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of Matter and
Radiation

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Oujda

ATLAS Forward Calorimeter Analysis

KTH/ FSO meeting
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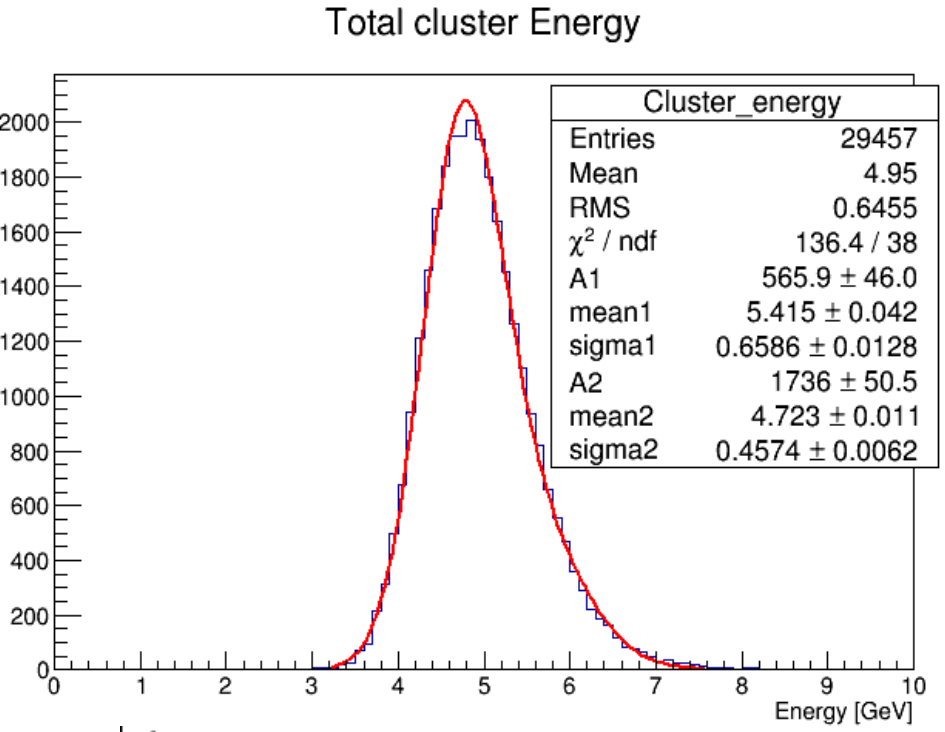
Electrons Analysis

- Reconstruction of energy in Fcal considering only the energy deposited in FC1.
- Cut of Eta between 3.4 & 4.4 .
- Cluster energy with a radius of 8cm fitted by double gaussian .
- Energy resolution.
- Position resolution.

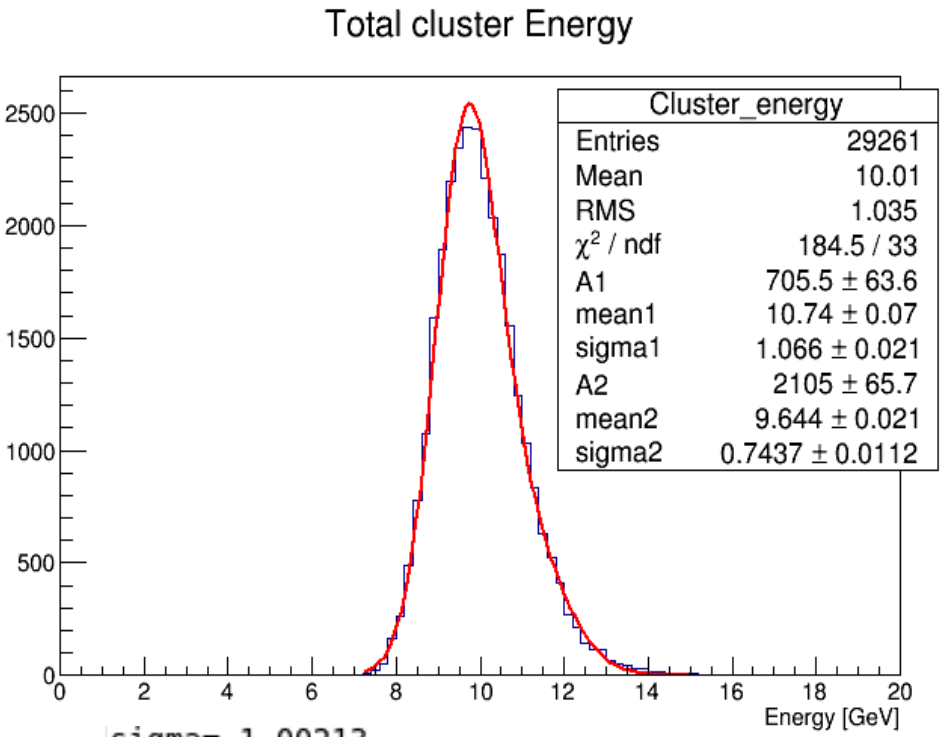
Electrons – Energy Reconstruction

- **Total cluster energy in FCal with a radius of 8cm .**
- **Fit with Double gaussian.**




```
sigma= 0.620479
mean= 4.94423
Energy resolution= 0.125496
error Energy resolution = 0.00577639
root [1]
```

5 GeV

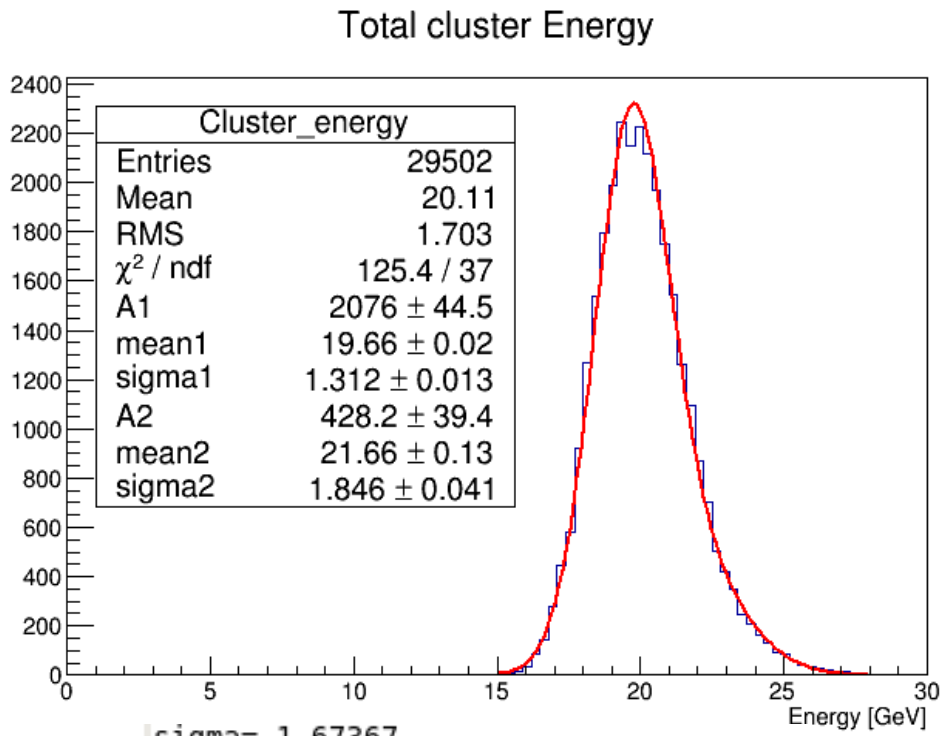



```
sigma= 1.00213
mean= 9.99892
Energy resolution= 0.100224
error Energy resolution = 0.00481356
root [3]
```

10 GeV

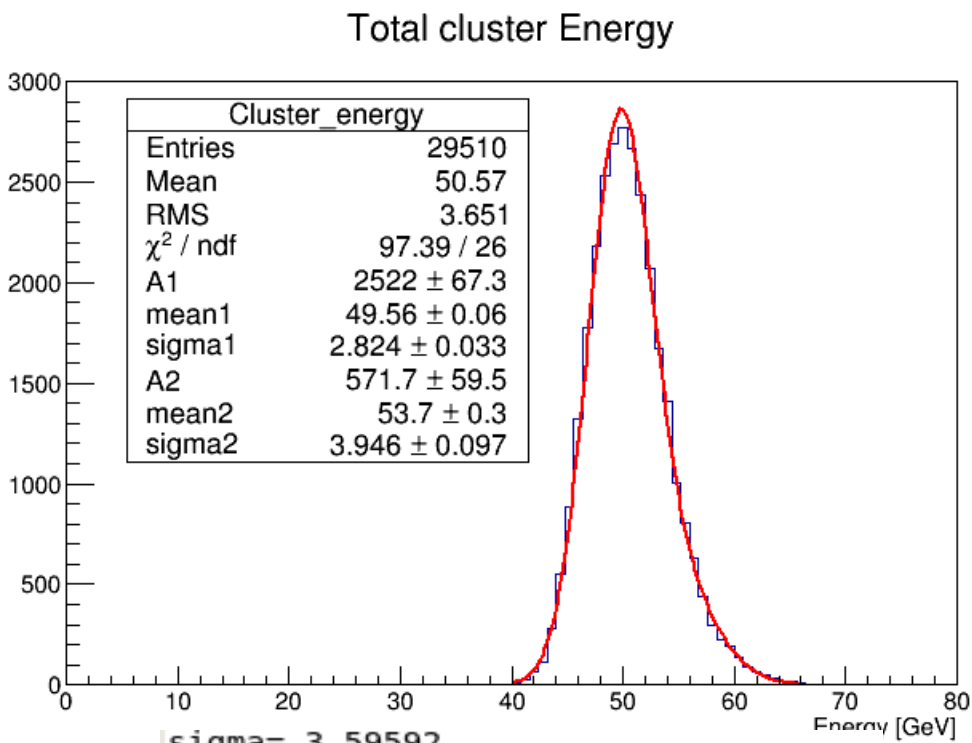
Electrons – Reconstruction of energy

- **Total cluster energy in FCal with a radius of 8cm .**
- **Fit with Double gaussian.**




```
sigma= 1.67367
mean= 20.1091
Energy resolution= 0.0832295
error Energy resolution = 0.00385409
root [4]
```

20 GeV

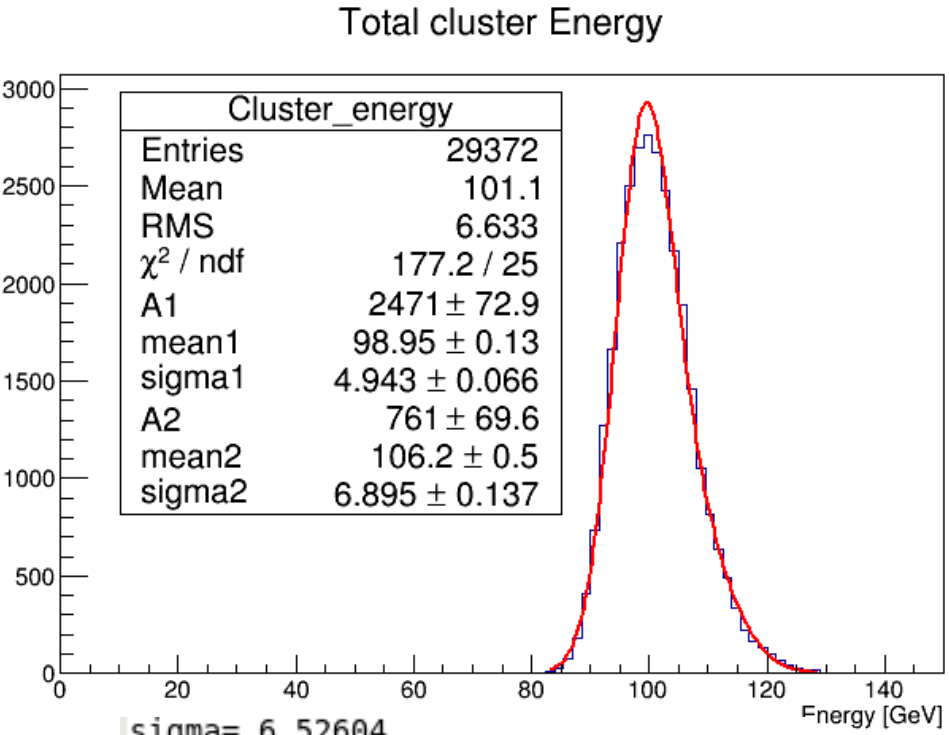



```
sigma= 3.59592
mean= 50.5565
Energy resolution= 0.0711267
error Energy resolution = 0.00370548
root [3]
```

50 GeV

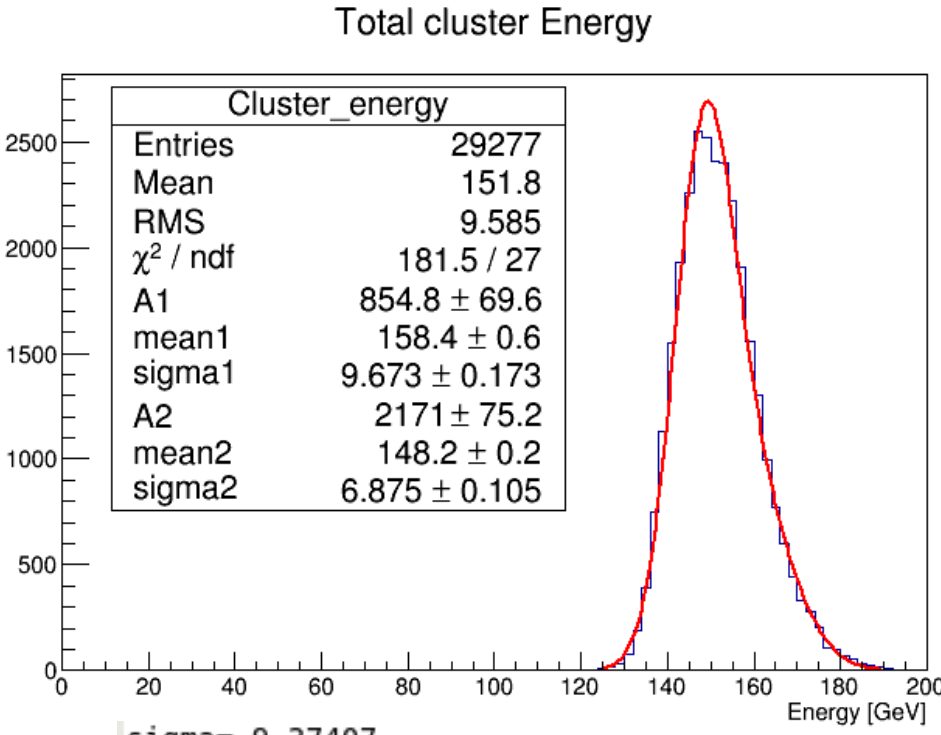
Electrons – Reconstruction of energy

- **Total cluster energy in FCal with a radius of 8cm .**
- **Fit with Double gaussian.**




```
sigma= 6.52604
mean= 101.14
Energy resolution= 0.0645249
error Energy resolution = 0.00305439
root [7]
```

100 GeV

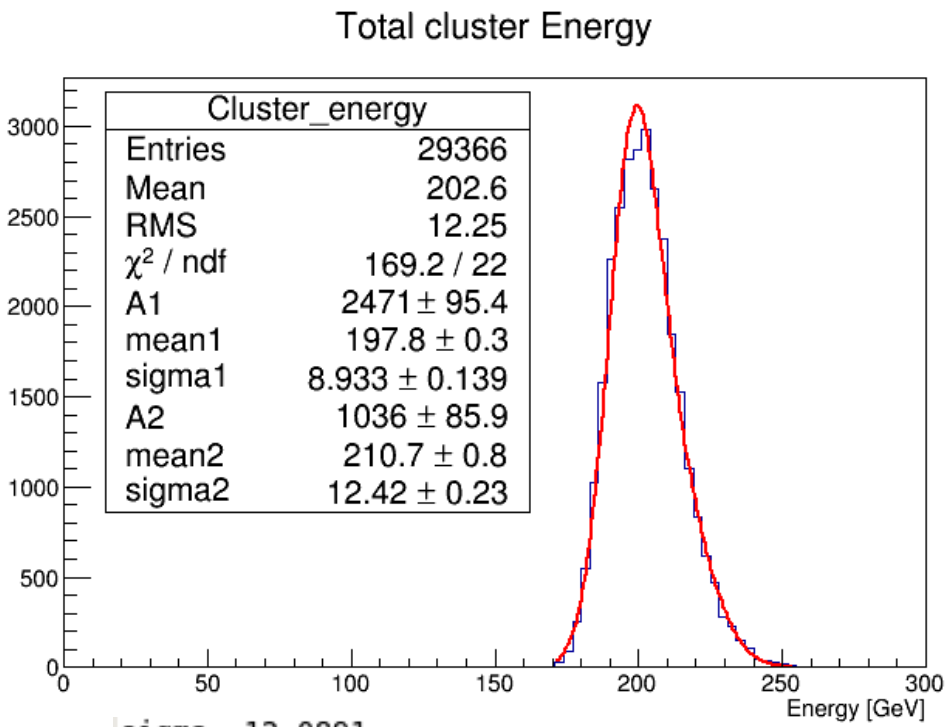



```
sigma= 9.37407
mean= 151.827
Energy resolution= 0.0617418
error Energy resolution = 0.00280467
root [8]
```

