Improvements to Neutral MC and Reconstruction

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Outline

- New shower library
- Overview of MC algorithm
- Major changes to MC
- Major changes to reconstruction
- Results
- To do

New Shower Library

- Generated using GEANT
  - Energy cutoff = 50 keV for both photons and electrons
- 325 position bins – uses octant symmetry
- 6 energy bins
- 9 x 9 angle bins for photons
- 15 x 15 angle bins for electrons
- 10 rings (13x13 blocks)
- 5 z bins stored for central 3 rings (13 blocks) of shower, no z segmentation for rest of shower
- Energy deposit in wrapping stored for central 3 rings (13 blocks) of shower

New Shower Library (cont)

- 200 bytes per shower
- Breakdown of shower storage
  - Header 2%
  - Total energy 1%
  - Block energy fractions 64%
  - Wrapping energy fractions 10%
  - Z segmentation 22%
  - Unused bits <1%
- 16 libraries (1 shower per bin)
  - ~33 Mb per photon library (157,950 showers)
  - ~93 Mb per electron library (438,750 showers)

Overview of MC Algorithm

- Read in one library each for photons and electrons – store in memory (CSRDSHL)
- Smear generated energy by function determined from data (ESMEAR)
- Select shower from library based on energy, position, and angle (CSGTSHL)
  - Interpolate logarithmically between bin boundaries to select energy bin
  - Interpolate linearly between bin boundaries to select angle bin
  - Shift generated position by amount that corrects for difference between generated angle and angle bin used
  - Select position bin

MC Algorithm (continued)

- Unpack shower info from stored library (CSRDSHL)
- Rotate unpacked shower into appropriate octant and scale shower energy to generated energy (CSSHLPRP)
- Convolute shower with measured CsI uniformities (CSCONVOL)
  - If z information is stored for a particular block, $E_{block} = \sum_{z=1}^{5} E_z \times U_z$
  - No z information for wrapping energies
- Add back energy lost in wrapping for large blocks (CSWRPCORR)
- Subtract energy lost in shims (CSSHIMCORR)
- Adjust for “sneaky energy” and “fluff”

Major changes in v7_00 MC

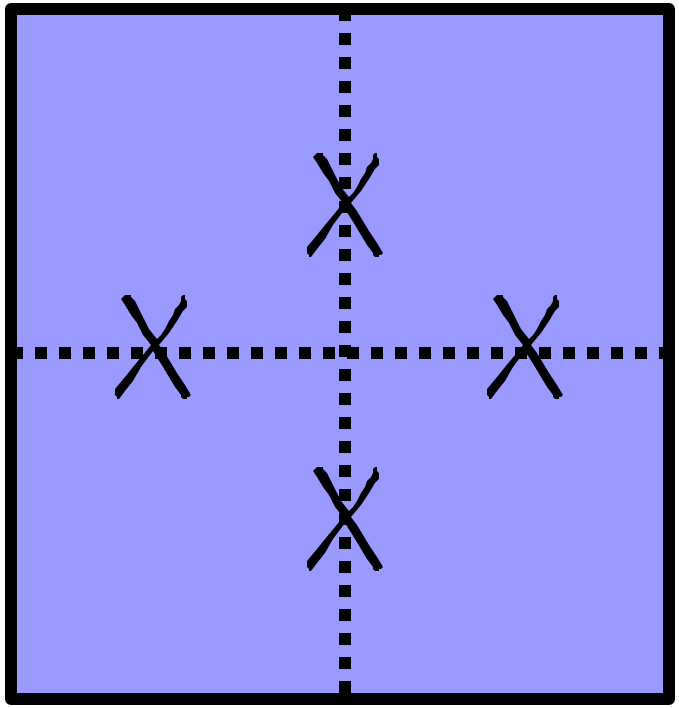
- All library reading and unpacking tools are new
- Angle correction to position
  - Old MC (CSIANGLE)
    - angles treated using CSIANGLE exclusively
    - CSIANGLE included unphysical correction to remove difference between track and cluster positions for electrons
  - New MC
    - Positions adjusted by the difference between desired angle and binned angle to reduce the effects of angle binning
    - Z position used to determine shift is a function of energy, angle, incident position, particle type, and block size – comes from SG study of position reconstruction

Major Changes (continued)

