Update on EMC in FastSim

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SuperB FastSim Meeting

Interaction types

- EM shower (PacSimHit::shower)
- Hadron shower (PacSimHit::hadshower)
- Others (normal, stop, interact, brems, compton, convert) are currently treated as if they are "normal" (ionization)

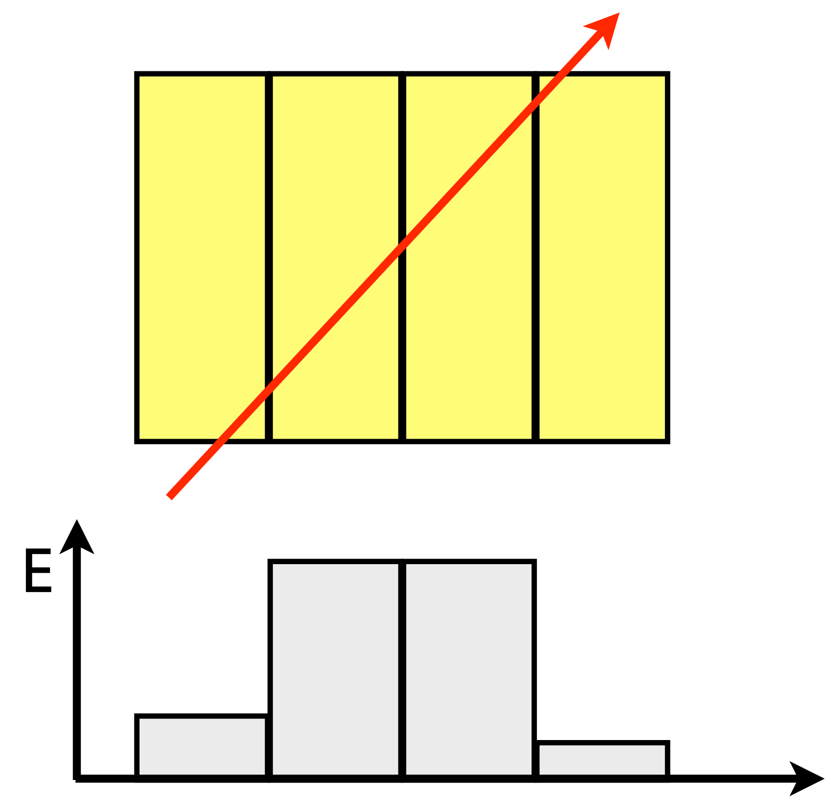
A longer version of this talk is shown on Oct.15 EMC R&D meeting
http://agenda.infn.it/materialDisplay.py?materialId=slides&confId=851

Ionizaiton

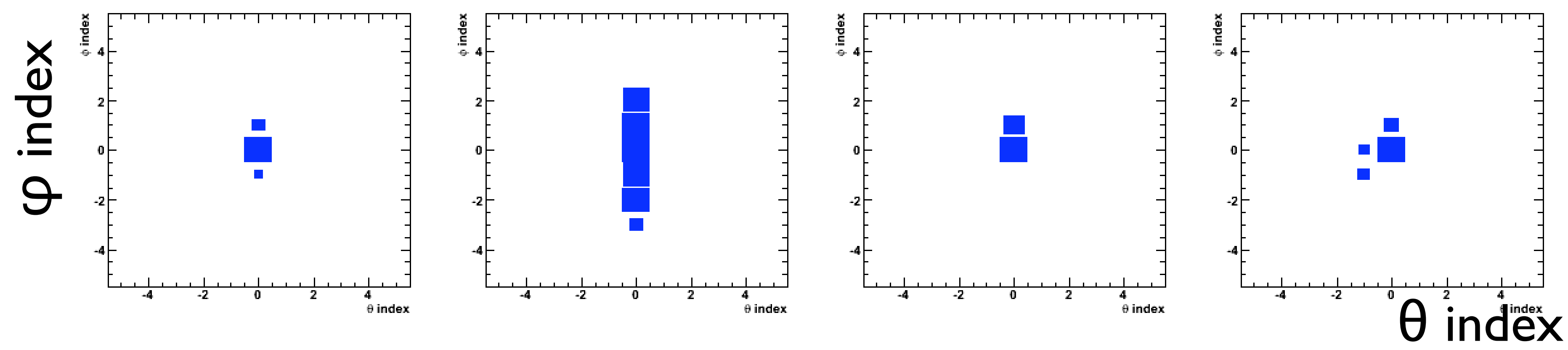
- If a particle is determined to be only interacting with the EMC "normally", we simply distribute the energy loss to the crystals it passes through. Energy is proportional to the path length in each crystal.
- Curving inside the EMC is ignored.
- Energy in each crystal is then smeared according to