150 GeV

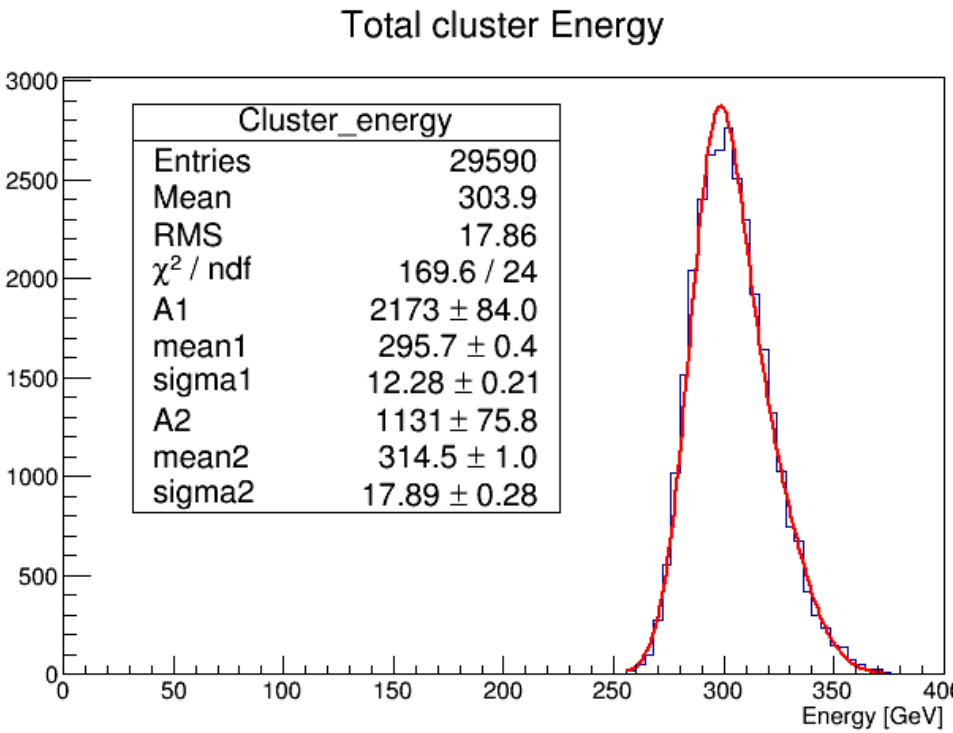
Electrons – Reconstruction of energy

- **Total cluster energy in FCal with a radius of 8cm .**
- **Fit with Double gaussian.**




```
sigma= 12.0891
mean= 202.581
Energy resolution= 0.0596754
error Energy resolution = 0.00277672
root [15]
```

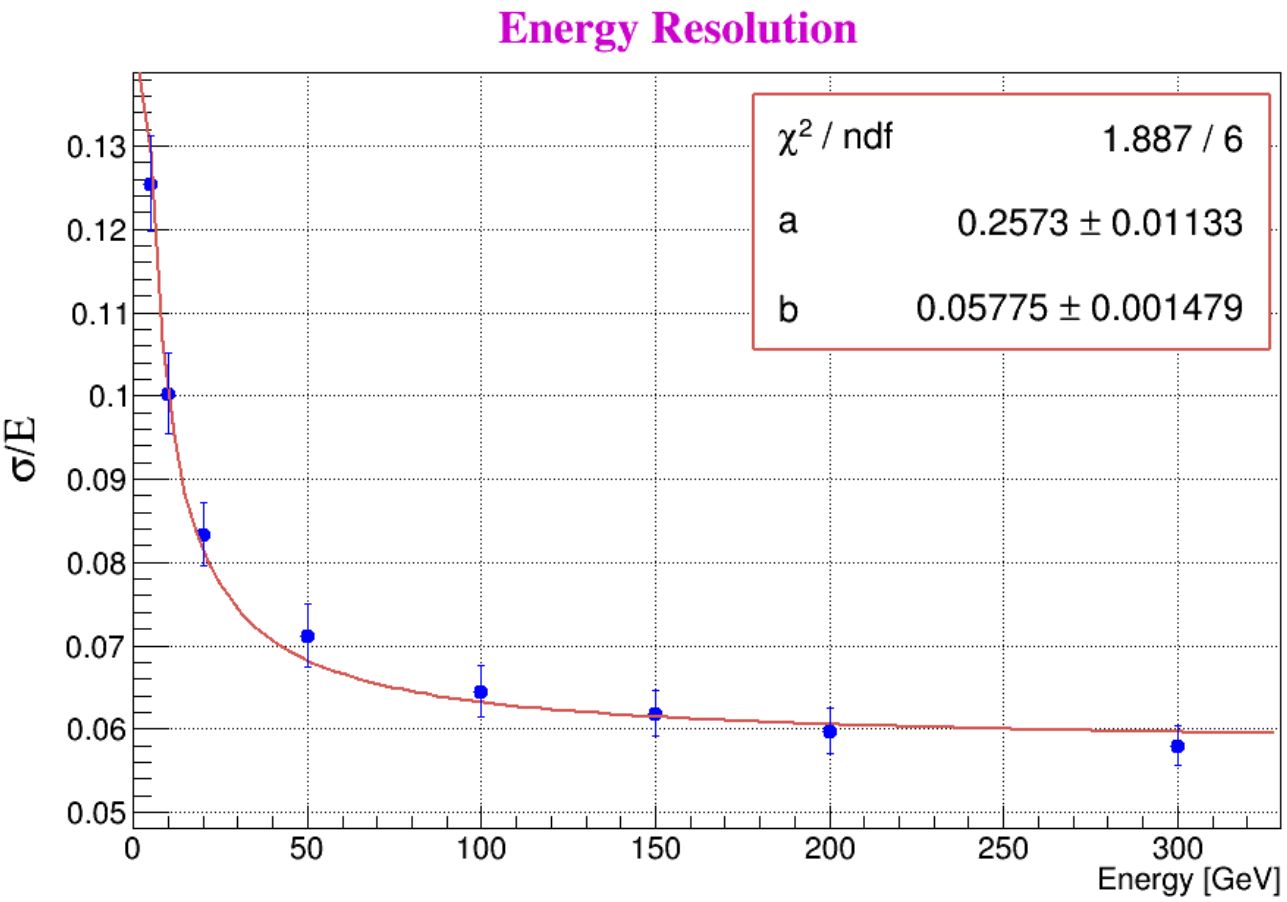
200 GeV




```
sigma= 17.6198
mean= 303.843
Energy resolution= 0.0579899
error Energy resolution = 0.00238118
root [20]
```

