GEMs Semester Report Spring 2008

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May 13, 2008

Abstract

There were several new peices of equipment added to the GEMs hardware this semester. Each piece will be reviewed and described. All problems that were encountered will be addressed and any solutions will be included. Also, all progress will be documented.

1 Introduction

Much progress has been made with the GEM detector hardware this semester. The detector is in a complete and assembled state and sustained operational voltage over a period of several days. Work is being done to understand the noise introduced by the self-capacitance of the readout. Currently the signal to background is poor and no pulses have been detected, but the readout is a large single channel plane. Once the size of the readout is small enough to eliminate the noise problems we should see signal. There are no longer any problems with sparking or high leakage currents and new equipment allows for close monitoring of conditions inside the detector.

2 Equipment

This section describes commonly used equipment and all new equipment introduced this semester.

2.1 Amplifier

The current setup uses the IO1195-1 RevA for signal amplification. Of the three amplifiers on hand two have been characterized and one, 'C', was bad. It overheated when voltage was applied. Currently, tests are being conducted to determine the level of noise introduced by the self-capacitance of the readout board. We found that at -5 and +2.5 Volts a copper plate with an area of about 17 square cm will produce minimal noise. Several tests show that there is background noise present on larger pieces of copper. On 23April08 capacitors were connected to the circuit and tested for the voltage when noise was first seen in the circuit. (see 23 April 08) From this it was determined that the small plate had a capacitance of about 2 pF. This data can be found in Appendix A. Tests are ongoing.

2.2 PicoAmmeter

Two new Keithley pAmmeters were ordered this semester. They belong to the GEMs project and not senior lab. The instruction manual was filed in the top drawer of tan filing cabinet. (For future reference this is where all instructions are kept.) The pAmmeters were found to work with GEMs 2 and 3 all the way up to operating voltage, but there were erroneous readings from the pAmmeter connected to GEM 1 after an input of about 2.5 volts. (see 15 April 08) The input and output of the pAmmeters should NOT be connected to the ground of the high voltage circuit, this causes overcurrents.

2.3 Moisture Meter

Another new piece of equipment is the Shaw Superdew moisture meter. This meter is commissioned and requires no servicing. The calibration was done in accordance with the operating instructions. The only additional piece of information needed for this calibration is that our sensor type is the ?Grey Spot? which has a dew point range of -80 to 0 °C. This meter showed normal functionality over the course of the semester.

2.4 Oxygen Meter

The Teledyne Oxygen Analyzer was also purchased this semester. This meter displays the amount of Oxygen present in the system in either percent or ppm. After the first calibration it occasionally showed a negative amount. The sensor was recalibrated in accordance with the instruction manual and under the same flow rate this problem has not reoccurred. This sensor will need serviced, approximately every six to twelve months, when the fuel cell will need to be replaced.

2.5 HV probe

The Fluke high voltage probe is capable of measuring up to 15kV. It plugs into a typical 10MΩ multimeter and uses the DC voltage setting. The voltage displayed on the screen is 1000 times less than the actual voltage. This probe requires that an external earth ground be connected via an alligator clip.

2.6 Flow Meter

The flowmeter requires no calibration, but it is important to know that the scale used refers to a calibration chart which can be found with the other manuals. It is important to know that 30 mm (30 on the scale displayed on the meter) is equivalent to 4 box volumes an hour. This was the standard setting used this semester.

2.7 Leak Hunter

The Matheson Leak Hunter Plus is a fairly cryptic, but useful device. To operate it switch on the power and select gas group 4. This includes CO_2. The PEAK HOLD button will lock the value at highest concentration found. It is important to note that there is a significant time delay when using this device because gases can become trapped in the sensor and must effuse through the small opening.

3 Problems

Several problems arose this year, and other were ongoing. These are common issues with the detector and how to address them.

3.1 High Leakage Currents

Once the detector was assembled and the structural problems dealt with we slowly turned on the voltage. This was done in $\frac{1}{2}$V increments up to 5 volts and then by $\frac{1}{5}$V increments. The leakage current across the GEMs was very large. This happened at about $\frac{1}{2}$ of the operating voltages. The detector was shut down and taken to the clean room for inspection. In the clean room it was disassembled and each GEM was tested for leakage currents individually. Appendix C shows a plot of these results. Two of the foils had a leakage current of about 3 nA when 300 volts was applied. The third showed a leakage current of 80 nA. This was replaced with a spare foil, which was also tested. The spare foil had a leakage current of 1 nA at 300 volts.

3.2 Loss of Pressure in Box

The first major problem was that the box was not gas tight. Appendix B shows a graph of pressure versus time when the box is initially pressurized to 40 kPag. The pressure test is important even though the experiment is conducted at atmospheric pressure. It reveals whether there are any significant leaks in the box that would allow air in during the experiment. It is vital that the 70:30 Ar:CO_2 ratio remain constant. Using the leak hunter most major leakage points were found around feed-throughs. These were sealed with stycast and the box was retested.

4 Progress/Results

Much of the progress made this semester was in commissioning the new equipment, but significant developments in powering the detector were made as well. The detector was at held at operating voltage for two days before being turned down. This is the first time in the current setup that such a voltage was reached.

