Studio delle performance di ECL

4th Belle-II Italian collaboration meeting,
Università di Roma 3,
December 22th, 2015

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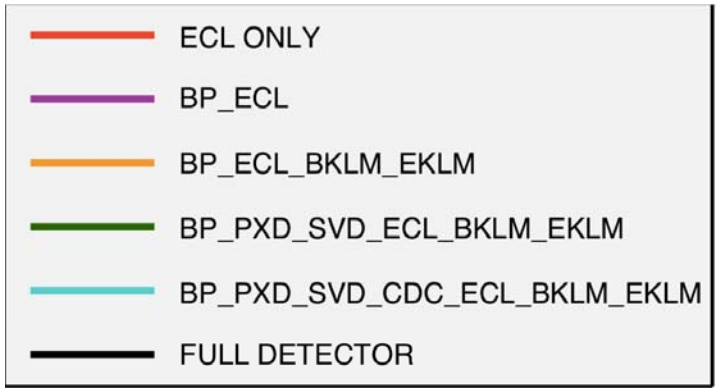
Outline

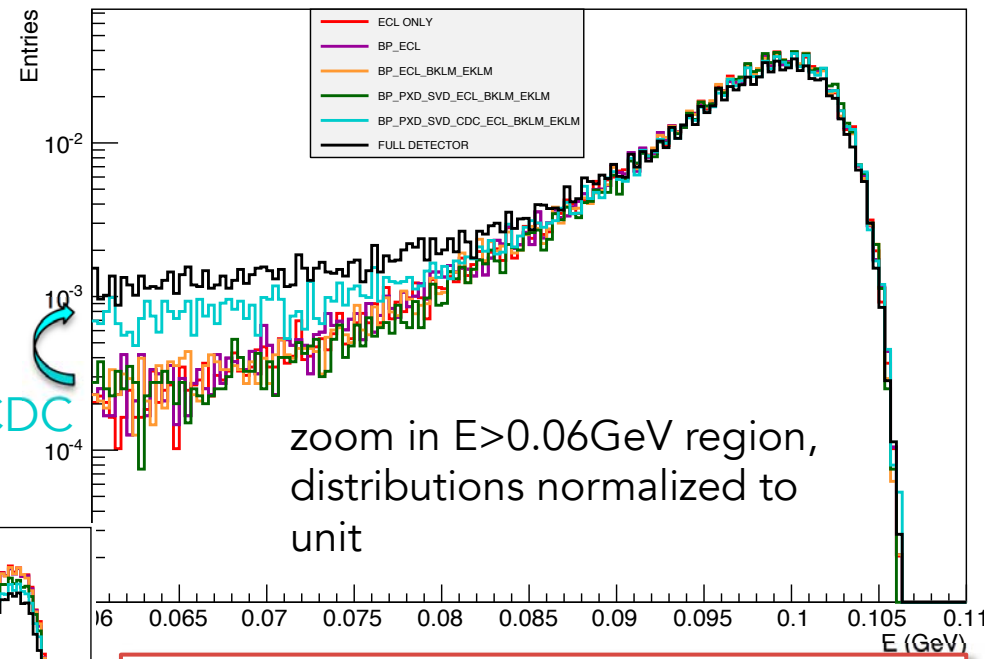
- FWD ECL performances as a function of material budget and angular acceprance
- Pile-up impact on energy resolution with single photons & official MC5 production

just a short summary today, all the details at last B2GM

- Ad-hoc reconstructed energy correction for release-00-06-00

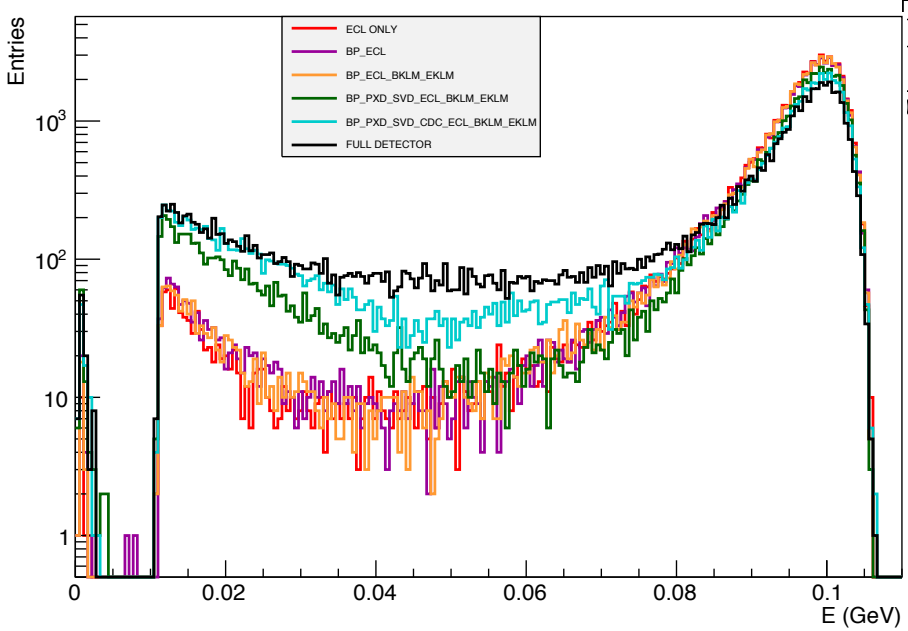
Reco'd energy distribution, FWD region, 100 MeV





ADD CDC

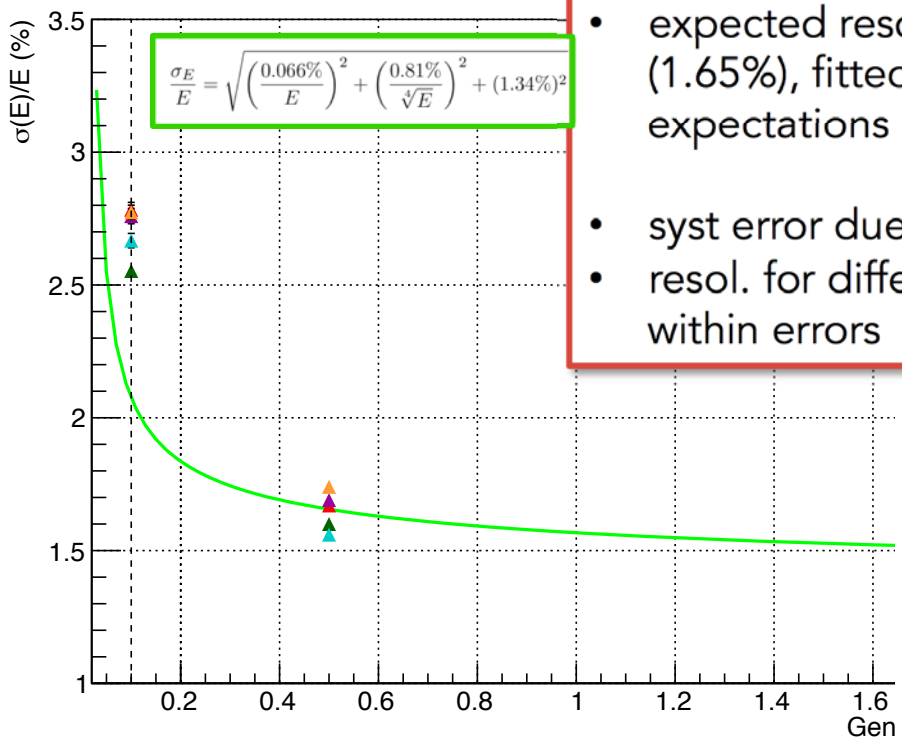
zoom in E>0.06GeV region, distributions normalized to unit



- In the fit region (E>0.06GeV), largest effects when adding CDC, SVD+PXD doesn't seem to have a big effect here
- SVD+PXD effect evident in the low energy region
- Black, Cyan and Green configs seem to have a narrower peak wrt other configs: events from peak region to tail, due to cluster splitting