300 GeV

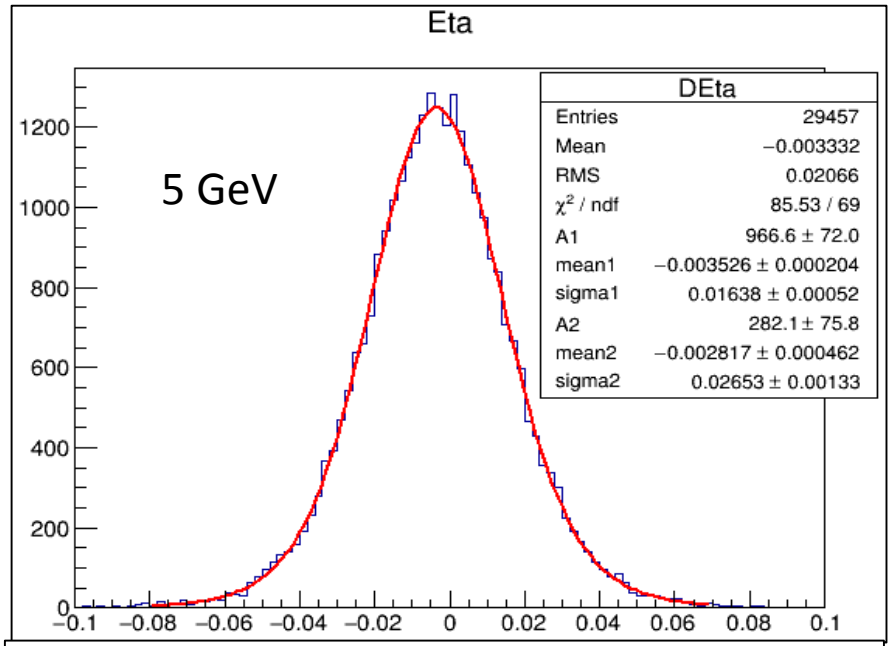
Electrons – Resolution of energy

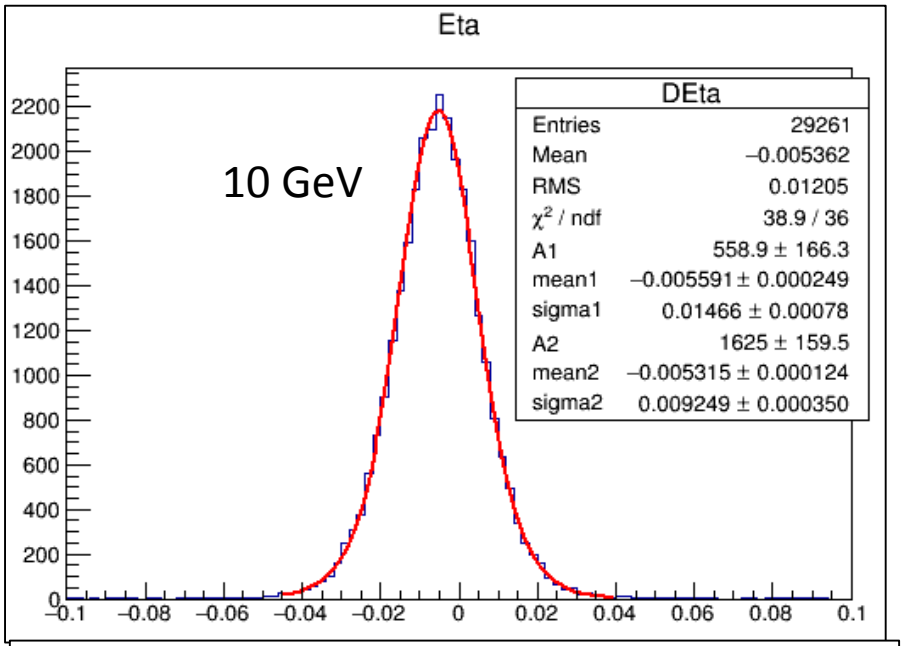


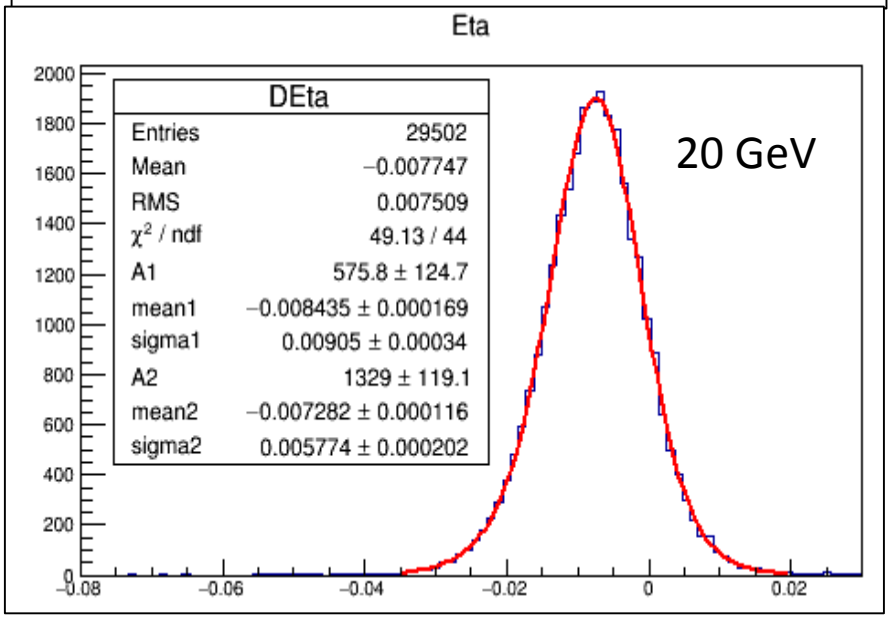
a= (25.73 ± 0.01) %$\sqrt{GeV}$

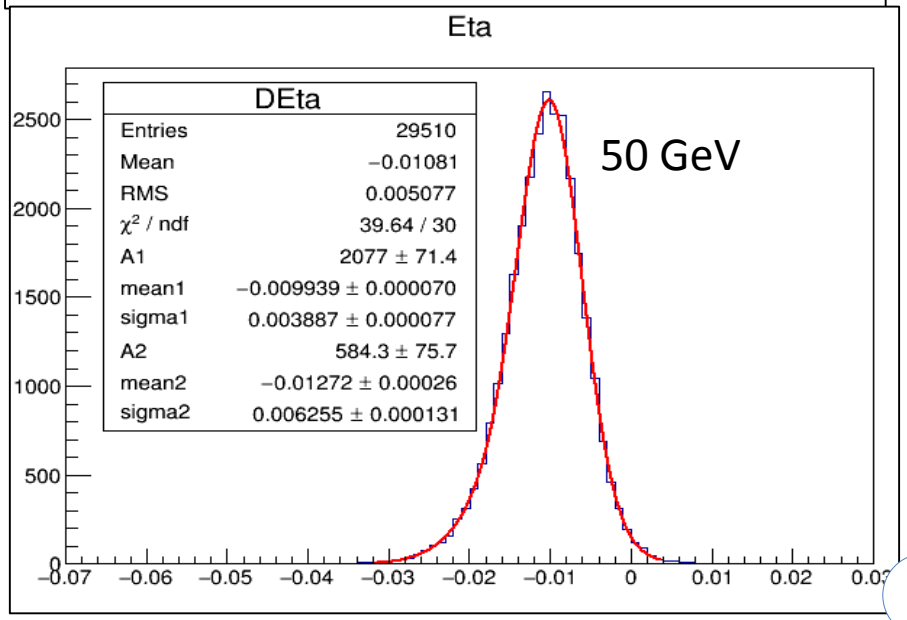
b= (5.7 ± 0.001) %

Electrons – η Position – fit with double gaussian

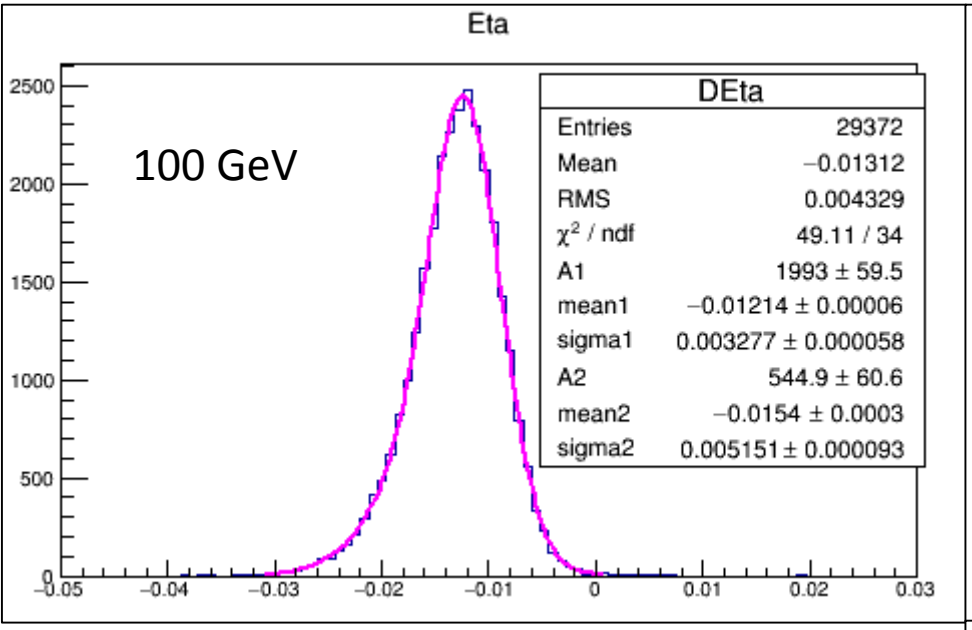


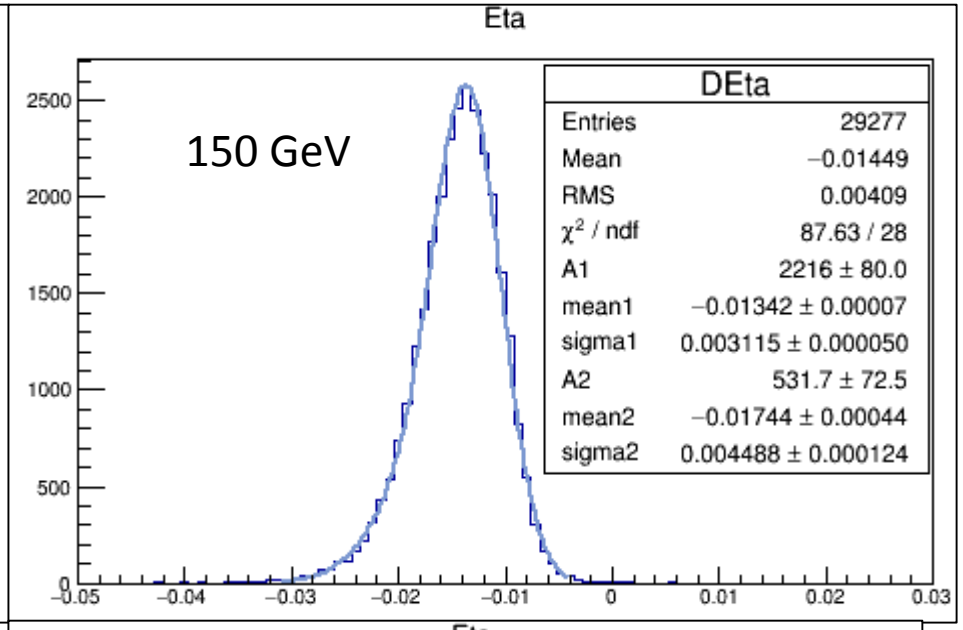


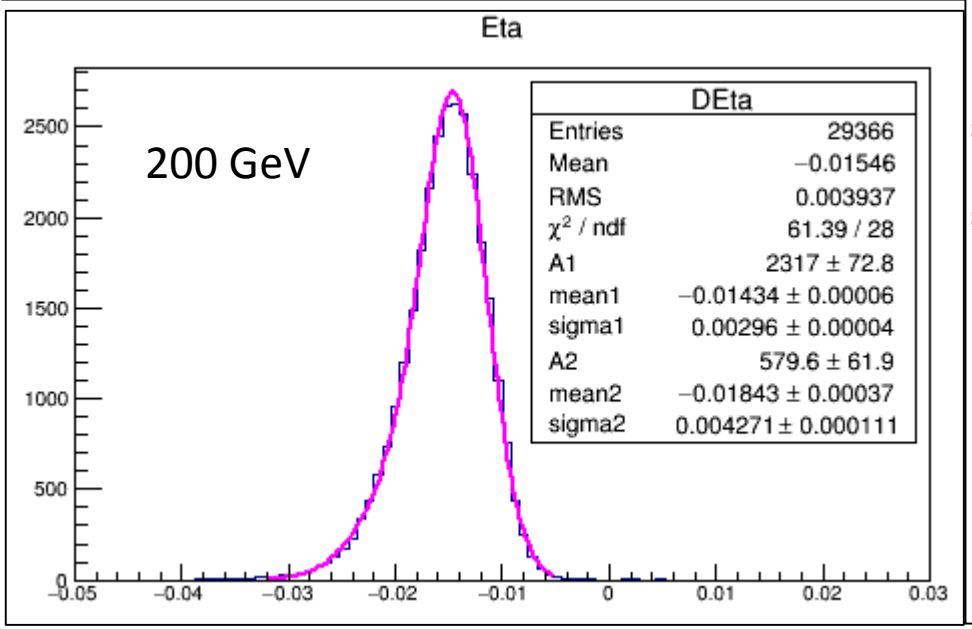


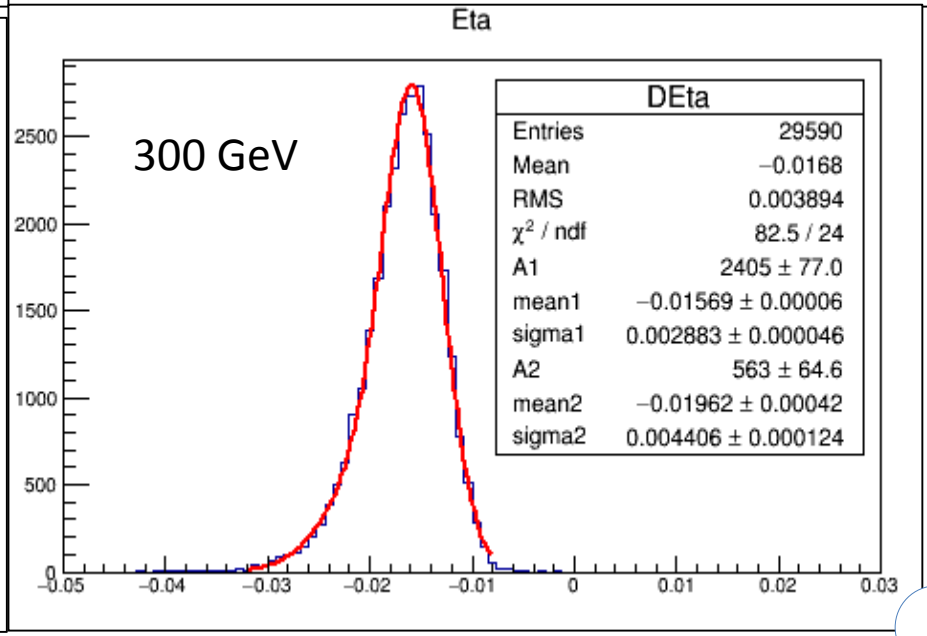


Electrons – η Position – fit with double gaussian

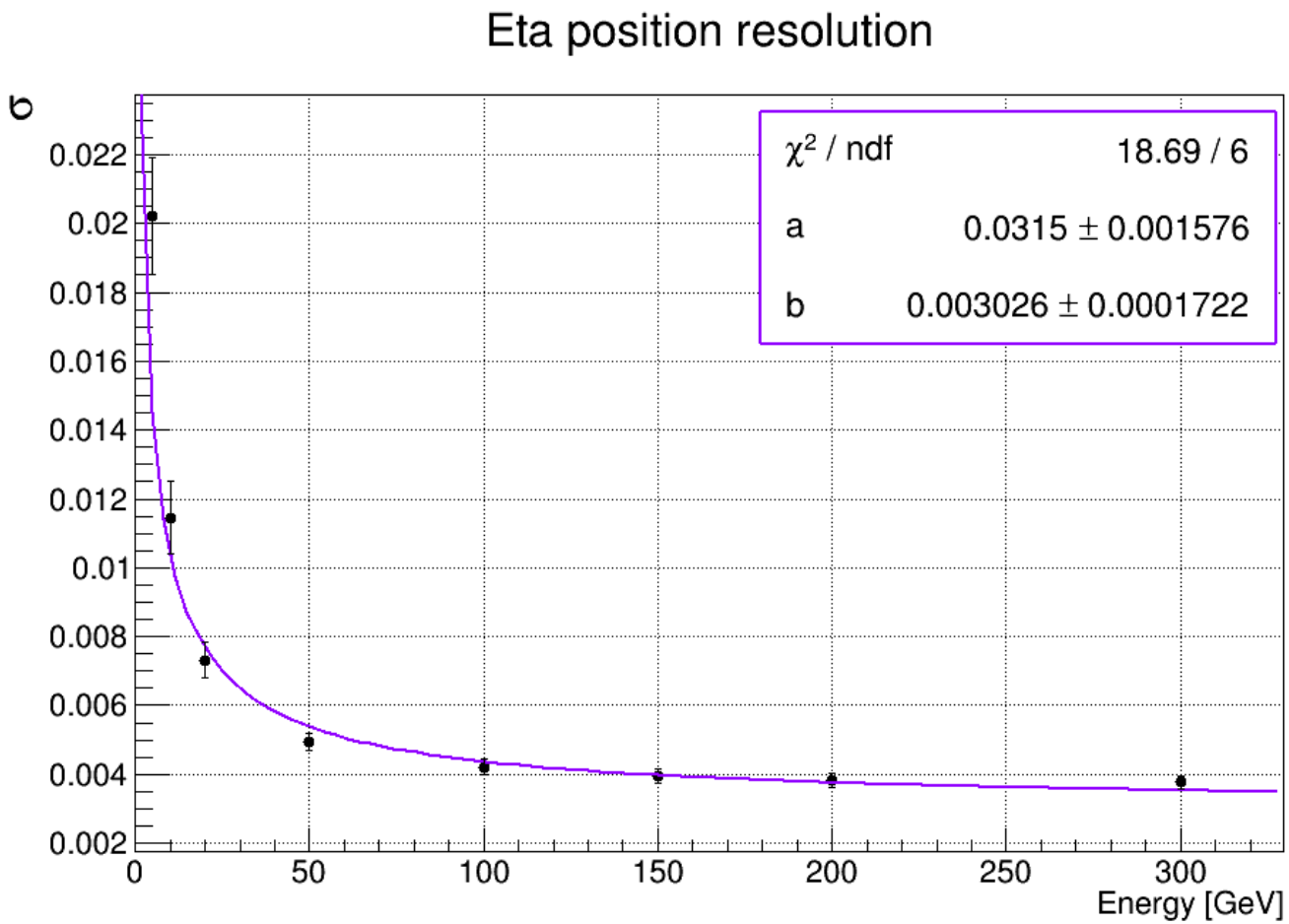








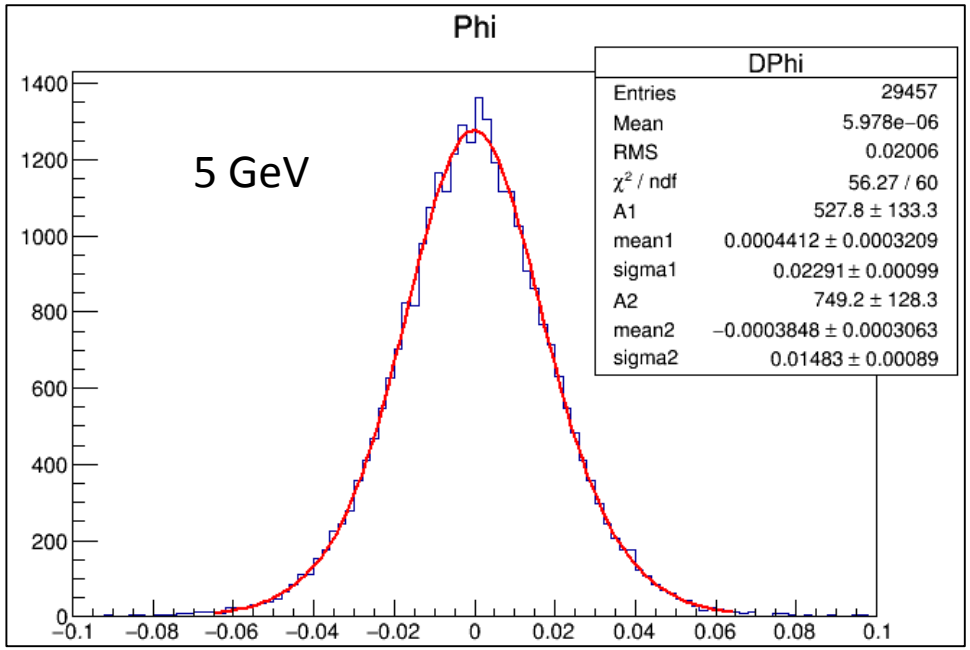
Electrons – η Position Resolution

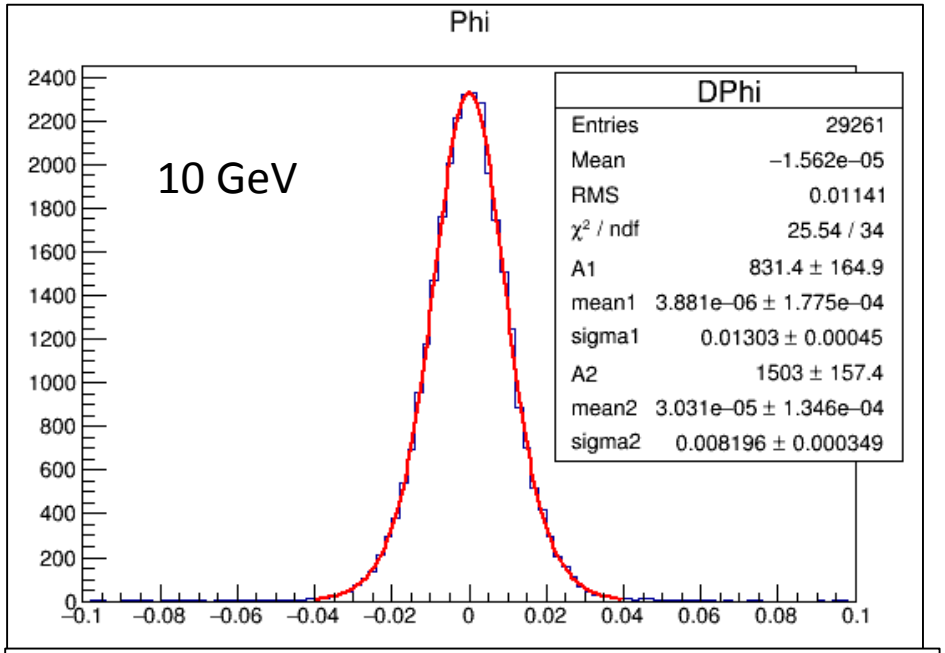


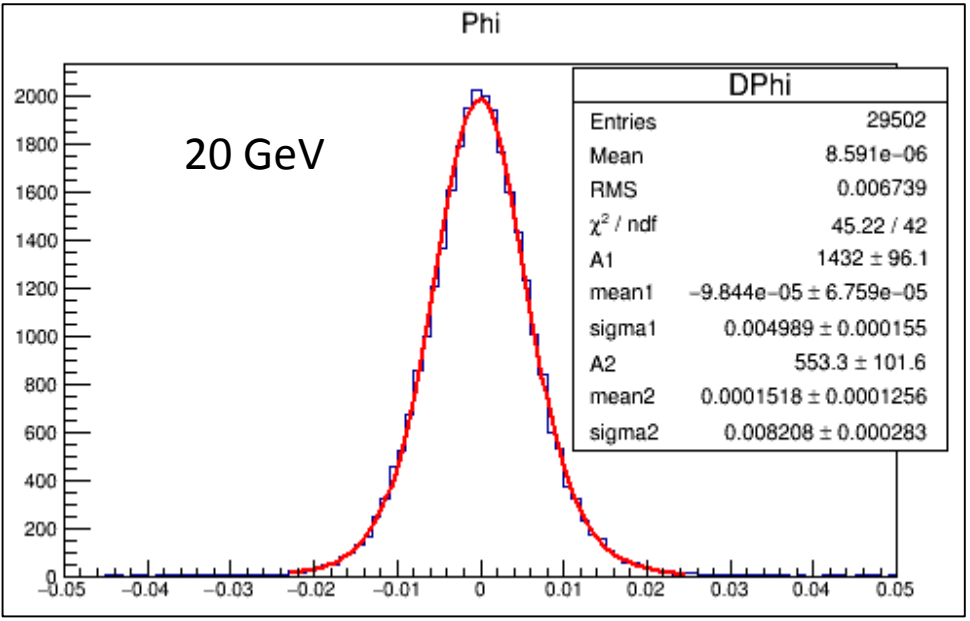
