

LCDROOT status and plan

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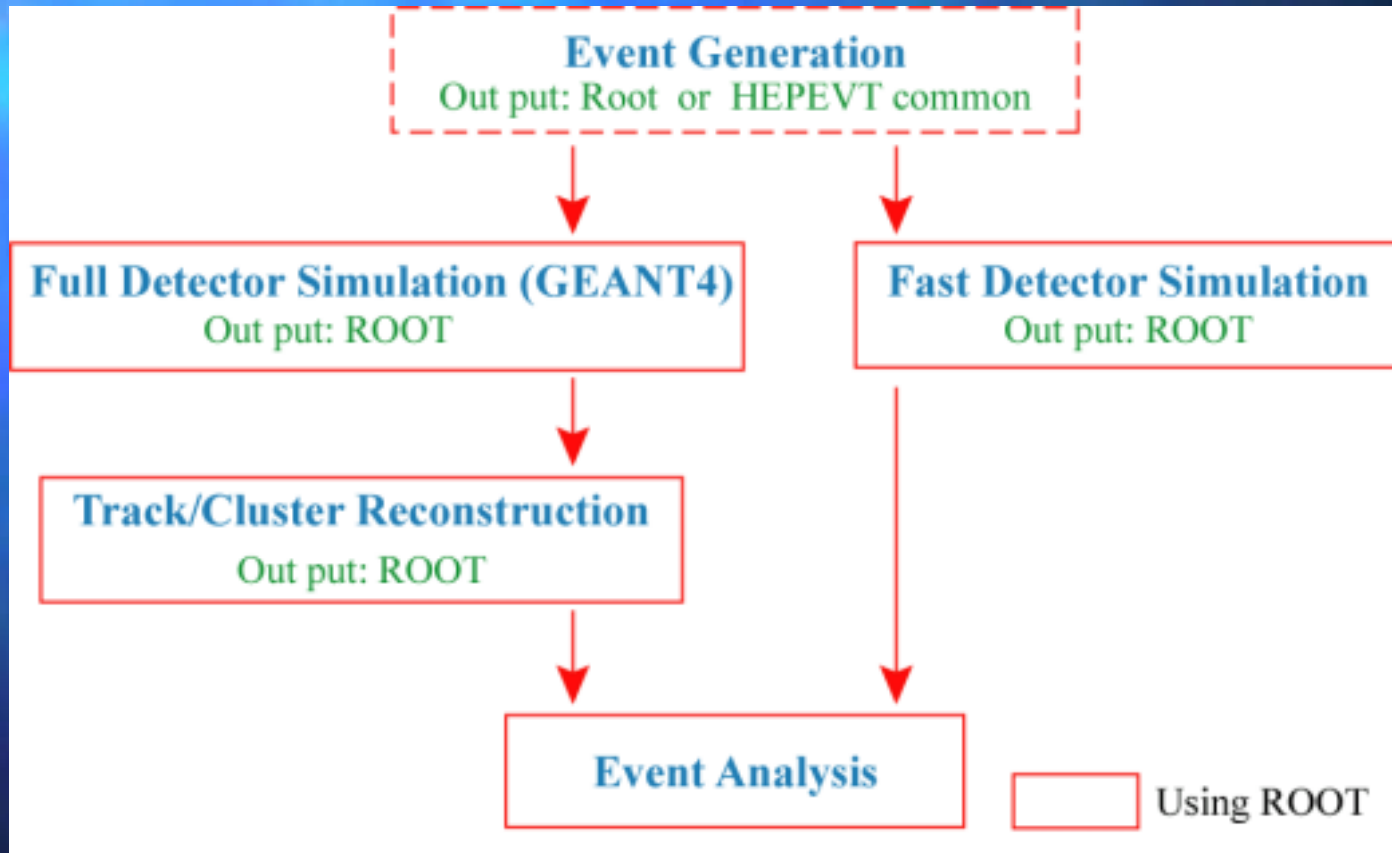
Introduction

- We have developed a simulation and analysis package based on ROOT.
→ LCDROOT
- We believe that vertexing and energy flow are very important for future linear collider experiments.
- In this talk, I will introduce what we can do with LCDROOT.

Topics of Discussion

- LCDROOT analysis flow
- Generator
- Fast MC
- Analysis
 - Vertexing (ghost track algorithm)
 - Energy flow
- Full simulation (GEANT4)
- Track fitter (Kalman Filter)

LCDROOT analysis flow



Generator

- PANDORA (C++) by M. Peskin with
PYTHIA/TAUOLA interface (M. Iwasaki)
Include beam polarization, beamstrahlung, ISR
Can directory handle in LCDROOT
→ main generator of LCDROOT
- PYTHIA (TPythia6 for interface class)
- Output: ROOT or stdHEP (not yet windows)
Or can be directly linked to FastMC

Simulation (Full Recon.)

