

Determination of Weighting Factor for PionTDR

Introduction to Weighting Factor: Table 1 lists material compositions of ECAL and HCAL of Mokka TDR. Since different active/passive materials are employed for ECAL and HCAL, responses of ECAL and HCAL are different. Weighting factor, W , was introduced to compensate the differences.

Table 1: Mokka TDR

Calorimeter	Active Layer	Passive Layer
ECAL	Si (0.5 mm)	Tungsten 1.4 mm (first 30 layers) 4.2 mm (last 10 layers)
HCAL	Polystyrene (6.5 mm)	Iron 18 mm (40 layers)

Increasing Statistics: In order to get an accurate value of the weighting factor statistics was increased. Table 2 list number of events associated with each incident pion energy.

Table 2: Statistics

Energy (GeV)	Number of Events
5	31428
10	44279
20	26093
50	10000
75	10975
100	18112

Calculation of W : The weighting factor was determined by plotting response curves for ECAL and HCAL. It was calculated using $W = \langle E_{ECAL} \rangle / \langle E_{HCAL} \rangle$ where $\langle E_{ECAL} \rangle$ and $\langle E_{HCAL} \rangle$ are the mean energies deposited in the ECAL and HCAL respectively [see Fig. 1]. For example, for 20 GeV pions, $\langle E_{ECAL} \rangle$ and $\langle E_{HCAL} \rangle$ are 491 ± 7.68 and 800.2 ± 1.964 respectively [Table 3].

Table 3: Data for Figure 1

Energy (GeV)	ECAL (MeV)	HCAL (MeV)
5	126.6 ± 0.721	199 ± 0.900
10	240.2 ± 1.114	391.7 ± 0.640
20	491 ± 7.68	800.2 ± 1.964
50	1227 ± 14.72	2041 ± 4.212
75	1557 ± 210	2989 ± 8.335

