$B \to K^* \nu\nu$ vs HAD tag: impact of bwd EMC and fwd PID

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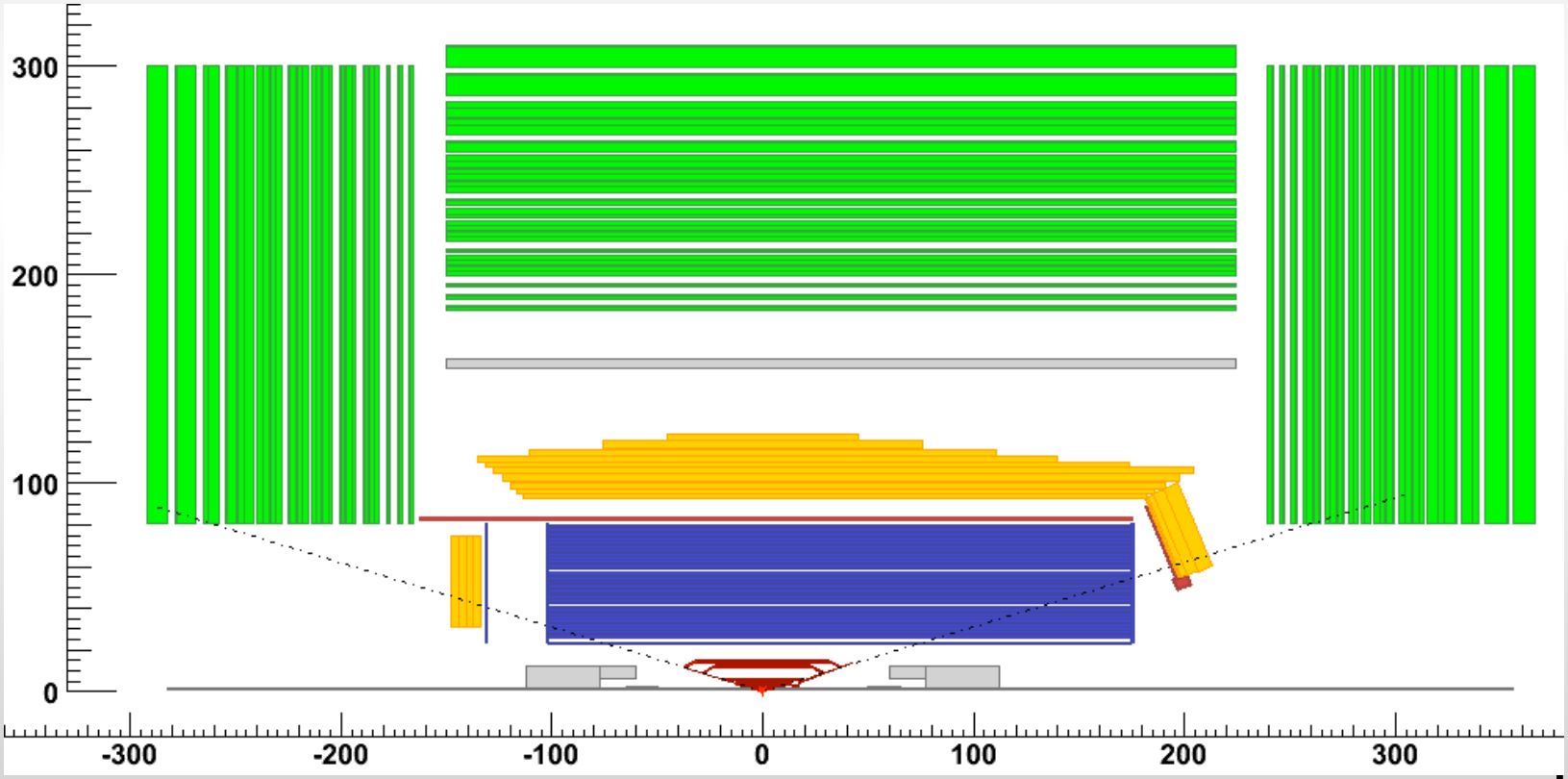
Outline

* DG configurations and samples from September production
* impact of fwd PID in Breco and Breco+Bsig selection efficiencies
* impact of bwd EMC used as a veto
* impact of material in front of Fwd EMC

Detector geometries

* DG_4 : SVT_L0 + fwd TOF+ bwd EMC
  - offline can study: impact of fwd PID, impact of bwd EMC
* DG_4a : as DG_4 but TOF made if Air (0-thickness TOF)
  - comparing with DG_4 , study impact of TOF material in front of the EMC



Sample used

* 2010_September production, FastSim release V0.2.5, revs 307 and 311

Sample	Bkg conditions	$N_{events}^{analyzed}(10^6)$
DG 4		
$B^0 \to K^{*0}\nu\bar{\nu}$ vs generic B^0	allbkgs	3.06
$B^+ \to K^{*+}\nu\bar{\nu}$ vs generic B^-	allbkgs	3.33
B^0 hadronic cocktail vs generic B^0	allbkgs	150.96
B^+ hadronic cocktail vs generic B^-	allbkgs	189.28
$B^0 \to K^{*0}\nu\bar{\nu}$ vs generic B^0	nopairs	2.97
$B^+ \to K^{*+}\nu\bar{\nu}$ vs generic B^-	nopairs	3.15
B^0 hadronic cocktail vs generic B^0	nopairs	377.20
B^+ hadronic cocktail vs generic B^-	nopairs	400.00
DG 4a		
$B^0 \to K^{*0}\nu\bar{\nu}$ vs generic B^0	allbkgs	3.15
$B^+ \to K^{*+}\nu\bar{\nu}$ vs generic B^-	allbkgs	3.12
$B^0 \to K^{*0}\nu\bar{\nu}$ vs generic B^0	nopairs	3.03
$B^+ \to K^{*+}\nu\bar{\nu}$ vs generic B^-	nopairs	3.00
B^0 hadronic cocktail vs generic B^0	nopairs	376.24
B^+ hadronic cocktail vs generic B^-	nopairs	325.28

Analysis strategy

* Baseline analysis
  - DG_4_allbkgs with Fwd TOF on and Bwd EMC off
  - Kaons form Bsig and Breco: likelihood based selectors TightLHKaonfTOFSelection
* impact of Fwd TOF:
  - DG_4_allbkgs with Fwd TOF off and Bwd EMC off
  - Kaons form Bsig and Breco: likelihood based selectors TightLHKaonSelection
* impact of Bwd EMC:
  - DG_4_allbkgs with Fwd TOF switched on and Bwd EMC switched on
  - cut on Eextra deposited in bwd EMC (+ usual cut on Eextra from Barrel+Fwd)

$$\frac{\delta\varepsilon}{\varepsilon} = \frac{\varepsilon_{xxx,on} - \varepsilon_{xxx,off}}{\varepsilon_{xxx,off}}$$

