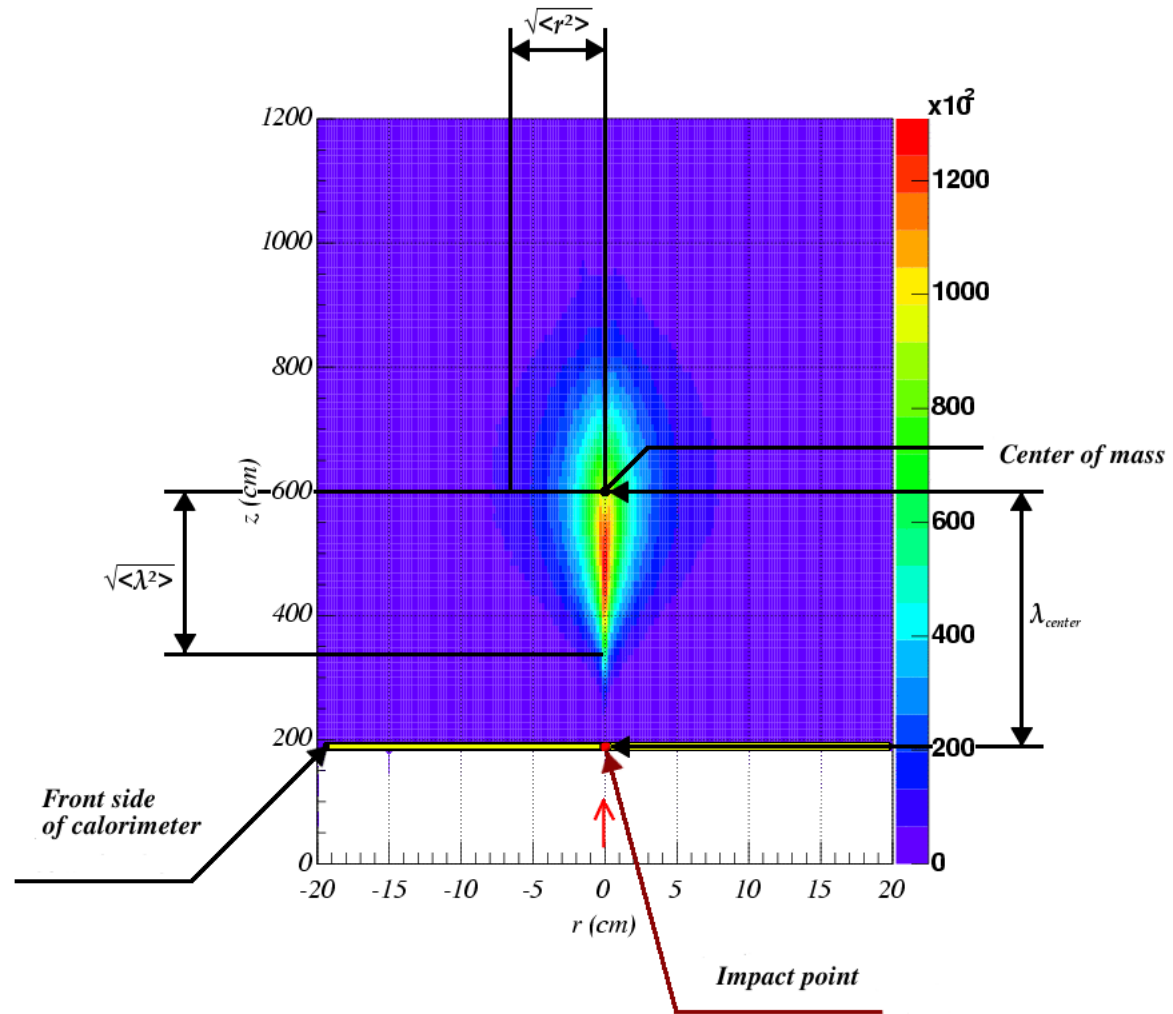


## Cluster classification estimating EM component of shower

- 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



Second moments definition:

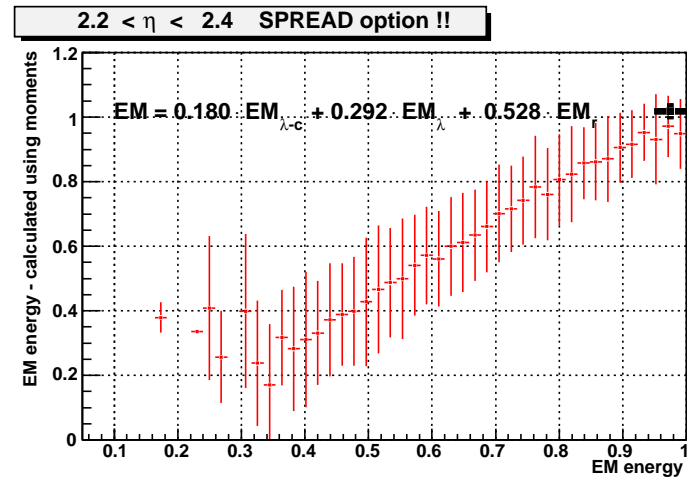
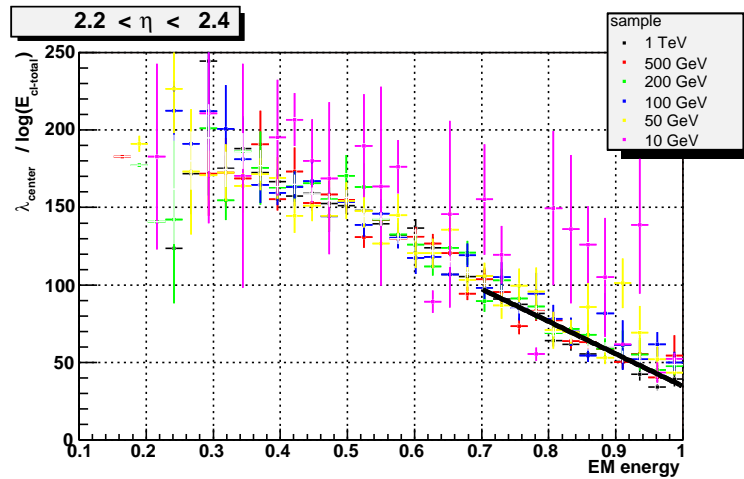
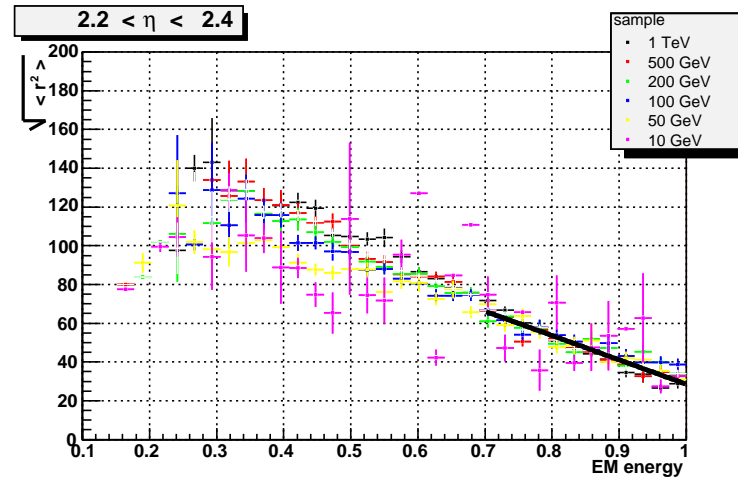
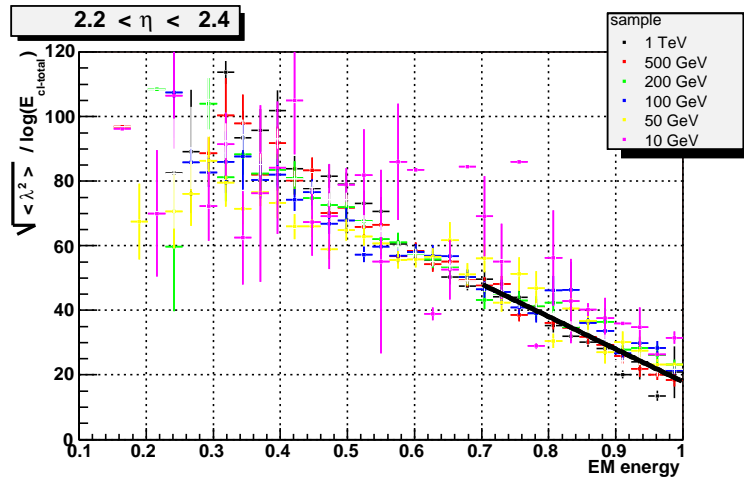
$$\lambda^2 = \frac{\sum_{i=1}^n \lambda_i^2 \cdot E_i}{\sum_{i=1}^n E_i} \quad r^2 = \frac{\sum_{i=1}^n r_i^2 \cdot E_i}{\sum_{i=1}^n E_i}$$

