



LCD Reconstruction and Analysis Tools

(not FastMC/Vertexing – see Wolfgang's talk)

(not Root based tools – see Masako's talk)

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SLAC – October-2000



Contents

? Reconstruction Status

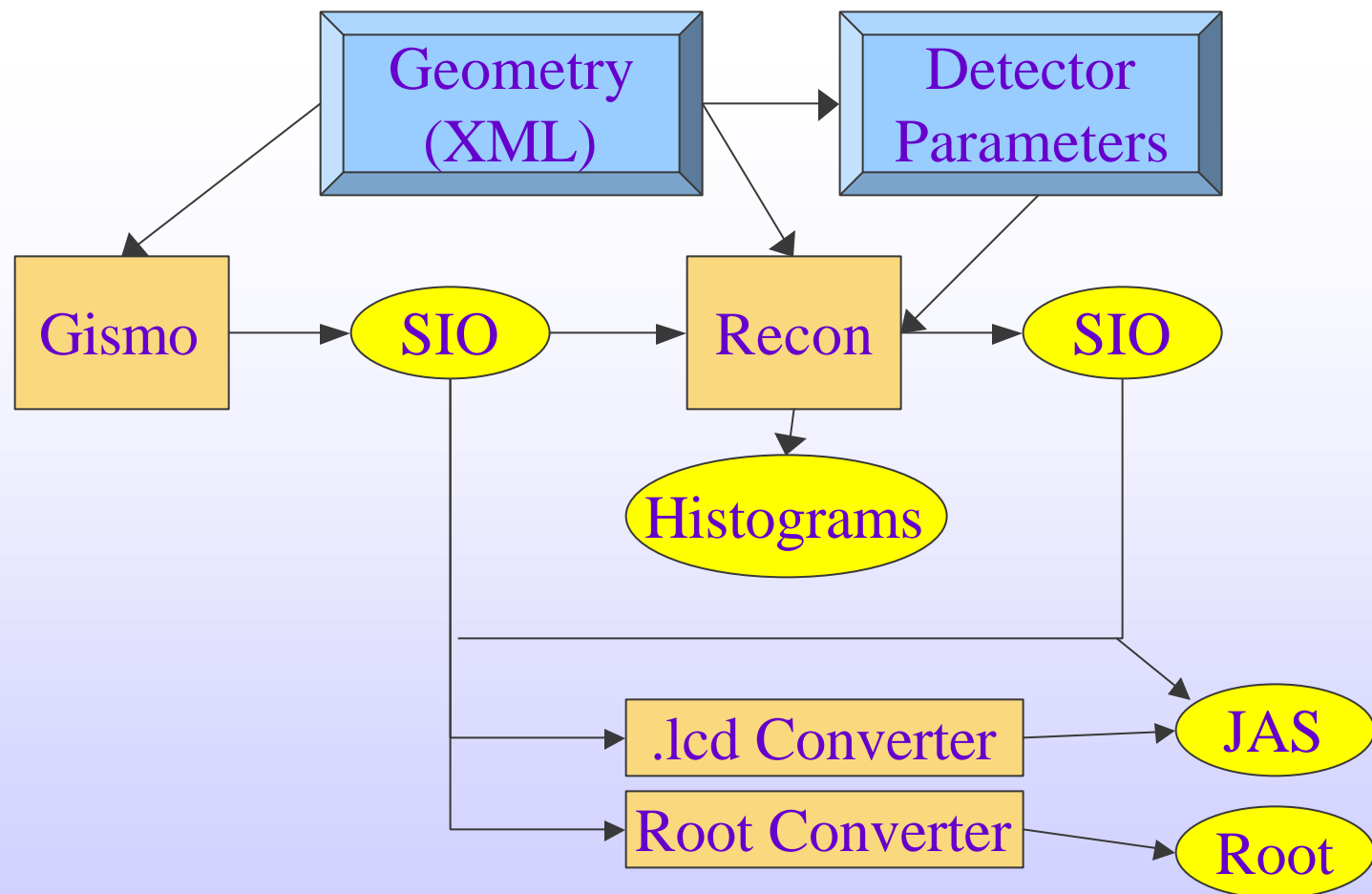
- Current Status
- Plans/To Do list

? Analysis Tools

- Java Analysis Studio
- LCD Utilities
- Event Displays

? Documentation

Reconstruction Road Map (Goal)



- Recon written in Java – totally portable to different platforms
- Recon can run standalone, or inside JAS



Reconstruction

? Track Reconstruction

- Track Finding uses M.Ronan's (TPC) pattern finding
 - Tuned for Large + Small detector
- Track Fitters:
 - SLD Weight Matrix Fitter
 - Can do Single Detector or Combined fit (e.g. VTX+TPC)

? Hit Smearing/Efficiency (Gismo gives “perfect” hits)

? Random Background overlay

? To Do:

- More Track Finding Algorithms (Cheater, Projective Geometry)
- More Track Fitting Algorithms (Kalman Filter)
- End Cap tracking, Hit Merging



Reconstruction cont.

