Clustering related issues

Benjamin Oberhof
LNF INFN

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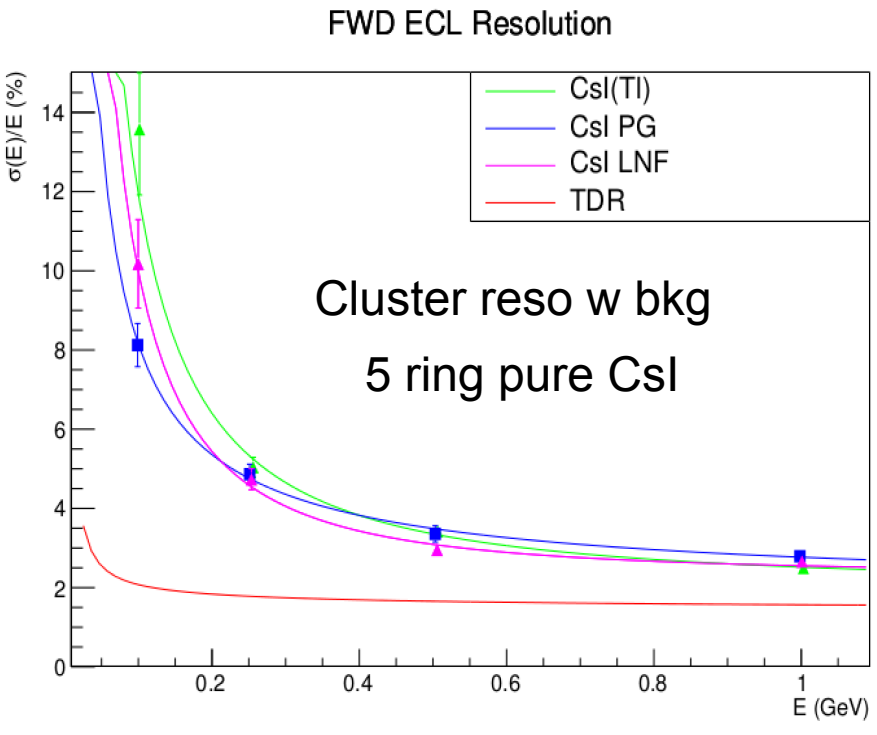
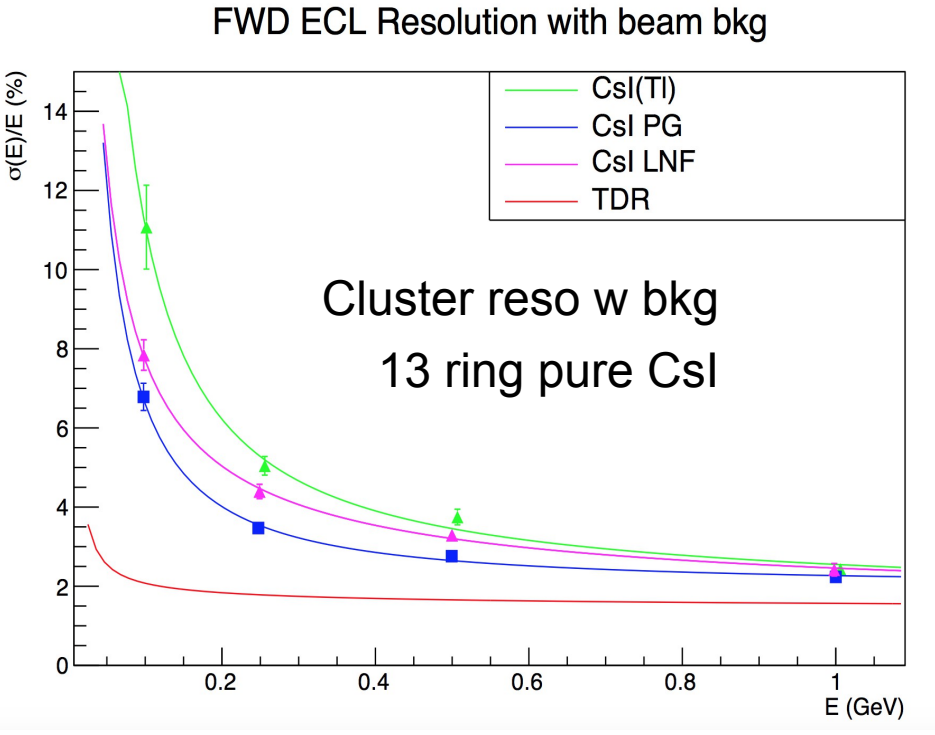
5 vs 13 layer pure CsI FWD with bkg

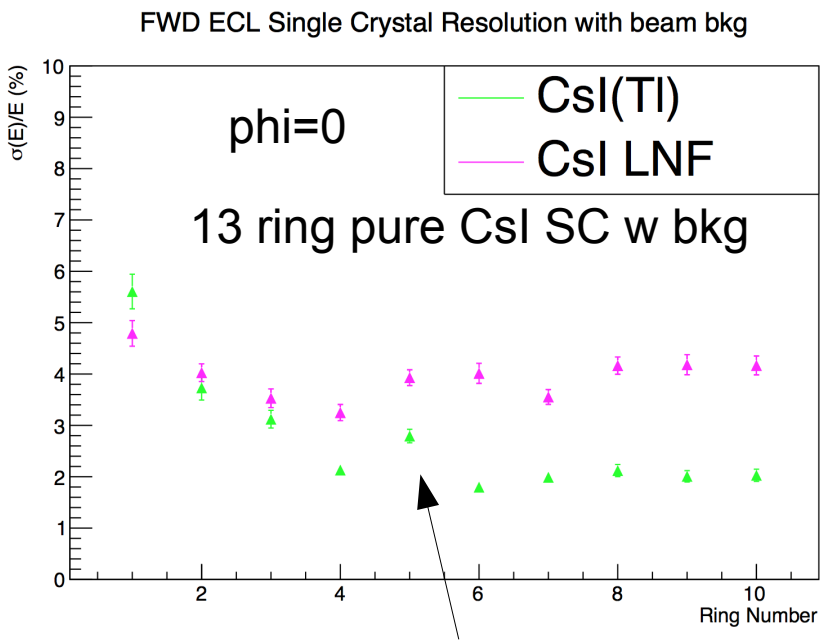
- Efficiency w bkg is seen to be better for a 13 ring pure CsI FWD rather than a 5 ring-only one: how reasonable is that?
- (Novosibirsk fit, 13 < theta < 30)



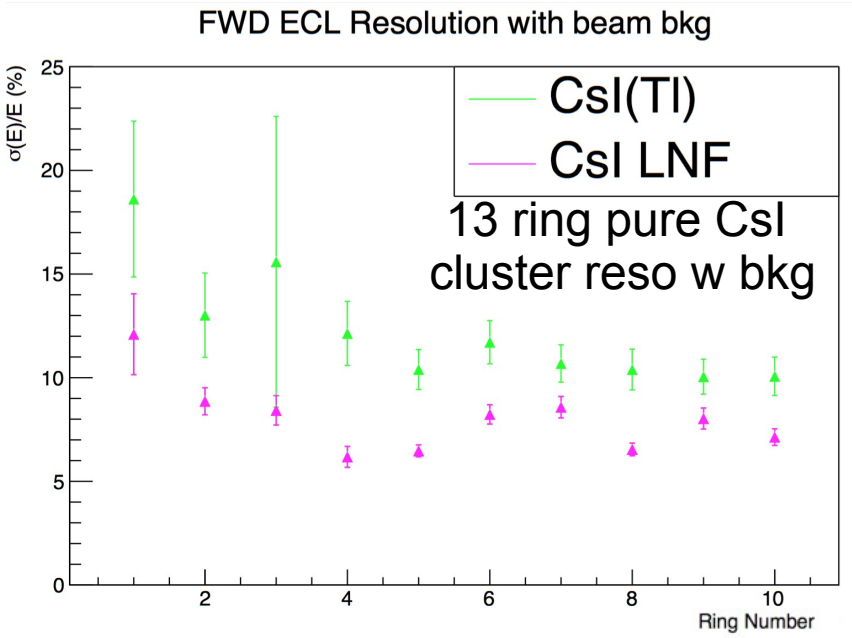


Single crystal studies with photons

- From previous result one could argue that even on the outer rings the bkg rate is high enough that pure CsI performs better than CsI(Tl)
- We perform a ring by ring scan to study this dependency comparing resolution on single crystal vs cluster resolution for 100MeV photons
- Left: energy resolution in signle crystal from $E_{reco} - E_{dep}$ (gauss sigma, NS mean)
- Right: cluster resolution (only selection is fit range i.e. 0.08<E<0.115)

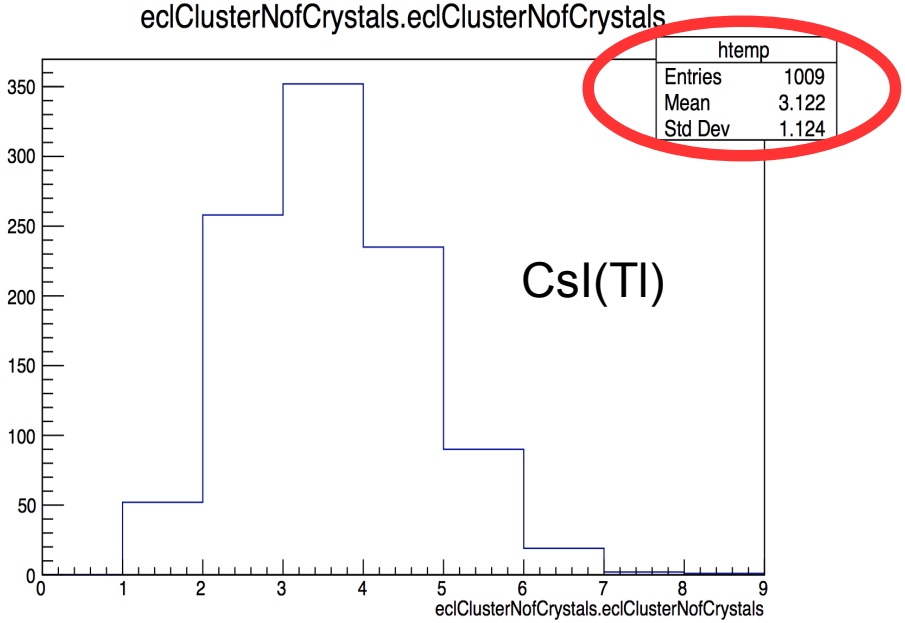


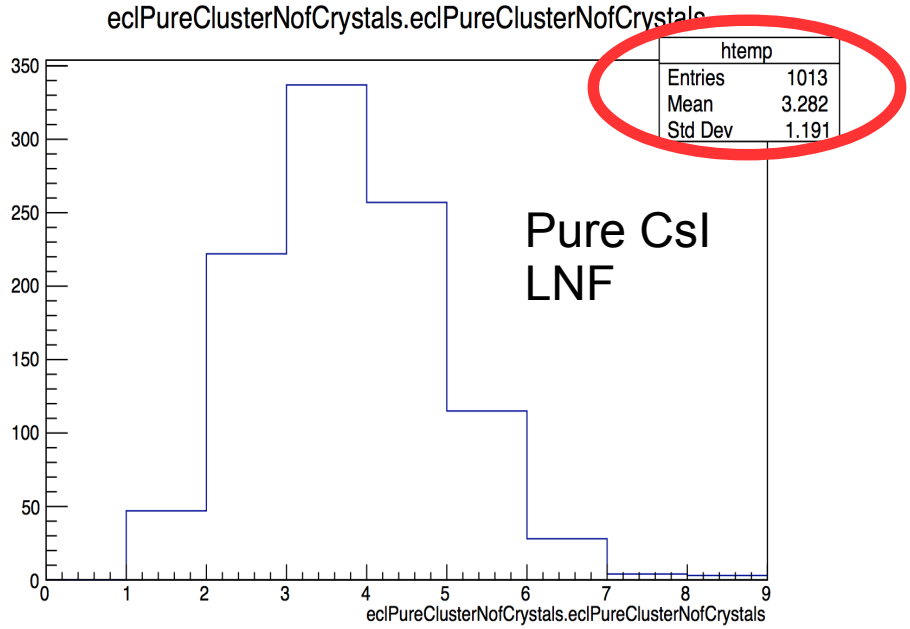
Ring 5 anomaly



NofCrystals in clusters w/o bkg

- When shooting single 100 MeV photons, w/o bkg, we observe that the multiplicity of crystals in cluster is low
- CsI(Tl) and CsI have very similar multiplicity

