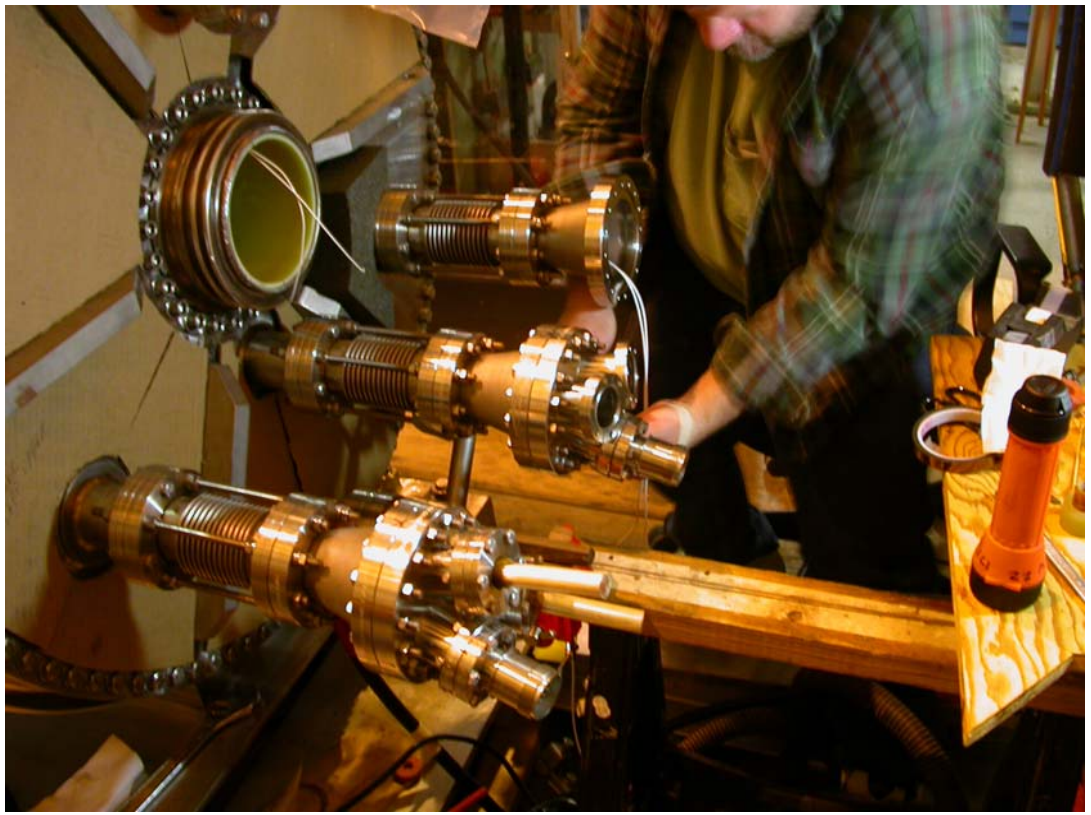
MERIT Magnet Testing Status
Neutrino Factory Muon Collider Collaboration Meeting
Monday March 13 2006



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titus@psfc.mit.edu,
http://www.psfc.mit.edu/people/titus

Status:

Safety Review Completed at CERN. Questions – Findings?

Low Current Test (.6T) with PTF Power Supply Complete.

-Still assembling things – Primarily insulation and N2 vent

PLC cooling water interlock logic was bypassed.

Power supply control system qualified for low current tests.

Higher voltage tap of the transformers (to support 700 v operation) will be done this week

Bus Bar connections are going through final assembly – Bent bar has been received. – These were clamped up for Low Current Test.

The ODH sensor has been received and we had a small tutorial on its use.

Vent pipe components are cut, many are welded. Roof sleeve has been installed.

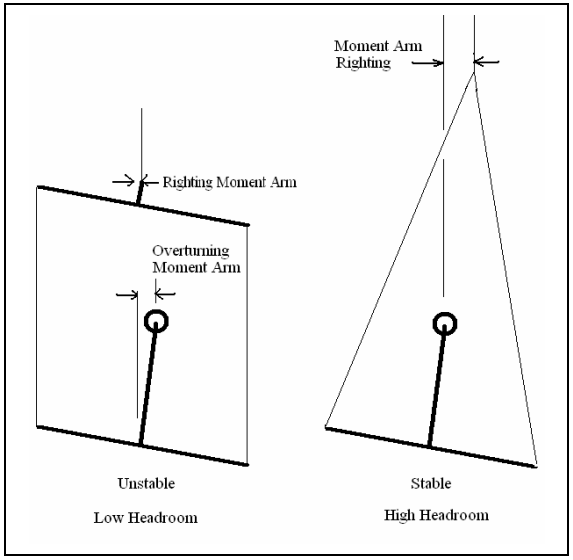
Cryogenic lines have been run. – Mostly insulated

Assembled Magnet Entering The Test Cell at MIT, Tuesday Jan 10 2006

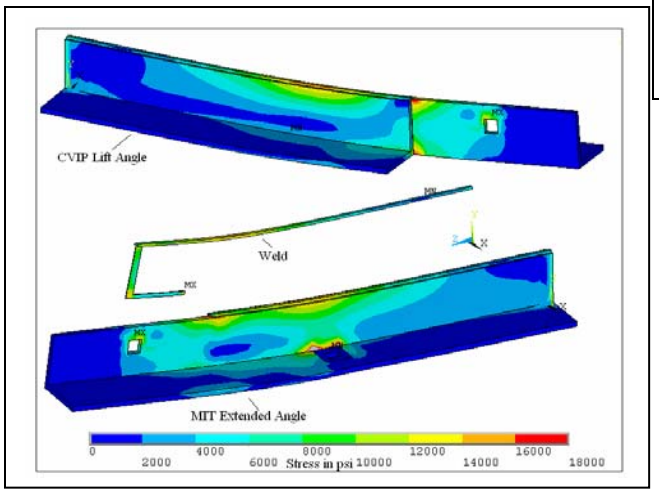
Peter Titus and Dave Tracey inspecting terminal ends of the MERIT Pulsed Magnet –In PTF Facility at MIT-PSFC

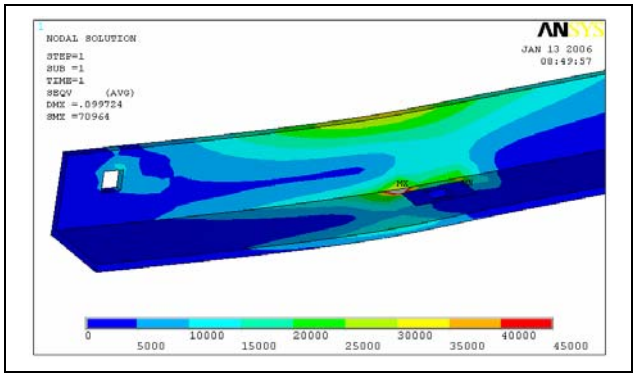
The Magnet has been Off-Loaded and Rigged into the PTF Test Area

The initial lifting rig was unstable. This can be seen in the diagram below. The triangular sling arrangement is planned for use. In order for the headroom to be acceptable, the spreaders supplied by CVIP had to be extended by about 7 inches. .



