Analog vs Digital Energy Measurement in the ECAL

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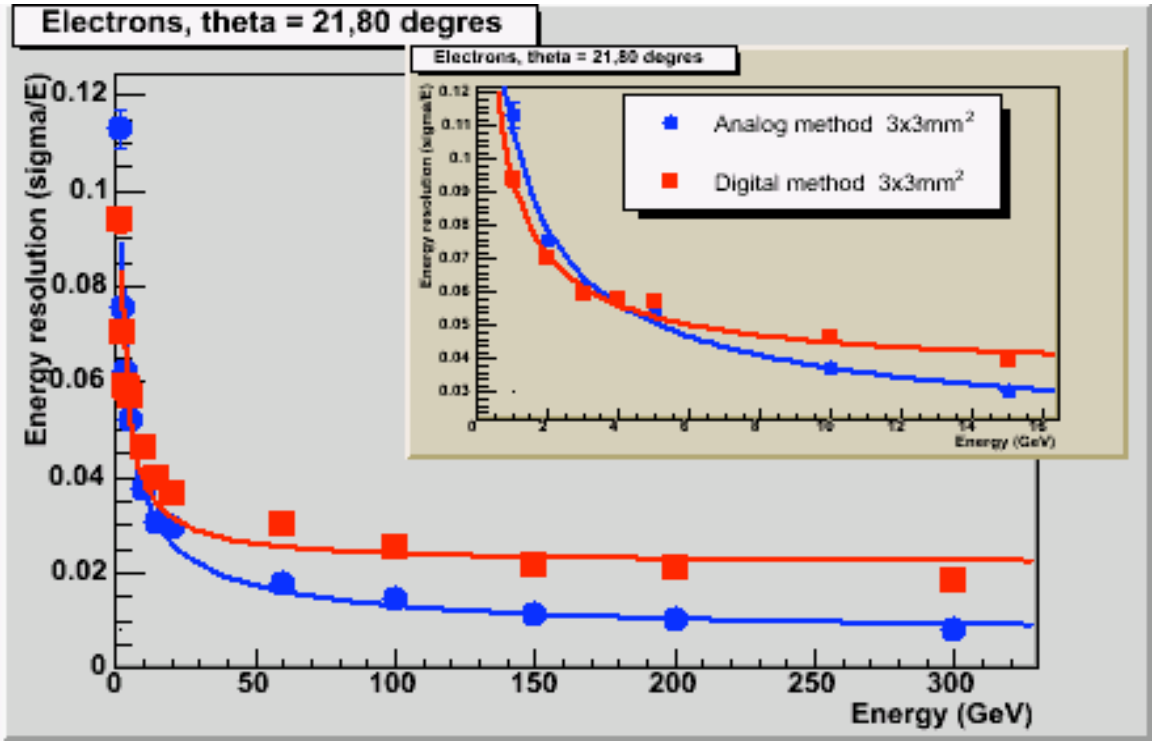
Casablanca, Morocco, September 22 - 24, 2010

Motivations



M. Krim, D. Benchekroun, J.Y. Hostachy, L. Morin
LC-DET-2007-004

Simulations with 3x3 mm^2 detection pads
Simulations with 10x10 mm^2 detection pads

Analog and Digital Energy reconstruction

- Data :

$$\mathrm{DESY}: 1 \rightarrow 6\,\mathrm{GeV} + \mathrm{CERN}\,(2006): 6 \rightarrow 45\,\mathrm{GeV}$$

- Energy reconstruction :

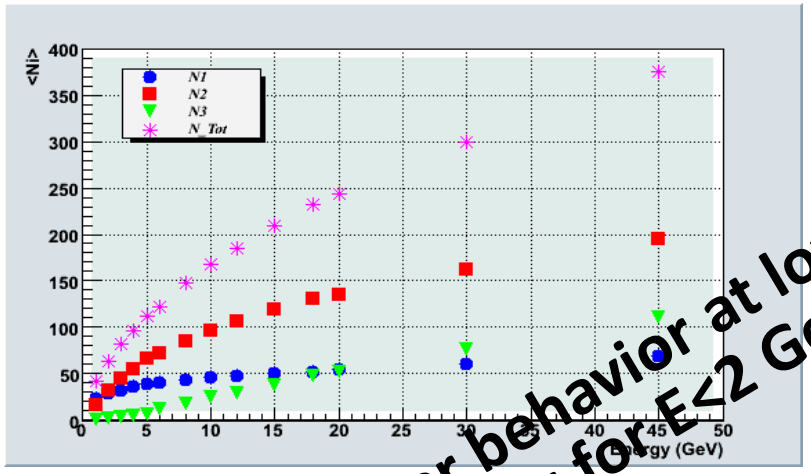
$$E_{ana} = \alpha\left(E_1 + 2E_2 + 3E_3\right) \qquad (1)$$

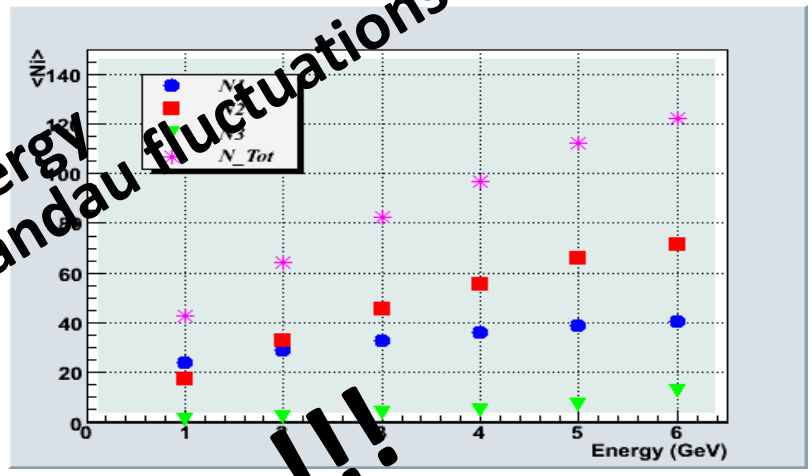
$$E_{dig} = \alpha'\left(\beta_1 N_1 + \beta_2 N_2 + \beta_3 N_3\right) \qquad (2)$$

