Cluster classification estimating EM component of shower

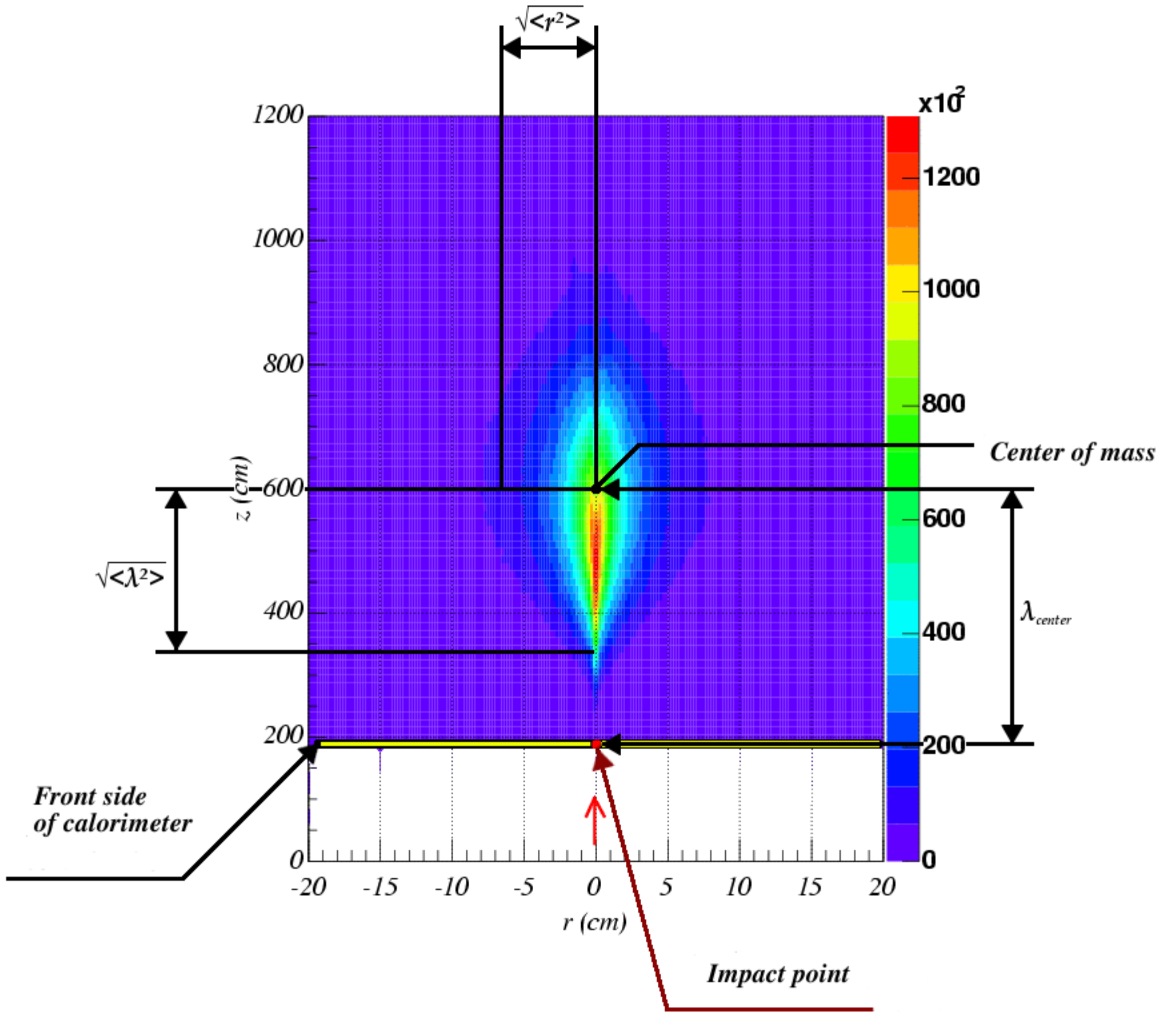
- We use three topological moments which are correlated with the EM fraction of deposited energy to calculate this fraction