- Track

 - Smear & bend charged particles

 - Set 5 parameter error matrix (B.Schumm)

 - Apply min-Hit & min-PT cut

- Cluster

 - Make clusters with Cheater Algorithm

 - (gather hits which are from the same particle)

Simulation (Fast MC)

- Track

 - Smear & bend charged particles

 - Set 5 parameter error matrix (B.Schumm)

- Cluster

 - Smear particle position and energy

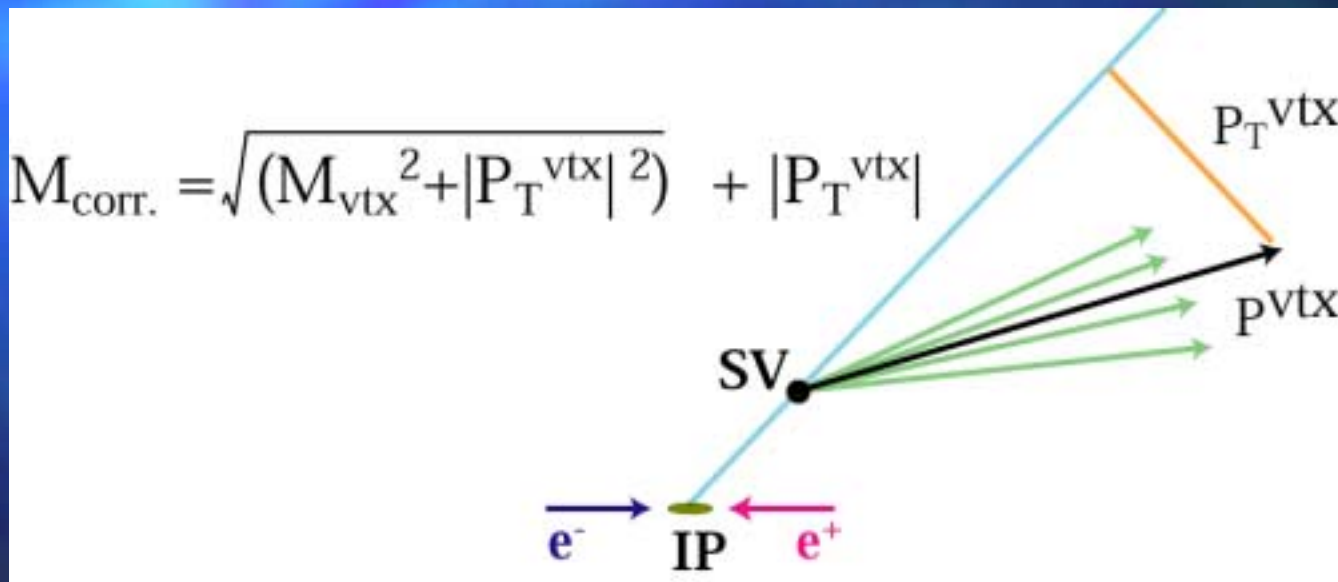
 - Cluster merging (for granularity study)

Analysis

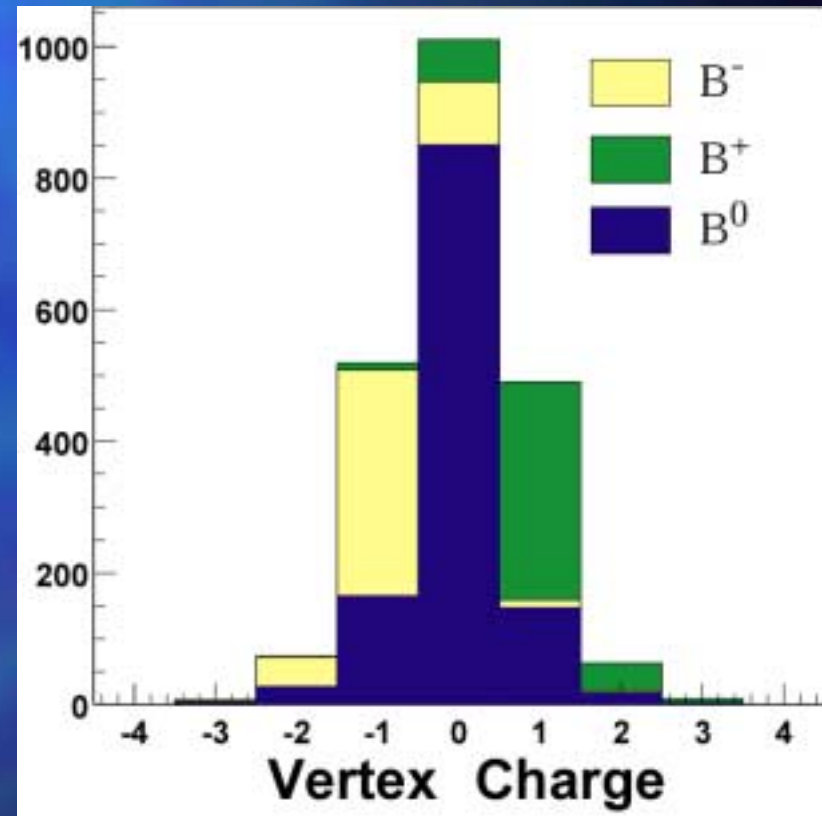
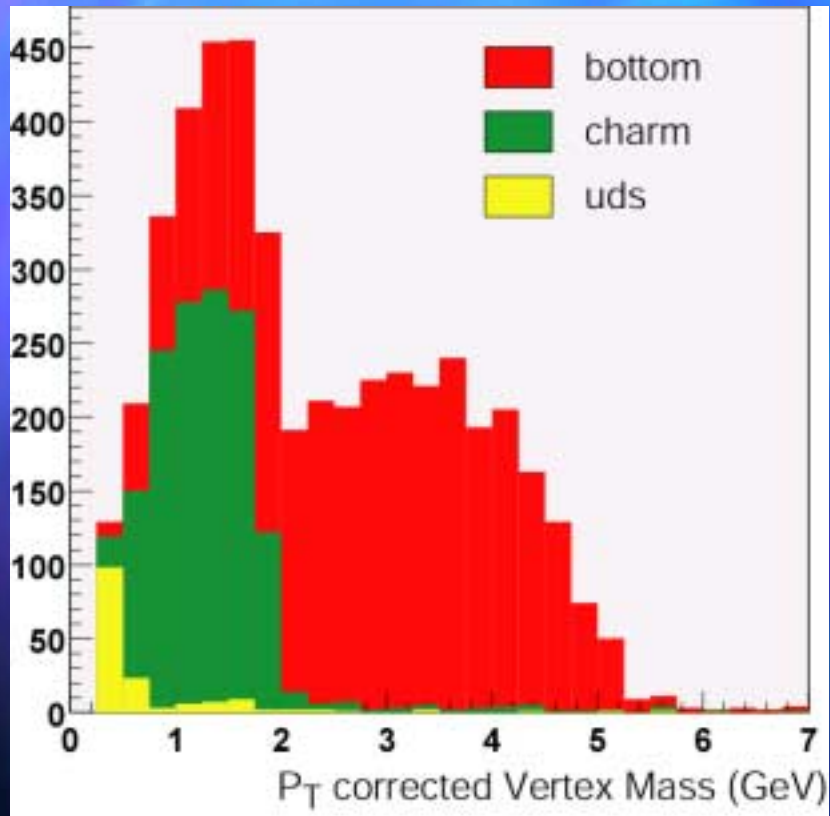
- We have several useful analysis tools for future linear collider studies
 - Jet Finder ... (Durham, Jade, Jade-E)
 - Thrust Finder
 - Particle extrapolator (for energy flow)
 - Vertex Finder and Flavor tagging

