Neutral reconstruction performances
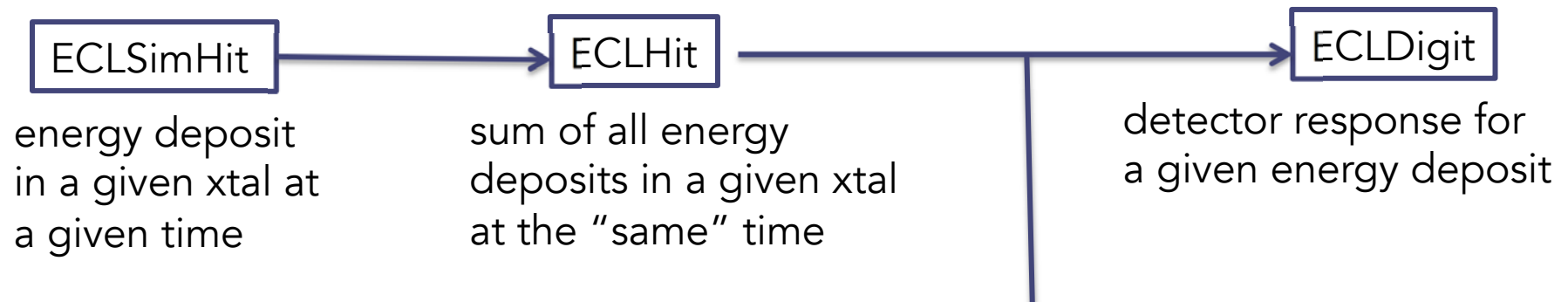
Third Belle II Italian Collaboration Meeting

LNF, 22/05/2015

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for the ECL software group

Aim of the study

- ## Digitizer validation

ECLSimHit	→	ECLHit	→	ECLDigit

energy deposit in a given xtal at a given time

sum of all energy deposits in a given xtal at the "same" time

detector response for a given energy deposit

- from Hit deposit, derive 31 samplings for waveform fit using hit energy, expected signal shape and <u>electronic (+machine bkg)</u> noise (covariance matrix)
- perform waveform fit through solution of a system of linear equation in which the covariance matrix enters
- covariance matrix updated by A. Bobrov & G. De Nardo, incorporating machine bkg effect → validation needed

- ## Performance studies for ECL upgrade
  - study fwd ecl performances with different photosensor+xtal configs

Code vesrion and samples

- build-2015-01-03 for simulation with old digitizer, build-2015-04-19 for simulation with new digitizer

- samples:
  - 1000 single-photon events @ 500 MeV with and without machine background, 2 angular acceptance: barrel (θ in [40°,120°]) and central fwd (θ in [20°,24°])
  - 1000 single-photon events @ 50 MeV with and without machine background (RadBhabha, Coulomb and Touschek), full angular acceptance

- Remarks on machine bkg: Rad Bhabha, Coulomb and Touschek from IXth background campaign
  - XIth is the latest but has some open issues under study

Steps towards pre-release validation (I)

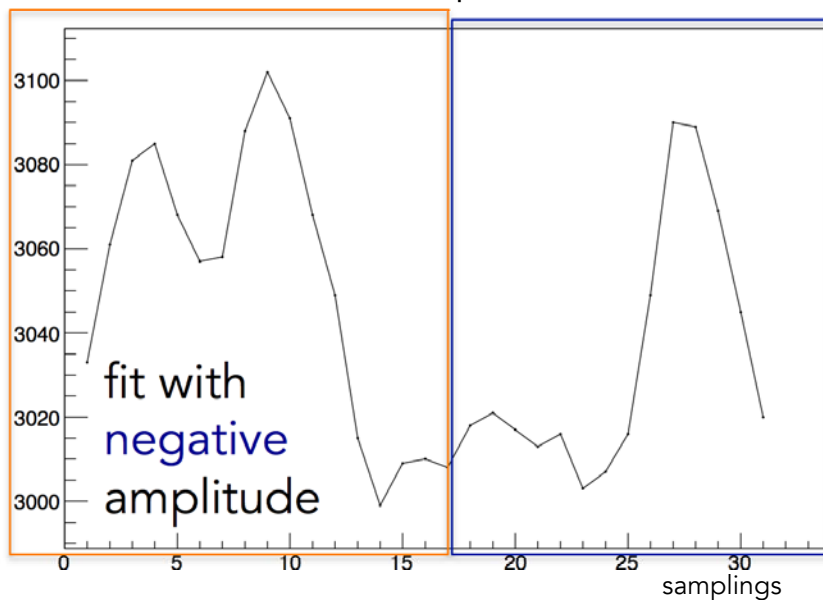- First version: no cut on negative amplitude → all xtals fired, then fixed
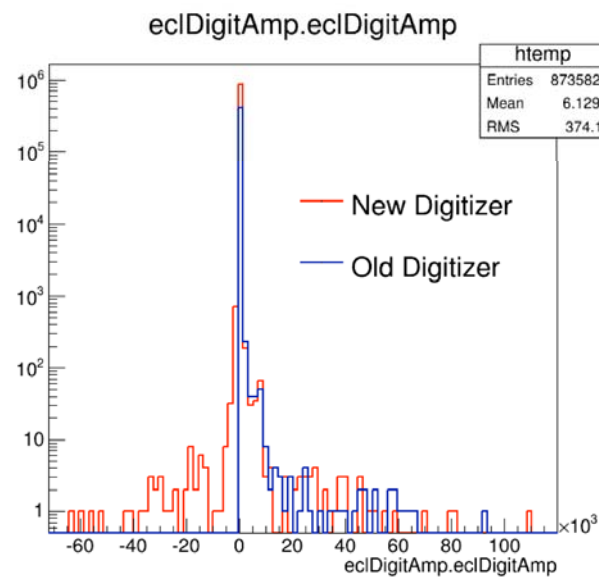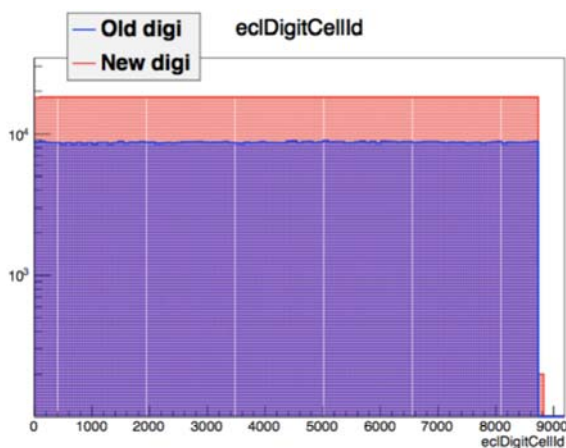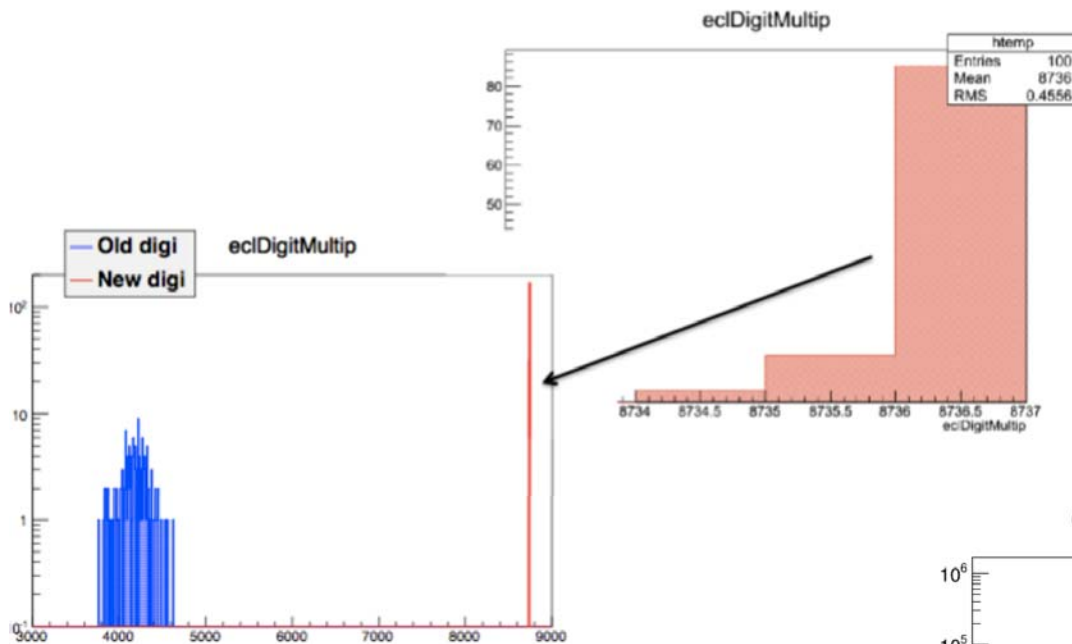
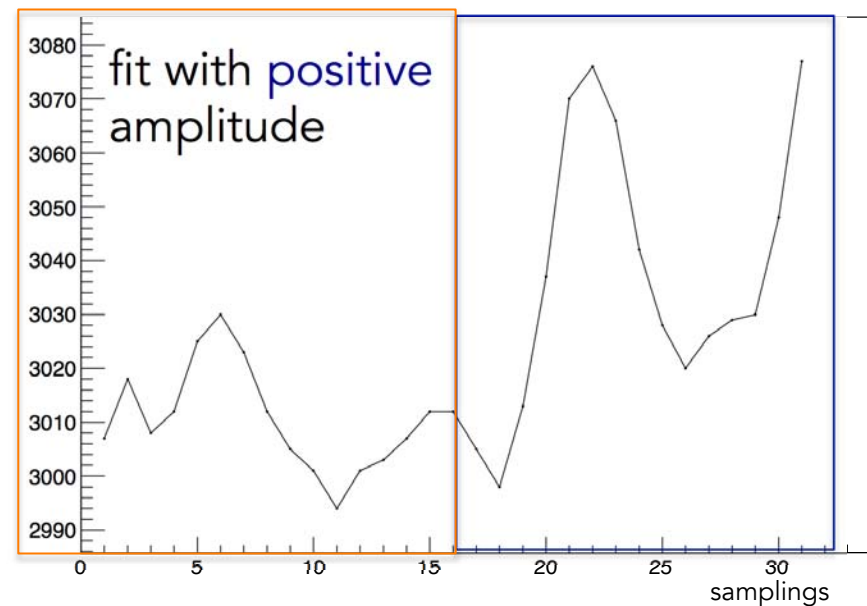# Steps towards pre-release validation (II)