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

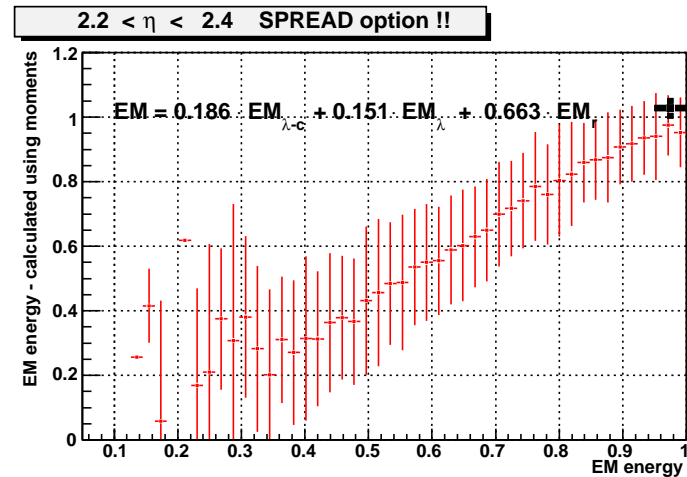
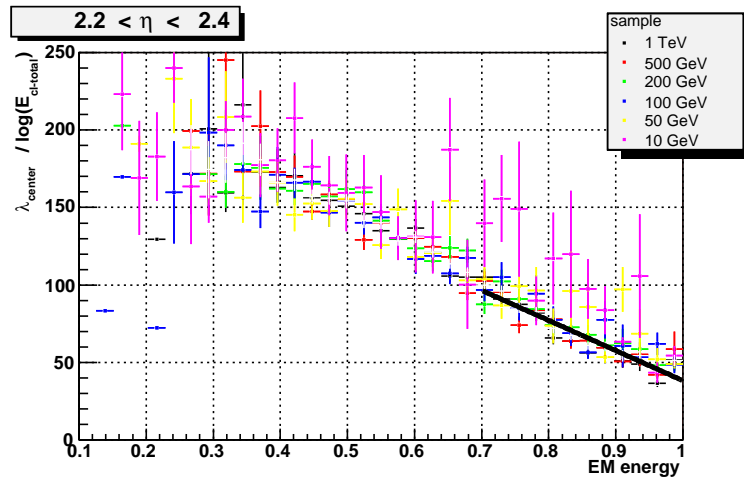
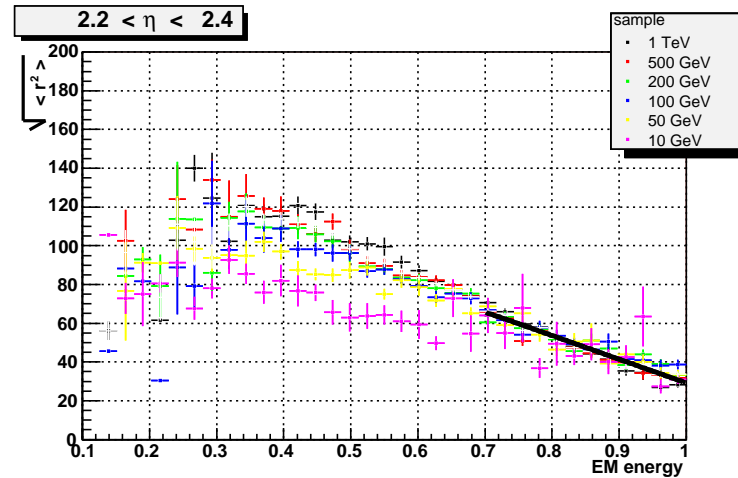
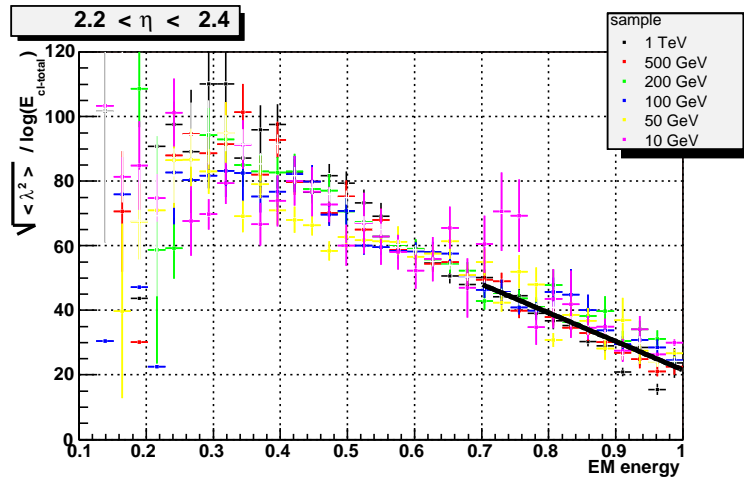
The calorimeter is divided into 25 equidistant  $\eta$  bins