4.1 Individual Testing

The first attempt resulted in large leakage currents so the foils were all individually monitored in the clean room. Individual testing showed that one of the foils had a high leakage current, while the other 3 were normal. This foil showed no abnormal physical damage and was cleaned. It is ready to be retested if it is needed in the future.

4.2 Drawing for G10 frames with a 4.5" active area

A CAD drawing for the frames was completed this semester and can be found on the common computer in the lab ?Marcus 1?. The file is saved in the common folder:
"c:⇒documents and settings⇒all users⇒shared documents⇒our gem"
This is a solidworks 2008 drawing and which needs tool paths added by the machine shop. With the addition of the tool path the frames can be made completely by the CNC. This will yeild a higher precision in the geometry of the frames. The current drawing uses a 4 $\frac{1}{2}$in. by 4 $\frac{1}{2}$in. active area.

4.3 Clean Room

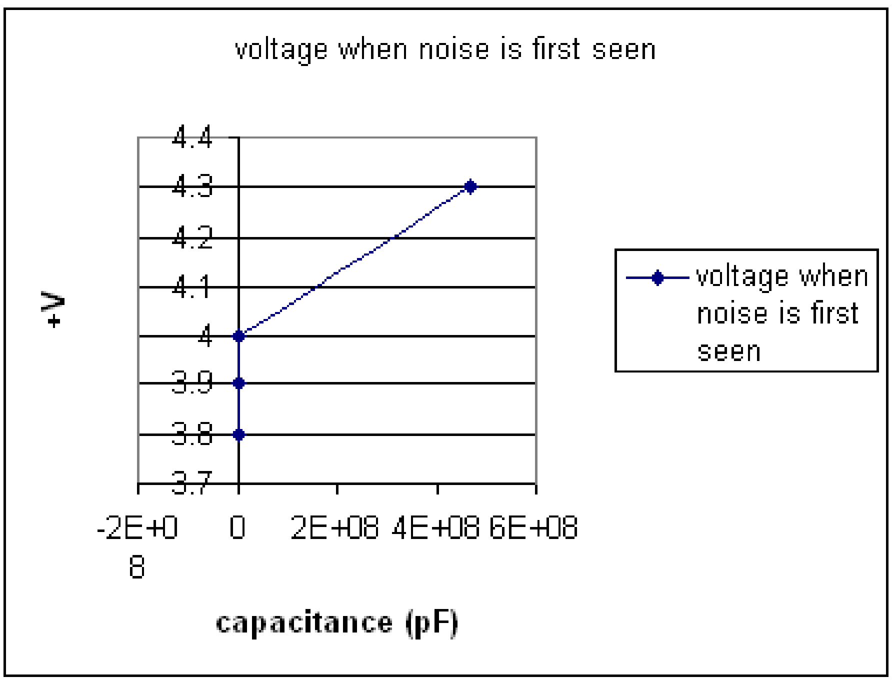
During the construction of the new GEM foils all procedures were carried out in the clean room. We obtained an ultrasonic bath and millipore water from Dr. Olsen in the chemistry department and used it to clean the frames before mounting the foils. The GEM foils were not cleaned prior to mounting.

The clean room garb consists of a lab coat, gloves, bouffant, shoe covers, and a face mask. Each item should be replaced as needed. There is also a mop and broom in the vestibule for use in the clean room.

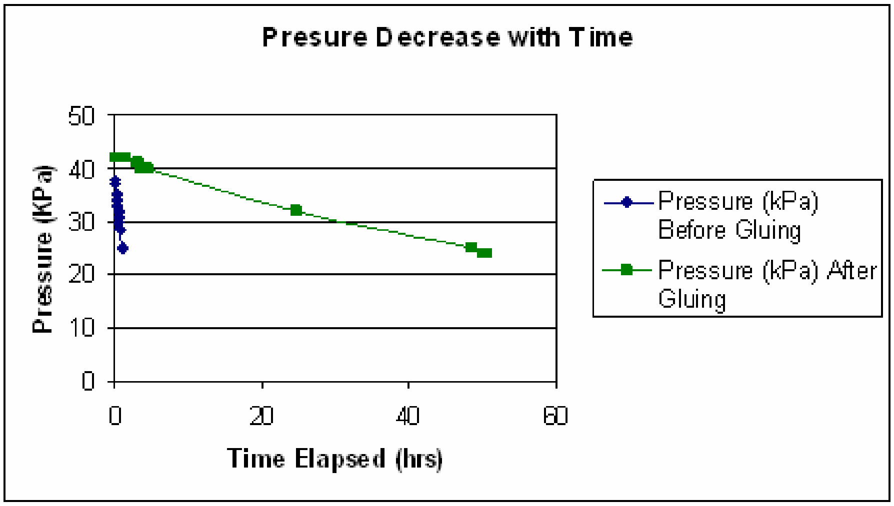
5 Conclusions

We have added several new pieces of equipment this semester in order to carefully monitor our gas levels. Also, the addition of two new picoAmmeters and the High Voltage probe for the multimeter are able to characterize the circuit and current through the GEM foils. The detector has been ran at operating voltage for about two days with no errors, but we are still seeing noise in the amplifier. This noise must be fully understood in order to get a clear enough signal to backgrouand that can be analyzed. This will be the next task to be completed.

Appendix A Capacitance in the Readout



Appendix B Pressure of the Detector



Appendix C Leakage Currents of the GEM foils