Using WIRED to study simulated Linear Collider Detector Events

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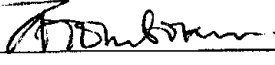
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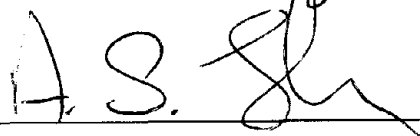
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Using WIRED to study simulated Linear Collider Detector Events. AYODELE ONIBOKUN, AYANAH GEORGE (Bethune Cookman College, Daytona Beach, FL 32114) TONY JOHNSON (Stanford Linear Accelerator Center, Menlo Park, CA 94025).

The purpose of this project is to enhance the properties of the LCD WIRED Event Display. By extending the functionality of the display, physicists will be able to view events with more detail and interpret data faster. Poor characteristics associated with WIRED can severely affect the way we understand events, but by bringing attention to specific attributes we open doors to new ideas. Events displayed inside of the LCD have many different properties; this is why scientists need to be able to distinguish data using a plethora of symbols and other graphics. This paper will explain how we can view events differently using clustering and displaying results with track finding. Different source codes extracted from HEP libraries will be analyzed and tested to see which codes display the information needed. It is clear that, through these changes certain aspects of WIRED will be recognized more often allowing good event display which lead to better physics results.

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About the Authors

Born Ayanah S. George in Seattle, Washington May 31, 1982. Growing up mostly in Seattle, she moved to Georgia to attend high school. In the fall of 2000 she attended Bethune-Cookman College in Daytona Beach to study engineering. Ayanah enjoys traveling, drawing and music, but most important she loves learning new things.

Born in Lagos-State, Nigeria. Ayodele Onibokun grew up in Ilesha Osun-state.. His greatest pleasure is reading and listening to music such as: R & B, Jazz, and Rap in the lowest volume. His favorite movie is the Matrix and his favorite hobbies are playing soccer, hanging out with friends, and going to movies at his most leisure time. His career interest is to become a physicist and computer scientist, which he had promised his parents that he would fulfill within four years of study at Bethune Cookman-College.

Introduction

In today's High Energy Physics World, experiments are usually carried out by big collaborations of many institutes, colleges, and universities over several countries. "High Energy" means high per particle energy and High Energy Physics- exploring the fabrics of space-time. Each of these institutes is equipped with a variety of computers to run analysis jobs, interactive tools and event displays. All institutes are connected to the Internet, which gives physicists access to the events of their experiments.

What is a Linear Collider?

The Stanford Linear Collider was built and completed in 1987. It is a 2-mile tunnel in which electrons and positrons are propelled near the speed of light to collide in the SLD at the end of a one half-mile loop. From these collisions, new sub-atomic particles are expected to emerge giving scientists clues to the search for a unified theory of all physical laws of gravity, electromagnetism and atomic forces (Stanford Linear Accelerator Center, 2001).

Next Linear Collider

The Next Linear Collider Detector is a proposed project to design a high-energy, large-scale positron-electron collider. It is one of the many anticipated e+e- collider of the next generation, a machine of center of mass energy 500-1500 GeV and an approximate length of 20 miles. This would make possible precision studies of the couplings of the heaviest particles now known – the W boson and the top quark – and would permit

sensitive searches for any new particle with weak or electromagnetic interactions (SLAC, 1995).

What is a Detector?

Detectors are the instruments that show what new materials has been formed from particle colliders, regardless of whether the colliding particles are electrons and positrons, or hadrons. They are large, complex devices with several types of detecting elements (McDunn, 2001). The Linear Collider Detector is a proposed detector designed to be used at the Next Linear Collider.

Java Analysis Studio and WIRED Event Display

Java Analysis Studio (JAS), an information-based interface used for data analysis is used in conjunction with WIRED. JAS is entirely written in Java and runs on any platform with a Java Virtual Machine, where it compiles, loads and runs High Energy Physics (HEP) codes. WIRED comes with a powerful graphics engine that is specially made to handle the display of events in different modes, or special projections (Donszelmann, 1998). These "special projections" reveal to scientists the numerous ways in which the data can be analyzed, they enable us to see what cannot be seen from normal views and expand the way we observe events. Special projections can be useful to enhance a particular aspect of the data that the user is studying (Drevermann, Kuhn, & Nilsson, 1995).

WIRED was initially designed as an event visualization framework using Java (JDK 1.3) inside the WWW browser. In its initial configuration, it was used for the DELPHI

experiment in August 1996 (Coperchio, Donszelmann, Gunnarson, Navarria, & Roveli, 1996). The recent introduction of the JAVA language enabled the transfer of codes across the World-Wide Web to be executed on a WWW browser. This new programming language made possible the implementation of the remote event display online. Java and WWW technology offer a worldwide availability of the event display, allowing an always- up-to-date (executable) code, a platform independent implementation, easy use and installation. Java became a lot faster and portable so, the early version of WIRED was rewritten completely to accommodate multiple experiments and to put emphasis on the visualization of High Energy Physics events (Coperchio et al, 1996).

