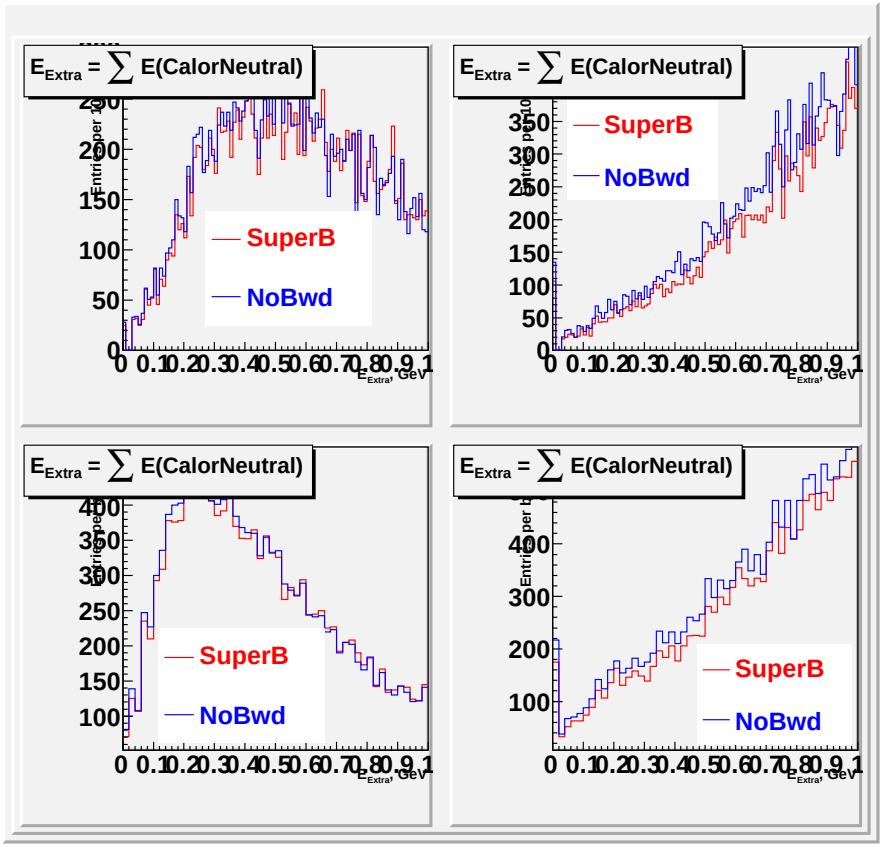
E_{extra}



November

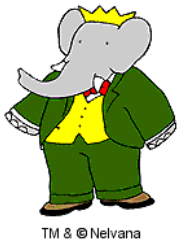


February

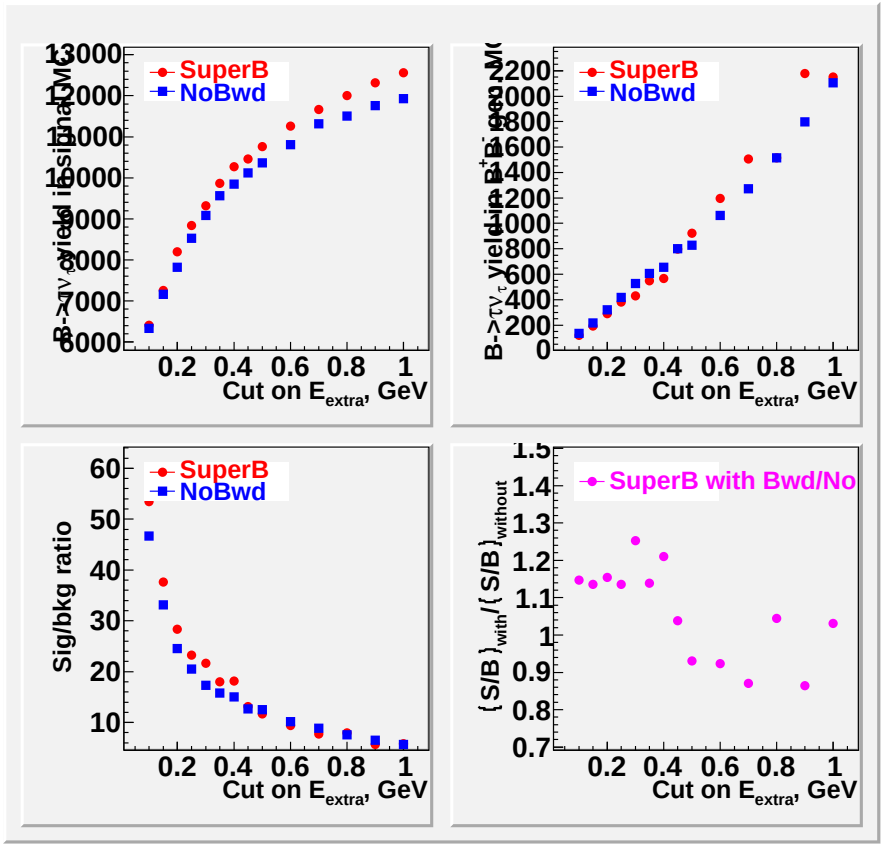


- Top: All B_{sig}, bottom: best B_{sig}
- Left: sig MC, right: generic MC