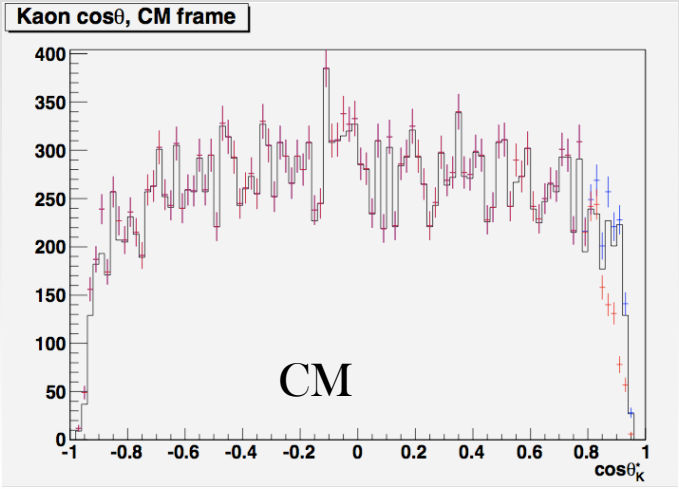
* impact of material in front of Fwd EMC
  - DG_4a_nopairs with Fwd TOF switched on and Bwd EMC switched off
  - evaluate π^0 mass and γ energy resolutions and compare with DG_4

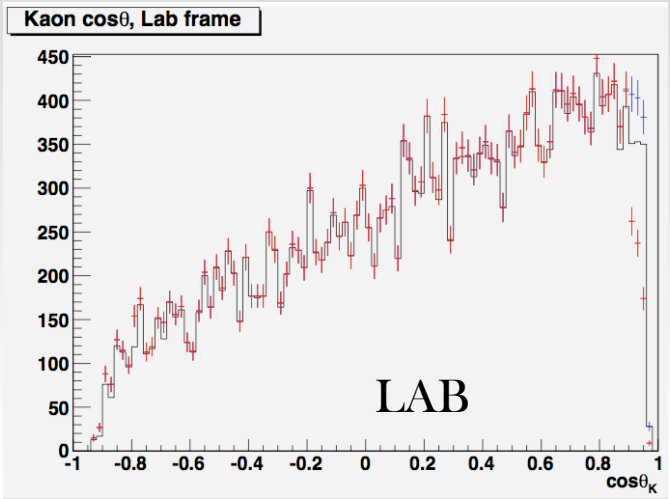
Impact of Fwd PID
DG_4, cocktail + signal
(all backgrounds)

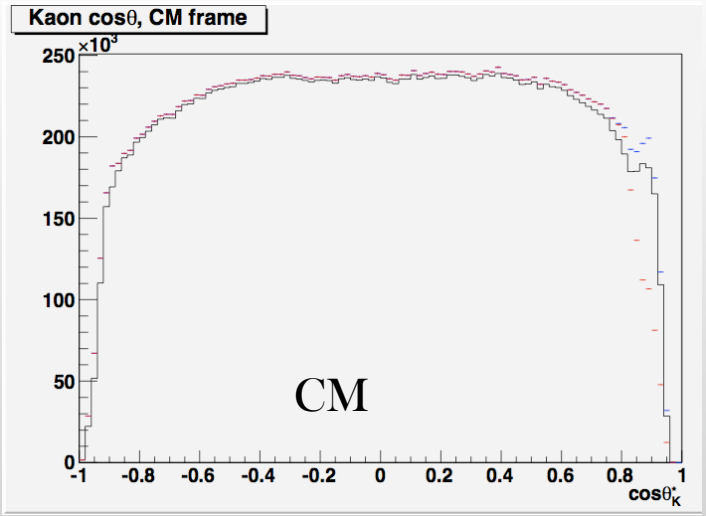
Reco side kaon angular distribution

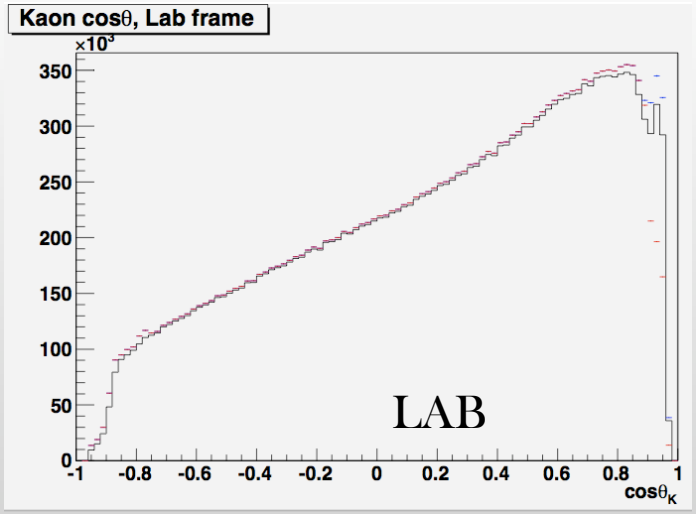
* $B^+ \to K^{*+} \nu\nu$ signal MC

- true value
- reco value, DCH+ TOF
- reco value DCH





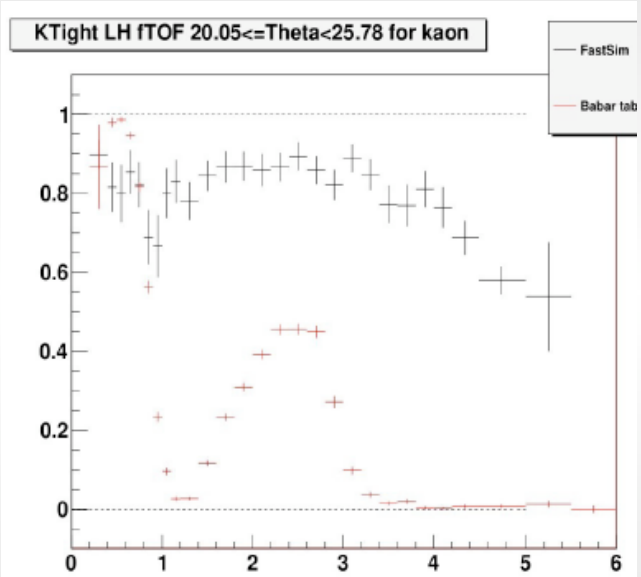




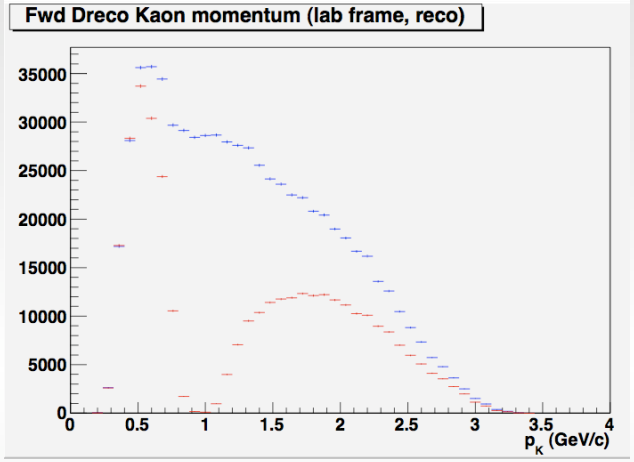
* B^+B^- cocktail

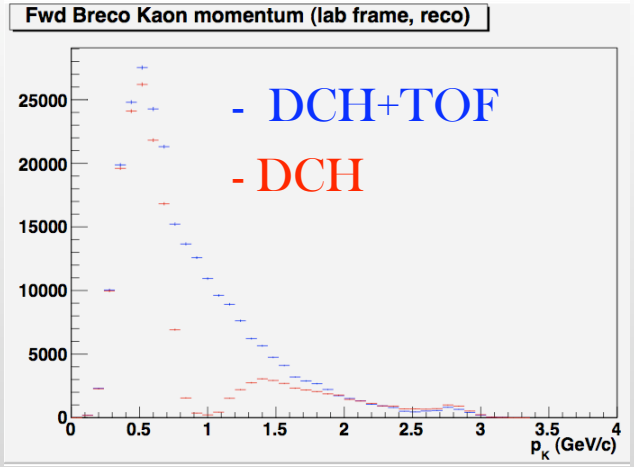
Reco side kaon momentum and multiplicity

