ALEPH 86-60
6.5.1986 Distr.:EMCAL

ALEPH-EMCAL off-line meeting, Glasgow University
on 09.04.86

Presents (see list)

ALBANESE J.P.	Marseille	LEFRANCOIS J.	LAL
AUBERT J.J.	Marseille	LLOYD OWEN D.	SACLAY
BONISSENT A.	Marseille	MICHEL B.	CLERMONT FERRAND
BOUARD G.	LAL	MARCH P.	ROYAL HOLLOWAY
CALLOT O.	LAL	MARTIN D.	GLASGOW
CHASE R.L.	LAL	MORRISSEY	RAL
CLIFFT R.	RAL	NORTON P.R.	RAL
CORDIER A.	LAL	PAYRE P.	MARSEILLE
HANSEN J.D.	COPENHAGUE	SMITH K.	GLASGOW
DUGEAY S.	LAL	TALEBZADEH	RAL
EDWARDS M.	RAL	THOMSON A.S.	GLASGOW
FLAVELL A.	GLASGOW	VEILLET J.J.	LAL
HUGUES I.	GLASGOW	VIDEAU H.	POLYTECHNIQUE
KARYOTAKIS	POLYTECHNIQUE	VIDEAU I.	POLYTECHNIQUE
KNOBOLCK	DORTMUNT	WITTAKER J.B.	RAL

TOPICS

1) Geometry definition of cells in e.cal ; remarks on shower integration (J.Badier-Ecole Polytechnique).

2) Status of Ecal-simulation in the Monte-Carlo (S.Karyotakis-Ecole Polytechnique)

3) Progress on Ecal/Hcal algorithm to identify neutral energy Hcal (A.Bonissent-Marseille)

4) Data analysis for the 1986 test run (B.Michel-Clermont-Ferrand)

5) Frame for Ecal reconstruction program (M.Green-Royal Holloway College)

6) Geometrical definition of Ecal detector - Comments on graphic situation (H.Videau-Ecole Polytechnique)

3

J. Badier

GEOMETRICAL DEFINITION of STOREYS and TOWERS

1 storey = 8 points = 24 coordinates
1 Tower = 24 points = 72 coordinates

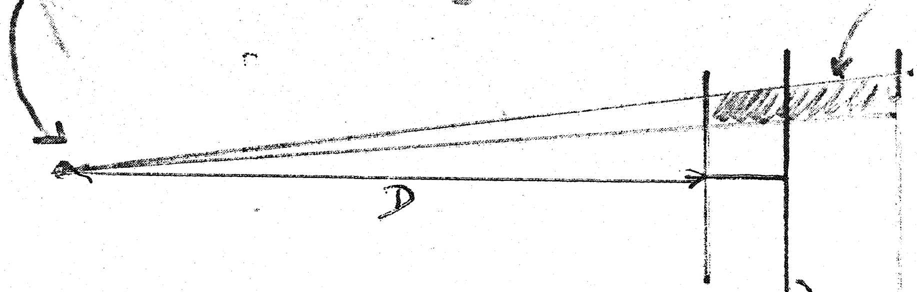
Such a definition is strongly redundant

- Attributs of one module.

• | 1 || 2 || 3 |

Distances between input and output planes of the stacks

• Point of convergence of the towers



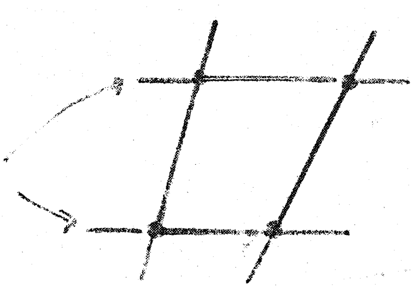
referential plane to be defined

- Attributs of one tower

• Module number

• Intersection with referential plane of the module

2 lines



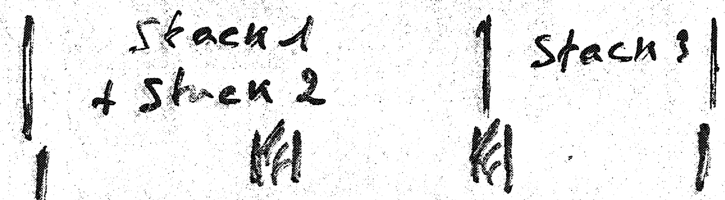
4 points = 8 coordinates
in fact TRAPEZE
= 6 parameters

RULES for approximations

Approximations are made and will be.

- For instance

  Monte-Carlo : only two adjacents modules



WHAT IS THE RULE TO PASS FROM THE TRUE TO THE SIMPLIFIED DESCRIPTION.

- Another example

  In the reconstruction program, it will be simple to consider that the line of flight of a photon is passing by the module convergence point.

  SEVERAL WAYS TO INSURE SUCH A CONDITION

  - Convergence point is the Aleph center
  - γ line of flight passing by the impact point and the convergence point
  - etc...

ALL THE RULES ARE GOOD BUT EVERYBODY HAS TO USE THE SAME

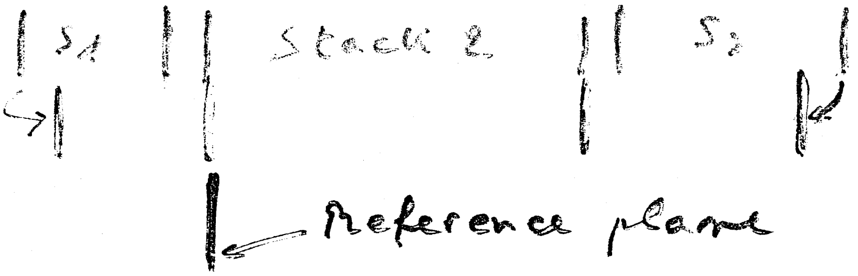
- MANY OTHER EXAMPLES

SOME PROPOSITIONS

- Distance between stacks.

STACK 2 is the more important

Mean medium have to be the mean layer.

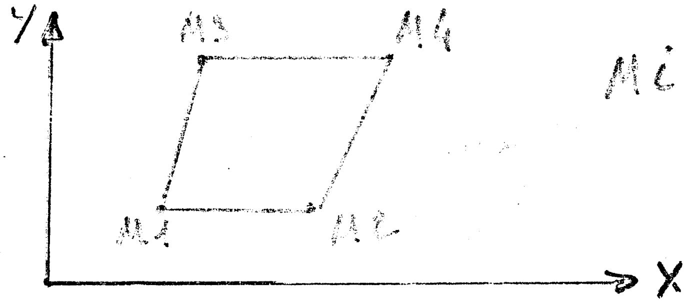


- Line of flight of a γ

Defined by the impact in the reference plane and the convergence point of the modules.

Module may be tilted by respect to the theoritical position.

- Tower description



$Mi = (Xi, Yi)$

Intersection of tower with a plane NON parallel to the reference is not a Trapèze

$Y2 = Y1 \quad , \quad Y4 = Y3$

$M1 = X1, Y1$

$M2 = X2, Y1$

$M3 = X3, Y3$

$M4 = X4, Y3$

IT MAY BE ANOTHER RULE BUT RULE is a NECESSITY

CONCLUSION

It is important to have only one way to calculate geometrical quantities, starting from the DATA BASE.

For instance limit between stack 2 and stack 3.

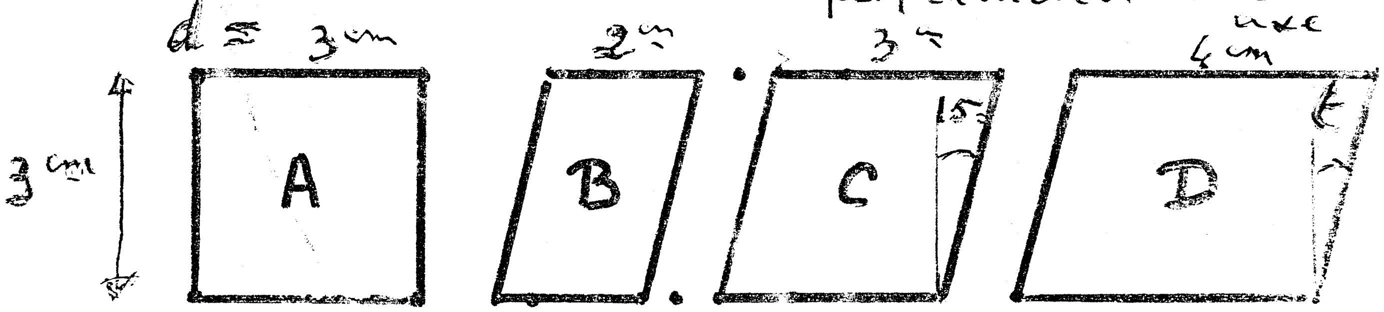
J. Badier

INTEGRATION of a DISTRIBUTION on a TOWER

Knowing the spatial distribution of a shower, what is the better way to estimate the mean signal of a tower?
The results presented here were obtained with the parametrisation of electromagnetic showers. They would be valid for photon showers.

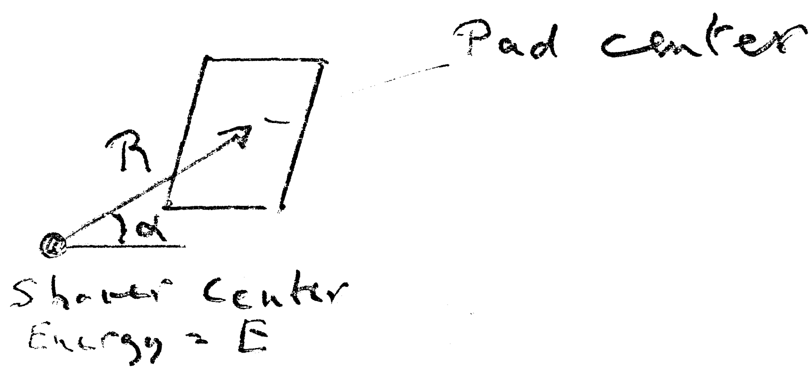
Shapes of Towers

Projected on the plane perpendicular to tower axe



Barrel | End Cap

Towers positions

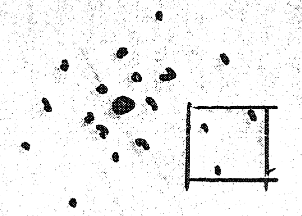


Parameters

$\boxed{R}$, E, α, d, t

METHODS of INTEGRATION

I. Random generation



Points are generated.

Signal ~ number of points inside the pad

Precision: n points/GeV $\Rightarrow \frac{\Delta e}{e} = \frac{1}{\sqrt{n e}}$

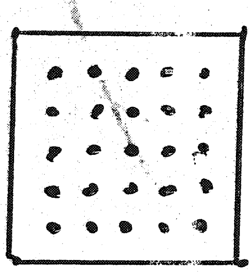
$$\boxed{n = 25 \longrightarrow .2/\sqrt{e}}$$

EMCAL GALCPH PRECISION

Reference

$$n = 100 \Rightarrow .1/\sqrt{e}$$

II. Predetermined points



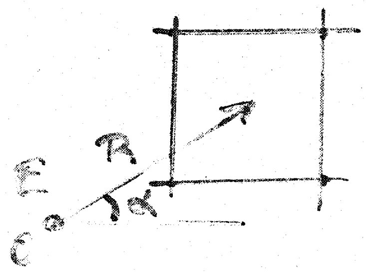
N points $i = 1, N$

$$\text{Integral} = \frac{\sum f(i)}{N}$$

I have compared methods with:

$$1, 4, 16, \underbrace{36, 144, 324}_{\text{RGAUSS}} \text{ points}$$

III. Direct Parametrization

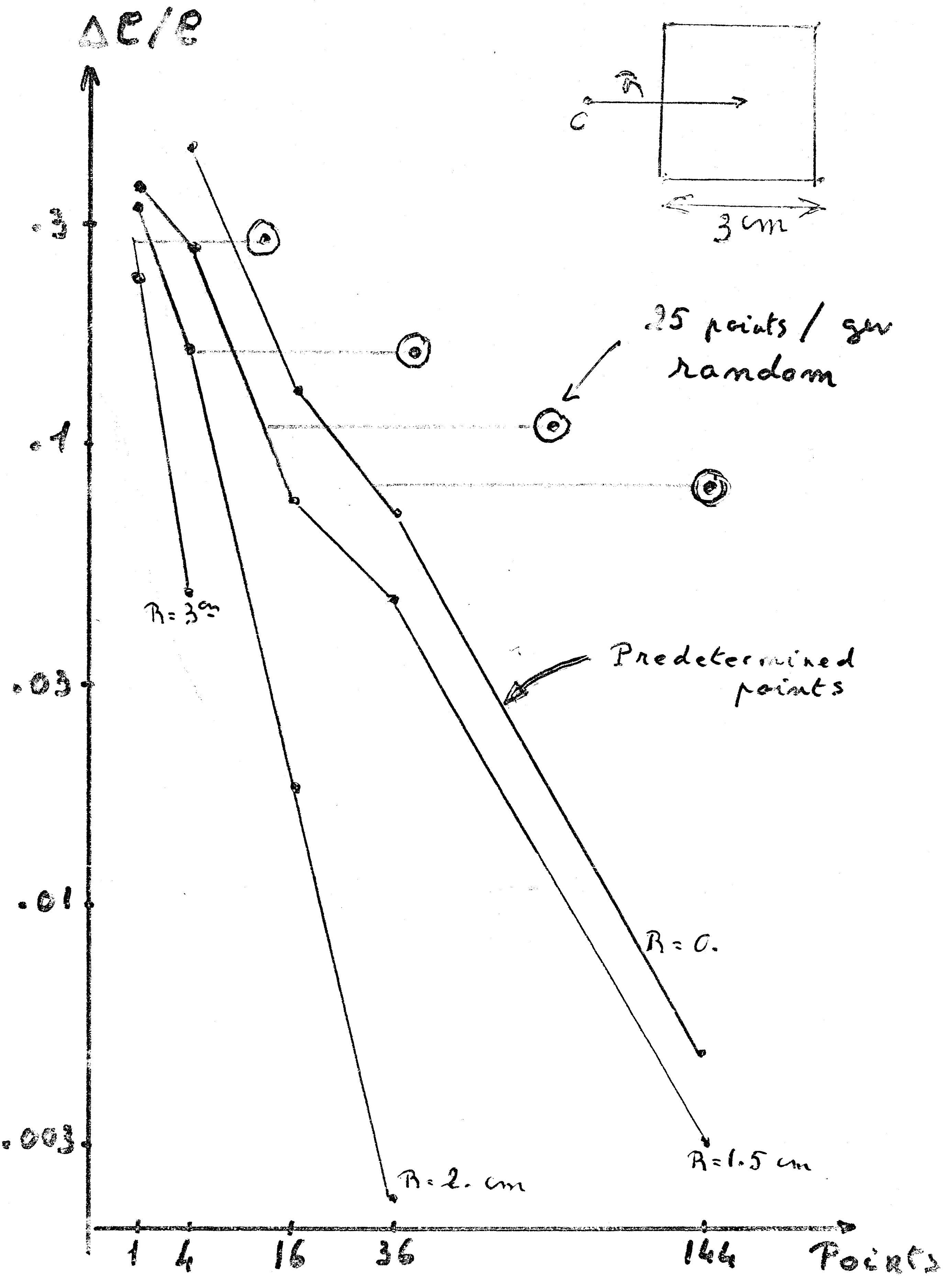


$$e = \frac{A E S}{1 + \left(\frac{R - C}{B}\right)^n}$$

A, B, C, n = constants or slightly dependent of

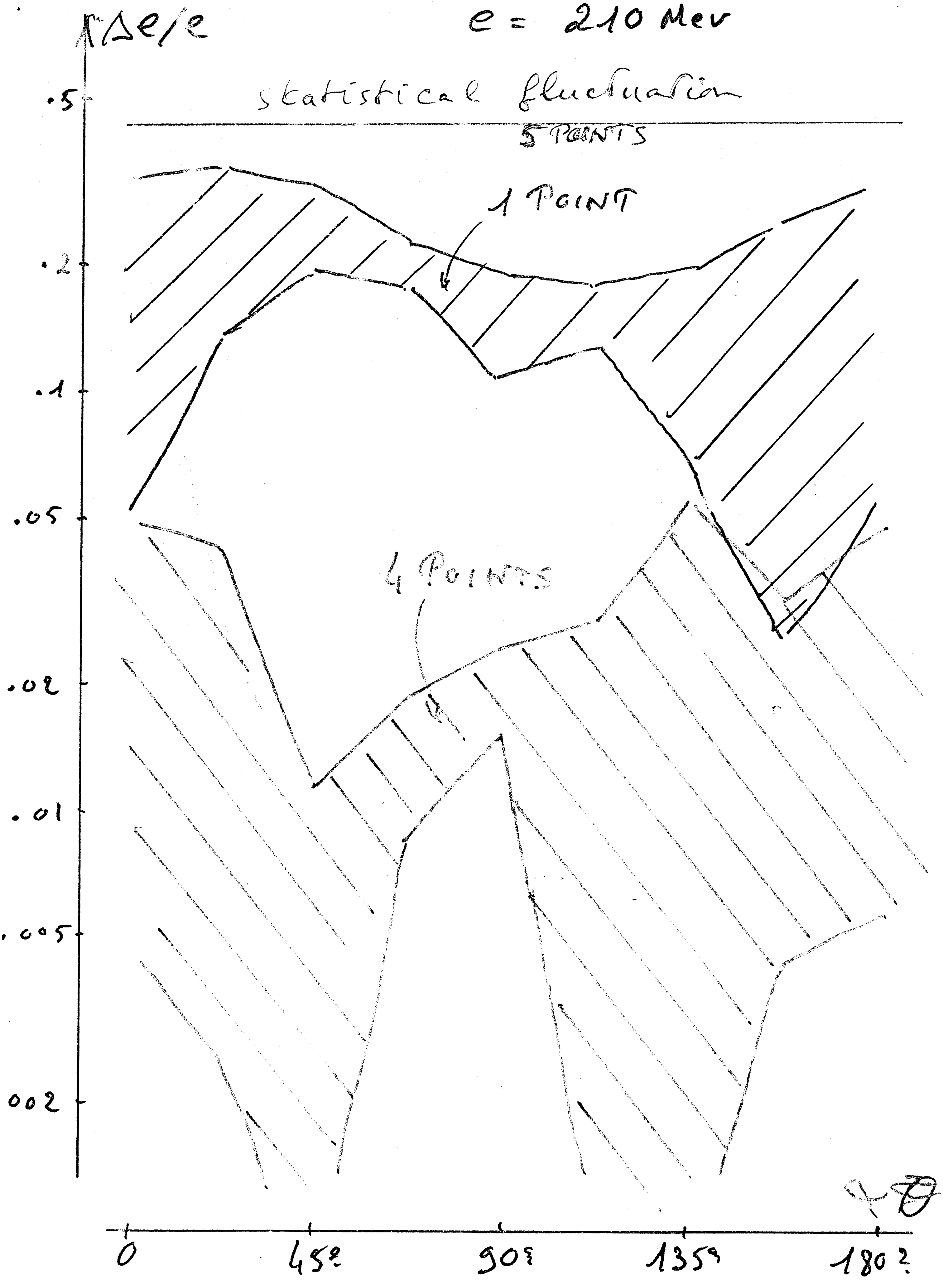
S = surface

E = 10 gev



ΔE/E
.3
.1
.03
.01
.003
c
3 cm
.25 points / gev
random
Predetermined points
R = 3cm
R = 0.
R = 1.5 cm
R = 2. cm
1
4
16
36
144
Points

E = 10 gev R = 4 cm
e = 210 Mev

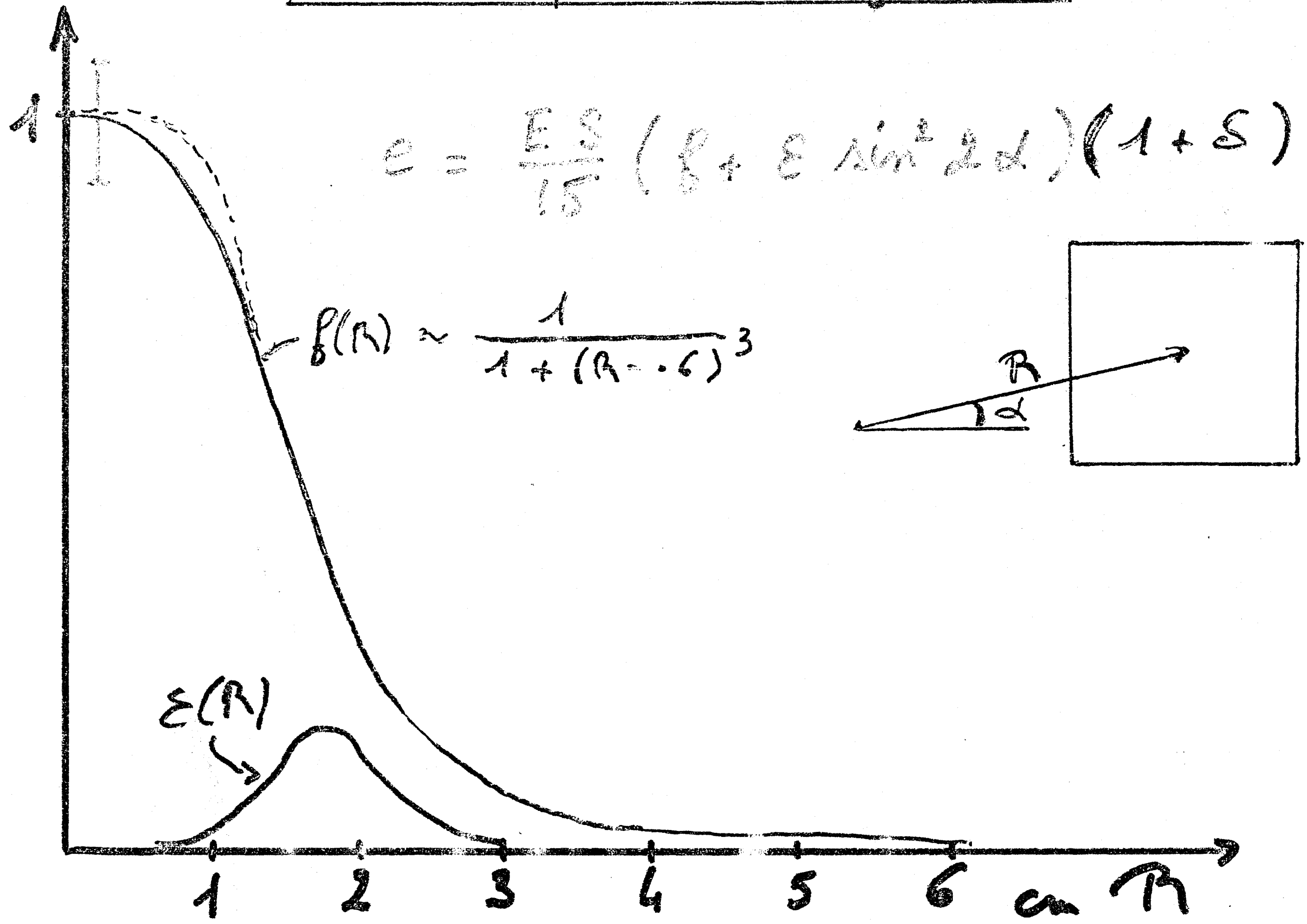


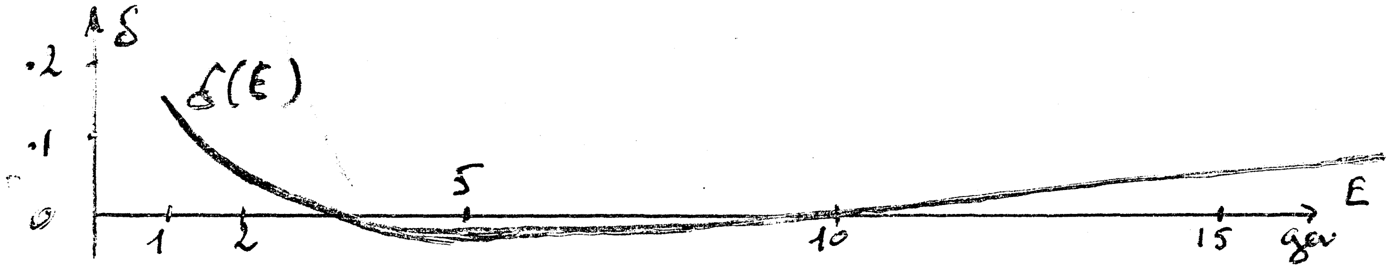
.3 1	.5 1	1 1	.5 1	.3 1
.5 1	3 1	10 4	3 1	.5 1
1 1	10 4	150 16	10 4	1 1
.5 1	3 1	10 4	3 1	.5 1
.3 1	.5 1	1 1	.5 1	.3 1