- Study of the origin of negative amplitudes → actually due to purely bkg events
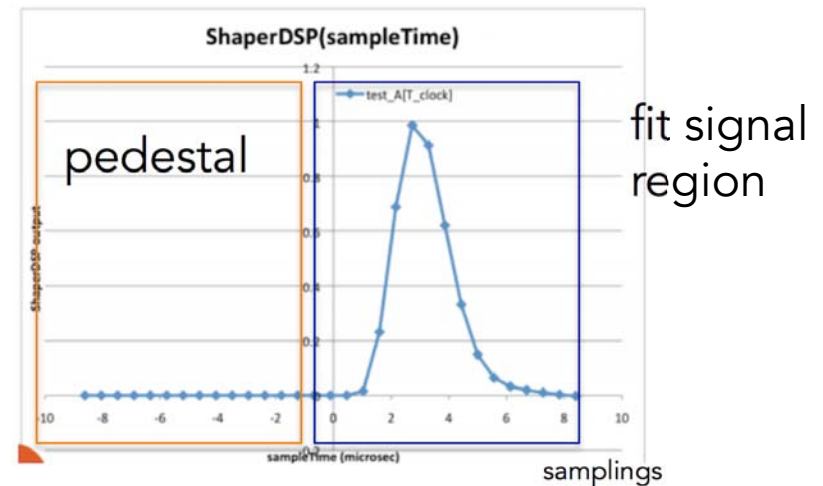
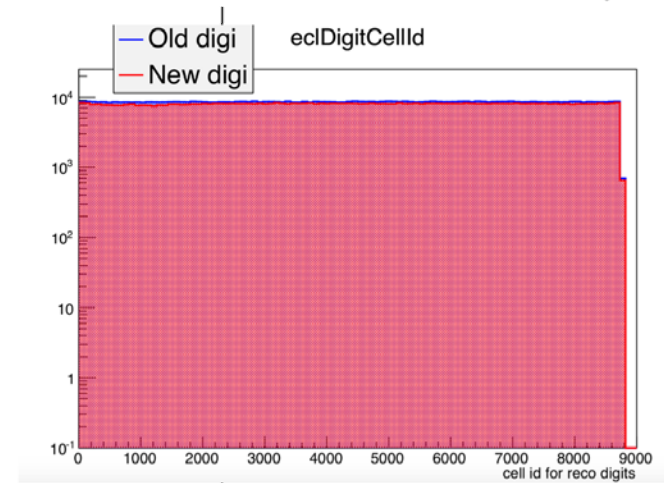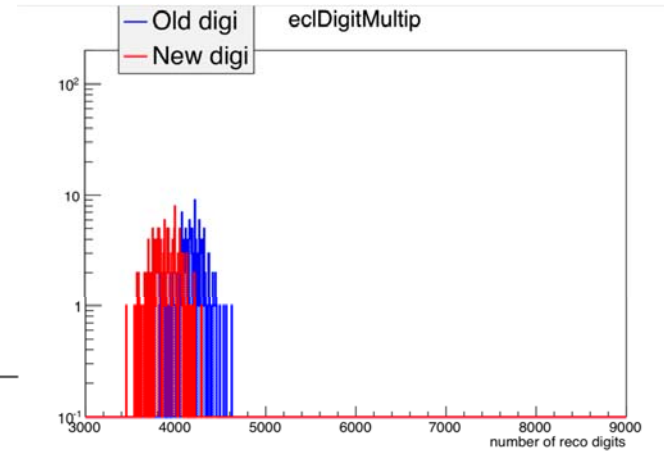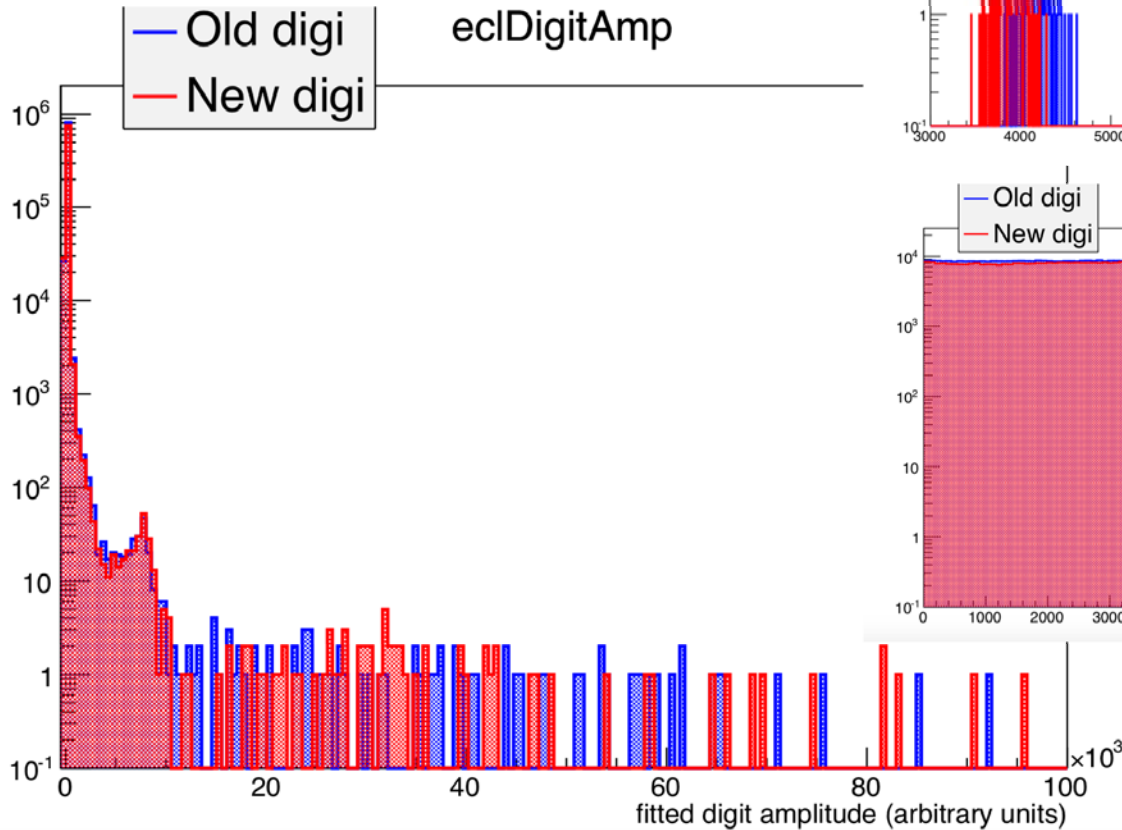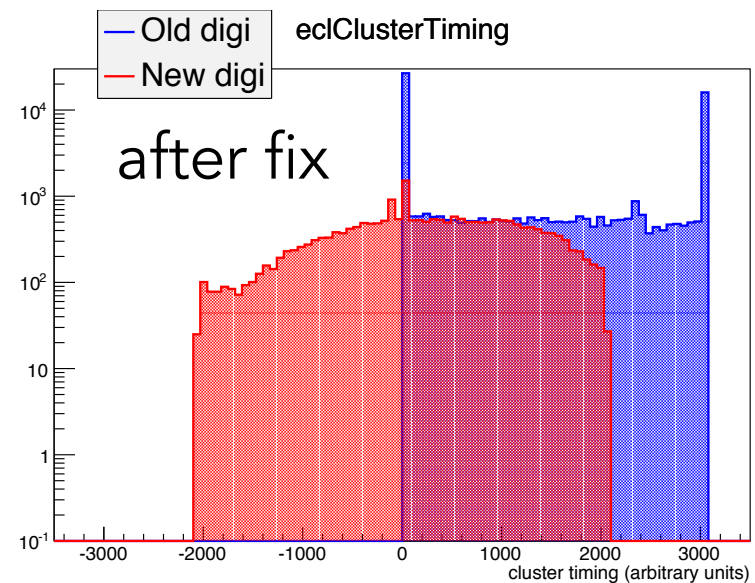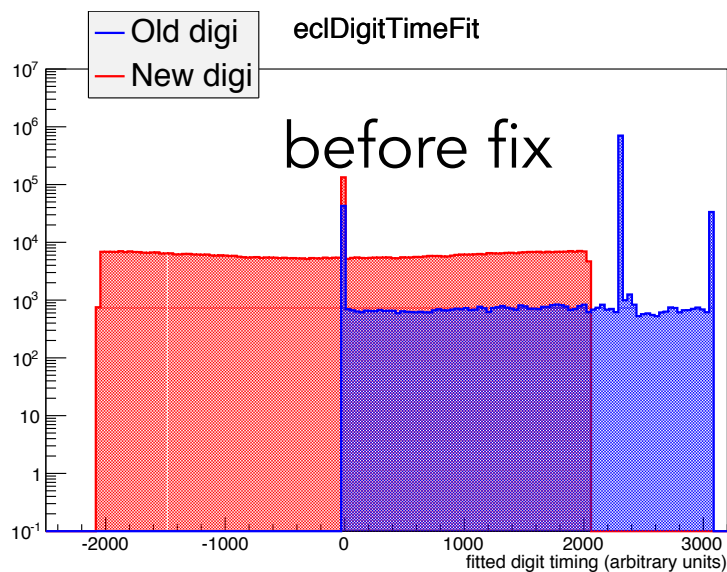# Steps towards pre-release validation (III)

