GEM TN-93-259

Calorimeter Simulation Workshop

December 7-8, 1992

Abstract:

Agenda, attendees, and presentations of the GEM Calorimeter Simulation Workshop held at the SSC Laboratory on December 7-8, 1992.

CALORIMETER SIMULATION WORKSHOP Dec 7-8, 1992 (Monday, Tuesday).

Time and place: 9:00 am, Dec 7th, SSCL Directorate Conf. Room No. 2

AGENDA

The original purpose was to bring together as many as possible of the people in GEM working on calorimeter simulation to share experience on a variety of issues, and to have 'tutorials' on general issues.
The formation of the Calorimeer working groups will give a new purpose: the organization and formation of the Calorimeter Simulation Working Group. The intent is to prepare us as well as possible for the PAC presentation in July, and do design studies for the TDR.
One task is to address basic issues as well as particular GEM ones, and to address the issue of computing requirements.
The workshop is deliberately planned NOT to overlap with the calorimeter group meeting so that simulators can attend both. Please feel free to attend and make presentations or lead discussions of topics.
As a workshop, people should expect to share codes and demonstrate them, so 2 days seems about the right length.

Below are some topics that are expected be covered. Possible contributors are indicated. Where there are ?? please consider whether you have a contribution to make. It may be that there are additional topics which should be addressed. Your advice is appreciated.

Since this is a workshop we expect the agenda to be somewhat flexible. The list below of topics below is a list of topics to be addressed in future meetings/workshops, if seen as important.

MONDAY DEC 7th

9:00 am. Goals of Workshop -- McFarlane, Womersley
9:15 am Discussion of Agenda and Workshop organization

Goals of simulation -- Group
  Important effects (missing energy, resolution, backgrounds, pileup, pointing, pizero)
  Simulation types: global, partial.
  Physics: key processes
  Time scales: TDR, PAC'93, future
  Impact on other systems (e.g. muons -- trigger, dE/dx...)

10:15 SSCL/GEM approach -- I. Sheer
10:45 Impact on other systems
      Tracker -- Jenny Thomas
      Muon System -- P. Dingus

11:15 am GEANT:
  GEANT 3.16 (what changes from 3.15) -- Lee Roberts
  Volume search algorithm -- Lee Roberts
  Optimization strategies -- Lee Roberts, Mike Seman
  Speed of searching in different volumes -- ??

11:45 am CALOR89 interface -- Brent Moore

12:15 pm LUNCH

1:30 pm Existing SSCL/GEM simulations
        SIGEM structure -- Yu. Fisyak (30 mins)

gemfast structure -- T. Skwarnicki (30 mins)

Parameterizations:
(Parameterization in gemfast -- T. Skwarnicki)
H1 approach (latest version derived from gflash) -- ?? (Stefan Peters will come to a later workshop)
Mixture level descriptions (range of validity) -- ??
Shower parameterization (Range of validity) -- ??
Shower library techniques -- ??

2:30 pm Special Geometries
Accordion -- Seman/Lelchouk
Strips ('preradiator') -- H. Ma
Asymmetric segmentation -- ??
Plate -- ??
Axial fiber calorimeter -- ORNL person?
Simulating fibers in detail -- ??

Speed of simulations
Comparison of approaches (Gemfast, UAZMIX, SIGEM -- Authors)

Features
Massless gaps

<6:00 pm Discussion of Working groups/Assignments

TUESDAY DEC 8th

9:00 am Data structures (HITs, DIGItizations information) -- Womersley

Data structures expected from DAQ and algorithms for finding energy and time from samples. -- Henk Uijterwaal

More on CALOR -- C. Zeitnitz

Algorithms
Weighting factors in heterogeneous systems -- ??
Clustering algorithms in gemfast and CLEO -- T. Skwarnicki
EM pattern recognition/reconstruction -- ??
Pointing, pizero rejection
Jet finding -- ??
Jet energy reconstruction -- ??

Pile-up and noise
Simulation and parameterization techniques (10^33 and 10^34) -- A. Vaniachine
(Pulse shape parameterization -- ??)

Integration Strategy -- Womersley
GEM calorimeter simulation plans -- can we coordinate to maximize use of manpower, computing facilities and optimize results?
Descriptions of simulations at Columbia, BNL, ORNL, CalTech, Mississippi?
Coordination of fast, mix and full simulations -- ??
SIGEM and its data structures -- Yu. Fisyak
Common MATE, ROTM, GEOM, HITS definitions-- ??
GEM tracker and muon simulations -- J. Thomas/I. Sheer? and P. Dingus?

Cal Sim Dec 7-8 It

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GEM

Calorimeter Simulation Workshop

Dec 7-8th, 1992

Goals
1. Good TDR
2. Good presentation at July PAC
3. Coherent approach to doing physics
4. Integration / Cooperation with other simulation groups (Tracker, Muon, ..)
5. Sharing of techniques, codes..
6. Common pool of software, results, event files ...
7. Formation of Cal. Sim. Working group.
8. Plans for future (next meeting?)

PHYSICS PERFORMANCE OF THE GEM DETECTOR

OUTLINE OF GEM TDR VOLUME 8

8.1 INTRODUCTION

8.1.1 Brief overview of electroweak and flavor symmetry breakings. Other physics beyond the standard model. Physics at $\mathcal{L} = 10^{33}\,\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$ and at $10^{34}\,\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$.

8.1.2 Brief summary of GEM detector features and strengths – γ, e, μ and $\mathcal{L} = 10^{34}\,\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$.

8.1.3 Overview / summary of Volume 8.

8.2 GEMFAST – PARAMETERIZED SIMULATION OF GEM

8.2.1 Overview of subsystems: CT, EC, HC, FC, MU, TR/DAQ — General description, coverages, cell sizes, acceptances.

8.2.2 GEMFAST parameterization of subsystem responses.

8.2.3 Plots of momentum resolutions vs. η for CT, MU; charge significances; single-particle energy resolutions in EC, HC, FC; missing E_T resolution, etc.

8.2.4 Jet definition and jet energy resolution.

8.2.5 Trigger strategies and efficiencies; special problems of $\mathcal{L} = 10^{33}\,\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$ and $10^{34}\,\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$.

8.2.5 Shortcomings, approximations of the physics simulations.

8.3 STANDARD MODEL HIGGS PHYSICS

8.3.1 $H^0 \to \gamma\gamma$ ($M_H = 80 - 150\,\mathrm{GeV}$). This and the associated production process should be studied for couplings smaller than standard model (as in the minimal supersymmetric standard model) to determine the limits of intermediate-mass Higgs detectability.

8.3.2 $t\bar{t} + H^0 \to \ell\gamma\gamma + X$ ($M_H = 80 - 150\,\mathrm{GeV}$). This process will be studied at luminosities $\mathcal{L} = 10^{33}\,\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$ and $10^{34}\,\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$.

8.3.3 $H^0 \to Z^0 Z^0 \to \ell^+\ell^-\ell^+\ell^-$ for $\ell = e, \mu$ ($M_H = 140 - 800\,\mathrm{GeV}$). For the 800 GeV Higgs, this process will be studied at $\mathcal{L} = 10^{33}\,\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$ and $10^{34}\,\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$.

8.3.4 $H^0 \to Z^0 Z^0 \to \ell^+\ell^-$ jet jet ($M_H = 800\,\mathrm{GeV}$).

8.3.5 $H^0 \to Z^0 Z^0 \to \ell^+\ell^-\nu\bar{\nu}$ ($M_H = 800\,\mathrm{GeV}$).

8.3.6 New, auxiliary Higgs studies, if any. For example, Z^0, $\ell^\pm$ and decay-plane angular distributions.

8.4 HEAVY FLAVOR PHYSICS

8.4.1 $t\bar{t}$ production for $m_t = 140\,\text{GeV}$ and $250 - 300\,\text{GeV}$ in standard ($t \to W^+ b$) and non-standard ($t \to H^+ b$ for $m_t \geq 200\,\text{GeV}$) decay modes and mass measurement via the $M_{\ell\mu}$ and multijet distributions. Tagging the $t\bar{t}$ events by an isolated lepton *plus* an inclusive muon from b-decay is a major test of GEM's abilities. The charged Higgs mass will be $M_{H^+} = 150\,\text{GeV}$ and we shall assume the decay modes $H^+ \to c\bar{s}$ and $\tau^+\nu_\tau$ with variable branching ratios. Identification of W^+ and H^+ in dijet decay modes is an important consideration here.

8.4.2 If time permits, we shall study the W polarization in $t \to W^+ b$ decay. This involves measuring the angular distribution, in the W rest frame, of the dijet from W decay relative to the W direction in the t-quark rest frame.

8.4.3 Single technieta production, $gg \to \eta_T \to t\bar{t}$. The object is to see a peak in the $t\bar{t}$ invariant mass or in the p_T distribution of the top quark.

8.5 JET PHYSICS

8.5.1 Quark substructure in production of jets with high-p_T and/or invariant mass (deviation from QCD cross sections at $p_T \gtrsim 4\,\text{TeV}$). Studies at $\mathcal{L} = 10^{33}\,\text{cm}^{-2}\,\text{s}^{-1}$ of the ISO model with substructure scale $\Lambda \cong 15 - 20\,\text{TeV}$. Special attention to jet energy measurement issues!

8.5.2 Studies at $\mathcal{L} = 10^{34}\,\text{cm}^{-2}\,\text{s}^{-1}$. Are these feasible? If so, what is the reach in Λ?

8.5.3 Devise a program for measurement of the parton distribution functions in experiments at low luminosity and carry out typical simulations (if time permits).

8.6 PHYSICS AT ULTRAHIGH LUMINOSITY

8.6.1 Quark/lepton substructure in $\bar{q}q \to \mu^+\mu^-$ at high invariant mass (a deviation from the Drell-Yan cross section at $\mathcal{M} \gtrsim 2\,\text{TeV}$) and ultrahigh luminosity, $\mathcal{L} = 10^{34}\,\text{cm}^{-2}\,\text{s}^{-1}$. Determination of the chiral structure of the contact interactions for substructure scale, $\Lambda = 25\,\text{TeV}$. Reach in Λ in one SSCD.

8.6.2 Signal and backgrounds for quark/lepton substructure at the scales $\Lambda = 25\,\text{TeV}$ in the Drell-Yan process $\bar{q}q' \to \mu^\pm\nu$. Chiral structure of the contact interaction will be probed via the η_μ distribution.

8.6.3 Signal and backgrounds for $Z'^0 \to \ell^+\ell^-$, with $\ell^\pm = e^\pm, \mu^\pm$. Precision measurements of mass, width (via e^+e^-) and asymmetries (via $\mu^+\mu^-$) for $M_{Z'} = 4\,\text{TeV}$. Determination of the reach in $M_{Z'}$ in 1 - 2 SSCD.

8.6.4 Signal and backgrounds for $W'^\pm \to \ell^\pm\nu_\ell$. Precision measurements of the mass, width and asymmetry; determination of the reach in $M_{W'}$.

8.6.5 Signal and backgrounds for color-singlet $\rho_T^\pm \to Z^0W^\pm \to \ell^+\ell^-\ell^\pm + \not{E}_T$ and $\ell^+\ell^-$ jet jet.

8.7 MISSING E_T PHYSICS — SUPERSYMMETRY

8.7.1 Missing-E_T requirements on the detector.

8.7.2 $\widetilde{gg}$ detection via the $\not{E}_T$ signature.

8.7.3 $\widetilde{gg}$ detection via the likesign dilepton signature. Although not strictly a missing-energy process, this complements the preceding search.

8.7.4 Squark production and detection via the $\not{E}_T$ signature. (Is squark-gluino production useful and/or interesting?)

8.8 CONCLUSIONS

8.9.1 Summary tables of discovery significances, reach, discovery/reach time, mass resolutions, etc. Brief summary discussions.

8.9.2 Plans for future simulations work – both detector and physics. A set of possible physics simulations is given in the "second priority" list of K. L. 's January 20, 1992 memo, "Physics Simulations for the GEM Technical Proposal". This needs more thought!

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Presentation by:

I. Sheer

Future Directions in GEM Software

J. Sheer
7/Dec/92

An Online Approach to Offline Software

We may have to
live with the code
we write today
for the next 20
years!

Lets try to do it
Right...

⇒ We need clean code that is <u>flexible</u>!

flexibility ≡
- modular
- scalable
- language independent
- platform independent

modular: programs / program architecture

scalable: multi-user/task/cpu

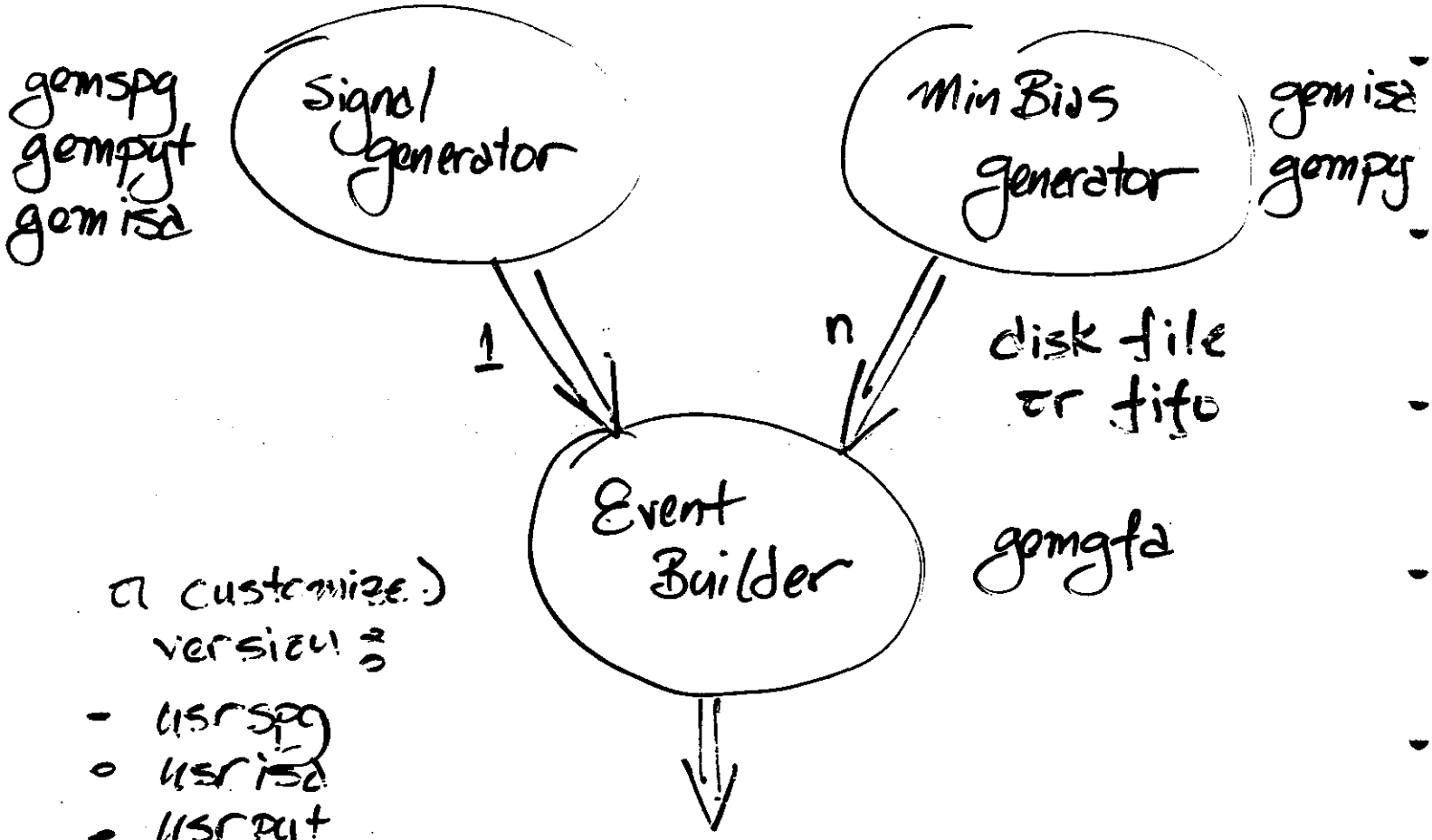
language independent: f77, c, c++, f90

platform independent: hp, sun, sgi, dec, ibm

The gen(gen) approach:

problem: generate SSC events using many different generators in a coherent way.

solution:



(customized) versions:

- usrspg
- usrisa
- usrpyt
- usrgfa

How to find out more about genigen?

* read manpages:

	genigen.
lilspg.3	genispg.1
lilisa.3	genisa.1
lilpyt.3	genipyt.1
lilgfa.3	genigfa.1

* look at demo's:

/gen1/demo/genigen/

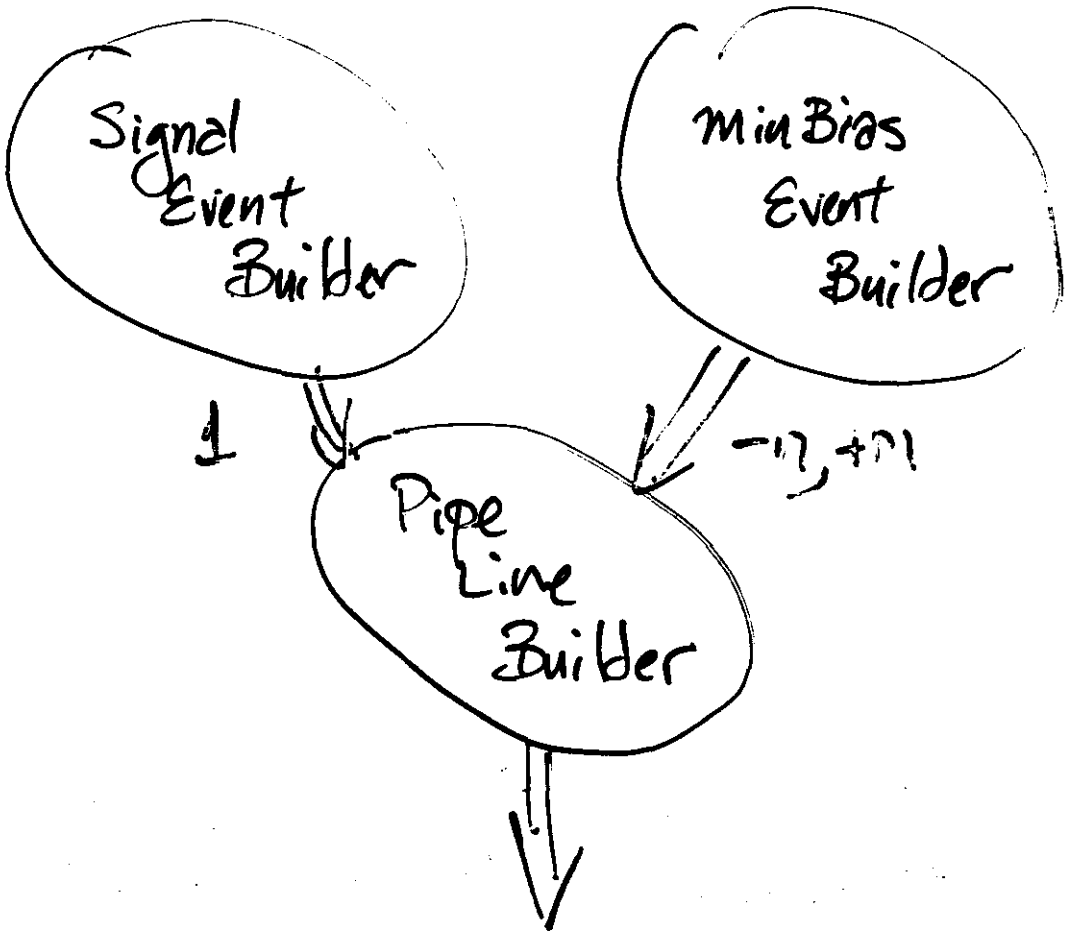
usrspg
usrisa
usrpyt
usrgfa

* ask me...

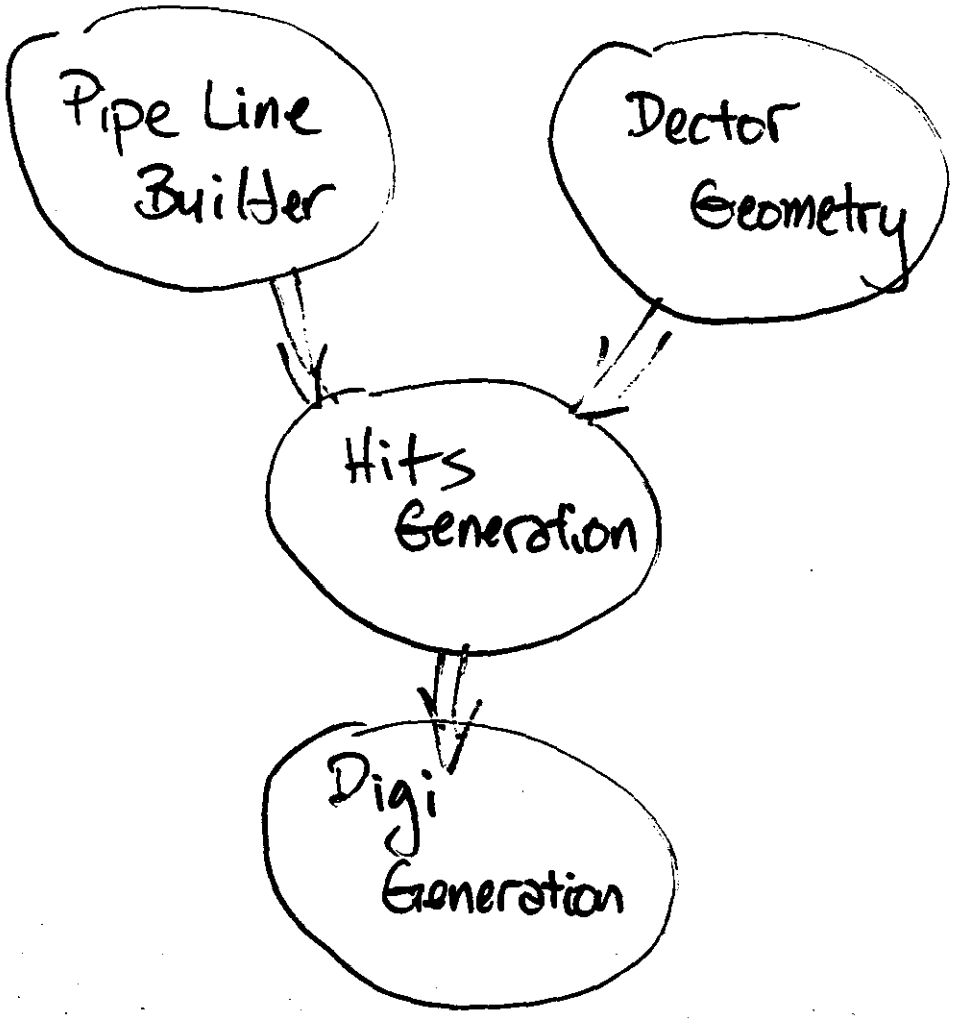
after you've read the manpages
and looked at the demo's

Where does the parallel?

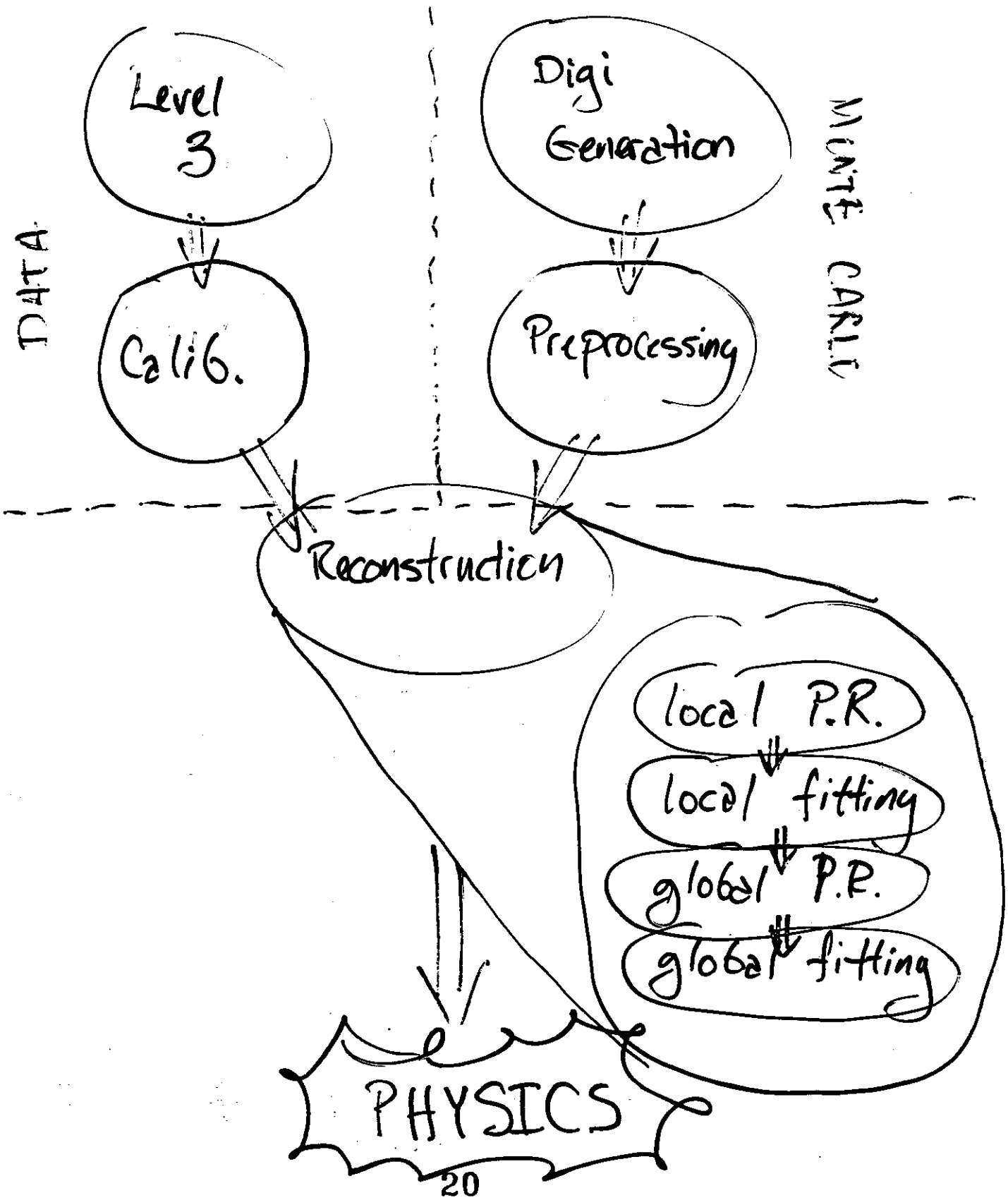
Pipe Line Builder:



Detector Simulation:



Detector Reconstruction:



Some words about program architecture:

highly structured:

```
main
  -> ut?defs   ! set defaults
  -> ut?init   ! initialize
  -> ut?loop   ! main program loop
  -> ut?done   ! termination
```

modular:

```
ut?xxxx
  -> ut?fanc
        -> ct?main   ! central tracker
        -> lc?main   ! liquid calor.
        -> sc?main   ! scifi calor
        -> fc?main   ! forward calor
        -> mu?main   ! muon spect.
        -> gd?main   ! global detector
        -> tr?main   ! trigger
        -> usr main  ! user
```

(customizable)

single entry point for each branch:

xx ?main

→ xx ?defs ! xx defaults

→ xx ?init ! xx initialization

→ xx ?loop ! xx loop

→ xx ?term ! xx termination

⇒ tree like architecture

easy to cut a branch or graft a new one ...

© Need participation in GEM software from people at outside institutes!

⇒ need system a distributed development environment

⇒ need system for code distribution

☆ RCS?

© Need people to support GEM software on different platforms!

hp:
sgi:
sun:
dec:
ibm:

put name here ←

Choice of maintenance / distribution strategy

① Time behaviour
Rolling
Fixed versions
② Push / pull

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Presentation by:

J. Thomas

J. Thomas

PROGRESS IN TRACKER SIMULATION: CAN WE HELP EACH OTHER?

- RECENT WORK IN TRACKER SIMULATION (GEANT)
- DESCRIPTION OF IMPORTANT TRACK PARAMETERS
- VOCABULARY
- SUGGESTION FOR ECAL-TRACKER RELATIONSHIP

RECENT WORK IN TRACKER SIMULATION

- BASELINE II GEOMETRY IS IN PLACE

  S_I STAGGERS LAYERS WITH SMALL LORENTZ TILT

  LADDERS NOT PIN-WHEELED, STACKED IN & OUT

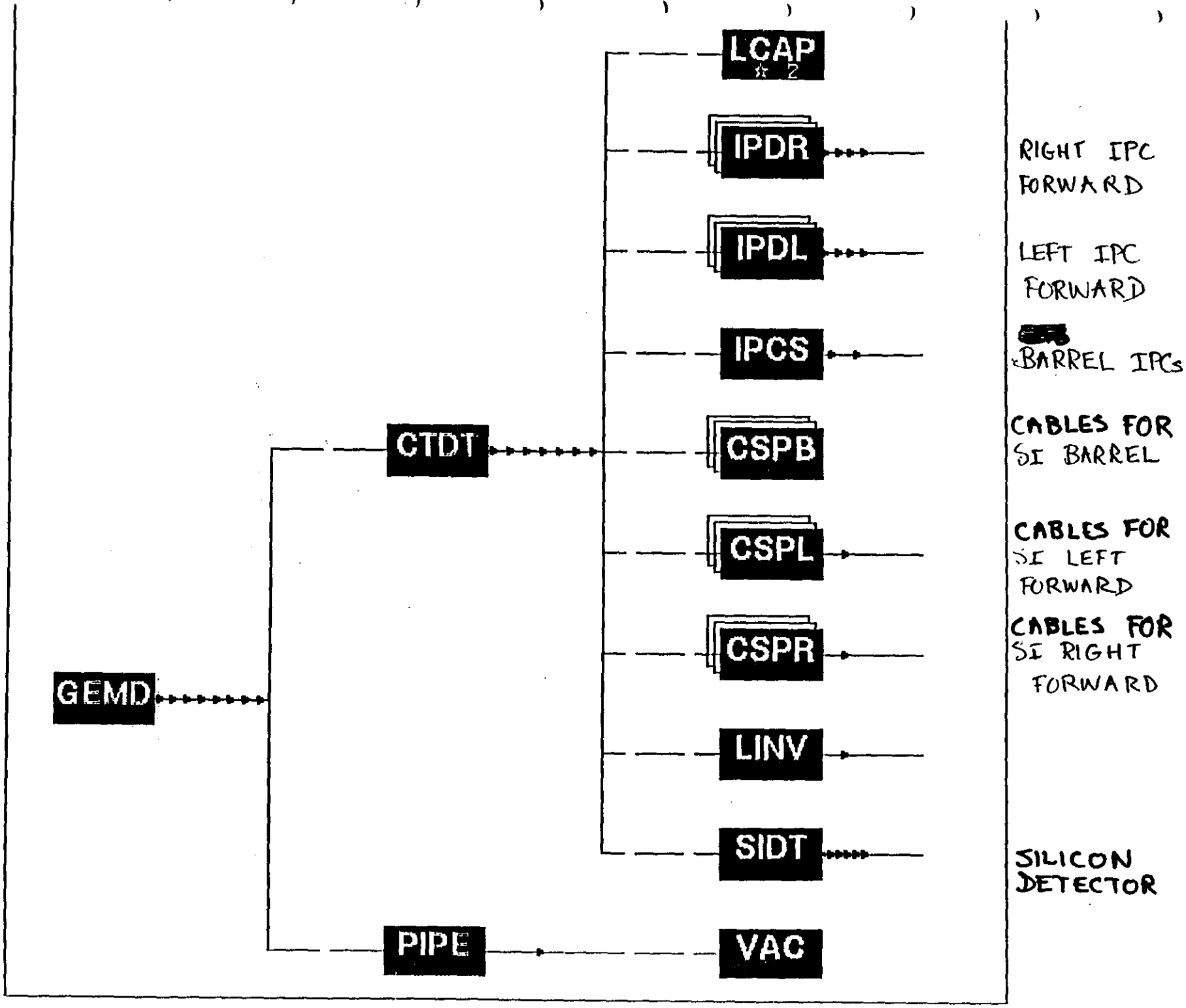
- OUTER RADIUS OF TRACKER IS 88CM

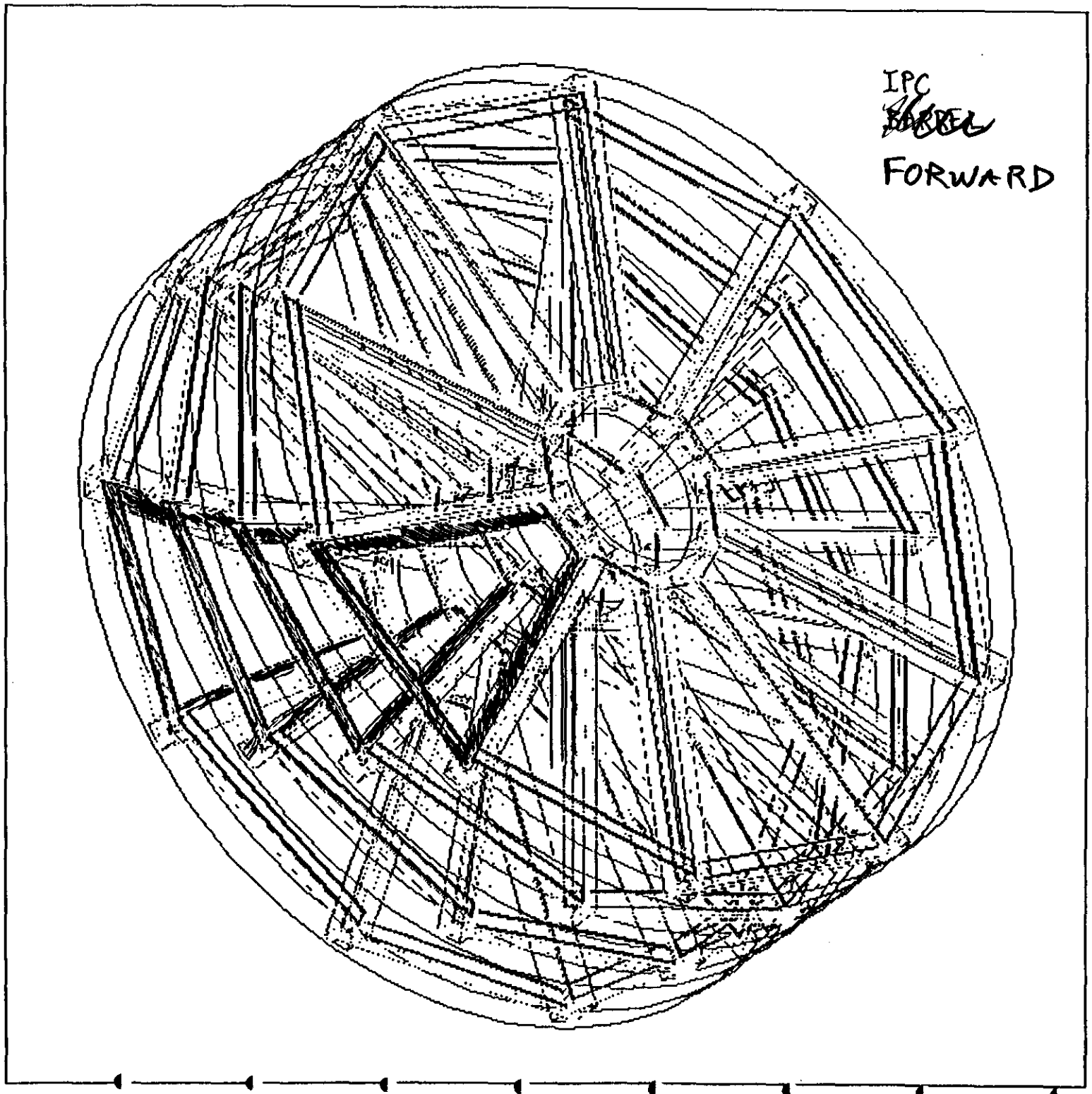
  + 2CM CLEARANCE
  + 5CM BORON LOADED POLYETHYLENE

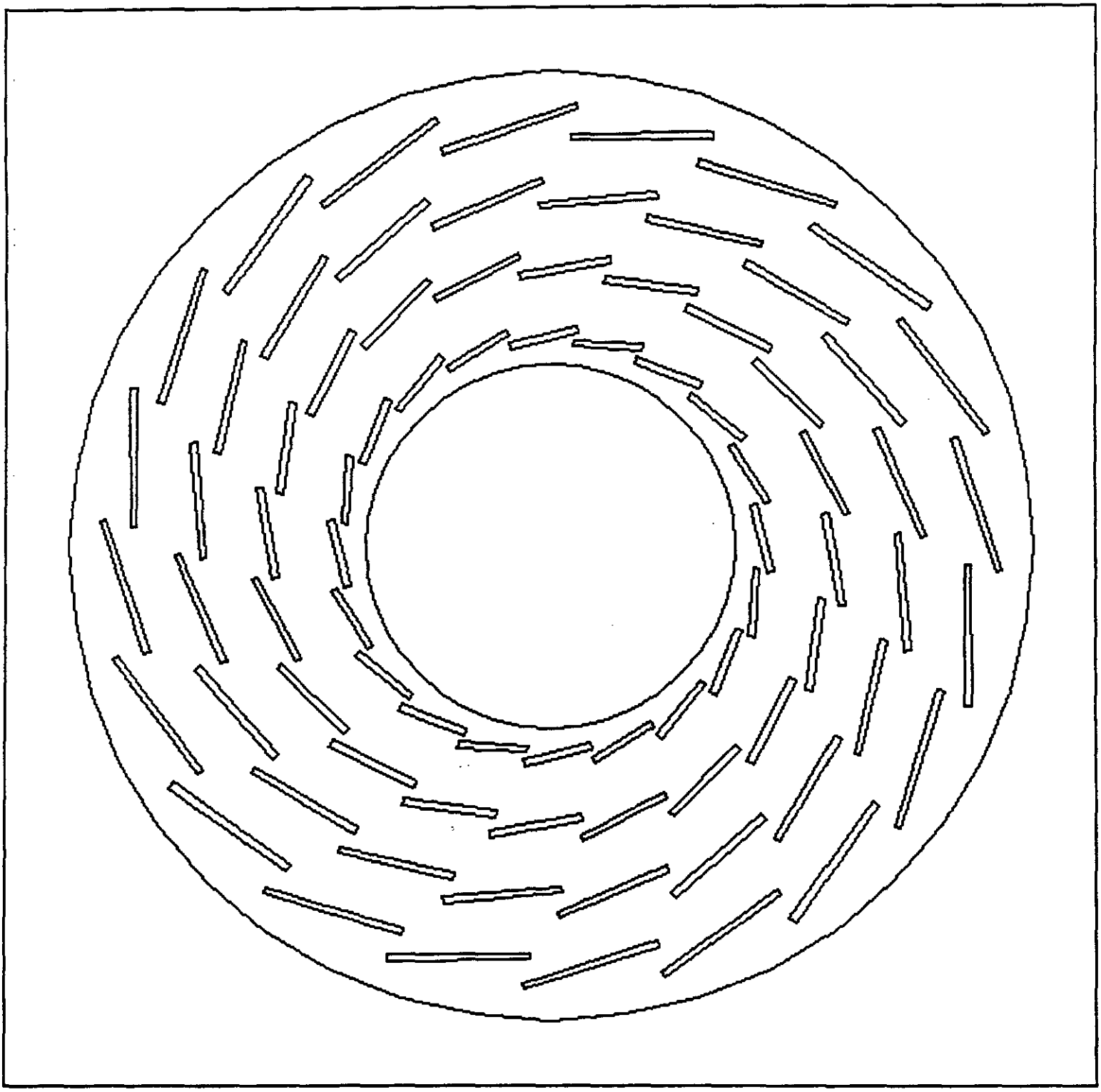
- LORENTZ ANGLE OF IPCS = 14°

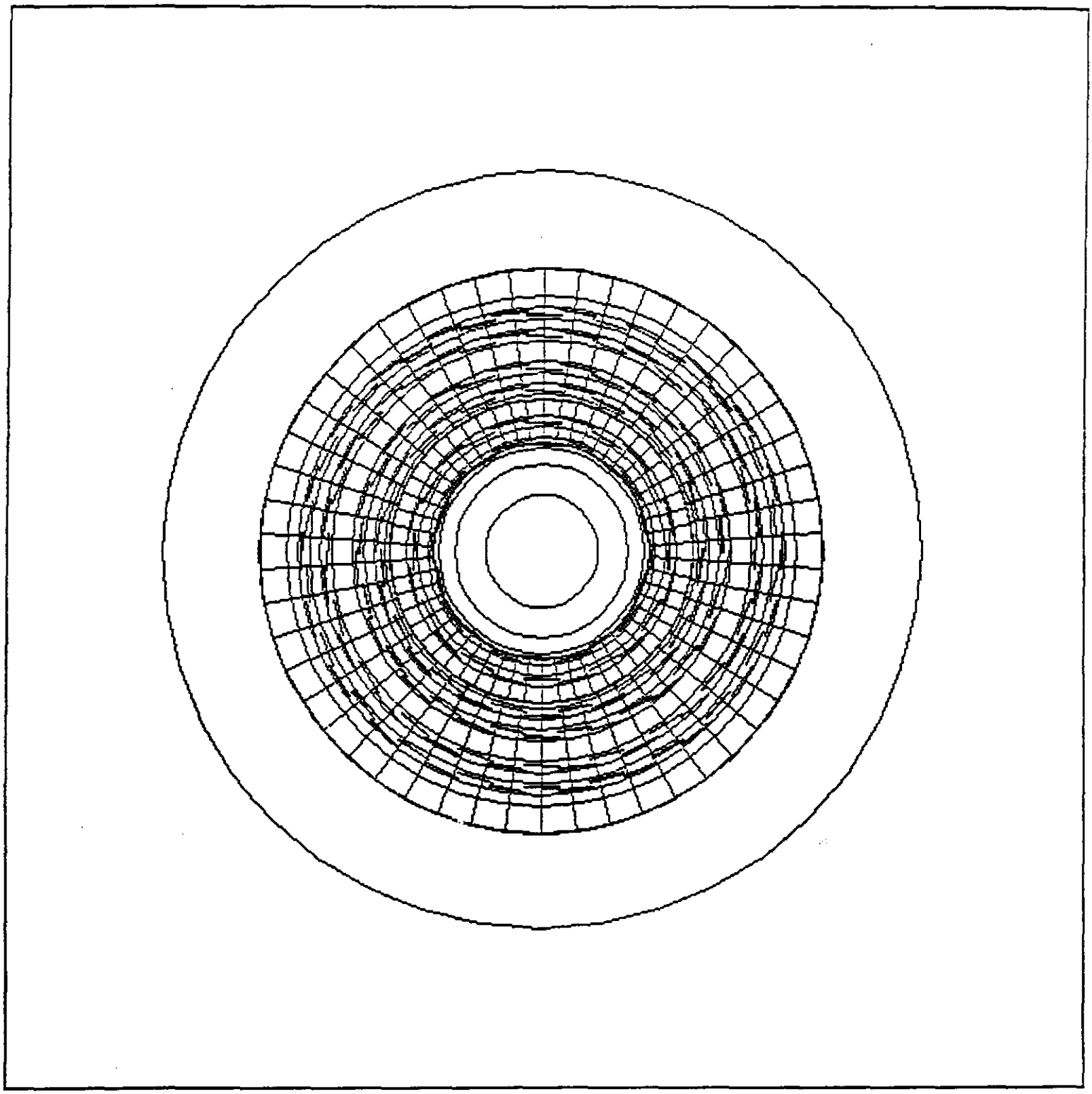
  20 CHAMBERS / SUPERLAYER

AS SHOWN . . . . . .

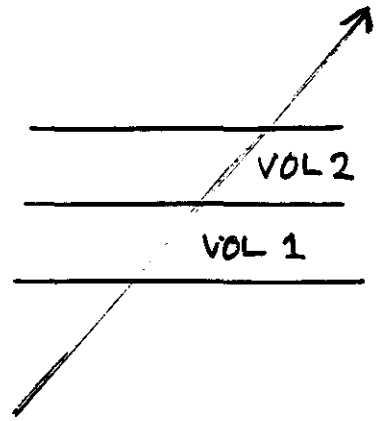

GEMD
CTDT
PIPE
LCAP
IPDR
IPDL
IPCS
CSPB
CSPL
CSPR
LINV
SIDT
VAC
RIGHT IPC FORWARD
LEFT IPC FORWARD
BARREL IPCs
CABLES FOR SI BARREL
CABLES FOR SI LEFT FORWARD
CABLES FOR SI RIGHT FORWARD
SILICON DETECTOR


IPC
~~BARREL~~
FORWARD





DESCRIPTION OF IMPORTANT TRACK PARAMETERS



- AT BOUNDARY OF EACH VOLUME, SAVE
  - ENERGY, MOMENTUM, POSITION - IN (PARTICLE)
  - ENERGY, MOMENTUM, POSITION - OUT (PARTICLE)

- MEASURED TRACK MOMENTUM AFTER CO-ORDINATE FINDING & PATTERN RECOGNITION

- CRUCIAL ISSUE: DOES THE MEASURED/FOUND TRACK BELONG TO PARTICLE WHICH MADE IT?

- DEFINE TRACK ≡ PARTICLE IF:
  - 50% OR MORE OF TOTAL HITS COME FROM THE PARTICLE

VOCABULARY

- THERE ARE THREE SEPARATE ENTITIES:

PARTICLES	CLUSTERS	TRACKS
GENERATE/PHYSICS	E.M. CAL	TRACKER

- NOT NECESSARILY ONE TO ONE CORRESPONDENCE

- IMPORTANT TO DEFINE & KEEP TRACK OF WHICH CLUSTER/TRACK CORRESPONDS TO WHICH PARTICLE

SUGGESTION FOR ECAL-TRACKER RELATIONSHIP

- GEANT DEPOSITS ENERGY IN CALORIMETER FROM GENERATED PARTICLE, USING E, POSITION & DIRECTION FROM LAST TRACKER VOLUME

- USE CLUSTER FINDING ALGORITHM TO IDENTIFY CLUSTERS' ENERGY, POSITION & POINTING

- DETERMINE SET OF CRITERIA TO ASSIGN A CLUSTER TO A GENERATED PARTICLE (LIKE IN TRACKER CASE)

- GIVE CLUSTERS CLOSE TO A MEASURED TRACK A LIST OF TRACKS ASSOCIATED WITH THEM USING ERROR ELLIPSE OF FOUND TRACK & DIRECTION OF CLUSTER

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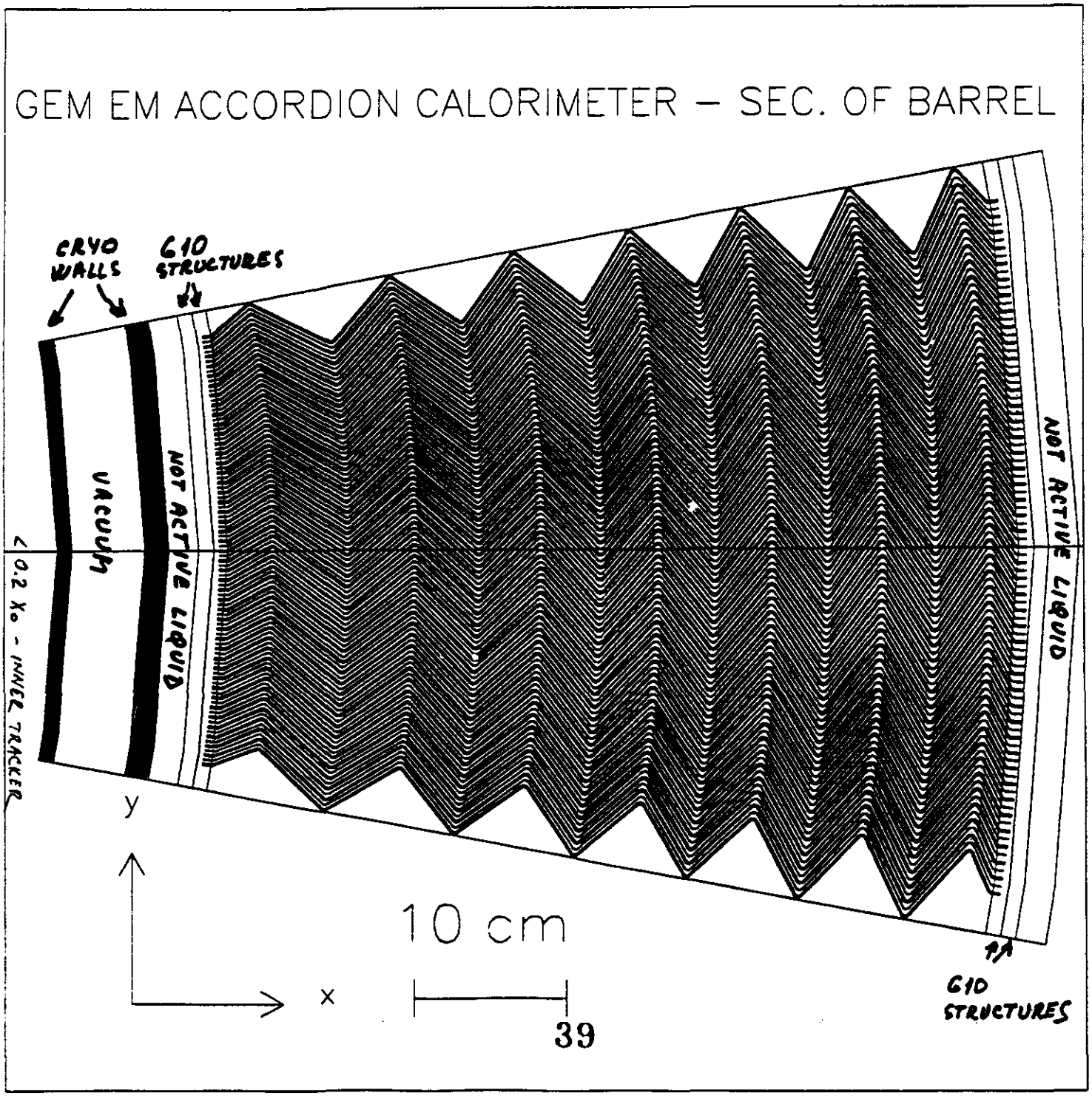
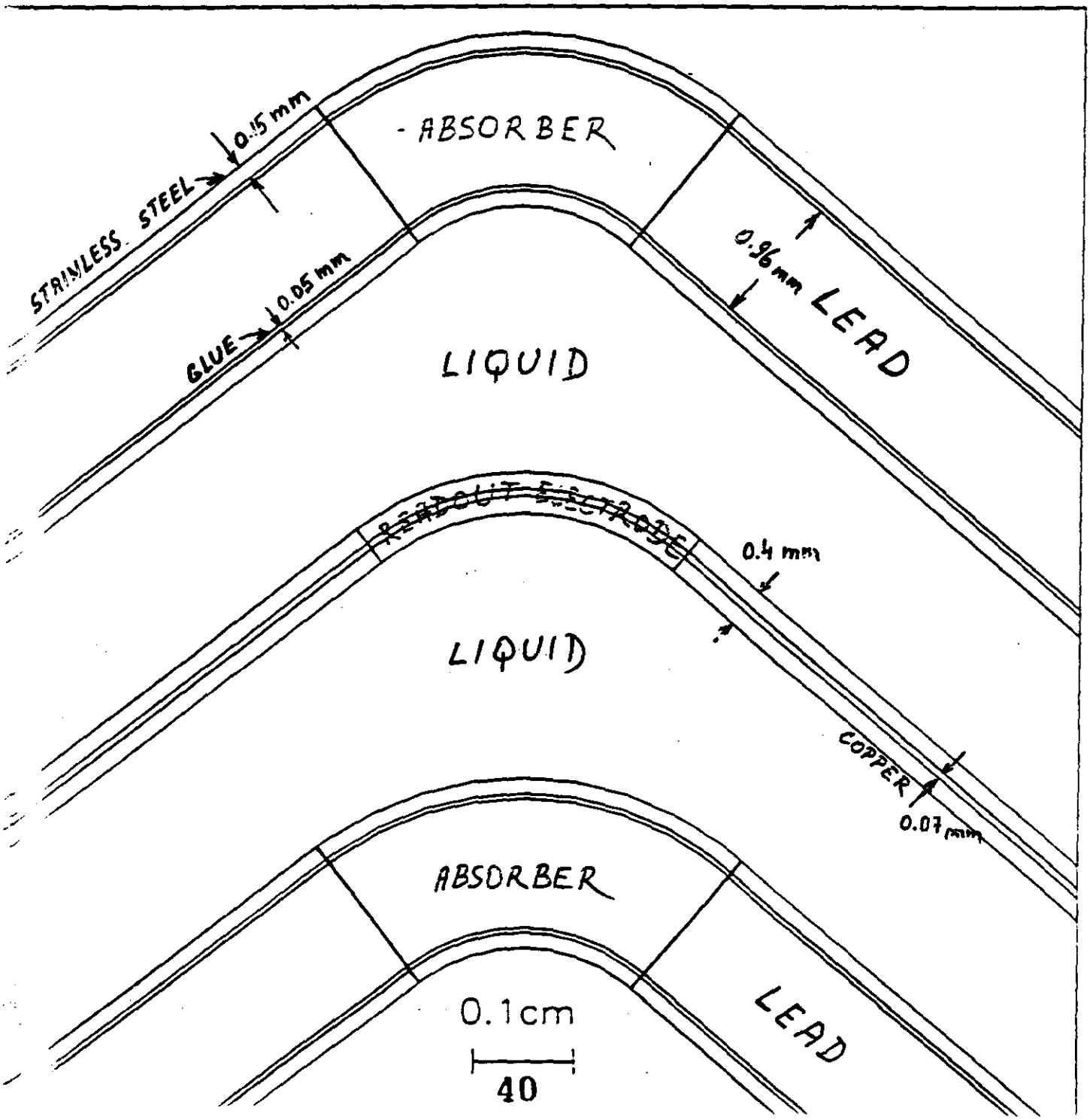
Presentation by:

M. Seman

M. Seman

B = 0.8 T


GEM EM ACCORDION CALORIMETER – SEC. OF BARREL
CRYO WALLS
G10 STRUCTURES
VACUUM
NOT ACTIVE LIQUID
NOT ACTIVE LIQUID
< 0.2 X₀ - INNER TRACKER
y
x
10 cm
G10 STRUCTURES


ABSORBER
0.15 mm
STAINLESS STEEL
GLUE
0.05 mm
0.96 mm
LEAD
LIQUID
READOUT ELECTRODE
0.4 mm
LIQUID
COPPER
0.07 mm
ABSORBER
LEAD
0.1cm

OPTIMIZATION OF VOLUME SEARCH ALGORITHM

(M. Seman)

- CASE WHEN STANDARD ORDERING IS NOT EFFECTIVE (e.g. to many daughters volumes positioned)

- TABLE OF NEIGBORN DAUGTER VOLUMES CAN HELP (can be prepared off-line)

- USER CONTROL OF VOLUMES SEARCH IS ACTIVATED BY [redacted] CALL GSNUEA (MOTHER_NAME, ISEARC)
  ↳ POSITIVE

- CALL GUNEAR IS ACTIVATED
  ANSWER QUESTIONS: IN WHICH VOLUME I AM ?
  WHERE I CAN GO ?

```
GUNEAR (ISEARC, ICALL, X_T, JNEAR)
        :
IQ(JNEAR+1) = NV
IQ(JNEAR+1+i) = list of volumes   i = 1,NV
```

- CAUTION:
  - SEARCH IS CONTROLED BY USER
  - ALL POSSIBLE NEIGBORN VOLUMES MUST BE SPECIFIED IN TABLE !
  - NO GEANT WARNING !
  - VERIFICATION - ISEARC = ϕ
    COMPARE SEED NUMBER OR RANDOM NUMBER GENERATOR AFTER FEW EVENTS

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Presentation by:

Lee Roberts

GEANT plans + directions

GEANT users meeting @ CERN on Sept. 28, 1992.

