π^0 Reconstruction Efforts

Rob Kroeger

June 14, 2006

To reconstruct single photon:

```
Xt_Fitter the_Xt_Fitter(myGamCluster);

 if(the_Xt_Fitter.valid_photon) {........}
```

To reconstruct 2-bump cluster:

```
Xt_Fitter the_Xt_Fitter(theIndexedPi0Bumps);
if(the_Xt_Fitter.valid_Pi0) {
        E0 = the_Xt_Fitter.Photon_E[0]/1000.;
        E1 = the_Xt_Fitter.Photon_E[1]/1000.;
        position0 = the_Xt_Fitter.Photon_pos[0];
        position1 = the_Xt_Fitter.Photon_pos[1];
        double myCalibEnergy0 =
            myCalibrator->energyOf(E0,position0);
         double myCalibEnergy1 =
            myCalibrator->energyOf(E1,position1);
```

To split one bump:

```
theIndexedBump.insert(std::map<TwoCoordIndex*, EmcBump
BbrPtrLess>::value_type (theCurrMaximaTCI, currBump));
 bool split_one_bump =true;
 Xt_Fitter this_Xt_Fitter(theIndexedBump, split_one_bump);
if (this_Xt_Fitter.valid_Pi0) { double E0 = this_Xt_Fitter.Photon_E[0]/1000.;
                                 double E1 = this_Xt_Fitter.Photon_E[1]/1000.;
                                HepPoint position0 =
                                            this_Xt_Fitter.Photon_pos[0];
                                HepPoint position1 =
                                            this_Xt_Fitter.Photon_pos[1];

                                double myCalibEnergy0 =
                                     myGamCalibrator->energyOf(E0,position0);
                               double myCalibEnergy1 =
                                     myGamCalibrator->energyOf(E1,position1);

 }
```

The GFLASH parameterization was used:

Shower parameterization:

Longitudinal:

$$\frac{dE}{dz} = \frac{E_0 (\beta z)^{\alpha - 1} e^{-\beta z}}{\Gamma(\alpha)}$$

Transverse (Grindhammer* form):

$$f(r) = \frac{2rR_{50}^2}{\left(r^2 + R_{50}^2\right)^2}$$

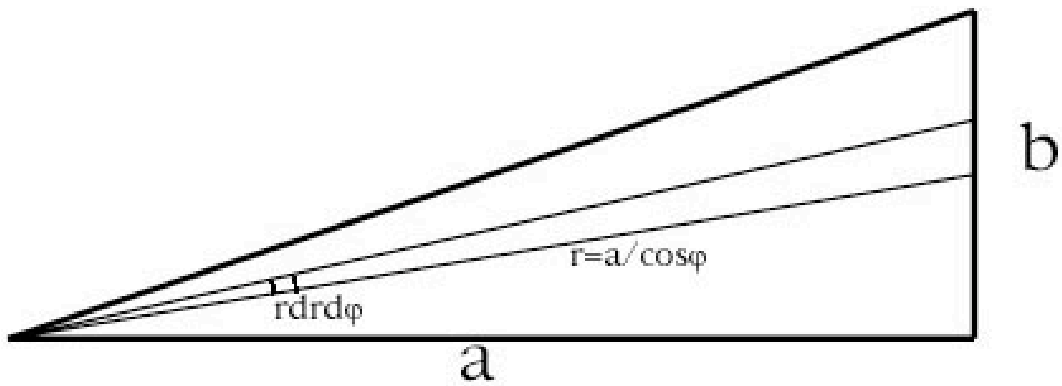
$$\langle R_{50} \rangle = \left[R_1 + \left(R_2 - R_3 \ln E\right)\right]^2$$

$$V_{R_{50}} = \left[\left(S_1 - zS_2 \ln E\right)\left(S_3 + S_4 z\right)\langle R_{50} \rangle\right]$$

*SLAC-PUB-5072

WHY?:

Transverse Grindhammer shower shape can be integrated analytically:

