# Electromagnetic showers energy estimation

LAPP – Annecy
Florian Brunet
Supervisor : Amina Zghiche

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# Outline

- Last results with Frank shower tool
- First results with my new shower tool
- A new MC production
- Efficiency calculation in numu-nue analysis

# MC Sample - OpRelease 4.0

**Sample of 1000 nue beam produced by Elisabetta**
**Sample of 1000 monochromatic electron produced by FB**
**MC samples without background**

- Processed through OpEmuIO
- Processed through OpEmuRec packages : CS, Scanback, Link, Alignment, Track & Shower by using all plates available in the brick
- All packages up to OpEmuRec Track are taken from the release $GROUP_DIR/soft/OpRelease4.0_emulsion_march2011/
- OpEmuRec Shower is released here : /sps/opera/scratch/flbrunet/analysis/OpRelease_2011-04-04_OKwithShower/4.0/OpEmuRec/

**FEDRA RELEASE (1210)**
**OPEMUREC(v3)/OPRELEASE(4.0)**

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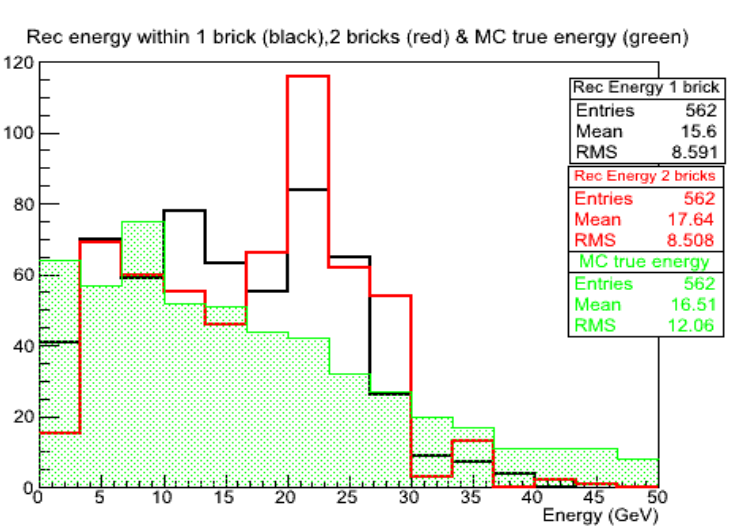
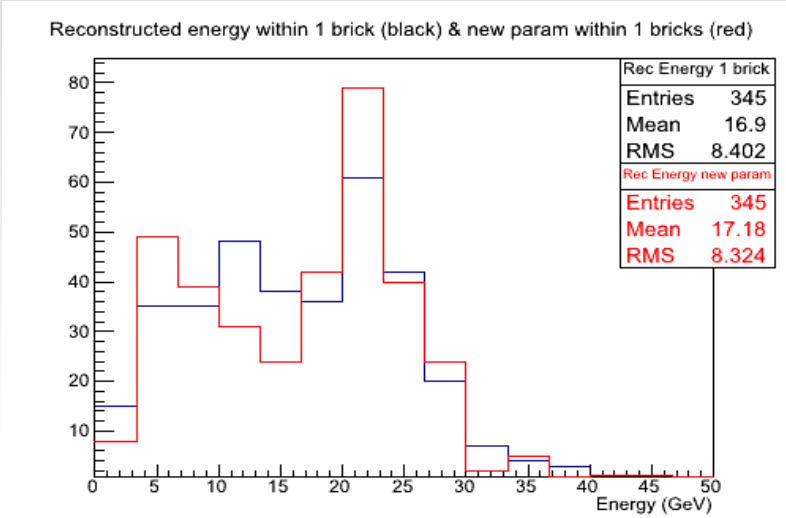
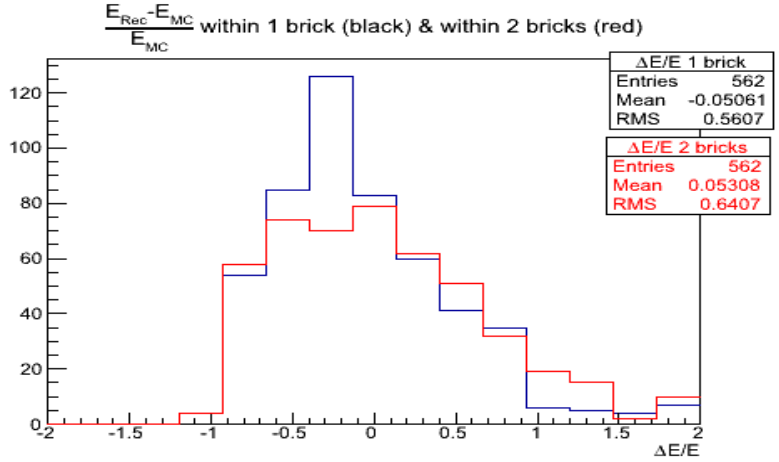
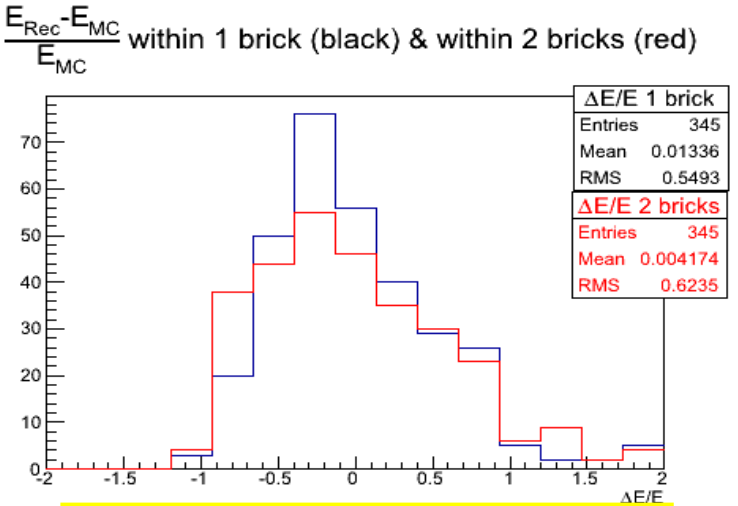
# Energy reconstruction : nue beam