- 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  $\eta$  bin

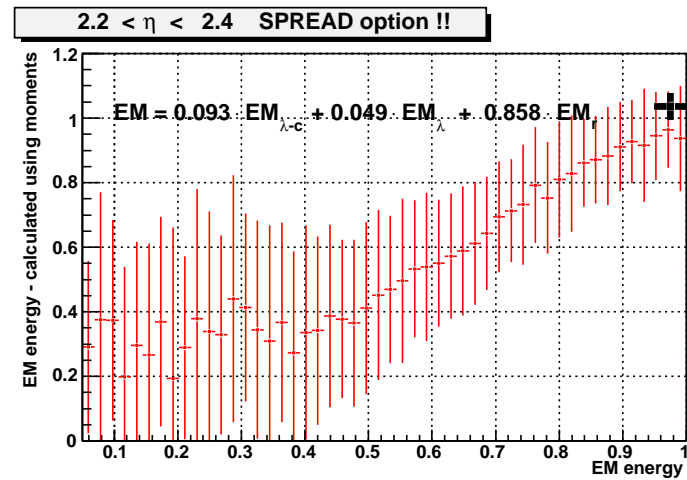
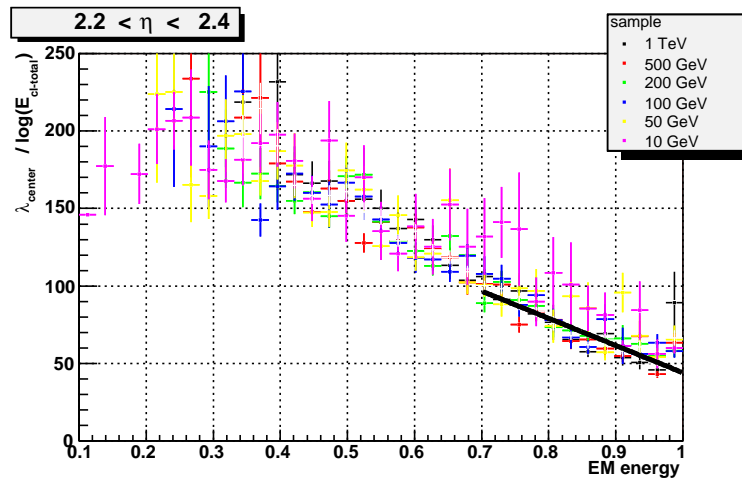
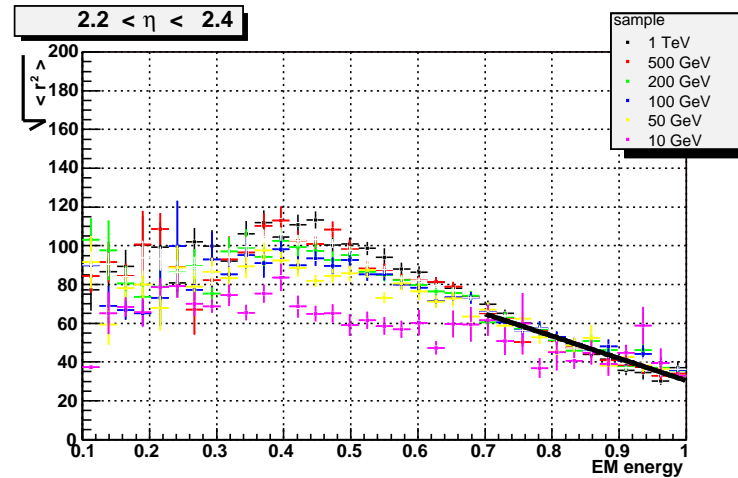