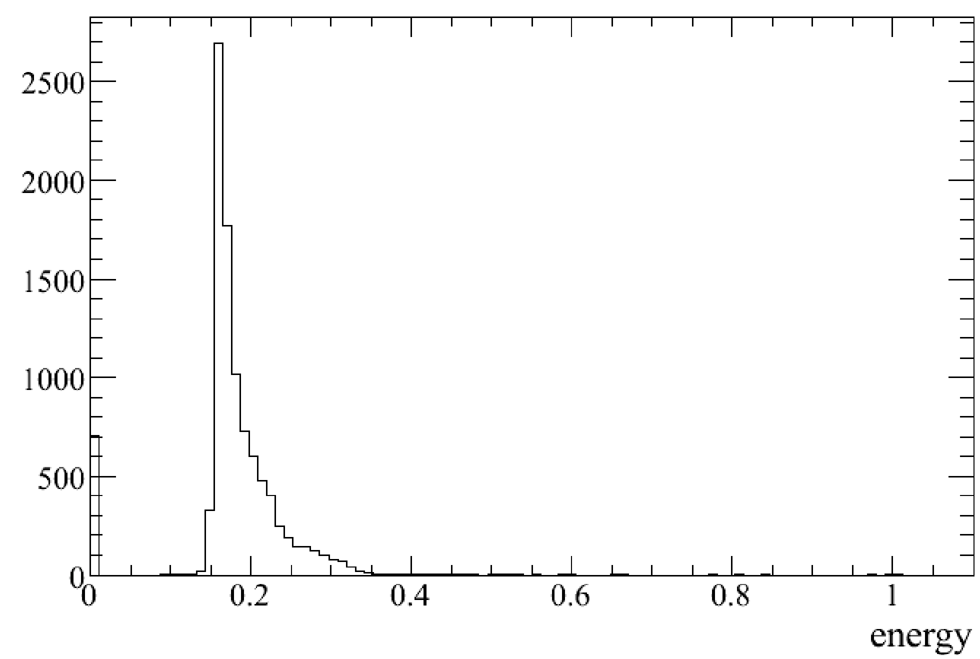
$$\frac{\sigma_E}{E} = \frac{a}{\sqrt[4]{E(\mathrm{GeV})}} \oplus b$$