Federico Carminati spoke about GEANT 3.15, 3.16, 3.20 plans, status, ...

GEANT 3.15

- Correction cradle 3.04 available Oct. 19
- Fixes to volume loss with MANY volumes and speed increases for use of GUNEAR for accordian geometry.

GEANT 3.16

- bugs corrected
- angular distributions in bremsstrahlung in atomic field and pair production
- photo electric effect angular distributions
- CADD GEANT → SET
- graphics surface shading
- MOTIF ++ GUI
- UV photon tracing
- repackaging of GXINT
  - main as source and object
  - routines in library
- shower parameterization (GFLASH)

Test version — end of October in NEW (?)
Release — end of November or middle of January 1993

Support status:

3.14 now frozen
3.15 to be frozen when 3.16 comes out
3.16 cradle maintained – only for bugs – even when 3.20 is released.

3.14 + 3.15 will be maintained until usage is low
3.16 will be maintained until last user is gone

3.16 is last backward compatible version

Documentation
(See next slide.)

Will be a problem for some time.

(This page intentionally left blank - Editorial Note)

GEANT 3.20

- new geometry
- user feedback is needed now on functionality and performance
- new GUI not ready – will take some months
- new geometry used 1.5 FTE

Stage #1
3.20 α-test in end-1992

- "backward compatible" at calling sequence level
- data structures provisional
- graphic tool for ray tracing from RZ 3.1X database
- overlapping volumes checking from RZ3.1X database.
- protruding daughters checking from RZ3.1X database.

Stage #2
Q1 1993

- new callable user interface
- complete graphics
- final data structure

Stage #3
Q2 1993

- interactive geometry editing
- first pre-release of 3.20

Release ⟶ next fall

GEANT Development Working Group

- upgrade strategy needed now
- critical path for LHC physics
- manpower is very scarce
  - only one baseline staff member (fca)
- need collaboration with users

Objectives
- list of hot problems with priorities and timescales
- review progress
- development plans
- document requests for resources
- meet every four weeks

Membership
- by invitation
- one person from every group of interested users
- not limited to CERN.

Asking for FORMAL commitment and increased collaboration from GEANT user community.

Why now?
- short manpower
- greater use of code
  ⋮

Need to consider
- language
- OOP
- database
- reconstruction framework
- event display
- parallel processing — role of MPP

Presentations at GEANT Users' Meeting

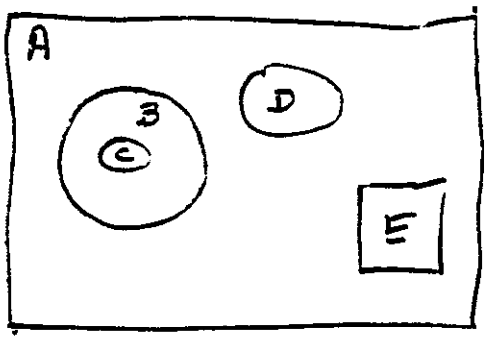
- Bremsstrahlung — Kati Lassila-Perini
  angular distributions
- Photoelectric effect — J. Chwastowski
  better cross section tables
  additional shells
  angular distributions
- Detector Design Tool (DDT) Jusko Vuoskoski
  AutoCAD ⟷ GEANT
  limits AutoCAD to GEANT 3.15 volumes
- Fast Calorimeter Simulation for H1 S. Peters
  GFLASH
- EM Shower parameterization in GEANT 3.16 I. Josa
  Implementation of GFLASH in GEANT.
- New Geometry V. Perevoztchikov
  accomplishments, plans through end of 1993
- Results of New Geometry F. Rabany
  can search for overlaps in RZ 3.1X databases
  memory requirements approximately equivalent
  tracking times:
  - γ, e faster } L3
  - other slower
  - all faster } Aleph

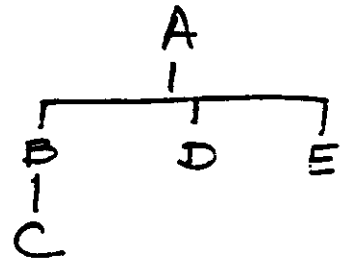
  New geometry binary tree not optimized to handle overlapping volumes. Works, but is slower.
- Optical Photons R. Jones
  photons in RICH
- Demonstration of MOTIF ++ GUI

GEANT Volume Search Algorithm

GEANT geometry tree.

- mother + daughter volumes





- volume division vs. volume positioning
- 'ONLY' vs. 'MANY'

Volume Search

- Level-by-level select correct daughter volume within each mother
  - division → easily calculated
  - positioning → search required
    OPTIMIZATION!

Volume Search with Positioned Volumes

- Default – search daughters in order of positioning

  SLOW!

- optimized – use "intelligence"
  - GSORD – create pseudo-divisions in geometry
    calculate pseudo-division
    search within pseudo-division
  - GSNEXT – user specifies neighbors to be searched
    first daughter found by default technique
    particle returning to mother uses neighbor information for search.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

Problems :

- 'ONLY' vs. 'MANY' overlapping volumes
- protruding daughters
- optimization missing volumes

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

gem

γeμ

Presentation by:

Brent Moore

CALOR89 BENCHMARKING (e/h)

	ZEUS	ZEUS	CDHS	DØ
CONFIGURATION	DU-SCSN	Pb-SCSN	Fe-SCSN	LAr-DU
THICKNESSES	0.33/0.26 cm	1.00/0.25 cm	2.50/0.25 cm	0.57/0.3 cm
CALOR89	1.01 ± 0.03	0.99 ± 0.03	1.17 ± 0.03	1.06
EXPERIMENT	1.01 ± 0.04	1.05 ± 0.02	1.19 ± 0.04	1.03 ± 0.015

Brent Moore

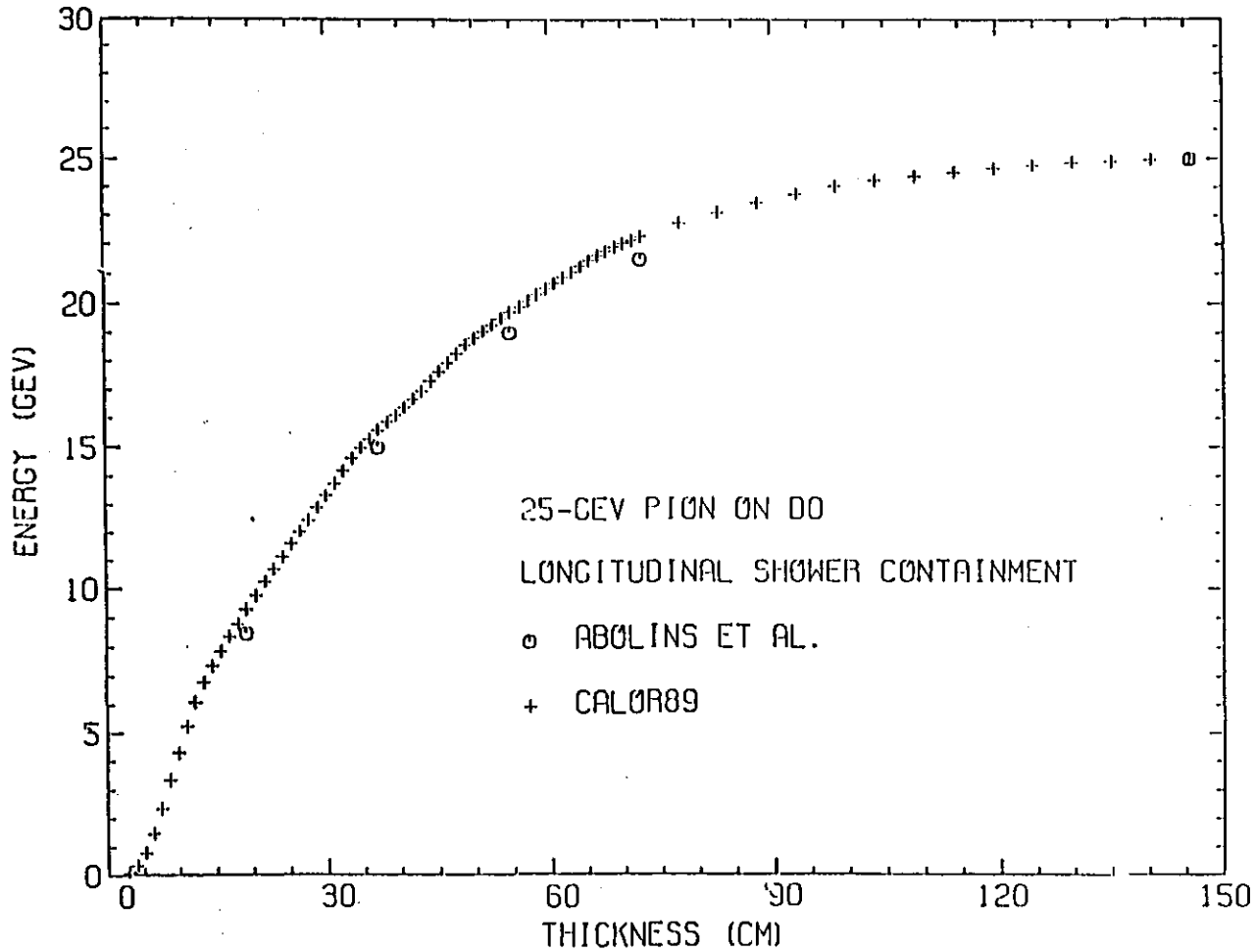


Fig. 4 Integrated shower containment for 25 GeV pion in the DO calorimeter as a function of depth.

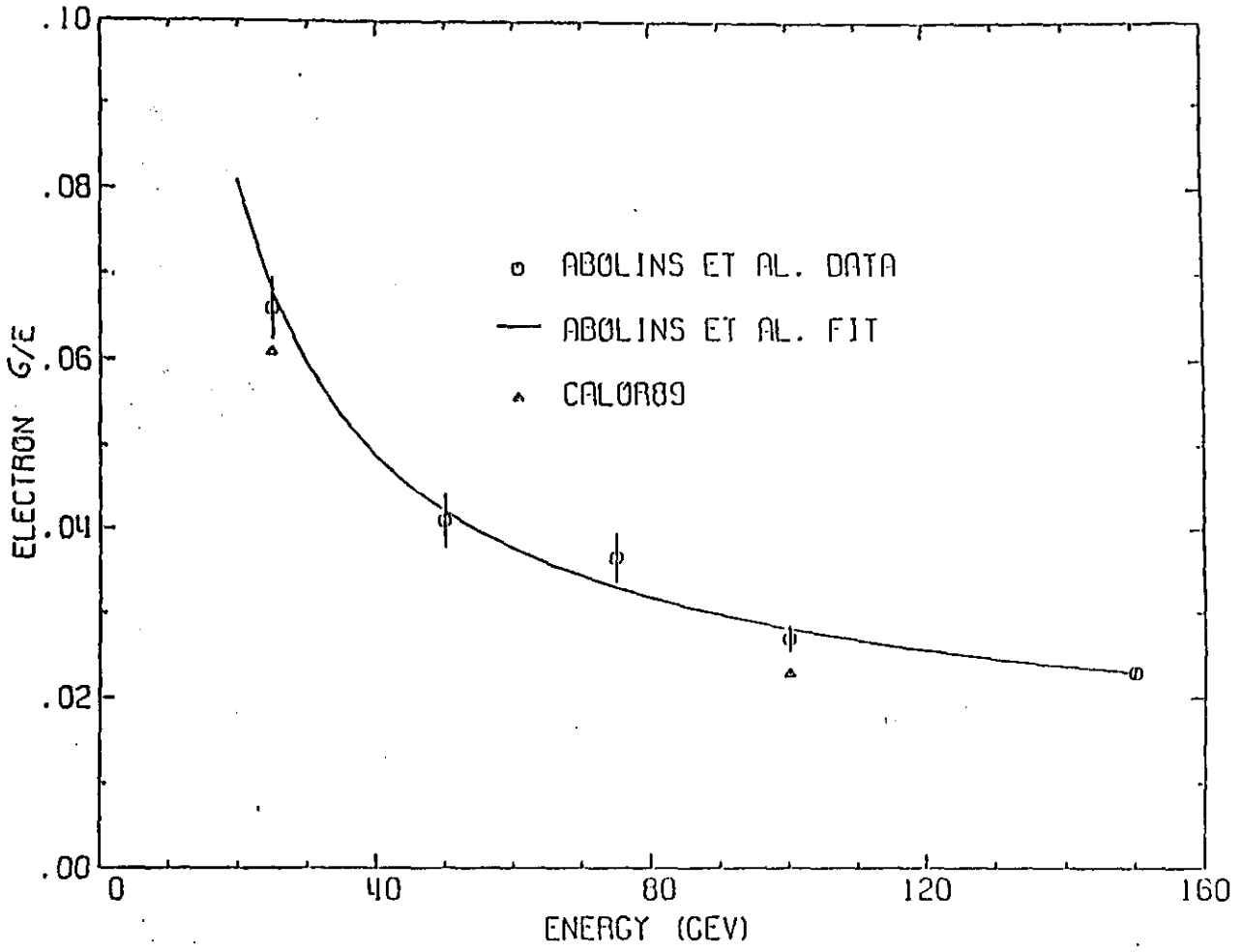


Fig. 5(a) Electron energy resolution for the DO calorimeter as a function of electron energy.

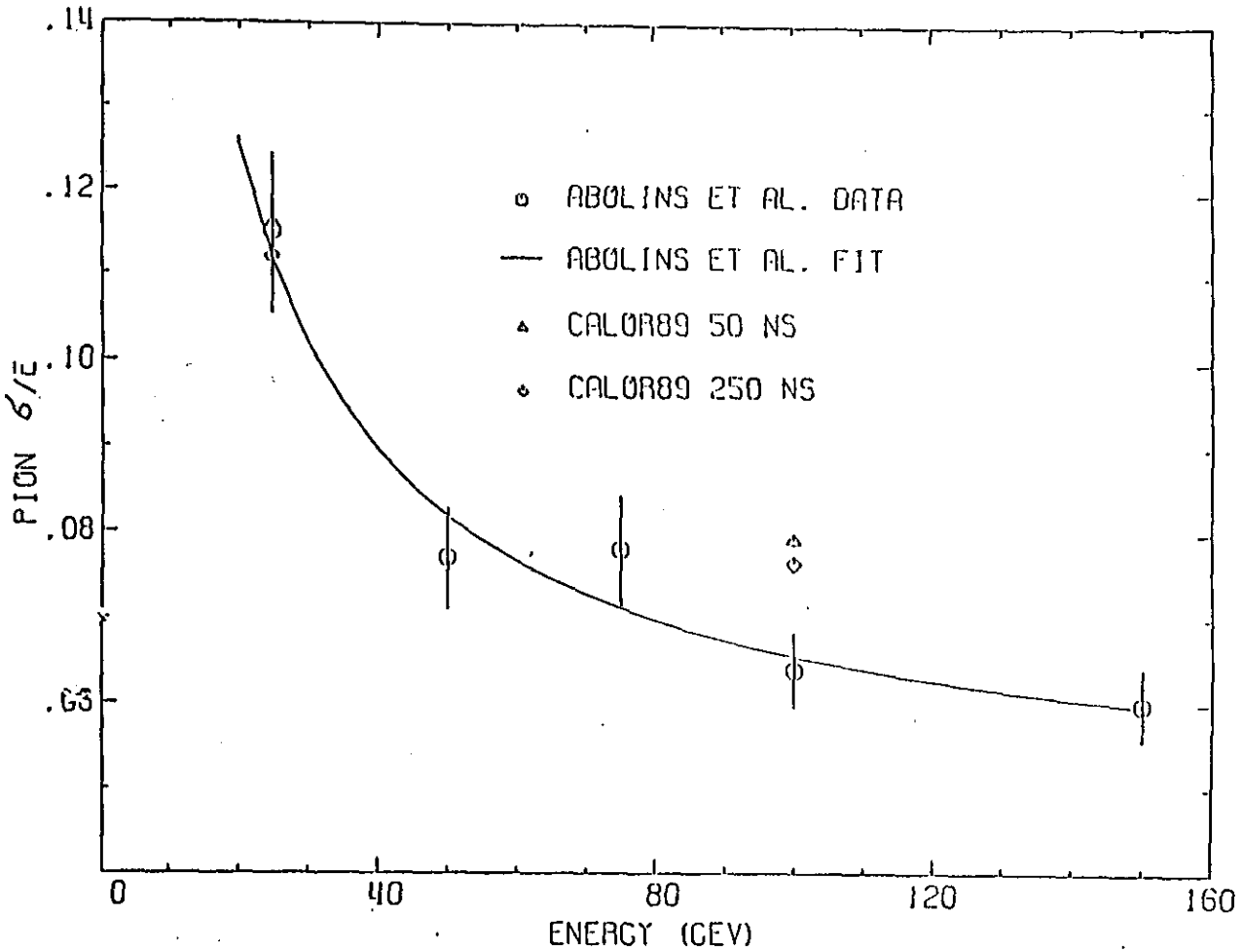
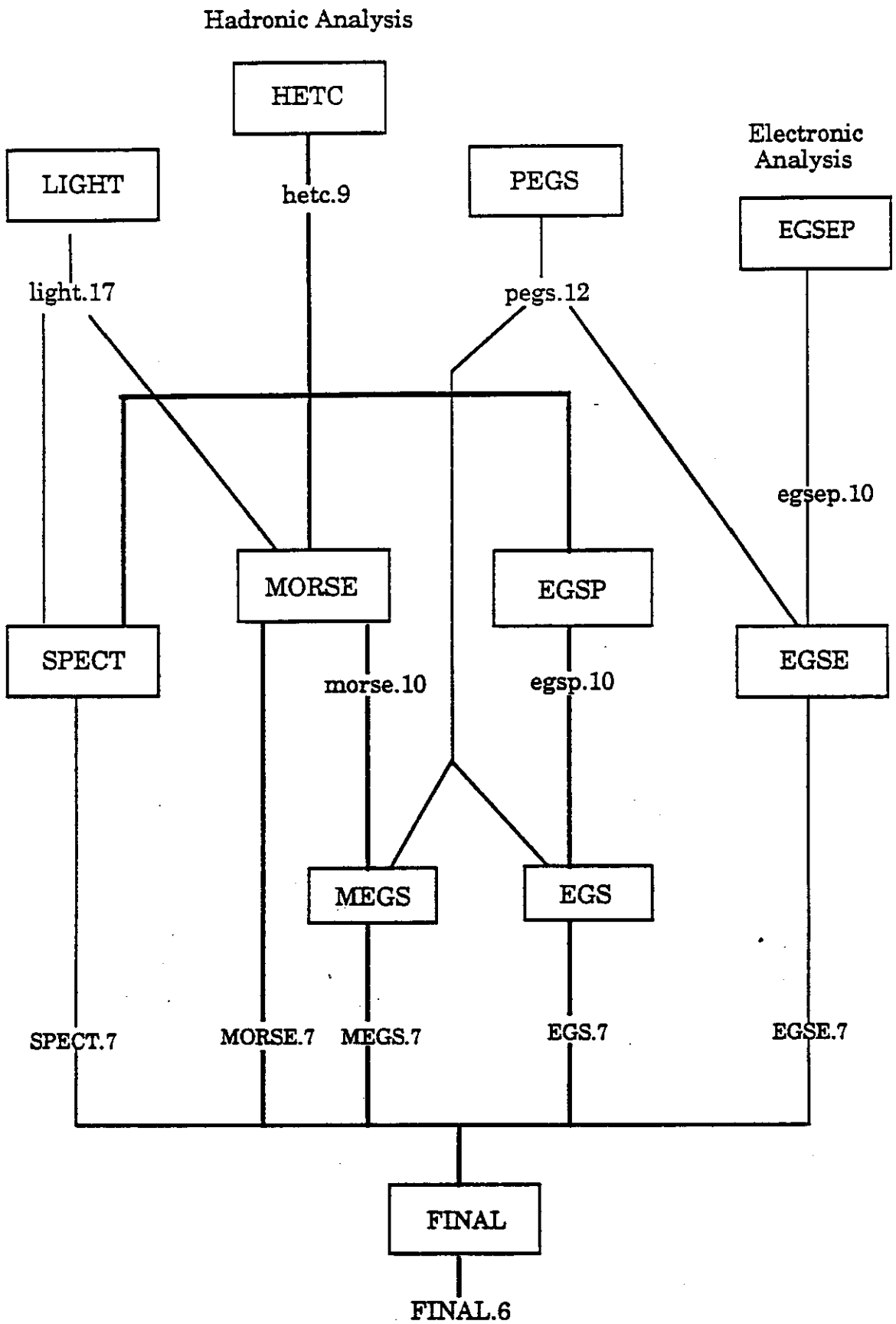


Fig. 5(b) Pion energy resolution for the DO calorimeter as a function of pion energy and integration time.

Overview of the CALOR89 - Unix Version 3 Package



UNIX VERSION 3 IN GENERAL GEOMETRY

SLAB CONFIGURATIONS - BASIC CALOR

/home/dssg0/sdc2/moore/c89u3g

~moore/c89u3g

/documentation* → Unix3		0.1 mb
/calor89		5.9 mb
/examples		6.5 mb
		12.5 mb

HARD COPY DOCUMENTATION: SDC-92-246
UMS/HEP/91/016

*IT IS ASSUMED THE USER HAS BASIC CALOR DOCUMENTATION FROM OAK RIDGE:

BARBARA BISHOP BLB@ORNLSTC

TONY GABRIEL TAG@ORNLSTC

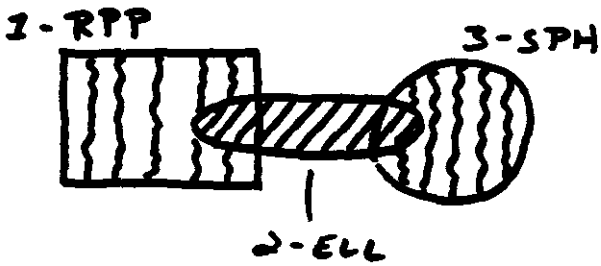
UNIX VERSION 4 IN COMBINATORIAL GEOMETRY

USES COMBINATIONS OF ELEMENTARY SHAPES TO CREATE COMPLICATED CONFIGURATIONS

~moore/c89u4c

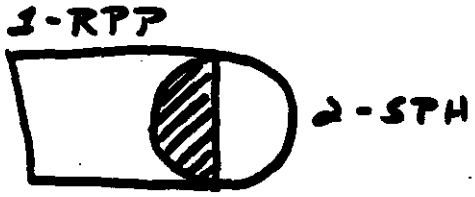
doc	0.1 Mb
src	6.0 Mb
ex	7.5 Mb
	13.6 Mb

- SPHERE
- RIGHT PARALLELEPIPED
- BOX
- RIGHT CIRCULAR CYLINDER
- TRUNCATED RIGHT CONE
- RIGHT ANGLE WEDGE
- ELLIPSOID
- RIGHT ELLIPTIC CYLINDER
- ARBITRARY POLYHEDRON (6-SIDED)



FE OR 1 - 2 OR 3 - 2

PB +2



CU + 1 + 2

C89-U4C

- MORE PARAMETERS ENTERED FROM INPUT FILES AS OPPOSED TO BEING CHANGED IN USER-WRITTEN SUBROUTINES

- PRIMARY INPUT FILE OVERRIDES OTHERS calor.5
  - CONVENIENCE
  - MINIMIZE STUPID MISTAKES

- C PROGRAM INCLUDED TO AUTOMATICALLY GENERATE GEOMETRY FILES FOR SLAB CONFIGURATIONS general/slabcom.c

- COMBINED MORSE/MEGS PROGRAM

MISSISSIPPI AUTOMATIC GENERATOR OF INPUTS FOR CALOR

ONE 'META-INPUT' FILE IS USED TO CREATE INPUT FILES FOR ALL MAJOR CALOR PROGRAMS
- HETC
- SPECT
- MORSE
- EGSPREP
- EGS4

X PEGS LIGHT

UNIX VERSION 5

THIS IS A UNIFIED CALOR PROGRAM.
NO HISTORY FILES ARE WRITTEN OUT.

ADVANTAGES

- SAVE DISK SPACE
- NUMBER OF EVENTS TO RUN NOT LIMITED BY DISK SPACE
- ALWAYS COMPLETE ONE EVENT BEFORE PROCEEDING TO THE NEXT
- SAVE I/O TIME

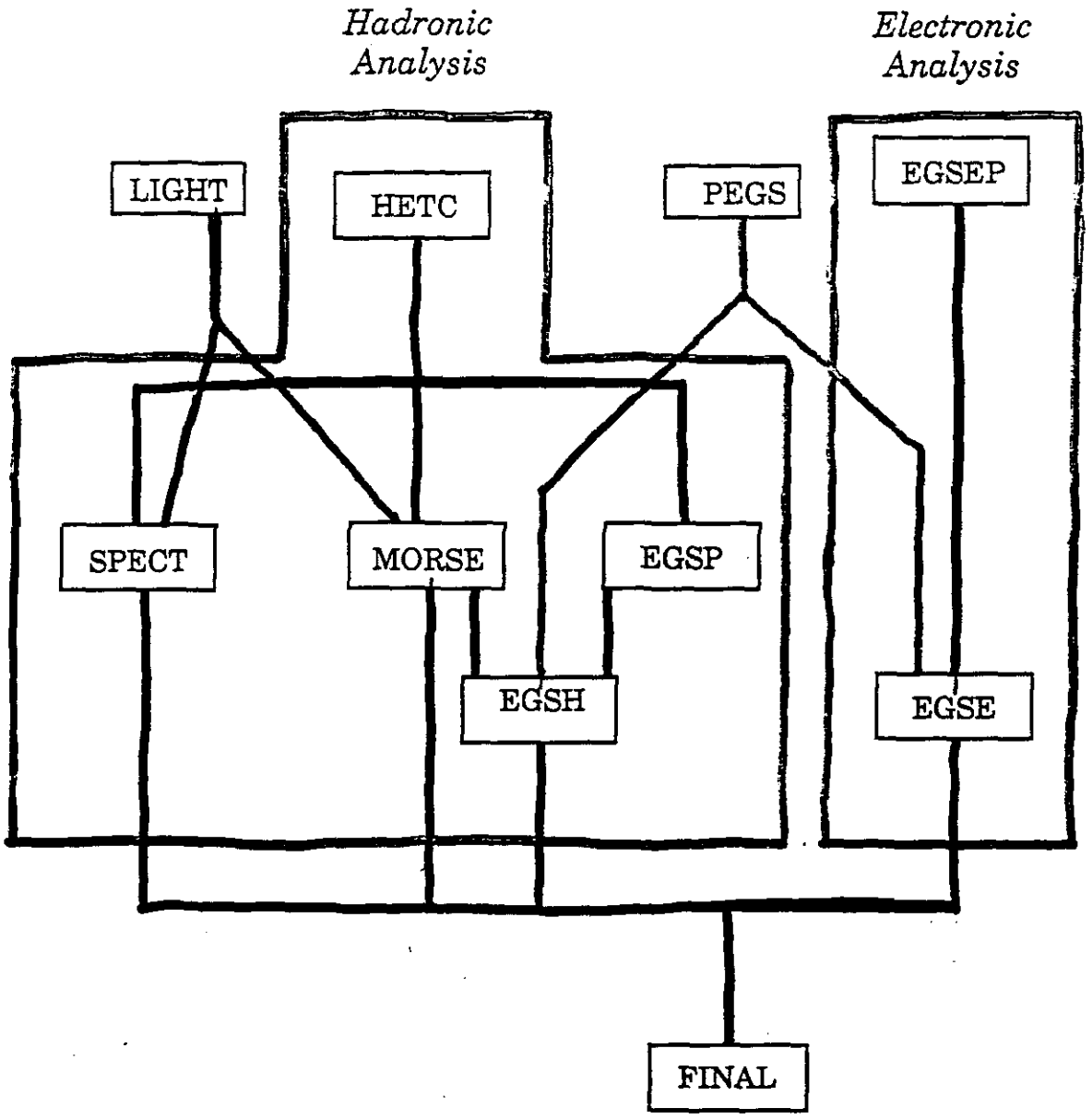
DISADVANTAGES

- MEMORY REQUIREMENTS (16, 24, 32 Mb)

IN FINAL STAGES OF DEVELOPMENT AT UNIVERSITY OF MISSISSIPPI

- ORGANIZING SUBROUTINES + FUNCTIONS W/MAKEFILE
- ELIMINATING EGS4 MODULE
- STREAMLINING ANALYSIS ROUTINES

Overview of CALOR89 - UNIX Version 5



FUTURE PLANS

- ONE ANALYSIS ROUTINE
- ISAJET INTERFACE
- ONE GEOMETRY PACKAGE
- SIMPLER INPUT (?)
- GEOMETRY PROGRAM (??)

SOURCE CODE DIRECTORIES

HETC

MAKEFILE

HENMT

CREATES BINARY X-SECTION FILES FOR HETC

RUN ONLY ONCE WHEN INSTALLING ON COMPUTER

COMPILE henmt.f

SPECT

MAKEFILE

ENERGY DEPOSITIONS IN fugit.f

MORSE

MAKEFILE

ENERGY DEPOSITIONS IN bankr.f

XSEC.MORSE

XSBCDBIN.F - BCD → BINARY

RUN THIS ONCE WHEN INSTALLING ON COMPUTER

XSBINBCD.F X

EGS4

EGSH, EGSE, MEGS

MAKEFILES: make.egsh, make.egse, make.megs

egsh.f egse.f megs.f

ausgab.f ausgabm.f

(TIME ANALYSIS)

PREP (EGSPREP)

MAKEFILE

PREPARES BINARY INPUT FILE OF SOURCE PARTICLES FOR EGSH + EGSE

PEGS

COMPILE pegs.f

GENERATES X-SECTIONS FOR EGS4 — pegs.12

RUN ONCE FOR EACH SET OF MEDIA OR IF ENERGIES CHANGE

LIGHT (CURVES)

GENERATES light.17 - A FILE READ BY SPECT AND MORSE TO CORRECT FOR SATURATION EFFECTS

FINAL

FINAL ANALYSIS OF OUTPUT FROM EGSH, (EGSE),

MEGS, SPECT, MORSE

avg.f final.f

↑ COMPILE USING PACKLIB FROM CERN

GENERAL

slabcom.c → v4c

slabgeom.f → v3G

slabid.f → id.15 CONTAINS DEPTH INFO

"CALL ZONEID(ZAV)"

Assignments

edit9.f

MAGIC

magic.f → COMPILE WITH GEANT LIBRARY (RANDOM #'s)

magic.5

MORSEGS

COMBINED MORSE AND MEGS

megs1.f gamma.f → ausgab.f megs2.f

INPUT/OUTPUT FILES

TWO-PART NAMES: program. unit_number

PRIMARY INPUT FILES: '.5'

INFORMATIONAL OUTPUT FILES: '.6'

BINARY E-DEP INFO FILES: 'SPECT.7', 'SPECT.11'

EM PARTICLE SOURCE FILES FOR EGS4: '.10'

(pegs.10 NOT USED)

GEOMETRY FILE: geom.18

HETC HISTORY FILE: hetc.9

SUMMARY EVENT INFO: '.report'

PEGS X-SECTIONS FOR EGS4: pegs.12

HETC X-SECTIONS: henmt.9, henmt.10

MORSE X-SECTIONS: morse.1

USER-WRITTEN ANALYSIS ROUTINES

SPECT - FVGIT

MORSE - BANKR

EGS4 - AVSGAB (EGSH, EGSE)

AVSGABM (MEGS)

XAV = (X + XOLD)/2. XBAR = (XNEW + XOLD)/2.

IZ = ZONEID(ZBAR)

STO(NEVENT) → '.7', '.report'

STON(NTIME, NRAD, NSLAB) - CUMULATIVE

STOT(NTIME, NRAD, NSLAB) → '.11'

THESE ROUTINES CONTAIN MANY COMMENTS,

ALL OF WHICH ARE GREATLY ENLIGHTENING

NOTES FOR COMPILATION OF CALOR89 CODES

- ALWAYS USE STATIC MODE FOR MAIN PROGRAMS

  HETC, MORSE, EGS4, FINAL

  SGI - f77 -static

  SUN - f77 (STATIC IS DEFAULT)

  HP - fort77 -K +ppu
  ↑ STATIC ↑ APPEND UNDERSCORES

- GEANT RANDOM NUMBER ROUTINE USED

  -L cernlib_dir␣-lgeant315

- HBOOK USED FOR HISTOGRAMS

  -L cernlib_dir␣-lpacklib

- IF INTRINSIC FLUSH UNAVAILABLE, USE DUMMY

- IF INTRINSIC LOC UNAVAILABLE,

  USE loc.c FROM /auxiliary

GENERAL PROPERTIES OF CALOR PROGRAMS

- I/O FILES OPENED AND CLOSED USING SUBROUTINE opener.f (EGS4: open_egsh.f, open_megs.f, ...)

- MAIN PROGRAM FOR HETC IS CONTAINED IN hetc.f, ...

- PARAMETER SET IN calor.5 GENERAL INPUT FILE OVERRIDE PROGRAM-SPECIFIC INPUT FILES

- INPUT FILE calor.5 IS READ BY readc5.f IN SPECT, MORSE, EGS4

- INCLUDE FILE parameter.h ASSIGNS MAXIMUM NUMBER OF EVENTS, TIME GATES, RADIAL BINS, AND DEPTH BINS (SLABS).

SPECIFIC PROGRAM NOTES

HETC

- BOUNDARY CROSSINGS

LINE C5 OF hetc.5

NUMBER OF MEDIA TO WRITE OUT BOUNDARY CROSSINGS FOR (Ø - ALL)

MEDIA NUMBERS

- ESKALE VALUE

5-15 GeV

MORSE

- MCOMM COMMON BLOCK

USED FOR GENERAL STORAGE (GEOMETRY, X-SECTIONS, --). CAN CHANGE THE SIZE BY CHANGING THE VARIABLE MCDIM IN THE INCLUDE FILE mcomm.h.

TYPE make TO RE-COMPILE.

- U238

IF PRESENT, MUST INCLUDE FISSION CROSS SECTIONS (ZEROES FOR ALL OTHER MEDIA).

MAGIC DOES THIS AUTOMATICALLY.

- CROSS SECTION INPUT

NMED NELEM NMIX

105	105	26	26	131	134	4	2	3	3	4	2	0	0
0	0	0	0	0	0	0	1	0	0	0			
13	14	15	16	21	22	23	24	17	18	19	20		
1	-2	0.03299	← Pb										
C → 2	1	0.00000	← Plastic Scintillator										
1 → 2	-3	0.04920											

SEE DOC. FOR X-SEC IDENTIFIERS

EGS4

- MEDIA NAMES IN INPUT MUST BE LISTED IN ORDER AND BE EXACTLY THE SAME AS THEY ARE GIVEN IN THE PEGS INPUT

- PARTICLE ENERGIES

BE SURE ALL PARTICLE ENERGIES ARE WITHIN RANGE FOR WHICH CROSS SECTIONS WERE CALCULATED IN PEGS.

COMPARISON OF TIME + DISK REQUIREMENTS

U3G Pb/SCINT: 245 UNIT CELLS

1 UNIT CELL = 1 X_0 (0.56 cm) Pb
+0.25 cm SCINT

1000 EVENTS

	10 GeV	50 GeV
HETC HISTORY	485 Mb	1620 Mb
MORSE OUTPUT	37 Mb	130 Mb
APPROX. TOTAL	600 Mb	1900 Mb
HETC	5:54	20:54
SPECT	16:39	59:48
EGSPREP	:50	2:47
EGSH	12:23	84:54
MORSE	20:44	98:07
MEGS	7:25	31:32
EGSE	30:35	166:40
TOTAL	~95 hrs	~465 hrs

TIMES FOR SGI 4D/20 - 7 MIPS

TIME & DISK SPACE

100 GeV π^- ON 12λ OF COPPER

hetc.9 0.19 mb/EVENT

morse.30 0.57 mb/EVENT

0.76 mb/EVENT

REAL TIME: 1.7 MIN/EVT

USER TIME: 1.6 MIN/EVT

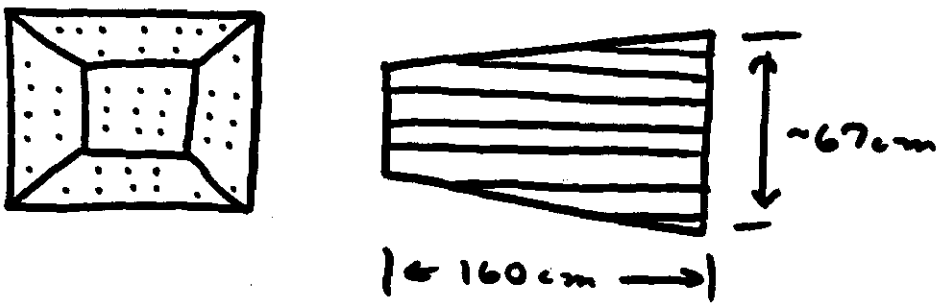
100 GeV π^- ON 12λ OF LEAD (SOME SCINT)

RUN MORSEGS
⇓
0.14 mb/EVENT

REAL TIME: 2.8 MIN/EVT

USER TIME: 3.6 MIN/EVT

SSCINT CAL SIMULATIONS



SPACING: 0.7925 cm

FIBERS → 86×86 = 7396

ACTIVE FIBER
DIAMETER : 0.125 cm

TOTAL # OF BODIES: 14,794

CLADDING: 0.05 cm

5 GeV π^- ~40 MIN/EVT

10 GeV π^- ~160 MIN/EVT

SUMMARY

- UNIX VERSIONS OF CALOR89 ARE ON PDSF

  /home/dssg0/sdc2/moore (= ~moore)

  c89u3g
  c89u4c
  c89u5c
  c89u4g
  c89u5g

  DOCUMENTATION AND SAMPLE PROBLEMS ARE INCLUDED

- HARD COPY DOCUMENTATION IS AVAILABLE FOR U3G NOW AND WILL BE SOON FOR U4C.

  SDC-92-246
  UMS/HEP/91/016

  BARBARA BISHOP BLB@ORNLSTC
  TONY GABRIEL TAG@ORNLSTC

- QUESTIONS CAN BE SENT BY E-MAIL TO MOORE ON SSCVX1 OR PDSF

gem

γeμ

Presentation by:

Yu. Fisyak

Structure of the GEM Full GEANT simulation

Fisyak, Yu.

Contents

1 Goals of the Full Simulation **2**

2 Computer model **3**

2.1 Title data base 3

3 SIGEM: from v0 to v1 **10**

1 Goals of the Full Simulation

The goal of the Full GEM simulation are formulated as the following:

- to create an adequate computer model for the detector;
- to simulate the detector response up to the level of data which will be obtained from the GEM DAQ system;
- reconstruction of events in order to provide reliable estimation of efficiencies for **e** 's, γ 's, μ 's and **jet** 's.

It is needed to provide at least 3 levels of computer model detailization for different subsytems:

- fast simulation — geometrical acceptance + parametrical model for detector responses;
- so called "mixture" level simulation — dead materials, background estimation and reconstruction;
- full simulation — detailed simulation up to DAQ accounting event pile-up effects.

It is important to stress that we have to provide the consistent simulation at these different levels.

2 Computer model

The computer model includes "title" data base which consists of:

- description of geometry
- magnetic field map
- material and tracking media definition
- sensitive element definitions
- definitions of "hits" providing information for digitization stage and reconstruction
- tools which provide possibility to work with this data base.

" Title data base ":

- title cards read by Zebra TZ package;
- RZ-file which can be read directly by any program in simulation / production chain.

There are tools which provide a possibility to create these title cards from GEANT geometry and to read these cards and to build the GEANT geometry.

The example of titles in TZ format are presented on the next pages.

book TZ

Title Handling

Zebra version 3.67

June 1991

J. Zoll

Chapter 1 User specifications for the TZ package

1.1 TZFIND – access to title banks

1.2 TZINIT – creating title banks from a text file

1.3 TZUSER – editing title banks during input

1.4 TZSHUN – insert banks into a title structure

1.5 TZINQ – inquire about the title d/s

Chapter 2 Formats for the text input to TZINIT

2.1 Out-line

2.2 Control-lines

2.3 Title header lines

2.4 Free-field input

2.5 Fortran formatted input

```
*CMZ :          02/12/92  18.30.36  by  Yu.Fisyak
*-- Author :
*DO  GPUR   1 -U -A4CW -c1/80     #. Title created on 921202 at 1642
 #. list of pure materials  A          Z        dens         X_0
"Hydrogen          "  1.0100      1.0000     0.70800E-01  865.00
"Deuterium         "  2.0100      1.0000     0.16200      757.00
"Helium            "  4.0000      2.0000     0.12500      755.00
"Lithium           "  6.9400      3.0000     0.53400      155.00
"Berillium         "  9.0100      4.0000      1.8480      35.300
"Carbon            "  12.010      6.0000      2.2650      18.800
"Nitrogen          "  14.010      7.0000     0.80800      44.500
"Neon              "  20.180      10.000      1.2070      24.000
"Aluminium         "  26.980      13.000      2.7000      8.9000
"Iron              "  55.850      26.000      7.8700      1.7600
"Copper            "  63.540      29.000      8.9600      1.4300
"Tungsten          "  183.85      74.000      19.300     0.35000
"Lead              "  207.19      82.000      11.350     0.56000
"Uranium           "  238.03      92.000      18.950     0.32000
"Air               "  14.610      7.3000     0.12050E-02  30423.
"Vacuum            " 0.10000E-15 0.10000E-15 0.10000E-15 0.10000E-17
"Argon             "  39.950      18.000     0.00000E+00 0.00000E+00
"Krypton           "  83.800      36.000     0.00000E+00 0.00000E+00
"Silicon           "  28.090      14.000      2.3300      9.3600
"Oxygen            "  16.000      8.0000     0.14300E-02  23944.
"Clorine           "  35.450      17.000     0.00000E+00 0.00000E+00
"Flourine          "  19.000      9.0000     0.00000E+00 0.00000E+00
"Silicon D         "  28.090      14.000      2.3300      9.3600
"Borom             "  10.811      5.0000      2.3400     0.00000E+00
"Barium            "  137.33      56.000     0.00000E+00 0.00000E+00
"Neobium           "  92.906      41.000      9.4100     0.00000E+00
"Titanium          "  47.880      22.000      4.5400      3.5600
"Mangan.           "  54.938      25.000     0.00000E+00 0.00000E+00
"Chromium          "  51.996      24.000     0.00000E+00 0.00000E+00
"Nickel            "  58.690      28.000     0.00000E+00 0.00000E+00
"Molybden          "  95.940      42.000     0.00000E+00 0.00000E+00
"Magnesium         "  24.305      12.000     0.00000E+00 0.00000E+00
```

```
*CMZ :          02/12/92  18.30.36  by  Yu.Fisyak
*-- Author :
*DO  GMIX   1 -U -A4CW -c1/50     #. Title created on 921202 at 1042
 #. list of mixtures#
"CO2                  "       2    0.19770E-02     comp.no.
          "Carbon             "    -1.0000         Volume (-) or Weig
          "Oxygen             "    -2.0000         Volume (-) or Weig
"Gas                  "       3    0.19573E-02     comp.no.
          "Carbon             "   -0.52000         Volume (-) or Weig
          "Oxygen             "   -0.40000         Volume (-) or Weig
          "Hydrogen           "    -8.0000         Volume (-) or Weig
"Insulation           "       6     1.6900         comp.no.
          "Helium             "   -0.25000E-01     Volume (-) or Weig
          "Carbon             "   -0.45000E-01     Volume (-) or Weig
          "Hydrogen           "   -0.36000E-01     Volume (-) or Weig
          "Oxygen             "   -0.18000E-01     Volume (-) or Weig
          "Aluminium          "   -0.50000E-01     Volume (-) or Weig
          "Iron               "   -0.18000         Volume (-) or Weig
"STR                  "       2     2.6400         comp.no.
          "Silicon            "    -1.0000         Volume (-) or Weig
          "Oxygen             "    -2.0000         Volume (-) or Weig
"Front/endEl          "       2     1.0000         comp.no.
          "Silicon            "   -0.95000E-01     Volume (-) or Weig
          "Lead               "   -0.50000E-02     Volume (-) or Weig
"Graph/Ep.Sp          "       3     1.5600         comp.no.
          "Carbon             "    -20.250         Volume (-) or Weig
          "Hydrogen           "    -20.000         Volume (-) or Weig
          "Oxygen             "    -2.0000         Volume (-) or Weig
"Freon-12             "       3    0.49300E-02     comp.no.
          "Carbon             "    -1.0000         Volume (-) or Weig
          "Clorine            "    -2.0000         Volume (-) or Weig
          "Flourine           "    -2.0000         Volume (-) or Weig
"Plexiglass           "       3     1.1800         comp.no.
          "Hydrogen           "    -8.0000         Volume (-) or Weig
          "Carbon             "    -5.0000         Volume (-) or Weig
          "Oxygen             "    -2.0000         Volume (-) or Weig
```

```
*CMZ :          02/12/92  18.30.36  by  Yu.Fisyak
*-- Author :
*DO  ROTI   1 -U -A4CW -c1/50     #. Title created on 921202 at 1642
"NULL"    "000D"    "180D"    "XYXD"    "YZXD"
"XZXD"    "90XD"    "ZSXD"    "90ZD"    "90YD"
"Z45P"    "Z45N"    "180X"    "90YZ"    "90XY"
"NEXT"
*DO  ROTM   1 -U -A4CW -C1/60     #. Title created on 921202 at 1642
"000D"                  90.000        0.00000E+00          Identifi
                        90.000         90.000
                      0.00000E+00    0.00000E+00
*DO  ROTM   1 -U -A4CW -C1/60     #. Title created on 921202 at 1642
"180D"                  90.000         180.00              Identifi
                        90.000         90.000
                        180.00        0.00000E+00
*DO  ROTM   1 -U -A4CW -C1/60     #. Title created on 921202 at 1642
"XYXD"                  90.000        0.00000E+00          Identifi
                        90.000         90.000
                        180.00        0.00000E+00
*DO  ROTM   1 -U -A4CW -C1/60     #. Title created on 921202 at 1642
"YZXD"                  90.000         180.00              Identifi
                        90.000         90.000
                      0.00000E+00    0.00000E+00
*DO  ROTM   1 -U -A4CW -C1/60     #. Title created on 921202 at 1642
"XZXD"                  90.000        0.00000E+00          Identifi
                        90.000         270.00
                      0.00000E+00    0.00000E+00
```

```
*CMZ :          02/12/92  18.30.36  by  Yu.Fisyak
*-- Author :
*DO  MATE   1 -U -A4CW -c1/60     #. Title created on 921202 at 1642
"Air                  "
*DO  TMED   1 -U -A4CW -c1/60     #. Title created on 921202 at 1642
"Air                  "
              0              1                                ISVOL, I
     8.0000         90.000        0.10000        0.10000    FIELDM,
    0.50000        0.10000                                   EPSIL, S
*DO  VOLU   1 -U -A4CW -c1/60     #. Title created on 921202 at 1642
"GEM "    "PCON"              "Air                  "
        27    0.00000E+00     360.00         8.0000         N,low_ph
              -7828.3        0.00000E+00     36.830         Z, R_min
              -2000.0        0.00000E+00     36.830         Z, R_min
              -1800.0        0.00000E+00     50.000         Z, R_min
              -1800.0        0.00000E+00     1090.0         Z, R_min
               1800.0        0.00000E+00     1090.0         Z, R_min
               1800.0        0.00000E+00     50.000         Z, R_min
               2000.0        0.00000E+00     36.830         Z, R_min
               7828.3        0.00000E+00     36.830         Z, R_min
*DO  ATT    1 -U -A4CW     #. Title created on 921202 at 1642
"GEM                    "   "SEEN                 "         0
```

```
*DO  DETV   1 -U -A4CW #. Title created on 921206 at 1827
"TRAK"    "PADW"          12200      1000          0
*DO  DETH   1 -U -A4CW #. Title created on 921206 at 1827
"TRAK"    "PADW"               8
 #. NAMESH NBITSH    ORIG            FACT
"XOUT"            19   75.00000       1000.000
"YOUT"            19   75.00000       1000.000
"ZOUT"            19   150.0000       1000.000
"DEDX"             0  0.0000000E+00  0.1000000E+08
"T_OF"            16  0.0000000E+00   10.00000
"YDET"             8   25.00000       200.0000
"ETA "             4  -1.440000       6.670000
"TRFT"            16  0.0000000E+00   10.00000
*DO  DETU   1 -U -A4CW #. Title created on 921206 at 1827
"TRAK"    "PADW"
              5  0.3000000E-01  0.2500000E-01  0.2500000
  0.1500000      0.5000000E-02
*DO  DETV   1 -U -A4CW #. Title created on 921206 at 1827
"CALO"    "C9HE"          22200      1000          0
*DO  DETH   1 -U -A4CW #. Title created on 921206 at 1827
"CALO"    "C9HE"               7
 #. NAMESH NBITSH    ORIG            FACT
"XOUT"            12   360.0000       1.000000
"YOUT"            12   360.0000       1.000000
"ZOUT"            12   550.0000       1.000000
"ELOS"             0  0.0000000E+00   100000.0
"TOF1"             0  0.0000000E+00   10000.00
"TOF2"             0  0.0000000E+00   1000.000
"TOF3"             0  0.0000000E+00   100.0000
*DO  DETV   1 -U -A4CW #. Title created on 921206 at 1827
"MUON"    "SW54"          31100      1000          0
*DO  DETH   1 -U -A4CW #. Title created on 921206 at 1827
"MUON"    "SW54"               6
 #. NAMESH NBITSH    ORIG            FACT
"XOUT"            23   2000.000       1000.000
"YOUT"            23   2000.000       1000.000
"ZOUT"            23   2000.000       1000.000
```

```
"DEDX"              0  0.0000000E+00  0.1000000E+08
"T_OF"             16  0.0000000E+00   10.00000
"TDRF"             14  0.0000000E+00   10.00000
*DO  DETU   1 -U -A4CW #. Title created on 921206 at 1827
"MUON"    "SW54"
              1  0.5000000E-02
```

3 SIGEM: from v0 to v1

```
     V0                          ==> V1
SI --- steering                  ==> SI
UT --- utilities                 ==> UT
XS --- eXperemental Setup        ==> XS
                                     TT titles
                                     RE reconstruction
Base line 1                      ==> Base line 2
```

The expected arrival time for the version 1 of SIGEM is January 1993.

gem

γeμ

Presentation by:

K. Shmakov

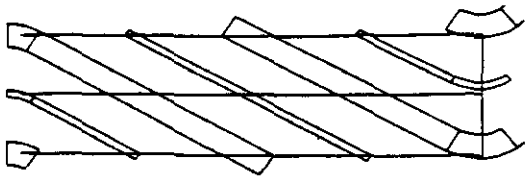
Accordion geometry for GEM detector simulations — SIGEM.

