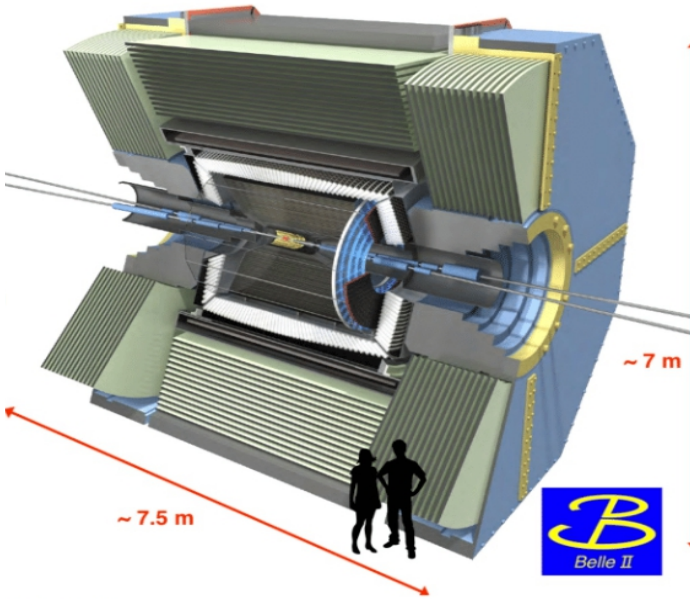
HADRONIC TAGGED BR(B->D0*lν): SOFT π0 AND GAMMAs INVESTIGATION



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Vxb 01/04/2019

[1]UniPg [2]INFN Pg [3]UniNa [4]INFN Na

OUTLINE

- ANALYSIS DATA SAMPLE, PRESELECTION,
- MAIN VARIABLES
- SOFT GAMMAS SELECTION
- SOFT πOs SELECTION
- CONCLUSION & PLANS

$B^- \to D0^* \ell \nu$ MC9 PHASE III_PRESEL

- $B^- \to D0^* \ell^- \nu$ from MC9 $B \to X_c \ell \nu$ with/without Bkg

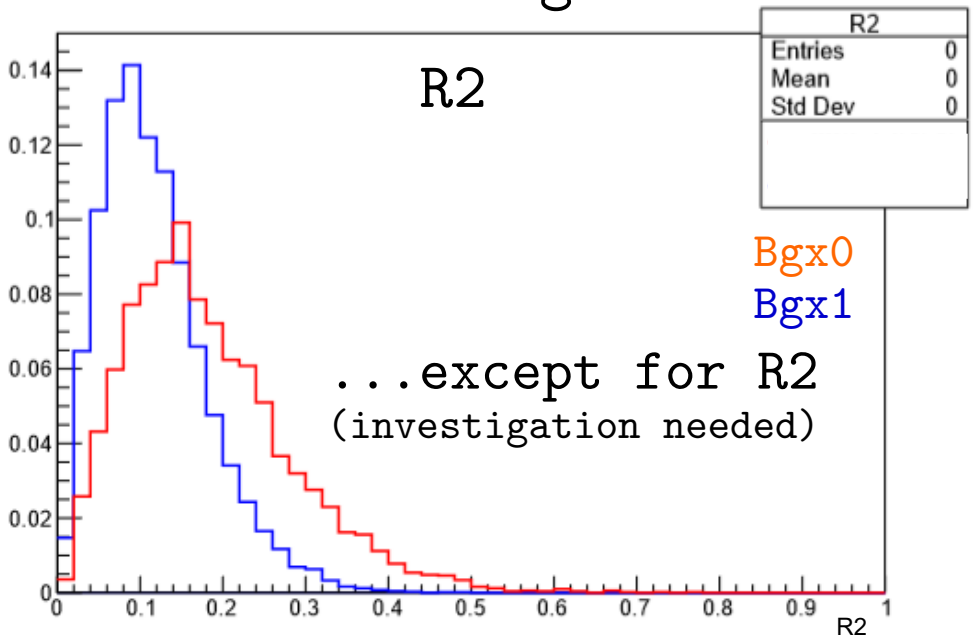
- TAG side
  - Official FEI Hadronic TAG Reconstruction (FEIv4_2018_MC9_release_02_00_01)
- Signal side reconstructed decay
  - $B \to D0^* e$, $B \to D0^* \mu$
    - $D0^* \to D0\pi0$,
    - $1.9 < m(D0^*) < 2.1$ GeV
      - $D0 \to K^-\pi^+$, $D0 \to K^-\pi^+\pi0$, $D0 \to K^-\pi^+\pi^-\pi^+$
      - $1.75 < m(D0) < 1.95$ GeV

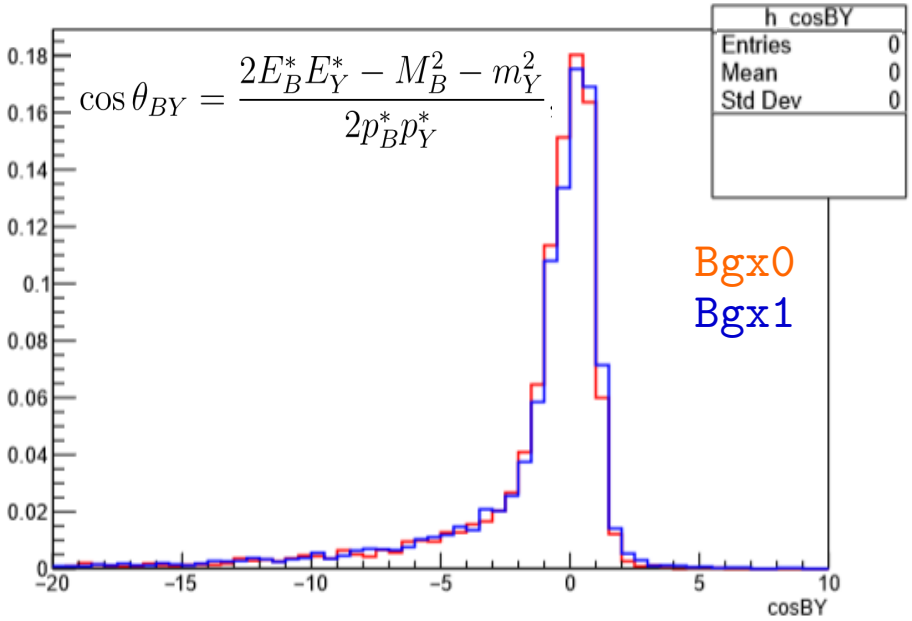
- Signal side
  - Standard particle list
- Photons cut:
  - $E > 0.050$ GeV
  - $\frac{|\text{clusterTiming}|}{|\text{clusterErrorTiming}|} < 1$
- $0.11 < m(\pi0) < 0.16$ GeV
- ExtraTrack=0
- ExtraPhotons selection

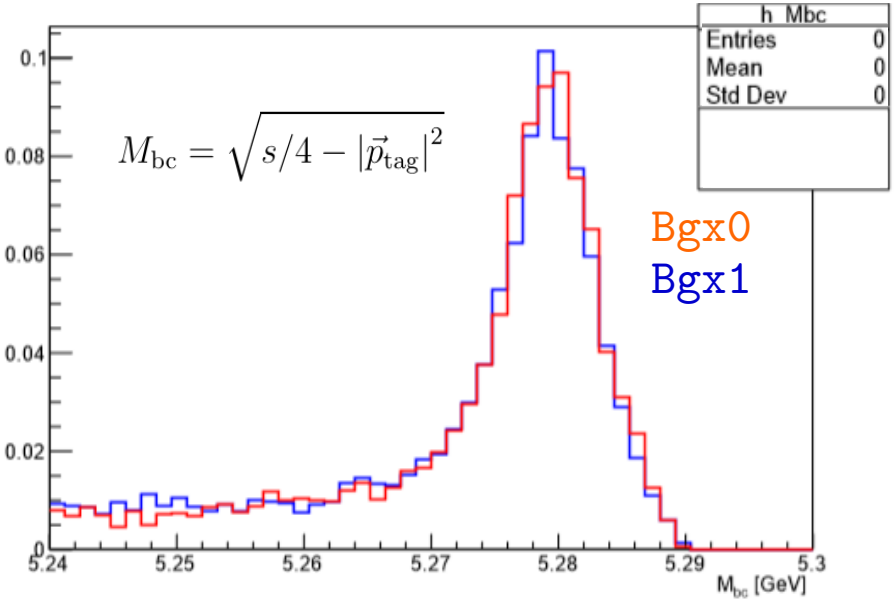
- MC9 $B \to X_c \ell \nu$ Bgx0 sample: 10M events ---> 2430, ε_{bgx0}=0.024%
- MC9 $B \to X_c \ell \nu$ Bgx1 sample: 40M events $\overset{\text{selection}}{\longrightarrow}$ 3688, ε_{bgx1}=0.009%
- Almost factor 2.5 between ε, mainly due to Tag

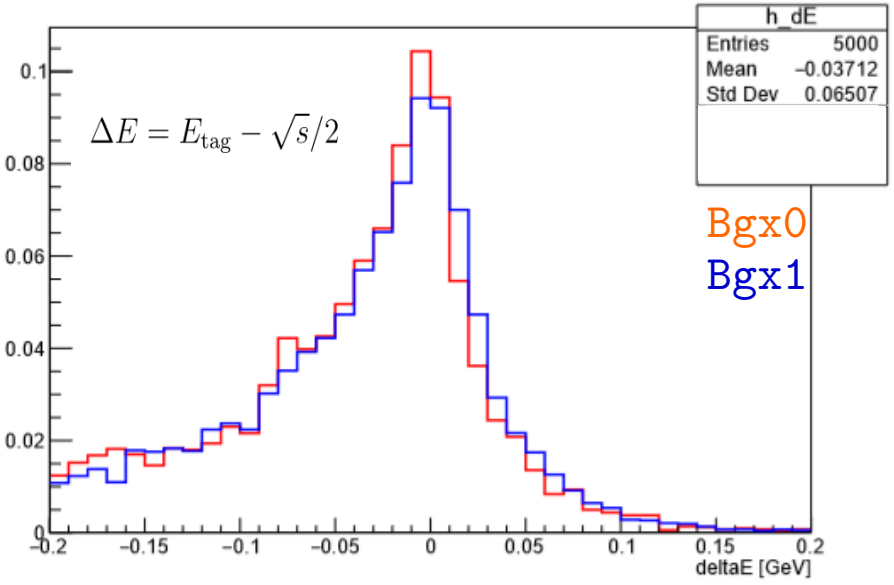
EVENT SHAPE & TAG SIDE

Good agreement between bgx0 and bgx1 shapes...

