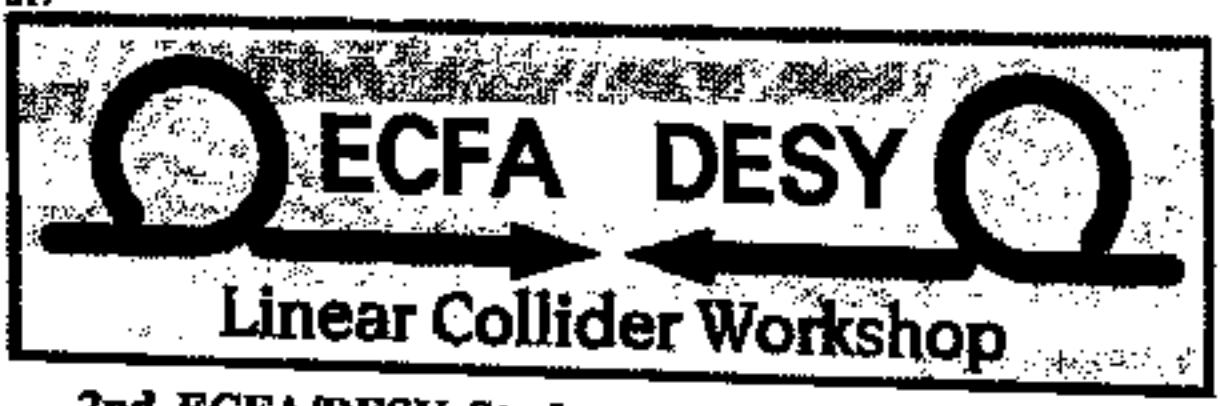
S17



2nd ECFA/DESY Study on Physics and Detectors for a Linear Electron-Positron Collider

LAL - Orsay - France, April 5-7, 1998

Date : April 6, 1998 - 16:45

Parallel groups to plan tasks :

Detector Simulation

Detector Simulation

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- Aim: To produce a working Geant-based detector description. (Geant 3 initially)

- Basis: CDR detector parameters

- Fix parameters for initial physics studies
  - maintain some flexibility for detector studies.

- Distribute responsibility (volunteers ?) for more accurate sub-detector description.

What exists so far?

- Basic Geant description of Calorimeter
  - projective geometry:
    - advantages: easy to define & modify
    - disadvantage: not realistic?
      - does this matter for initial studies?
    - no cracks - should we define how to treat these at this stage?
  - Calorimeter towers:
    - full geometry (planar) available
      - good for detailed studies
      - bad for generation (very slow)

      → need to define a "porridge" Calorimeter + Smearing → work in progress (G.S).

- Tracking detectors

  not yet implemented (volunteers?)
  ↳ Put 'present' as material.