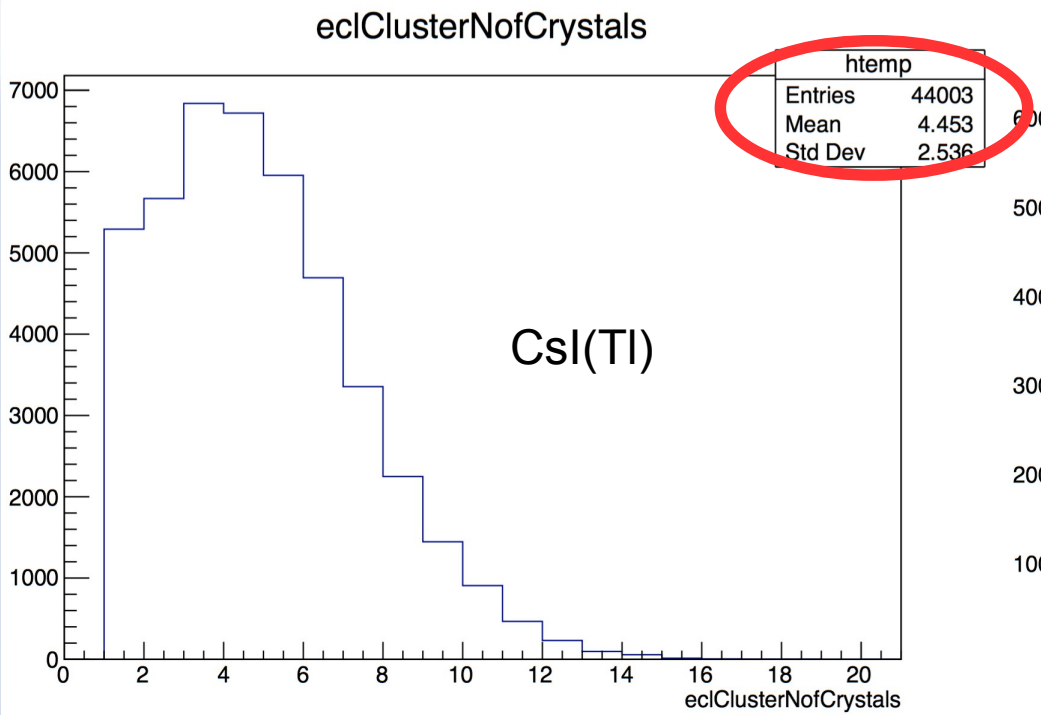


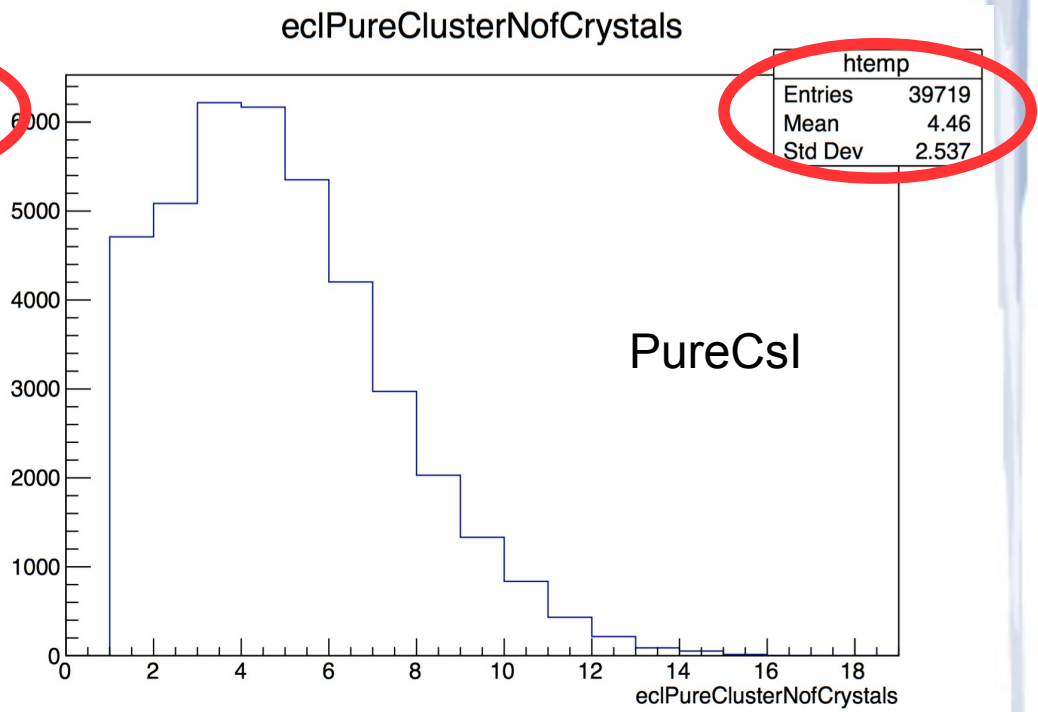


13 ring pure CsI

NofCry. in clusters w bkg, FULL sample

- Much broader distribution, on average 2 more crystals per cluster
- Minimal difference for the 2 set-ups
- NOTE: that's all clusters

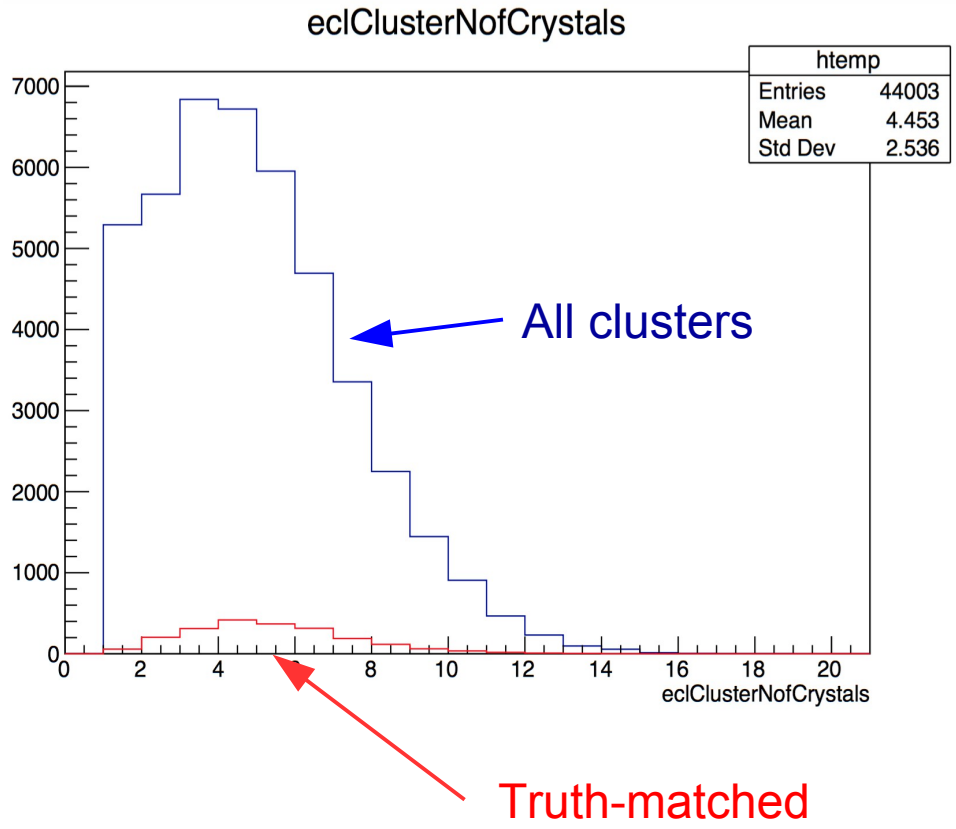


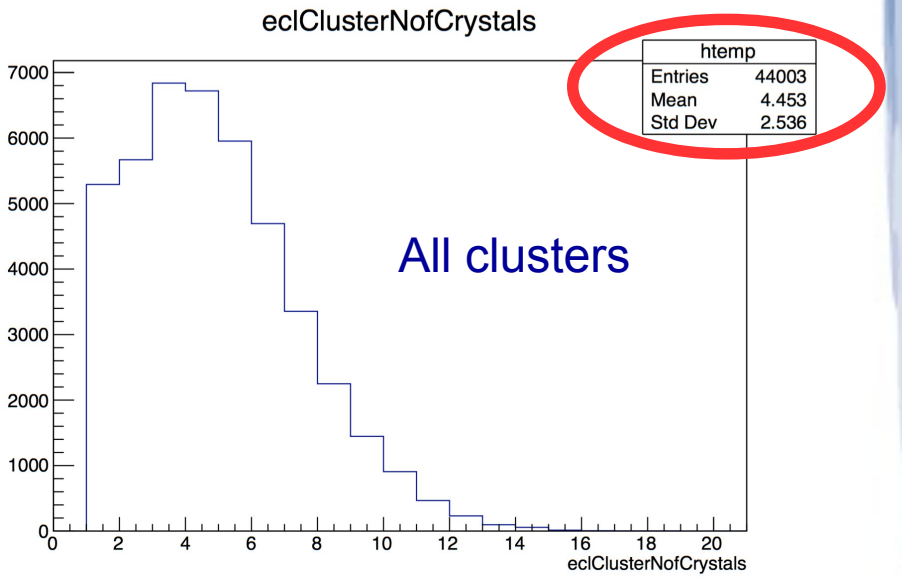


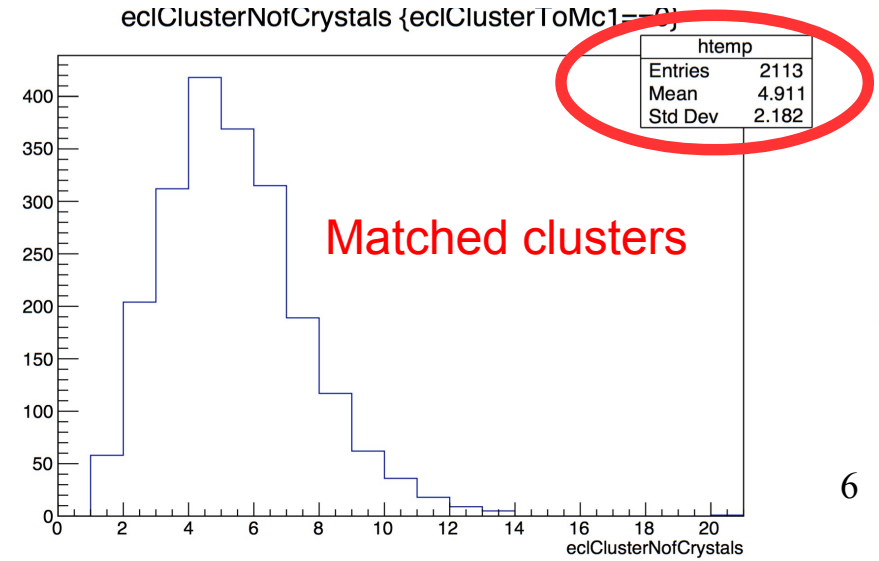
13 ring pure CsI

NofCry. in clusters w bkg w MC match

- From now on only results for CsI(Tl) shown
- On average higher number of crystals if MC truth is required 4.45 -> 4.9