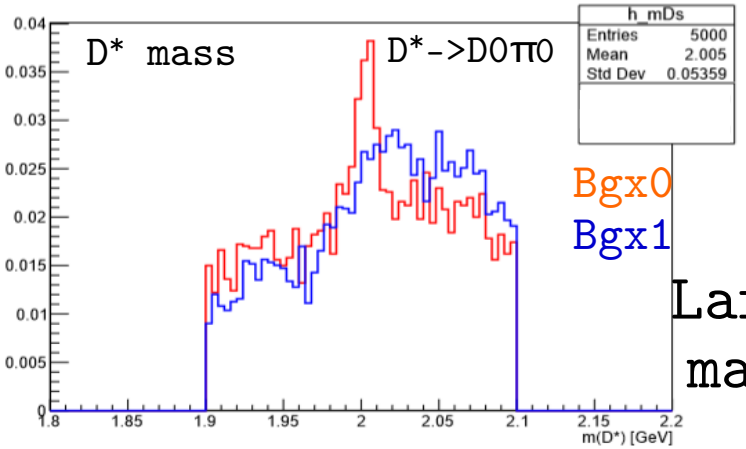


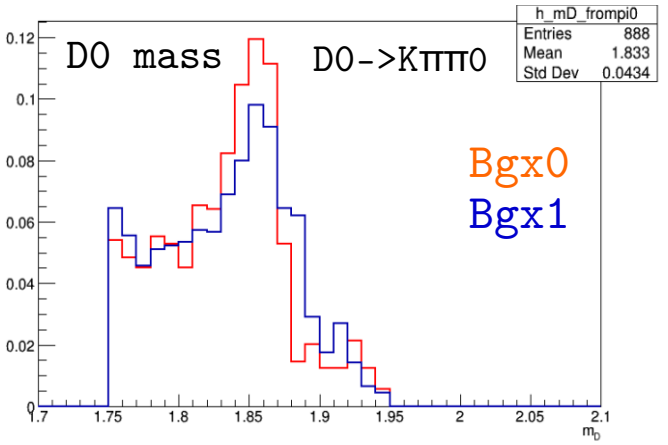




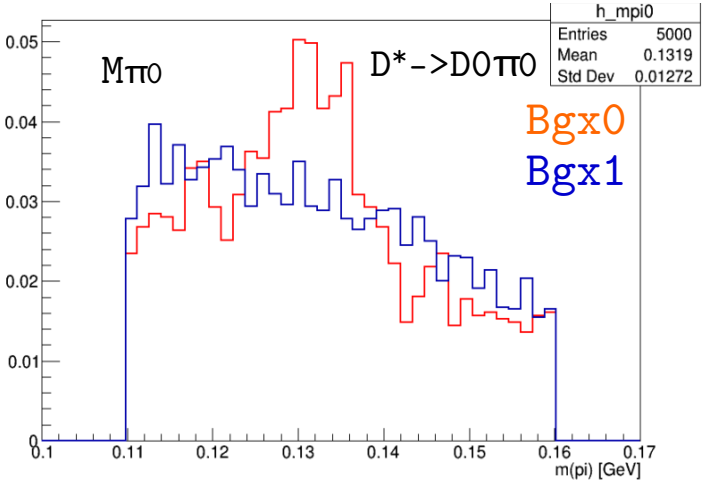


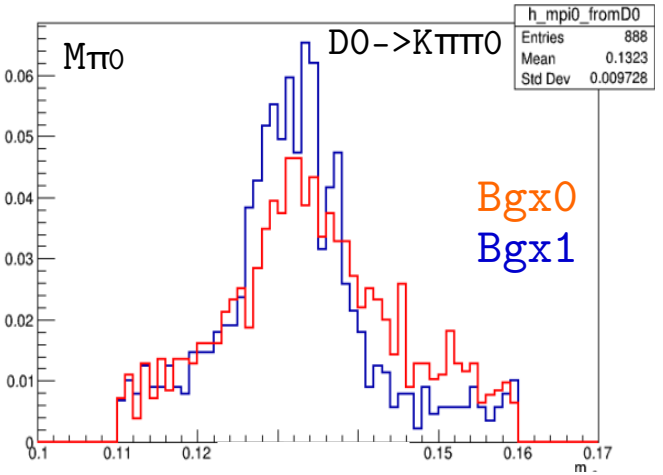
D*0->D0π0 AND D0->Kππ0 COMPARISON



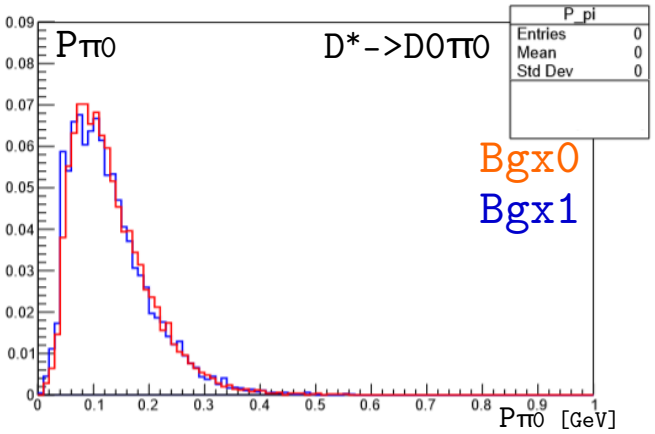


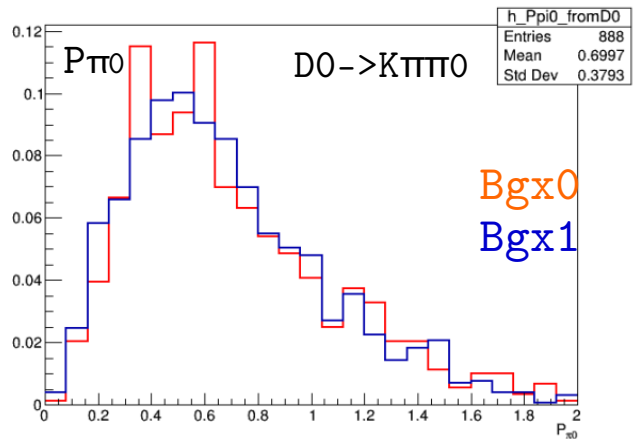
Large impact of machine bkg on D* masses (low on D0)



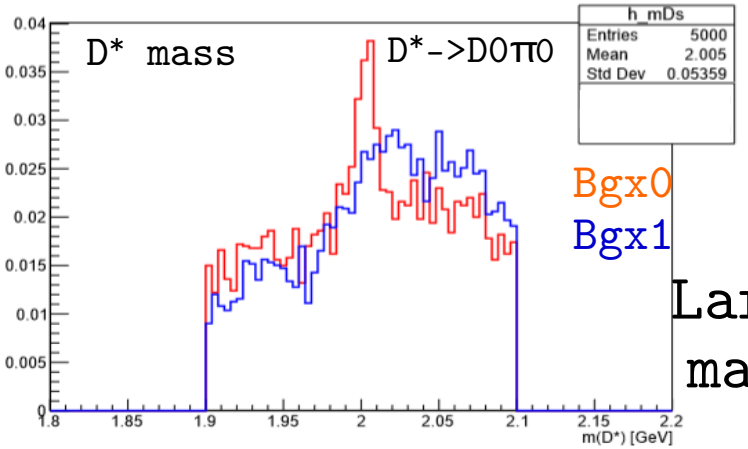


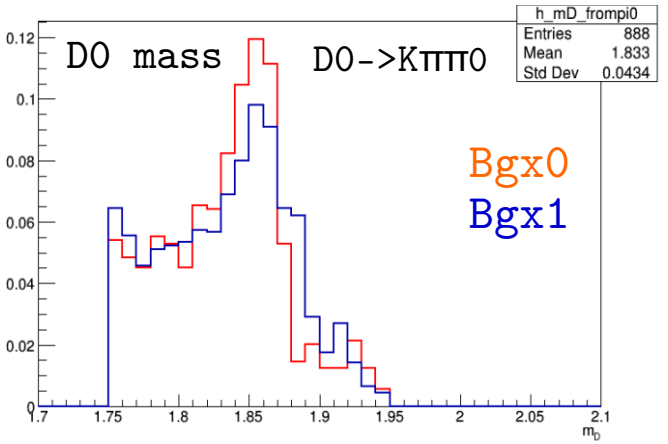
Likely due to different π0s momentum windows



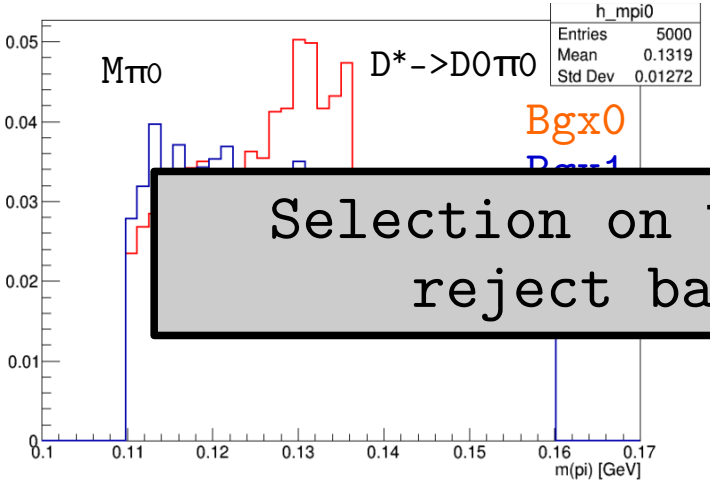


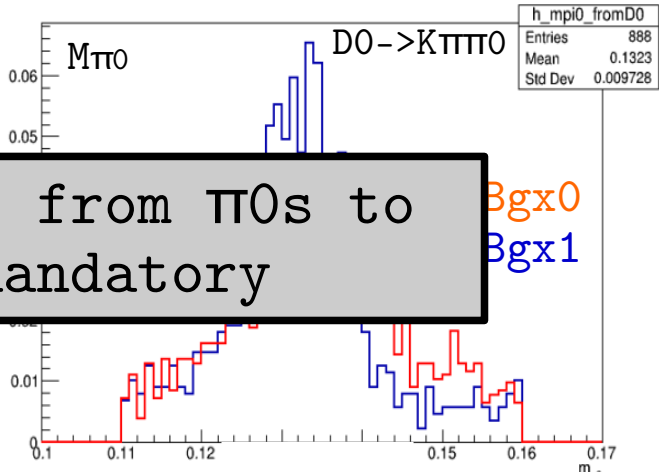
D*0->D0π0 AND D0->Kππ0 COMPARISON





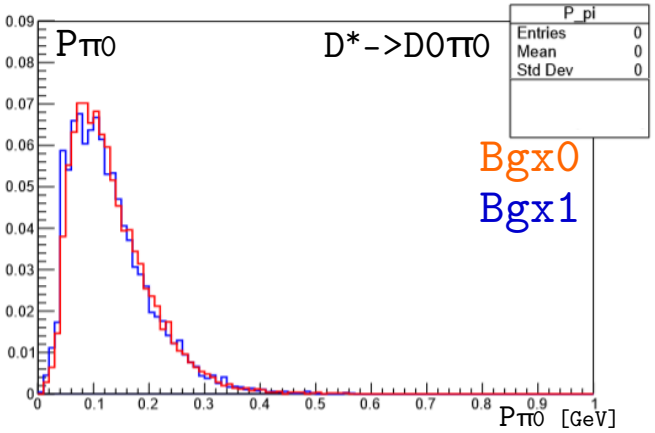
Large impact of machine bkg on D* masses (low on D0)