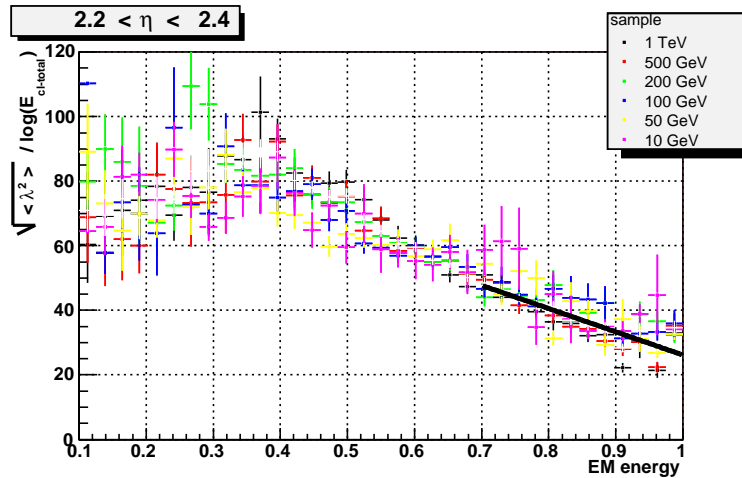
cut:  $E_T = 1500 \text{ MeV}$  ( $\pi^-$ )



cut:  $E_T = 1000 \text{ MeV}$  ( $\pi^-$ )



cut:  $E_T = 500 \text{ MeV}$  ( $\pi^-$ )