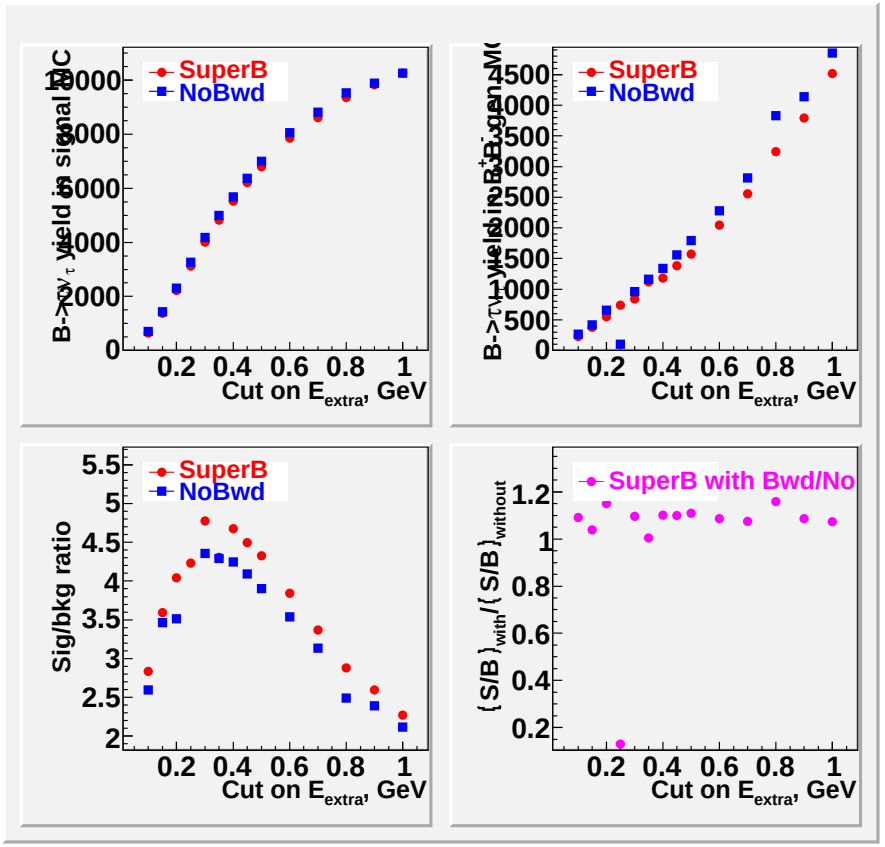
Sig and Bkg Yields



November

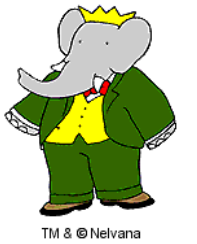


February



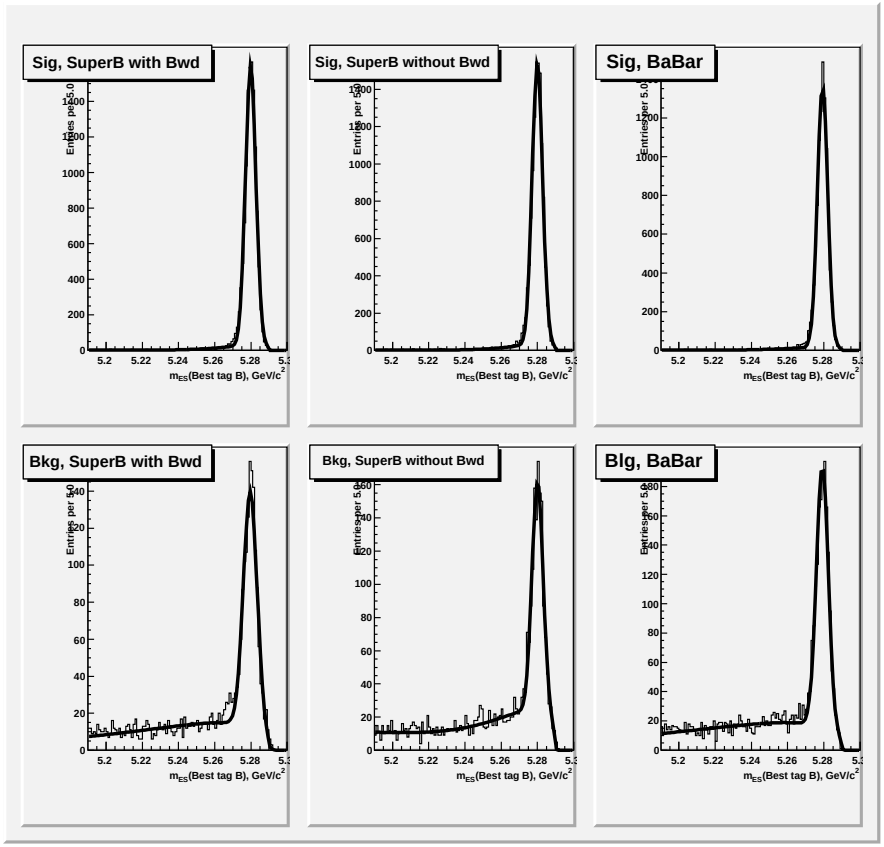
- Strange change of the S/B shape over time
- The points are a bit scattered because the fits are not that good...