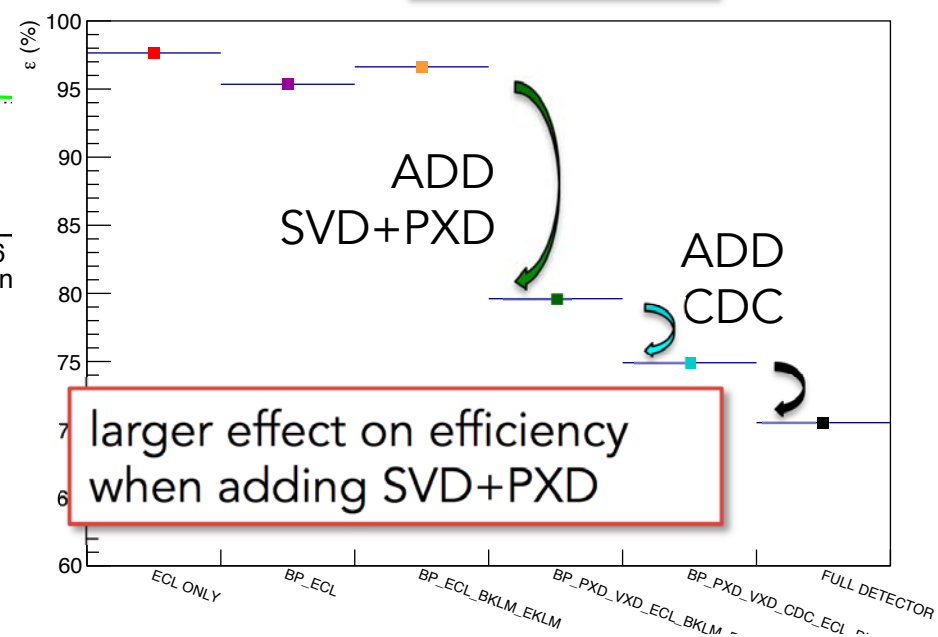
Material budget effect: resolution summary

Energy resolution



- expected resolution @ 100 MeV (500 MeV): 2.07 % (1.65%), fitted values far from (in agreement with) expectations
- syst error due to change in fit range ~ 0.1%
- resol. for different detector configs compatible within errors

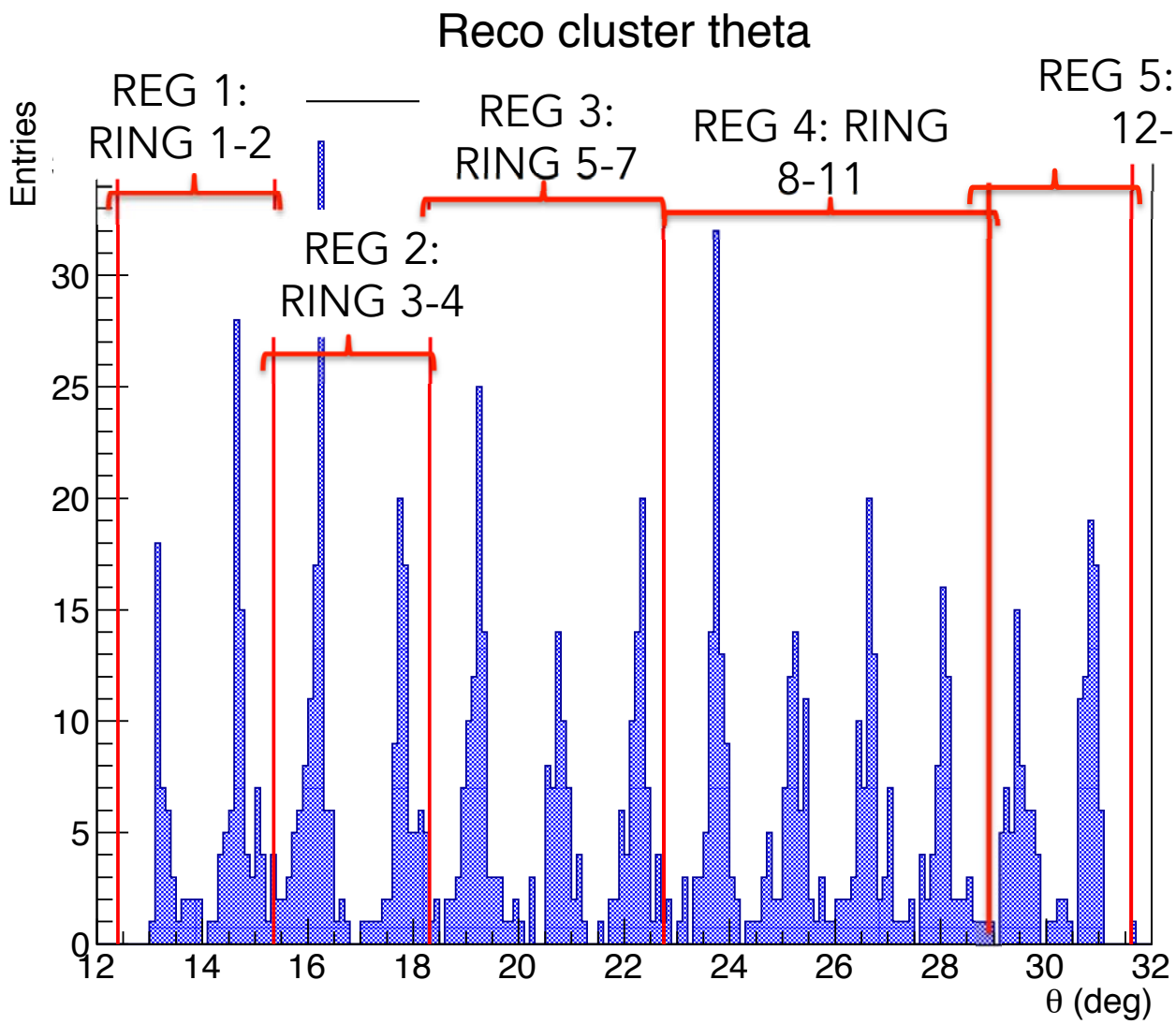
Efficiency (0.06-0.105 MeV range)

