# Analysis highlights from Argonne meeting

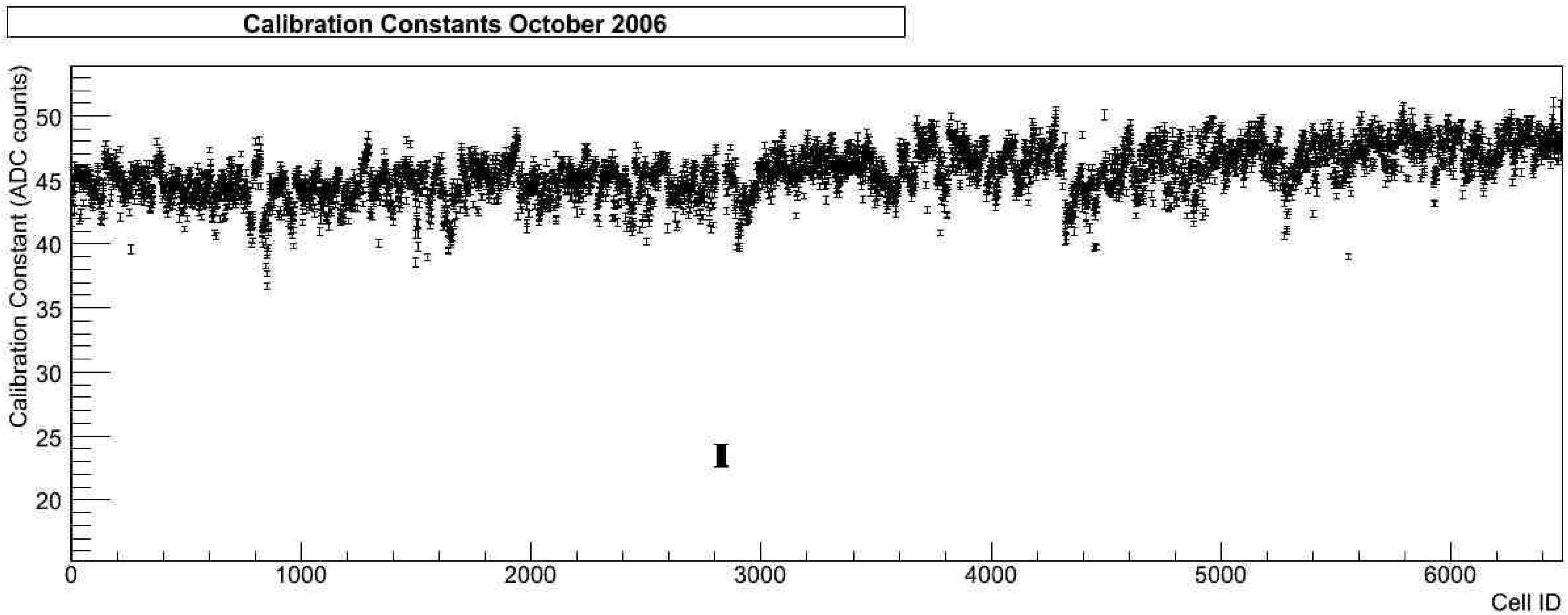
- Entirely plagiarised from other people's talks:
  - Marcel Reinhard – calibration issues
  - Djamel Boumediene – ECAL alignment
  - Cristina Cârloganu – ECAL paper – resolution, linearity
  - Georgios Mavromanolakis – transverse shower shape
  - Valeria Bartsch – longitudinal shower profile
  - Nicola d'Ascenso – muons in AHCAL
  - Erika Garutti – electrons and pions in AHCAL
  - Beni Lutz – leakage from AHCAL
  - Plans

# Marcel

ECAL Calibration issues

# Some issues: Focus on calibration studies

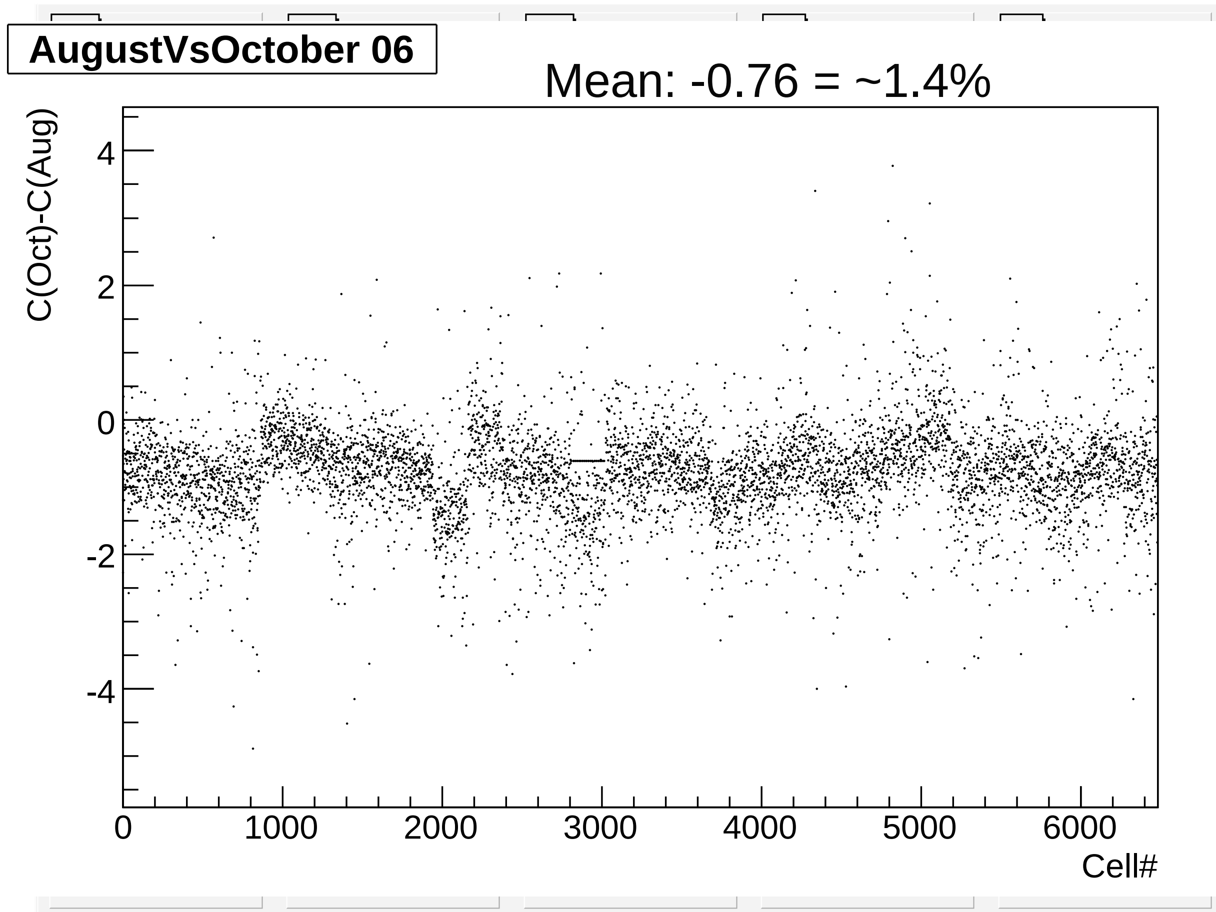
Currently in database: 1 set of constants obtained with muon runs from october 2006 CERN period




Now additionally: constants for 3 other periods (August 2006, July 2007 (0 deg), August 2007 (20 deg)

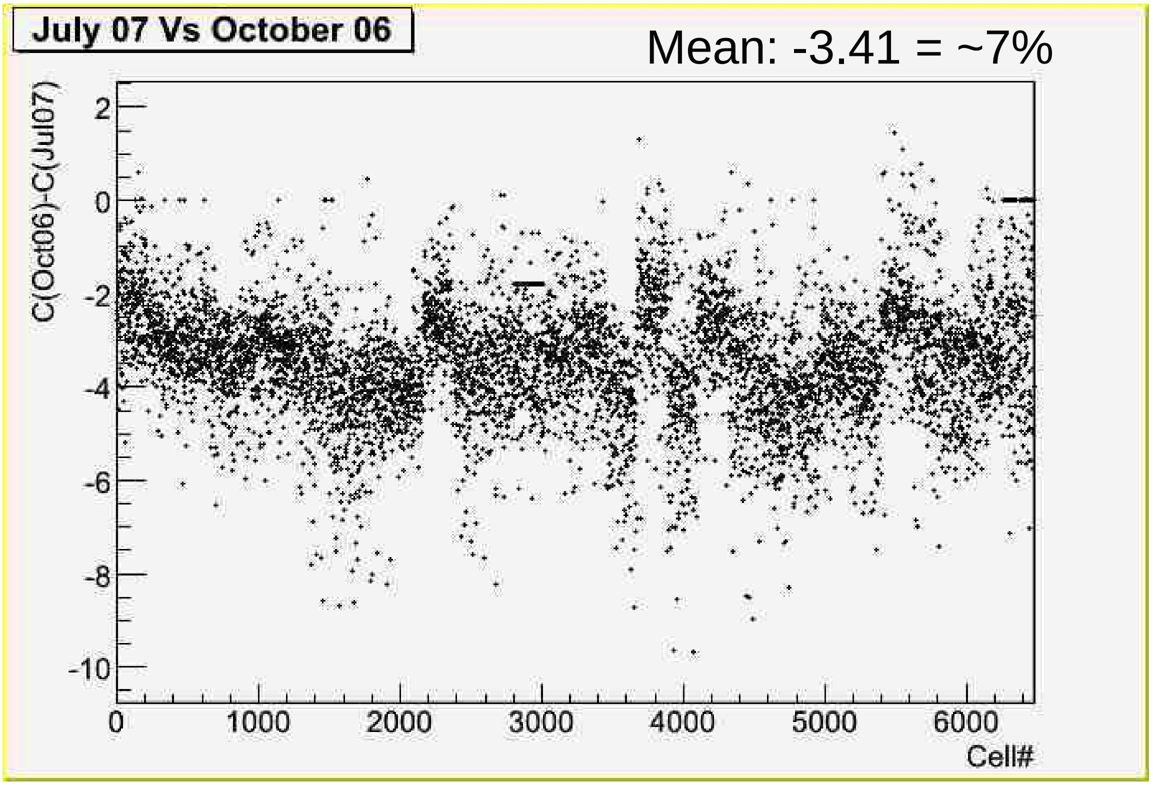
# August 2006

- Dead cell map looks good
- Significant systematic shift of calibration values



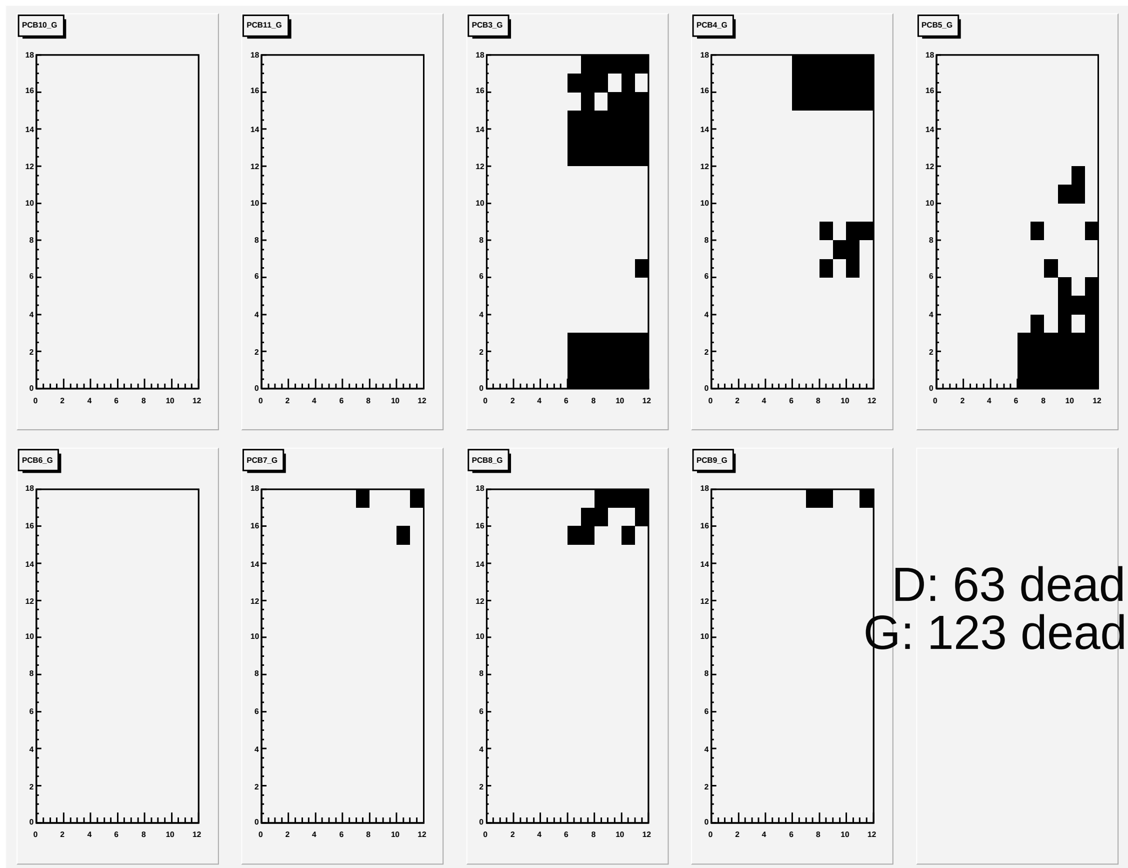
# July 2007 (0 deg): central slabs

- Dead map looks ok, readout problem of last layer, 44 dead
- Confirms data quality checks in Prague
- Significant systematic shift of calibration values
- Few slabs with less effect: influence of old patch panel ?



