Squid Screening SOP:
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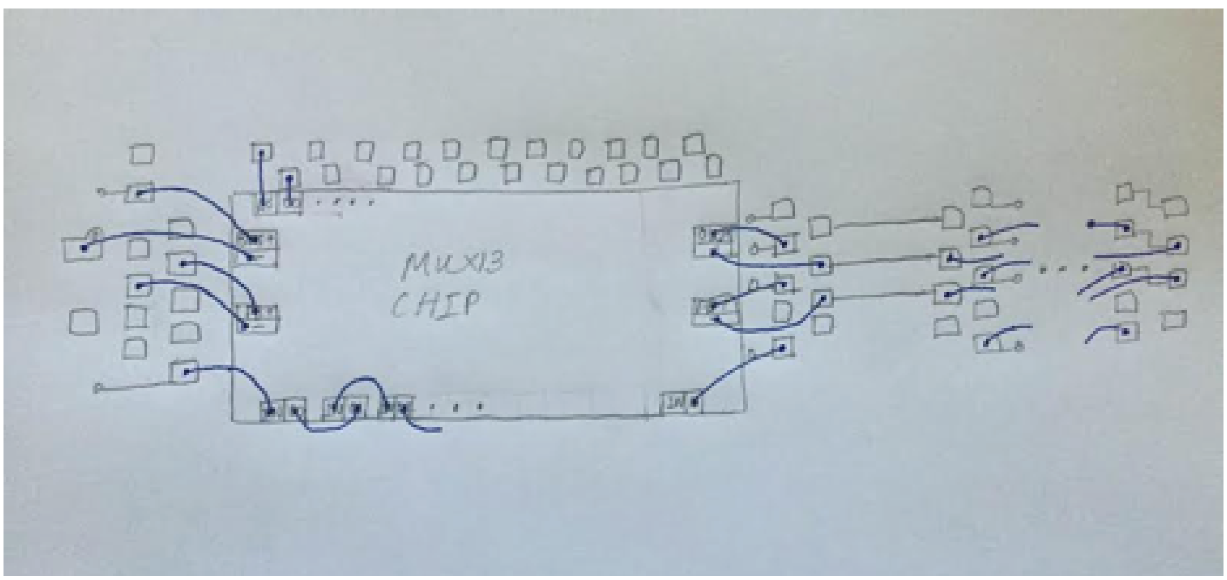
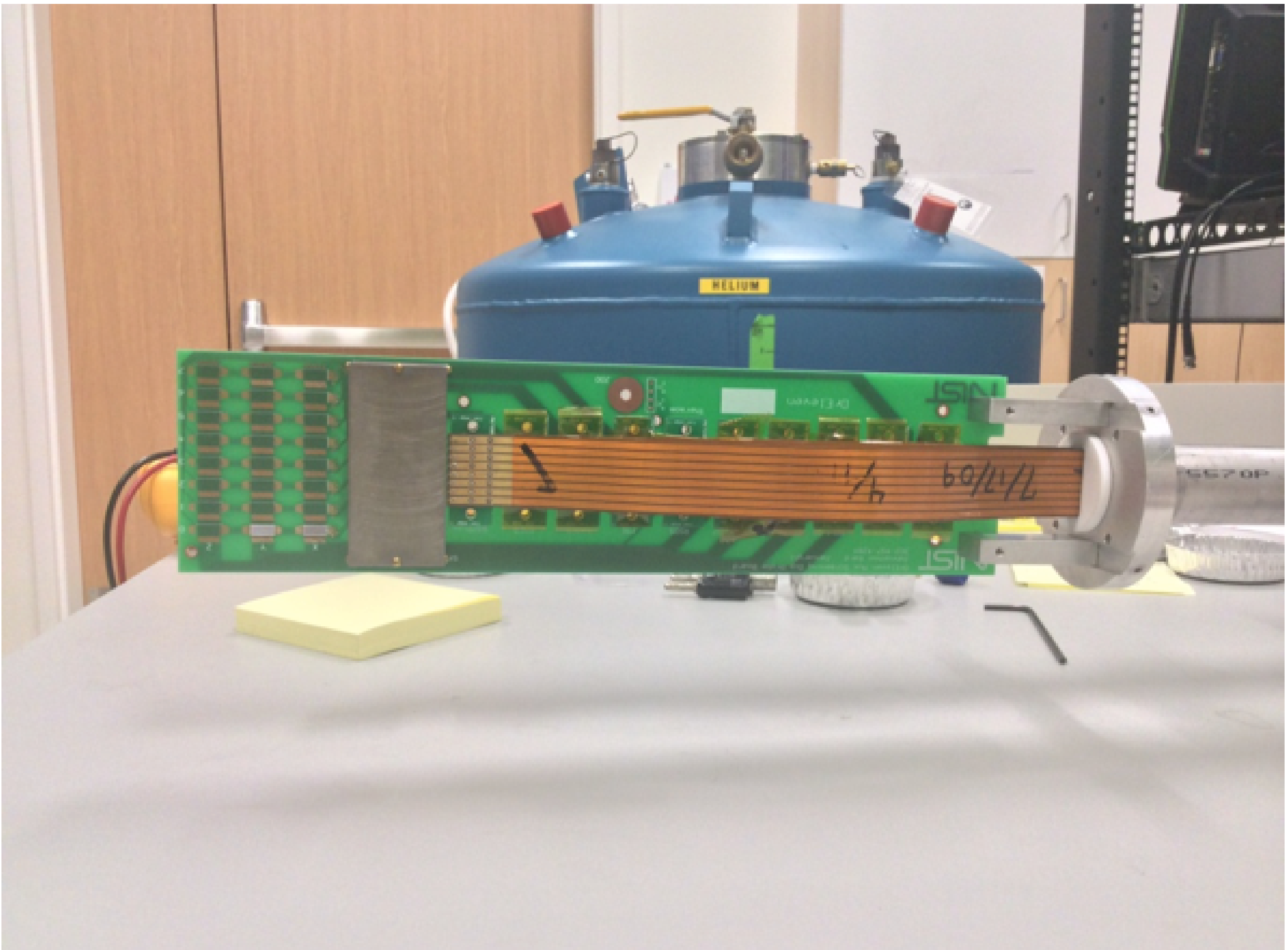
SOP

