Selection studies for ECL leakage corrections + first look at the pure CsI simulation

BelleII Italia - Pisa
20/11/17, ECL SESSION

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Introduction

- We've completed, during the Summer, the AD-HOC leakage correction studies for MC9 production, with newest machine background samples (BG15)

- We'd like now to investigate an alternative method, which aims to be more efficient than producing and studying new MC samples each time the machine background condition changes, in view of the real data-taking.

- Leakage effects can be factored in:
  1. machine background effect → can be studies by using MC single photon samples in BGx1 configuration
  2. geometry effects (inter-crystals gaps and material, longitudinal leakage, barrel-endcap cracks) → can be studies by using MC single photon samples in BGx0 configuration and using Belle correction (same geometrical structure)

- Preliminary studies on geometrical effects and selection algorithms discussed today

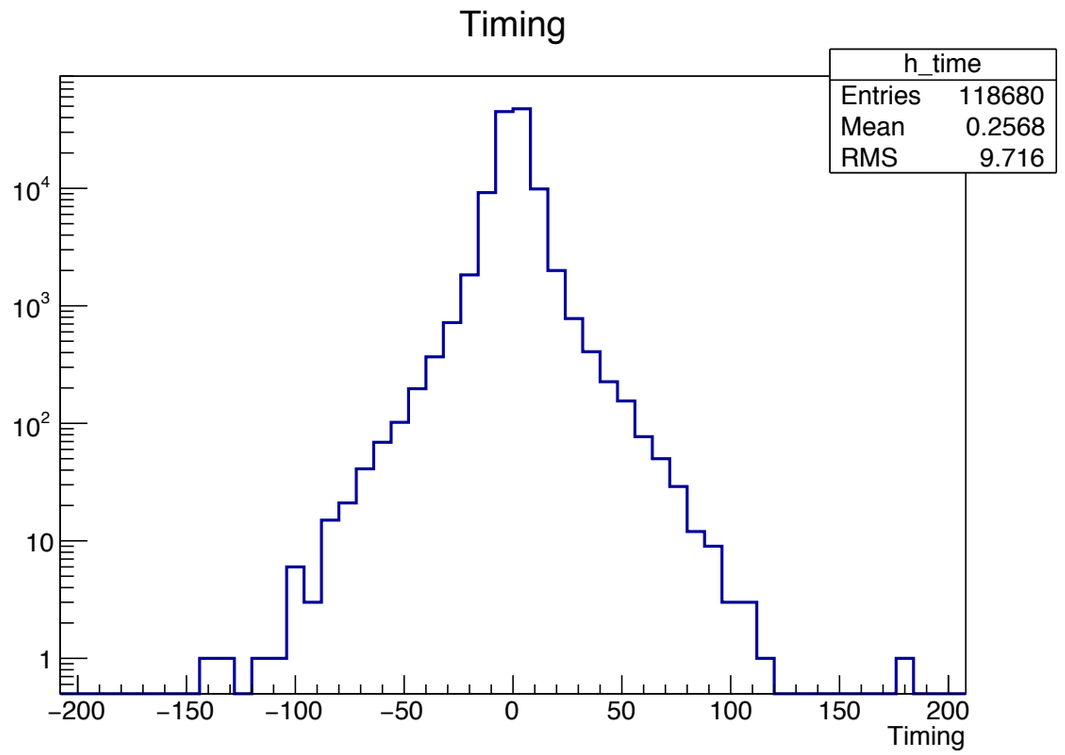
SELECTION STUDIES

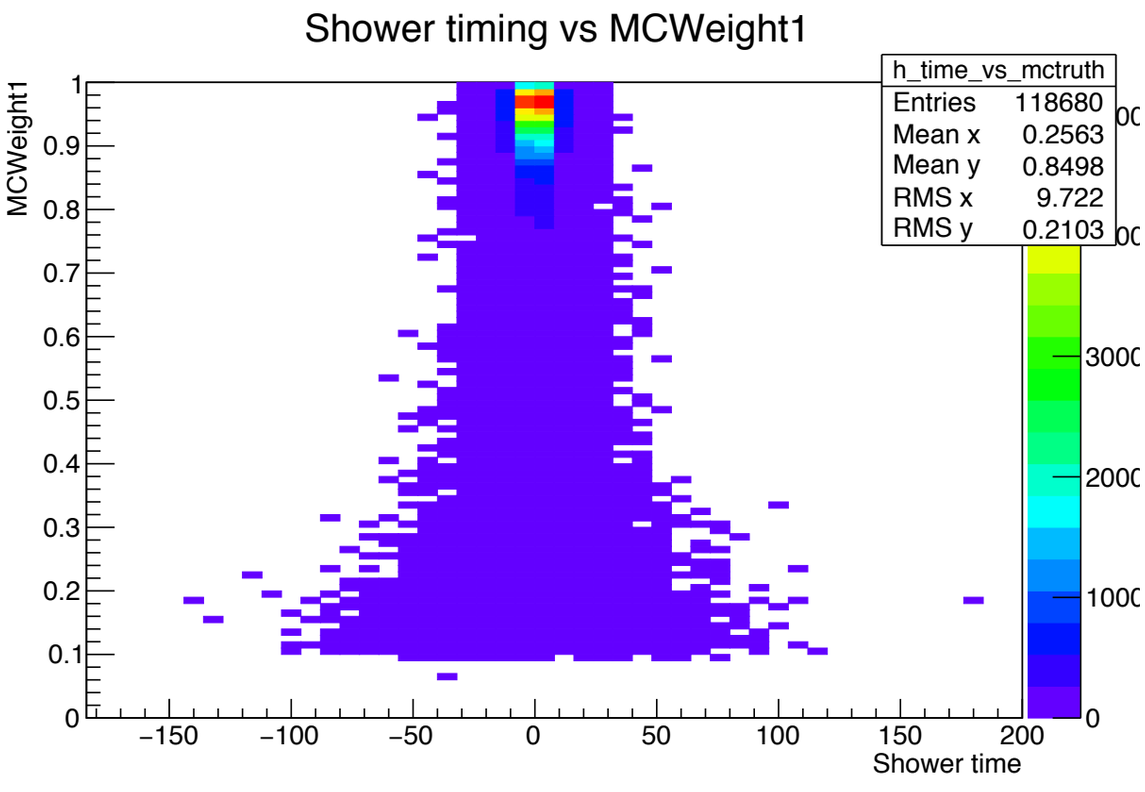
Energy and timing spectra, BGx0

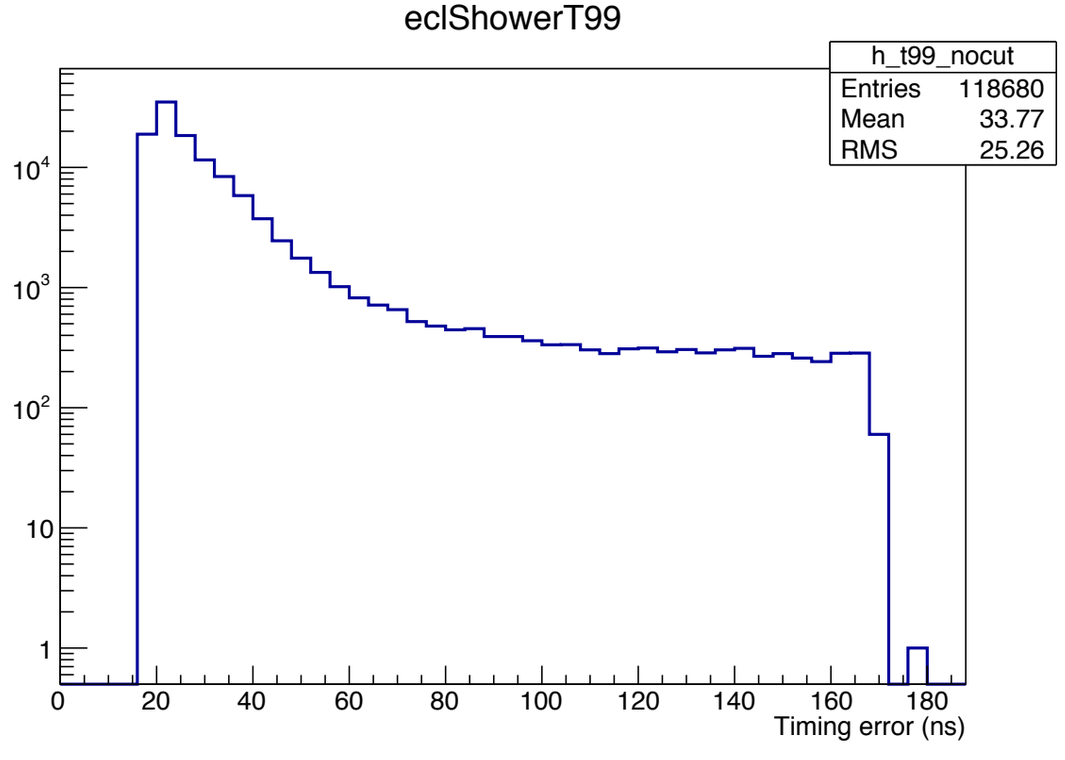
BARREL ECL, BGx0

- 100 MeV single photons, no machine background superimposed, BARREL REGION

- Timing information:





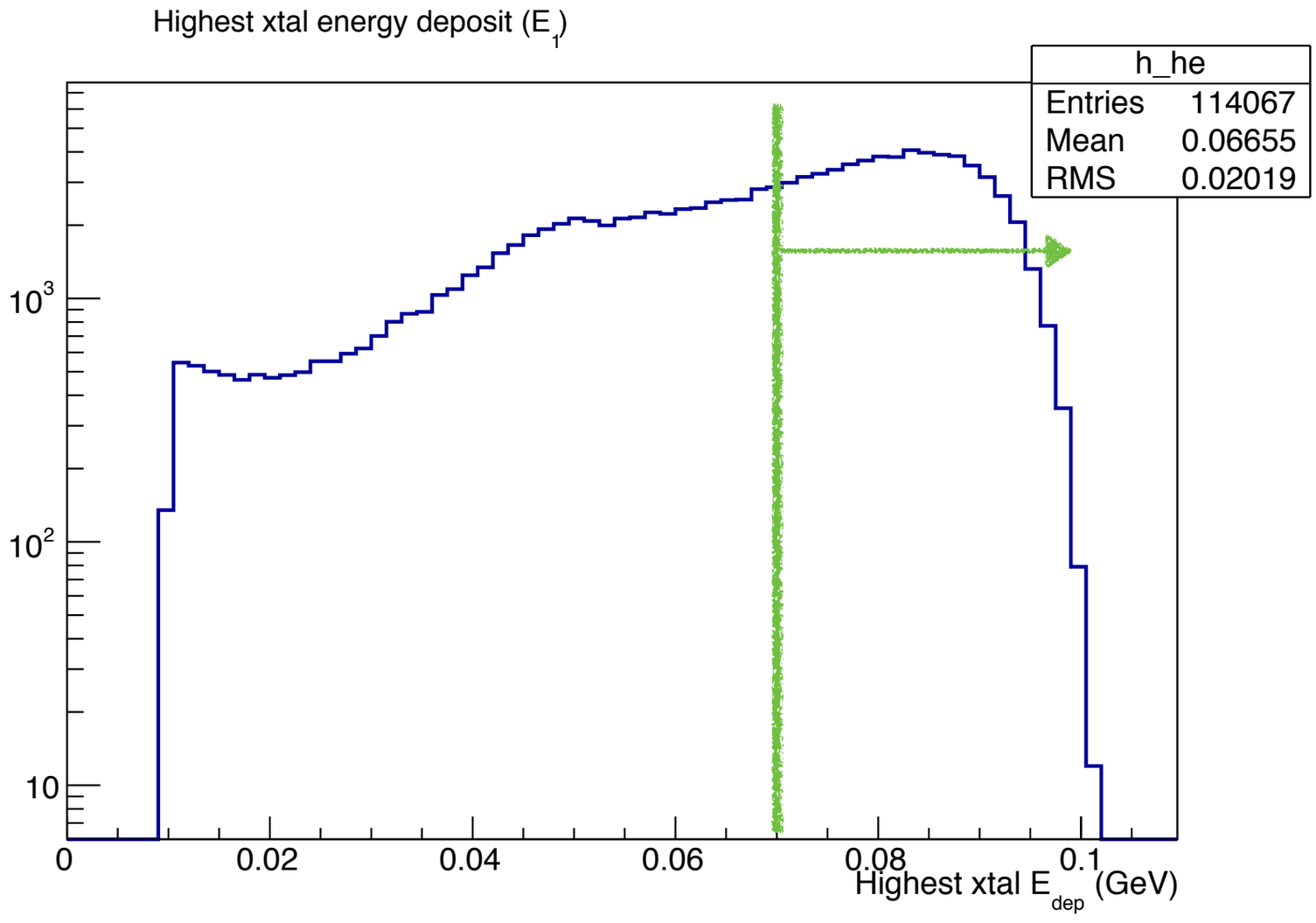


Best candidate selection and E1 cut

BARREL ECL, BGx0

- Select best shower candidate according to smallest |timing|

- Shower E1 (highest energy deposit in the shower) after best candidate selection:



