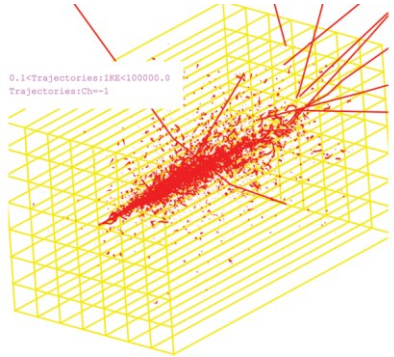
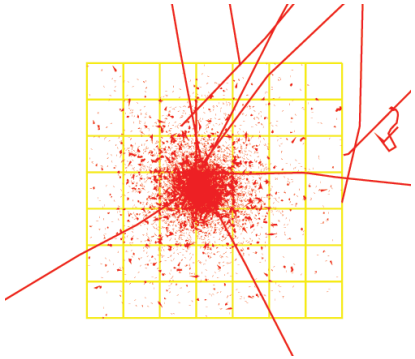
Geant 4: “Pb Glass” Showers
100 GeV photons vs. 100 GeV pi0’s
S. Heppelmann

7x7 Array Pb Glass (3.81x3.81) blocks
20 GeV Photon ;
Normal incidence
X=-1.41.4 cm Y=0. cm (from center)
Shown are all electrons with KE>100 KeV

- Simulate 10 GeV photons and pi0’s over at locations over a cell in Geant4.
- Generate shower shape parameters (using Minuit to find A & B parameters)
- Force 1 photon recon model with new shape and error function.
- dev = fraction of cluster energy in a cell – predicted value from fit.
- Plot dev as a function of (photon reconstructed position – cell position).

