Sim & Reco of Pure CsI in basf2

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Belle II

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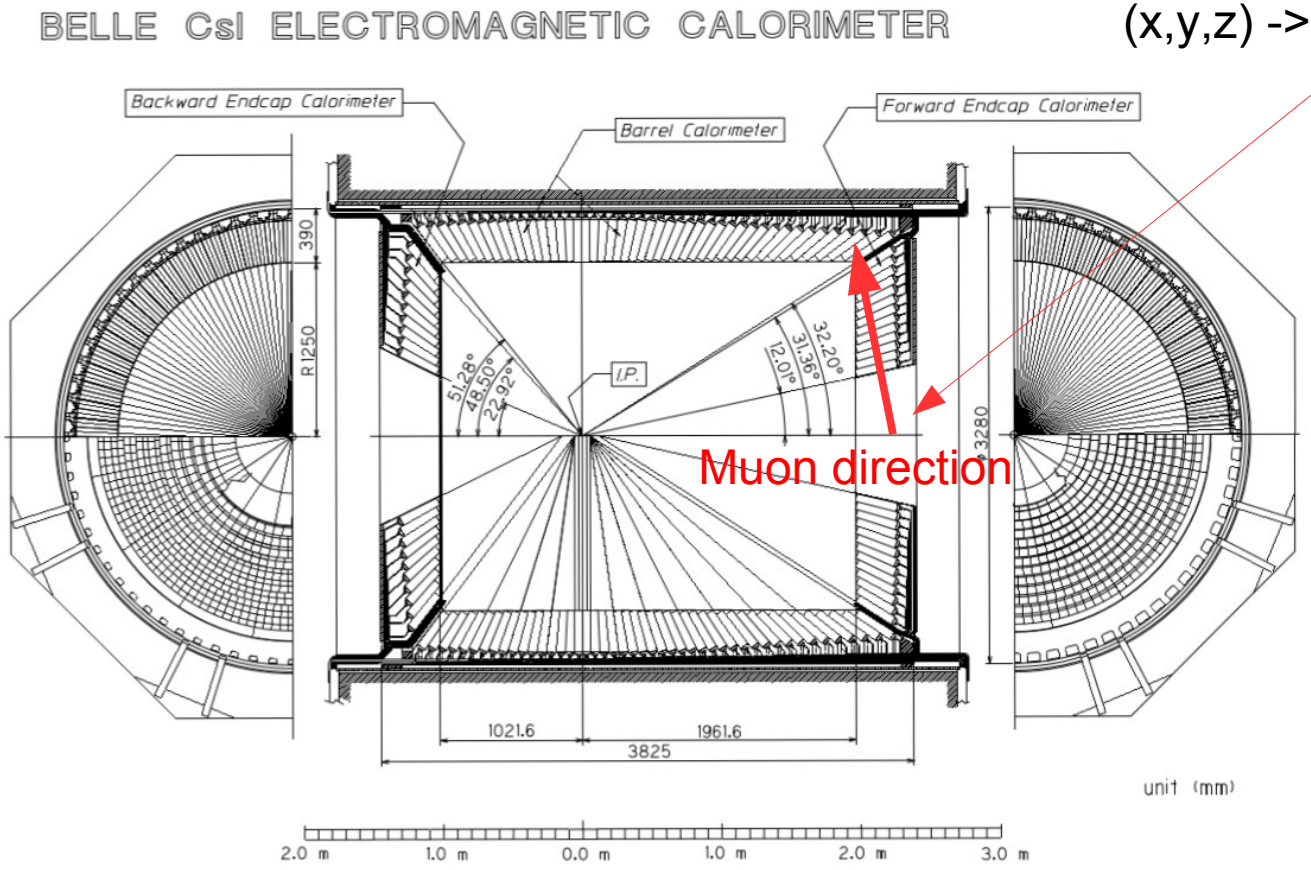
Cosmic Test

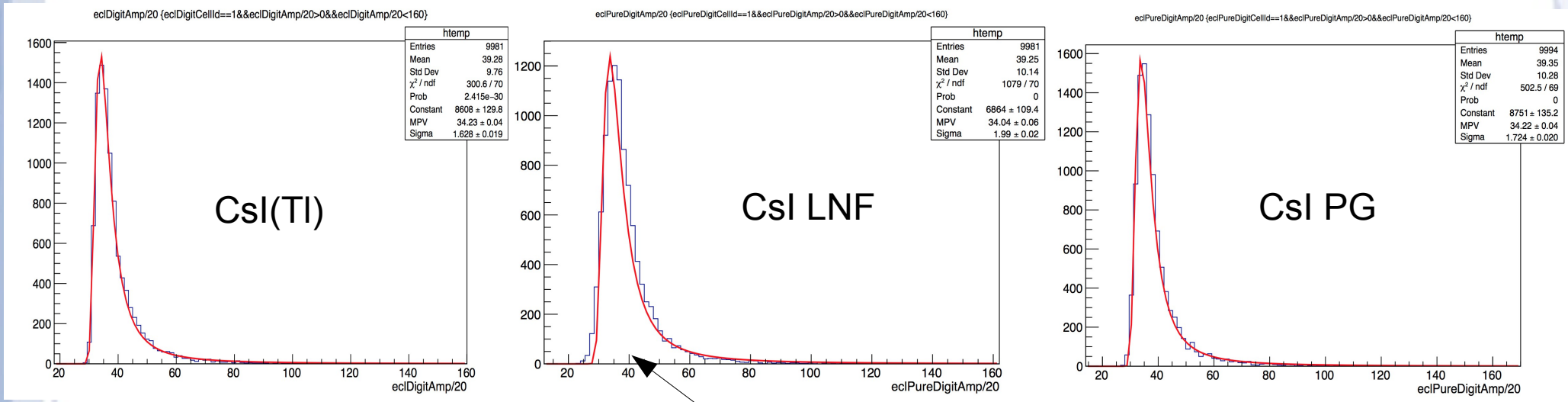
- Goal is to compare simulation and lab results
- We start shooting 10 GeV muons from beam-axis on face of crystal #1 of 1st ring (middle point)
- Code revision r24746, geometry: ECL only

p=10 GeV
(theta, phi) -> (102.4,3.5)
(x,y,z) -> (0,0,221.55)



Cosmic Test (2)

- 3 configurations studied:
  - Baseline (CsI(Tl))
  - Pure CsI LNF version (ENE=1.3, PS=0.40)
  - Pure CsI PG version (ENE=0.7, PS=0.20)



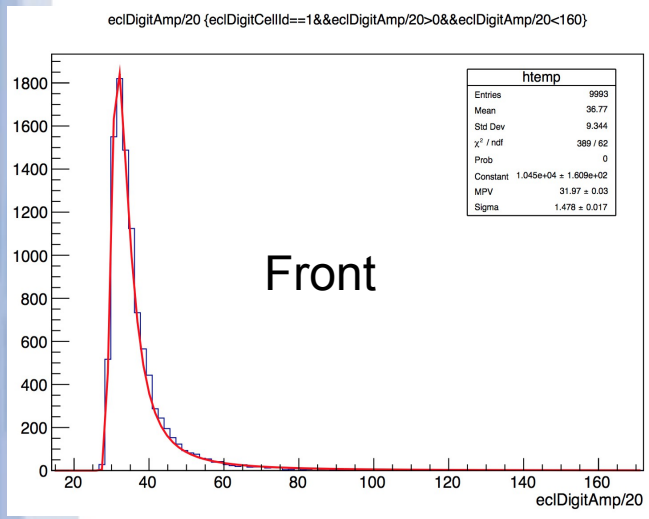
Crystal #1

Not well described by Landau f

E loss test

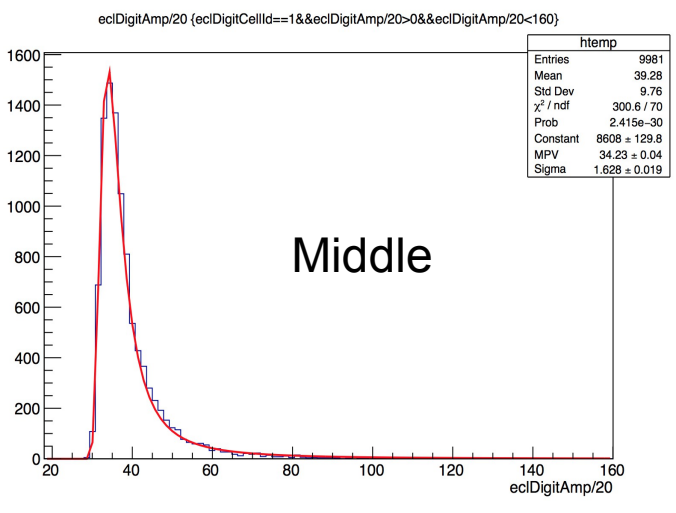
- From nominal position we move 13 cm forward and backward along z to sense crystal thickness

CsI(Tl)



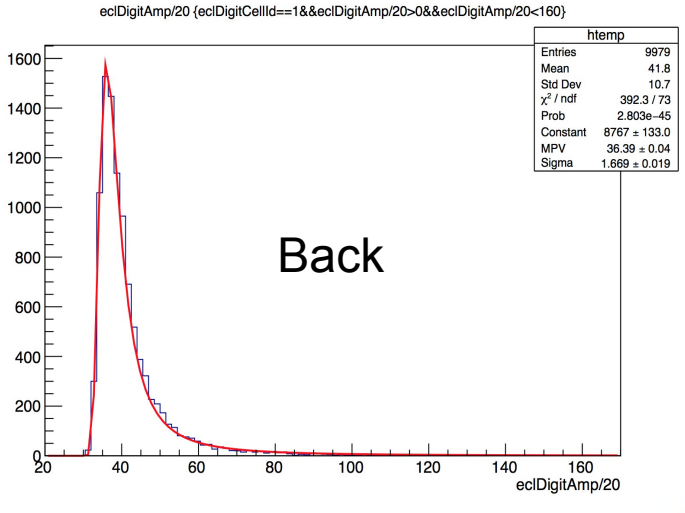
MPV=31.97 MeV

CsI(Tl)



MPV=34.23 MeV

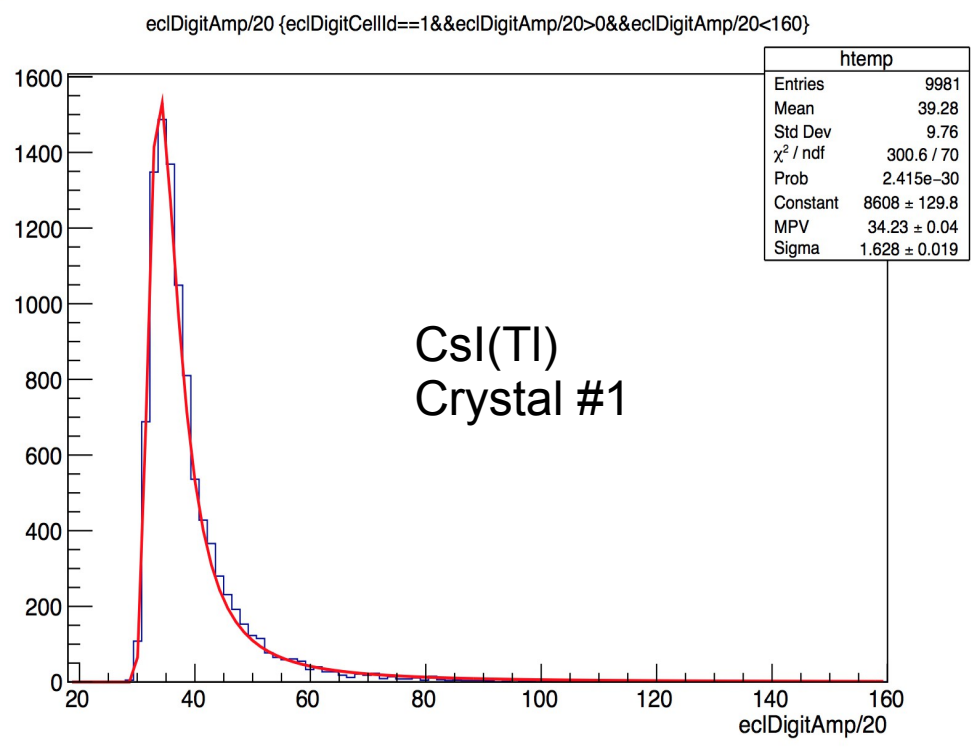
CsI(Tl)

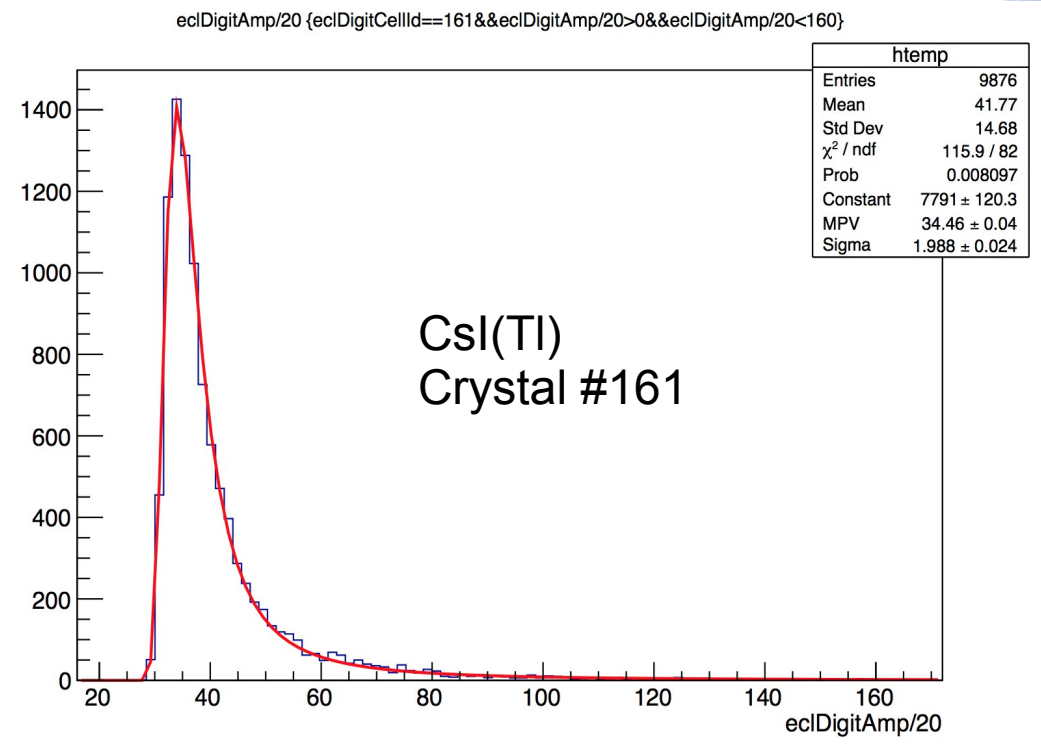


MPV=36.39 MeV

Tuning

- To cope with different bkg conditions we analyzed crystal #1 (ring1) and #161 (ring4)
- No significant difference in MPV due to geometry

