New Facilities and Instrumentation

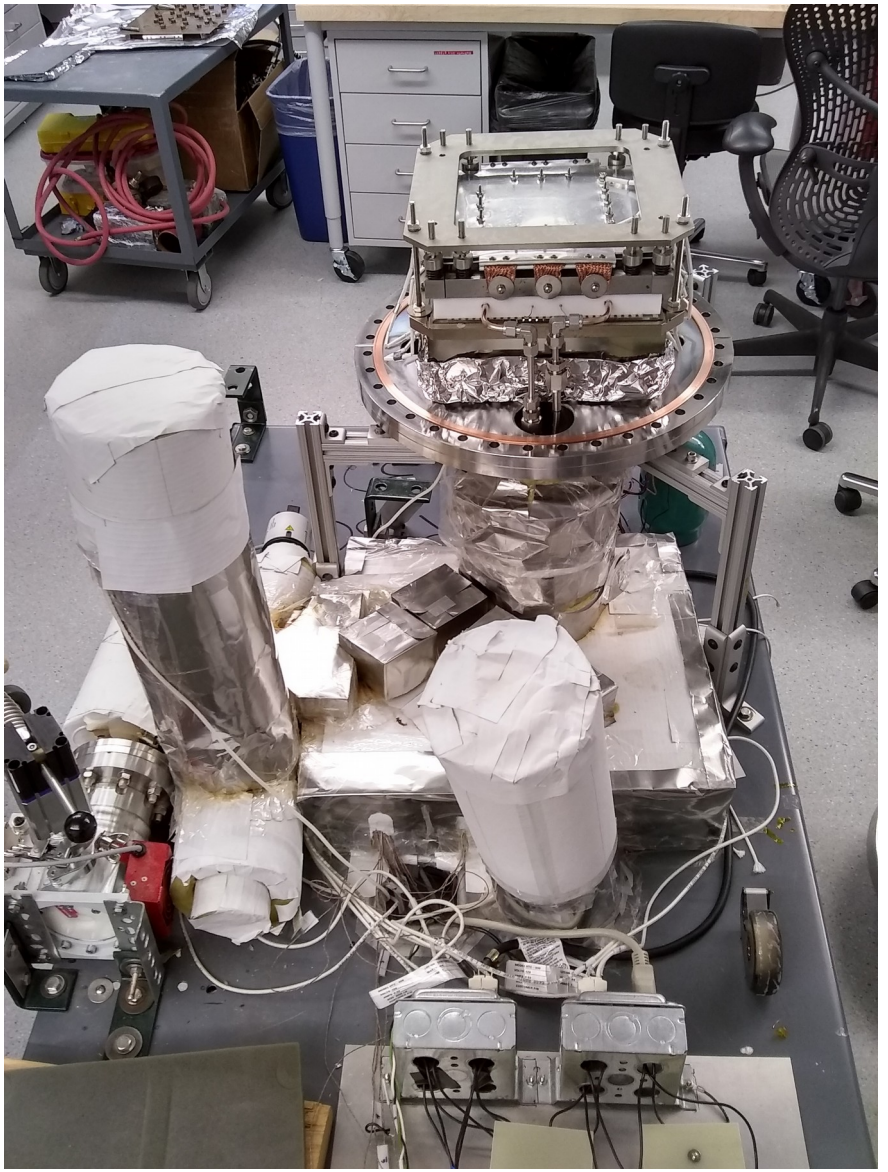
- Moved into new lab with sink and regular mopping
- Created Margherita II, an improved tile processing facility
- Upgraded Margherita I, in particular heaters and manifold
- Upgraded QE measurement system with 2-D translation stage and dark box

New Lab

- Not a cleanroom, but eliminates dust traps under desks and is regularly mopped
- Greatly streamlined workflow for parts cleaning due to sink and wet lab
- Can acid-etch indium wire without an appointment
- Overhead hoist—useful for Margherita II

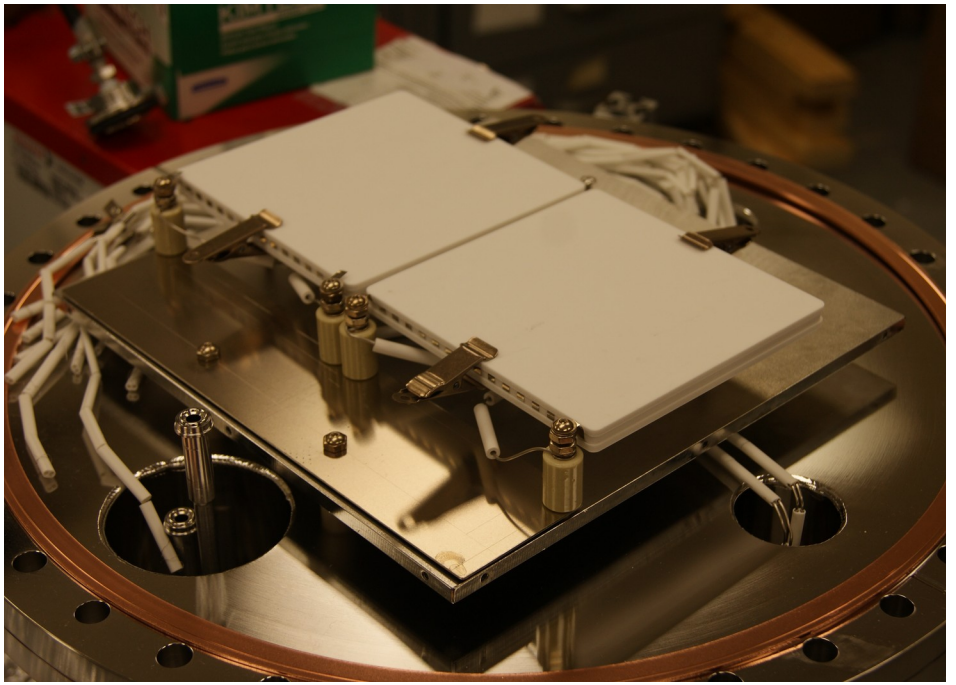
Margherita II

- Tile fixture temperature now uniform to within ~5 C due to heating from top and bottom
- Heaters no longer emit visible light
- Manifold pumps to below detection limit at gauge; nominally 2e-9 mbar
- Greatly improved physical access to tile after sealing



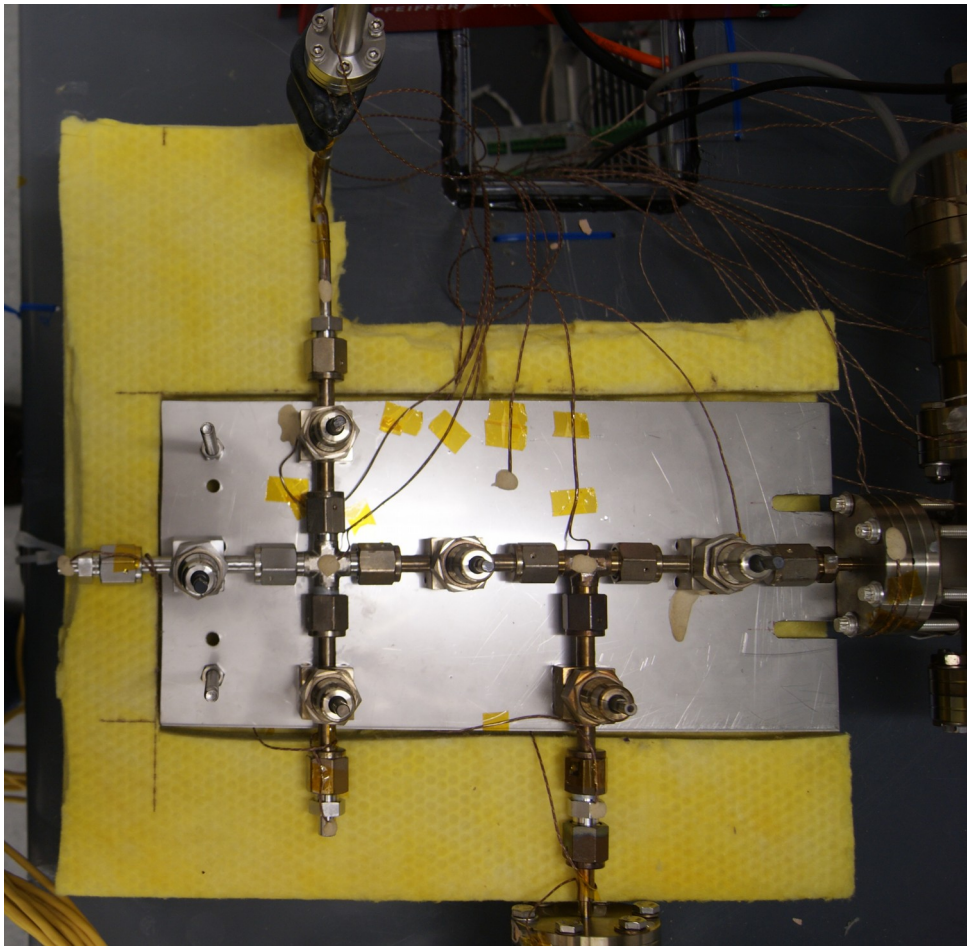
Infrared Heating Elements

- We attempted to buy a vacuum-compatible infrared heating element, but did not find anything suitable
- Consequently we designed and built several heaters with Nichrome 60 ribbon wound around an alumina plate