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




**FULLY CONTAINED**

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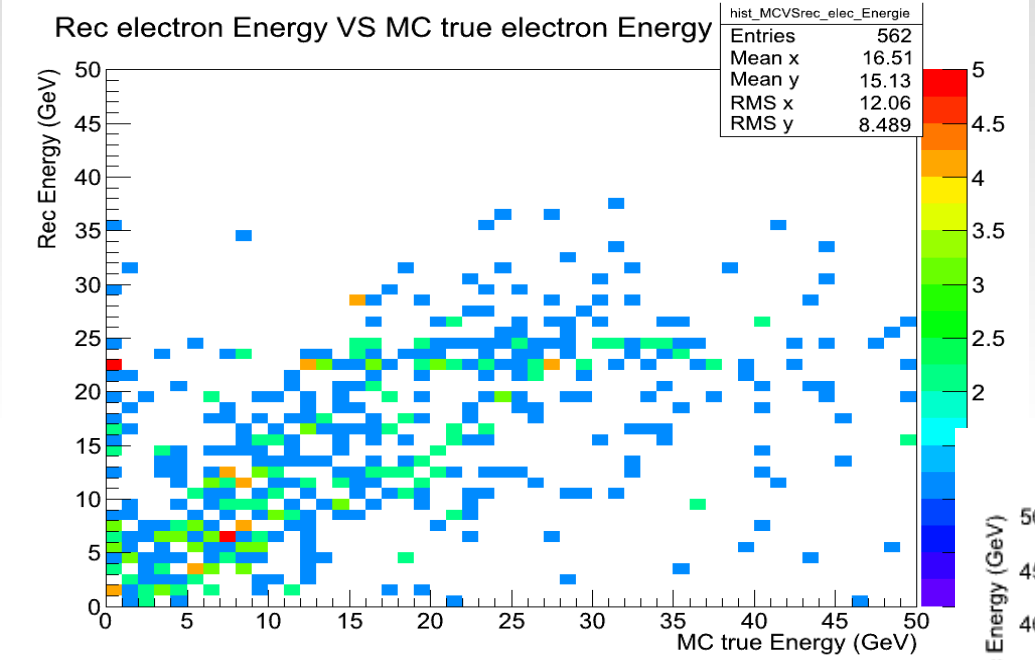
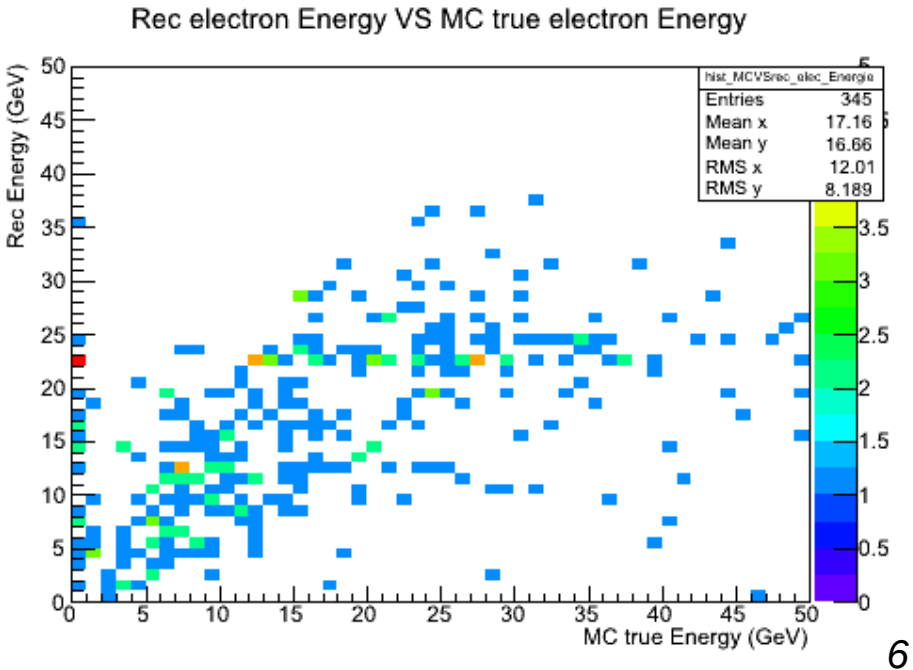



**FULLY CONTAINED**



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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 stabilise the output of the energy estimation unsuccessfully

- It has been decided to build a new tool to estimate the energy
- A new tool is being built : a first test a low statistics and discrete energy works & some ideas came up in the EWG
- Need a large statistics sample : new MC production

- In the meantime Frank try to understand the differences between his tool and mine