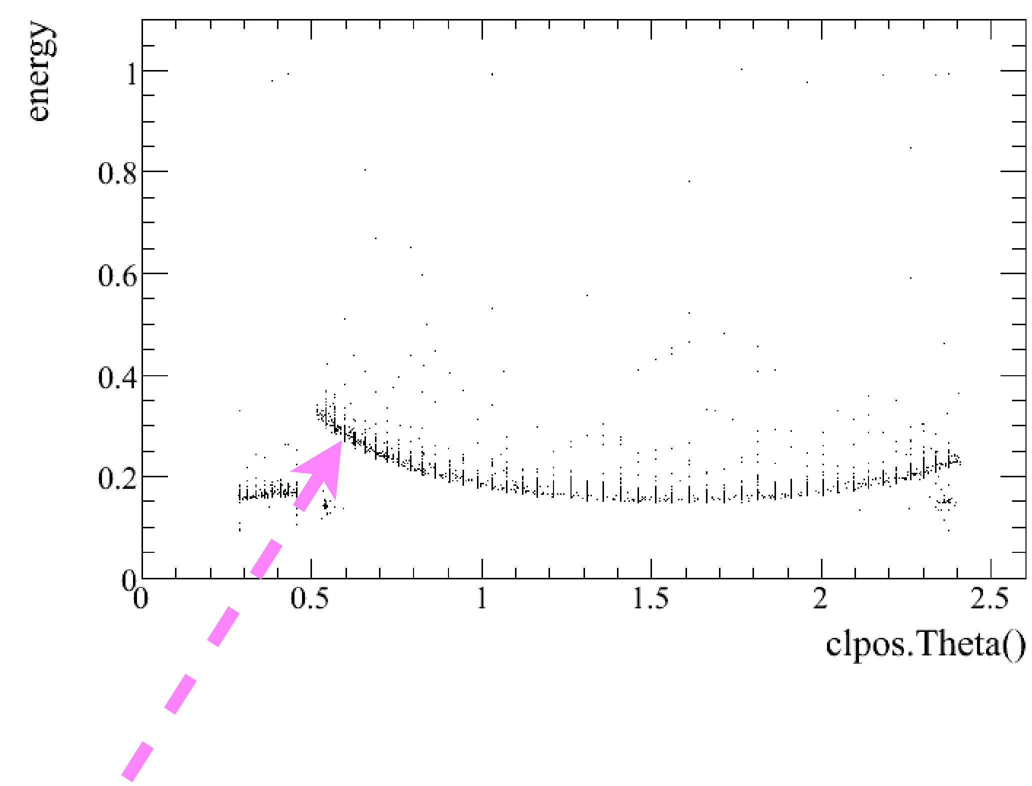
In the following, I use
a= 1% ; b= 1.2%



Test with 1-GeV/c muons

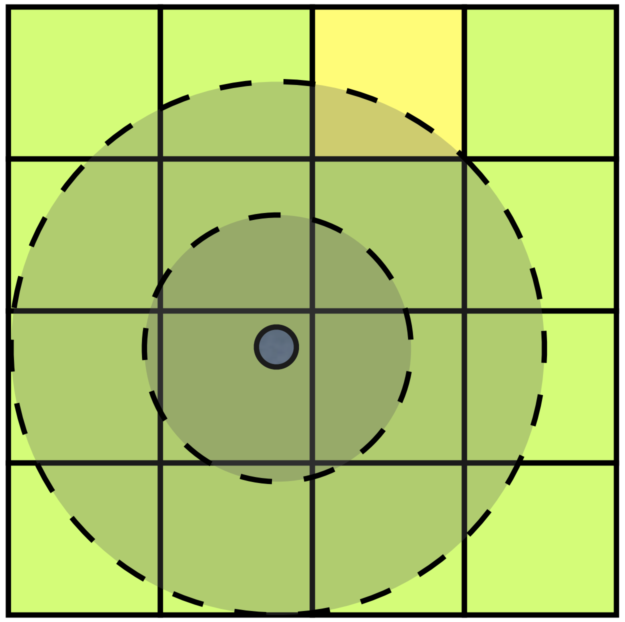






- Path is longer at shallow angle in barrel because the thickness is assumed uniform; need fix.