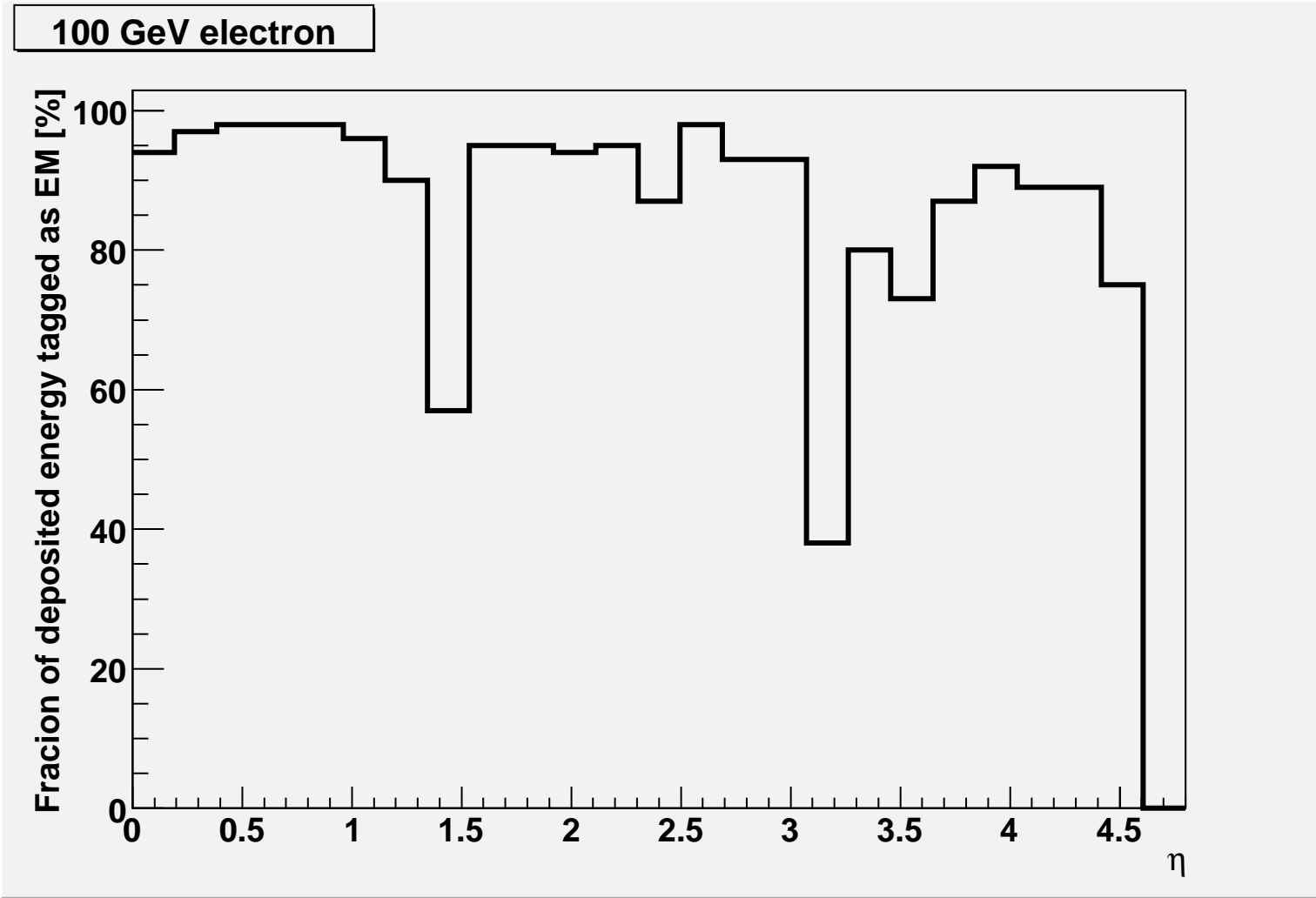




Slice	$E_{Tcut}[MeV]$
0	1000
1	1500
2	1500
3	2000
4	3000
5	2500
6	1500
7	1000
8	1000
9	1000
10	500
11	500
12	500
13	500
14	500
15	500
16	500
17	500
18	500
19	500
20	500
21	500
22	500
23	1000
24	-

