Wire Chambers: A Brief How-to

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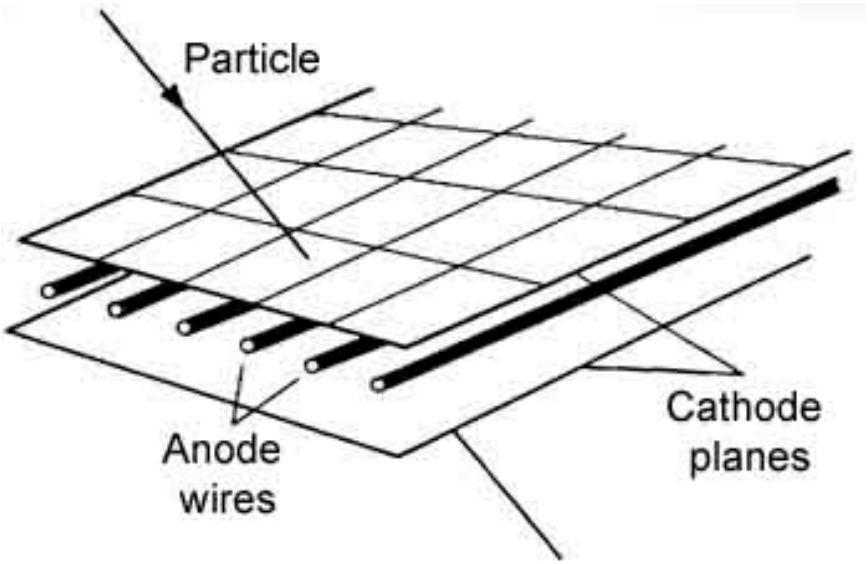
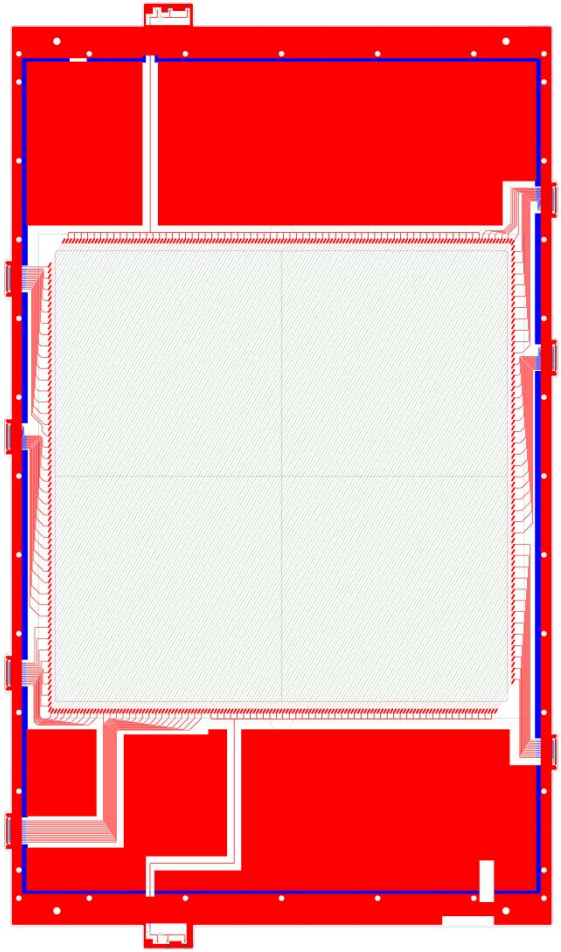
What is a Wire Chamber?

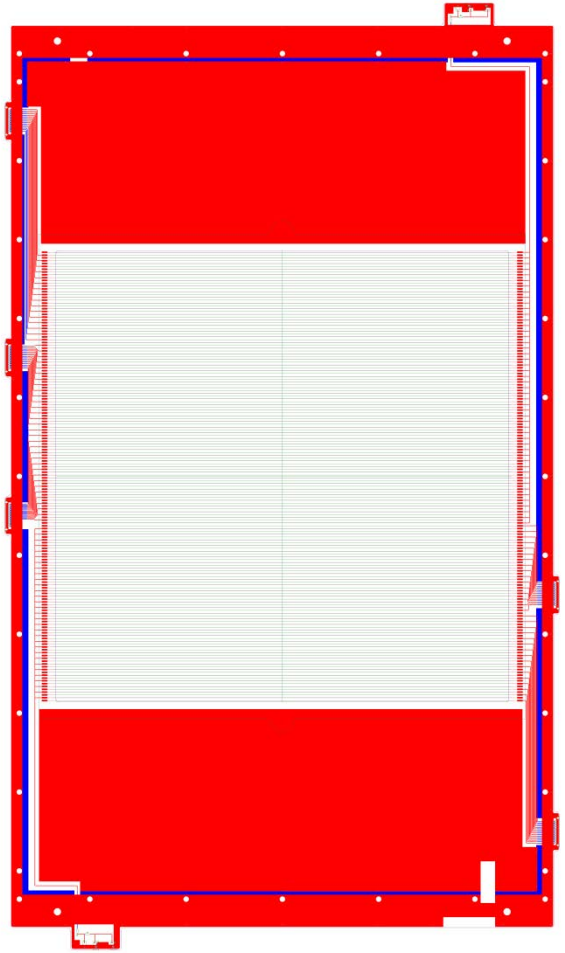
- Gas ionization detector.
- Charged particle passing through detector, ionizes gas and then electrons drift to anode wires
- Careful selection of wire patterns can allow particle trajectory to be determined.



SHMS Wire Chambers

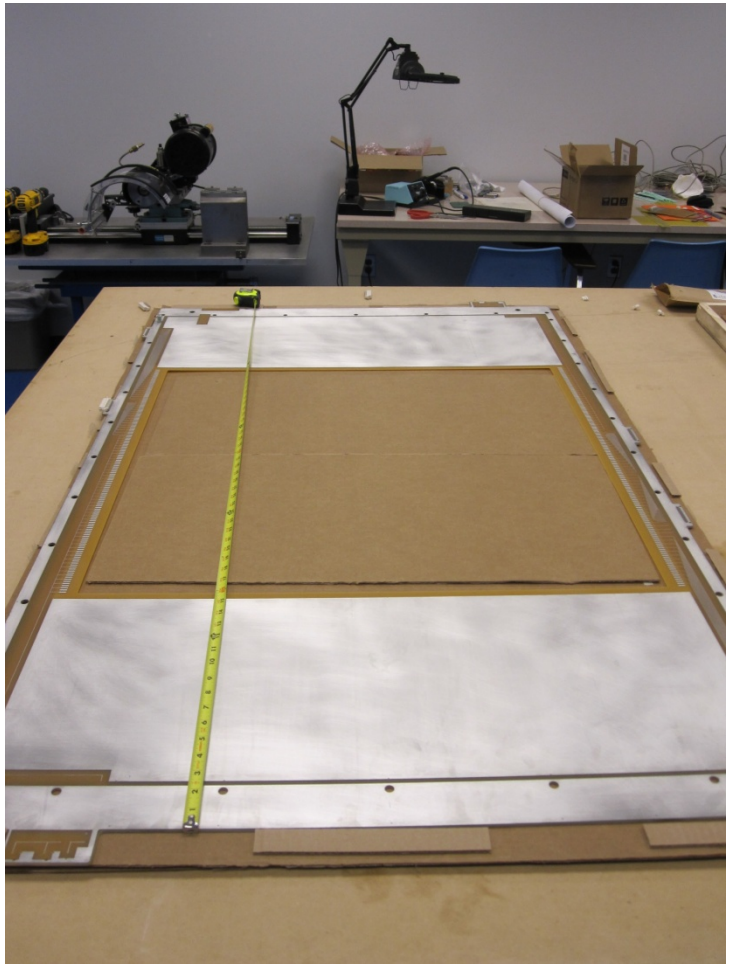
- Very large acceptance detectors – 80cm X 80cm.

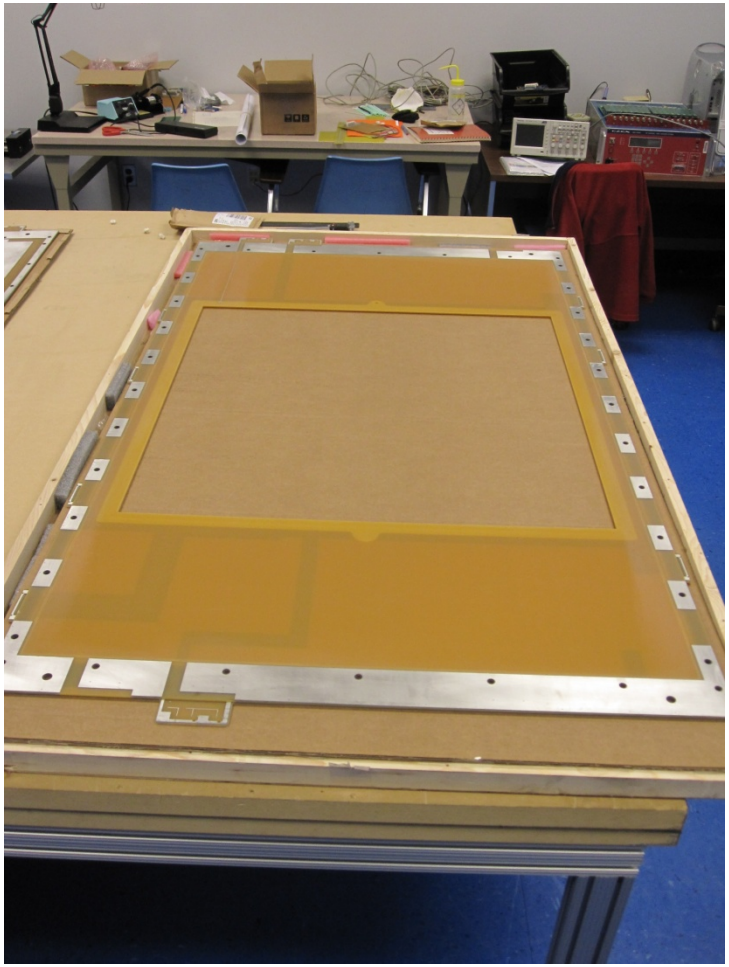




Printed Circuit Boards in Reality

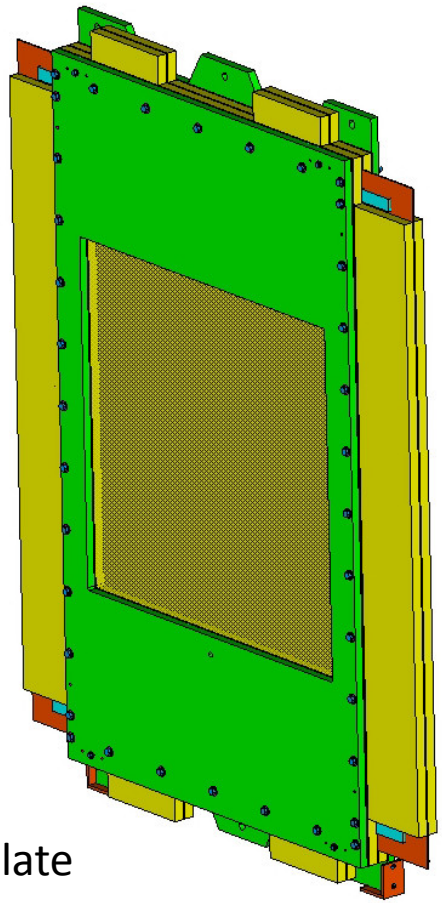
- Front and back views of the first X-plane.



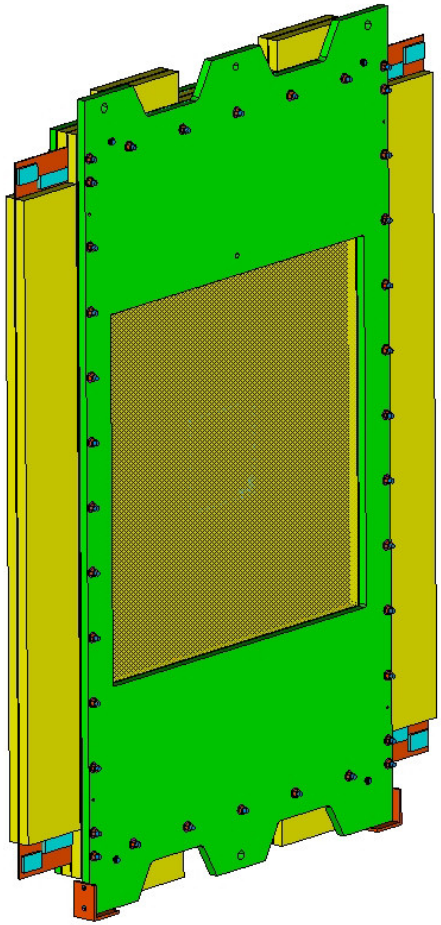


Mounting Plate Design

- Working closely with Hall C engineer to ensure sufficient lifting and adjustment points.

