Performances of EMC and physics related studies

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III SuperB Collaboration Meeting - LNF

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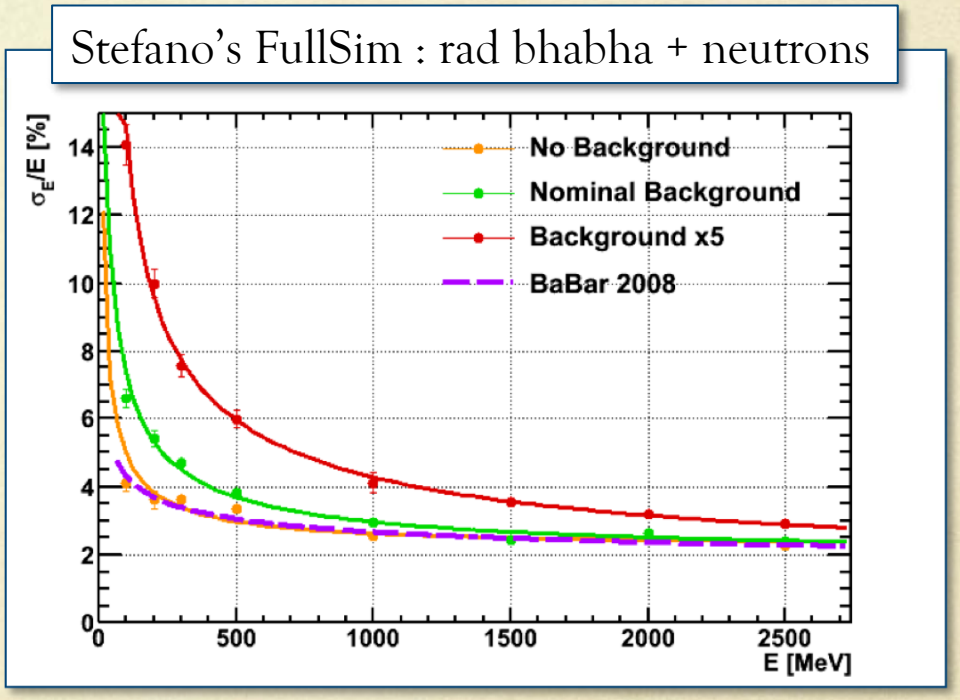
Outline

- Aim of the study, samples and bkg configurations
- HAD Breco side
  - efficiency
  - γ, π^0 and B_{reco} reconstruction
- $B^+ \rightarrow K^{*+} \nu\nu$ signal MC studies
  - efficiency
  - E_{extra} shapes
  - extra-γ and -π^0 properties
- Conclusions

Aim of the study

- Test impact on physics of different bkg configurations with FastSim
- Hypotheses:
  - FastSim correctly reproduce energy resolution dependence on background
  - Radiative bhabha is the main source of bkg for EMC measurements

Stefano's FullSim : rad bhabha + neutrons



FastSim EMC configuration

- FastSim release V0.3.1
  - improved clustering algorithm (see Chih-hsiang talk at 02/15 EMC and 02/23 PhysTools meetings)
  - lookup tables for signal timing model: CSP integration time = 130 μs , shaping time = 300 ns (PacEmc/preamp-models/CsI-140u-300n-Luigi.txt)
- BaBar resolution for both barrel and Fwd
- Default LYSO Fwd

Background configurations

- Consider Radiative Bhabha (+ neutrons) only
- 3 bkg configuration tested
  - No machine background
  - Nominal bkg
  - 3x Nominal bkg

Bkg config/ sec/evt	signal MC	BB generic
No bkg	~ 0.12	~ 0.40
1x bkg	~ 0.07	~ 1.06
3x bkg	~ 2.64	~ 5.80

- 5x Nominal Radiative Bhabha (+ neutrons):
  - current clustering algorithm too time consuming (~ 40 sec/evt for signal MC)
  - Not able to produce proper amount of signal and BB generic MC for this meeting

B^+B^- generic MC

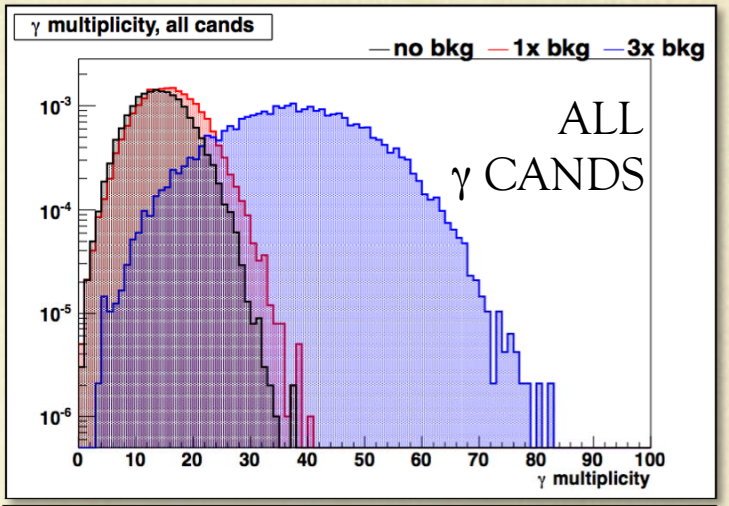
Selection and event counting

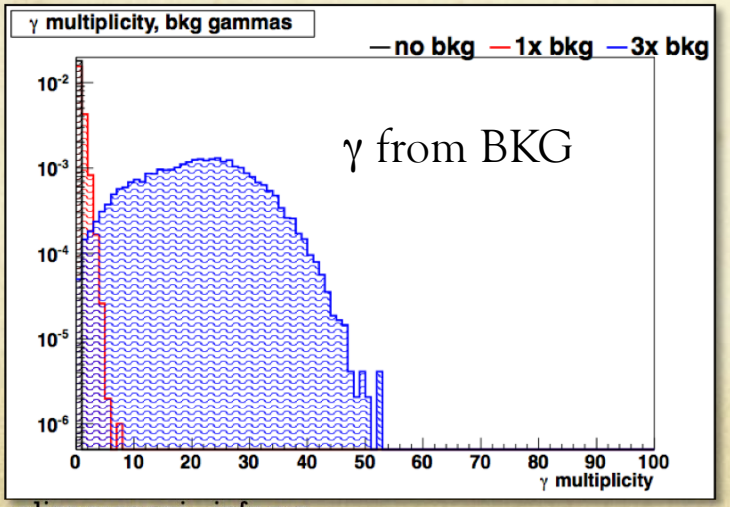
Bkg config/evts	gen	ε_{Breco} (%)
No bkg	$1x10^6$	1.793 ± 0.013
Nominal bkg	$1x10^6$	2.077 ± 0.014
3x Nominal bkg	$0.48x10^6$	2.92 ± 0.012

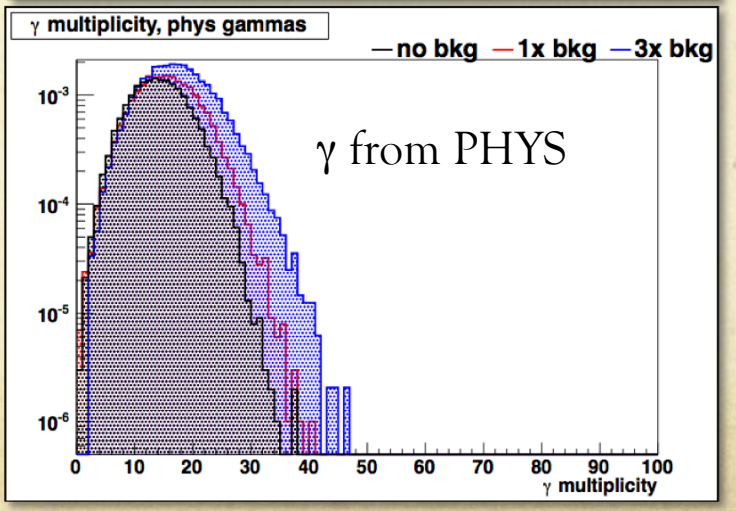
- Selection: at least 1 B_{reco} , tight PID requirements on kaons
- In the next slides:
  - gammas from physics (bkg): (not) mctruth-associated to particles produced in BB decays