- Our estimation of EM component of deposited energy is calculated as weighted mean value of particular estimations

- It was shown that our estimation and MC truth are strongly correlated if deposited energy is not too small

- I use the following moments to identify EM clusters:
  - SECOND_R -second radial moment (shower effective radius)
  - SECOND_LAMBDA -second longitudinal moment (shower effective half length)
  - CENTER_LAMBDA

- As was already mentioned the moments are correlated with the electromagnetic component of the deposited energy



$\sqrt{<r^2>}$
x10^2
1200
1000
800
600
400
200
0
Center of mass
$\sqrt{<\lambda^2>}$
λ_{center}
z (cm)
Front side
of calorimeter
-20
-15
-10
-5
0
5
10
15
20
r (cm)
Impact point

Second moments definition:

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

- 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

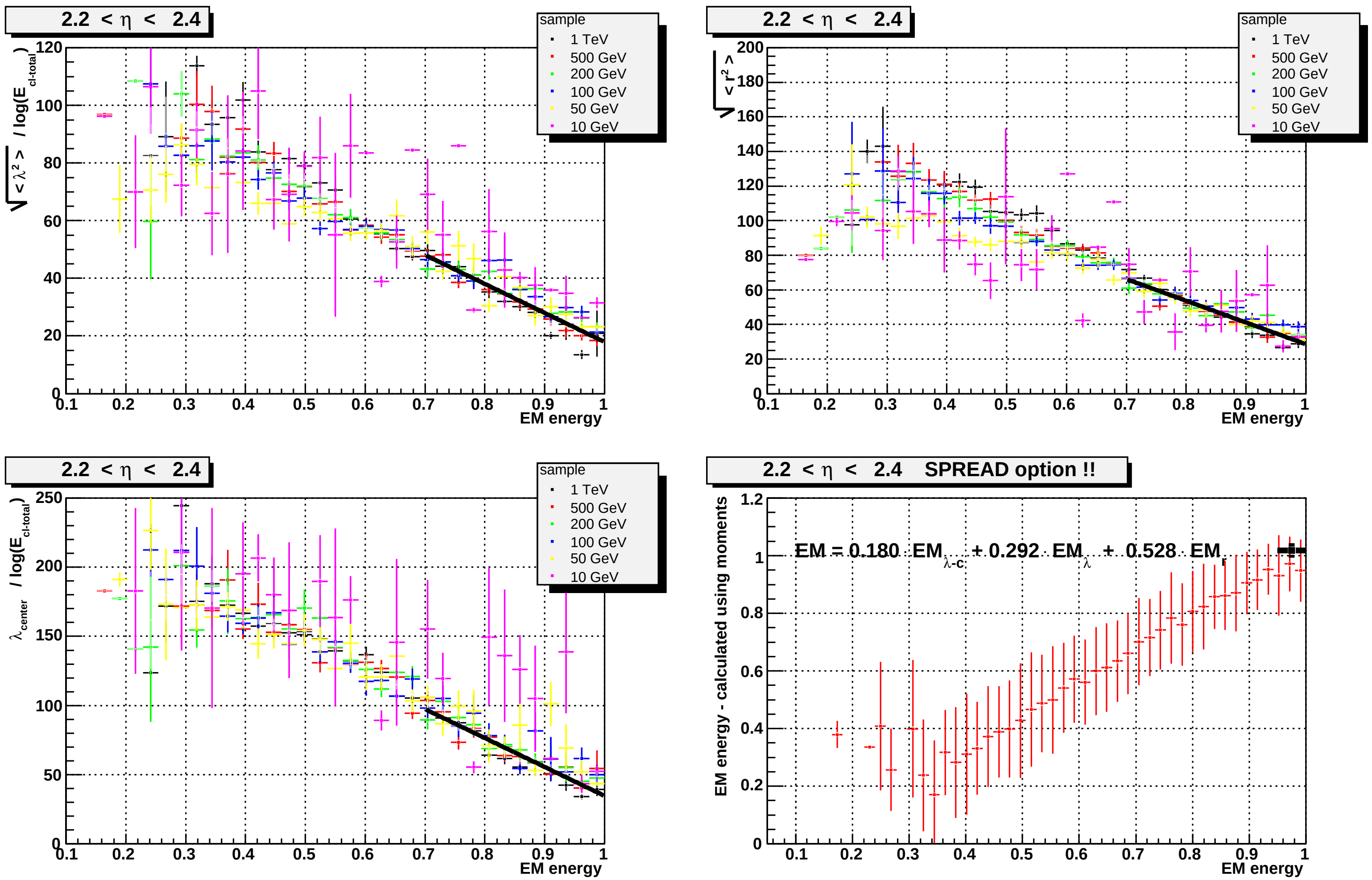
The calorimeter is divided into 25 equidistant η bins

