GlueX-doc-1895-v1 (activity 1532050)

Hall D Online Event Display

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1 Requirements

The online event display will be used extensively in the Hall D Online as well as by the offline analysis effort. Below is a list of requirements:

- Accept event data in EVIO format from a file, ET system or a cMsg message. Implement event I/O generically to allow import of data in other formats if required.
- Display raw data banks as well as processed DANA objects.
- Implement commonly used interactive features typical of event displays, including pan and zoom, display of single detector or the entire detector system, overlay hits and tracks, etc.
- Implement customizable statistics accumulation modes along with associated displays.
- Easily accommodate addition of new detectors, data banks and DANA objects.
- Multiple 2-D views of the detectors.

In addition, it is desirable that the display be able to render a 3-D image. This is not considered a requirement however since a carefully chosen set of 2-D displays can often present data more effectively than a 3-D display.

2 Framework

Work has been done to seriously investigate two frameworks on which to build the Hall-D event viewer. Working prototypes have been built using both of them to varying degrees of ability and these are described in the following sections. The construction of the original viewer motivated numerous changes to the JANA reconstruction framework in order to accommodate the type of program flow typical of a single event viewer. In particular, most GUI programs implement their own primary event loop (GUI events as opposed to physics events) with some type of callback mechanism for communicating interactions with GUI elements to user code. No further development of the JANA framework will be required to accommodate the event viewer.

2.1 ROOT

The ROOT software package encompasses many features. Among them is a set of classes for developing full featured GUIs in C++ with ROOT rendering elements integrated. This naturally fits in with the C++ event reconstruction framework used in Hall-D (JANA) while providing facilities to easily draw histograms or similar plots within the viewer. In 2007, a program named *hdview2* was developed using the ROOT framework. The original motivation was to provide a diagnostic tool to aid in development of the simulation and reconstruction software. A screen shot of the main window of *hdview2* can bee seen in figure 1 and one of the options windows in fig. 2. The program has grown somewhat organically as the needs of its diagnostic role have dictated. It was always assumed that while the program provided many proofs-of-principle, a new viewer designed specifically for the task of online event viewing would be eventually be written.