a= (3.15 ± 0.001) %$\sqrt{GeV}$

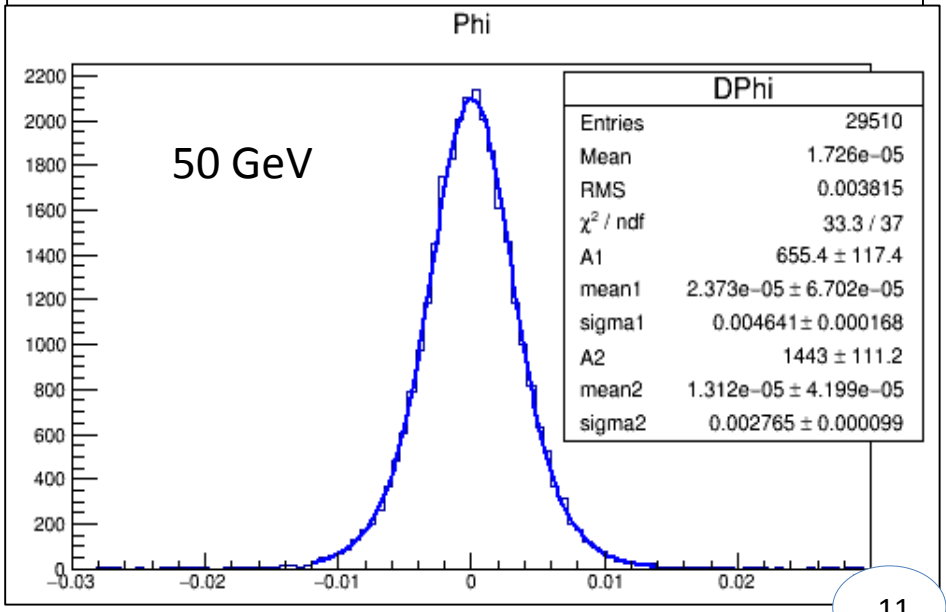
b= (0.3 ± 0.0001) %

Electrons – φ Position – fit with double gaussian

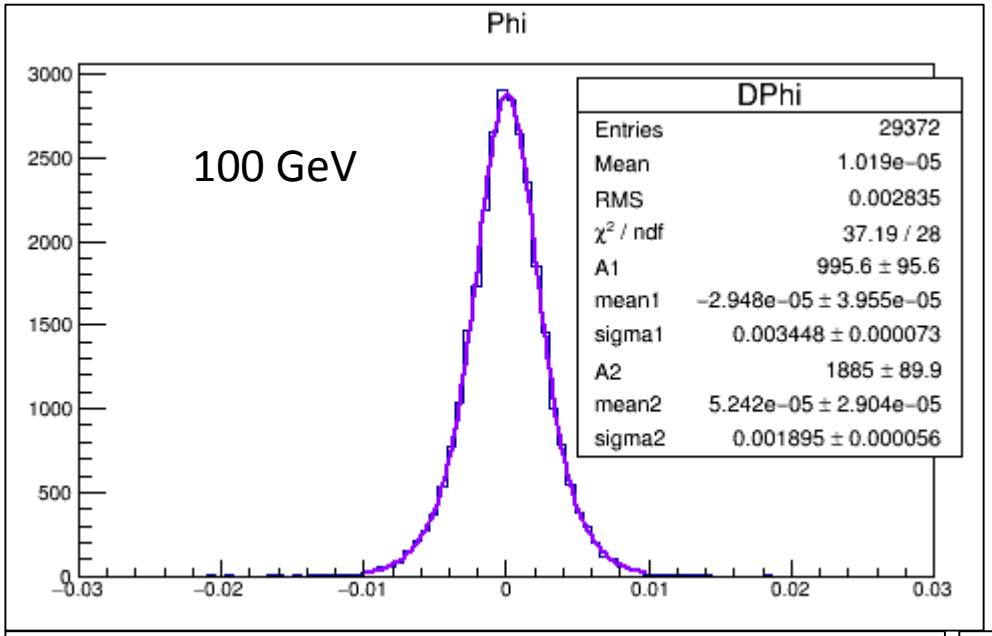


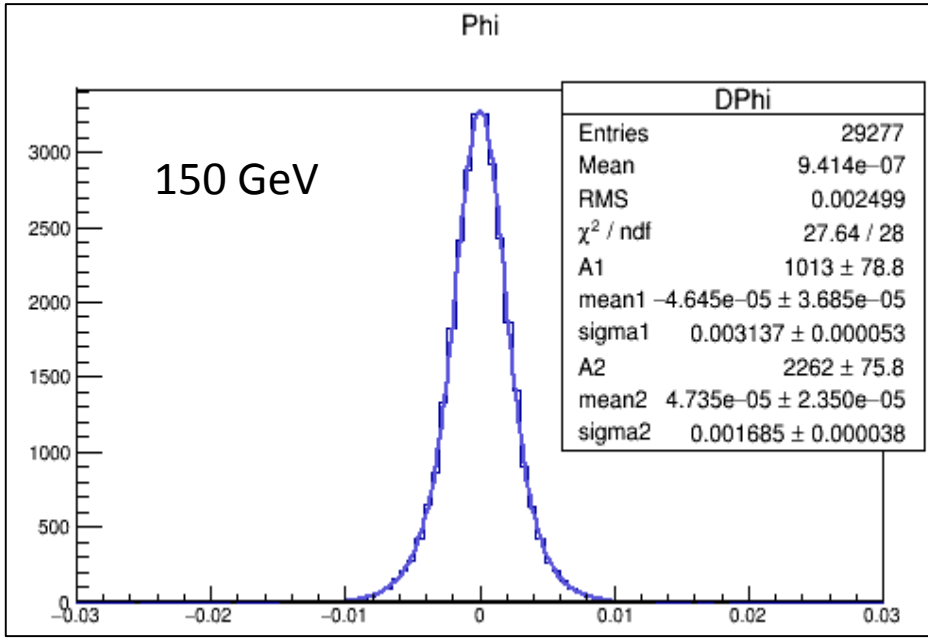


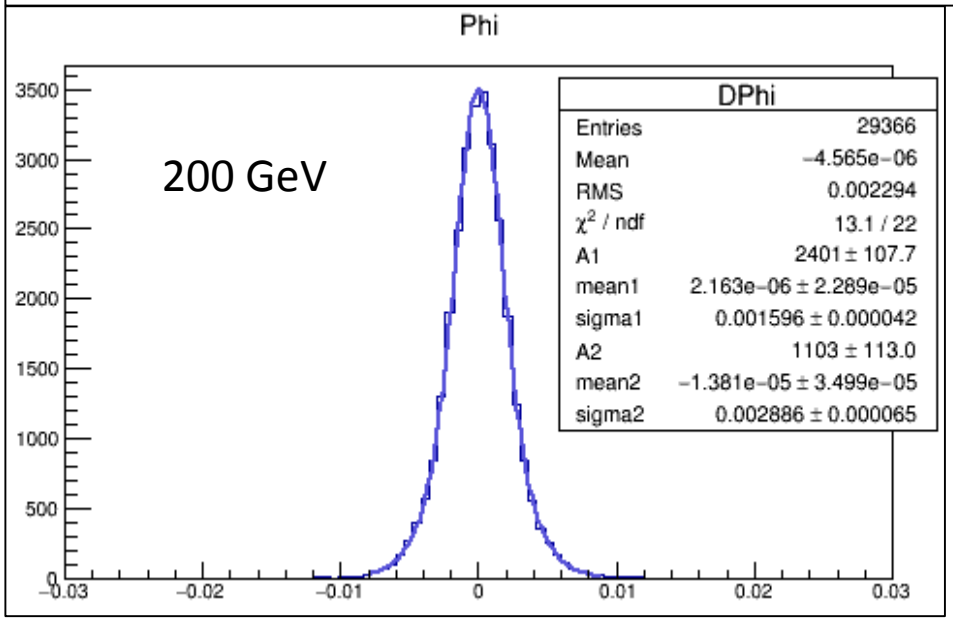


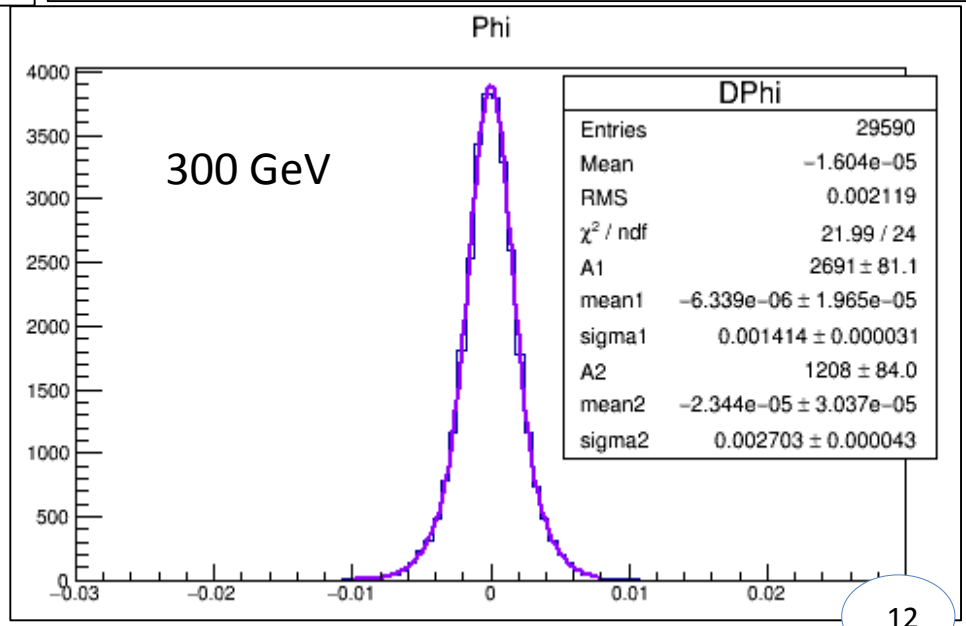


Electrons – φ Position – fit with double gaussian

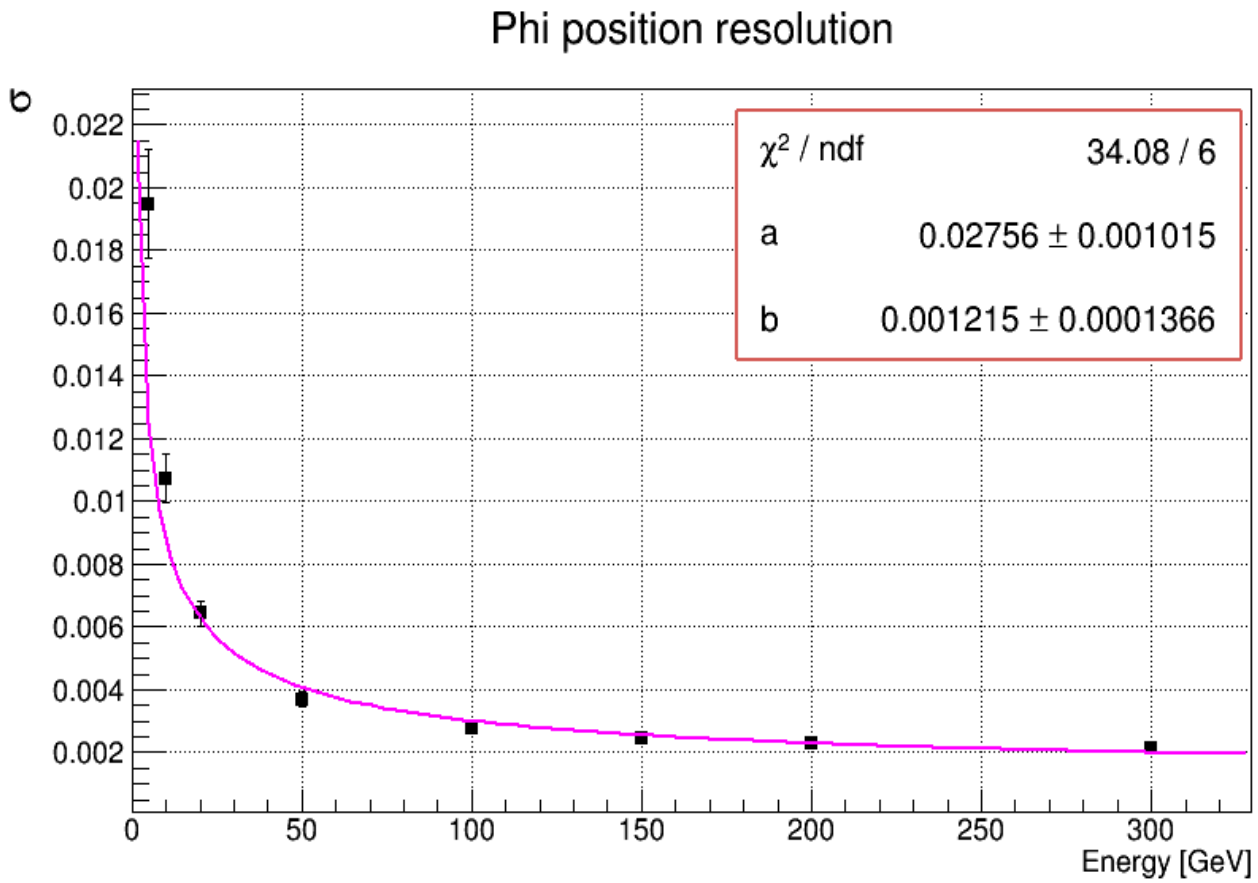








Electrons – φ Position Resolution



a= (2.75 ± 0.001) %

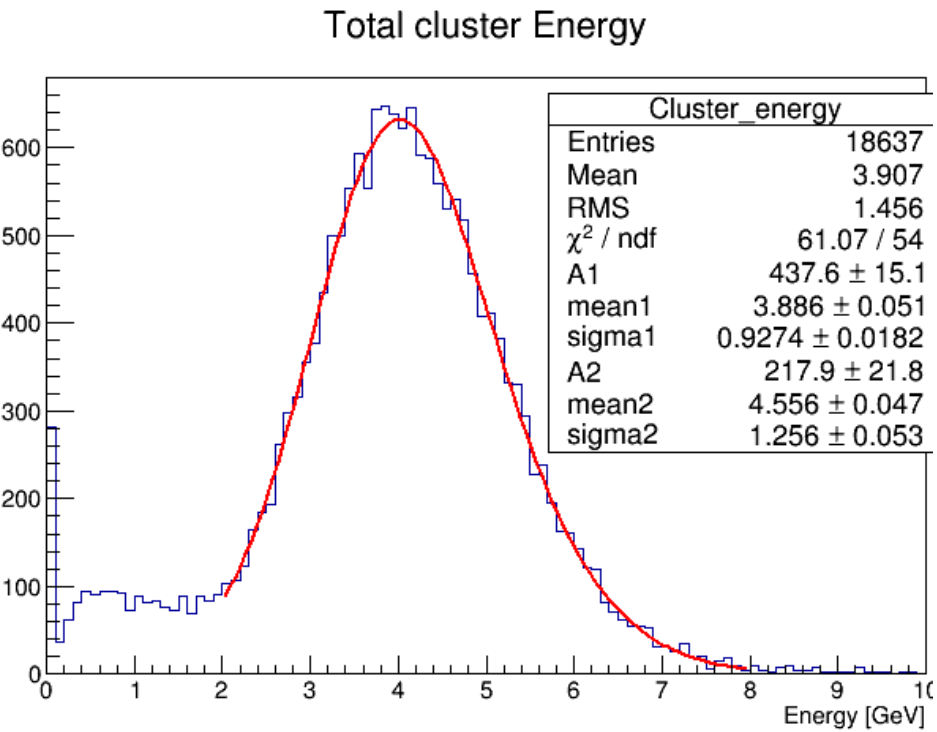
b= (0.12 ± 0.0001) %

Pions Analysis

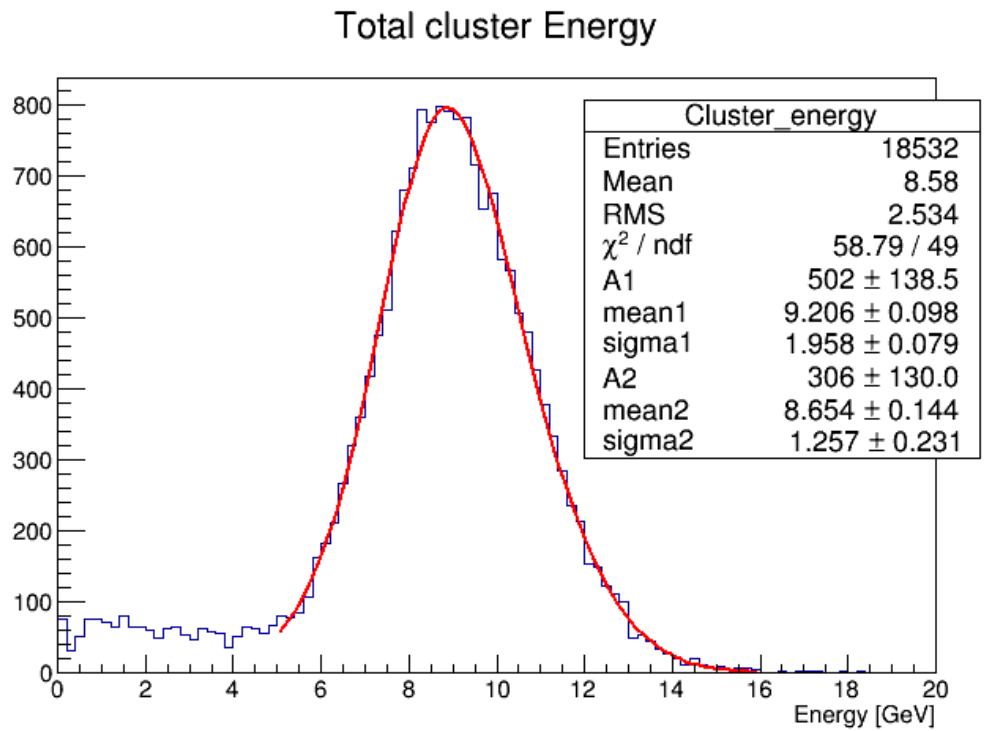
- Reconstruction of energy in Fcal .
- Cut of Eta between 3.5 & 4.1 .
- Cluster energy with a radius of 16cm fitted by double gaussian .
- Energy resolution.
- Position resolution.

