Intoroduction to tools for LC Physics Study

LC Physics Study Group meeting
25-May-2003
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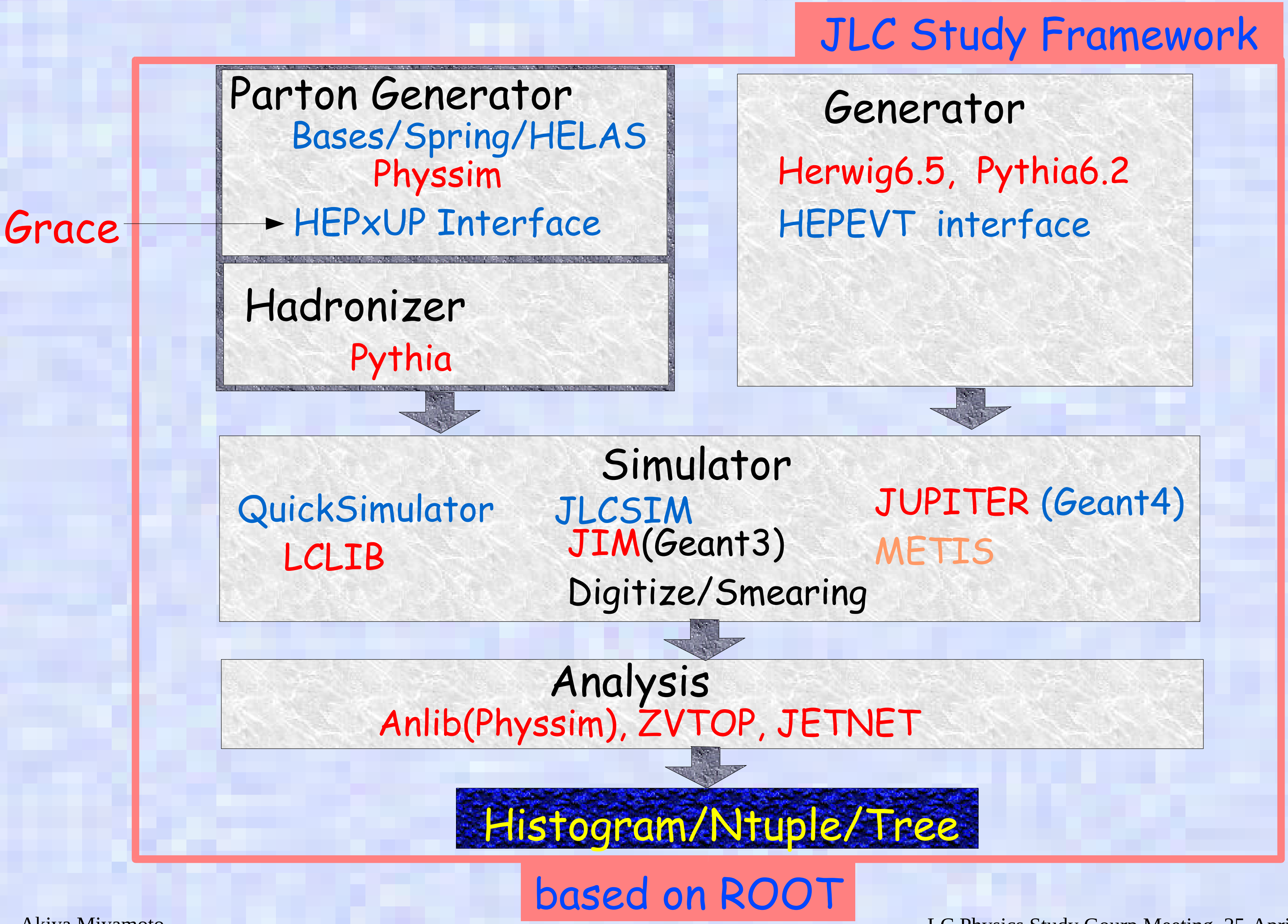
TOPICS:

