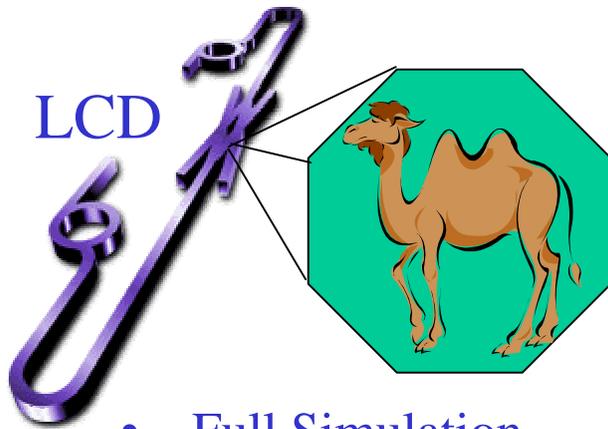


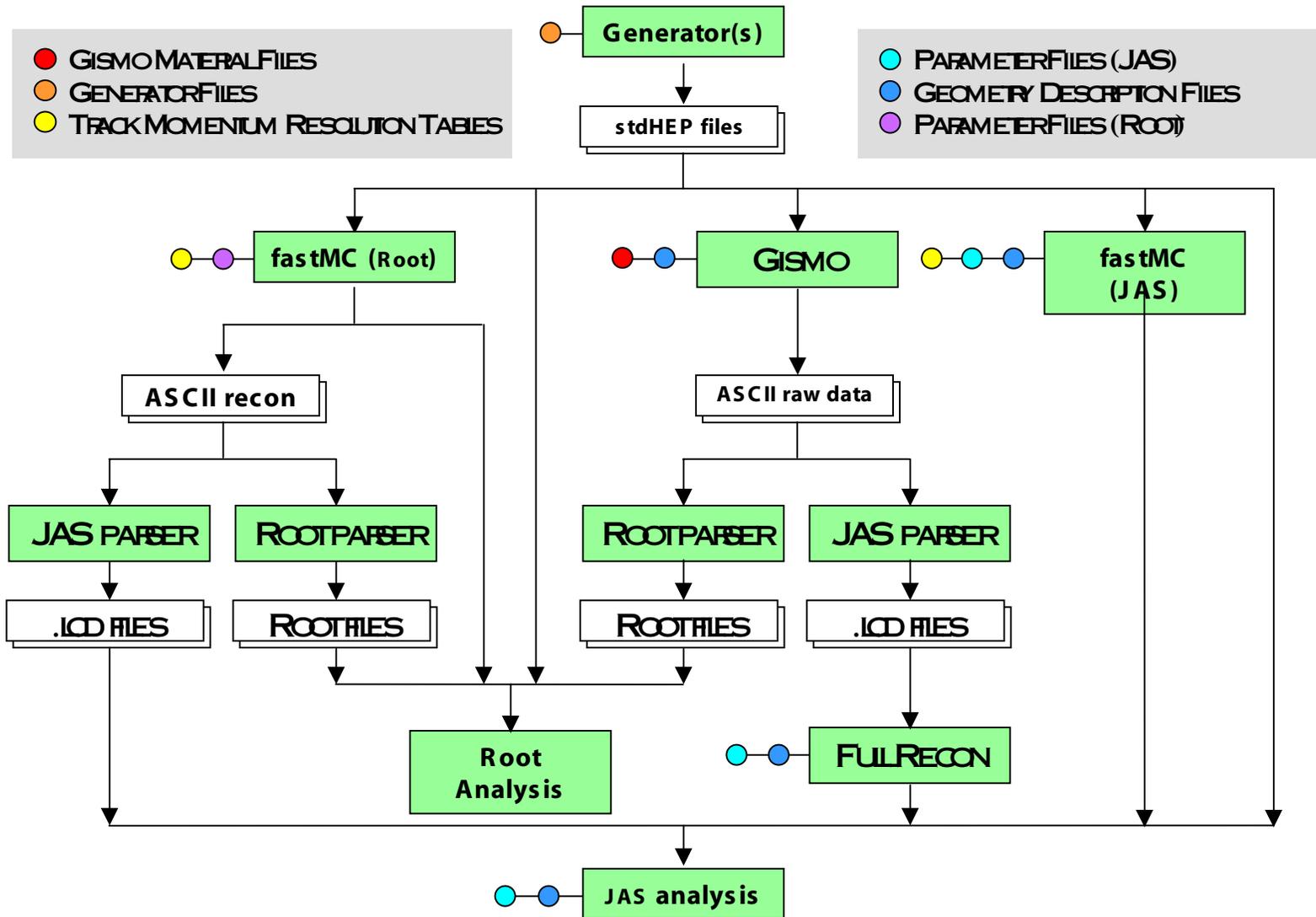
North American Simulations



- 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

LCD ROAD MAP

R.Dubois



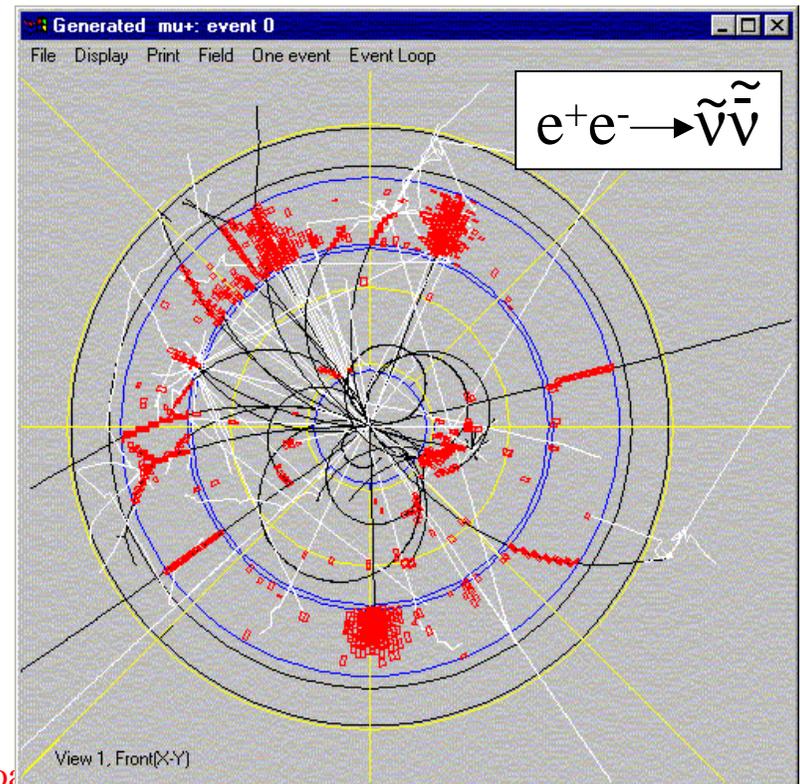
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Gismo: Full Simulation

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

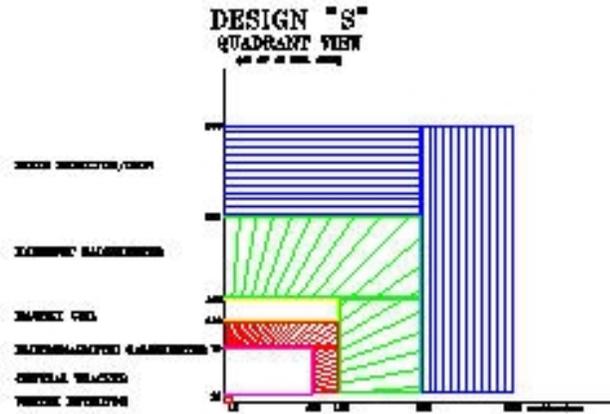


Full Sim: Geometry Elements

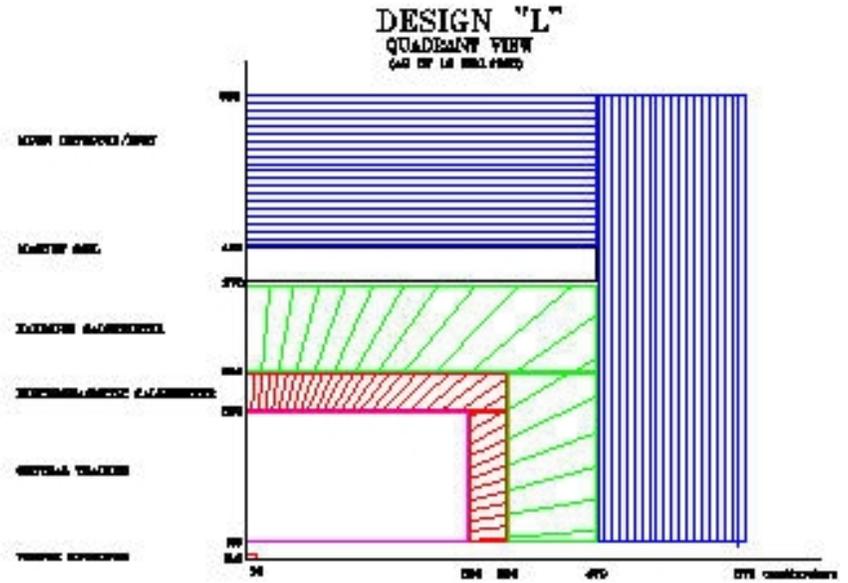
- Most detector types are cylinders
 - input by ascii detector file
 - trackers and calorimeters can have inner/outer skins and endplates
 - tracker/VXD layers can be individually positioned and sized
 - user sets longitudinal cell composition (multi-materials allowed) and ‘sensitivity’
 - conical masks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