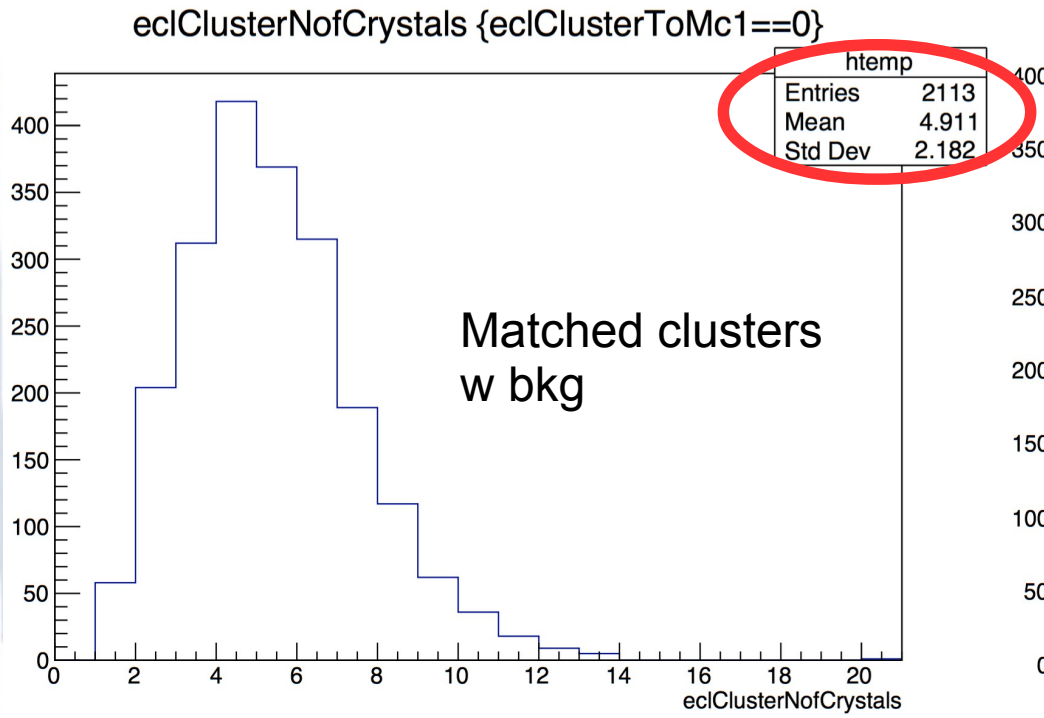


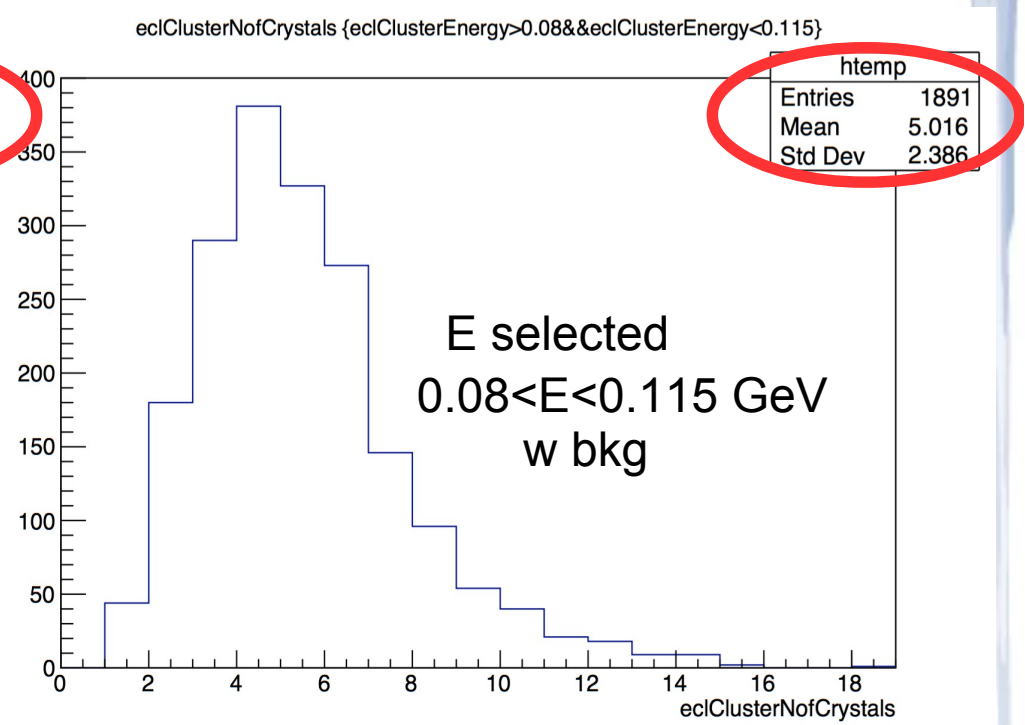


CsI(Tl)

NofCry. in clusters w bkg no MC match

- For fitting cluster energy we use only selection given by fit interval (0.08<E<0.115 GeV)
- Selection based on energy cut reproduces well spectrum from MC truth



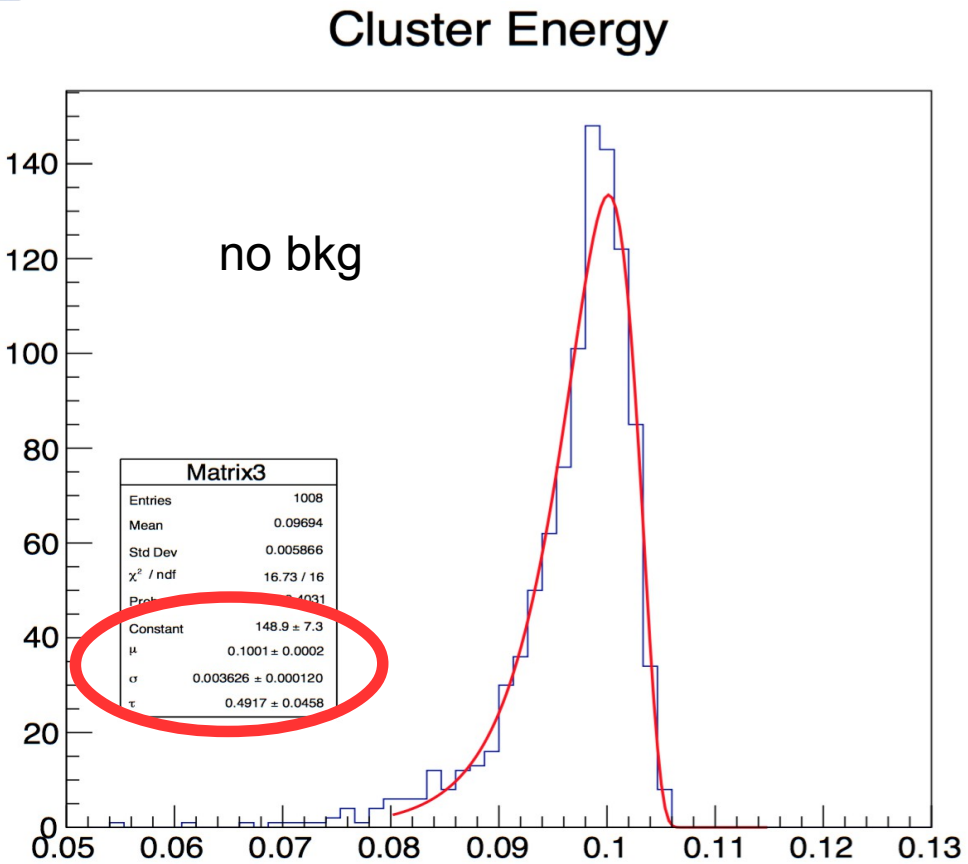


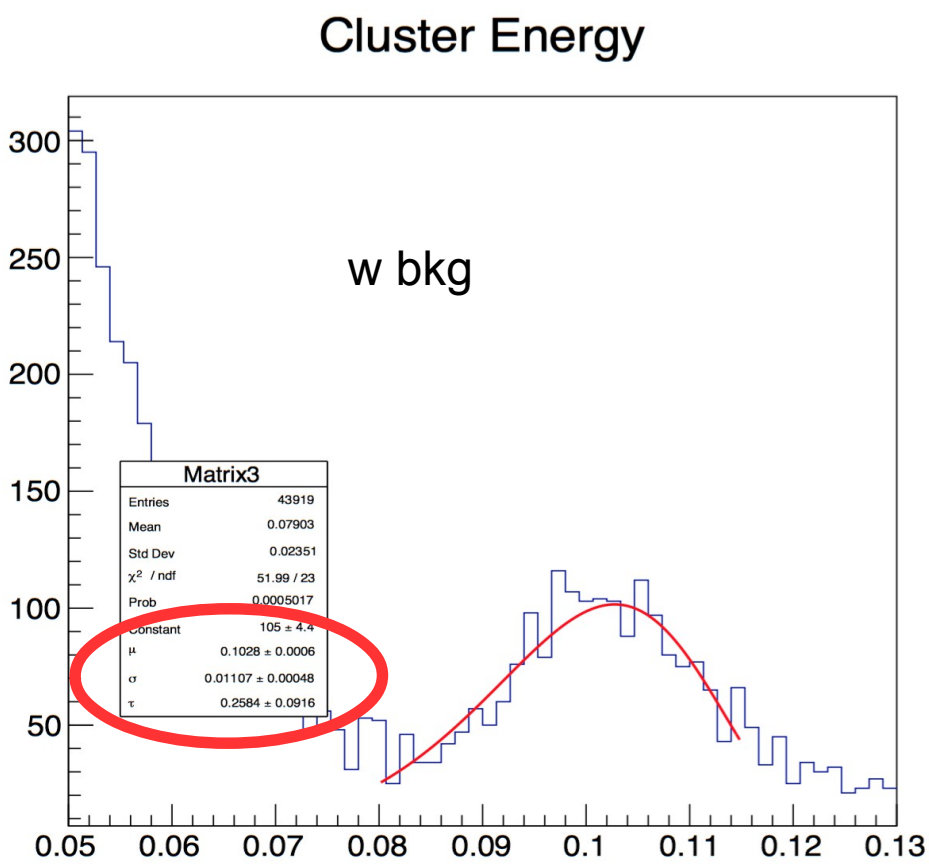
CsI(Tl)

Bare cluster resolution

- Here only selection applied is fit interval 0.08 < E < 0.115
- Reference values for full cluster: 3.6% w/o bkg, 11% w bkg

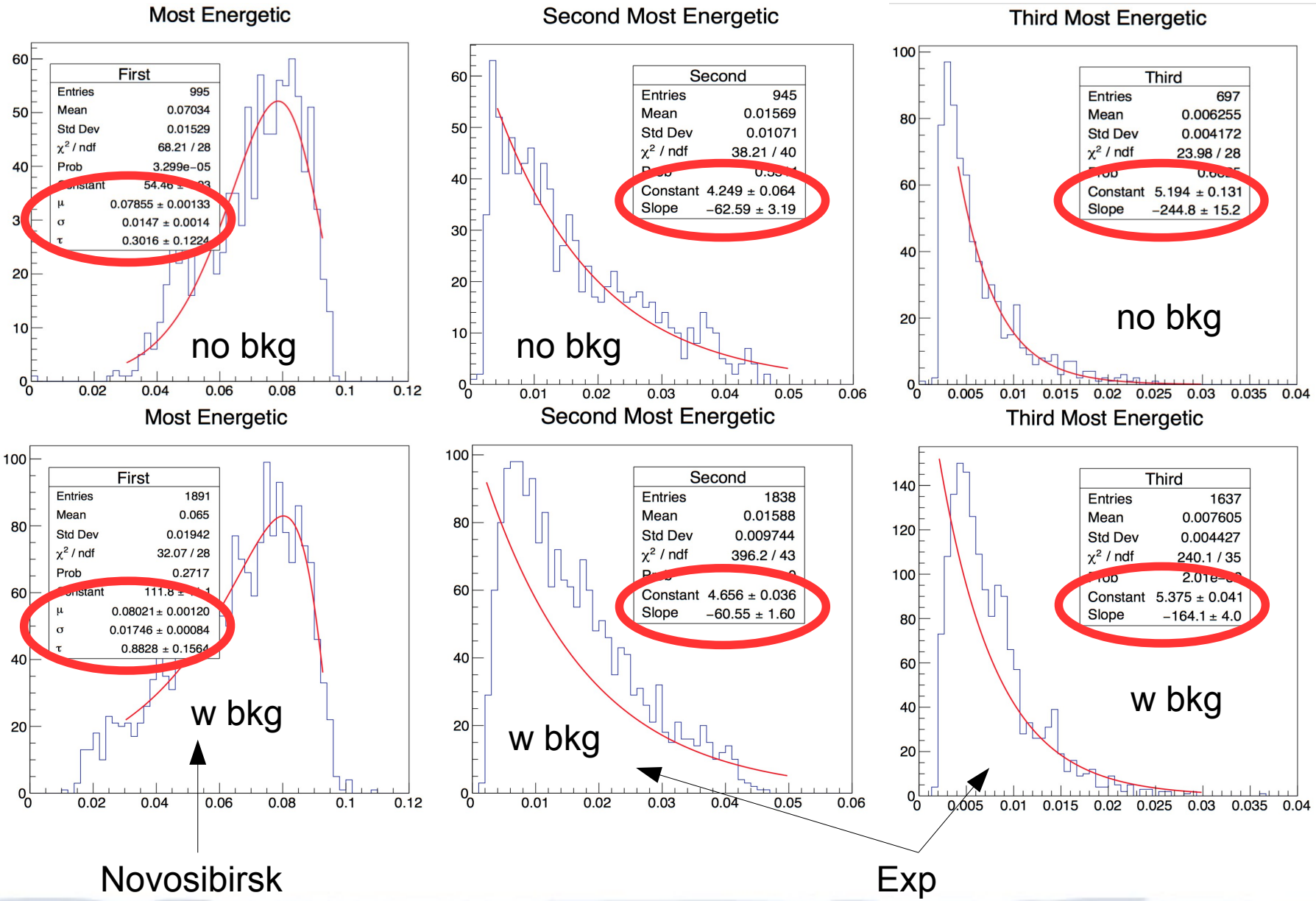
CsI(Tl)





