

Fast Simulation: EMC Status and Plan

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Introduction

- SuperB will reuse the BaBar EMC Barrel (cylinder).
- Forward endcap will be using new crystals, but the overall geometry (cone) will likely be the same; alternative geometry: disk.
- Backward calorimeter (likely a disk).
- PravdaMC has only very simple smearing for photons, nothing for other neutrals and tracks.
- PacTrk provides true simulated tracks to (and through) the EMC.
- Detector response will be parameterized/sampled from a shower library, which can be created from BaBar and/or GEANT4 full simulation, based on incident particle's species, momentum, and entry angle, etc.
- FastSim creates reconstructed objects, and then builds particle candidate lists.

Data representation

- Original idea was to compile a library of high-level properties (energy, #crystals, various moments, etc.) and sample from it. However, the distributions and (especially) the correlations are not trivial. Plus, the numbers need to be stored may exceed the number of crystals per shower.
- New idea: create a simplified EmcCluster class to store crystal indices and energy deposits. All high-level quantities can be calculated easily (code available in BaBar). We can even merge clusters.
- Need to build space point → crystal index map.

How to make a shower library

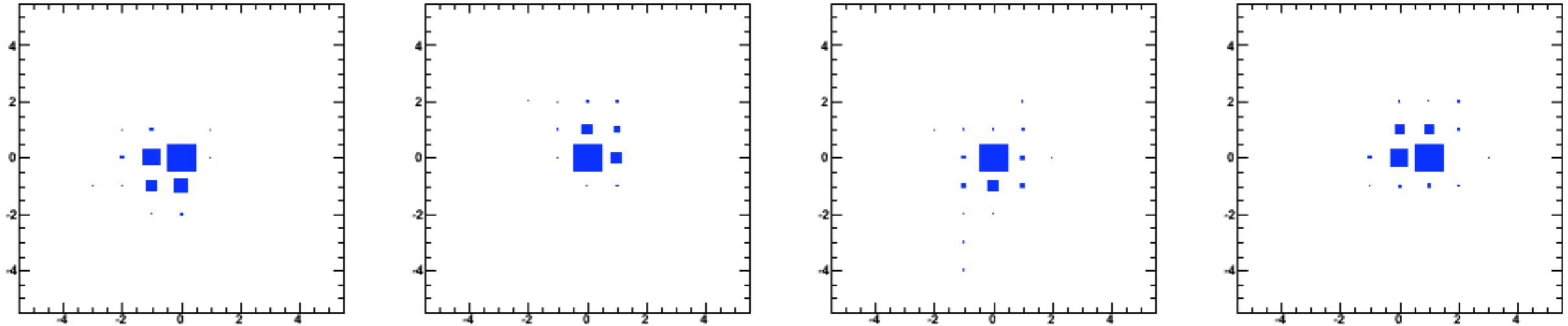
- One needs: true particle type, momentum and angle at the entry, the intersection with the detector, and the associated shower cluster.
- For barrel (and endcap at validation stage), we can simply shoot particles at the EMC using full BaBar simulation.
 - Can be done quickly; all effects are simulated (electronics, digitization, calibrations, etc.)
 - Crystal-level detail only, no 3rd dimensional information.
- For new parts, we need to run GEANT4 simulation.
 - Can get every energy deposit in 3D space.

