Electromagnetic showers energy estimation

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New tool status

- 3 meetings in the former weeks to understand the result shown just before
- Different checks have been made in order to stabilize the output of the energy estimation unsuccessfully

- It has been decided to build a new tool to estimate the energy on a large statistics sample : new MC production
- The goal is to build a tool :
  - more stable wrt energy in a range of [2,30] GeV
  - more flexible : only one ANN or one per BT efficiency
  - Can be extended to 2 bricks : adjacent (same wall) or downtream

New MC production

Electron Energy estimation : New training of the neural network in the shower reconstruction tool

- MC sample statistics : 50k electrons – [0,30]GeV [-500,+500]mrad incoming angle

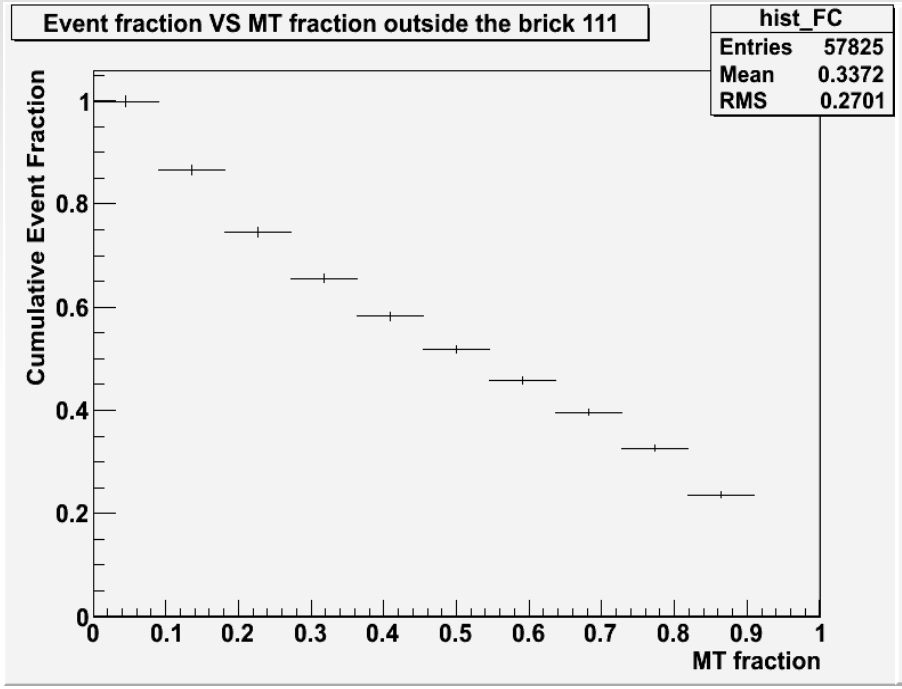
- A test production is done → 10k electrons
  - CS Efficiency → 6.4k electrons only
  - After Electron ID efficiency → 5.2k electrons
  - CS efficiency free sample is being processed

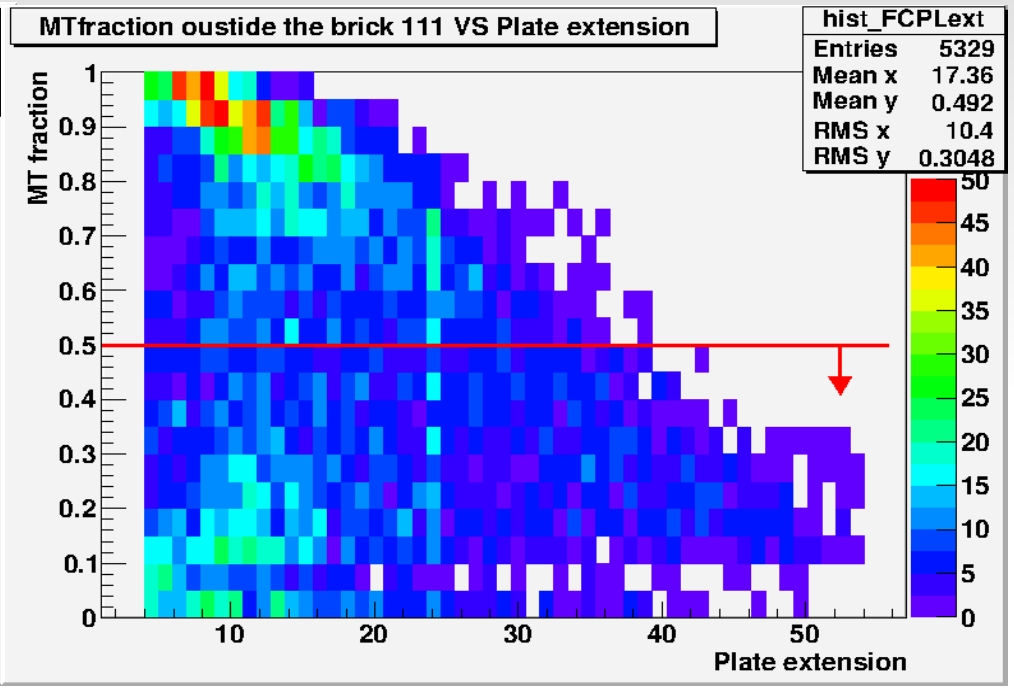
New Shower Tool

Generation parameters : [0,30]GeV, [-0.5,0.5]rd, randomly distributed in the OPERA detector

- Training Sample : 1387 Fully Contained electrons
- Test sample : 1387 Fully Contained electrons
- Methods used : Linear Discriminant, ANN MLP
- Input variables : BT multiplicity, Plate extension, Longitudinal profile : 22 plates described by 10 variables (BT content in the plates 1-4, plate 5&6, plates 7&8 up to 21&22), angular information