- After fix on ECLDigitAmp>0

Steps towards pre-release validation (III)

- Time distribution not as expected by Guglielmo and Alex even with cut on negative amplitude → covariance matrix configuration file not properly loaded
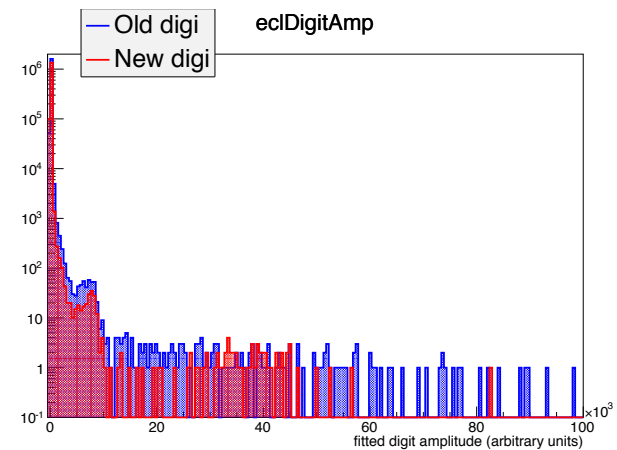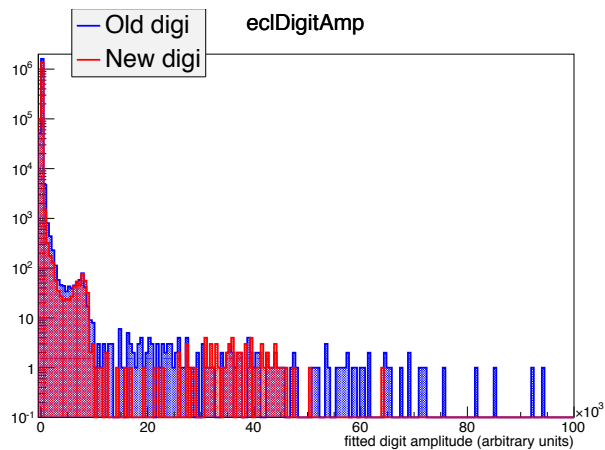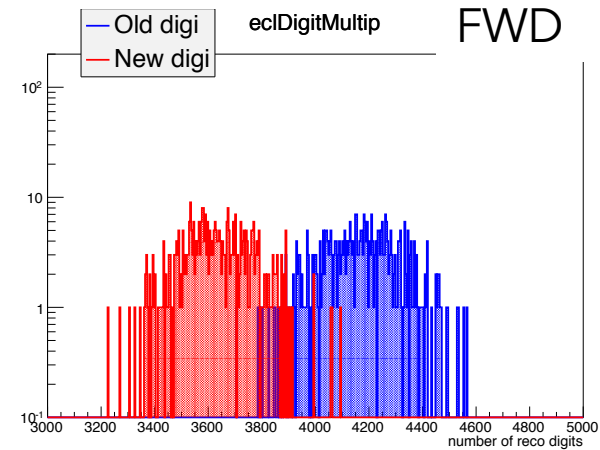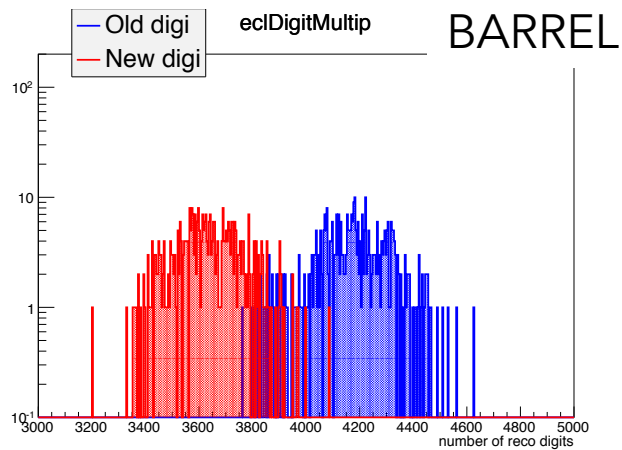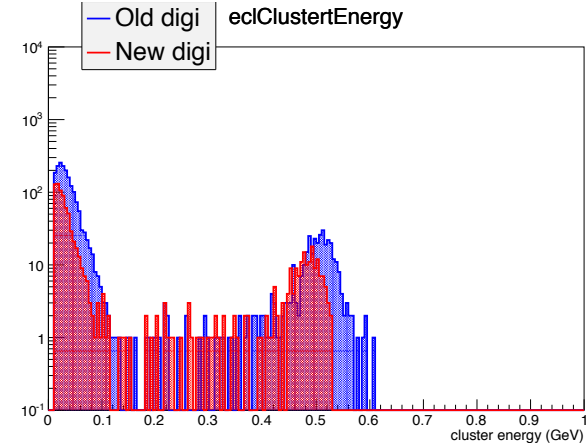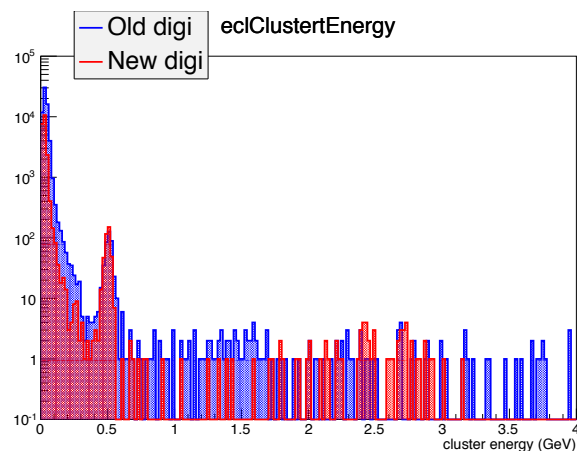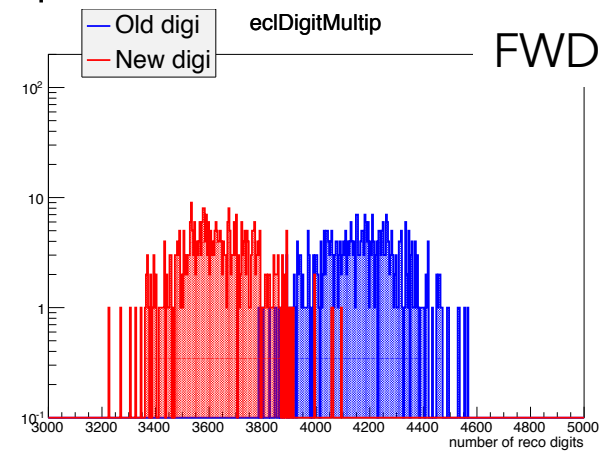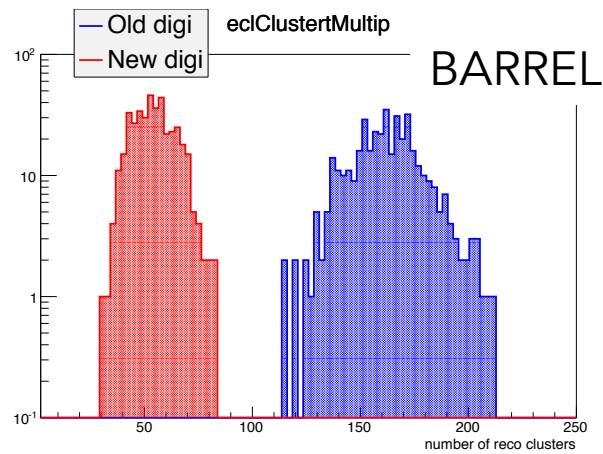
PRE-RELEASE VALIDATION

