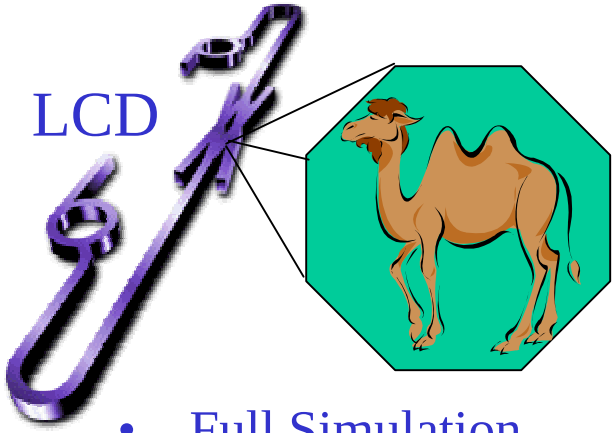


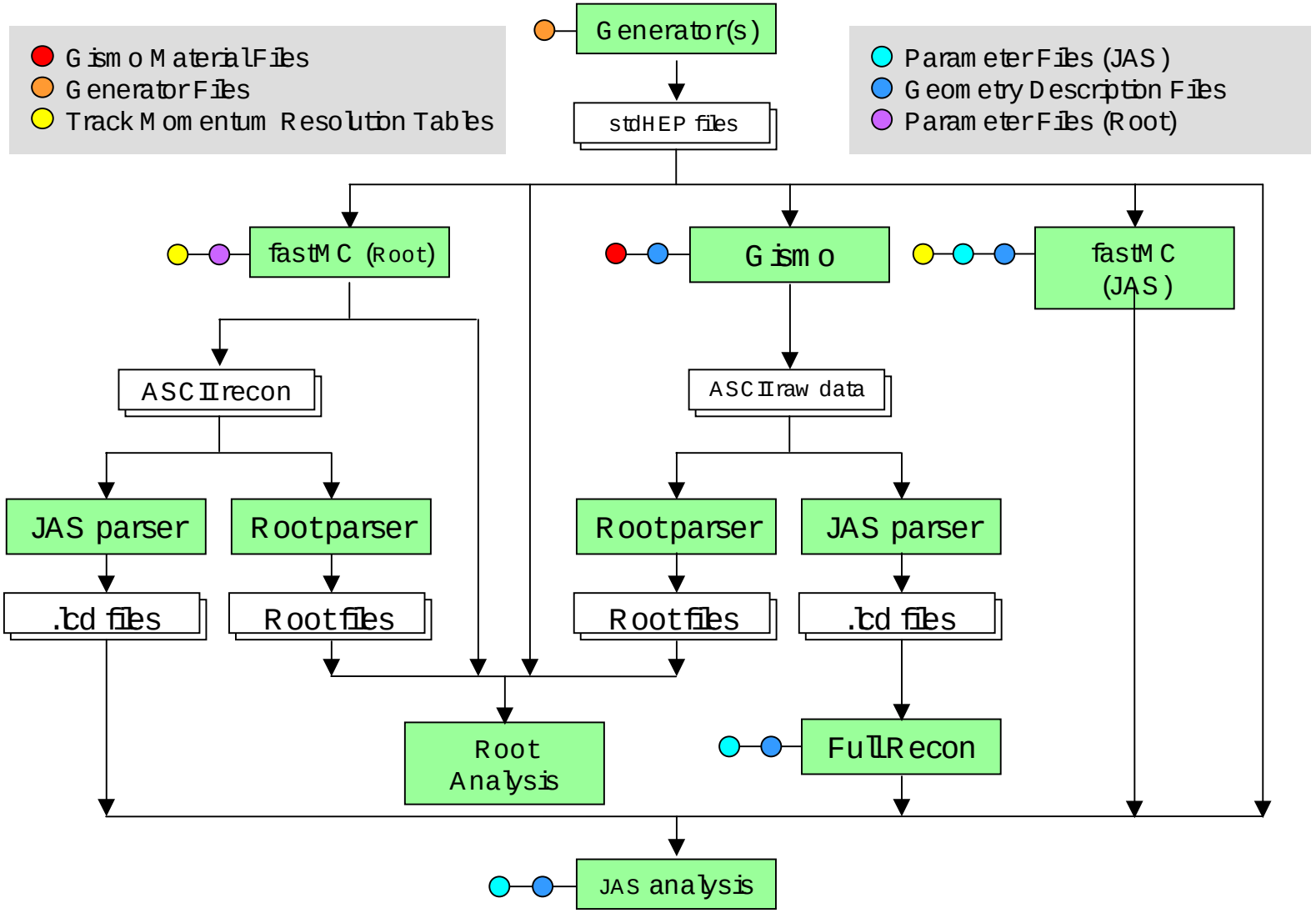
North American Simulations

R.Dubois

- Full Simulation
  - flexible geometry specs within some constraints
  - what you get
  - platform support
  - MC Farms
- Fast MC
  - track smear strategy
  - Calorimeter smear
- Use New Tools for Analysis
  - using Root for simulation analysis and FastMC
  - using JAS for all phases
- Plans
  - 2nd round detector designs
  - beam backgrounds overlay
  - GEANT4
  - parameters handling
  - binary I/O
  - event display

LCD Road Map

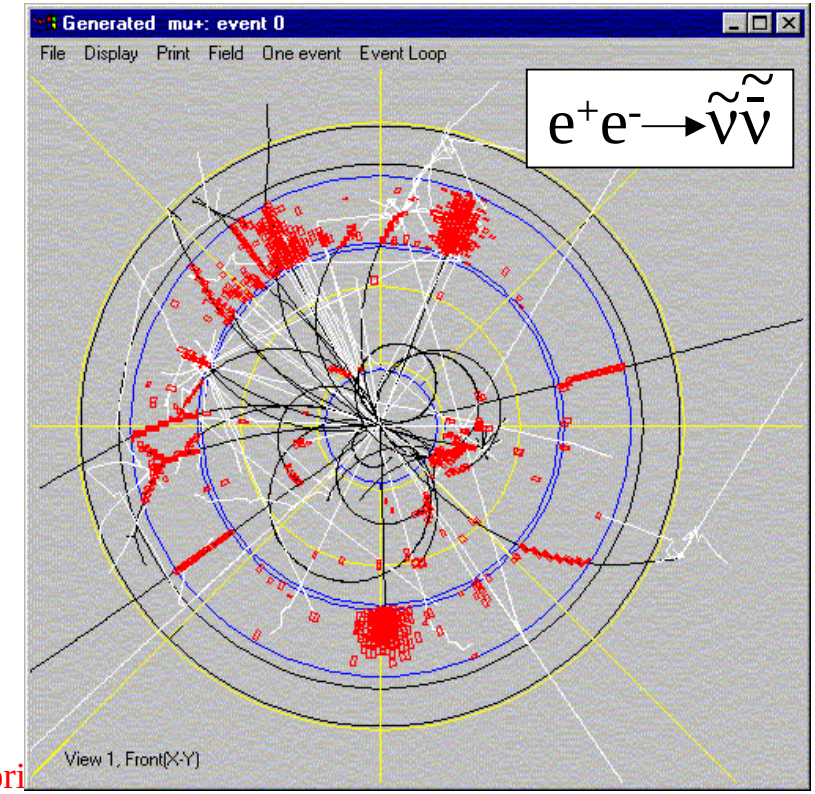
R.Dubois



Gismo: Full Simulation

R.Dubois

- Reasonably full-featured full simulation package - C++
  - complex geometries
  - EGS & GHEISHA
    - cutoffs set at 1 MeV
  - multiple scattering, dE/dx, etc
- Generator input from /HEPEVT/ via FNAL STDHEP I/O package
- Digitization supplied by ‘user’
  - tracking
    - hit points at tracking/VXD layers
  - calorimeters
    - total energy per channel
  - muon strips
  - all digi’s have full MC record
- Output to ascii file
  - allows parsers to translate to JAS & Root for further analysis/processing



Full Sim: Geometry Elements

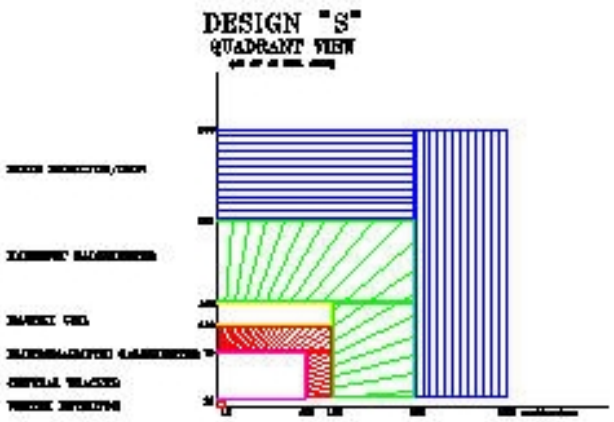
- Most detector types are cylinders
  - input by ascii detector file
  - trackers and calorimeters can have inner/outer skins and endplates
  - tracker/VXD layers can be individually positioned and sized
  - user sets longitudinal cell composition (multi-materials allowed) and ‘sensitivity’
  - conical masks configurable
    - next round will have instrumented masks

