Software tools for GLC studies

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Representing ACFA-Sim Group
http://acfahep.kek.jp/subg/sim/

Contents

- JSF: the Flow Controller
- Jupiter (Geant4 Full Detector Simulator)
- Summary

List of software tools

- LCLIB - Quick Simulator and old fortran utilities
- JLCSIM – Geant3 based full detector simulator
- PHYSSIM – Event generators based on HELAS and Analysis packages consists of Jet Clustering and four vector manipulation
- JSF – Root based software study framework
- Jupiter – Geant4 based full detector simulator
- Satellites – Analysis modules, in preparation

General information from ACFA-Sim Home Page
http://acfahep.kek.jp/subg/sim/index.html
Packages are maintained on CVS, available at http://jlccvs.kek.jp/

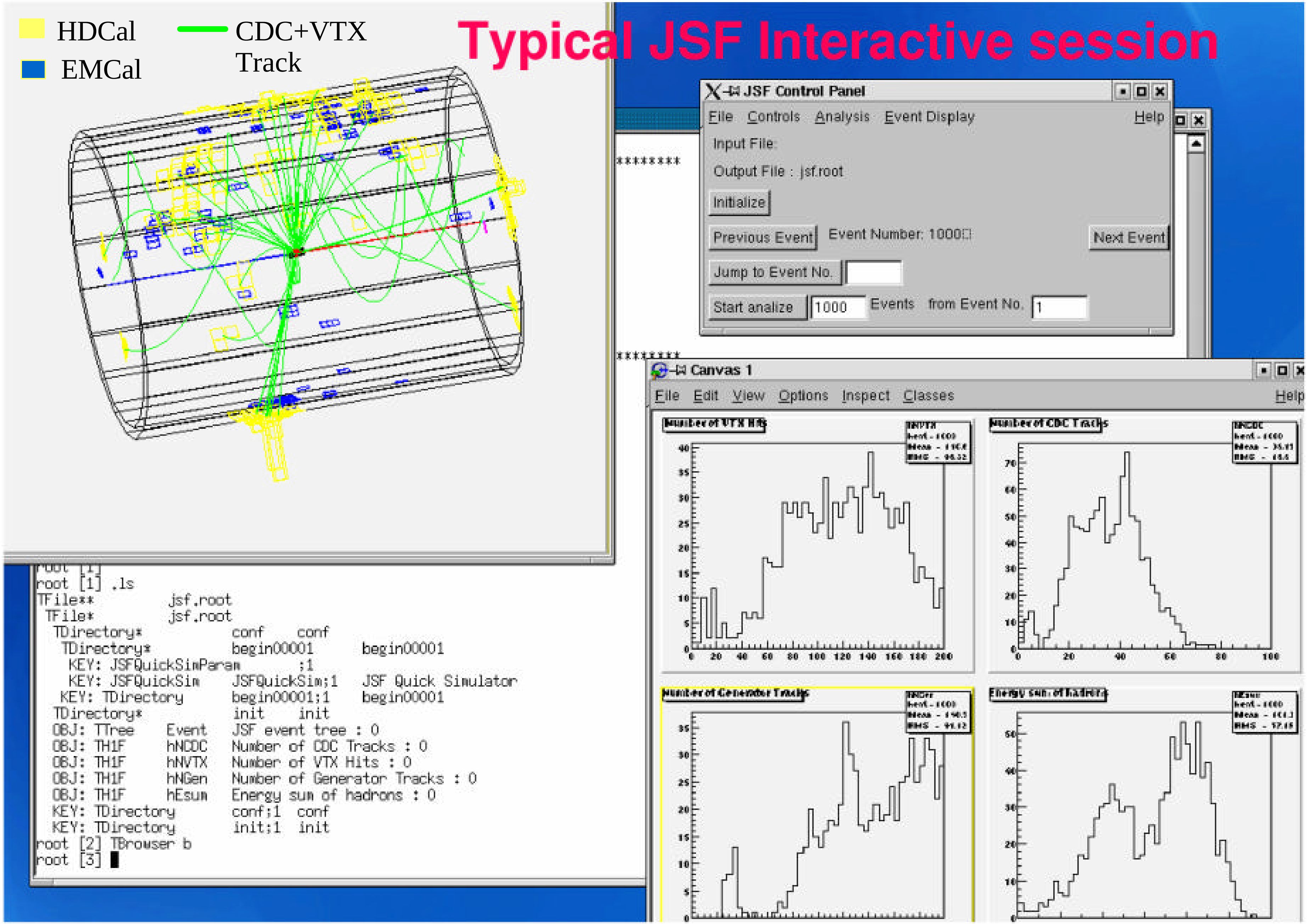
JSF : the Flow Controller

- Based on ROOT: C++
- Modular: Unified Framework for
  - Event generation
  - Detector Simulation
  - Event Reconstruction
  - Physics Analysis
  - Beam test
- Object I/O
  - Each module's data in a ROOT tree
  - User data (hits, ntuple, parameters) also in the same tree
- Unified User Interface for Batch and Interactive
  - GUI/CUI (user definable command line args. and default vals.)
  - Simple built-in event display

Packages provided with JSF

- JSF includes the following sub-packages
  - Generator interface to Pythia, Physsim, Grace
  - Hadronizer (Pythia, Herwig)
  - QuickSim (C++ wrapper for LCLIB)
  - C++ version of Bases/Spring
