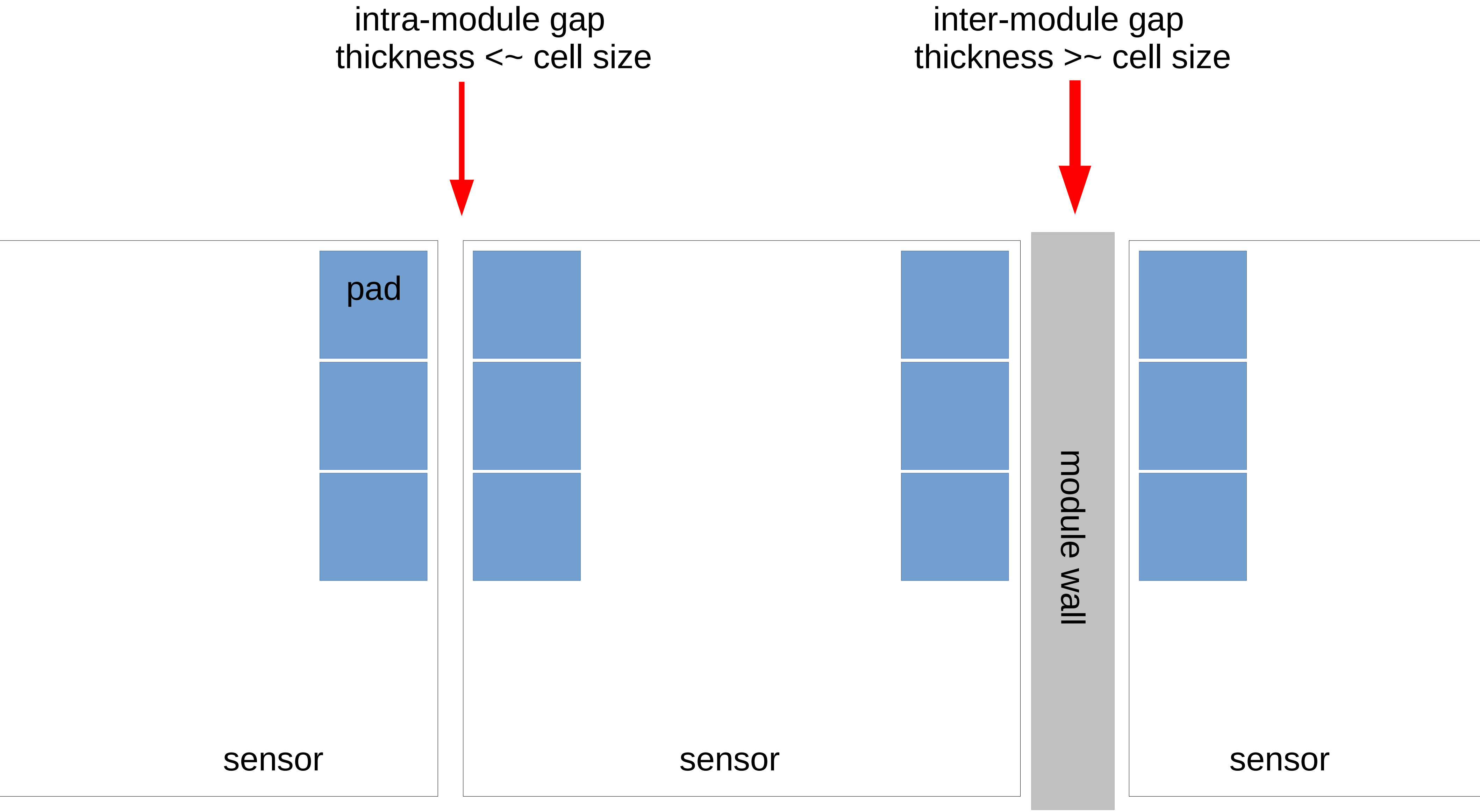
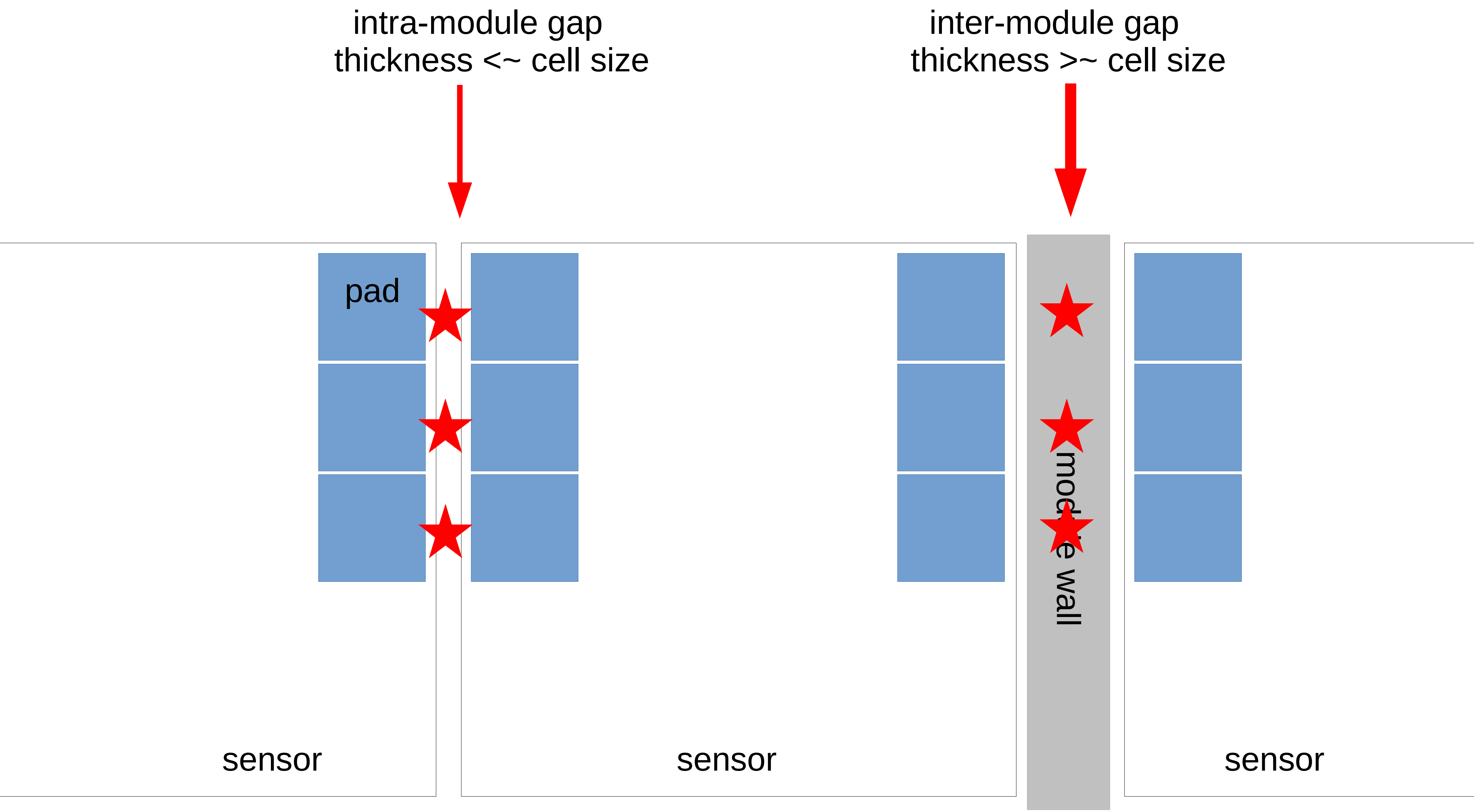
photon energies in ILD simulation model

ilcsoft v02-00-02
detector model ILD_l5_o1_v02 (silicon-W)

Daniel Jeans, KEK; late Nov 2019.