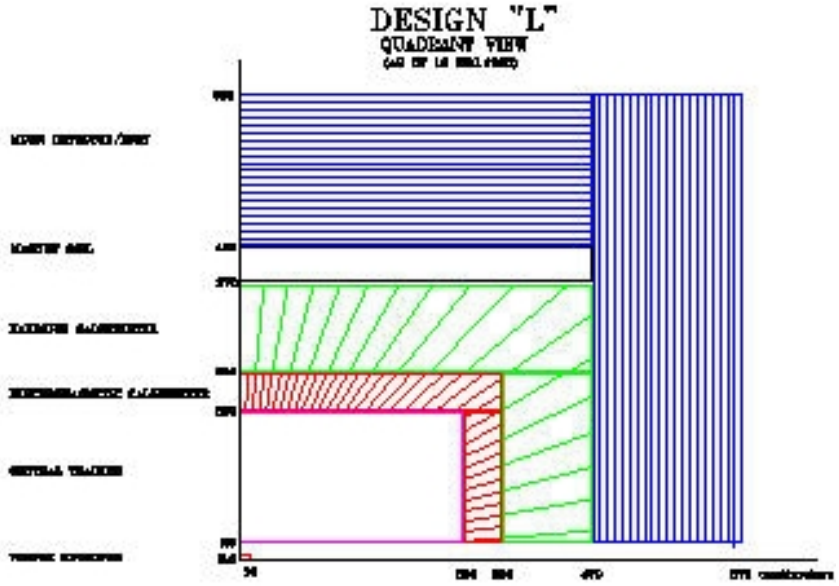
Two Detector Designs

- Large (v. L1, L2)
  - large!
  - Large tracker
    - optimal tracking resolution
  - Large calorimeter
    - optimal separation of clusters
  - size limits B field
    - may limit vertex detector inner radius due to e^+e^- pairs
- Small (v. S1, S2)
  - small!
  - Small detector
    - larger B field possible
  - Small calorimeter
    - allows high granularity (Si/W)
  - Small tracker
    - Si strips/drift
  - large B field
    - better containment of pairs, closer-in vertex detector

S1

L1





B=6T

B=3T

Small Strawman Design

R.Dubois

Coil: 23 cm Al - **between EM & HAD cals!**

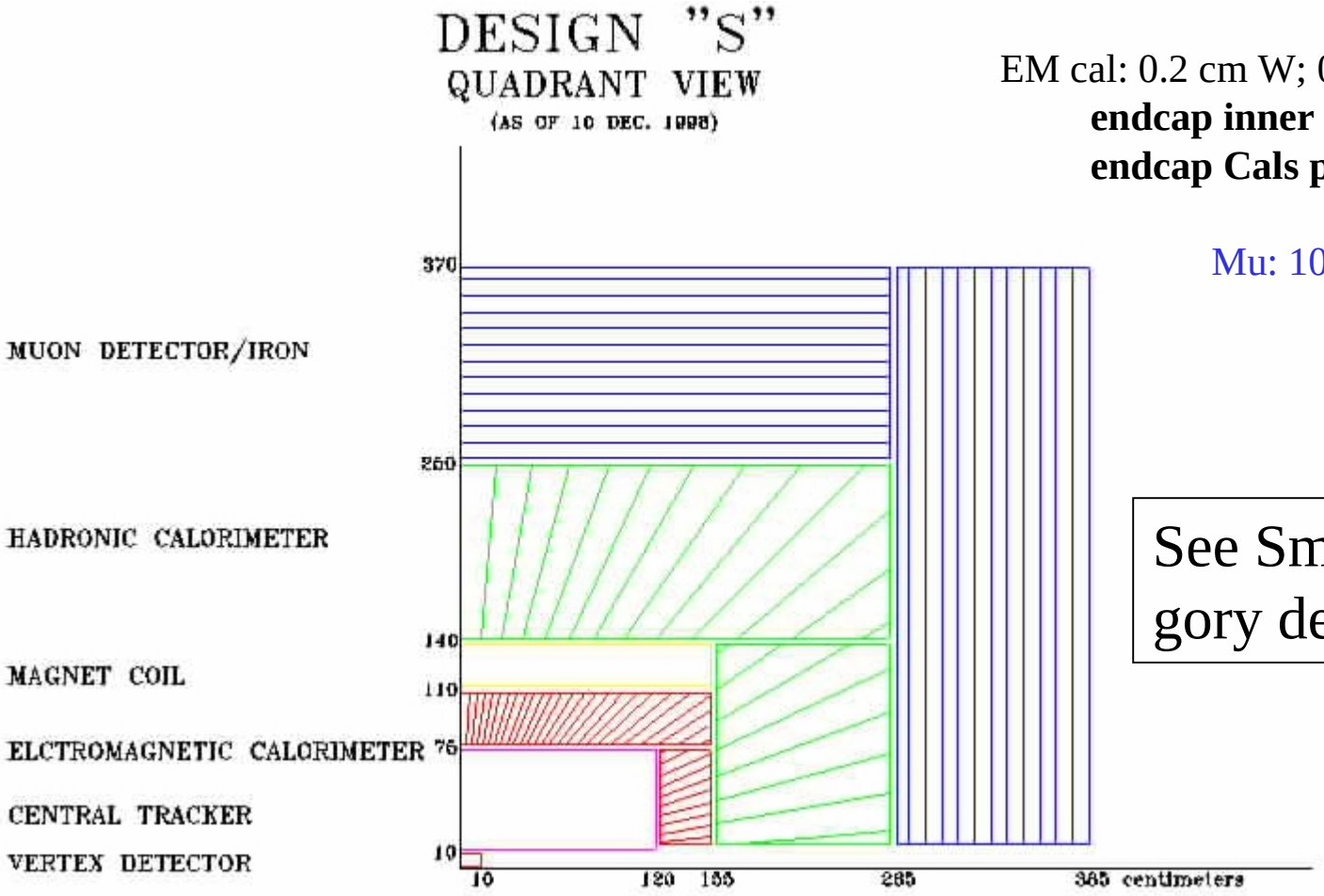
HAD cal: 2 cm Cu; 0.5 cm scint

EM cal: 0.2 cm W; 0.03 cm Si

endcap inner z = 155 cm

endcap Cals pushed out 30 cm

Mu: 10 cm Fe; 2 cm gas



See Small.ini for the gory details!

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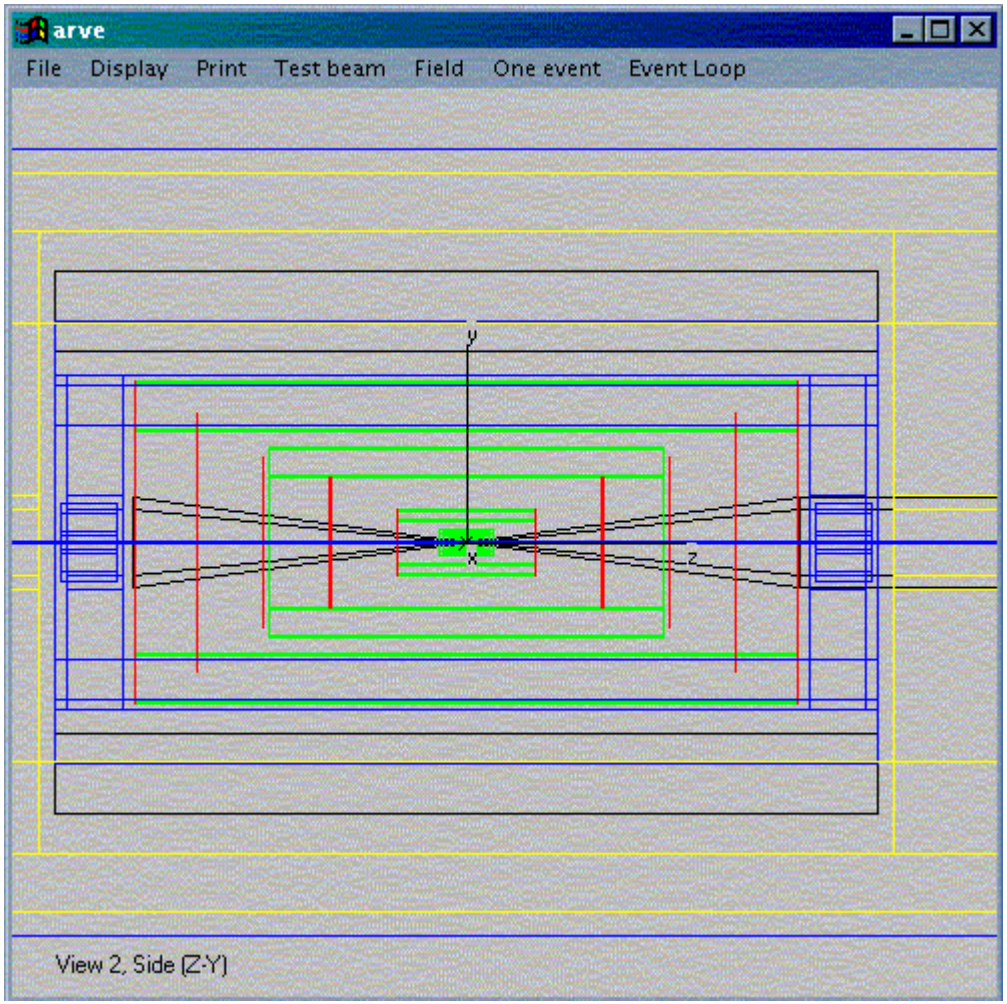
Small Detector: Central Detector