1^{st}, 2^{nd}, 3^{rd} highest E crystals

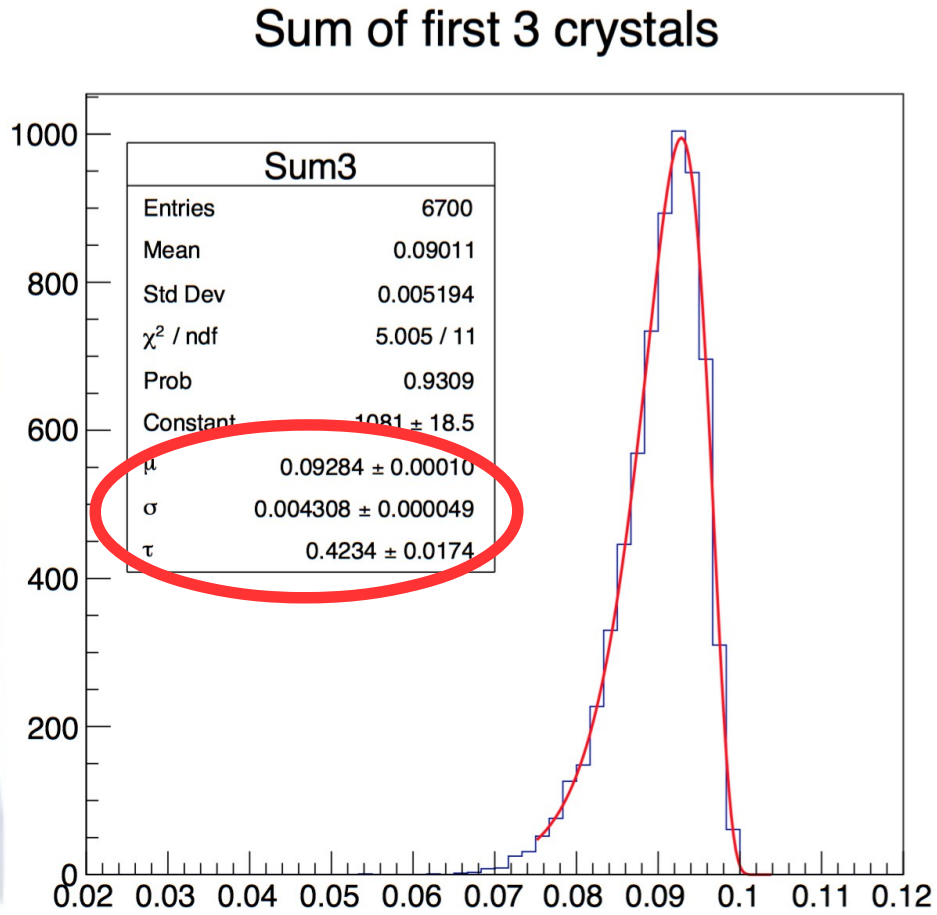
- Single crystal energy deposit (eclCalDigit) for three highest deposits in cluster

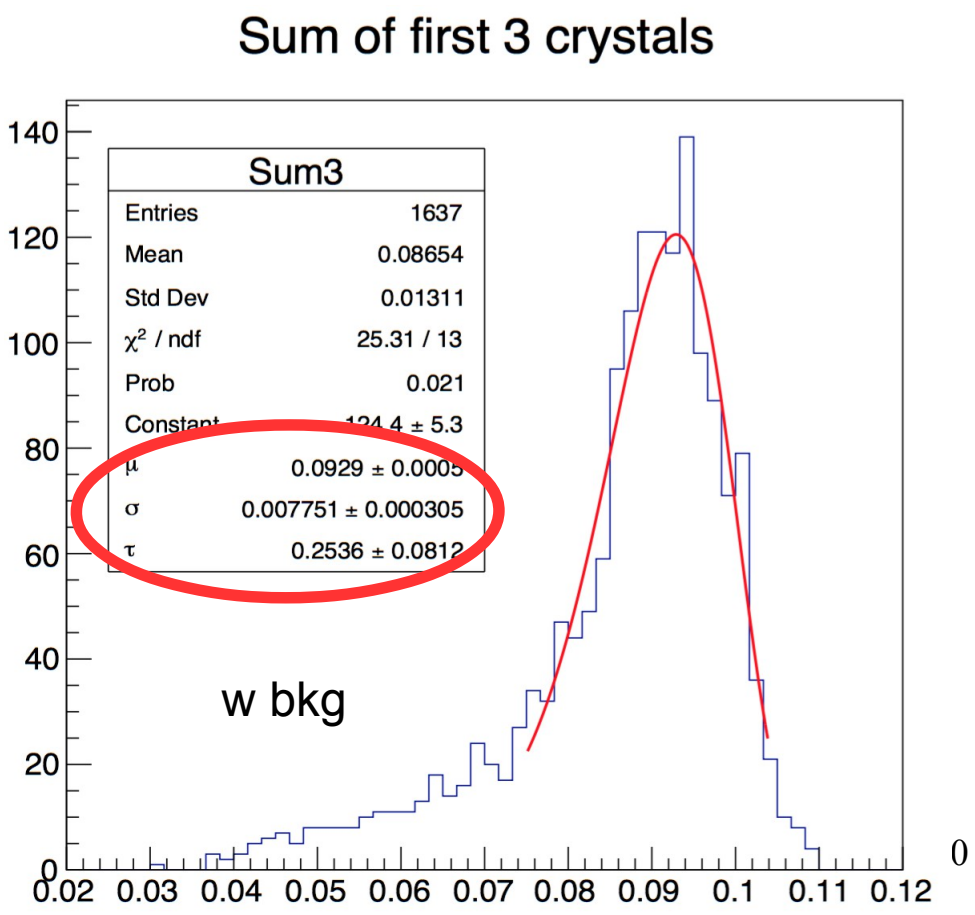


1^{st}, 2^{nd}, 3^{rd} highest sum

- Resolution of distribution of 3 most energetic cyrstals with beam bkg is better than full cluster

CsI(Tl)

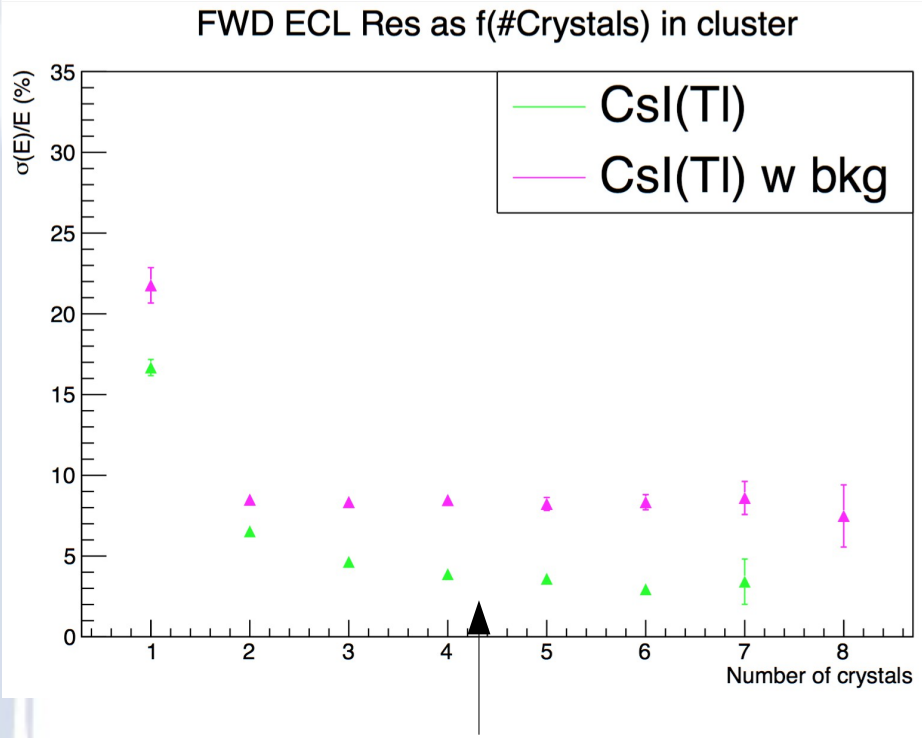




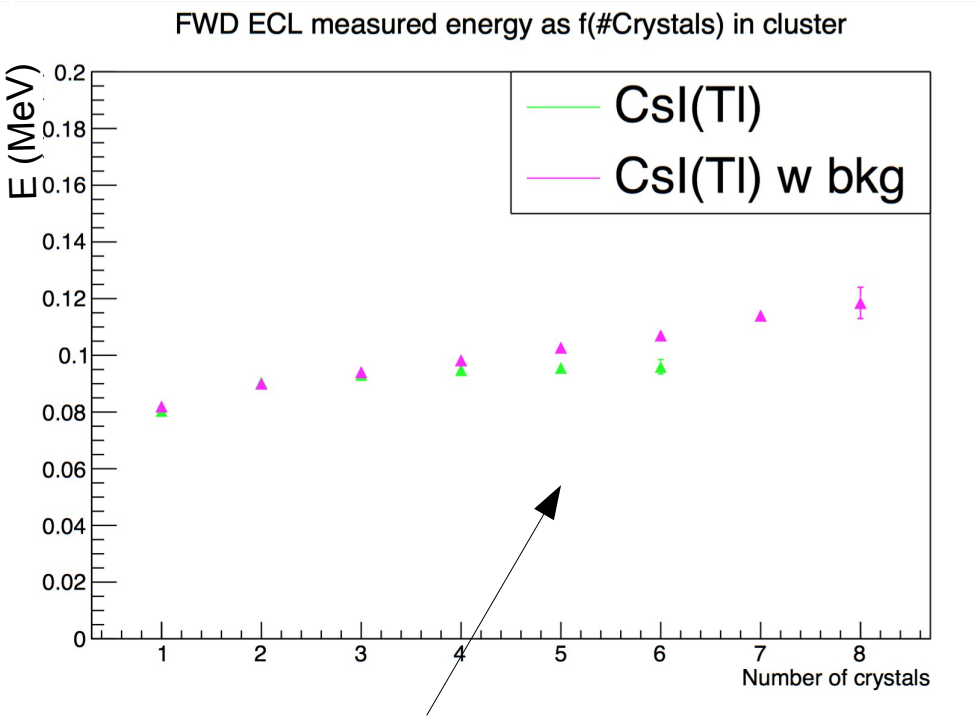
Summing over highest E crystals

- What does happen if we keep just the most energetic digits in cluster?
- (Please note: points are obtained summing highest energy crystals of ALL clusters with NofCrystals > N)

CsI(Tl)