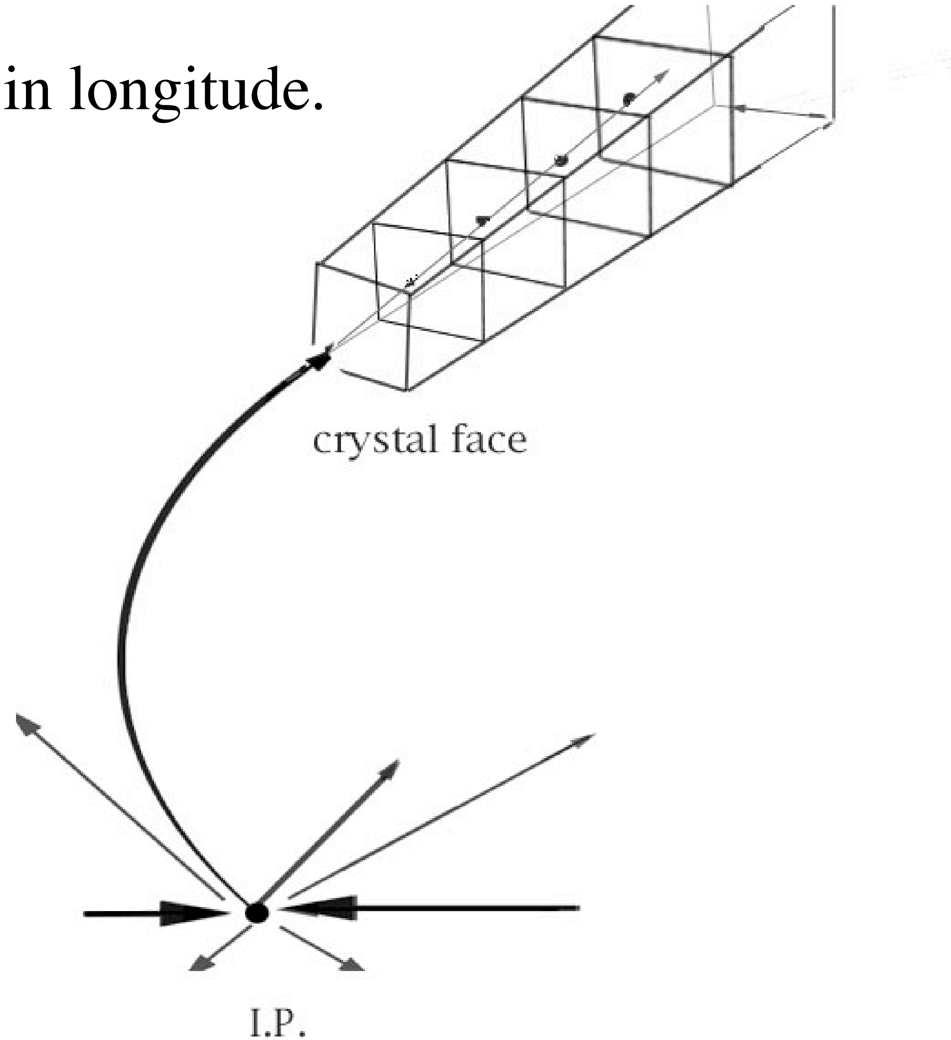


$$\frac{dE_{pad}}{dz} = \frac{dE}{dz}\int_{\phi=0}^{\arctan(a/b)}\int_{r=0}^{a/\cos}\frac{2rR_{50}^2}{\left(r^2+R_{50}^2\right)^2}dr\,d\phi$$