Pions – Reconstruction of energy

- Total cluster energy in FCal with a radius of 16cm .
- Fit with Double gaussian.



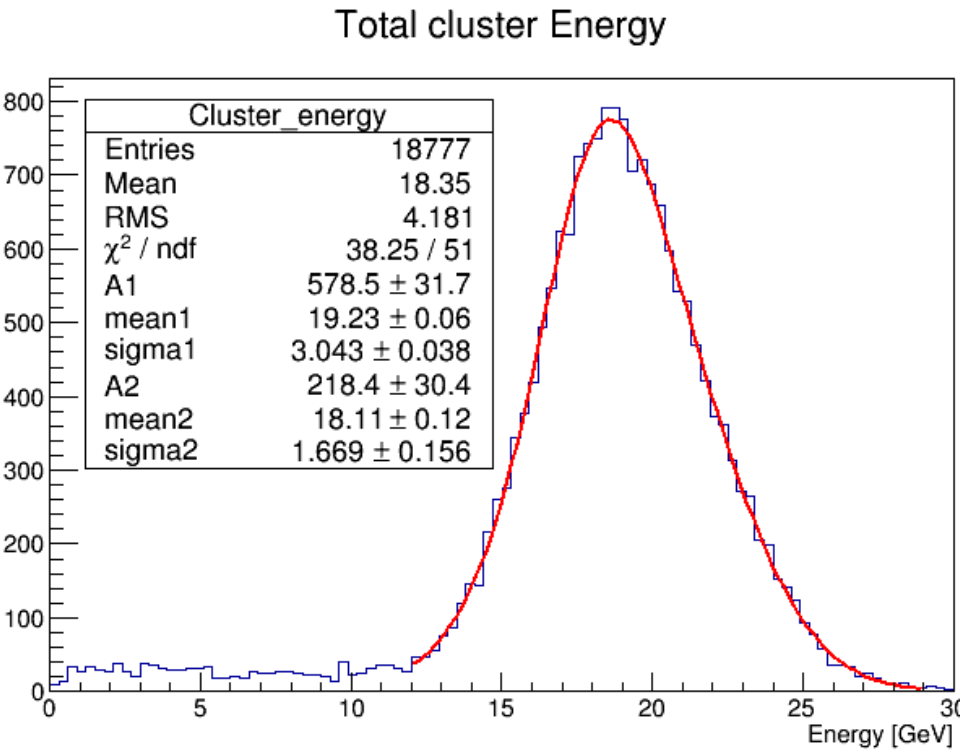
5 GeV



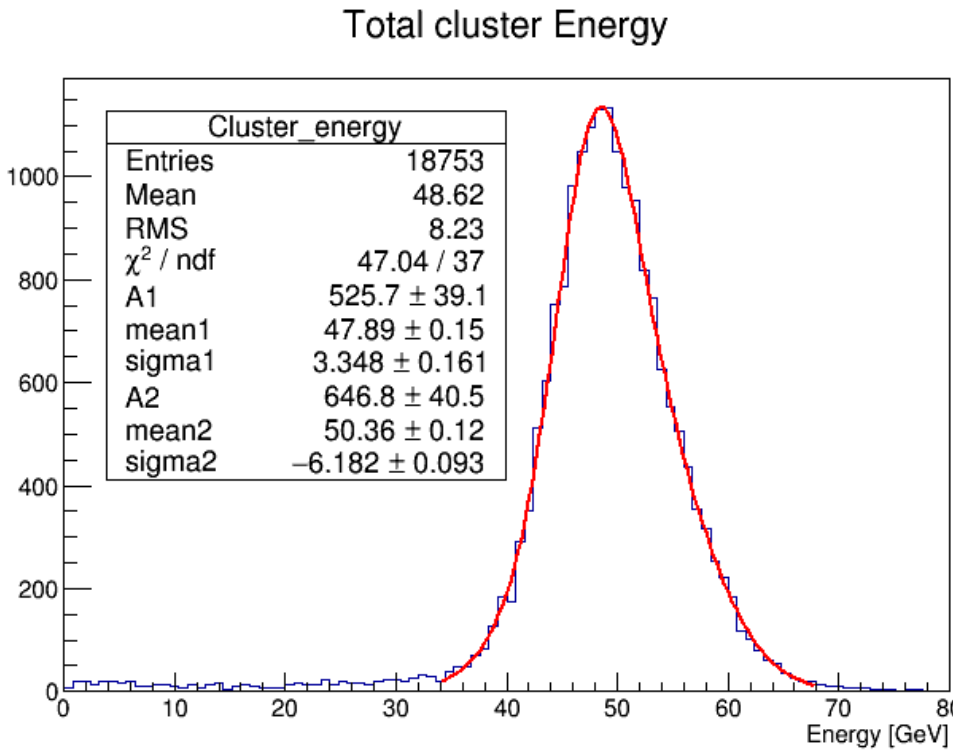
10 GeV

Pions – Reconstruction of energy

- Total cluster energy in FCal with a radius of 16cm .
- Fit with Double gaussian.



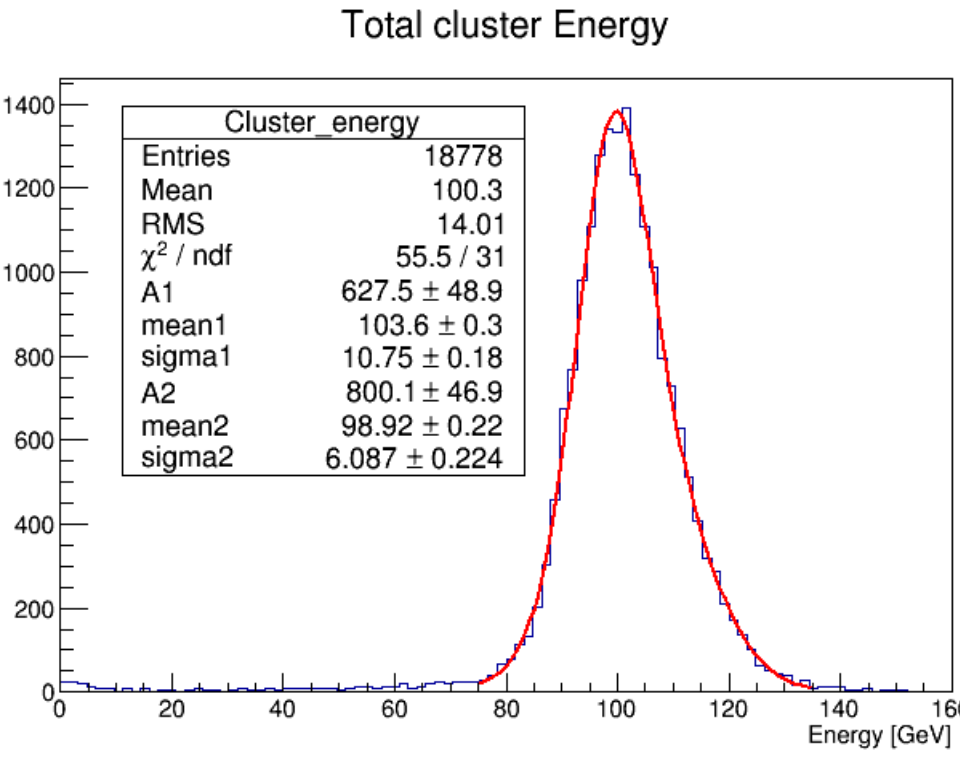
20 GeV



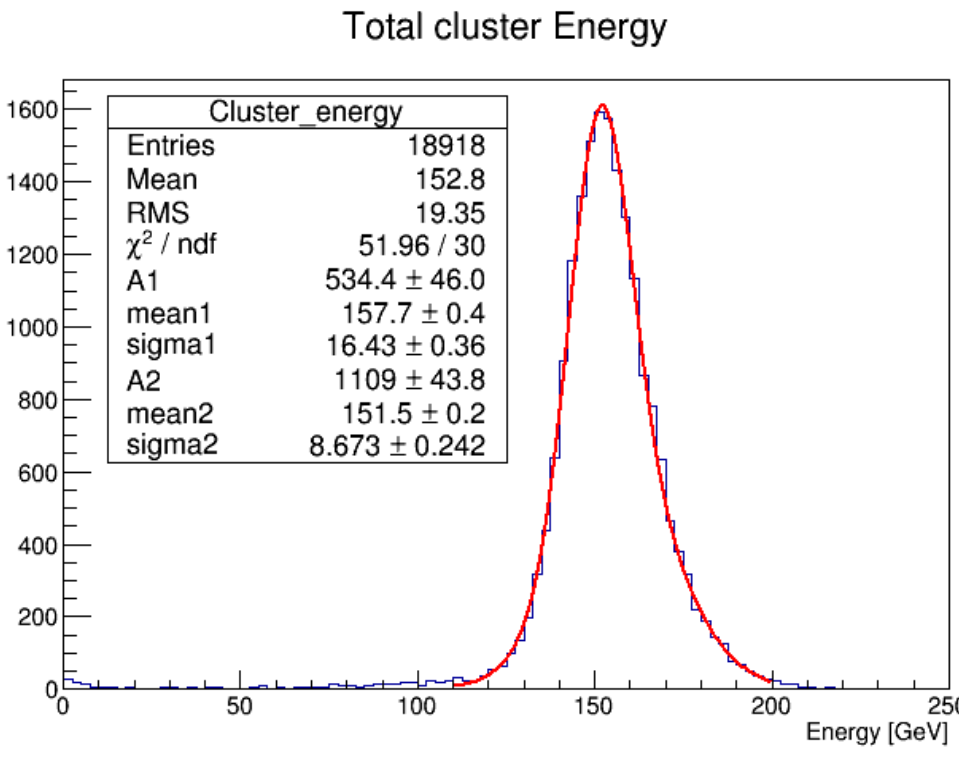
50 GeV

Pions – Reconstruction of energy

- Total cluster energy in FCal with a radius of 16cm .
- Fit with Double gaussian.



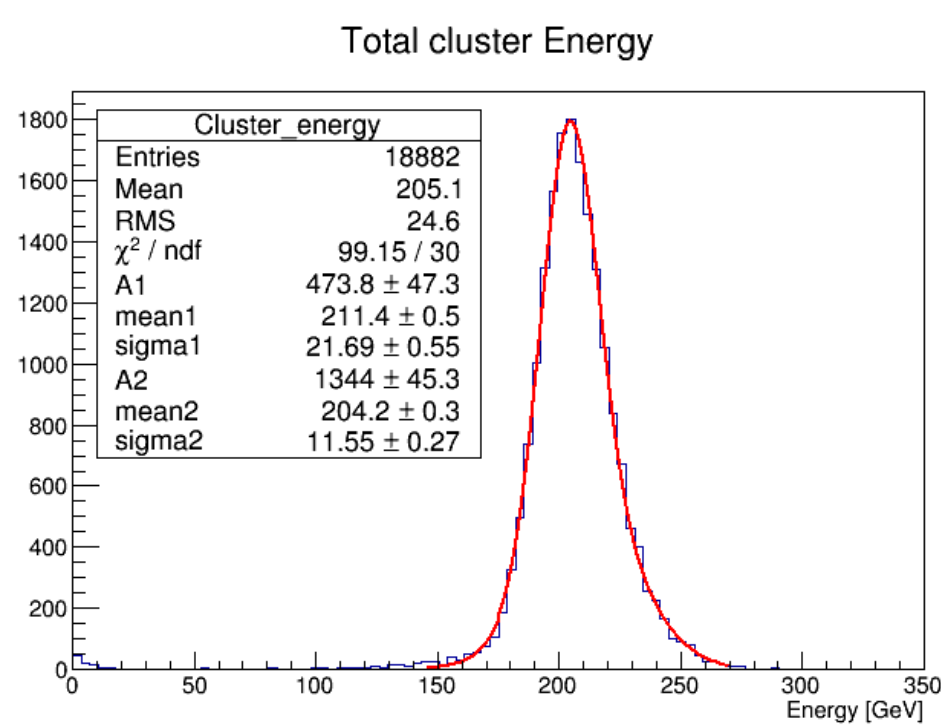
100 GeV



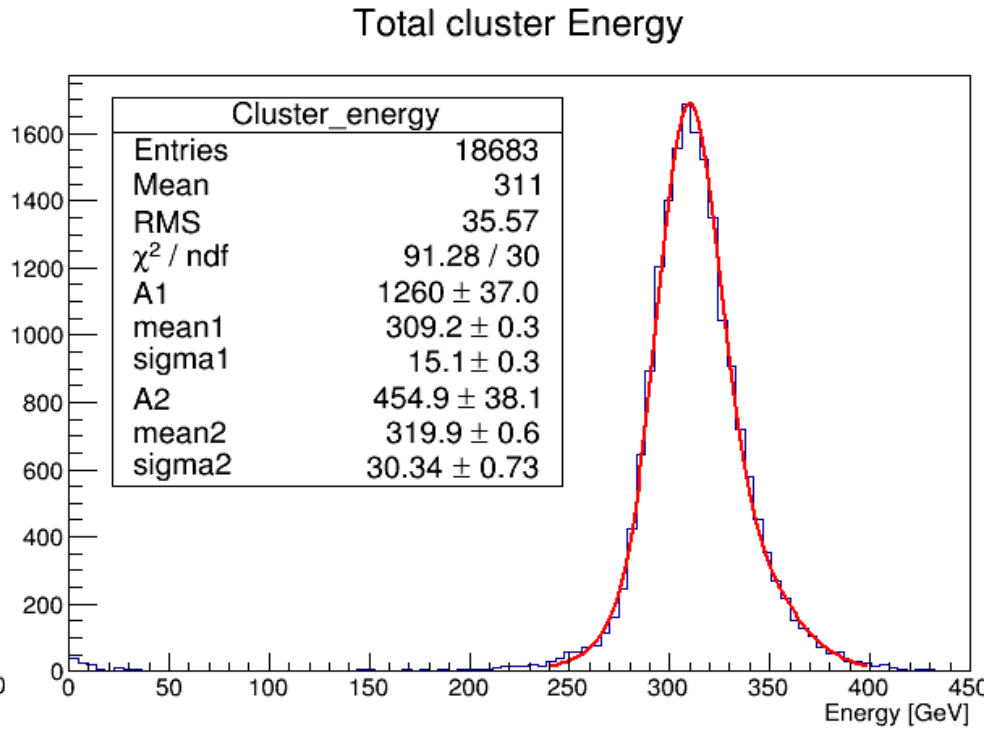
150 GeV

Pions – Reconstruction of energy

- Total cluster energy in FCal with a radius of 16cm .
- Fit with Double gaussian.