WIRED is created to work on any independent platform; currently, it can read data from any source that either provides High Energy Physics Representation (HEPREP), Extensible Markup Language (XML), Remote Method Invocation (RMI), Standard Input and Output files (SIO), and Standard High Energy Physics (STD). The data source may be processed on another computer or on a remote server. The data can be accessed world wide as long as the computer supports the Java Virtual Machine (JVM).

The architecture of WIRED is based around a client-server model. It can be run in three different configurations: as a stand-alone mode, pre-installed on a machine, with local access to geometry and event data on that machine in the form of files or the client can receive its geometry and/ or event data from a remote server (M. Donszelmann, 1996). Local access to data can still be established on this remote server. In the last configuration, WIRED is run as an applet inside a browser. The actual code is downloaded from a WWW server, and for geometry and event data, the same server as the second configuration is used. The server provides the Applet with event and detector

geometry data, these data may be distributed over a number of servers in different formats. Furthermore, multiple data access mechanisms are used. Sequential access to the geometry data may be provided by an ordinary HTTP server. The Applet uses local resources to allow the user to interact with the event. It consists of a store to cache the data, a set of viewing pipes to filter and convert the data, and the graphical user interface (GUI) to display them. The viewing pipe is divided into two parts: the event and geometry data are converted into 3D polyhedrons; different conversions are used for hits, tracks and energy depositions in calorimeters, and experiment extensions are possible. Selections of hits, tracks and energy depositions take place in this part of the viewing pipe (M. Donszelmann, 1996).

This project involves enhancing some of the attributes in the LCD WIRED event display. Enhancements will include the ability to view clustering, by categorizing different clusters using different colors, adding new menu items using "plug-ins", controlling which hits are displayed by using a slider; this function will also reject hits below certain energy rate. All new features will be accessed through menu items, which will easily be available and recognized. These enhancements will also make the WIRED event display more advanced as well as improve the way analysts interpret data. Through new added properties, users can expand their view on events detected and analyze data thoroughly

Results

This project resulted in an upgraded version of the WIRED event display; several attributes were modified to complete this change. By writing and adding more plug-ins to the existing HEP code, we are able to differentiate between the old features of the LCDWired Event Display and the new one. Figures 1a and 1b display the WIRED event display in its initial stage and after the color-clusters were added. This figure was created to show the difference between the two views, clustering the hits makes observing them simpler.

Figure 2 illustrates an array of sixty-four colors that was created to display different colors associated with the clusters.

Figure 3a, b and c represents a Java Frame, which consists of a slider that determines the energy level of the clusters, calorimeter hits, and Mctracks that are displayed in the WIRED LCD Event. Two checkbox that is responsible for the on/off of the histograms, it enables the user to choose whether to represent the energy in logarithmic or linear mode; and the second checkbox inverts the energy, hits and mctracks that are currently displayed. The slider is actually the "energy cutter" on the LCDWired Event Display; in other words, whenever the knob is moved below or above certain energy level, the cluster energy, hits and Mctracks are represented on the histogram(s) depending on which mode of histogram representation the user selects.

Figure 4a consists of the clusters and McTracks. The McTracks represents the direction of the clusters based on the amount of energy each contains. Thus, the diagram is to illustrate how the energy level of each cluster, and the McTracks were being cut, therefore making each of histograms correspond with the slider according to energy level. Figure 4b consists of the calorimeter hits and the clusters. We can now differentiate between group of hits and group of clusters.

Conclusions

WIRED is very extensive and portable. The event display plays an enormous role on collaborations of institutes dealing with High Energy Physics; and also, it changes the way we view events. Through newly added routines and plug-ins, we have improved the performance of WIRED Event Display to include new attributes and features such as the ability to group hits into an assortment of clusters, sort the clusters with different colors according to their energy capacities, cut the energy of the hits below or above certain energy level and some additional drop-down menus were also added. Also, the grouping of hits into single units of clusters plays an important role in high-energy physics: it enables physicists to see the total number of clusters generated in each event, total number of hits for each events, and the minimum and maximum number on x and y-axis respectively. The Graphical User Interface (Java Frame) with its checkboxes, slider, and histogram(s) allows the user to easily view events in different ways and to interact with them.