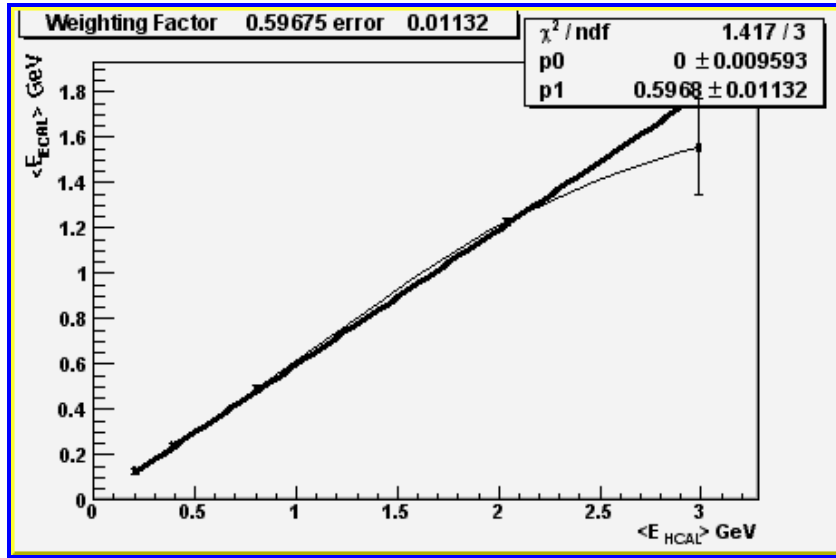


Figure 1: Calculation of weighting factor for Mokka TDR

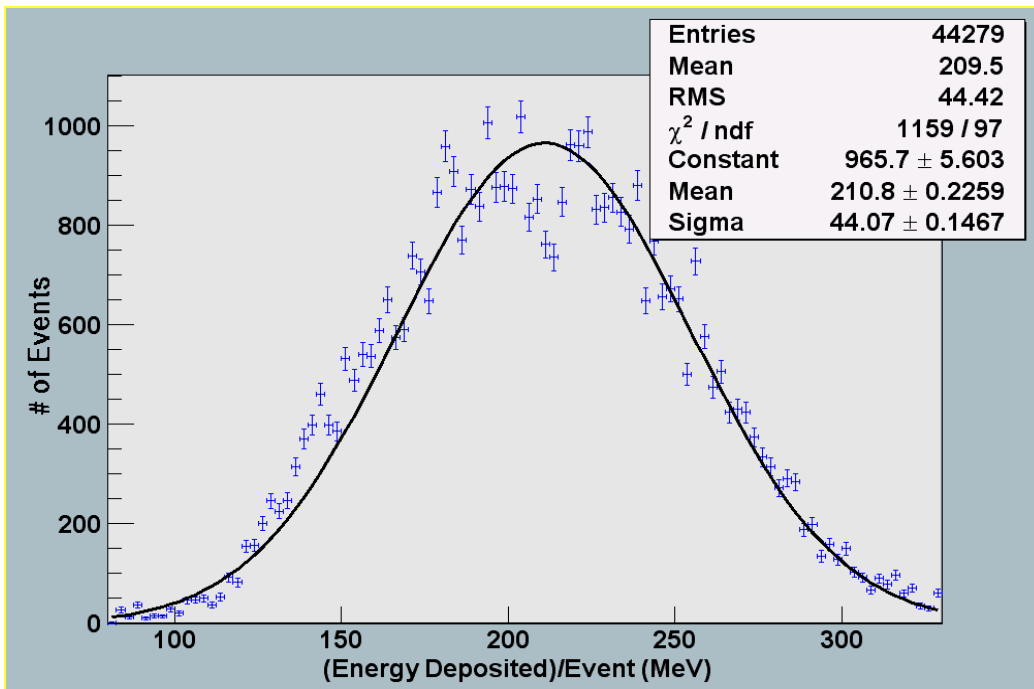


Figure 2: Total live energy distribution for 10 GeV pions using W=0.55

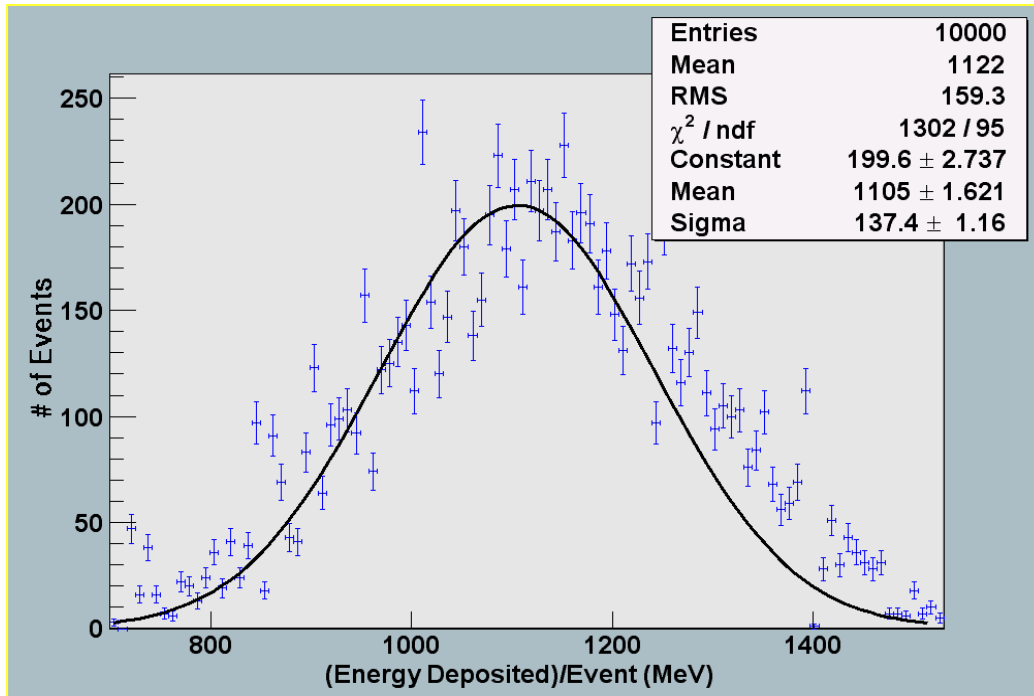


Figure 3: Total live energy distribution for 50 GeV pions using W=0.55

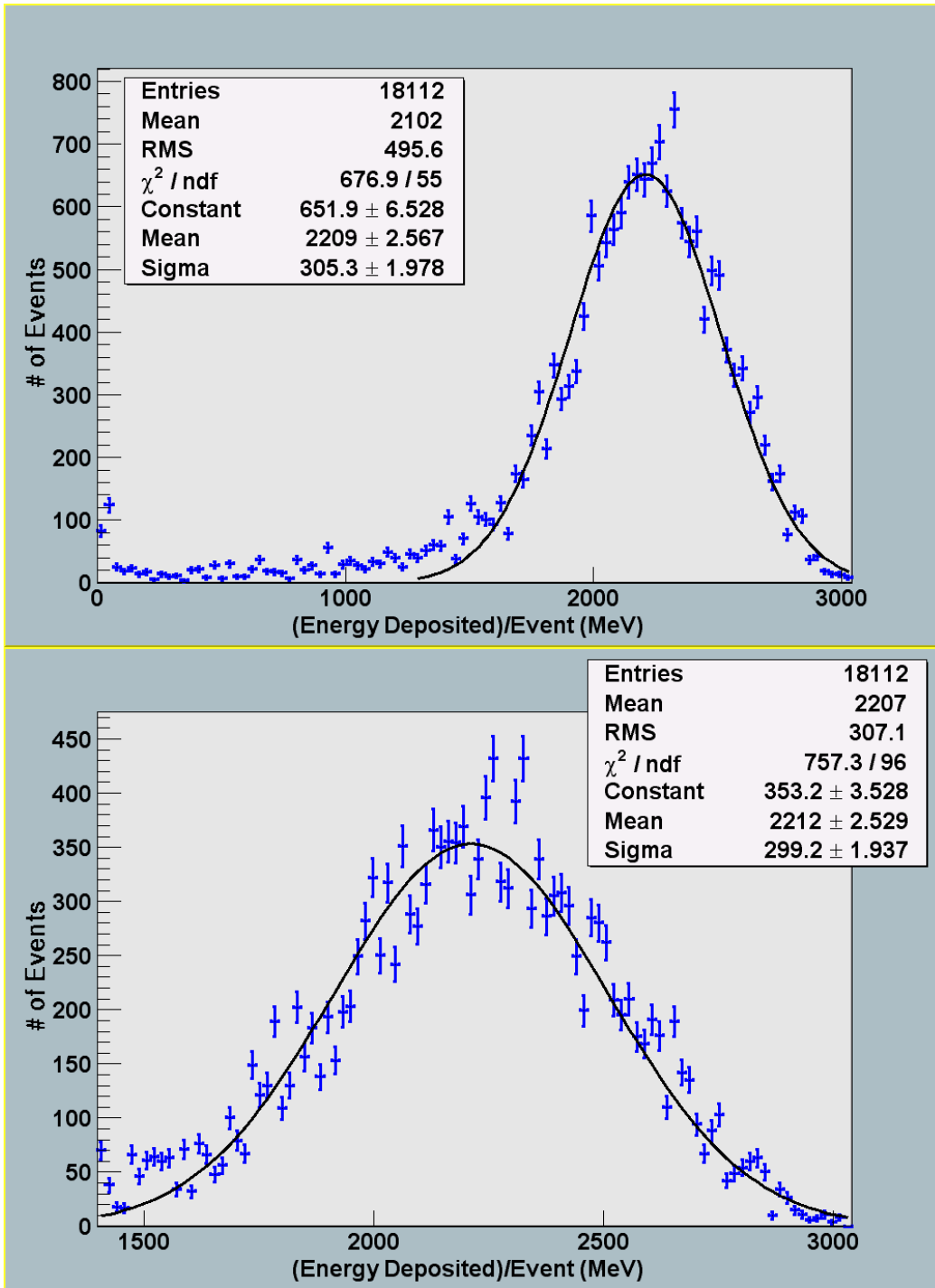


Figure 4: Total live energy distribution for 100 GeV pions with two gaussian fit ranges for the determination of the systematic error.

Response Curve

Table 5a: Data for Figure 5

Energy (GeV)	Mean Energy (MeV)	c^2 / dof
5	115.5±0.186	1114/52
10	210.2±0.222	828.5/61
20	431.5±0.491	384.81/56
50	1124±1.69	321.2/54
75	1661±2.533	518.9/55
100	2209±2.567	676.9/55

Table 5a: Data for Figure 5

Energy (GeV)	Mean Energy (MeV)	c^2 / dof
5	110.9±0.183	781.9/97
10	210.8±0.226	1159/97
20	430.6±0.486	675.5/96
50	1105±1.621	1302/95