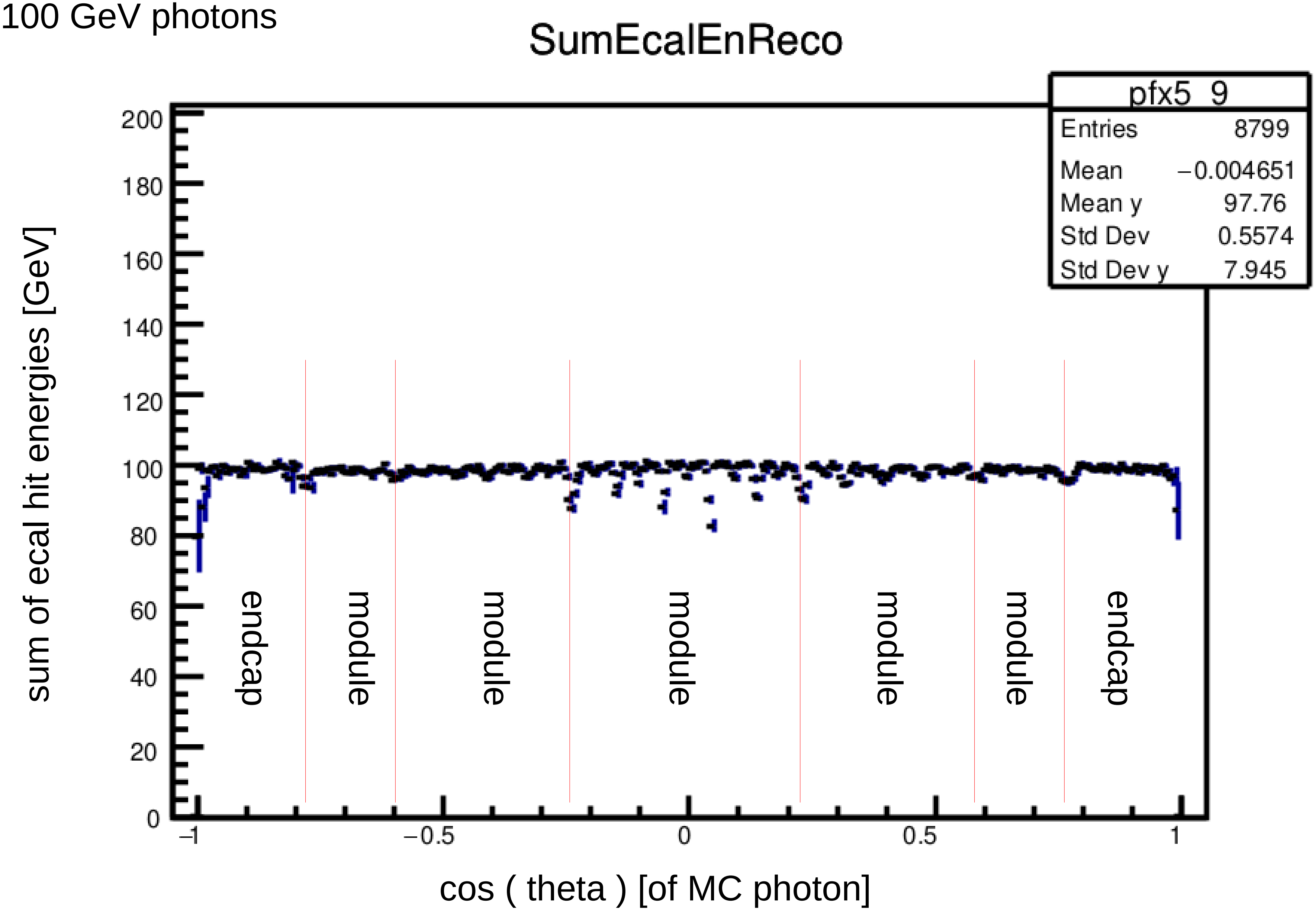
correction of gaps in ECAL coverage



currently:
at hit reconstruction level, the "BruceForceEcalGapFiller" creates additional hits in the gaps, with energy estimated by considering energy density in neighbouring cells and the size of the insensitive area

mono-energetic single photon events shot from IP
sum of ecal hit energies (after hit reconstruction, before clustering)
without the additional gap hits

100 GeV photons

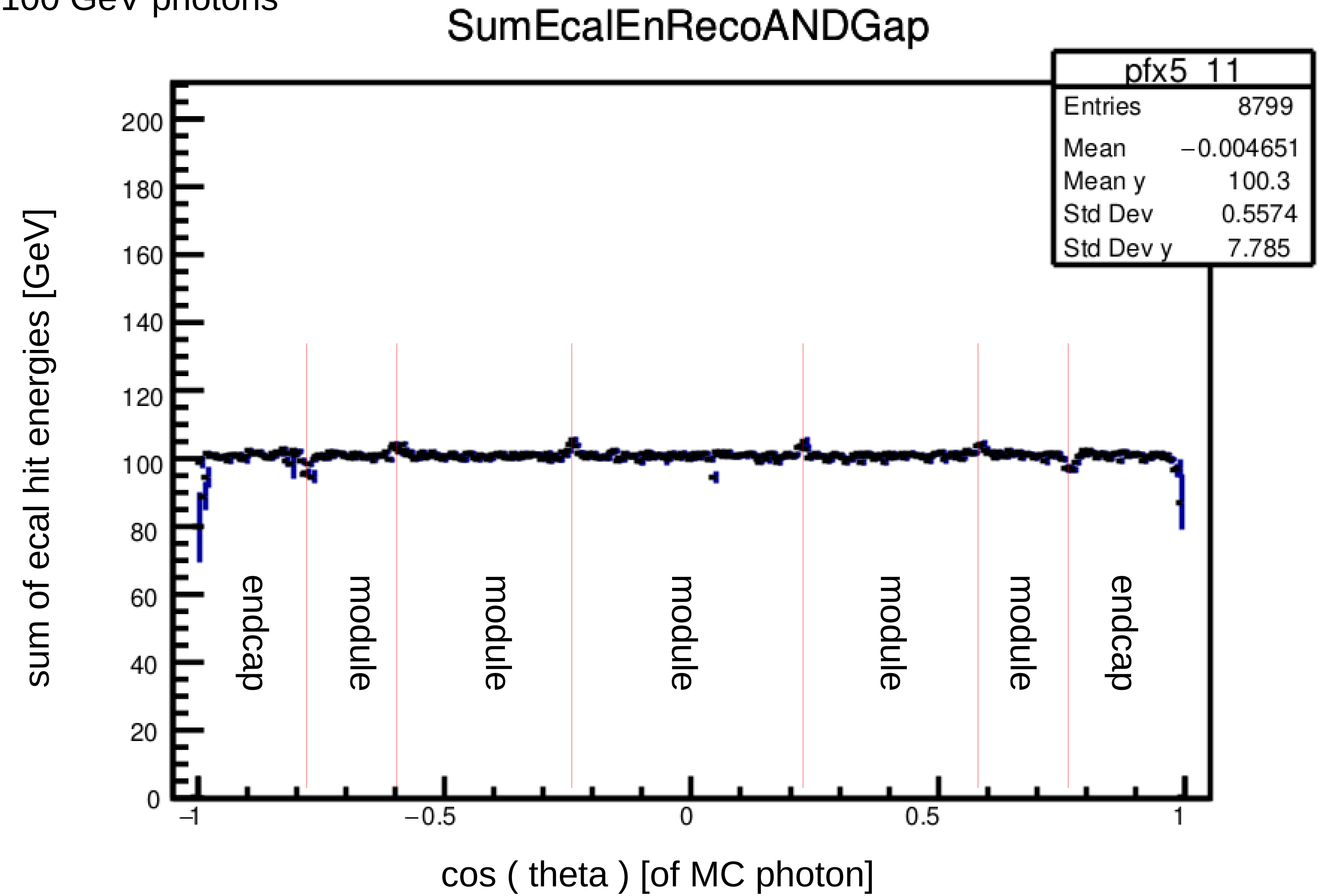


mono-energetic single photon events shot from IP
sum of ecal hit energies (after hit reconstruction, before clustering)