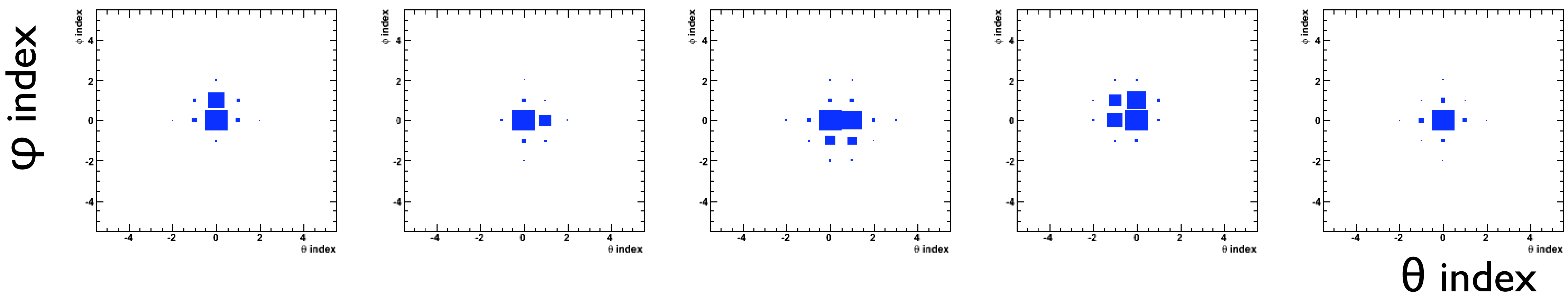
EM showers

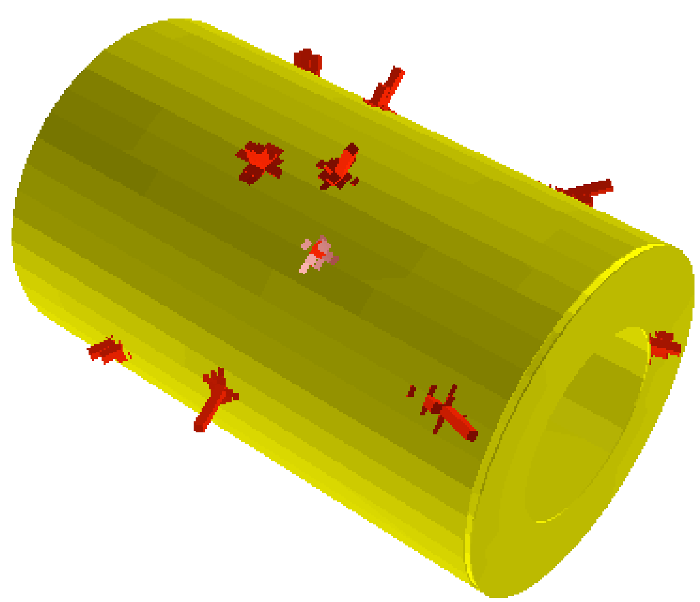


- Starting with the crystal a particle hits, calculate the integral of f(r) [3Gaussian] over each crystal.
- Energy is distributed over crystals according to the integral.
- Here I use R_M=3.7cm, and allow it to fluctuate by 10%.
- Energy in each crystal is fluctuated by

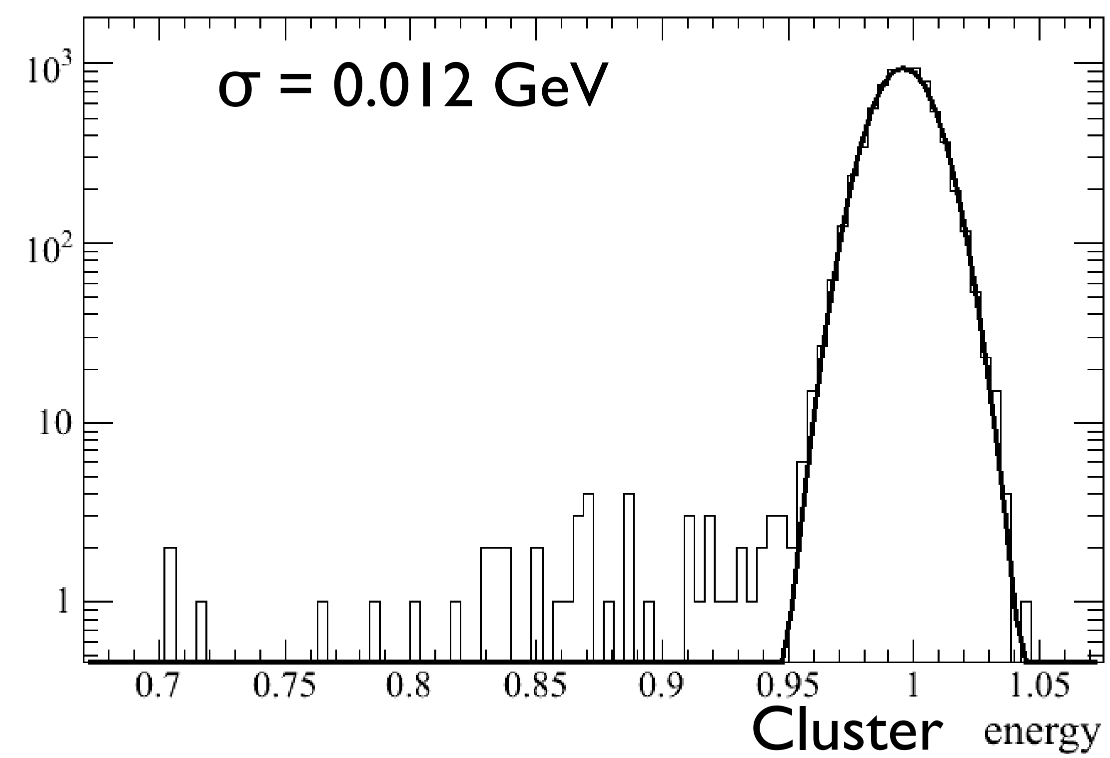
$$\frac{\sigma_E}{E} = \frac{a}{\sqrt[4]{E(\mathrm{GeV})}} \oplus b$$

