ALCPG Simulation Status and Plans

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(SLAC)

ECFA LC Workshop,
Durham Sep. 2, 2004

Outline

- Detector Simulation
- Hit Digitization
- Event Reconstruction
- Event Analysis
- LCIO, JAS3 & Visualization
- org.lcsim reconstruction code

Simulation Workshop III @ ANL

- Four days (June 2-5) of talks, meetings and tutorials.
- ~Two dozen participants.
- Several projects/ideas spawned then were developed and reported on at Victoria.
- http://www.hep.anl.gov/lcsw/
- Will be discussing when and where to hold LCSimIV soon. Internationalize!

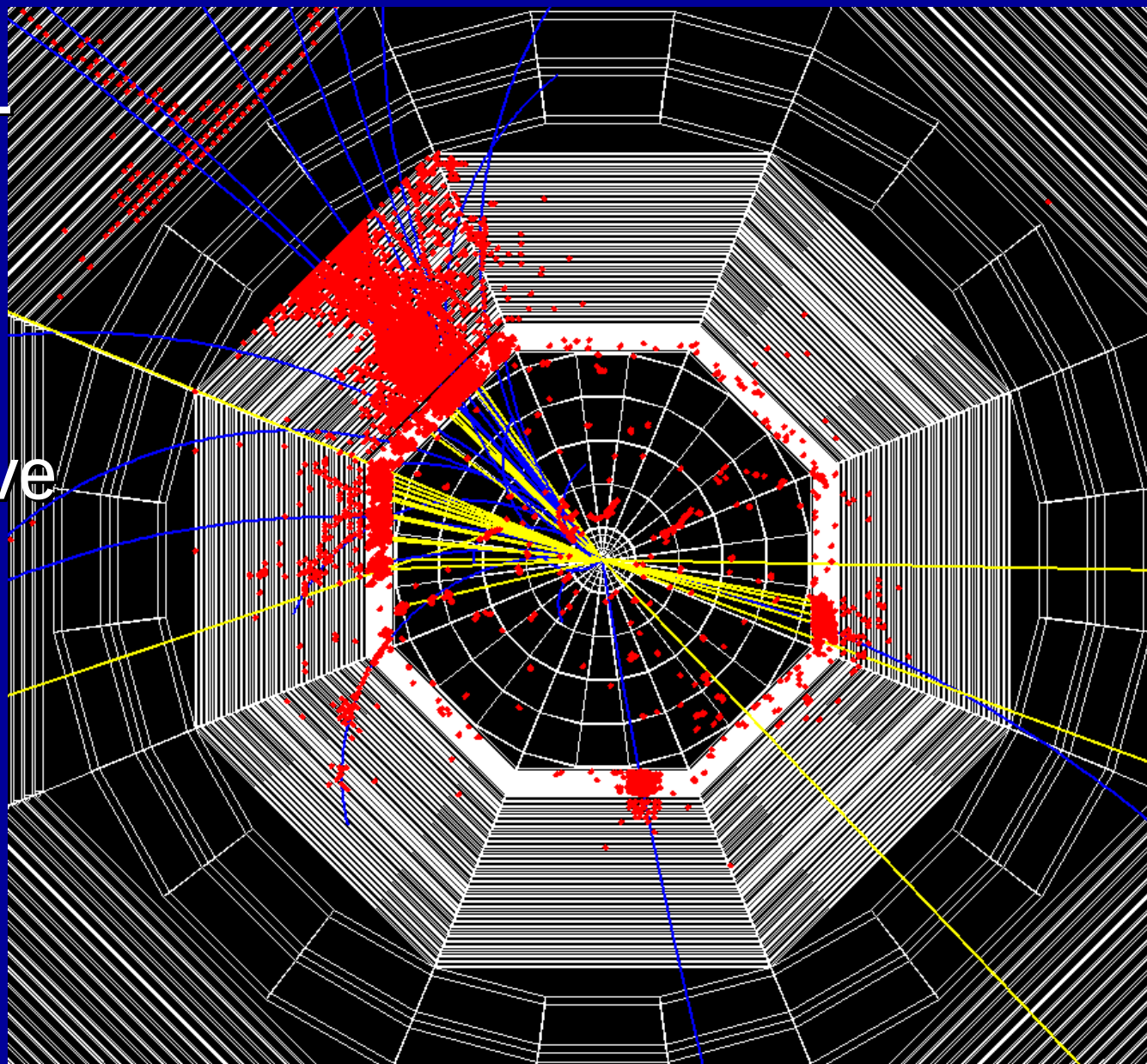

Greetings from Simulation Workshop III !