B=6T



B=3T

Small Strawman Design

R.Dubois

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

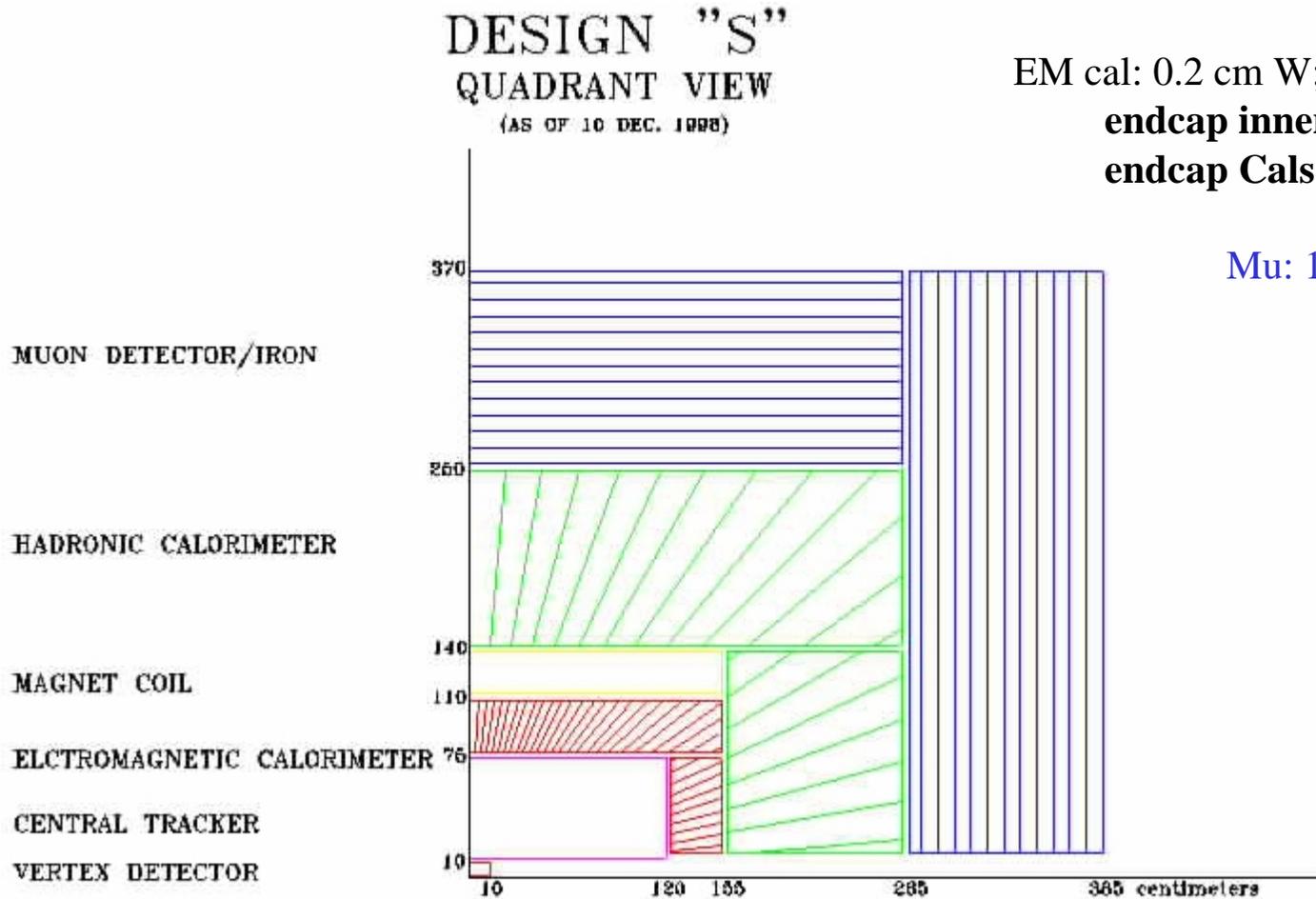
HAD cal: 2 cm Cu; 0.5 cm scint

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



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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

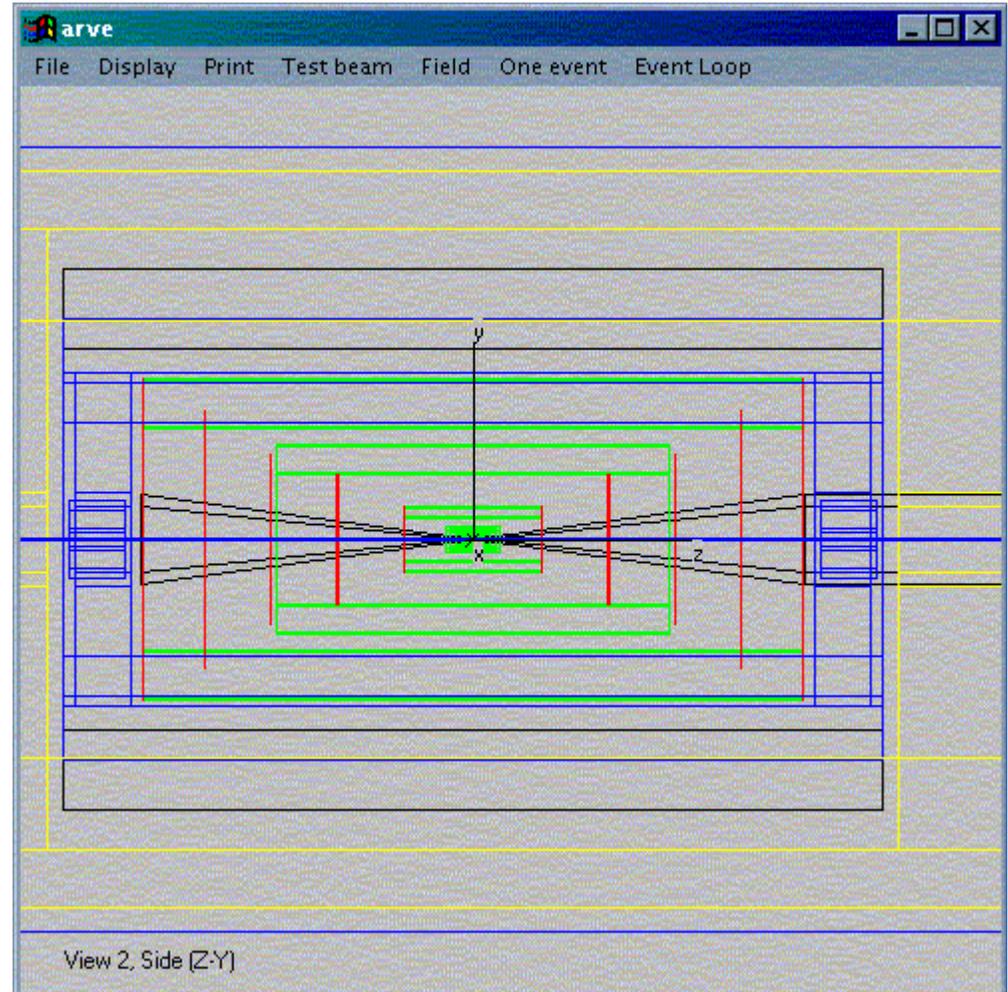
inner r follows $\cos\theta=0.99$

Luminosity monitor (Si/W)