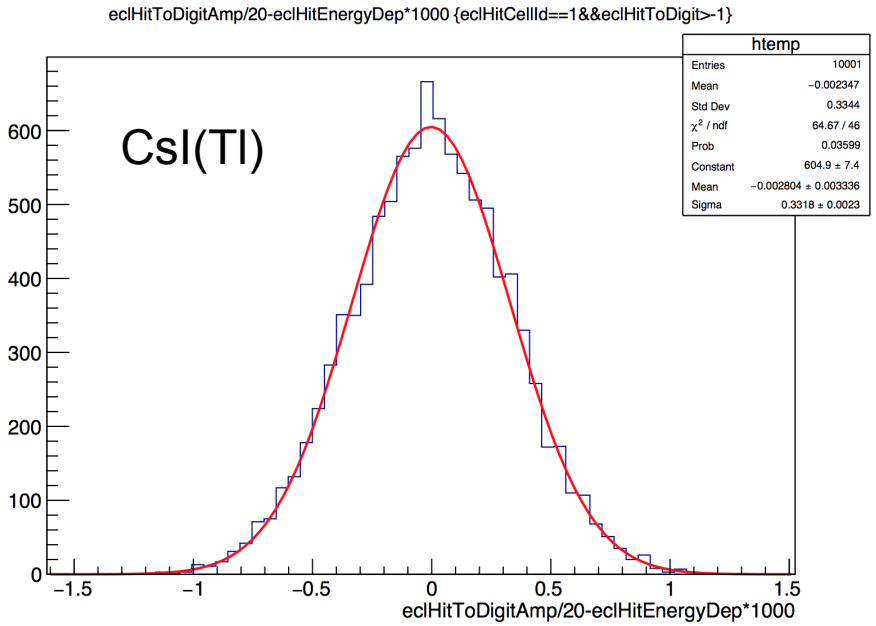


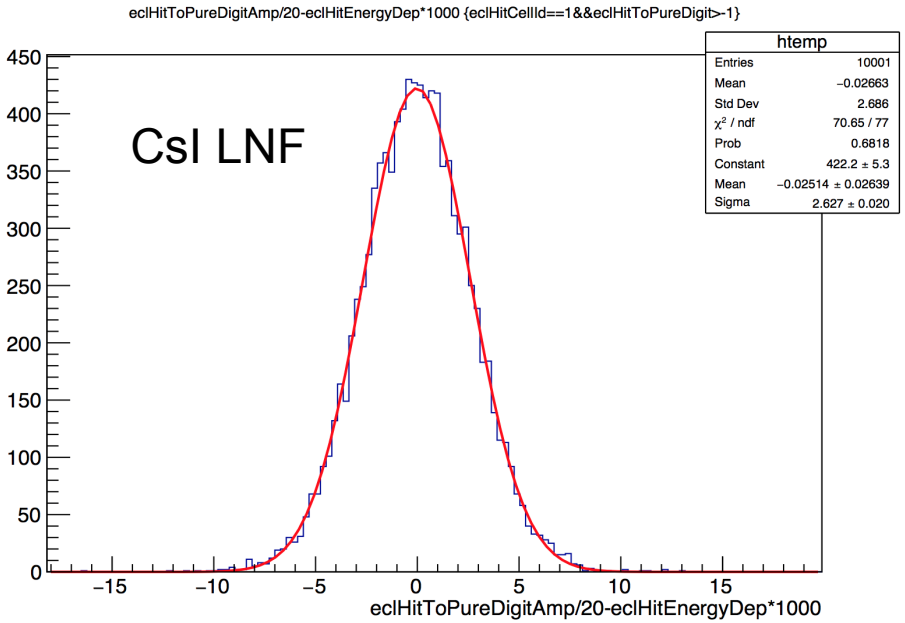


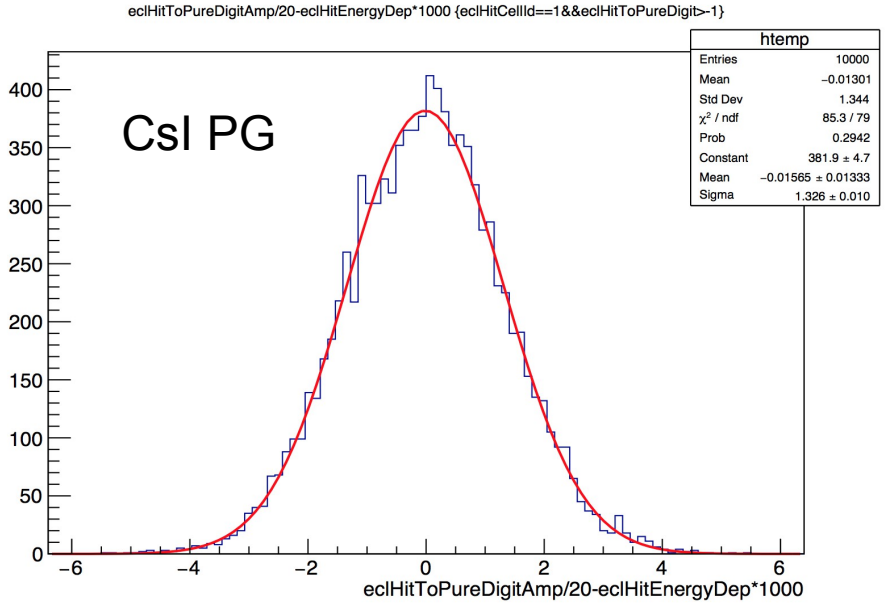
Resolution w/o bkg

- Ereco – Edep hit level
- CsI(Tl) : 0.97%
- CsI LNF : 7.72%
- CsI PG : 3.87%

sigma(gaus)/MPV(landau)