Detector Simulation

- Geant4 now default production engine.
  - Strong support from SLAC Geant4 team.
- xml file format used for Geant4 input for flexibility and ease of construction.
- Improving some “standard” designs
  - Simulating more realistic detector elements.
- Others easily generated by users or upon request.
  - Sampling detector phase space to optimize design.
- lcdg4 (NICADD) writes sio files.
- lcs (SLAC) writes lcio files.

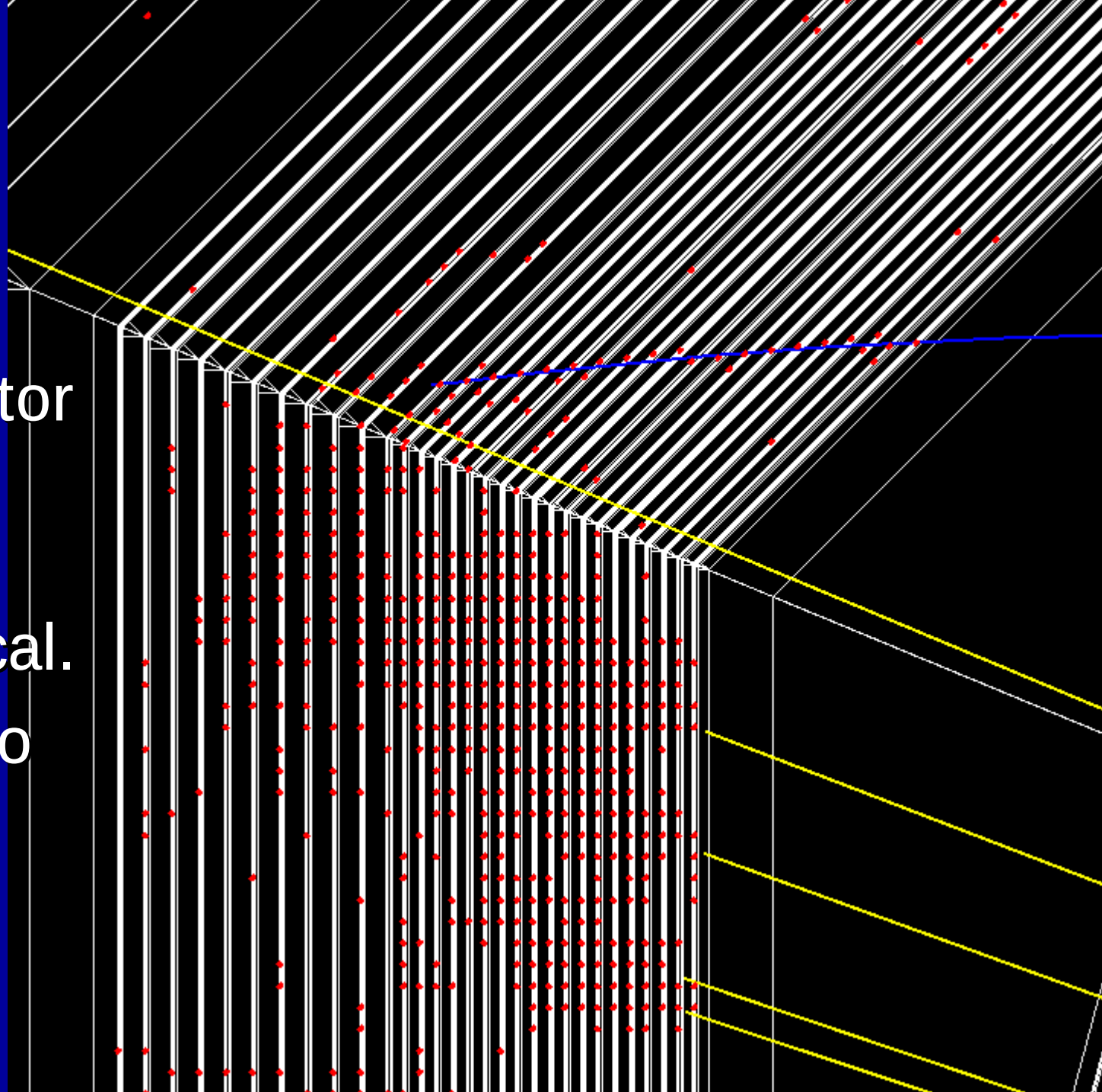
Updated Geometries

- Can define n-sided detectors.
- User-defined slicing of stave modules.
- Developing new xml schema for geometries.



Slicing

- Arbitrary slicing of subdetector staves.
- e.g. SiD Si/W EMcal.
- Could also use for hybrid Si/Sci.