active from 30-116 mrad

'Vestigial' mask

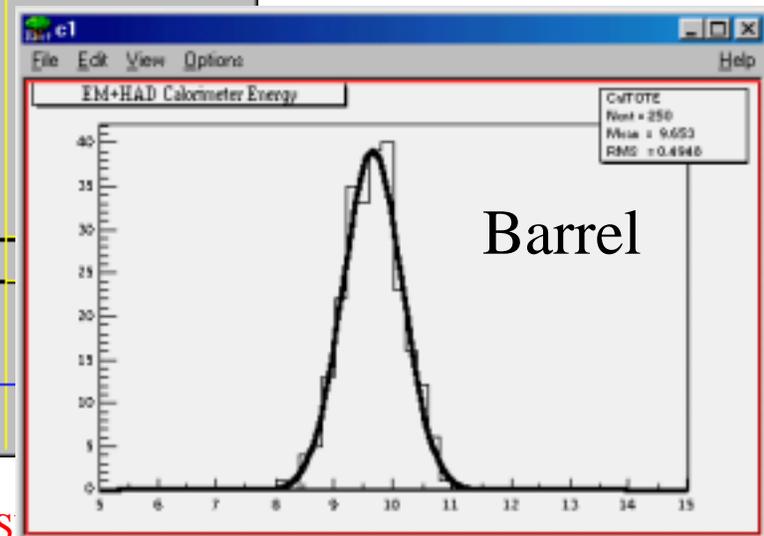
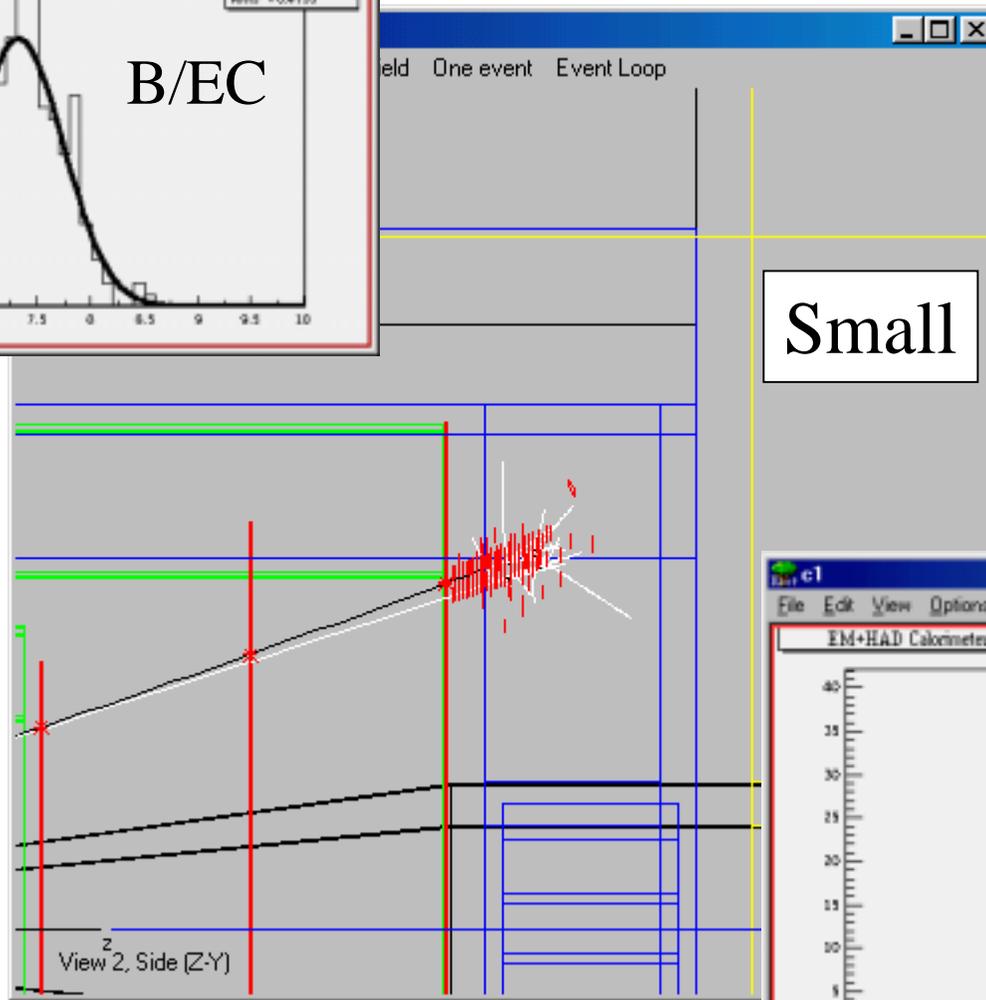
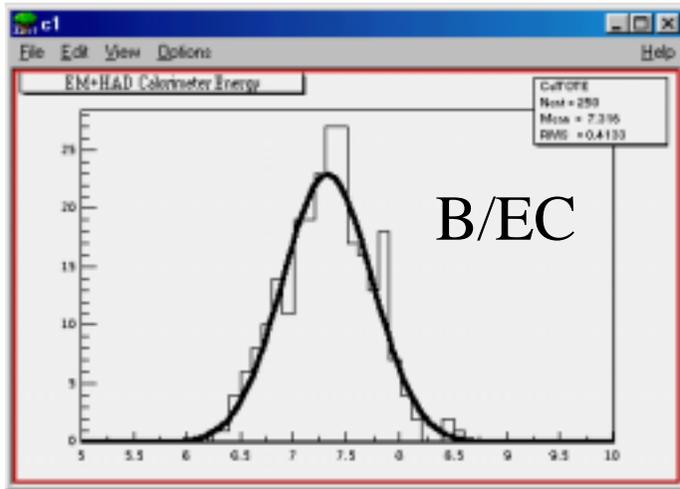
cone from $r=1.2$ cm at $z=10$ cm to
 $r=20$ cm at $z=155$ cm



Barrel/Endcap Region

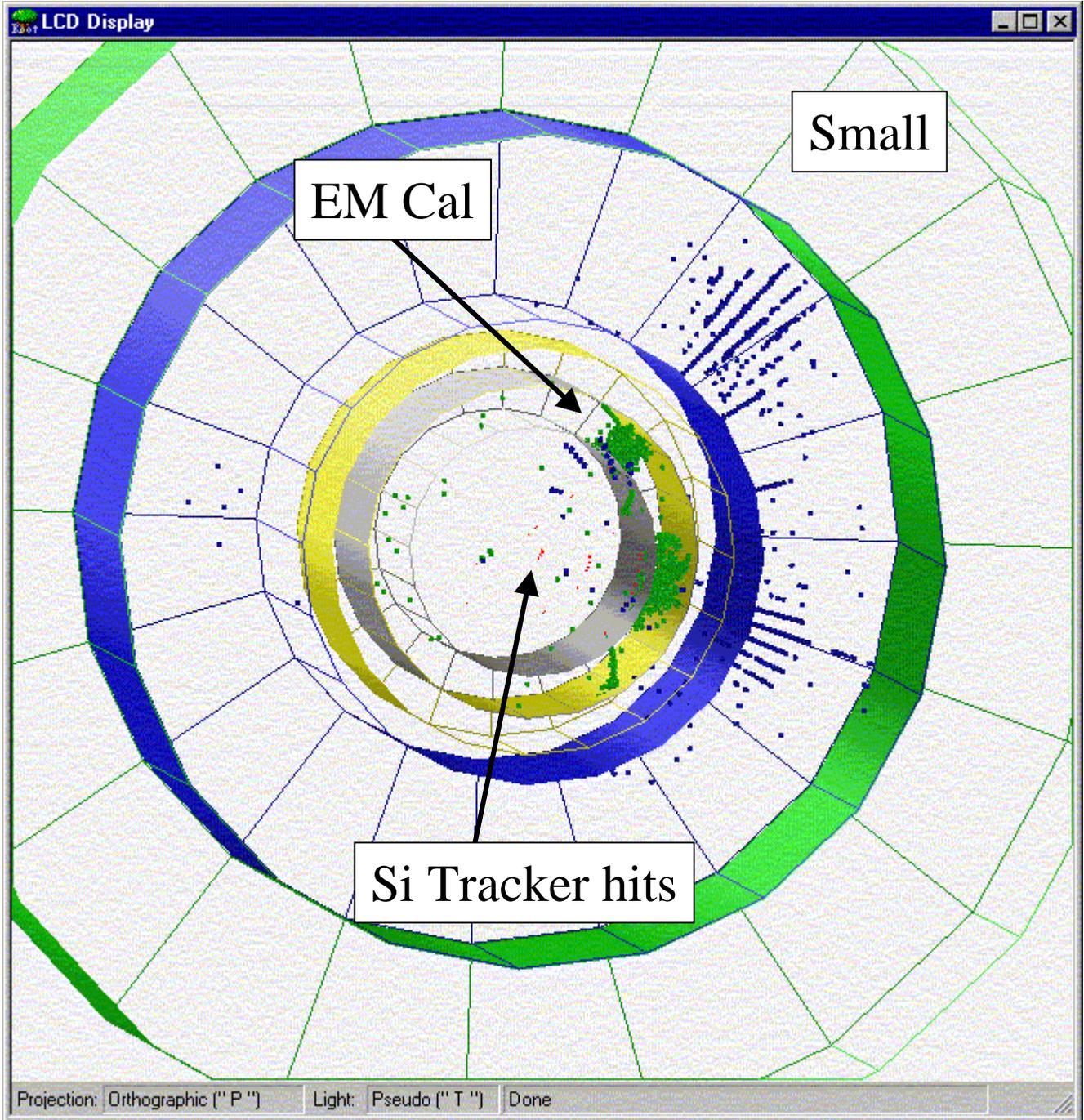
R.Dubois

- $\langle E \rangle$ 15% lower than barrel
- $\sigma/\langle E \rangle$ 15% higher



