Event viewer for HRS-L

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1 Introduction

For my summer project at F2 department at Institute of Jozef Stefan I made event viewer (EVe) for Left High Resolution Spectrometer (HRS-L), located in Hall A at Jefferson Lab (Newport News, Virginia). The main purpose of event viewer is to show hits in detectors of spectrometer. With Eve we can see if spectrometer is working properly and can use it for searching and fixing errors.

Event viewer for Big Bite detector (BB), which is also positioned in Hall A, was made in 2008 by dr. Miha Mihovilovič. In project I changed event viewer source code for BB detector and added some new classes specified for HRS-L.

Report contains description of detector package and its event viewer. I will describe how I made Eve, how to use it and its current problems.

2 Detector package

Left High Resolution Spectrometer contains seven detectors: two vertical drift chambers (VDCs) for tracking, two scintillation detectors (S1 and S2m) for triggering and time-of-flight measurements, a Cherenkov detector for identification of electrons and two Shower detector for additional particle identification (Figure 1). In detector's coordinate system axis z is orientated in direction of central ray with $z = 0$ at the beginning of the first VDC. Positions of all detectors in HRS-L are in that coordinate system. Next subsections contains description of these detectors and data used in EVe.
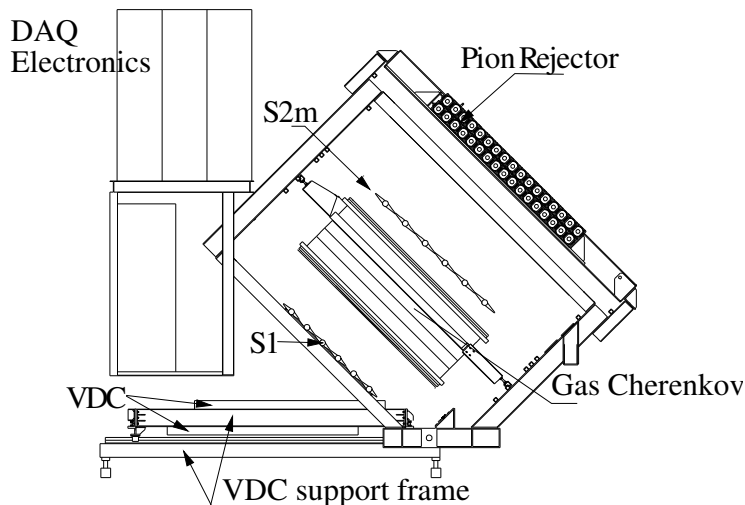

Figure 1: Figure shows Left High Resolution Spectrometer.

2.1   Vertical Drift Chambers

Vertical Drift Chambers lie in the laboratory horizontal plane at the bottom of the detector package. A size of active area of VDCs is 2188 mm × 288 mm, thickness of chamber is 10.5 mm. There are two planes (U and V) of wires in each chamber. Each plane contains 400 wires, 32 grounded (16 wires at each end of wire plane) and 368 sense wires spaced 4.42 mm apart. Wires in each plane are orthogonal to each other and are inclined at an angle of 45° with respect to both dispersive and non-dispersive direction. The vertical spacing between the first and second chamber is 230 mm. Distance between the beginning of the first VDC ($z = 0$) and beginning of the second VDC is 0.474 m (in detector's coordinate system). The VDCs are inclined at an angle of 45° with respect to axis z.

2.2   Scintillator detector

There are two scintillation detectors in HRS-L, called S1 and S2m. The first plane, S1, is made of six paddles, each is 35.5 cm long, 29.5 cm wide and 5 mm thick. It is positioned at $z = 1.2873$ m in detector's coordinate system. The light signal from each scintillator paddle is collected by two 2-inch photomultiplier tubes. The second detector, S2m, located at $z = 3.1415$ m is made of sixteen paddles with dimensions of 43.2 cm by 14.0 cm by 5.1 cm. Each paddle is, as in S1, viewed by two 2-inch photomultipliers.

2.3   Cherenkov detector

The HRS Cherenkov detector is located between the S1 and S2m scintillator planes and is 1 m long, with entrance surface size of 250 cm × 80 cm. The Cherenkov radiation is emitted when a particle travels through a medium faster than the speed of light and is collected by ten mirrors mounted on the side of the detector housing and focused on 5-inch photomultipliers. Detector is mounted at $z = 1.72$ m.