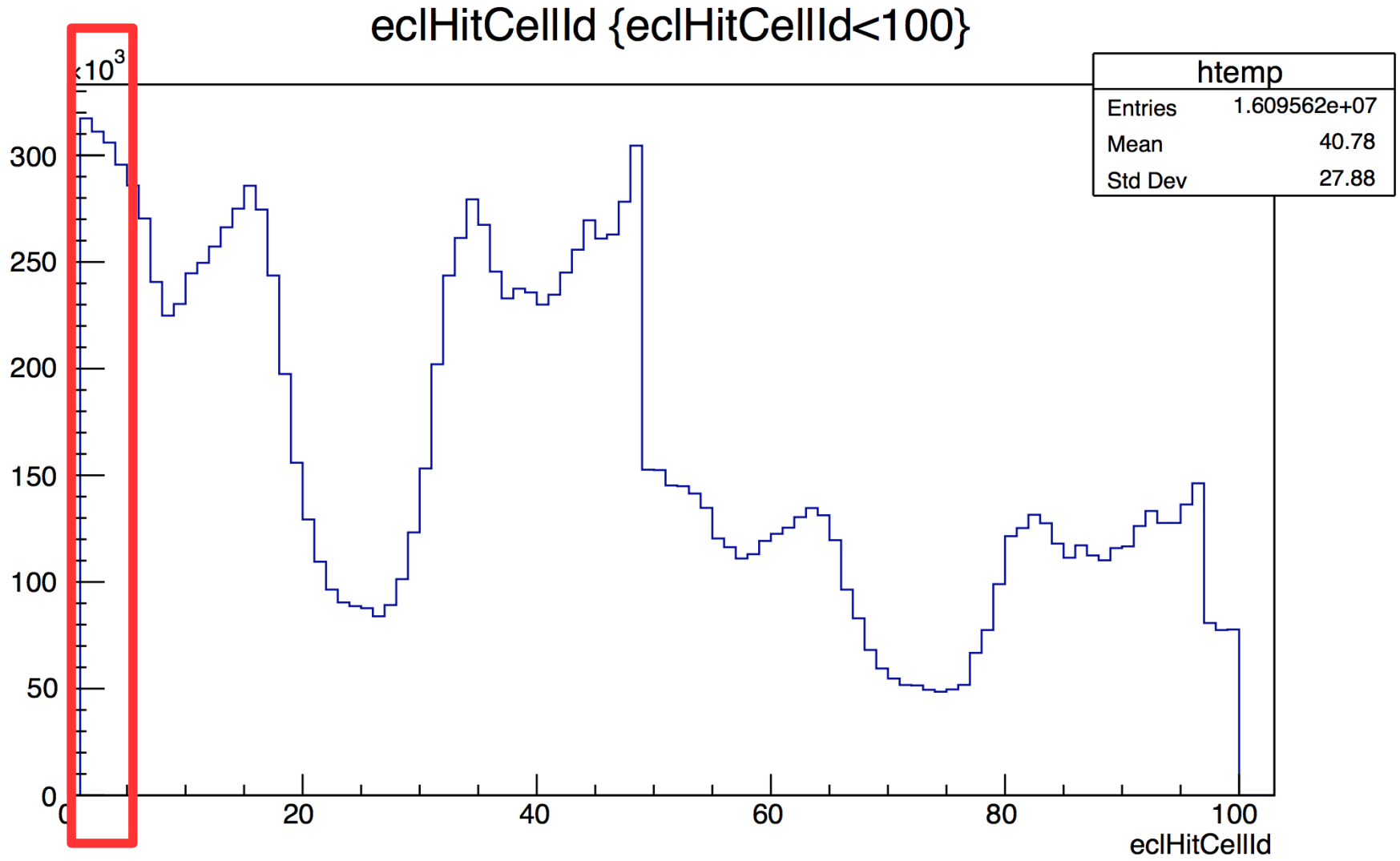






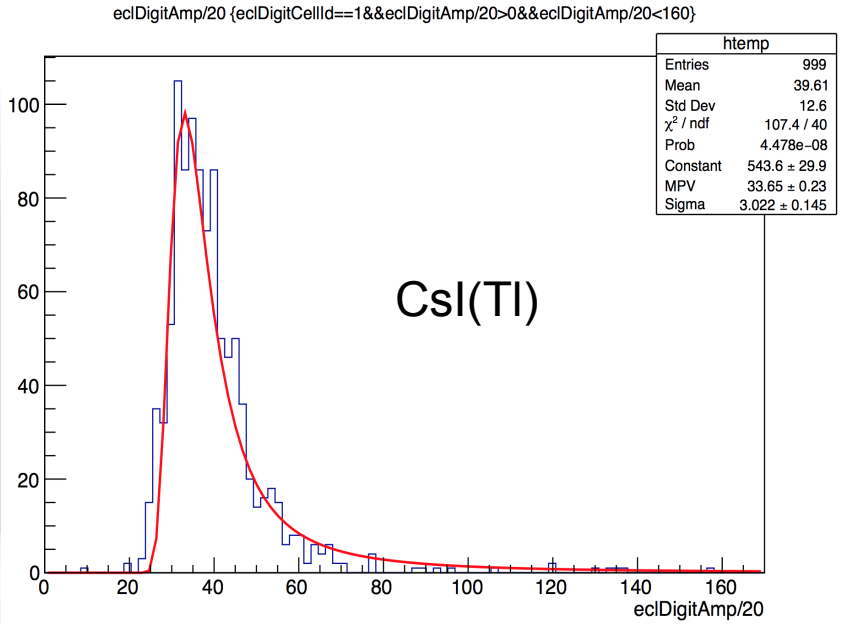
bkg modulation

- Crystal #1 and #161 are in the phi=0 region -> maximum bkg

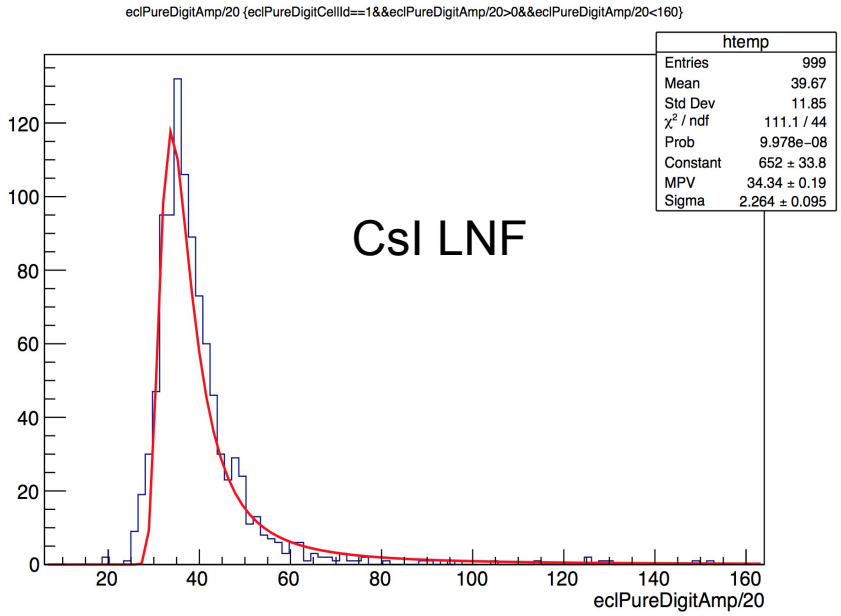


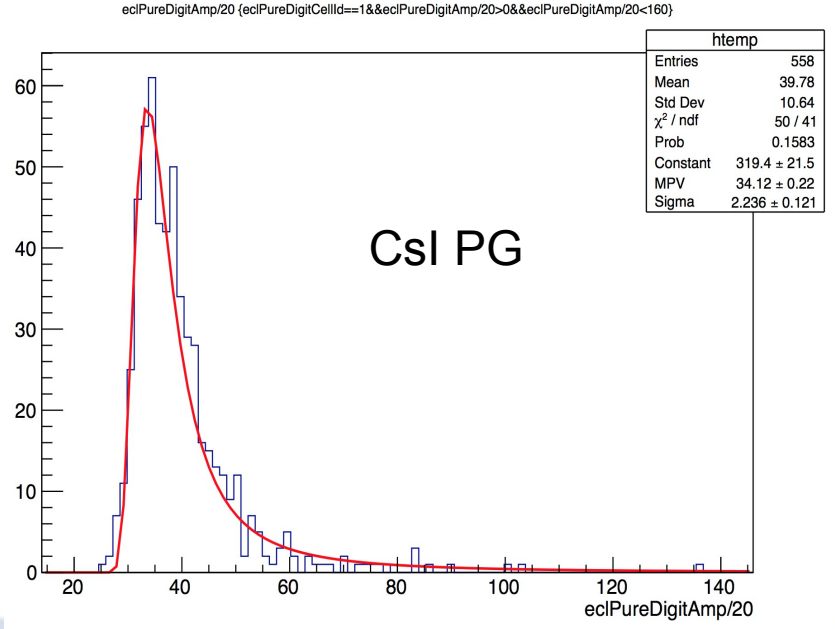
Crystal #1 w bkg

- No sizeable difference in MPV



Crystal #1

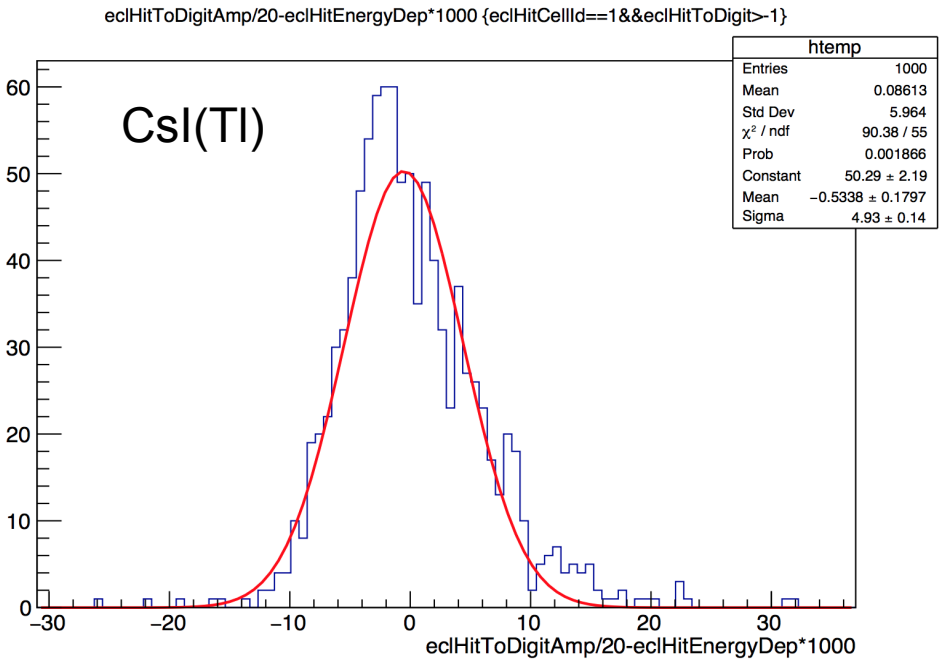


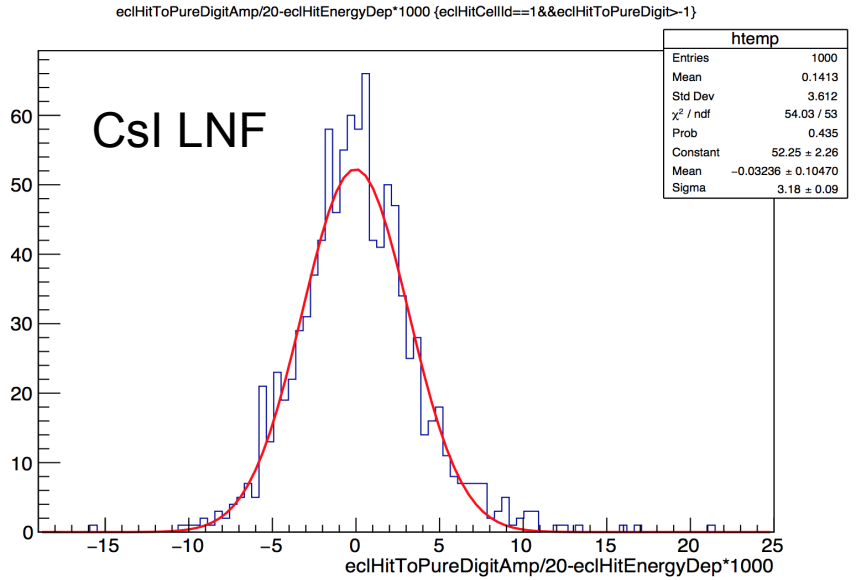


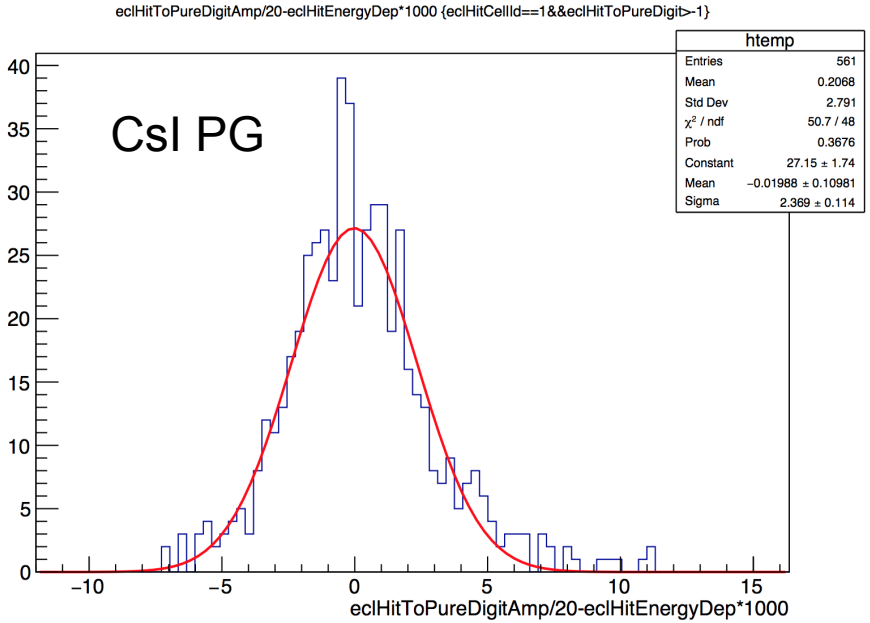
Resolution w bkg ring1

- Crystal #1
- CsI(Tl) : 14.6 %
- CsI LNF : 9.2 %
- CsI PG : 6.94 %

sigma(gaus)/MPV(landau)



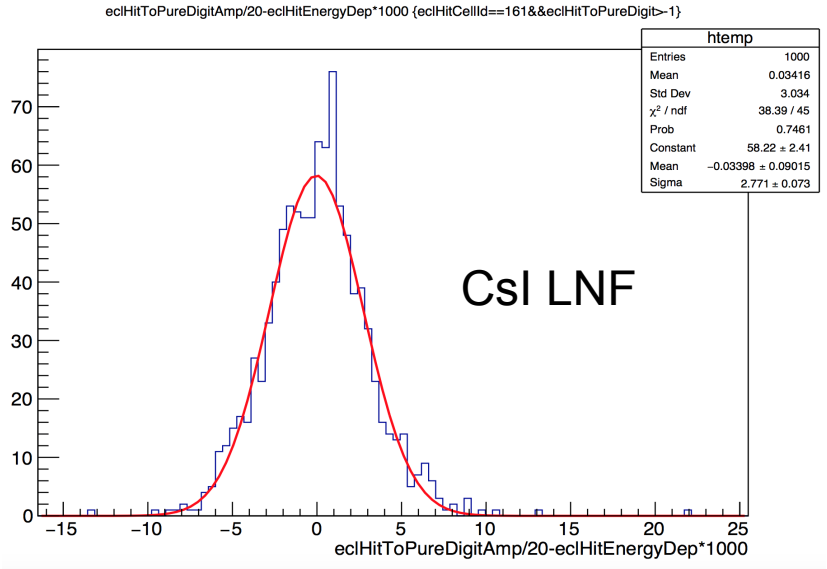


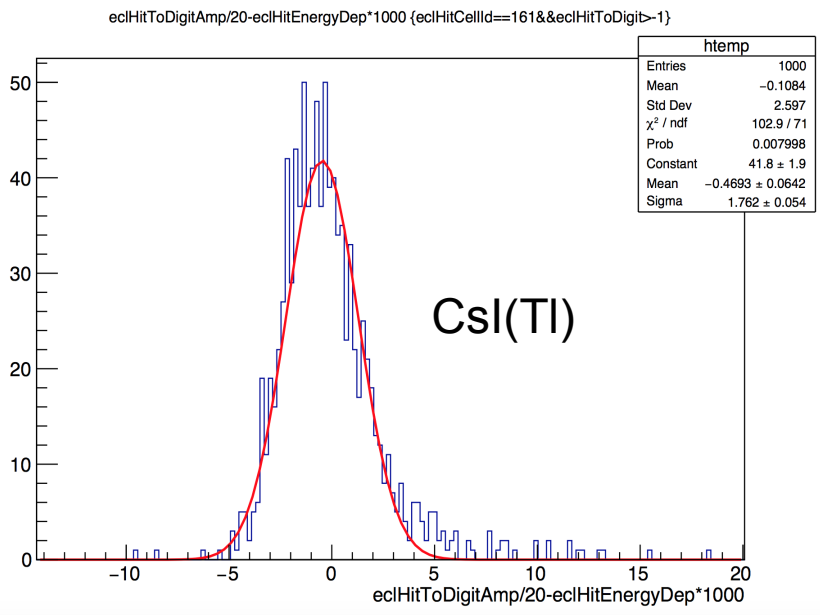


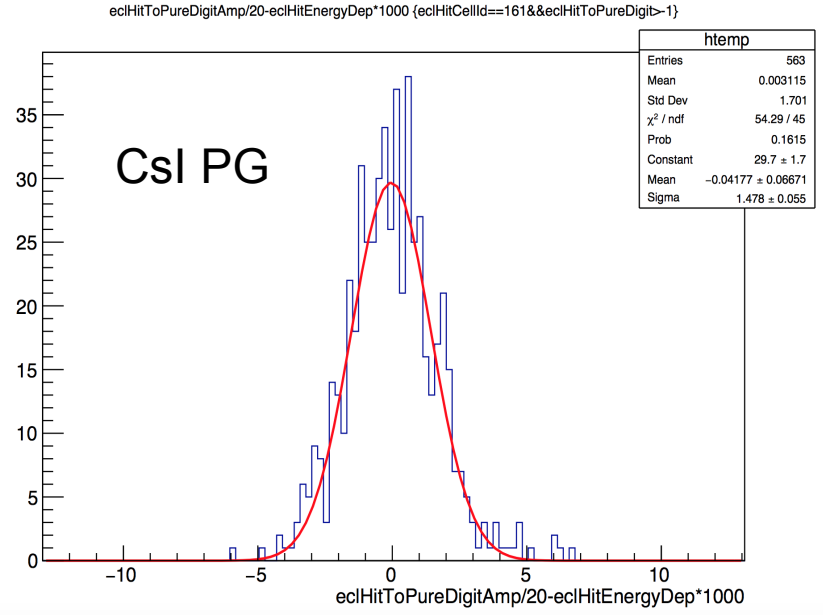
Resolution w bkg ring4

- Crystal #161
- CsI(Tl) : 5.15 %
- CsI LNF : 8.07 %
- CsI PG : 4.36 %

sigma(gaus)/MPV(landau)

