Plastic scintillator bar with WLS fiber calorimeter for neutrino physics

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Why here ...

Technique initially developed for 1^{st} generation LBL ν expt's (NGS)

BUT

Assuming ν oscillations hypothesis will be soon experimentally confirmed

we will still be involved in 2^{nd} generation NuFACT LBL programs

- ◇ Precise measurements of Oscillation Parameters
- ◇ CP violation studies
- ◇ ν Physics beyond oscillations

Detectors

- Large Mass
- Event "shape"
- Precise Energy measurements

also Atmospheric ν's

Still desiring a clear confirmation of the Atmospheric ν anomaly

- Atmo ν_μ Disappearance experiment
- Technique different from Cherenkov

Good resolution in L/E

- Precise measurement of deposited energy including final state hadronic particles
- Direction of incoming ν's (measurement of momentum, possibility of magnetic detector)

Analysis of L/E event by event

Little Summary:

- Good granularity
- Large volumes

imply

Many many channels

Governments often kindly suggest to have a low cost per channel

One possible solution: ν Calorimetry with

Plastic Scintillator Bars

with

Wave Lenght Shifting Fibres

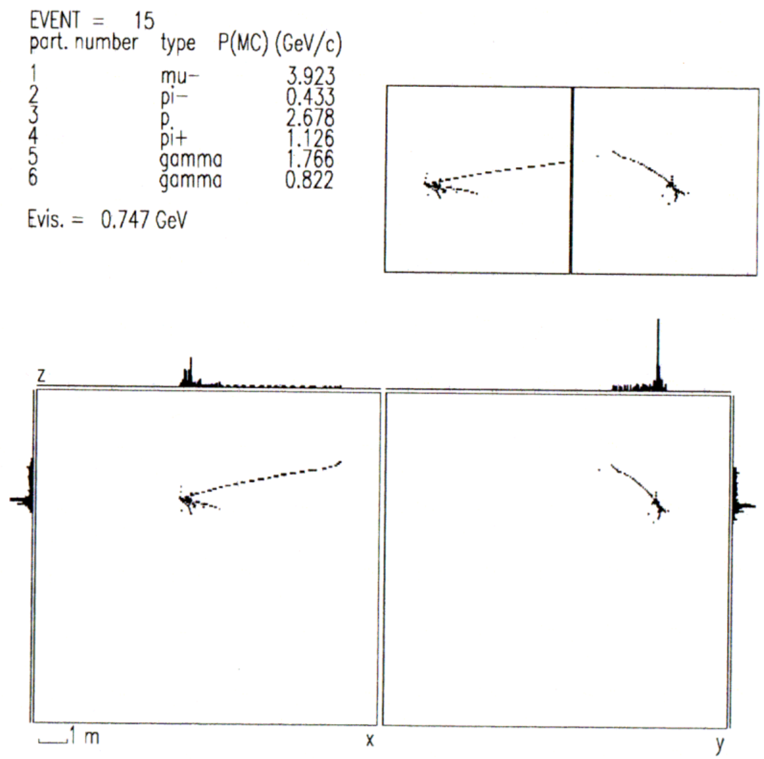
- Bars → sampling medium
- WLS fibres → signal transmission

ν oscillations studies

Examples:
NC/CC analysis
or Wrong Sign μ

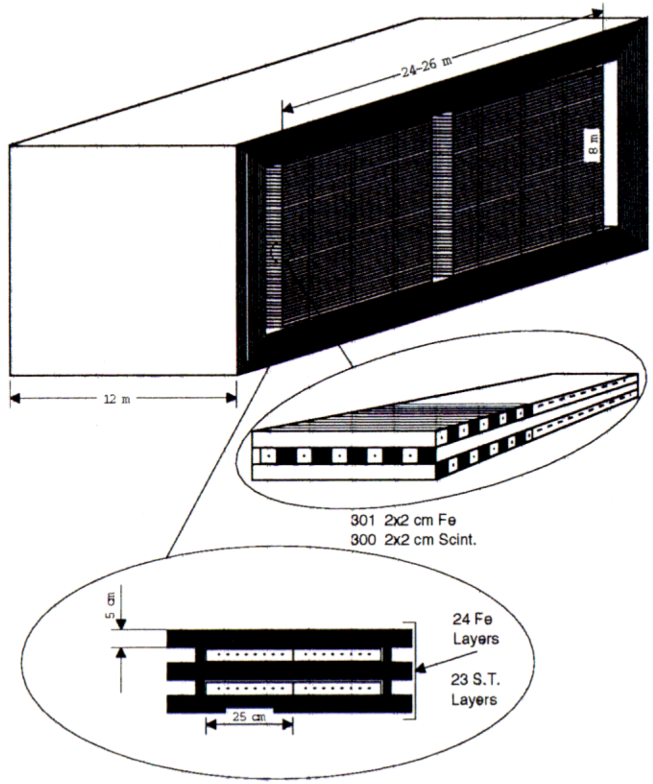
For ex.: NICE proposal (1998):