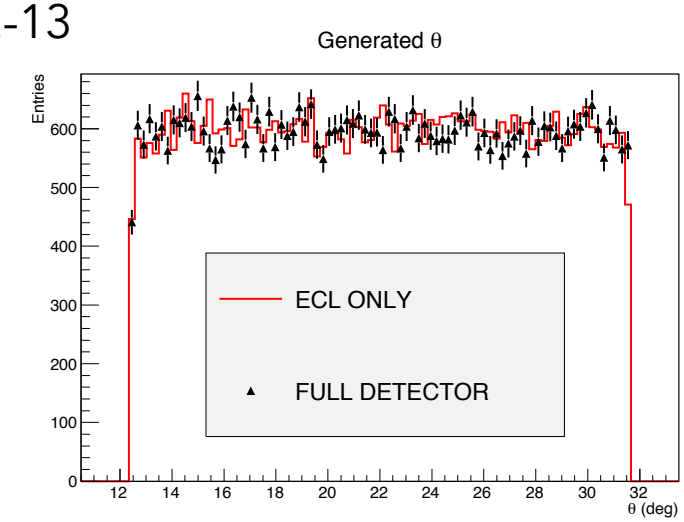


larger effect on efficiency when adding SVD+PXD

single photons, NO MACHINE BKG, fitted points in fwd ECL acceptance

FWD angular acceptance: selected sub-regions

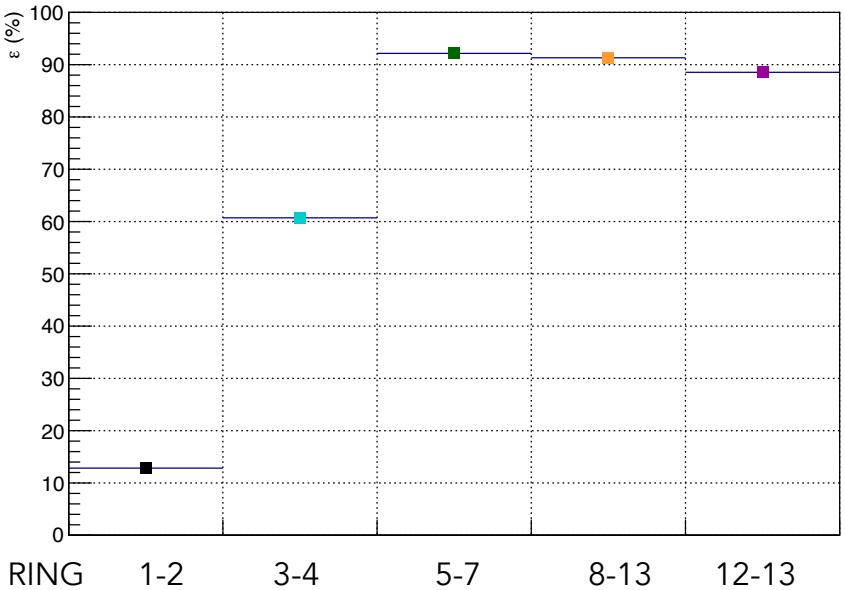




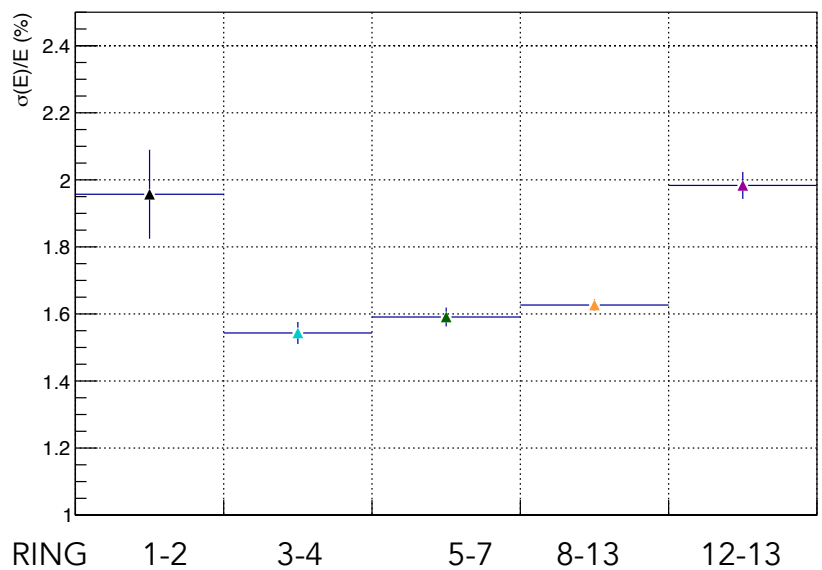
- events generated with 'thetaParams': [12.398°, 31.62°] with uniform distribution

FWD angular acceptance: resolution and efficiency summary @ 500 MeV

efficiency (0.4-0.53 MeV range)



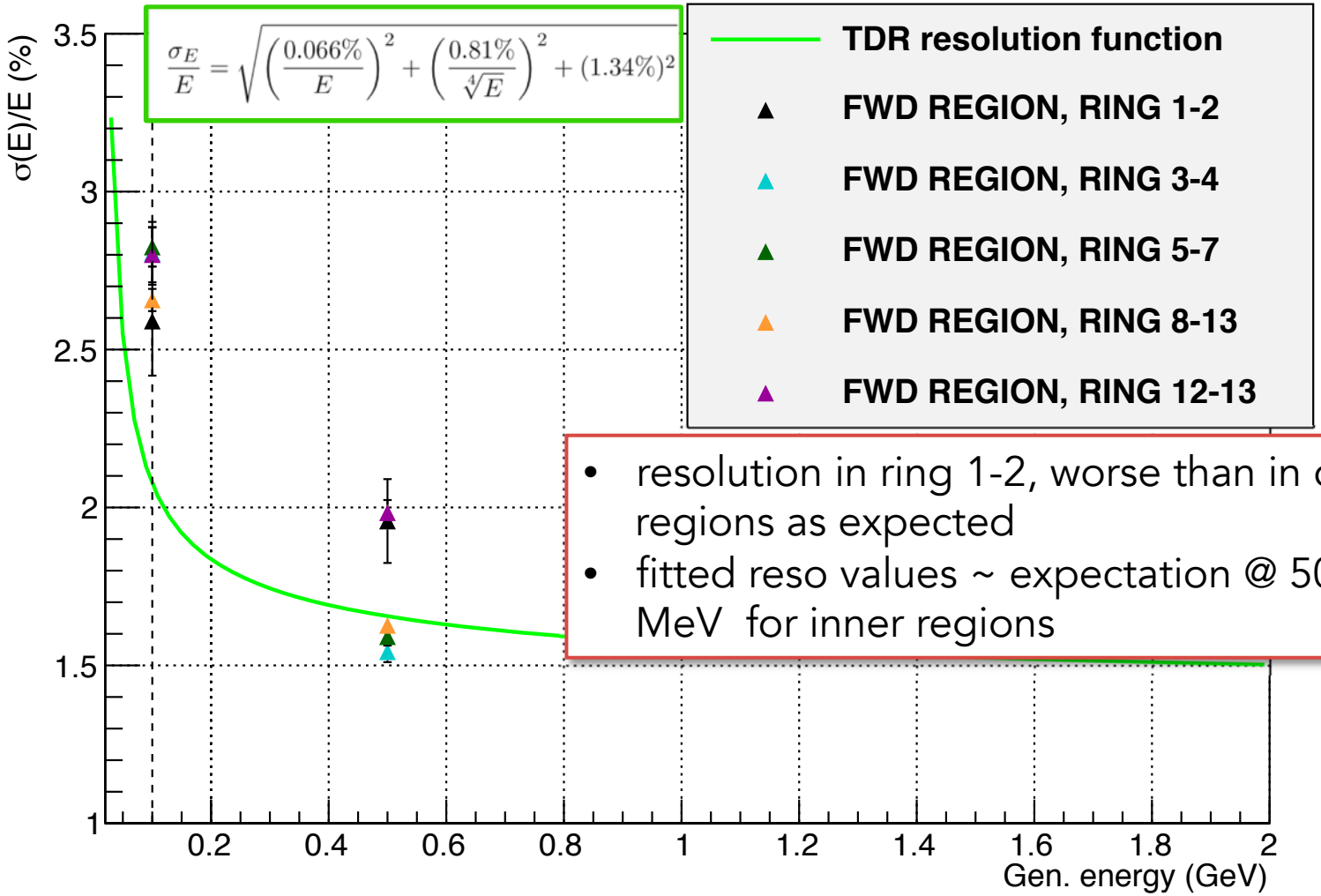
resolution from CB fit



single photons,
NO MACHINE BKG,
fitted points in
fwd ECL acceptance

FWD angular acceptance: resolution summary

Energy resolution



- resolution in ring 1-2, worse than in other regions as expected
- fitted reso values ~ expectation @ 500 MeV for inner regions

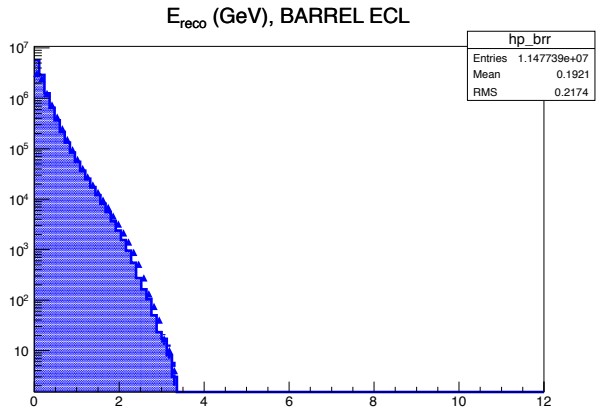
– histo = reconstructed energy
– ▲ = generated energy