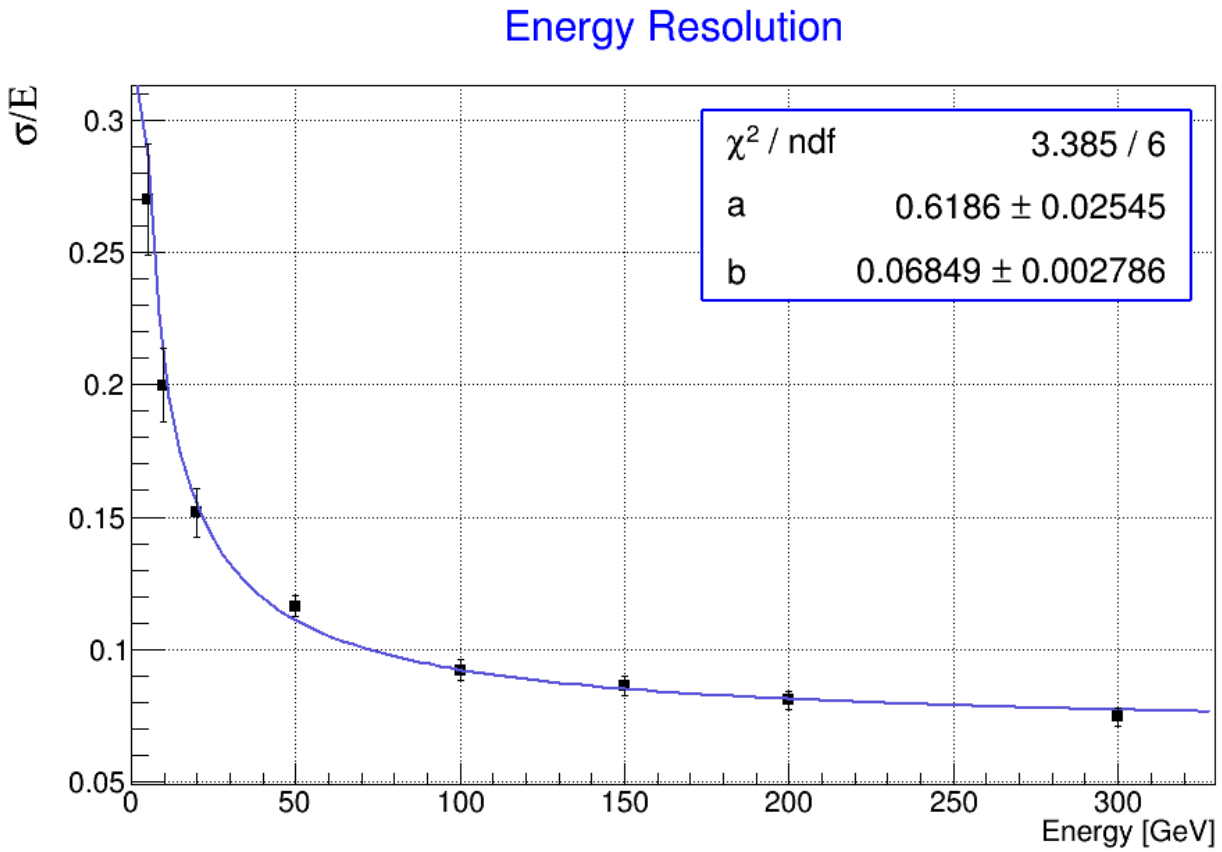


200 GeV



300 GeV

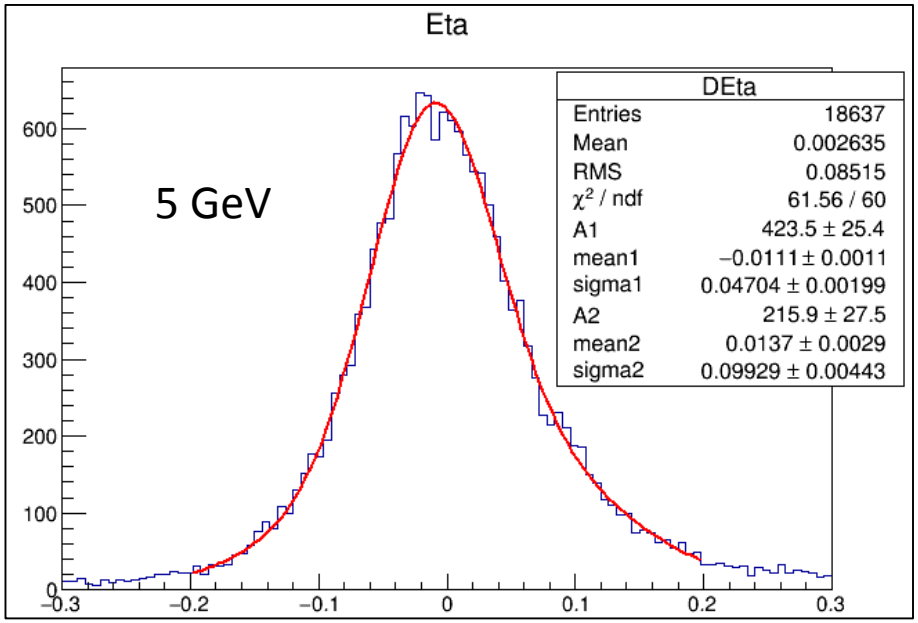
Pions – Resolution of energy

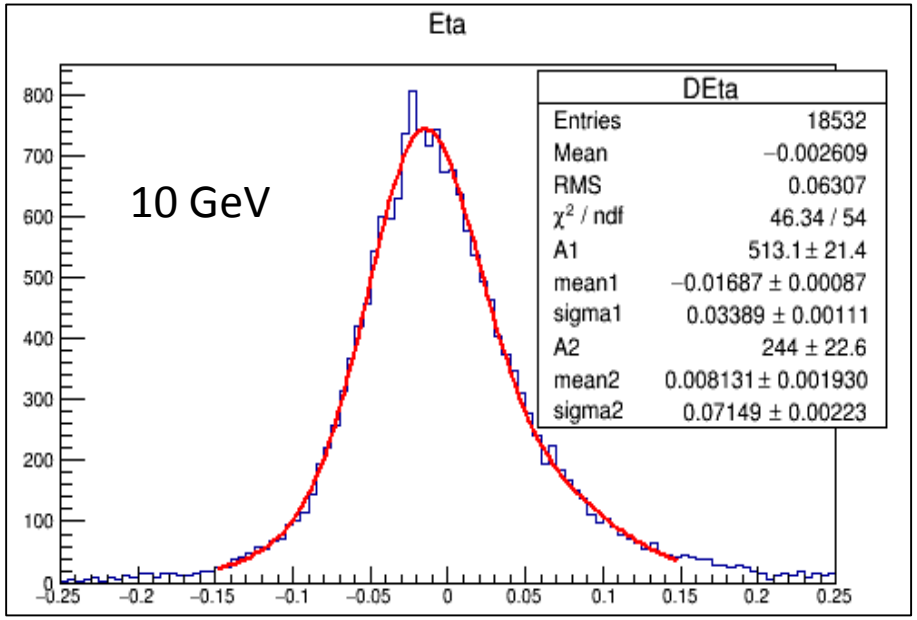


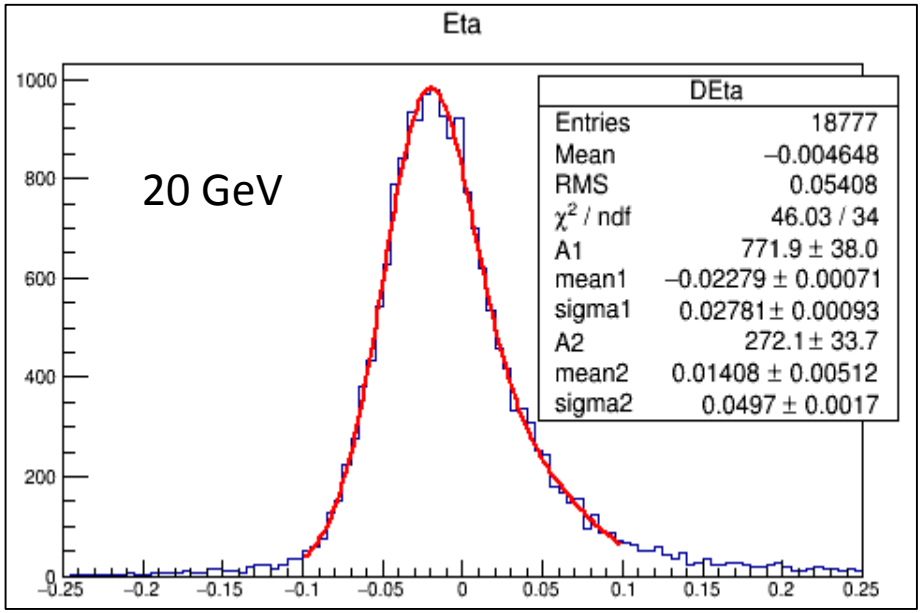
a= (61.86 ± 0.02) %$\sqrt{GeV}$

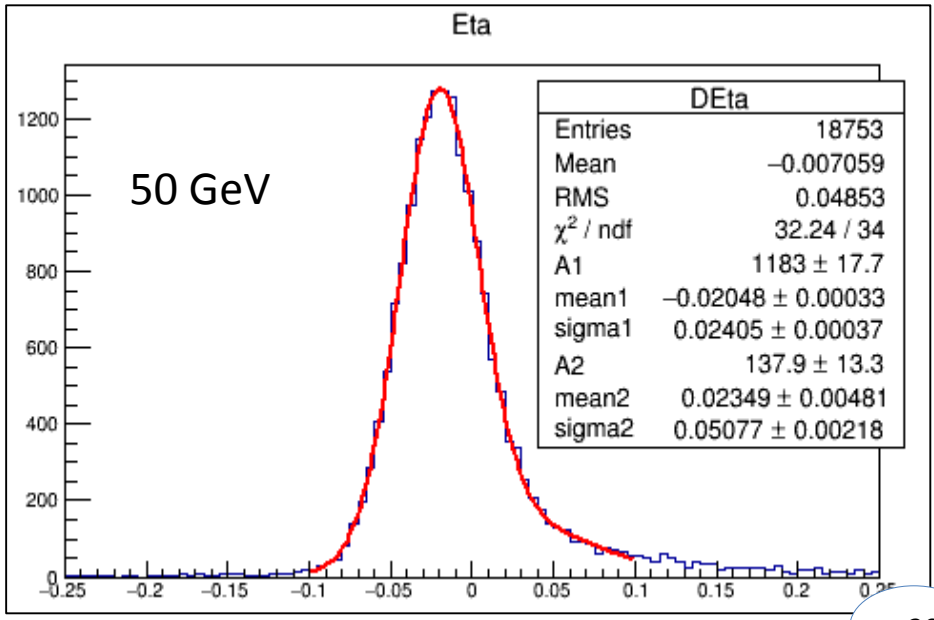
b= (6.8 ± 0.002) %

Pions – η Position – fit with double gaussian

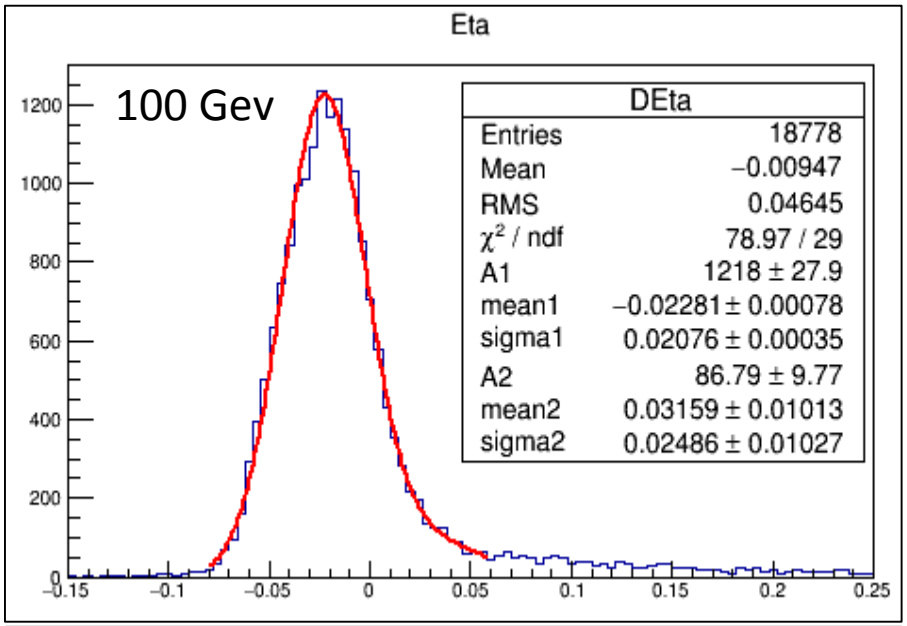


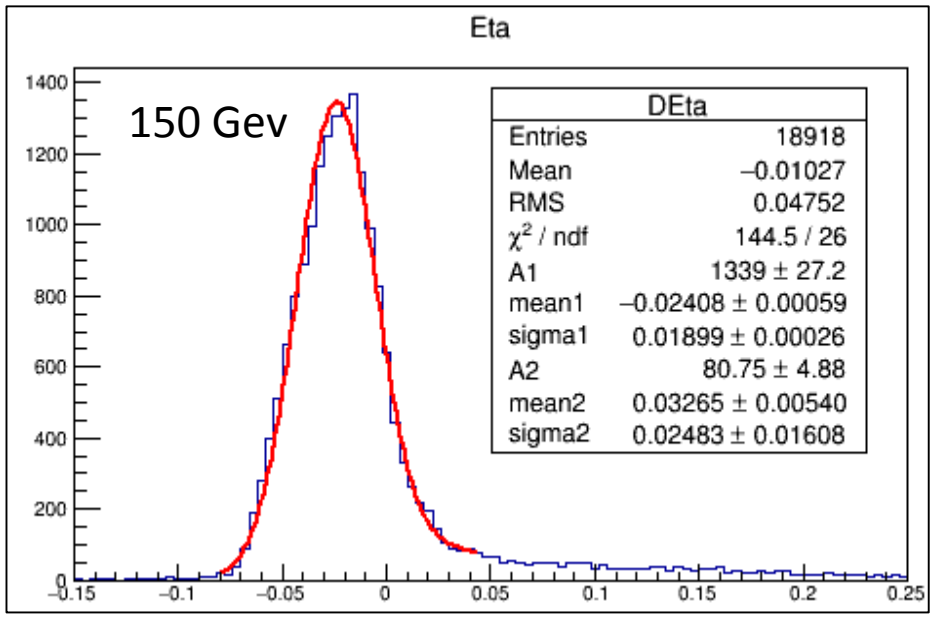


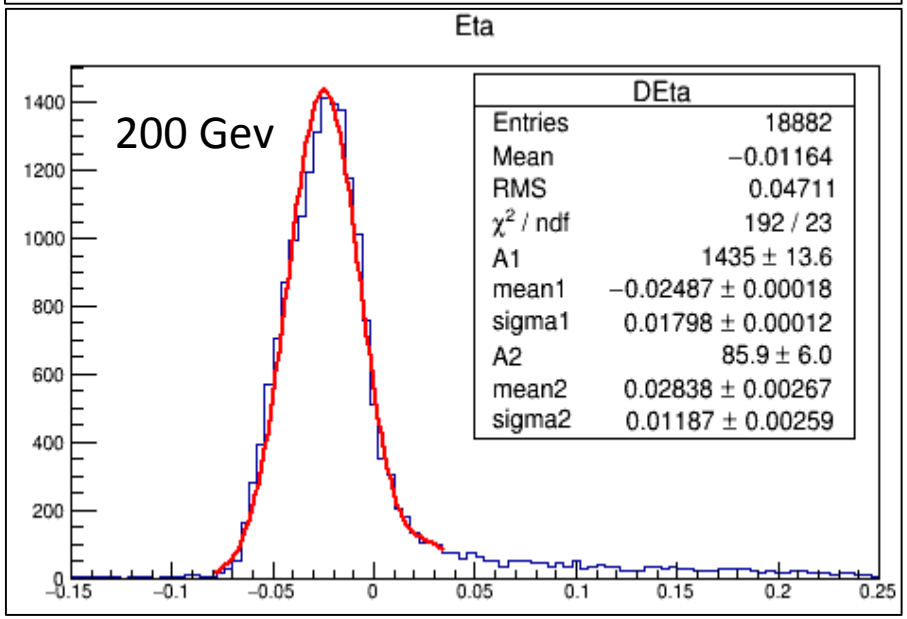


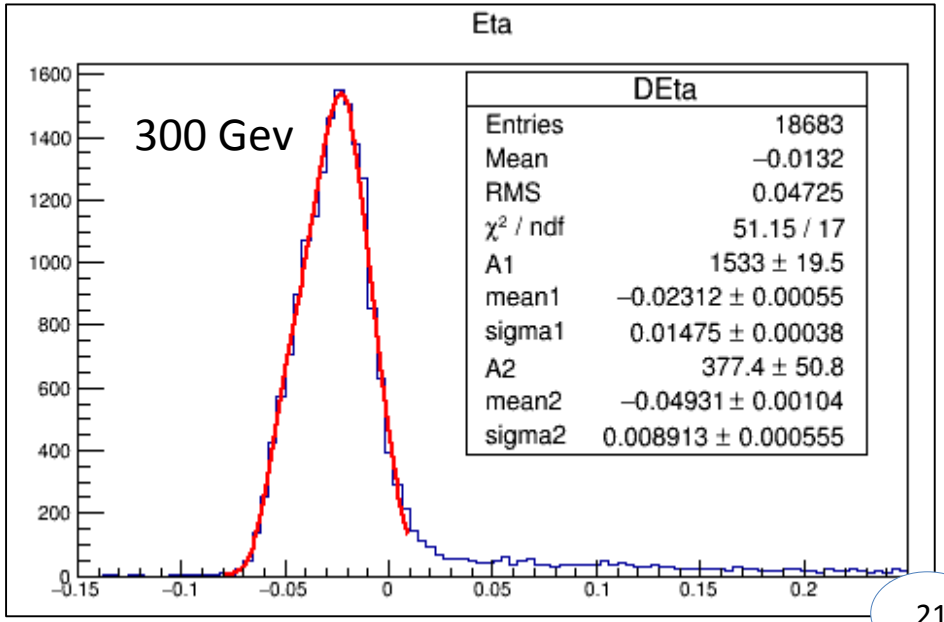


Pions – η Position – fit with double gaussian

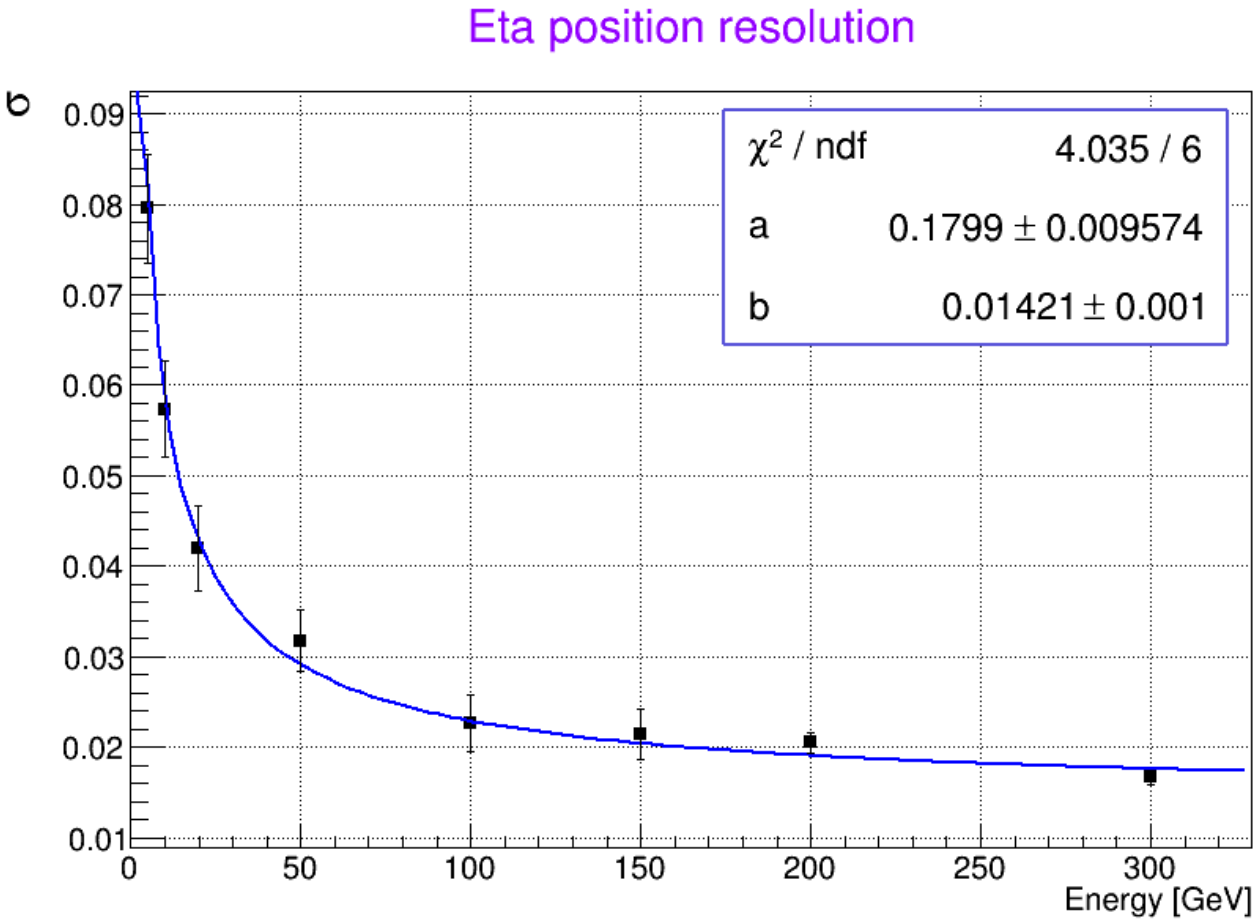








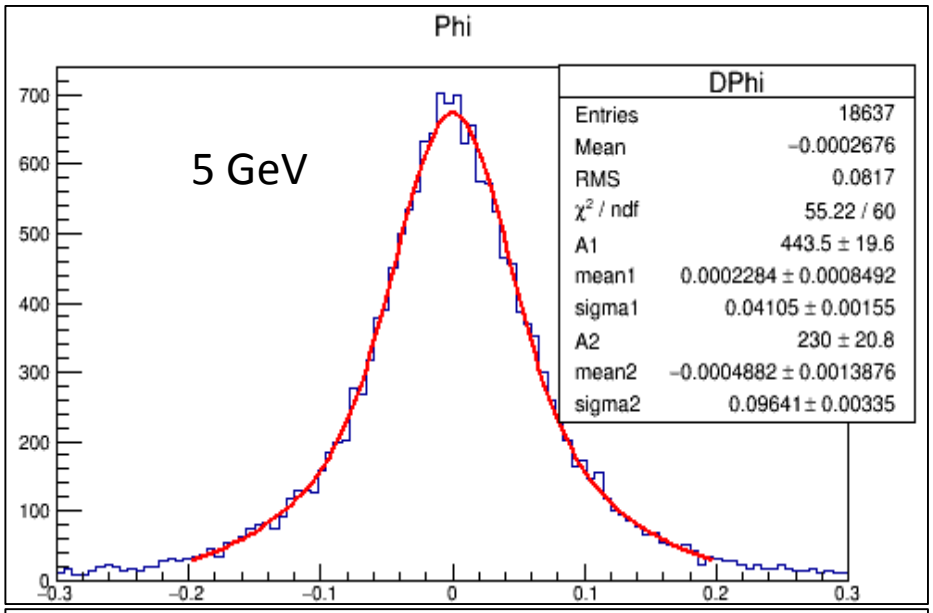
Pions – η Position Resolution

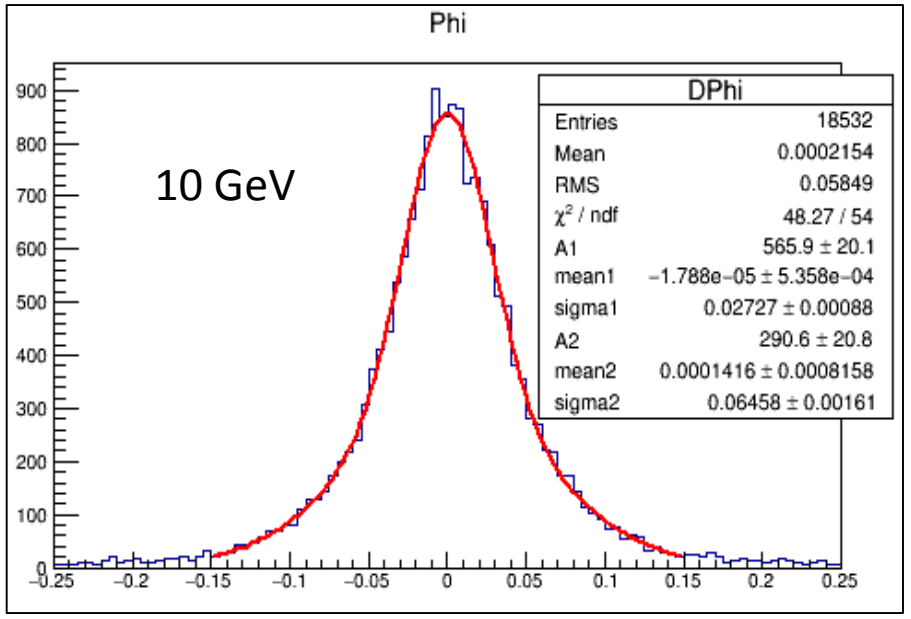


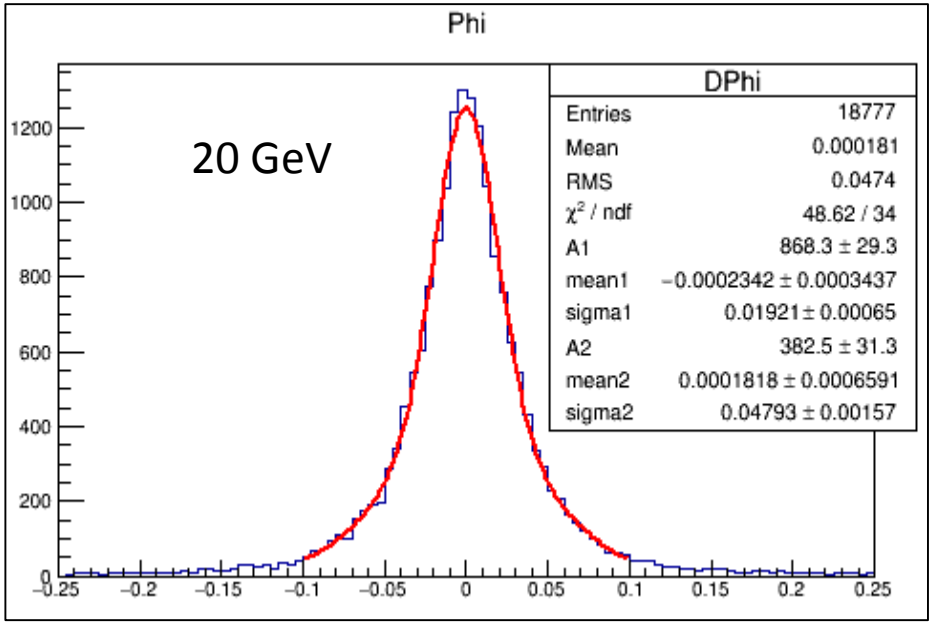
a= (18 ± 0.009) %$\sqrt{GeV}$

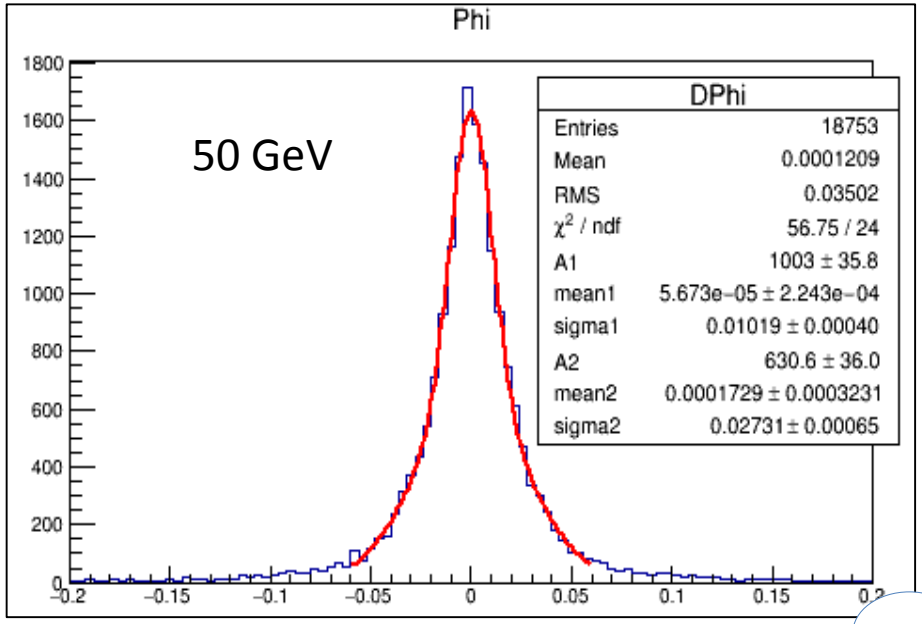
b= (1.4 ± 0.001) %

Pions – φ Position – fit with double gaussian

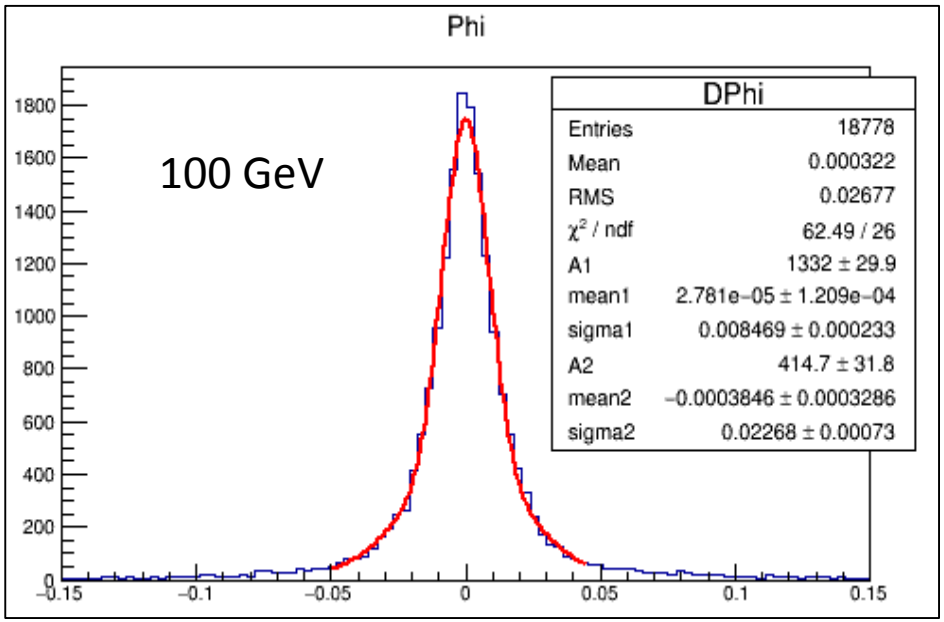


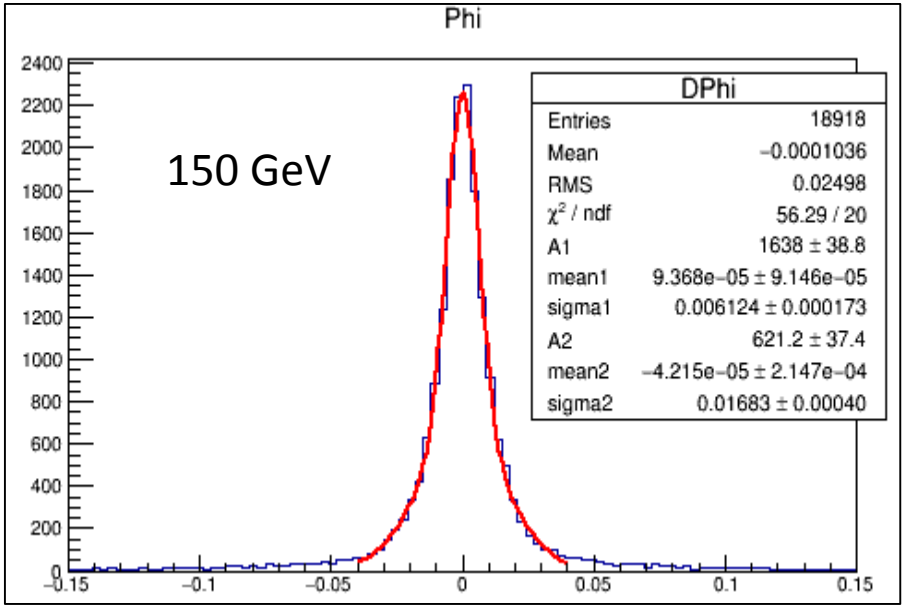


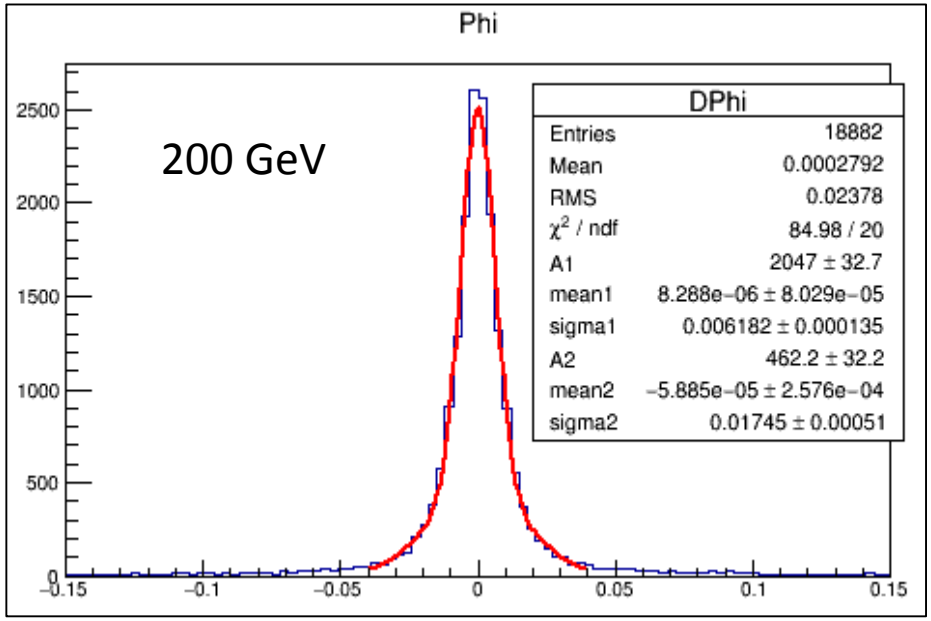


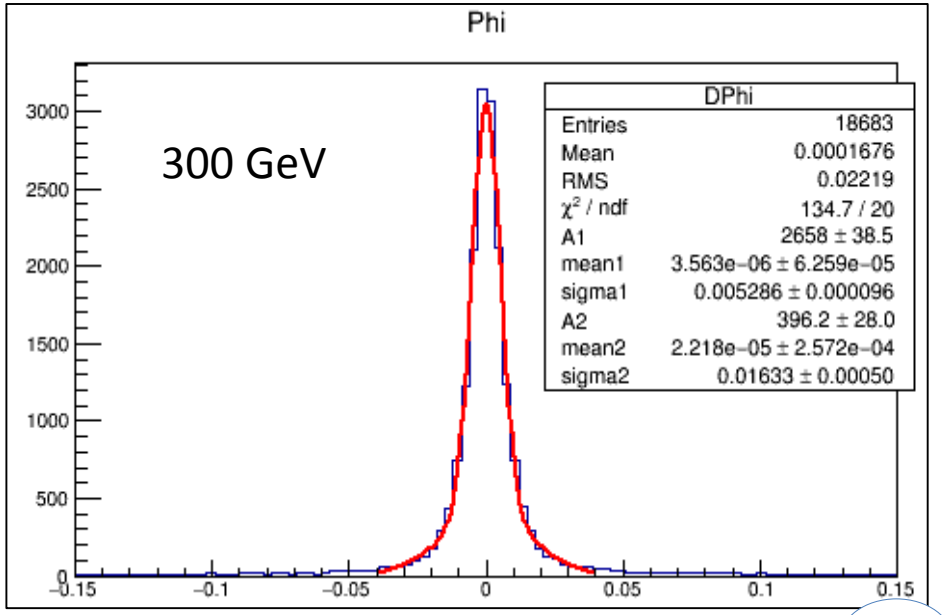


Pions – φ Position – fit with double gaussian

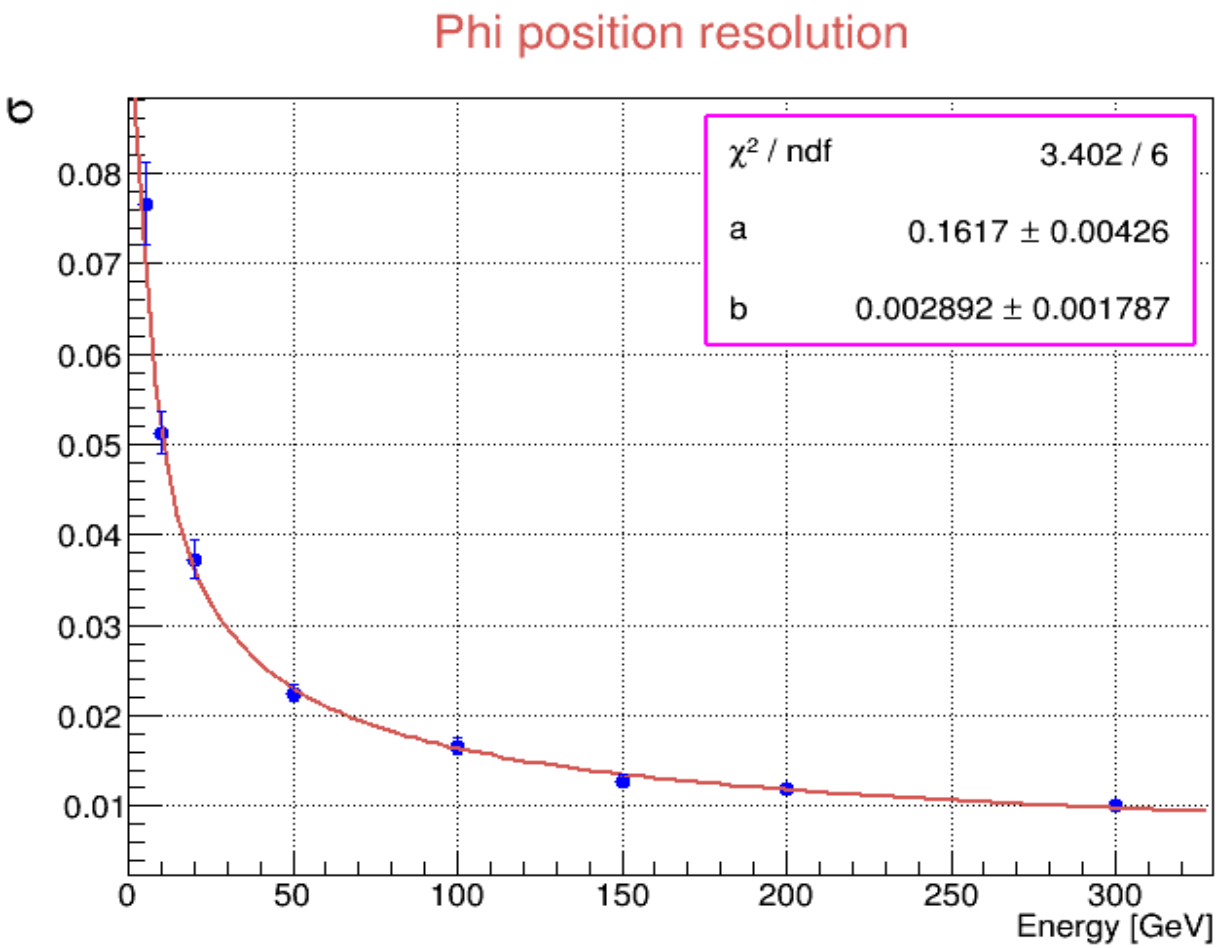








Pions – φ Position Resolution



a= (16.17 ± 0.004) %

b= (0.3 ± 0.001) %

Calcul of resolution error

$$d\left(\frac{\sigma}{\mu}\right) = \frac{d\sigma}{2\sigma\mu} + \frac{d\mu}{\sigma\mu}$$

$$d\sigma = \left|\frac{\partial\sigma}{\partial A_1}\right| dA_1 + \left|\frac{\partial\sigma}{\partial A_2}\right| dA_2 + \left|\frac{\partial\sigma}{\partial \mu_1}\right| d\mu_1 + \left|\frac{\partial\sigma}{\partial \mu_2}\right| d\mu_2 + \left|\frac{\partial\sigma}{\partial \sigma_1}\right| d\sigma_1 + \left|\frac{\partial\sigma}{\partial \sigma_2}\right| d\sigma_2$$

$$d\mu = \left|\frac{\partial\mu}{\partial A_1}\right| dA_1 + \left|\frac{\partial\mu}{\partial A_2}\right| dA_2 + \left|\frac{\partial\mu}{\partial \mu_1}\right| d\mu_1 + \left|\frac{\partial\mu}{\partial \mu_2}\right| d\mu_2 + \left|\frac{\partial\mu}{\partial \sigma_1}\right| d\sigma_1 + \left|\frac{\partial\mu}{\partial \sigma_2}\right| d\sigma_2$$