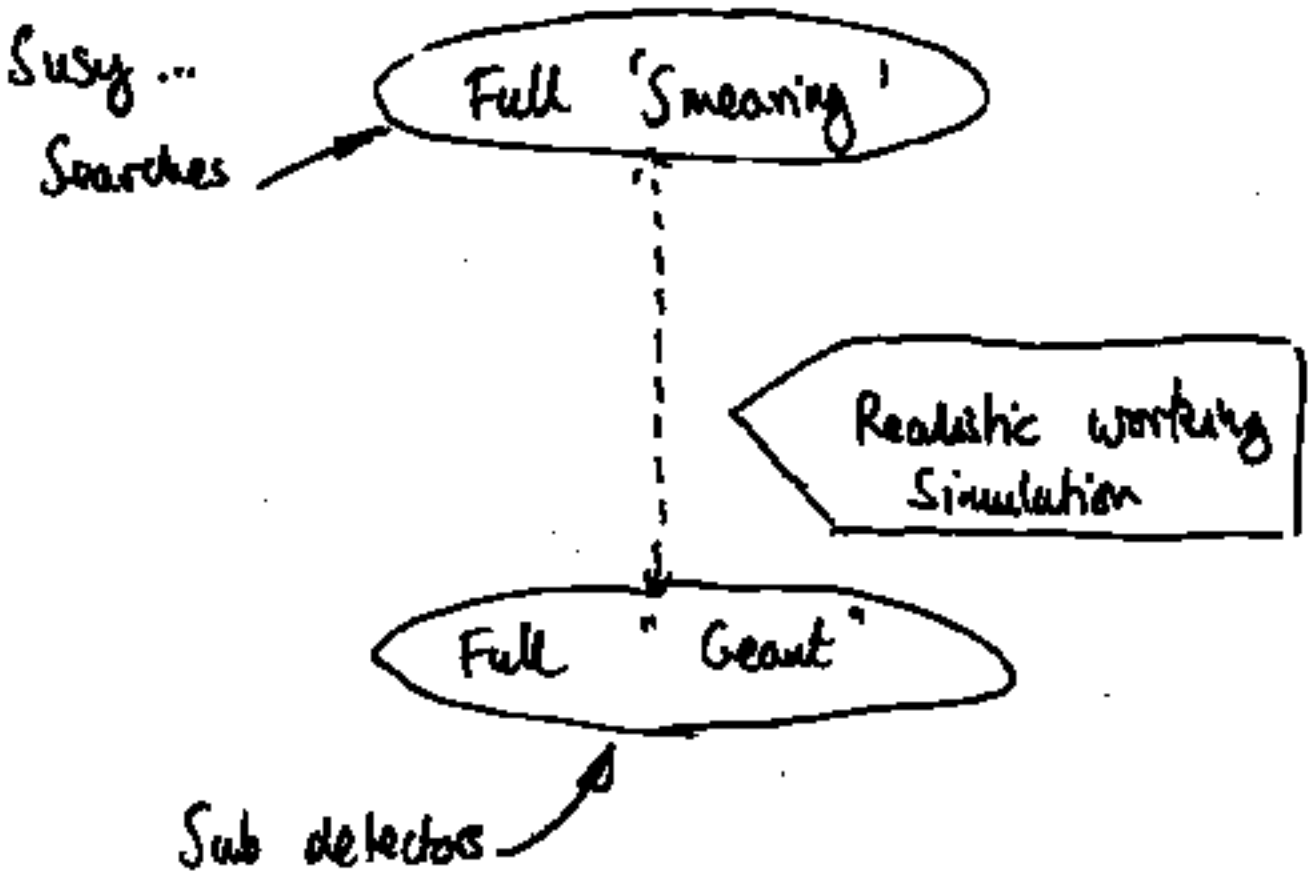
  VXD needs expert treatment.

- Luminosity detector – not yet present
  – again, needs an expert.

- Muon detection – needs an expert
  – how much detail do we require here?

- Cracks + cables etc – what detail should we demand at this stage?

Other!:



Where the arrow lies will be a function of effort.