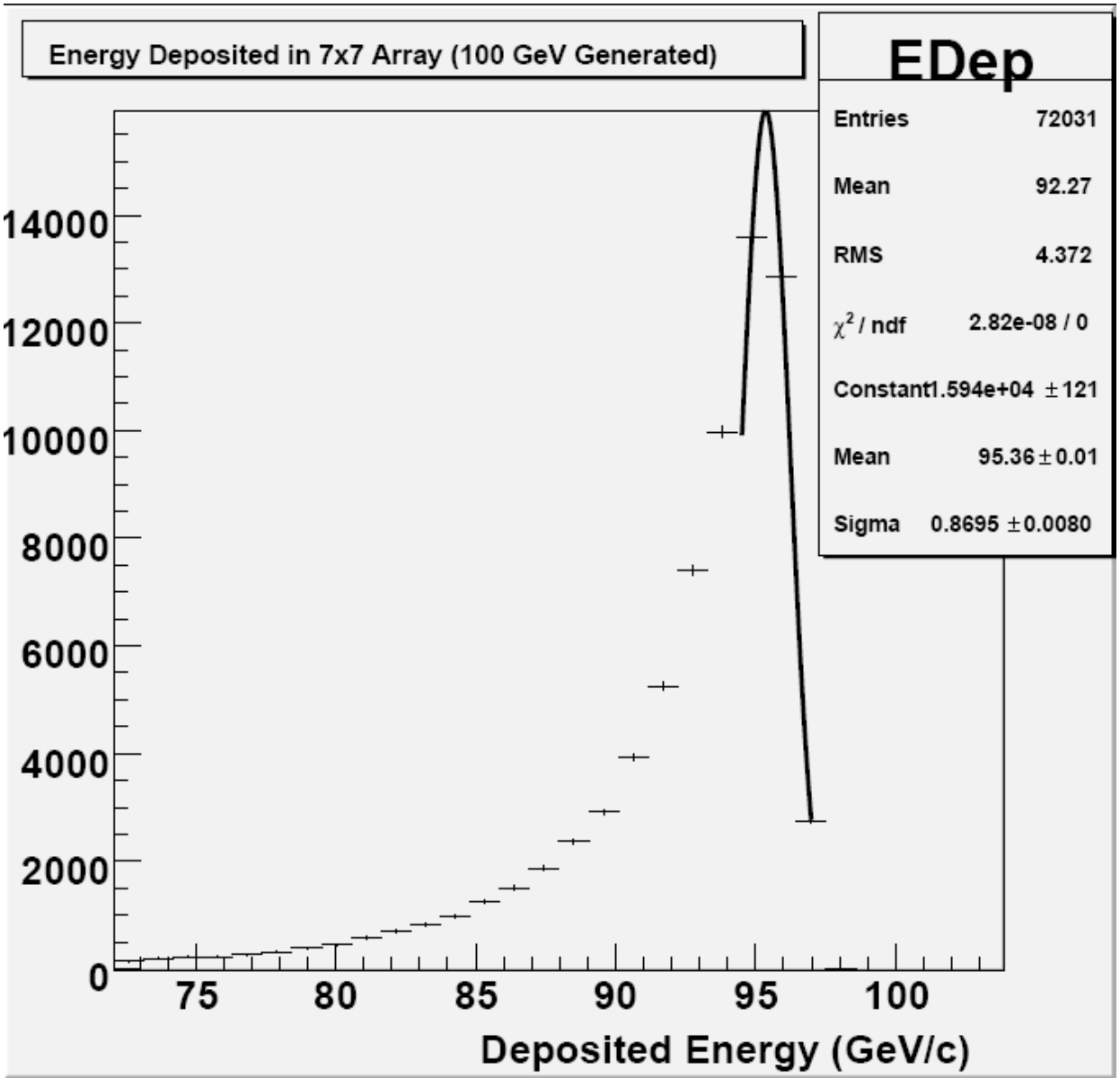




Pb Glass

```
//Pb Glass

G4Material* Pbg386 = new G4Material("PbGlass386", density= 3.86*g/cm3, nel=5);

 G4double fudge=65.4/60.712;
 G4double fudge2=(100.-65.4)/(100.-60.712);
 fudge=1.;
 fudge2=1.;

 Pbg386->AddElement(PbE,fudge*60.712*perCent);
 Pbg386->AddElement(K,2.324*perCent*fudge2);
 Pbg386->AddElement(Si,14.771*perCent*fudge2);
 Pbg386->AddElement(O,22.041*perCent*fudge2);
 Pbg386->AddElement(As,.152*perCent*fudge2);
 G4Material* PbGl=Pbg386;



  NbOfCells = 49;
  CellWidth = 3.81*cm;
  CellSpacing=3.82*cm;
  CellLength=45.*cm;
```

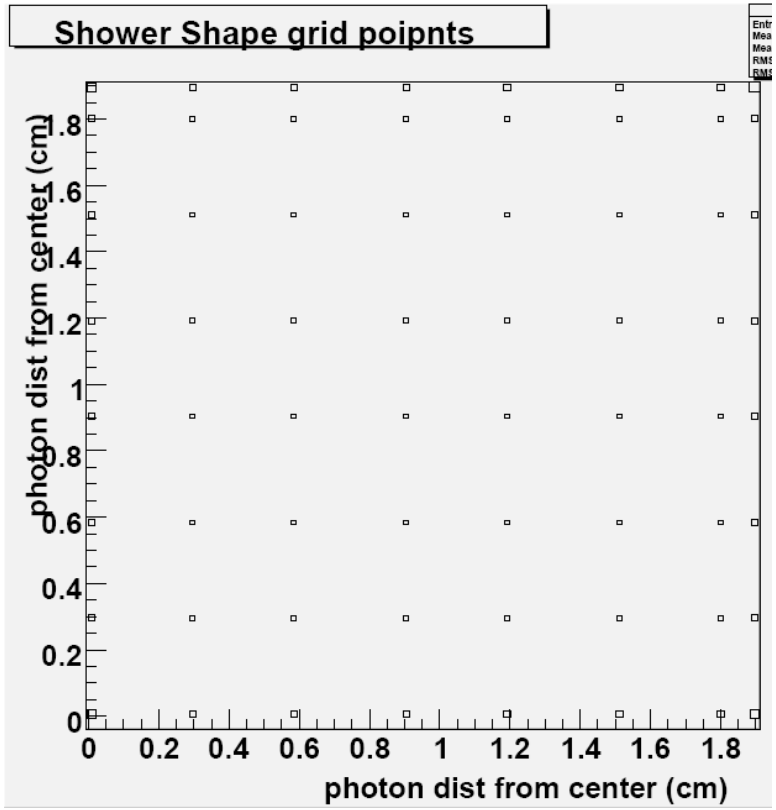
Photon Energy Deposited in 7x7 Array when 100GeV Photons strike Central Cell (Distribution from previous page)