$$\frac{\partial\sigma}{\partial A_1} = \frac{1}{2\sigma}\left[\frac{\sigma_1\left(\sigma_1^2+\mu_1^2\right)\left(A_1\sigma_1+A_2\sigma_2\right)-\sigma_1\left(A_1\sigma_1\left(\sigma_1^2+\mu_1^2\right)+A_2\sigma_2\left(\sigma_2^2+\mu_2^2\right)\right)}{\left(A_1\sigma_1+A_2\sigma_2\right)^2} - 2\left(\frac{A_1\sigma_1\mu_1+A_2\sigma_2\mu_2}{A_1\sigma_1+A_2\sigma_2}\right)\left(\frac{\sigma_1\mu_1\left(A_1\sigma_1+A_2\sigma_2\right)-\sigma_1\left(A_1\sigma_1\mu_1+A_2\sigma_2\mu_2\right)}{\left(A_1\sigma_1+A_2\sigma_2\right)^2}\right)\right]$$

$$\frac{\partial\sigma}{\partial A_2} = \frac{1}{2\sigma}\left[\frac{\sigma_2\left(\sigma_2^2+\mu_2^2\right)\left(A_1\sigma_1+A_2\sigma_2\right)-\sigma_2\left(A_1\sigma_1\left(\sigma_1^2+\mu_1^2\right)+A_2\sigma_2\left(\sigma_2^2+\mu_2^2\right)\right)}{\left(A_1\sigma_1+A_2\sigma_2\right)^2} - 2\left(\frac{A_1\sigma_1\mu_1+A_2\sigma_2\mu_2}{A_1\sigma_1+A_2\sigma_2}\right)\left(\frac{\sigma_2\mu_2\left(A_1\sigma_1+A_2\sigma_2\right)-\sigma_2\left(A_1\sigma_1\mu_1+A_2\sigma_2\mu_2\right)}{\left(A_1\sigma_1+A_2\sigma_2\right)^2}\right)\right]$$

$$\frac{\partial\sigma}{\partial\mu_1} = \frac{1}{2\sigma}\left[\frac{2A_1\mu_1\sigma_1}{A_1\sigma_1+A_2\sigma_2} - \frac{2A_1\sigma_1\left(A_1\sigma_1\mu_1+A_2\sigma_2\mu_2\right)}{\left(A_1\sigma_1+A_2\sigma_2\right)^2}\right]$$

$$\frac{\partial\sigma}{\partial\mu_2} = \frac{1}{2\sigma}\left[\frac{2A_2\mu_2\sigma_2}{A_1\sigma_1+A_2\sigma_2} - \frac{2A_2\sigma_2\left(A_1\sigma_1\mu_1+A_2\sigma_2\mu_2\right)}{\left(A_1\sigma_1+A_2\sigma_2\right)^2}\right]$$

$$\frac{\partial\sigma}{\partial\sigma_1}=\frac{1}{2\sigma}\left[\frac{3A_1\sigma_1^2(A_1\sigma_1+A_2\sigma_2)-A_1\left(A_1\sigma_1(\sigma_1^2+\mu_1^2)+A_2\sigma_2(\sigma_2^2+\mu_2^2)\right)}{(A_1\sigma_1+A_2\sigma_2)^2}-\right.$$
$$\left.2\left(\frac{A_1\sigma_1\mu_1+A_2\sigma_2\mu_2}{A_1\sigma_1+A_2\sigma_2}\right)\left(\frac{A_1\mu_1(A_1\sigma_1+A_2\sigma_2)-A_1(A_1\sigma_1\mu_1+A_2\sigma_2\mu_2)}{(A_1\sigma_1+A_2\sigma_2)^2}\right)\right]$$