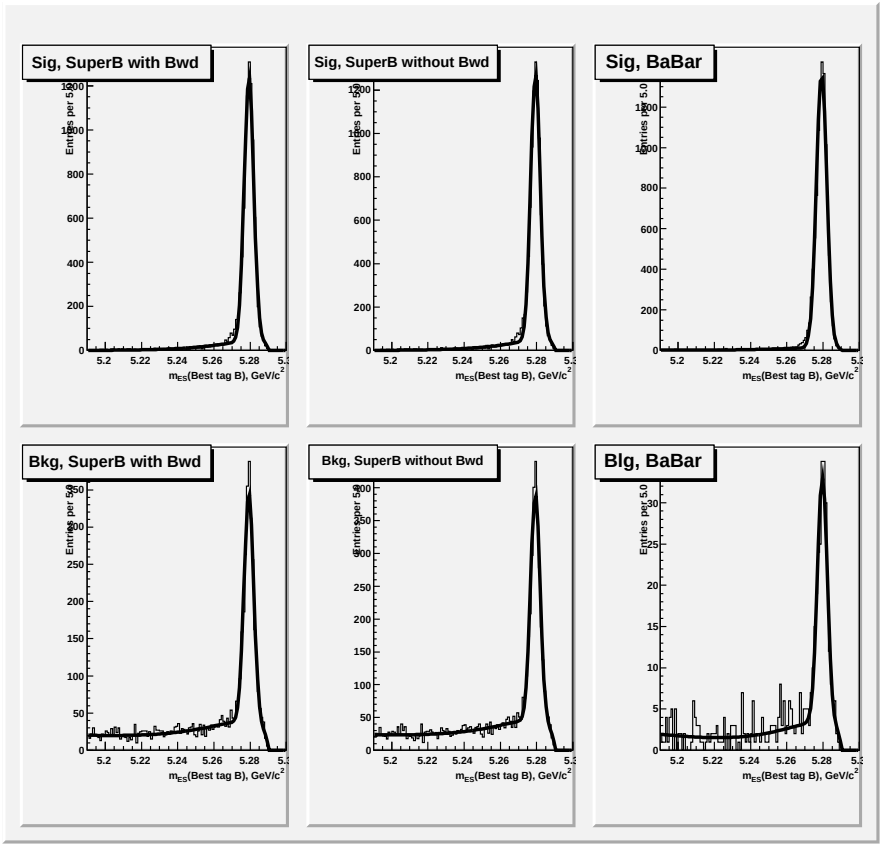
Example: fit for 10^{th} bin



November

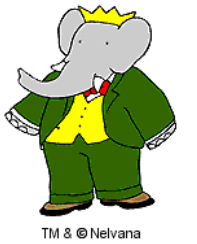
February





I am fitting with Gaussian + ARGUS $\times$ polynomial but maybe there are better ways...