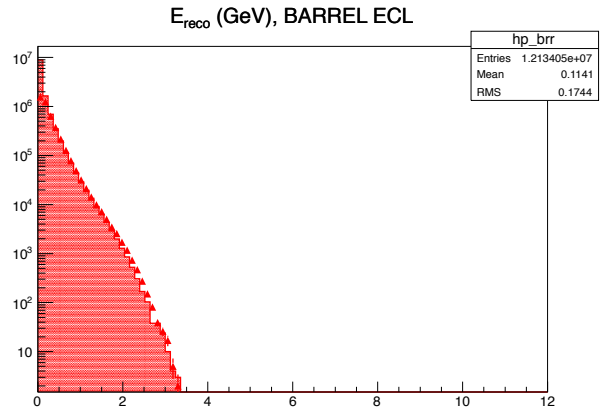
MCS BOBobar sample

Pile-up and resolution: Energy spectra

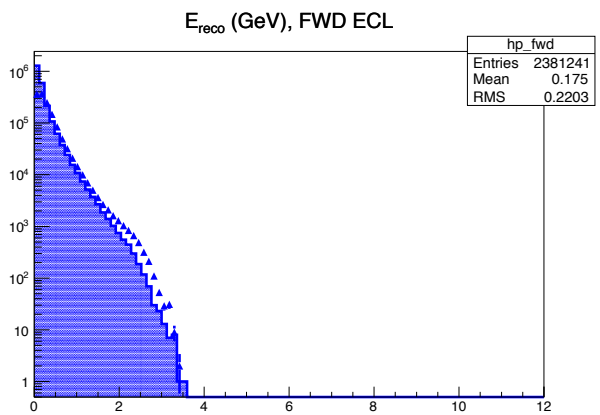
w/o machine bkg | w machine bkg

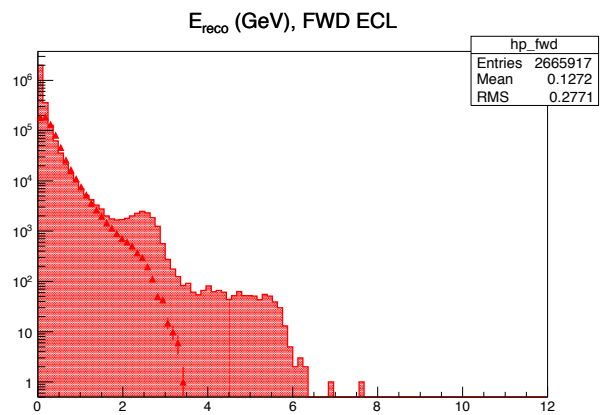
BARREL





FWD





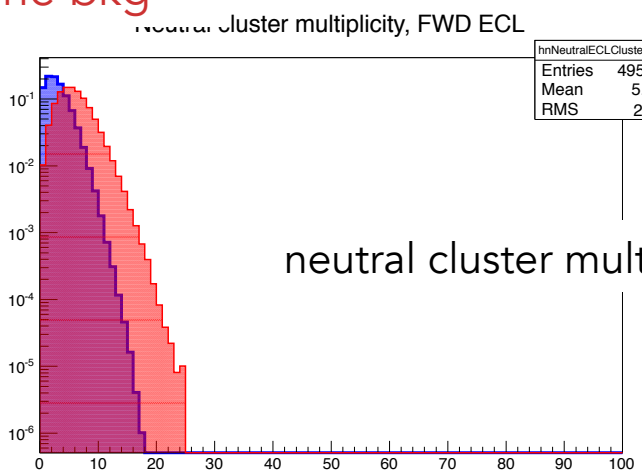
- similar shape for generated spectra w and w/o machine bkg both for barrel and fwd
- unexpected peaks in the above-2-GeV region for FWD region w bkg: few hard machine bg-frame event hitting 1 xtal of Ring 4, re-used several time

MCS BOBObar sample

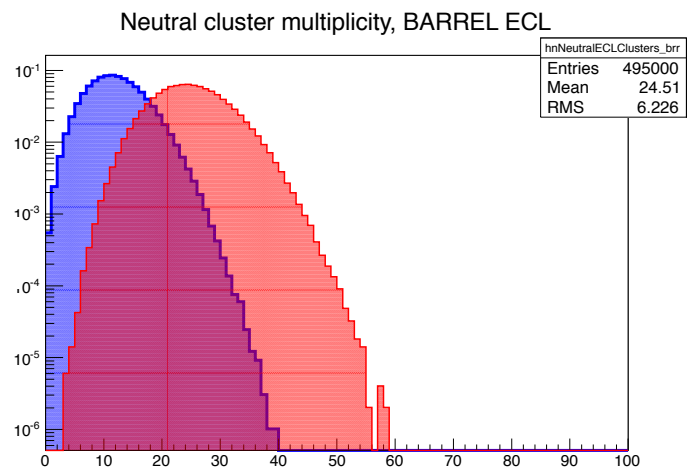
Pile-up and resolution: W bkg vs and W/o bkg