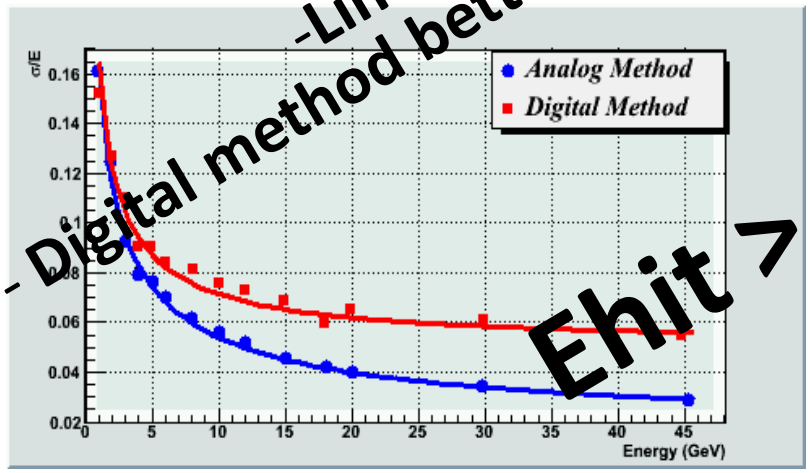
N_i : Number of hits in the compartment i (i=1,2,3)

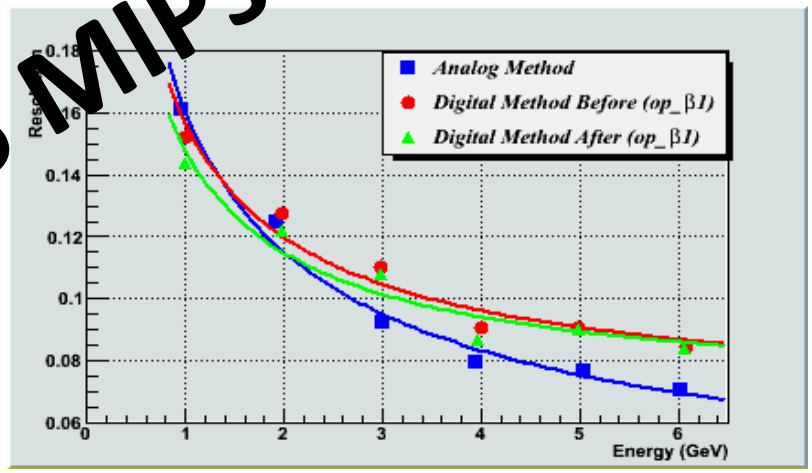
Applied cuts : Cuts on X_b , Y_b , Z_b , σ_x , σ_y and σ_z

Existing reconstructed data
E_{hit} > 0.5 MIPs









-Linear behavior at low energy

- Digital method better for E<2 GeV : Landau fluctuations

Ehit > 0.5 MIPs !!!

New REC DATA without threshold

Initializing the threshold : CALICE RAW2CALOHIT package

```
// ...
    _signalThreshold = 0.;
// …
```

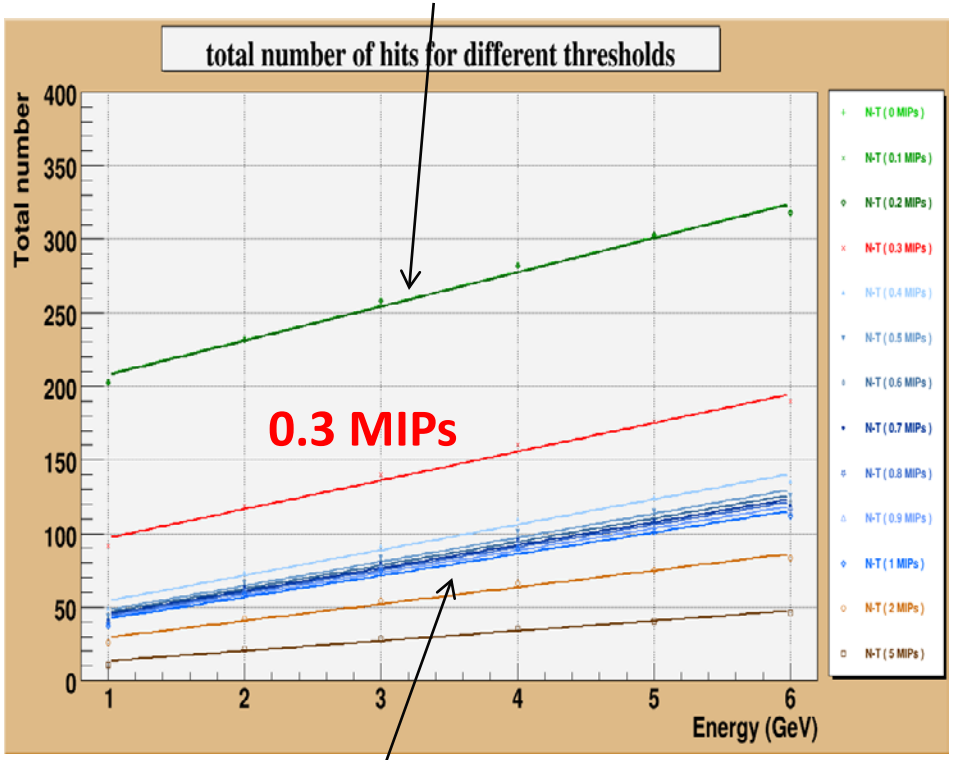
- **New Rec Data** : The localization of the output is the following :