γ multiplicity

- Default E_{min}^{γ} cut = 20 MeV



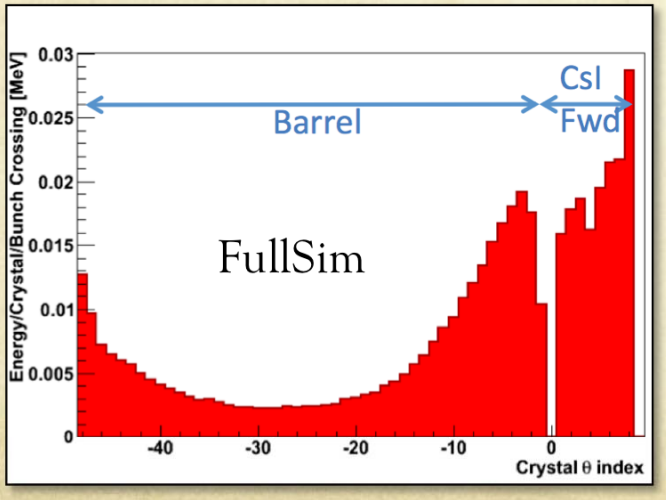


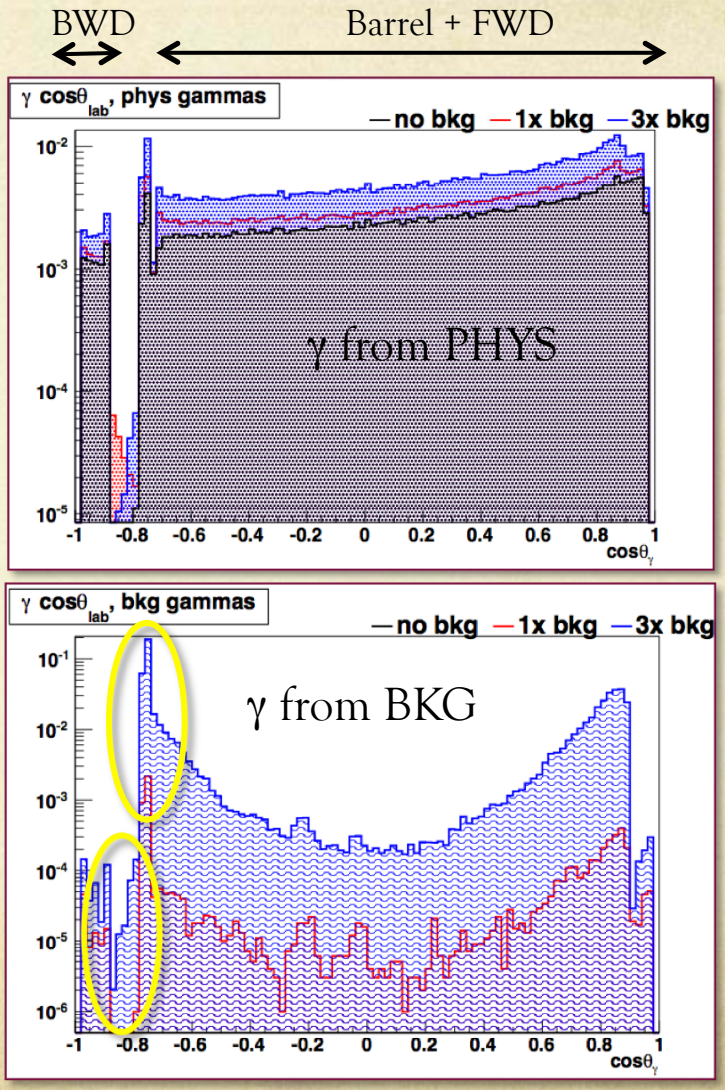


γ angular distribution

- Bugs in PacEmc (now fixed)
  - reco γ in gap between barrel and fwd
  - barrel region: higher occupancy near bwd wrt to fwd

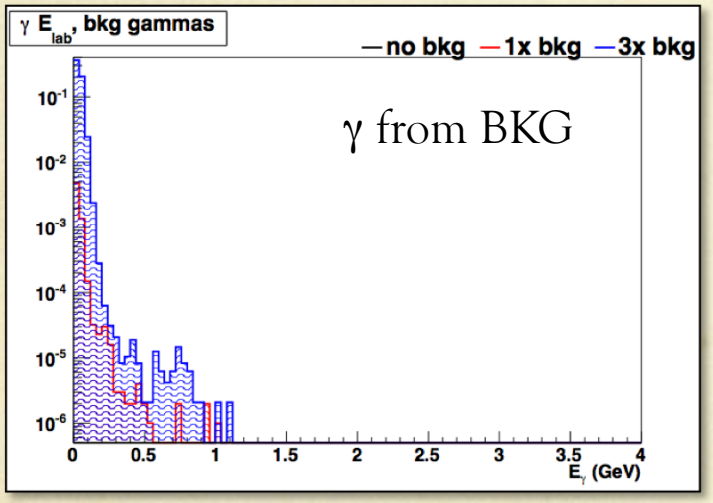
Should affect just γ in the last Barrel ring