? Cluster Finding

- Three Clustering Algorithms Currently Implemented
 - Cluster Cheater (uses MC truth to “cheat”)
 - Simple Cluster Builder (Touching Cells)
 - Radial Cluster Builder
 - All algorithms tend to produce many very low energy clusters - important to set sensible thresholds

? To Do

- Cluster Refinement Stage
 - Combine HAD + EM clusters
 - Endcap + Barrel overlap region
- Track Cluster Association
- Need to Extend Definition of Clusters to exploit fine segmentation
 - Directionality, Entry point to calorimeter



Code Availability

? Reconstruction

- All code in CVS for universal access
 - Browse CVS repository on Web
 - Connect with your favorite CVS client
- Platform independent make (jmk) now used
 - Builds identically on NT and Unix



Recent Work

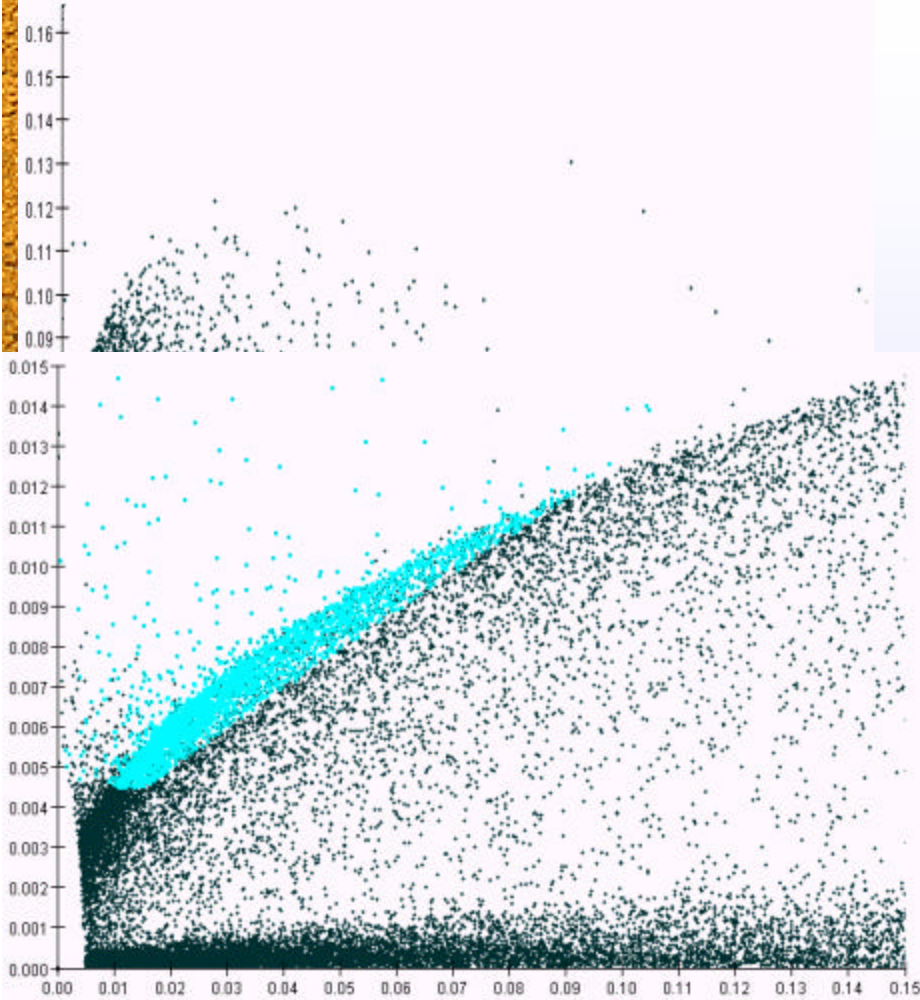
- ? Switch to SIO format (replaces ASCII file)
 - SIO reading working
 - ToDo:
 - SIO recon output format needs to be defined
 - SIO writing needs to be completed
 - Converter utilities (sio->lcd, sio->root) need to be upgraded
- ? Support for S2, L2 (+ old) detectors
 - Retune recon for new geometries
- ? Calorimeter Geometry now more flexible
 - Calorimeter Cell Merging in process
 - Will allow detailed studies of calorimeter clustering without re-running Gismo



