Fast Simulation - EMC

Chih-hsiang Cheng
Caltech
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What we have now

- In the first release, EMC only deals with EM showers and ionization.
  - EM shower: energy loss is distributed based on Moliere radius (2-dimension Gaussians) with smearing in each crystal.
  - Ionization: energy loss (from PacTrk) is distributed based on path length in each crystal (without smearing [should have]).
- Current energy resolution is too good compared to Babar. Shower shape is not tuned yet either.

To-do list

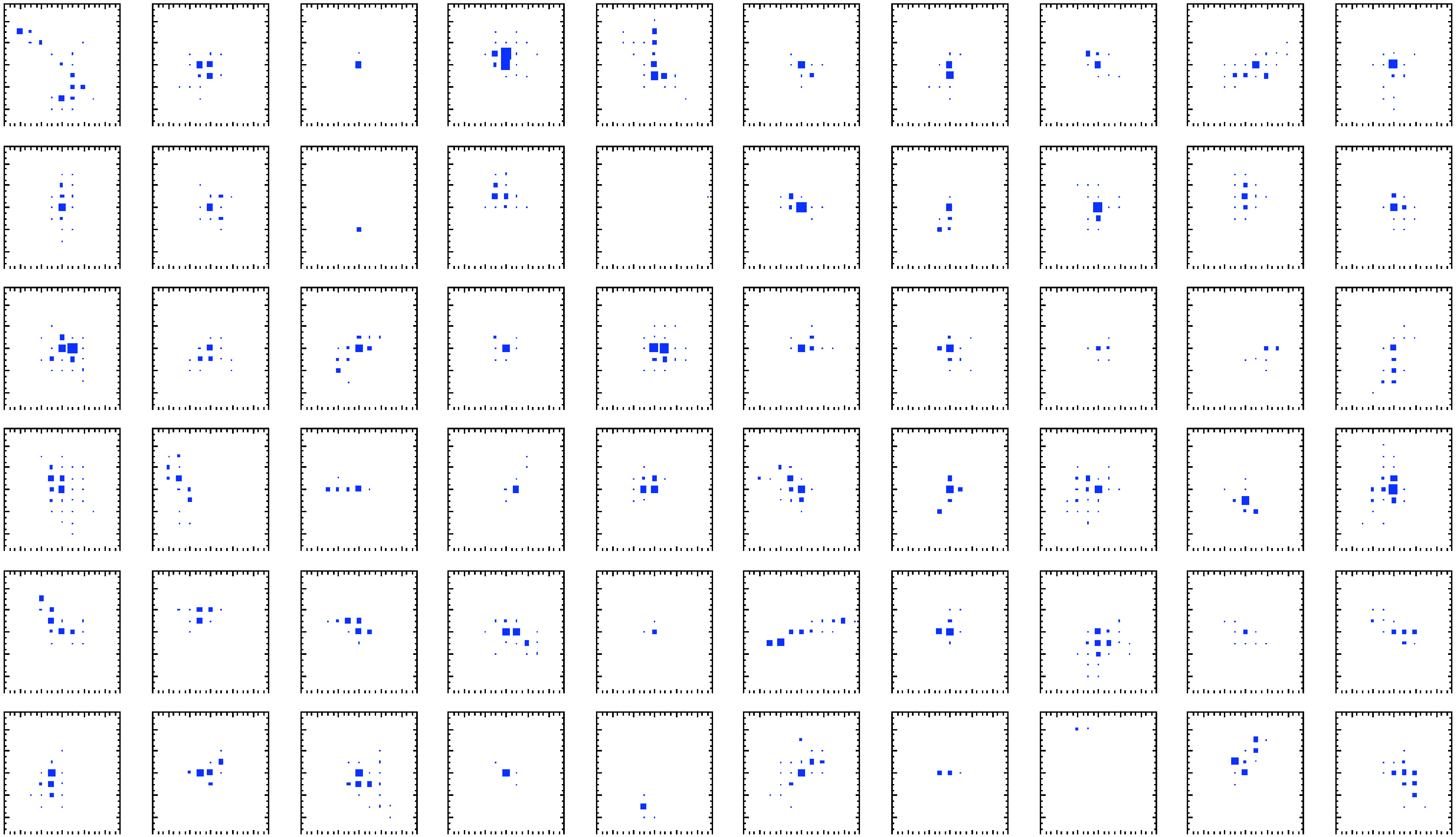
- Hadron showers
- Track-cluster matching
- Transverse shower shape tuning
- Energy resolution tuning
- New materials (not available in Babar simulation)
- Cluster merging/splitting
- Variable barrel thickness
- Forward/Backward endcap
- Validation plots macro