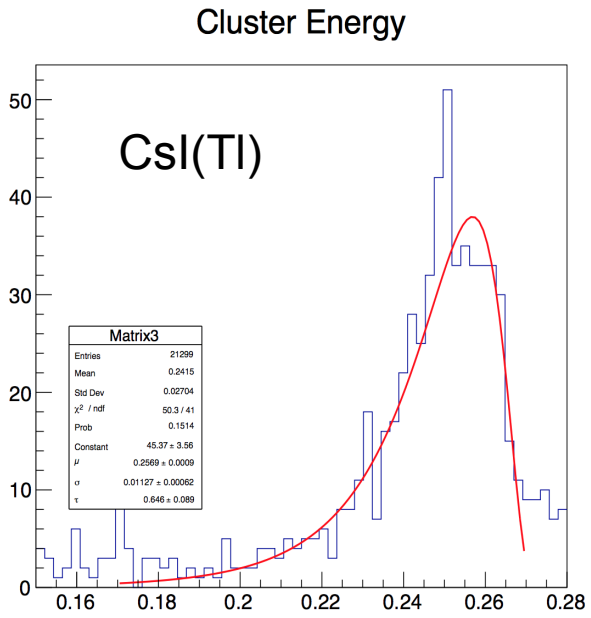


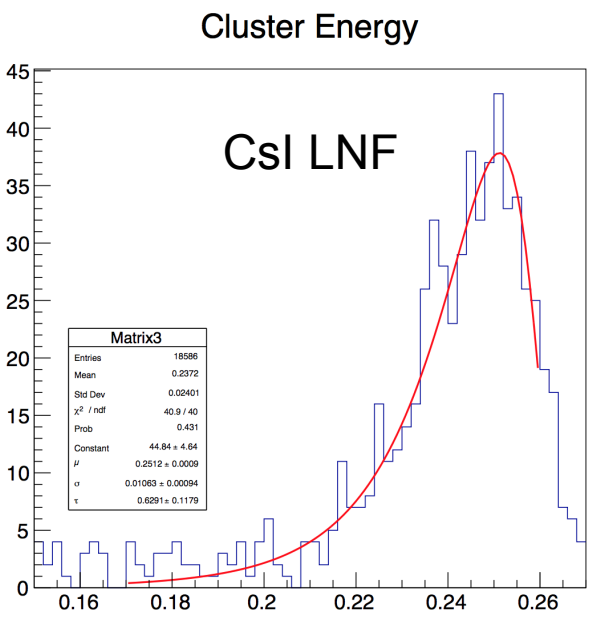


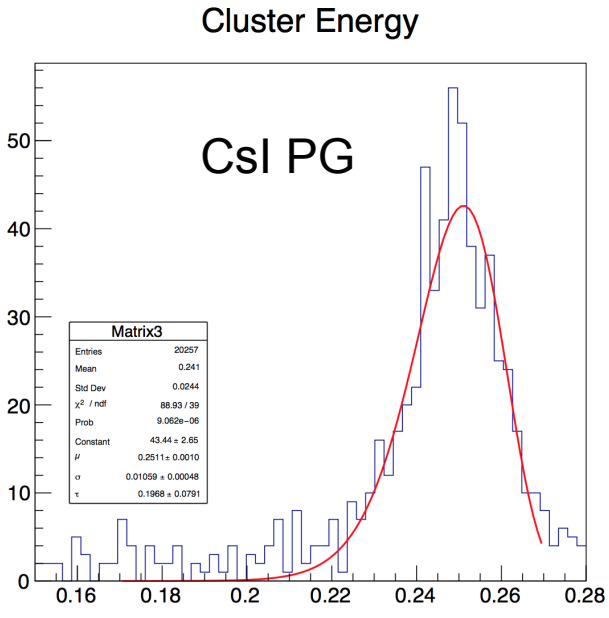


Energy resolution full FWD

- Elisa had shown at last B2GM resolution as f(E) with ECL only w and w/o bkg
- Using similar approach (i.e. Novosibirsk fit) we studied:
  - the effect of material
  - different settings for pure CsI



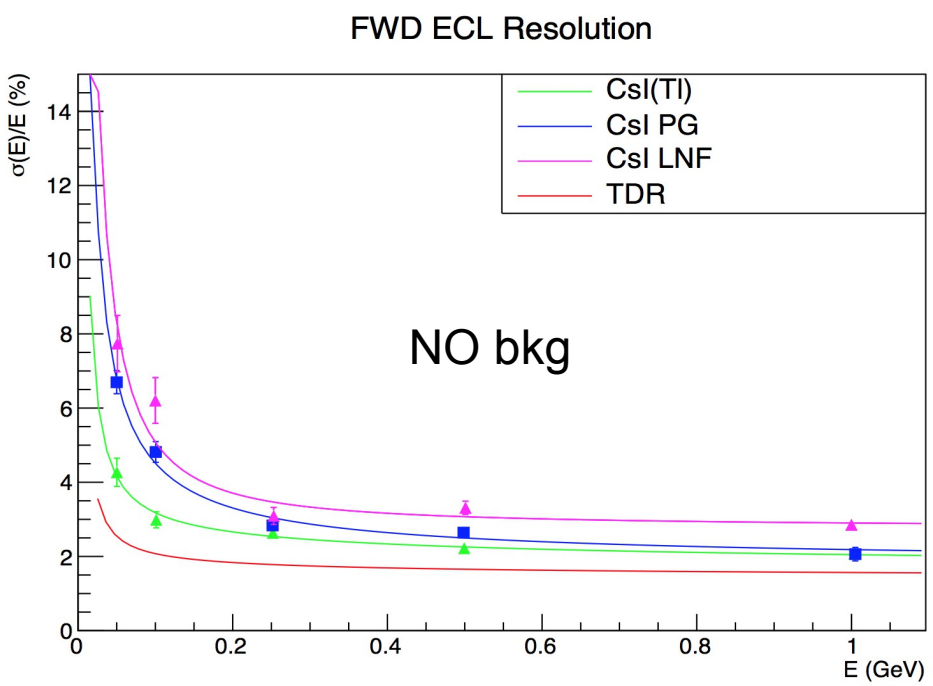


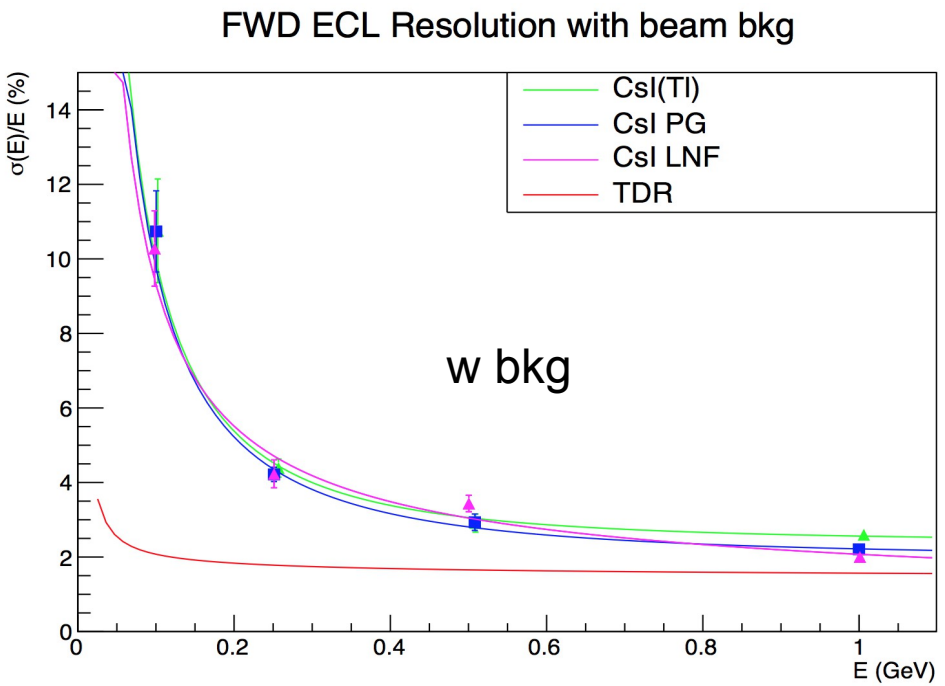


(note that for Novosibirsk f sigma=FWHM/2.36)

Fullsim results

- Single photon 10<theta<30, energy scan
- Fit: Sqrt((A)^2+(B/x)^2+(C/x^1/4)^2+(D/x^1/2)^2), D=0 for CsI(Tl), C fixed to 0.81 for pure CsI

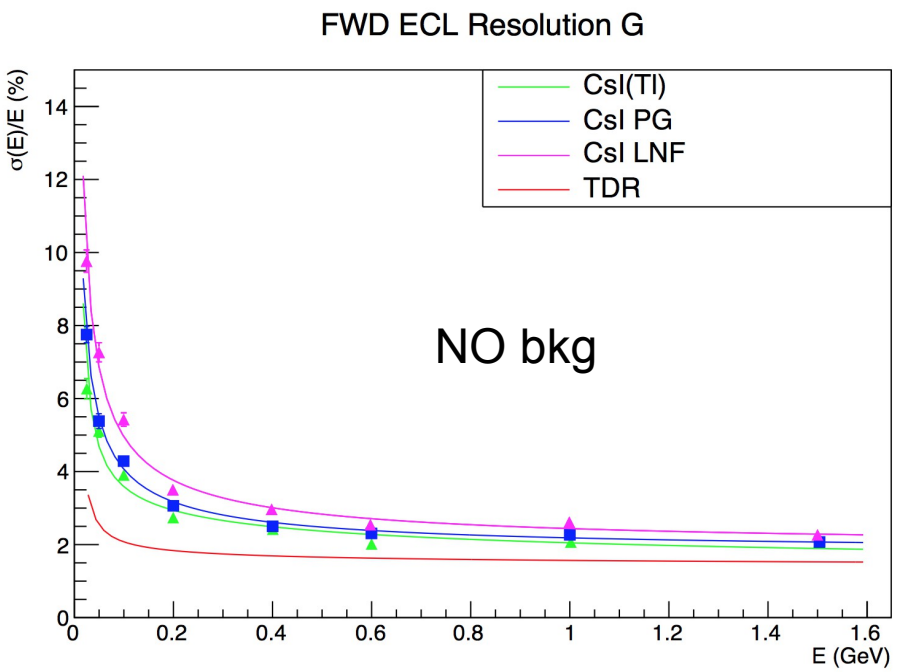


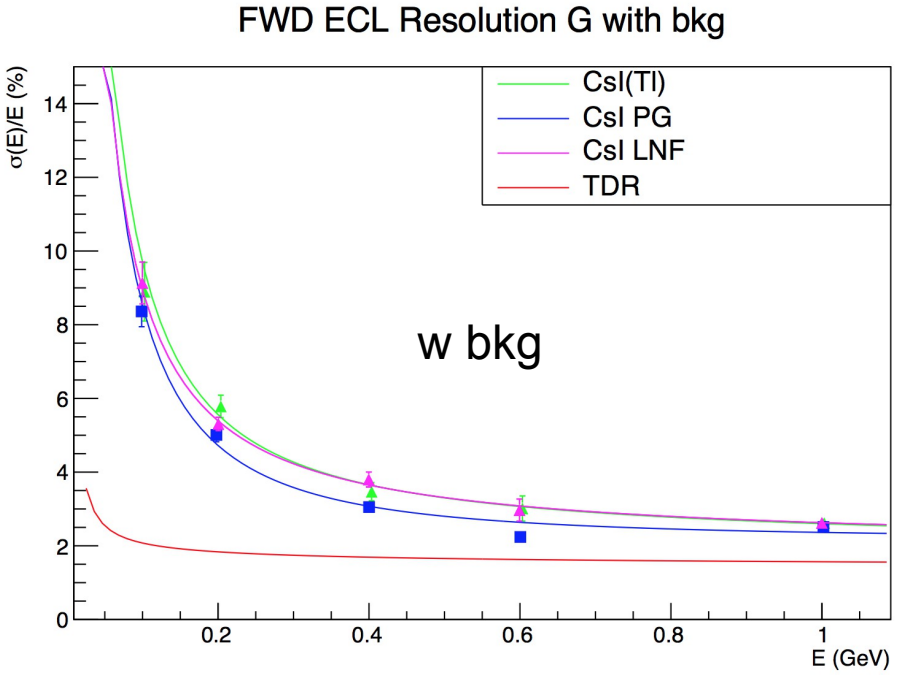


r24746 and latest bkg files, i.e. 12th campaign

Fullsim results ECL only

- Single photon 13<theta<25, energy scan, no material in front of ECL
- Same fit function



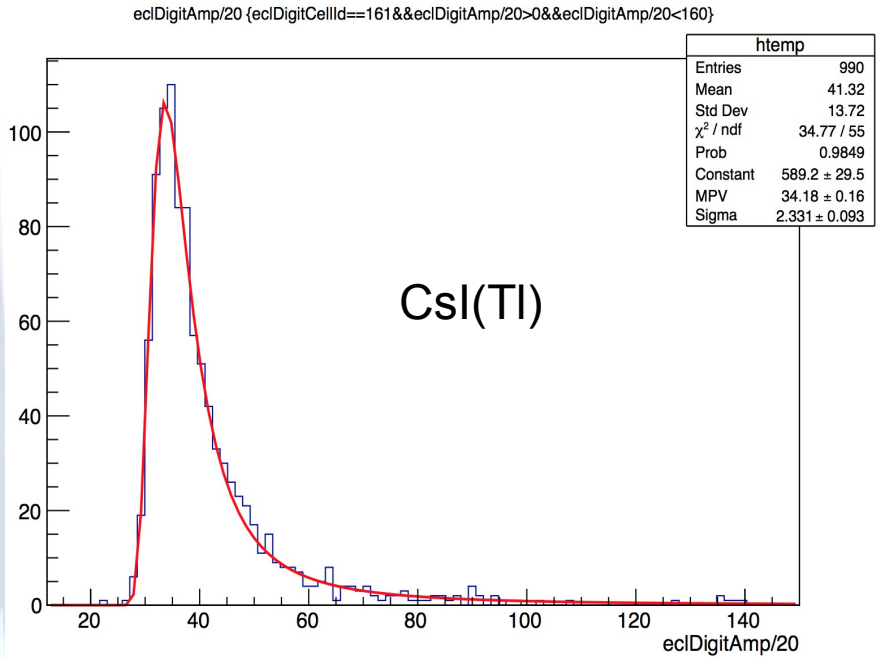


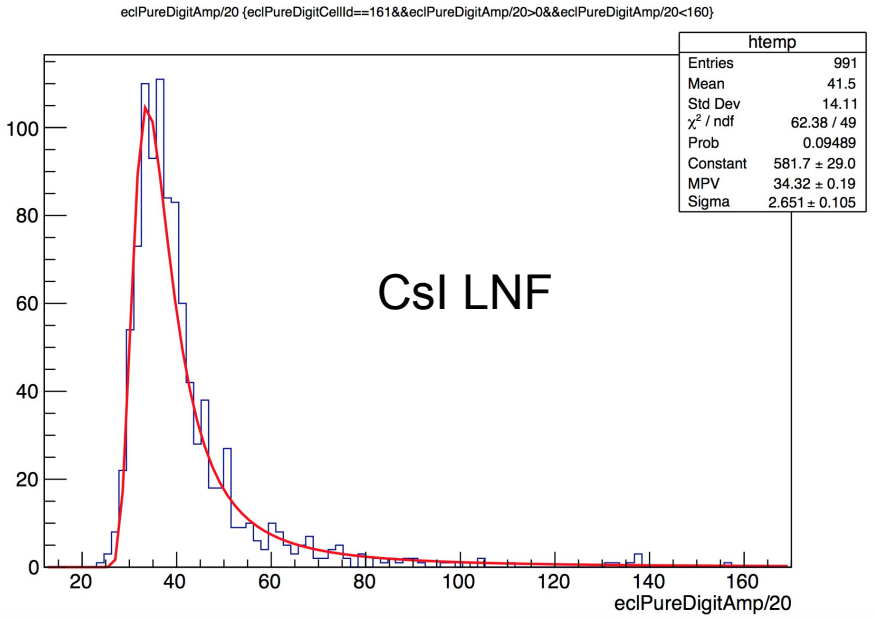
r24746 and latest bkg files, i.e. 12th campaign