3 Tracker Doublets
- 1.1 mm G10, 600 μm Si
- r = 14, 42, 71 cm
- **outer layers extend to z=149 cm**

5 EC Tracker disks
- z = 31, 61, 91, 121, 149 cm
- inner r follows cosθ=0.99

Luminosity monitor (Si/W)
- active from 30-116 mrad

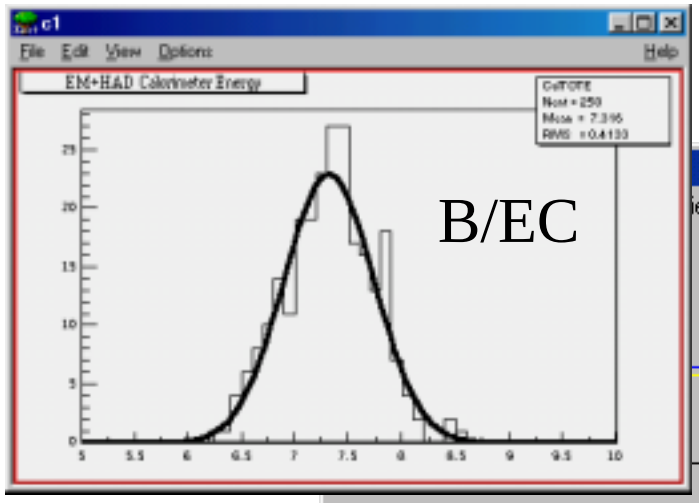
'Vestigial' mask
- cone from r=1.2 cm at z=10 cm to r=20cm at z=155 cm

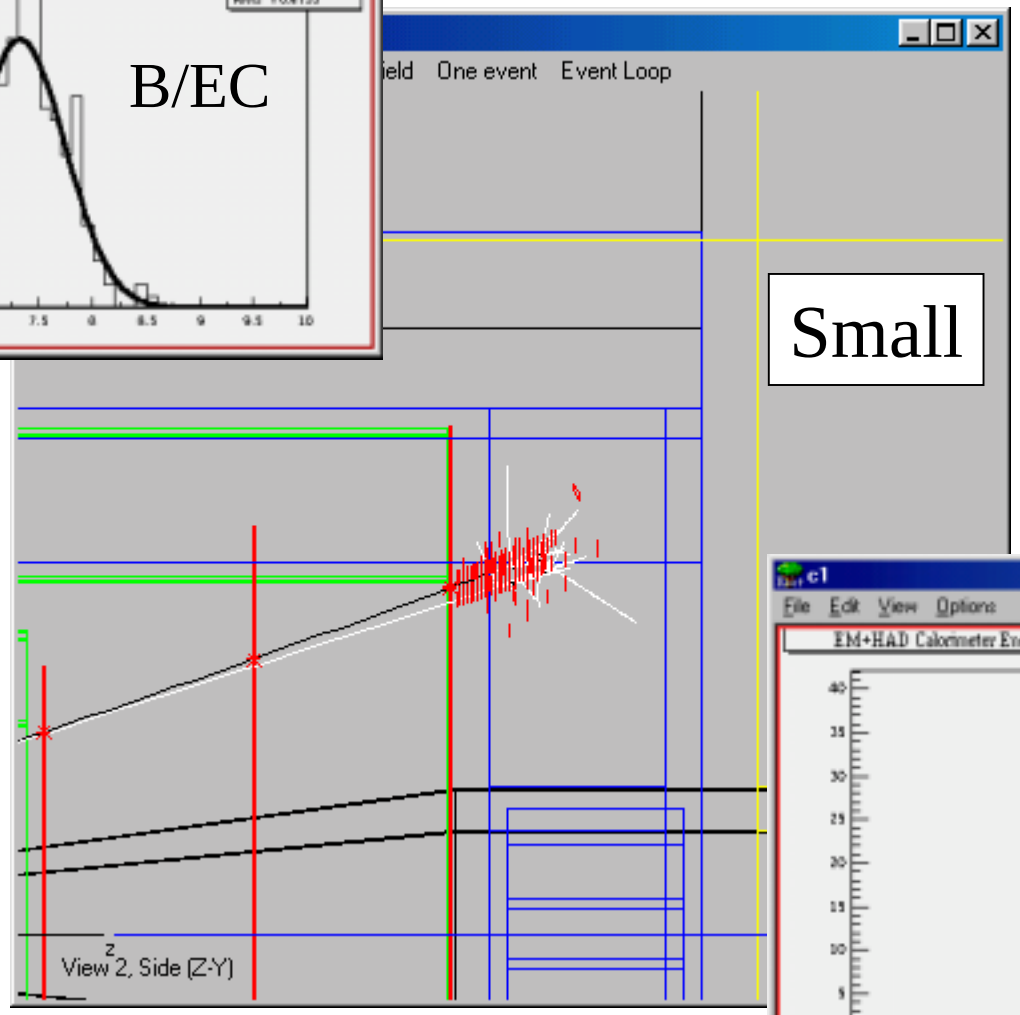


Barrel/Endcap Region

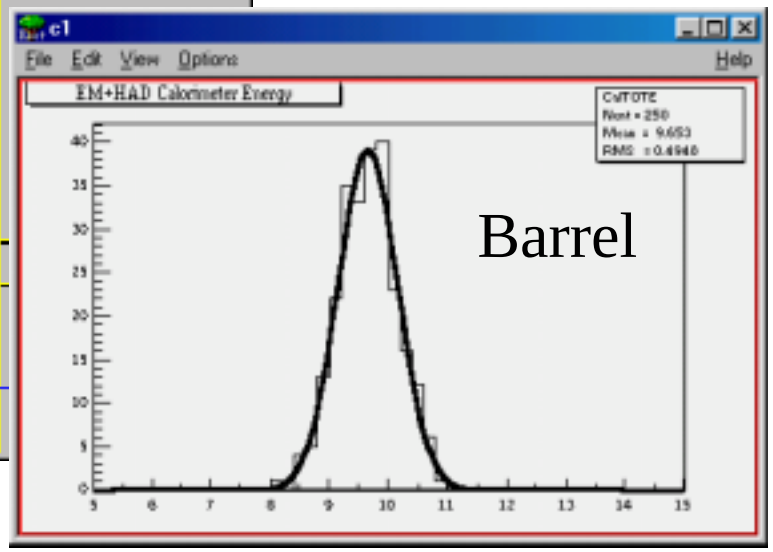
R.Dubois

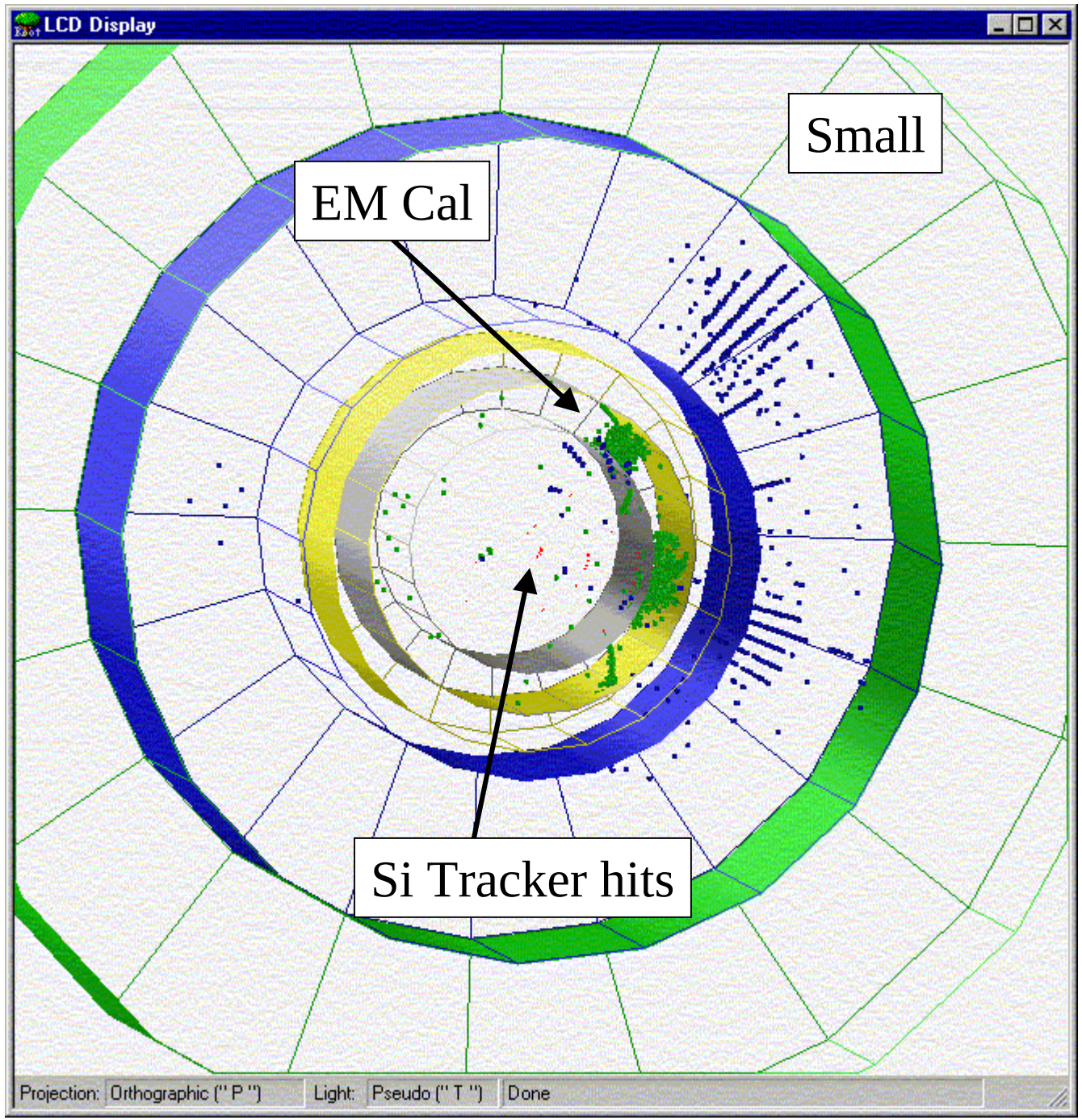
- <E> 15% lower than barrel
- σ/<E> 15% higher