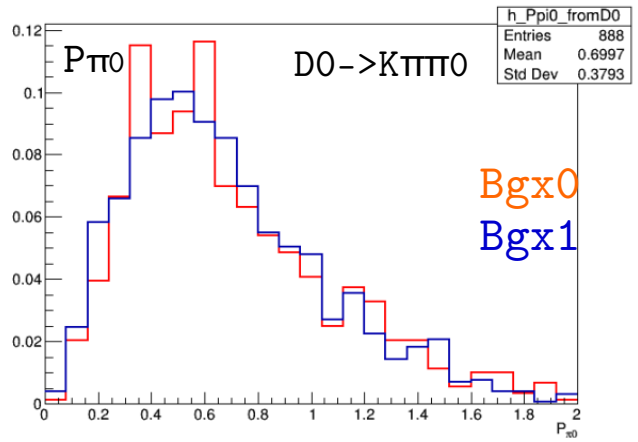




Selection on π0 and gammas from π0s to reject background is mandatory

Likely due to different π0s momentum windows





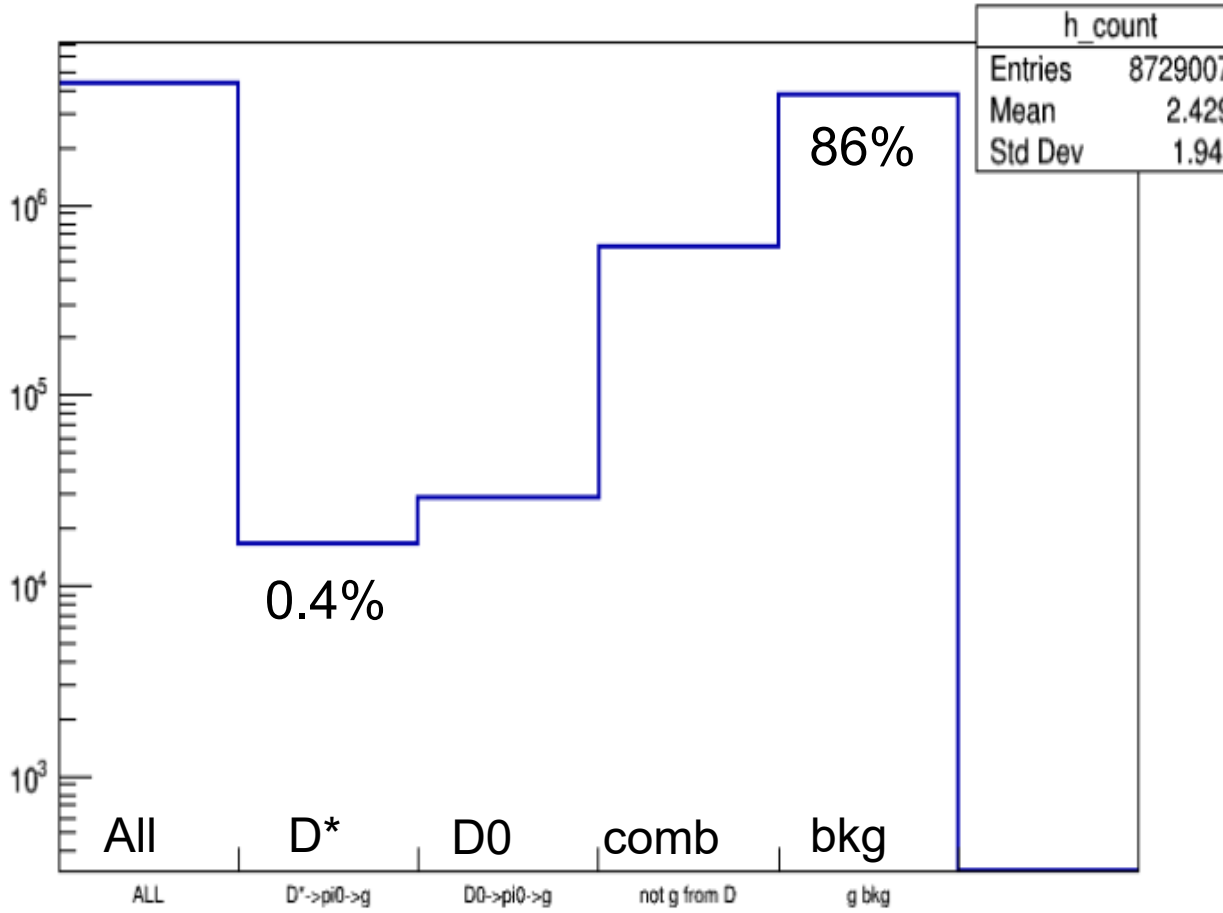
GAMMAS SELECTION

GAMMAS SAMPLE

- GOAL: find a selection to reject background and select soft gammas (from softπ0, maybe could become a more general)
- Generic BB with prerelease-03-00-00b for release3 validation
- gammas_all list (candidate wise, one cand_= one gamma)

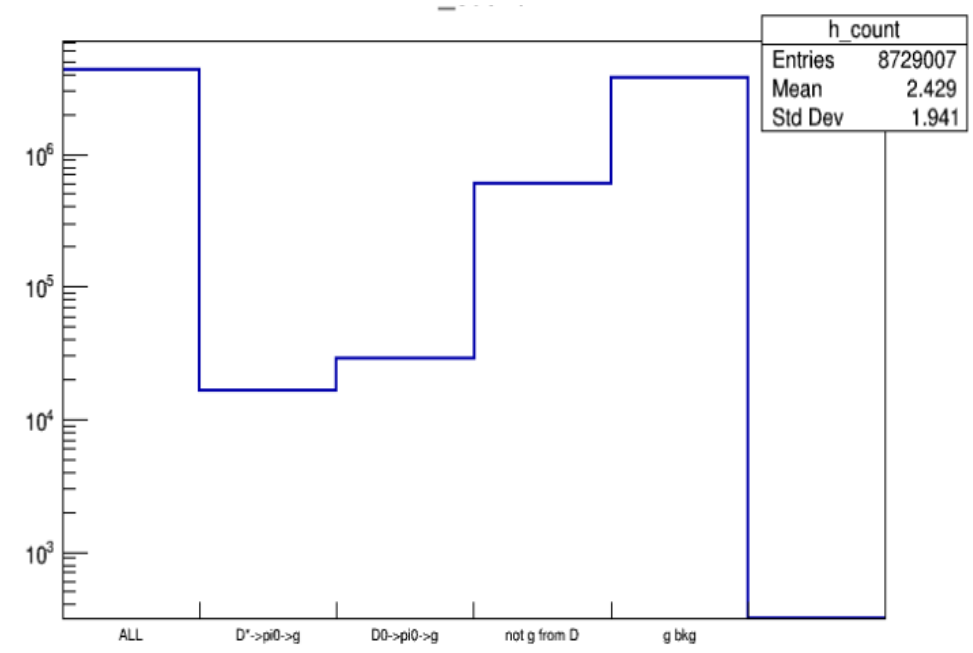
MC-TRUTH BASED CATOGORIES

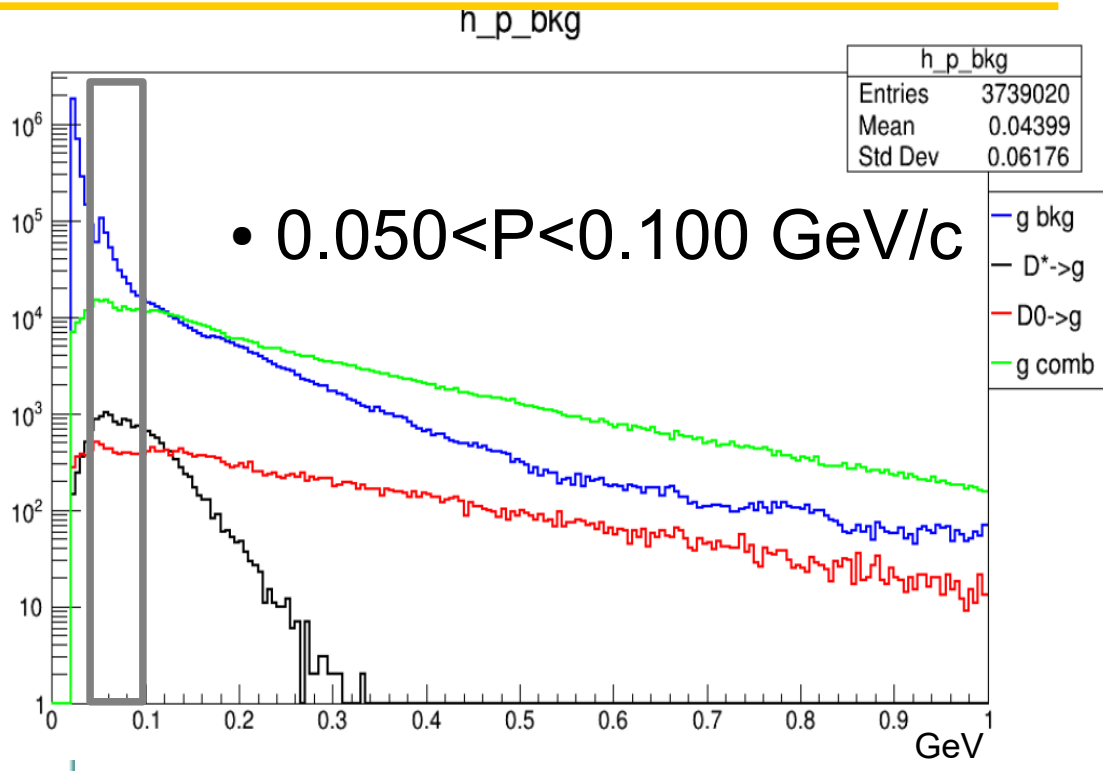
- D0: gammas from physics, D0->π0->gg
- Dst:gammas from physics D*->π0->gg
- Comb: generated gammas not from D0/D*
- Bkg: gammas from machine background