  - GUI, Event Display, ZVTOP, JETNET, Jupiter
  - ……

Typical JSF Interactive session



Input File:

Output File : jsf.root

Event Number: 1000

1000 Events from Event No. 1

```
root [1]
root [1] .ls
TFile**         jsf.root
 TFile*         jsf.root
  TDirectory*           conf    conf
   TDirectory*          begin00001      begin00001
    KEY: JSFQuickSimParam       ;1
    KEY: JSFQuickSim    JSFQuickSim;1   JSF Quick Simulator
   KEY: TDirectory      begin00001;1    begin00001
  TDirectory*           init    init
  OBJ: TTree    Event   JSF event tree : 0
  OBJ: TH1F     hNCDC   Number of CDC Tracks : 0
  OBJ: TH1F     hNVTX   Number of VTX Hits : 0
  OBJ: TH1F     hNGen   Number of Generator Tracks : 0
  OBJ: TH1F     hEsum   Energy sum of hadrons : 0
  KEY: TDirectory       conf;1  conf
  KEY: TDirectory       init;1  init
root [2] TBrowser b
root [3] █
```

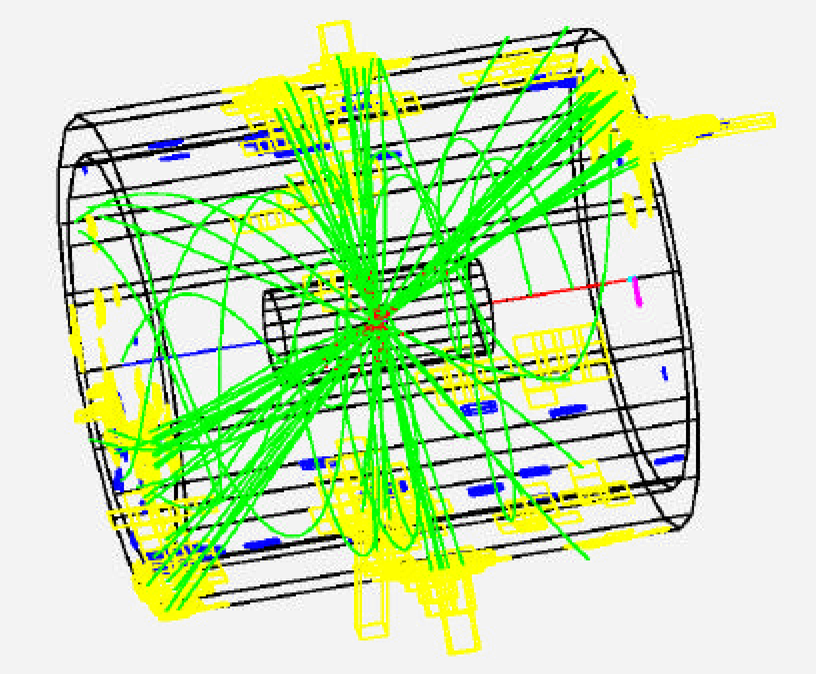
Les Houche Interface in JSF

- Les Houches 2001 standard for the interface of a parton generator and a shower generator was implemented in JSF.
  - A parton generator outputs parton information a la Les Houches format in a ASCII file.
  - Interfaces in JSF read it and does parton shower using Pythia (Herwig in Future)
- Example:
  - LCGrace :
    - LC version of the GRACE event generator, including all diagrams for a given process.
    - Parton four momenta generated by SPRING package are saved with Les Houche format in an ASCII file.
    - ~30 processes have been prepared such as