75	1669±2.485	610.1/95
100	2211±2.548	841.1/96

Statistical error and Systematic error: A gaussian fit has three parameters – constant c , mean μ and sigma σ . When a gaussian fit is performed on a histogram, ROOT calculates the three parameters (c, μ, σ) and displays them along with the errors. Since the c^2 / dof was not one, the error in the mean and sigma were recalculated using

$e = e_{err} \sqrt{(c^2 / dof)}$ where e_{err} and c^2 / dof are the statistical error, chi square and the degree of freedom from the gaussian fit.

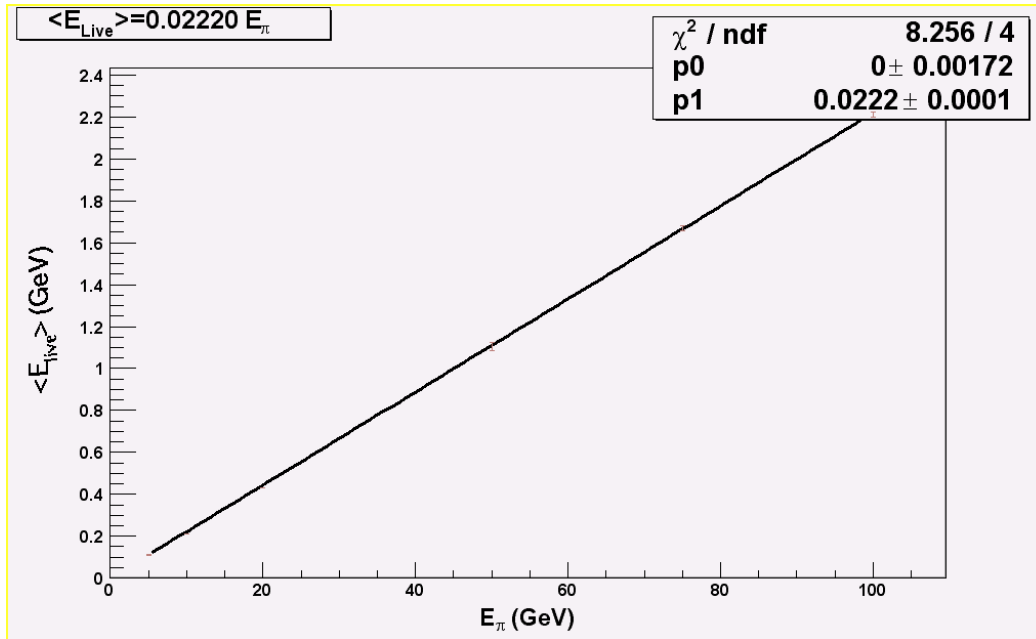


Figure 5: Response curve for Mokka TDR after taking into account the differences in responses of HCAL and ECAL.

Response of Mokka TDR, with compensation, was calculated to be $0.0222 \pm 1.0 \text{E-}04$ while without compensation it was $0.03745 \pm 3.77 \text{E-}04$. Response curve in both cases is linear.