* fraction of kaons in the Fwd region (θ = [15°,25°]) : 5-7%
* efficiency gain depend on kaon momentum spectrum and multiplicity



n_K	B^+ cock	B^0 cock
0	8%	12%
1	76%	64%
2	5%	10%
3	10%	13%
$< n_K >$	1.23	1.16





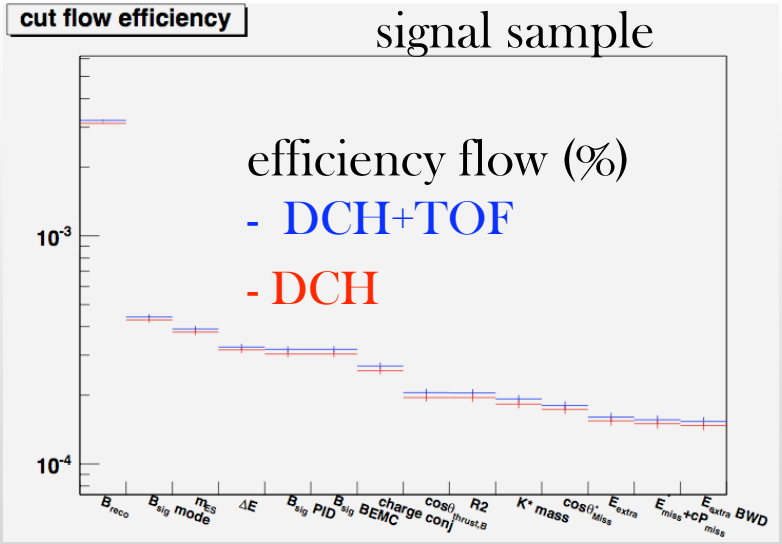
$B^0 \to K^{*0}(K^+\pi^-)\nu\nu$: Cut flow efficiency

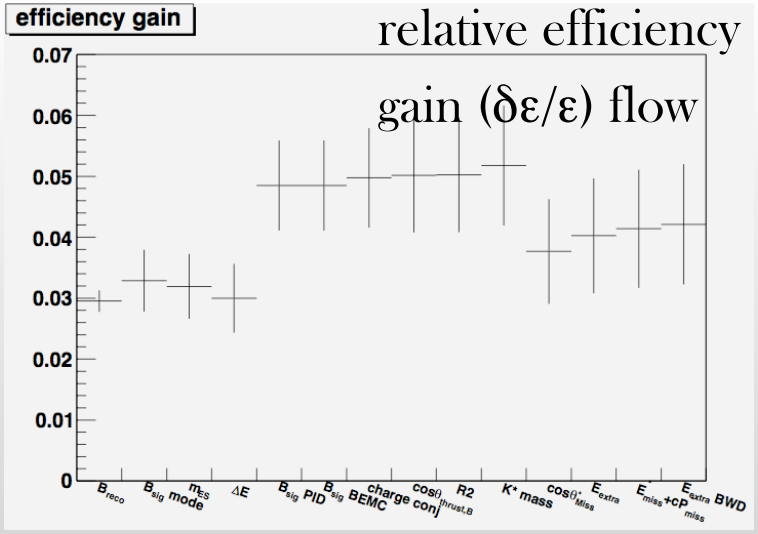
$\delta\varepsilon/\varepsilon$	signal MC	B^0 Cock
B_{reco} reconstr.	$(2.95 \pm 0.18)\%$	$(2.490 \pm 0.009)\%$
B_{reco} sel.	$(3.0 \pm 0.6)\%$	$(2.8 \pm 0.6)\%$
B_{sig} reconstr.	$(1.8 \pm 0.7)\%$	$(2.1 \pm 1.0)\%$
Full sel.	$(4.2 \pm 1.0)\%$	-

efficiency on Breco reconstr. and sel. normalized to # of gen evts

efficiency on Bsig reconstr. normalized to # of sel Breco events

totalsel efficiency normalized to # of gen evts





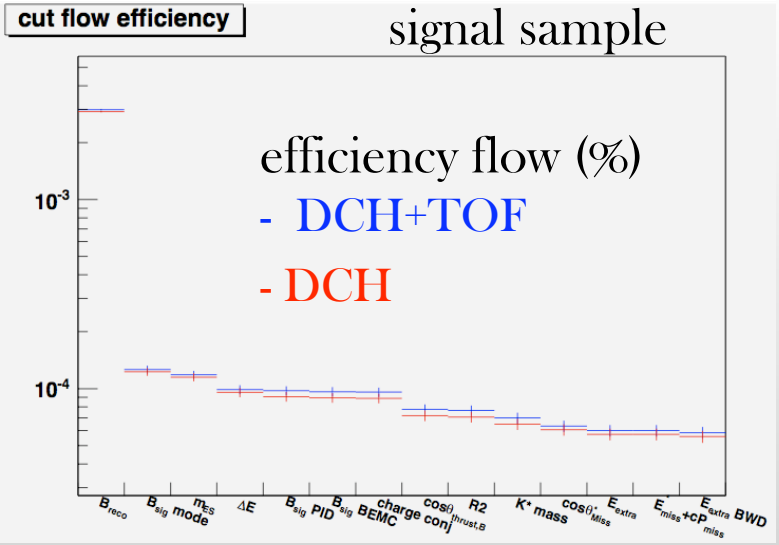
$B^+ \to K^{*+}(K^+\pi^0)\nu\nu$: Cut flow efficiency

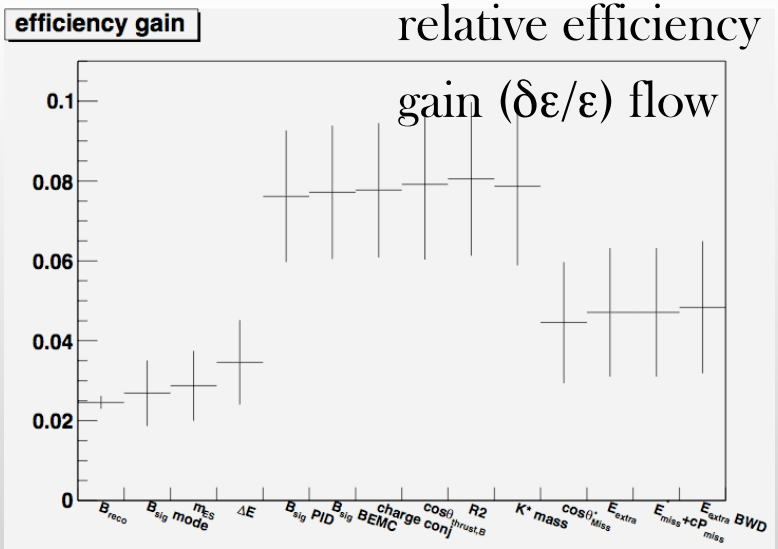
$\delta\varepsilon/\varepsilon$	signal MC	B^+ Cock
B_{reco} reconstr.	$(2.46 \pm 0.16)\%$	$(2.513 \pm 0.008)\%$
B_{reco} sel.	$(3.5 \pm 1.1)\%$	$(4.2 \pm 1.9)\%$
B_{sig} reconstr.	$(4.0 \pm 1.6)\%$	$(2.5 \pm 3.2)\%$
Full sel.	$(4.8 \pm 1.6)\%$	-