- Tracking:
  - events were divided in long (CC) & short (NC)
  - incoming ν direction measure
- EM & Hadronic calorimetry:
  charged leptons & hadronic final state



Example of Detector Layout

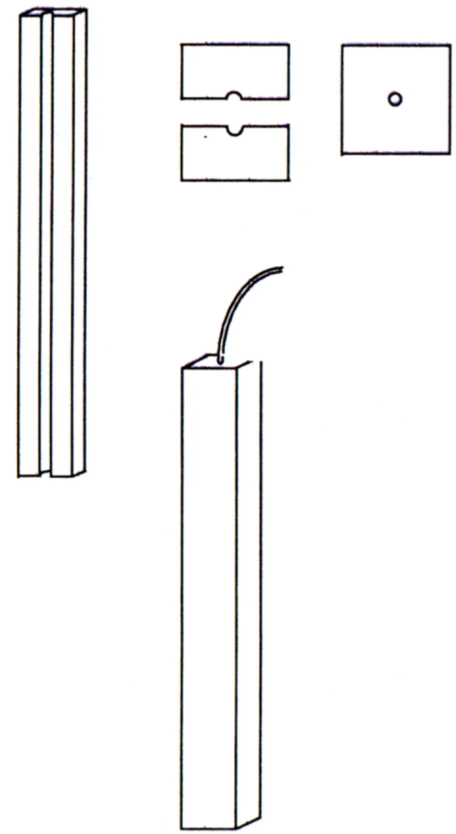
Not only
Steel/Scintillator Planes
Bars → more
isotropic design



CALORIMETER PROTOTYPE

BARS

- 180 Scintillator bars (2x2x75 cm^3 each)
  - Injection Moulding (General Service, Trieste)
  - Polystyrene + pTP/PPO (1%) + bisMSB/POPOP(0.01%)
  - WLS fibers 2mm S248 (Pol.hi.tech. Carsoli)
  - Silicon Gel two component glue
  - Teflon tape + Al Mylar wrapping



