


# Fermilab

**Synoptic Displays for the HBESL and NML Laser System**

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## **Synoptic Displays for the HBESL and NML Laser System**

### **I. Abstract**

Creating synoptic displays for high-energy physics experiments have proven to be very effective in the sense that users can interact with electronic devices using images that they can clearly observe instead of text commands. This project aimed to produce synoptic displays for two experiments: HBESL, the High Brightness Electron Source Laboratory and NML Laser experiment in order to assist the control of these facilities in the accelerator control network of Fermilab. Both displays were successfully produced and added on the ACNET (Accelerator Control Network) page.

### **II. Introduction**

Synoptic is a graphical display tool used in the accelerator control system of Fermilab. It is basically a system for graphical representation of real-time data in the control system. It creates diagrams representing a certain machine or process along with actual reading from the control system indicating its current state. Indeed, it also supports setting data back from the control system. In other words, synoptic can be easily described as a set of several components hooked up together with other parts of the control system. The infrastructure includes a web server and a central repository with version control, which stores all public displays, allowing for sharing them among multiple users. Perhaps one of the most important functions of synoptic is that it makes real-time data from the control system available anywhere at any time.

This research was designed to create synoptic displays for the HBESL (High Brightness Electron Source Laboratory) and newly-built NML laser lab so that it is easier for users to control and monitor these facilities. Since no displays for these facilities existed, we were required to start from scratch building the HBESL synoptic display. For the laser experiment, we

created an initial display that will have to be updated as the building progresses through addition of different parts.

This paper presents how the synoptic displays for HBESL and NML laser experiment were created including what was achieved and what needs to be done in the future.

### **III. Materials and Methods**

#### **III.1. Background Information**

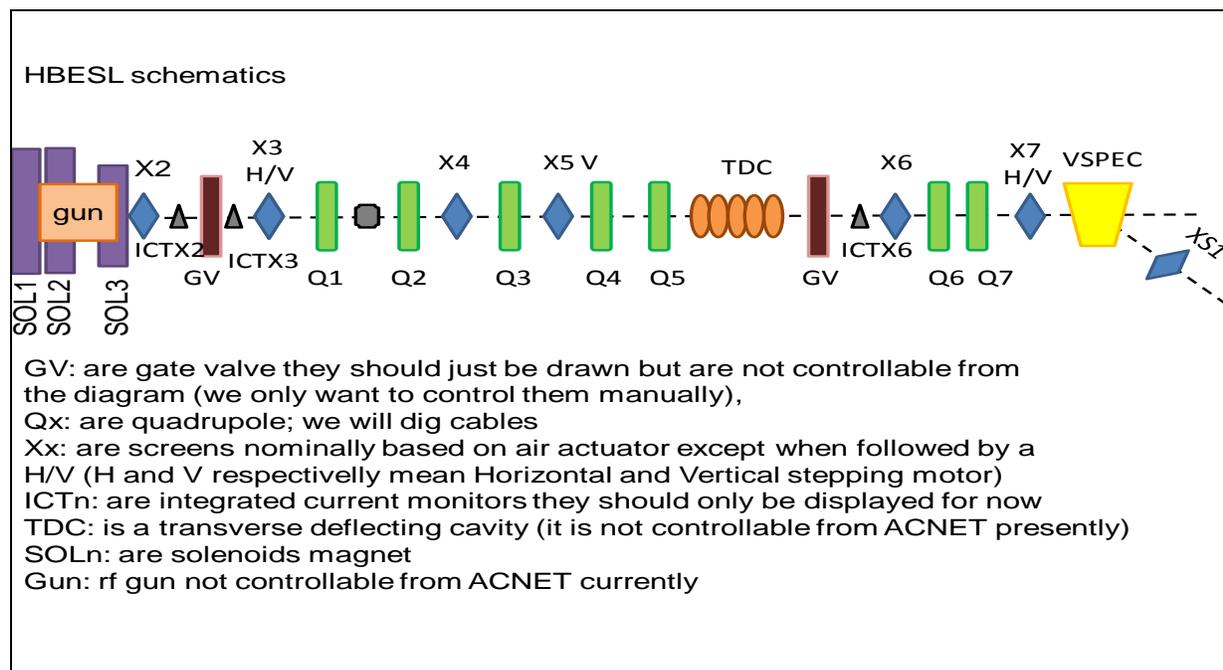
Synoptic consists of 5 different parts that are used to build and execute displays as well as maintaining them for the purpose of making them available to users. These parts are the builder application, the viewer application, web viewer, web engine, and central repository. The builder application is used to build and edit displays while the viewer application is used to execute displays in the runtime. The web engine launches displays upon request and facilitates the execution of web viewers. The web viewer is a combination of a generic SVG renderer and java script executed inside web browsers, and it is used to restore displays based on the information received from the web engine whereas the central repository stores all the public displays.