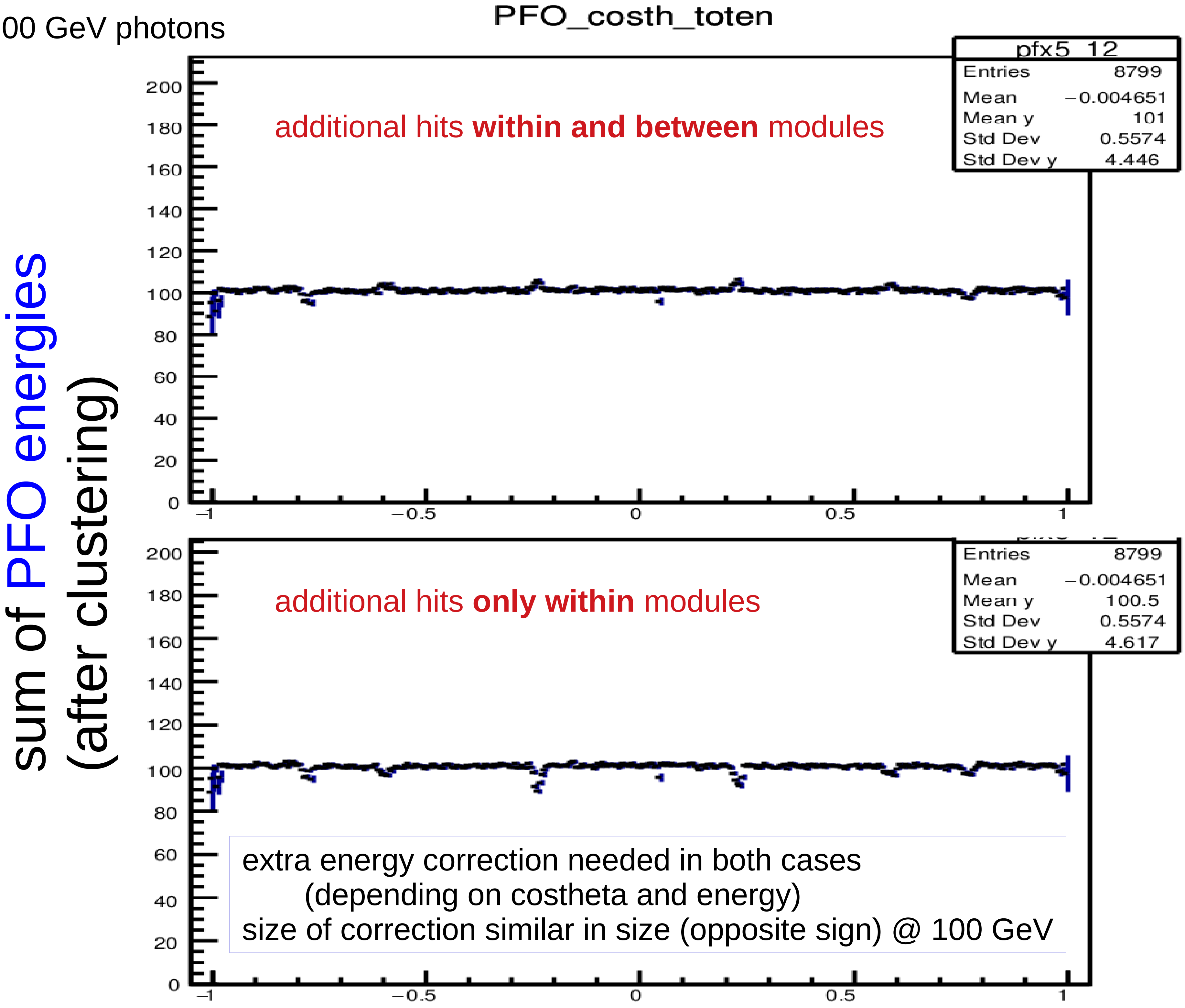
with the additional gap hits

→ works well within barrel modules,
but for high energy photons (>50 GeV) over-corrects energy loss between modules