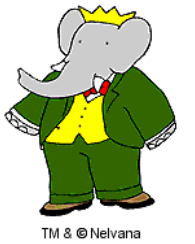
Bhabha scattering

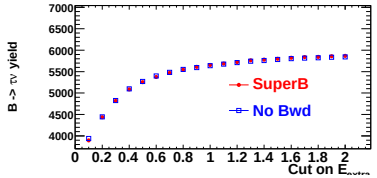
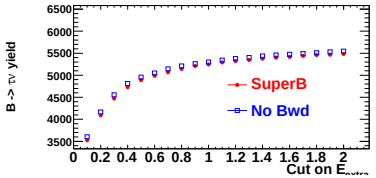
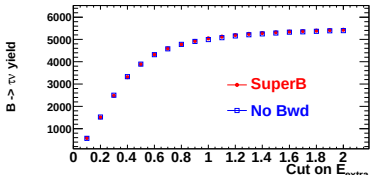
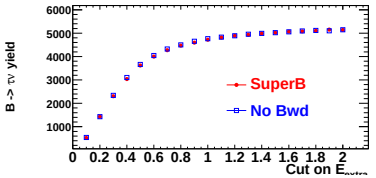
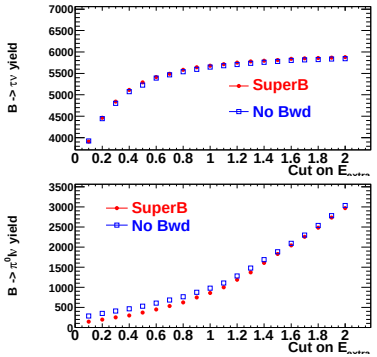
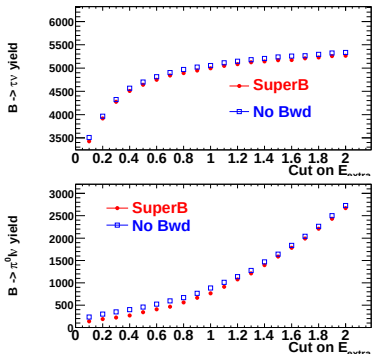
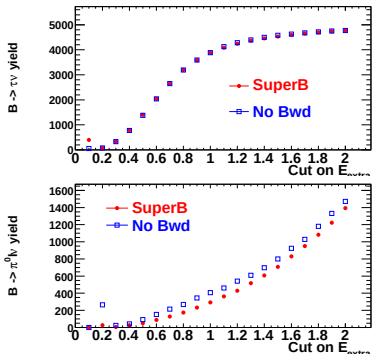
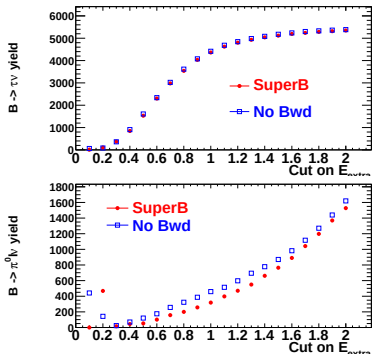


To investigate problems with Bhabha we generated 48 MC samples (10000 events each) by using FastSim V0.2.1 installed at CNAF:

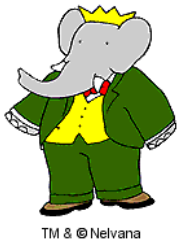
- signal $B \to \tau\nu_\tau$ and background $B \to \pi^0\ell\nu$ (2)
  - simplest tag $B \to D^0\pi$, $D^0 \to K\pi$
- for SuperB, NoBwd and BaBar (3)
- for no Bhabha, MixBhabha only, MixRadBhabha only, MixBhabha and MixRadBhabha (4)
- for default time window (500 ns) and extended time window (1000 ns) (2)
- In total: $2 \times 3 \times 4 \times 2 = 48$ MC samples

