Calibration Method

Instances of the **Cell** class (one instance for each FMS cell) contain ADC raw data and methods associated with each particular FMS cell. The calibration method includes event selection (Class Cell Creation) followed by iteration of reconstruction and recalibration for each Cell. The steps are showed below.

1. **Cell Class Creation.** For each small cell, an instance ($Cell_i$) of the Cell class is created containing information about events associated with the cell. Events are added to the Cell instance $Cell_i$ only if the following are satisfied.
   - The event has 2 photons where the higher energy photon lands in the cell in question.
   - A photon is counted only if photon energy > 4 GeV. Events are included in the instance if there are 2 and only 2 photons in an angular cone of .045 Radians.

2. **Iterate for calibration constants** (like those found in Fpdcorr.txt) events in each Cell class instance are re-reconstructed based upon current calibration constants. The result of iteration is that the calibration constants can change. The steps in an iteration cycle are:
   - **Reconstruct events** in a particular cell instance.
   - **Make mass vs energy distribution** for events with pair energy > 10 GeV and with the high energy photon in the cell in question.
   - **Make an energy distribution** for photon pairs that have mass between .01 GeV and 0.3 GeV.
   - **Fit the mass vs energy distribution** to a linear function M(E). Evaluate M(45 GeV).
   - **For each cell, we count the number of events per GeV at energy of 65 GeV**. Fit the high energy part of the energy distribution to a form $N(E) = N_0 e^{-\left(\frac{E-65GeV}{.2GeV}\right)}$, where N is the number of events in 1 GeV energy bins. For each Cell "i", the constant $N_0 \rightarrow (N_0)_i$ is determined in a fit to the energy distribution in the i'th cell.
   - **Compare events per GeV @ 65 GeV to model.** As a model for the rapidity and energy dependence, we will start with the form:

     $$n(E,Y) = n_0\ p4(Y)\, e^{(Y-3.65)} e^{-(E-65GeV)}$$

     (For this data set, we choose n_0 =3.0) and where p4(Y) is a 4th order polynomial in Y, Initially we will assume p4(Y)=1 but the polynomial will change on each round of iteration. The ratio of measured count to modeled count is

$$r_i = \frac{\left(N(65GeV)\right)_i}{n(65GeV, Y_i)}.$$

- For each cell, two factors are determined. The first is

$$Factor_1 = \frac{.135}{M(45GeV)}$$

For each cell, the second factor is determined by the ratio of r_i to 1. We define the second factor,

$$r_i = \frac{n\left(Factor_2\left(65GeV\right), Y_i\right)}{n(65GeV, Y_i)}$$
$$r_i = e^{-\left(\frac{Factor_2 - 1}{5GeV}\right)65GeV}$$
$$5GeV\ Log\left(r_i\right) = 65\left(1 - Factor_2\right)$$
$$Factor_2 = 1 - \frac{5GeV\ Log\left(r_i\right)}{65GeV} = 1 - .077Log\left(r_i\right)$$

- **The gain correction for this cell will be changed** $gcorr_{i+1} \rightarrow \frac{(Factor_1 + Factor_2)}{2} gcorr_i$.

3. **Update p4(Y) to fix average masses vs. rapidity.** After the gains of each cell has been independently modified as mentioned above in step 2), the polynomially p4(Y) is adjusted. A plot of $Factor_1$ vs. pseudo-rapidity for all cells is fitted to a polynomial and the resulting function multiplies the old p4(Y) to get a new p4(Y). Finally, we return to item 2 and iterate. In short, the model distribution as a function of pseudo-rapidity is modified for the next round of iteration so that the masses tend toward the pion mass at each region of pseudo-rapidity.

4. This means that the changes in gain will be weighted 50% toward bringing the average mass in each region of pseudo-rapidity to the pion mass and 50% toward bringing the event rate @65 GeV toward the nominal rapidity shape. This is basically tending to make the event rate @65 GeV smooth as a function of rapidity but does not presuppose the shape of that rapidity dependence of the cross section.
We do the iterations either on a set of "Cell" instances. Reconstruction of the all the SMALL

Cell FMS instances takes several hours on one of our PC's running linux. It can also be submitted via condor, one job per cell where iteration can take a small fraction of an hour per pass.