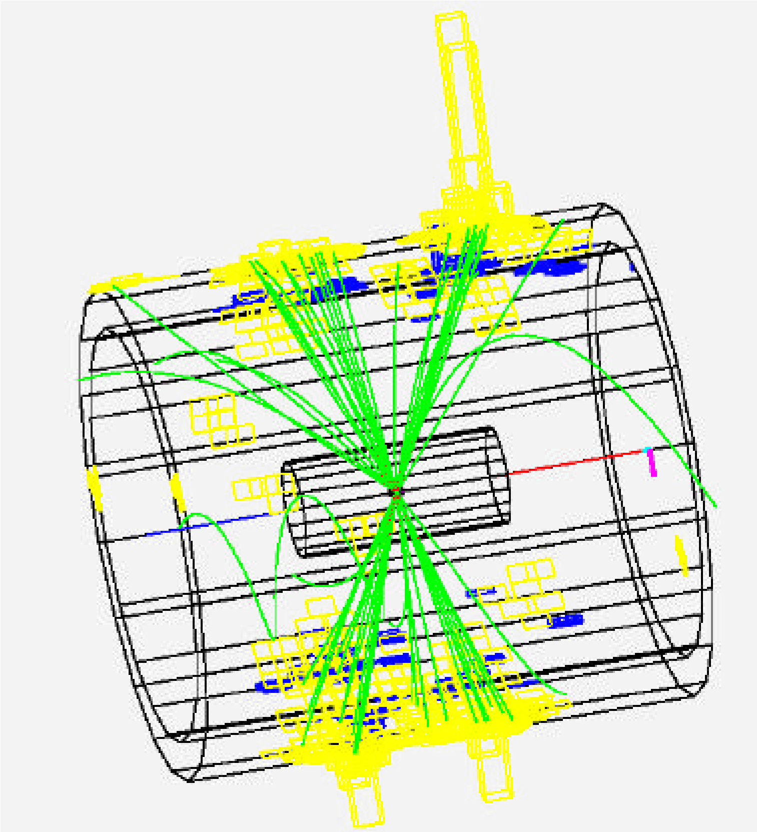
$$e^+e^- \to W\bar{W}H,\ t\bar{t}H,\ 4f,\ 6f,\ 4f+H\ \ (f=u,\ell,q)$$

