Had Breco analysis: Eextra studies and bkg characterization

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Outline

* Eextra studies
  - Checks and validation
  - updated results
  - conclusions

* Bkg studies
  - BaBar experience
  - SuperB preliminary results (BB generic sample w and w/o bkg)
  - (preliminary) conclusions

* to do lists

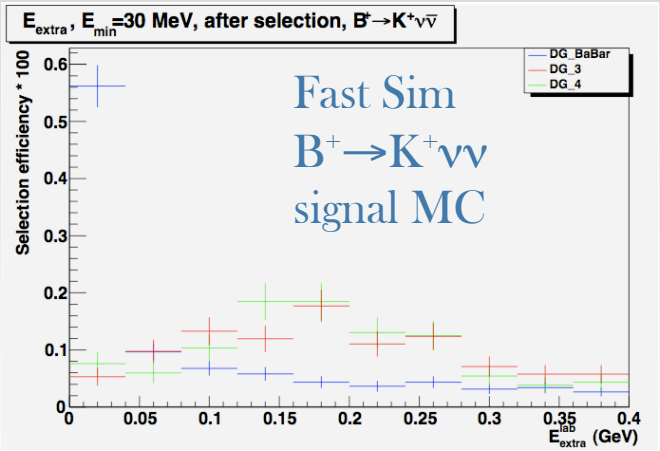
Eextra studies

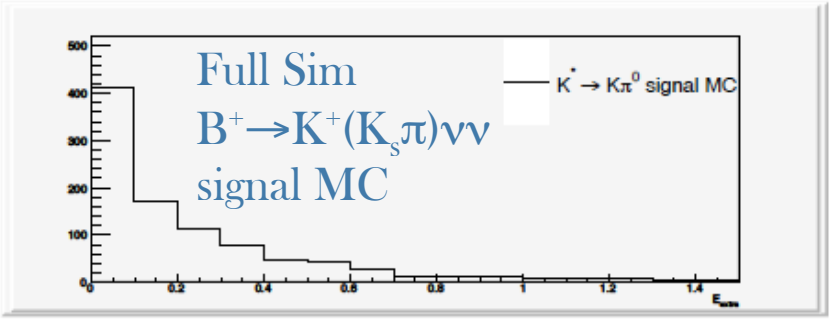
Eextra shape and background mixing

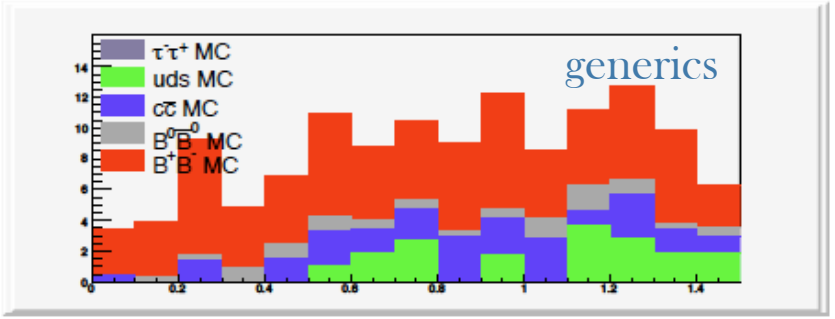
February production analysis:

* background (radiative BhaBha) dramatically increase the number of reconstructed neutrals → in signal MC Eextra shifts at high values, loosing the bin 0 discriminating power

* in this production, not enough generic statistics with background in, to study the bkg Eextra shape (probably shifted → need to enlarge the signal region to be more discriminant)







Analysis strategy

* February production tuples: background mixing switched on, will use:
  - $B^+ \to K^+ \nu\nu$ signal MC
  - B+B- and B0B0bar generic MC

* results shown at past meetings: Eextra computed at reconstruction level, $E_{\gamma min}$=30 MeV

* current study: compute Eextra at ntuple level (gamma block)
  - remove gammas overlapping with Breco or Bsig
  - sum extra-gamma energy if $E_\gamma > E_{\gamma min}$

* ¼ background scaling
  - use February production tuples with bkg mixing
  - identify gammas from background by using mctruth infos
  - associate to each extra-gamma (in the barrel emc) a random number $\in$ [0,1]
  - if randnum>0.25, reject the extra-gamma , otherwise use it to compute Eextra

Offline Eextra computation

* not perfect matching between Eextra's computed at reconstruction level and offline