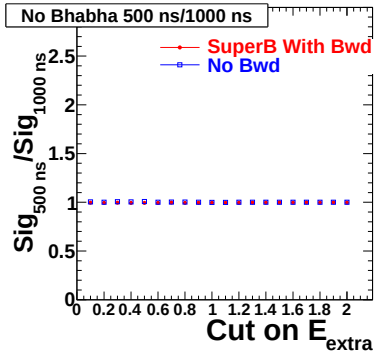
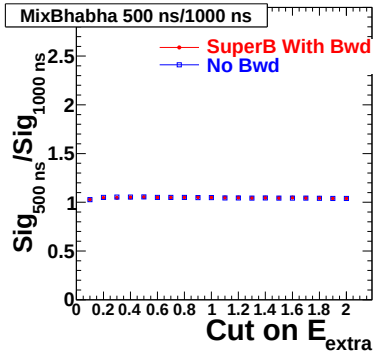
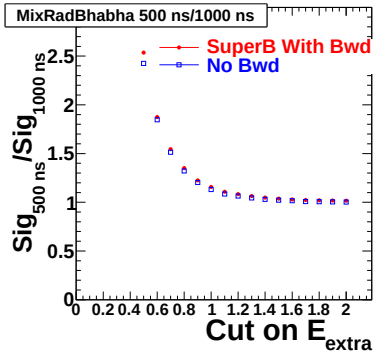
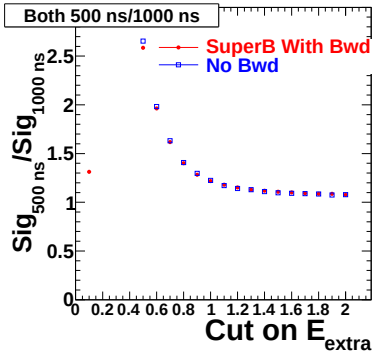
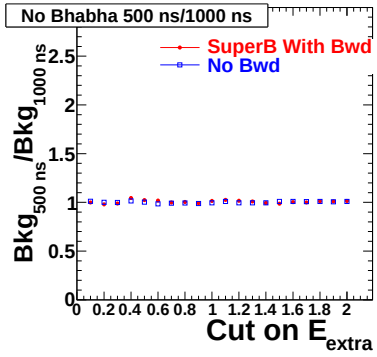
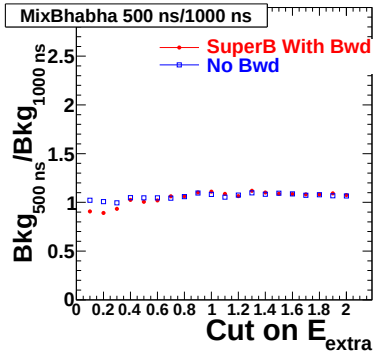
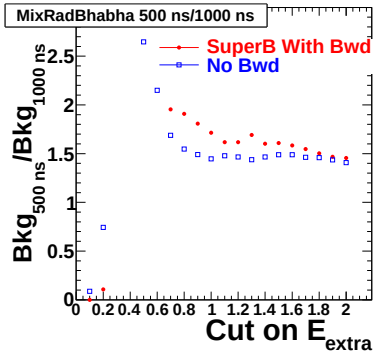
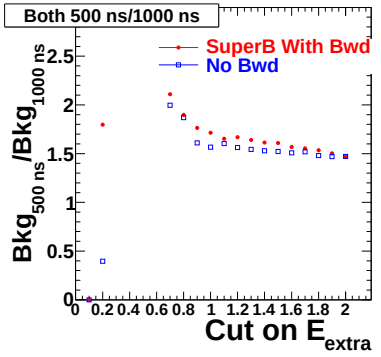
Sig and Bkg Yields