efficiency on Breco reconstr. and sel. normalized t o# of gen evts

efficiency on Bsig reconstr. normalized to # of sel Breco events

totalsel efficiency normalized to # of gen evts





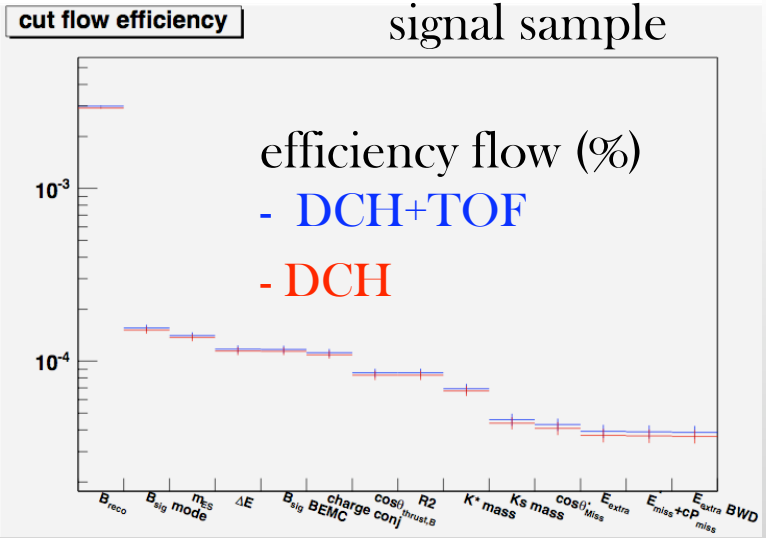
$B^+ \to K^{*+}(K_S\pi^+)\nu\nu$: Cut flow efficiency

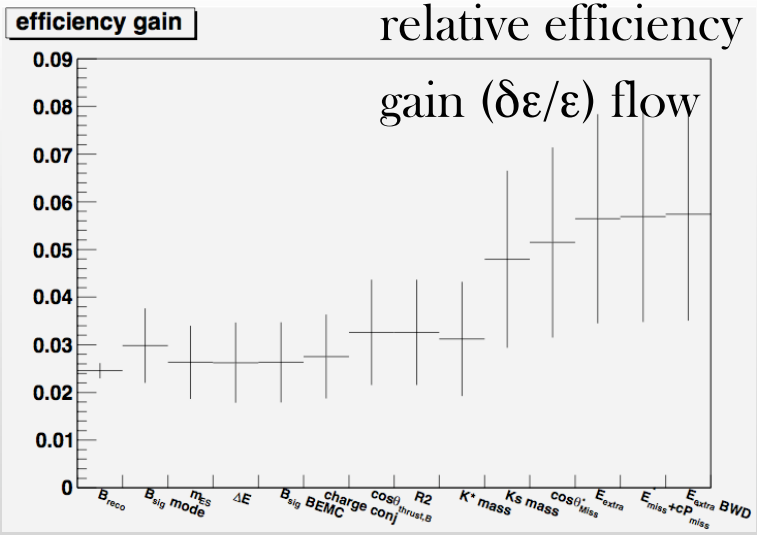
$\delta\varepsilon/\varepsilon$	signal MC	B^+ Cock
B_{reco} reconstr.	$(2.46 \pm 0.16)\%$	$(2.513 \pm 0.008)\%$
B_{reco} sel.	$(2.6 \pm 0.8)\%$	$(2.4 \pm 0.4)\%$
B_{sig} reconstr.	-	-
Full sel.	$(5.7 \pm 2.2)\%$	-

efficiency on Breco reconstr. and sel. normalized to # of gen evts

efficiency on Bsig reconstr. normalized to # of sel Breco events

total sel efficiency normalized to # of gen evts

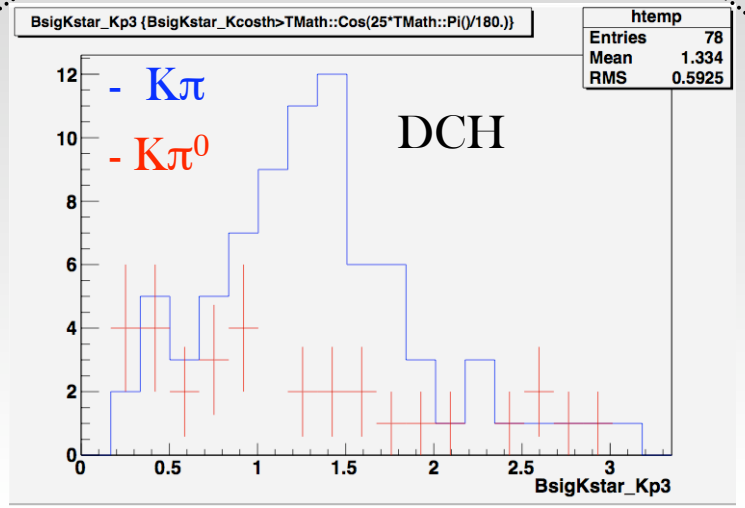


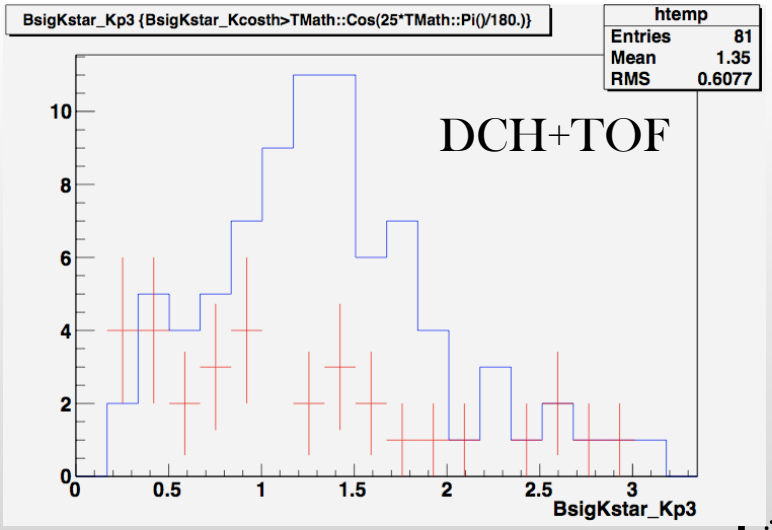


Remarks on $K\pi^0$ vs $K\pi$

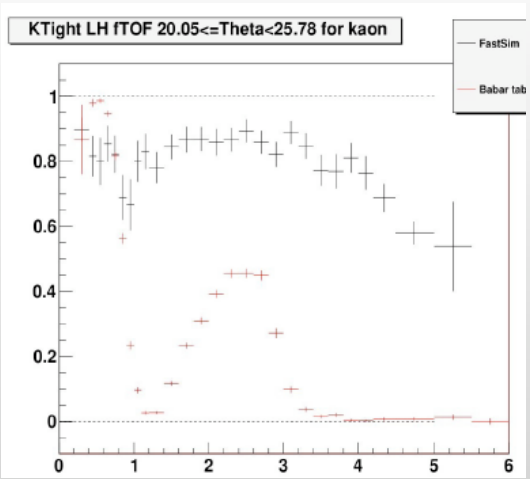
* Signal side Kaon momentum, before PID requirements