Sample events

$e^+e^- \to t\bar{t}\,H$



$e^+e^- \to n\bar{n}\,HH$



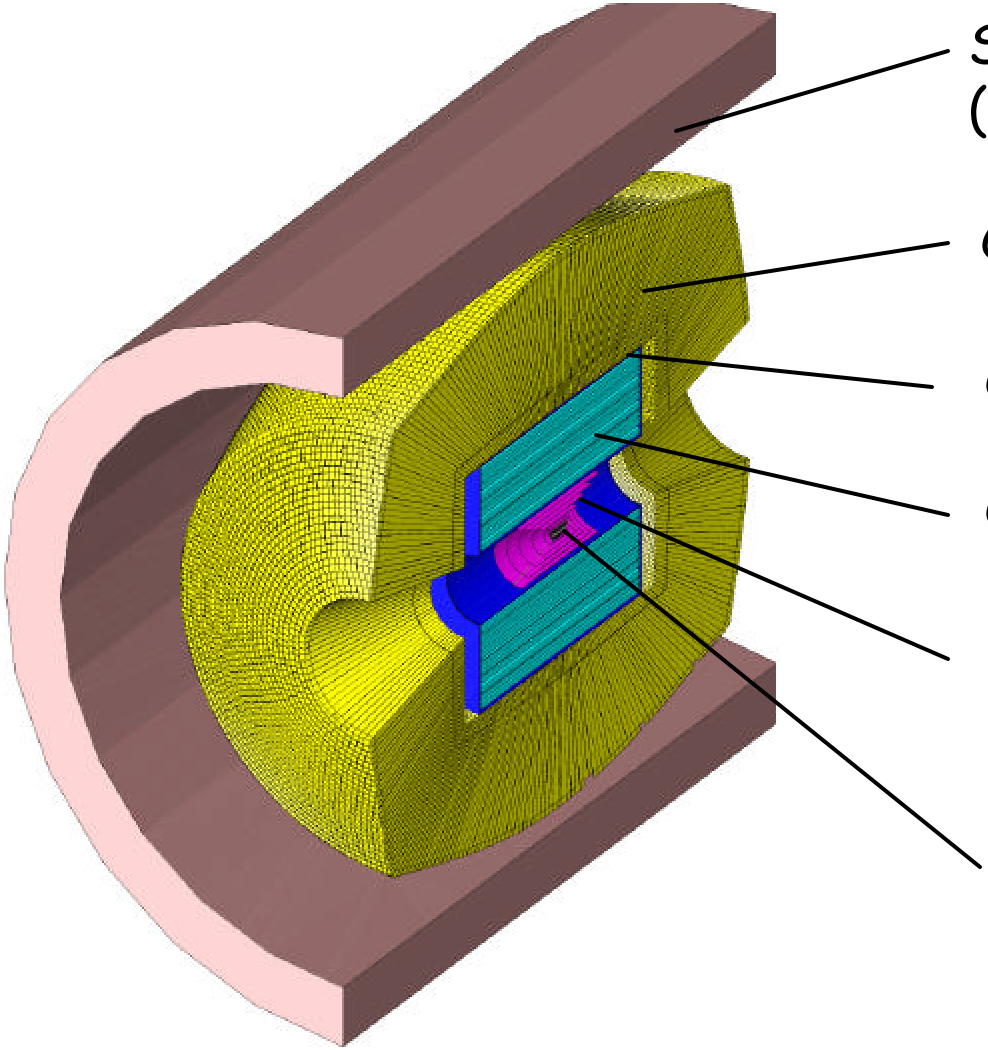
Jupiter : Geant4 based Full Detector Simulator

- Features:

Core developper: K.Hoshina and K.Fujii

  - Modular structure for easy update, install/uninstall of sub-detectors
  - Powerful base classes that provide unified interface to
    - facilitate easy (un)installation of components by methods such as InstallIn, Assemble, Cabling
    - Help implementation of detailed hierarchiral structures. This helps to save memory size.