- Random generation
- Integration

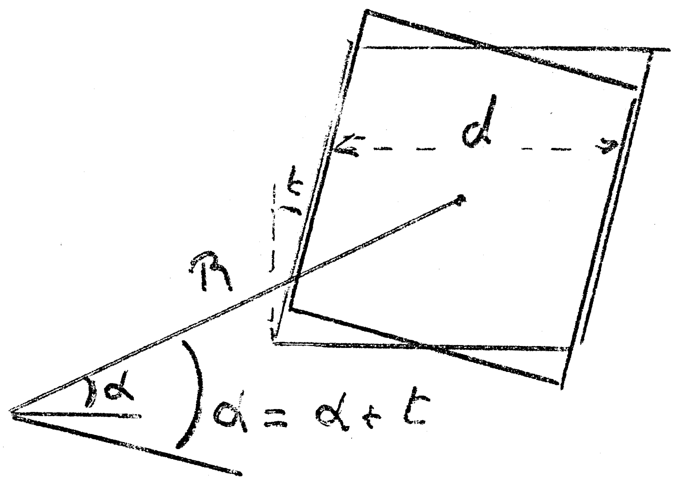
Barrel parametrization

$$e = \frac{E\,S}{15}\left(\beta + \varepsilon \sin^2 2\alpha\right)(1+\delta)$$

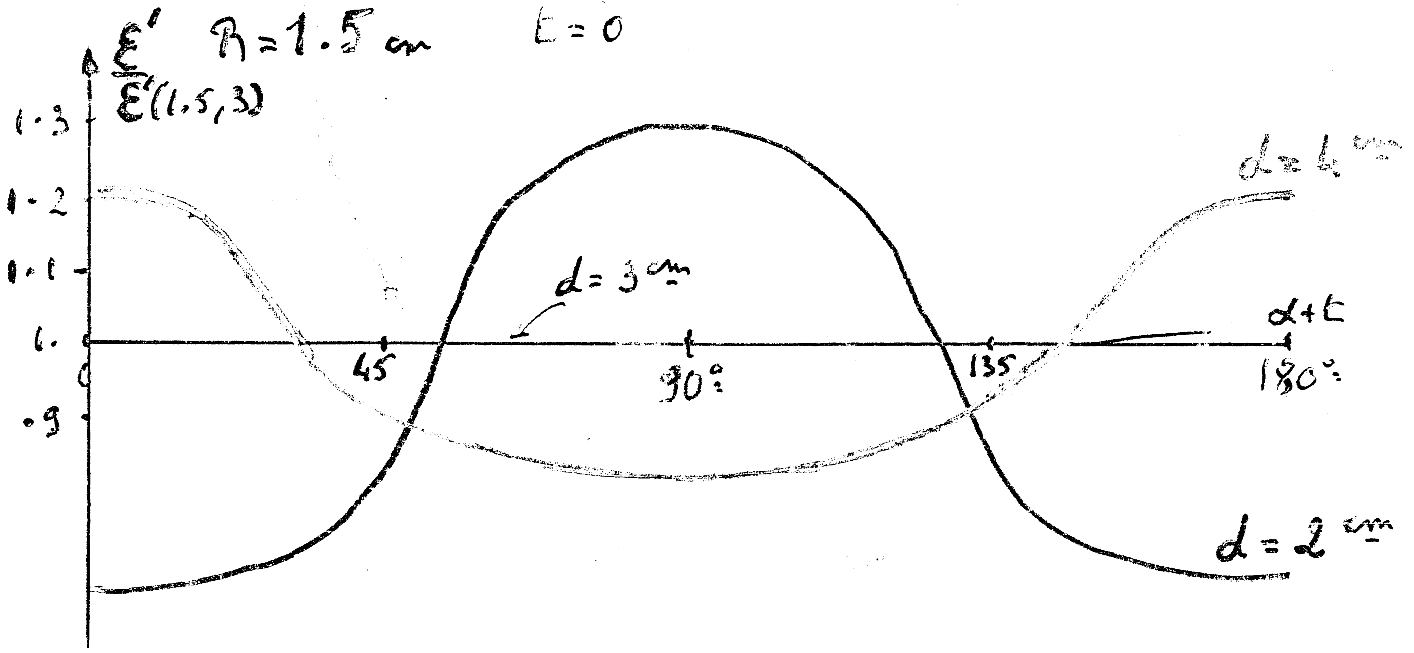


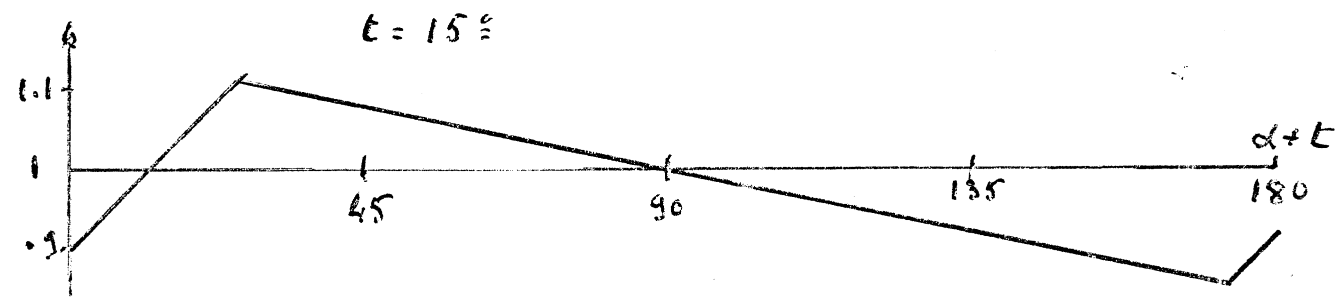


End Cap paremetrigation



$$e \sim f + \varepsilon'(R, d)\,\sin^2 2(\alpha + t)$$





CONCLUSION.

Several methods to estimate a tower signal

A - Random generation of points

25 points/gev $\longrightarrow$ $.2/\sqrt{E}$

B - Direct parametrization

— crude formula $1./(1.+(R-.6)^3)$

$\hookrightarrow \sim .2/\sqrt{E}$

— Corrective terms

C. Integration

$R > 4$ cm	1 point	$E = 10$ gev
$R < 4$ cm Non impact tower	4 points	
Impact tower	16 points	

$\Delta E \simeq 3$ to 10 smaller than A

But

A give statistical errors

B and C systematic errors

A good for Monte-Carlo: adding 10^3 events, precision is keeped on mean values.
B and C good for separation criteria in a reconstruction program

The ECAL Simulation status.

S. Karyotakis

→ TRACKING

Create Track elements

Tune the GEANT3 tracking constants, for an homogeneous medium.

→ HITS Deposited energy by a track element.

Create analog signals.

→ Track element if $E > E_c$ 'tuned'

→ Shower if $E < E_c$ to be tuned.

Energy deposition, Read-out geometry, BOS Banks.

→ DIGITIZATION Digitize a hit.

→ Gain

→ Noise

→ Zero suppression

BOS Output.

→ TRIGGER Signals

Construct trigger signals as hardware does

BOS output.

A 1st Version is working

Writeup is also in progress.

OUTPUT.

BOS Banks.

Hits

- Towers 'ETHT'
  $Ad / S_1 / S_2 / S_3$

- Wires 'EWHT'
  Ad / 45 words ; on for each plane.

Digits.

- Towers 'ETDI"
  Same structure as ETHT

- WIRES 'EWDI'
  Same structure as EWHT.

Trigger

'ETTR"
$12\ (\theta \text{ regions}) \times \{ 24\ \varphi \text{ regions} \times 3 \text{ stacks} \}$

"EWTR'
$2 \times (3 \times 12$ regions.)

History.

'ETTD' , 'EWTD"
tracks to Towers and digits.

'EDNO'
Noise + Gain for each tower stored.

Create analog signals.

Electrons & photons.

Signal ~ Energy deposited by the track element computed by GEANT3

Hadrons + μ

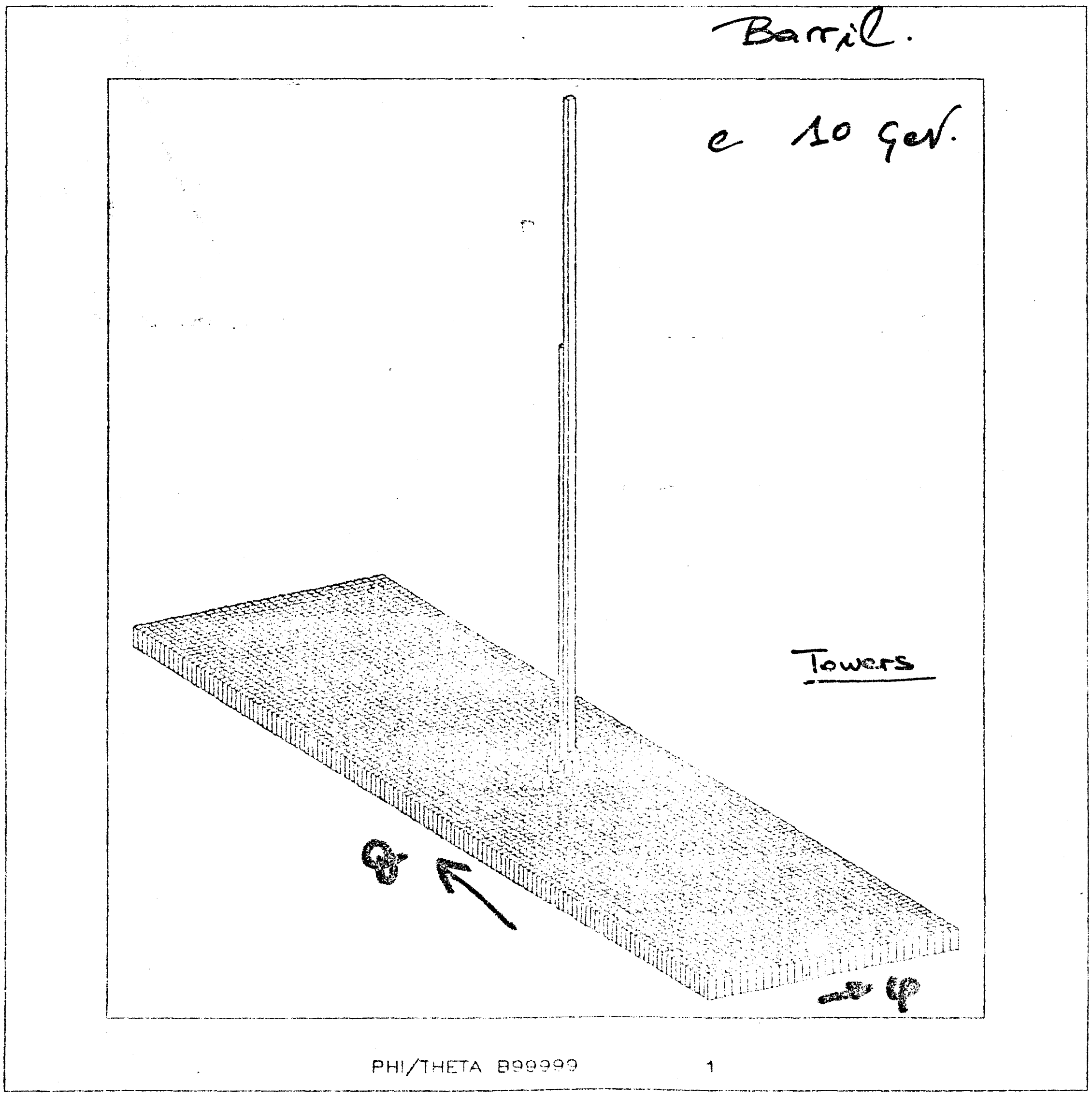
Signal ~ Length of the track element.

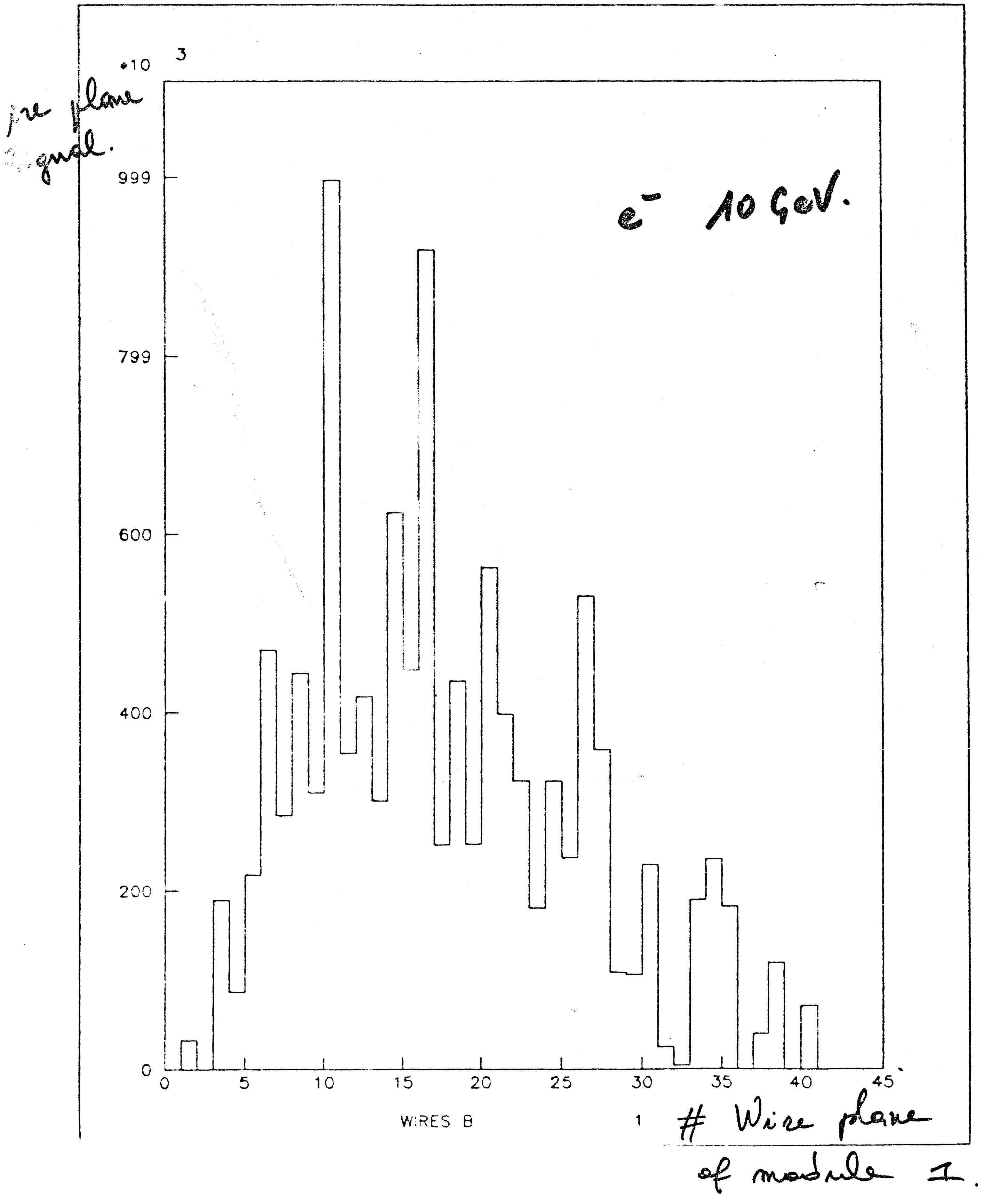
A program reading the Monte-Carlo events and the future Test data is available.

- Read BOS Banks EPIO / Natif
- Clear debug of BOS banks.
- Plots using HPLOT barril modules
- Cluster finding.

