B→K*νν HAD tag vs bwd EMC and fwd PID

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Outline

* samples and DG configuration from September production
* impact of fwd PID in Breco and Breco+Bsig selection efficiencies
* impact of bwd EMC used as a veto
* validation and other to-do-lits items

PacHadRecoilUser code

* SemiExclusive reconstruction of Hadronic B modes

$B \to DX$

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

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

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

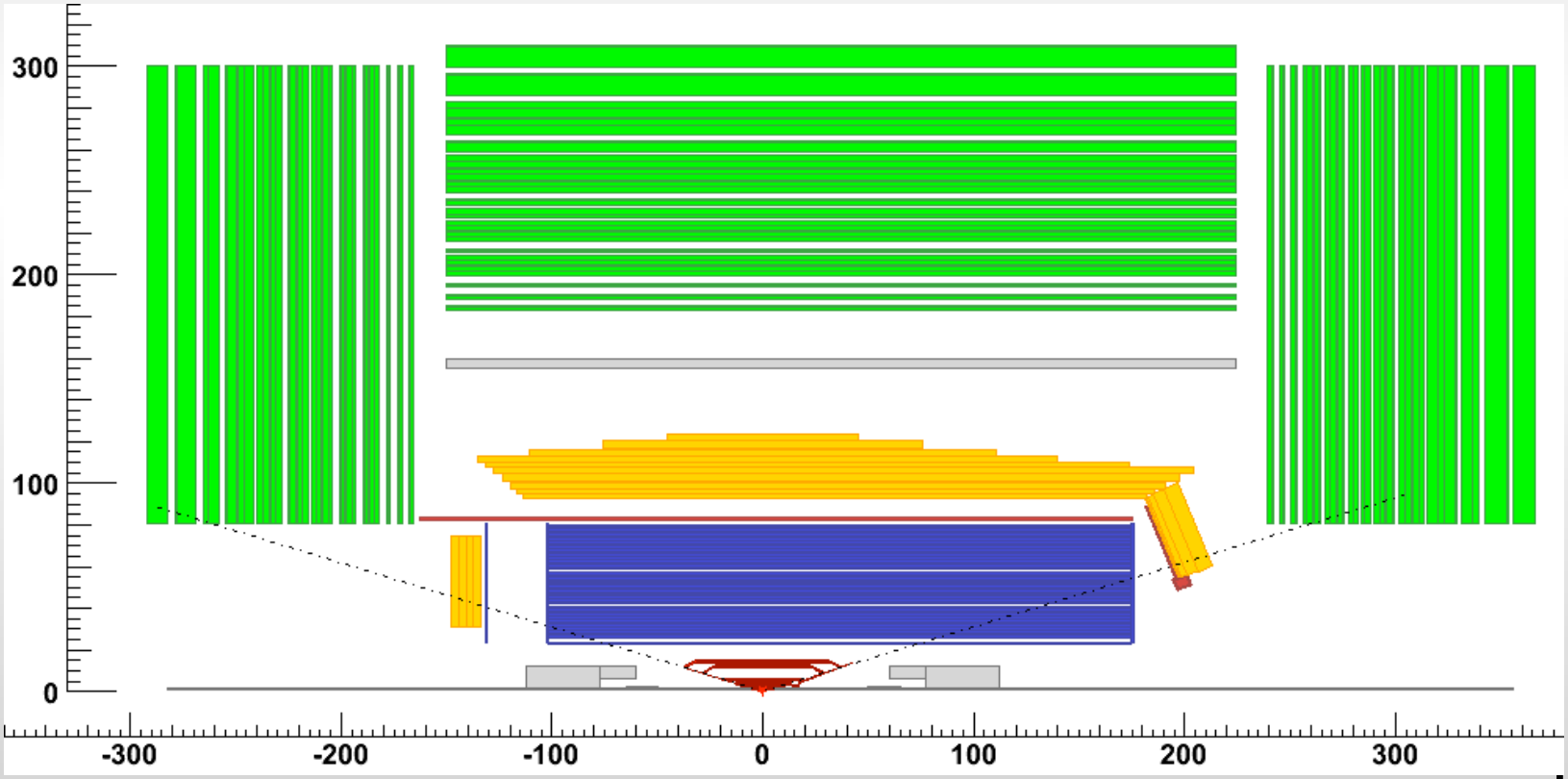
$X = n\pi + mK + rK^0_S + q\pi^0$
$n+m+r+q<6$

* 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 $\tau \to e\nu\nu$, $\mu\nu\nu$, $\pi\nu$, $\rho(\pi\pi^0)\nu$, $a_1(\rho\pi)\nu$

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_February production, FastSim release V0.2.5, revs 307 and 311

Sample	geometry	Bkg conditions	$N_{\text{events}}^{\text{analyzed}}(10^6)$
$B^0 \to K^{*0}\nu\bar{\nu}$ vs generic B^0	DG 4	nopairs	3,00
$B^+ \to K^{*+}\nu\bar{\nu}$ vs generic B^+	DG 4	nopairs	3,00
B^0 hadronic cocktail vs generic B^0	DG 4	nopairs	$^{(*)}$313,92
B^+ hadronic cocktail vs generic B^+	DG 4	nopairs	$^{(*)}$378,08

* additive samples (generics), DG (DG_4a), and bkg conditions available (some ready some coming soon) and to be analyzed
* DG_BaBar ntuples analyzed to validate production (see talk @yesterday FastSim session)