Margherita I Upgrades

- Same infrared heaters as in Margherita II
- Same manifold configuration as in Margherita II
- Thermal uniformity still not nearly as good; currently used primarily for MCPs and glass tiles



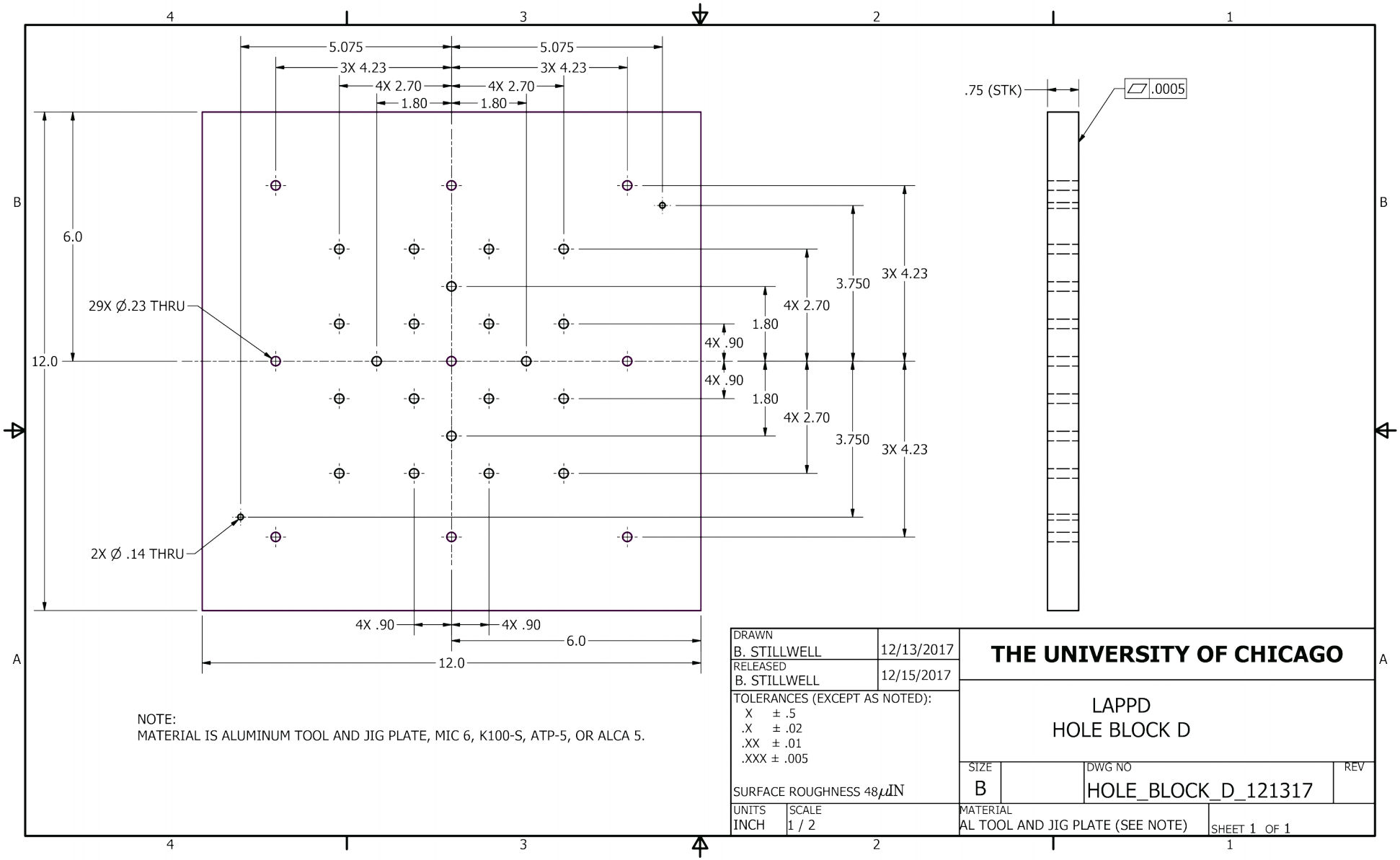
Process Steps

1)Measure LTA and allocate spacers
2)Check seal gap
3)Pre-bake of MCPs
4)Install electrodes and getter
5)Final assembly in process chamber
6)Make window seal
7)Helium leak testing
8)Make photocathode
9)Pinch-off

Measurement of LTA

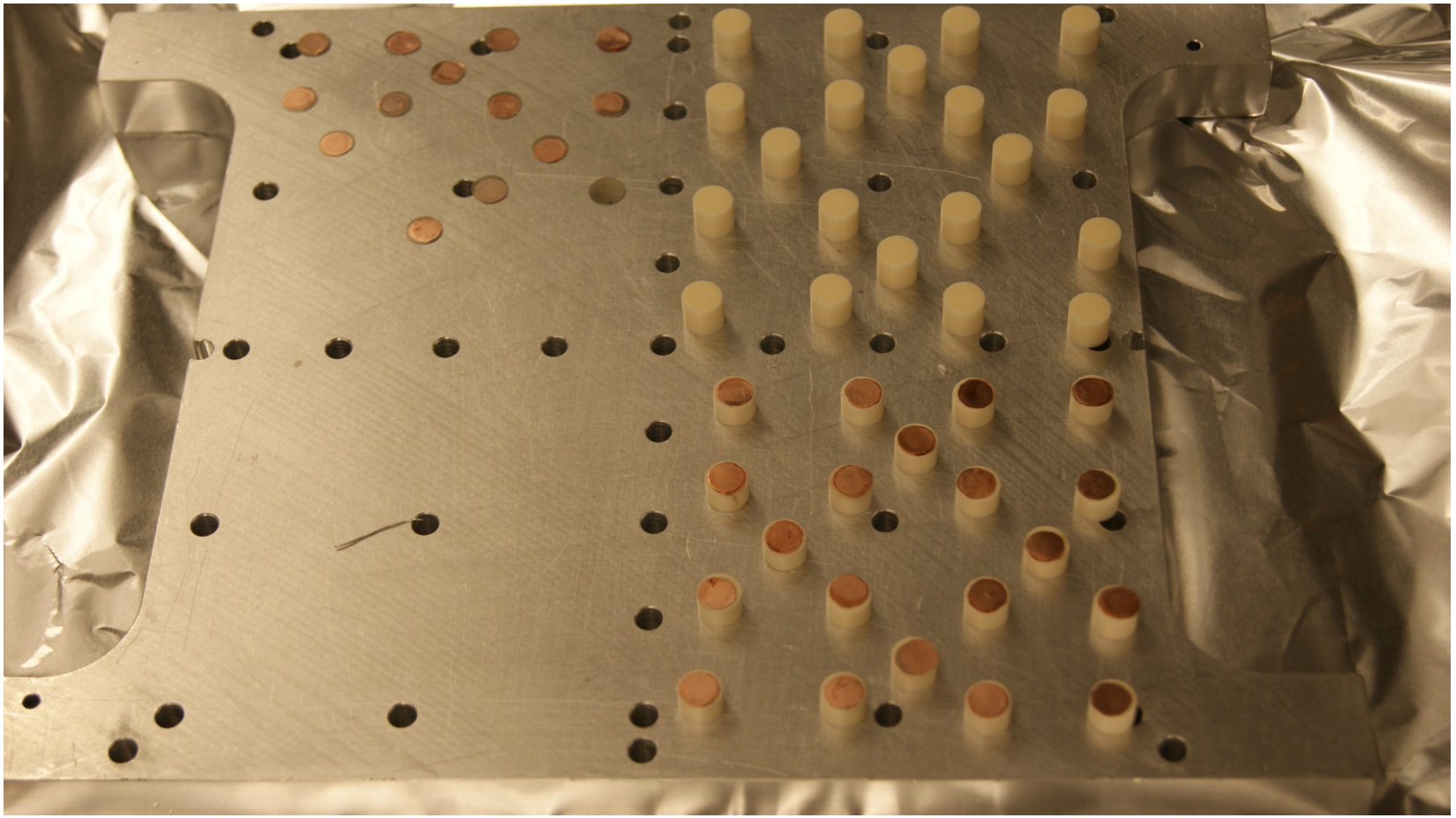
- Spacer columns must be .001” to .003” low relative to sidewall to ensure clearance
- Depth of LTA relative to sidewall must be measured in order to achieve this
- We have a new fixture for making this measurement with a depth micrometer, which is flatter and easier to use, eliminating some systematic error
- The new fixture has the measurement points at the same location as the spacer columns
- The new fixture has been checked for flatness against a surface plate