Sigma/E measured

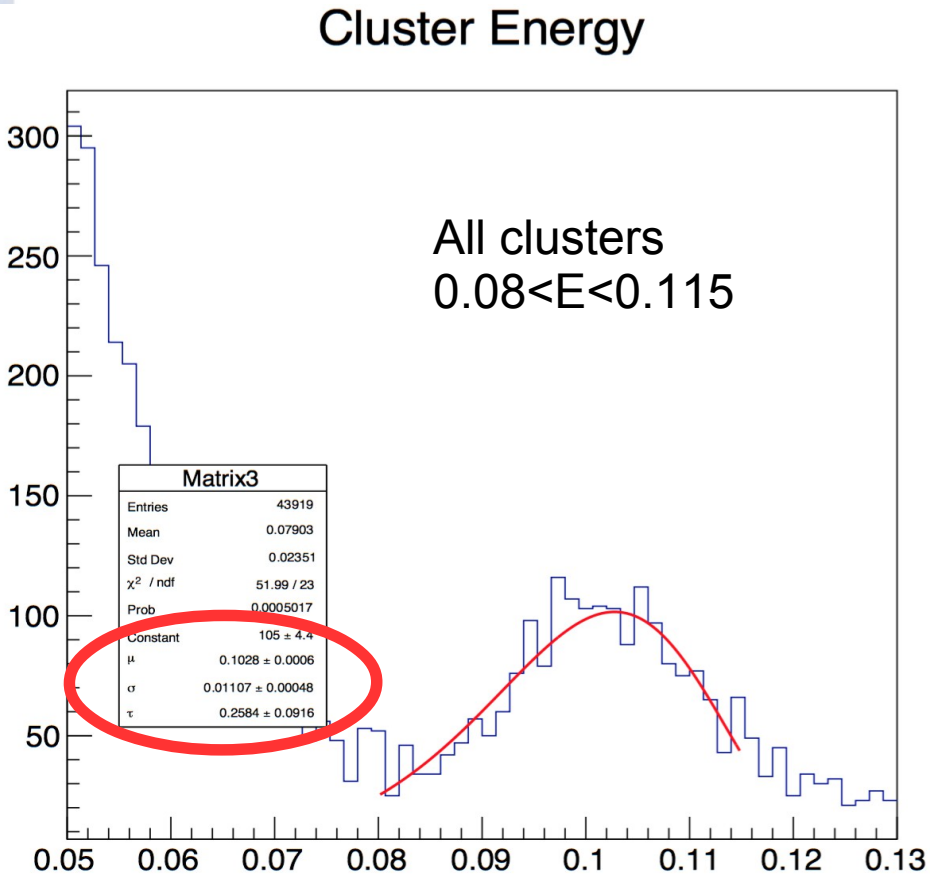


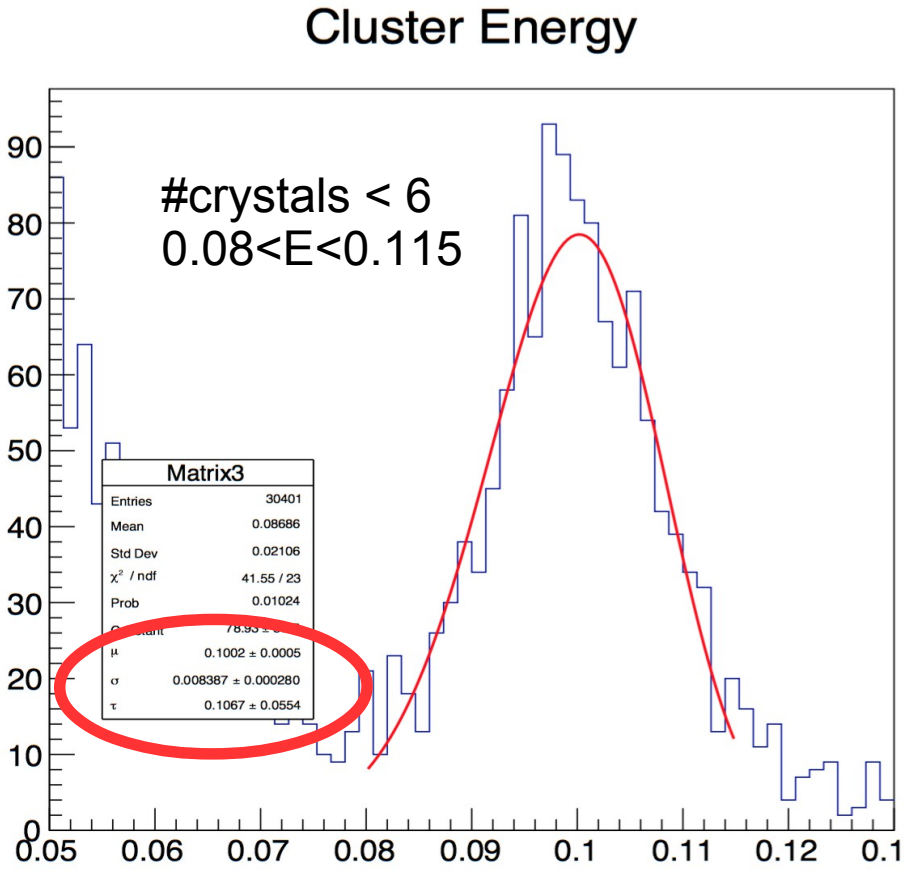
Energy bias

Resolution as function of #crystals

- Previous plot not so easy to read -> we study resolution as f(NofCrystals(Cluster))
- If we keep just clusters with a low number of crystals resolution is seen to better in the presence of bkg

CsI(Tl)





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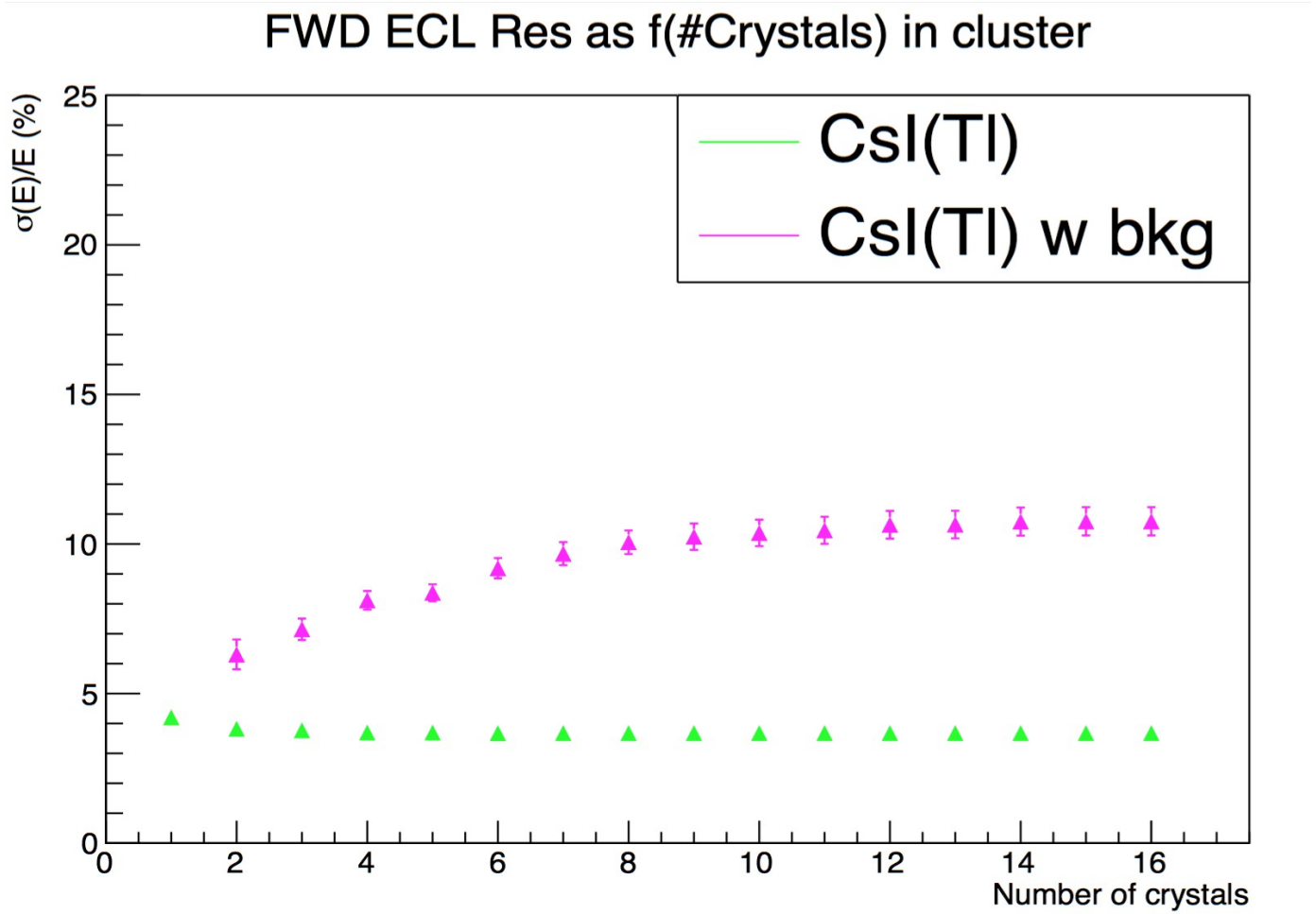
CsI(Tl)



(Preliminary) Conclusions

- When bkg is added the comparison of pure CsI and CsI(Tl) shows an unexpected behavior
- When beam bkg is added baseline ECL resolution worsens when adding more and more crystals in clustering
- This points clearly out that our algorithm isn't optimized for Belle2 bkg rates
- Current physics performance is expected to improve significantly even for baseline configuration
- Difficult to make a reasonable performance comparison for pure CsI and CsI(Tl) without optimized clustering

Additional Slides

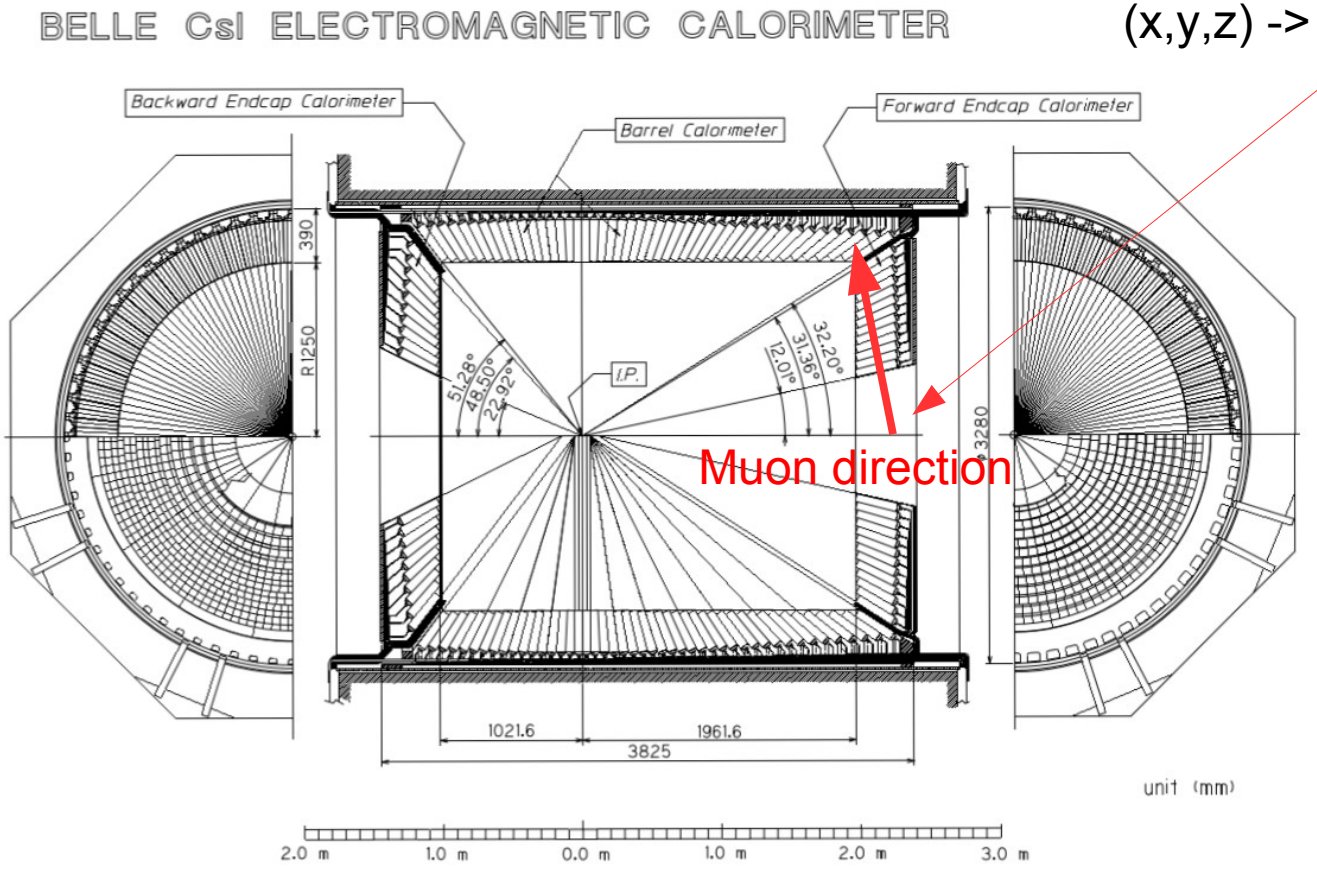
Outline

- Our study was initially triggered by the aim to compare results obtained in lab for pure CsI with basf2 simulation:
  - Response to cosmics w and w/o bkg
  - Response to single gammas w and w/o bkg
- 3 crystal configurations compared: baseline and 2 different pure CsI settings (see later)
- Code revision build-2016-04-10 (pre-release 07 build ndr) + r27501 for eclDigitizer and eclDataAnalysis
- bkg from 12th campaign (1ms equivalent, r24370)