- I use simple linear fit to calculate the electromagnetic component of the deposited energy (i.e.I receive 3 different but strongly correlated calculated EM components)

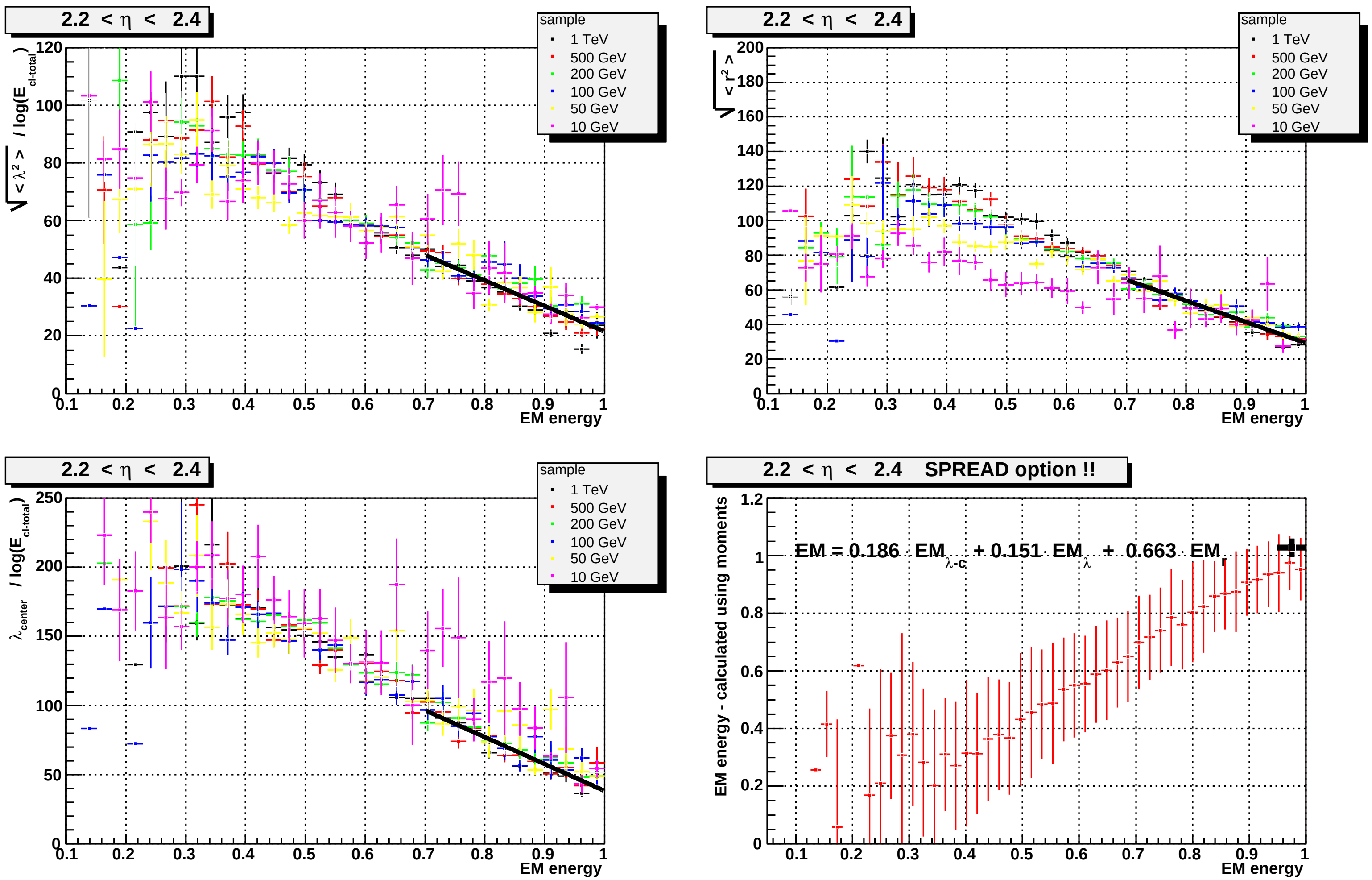
- afterwards I try to find optimal weighted mean value of calculated EM components using MINUIT to minimize the spread (I plot calculated vs. $trueEM$ component - big black square are 100 GeV electrons)