Beam Background Overlays

- Take output from Guinea Pig beam
- Feed events into full Gismo simulation
- Build library of simulated background bunches
- Overlay backgrounds on signal events at start of reconstruction
 - Adjust timing of hits (for TPC e.g.)
 - Combine (add) energy in calorimeter cells
 - Allows to change #bunches/train, bunch timing
- ToDo
 - Ability to overlay events
 - Time shifts in TPC, Merge hits in calorimeter

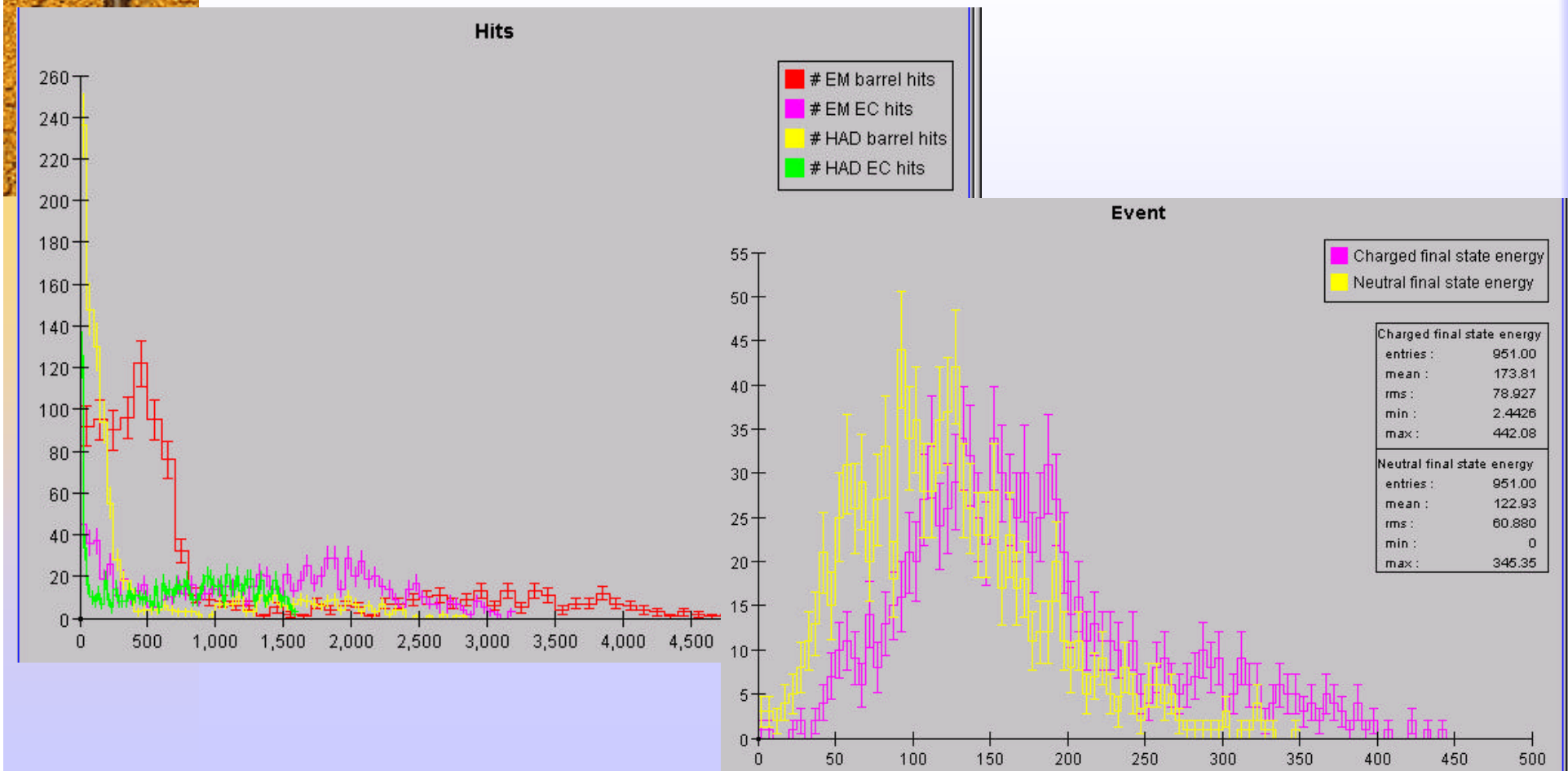
Background Overlays



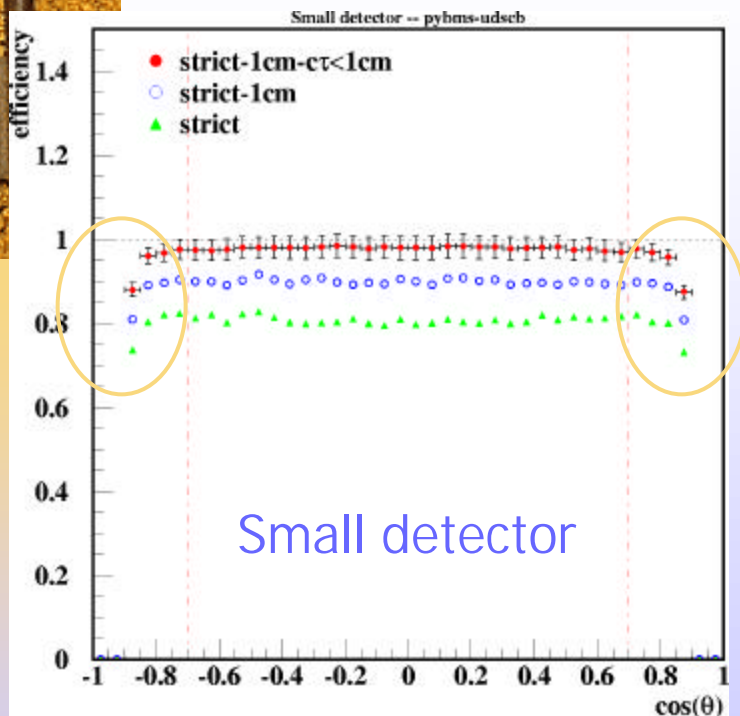
- ? L1 Detector
 - 4 Tesla field
 - 1cm beampipe \pm 5cm from IP
- ? Primary particles from single bunch crossing
 - 90k particles/bunch
 - 95 bunches/train
- ~~✍~~ Blue particles interact with detector in central region
 - ~~✍~~ 80k particles/physics event
- ~~✍~~ Effects on recon yet to be studied

Quality Control (Ron Cassell)

? Standard set of diagnostic plots for checking generator/simulation/reconstruction output.



Track Reconstruction Efficiency (Wolfgang Walkowiak)



? Obtained efficiencies: (all cuts)

Cuts	?(small)	?(large)
Strict	80.9%	80.8%
Strict-1cm	90.0%	92.6%
Strict-1cm-ct1cm	97.9%	97.7%

- ? Pythia+bms udsdb samples
- ? Low efficiency at low momentum.
- ? Forward disks missing in reconstruction.