Fast — 4 – 8 sec/ev/1 GeV with 10 keV thresh.

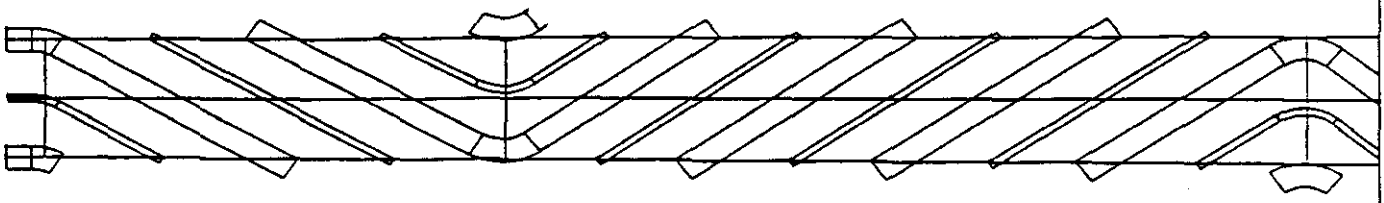
Flexible

4π geometry

Accordion geometry



1-st mother volume
includes 11 (seen) + 2×11 (not seen)

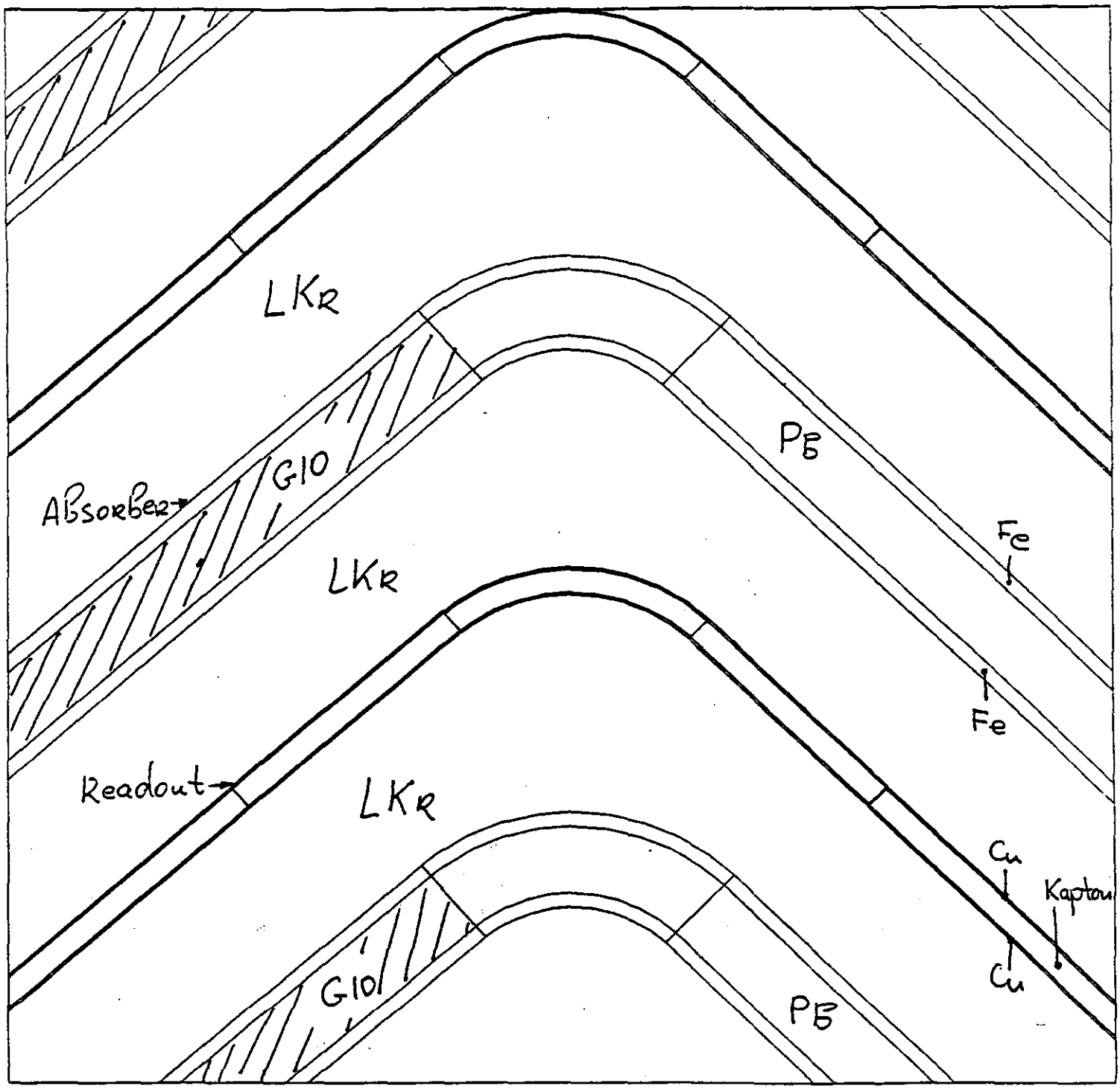


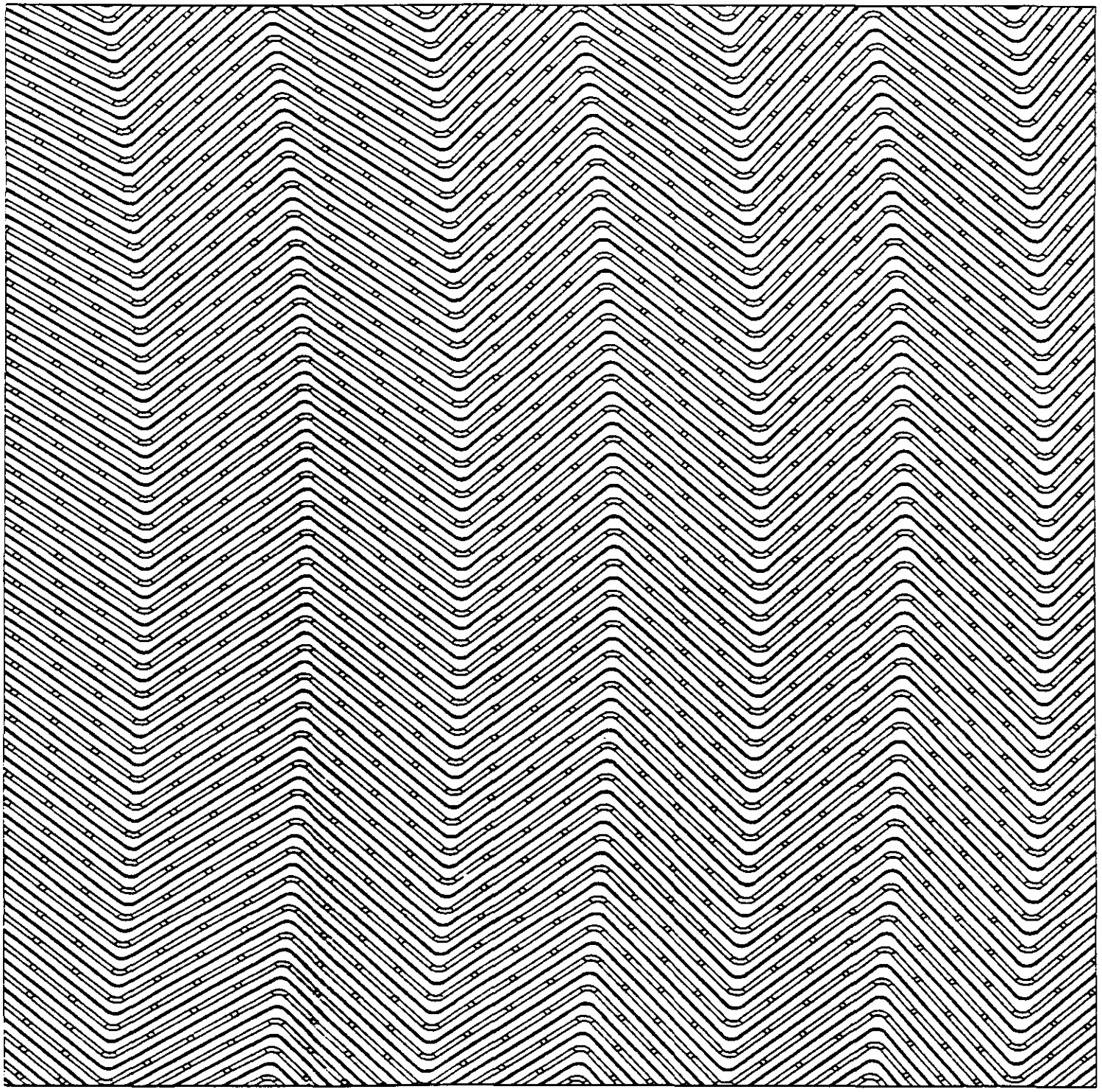
one φi-cell

total → 960 φ cells

total number of volumes → 33×19 = 627

Massless gap





```
*****************************************************************
*                ACTIVE ACCORDION PARAMETERS                    *
*****************************************************************
Rmin     =  95 cm          -  internal radius of the criostat
DRactive =  52 cm          -  length of the ACTIVE part of accordion
```

	Radiuses (cm)	Alfa (deg.)	Length (cm)	Center radius(cm)	Samping thickness(cm)	
1	106.600	.000	.200	106.700	.698	(1)
2	106.800	30.501	2.817	106.800	.602	(2)
3	109.237	34.251	5.181	111.327	.602	
4	113.519	37.163	5.006	115.470	.602	
5	117.509	39.561	4.908	119.361	.602	
6	121.293	41.608	4.854	123.070	.602	
7	124.922	43.396	4.827	126.641	.602	
8	128.430	44.984	4.820	130.101	.602	
9	131.839	46.414	4.825	133.470	.602	
10	135.166	47.713	4.841	136.764	.602	
11	138.423	48.904	4.864	139.992	.602	
12	141.621	50.002	4.893	143.164	.602	
13	144.767	51.021	4.928	146.288	.602	
14	147.866	51.970	4.965	149.368	.602	
15	150.926	52.859	5.006	152.409	.602	
16	153.948	53.694	5.050	155.416	.602	
17	156.939	54.481	2.524	158.391	.602	(2)
18	158.391	.000	.200	158.491	1.037	(1)

(1) - straight parts of 0.2cm
(2) - "half" of the accordion line

Advantage

1. Flexible
2. "Final" number of volumes

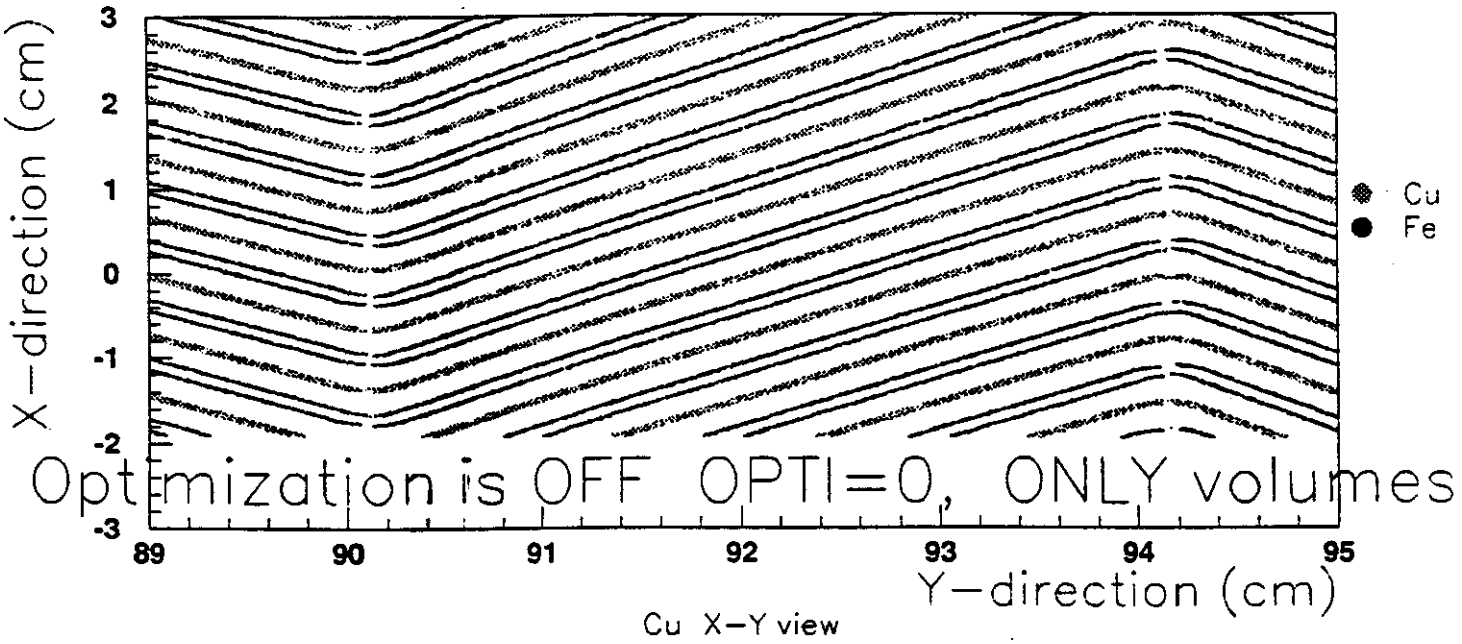
   600 vs 200,000

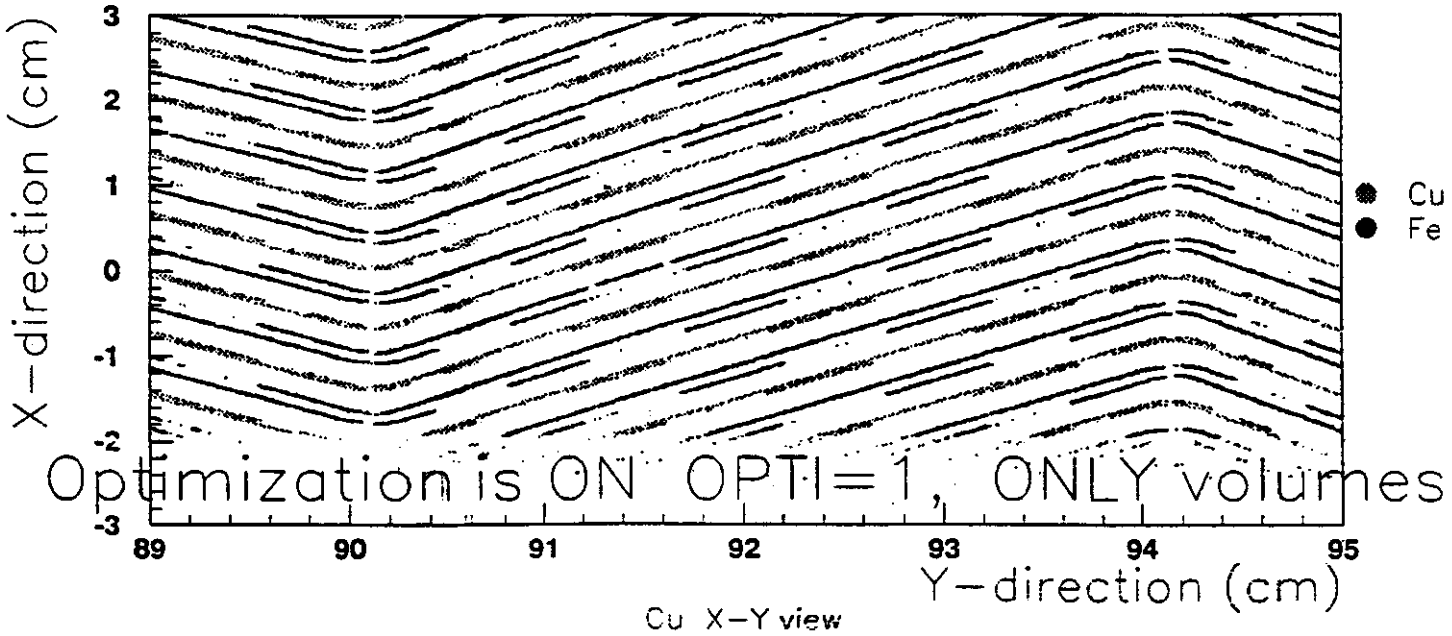
3. 4π geometry — includes transition zone at $\eta \simeq 1$
4. Use natural GEANT division.

"Disadvantage"?

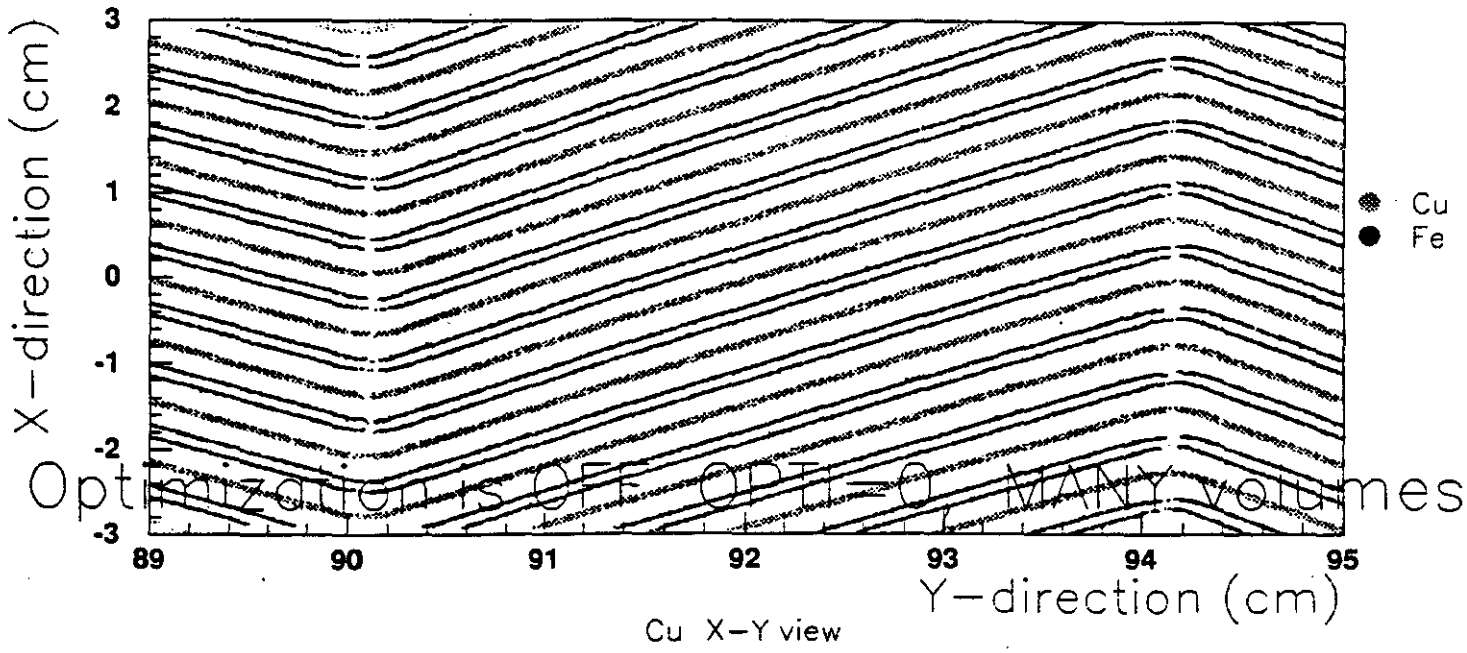
1. Use overlaying volumes
2. Position daughter volumes outside mother.

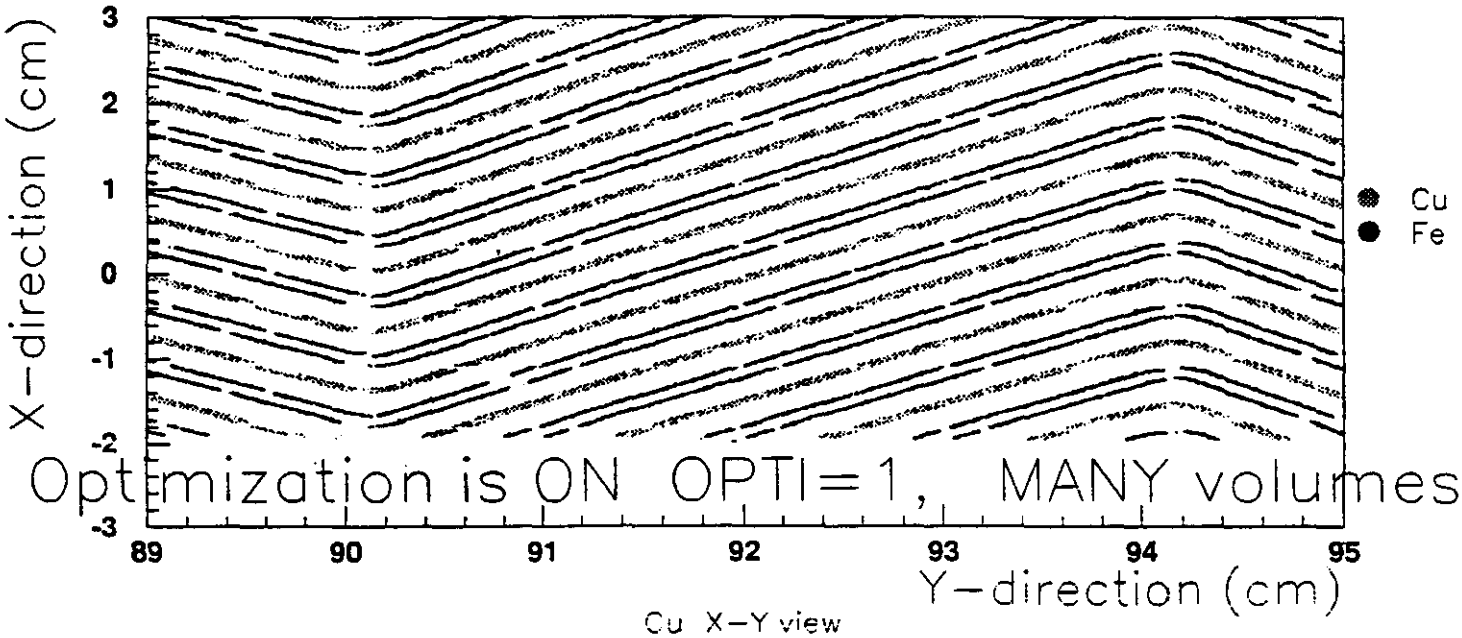
How 10 GeV muons see the accordion



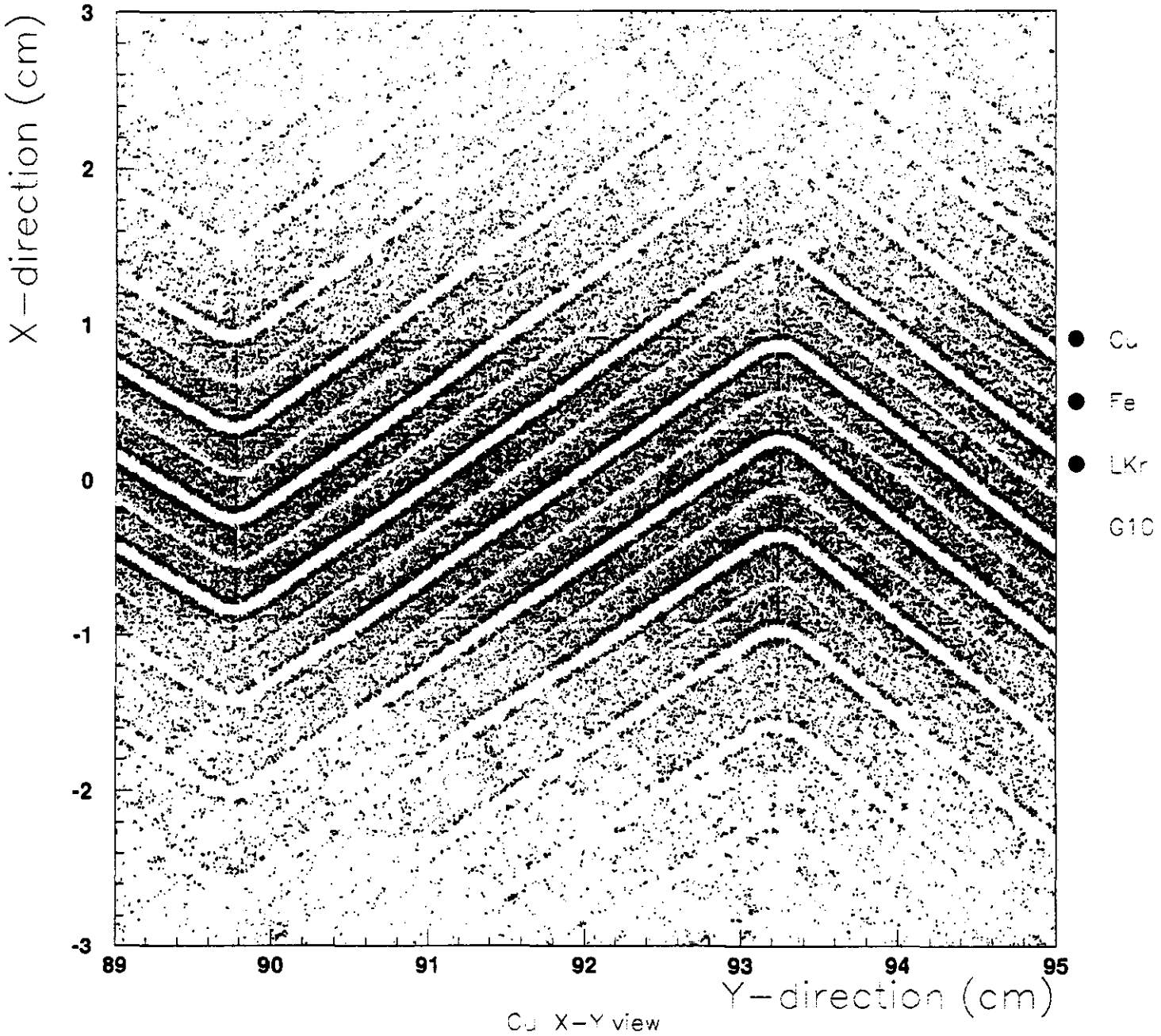


How 10 GeV muons see the accordion

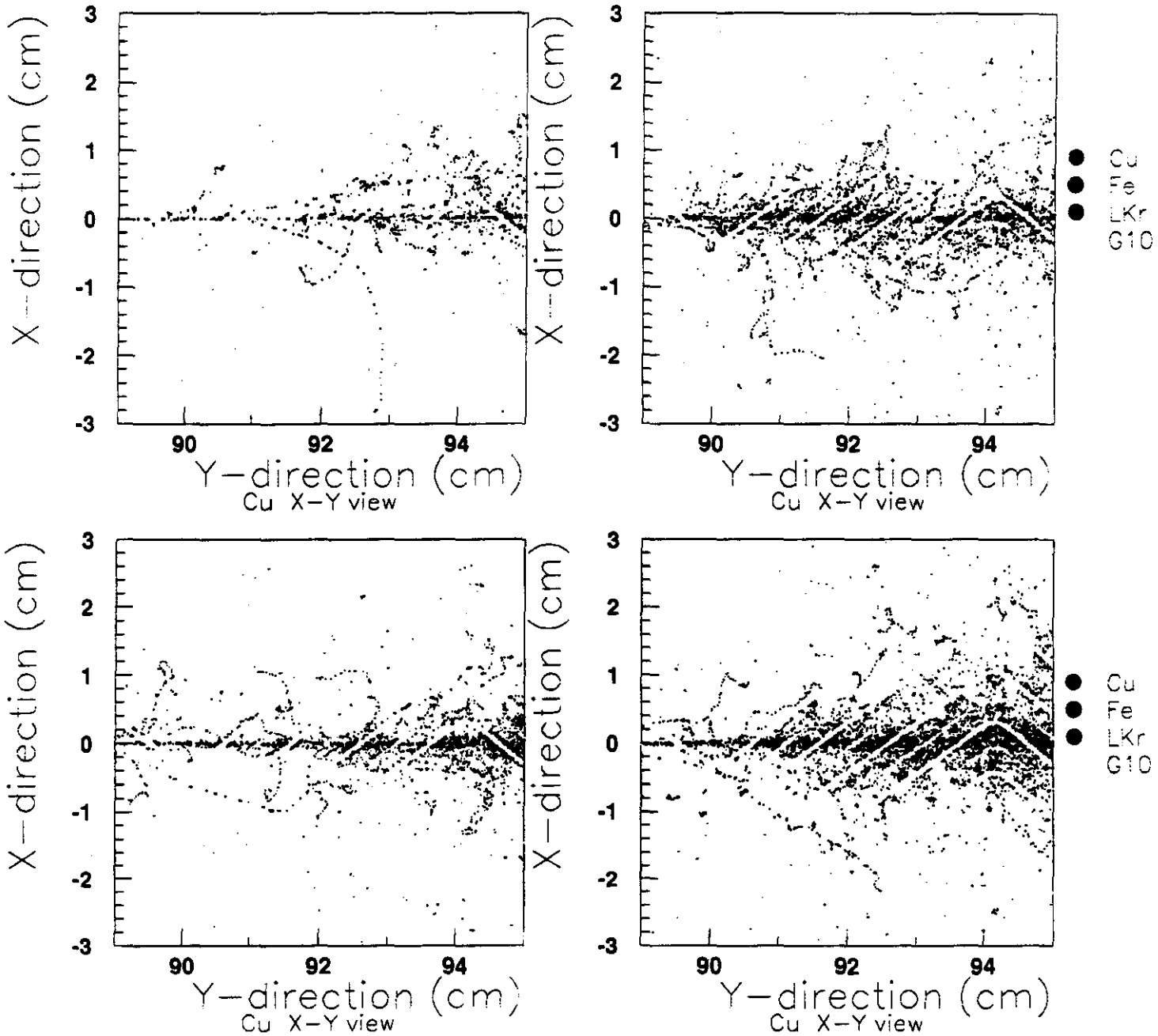




How 20 GeV electrons see the accordion



How 20 GeV electrons see the accordion

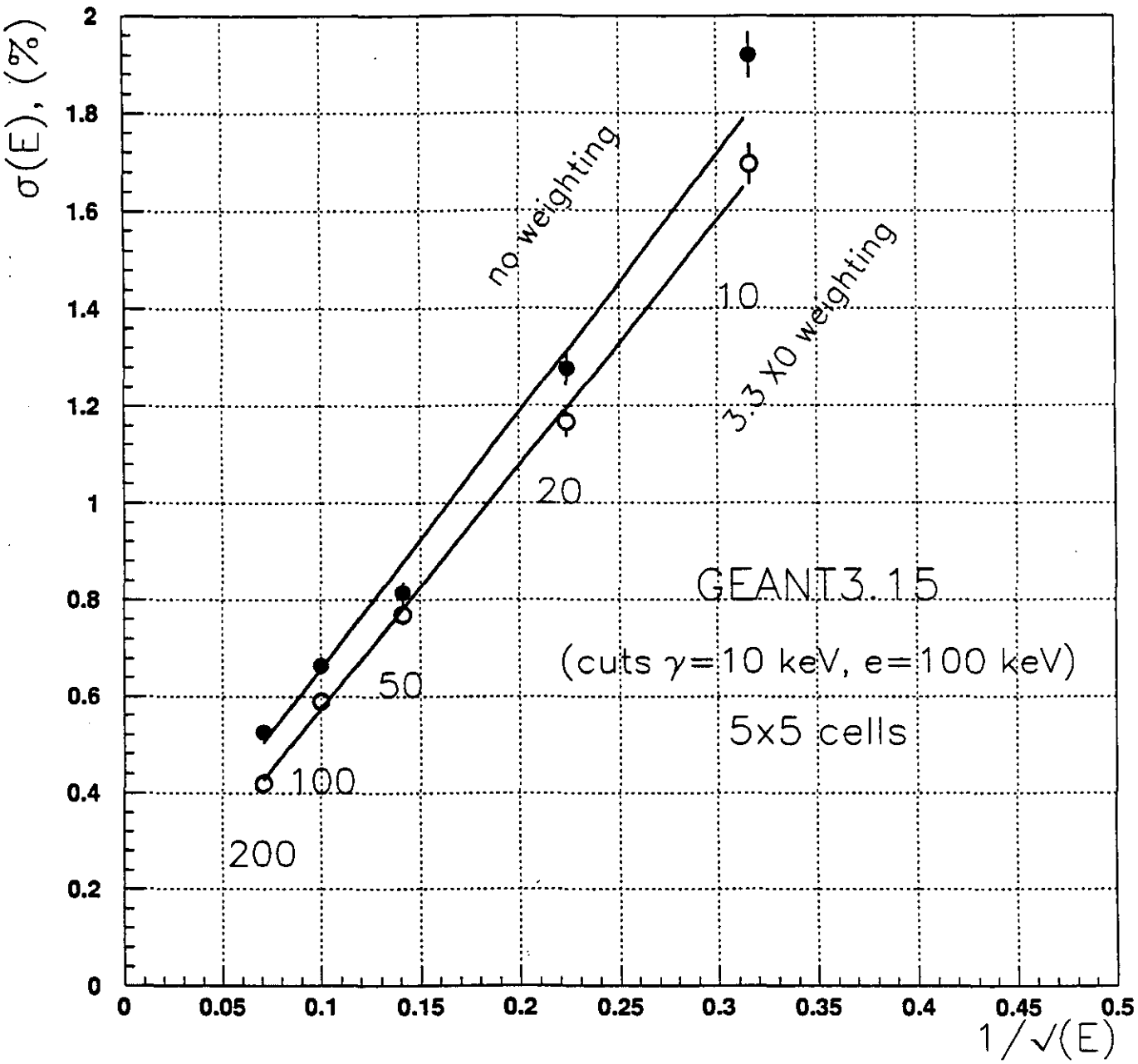


Conclusion :

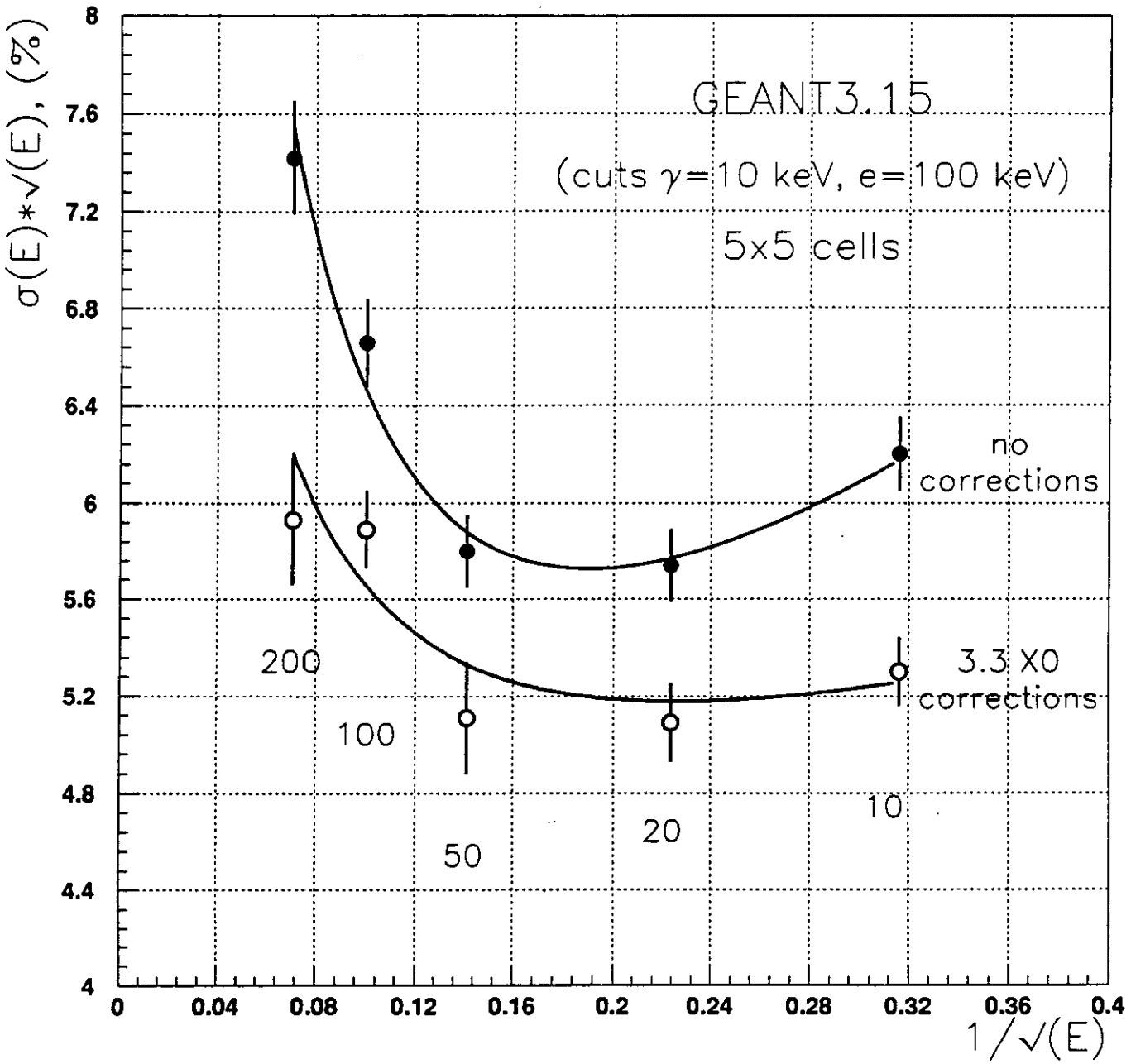
- Care should be taken during search optimization procedure.
- OPTI doesn't work !
- optimization with GSORD.

- Fast flexible code (geometry) is available for SIGEM simulations of whole GEM detector. (Barrel)
- Can be used also distinctly for optimization of accordion. (was using)

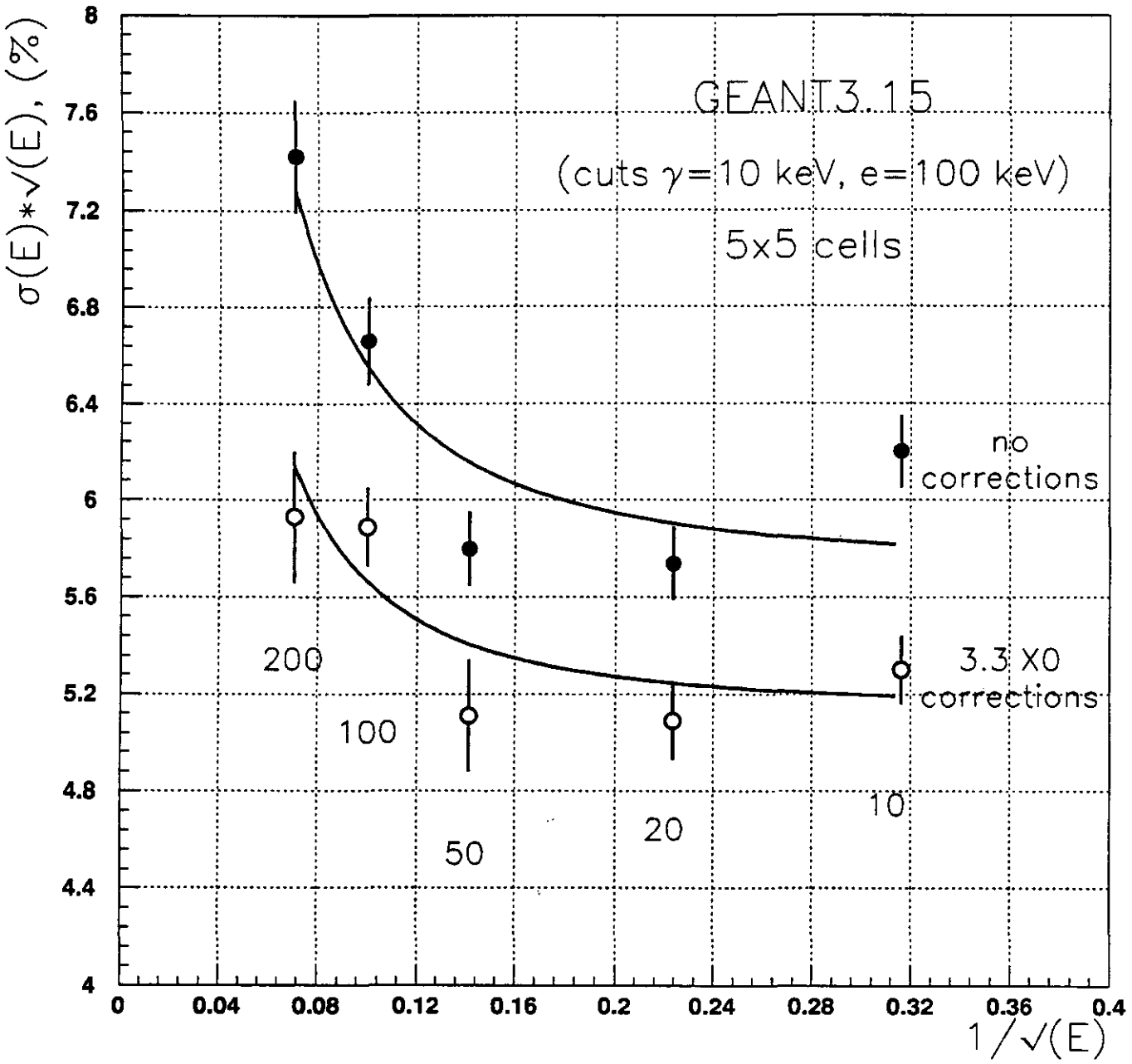
LKr accordion - resolution at 90 deg.



LKr accordion - resolution at 90 deg.



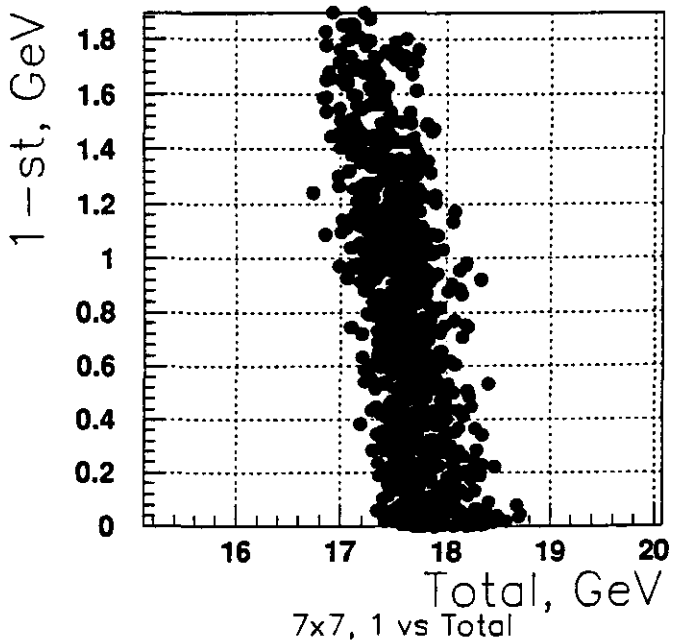
LKr accordion - resolution at 90 deg.



$5.73 \pm 0.11/\sqrt{E} \oplus 0.32 \pm 0.03$

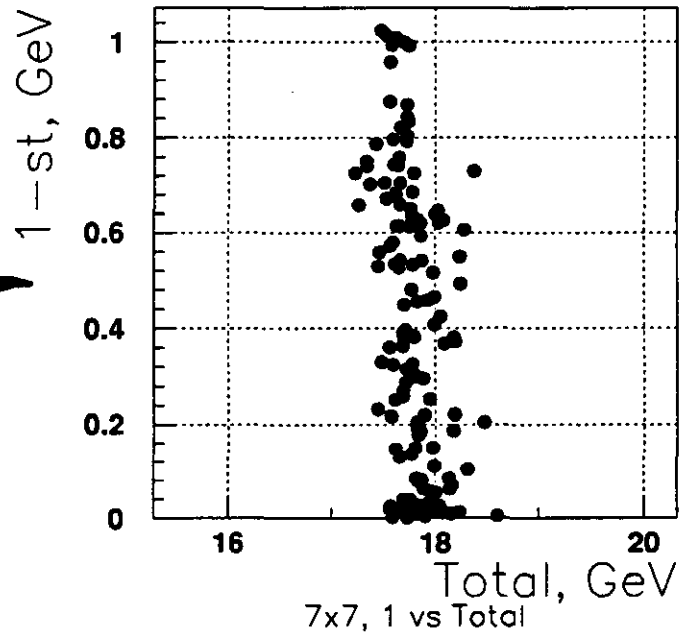
$5.14 \pm 0.11/\sqrt{E} \oplus 0.24 \pm 0.04$

50 GeV photon, 35 deg.



No massles gap

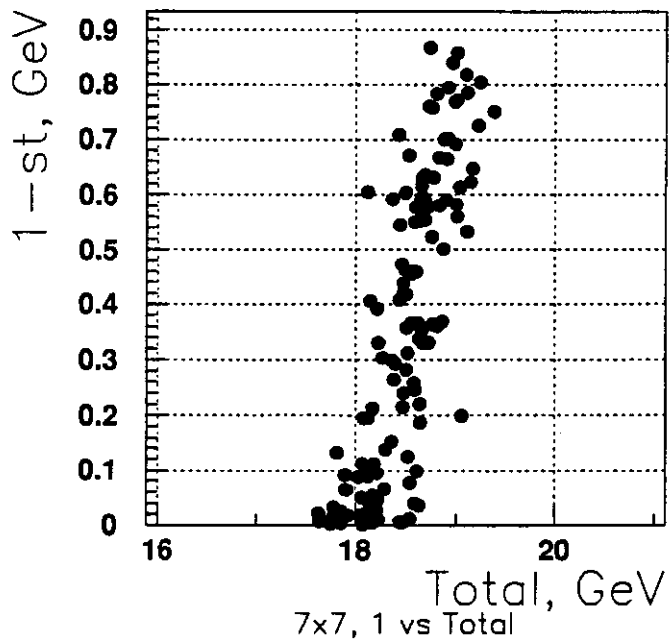
1.18 X_0 dead materials at 90°



0.56 X_0 (90°)

massless gap

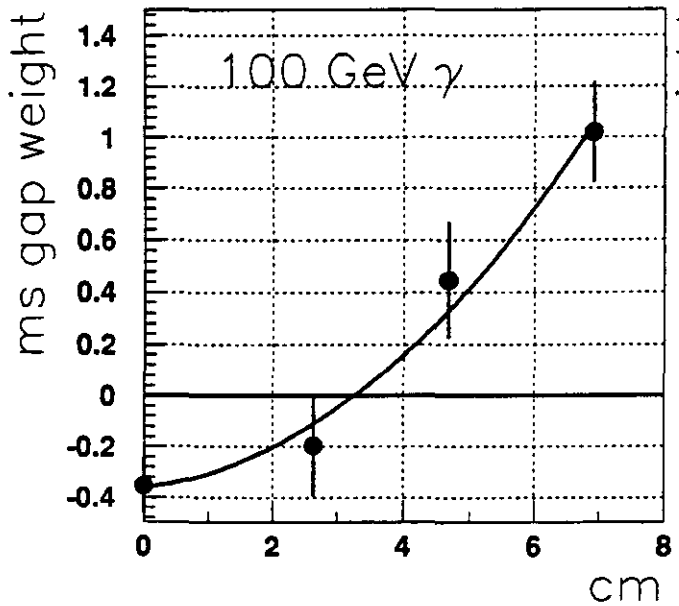
50 GeV photon, 35 deg.