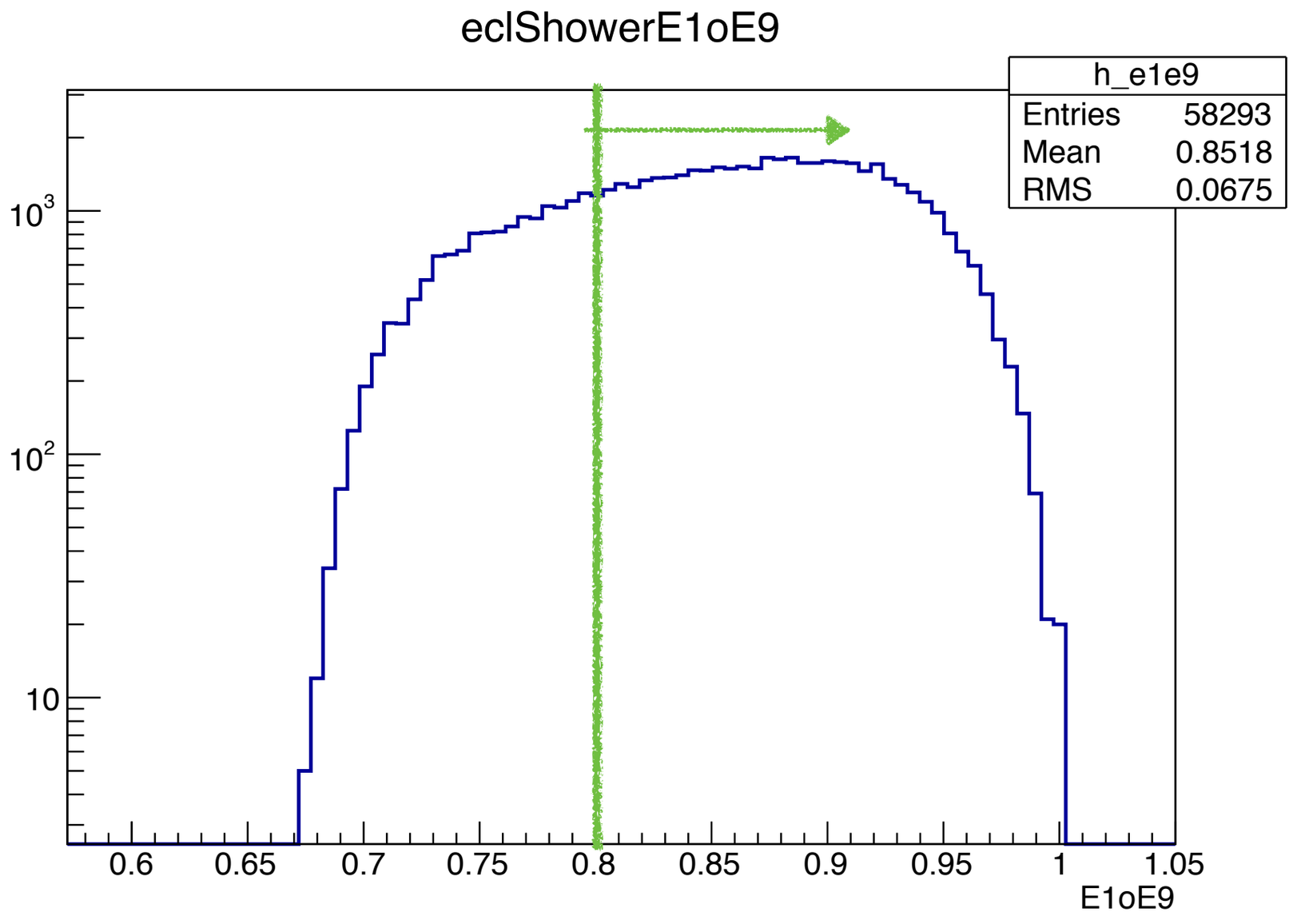
- Apply selection on E1:
  - Shower E1 > 0.07
  - this rely on the knowledge of the generated energy. To avoid this a cut on E9oE21 may be applied (under study)

E1/E9 after best candidate selection

BARREL ECL, BGx0

- Distribution of Shower E1oE9 after best shower selection and cut on E1:

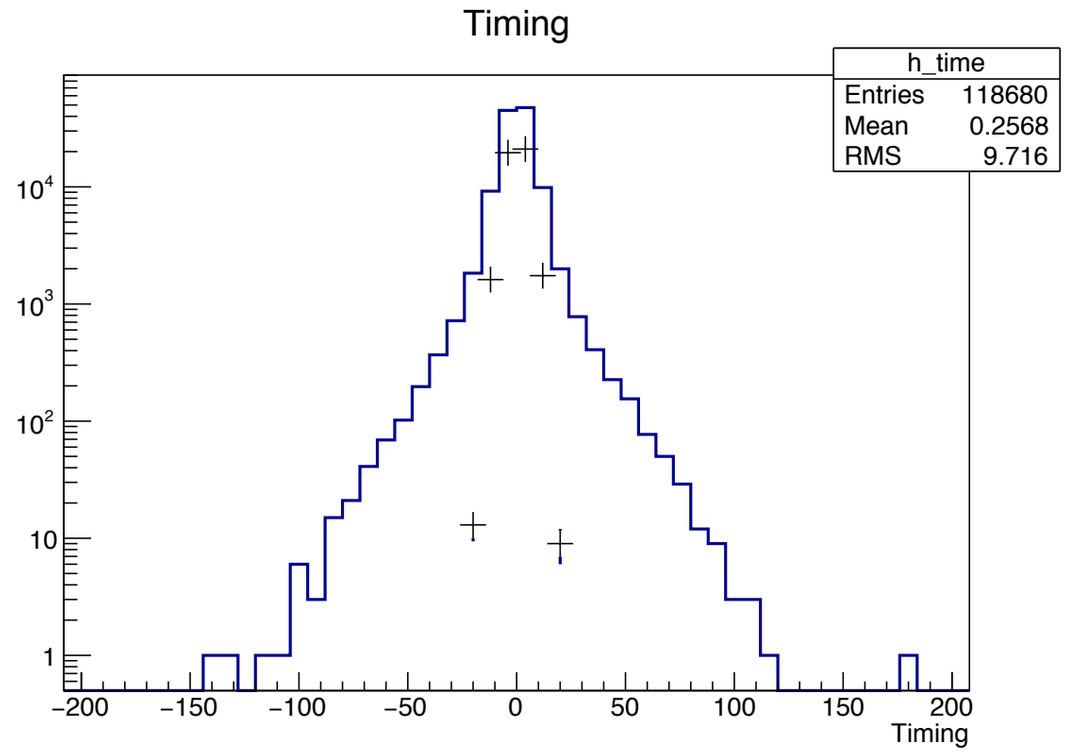
- Cut on Shower E1oE9 at 0.8

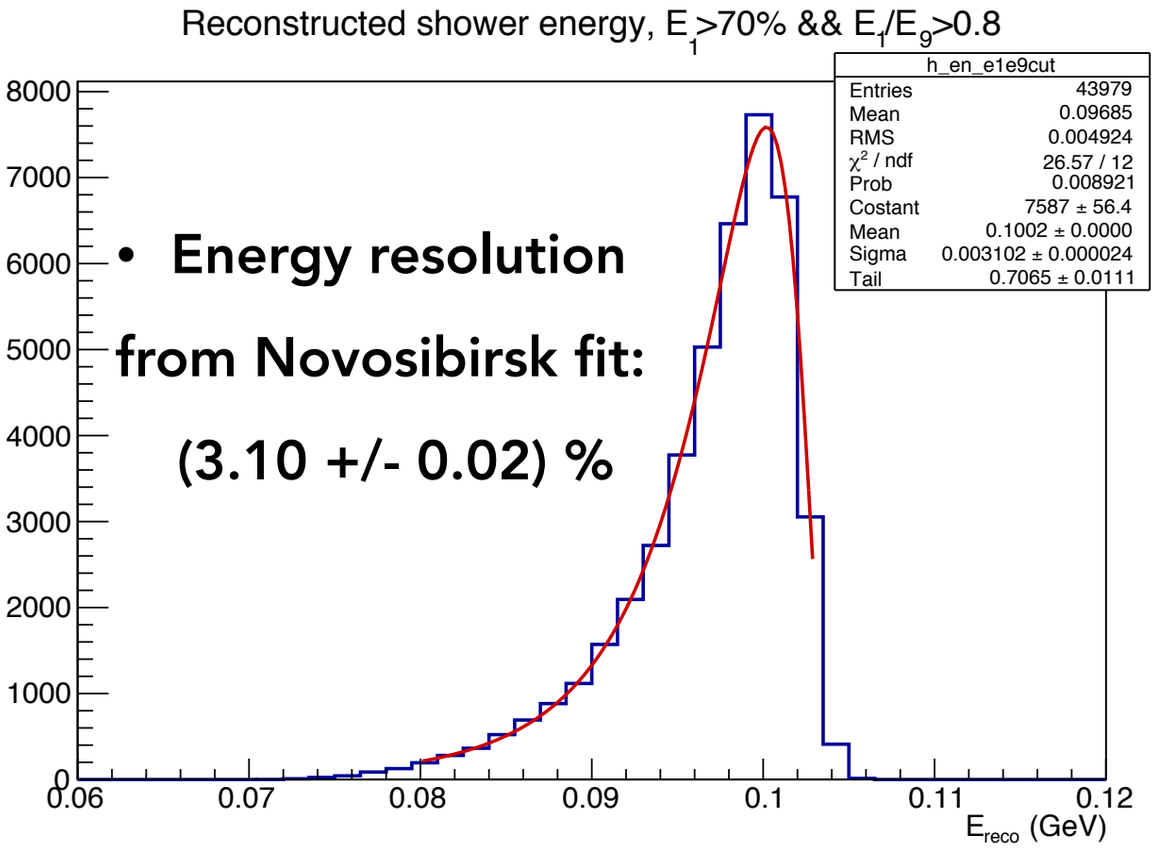


Distribution before and after selection

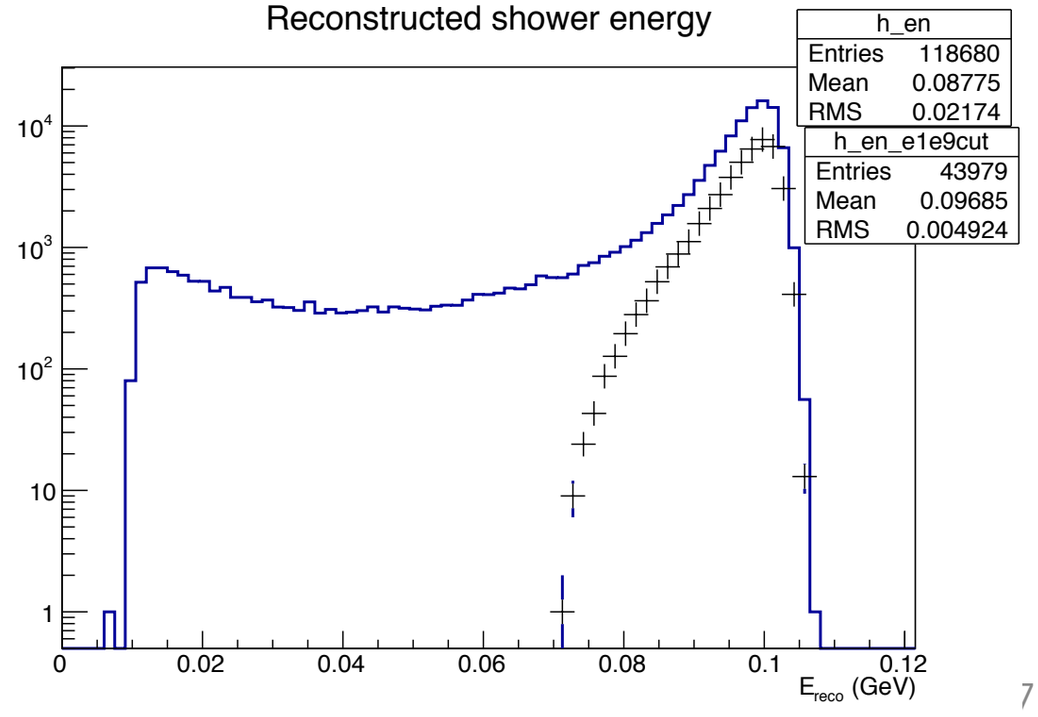
BARREL ECL, BGx0

- Timing information and reconstructed energy after best shower selection and cuts on E1 and E1/E9
  - full hist = before cuts
  - cross = after selection
- Low energy tails in energy distribution removed





- **Energy resolution from Novosibirsk fit: (3.10 +/- 0.02) %**

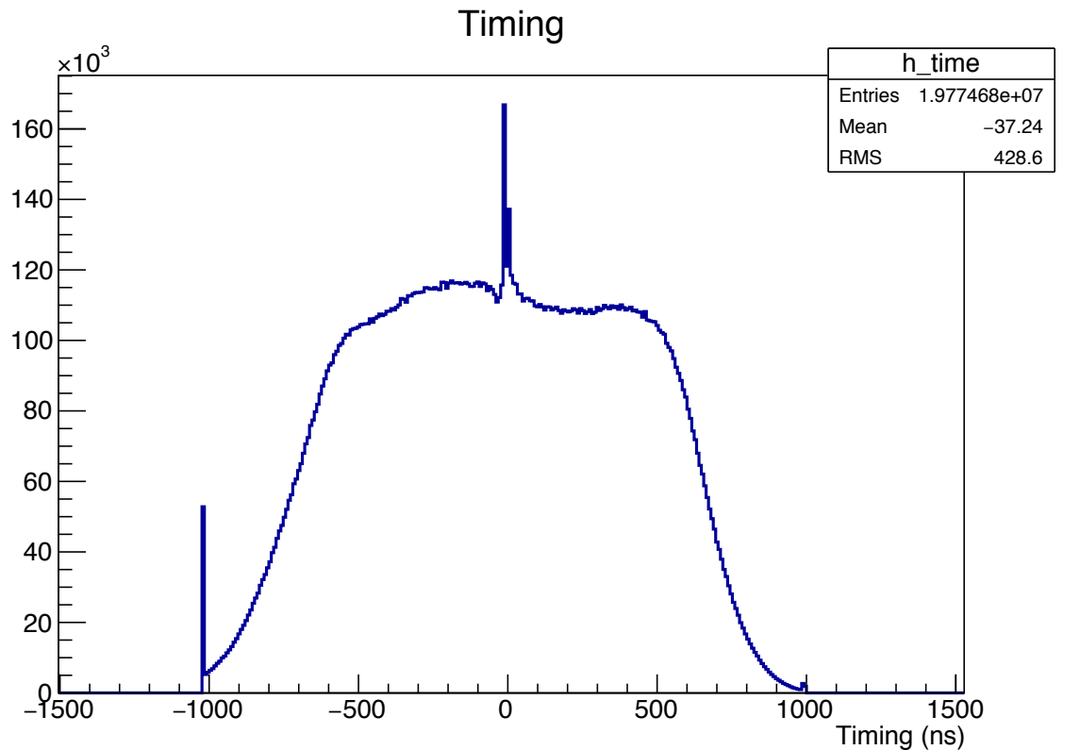


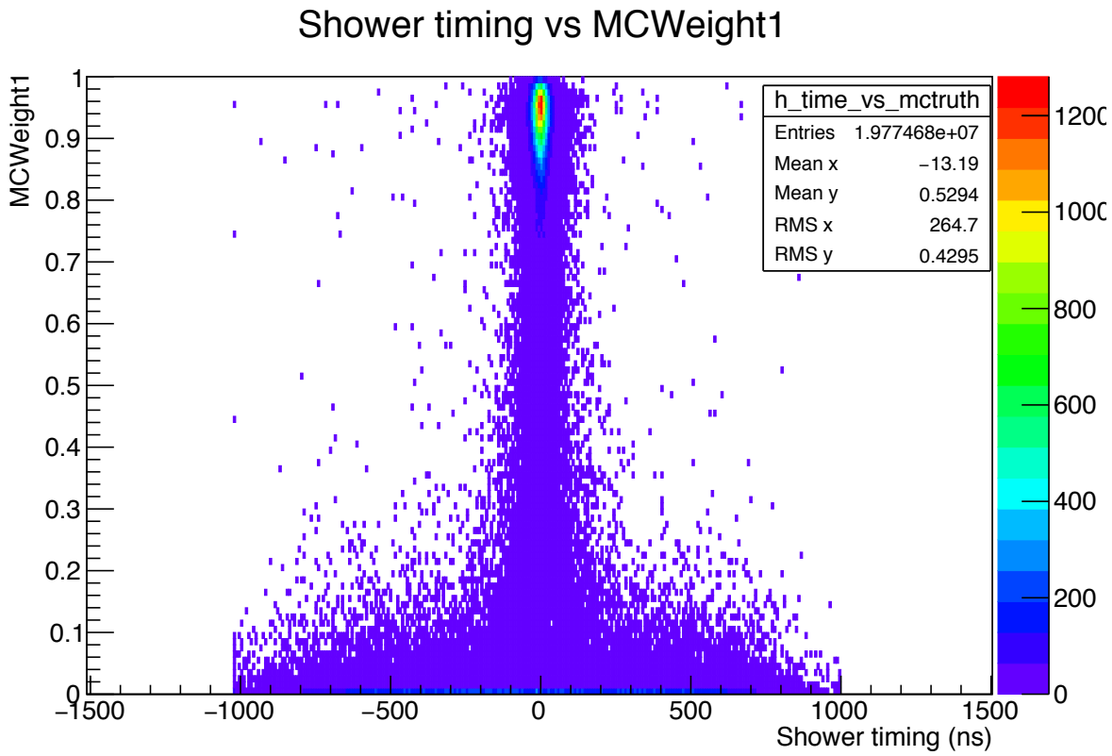
Moving to BGx1 samples, Energy and timing spectra