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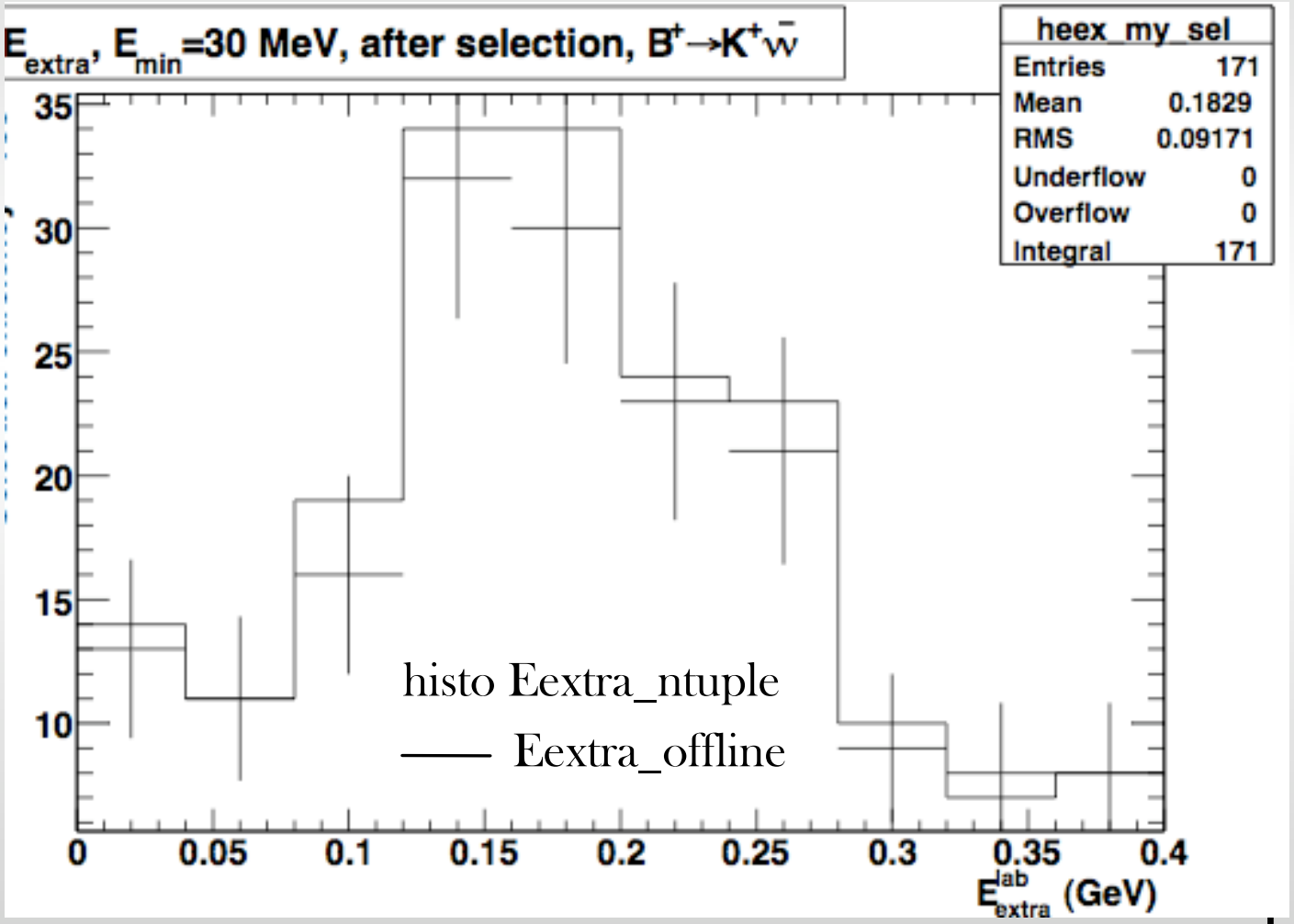

Sources of disagreement

1. some minor code issues
2. emc coverage ($\cos\theta_{lab}$) :
   - FastSim and FullSim bwd [-0.9782, -0.8965], brr+fwd [-0.777,0.9625]
   - PacHadRecoilUser bwd [-0.9655,-0.8581], brr+fwd [-0.7859,0.9622]

   → apply same $\cos\theta_{lab}$ cuts as in PacHadRecoilUser
3. duplicate candidates: at ntuple level the i^{th} Y cand owns the UsrVariables (mES, ΔE, Eextra...) of the first