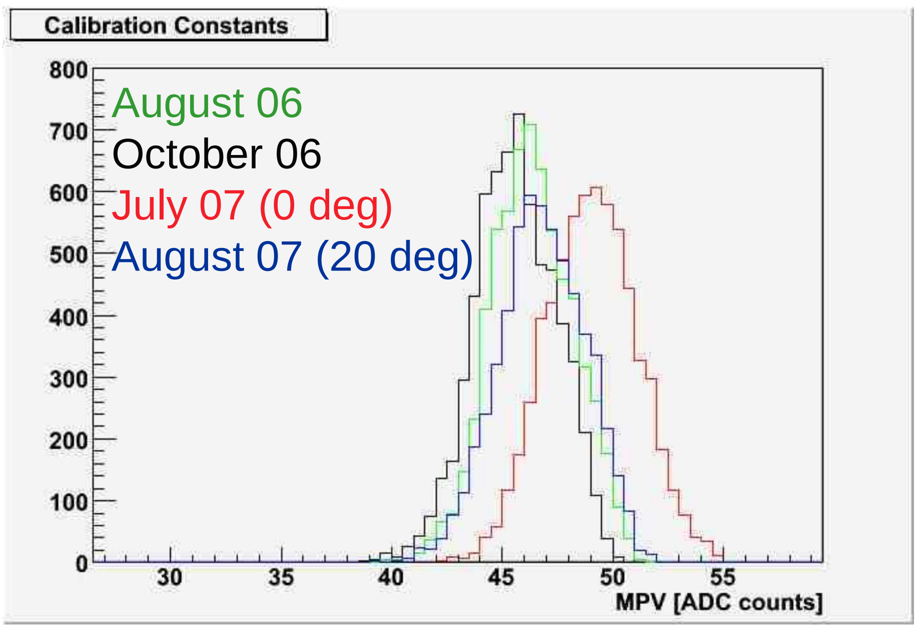
# July 2007 (0 deg): bottom slabs

- Quite some dead cells, even entire chips
- Confirms data quality checks in Prague



# Calibration Constants overview central slabs

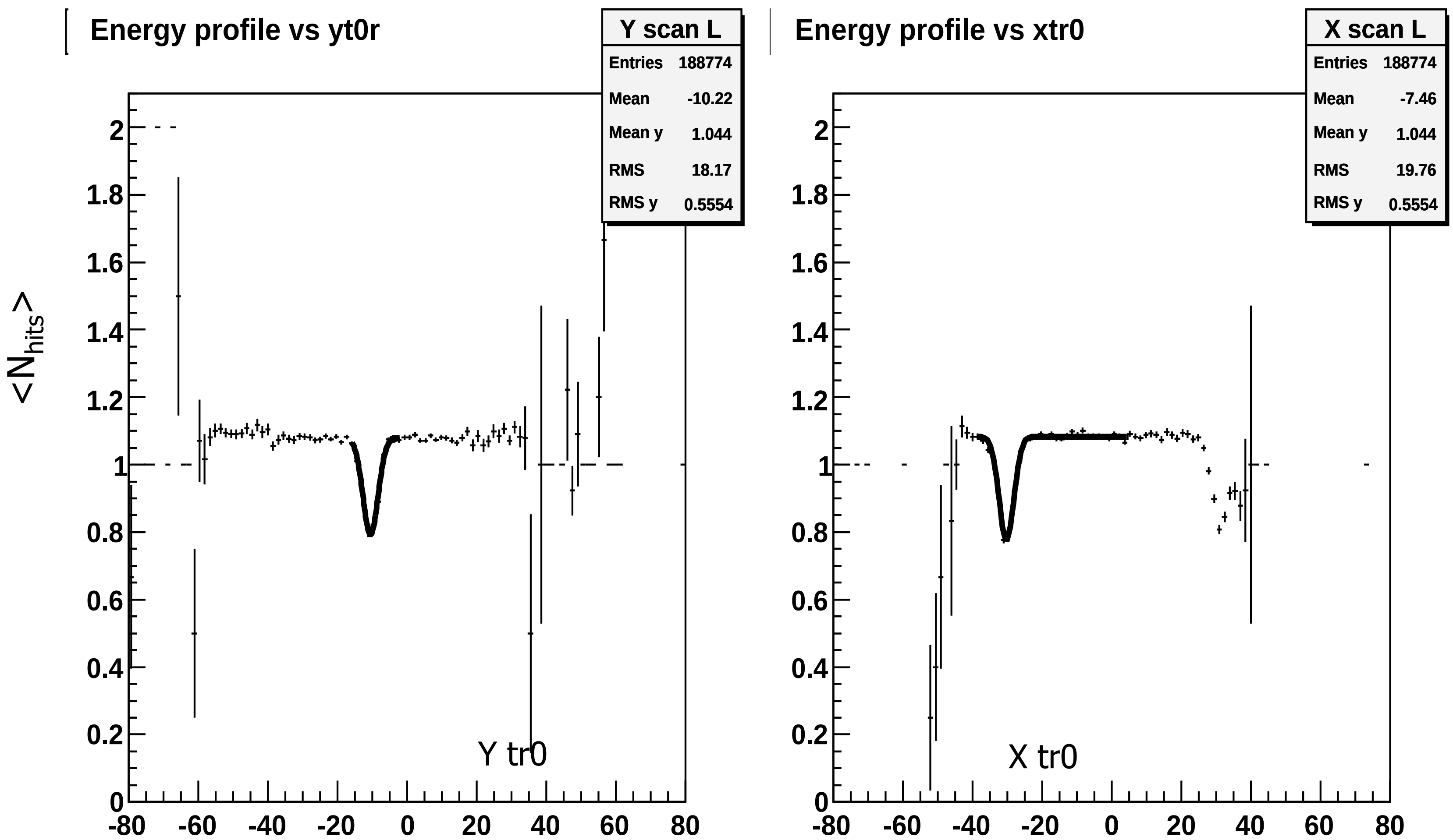
- Significant shifts between all periods – why? Not seen in e- runs
- Si diodes known to be stable regarding temperature, operated on saturation plateau at 200V
- 2 (?) possibilities
  - 1st: Hold Value/Trigger issues (same setup in Jul/Aug 07 ! )
  - 2nd: stability of on-board electronics (gain variation with Temp and Voltage)



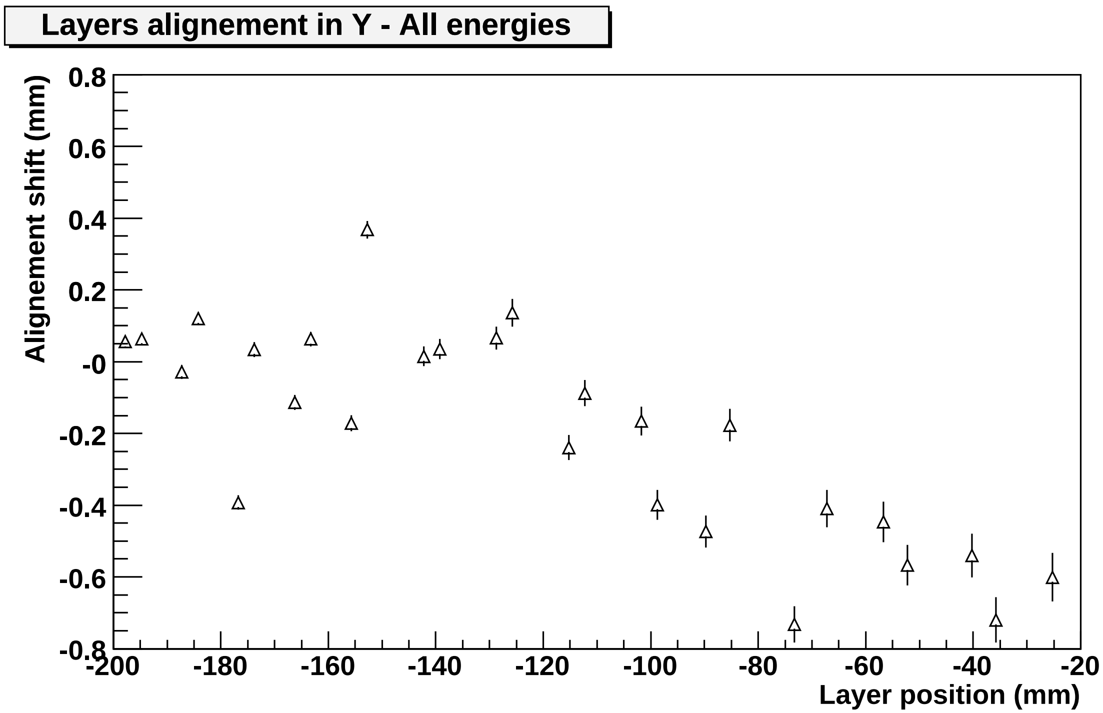
# Djamel

Alignment in ECAL

# Nb hits vs. track position (π/μ)



# Mean *y* positions from 2006 π data




Précision better than

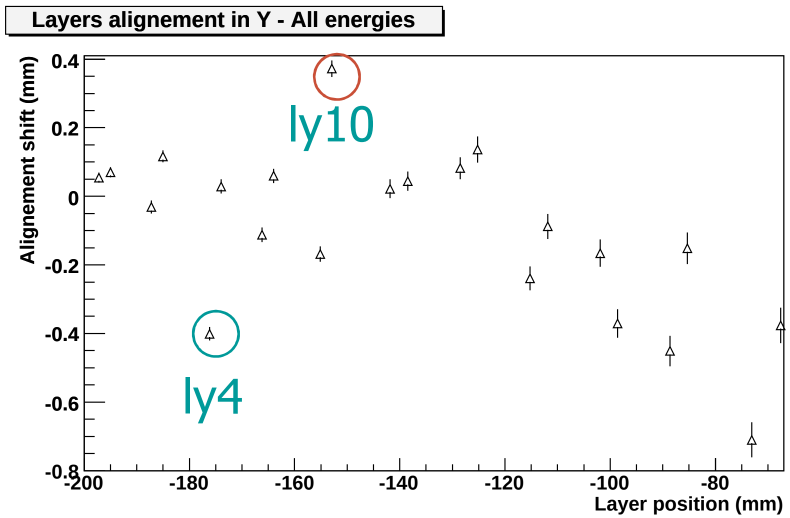
30 μm in first stack

50 μm in second stack

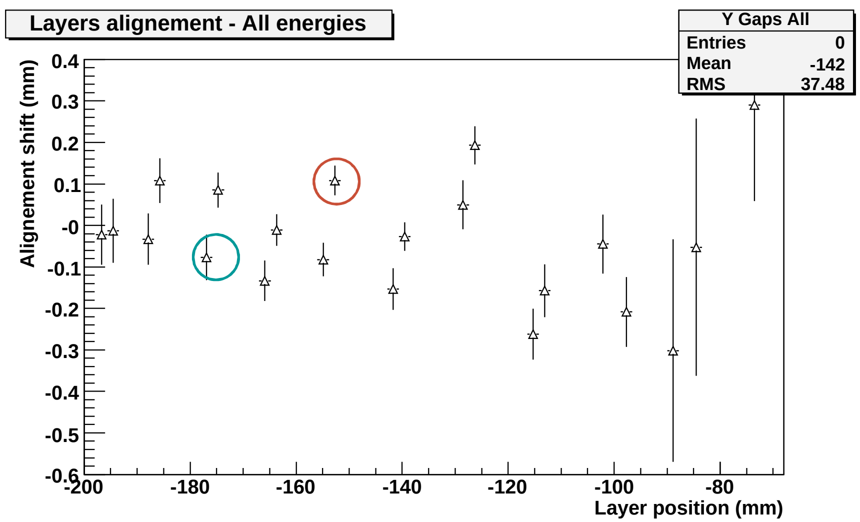
80 μm in third stack

# Mean $y$ positions over different 2006 $\pi$ data

$\pi$ data

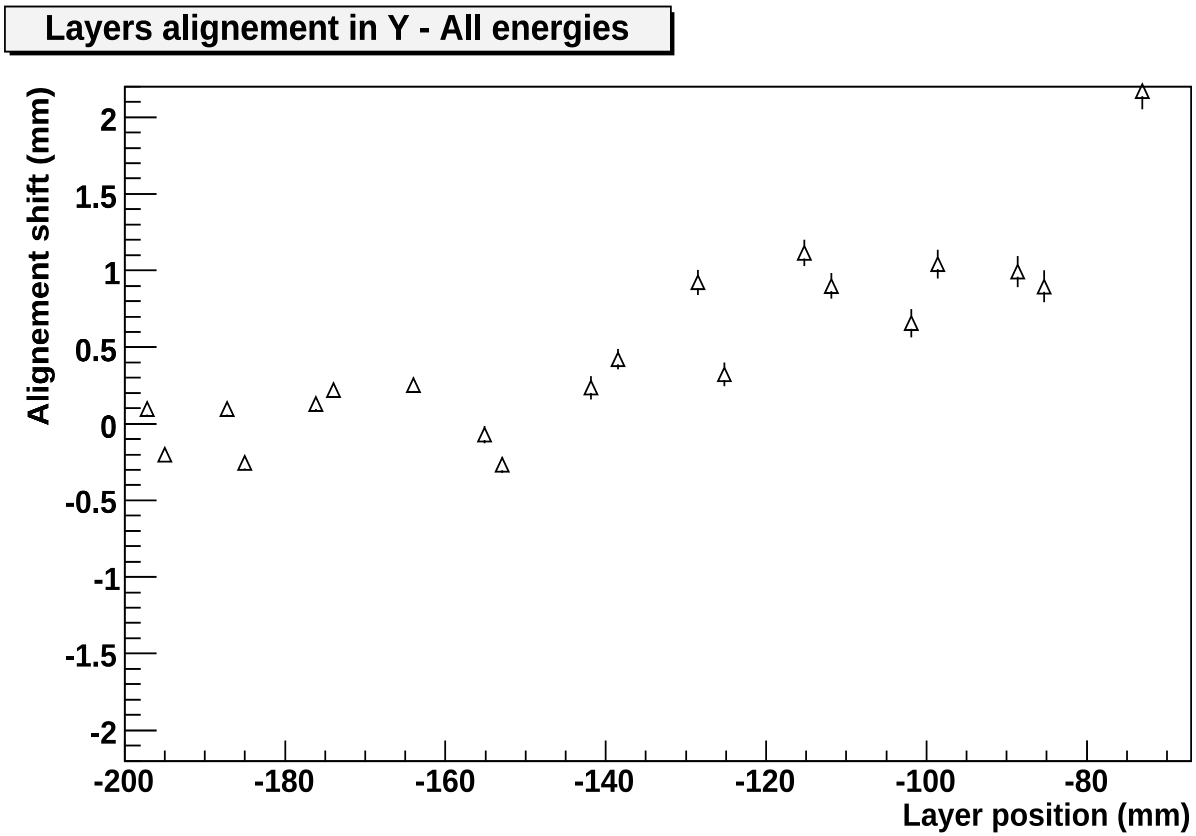



$e^-$ data




- ly4 & 10 : to be understood
- Need to be refined : position per day

# Mean *x* positions over 40 GeV π data




The nominal shifts of 2.5mm/slab and 1.3mm layer/layer were subtracted

# Cristina

ECAL electron analysis paper

# Paper layout

1. Introduction
   - ILC physics highlights
   - ECAL performance goals
   - Prototyping and testbeam

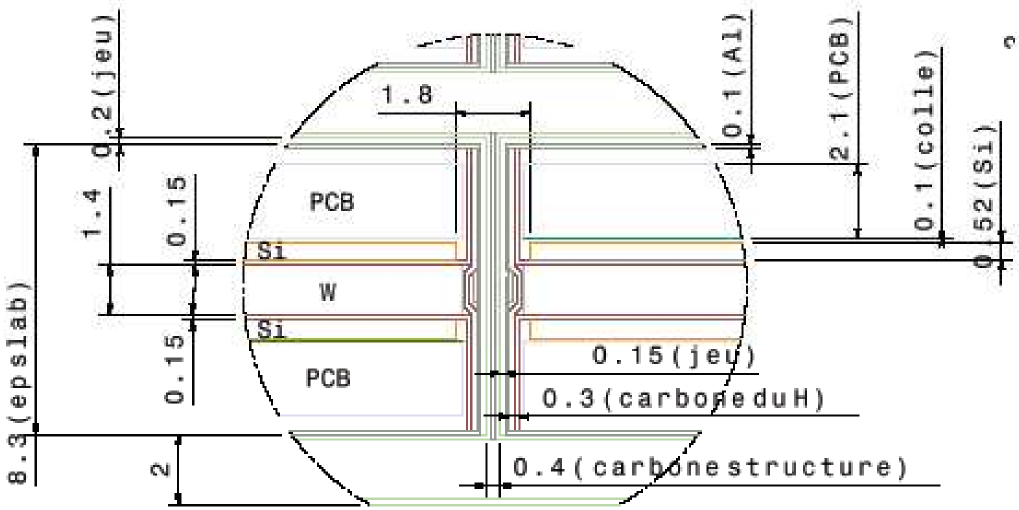
2. Experimental setup and collected data
   - Testbeam setup
   - Mechanical alignment
   - Summary of the collected data

3. The ECAL prototype
   - Conclusion of the hardware paper on the detector performance
   - Number of dead cells
   - Noise level
   - Stability

