DGWG parallel session, September 29th 2010

Fwd-PID and Bwd-EMC Studies SL recoil analyses

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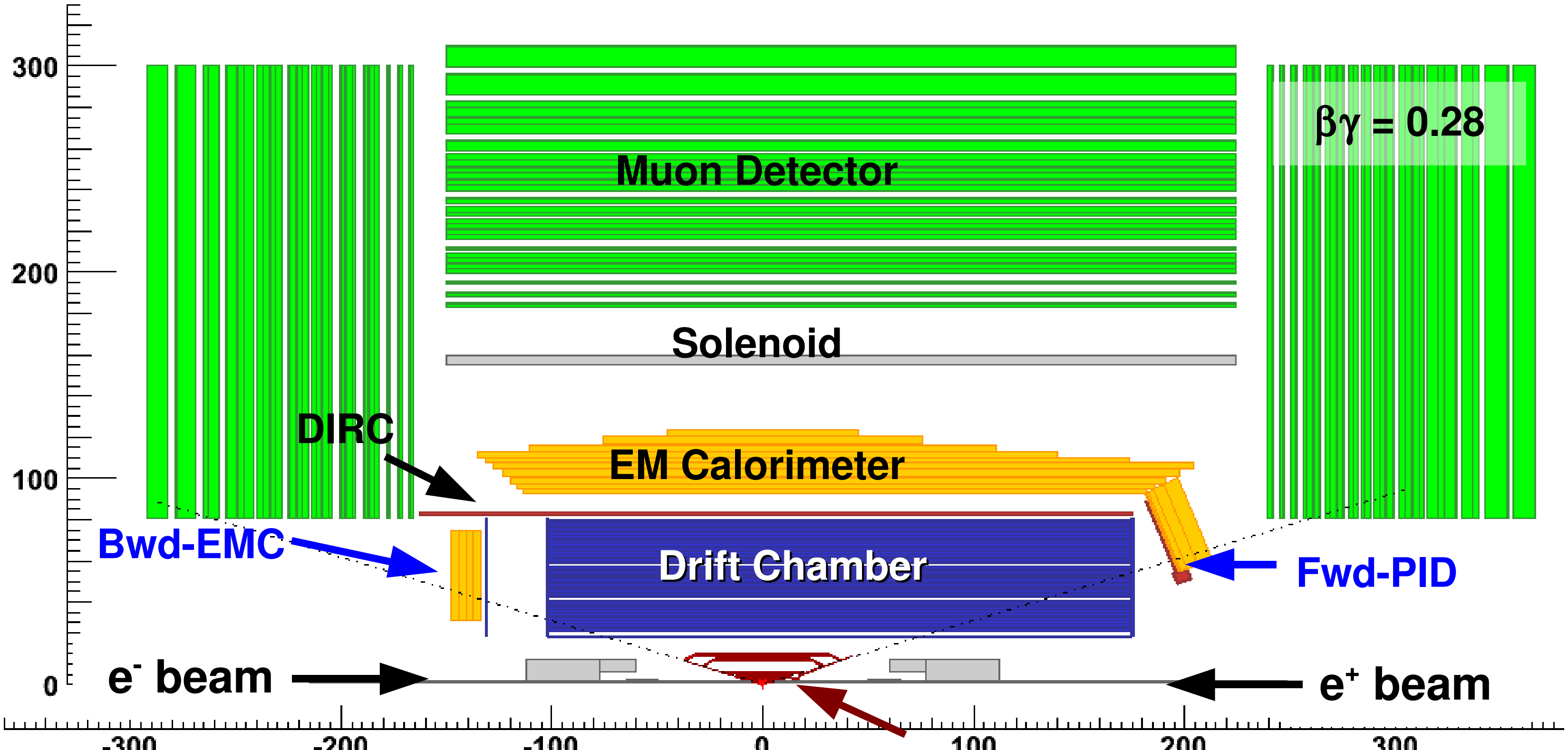
LABORATOIRE DE L'ACCÉLÉRATEUR LINÉAIRE

Outline

- **Detector Geometries**
- **Samples used**
- **Fwd-PID studies strategy**
- **Bwd-EMC studies strategy**
- **Results on Fwd-PID Studies**
- **Results on Bwd-EMC Studies**
- **Summary and outlook**

Detector Geometries

- Baseline configuration: BaBar with reduced boost ($\beta\gamma = 0.28$)
- Generated geometries:
  - Baseline + Bwd-EMC + Fwd-PID (quartz) (**DG_4**)
  - Baseline + Bwd-EMC + Fwd-PID (air) (**DG_4a**)



July/September 2010 Production

- **Signal samples:**
  - $B^+ \to K^+ \nu\nu$ (DG_4/DG_4a): 4.02/3.03 M
  - $B^0 \to K^0 \nu\nu$ (DG_4/DG_4a): 3.00/3.00 M
  - $B^0 \to K^{*0} \nu\nu$ (DG_4/DG_4a): 3.00/2.94 M
  - $B^+ \to K^{*+} \nu\nu$ (DG_4/DG_4a): 2.97/3.00 M
- **Background Samples:**
  - B^+B^- SL-cocktail (DG_4/DG_4a): 213.68/116.16 M (~80% of total)
  - B^0B^0 SL-cocktail (DG_4/DG_4a): 180.72/102.08 M (~80% of total)
- **All samples generated with bkg mixing NoPairs (V0.2.5 Rev 307)**

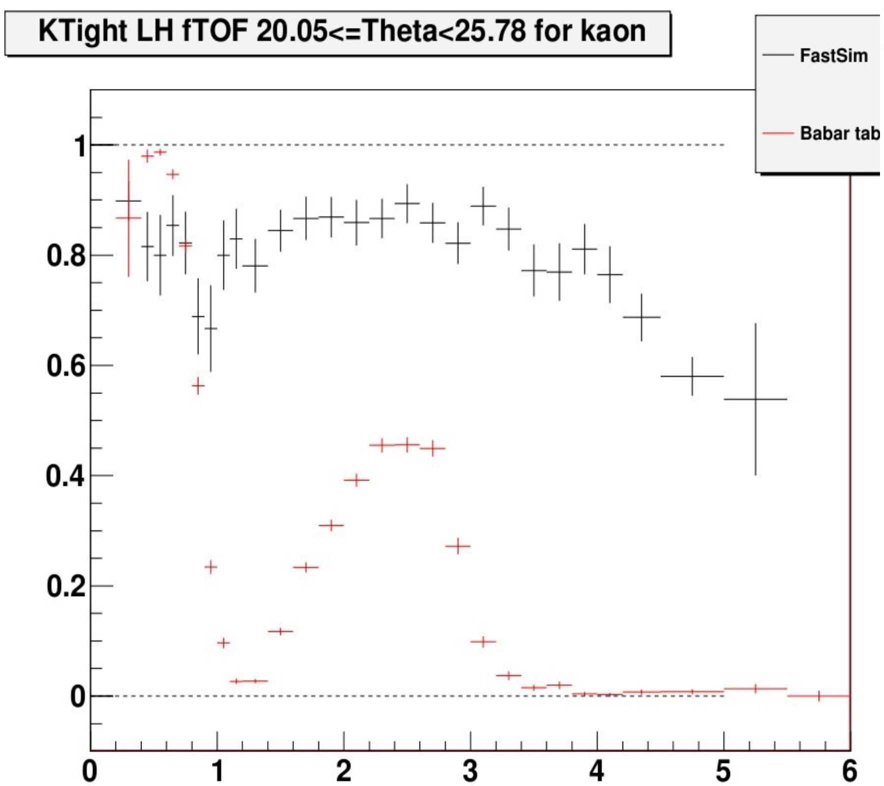
Fwd-PID Studies Strategy

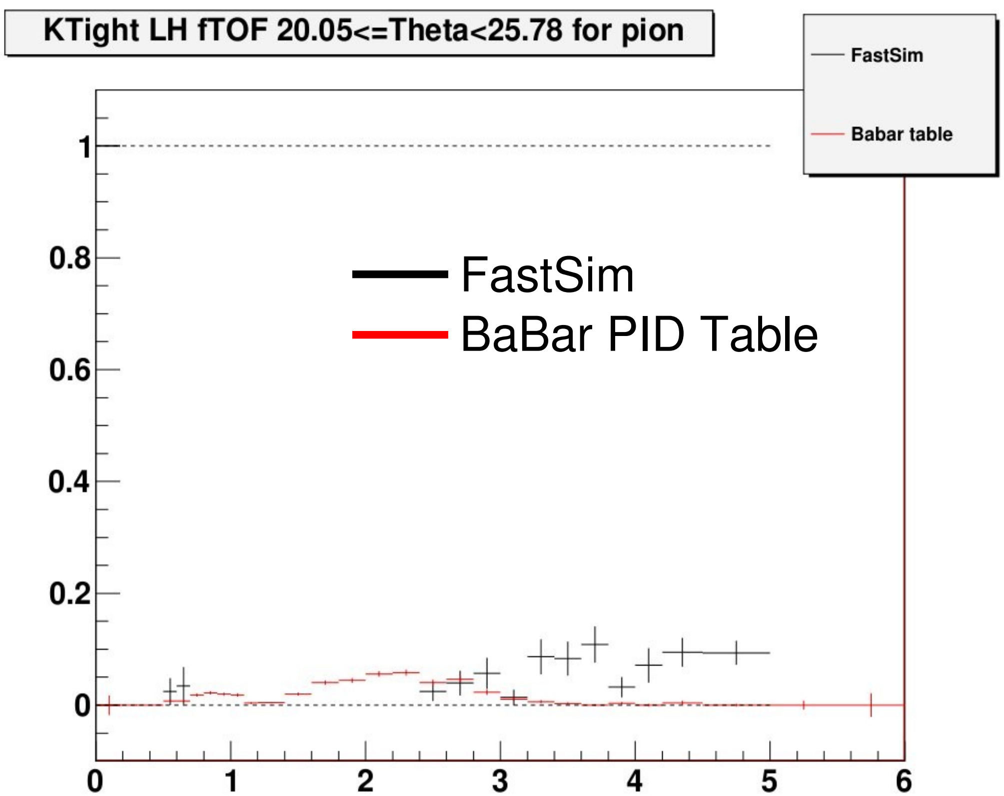
- **Latest studies from full simulation showed that fTOF material has negligible effect on Fwd-EMC**
- **Generate two samples to estimate Fwd-PID impact:** DG_4 and DG_4a
- **Compare DG_4 and DG_4a to estimate the effect of the fTOF material**