- This method works only for clusters with the deposited energy above the E_T cut for the corresponding η bin

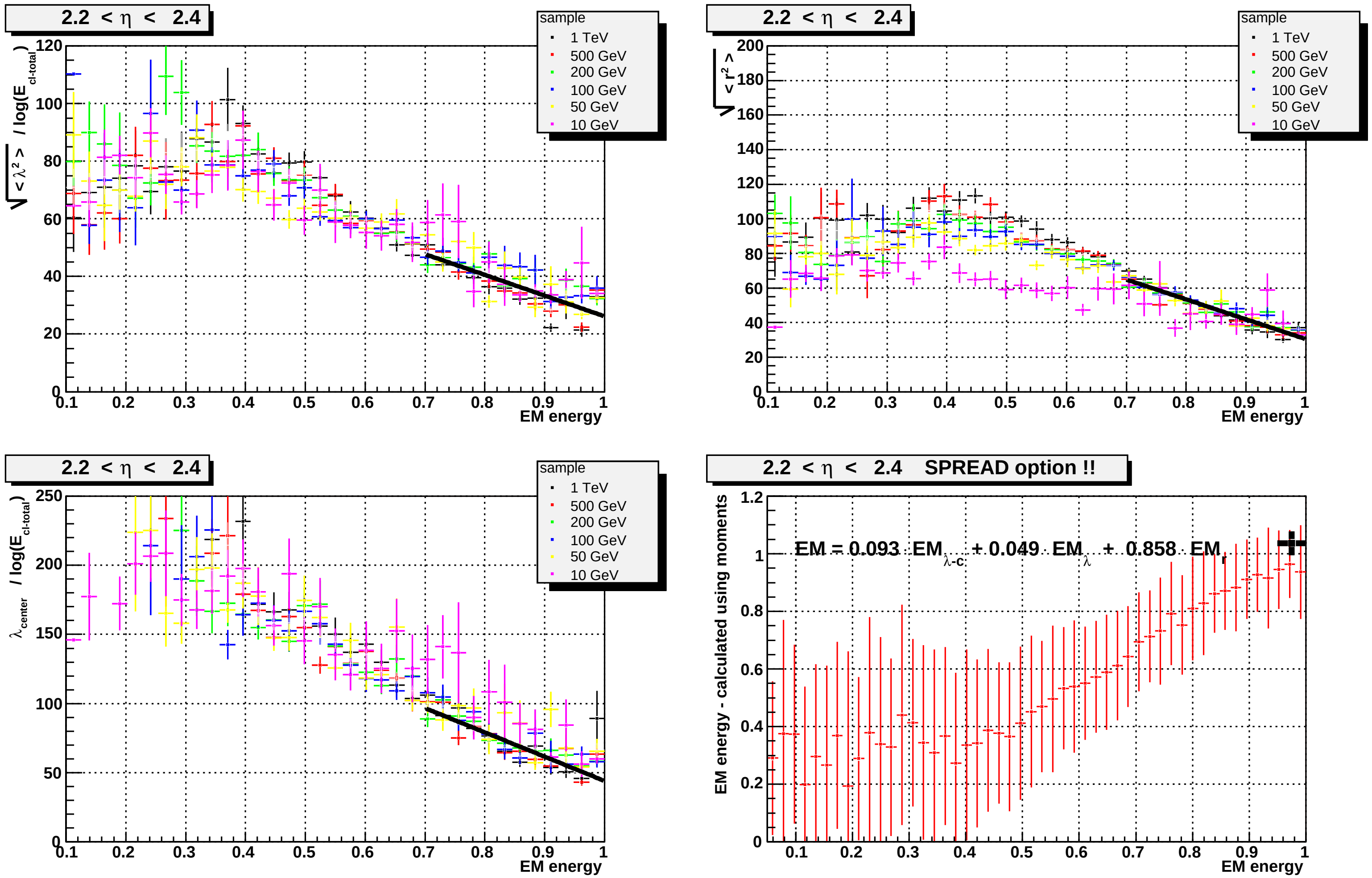
cut: $E_T = 1500 MeV \quad (\pi^-)$



cut: $E_T = 1000 MeV \quad (\pi^-)$



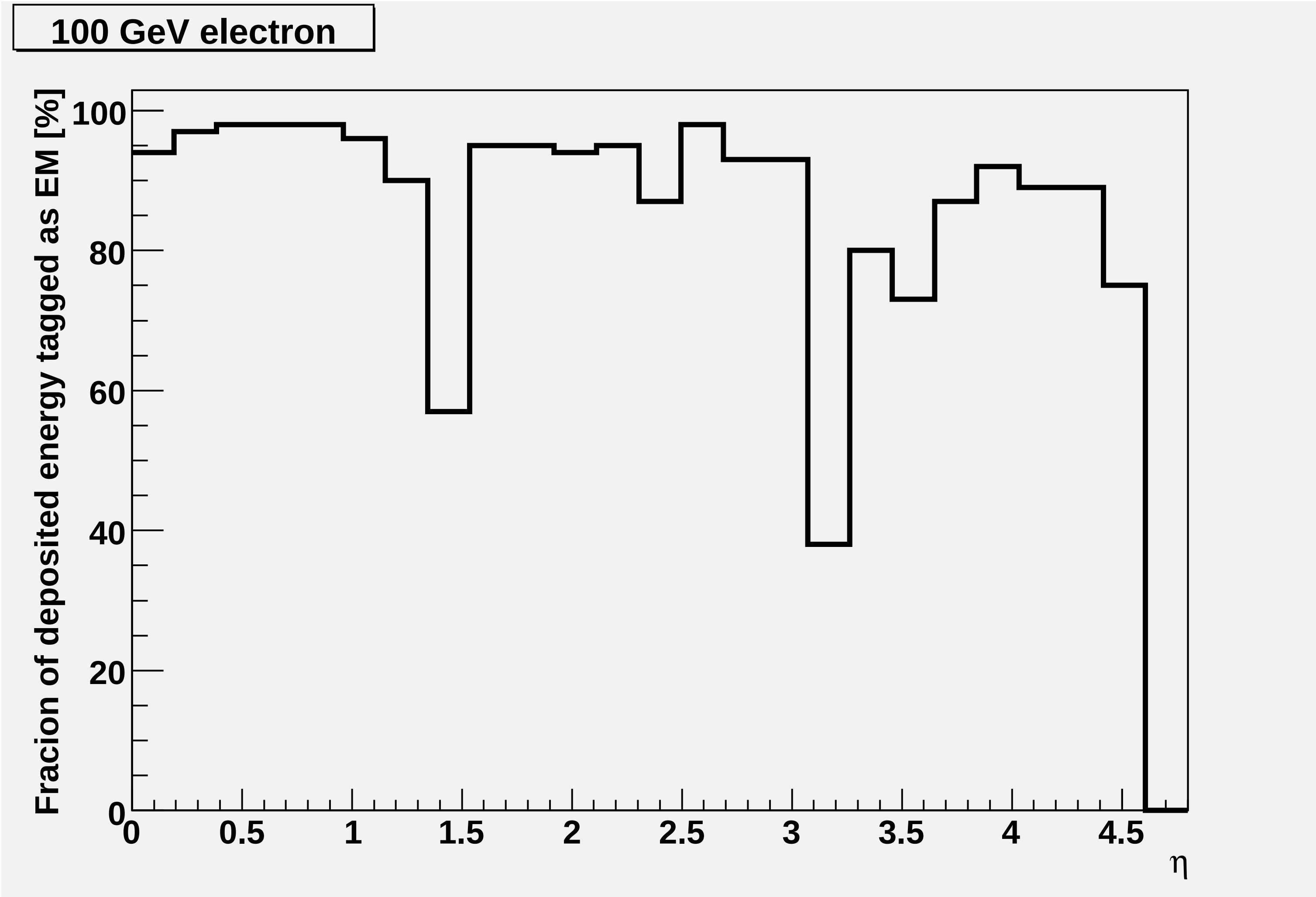
cut: $E_T = 500 MeV \quad (\pi^-)$



Slice	$E_T cut[MeV]$
0	1000
1	1500
2	1500
3	2000
4	3000
5	2500
6	1500
7	1000
8	1000
9	1000
10	500
11	500
12	500
13	500
14	500
15	500
16	500
17	500
18	500
19	500
20	500
21	500
22	500
23	1000
24	-