Magnet lowered into place in front of PTF split pair magnet.





Safety Review – Geneva, Switzerland Feb 4 2006 Presentation: http://198.125.178.188/bnlpulsed/CERNSafety06.pdf.

Possible Findings??:

- Planned testing at MIT-PSFC was described and the safety review panel expressed interest in obtaining ***test reports*** and operating experience with the magnet. These will be provided. Progress with the tests is being posted at http://198.125.178.188/bnlpulsed/testplan4.pdf.
- Concerns were expressed with respect to the cryogenic performance of the ***foam insulation*** on the non-vacuum jacketed end of the cryostat. In particular, the possibility of O2 condensation in cracks and voids in the insulation, and possible resulting fire hazard. P. Titus will document all materials used in this insulation, and provide results of tests performed at MIT
- A ***Quality Documentation package*** is needed for the magnet, including Welder qualifications and certifications, and material certifications. I explained that the vessels were manufactured to the quality levels of ASME VIII, but not stamped, and it was expected that quality documentation consistent with this practice would be made available. Certification by a Professional Engineer was discussed. P. Titus is a P.E. in the state of Massachusetts and can provide a stamp.

  (CVIP and Everson have been requested to add to documentation already assembled)
- The ***pressure test*** performed on the magnet was a 110% test, at room temperature, pneumatically qualifying 15 atm according to ASME VIII standards. Pressurized service is only possible with cold nitrogen inside the vessel, and the bolt strength, which limits the pressure capability of the vessel, increases with lower temperatures. CERN requires a 125% test and intends to perform these tests at CERN upon receipt –probably at room temperature. The plan is to de-rate the vessel to 13 Bar, and set the pressure relief at 11 bar. The design of the cryogenic system is targeting less than 2 bar in order to keep the LN2 near its 77K one atm saturation pressure. The vessel can be de-rated further if needed for qualification at CERN.
- The strength of bolting of the inner cover bolt circle was discussed. ***Bolt thread shear calculations*** were questioned and need to be clarified. The calculations presented were for the male thread. The shear strength of the female thread, which has a larger shear cylinder needs to be described.
- ***A design/analysis report*** was to be a part of the quality documentation. This was largely available at the review, and a final version of the report would be shipped or made available electronically when the magnet was shipped.

Vacuum Jacket Pressure is holding at 60 Millitorr.

Vacuum Measurements

Baseline at CVIP	Jan 2006	5 millitorr minimum, 9 millitorr after shut down of vacuum pump, 100 millitorr after sitting over night
After receipt at MIT	Feb 7 2006	9.0 Torr = 9/760 = .012 atm
After an hour pump down	Feb8 2006	59 millitorr
Friday Feb 10		40 millitorr
Tuesday Feb 14 9:00 AM		60 millitorr
Thurs Feb 16 2:10 PM		60 millitorr

Magnet Component Magnetic Survey Feb 7 2006

316 components:
Most of the heat effected zones are slightly magnetic. Where the ribs are welded to the cover is slightly magnetic. The cover bolts on the outer bolt circle are slightly magnetic, the high strength bolts at the inner bolt circle are not

304 components
The Vacuum jacket dished head is magnetic. The rolled shell of the vacuum jacket is not magnetic. The loads on the dished heads may be significant.

PTF Test Area Magnetic Materials

In the Test Area

Large Valves Operator Wheels	Magnetic	Remove
Split Pair Ring Gear and Worm Assembly	Magnetic	Remove?
Large Embedded studs in concrete pillar	Non-Magnetic	
PTF water circulating pump	Magnetic	Brace?

The Coil has been properly Identified

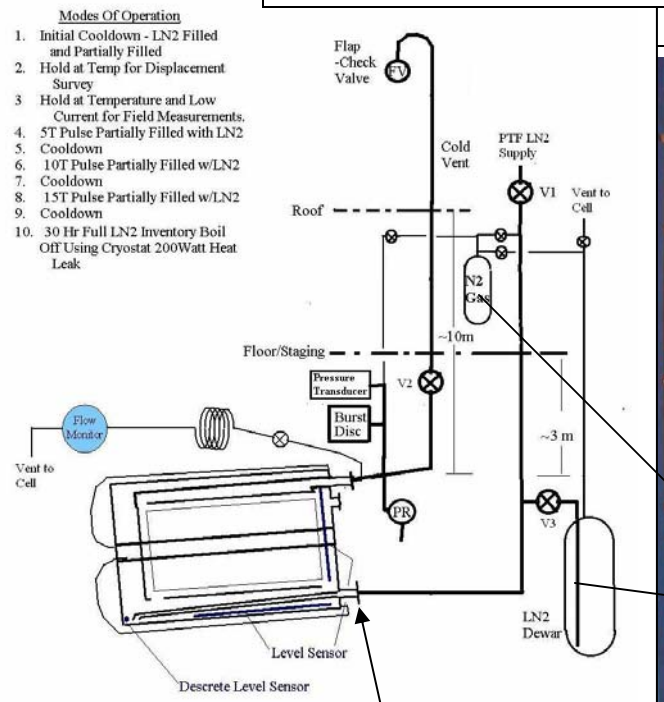
BNL-MIT-PSFC loan agreements have been signed