$K\pi$		
	DCH	DCH+TOF
fwd sig K	$(6.0 \pm 0.6)\%$	$(6.0 \pm 0.6)\%$
fwd sig K, PID OK	$(35 \pm 5)\%$	$(60 \pm 5)\%$
$K\pi^0$		
	DCH	DCH+TOF
fwd sig K	$(7.6 \pm 1.3)\%$	$(7.6 \pm 1.3)\%$
fwd sig K, PID OK	$(13 \pm 6)\%$	$(66 \pm 8)\%$





* high gain in $K\pi^0$ sample due to "low" DCH efficiency wrt to TOF



Remarks on $K_s\pi$

* After Breco sel. + Bsig mode reconstr. :
  - Kpi: nTOF+DCH – nDCH = 45
  - Ksp: nTOF+DCH – nDCH = 10

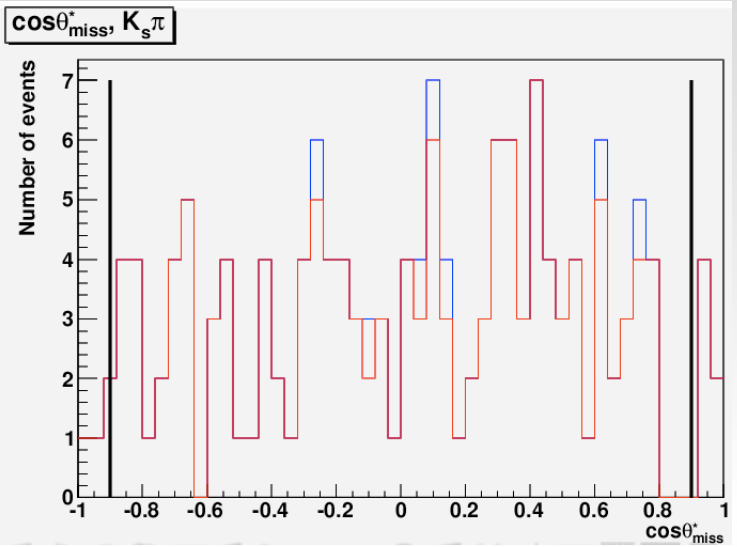
* After Breco+Bsig sel. :
  - Kpi: nTOF+DCH – nDCH = 19

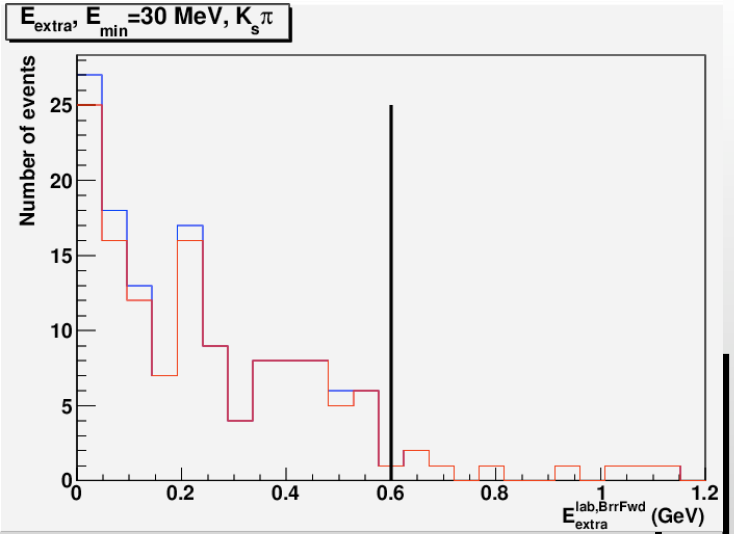
  (42% of gained events falls in the signla box)
  - Ksp: nTOF+DCH – nDCH = 7

  (70% of "gained" events falls in the signal box)

→ most of the Kspi events gained with TOF (i.e. higher Breco reconstruction) survive the full selection

→ full selection efficiency gain higher than Breco efficiency gain





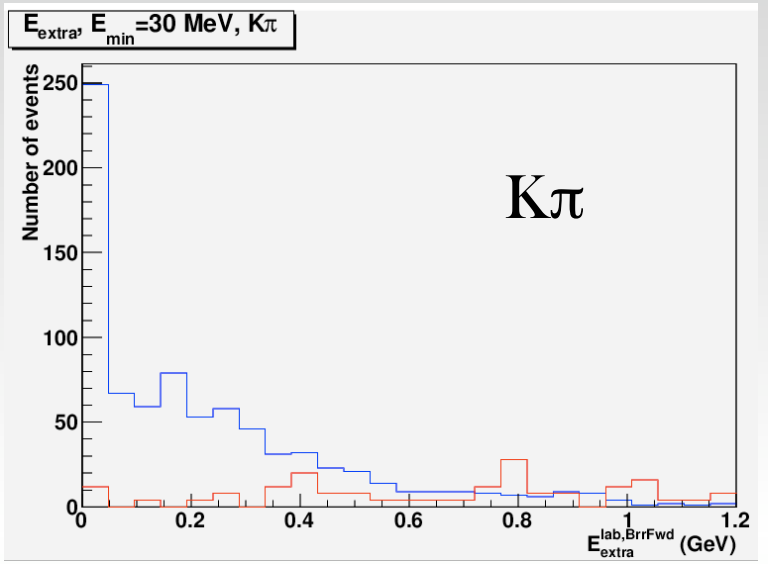
Impact of Bwd EMC
DG_4 cocktail + signal
(no pairs)