Hit Digitization

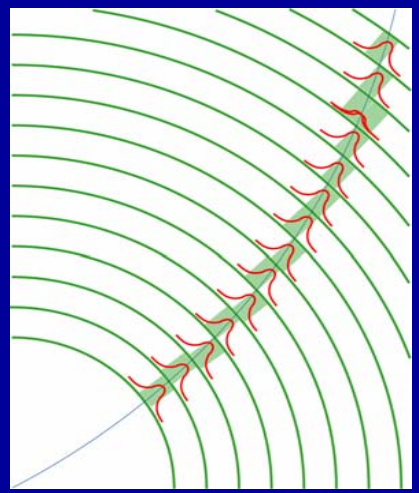
- Calorimeter information quantized at Geant4 stage. Digitization package being designed.
- Tracker information requires post-processing.
  - Enables studies of detector strip, pixel sizes, charge sharing, electronic noise, etc.
- Provides more realistic simulation of effects of backgrounds and noise
  - Nearby hits merged
  - Hit-specific measurement uncertainties.
  - Ghosts.

CCD Digitization (N. Sinev)

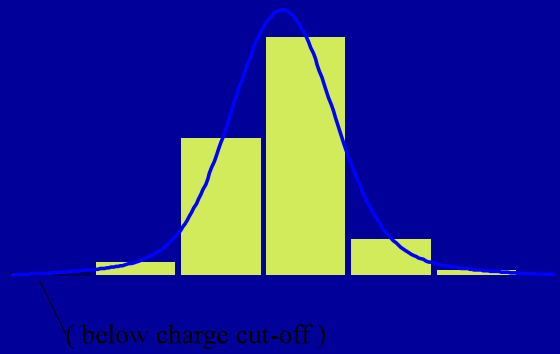
- VXD hits from simulated events, finds charge deposited in each pixel, adds electronics noise and digitizes signal.
- Finds CCD clusters, splitting if necessary.
- Coordinates of found centers are used to replace tracker hits in the simulated events. Further event processing (track finding, fitting, and so on) proceeds the same way as it was before.
- Can set CCD parameters (like thickness, depleted layer depth, epitaxial layer thickness and so on), electronics parameters (noise, ADC conversion scale, pixel and cluster thresholds), processing parameters (like cluster center calculation method).
- hep.lcd.mc.CcdSim

TPC Digitization: D. Peterson

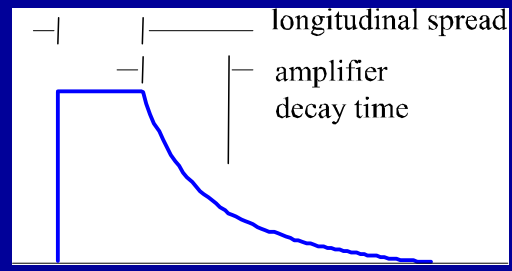
Create hits, with time and pulse height, centered on the average position in the cell



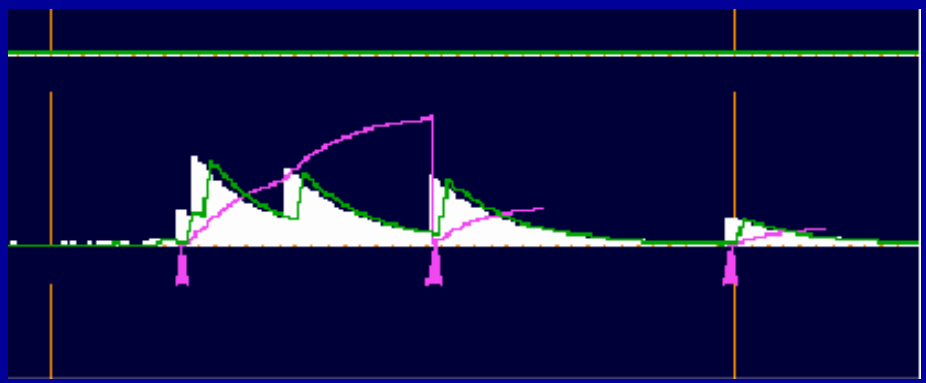
Gaussian charge spreading on the pads:

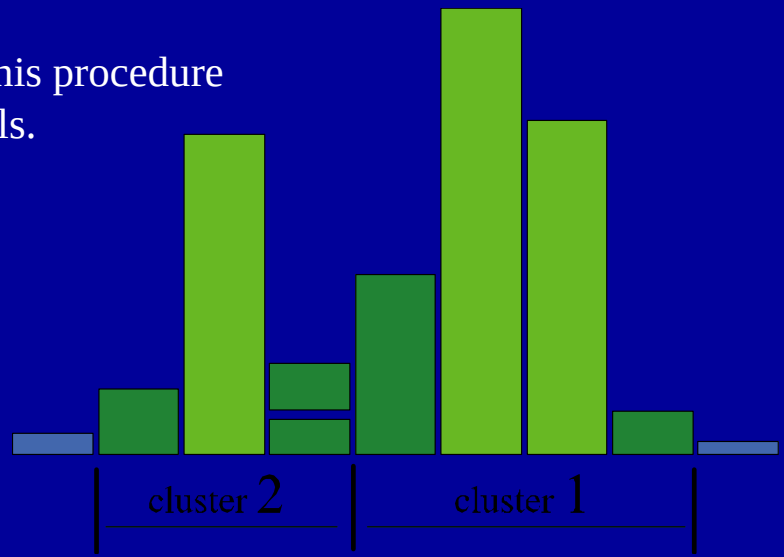


Wave Form to simulate time (= Z) response



Threshold crossings found in this procedure replace the original pad signals.