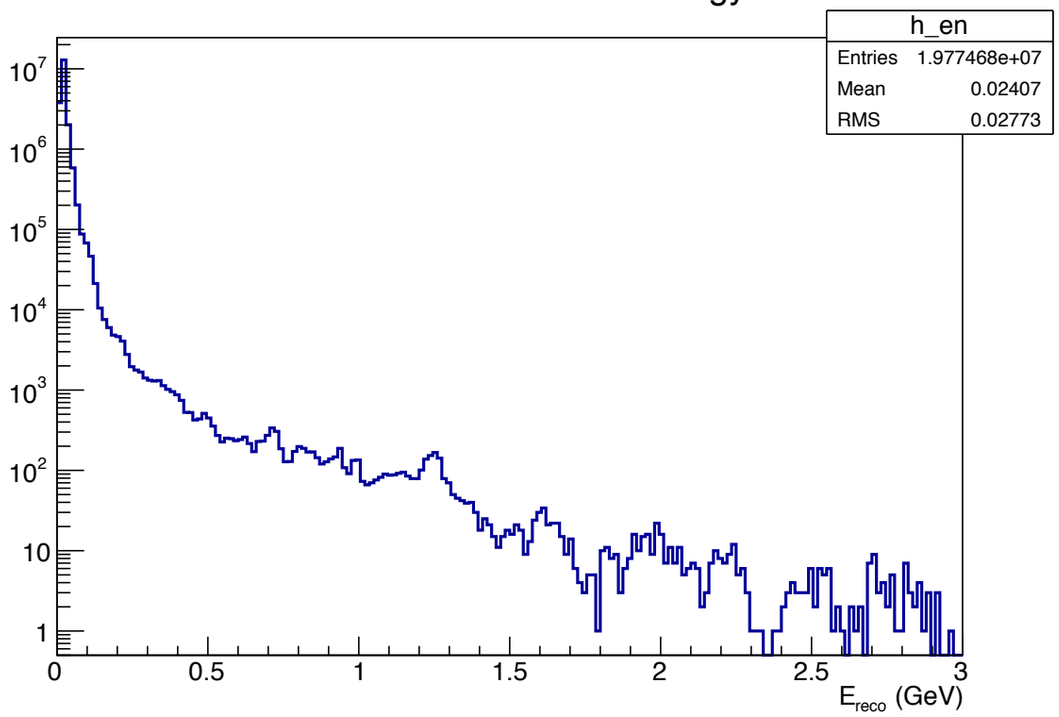
BARREL ECL BGx1, 15th machine bkg campaign

- 100 MeV single photons, machine background superimposed, BARREL REGION

- Much larger tails on energy and timing info wrt BGx0 (pag6), as expected
  - peak at 100MeV not visible in energy spectrum



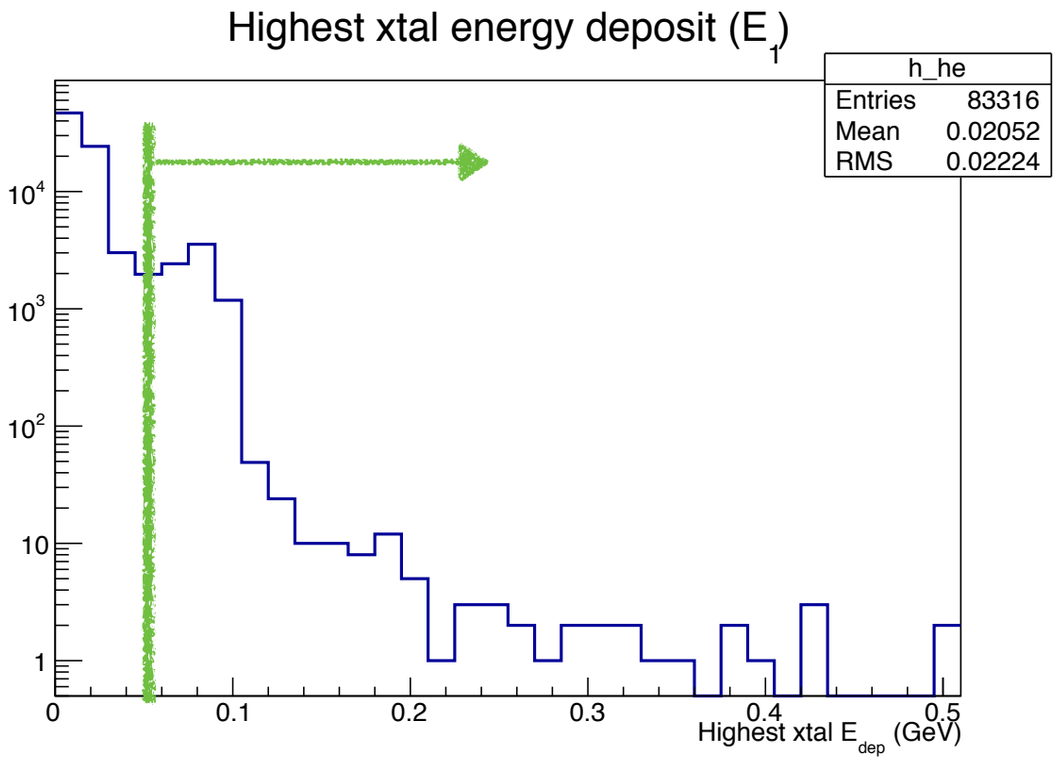




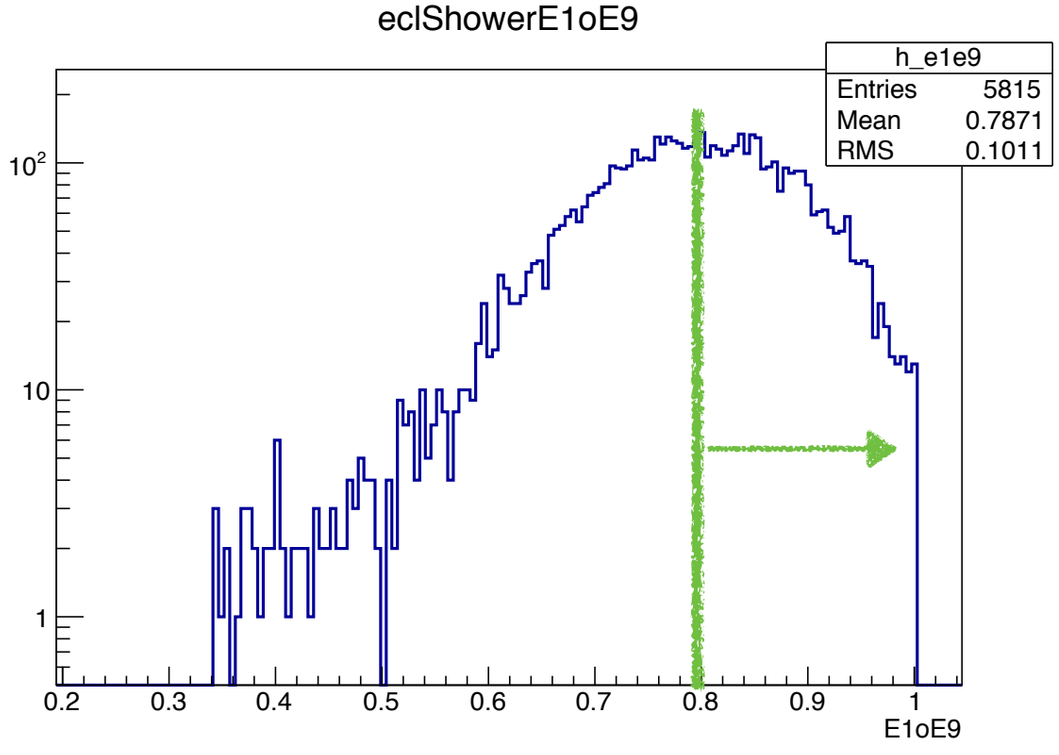
Selection variables

BARREL ECL BGx1,
15th machine bkg campaign

- E1 after best candidate selection



- E1/E9 after best candidate and E1 selection

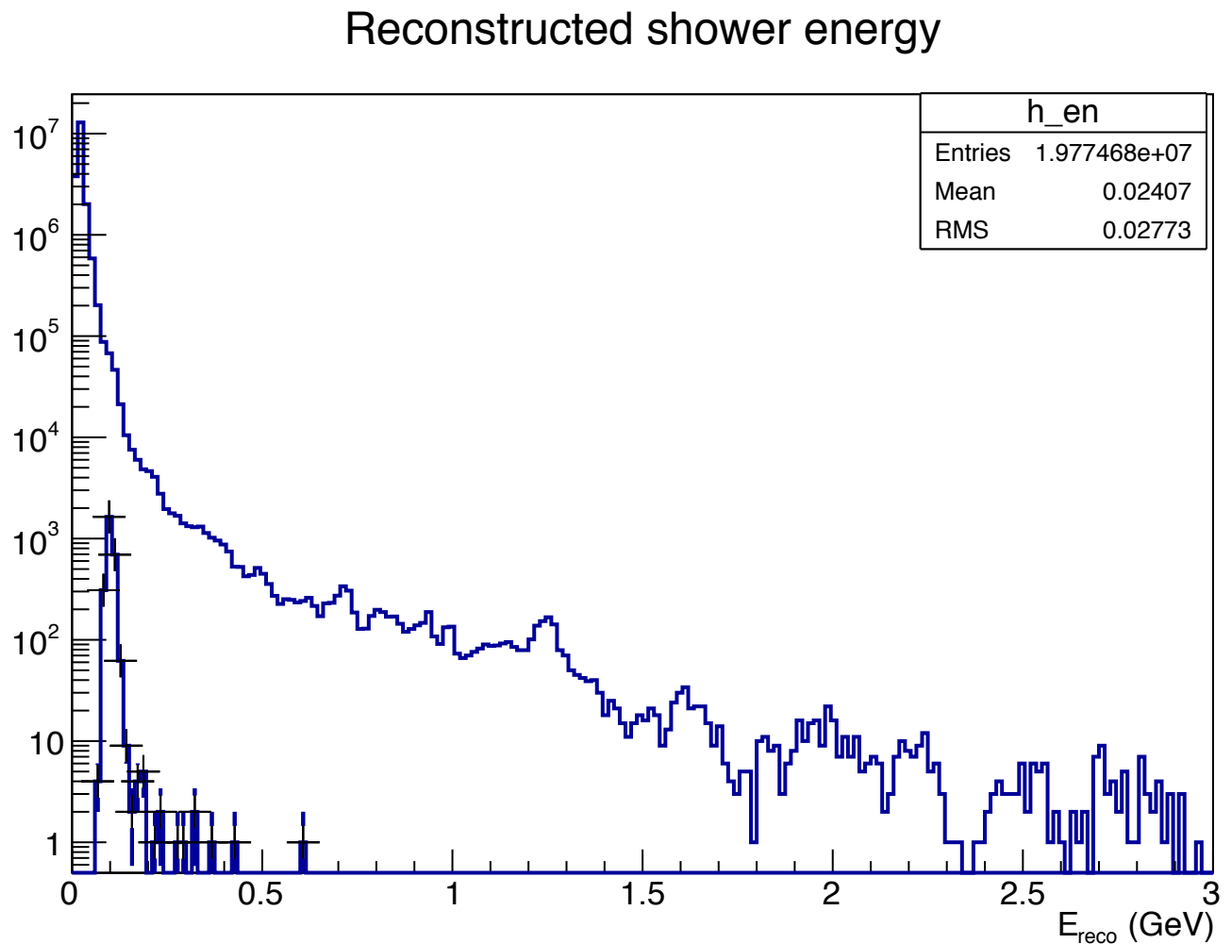


Energy distribution before and after selection

BARREL ECL BGx1,
15th machine bkg campaign

- Reconstructed energy after best shower selection and cuts on E1 and E1/E9
  - full hist = before cuts
  - cross = after selection

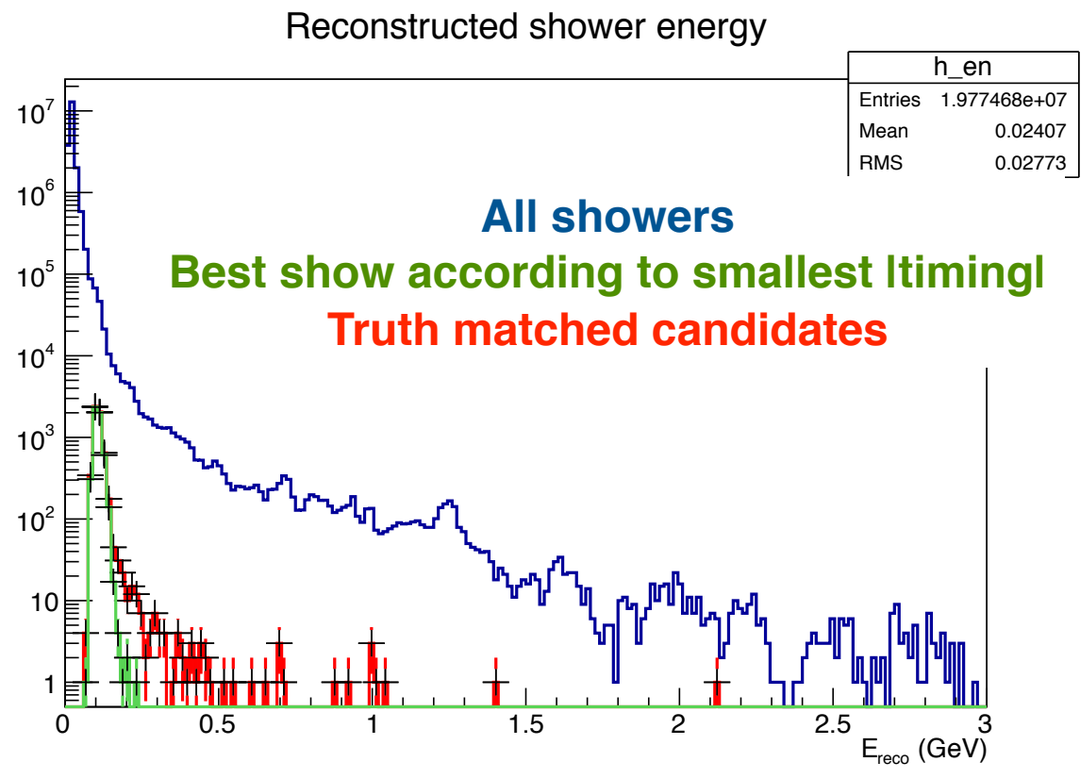
- Before selection, signal peak completely covered by background.