	No Bhabha	MixBhabha	MixRadBhabha	Both
500 ns				
1000 ns				

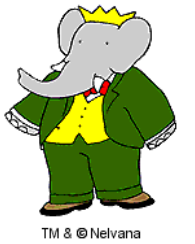
Yield Ratios 500 ns/1000 ns

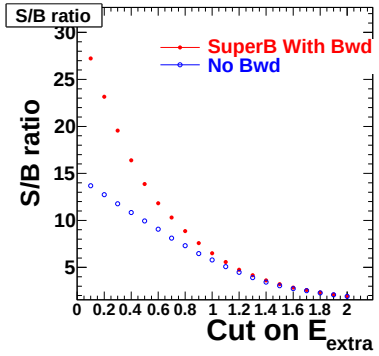
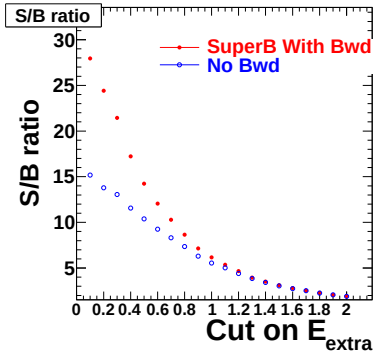
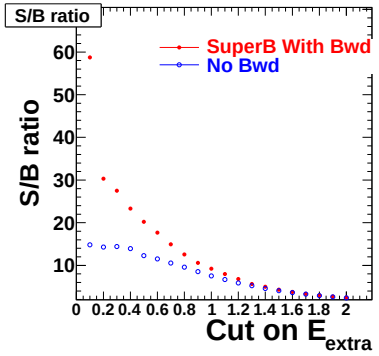
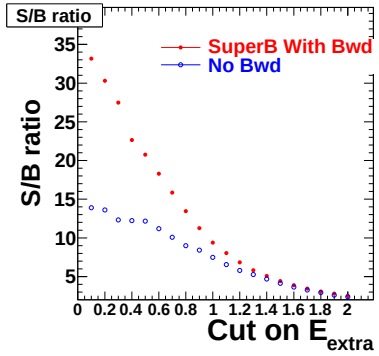
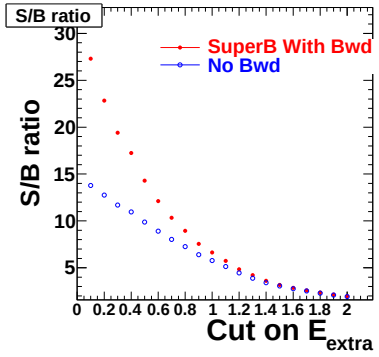
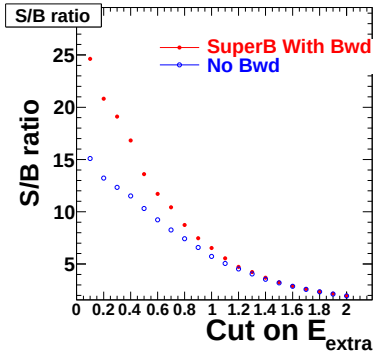
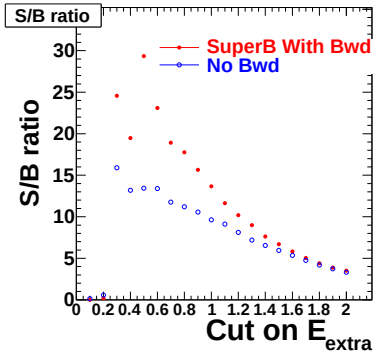
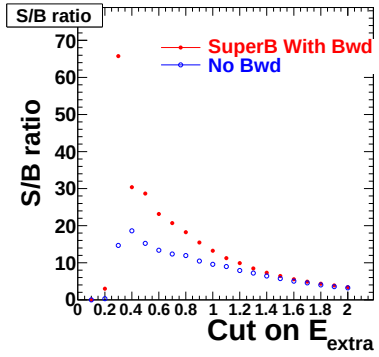


	No Bhabha	MixBhabha	MixRadBhabha	Both
Signal				
Background				

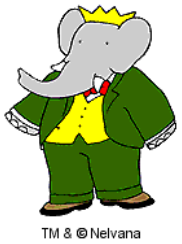
MixRadBhabha gives larger signal and much larger background for 500 ns