1. JLC Study Framework
2. Detector Model and Quick Simulator
3. A sample analysis
4. Plan for study
5. Summary

JSF and related packages



JSF Features - 1

1. JSF is based on ROOT
   - ☛ User needs to lean just one language, C+
2. JSF provides a framework for modular analyses
   - ☛ Common framework for event generation, detector simulation, and analyses.
   - ☛ Same framework for beam test data analysis
3. Unified framework for interactive and batch jobs
   - ☛ GUI for control of an interactive run
     Histogram and event display packages included
   - ☛ A file similar to .rootrc is used to set parameters
     Default values an be overidden by command line argument at run time.

JSF Features - 2

4. Object I/O
   - ☛ Each modules can save/read their event data as branches of a root tree.
   - ☛ Job parameters, histograms, ntuples and private analysis tree can be saved in the same file

Crosssection of JLC detector

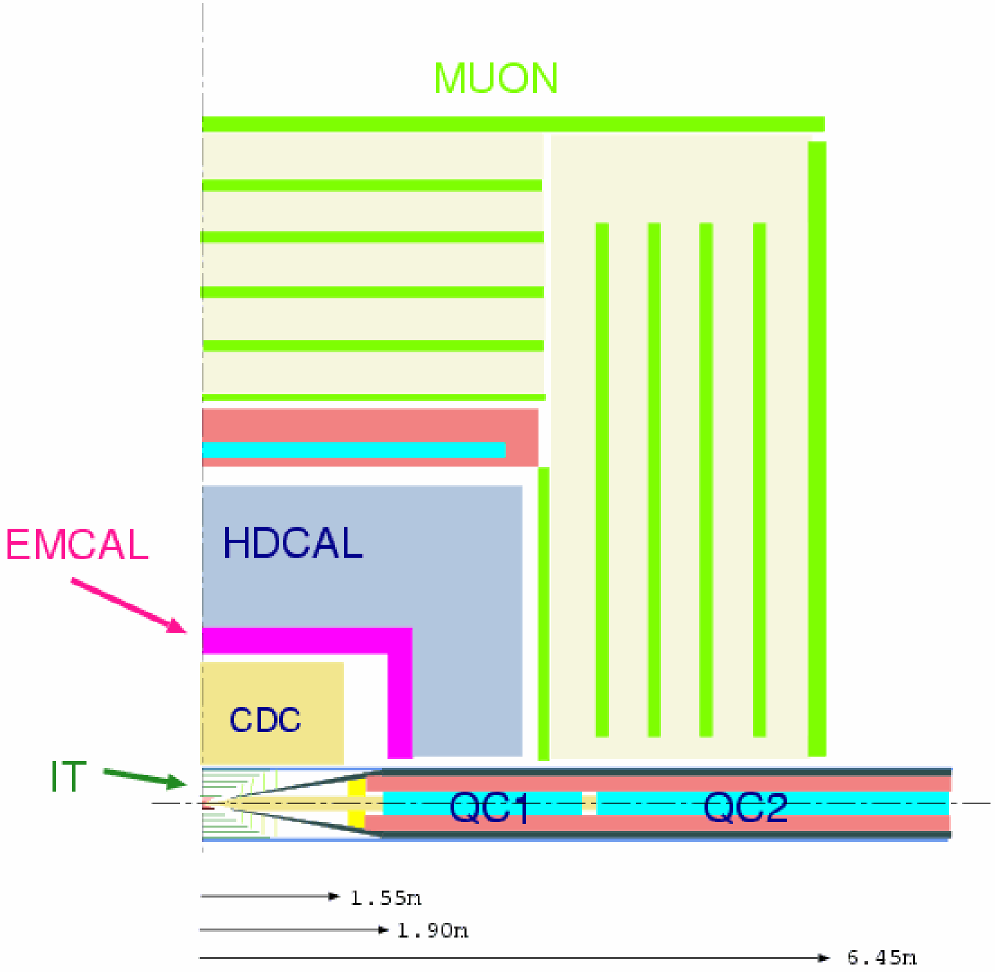
Detector size 8m(ϕ)x7.1m(z)
Magnet 3 tesla
Muon Number of superlayers : 6
Calorimeter Lead/Scint., compensated