    - Minimize user-written source code by
      - Automatic naming system & material management
      - B-field compositions for accelerators
  - Input : HEPEVT, CAIN (ASCII) or generators in JSF.
  - Output
      - Output class allows extrnal methods. Using this mechanism, it can output ASCII flat file and JSF/ROOT fie.

Standard Geometry of Jupiter



Super Conducting Solenoid (SOL)

Calorimeter(HCAL)

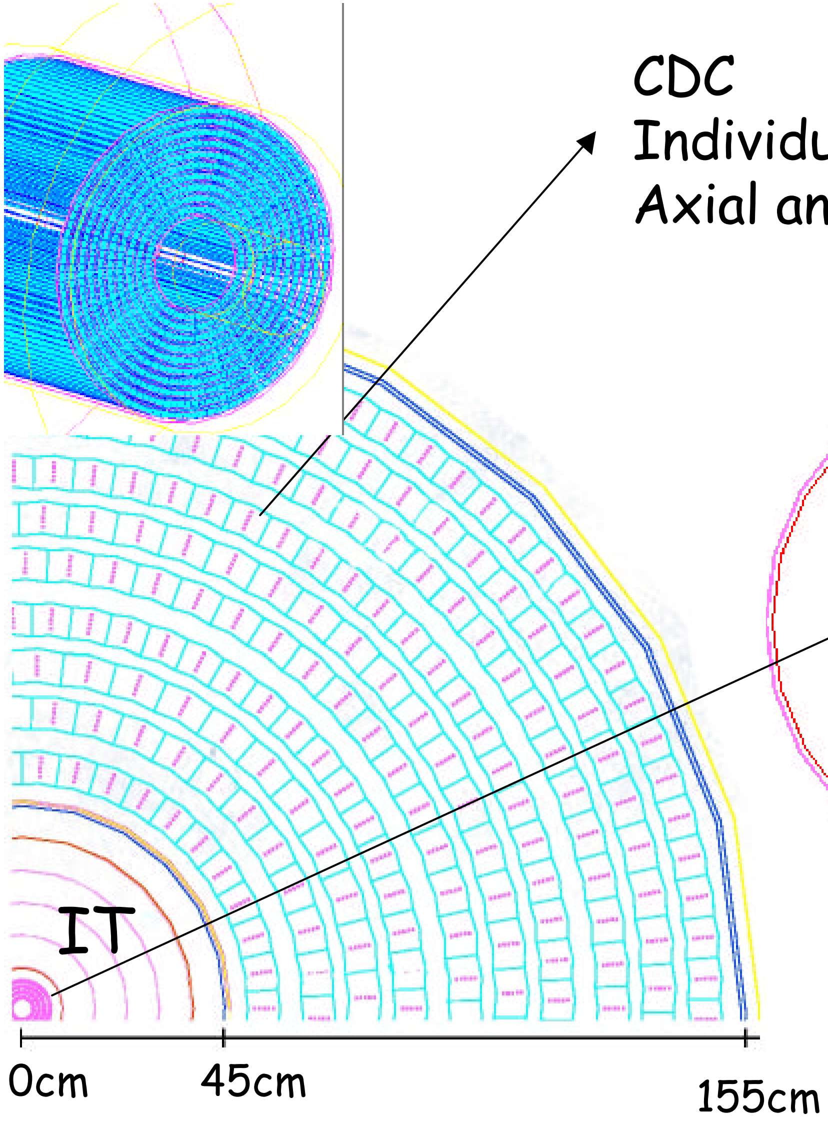
Calorimeter(ECAL)