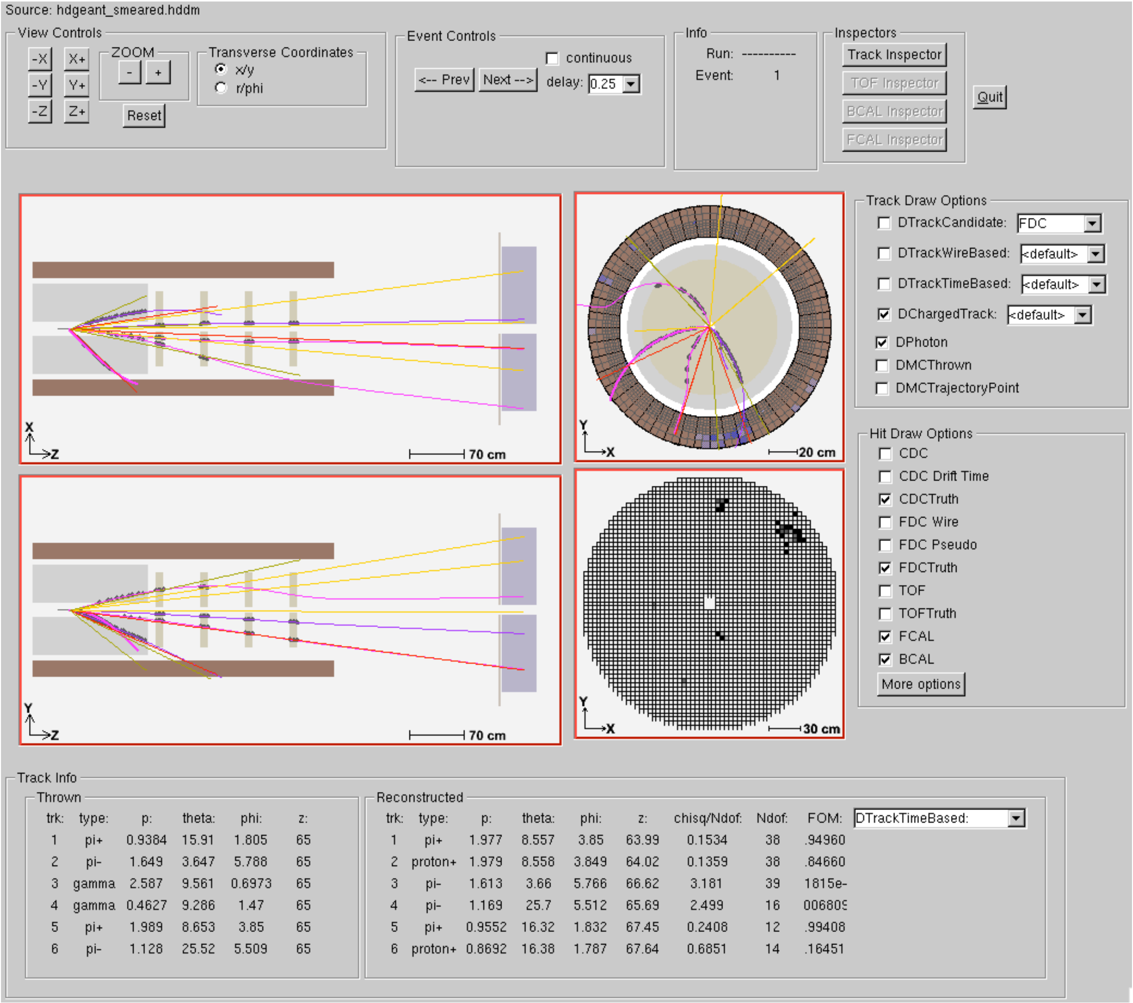
2.2 bCNU

The CLAS12 collaboration has developed an event viewer to work with their CLARA services framework for event reconstruction. The *bCNU* framework is Java-based and written to be independent of any specific detector. In 2010-2011 a CNU student successfully implemented the core Hall D detector geometry in the bCNU framework. Certain challenges remain with integrating the viewer with the existing Hall-D reconstruction in an interactive way[1]. Another CNU student will continue development of the *ded* viewer in the Summer of 2012 under the guidance of both Dave Heddle (the bCNU framework's lead developer) and scientists within the Hall-D collaboration.

3 Manpower

The schedule lists 13 manweeks for planning of the online viewer. This may be accurate for the amount of time spent on development of *hdview2* and *ded*, although that was funded by sources other than the project. The writing of the event display is listed as 44 manweeks which is also considered accurate, though it is unclear at this time what fraction of that will come from University contribution as opposed to project funds.

[1] Primarily coupling C++ with Java.



Source: hdgeant_smeared.hddm

View Controls

Transverse Coordinates
● x/y
○ r/phi

Event Controls
□ continuous
delay: 0.25

Info
Run: ----------
Event: 1

Inspectors

Track Draw Options
□ DTrackCandidate: FDC
□ DTrackWireBased: <default>
□ DTrackTimeBased: <default>
☑ DChargedTrack: <default>
☑ DPhoton
□ DMCThrown
□ DMCTrajectoryPoint

Hit Draw Options
□ CDC
□ CDC Drift Time
☑ CDCTruth
□ FDC Wire
□ FDC Pseudo
☑ FDCTruth
□ TOF
□ TOFTruth
☑ FCAL
☑ BCAL