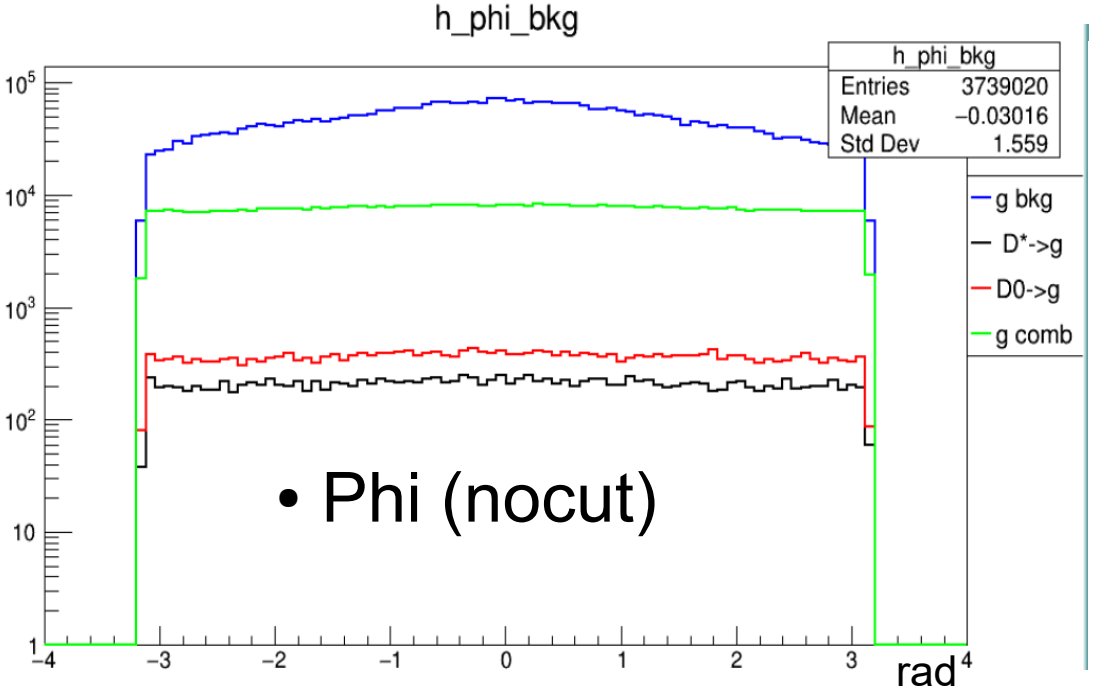
- Dst purity=N(Dst)/N(all)=0.4%

VARIABLES

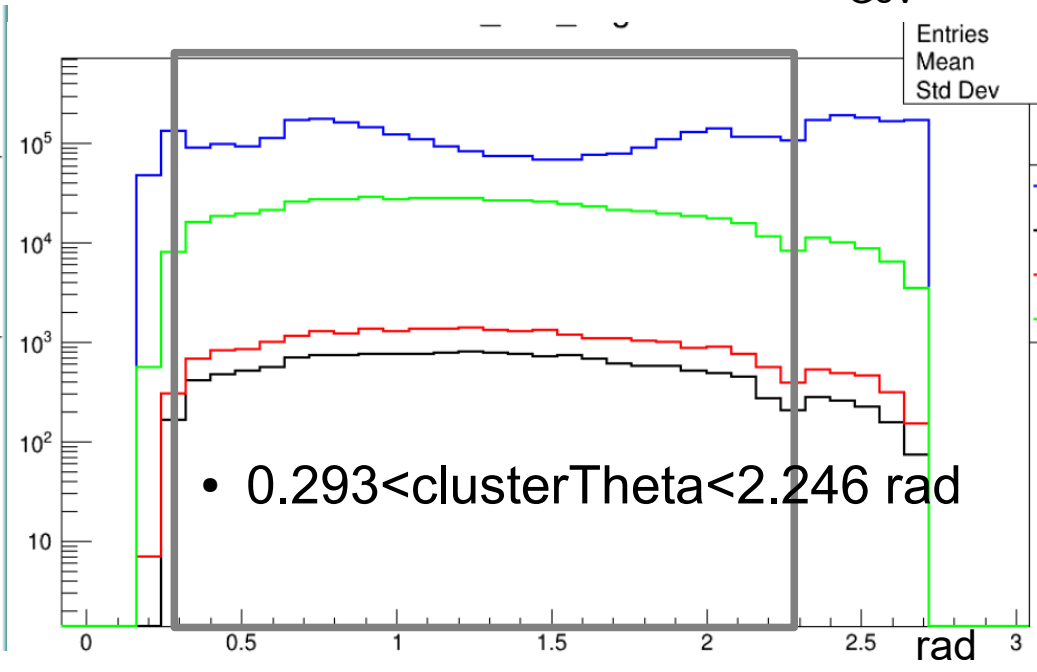




- 0.050<P<0.100 GeV/c

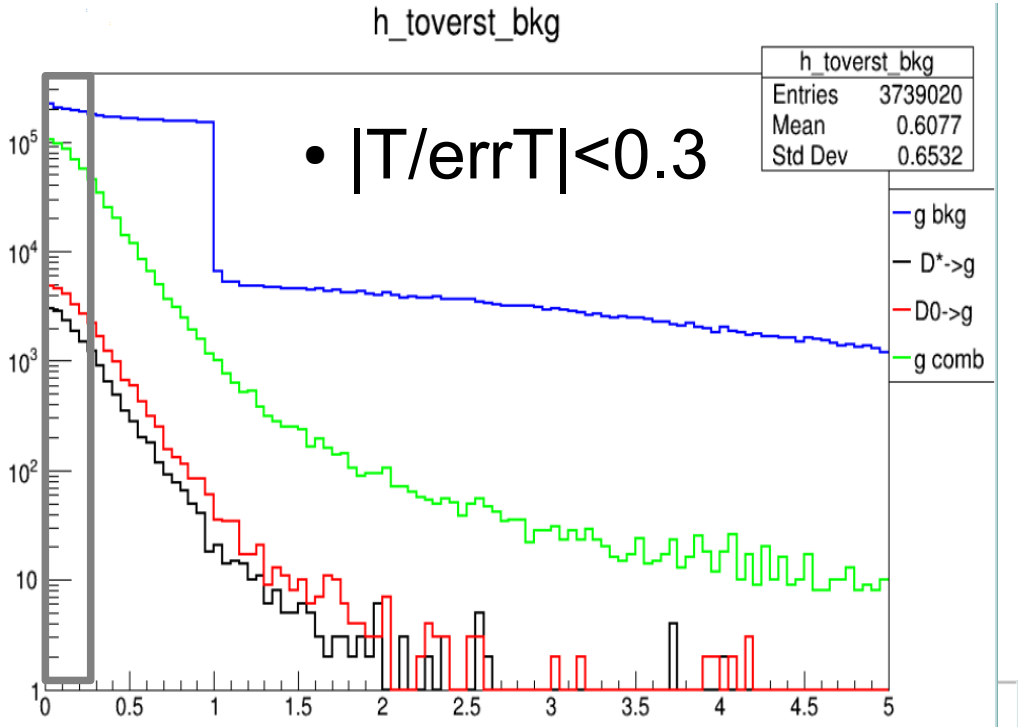


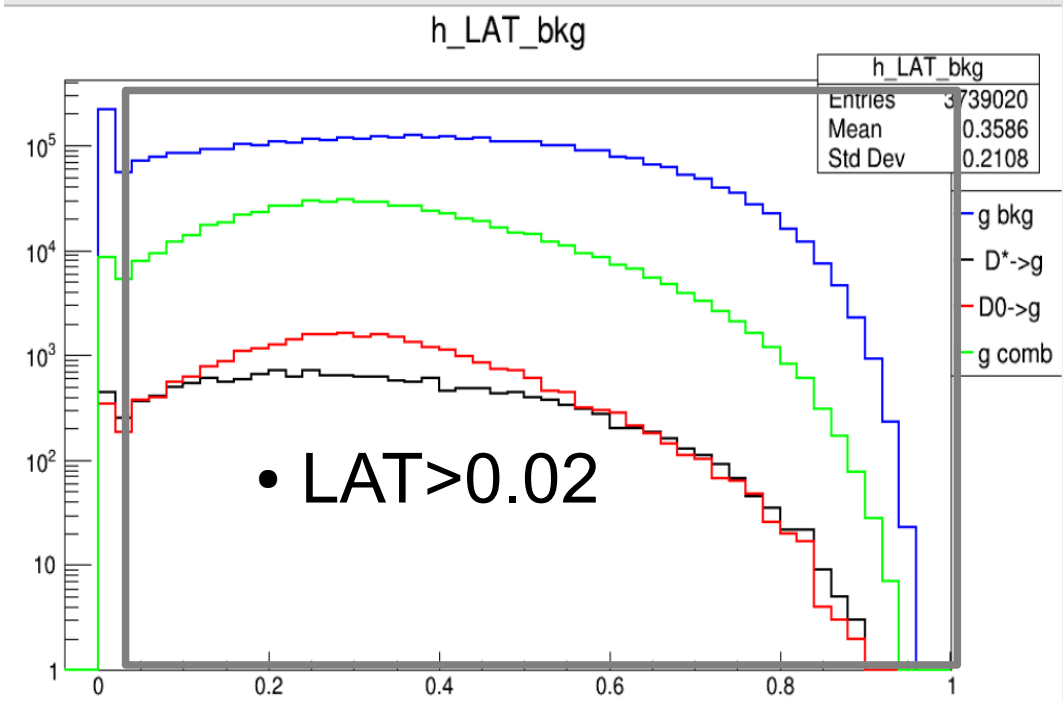
- Phi (nocut)