PROTOTYPE LAYOUT

- Chessboard like

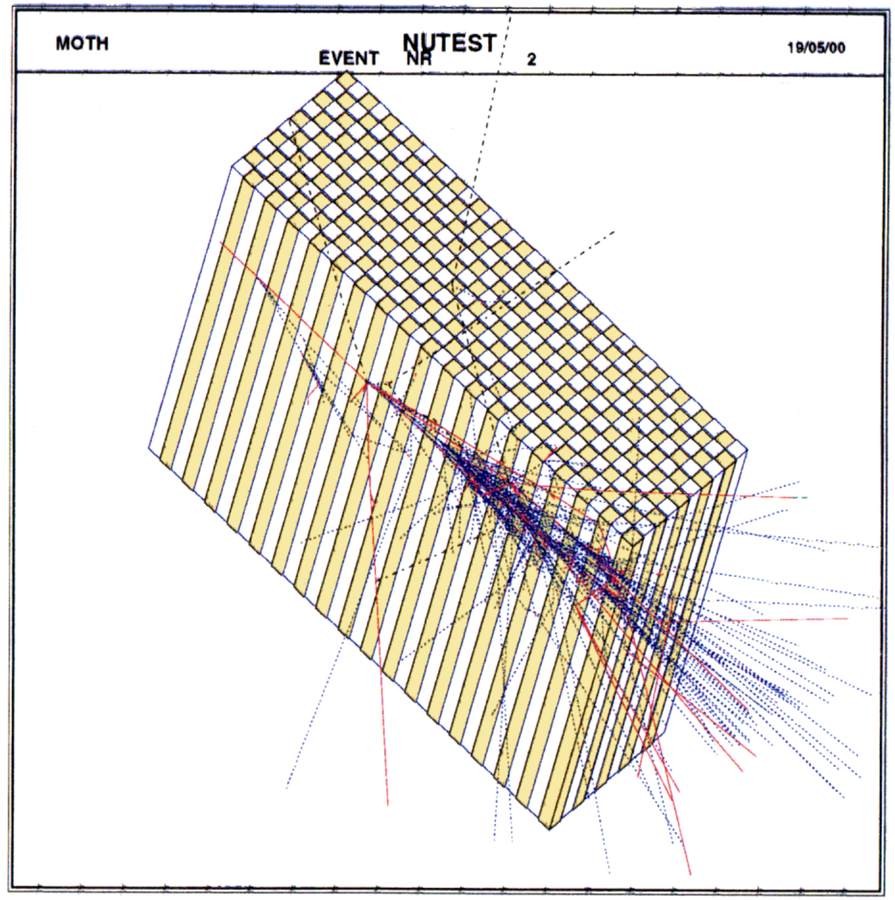
  cross section 10x36

  20x72x150 cm^3

  total size ,

  700 Kg

  total weight



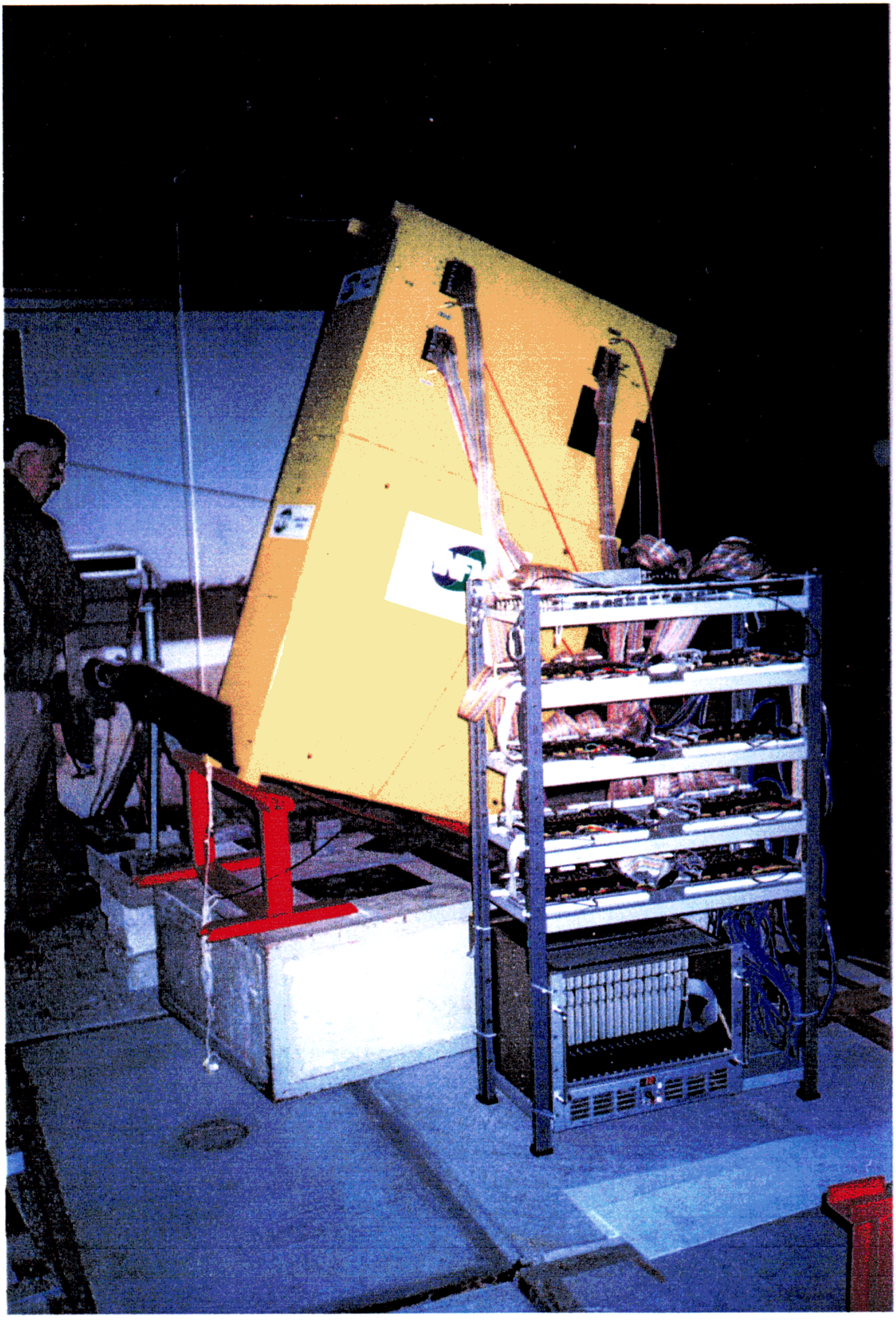
DAQ