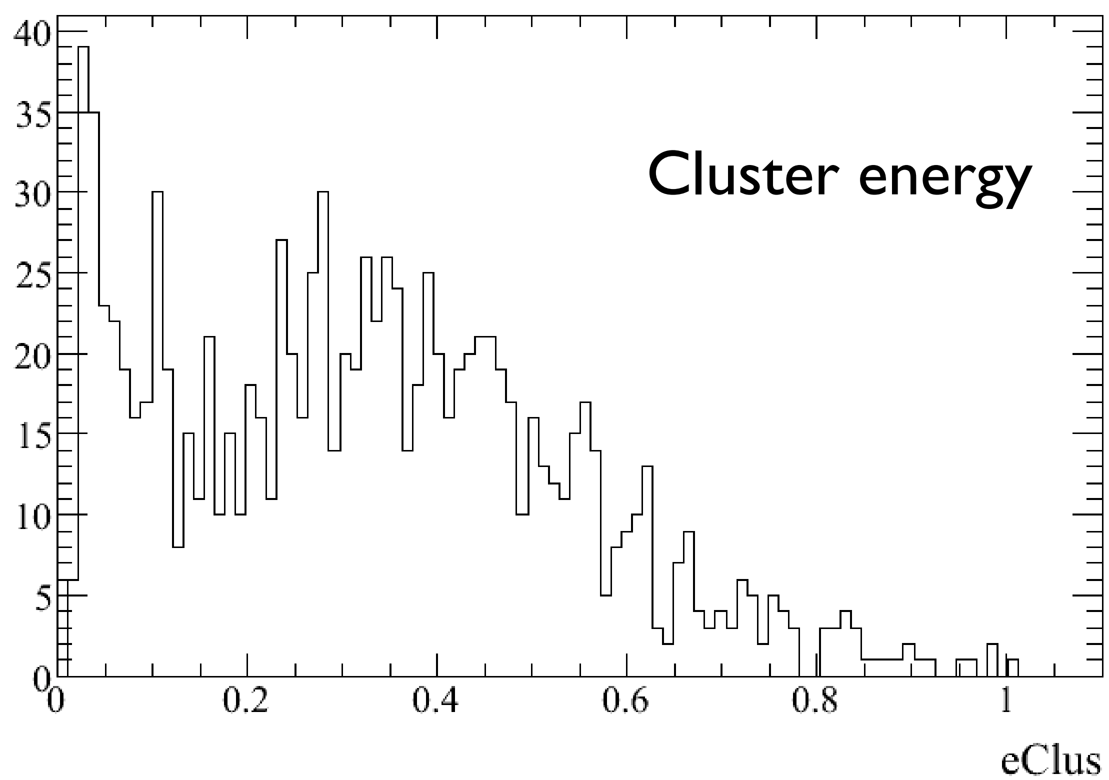
Hadronic shower modeling problem

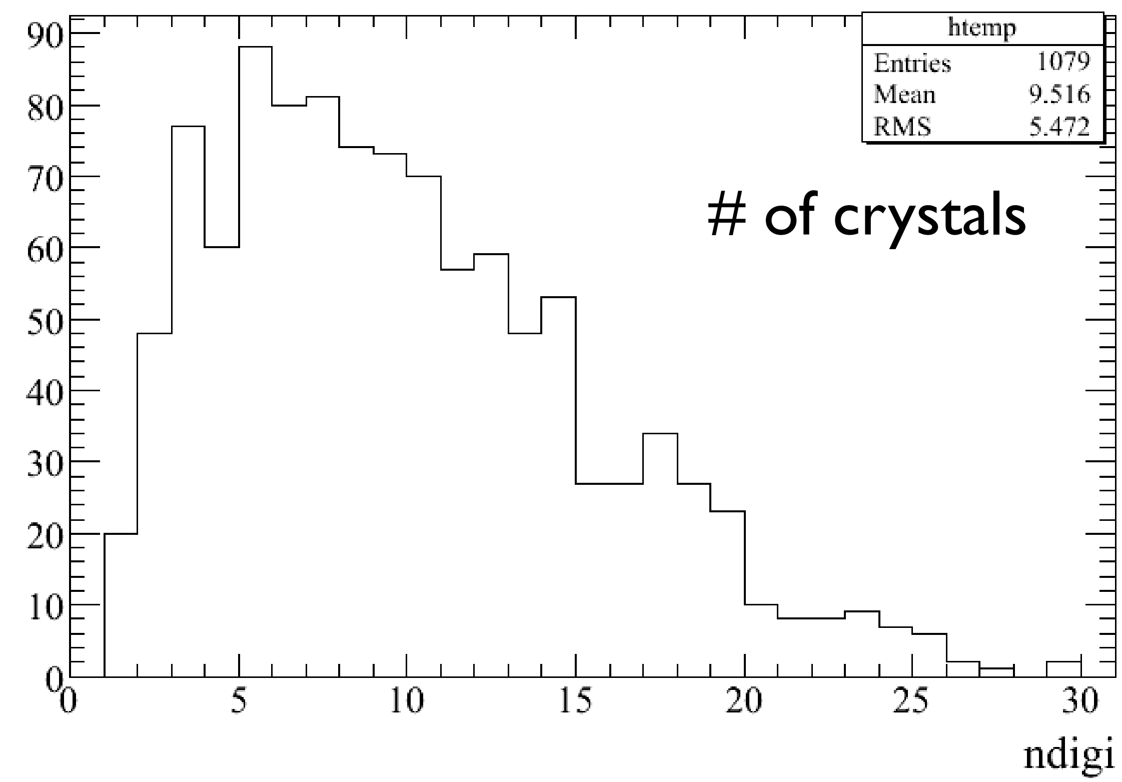
- Hadronic showers are irregular and difficult to model with simple parametrization.
- Shower library is not easy to implement either. A complete implementation requires large space, non-trivial look-up scheme, and running full simulation each time geometry or material is changed.