Cosmic Test

- We shoot 1GeV pGun muons from beam-axis on face of crystal #1 of 1st ring (in the middle) (phi=0 -> max bkg expected)
- Geometry: ECL only, 13 ring full pure CsI FWD

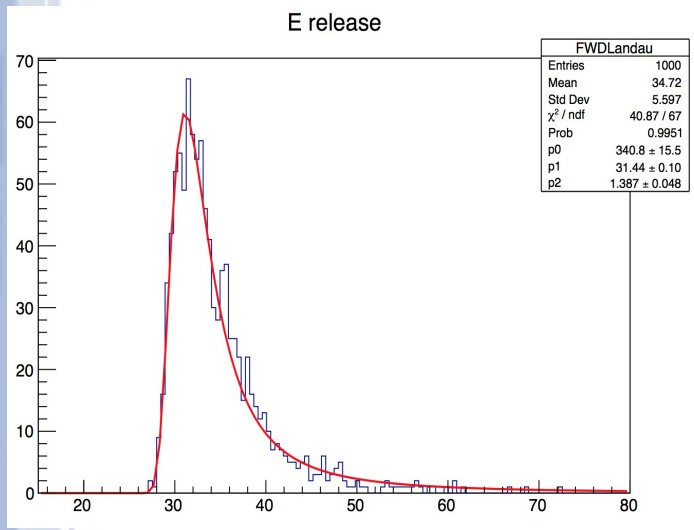
p=1 GeV (was 10 GeV)
(theta, phi) -> (102.4,3.5)
(x,y,z) -> (0,0,221.55)



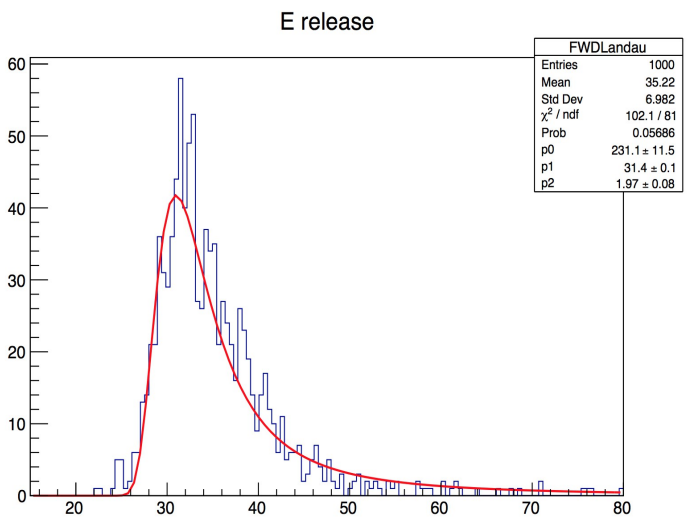
Cosmic Test

- 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)

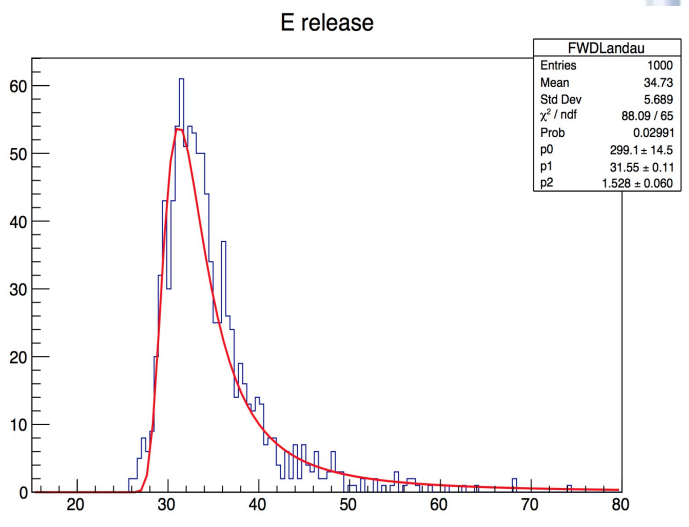
CsI(Tl)



CsI LNF



CsI PG

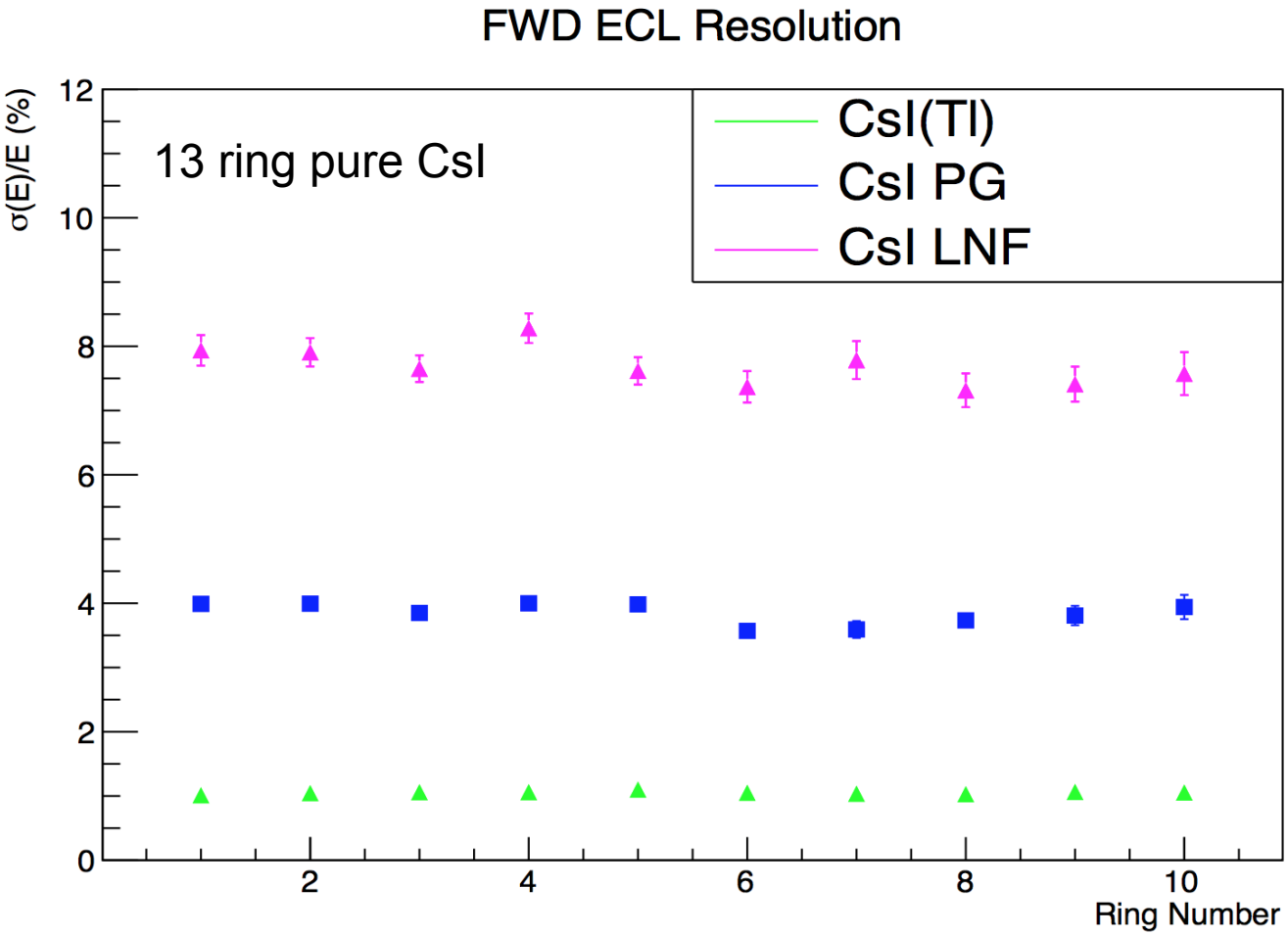


Energy loss in crystal Landau fit

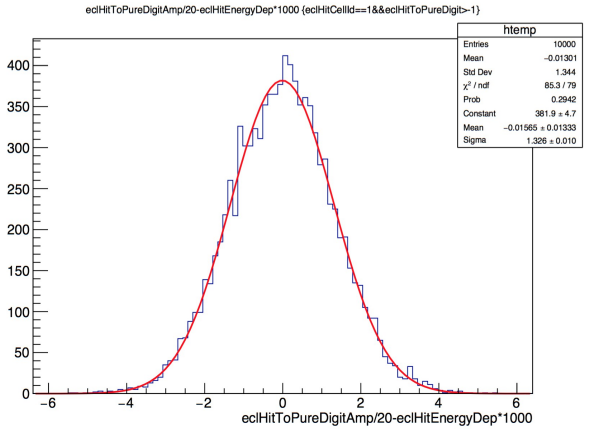
Crystal #1

Cosmics: resolution w/o bkg S.C.

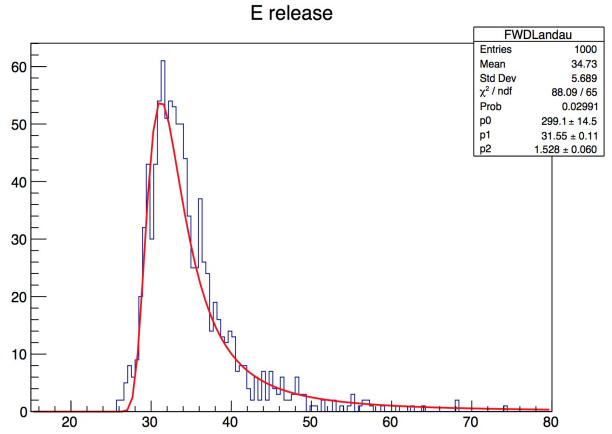
- Resolution studied for single crystals
- Sigma: $E_{reco} - E_{dep}$ (hit level), sigma from gaussian fit
- Mean: E_{reco}, Landau fit