What goes to the library

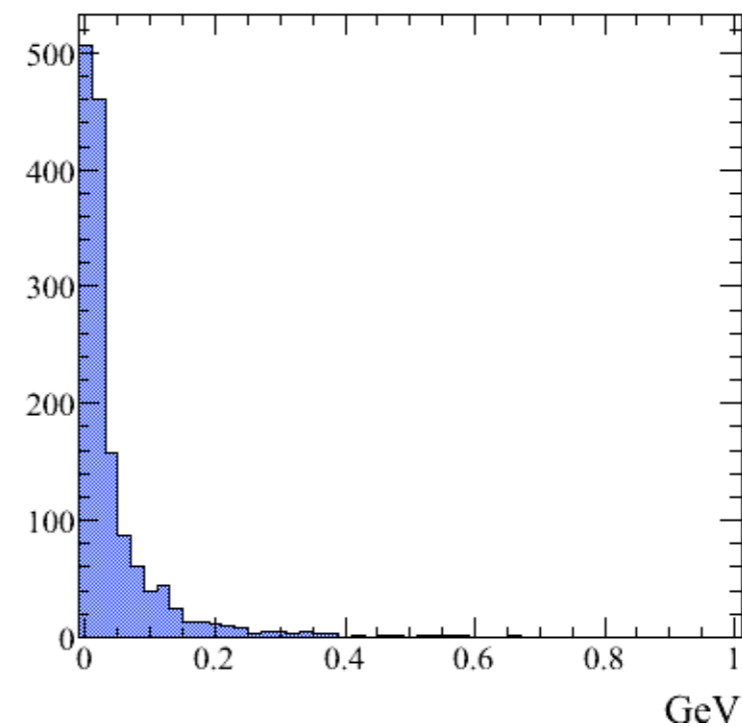
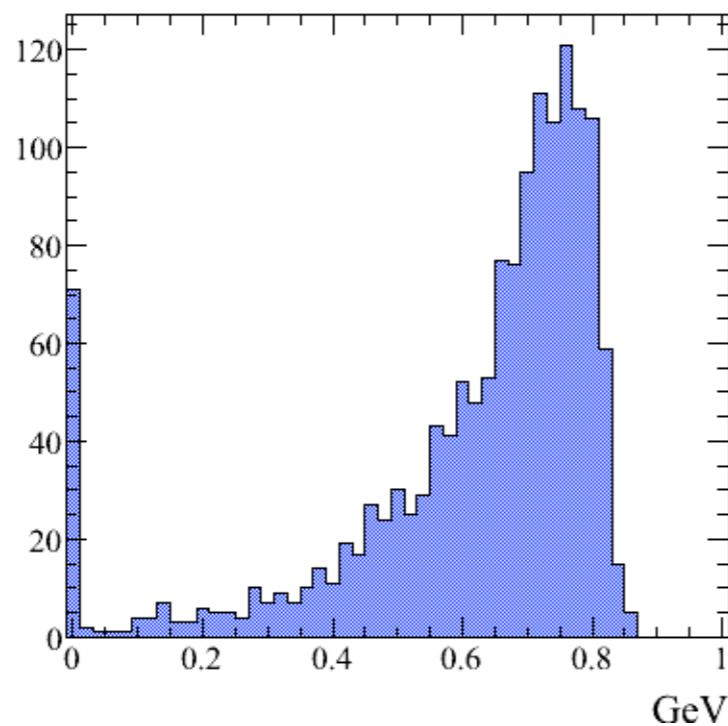
- (earlier idea)
 - Using BaBar, we could store a 3D histogram (x, y, energy) for each species in each bin of momentum, entry angle, etc.
 - When generating, we pick up the corresponding 3D histogram and for each crystal (x,y) we sample the energy from the 1D histogram.