- New idea (originated from Dave Brown's) is to randomize distributions large enough to produce irregularity from a smooth function.

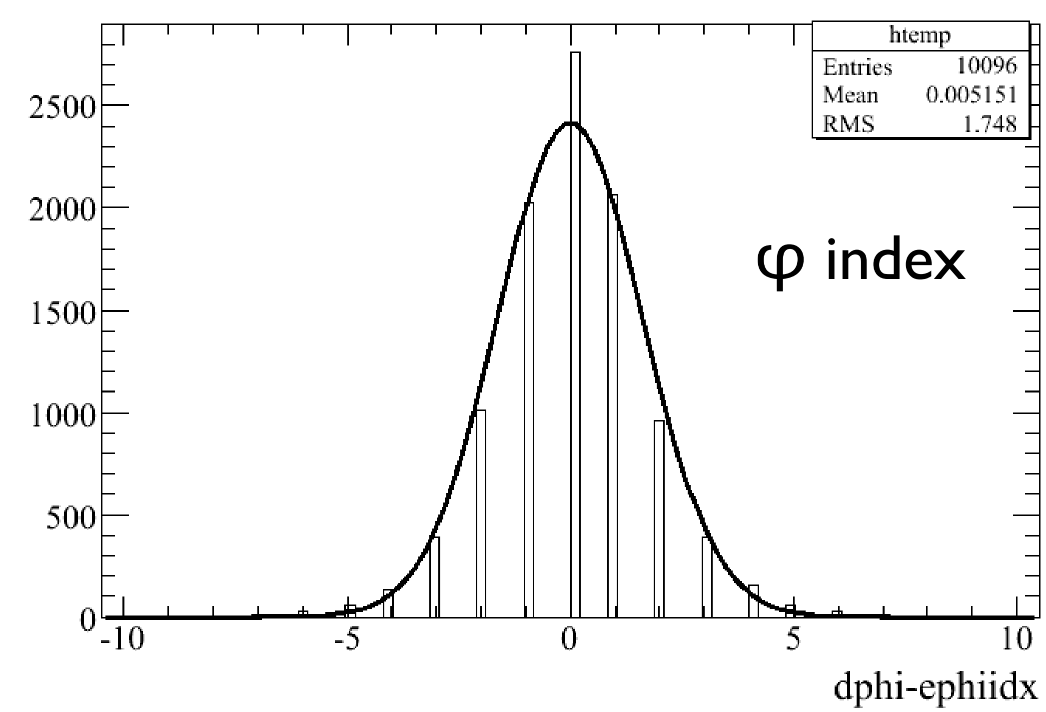
What hadronic showers look like

- Samples of 1GeV/c KL shower shapes from Babar full simulation (only about 1/2 of all KL leave a cluster in Babar EMC)