Comparison with MC-truth requirements

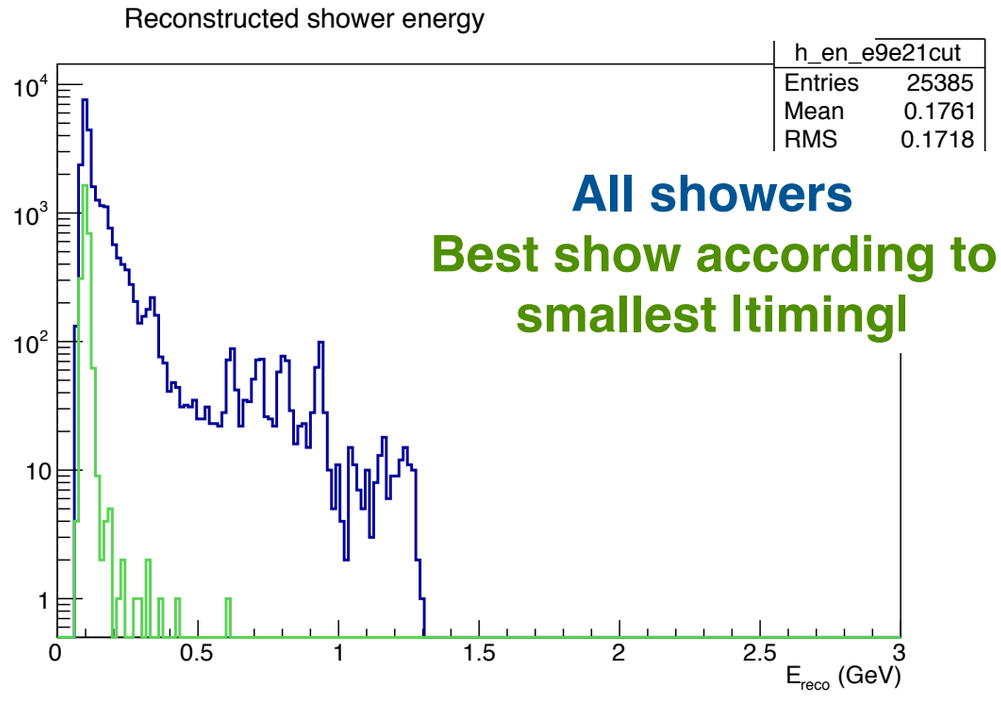
BARREL ECL BGx1,
15th machine bkg campaign

- Energy distribution after best candidate selection according to smallest absolute timing



- Energy distribution after best candidate + E1 + E1/E9 selection

- Large energy tails removed

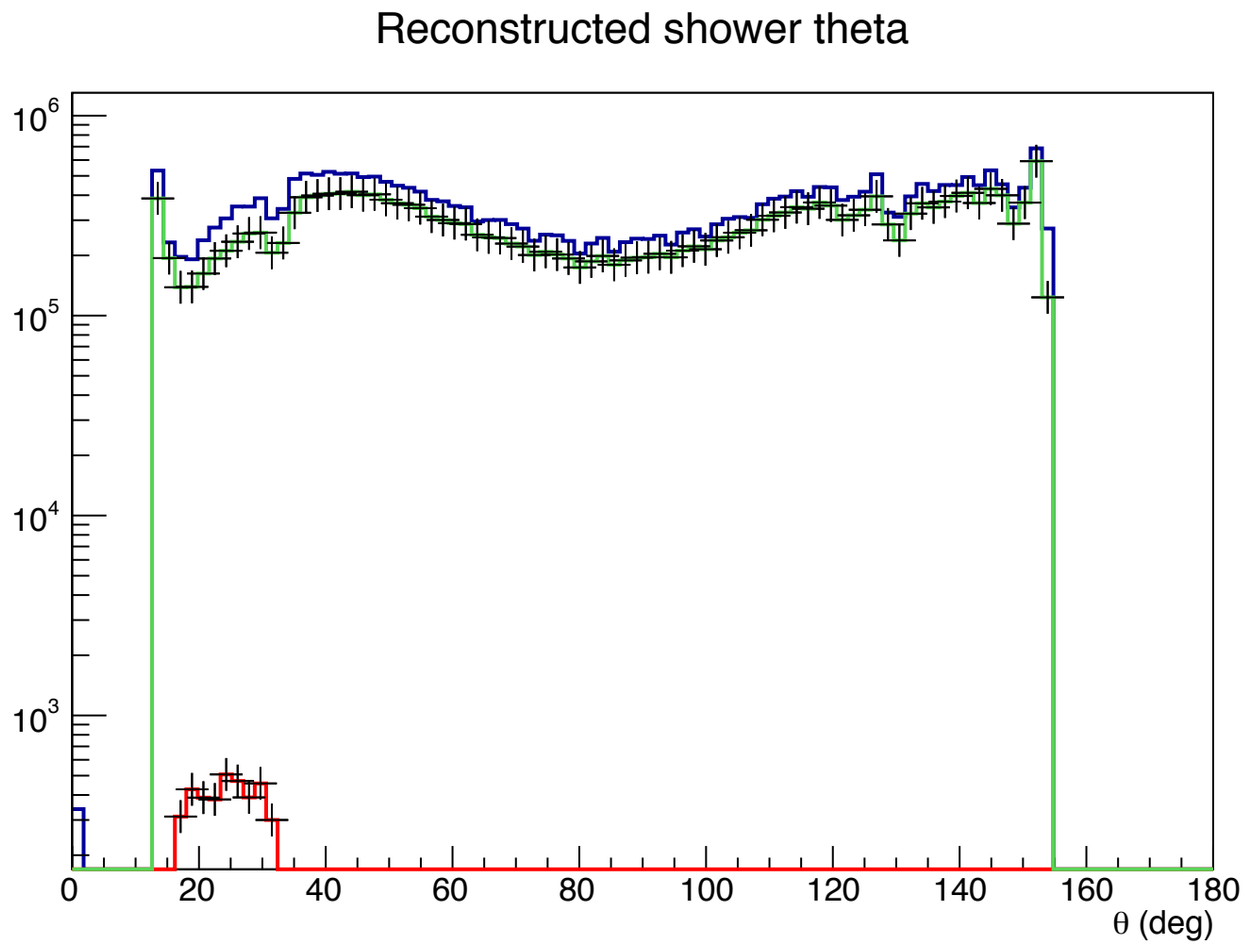


In the FWD region: reconstructed theta distribution

- Applying same analysis to 100-MeV sample in the FWD region+machine bkg

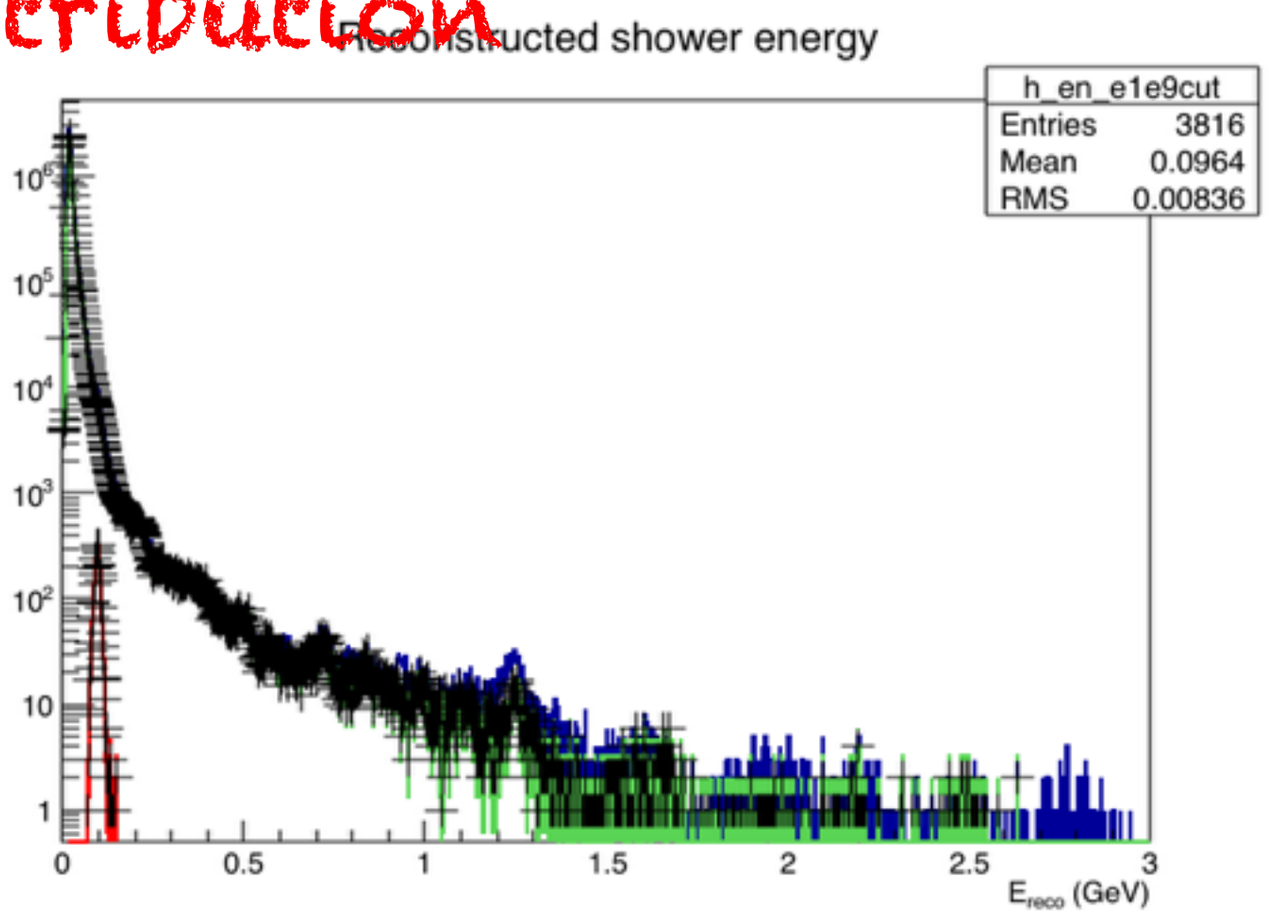
- Shower Theta distribution for ALL SHOWERS, BEST TIMING+ E1 && E1/E9 SELECTED SHOWERS, REJECTED SHOWER (~ background only deposits or real photons +large machine bkg deposits)

- "background" deposits in the full ECL range as expected, with implemented selection we're able to isolate deposits in the FWD ECL only, where the real photon was shot, the price to be paid is a very low efficiency: 3% of generated events have a candidate passing the selection



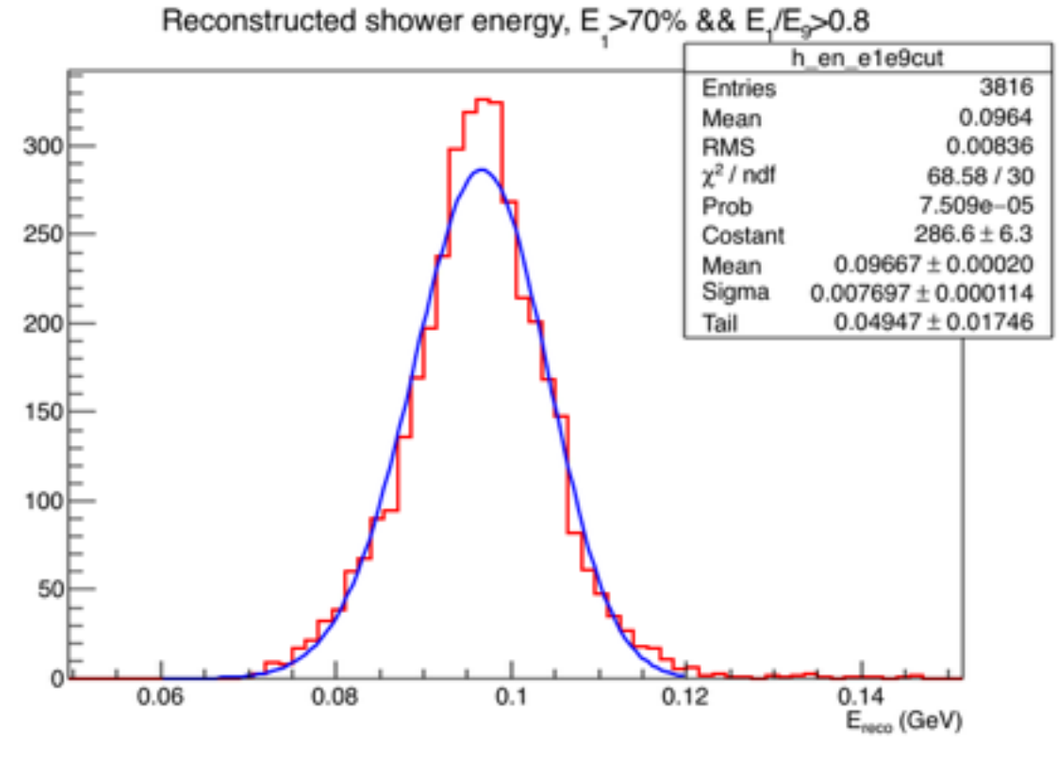
In the FWD region: reconstructed theta distribution

- Shower Energy distribution for ALL SHOWERS, BEST TIMING+ E1 && E1/E9 SELECTED SHOWERS, REJECTED SHOWER (~ background only deposits or real photons +large machine bkg deposits)



- After all selection applied:
  - energy resolution from Novosibirsk fit:

    (7.96 +/- 0.12) %



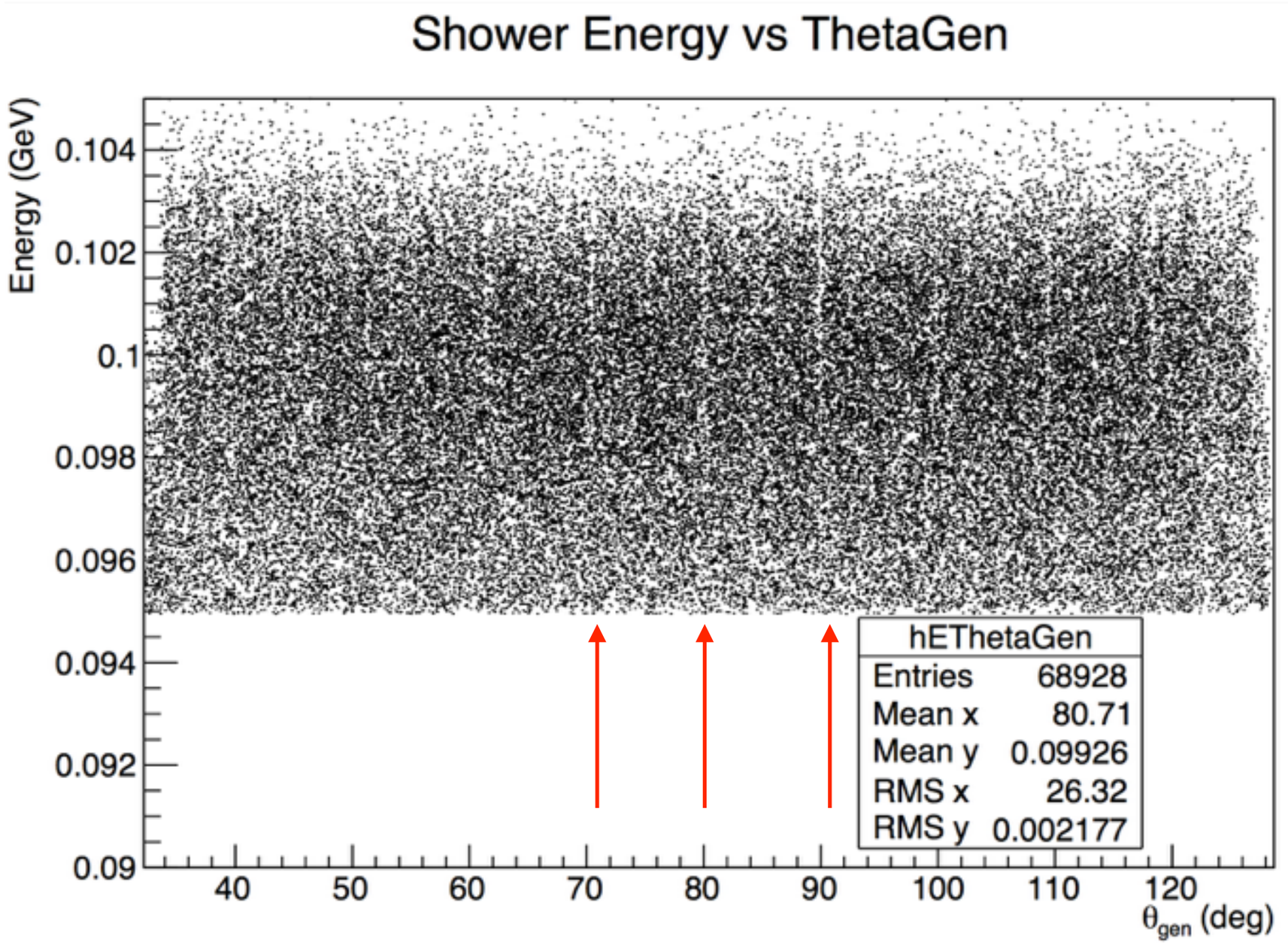
GEOMETRICAL STUDIES

Generated Theta vs Energy, BGx0

- 100 MeV single photons, no machine background superimposed, BARREL REGION

- Reconstructed energy vs GENERATED theta

- 9 structures visible
  - 45 rings, divided in 9 5-rings substructures

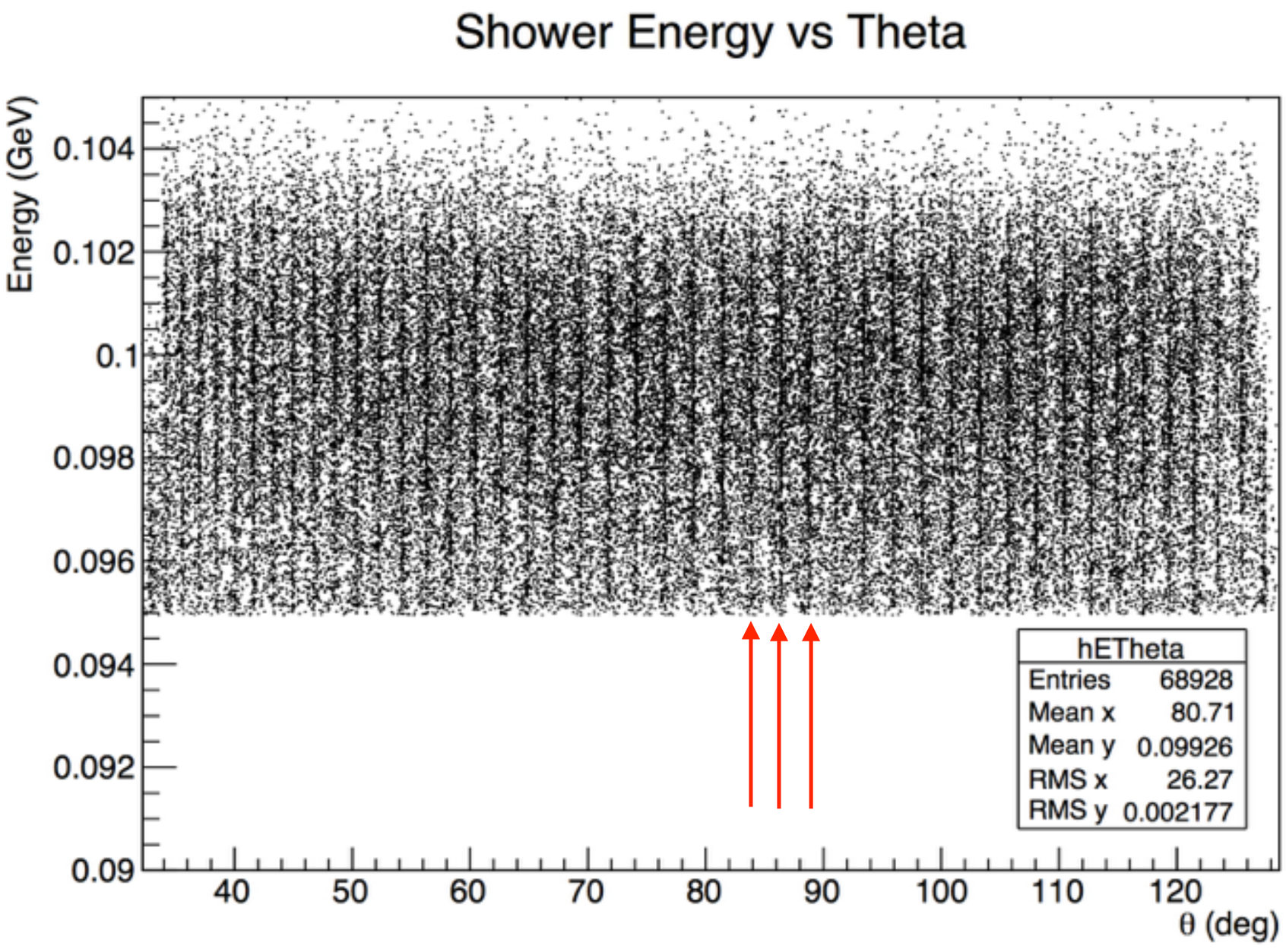


Reconstructed Theta vs Energy, BGx0

- 100 MeV single photons, no machine background superimposed, BARREL REGION

- Reconstructed energy vs RECONSTRUCTED theta

- 45 structures visible
  - 45 rings: effect introduced in the computation of theta with the barycentre of the energy

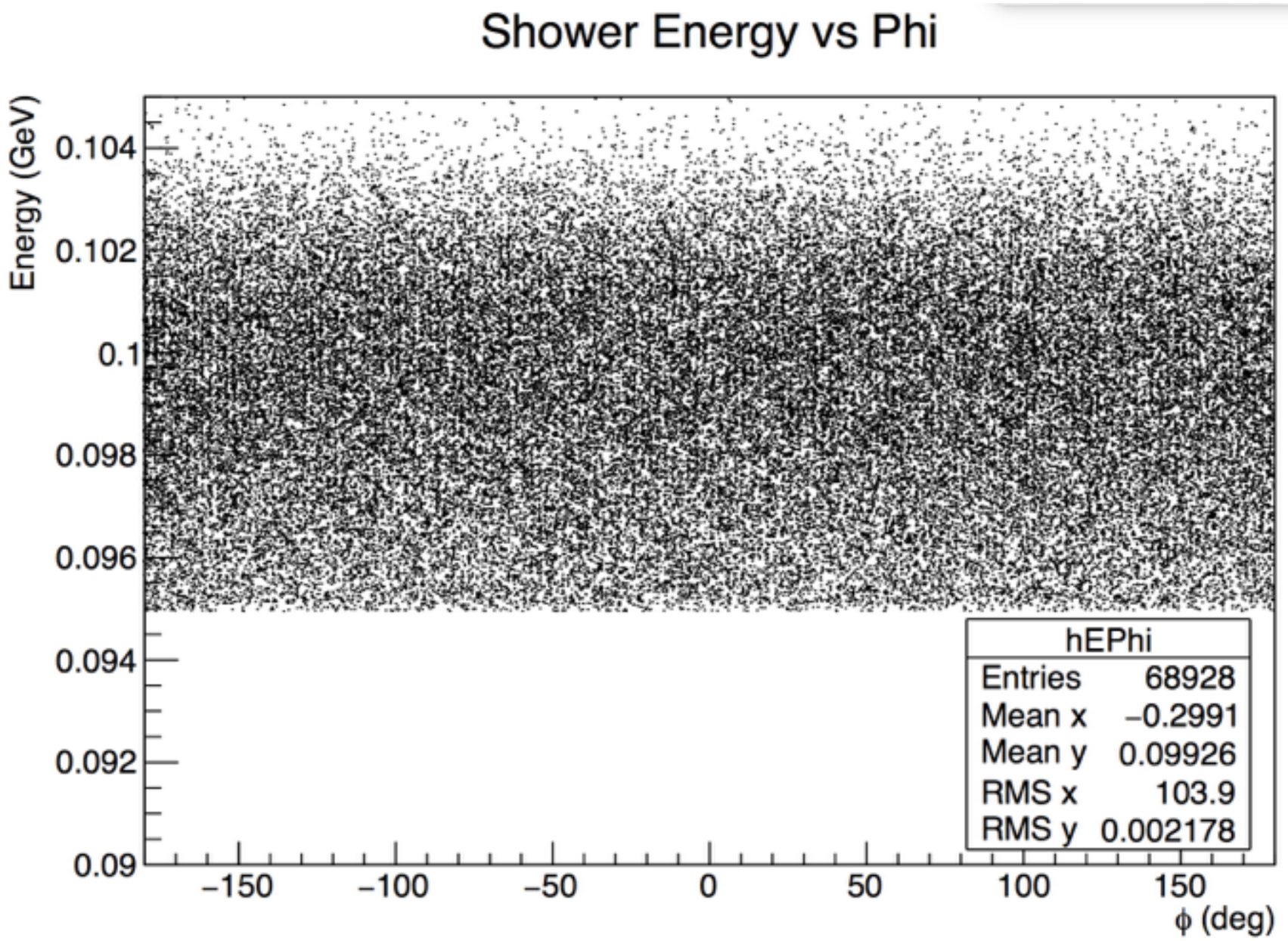


Reconstructed Phi vs Energy, BGx0

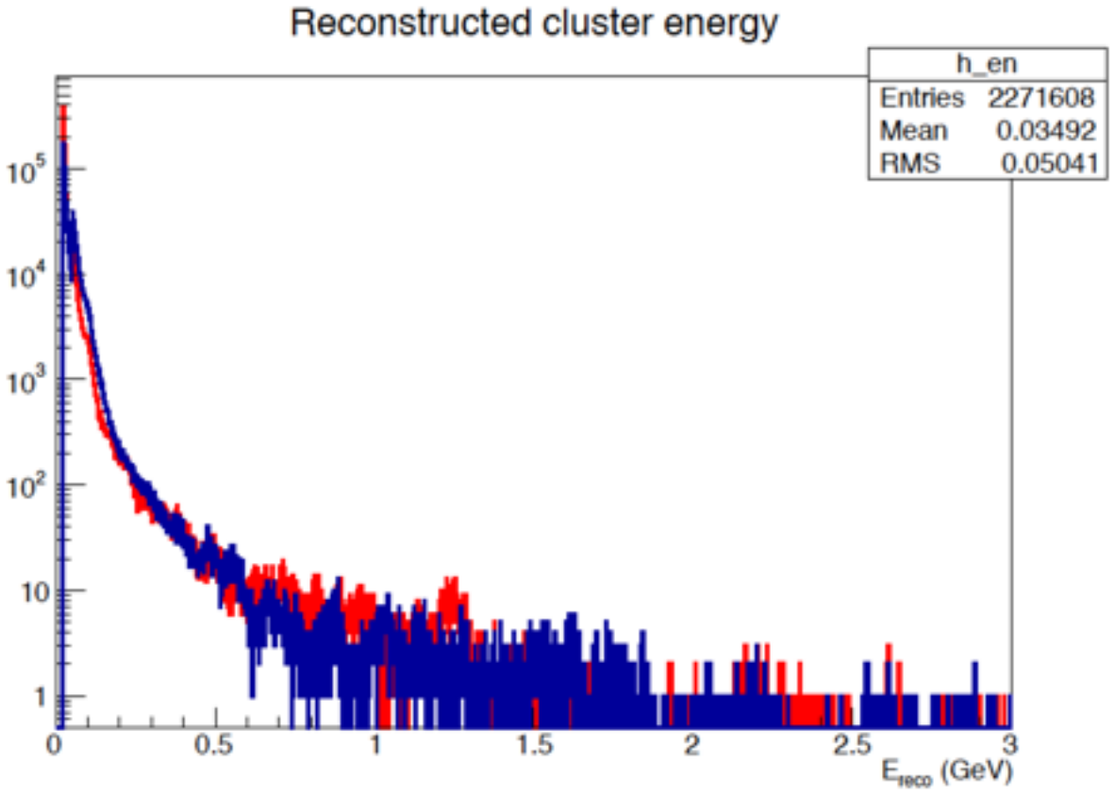
- 100 MeV single photons, no machine background superimposed, BARREL REGION