(note different scales on plots)





R.Dubois

$e^+e^- \rightarrow ZZ$

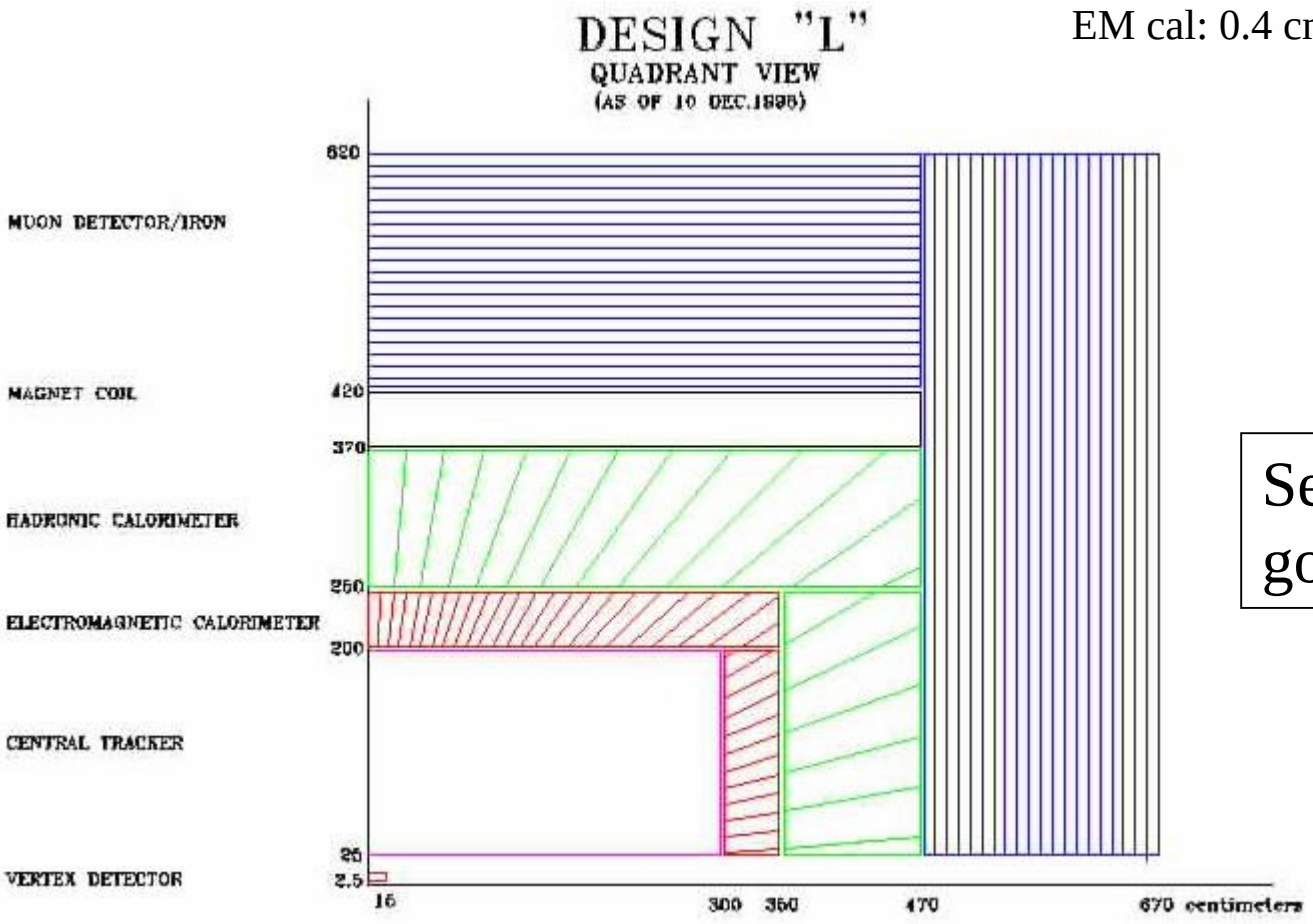
Large Strawman Design

R.Dubois

Coil: 40 cm Al - between HAD and MU cals

HAD cal: 0.8 cm Pb; 0.2 cm scint

EM cal: 0.4 cm Pb; 0.1 cm scint



Mu: 5 cm Fe; 3 cm gas

See Large.ini for the gory details!