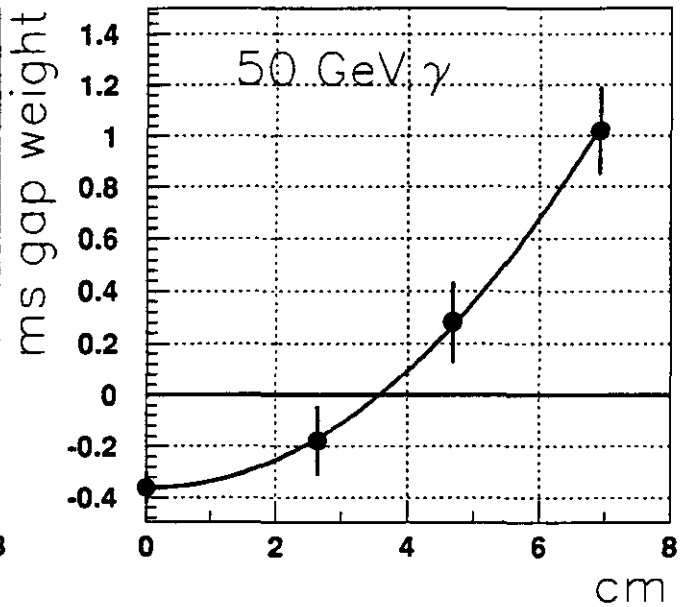


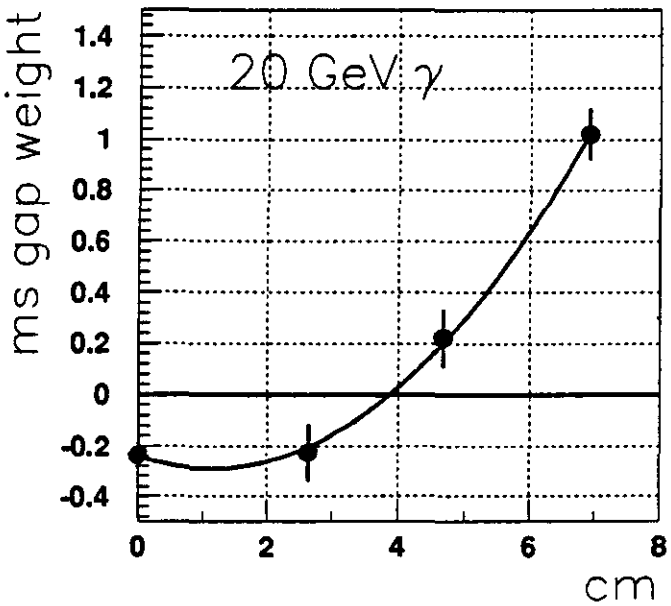
1.35 X_0 massless gap

"overpompensation".

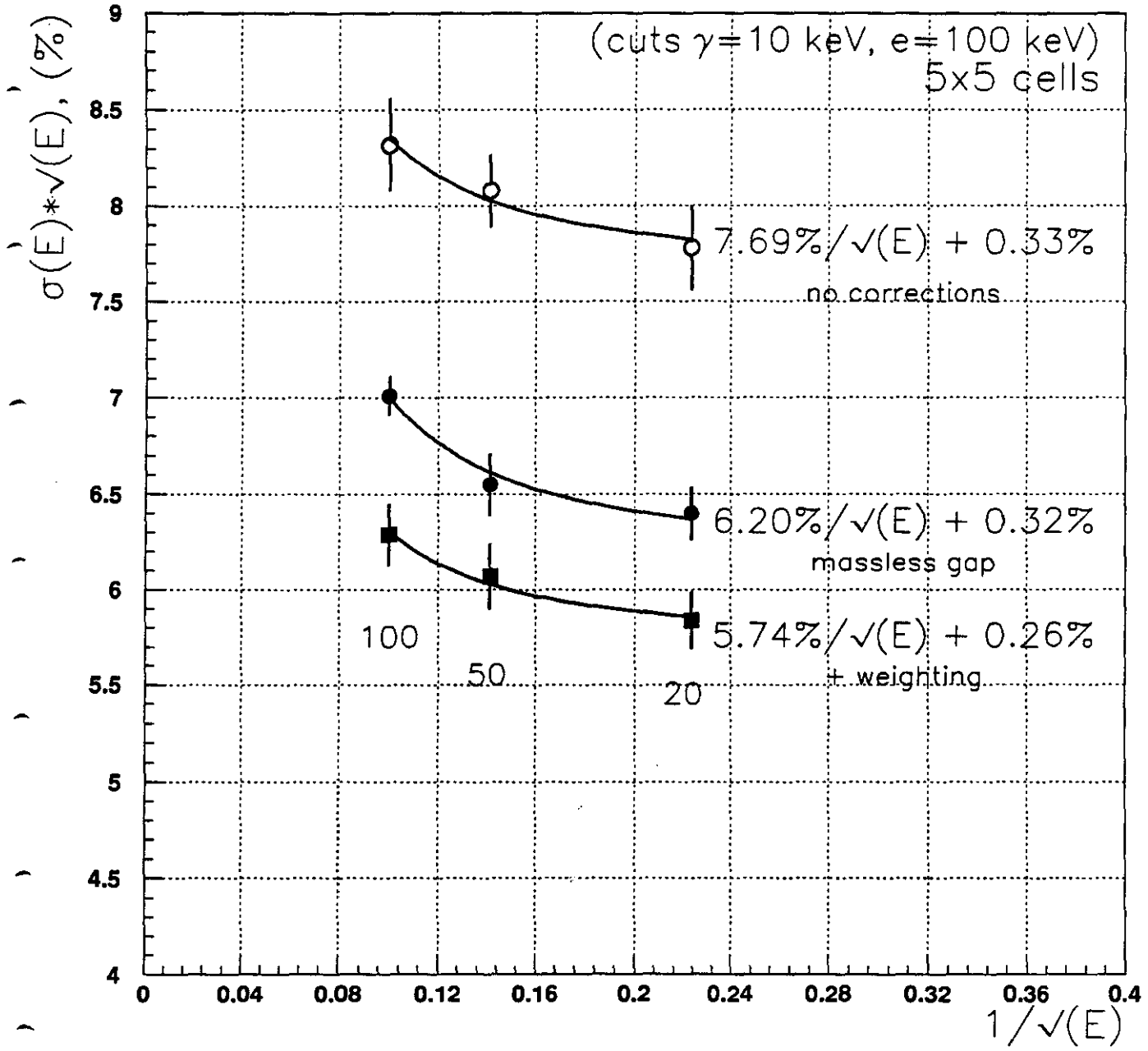
Optimization of ms gap at 45 deg.



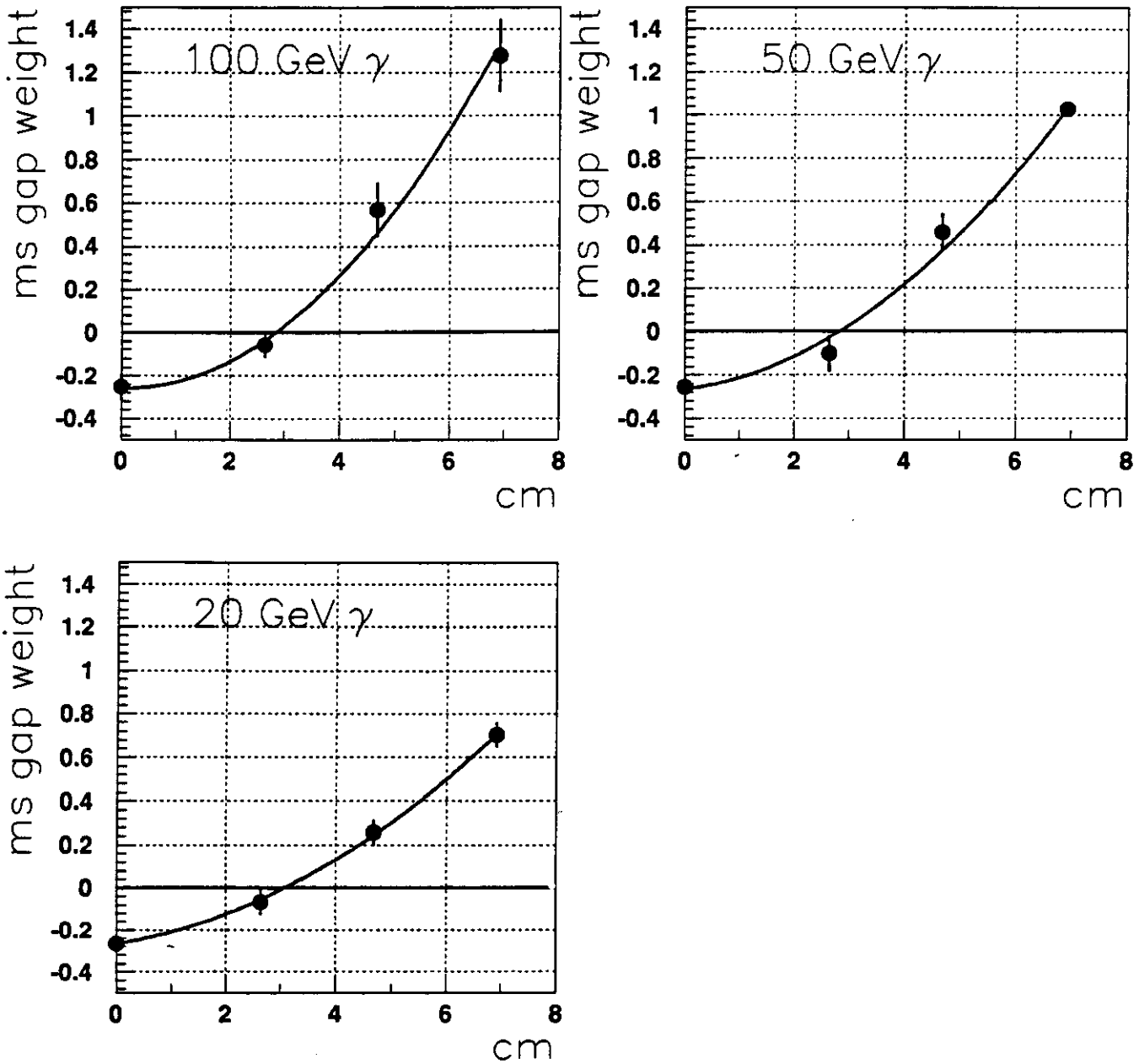




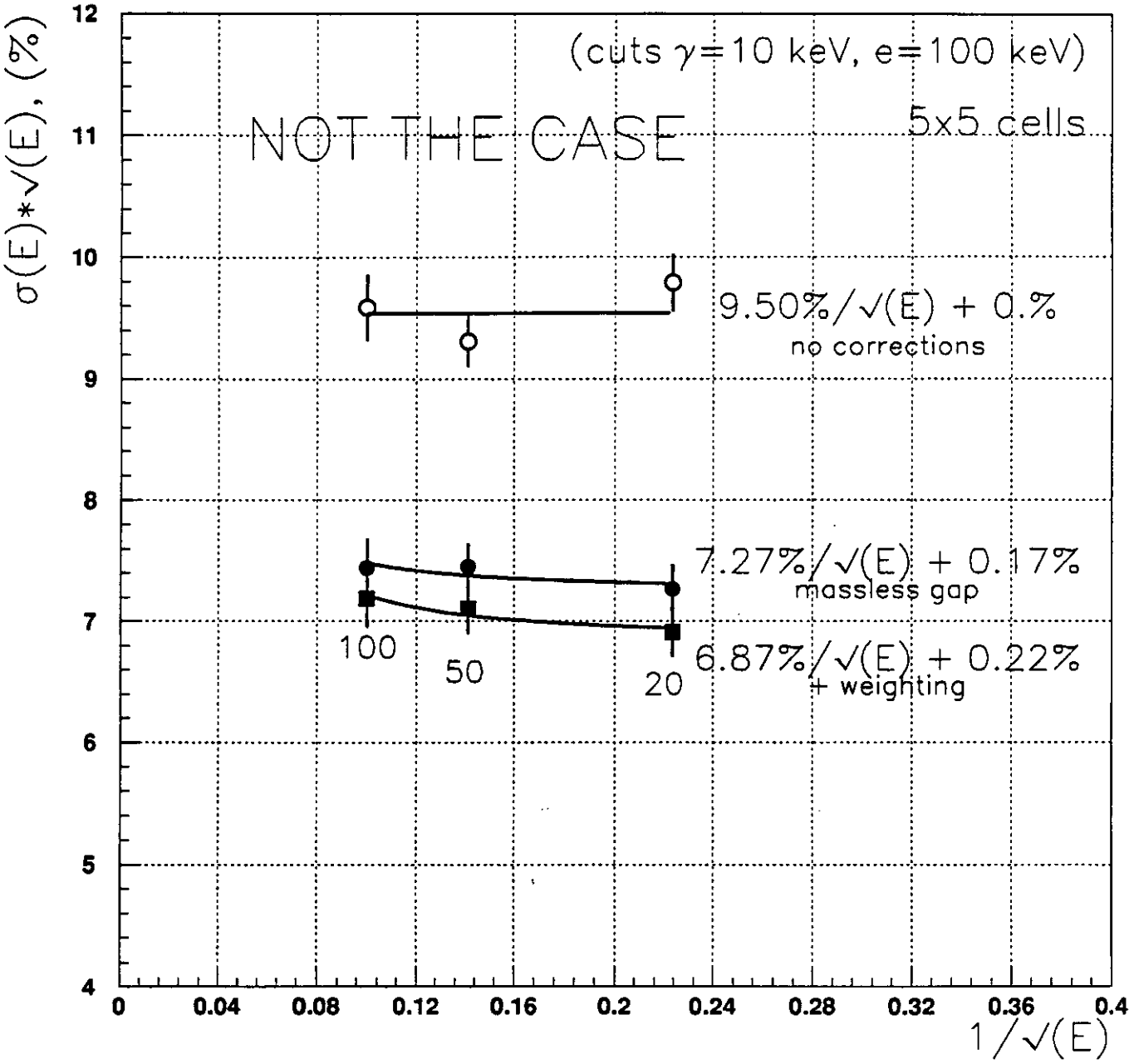
LKr accordion - resolution at 45 deg.



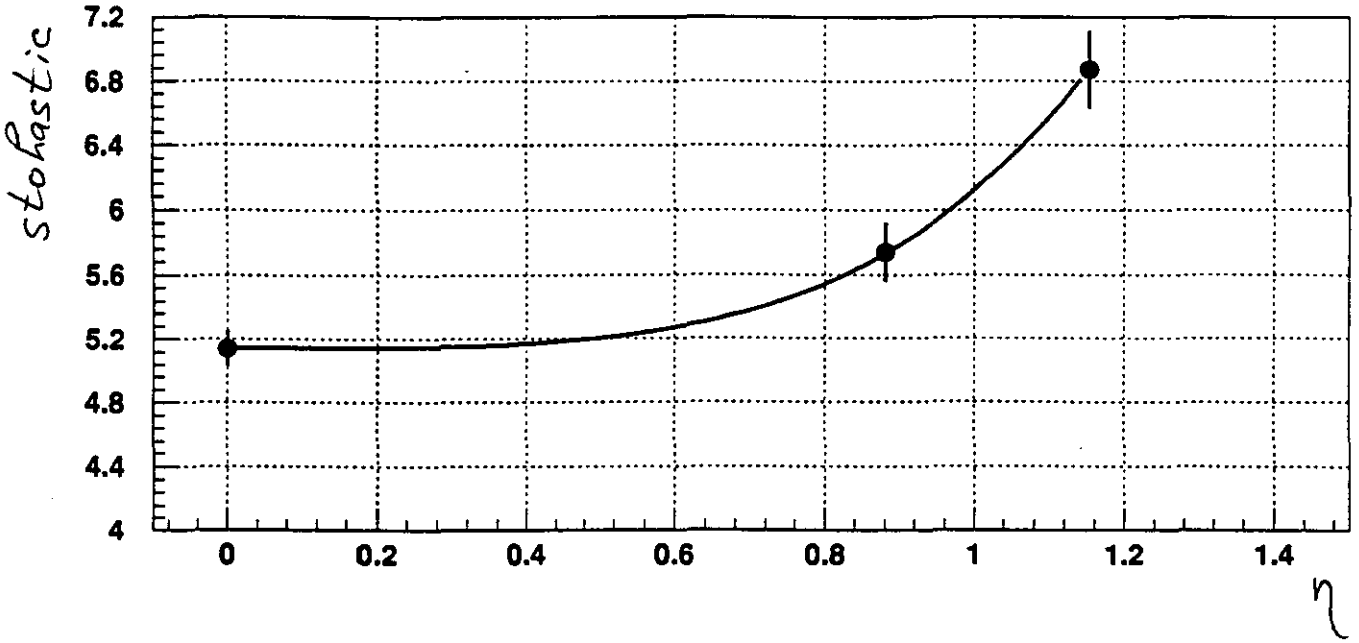
Optimization of ms gap at 35 deg.

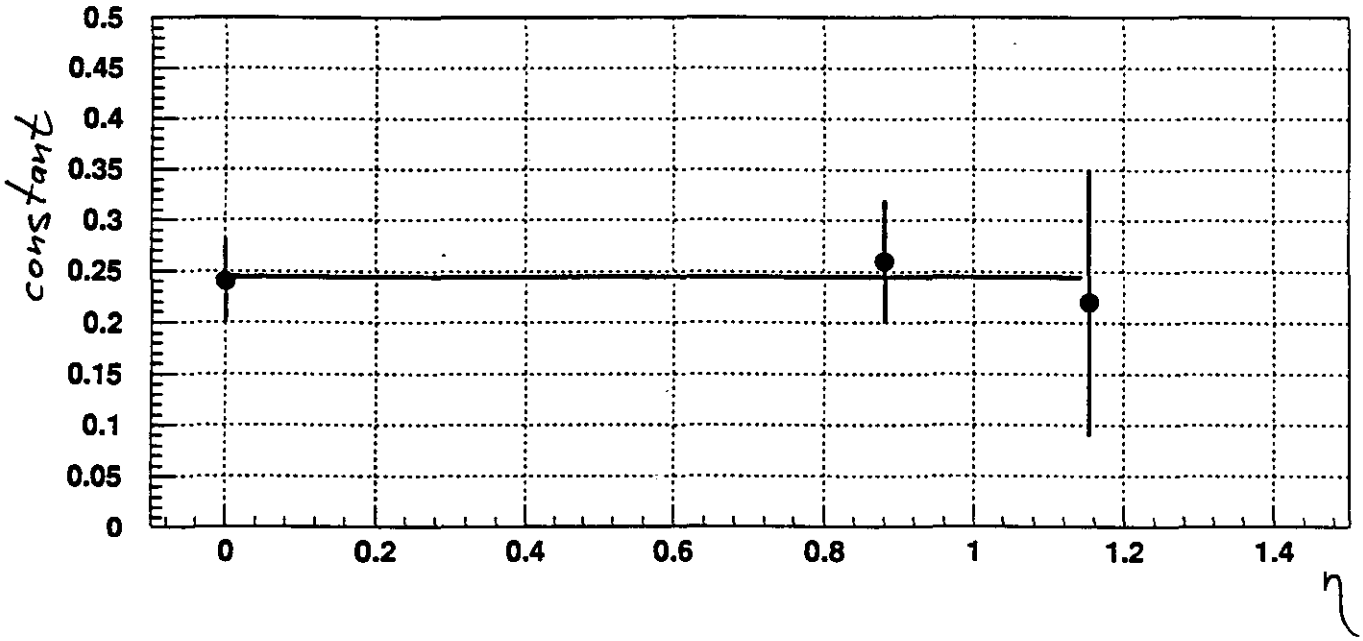


LKr accordion - resolution at 35 deg.



Stohastic and Constant term in energy resolution





gem

γeμ

Presentation by:

Xiaorong Shi

Suggestions of Pileup Noise Implementation in GEMFAST

Xiaorong Shi
Caltech
Dec. 7, 1992

* Current Implementation
* Proposed Implementation
* Advantage of proposed Implementation

Current GEMFAST Pileup Simulation

About 10 fixed files:

Contain the detector responses to the pregenerated minimum biased events at a <u>specific luminosity</u>.

urrent crossing

PYTHIA signal ⇘ + ⇙ PYTHIA min-bias ← Poisson($m/\langle MB \rangle$)

/ repeat /

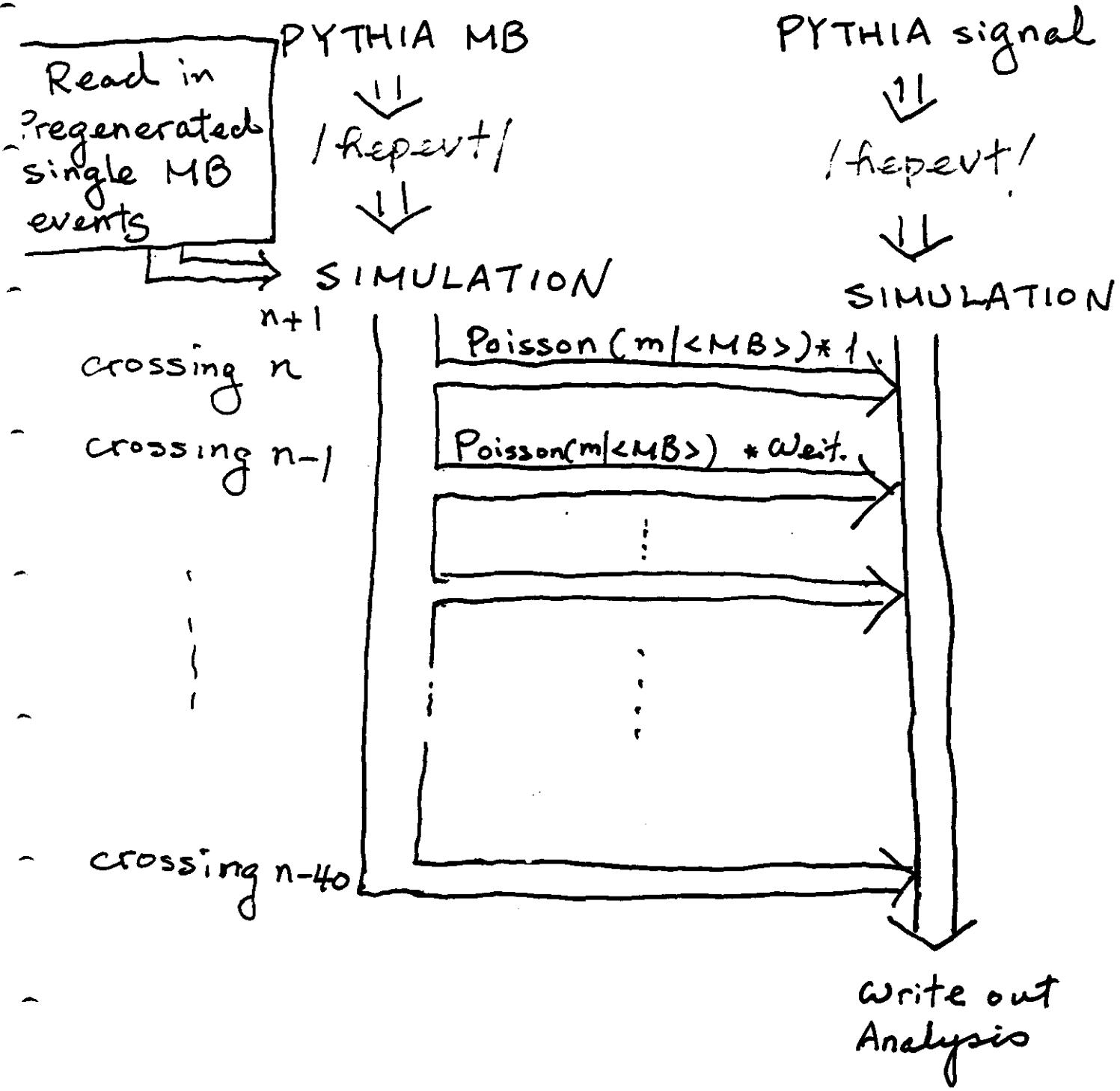
⇓

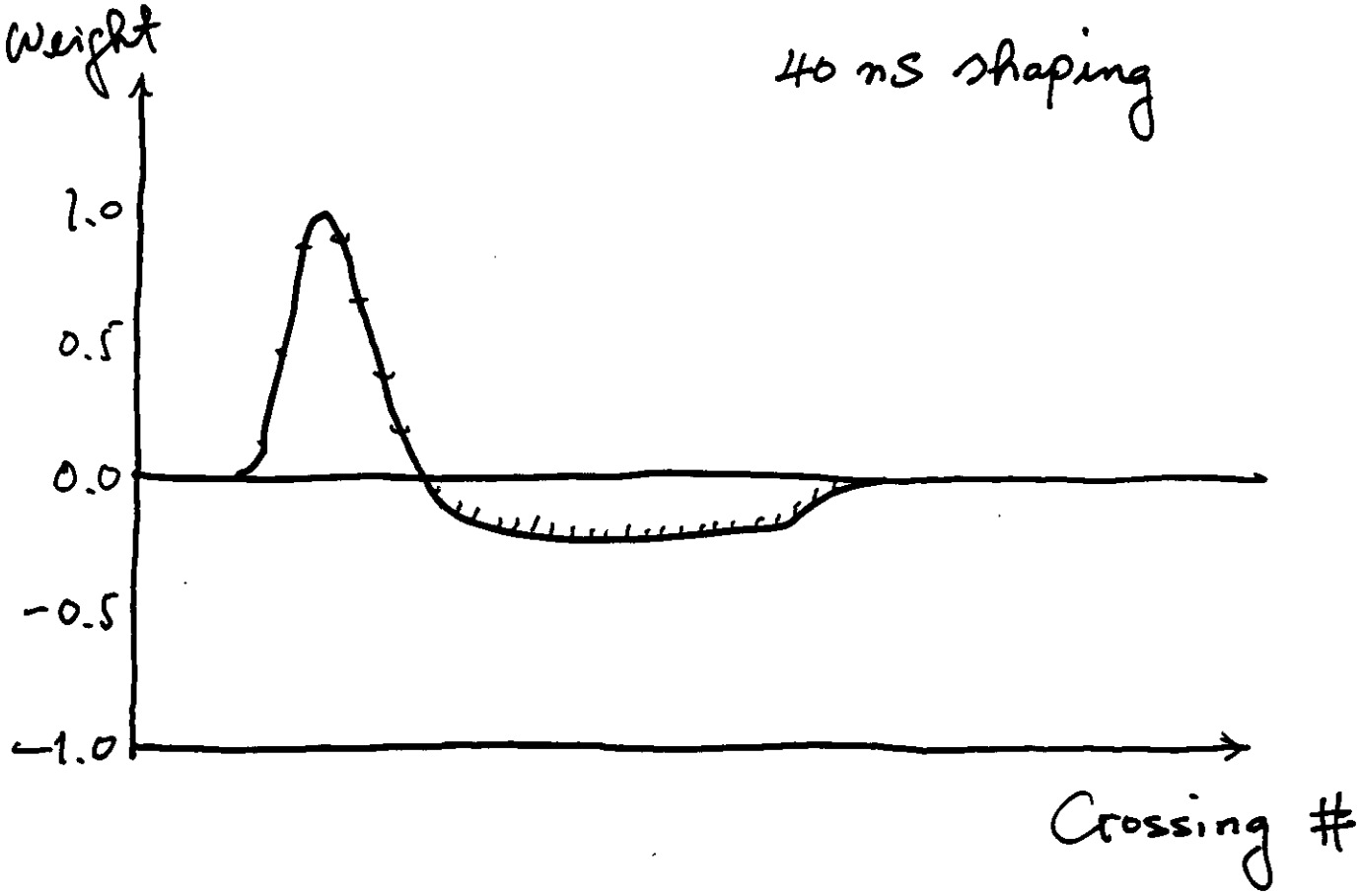
SIMULATION

other crossing

pick one configuration of MB events from the fixed file. Add that to the detector response.

Proposed Change




Weight
40 ns shaping
1.0
0.5
0.0
-0.5
-1.0
Crossing #

Program change Needed

From:

```
init
  bofr
    evnt  <  init. det. response
             loop
  eofr
done
```

To:

```
init
  bofr
    bofe  ---> init. det. response
      evnt --> loop over all signal
               sources past/current/future
    eofe  ---> could be dummy
  eofr
done
```

Advantage !

- can used to generate fixed file easily.

- It is even possible to have time dependent luminosity (exponential decay).

- Model pileup realistically in Calorimeter

- For central tracker, it provide a ground that the time resolution can be taken into account properly at hits level. It can be used to test efficiency of Pattern recognition, etc. $\boxed{(e\ ID,\ \gamma\ ID)}$

Disadvantage

- A factor of 60 slower than the current fixed files if we generate MB events on the fly.

- A factor of 2-3 slower if we use pregenerated response of Single MB events.

PS: This concept can be generalized to GEANT simulation too!

gem

γeμ

Presentation by:

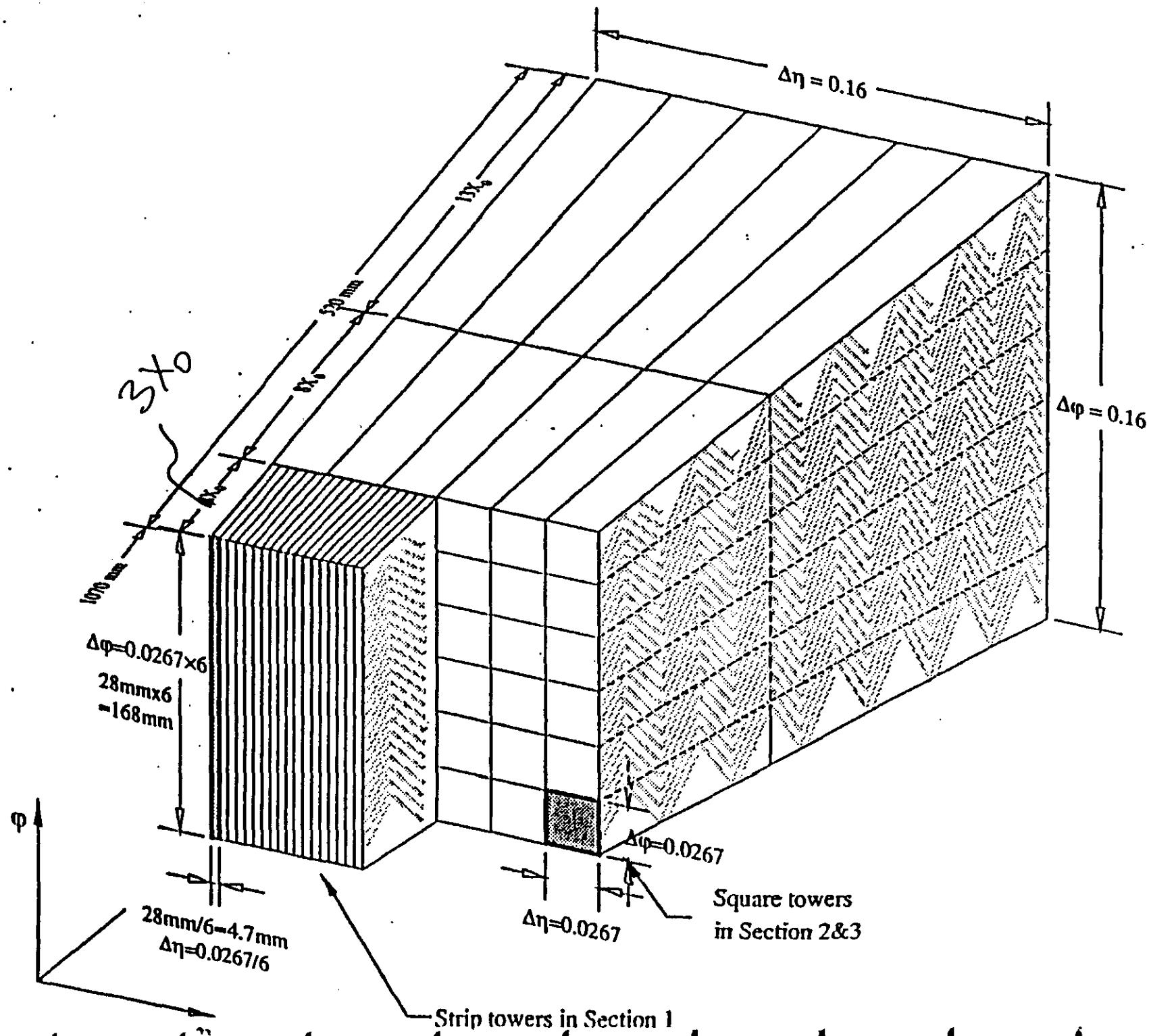
A. Vanyashin

A. Vanyashin

12-8-92

Pileup noise in Baseline 2

1. New EM design = (new optimal shaping times, new electronics noise)
   a) not available yet
   b) what times should be optimized?
      - for 4x4 or 5x5 in EM
      - for each floor? different shaping for preradiator and towers?
2. Hadron Liquid:
   optimization for particles or for jets?
   → for particles (isolation)
3. no pilup noise in scint. cal.
4. ~~Separate sh~~
   different shaping for trigger sums and for cells


Δη = 0.16
Δφ = 0.16
3X0
Δφ=0.0267×6
28mmx6
=168mm
28mm/6=4.7mm
Δη=0.0267/6
Δη=0.0267
Δφ=0.0267
Square towers
in Section 2&3
Strip towers in Section 1
φ

Pileup noise affects differently

1. EM Energy measurement of the shower

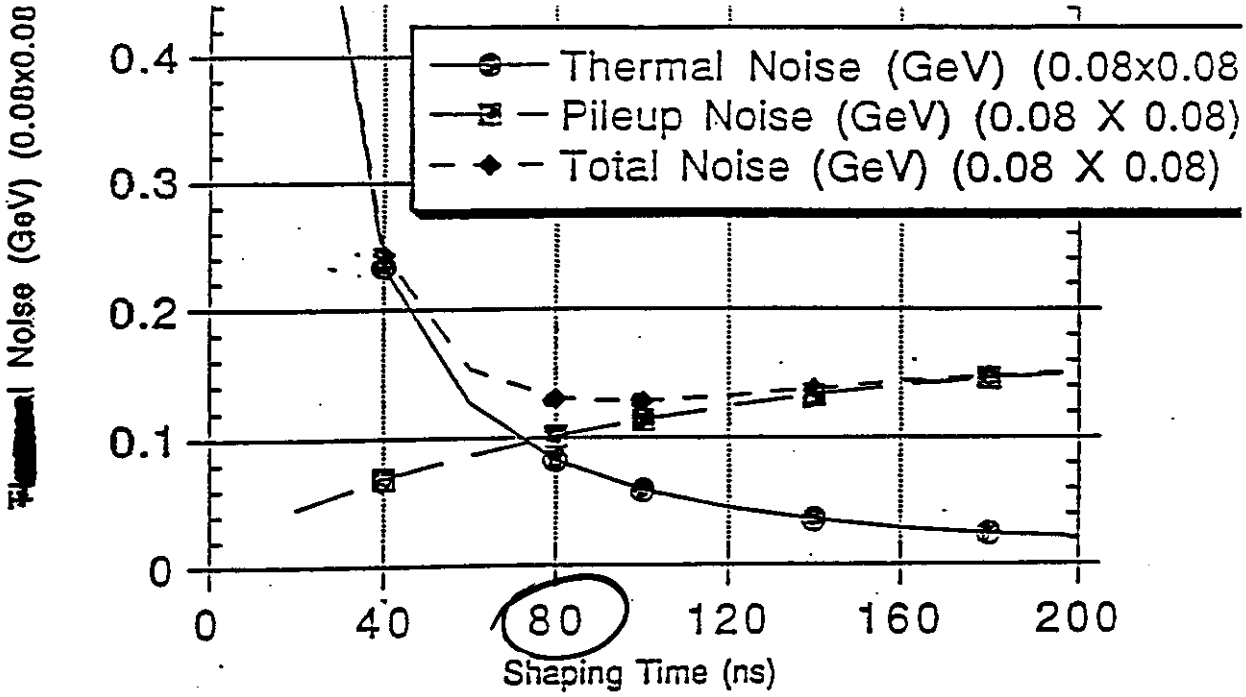
2. Jet energy measurement

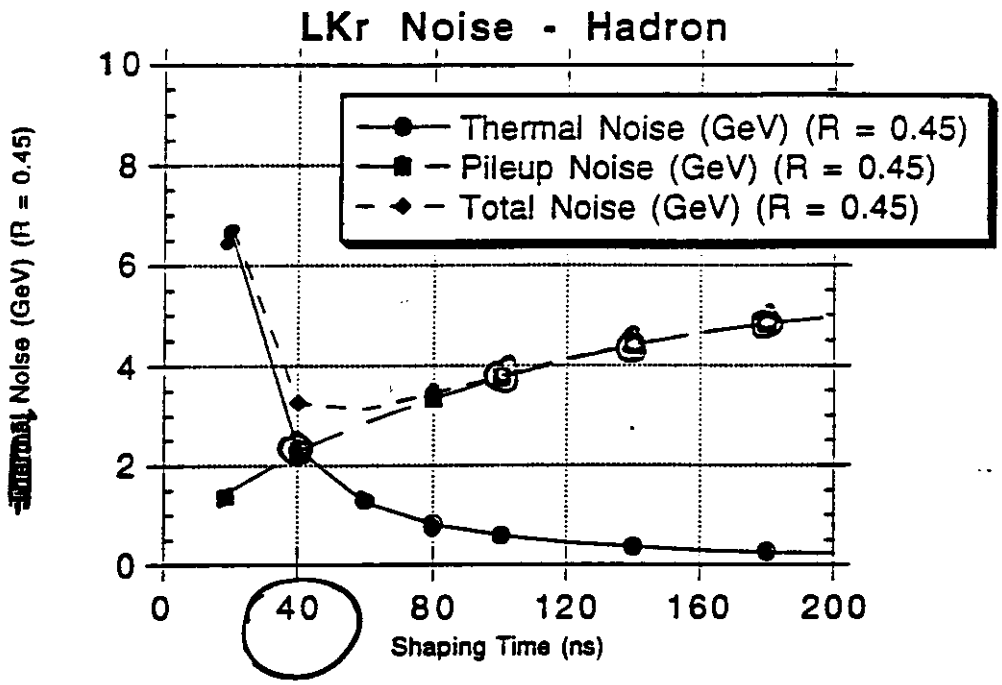
3. Energy in the cone (of ~0.45) needed for isolation cut

optimal shaping time is different

A. for each purpose:

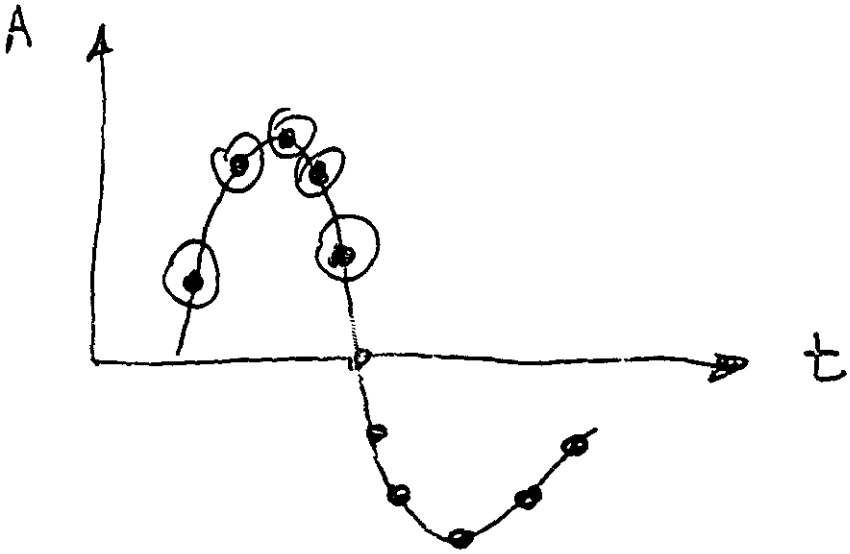
B. for each Luminosity


Thermal Noise (GeV) (0.08x0.08
Pileup Noise (GeV) (0.08 X 0.08)
Total Noise (GeV) (0.08 X 0.08)
0.4
0.3
0.2
0.1
0
0
40
80
120
160
200
Shaping Time (ns)


LKr Noise - Hadron
Thermal Noise (GeV) (R = 0.45)
Pileup Noise (GeV) (R = 0.45)
Total Noise (GeV) (R = 0.45)
10
8
6
4
2
0
0
40
80
120
160
200
Shaping Time (ns)

GEM calorimeter Electronics :

- Amplitudes sampled every 16.7ns and pipelined
- 5 samples available to analize



offline : χ^2 - square fit
provides A and τ for
energy deposition

on-line : Optimal filtering

infinite sampling limit :

$$\sigma_A = \left(8\, \rho_T\, \tau_{drift} \cdot \rho_P\right)^{1/4}$$

independent on shaping time !

W. E. Cleland and E. G. Stern

PILEUP NOISE

The number of events of type i per crossing (in time $T_c = 16$ ns) is:

$$\overline{n_i} = \mathcal{L} T \sigma_i$$

These give rise to a transverse energy deposition in a calorimeter cell, whose variance is:

$$\rho_p^2 = \frac{\sum_i E_i^2}{n} - \frac{(\sum_i E_i)^2}{n^2},$$

The "pileup noise density" ρ_p is defined by:

$$\sigma_p^2 = \rho_p^2 T_c \sum_{i=-\infty}^{\infty} g^2(t_i) = \rho_p^2 S_p$$

We have evaluated ρ_p for minimum bias and two-jet events using QFL/ISAJET in a spherical calorimeter:

$$\boxed{\rho_p = 380(\Delta\eta\Delta\phi)^{0.76}\sqrt{\frac{\mathcal{L}}{\mathcal{L}_0}}\,\mathrm{MeV}/\sqrt{\mathrm{ns}}}$$

Luminosity dependence →

SUMMARY (cont)

- The value of σ_A and $A\sigma_\tau$ can be estimated from the thermal and pileup noise densities

$$\rho_t = \frac{1}{\sqrt{2}} \frac{e_n C_{tot} W_{ion} a_e}{\eta_s q_e}$$ design dependent

$$\rho_p = 380(\Delta\eta\Delta\phi)^{0.76}\sqrt{\frac{\mathcal{L}}{\mathcal{L}_0}}\mathrm{MeV}/\sqrt{\mathrm{ns}}$$

using the "infinite sampling limit":

resolution: $\boxed{\bar{\sigma}_A^2 = \sqrt{8\, t_d\, \rho_t\, \rho_p^3}}$ $\quad A^2\bar{\sigma}_\tau^2 = \sqrt{8 t_d^3\, \rho_t^3\, \rho_p}$

if $t_{zc} < \bar{W} \approx 1.4\, t_m^0 < T_c$.

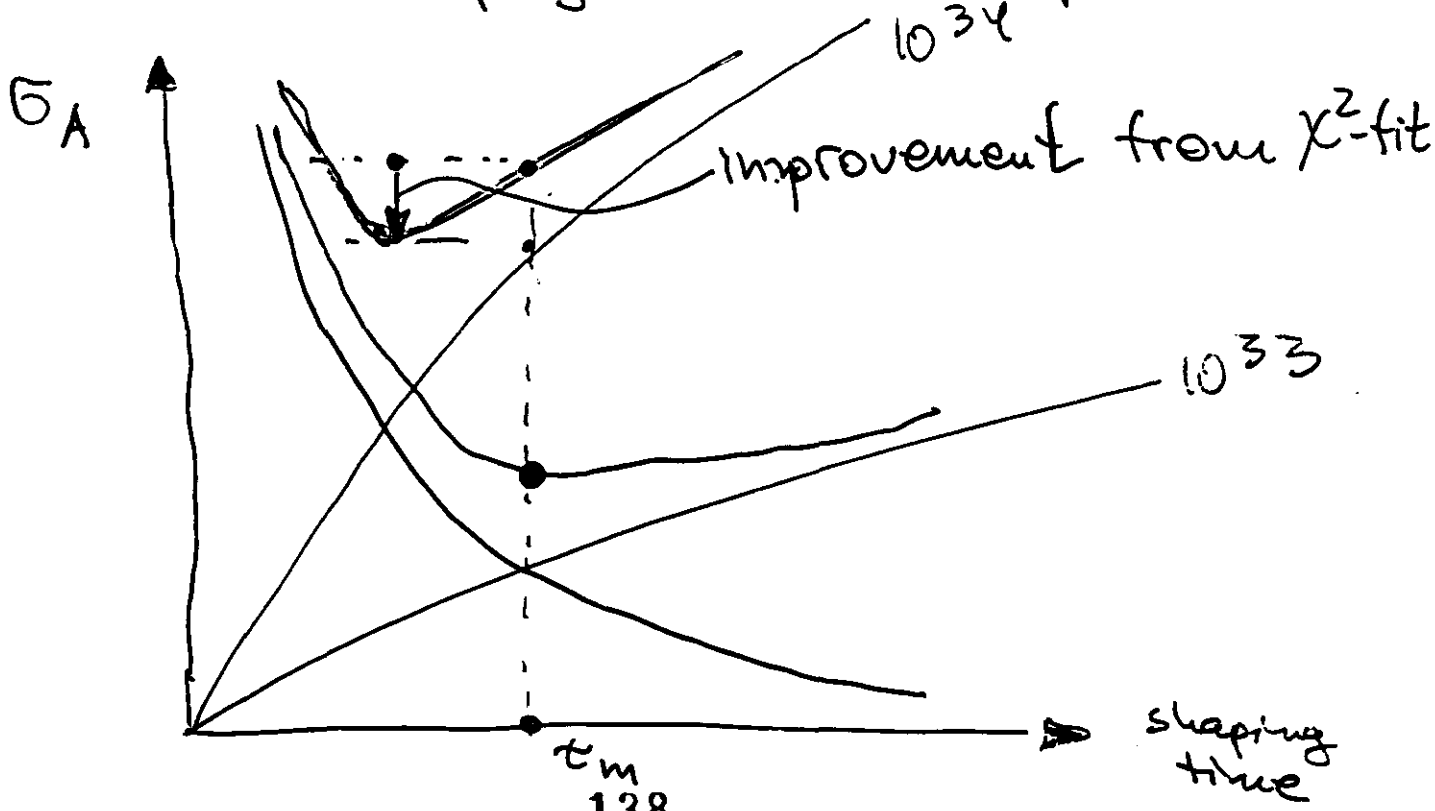
- If $t_m \approx t_m^0$, effect of optimal filter (or χ^2-fit) is minimal.

- for higher luminosities will provide about 25% effect

Proposal for Baseline 2

GEMFAST

1. Pileup files for different luminosities after thermal noise and χ^2-fit taken into account. (this will reduce pileup at higher Luminosity) (about 25% at 10^{34})
2. for standard Luminosity (10^{33}) χ^2 fit do not provide improvement because shaping time is optimal



gem

γeμ

Presentation by:

Hong Ma

Simulation of Baseline II LKr EM Calorimeter

Hong Ma
BNL

Outline

- Tools and Geometry.
- Energy resolution, (massless gap)
- Angular resolution
- Multi-photon rejection
- Overall optimization.