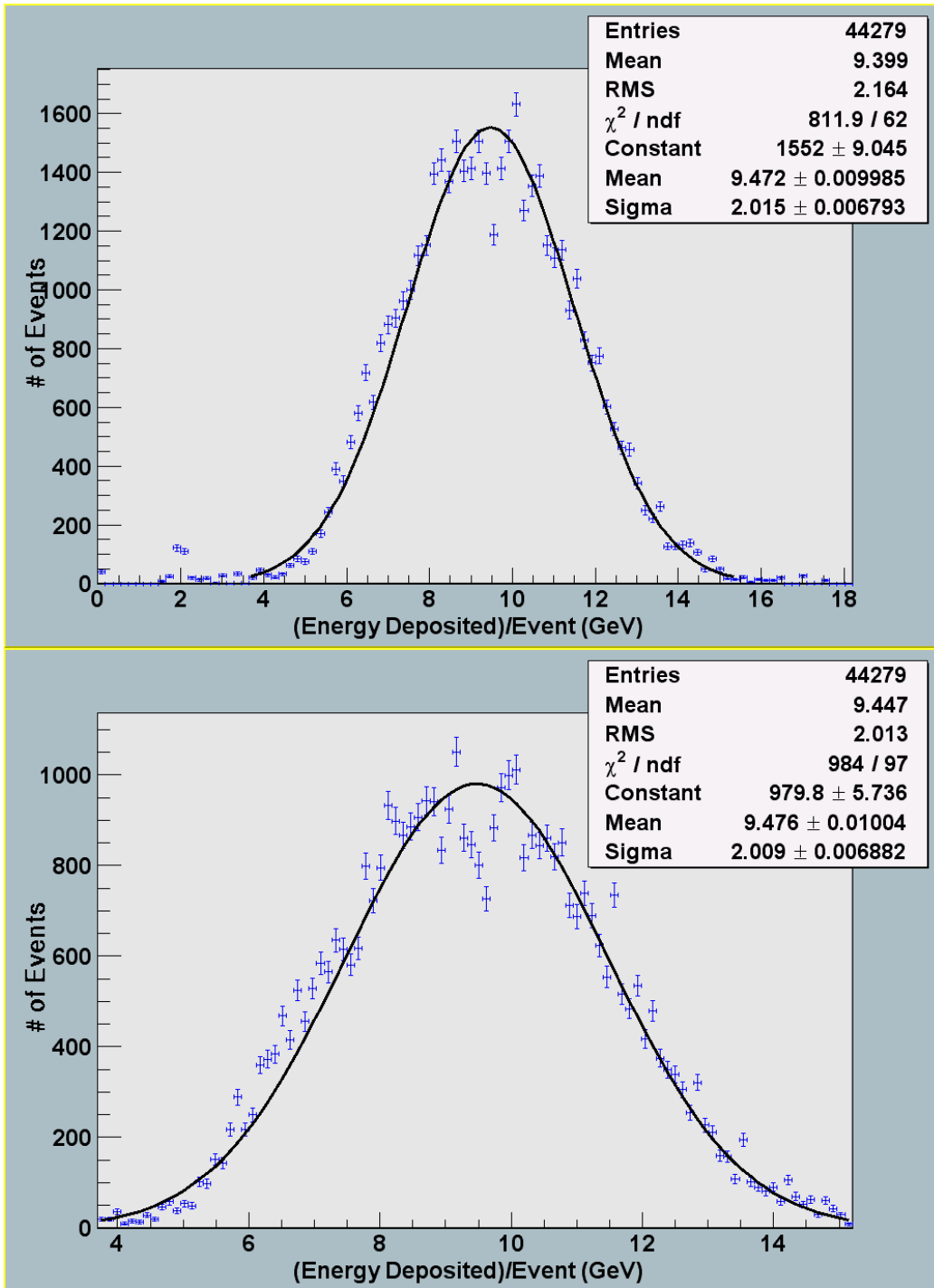


Figure 6: Total corrected energy distribution for 10 GeV pions with two gaussian fits for the determination of a systematic error.

Resolution

Table 6a: Data for Fig. 7

Energy (MeV)	Mean (GeV)	Sigma (MeV)	χ^2 / dof
5	5.02±0.008	1.279±0.005	1109/52
10	9.472±0.01	2.015±0.007	811.9/62
20	19.46±0.022	3.463±0.016	336/56
50	50.49±0.076	7.094±0.053	393.4/54
75	74.82±0.114	10.21±0.073	532.1/55
100	99.41±0.116	13.7±0.087	690.2/55

Table 6b: Data for Fig. 7

Energy (MeV)	Mean (GeV)	Sigma (MeV)	χ^2 / dof
5	4.988±0.008	1.339±0.006	706.7/93
10	9.476±0.010	2.009±0.007	984/97
20	19.42±0.022	3.391±0.015	589.7/95
50	50.7±0.077	7.112±0.057	561.9/95
75	75.17±0.111	10.33±0.080	668.2/95
100	99.54±0.114	13.47±0.08	879.5/97

Comparing Fig. 7 and Fig. 8 at different energy bins it is observed that Fig. 7 is consistent with the Fig. 8 though Fig. 8 is the resolution of HCAL and Fig. 7 is the resolution of Mokka TDR, that is, it includes both ECAL and HCAL. Also Fig. 7 was obtained for π^{-1} while Fig 8 is the resolution for K_L^0

