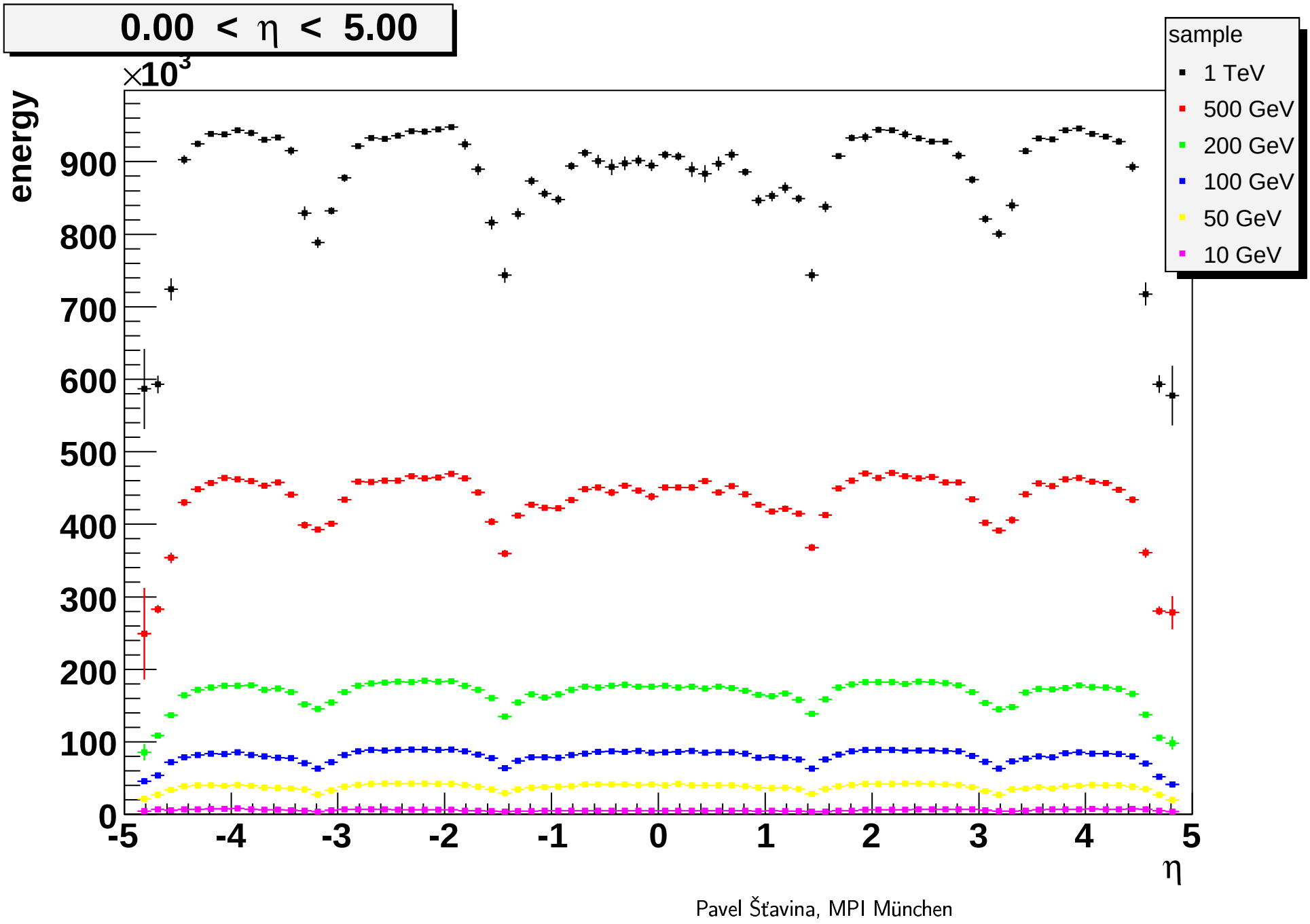
EM clusters identification

- Moments
- Identification of EM clusters
- Estimation of EM component using moments
- Simulation and reconstruction of jet data


0.00 < η < 5.00
×10³
energy
900
800
700
600
500
400
300
200
100
0
-5
-4
-3
-2
-1
0
1
2
3
4
5
η
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV

Moments and other quantities on cluster level

- Some moments were implemented into athena. The following list contains moments and cluster information important for our investigation
  - SECOND_R -second radial moment (shower effective radius)
  - SECOND_LAMBDA -second longitudinal moment (shower effective length)
  - DELTA_ALPHA - full angle between IP axis and shower axis
  - cl_nc - number of cells in cluster
  - CENTER_LAMBDA

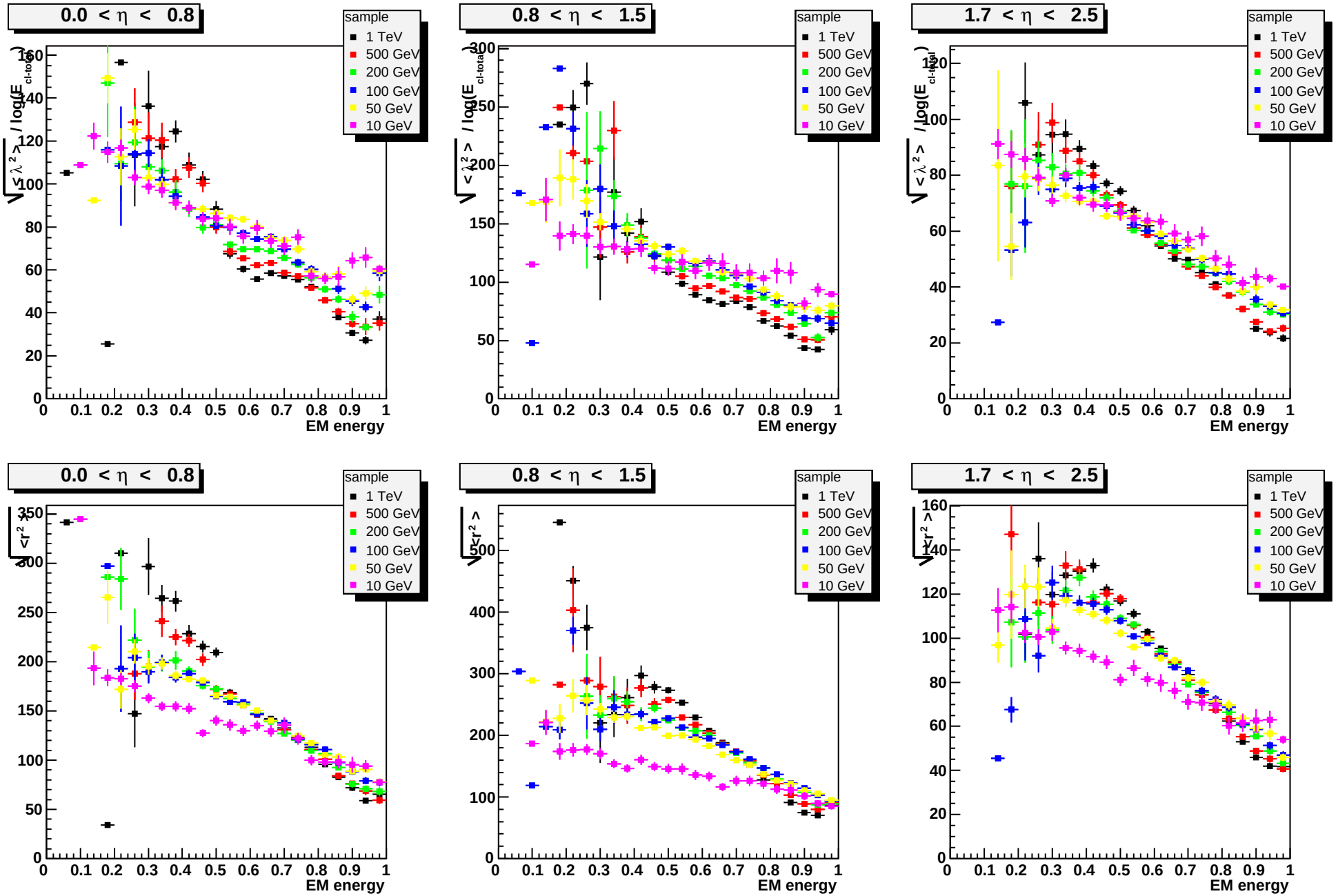
Second moments definition:

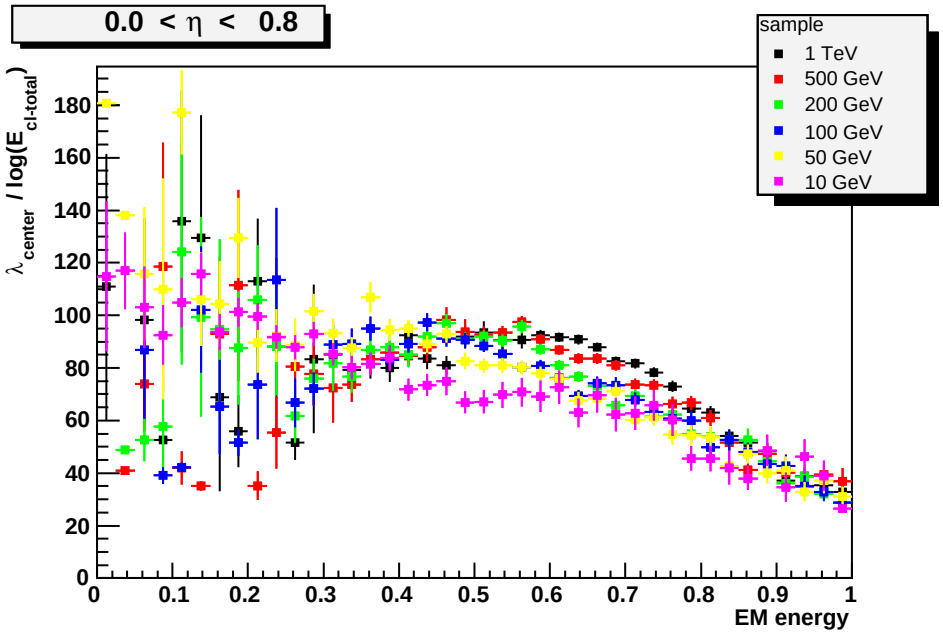
$$\lambda^2 = \frac{\sum_{i=1}^{n} \lambda_i^2 \cdot E_i}{\sum_{i=1}^{nl} E_i}$$

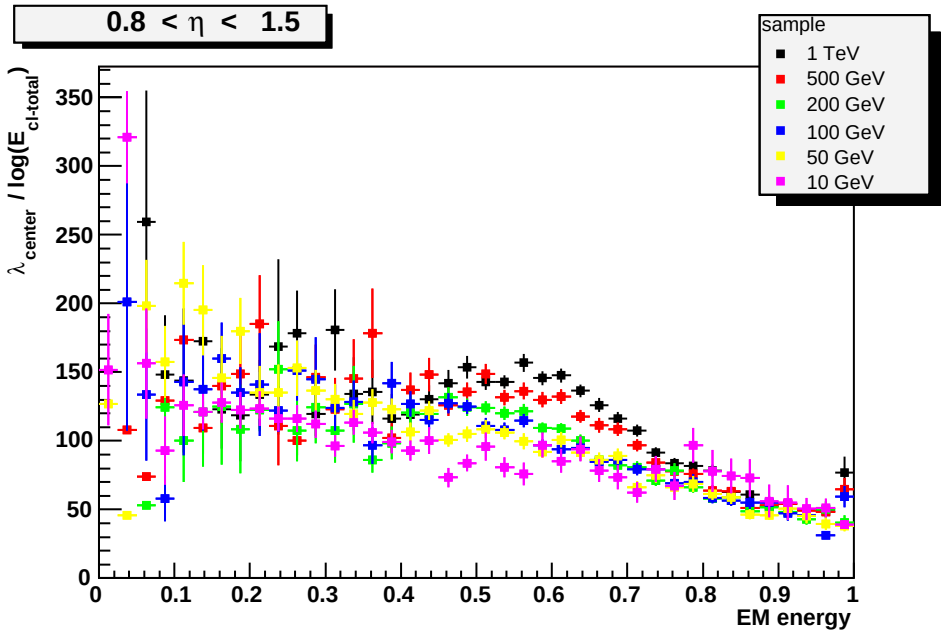
$$r^2 = \frac{\sum_{i=1}^{n} r_i^2 \cdot E_i}{\sum_{i=1}^{n} E_i}$$

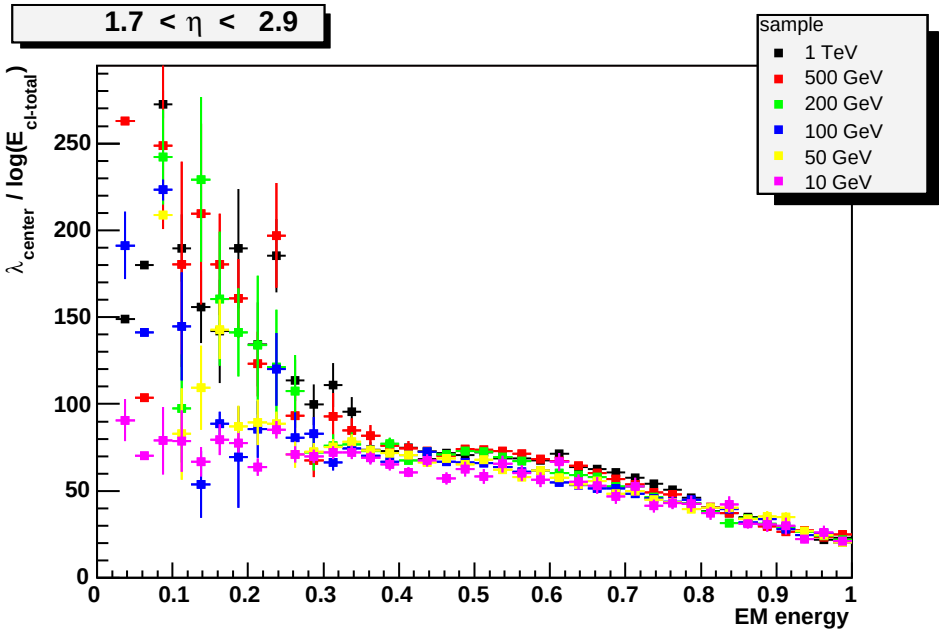
where

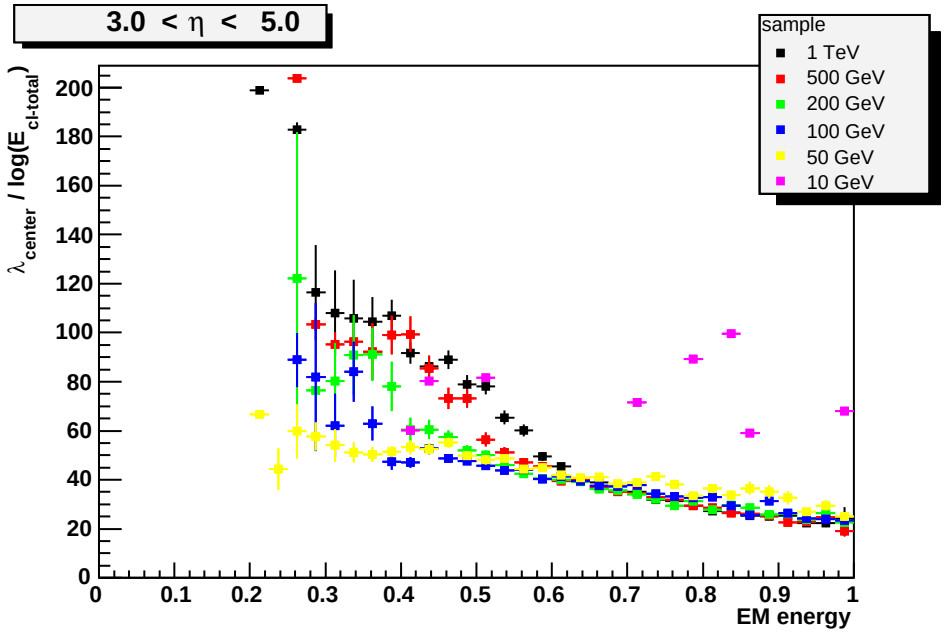
- r_i - radial distance of i-th cell from shower axis
- λ - longitudinal distance of i-th cell from shower center
- E_i - energy deposited at i-th cell
- n - number of cells in cluster

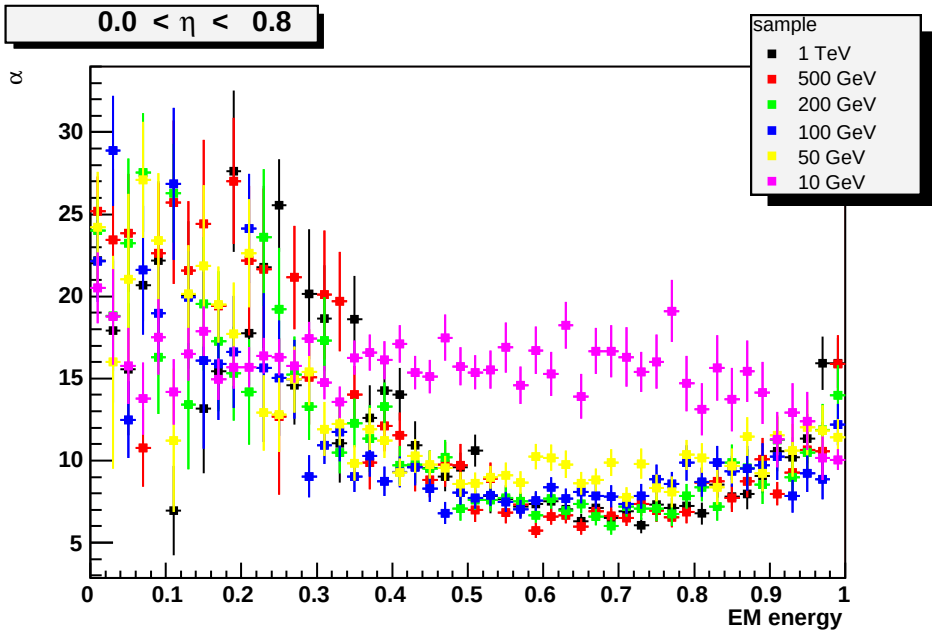

0.0 < η < 0.8
0.8 < η < 1.5
1.7 < η < 2.5
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
EM energy
<λ²> / log(E cl-total)
<r²>

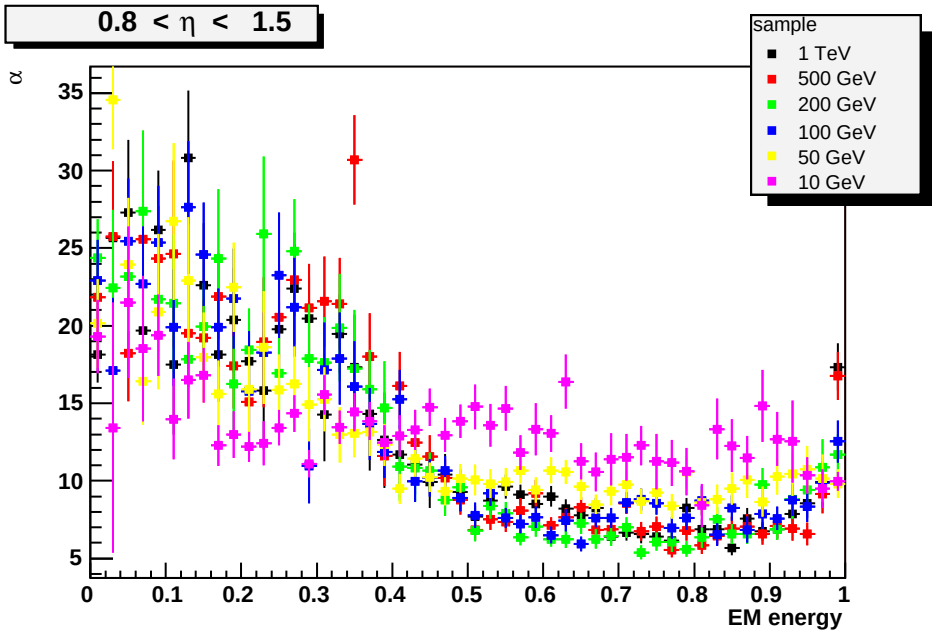

0.0 < η < 0.8
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
λcenter / log(Ecl-total)
EM energy