- Convolution with uniformities (CSCONVOL)
  - Old MC
    - 49 blocks with some z information -- 4 central blocks had full 25 bin z segmentation, average 25 bin longitudinal profile stored for remaining 45
    - 25 z bins convoluted with 10 measured uniformities by interpolating uniformities to 25 bins
  - New MC
    - 13 central blocks have 5 bin z segmentation
    - 5 z bins convoluted with 10 measured uniformities by averaging uniformities

Major Changes (continued)

- Wrapping correction
  - GEANT showers in library generated as grid of 13x13 small blocks with wrapping
  - Wrapping is 12.5 μm thick – 1 layer on 3 sides, 3 layers on top
  - Large blocks simulated by summing 4 small blocks
  - Old MC – no wrapping correction
  - New MC
    - Energy deposit in wrapping stored for 13 central blocks
    - Energy deposited in wrapping added back to large block where appropriate



Major Changes (continued)

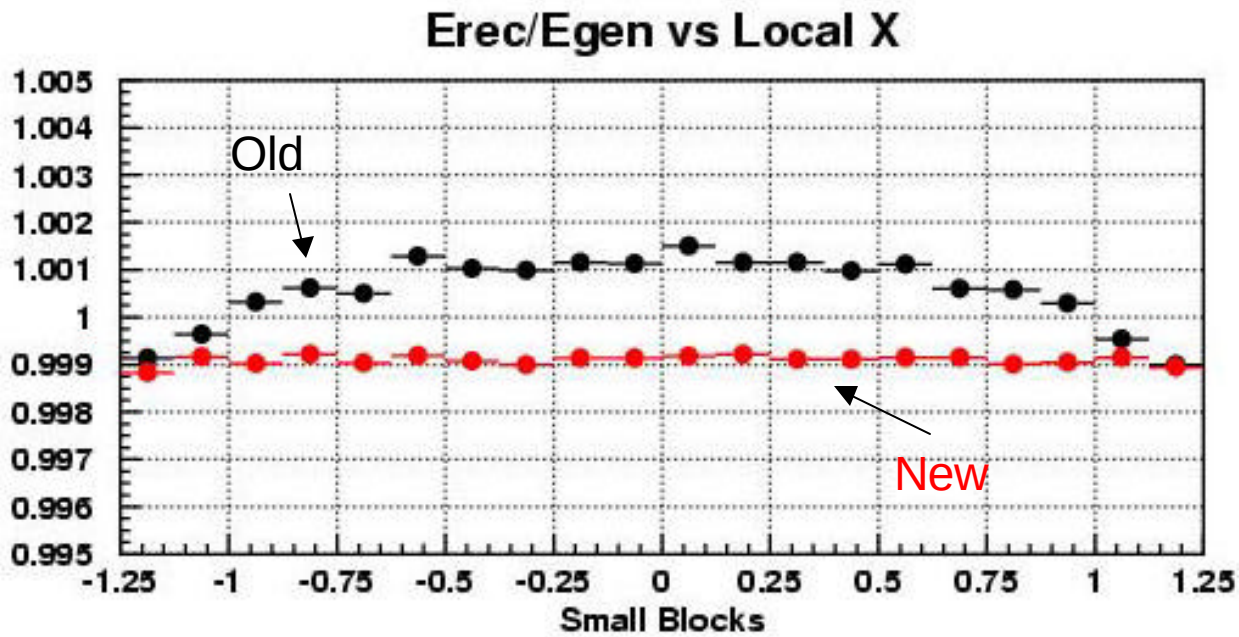
- Shim Correction
  - During stacking of calorimeter, shims were placed between some large blocks
  - Shims up to ~125 μm thick
  - Old MC – shims not simulated
  - New MC
    - Shim associated with each block is stored in DB
    - Energy deposit in shim is estimated by scaling energy deposit in wrapping for each block by ratio of shim thickness to wrapping thickness
    - Energy loss in shim is divided equally between 2 neighboring blocks and subtracted