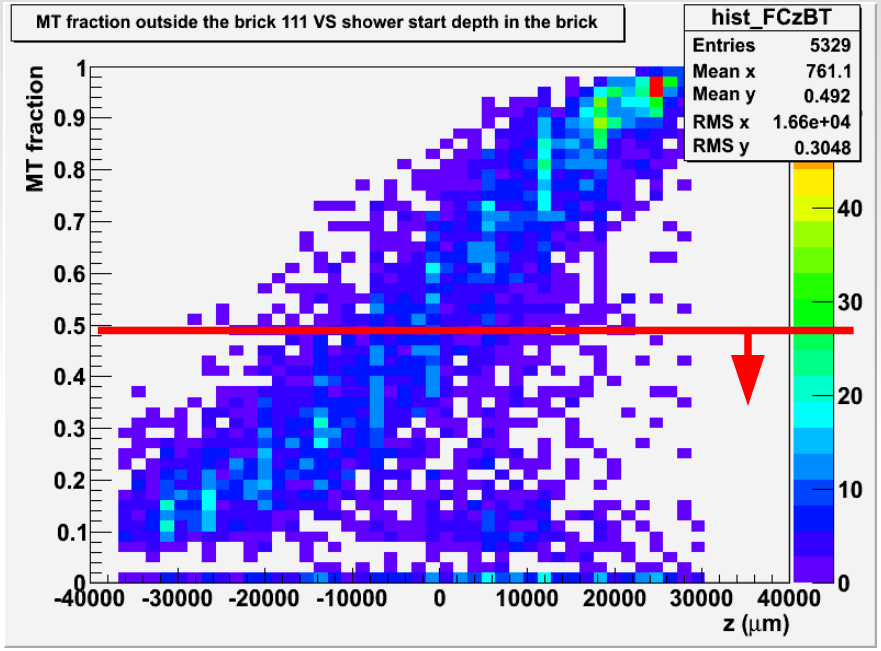
New Shower Tool : FC selection

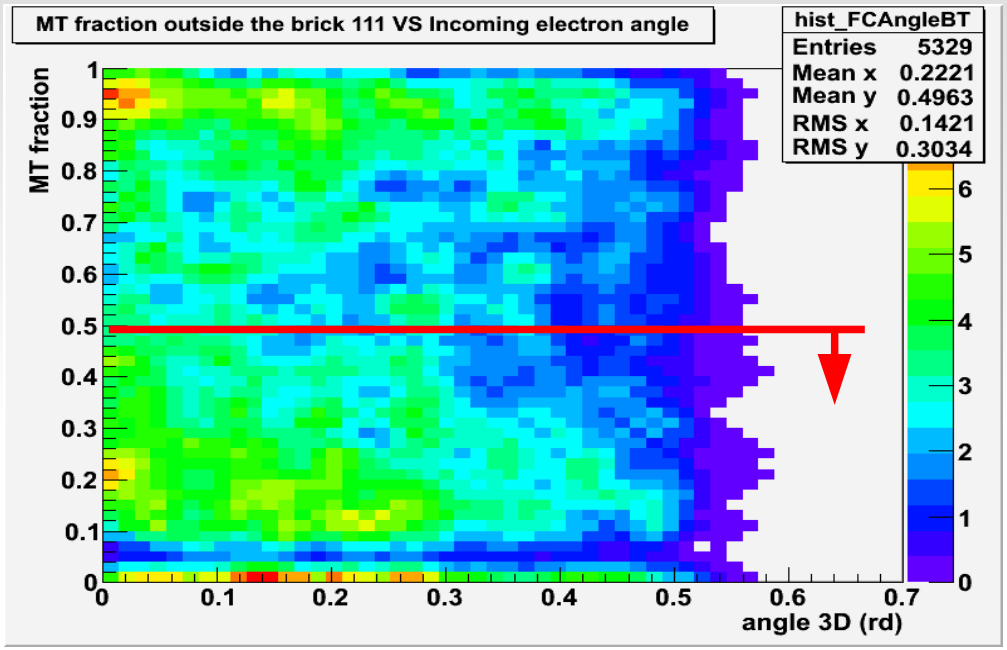




- Selecting Fully Contained showers (at least 50% MT inside the located brick)
- The 0.5 cut on MT fraction seems reasonable by removing the cluster high MT fraction + low plate extension
- A cut on Plate extension requiring shower with at least 5X0 would be a good idea BUT the statistics of remaining shower decreases drastically :