1 GeV : /grid/calice/users/khoulaki/tb-desy/My_REC_without_threshold/ Run230098_rec_kh.000.slcio
2 GeV : /grid/calice/users/khoulaki/tb-desy/My_REC_without_threshold/ Run230099_rec_kh.000.slcio
3 GeV : /grid/calice/users/khoulaki/tb-desy/My_REC_without_threshold/ Run230100_rec_kh.000.slcio
4 GeV : /grid/calice/users/khoulaki/tb-desy/My_REC_without_threshold/ Run230101_rec_kh.000.slcio
5 GeV : /grid/calice/users/khoulaki/tb-desy/My_REC_without_threshold/ Run230104_rec_kh.000.slcio
6 GeV : /grid/calice/users/khoulaki/tb-desy/My_REC_without_threshold/ Run230248_rec_kh.000.slcio

→ Thresholds and defined by hand during the analysis

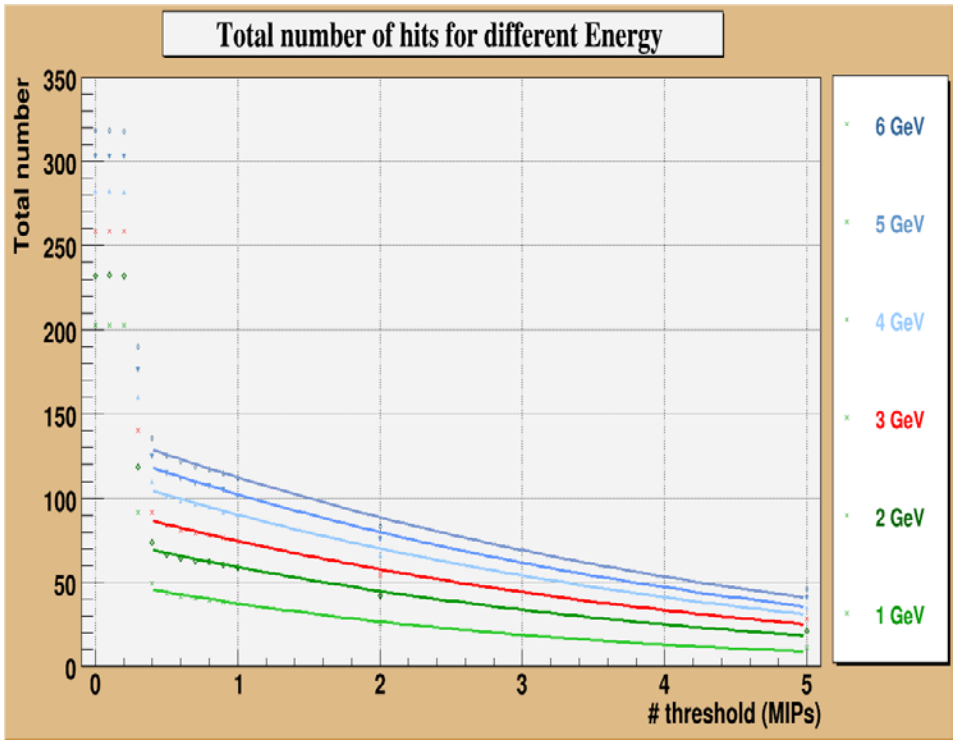
Linearity for different thresholds

0 MIPs ≤ E_{hit} ≤0.2 MIPs

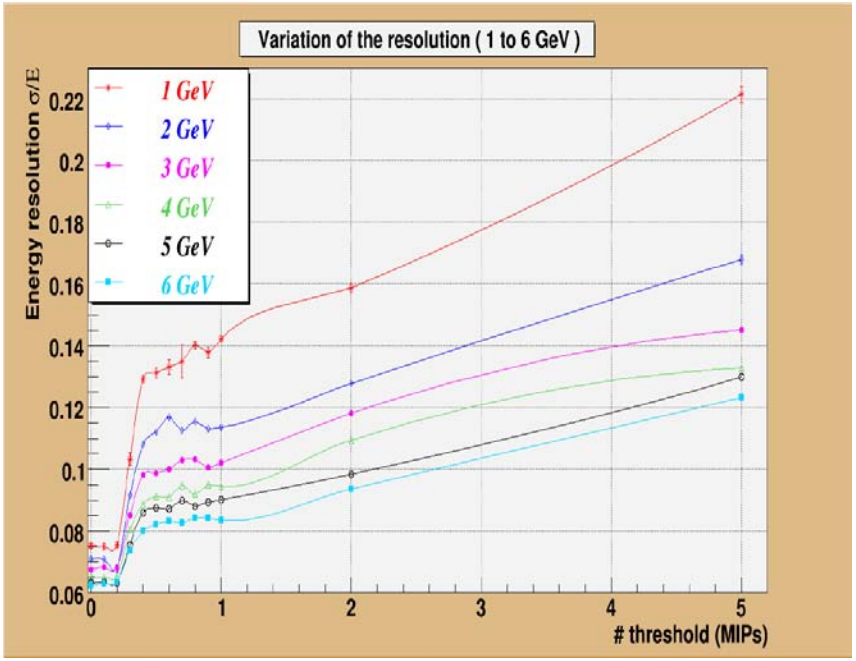


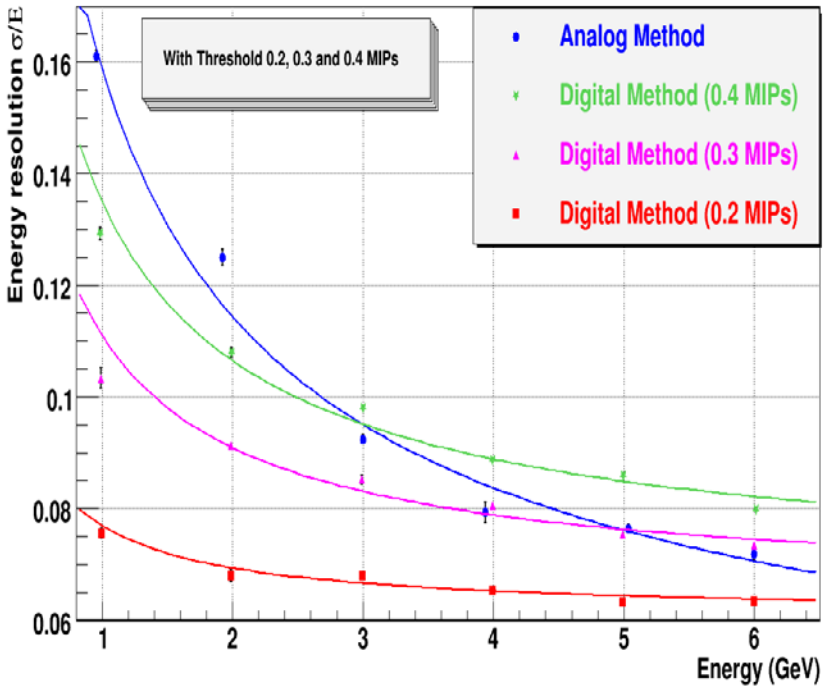
0.3 MIPs

0.4 to 1 MIPs



Resolution for different thresholds