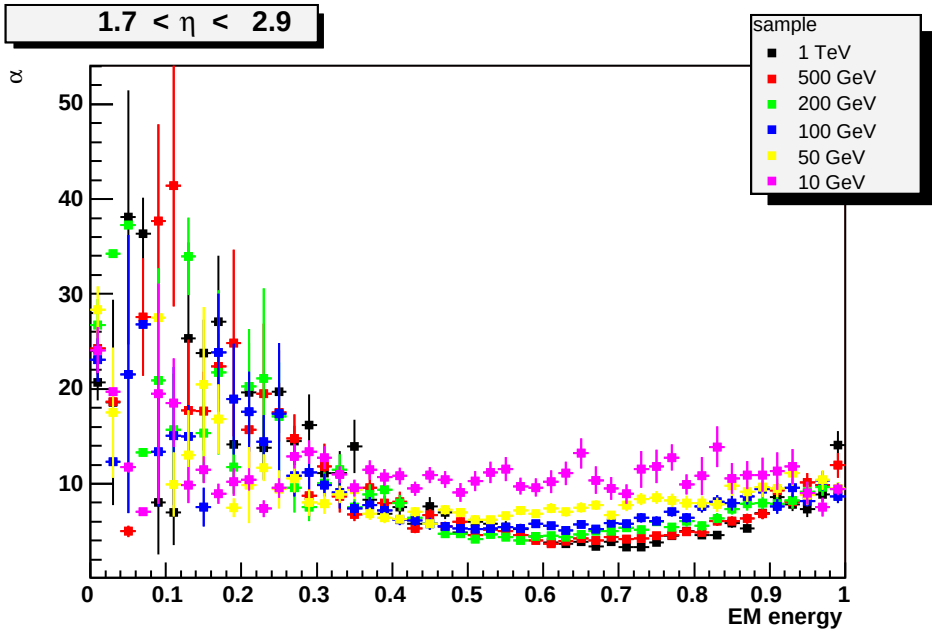

0.8 < η < 1.5
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
λcenter / log(Ecl-total)
EM energy

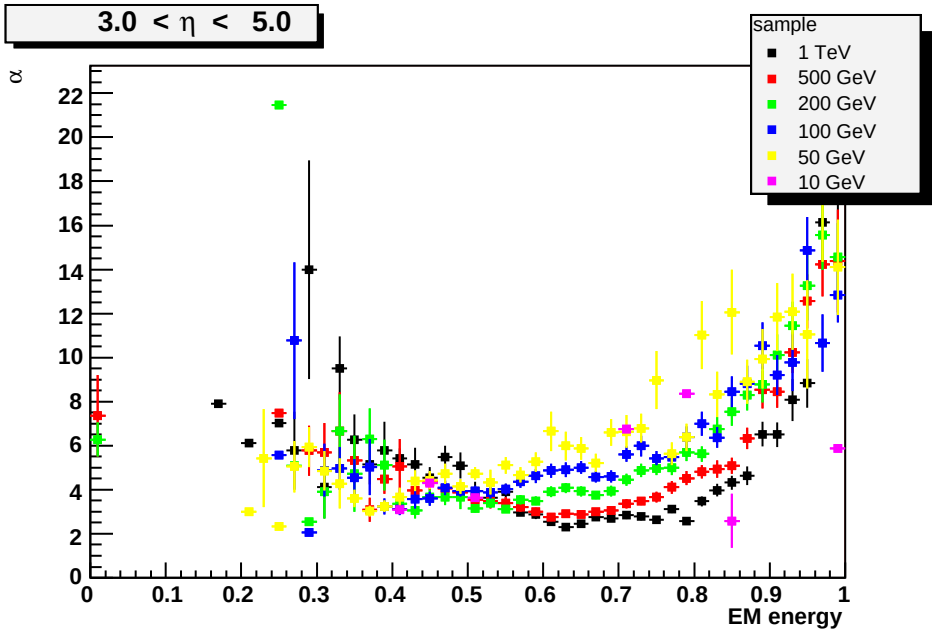

1.7 < η < 2.9
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
λcenter / log(Ecl-total)
EM energy

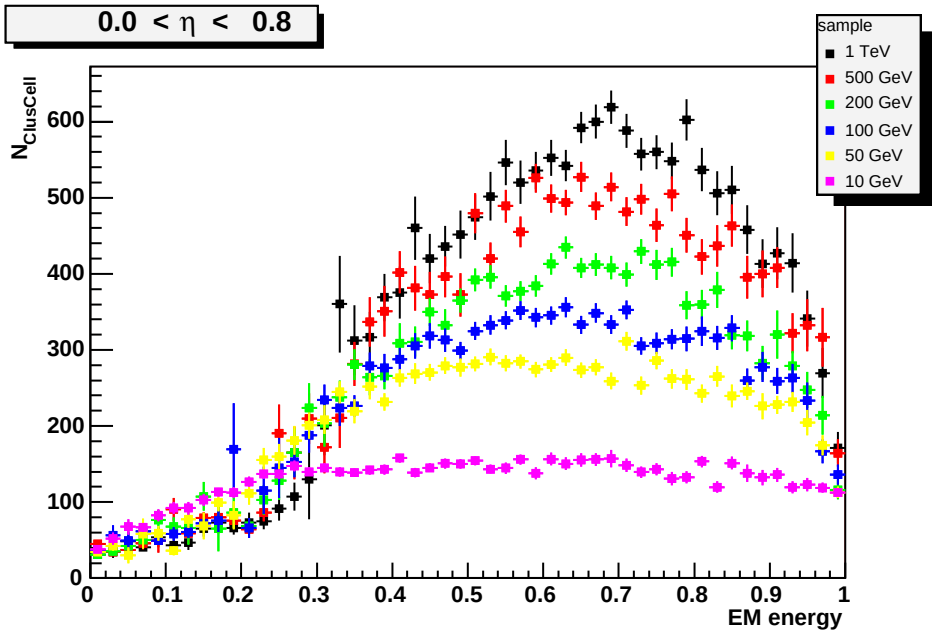

3.0 < η < 5.0
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
λcenter / log(Ecl-total)
EM energy

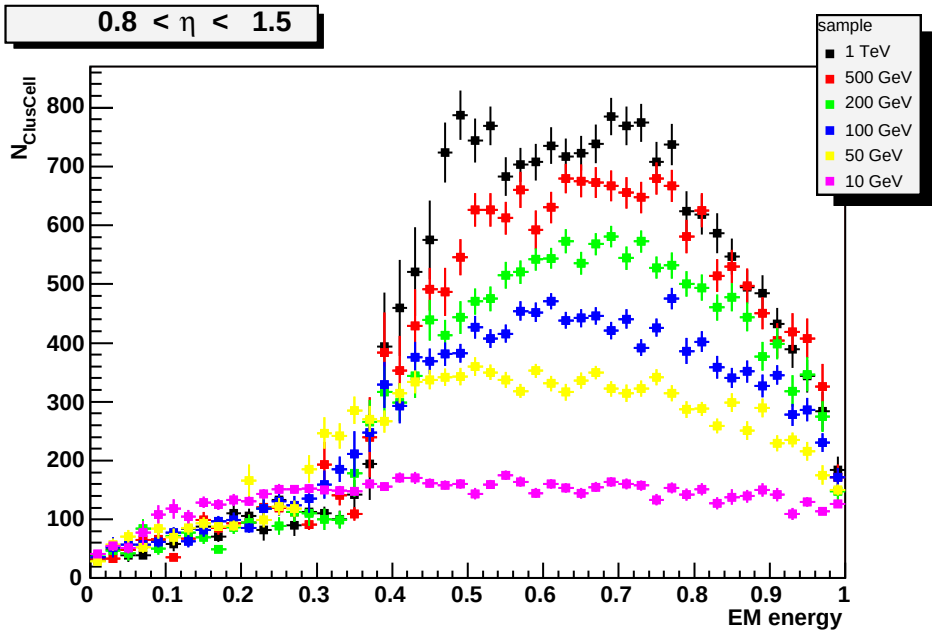

0.0 < η < 0.8
α
EM energy
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV

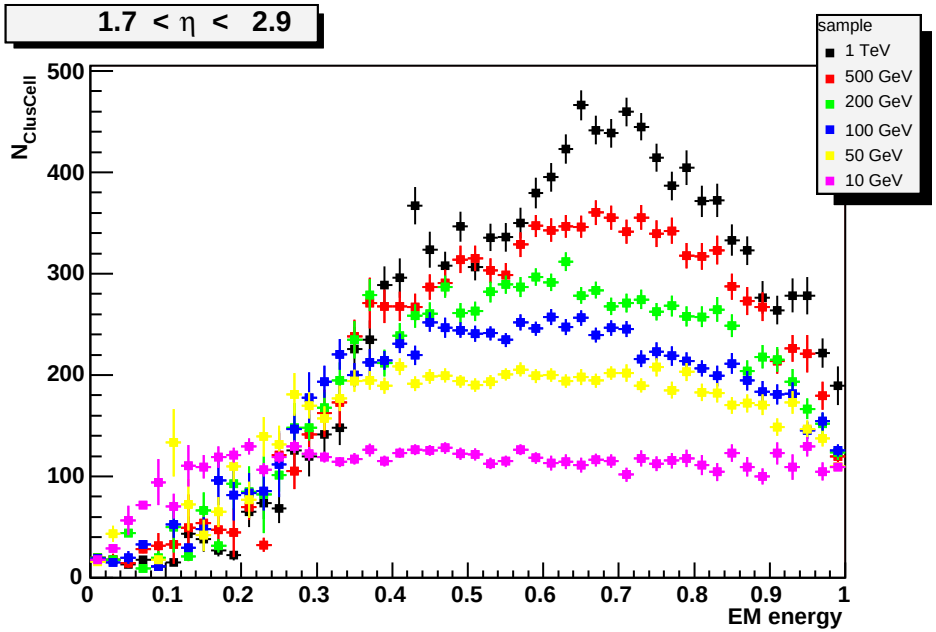

0.8 < η < 1.5
α
EM energy
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV

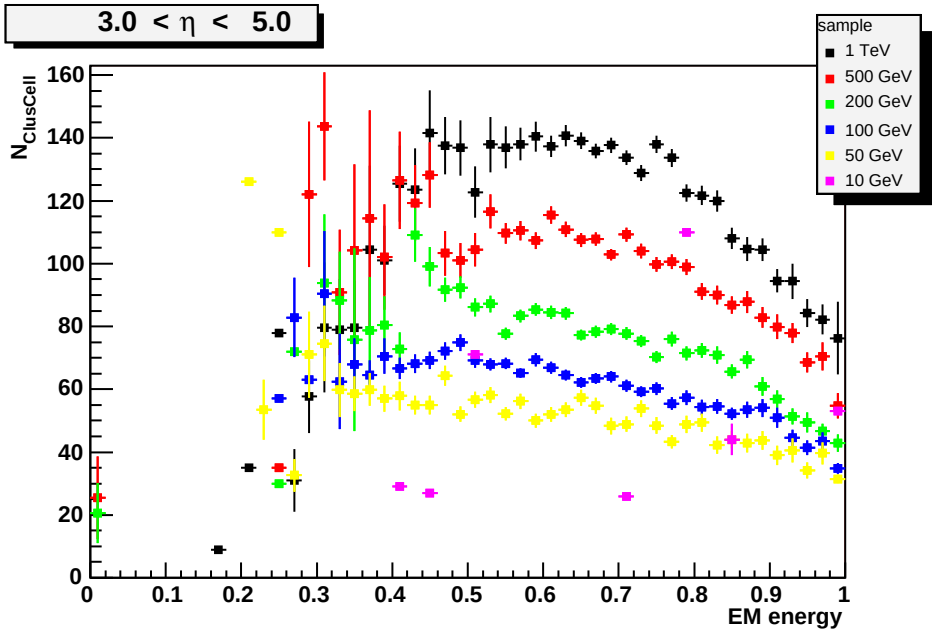

1.7 < η < 2.9
α
EM energy
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV

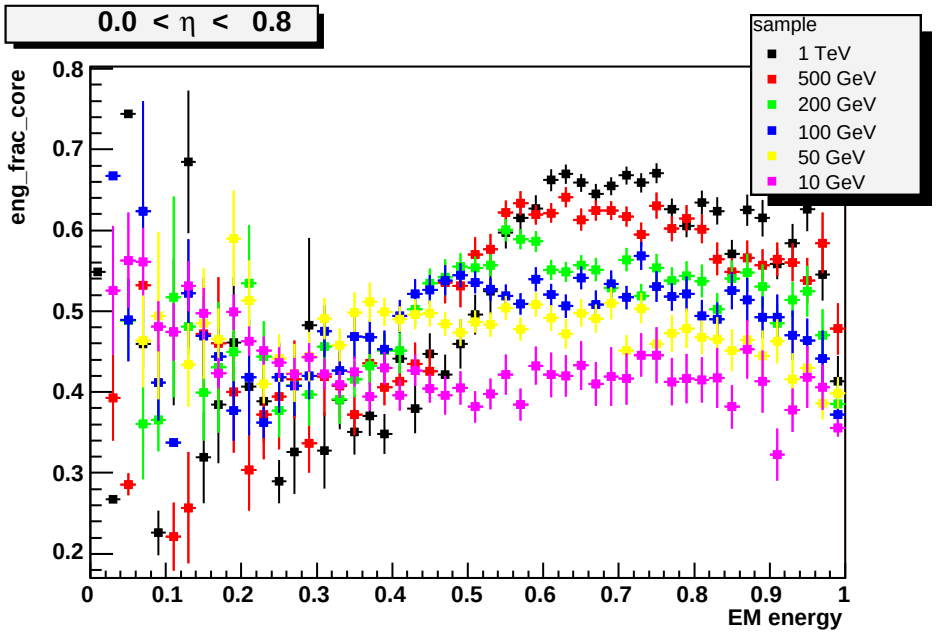

3.0 < η < 5.0
α
EM energy
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV

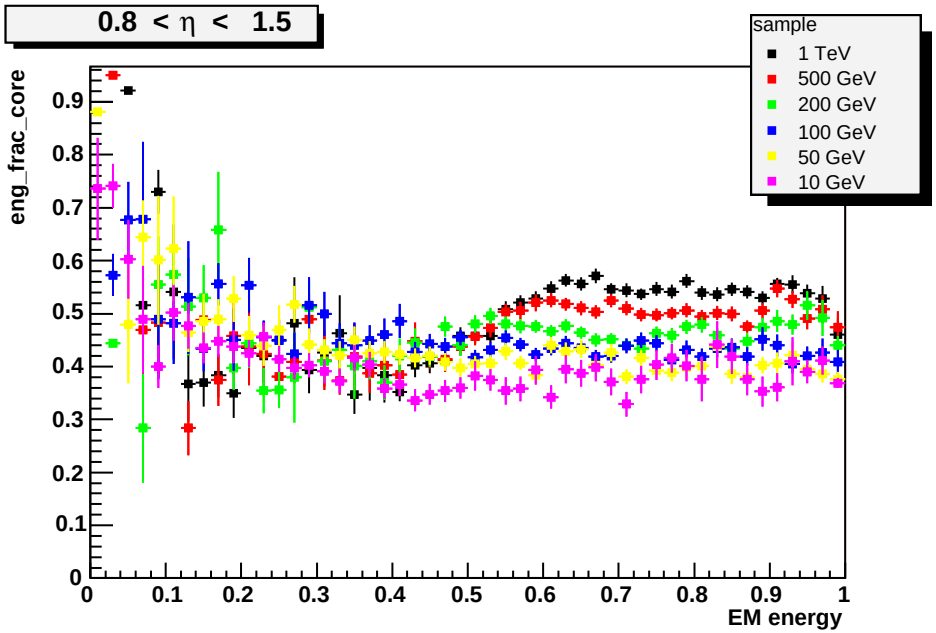

0.0 < η < 0.8
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
N_ClusCell
EM energy

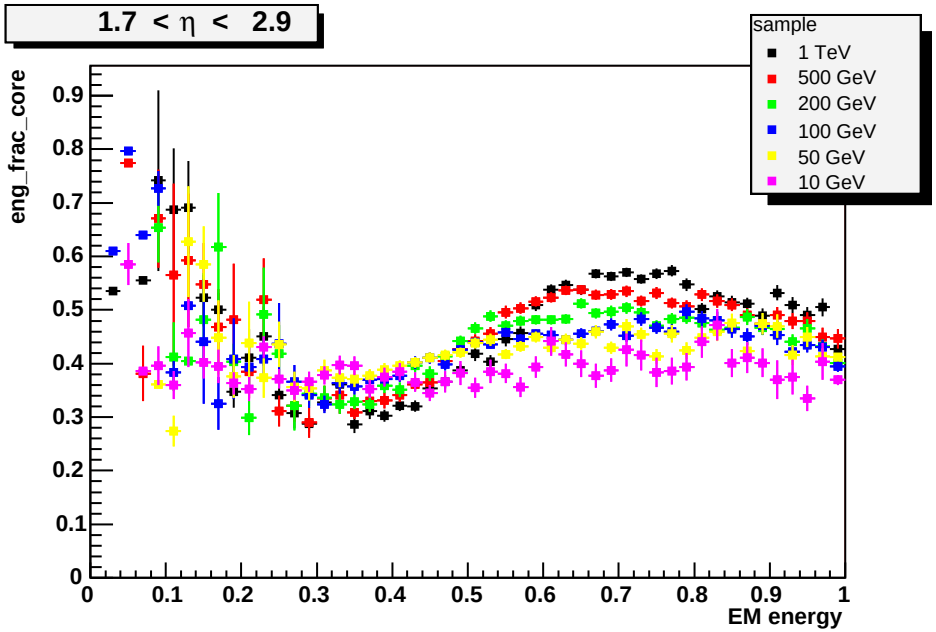

0.8 < η < 1.5
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
N_ClusCell
EM energy