Acknowledgements

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SLAC. (1995) Next Linear Collider.
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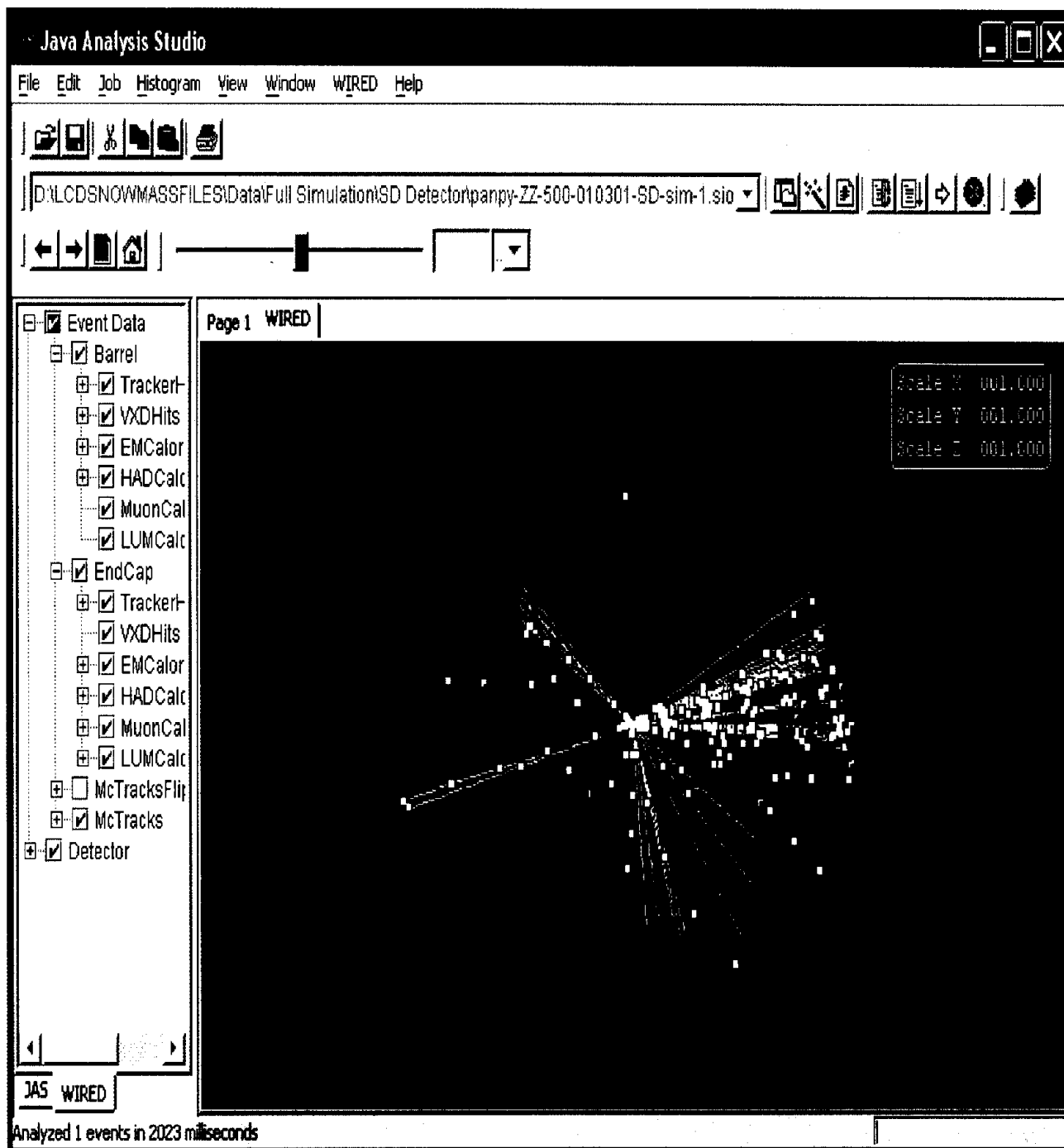
Figure 1a illustrates the initial version of the WIRED Event Display consisting of   just
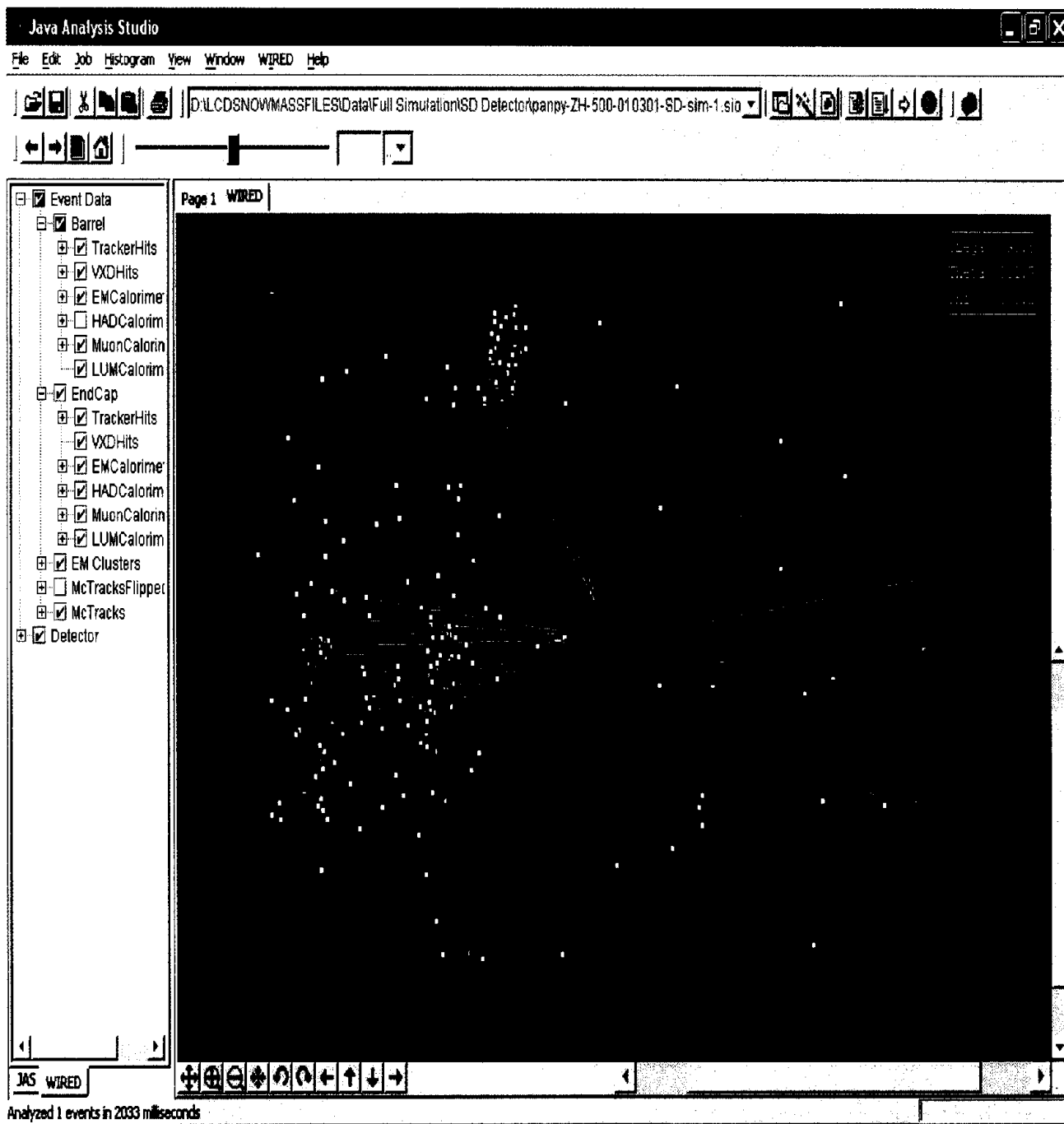
hits.