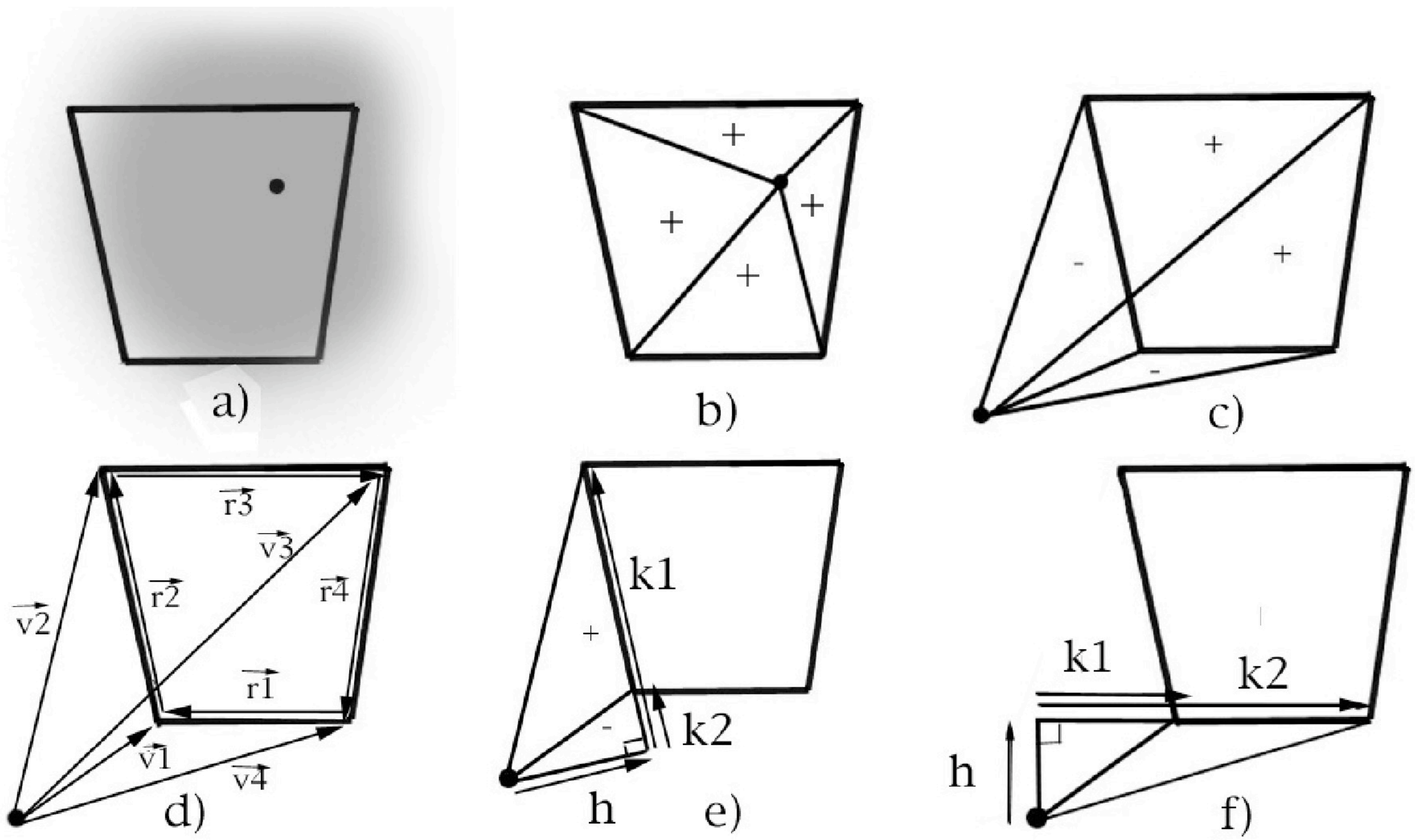
$$= \frac{dE}{dz}\frac{a}{2\pi\left(r^2+R_{50}^2\right)^{1/2}}\arctan\left(\frac{b}{\sqrt{a^2+R_{50}^2}}\right)$$

χ^2 fit to Grindhammer form

Sum over slices in longitude.



Each trapazoidally shaped pad devided into eight right-triangles



$$Triag_{ij} = I(h_{ij}, k1_{ij}) - I(h_{ij}, k2_{ij})$$

Bogus Fast Shower Parameterization, D. Bernard BABAR Note 476

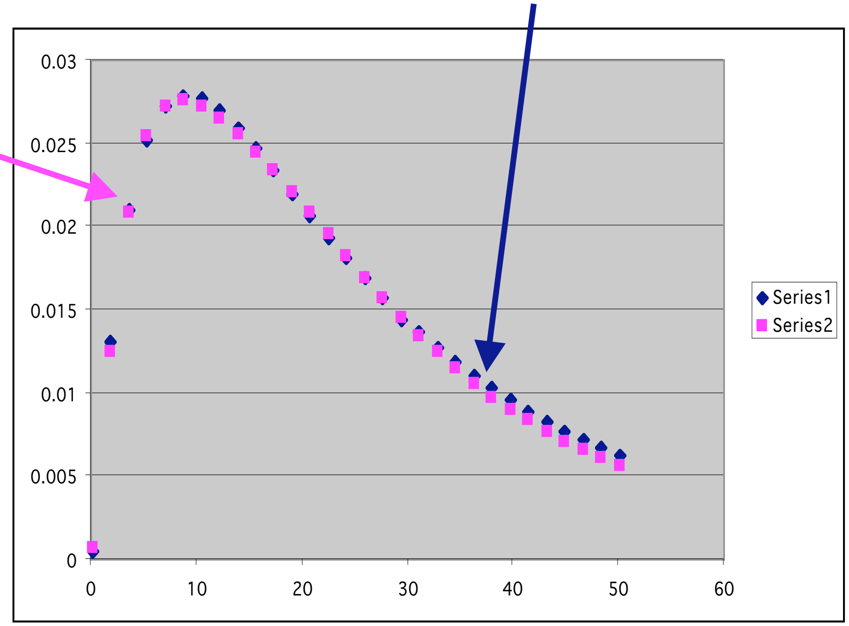
$$dE_{dep} = E_0 \;\; f_z(z) \;\; f_r(r,z) \; \tfrac{1}{2\pi} d\phi dz dr$$