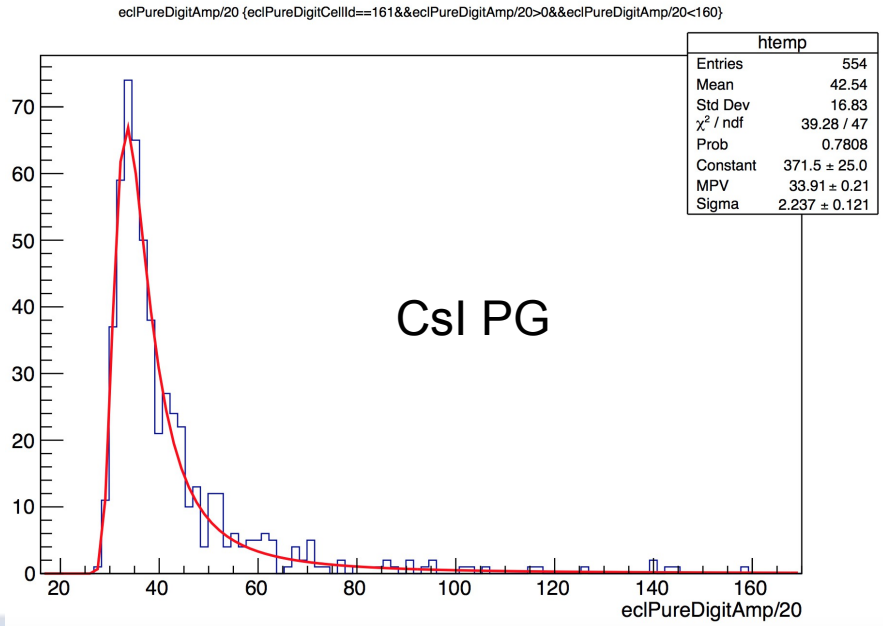
Backups

Crystal #161 w bkg

- No sizeable difference in MPV

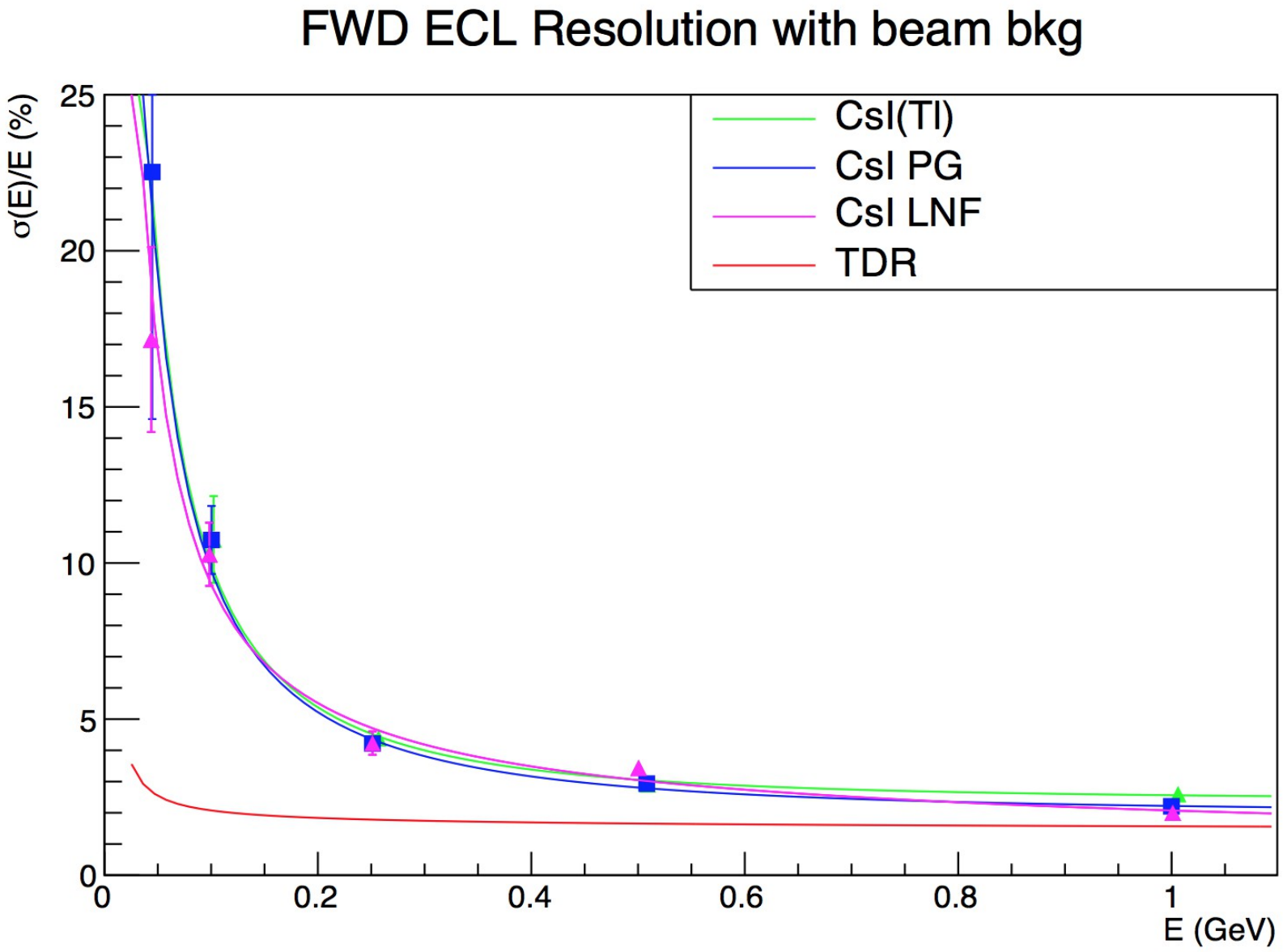




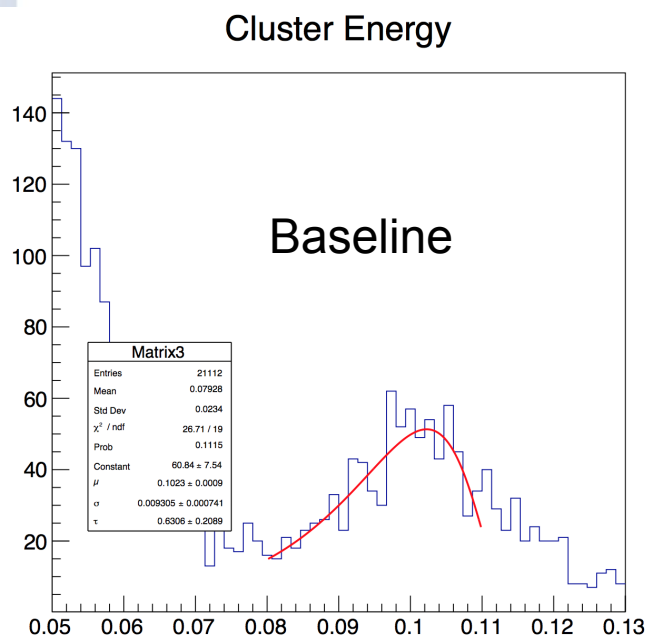


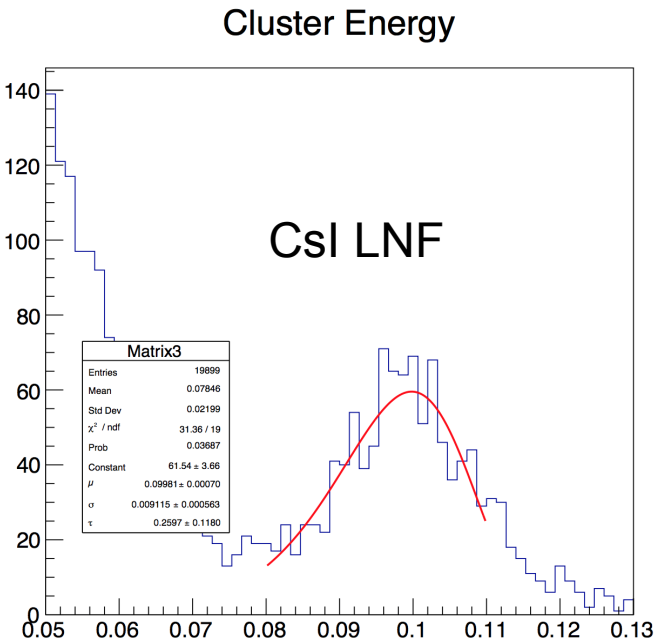
Crystal #161

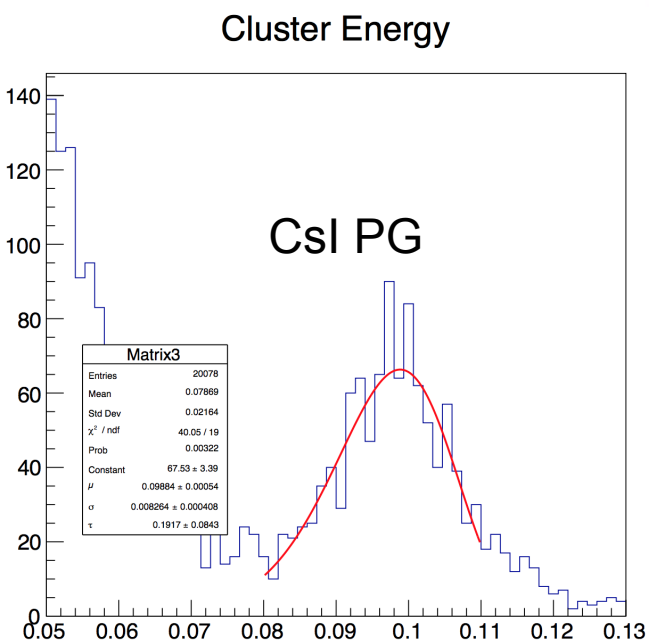
FullSim Reco – Broader View



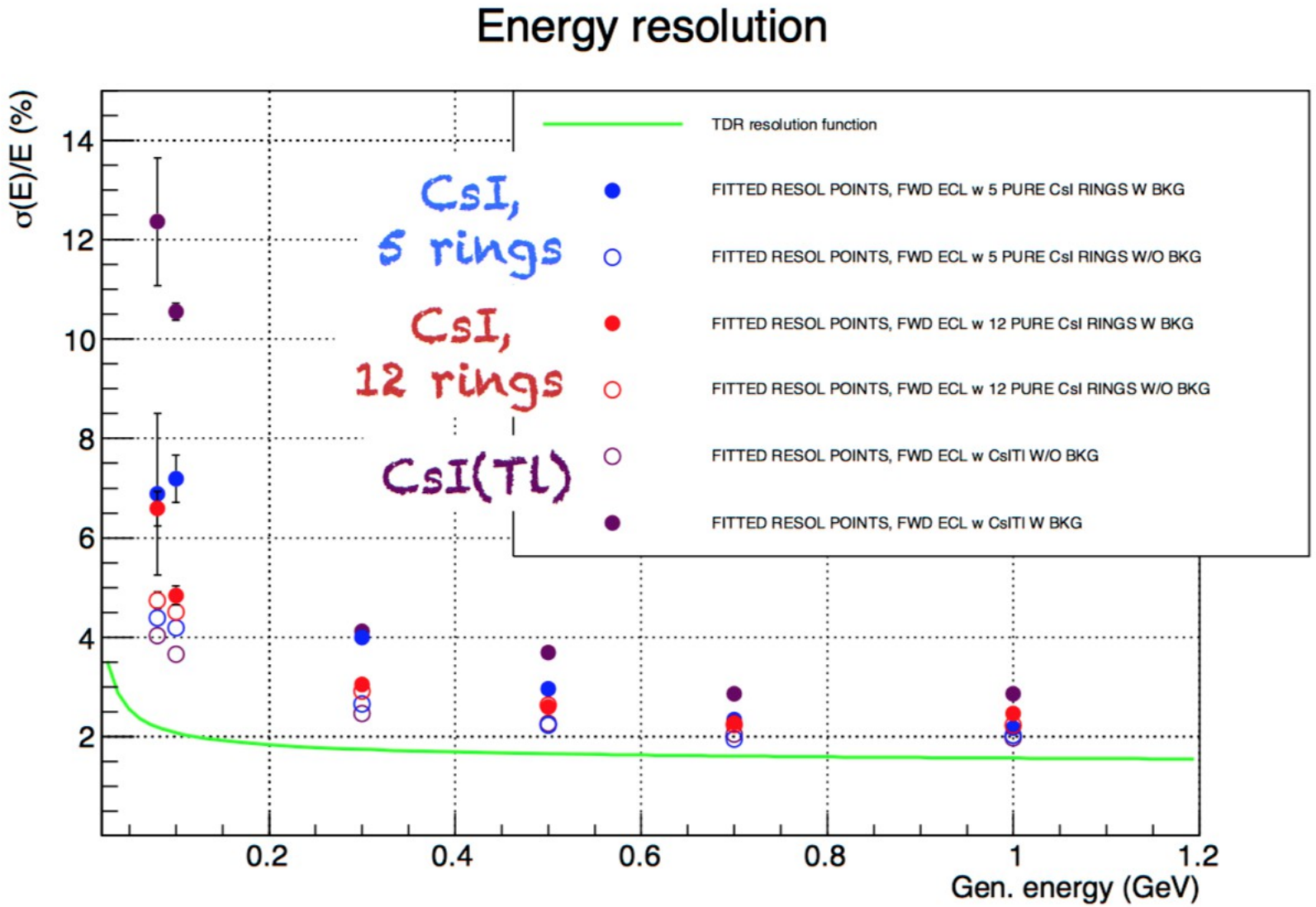
100 MeV Fit, bkg, no material





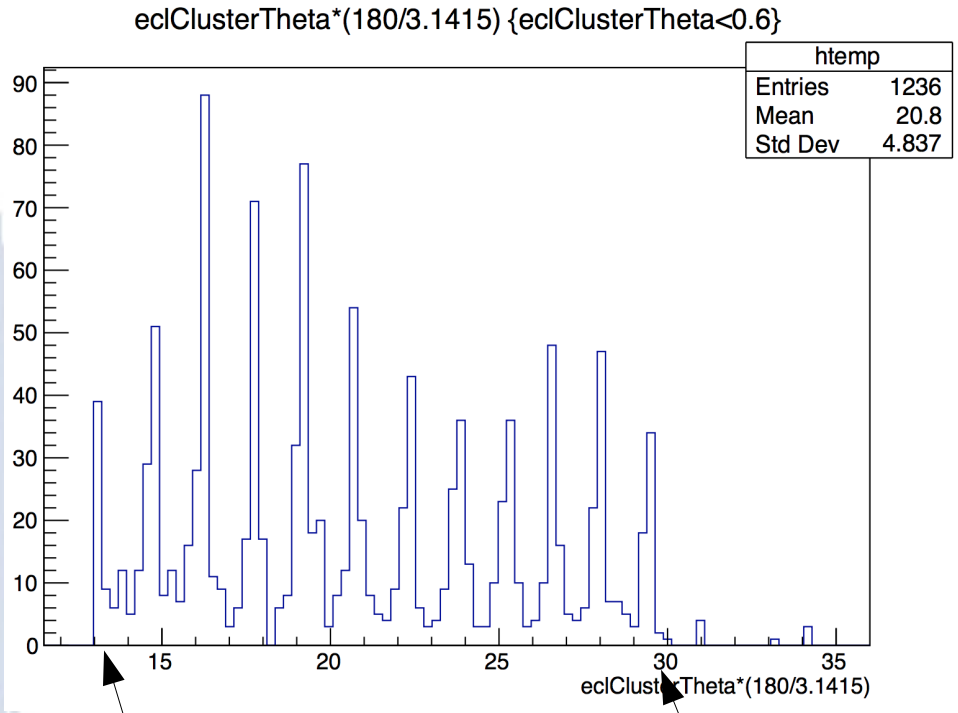