$^{(*)}$ 50% of the requested samples

Analysis strategy

* Baseline analysis
  - DG_4 with Fwd TOF switched on and Bwd EMC switched off
  - Kaons form Bsig and Breco: likelihood based selectors TightLHKaonTOFSelection

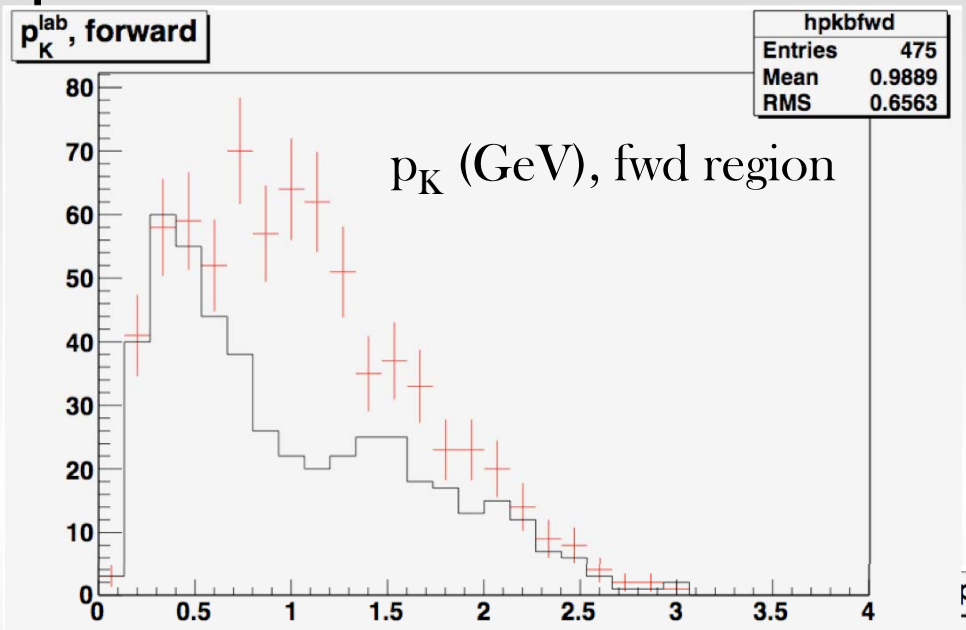
* impact of Fwd TOF:
  - DG_4 with Fwd TOF switched off and Bwd EMC switched off
  - Kaons form Bsig and Breco: likelihood based selectors TightLHKaonSelection

* impact of Bwd EMC:
  - DG_4 with Fwd TOF switched on and Bwd EMC switched on
  - cut on Eextra deposited in bwd EMC (+ usual cut on Eextra measured from Barrel+Fwd)

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

Impact of Fwd PID

Kaon momentum distribution



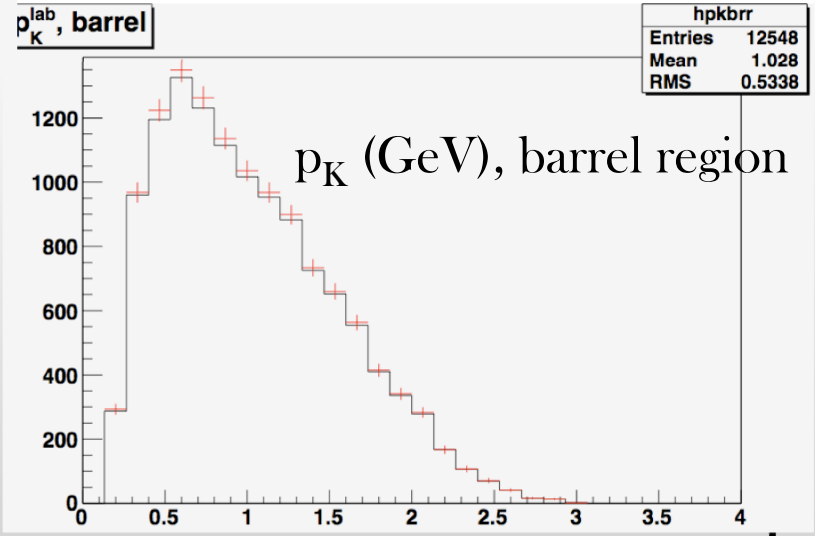
$B^0 \to K^{*0}\nu\nu$ signal sample

black : DCH only

red: DCH+TOF

All Kaons in the event (from Bsig, Btag, and Dtag)

Lab Frame



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

$(\delta\varepsilon/\varepsilon)_{\text{Breco,sel}} = (2.38 \pm 0.20)\%$

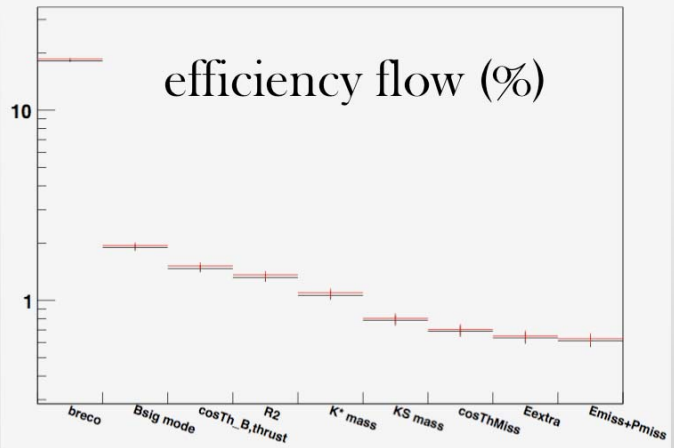
	$B^+ \to K^{*+}(K_S\pi^+)\nu\bar{\nu}$	
	DCH	DCH+TOF
B_{reco} sel	5779 ± 76	5920 ± 77
B_{sig} mode	603 ± 25	618 ± 25
$cos\theta_{B,thrust}$	468 ± 22	483 ± 22
R_2	419 ± 20	433 ± 21
m_{K^*}	338 ± 18	349 ± 19
m_{K_S}	250 ± 16	256 ± 16
$cos\theta^*_{miss}$	219 ± 15	224 ± 15
E^{BrrFwd}_{extra}	202 ± 14	207 ± 14
$E_{miss} + cp_{miss}$	195 ± 14	200 ± 14