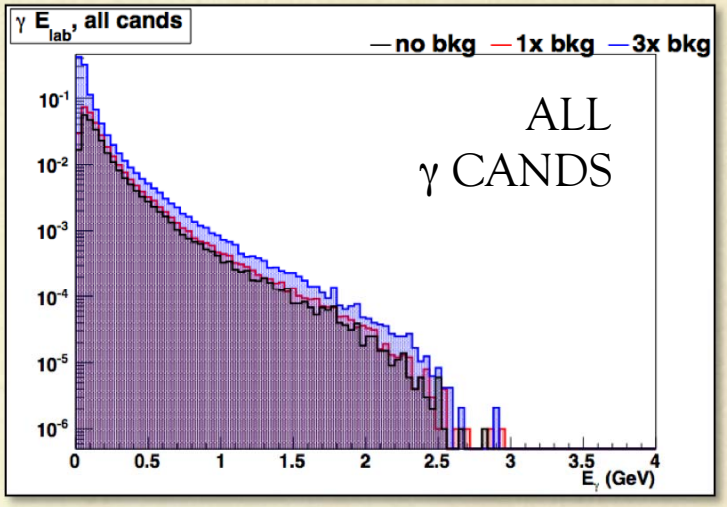


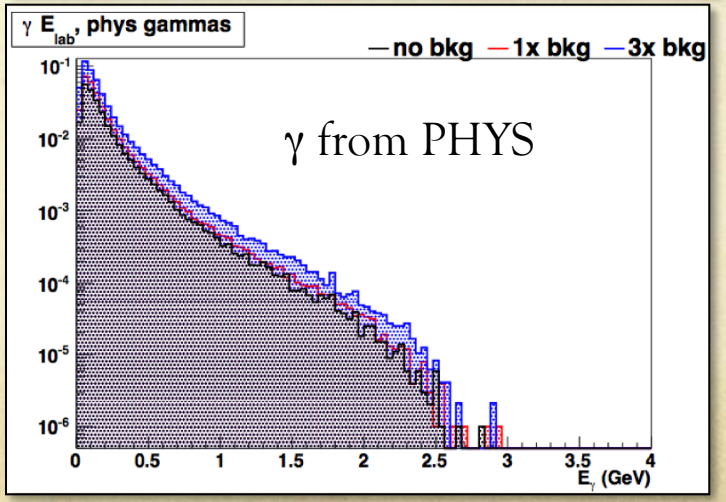


γ energy

- γ's from BKG populate low E region as expected

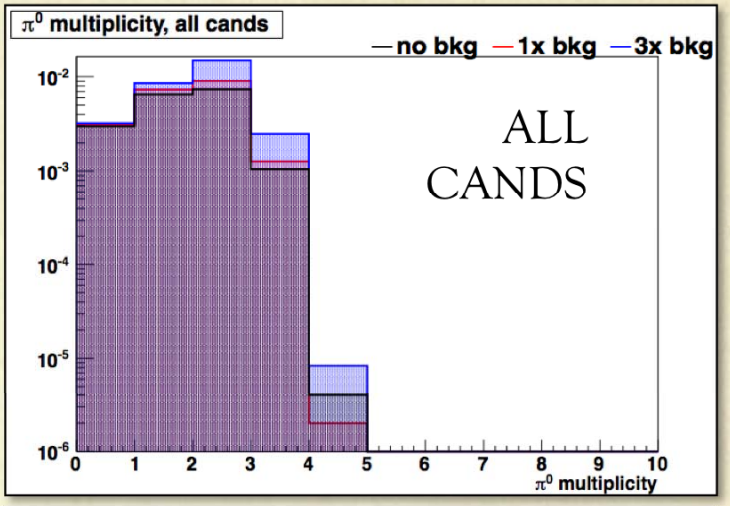


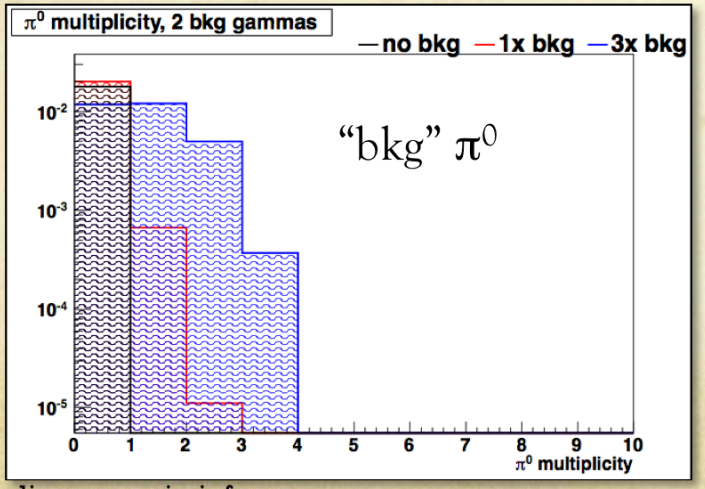


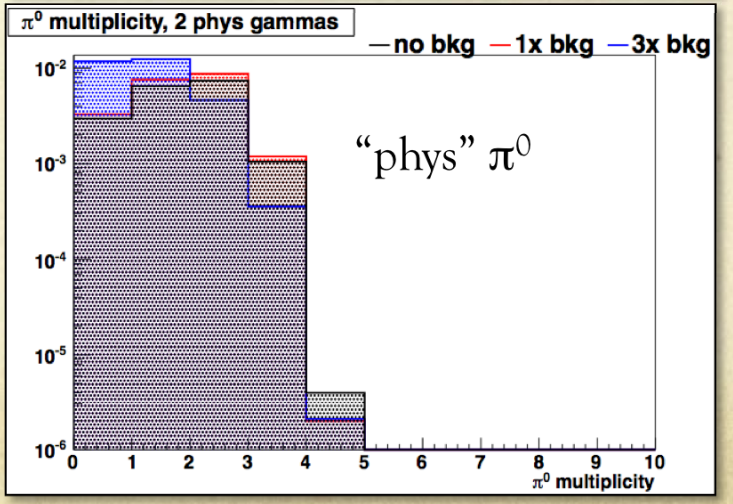


π^0 multiplicity

- "phys" π^0 = both gammas from BB
- "bkg" π^0 = at least 1 gamma not from BB

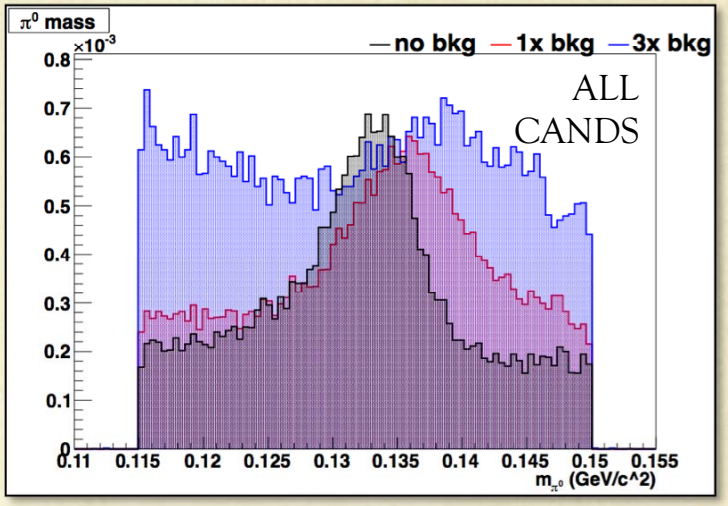


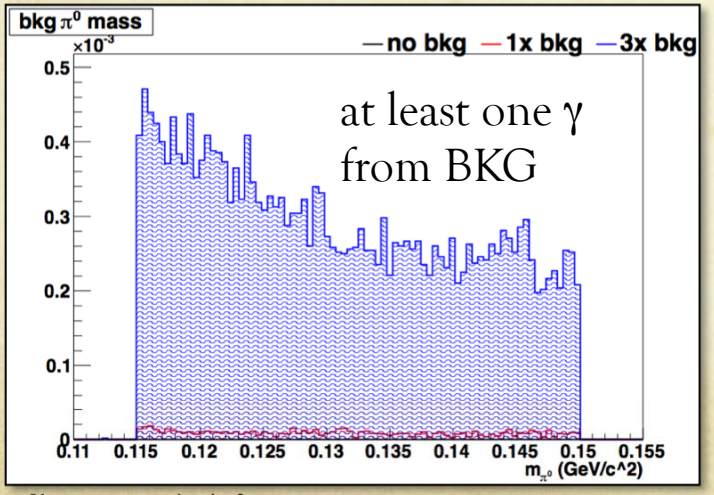


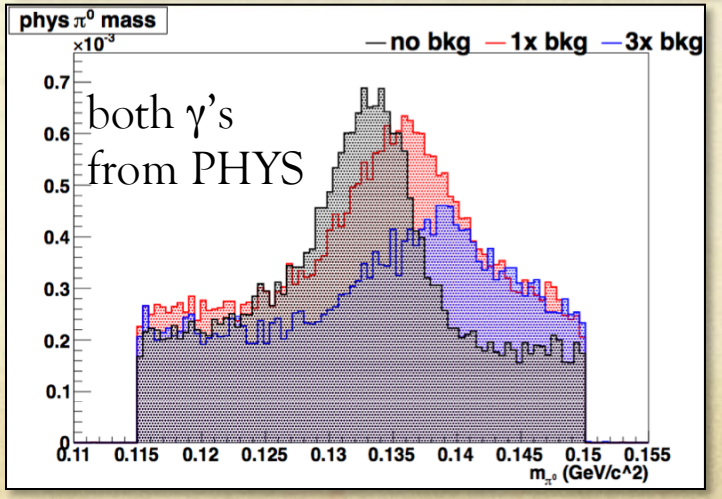


π^0 mass

- Huge combinatoric bkg from "background" π^0 in the 3x configuration
- "Phys" π^0 peak shifted with increasing machine bkg