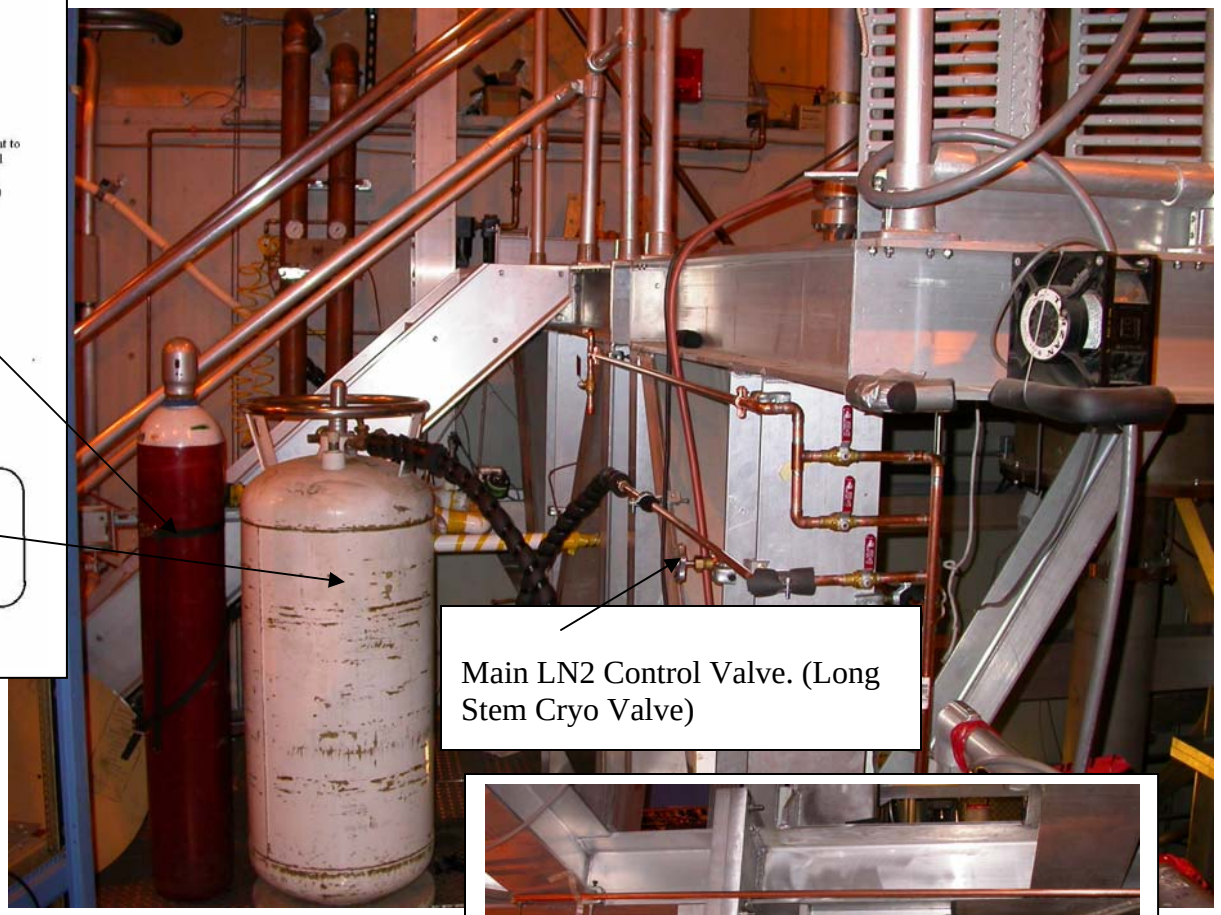
MERIT Magnet Officially Bar Coded by BNL and CVIP Label Applied to the Base of the Magnet System

Cryogenic System – Connection to the magnet is complete, Some gas lines not connected yet. Cold lines are mostly insulated.

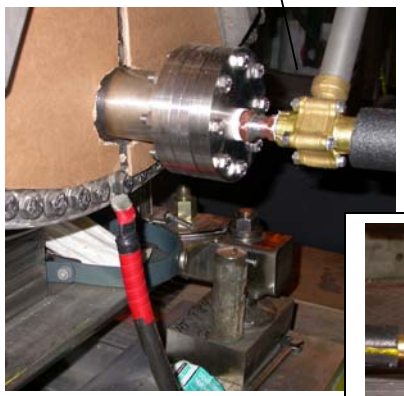
Modes Of Operation

1. Initial Cooldown - LN2 Filled and Partially Filled
2. Hold at Temp for Displacement Survey
3. Hold at Temperature and Low Current for Field Measurements.
4. 5T Pulse Partially Filled with LN2
5. Cooldown
6. 10T Pulse Partially Filled w/LN2
7. Cooldown
8. 15T Pulse Partially Filled w/LN2
9. Cooldown
10. 30 Hr Full LN2 Inventory Boil Off Using Cryostat 200Watt Heat Leak



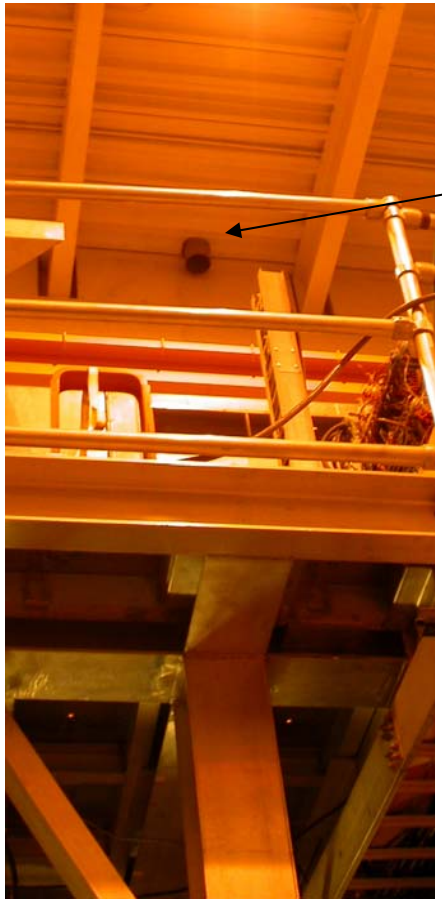


Main LN2 Control Valve. (Long Stem Cryo Valve)



Gas Lines and N2 Gas Volume Measuring Line

Nitrogen Vent Status – Getting close to being hung



Roofers have installed the sleeve

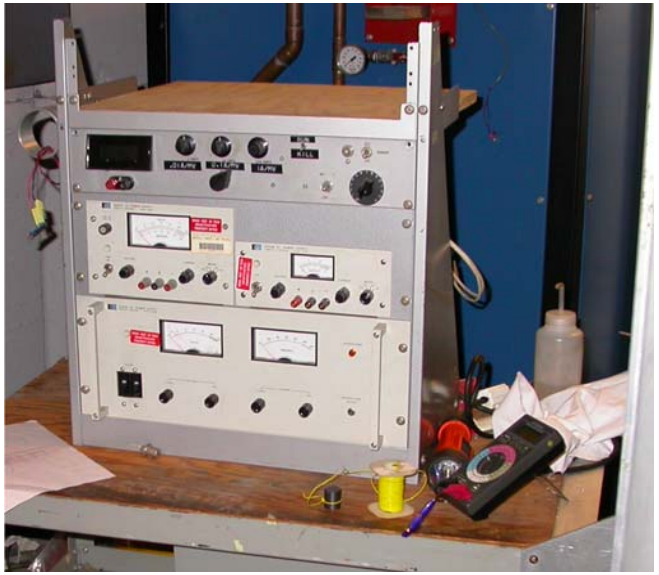
Armaflex Insulation

Low Current Power-Up

10 volts was applied over about 5 seconds and the current, as measured by the power supply meter, stabilized at 22 amps. Welder current meter (hand held meter which forms a loop around the power lead) showed ~27 amps. The coil is at room temperature.