- ? Problems with e.g. K_s^0 and ? decay vertices.
 - Believed fixed – needs checking



Recon To Do List

- ? Tracker hit merging
- ? Support for merging signal/backgrounds
- ? Additional Track Finders (projective, “cheater”)
- ? Improved Cluster Description
- ? Track/Cluster Association
- ? Cluster Refinement
- ? Define recon output structures
- ? Support for SIO format writing/SIO data converters
- ? Switch to XML based geometry description
- ? Define “standard” recon for batch running
- ? Small Angle Tracking

– **Volunteers Needed!!!**



LCD Analysis Tools

Java Analysis Studio

The screenshot displays the Java Analysis Studio (JAS) interface. The main window is titled "Java Analysis Studio" and contains a menu bar (File, Edit, Job, Histogram, View, Window, BeanShell, WIRED, Help) and a toolbar. The current file is "C:\Temp\SingleMuons-L2-sim-1.sio".

On the left, a tree view shows the project structure under "Default Job":

- Data
 - C:\Temp\Single...
- Programs
 - LCDResolution
- Histograms
 - EM nhits
 - EM Energy
 - HAD nhits
 - HAD Energy
 - MU nhits
 - MU Energy
 - Total Energy

The central "WIRED" window shows a 3D wireframe model of a detector with a particle track. A yellow box displays "Alpha 0000.012".