$$f_z(z) = \frac{\beta(\beta z)^{\alpha-1} e^{-\beta z}}{\Gamma(\alpha)}$$

$$f_r(r,z) = \frac{\left(\sqrt{\frac{r}{\lambda_r}}\right)^{\alpha-2} e^{-\sqrt{\frac{r}{\lambda_r}}}}{2\lambda_r \Gamma(\alpha_r)}.$$

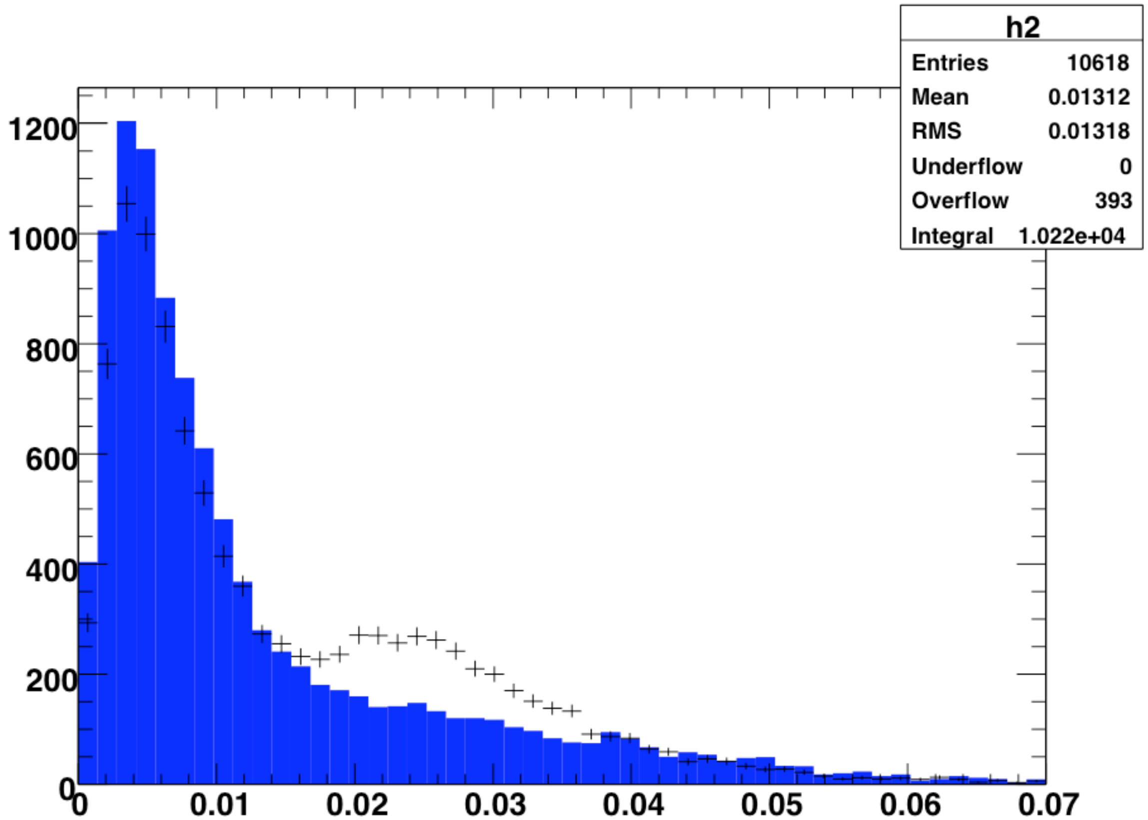
Transverse distribution approximated by sum of Grindhammer terms:

$$f_r(r) \approx \frac{\varepsilon_1 2rR_1 2}{\left(r2 + R_1 2\right)^2} + \frac{\varepsilon_2 2rR_2 2}{\left(r2 + R_2 2\right)^2} + \frac{(1-\varepsilon_1-\varepsilon_2)2rR_3 2}{\left(r2 + R_3 2\right)^2}$$