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$$e^+e^- \rightarrow ZZ$$

Large Strawman Design

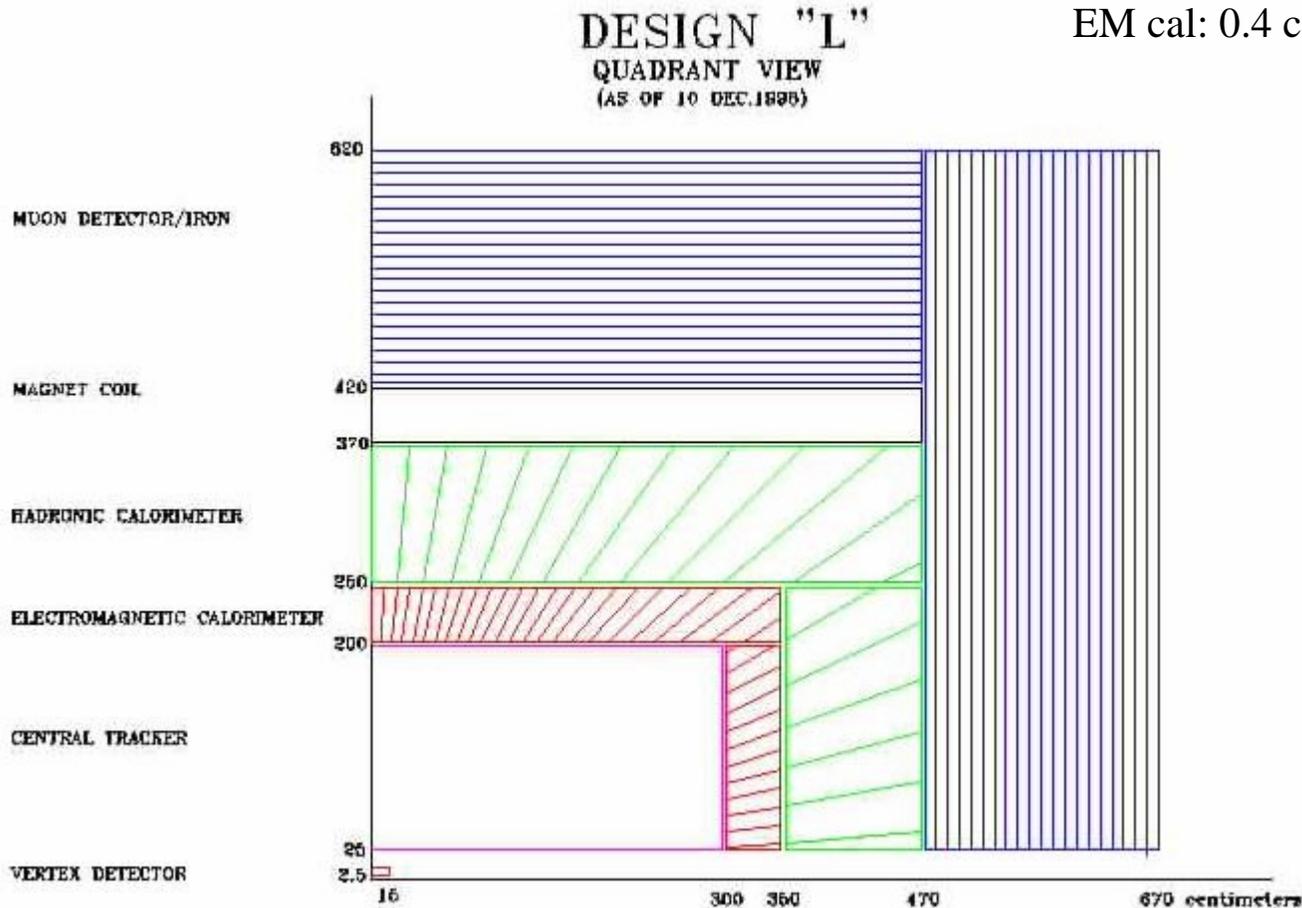
R.Dubois

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



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Large Detector: Central Detector

144 Layer TPC

$r = 25\text{-}200\text{ cm}$

length = 5.8 m

4.5 cm Al endplates

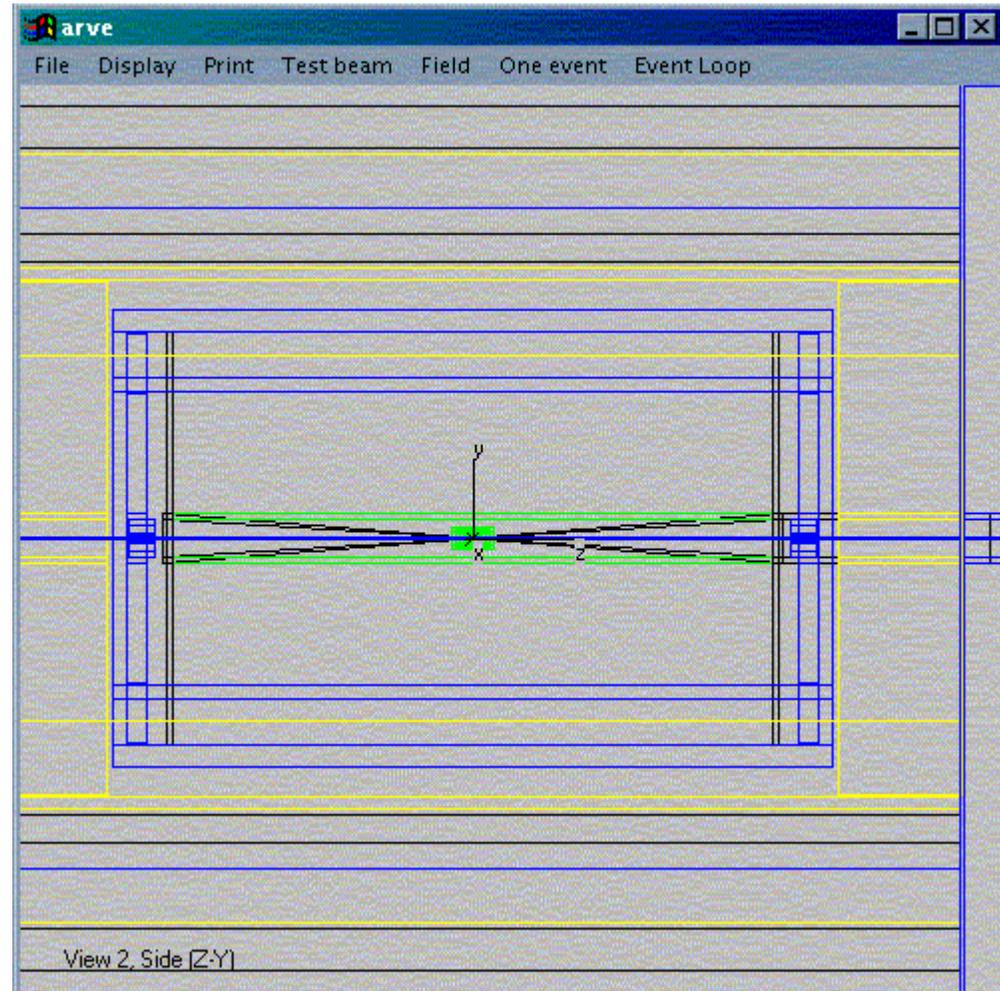
0.18 cm Al inner/outer skins

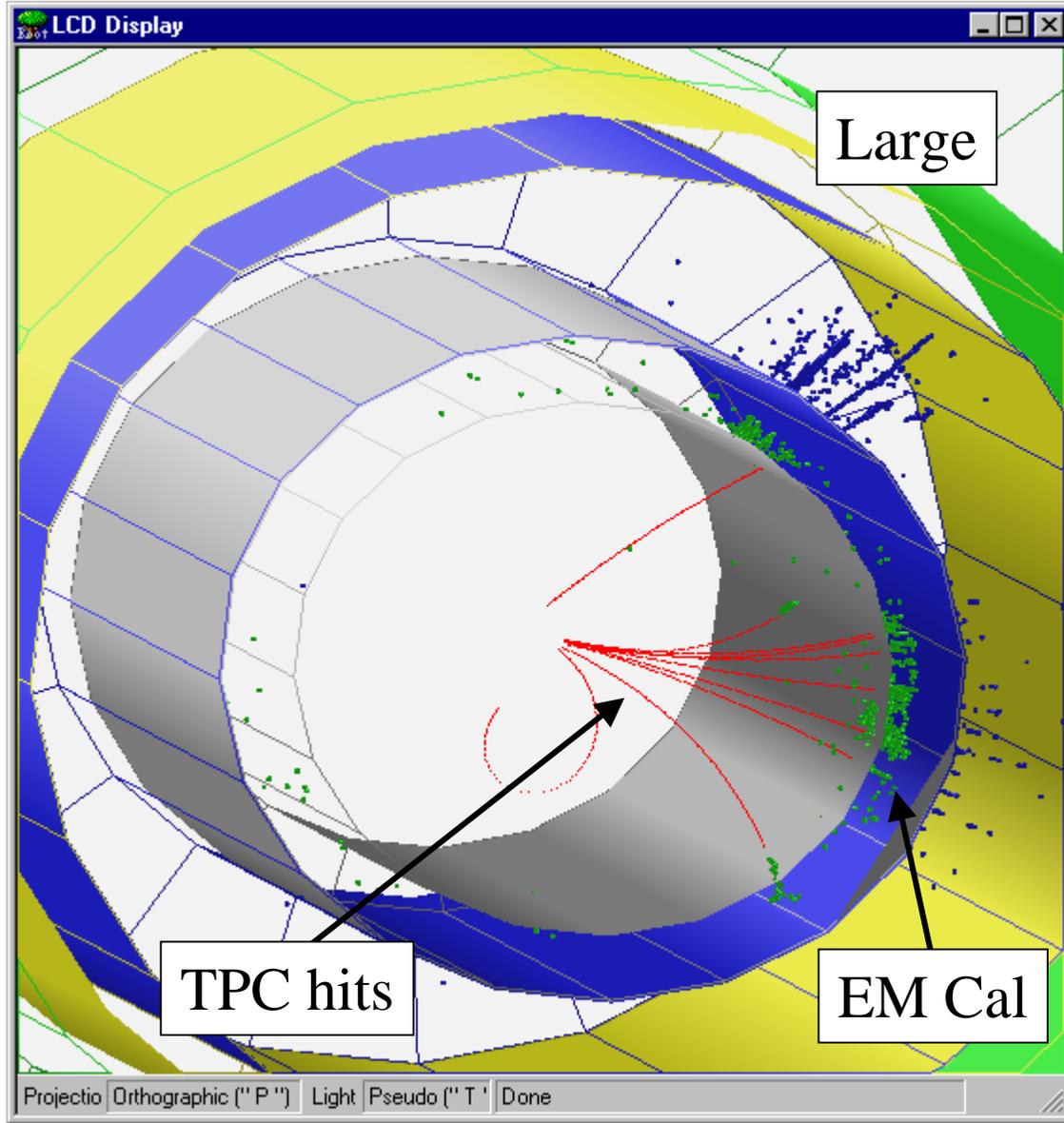
Luminosity monitor (Si/W)

active from 16-83 mrad

'Vestigial' mask

cone from $r=1.2\text{ cm}$ at $z=10\text{ cm}$ to
 $r=25\text{ cm}$ at $z=300\text{ cm}$





$$e^+e^- \rightarrow ZZ$$

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 brems photons in the central detector. The bremsing electron is terminated and e, γ daughters carry on.