Measurement of LTA



Allocate spacers

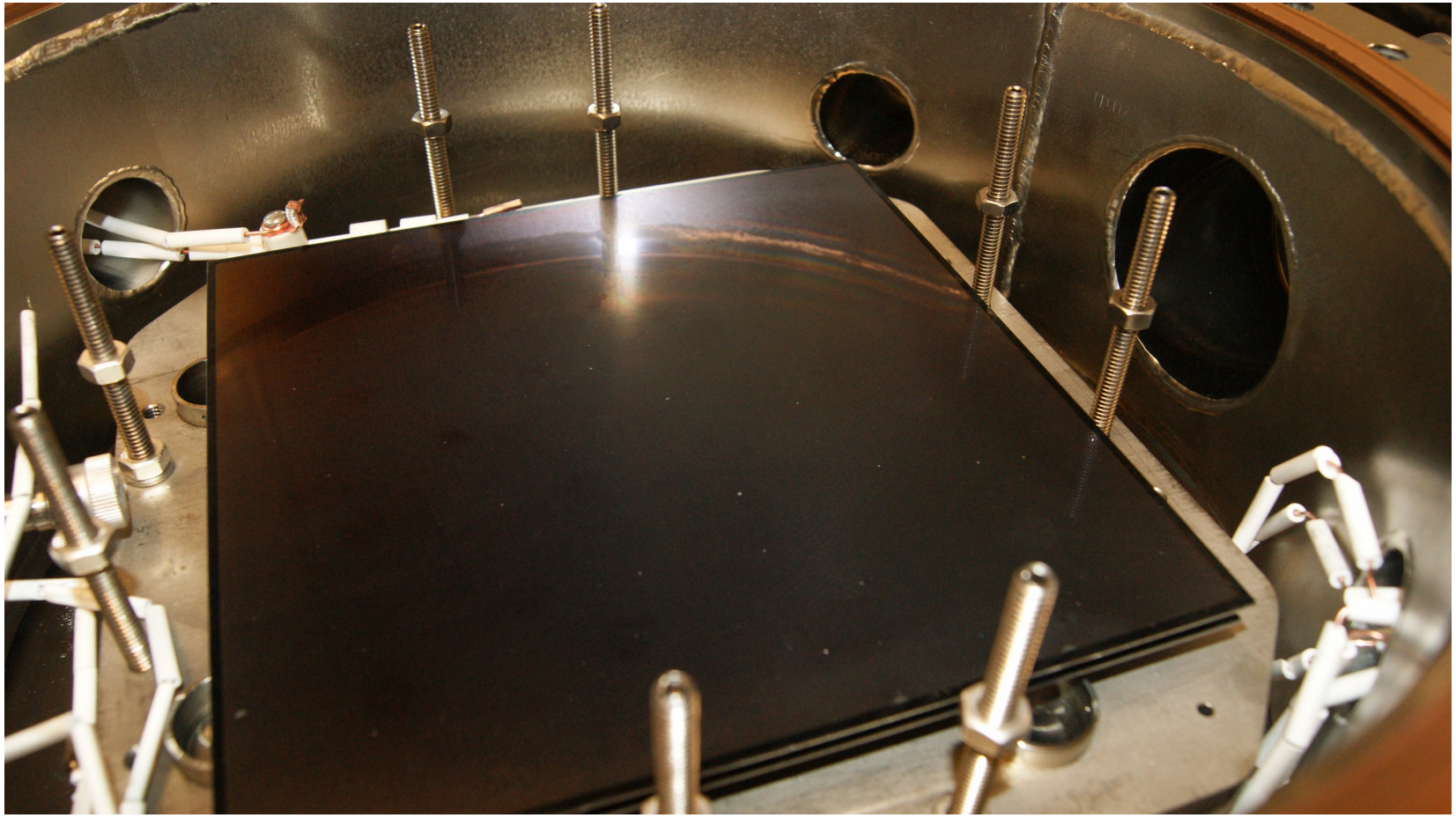
Tops of spacer columns should be .001” to .003” low relative to sidewall



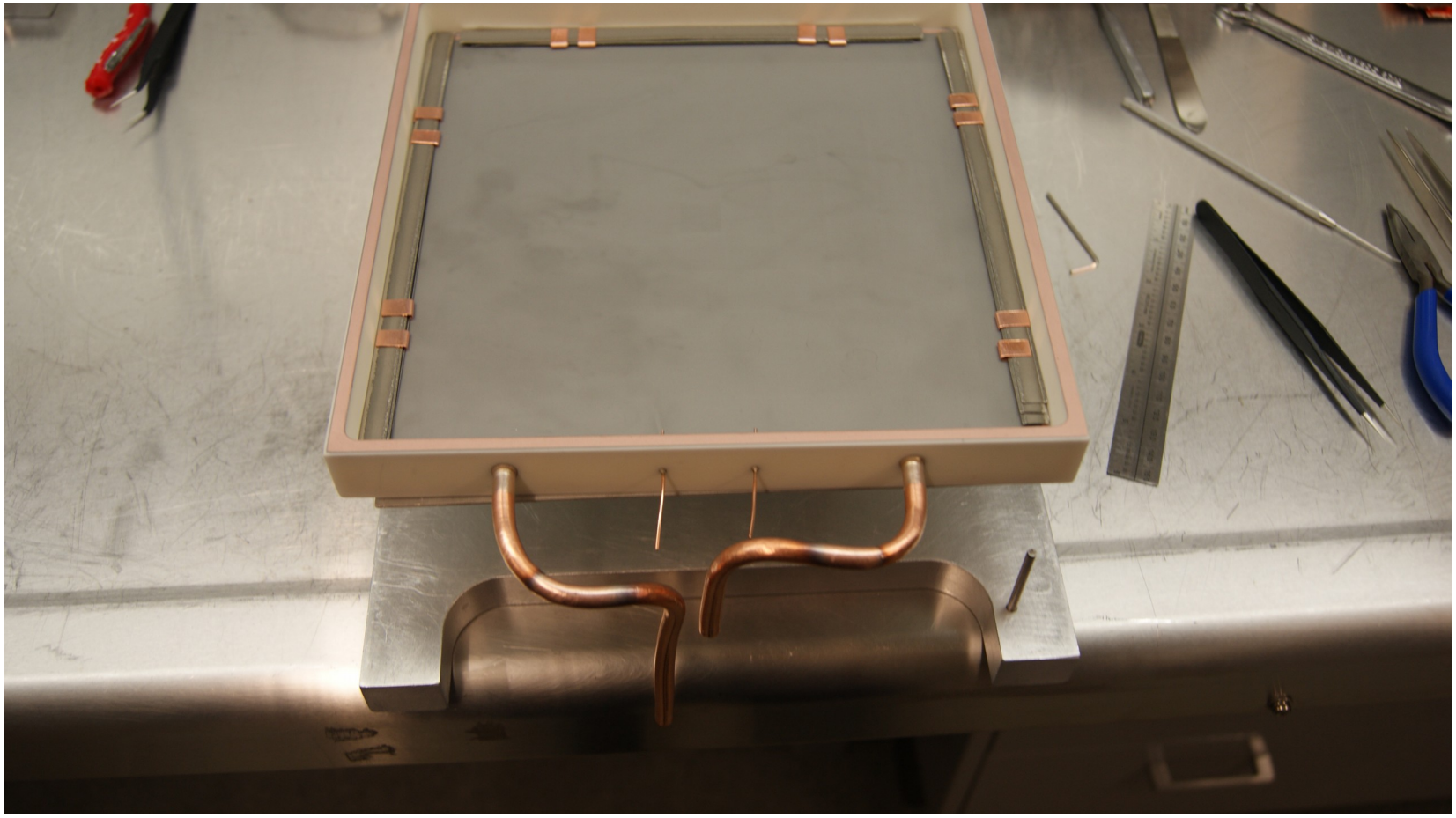
Check Seal Gap

- All internal components are inside
- It is critical that the window not be supported on internal hardware
- Some .0015” gaps are allowable, but not .002”