Digit multipligity $ amplitude

- 500 MeV photons with bkg
- Resolution seems improved already at Digit level
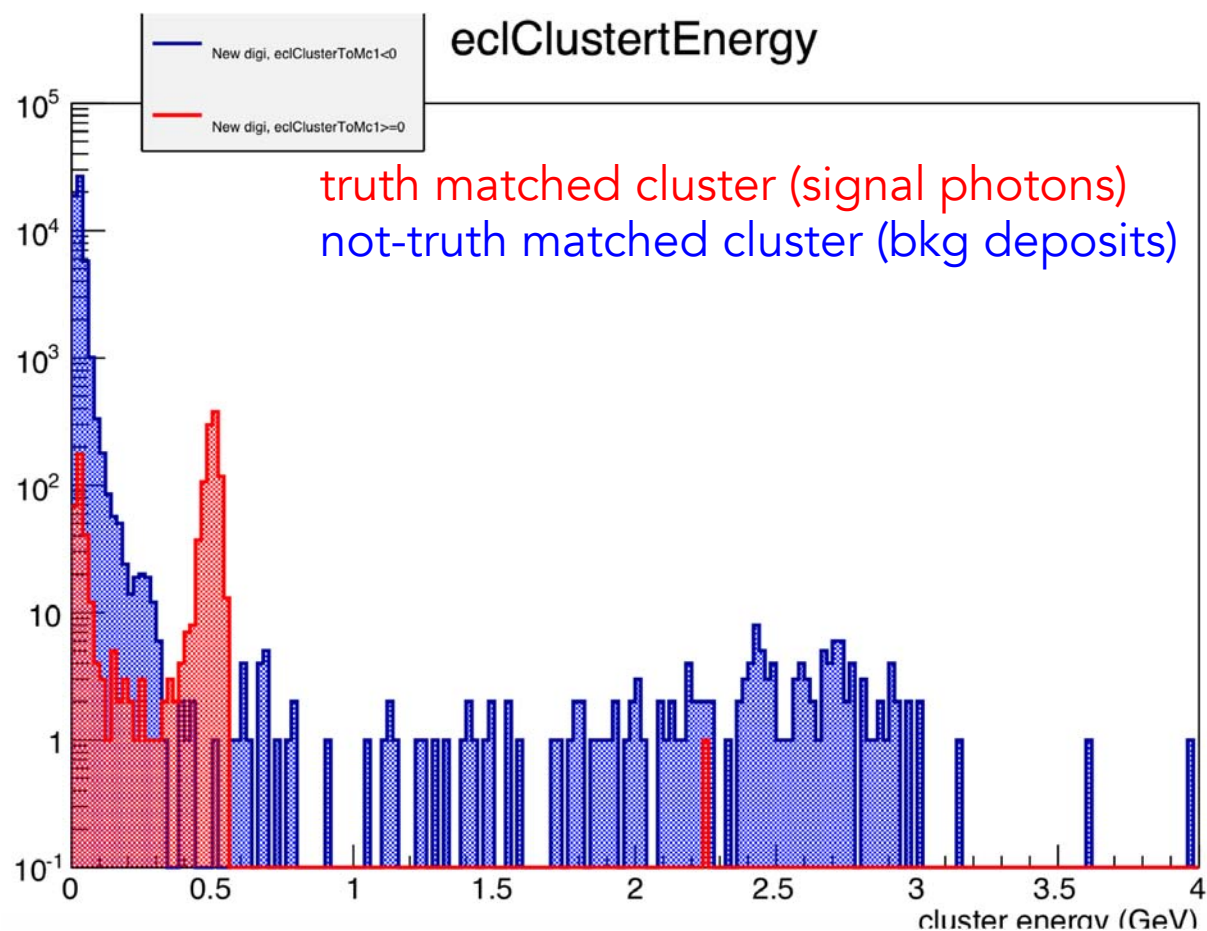
Cluster multiplicity and energy

- 500 MeV photons with bkg
- Sizable reduction of Cluster Multiplicity
- Resolution on Cluster Energy clearly improved

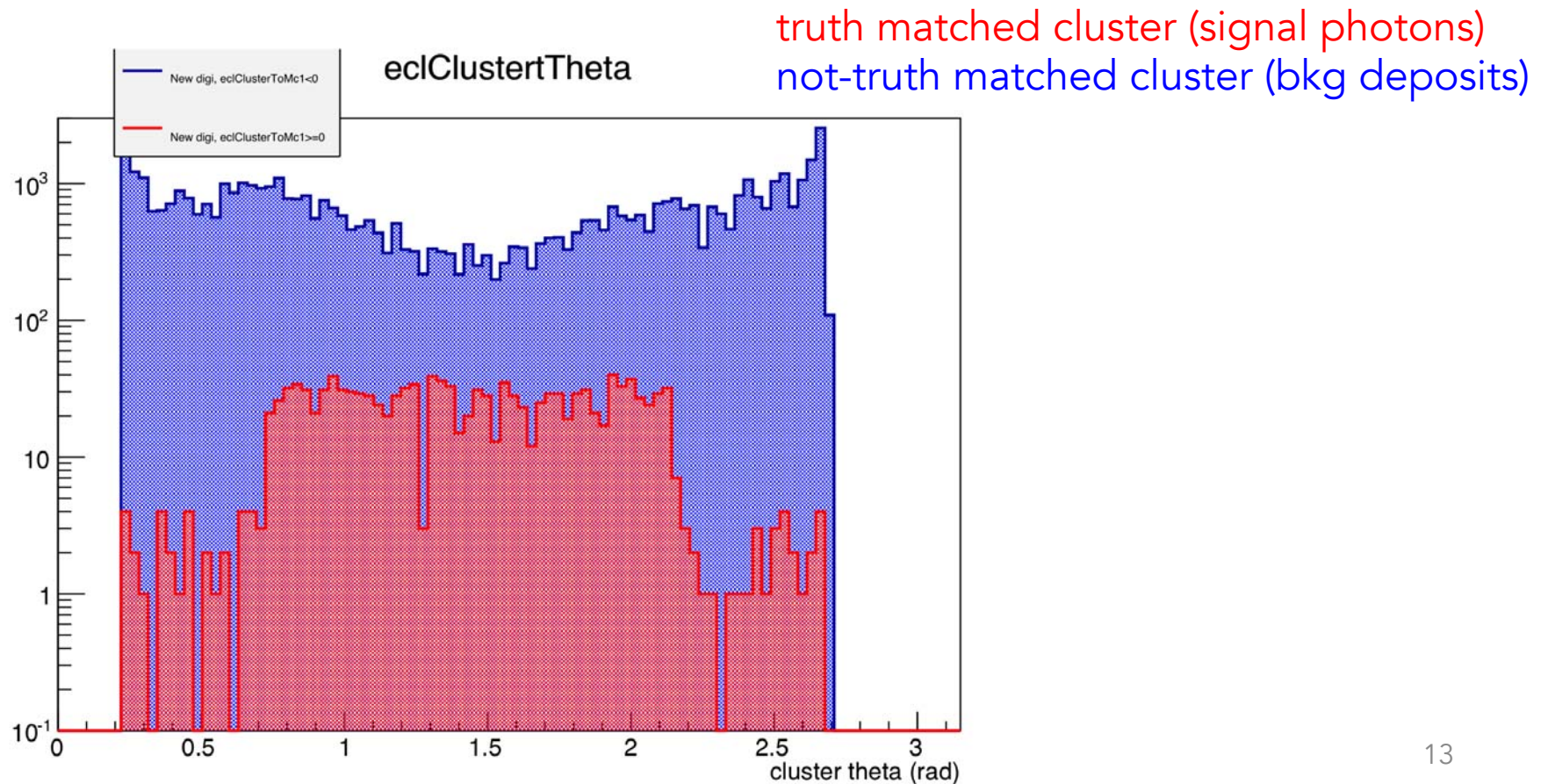# MCTRUTH STUDIES (PRE-RELEASE CODE, NEW DIGITIZER)