Parameters :

Pointing:

φ : front + Back + Total = 3x3

η : Strips + front + Back + Total = 3x4

+ θ, z 2

Pi^0 Rejection:

Shower shape (towers)

φ 2

η 2

shower shape (strips)

Threshold, etc 2

Likelihood 5

34

Eta dependent

Energy dependent

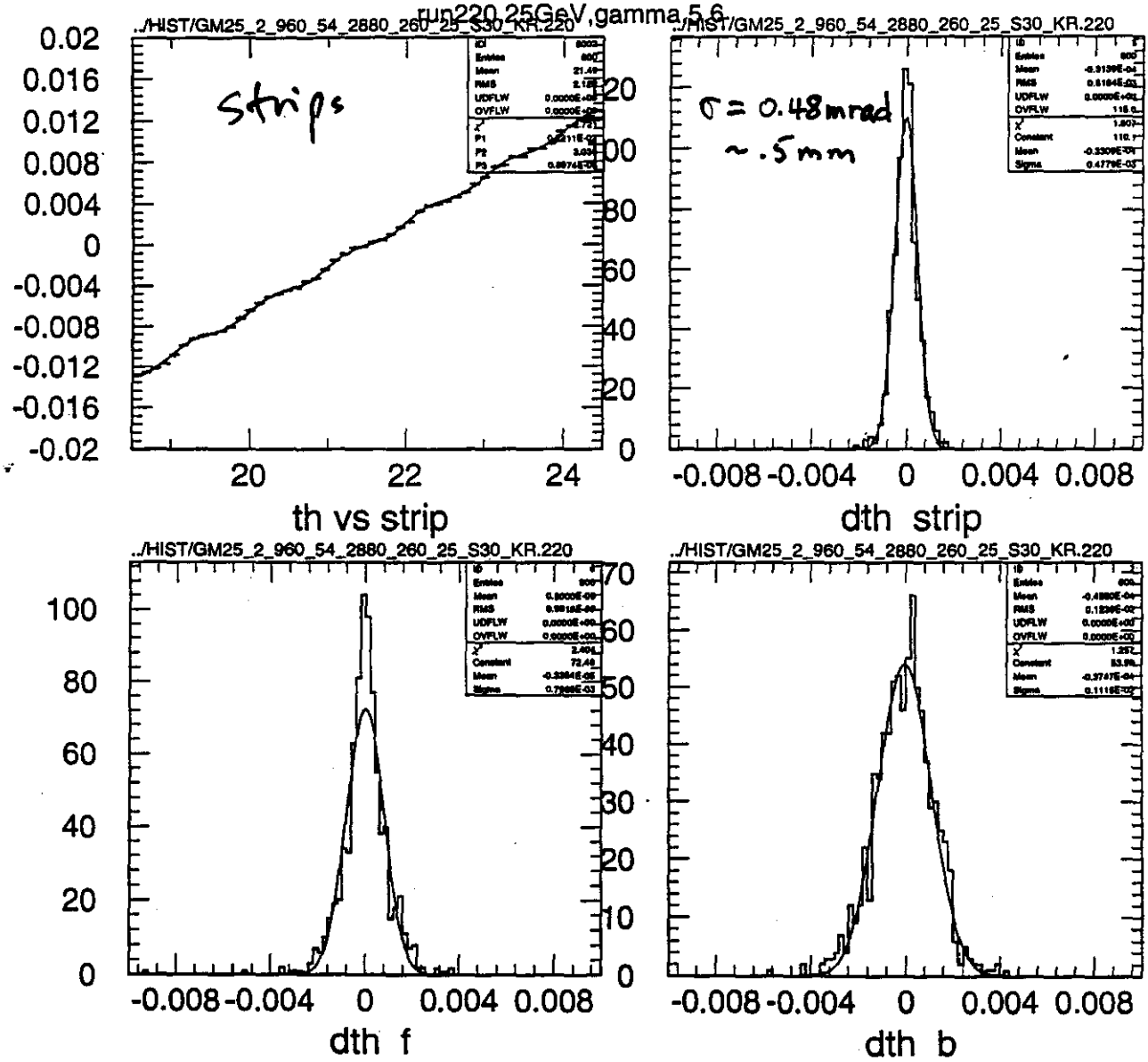
Energy

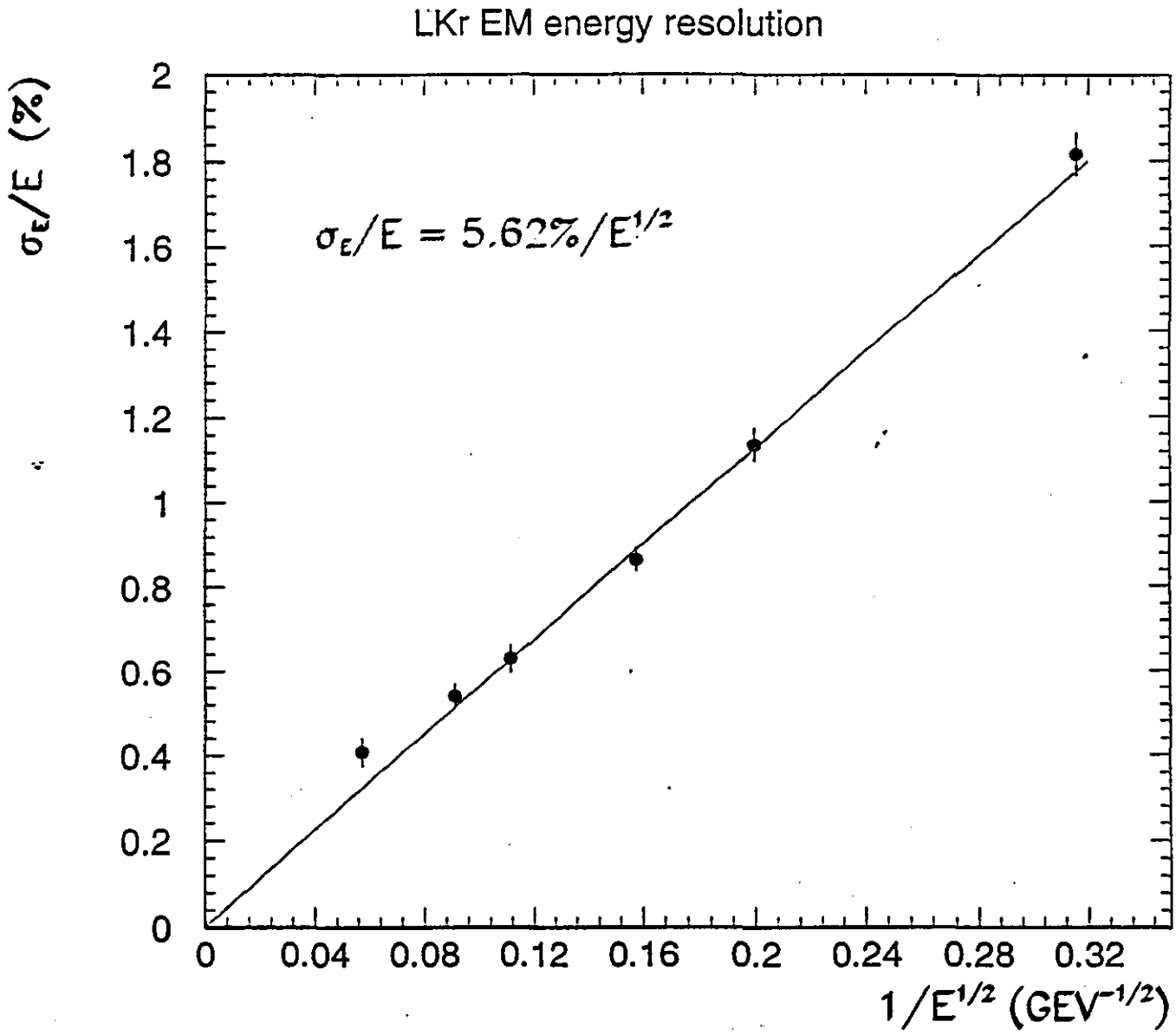
Longitudinal 2

transverse 2

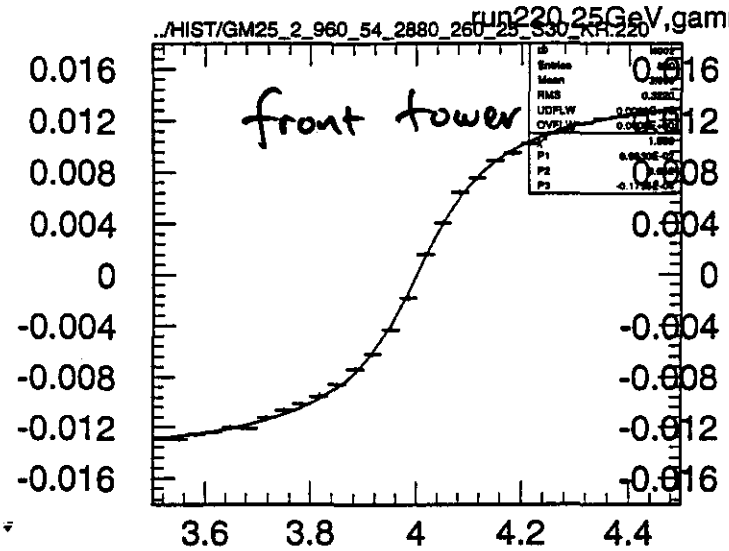
4

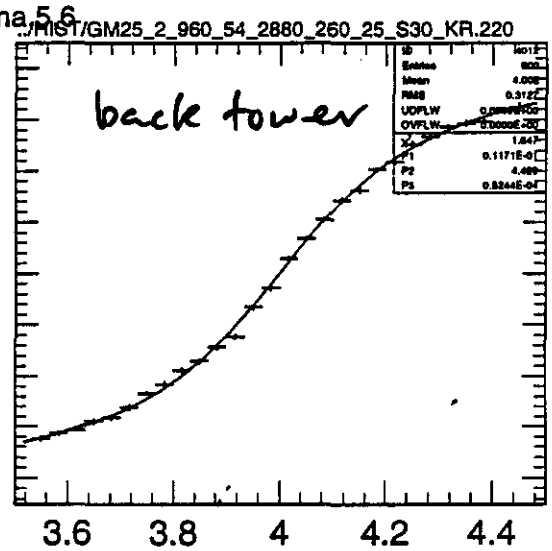
run220 25GeV gamma 5.6

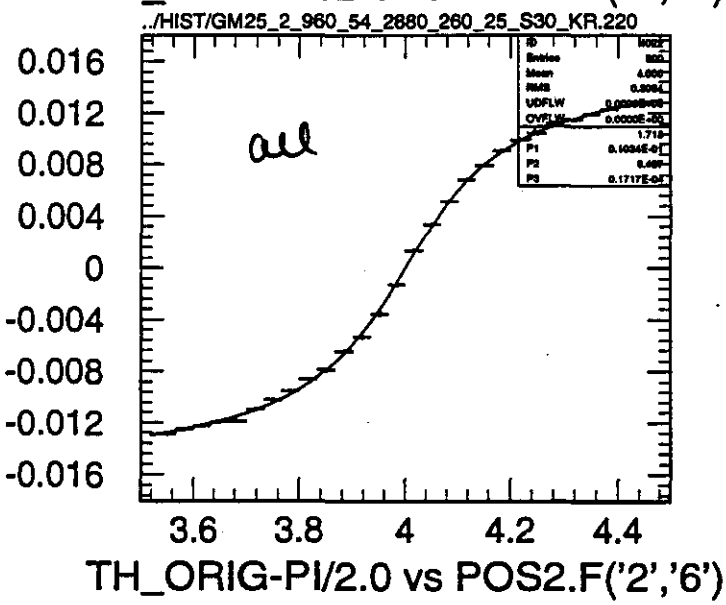



LKr EM energy resolution
$\sigma_E/E = 5.62\%/E^{1/2}$
σ_E/E (%)
$1/E^{1/2}$ (GEV$^{-1/2}$)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0.04
0.08
0.12
0.16
0.2
0.24
0.28
0.32

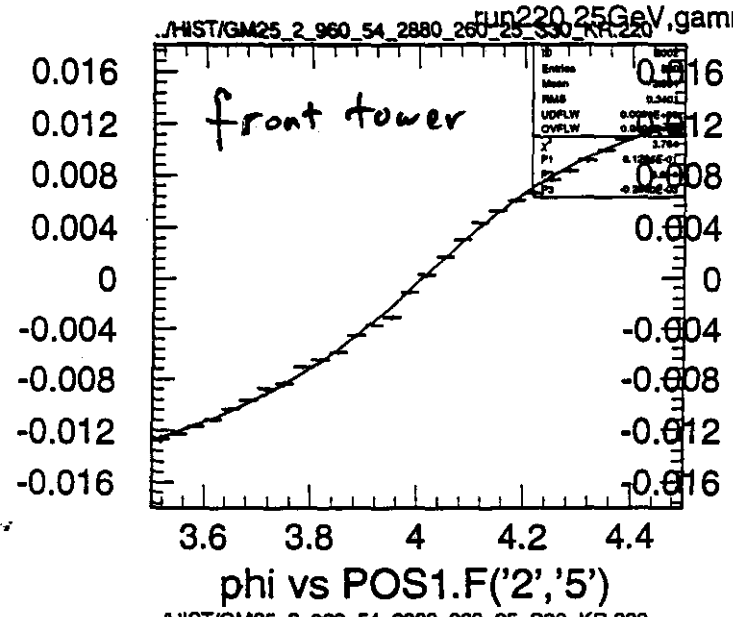
run220 25GeV,gamma 5.6

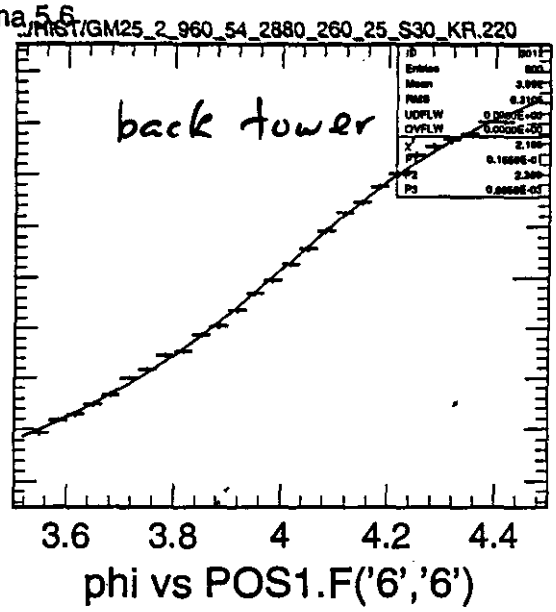


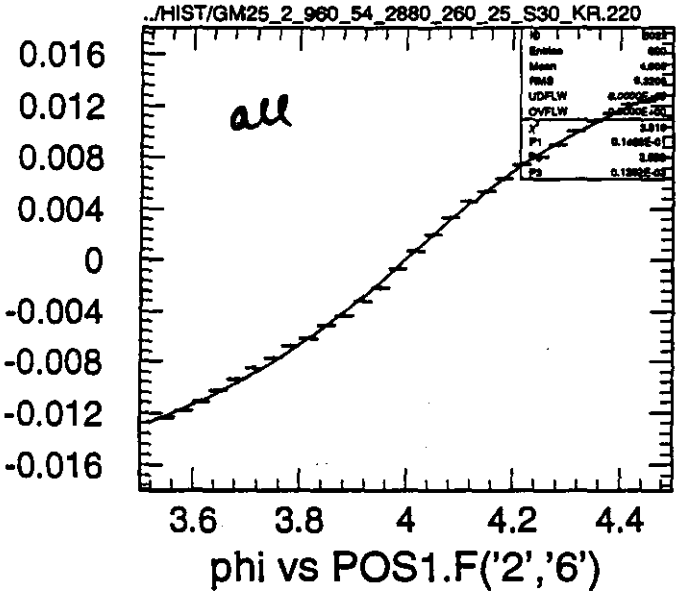




run220 25GeV gamma 5.6

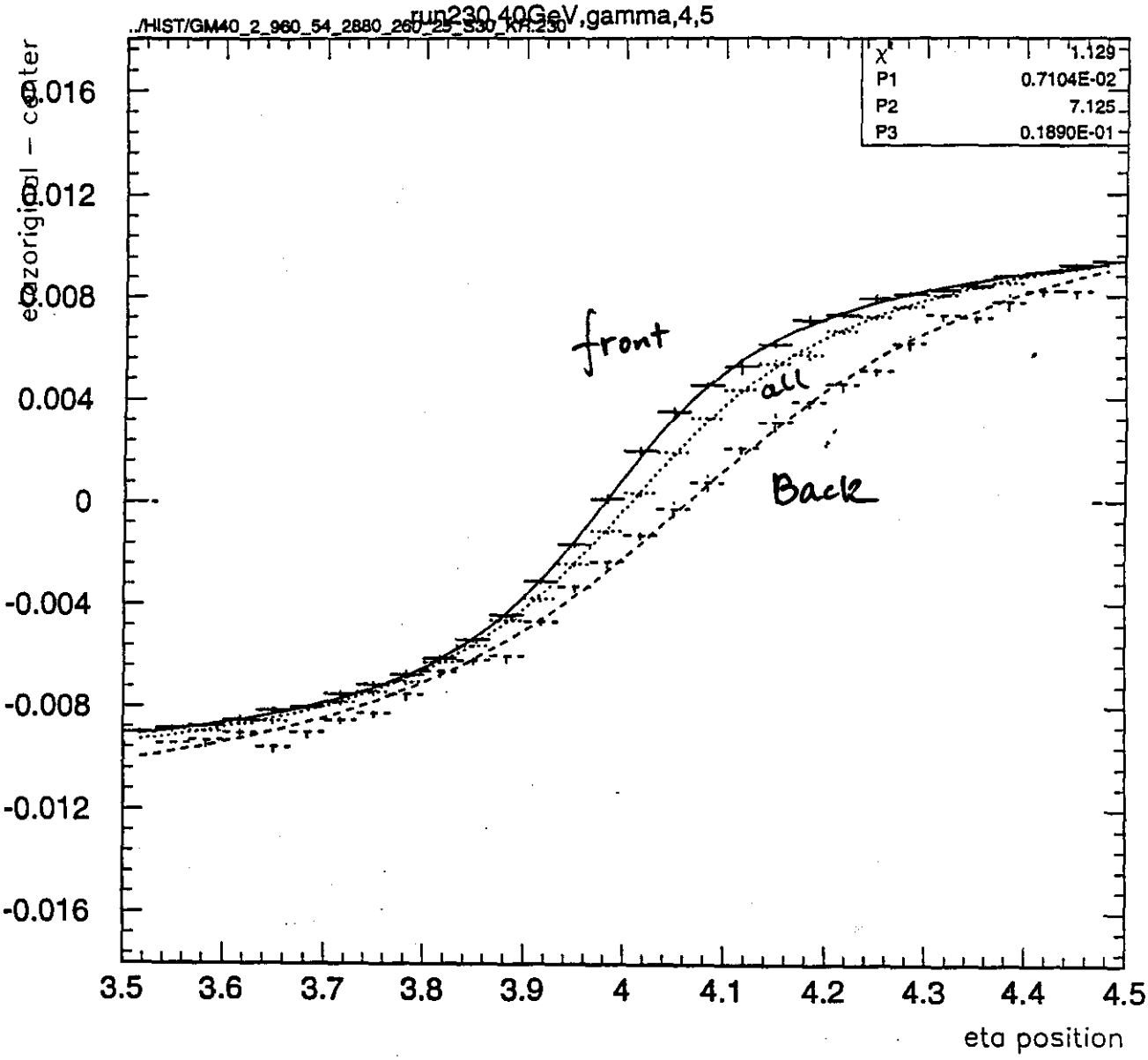




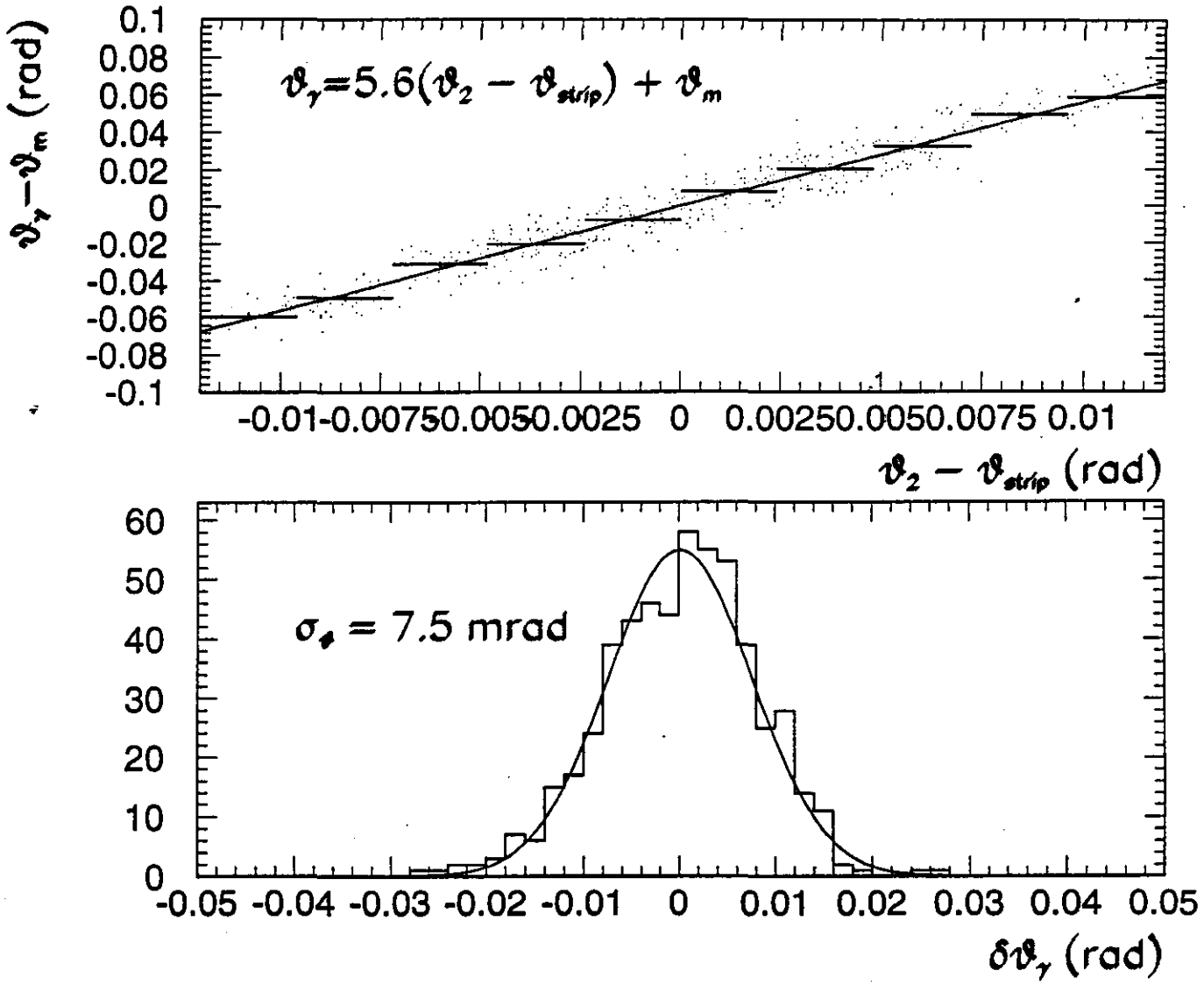


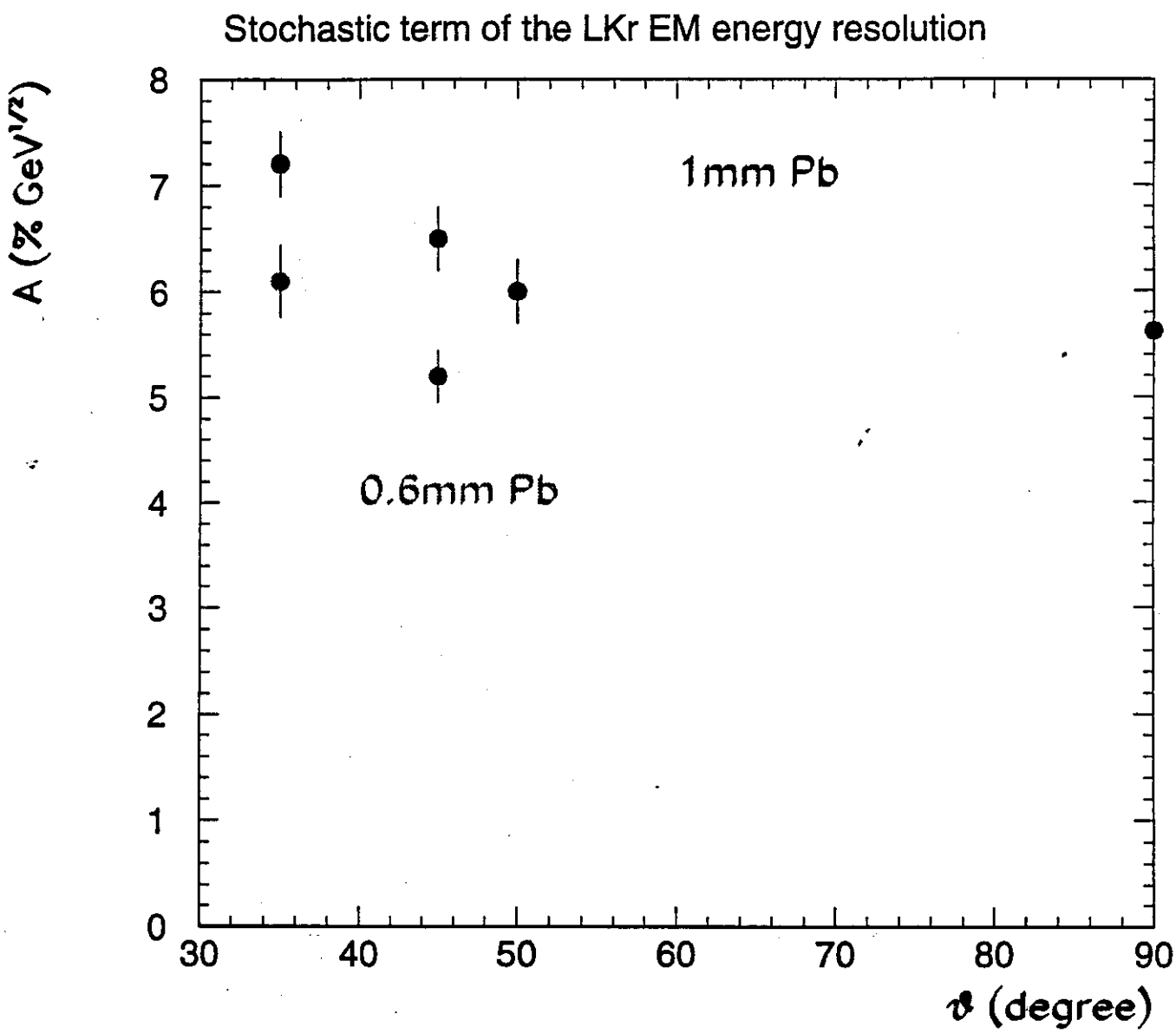
$\theta = 45°$

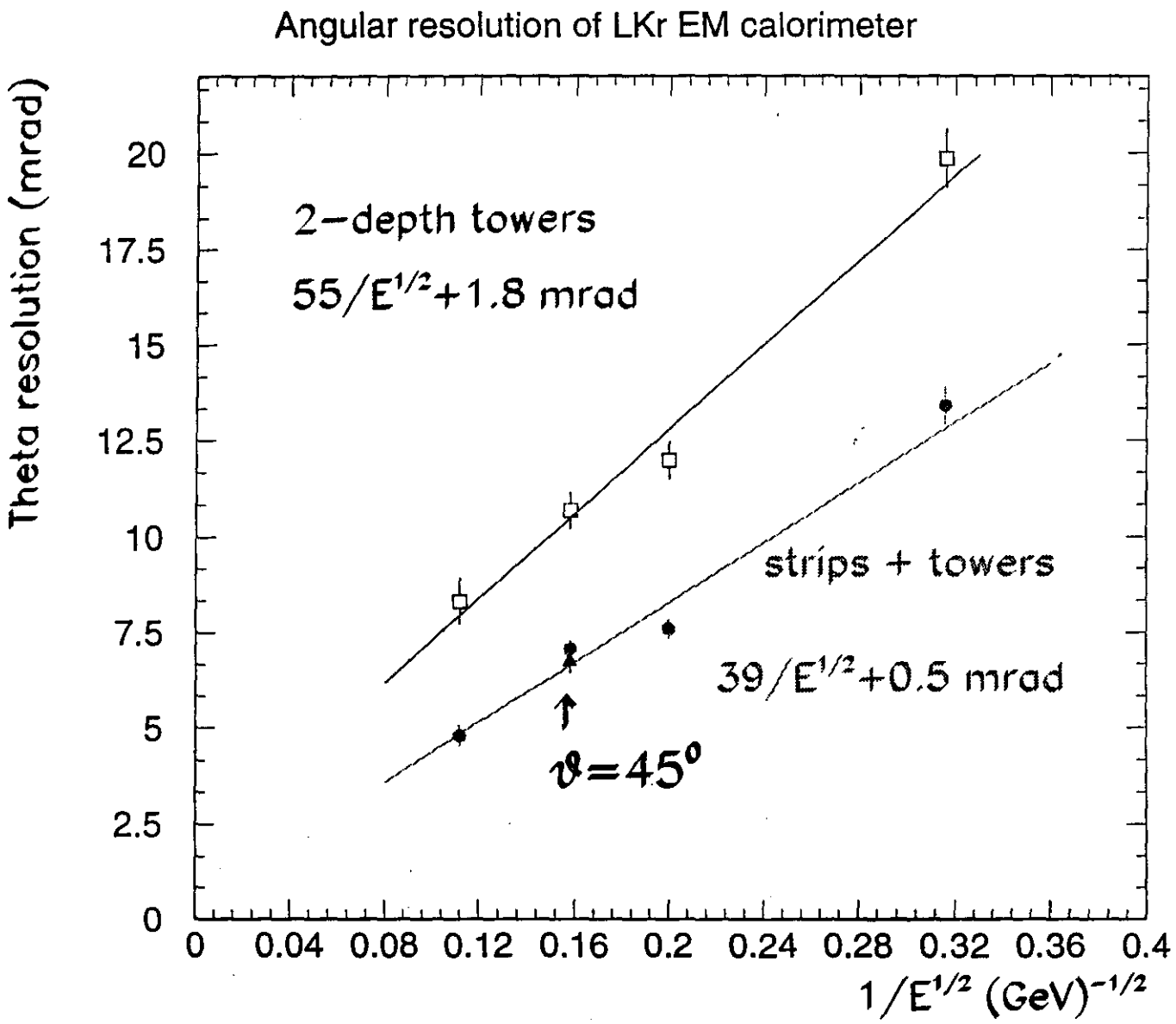
92/12/05 04.18



Photon angular measurement using strips and towers, 25 GeV

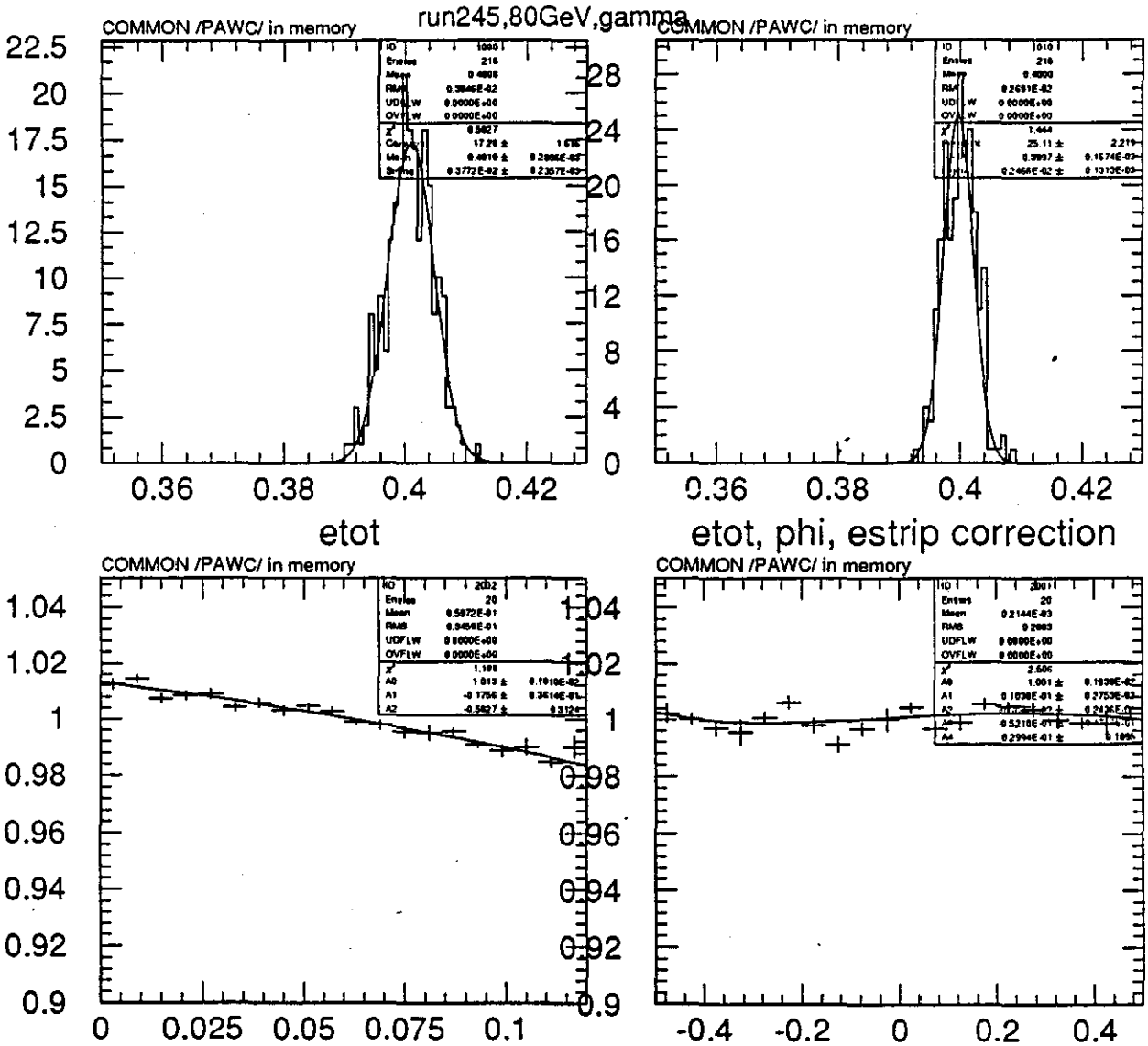


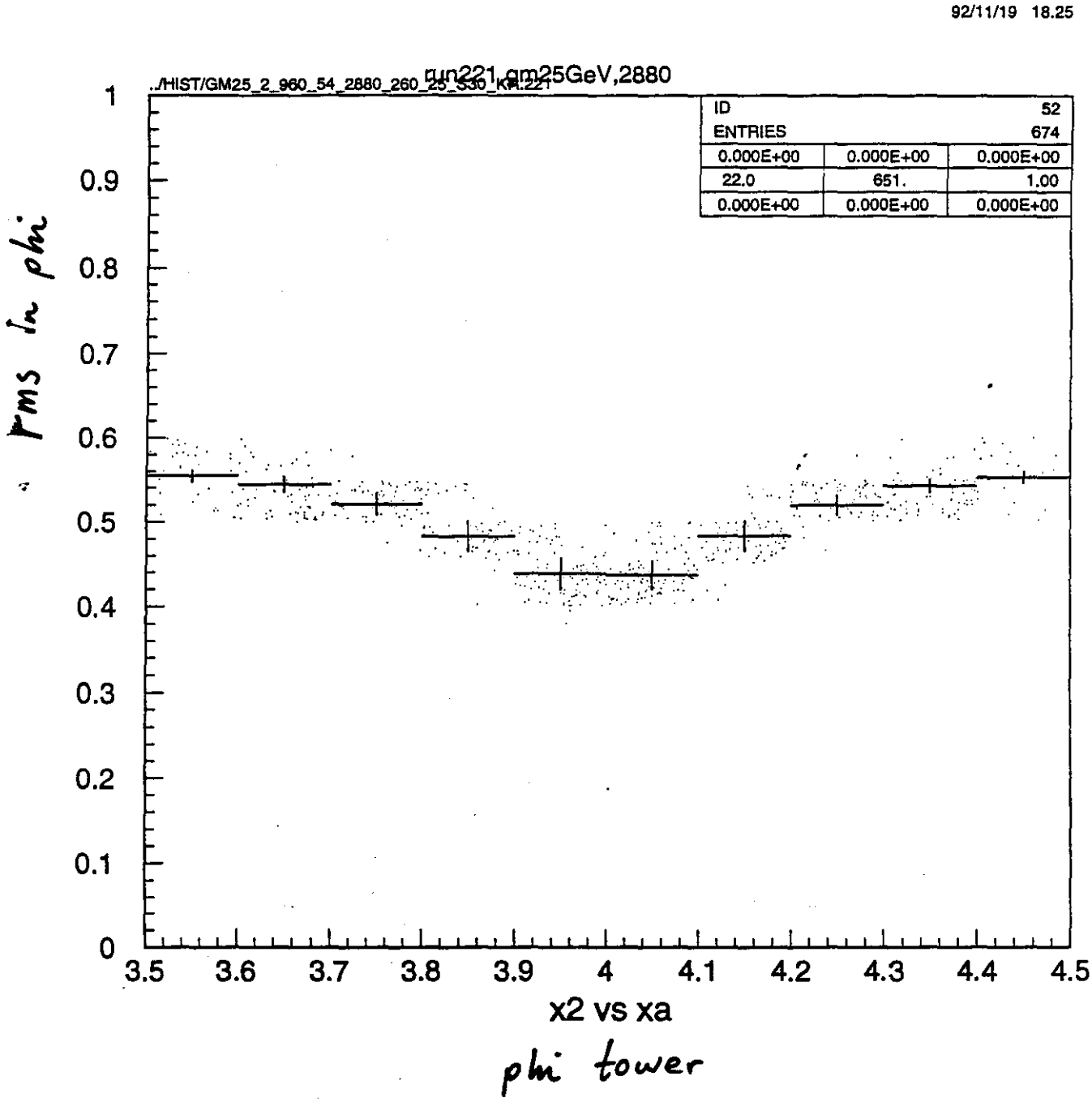

Stochastic term of the LKr EM energy resolution
A (% GeV^1/2)
8
7
6
5
4
3
2
1
0
30
40
50
60
70
80
90
ϑ (degree)
1mm Pb
0.6mm Pb

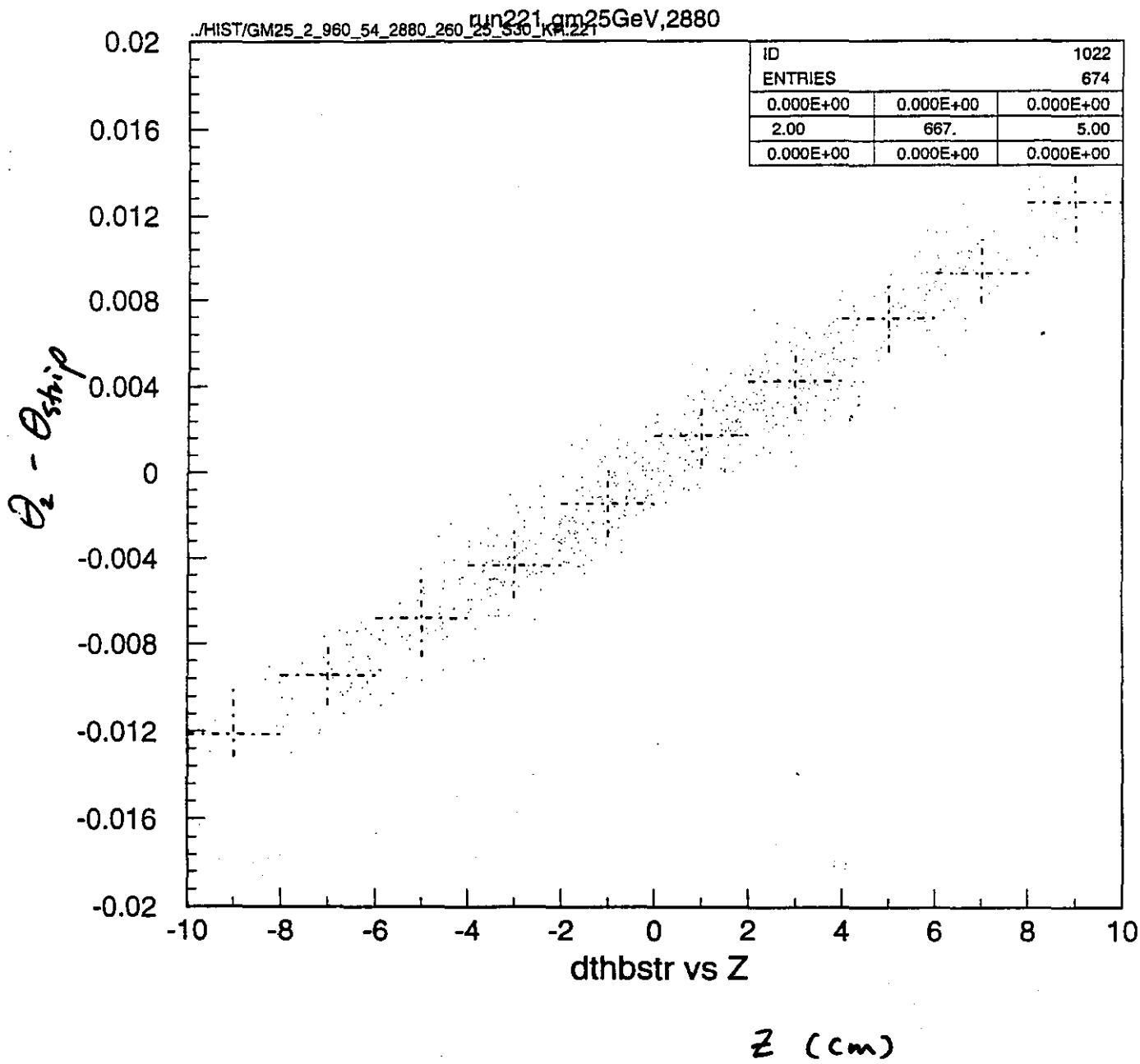

Angular resolution of LKr EM calorimeter
Theta resolution (mrad)
20
17.5
15
12.5
10
7.5
5
2.5
0
2−depth towers
55/E^1/2+1.8 mrad
strips + towers
39/E^1/2+0.5 mrad
ϑ=45°
0
0.04
0.08
0.12
0.16
0.2
0.24
0.28
0.32
0.36
0.4
1/E^1/2 (GeV)^-1/2

$\theta = 35°$, 0.6 mm Pb

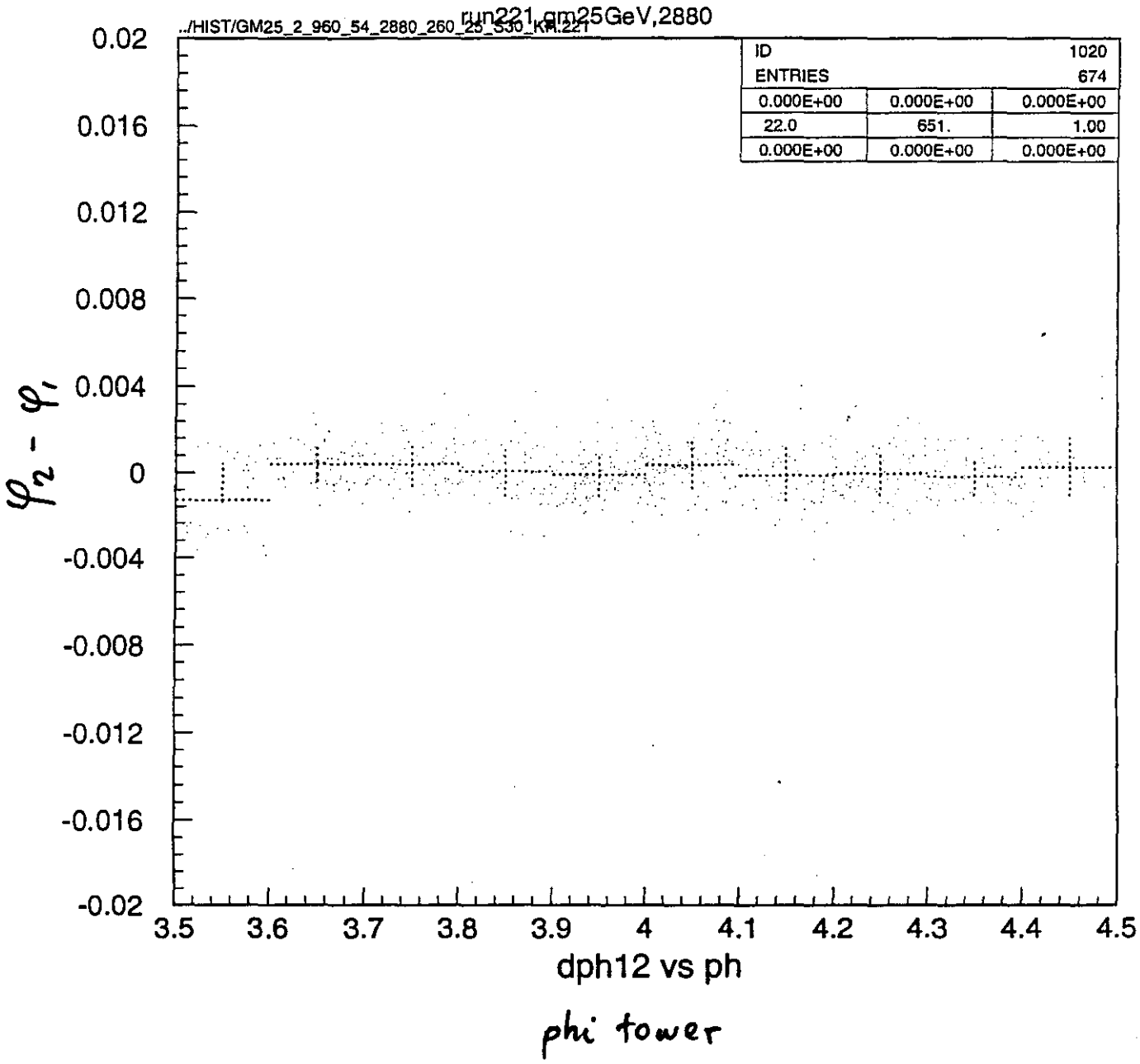
92/12/04 13.57



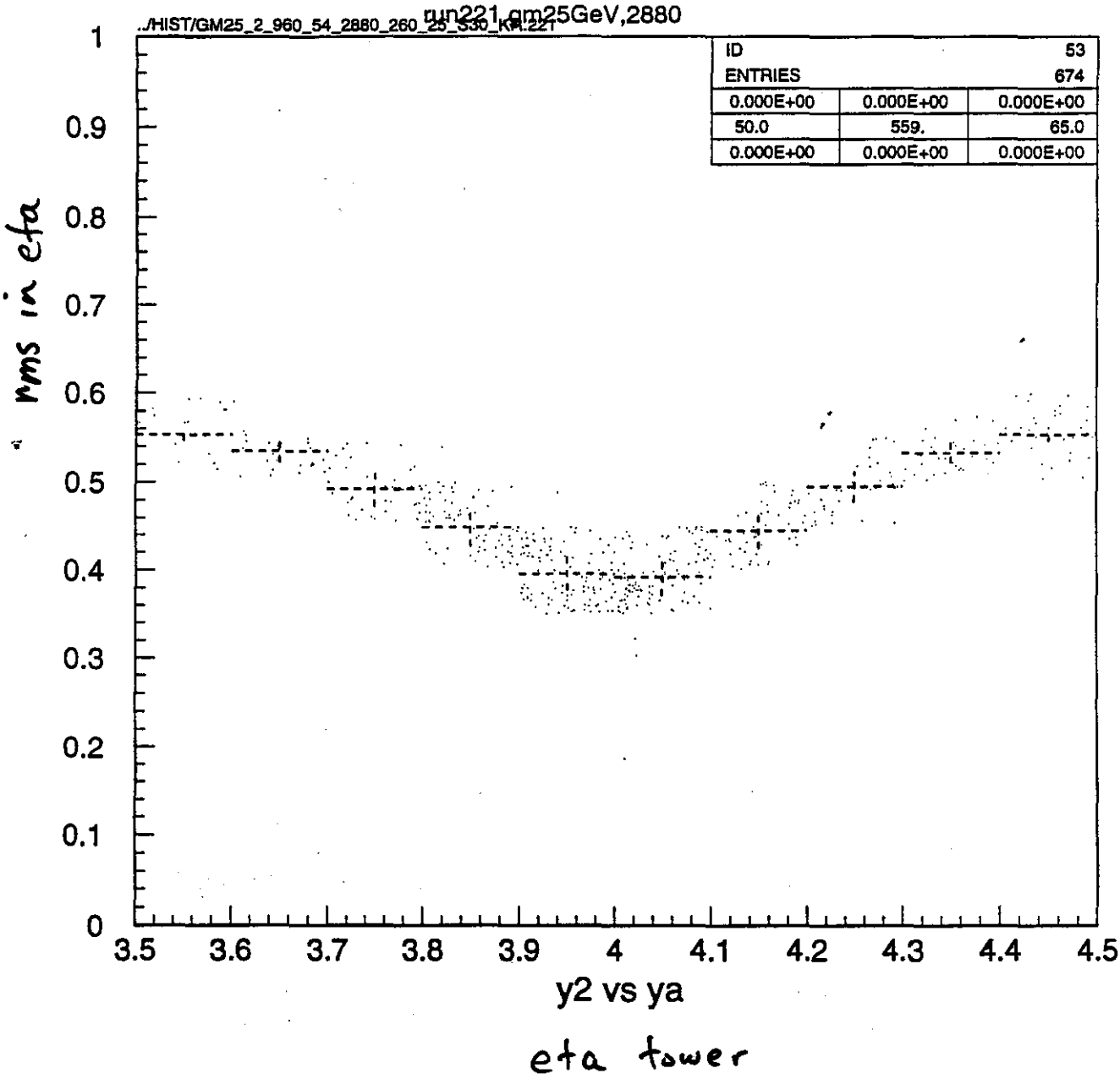

92/11/19 18.25
../HIST/GM25_2_960_54_2880_260_25_330_KR.221
run221,gm25GeV,2880
ID 52
ENTRIES 674
0.000E+00 0.000E+00 0.000E+00
22.0 651. 1.00
0.000E+00 0.000E+00 0.000E+00
rms in phi
x2 vs xa
phi tower

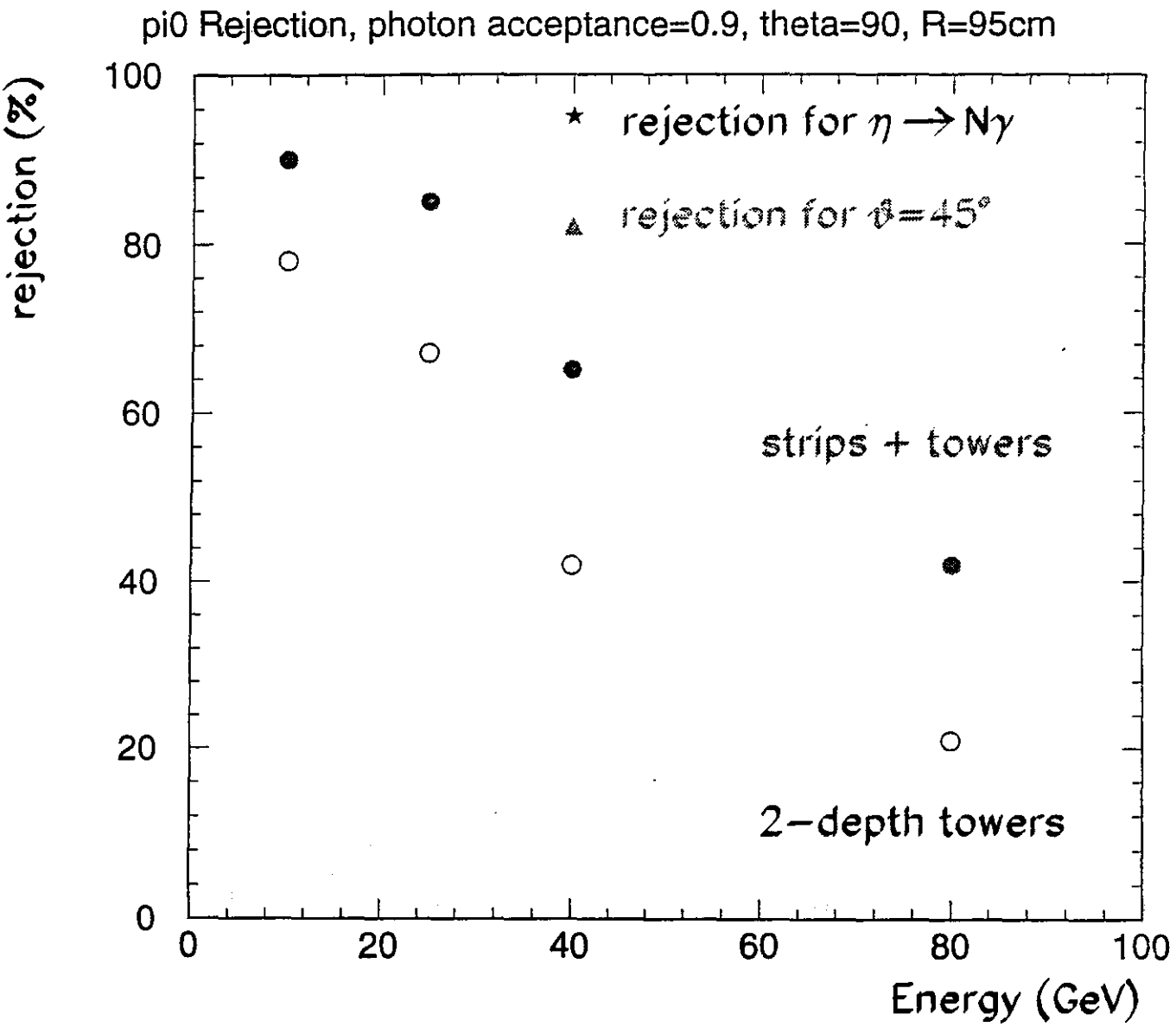

92/11/19 18.25
../HIST/GM25_2_960_54_2880_260_25_330_KR.221
run221,gm25GeV,2880
ID 1022
ENTRIES 674
0.000E+00 0.000E+00 0.000E+00
2.00 667. 5.00
0.000E+00 0.000E+00 0.000E+00
0.02
0.016
0.012
0.008
0.004
0
-0.004
-0.008
-0.012
-0.016
-0.02
-10
-8
-6
-4
-2
0
2
4
6
8
10
dthbstr vs Z
$\theta_2 - \theta_{strip}$
Z (cm)

92/11/19 18.25


../HIST/GM25_2_960_54_2880_260_25_530_KM.221
run221 gm25GeV,2880
ID 1020
ENTRIES 674
0.000E+00 0.000E+00 0.000E+00
22.0 651. 1.00
0.000E+00 0.000E+00 0.000E+00
0.02
0.016
0.012
0.008
0.004
0
-0.004
-0.008
-0.012
-0.016
-0.02
3.5 3.6 3.7 3.8 3.9 4 4.1 4.2 4.3 4.4 4.5
dph12 vs ph
$\varphi_2 - \varphi_1$
phi tower

92/11/19 18.25


run221,gm25GeV,2880
../HIST/GM25_2_960_54_2880_260_25_S30_KR.221
ID 53
ENTRIES 674
0.000E+00 0.000E+00 0.000E+00
50.0 559. 65.0
0.000E+00 0.000E+00 0.000E+00
rms in eta
y2 vs ya
eta tower


pi0 Rejection, photon acceptance=0.9, theta=90, R=95cm
rejection (%)
100
80
60
40
20
0
0
20
40
60
80
100
Energy (GeV)
rejection for $\eta \rightarrow N\gamma$
rejection for $\vartheta=45°$
strips + towers
2−depth towers

gem

γeμ

Presentation by:

J. Womersley

J. Womersley

EXPERIENCE WITH SHOWER LIBRARIES IN DØ.