EM Cal: Thickness : 27.1X_0
Segmentation : 4x4 (cm^2)
Radius(barrel) : 1.6 ~ 1.86m
$\sigma_E/E(\%) = 15\%/\sqrt{E} \oplus 1\%$

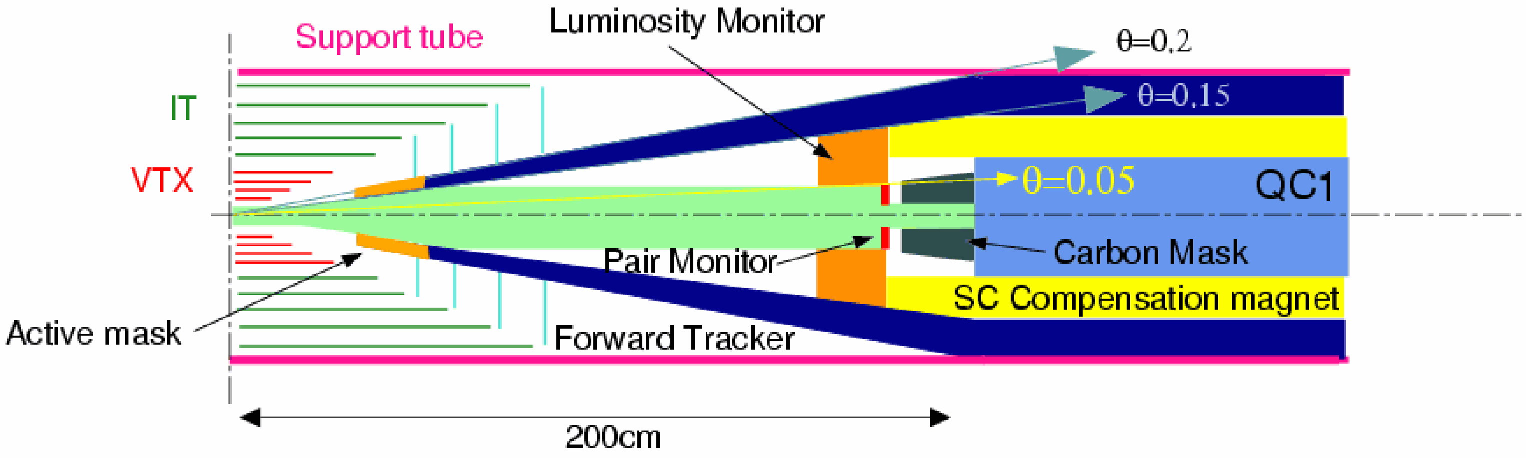
HD Cal: Thickness : 6.5λ
Segmentation : 12x12 (cm^2)
Radius(barrel) : 1.86 ~ 3.4 m
$\sigma_E/E(\%) = 40\%/\sqrt{E} \oplus 2\%$

Central Drift Chamber(CDC)
Small cell jet chamber
Number of sampling : 50
Position: r=0.45 to 1.55m, |Z|<1.55m
Position Resolution: $\sigma_{r\varphi} = 100\mu m(\text{axial})$
$\sigma_z = 1mm(\text{stereo})$
Momentum Resolution:

$$\sigma_{p_t}/p_t = 3 \times 10^{-4} p_t \oplus 1 \times 10^{-3}$$
$$\sigma p_t/p_t = 0.9 \times 10^{-4} p_t \oplus 1 \times 10^{-3} (\text{w.vtx})$$