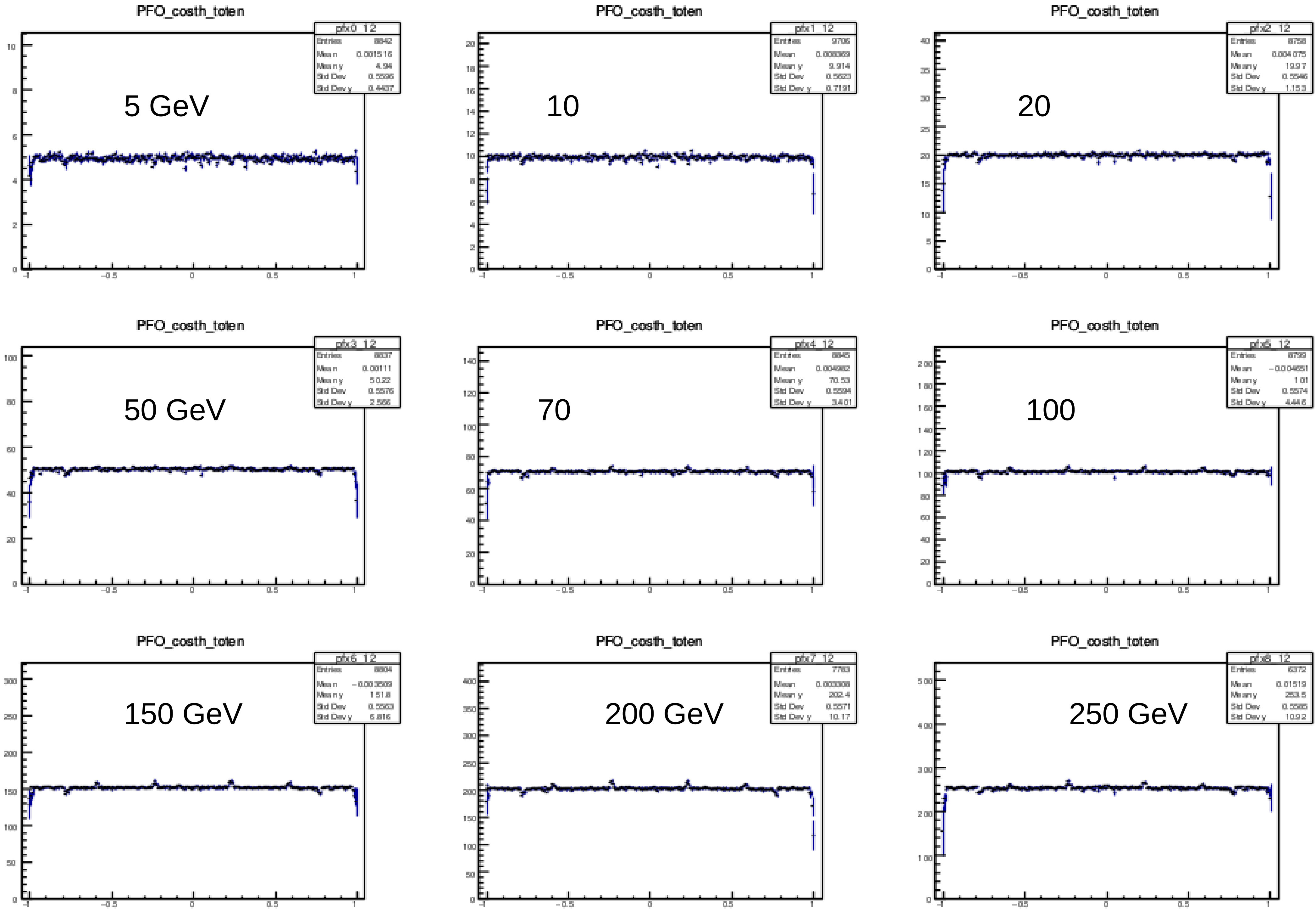
100 GeV photons



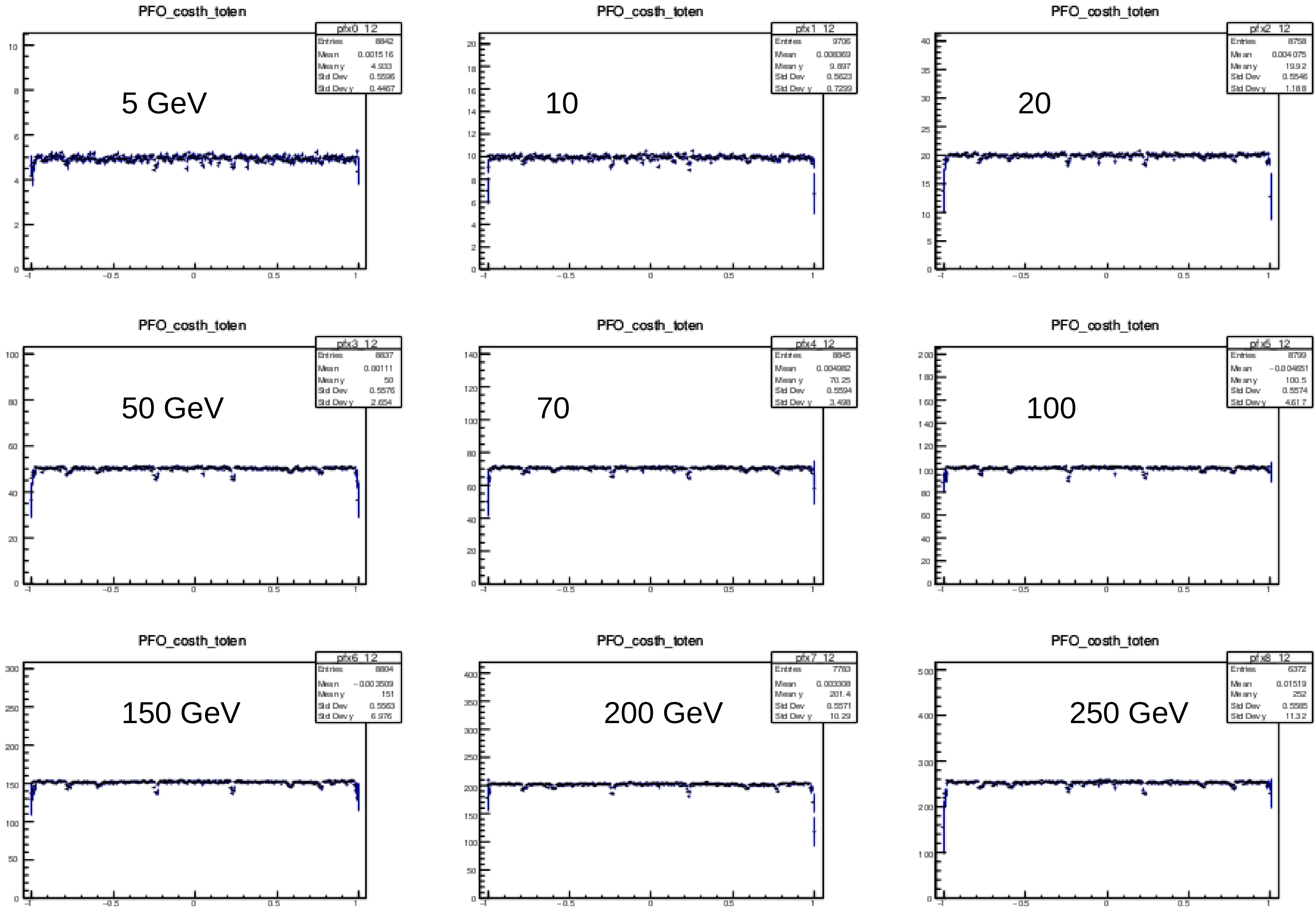
100 GeV photons



sum PFO energies vs cos(theta) at different energies [**with** inter-module gap hits]

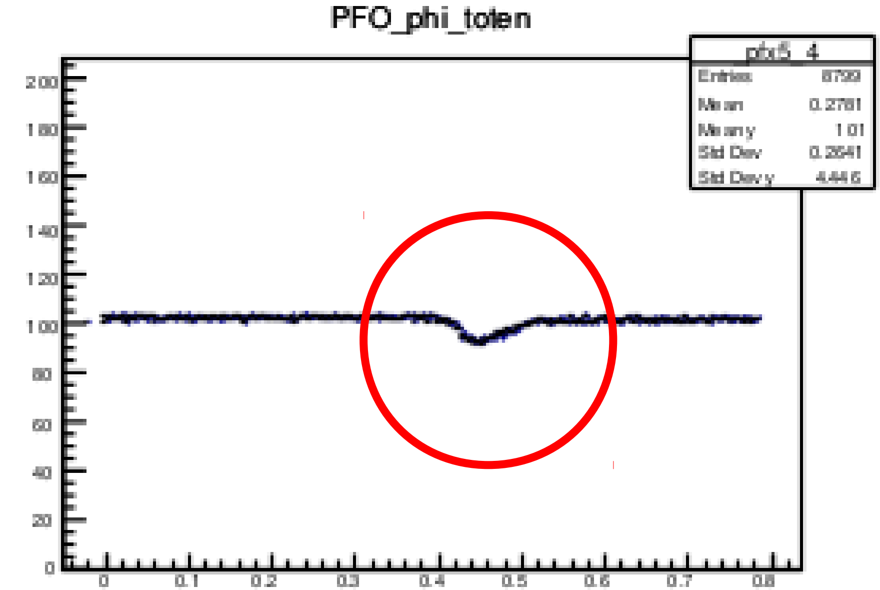


sum PFO energies vs cos(theta) at different energies [**no** inter-module gap hits]