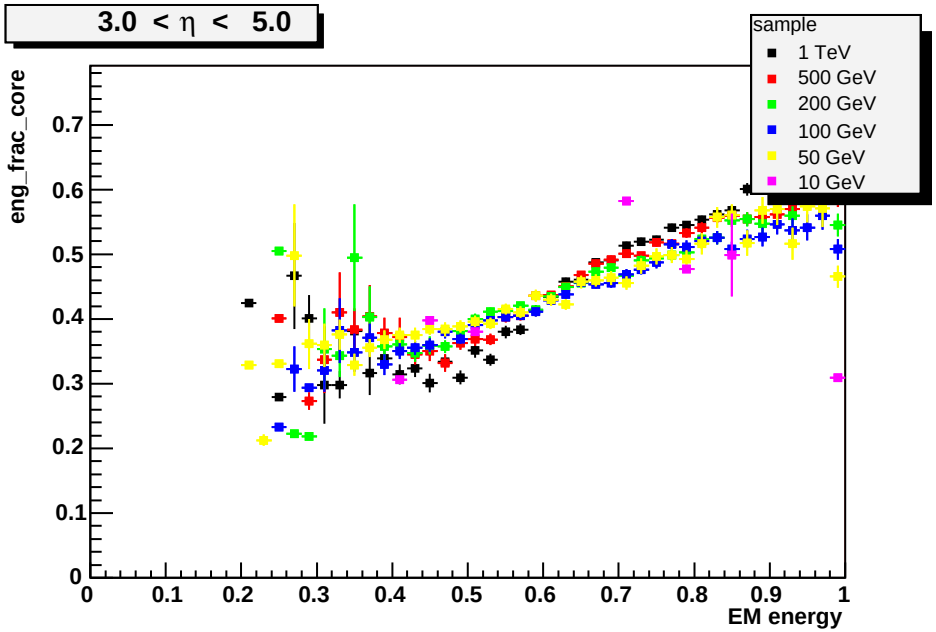

1.7 < η < 2.9
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
N_ClusCell
EM energy

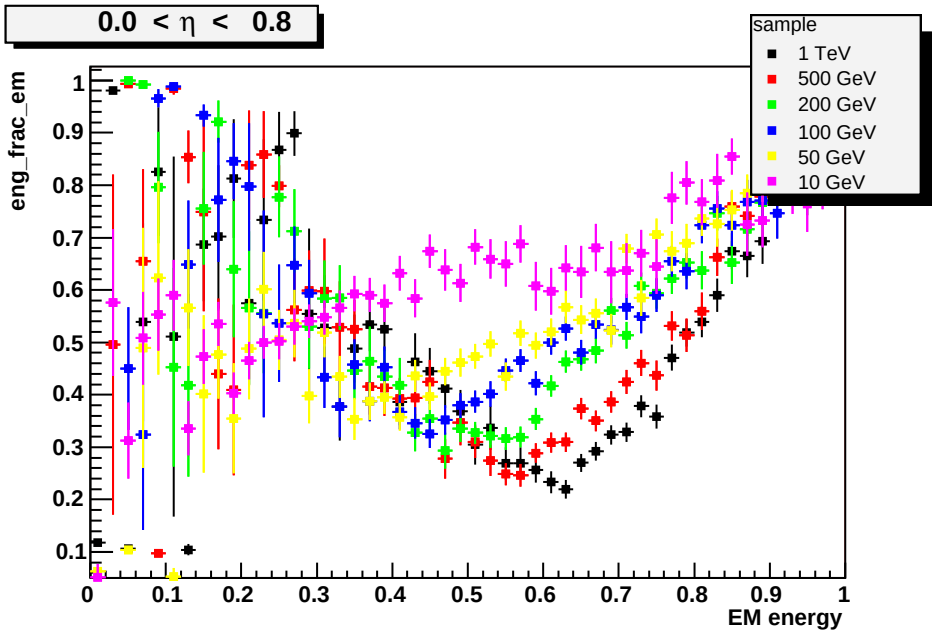

3.0 < η < 5.0
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
N_ClusCell
EM energy

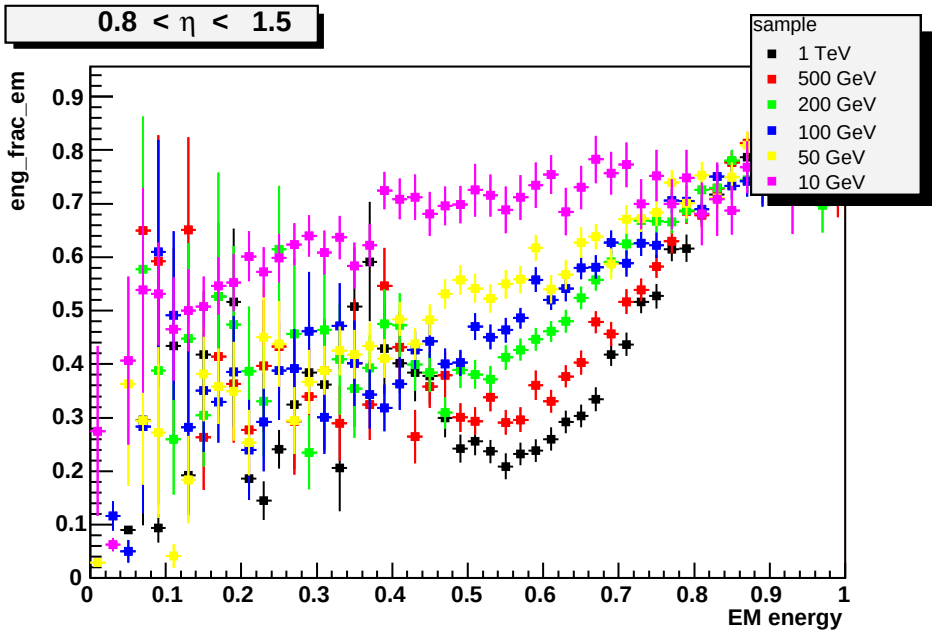

0.0 < η < 0.8
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
eng_frac_core
EM energy

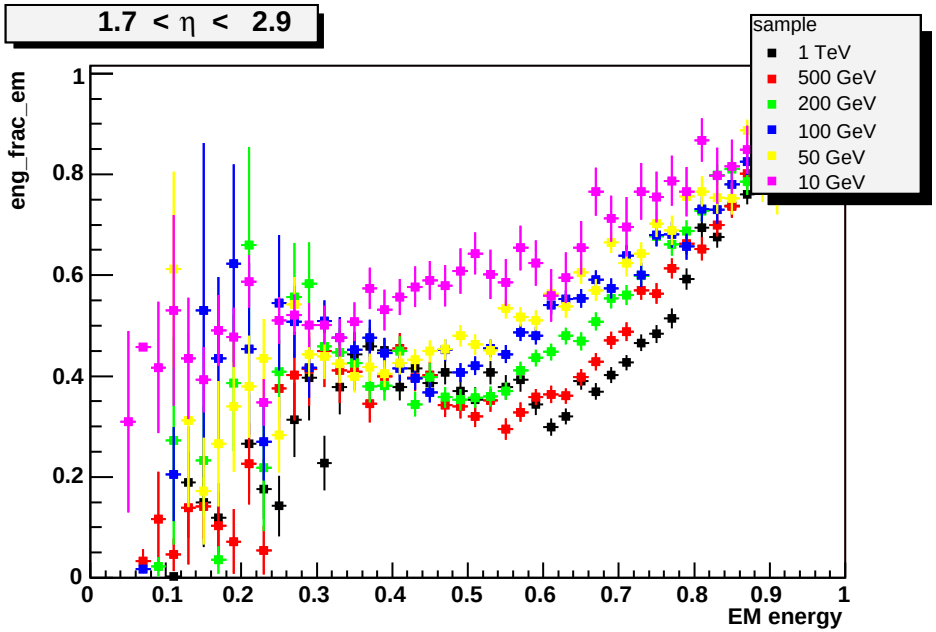

0.8 < η < 1.5
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
eng_frac_core
EM energy

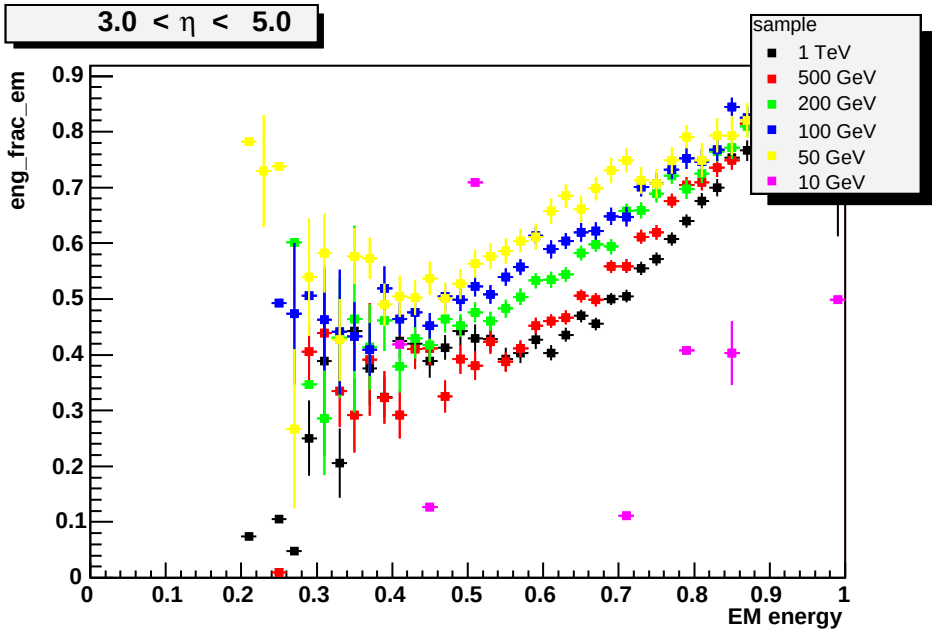

1.7 < η < 2.9
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
eng_frac_core
EM energy

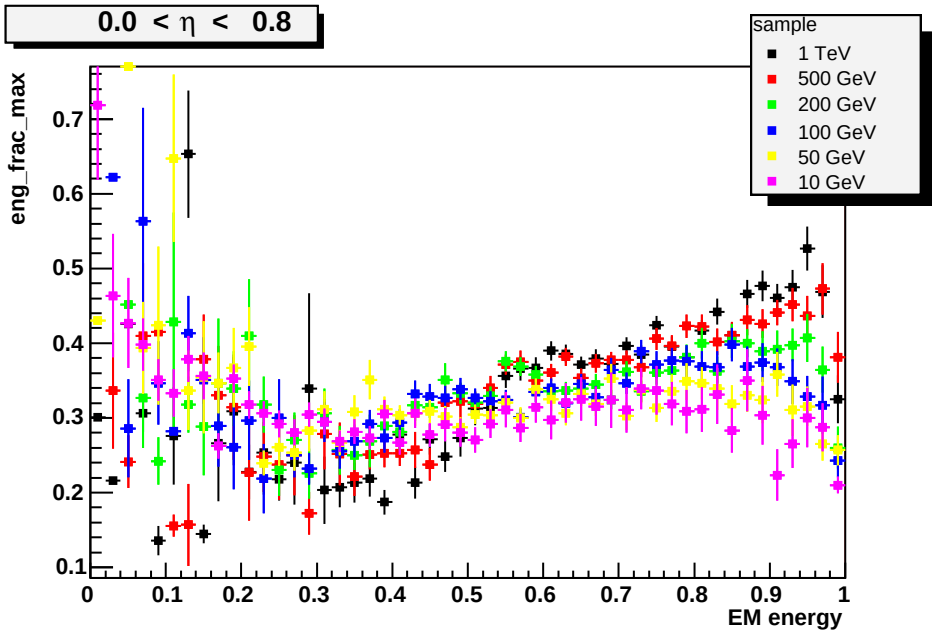

3.0 < η < 5.0
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
eng_frac_core
EM energy

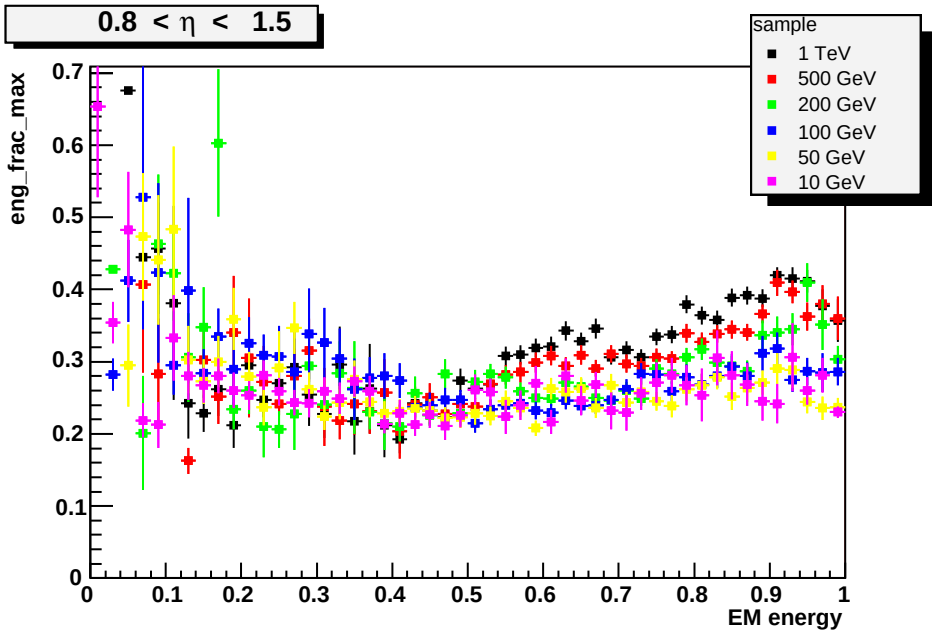

0.0 < η < 0.8
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
eng_frac_em
EM energy

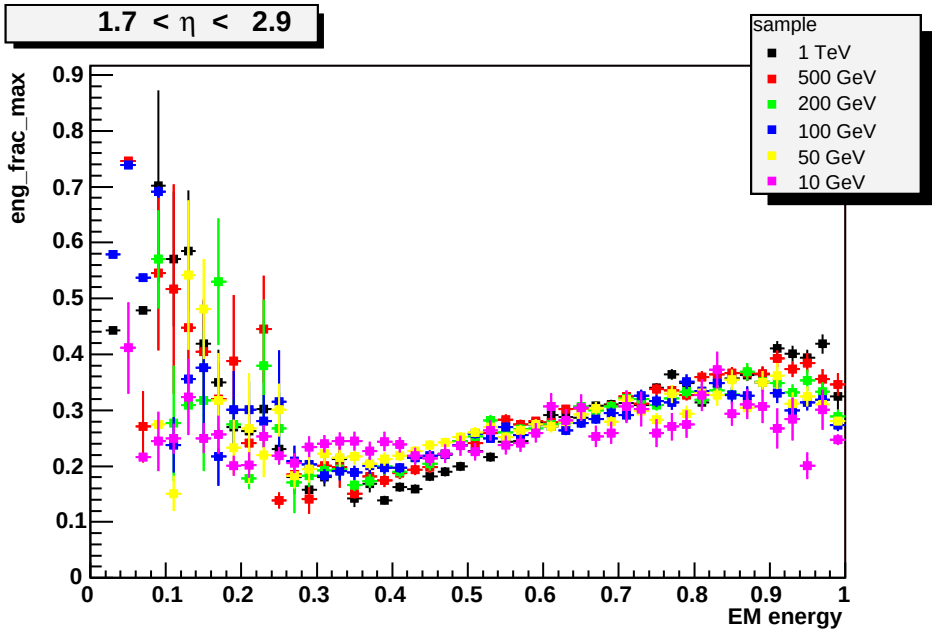

0.8 < η < 1.5
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
eng_frac_em
EM energy

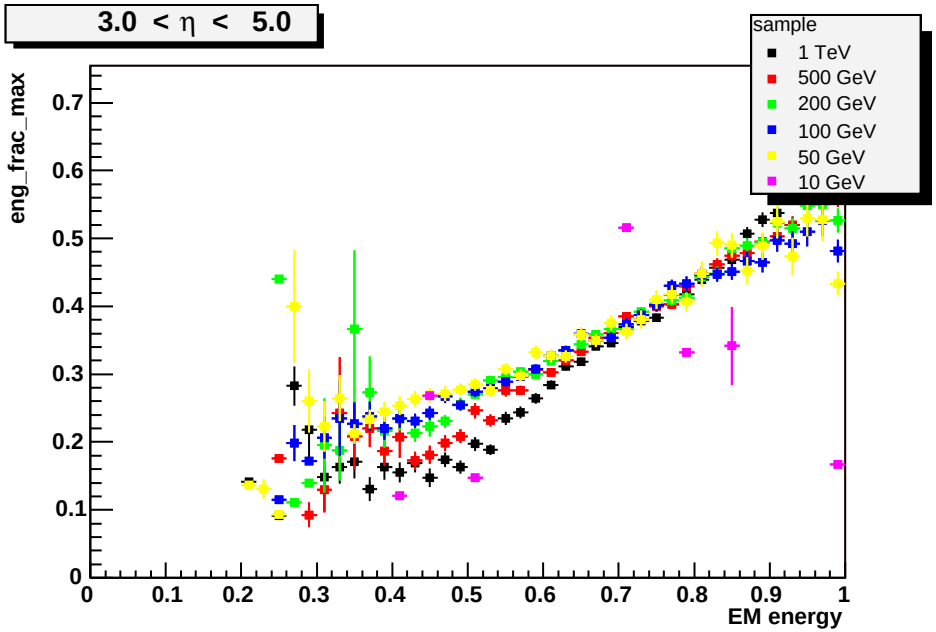

1.7 < η < 2.9
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
eng_frac_em
EM energy


3.0 < η < 5.0
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
eng_frac_em
EM energy

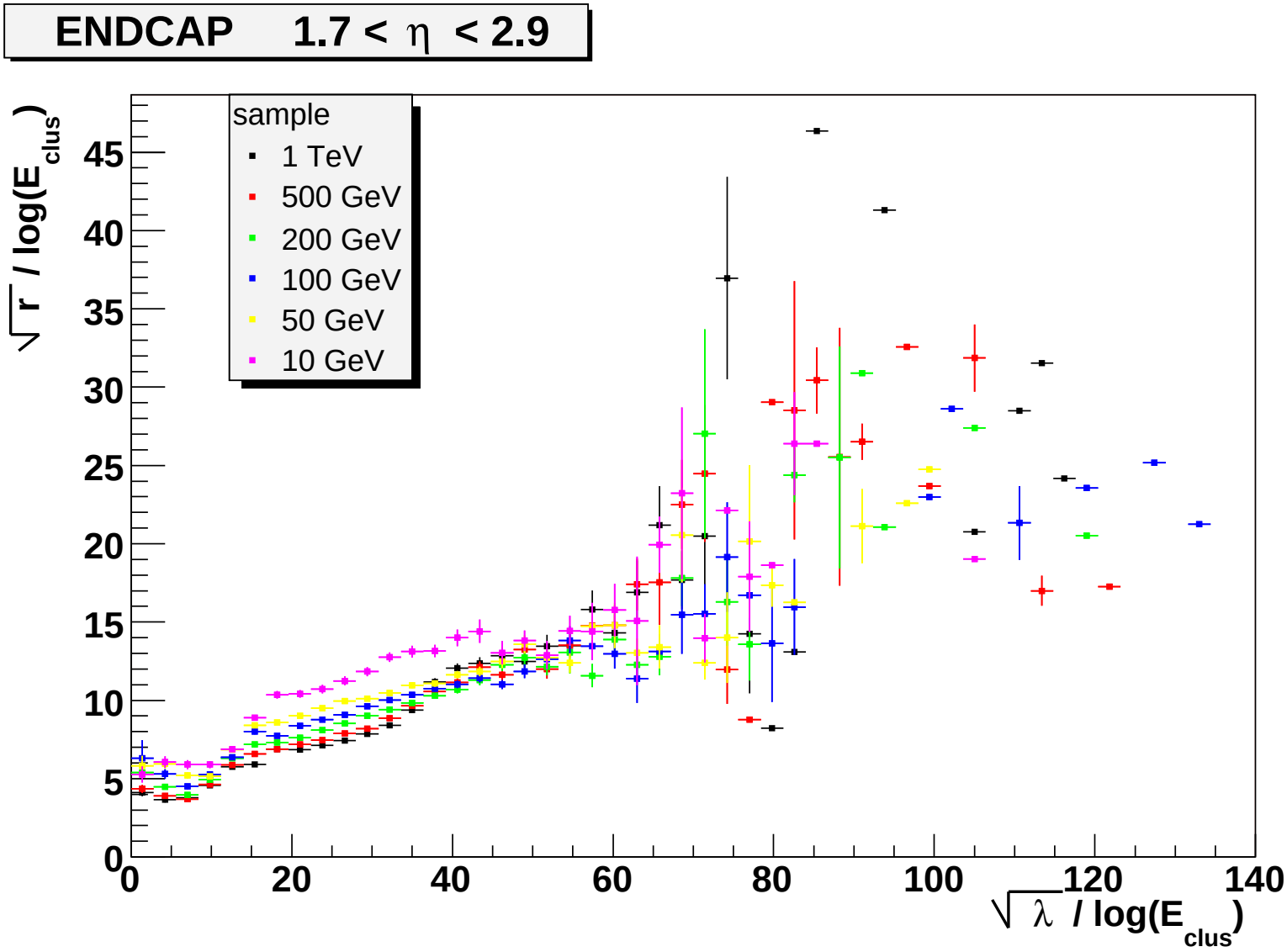

0.0 < η < 0.8
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
eng_frac_max
EM energy