Each display was built using different components in the synoptic builder such as active components, static shapes, data links, and embedded displays. Active components are those that accept and produce data while data links are those that pass data to one another. Static shapes represent images of different devices and have no connection with data whereas embedded displays are components such as gauges, plots, and controls.

The general process of building synoptic displays remained almost the same for both HBESL and the NML laser lab. After a schematic was provided, the next step was to use the builder application of synoptic to create a display that resembles the schematic provided. After

building the display in synoptic builder, the display was run to check and make sure that the resulting image matches the schematic previously provided. Then, the display was saved in the central repository to ease its accessibility on the web viewer, and later on, was added on the ACNET console environment under the NML page to allow its day to day monitoring in the control system of Fermilab.

### III. 2. Editing HBESL in Synoptic Builder

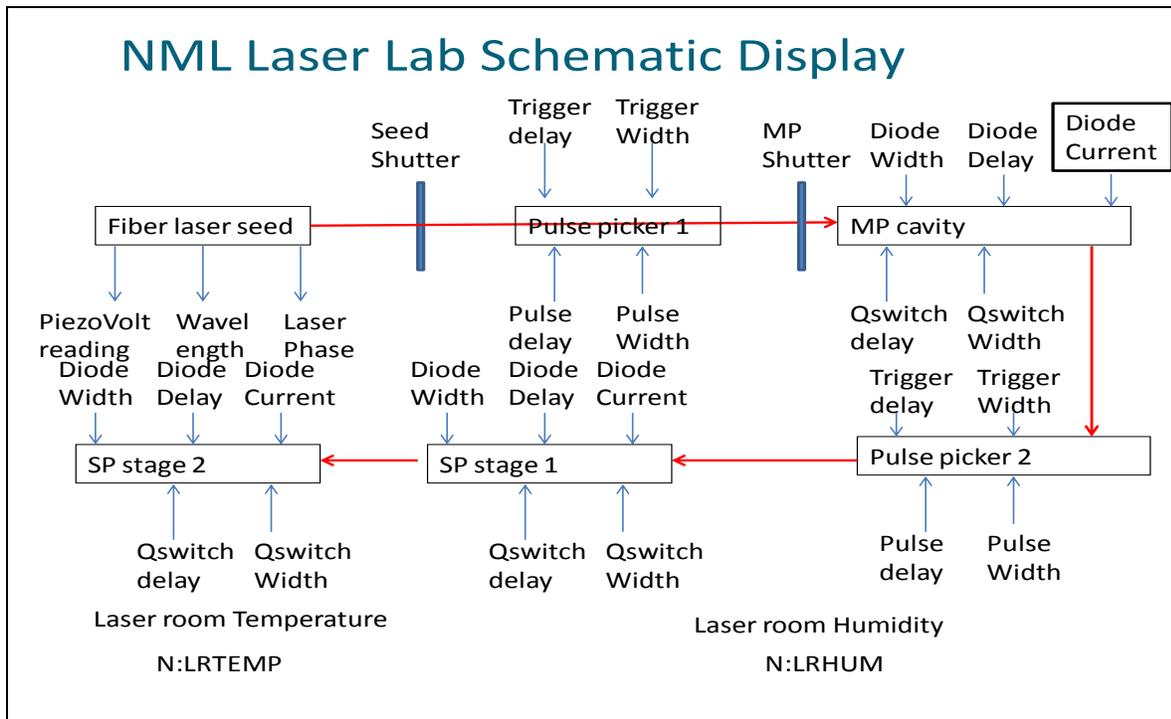


**Figure 1 shows the overall schematic for the HBESL. It also indicates all different parts of the device and provides brief information about the functions of each part.**

From the above figure, it is important to notice that the schematic was given with a bit of details on whether certain devices should or should not be controlled from the ACNET console, which turns out to be very important when monitoring devices. For example, the magnets were not supposed to be controlled from ACNET, which means that we only had to read out the amount of current passing through the solenoid. On the other hand, the vertical and horizontal stepping motor had to be controlled from the ACNET, which indicates that in addition to reading

out the values, we had to be able to change values if necessary. Being able to control certain parts of such devices becomes crucial, especially when read-out values go out of the desired range. This makes it easier to set data back to normal values.