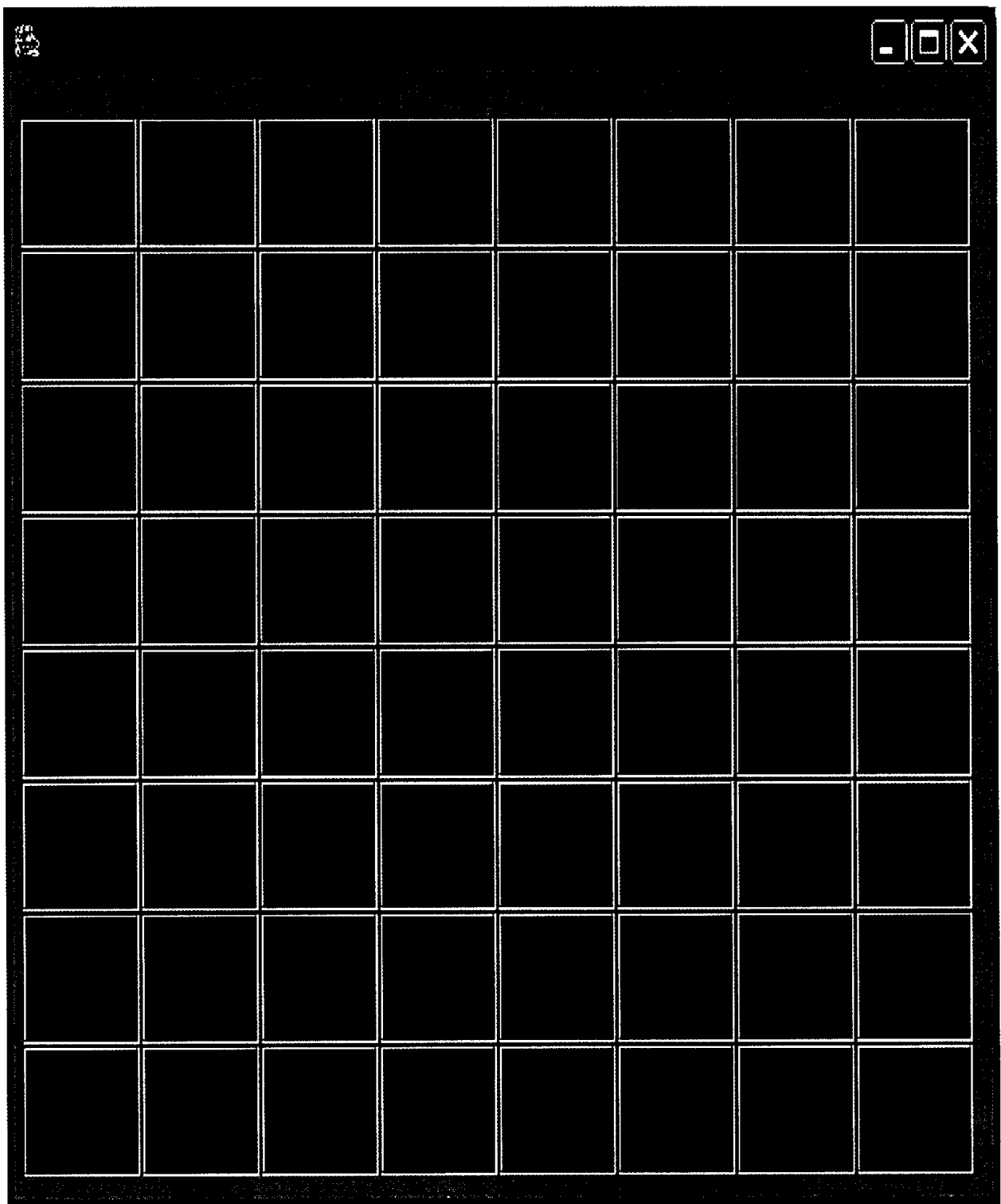Figure 1b shows the new version of the WIRED Event Display, which consists of just the Clusters and the hits.