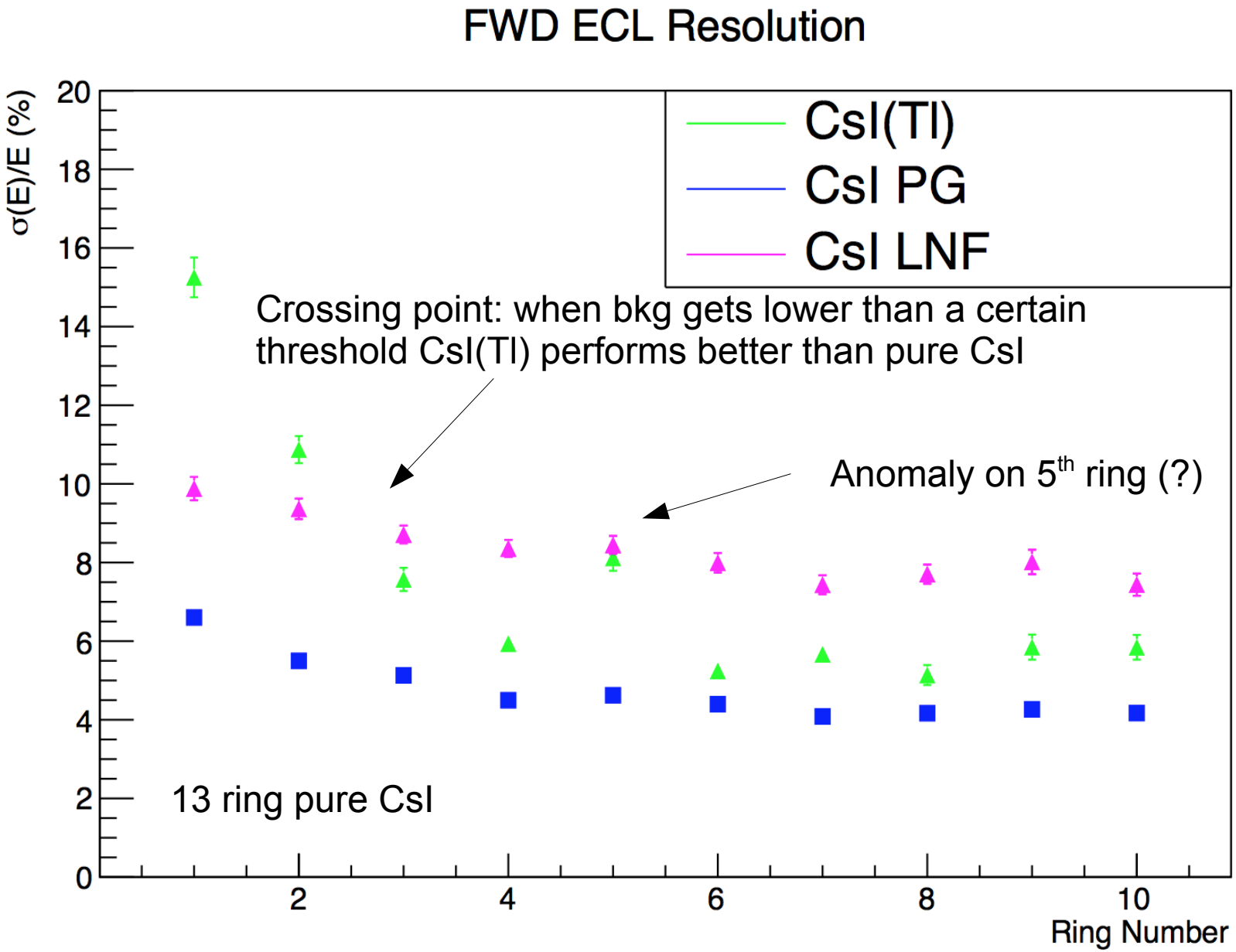
Gaus fit



Novosibirsk fit

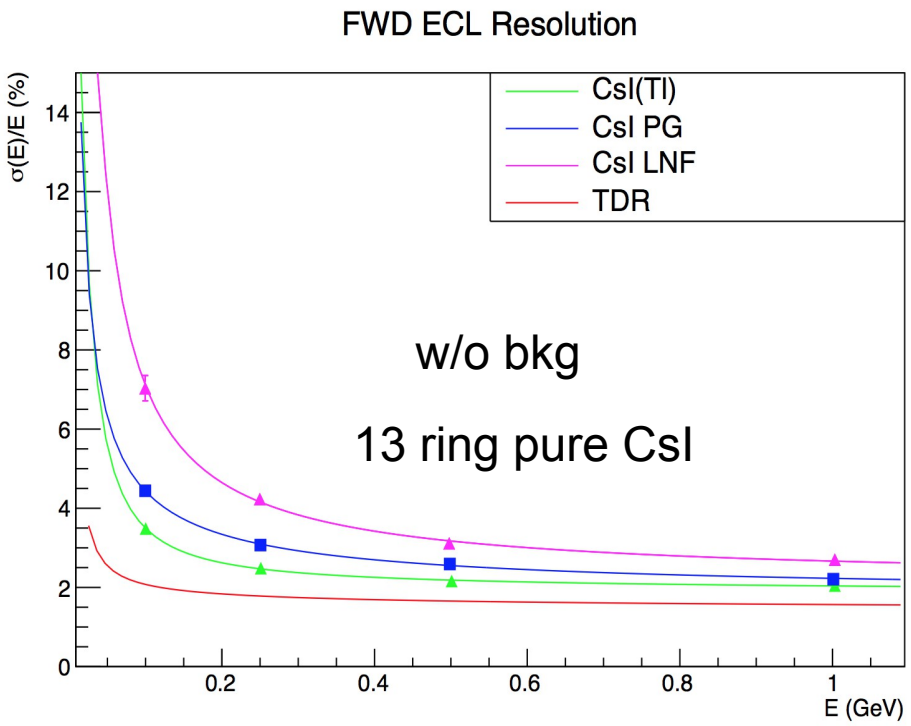


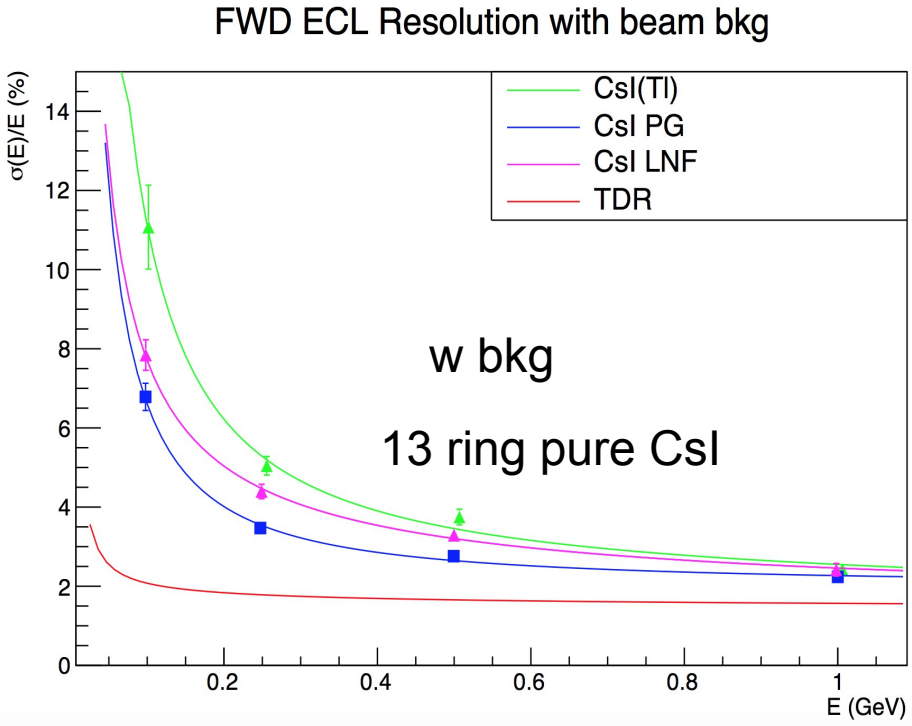
Cosmics: resolution w bkg S.C.



Cluster resolution for photons

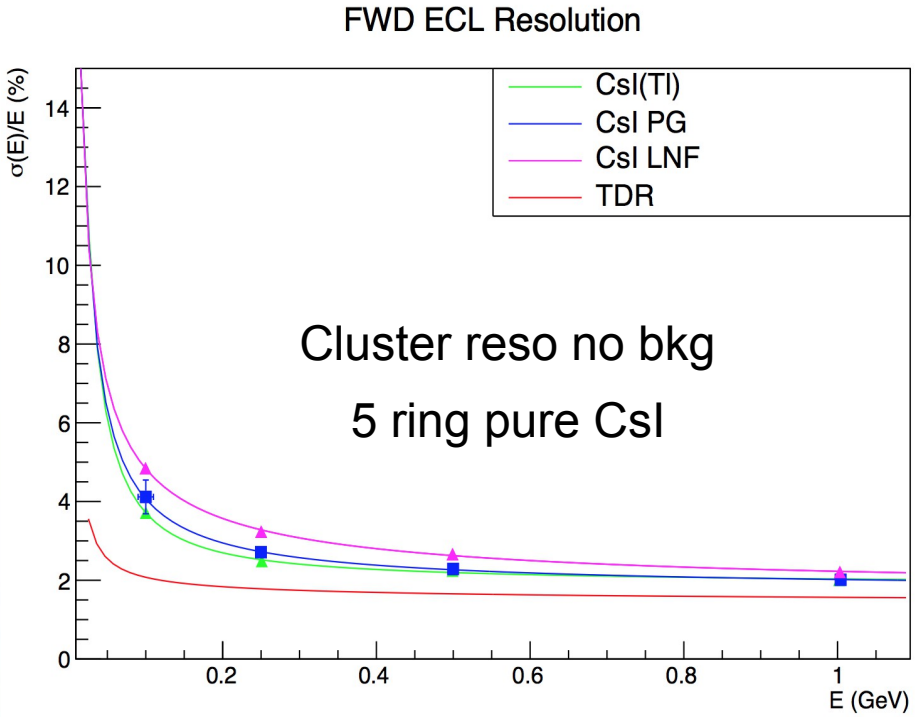
- Single photon 13<theta<30, energy scan, no material in front of ECL
- Individual Novosibirsk fit, sigma=FWHM/2.36
- 13 and 5 ring (ring: 1, 2, 3, 4, 5) pure CsI configuration studied