## Classification validation

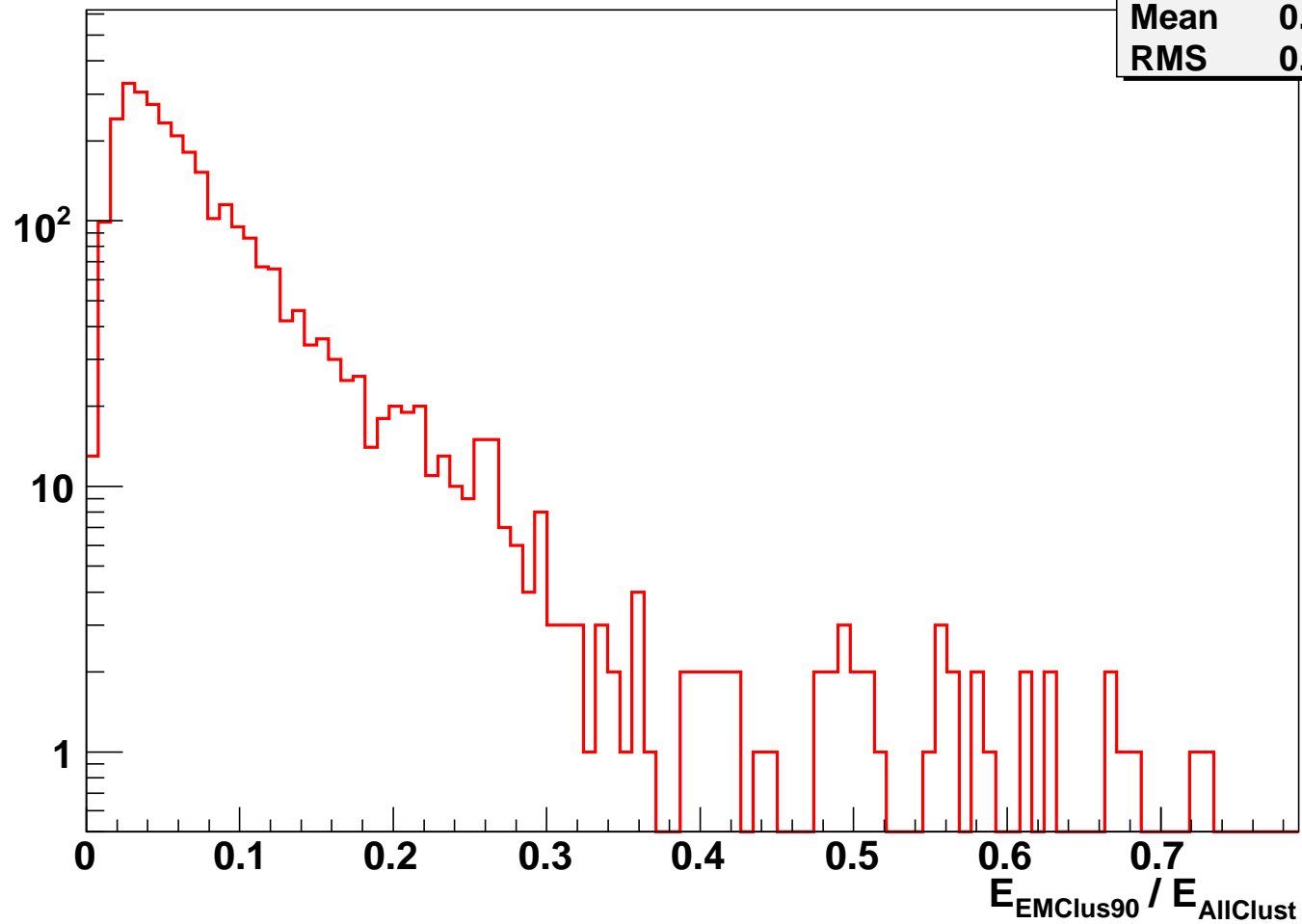
- For validation of this classification method (derived from MC single pions data) the both of electrons and QCD di-jets samples were used
- Above mentioned method works for electrons - the most of energy belongs to clusters which are tagged as EM



- 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 than 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)*