1 GeV photon example

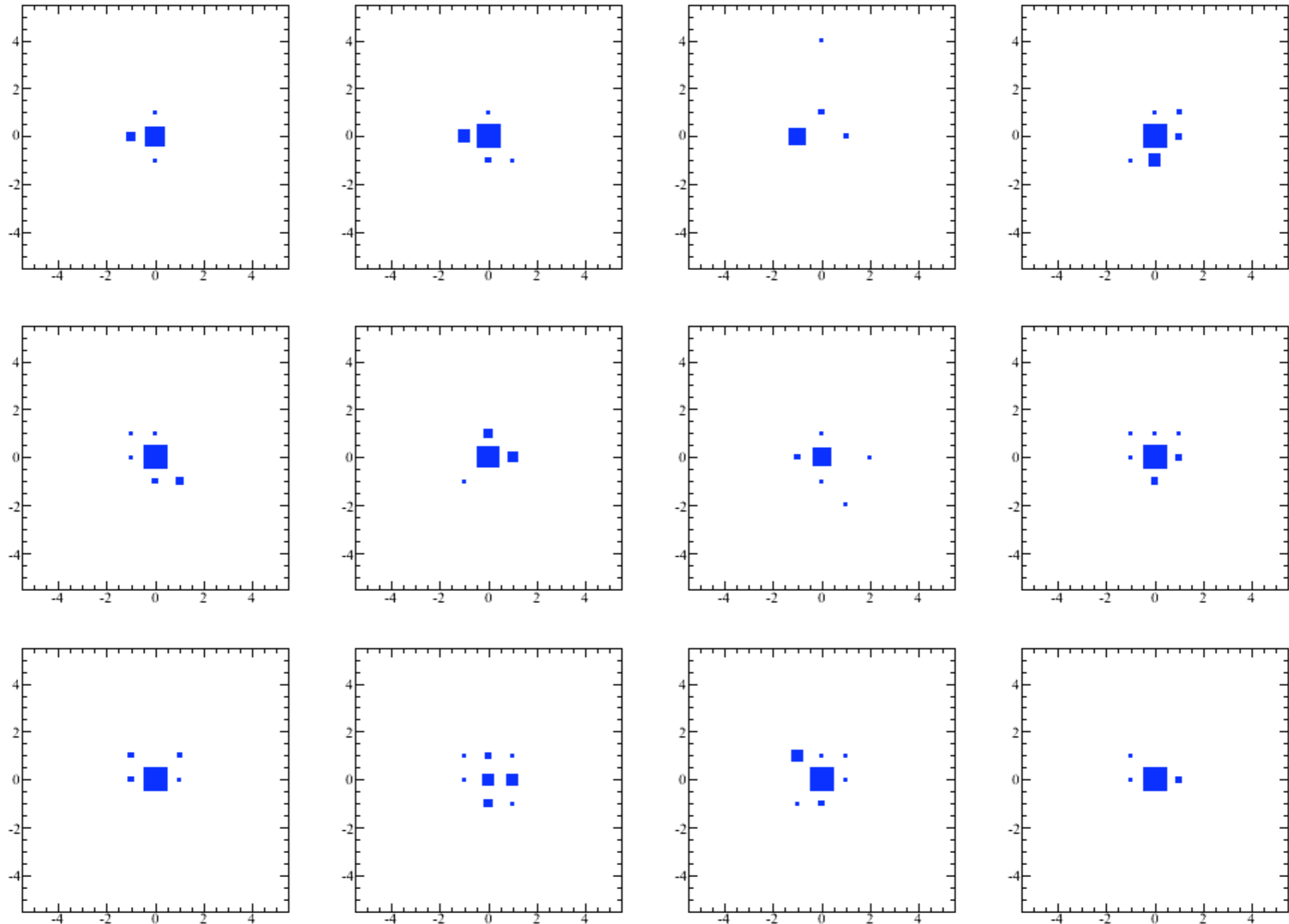
- Samples of shower shape



- Energy profiles of central crystal and one next to it.