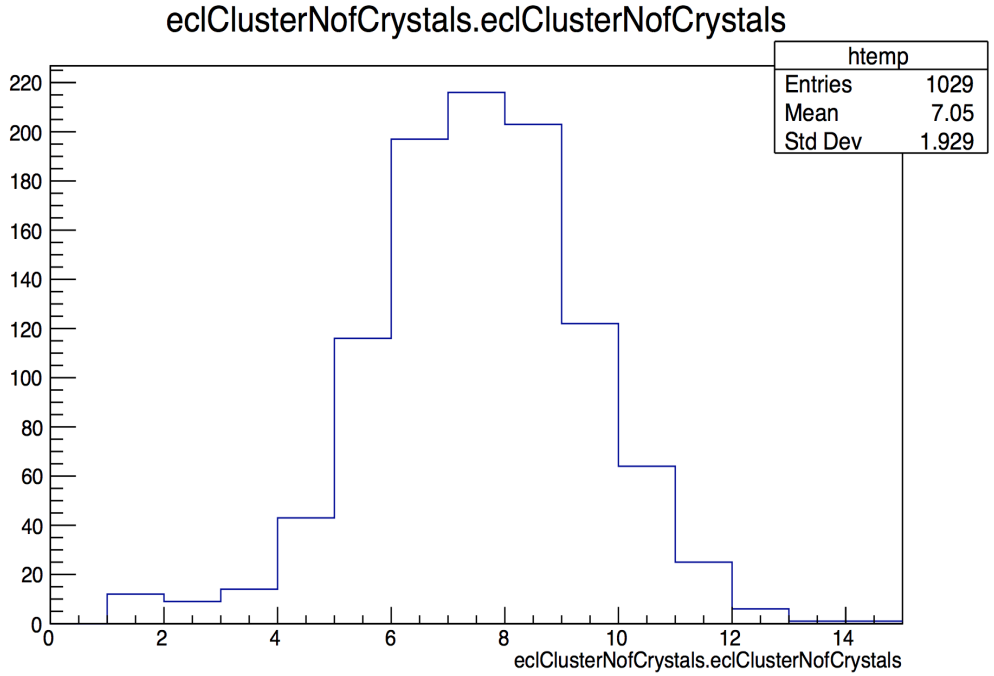
Febraury B2GM results



Clustering and seeding

500 MeV gammas 10<theta<30



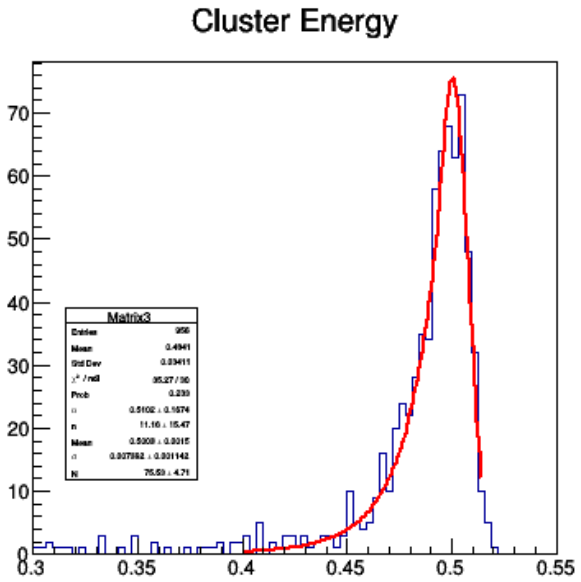


First ring

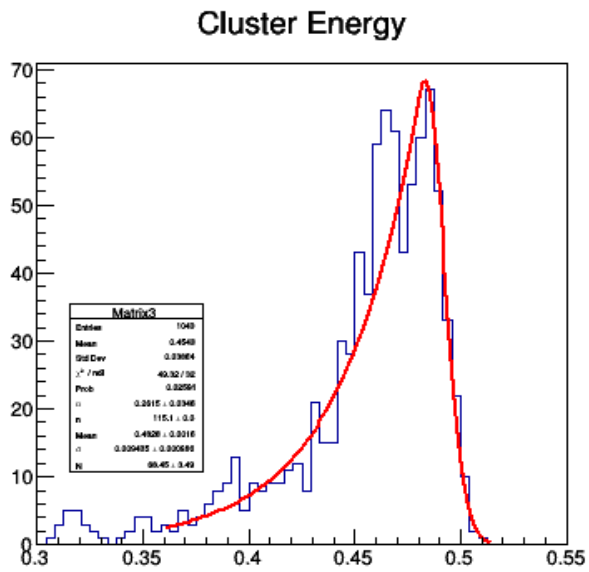
This is not the last FWD ring!

Energy bias

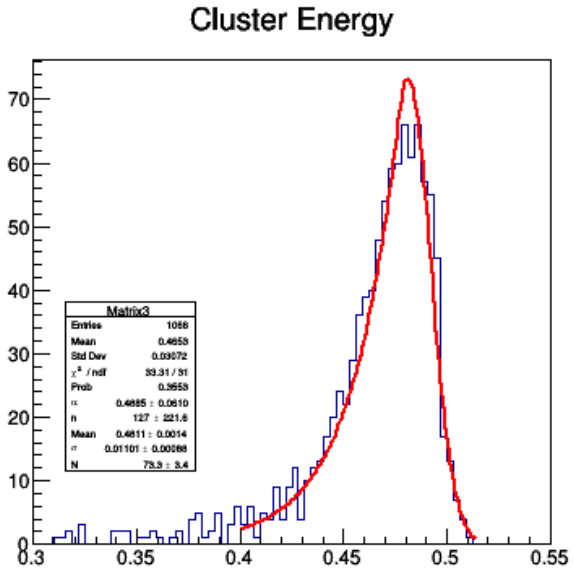
- Shooting single photons in some random directions we observe a shifted energy spectrum when compared to the ECL average
- More detailed study is needed for a precise map