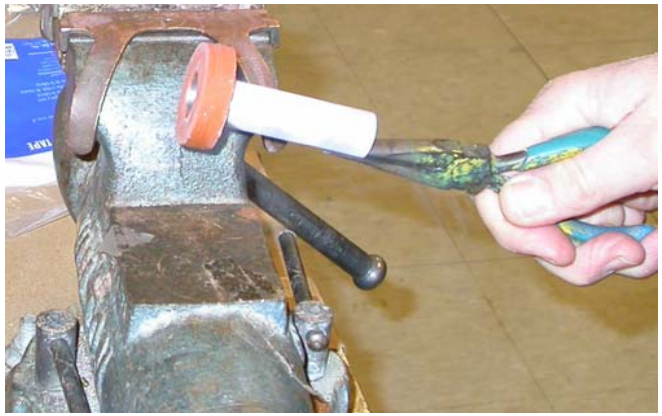
Date	Outer Segment #3	Inner Segment #1	Middle Segment #2	Coil	Current on Power Supply meter	Current From Welder Hand Held meter	Field Measured by the Gauss meter
Feb 16, 2006	4.55v	1.94v	3.25v	9.74v	22		85-25=60 milliT
Feb 16, 2006				9.77v	22	26.5A	85-25 =60 milliT

After a day warm up. It zeroed properly and read 60 milliT



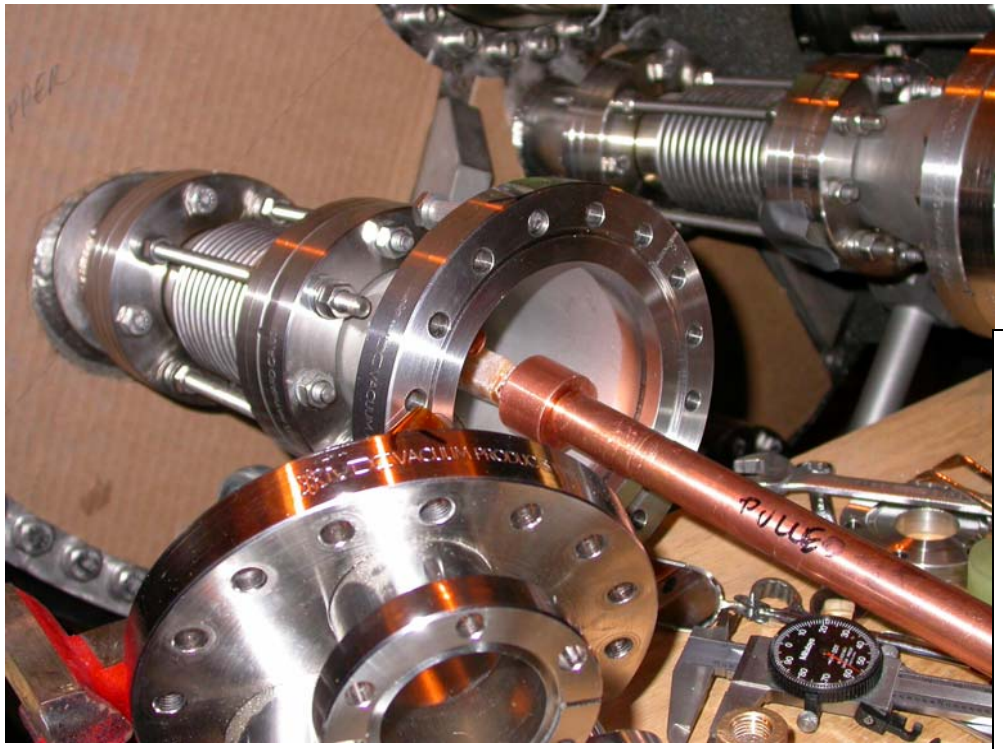
10 v 100 Amp Supply

Terminal Gland Seal Tests



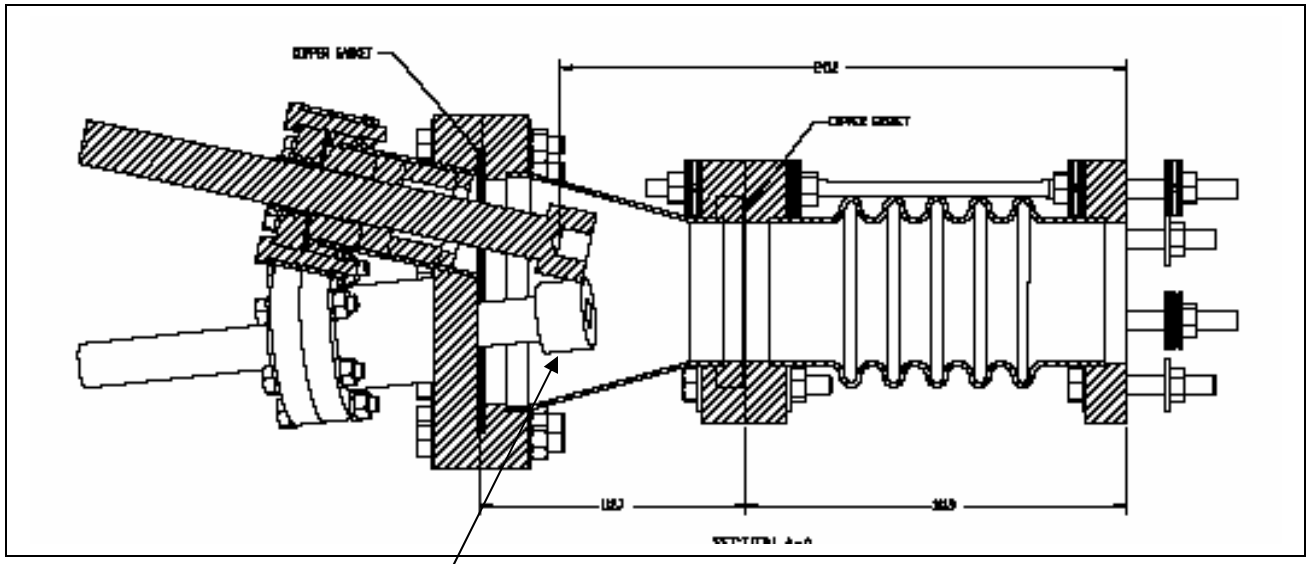
LN2 Dunk Test: Feb 9 2006 The gland for the power lead did not shatter – but it was rigid.