  Result: effect is negligible ⇒ DG_4 and DG_4a samples equivalent
- **Store at the n-tuples two selectors for the same particle type and tightness (i.e.)**
  - KaonLHTightSelector (no use of timing information from fTOF)
  - KaonLHTight_fTOFSelector (use of timing information from fTOF when available)
- **Merge DG_4 and DG_4a samples (DG_4+DG_4a)**
- **Use this sample to estimate fTOF impact:**
  - **fTOF out place:** use KaonLHTightSelector
  - **fTOF in place:** use KaonLHTight_fTOFSelector
- **Gain due to fTOF will be the increase in efficiency**

PID requirements

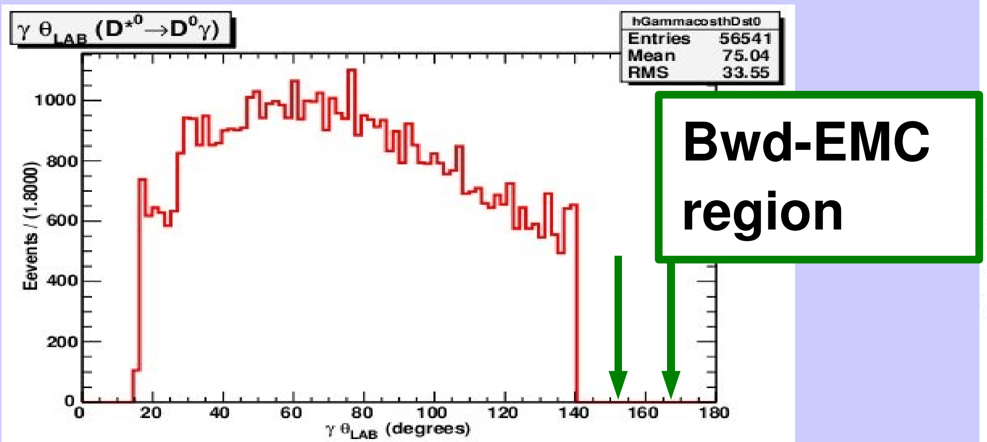
- **Tag-Side:**
  - Use KaonLHTight
- **Signal-Side:**
  - Use KaonLHTight

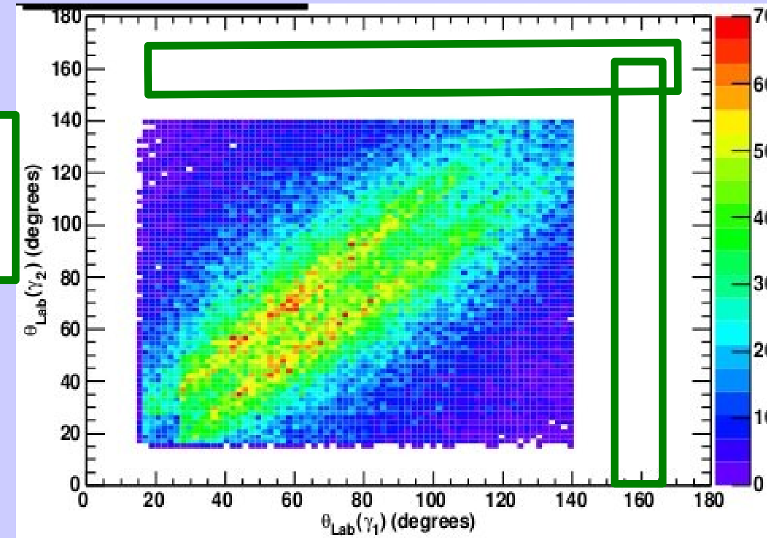




Bwd-EMC Studies Strategy: Veto device

- B_{tag} and B_{sig} candidates reconstructed without neutrals from Bwd-EMC



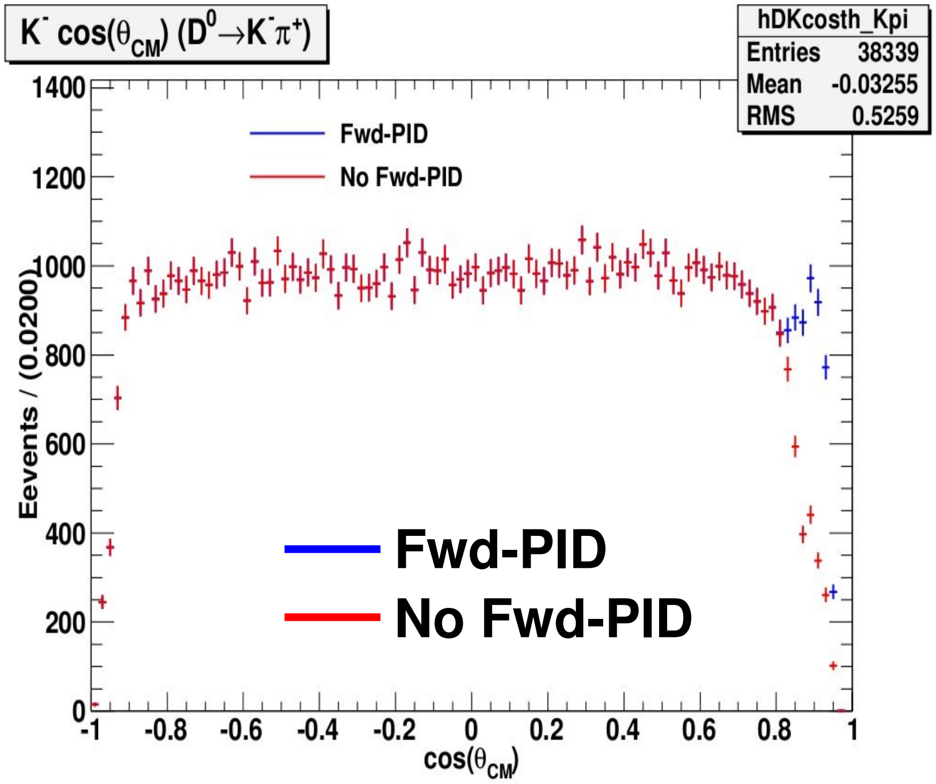


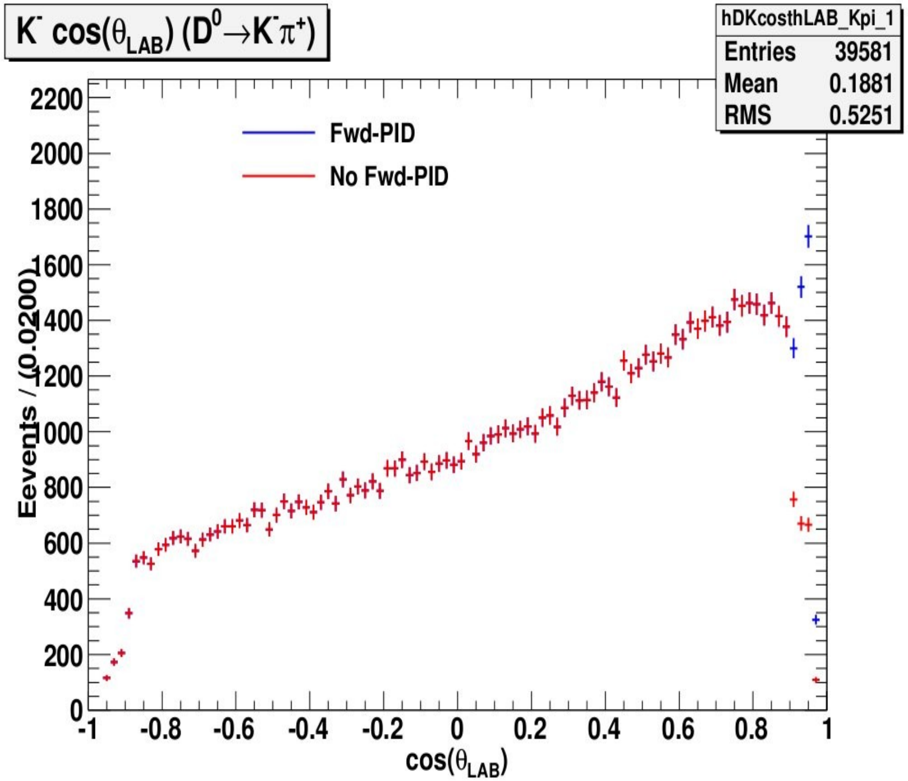
- Two types of E_{extra} variables:
  - E_{extra}(Barrel-Fwd) = Σ(extra neutrals on Barrel-Fwd EMC)
  - E_{extra}(Bwd) = Σ(extra neutrals on Bwd EMC)
- Can used E_{extra}(Bwd) to cut on and E_{extra}(Barrel-Fwd) to perform a fit
- Test different $E(\gamma)_{min}$ cut for Bwd-EMC photons (none, 30, 50, 70 MeV)
- Try to define an optimum cut that maximizes a figure of merits