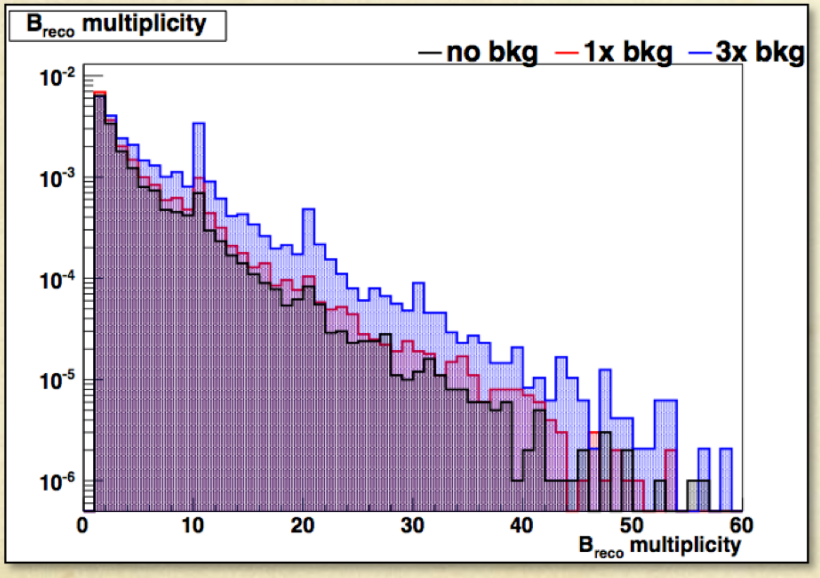


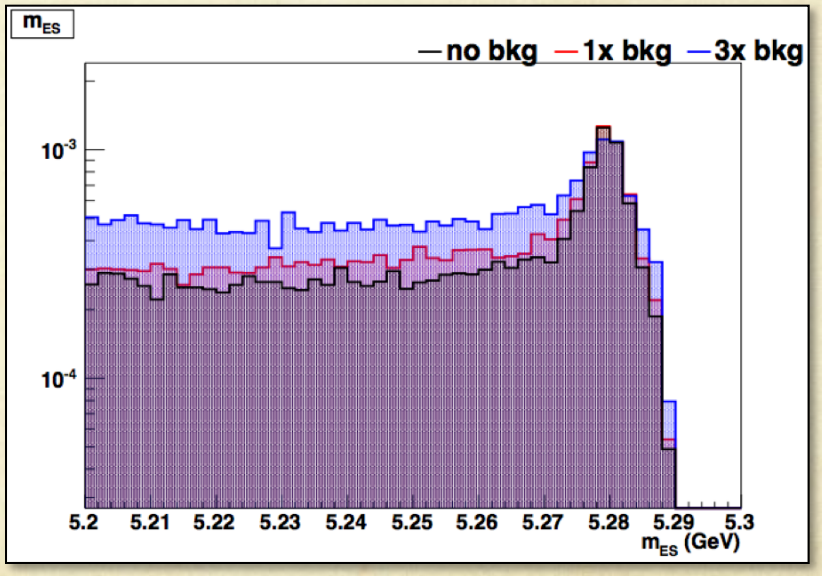




B_{reco} multiplicity and m_{ES}

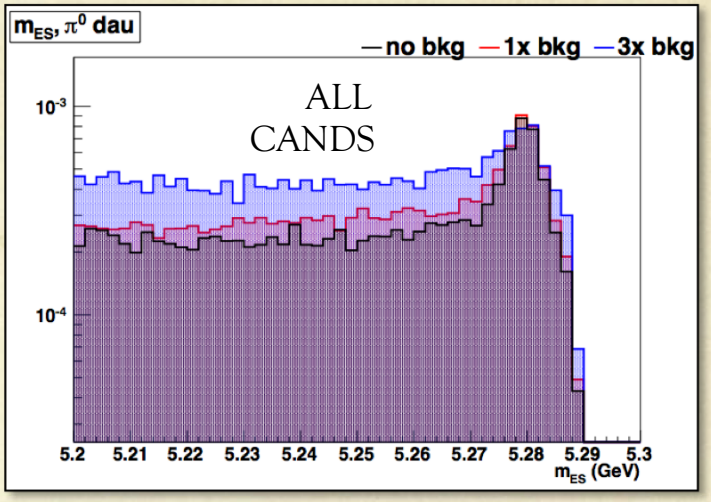
- Breco multiplicity and m_{ES} tails increasing with machine bkg (higher combinatoric)

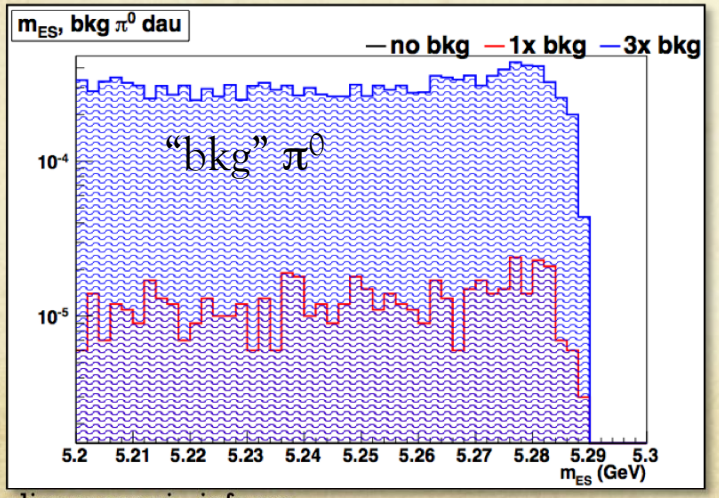


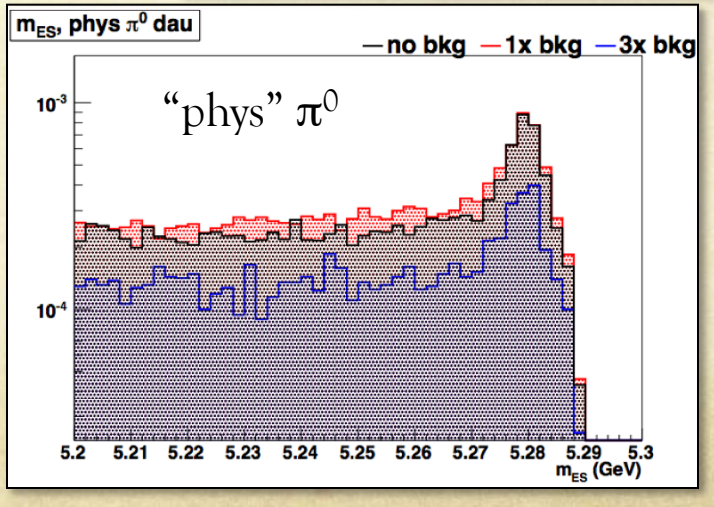


m_{ES} for B_{reco} with π^0 daughters

Bkg config/ eff (%)	B_{reco} w π^0 dau	phys π^0	bkg π^0
No bkg	1.494 ± 0.012	1.494 ± 0.012	-
1x bkg	1.765 ± 0.013	1.697 ± 0.013	0.068 ± 0.003
3x bkg	2.594 ± 0.022	0.856 ± 0.013	1.739 ± 0.019