Figure 2 shows sixty-four different colors that were created in order to be able differentiate between the clusters and the hits.
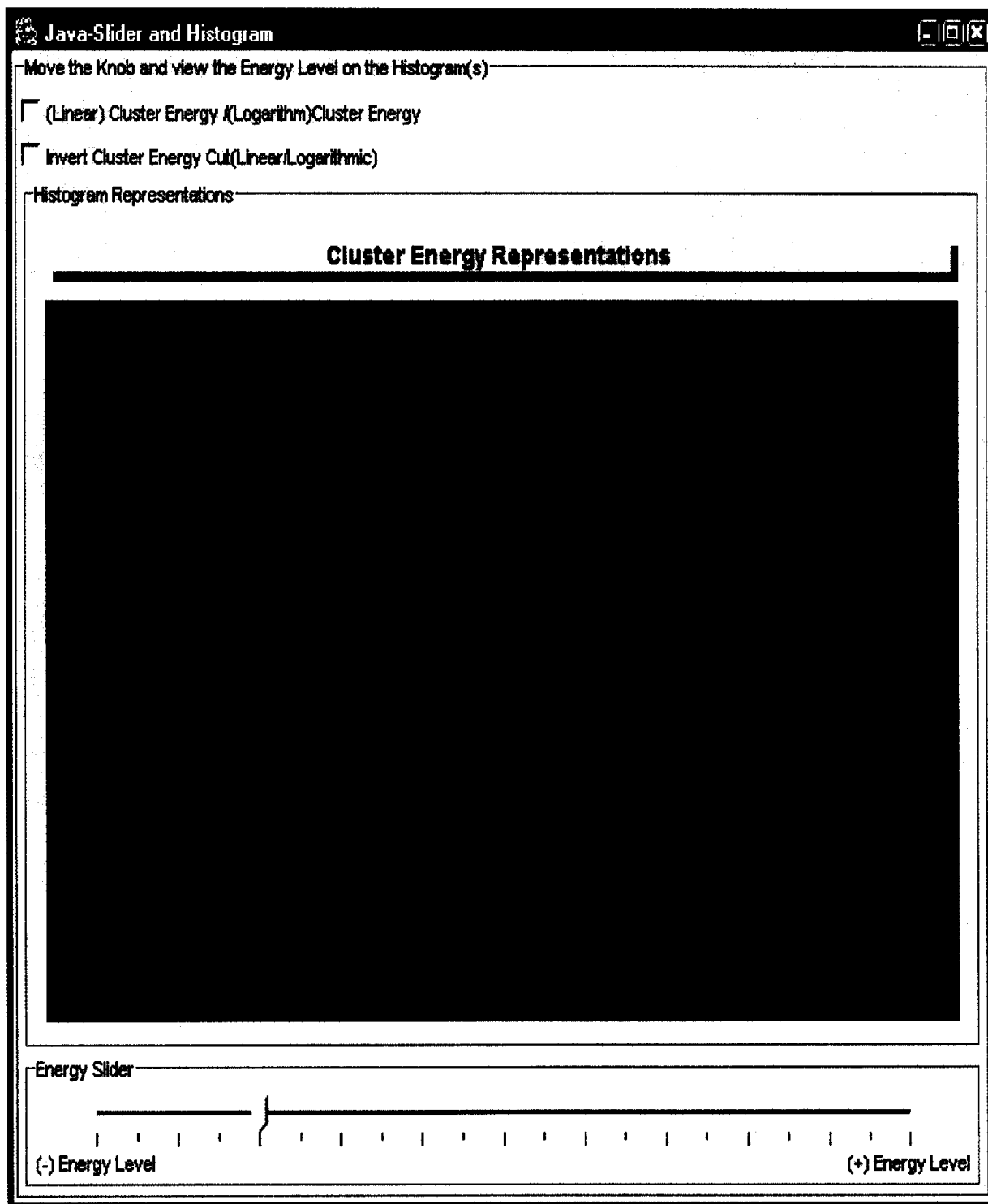
Java-Slider and Histogram

┌─ Move the Knob and view the Energy Level on the Histogram(s) ──────────────

☐ (Linear) Cluster Energy /(Logarithm)Cluster Energy

☐ Invert Cluster Energy Cut(Linear/Logarithmic)