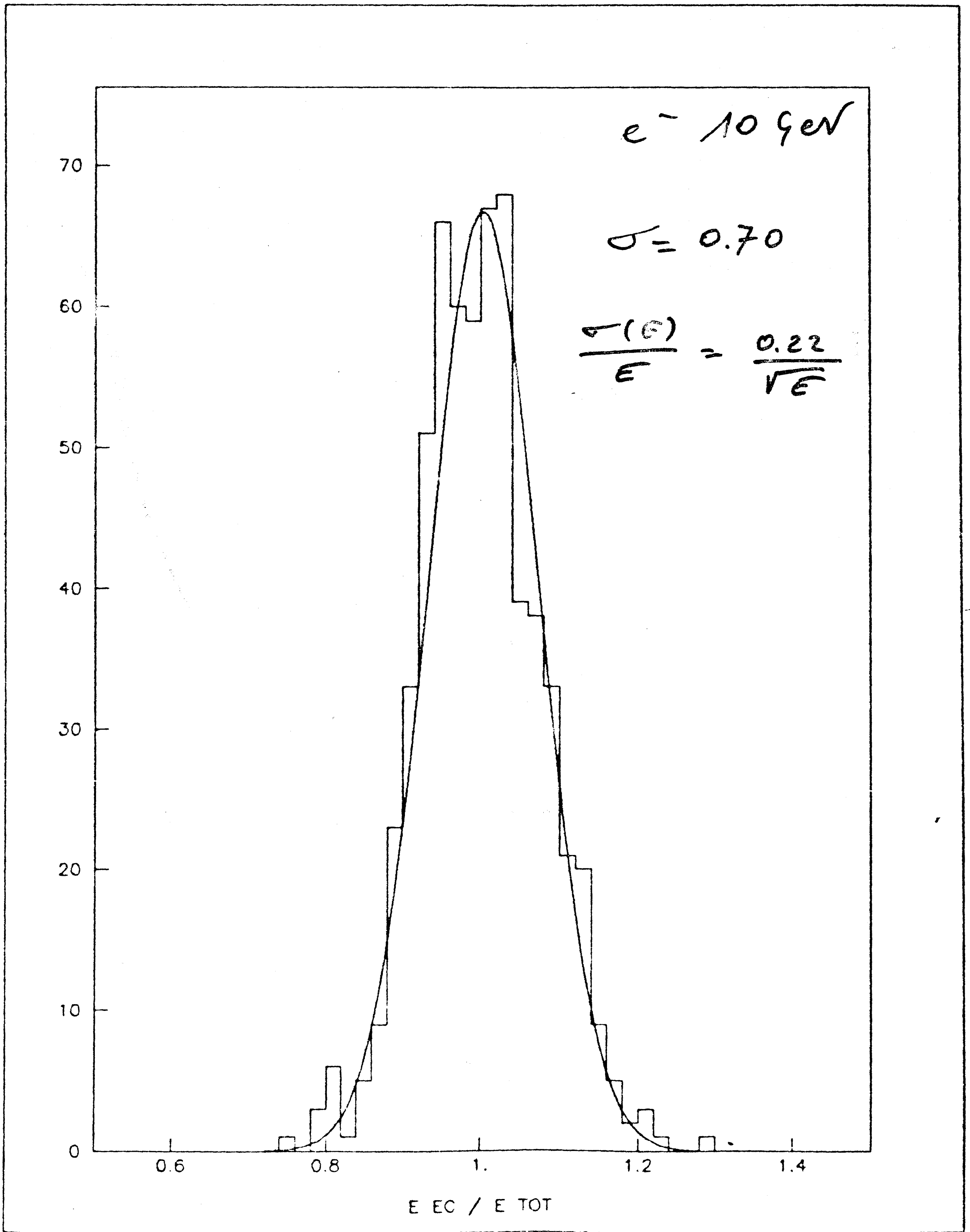
Main purpose: Compare Data to Monte Carlo, test algorithms for reconstruction.

Electron event as seen in the barril towers.





*10 3
999
799
600
400
200
0
0 5 10 15 20 25 30 35 40 45
WIRES B 1
e⁻ 10 GeV.
...ire plane
...gnal.
Wire plane
of module I.

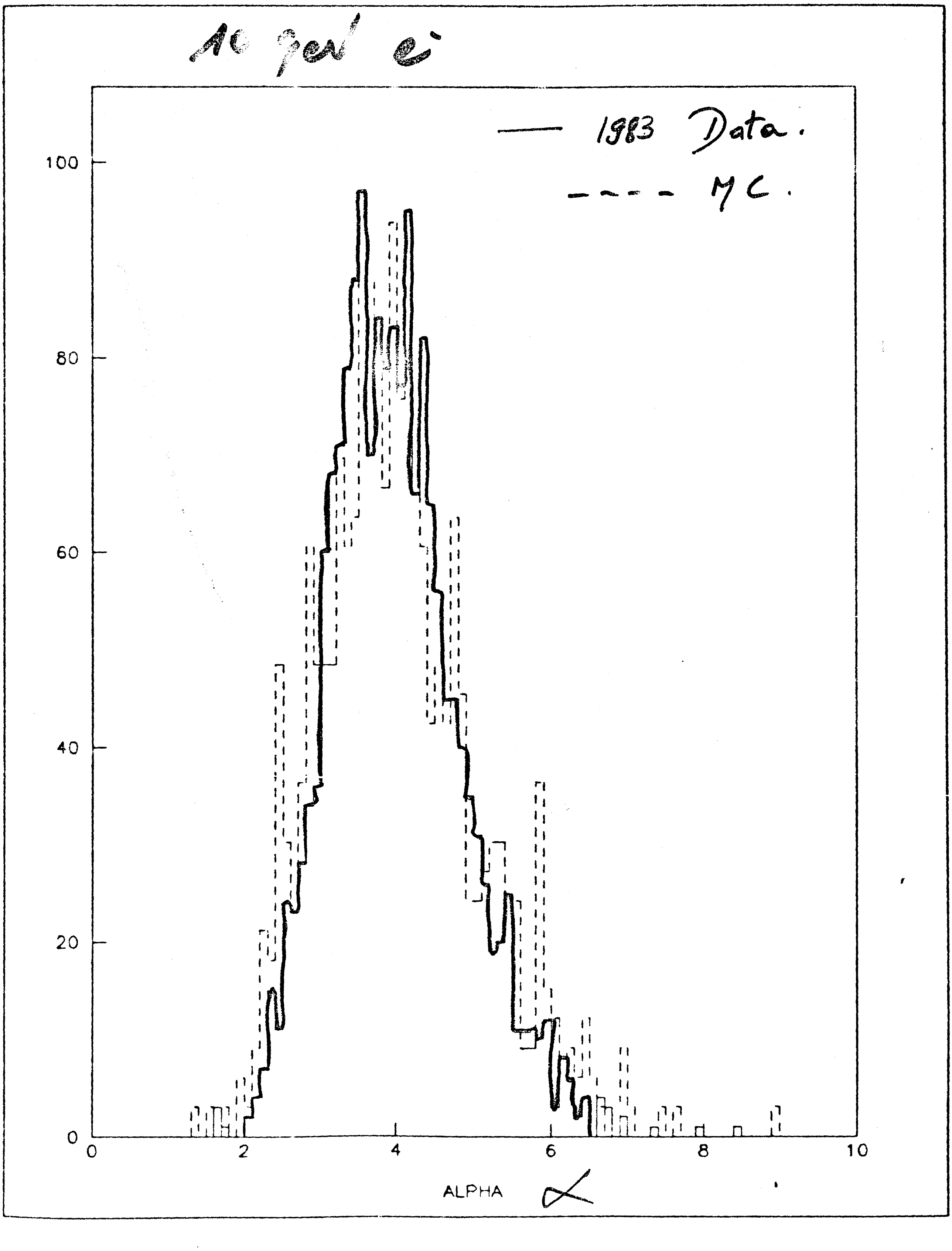


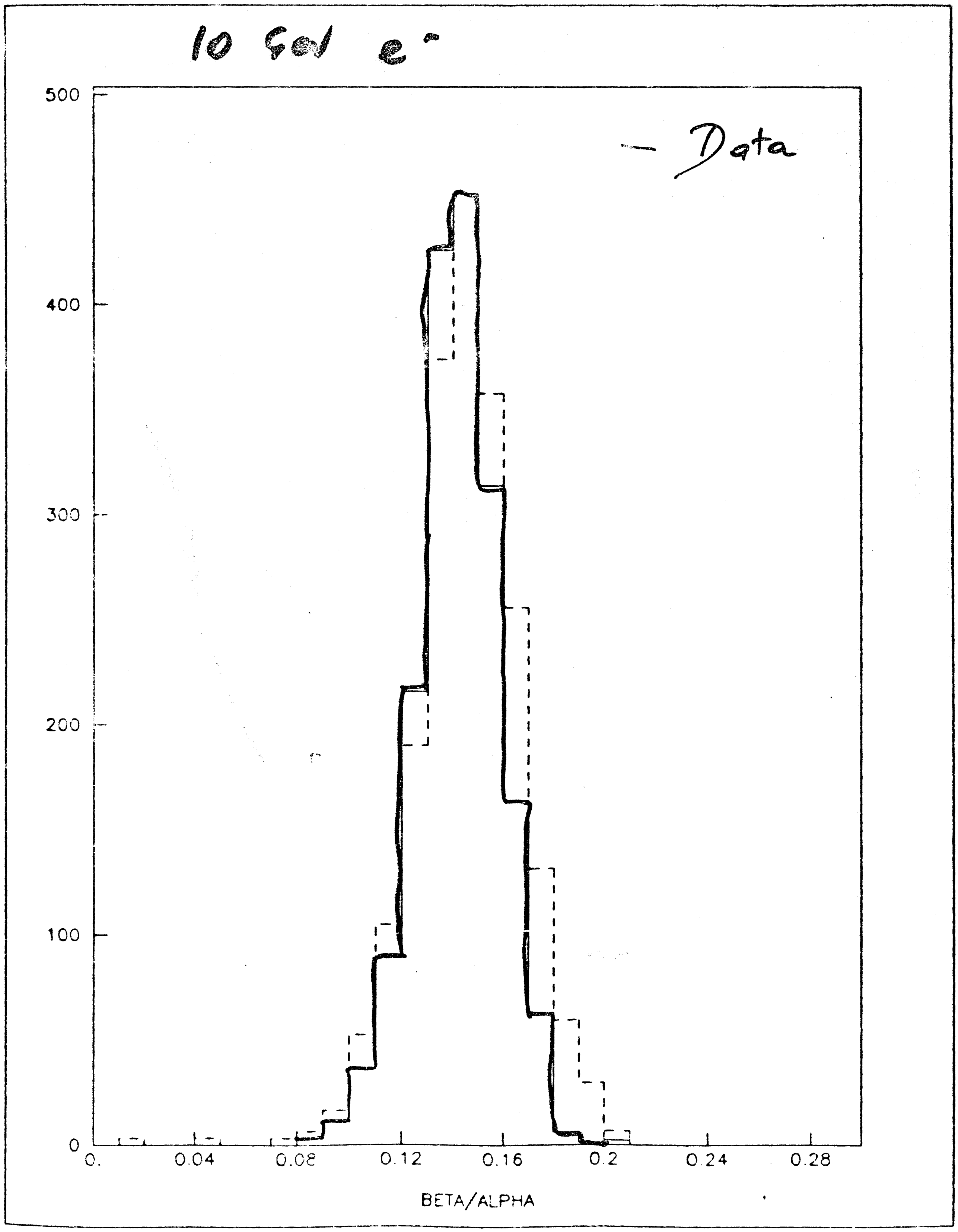
Ecalorimeter

Longitudinal distribution.

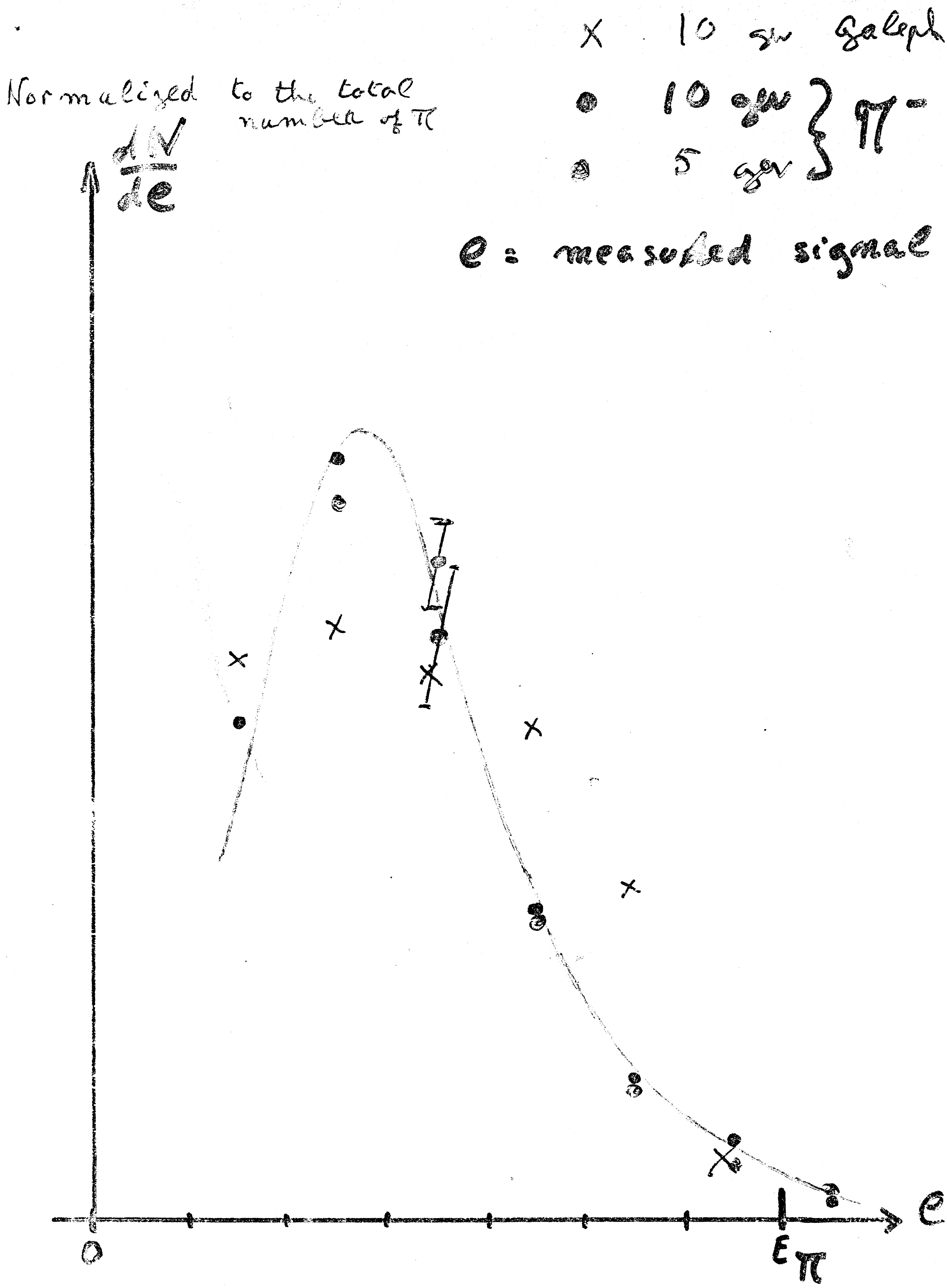
$$\frac{dn}{dl} = \left(A_1 s^{\alpha-1} + A_2\right) e^{-\beta s}$$

s: radiation length.