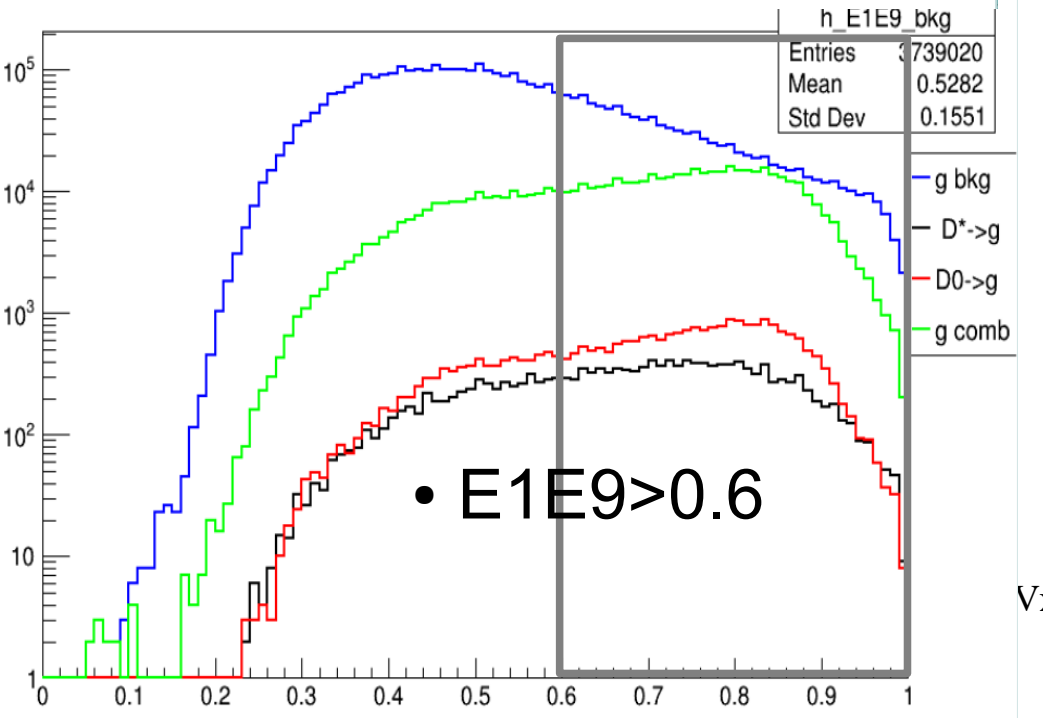


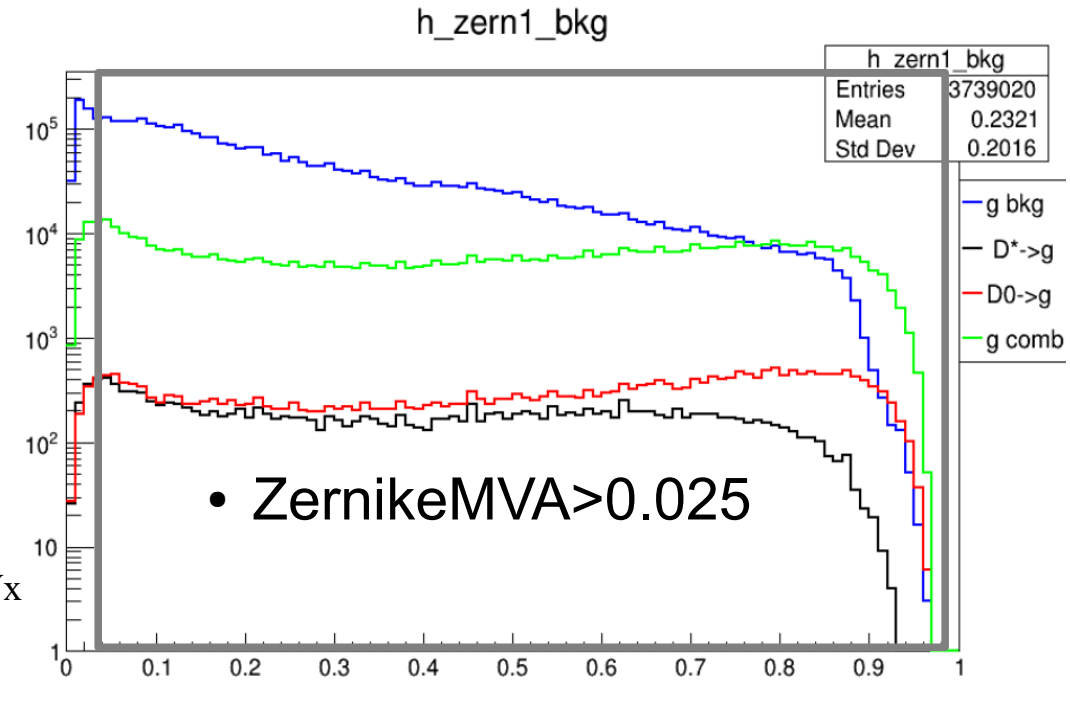
- 0.293<clusterTheta<2.246 rad

VARIABLES



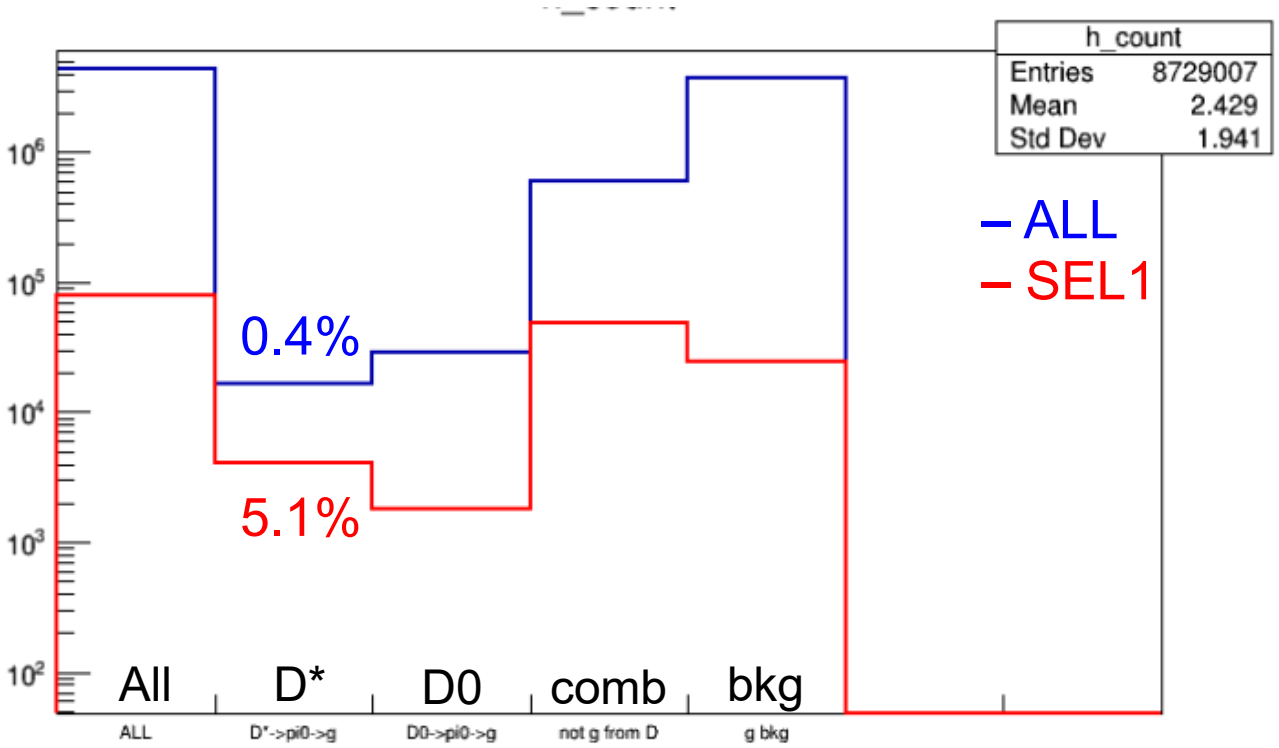






Vx

GAMMAS SELECTION RESULTS



SEL1:

- 0.050<P<0.100 GeV/c
- abs(T/sigmaT)<0.3
- clusterE1E9>0.6
- 0.293<clusterTheta<2.246 rad
- LAT>0.02
- ZernikeMVA>0.025

gammas	ε [%]	σε [%]
ALL	1,84	0,01
!Dst	1,75	0,01
D0	6,31	0,14
comb	8,05	0,04
g_bkg	0,661	0,004
Dst	24,68	0,34

- Gammas selection reject more than 99.3% of machine background photons, and more 98.3 % of !D* gammas, with 25% efficiencies on D* gammas
- Purity still not high, 5% (was 0.4%)

Π^0S SELECTION

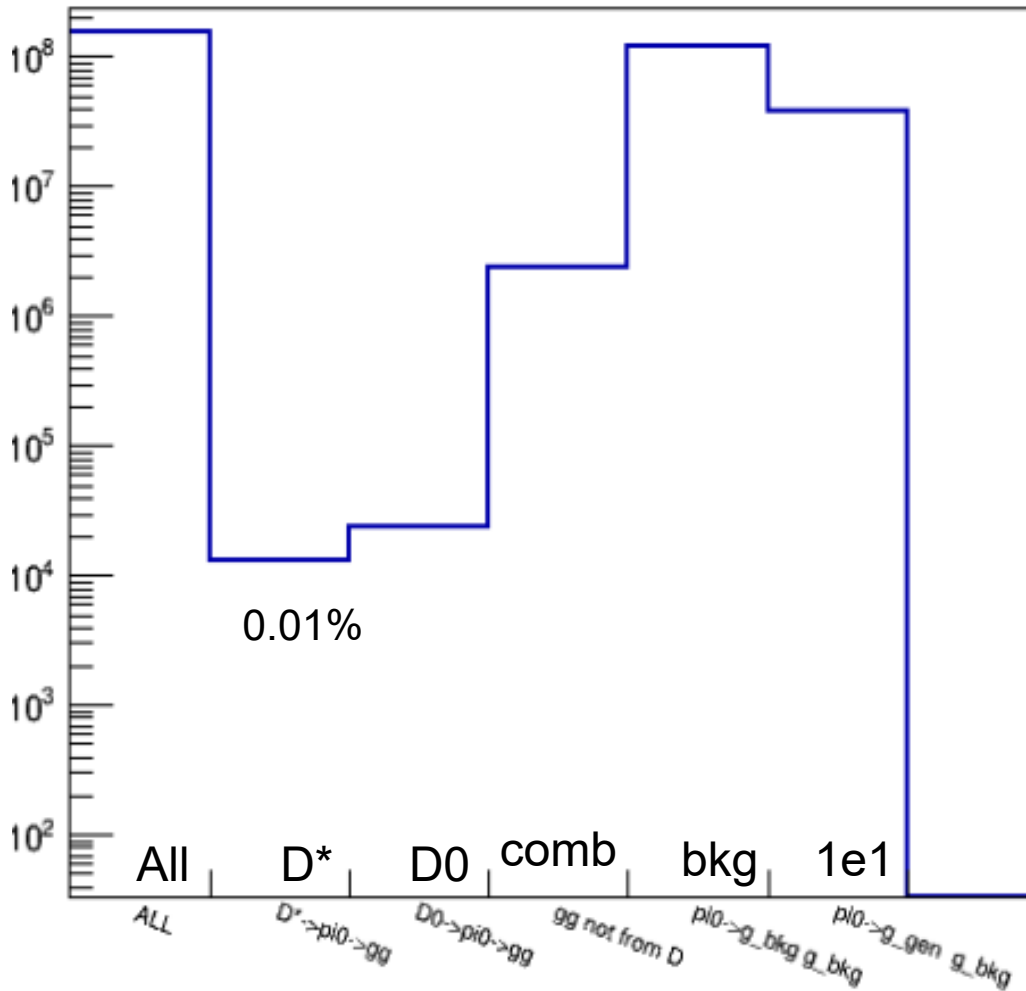
π0 SAMPLE

- GOAL: see effect of previous gammas selection (sel1) on π0s and add 2γ selection
- Generic BB with prerelease-03-00-00b for release3 validation
- π0_all list: all π0 from all gammas 2by2 combination

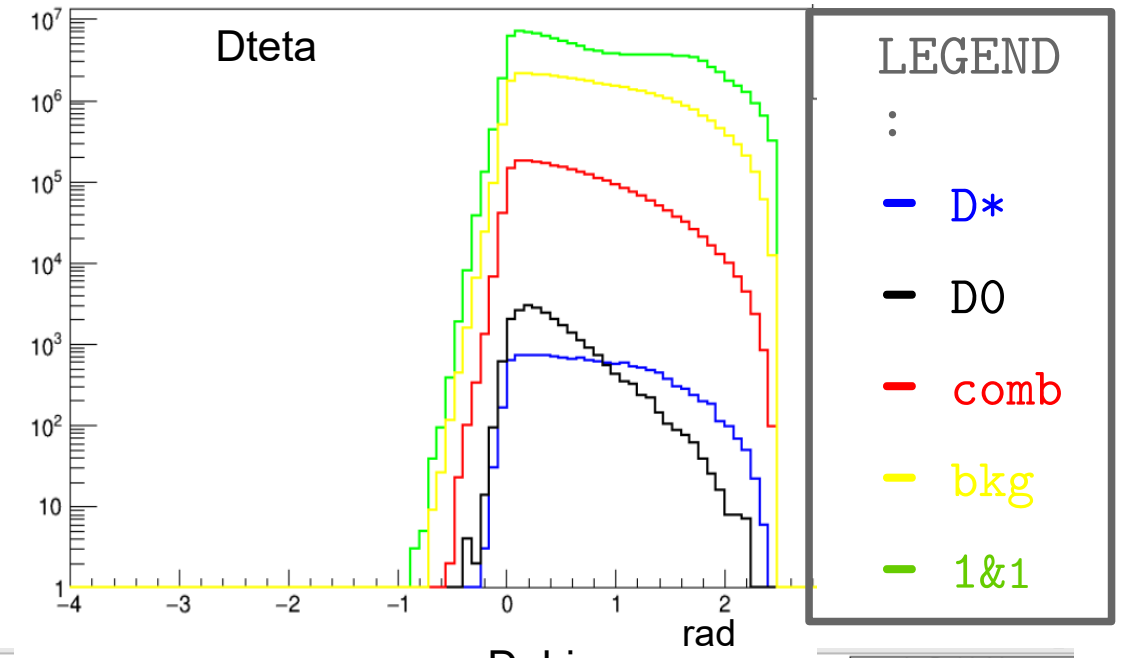
one cand = one π0

MC-TRUTH BASED CATEGORIES:

- D0: both gammas from physics, D0->π0->gg
- D*: gammas from physics, Dst->π0->γγ
- Comb:gammas from physics, at least one with GDM not D0 or D*
- Bkg: both gammas from machine bkg
- 1e1: one γ from physics and one γ from bkg