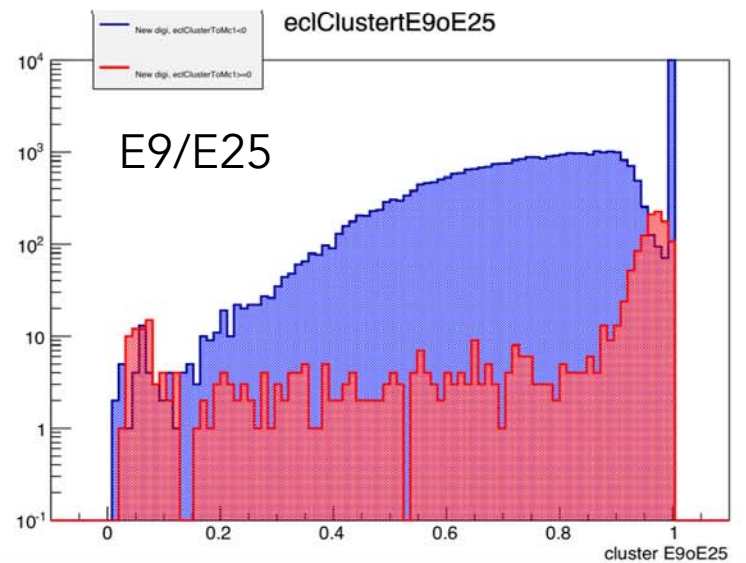# Cluster energy

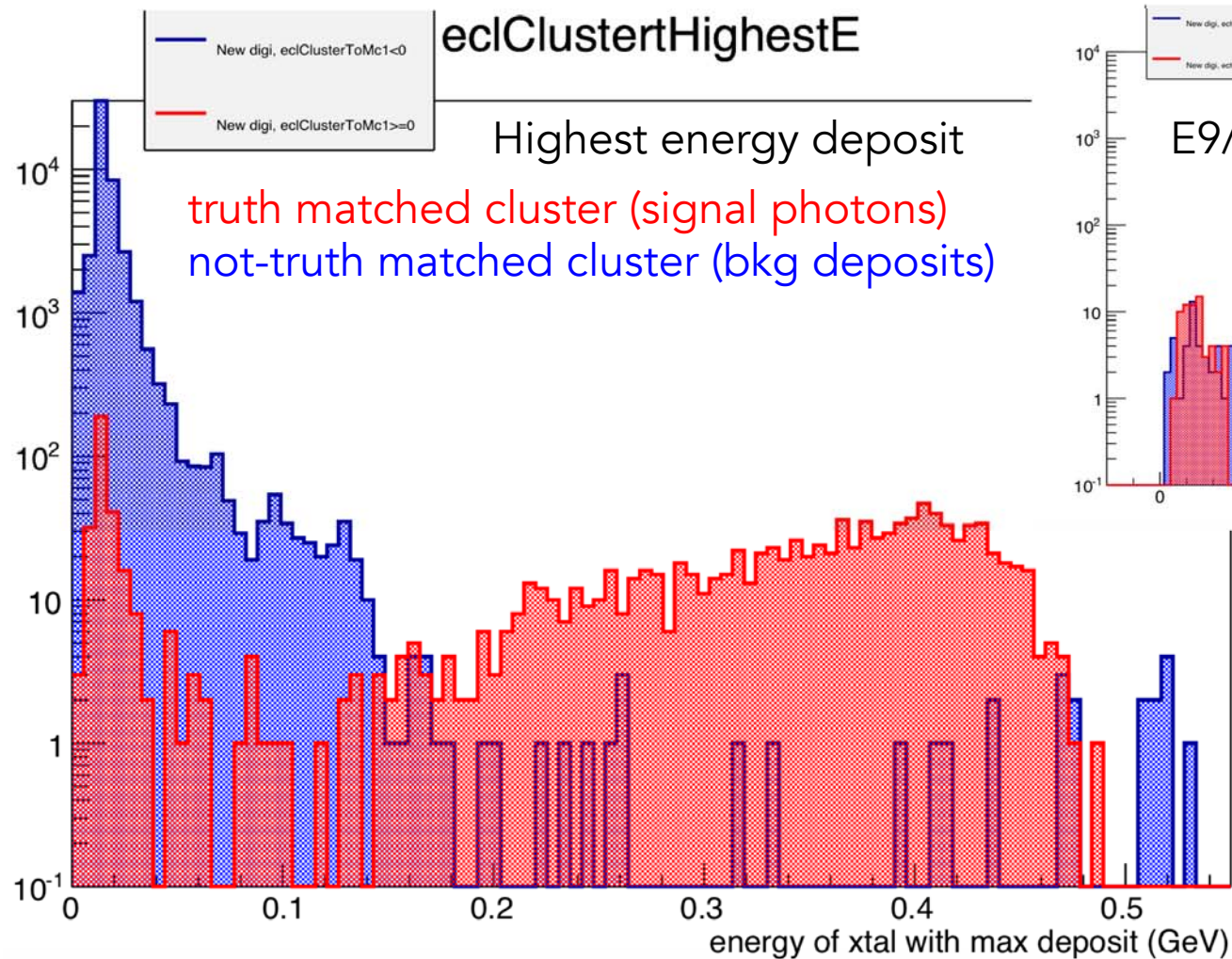- 500 MeV photons with bkg

Cluster theta

- 500 MeV photons with bkg
- Background contribution dominates endcap occupancy

truth matched cluster (signal photons)
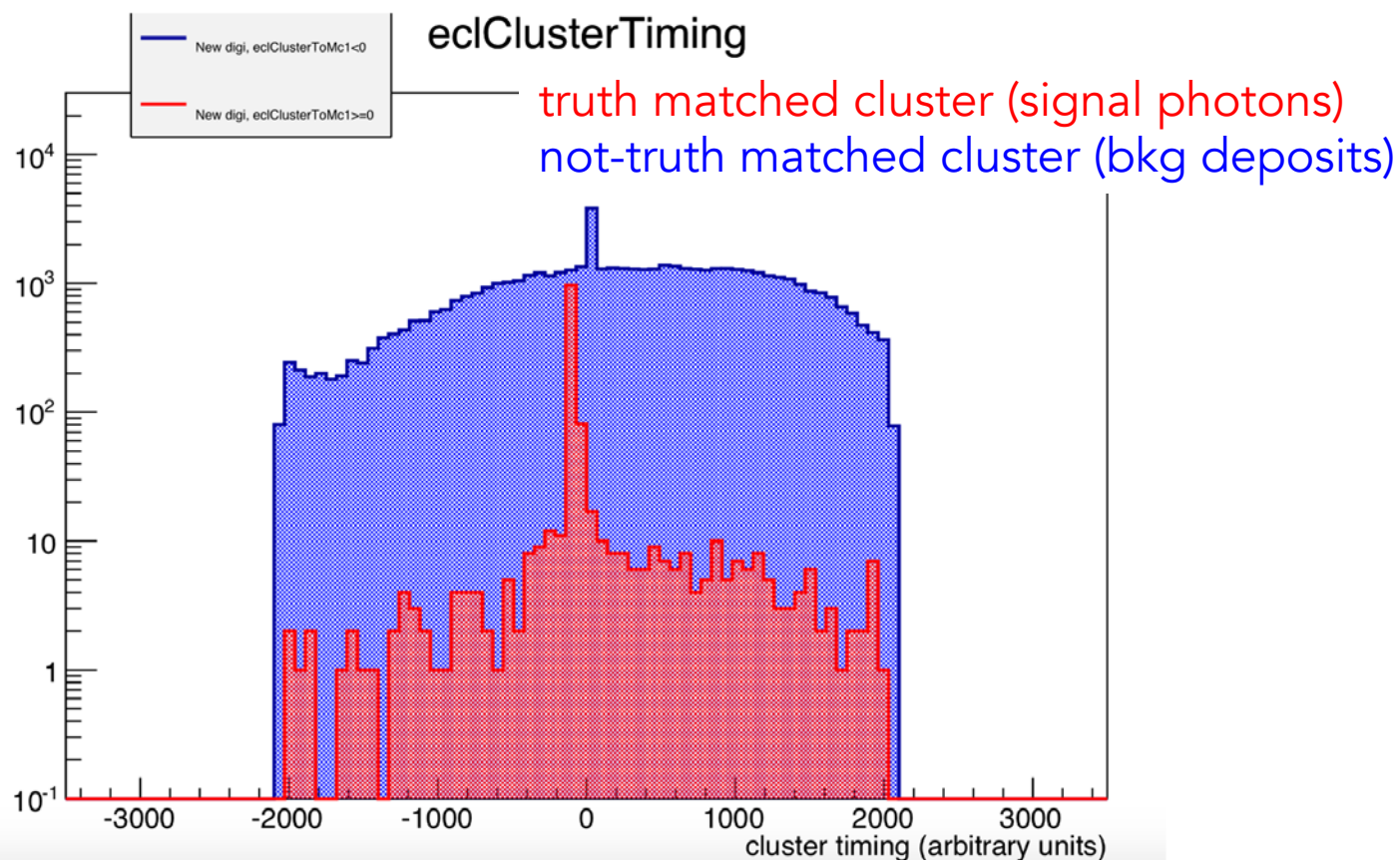not-truth matched cluster (bkg deposits)