Vertex finder

- SLD's unique topological vertex finder + mass tag
D.J.Jackson NIM A388, 247 (1997)
SLD collaboration PRL 80, 660 (1998)



Vertex finder

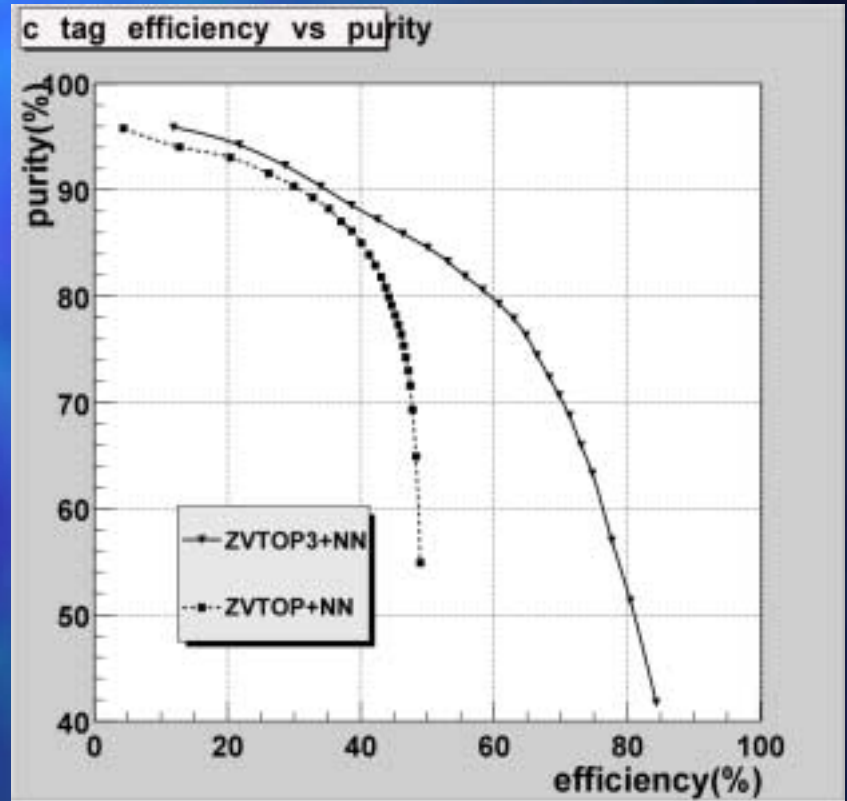
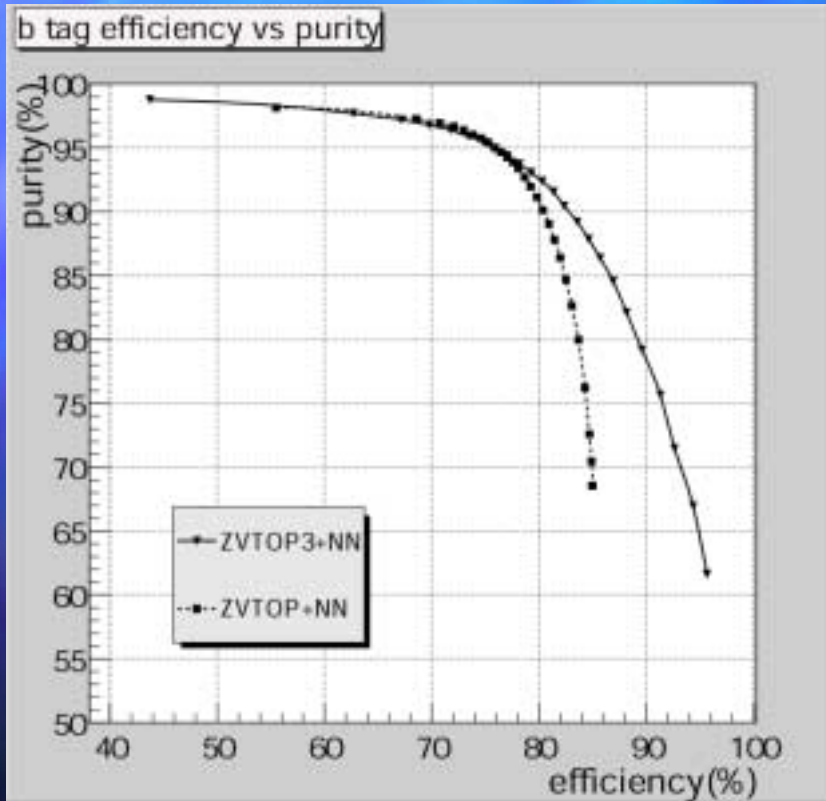