   → choose the first Y as best candidate

Sources of disagreement

1. some minor code issues
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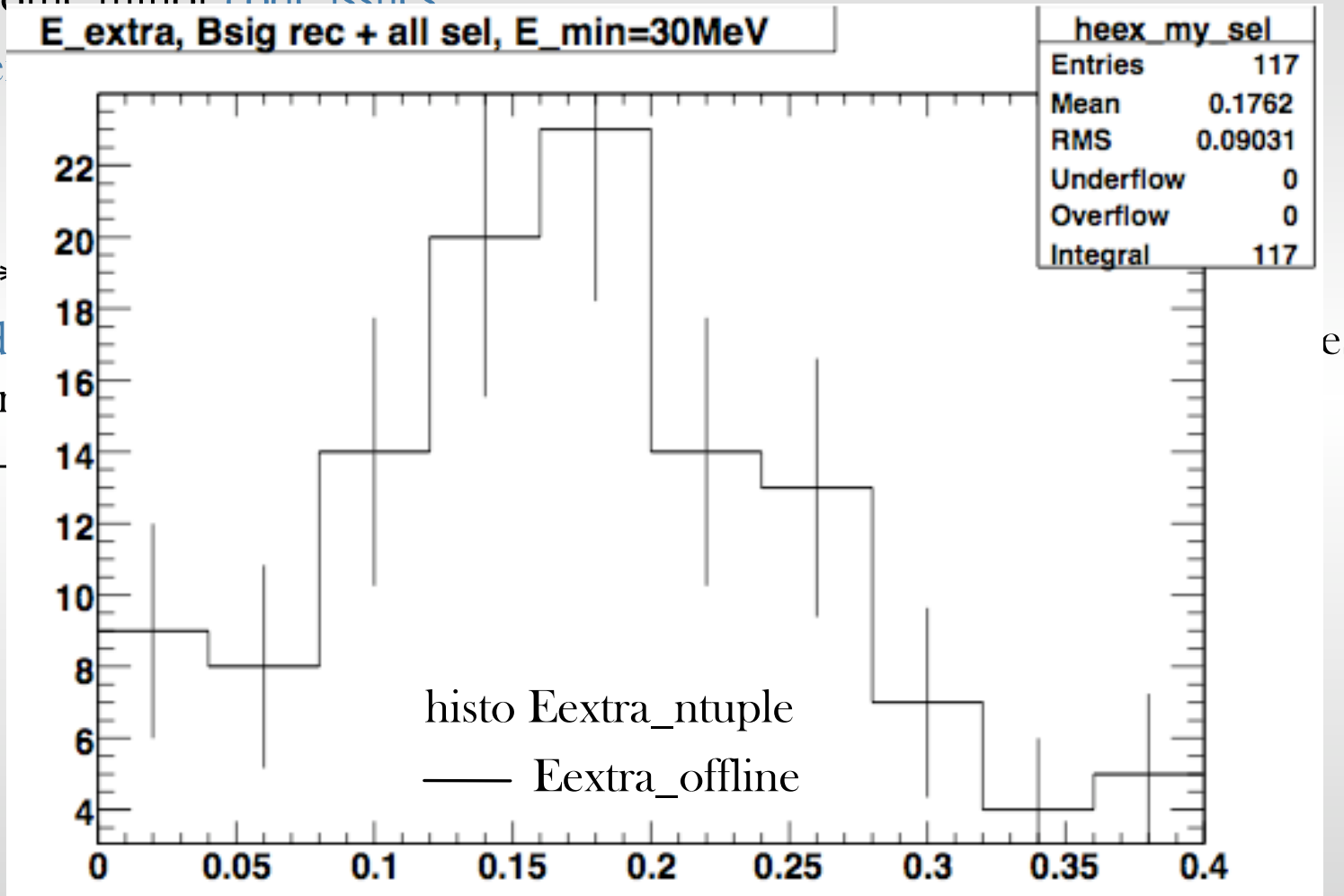
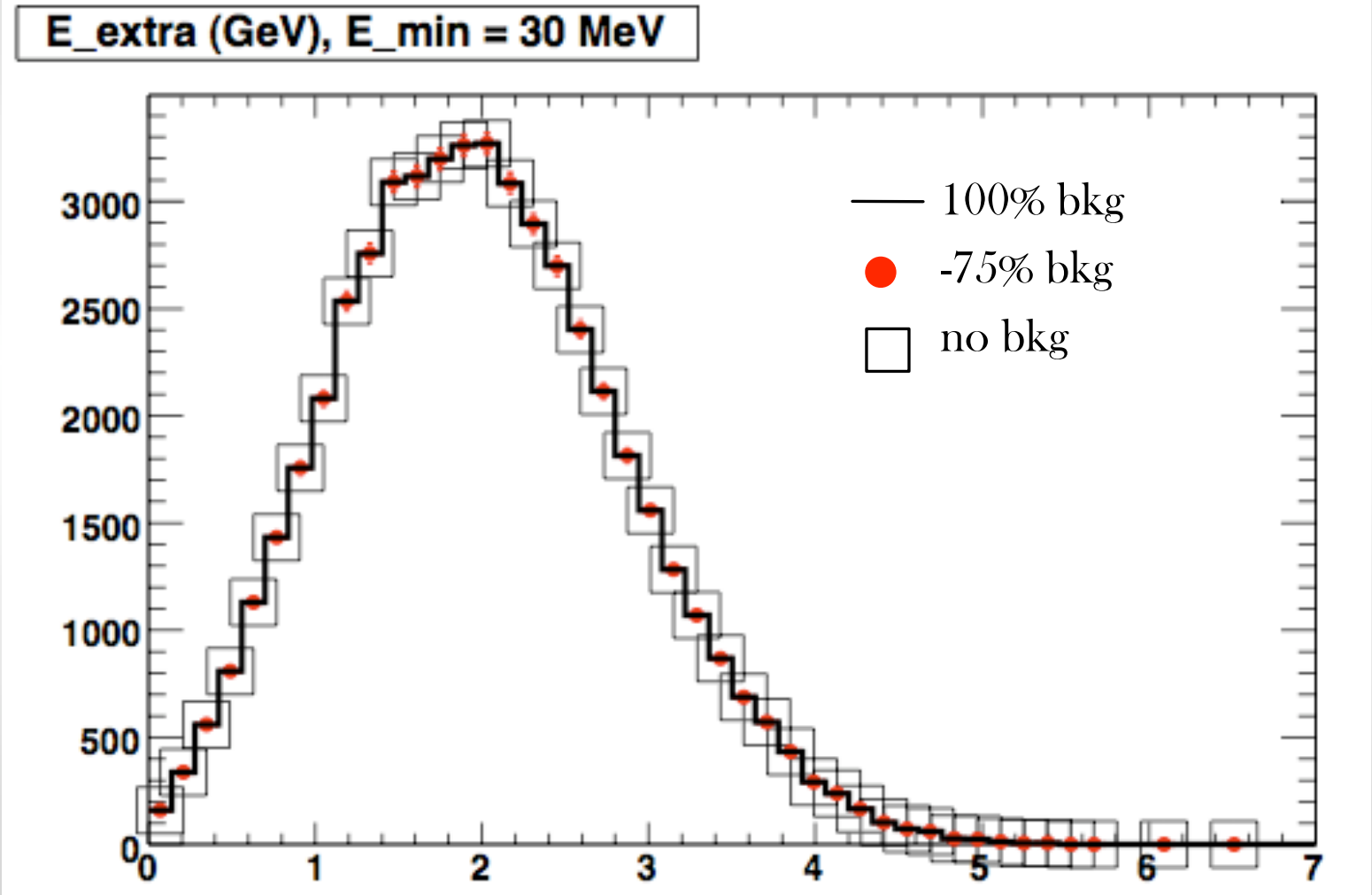


Scaling algorithm validation

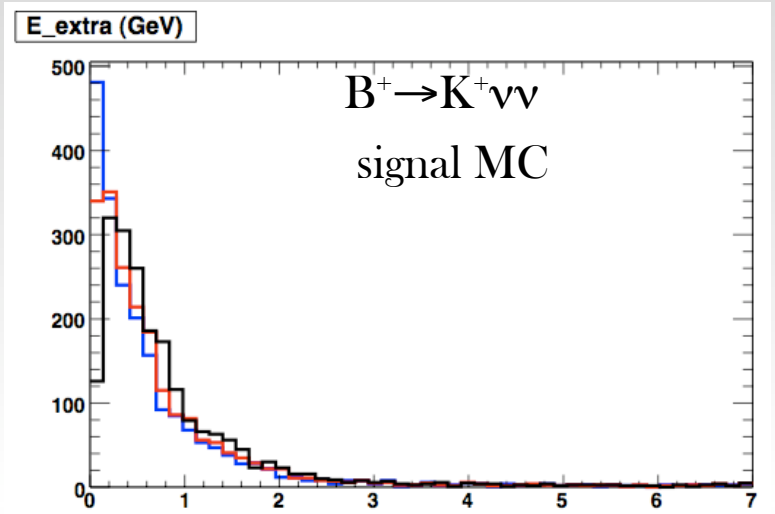
* B+B-_generic sample, without bkg mixing