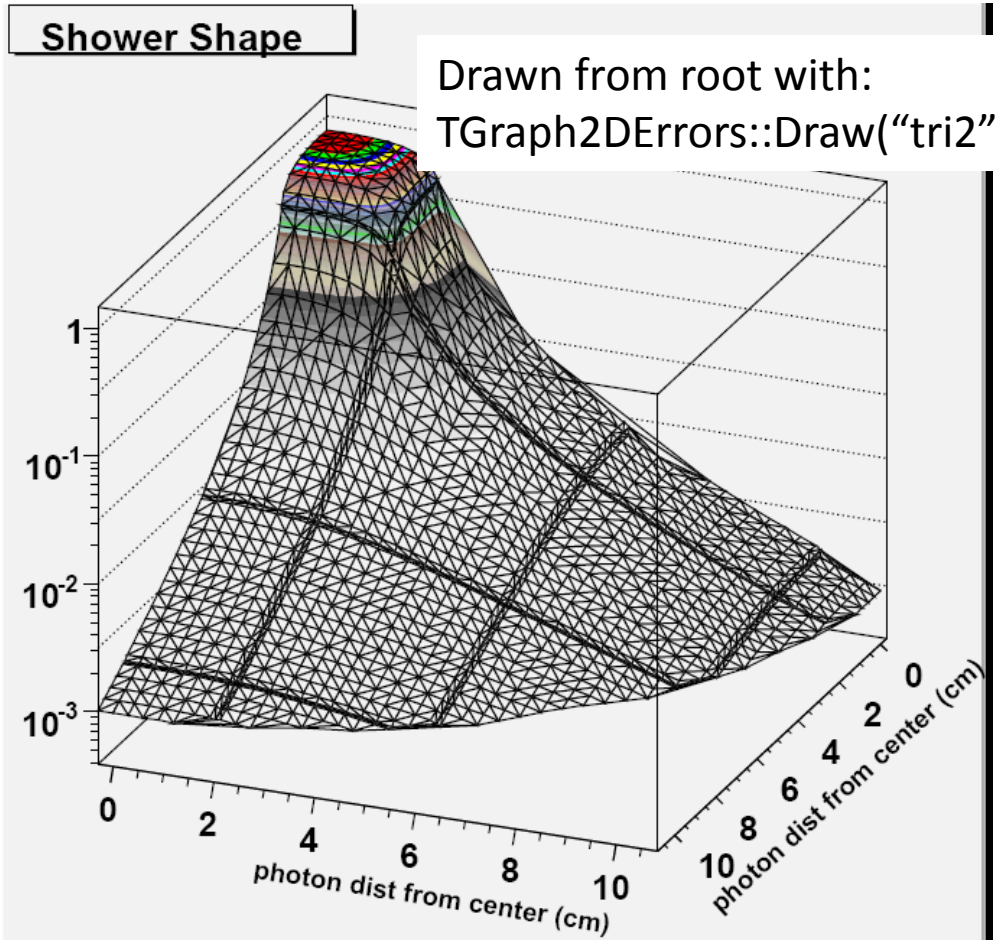


Transverse Shower Shape

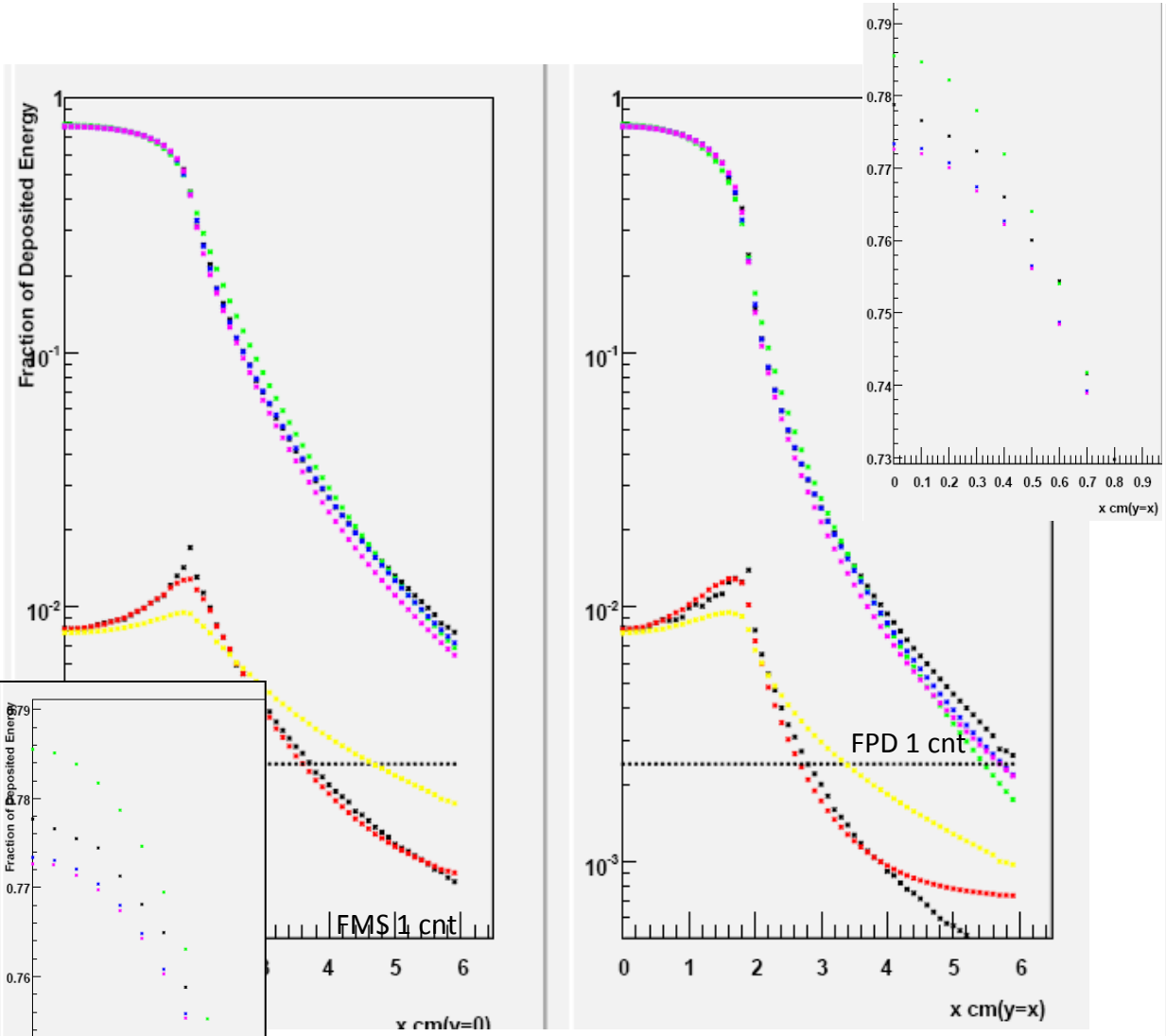
2000 photons and 2000 π^0's are directed (normal incidence) at each location (x,y) shown in the grid below-left.
Incident directions are along "z" axis. Resulting shape shown below-right.
(Fraction Energy deposited vs. distance from photon to cell center)

Triangular interpolation between function at grid points to generate continuous function Shape(x,y).





100 GeV Photon Shapes



Black upper: Shower shape from Geant4 analysis.
Black lower: Error shape from Geant4 analysis.