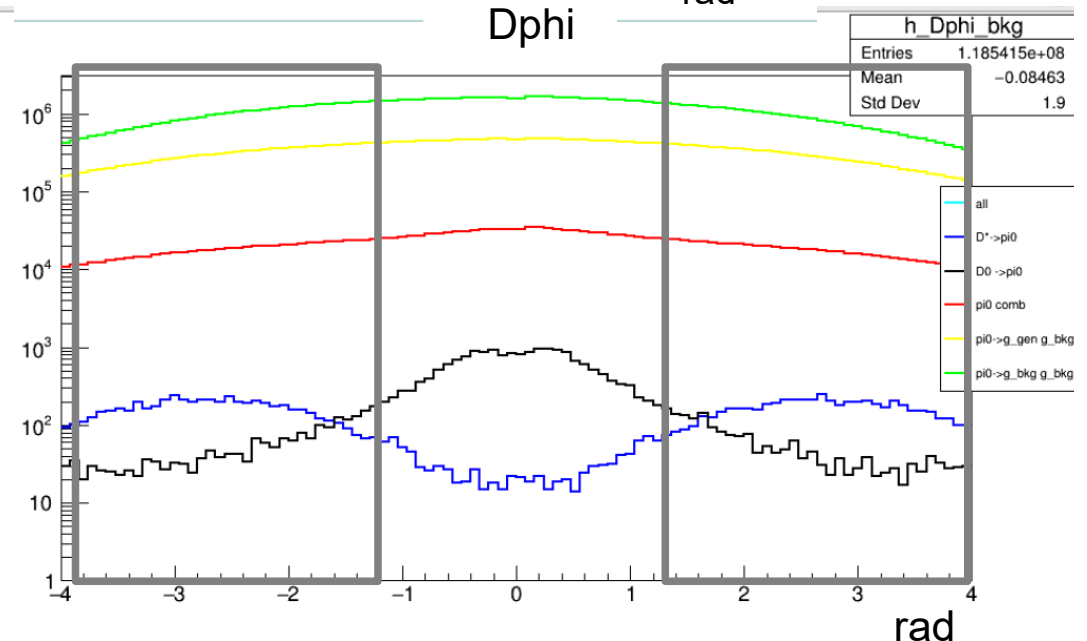


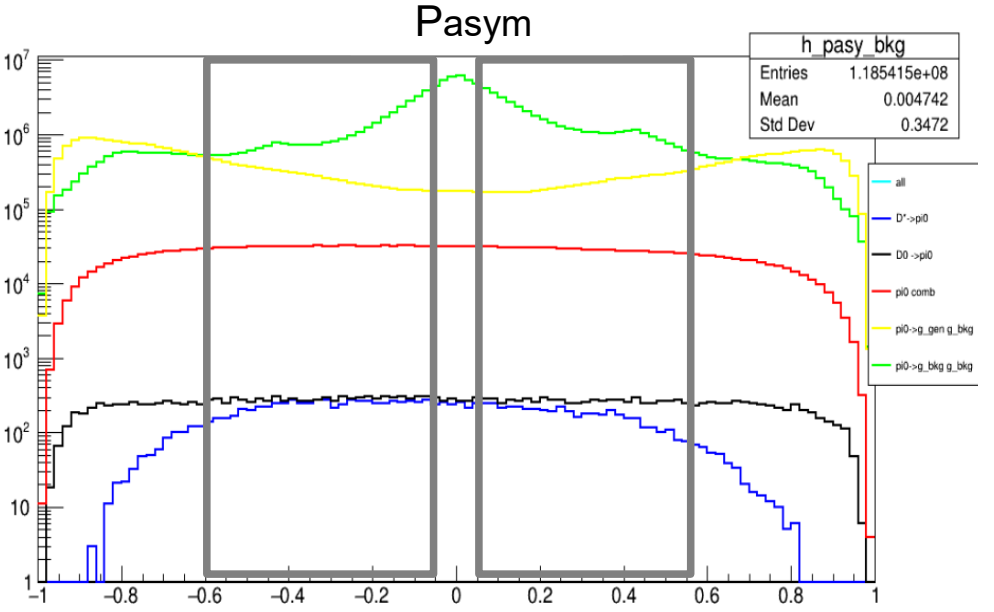
2PHOTONS SELECTION



- Dteta=teta_gamma1-teta_gamma2
- Dphi=phi_gamma1-phi_gamma2
- $P_{asym}=\frac{P\_gamma1-P\_gamma2}{P\_gamma1+P\_gamma2}$

SEL1+2:
- SEL1
- |Dphi|>1.2 rad
- 0.05<|Pasym|<0.55





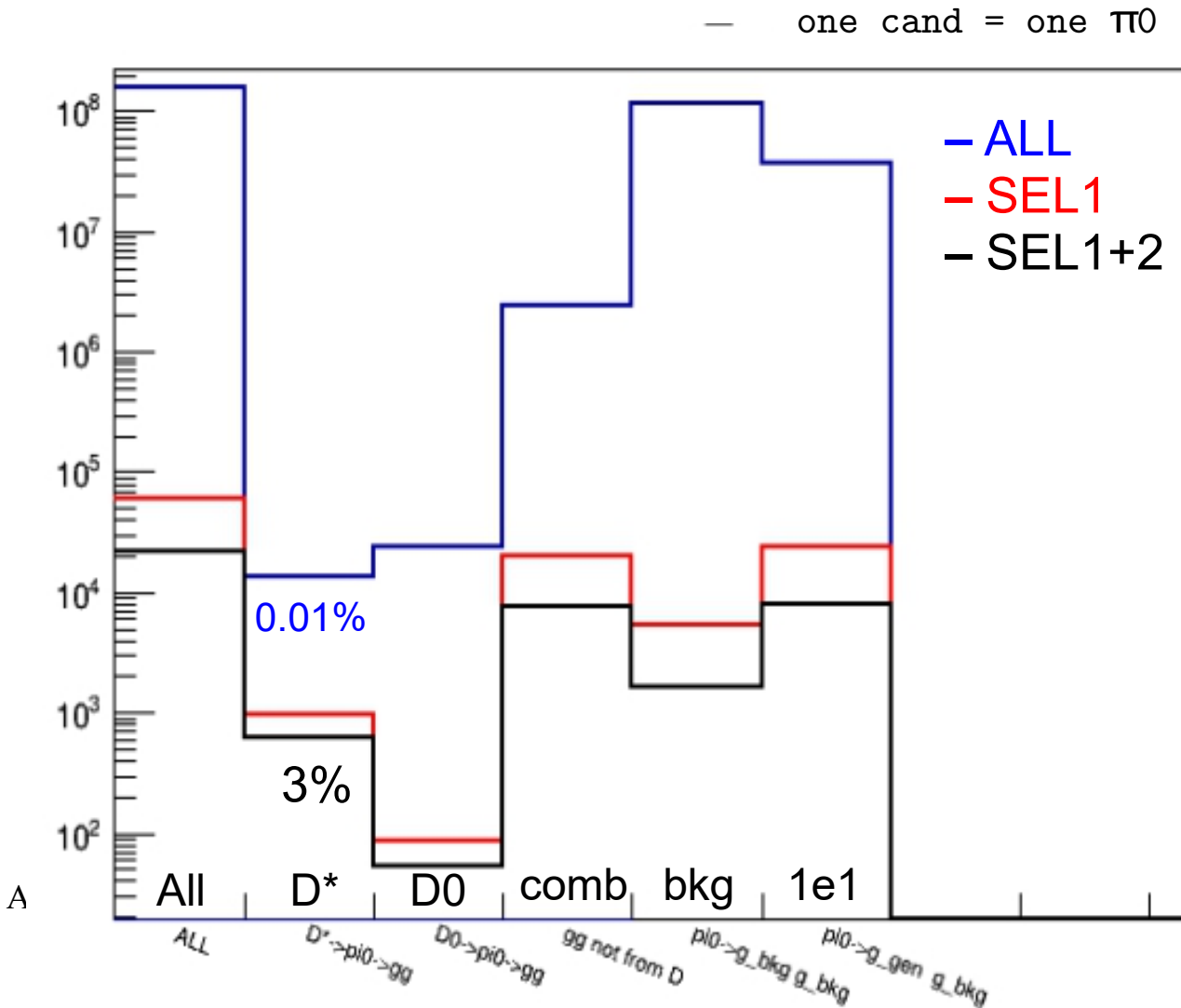
EFFICIENCIES OF π0 SELECTION

SEL1:
- 0.050<P<0.100 GeV
- abs(T/sigmaT)<0.3
- clusterE1E9>0.6
- 0.293<clusterTheta<2.246 rad
- LAT>0.02
- ZernikeMVA>0.025

SEL1+2:
- SEL1
- |Dphi|>1.2
- 0.05<|Pasym|<0.55 rad

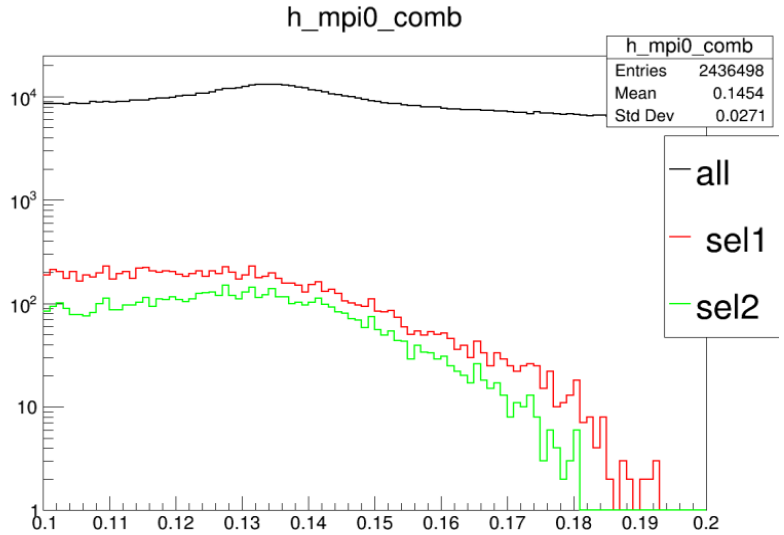
pi0s	ε [%]	σε [%]
ALL	0,013	$<10^{-4}$
!Dst	0,013	$<10^{-4}$
D0	0,22	0,03
comb	0,316	0,004
g_bkg	0,0014	$<10^{-5}$
1e1	0,022	$<10^{-3}$
Dst	4,65	0,18

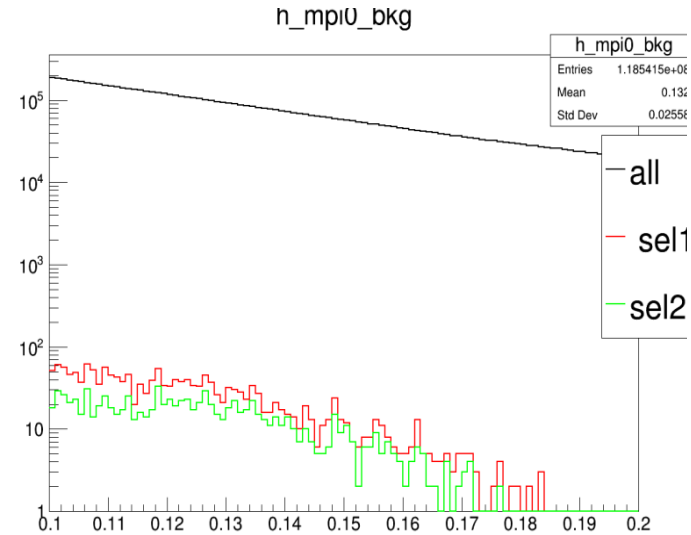
- π0s selection reject 99.987 % of !D* candidates, with 4.65% eff on D* π0s;
- Purity after selection still low, 3% (was 0.01%)