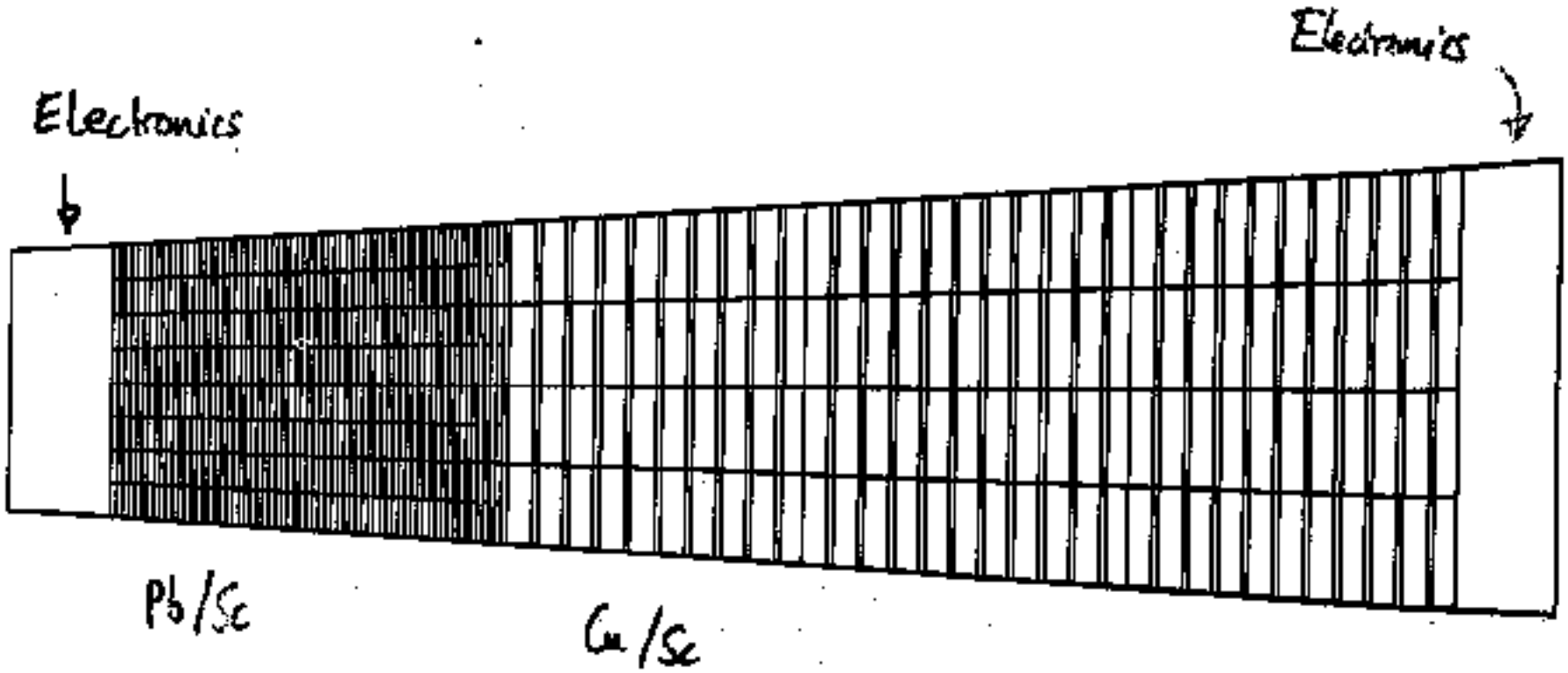
Important issues to discuss:

- Event format + Code management
- Energy flow output (what degree of detail?).
- What about 'standard' background generation? – Could save a lot of effort in the long run ...

Summary

- Work has begun on coding the CDR detector into a workable Geant description.
- Much work needs to be done on more detailed sub-detector description (anyone is very welcome to contribute).
- The sooner we get our physics groups playing with a 'real' detector, the better.
- We can hope to have a first working version to complement the 'SIMDET' approach within a couple of months (?) — depends on input of effort

join in!