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

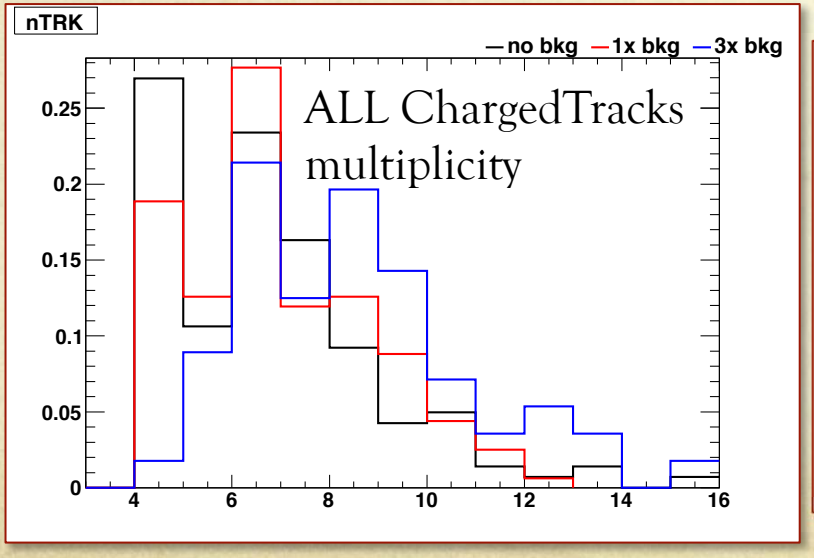
Selection and event counting

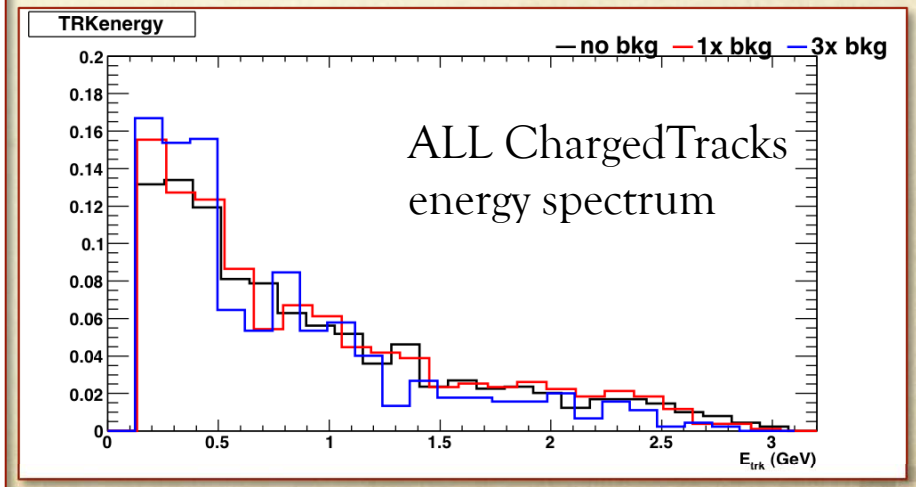
Bkg config/ evts	ε_{Breco} (10^{-3})	$K^{*+}(K_s\pi)$: $\varepsilon_{Breco} x \varepsilon_{Bsig}$ (10^{-4})	$K^{*+}(K\pi^0)$: $\varepsilon_{Breco} x \varepsilon_{Bsig}$ (10^{-4})
No bkg	2.39 ± 0.03	2.20 ± 0.10	1.59 ± 0.09
Nominal bkg	2.55 ± 0.04	1.58 ± 0.09	1.11 ± 0.07
3x Nominal bkg	4.09 ± 0.04	0.98 ± 0.07	0.67 ± 0.06

- 2M generated events for each config
- Selection: at least 1 B_{reco} , tight PID requirements on kaons, 1 reconstructed K^{*+} in the signal side and no extra-tracks

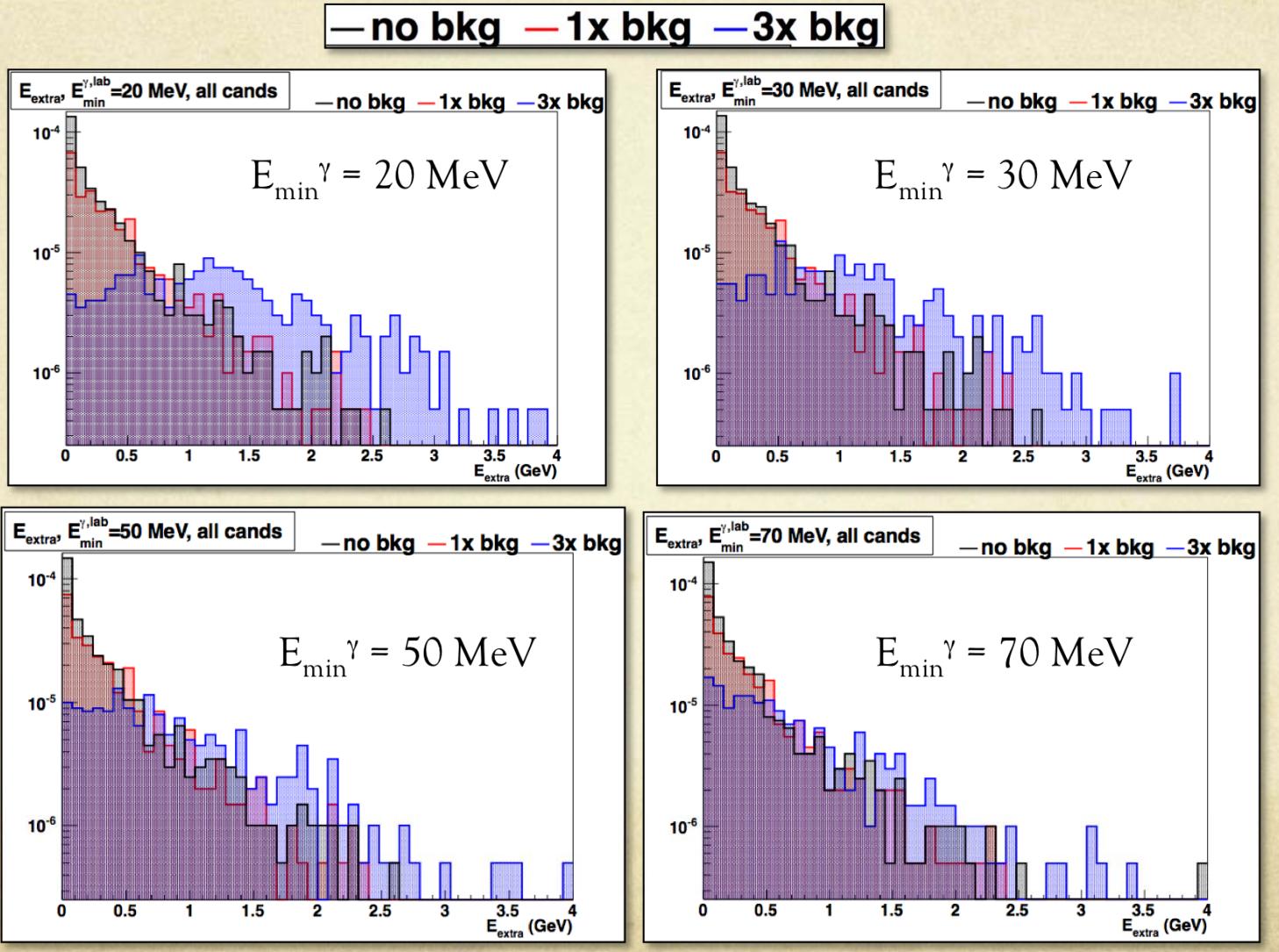
Tracking-related effect?

- B_{reco} efficiency increase with bkg, opposite trend for B_{sig} efficiency vs bkg
- same loss in K* reco for both $K_s\pi$ and $K\pi^0$ channels
- higher amount of extra-tracks?