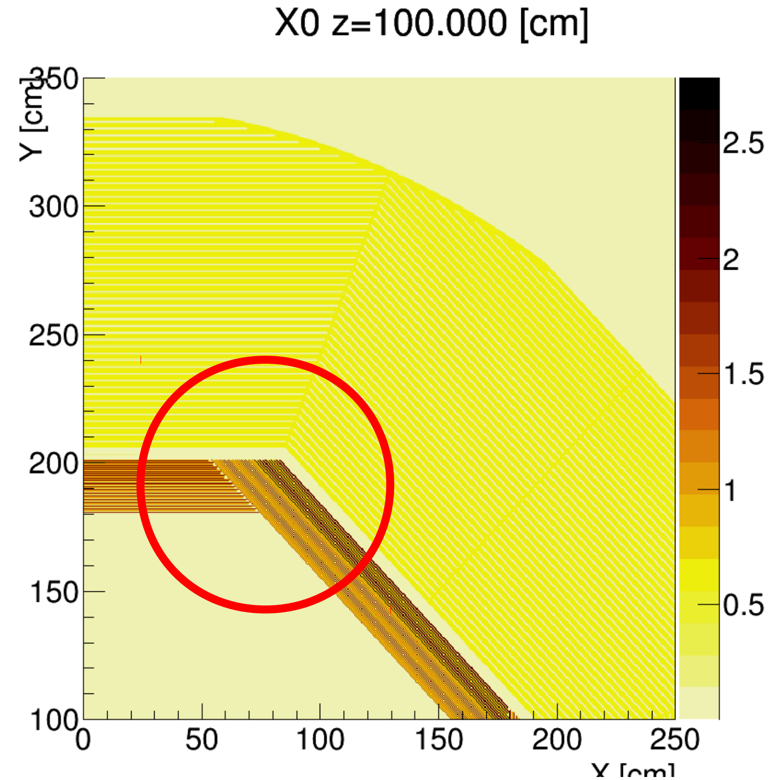


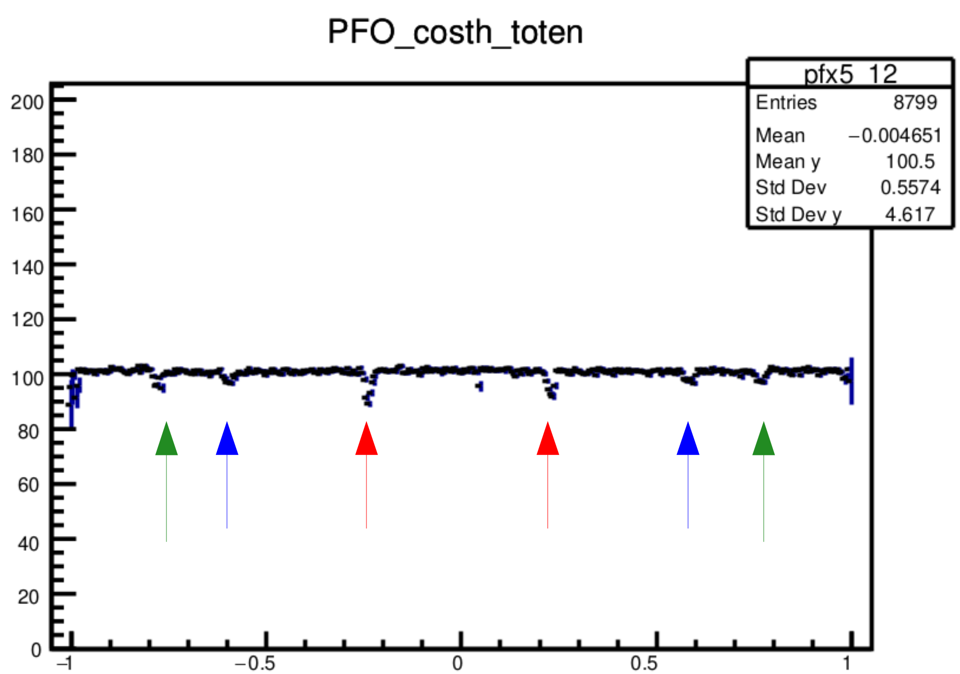
on top of these additional gap hits,
still need PFO-level photon energy corrections
based on PFO direction and energy

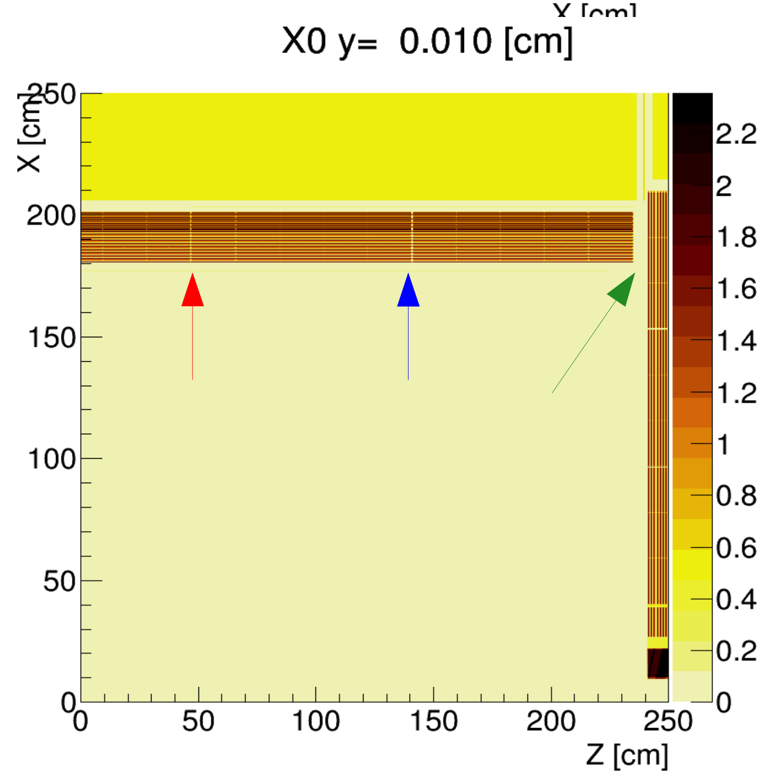
remaining features in the barrel



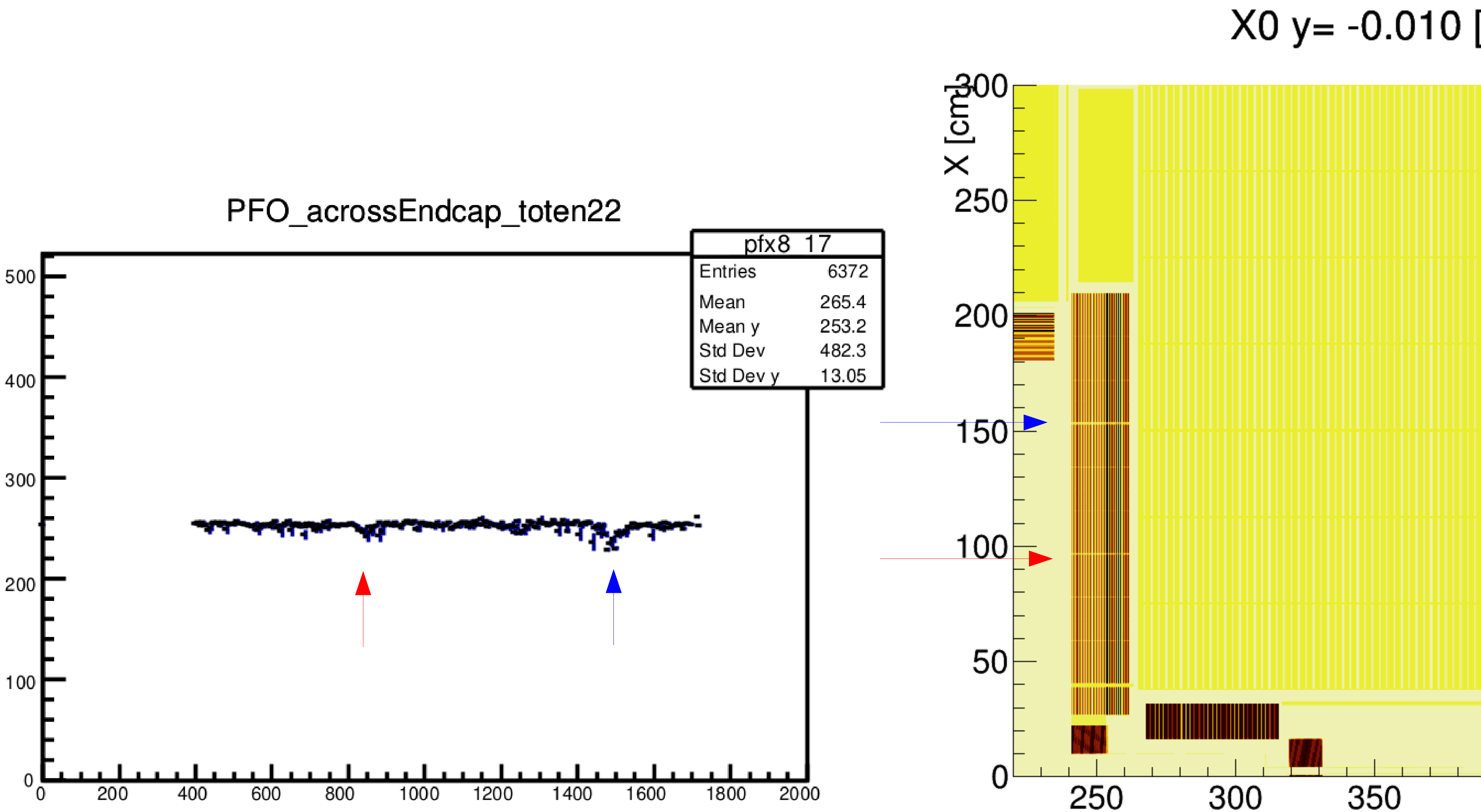
phi (folded)







there are also gaps in the endcaps...