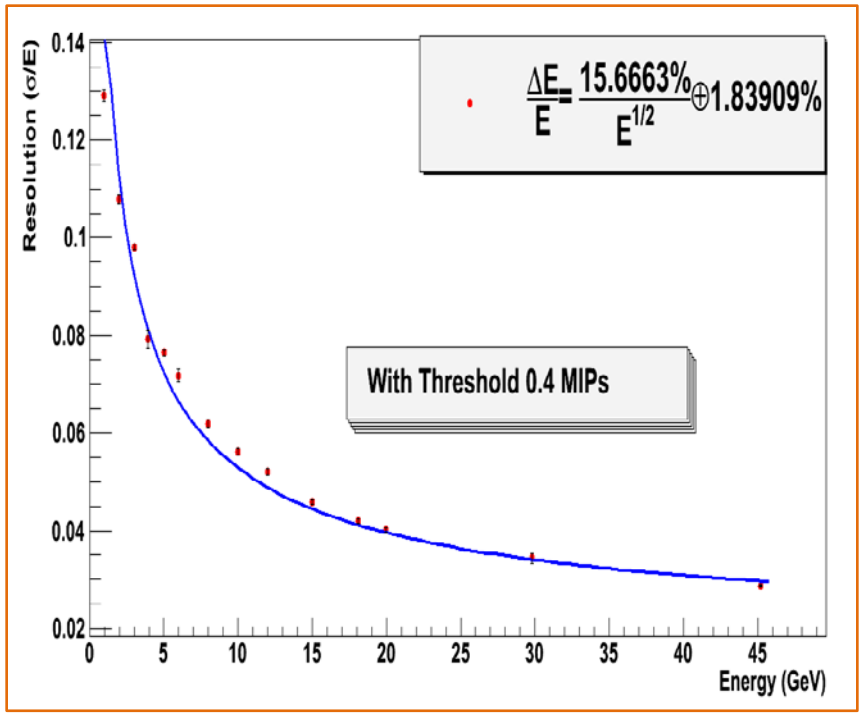


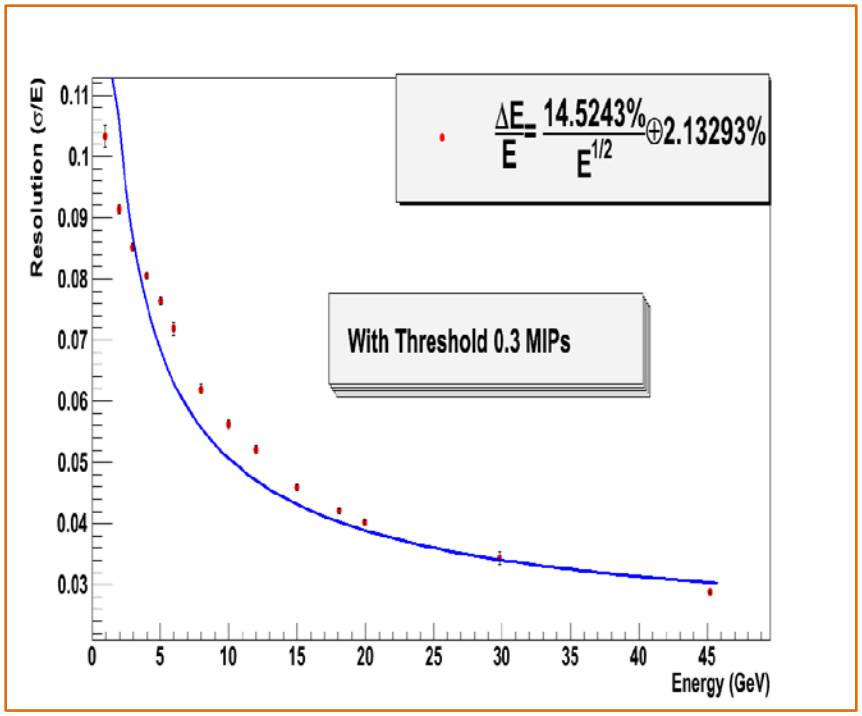


- Same behavior for all energies
- Better resolution around 0.2 – 0.3 GeV

E_{hit} > 0.3 MIPs : E < 5 GeV

E_{hit} > 0.4 MIPs : E < 3 GeV



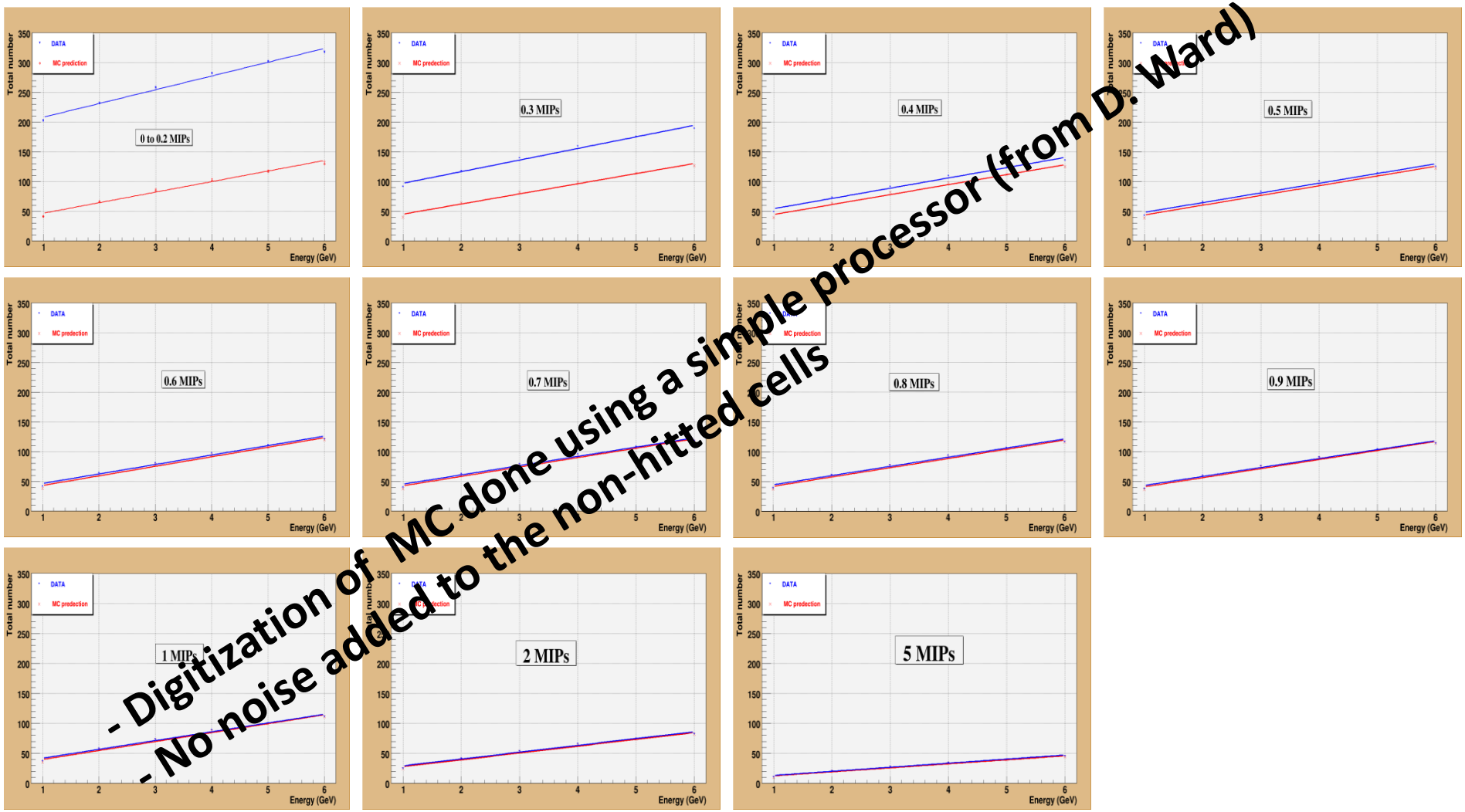


- $E < E_{cross}$: resolution taken from digital
- $E > E_{cross}$: resolution taken from analog

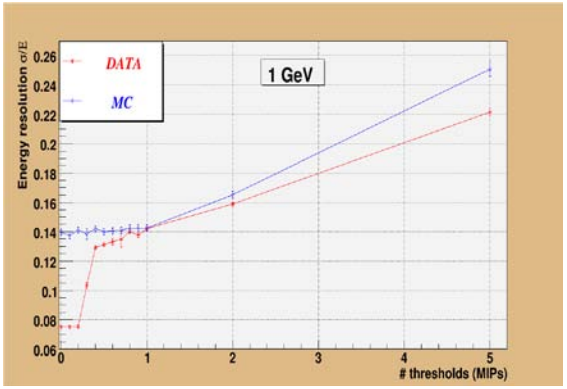
$$\frac{\sigma(E)}{E} = \frac{a}{\sqrt{E}} \oplus c$$