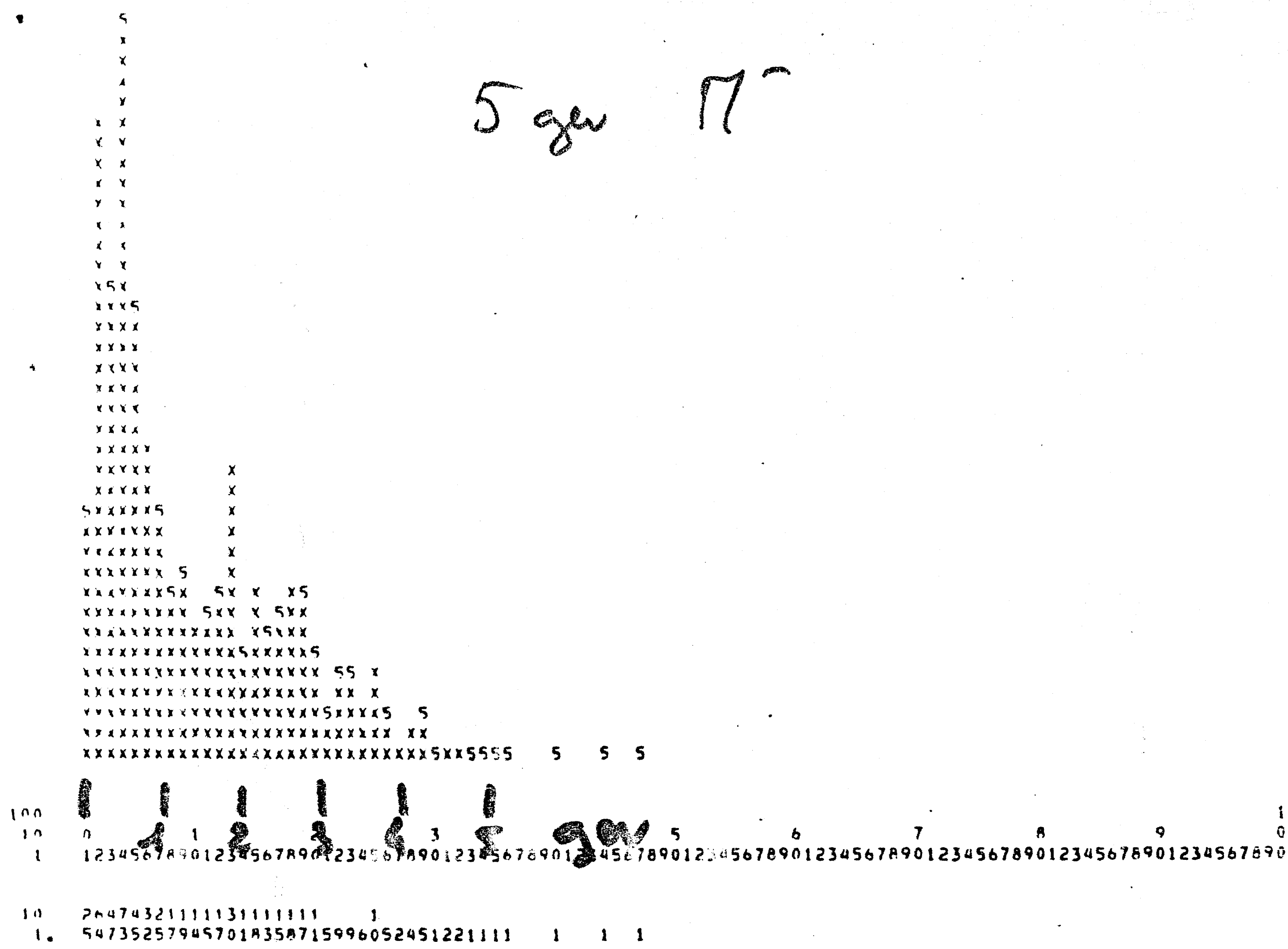

10 GeV e⁻
— Data
500
400
300
200
100
0
0.
0.04
0.08
0.12
0.16
0.2
0.24
0.28
BETA/ALPHA

β/α.

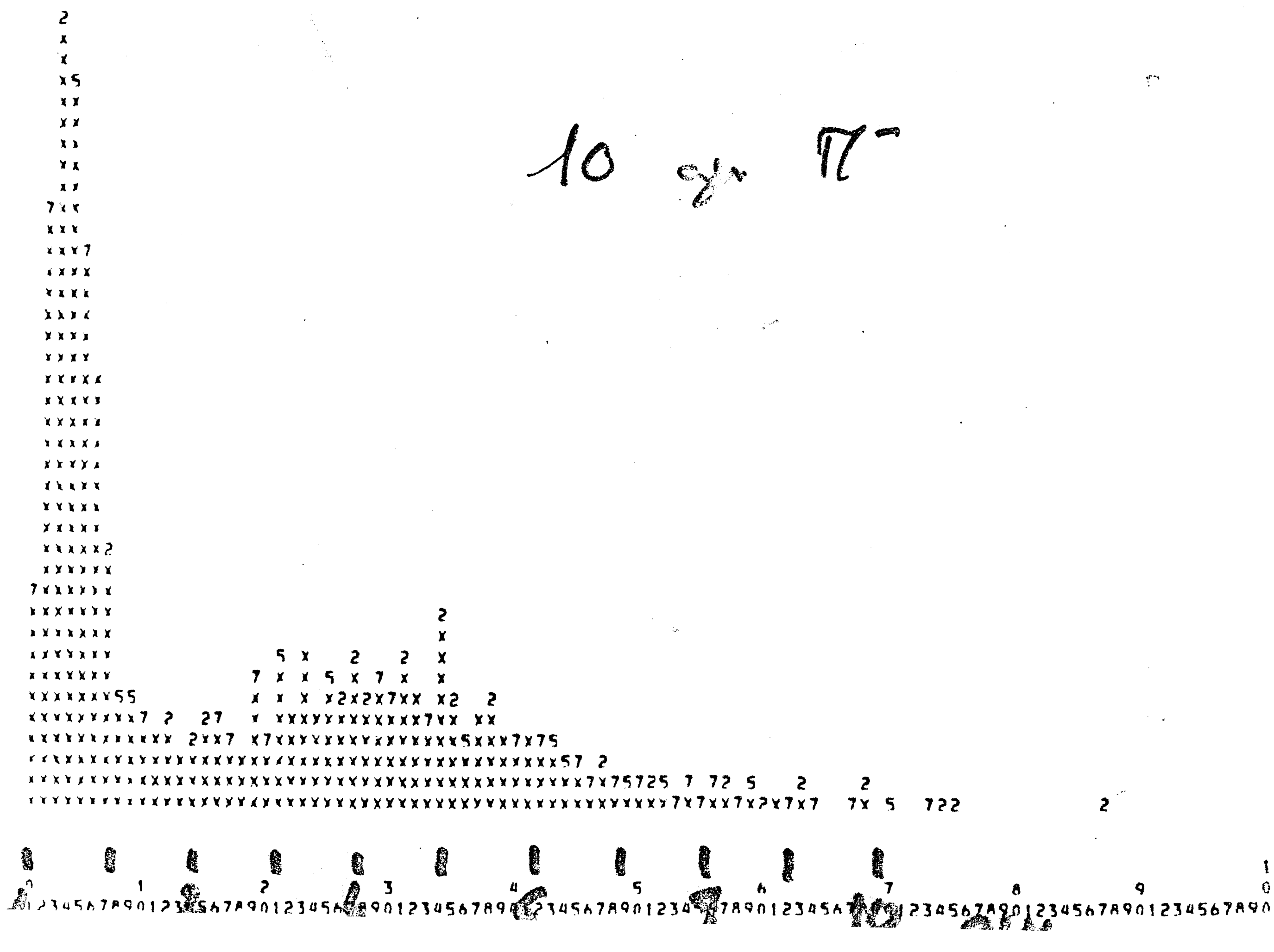


Normalized to the total number of π
dN/de
10 gev
10 gev
5 gev
π⁻
e : measured signal
0
Eπ
e

5 gev π^-



10 gev π^-



A. Bonissent

Search for neutral energy

- π-γ overlap, clusters identification and e.m. energy determination.
  Michel Belliard.

- Identification of neutral clusters in the hadron calorimeter.
  Alain Bonissent.

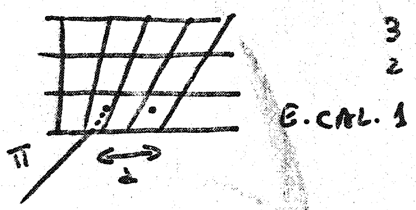
C.P.P.M

DECONVOLUTION of the E.M. ENERGY in the E.CAL. ($\pi\gamma$) clusters –

_ Monte carlo and experimental approach –

- PREVIOUS RESULTS on MONTE CARLO (Galeph. 2):

→ 3 tests:



* energy balance between cluster and track

* distance (d)

* compactness of the energy deposition in Levels 1 and 2.

→ RESULTS ON Galeph presented during previous Ecal meeting and published (e.m. col. 86-0?)

10^5 ($\pi+\gamma$)

* **42%** are characterized, and they carry **73%** of the total e.m. energy of the sample.

* no contamination by isolated π

* Mean values of incident particles

π : 5 GeV

γ : 2 GeV

- REFINED ALGORITHM:

* Adjusting parameters of balance test

* Replacing compactness test at level 1+2 by a compactness test at level 1.

⇒ * 54% ± 5% of ($\pi\gamma$) clusters are characterized, and they carry 83% ± 4% of the total e.m. energy of the sample.

* Isolated π contamination ~ 6‰

- (πe) CHARACTERIZATION with EXPERIMENTAL DATA:

→ data from 90° and 45° E.CAL. tests at C.E.R.N.

→ 1000 (π e) clusters with RNDM distances according to MONTE CARLO

→ Tagging ALGORITHM RESULTS:

$\pi^{\pm}$ \ $e^{\pm}$	2 GeV	5 GeV
5 GeV	50% ± 2%	99% ± 1%
10 GeV	43% ± 2%	93% ± 1%

E.M. energy deconvolution:

Method:

* e.m. contribution is proportional to the energy in levels 1 and 2, from 5 towers located on the leading storey at level 1.

hadronic contribution in these storeys, parametrized by the distance to the track, is subtracted.

* e.m. energy calibration function:

$$E_\gamma = a E_5 + b$$

> Results on Monte carlo data (Lund events)

* 54% ± 5% of $\pi\gamma$ clusters are labelised
* Average energy contribution of the γ in tagged ($\pi\gamma$) clusters:

EXACT: 3.0 GeV

ESTIMATED: 3.1 GeV

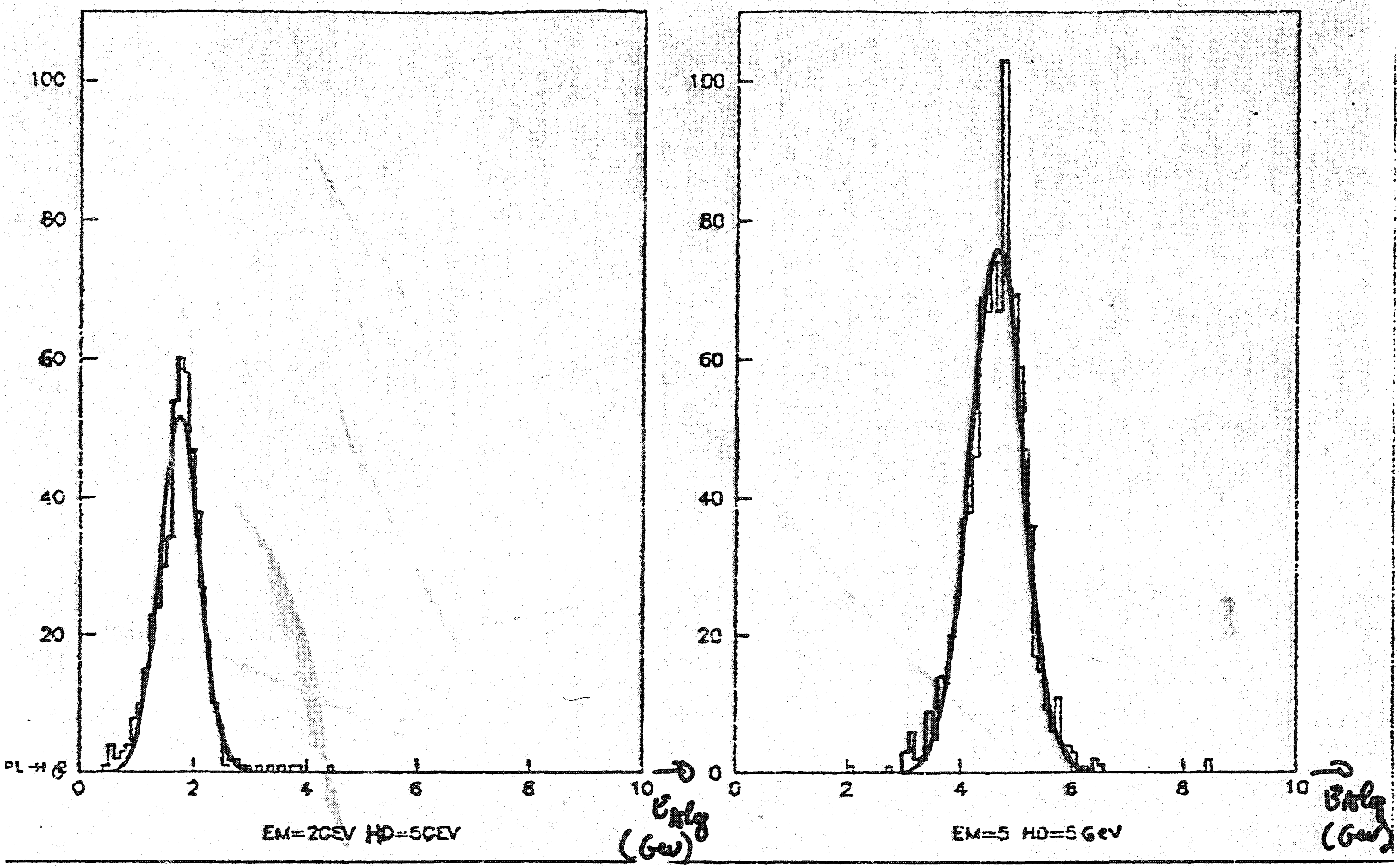
> Results on experimental data:

$\pi^\pm$ \ $e^\pm$	1.9 GeV	4.8 GeV
5 GeV	50% ± 2% 1.75 GeV 29%	99% ± 1% 4.7 GeV 23%
10 GeV	43% ± 2% 1.8 GeV 29%	93% ± 1% 4.75 GeV 23%
:	400 MeV	500 MeV

. % of tagged πe cluster

. e.m. energy estimation (M.V.)