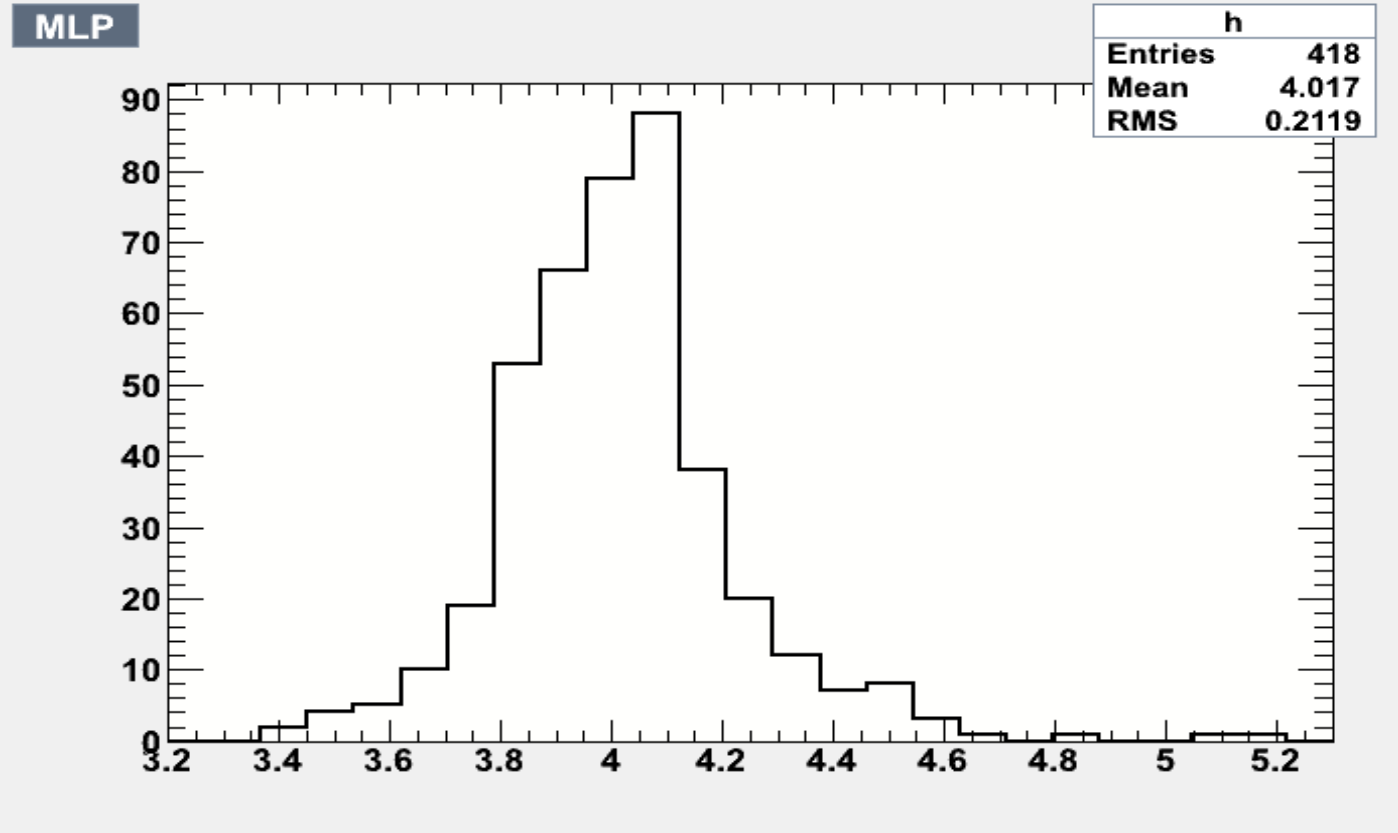
# First attempt

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

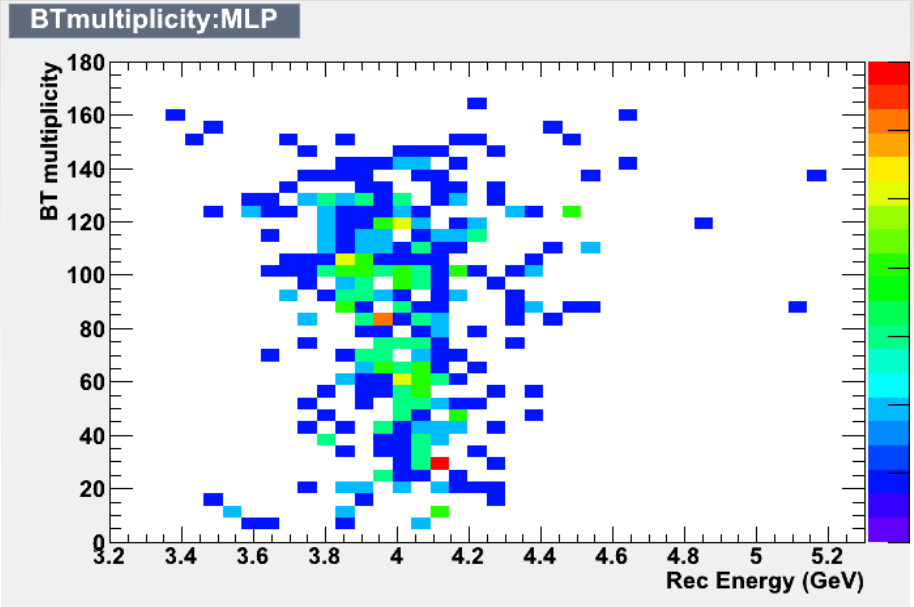
- Framework of the NN : TMVA : MLP class
- MC sample to train & test the new NN : OpRelease 4 (Geant 3, OpEmuIO, OpEmuRec) → sample 4 GeV electron interacting randomly in the brick (incoming angle : [-0.5,0.5] rd
- MC sample statistics : 1k (NN check)
- Input variables : BT multiplicity, Plate extension, longitudinal profile (10 plates → coupling bins by 2 = 5 variables)