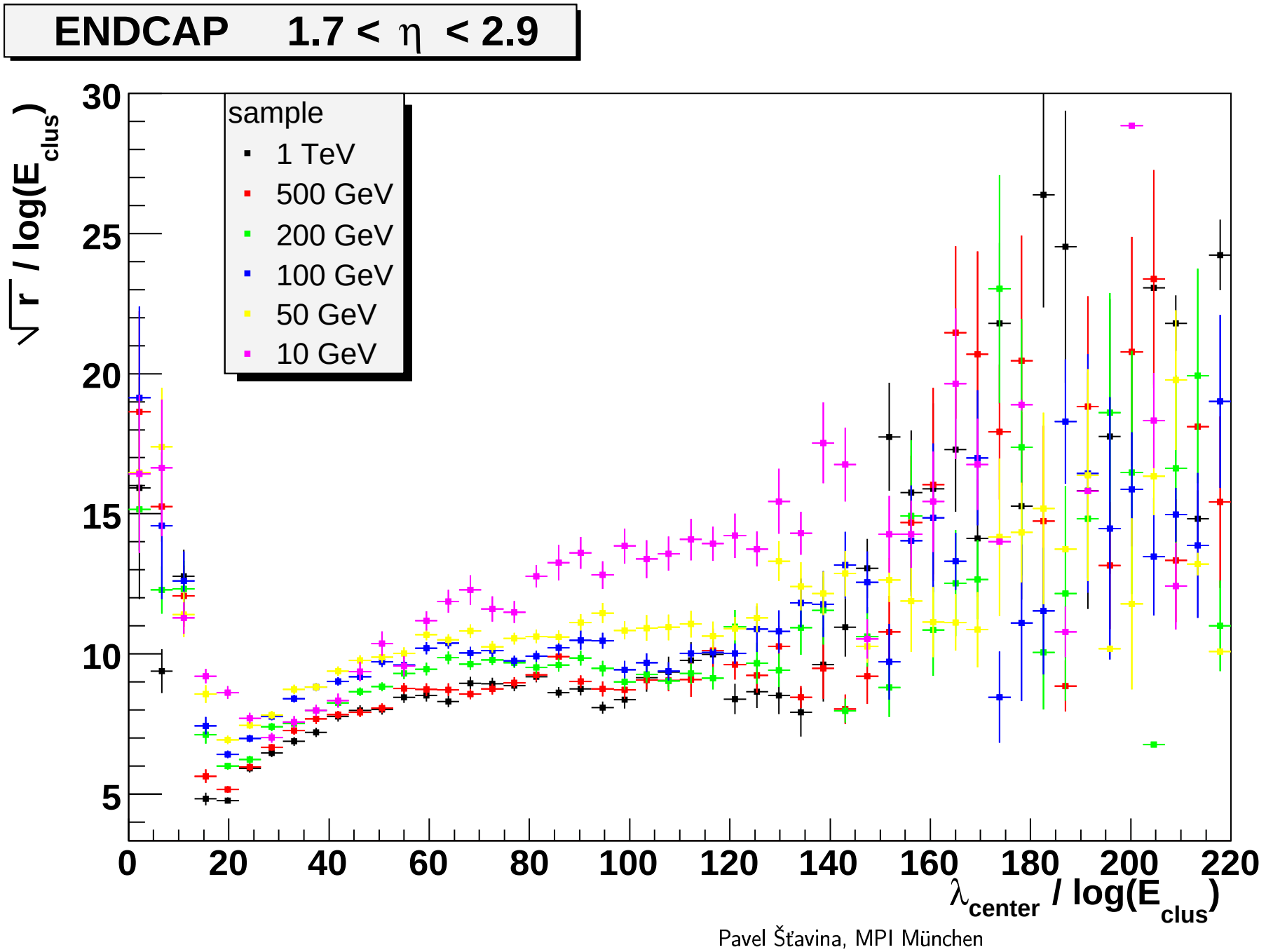

0.8 < η < 1.5
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
eng_frac_max
EM energy

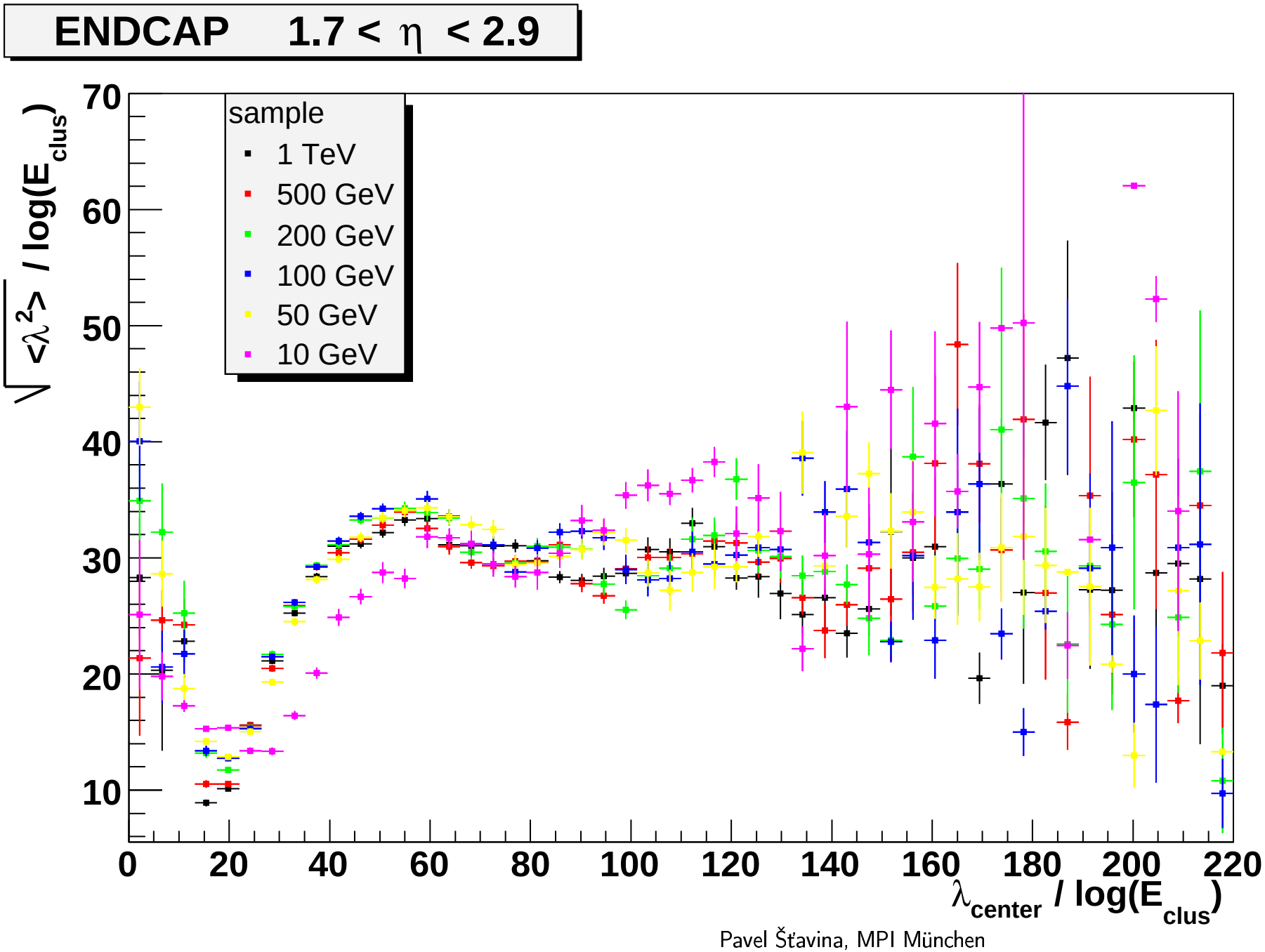

1.7 < η < 2.9
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
eng_frac_max
EM energy


3.0 < η < 5.0
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
eng_frac_max
EM energy

Correlations - momements are presumably strongly correlated

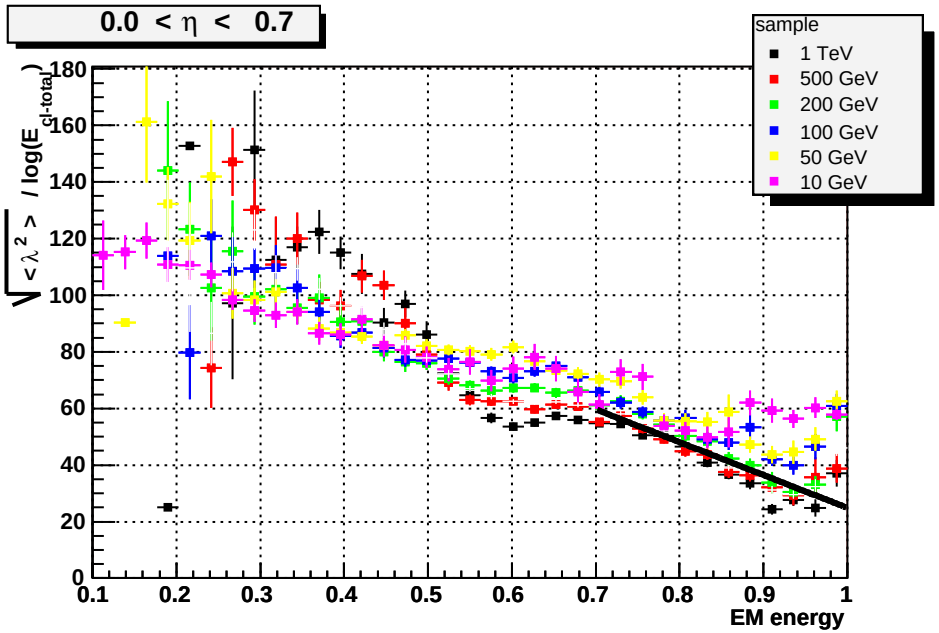


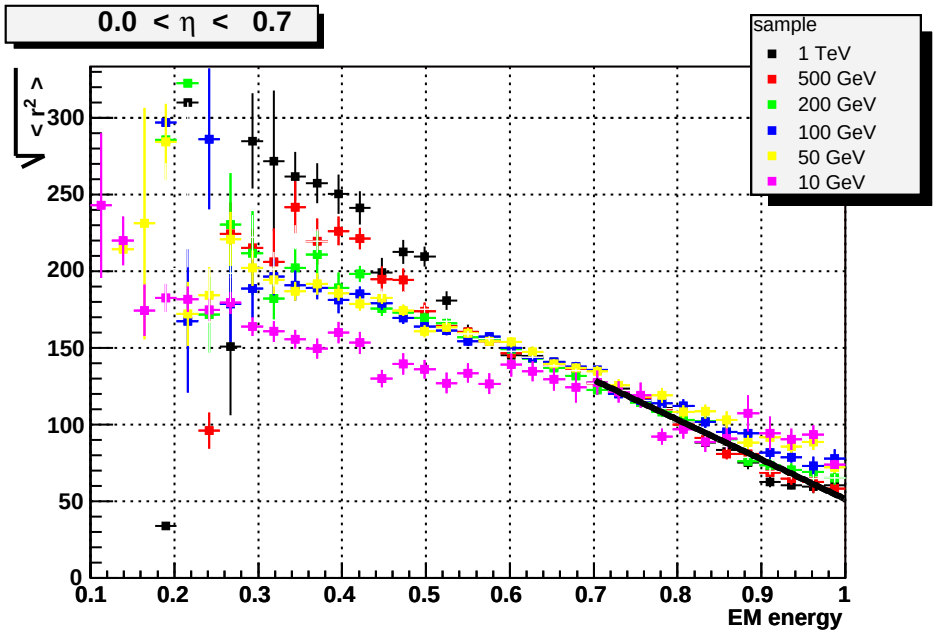

ENDCAP 1.7 < η < 2.9
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
√r / log(E_clus)
λ_center / log(E_clus)
0
20
40
60
80
100
120
140
160
180
200
220
5
10
15
20
25
30

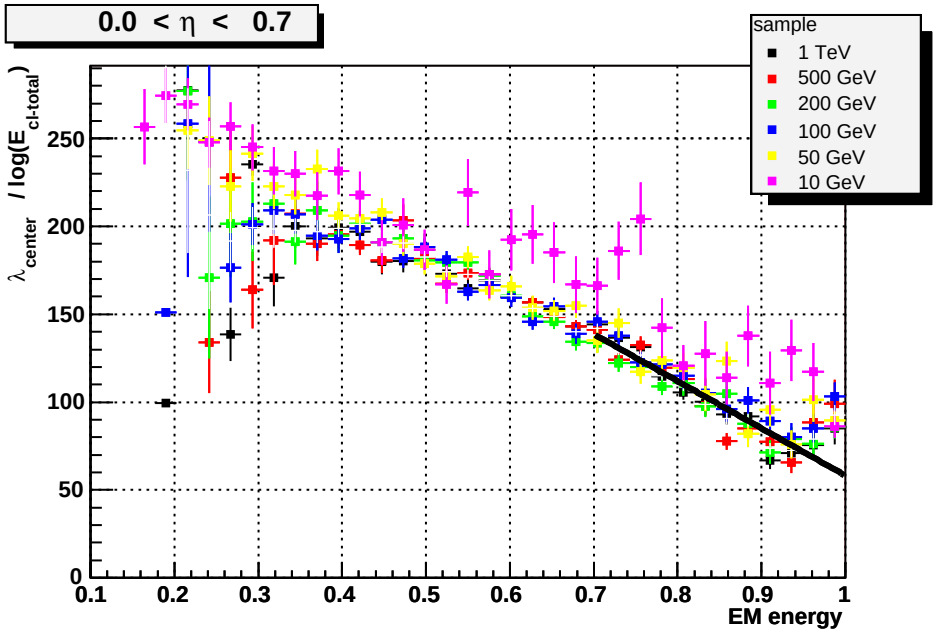

ENDCAP 1.7 < η < 2.9
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
$\sqrt{\langle\lambda^2\rangle}$ / log(E_{clus})
λ_{center} / log(E_{clus})
0
20
40
60
80
100
120
140
160
180
200
220
10
20
30
40
50
60
70

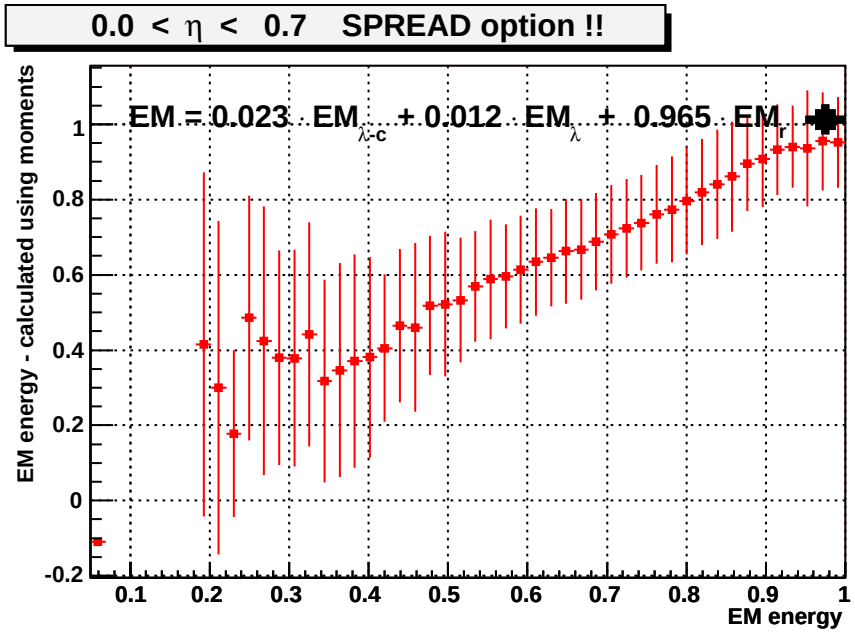
Estimation of EM component using moments

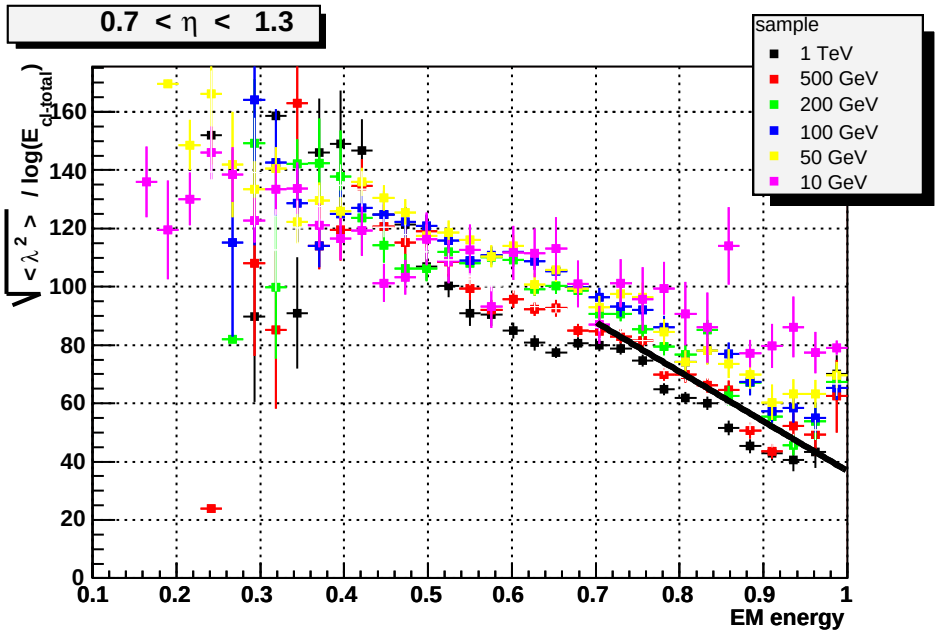
- The aim is to identify EM clusters and exclude them from weighting procedure
- All the topological moments are functions of electromagnetic component of the deposited energy
- We use simple linear fit to calculate the electromagnetic component of the deposited energy from topological cluster moments
- The next step is to find weighted mean value of calculated EM components using MINUIT to minimize the spread