Work on the Terminals slowed Progress a couple of Days.



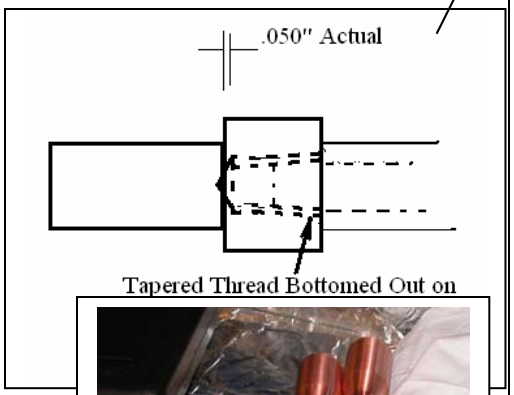
The thread of one of the copper bar extensions was stripped while attempting to tighten it. We decided to inspect and re-work all threaded connections as needed.

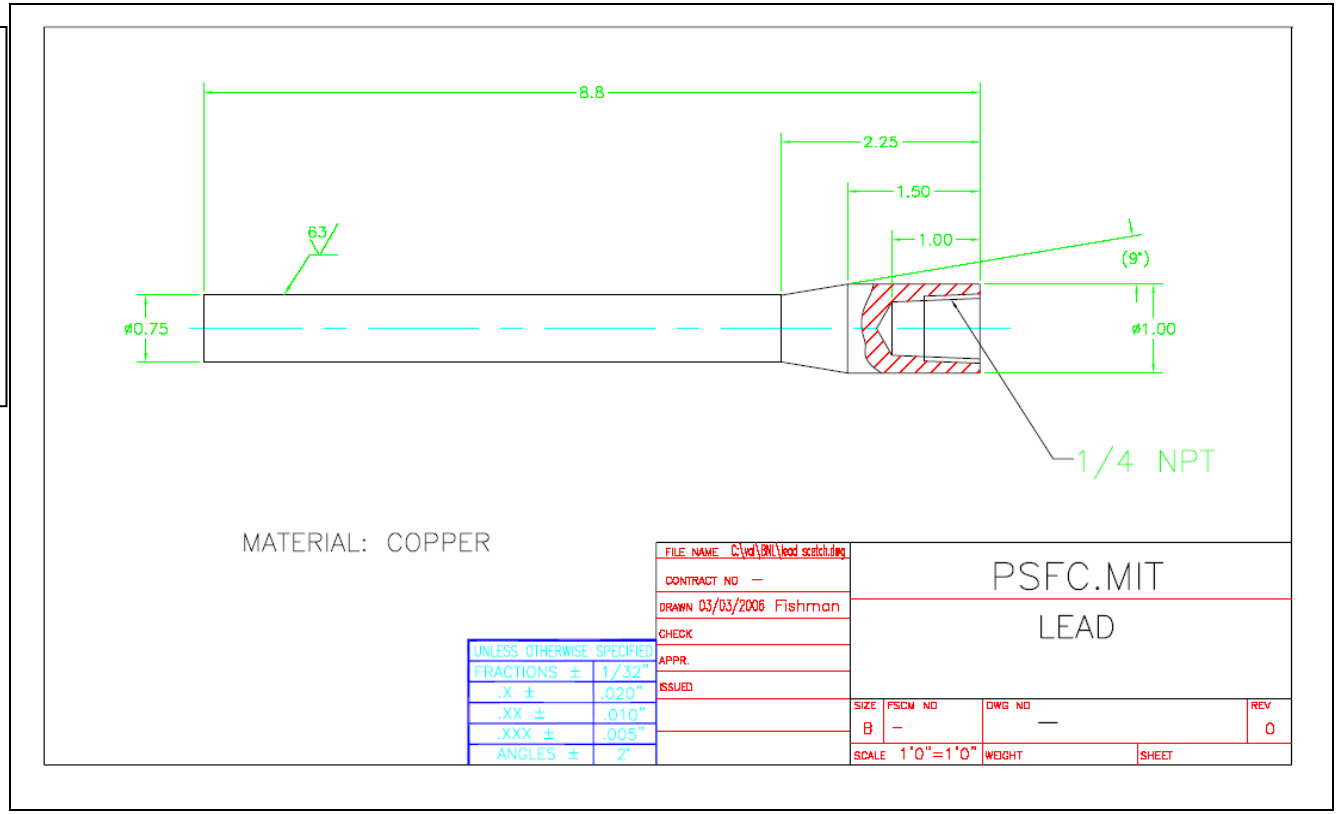
Six new Copper Bar Extensions were manufactured.