Detector system near IP



Intermediate Tracker(IT): Silicon strip/pixel

Geometry: 5 layers, r=9cm to 37cm, |cosθ|<0.9

Position resolution: σ = 40μm

Vertex Detector (VTX) : CCD

Position: 4 layers, r=2.4cm to 6cm, |cosθ|<0.9

Position resolution: σ = 4μm

Impact parameter resolution:

$$\delta = 3 \oplus 24/p^{3/2} sin^{3/2}\theta(\mu m)$$

Forward Tracker(FT) : Silicon pixel/strip

4 layers silicon

Coverage: 0.90 < |cosθ|<0.98

Pair monitor

Silicon 3D detector to monitor beam property

Luminosity monitor

W + Si pad, 42.9X_0

Coverage: 0.05 < θ <0.15(radian)

Segmentaion: radial 32, azimuthal 16

Active mask

8 layers of W + Si pad

Coverage: 0.15<θ<0.20(radian)

Segmentaion: radial 8-10, azimuthal 32

Quick Simulator

Detectr components:

VTX, IMT, CDC, CAL are included.
Detector parameters (resolution,geometry, etc) can be changed be a parameter file

Signal generation:

Particles are swimmed through VTX, IMT, CDC, and CAL.

Particles are smeared by multiple scattering by matterials such as VTX, IMT, etc.

VTX and CDC

Equally spaced N sampling with given $\sigma_{r\phi}$ and σ_Z in solenoid field
5 dimensional error matric of the track parameter are smeared including the effect of the multiple scattering due to chamber gas.
VTX and CDC parameters are then averaged to get combined helix parameter

IMT Just create smeared hit points

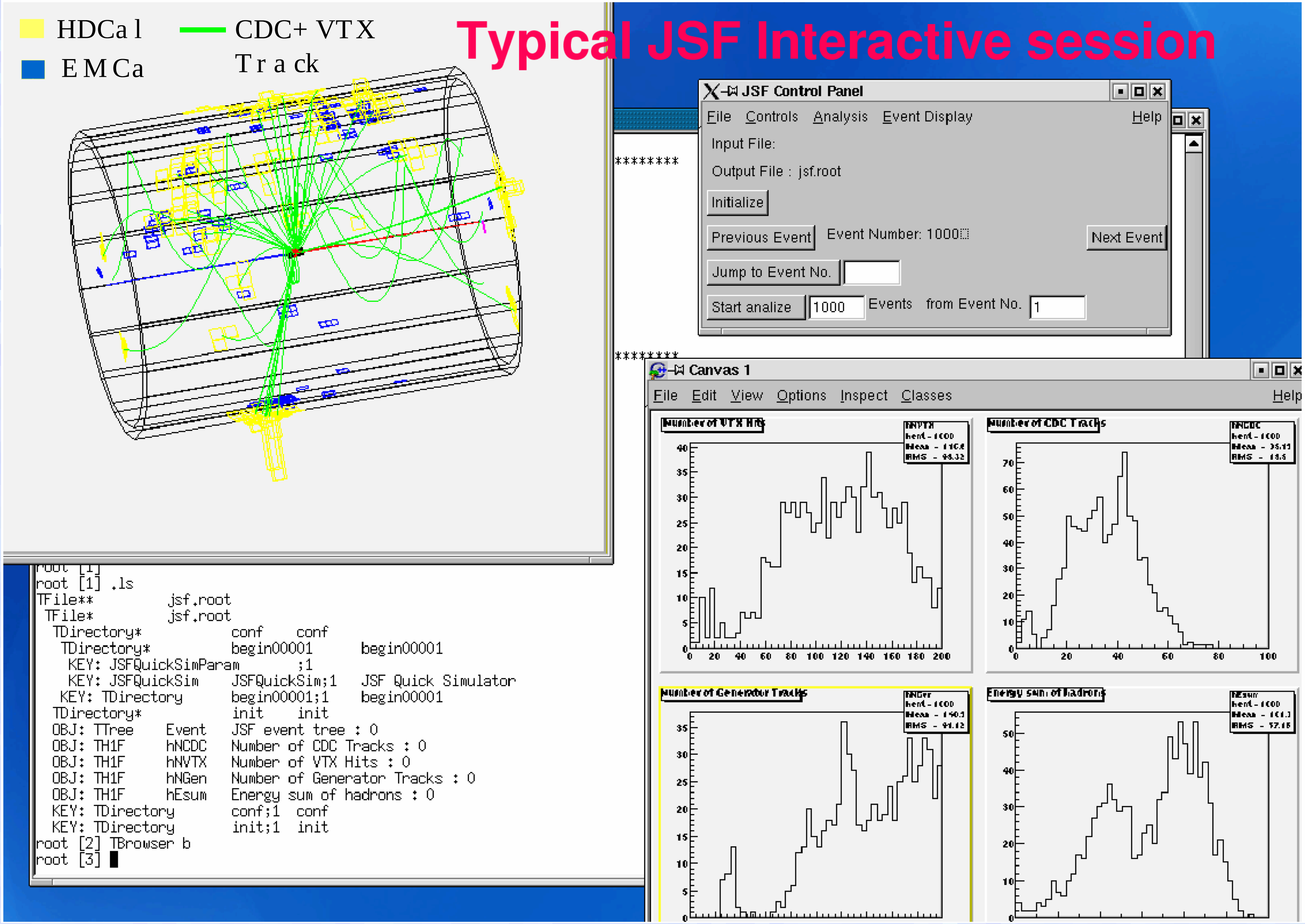
CAL: Particle energy is spread laterally by $f(x) = a_1 \exp(-|x|/\lambda_1) + a_2 \exp(-|x|/\lambda_2)$