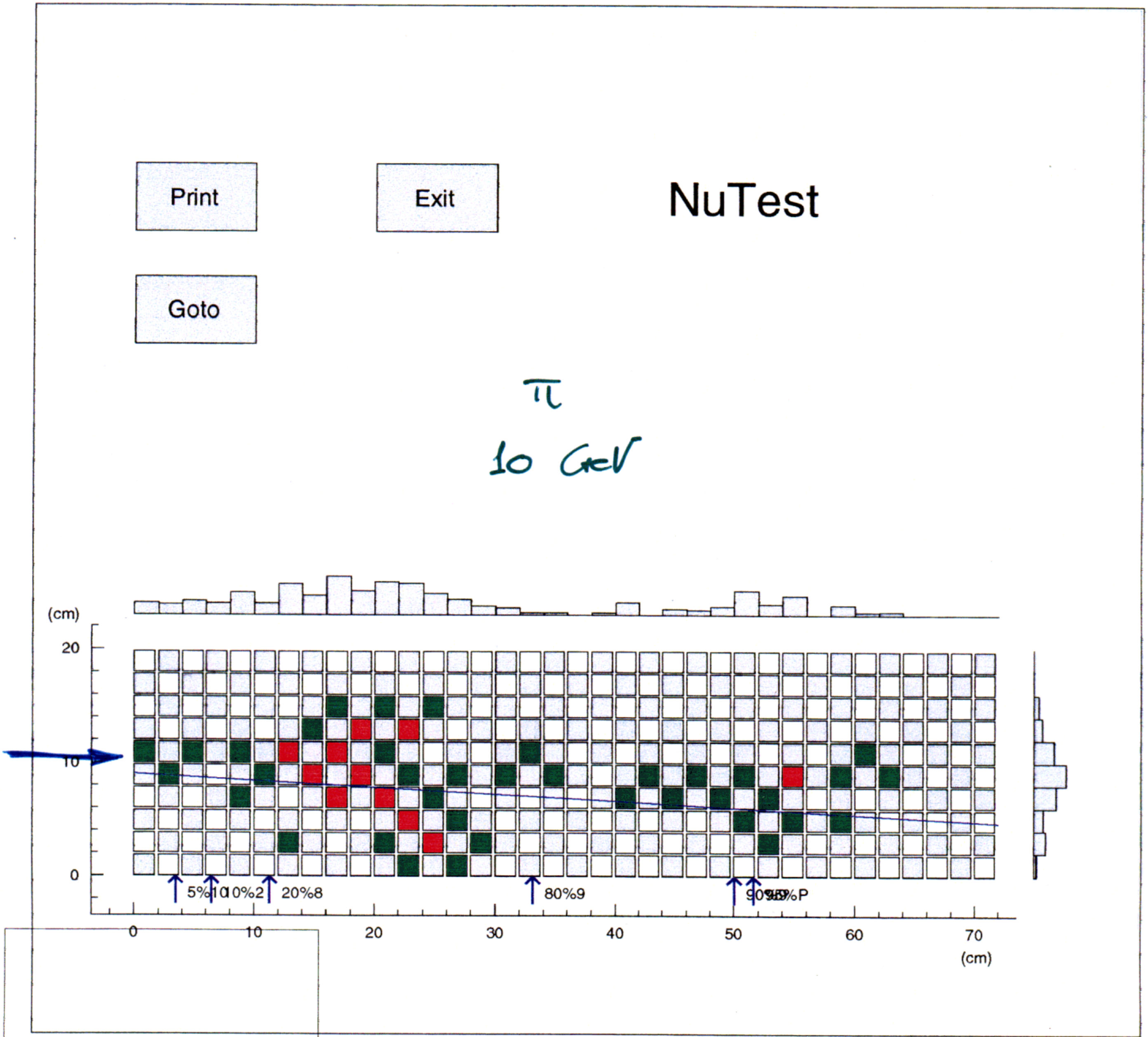
- 12 R5900-M16 (4x4) Hamamatsu Photomultipliers (192 total pixels)
- A.T.P. (Amplitude-Time-Pattern) Self-triggering Electronics (192 channels)
- CAMAC+C111+PC based DAQ