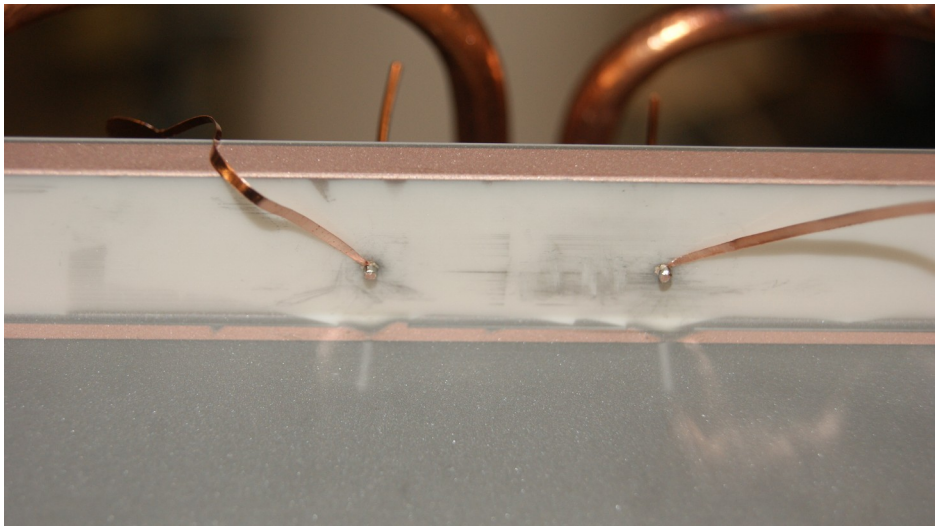
MCP pre-bake

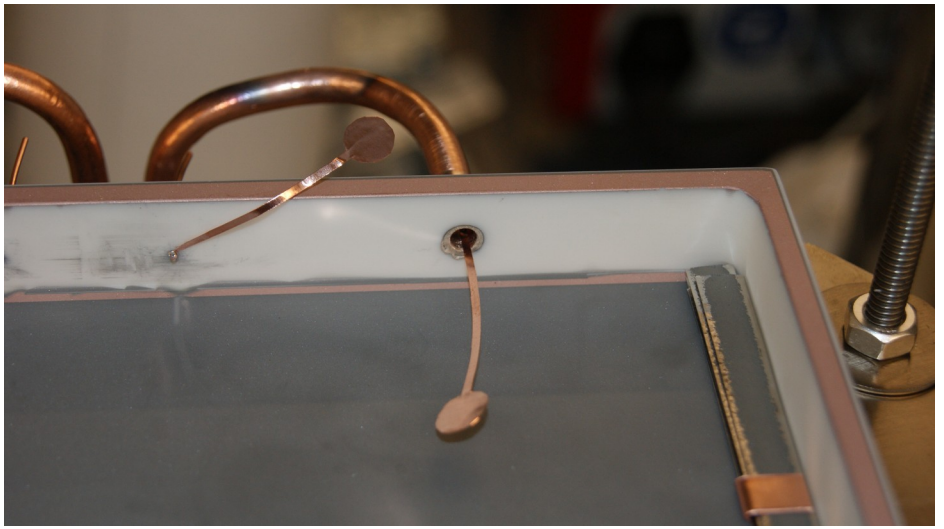


Install getter



Install electrodes



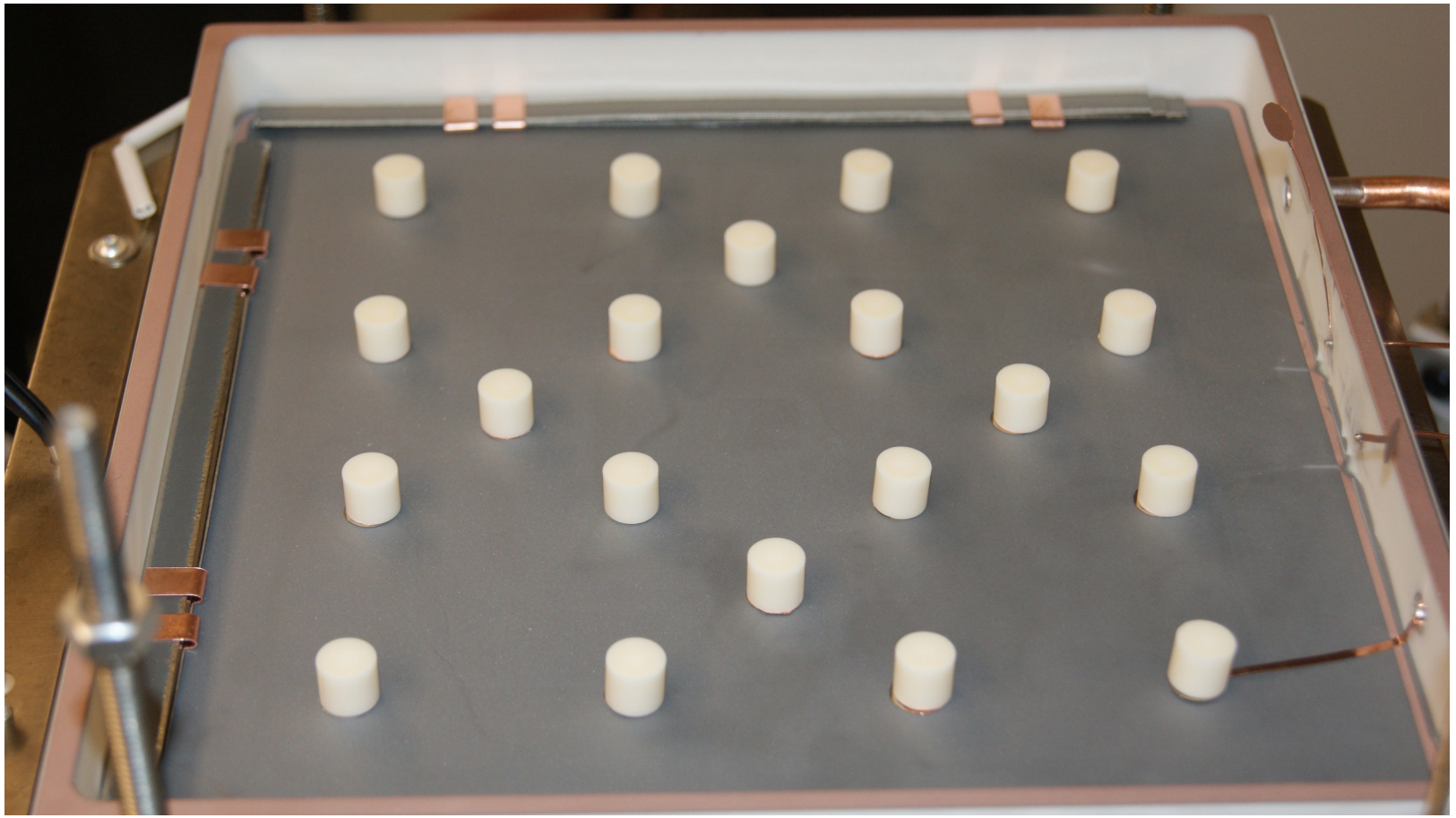


Final Assembly

- Connect LTA to manifold and test for leaks

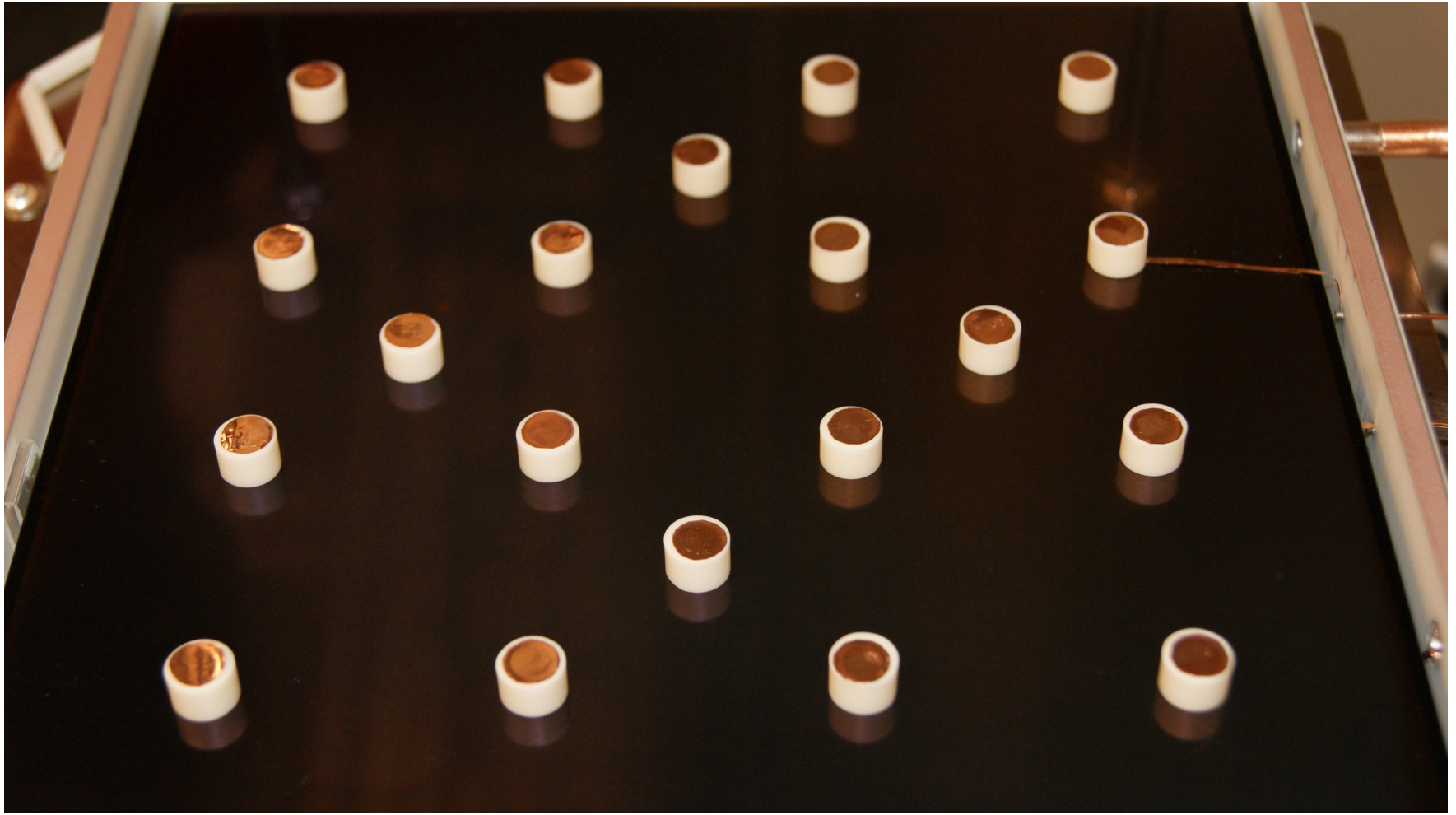