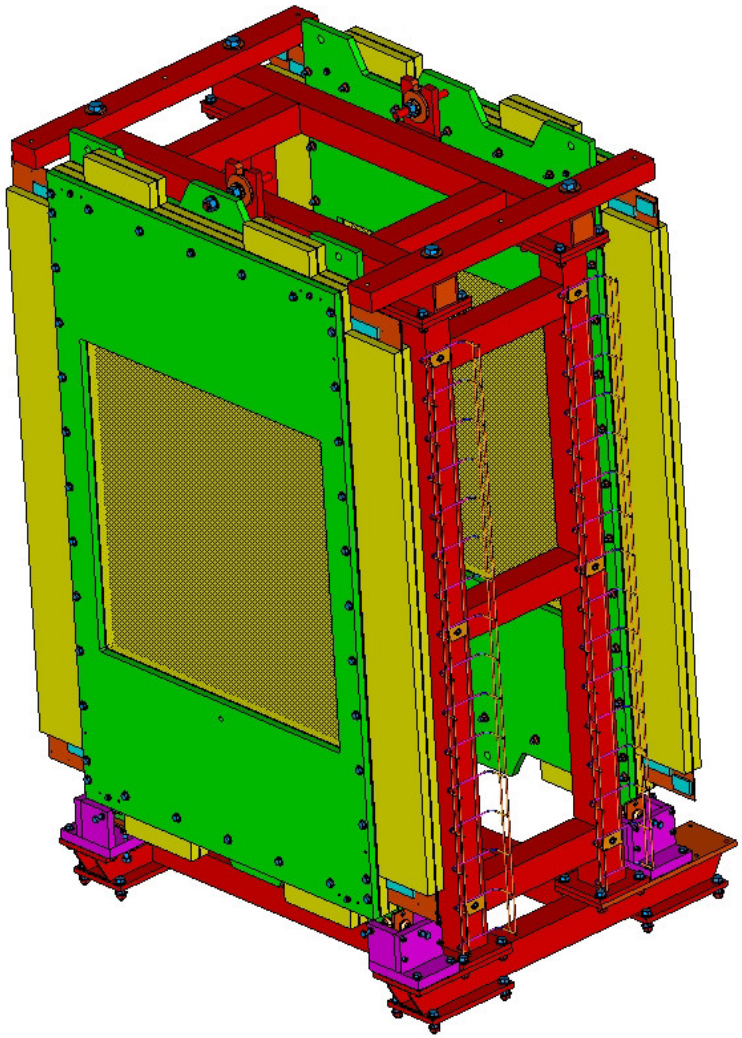


Rear plate



Front plate

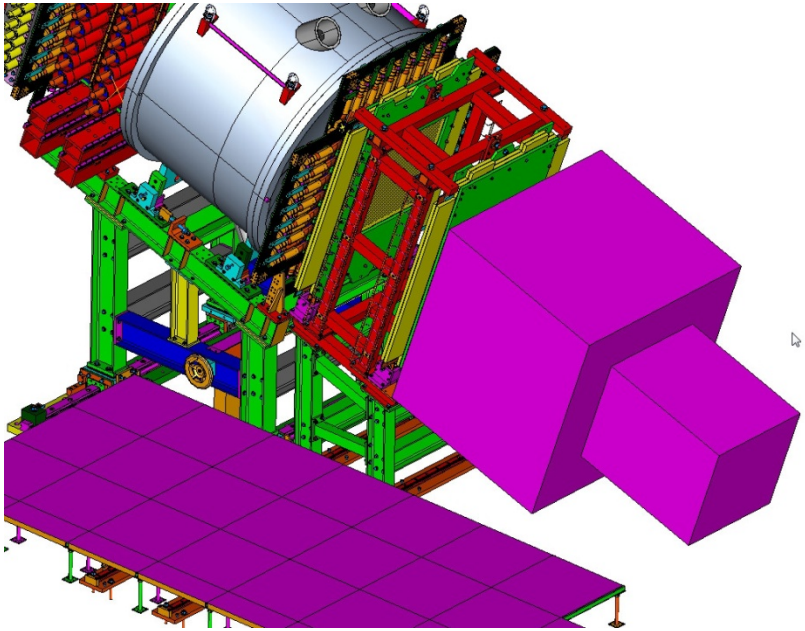
Mounting Frame for the Detectors



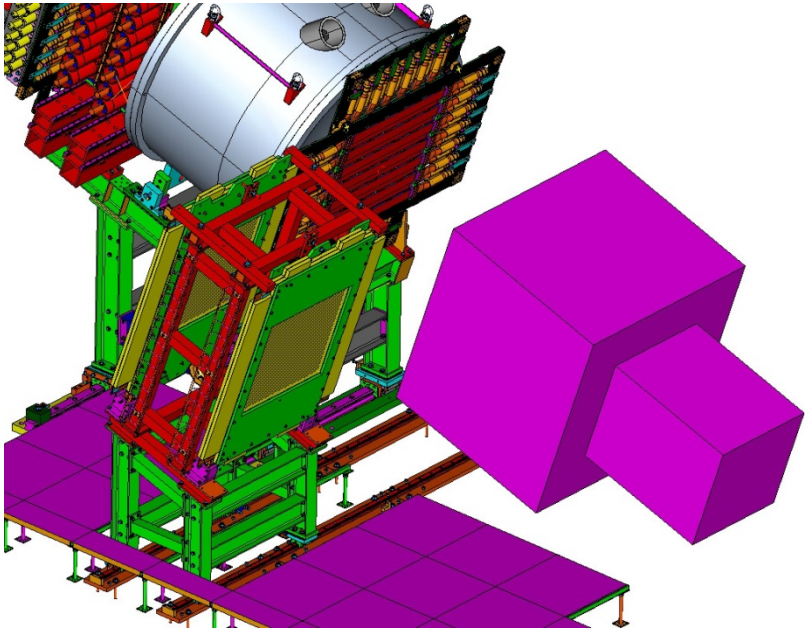
- Designed by Bert Metzger.
- Frame allows fine adjustment of wire chamber positions.
- Various interferences have been identified and fixed.
- Frame keeps the chambers mounted together as a pair.

Mounting the Detector in the Spectrometer

- The chambers are mounted together on a frame that can be inserted and removed from the detector stack.



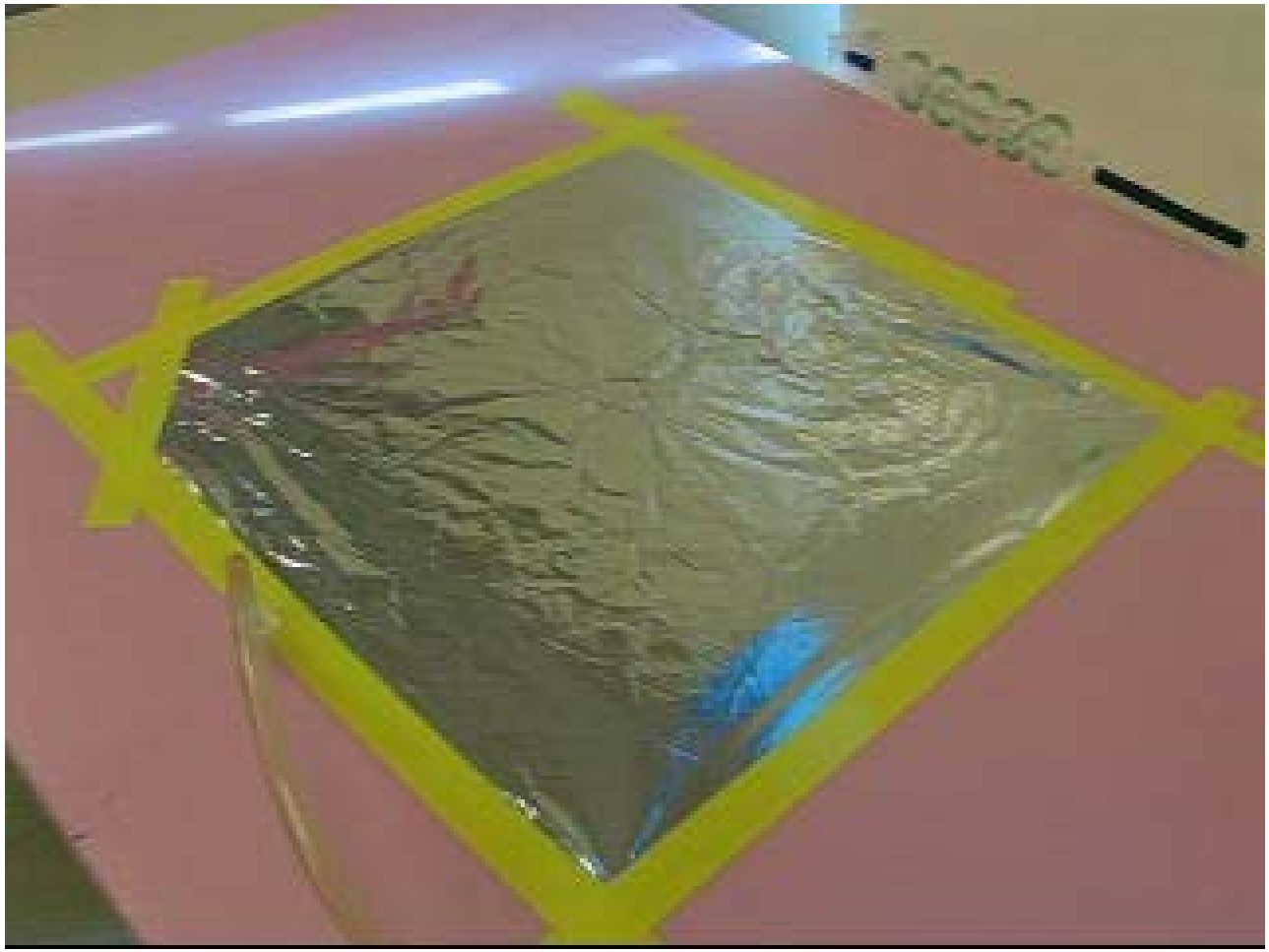
In the stack



Out of the stack

Test Foil Stretching

- Build a mock-up model with hard foam and tape; proof of principle!



Foil Stretching Jig

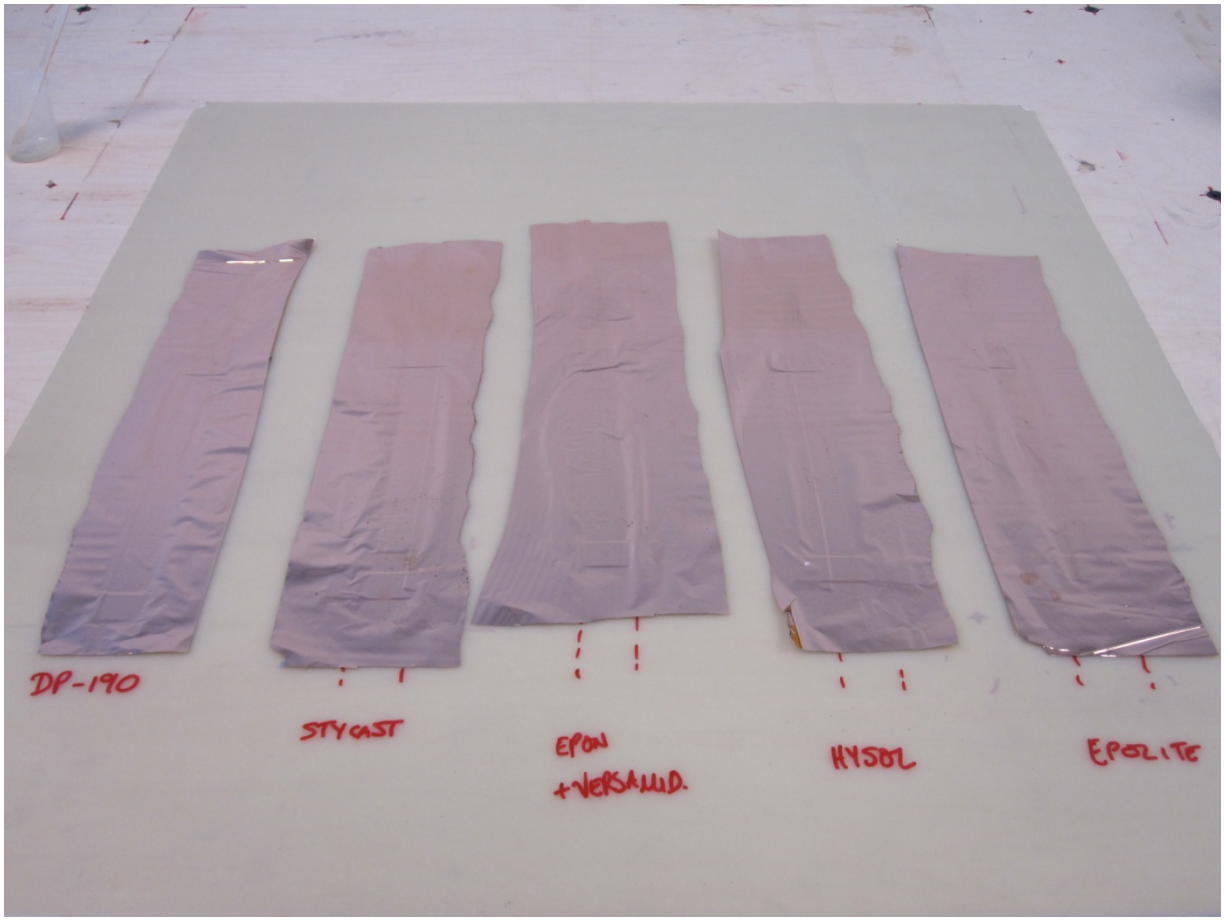
- Build a full size jig to stretch the cathode foil using a vacuum.
- Wooden bed and frame, with polished polyethylene block to stretch foil over.

Full Scale Tests

- Try a full scale test of the vacuum stretcher with some mylar foil.