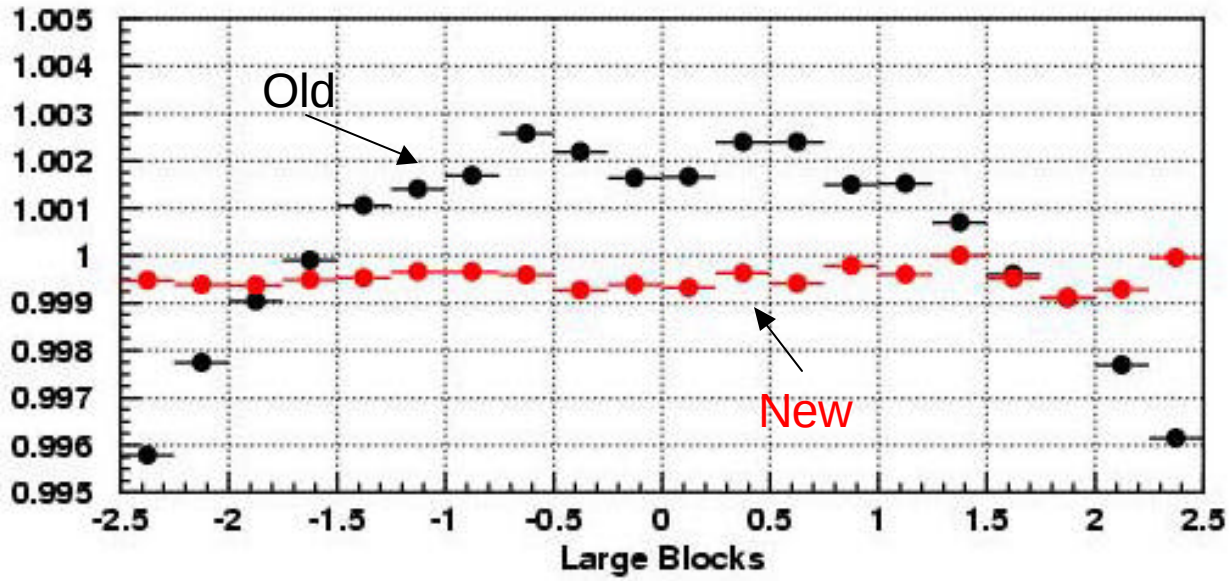
Major Changes in v7_00 Reconstruction

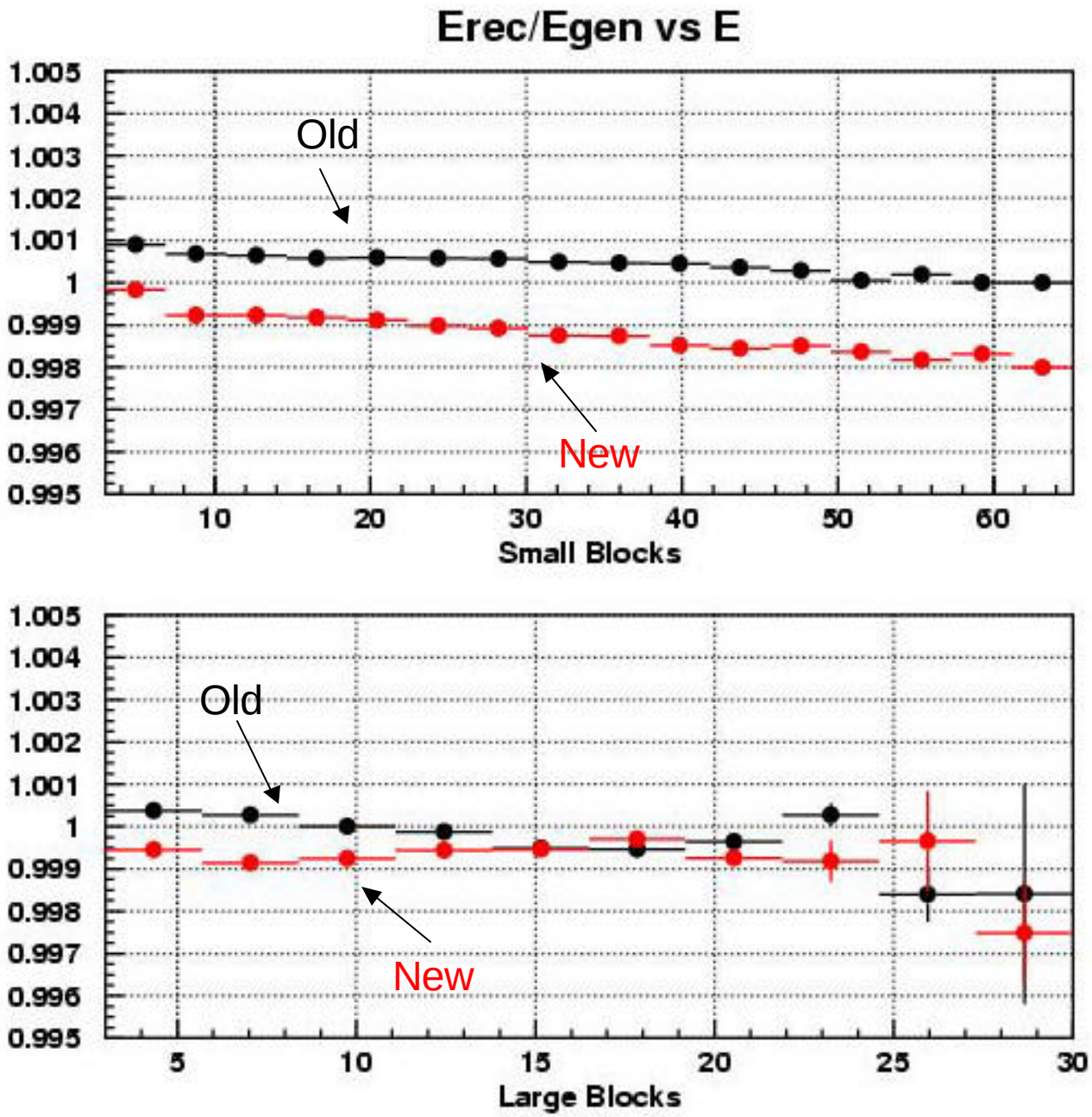
- Subroutine which applies clustering corrections (CSICORR) split
  - CSIBLKCORR applies block level corrections
  - CSICLUSCORR applies scale corrections
  - Eventually will be able to call each iteratively
- Longitudinal Uniformity Correction
  - Corrects for non-uniformity of CsI response as function of z
  - Old Recon
    - Average longitudinal distribution of shower energy for photons and electrons was convoluted with measured CsI uniformities
    - Scale correction was calculated by summing convoluted responses of blocks in the cluster
  - New Recon
    - Longitudinal distribution of shower energy is stored in DB as function of shower energy, block position in shower, position of incidence on seed block, and particle type
    - Block energies are corrected by convoluting appropriate longitudinal distribution with measured CsI uniformities for that block