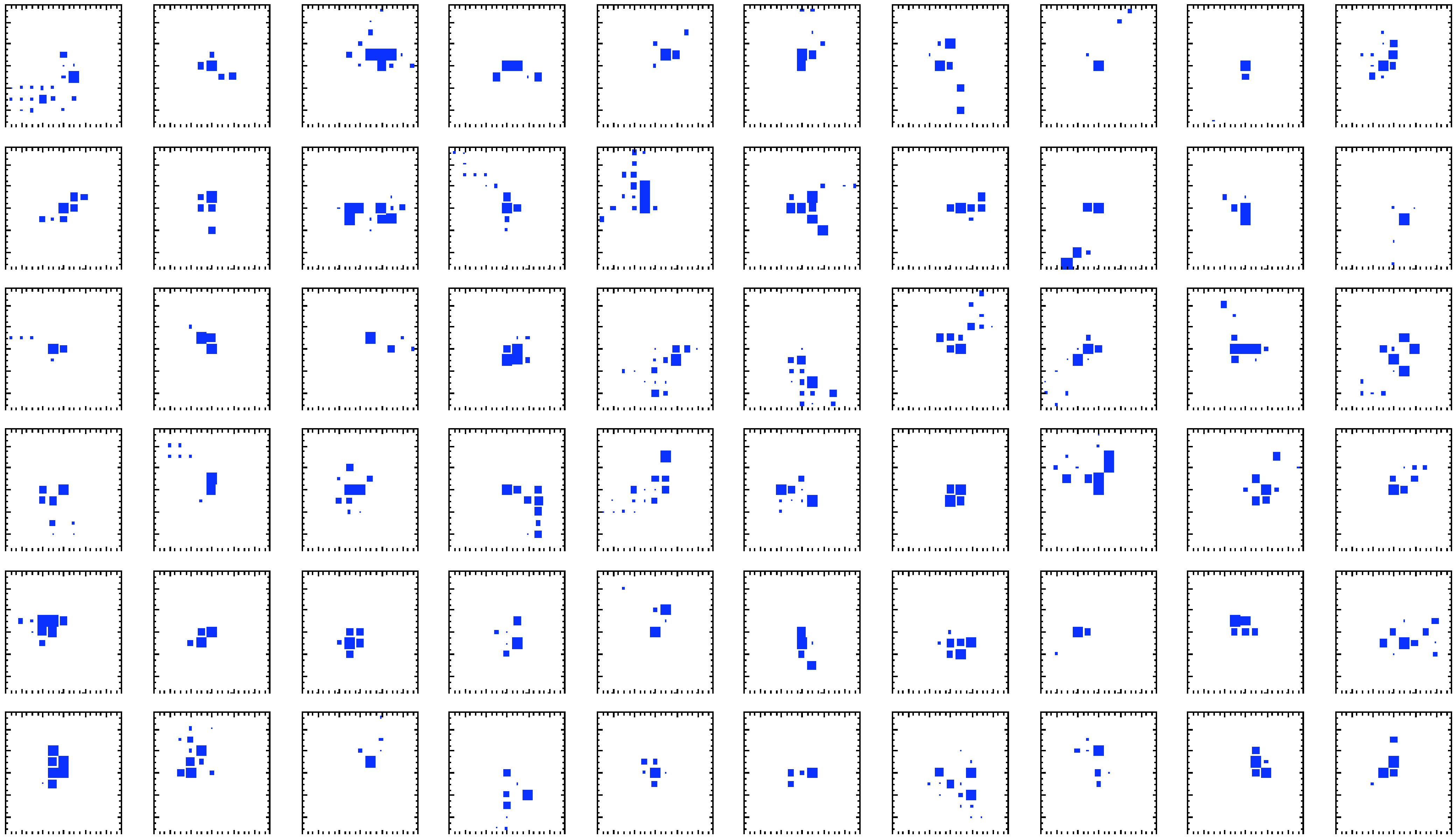
- Energy distributed in a wide range.
- Average shower shape is a Gaussian.