Small Cell Results

The idea of the previous procedure is to calibrate with the constraint that

1. the two photons mass should reconstruct to the nominal π^0 mass and
2. that the cross section for π^0 production should be independent of azimuth.

The basic assumption is that at high energy, the number of π^0 events that deposit the higher energy photon in a particular cell and with π^0 energy between 65 and 66 GeV should be relatively unaffected by trigger threshold or geometrical acceptance. Clearly the assumptions are only approximately true.

The gain iteration history for each small FMS cell is found here. This file contains a history graph (gaincorr vs iteration number) for every cell starting with the lower left cell in Figure 1 (referred to as Row_0_c0_d2) meaning row=0, col=0, North.

The resulting energy and mass distributions are shown here. There is one page per cell. In red is a the energy and mass distribution for the cell in question. On the right, we see the energy and mass distributions for simulated data (simulation trigger not yet correct).

Figures similar to Figure 1, Figure 2 and Figure 3 for Monte Carlo simulations are shown here. More must be done on simulation result.

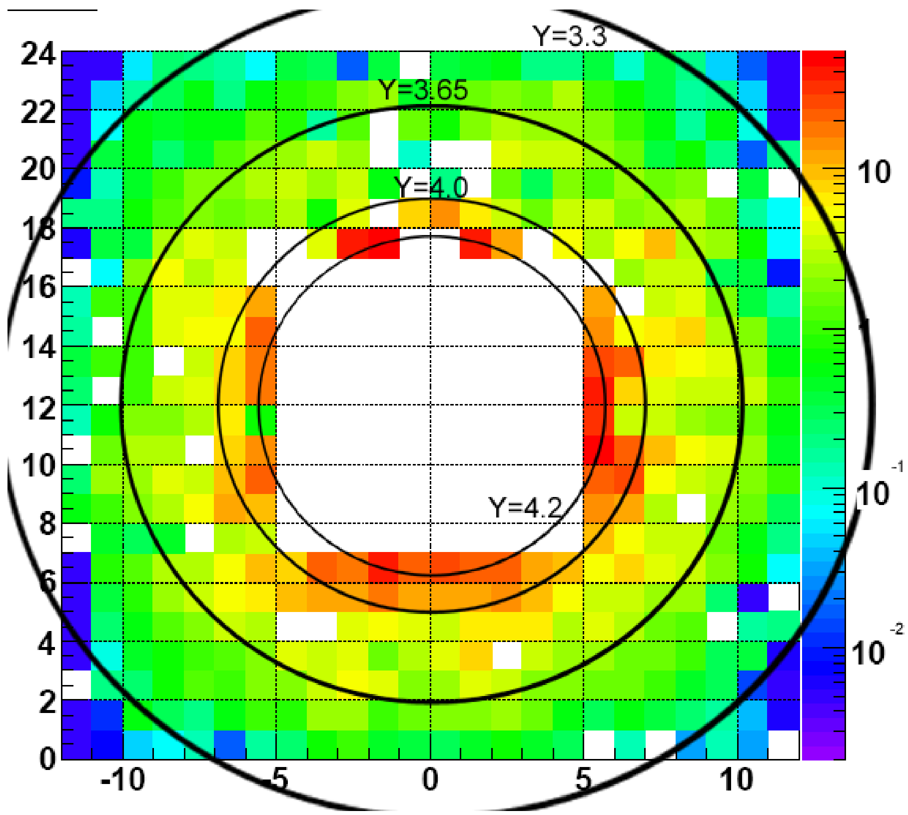

Figure 1: The color indicates the number of events per energy bin @65 GeV for all small cells.