$\Rightarrow S/\sqrt{(S+B)}$

Results on Fwd-PID Studies

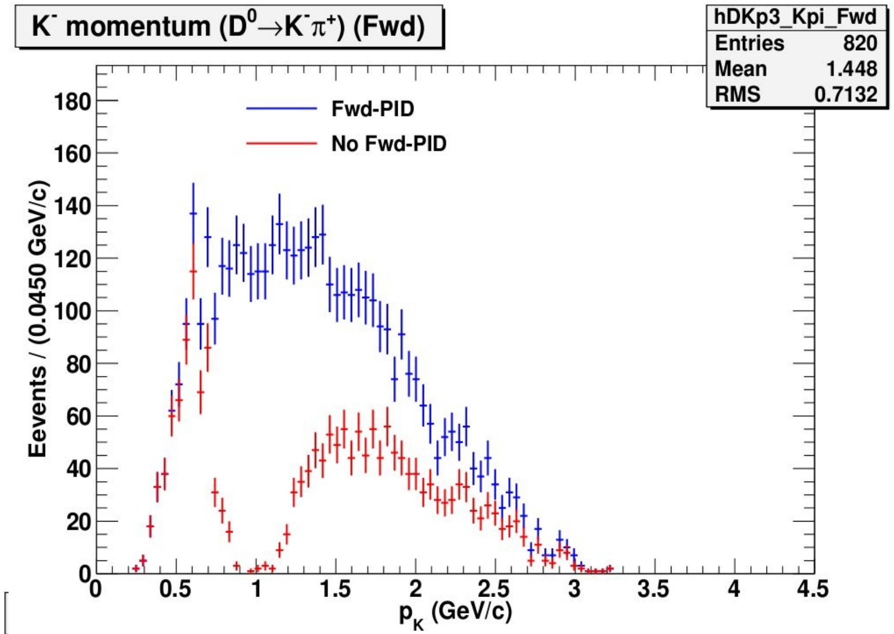
Fwd-PID studies: $B^+ \to K^+ \nu\nu$

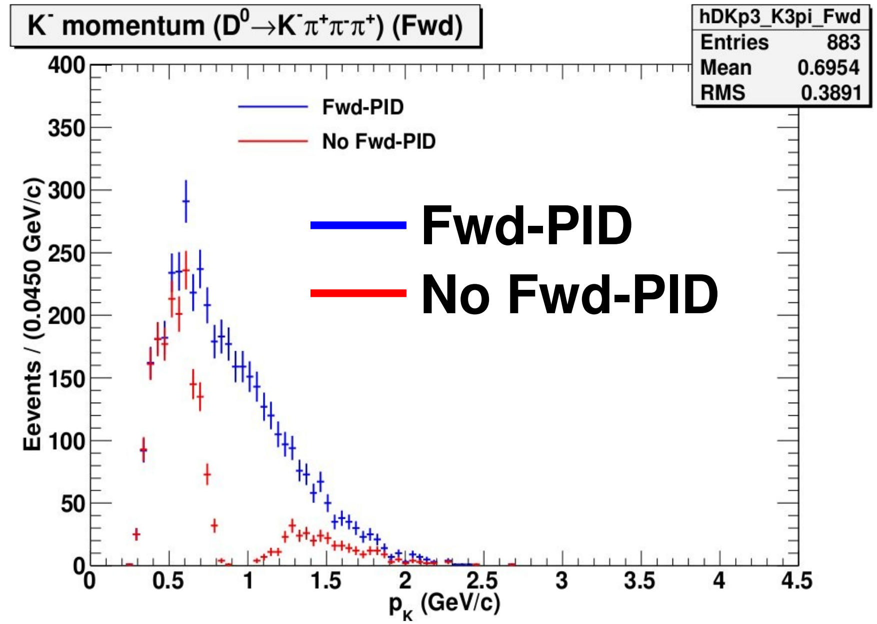


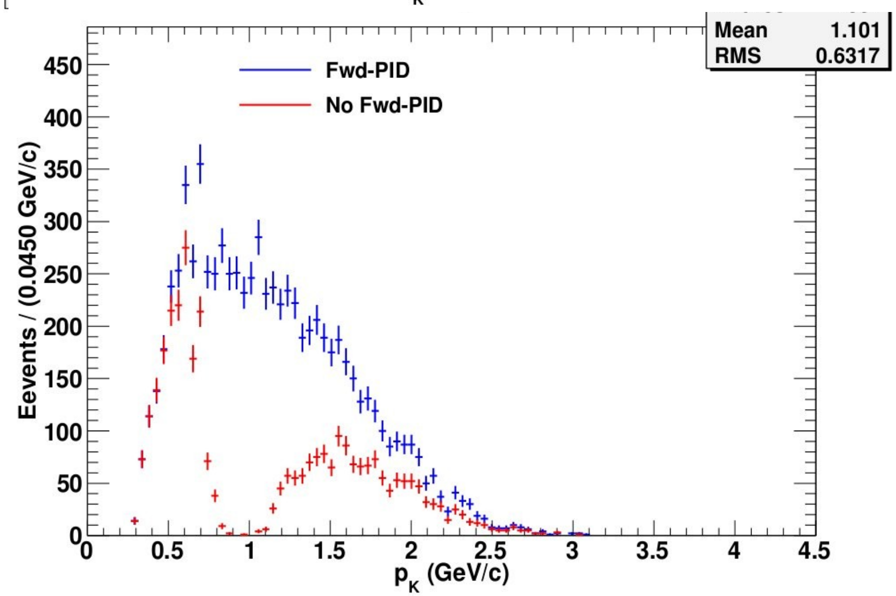


- **Events in the Fwd region (15-25 degrees) are 5% of the total sample if cos(θ) (CM) is flat**
- **f-TOF seems to recover the events in the Fwd**
- **Gain from fTOF not expected to be higher than 5% for each identified kaon**

Fwd-PID studies: $B^+ \to K^+ \nu\nu$







- fTOF in: number of events in the Fwd gets doubled

  $\Rightarrow$ gain on tag-side side ~2.5%

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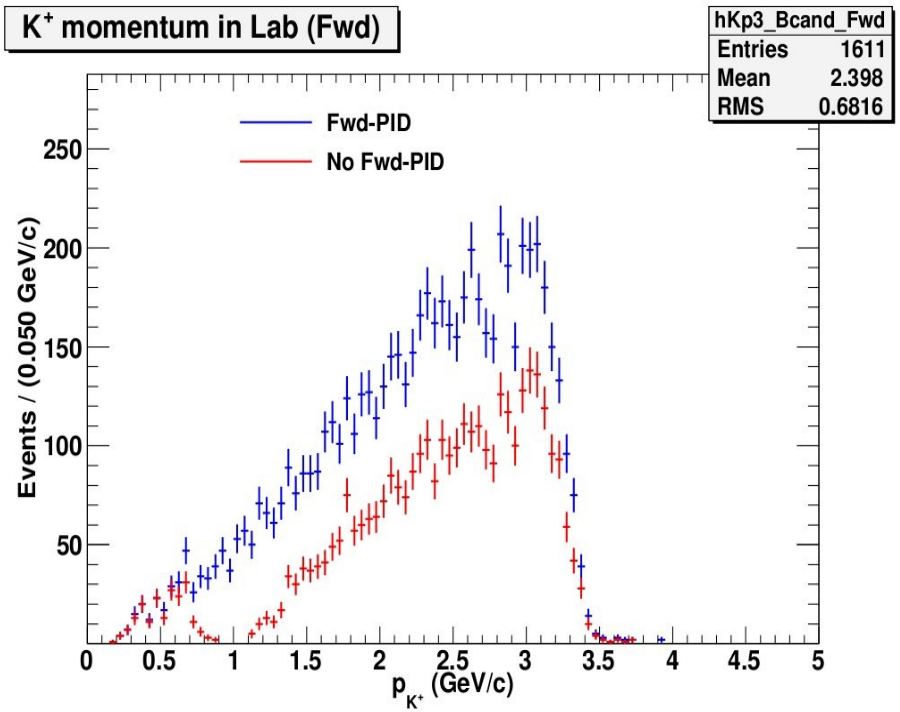
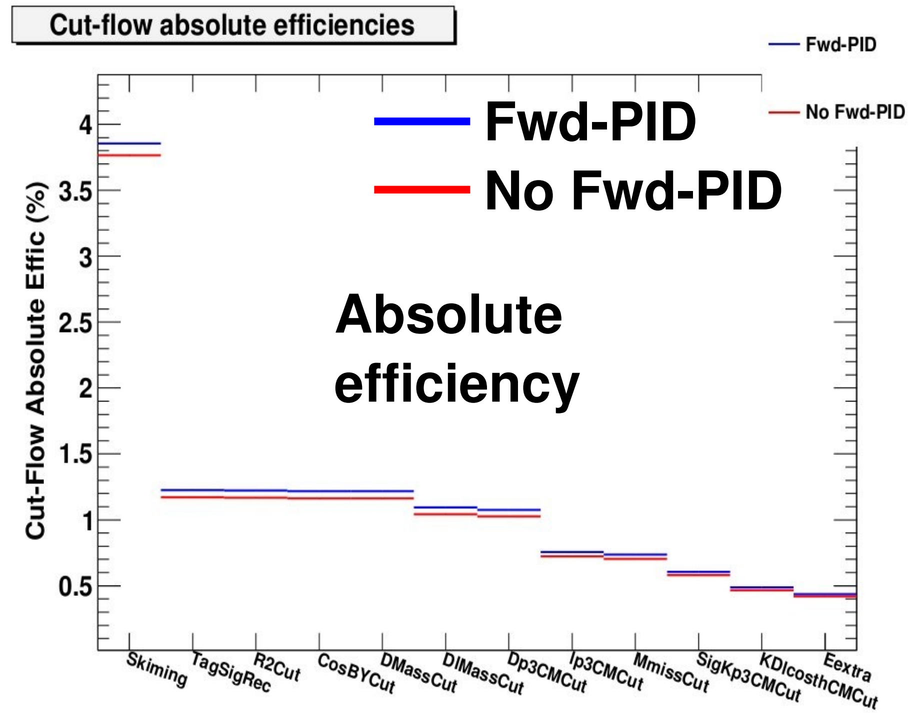
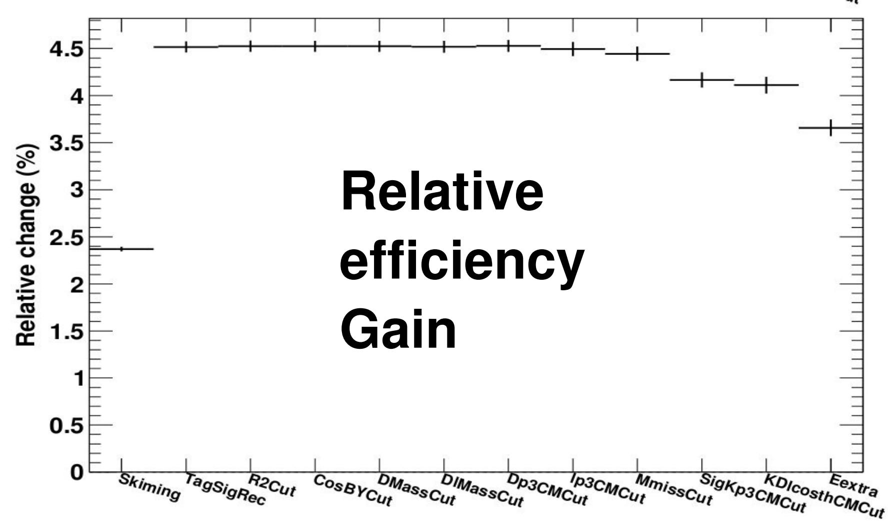
Fwd-PID studies: $B^+ \to K^+ \nu\nu$