MC Farms & Platforms

- MC Farms

- SLAC ran udsbc (AIX,Sun)
- Michigan ran tt̄ (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

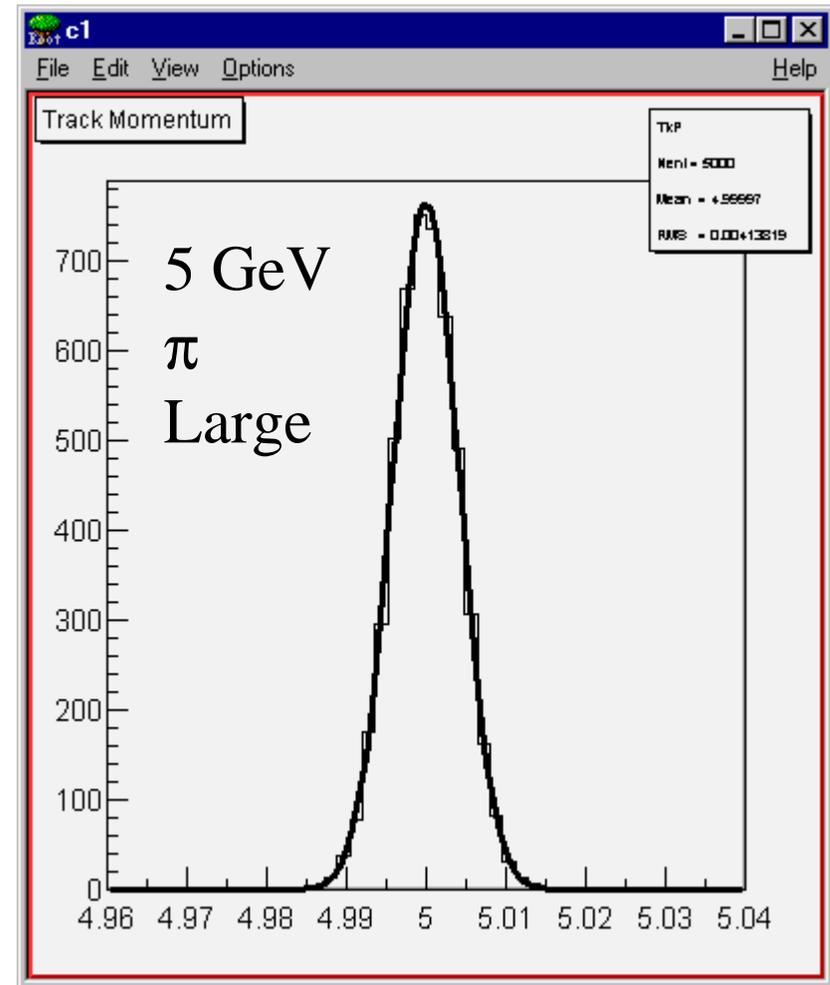
- ~2 mins/event for udsbc 500 GeV on 400 MHz Solaris

- Platforms

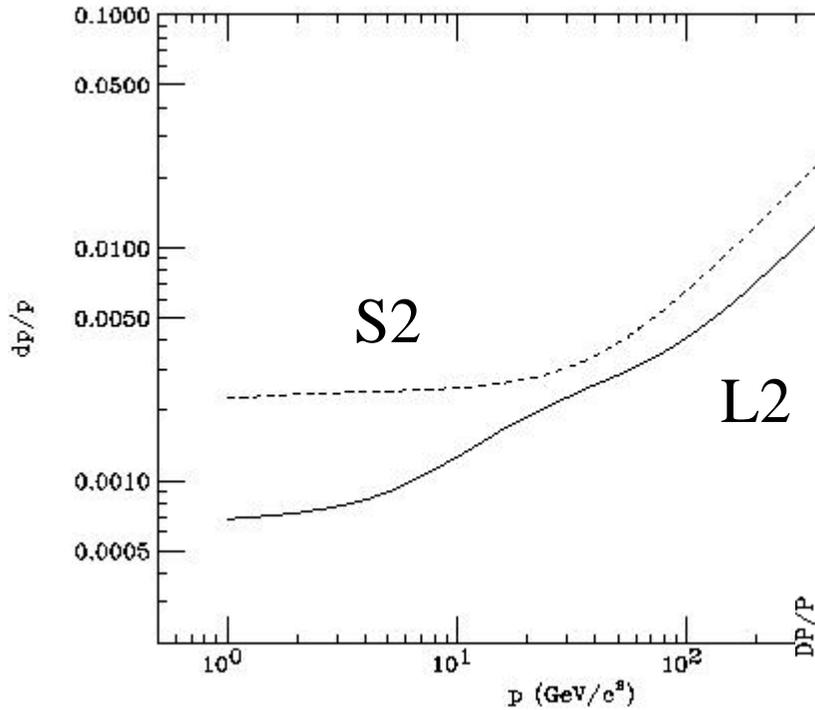
- AIX
- Solaris
- DEC Unix
- Linux
 - compiler bug - can only run non-optimized
- Windows