Very Fast simulation of calorimeter

Choose library entry from "bin"

- Scale in E
- Rotate in ϕ
- Copy into detector banks

Problems:

I/O bandwidth
Size of disk file and access time
Need to build library
Statistical significance worries

→ Basically not used so far.

Maybe important to use a test beam library for jet response...

gem

γeμ

Presentation by:

M. Leltchouk

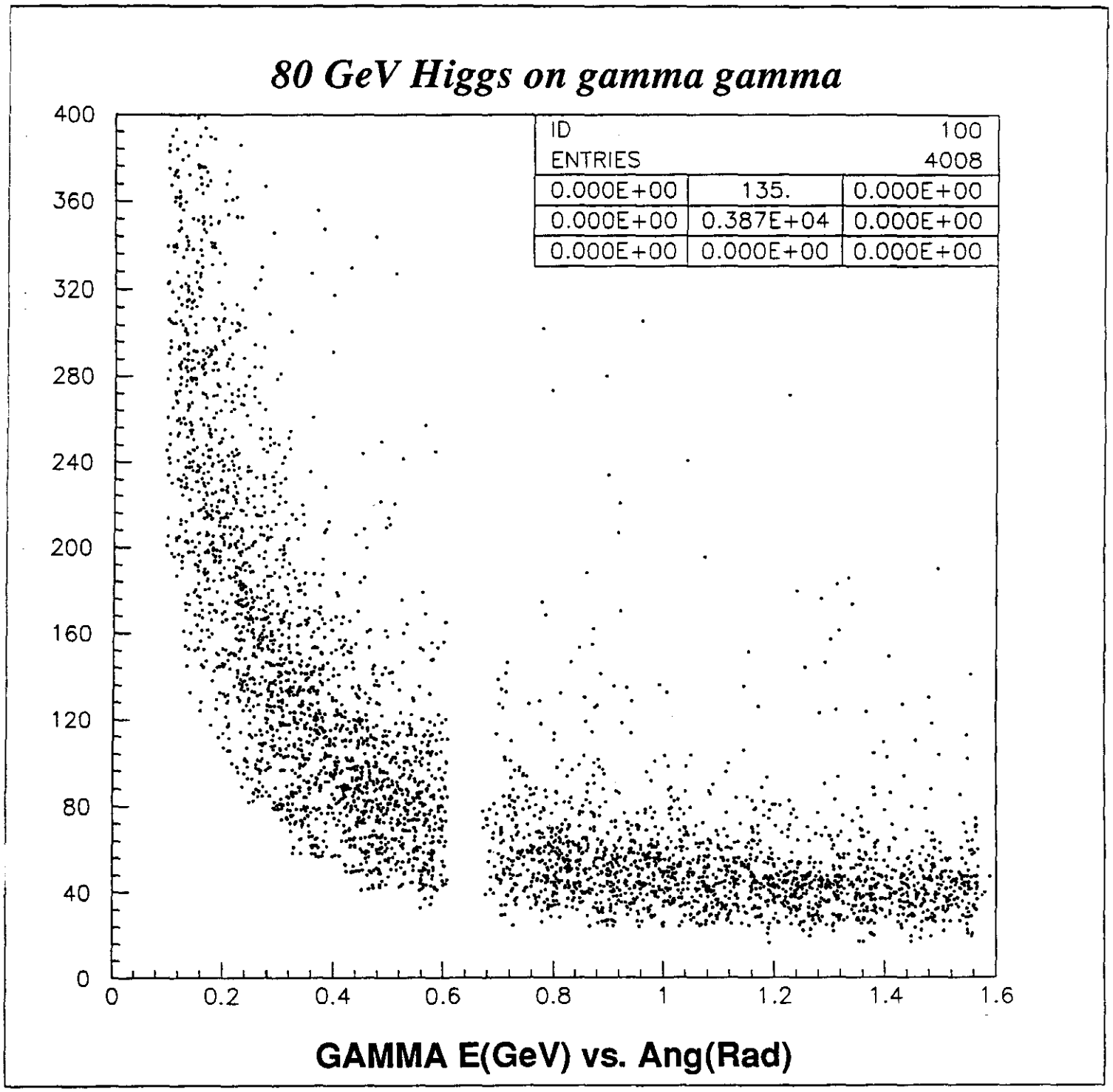
M. Feltchenko

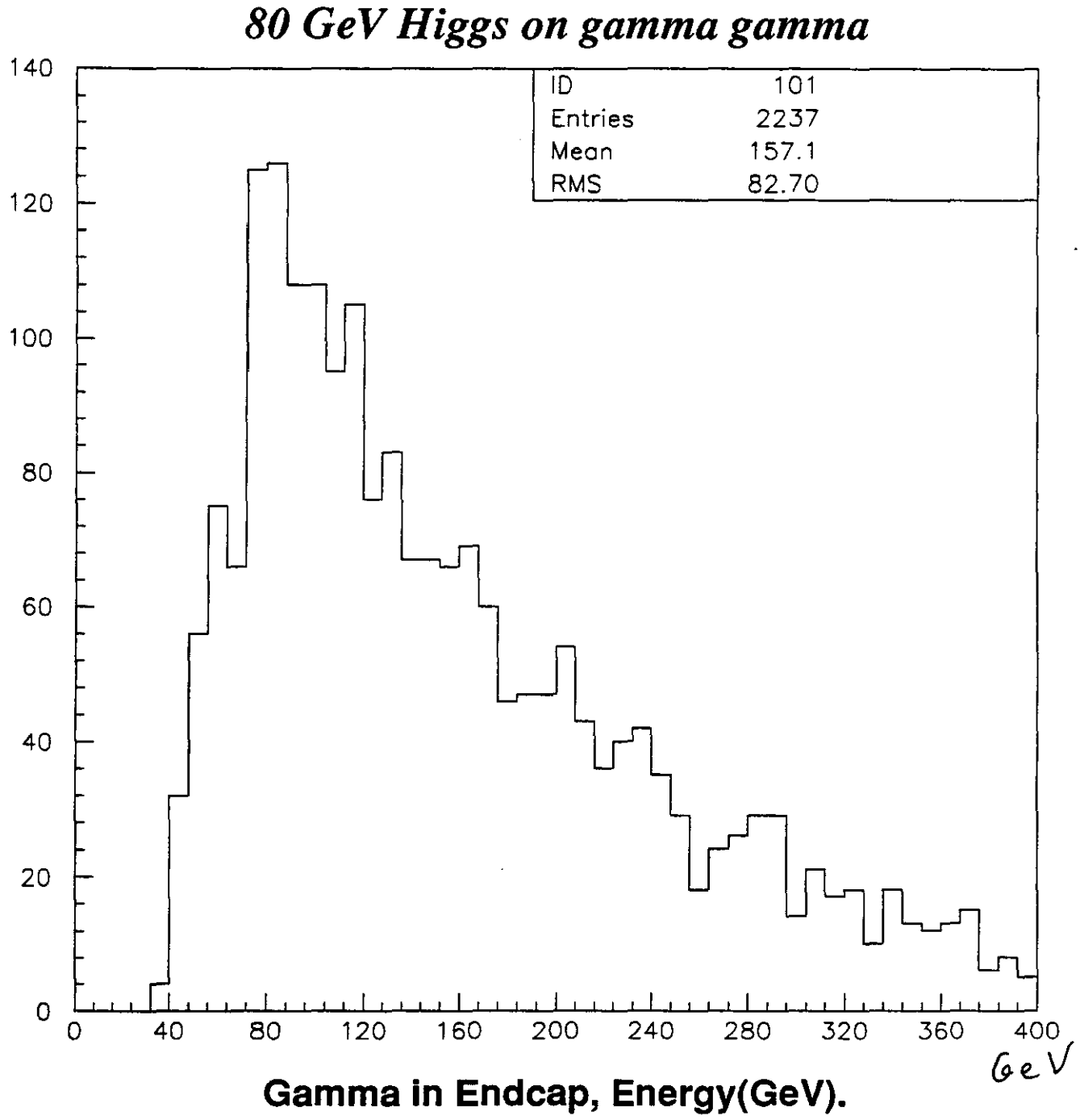
Higgs(80 GeV) on Gamma Gamma

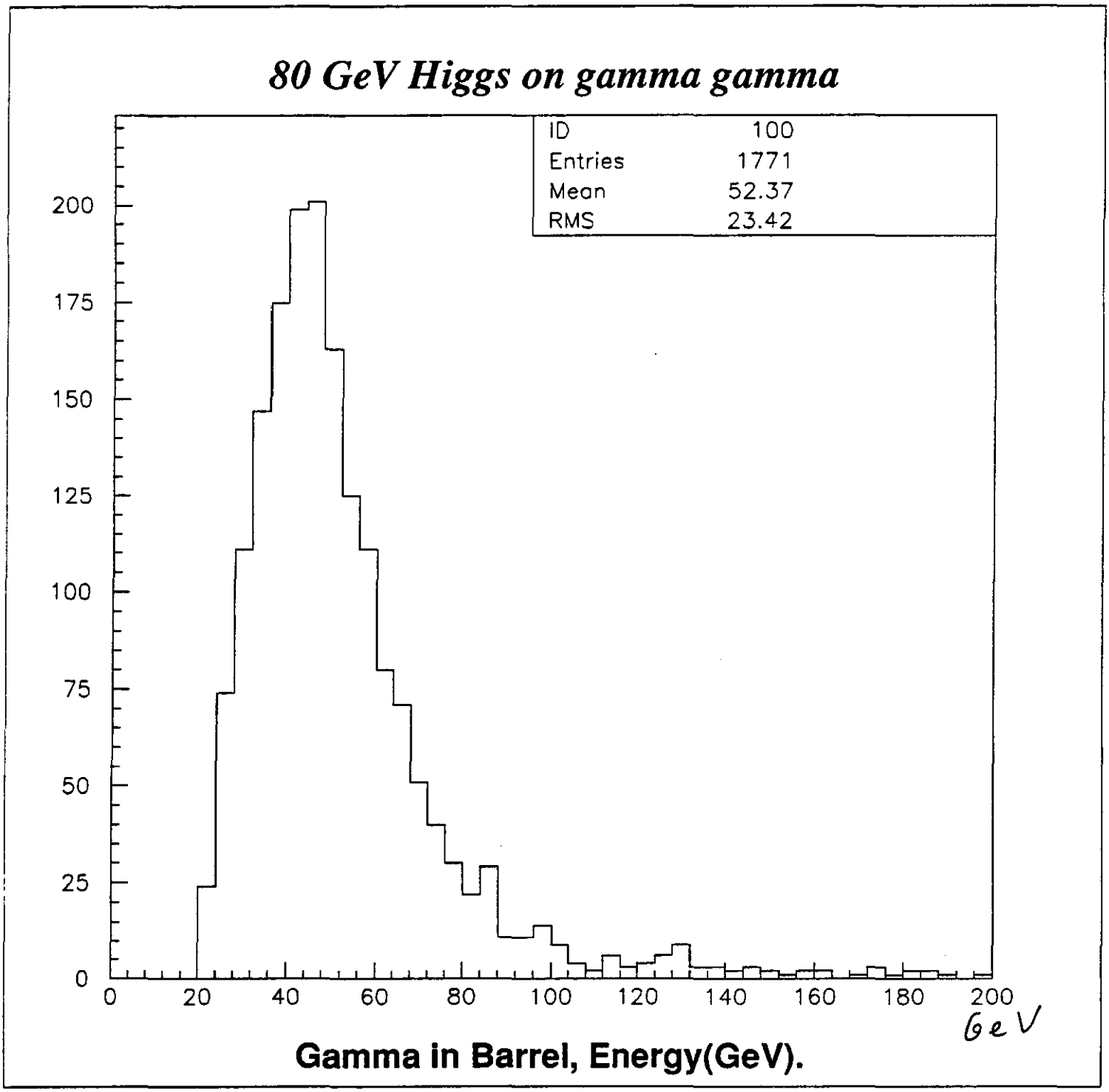
Events occupation:

33%	*23%*	*44 %*
Barrel-Barrel	*Barrel-Endcap*	*Endcap Encap*

Yu.Efremenko


80 GeV Higgs on gamma gamma
ID 100
ENTRIES 4008
0.000E+00 135. 0.000E+00
0.000E+00 0.387E+04 0.000E+00
0.000E+00 0.000E+00 0.000E+00
400
360
320
280
240
200
160
120
80
40
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
GAMMA E(GeV) vs. Ang(Rad)


80 GeV Higgs on gamma gamma
ID 101
Entries 2237
Mean 157.1
RMS 82.70
140
120
100
80
60
40
20
0
0
40
80
120
160
200
240
280
320
360
400
GeV
Gamma in Endcap, Energy(GeV).


80 GeV Higgs on gamma gamma
ID 100
Entries 1771
Mean 52.37
RMS 23.42
0
25
50
75
100
125
150
175
200
0
20
40
60
80
100
120
140
160
180
200
GeV
Gamma in Barrel, Energy(GeV).

UAZMIX (Mike Shupe)

- Fast GEANT based simulation
  - use MIXTURES & simple volumes TUBE, BOX, CONE
  - ASCII - based geometry - building tool

- Intermediate level of detail between
  GEMFAST w/ parametrization and { SIGEM and detailed detector simulation eg Accord

- Useful for: study of cryostat walls
  $\eta = 1.3$, $\eta = 3$, $\eta = 5$ transitions
  $\not{E}_T$ esp. FCAL design
  effect of $e/h \neq 1$
  jet energy resolution w/ weights for layers
  n-flux (using GEANT $\leftrightarrow$ CALOR interface)

- Geometry $\approx$ coded
  information on e/h, σ_{EM}, σ_{HAD} needed
  to smear energies in GUSTEP

gem

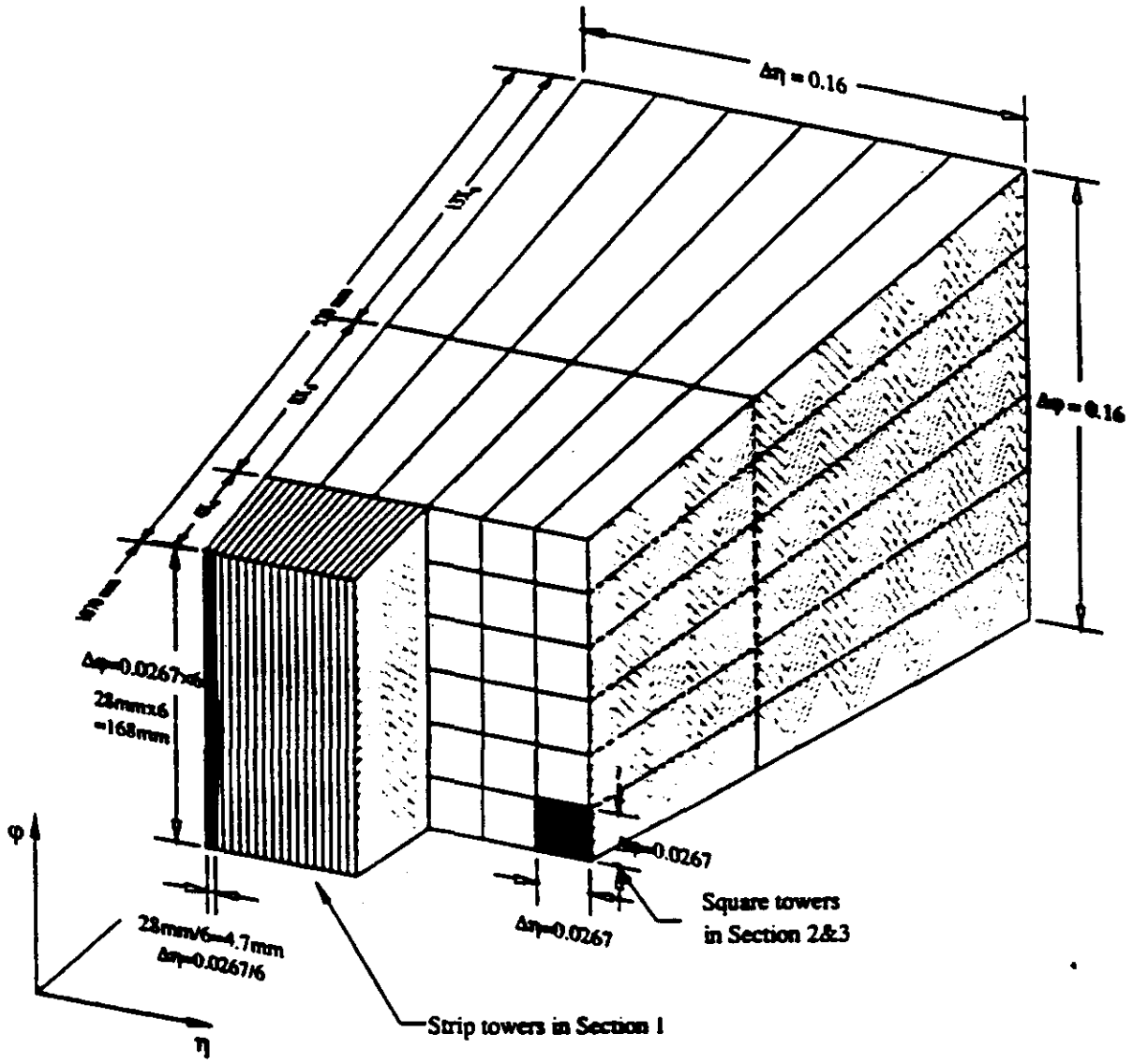
γeμ

Presentation by:

M. Seman

M. Seman

EM Accordion Segmentation



List of gamma-pizero separation parameters

1) FA - "far" amplitude (outside radius KR from peak) 2
FA - max signal outside KR strips with the center at hottest strip.

KR=5 was used for strip width about 2 mm
In this case FA - max signal outside 9 strips with the center at hottest strip.

2)

H3 = E3/S2	Relative signal heights	3
H4 = E4/S2	normalized on sum	4
H5 = E5/S2	of 2 largest signals	5
H6 = E6/S2		6

3)

W2 - width of 2 max energy bins	Widths, which sensitive	12
W3	to holes in lateral	13
W4...	energy distribution	14

ALH36→

19

4) WR - width of a base (width at relative threshold TW) 20 21
TW = TRELW*S2 Example: TRELW = 0.1
IF (TW .LT. TA) TW=TA TA = 5 MeV + 2 sigma of noise

5) ALC1 combination of previous parameters:
an attempt of including different information to one parameter 1

C1 = W2*W3*H3*H4*H5*WR*FA
IF (C1 .GT. 1.E-10) ALC1 = ALOG(C1)

6)
SEM = (SA - E1)*E1R here SA - sum of strip signals, higher than TA
example: TA = 5 MeV + 2 sigma of noise
SEM - ratio of signal sum except max signal to max signal
23

7)
WSEM = ESEM/ETHREE
SE = ESEM*E1R

ESEM = WLEFT + WRIGHT
ESEM - sum of 16 strip signals out of 3 "central" strips
25
WSEM - ratio of this sum to signal sum of 3 "central" strips
SE - ratio of this sum to max signal
22

8)
WSE = (WLEF + WRIGH)*E1R 24

WSE - ratio of sum of 16 strip signals out of 2 "central" strips to max signal

9) asymmetry

```
ASEM = (WRIGHT-WLEFT)*E1R
IF (ASEM .LT. 0.) ASEM = -ASEM
```

27

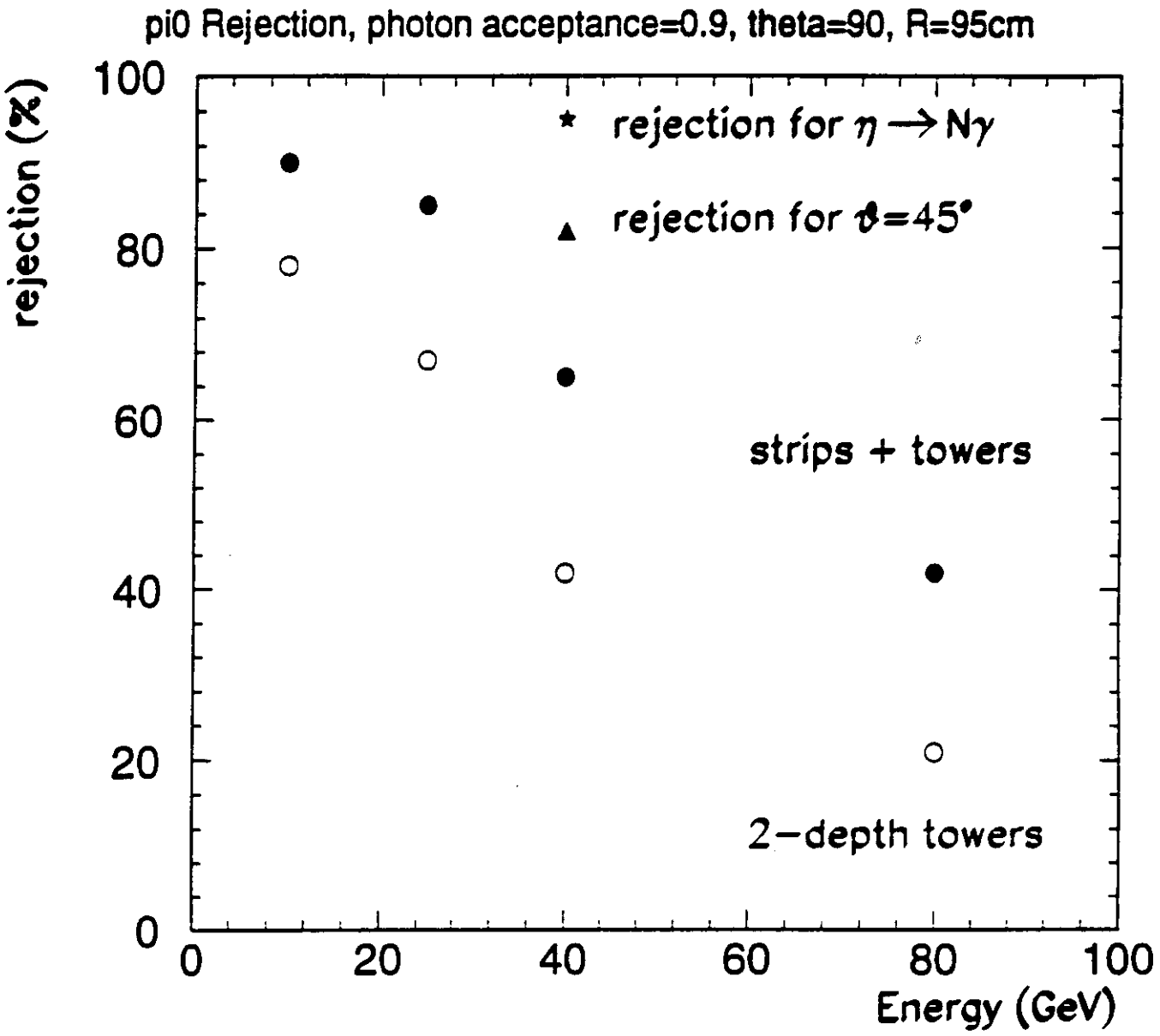
ASEM - absolute value of asymmetry outside of 3 "central" strips normalized to max signal

```
ASE = (WLEF - WRIGH)*E1R
IF (ASE .LT. 0.) ASE = -ASE
```

26

ASEM - absolute value of asymmetry outside of 2 "central" strips normalized to max signal

SIM


pi0 Rejection, photon acceptance=0.9, theta=90, R=95cm
rejection (%)
100
80
60
40
20
0
0
20
40
60
80
100
Energy (GeV)
rejection for $\eta \rightarrow N\gamma$
rejection for ϑ=45°
strips + towers
2−depth towers

9) asymmetry

```
ASEM = (WRIGHT-WLEFT)*E1R
IF (ASEM .LT. 0.) ASEM = -ASEM
```

27

ASEM - absolute value of asymmetry outside of 3 "central" strips normalized to max signal

```
ASE = (WLEF - WRIGH)*E1R
IF (ASE .LT. 0.) ASE = -ASE
```

26

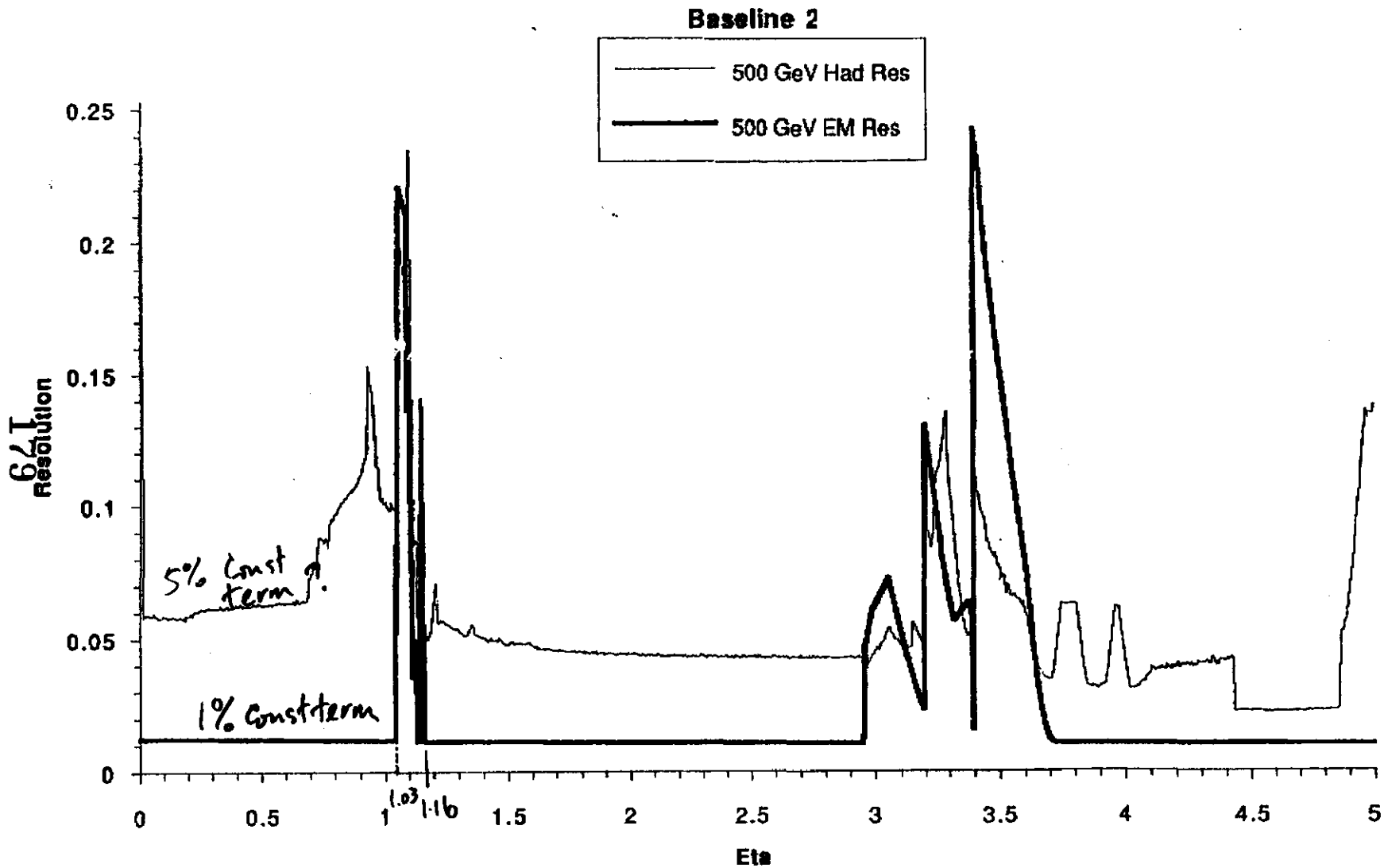
ASEM - absolute value of asymmetry outside of 2 "central" strips normalized to max signal

gem

γeμ

Presentation by:

Hong Ma

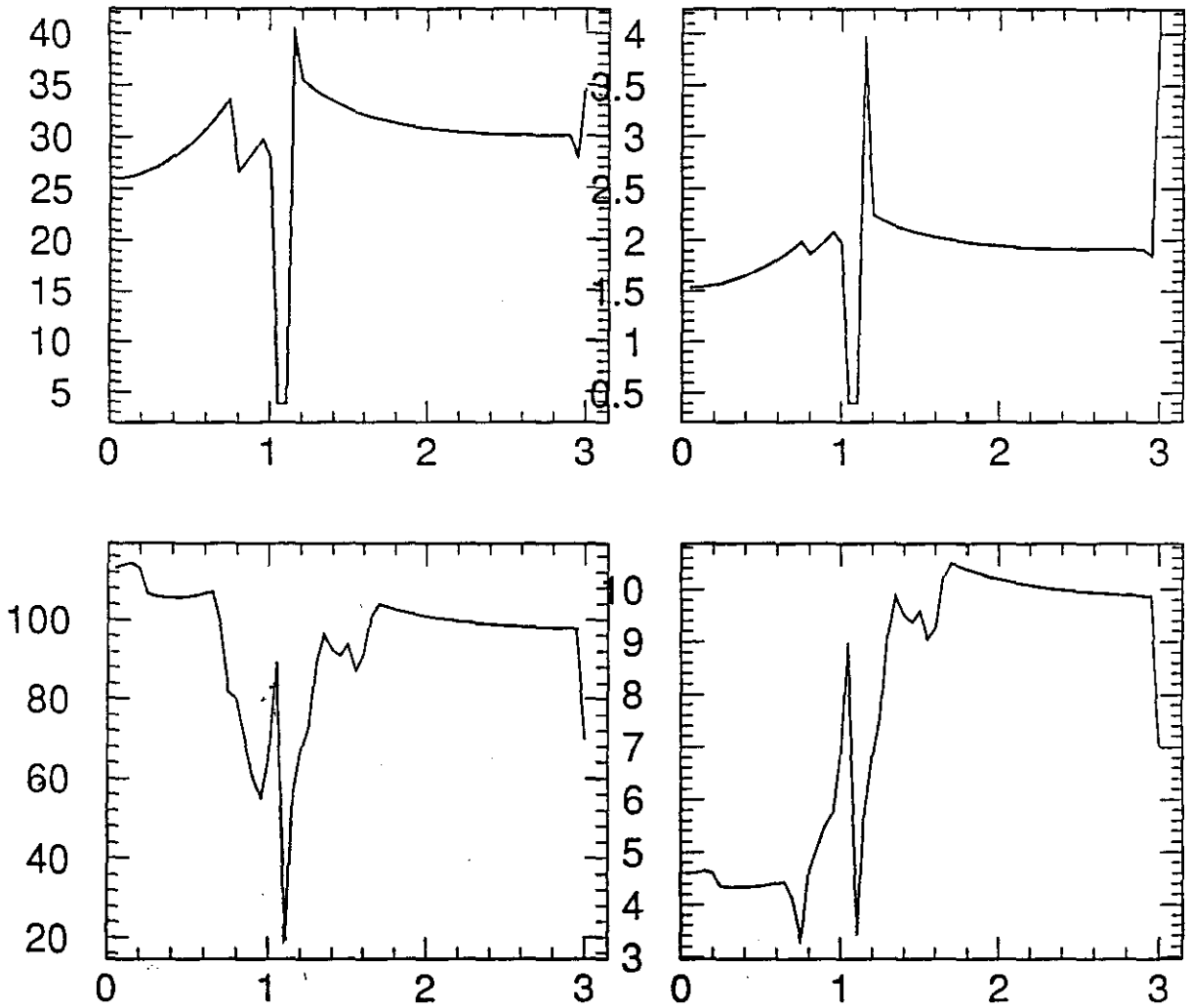


H. Ma
description of Martin Marietta model

1

Ma ②
MMA

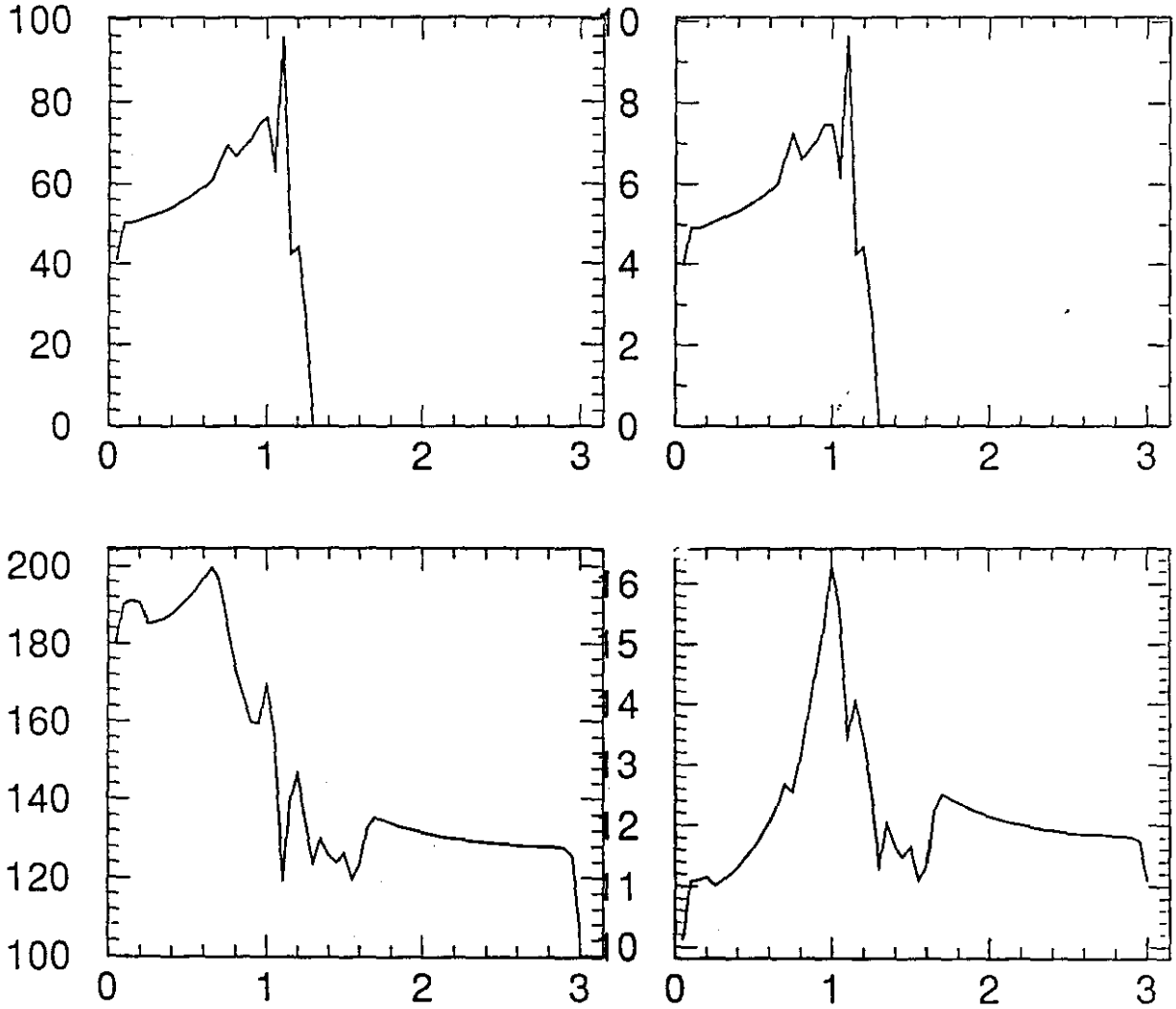
EM and LKr HAD X0 and lambda



③

Mo / MMA

SF and total X0 and lambda



gem

γeμ

Presentation by:

Ken McFarlane

Impromptu Comments on AXIAL FIBER CALORIMETER
(newly adopted)

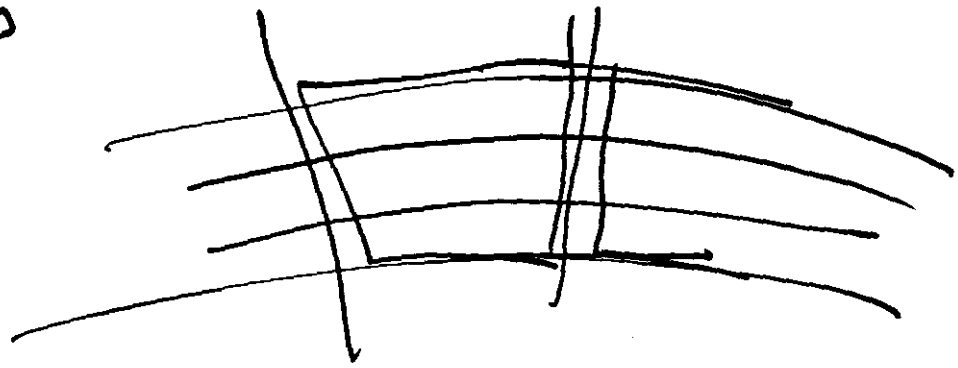
KMCF

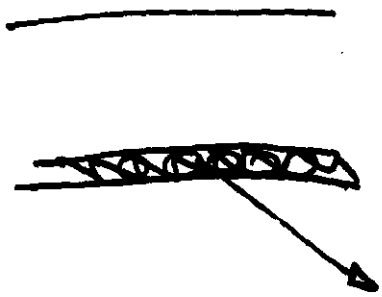
Baseline 2 geom

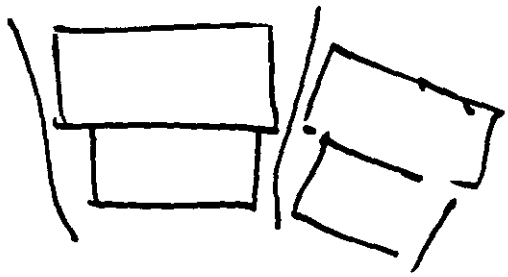
60 cm Cu, 6% Sci (volume)

10 layers

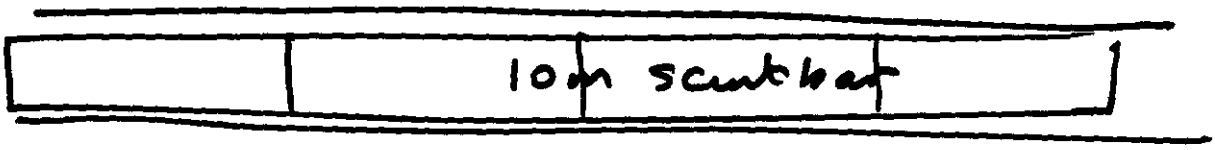
160 in ϕ







light in Tankovsky.



Material n shielding
punch through

Instrumented

1. tails (esp at $\eta \sim 1.2$)
2. μ's timing (MIPS)
3. μ ~~[illegible]~~. correction
   Cat. Elos.

Tails - $\frac{A}{\sqrt{E}} + B$? after 6λ.

- "size" of tail (in z, ϕ) vs. energy

character of signal from fiber

$\phi - z$ lego plots of tail

other issues: readout channels ?

~~[illegible]~~

gem

γeμ

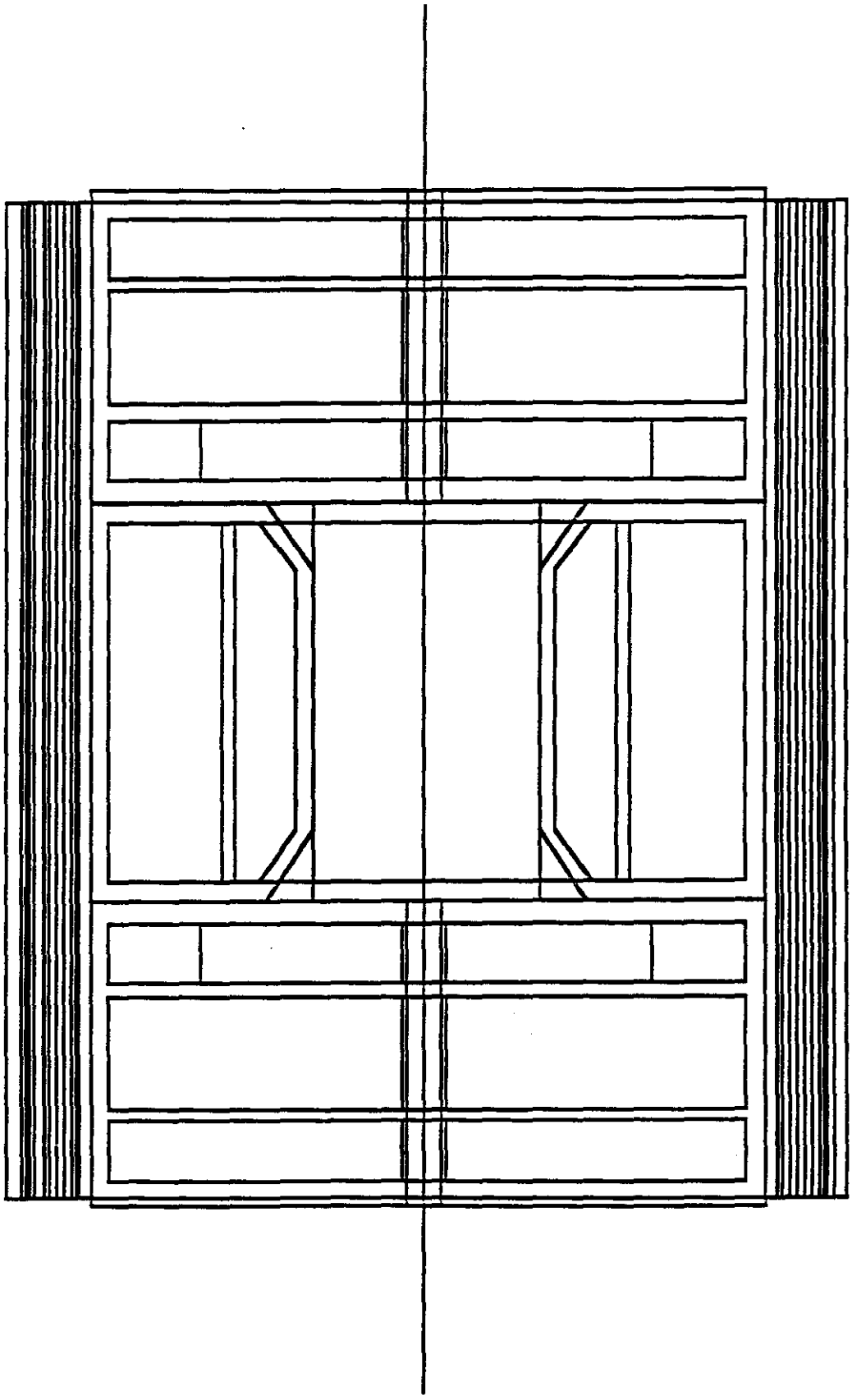
Presentation by:

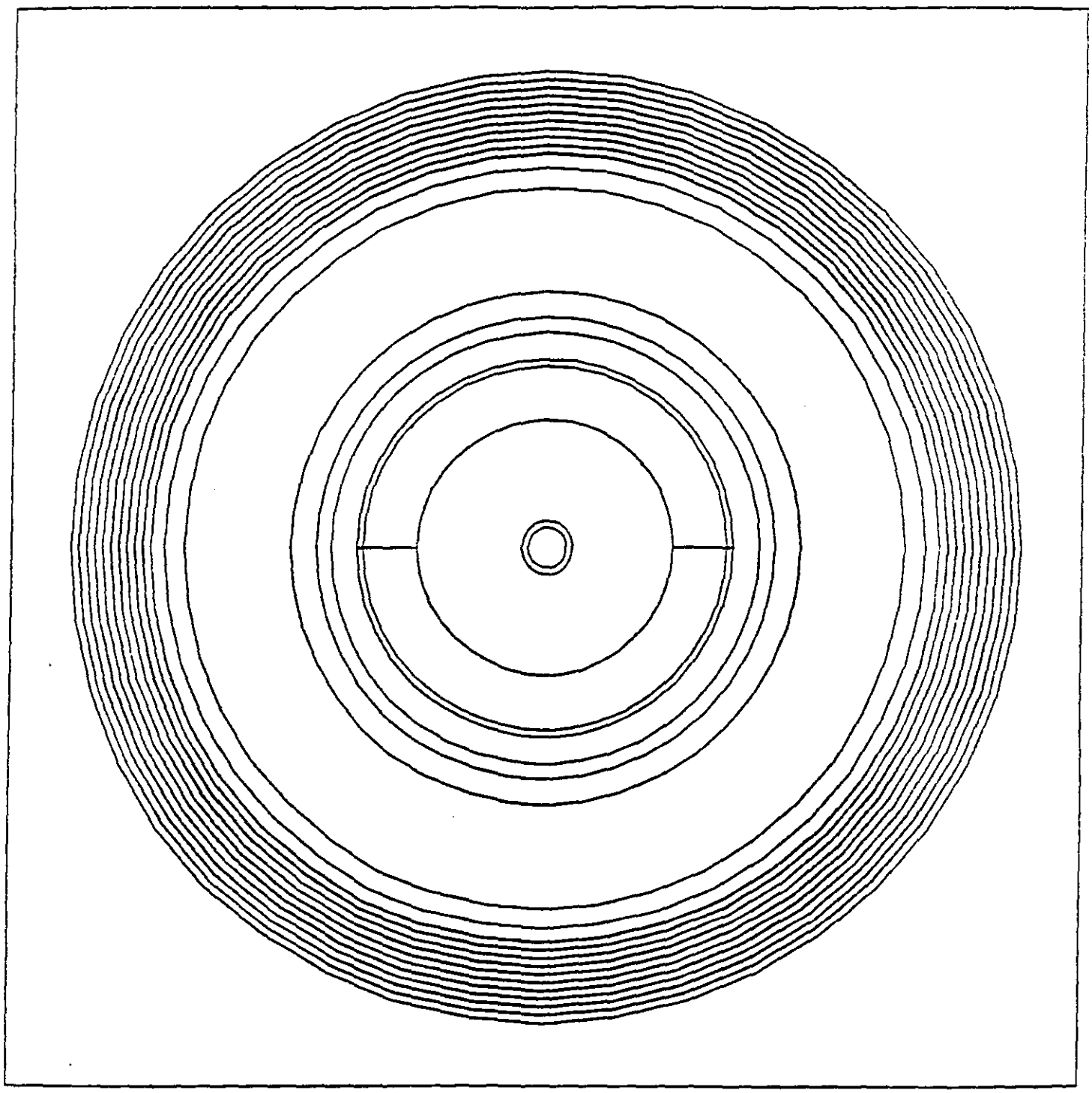
Y. Efremenko

&

A. Savin

ORNL geometry (Savin, Efremenkov)





gem

γeμ

Presentation by:

H. Uijterwaal

H. Uijterwaal

CALORIMETER DATA STRUCTURES.

Input: • PRELIMINARY versions of the TDR.

• Not much has been defined; most questions are unanswered (if they ~~are~~ have been asked at all).

⇒ This talk is mainly an attempt to list ~~the problems~~ what should be done.

The Problem.

"REAL LIFE"

1) DETERMINE E, t (time w.r.t. Bunch X-ing) for every cell!
   ⇒ Algorithm. (Precision, processing time).
2) Make data available to the USERS:
   - L1 trigger
   - L2 trigger
   - Offline/L3 trigger.

   • Data description language
   • Tools to manipulate the data

   ⇒ these are GEM problems, not CAL problems!

"Simulated life"

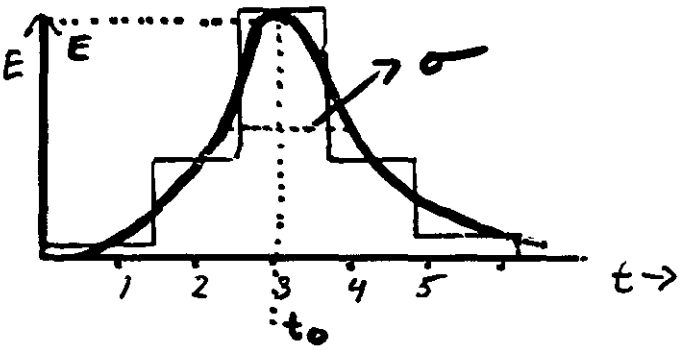
1,2) as in Real life

3) Make the data look like "REAL DATA".