Projective cells . 3 Longitudinal ECAL/HCAL

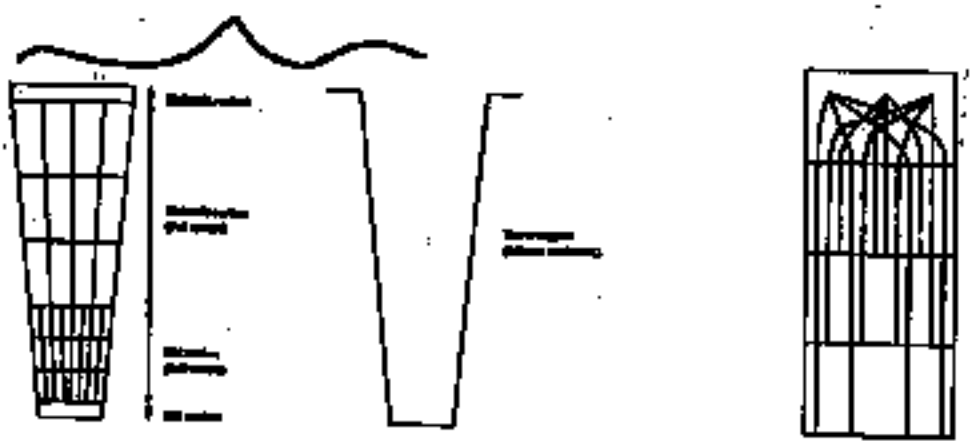
ECAL 8×8 cells transverse

HCAL 4×4 " "

Implemented