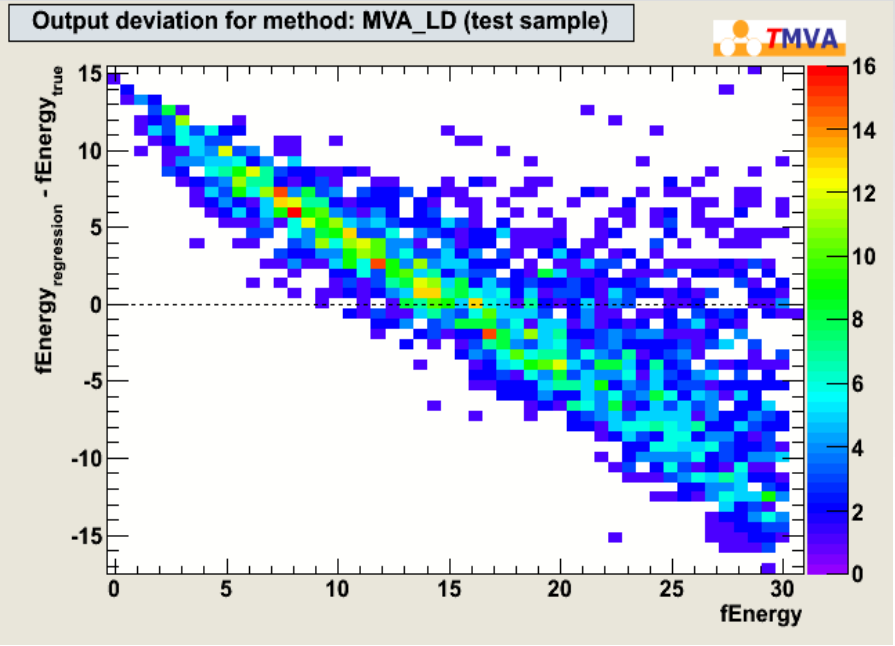
New Shower Tool : FC selection

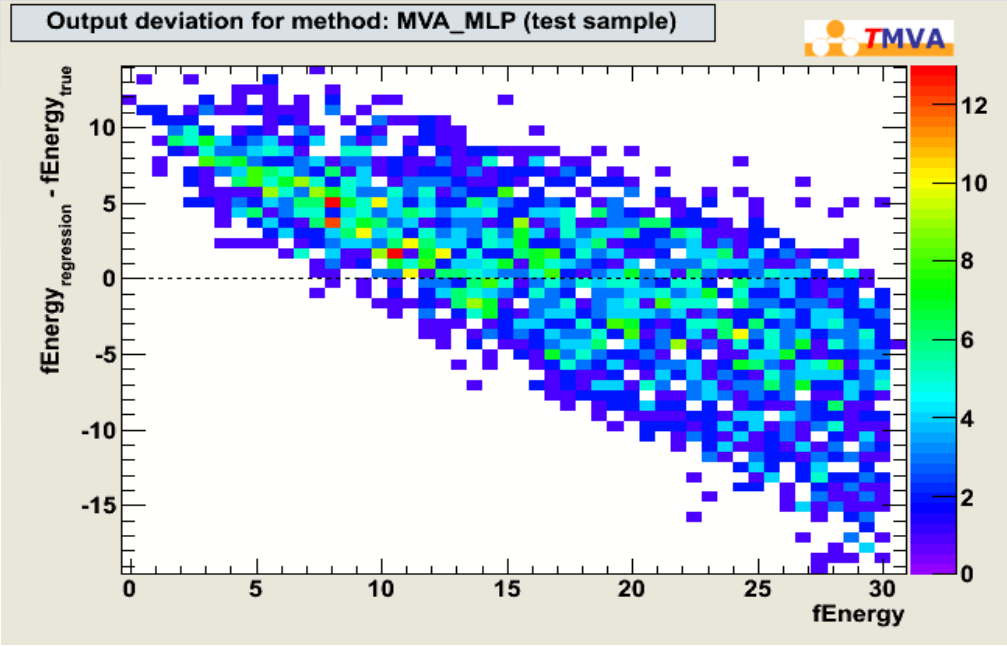




- Selecting Fully Contained showers (at least 50% MT inside the located brick)
- The 0.5 cut on MT fraction seems reasonable by removing the cluster high MT fraction + vertex depth dowstream in the brick

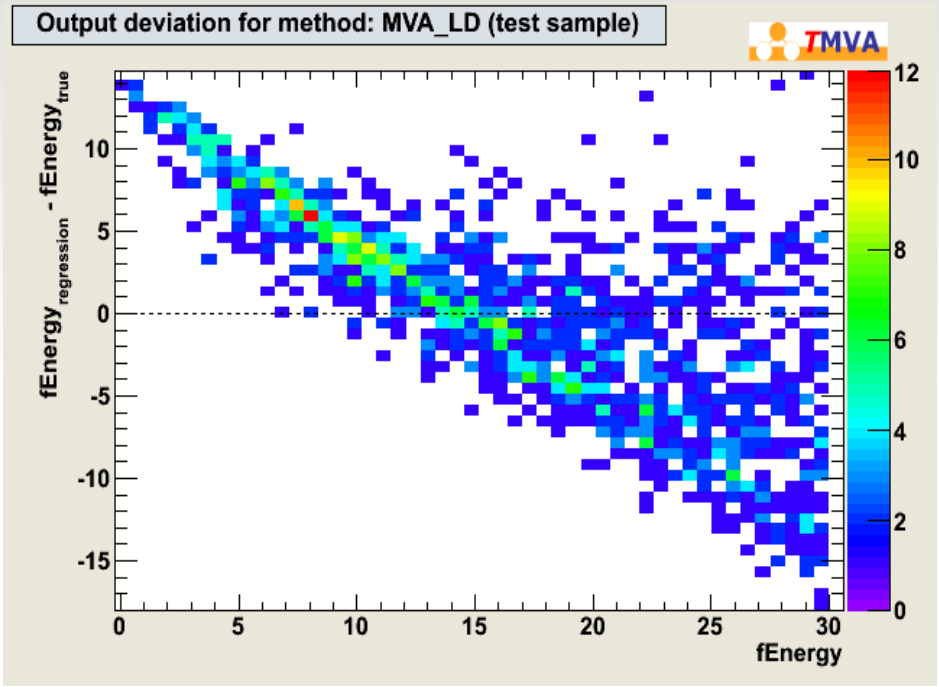
New Shower Tool : former result

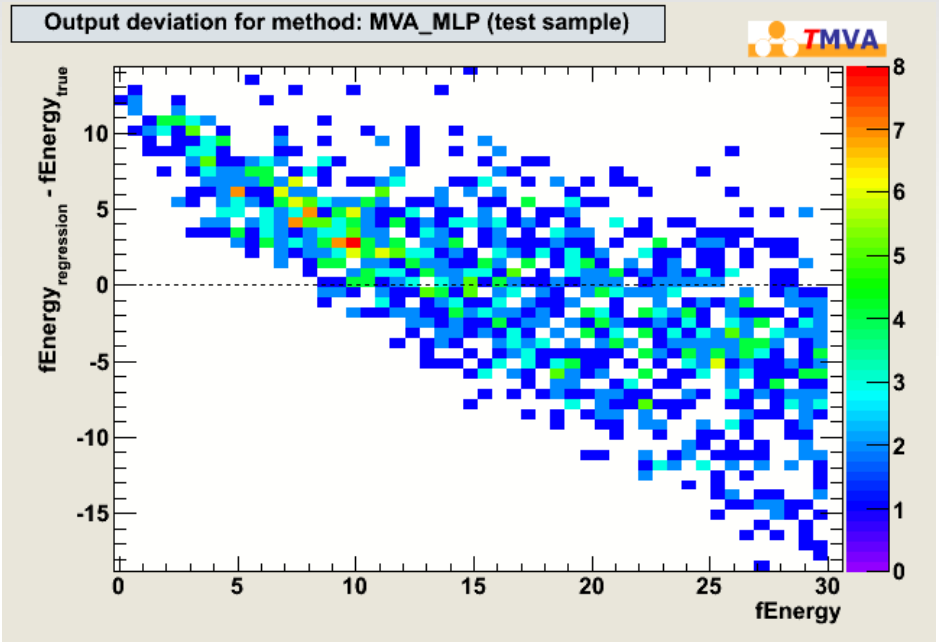




- 50% resolution wrt MC energy at 15 GeV
- Regression ineffective (small weights) → « always the mean value »