- Tracking

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

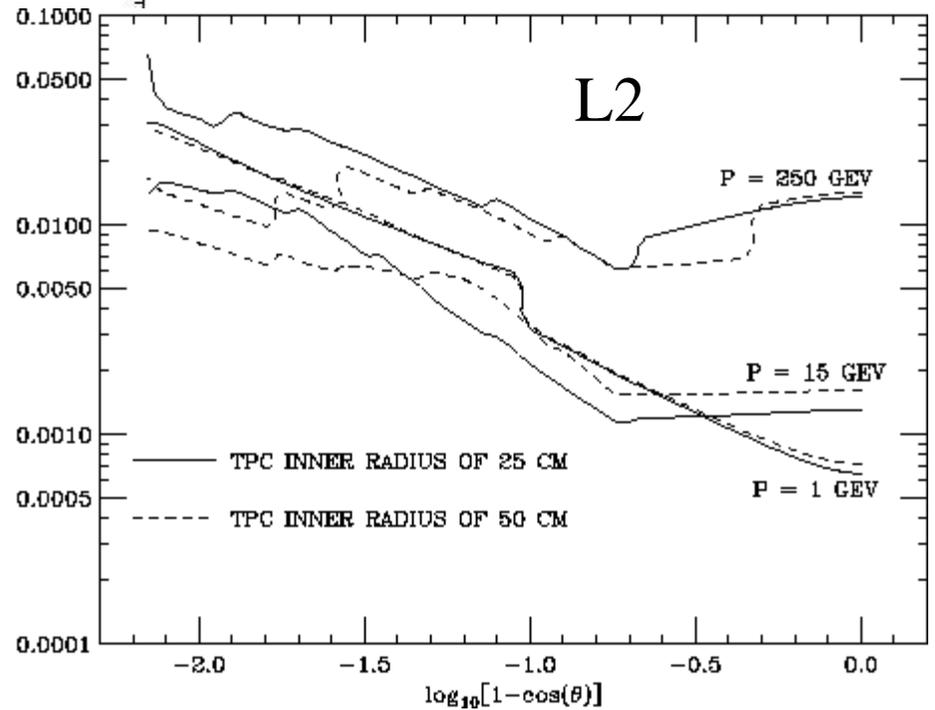


Track Resolution



vs p

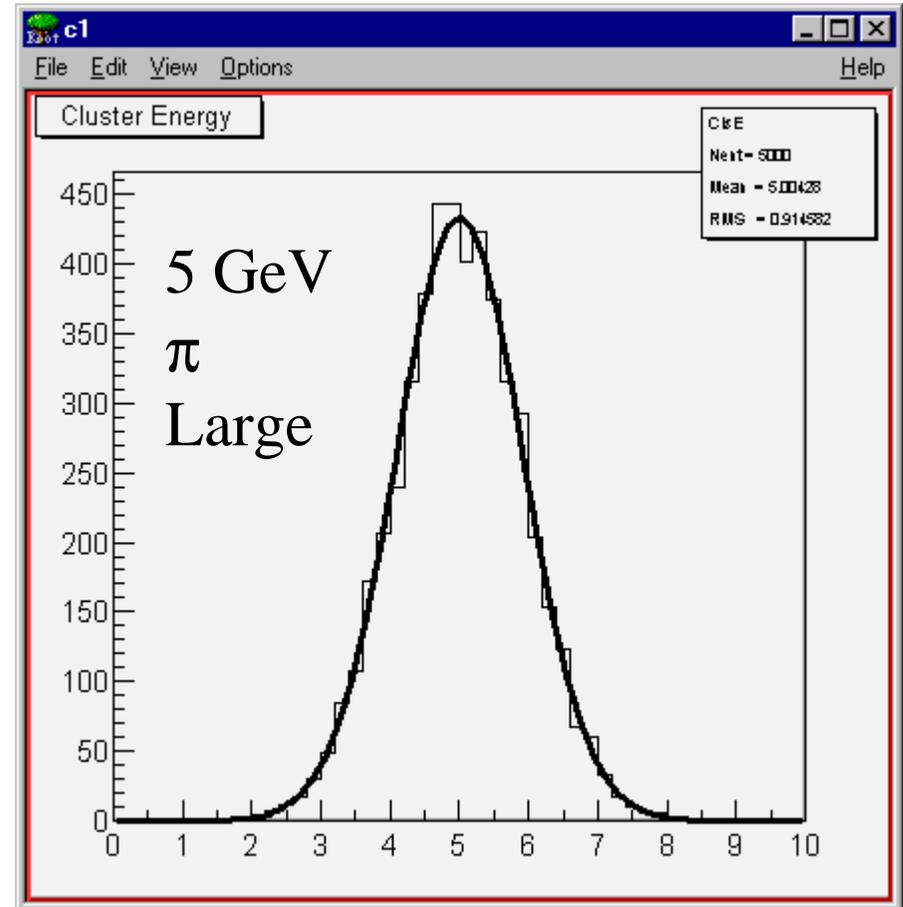
vs polar angle



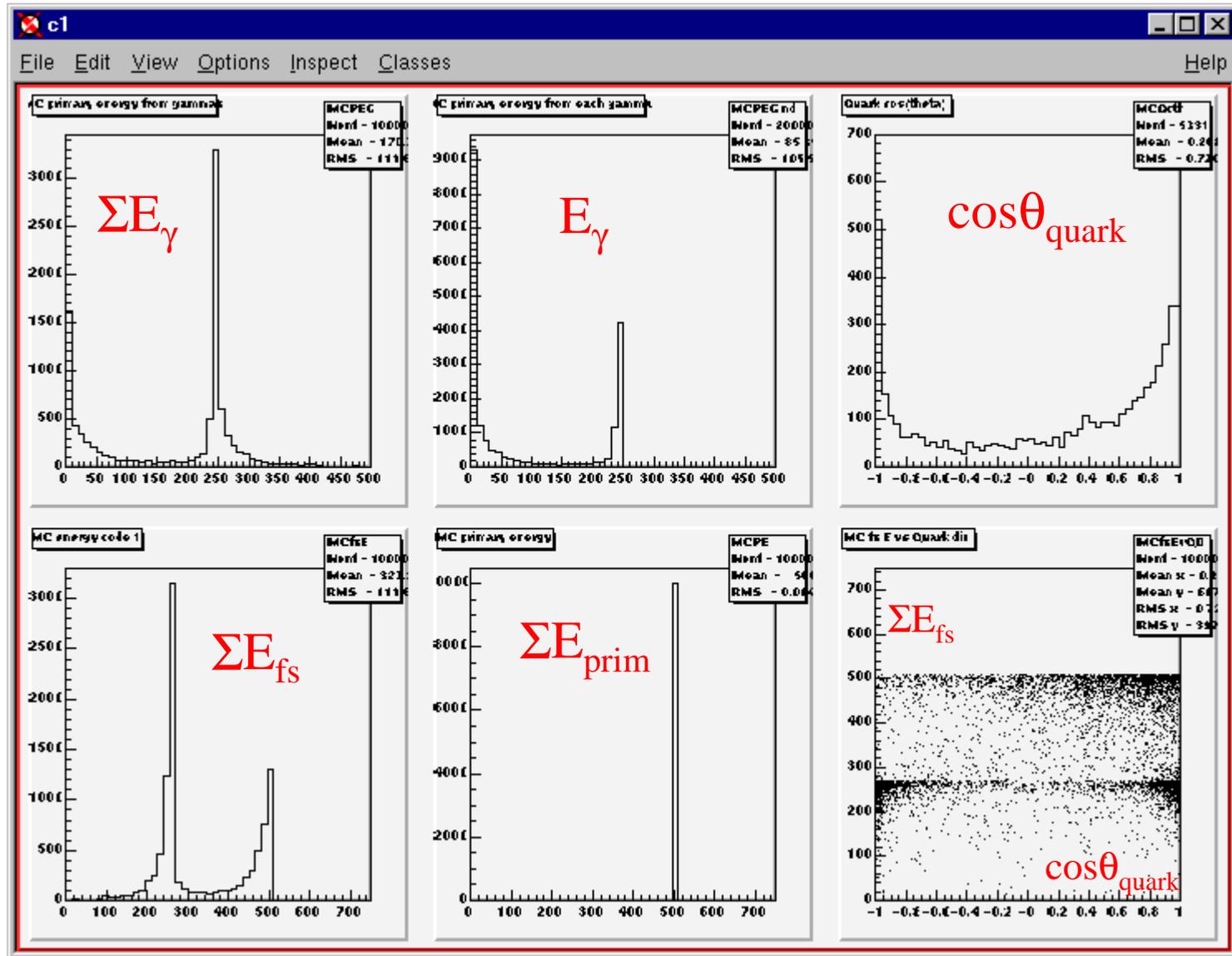
- Calorimetry

- extrapolate final state particles to Cal front face (linear or helix)
- supply $\langle X_0 \rangle$, $\langle \Lambda \rangle$ 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.