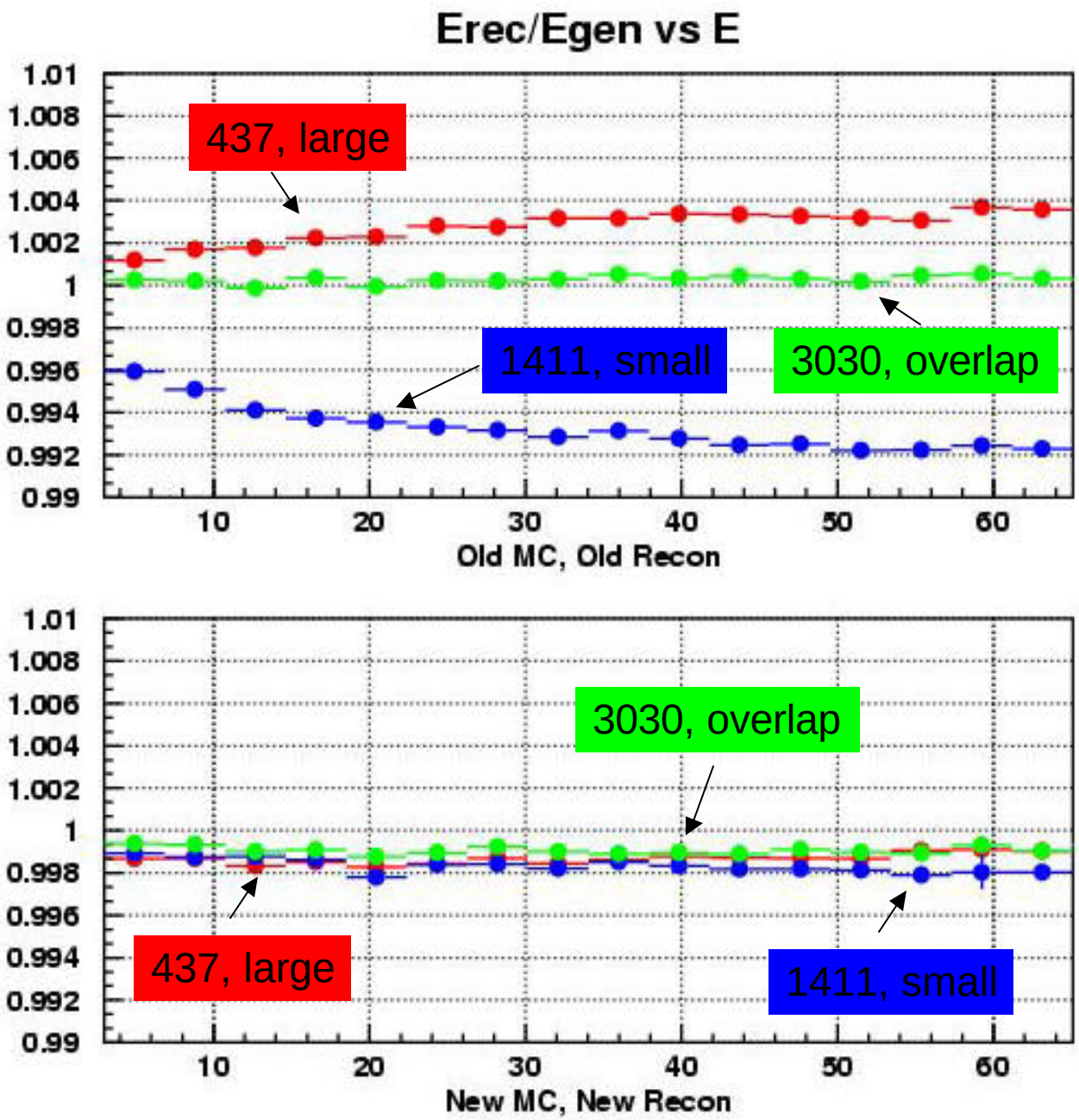
Major Changes (continued)