This is a procedure for screening SQUID based TDM chips, specifically measuring $I_{c,min}$ and $I_{c,max}$ for each squid.

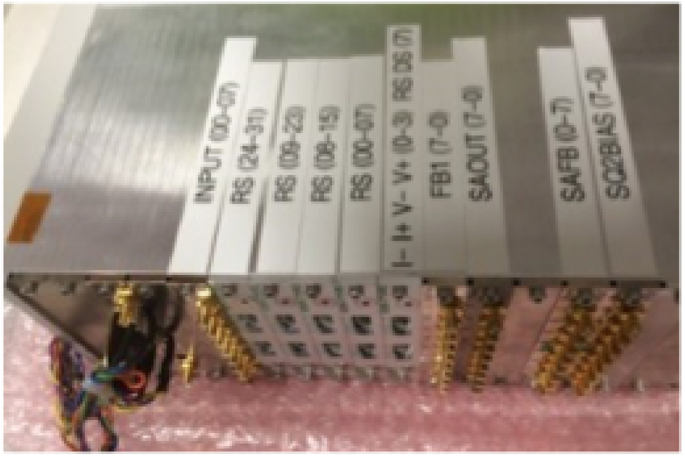
Wirebond the TDM chips to the PCB according to following diagram:



Next, carefully mounting the SQUID Series Array (the aluminum box) on the PCB board, and then fixing the PCB board to the dip probe with screws. Connecting all the flex cables to the PCB board.

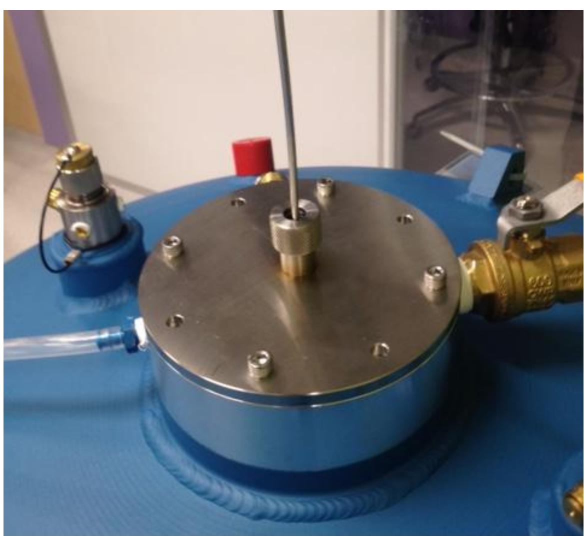


Pre-Dip measurements:
Using multimeter to check the resistance of all the FB1, SAFB and SAOUT connecters on the tower. Make sure that the multimeter is set to Mega Ohm range. Check all the row selector resistance using the rack mounted Keysight 34970A. (If you measure 197 KOhm, that means that row is open)