The "Page 1" window shows a histogram titled "Total Energy". The x-axis ranges from 1.0 to 2.0, and the y-axis ranges from 0 to 140. A purple box provides the following statistics:

entries	: 735.00
mean	: 1.5041
rms	: 0.23940
min	: 0.99241
max	: 3.3353

The bottom window shows the source code for "LCDResolution.java":

```
public void processEvent(EventData d)
{
    LCDEvent header = (LCDEvent) d;

    CalorimeterHits hits = header.getEMCalorimeterHits();
    double EMEnergy = sumEnergy(hits.getHits());

    histogram("EM nhits").fill(hits.getNHits());
    histogram("EM Energy").fill(EMEnergy);
}
```

At the bottom left, there are buttons for "JAS" and "WIRED". A status bar at the bottom indicates "Histogram: Total Energy (entries=735)".



JAS – New Release -- 2.2.1

? New Features (of importance to LCD)

- Much easier to compare plots from different datasets/algorithms
- Much easier to download/install plugins (e.g. lcd.jar file)
- Support for printing plots greatly improved



Physics Utilities

? Physics Utilities

- 4-vector, 3-vector classes
- Event shape/Thrust finder
- Jet Finder
 - All standard e^+e^- algorithms implemented
 - Extensible to allow implementation of other algorithms

? Contrib. Area

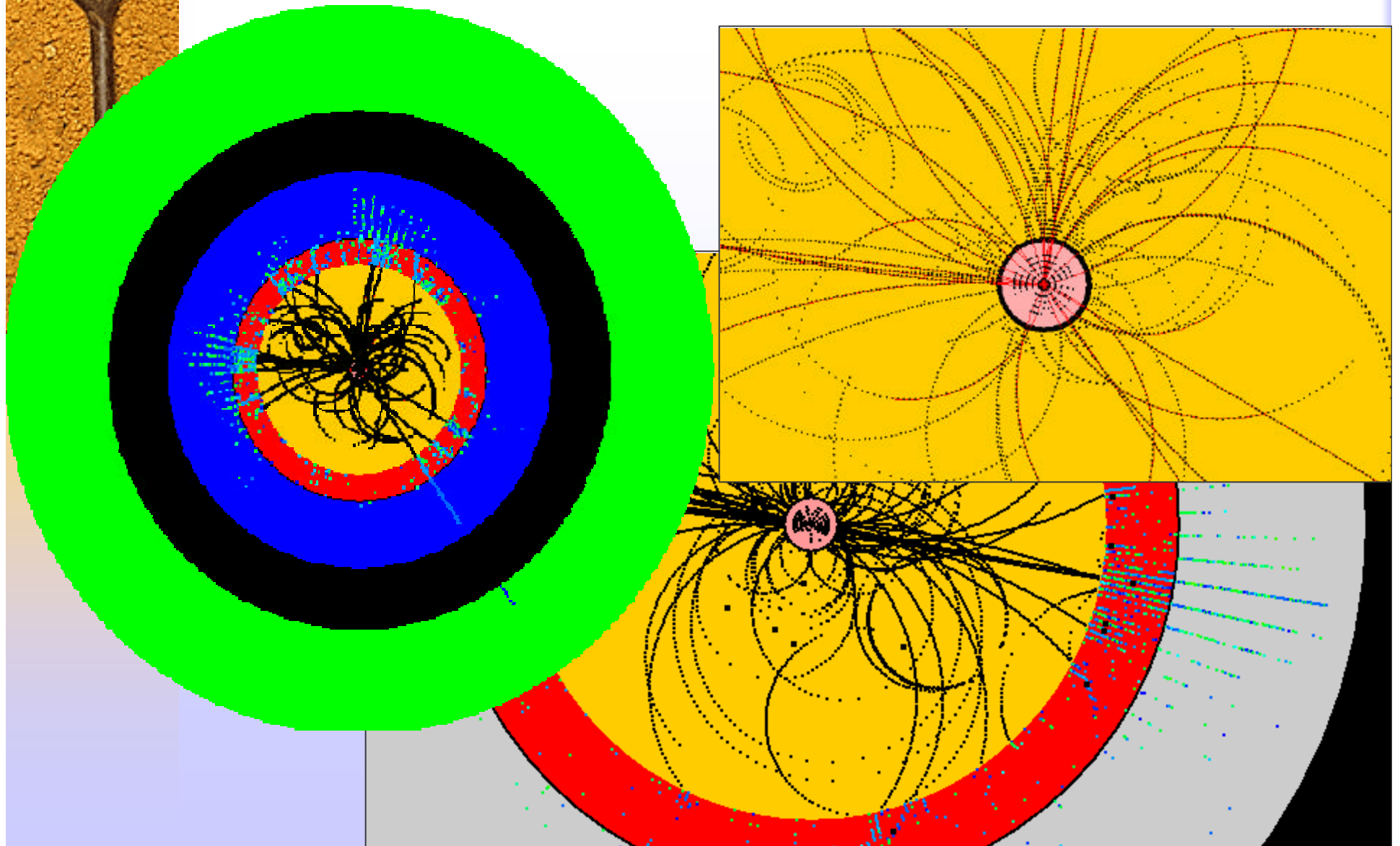
- Analysis Utilities and sample analyses provided by users