Central Tracker(CDC)

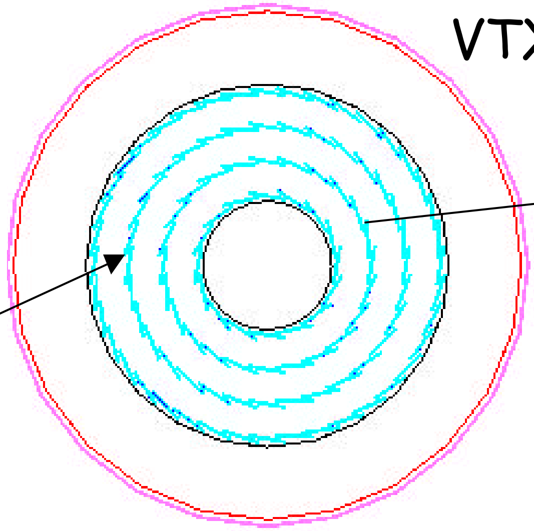
Intermediate Tracker(IT)

Vertex Detector(VTX)

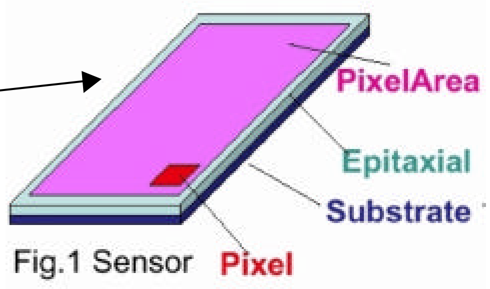
Detector geometries in Jupiter



CDC
Individual drift cells and wires
Axial and stereo geometry



VTX detector



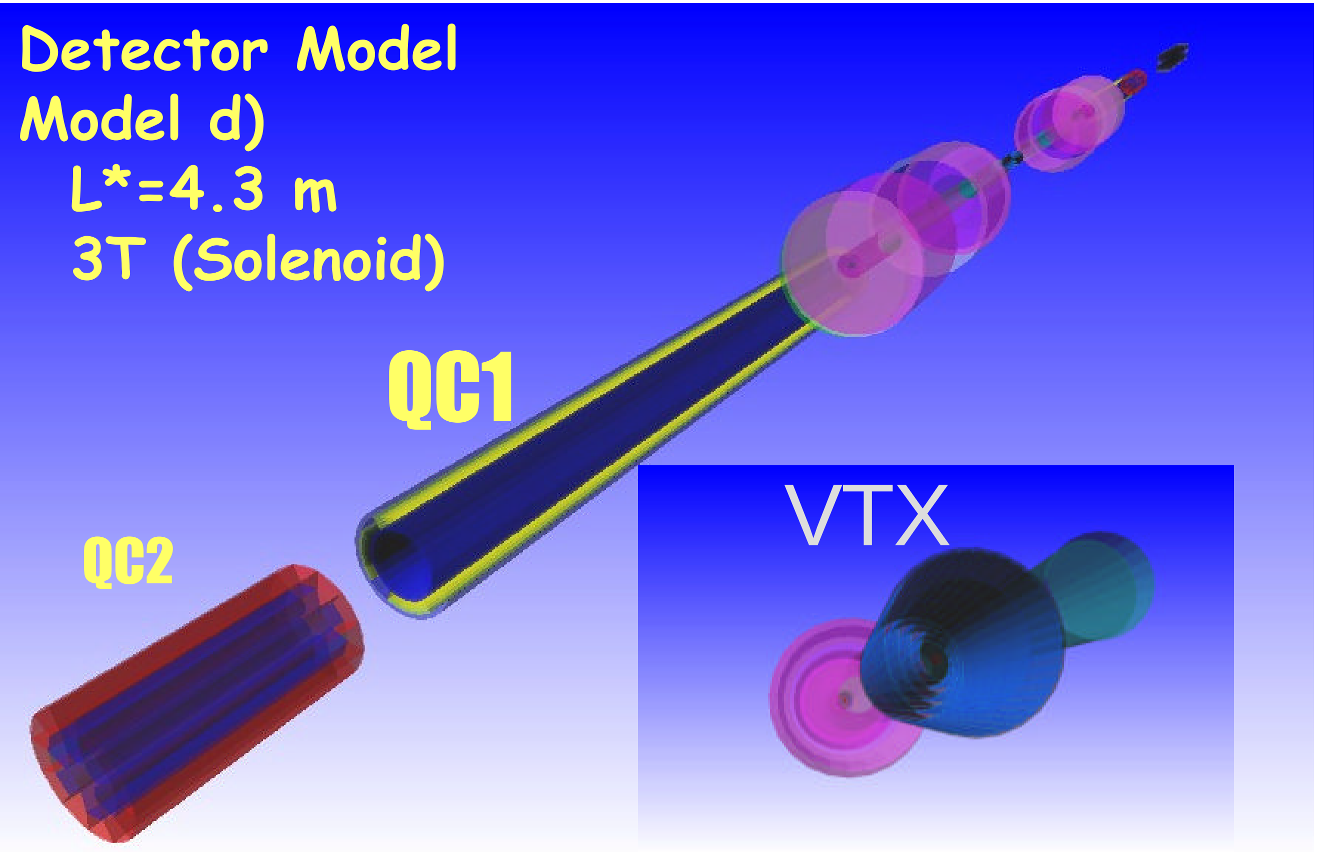
VTX sensor

Geometry parameters
such as #layers, #pixels,….
controled by a ParameterList class
for easy modification

Beam Delivery System

for Beam BG Study

T.Aso



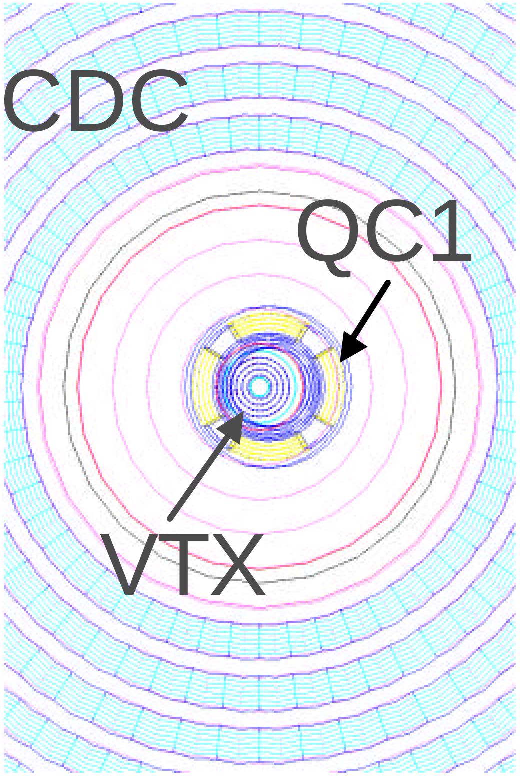
Detector Model

Model d)