w/o machine bkg
w machine bkg

FWD

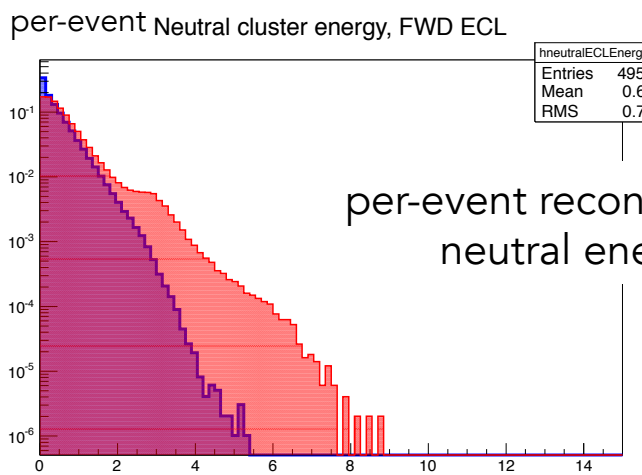


BARREL

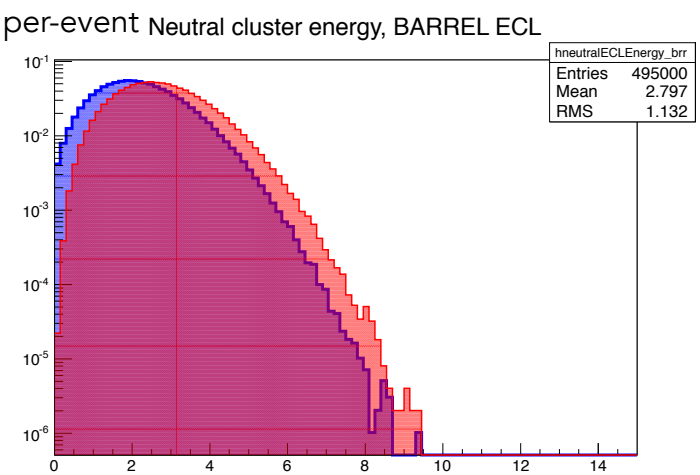


neutral cluster multiplicity

per-event



per-event



per-event reconstructed neutral energy

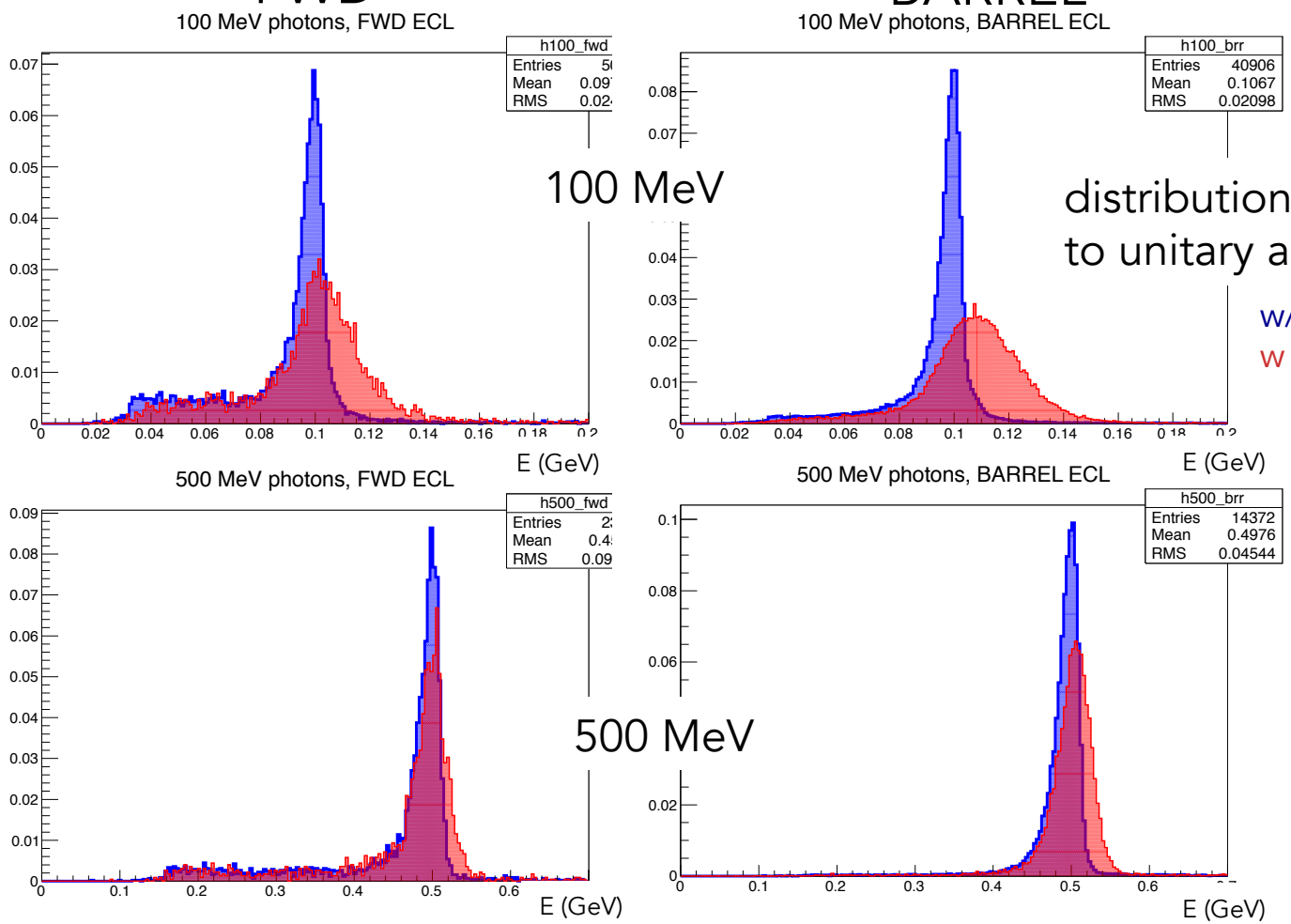
- large shift in neutral cluster multiplicity and per-event reco'd energy in presence of bkg as expected

MCS BOBObar sample

Pile-up and resolution: some distributions

FWD

BARREL



100 MeV

500 MeV

distribution normalized to unitary area

w/o machine bkg

w machine bkg

- shift in peak position and distribution smearing in presence of machine bkg

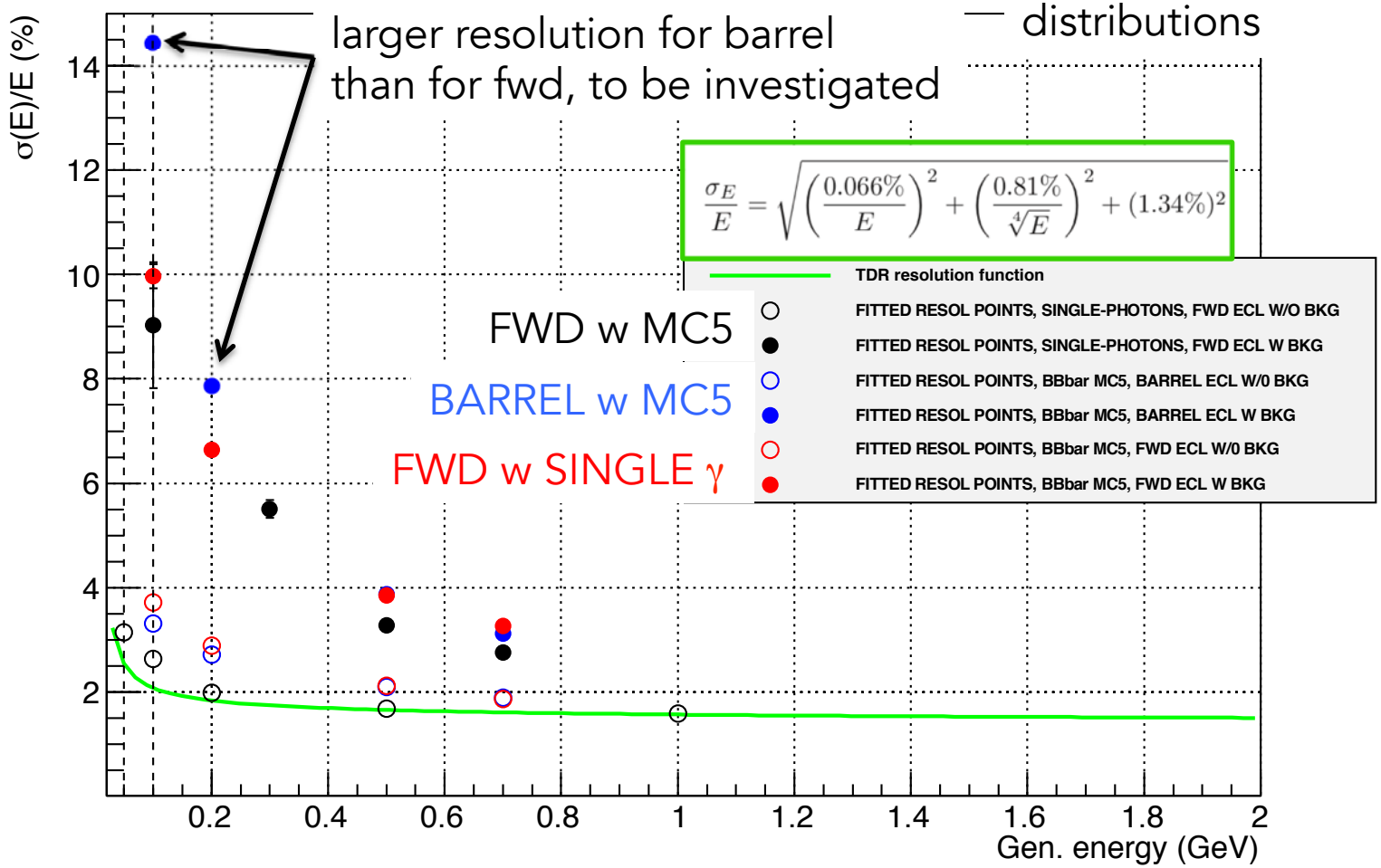
Pile-up and resolution: summary

MC5 BOBobar
+ single photons

Energy resolution

Resolutions from Crystal-Ball fits to reconstructed energy distributions

larger resolution for barrel than for fwd, to be investigated



$$\frac{\sigma_E}{E} = \sqrt{\left(\frac{0.066\%}{E}\right)^2 + \left(\frac{0.81\%}{\sqrt[4]{E}}\right)^2 + (1.34\%)^2}$$