Final Assembly

- Install spacers, electrodes and MCPs



Final Assembly

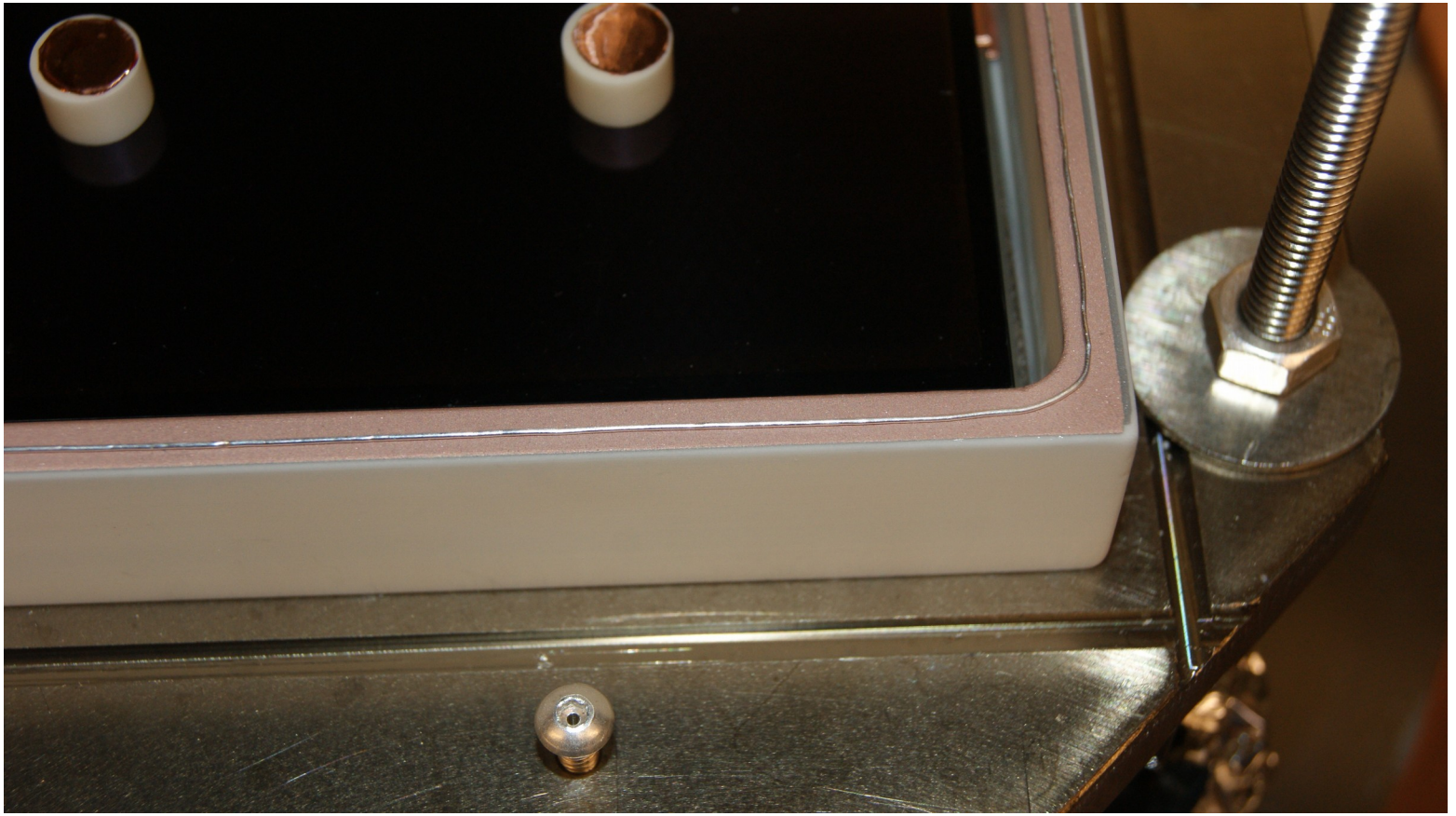
- Install spacers, electrodes and MCPs



Final Assembly

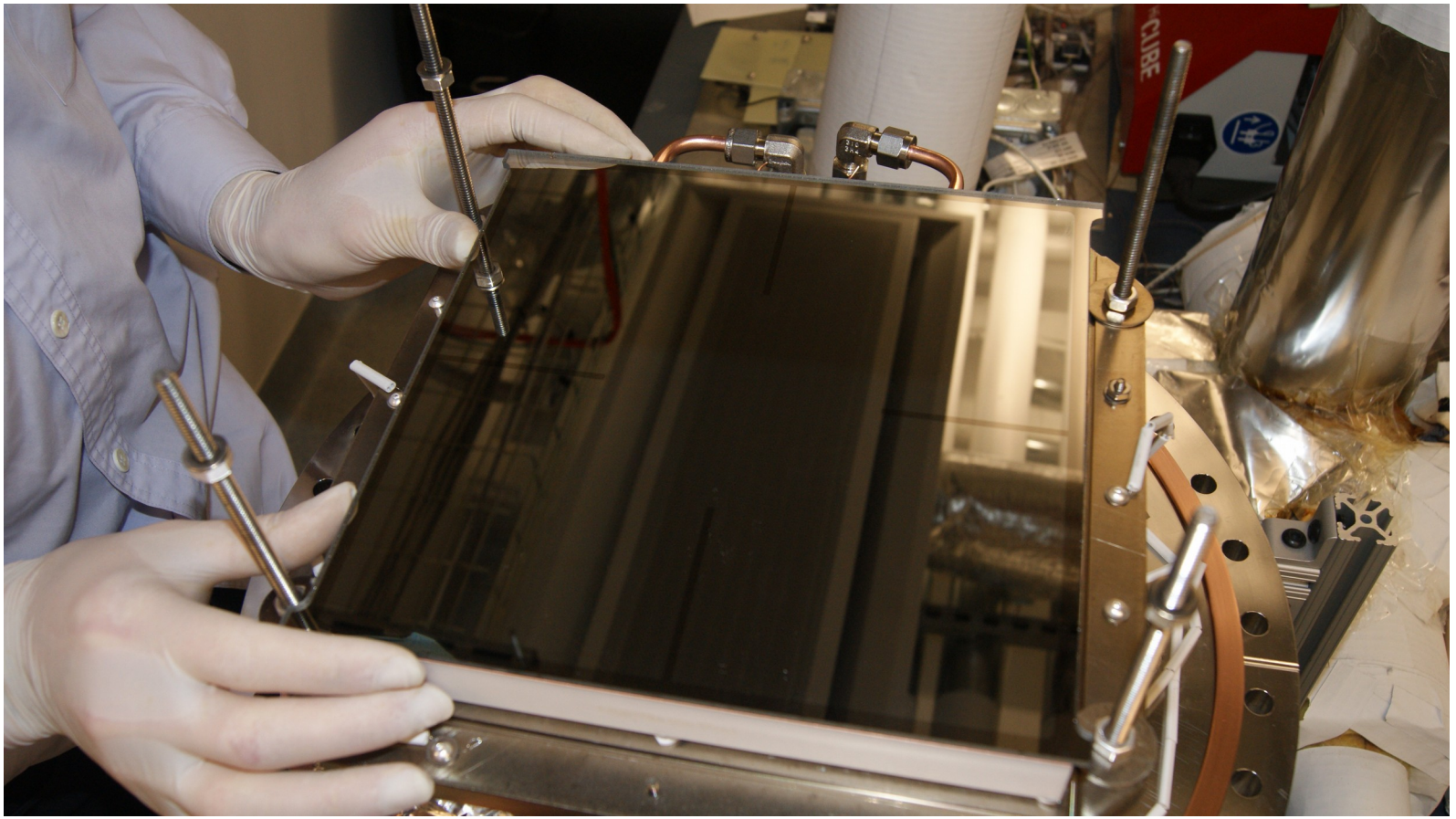
Ensure that no visible dust is present in seal area