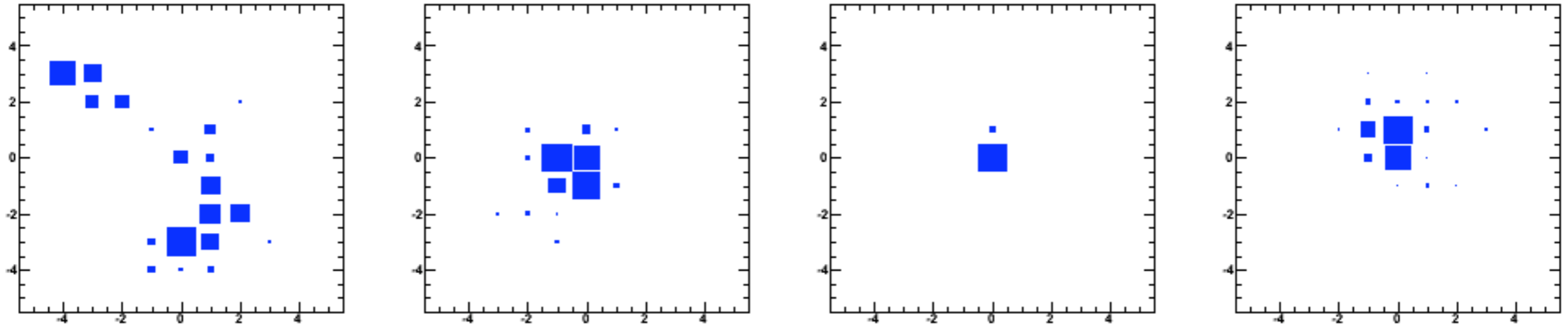


Generated clusters look more or less OK

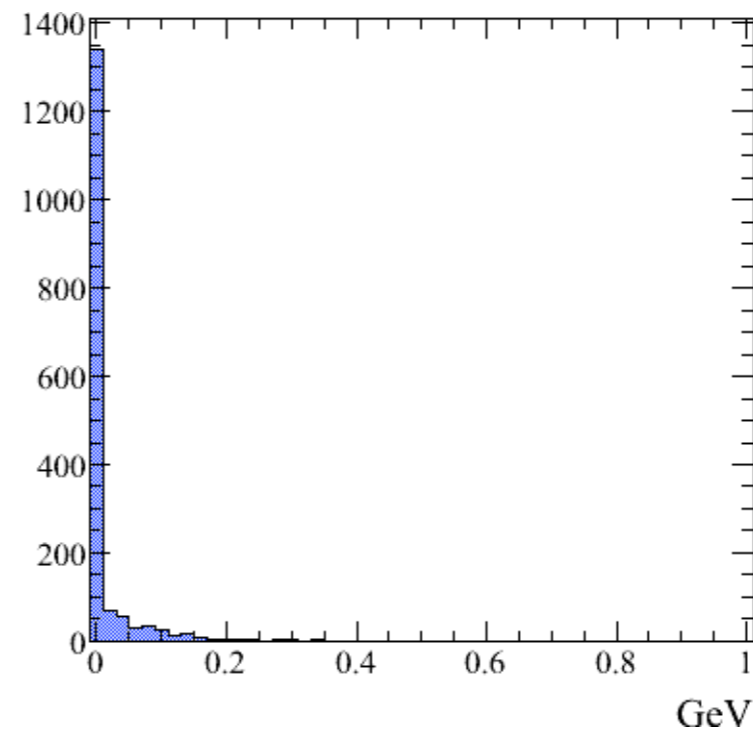
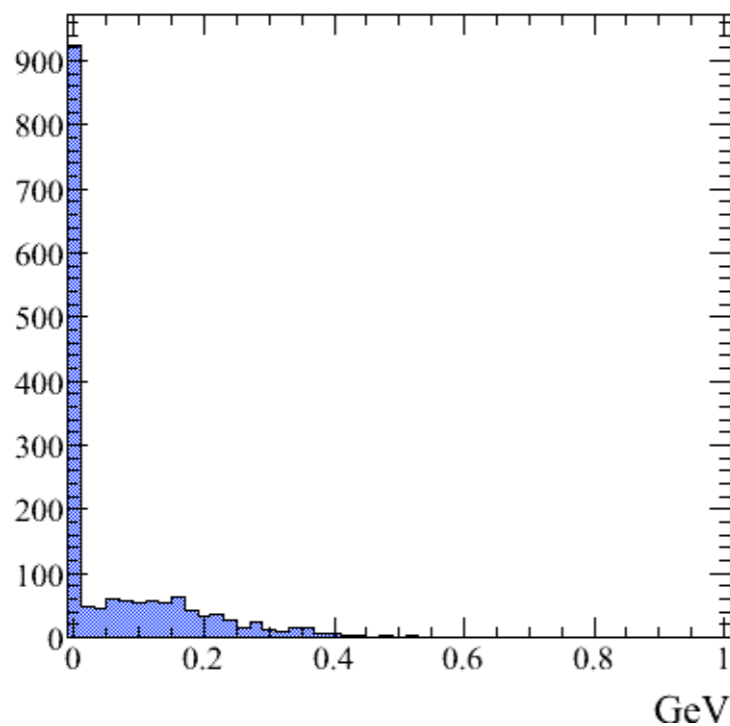