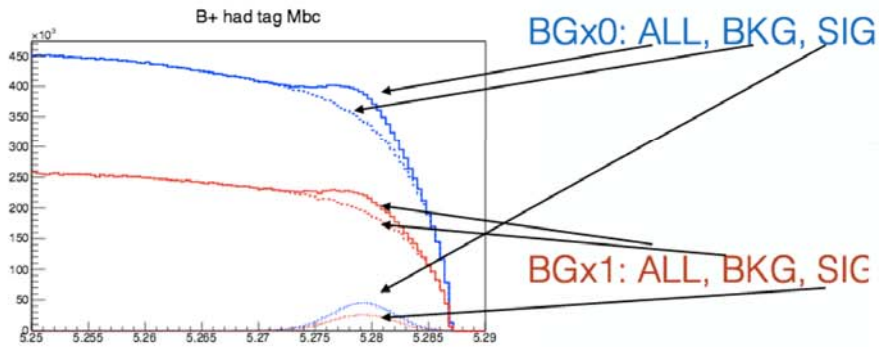
Ad-hoc energy correction: aim and samples

- Shift in reco'd neutral energy observed in MC5 sample
- Large impact on physics, e.g.:

First look at the samples

Q: Does FEI trained on MC sample without beam background (BGx0) perform well on a MC sample with beam background (BGx1)?

A: No. The reconstruction efficiency is for about 40% lower, while the purity seems to be the same. The reason for lower efficiency is IMO the photon energy bias in the case of BGx1 sample, which in turn introduces shift in m(pi0), m(D0) and Delta E in Btag modes including pi0s.



BGx1 histograms are scaled up by factor of 4 on account of difference in sample sizes (80 vs. 40 fb-1)

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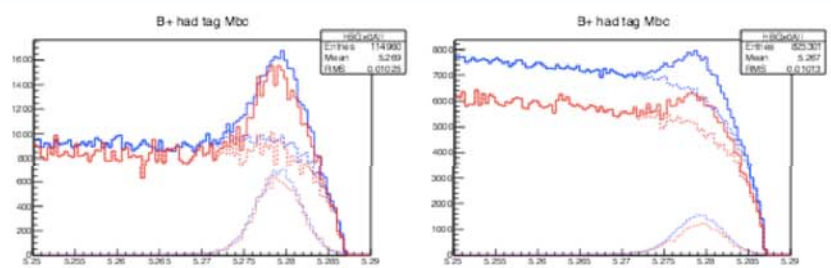
Anze Zupanc at last WG1 meeting, Dec 16th 2015

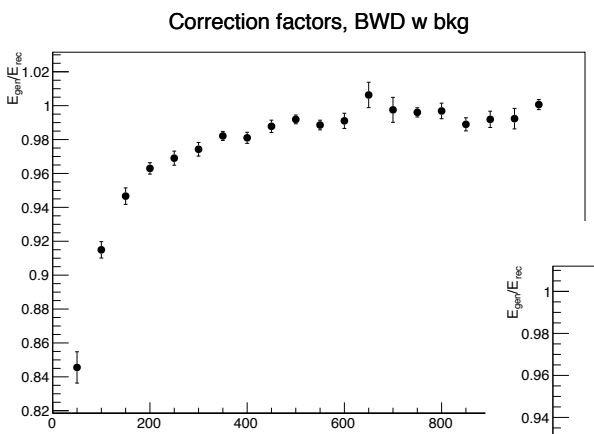
$B^- \to D^0\pi^-$ $\quad$ $B^- \to D^0\pi^-\pi^0$

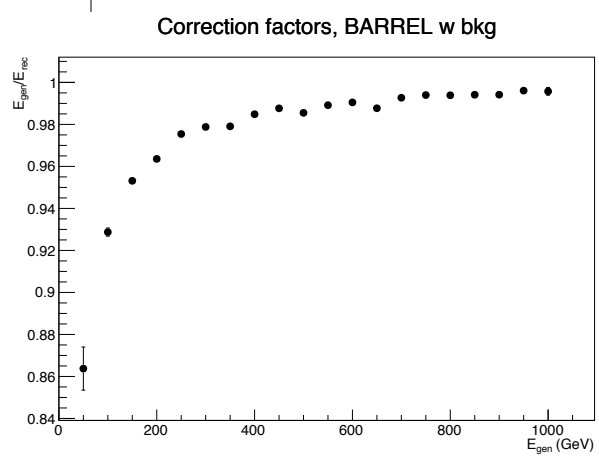


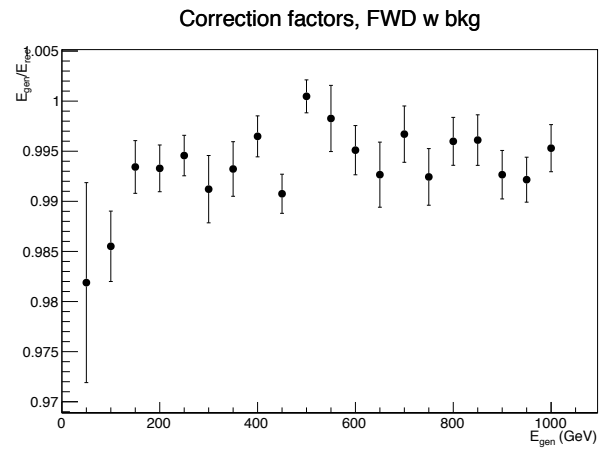
($D^0 \to K^+\pi^-$)

Ad-hoc energy correction: strategy

- Use MC5 OFFICIAL PRODUCTION : B0B0bar generic events w and w/o machine bkg superimposed
- E_{rec} from Novosibirsk fits to reco'd energy distribution for different energy points
- Look-up table provided with correction factors



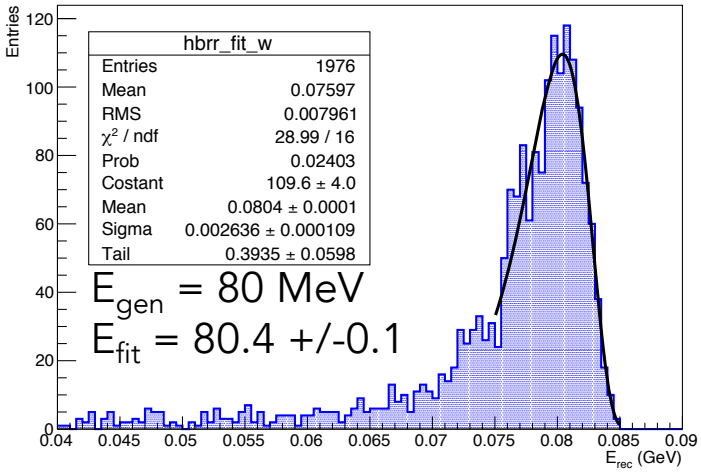




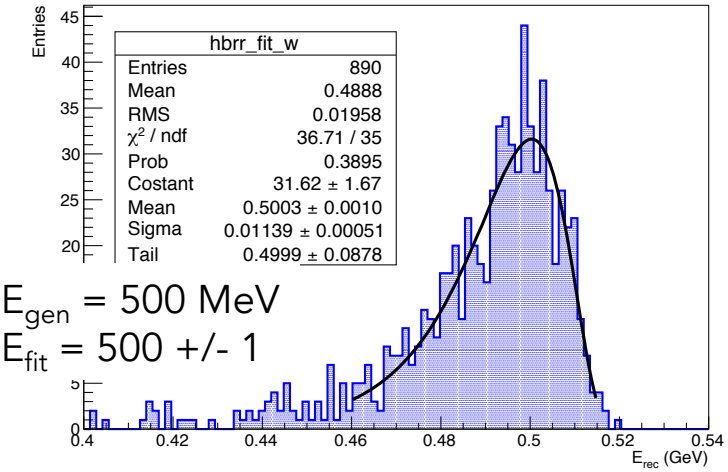
(smaller effect in no-bkg sample)