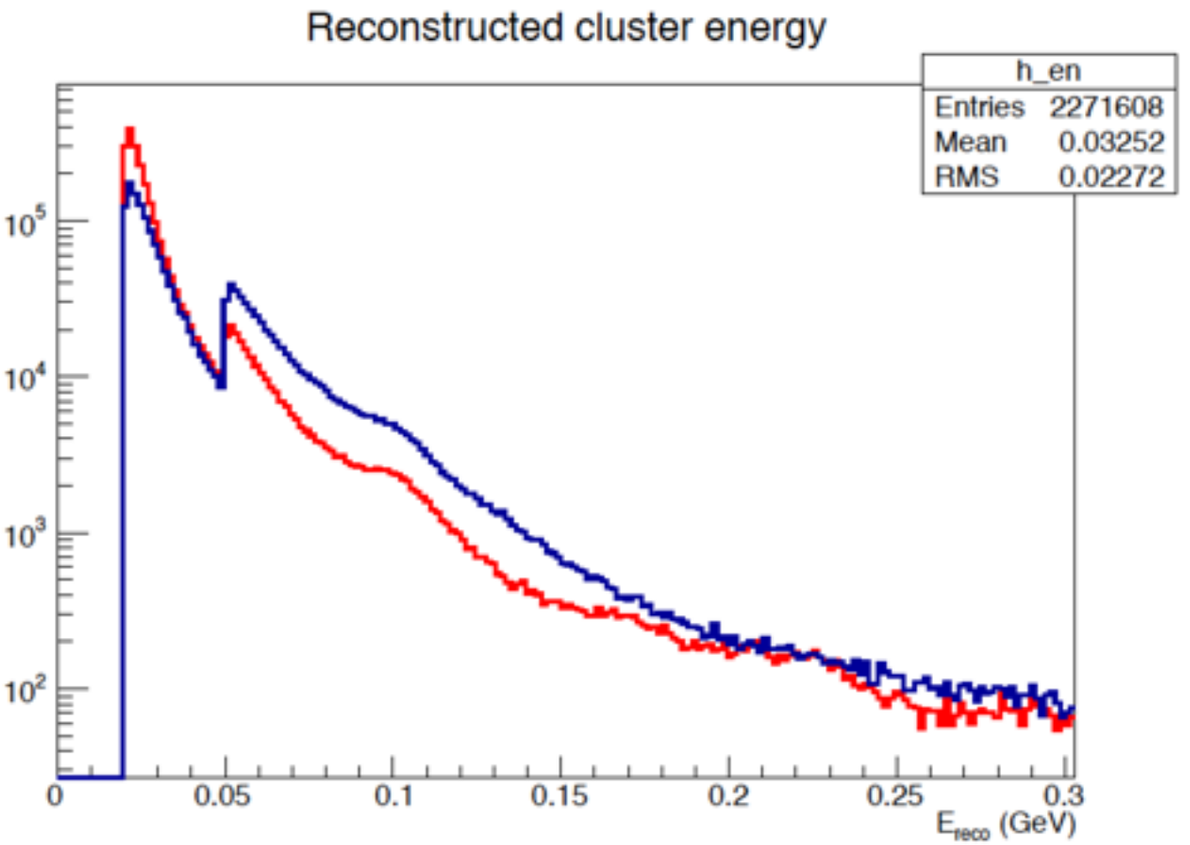
- Reconstructed energy vs RECONSTRUCTED phi

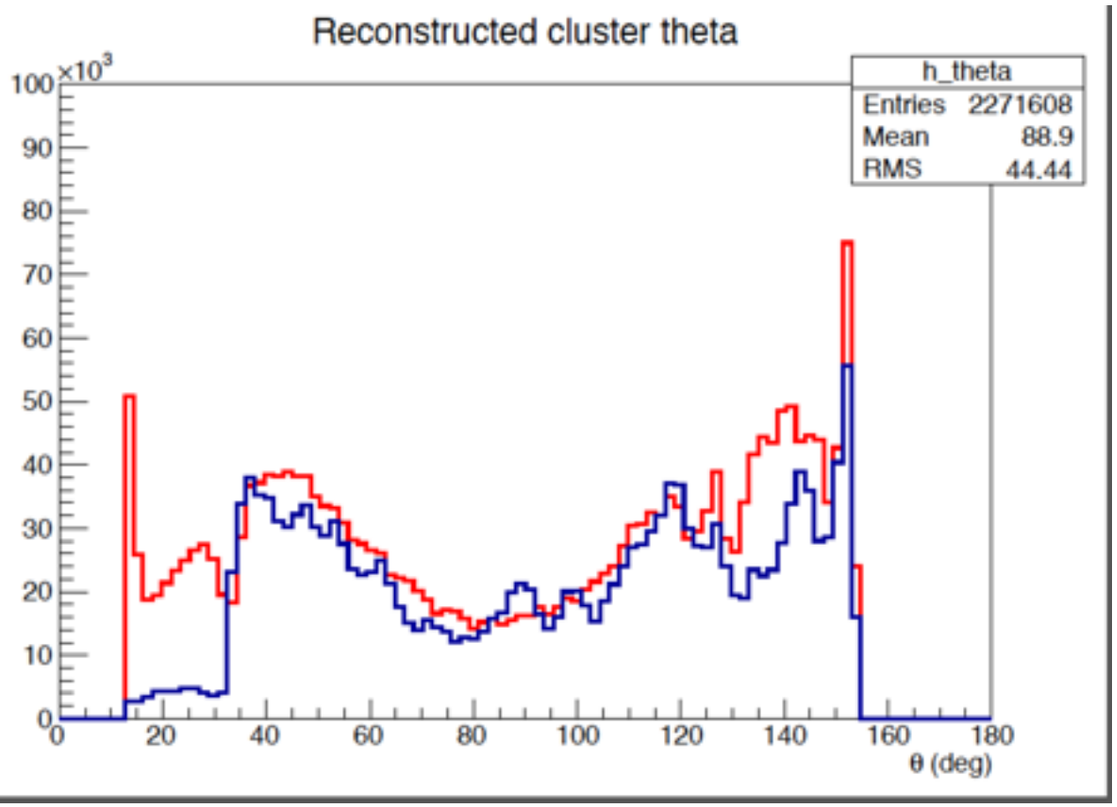
- 144 structures visible (less evident than for theta)
  - 144 layers: effect introduced in the computation of phi with the barycentre of the energy



Pure CsI: some distributions



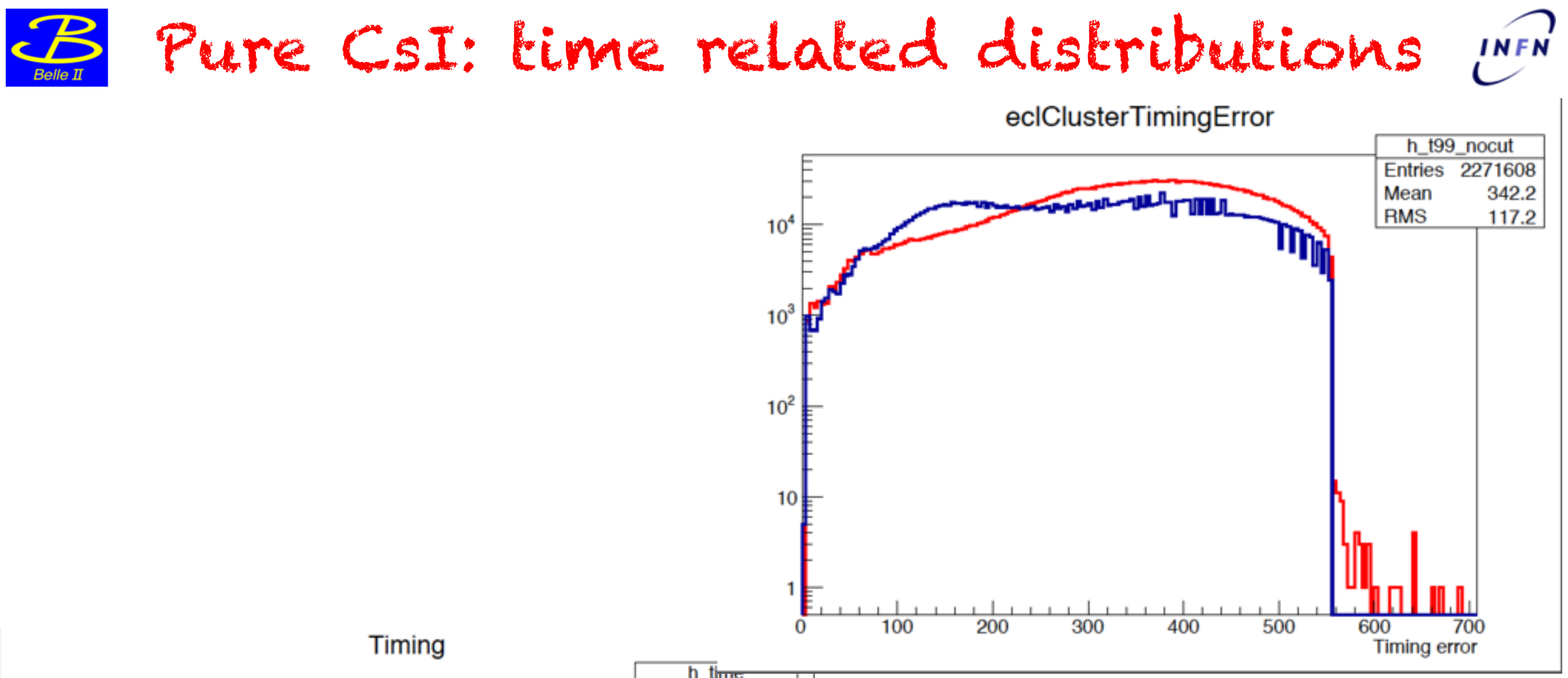


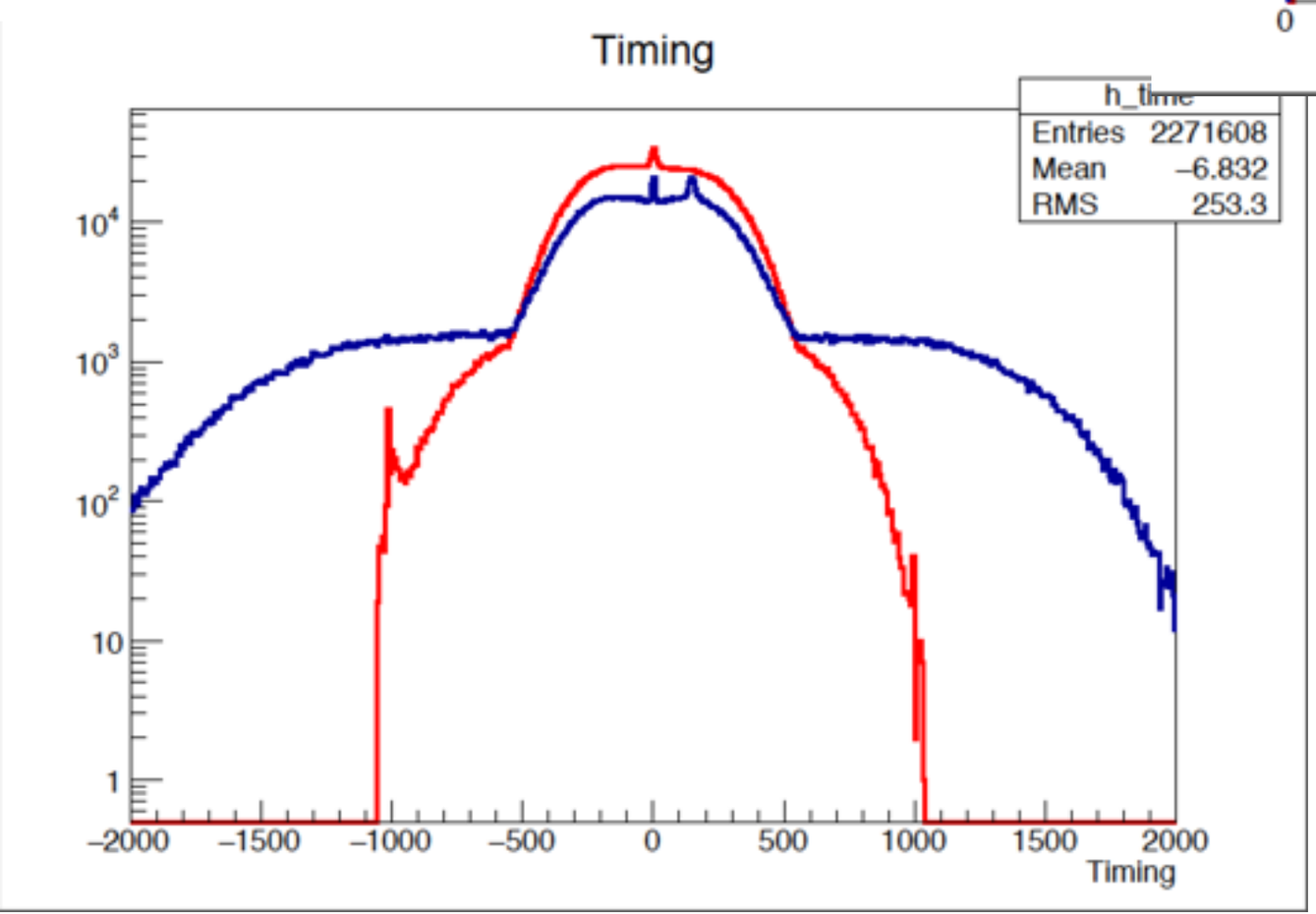


CsI

CsI(Tl)