Track Info

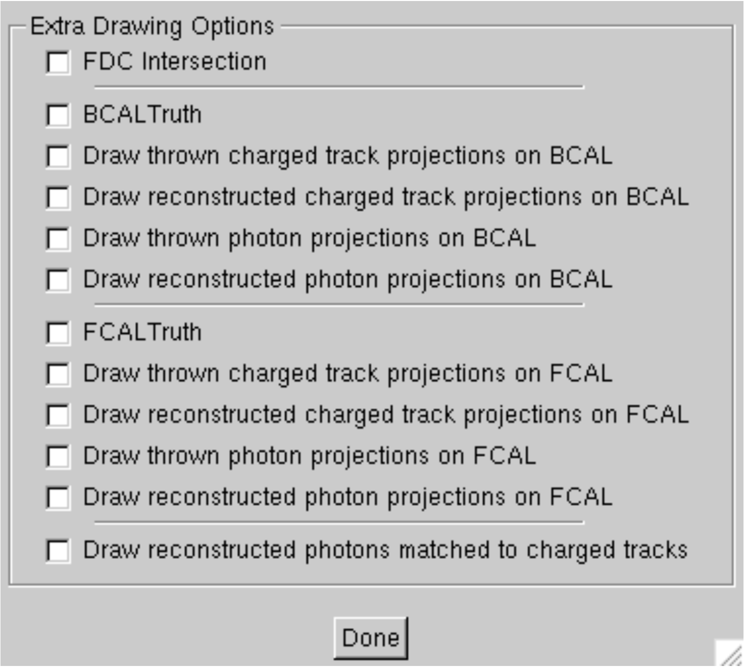
Thrown

trk:	type:	p:	theta:	phi:	z:
1	pi+	0.9384	15.91	1.805	65
2	pi-	1.649	3.647	5.788	65
3	gamma	2.587	9.561	0.6973	65
4	gamma	0.4627	9.286	1.47	65
5	pi+	1.989	8.653	3.85	65
6	pi-	1.128	25.52	5.509	65

Reconstructed

trk:	type:	p:	theta:	phi:	z:	chisq/Ndof:	Ndof:	FOM: DTrackTimeBased:
1	pi+	1.977	8.557	3.85	63.99	0.1534	38	.94960
2	proton+	1.979	8.558	3.849	64.02	0.1359	38	.84660
3	pi-	1.613	3.66	5.766	66.62	3.181	39	1815e-
4	pi-	1.169	25.7	5.512	65.69	2.499	16	00680
5	pi+	0.9552	16.32	1.832	67.45	0.2408	12	.99408
6	proton+	0.8692	16.38	1.787	67.64	0.6851	14	.16451

Figure 1: Main window of the *hdview2* program. The program is primarily a diagnostic tool for developing reconstruction algorithms. However, many of its features we will want incorporated into the final online event viewer.