┌─ Histogram Representations ──────────────

Cluster Energy Representations

┌─ Energy Slider ──────────────

(-) Energy Level   (+) Energy Level

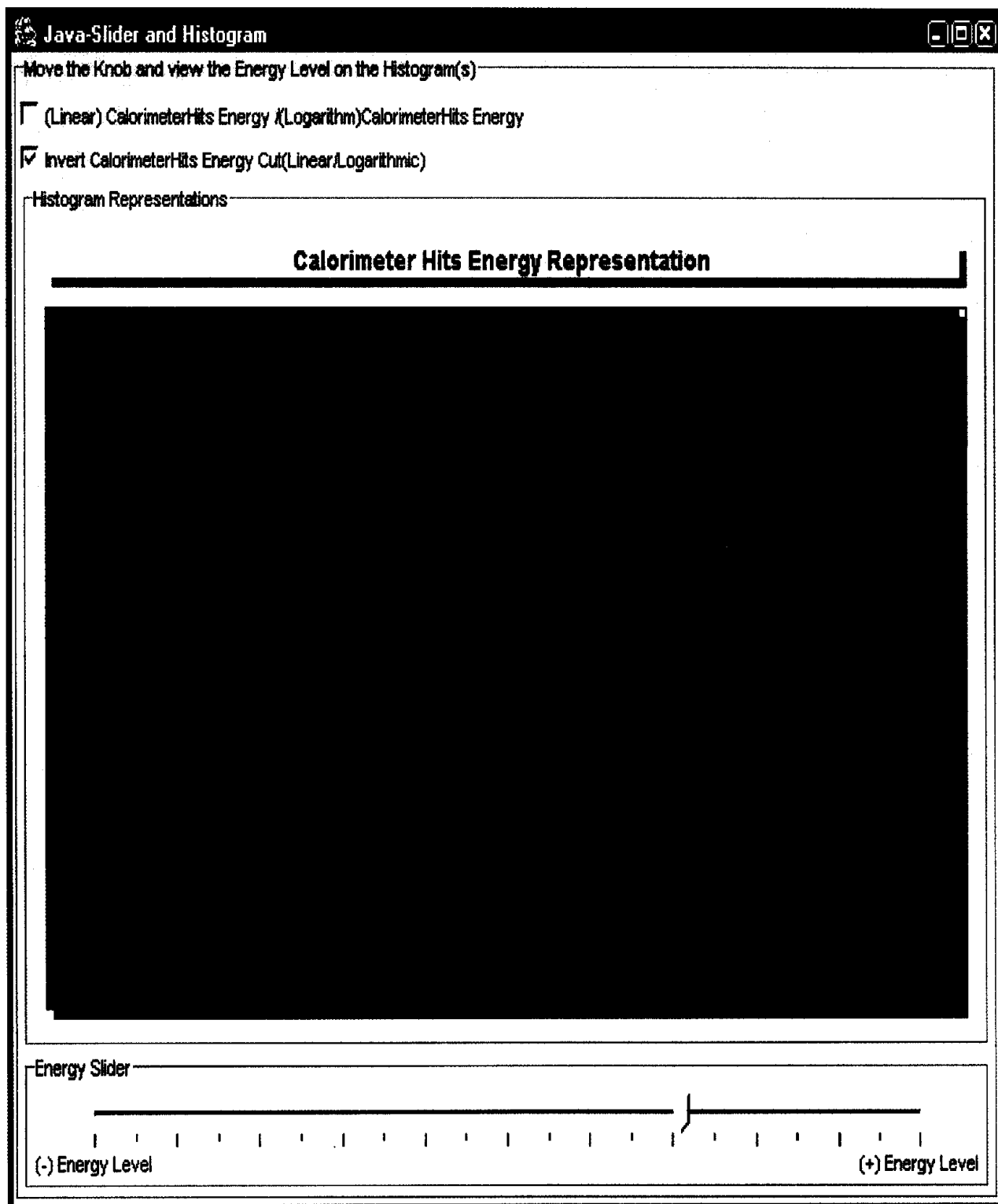Figure 3a – shows a Java Frame – consists of a slider, a checkbox and a histogram(s). The java frame represents cluster energies.