Lay preform of etched 4N purity extruded indium wire



Final Assembly

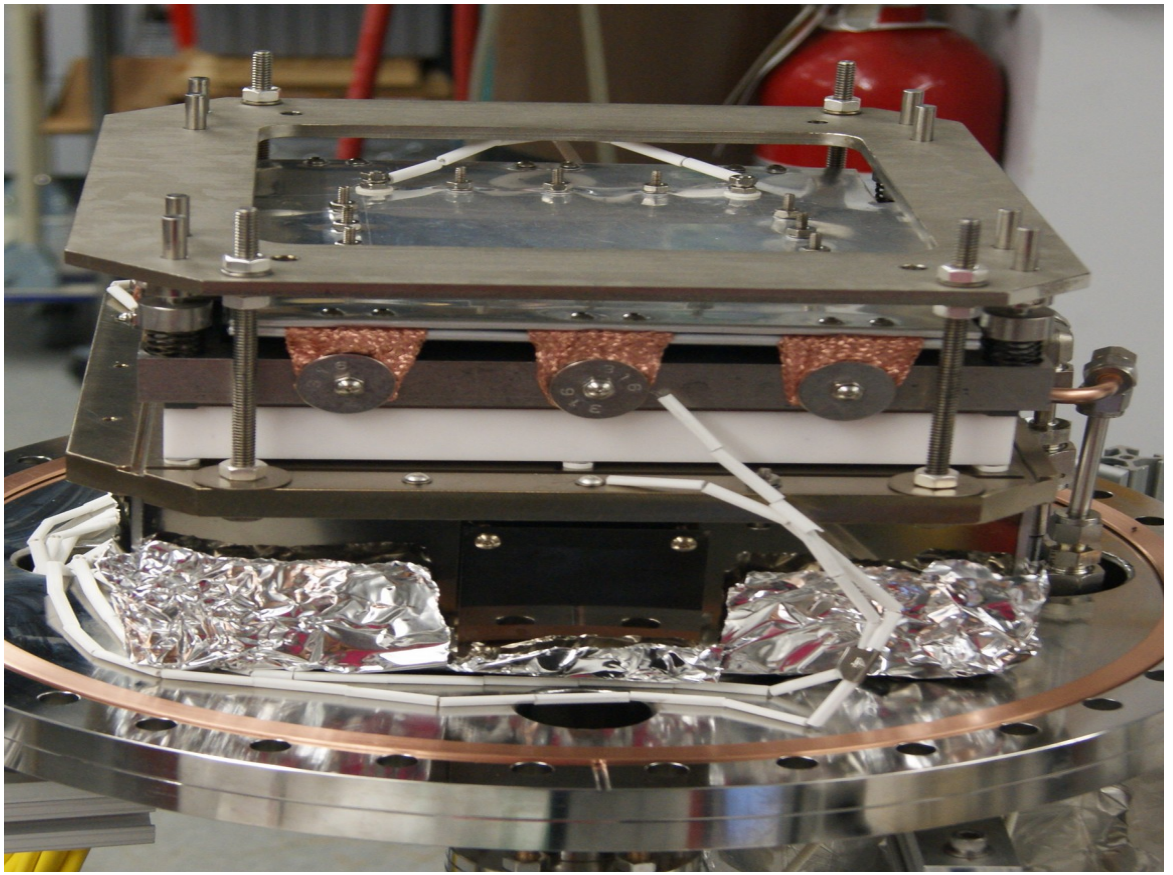
Lay window and check alignment with LTA



Final Assembly

Mount sealing hardware:

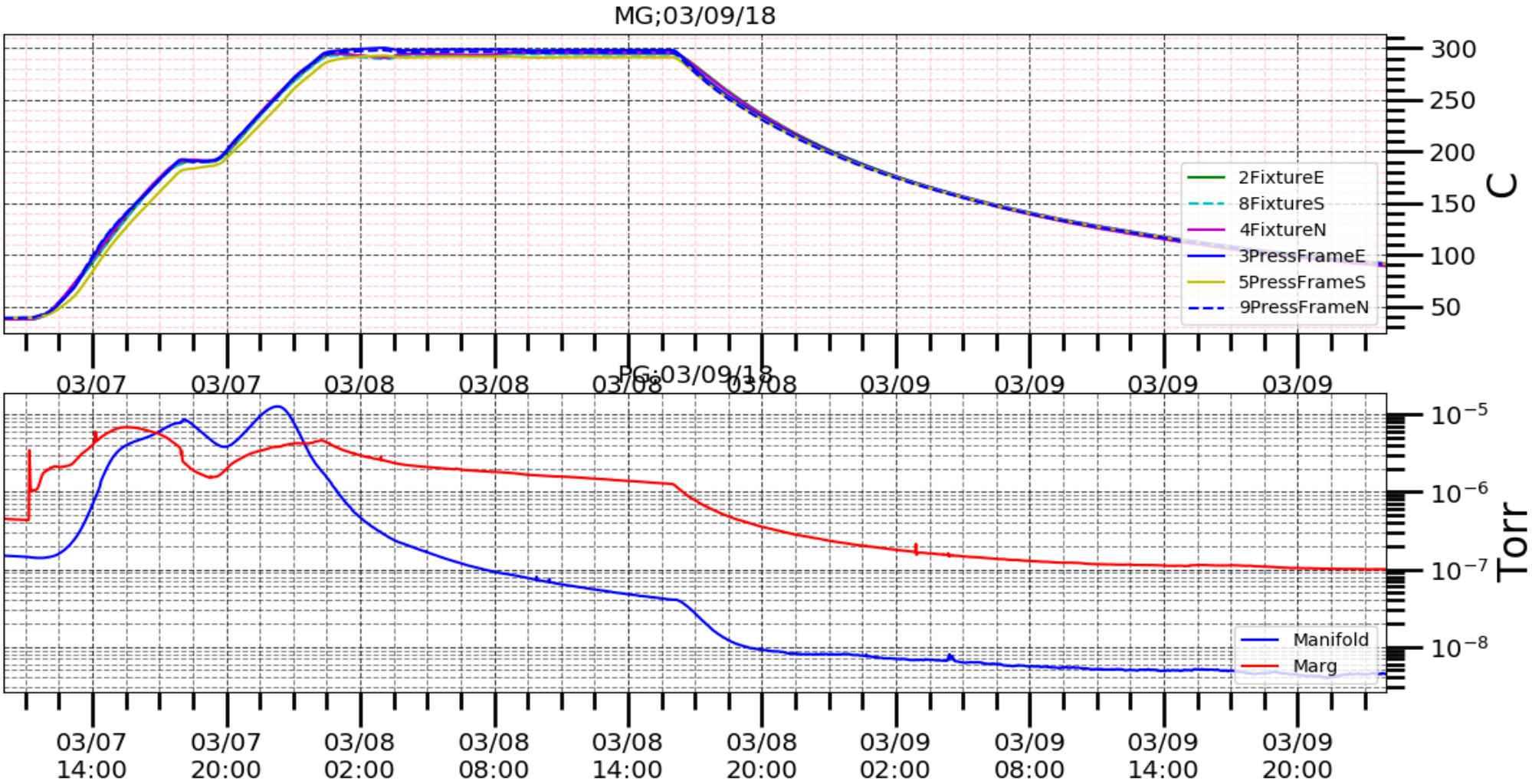
- Upper heater
- Press frame
- Insulation (not shown)



