

4/5/2009

Review of Gas Electron Multiplier Development during Spring 2009

I. Sparking

One of our big problems in the past has been sparking between GEM foils. We have completely lost one foil (Foil 1) to this problem (it can no longer hold current), and two others appear to have been damaged upon inspection. This sparking can be caused by either...

- a. Poor stretching which can warp the foil and the field it creates, or
- b. Foreign materials on a foil which block the holes that produce the electric field.

Our first step in fixing this issue was to purchase a glue dispenser so that we can apply glue more evenly during the stretching process. The second problem is a more complicated matter. To start with, the quality of the foils that we have received from Tech-Etch has been questionable. There are visible marks on the foils, and inspection under a microscope revealed some glue-like substance staining one of them.

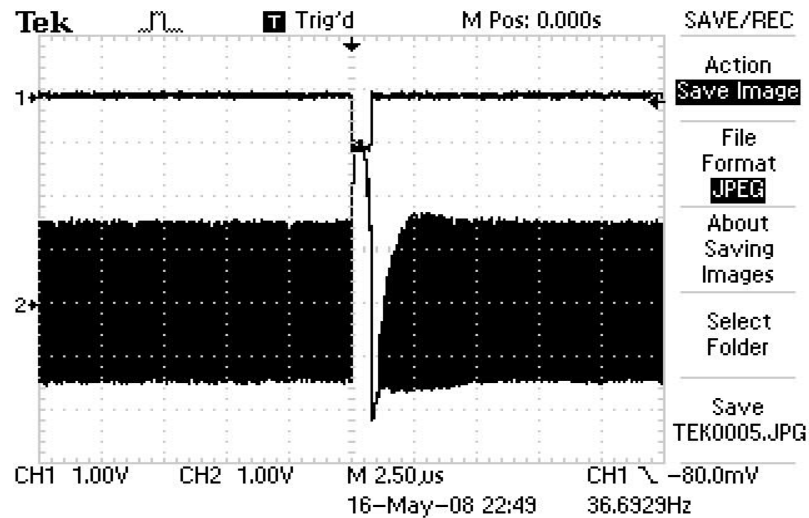
Recently, we have been testing the quality of our clean rooms for GEM framing purposes. Initial results rank between an ISO 8 and ISO 7 (or just short of a class 10,000) in the GPL clean room, and a class 10,000 in the high bay clean room. Leaving the room sit without anyone going in and out, as well as covering the intake vent has been shown to bring the GPL clean room to a class 10,000 as well. In the measurement of $0.3\mu\text{m}$ particles, both clean rooms meet ISO 6 requirements but fail on the full range of particle sizes that are picked up by our detector. Our goal is to reach class 1000 level before framing any more GEM foils.

II. Recent Developments

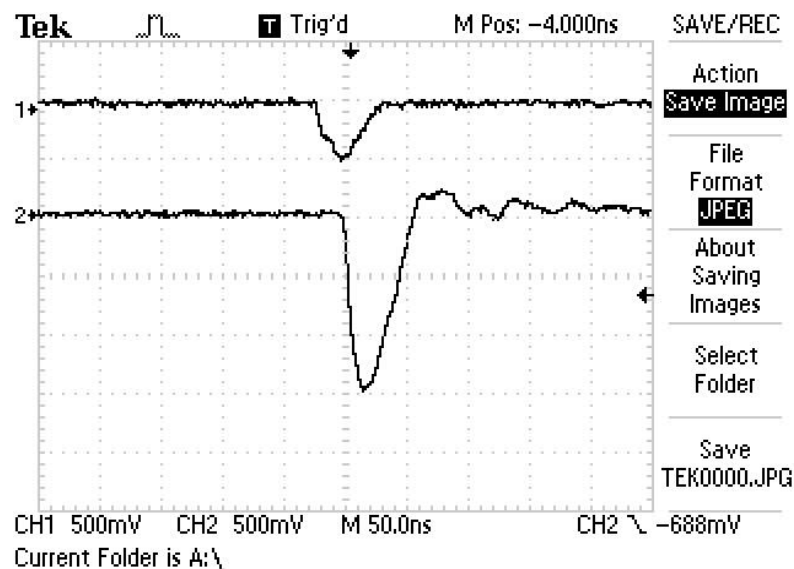


This semester, we produced a new lid for the detector (seen above). The components are now welded directly to the lid to replace the leaky, fragile gluing of our old lid. Each wire on the lid has its own label, and we also have a simple diagram in the lab labeling the location of each connection. Our first “New Lid” attempt warped during welding, so for the second attempt we used a thicker steel plate. Unfortunately, our new lid can not hold pressure. Even after re-tightening all the feedthroughs our GEM box lost 50 Kilopascals of pressure in 2 minutes. This has to be a problem with the connection where the feedthrough meets the copper washer, and I believe that the next course of action is to try replacing the copper washers.

Readout electronics have been problematic, with large oscillations due to input capacitance (noise). In an attempt to improve our signal to noise ratio, we attached a readout strip directly to the amplifier chip and moved the electronics into the gas box, hoping this would shield it from outside interference. Unfortunately, we still received too much noise (seen on the following page), this time presumably due to interference from the large electric field inside the box.



Our next step was to reduce the area of the readout plane to an area of 7mm by 1mm. This reduced the oscillations and we received much cleaner test signals.



Earlier this year we framed new GEM foils, bringing us to a total of seven (including the one that was destroyed by sparking). Unfortunately, when assembling our new lid last month, the connections on two of our framed foils (Foils 2 and 3) became torn. We attempted to salvage them by cutting into the G10 frame and making new connections, but since that point they are unable to hold a current. We believe this to be due to particle contamination from the cutting and soldering process. This has forced us to use the previously mentioned foils of questionable reliability that appear to have sparking damage.

We have received three new foils to go with a new GEM box from CERN. This slimmed down GEM box is ready for use once we frame and install the foils, but we plan to improve the quality of our clean room before working with them.

III. Summary

- a. We have a new lid which still needs work to become gas tight.
- b. We have a new readout which is so far functioning correctly.
- c. We have not yet recorded signals from radiation. We probably won't see any such signals until we can frame more GEM foils.

IV. Future plans

One proposed solution to the task of improving our clean rooms is to purchase a laminar flow hood to be set up inside one of our clean rooms for the purpose of GEM framing.

The next step after getting good results from our current detector is to produce a larger detector.