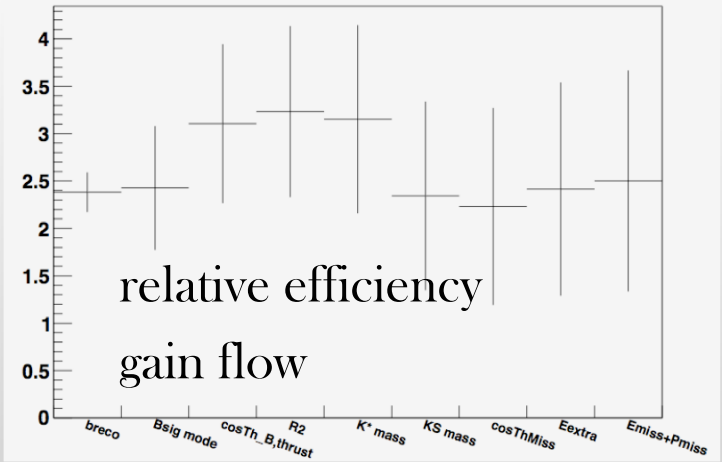
$(\delta\varepsilon/\varepsilon) = (2.5 \pm 1.1)\%$

$(\delta\varepsilon/\varepsilon)_{\text{Breco,sel}} = (2.430 \pm 0.008)\%$

	B^+B^-	
	DCH	DCH+TOF
B_{reco} sel	3990270 ± 1998	4089600 ± 2022
B_{sig} mode	6588 ± 81	6765 ± 82
$cos\theta_{B,thrust}$	5418 ± 74	5564 ± 75
R_2	4609 ± 68	4744 ± 69
m_{K^*}	2830 ± 53	2908 ± 54
m_{K_S}	1530 ± 39	1563 ± 39
$cos\theta^*_{miss}$	1156 ± 34	1177 ± 34
E^{BrrFwd}_{extra}	74 ± 9	73 ± 8
$E_{miss} + cp_{miss}$	50 ± 7	51 ± 7

signal sample





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

$(\delta\varepsilon/\varepsilon)_{\text{Breco,sel}} = (2.38 \pm 0.20)\%$

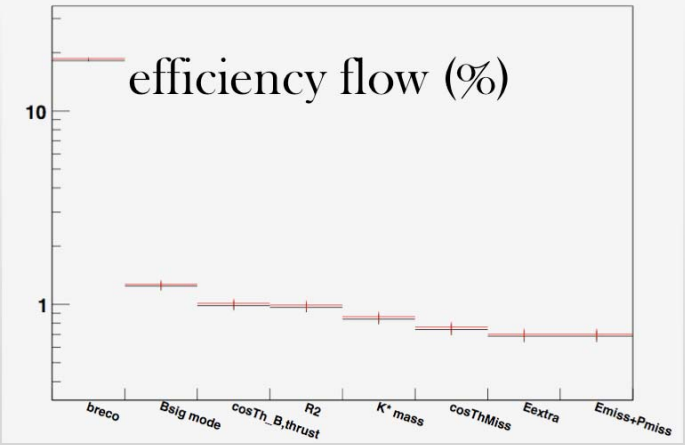
	$B^+ \to K^{*+}(K^+\pi^0)\nu\bar{\nu}$	
	DCH	DCH+TOF
B_{reco} sel	5779 ± 76	5920 ± 77
B_{sig} mode	395 ± 20	404 ± 20
$cos\theta_{B,thrust}$	314 ± 18	322 ± 18
R_2	307 ± 17	315 ± 18
m_{K^*}	267 ± 16	275 ± 16
$cos\theta^*_{miss}$	236 ± 15	243 ± 16
E^{BrrFwd}_{extra}	218 ± 15	223 ± 15
$E_{miss} + cp_{miss}$	218 ± 14	223 ± 15

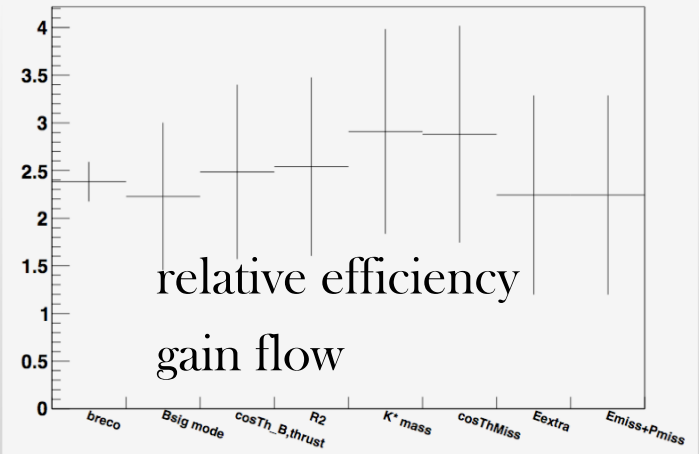
$(\delta\varepsilon/\varepsilon) = (2.2 \pm 1.0)\%$