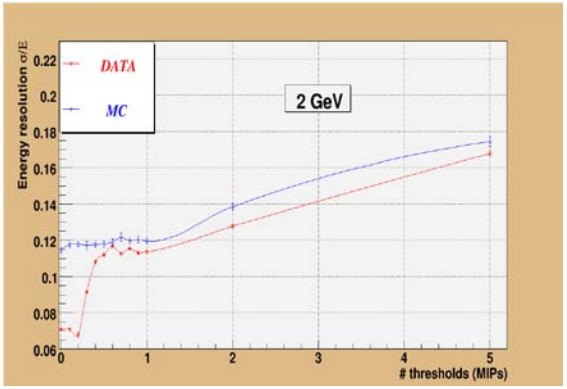
Method	a(%)	C(%)
Analog	16.3078	1.61853
Analog + Digital (0.4 MIPs)	15.6663	1.83909

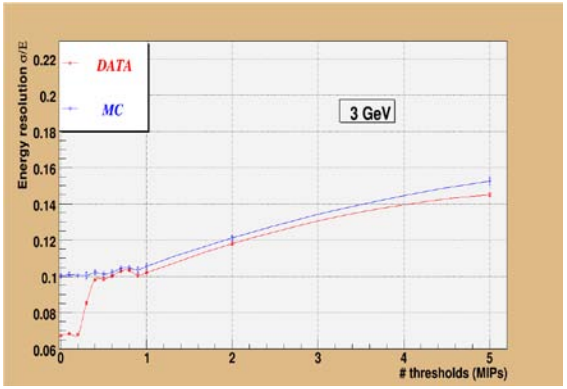
Data – MC Comparison



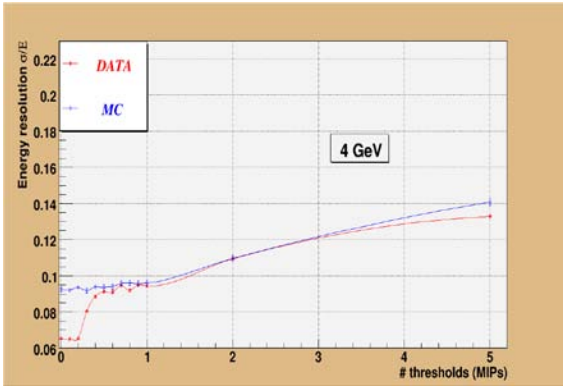
Resolution : Comparison between the DESY data and the MC prediction

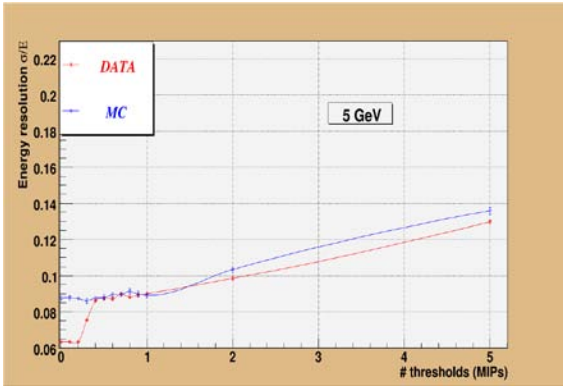


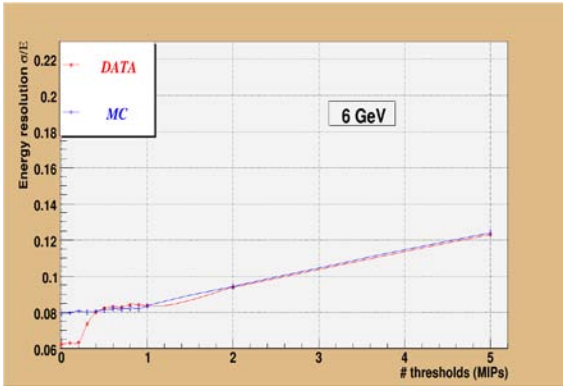




- Same behavior with threshold > 0.4 MIPs
- Data and MC prediction have similar distributions for E ≥ 3 GeV