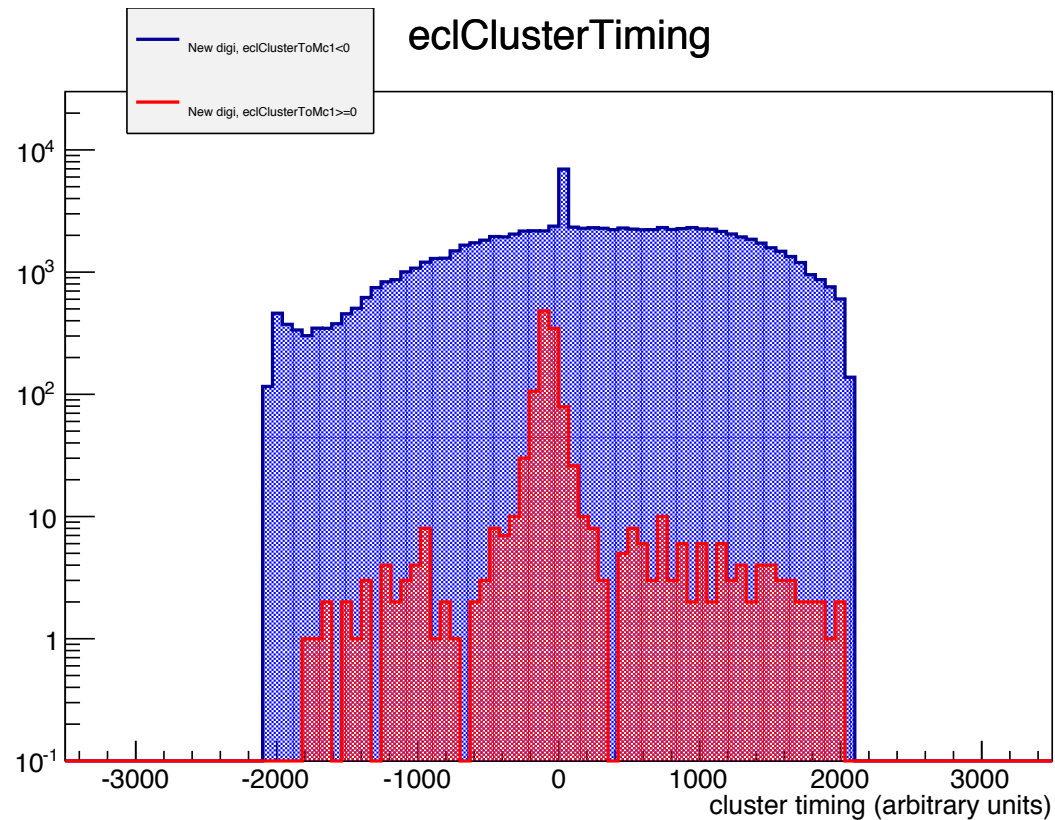# Cluster shape variables

- 500 MeV photons with bkg

Cluster timing

- 500 MeV photons with bkg
- Different timing for signal and background (to be investigated by A. Bobrov)
  - Signal peaked around -80 a.u.
  - Background peak at zero due to waveform fits with no TimeFit output

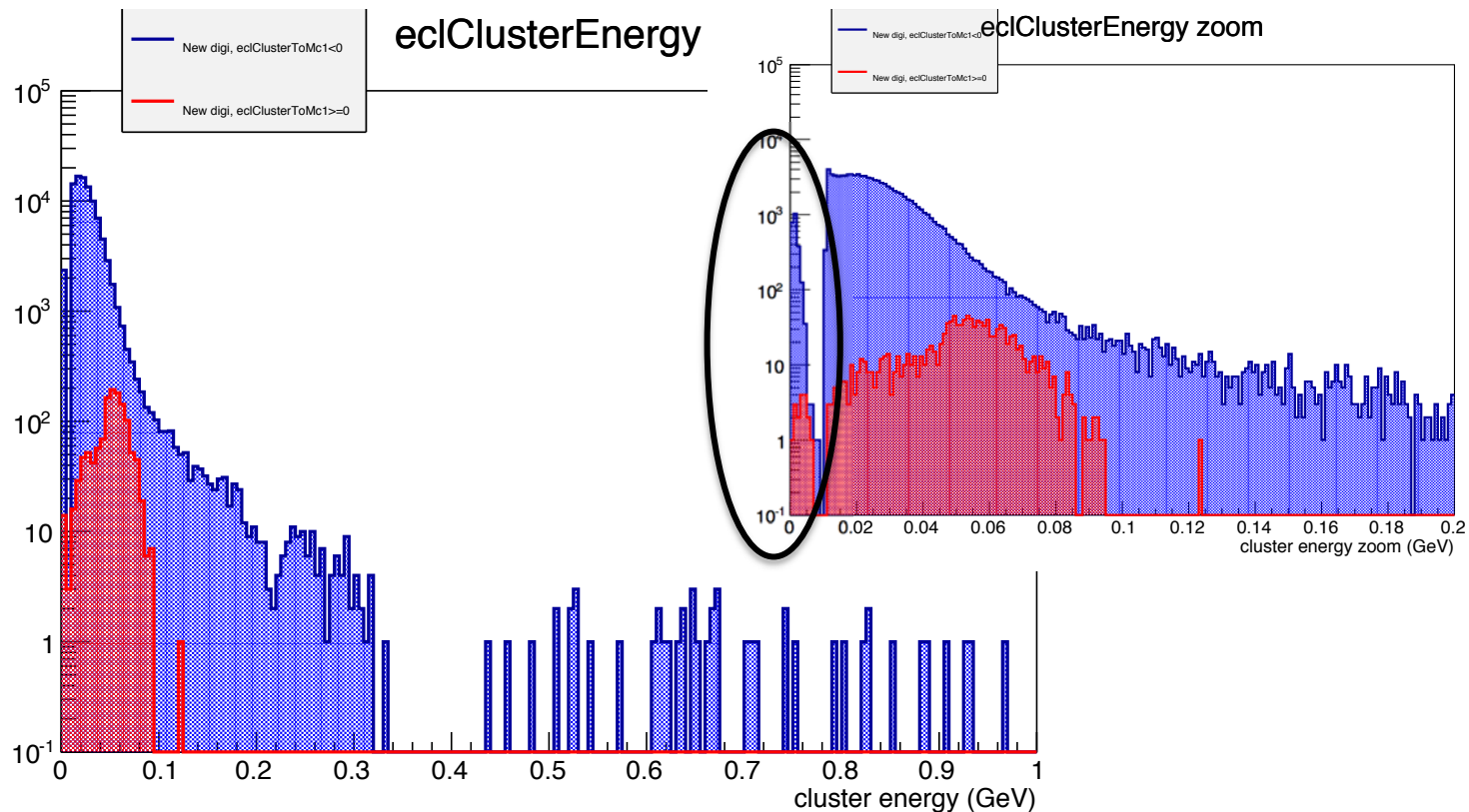# X-check with 50 MeV single photons + bkg (I)