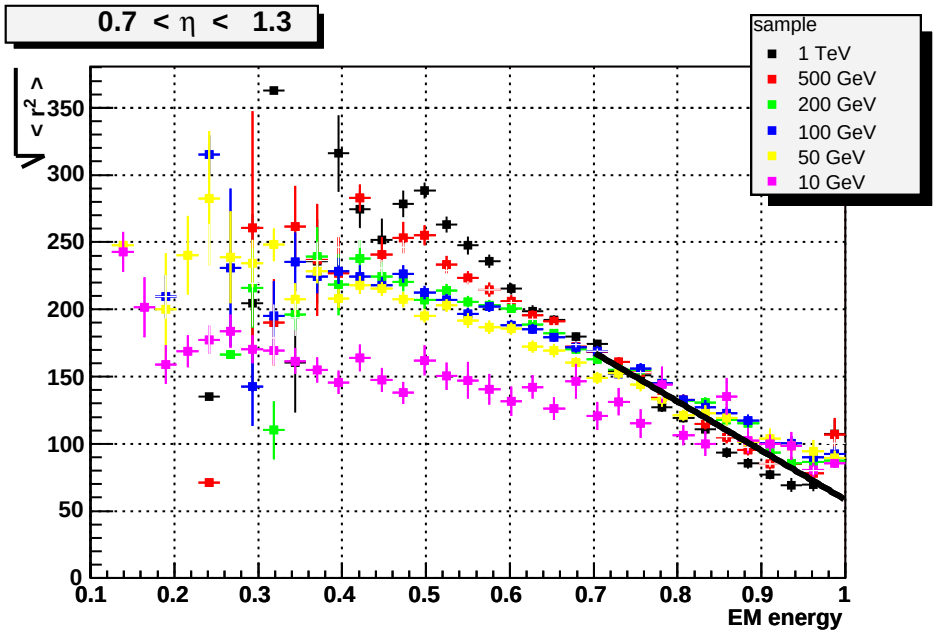

0.0 < η < 0.7
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
√< λ 2 > / log(E cl-total)
EM energy

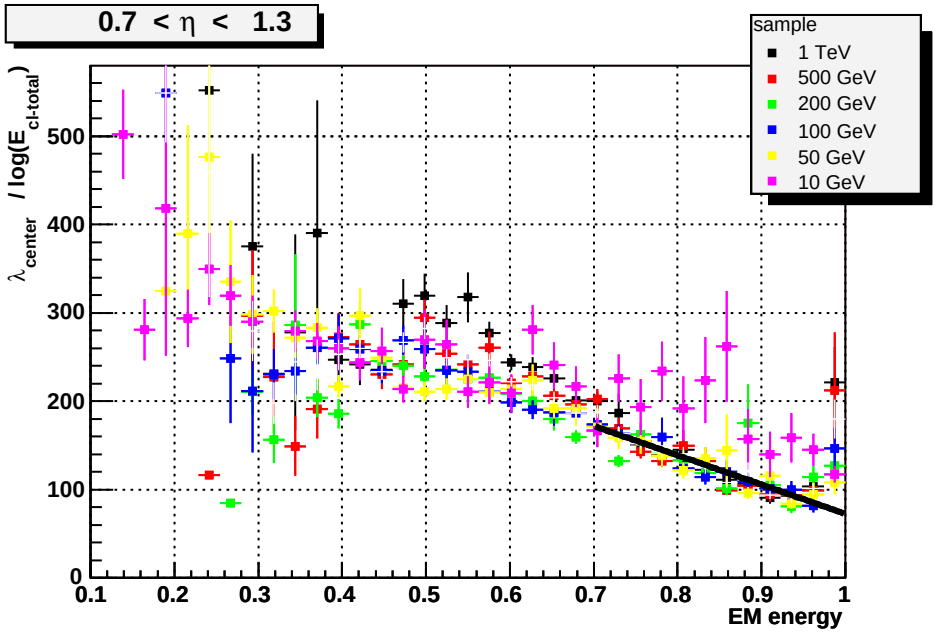

0.0 < η < 0.7
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
√< r2 >
EM energy

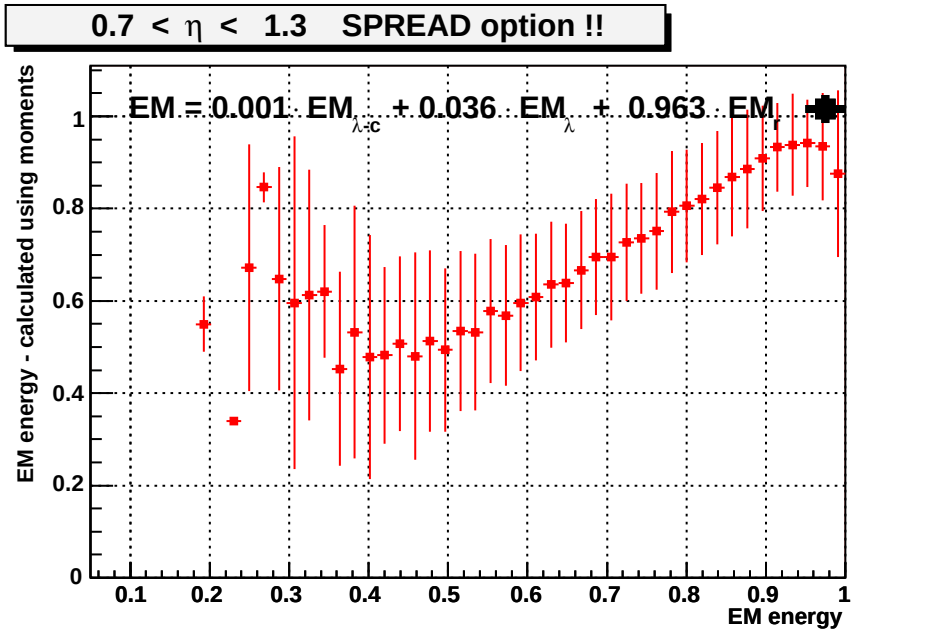

0.0 < η < 0.7
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
λcenter / log(E cl-total)
EM energy

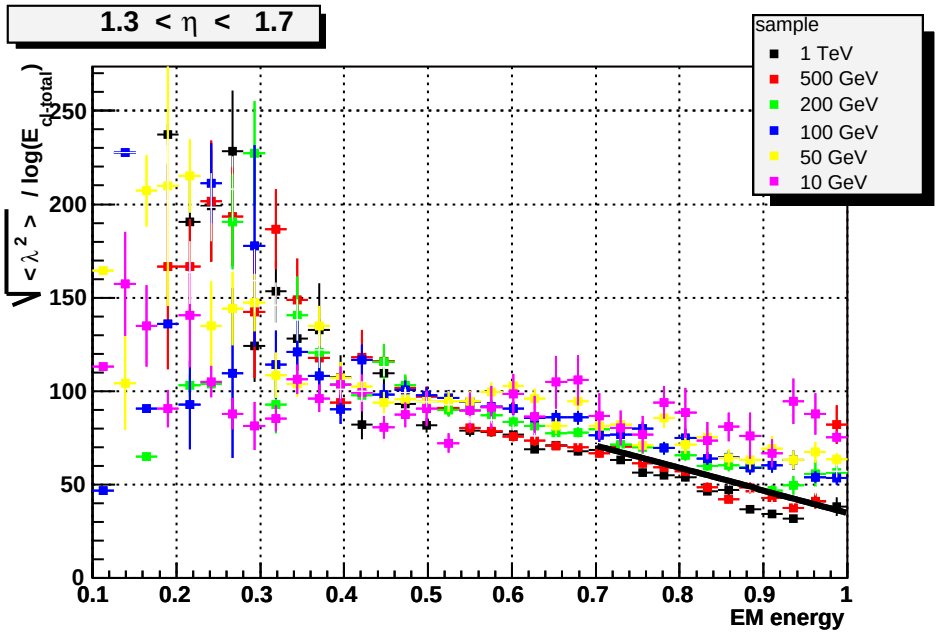

0.0 < η < 0.7 SPREAD option !!
EM = 0.023 EM λ-c + 0.012 EM λ + 0.965 EM r
EM energy - calculated using moments
EM energy

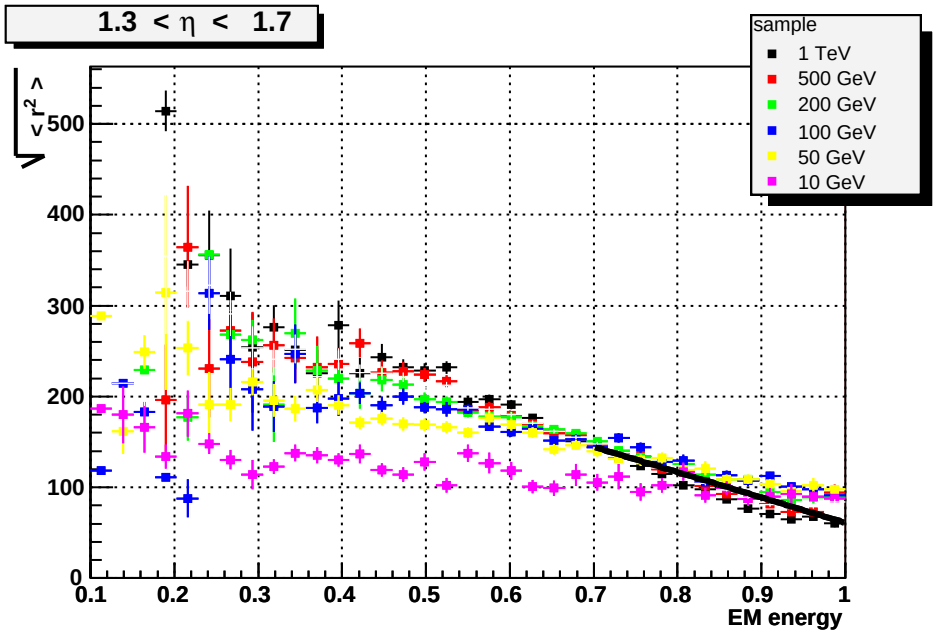

0.7 < η < 1.3
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
√< λ 2 > / log(E cl-total)
EM energy

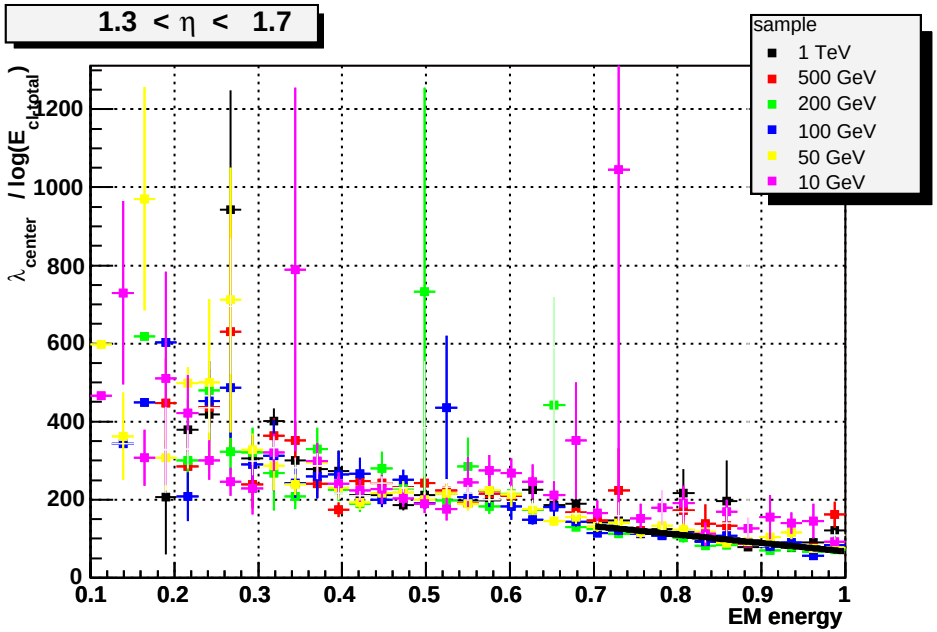

0.7 < η < 1.3
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
√< r2 >
EM energy

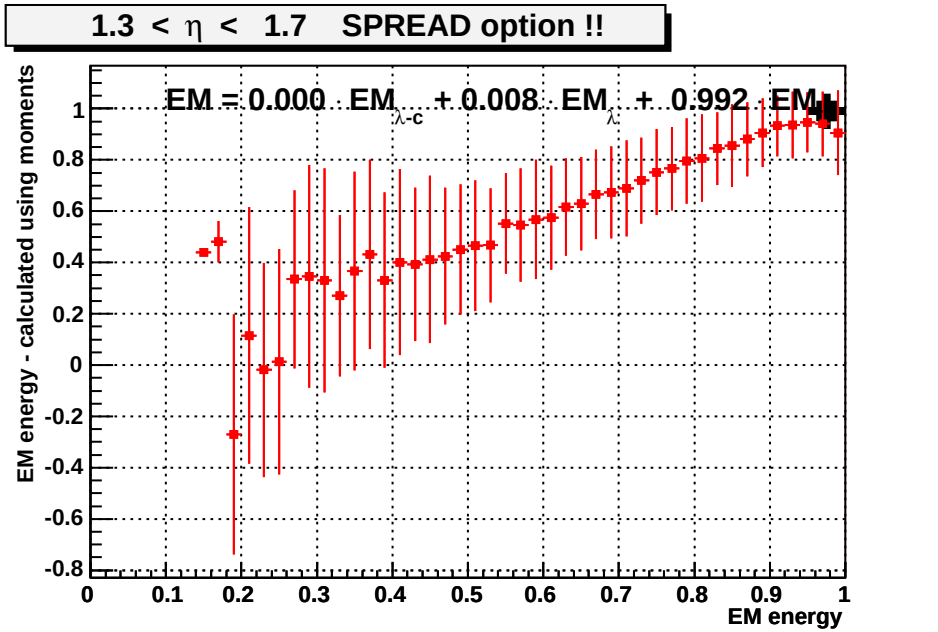

0.7 < η < 1.3
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
λcenter / log(E cl-total)
EM energy

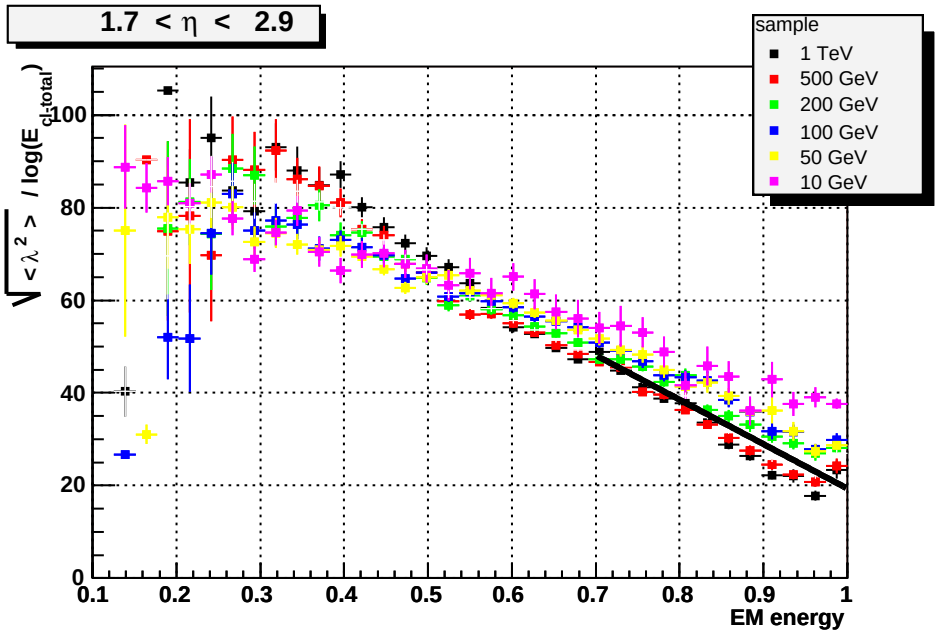

0.7 < η < 1.3 SPREAD option !!
EM = 0.001 EM λ-c + 0.036 EM λ + 0.963 EM f
EM energy - calculated using moments
EM energy

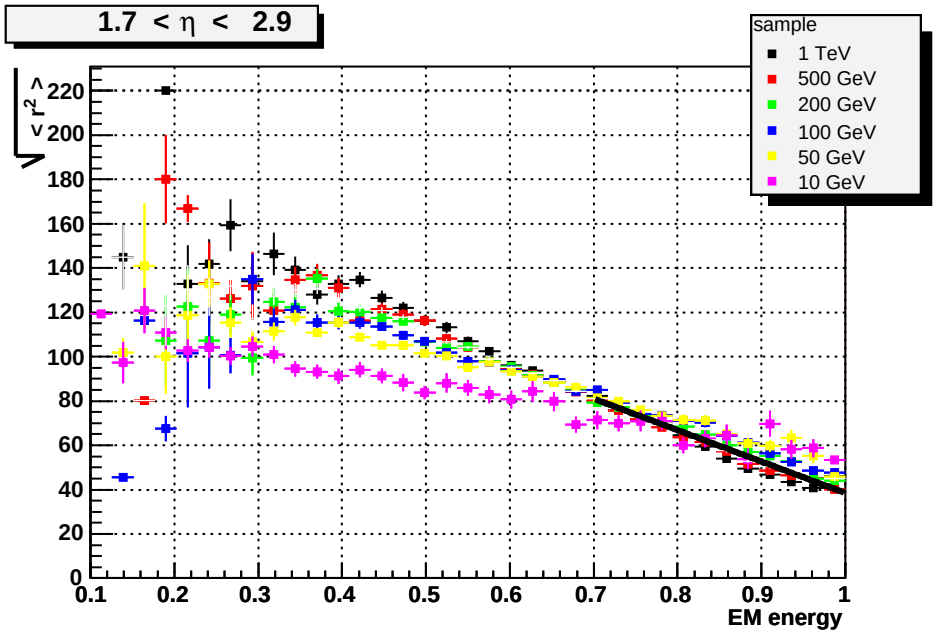

1.3 < η < 1.7
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
$\sqrt{<\lambda^2>}$ / log($E_{cl,total}$)
EM energy

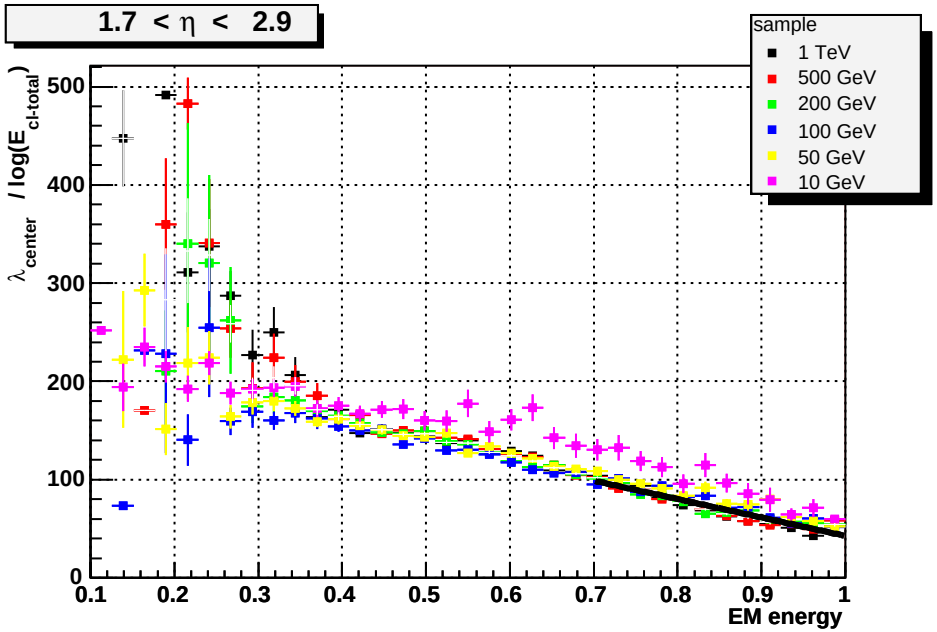

1.3 < η < 1.7
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
$\sqrt{<r^2>}$
EM energy