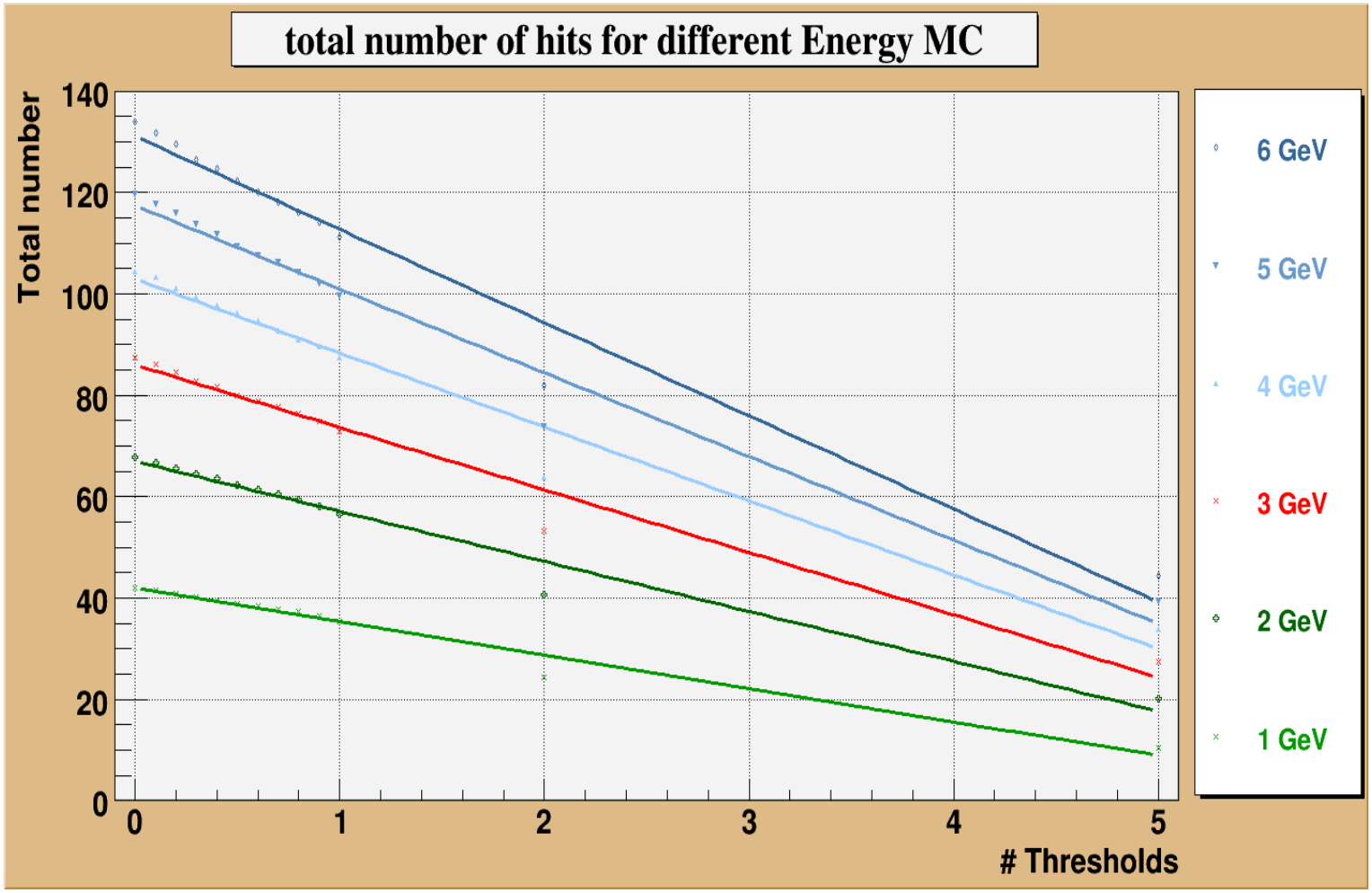
Conclusion and Perspectives

- Digital method can give better resolution using lower thresholds (0.3 -0.4 MIPs)
- Results to be confirmed by MC simulations

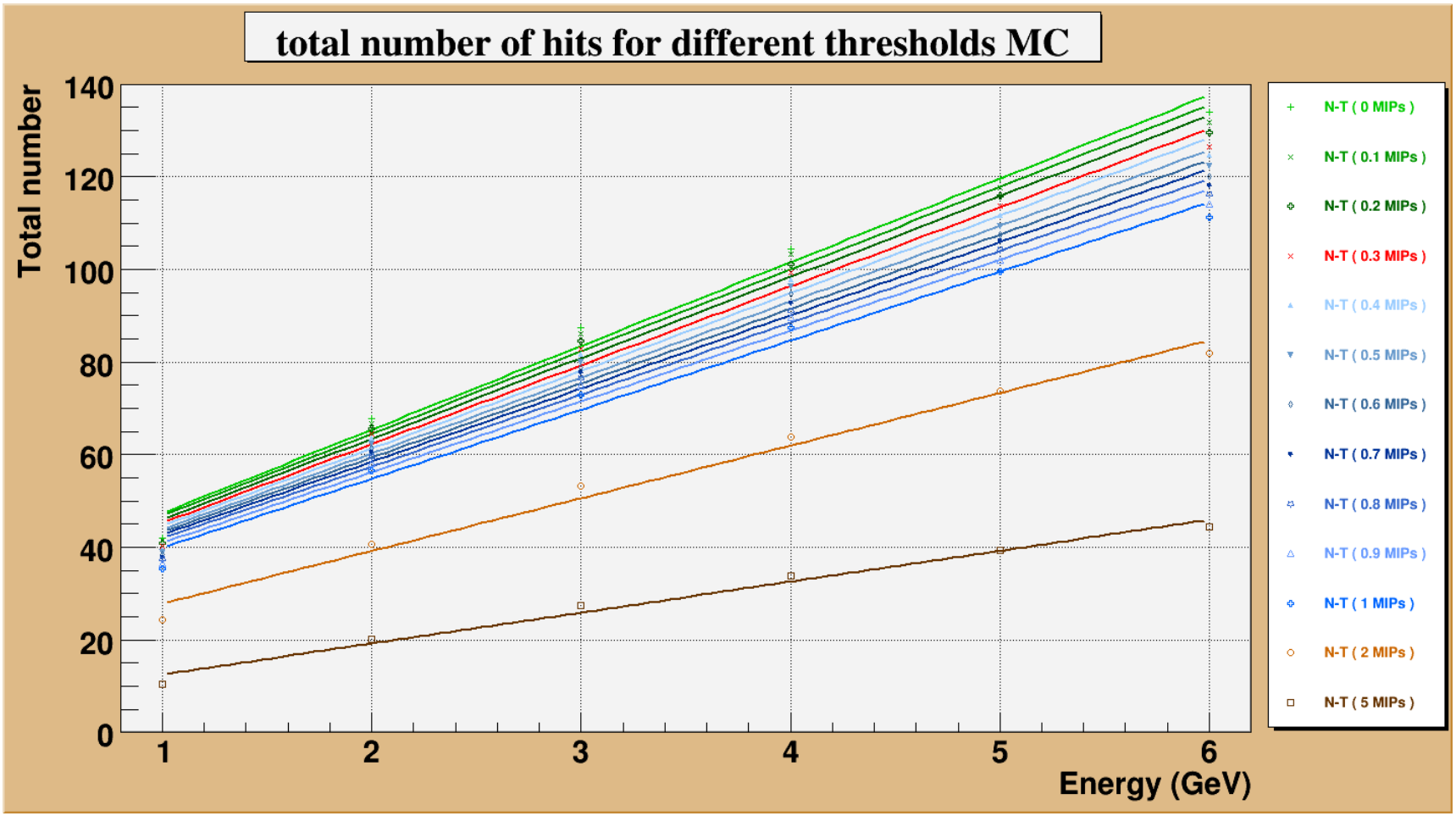
  (for the E_{hit} > 0.4 MIPs)
- Next steps :
  - ✓ digitization MC
  - ✓ Simulations for 5x5 mm^2 detection pads