Ghost track algorithm



- Ghost-track vertex finding algorithm implementation
- Use straightness of b-decay chain

H.F. jet tag with N.N.

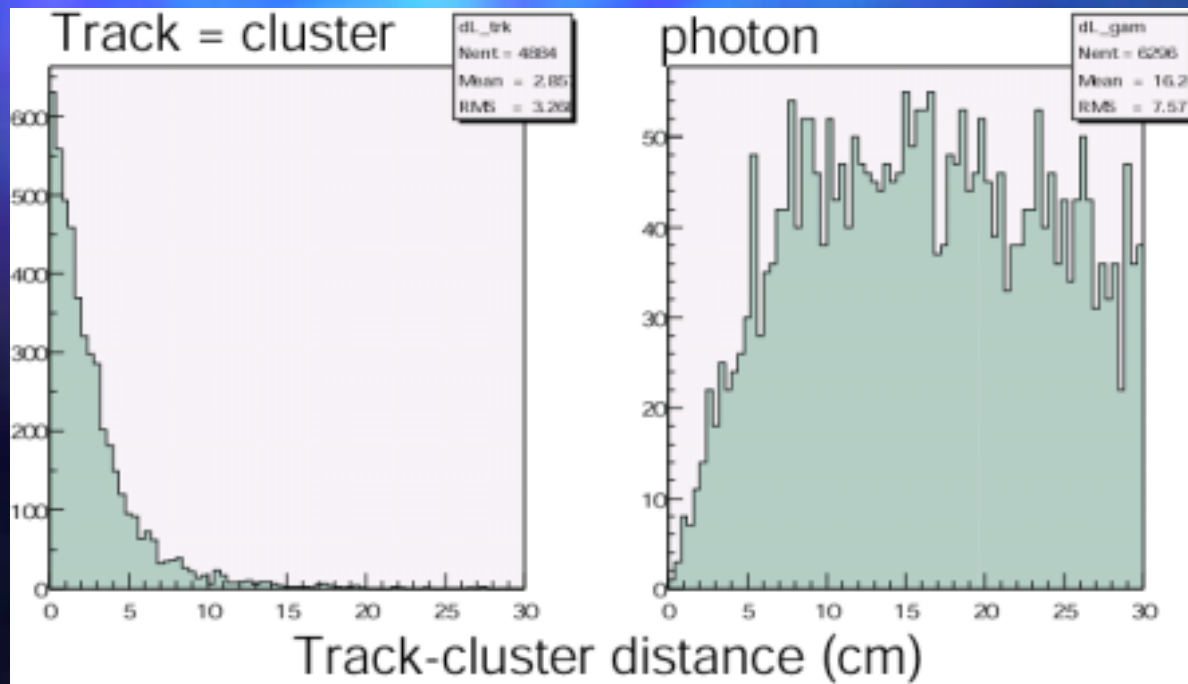


Energy flow analysis

- Requirements from future linear collider
 - very good jet energy resolution
 - needs energy flow method
 - typical multi-jet event
 - chrg. part. carry 64% $E \rightarrow$ tracker
 - photon carry 25% $E \rightarrow$ EM cal.
 - neut. Had. carry 11% $E \rightarrow$ HAD cal.
- Calorimeter must be optimized for energy flow. \rightarrow need detailed detector study.