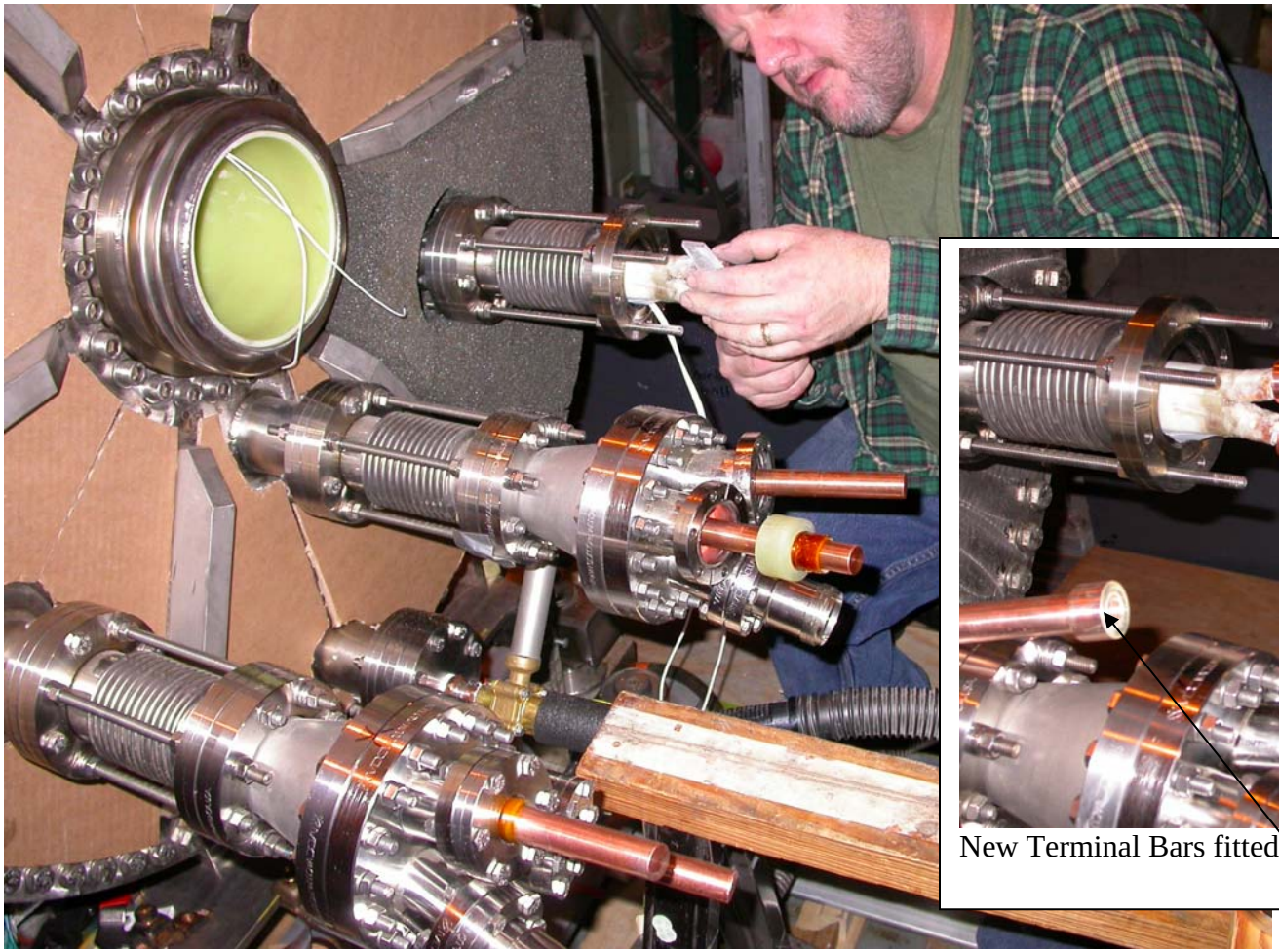
Terminal bars need re-work for low current tests and replacement for high current tests

Ends will be wrapped in Kapton due to proximity of the female threaded sections and all threads are being brush silver plated.



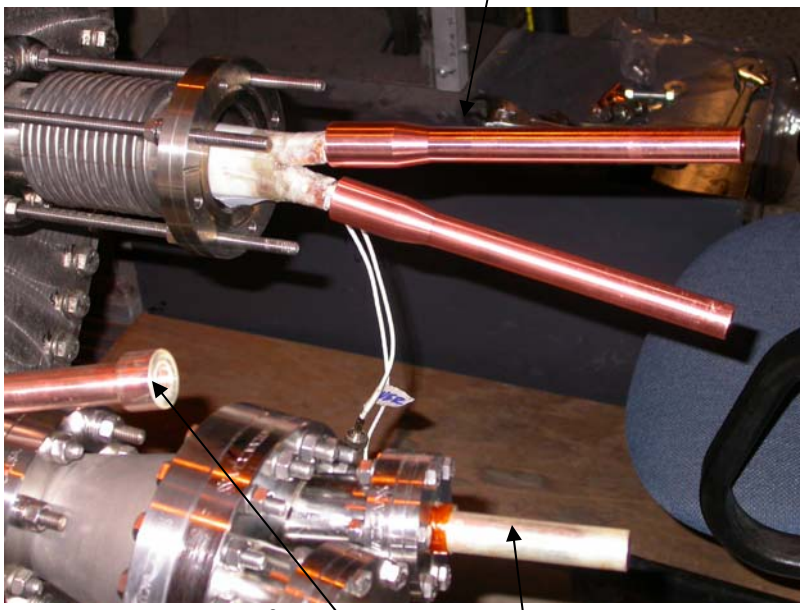


Terminal Bar Repair



Dave is filing the corners off the end of the threaded portion of the square conductor to allow tightening of the copper bar extensions on the conductor ¼ NPT thread

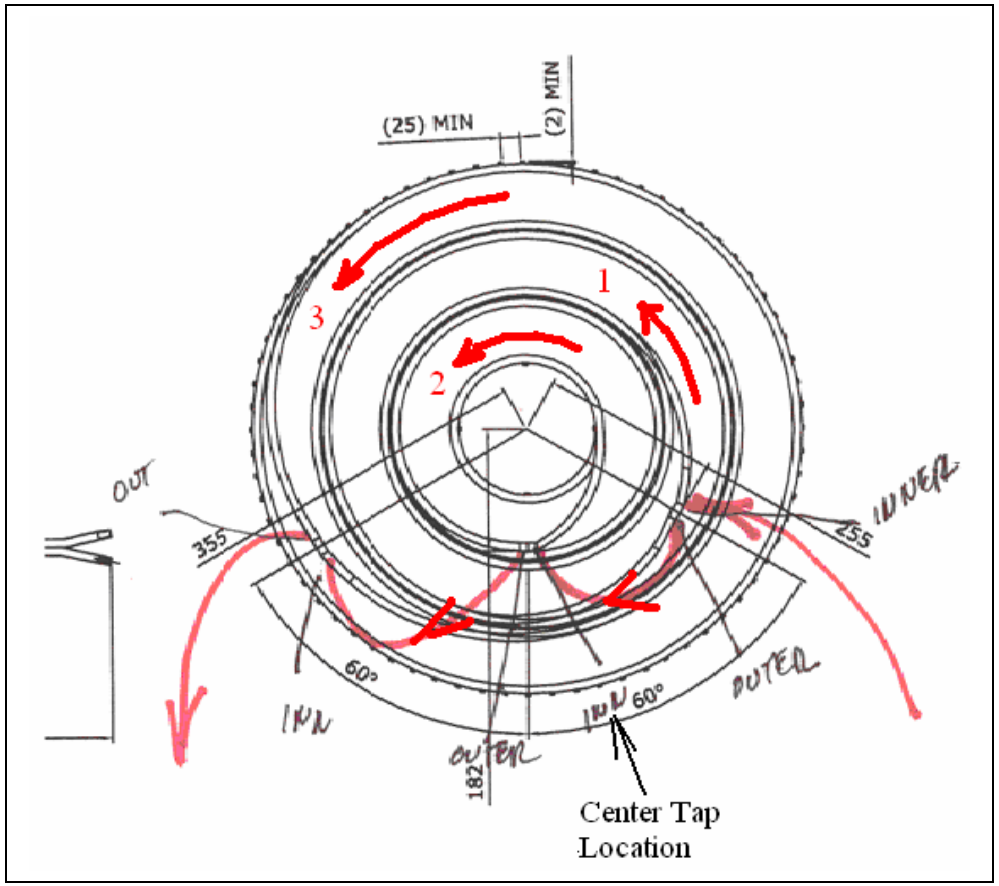
New Bars Machined on MIT-PSFC's new CNC Lathe



New Terminal Bars fitted.