Uniform



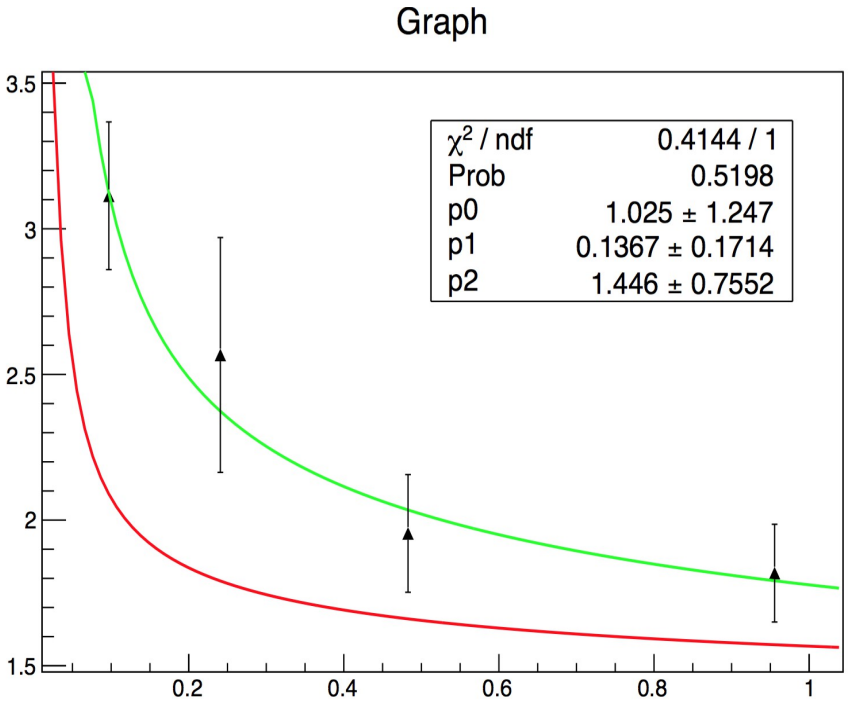
Theta=90, Phi=0



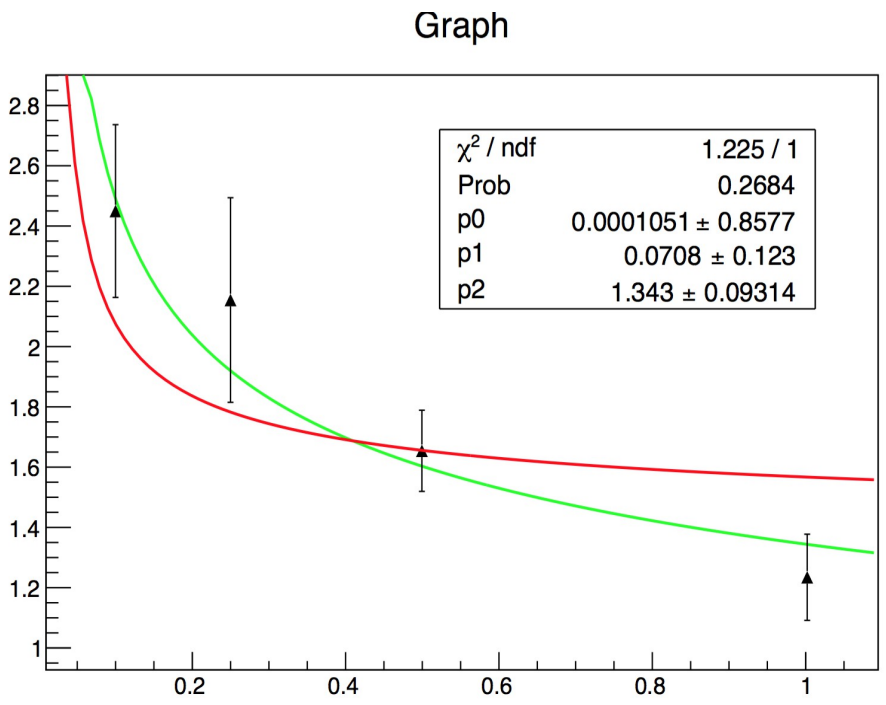
Theta=80, Phi=90

Energy bias and resolution

Crystal Ball fit sigma/E



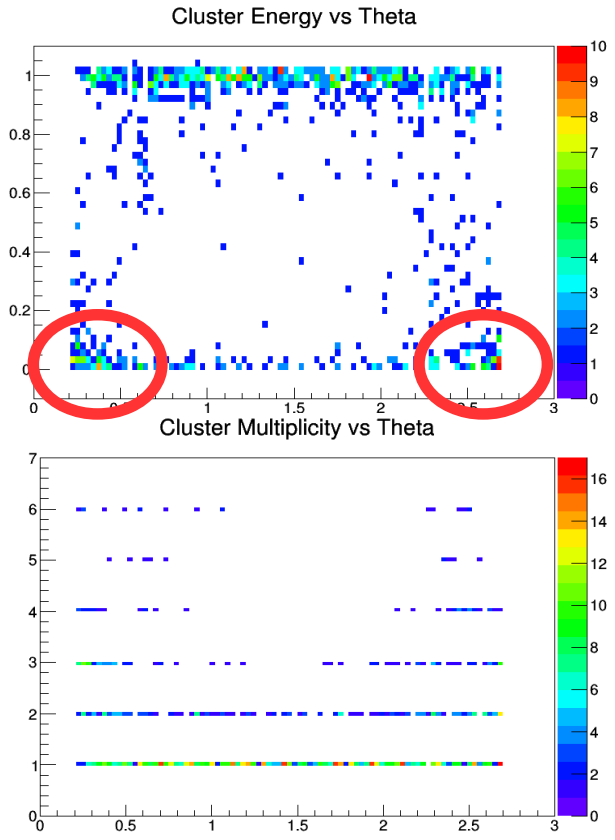
Uniform

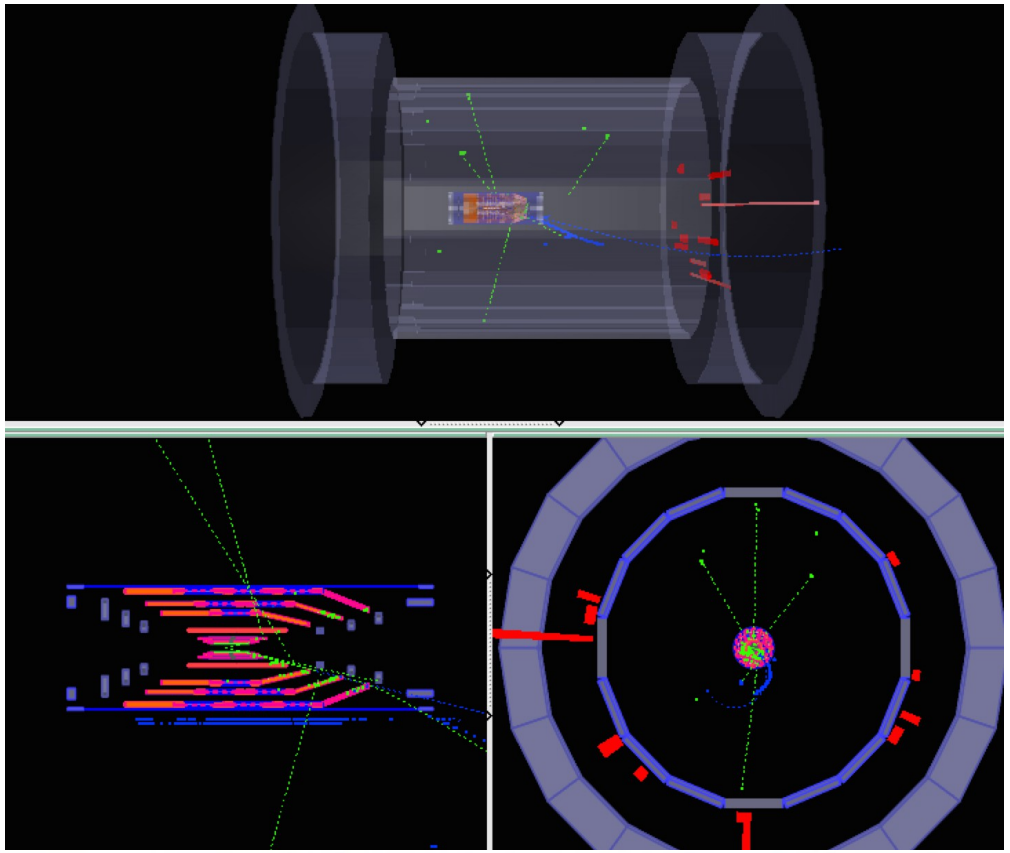


Fixed

From June 2015 B2GM

- Non-negligible effect of material budget, especially in FWD direction, causes
  - Fragmentation -> higher multiplicity
  - Energy loss -> resolution smearing





Material & MC Truth

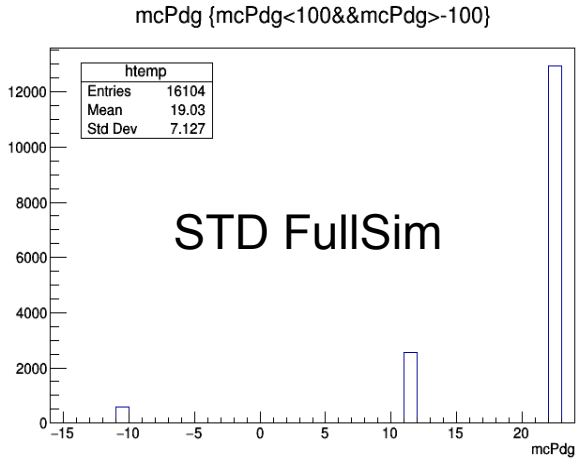
- If a primary particle interacts with detector material all subsequent cluster information is linked to that particle
- Currently MC information for (non-generator) secondaries (i.e. GEANT created) particles in not stored by default
- (CAVEAT: if the particle is charged and has a corresponding TrackCandidate, MC information is recovered)

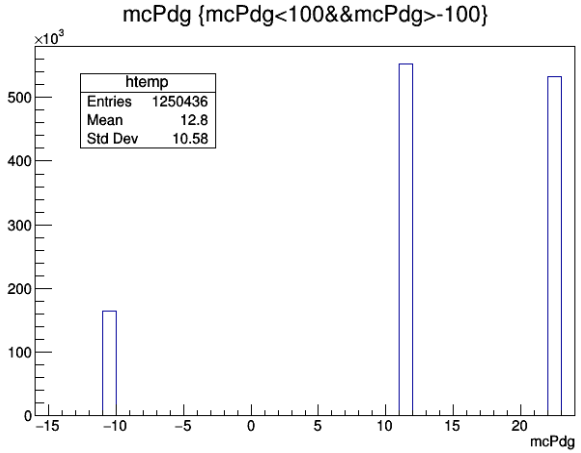
- One may want to study conversion rates or some sophisticated photon reconstruction algorithms
  -> requires MC-info also for daughter particles
- Also needed for some other reconstruction tasks (e.g. Bremsstrahlung recovery)

- Which particles (secondaries) do we want to store?

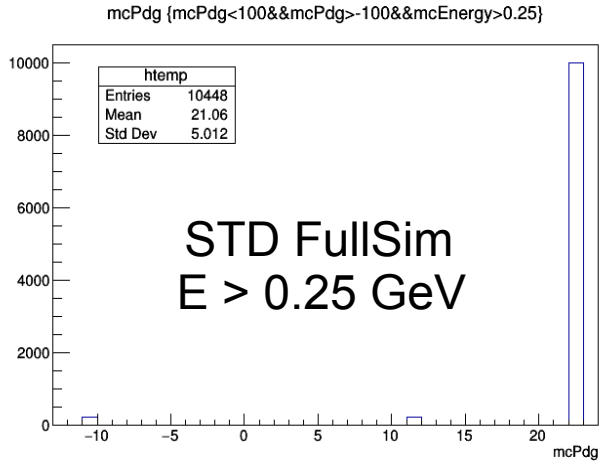
Including secondaries

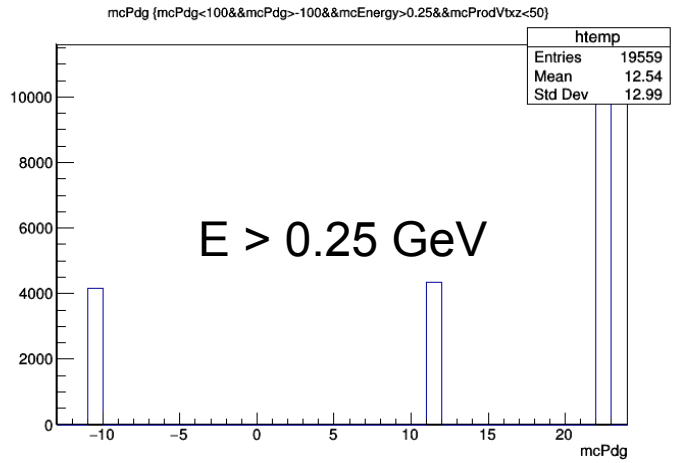
- Using “StoreAllSecondaries” parameter of FullSim we store all daughters with E>1MeV, for a 0.5 GeV photon 13<theta<16





- Applying some reasonable selection criteria:

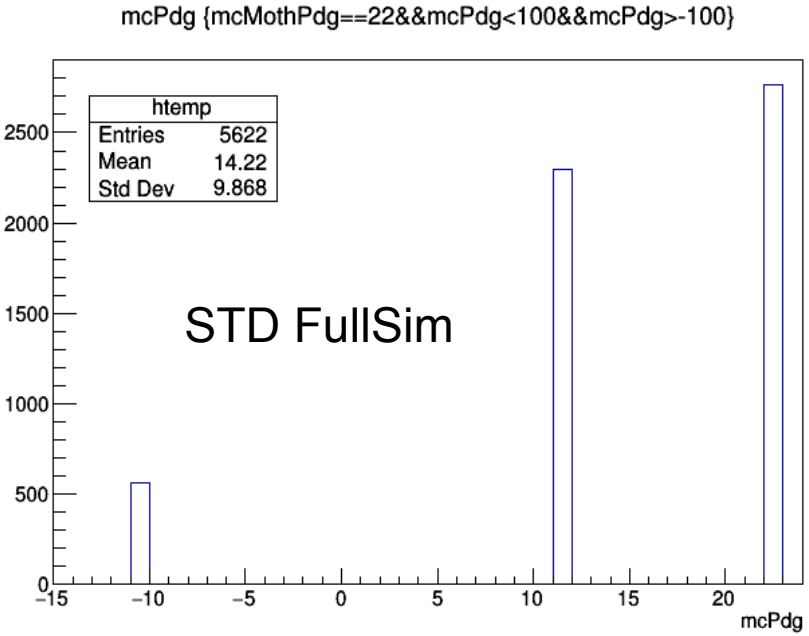


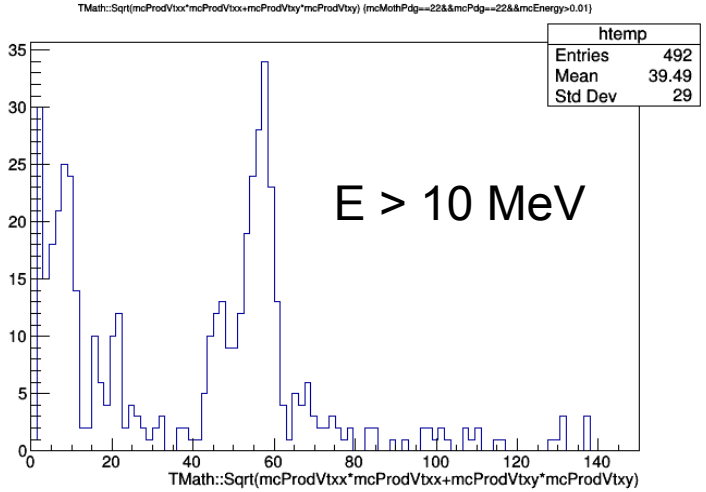


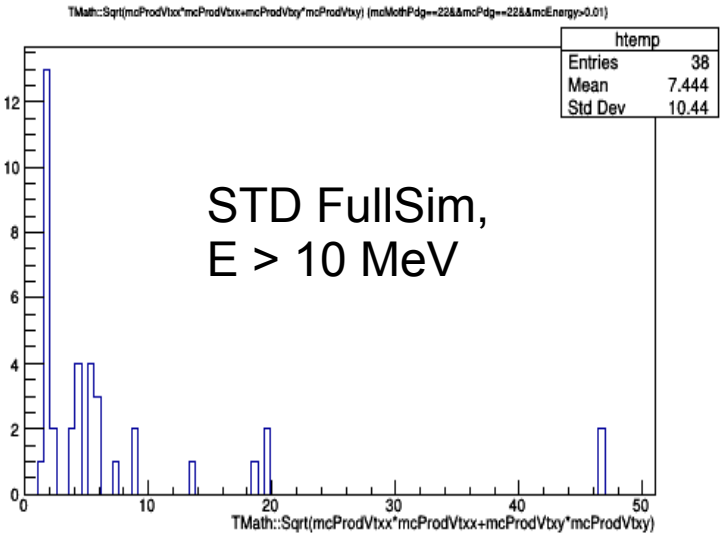
- Very different picture!