E, t Reconstruction (Nevis/Columbia U)

→ We all know why we want to reconstruct the Energy, but the arrival time w.r.t. bunch crossing is as least as important:
1) Bunch Xing determination.
2) Help "slower" components in CEM
3) Backgrounds

→ Algorithm (Basic idea): E



- Assume constant pulse shape (σ): Gauss+tail.

- 5 samples (@ 60 MHz). (Minimum).

- #1, #5 : Pedestal
- #2, #4 :⇒ t_0
- t_0 + #3 ⇒ E

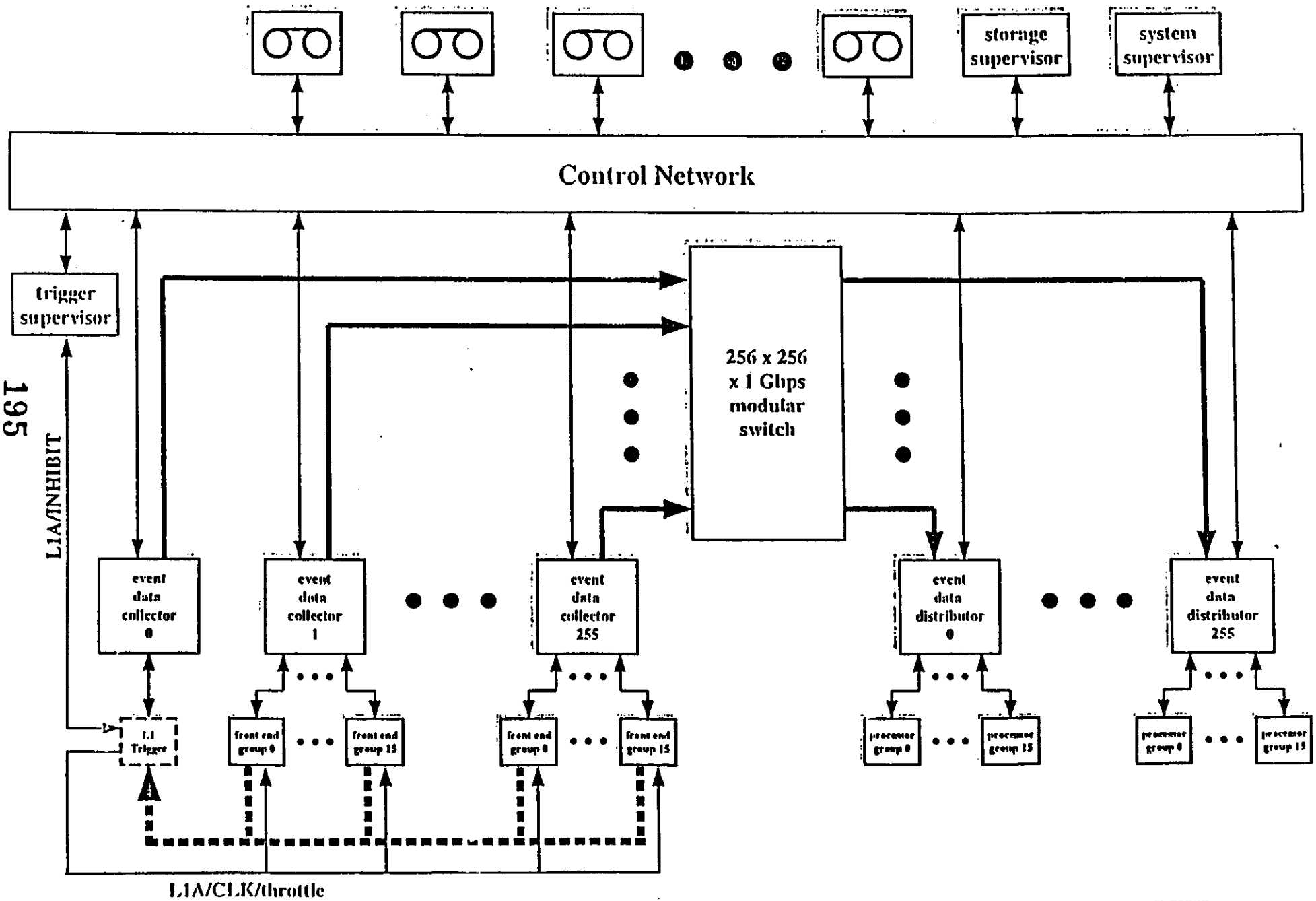
→ Precision

L3 :→1 bit = 1σ of noise } 18 bits for E.
6 TeV maximum
→0,3 ps resolution in t_0

Details Thursday ~~Wednesday~~ Afternoon

L1 →12 bits (6 TeV in 1,5 GeV steps)
→ t_0 with 2–3ns accuracy.

DAQ OVERVIEW



TDR DAQ CHAPTER, PAGE 2,

SSCL PRD Draft - 0.9

GEM Data Acquisition System

Introduction

The Data Acquisition System is responsible for bringing the data for the relevant physics events to mass storage in an efficient way. It also provides the context in which the level 2 and level 3 triggers run and brings the data to these triggers.

A design goal specific to the GEM DAQ system is that the front end chips are read out after each level 1 trigger. This way no data has to be stored on the front end chips during the level 2 decision. Only buffers of moderate size will be needed to de-randomize the level 1 trigger rate fluctuations. It also allows for a level 2 implementations with a large latency.

The level 2 and 3 algorithms will be executed in general purpose processors in the on-line farm. This means that the event data must be transported to the farm at rates up to the maximum specified level 1 trigger rate of 100 kHz. It also means that there are basically only two levels of triggering: a low latency trigger (level 1) and the combination of level 2 and 3 that forms a high latency trigger. The latency for level 1 is fixed by the depth of the pipeline buffers on the front end chips. The latency for level 2 and 3 is variable and limited by the cost of buffer memory.

Because front-end occupancies, trigger rates and trigger processing times are not yet well known, the initial design for the GEM data acquisition system places a large emphasis on scaling and flexibility. With proper balancing of the front-end data rates, a total throughput of greater than 20 GBytes/sec is possible. A compromise must be found between reading out strongly zero suppressed 200 kByte events at up to 100 kHz or minimally zero-suppressed 2 MByte events at up to 10 kHz.

We propose a model (Fig. 1) where, for each level 1 accept, the data for all front end boards are read out via serial links of moderate speed. The data are stored in a number Event Data Collector modules (EDCs). These modules contain the large buffers where event data remains during the long level 2 execution times. Data needed by the level 2 and level 3 algorithms are transported on high speed fibers to the farm via a switching network (Event Builder). They are received by Event Data Distributor modules (EDDs). The EDDs forward the data to the processors in the farm, again via moderate speed links. Data for each event originate in different EDCs. Data fragments for events are combined in the EDDs before they are passed to the relevant processor.

Below we describe the properties of the system in more detail.

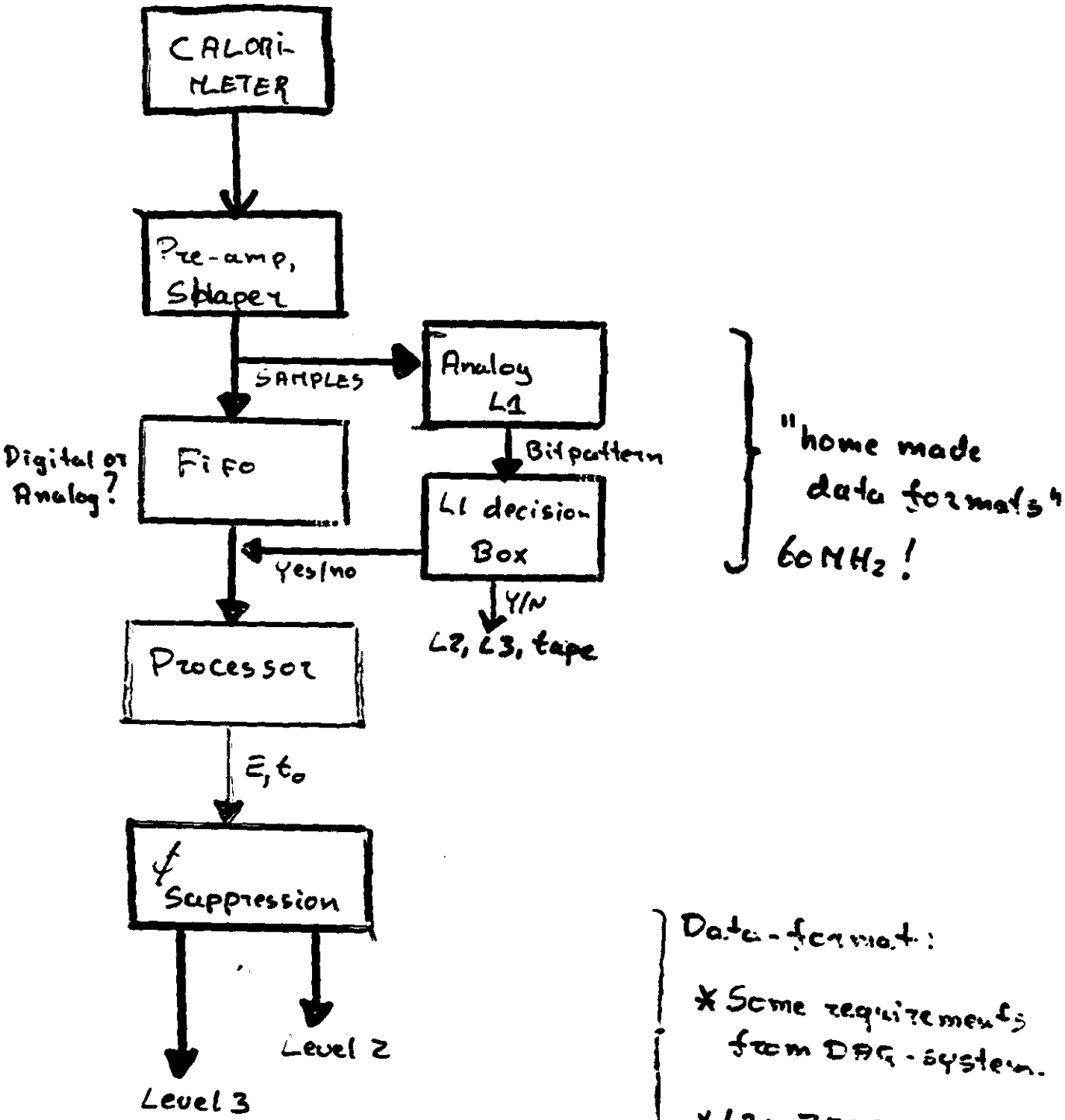
Data Collection

The table below lists the major GEM subsystems with estimates of channel counts, number of front end boards, number of bytes per events and data volume at a level 1 trigger rate of 100 kHz.

Subsystem	Channels	FE Links	Bytes/event	Data Volume
Calorimeter	82 k	1640	50 kB	5 GB/s
IPC	446 k	1742	80 kB	8 GB/s
Silicon	3230 k	1262	20 kB	2 GB/s
Muon	518 k	518	40 kB	4 GB/s
Total	4276 k	5162	190 kB	19 GB/s

The initial estimate for level 1 trigger rate is 10 to 20 kHz. The data acquisition system should therefore provide a minimum capacity of 4 GBytes/second (190 kB/event * 20 kHz). To accommodate increases in trigger rates or data volumes, the design bandwidth must be scalable by a factor of five (preferably without replacement of any existing components).

CALORIMETER DATA FLOW.



Data-format:

* Some requirements from DAQ-system.

* L3: ZEBRA
  ADAMC
  ....

* L2: Home made ??
  Same as L3??

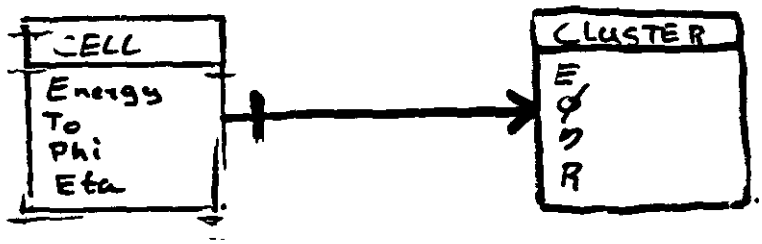
DATA FORMATS.

- ZEBRA : CERN standard but
  - → Not easy to use: "Y = Q(LQ(JHIT-1)+1)"
  - → No standard data description Language
  - → .....
- A more sophisticated tool? ADAMO.

1) DESCRIBE DATA IN AN EASY TO UNDERSTAND FORMAT:

"Entity Relationship Diagram"
"Data Description Language"

ERD



1-1 RELATION

DDL

```
CELL = { Energy = REAL;
         TIME   = REAL;
         PHI    = INTE[0,80];
         ETA    = INTE[0,76] }
CLUSTER = { ---- }
```

```
DEFINE RSET
  (CELL [0,1] → [1,*] cluster)
```

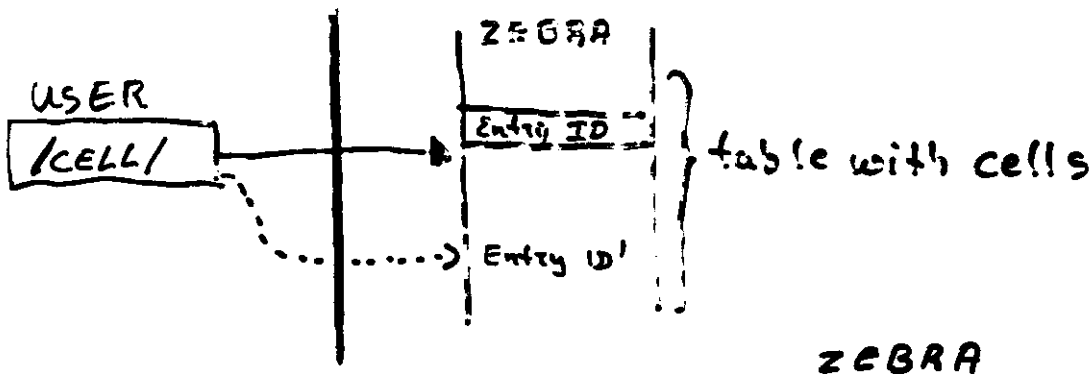
2) USE A PRE-PROCESSOR TO CREATE:

- FORTRAN Commons: COMMON /CELL/ CELL_ENERGY,
  + CELL_TIME,
  + ...

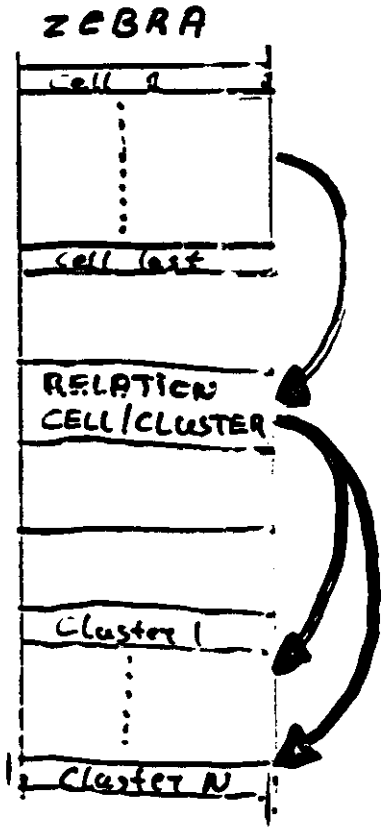
- C structures
- Initialisation code for Data base management.

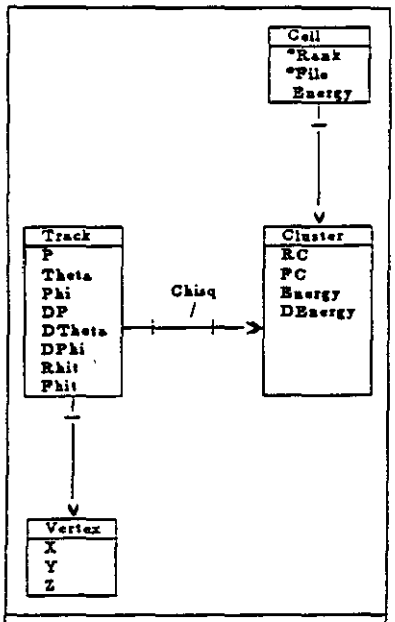
3) HIDE USER FROM the DATABASE.

1) Access DATA: FETTAB (CELL, ID)



2) RELATIONS
- INSREL (CELL, CLUSTER)
- NATREL (" , ")
- NAFREL (" , ")





1 – ER Data diagram

```
DEFINE ESET

Cell
    :'Calorimeter cells'
    = (Rank = INTE [1,10] :'Rank or row',
       File = INTE [1,10] :'File or column',
       Energy = REAL [0.0,100.]  :'Deposited energy')
    KEY Number = (Rank,File) :'Cell number'; END KEY;

Cluster
    :'Calorimeter cluster'
    = (RC = REAL [0.0,20.]  :'Centroid (Rank)',
       FC = REAL [0.0,20.]  :'Centroid (File)',
       Energy = REAL [0.0,100.]  :'Energy in GeV',
       DEnergy = REAL [0.0,10.]  :'Error on energy');
END ESET

DEFINE RSET
    (Cell [0,1] -> [1,*] Cluster)
    :'Calorimeter cells merged to form cluster';
END RSET
```

2 – Data Definition

```
      DO 100 IC1 = 1,COUTAB(Cell)
        CALL FETTAB (Cell,ID,IC1)
C   Cell not used and above initial threshold?
        IF (Cell_Cluster.EQ.INULL .AND.
     +    Cell_Energy.GE.INITER) THEN
          Cluster_ID = NEXT
          CALL CLUPAR (1)
          CALL INSENT (Cluster)
          CALL INSREL (Cell,Cell_Cluster,Cluster)
C   Add this cell to the stack
          TOSP = 1
          RSAVE(TOSP) = Cell_Rank
          FSAVE(TOSP) = Cell_File
C
C   Here begineth the simulated recursion
C
   50     CONTINUE
C   Loop over this cell's neighbours
          DO 80 IC2 = 1,8
            Cell_Rank = RSAVE(TOSP) + ROFF(IC2)
            Cell_File = FSAVE(TOSP) + FOFF(IC2)
            CALL SELTAB (Cell,NUMBER,CUR1,CUR2)
C   Does neighbour exist in the table?
            IF (CUR1 .LE. CUR2) THEN
```

3 – Data manipulation in FORTRAN

```
|-------------------------------|
| Table:  Cell          ADAMO/TAP |
| Count =   32                    |
| Printed along:  Cluster [17,27]|
|-------------------------------|
|ID   |Rank|File|Energy $Cluster  |
|----|----|----|-------$---------|
|  11|   4|   9| 0.060$        4|
|  16|   5|   8| 0.040$        4|
|  17|   5|   9| 0.750$        4|
|  18|   5|  10| 0.070$        4|
|  21|   6|   8| 0.130$        4|
|  22|   6|   9| 2.870$        4|
|  23|   6|  10| 1.010$        4|
|  24|   7|   8| 0.070$        4|
|  25|   7|   9| 1.880$        4|
|  26|   7|  10| 0.760$        4|
|  30|   8|   9| 0.520$        4|
|-------------------------------|
```

4 – Tabular printout of results

Figure 1.1: A summary of the use of ADAMO

+ 1) It becomes much easier to access the data.
2) Documentation automatically provided.
3) No coding of DB management related code.

− 1) It uses processor time (less suitable for LZ)
2) Need manpower to maintain the system
3) I/F with existing packages
→ GEANT (ZEBRA)
→ online formats

The application of ADAMO-LIKE DB systems in GEM should be studied.

1) This is a GEM problem, not a CAL problem

2) We will use a DB system for 20 years!

Comments on a <u>successful</u> use of common blocks – not recommended

KM Fabens

(1) Common blocks defined by software ~~Bar~~.

(2) Specific structure

6char name

/ —— / no. of words , ...

name

(3) Preprocessor which created I/O

(4) An <u>event</u> consisted of a list of common blocks.

MORTRAN

TASK

gem

γeμ

Presentation by:

J. Womersley

J. Womersley

DATA STRUCTURES WORKING Grp.

J.W.
Henk Uijterwaal
Yuri Fisyak
Irwin Sheer

Integration of

Calorimeter data structures
- files
- rotation matrices
- materials
- media
- volume names

Formulate a draft policy.

gem

γeμ

Presentation by:

Ken McFarlane

KMCF

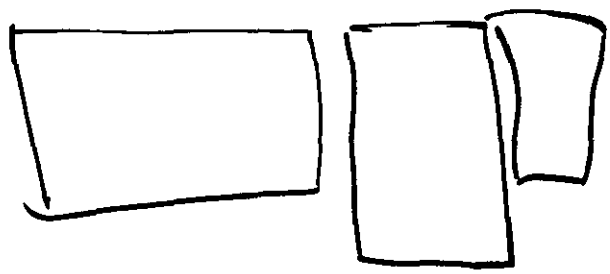
It is necessary to define a set of acronyms for the various parts of the detector for several purposes:

1. WBS
2. GEANT

BIE

ESC

?



There are almost as many schemes as there are people who need a scheme! (see next 3 slides)

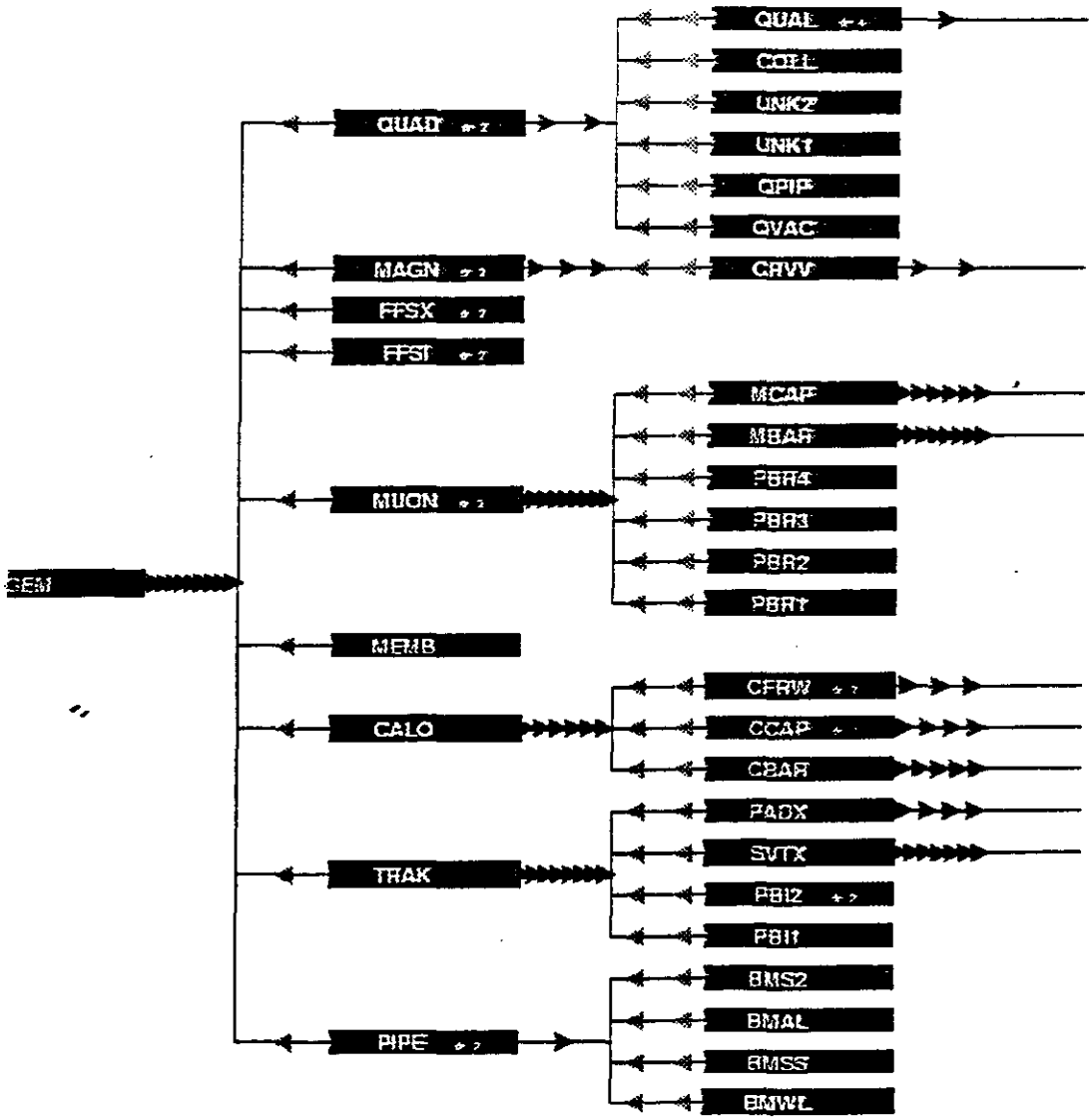
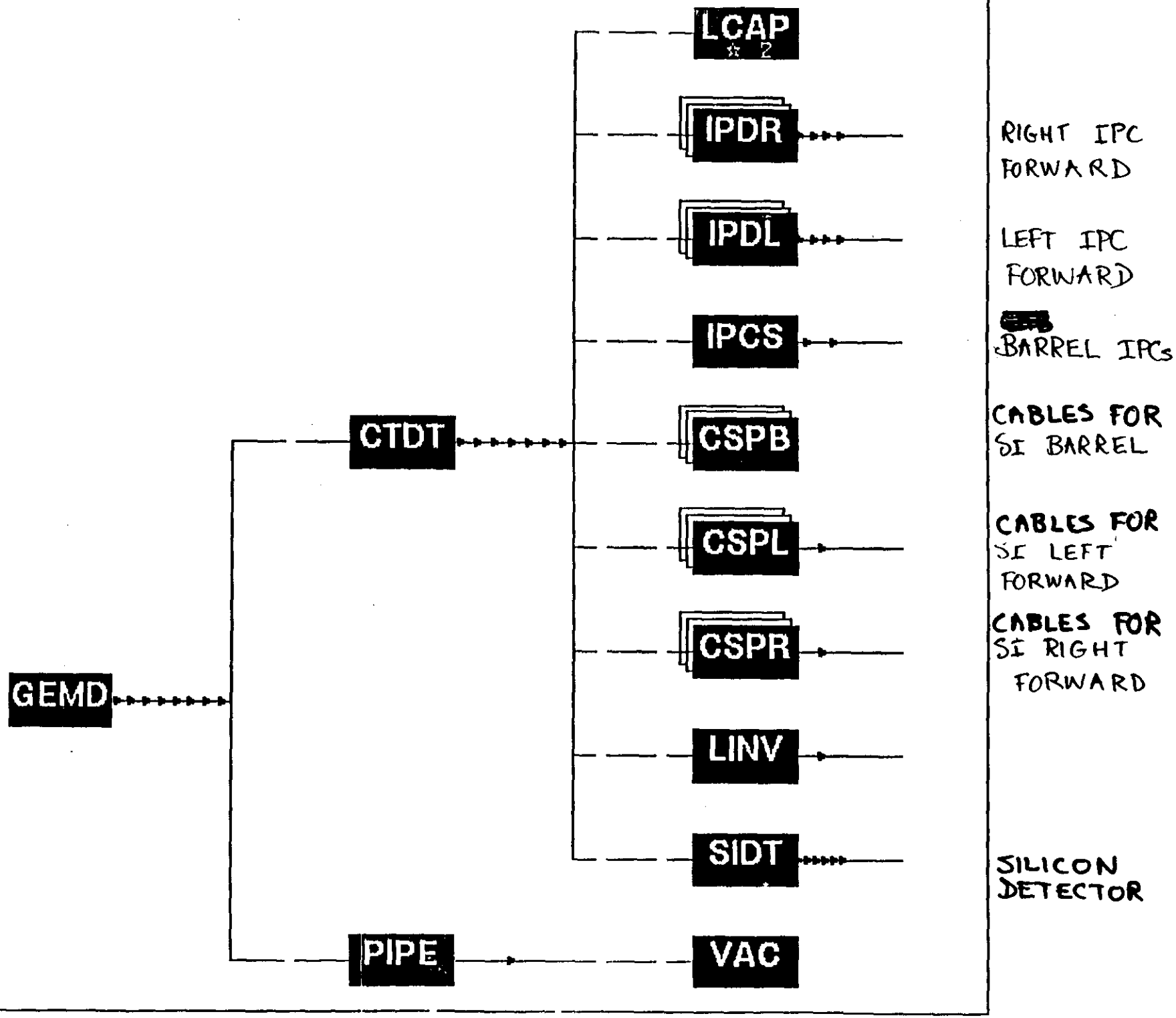
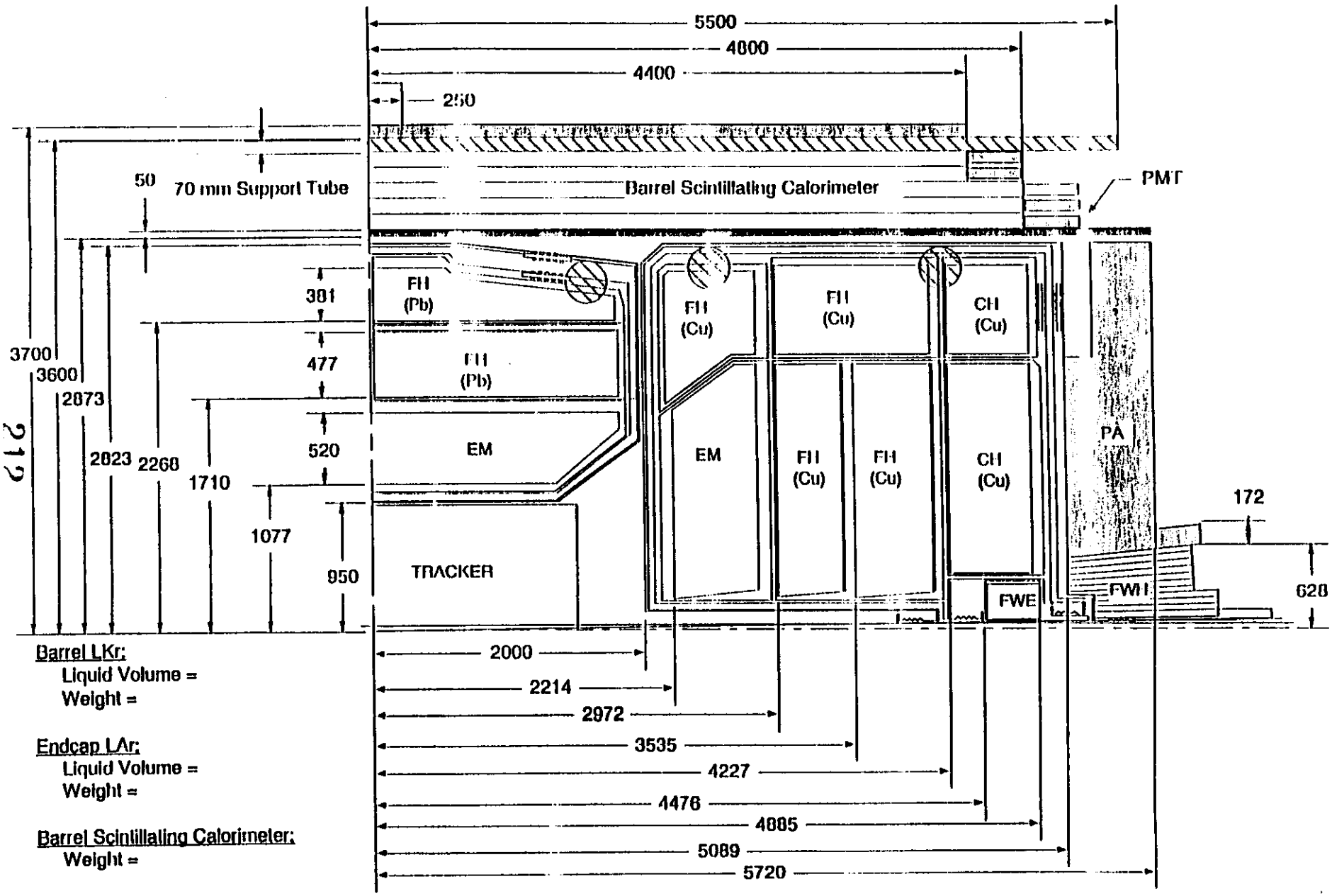


Figure 1: The GEM geometry structure in SIGEM


GEMD
CTDT
PIPE
LCAP
IPDR
IPDL
IPCS
CSPB
CSPL
CSPR
LINV
SIDT
VAC
RIGHT IPC FORWARD
LEFT IPC FORWARD
BARREL IPCs
CABLES FOR SI BARREL
CABLES FOR SI LEFT FORWARD
CABLES FOR SI RIGHT FORWARD
SILICON DETECTOR

GEM Calorimeter



Barrel LKr:
Liquid Volume =
Weight =

Endcap LAr:
Liquid Volume =
Weight =

Barrel Scintillating Calorimeter:
Weight =

gem

γeμ

Presentation by:

H. Uijterwaal

LEVEL 2 JET FINDING ALGORITHM.

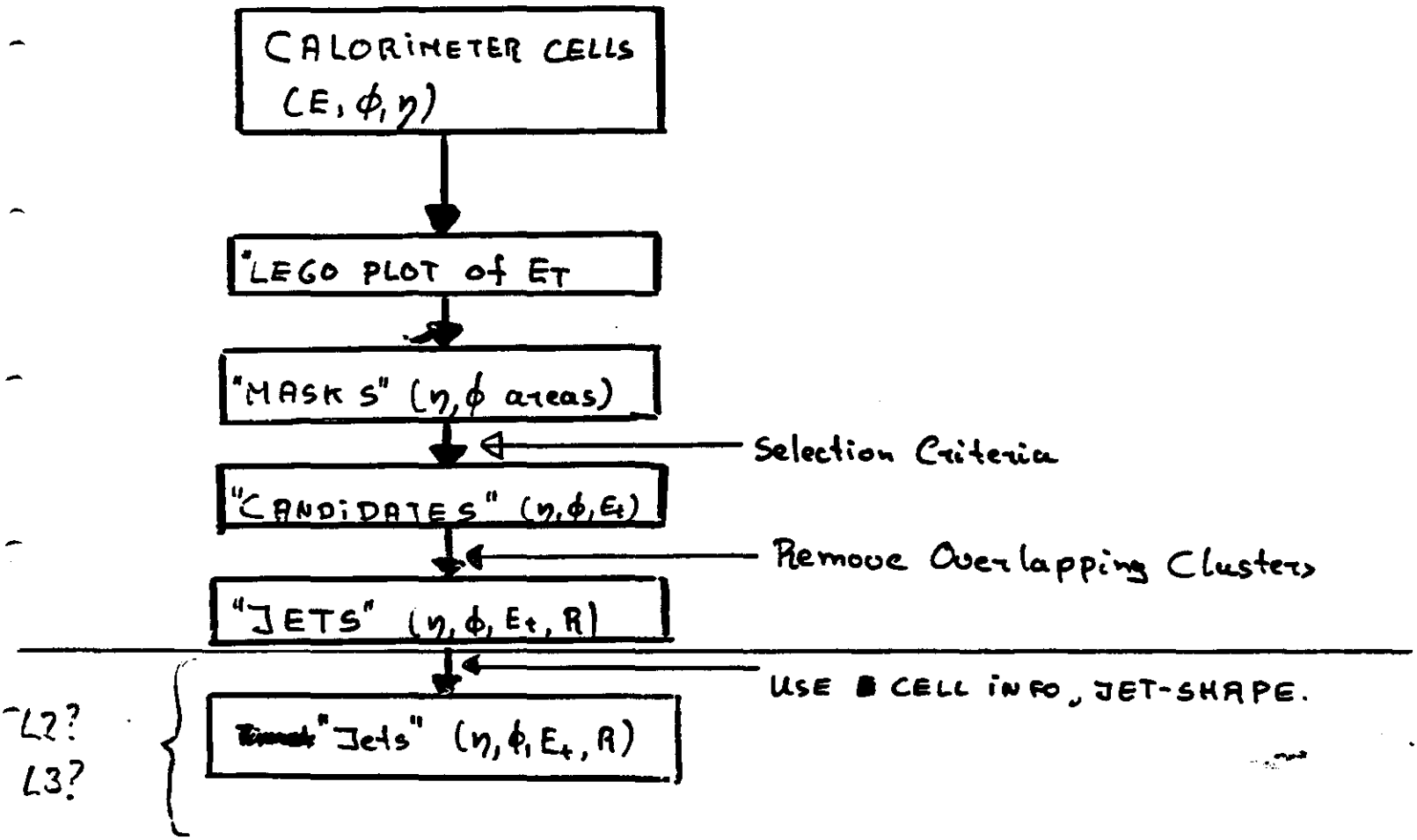
Jheroen Dorenbosch
HENK Uijterwaal.

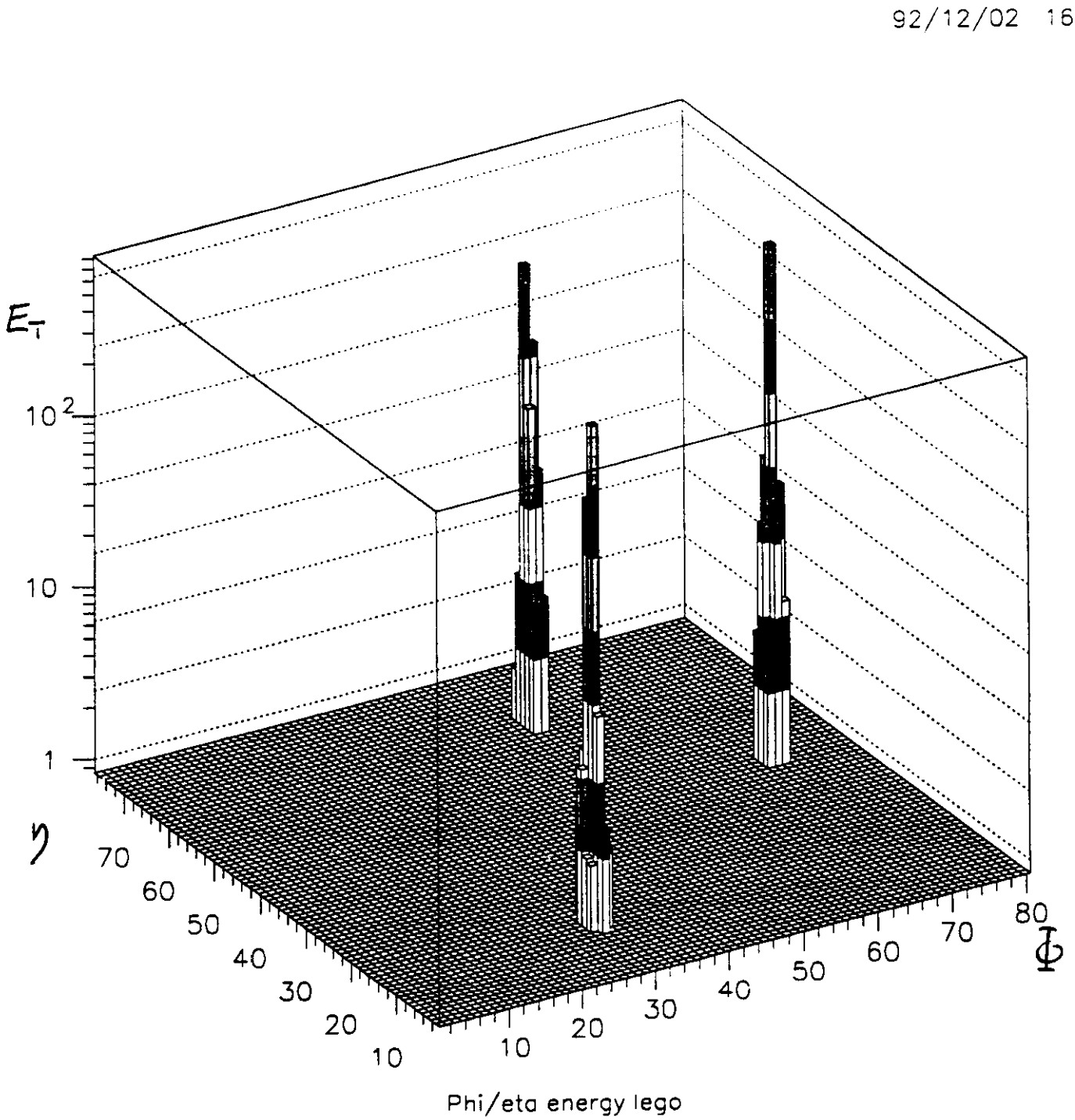
WHY? 1) Get some idea about the processing time of a "REAL" L2 algorithm.

2) Starting point for trigger studies (Jets in physics and background events).

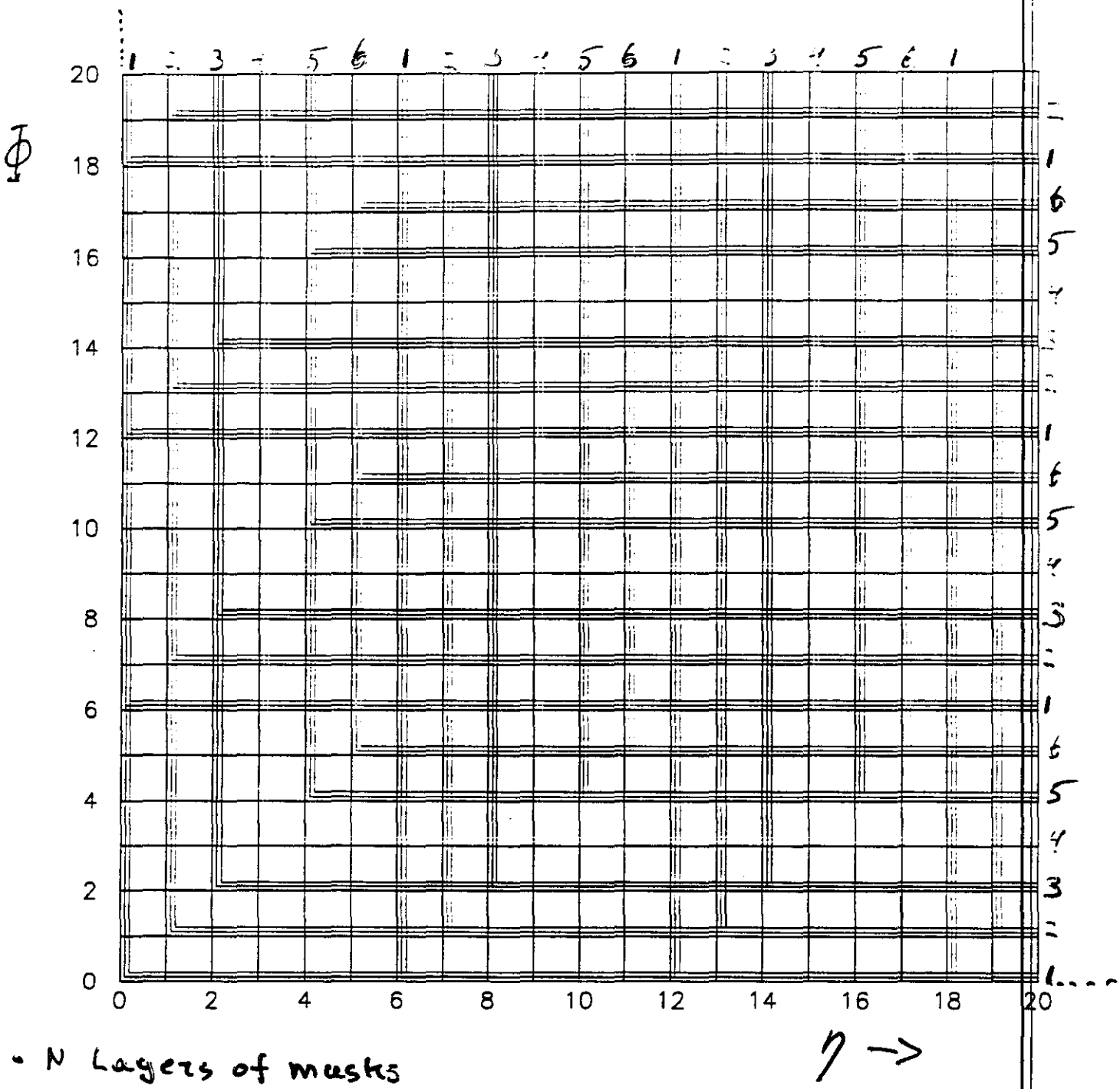
3) Jets are interesting, determine: ϕ, η, E_t, R

Algorithm: Based on the UA1 Jet trigger:




92/12/02 16.01
E_T
10^2
10
1
η
70
60
50
40
30
20
10
10
20
30
40
50
60
70
80
Φ
Phi/eta energy lego

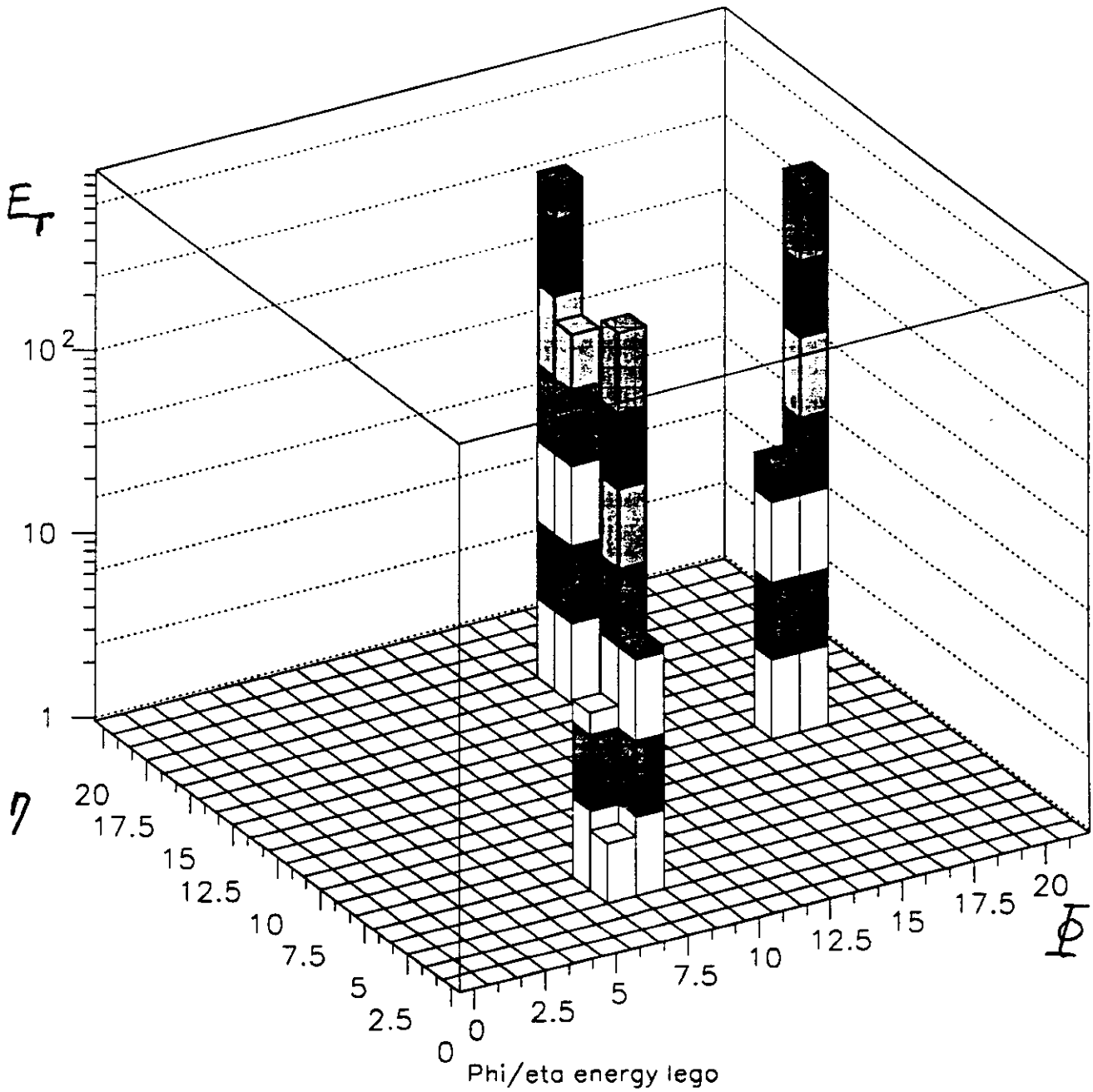
Masks on LEGO plot



- N Layers of masks
- Size = Jet Radius (0.3; 0.5; 0.7) { too big : 2 jets will be merged. / too little: jets will be cut into pieces
- Direction only ↗ or also along η or φ ?

Lego plot ~~[illegible]~~ after masks have been applied.