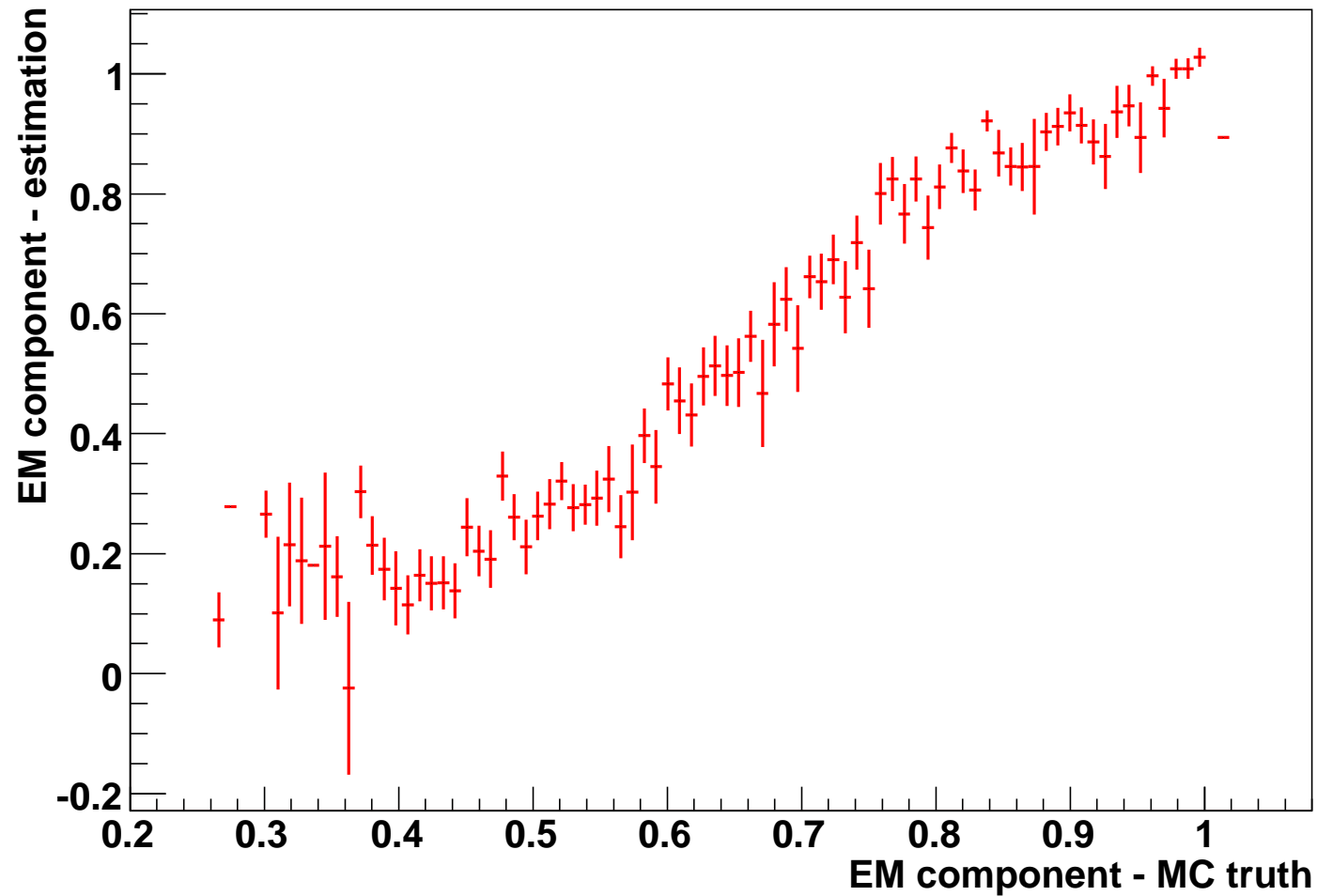
**ENDCAP**

htemp	
Entries	3060
Mean	0.08114
RMS	0.08066



- ... 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



## Conclusions

- Using the calibration hits and moments information we are able to estimate EM component 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