$(\delta\varepsilon/\varepsilon)_{\text{Breco,sel}} = (2.430 \pm 0.008)\%$

	B^+B^-	
	DCH	DCH+TOF
B_{reco} sel	3990270 ± 1998	4089600 ± 2022
B_{sig} mode	480 ± 22	488 ± 22
$cos\theta_{B,thrust}$	380 ± 19	387 ± 19
R_2	370 ± 19	377 ± 19
m_{K^*}	283 ± 17	289 ± 17
$cos\theta^*_{miss}$	172 ± 13	175 ± 13
E^{BrrFwd}_{extra}	36 ± 6	38 ± 6
$E_{miss} + cp_{miss}$	36 ± 6	38 ± 6

signal sample





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

$(\delta\varepsilon/\varepsilon)_{\text{Breco,sel}} = (2.67 \pm 0.22)\%$

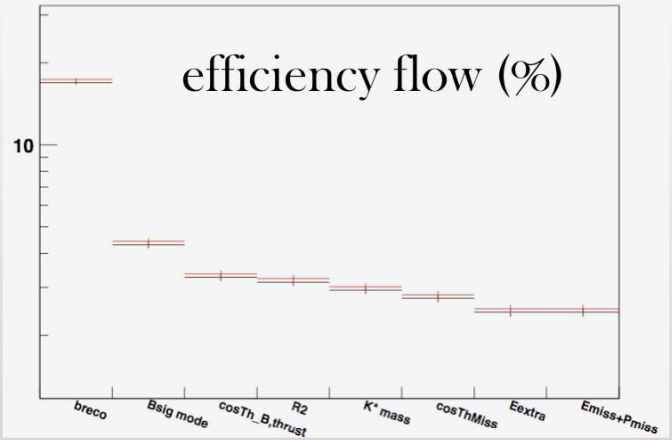
	$B^0 \to K^{*0}\nu\bar{\nu}$	
	DCH	DCH+TOF
B_{reco} sel	5071 ± 71	5210 ± 72
B_{sig} mode	1288 ± 36	1328 ± 36
$cos\theta_{B,thrust}$	980 ± 31	1008 ± 32
R_2	941 ± 31	969 ± 31
m_{K^*}	880 ± 30	906 ± 30
$cos\theta^*_{miss}$	821 ± 29	845 ± 29
E^{BrrFwd}_{extra}	729 ± 27	750 ± 27
$E_{miss} + cp_{miss}$	729 ± 27	750 ± 27

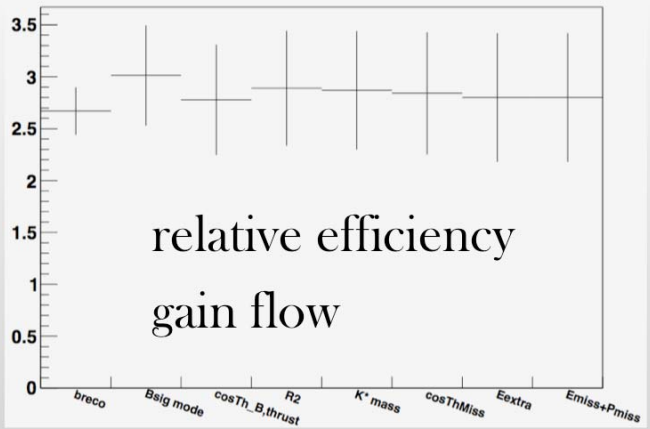
$(\delta\varepsilon/\varepsilon) = (2.8 \pm 0.6)\%$

$(\delta\varepsilon/\varepsilon)_{\text{Breco,sel}} = (2.401 \pm 0.010)\%$

	$B^0\bar{B}^0$	
	DCH	DCH+TOF
B_{reco} sel	2499820 ± 1581	2560670 ± 1600
B_{sig} mode	2312 ± 48	2358 ± 49
$cos\theta_{B,thrust}$	1840 ± 42	1871 ± 43
R_2	1704 ± 41	1733 ± 42
m_{K^*}	1410 ± 37	1434 ± 38
$cos\theta^*_{miss}$	1052 ± 32	1068 ± 33
E^{BrrFwd}_{extra}	108 ± 10	108 ± 10
$E_{miss} + cp_{miss}$	105 ± 10	105 ± 10