Generated energy is distributed to each countes after smearing according to the resolution.

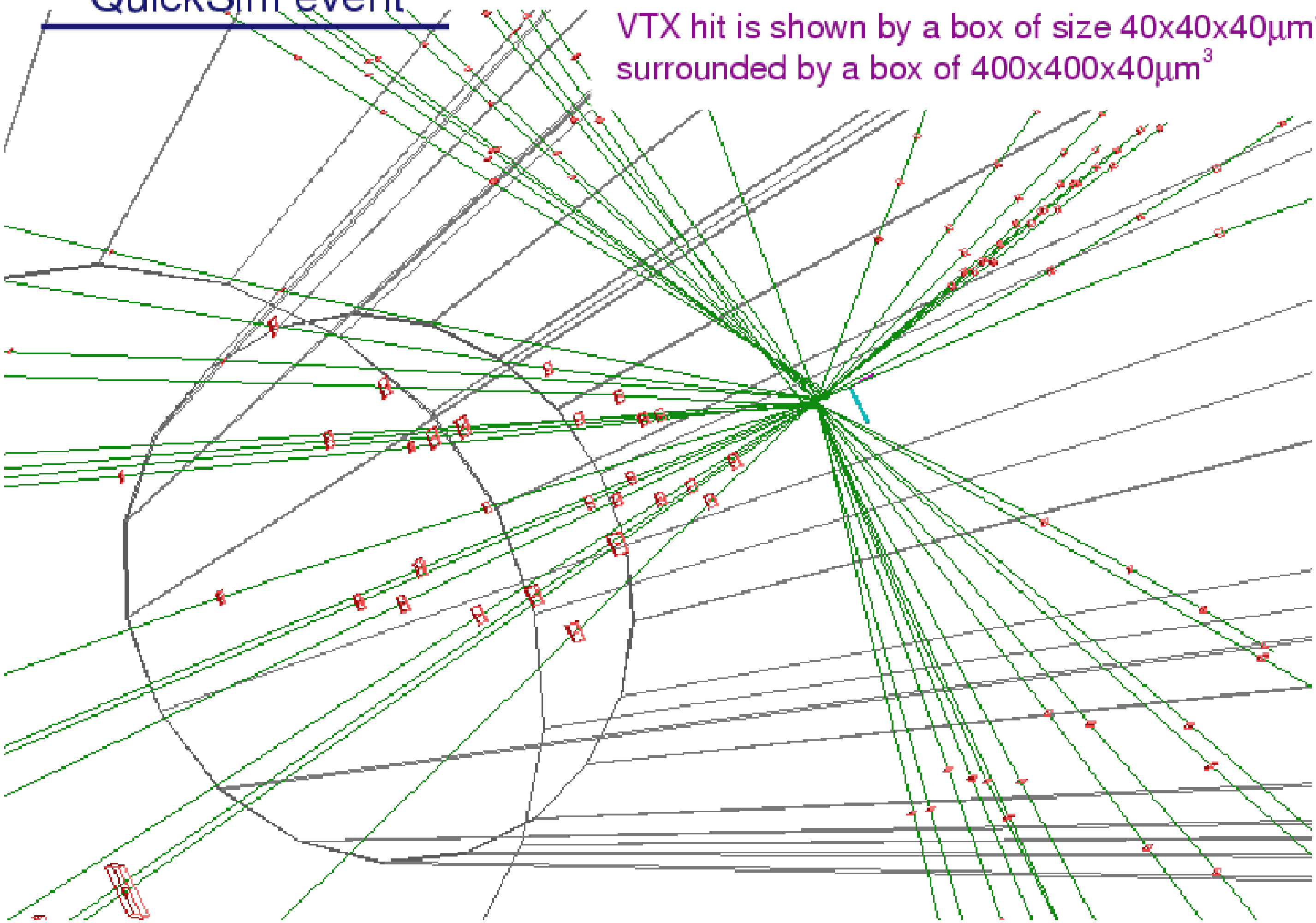
e and γ : Deposite energy only in EM calorimter
hadrons : Deposite energy only in HD calorimter
μ : No energy deposite in calorimeters

LCWS2000 A.Miyamoto

Typical JSF Interactive session



QuickSim event



VTX hit is shown by a box of size 40x40x40μm^3 surrounded by a box of 400x400x40μm^3

Performance of JSF - a sample analysis

Method

1. Run a job consists of

   (1) Generate $e^+e^- \to ZH$ by Pythia

   $M_H = 120$ GeV, $\sqrt{s} = 300$ GeV

   with ISR and Beamstrahlung, $\Delta E_{beam}/E_{beam} = \pm 0.2\%$

   (2) QuickSimulator

   (3) Analysis Higgs selection in

   $ZH \to 4$ jets

   $ZH \to \nu\nu b\bar{b}$

   $ZH \to e\bar{e}b\bar{b}$ or $\mu\bar{\mu}b\bar{b}$

   Create tree Trees in a root file.

   (Tree consistes of variables such as jet momenta for event selection)

   Number of generate events corresponds to about 500 fb^{-1}

2. Analize Root file, select events and create plots

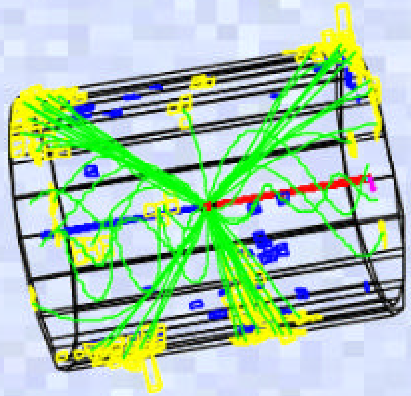
Higgs study by JSF

$\sqrt{s} = 300$ GeV, $M_H = 120$ GeV

4-jet selection:

1. $E_{vis} > 260.0$ GeV
2. Thrust < 0.9
3. Forced four jets clustering
4. Mass of 2jets from 'Z' $= M_Z \pm 5$ GeV
5. Missing mass of 2 jets from $'H'$ is $80 \sim 120$ GeV
6. No. of Off-Vertex tracks from $'Z' < 4$
7. No. of Off-Vertex tracks from $'H' > 4$

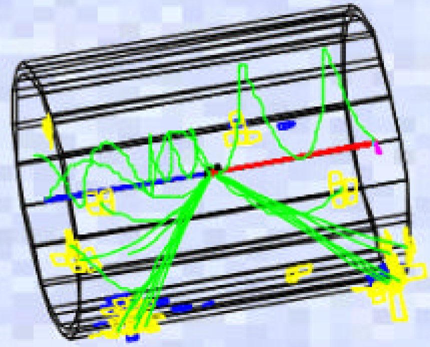
M_{Higgs} = Mass of H-Jet1 + H-Jet2



2-jet selection:

1. $170 > E_{vis}(\text{GeV}) > 90$
2. No. of Chraged tracks> 6
3. Missing $p_t > 20$ GeV
4. $|\cos\theta_{j1/j2}| < 0.8$
6. No. of Off-Vertex tracks > 4

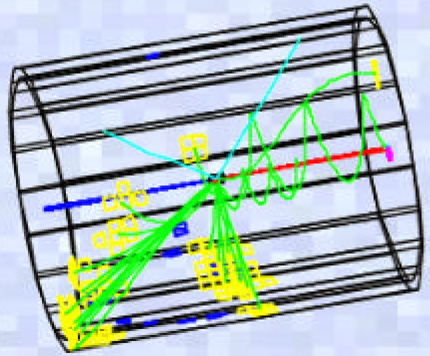
M_{Higgs}= Invariant mass of all particles