not implemented.

(yet...)



Gross Dimensions input to Geant.

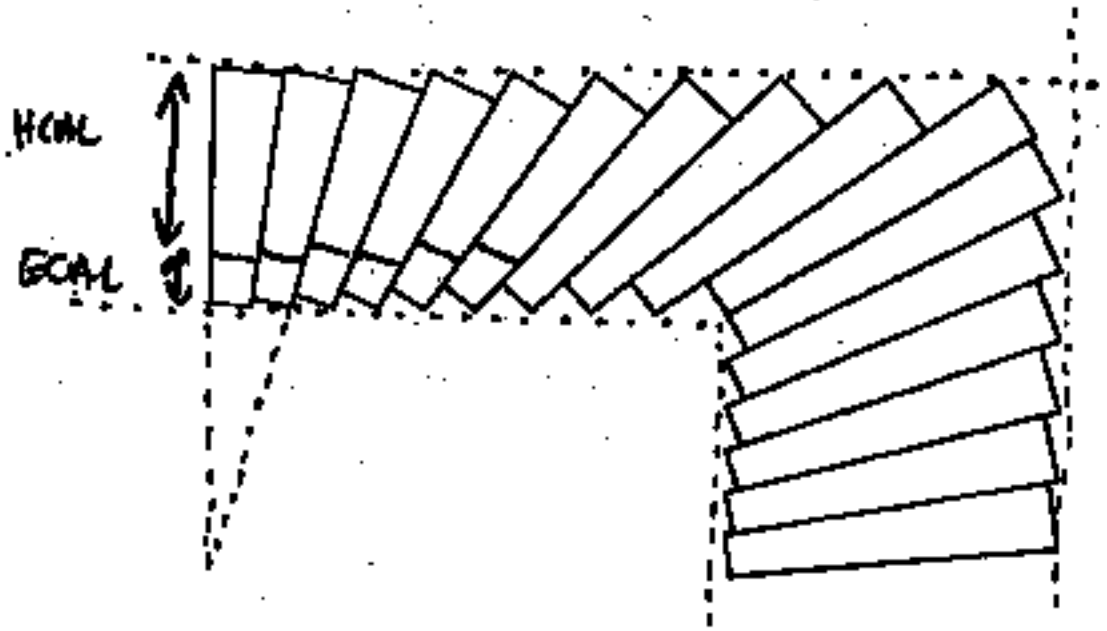
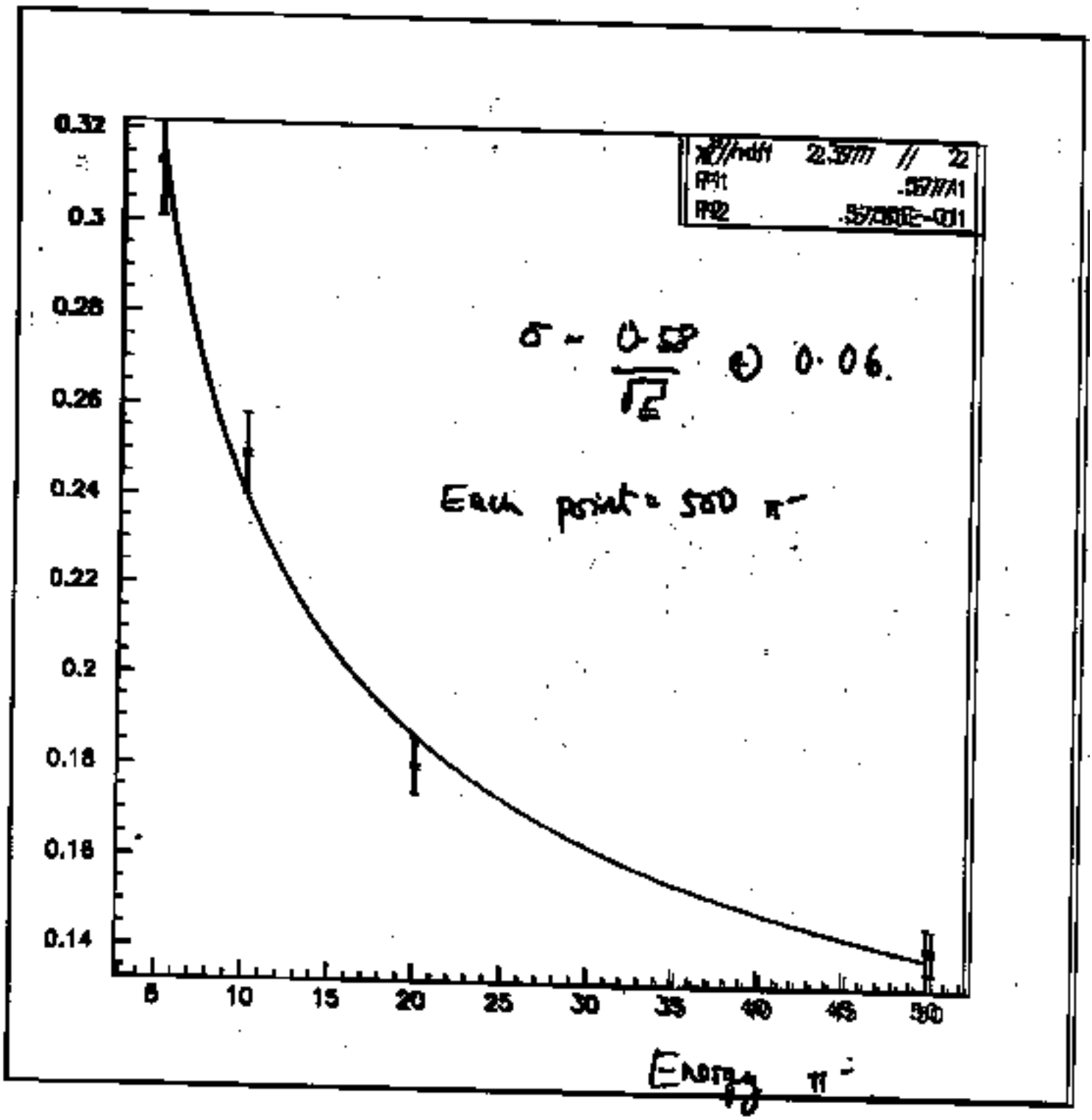