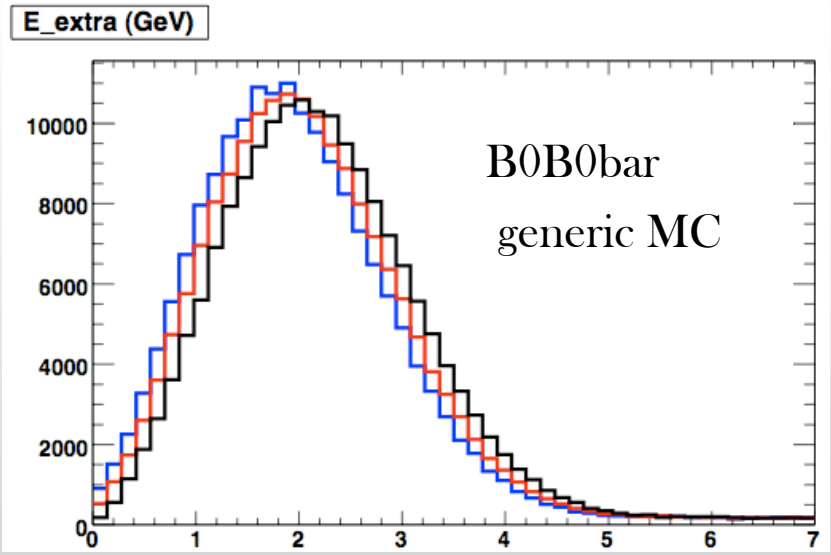


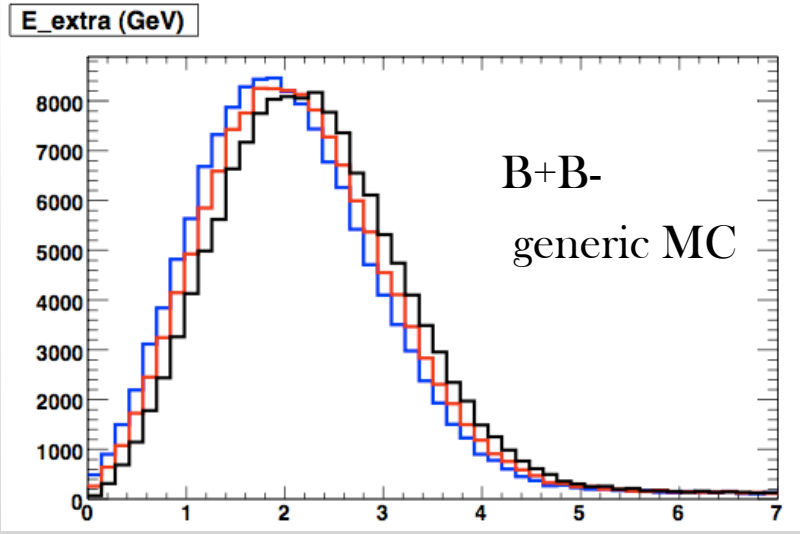
Eextra as a function of $E_{\gamma min}$