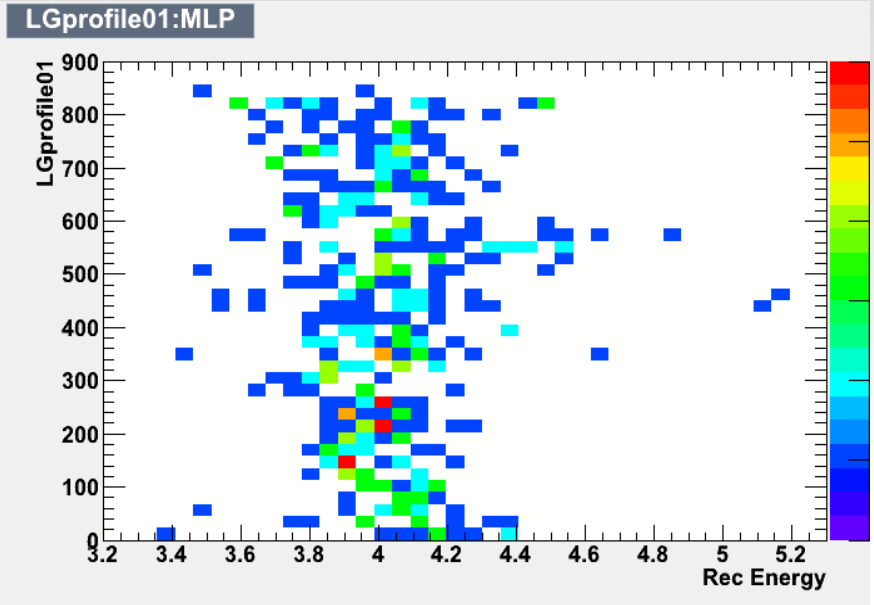
# First attempt : MLP results

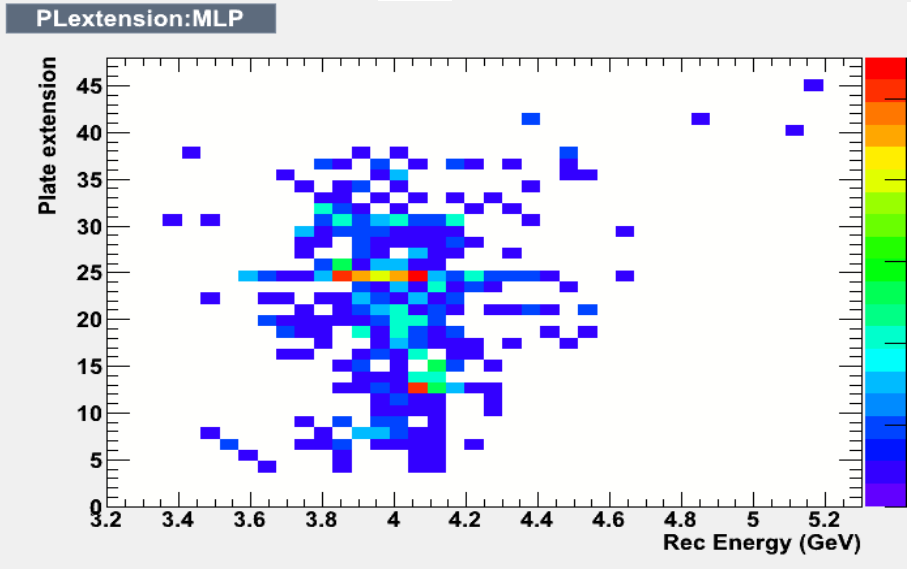
- With the MLP class, the energy reconstructed on the test sample is good.
- But non-gaussian shape of the energy distribution → variables ?