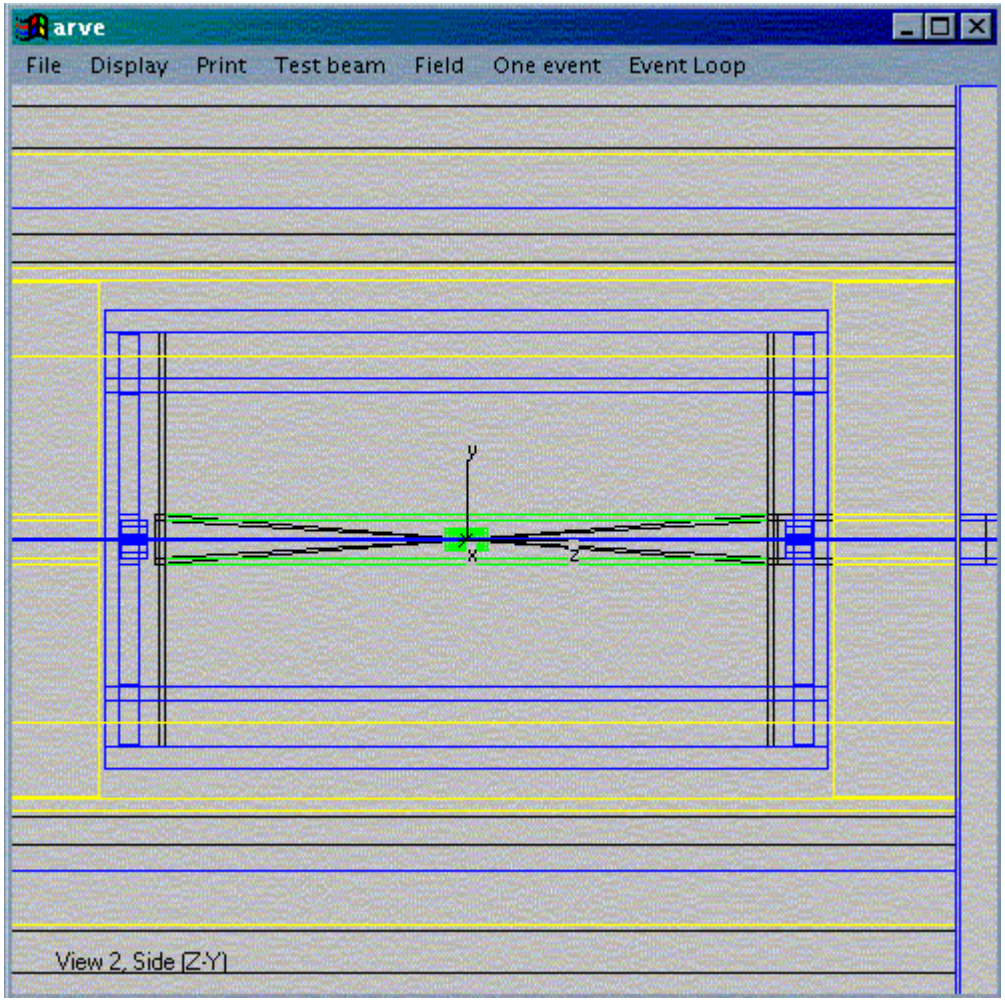
R.Dubois

Large Detector: Central Detector

144 Layer TPC
- r = 25-200 cm
- length = 5.8 m
- 4.5 cm Al endplates
- 0.18 cm Al inner/outer skins

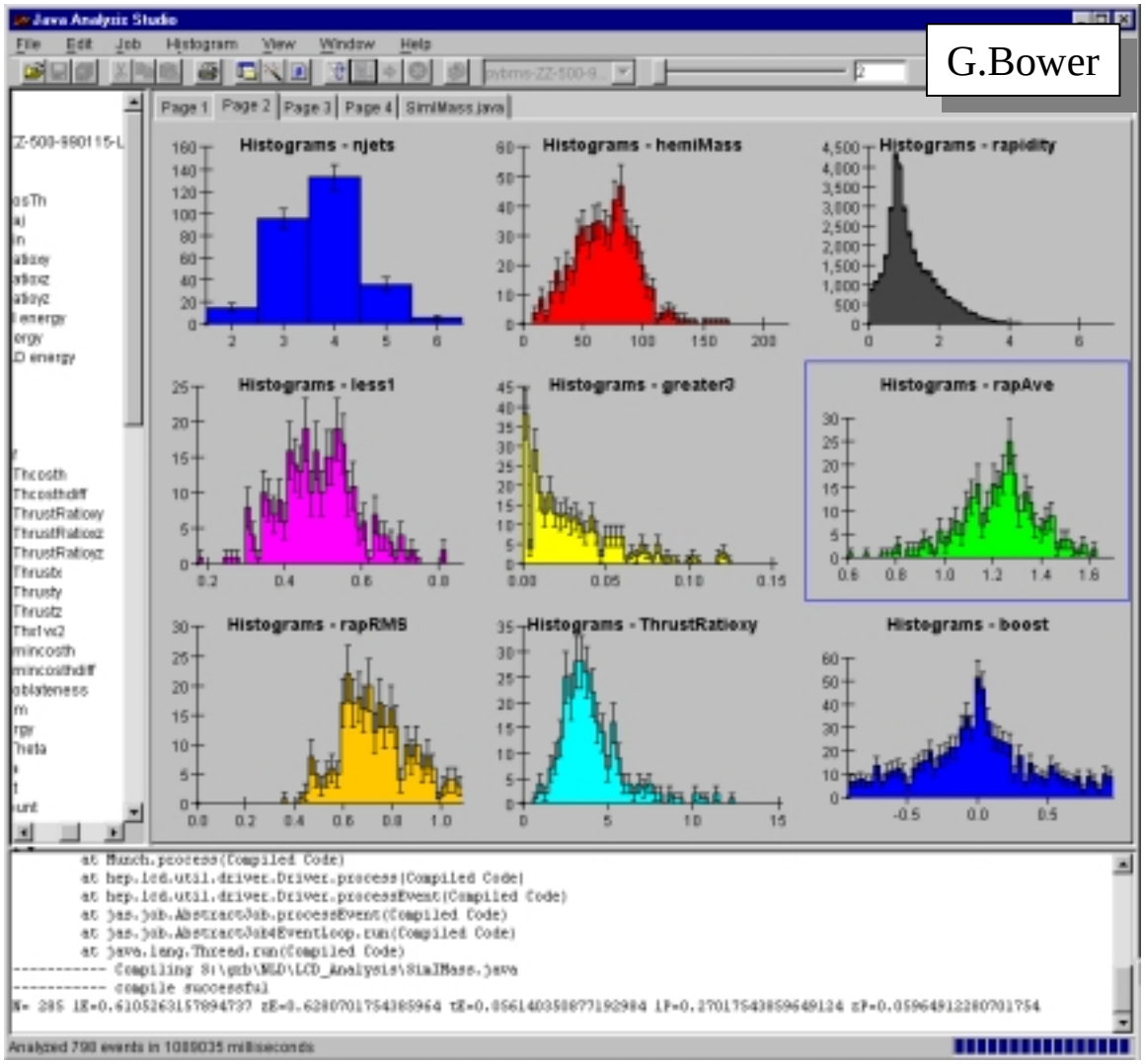
Luminosity monitor (Si/W)
- active from 16-83 mrad

'Vestigial' mask
- cone from r=1.2 cm at z=10 cm to r= 25 cm at z=300 cm



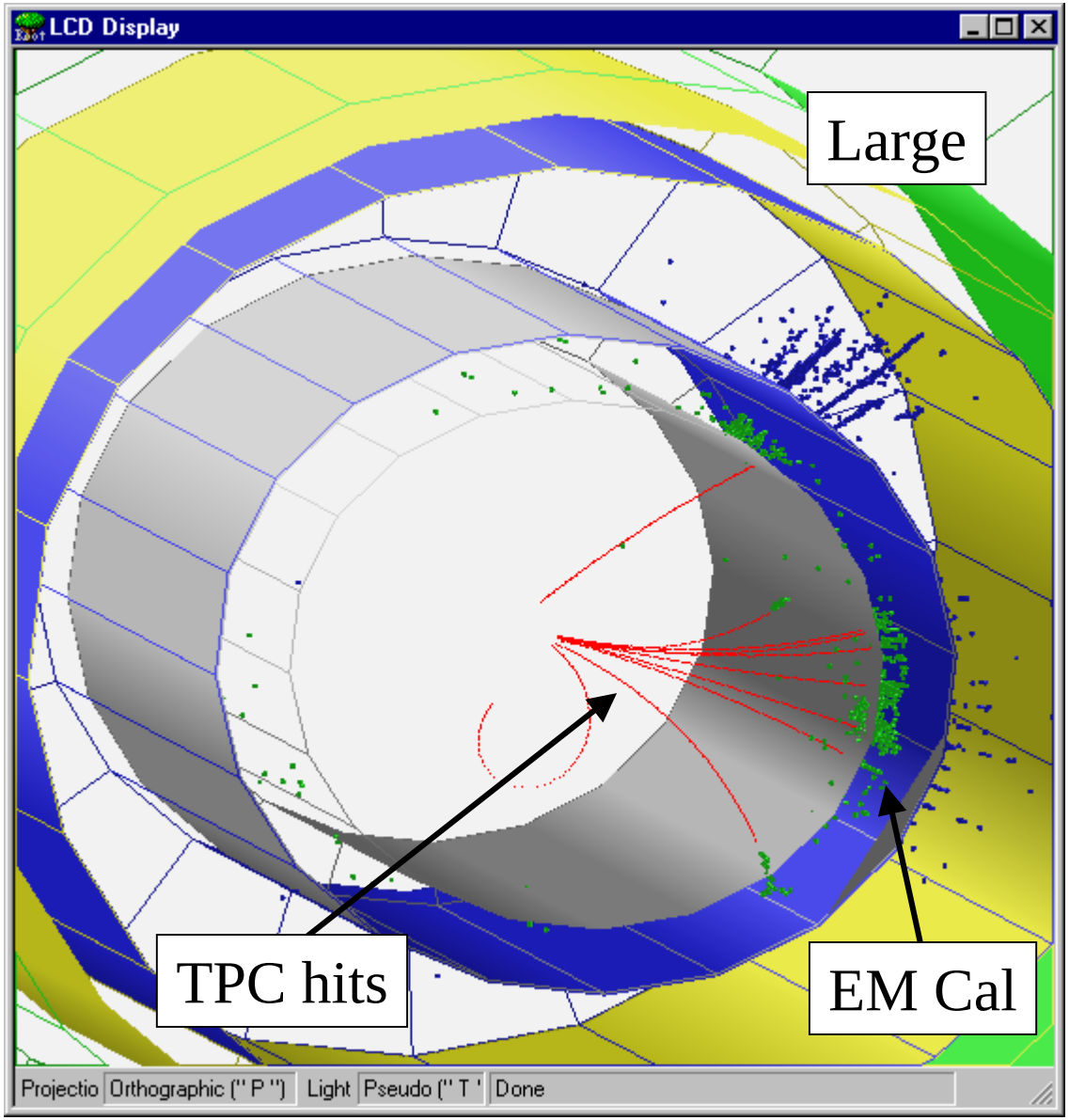
R.Dubois

Example of Event Shape Analysis



G.Bower

Large: ZZ events



$e^+e^- \rightarrow ZZ$

What You Get from FullSim

- Tracking
  - hit ID
  - (x,y,z) of trajectory crossing layer
  - layer ΔE
  - ptr to MC parent
  - hit smearing held off until recon
- Calorimeters
  - hit ID (contains location)
  - total energy deposited
  - list of (MC parents, ΔE)
- MU Strips
  - hit ID (contains location)
  - list of MC parents
- Full MC Truth Table
  - (x,y,z) at termination point
  - initial (p_x, p_y, p_z)
  - type & charge
  - pointer to parent
  - position & momentum at Cal front face
  - MC Notes:
    - top entry is 'documentation': only for bookkeeping and has no parent
    - GISMO loves to bremm photons in the central detector. The bremming electron is terminated and e, γ daughters carry on.