Extra Drawing Options

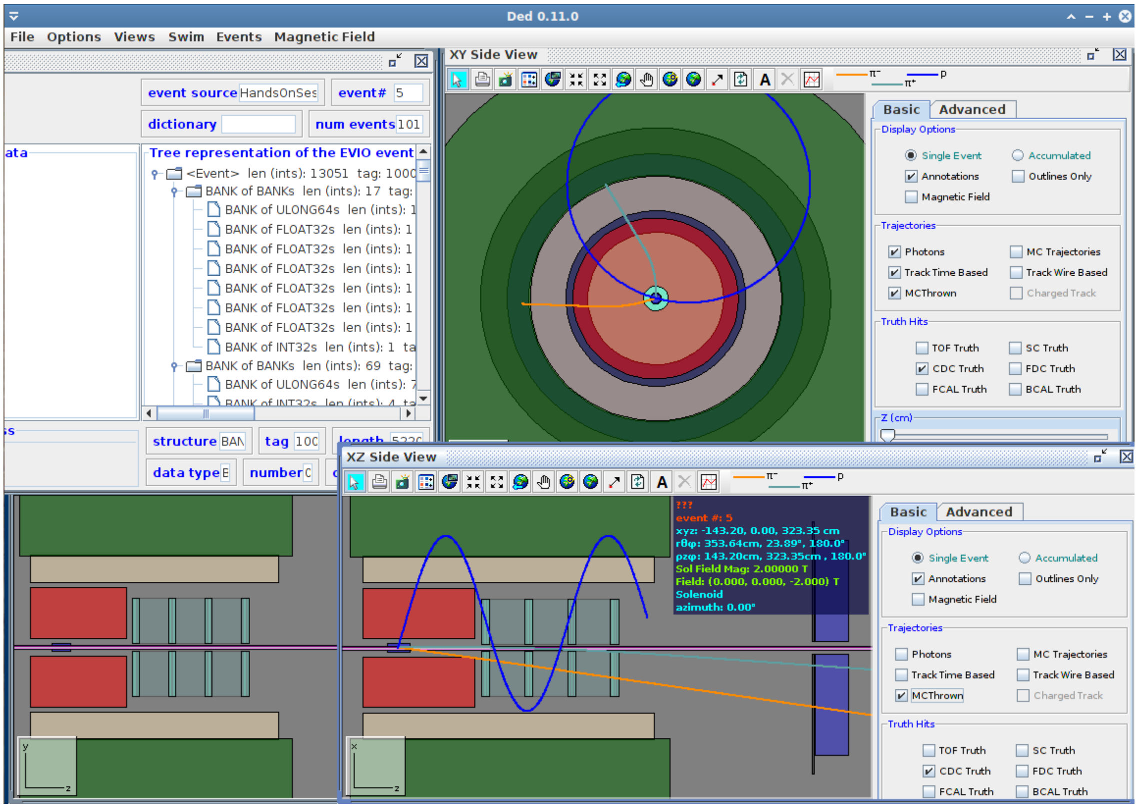
□ FDC Intersection

□ BCALTruth
□ Draw thrown charged track projections on BCAL
□ Draw reconstructed charged track projections on BCAL
□ Draw thrown photon projections on BCAL
□ Draw reconstructed photon projections on BCAL

□ FCALTruth
□ Draw thrown charged track projections on FCAL
□ Draw reconstructed charged track projections on FCAL
□ Draw thrown photon projections on FCAL
□ Draw reconstructed photon projections on FCAL

□ Draw reconstructed photons matched to charged tracks

Figure 2: Window giving additional display options in *hdview2*. Similar options will be needed in the final online event viewer.



event source HandsOnSes | event# 5
dictionary | num events 101

Tree representation of the EVIO event

```
<Event>  len (ints): 13051  tag: 1000
  BANK of BANKs  len (ints): 17  tag:
    BANK of ULONG64s  len (ints): 1
    BANK of FLOAT32s  len (ints): 1
    BANK of FLOAT32s  len (ints): 1
    BANK of FLOAT32s  len (ints): 1
    BANK of FLOAT32s  len (ints): 1
    BANK of FLOAT32s  len (ints): 1
    BANK of FLOAT32s  len (ints): 1
    BANK of INT32s  len (ints): 1  ta
  BANK of BANKs  len (ints): 69  tag:
    BANK of ULONG64s  len (ints): 7
    BANK of INT32s  len (ints): 4  ta
```

structure BAN | tag 10C | length 522C
data type E | number C

XY Side View:

Display Options
● Single Event ○ Accumulated
☑ Annotations □ Outlines Only
□ Magnetic Field

Trajectories
☑ Photons □ MC Trajectories
☑ Track Time Based □ Track Wire Based
☑ MCThrown □ Charged Track

Truth Hits
□ TOF Truth □ SC Truth
☑ CDC Truth □ FDC Truth
□ FCAL Truth □ BCAL Truth

Z (cm)

XZ Side View:

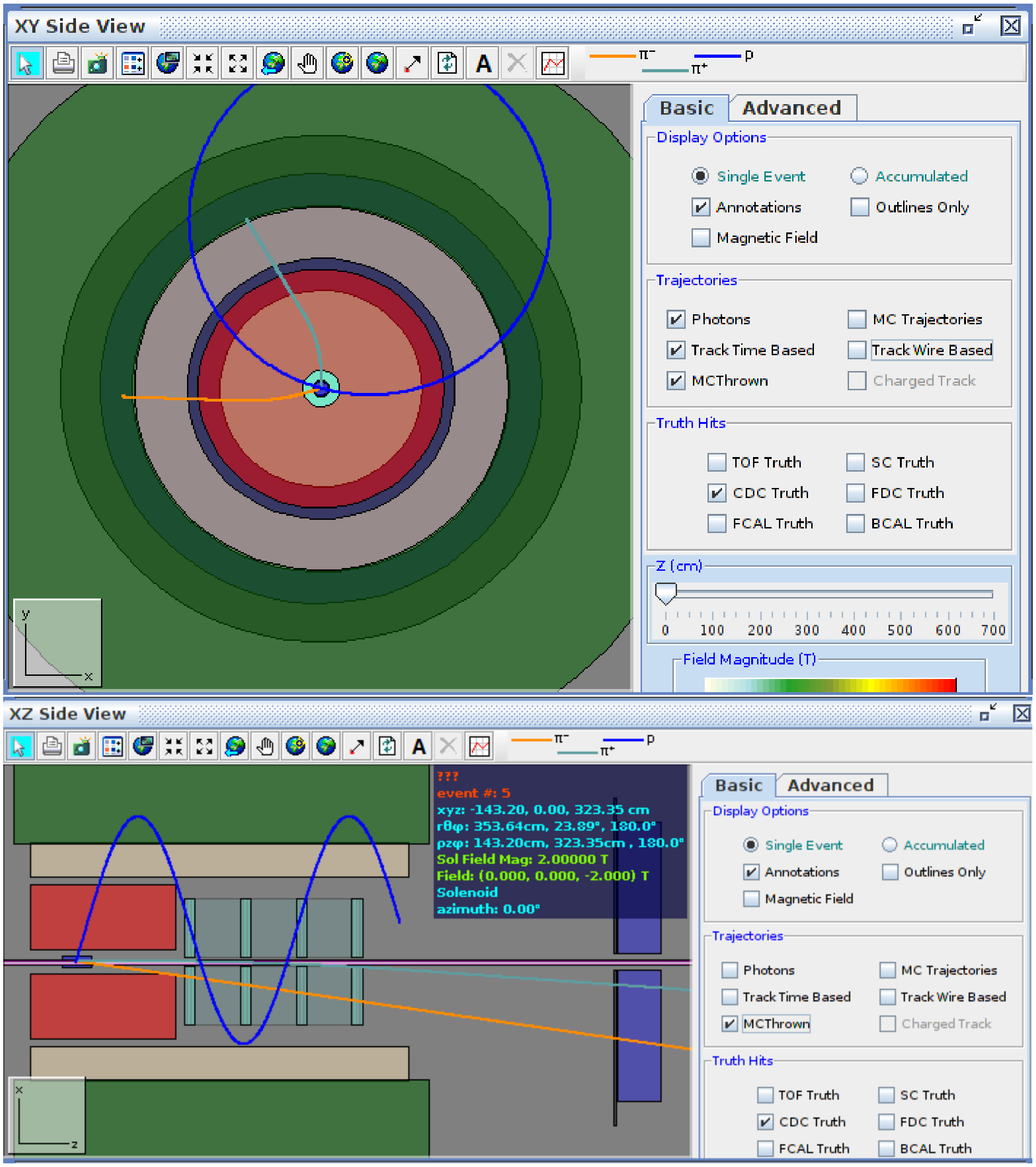
```
???
event #: 5
xyz: -143.20, 0.00, 323.35 cm
rθφ: 353.64cm, 23.89°, 180.0°
ρzφ: 143.20cm, 323.35cm , 180.0°
Sol Field Mag: 2.00000 T
Field: (0.000, 0.000, -2.000) T
Solenoid
azimuth: 0.00°
```

Display Options
● Single Event ○ Accumulated
☑ Annotations □ Outlines Only
□ Magnetic Field

Trajectories
□ Photons □ MC Trajectories
□ Track Time Based □ Track Wire Based
☑ MCThrown □ Charged Track

Truth Hits
□ TOF Truth □ SC Truth
☑ CDC Truth □ FDC Truth
□ FCAL Truth □ BCAL Truth

Figure 3: *ded* event viewer with full screen view. In the upper left corner, and EVIO data browser can be seen.



Display Options

● Single Event ○ Accumulated

☑ Annotations □ Outlines Only

□ Magnetic Field

Trajectories

☑ Photons □ MC Trajectories

☑ Track Time Based □ Track Wire Based

☑ MCThrown □ Charged Track

Truth Hits

□ TOF Truth □ SC Truth

☑ CDC Truth □ FDC Truth

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```
???
event #: 5
xyz: -143.20, 0.00, 323.35 cm
rθφ: 353.64cm, 23.89°, 180.0°
ρzφ: 143.20cm, 323.35cm , 180.0°
Sol Field Mag: 2.00000 T
Field: (0.000, 0.000, -2.000) T
Solenoid
azimuth: 0.00°
```

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Figure 4: Close ups of a end view and side view of the textitded event viewer.