Table 7: Comparing Figs. 7 and 8

Energy (GeV)	Figure 7	Figure 8
5	27%	29.5%
20	17.5%	17.5%
100	14%	14%

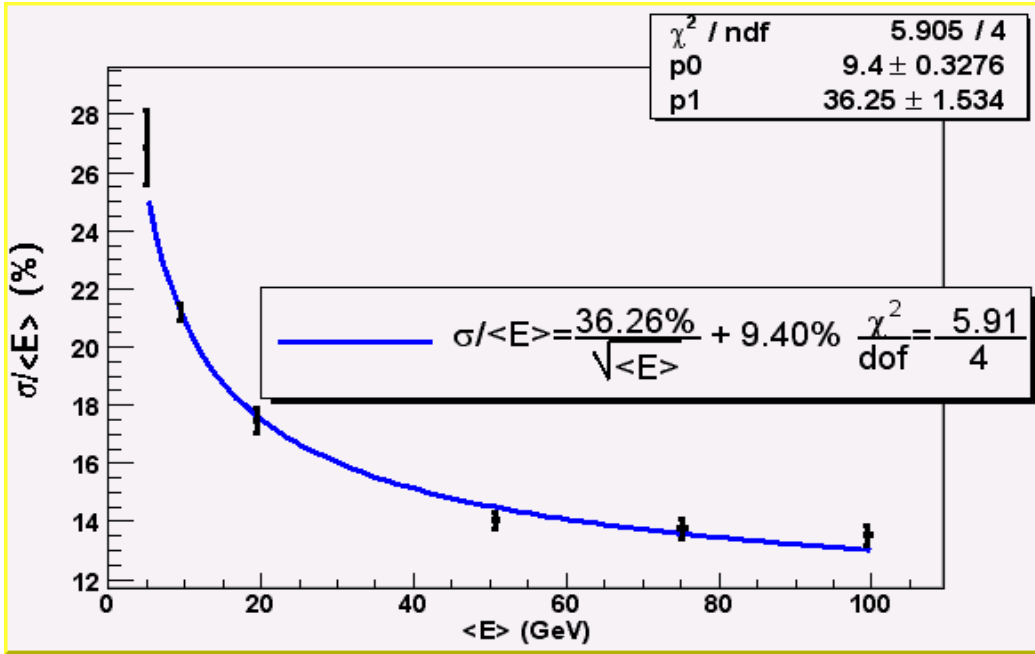


Figure 7: Resolution curve of Mokka TDR after taking into account the differences in response of ECAL and HCAL