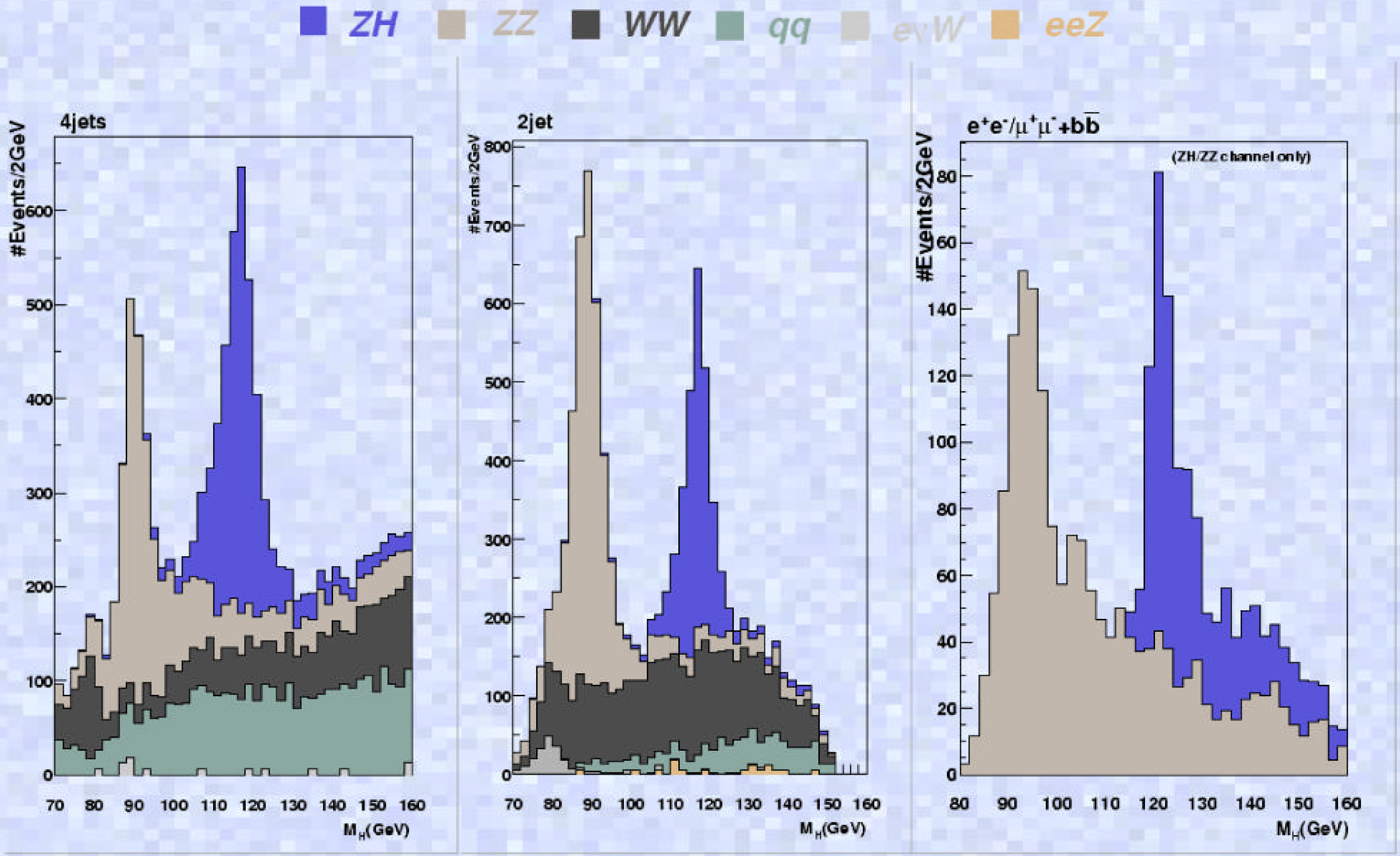
ll-Higgs selection

1. $E_{vis}(\text{GeV}) > 250.0$
2. $\mu^+\mu^-$ or e^+e^- events
3. $|\cos\theta_{track}| < 0.80$
4. Mass of $\mu^+\mu^-$ or e^+e^- is within 80 to 100 GeV
6. No. of Off-Vertex tracks > 2

M_{Higgs} = Missing mass of $\ell\bar{\ell}$



Higgs signal at 500 fb^{-1}



Where to get package information

Mailing list

acfa-ism@acfahep.kek.jp

Web

http://acfahep.kek.jp/subg/sim

http://www-jlc.kek.jp/subg/offl/lclib.html
http://www-jlc.kek.jp/subg/offl/physsim.html
http://www-jlc.kek.jp/subg/offl/jsf.html

Latest version is on cvs repository

http://jlccvs.kek.jp/

Many example codes are in jsf/example directory.
Further example will be added.

Where to start analysis

Bases

Bases result

Spring

Spring parton data (ASCII)

Hadronize + QuickSim

SIMDST

Jet Clustering/Paring & Vertexing

MiniDST

Cut optimization and final plot

Final Plot

Plan of Mini-DST for novice

for Higgs sub-group ?!

ROOT File, event information is saved as a root tree

A tree contains

- Event Shape variables (Thrust)
- Array of Jet

  Jet its 4 momentum

  #Tracks

  vertex tagging information such as Nsig/MSPTM

  Flags for isolated track

Example to draw histogram:

```
JetTree->Draw(“Pair(0,1).M():Pair(2,3).M()”,”NJ()>3”)
```

Real format of Mini-DST will depend on Physics

A code to create Mini-DST will be an example

Summary

1. A ROOT based framework, JSF, is available for LC Physics Study
2. Quick Simulator for the JLC detector is included in JSF
3. Many studies have been performed using JSF. Packages are already available on WEB
4. A sample program to create Mini-DST is in preparation. First version of them will be ready by mid-May. Help to prepare analysis codes and Mini-DST production are highly welcomed.