### III.3. Editing the NML Laser Lab in Synoptic Builder



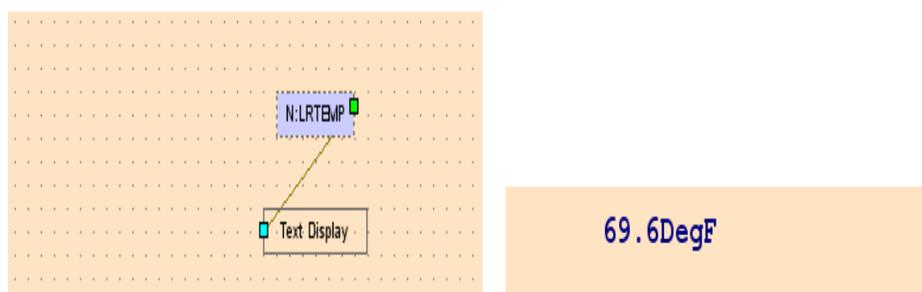
**Figure 2 shows the schematic for the NML laser lab and all different parts. The red arrow(s) indicates the path followed by a laser light.**

On this figure, each of the blue incoming arrows indicates that the read-out of the device will need to be controlled from the ACNET while each of the blue outgoing arrows indicates only reading out without the control from ACNET.

One of the most essential features of synoptic is the ability to read, change and set values of devices such as currents, temperature, humidity and send them back to the control system. In order to read-out or set values of any device, it has to be connected to the ACNET so that its read-out values may be imported in synoptic. Each device is given an 8-character name, and it is

the special name for representation. To read out any device value, the output of the device name is connected to input of the “text display”. The special name is imported by clicking “Reading tab” in the “Data acquisition column”. Then, after the correct name is entered in the provided box, the box is connected to the “Text Display tab” under the “Gauges” by using the “Place Link” button. The value read off will appear in the text display place in the synoptic viewer.

The process of reading off and setting data back to the control system at the same time is more complex than only reading off. After the ACNET device name is imported, it is connected to the input of the “spinner” and the output of the spinner gets connected back to the input of the device name. During this process, the first connection is almost the same as in reading-off except that the “spinner” under the “Controls” column is used instead of the “text display”. Then, the second connection is operated by linking the output of the spinner to the input of the device name by importing it on the “setting tab” under the “data acquisition column”.



**Figure 3 shows the reading of the laser room temperature in synoptic builder while Figure 4 shows what will appear in synoptic viewer after running figure 3. The current temperature at that time was 69.6 DegF.**

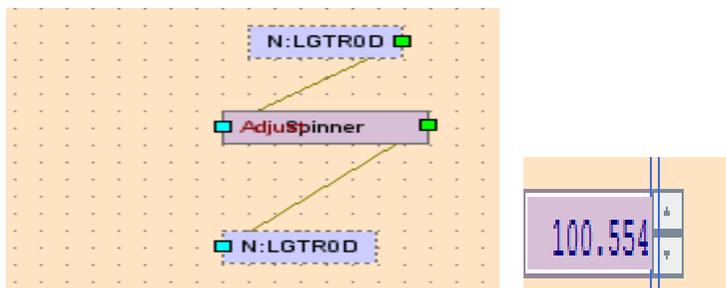


Figure 5 shows the setting process in synoptic builder while figure 6 shows the results after running figure 5 in synoptic viewer. At this time, the trigger delay of this laser experiment shows 100.554 microseconds.

## IV. Results

Upon their completion, both GUIs for the HBESL and NML laser lab were produced and were added on web viewers at [2] [3] to facilitate users and to ease their access anywhere at any time. They were also added to the ACNET page to enable the appearance of both GUIs in the control system of Fermilab.