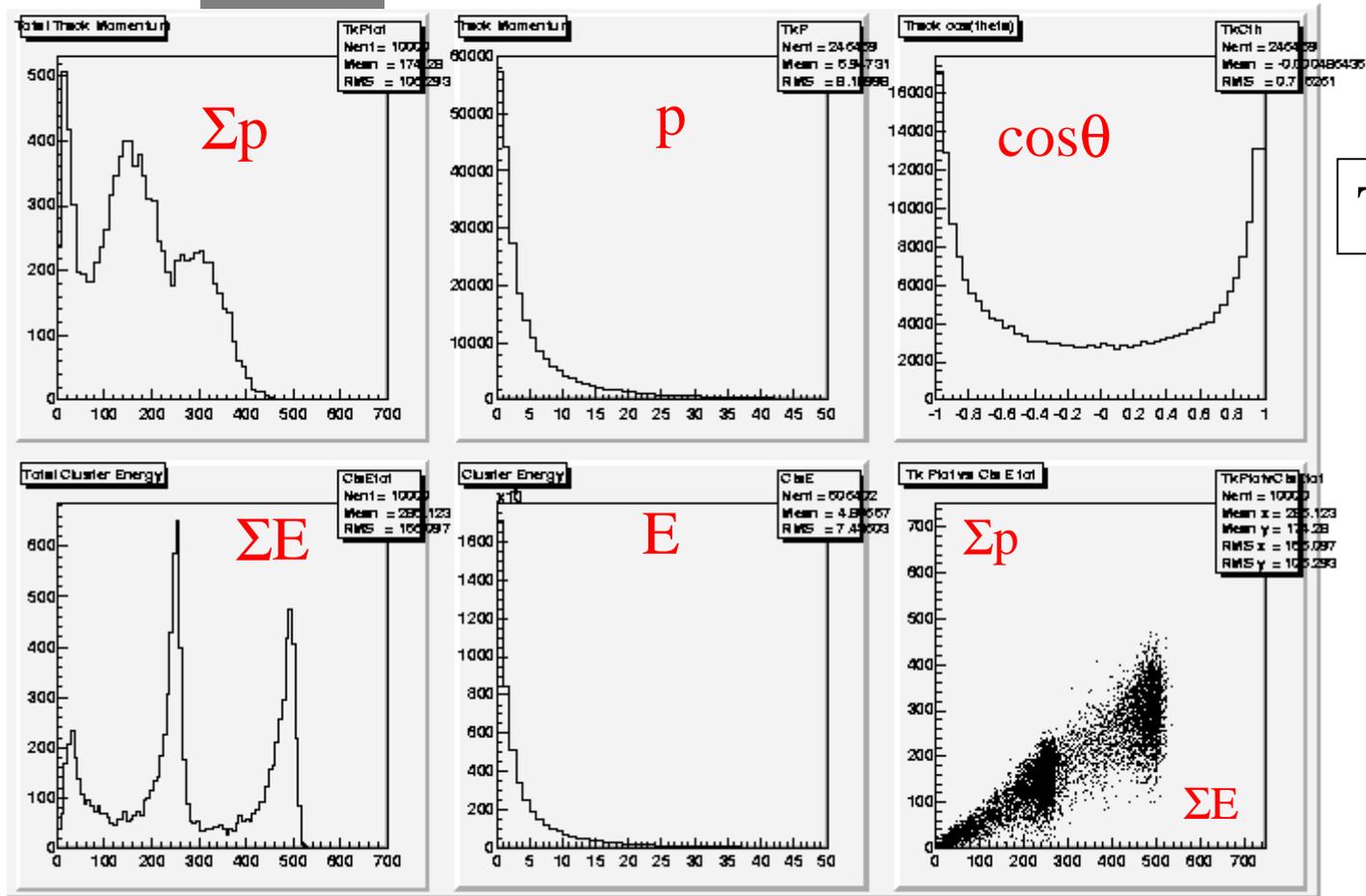
MC Truth for udscb



udscb Detector Quantities

R.Dubois

Small



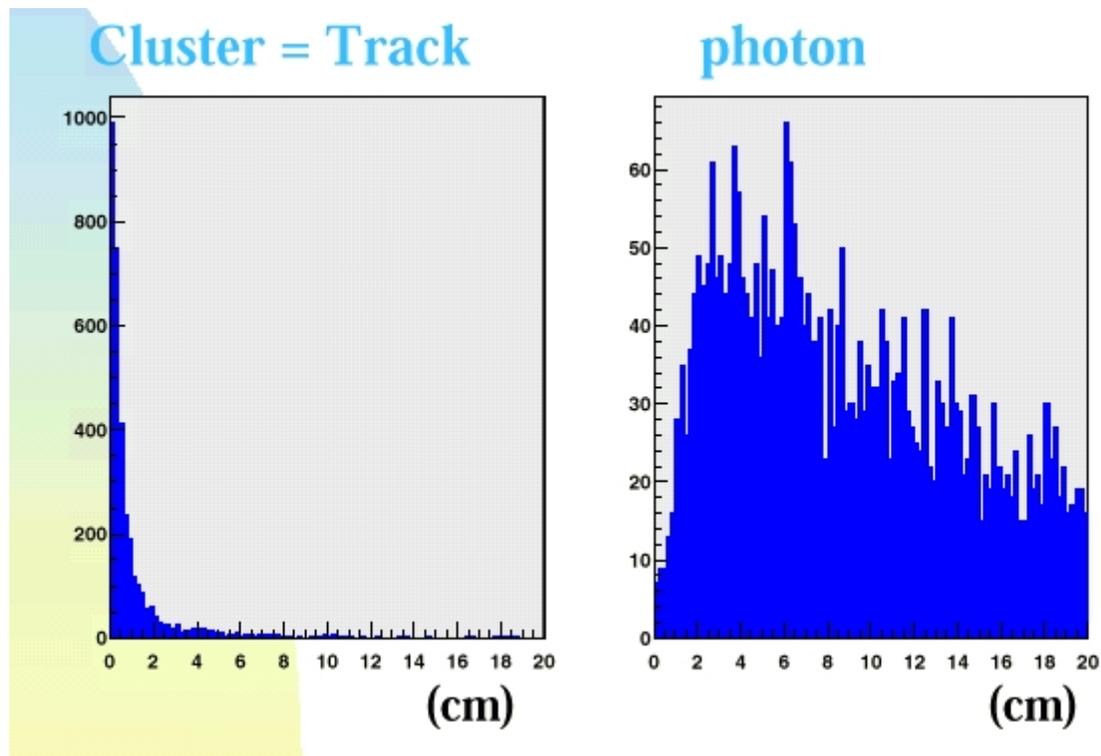
Tracks

Clusters

What you get from the FastMC

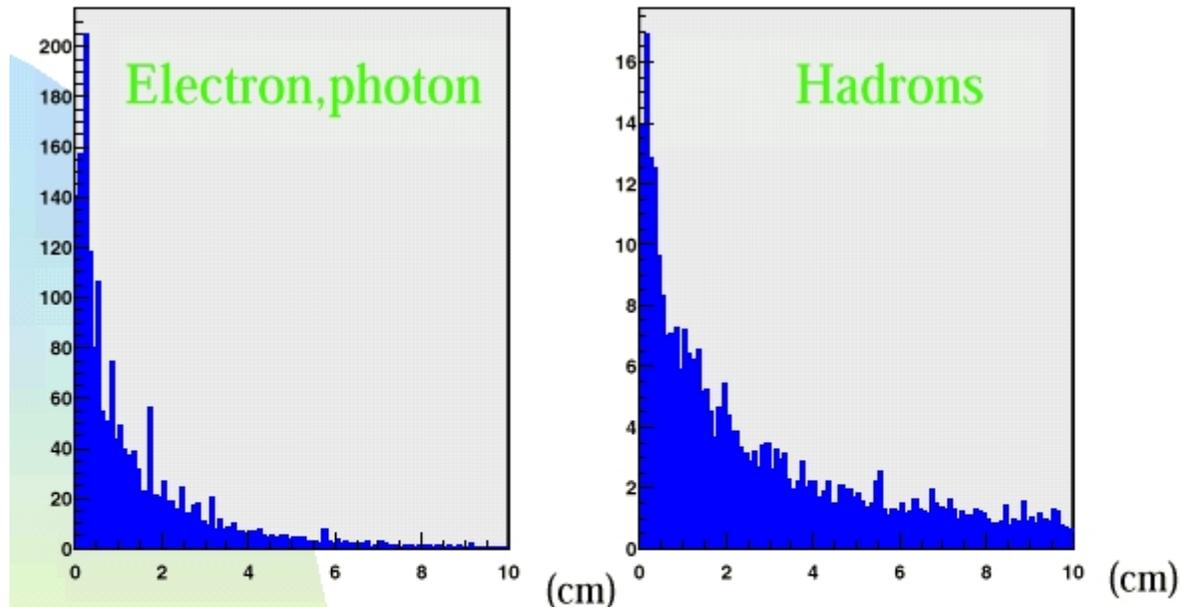
- Tracks
 - (x,y,z) , (p_x, p_y, p_z) at IP
 - charge
 - helix parameters and diagonal error matrix
- MC Truth table
 - same as for fullSim
- Calorimeter Clusters
 - $\langle \cos\theta \rangle$, $\langle \phi \rangle$, ΣE
 - list of MC parents and how much energy they contributed