4. Monte Carlo simulation
5. Electron Selection
6. Performance studies
7. Interwafer gaps correction
8. Conclusion

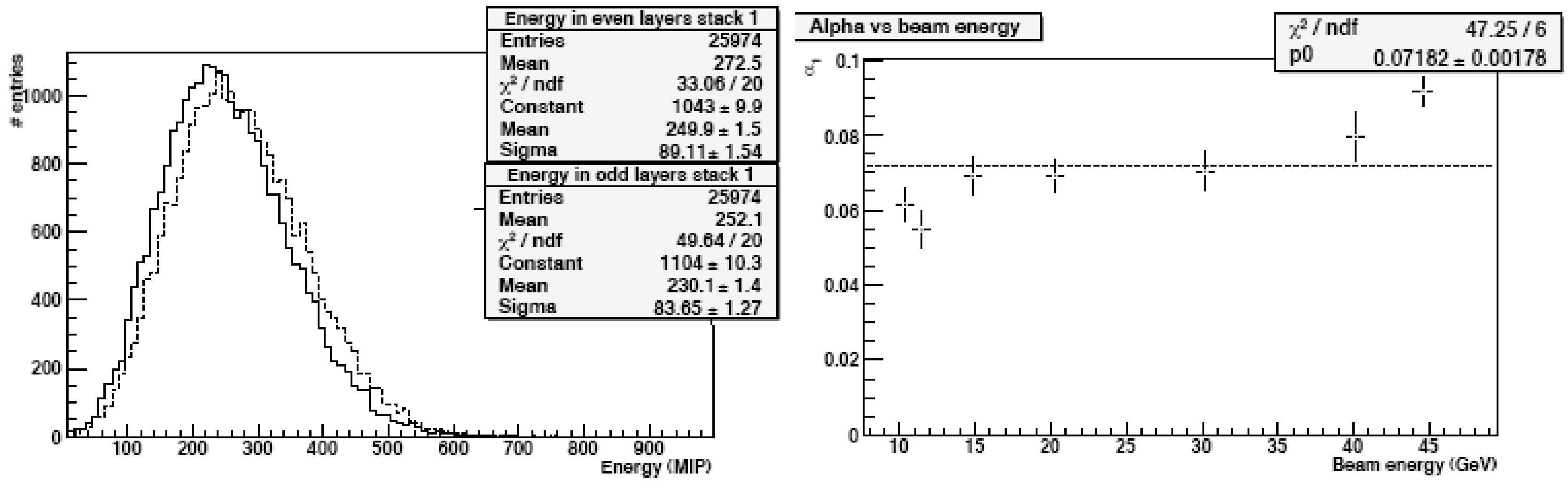
Add longitudinal and transverse shower shape studies if ready.

$$E_{meas} = (\,\alpha_1\, E(1\text{-}10) + \alpha_2\, E(10\text{-}20) + \alpha_3\, E(21\text{-}30)\,)\,/\,\beta$$




$$X_0^{W1} \times \begin{pmatrix} 1 \\ 1+\alpha \\ 1 \\ 1+\alpha \\ \vdots \\ 1+\alpha \end{pmatrix} \begin{pmatrix} \alpha_{10} \\ \alpha_{10}+\alpha \\ \alpha_{10} \\ \alpha_{10}+\alpha \\ \vdots \\ \alpha_{10}+\alpha \end{pmatrix} \begin{pmatrix} \alpha_{20} \\ \alpha_{20}+\alpha \\ \alpha_{20} \\ \alpha_{20}+\alpha \\ \vdots \\ \alpha_{20}+\alpha \end{pmatrix}$$

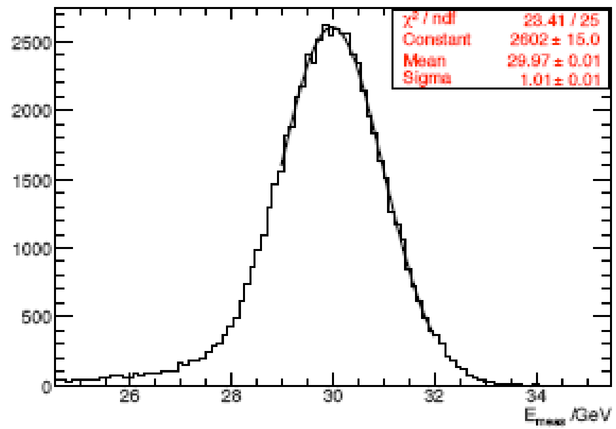
$$X_0^{W1} = \frac{0.4\text{mm}}{3.5\text{mm}},\ \alpha_{10} \simeq 2 \text{ and } \alpha_{20} \simeq 3.$$

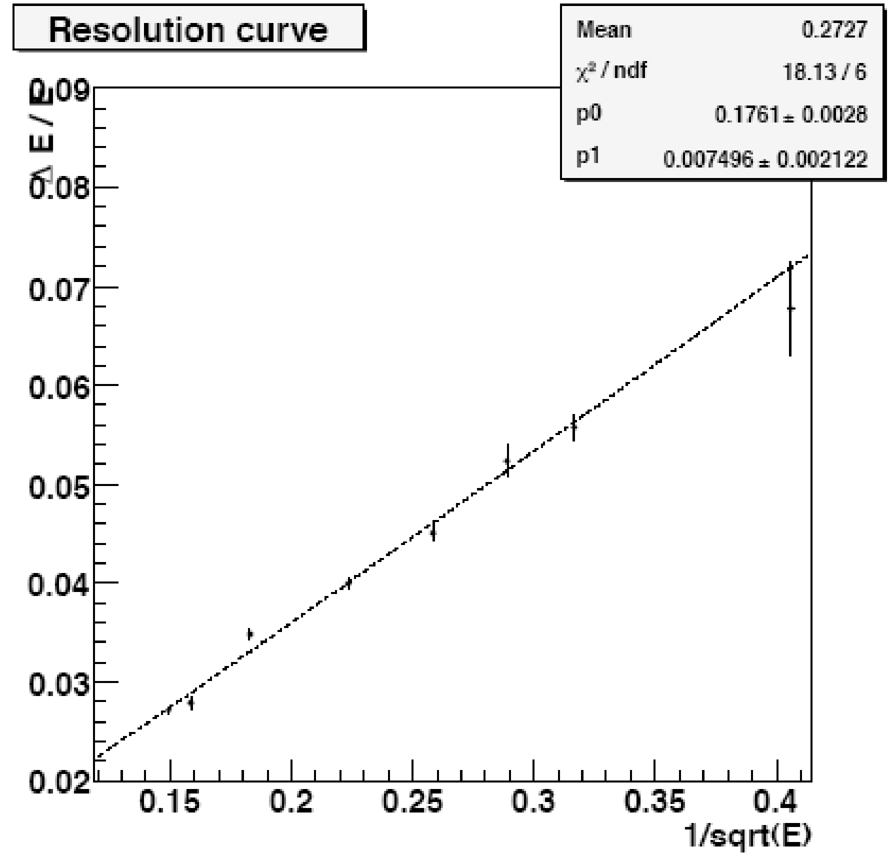



CIN-002 ``Radiation length of the Si-W calorimeter components and impact on the energy resolution'' , D. Boumediene, https://twiki.cern.ch/twiki/pub/CALICE/CaliceInternalNotes/

$$\alpha_{2006\ \mathrm{CERN}} = (7.2 \pm 0.18 \pm 1.7)\%$$

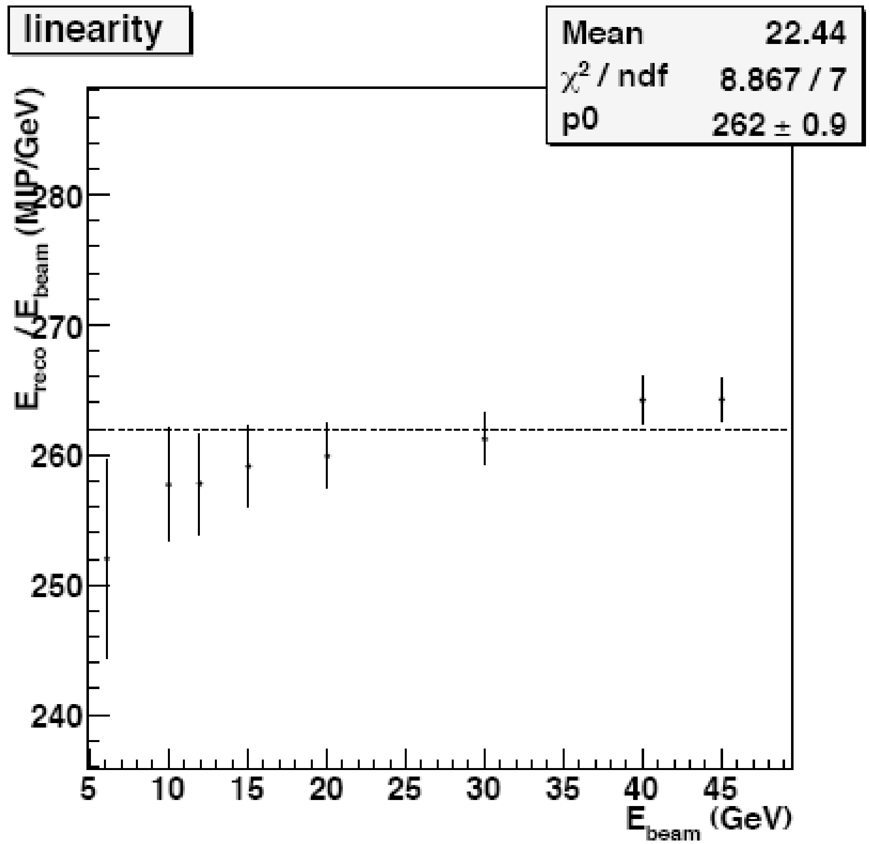
The improvement of the order of 0.3% on the sampling term (ct term not affected)




$$\frac{\Delta E}{E}(\%) = \frac{17.6 \pm 0.3}{\sqrt{E\,(\mathrm{GeV})}} \oplus (0.75 \pm 0.21)$$

$(\alpha_1, \alpha_2, \alpha_3) = (1, 2, 3)$

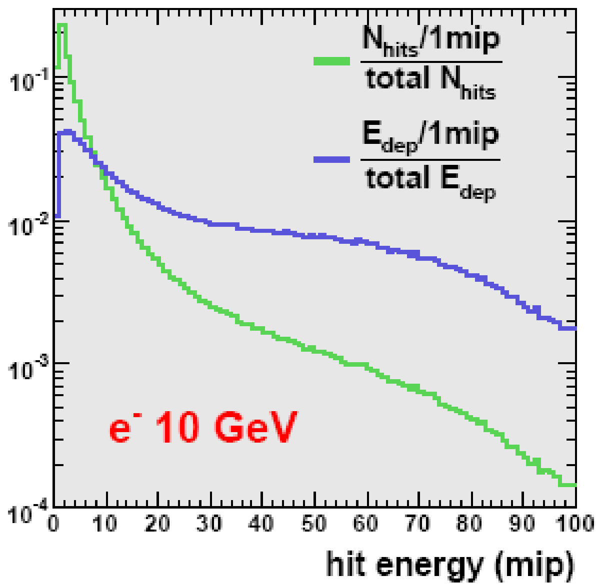



Error on the beam: $\frac{\Delta E}{E} = 0.5\% \oplus \frac{0.15\ \mathrm{GeV}}{E}$

# Georgios

Transverse shower shapes

# Shower composition




- e.g. for a 10 GeV electron shower

  the low-end : the lower energy hits that account for 22% of the total Nhits contribute 2.6% of the total deposited energy

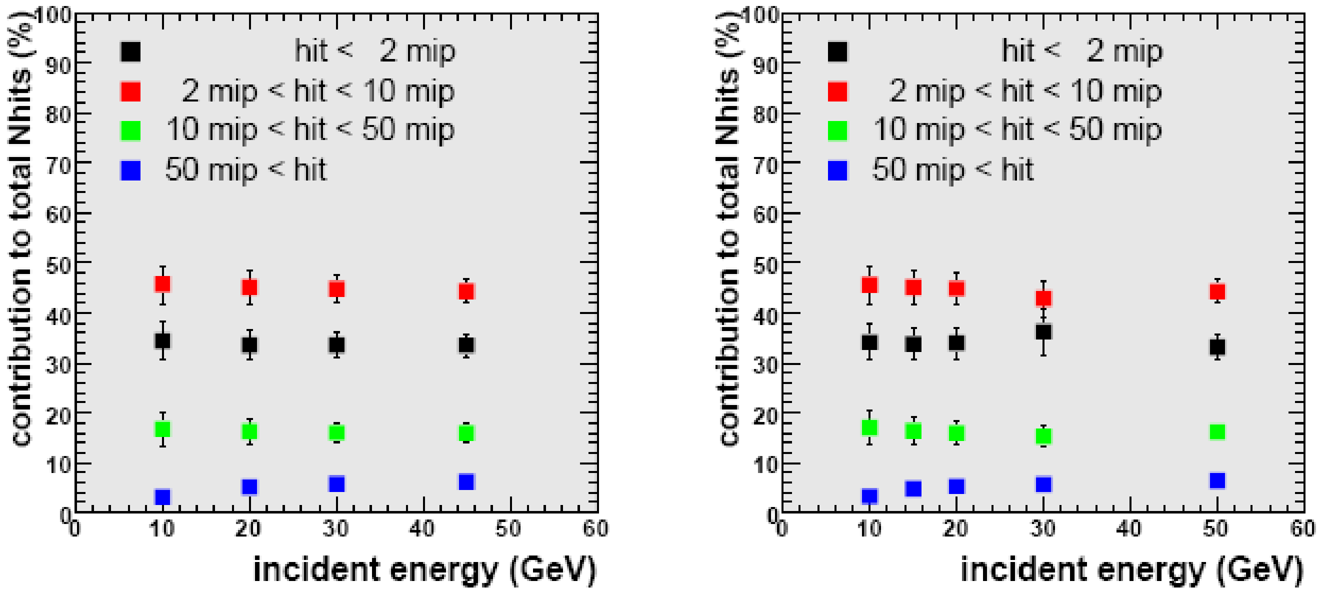
  the high-end : the higher energy hits that account for 3% of the total Nhits contribute 24% of the total deposited energy

- divide shower in 4 "components" and study their contributions, profiles, etc

| | | | | |
|---|---|---|---|---|
| | | Ehit | < | 2 mip |
| 2 mip | < | Ehit | < | 10 mip |
| 10 mip | < | Ehit | < | 50 mip |
| 50 mip | < | Ehit | | |