BACKUP SLIDES

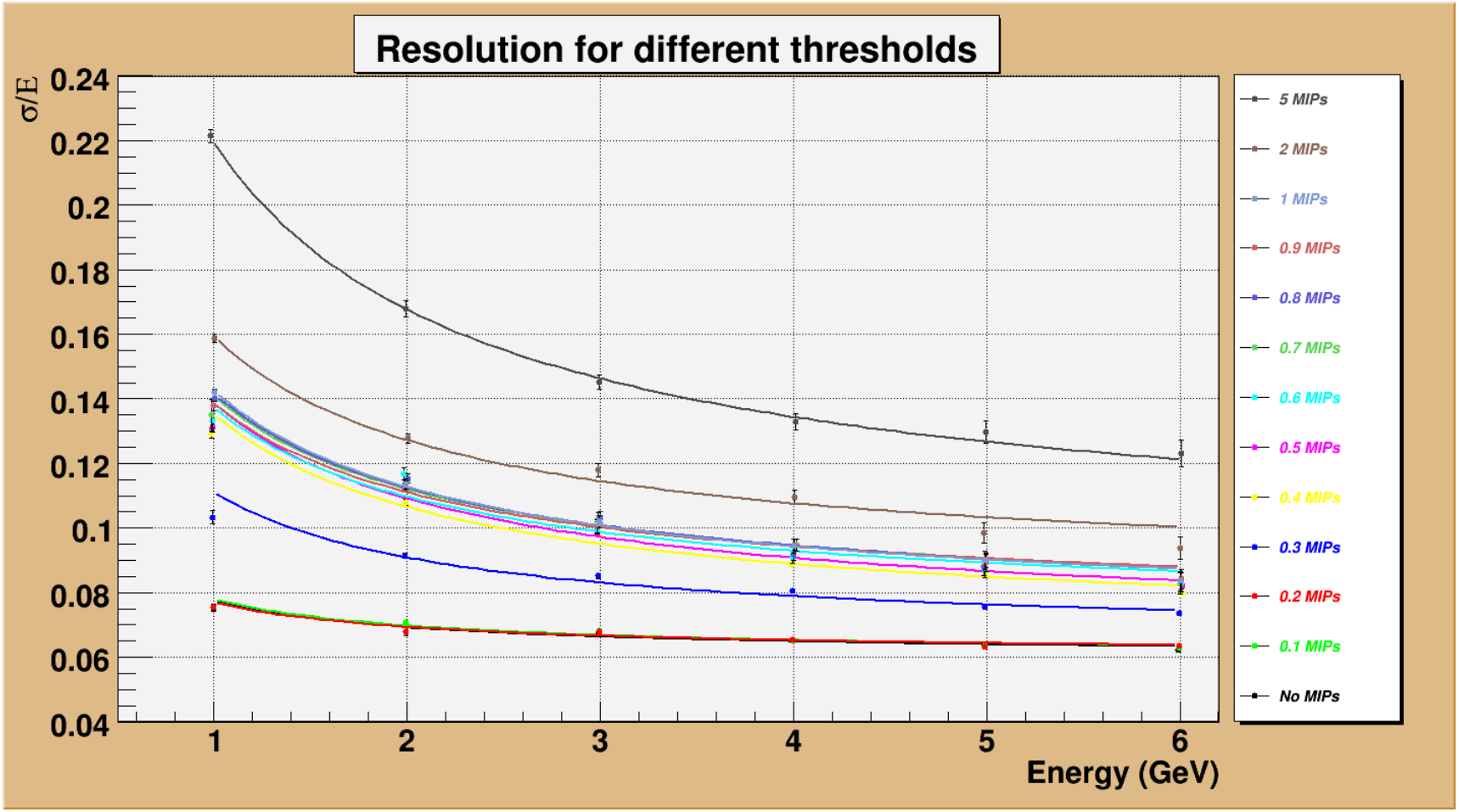
Total Number of hits for different Energies (MC Predictions)



Total Number of hits for different thresholds (MC Predictions)



Resolution for different thresholds (DESY DATA)



Resolution for different thresholds (MC Predictions)