1 GeV K_L example

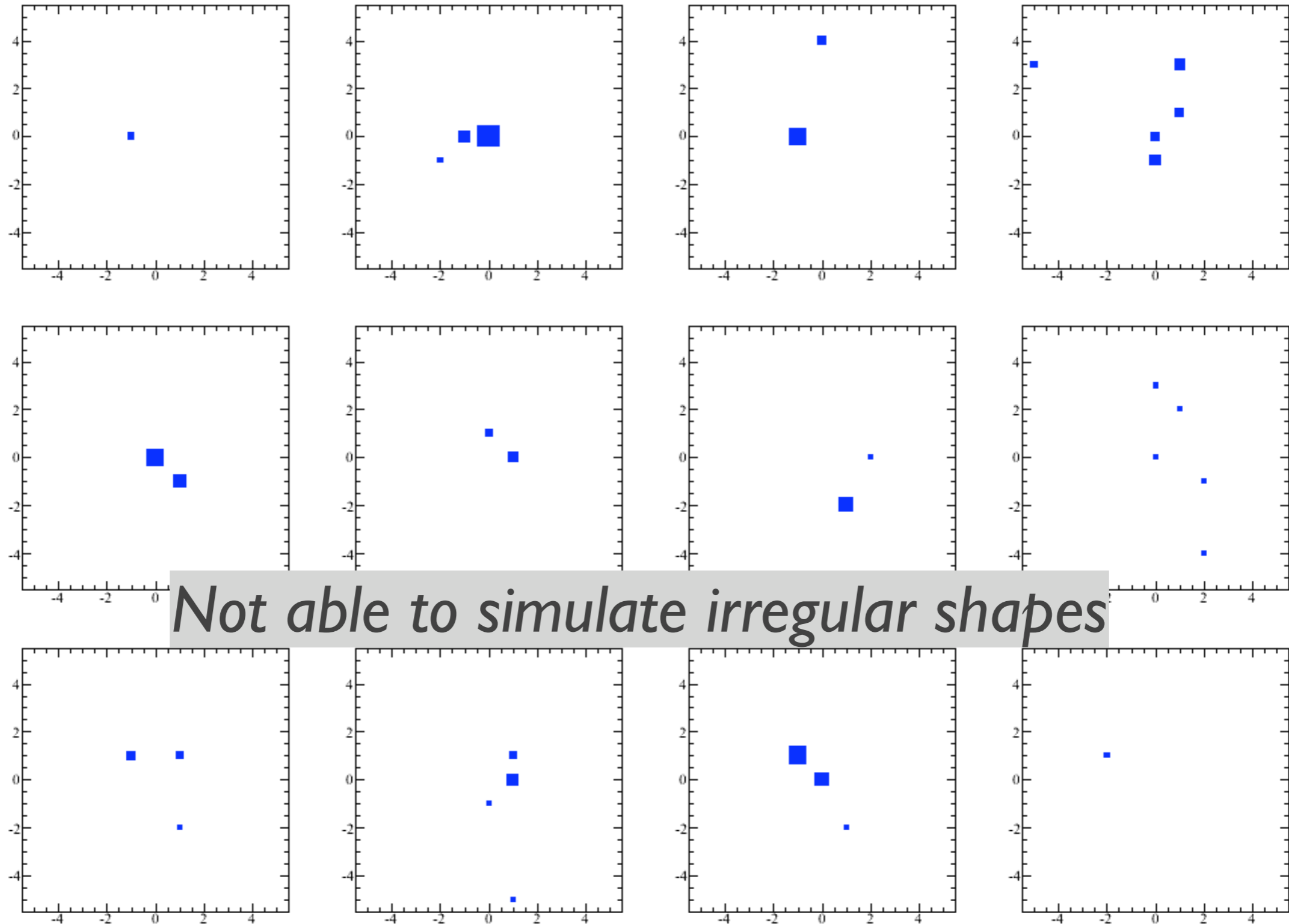
- Samples of shower shape



- Energy profiles of central crystal and one next to it.