17. G.Mavromanolakis, CALICE Collaboration Meeting, Argonne

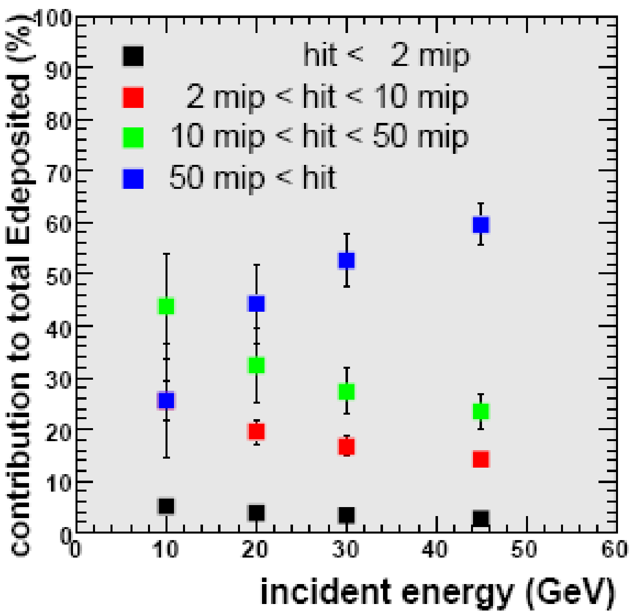
# Shower composition wrt Nhits



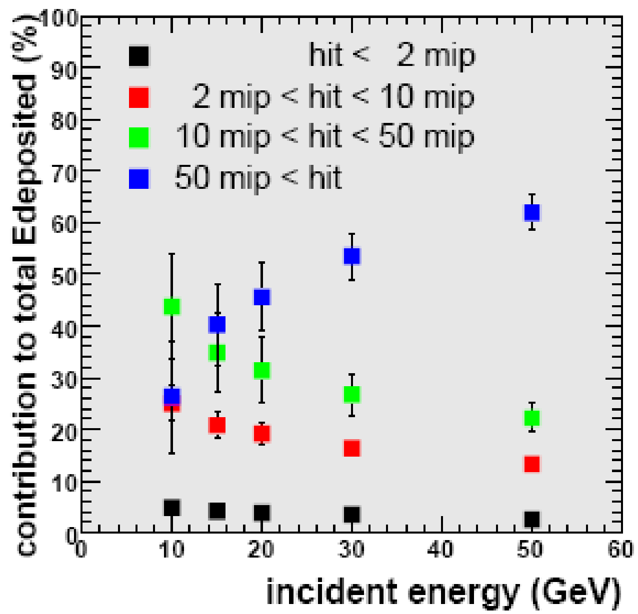

(electron data CERN2006) (positron data CERN2006)

18. G.Mavromanolakis, CALICE Collaboration Meeting, Argonne

# Shower composition wrt Edeposited




(electron data CERN2006)

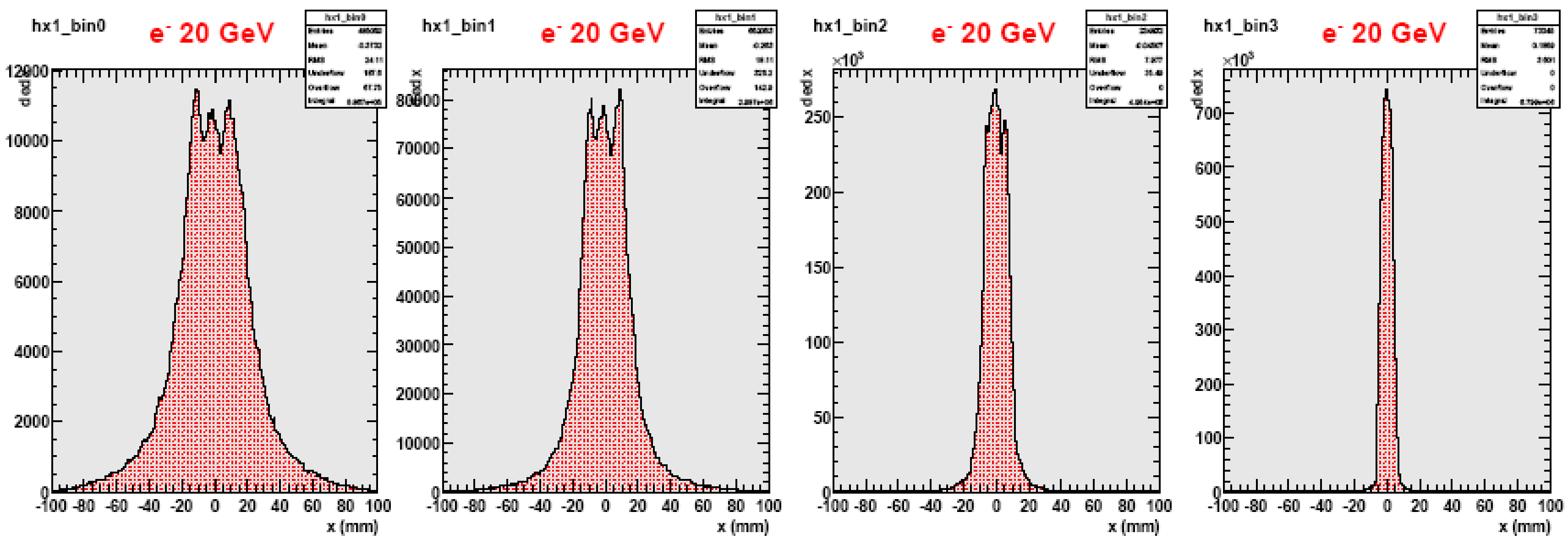



(positron data CERN2006)

19. G.Mavromanolakis, CALICE Collaboration Meeting, Argonne

# Shower profiles along X (e$^{-}$ example)

(energy weighted distribution of $X_{hit} - X_{barycenter}$)

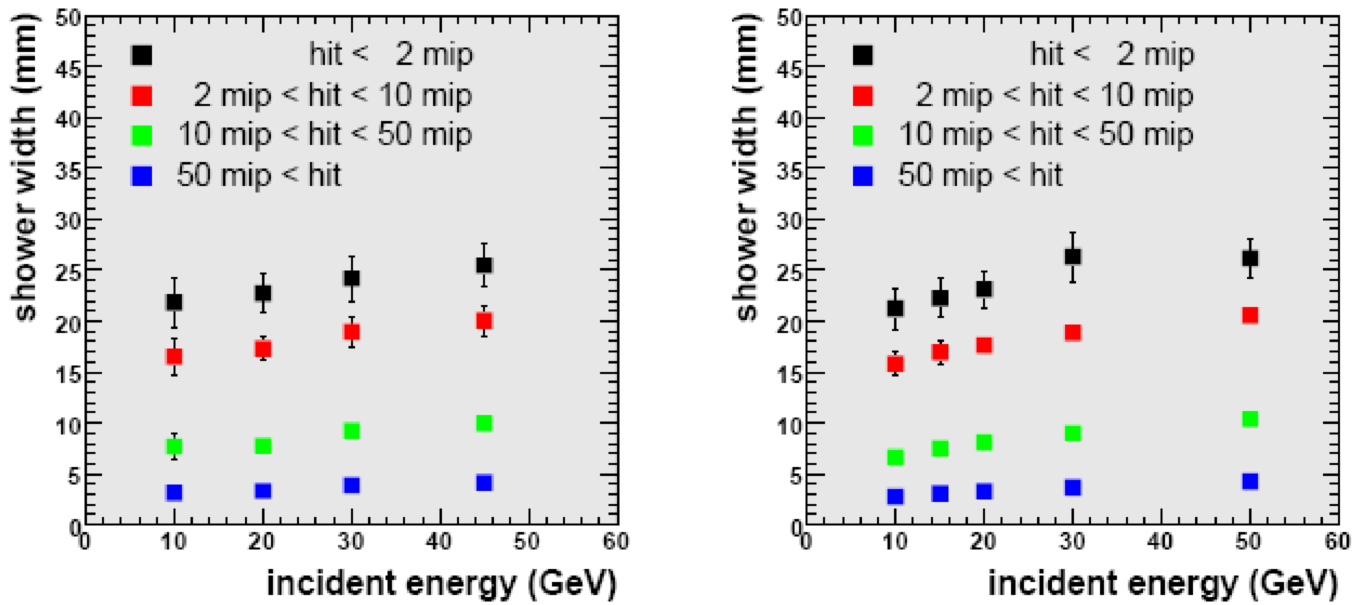



(hit < 2 mip) (2 mip < hit < 10 mip) (10 mip < hit < 50 mip) (50 mip < hit)

**alternate layers are staggered along X** (by 2.5mm)

20. G.Mavromanolakis, CALICE Collaboration Meeting, Argonne

# Transverse width per component



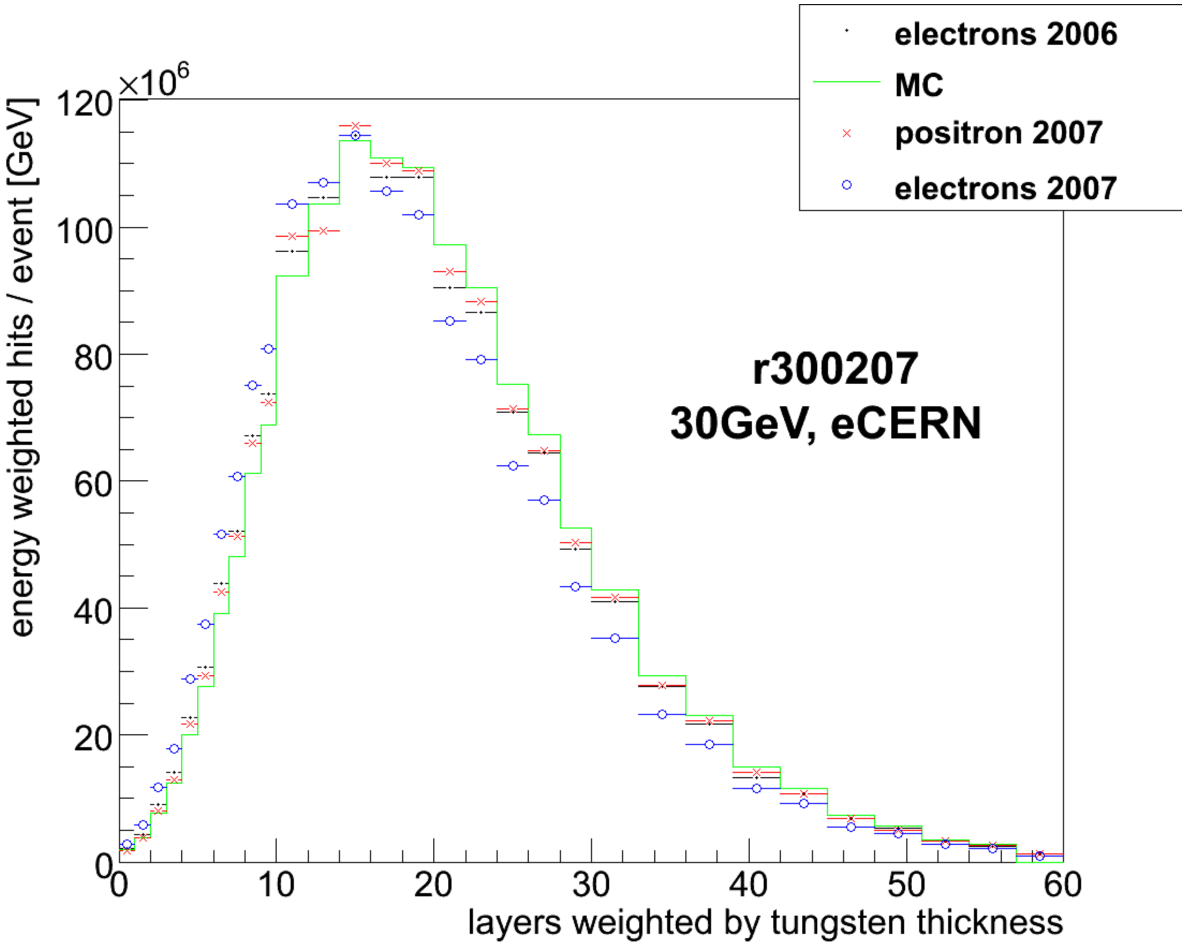

(electron data CERN2006) (positron data CERN2006)

23. G.Mavromanolakis, CALICE Collaboration Meeting, Argonne

# Valeria

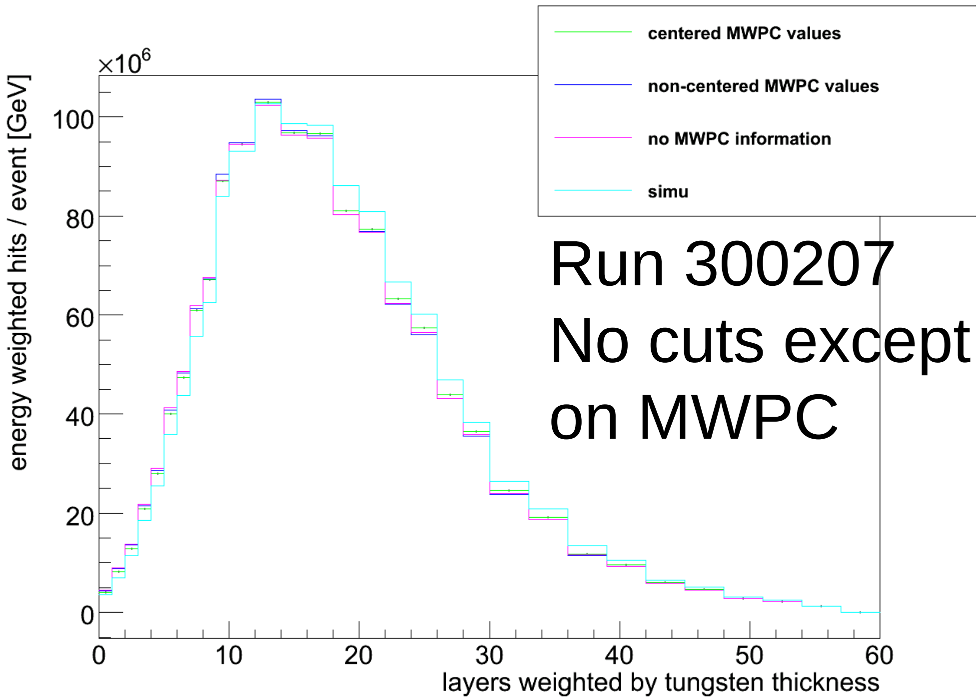
Longitudinal profile

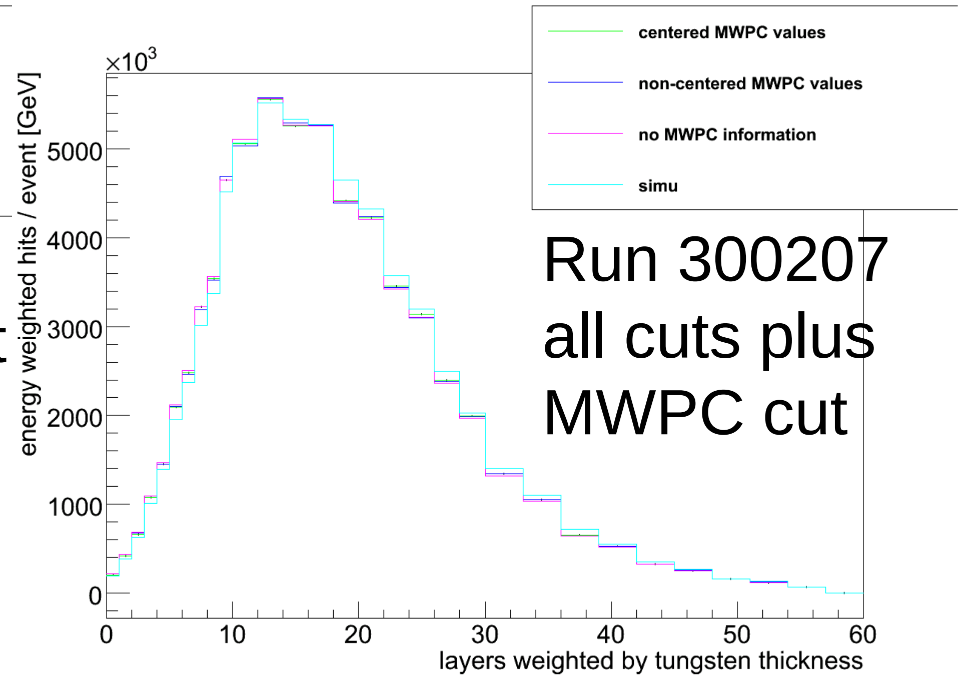
# 2006 -2007 comparison




- all of David's cuts incorporated
- electron profile quite different between 2007 and 2006