Cathode Foil

- Copper coated kapton foil found to easily peel off the test board
- Tested five different epoxies for peel strength

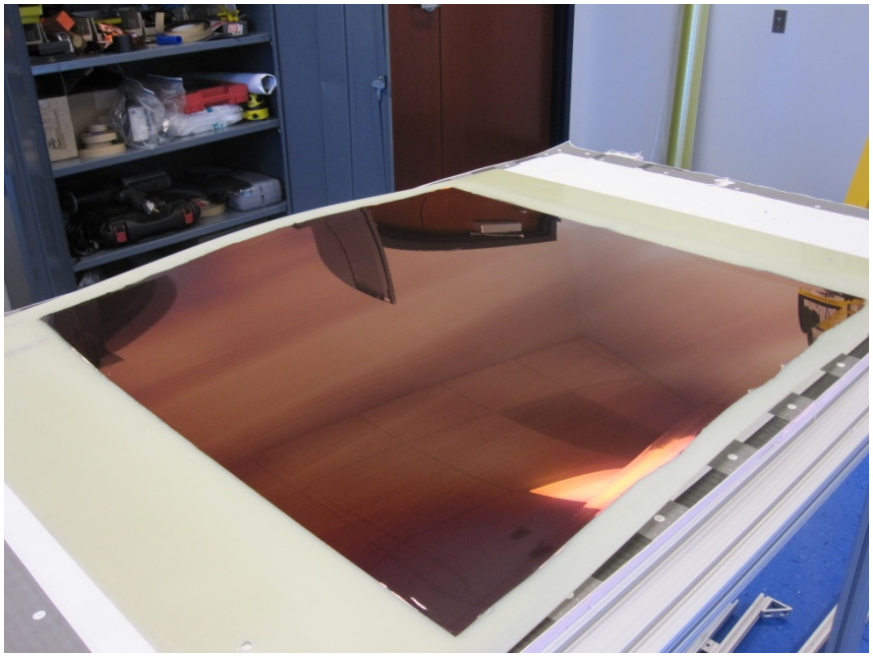


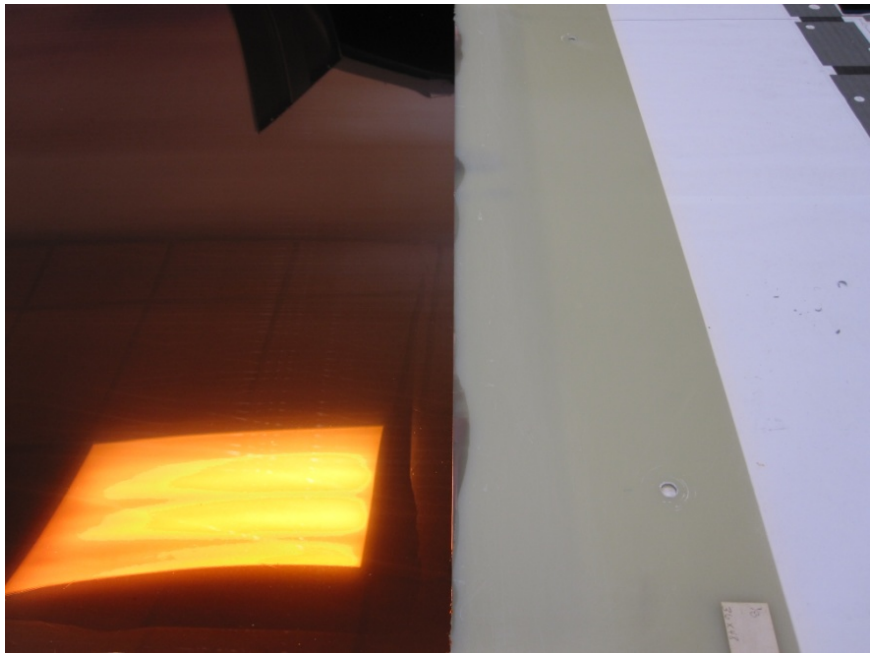
Glue Test Results

- Simple peel test showed 3M DP-190 epoxy worked best!

Cathode Foil Glue Test

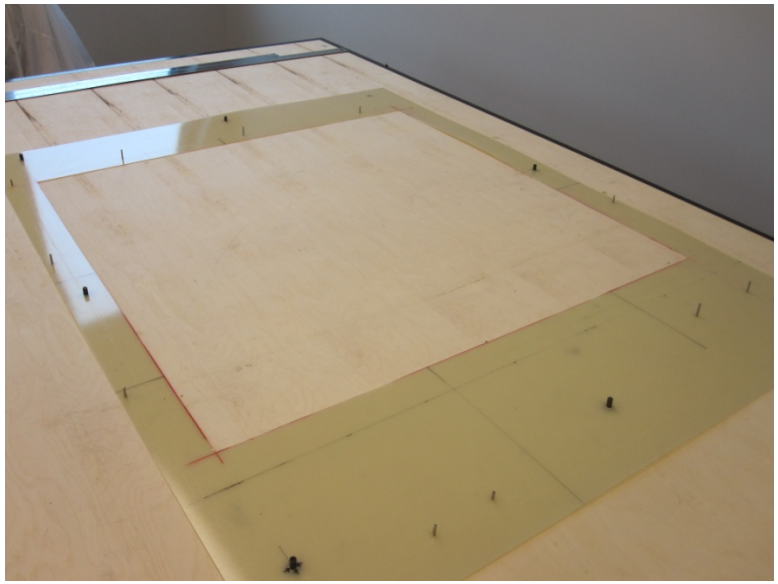
- Now the foil can be trimmed without causing the cathode plane to peel and separate off the glue joint.

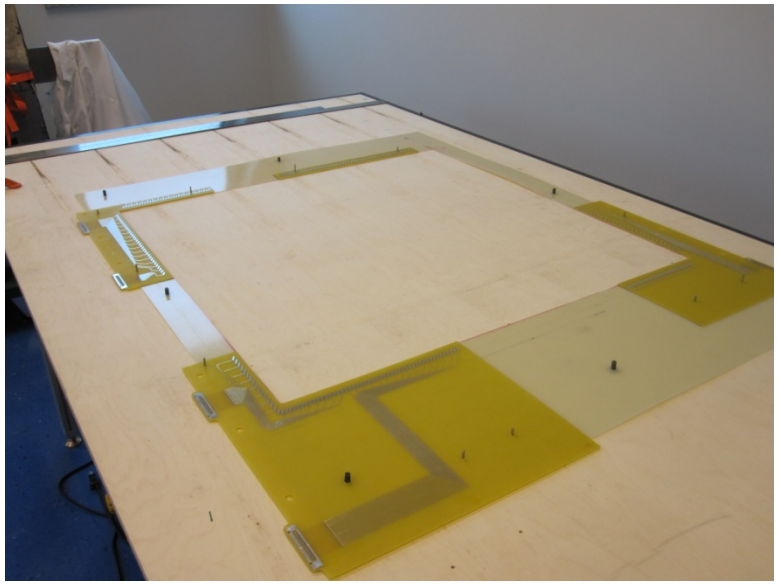




Prototype Wire Plane (U)

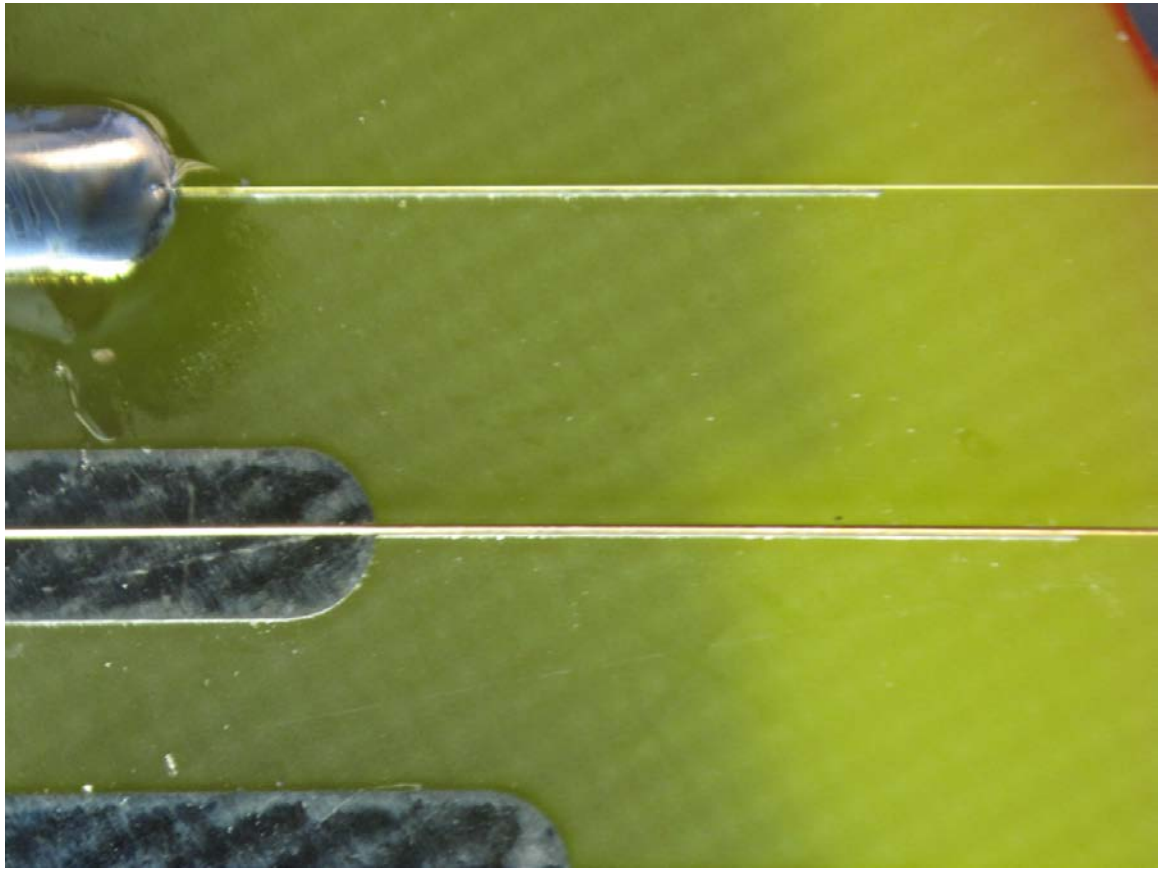
- Sets of four small PCBs manufactured courtesy of JLab.
- Each pcb is a cut out of part of the full size wire plane board.
- Mounted on the corners of the acceptance of a dummy board.
- Allows a stringing test with components on the same scale as the full size boards.





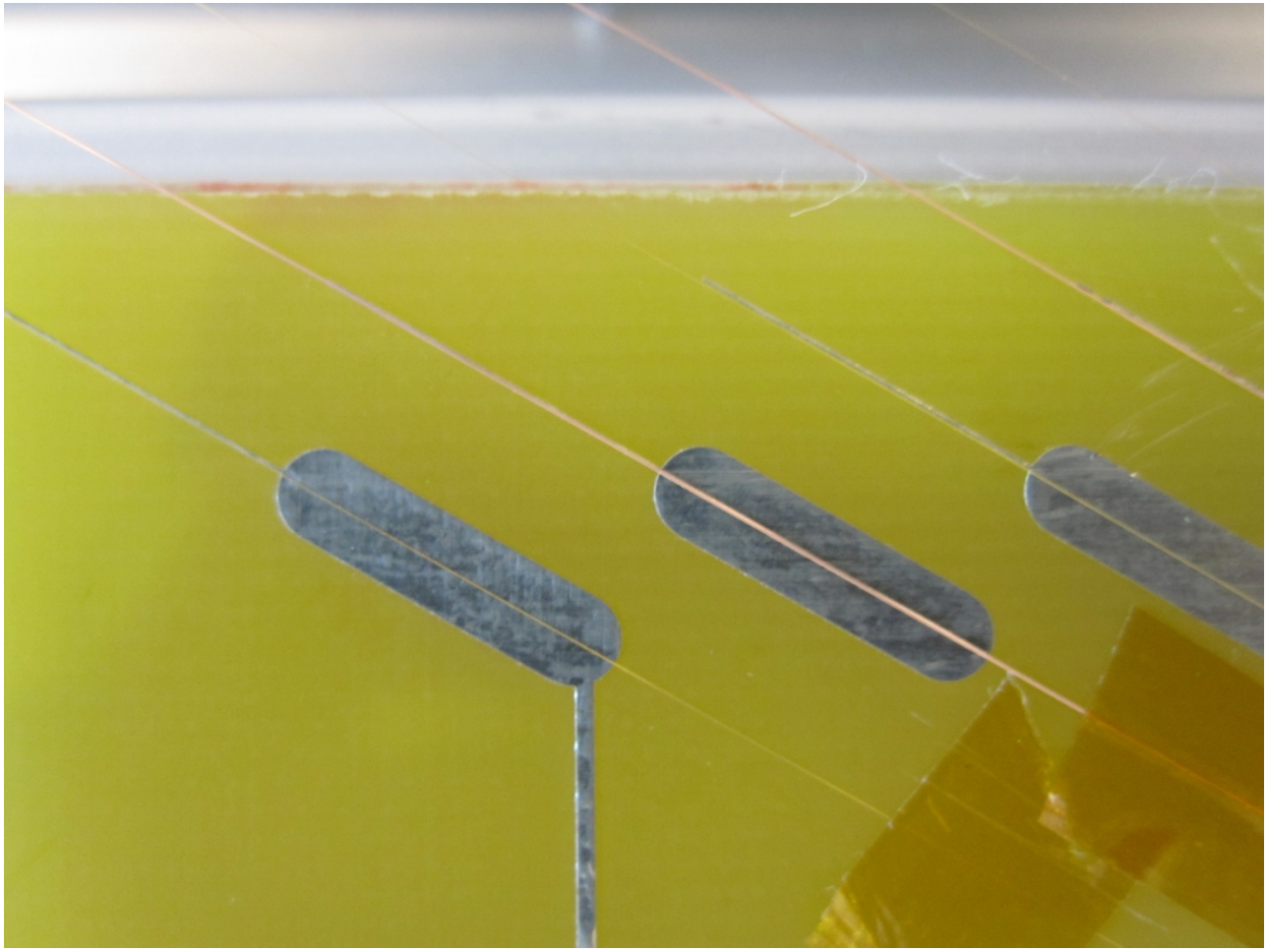
Wire Alignment - 1

- Thinner signal wires tend to roll off the alignment marks.
- Lightly sand the surface of the alignment marks to flatten them.