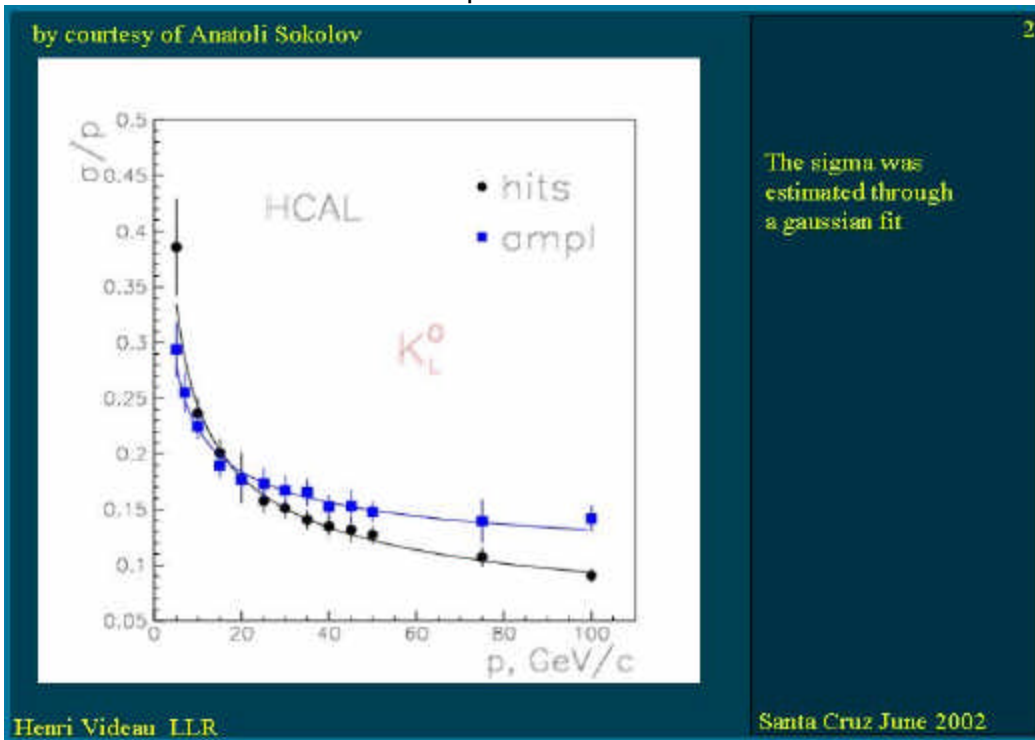


Figure 8: Resolution of HCAL for K_L^0

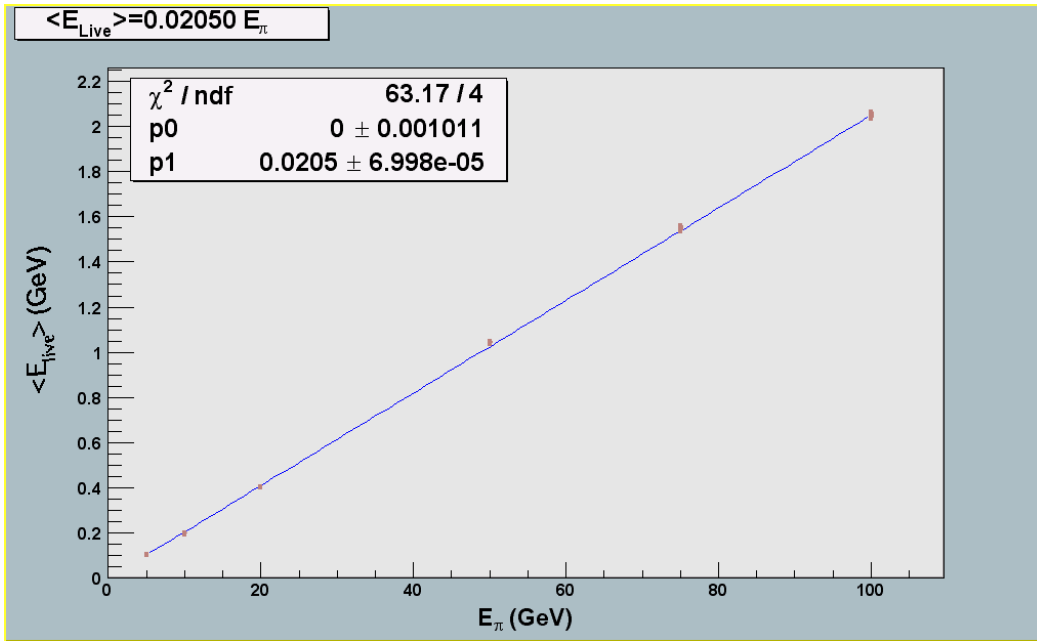


Figure 9: Response of Mokka TDR – W=0.5

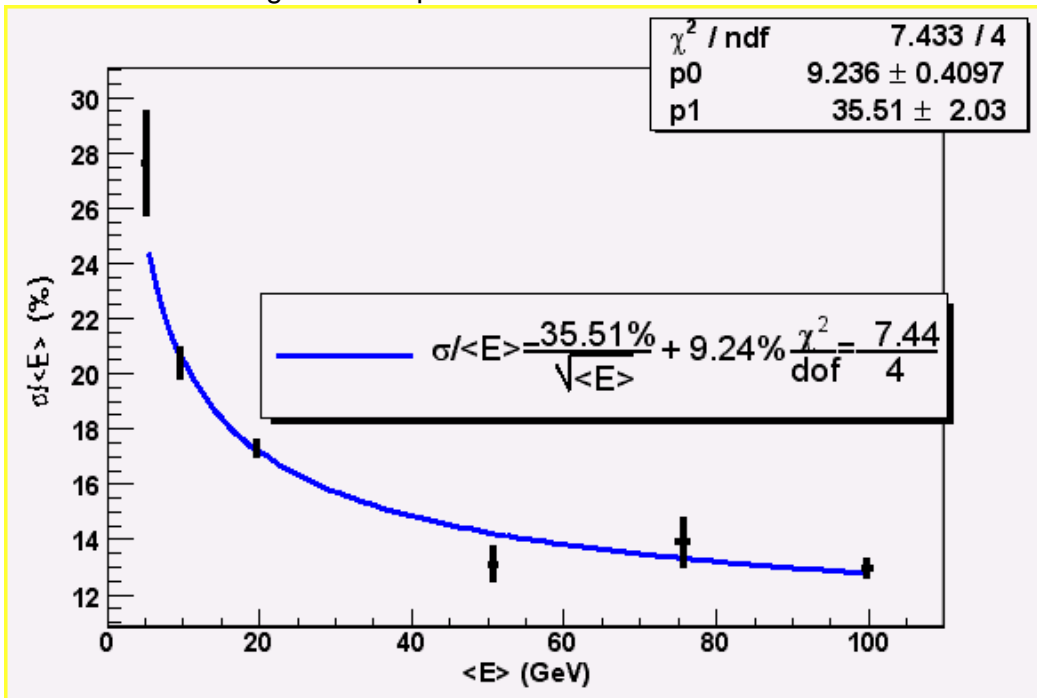


Figure 10: Resolution of Mokka TDR – W=0.5

Weighting Factor 0.6

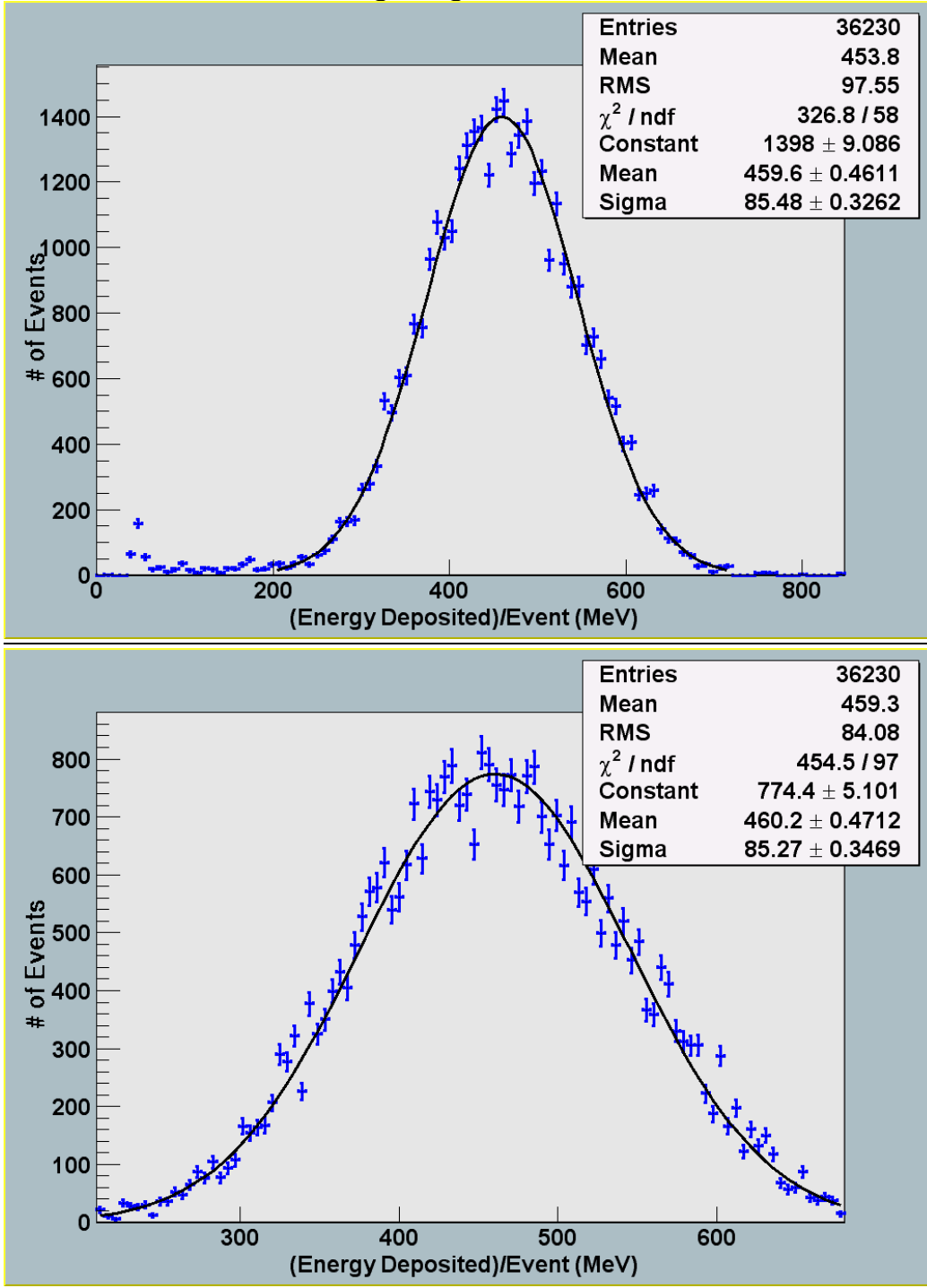