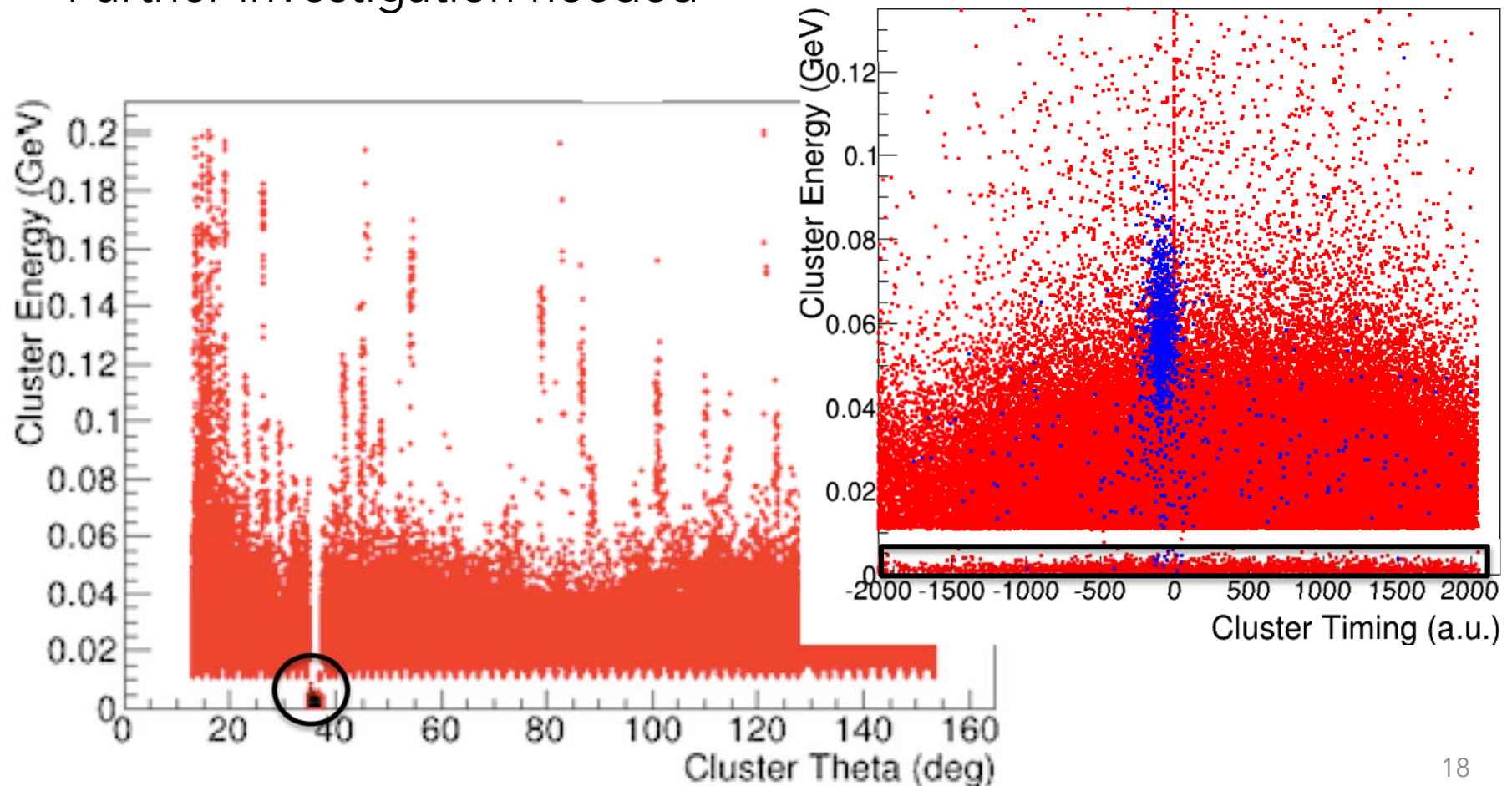- No peak at "0" for signal events even with very low energy photons

X-check with 50 MeV single photons + bkg (II)

- Unexpected deposits with energy below 10 MeV threshold applied at clustering level

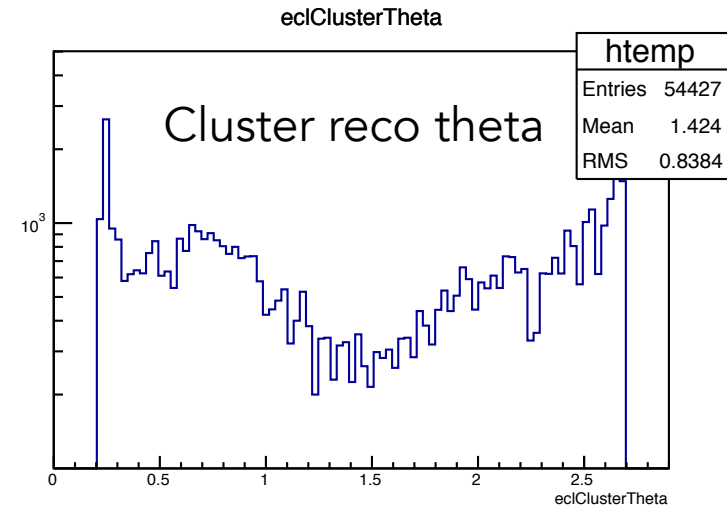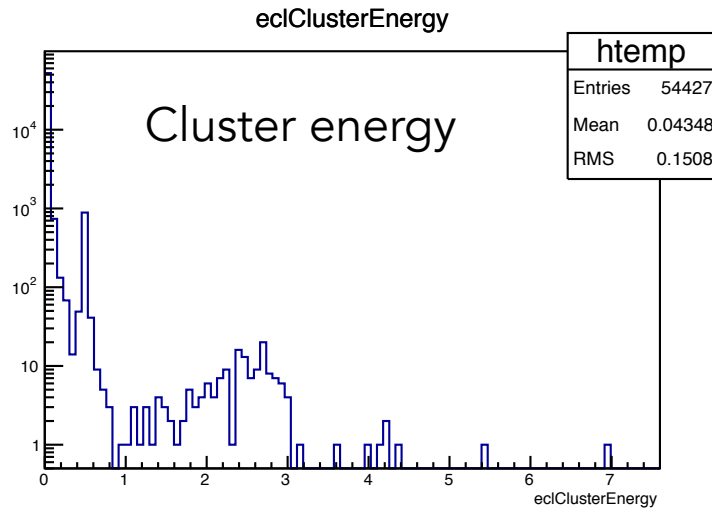# X-check with 50 MeV single photons + bkg (III)

- Unexpected deposits are located in θ [35°,37°] corresponding to gap between barrel & endcap
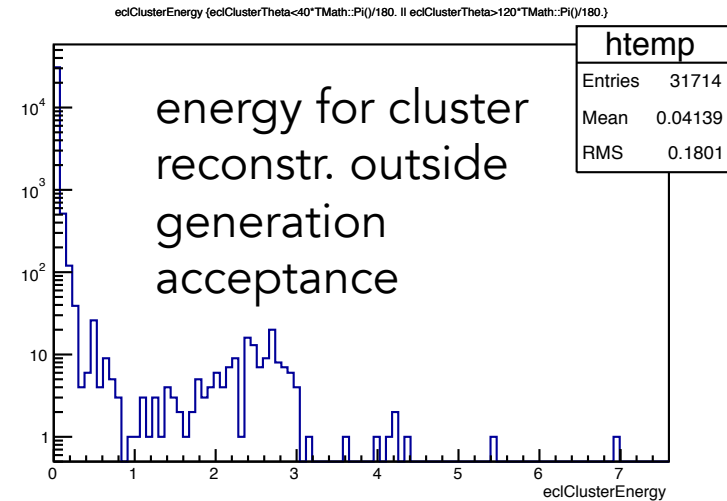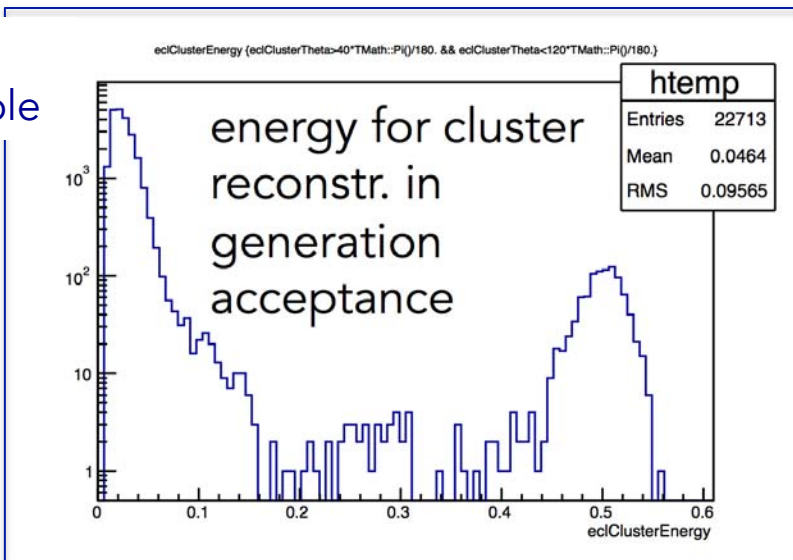- Further investigation needed

RESOLUTION STUDIES (PRE-RELEASE CODE, NEW DIGITIZER)