DATA

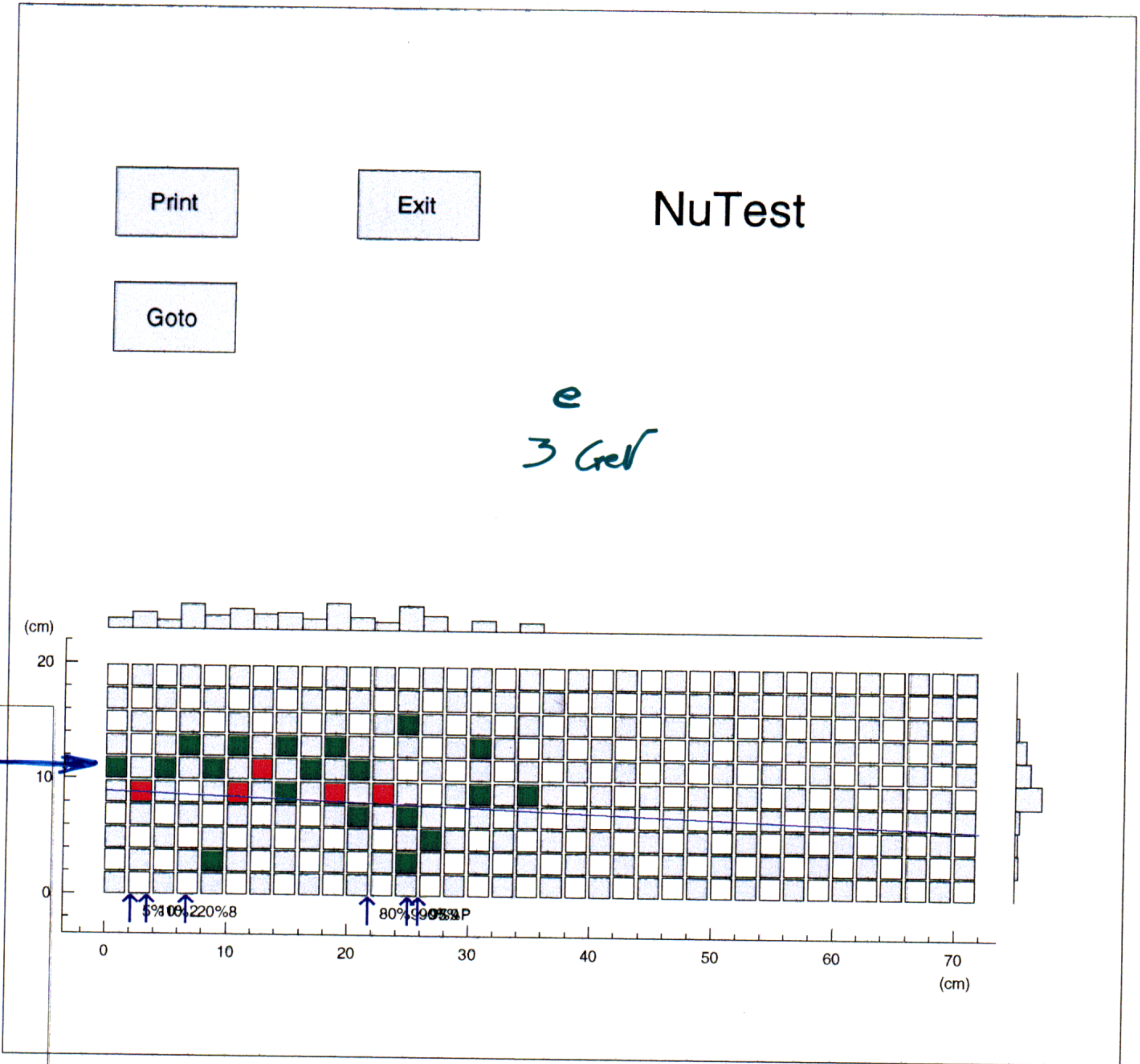
1999 Test Beam Measurements

- electron and pion beams p = 1 – 15 GeV/c
  - Particle identification and separation
  - Angular resolution
  - Energy resolution and linearity
- Muon runs for min. ion. dE/dx
- Cosmic rays