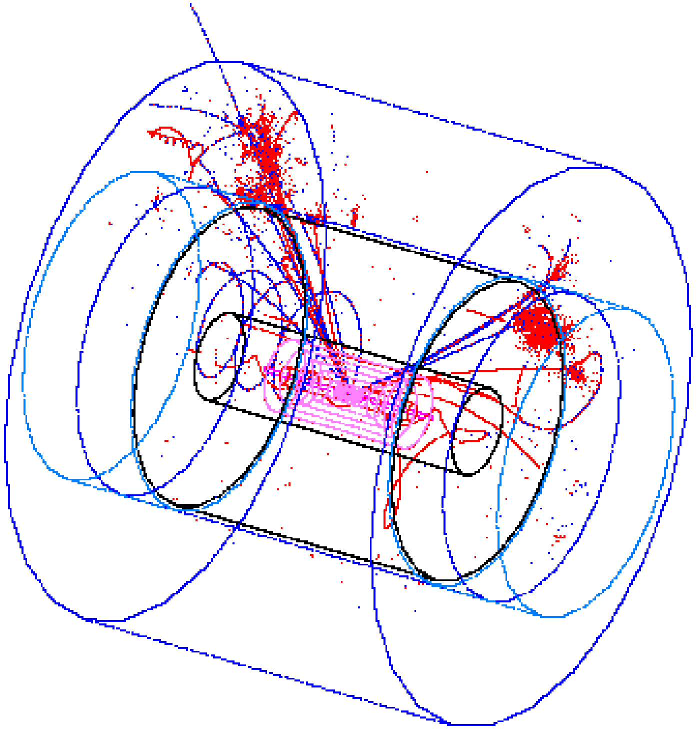
L*=4.3 m

3T (Solenoid)

Crossing 3mrad



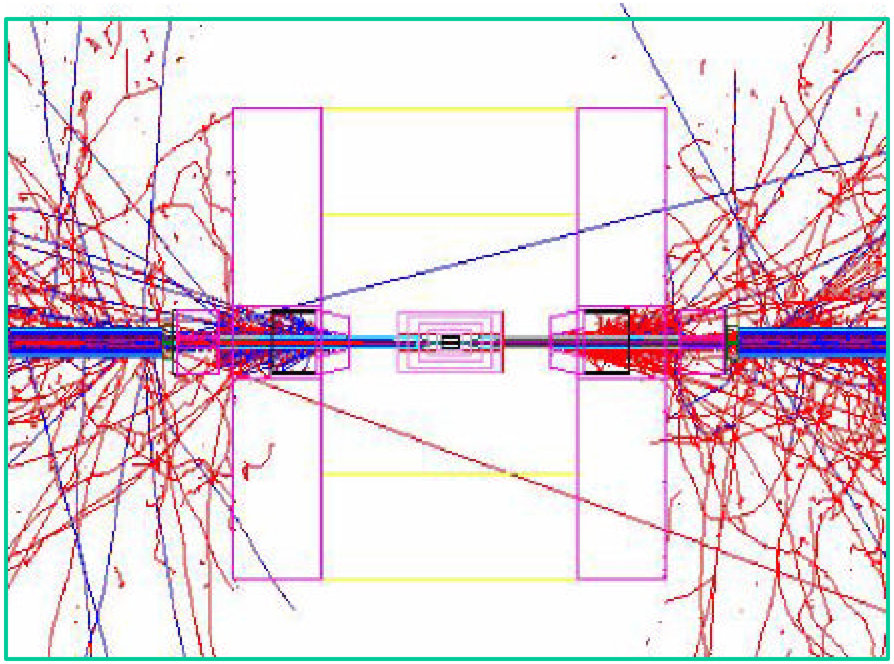
Sample events by Jupiter



$e^+e^- \to Z^0H^0$ event

$\sqrt{s} = 350$GeV

Beam Background Simulated
By Jupiter



Event source : CAIN

Summary

- JSF framework has been developed based on ROOT.
  Study tools and interface to them are provided with JSF.
  It has been used for physics and detector studies.
- Jupiter framework has been developed based on Geant4.
  - Basic detector components and beam delivery system has been implemented. It has been used for studies of detector performance and beam background.
- Future plan for Jupiter includes,
  - Make them LCIO-compliant
  - XML-based description of a detector geometry
  - Improve geometry outside the tracking volume.
  - ….