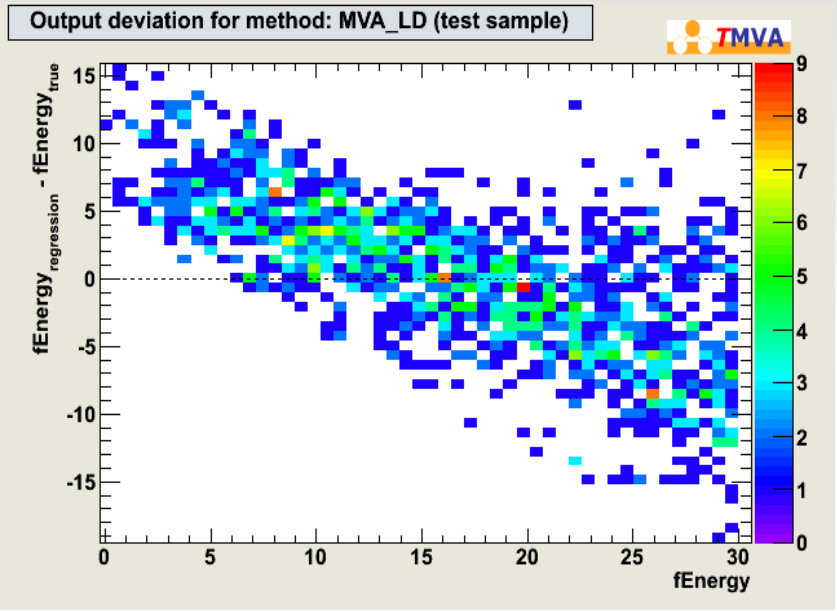
New Shower Tool : + FC showers

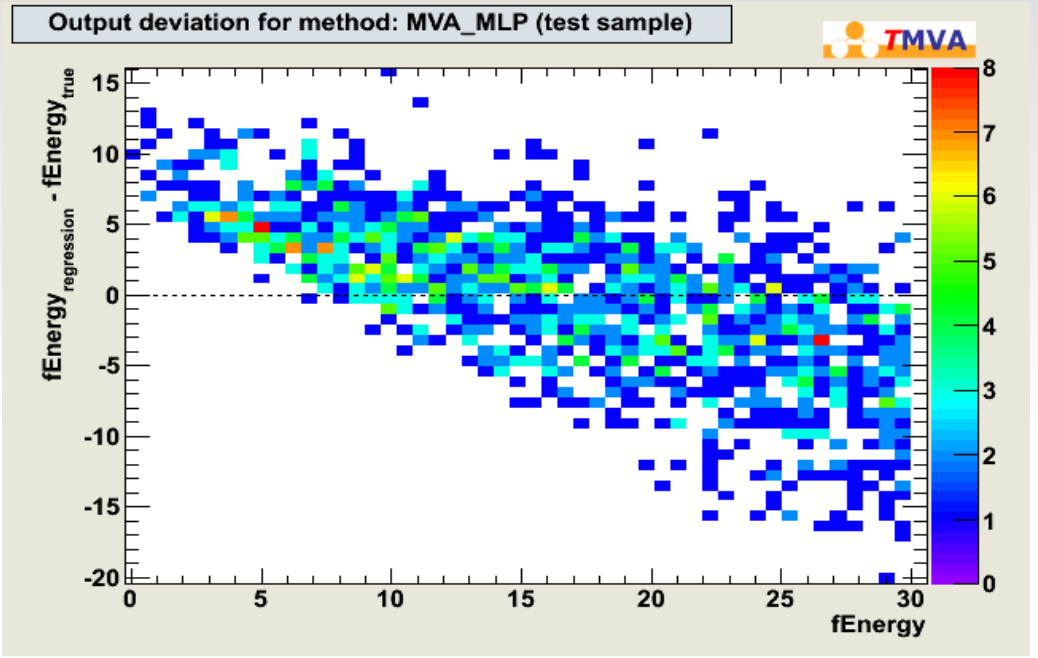




- Regression ineffective (small weights) → « always the mean value »
- No improvements

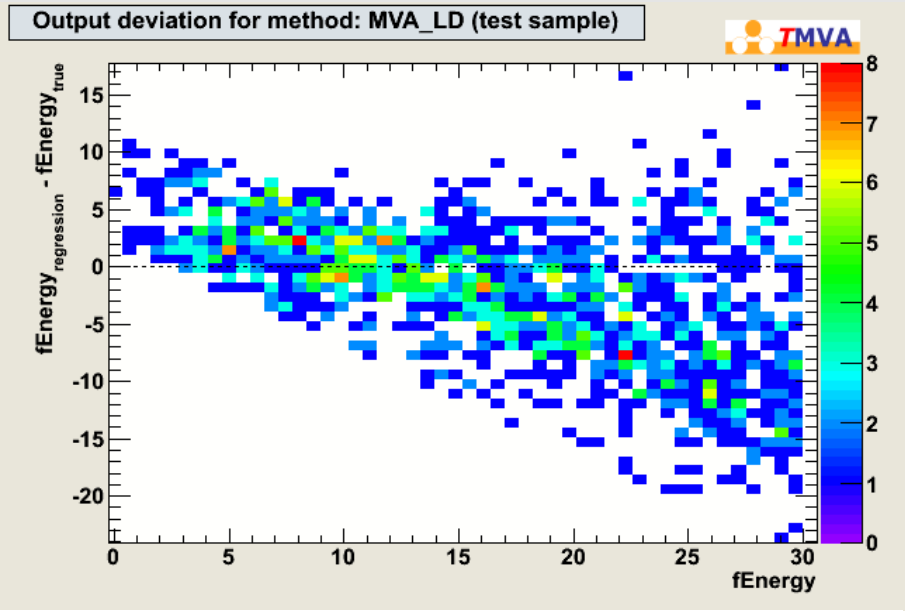
New Shower Tool : FC showers + 1 angular information