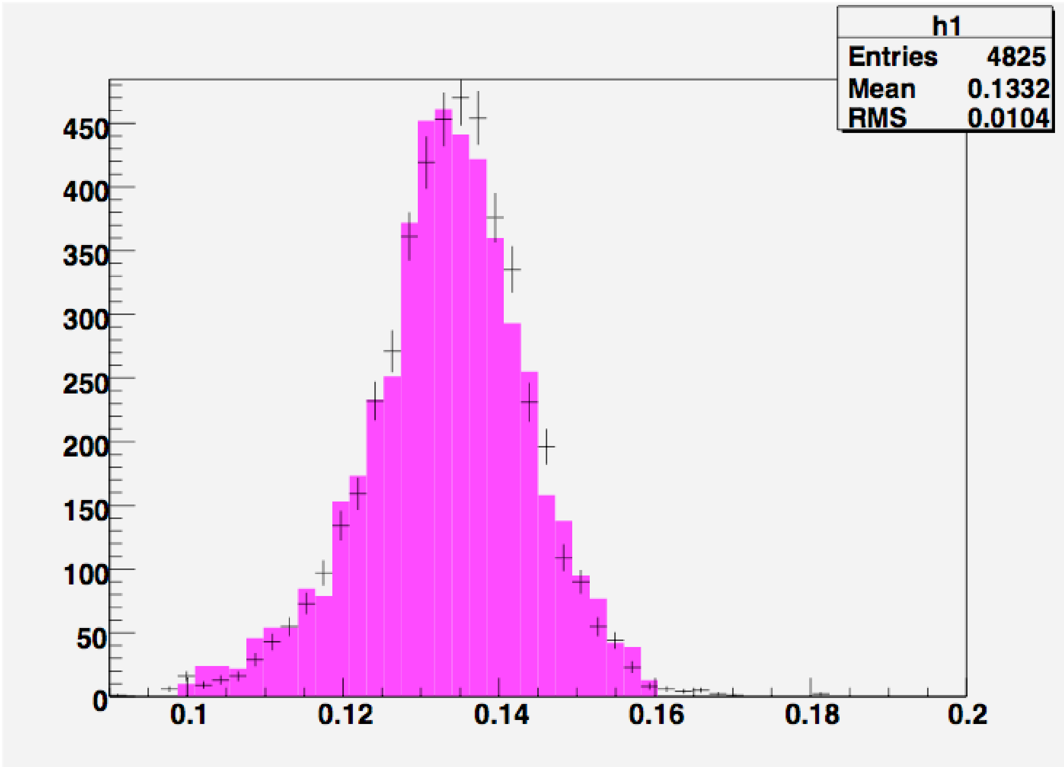
June 14, 2006

Photon Reconstruction

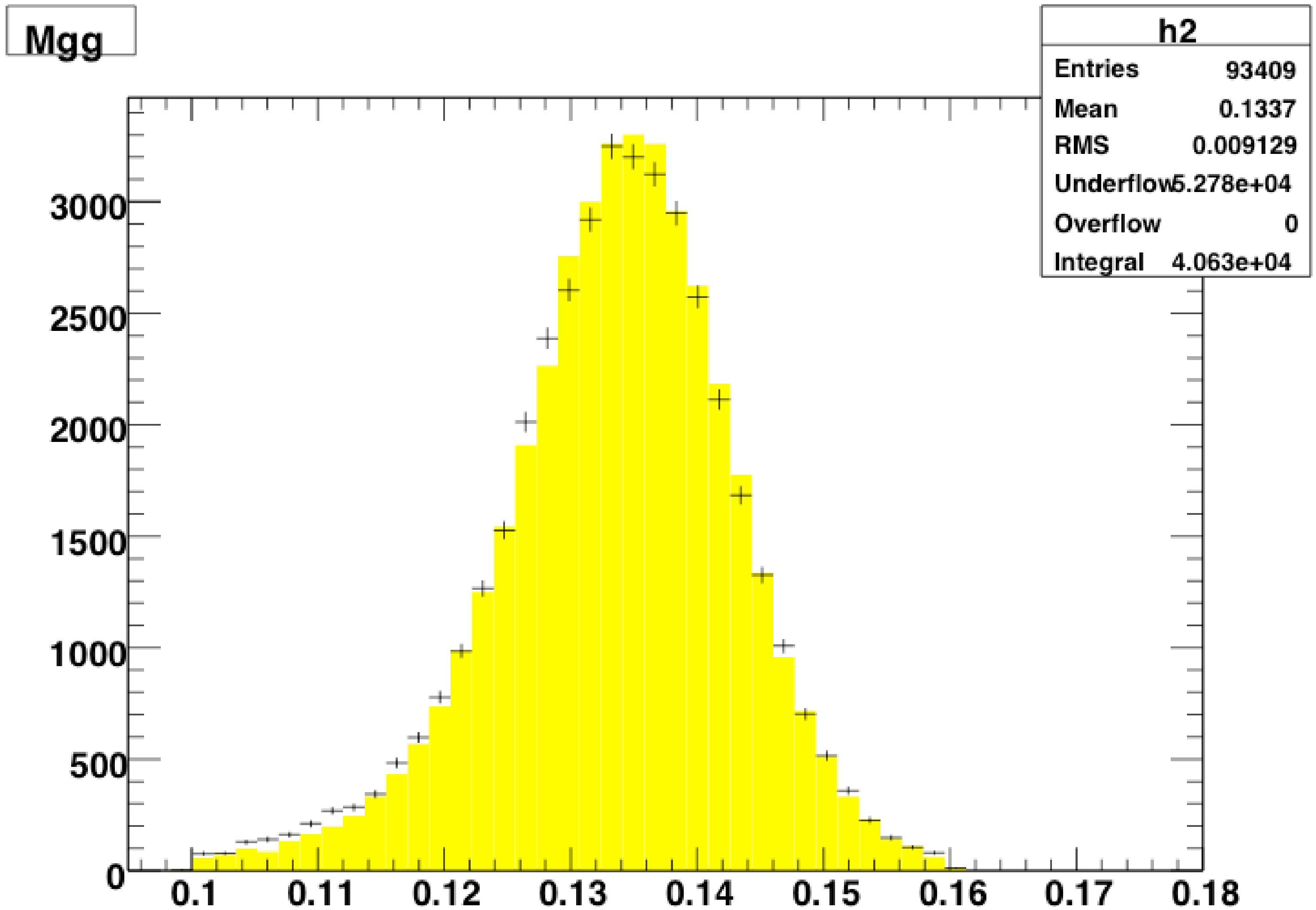


Angular Reconstruction Error
1γ reco compared to prod code

π^0 Reconstruction



Marginal improvement (?) for π^0


Mgg
h2
Entries 93409
Mean 0.1337
RMS 0.009129
Underflow 5.278e+04
Overflow 0
Integral 4.063e+04
3000
2500
2000
1500
1000
500
0
0.1
0.11
0.12
0.13
0.14
0.15
0.16
0.17