Family-tree

- Comparing particle PDG it becomes unclear why sometimes daughters are stored and sometimes not

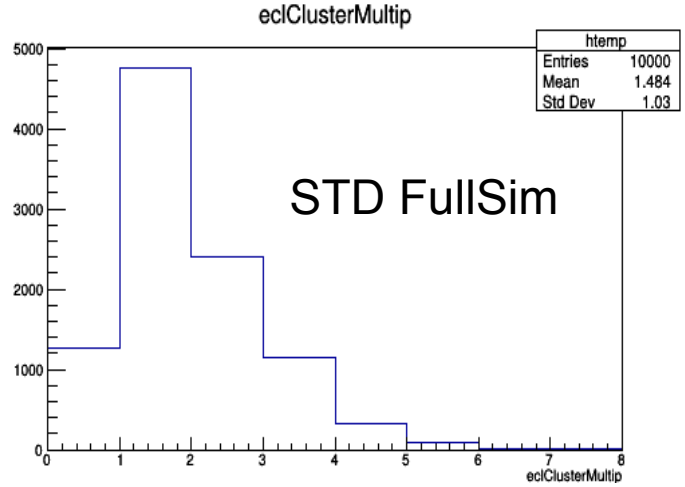


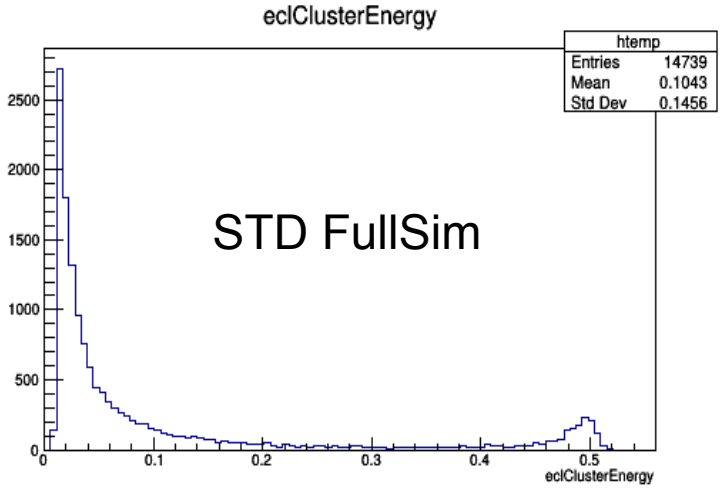


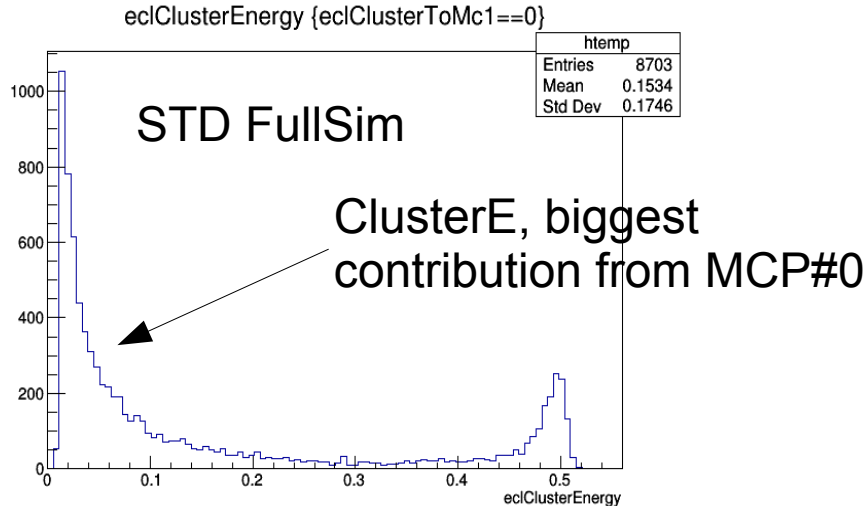


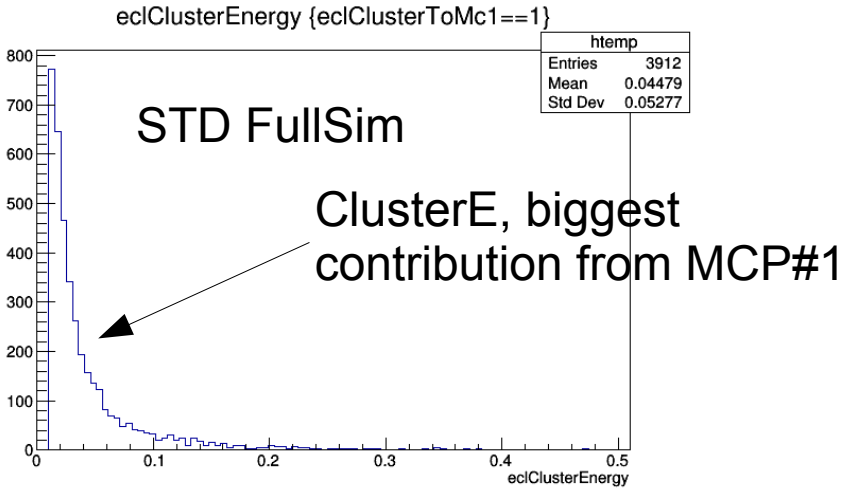
Clusters STD

- Having daughter information gives a more realistic picture of cluster formation



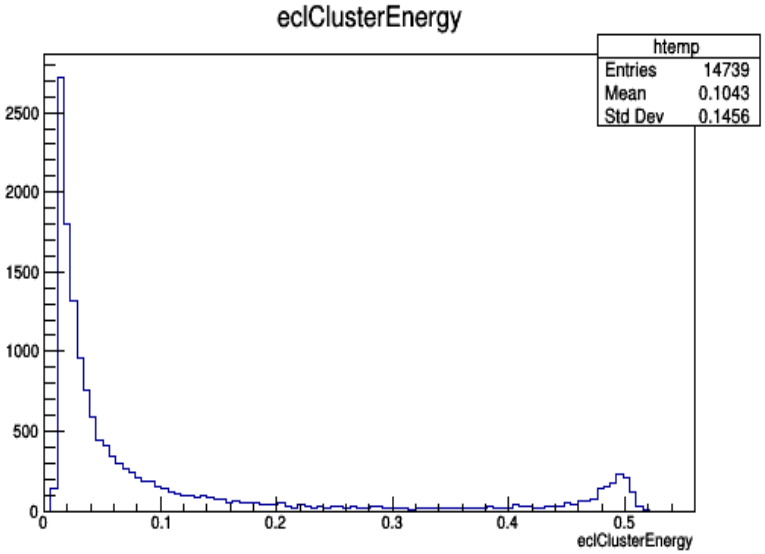




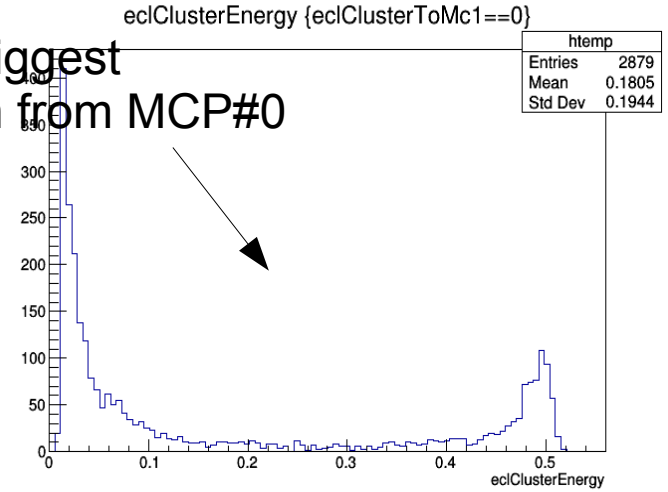


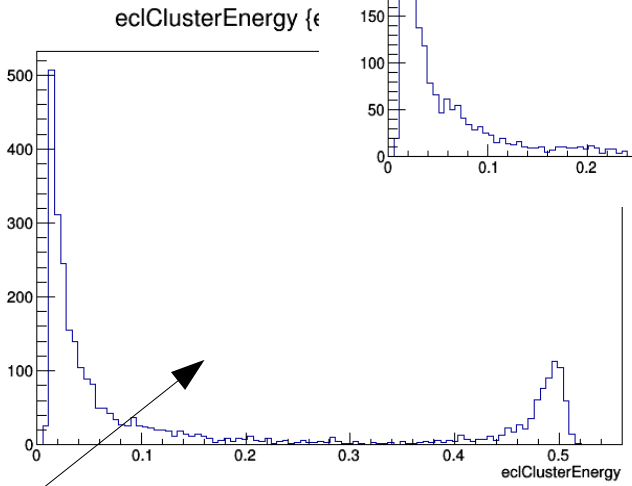
Clusters

- Having daughter information gives a more realistic picture of cluster formation

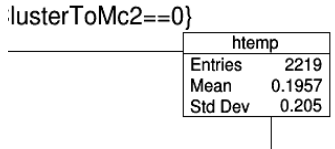


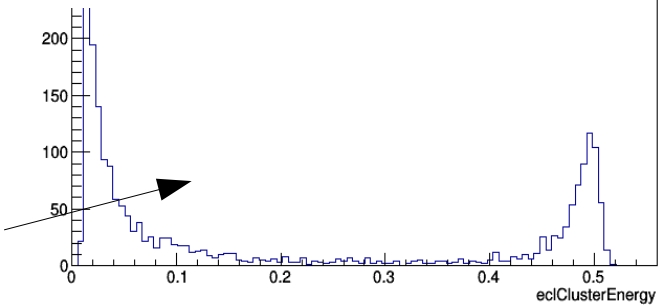
ClusterE, biggest contribution from MCP#0





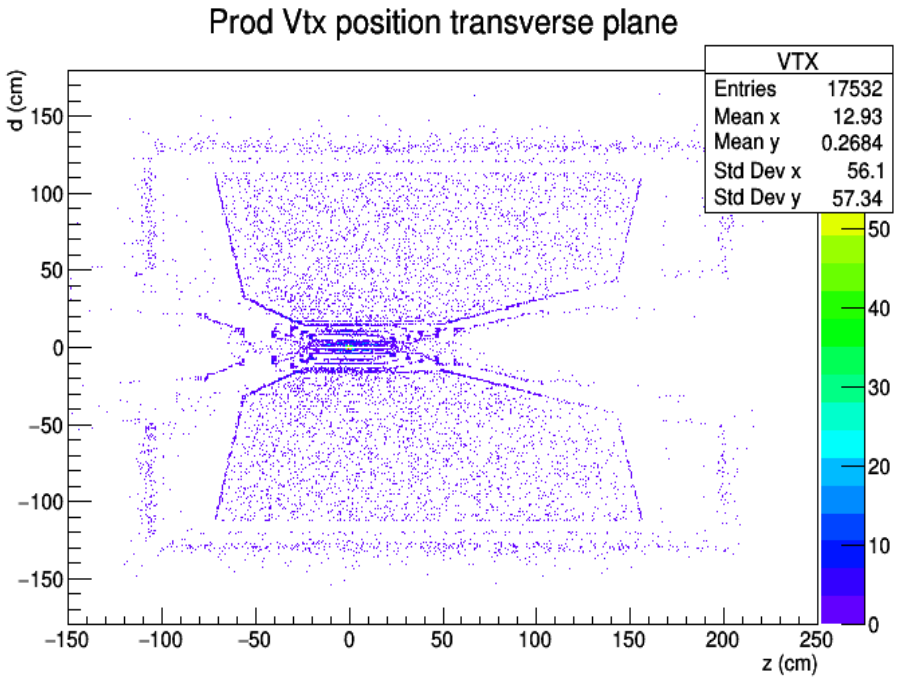
ClusterE, biggest contribution from MCP#1



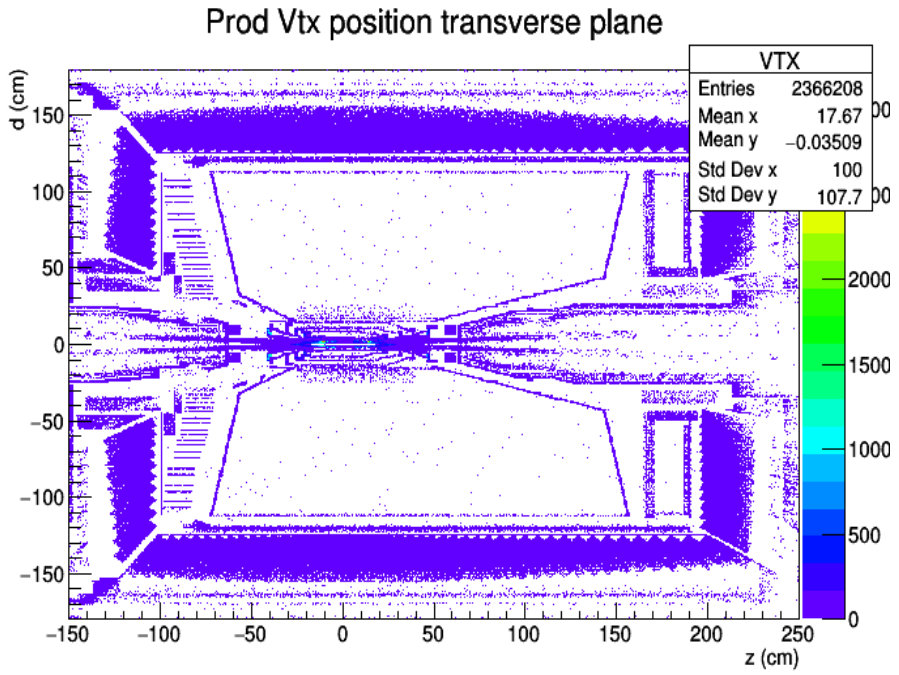


ClusterE, fror cluster which has second biggest contribution from MCP#1

Secondary production vertex map



STD FullSim



E > 10 MeV

- Simplest solution to keep information and save memory would be to define an appropriate volume inside the ECL in which we keep secondaries. Which one?

“Active volume” definition

- In principle a simple cylinder contained in ECL should be fine but what about back-scattering on (or near) inner crystal surface?
- Not so rare, a precise evaluation is ongoing