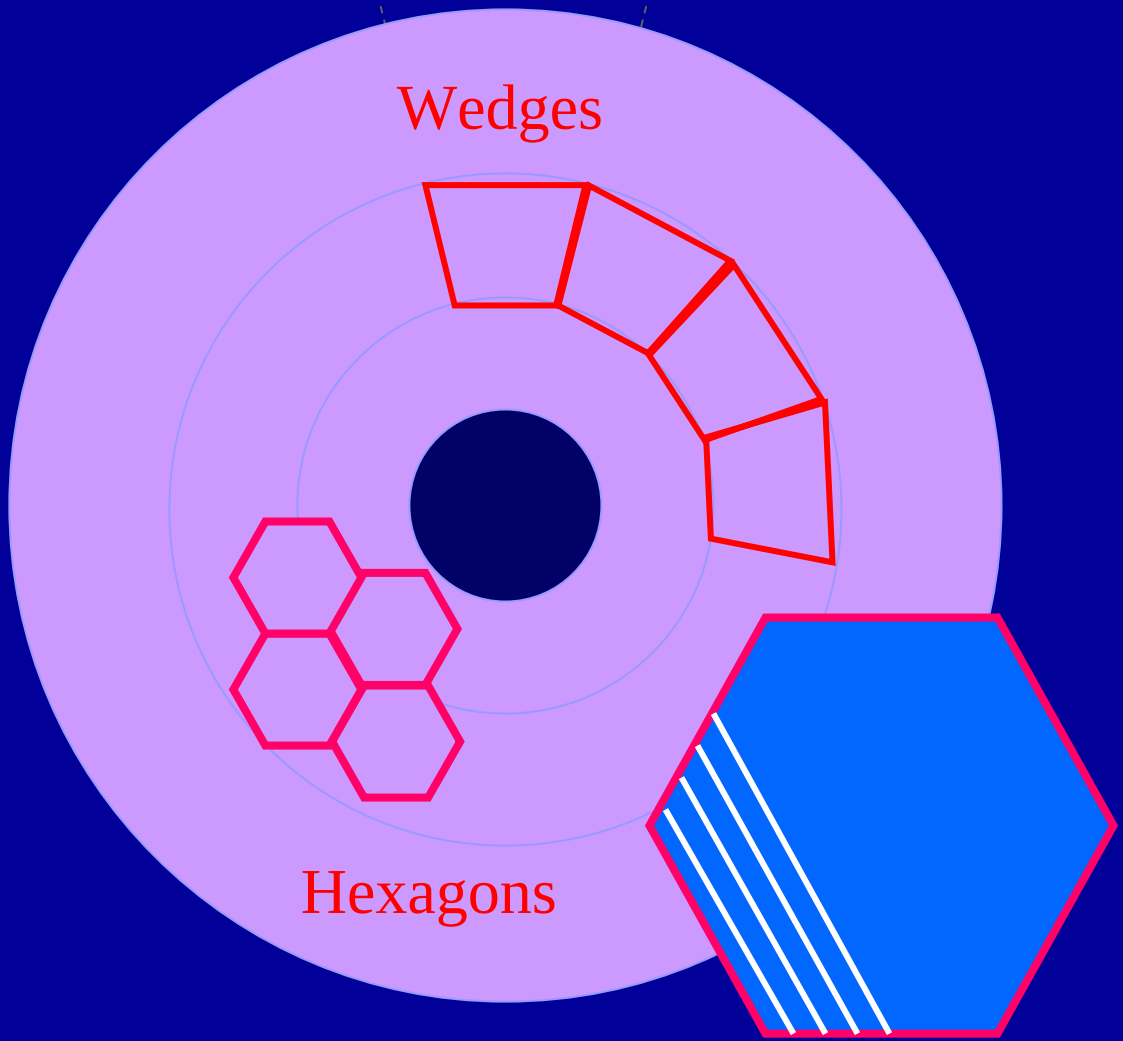




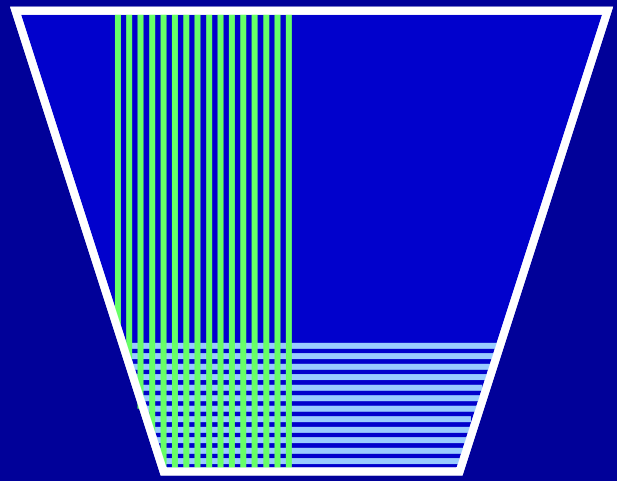
Si μstrip

- Digitization package which generates charge sharing among strips and readout noise developed.
- Several efforts devoted to tiling studies of subdetectors.
- Allows occupancies to be studied as functions of strip lengths, orientation, charge sharing, and ghosting due to stereo strip associations.

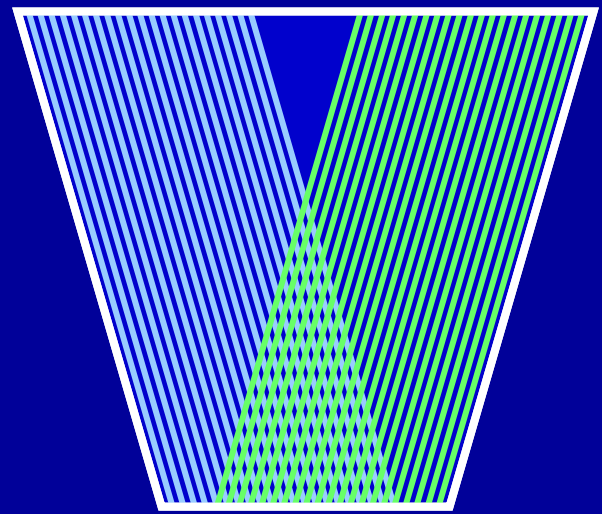
Tiling Forward Disks



Large Angle Stereo



Shallow Angle Stereo



Event Reconstruction: Tracking

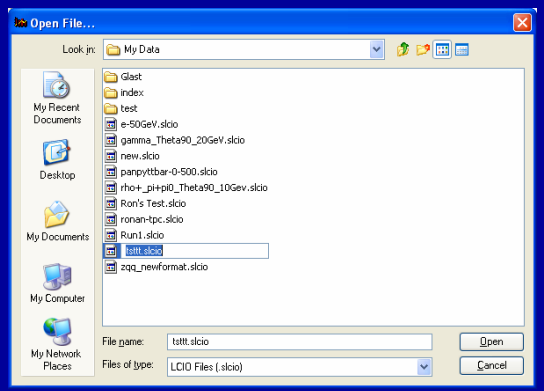
- Quite a bit of effort being devoted to developing and improving track finding:
- Forward Tracking code implemented.
- VXD standalone tracking developed (N. Sinev)
  - works even in presence of full backgrounds!
- Barrel track finding for SiD being developed
  - inside-out (S. Wagner)
  - outside-in (E. von Toerne, D. Onoprienko)
- TPC tracking being improved on (D. Peterson)