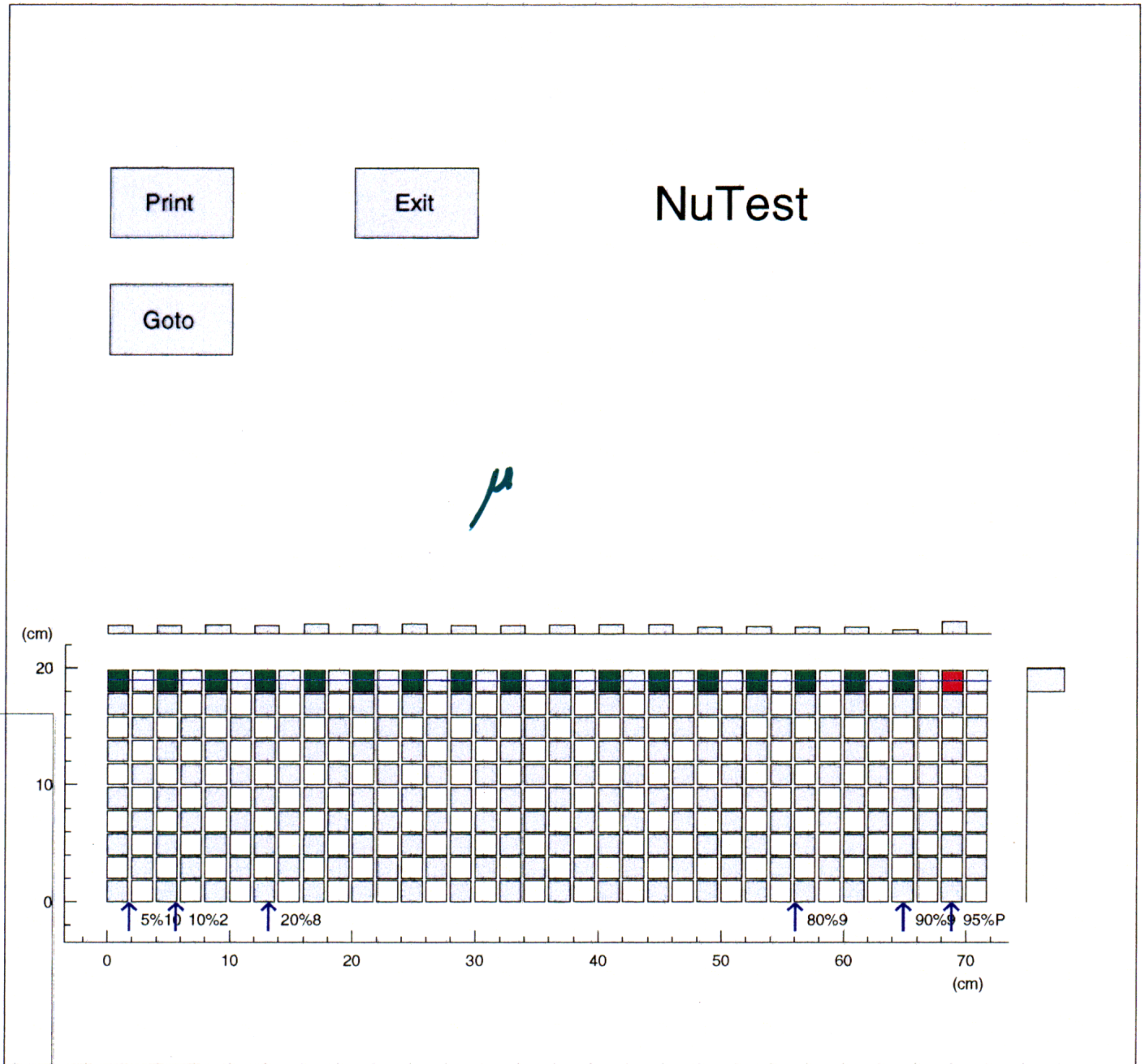




Run 662 Event 17 View XY

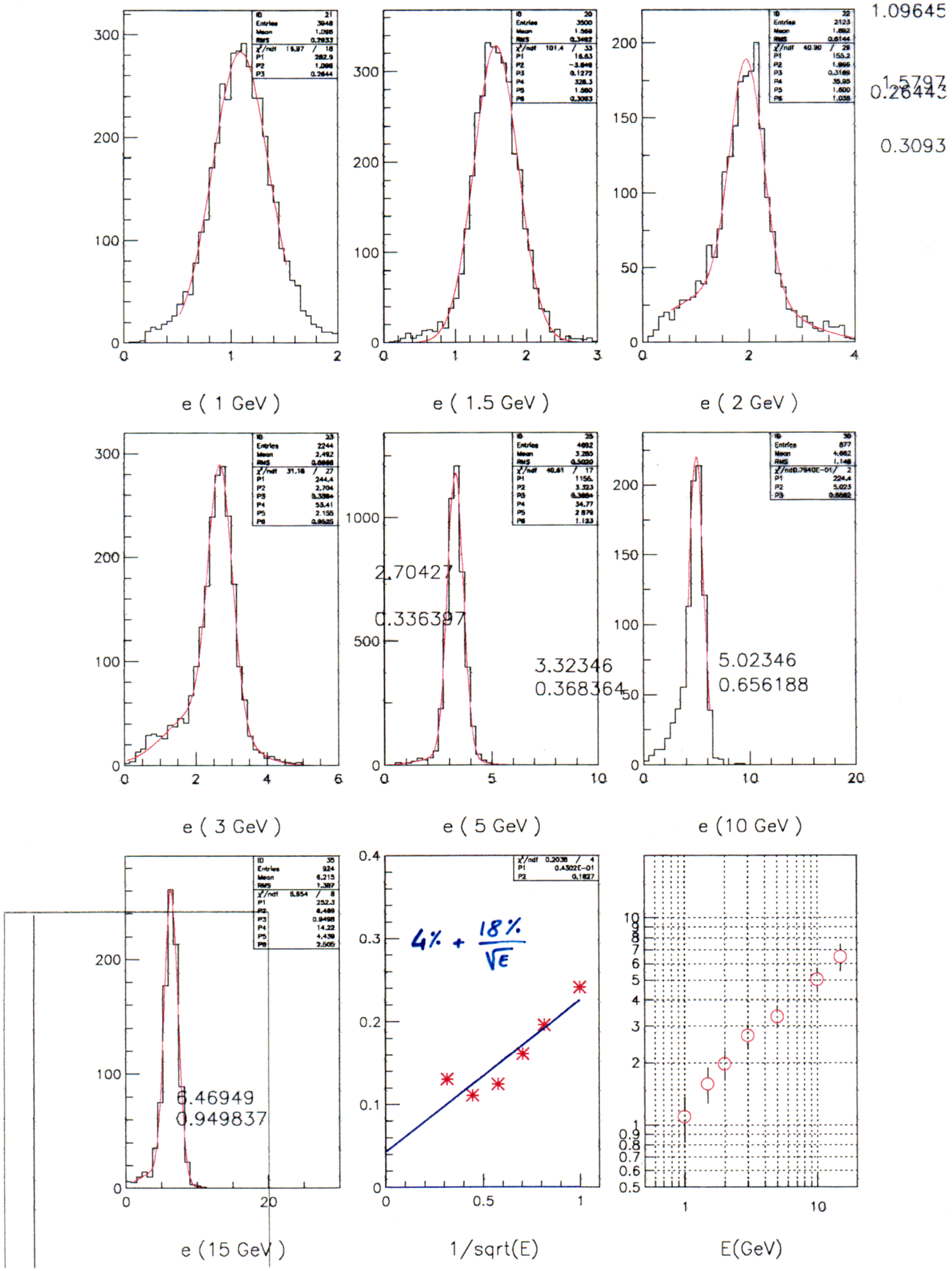


Run 1 Event 58 View XY



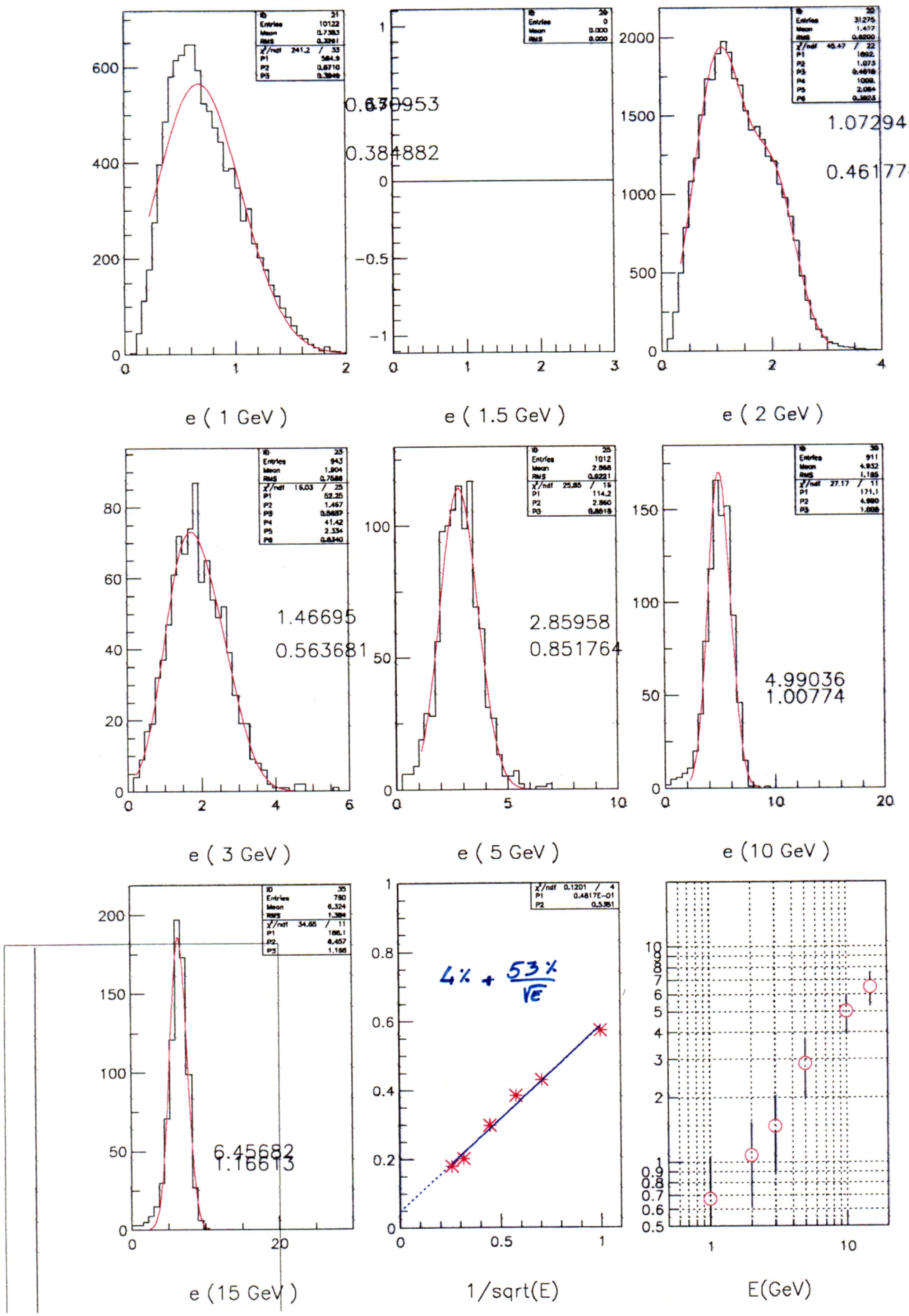
Run 1 Event 515 View XY

DATA e



1.09645
1.5797
0.26443
0.3093
e (1 GeV)
e (1.5 GeV)
e (2 GeV)
2.70427
0.336397
3.32346
0.368364
5.02346
0.656188
e (3 GeV)
e (5 GeV)
e (10 GeV)
6.46949
0.949837
4% + 18%/√E
e (15 GeV)
1/sqrt(E)
E(GeV)

DATA π



0.670953
0.384882
e (1 GeV)
e (1.5 GeV)
1.07294
0.461774
e (2 GeV)
1.46695
0.563681
e (3 GeV)
2.85958
0.851764
e (5 GeV)
4.99036
1.00774
e (10 GeV)
6.45682
1.16613
e (15 GeV)
4% + 53%/√E
1/sqrt(E)
E(GeV)

Parallel measurements

were conducted by the Rome group of the collaboration:

- study & test of a readout system based on EBCCD as a low cost photon multi-pixel detector for high granularity tracking and calorimetry
- A comparison was made among bars with
  - different construction tecniques
  - different dopants
  - different wrapping methods
- Various WLS fibres were also tested

Conclusions

- Large Iron - Scintillator Bars Magnetized Detectors can be a good choice for 2^{nd} generation LBL ν studies
- "Real Scale" working prototype with 180 $2x2x75\ cm^3$ bars, WLS fibres, Multi-Anode PMT's
- Good physics performances