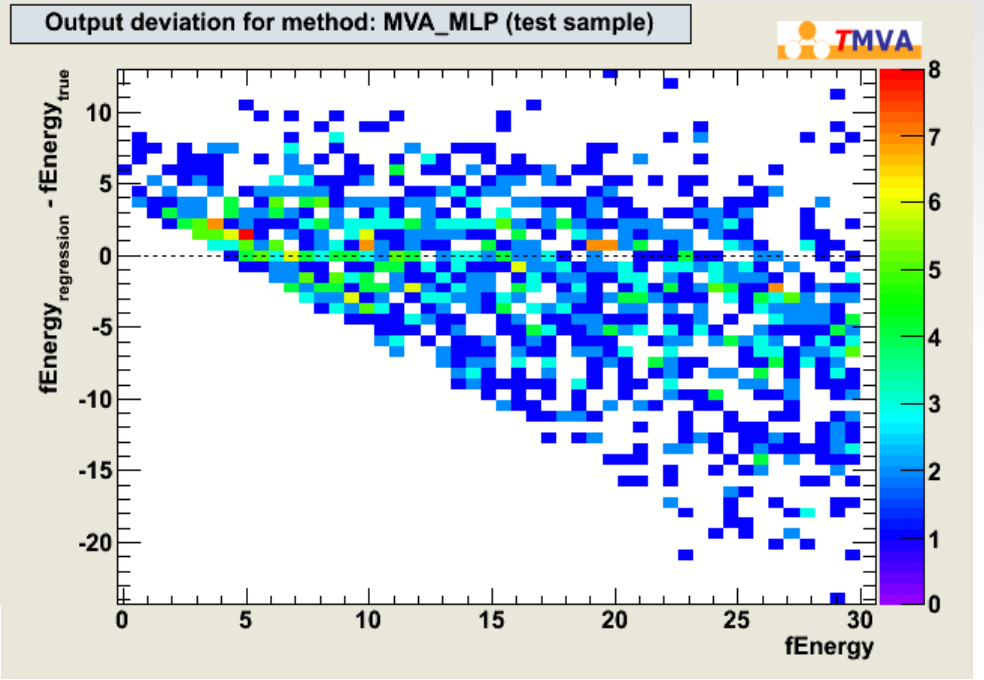




- Selecting Fully Contained showers (at least 50% MT inside the located brick)
- Adding the incoming electron track angle as an input variable
- Next step : Komatsu-san idea → adding the angular difference between basetracks and shower axis (mean and RMS)

New Shower Tool : FC showers + weighted with the MC true energy





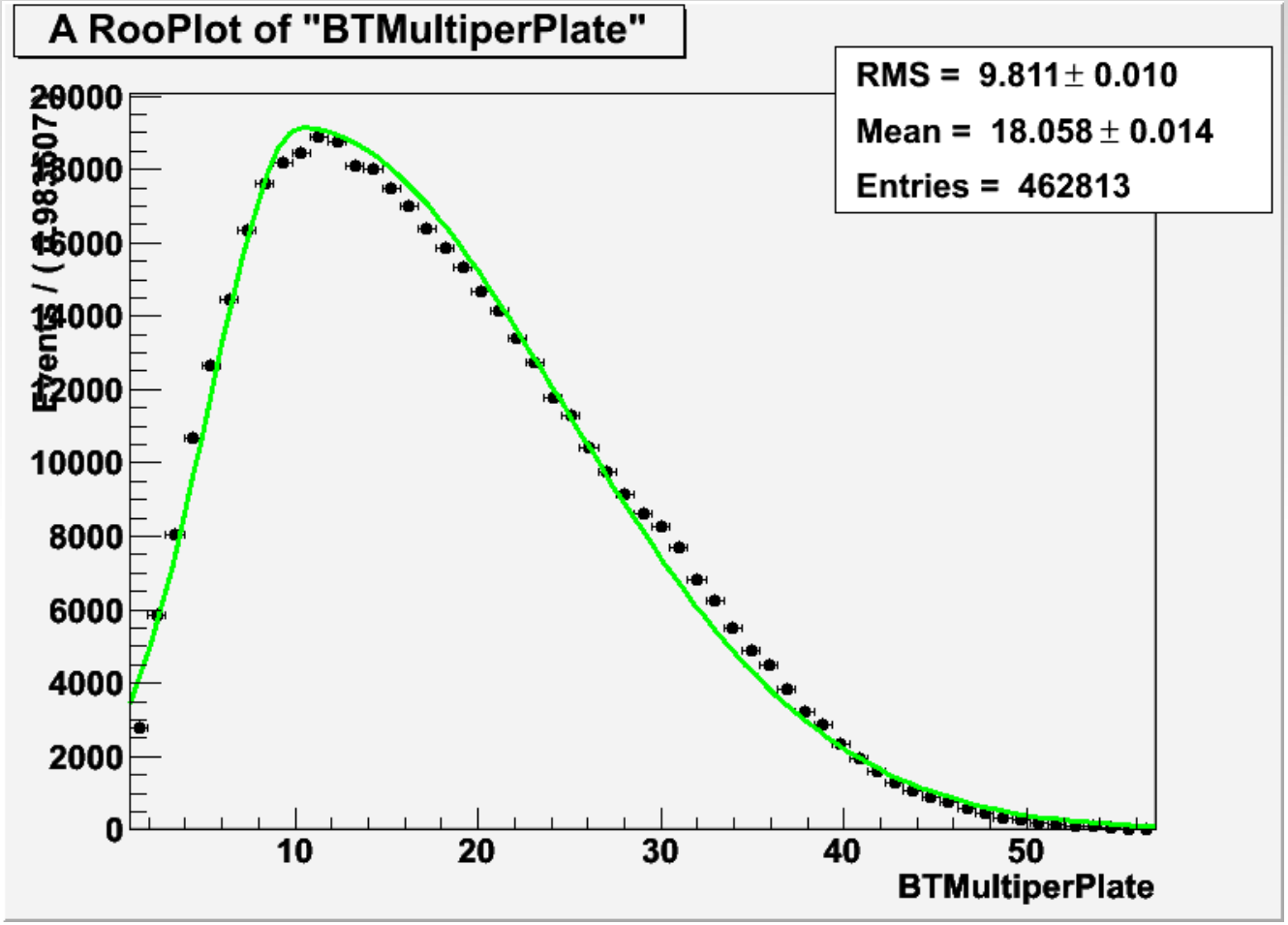
- Selecting Fully Contained showers (at least 50% MT inside the located brick)
- Event Weight = 1/E(MC)