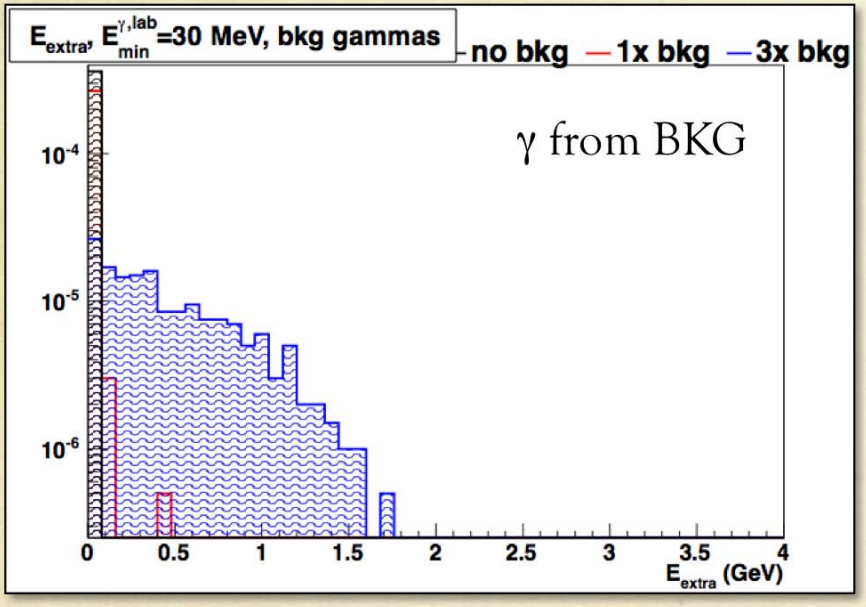


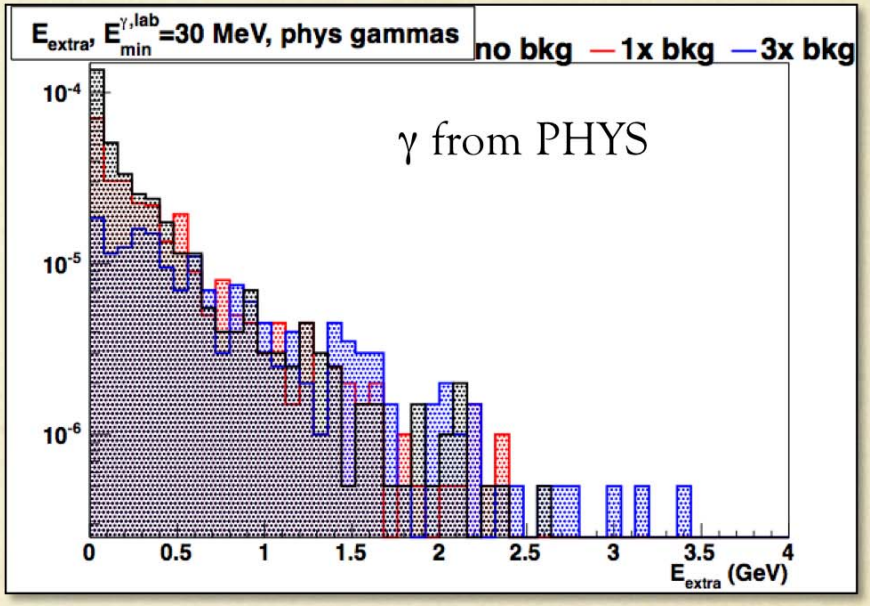
E_{extra}: bkg level and E_{min}^{γ}



E_{extra}: bkg vs phys

- E_{min}^{γ} = 30 MeV

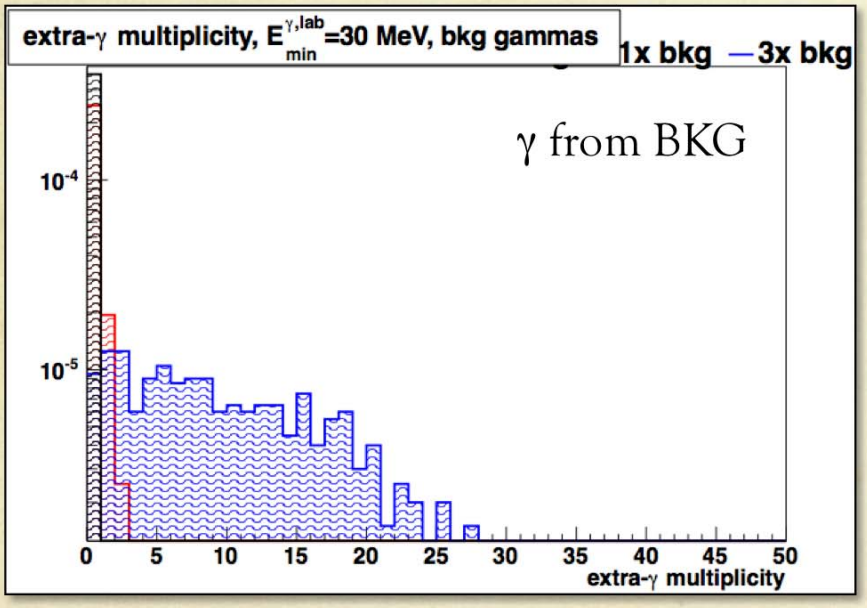


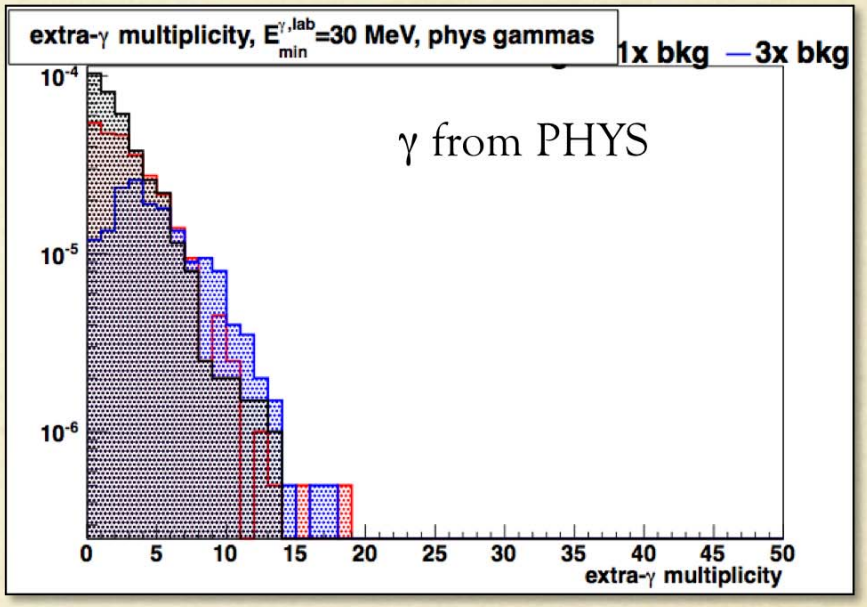


—no bkg —1x bkg —3x bkg

Extra-γ multiplicity

- E_{min}^{γ} = 30 MeV

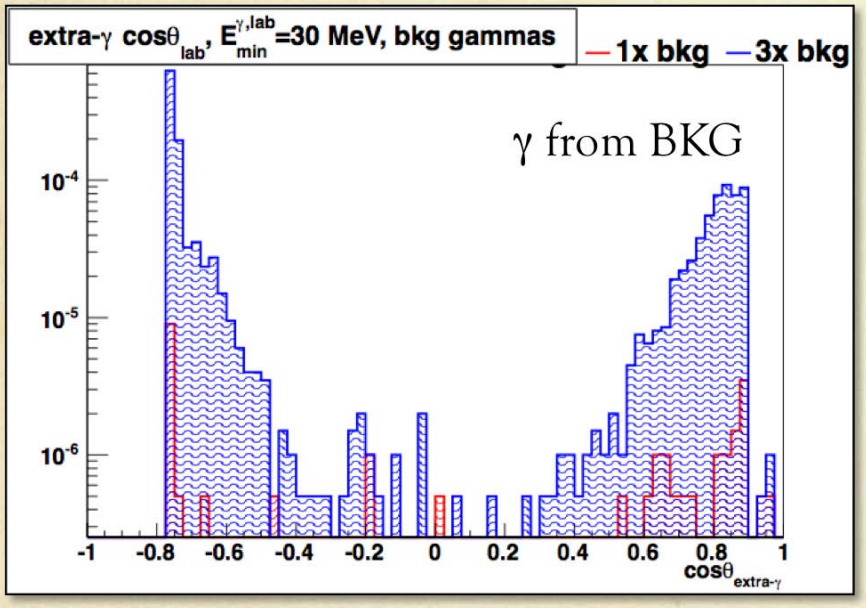


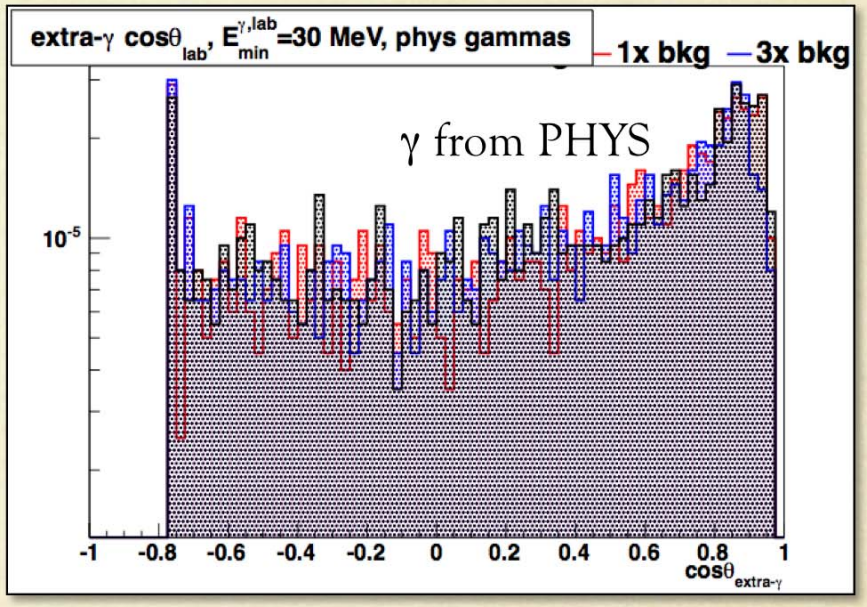


no bkg 1x bkg 3x bkg

Extra-γ angular distribution

- E_{min}^{γ} = 30 MeV

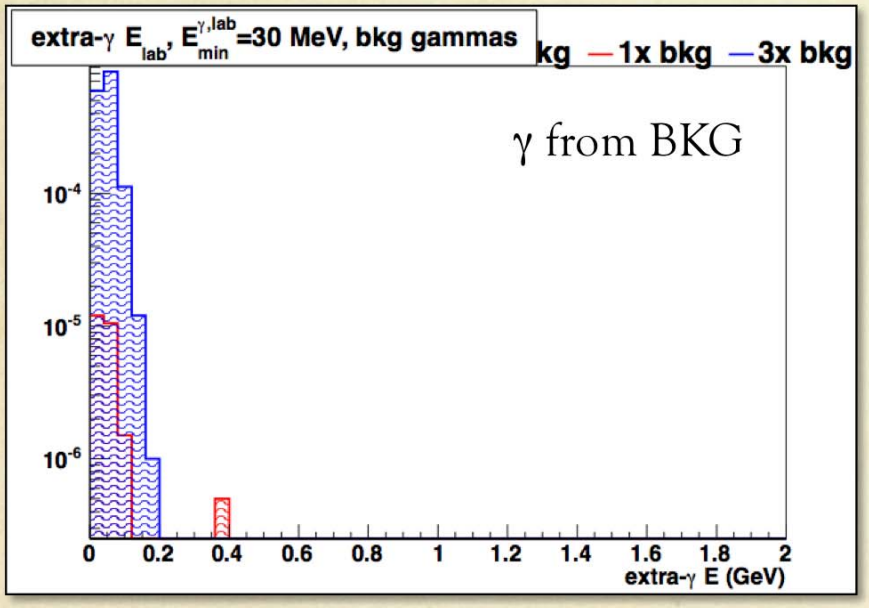


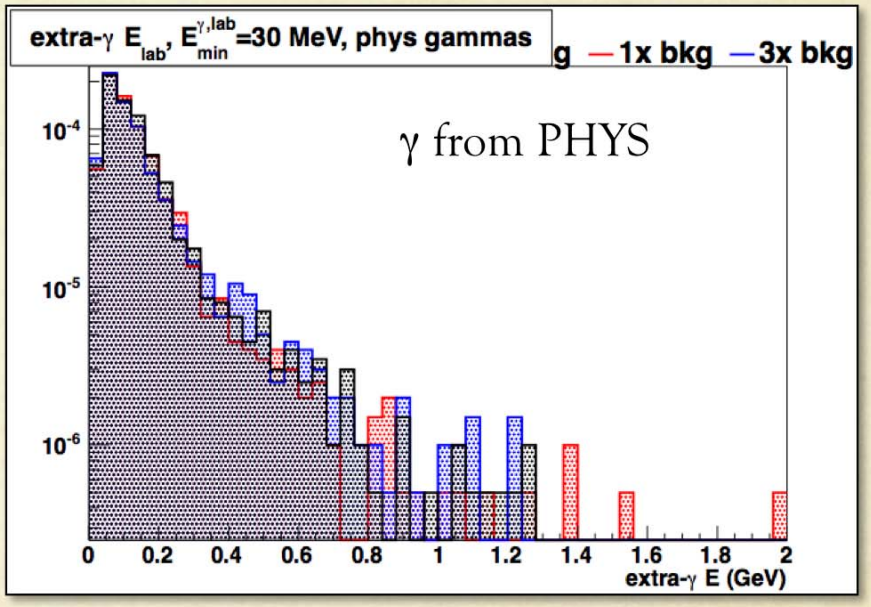


no bkg 1x bkg 3x bkg

Extra-γ energy

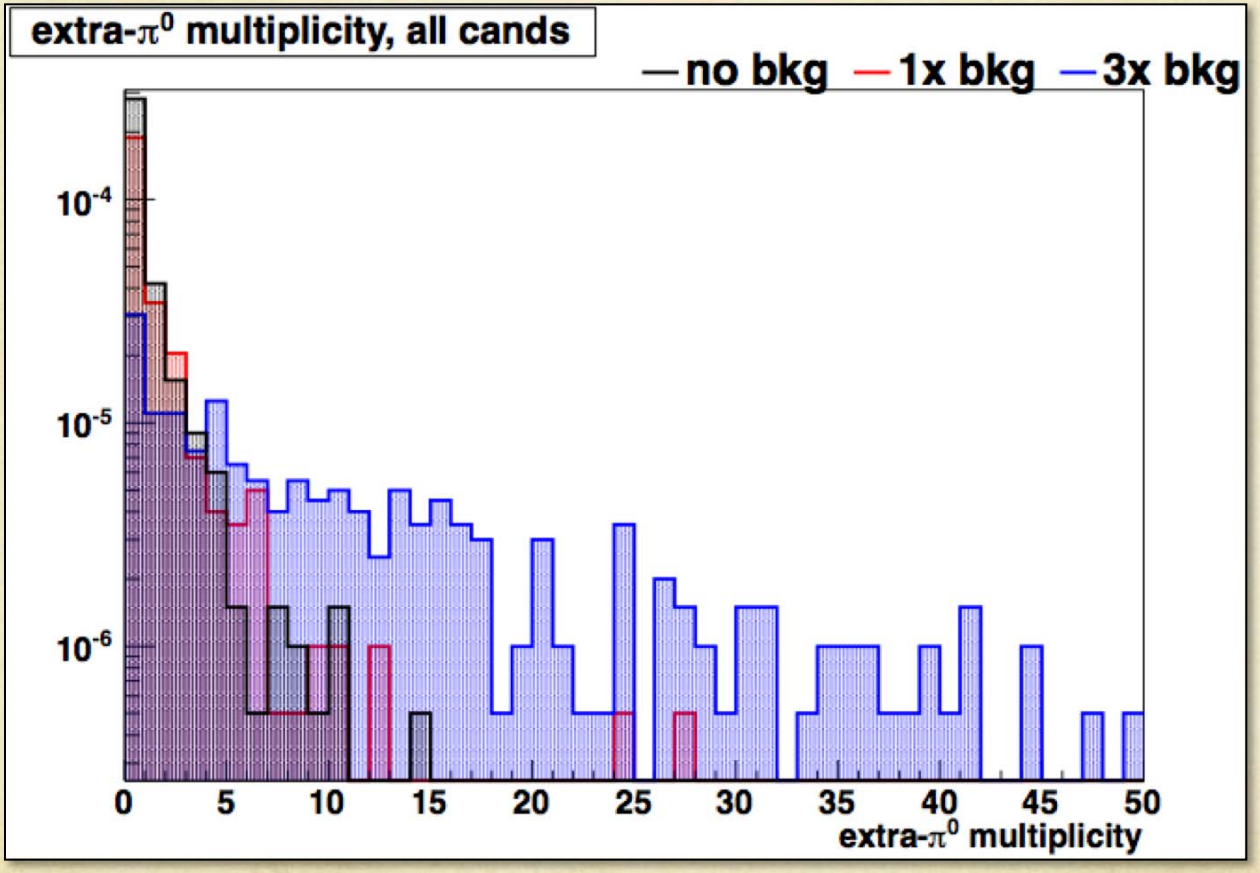
- E_{min}^{γ} = 30 MeV





—no bkg —1x bkg —3x bkg

Extra-π^0 multiplicity

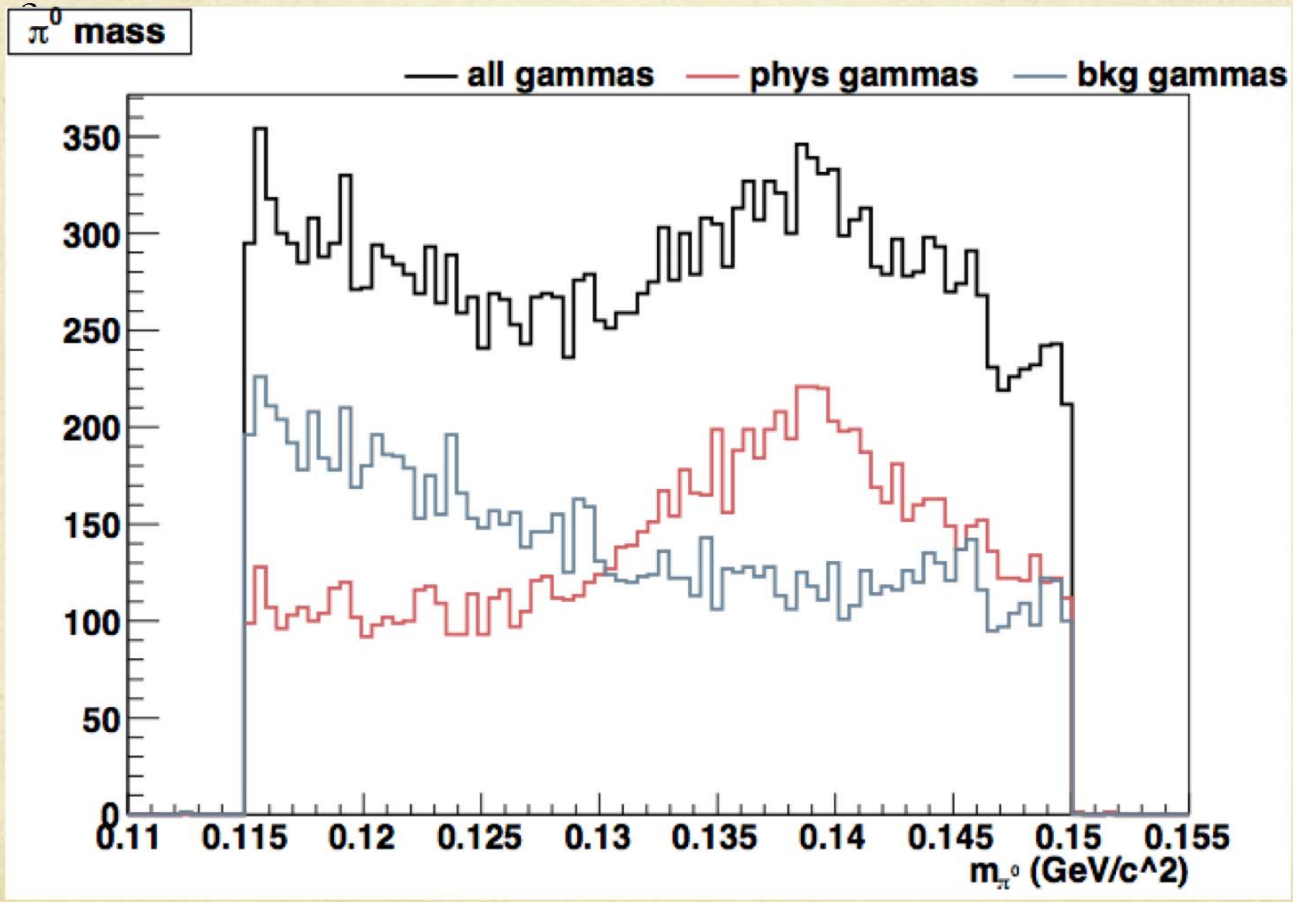


Conclusions