Classification validation

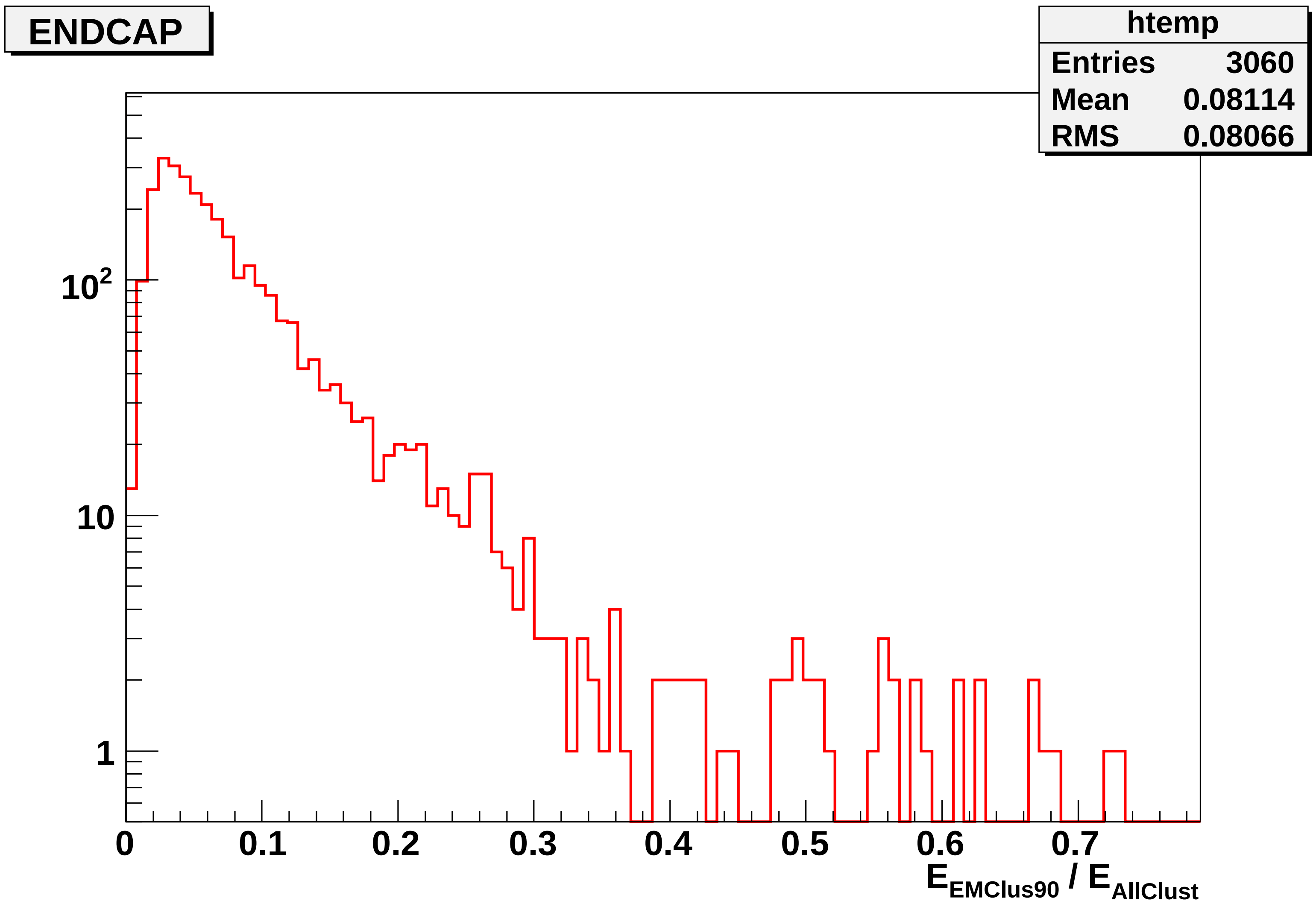
- For validation of this classification method (derived from MC single pions data) the both of electrons and QCD di-jets samples were used
- Above mentioned method works for electrons - the most of energy belongs to clusters which are tagged as EM


100 GeV electron
Fracion of deposited energy tagged as EM [%]
0
20
40
60
80
100
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
η