### IV.1. HBESL Synoptic Display

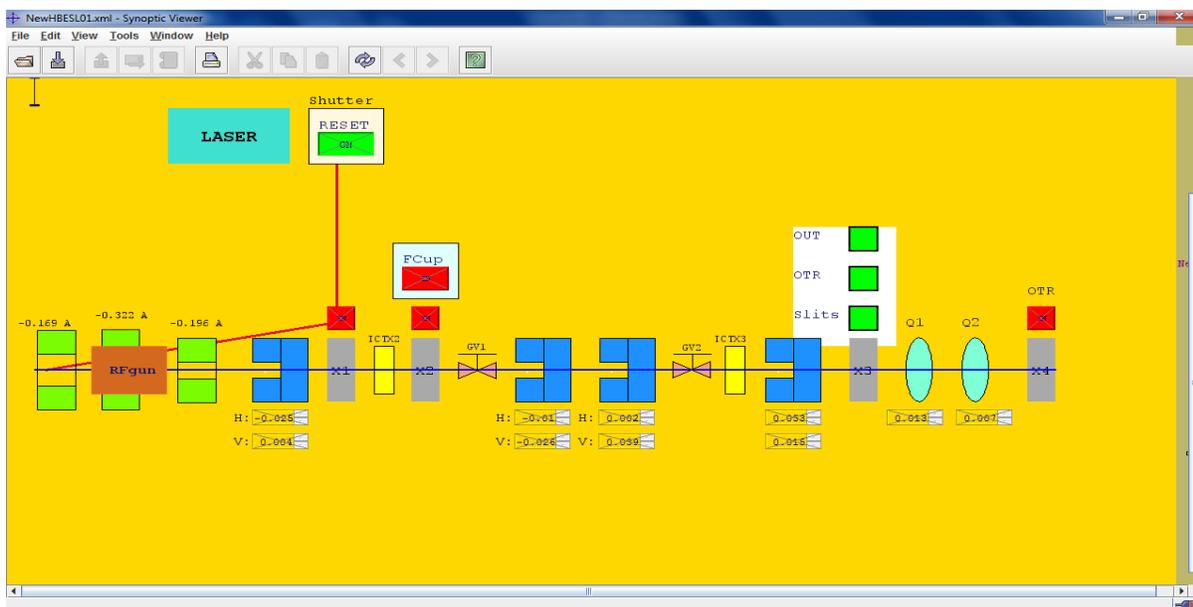
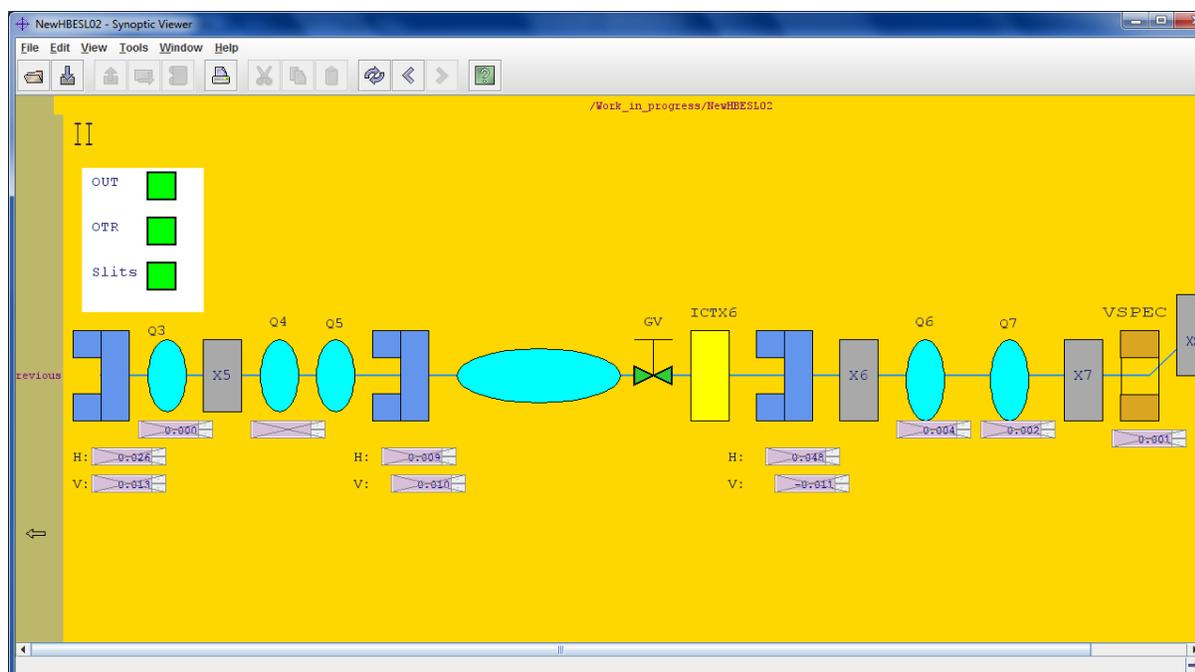


Figure 6 shows the first page of HBESL



**Figure 7** shows second page of HBESL

It is essential to note that page-1 and page-2 represent the whole HBESL synoptic display. We had to put the whole display on two pages, because it couldn't fit on a single page. The colors for different devices were usually randomly chosen, but others were chosen with a clear purpose. For example, the toggle button of the FCup (faraday cup) on figure-3 indicates red when the beam is not there and green when it is passing through there. The same is true for the reset button in the shutter. It goes to green when the beam is present and red when the beam is absent. On both of these displays, the measurement on the vertical and horizontal stepping motor had to be controlled from the ACNET, which is the reason why the values are displayed in a box to allow users to change measurements whenever they need to.