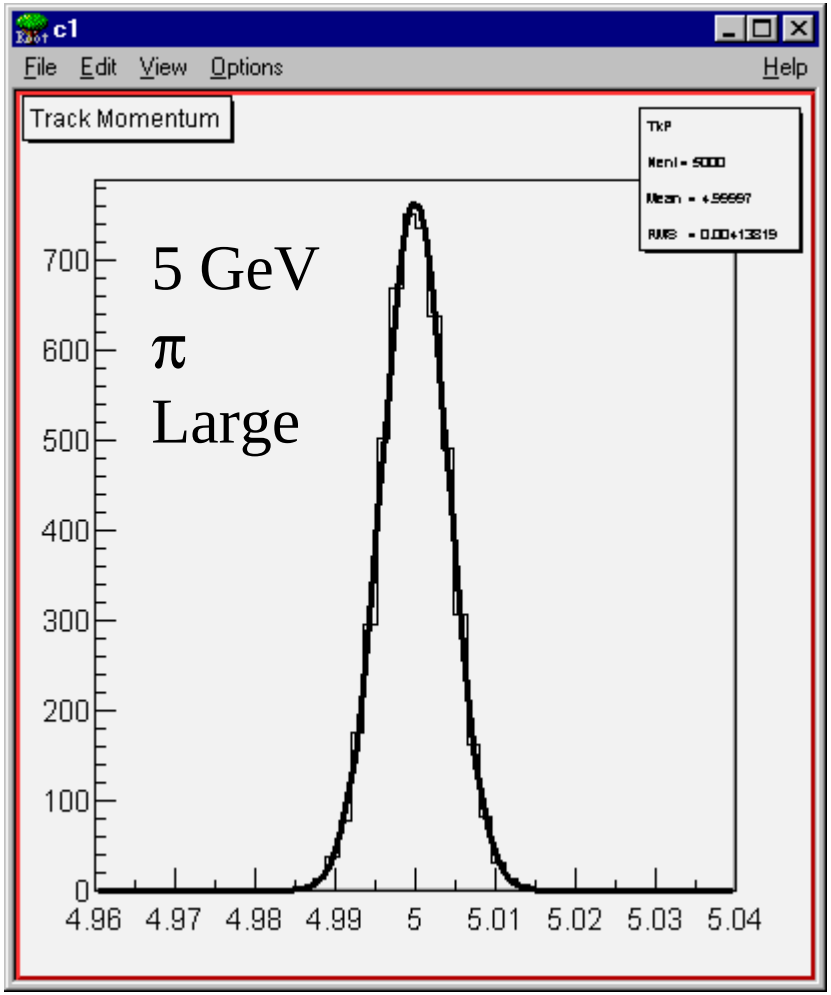
MC Farms & Platforms

- MC Farms
  - SLAC ran udscb (AIX,Sun)
  - Michigan ran $t\bar{t}$ (DEC unix)
  - Penn ran ZZ, WW (AIX)
  - Colorado ran selectron pairs (DEC unix)
  - Code installed but yet to run production at Vanderbilt (DEC) & FNAL (Linux)
- data repository at Penn
  - 'push' scripts for file transfer from farms
  - server access via JAS
  - ftp access for Root
- Timing
  - ~2 mins/event for udscb 500 GeV on 400 MHz Solaris
- Platforms
  - AIX
  - Solaris
  - DEC Unix
  - Linux
    - compiler bug - can only run non-optimized
  - Windows

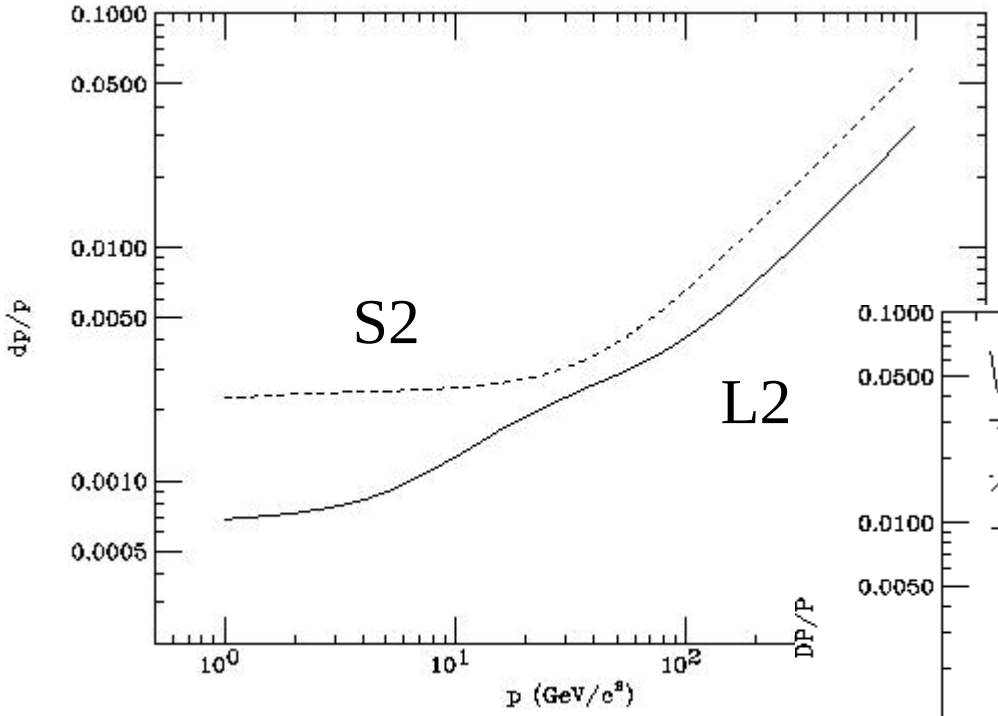
FastMC

R.Dubois

- Tracking
  - revised algorithm from tracking working group
  - use lookup tables in (cosθ,p) for resolution for each helix parameter.
    - tables produced by Bruce Schumm
      - code & doc available from web
      - based on Billoir **NIM225, 325(1984**)