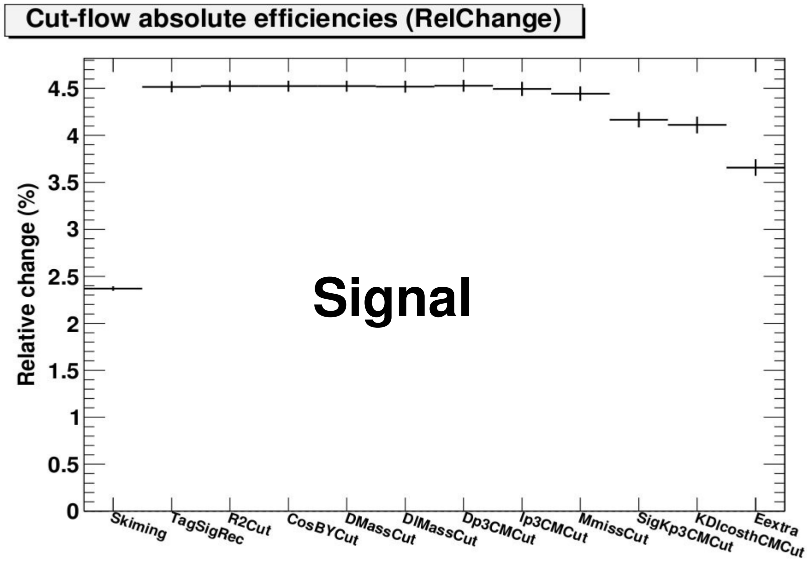




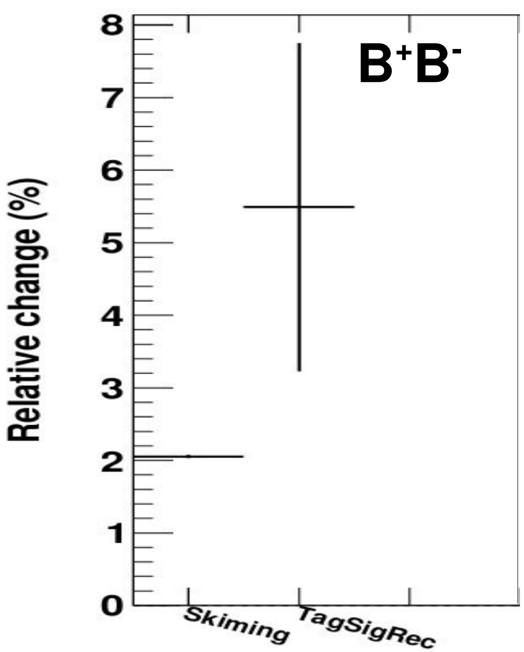
- **Different gain is obtained on the signal-side due to the different Kaon momentum spectrum (harder w.r.t tag-side)**

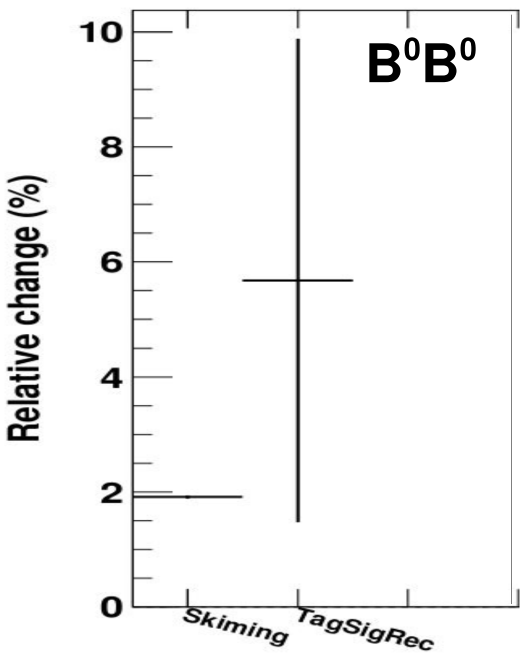
  ⇒ gain in signal-signal side ~2%

Fwd-PID studies: $B^+ \to K^+ \nu\nu$

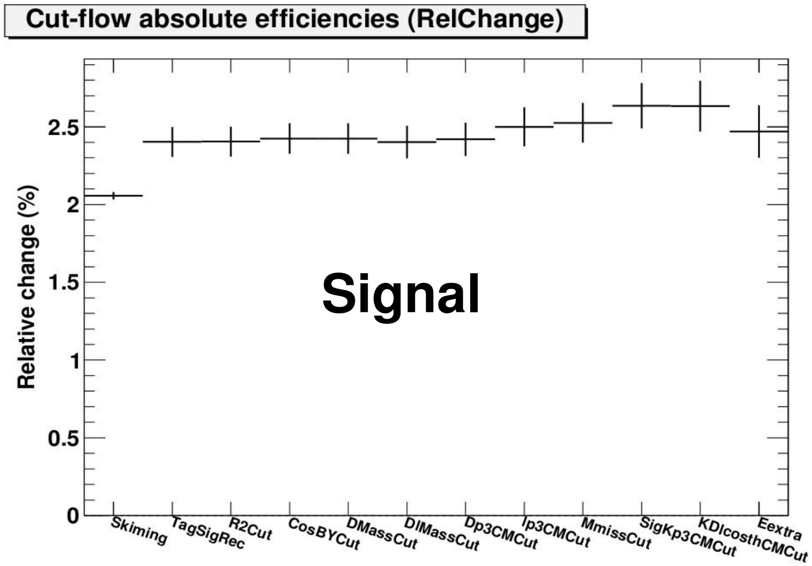


- **Signal:** - Tag-side: 2.4 %
  - Sig-side: 2.1 ± 0.1%
- **B^+B^-:** - Tag-side: 2.0 %
  - Sig-side: 3.3 ± 2.1%
- **B^0B^0:** - Tag-side: 2.0 %
  - Sig-side: 3.5 ± 4.0%

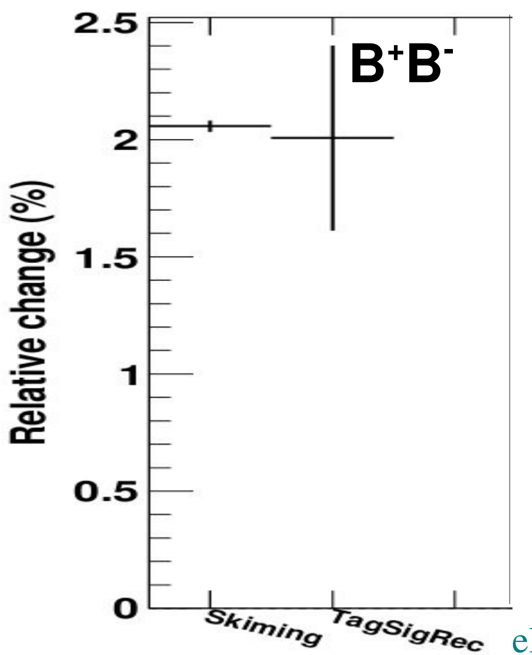




Fwd-PID studies: $B^0 \to K^0 \nu\nu$



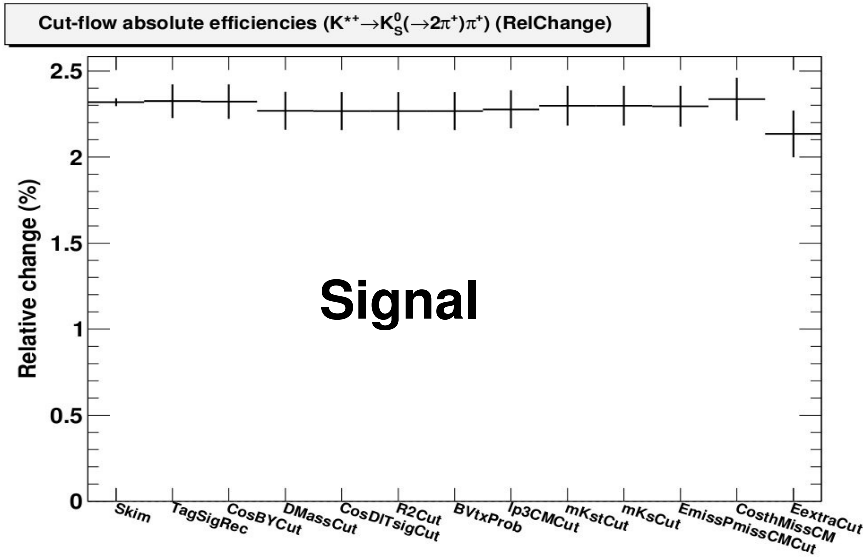
- **Signal:** - Tag-side: 2.1 %
  - Sig-side: 0.3 ± 0.2%
- **B^+B^-:** - Tag-side: 2.1 %
  - Sig-side: 0.05 ± 0.40%
- **B^0B^0:** - XXX
  - XXX