Hadronic shower modeling procedure

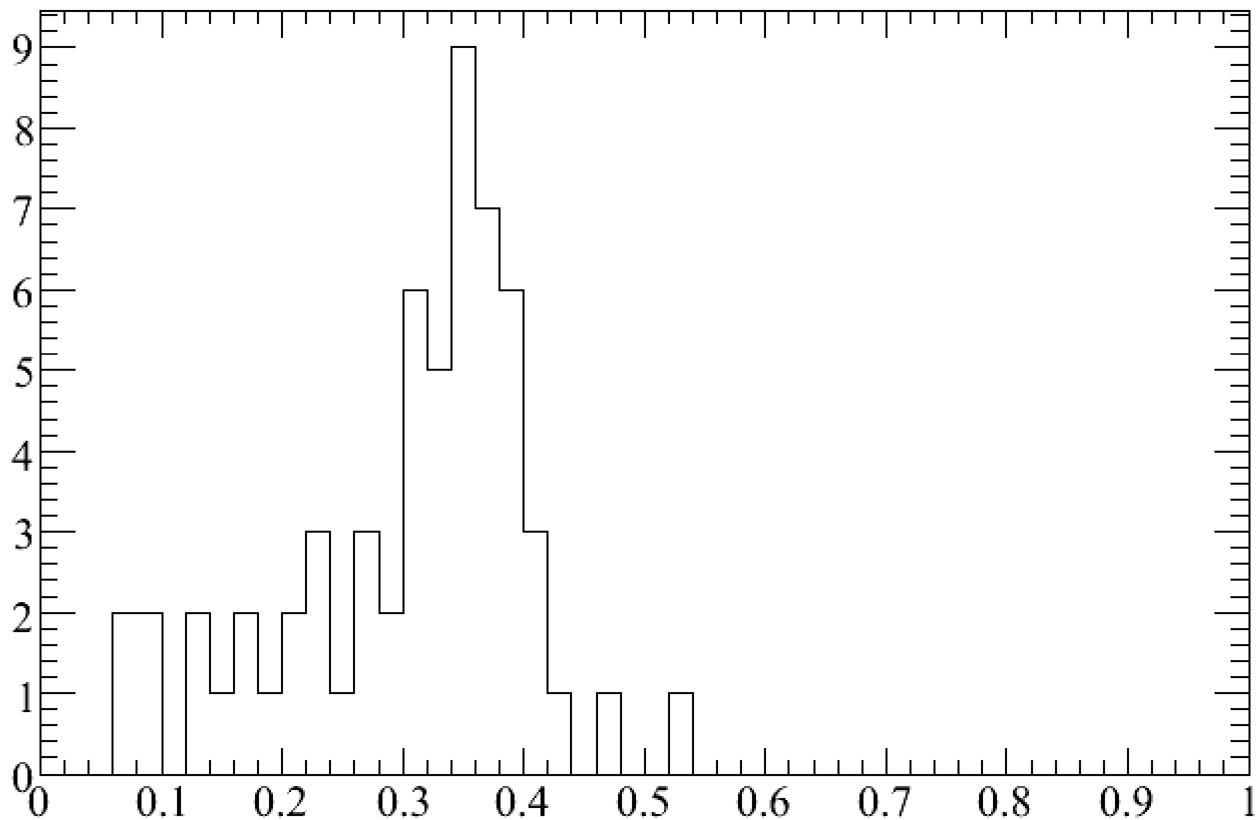
1. Determine the total deposited energy E.
2. Start from the crystal (i,j) where a hadron enters.
3. Determine the average energy Eij in that crystal (a fraction of E) based on an integral of a 2D Gaussian.
4. Fluctuate Eij using a Poisson with a large quanta.
   - Eij = TRandom::Poisson(Eij/quanta) * quanta
   - and then smear it : Eij = Eij + TRandom::Gaus(0,σE)
5. Fill that crystal with Eij, and reduce E by Eij.
6. Random walk to a nearby crystal (i', j'). If (i', j') has already been dealt with, walk again.
7. Repeat step 3 until E <= 0.