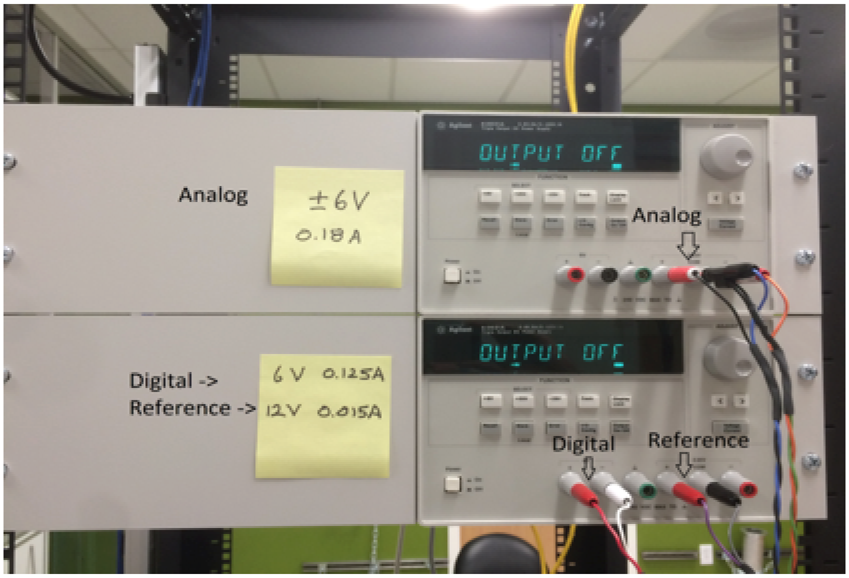
Important Preliminaries. The following steps should be taken before performing a dip:

1. Make sure the probe is in the following state: The tower is on the table, unplugged. The shield is removed. The mux card is attached to the tower and the squid chips are attached and wirebonded. The squid array is mounted onto the series array pins.
2. Check that the blue dewar has at least ~10’’ of helium. This is the minimum amount required for a dip. To measure the helium level, remove the cork in the transfer port and thump the dewar. **RECORD** value in lab book.



3. The computer should be running Carl’s software package, used for interfacing with the tower.Alternatively DRAGON (the NIST version) can be used.
4. All electronics should be powered on, with all outputs off. MOST IMPORTANTLY, make certain that the power supplies (2 Agilent E3631A’s) are set to the proper output voltage and current limits. These settings should be stored in RECALL 1: (PHOTO)

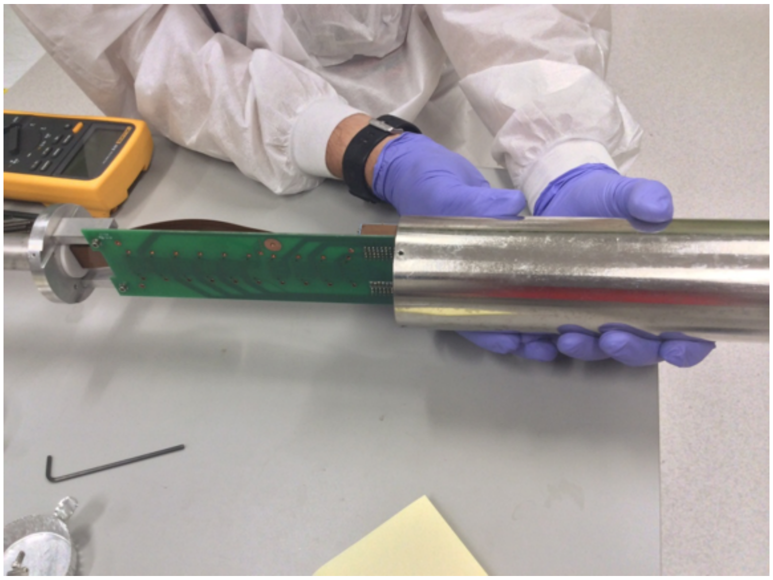
a. Analog: +25V output set to +6V, 180 mA; -25V output set to -6V, 180 mA
b. Digital: +6V output set to +6V, 125 mA
c. Voltage Reference: +25V output set to +12V, 15 mA
d. If the voltage and current limits are not set to these values, **you risk blowing the tower**. This is in fact the most common mode of human-caused failure in this dip probe. **DOUBLE CHECK THE LIMITS BEFORE TURNING ON THE OUTPUTS.**