Figure 2.2.9: *Schematic drawings of a Shashlik supertower (top left), of the steel band support (top center), of the WLS readout fibers (top right) and of the arrangement of the rings of supertowers(bottom).*

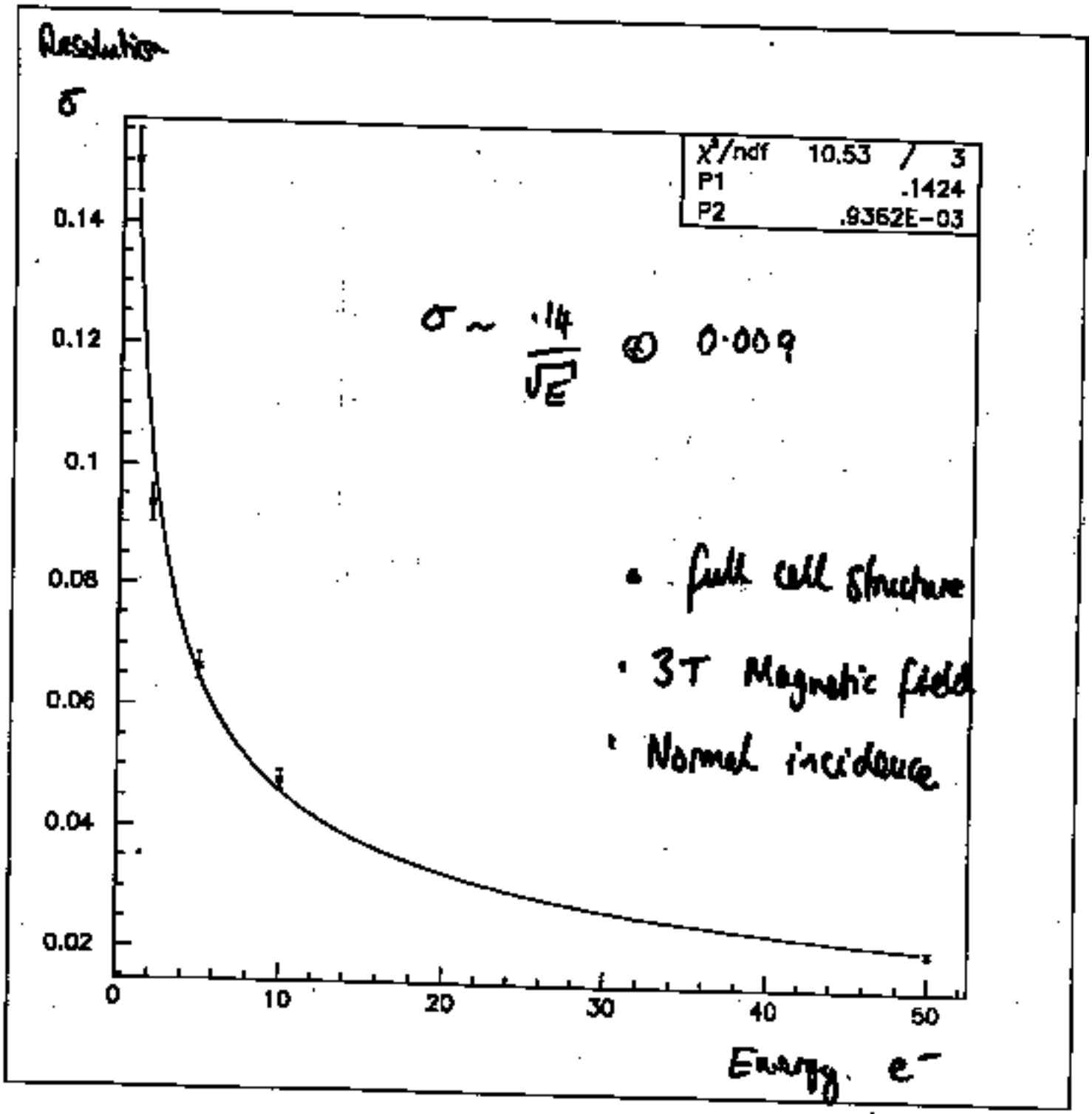
projective tower.

HCAL – Single pions



Very approximate compensation – so results v. preliminary.

ECAL



Each point represents 500 generated particles.

Summary of initial Calorimeter Studies:

- Much good work was done for the last workshop (C. Issi et al.)

  → ECAL $\frac{\Delta E}{E} \sim \frac{0.10}{\sqrt{E}} \oplus 0.01$

  HCAL $\frac{0.50}{\sqrt{E}} \oplus 0.04$.

- New studies involving full magnetic field & projective geometries reach similar, but not identical (statistics?) conclusions

  Work in progress ...

- A combination of full Geant / detector smearing will probably be the way to go.