Test with 1-GeV photons



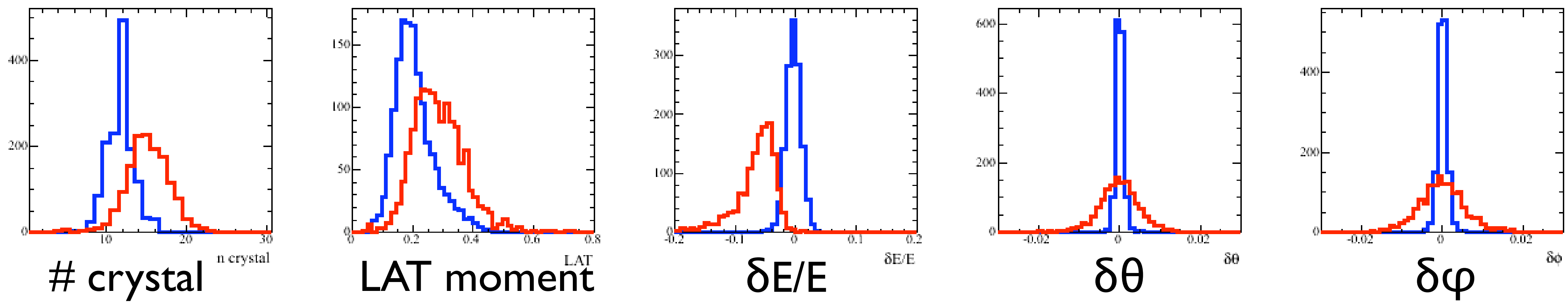


“event display”