Track extrapolator

- Reconstructs jets from tracks + neutral clusters
- Select neutral clusters by seeing track-cluster matching



Track-cluster cut: 8cm
Reject 93% charged
Keep 92% neutral

Detector geometry

- Detector geometry must be flexibly set.
 - We do not want to make executables detector by detector.
- Current solution is XML.

XML is a text file and easily change detector geometry.

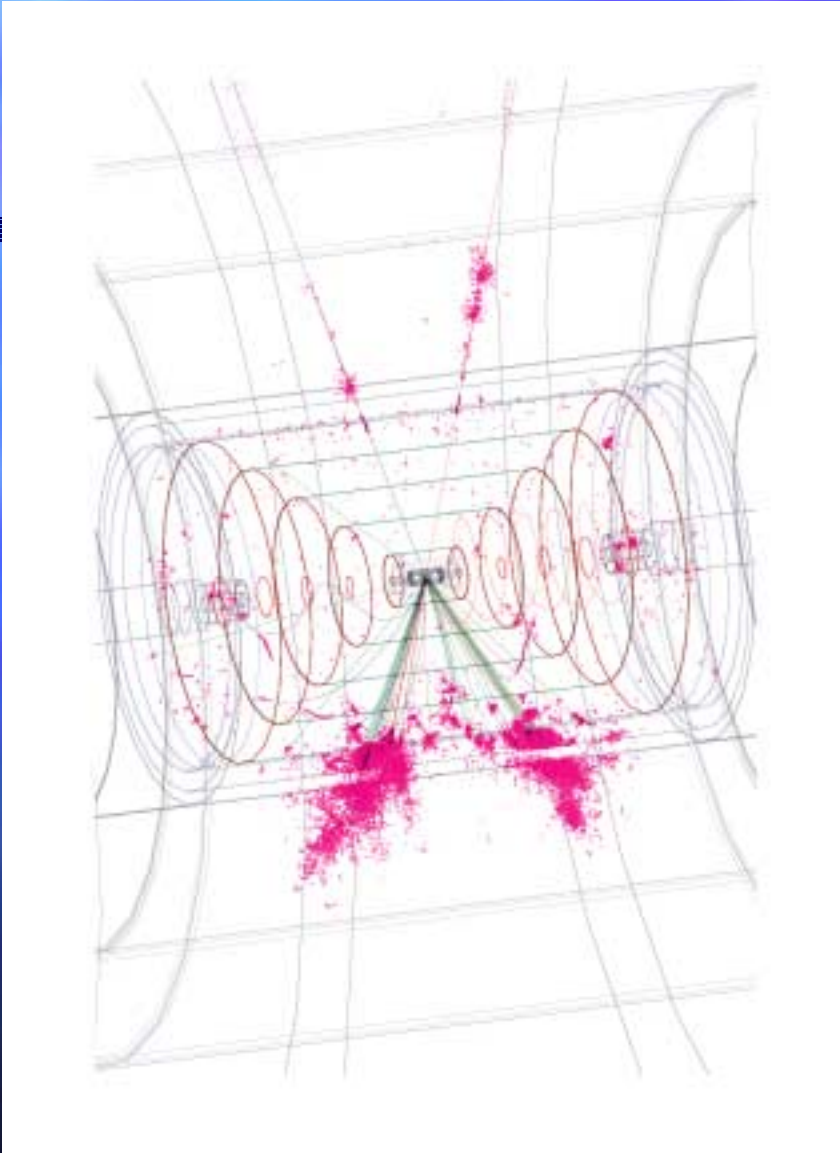
An example of XML file

```
<volume id="EM_BARREL" rad_len_cm="0.7248" inter_len_cm="0.028" >
  <tube>
    <barrel_dimensions inner_r = "127.0" outer_z = "210.0" />
    <layering n="30">
      <slice material = "W" width = "0.25" />
      <slice material = "Si" width = "0.04" sensitive = "yes" />
      <slice material = "G10" width = "0.2" />
      <slice material = "Air" width = "0.01" />
    </layering>
    <segmentation cos_theta = "840" phi = "1680" />
  </tube>
  <calorimeter type = "em" />
</volume>

<volume id="HAD_BARREL" rad_len_cm="1.133" inter_len_cm="0.1193">

  <tube>
    <barrel_dimensions inner_r = "153.0" outer_z = "312.0" />
    <layering n="34">
      <slice material = "Stainless_steel" width = "2.0" />
      <slice material = "Polystyrene" width = "1.0" sensitive = "yes" />
    </layering>
    <segmentation cos_theta = "600" phi = "1200" />
  </tube>
  <calorimeter type = "had" />
</volume>
```

$ee \rightarrow ZH ; Z \rightarrow \mu\mu$ (with SD)



VXD: CCD

Tracker: Silicon strip
(5 layers)

Magnet: 5 Tesla

EM Calorimeter:

Si+W

$5 \times 5 \text{ mm}^2$

$R = 127 \text{ cm}$

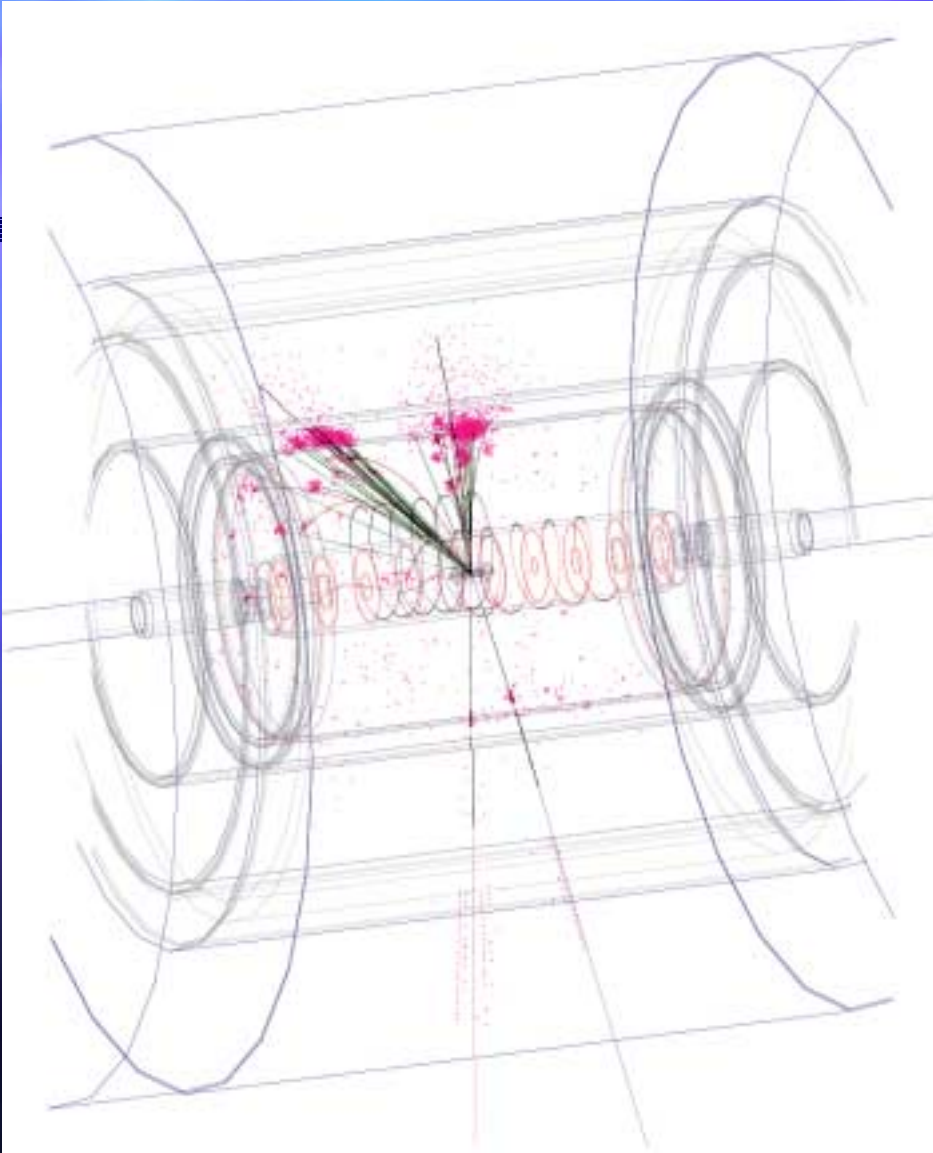
HAD Calorimeter:

Stainless Steel

+ Scintillator

$1 \times 1 \text{ cm}^2$

$R = 143 \text{ cm}$



$ee \rightarrow ZH ; Z \rightarrow \mu\mu$ (with LD)

VXD: CCD

Tracker: TPC

Magnet: 3 Tesla

EM Calorimeter:

Pb+Scintillator

$5 \times 5 \text{ cm}^2$

$R = 200 \text{ cm}$

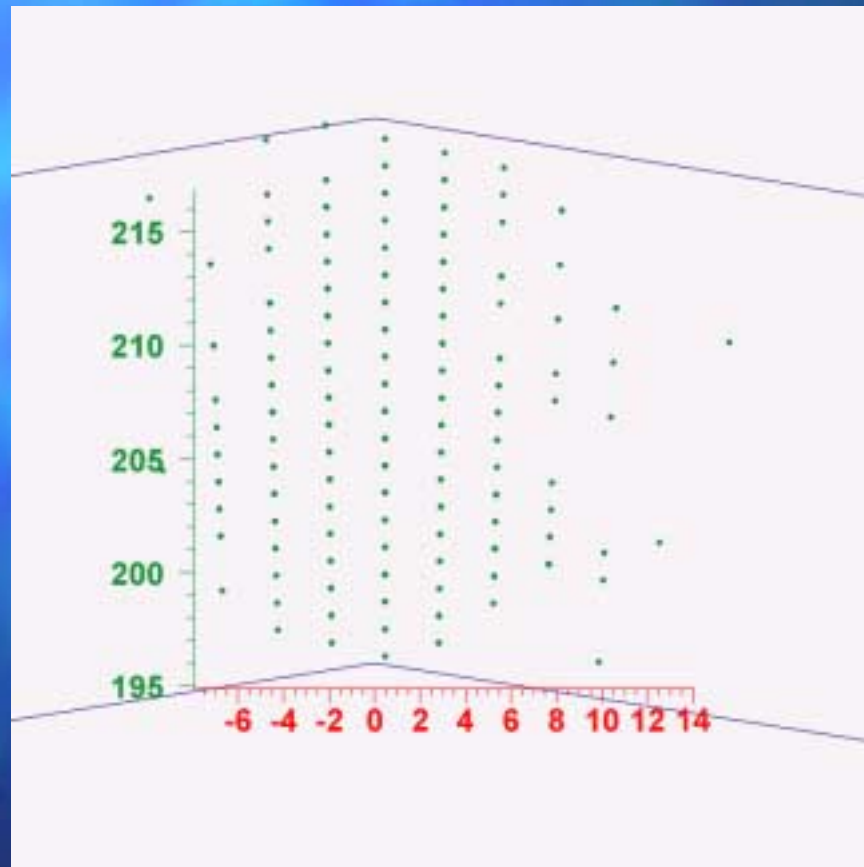
HAD Calorimeter:

Pb+Scintillator

$20 \times 20 \text{ cm}^2$

$R = 250 \text{ cm}$

Staggered geometry (New)



10 GeV photon
EM calorimeter

LCDGEANT4

- We use GEANT4.4.0 and ROOT3.2.7.
- Input generator data is ROOT file format or STDHEP format.
- Output data (hits,...) is written in ROOT file format.
- The application program works on various computer platforms (Linux, SunOS, Windows).

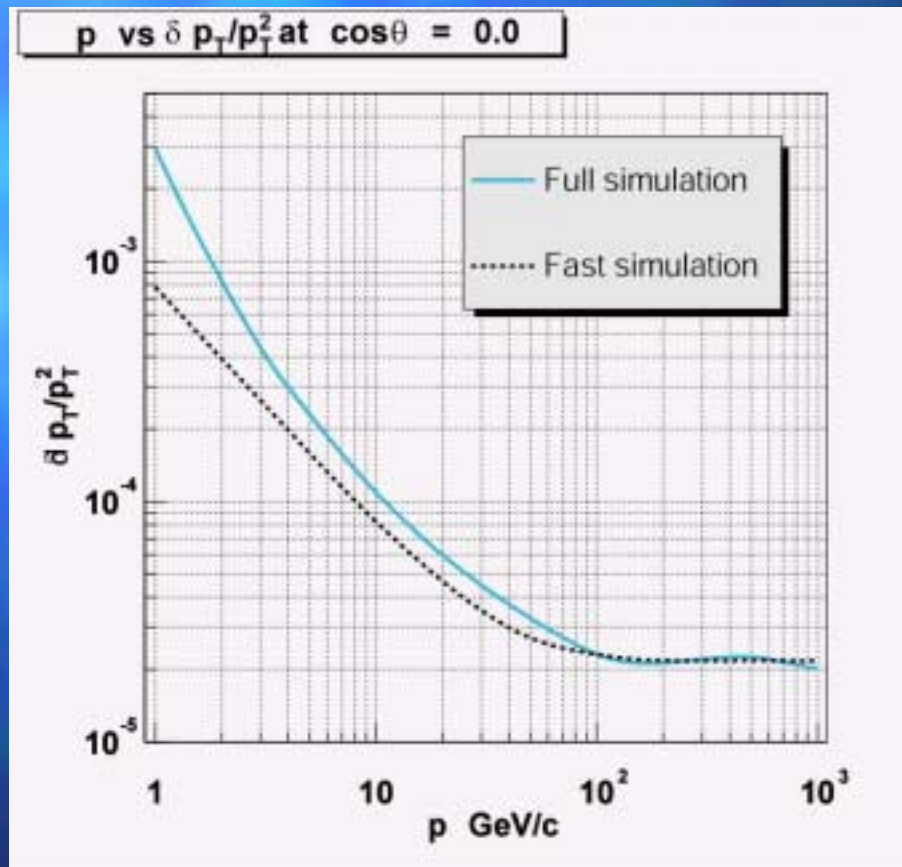
BgsG4Extension (new)

- When we try to reconstruct tracks using GEANT4, we find track hit point accuracy is not enough.
- In order to solve the problem, we use BgsG4Extension package developed by David.C.Williams (thanks!!!).
- BgsG4Extension package works very fine with LCDGEANT4.