Detector Simulation for LC98

M. Pohl, ETH Zürich

Orsay

April 5-7, 1998

- Do we need detector simulation and for what?
- Which detector(s) do we simulate?
- Simulation tools
- Input interface
- Output interface

Do we need detector simulation?

Detector simulation vs parametric MC:

Pros:

- **Parametric MC does not simulate granularity (calorimeters)**
- **Difficult to implement variations of resolution with phase space (conversion, multiple scattering, dead material etc.)**
- **Correlations generally ignored (double track resolution, lepton isolation etc.)**
- **Performance estimates generally optimistic**

Cons:

- **CDR detector is idealistic anyway**
- **No holes, no cracks, no supports, no cables**
- **Detector simulation is useless when there is no reconstruction**
- **Performance estimates generally optimistic**

Detector simulation vs parametric MC

My opinion:

- Need simulation to verify and refine parametric MC
- Need simulation to study granularity and coverage for selected physics cases
- Need simulation to study trigger requirements and trigger detectors
- Should aim for full simulation of a simple CDR detector
- Flexible enough to include (limited amount of) new ideas
- Used as a tool for physics studies, supplementing parametric MC studies

Detector simulation tools

GEANT 3:

- Program available
- Expertise available
- Previous CDR detector implementation available
- More complete detector description under way
- Limited lifetime

GEANT 4:

- Modern concept (OO)
- Much more sexy
- Available for test end of 1998(?)
- No expertise, no model
- Long lifetime

My opinion:

- For this round, use GEANT 3 as production tool
- Set up subgroup to study GEANT 4
- Live with some amount of wasted effort