S/B Ratios

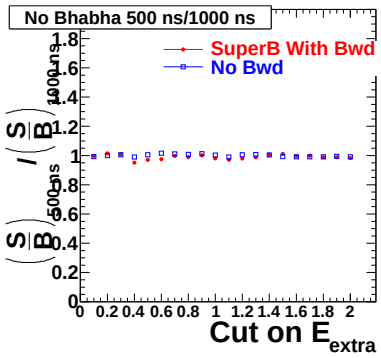


	No Bhabha	MixBhabha	MixRadBhabha	Both
500 ns				
1000 ns				

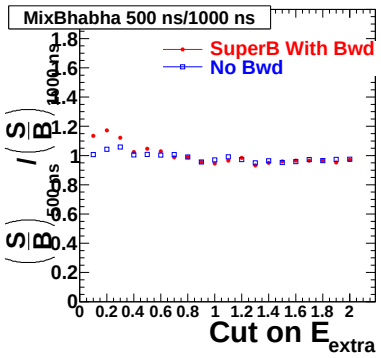
Ratios of S/B Ratios (500 ns/1000 ns



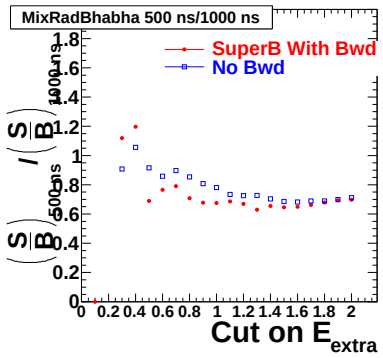
No Bhabha



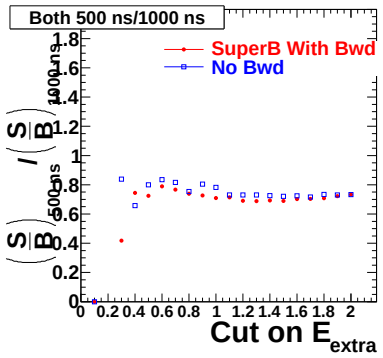
MixBhabha



MixRadBhabha

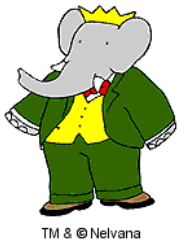


Both



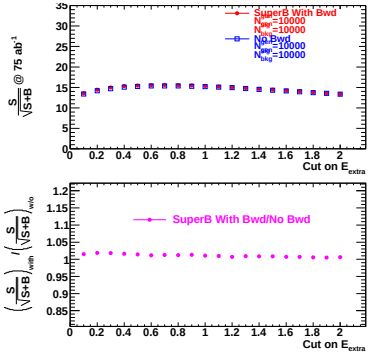
MixRadBhabha significantly decreases S/B ratio

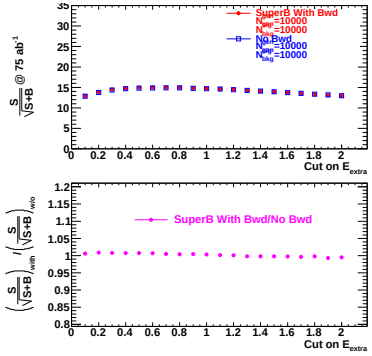
$$\frac{S}{\sqrt{S+B}}$$

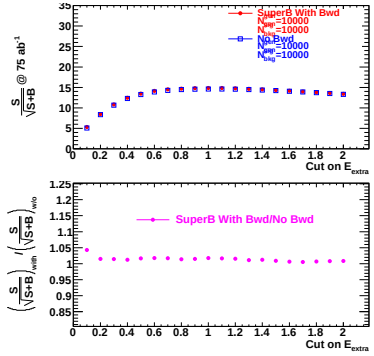


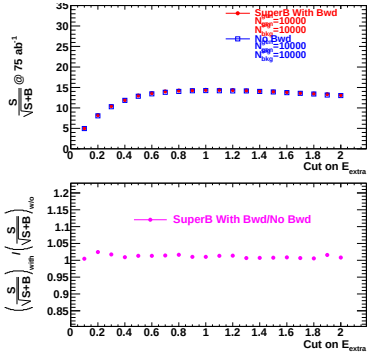
No Bhabha | MixBhabha | MixRadBhabha | Both