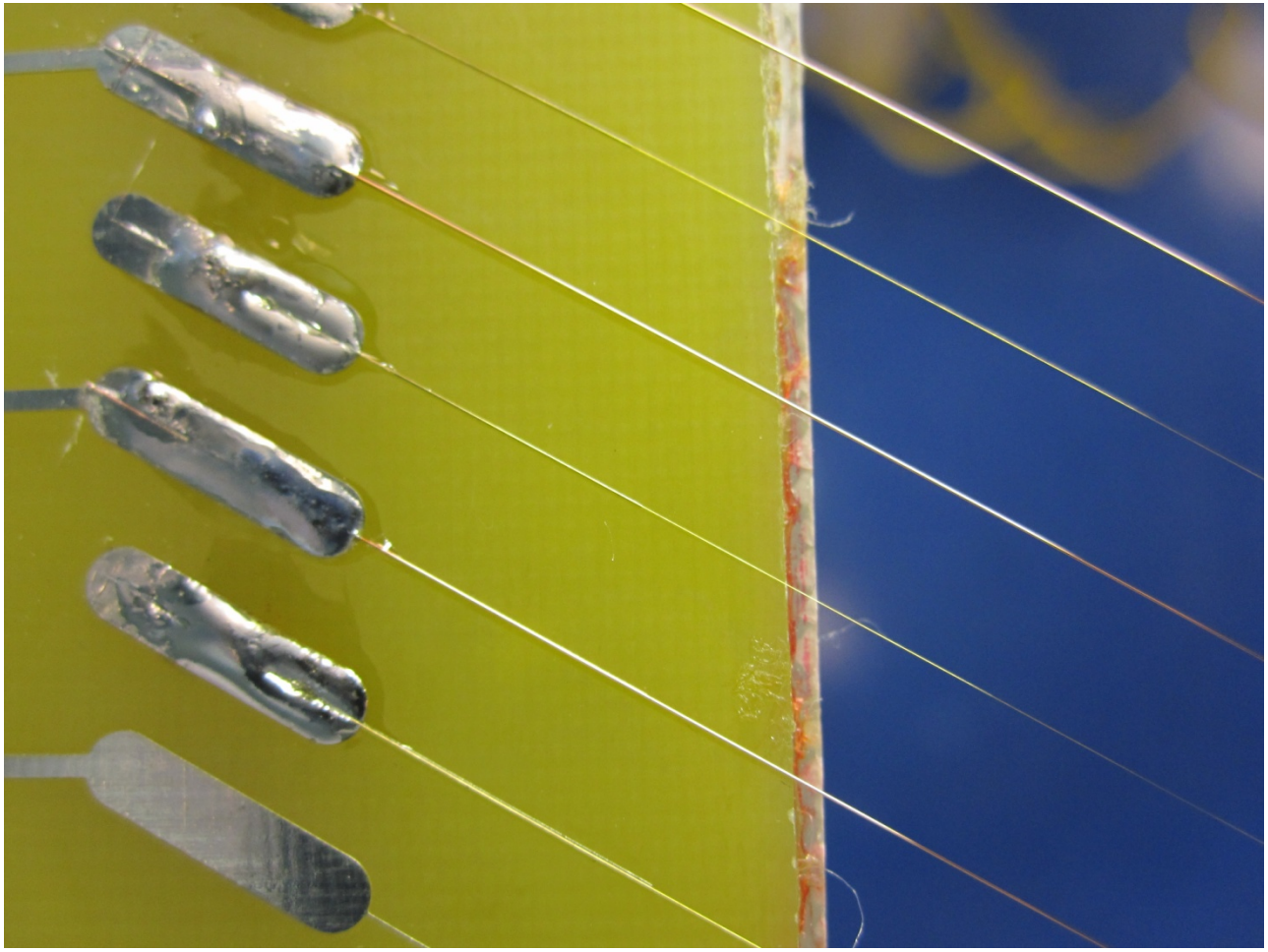
Wire Alignment - 2

- Must align both ends of the wire on the trace.



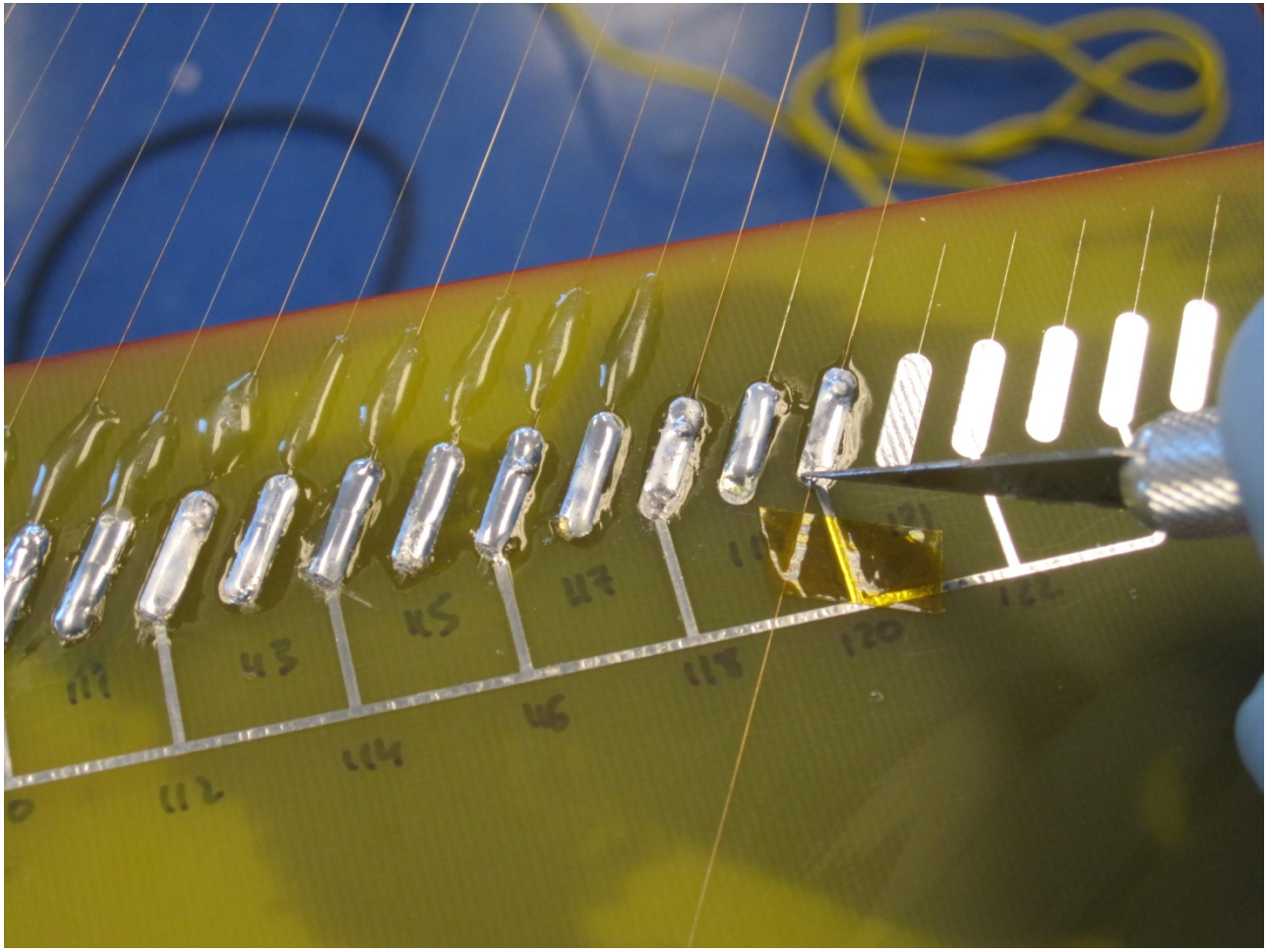
Attaching the Wire

- Solder one end of the wire, once it is aligned correctly



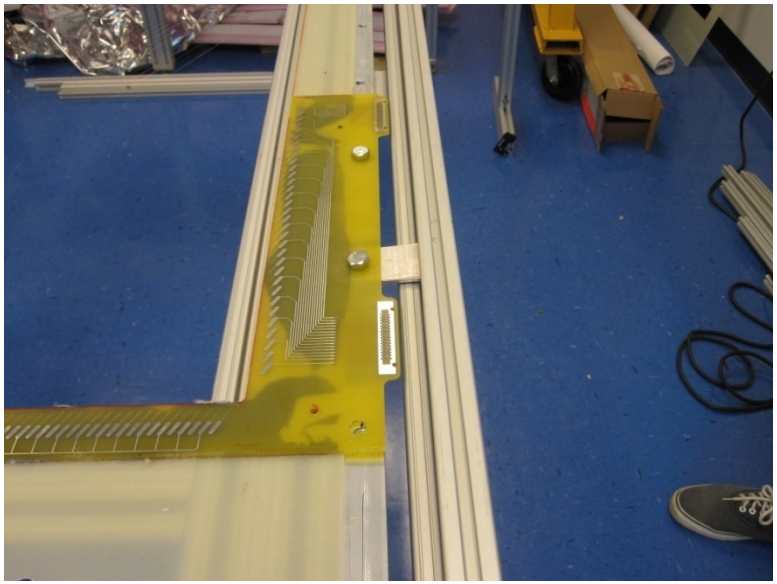
Test Wire Stringing

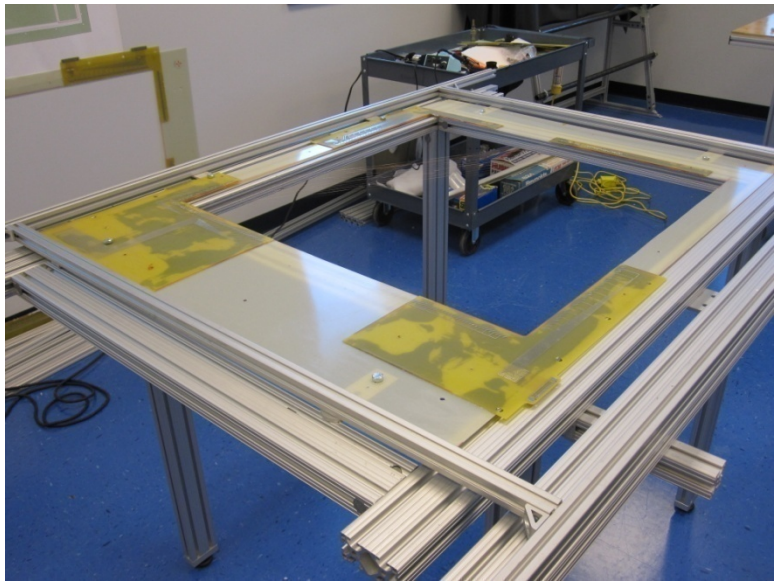
- Wires are epoxied after being tensioned and soldered.