? 2 Event Displays

- 2D - Suitable for debugging reconstruction and analysis
- Wired for full 3D support

? MC Particle Hierarchy Display/MC Particle Table

2D Event Display



Wired Event Display



Java Analysis Studio

File Edit Job Histogram View Window WIRED Help

pybms-tt-500-990115-Small-sim-1.dat.gz

Page 1 WIRED

Alpha 0000.022

- Event Data
 - Barrel
 - EndCap
 - Tracks
- Detector
 - Detector
 - Barrel
 - EndCap
 - MultiLayer
 - MU_EndC
 - LUM_EndC
 - MU_EndC
 - EM_EndC
 - LUM_EndC
 - HAD_EndC
 - EM_EndC
 - HAD_EndC

Actions

Mouse Mode

Bar Mode

Projections

- X-FishEye
- FishEye
- Y-FishEye
- Perspective
- Z-FishEye
- Z-Phi
- Phi-Theta
- Rho-Z
- Parallel
- Rho-Phi

Ordering

Drawing

Re-Represent

Re-Project

Re-Order

Re-Draw

JAS WIRED

Start | LC... | FN... | Si... | Inb... | E... | Pa... | JA... | J... | 11:50 AM

MC Particle Table

Java Analysis Studio

File Edit Job Histogram View Window LCD Help

StdHEP/Pythia-gen

Page 1 | Welcome MC Table

Run:0 Event: 1 Etot: 91.260

N	Type	Status	Parent	PX	PY	PZ	E
0	e+	Documentation	0	0	0	45.630	45.630
1	e-	Documentation	0	0	0	-45.630	45.630
2	e+	Documentation	0	0	0	45.630	45.630
3	e-	Documentation	1	0	0	-45.630	45.630
4	e+	Documentation	2	0	0	45.630	45.630
5	e-	Documentation	3	0	0	-45.630	45.630
6	Zo	Documentation	4,5	0	0	-9.8320E-8	91.260
7	b	Documentation	6	-4.2967	-0.19971	45.172	45.630
8	b_bar	Documentation	6	4.2967	0.19971	-45.172	45.630
9	Zo	Intermediate	6	0	0	-9.8320E-8	91.260
10	gamma	Final State	0	0	0	1.1267E-7	1.1267E-7
11	gamma	Final State	1	0	0	-1.4351E-8	1.4351E-8
12	b	Intermediate	7	-10.435	5.1745	19.271	23.024
13	gluon	Intermediate	7	-0.54817	-2.3544	4.0034	4.6767
14	gluon	Intermediate	7	0.39785	0.060380	0.64574	0.76086
15	gluon	Intermediate	7	1.7791	-1.3330	7.0767	7.4177
16	gluon	Intermediate	7	1.1111	-2.0143	5.0487	5.5481
17	gluon	Intermediate	7	0.76648	0.64118	1.7788	2.0403
18	gluon	Intermediate	7	2.9282	-0.36018	4.2306	5.1578
19	gluon	Intermediate	8	-0.065443	0.15341	-0.071891	0.18162
20	b_bar	Intermediate	8	4.0657	0.032525	-41.084	47.452

JAS

Analyzed 1 events in 10 milliseconds



Physics Utilities

? Diagnostic Generator

- N particles per event
 - Any particle type
 - Particle/Anti-particle mixture
- Can generate pairs of particles for track separation tests
- Can generate displaced vertices for vertex finder testing

? Can be run directly in JAS

- E.g. for running FastMC tests

? Can be run standalone

- E.g. for writing stdhep files

? Generator framework extensible for other generators



Documentation

- ? All documentation updated for latest release of JAS/hep.lcd
- ? Tutorial being updated and extended
 - Wired Event Display
 - Diagnostic Generator
 - Automatic testing of all tutorial code with each release
- ? <http://www-sldnt.slac.stanford.edu/jas/documentation/lcd/>