Test one

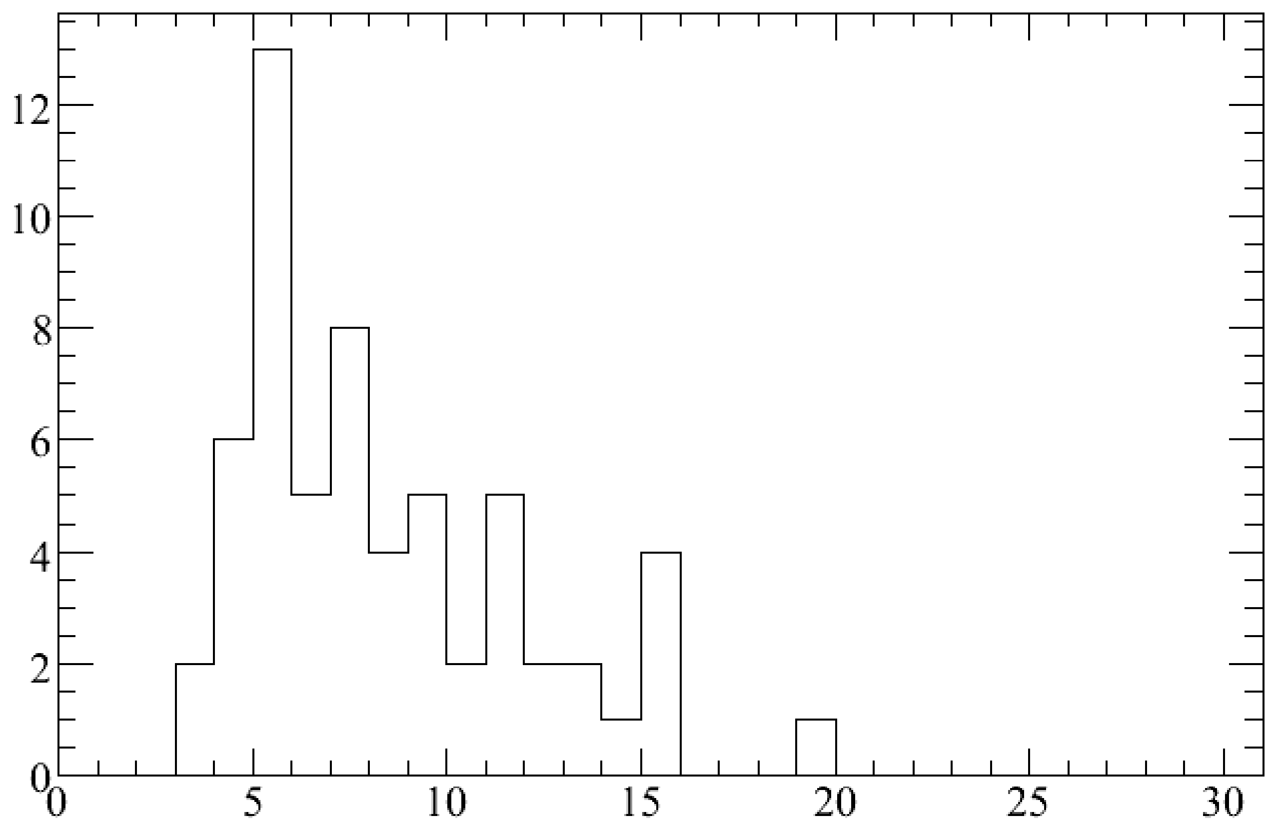
- E= 300, quanta=50, σE=10 (MeV); smooth Gaussian σ= 1.7 crystal size. (Test is done with a simple root macro.)



Test one (cont.)