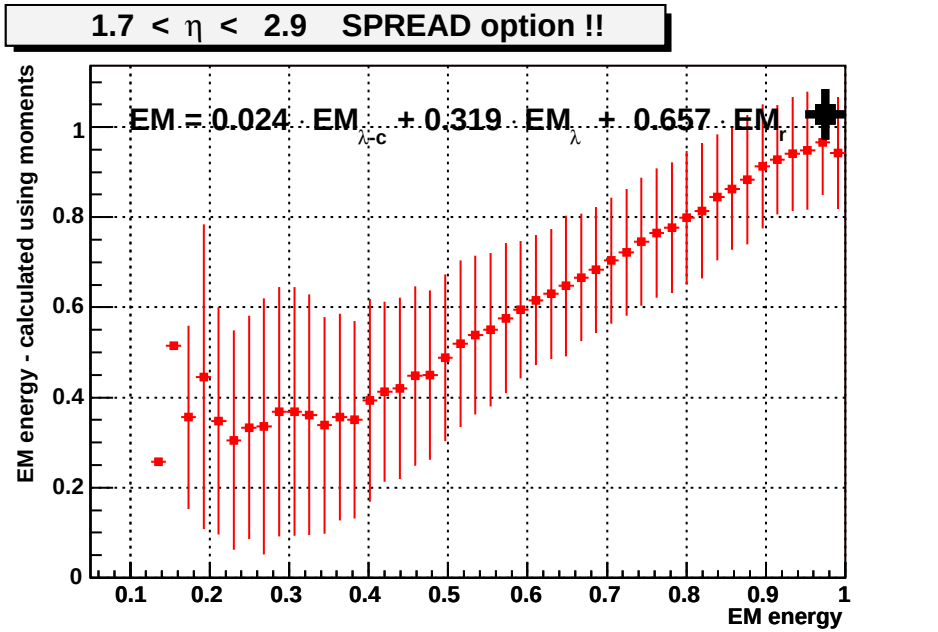

1.3 < η < 1.7
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
λ_{center} / log($E_{cl,total}$)
EM energy

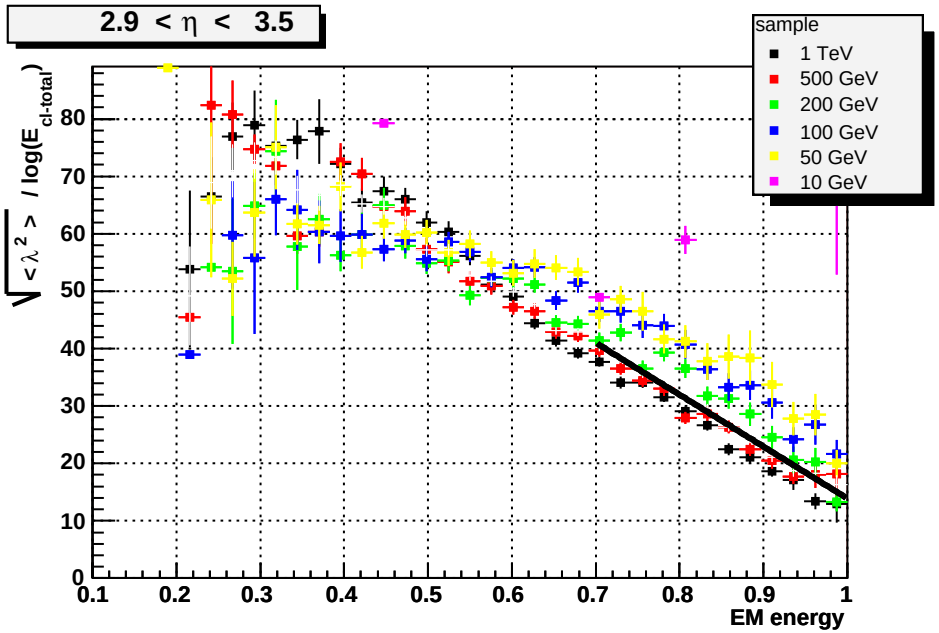

1.3 < η < 1.7 SPREAD option !!
EM = 0.000 EM$_{\lambda\text{-}c}$ + 0.008 EM$_{\lambda}$ + 0.992 EM$_{r}$
EM energy - calculated using moments
EM energy

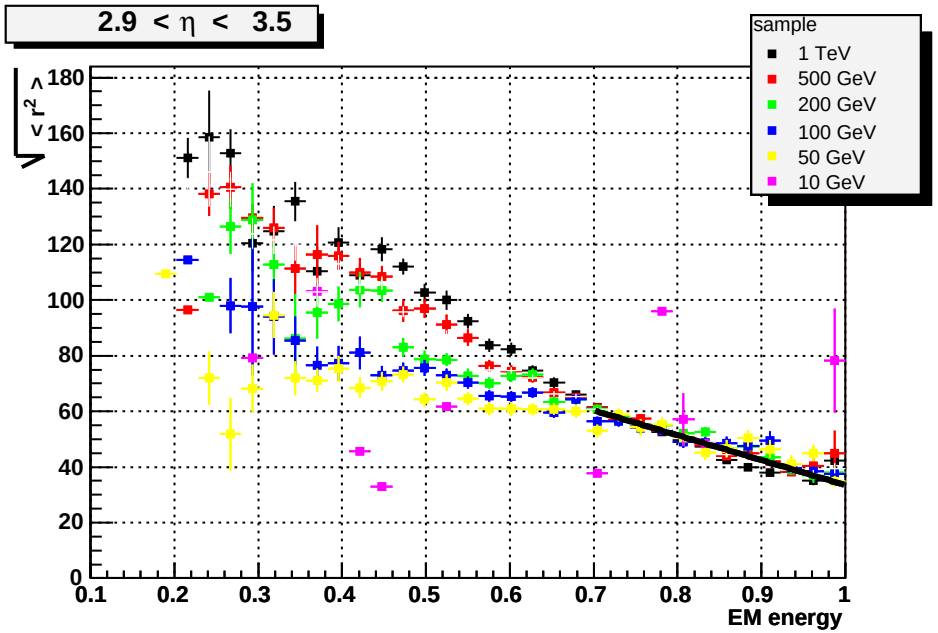

1.7 < η < 2.9
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
$\sqrt{<\lambda^2>}$ / log($E_{cl-total}$)
EM energy

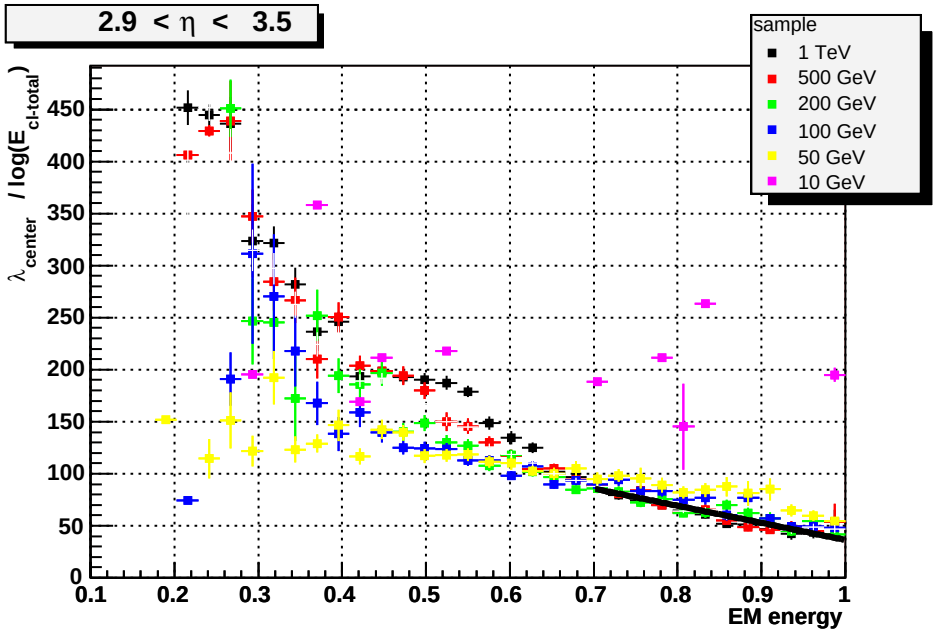

1.7 < η < 2.9
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
$\sqrt{<r^2>}$
EM energy

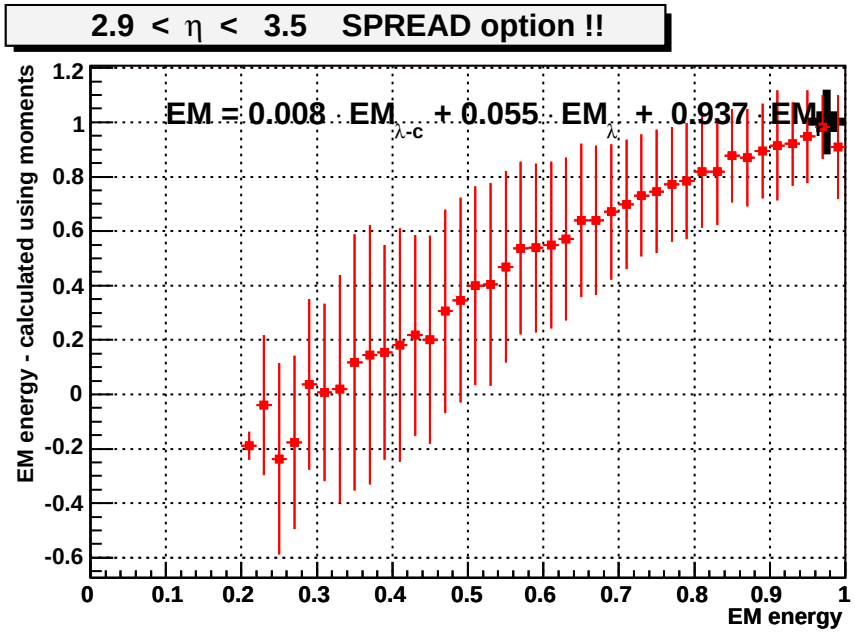

1.7 < η < 2.9
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
λ_{center} / log($E_{cl-total}$)
EM energy

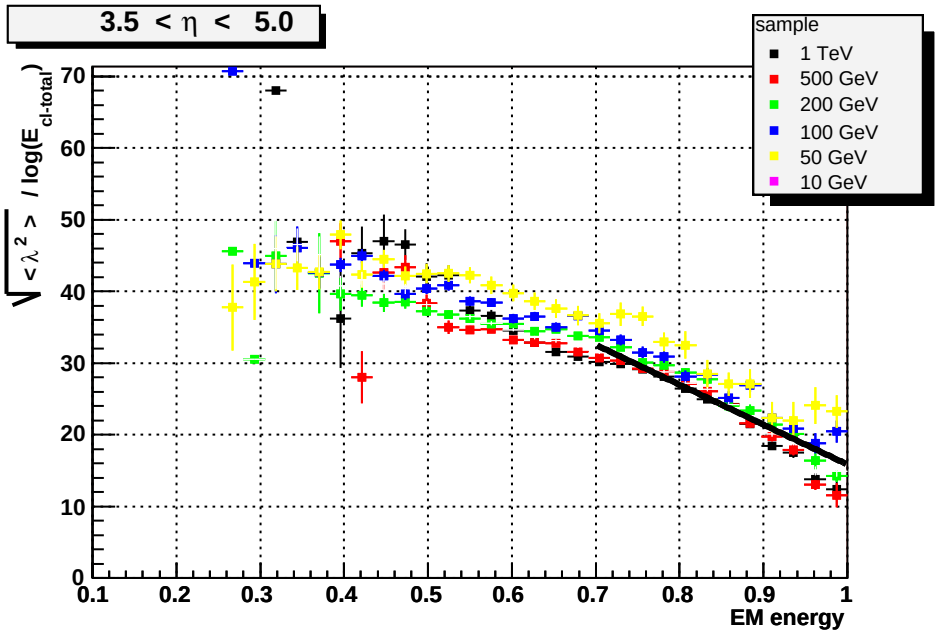

1.7 < η < 2.9 SPREAD option !!
EM = 0.024 EM$_{\lambda-c}$ + 0.319 EM$_{\lambda}$ + 0.657 EM$_{r}$
EM energy - calculated using moments
EM energy

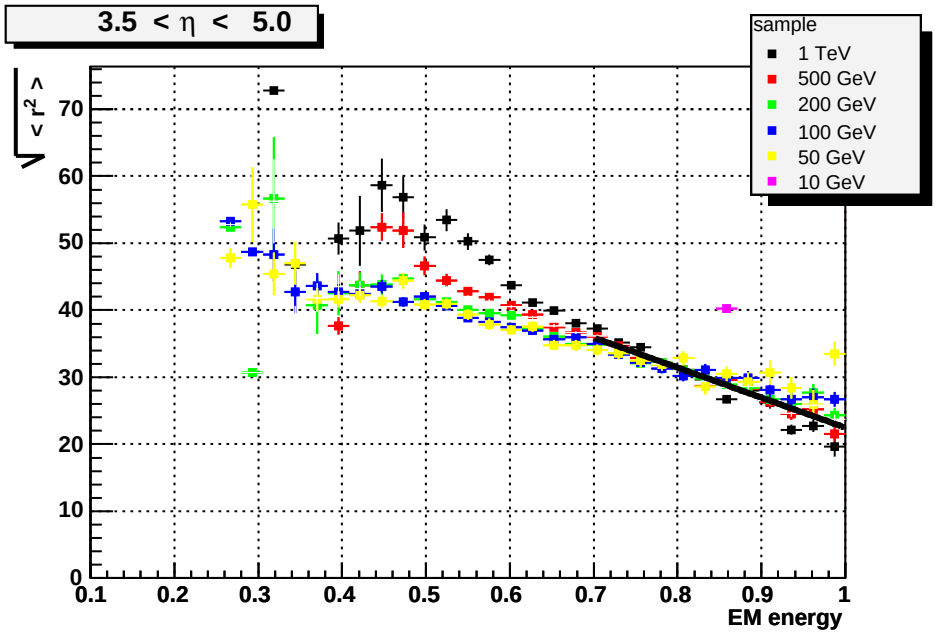

2.9 < η < 3.5
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
$\sqrt{<\lambda^2>}$ / log($E_{cl\text{-}total}$)
EM energy

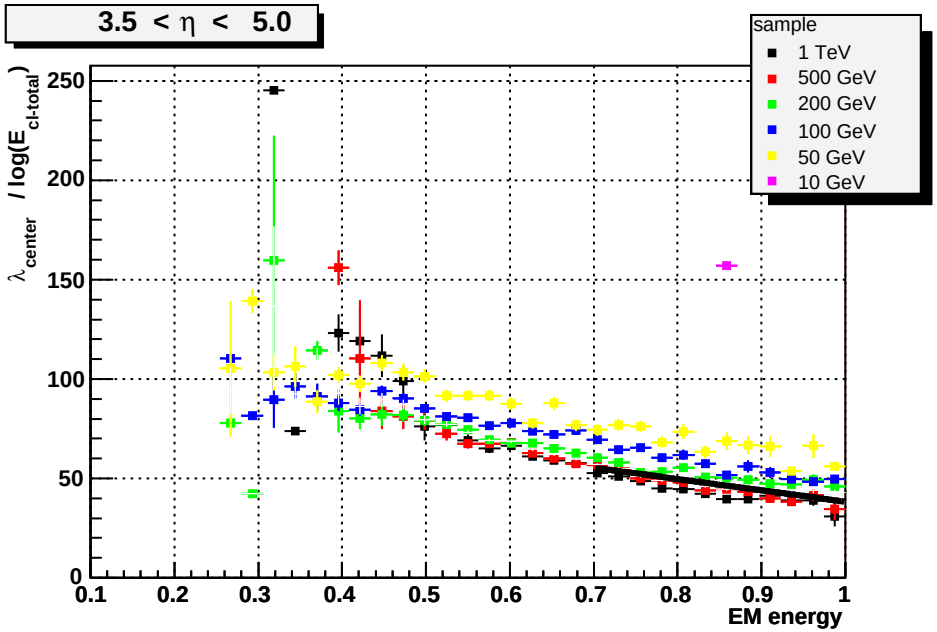

2.9 < η < 3.5
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
$\sqrt{<r^2>}$
EM energy

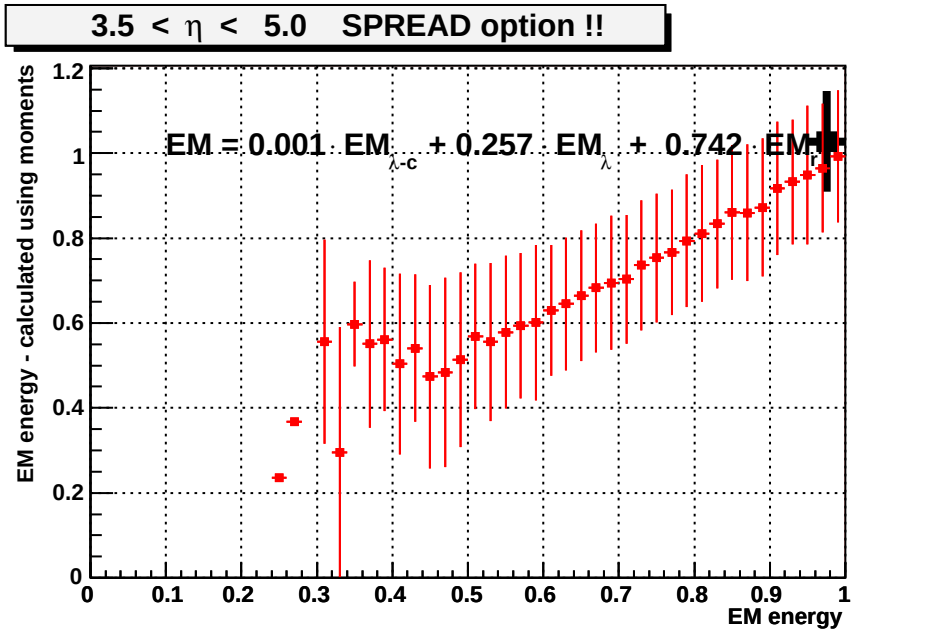

2.9 < η < 3.5
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
λ_{center} / log($E_{cl\text{-}total}$)
EM energy