500 ns

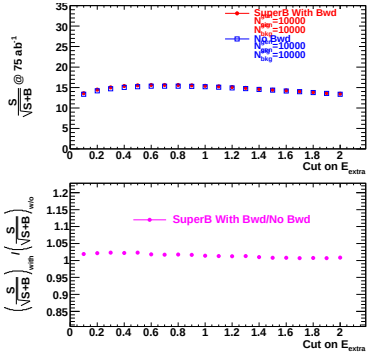


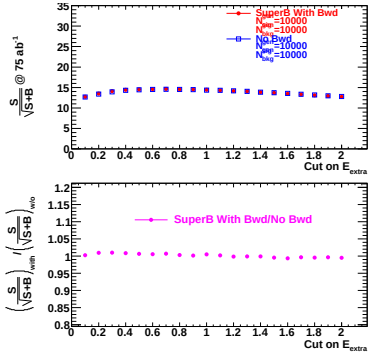


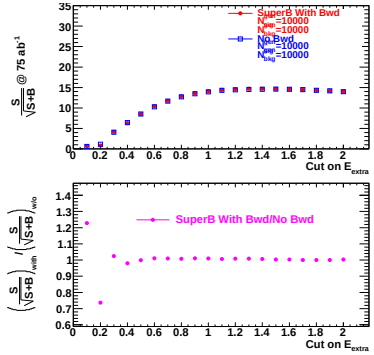


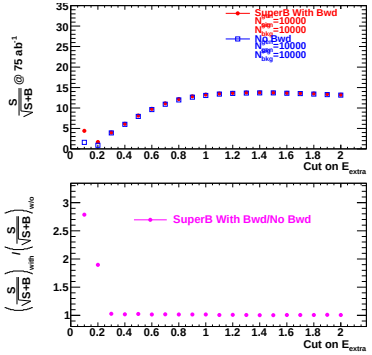


1000 ns



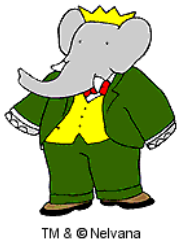




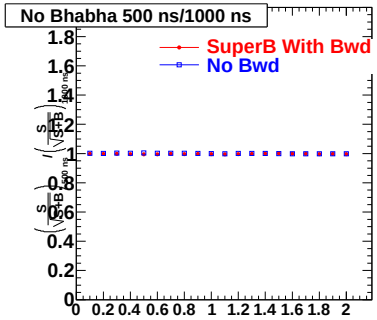


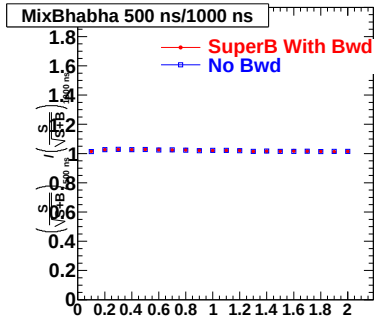
$\frac{S}{\sqrt{S+B}}$ falls faster with decrease of E_{extra} cut value for MixRadBhabha for 1000 ns than for 500 ns

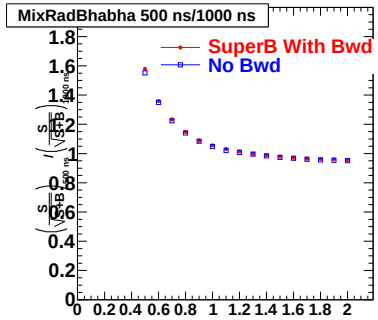
$$\left(\frac{S}{\sqrt{S+B}}\right)_{500\ ns} \Big/ \left(\frac{S}{\sqrt{S+B}}\right)_{1000\ ns}$$

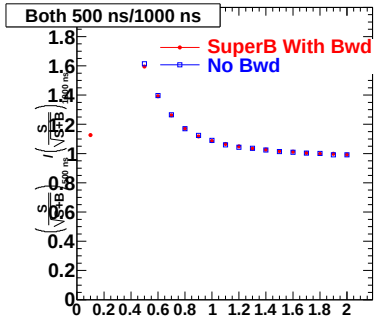


No Bhabha | MixBhabha | MixRadBhabha | Both



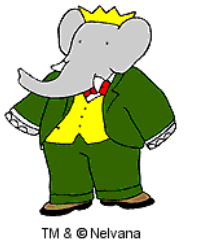






Again, the ratio of $S/\sqrt{S+B}$ is larger for 500 ns

Conclusion



- The ratios of yields between different timing windows are reasonably close to 1 as long as MixRadBhabha is not involved
- MixRadBhabha gives more signal and much more background at 500 ns than at 1000 ns
- The S/B is lower for 500 ns than for 1000 ns by about 30%
- Although, $S/\sqrt{S+B}$ (@ 75 ab^{-1}) is higher for 500 ns than for 1000 ns
- Inclusion of MixRadBhabha significantly changes physics results for $B \to \tau\nu$ analysis (even in the approximation of the simplest tag B decay)