B^0B^0

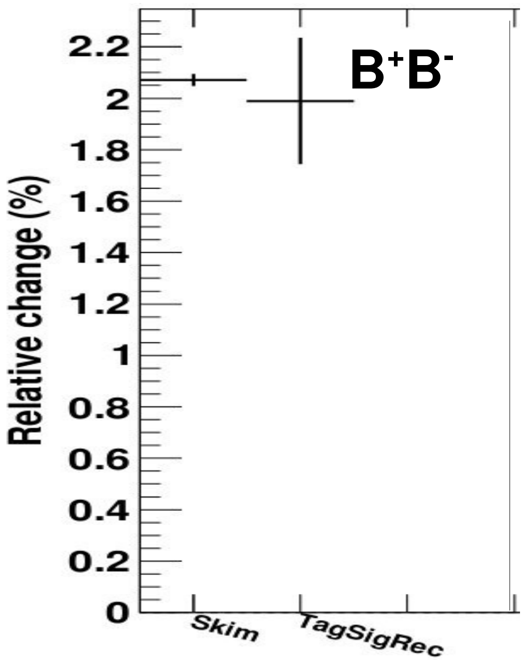
Problem with this plot

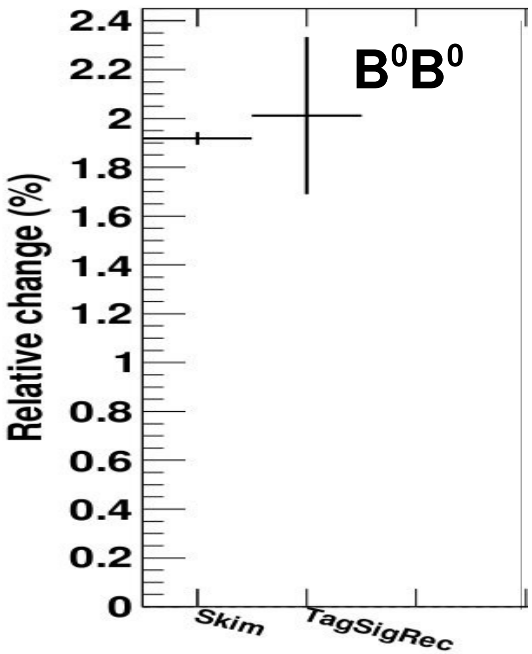
Fwd-PID studies: $B \to K^{*+} \nu\nu$



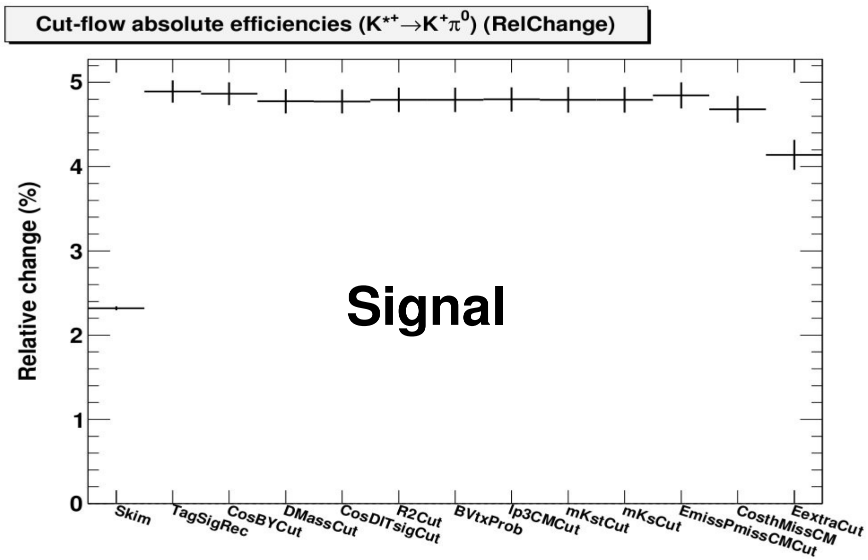
$K^{*+} \to K^0_S(\to 2\pi^+)\pi^+$

- **Signal:** - Tag-side: 2.3 %
  - Sig-side: 0.0 ± 0.1%
- **B^+B^-:** - Tag-side: 2.1 %
  - Sig-side: -0.1 ± 0.2%
- **B^0B^0:** - Tag-side: 1.9 %
  - Sig-side: 0.1 ± 0.3%



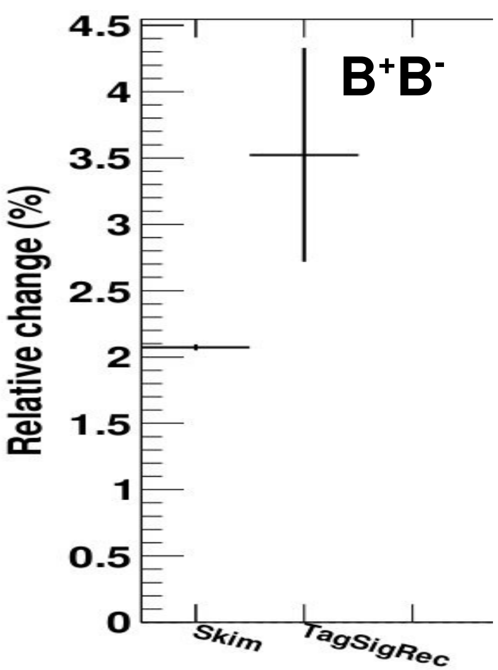


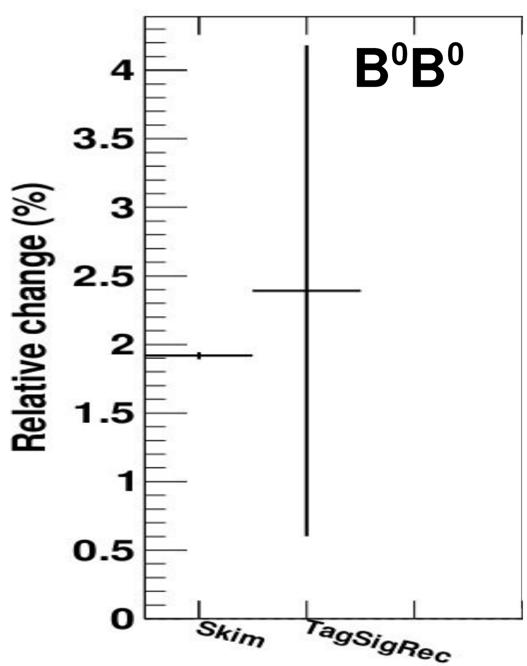
Fwd-PID studies: $B \to K^{*+}\nu\nu$

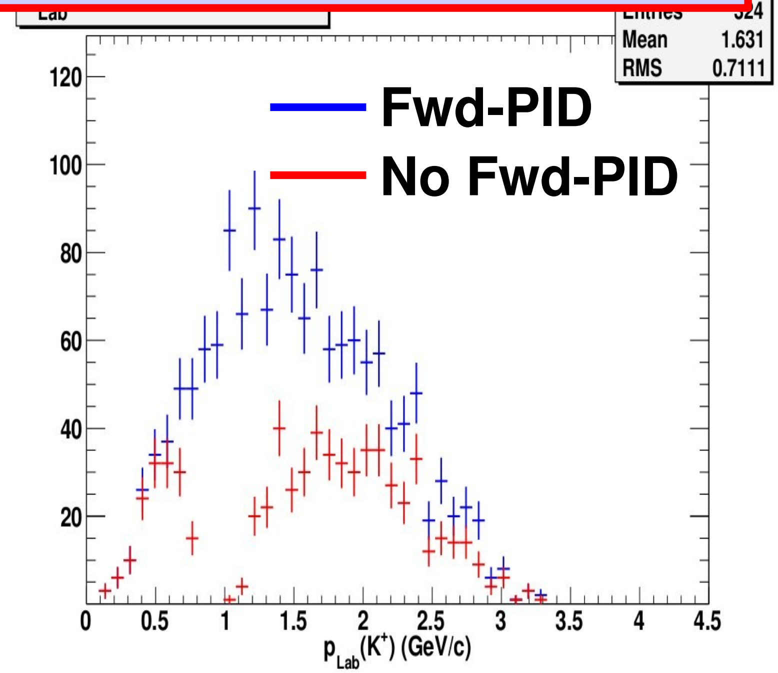


$K^{*+} \to K^+\pi^0$

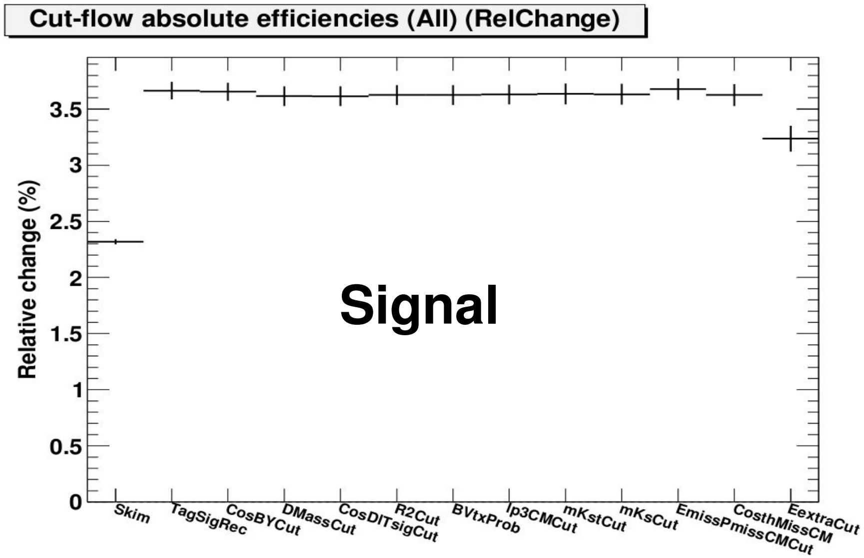
- **Signal:** - Tag-side: 2.3 %
  - Sig-side: 2.6 ± 0.1%
- **B^+B^-:** - Tag-side: 2.1 %
  - Sig-side: 1.4 ± 0.8%
- **B^0B^0:** - Tag-side: 1.9 %
  - Sig-side: 0.5 ± 1.8%