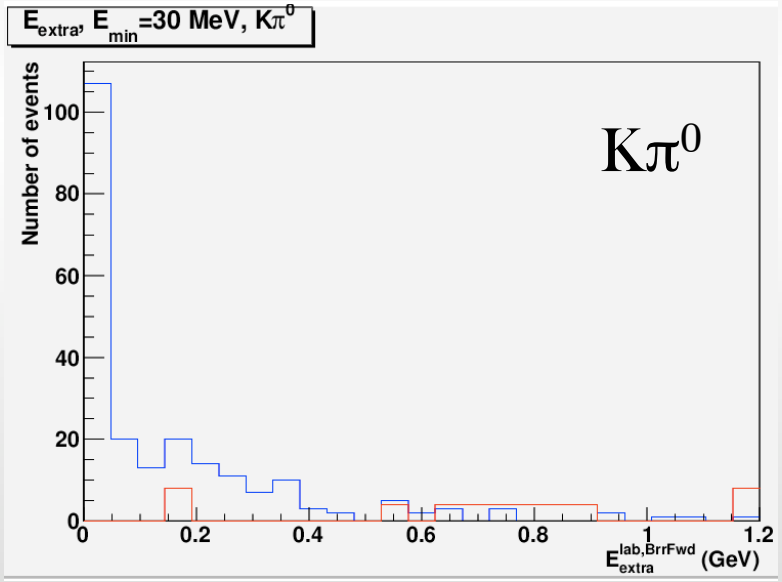
Eextra distributions : barrel + forward

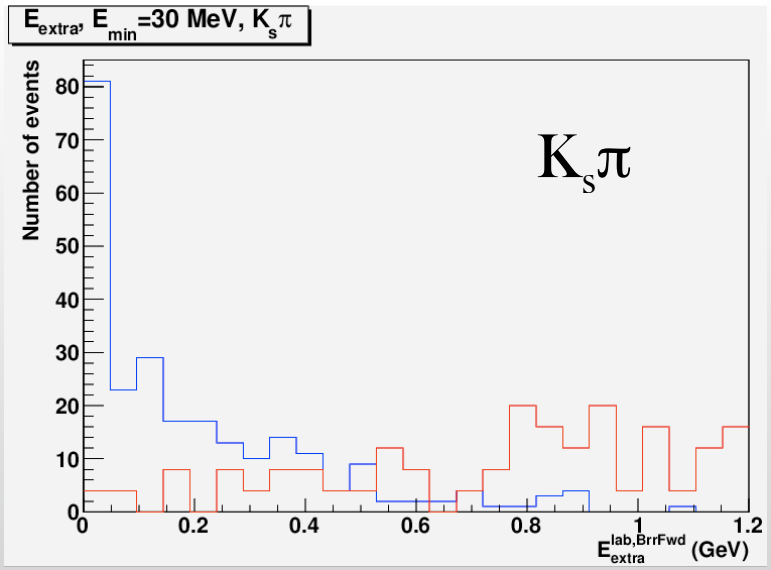
minimum gamma energy = 30 MeV

signal MC

BB cocktail





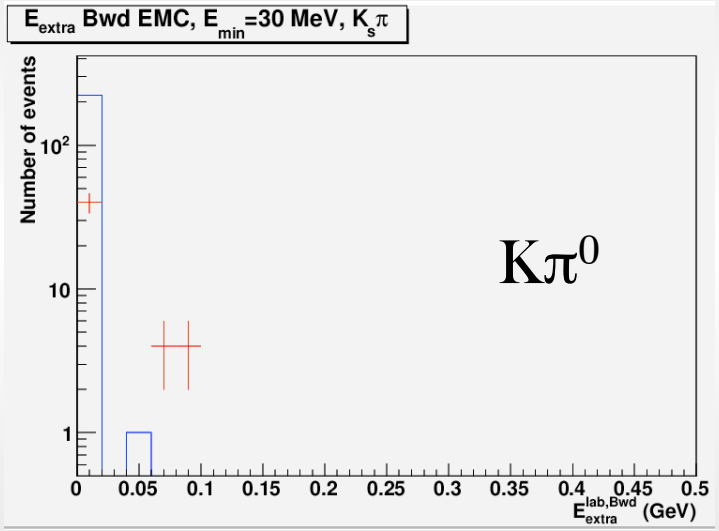


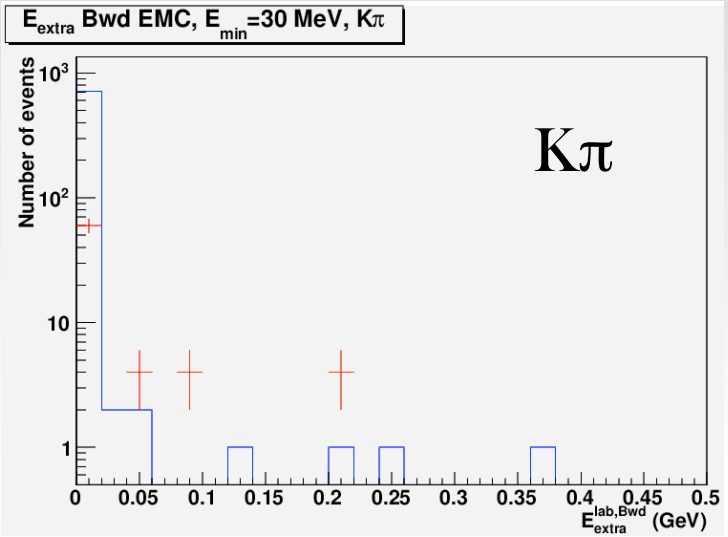
Eextra distributions : backward

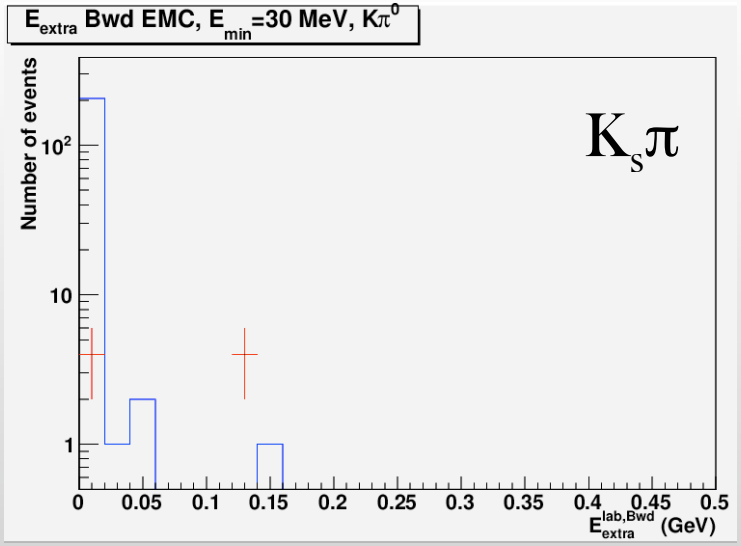
minimum gamma energy = 30 MeV

signal MC

BB cocktail

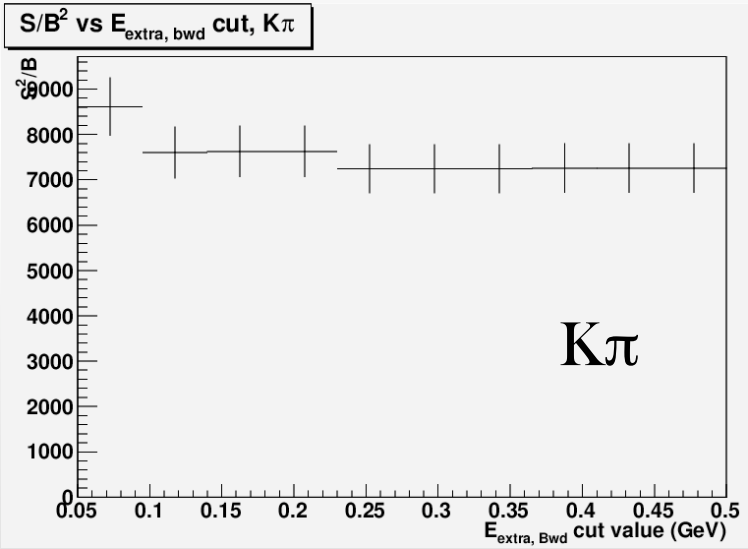


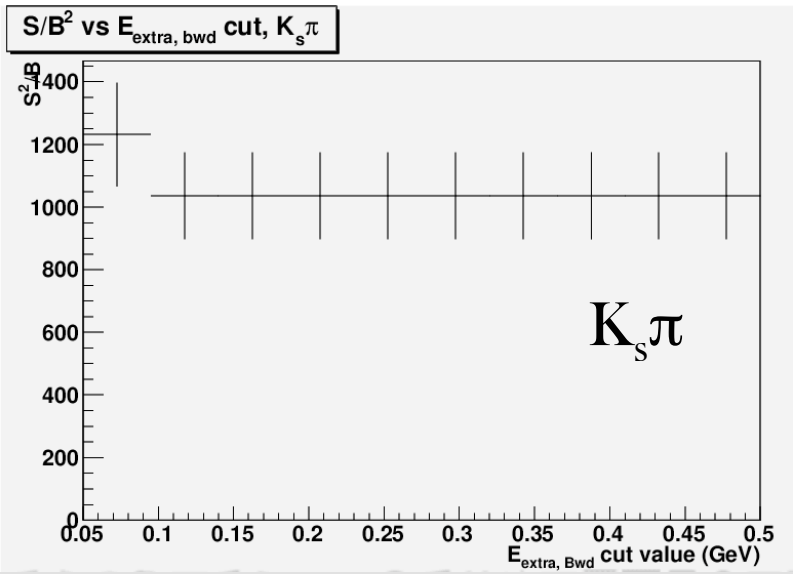




Eextra_bwd cut: optimization

* Strategy:
  - scan the region Eextra_Bwd ∈ [0.05,0.5] GeV and compute FOM = S/sqrt(B)
  - optimal cut ↔ maximum FOM





Eextra_bwd cut: results

* EextraBwd < 0.05 GeV:

$B^0 \to K^{*0}\nu\bar{\nu}$					
Sample	$N_{\rm sel}$	$\varepsilon_{\rm tot}$	$N_{\rm sel,Bwd}$	$\varepsilon_{\rm tot,Bwd}$	$\delta\varepsilon/\varepsilon$
$B^0 \to K^{*0}\nu\bar{\nu}$	727	$(24.8 \pm 0.9) \times 10^{-5}$	719	$(24.2 \pm 0.9) \times 10^{-5}$	(2.4±)%
B^0 had cocktail	76	$(20 \pm 2) \times 10^{-8}$	60	$(16 \pm 2) \times 10^{-8}$	21%
$S/\sqrt{B}$	83 ± 7		93 ± 9		
$B^+ \to K^{*+}(K_z\pi^+)\nu\bar{\nu}$					
Sample	$N_{\rm sel}$	$\varepsilon_{\rm tot}$	$N_{\rm sel,Bwd}$	$\varepsilon_{\rm tot,Bwd}$	$\delta\varepsilon/\varepsilon$