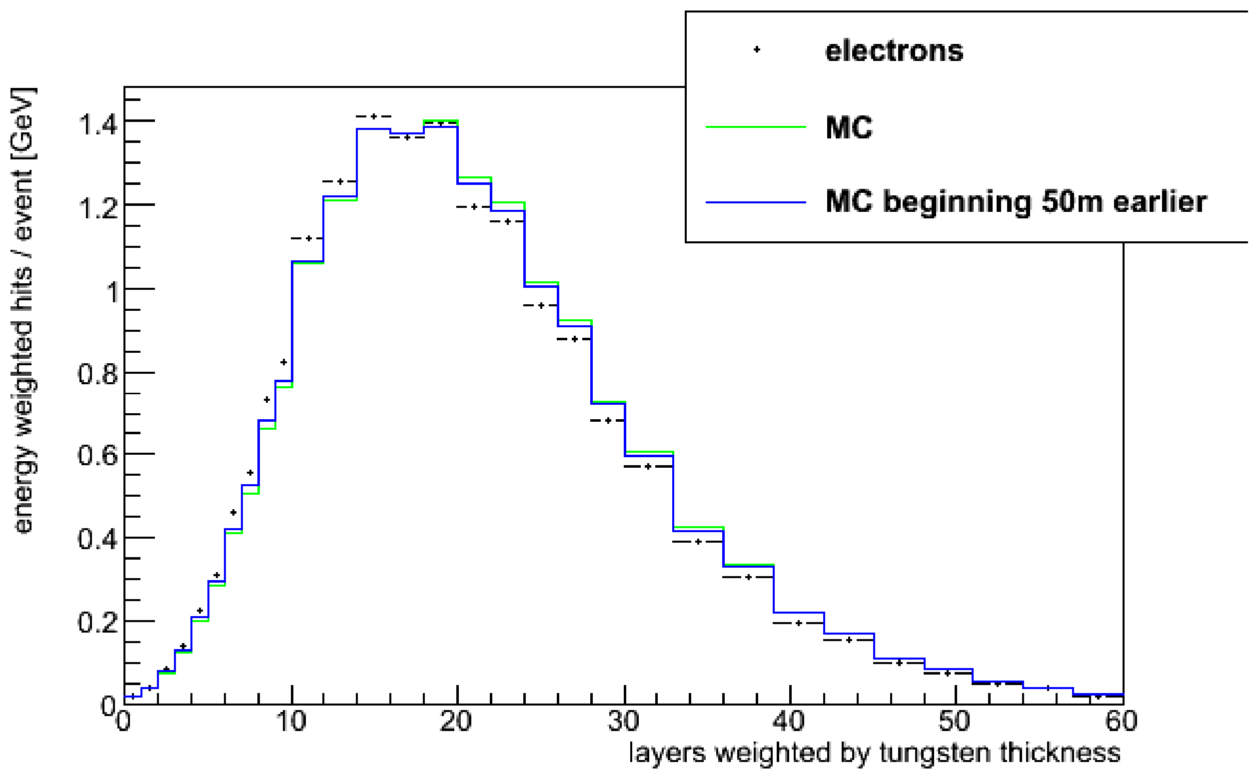
# MWPC tracks




- MWPC cut highly correlated to double event cut
- plus reduces data and MC by 50% because of efficiency of MWPC

# simulation of air in front of testbeam setup



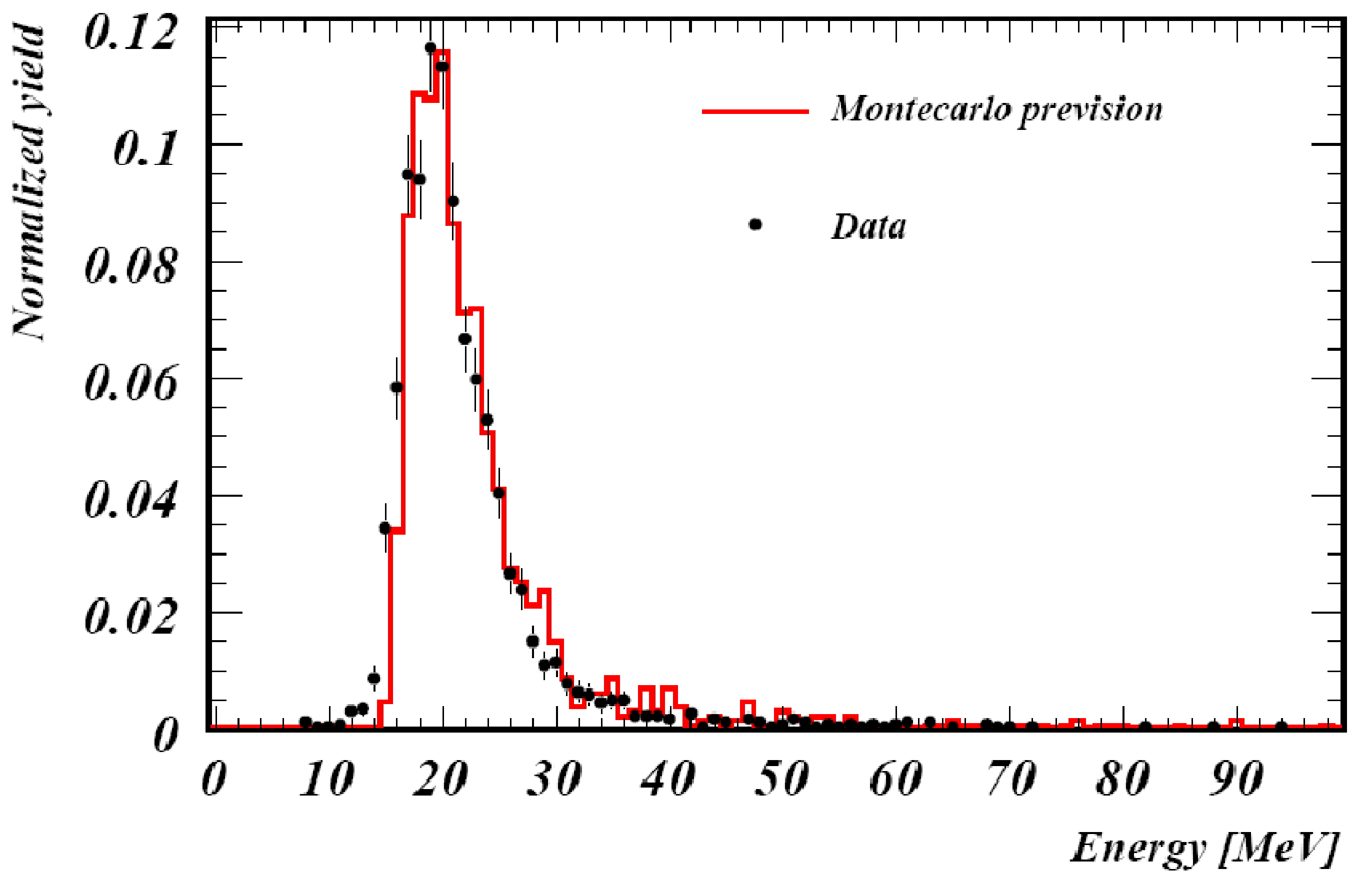

slight improvement with David's MC samples

# Nicola

Muons in AHCAL

# Reconstruction of the visible energy

**The total visible energy in a tube of 3cm x 3 cm (1 cell) around the found track in the HCAL is measured**

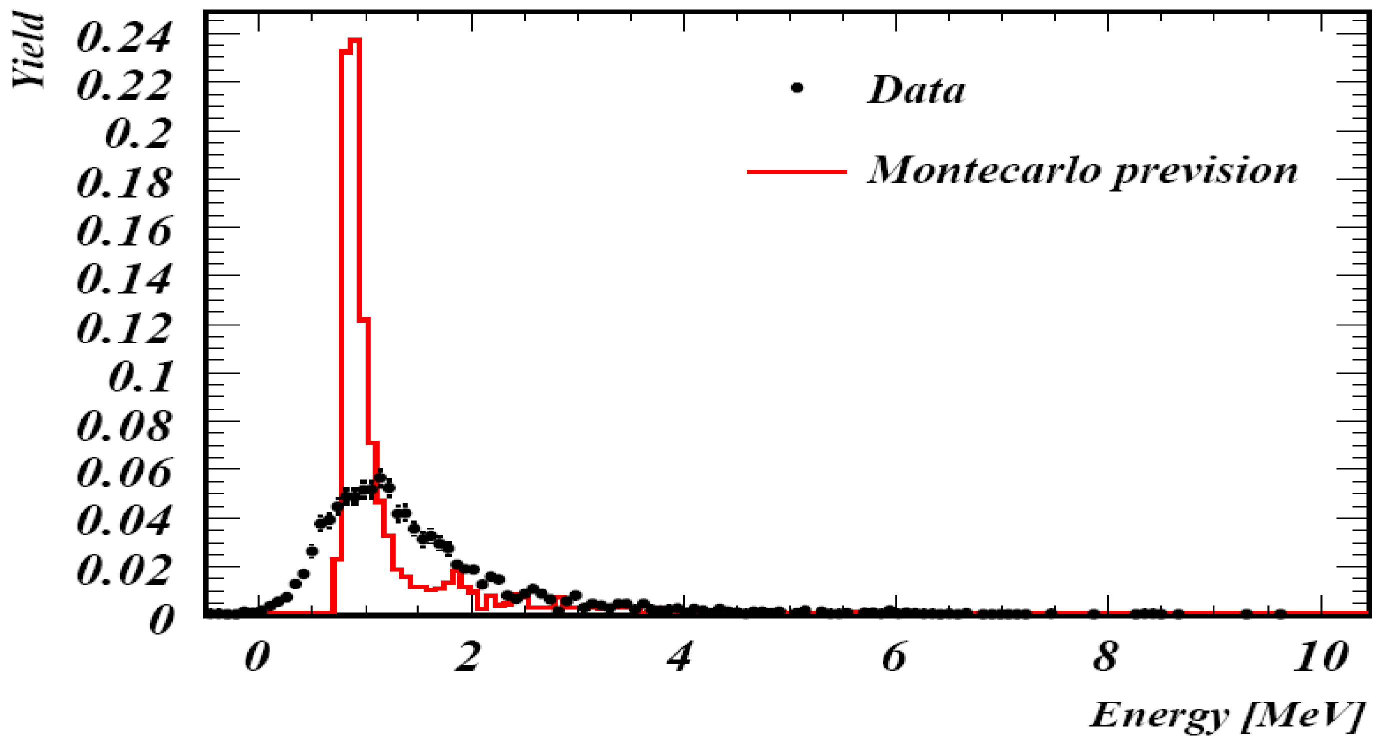



**A very good agreement between data and montecarlo! – NO DIGITIZATION!**

**The smearing effect of the detector dies out just statistically when summing up the cells…**

# Reconstruction of the visible energy : single layer

**The total energy deposited in a single hcal layer (1 cell) is shown. The contrbution of the detector smearing (both Poisson and noise) is relevant.**



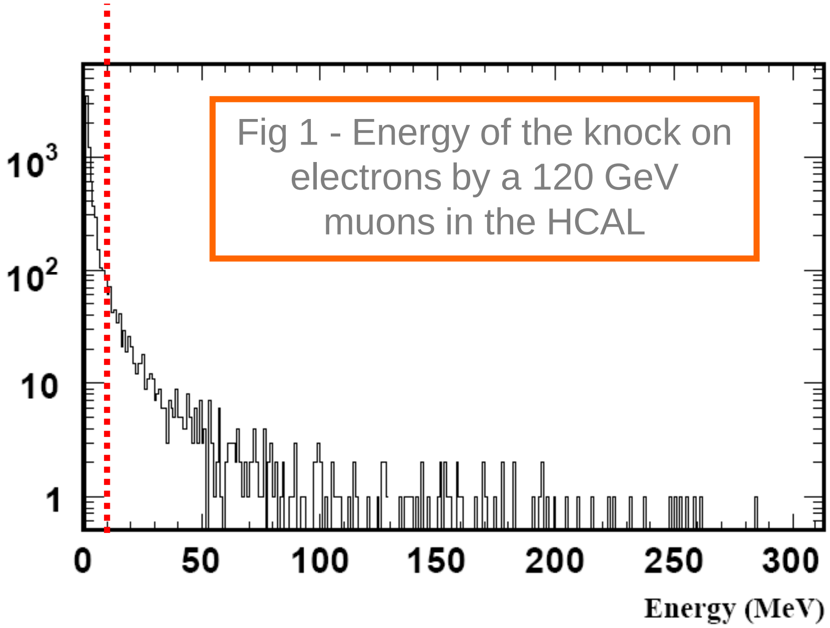

The disagreemet between DATA and MC is huge.

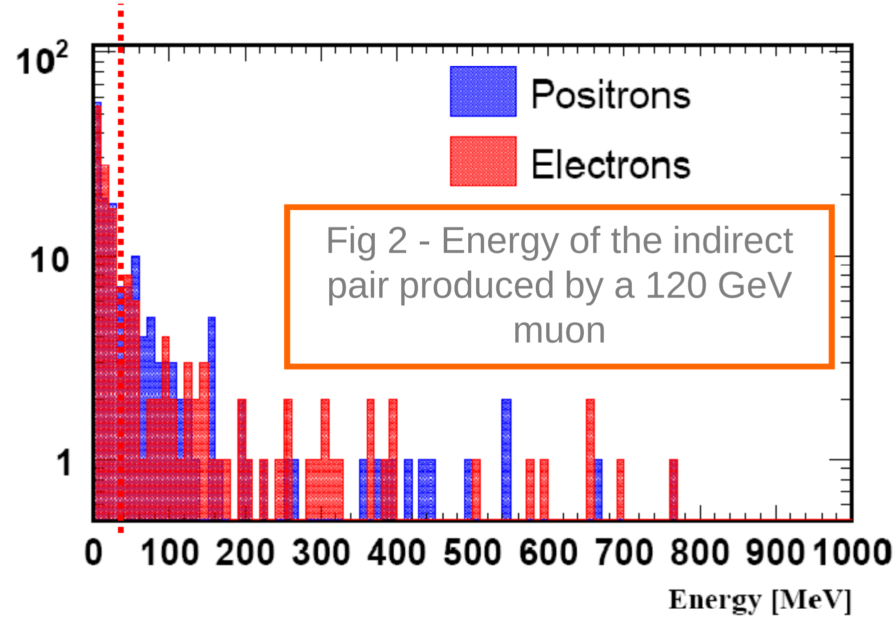
The noise can not be extracted with the simple landau convoluted with gaussian.