Ad-hoc energy correction: validation (I)

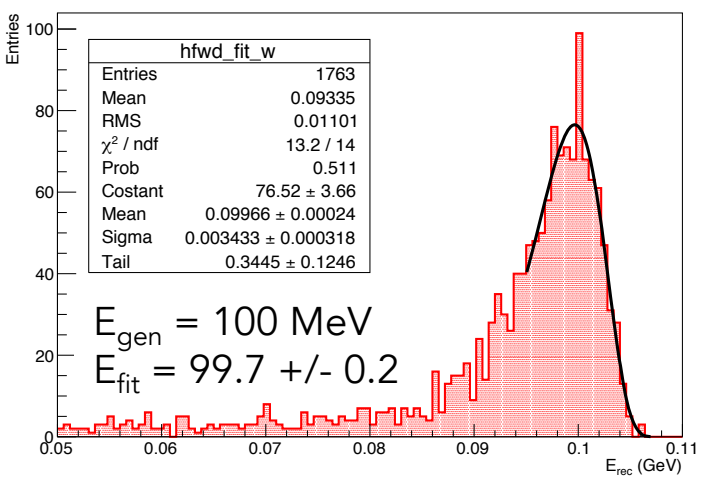
Barrel, with bkg, fit region



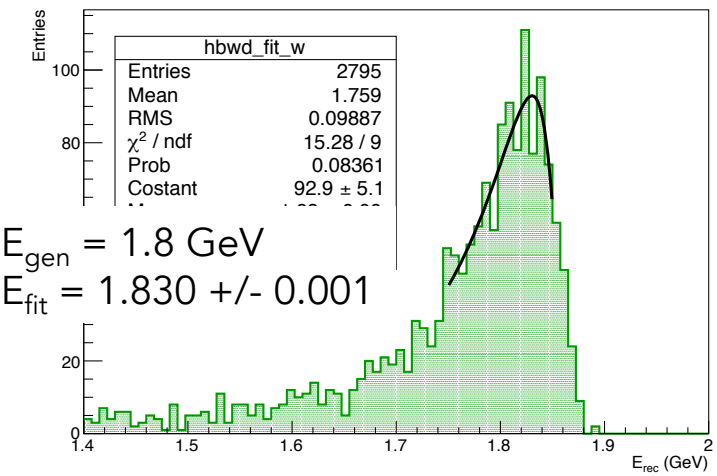
Barrel, with bkg, fit region



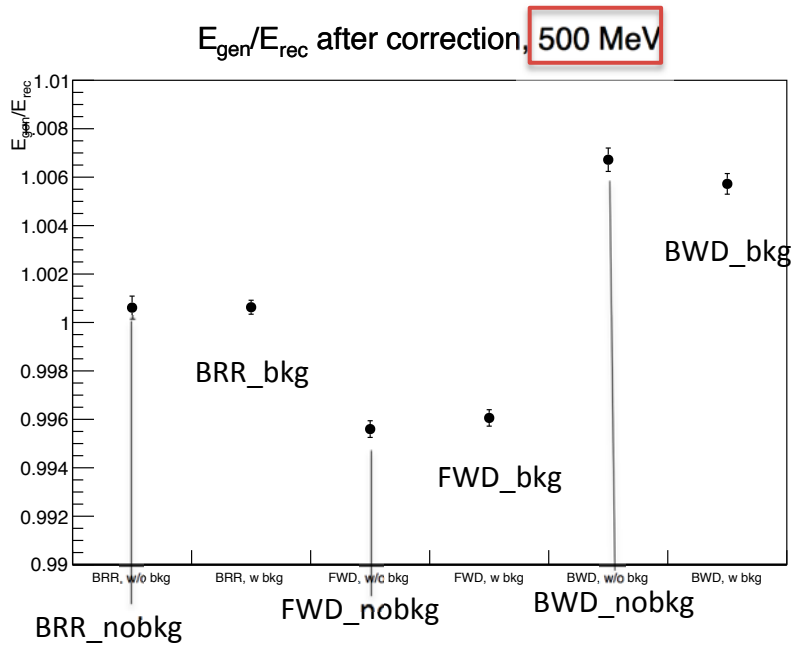
Fwd, with bkg, fit region



Bwd, with bkg, fit region



Ad-hoc energy correction: validation (II)



- validation performed at several energy points, gives satisfacory results;
- additional validation studies from physics group and software group
  - e.g. π^0 mass peak back to where expected

Correction blessed and incorporated in ECL code for next release.

Conclusions (I)

- Negligible material budget effect on FWD ECL resolution
  - adding SVD+PXD, CDC and PID cause cluster splitting
  - narrower energy distribution, lower efficiency in fit region
  - major effect in efficiency due to SCV+CDC

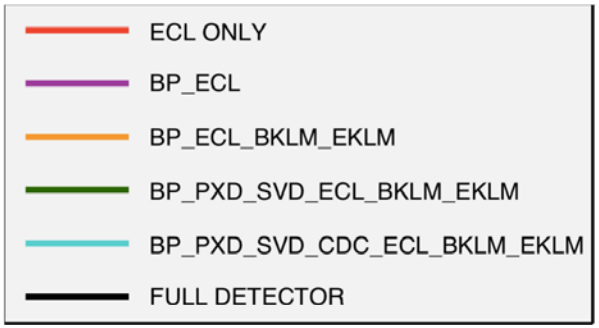
- Dividing FWD in slices:
  - no difference between FWD ECL regions in terms on resolution
  - at all investigated energies, innermost region is the most problematic in terms of efficiency and resolution

Conclusions (II)

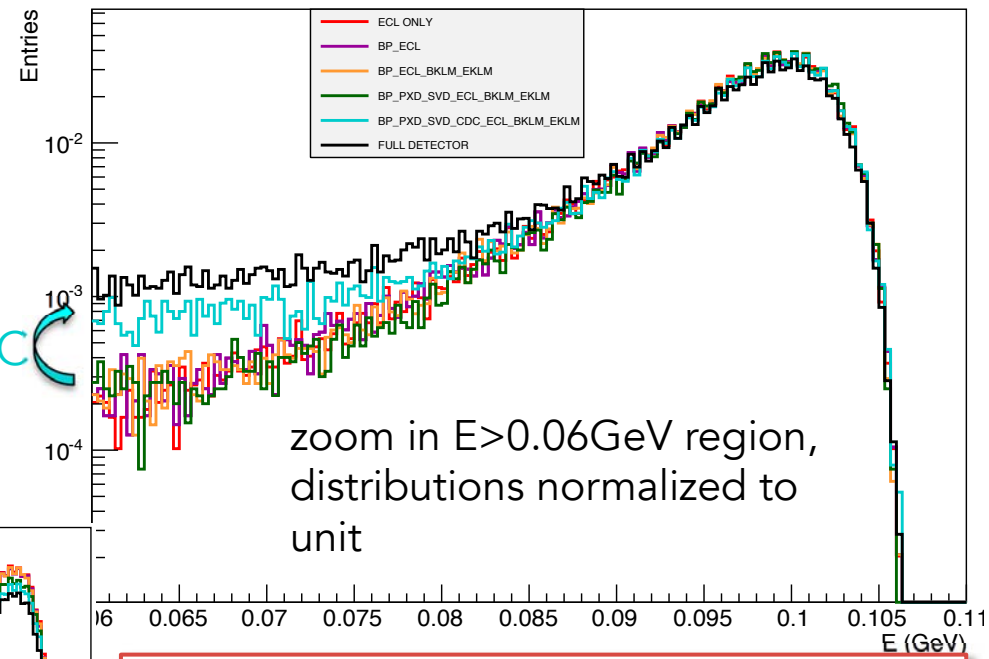
- Overall resolution without machine background:
  - fitted reso compatible with expectation above 200 MeV, far from expectations at 100 and 50 MeV
- Adding pile-up:
  - @ 100 MeV: from ~3% (w/o bkg) to 10-15%
  - @ 500 MeV: from ~2% (w/o bkg) to ~4%
- Improvements in reconstruction alghoritm (energy threshold used in clustering? timing cut?) may improve ECL performances
- Ad-hoc cluster energy correction
  - Shift at some-% to some-tenth-% level observed in cluster reconstruction in MC5
  - After correction implementation:
    - satisfactory results for barrel and fwd (E_{gen}/E_{rec} after correction deviates from 1 at per mille level)
    - larger discrepancy in bwd, much lower than before the correction (low statistic samples used to extract the correction had the lowest statistics)
  - Part of release-00-06-00 code