Lifting Frame for Wire Planes

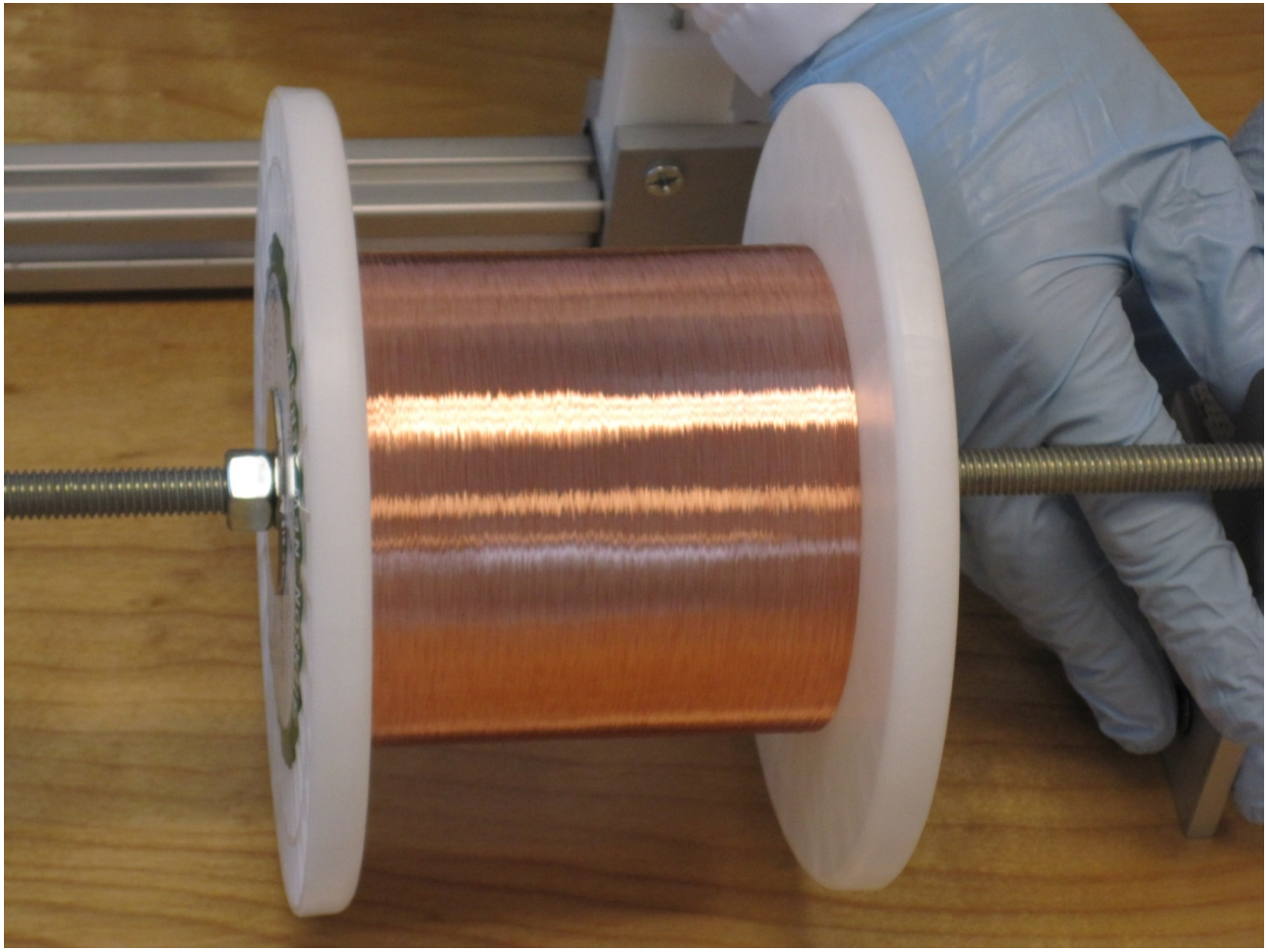
- Lifting frame boundary is outside the wire plane footprint.
- Add supports to stringing jig at the side; attach side rails of lifting frame to the wire plane at two points.
- Slide bottom rails on to side rails and attach to wire plane.





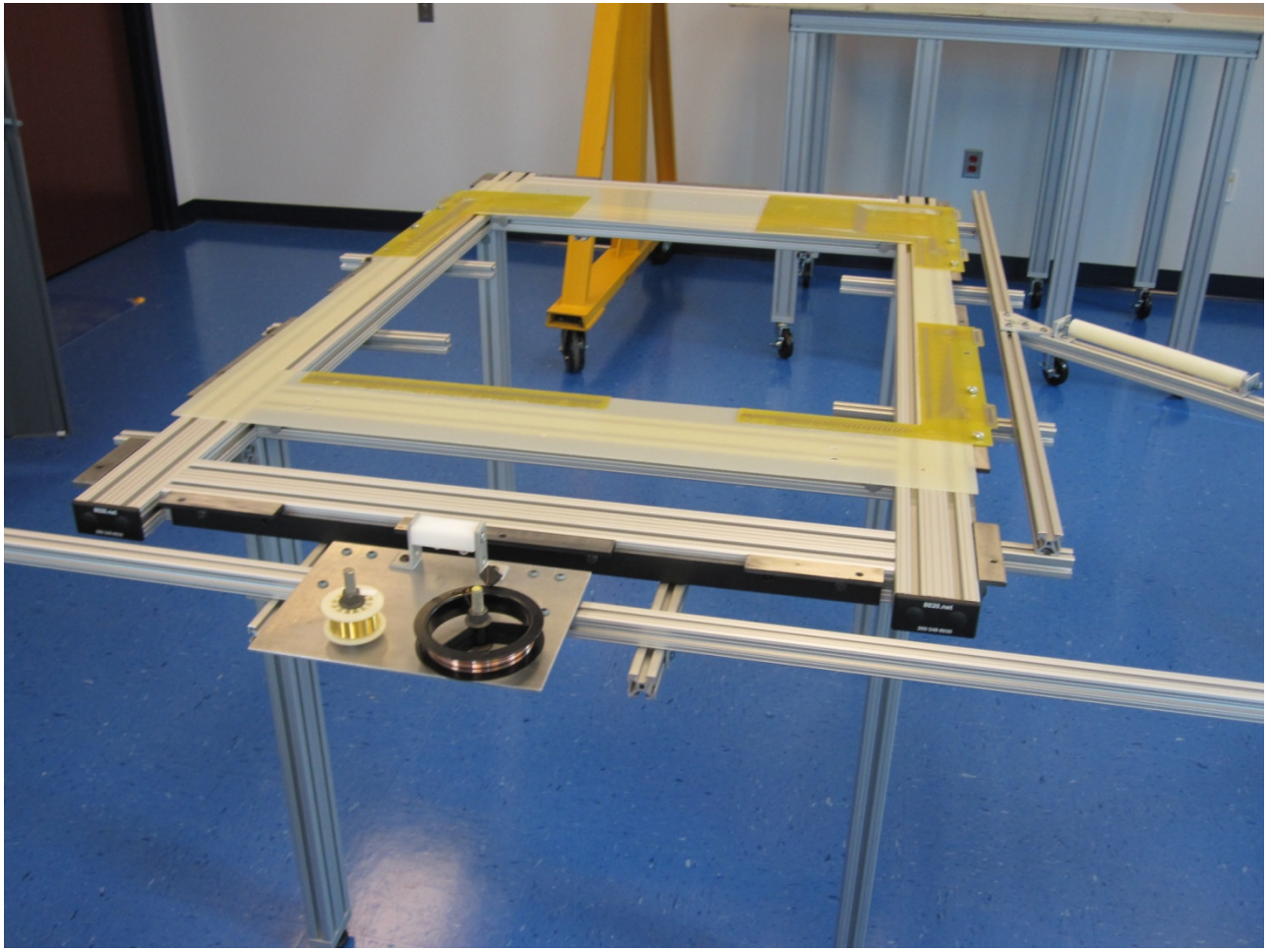
Managing the Wire

- High voltage wire is copper beryllium, all on a single spool!.



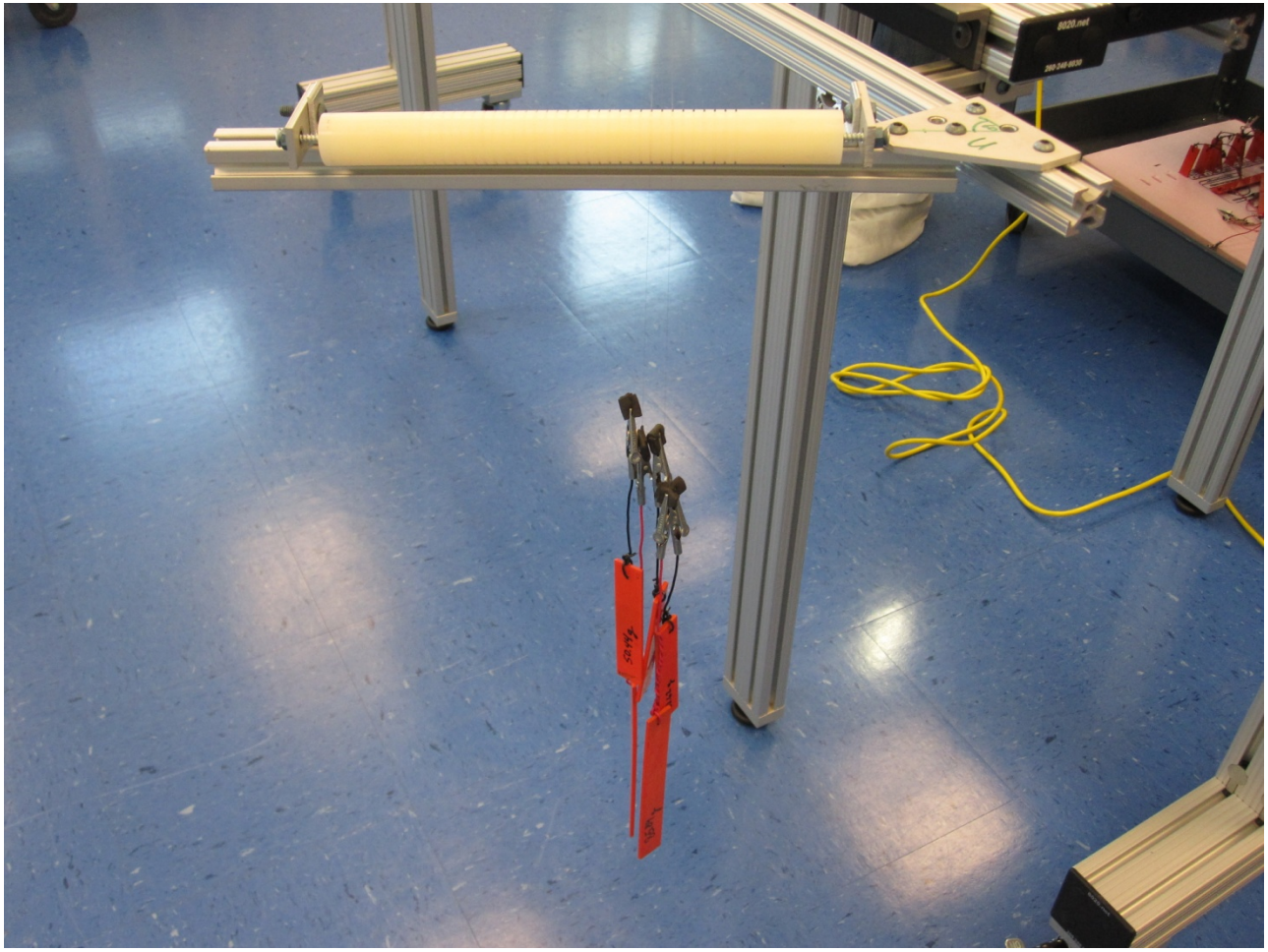
Prototype set-up for Stringing

- Test board placed on jig and set-up just as for the full size planes.



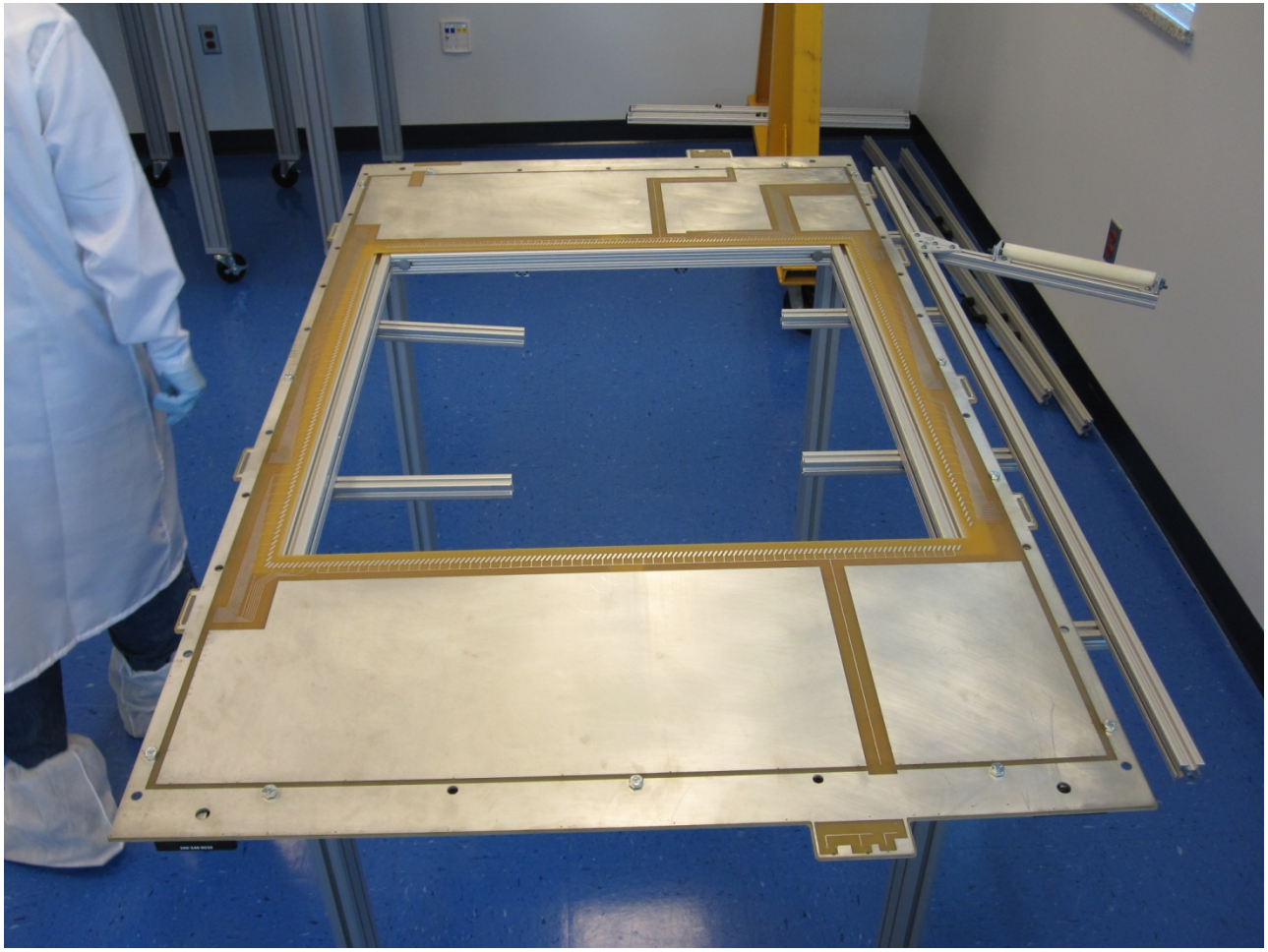
Tensioning the Wires

- Weights used to tension wires are hung over a suitable pulley.