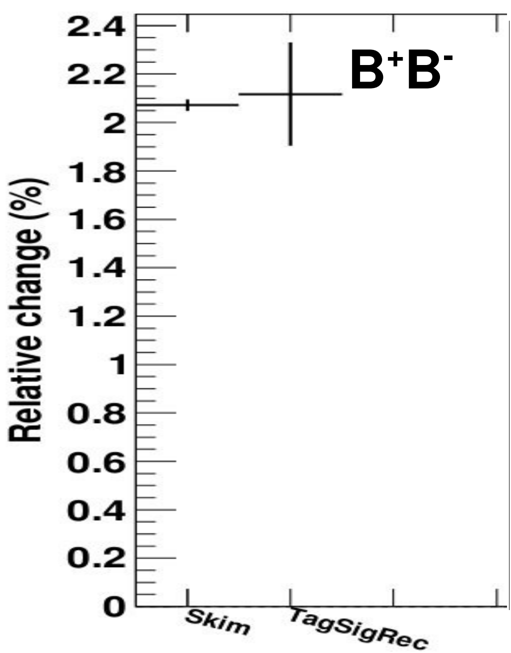


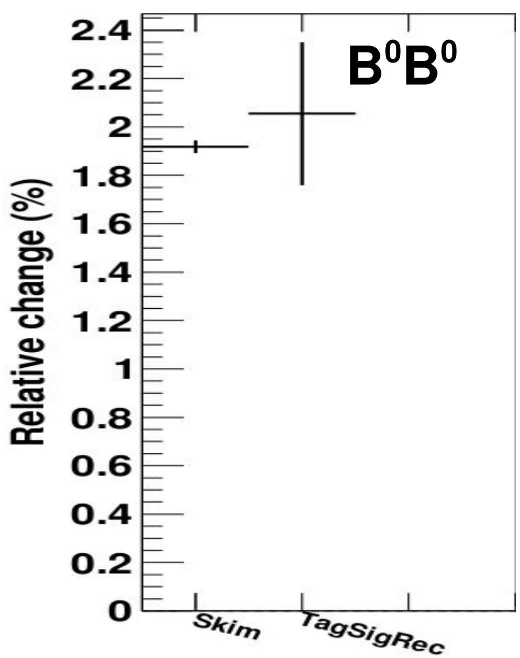
Fwd-PID studies: $B \to K^{*+} \nu\nu$



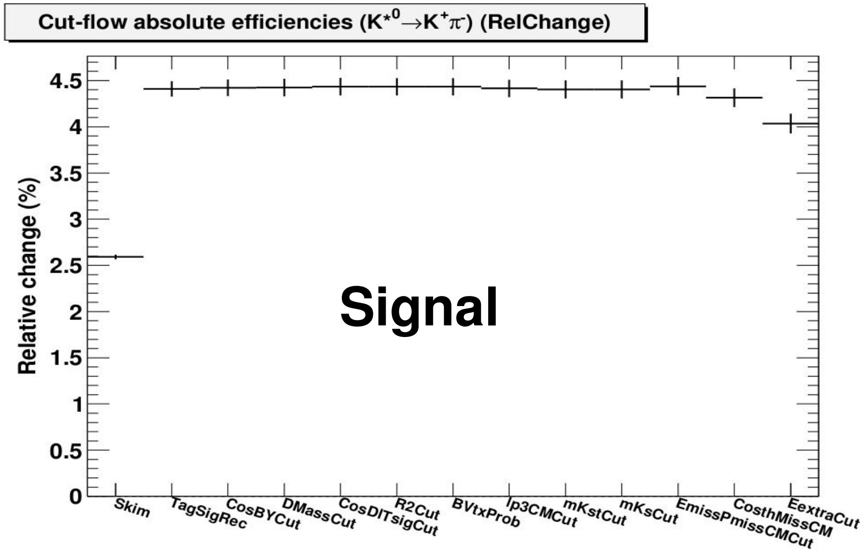
All K^{*+} modes

- **Signal:** - Tag-side: 2.3 %
  - Sig-side: 1.4 ± 0.3%
- **B^+B^-:** - Tag-side: 2.1 %
  - Sig-side: 0.0 ± 0.2%
- **B^0B^0:** - Tag-side: 1.9 %
  - Sig-side: 0.2 ± 0.3%



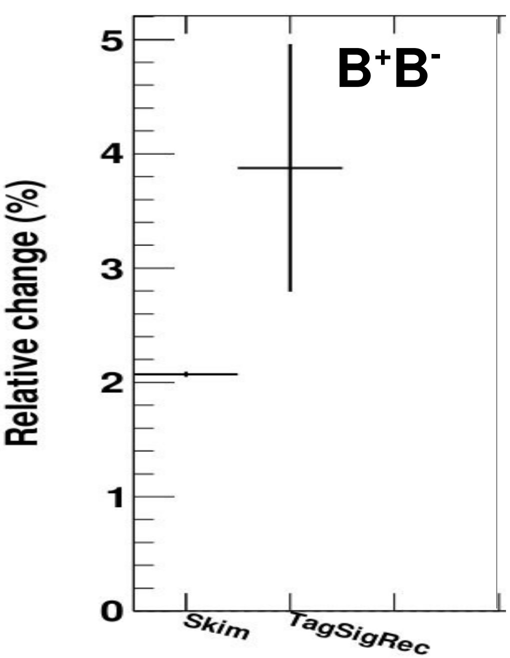


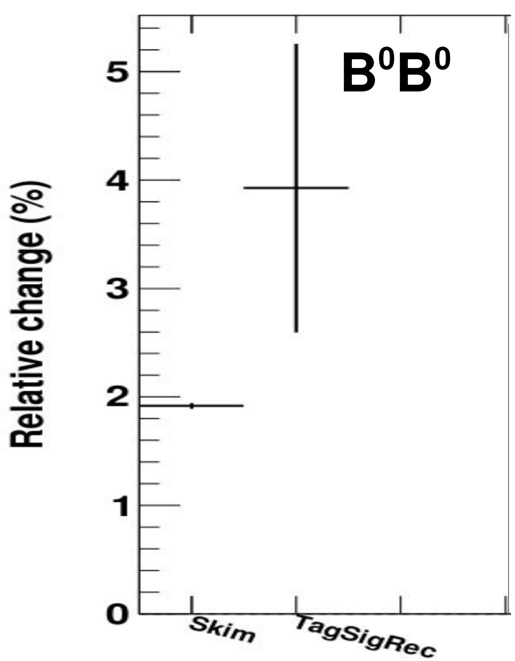
Fwd-PID studies: $B \rightarrow K^{*0} \nu\nu$

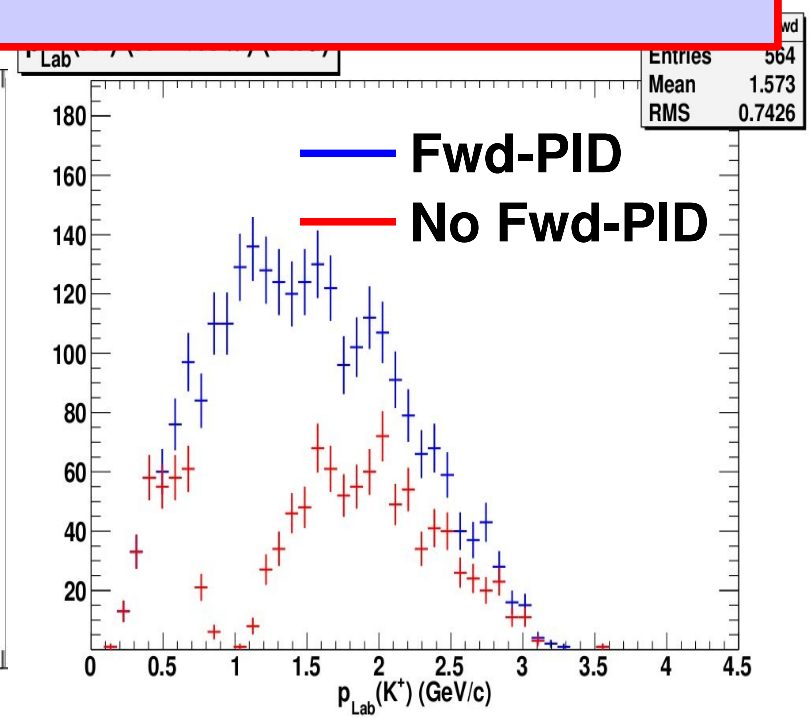


$K^{*0} \rightarrow K^+\pi^-$

- **Signal:** - Tag-side: 2.6 %
  - Sig-side: 1.8 ± 0.1%
- **B^+B^-:** - Tag-side: 2.1 %
  - Sig-side: 1.7 ± 1.2%
- **B^0B^0:** - Tag-side: 2.0 %
  - Sig-side: 2.0 ± 1.2%