Pure CsI: time related distributions

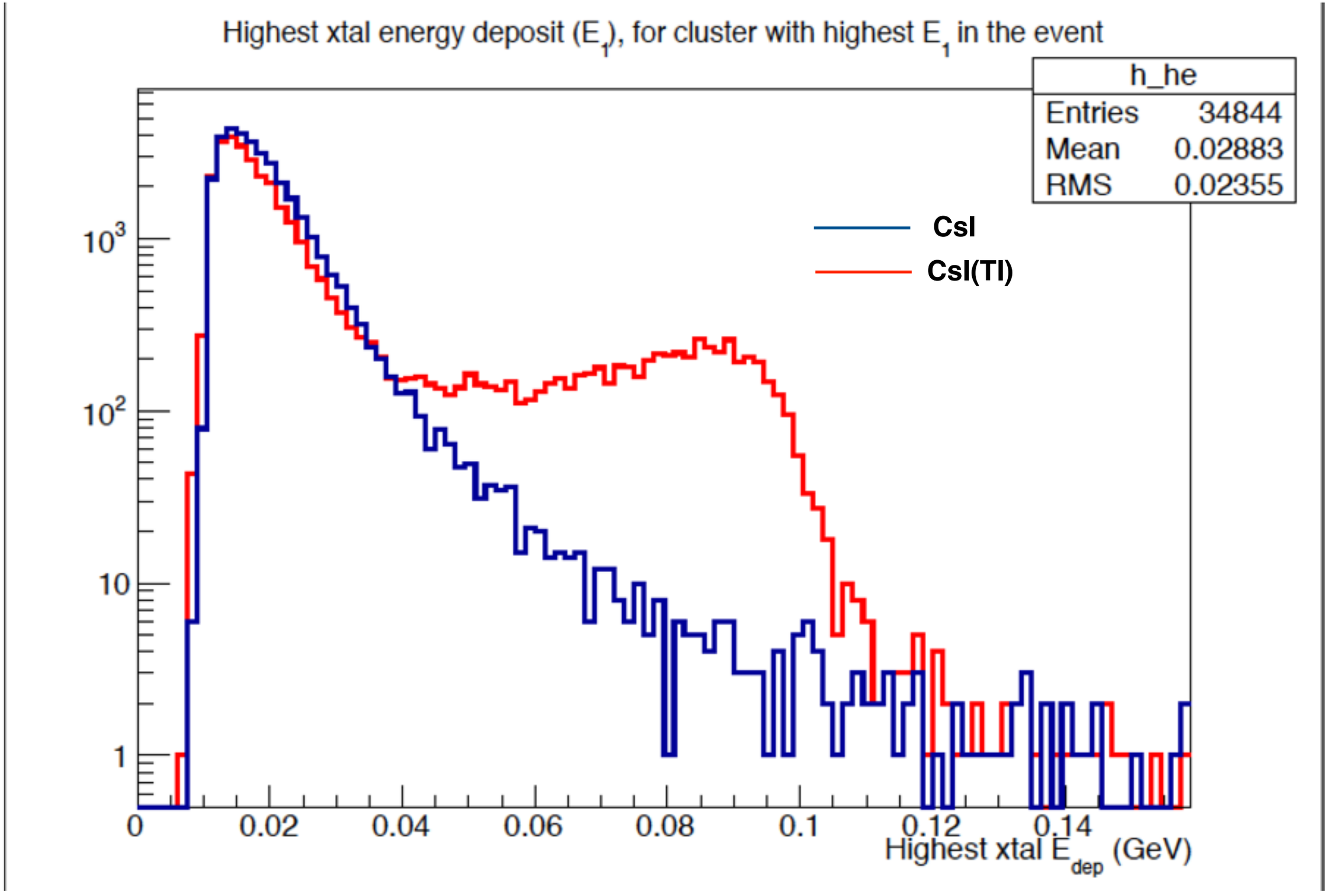




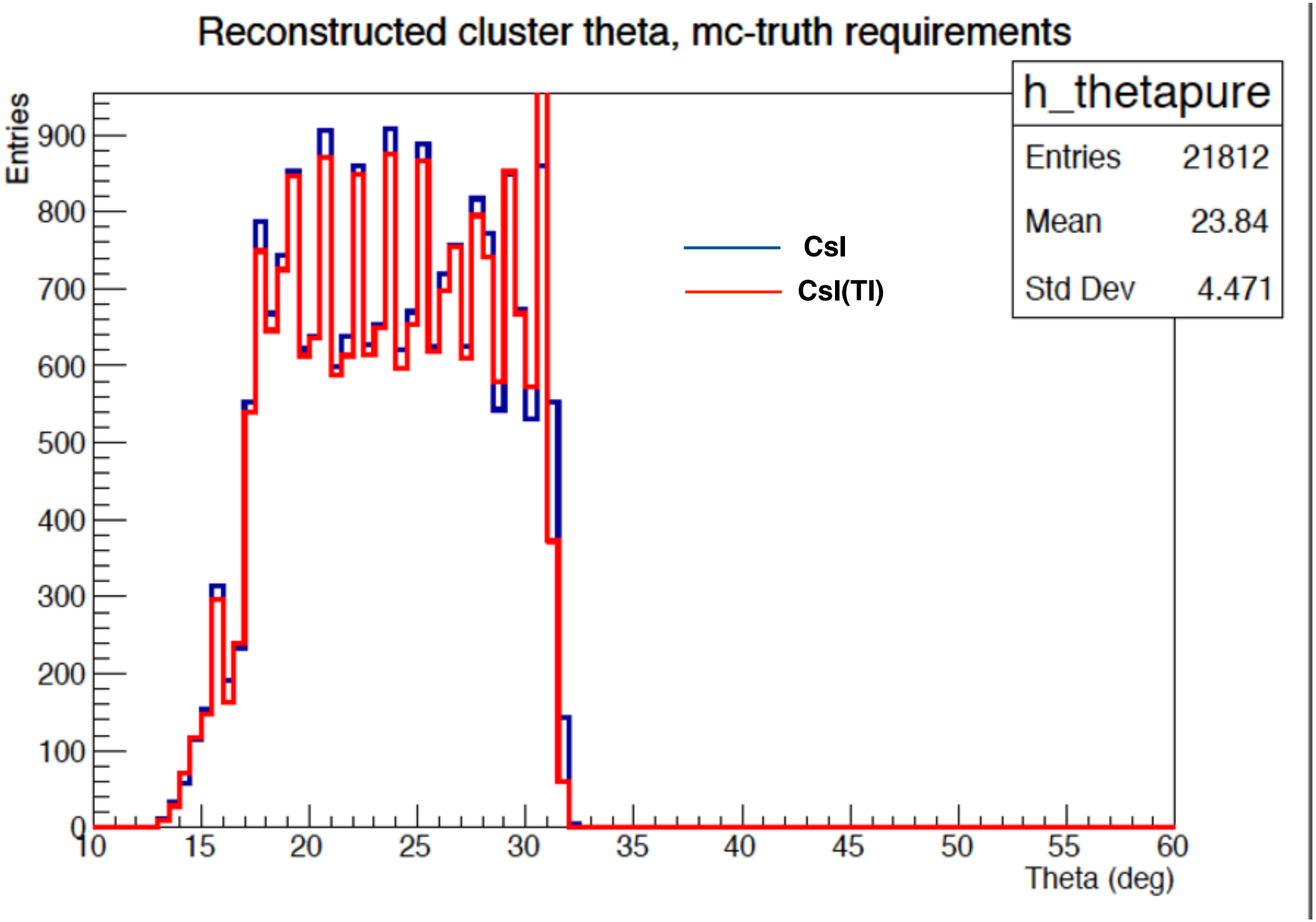
CsI

CsI(Tl)

Pure CsI: most energetic deposit

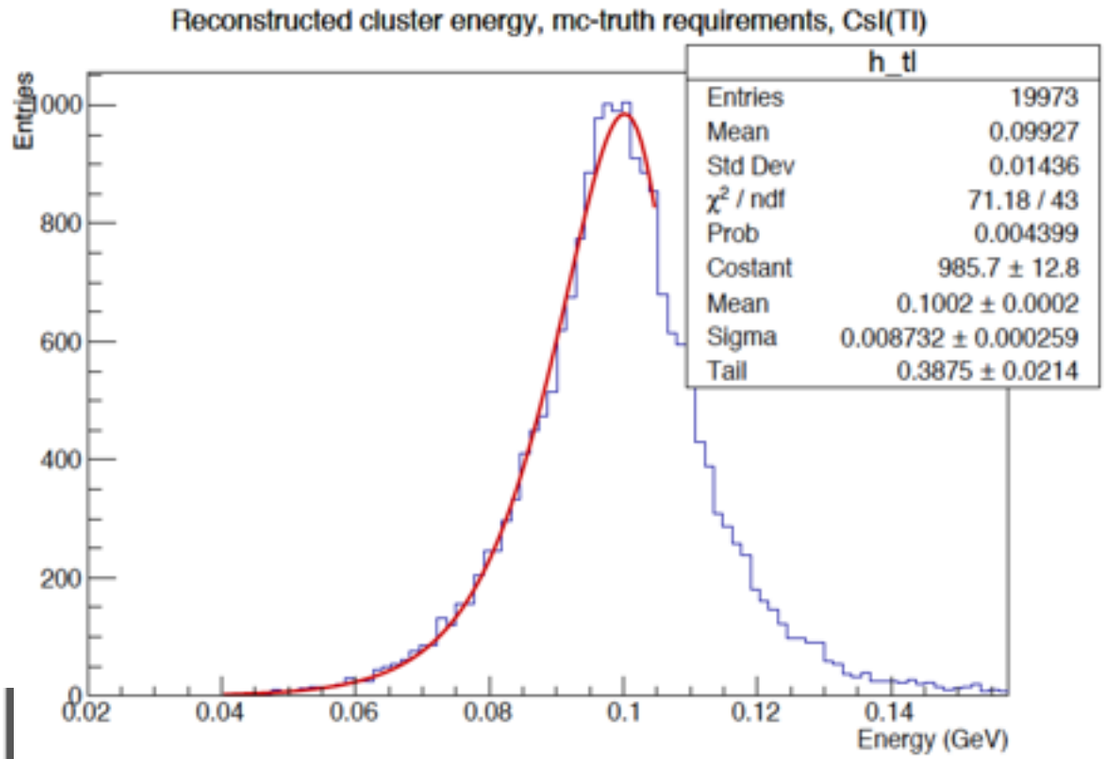


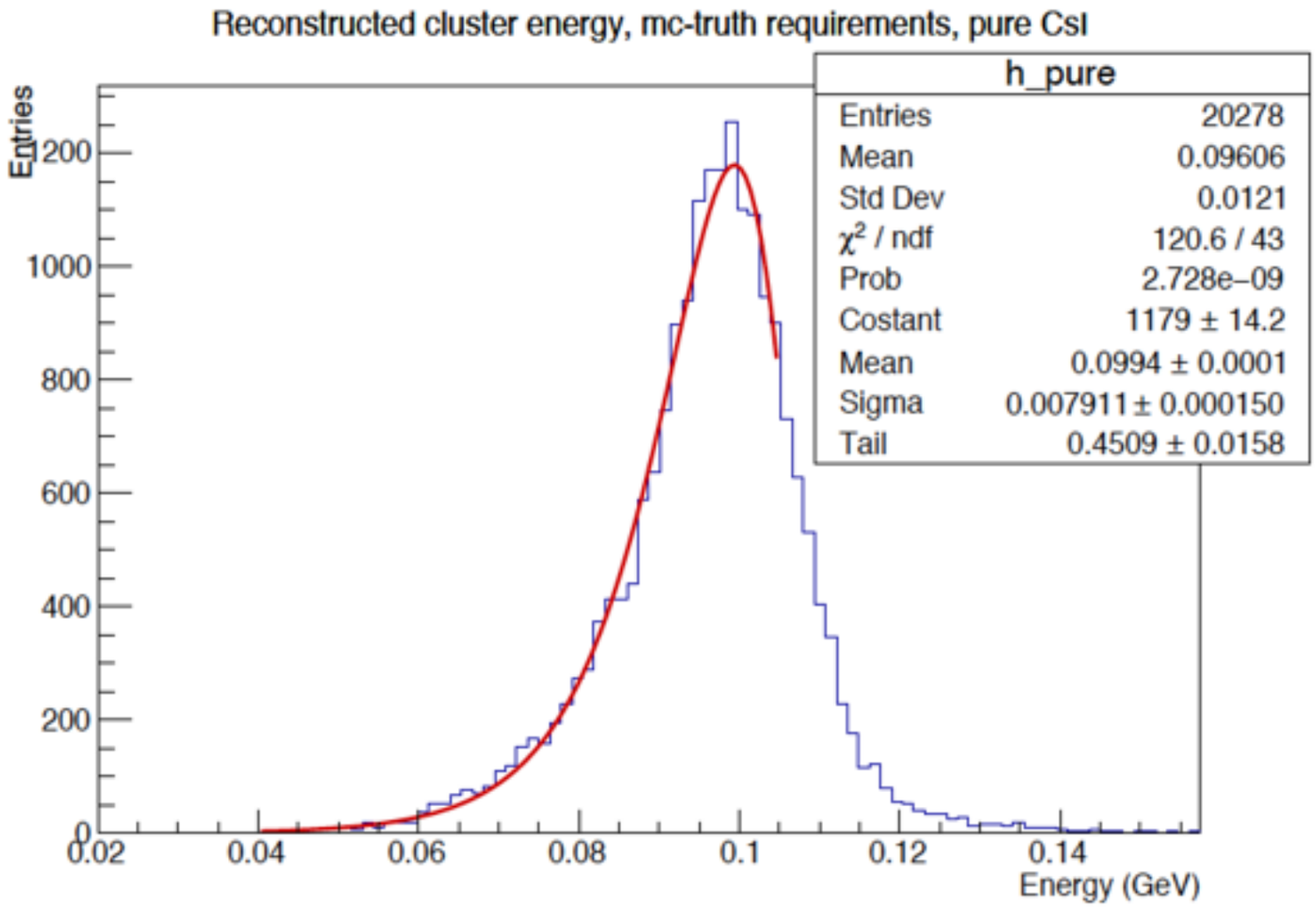
theta after Mc-truth selection



Pure CsI: selection based on mc-truth
100 MeV photons

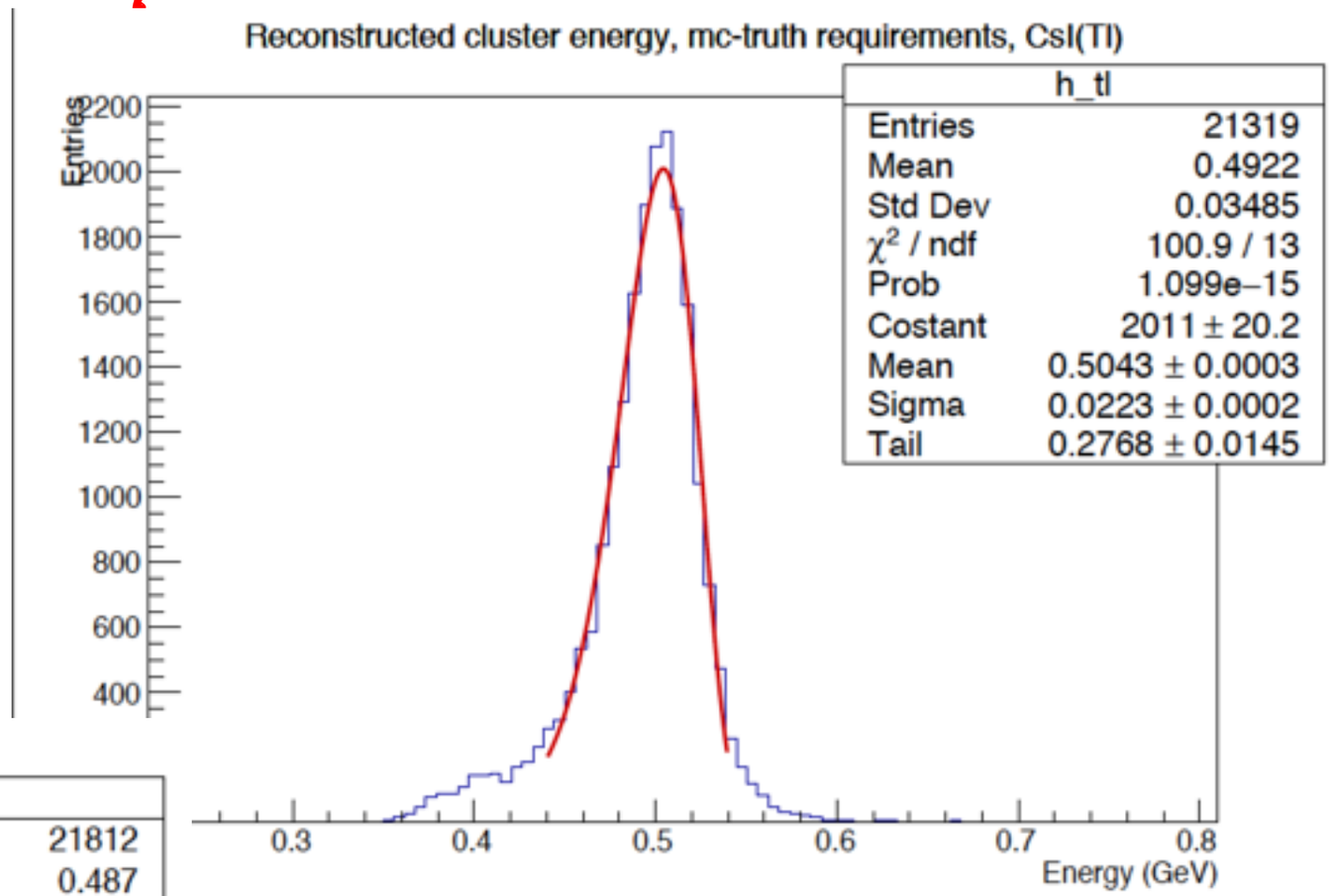
- CsI(Tl): ~8.7% resolution
- CsI: ~7.9% resolution