tt 6 jets with FastMC



Track-cluster association

Cluster Separation



Distance between McPart and CAL Hit

Small 1.3 ± 0.3 cm

3.2 ± 0.3 cm

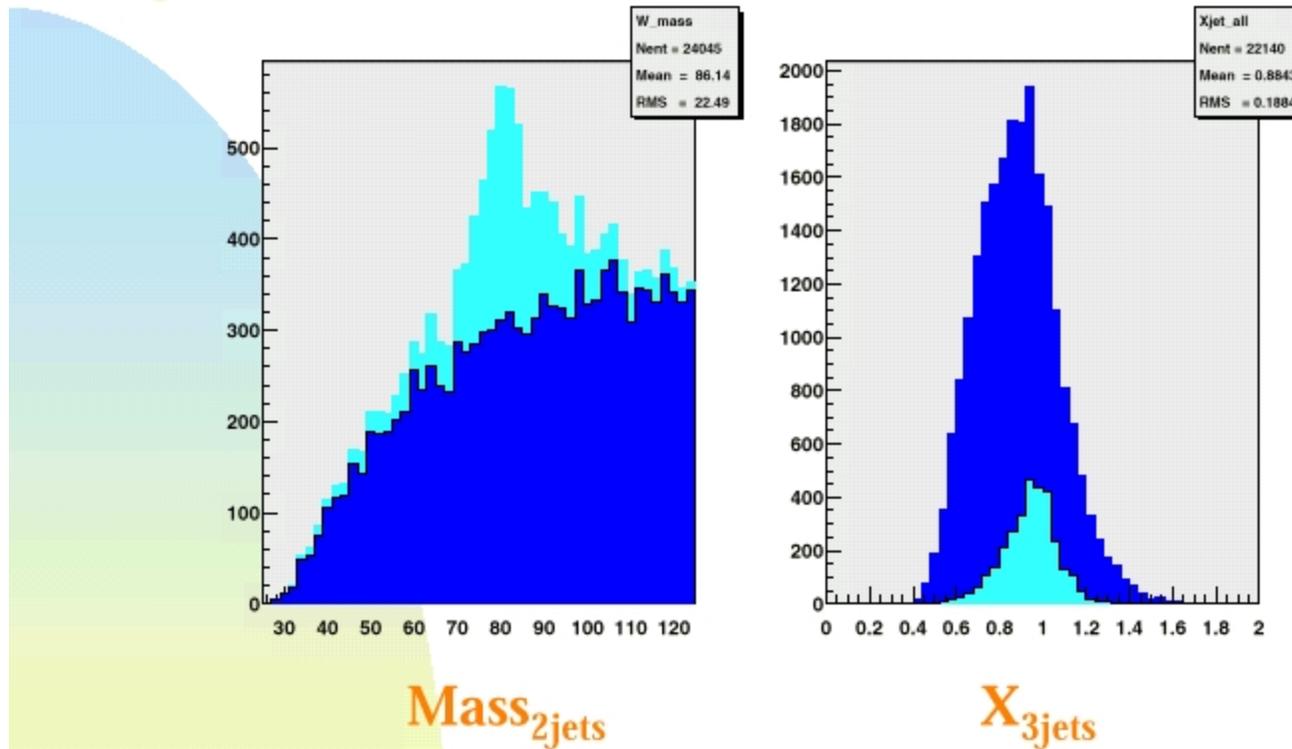
Large 1.3 ± 0.4 cm

3.5 ± 0.4 cm

Tune FastMC to Full MC response

Reconstructing 6 jets

$tt \rightarrow 6\text{jets}$ reconstruction

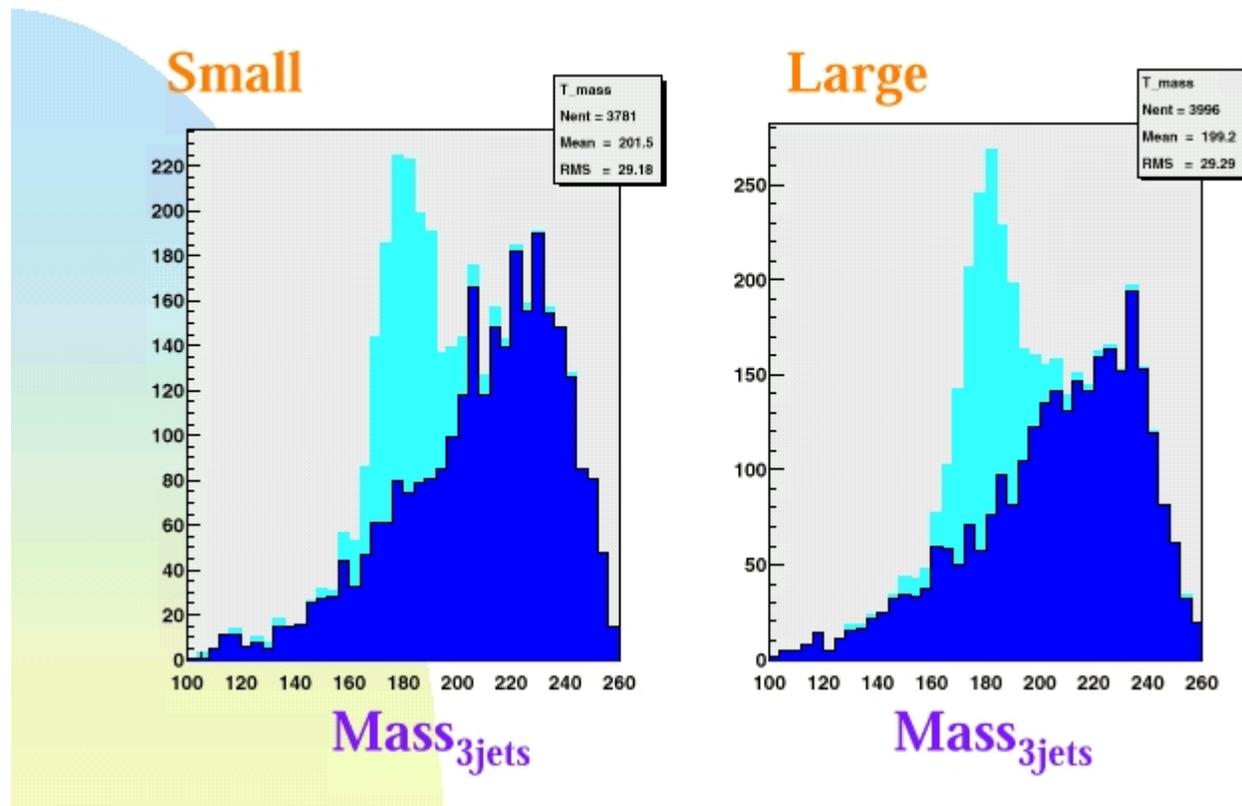


Reconstructed W mass resolution ~ 8.4 GeV

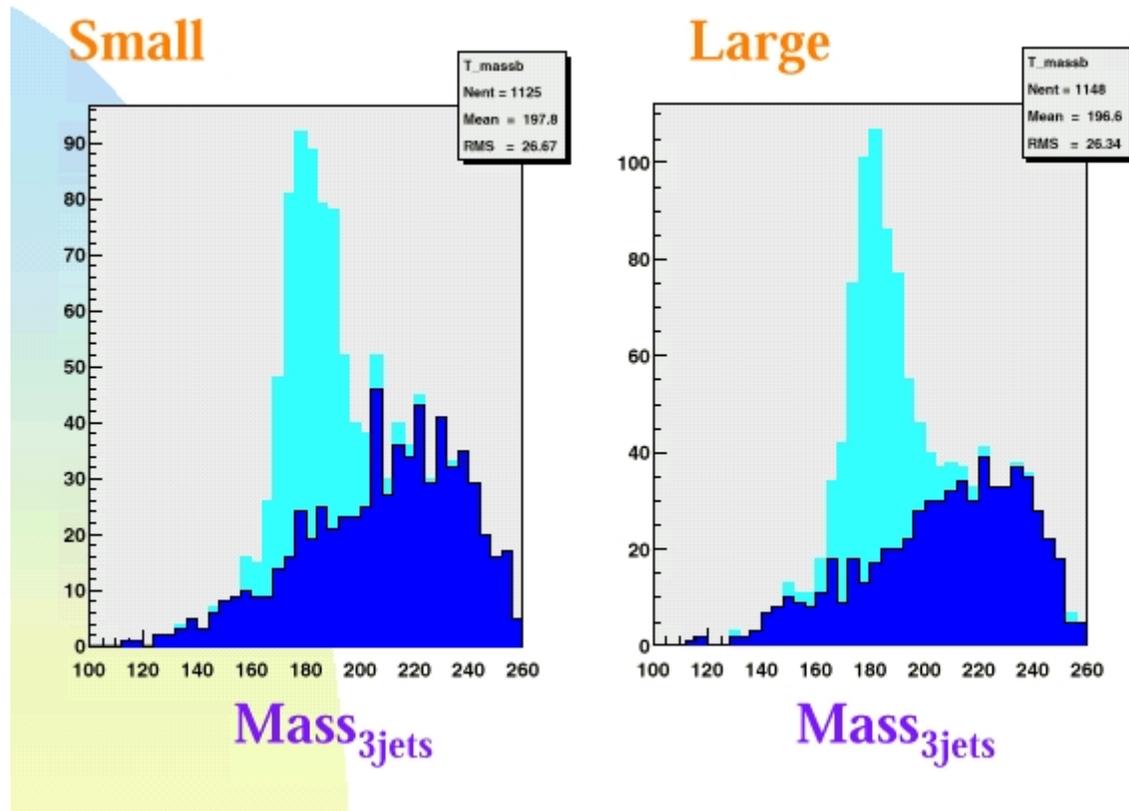
Chg trks use tracker; unassoc clusters use CAL

3-jet masses

$tt \rightarrow 6\text{jets}$ reconstruction



3 jet masses with b-tag



Miscellany

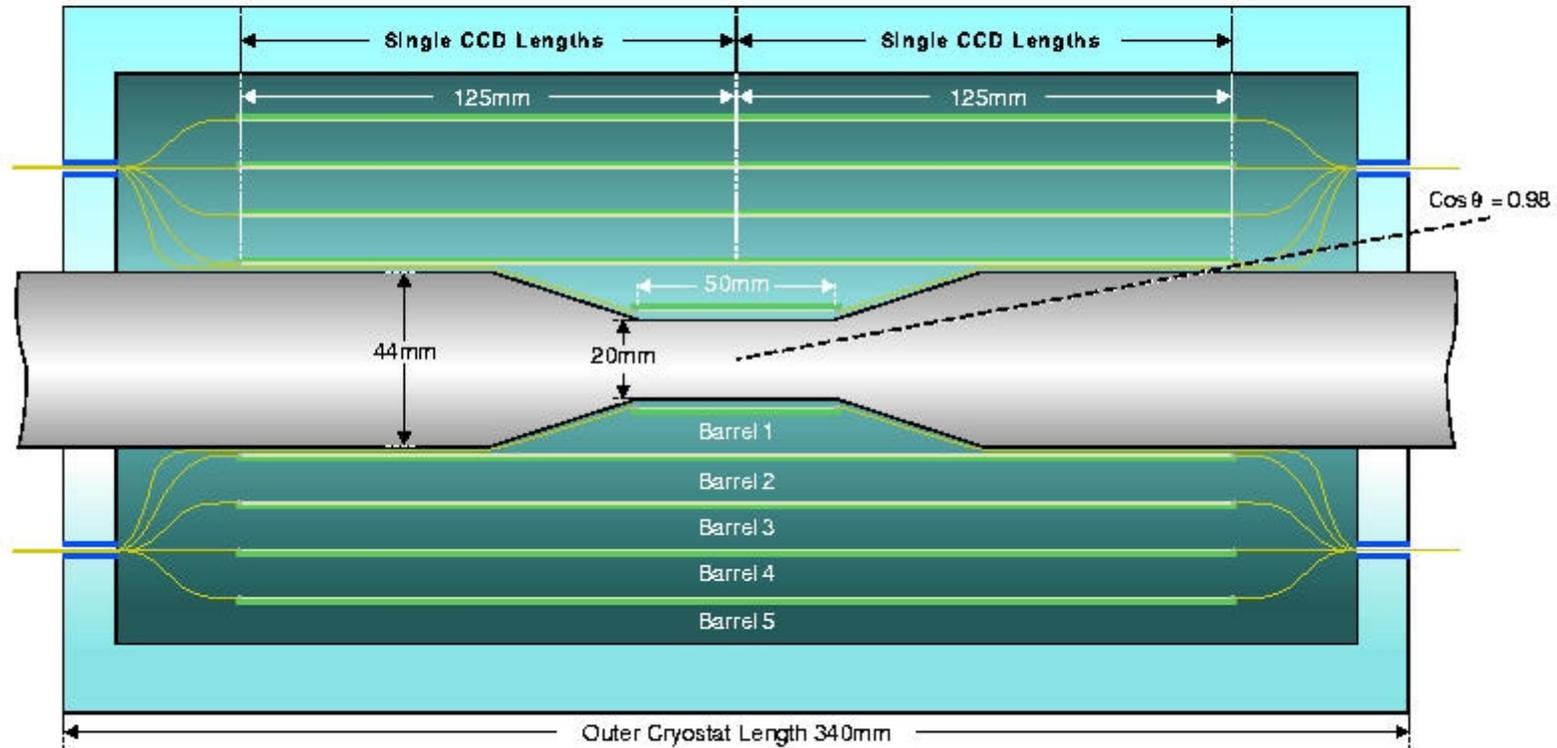
R.Dubois

- 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

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Beam Backgrounds Overlays

- 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)