signal sample

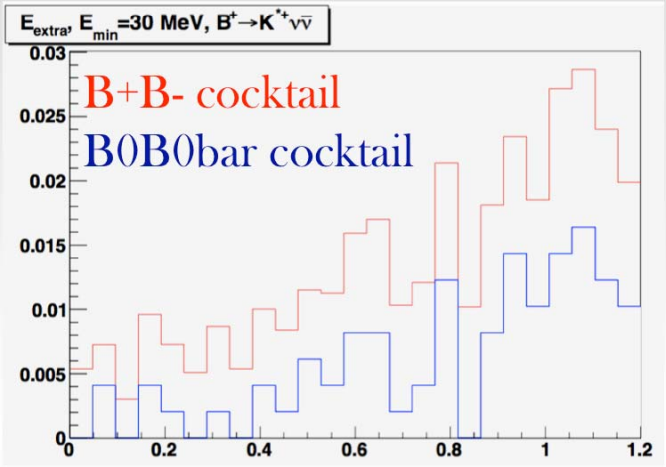


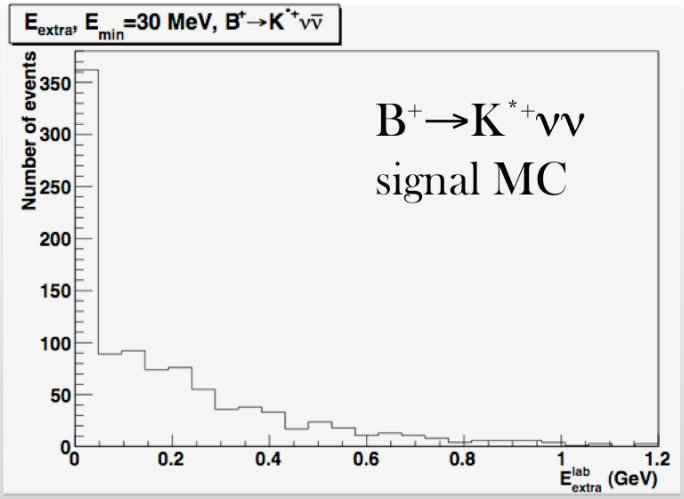


Impact of Bwd EMC

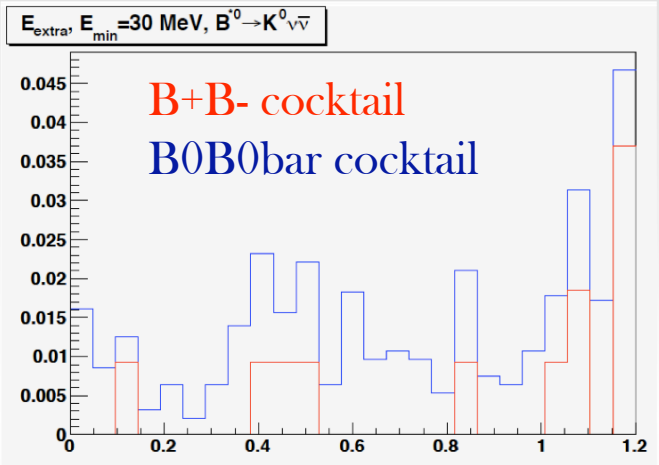
Eextra_brrfwd before Bsig selection (I)

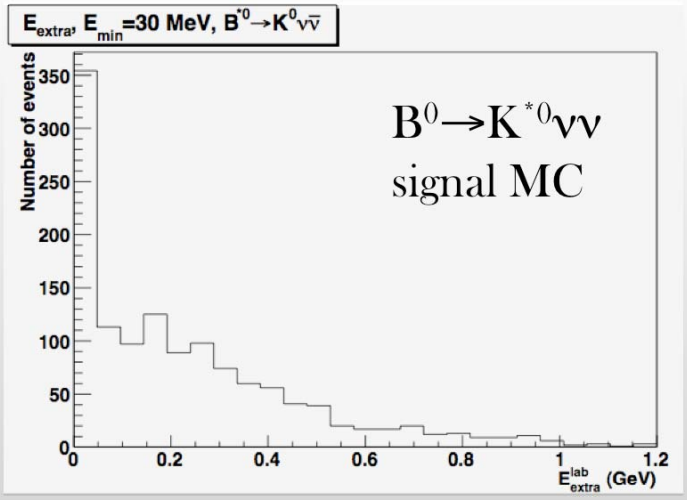
* $B^+ \to K^{*+}\nu\nu$ selection





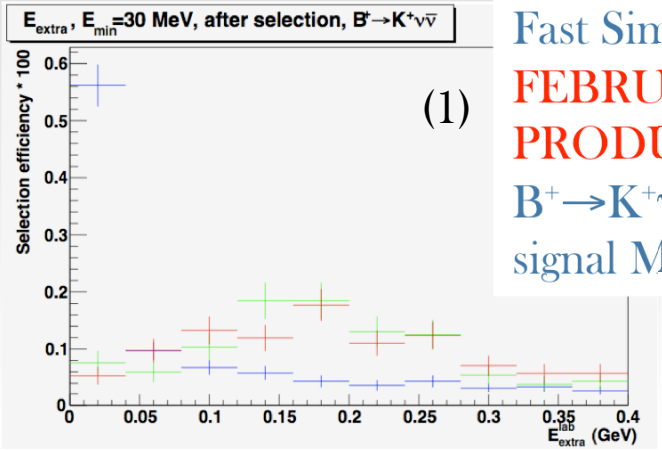
* $B^0 \to K^{*0}\nu\nu$ selection





Eextra_brrfwd before Bsig selection (II)

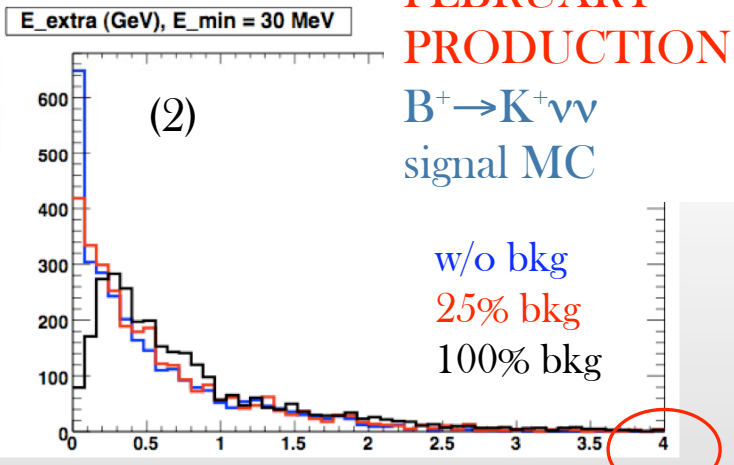
* evolution of Eextra distribution from February to Summer production