Green: default Shower Shape from reconstruction

```
float a0[3]={.8,.3,-.1};
float b0[3]={.8,.2,7.6};
```

Yellow: default Error shape

$$\Delta E_{cell} = \sqrt{(.03)E_{cell}\left(1-\frac{E_{cell}}{E_{photon}}\right)}$$

Blue: Suggested Shape:

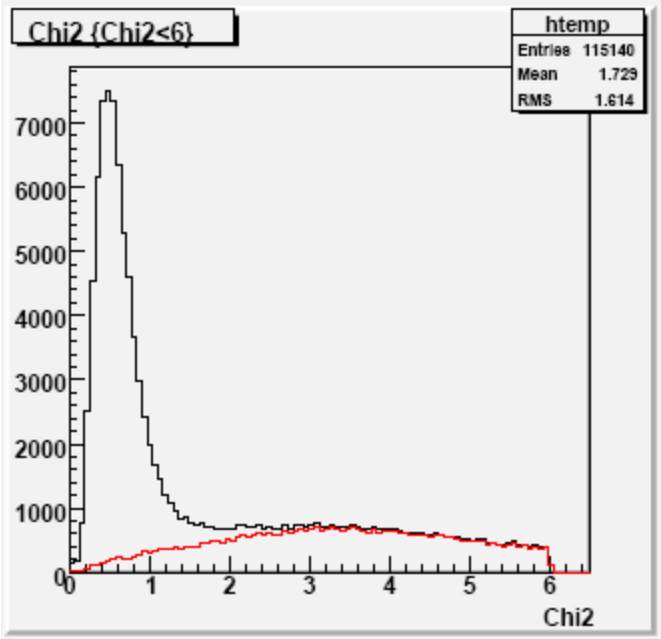
```
float b1[3]={. 0.53, 0.51, -0.041};
float a1[3]={. 0.94, 0.20,  10. };
```

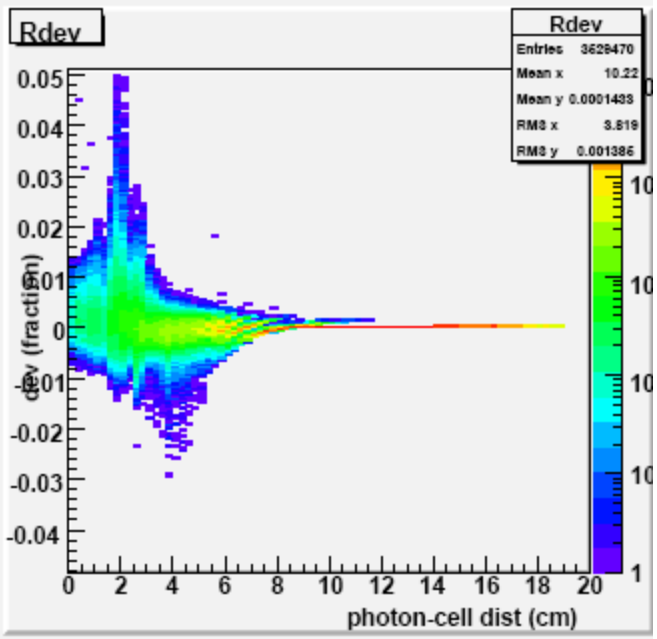
Red: Suggested Error:

$$\Delta E_{cell} = \sqrt{(.24)\left(\frac{E_{cell}}{E_{\gamma}}\right)^{1.85}\left(1-\frac{E_{cell}}{E_{\gamma}}\right)^{2}E_{\gamma}}$$