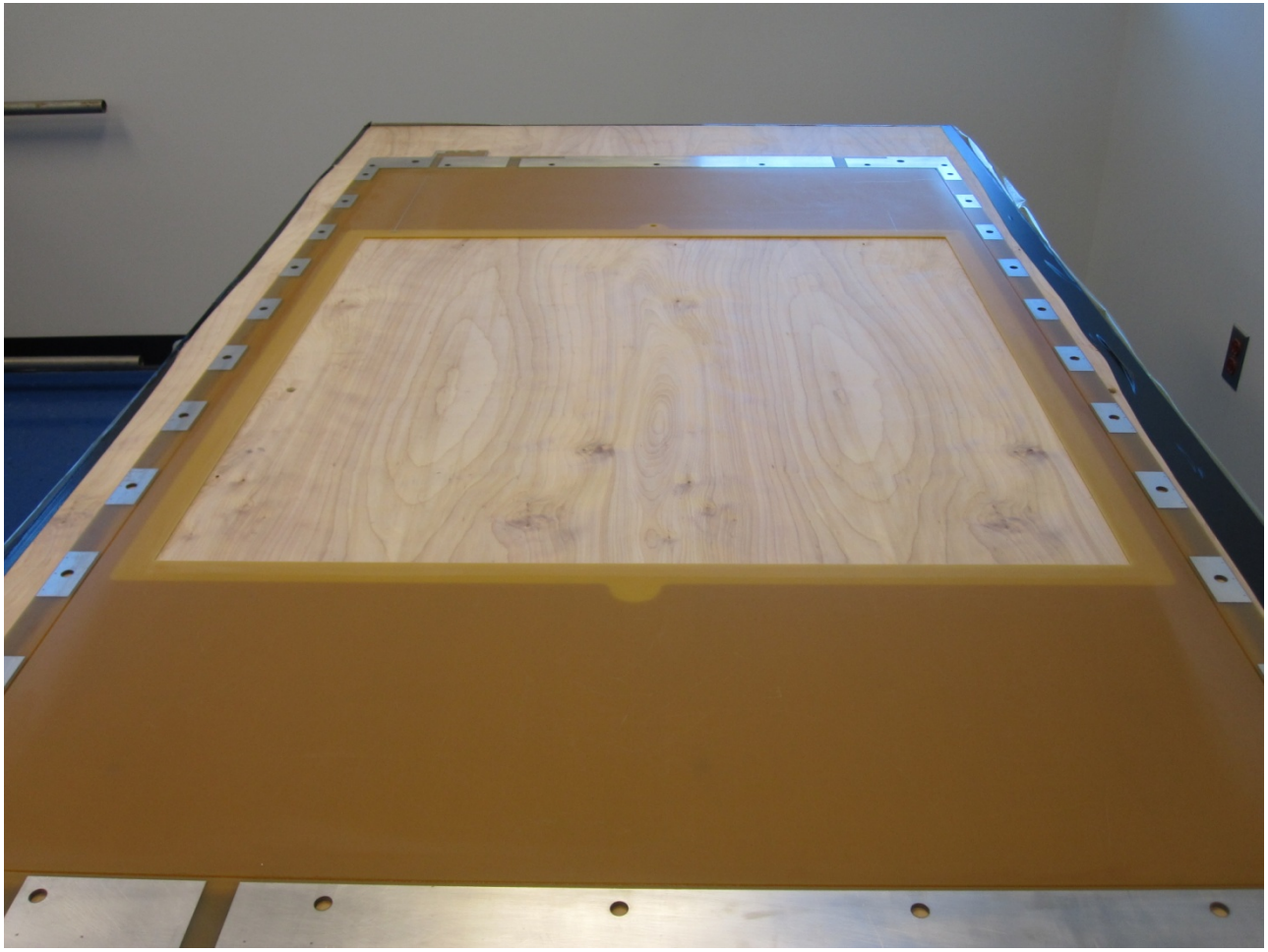
Test Wire Stringing

- Training students on the prototype first, before proceeding to the actual wire plane.



Making a Cathode Plane

- Apply epoxy to bare cathode board around the edge of the acceptance region

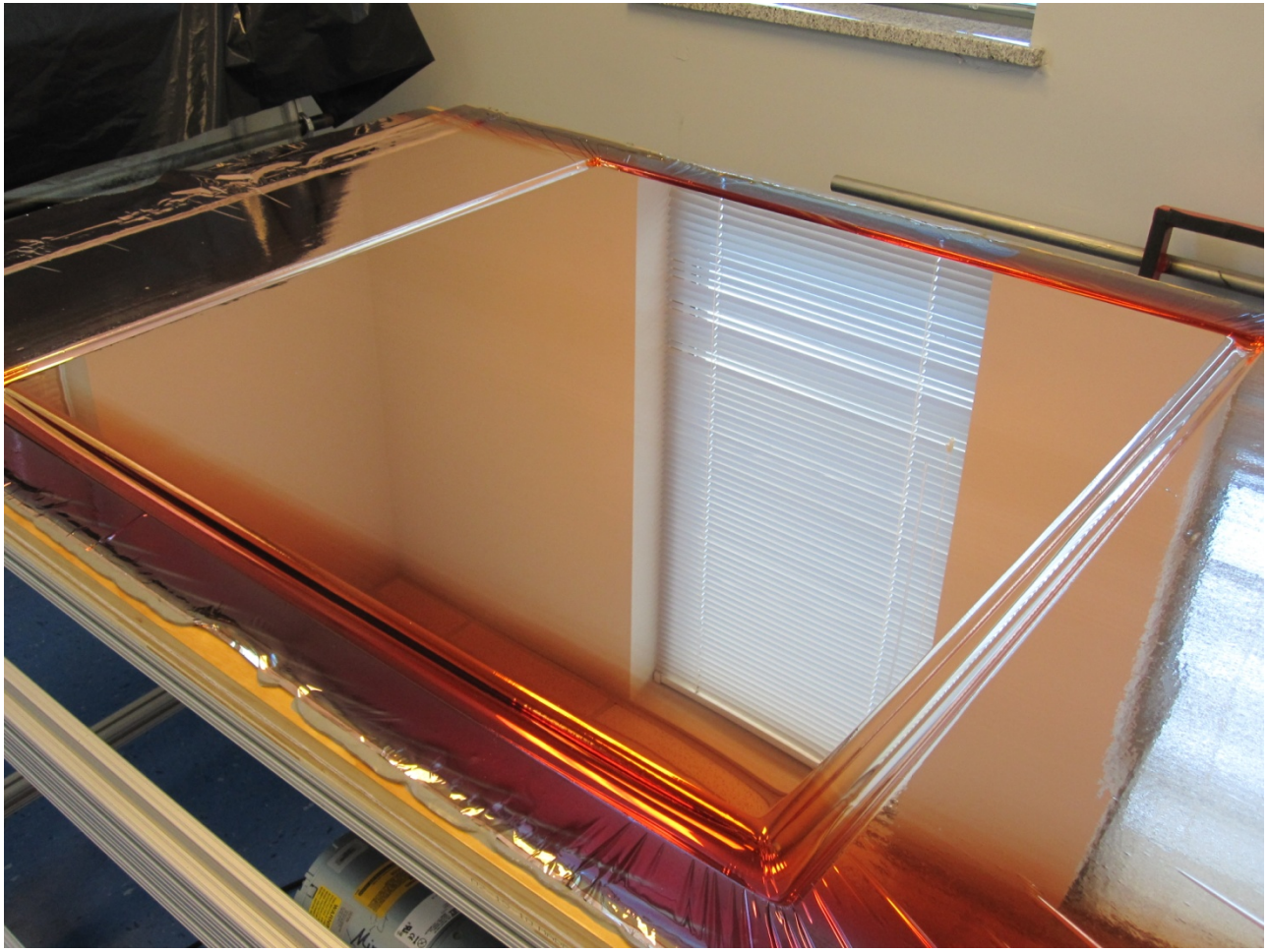


Prepare the Vacuum Stretcher

- Lay out foil on vacuum stretcher and press into vacuum putty.

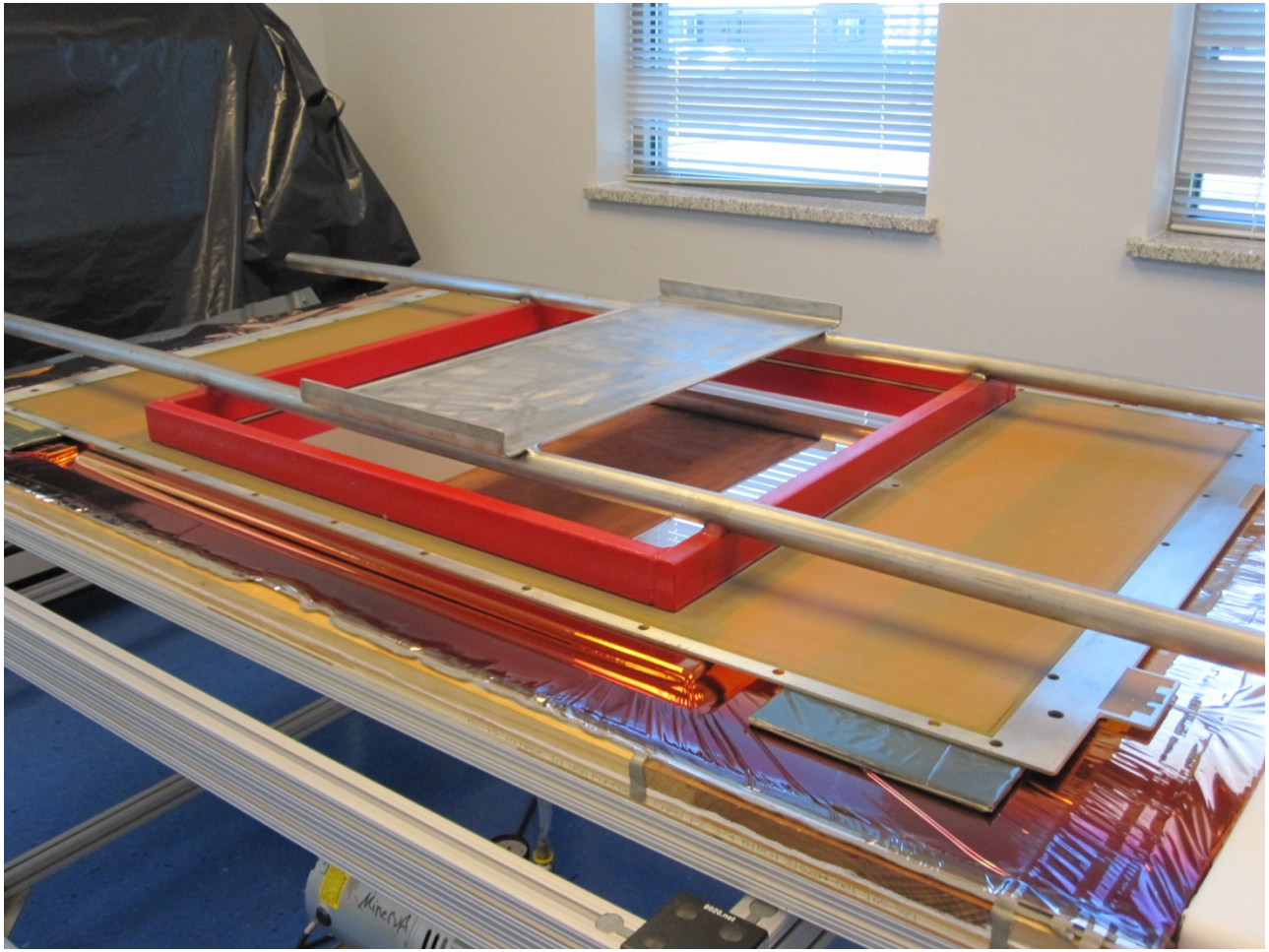
Stretch the Foil

- Test to make sure foil does not separate from vacuum putty.