* 100% background

$E_{\gamma min}$ = 70 MeV
$E_{\gamma min}$ = 50 MeV
$E_{\gamma min}$ = 30 MeV

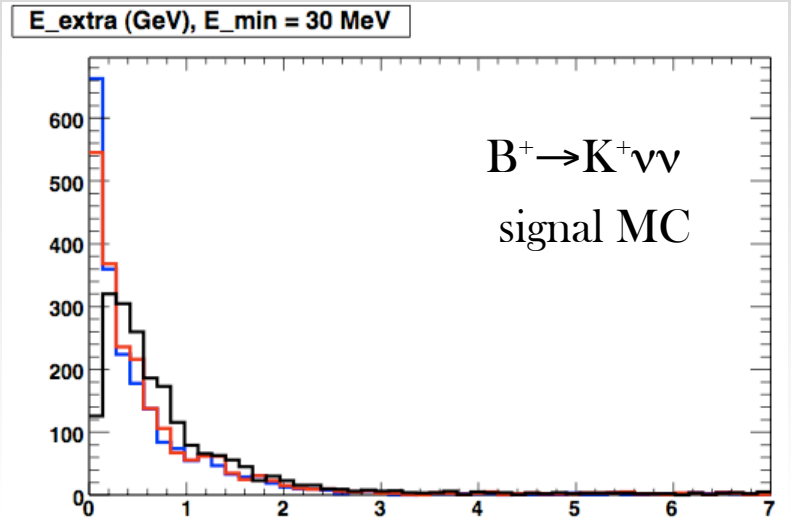


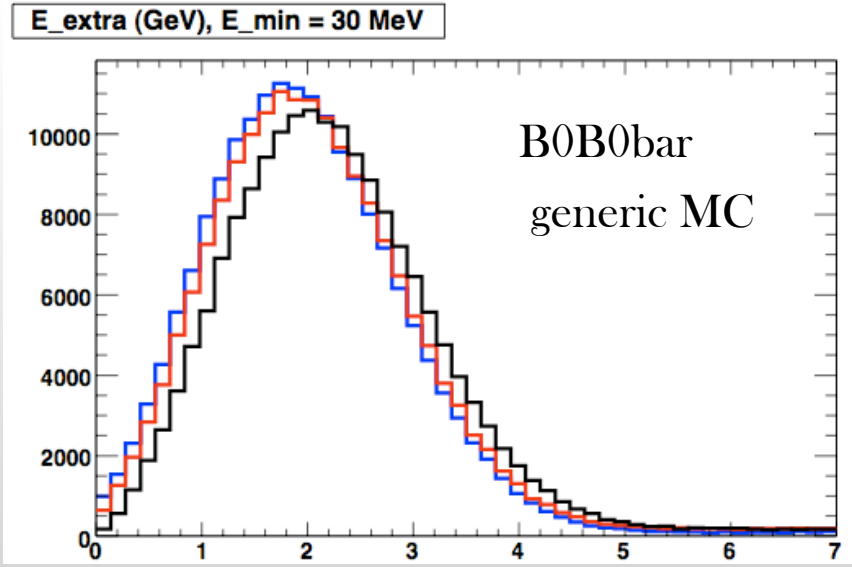


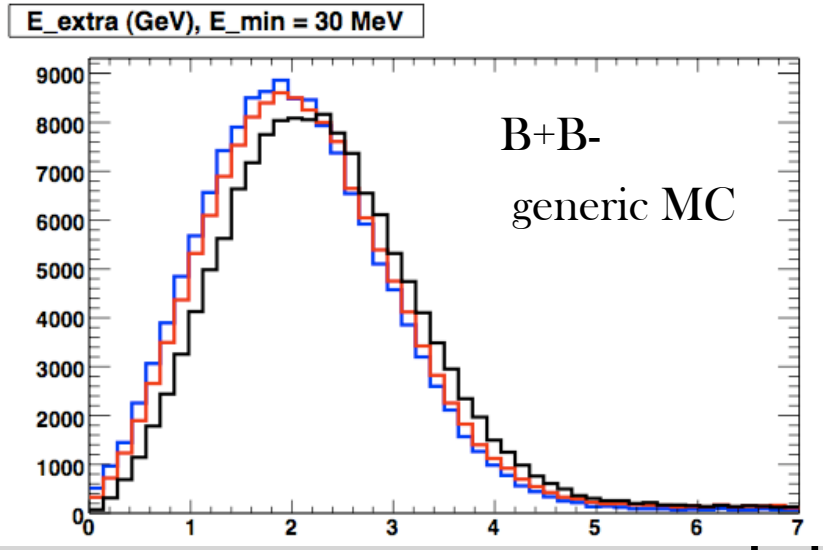


Comparing bkg scenarios: Eextra

w/o bkg
25% bkg
100% bkg



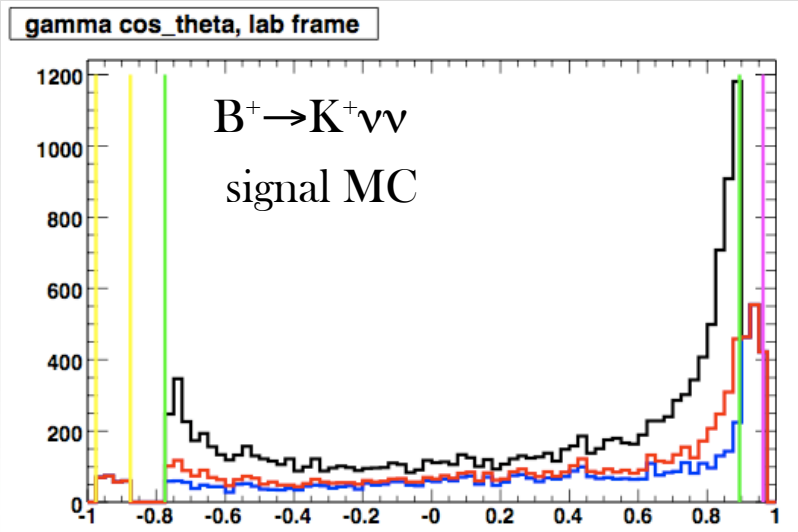


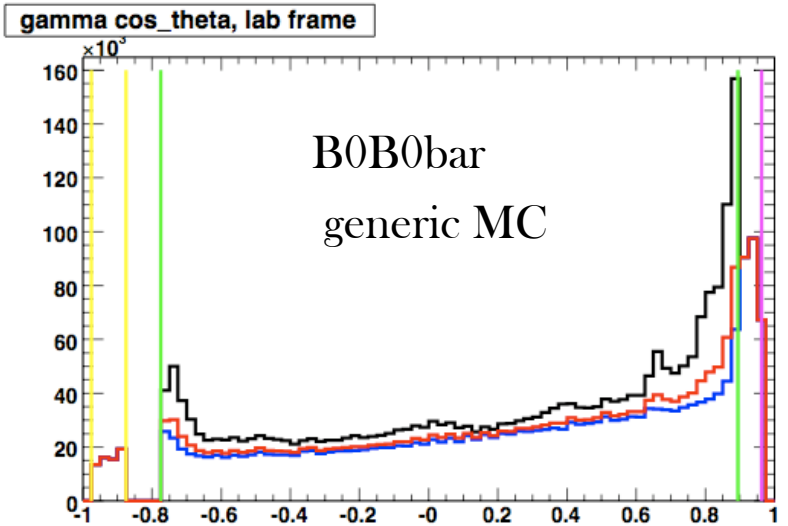


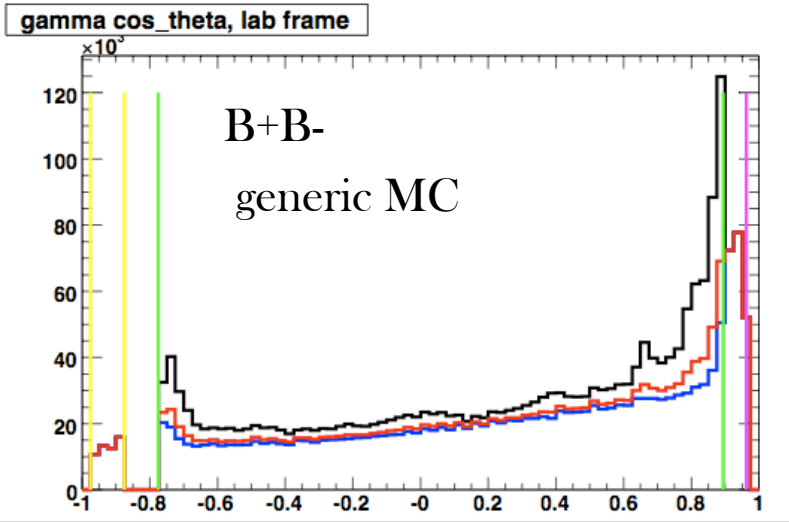
Comparing bkg scenarios: gamma $\cos\theta_{lab}$