An example: barrel w machine bkg

- 500 MeV photons with bkg

Crystal-ball fits

Resolution sumamry

Energy resolution

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

Legend:
- —— TDR resolution function
- △ fwd, no machine bkg
- ▲ fwd, w machine bkg
- □ barrel, no machine bkg
- ■ barrel, w machine bkg
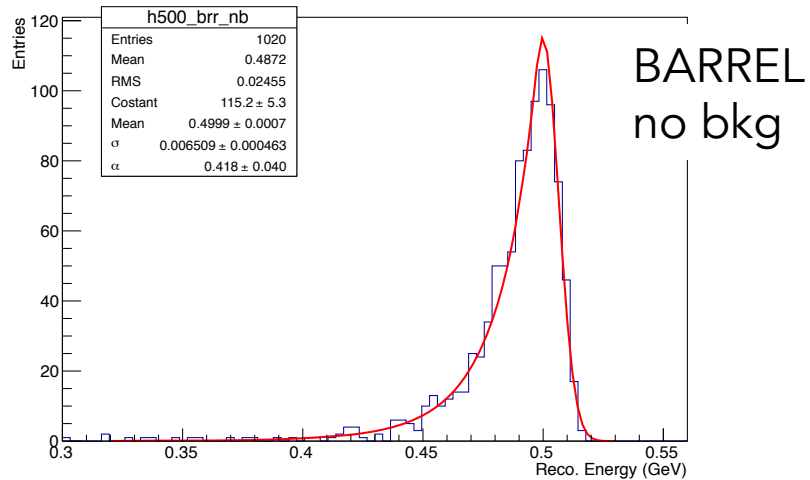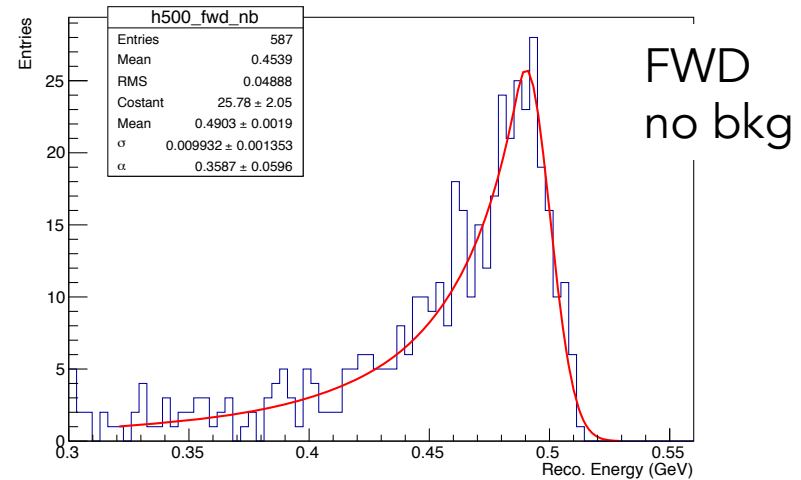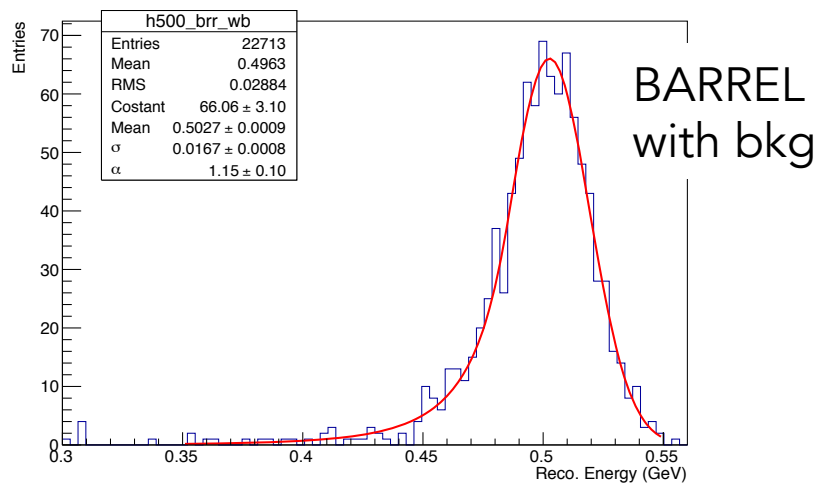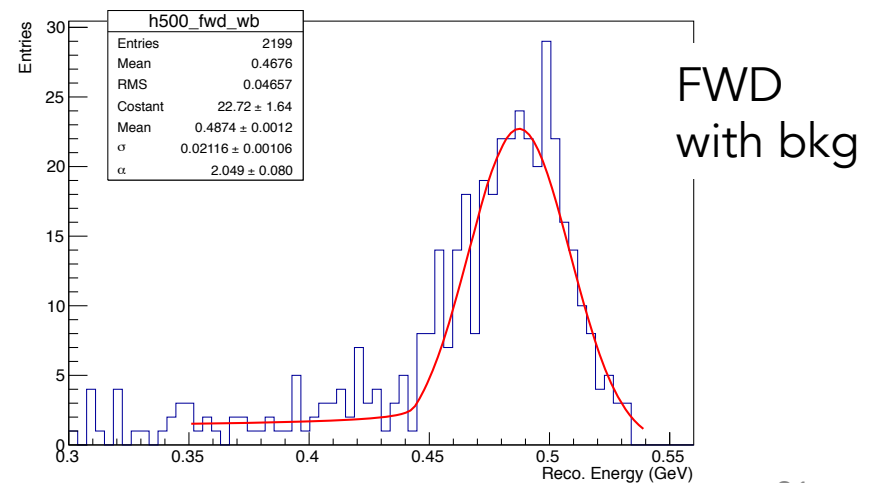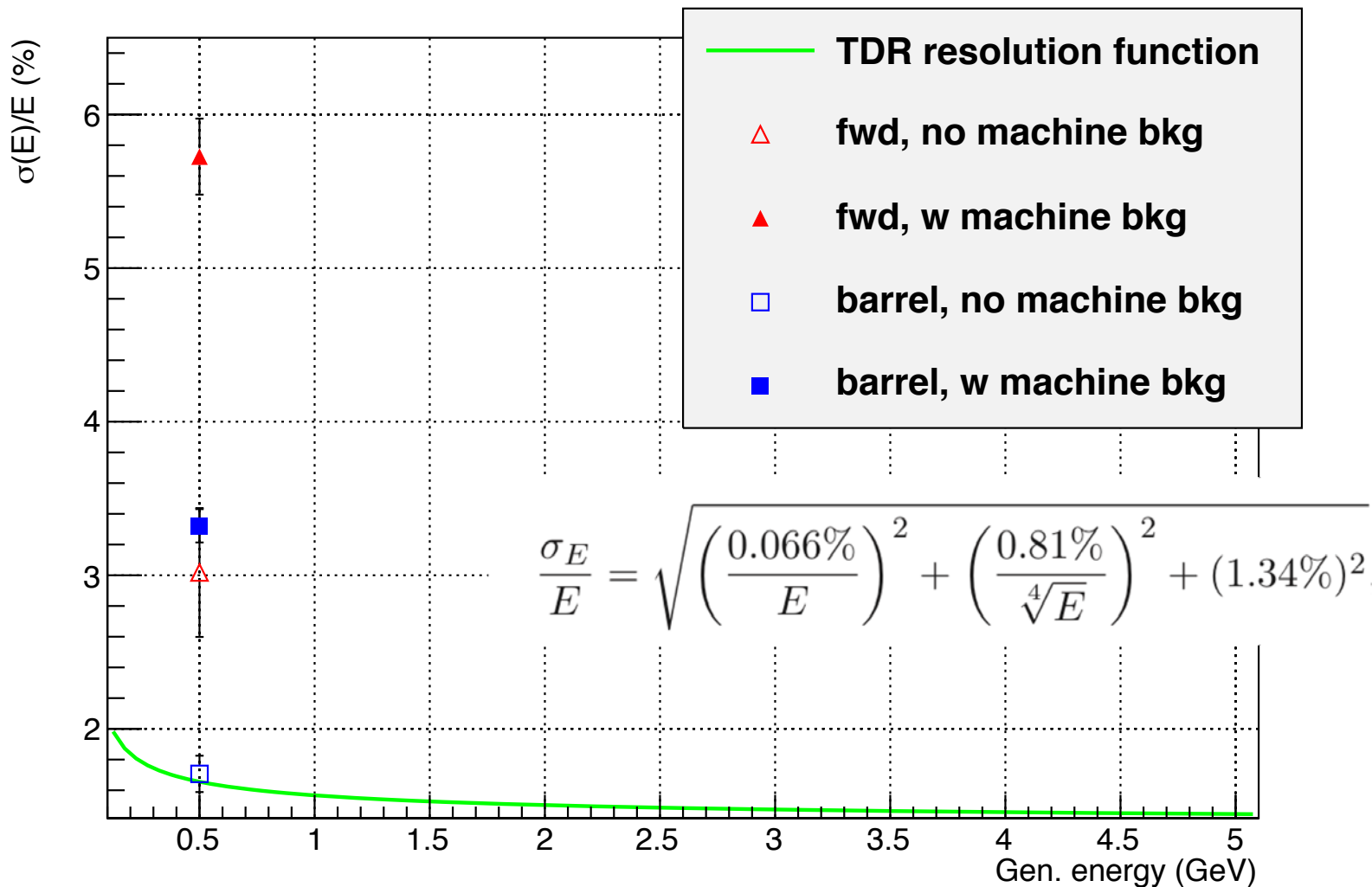
Conclusions

- Validated New ECL Digitizer for pre-release build ✔
  - old digitizer vs new digitizer @ digi level, for barrel e fwd regions, with and without bkg
  - old digitizer vs new digitizer @ cluster level, for barrel e fwd regions, with and without bkg

- MC-truth studies to distinguish background and physics contributions performed ✔

- Timing of signal and background to be investigated (A. Bobrov). What should we do with events with eclClusterTiming = 0? (Events related to waveform fitting not providing a TimeFit)

- Signal/Background study with a sample of low-energy 0.05 GeV single-photon events started ✔

- To further reduce background contribution: Timing information to be exploited at the Clustering algorithm level together with a threshold on the eclDigitAmp

→ New ECL Digitizer inserted in the May Integration build

- First resolution studies performed
  - some issue on reconstruction on fwd ecl to be investigated
  - systematic study @ several energies to be performed