. e.m. energy estimation ($\sigma = x\% \frac{E}{\sqrt{E}}$).



$e^{\pm}$ 2 GeV + $\pi^{\pm}$ 5 GeV
distance Rndm Montecarlo

| MV : 1.75 GeV
| σ : 400 MeV

~ 500 entries

$e^{\pm}$ 5 GeV + $\pi^{\pm}$ 5 GeV
distance Rndm Montecarlo

G. | MV : 4.65 GeV
| σ : 500 MeV

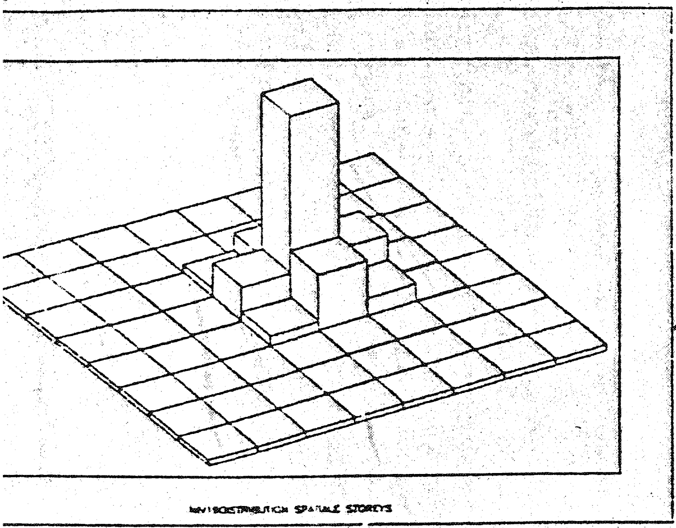
~ 990 entries

E_{alg} : estimation of the deposited e.m. energy

"Leading storey NiV. 1" Test:

$e^{\pm}$ 5GeV – Ecluster > 1GeV –

$\pi^{\pm}$ 10GeV – Ecluster > 1 GeV –



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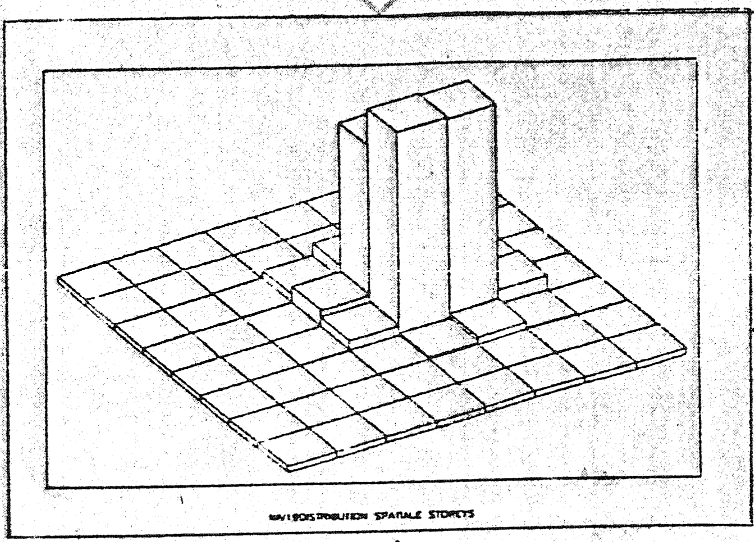
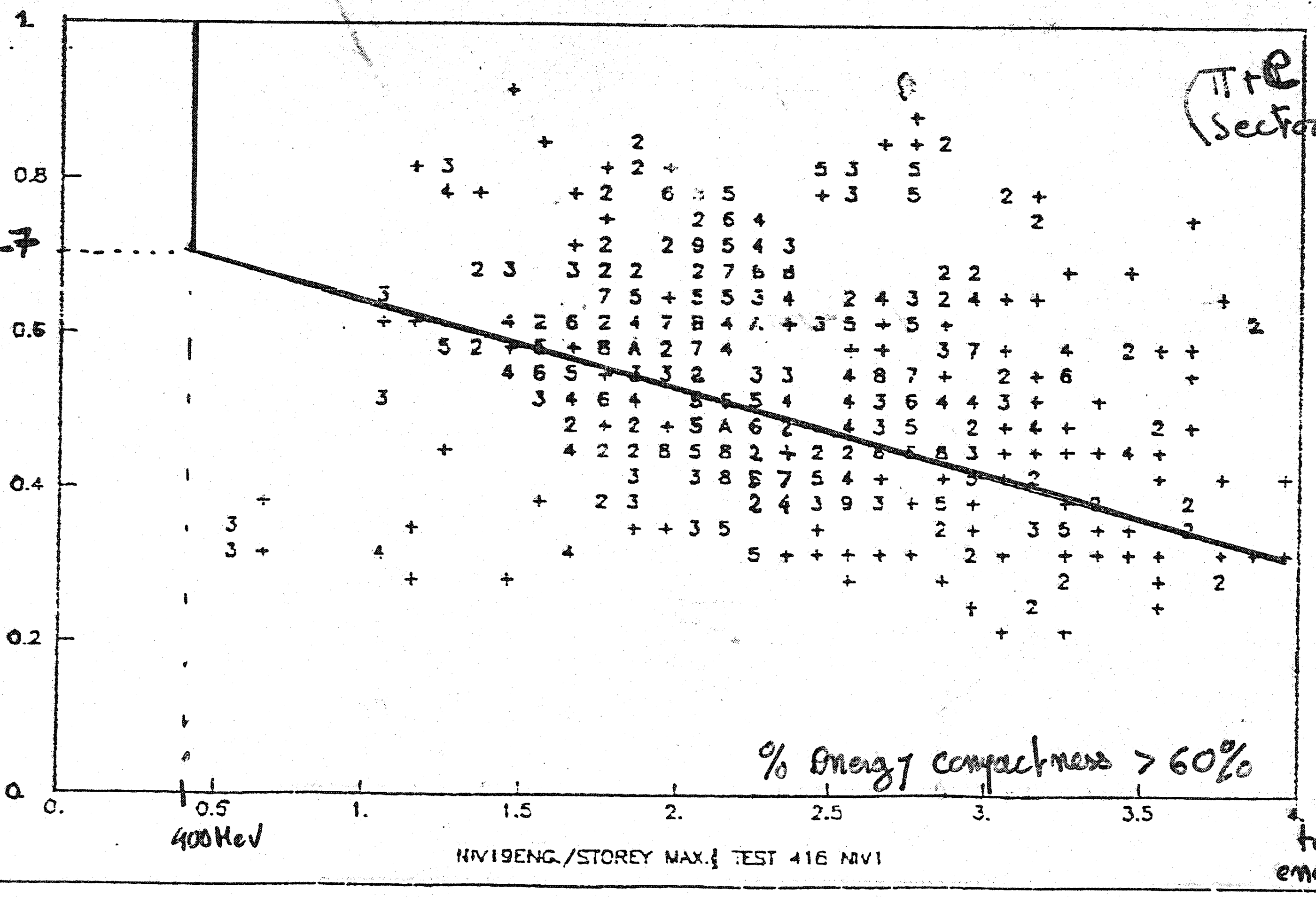


NiV 1 ECAL   Transversal distribution (Normalized)   NiV 1. ECAL

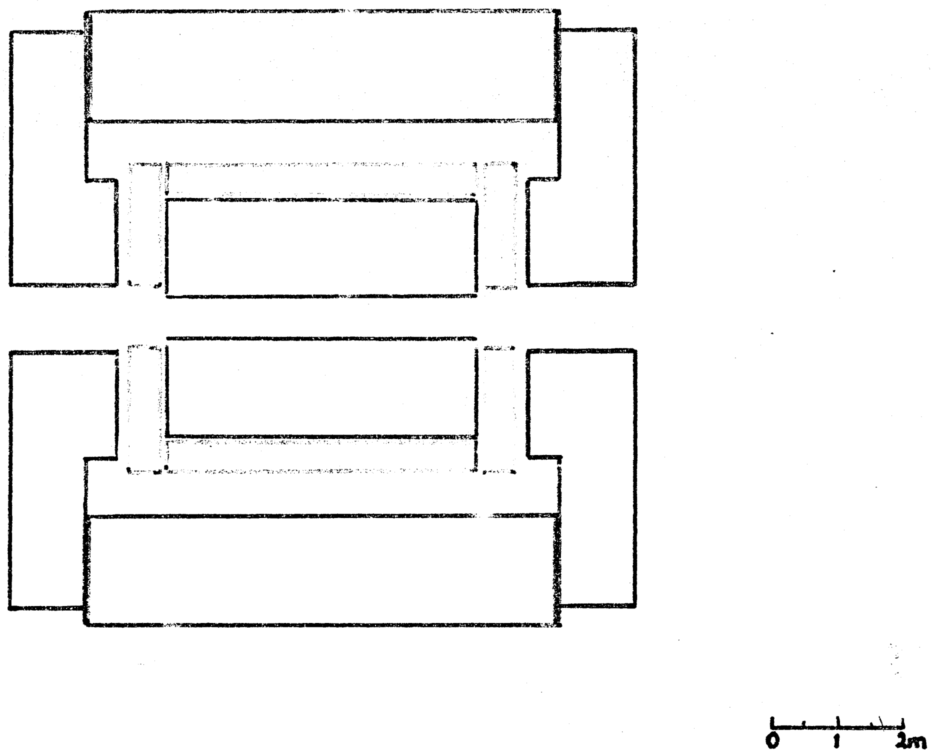
ding storey: of Level 1 gy calling



Sample: $e^{\pm}$ 5GeV – $\pi^{\pm}$ 10 GeV – distance RNDM Montecarlo –

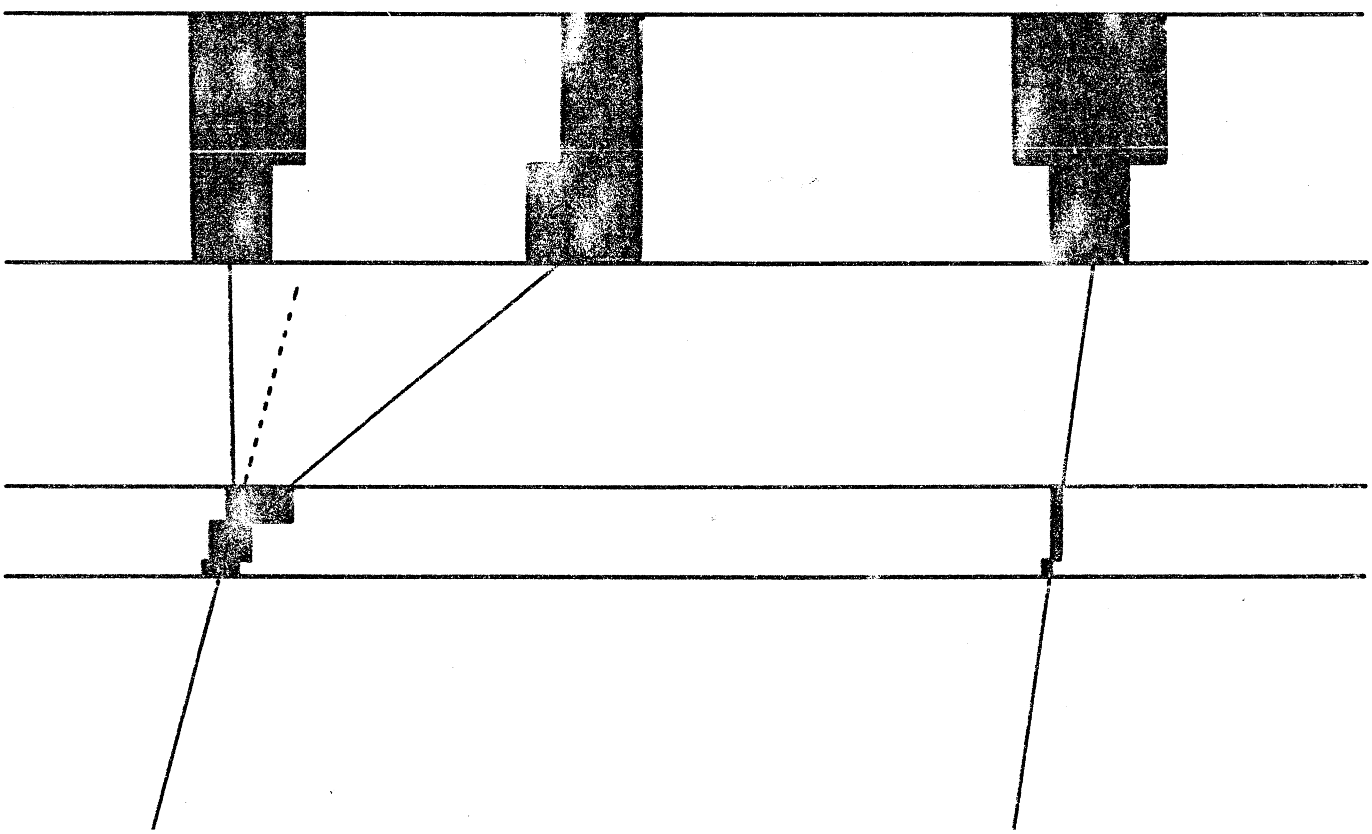
TPC

HCAL



.AL

'PC



Strategy for HCAL-TPC Association

- Extrapolate TPC tracks in ECAL, and associate with ECAL clusters

- Tracks associated with no ECAL cluster or with track cluster (M.I.P.) are further extrapolated for direct association with HCAL clusters.