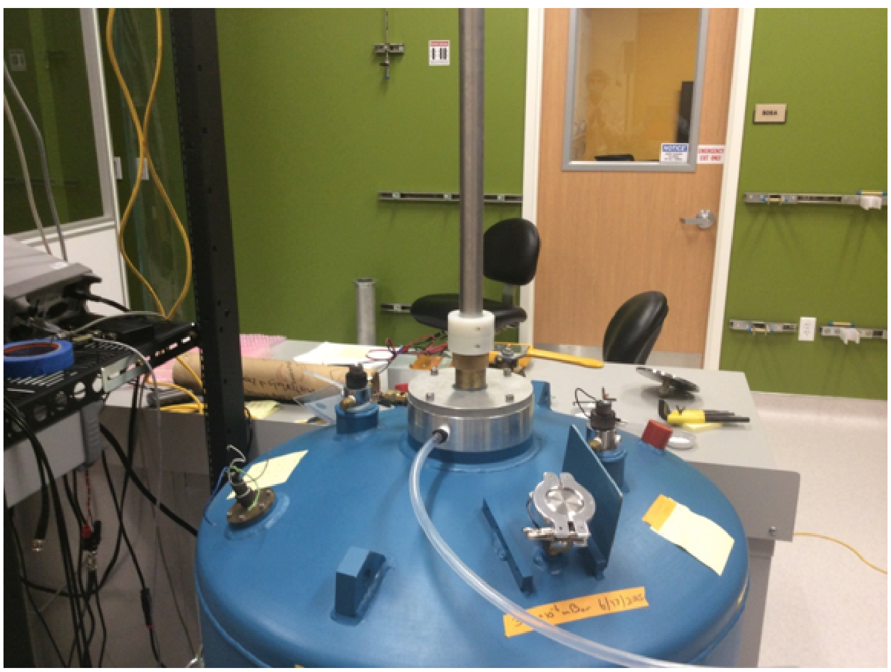
Dipping procedure: Read the entire procedure and make sure you understand all steps before dipping.

1. Thump the dewar through the port in the center of the neck to ensure that there is at least 12” of helium
    a. the reservoir of the dewar has a narrow, 12’’ tall extension where the probe rests, and a larger diameter belly above. If you thump the dewar through one of the side ports, you will not reach the bottom of the extension.
2. If there is not enough helium, transfer more into the dewar, using the process described in Blue Dewar Transfer Procedure

3. Carefully mount the shield over the chip using the 4 screws. Avoid bumping the cryoperm. This can ruin its shielding ability.



4. Unscrew and remove the top plate
5. Insert probe carefully. Avoid bumping cryoperm shield. Hand tighten the screws attaching the probe to the dewar.