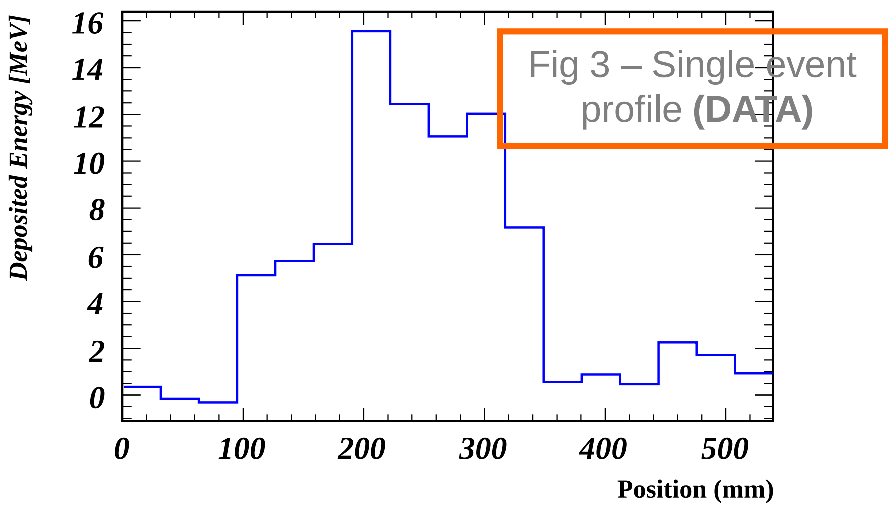
**How can we extract the physics information cell by cell?**

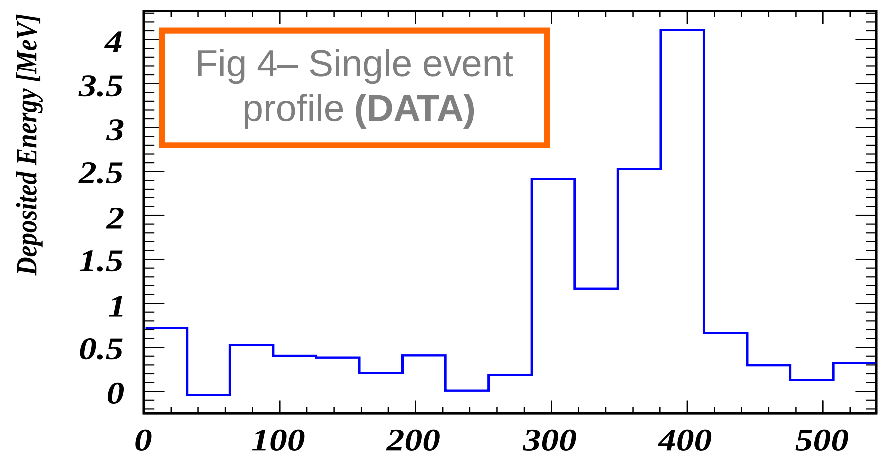
# Muon interaction in the iron : transversal profile

**The study of the transversal profile points to identify some variables which are typical of the muon**



# Delta ray production around the muon track

**The total number of showering knock on electrons is seen as first variable which identifies a m.i.p. track**

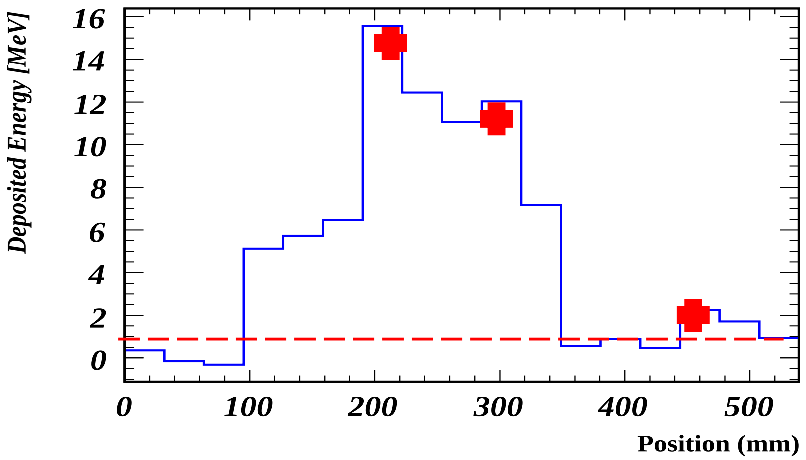



Fig 1 – Delta rays finder. **The threshold is the 5th bin of the likelihood binning.**

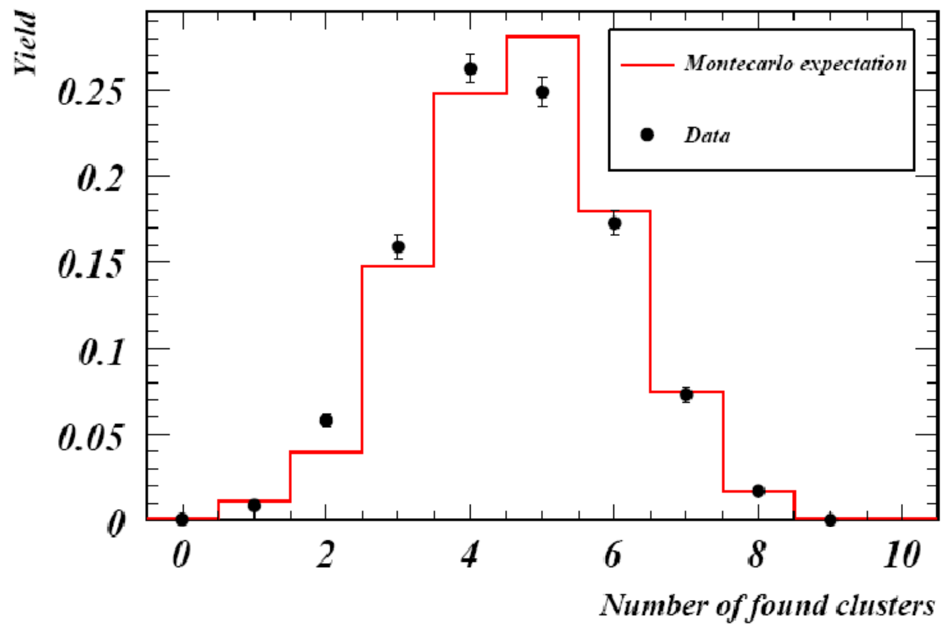



Fig 2 – Number of showering delta rays found in data and MC

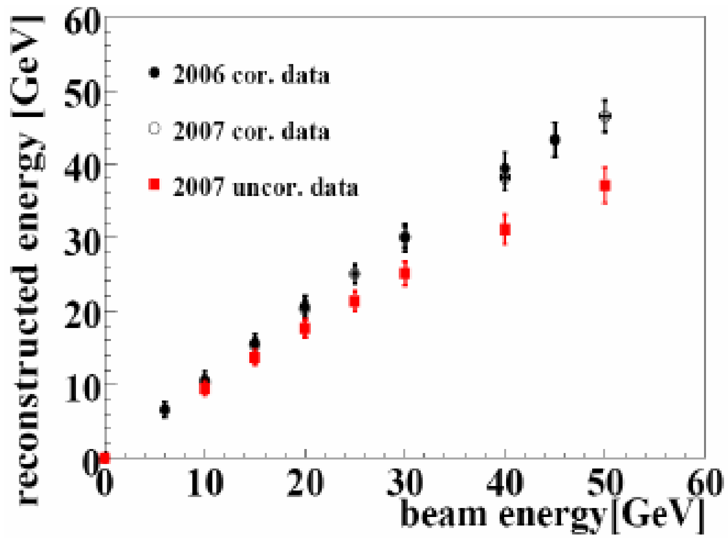
The agreement between data and montecarlo is achieved only using statistical techniques.

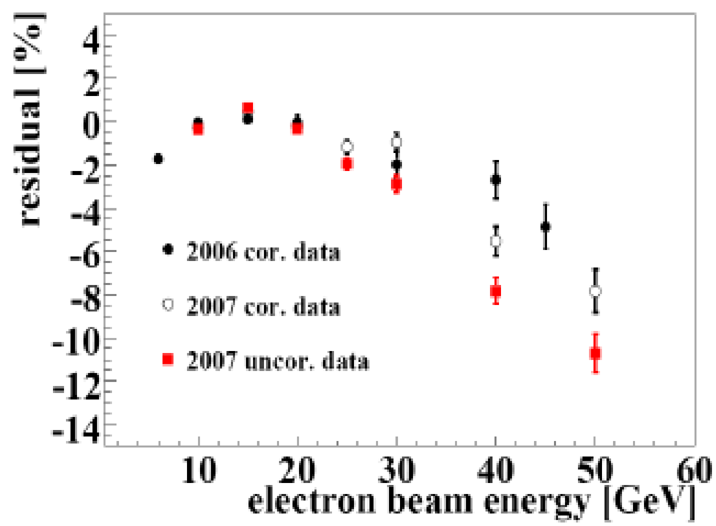
**NO DIGITIZATION NEEDED!**

# Erika (p.p. Nanda+Oli)

Electrons (Nanda); Hadrons (Oli) in the AHCAL

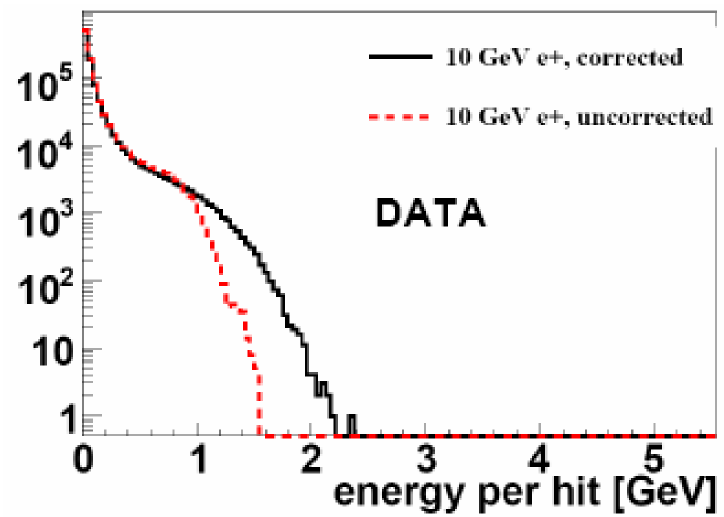
# EM analysis (NW)

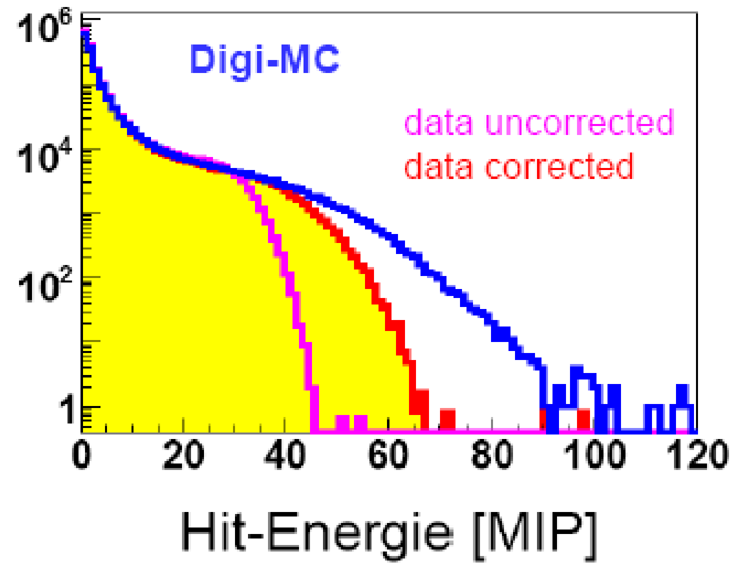



status already presented at last CALICE meeting
6 < E < 30 GeV linearity ~2%
E > 30 GeV linearity ~8% ➔ saturation correction to be improved

# Hit energy distribution




ongoing work to understand the effects of saturation on digitized MC (SR)

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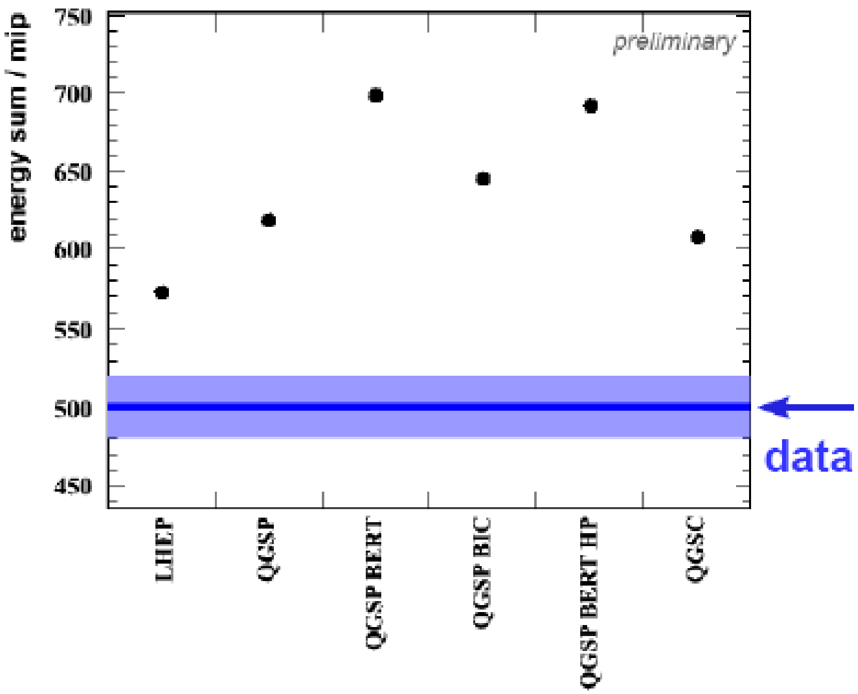
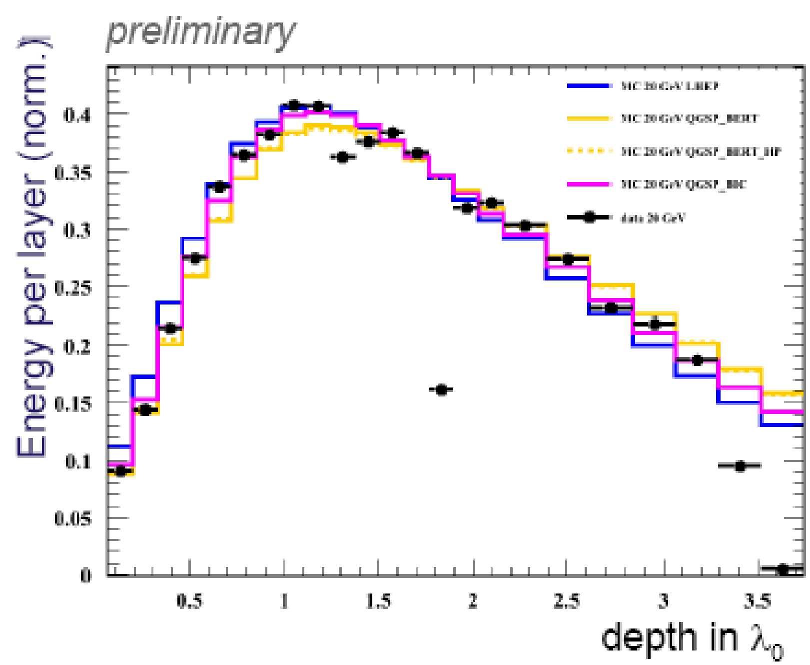
# HCAL pion analysis (OW)

20 GeV pion shower,  HCAL 2006 is used, track in ECAL required

no threshold / no digitalization in MC !!