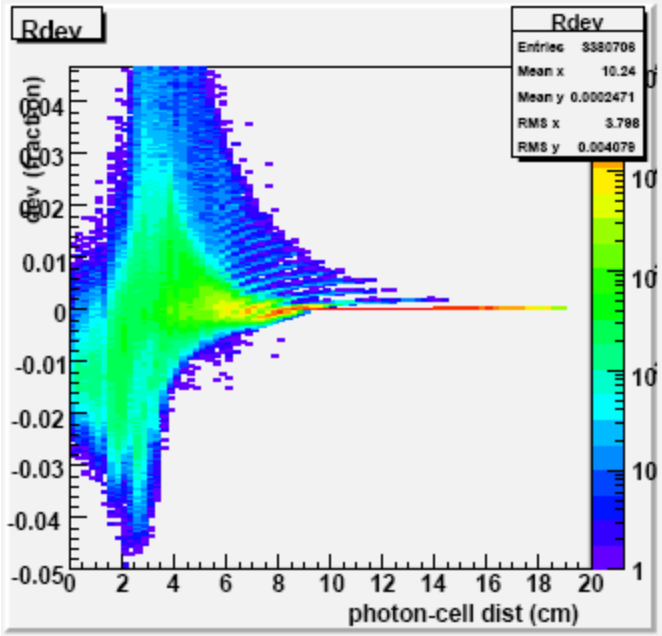
Energy photon or pi0 = 100 GeV

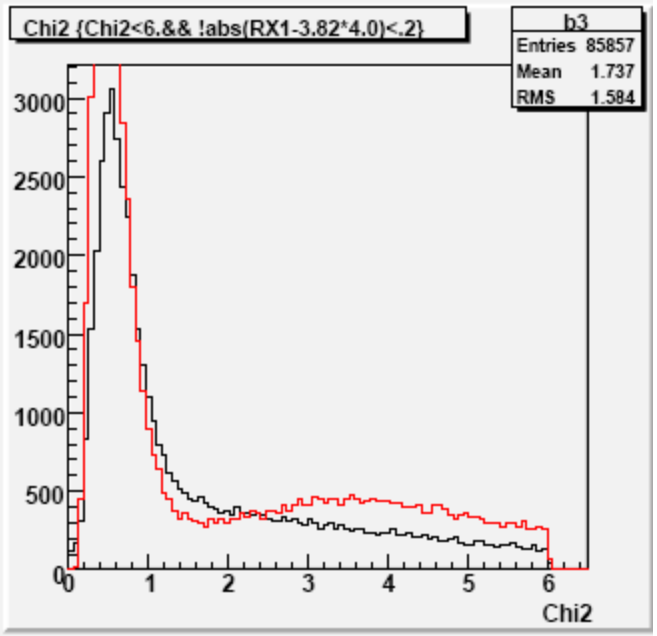
Energy digitization step = .2 GeV





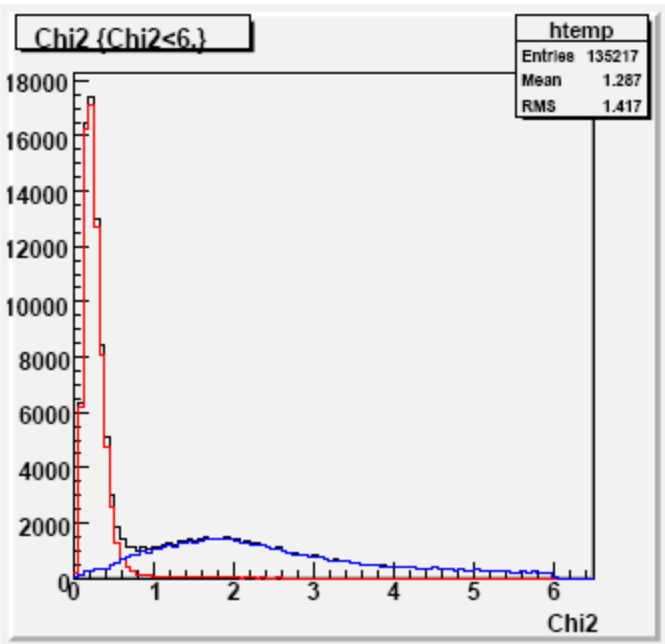
Const Err=.1 GeV

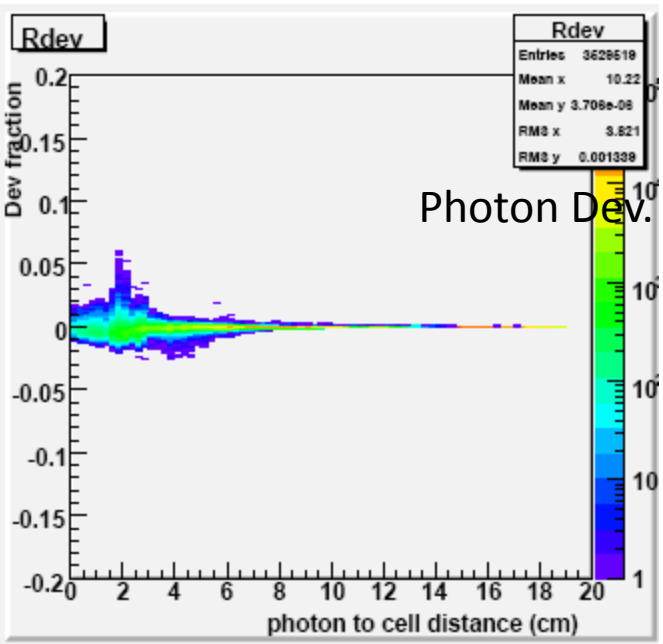