6. Lower the tower: keep a gloved hand on the tower for the entire process.

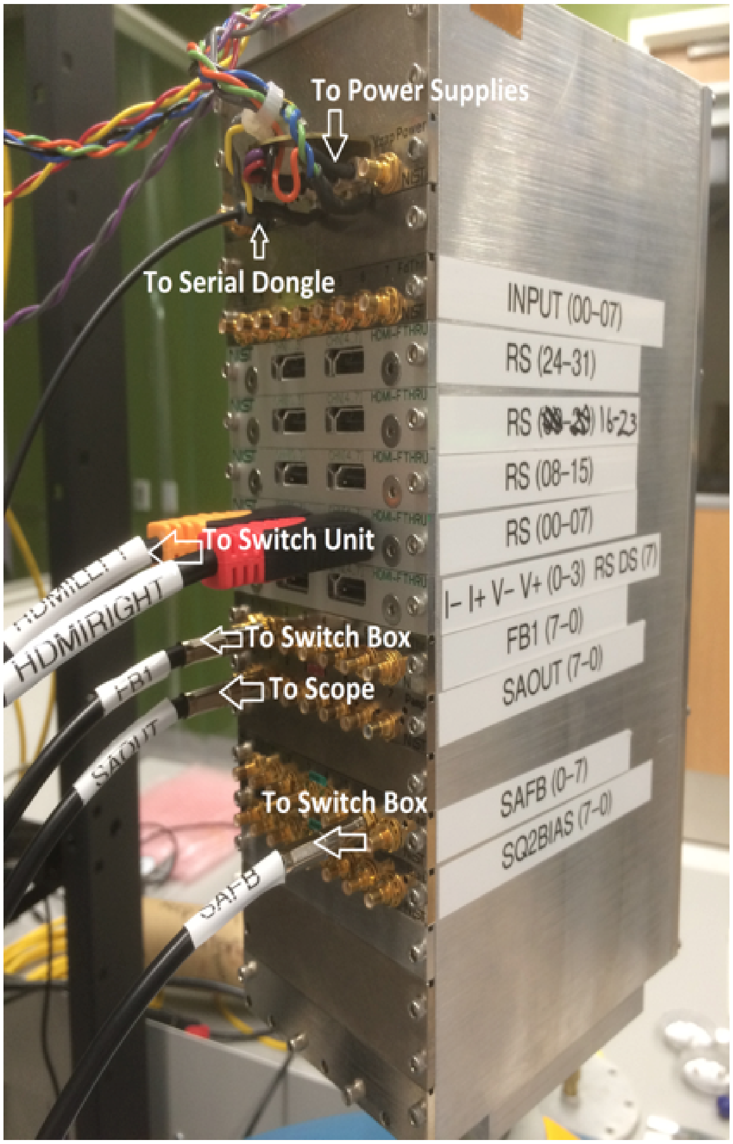
    a. Loosen the top clamp, raise the clamp, and retighten
    b. Loosen, raise, and retighten the bottom clamp
    c. Loosen the knurling and slowly lower the tower so the clamps are resting on the knurling
    d. Tighten the knurling

   e. Wait 2-3 minutes while checking the pressure in dewar through the boil-off tube, making sure there is low but positive outflow.

7. Repeat step 4 until top clamp is within 1 inch of top of shaft.
8. This process should take at least 20 minutes to preserve liquid helium and keep the probe from being damaged. In terms of how much to lower the probe at each step: (You want to allow time for vapor cooling so take extra time on the first few steps)

Electronics setup:

1. Plug tower into power supplies (match cable colors except red+white -> red+yellow). DOUBLE CHECK VOLTAGE AND CURRENT LIMITS!
2. Plug in fiber optic cable (serial dongle) from computer through USB serial gear box
3. T the output of the function generator into channel 1 of the oscilloscope and connect this to a BNC-SMB cable which will be referred to as BNC 1.
4. Connect bluebox (switchbox) and voltmeter



Screening for chips in Channel X:

1. Plug SAFB BNC into port X of the SAFB card
2. Connect channel 2 of oscilloscope (called SAOUT BNC) to port 7-X of the SAOUT card (this card is inverted)
3. Turn on the function generator to a ramp of 1V peak to peak and 800Hz
4. **We now will calculate the Series resistance of the SQUID array**
5. The mutual inductance of input and feedback loop of SSA is provided by NIST. For example, M_in(pH) = 103.3, and M_fb(pH) = 43.9.
6. The current change in the feedback loop that corresponds to one phi_0 is:

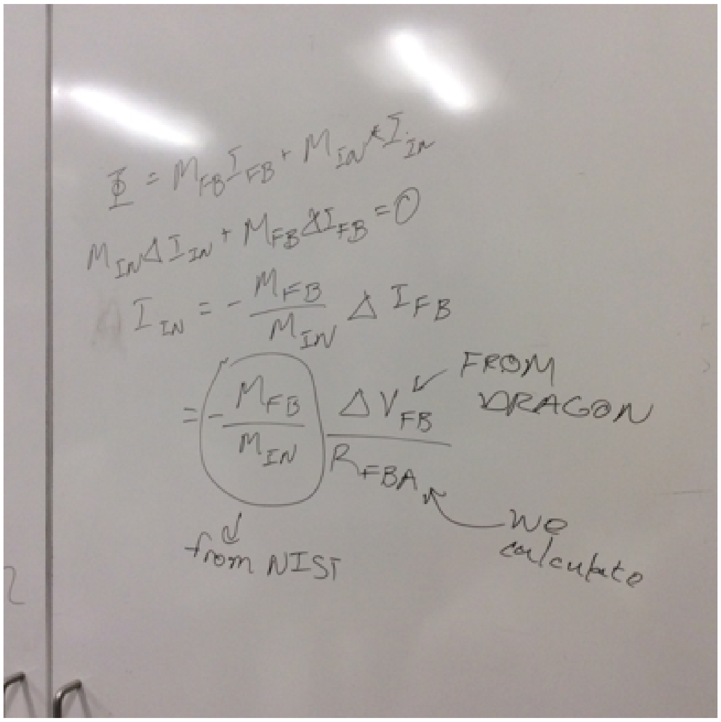
   $I_{FBA}= phi_0/ M\_fb$,
7. We set the switch box to SAFB, the signal generator thus provides a triangle wave signal to SAFB. By increasing the the SSA bias, we are able to maximize the modulation depth

of the V- F curve of the SSA. We then switch the signal generator from triangle wave to constant Dc output. By varying the DC output to switch a full phi_0, we get V_{FBA}, therefore the series resistance of the feedback loop of SSA, $R_{FBA} = V_{FBA}/ I_{FBA}$

8. Adjust the vertical scale of channel 2 so the waveform barely takes up the entire screen
    a. **RECORD** this SA_BIAS level. This value will remain constant for screening all chips in this channel and will is used in the above calculation as V_{FBA}

9. **Now we measure the Ic,col of flux actuated switch (FSA), this is the lowest value of the entire row selectors in the same column**
10. Change the switchbox to FB1
11. Set the blue box voltage to 0. We are not biasing any switches. With these conditions the RS switches are fully superconducting
12. We slowly increase the SQ1 bias, at the same time; we tune SAFB so that the V- F curve always remains at the center of screening. By tuning SAFB we make the SSA always work at the steepest working point. When a Sine wave begins to form on the oscilloscope, it means that we just reach the smallest critical current of the entire row selectors in that column.

This current is defined as Ic_col. Calculate this current from the following:



a. **RECORD** this value

13. We now calculate the critical currents $I_{c,min}$ and $I_{c,max}$ of the SQUID 1's
14. Now set the blue box to 450mV and close the first channel on the mounted switchbox
15. Center the SAOUT signal by increasing SA_FB on the software
    a. **RECORD** this bias value
16. Find the $I_{c,min}$ of the flux activated switch by alternately increasing SQ1_BIAS and SA_FB to keep the flat line of channel 2 in the center of the screen until a waveform starts to appear.
    a. **RECORD** these voltage values

17. $I_{c,min}$ is given by Ic,min = (M_fb/M_in)*[(SAFB-SAFB_offset)/R_{SAFB}]

18. Continue increasing SQ1_BIAS and SA_FB until the flat sections of the curve disappear
    a. **RECORD** the SQ1_BIAS and SA_FB values and voltages this is $I_{c,max}$ as well as the modulation depth of the waveform.

19. Open the switchbox channel and repeat for eight total channels
20. Move USBs up a row, here CHN(8-11,12-15), , zero SQ1_BIAS and SA_FB,
    a. and repeat steps 13-18 above for all 32 channels
    b. Do the same for the Dark Squid (DS) channel

Repeat entire screening (steps 1 - 20) with each chip

Probe warm-up:
1. Keep one gloved hand on the tower at all times
2. Unplug tower from all electronics
3. Sanity check pressure of dewar.
4. Loosen bottom white collar clamp.
5. Loosen knurling
6. Raise tower 4-5’’
7. Tighten knurling
8. Lower and tighten bottom clamp
9. Loosen then lower and tighten the top clamp
10. Wait 2-3 minutes then repeat
11. Stop when the distance from the bottom of the box to the plate is 25’’
12. Carefully unscrew the plate and remove the probe
13. Replace the lid and hand tighten it to the dewar
14. Use a heat gun on low (2-3) (barely hotter than room temperature) to thaw the mu-metal. Start this as quickly as possible to prevent excessive condensation on the chips
15. When the shield is thawed, remove the shield and thaw the SA and chips. Be careful never to blow directly on the squids as this can damage the wire bonds.