too early to draw conclusion on which phys. list is favored by the data

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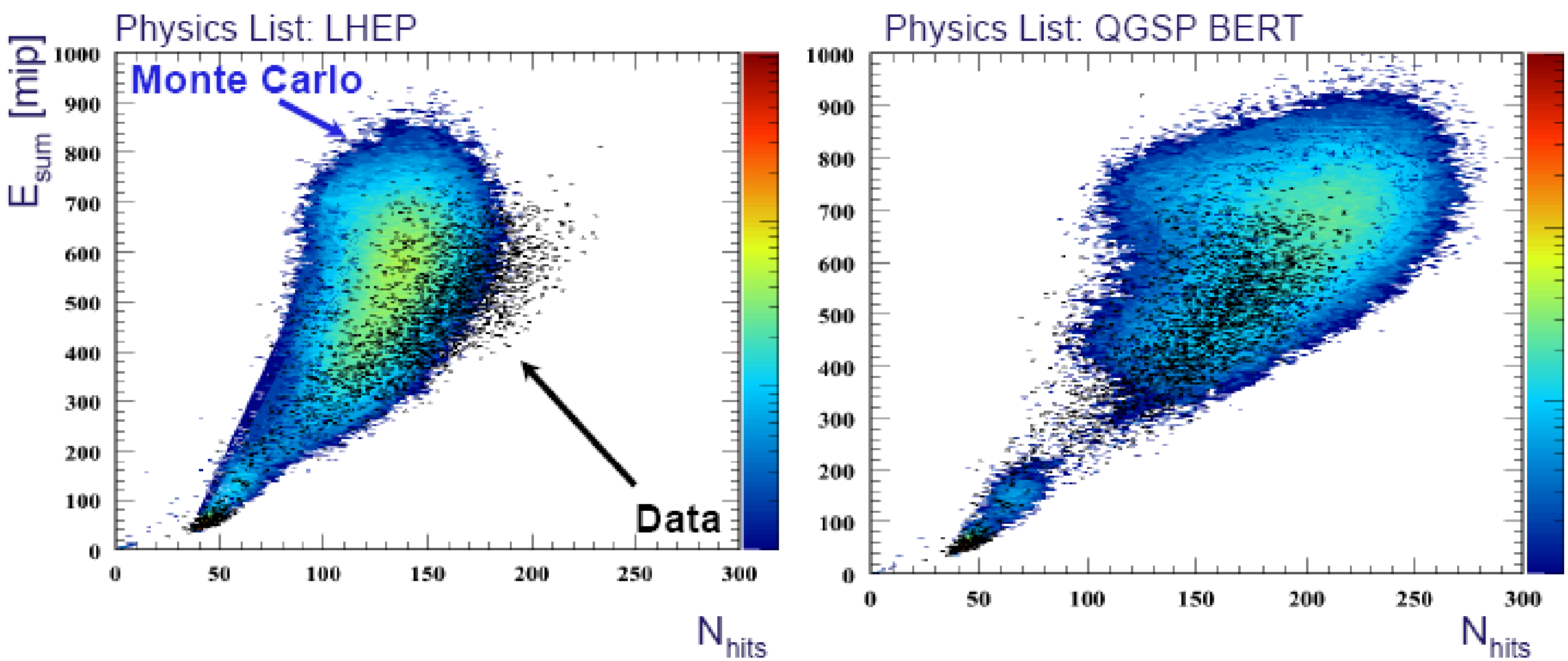
Comparison of physics lists - see a publication of the G4 group: CERN-LCGAPP-2007-02

# more power on MC models discrimination




different correlations can be used to better discriminate between MC models

… after correct calibration and proper threshold cut in MC

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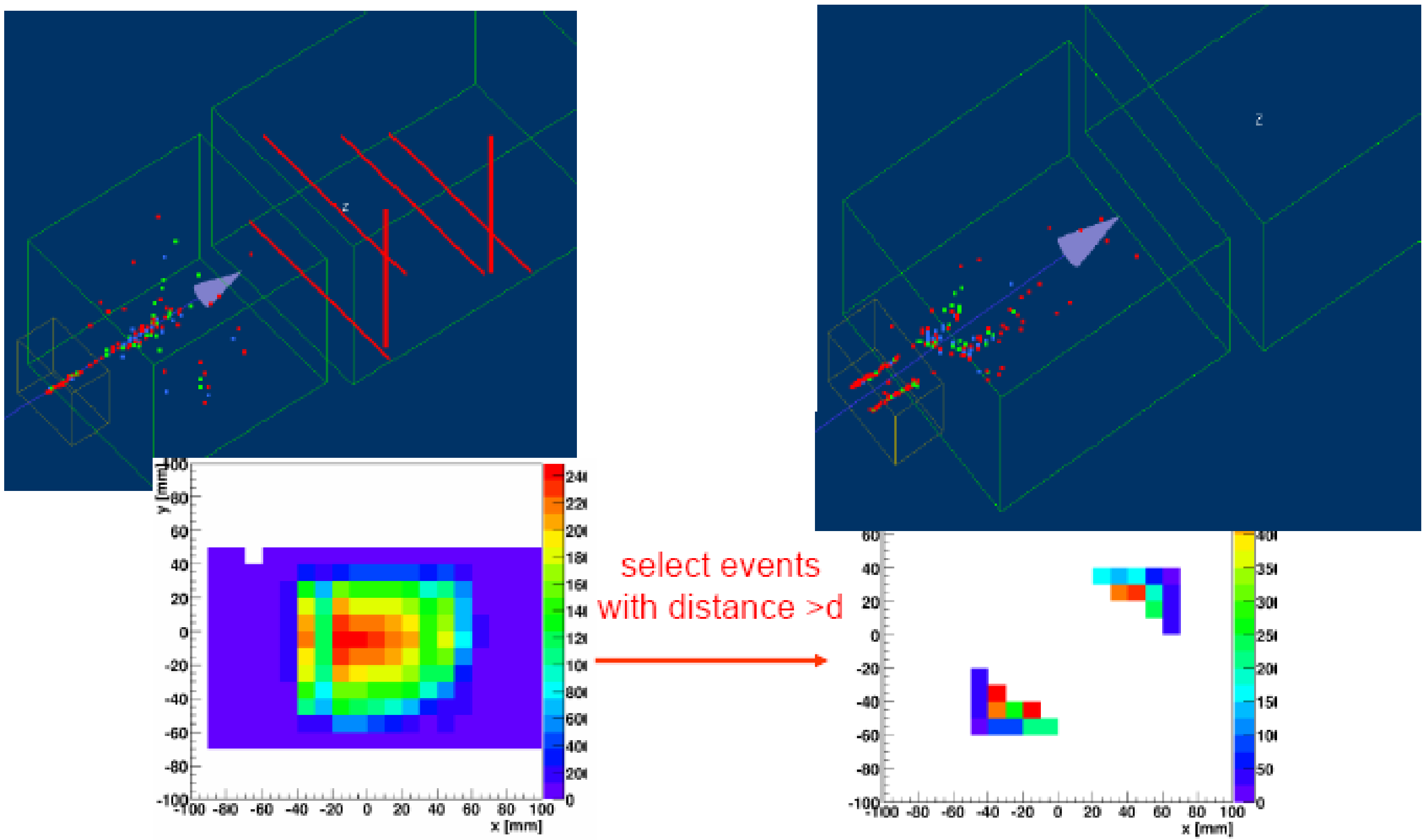
# Overlay of showers

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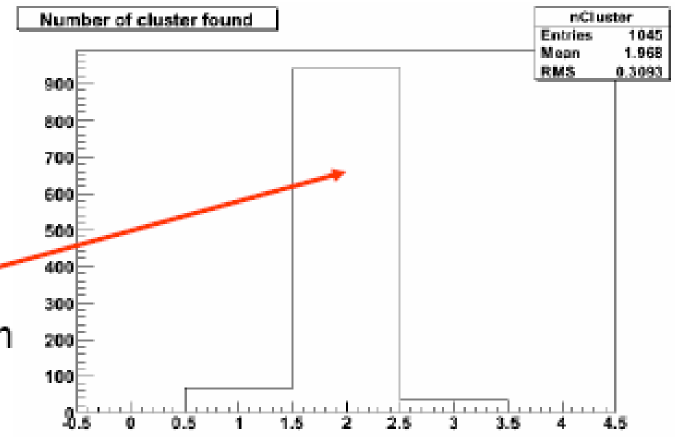
# Shower clustering

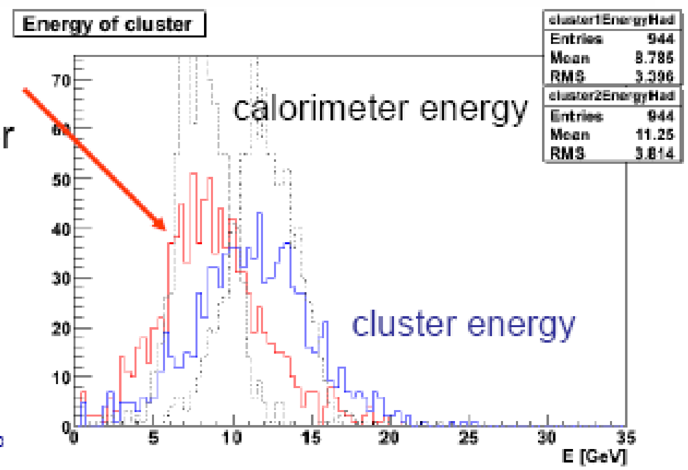
Track-wise clustering algorithm applied to overlaid showers

example for 8 GeV and 12 GeV pions

→efficiency of 2 cluster found > 90% for 10 cm distance between clusters

→cluster energy has a broader distribution than reconstructed particle energy in calorimeter

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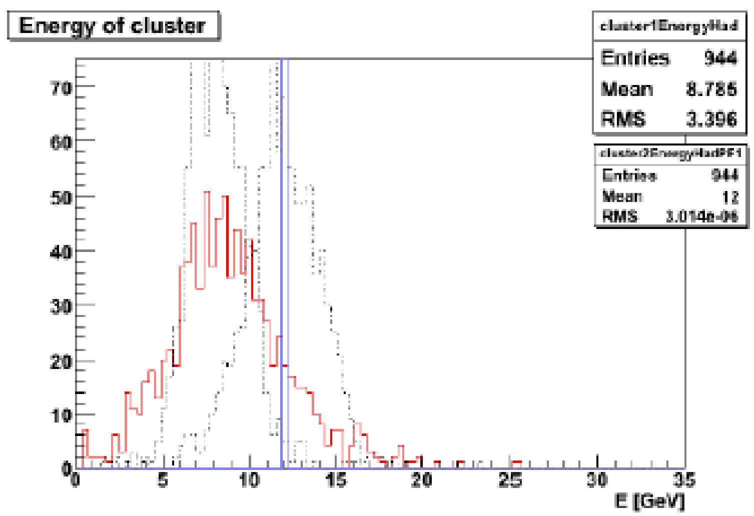
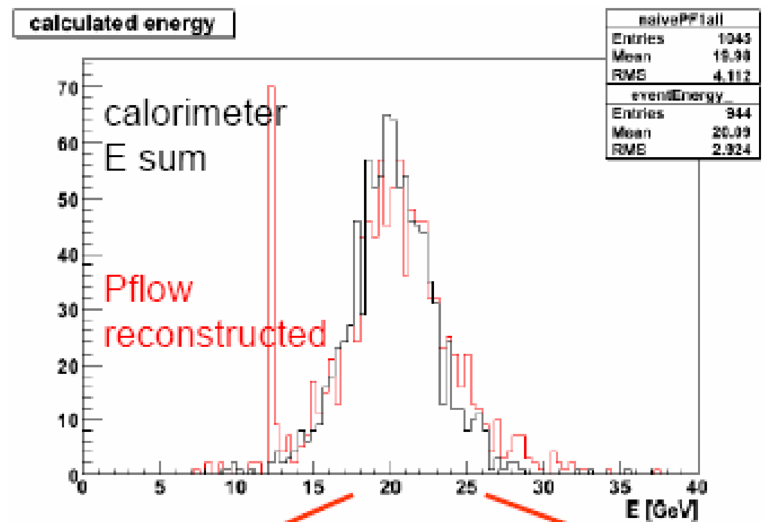
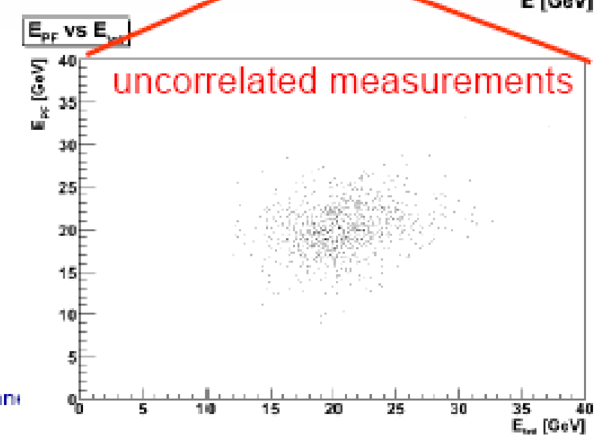
# Naïve particle flow




from reconstructed clusters
•assume one to belong to a charge particle
•substitute energy with known momentum
•sum clusters to a Pflow reconstructed object

compare to E sum in the calorimeter

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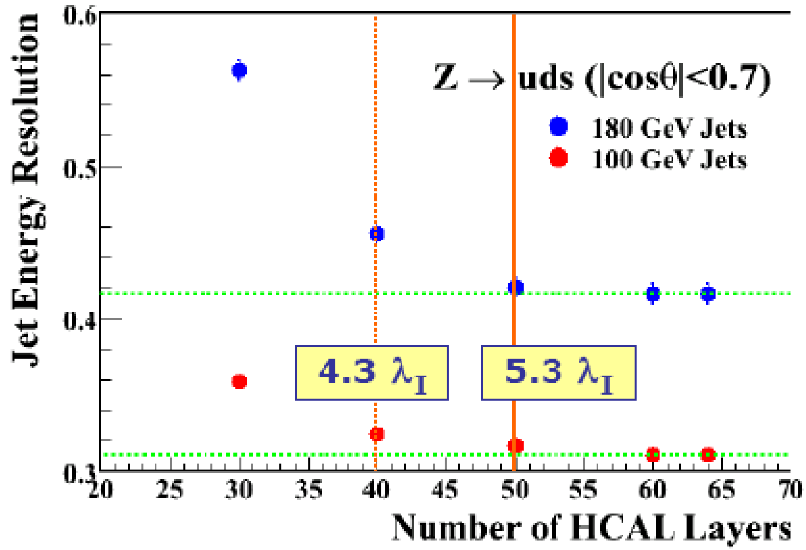
# Felix (p.p. Beni)

Leakage

# Depth and PFLOW

- Recently affirmed by M.Thomson
  - May want more detailed understanding
  - No use of tail catcher in reco yet
  - No leakage estimation from shower shape yet
- Best "state-of-the-art" estimate to-date