New Shower Tool : Summary

- Select FC showers + Adding variables (angular) + weighting events (Energy) improve the rec energy
- But it is still unstable

- New idea : use a fitted longitudinal profile

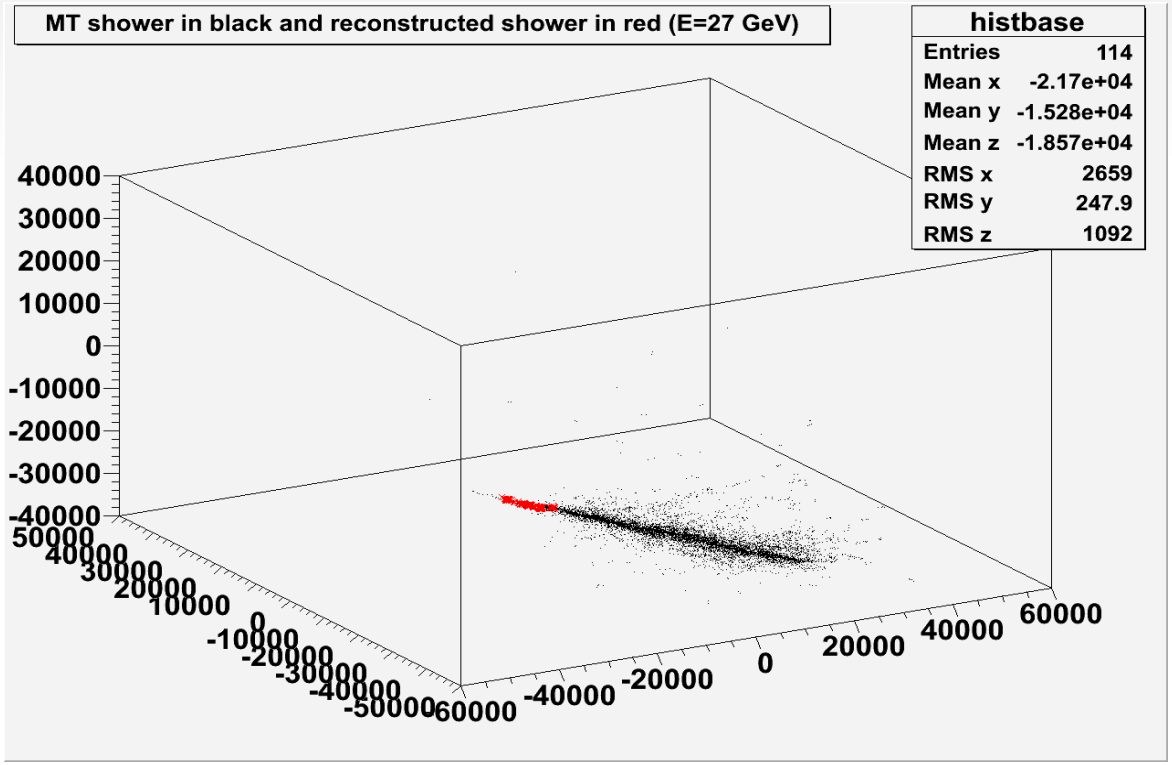
New Shower Tool : mean long. profile



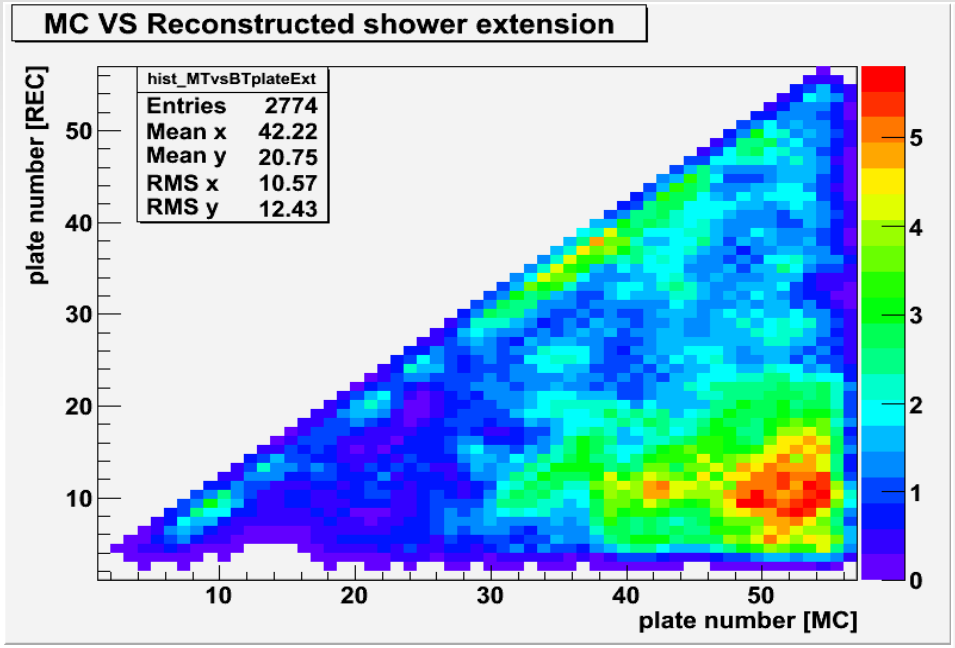
- Fit the longitudinal profile with an asymetric gaussian + asymetric tails (5 parameters function)
- See how it fits a single shower profile and then if multiple shower fits are converging