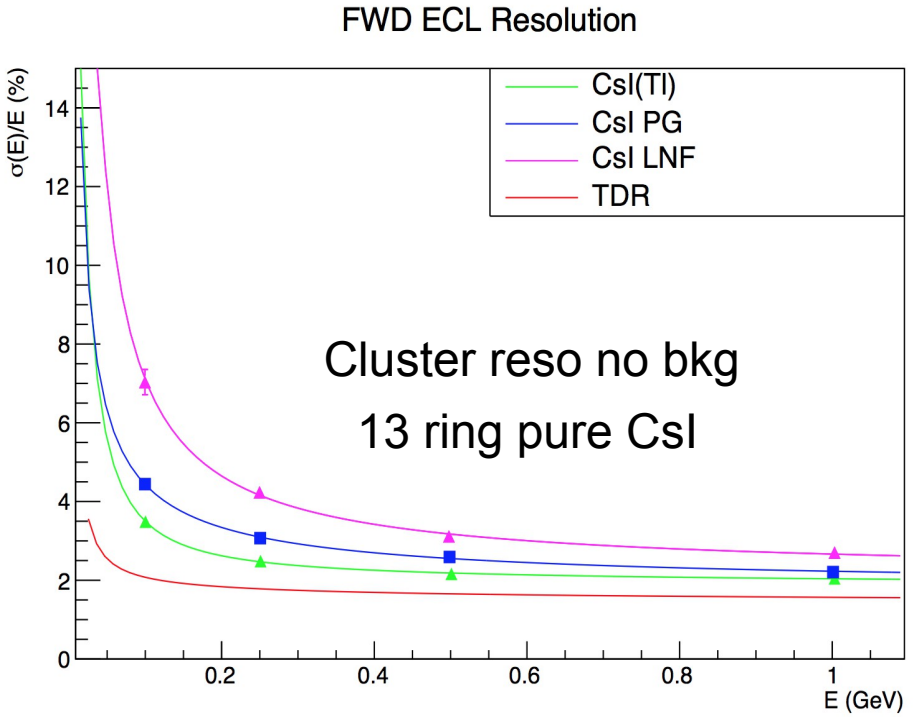




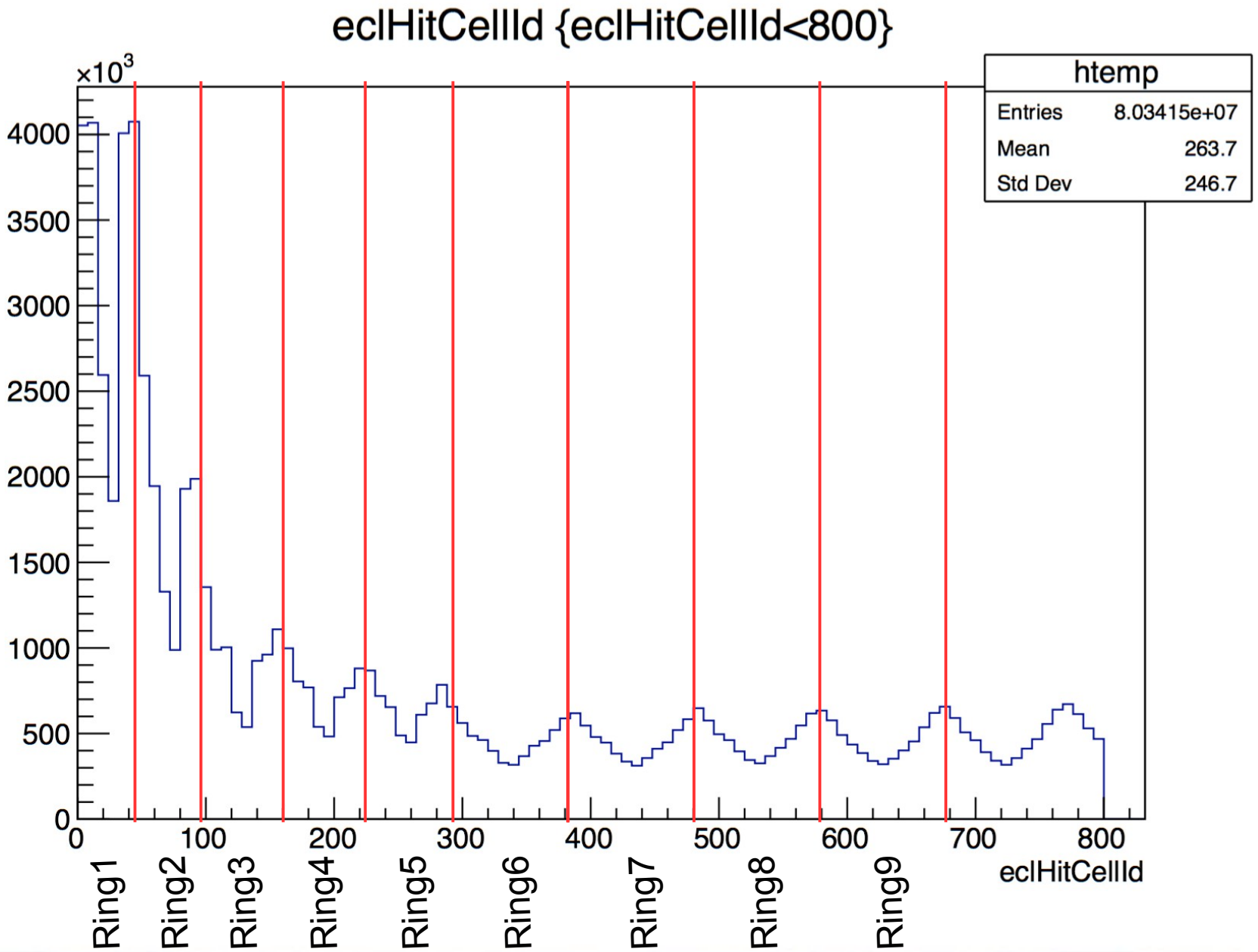
5 vs 13 layer pure CsI FWD w/o bkg

- Without bkg a 5 layer pure CsI FWD performs better than a 13 ring one as expected



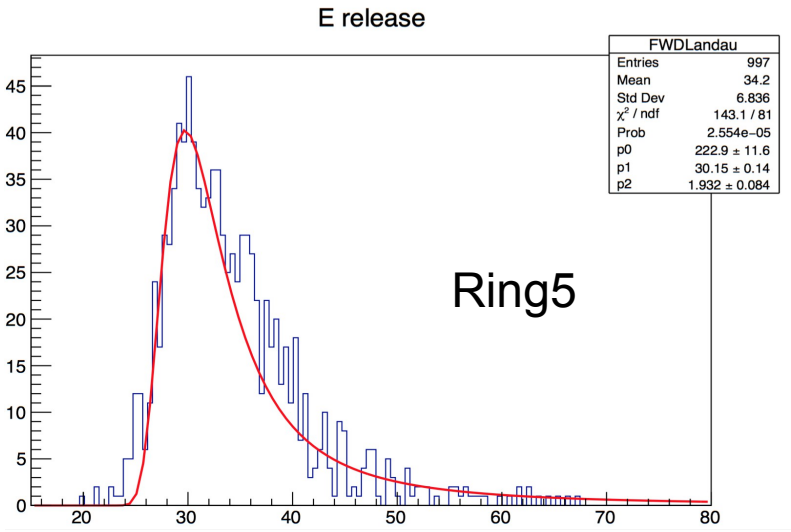


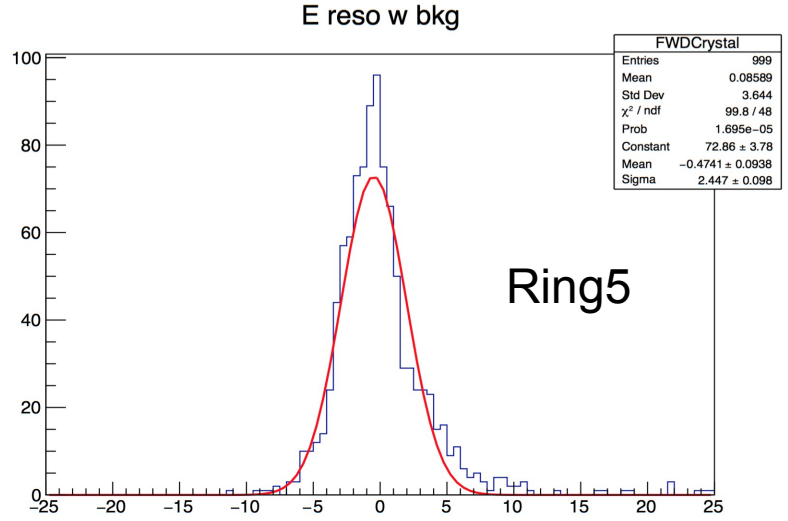
Bkg hits a f(crystal #)

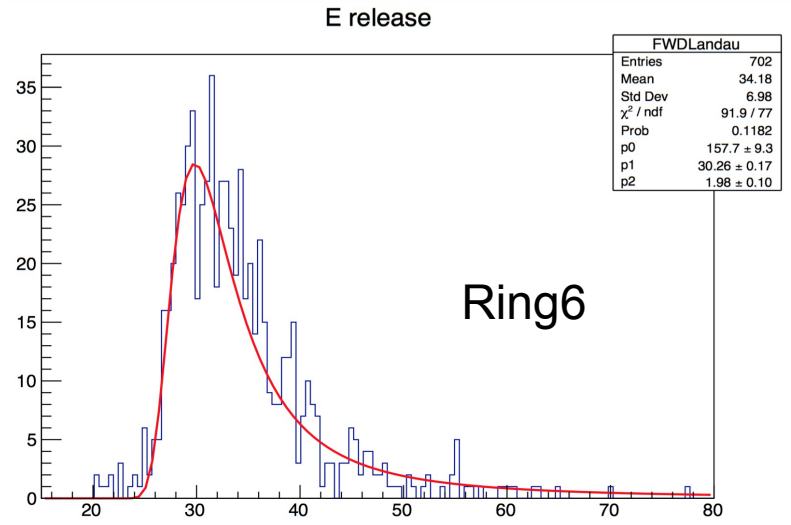


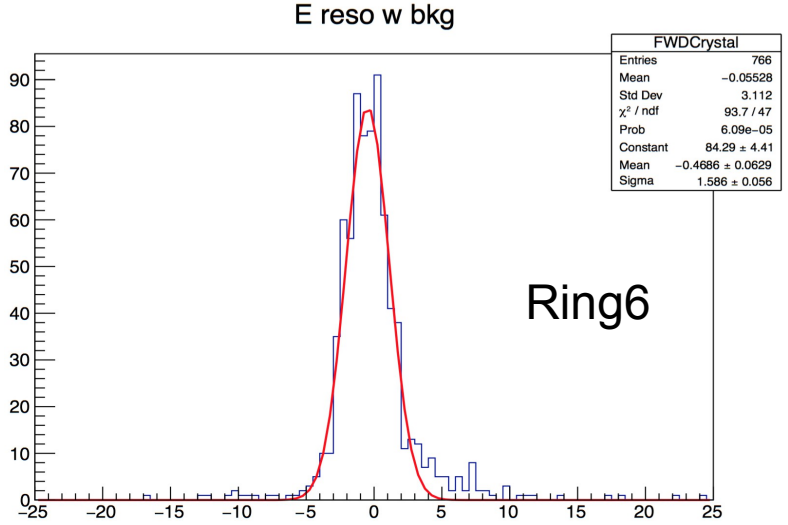
Ring 5 in cosmics test

- Very bad efficiency on ring 5 (ref. Pag. 6)



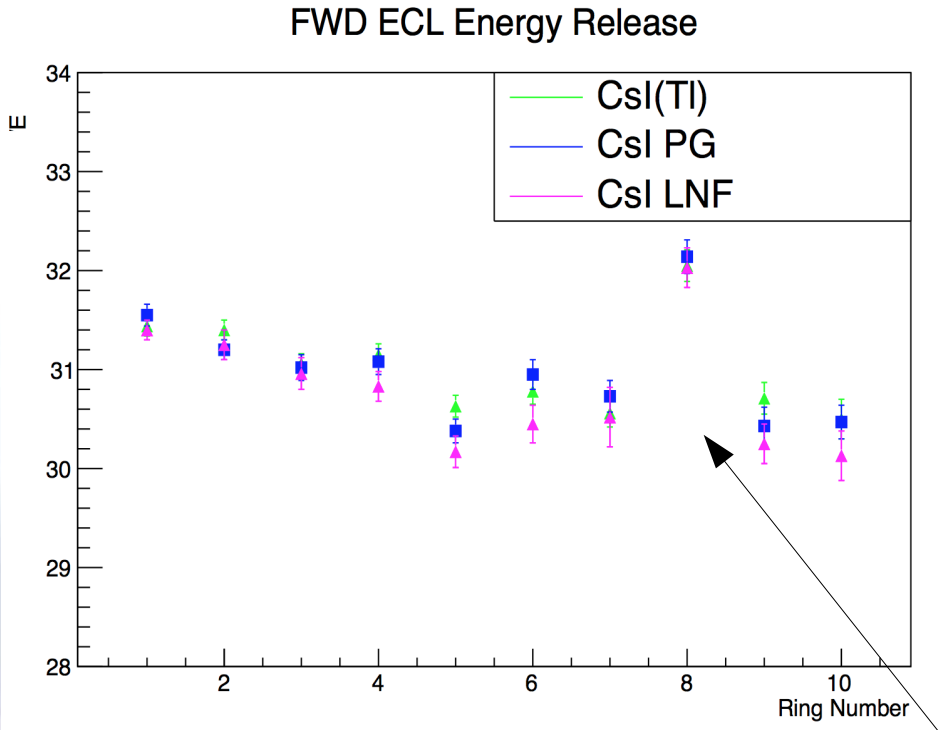




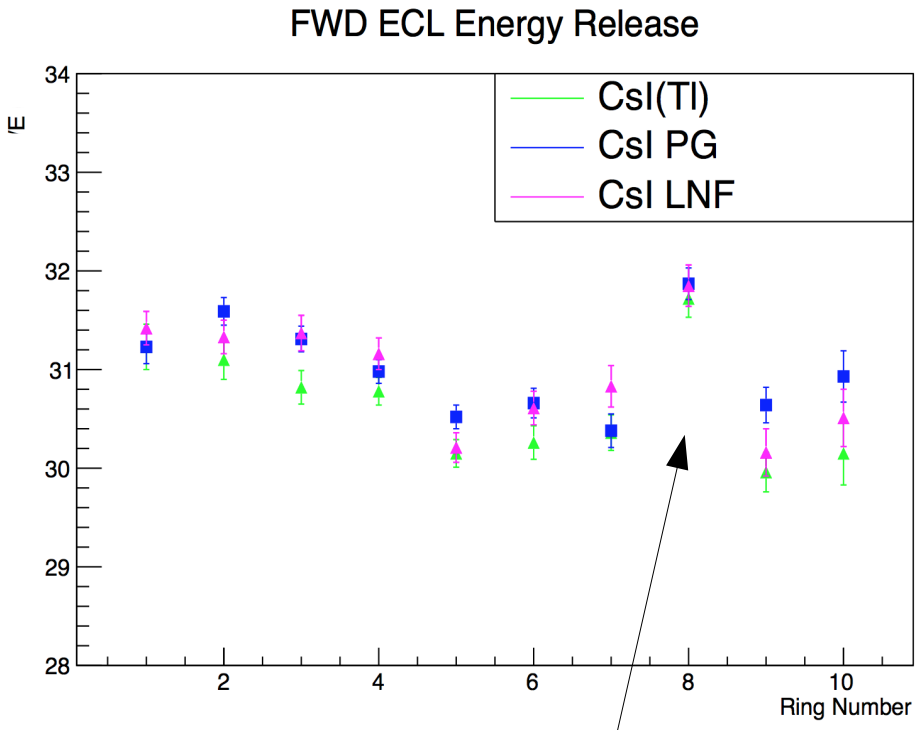


Cosmics: E release as f(ring #) S.C.

- Energy release for “cosmic” in crystal as function of the ring number
- Less energy collected for higher ring number, anomaly at ring 8



w/o bkg



w/o bkg

Probably an “acceptance” effect