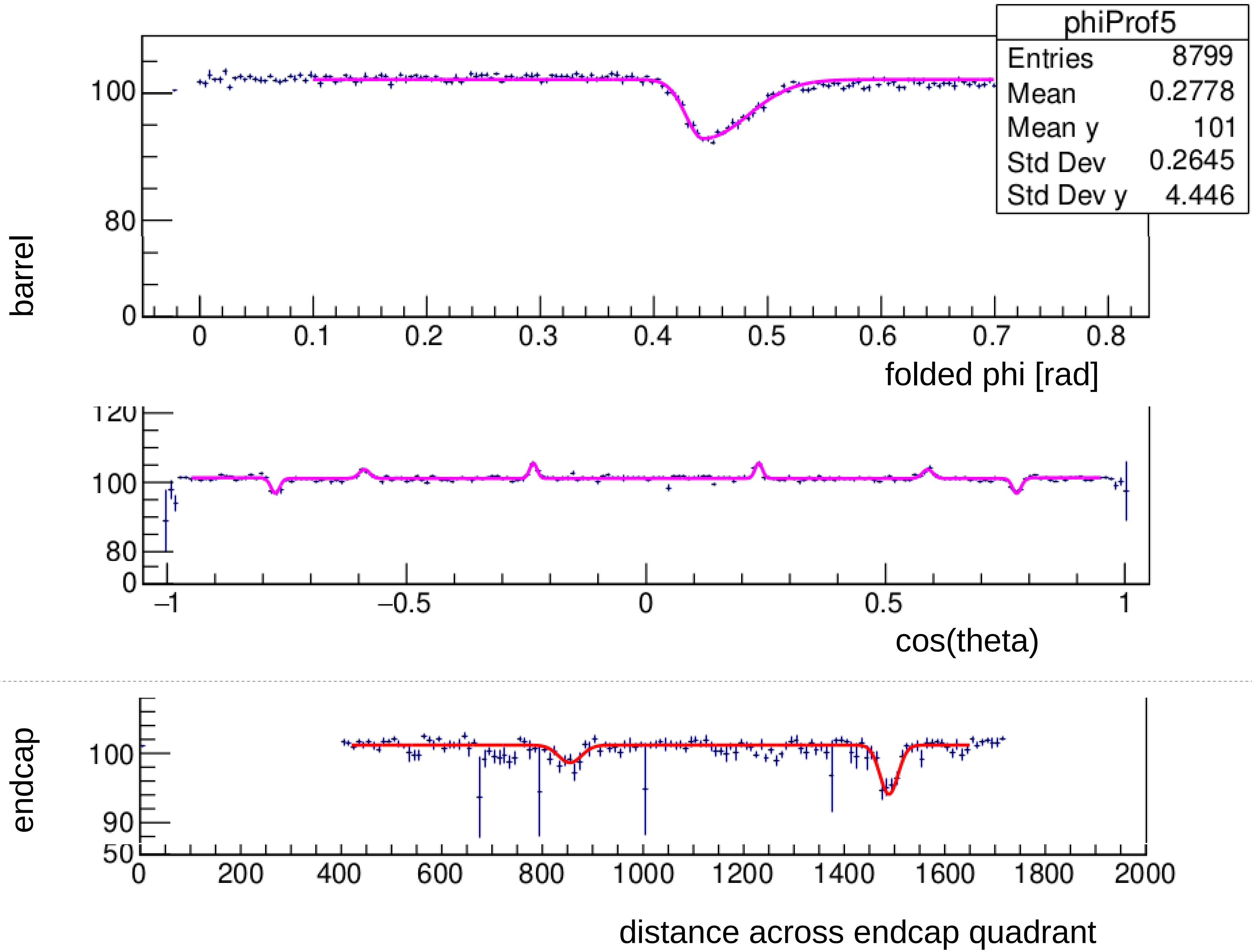
position across endcap quadrant (folded) [mm] fit these geometrical energy variations in steps

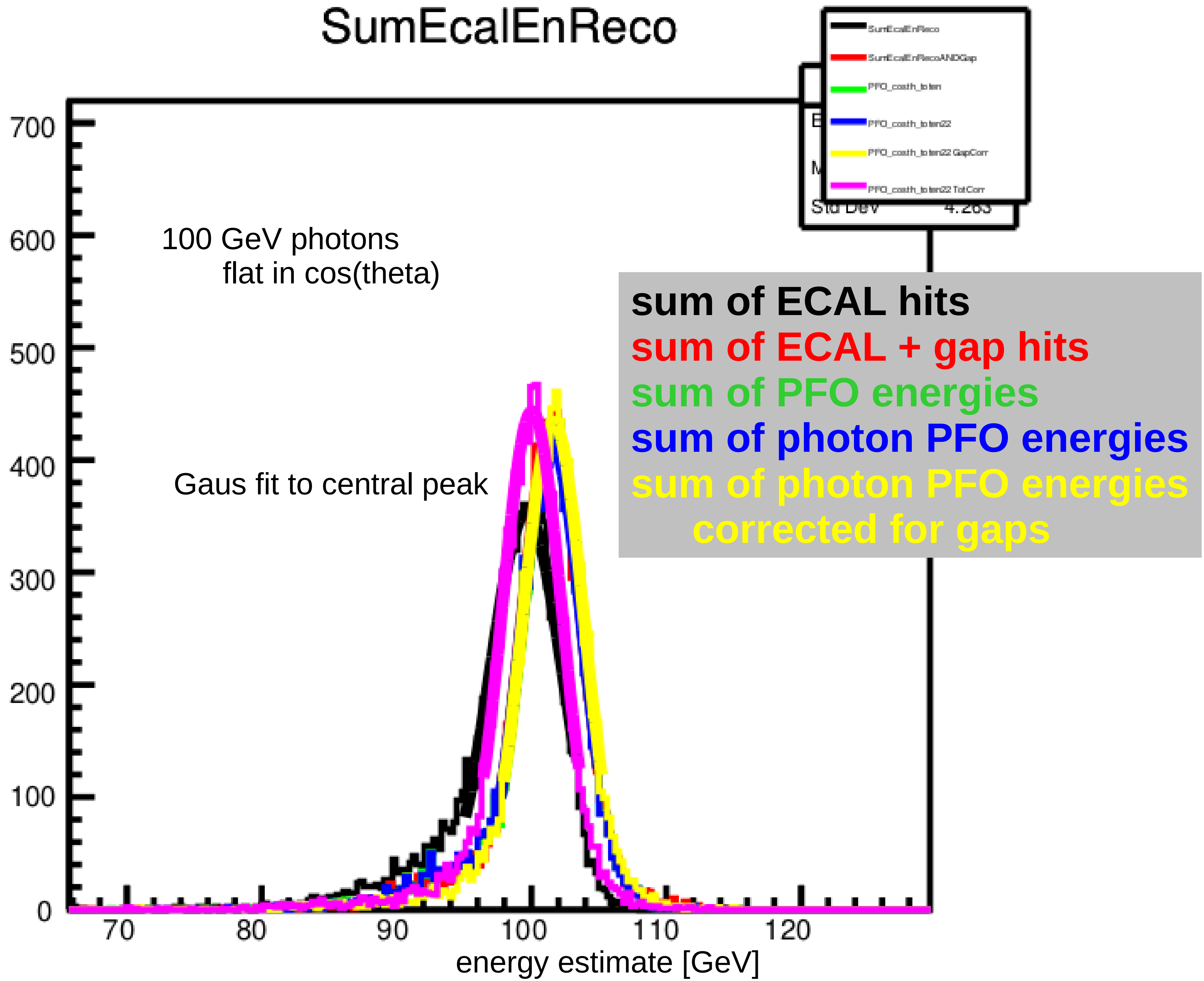
1. equalise response across detector:
   → phi cracks in barrel
   → inter-module gaps in barrel, bar-end overap
   → inter-module gaps in endcap

   modelled with (sometimes asymmetric) Gaussians,
   with parameters that may depend on energy