# First attempt : MLP results

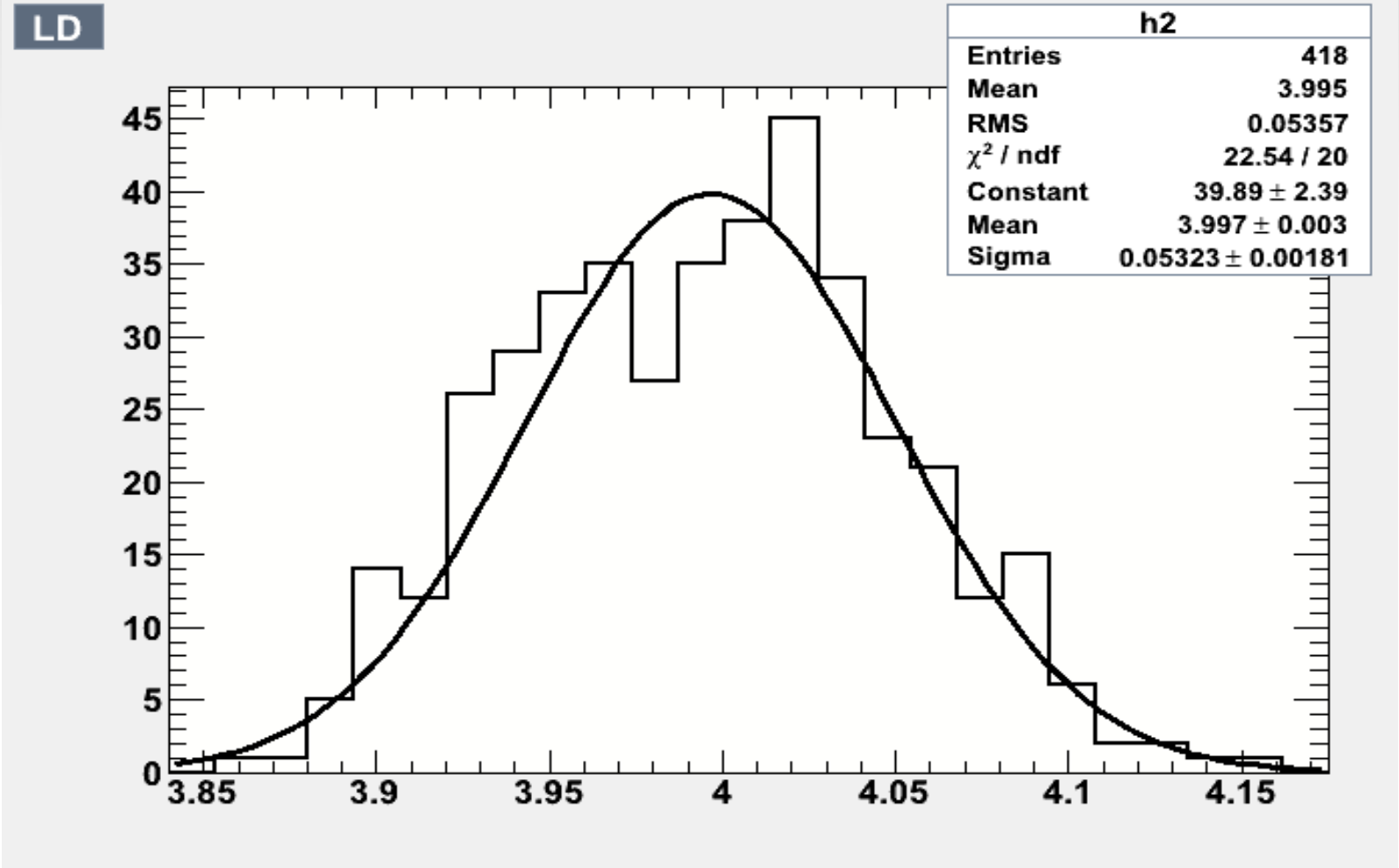


# First attempt : LD results

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



# Prospects

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

- Framework of the NN : TMVA → MLP class or other methods (LD)
-
- MC sample to train & test the new NN : OpRelease 4 (Geant 3, OpEmuIO, OpEmuRec)

- MC sample statistics : 1k → 10k (NN more checks) then 50k (CCAGE needed) using fully contained in one brick showers ?

- Input variables : BT multiplicity, Plate extension, longitudinal profile (depend on Energy & angle) (as described in the 1st attempt) OR fitted shower model

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# 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

- Before Christmas vacation, I asked for a restricted batch queue in ccage with larger amount of memory available (8Gb) & an extended disk space to store MC production (5Tb)
- Elisabetta has provided a restricted queue for me (16Gb) and a folder in the official production space to store the MC production (new space available in ccage 9Tb)
- Production started on Tuesday (17th january) → 10k electrons OpEmuIO step done
  - I had to split the 10k events into 2 subsamples of 5k because of OpDigit (new problem?)

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Aki

# Toward paper

MC studies

Efficiency calculation

- location efficiency
- electron ID

Signal/Noise estimation

kinematical cuts