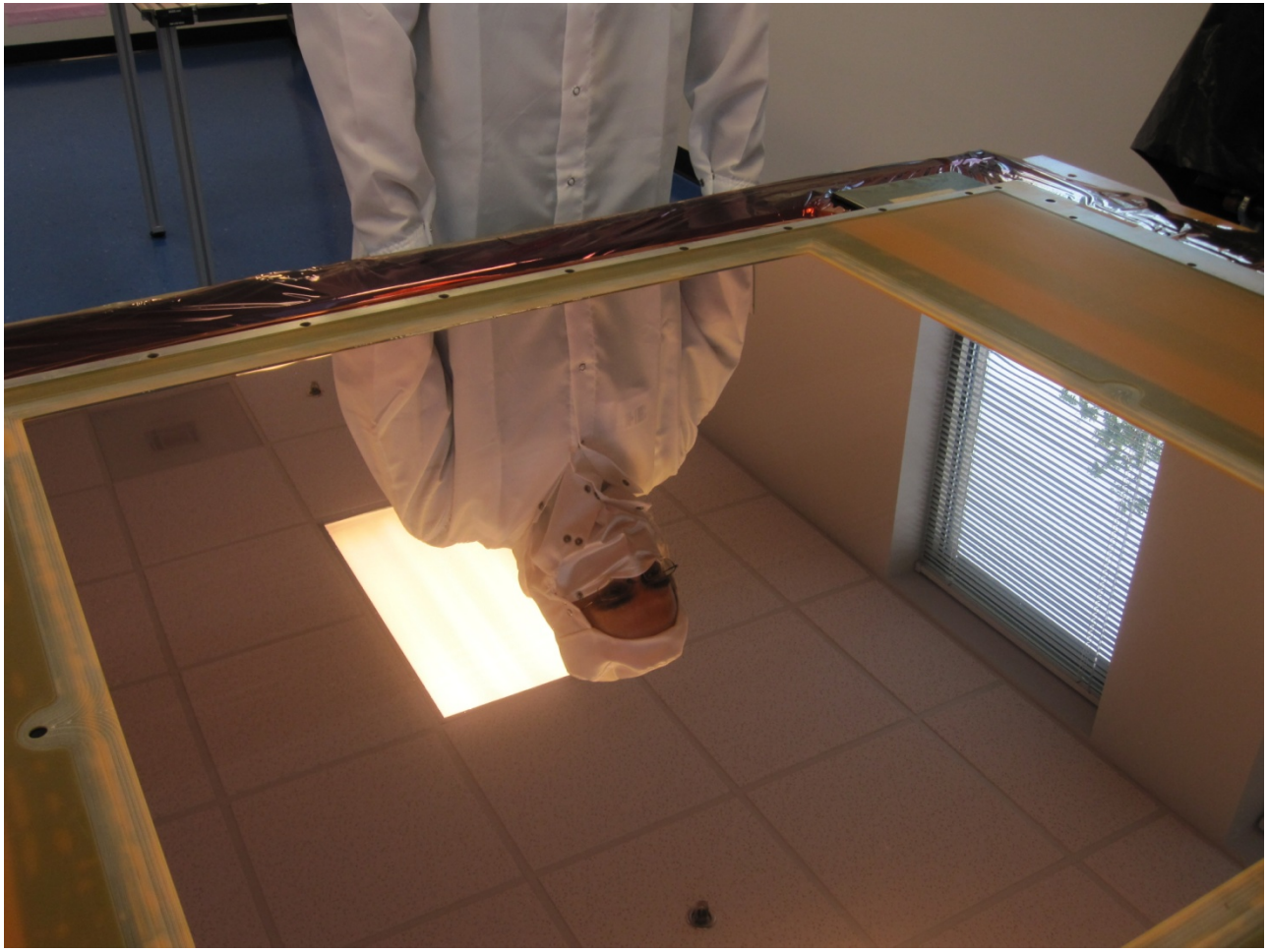
Glue the foil to the cathode plane

- Place cathode board epoxy side down onto foil; weight it down!



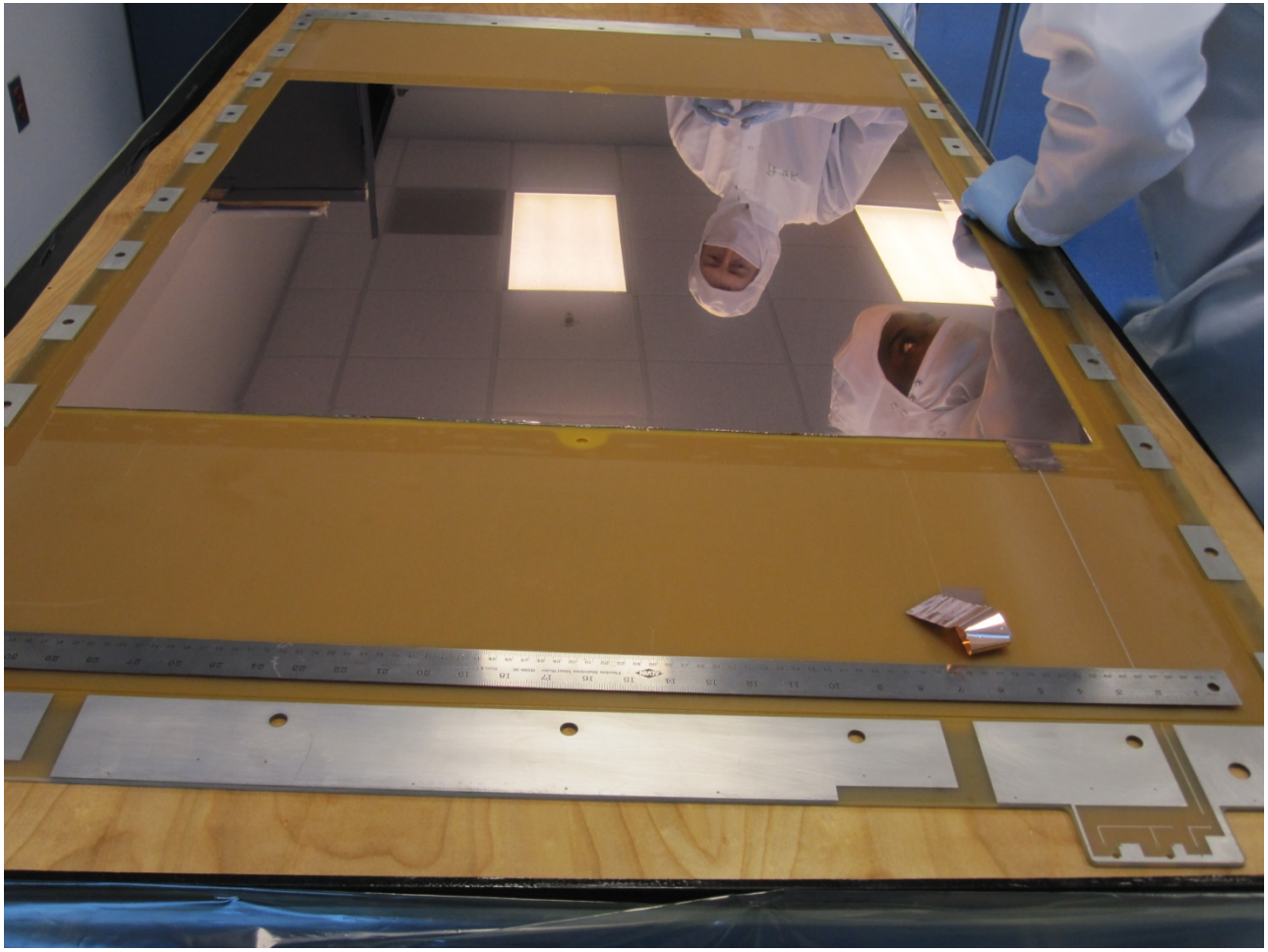
Let Epoxy Cure

- Cathode board should be a good mirror – NO creases!



Finishing the Cathode Plane

- Trim off excess foil, cutting up to the boundary of the epoxy.

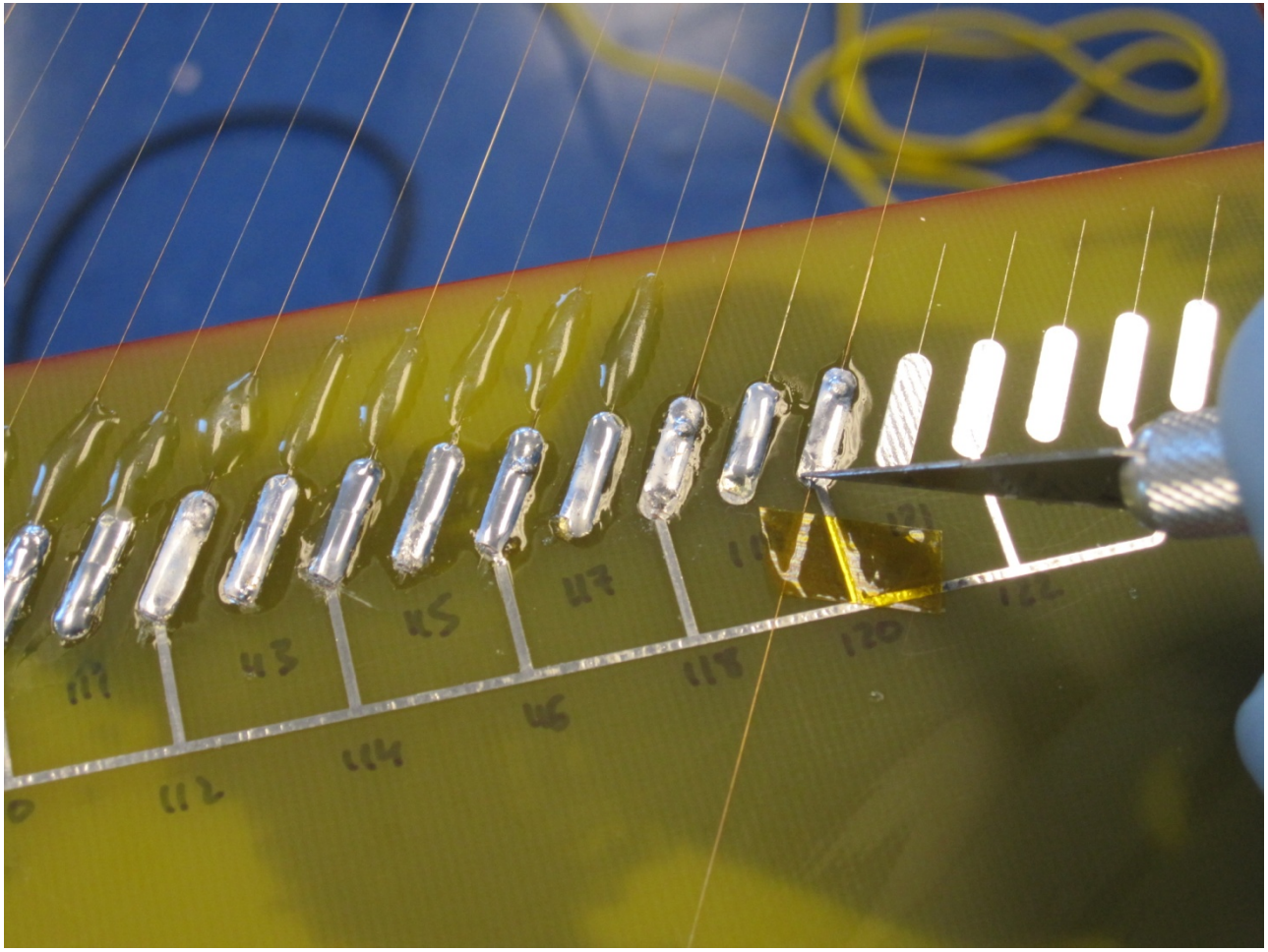


Summary

- Different styles of wire chamber can be built.
- Design driven by requirements of experimental program and equipment being used with wire chambers.
- Resources – money, time and equipment available – affects design and construction procedures.
- Prototyping helps highlight problems and potential construction difficulties.
- Lots of testing and problem-solving throughout the project.

Test Wire Stringing

- Wires are epoxied after being tensioned and soldered.