0.18

- Attempt to estimate axis of decay:

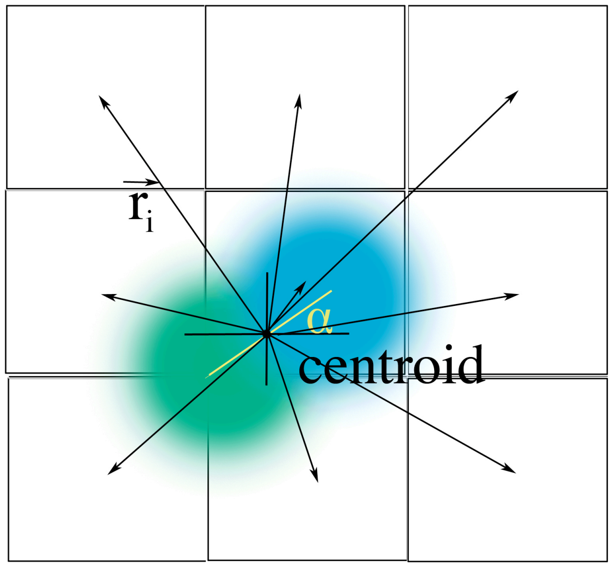
$$\frac{\partial}{\partial\alpha}\left[\sum_i \left(\vec{r}_i \bullet \vec{\alpha}\right)^2 E_i^2\right] = 0$$

$$\vec{r}_i = \vec{x}_i - \langle \vec{x} \rangle$$

$$\left[\sum_i 2\left(\vec{r}_i \bullet \vec{\alpha}\right) E_i^2 \frac{\partial\left(\vec{r}_i \bullet \vec{\alpha}\right)}{\partial\alpha}\right] = 0$$