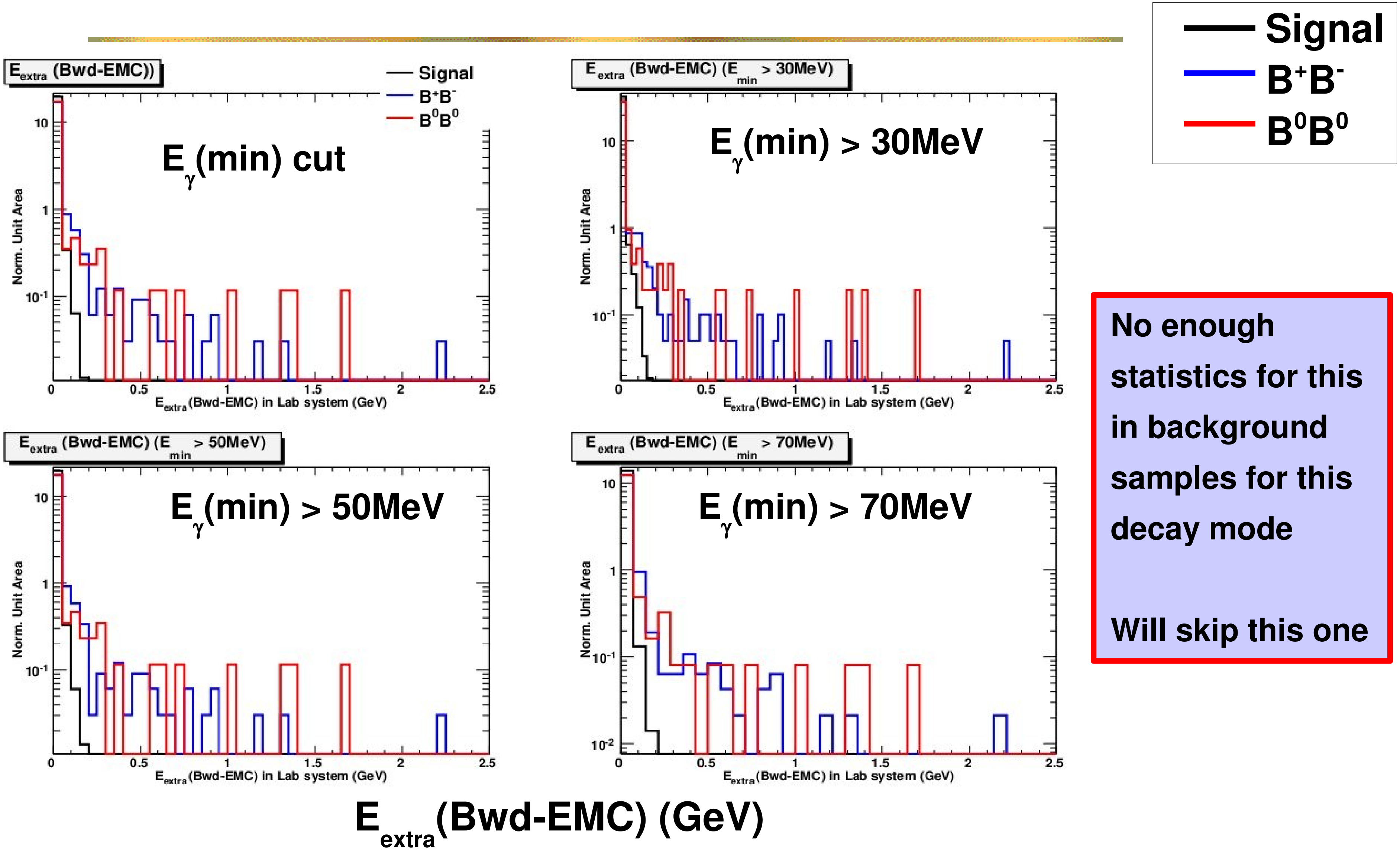






Results on Bwd-EMC Studies

Bwd-EMC studies: $B^+ \to K^+\nu\nu$

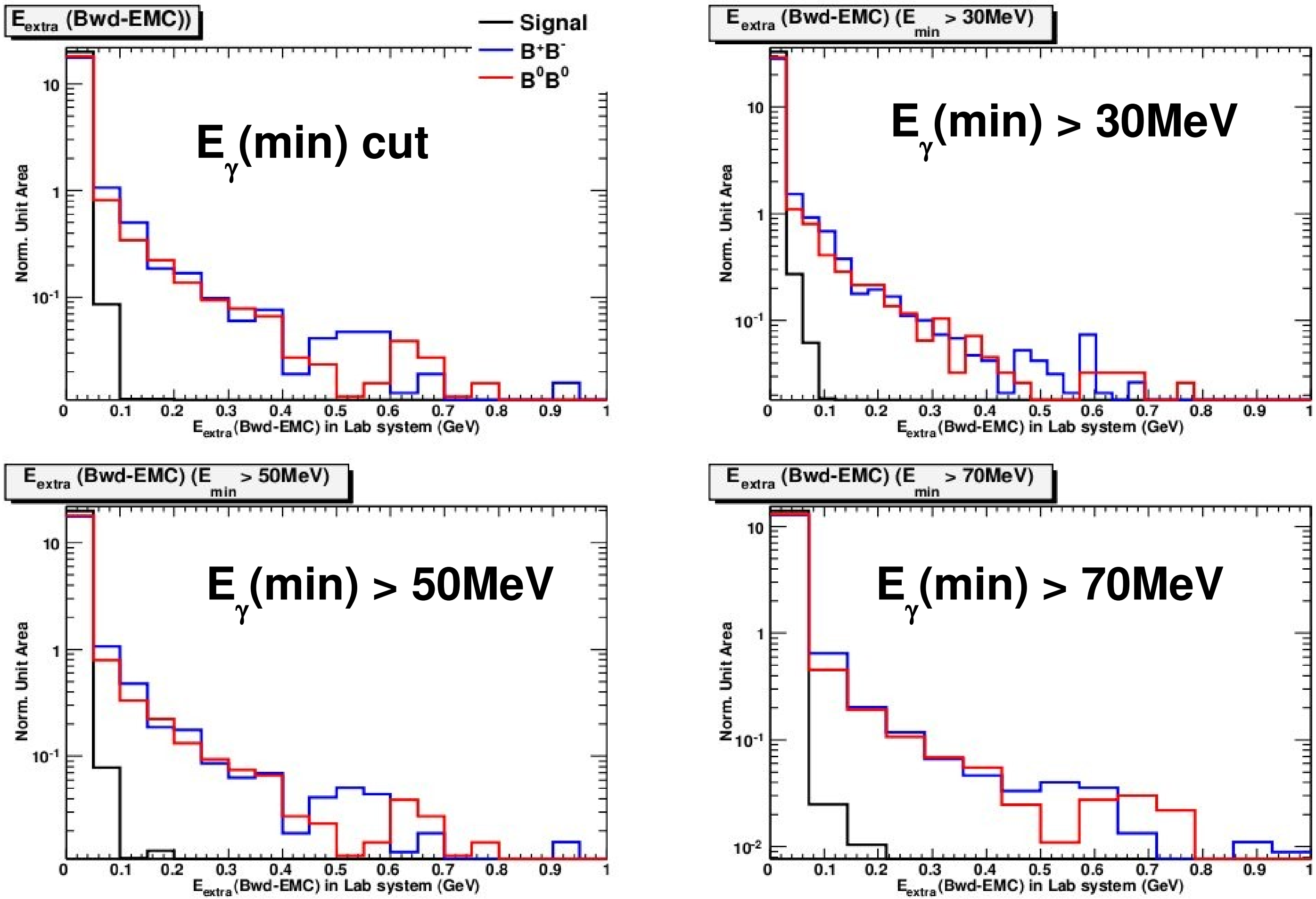


No enough statistics for this in background samples for this decay mode

Will skip this one

Bwd-EMC studies: $B^0 \to K^0 \nu\nu$

- Signal
- B^+B^-
- B^0B^0



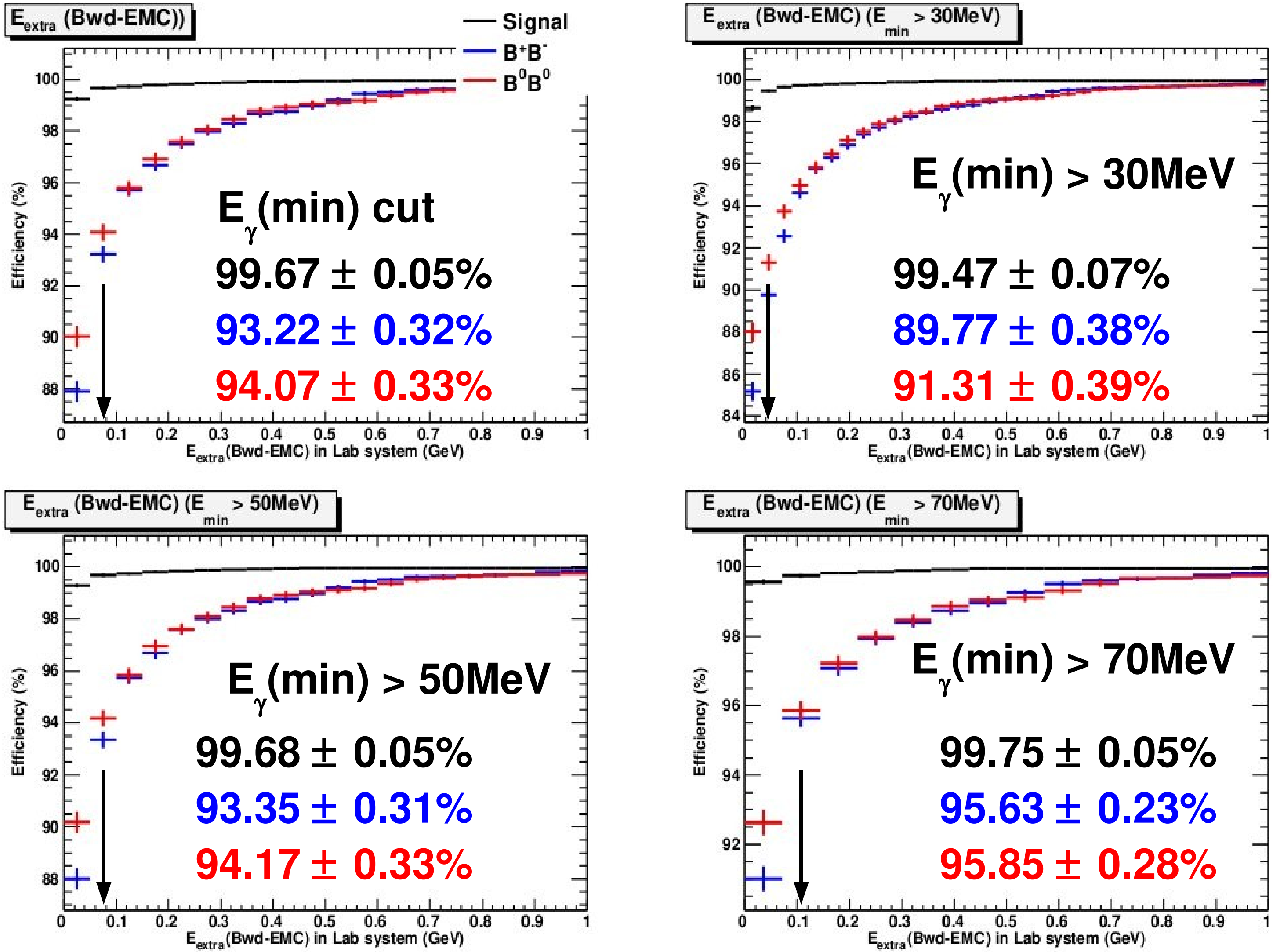
E_{extra}(Bwd-EMC) (GeV)