(1)

Fast Sim
FEBRUARY PRODUCTION
$B^+ \to K^+ \nu\nu$
signal MC

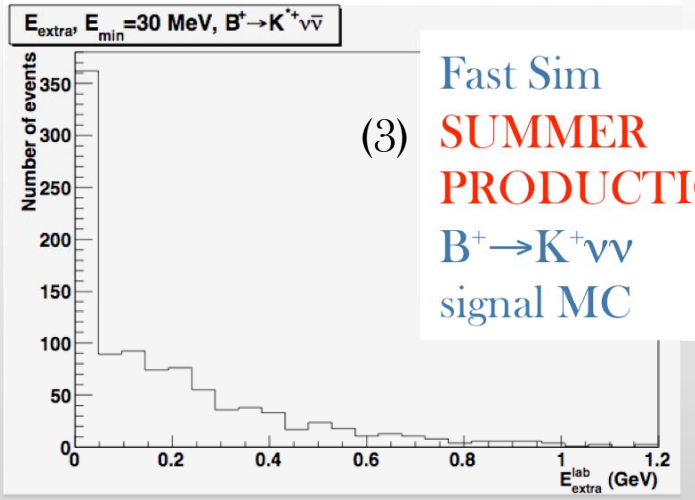
← 4 times the expected machine bkg; reducing amount of bkg photons by hand we expect...



(2)

Fast Sim
FEBRUARY PRODUCTION
$B^+ \to K^+ \nu\nu$
signal MC

w/o bkg
25% bkg
100% bkg



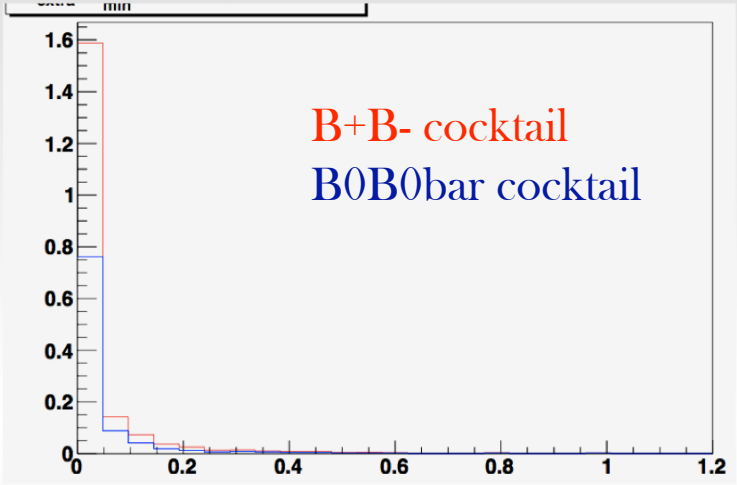
(3)

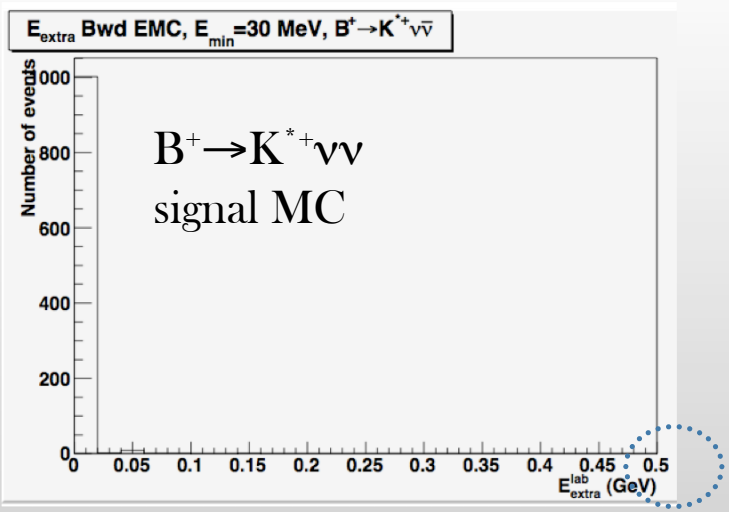
Fast Sim
SUMMER PRODUCTION
$B^+ \to K^+ \nu\nu$
signal MC