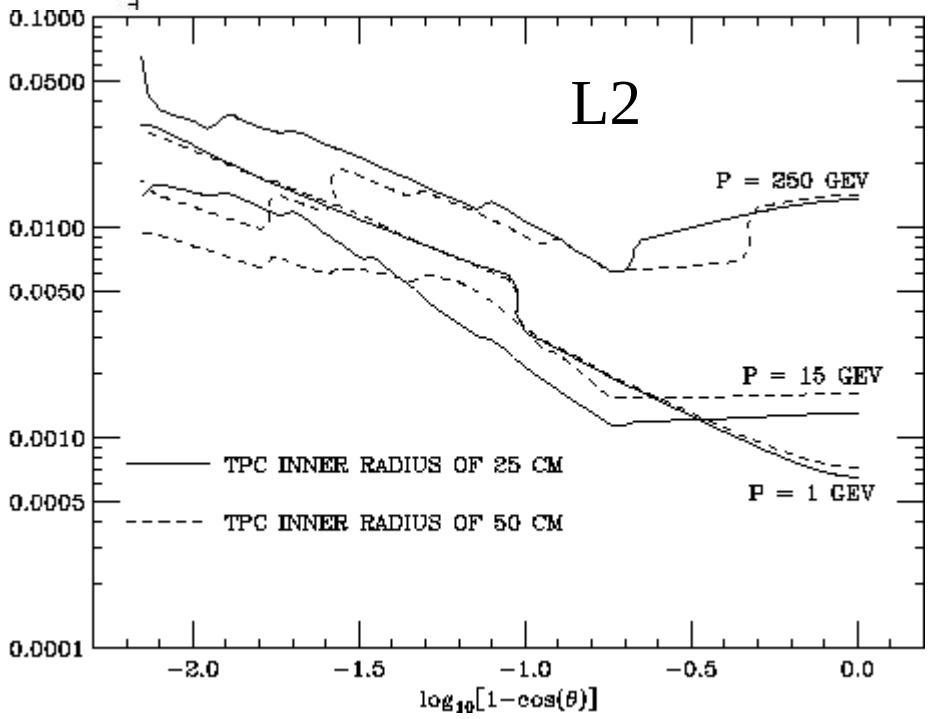


Track Resolution



vs p

vs polar angle



⇑ cos θ =0.99

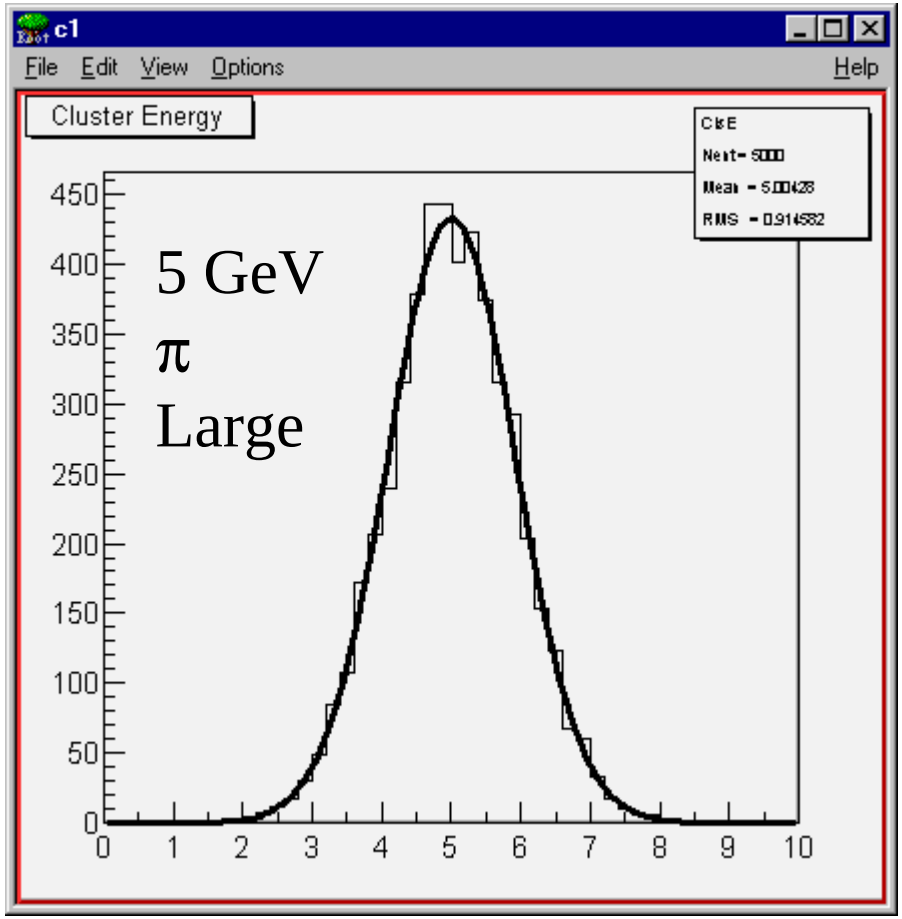
⇑ cos θ =0.90

⇑ cos θ =0.0

FastMC

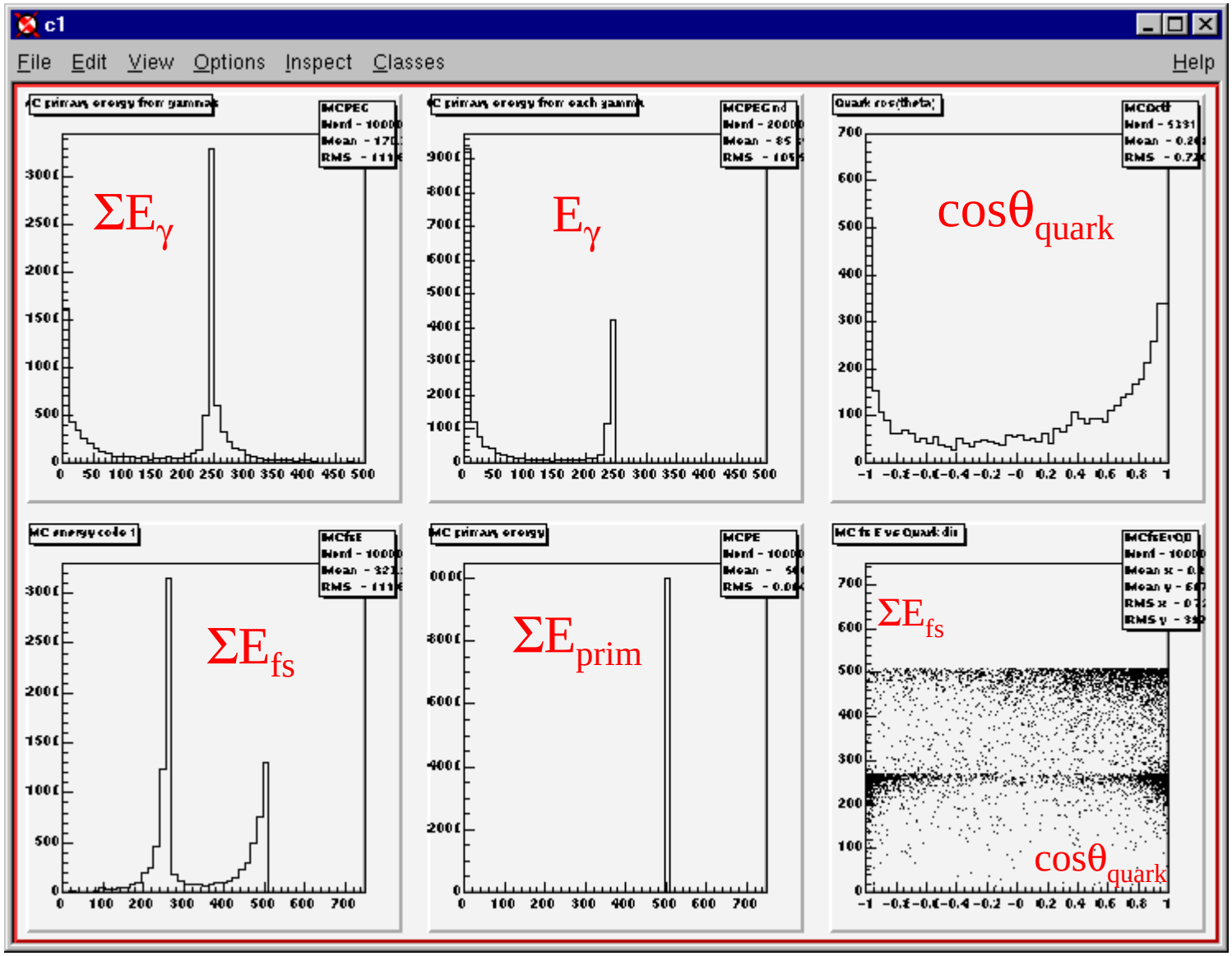
R.Dubois

- Calorimetry
  - extrapolate final state particles to Cal front face (linear or helix)
  - supply $<X_0>$, $<\Lambda>$ for each Cal to pick shower start point
  - has its own geometry spec for barrel and endcap cals.
  - Performance specs:
    - Small:
      - EM: $\sigma(E)/E = 0.12/\sqrt{E} \oplus 0.01$
      - HAD: $\sigma(E)/E = 0.50/\sqrt{E} \oplus 0.02$
    - Large:
      - EM: $\sigma(E)/E = 0.15/\sqrt{E} \oplus 0.01$
      - HAD: $\sigma(E)/E = 0.40/\sqrt{E} \oplus 0.02$
    - Both have $\sigma(x)$=1 and 5 cm for EM and HAD.



MC Truth for udscb

R.Dubois



0.03 s/event on 400 MHz Sun

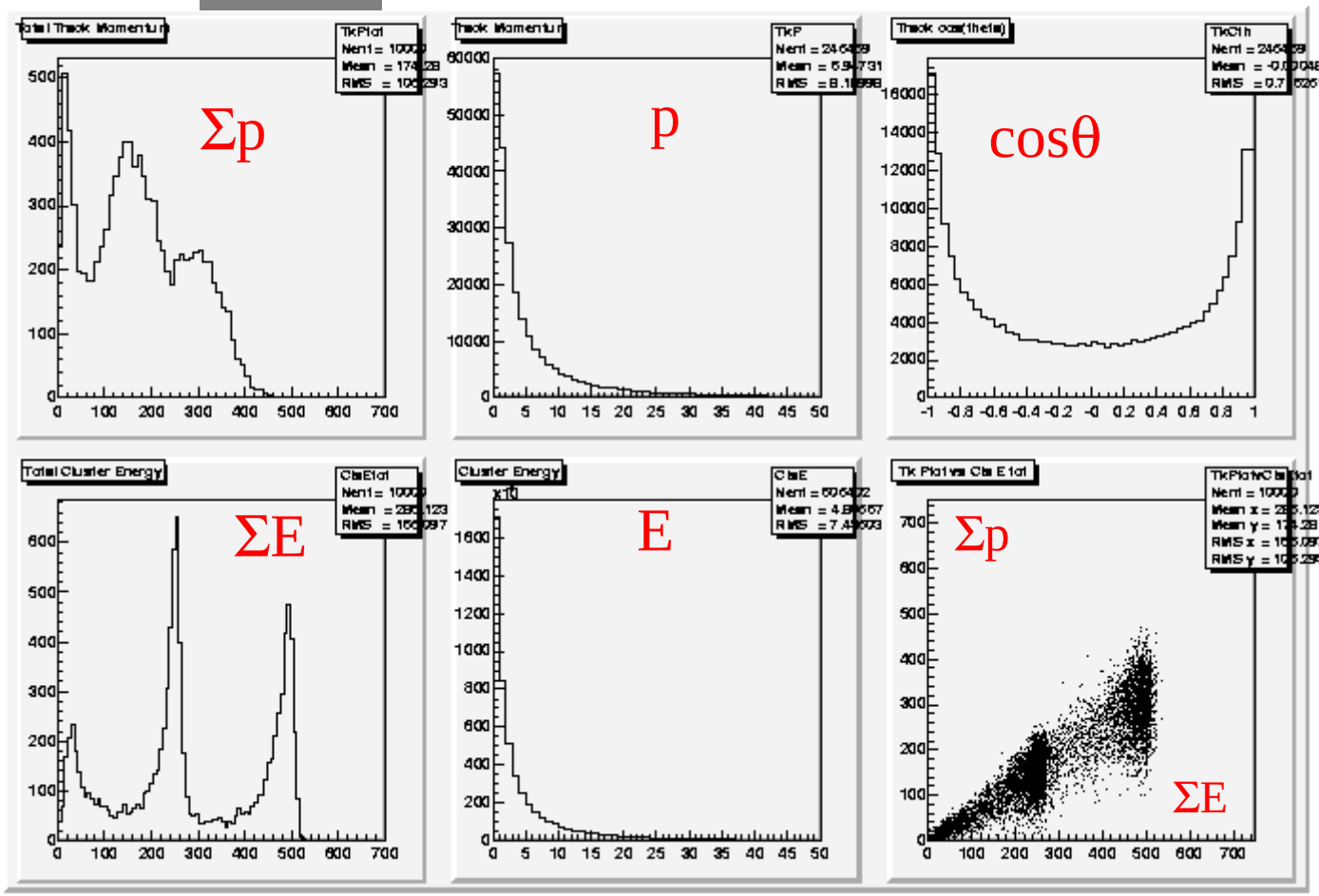
udscb Detector Quantities

R.Dubois

Small

Tracks

Clusters



What you get from the FastMC

- Tracks
  - (x,y,z), (p_x, p_y, p_z) at IP
  - charge
  - helix parameters and diagonal error matrix
- Calorimeter Clusters
  - $\langle\cos\theta\rangle$, $\langle\varphi\rangle$, ΣE
  - list of MC parents and how much energy they contributed
- MC Truth table
  - same as for fullSim