2. linearise the energy response

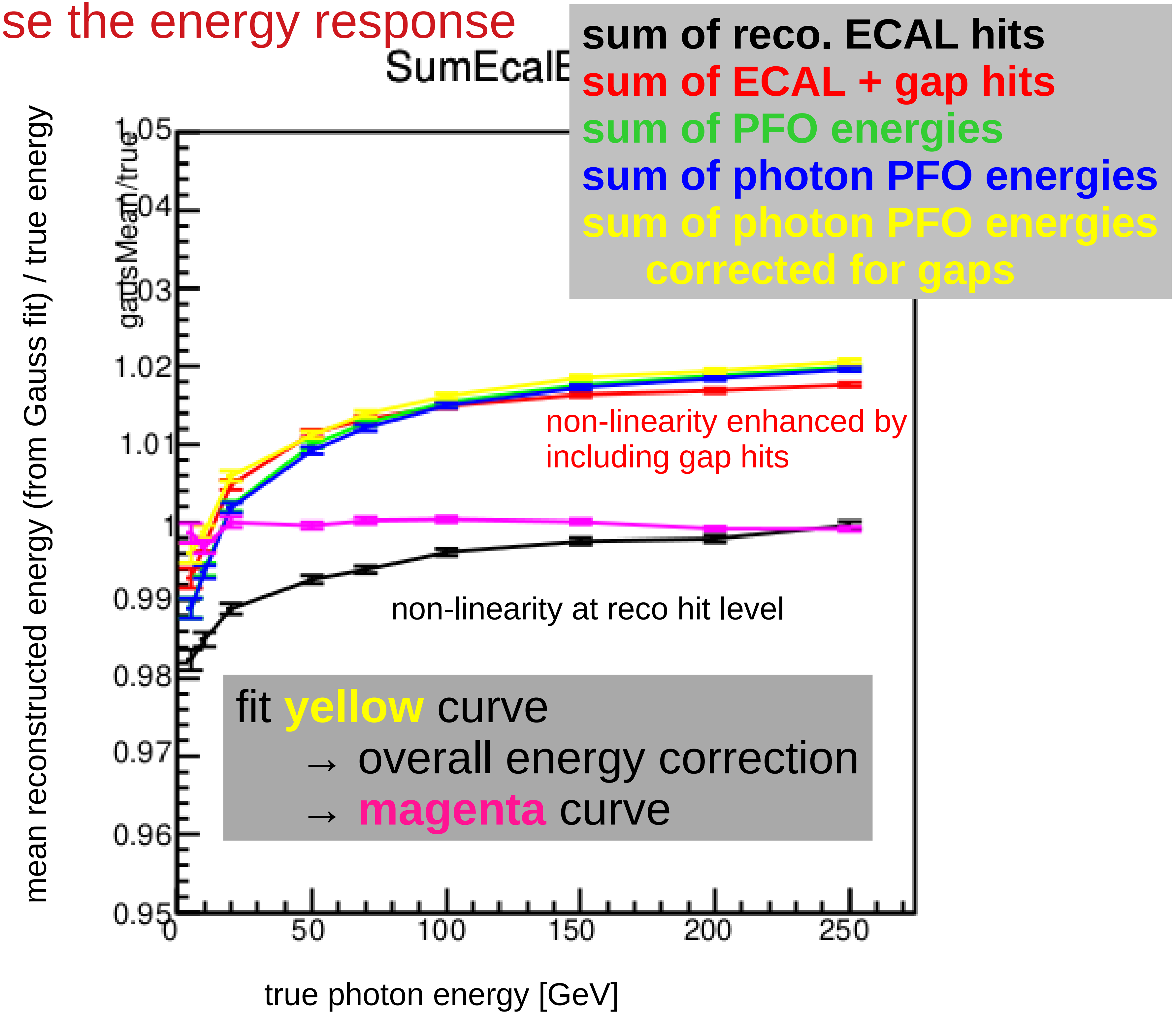
1. equalise response across detector:





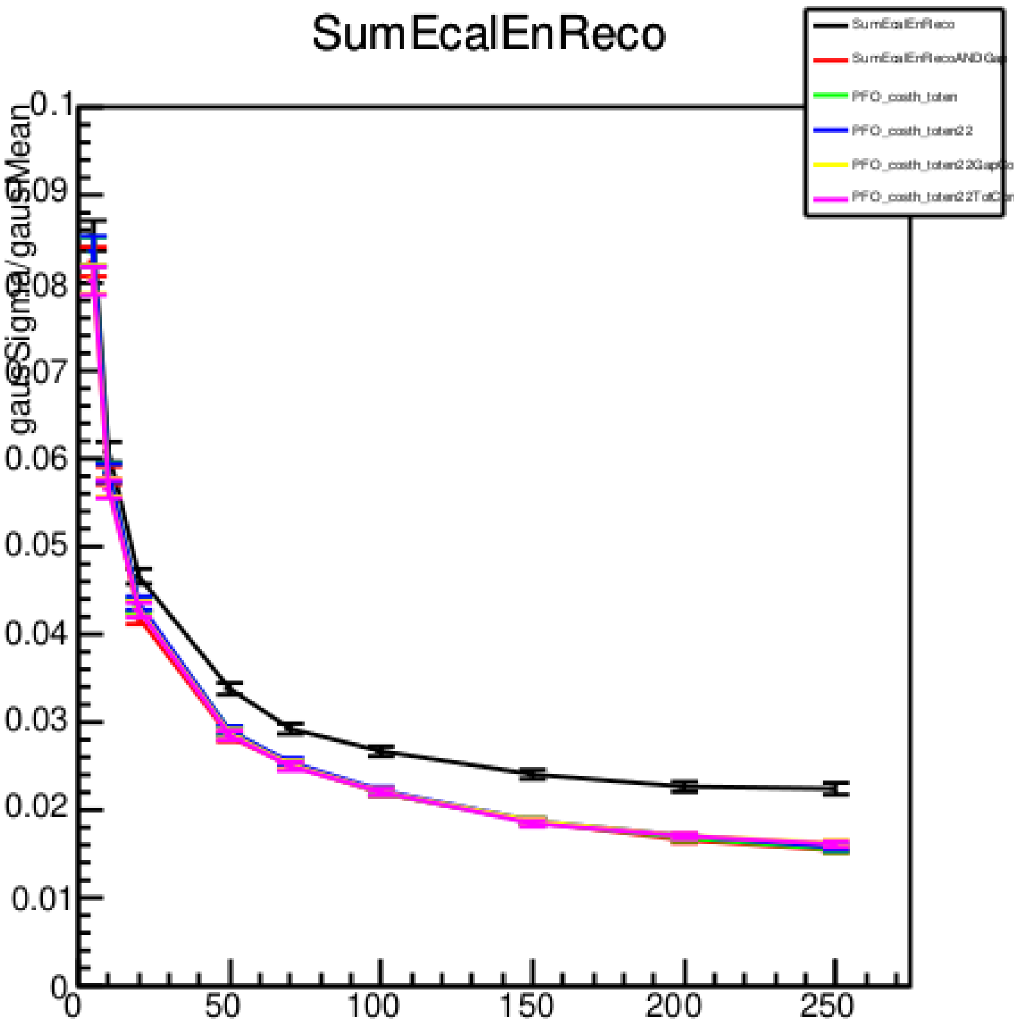
SumEcalEnReco
SumEcalEnReco
SumEcalEnRecoANDGap
PFO_costh_toten
PFO_costh_toten22
PFO_costh_toten22 GapCorr
PFO_costh_toten22 TotCorr
100 GeV photons
flat in cos(theta)
Gaus fit to central peak
sum of ECAL hits
sum of ECAL + gap hits
sum of PFO energies
sum of photon PFO energies
sum of photon PFO energies
corrected for gaps
0
100
200
300
400
500
600
700
70
80
90
100
110
120
energy estimate [GeV]