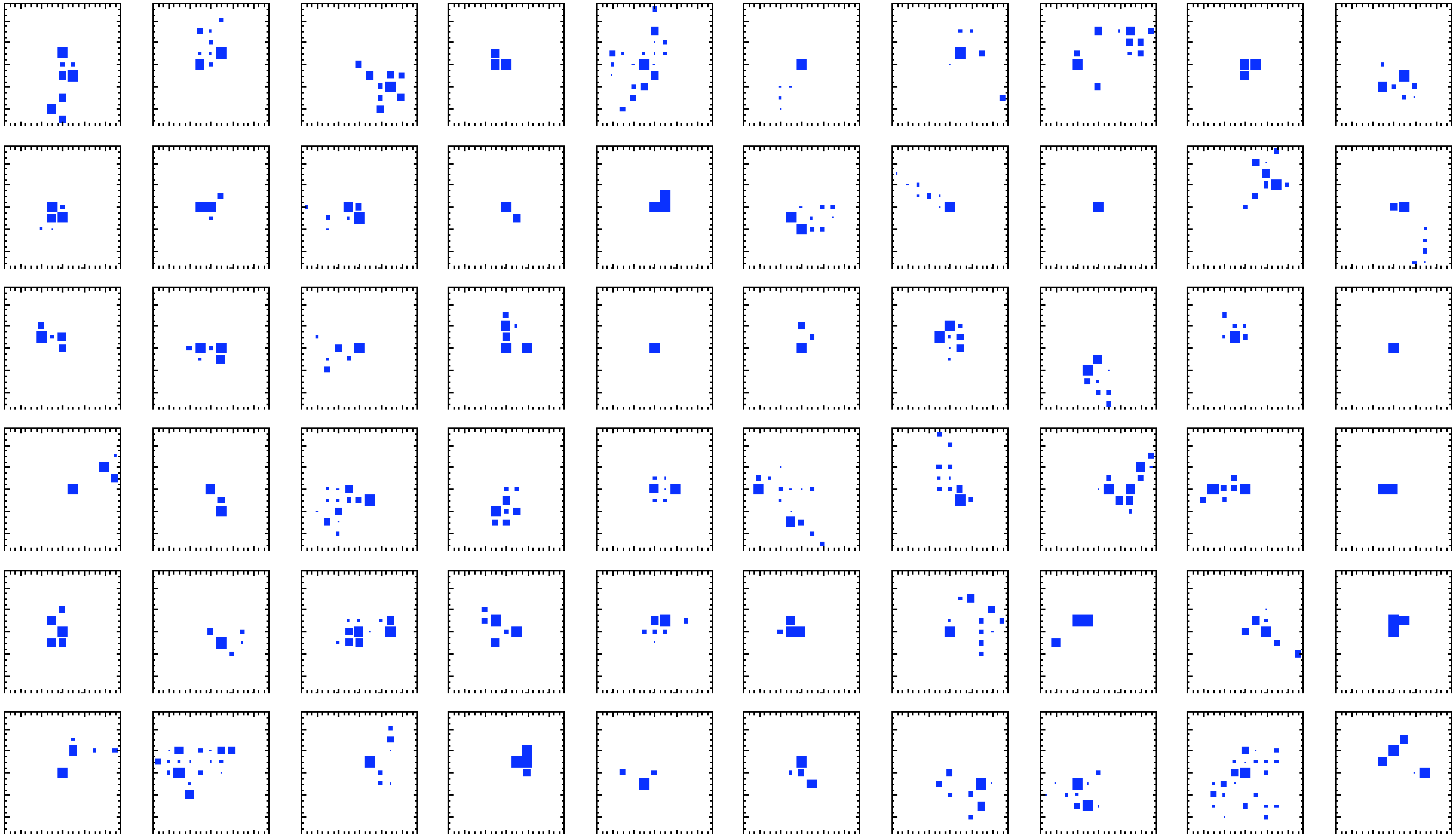
cluster energy



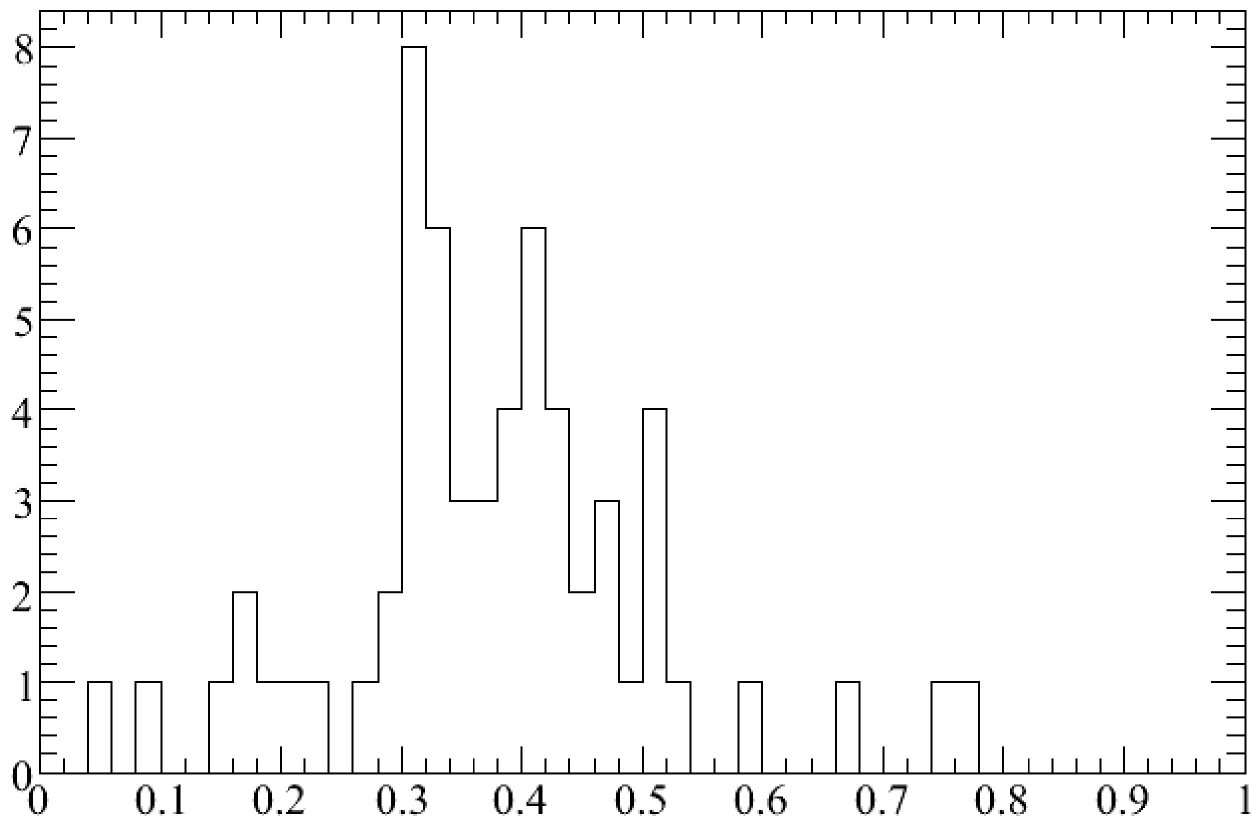
crystals

Test two

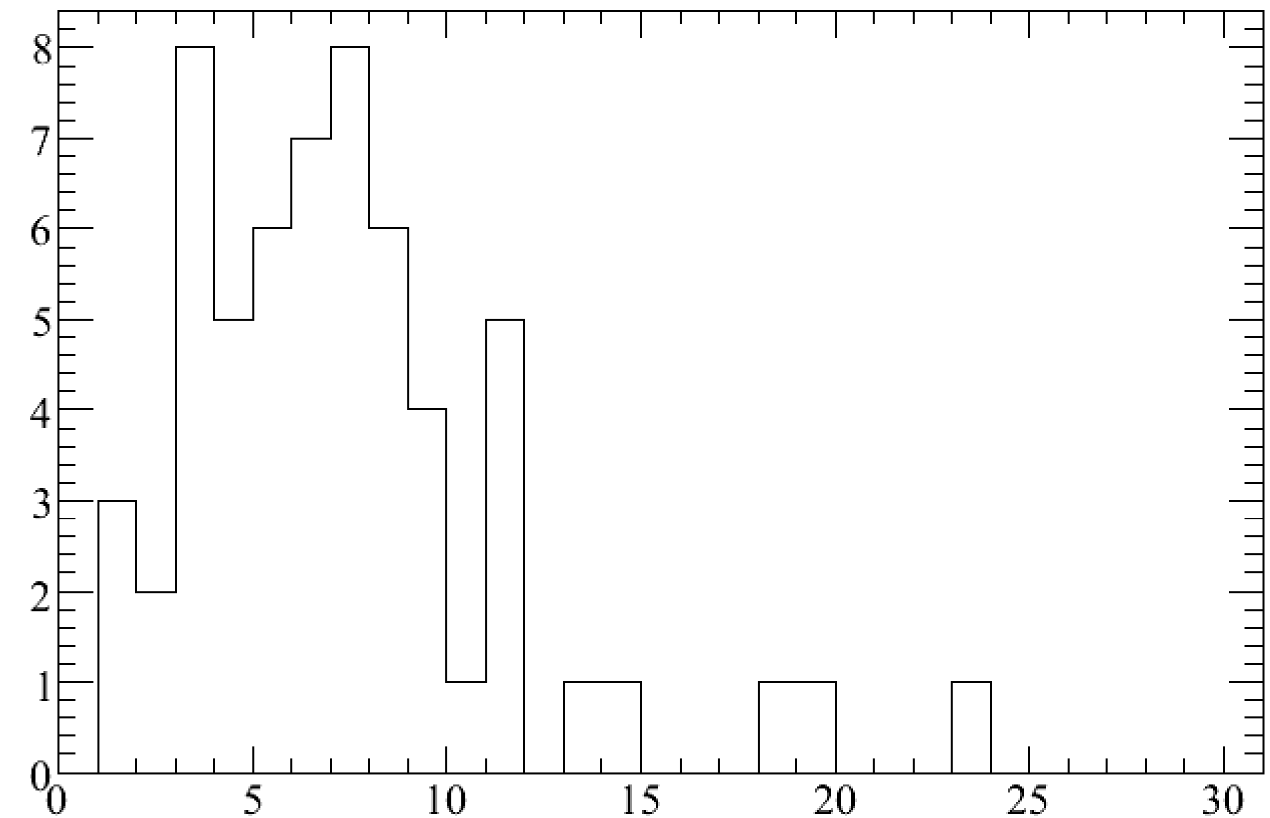
- E= 300, quanta=100, σE=30 (MeV); smooth Gaussian σ= 1.7 crystal size.



Test two (cont.)



cluster energy



crystals

Comments

- This procedure is able to produce quite irregular distributions. Considering this is the first try with randomly guessed parameters, it performs quite well.
- Need to quantify the differences between this procedure and full MC.
- The differences may or may not be resolved by tuning parameters.
- There seem to be more split clusters than it should be.
- Will implement this in PacEmc for further test.