Miscellany

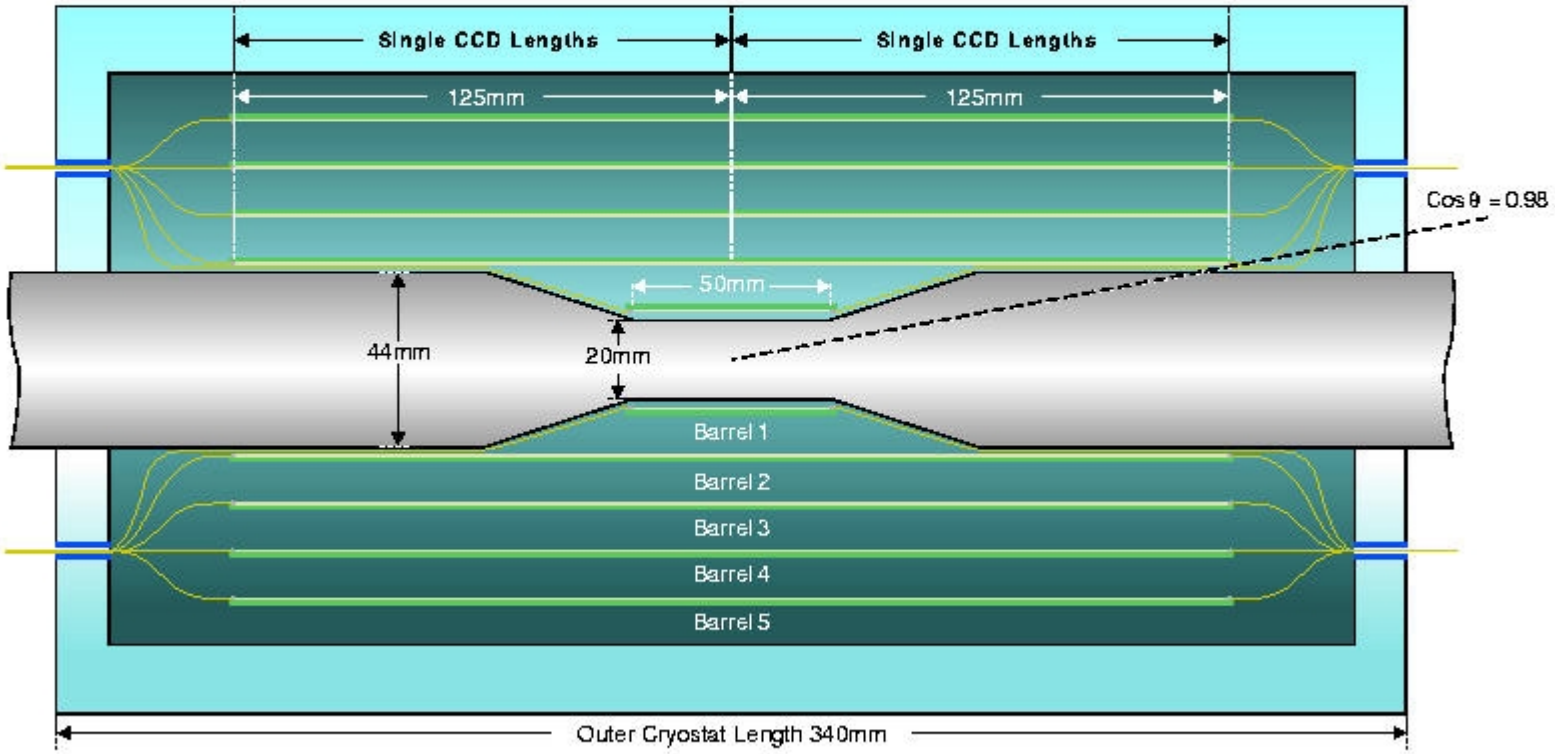
R.Dubois

- Translated ‘standard’ thrust and jet finders to Java and Root
  - submitted the Root versions to Root-central after Sitges
- Code Management
  - Full Simulation code is all in CVS
  - created project package to manipulate environment variables for TEST/DEV/PROD by facility (eg CAL, TKR, Util)
- Developing test suite for verifying new code versions
- Interesting competition between JAS & Root use
  - no one (yet) to ask for PAW
  - JAS seems easier to use; fewer features
  - Root can do everything, but it’s much harder to figure out how
    - most users gravitating, so far, to JAS

Plans: Detector Designs

R.Dubois

Suggested layout of Vertex Detector for future $e^+ e^-$ Linear Collider (Updated November 1998)



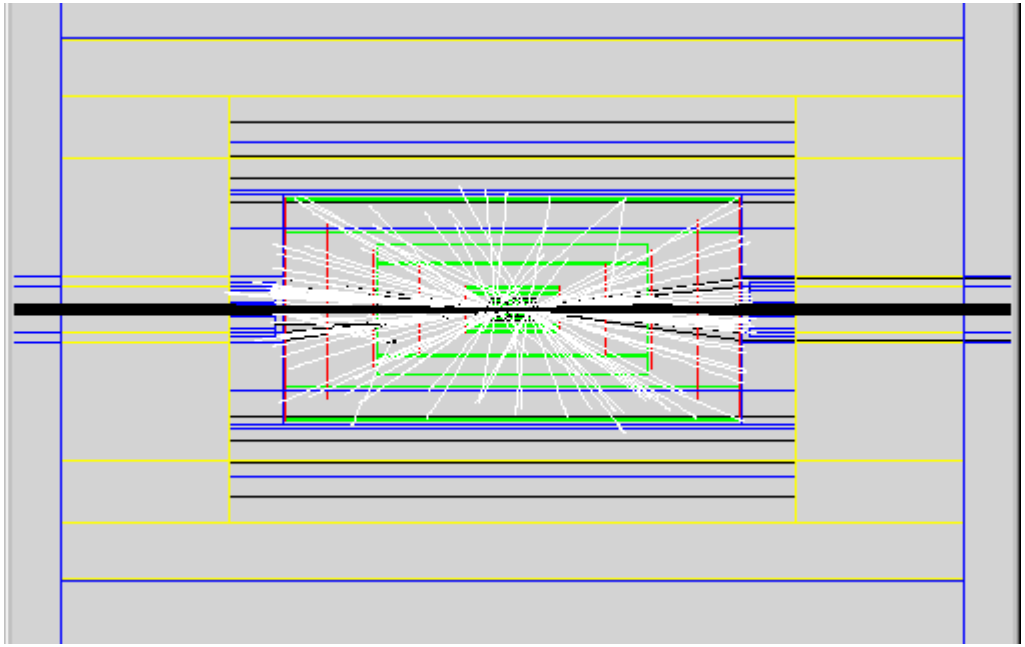
- Forward tracking added to L design
- Smaller radius vert.det. in L design
- Finer calorimeter segmentation
- revised beampipe and instrumented mask

Beam Backgrounds Overlays

R.Dubois

- Background particles from Guinea Pig machine simulation
- We plan to create a separate library of background events to overlay on top of the generator events.
- Will have to apply cuts to the GP output to allow a reasonable particle count
  - large fraction don't get to the beampipe because of the B field (by design!)

4000 Beamstrahlung particles
in the Small detector
(A normal event will have
88,000/bunch x 95 bunches/train)



Plans (cont'd)

- Parameters handling: XML
  - flexible design package makes parameters 'volatile'
  - need method to allow access to params from all stages (simulation through analysis)
  - imminent
- **Move to GEANT4**
  - Gismo gave us two years value and training
  - it has limitations
  - production G4 version released
- Binary I/O
  - ascii files lose numeric precision
  - imminent
- Event Display
  - develop 3D displays
    - Root prototype does 3D
    - WIRED for JAS is in the pipeline
- Improvements to FastMC
  - cluster merging in calorimeter
  - correlated errors in tracking
- **Carry on with Reconstruction Tasks**
  - Track finding/fitting already going well (M.Ronan's talk)
  - exploit tremendous segmentation of Strawman calorimeters with good clustering