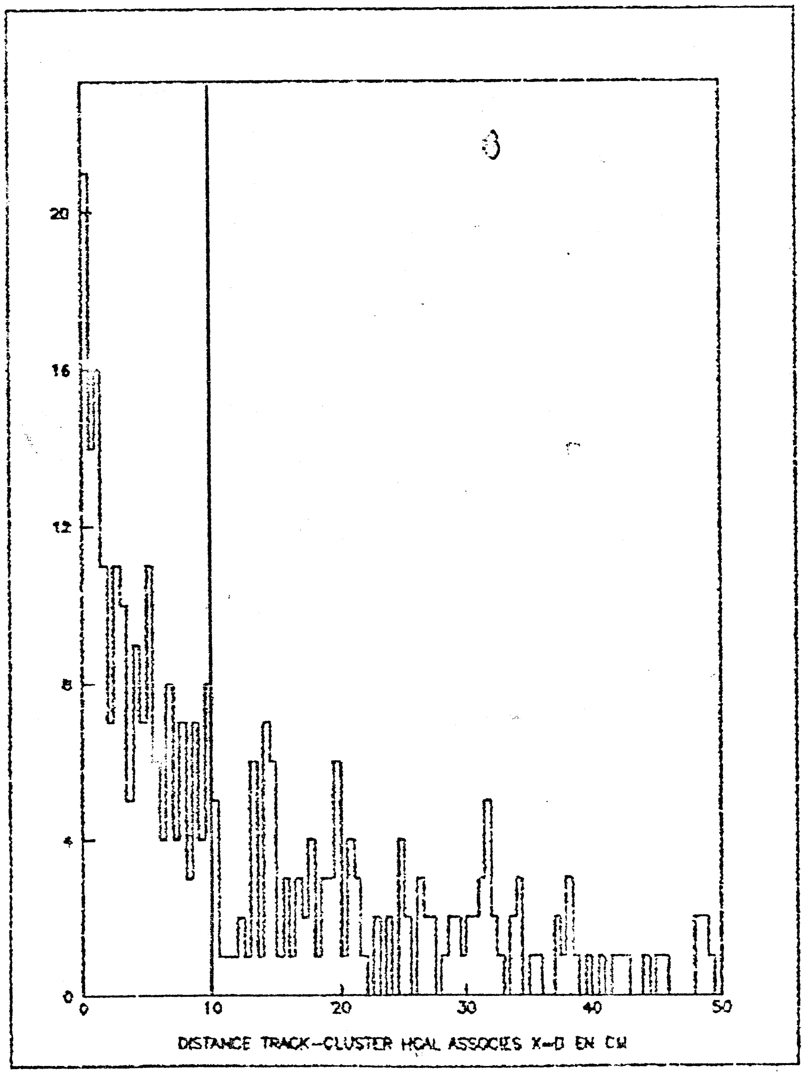
- Other tracks are associated with HCAL, through the ECAL cluster.

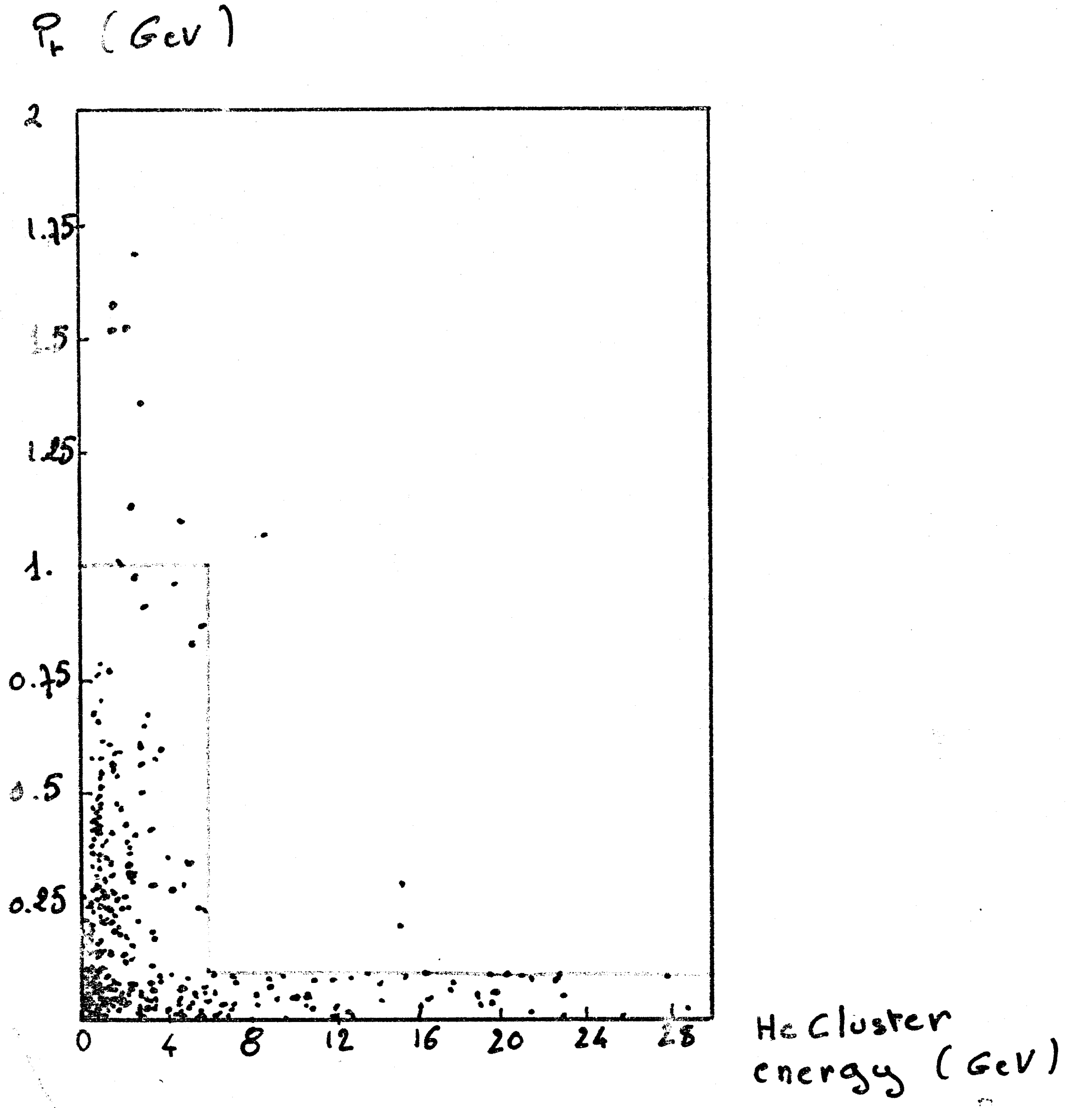
- All HCAL clusters which are associated to no TPC track are considered as neutral.

Minimum distance between one HCAL cluster and the extrapolated track to which it is really connected (cm)

Galeph2 + Lund

ι-H.320





P_t = Hc Cluster Energy x sin (θ)

= Secondary Particle Momentum x sin (θ)

HCAL clusters and TPC tracks arising from the same primary particle (charged)

Galeph2 + Lund

Exact

	neutral	charged	total
neutral	0.7 3.0 3.0	0.7 1.3 0.3	1.4 4.3 3.3
charged	0.5 0.6 0.6	8.3 37.8 3.6	8.8 38.4 4.2
total	1.1 3.6 3.6	9.1 39.1 3.9	

number of such clusters per event
total energy of such clusters, per event
neutral energy in such clusters, per event

Averages are over 250 Lund events
(Galeph 2)

B. Michel 1

DATA ANALYSIS FOR TEST BEAM 1986.

PURPOSE Have a program ready in July 86 to check "on line" ECAL module performances:

- Energy resolution.
- Spatial resolution.
- Efficiency to single electron signature

Must be a simple and fast program and not the total ECAL Recons.

ASSUMPTIONS. No HCAL prototype behind ECAL modules.

Same test beam equipments than for prototype tests during last three years.

- Beam spectrometer.
- Position chambers.

Software already exists.

DATA ANALYSIS in the same sense than for prototype with some modifications and improvements

New pad geometry

New interface with data acquisition

(Pedestal subtraction, Zero suppression ?)

Energy resolution: $E = c_1 E_1 + E_2 + c_3 E_3$

$$E_k = \sum_{i=1}^{n} \sum_{j=1}^{n} \frac{e_{ijk}}{c_{ijk}}$$

$c_{ijk} \rightarrow$ improvement of the energy resolution.

Optimize c_1, c_3 and n to find a compromise between energy resolution and electronic noise.

For 5 and 10 GeV electrons we found:

$c_1 = 1.15$, $c_3 = 1.09$, $n = 4$.

c_{ijk} : Partly measured when pulsing wire planes.

Take into account:

- Missing wires and pads (if any)
- Fluctuation on capacitances between wires and pads
- Fluctuation on gain from one electronic channel to the other.

Spatial resolution.

$$x = \sum_{i=1}^{n} \sum_{j=1}^{n} \frac{e_{ij}^{k}}{c_{ij}^{k}} x_{ij}^{k}$$

$$x_c = f(x)$$

Find n, k, $f(x)$ to optimize spatial resolution.

For 5 and 10 GeV electrons $n = 2$, $k = 2$,

and $f(x) = x + a \sin\left(\frac{\pi x}{e} + b \sin \frac{\pi x}{e}\right)$

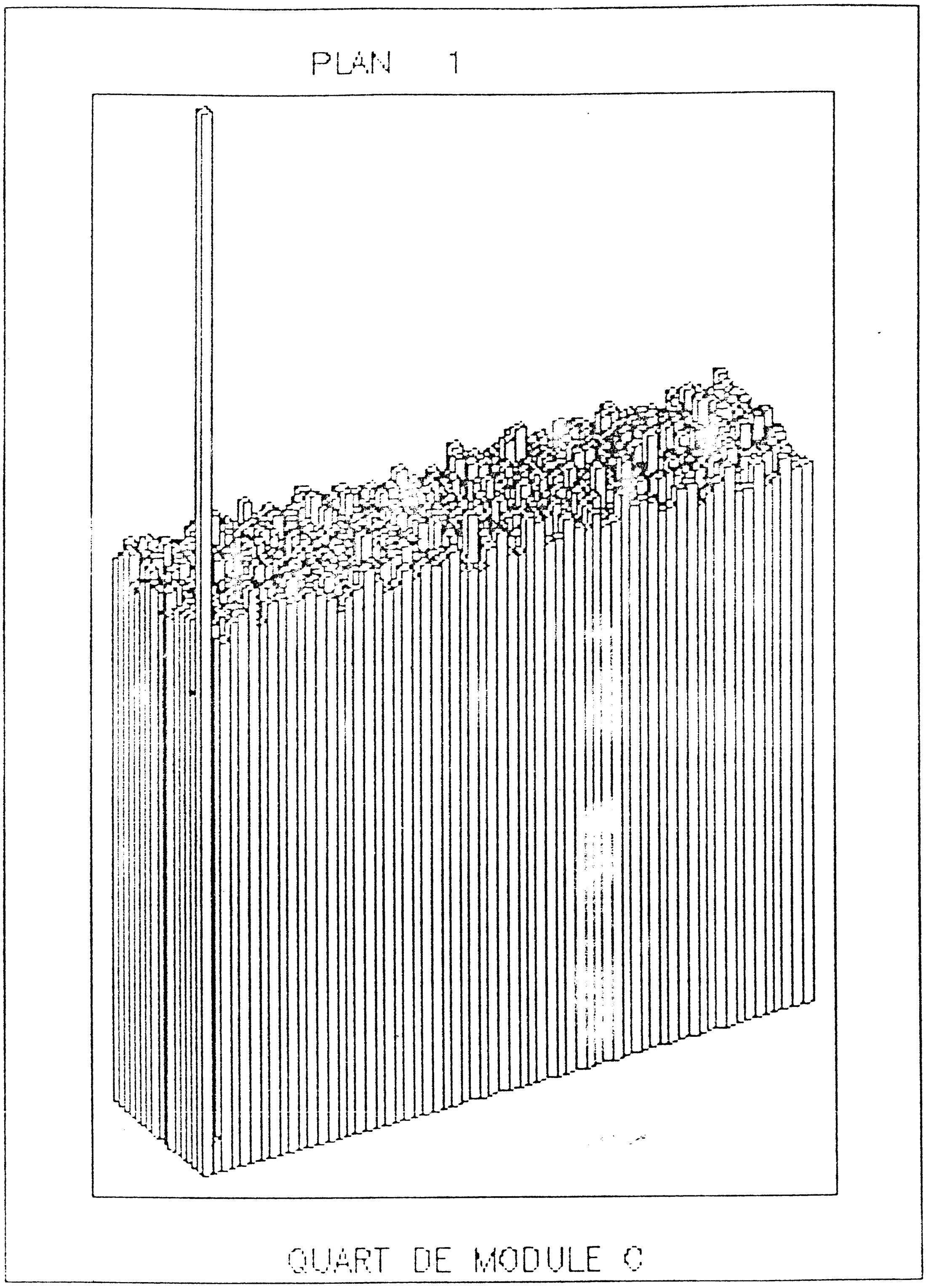
This correction probably needed to check quickly the alignment of ECAL module with respect to position chambers.