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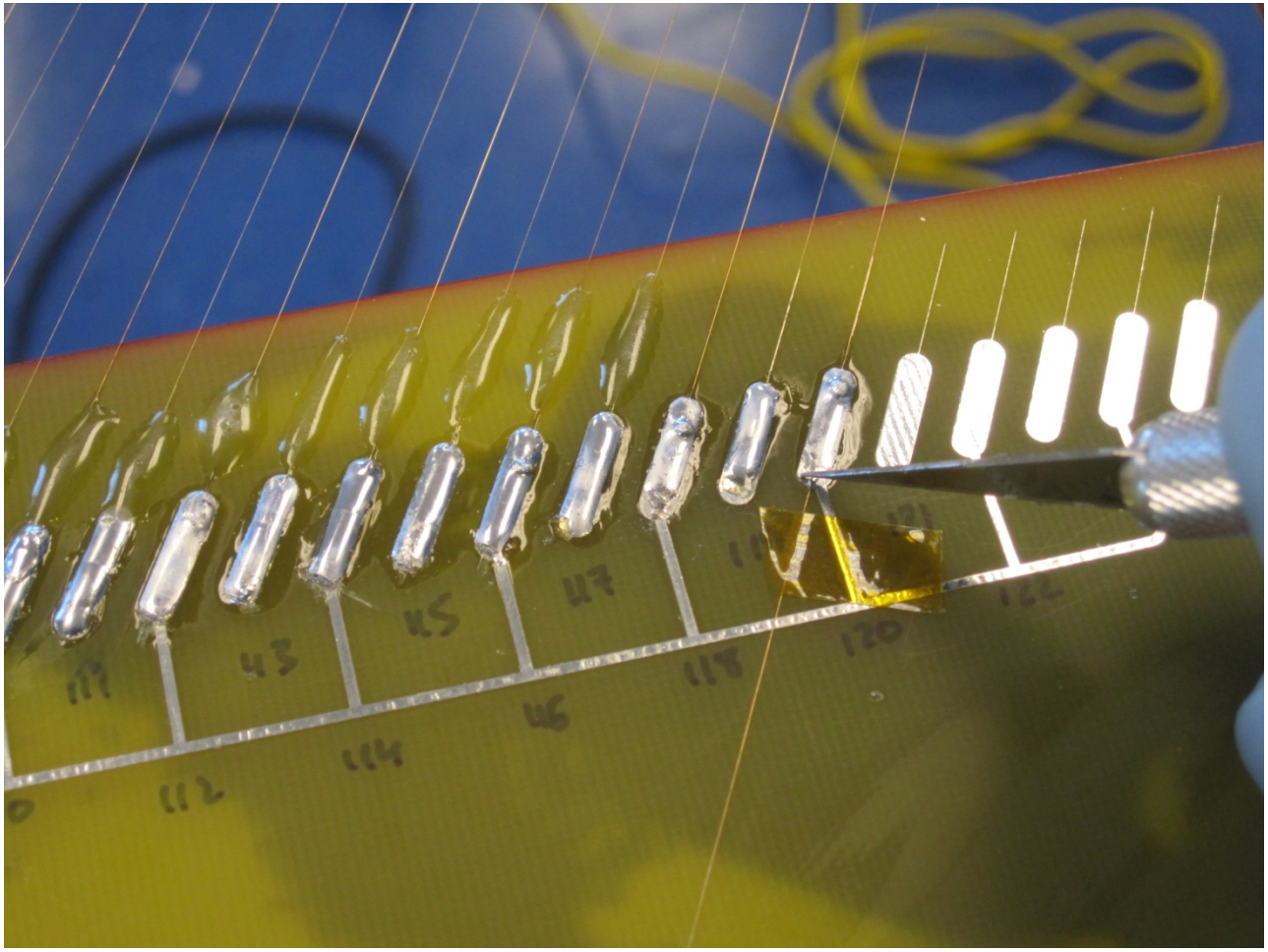

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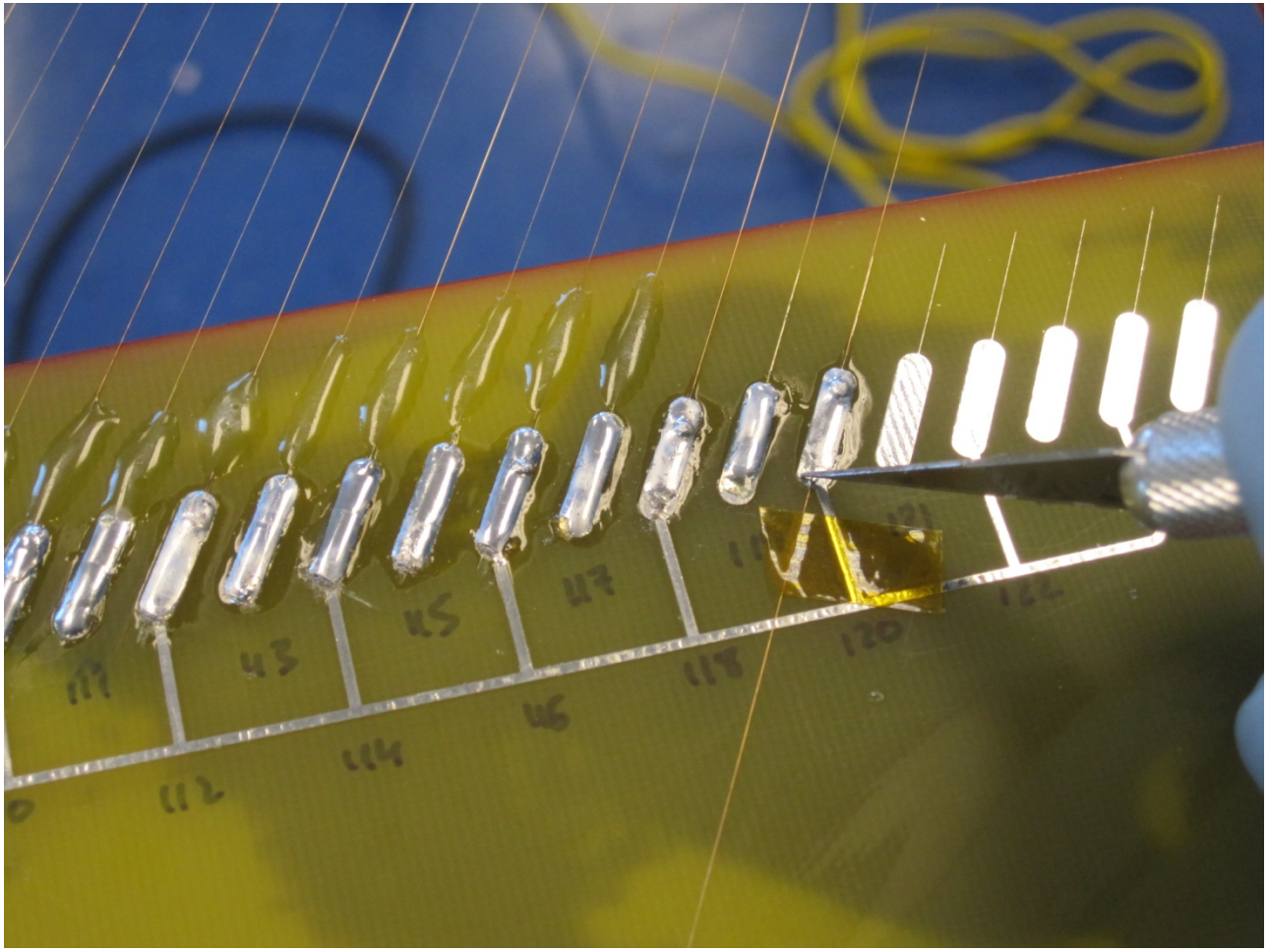

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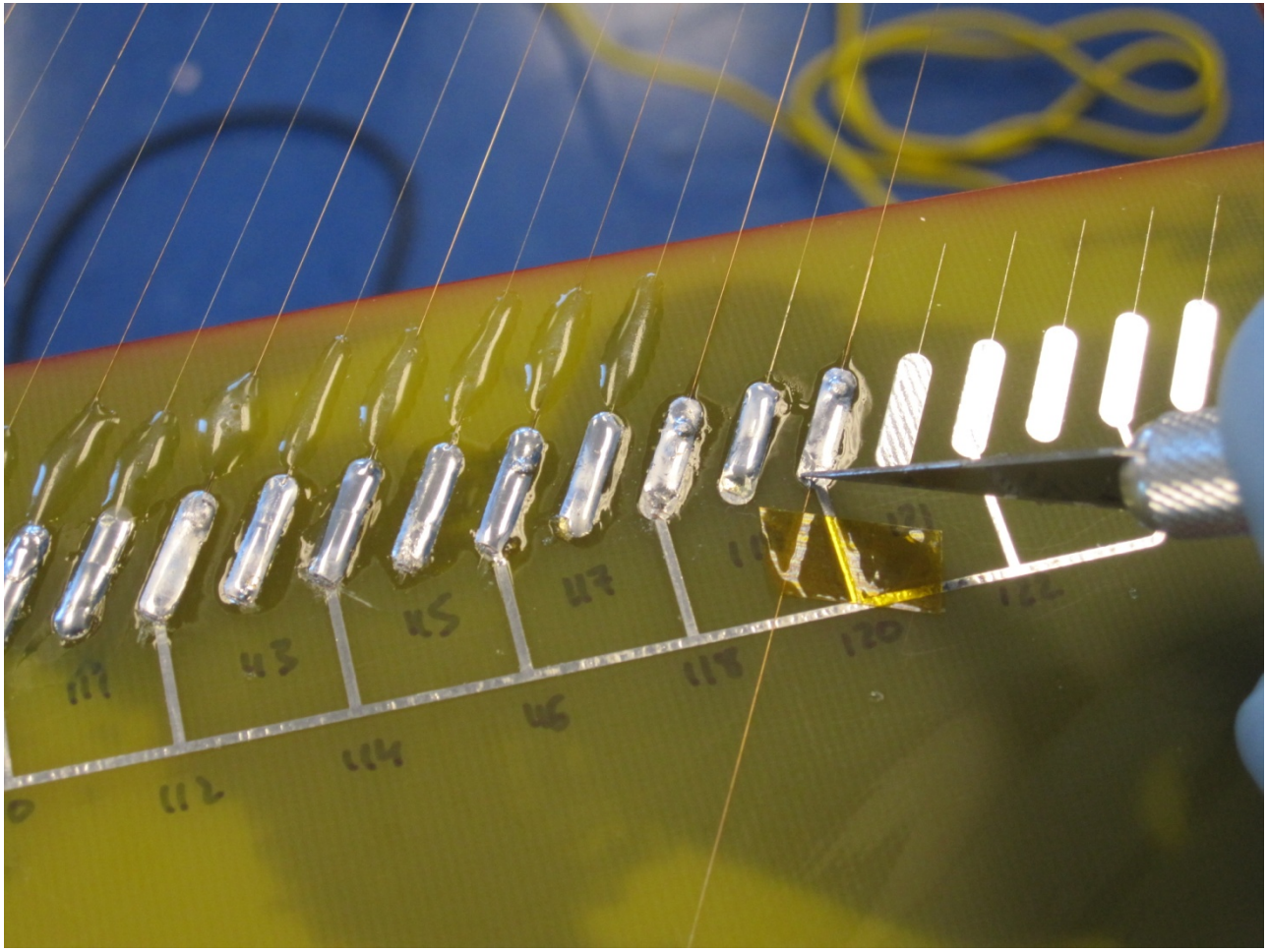

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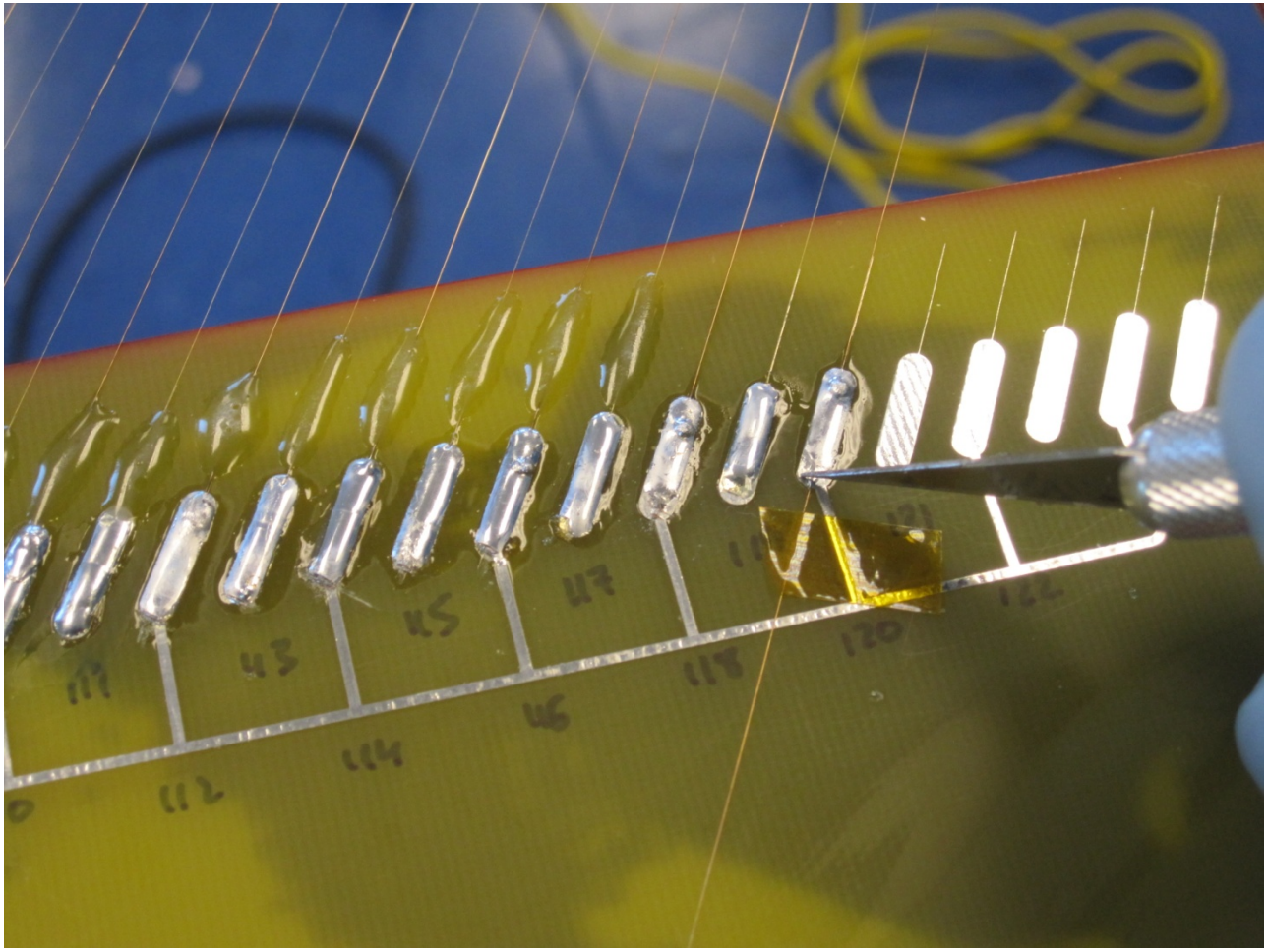
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