$B^+ \to K^{*+}\nu\bar{\nu}$	223	$(7.1 \pm 0.5) \times 10^{-5}$	217	$(7.0 \pm 0.5) \times 10^{-5}$	1.4%
B^+ had cocktail	48	$(12.0 \pm 1.7) \times 10^{-8}$	40	$(10.0 \pm 1.7) \times 10^{-8}$	17%
$S/\sqrt{B}$	32 ± 4		35 ± 5		

$$\delta\left(\frac{S}{\sqrt{(B)}}\right) = \frac{\left(\frac{S}{\sqrt{(B)}}\right)_{bwd} - \left(\frac{S}{\sqrt{(B)}}\right)_{nobwd}}{\left(\frac{S}{\sqrt{(B)}}\right)_{nobwd}} = \begin{cases} K\pi : (10 \pm 3)\% \\ K_s\pi : (8 \pm 3)\% \end{cases}$$

Impact of material in front of fwd EMC
DG_4a cocktail + signal

π^0 and γ reconstruction

	DG 4	DG 4a
brr π^0 reco eff	$58.76 \pm 0.01\%$	$58.73 \pm 0.01\%$
brr π^0 truth eff	$25.40 \pm 0.01\%$	$25.45 \pm 0.01\%$
fwd π^0 reco eff	$21.81 \pm 0.08\%$	$22.17 \pm 0.08\%$
fwd π^0 truth eff	$36.4 \pm 0.2\%$	$43.8 \pm 0.2\%$
brr γ reco eff	$4.8583 \pm 0.0006\%$	$4.8159 \pm 0.0006\%$
brr γ truth eff	$5.932 \pm 0.003\%$	$5.950 \pm 0.003\%$
fwd γ reco eff	$9.231 \pm 0.004\%$	$9.213 \pm 0.004\%$
fwd γ truth eff	$7.14 \pm 0.01\%$	$7.20 \pm 0.01\%$

* more on π^0 mass resolution and gamma energy resolution @ tomorrow EMC session

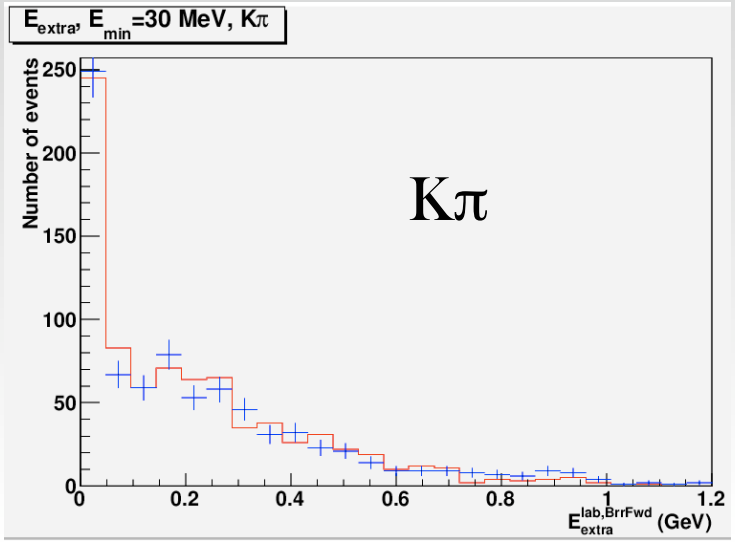
Impact on physics results (I)

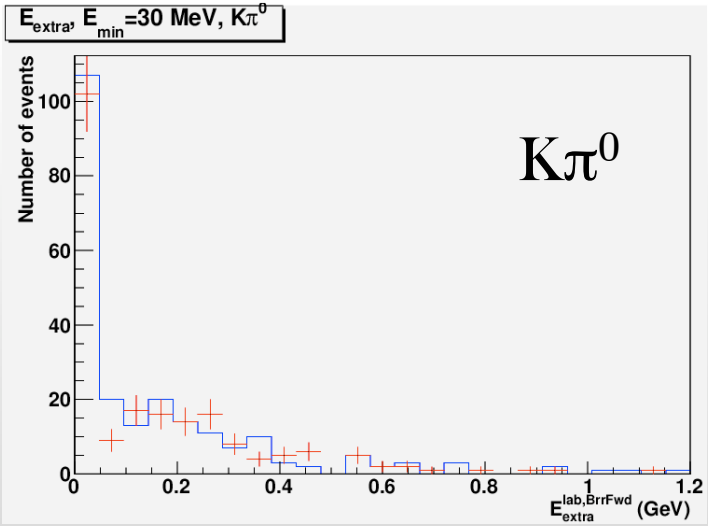
* Eextra barrel + forward distributions, before Eextra cut