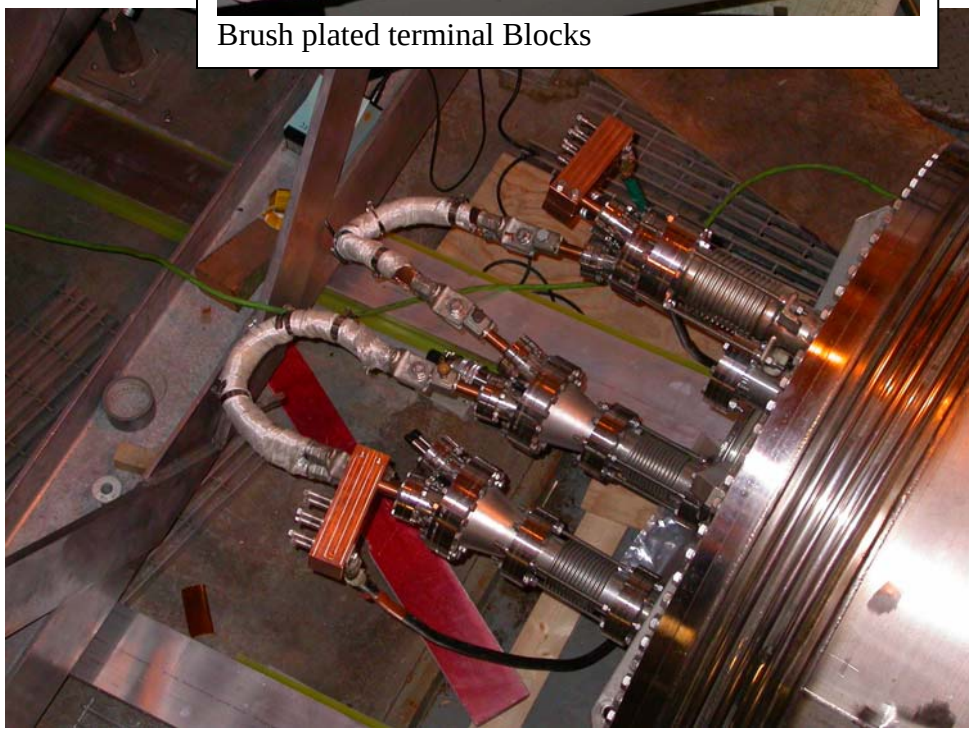
Old Bars with poor female pipe thread

Jumper Connections



Jumper and Bus Bar Connections

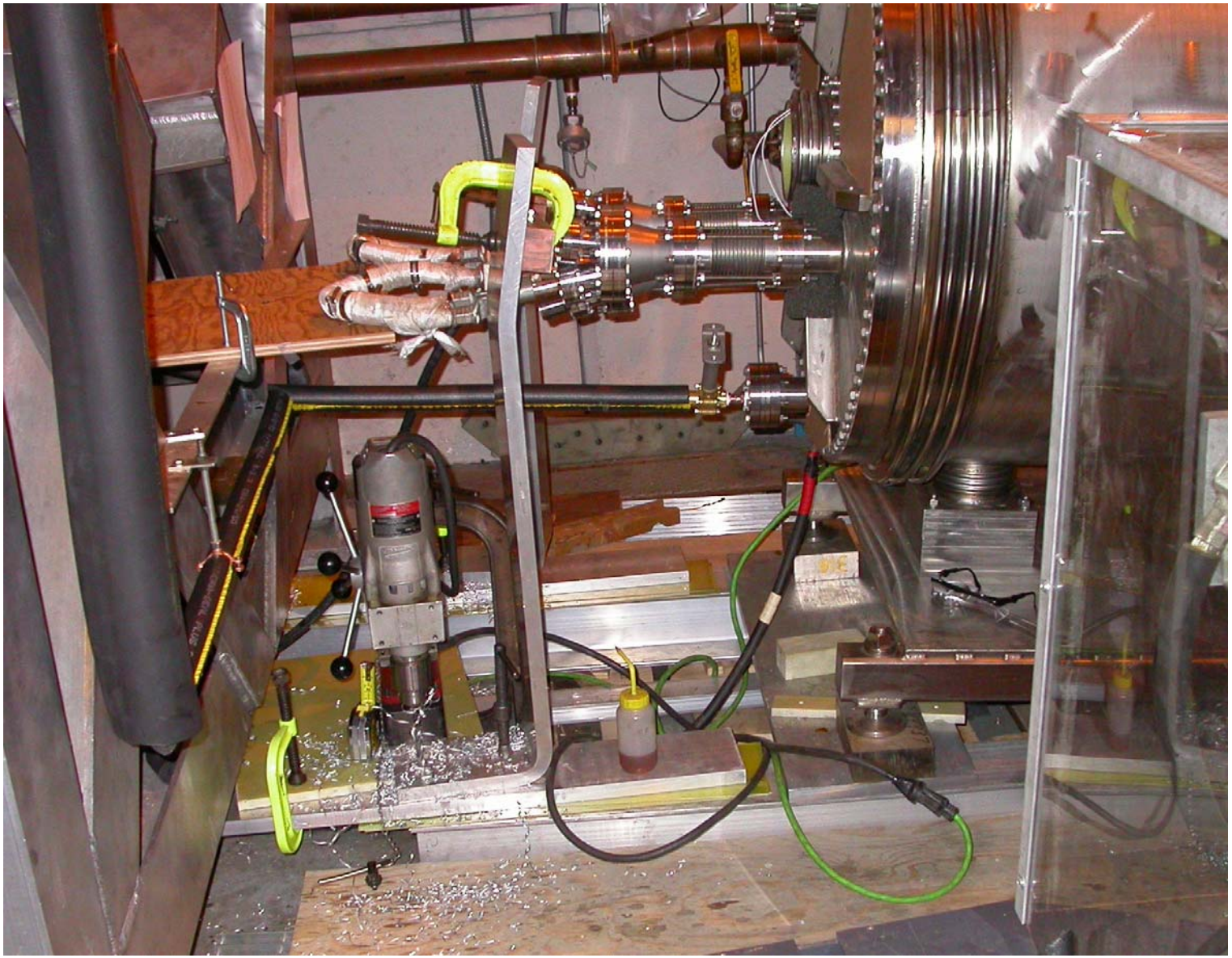
Brush plated terminal Blocks

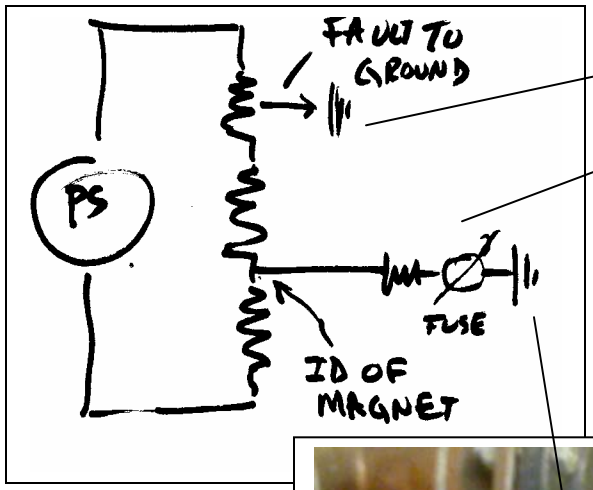


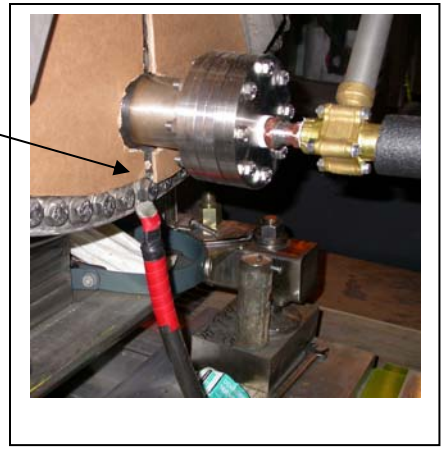