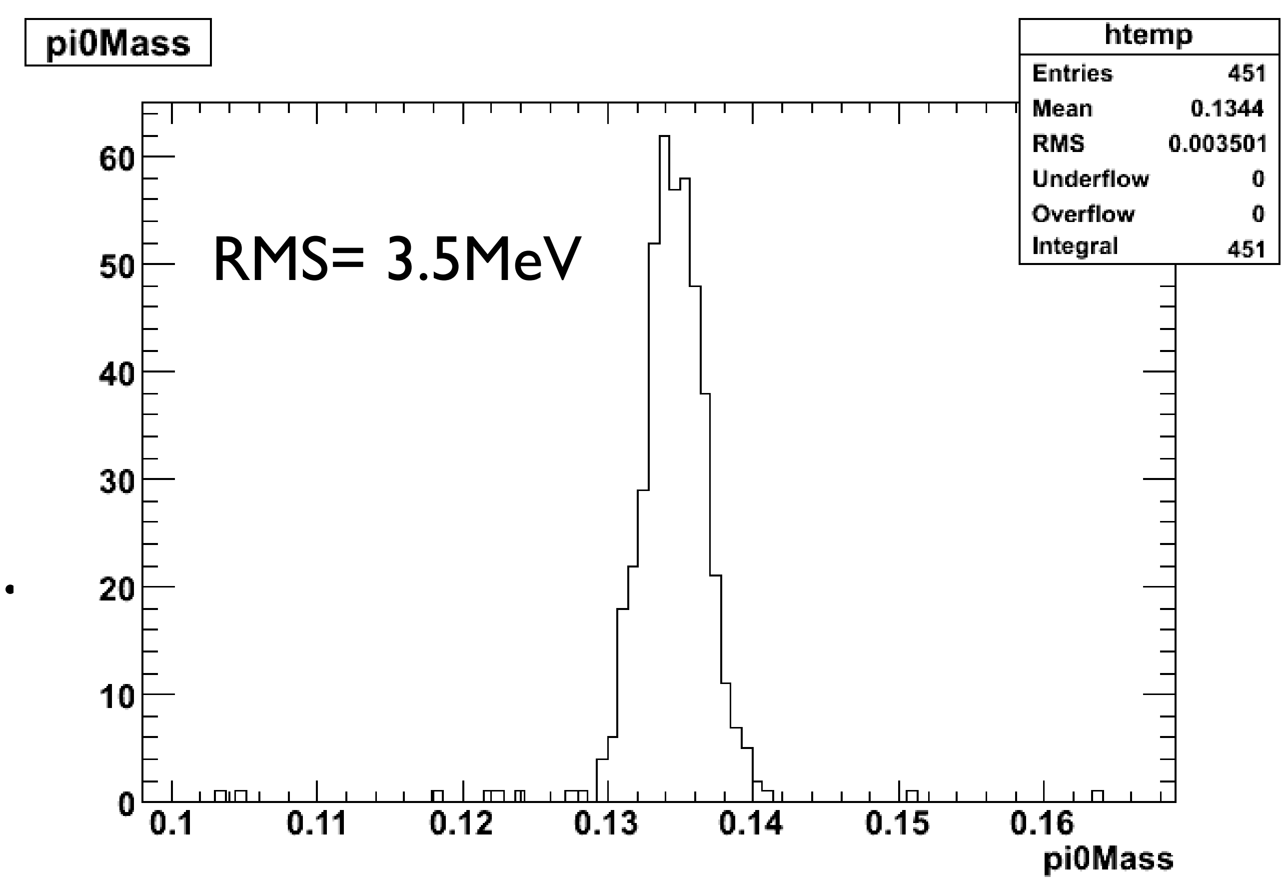
Performance

- One-GeV photons: Blue= FastSim; Red= full Sim



- π0 from B → π+ π0 simulation

- Resolution is clearly too good.
- Does not simulate energy leaks.
- Need some more "noise".