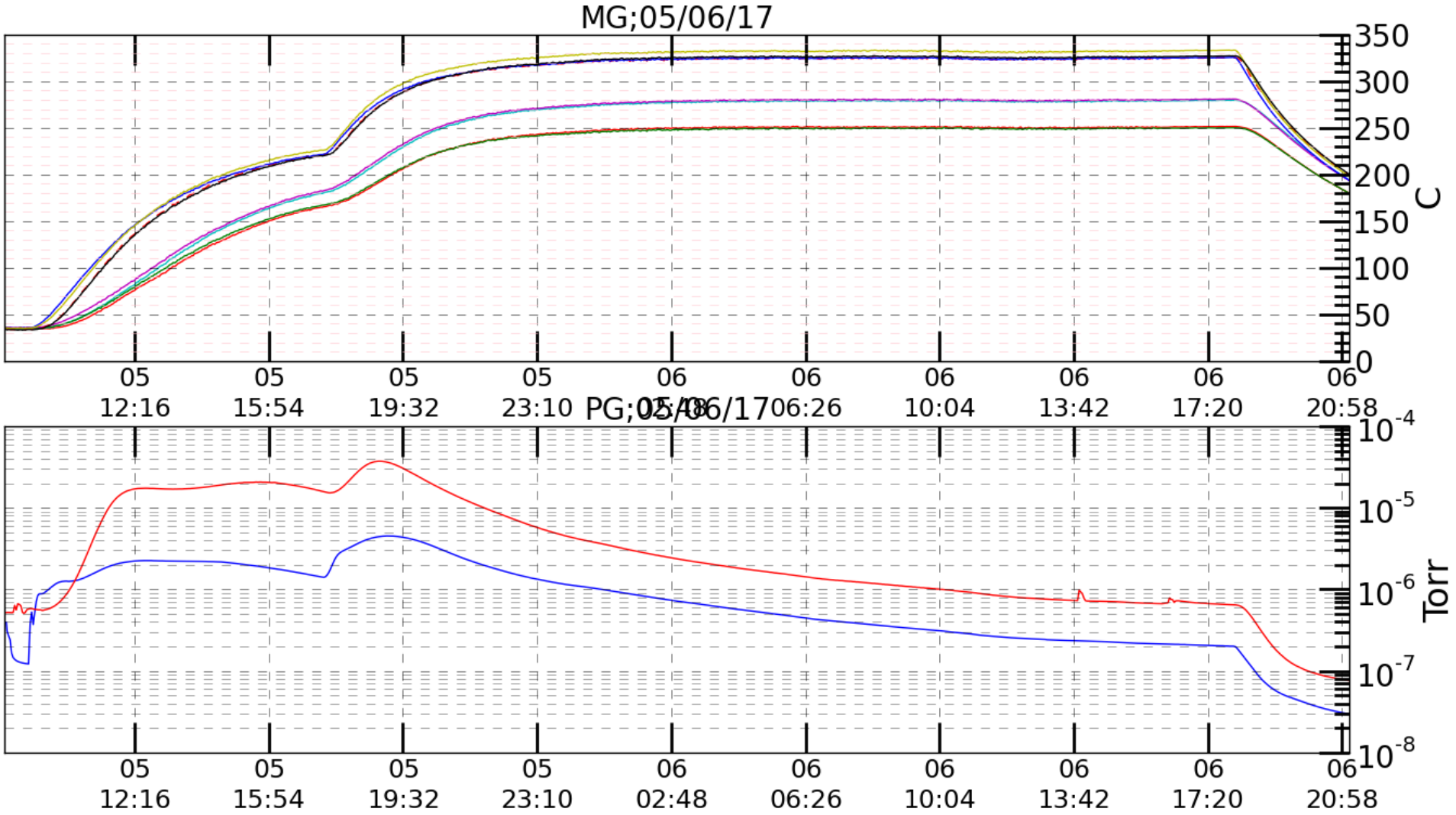
Window Seal Process

1) Close sealing chamber and pump to <5e-7 mbar
2) Ramp temperature to 190 C in 6.5 hours
3) Hold 1.5 hours
4) Ramp temperature to 295 C in 5 hours
5) Hold 16 hours
6) Cool to 50 C before opening sealing chamber

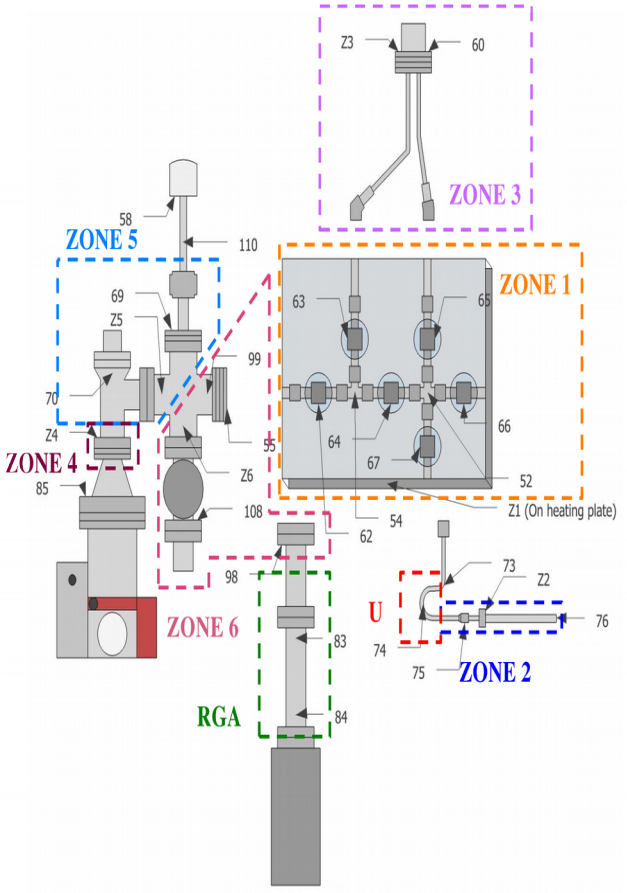
Window Seal Process



Previously...


MG;05/06/17
350
300
250
200
150
100
50
0
C
05 12:16
05 15:54
05 19:32
05 23:10
06 02:48
06 06:26
06 10:04
06 13:42
06 17:20
06 20:58
PG;05/06/17
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
Torr
05 12:16
05 15:54
05 19:32
05 23:10
06 02:48
06 06:26
06 10:04
06 13:42
06 17:20
06 20:58

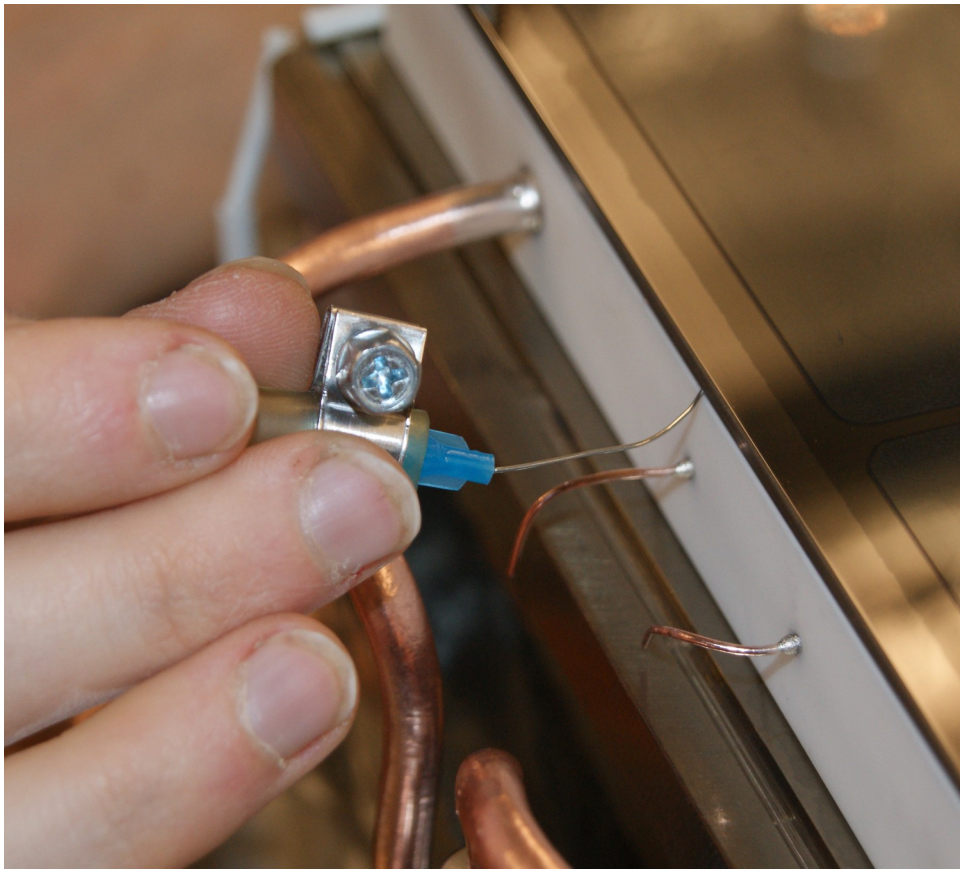
Window Seal Process



- Manifold is baked out at 280 C beforehand and vented to dry nitrogen gas while still hot
- This enables pressure at gauge to reach below 2e-9 mbar by the time sealing is complete