## IV.2. NML Laser Lab Synoptic Display

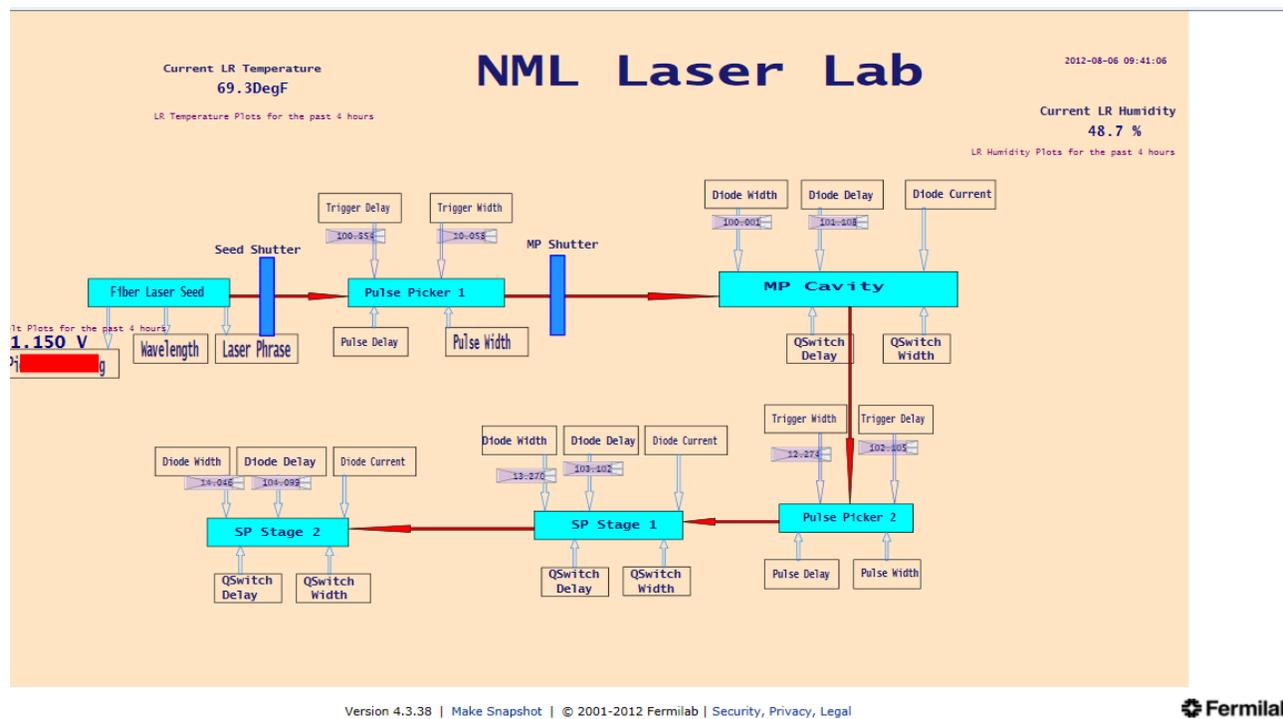


Figure 8 shows the synoptic display of the laser at NML. The larger red arrows in the middle indicate the path followed by a laser.

Figure 8 shows the overall laser experiment and different measurements we were able to do either by reading out or setting data. By reading out both the temperature and the humidity of the laser room, users know whether the experiment is being conducted under normal conditions since out of range measurements can alter the experiment. By measuring these values for the past x- number of hours; we have a good idea of how the experiment was affected especially when no one has been checking constantly for a while. Any incoming blue arrow indicates that we had to control that device while any outgoing arrow indicates that we had to read out the device value. Therefore, we controlled the following devices: triggers, diodes, pulses, and Qswitches. Triggers includes trigger delay and trigger width; diodes consist of diode with, diode delay, and diode

currents. Pulses consist of pulse delay and pulse width whereas Qswitches include Qswitch delay and Qswitch width. We only had to read out the piezovolt reading, the wavelength, and the laser phase.