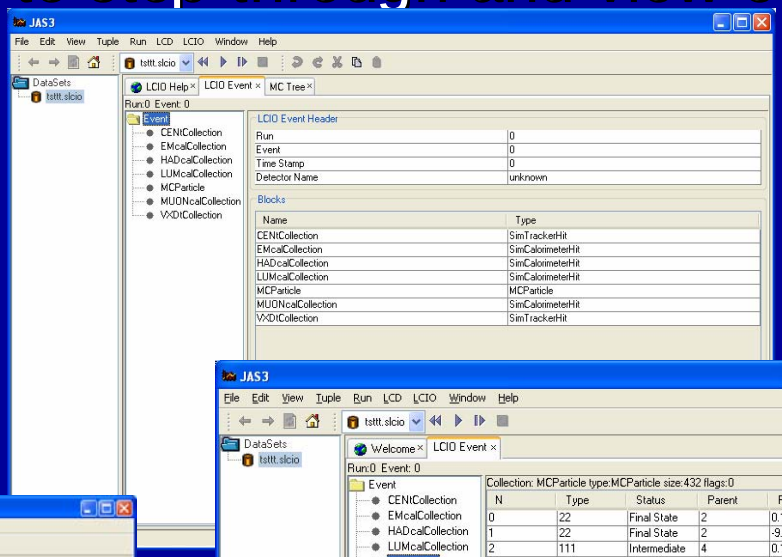
Event Analysis

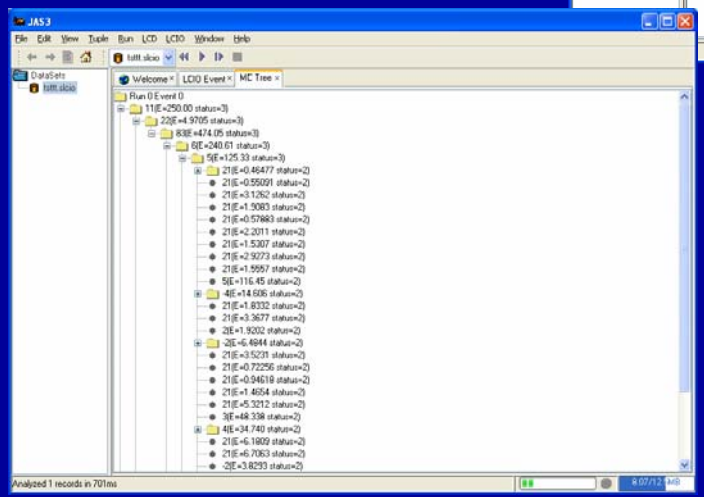
- Aim is to demonstrate full “Particle Flow” reconstruction.
- ReconstructedParticle concept and example implementation being implemented.
  - Several groups now working on various aspects
- Finishing up γ-finding high priority.
- Refining track-cluster association.
- Forward tracking code released.
- Muon-finding software actively worked on.

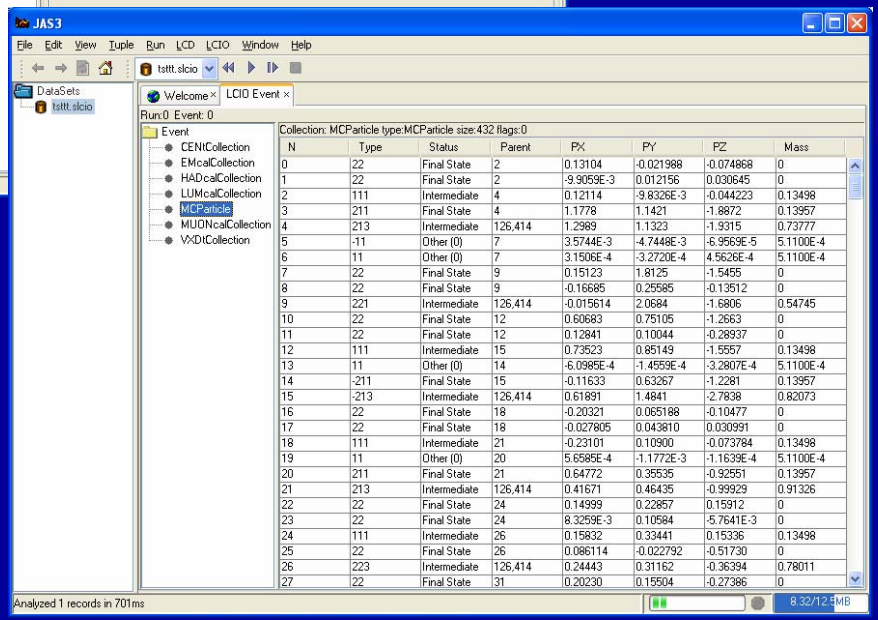
LCIO plugin for JAS3

- Works with any LCIO file
- Diagnostic tools allow to step through and view events