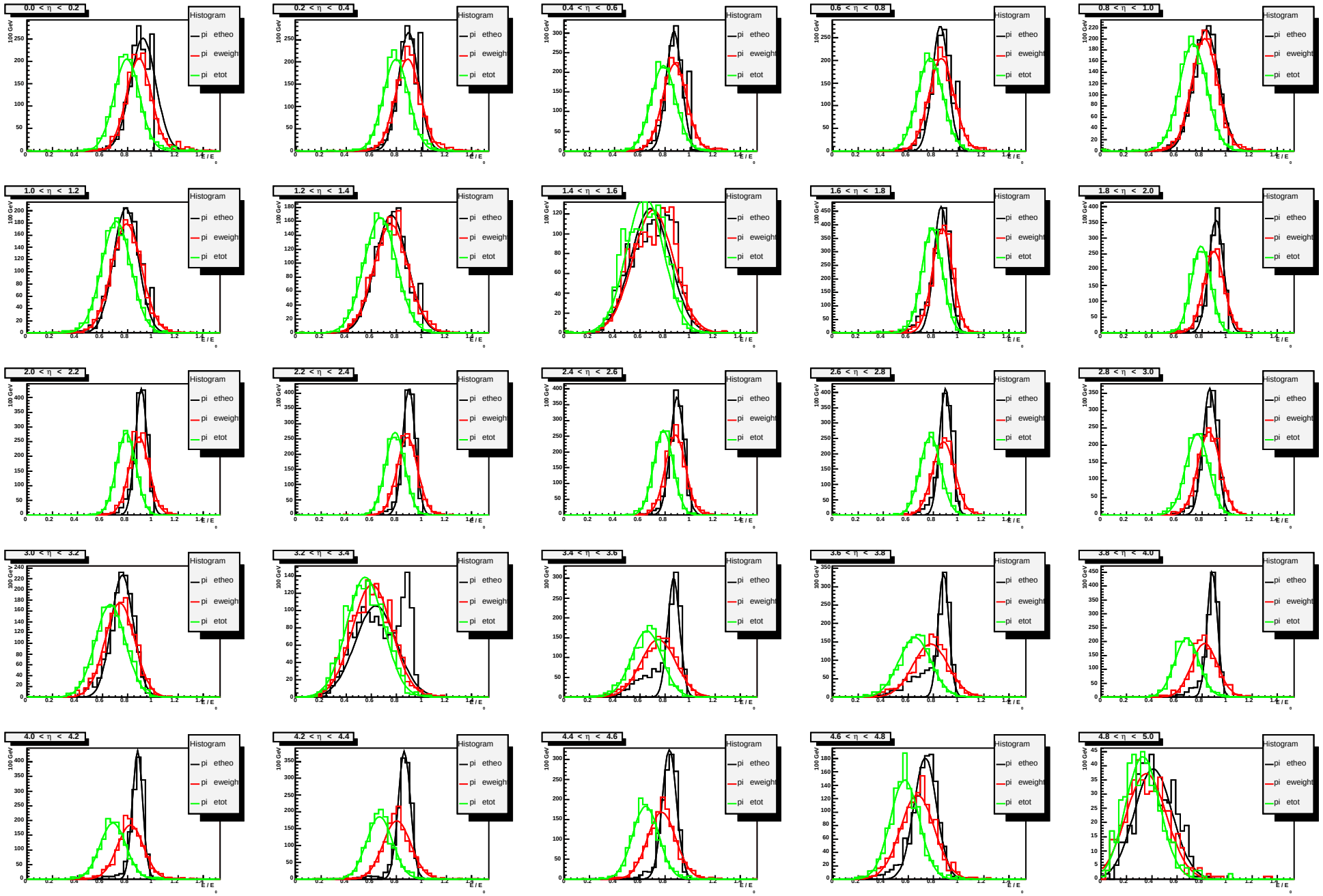

2.9 < η < 3.5 SPREAD option !!
EM = 0.008 EM$_{\lambda\text{-}c}$ + 0.055 EM$_{\lambda}$ + 0.937 EM$_{r}$
EM energy - calculated using moments
EM energy

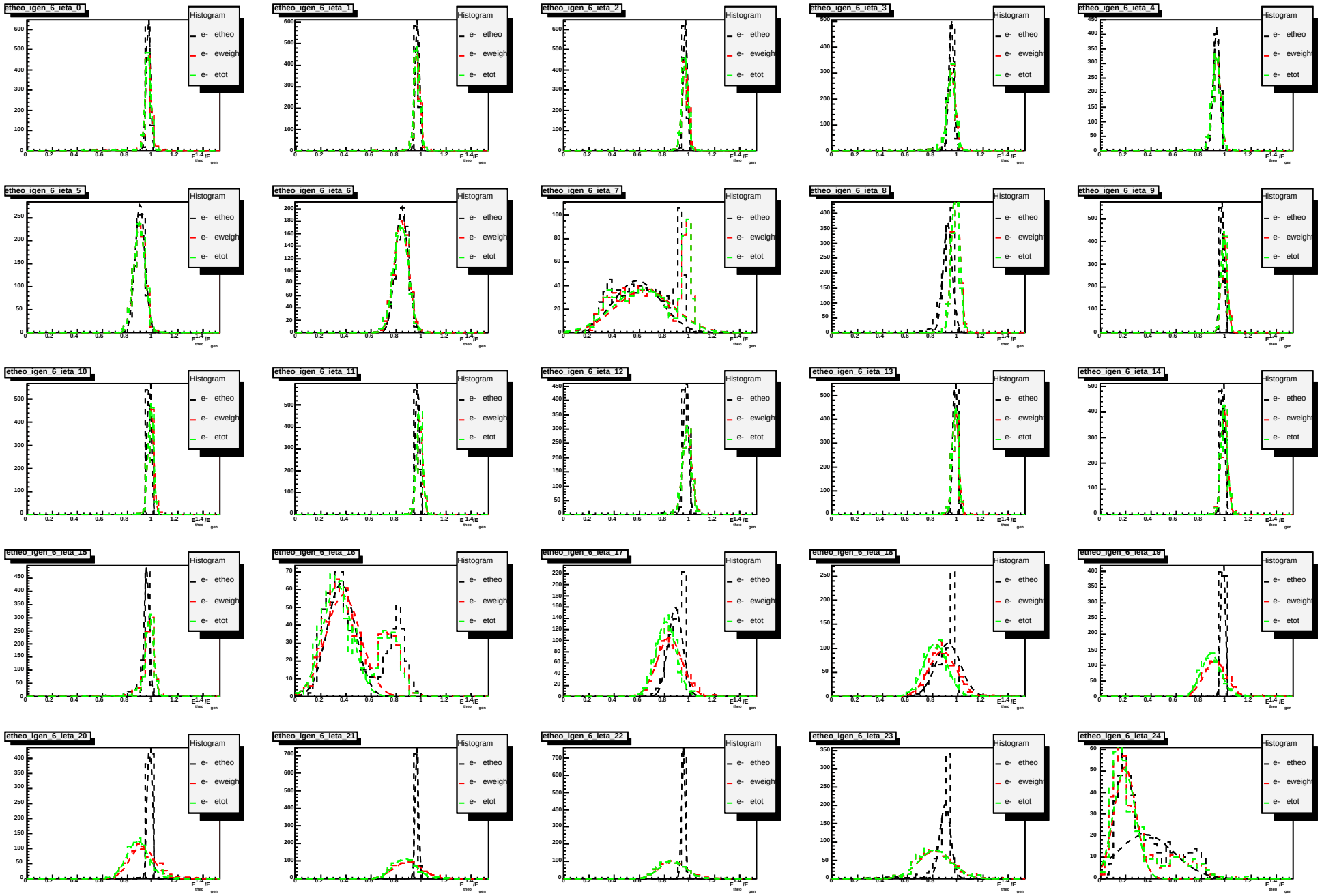

3.5 < η < 5.0
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
√< λ² > / log(E_cl-total)
EM energy

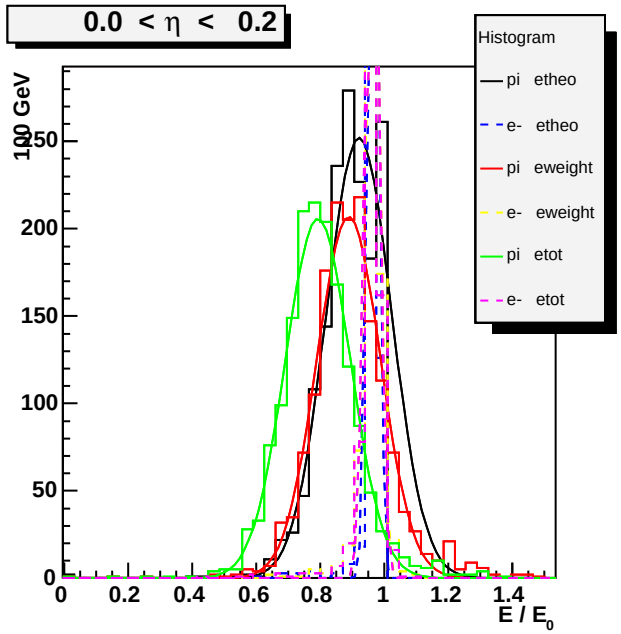

3.5 < η < 5.0
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
√< r² >
EM energy

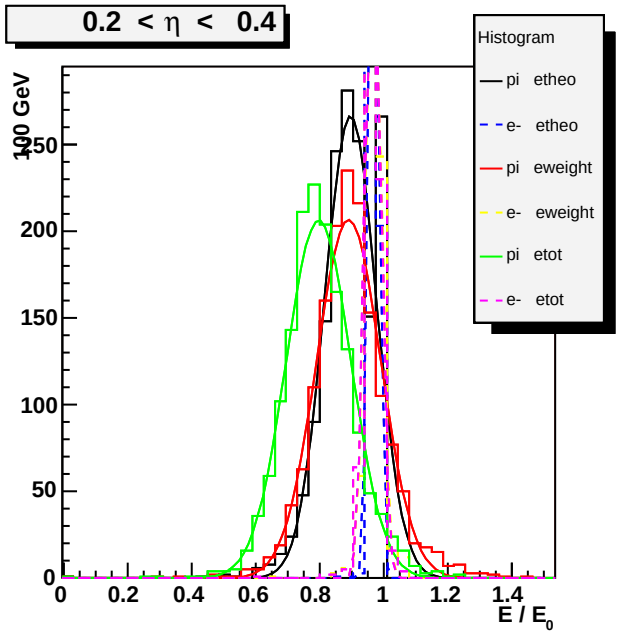

3.5 < η < 5.0
sample
1 TeV
500 GeV
200 GeV
100 GeV
50 GeV
10 GeV
λ_center / log(E_cl-total)
EM energy

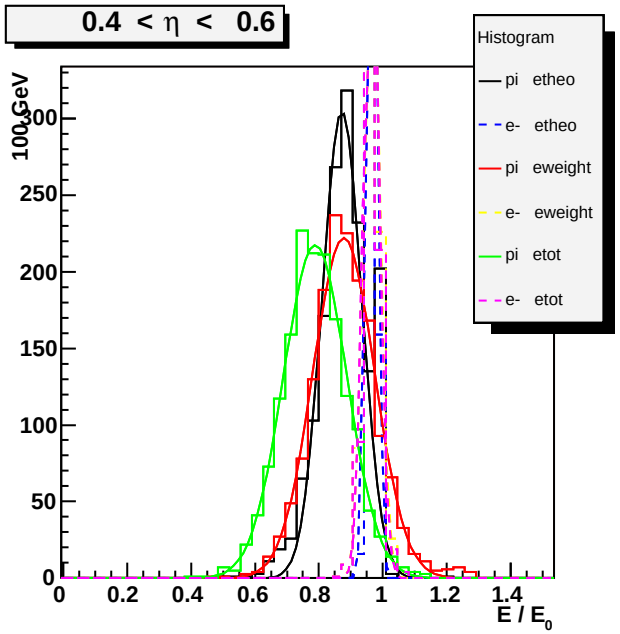

3.5 < η < 5.0 SPREAD option !!
EM = 0.001 EM_λ-c + 0.257 EM_λ + 0.742 EM_r
EM energy - calculated using moments
EM energy

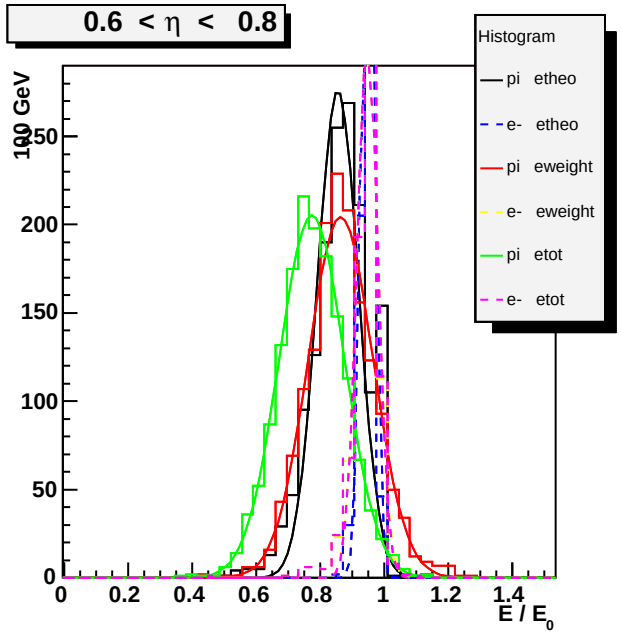

0.0 < η < 0.2
0.2 < η < 0.4
0.4 < η < 0.6
0.6 < η < 0.8
0.8 < η < 1.0
1.0 < η < 1.2
1.2 < η < 1.4
1.4 < η < 1.6
1.6 < η < 1.8
1.8 < η < 2.0
2.0 < η < 2.2
2.2 < η < 2.4
2.4 < η < 2.6
2.6 < η < 2.8
2.8 < η < 3.0
3.0 < η < 3.2
3.2 < η < 3.4
3.4 < η < 3.6
3.6 < η < 3.8
3.8 < η < 4.0
4.0 < η < 4.2
4.2 < η < 4.4
4.4 < η < 4.6
4.6 < η < 4.8
4.8 < η < 5.0
Histogram
pi etheo
pi eweight
pi etot
100 GeV
E / E

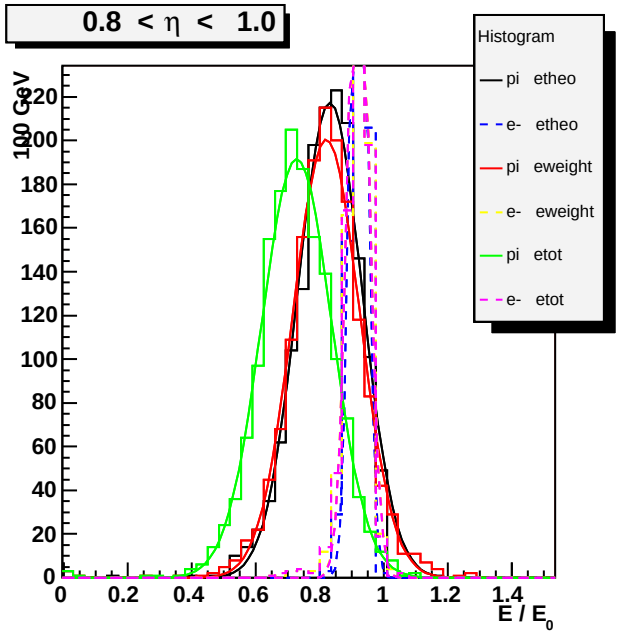

etheo_igen_6_ieta_0
etheo_igen_6_ieta_1
etheo_igen_6_ieta_2
etheo_igen_6_ieta_3
etheo_igen_6_ieta_4
etheo_igen_6_ieta_5
etheo_igen_6_ieta_6
etheo_igen_6_ieta_7
etheo_igen_6_ieta_8
etheo_igen_6_ieta_9
etheo_igen_6_ieta_10
etheo_igen_6_ieta_11
etheo_igen_6_ieta_12
etheo_igen_6_ieta_13
etheo_igen_6_ieta_14
etheo_igen_6_ieta_15
etheo_igen_6_ieta_16
etheo_igen_6_ieta_17
etheo_igen_6_ieta_18
etheo_igen_6_ieta_19
etheo_igen_6_ieta_20
etheo_igen_6_ieta_21
etheo_igen_6_ieta_22
etheo_igen_6_ieta_23
etheo_igen_6_ieta_24
Histogram
e- etheo
e- eweigh
e- etot
E^1.4 /E
theo gen

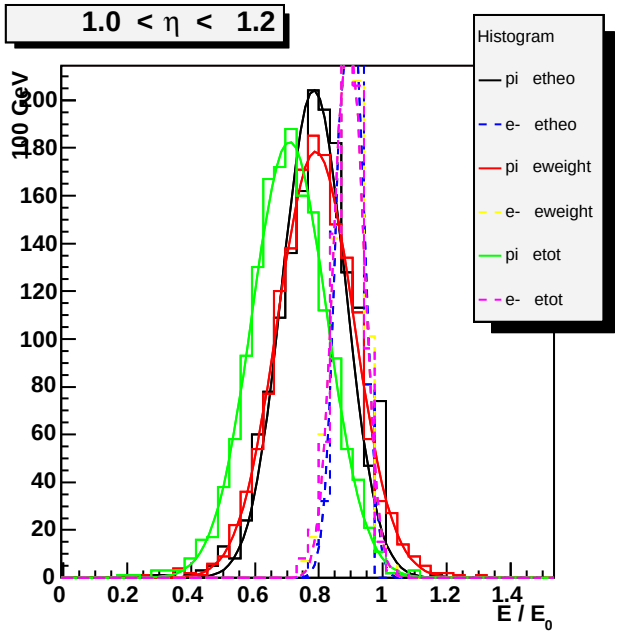

0.0 < η < 0.2
Histogram
pi etheo
e- etheo
pi eweight
e- eweight
pi etot
e- etot
100 GeV
E / E0

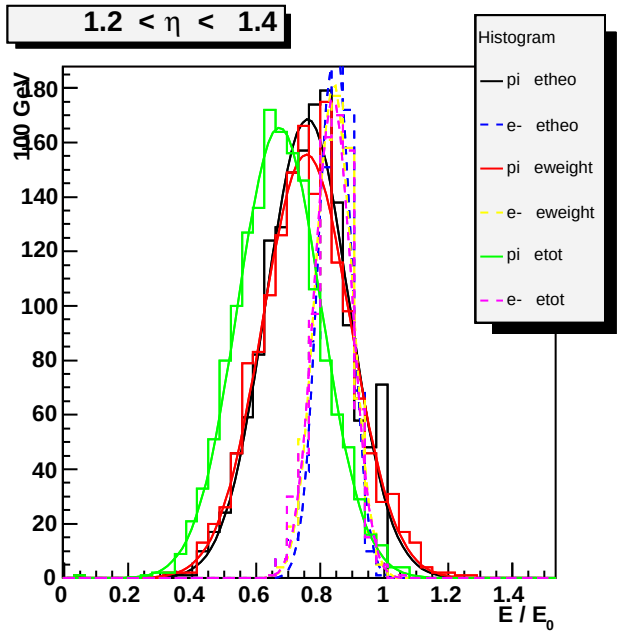

0.2 < η < 0.4
Histogram
pi etheo
e- etheo
pi eweight
e- eweight
pi etot
e- etot
100 GeV
E / E0

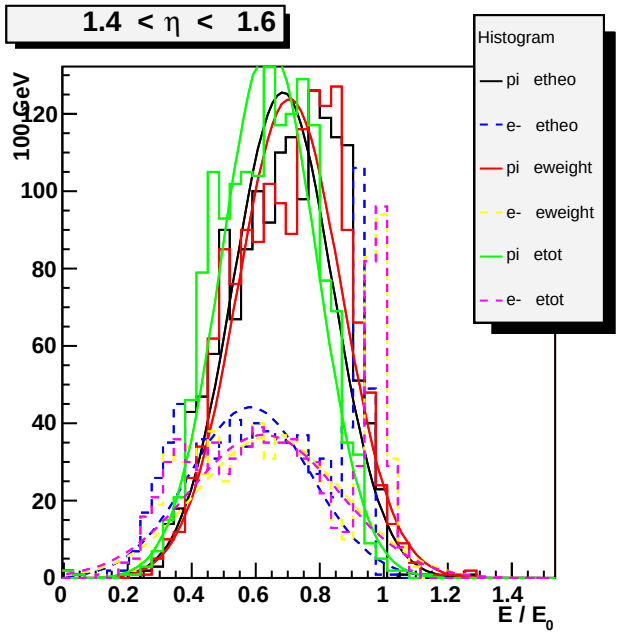

0.4 < η < 0.6
Histogram
pi etheo
e- etheo
pi eweight
e- eweight
pi etot
e- etot
100 GeV
E / E0