w/o bkg
25% bkg
100% bkg

bwd region
barrel region
fwd region

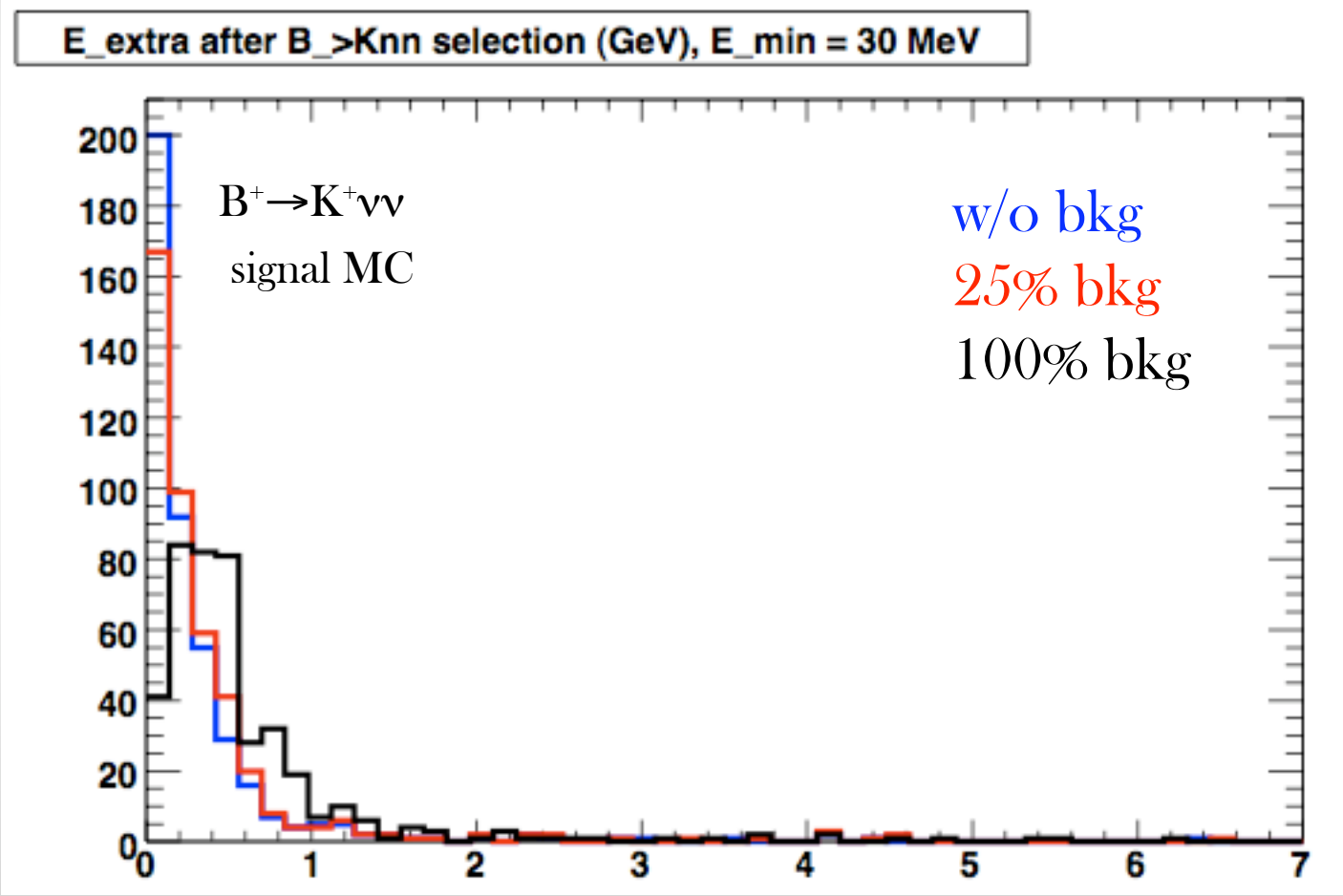






Eextra after $B^+ \to K^+ \nu\nu$ selection

* cut and count selection a-la-BaBar, removing requirements on extra π^0 and Eextra



Conclusions on Eextra studies

* Eextra computation and scaling algorithms seem to work properly

* $E_{\gamma min}$ changes Eextra shape, cut at 70 MeV make signal MC shape peaky at 0 GeV even with 100% background

* scaling the number of not matched extra-gamma to 25%, Eextra has peaky shape in signal MC; both in signal and generics Eextra range is enlarged: need to properly define a new signal region wrt BaBar

Background characterization

Bkg characterization and next production

* need a high statistic sample to investigate the Eextra shape for generic samples after all the selection cuts are applied
* generating enough generic samples: too time- and resource- consuming
* need to find a "smart" samples which affect the physics results as little as possible (anyway, the main purpose are DGWG studies)

* BaBar (sig+reco) efficiencies for $B \to K^{*0}\nu\nu$ cut and count analysis:

Table 14: Cumulative efficiencies ($\times 10^{-4}$) for $K^{*0} \to K\pi$ decay mode.