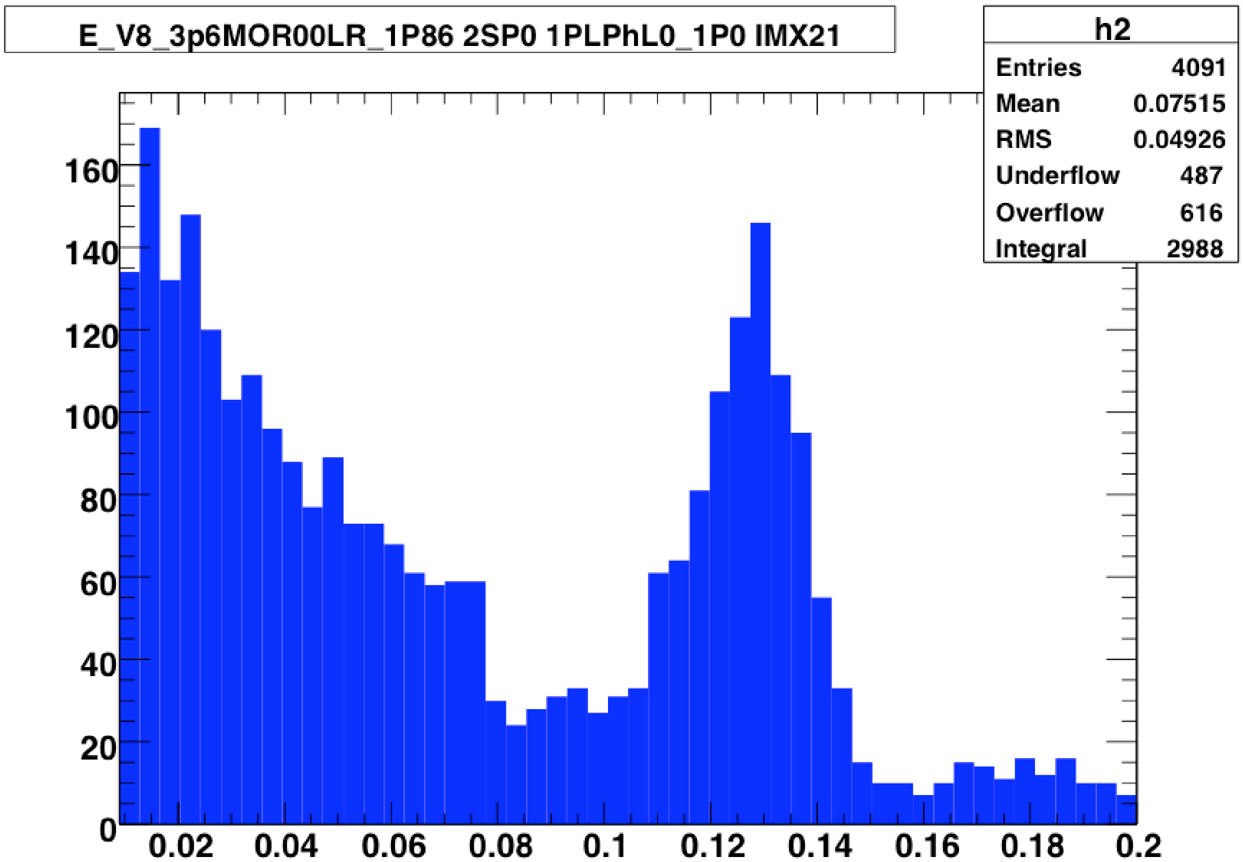
$$\sum_i 2E_i^2 \left(r_{ix}\cos\alpha + r_{iy}\sin\alpha\right)\left(-r_{ix}\sin\alpha + r_{iy}\cos\alpha\right) = 0$$

$$\alpha = \tfrac{1}{2}\arctan\left(\frac{2\sum_i E_i^2 r_{ix} r_{iy}}{\sum_i E_i^2\left({r_{iy}}^2 - {r_{ix}}^2\right)}\right)$$



One Bump merged Pi0 candidates in

MergedPi0Tight $B^0 \to \pi^0\pi^0$



One Bump merged Pi0 candidates in

Single Pi0