Electron signature.

Cuts on: longitudinal profile of showers (towers + wires)

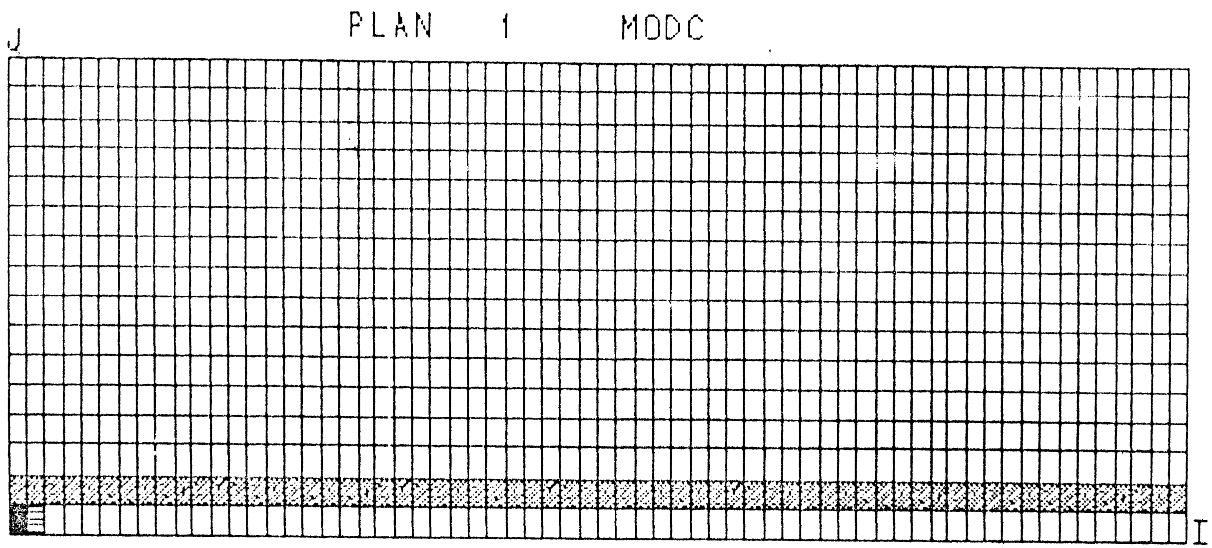
Σ_4 / Σ_{16}

x, y.



Pads response to wire pulsing.

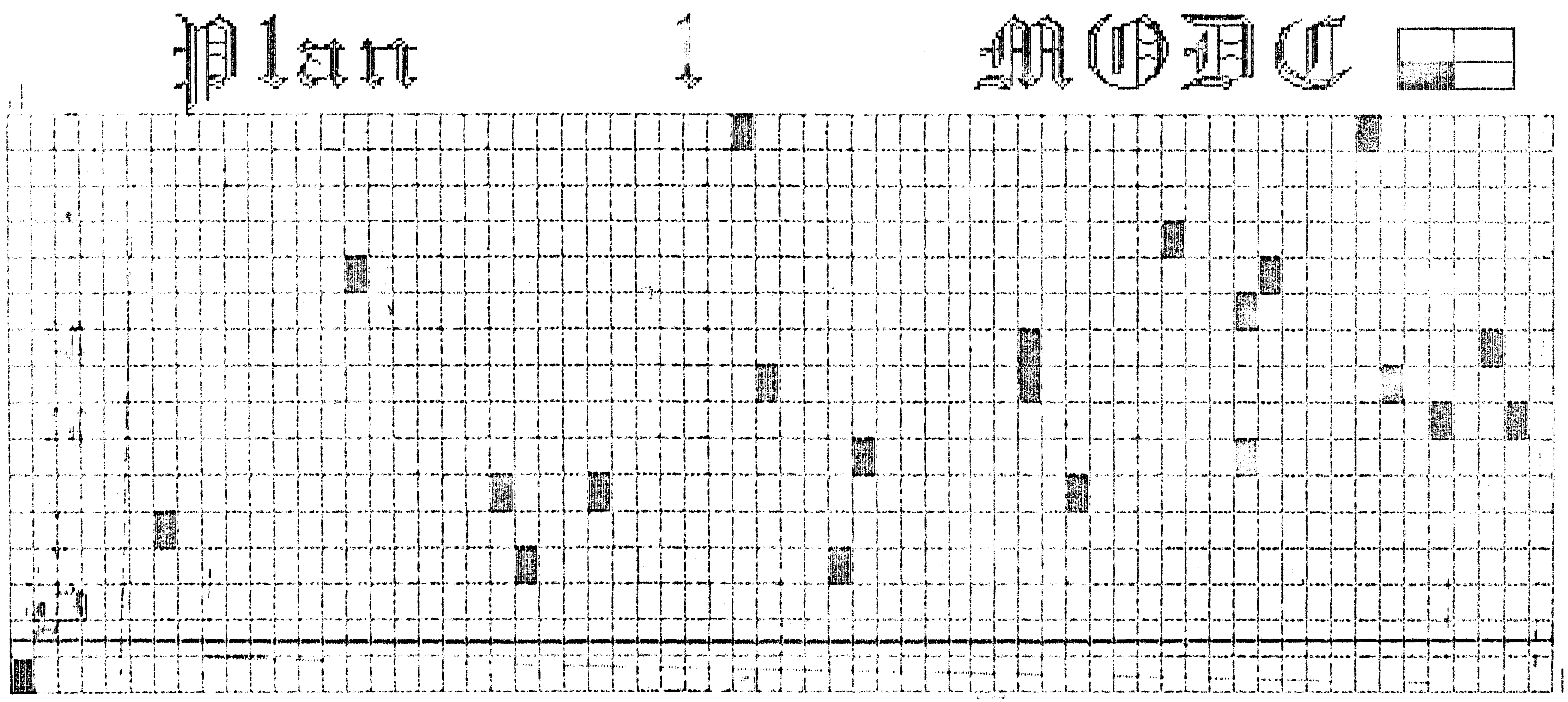
```
PAD VIDE      I            J
              0            1
PAD FORT   I          J
           1          1
PROBLEME FIL SOUS RANGEE (J) DE PAD
  84.60670    % DU SIGNAL MOYEN SOUS RANGEE          2
```

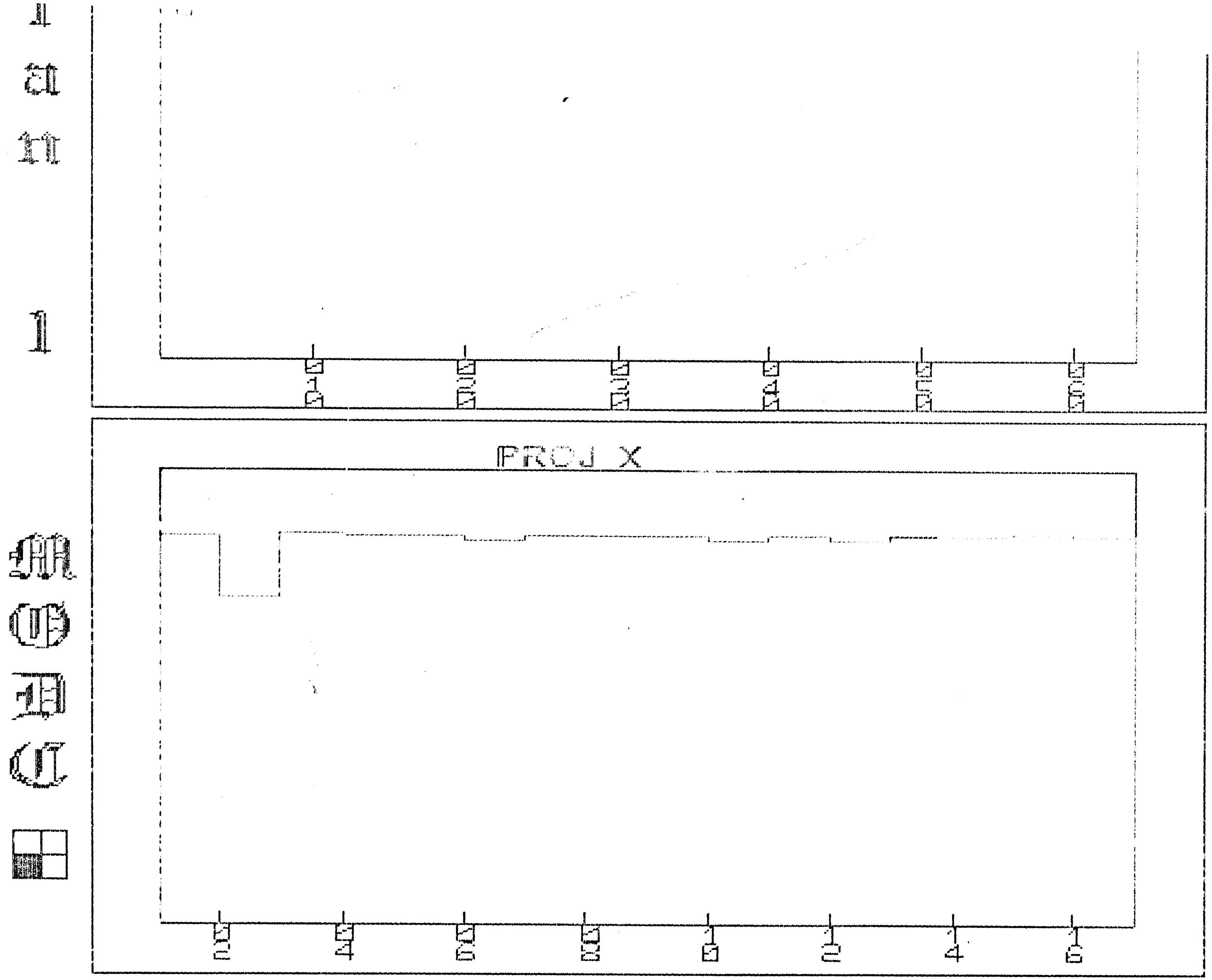


Pad response to wire pulsing.

[illegible]

84.0 % DU SIGNAL MOYEN SOUS RANG1 2





Pad response to wire pulsing.

- Some parts of this program already exist.

They have to be checked at various beam energies and angles.

Taking into account the new geometry of ECAL modules.

M. Green

The Reconstruction Program

(with particular reference to ECAL)

1. Dataflow diagrams (DFDs) complete & stable, passing checks by ADAMO & TEK tools

2. Entity-Attribute-Relationship Diagrams (EAR) nearing completion

3. Data Dictionary (DDL) describing DFDs & EARs prepared (following the new formats of Aleph Note 142 (revised))
   This DDL passes checks imposed by the ADAMO tools

   but (i) some dataflows still to be defined
   (ii) detector description still under active discussion.

4. DFDs converted to Structure Charts
   (i) program frame by J. Bunn & J. Knobloch
   (ii) calorimeter DFDs by Marseille group

5. Fortran code for program frame written by J. Bunn & running on VAX & IBM

6. Program frame being used with additions:-

(i) incorporation of structure chart of 4(ii)

(ii) reading of some prototype data pretending to be real data with cluster finding à la JP Albanese

(iii) some graphics incorporated for ECAL

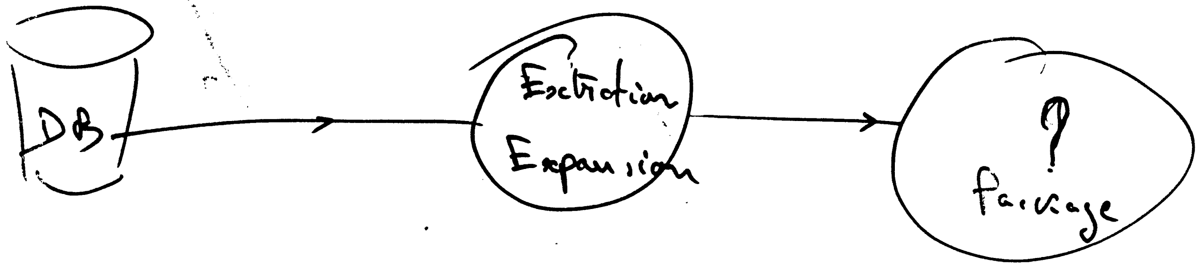
H. Videau

- Geometry of the detector -

The Data Base information to describe in a non redundant (update) (standardized ... → betw Components, betw users groups) manner the geometry of the detector for the purpose of

Reconstruction (Analysis)

and Monte-Carlo. (Read-out)



⟹ Model { kernel
Expanded

→ approximations.

agreement between physicists on the model.
at least on the approximations.

⟹ paper and some discussion (next meeting!)

Status report on graphics.

Published guidelines ~ obsolete

Pions ✝ but

application program by Wisconsin
developped (continued up to)
for TPC, Ecal, Hcal

works on Megatek Wizzard VAX
Apollo DN330 inadequate implementation

to be used for limited pattern studies
to know what to do.

independently
other application program by Drevermann
GKS on VAX
to be installed on Apollo

to be used into Recons as a first step

Future

GKS 3D
[PHIGS]

ccc decision.

= GKS-3D almost a standard (beg 87)
⟹ independent (inherits 2D) of hardware
if drivers.

~ no structure (comes from the application)

only implementation GTS-grал
Apollo - VAX..

device drivers : → skeleton for dumb terminals
— negotiations Apollo-gral for 3D driver
on DN580 (currently Phigs)
— no driver for Megatek
Cern to write it ⟶ summer 87

= Phigs
interesting hardware (IBM)
strong market CAD
not yet standardized

Aleph
Go for GKS 3D

keep an eye on Phigs hardware
compatibility

Aleph graphics activity.

- a requirement paper
  due to conceptual, psychological misunderstanding
  need to know what we want really
  what we are speaking about.

  group of ~ 10 people
  next plenary meeting?

- update of Aleph guidelines

- an understanding of the structure to be used with GKS 3D
  connection of graphical attributes to our structure.

- ~~addition~~ completion of Piony application progr.

- Dreadnoughts → Apollo
  Recons