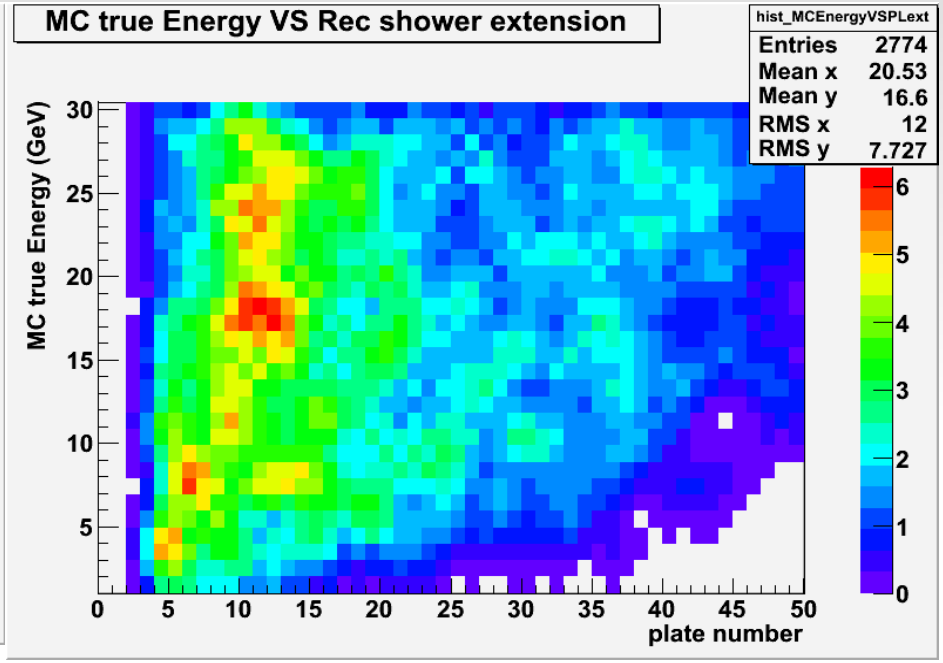
New Shower Tool : single shower long. profile

- Fitting process on single shower profile fails → because of a bug



New Shower Tool : single shower long. profile





- High energy showers with a 10 plates mean extension = 35%
- Bug tracking : when linking access zones and view information → most of these object are empty
- NEW : Michele is checking my output : he saw 38 views → no empty views but missing views

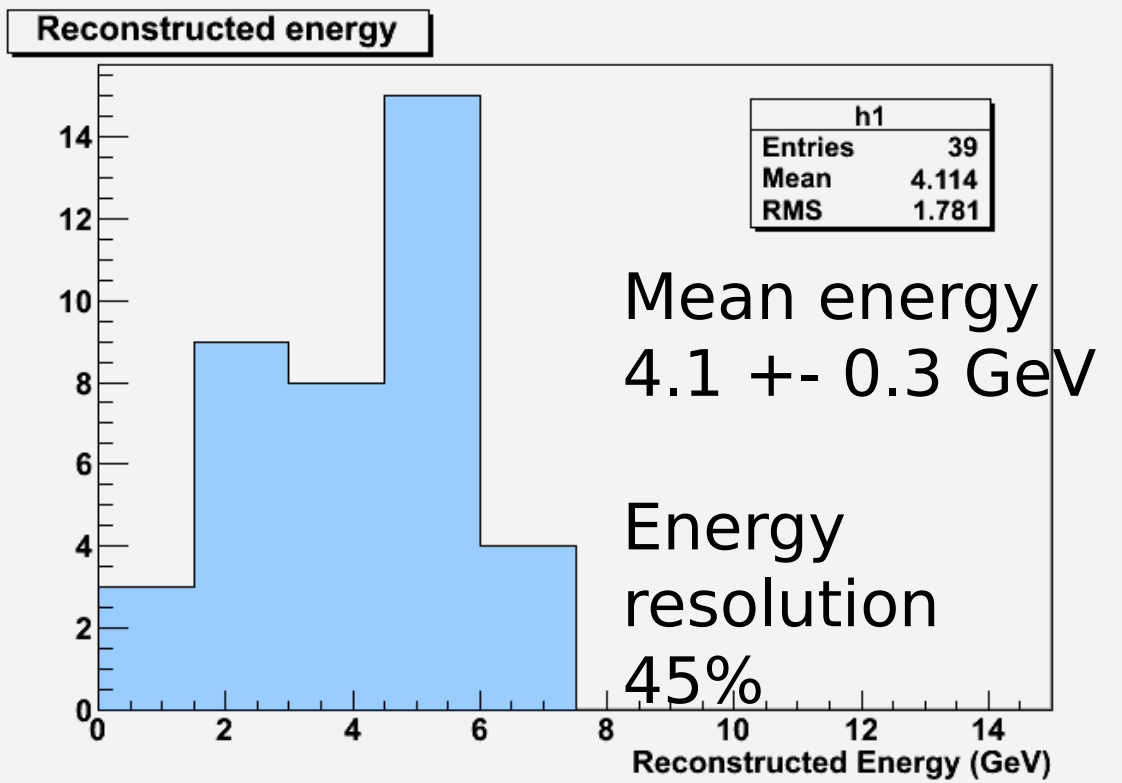
Calibration Data Energy estimation

BT efficiency is parameterized

```
double angle[7] = { 0.0 , 0.1,  0.2 , 0.3 , 0.4 , 0.5 , 0.6 };
double eff[7]   = { 1.00, 0.70, 0.55, 0.46, 0.46, 0.46, 0.46};
```

Energy measured for 39 electrons

removing pions and ambiguous events.