92/12/02 16.01

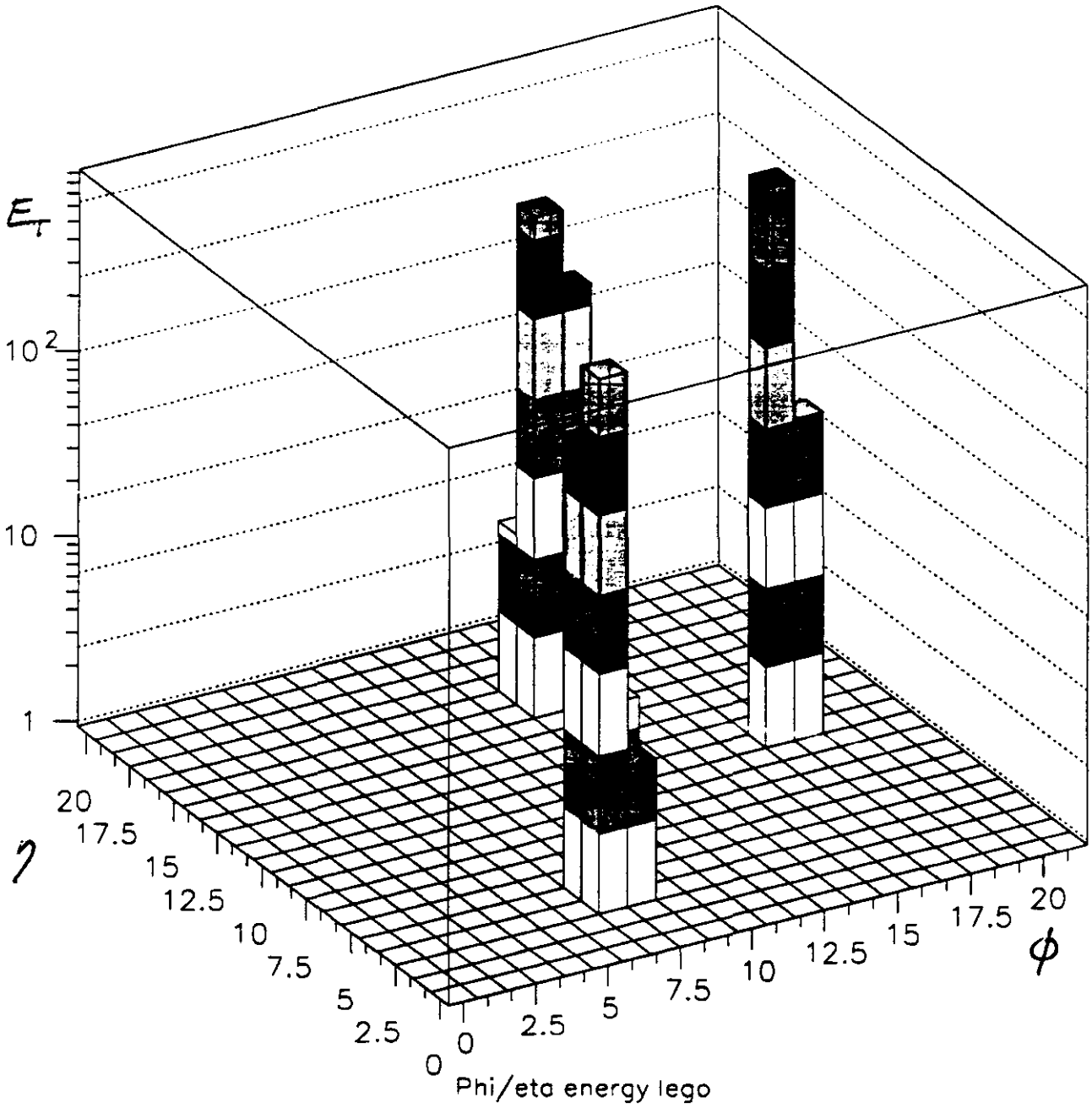


<u>Candidates</u> :

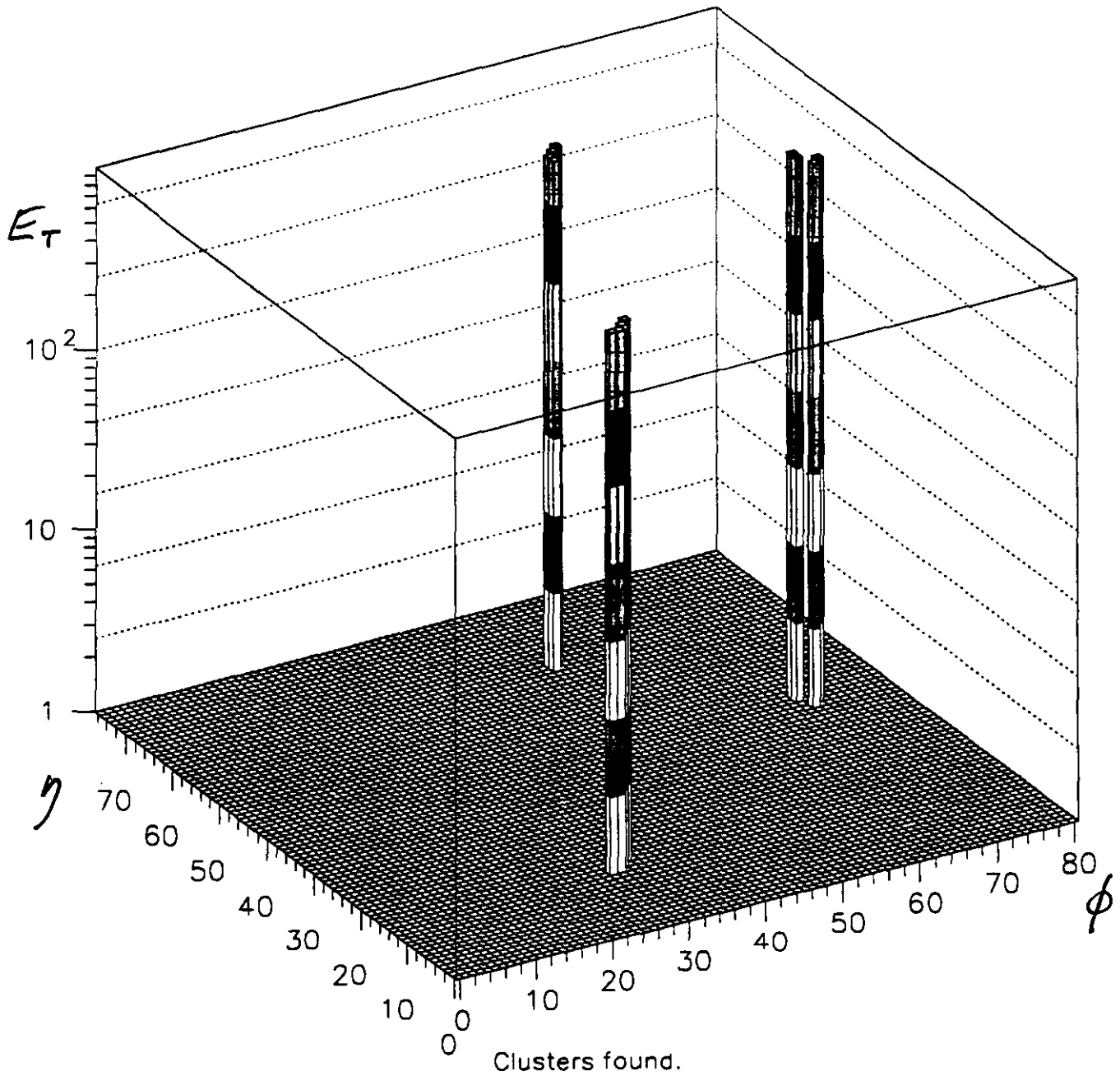
- $E \geqslant$ threshold
- $\begin{cases} \sum_{NB} E < \alpha \cdot E_{mask} & : (\alpha \approx 5\%) \quad \text{Candidate in 1 mask-cell.} \\ \sum_{NB} E > \beta \cdot E_{mask} & : (\beta \approx 95\%) \quad \text{Not a candidate} \\ \text{Else} & : \quad \text{Candidate in} \geqslant 1 \text{ mask-cell.} \end{cases}$

LEGO plot

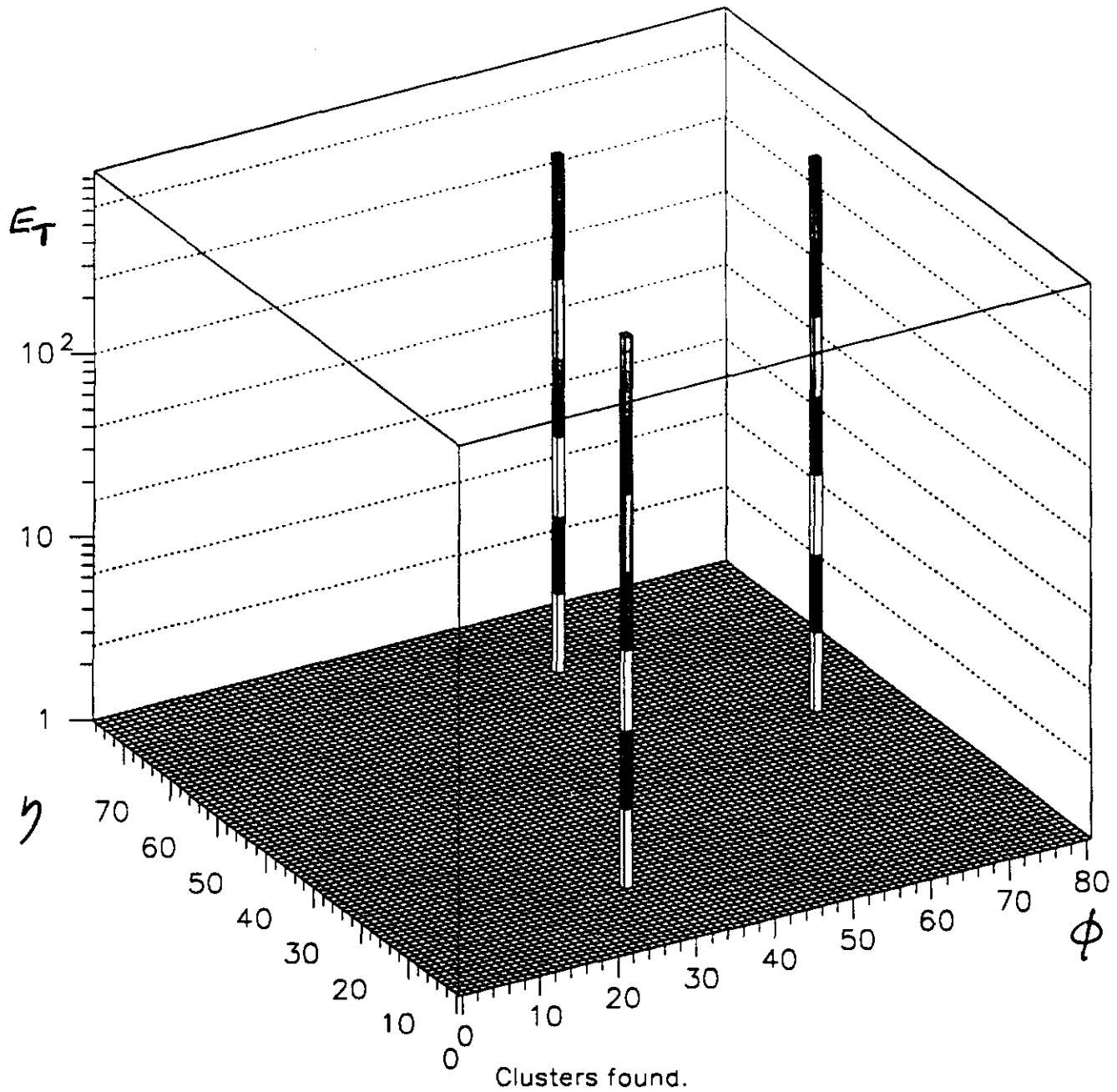
92/12/02 16.01



92/12/02 16.02


E_T
10^2
10
1
η
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
ϕ
Clusters found.

92/12/02 16.02



Clusters found.

[illegible]

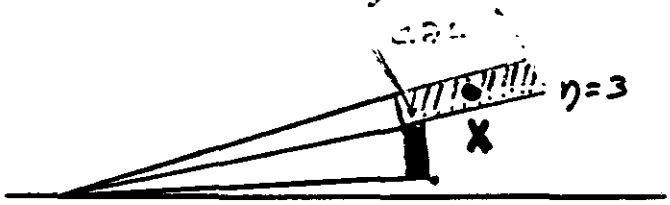
Input
- 1 to 8 quarks with random ϕ, η, E, [illegible] fragmented.
- $|\eta| \leq 3$, $0 \leq \phi \leq 2\pi$, $10\,\text{GeV} \leq E \leq 10\,\text{TeV}$

$\Rightarrow$ 1 to 8 uncorrelated jets.

Quark & JET

Φ: Perfect.

η: Problems at $\eta \approx \pm 3$. (Intrinsic problem of the algo).

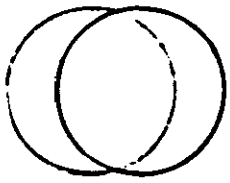


E_T: PERFECT.

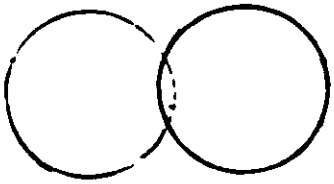
Any difference between E_{quark} and E_{JET} due to CAL RESOLUTION.

Multi Jet events:

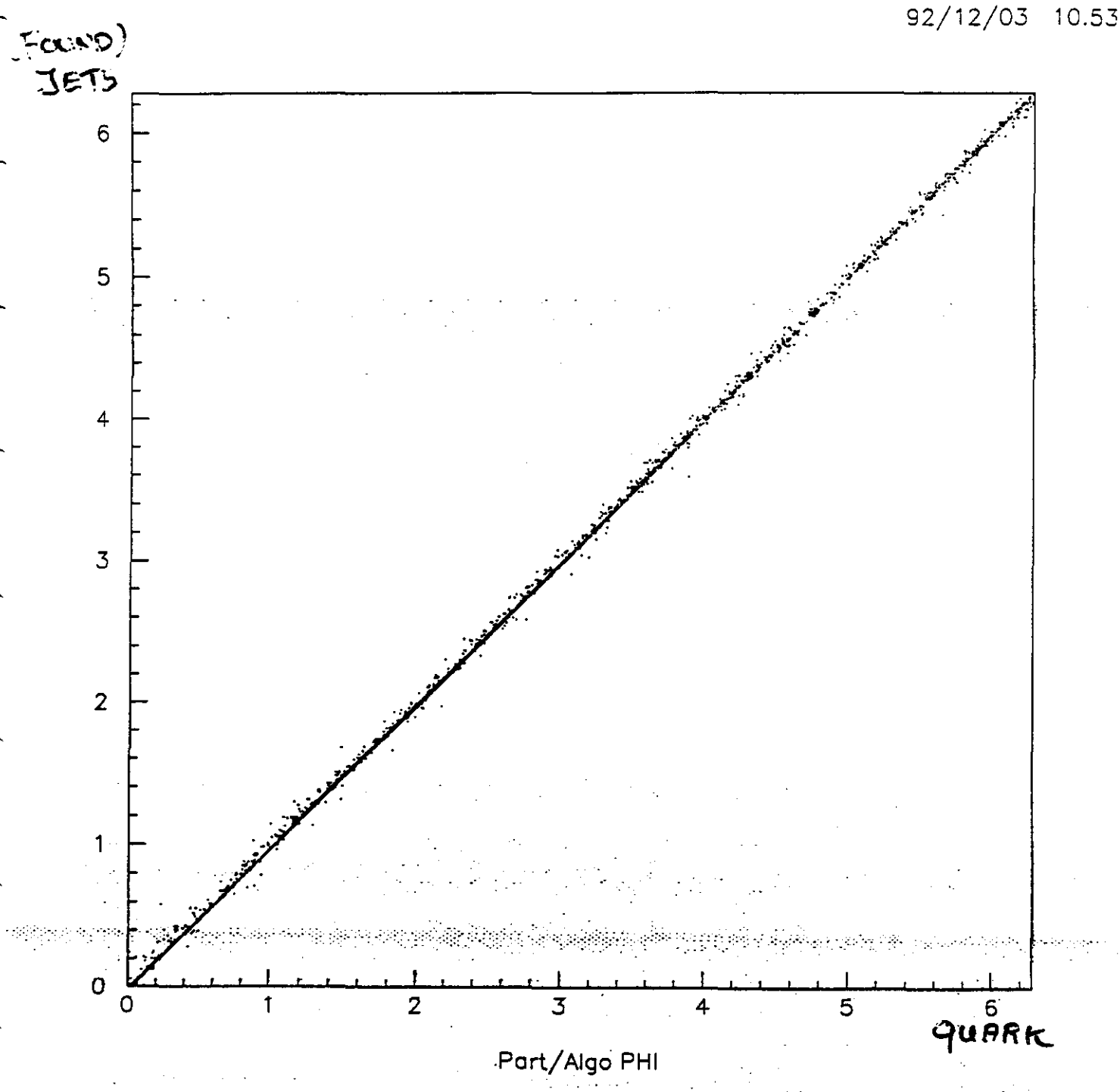
- Looks ok.
- 4 JETS : 75% chance of finding all 4 jets
  95% " " " at least 3 } CONE = 0,5
- slightly better for 0,3 cones, slightly worse for 0,7 cones
- Further improvement by more refined overlapping criteria



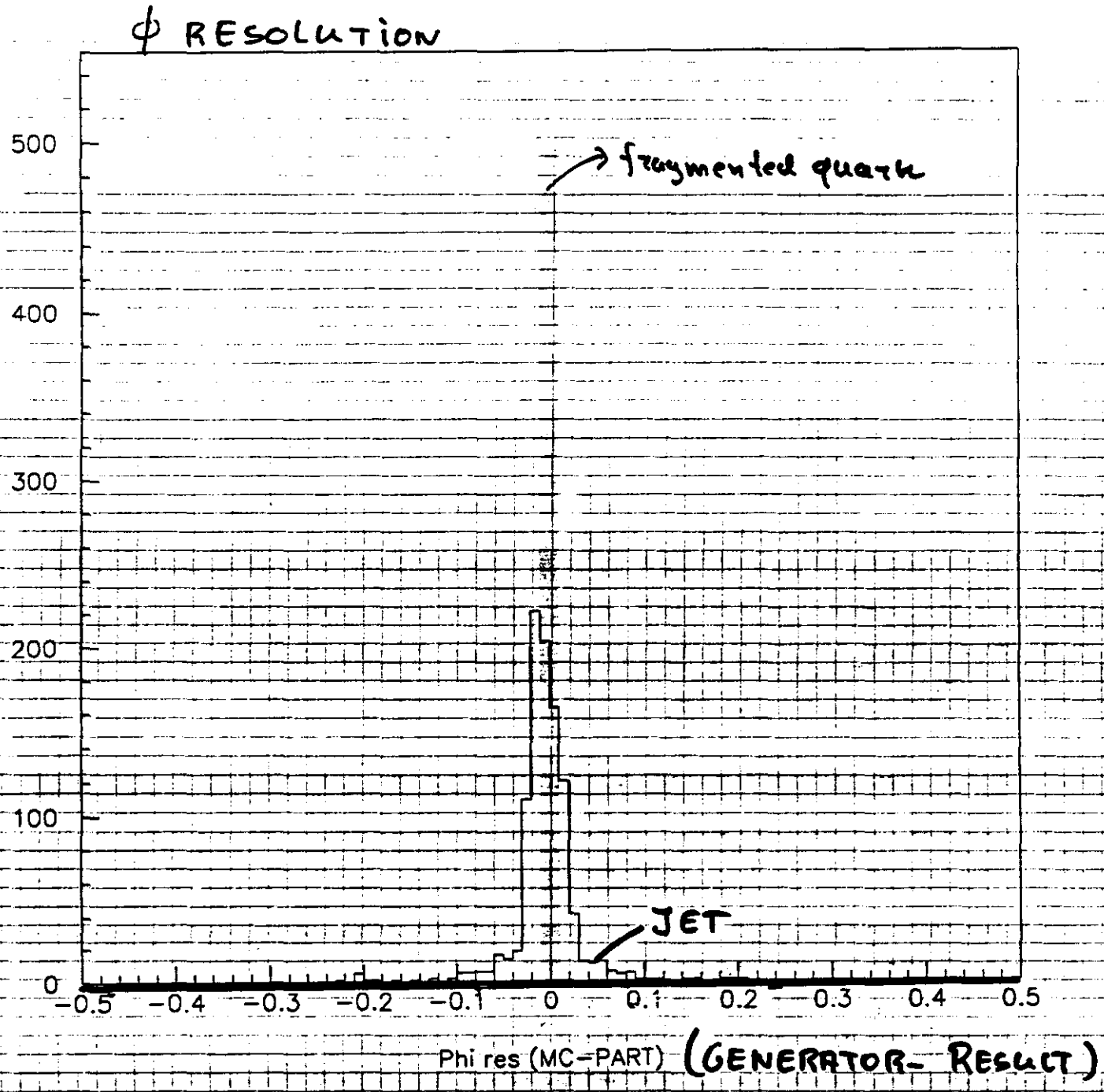
: 1 jet



: 1 jets
2 touching??

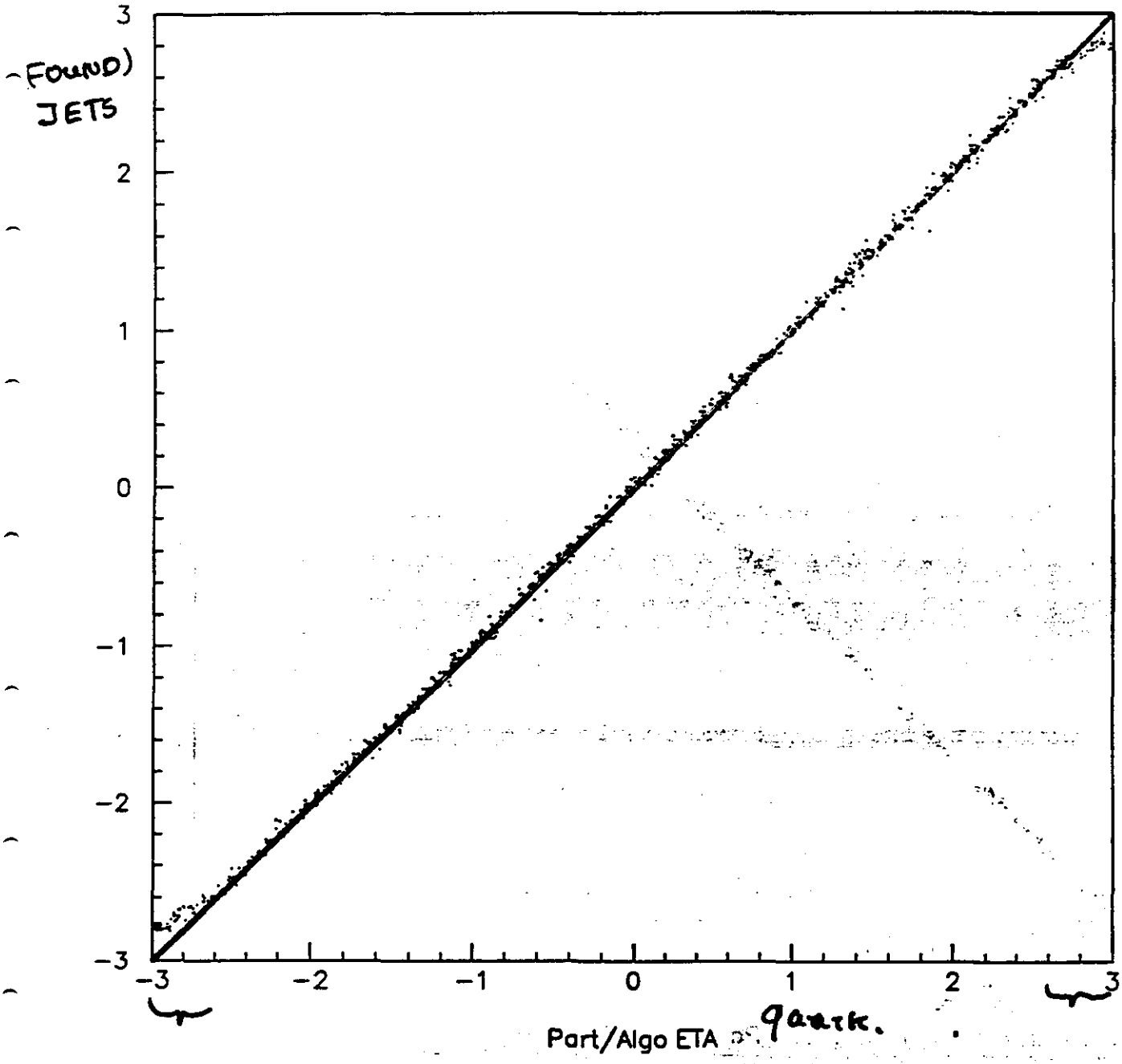

92/12/03 10.53
(FOUND) JETS
6
5
4
3
2
1
0
0
1
2
3
4
5
6
QUARK
Part/Algo PHI

92/12/03 14.51


φ RESOLUTION
500
400
300
200
100
0
fragmented quark
JET
−0.5
−0.4
−0.3
−0.2
−0.1
0
0.1
0.2
0.3
0.4
0.5
Phi res (MC−PART)
(GENERATOR- RESULT)

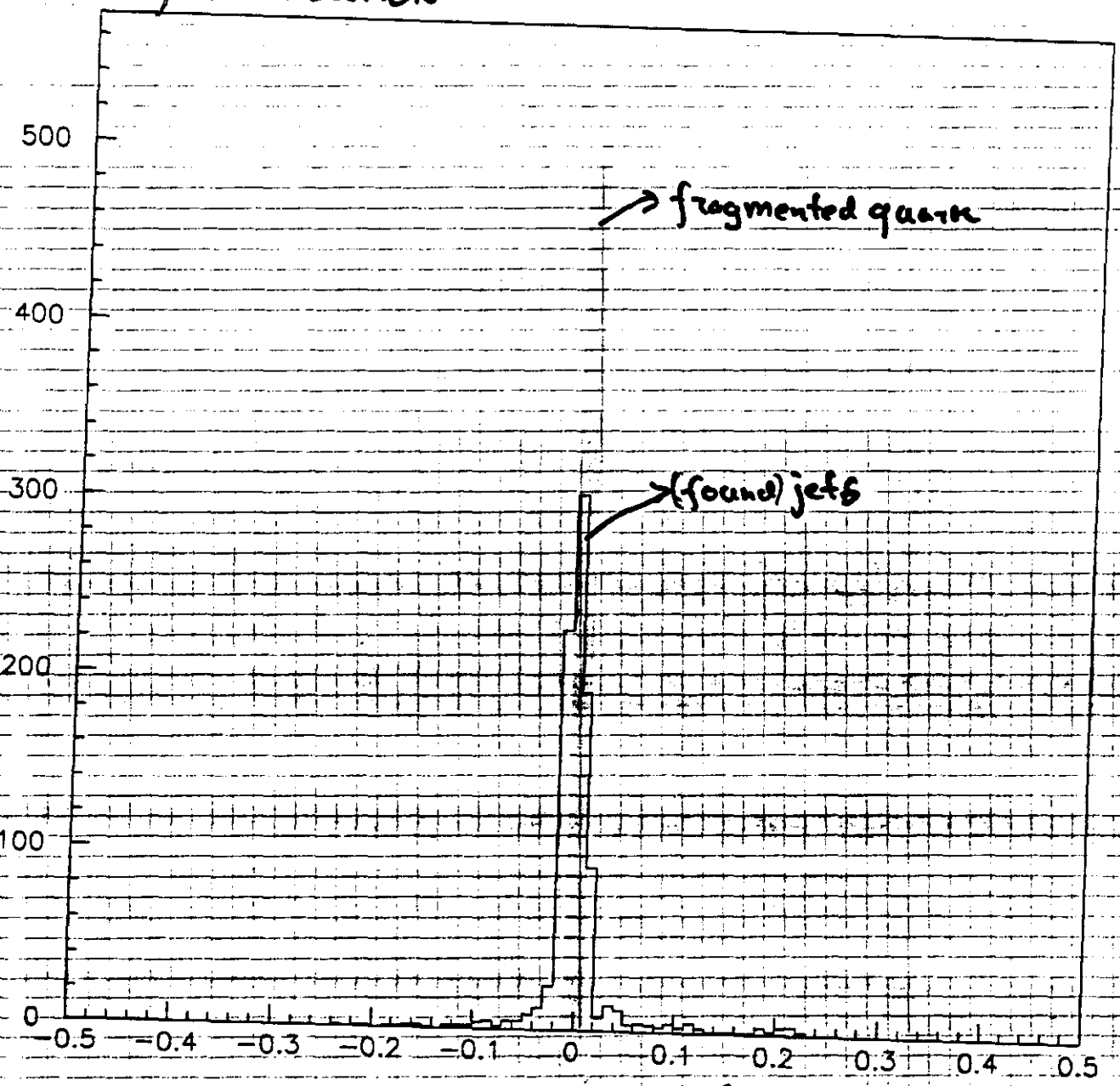
η of quark & Jet.

92/12/03 10.53



92/12/03 14.51

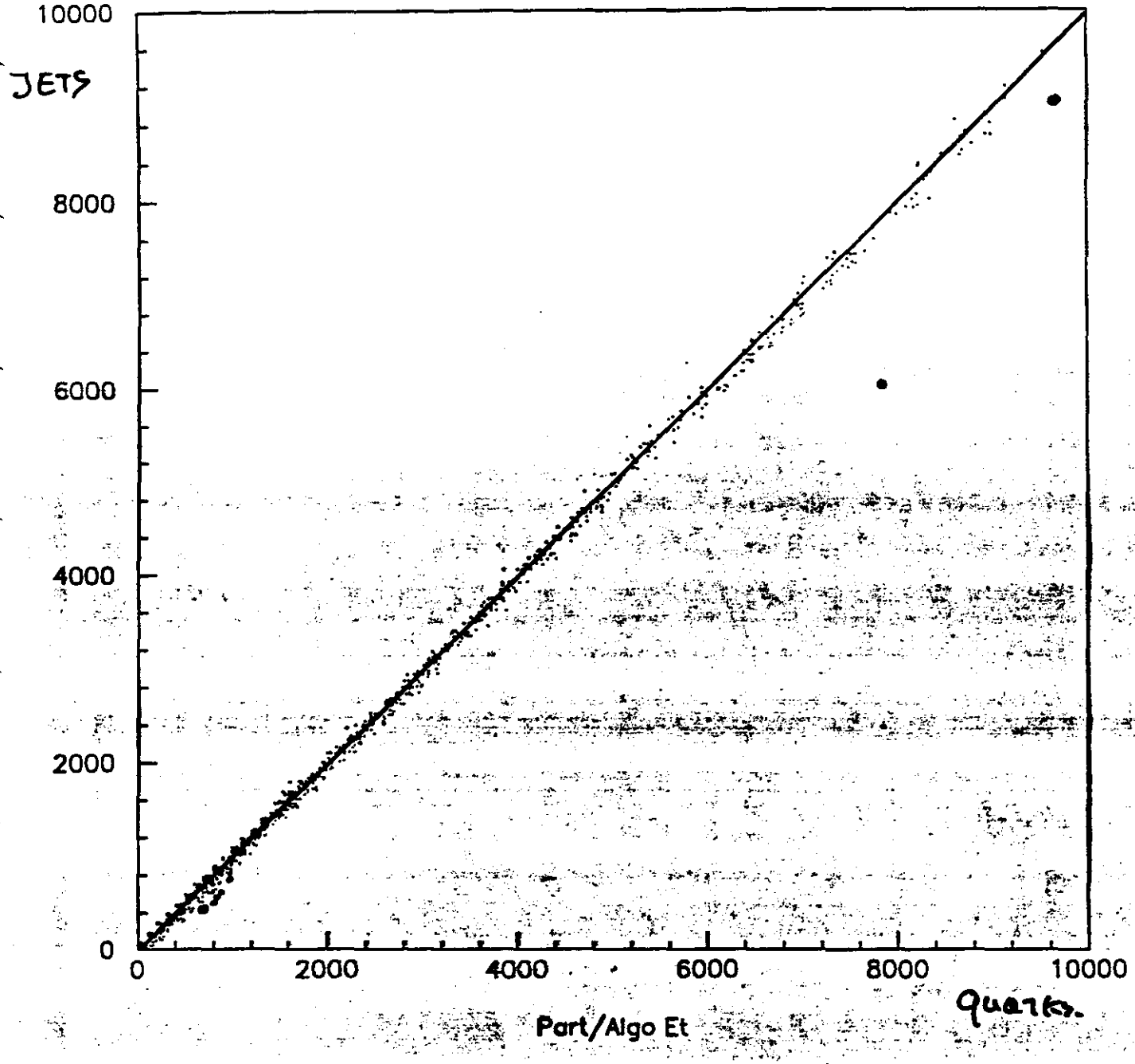
η RESOLUTION



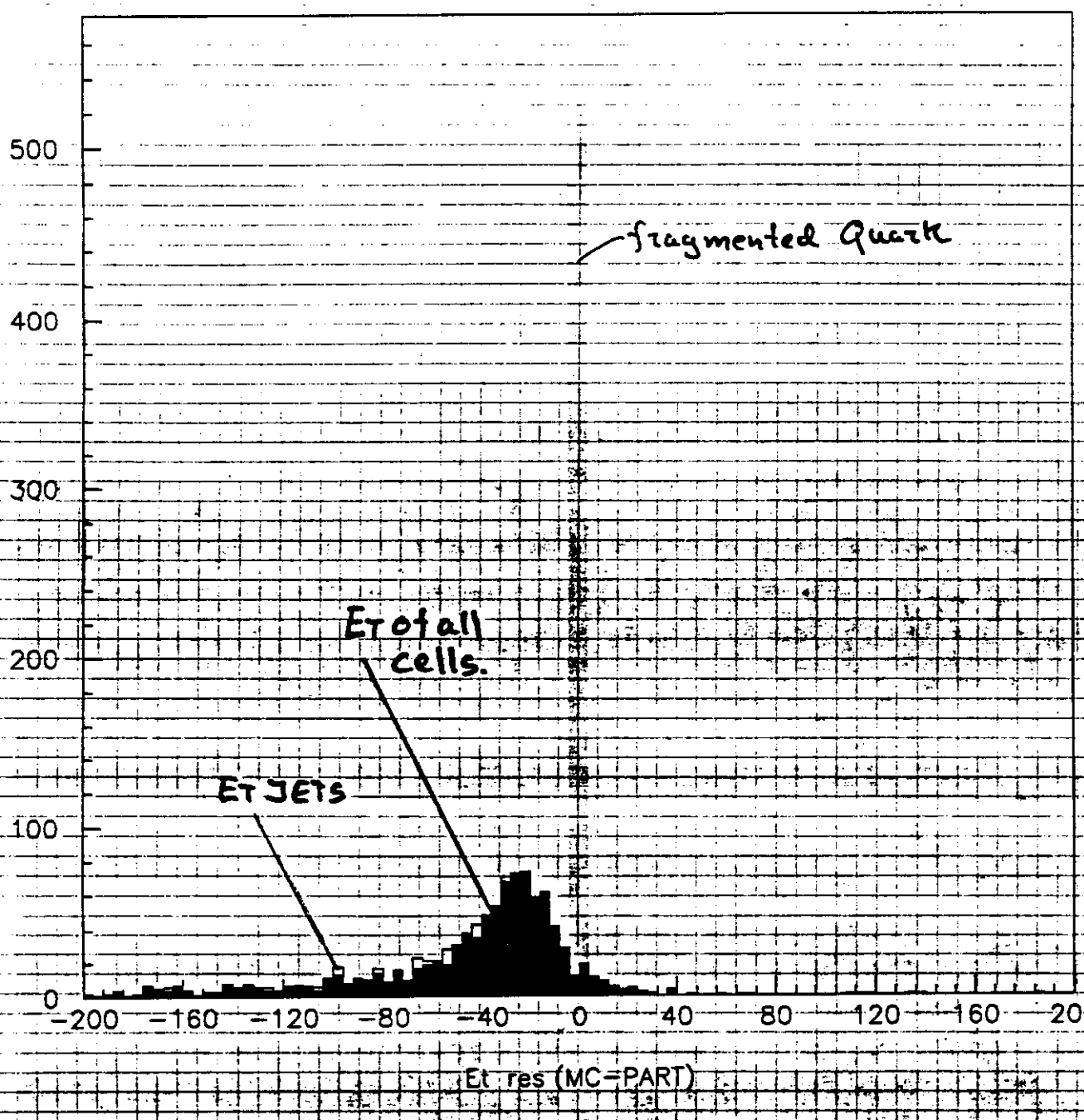
(GENERATOR−RESULT)

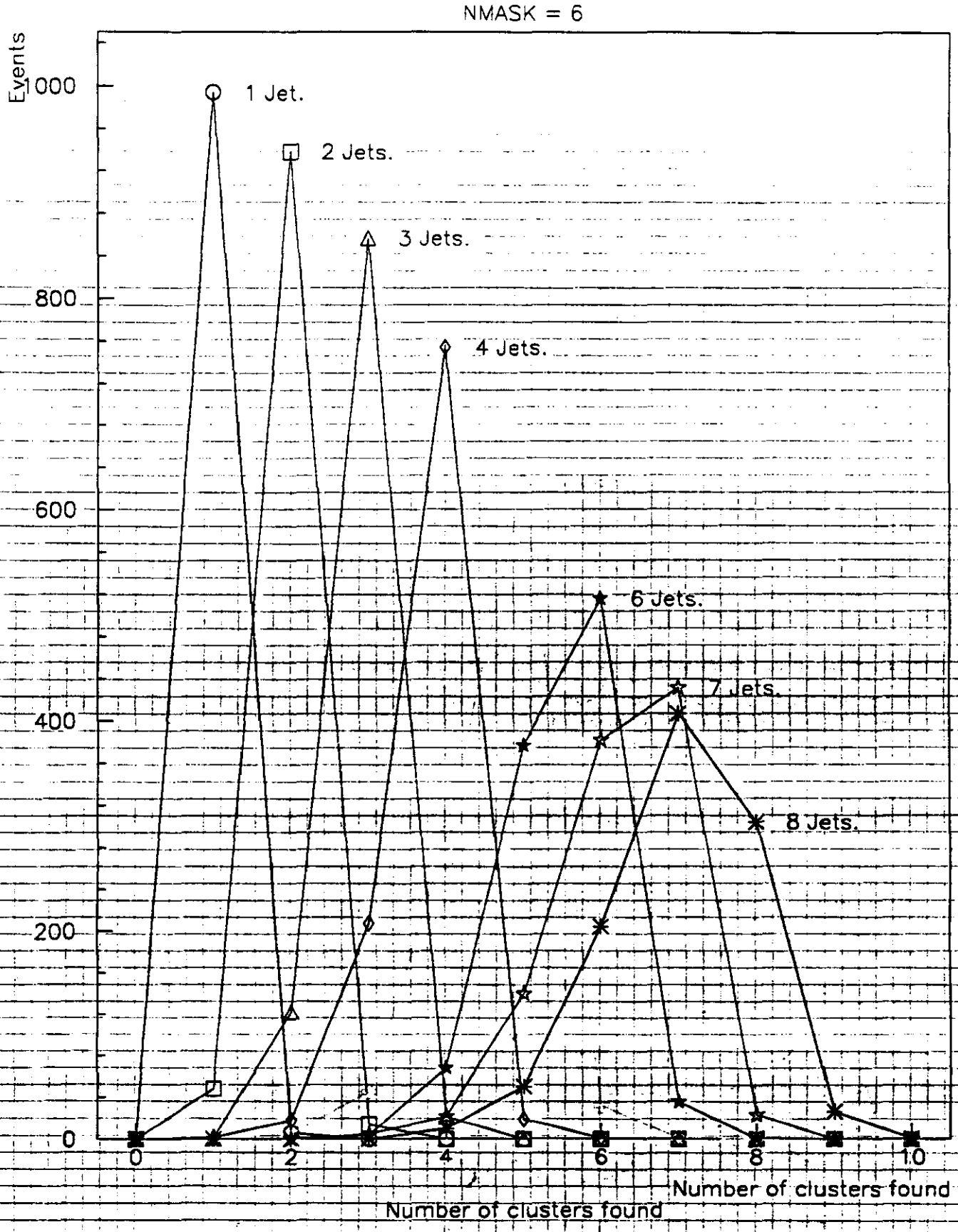
E_T of quark & JET

92/12/03 10.53

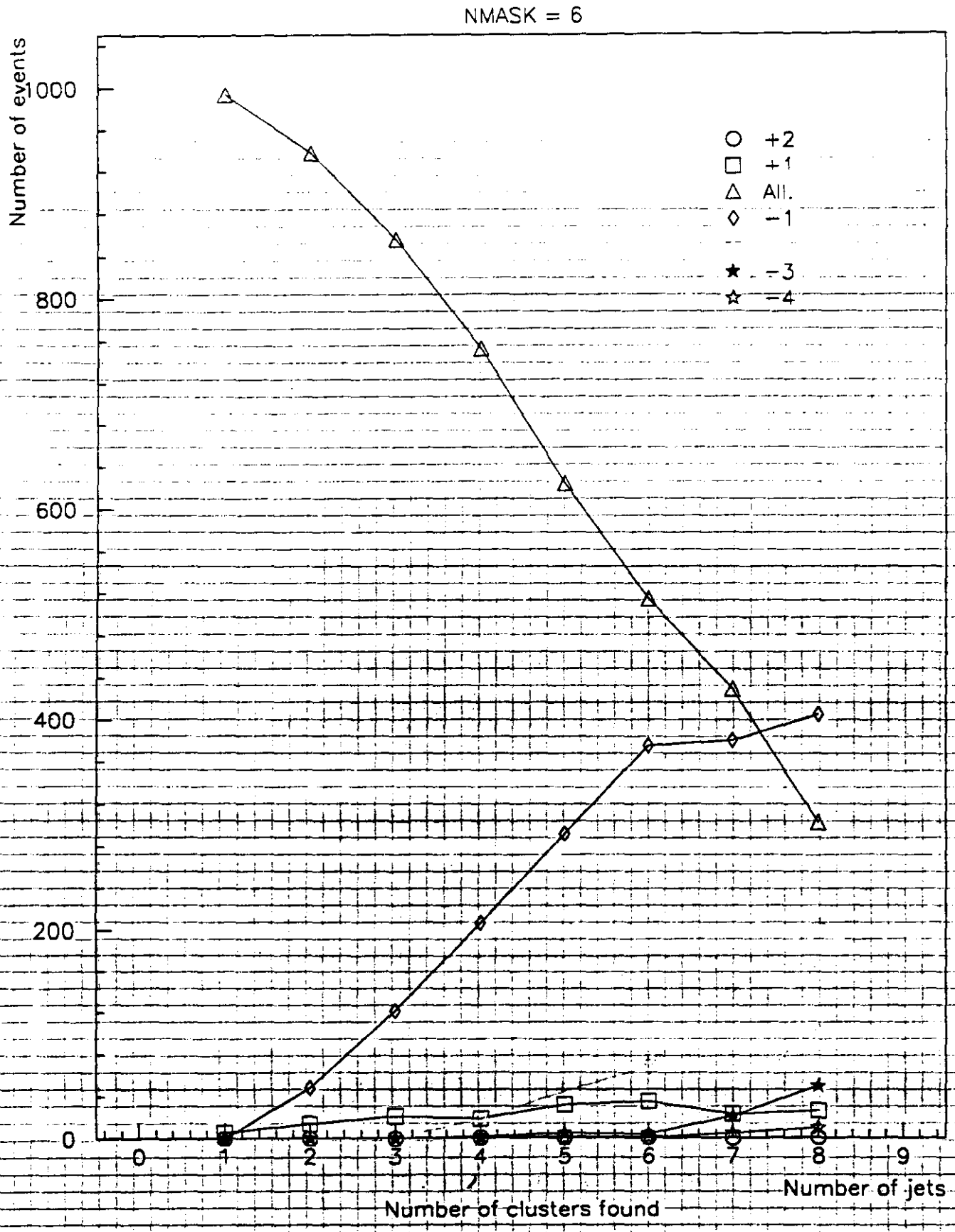


92/12/03 14.51


500
400
300
200
100
0
fragmented Quark
ET of all cells.
ET JETs
−200
−160
−120
−80
−40
0
40
80
120
160
200
Et res (MC=PART)



Number of clusters found


NMASK = 6
Number of events
1000
800
600
400
200
0
+2
+1
All.
−1
−3
−4
0
1
2
3
4
5
6
7
8
9
Number of jets
Number of clusters found

Processing Time.

VERSION 1 : 0.25 s/Event on HP in PDSF

- Finds JETS
- Looping over data, Multi-Dim. Arrays, Error-checks, calculate addresses for each event, ...

VERSION 2 : 25 ms/Event on HP in PDSF.

- Does not find jets, only executes the necessary processor instructions.
- Lookup-tables, 1DIM arrays, no error-checks.

@ L2 : 100 kHz, 1000 processors ⇒ 10 ms/Event.

CAL-L2 : 2.5-5 ms

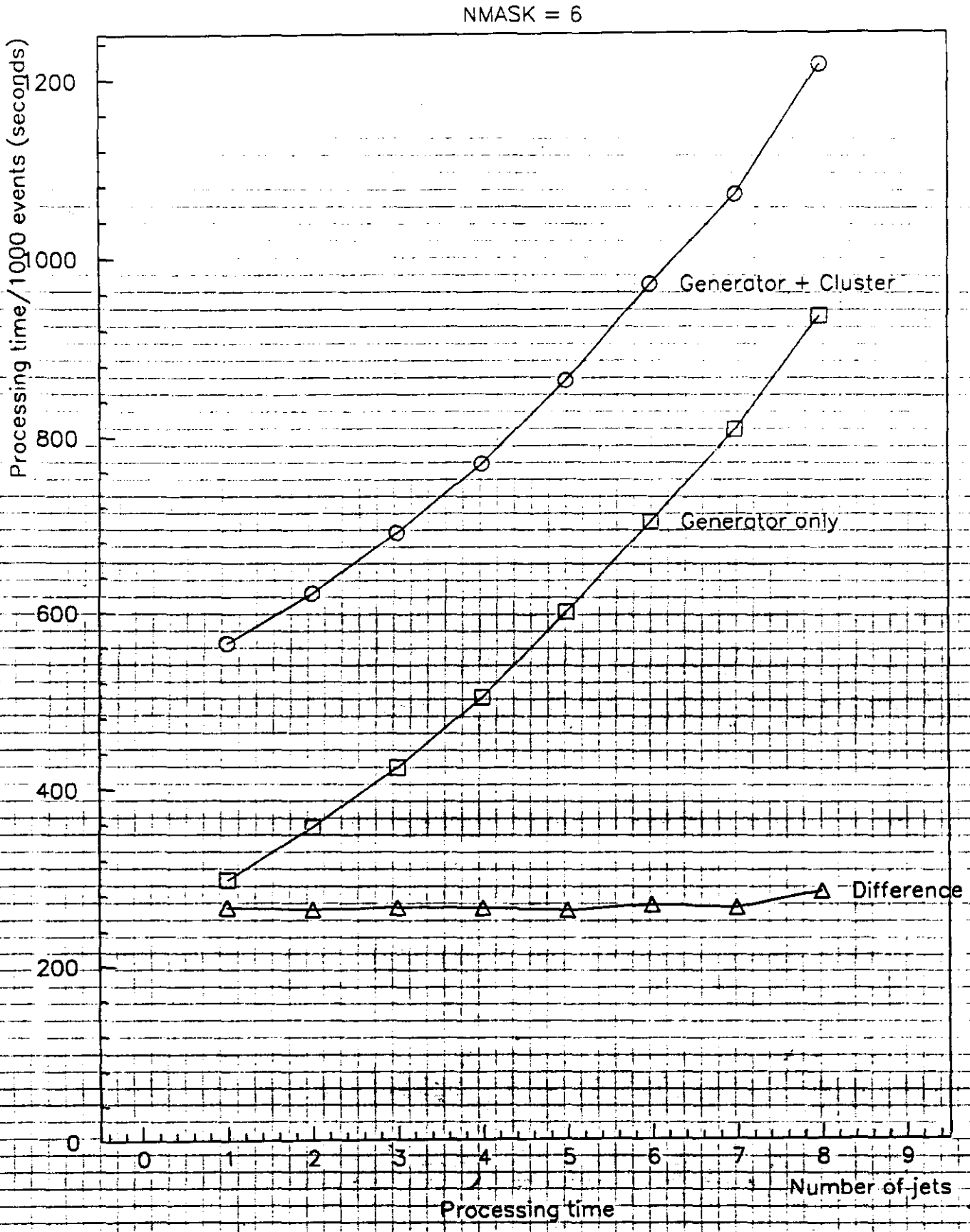
Factor 5 to 10 improvement needed.

NEXT STEPS.

1) MERGE the two versions of the algorithm.
2) Baseline II version.
3) Corrections in y, ϕ_i.
4) Cluster merging.
5) Effects of #MASKS (cluster radius), thresholds, etc.

6) TEST with Jet-JET events.

7) $\not{E}_T$ from jets only.
8) Effects of reduced input data; for example only L1 towers.
9) ....


NMASK = 6
Processing time/1000 events (seconds)
1200
1000
800
600
400
200
0
Generator + Cluster
Generator only
Difference
0
1
2
3
4
5
6
7
8
9
Number of jets
Processing time

CONCLUSION:

This jet finding algorithm works in principle but there's still a lot of work to be done.

gem

γeμ

Presentation by:

J. Womersley

LIST OF CALORIMETER SIMULATION TASKS

'Full' means tasks that require a fully detailed level of simulation within GEANT, though not necessarily for the full GEM configuration. Full simulation geometries should be created for the accordion (basically done by Ma and Seman), and for the hadronic layers behind.

'Mixture' means tasks that can be performed with a 'mixtures' level of simulation (individual modules replaced by single materials) within GEANT, modelling of the full GEM detector being required.

EM:

1) Gamma resoloution as a function of eta. (Full)
   a) Variable density of Pb. — Misha Leltchouk
   b) Massless Gap. — Misha Leltchouk

2) Accordion structure. (Full)
   a) geometry beta/delta — Michael Seman
   b) Field effects. — Iuliu Stumer

2) Pointing resolution as a function of eta. (Full)
   a) Granularity — Jean-Yves Hostachy
   b) Longitudinal segmentation.

3) Gamma/jet rejection as a function of eta. (Mixture and Full)
   a) Shower shape — Hong Ma
   b) Fine theta granularity (strips) — Misha Leltchouk

Use of the first hadronic section to optimize the Isolation cut. Here we can see what the optimal transverse granularity is. This is both for isolated gammas and for electrons near the jet axis.

4) Optimization of Jet rejection.
   Using existing structure. — S.Vanyashin

5) Gamma resolution at very high energies. Use of the first hadronic section as a tail catcher. (Full)

6) Acceptance. (Mixture)
   How far in eta must be covered. eta=1.1 transition.

Hadronic sections:

1) Single particle resolution and linearity of liquid section (Full)
   --- what segmentation is needed?
   Washington, Rochester?
2) Single particle resolution and linearity of scintillator section (Full)
   --- how to unfold timing resolution?
   --- what is two track response?
   Oak Ridge
3) Single Particle and Jet resolution of combined system
   as a function of eta.
   (Mixture may be OK, may need full)
   --- Weighting schemes. Can weights be made independent of E, eta, particle type?
   --- jet-jet mass resolution, esp. impact of scintillator (Mixture)

4) Maybe need specialized e/pi simulation? Do we believe GEANT?
   GEANT 3.14 will predict liquid argon e/pi to 0.05.
   Krypton is untested.
   CALOR89 predicts e/pi to 0.03 in D0. Maybe we need to get Mississippi people (Brent Moore) involved here.

5) Missing E_T for the whole detector. (Gemfast, Mixture) Mike Shupe
   Here the emphasis is on the Dead material due to the cryostats, also cableways and the eta=1.5 and eta=3 transitions.

6) Missing E_T for the forward Cal. (Gemfast, Mixture) Mike Shupe
   Here the empahsis is on the Forward Cal performance and beam pipe.

7) Neutron problem of the forward cal. L. Waters/Nelson Desilva.
   C. Zeitnitz (Arizona) will help.

Muons

(list of questions from Peter Dingus)

1) Muon identification in liquid section
   --- is the noise low enough to see (80 MeV/cell) MIPs?

2) Muon identification/triggering in scintillator section

3) What level of multiple scattering do we get in the calorimeter?
   --- Cu vs Pb

4) Muon catastrophic energy loss:
   --- can the energy be recovered? How well does it need to be measured in the scintillator calorimeter? Do we really need time structure for isolated muons?
   --- is the muon ever confused with a jet punching through?

5) Is 12 λ really needed? Or is it better to curl up tracks in air?

Note: TDR date is now April 30, 1993