2.4   Pion Rejector

Pion rejector (also called electromagnetic calorimeter) is positioned behind S2m scintillation plane. The detector consists of two layers of lead glass blocks. The first (front) layer is made of 34 lead glass blocks, of dimensions 15 cm × 15 cm × 30(35) cm. The second layer is made of 34 similar blocks. First layer is located at $z = 3.75$ m and second at $z = 3.90$ m.

2.5   Data

The data EVe is using contains informations about wires in VDCs (which wires were hit in one event), information about scintillators and Cherenkov detector (which photomultiplier was hit, TDC (Time to Digital Converter) and ADC (Analog to Digital Converter) values, in case of scintillators, also position where scintillator was hit-calculated from TDC values) and information about Pion rejectors (numbers and ADC values of hit photomultiplier).

3   Making of EVe

Source code for HRS-L event viewer is based on source code for planar view of Big Bite event viewer, which was made in 2008 by dr. Miha Mihovilovič. BB detector consists of two multi wire drift chambers (MWDC) and two scintillation planes (Figure 2). During my project I changed classes from BB Eve source code (classes for making scintillation plane, drift chambers and planar trajectory) and add classes for Cherenkov detector and Pion rejectors.
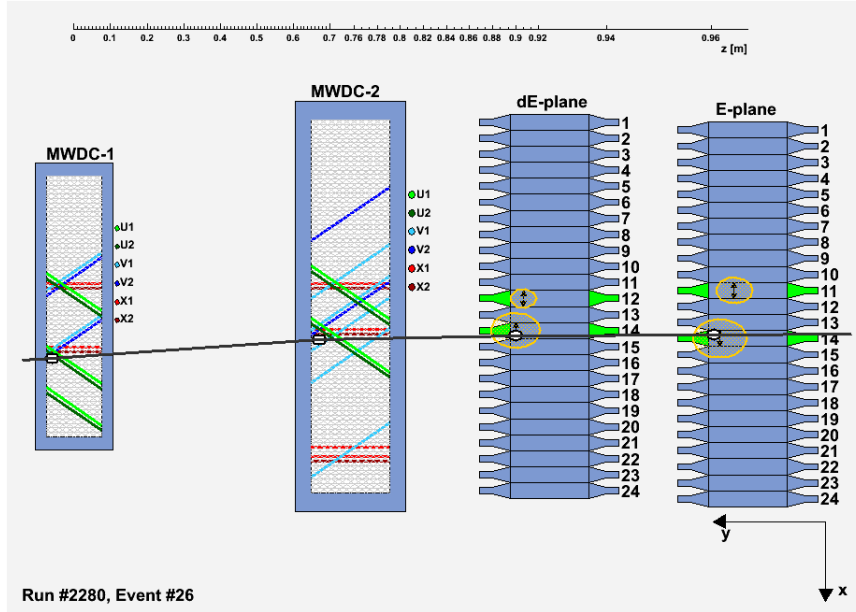
Figure 2: Figure shows planar view of EVe for Big Bite detector.

The most important thing in VDC class is array of gray lines which represents wires. An index in array represents number of wire in VDC. When wire is hit, it change color to green in U-plane and to red in V-plane.

Every object from scintillation class has two blue photomultipliers. When scintillator is hit its photomultipliers change color to green (it is also possible that only one photomultiplier gets light signal-in that case photomultiplier change color to red). With black arrow is marked where scintillator was hit (calculated from TDC) and with yellow circle ADC hit (radius is proportional to ADC value).

Objects from Cherenkov class are made of mirrors and its photomultipliers. When photomultiplier is hit, mirror and photomultiplier changed color. Like in scintillation class, ADC hits (yellow circles) are marked.

Object in Pion rejector class is made of block of glass and photomultiplier on one side. When block is hit photomultipliers change color to green. In that detector we have only ADC hits.

I also changed class for planar trajectories by adding information about HRS-L. Class is used to draw reconstructed particle trajectory through detector.

4   Use of EVe

User can install EVe by downloading EVeNew1.zip which contains all files needed. After extracting, event display must be compiled by using "make" command in the directory where file was extracted. In same directory root file from $http://descartes.ijs.si/miham/xfer/$ must be downloaded (e.g. $eed\_HRSL\_rootfile\_1457.root$). EVeNew1.zip contain executable file simEVe.C which must be run in root with command ".x simEVe.C". Program than asks user for run number ($xxxx$ in $eed\_HRSL\_rootfile\_xxxx.root$). After that, EVe is created.