Kalman filter track fit (New)

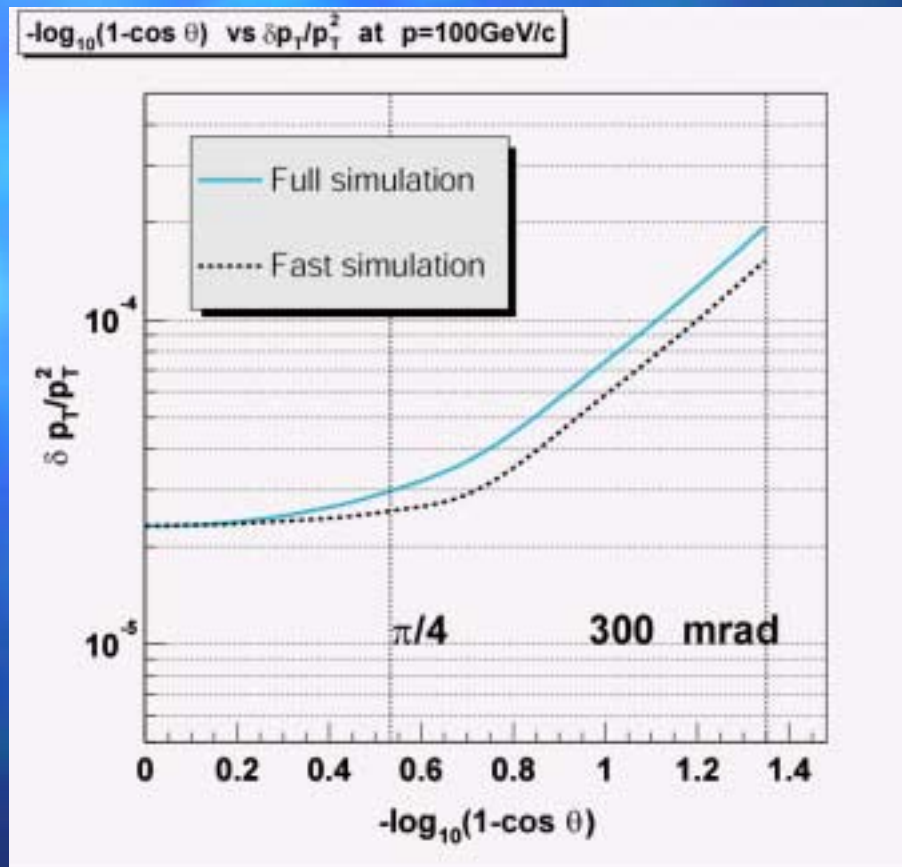
- Need to study non-gaussian effects from multiple scattering and energy loss.
- Track fitting with Kalman filter is implemented for LCDROOT, taking care of these effects.

Momentum resolution



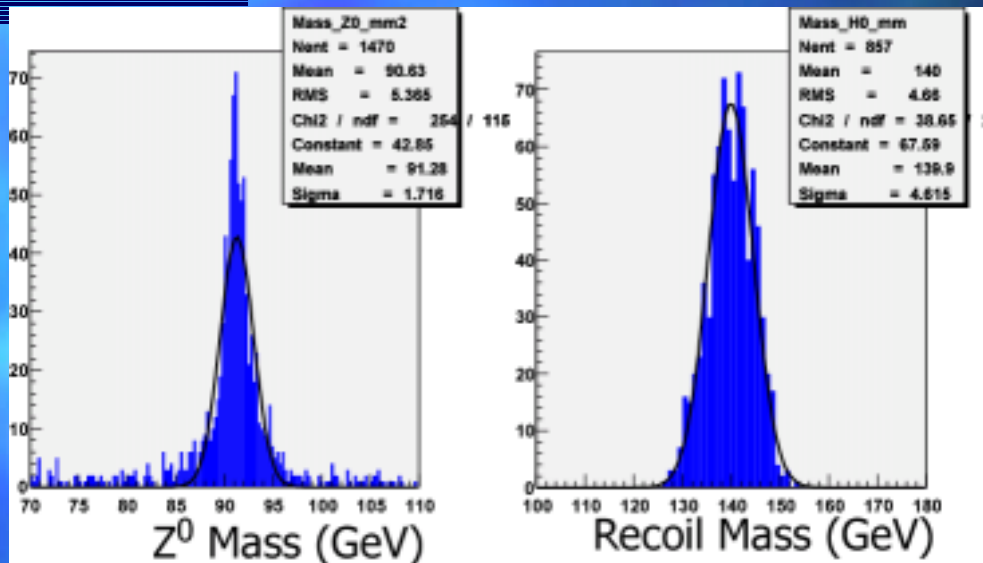
SDMar01

Momentum resolution 2



SDMar01

Recoil Higgs mass resolution



by M.Iwasaki

Reconstructed Z^0 mass

Recoil H^0 mass

$Z^0 \rightarrow \mu^+\mu^-$ mode

91.3 ± 1.27 GeV

139.9 ± 4.63 GeV (FASTMC)

91.3 ± 1.72 GeV

139.9 ± 4.61 GeV (GEANT4)

$Z^0 \rightarrow e^+e^-$ mode

91.2 ± 1.45 GeV

139.9 ± 4.63 GeV (FASTMC)

90.8 ± 1.94 GeV

141.3 ± 5.56 GeV (GEANT4)

Summary

- We have developed simulation/analysis tools for the future Linear Collider experiments
- The simulation/analysis tools based on ROOT
→ work well!
- With these new features, new LCDROOT3.6 will be released soon.
- There is a LCD Root web page!
http://www-sldnt.slac.stanford.edu/nld/New/Docs/LCD_Root/root.htm