Figure 3b illustrates a histogram representation of the hits.
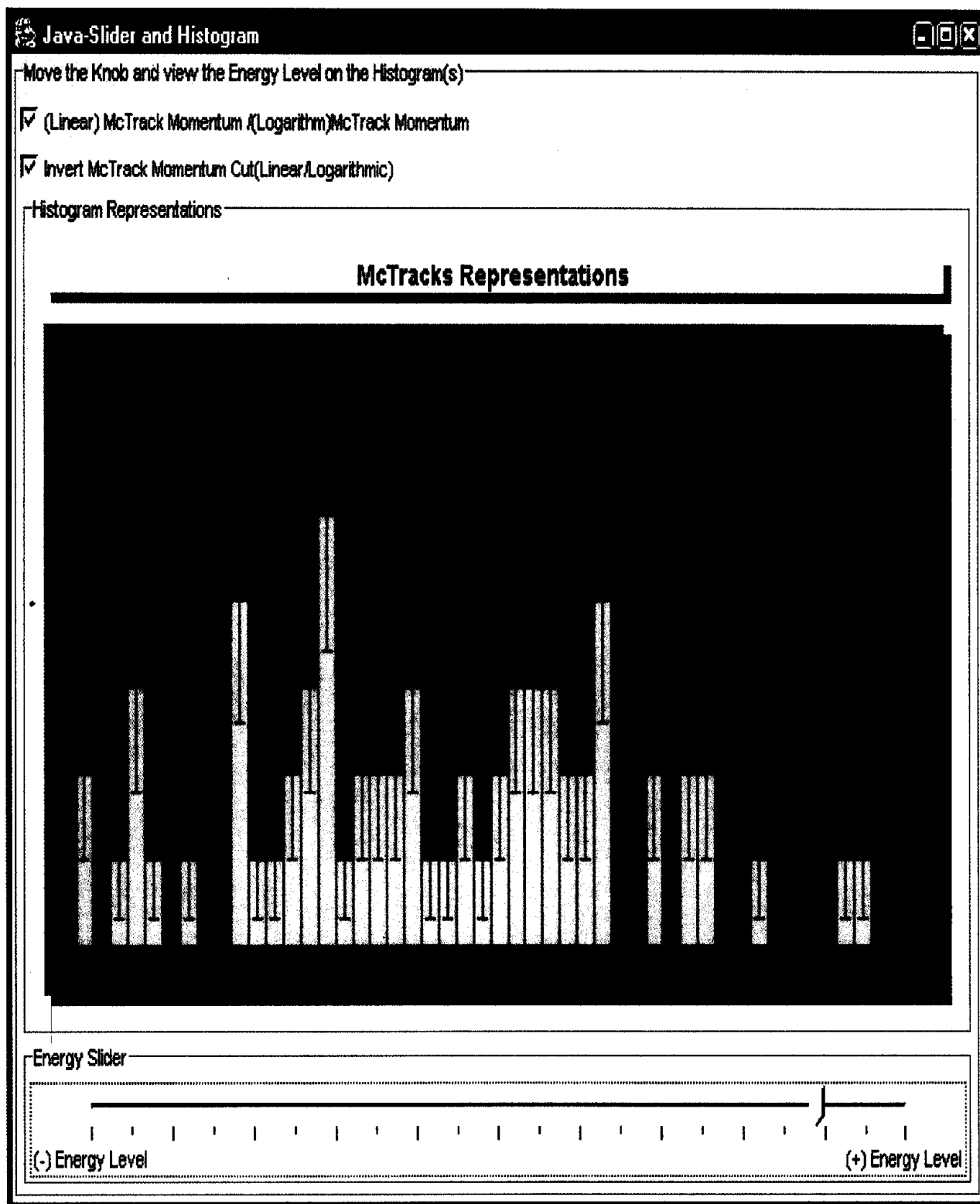
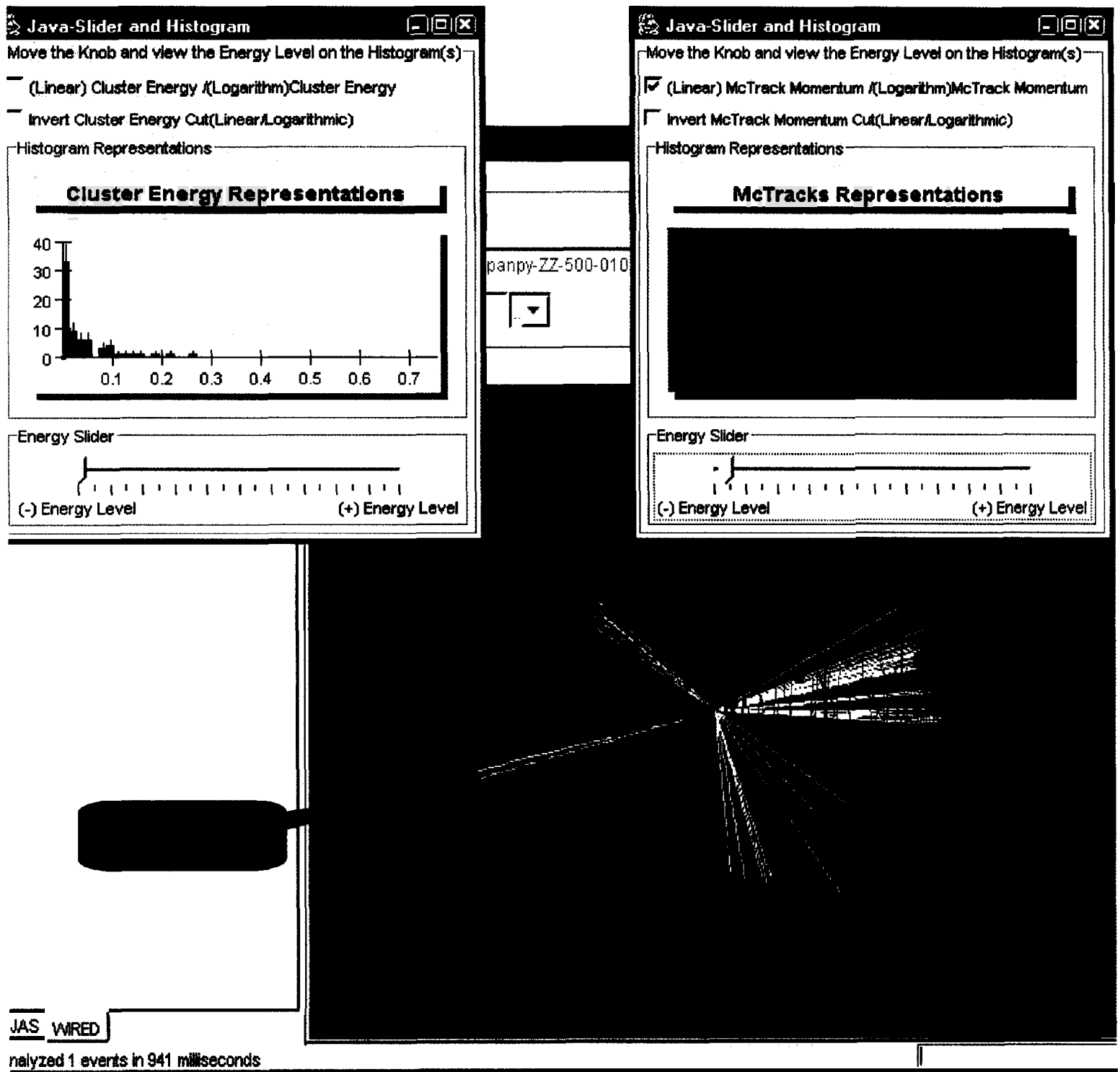Figure 3c represents a histogram representation of the McTracks