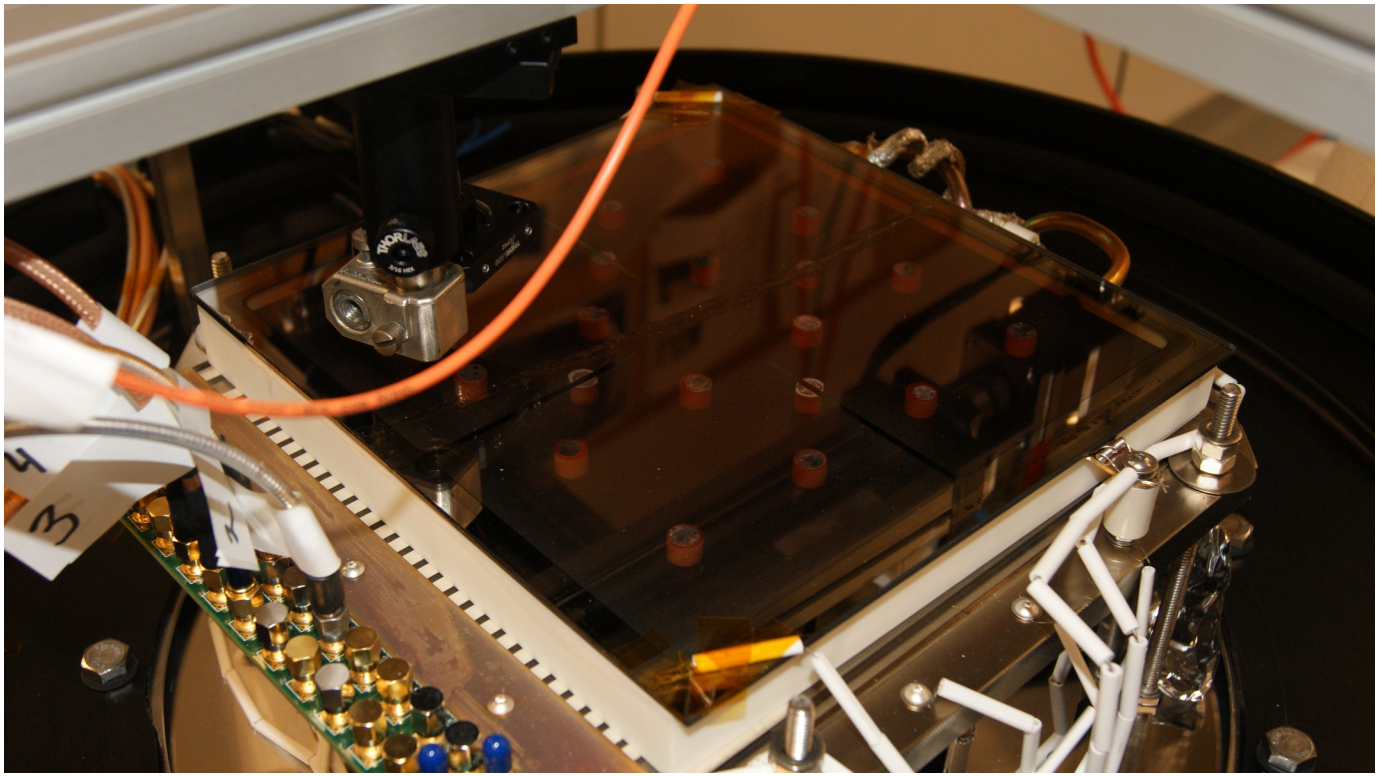
Leak detection

- Leaks from accessible areas can be probed by externally applied helium in the usual way
- The small tube manifold has several valves and many VCR connections which are hard to access due to thermal insulation
- A global leak rate can be obtained by closing a valve to isolate the whole manifold and measuring the build-up of nitrogen when the valve is re-opened



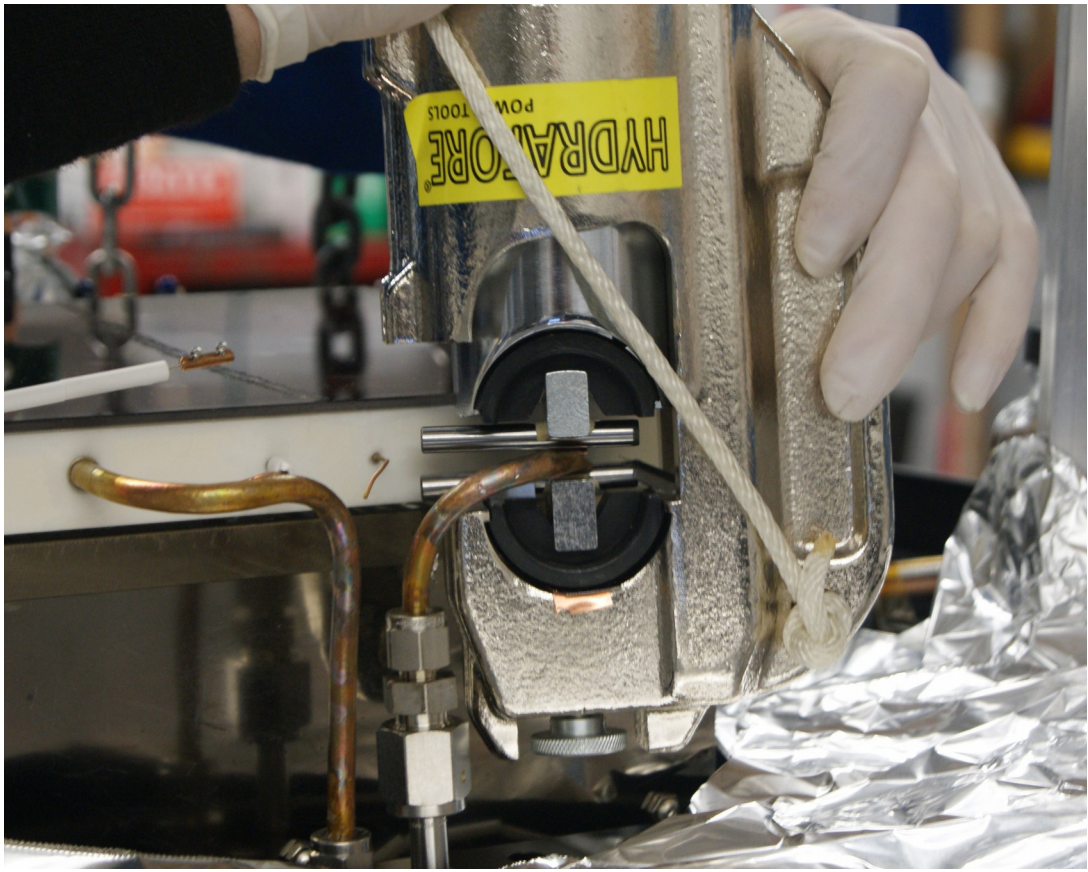
Photocathode Formation

- We will discuss this in detail later
- Once the leak rate threshold is met, we admit Cs from a source at 145-195 C
- In tile 21, after 3 days almost all of the Sb film had become photosensitive



Pinch-off

- We pinched the tubes of Tile 21 between a pair of 1/4” stainless steel dowel pins using a hydraulic crimp tool
- We tried this pinch process on tubing cut off from Tile 21 during assembly, and it seems robust
- In future we will likely use the commercial tool, since it is more convenient



Schedule of Mildly Streamlined Process

Item	Time
Measure LTA and allocate spacers	1 hour
Check seal gap	1 hour
Pre-bake MCPs	1.5 days (could go in parallel)
Install electrodes and getter	1 hour
Final assembly in process chamber	1 hour
Make window seal	5 days
1 week and change	1 hour
Make photocathode	4 days
Pinch-off	0.25 hours
Total	~10 days

- The Mildly Streamlined Process is our procedure, except that all handicraft is to be assisted by simple and inexpensive but purpose-built tools
- The window seal procedure could almost certainly be done faster; cooling makes up 3 of the 5 days