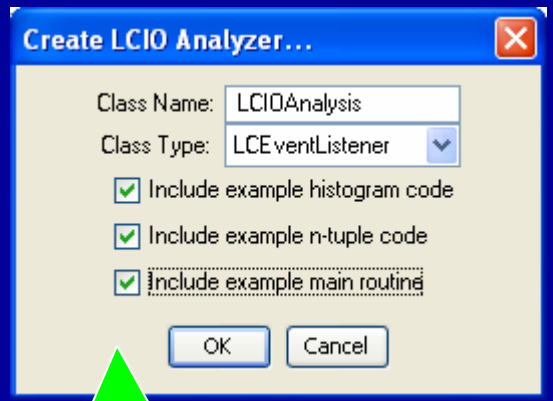




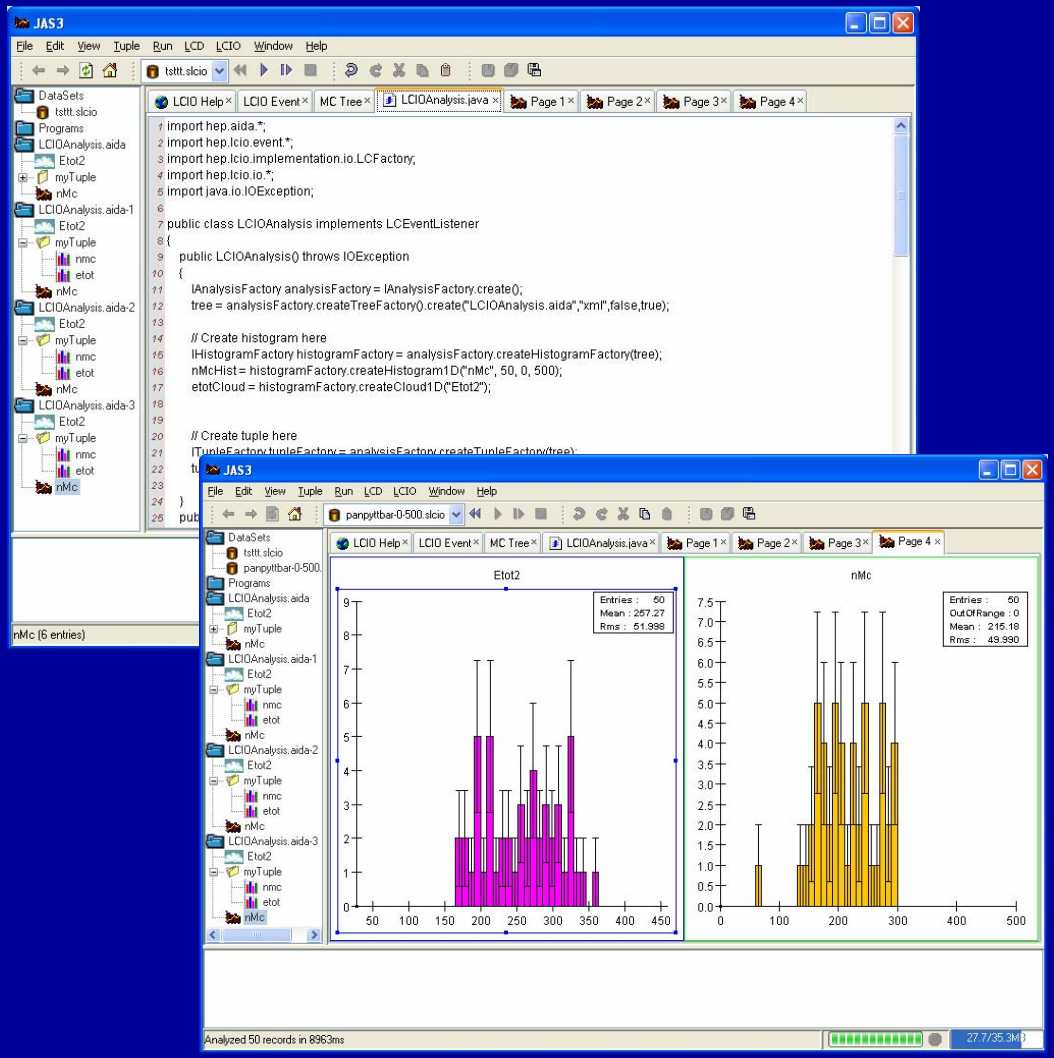


LCIO plugin for JAS3

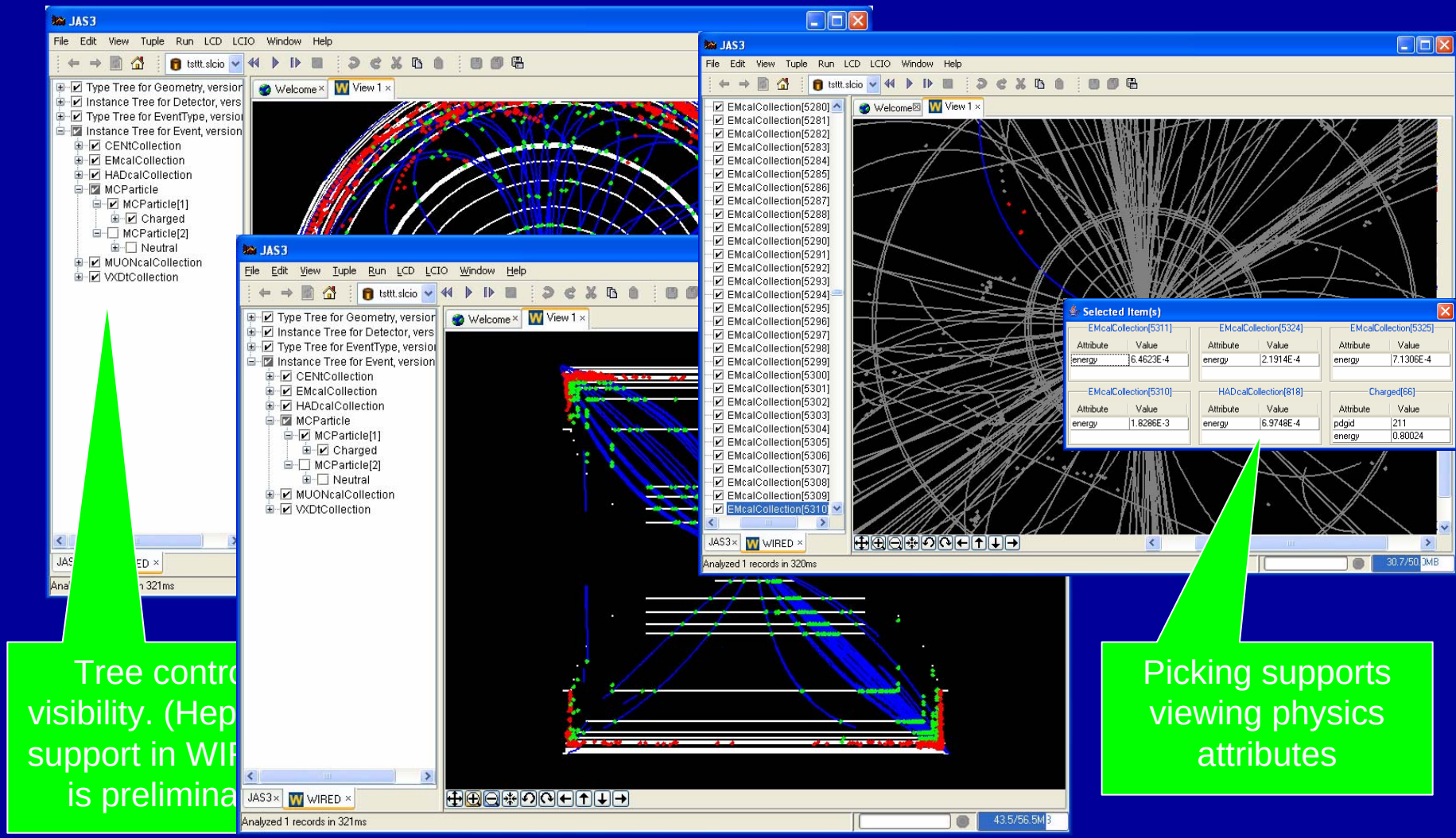
- Event Analysis



Wizard will create outline of analysis, and can include sample analysis code. Main routine allows running outside of JAS



WIRED3 with LCIO Plugin



Tree contro
visibility. (Hep
support in WI
is prelimina

Picking supports viewing physics attributes

org.lcsim Goals

- Retain core functionality from hep.lcd package
  - Full suite of reconstruction and analysis tools available to all LCIO users
- Update to use LCIO for IO and as basis for simulation, raw data and reconstruction event formats.
- Update/simplify framework using experience from hep.lcd
- Internationalization
  - Try to make package independent of detector, geometry assumptions so can work with any detector
  - Read properties of detectors at runtime
- Update to Java 1.4 (or 1.5)
  - Many improvements since hep.lcd framework was created.
- Ability to run standalone or in JAS3
- Revitalize work on reconstruction algorithms

org.lcsim Status

- Physics Utilities - done
  - stdhep reader
  - 3, 4-vector utilities
  - diagnostic generator
  - Jet finder, event shape utilities
- Org.lcsim package – Phase I
  - Conditions framework – done
    - Ability to read detector constants from “zip” file