Figure 11: Total live energy distribution for 20 GeV pions

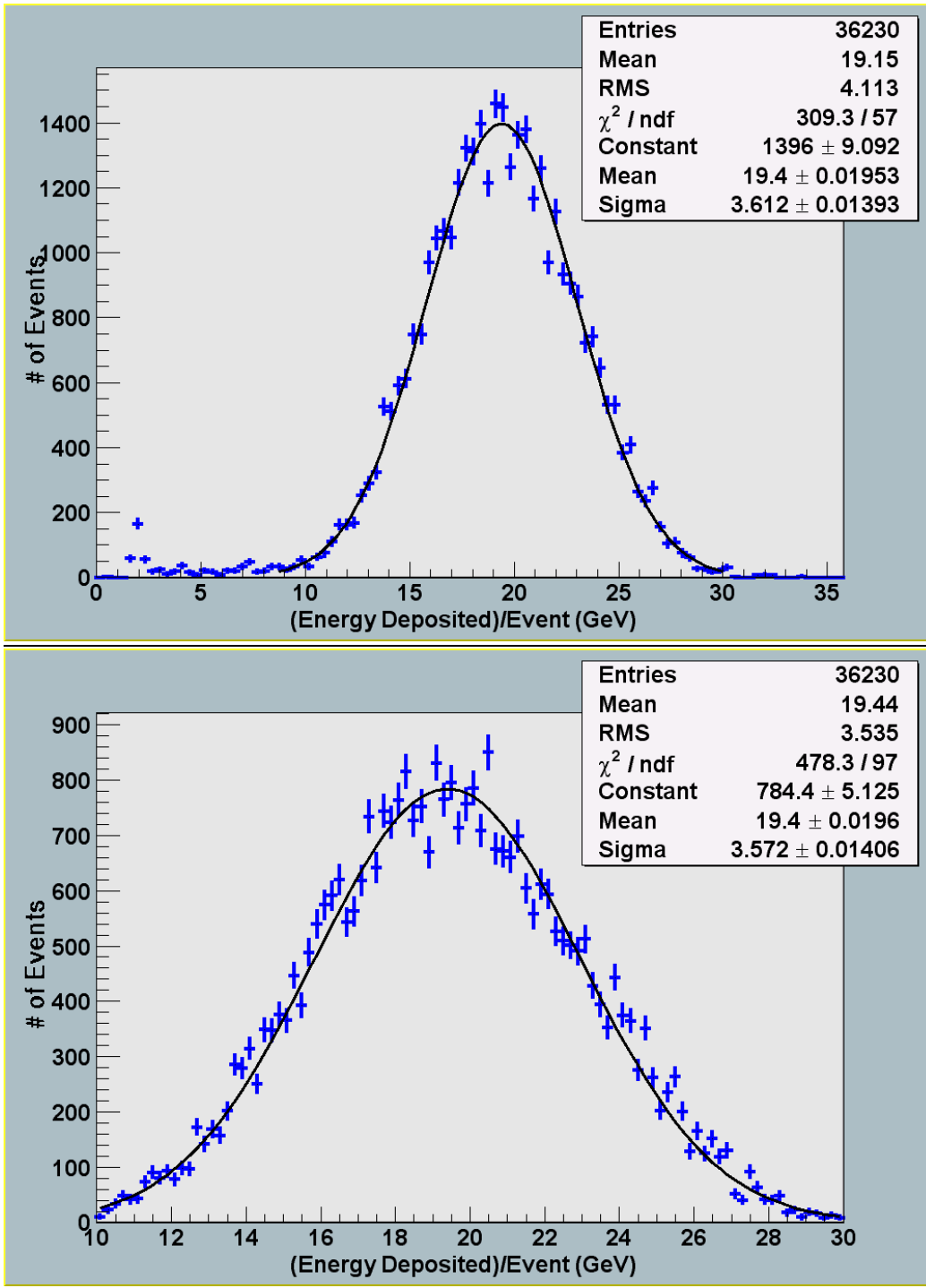


Figure 12: Total corrected energy distribution for 20 GeV pions

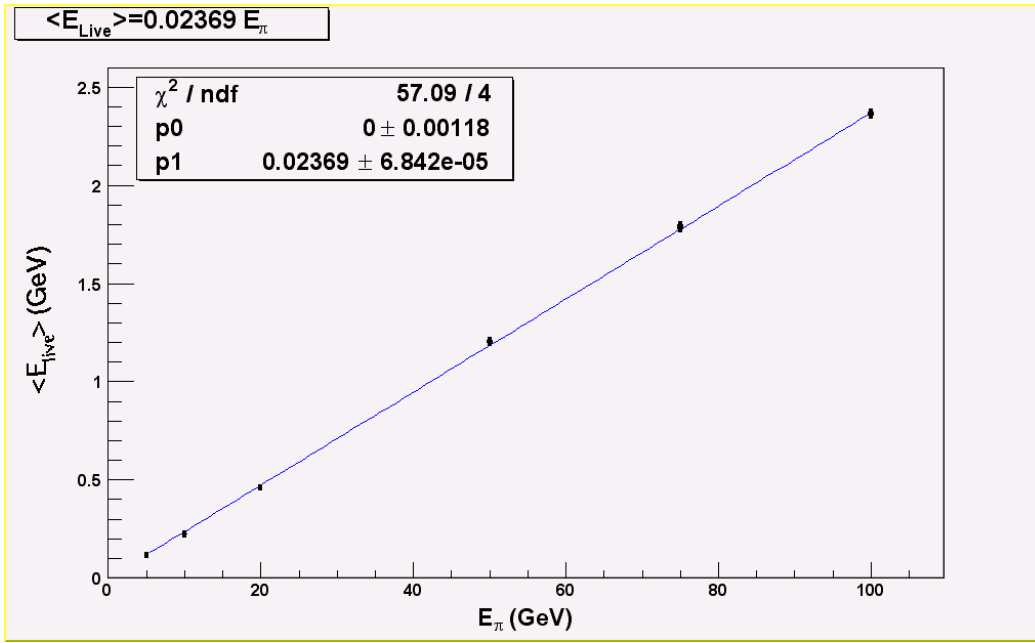


Figure 13: Response of Mokka TDR – W=0.6

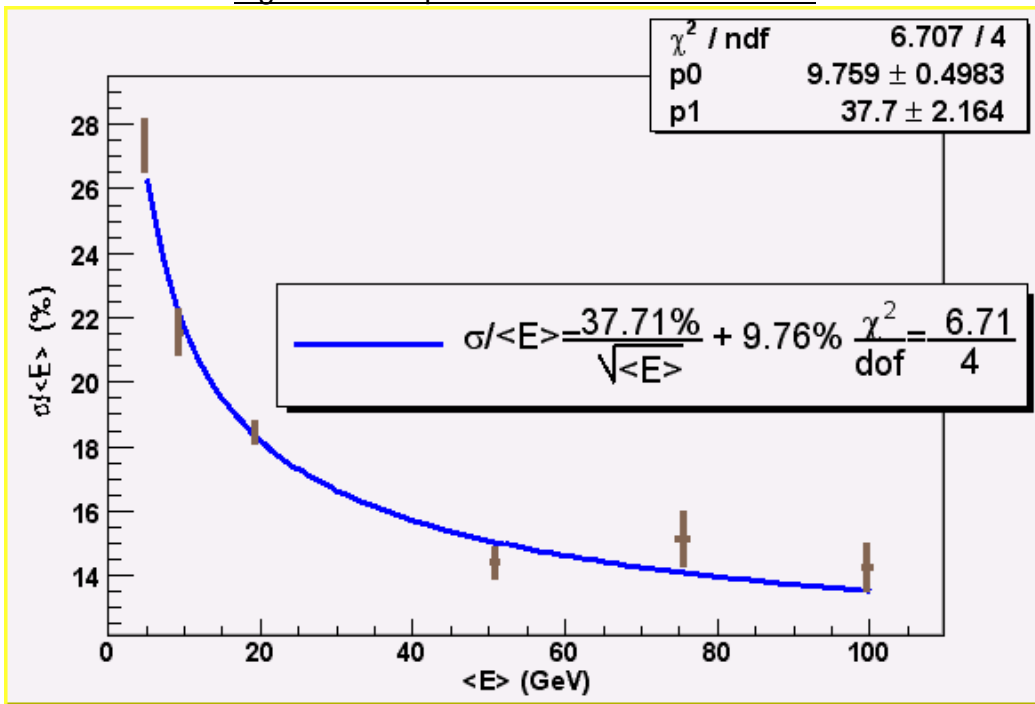


Figure 14: Resolution of Mokka TDR – W=0.6

Table 8: Summary

W	Response	Resolution	χ^2 / dof
0.5	$0.0205 \pm 6.998e-05$	$\frac{(37.71 \pm 2.164)\%}{\sqrt{E}} + (9.76 \pm 0.4983)\%$	6.71/4
0.55	$0.0222 \pm 1.0e-04$	$\frac{(36.25 \pm 1.534)\%}{\sqrt{E}} + (9.4 \pm 0.3276)\%$	5.905/4
0.66	$0.0237 \pm 6.842e-05$	$\frac{(35.51 \pm 2.63)\%}{\sqrt{E}} + (9.24 \pm 0.4097)\%$	7.433/4