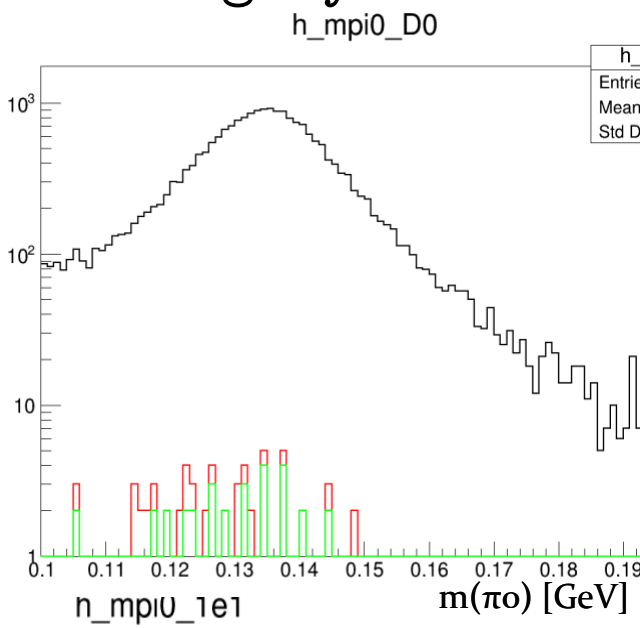


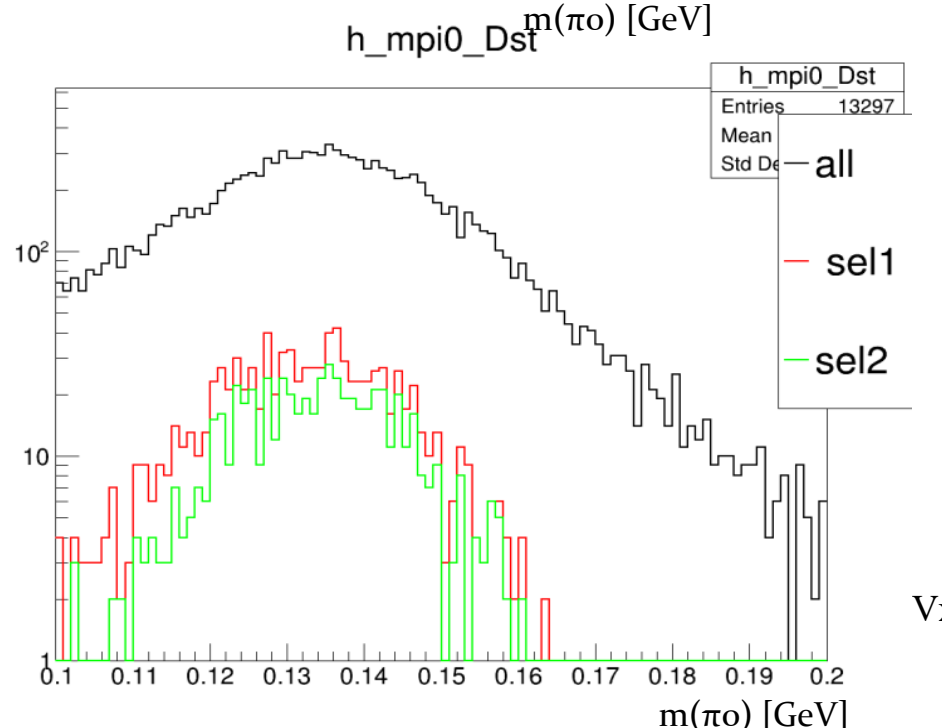
π0 MASS VS SELECTION

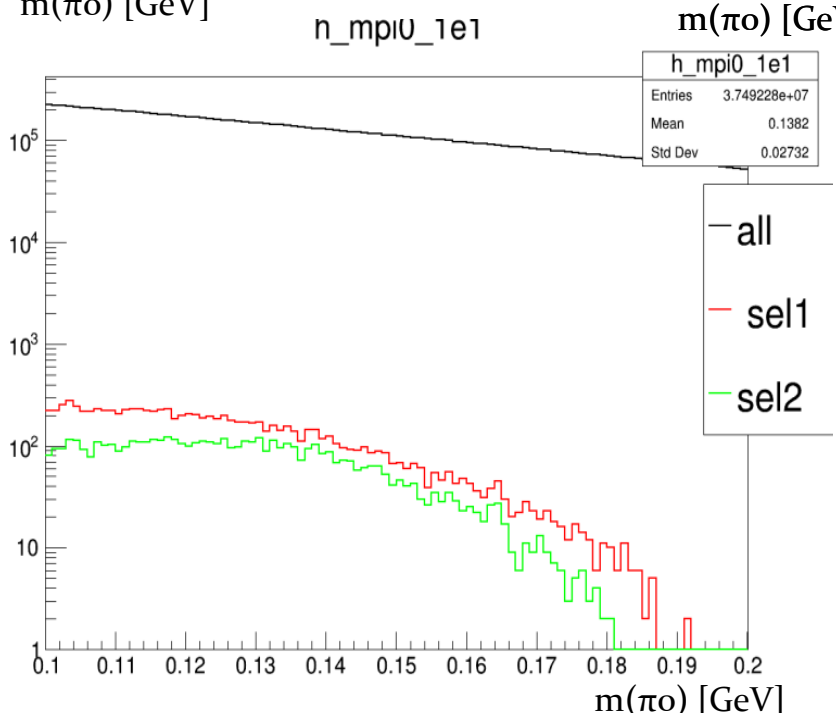
- Selection effect on π0 mass shape for each category







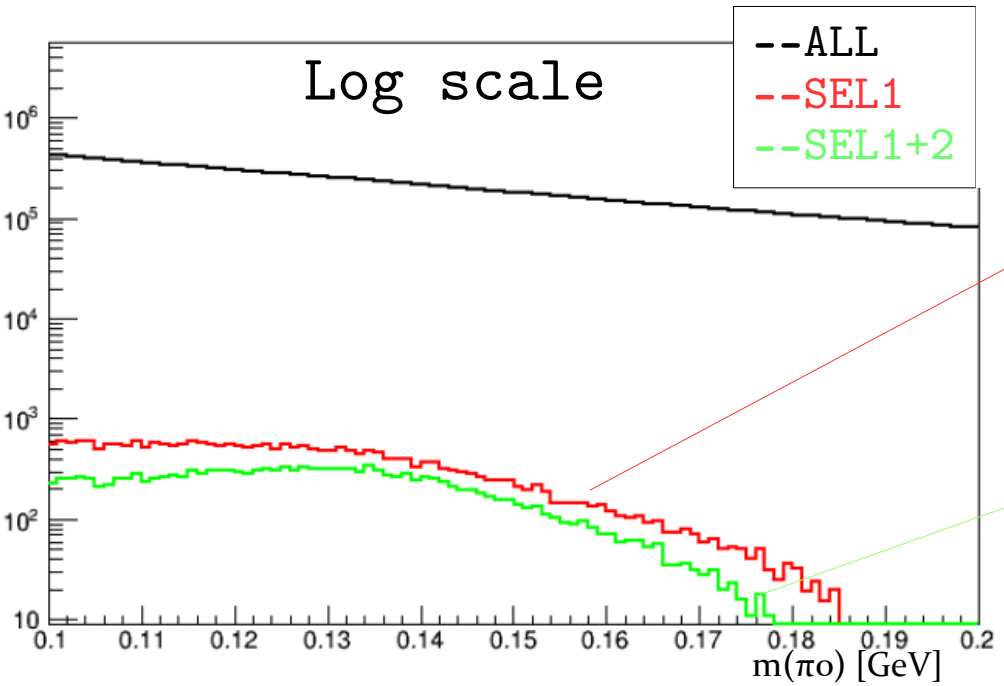


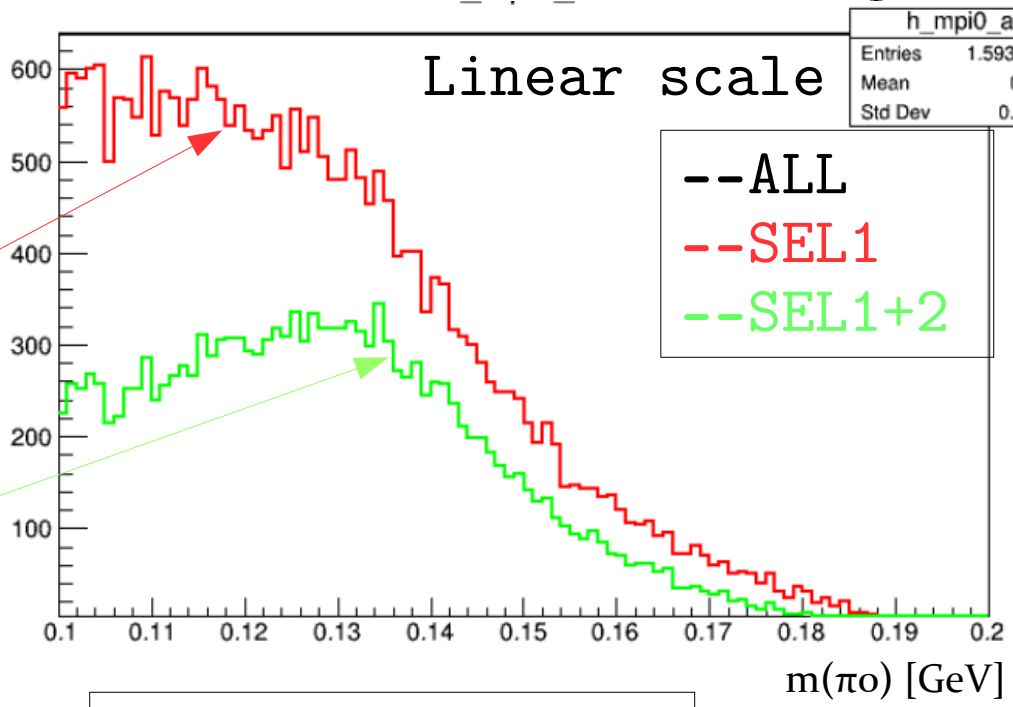


Vxb - 01April

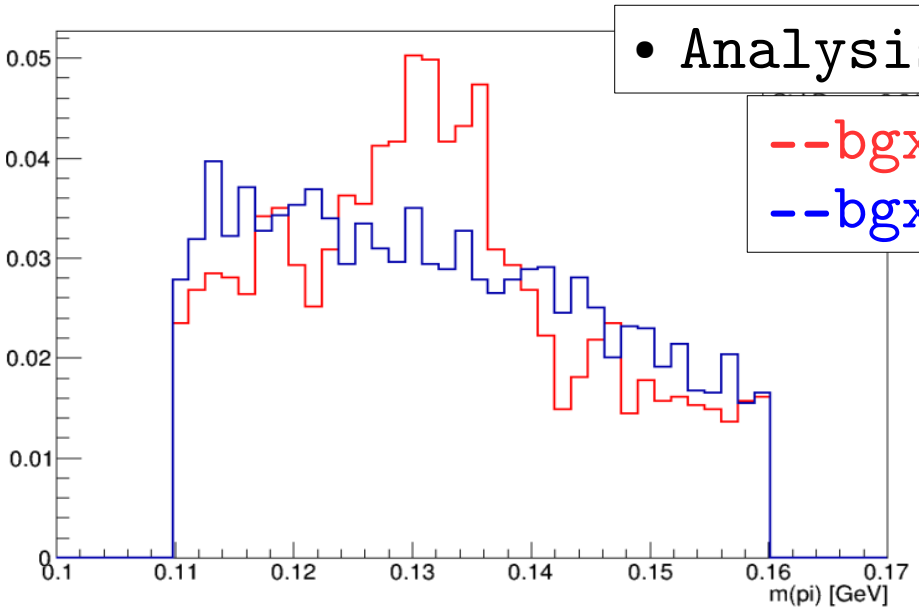
π0 MASS

- Selection effect on π0 mass shape for all candidates (π0 sample)





- Analysis sample



CONCLUSIONS

- Gammas selection reject 99.0% of machine background photons, and 98.3 of !D^* gammas, with 25% efficiencies on D^* gammas
- Selection could be applied as a soft photon selection (?)