EXTRA-SLIDES

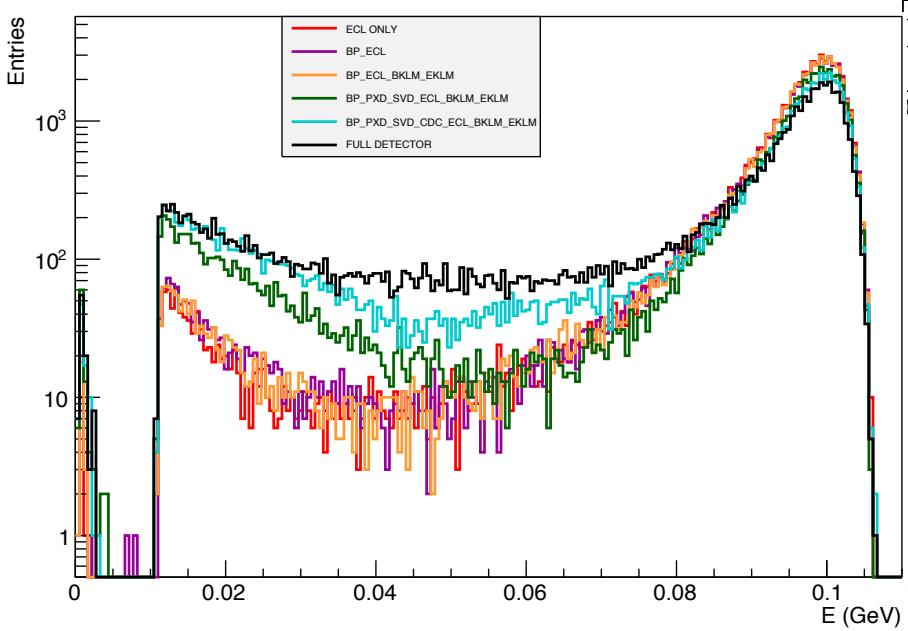
Reco'd energy distribution, FWD region, 100 MeV



ADD CDC



zoom in E>0.06GeV region, distributions normalized to unit



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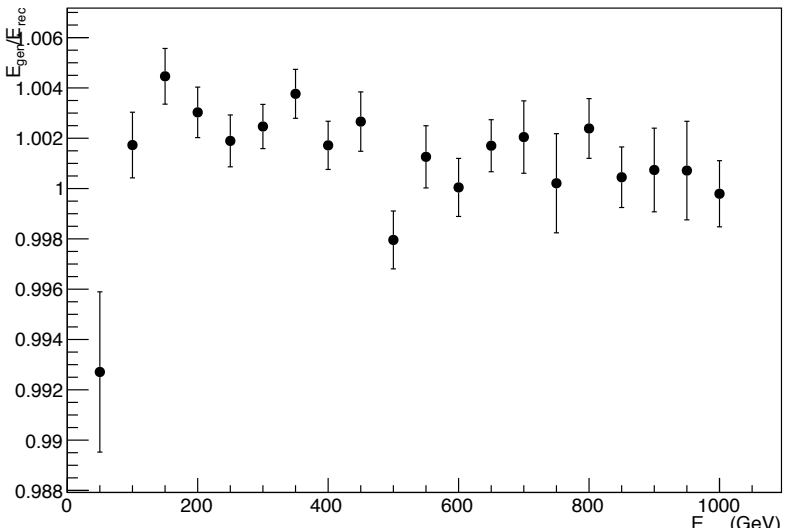
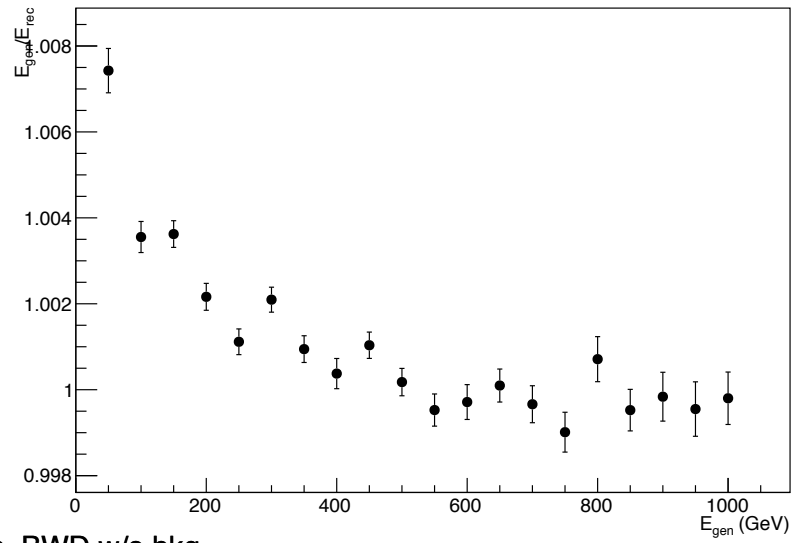
- SVD+PXD effect evident in the low energy region
- Black, Cyan and Green configs seem to have a narrower peak wrt other configs: events from peak region to tail, due to cluster splitting

E_{gen}/E_{rec} vs energy: w/o bkg

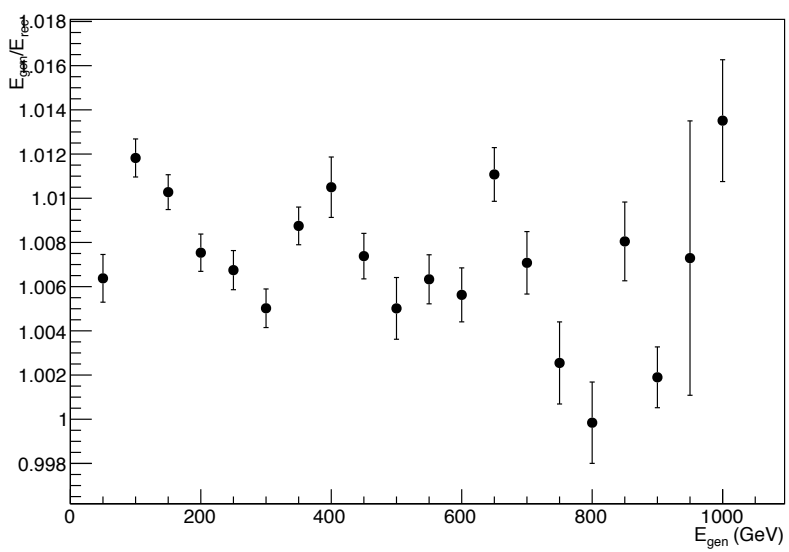
Correction factors, FWD w/o bkg



Correction factors, BARREL w/o bkg



Correction factors, BWD w/o bkg



Energy resolution: Method

- Create single photon-like sample by:
  - choosing energies of interest [E_{peak} = 100, 200,500,700 MeV]
  - selecting events with GENERATED energy in the range $E_{peak} \pm \sigma_{fit}$ with $\sigma_{fit} \sim$ ½ σ expected without bkg

- Need MCtruth info --> select only MCTruth-matched photons
  - pure physics photons
  - pure physics photons + machine bkg superimposed
  - (not accounting for contribution from pure bkg photons)