$$\frac{\partial\sigma}{\partial\sigma_2}=\frac{1}{2\sigma}\left[\frac{3A_2\sigma_2^2(A_1\sigma_1+A_2\sigma_2)-A_2\left(A_1\sigma_1(\sigma_1^2+\mu_1^2)+A_2\sigma_2(\sigma_2^2+\mu_2^2)\right)}{(A_1\sigma_1+A_2\sigma_2)^2}-\right.$$
$$\left.2\left(\frac{A_1\sigma_1\mu_1+A_2\sigma_2\mu_2}{A_1\sigma_1+A_2\sigma_2}\right)\left(\frac{A_2\mu_2(A_1\sigma_1+A_2\sigma_2)-A_2(A_1\sigma_1\mu_1+A_2\sigma_2\mu_2)}{(A_1\sigma_1+A_2\sigma_2)^2}\right)\right]$$

$$\frac{\partial\mu}{\partial A_1}=\frac{A_2\sigma_1\sigma_2(\mu_1-\mu_2)}{(A_1\sigma_1+A_2\sigma_2)^2}$$

$$\frac{\partial\mu}{\partial\mu_2}=\frac{A_2\sigma_2}{A_1\sigma_1+A_2\sigma_2}$$

$$\frac{\partial\mu}{\partial A_2}=\frac{A_1\sigma_1\sigma_2(\mu_2-\mu_1)}{(A_1\sigma_1+A_2\sigma_2)^2}$$

$$\frac{\partial\mu}{\partial\sigma_1}=\frac{A_1A_2\sigma_2(\mu_1-\mu_2)}{(A_1\sigma_1+A_2\sigma_2)^2}$$

$$\frac{\partial\mu}{\partial\mu_1}=\frac{A_1\sigma_1}{A_1\sigma_1+A_2\sigma_2}$$

$$\frac{\partial\mu}{\partial\sigma_2}=\frac{A_1A_2\sigma_1(\mu_2-\mu_1)}{(A_1\sigma_1+A_2\sigma_2)^2}$$

• Example of 200 GeV electron

```
  EXT PARAMETER                                          STEP         FIRST
  NO.   NAME      VALUE            ERROR                 SIZE      DERIVATIVE
   1  A1           1.03597e+03   8.58850e+01   8.50433e-02  -3.80759e-05
   2  mean1        2.10747e+02   7.96725e-01   1.02389e-03  -4.96627e-03
   3  sigma1       1.24234e+01   2.30516e-01   6.40634e-04  -4.72996e-03
   4  A2           2.47056e+03   9.54426e+01   1.34486e-01   1.10403e-05
   5  mean2        1.97819e+02   2.67662e-01   5.28193e-04  -2.58682e-03
   6  sigma2       8.93341e+00   1.38866e-01   3.04350e-04   1.32593e-03
sigma= 12.0891
mean= 202.581
Energy resolution= 0.0596753
error Energy resolution = 0.00277663
root [3]
```

$A_1 = 1000$ $A_2 = 2000$

$\mu_1 = 200$ $\mu_2 = 200$ ➡ $d\sigma = 11.4$ & $d\mu = 0.47$

$\sigma_1 = 12$ $\sigma_2 = 8$

Value of resolution error 0.00253809194