2. linearise the energy response

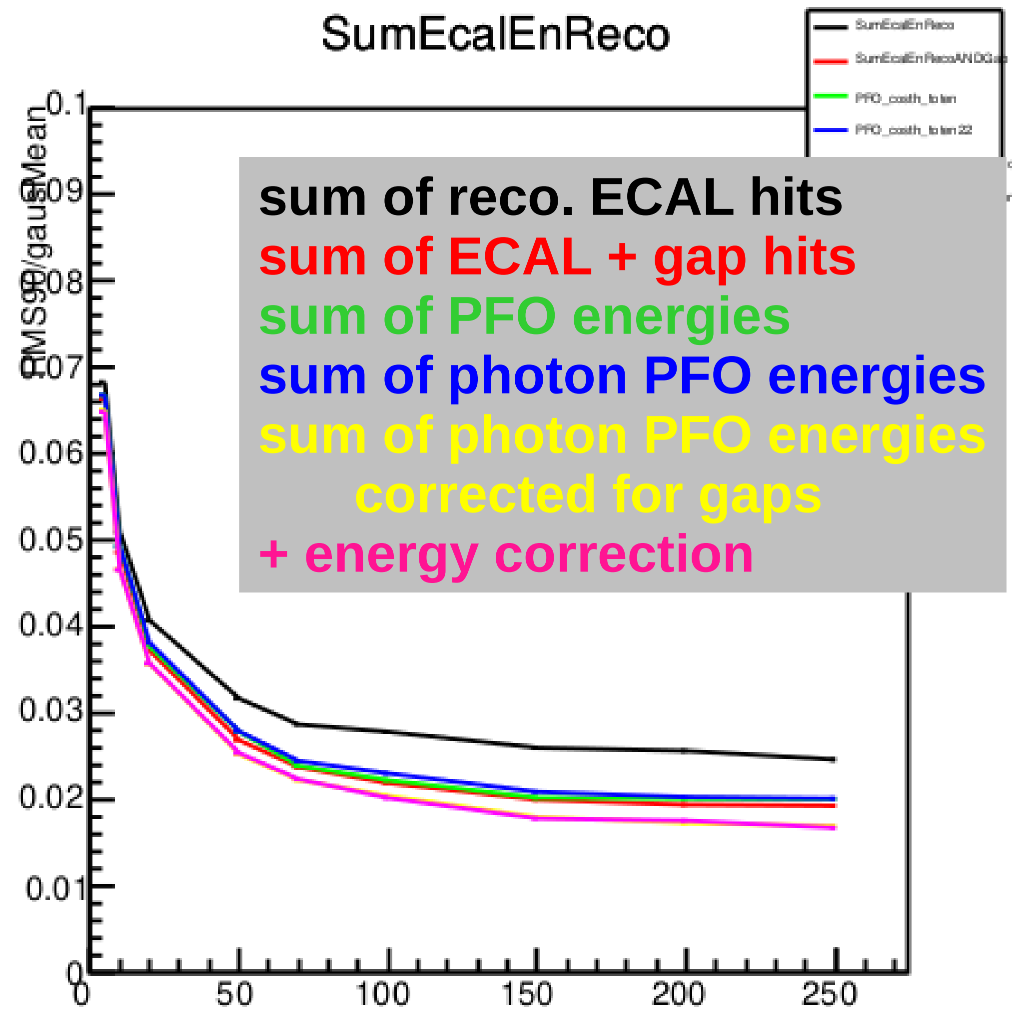


relative energy resolution

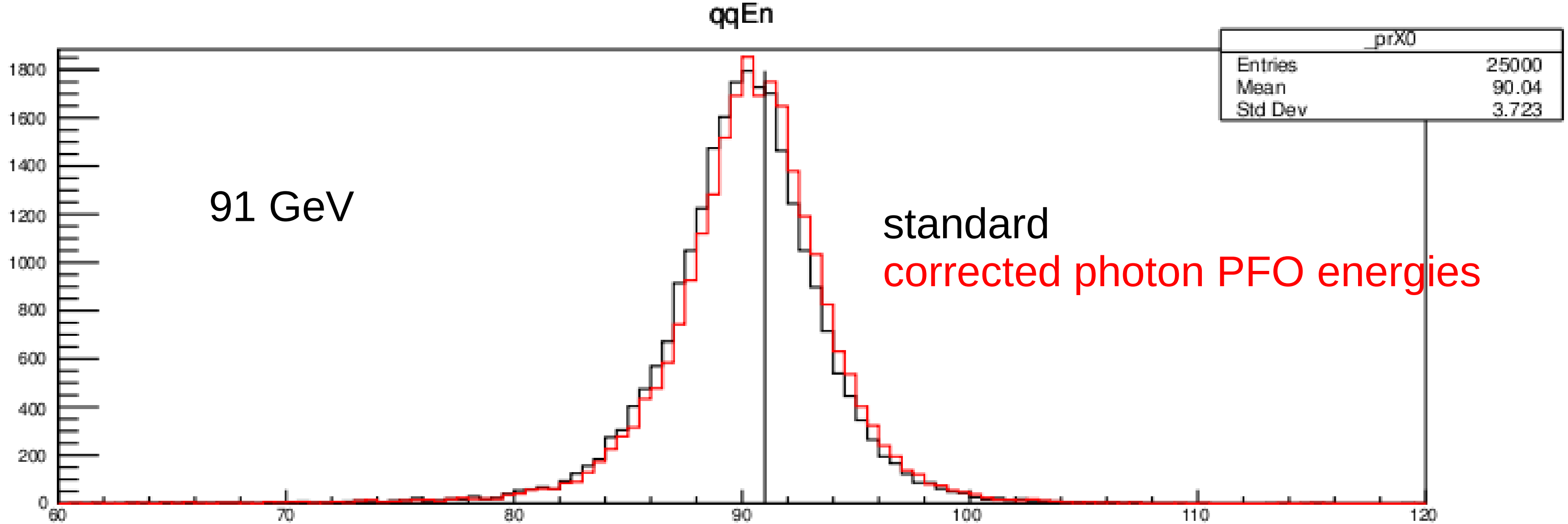
from central Gaussian fit +/- 1.5 sigma
→ well contained showers



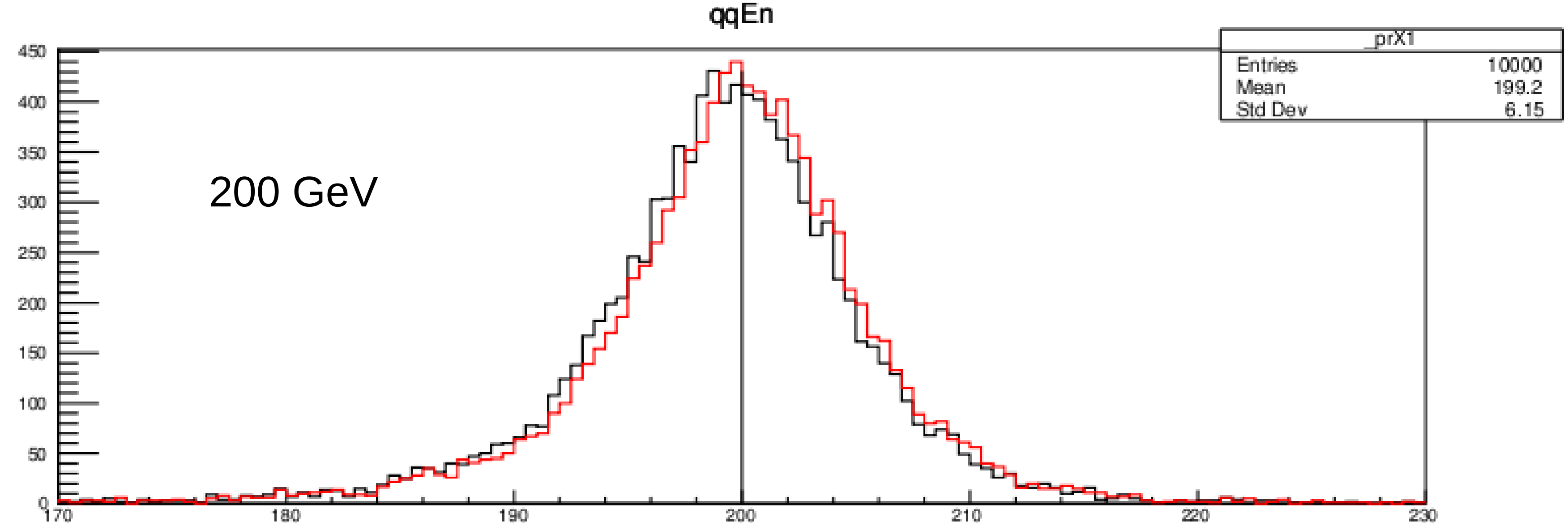
from RMS90 / Mean90
→ include photons in “shoulders”



apply correction to type==22 PFOs in di-quark (uu) calibration events
(in this case, we do have "gap hits" between the modules)



sum of PFO energies



small enhancement of total reconstructed event energy (probably an improvement)

summary

propose to use the local “gap filler” only for
gaps within ECAL modules,
and not for gaps between modules

defined ~simple PFO-level corrections to photon energies
→ improve uniformity across detector
→ reduce tails of energy distributions
→ better “RMS90” energy resolution for photons
→ ~2% energy non-linearity between 5 and 250 GeV
which is already present at hit level
reduced to few-per-mille level after energy correction

propose to apply these energy corrections to
the photon PFOs produced by Pandora.

quick test done on hadronic events: probably some slight improvement?

comments are welcome!