SEL1:
- 0.050<P<0.100
- abs(T/sigmaT)<0.3
- clusterE1E9>0.6
- 0.293<clusterTheta<2.246
- LAT>0.02
- ZernikeMVA>0.025

- π^0s selection reject 99.987 % of !D^* candidates, with 4.6% eff on D^* π^0s;
- Purity after selection still low (3%, was 0.01%)
- More difficult categories to reject are combinatorial π^0 and π^0s with only one photon from machine background

SEL1+2:
- SEL1
- |Dphi|>1.2
- 0.05<|Pasym|<0.55

PLANS ON π0/GAMMAS & D0*

- GAMMAS&π0 SAMPLE:
  - Cut analysis optimization:
    - Improve cut optimization
    - MVA analysis (already started on FastBDT)

  - Apply gammas selection on single photons generated bgx1 samp
    to check if could be use as a general soft-photons selection

- ANALYSIS SAMPLE (D0*):
  - Apply π0s selection on D0* analysis sample to see
    if D* π0s mass distribution gets better

  - Define a candidate ranking that includes m(π0)

  - Start to look to D*->D0 g channel;
    if same problems appears, define a similar gammas selection

  - Switch to MC12 with hadFEI trained on MC10
    (sample already produced, waiting for MC11-12 training)

PLANS FOR PHASEIII DATA ANALYSIS

- Finalize soft gammas/π^0 selection, and document in a note
- Finalize analysis strategy for $B \to D^{0*} \ell^- \upsilon$, ready for DATA!
  ($D^{0*} \to D^0 \pi^0$ first, than $D^{0*} \to D^0 g$)
- Focus aon $B^0 \to D^{*+} \ell^- \upsilon$
  - No soft π^0, easier (?) to reconstruct

PLANS FOR PHASEIII DATA ANALYSIS

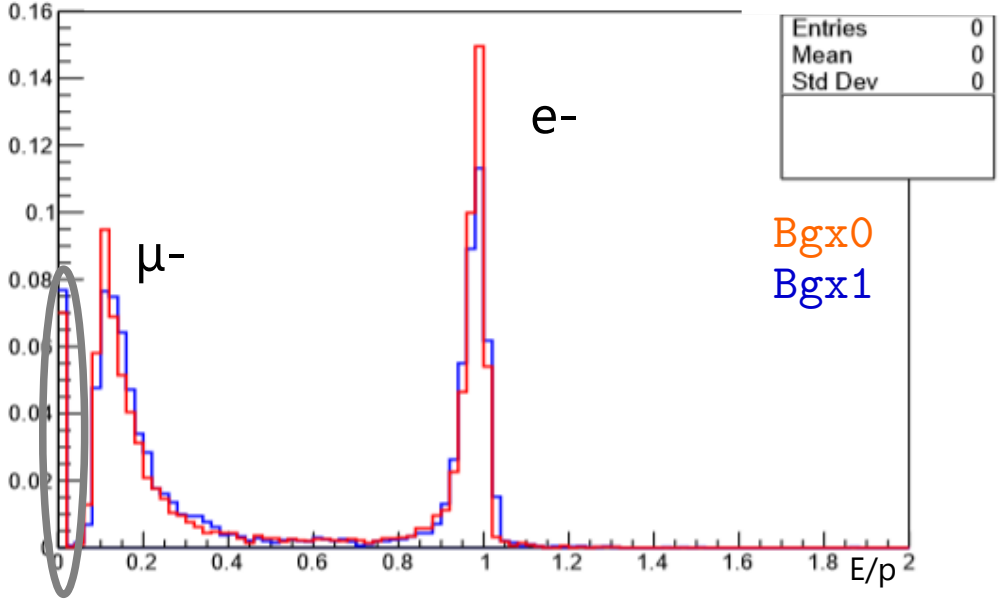
- Finalize soft gammas/π0 selection, and document in a note
- Finalize analysis strategy for B->D0*$\ell^-\upsilon$, ready for DATA!
  (D0*->D0π0 first, than D0*->D0g)
- Focus aon B0->D*$^+\ell^-\upsilon$
  - No soft π0, easier (?) to reconstruct

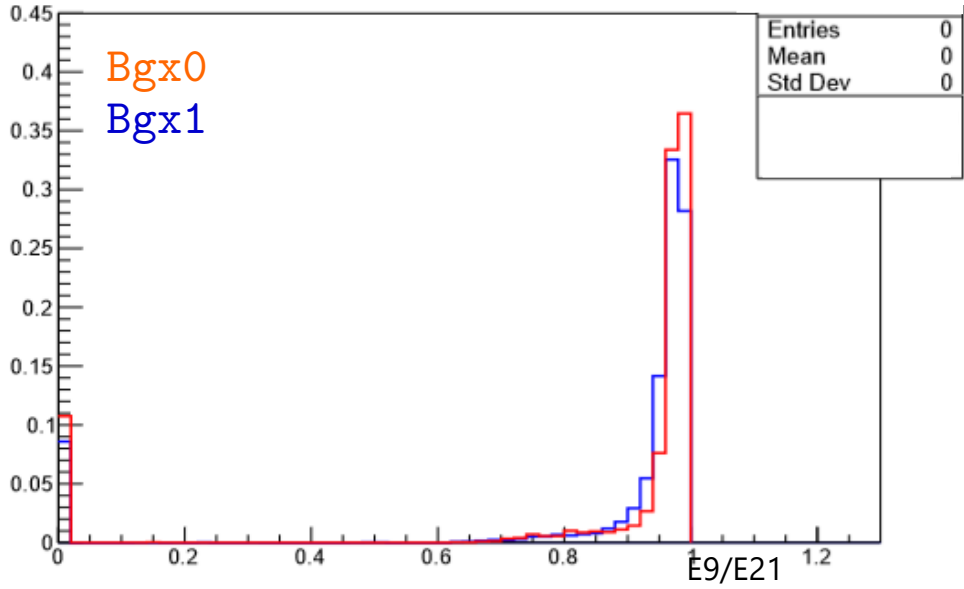
THANK YOU FOR YOUR ATTENTION

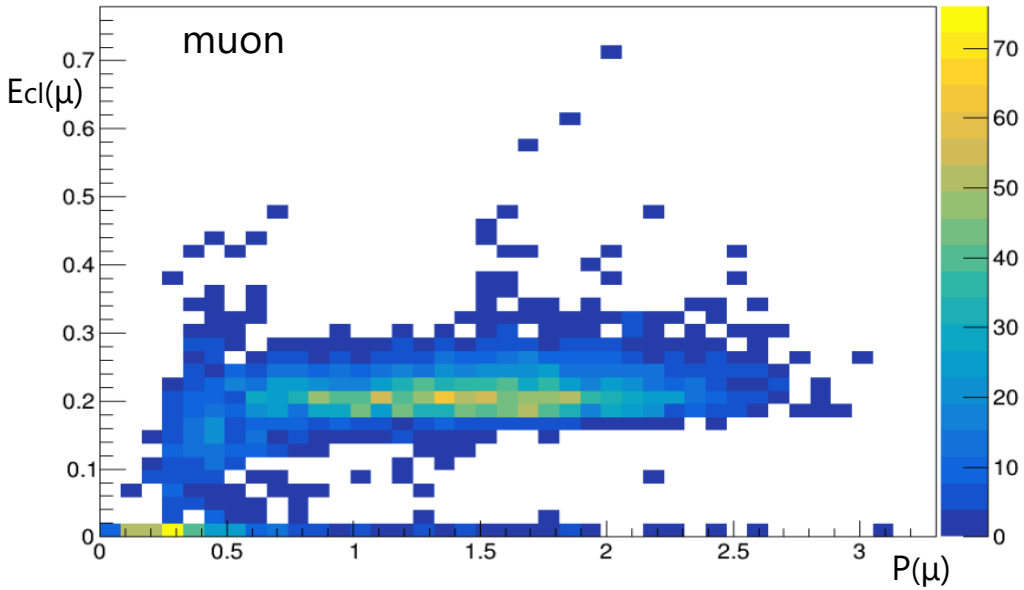
SPARES

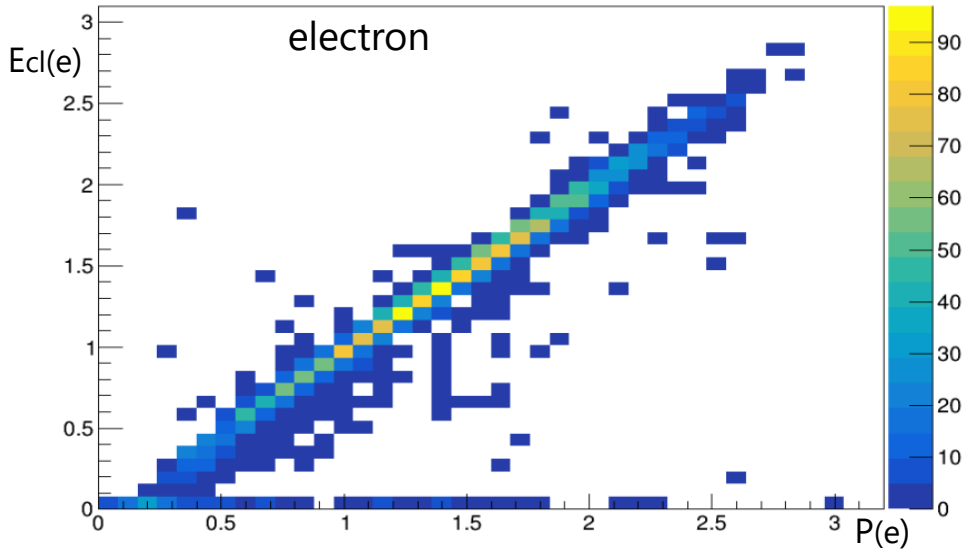
D*0lν MC PHASE III – LEPTONS

Good agreement between bgx0 and bgx1 shapes









Ecl=0 mainly due to low momentum muons

GAMMAS CATEGORIES

- GAMMAS:
- D0: gammas from physics, D0->π0->gg
  gamma_mcPDG=22&&gamma_Mother=111&&gamma_GDMother=421
- Dst:gammas from physics, D*->π0->gg
  gamma_mcPDG=22&&gamma_Mother=111&&gamma_GDMother=423
- Comb: generated gammas with not ftom D/D*
  GDmother_gamma!=421or423
- Bkg: gammas from machine bkg (gamma_mcPDG!=22)

```
# all photons (reconstructed using the N1 clustering)
if listtype == 'all':
    fillParticleList('gamma:all', 'clusterHasNPhotons', True, path)
# all photons within the cdc tracking acceptance: remove un track-matched
# electrons from outside the tracking acceptance
elif listtype == 'cdc':
    stdPhotons('all', path)
    cutAndCopyList(
        'gamma:cdc',
        'gamma:all',
        'theta > 0.296706 and theta < 2.61799',
        True,
        path)
```

πOs CATEGORIES

- D0: both gammas from physics,D0->π0->gg
- (gamma1/2_mcPDG=22&&gamma1/2_Mother=111&&gamma1/2_GDMother =421)
- Dst: gammas from physics,Dst->π0->g g
- (gamma1/2_mcPDG=22&&gamma1/2_Mother=111&&gamma1/2_GDMother =423)
- Comb:gammas from physics where at least one with GDM not D0 or D*
  (gamma1/2_mcPDG=22&& GDmother_ gamma1/2!=421or423)
- Bkg: both gammas from machine bkg (gamma1/2_mcPDG!=22)
- 1e1: one from physics and one from bkg (gamma1/2_mcPDG!=22 &&gamma2/1_mcPDG==22)

```
if listtype == 'all':
    stdPhotons('all', path)
    reconstructDecay('pi0:all -> gamma:all gamma:all', '', 1, True, path)
```