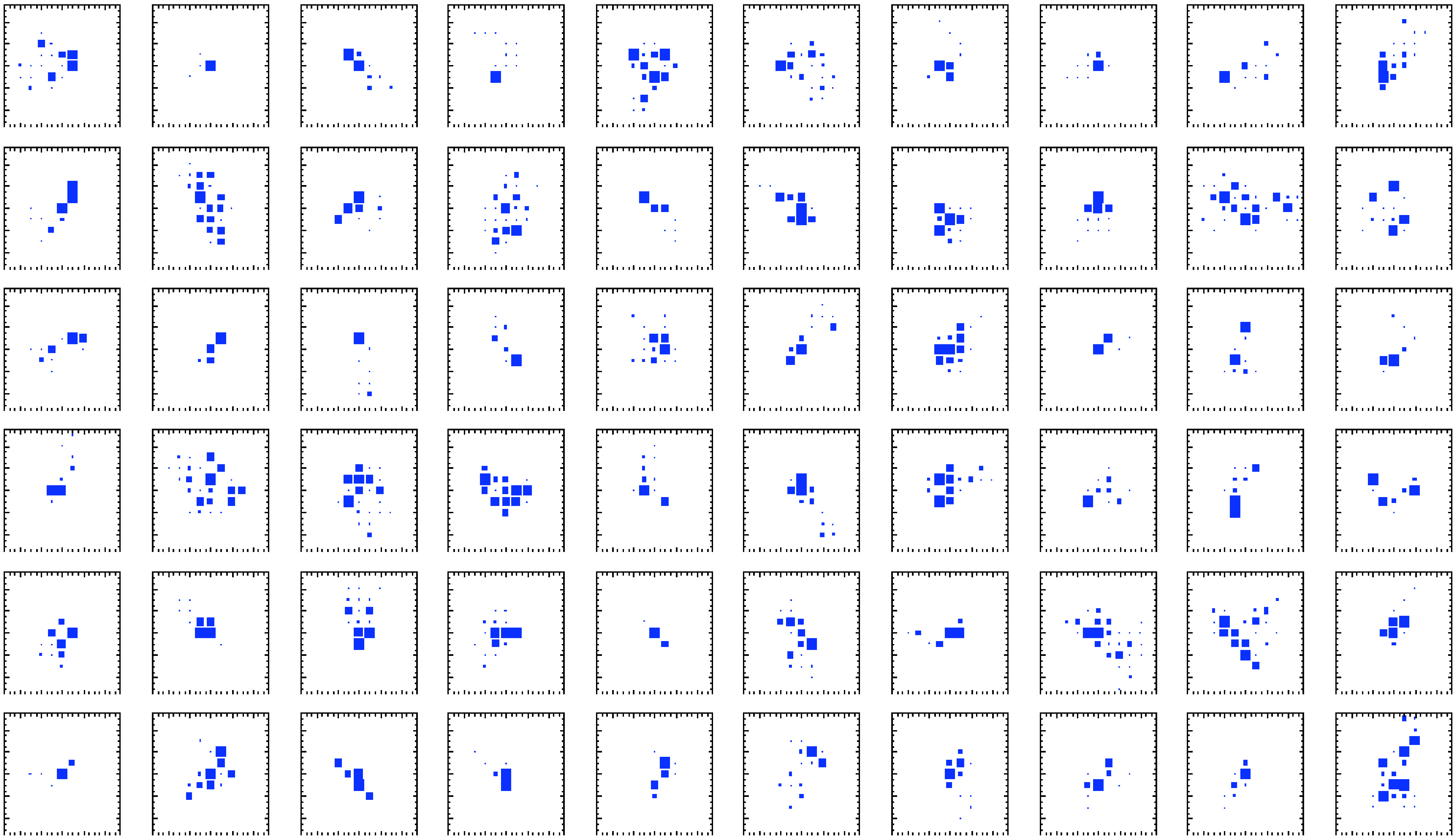
Hadronic shower modeling procedure

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,σ_E)
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 or has walked too far.