← ...and in the summer production we obtain

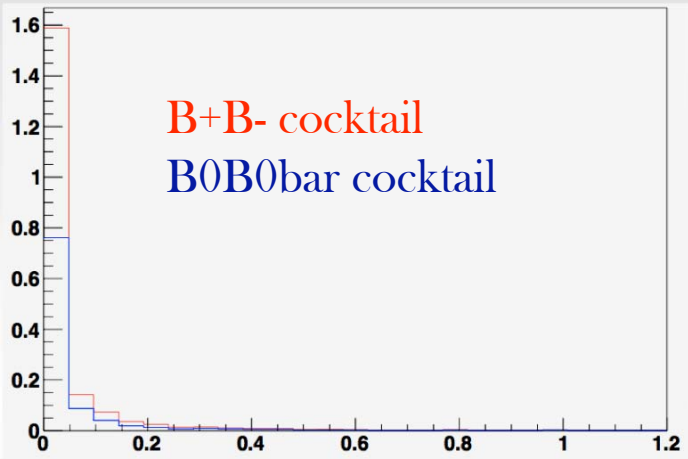
Eextra_bwd before the selection

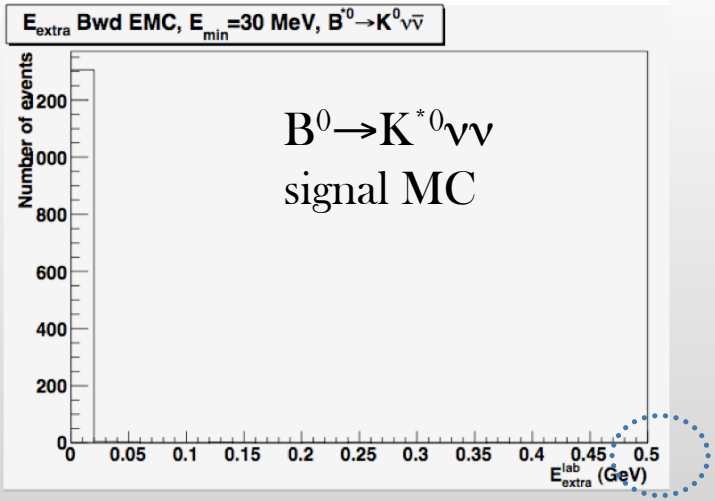
* $B^+ \to K^{*+}\nu\nu$ selection





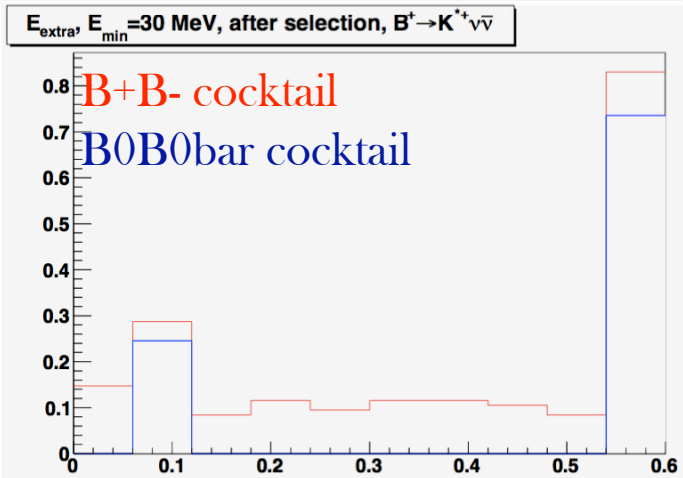
* $B^0 \to K^{*0}\nu\nu$ selection

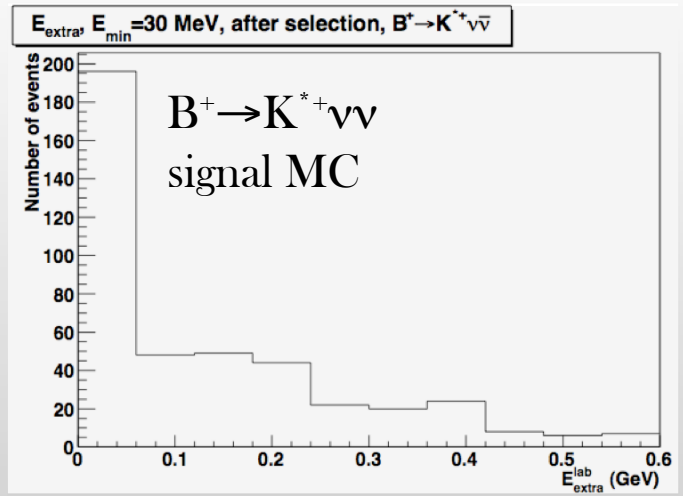




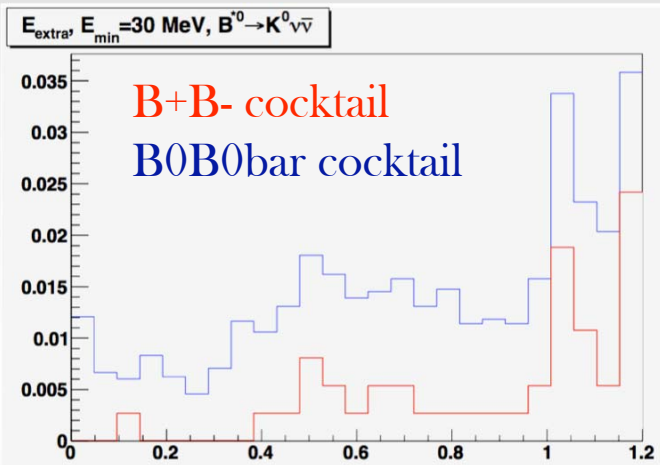
Eextra_brrfwd after selection

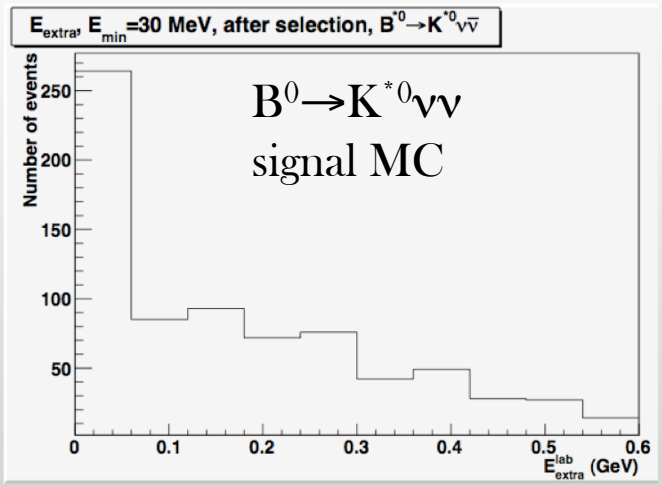
* $B^+ \to K^{*+}\nu\bar{\nu}$ selection