Warning:
log-scale in the vertical scale

Backgrounds have longer tails to high values w.r.t signal

Bwd-EMC studies: $B^0 \to K^0 \nu\nu$

- **Signal**
- **B^+B^-**
- **B^0B^0**



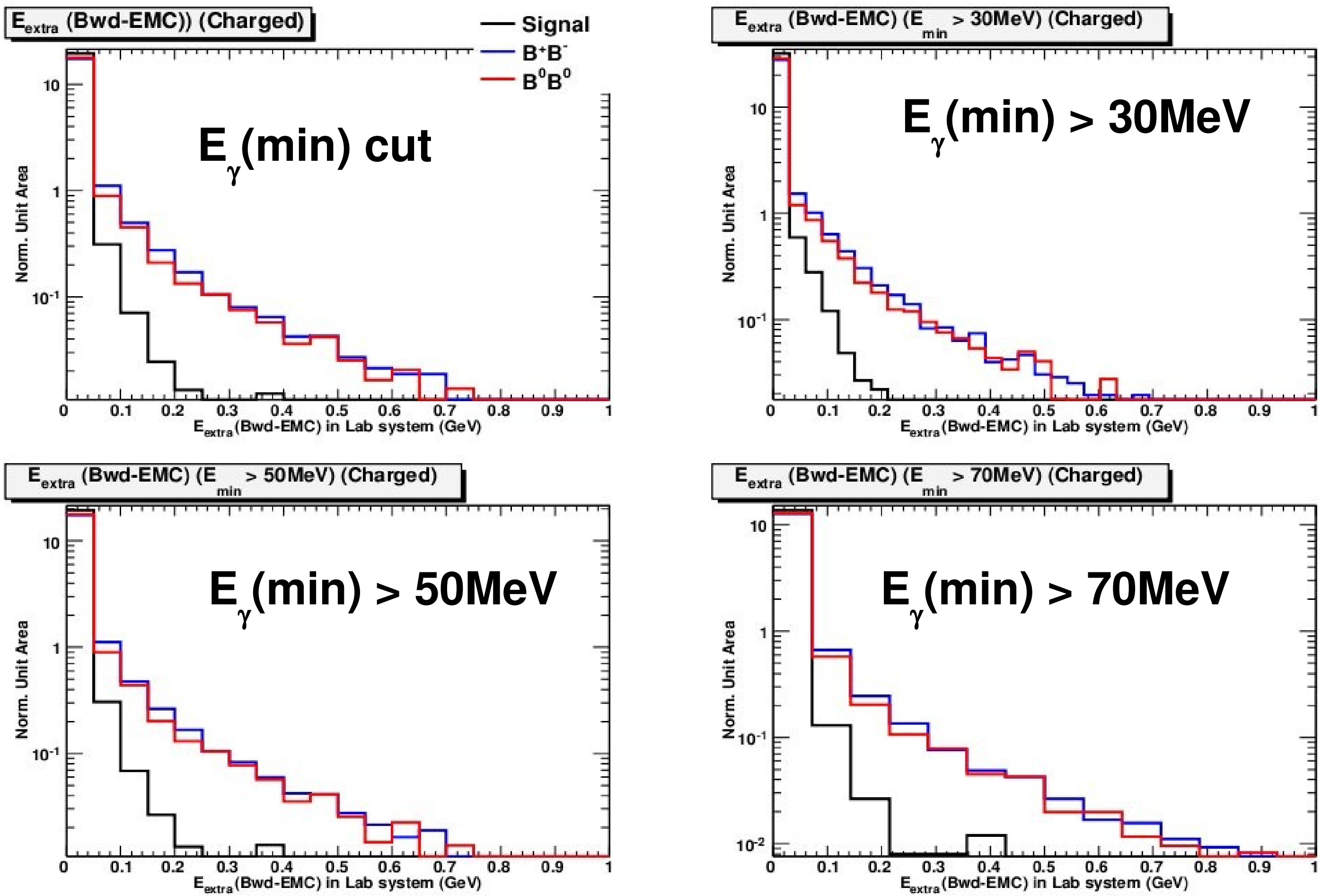
E_{extra}(Bwd-EMC) (GeV)

Seems that it is better to use E_γ(min) > 30MeV

Could reduce backgrounds by around 10%

Bwd-EMC studies: $B^{*} \to K^{*}\nu\nu$

Signal
B^+B^-
B^0B^0

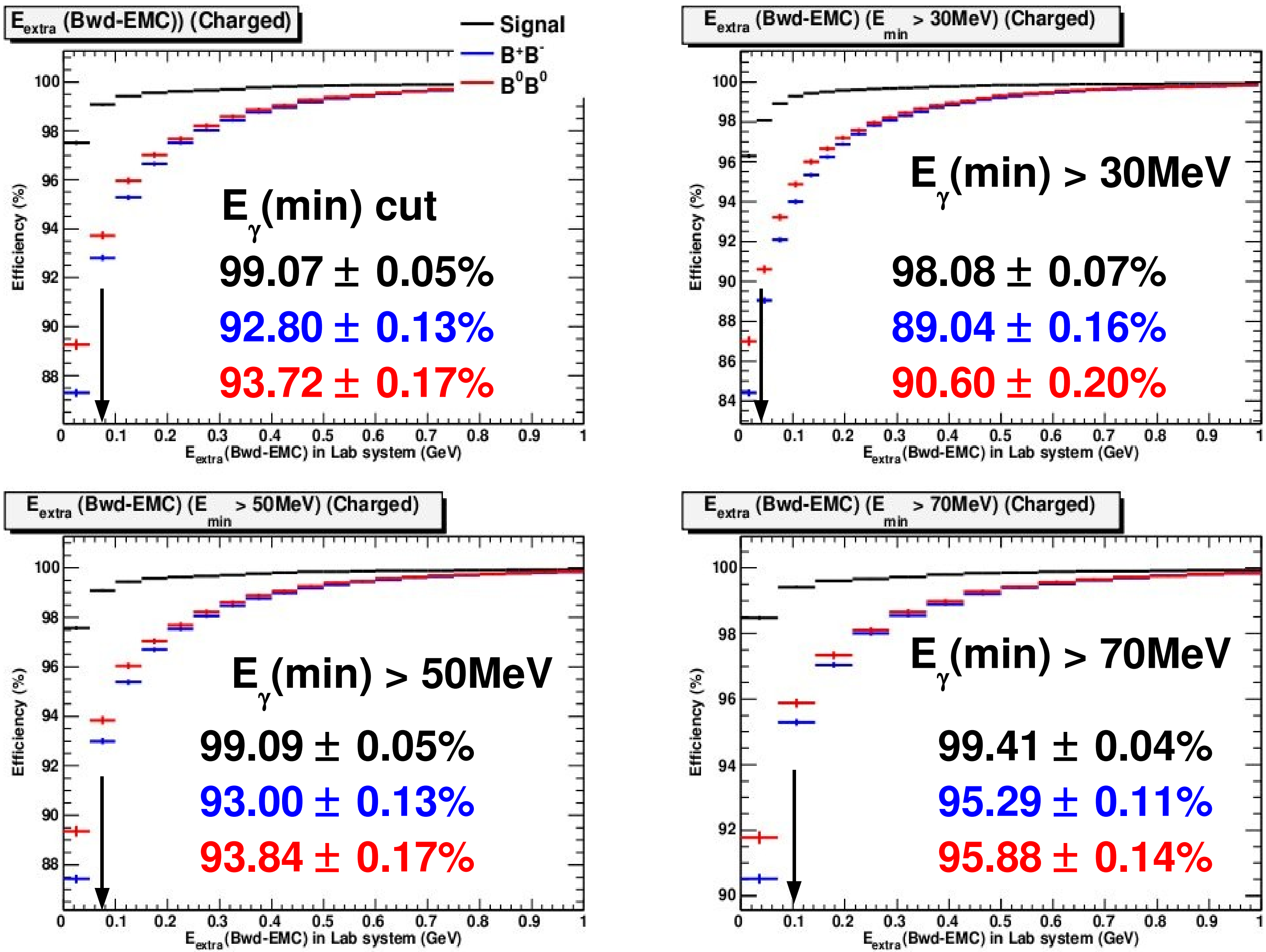


E_{extra}(Bwd-EMC) (GeV)

Warning: log-scale in the vertical scale

Backgrounds have longer tails to high values w.r.t signal

Bwd-EMC studies: $B^* \to K^* \nu\nu$



E_{extra}(Bwd-EMC) (GeV)

Signal
B^+B^-
B^0B^0

Seems that it is better to use E_γ(min) > 30MeV

Could reduce backgrounds by around 10%

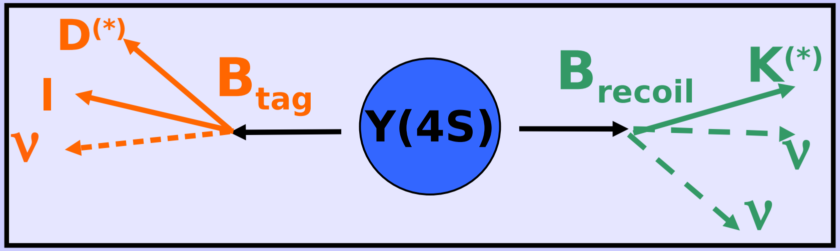
Summary and outlook

- **Many samples to play with out of July/September 2010 production**
- **Cocktails increased significantly the statistics need for the DGWG analyses**
- **Fwd-PID studies:**
  - Gain from 2.0 to 2.5% per identified kaon (depends on momentum spectrum)
  - Signal samples with (without) a charge kaon on signal-side get an overall relative increase on efficiency of ~4.5% (~2.5%)
  - Background samples efficiency increases due to better tag-side efficiency, not significant increase on signal-side efficiency (error bars still big)
- **Bwd-EMC studies:**
  - All analyses give similar performances for this device
  - It seems that we can reduce the two main background samples by about ~10% with negligible reduction on signal efficiency using using $E\gamma(\mathrm{min}) > 30\mathrm{MeV}$
- **Next steps:**
  - Analyse the rest to of the MC produced until now (~20%)
- **Many thanks to the production team who provided the samples needed for these studies**

Backup

Reminder: SL technique

- Search for $B \to D^{(*)} l \nu$



- Reconstruction steps:
  - Reconstruct $D^{(*)} \to$ hadrons

$D^{*+} \to D^0 \pi^+$
~~$D^{*0} \to D^0 \pi^0$~~
$D^{*0} \to D^0 \gamma$

$D^0 \to K^- \pi^+$
$D^0 \to K^- \pi^+ \pi^0 (\gamma\gamma)$
$D^0 \to K^- \pi^+ \pi^+ \pi^-$
$D^0 \to K^0_S \pi^+ \pi^-$

$D^+ \to K^- \pi^+ \pi^-$
$D^+ \to K^- \pi^+ \pi^- \pi^0$
$D^+ \to K^0_S \pi^+$
$D^+ \to K^0_S \pi^+ \pi^- \pi^+$
$D^+ \to K^0_S \pi^+ \pi^0$

  - Use $D^{(*)}$ and add lepton ($e^{\pm}, \mu^{\pm}$) to form a $D^{(*)} l$ candidate

- Sample of 14 decay modes (charged + neutrals)
- Kinematics is unconstrained due to neutrinos
- Relatively high reconstruction efficiency ~2%