	signal MC	B^+B^-	$B^0\overline{B}^0$	$c\bar{c}$	uds	$\tau^+\tau^-$	data
R_2	3.1834	0.0036	0.0150	0.0060	0.0019	0	0.0043
$\lvert\cos\theta^*_{\rm thrust}\rvert$	2.8091	0.0027	0.0126	0.0016	0.0006	0	0.0025
m_{K^*} GeV/c^2	2.6026	0.0021	0.0104	0.0013	0.0005	0	0.0021
$\cos\theta^*_{\rm miss}$	2.5416	0.0018	0.0086	0.0009	0.0003	0	0.0017
$E^*_{\rm miss} + p^*_{\rm miss} > 4.5$ GeV	2.24868	0.00020	0.00154	0.00003	0	0	0.00019
$E_{\rm extra}$ GeV	1.73731	0.00006	0.00081	0.00002	0	0	0.00010

Bkg characterization in BaBar analysis

* $B \to K^* \nu\nu$ cut and count analysis
  - bkg characterization after all selection is applied

Table 15: MC truth studies for $B\overline{B}$ events surviving the event selection defined in Section 6.

	$K^{*+} \to K^+\pi^0$	$K^{*+} \to K^0_S(\pi^+\pi^-)\pi^+$	$K^{*0} \to K^-\pi^+$
$B \to D\ (D^*)\ e\ \nu_e$ (n γ)	13	7	30
$B \to D\ (D^*)\ \mu\ \nu_\mu$ (n γ)	2	11	19
$B \to D\ (D^*)\ \tau\ \nu_\tau$ (n γ)	12	2	2
hadronic B decays	7	1	2

In Table 15 the contributions of background decays to each K^* decay mode are summarized. For all the three channels the main contribution comes from semileptonic decay in which the lepton and some hadrons coming both from the B_{tag} and the D (D^*) on the signal side have not been reconstructed. A study on the kinematic properties of the lepton coming from the tag side shows that in most of the events this particle is not reconstructed since its momentum lies along the beam axis, as a consequence this is an irreducible background. Few events belong to the hadronic B decays category: in these cases a true K^* is produced and most of the particles are missing or there is a low multiplicity final state in which a pion and a kaon are randomly paired.

  - no info found for $B \to K\nu\nu$ and $B \to \tau\nu$

MC truth studies

* According to Matteo's suggestion:
  - "A) study of the bkg composition when the tag side (SL or HAD) is selected, independently on the signal selected in the other side."
  - " B) study of the bkg composition when a specific signal is reconstructed."

* mc truth variable implemented in PacHadRecoilUser: YTagB_mc_decayMode
  - look at the MC decay tree and count the number of K, pi, Ks, pi0
  - check the compatibility with one of the >1100 Breco modes
  - assign YTagB_mc_decayMode=XXXYY (XXX=D dec mode, YY=B dec mode)

  (no infos on modes not included in the Breco mode list)

* in the next tables:
  - matched : reconstructed decay mode = true decay mode
  - matched B/D dec : reco B/D mode = true B/D mode
  - Breco modes : true mode = had mode in the breco mode list (!= reco mode)
  - other hadronic modes : true mode= had modes, not in the breco mode list
  - sl modes = at least one generated charged lepton

Preliminary results: A) Breco selection with bkg mixing

* BB generic sample with background mixing
  - 5.27 < mES < 5.288
  - -0.09 < deltaE < 0.05

pur > 50%	matched	matched B dec	matched D dec	Breco modes	other hadronic modes	sl modes
B0B0bar	10.9%	11.9%	10.1%	22.6%	38.7%	5.8%
B+B-	17.8%	24.8%	3.1%	35.2%	16.9%	2.2%

B0B0bar : 30,883 evts, B+B-: 32,861 evts

pur > 80%	matched	matched B dec	matched D dec	Breco modes	other hadronic modes	sl modes
B0B0bar	38.5%	40.3%	3.6%	8.8%	6.9%	1.9%
B+B-	38.2%	40.6%	1.2%	14.5%	4.8%	0.7%

B0B0bar : 3,080 evts, B+B-: 2,507 evts

Preliminary results: A) Breco selection w/o bkg mixing

* BB generic sample without background mixing
  - 5.27 < mES < 5.288
  - -0.09 < deltaE < 0.05

pur > 50%	matched	matched B dec	matched D dec	Breco modes	other hadronic modes	sl modes
B0B0bar	15.0%	16.2%	11.7%	22.3%	30.1%	4.7%
B+B-	21.3%	27.3%	2.7%	28.4%	18.3%	2.0%

B0B0bar : 446,078 evts, B+B-: 515,461 evts

pur > 80%	matched	matched B dec	matched D dec	Breco modes	other hadronic modes	sl modes
B0B0bar	40.6%	42.5%	3.6%	8.0%	4.0%	1.3%
B+B-	39.5%	41.7%	1.1%	9.4%	7.1%	1.2%

B0B0bar : 65,016 evts, B+B-: 43,202 evts

Preliminary results: B) Breco+B→Kνν selection selection w/o bkg mixing

* BB generic sample without background mixing
  - see back up slides for cut list

pur > 50%	matched	matched B dec	matched D dec	Breco modes	other hadronic modes	sl modes
B0B0bar	0%	0%	0%	4.3%	69.6%	26.1%
B+B-	31.3%	39.5%	3.5%	23.6%	0.7%	1.3%

B0B0bar : 23 evts, B+B-: 453 evts

pur > 80%	matched	matched B dec	matched D dec	Breco modes	other hadronic modes	sl modes
B0B0bar	0%	0%	0%	0%	0%	0%
B+B-	42.2%	43.7%	0%	12.5%	0%	1.6%

B0B0bar : 0 evts, B+B-: 64 evts

Preliminary conclusions on bkg studies

* purity cut (from 50% to 80%) changes bkg composition:
  - higher fraction of matched events in the pur>80%-scenario

pur >	reco modes	max trk muliplicity	max π0 multiplicity
50%	194	9	3
80%	17	7	2

→ (1) may cut on purity help?