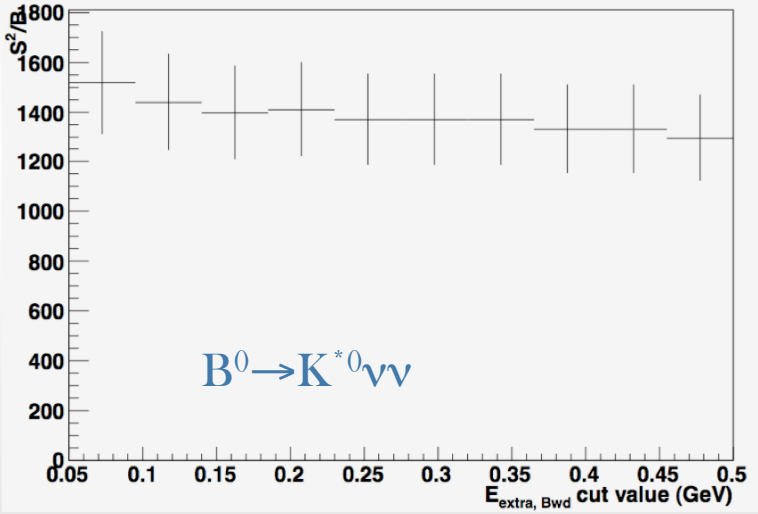
* $B^0 \to K^{*0}\nu\nu$ selection

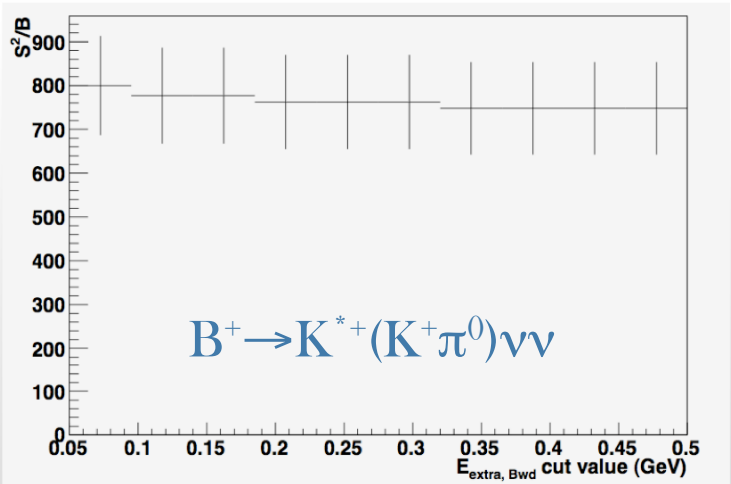




Eextra_bwdEMC cut: optimization

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





Eextra_bwdEMC cut: results

* EextraBwd < 0.05 GeV:

$B^0 \to K^{*0}\nu\bar{\nu}$					
Sample	$N_{\rm sel}$	$\varepsilon_{\rm tot}$	$N_{\rm sel,Bwd}$	$\varepsilon_{\rm tot,Bwd}$	$\delta\varepsilon/\varepsilon$
$B^0 \to K^{*0}\nu\bar{\nu}$	750	$(25.0 \pm 0.9) \times 10^{-5}$	742	$(24.7 \pm 0.5) \times 10^{-5}$	1.2%
B^0 had cocktail	105	$(33 \pm 3) \times 10^{-8}$	92	$(29 \pm 3) \times 10^{-8}$	12%
$S/\sqrt{B}$	73		77		
$B^+ \to K^{*+}(K^+\pi^0)\nu\bar{\nu}$					
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	$(7.0 \pm 0.5) \times 10^{-5}$	217	$(6.8 \pm 0.5) \times 10^{-5}$	2.8%
B^+ had cocktail	38	$(10.0 \pm 1.6) \times 10^{-8}$	31	$(8.2 \pm 1.5) \times 10^{-8}$	18%
$S/\sqrt{B}$	36		39		

$$\delta\left(\frac{S}{\sqrt{(B)}}\right) = \frac{\left(\frac{S}{\sqrt{(B)}}\right)_{bwd} - \left(\frac{S}{\sqrt{(B)}}\right)_{nobwd}}{\left(\frac{S}{\sqrt{(B)}}\right)_{nobwd}} =$$

$(5.4 \pm 1.9)\%$
$B^0 \to K^{*0}\nu\bar{\nu}$

$(7.2 \pm 4.1)\%$
$B^+ \to K^{*+}(K^+\pi^0)\nu\bar{\nu}$

Conclusion

* Preliminary studies on September_2010 Production for DGWG purposes
  - also some results on validation have been discussed

* FWD PID: gain on Breco and Bsig efficency ~ 2-3%
  - thigh likelihood based selector applied
  - need to repeat the study with full available sample and bkg configuration
  - some issues to be understood

* BWD EMC
  - preliminary studies indicates a 5-7% enhancement in the FOM when applying the Eextra_bwd cut

To do list

* Work to be done before considering the results as "final"

  - complete validation with additional DG_BaBar events, understand if "FastSim-effects" may affect detector performances estimation

  - study systematic effects due to the usage of Hadronic Breco cocktail in place of BB generic

  - repeat the analysis with the full sample and the full bkg simulation

  - tune analysis cuts: variable distributions may have changed wrt BaBar due different machine condition

  - study impact of fwd TOF material on the Fwd EMC performances (DG_4a)

Many Thanks to Luca, Armando and all the DCG

Back-up slides