Energy photon or pi0 = 100 GeV

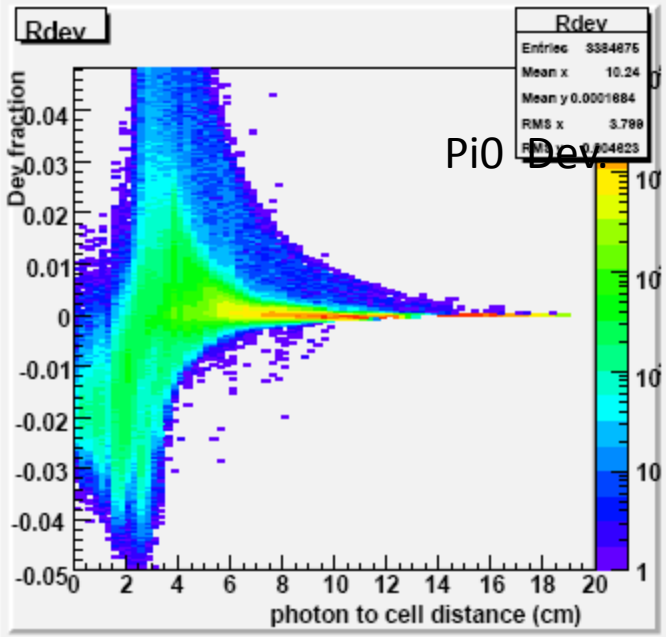
Energy digitization step = .05 GeV



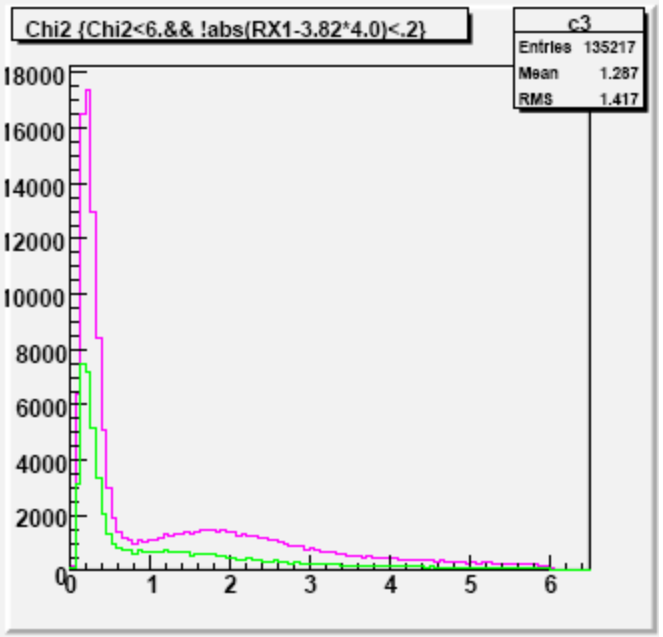


Photon Dev.

Const Err=.1 GeV



Pi0 Dev.



Energy photon or pi0 = 80 GeV

Energy digitization step = .05 GeV