    - To define new detector just create new zip file and place on web
      - File is read and cached locally
  - Driver framework – done
  - Fast MC – done
  - IO Framework – working, needs final LCIO 1.2
  - Event Display interface – in progress

Necessary R&D

- Many of the tools necessary for characterizing detector designs exist:
  - fast and flexible detector response simulation
  - signal & background samples and merging code
  - detector digitization, hit merging
  - track and calorimeter cluster reconstruction
  - various parts of Particle Flow reconstruction exist
- Need more people to use and develop!

Summary

- Significant progress during the last months.
- GEANT4 established as default.
- LCIO reco event model actively developed.
- Much progress in tracker detector digitization.
- Track finding strategies applied to different topologies.
- The developer/user community is growing & there is rapid progress in developing reconstruction algorithms, especially Particle Flow.

Links

- LCIO: http://lcio.desy.de
- hep.lcd: http://www-sldnt.slac.stanford.edu/jas/Documentation/lcd/
  - **Tutorials**:
    - http://jas.freehep.org/jas3/Tutorial/index.html
    - http://www-sldnt.slac.stanford.edu/snowmass/Welcome.html
- JAS3: http://jas.freehep.org/jas3
- WIRED: http://wired.freehep.org/
- HepRep: http://heprep.freehep.org/
- **Discussion Forums:**
  - http://forum.linearcollider.org