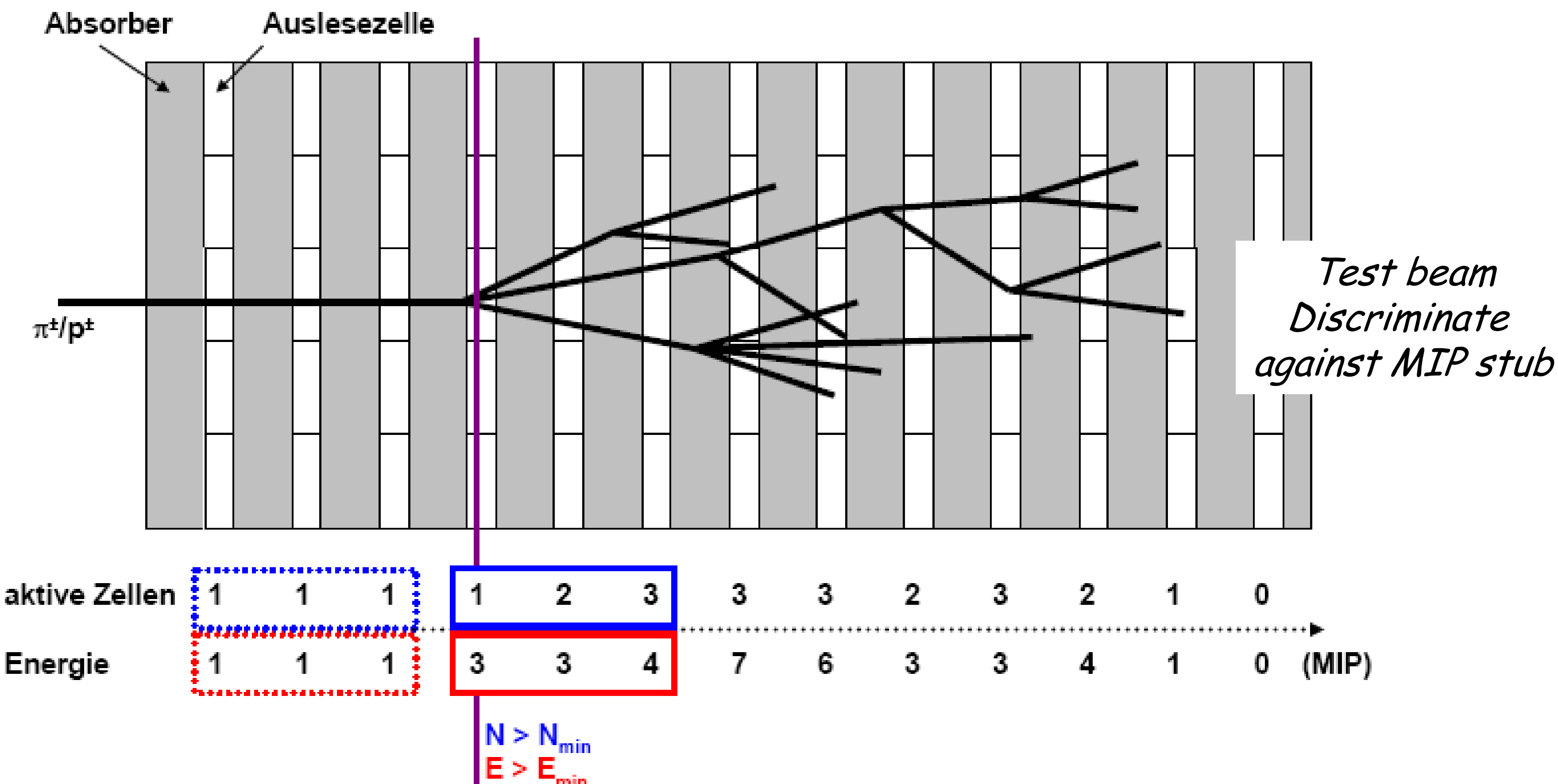
- It is logically impossible to demonstrate that it cannot be improved
  - Proponents of thinner HCAL must demonstrate equivalent performance




- Here:
  - Mokka layer 1.8 cm
- For 2cm absorber layers
  - $5.3\lambda$ = 45 layers

# Shower starting point

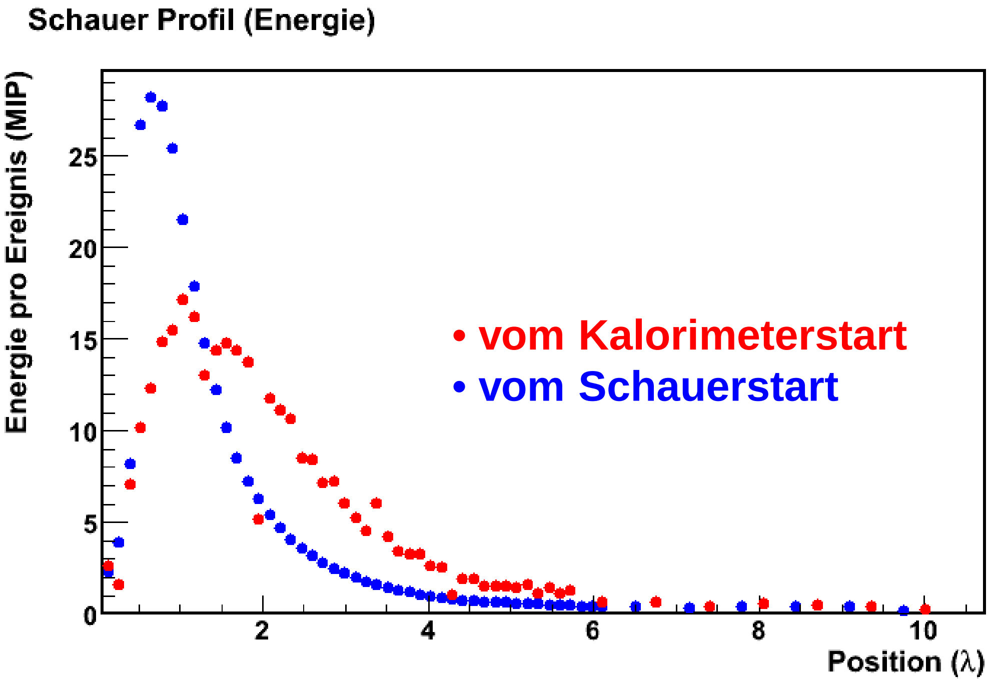
- Find first hadronic interaction

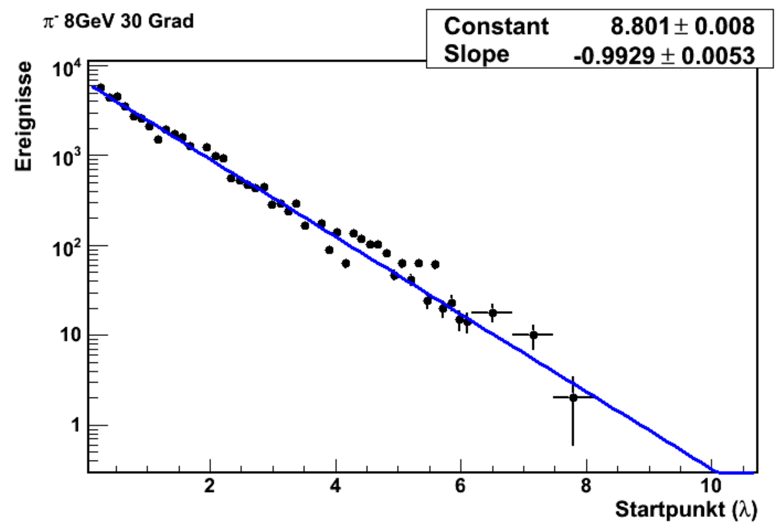


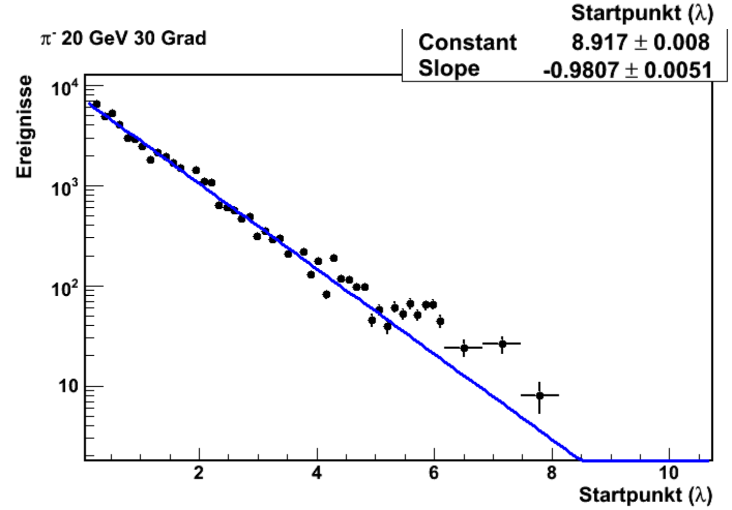
# Shower profile, deconvoluted

- Test beam data, HCAL + TCMT
- Reconstruct starting point
  - > 5 hits, 8 MIP in 3 consec, layers
- Shower profile:

*B.Lutz*



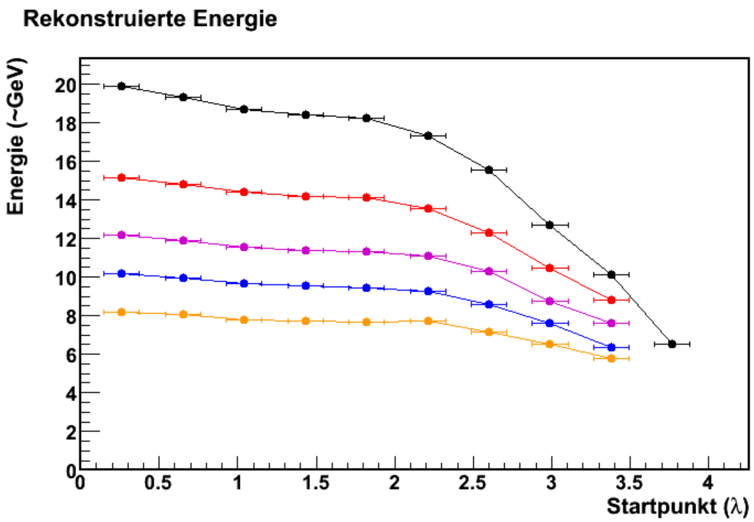



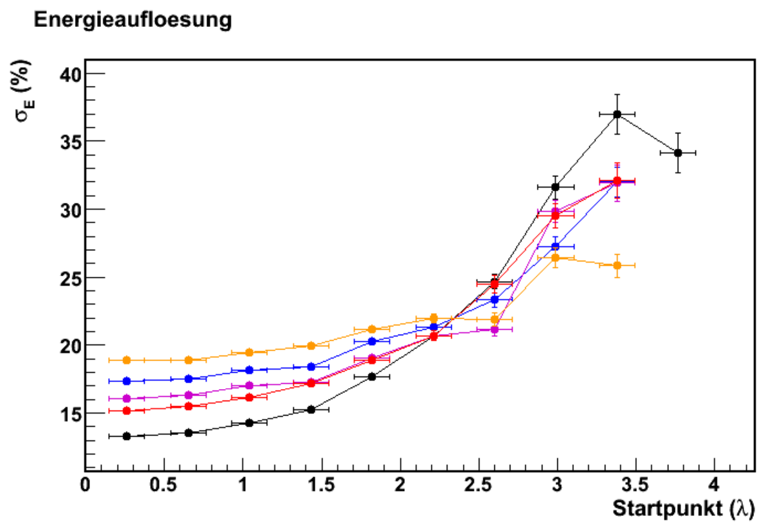



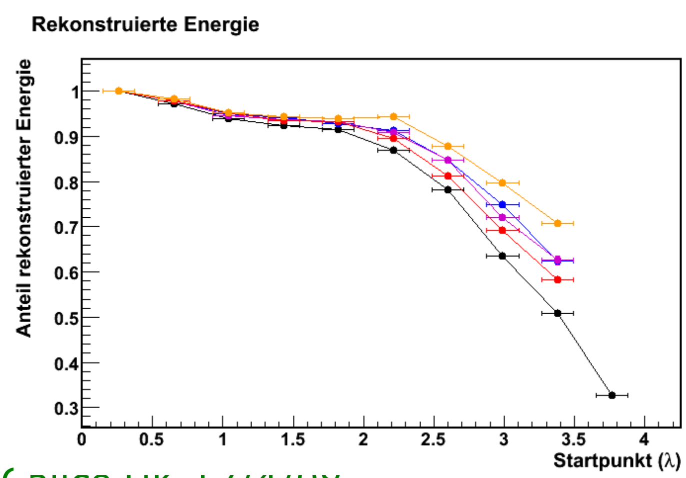

CALICE Calorimeter for LC

CAMBRIDGE

# Reconstructed energy



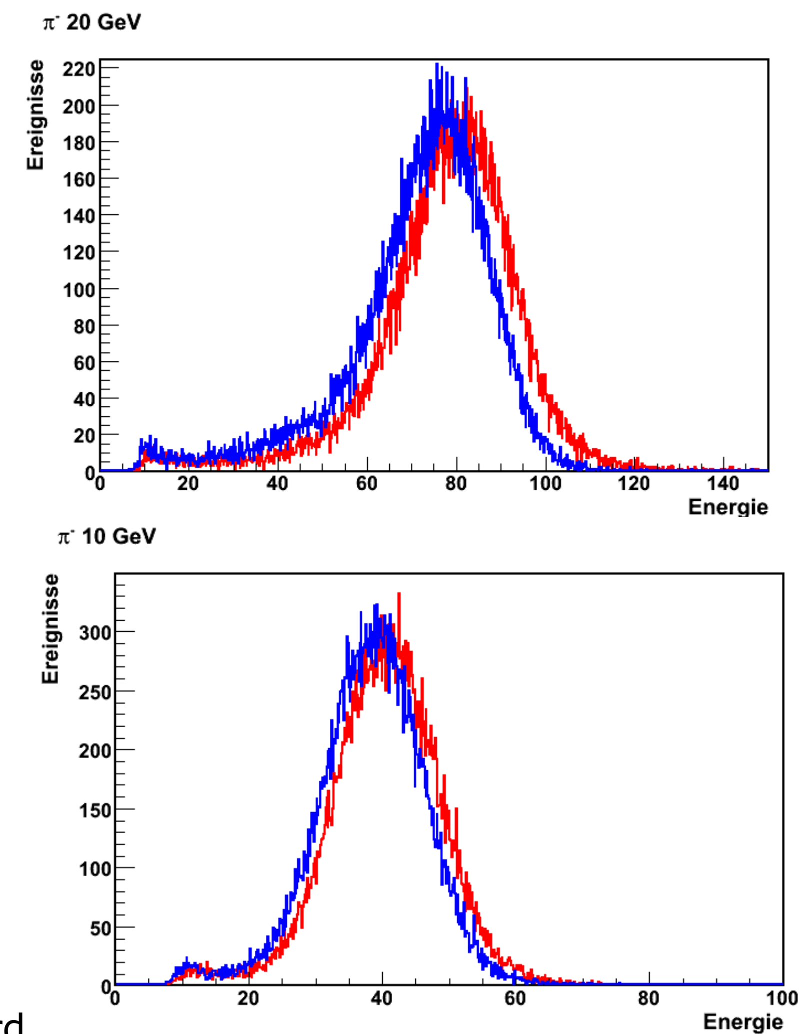




- "onset" of leakage when shower max moves out
  - Depends on energy
- Resolution degrades as energy is lost

# Corrected energy

- Correct with starting-point dependent weight
- Recover correct mean
- Do not recover resolution
- Still tails: leakage from early showers

- Can certainly be optimized
  - Include more topology information
  - Multivariate analysis, NN
- However, limitations seen are intrinsic
  - Fluctuations, loss of information
- Ł Containment is unbeatable



# Plans

- Upcoming Conferences
  - CALOR’08 (Pavia, 26-30 May)
  - ECFA ILC Workshop (Warsaw, 9-12 June)
  - NDIP 2008 (Aix les Bains, 15-20 June)
  - ICHEP’08 (Philadelphia, 29 July-5 August)
  - PSD8 (Glasgow, 1-5 September)
  - IEEE (Dresden, 19-25 October)
  - IPRD08 (Siena, 1-4 October)
- 16 Abstracts submitted to CALOR’08; 4 to ICHEP.
- Papers/Analysis notes
  - ECAL Commissioning paper (Anne-Marie)
  - ECAL electron response paper (Cristina)
  - Three AHCAL notes planned
  - “Final” ScEcal note on 2007 data