- Out of Cone Correction
  - Corrects for energy in shower not included in 7x7 small blocks or 3x3 large blocks
  - Old Recon
    - Generated from GEANT 8 GeV showers
    - One correction for clusters containing all small blocks, one correction for clusters containing any large blocks
  - New Recon
    - Generated from GEANT – same code used to generate new shower library
    - Correction parameterized as function of position of incidence, angle of incidence, energy of shower, particle type, and region of calorimeter (small vs mixed/large)
    - May be possible to eliminate angle dependence of out-of-cone by using compensation between position algorithm and out-of-cone effects – desirable because it would reduce iterations necessary in reconstruction

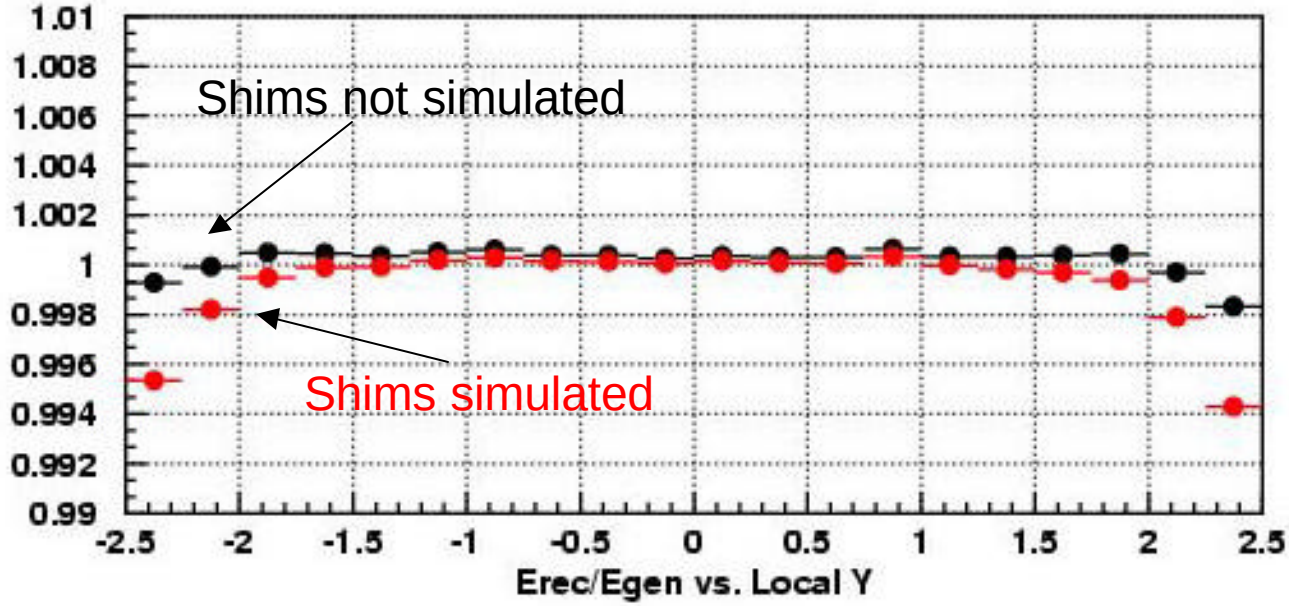

Erec/Egen vs Local X
Old
New
Small Blocks
1.005
1.004
1.003
1.002
1.001
1
0.999
0.998
0.997
0.996
0.995
-1.25
-1
-0.75
-0.5
-0.25
0
0.25
0.5
0.75
1
1.25

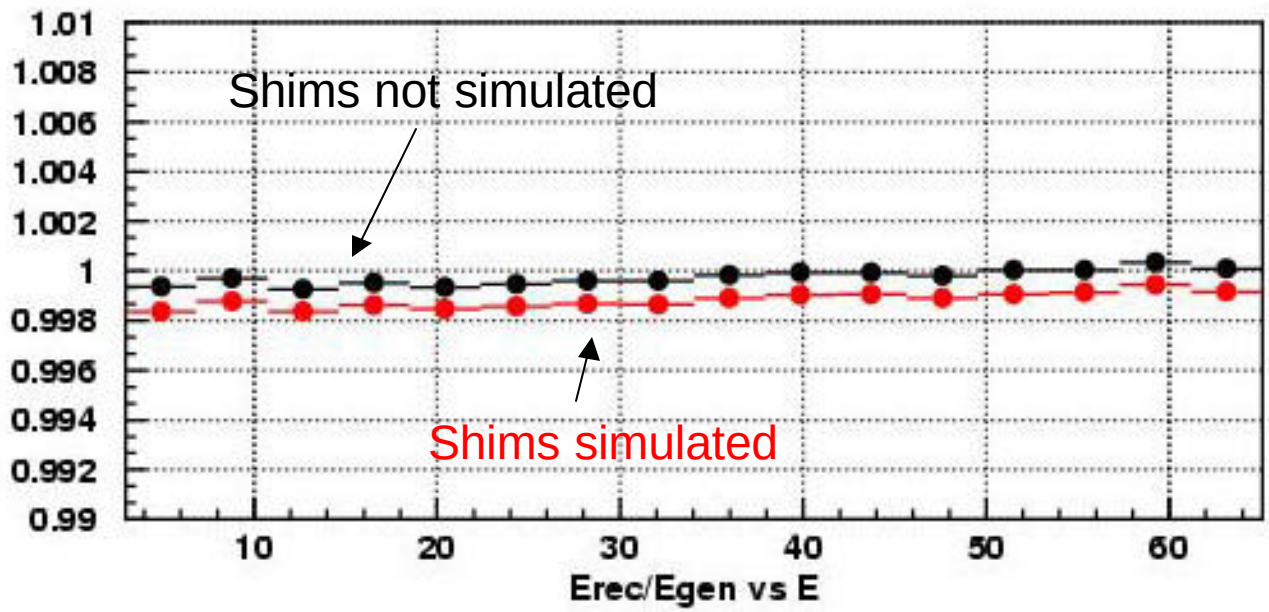

Old
New
Large Blocks
1.005
1.004
1.003
1.002
1.001
1
0.999
0.998
0.997
0.996
0.995
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5


Erec/Egen vs E
1.005
1.004
1.003
1.002
1.001
1
0.999
0.998
0.997
0.996
0.995
Old
New
10
20
30
40
50
60
Small Blocks
1.005
1.004
1.003
1.002
1.001
1
0.999
0.998
0.997
0.996
0.995
Old
New
5
10
15
20
25
30
Large Blocks


Erec/Egen vs E
437, large
1411, small
3030, overlap
Old MC, Old Recon
3030, overlap
437, large
1411, small
New MC, New Recon

Effect of Shims





To Do

- Prepare private code for release to ktevana and ktevmc v7_00
- Make MC position lookups and transverse energy maps
- Finalize decision about out-of-cone correction
- Calibrate data
  - Position lookups and transverse energy maps
  - Gains
  - Intra-block correction
  - Gains
  - Channel-by-Channel linearity correction
  - Time-by-Spill correction
- Calibrate MC
  - Intra-block correction ??
  - Channel-by-Channel linearity correction
  - Energy resolution