- electron energy reconstruction
- neutrino energy reconstruction

Data: nue candidates with all valuables

Shower reco volume, primary track info, TT info

Physics messages and plots.

# Final Efficiency calculation

```
-----------------------------------------------------------
|| Total || OpCarac | Brick finding | CS | Scanback | Vertex ||
-----------------------------------------------------------
||1.00000||0.7720000|0.5210000000000|0.50|0.44100000|0.340000||
-----------------------------------------------------------
```

| | OpCarac | BF | CS | SB (pl<55&5plvtx) | VTX(at least 2trks,pl<55) |
|---|---|---|---|---|---|
| ***NueOsc**** | **0.856±0.038** | **0.541±0.035** | **0.523±0.035** | **0.438±0.031** | **0.403±0.030** |

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Code developments :

- A modified OpNtpWriter to include Shower information (using STL std::vector)
- A code to compute efficiency from outputs of modOpNtpWriter on all channels (nue oscillated, nue beam, nueQE, numuNC, tau → e, tau → e QE)

- Next step is to implement CS electron trigger and estimate its efficiency

# Outlook

1/ Electron Energy estimation

a/ production of new MC sample

b/ build a new tool to estimate the energy of showers

c/ Calibration of shower tool with electron data

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

2/ numu → nue analysis : final efficiency calculation (including kinematical selection once the new shower tool will be ready)

# Backup slides