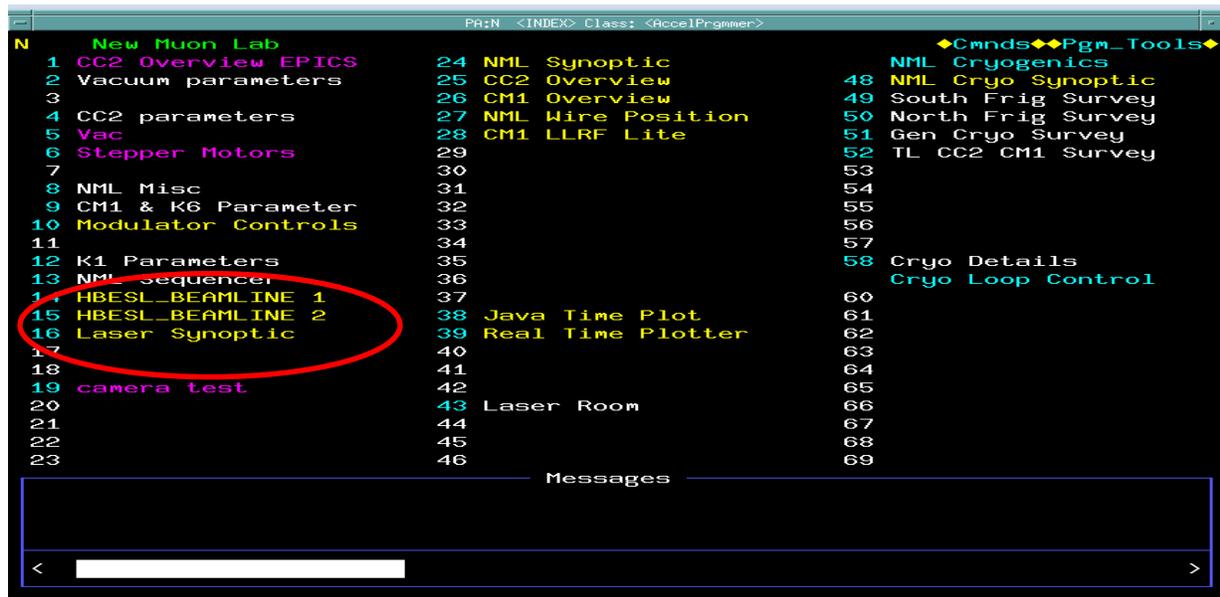


Figure 9 shows both displays (HBESL and the laser lab) on the ACNET console under the NML page. The HBESL is represented by its first and second page under the N-14 and N-15 respectively whereas the laser experiment is under N-16.

## V. Conclusion

Both displays for HBESL and the laser experiment were successfully produced and added on the ACNET console under the NML page. Having these displays allow both users and scientists to be able to constantly control their experiments anywhere at any time. Being able to read out and set experimental parameters help users to protect the efficiency of experiments as well as avoiding extreme inaccuracy and inadequate conditions of experiments.

Even though we have done a great deal of work on the laser experiment, there are still lots of things to do in order to fully finish the laser lab display. Some of the address names for

different devices are still missing because they are not set up yet. Therefore, the next step will be to add those device values once they can be measured, and then update the whole display.

## **VI. Acknowledgements**

This research was conducted at Fermi National Accelerator Laboratory during the summer of 2012. I would like to express my gratitude to all people who made this internship a fun and a very educational experience for me. My appreciation goes to Dianne Engram, Jamieson Olsen as well as the entire SIST committee for funding this project. I would also like thank my supervisor for this project, Jinhao Ruan, and his assistant, James Santucci. My thanks also go to Dr. James Davenport, and my mentors Elmie Peoples-Evans, and David Peterson for their support throughout this project.

## **VII. References**

[1] <http://synoptic.fnal.gov/doc/guide/index.html>

## **VIII. Useful Links**

[2] [http://www-bd.fnal.gov/synoptic/display/Work\\_in\\_progress/NewHBESL01](http://www-bd.fnal.gov/synoptic/display/Work_in_progress/NewHBESL01): This is the synoptic display for HBESL on web viewer.

[3] [http://www-bd.fnal.gov/synoptic/display/Work\\_in\\_progress/New\\_NML\\_LaserLab](http://www-bd.fnal.gov/synoptic/display/Work_in_progress/New_NML_LaserLab): This is the web viewer synoptic display of the NML Laser experiment.