* not matched events: at Breco selection stage, most of the contamination come from hadronic modes (50% in the breco mode list – 50% other breco modes)
  → (2) may a hadronic cocktail be suitable?

* applied few cuts on the signal selection list
  - not matched Breco are in the breco list or other had modes
  → need to study their multiplicity
  → (3) may "B generic vs low muliplicity B modes" be suitable?

To do list

* DGWG related items
  - further investigation on bkg characterization
  - PID studies comparing DG_3/DG_4 and loose/tight kaon PID

* code related items
  - fix duplicate Breco bug
  - understand some FastSim/FullSim disagreement
  - refine and commit validation code
  - wiki documentation (I've easily started writing it)

Back-up slides

generated BaBar samples ($B \to K^* \nu\nu$ analysis)

sample	SP8 mode	generated evt ($\times 10^3$)	ϵ_{skim}(%)	equiv lumi (fb^{-1})	weight
$B^+ \to K^{*+}\nu\bar{\nu}$ signal	3656	7 767	0.56	504 350	7.600×10^{-4}
$B^0 \to K^{*0}\nu\nu$ signal	2585	5 270	0.49	342 207	7.460×10^{-4}
B^+B^- generic Run1	1235	28 924	6.8	52.59	0.3880
B^+B^- generic Run2	1235	94 808	6.8	172.38	0.3543
B^+B^- generic Run3	1235	49 618	7.0	90.21	0.3578
B^+B^- generic Run4	1235	167 994	6.9	305.44	0.3283
B^+B^- generic Run5	1235	244 192	6.7	443.98	0.2992
B^+B^- generic Run6	1235	100 818	6.9	183.30	0.3607
$B^0\bar{B}^0$ generic Run 1	1237	37 200	6.0	67.63	0.3017
$B^0\bar{B}^0$ generic Run 2	1237	103 356	5.9	187.92	0.3250
$B^0\bar{B}^0$ generic Run 3	1237	48 466	6.2	88.12	0.3663
$B^0\bar{B}^0$ generic Run 4	1237	167 332	6.0	304.24	0.3296
$B^0\bar{B}^0$ generic Run 5	1237	241 224	5.8	438.59	0.3029
$B^0\bar{B}^0$ generic Run 6	1237	102 348	5.9	186.09	0.3553
$e^+e^- \to c\bar{c}$ Run1	1005	58 900	5.5	45.31	0.4504
$e^+e^- \to c\bar{c}$ Run2	1005	168 844	5.5	129.88	0.4702
$e^+e^- \to c\bar{c}$ Run3	1005	83 974	5.6	64.60	0.4997
$e^+e^- \to c\bar{c}$ Run4	1005	252 830	5.6	194.49	0.515
$e^+e^- \to c\bar{c}$ Run5	1005	366 758	5.5	282.12	0.4710
$e^+e^- \to c\bar{c}$ Run6	1005	155 910	5.8	119.93	0.5513
$e^+e^- \to u\bar{u}, d\bar{d}, s\bar{s}$ Run1	998	47 180	3.4	22.57	0.904
$e^+e^- \to u\bar{u}, d\bar{d}, s\bar{s}$ Run2	998	130 858	3.4	62.61	0.9755
$e^+e^- \to u\bar{u}, d\bar{d}, s\bar{s}$ Run3	998	66 722	3.4	31.92	1.0017
$e^+e^- \to u\bar{u}, d\bar{d}, s\bar{s}$ Run4	998	205 204	3.5	98.18	1.0214
$e^+e^- \to u\bar{u}, d\bar{d}, s\bar{s}$ Run5	998	317 846	3.4	152.08	0.8737
$e^+e^- \to u\bar{u}, d\bar{d}, s\bar{s}$ Run6	998	127 926	3.6	61.21	1.0800
$e^+e^- \to \tau^+\tau^-$ Run1	3429	20 378	0.017	21.68	0.9412
$e^+e^- \to \tau^+\tau^-$ Run2	3429	55 546	0.017	59.09	1.0336
$e^+e^- \to \tau^+\tau^-$ Run3	3429	27 988	0.018	29.77	1.0842
$e^+e^- \to \tau^+\tau^-$ Run4	3429	90 032	0.018	95.78	1.0470
$e^+e^- \to \tau^+\tau^-$ Run5	3429	132 218	0.018	140.66	0.9446
$e^+e^- \to \tau^+\tau^-$ Run6	3429	56 436	0.023	60.04	1.1013

Preliminary results: B) Breco+B→Kνν selection selection w/o bkg mixing

* BB generic sample without background mixing
  - Qtag, mES, B→K

pur > 50%	matched	matched B dec	matched d dec	Breco modes	other hadronic modes	sl modes
B0B0bar	0%	0%	0%	5.7%	68.6%	25.7%
B+B-	33.4%	39.8%	3.2%	21.3%	1.2%	1.1%

B0B0bar : 35 evts, B+B-: 837 evts

pur > 80%	matched	matched B dec	matched d dec	Breco modes	other hadronic modes	sl modes
B0B0bar	0%	0%	0%	0%	0%	100%
B+B-	43.7%	46.2%	0.4%	9.2%	0%	0.5%

B0B0bar : 2 evts, B+B-: 119 evts

$B^+ \to K^+ \nu\nu$: selection efficiency

* BaBar-like cut and count analysis

$Q_{tag} = \pm 1$
$5.270 < m_{ES} < 5.288$ GeV/c^2
$|\cos\theta_{Breco,Thrust}| < 0.85$

K candidate from Bsig
$|\cos\theta^*_{trk}| < 0.85$
~~$N_{extraTrk} < 3$~~
~~$E_{extra} < 0.4$ GeV~~
~~$N_{\pi 0} = 0$~~
~~$p_K^B > 1.1$Gev/c~~
~~$-0.85 < \cos\theta_{pmiss} < 0.9$~~