Figure 4a shows the newer version of LCD WIRED displaying the clusters and McTracks
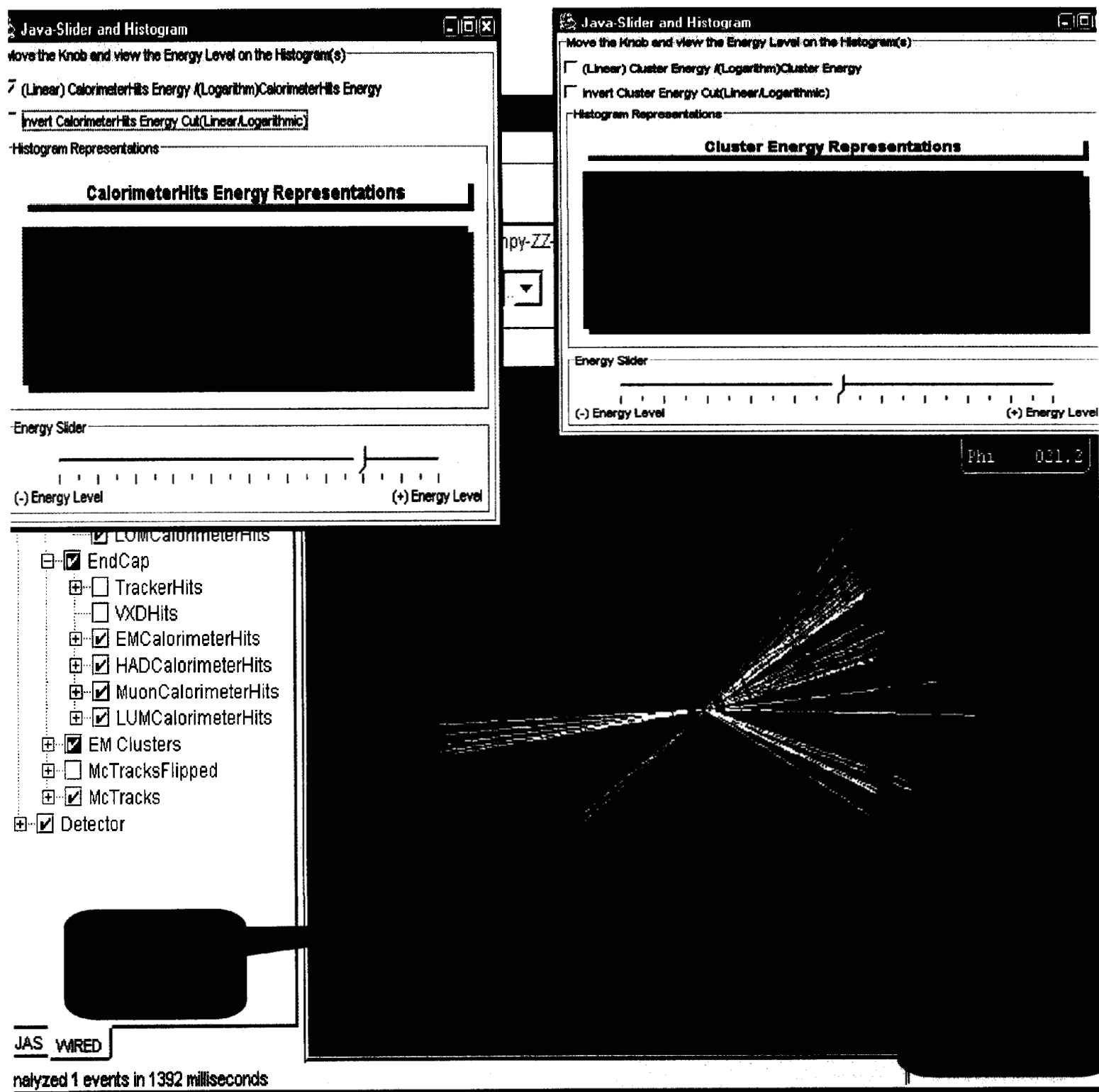
Figure 4b also shows the newer version of LCD WIRED displaying the calorimeter hits,

clusters and the McTracks.