With EVe user can observe events of chosen root file. At the bottom of EVe is written run number of root file and number of current event in it. By clicking "next" user can see all events in file and by clicking "next good" only events in which trajectory was reconstucted (sometimes only scintillators, mirrors or Pion rejectors were hit-in that case trajectory is not reconstructed) (Figure 3). It could also happen that trajectory is reconstructed, but no scintillator was hit or more than one trajectory is reconstructed (Figure 4).

User can also click buttons "previous" and "previous good" or write number of event and jump to it by clicking "show this event".
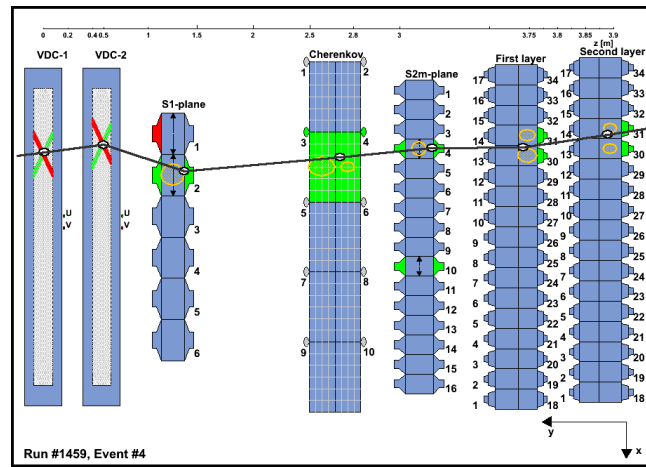
(a)
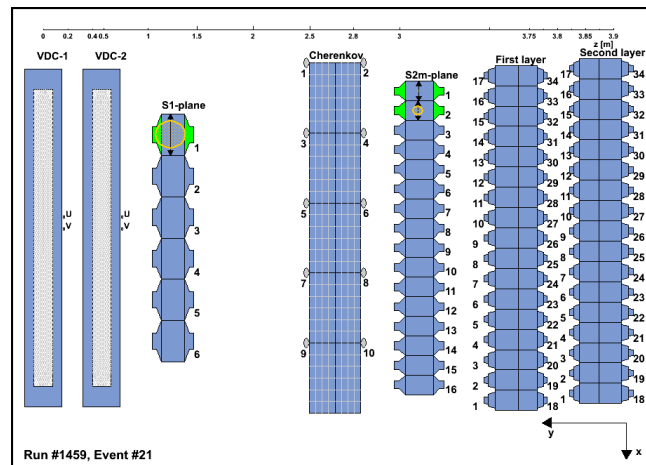
(b)

Figure 3: Figure shows EVe for HRS-L detector when trajectory was reconstructed (a) and when only scintillators were hit (b).
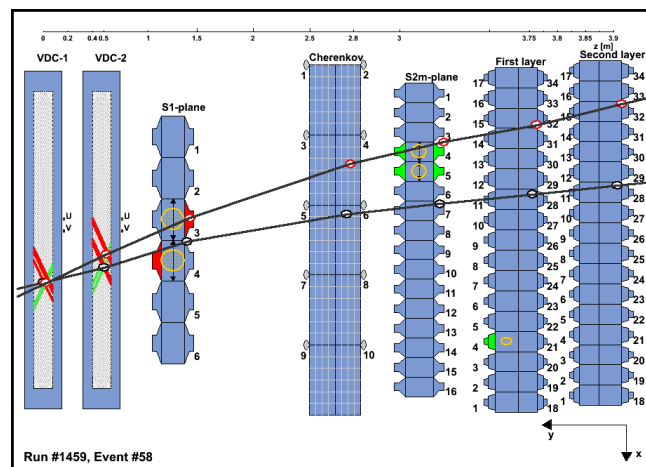

Figure 4: Figure shows case when two trajectories were reconstructed.

4

5 Conclusion

Current problem with EVe is associated with position of tracks in spectrometer. I figured out that x component of tracks is a little bit higher than x value where particle actually hit certain detector. Because of that I reduce all x components of tracks for $10\% - 20\%$, and partial fixed problem (at least for purposes of EVe).

By making my summer project I learned a lot about spectrometers, particle detection and object-oriented programming in C++. I specially would like to thank dr. Miha Mihovilovič who was helping me during the whole project and provided all needed information about HRS-L.

References

[1] http://descartes.ijs.si/ miham/xfer/

[2] http://hallaweb.jlab.org/equipment/Hall-A-NIM.pdf