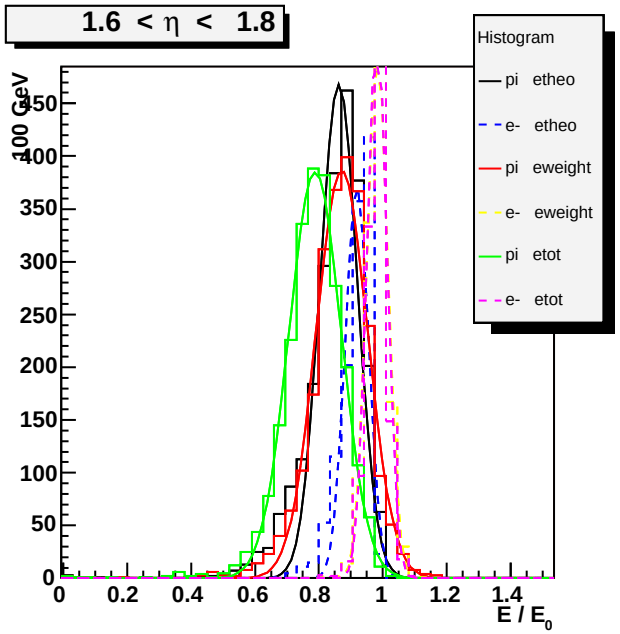

0.6 < η < 0.8
Histogram
pi etheo
e- etheo
pi eweight
e- eweight
pi etot
e- etot
100 GeV
E / E0

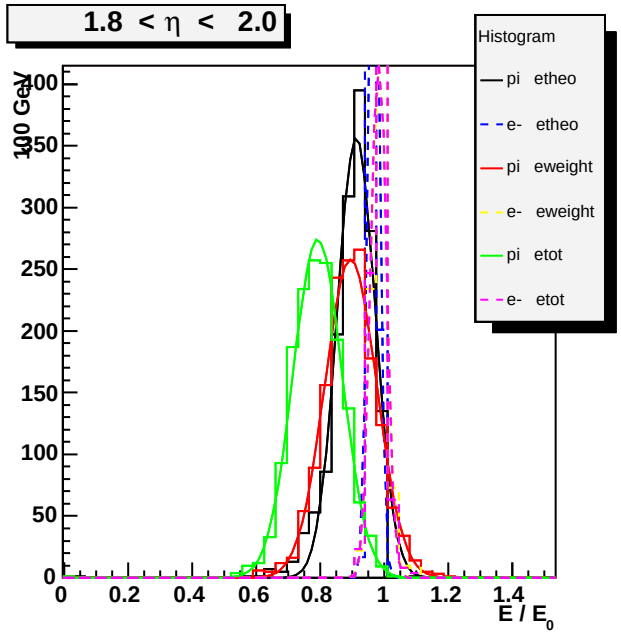

0.8 < η < 1.0
Histogram
pi etheo
e- etheo
pi eweight
e- eweight
pi etot
e- etot
100 GeV
E / E0

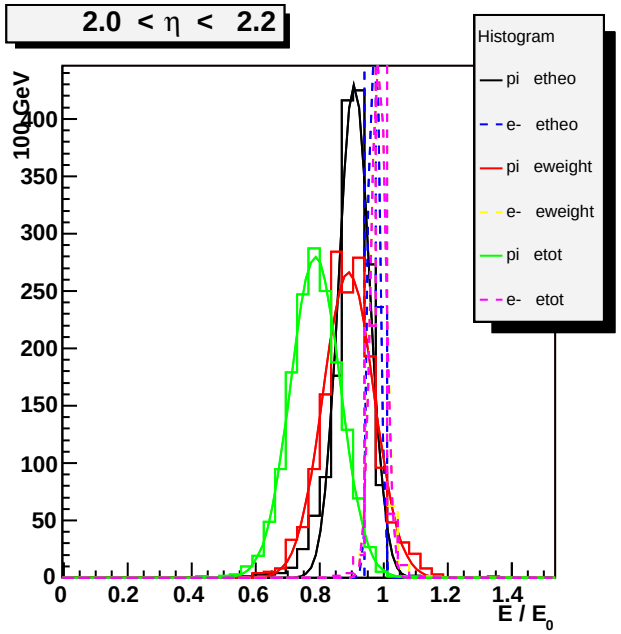

1.0 < η < 1.2
Histogram
pi etheo
e- etheo
pi eweight
e- eweight
pi etot
e- etot
100 GeV
E / E0

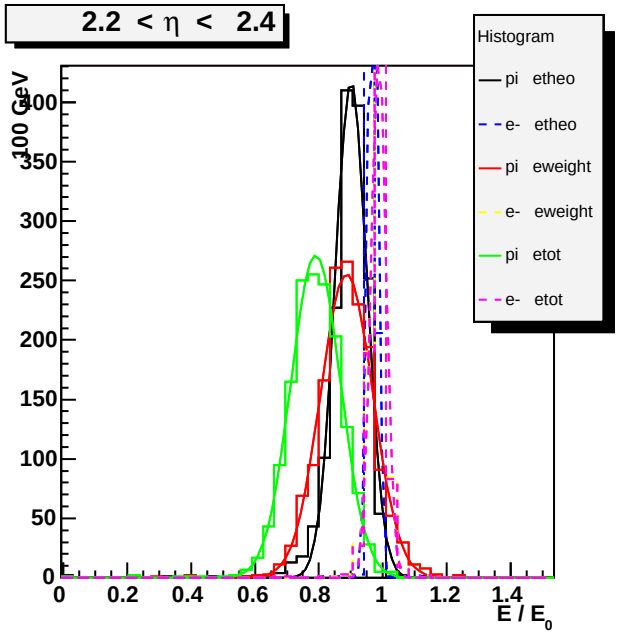

1.2 < η < 1.4
Histogram
pi etheo
e- etheo
pi eweight
e- eweight
pi etot
e- etot
100 GeV
E / E0

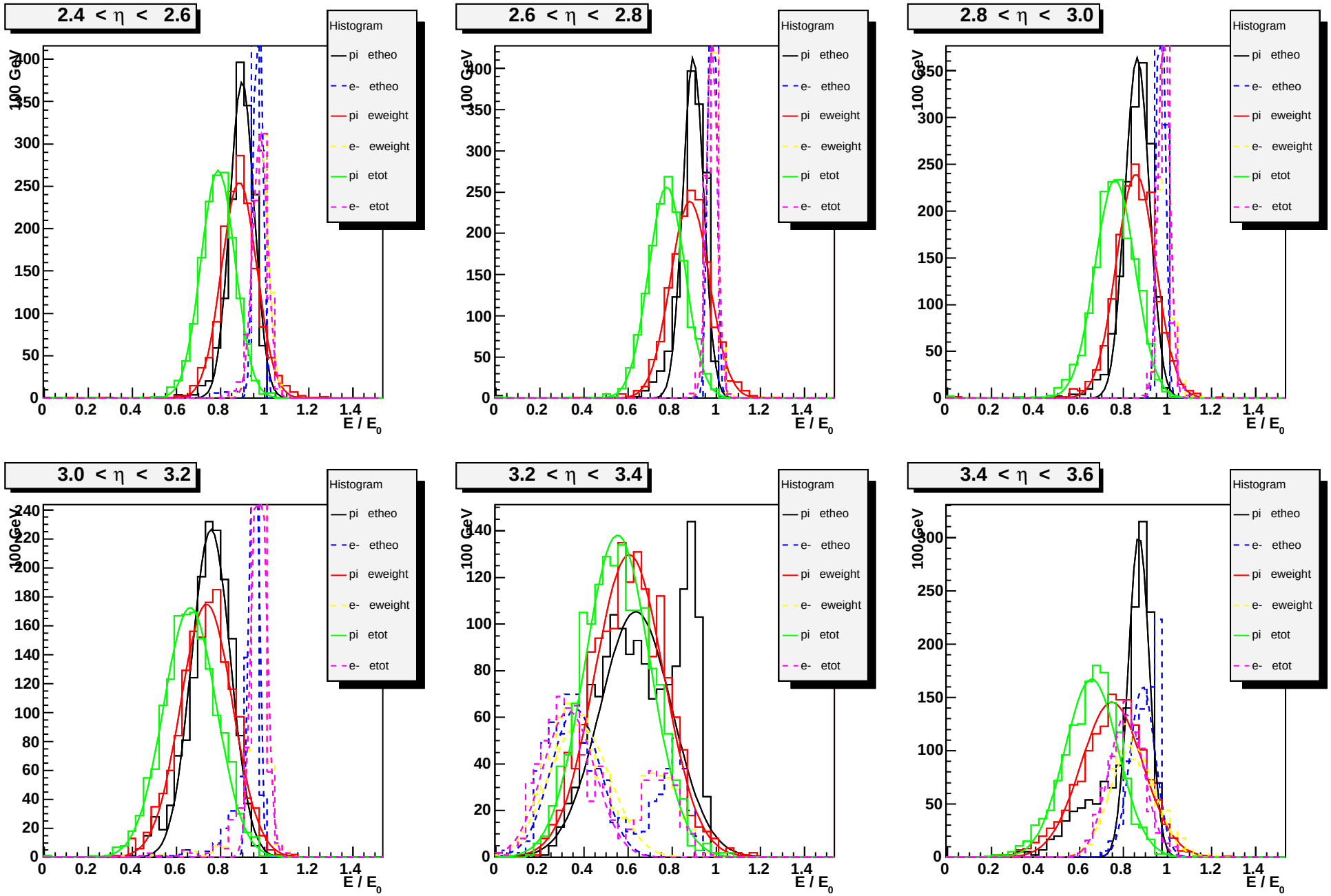

1.4 < η < 1.6
Histogram
pi etheo
e- etheo
pi eweight
e- eweight
pi etot
e- etot
100 GeV
E / E0

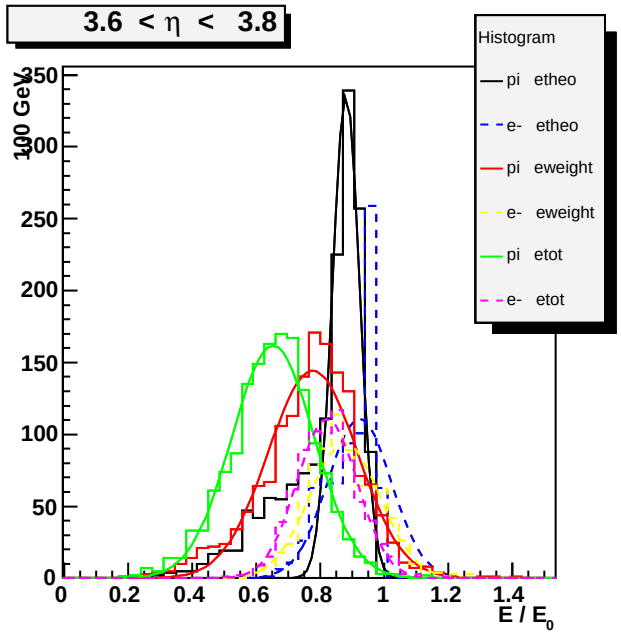

1.6 < η < 1.8
Histogram
pi etheo
e- etheo
pi eweight
e- eweight
pi etot
e- etot
100 GeV
E / E0

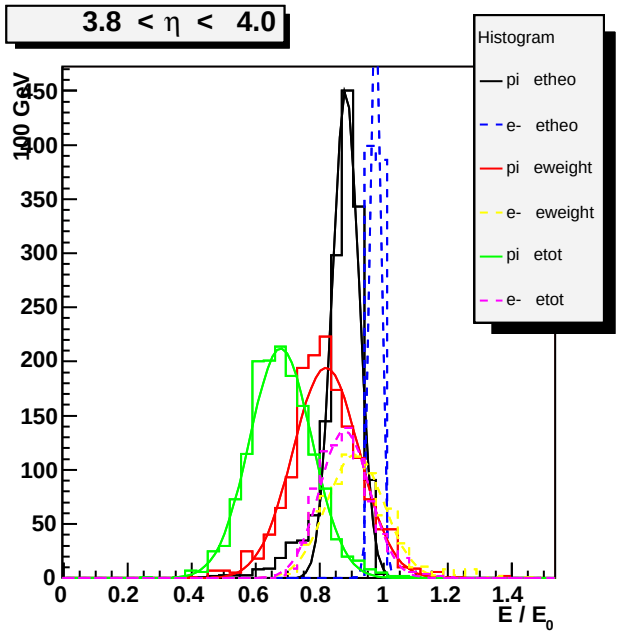

1.8 < η < 2.0
Histogram
pi etheo
e- etheo
pi eweight
e- eweight
pi etot
e- etot
100 GeV
E / E0

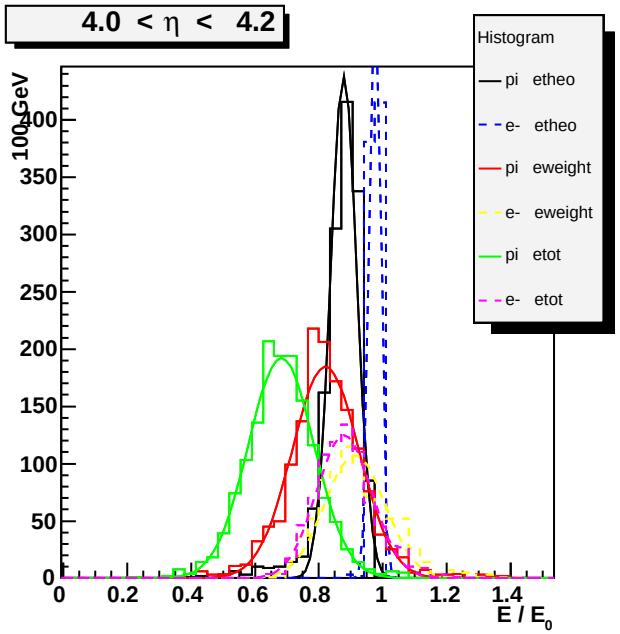

2.0 < η < 2.2
Histogram
pi etheo
e- etheo
pi eweight
e- eweight
pi etot
e- etot
100 GeV
E / E0

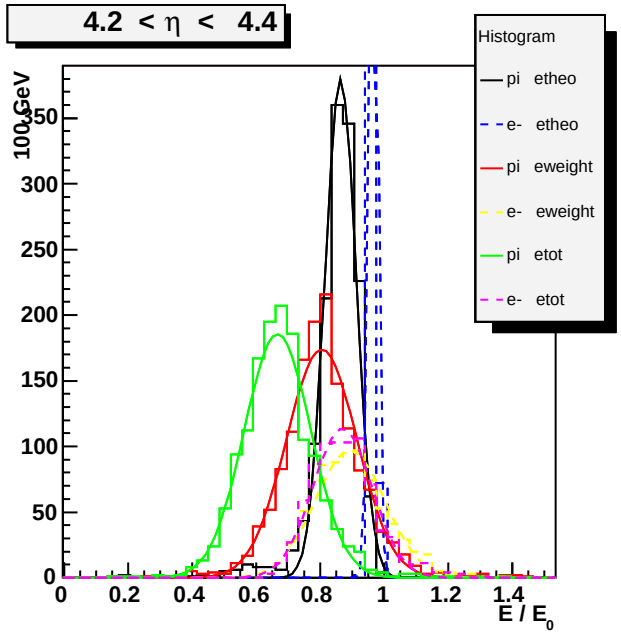

2.2 < η < 2.4
Histogram
pi etheo
e- etheo
pi eweight
e- eweight
pi etot
e- etot
100 GeV
E / E0

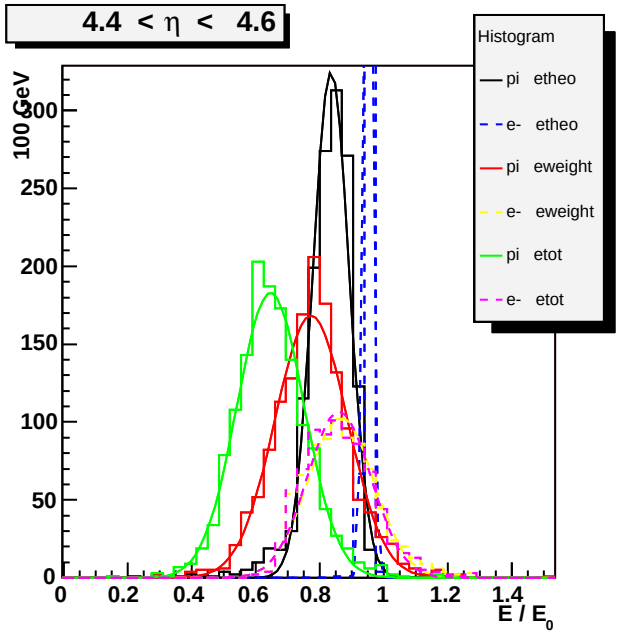

2.4 < η < 2.6
2.6 < η < 2.8
2.8 < η < 3.0
3.0 < η < 3.2
3.2 < η < 3.4
3.4 < η < 3.6
Histogram
pi etheo
e- etheo
pi eweight
e- eweight
pi etot
e- etot
100 GeV
E / E0

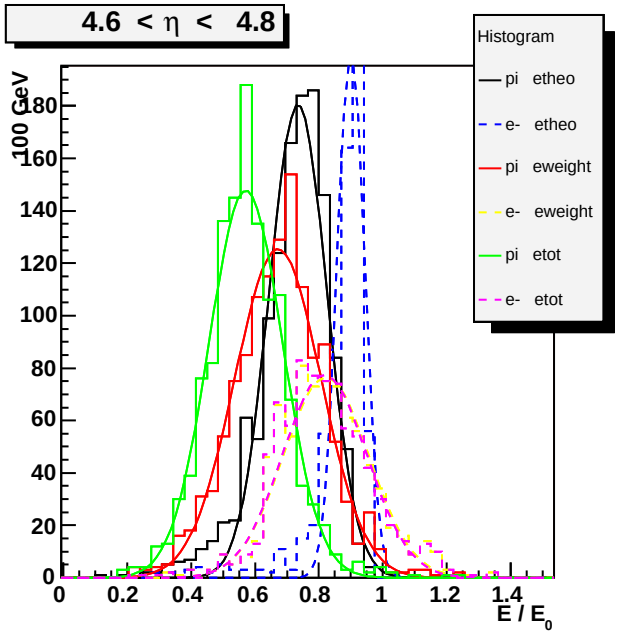

3.6 < η < 3.8
Histogram
pi etheo
e- etheo
pi eweight
e- eweight
pi etot
e- etot
100 GeV
E / E0


3.8 < η < 4.0
Histogram
pi etheo
e- etheo
pi eweight
e- eweight
pi etot
e- etot
100 GeV
E / E0


4.0 < η < 4.2
Histogram
pi etheo
e- etheo
pi eweight
e- eweight
pi etot
e- etot
100 GeV
E / E0


4.2 < η < 4.4
Histogram
pi etheo
e- etheo
pi eweight
e- eweight
pi etot
e- etot
100 GeV
E / E0


4.4 < η < 4.6
Histogram
pi etheo
e- etheo
pi eweight
e- eweight
pi etot
e- etot
100 GeV
E / E0


4.6 < η < 4.8
Histogram
pi etheo
e- etheo
pi eweight
e- eweight
pi etot
e- etot
100 GeV
E / E0

Conclusions

- Using the calibration hits and moments information we are able to estimate EM compoment of single pion signal.
- Using above mentioned result it is possible to identify EM clusters and exclude them from weighting procedure
- Jet data processing in progress