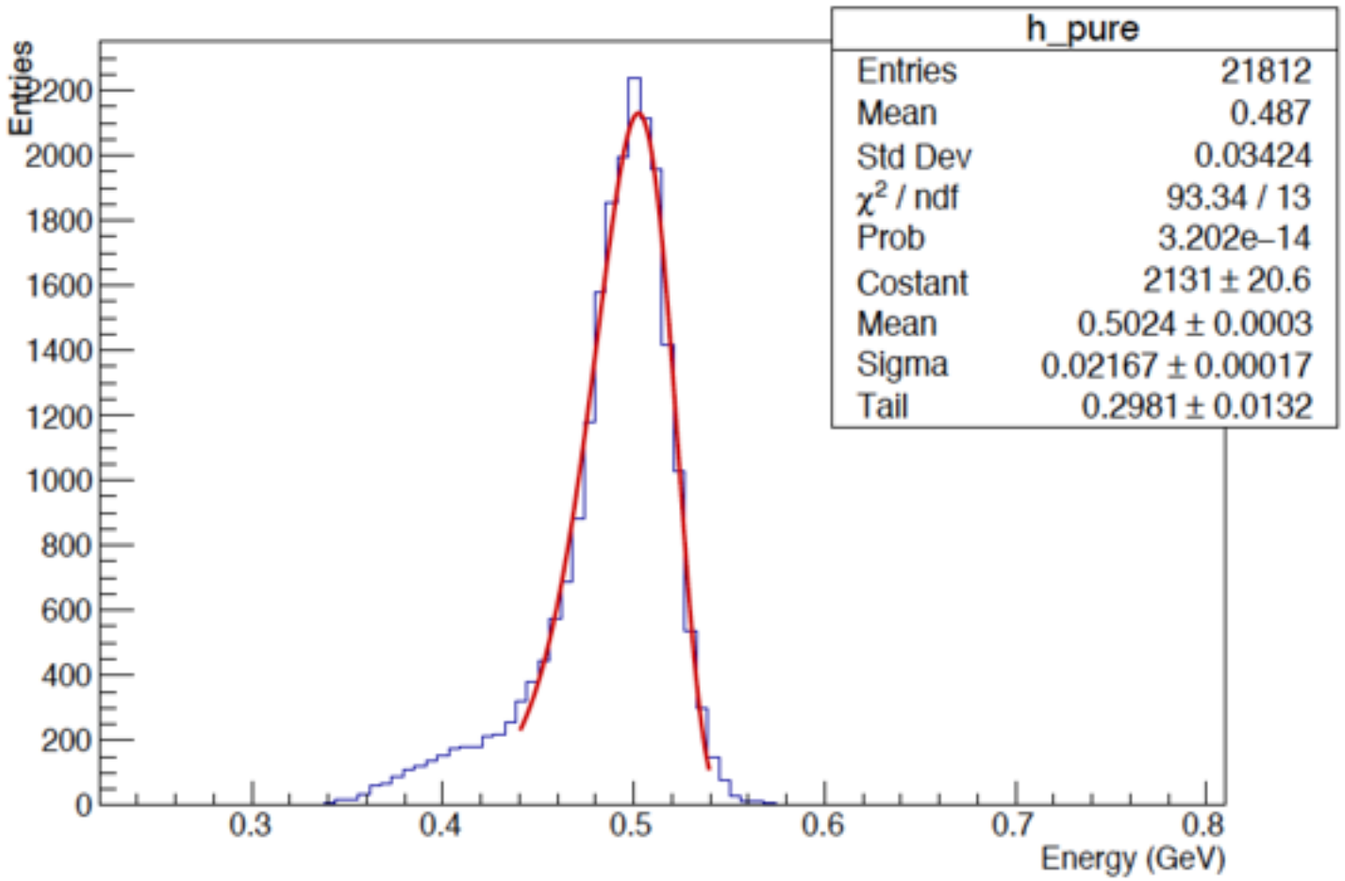




Pure CsI: selection based on mc-truth 500 MeV photons

- CsI(Tl): ~4.5%
- CsI: ~4.3%

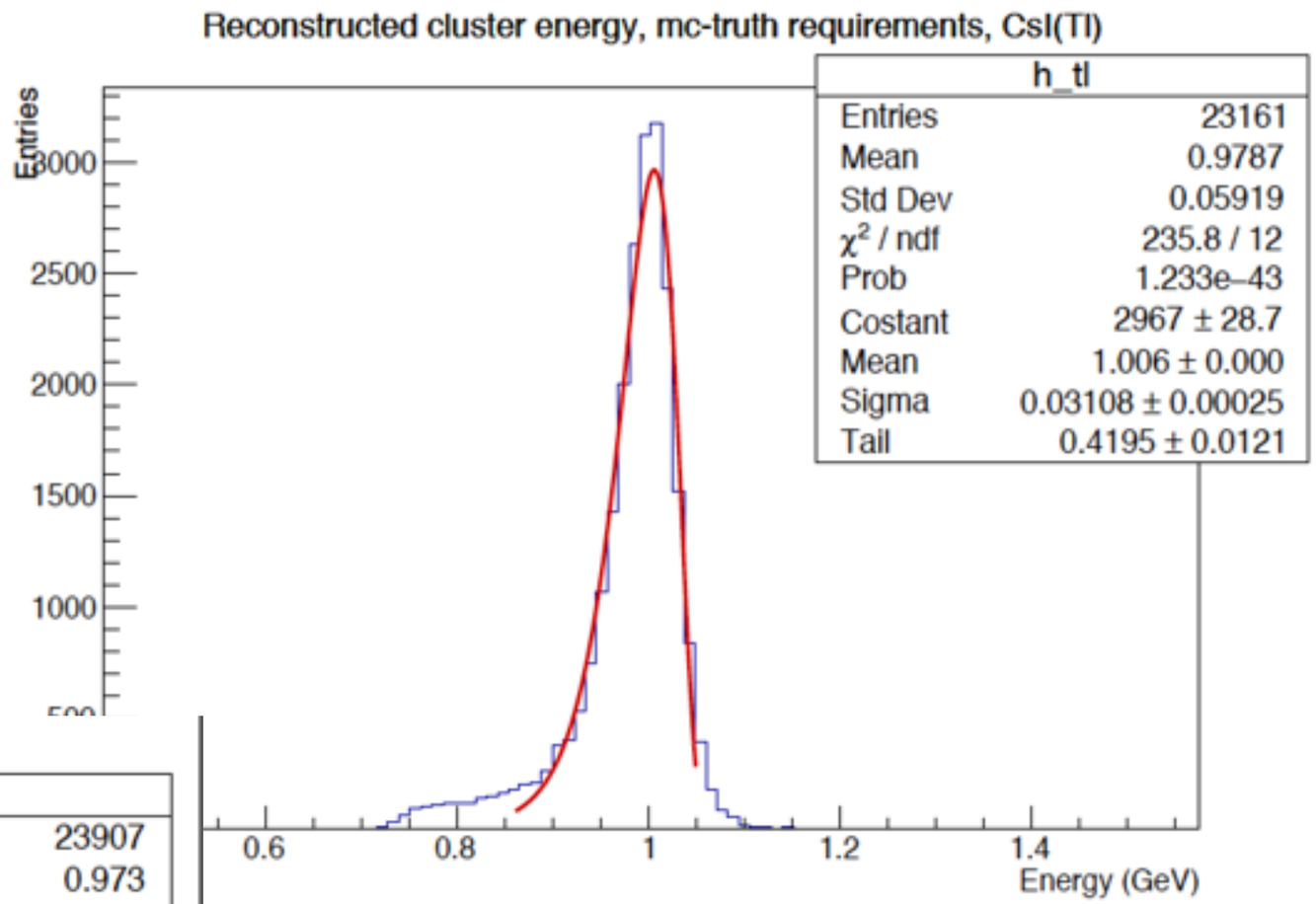


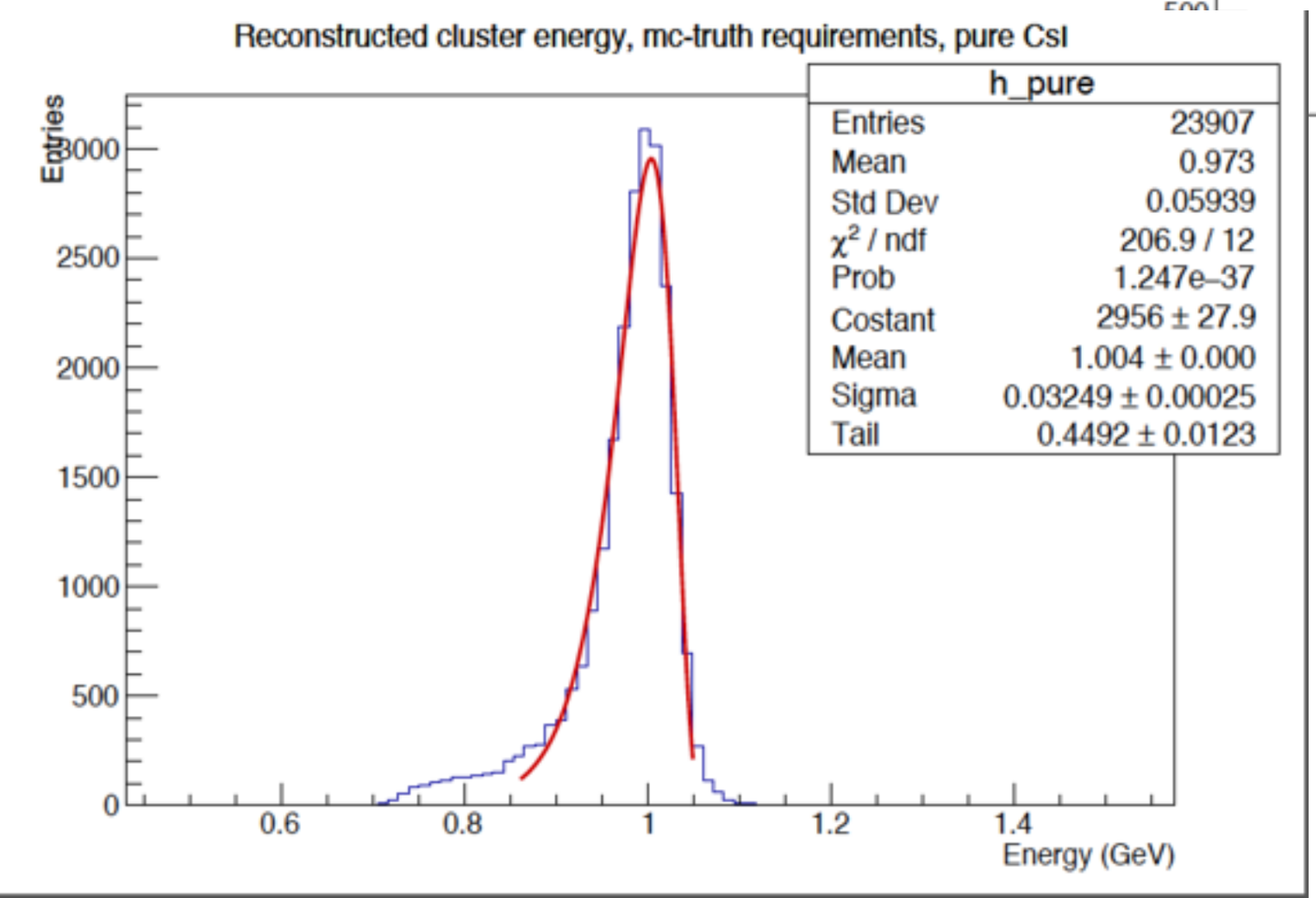


Pure CsI: selection based on mc-truth

1 GeV photons

- CsI(Tl): ~3.1%
- CsI: ~3.2%





Conclusions

- **Plans for studying effects related to leakage:**
  - geometrical effect in the barrel due to crack between crystals (shown today)
  - geometrical effect in the endcaps (different from barrel due to different modularity)
  - effects due to gap between barrel and endcaps
  - longitudinal leakage (mainly for BGx1 case)

- **Selection studies to identify suitable energy distribution for leakage studies**
  - reconstructed timing and crystal energy distribution quantities fro BGX0 and BGX1 cases studied
  - similar performances, in terms of energy distribution shapes, wrt mc-truth based selection
  - energy resolution (8% @ 100 MeV in FWD) comparable with performances obtained with 12th machine background campaign, but factor x3 in background makes very difficult the extraction of the signal peak → **paid price in efficiency** (effect under study)

Conclusions

- **Pure CsI first look:**
  - basic distributions show some strange behaviour in the pure CsI → to be understood
  - on a mc-truth based selection the resolution looks better than CsI(Tl); NO optimisation of the clustering has been applied, novosibirsk fit is very range dependent
  - In case of good reconstruction the **efficiency** would be much higher than for the CsI(Tl), but at this stage is not possible to evaluate it

- For release-01-00-00, leakage correction used for the last production still valid (no new machine background samples foreseen) → validation of the release will start tomorrow

EXTRA SLIDE