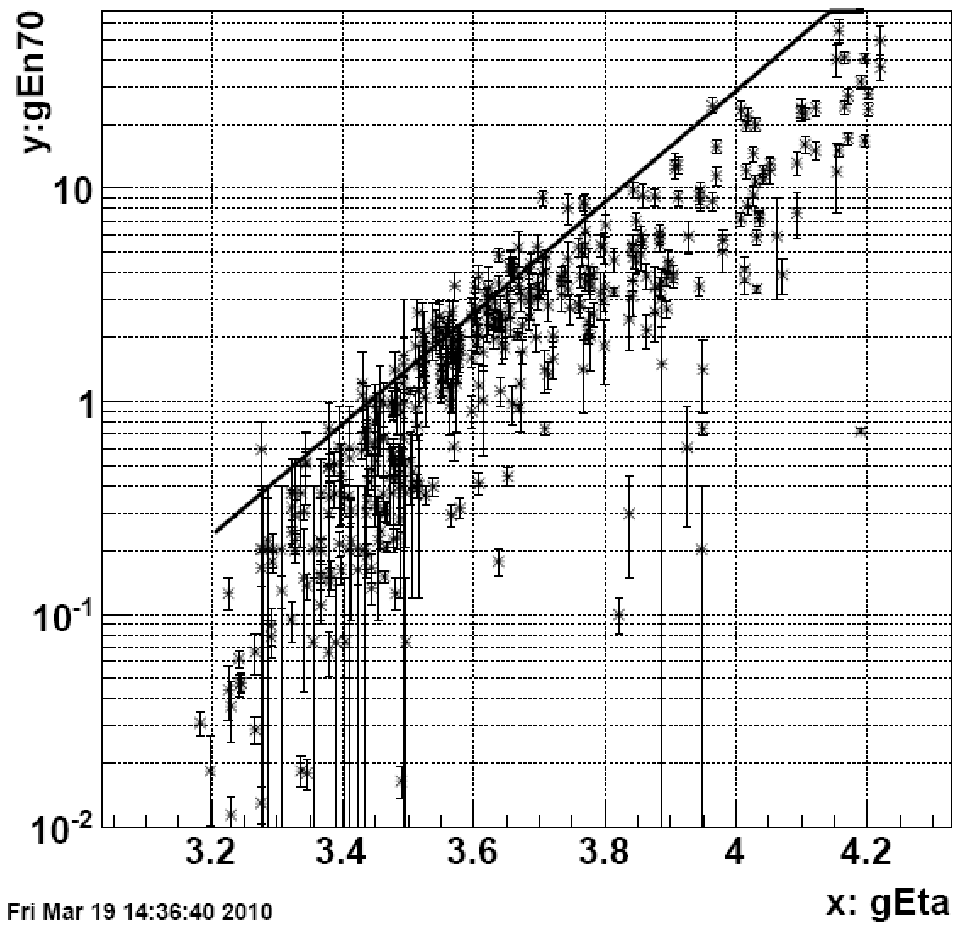

Figure 2: The same data shown in Figure 1 (one point per cell) but plotted as a function of cell rapidity.

Si

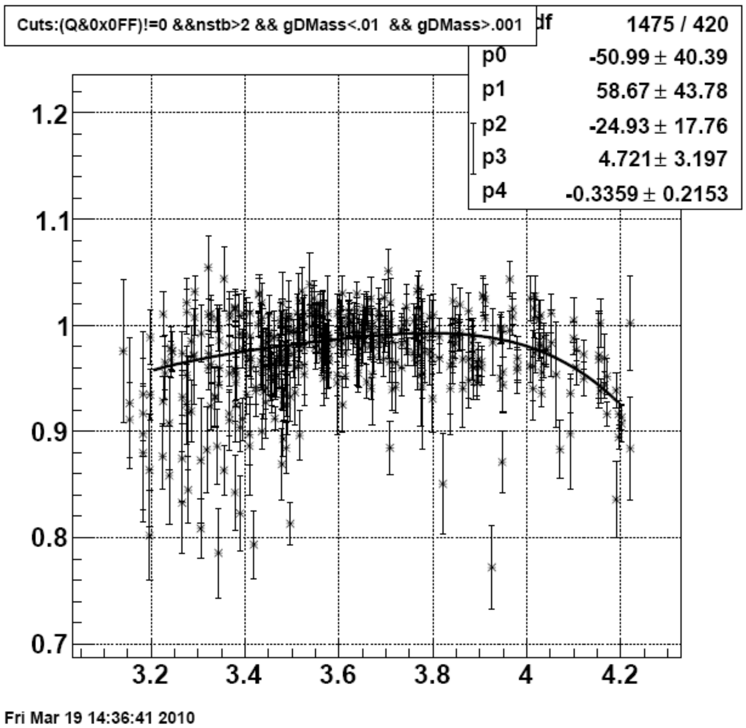

Figure 3: Ration of 0.135 to pion mass for each small FMS cell.