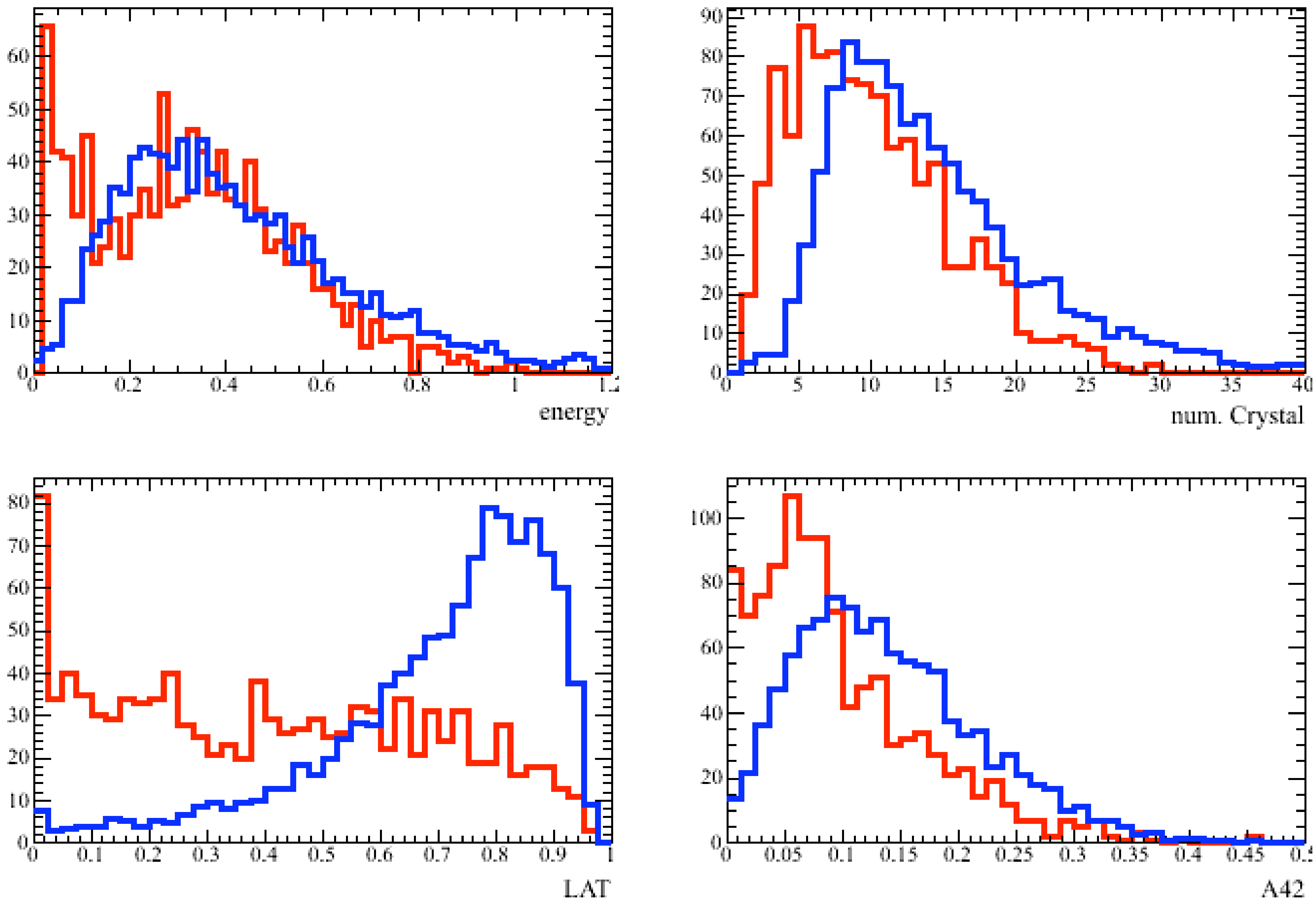
Test with 1-GeV/c K_L^0

- Parameters:
  - Overall profile σ= 8 cm
  - Maximum distance: 30 cm
  - Energy "quanta" = 50 MeV
  - Extra fluctuation σ_E = 10 MeV
  - Minimum energy = 1 MeV
- Caveat: currently in fastSim when KL interacts, all its energy is lost in that detector element. So we always end up with 1 GeV to begin the process described in the previous page.
  - In the future, energy leaks beyond EMC will be allowed.

Test examples



Compare with full simulation



FastSim produces too large lateral moment.

Comments

- Random walk scheme can produce irregular shapes but may be running too wild.
- Need to test on wider range of momentum and particle types to get some sense of how one should tune the parameters or modify the scheme.
- Some parameters may need scaling by momentum or other quantities, rather than fixed for all situation.
- Talk yesterday at the EMC R&D meeting did not get much feedback.
  - Do we simulate back scattering?
  - It looks like backward endcap simulation is easy; simply defining the geometry and putting in some rough resolution should be good enough.