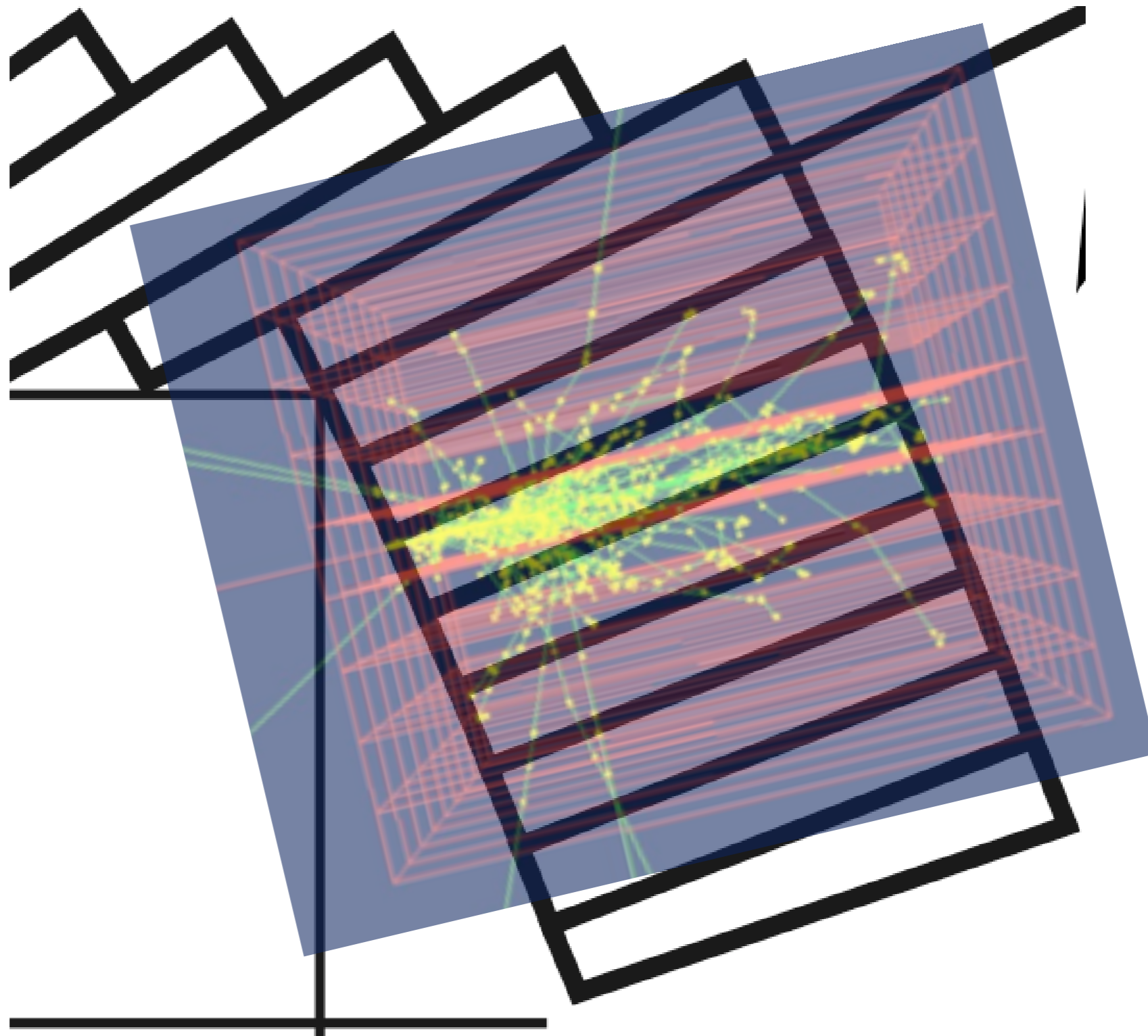


Generated clusters look BAD



Store actual samples of clusters

- Store many actual samples of clusters for each species and each bin of momentum, entry angle, etc..
- When running simulation, simply pick up one cluster from appropriate bin.
 - Only a limited number of samples; how many is enough?
- In full GEANT4 simulation, we can store samples of 3D showers.
- Simulate: pick up a sample, rotate the shower to appropriate angle, go through the space points where energies are deposited, and fill the energies to crystals.
 - Need an extra layer to parameterize other effects (electronics, light transmission, calibration, etc.)



Questions

- How many samples per momentum bin are adequate?
- What's the acceptable size of the library?
- How to access the library efficiently?
- How to deal with transition from barrel to endcap?
- Backward EMC has inactive layers (Pb) -> different treatment from the homogeneous crystals.
- Your questions here.

Status

- Tested a couple of ideas of shower library. We think we have a good one now.
- Will soon implement PacEmc
- Need to cooperate with GEANT simulation.
- Your questions and comments are welcome.