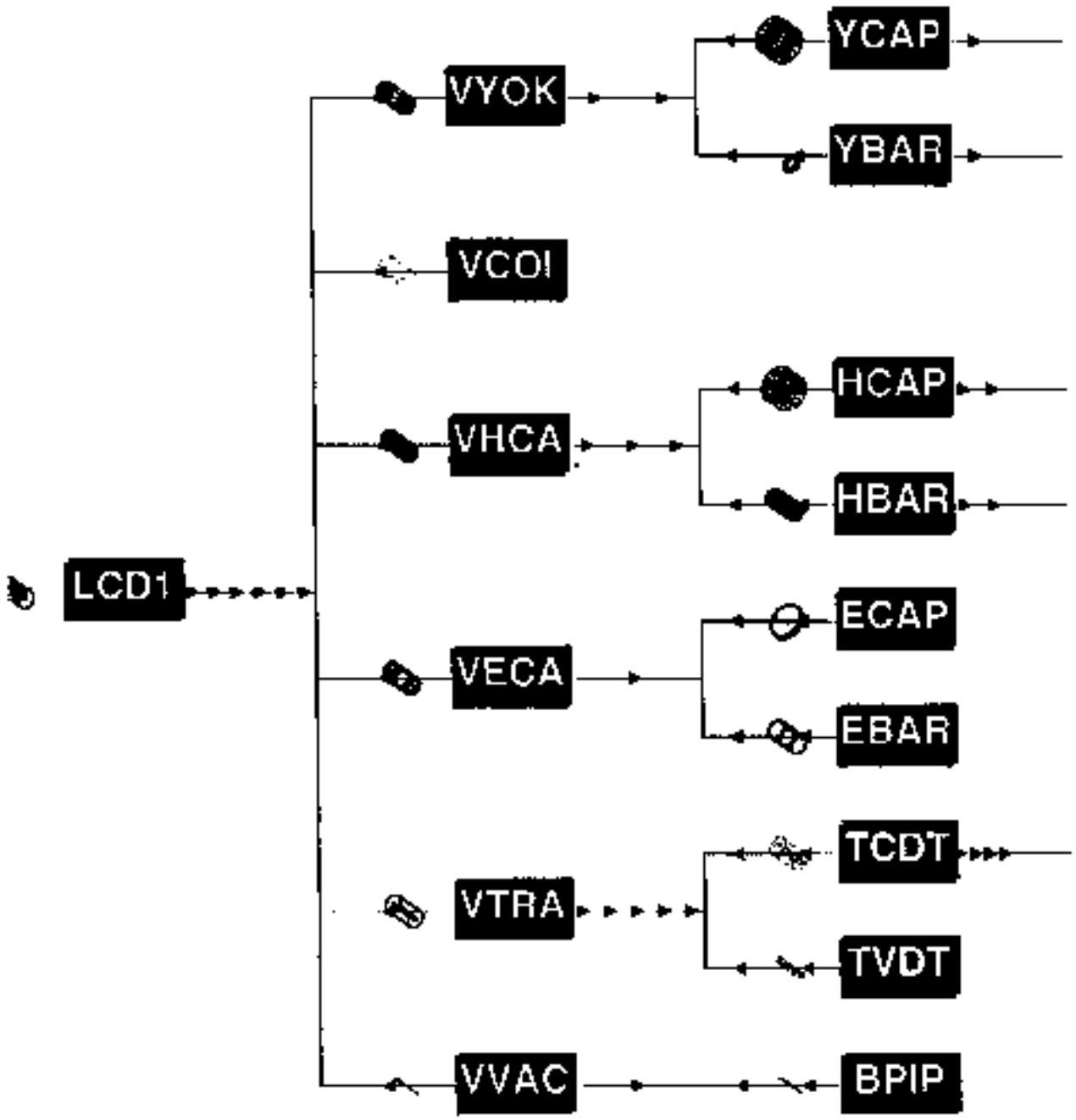
Detector description strategy

Free bore concept:

- Identify major subsystems
  - Vacuum chamber: beam pipe, masks
  - Tracker: inner, intermediate, main, forward
  - Electromagnetic calorimeter
  - Hadron calorimeter
  - Magnet
  - Instrumented yoke
- Assign simple shape with overall dimensions (free bore)
- Find a subsystem expert to specify/implement contents:
  - geometry
  - materials (composites)
  - active elements
  - digitisation model (resolution)
- Integrate at the top level (no overlap)
- Good model of how to build the detector

GEANT volume tree

LC96/97 study:



GEANT for LC98

LC96/97:

- Main subsystems still valid
- All details out of date
- No digitisation
- No input and output interface

LC98:

- Review geometry and materials
- Implement much richer substructure
- Implement (rudimentary) digitisation
- Define and implement input interface to generators
- Define and implement output interface to (rudimentary) pattern recognition and reconstruction

Pattern recognition and reconstruction

Pattern recognition:

- **Tracks: cheat**
- **Calorimeters: generic cluster algorithm**
- **Matching: geometric and kinematic algorithm**

Reconstruction:

- **Energy flow objects:**
  - **Photon: lone electromagnetic cluster**
  - **Neutral hadron: lone hadronic cluster**
  - **Electron: track + matched em cluster**
  - **Charged hadron: track + matched em cluster + matched hadronic cluster**
  - **Muon: track + matched em cluster + matched hadronic cluster + track in yoke**

Energy flow objects

Energy flow approach:

- **Optimise object classification**
- **Optimise E/p measurement on object class level**
- **Automatically optimises visible and missing energy and momentum measurement**
- **Little dependence of classification and E/p measurement on the physics process**
- **Expertise available at LEP/HERA**

Input and output interface

Input via HEPEVT common:

```
+KEEP, NMXHEP
       PARAMETER (NMXHEP=2000)
+KEEP, HEPEVT
+SEQ, NMXHEP
       COMMON/HEPEVT/NEVHEP,NHEP,
      &ISTHEP(NMXHEP),IDHEP(NMXHEP),
      &JMOHEP(2,NMXHEP),JDAHEP(2,NMXHEP),
      &PHEP(5,NMXHEP),VHEP(4,NMXHEP)
       DOUBLE PRECISION PHEP,VHEP
       SAVE /HEPEVT/
```

Output in an analogous structure?

Any standards from parametric MC's?