The STAR Pad Monitor

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An X-Windows application called *Pad Monitor* was developed to display a graphical representation of raw pixel data from the STAR TPC and SVT detectors, as well as other 3-dimensional drift detectors. The tool is easy to use and is particularly useful for debugging. It features a color scheme in the display that guides the eye to problems associated with the data.

Key words: object-oriented methods, data presentation, graphics, GUI's

1 Introduction

Brookhaven National Laboratory's Relativistic Heavy Ion Collider (RHIC) will collide 100 GeV/c per nucleon $Au + Au$ nuclei (40 TeV center of momentum energy), and the STAR (Solenoidal Tracker At RHIC) experiment will study the collision products (as many as 5000 particles may enter STAR's acceptance) for signatures of quark-gluon plasma (QGP) formation. Tracking, particle-identification, and momentum analysis will be done for the charged particles using a time projection chamber (TPC) and a silicon vertex tracker (SVT) which are located inside a large solenoidal magnet.

To aid the process of debugging the many TPC and SVT channels (TPC: 150,000 pads, each with 512 time bins; SVT: 100,000 anodes, each with 128 time bins) an X-Windows application called *Pad Monitor* was developed to display, graphically and comprehensively, the raw data. The tool features color schemes in the display which "guide the eye" in assessing detector performance.

2 Description

The original *Pad Monitor* was developed by H. Wieman at LBNL for the EOS experiment's TPC (at LBNL's Bevalac) using Sun's OpenLook User Interface. The version described here is written in C and uses the Motif User Interface Definition and standard libraries available on modern Unix workstations. Within STAR, *Pad Monitor* is used on HP, SGI, and Sun workstations without modification to the source code. To make the application useful for different detectors of different hardware configurations, the look and feel, pad organization, and specifics of the data format are customizable through an ASCII script.

Figure 1 shows a screen dump of *Pad Monitor* as used to visualize data from a STAR TPC sector. *Pad Monitor* allows interchangeable I/O routines, while the overall interface remains much the same. The interface between *Pad Monitor* and a "Get Event" routine is contained in a separate file and consists of a structure with pointers to arrays containing the time ordered ADC values of each pad.

To read in data, the "Open DAQ" or "Open File" menu items in the "File" menu must be selected. Then prompts for additional information about the source appear in a popup window. The "Get Event" button in the main window, or the item of the same name in the "File" menu, acquires events and displays them in the main window.

A major part of the main window is occupied by a two-dimensional representation of the pad plane. Details of the layout are determined by an ASCII configuration file read at startup. Each rectangle

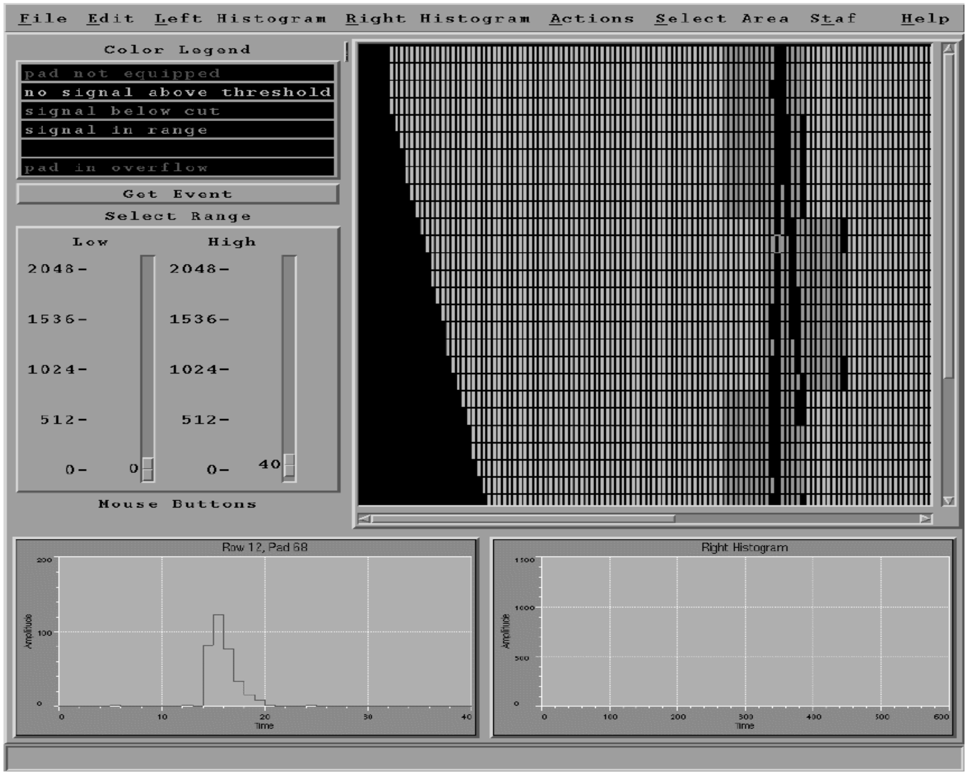

Fig. 1. A screen dump of the main window of *Pad Monitor*

in the display represents a pad, color coded according to some cut criterion, as follows. Each pad is represented by a single value – chosen to be the maximum or minimum ADC value in its time spectrum, or the sigma, or the rms of all ADC values. The time range in which this value is determined can be restricted between an upper and lower time bucket as explained later. Then each pad is compared to minimum and maximum cut values which are user adjusted with two sliders on the left of the display. Pads that are below the minimum cutoff appear light blue, pads above the maximum cutoff appear rusty brown, and pads between the two cutoffs are green. If all ADC values are zero, the pad appears light gray, and pads that have values indicating overflow are marked in red. In the configuration file pads can be marked as "not present", e.g. if there are no electronics attached to them. These pads are colored dark gray in the display.

Two histograms are at the bottom of the screen. The left one plots the value of a single pad vs. time bucket. The right one will be implemented later. The left mouse button selects which pad to display on the histogram. Upon clicking on a pad, an indicator (bright red rectangle) is drawn around the selected pad. The pad row/number will appear over the left histogram, and value vs. time is plotted. The items in the "Left Histogram" menu allow to magnify a region of interest by clicking the left mouse button at one corner of the region of interest in the histogram and then drawing a rectangle to the opposite corner while keeping the button pressed. "Request Position" in the same menu lets one click on one of the histogram bins to display the position and contents of this bin in the bottom message area. The histogram is also used to adjust the time window within which the cut value for each pad is determined. "Low Limit" and "High Limit" in the histogram menu lets one choose the left and right boundaries for calculating the cut value. The selection is done by simply clicking on the appropriate position in the histogram. The histogram can be converted to a PostScript file by selecting the appropriate item in the histogram menu.

The currently displayed event can be used as a pedestal event to be subtracted from future events with the "Save current as Pedestal" item in the "Actions" menu. Pedestal subtraction is then turned on or off with the "Subtract Pedestal" item in the same menu. In the configuration file one can set an offset so that the resulting values stay positive.

The last item in the "Actions" menu pops up a window with a two-dimensional display of one pad row at a time. Each pixel in this display represents a time pixel in the selected pad row. The X-axis represents the pad direction within the pad row, the y-axis represents increasing time from top to bottom. Each pixel is color coded according to the cut values set with the two sliders in the main display. The values between the minimum and maximum cut are further shaded in different brightnesses of green, where the darker green is closer to the minimum cut. The pad row is selected with the slider on top of the popup window. An area of interest can be magnified by drawing a rectangle with the mouse around the area.

Acknowledgement

This work was supported in part by the U. S. Department of Energy and The Robert A. Welch Foundation.