- Impact on physics of different bkg configurations with FastSim studied
  - radiative bhabha (+ neutrons) ; no machine bkg, 1x bkg, 3x bkg
- HAD B_{reco} side (BB generic sample)
  - higher reco efficiency mainly due to combinatoric
  - π^0 mass distribution suffering from high combinatoric contamination + peak shift with increasing bkg → use tighter requirements on π^0 lists?
- $B^+ \to K^{*+} \nu\nu$ signal MC studies
  - lower B_{sig} efficiency probably due to higher extra-trtacks multiplicity ?
  - E_{extra} shapes loose peaky shape at low energy with increasing bkg → important to compare signal MC and BB generic E_{extra} shape to evaluate the discriminating power (high BB stats needed)

Extra Slides

π^0 mass, 3x machine bkg



π^0 lists

```
mod clone SmpMakerDefiner pi0AllDefault
talkto pi0AllDefault {
  decayMode  set "pi0 -> gamma gamma"
  daughterListNames set CalorNeutral
  daughterListNames set CalorNeutral
  fittingAlgorithm   set "Add4"
  fitConstraints     set "Mass"
  fitConstraints     set "Momentum"
  fitConstraints     set "PrimaryVertex"
  preFitSelectors    set "Mass 0.115:0.150"
}
```

```
mod clone SmpMakerDefiner pi0SoftDefaultMass
talkto pi0SoftDefaultMass {
    decayMode         set "pi0 -> gamma gamma"
    daughterListNames set CalorNeutral
    daughterListNames set CalorNeutral
    preFitSelectors    set "Mass 0.115:0.15"
    preFitSelectors    set "CmsP :0.45"
    fittingAlgorithm   set "Add4"
    fitConstraints     set "Mass"
    fitConstraints     set "Momentum"
    fitConstraints     set "PrimaryVertex"
}
```

BaBar E_{extra} distributions