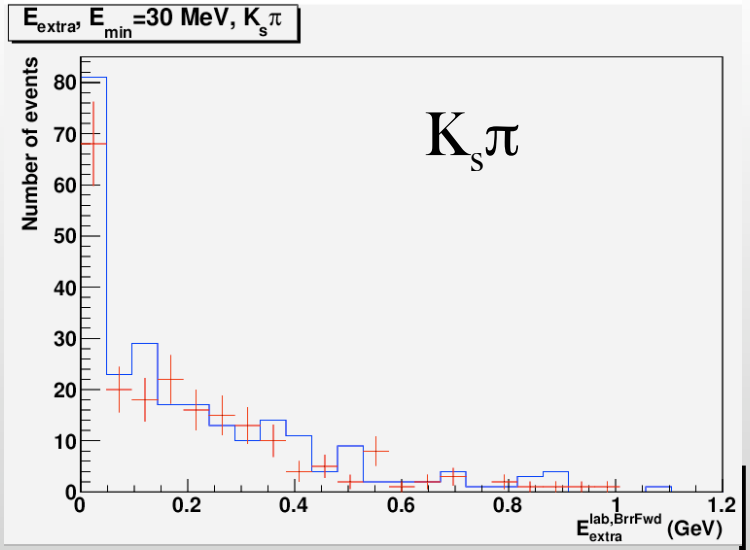
minimum gamma energy = 30 MeV

DG_4 signal MC

DG_4a signal MC





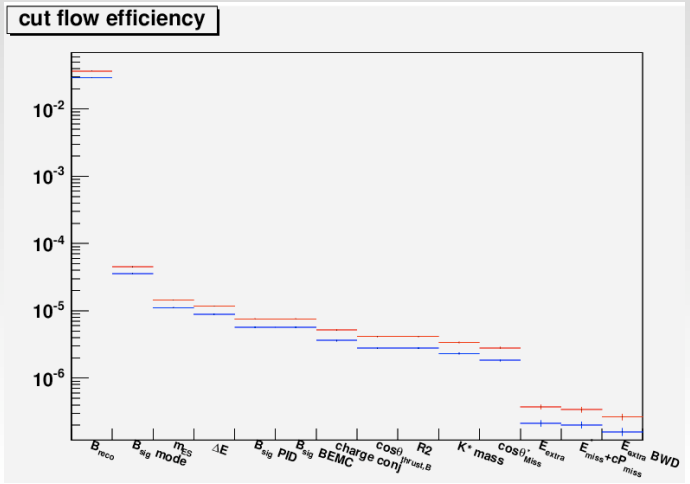


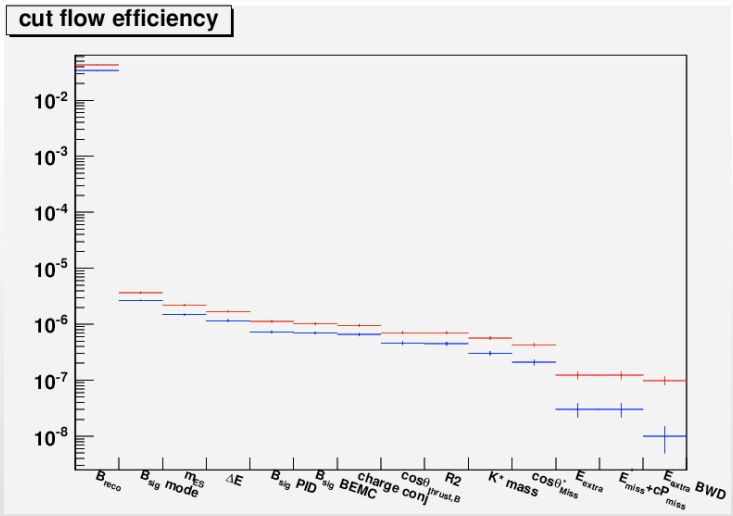
Impact on physics results (II)

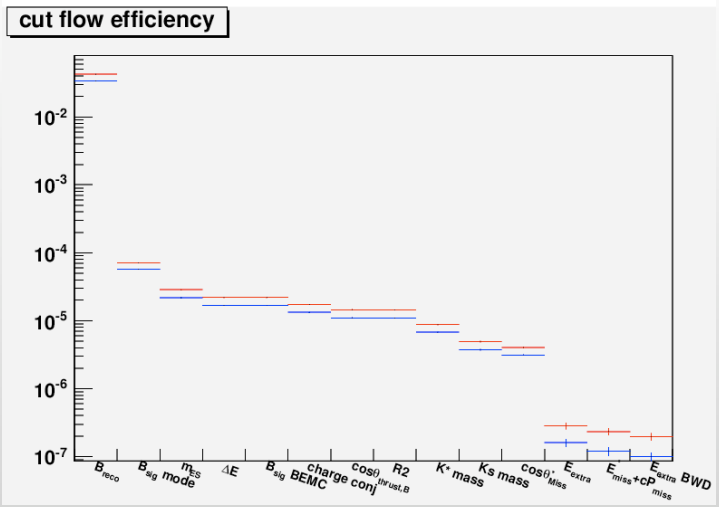
DG_4 signal MC

DG_4a signal MC

* cut flow efficiency: DG_4 and DG_4a consistent within statistical error







Conclusions

Conclusion

* DG studies performed using September_2010 Production

* FWD PID:
  - gain on Breco reconstruction around 3%
  - gain when applying PID requirements on the signal side around 2-4%
  - total gain is expected to be 3% + 2-4% but selection cuts reduce the overall gain (some sanity check needed)

* BWD EMC
  - preliminary studies indicates a 10% enhancement in the FOM when applying the Eextra_bwd cut

* EFFECT OF MATERIAL IN FRONT OF FWD EMC
  - 1.5% loss in π^0 efficiency reconstruction, gamma reconstruction efficiency almost unchanged
  - physics performances doesn't seem to change on signal MC
  - more will be discussed at tomorrow EMC session

Back-up slides

PacHadRecoilUser code

* SemiExclusive reconstruction of Hadronic B modes

$B \to DX$

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

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

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

$X = n\pi + mK + rK^0_S + q\pi^0$
$n+m+r+q<6$

* limit the number of reconstructed Breco channels
  - reconstruct only modes with purity >50%
  - generate ad-hoc BB cocktail sample instead of generic

* Available Bsig modes
  - $K^*\nu\nu$
  - $K\nu\nu$, $K_s(\pi\pi)\nu\nu$
  - $\tau\nu$, with $\tau \to e\nu\nu$, $\mu\nu\nu$, $\pi\nu$, $\rho(\pi\pi^0)\nu$, $a_1(\rho\pi)\nu$