Calibration Data

- Aki selected best showers rejecting all no good « by visual checks »
- He also applied special quality cut and angular cut, he used an efficiency slightly different from those in available in MC

- TO DO : I have to produce a small sample of electron in the same reconstruction conditions as Aki

  → estimate the energy in the MC

  → show to the electron WG I can estimate showers at 4 GeV by selecting the beautiful ones

Outlook

1/ Electron Energy estimation

a/ production of new MC sample for building a new energy tool → 40k remaing events

b/ build a new tool to estimate the energy of showers → Bug to solve then check/tune my function is converging for single shower

c/ Calibration of shower tool with electron data → see Ariga's talk

d/ Data analysis : comparison of my result with the one already produced by scanning labs

Backup slides

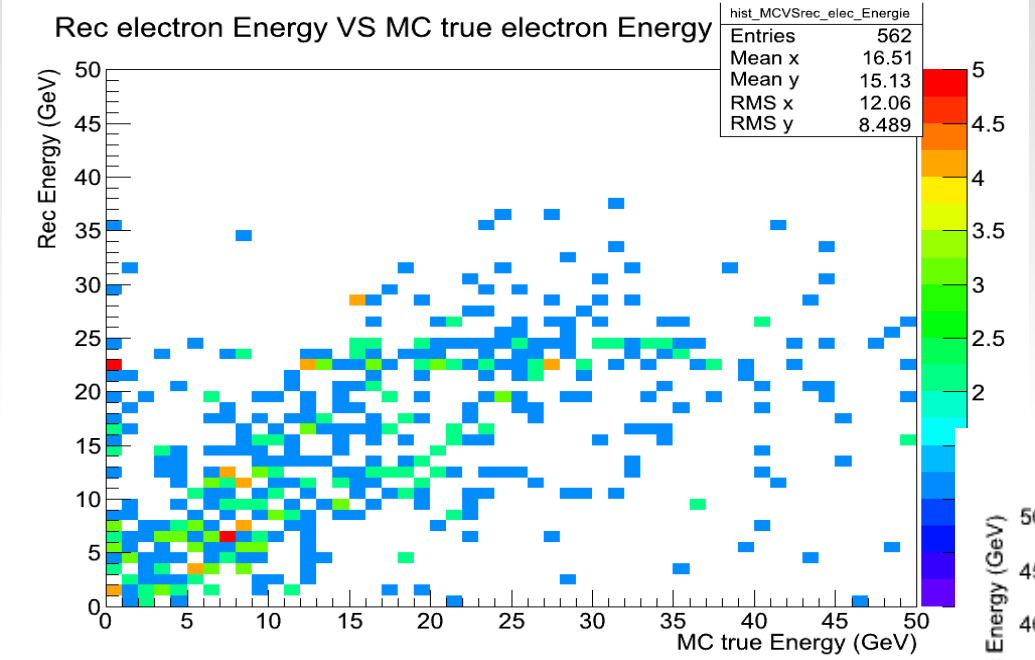
First attempt

- Framework : TMVA::MLP class or other methods (LD)
- MC sample to train & test the new tool : 4 GeV electrons (1k) interacting randomly in the brick with an incoming angle : [-0.5,0.5] rd
- Input variables : BT multiplicity, Plate extension, longitudinal profile (depend on Energy & angle) OR fitted shower model ?

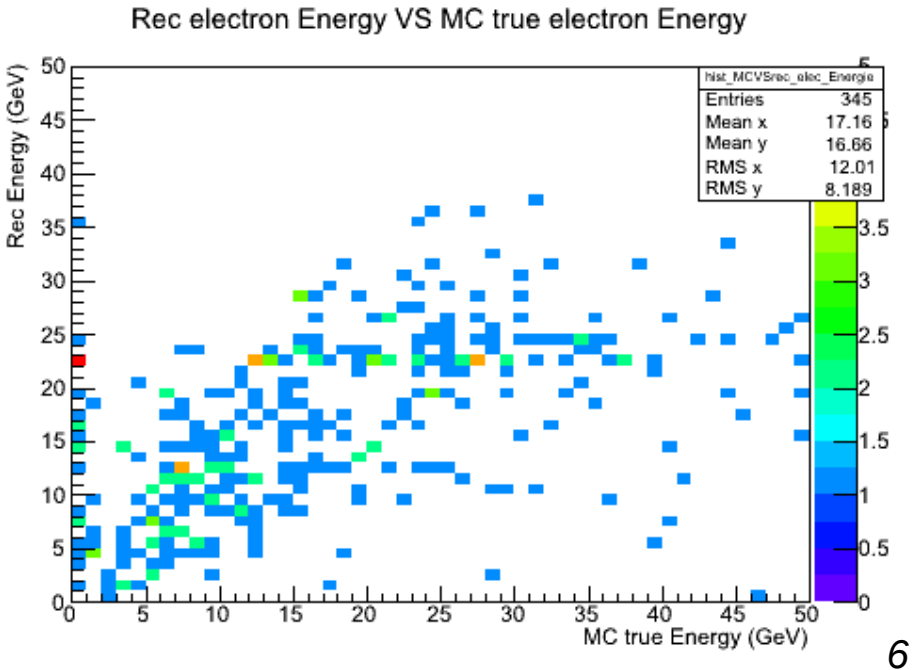
- Since production takes time, in the meantime, I will process in the « first attempt » tool a nue sample to look at how output depends on input variables and reliability of the different methods (ANN, LD).

Energy reconstruction : nue beam

Goal :comparison with a sample containing only 1-brick fully contained showers



FULLY CONTAINED



First attempt : LD results

- Another method : Linear regression
- But non-gaussian shape of the energy distribution → variables ?