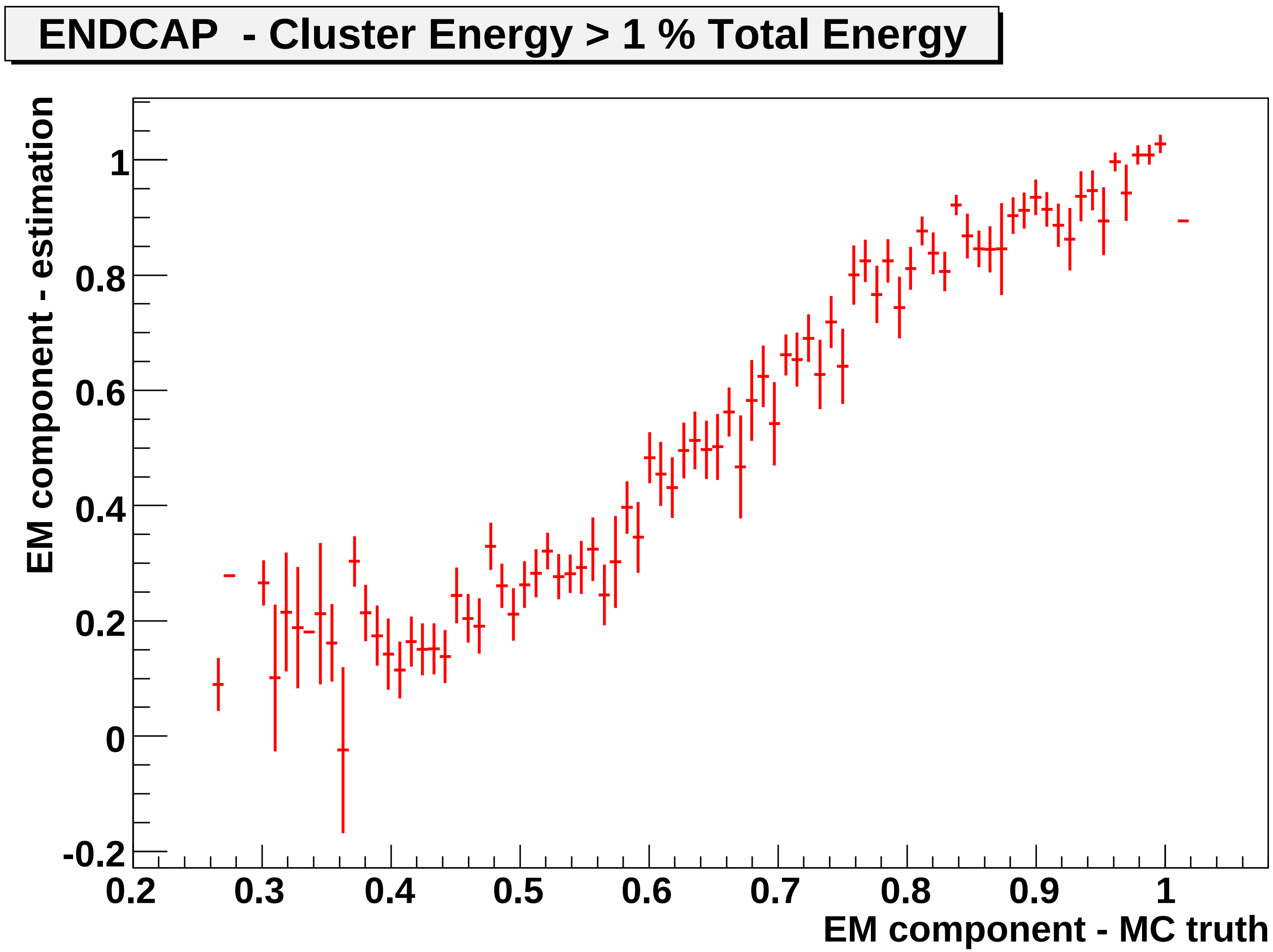
- For QCD di-jets in generally only small fraction of energy belongs to clusters which contains more than 90% of EM energy ($\sim 8\%$)
  (Note that more then 60% *of jet energy is deposited through EM interaction !)*

- The most of such (EM) clusters contains only very small deposited energy

- Looking to the results for this group of clusters only $\sim 25\%$ of energy belongs to clusters which are tagged as EM
  (Note that 100% *is energy which should be tagged as EM following MC truth info)*


ENDCAP
htemp
Entries 3060
Mean 0.08114
RMS 0.08066
10^2
10
1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
$E_{EMClus90} / E_{AllClust}$

- … but EM component estimation works for jet clusters as well
- … if they contain enough deposited energy, of course …
- this information can be used for more sophisticated classification of the most energetic hadronic clusters



ENDCAP - Cluster Energy > 1 % Total Energy
EM component - estimation
EM component - MC truth
1
0.8
0.6
0.4
0.2
0
-0.2
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

Conclusions

- Using the calibration hits and moments information we are able to estimate EM compoment of single pion signal
- In a case of electrons as an incident particle the most of energy belongs to clusters which are tagged as EM
- Estimated EM component of deposited energy for jet clusters is well correlated with MC truth