MERIT Pulsed Magnet –In PTF Facility at MIT-PSFC With Jumpers Connected

Bent Vertical Bus Bars have been received from Ramsey Welding

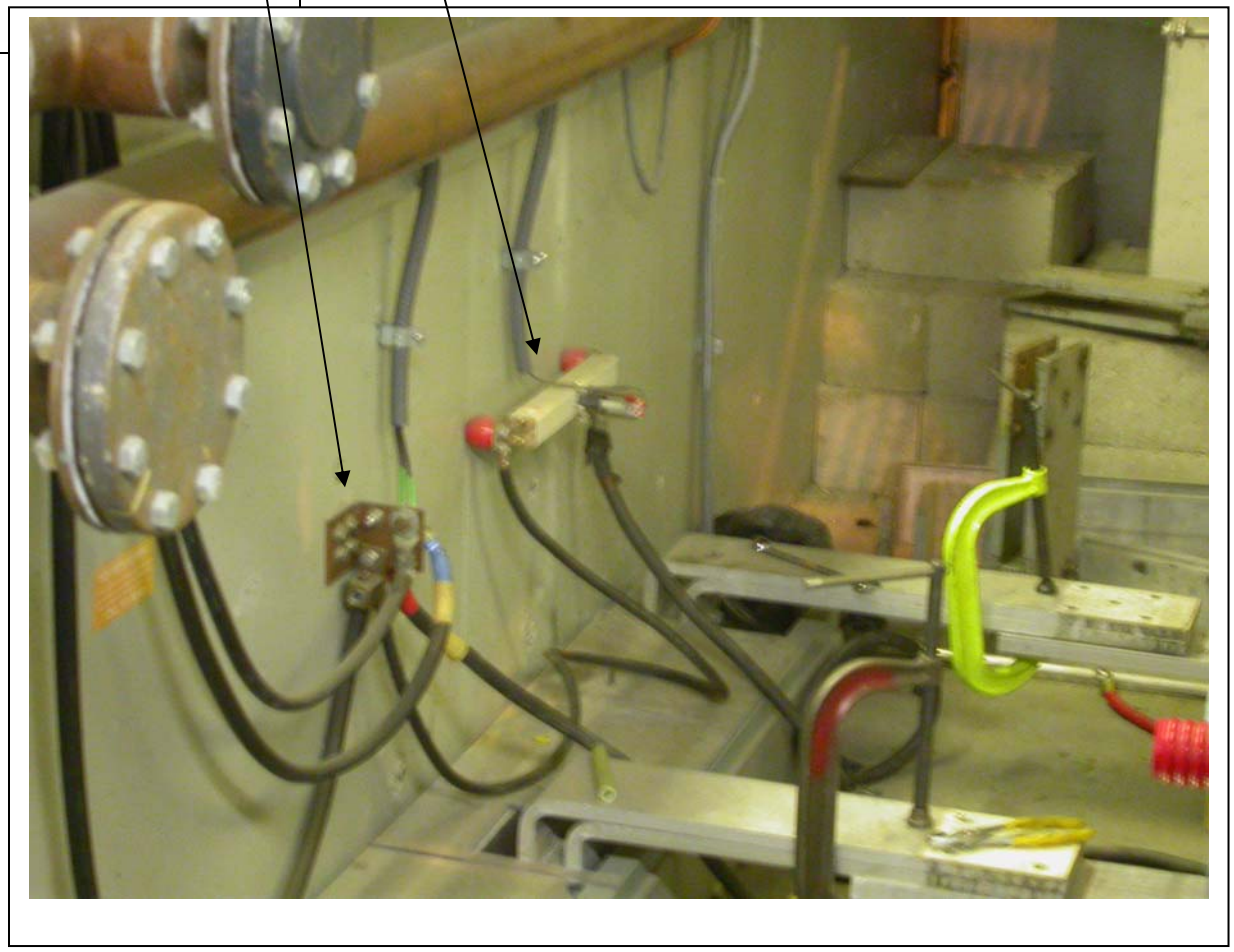
Drilling the Bolt Holes for the Bus Bar Connections – These were clamped up for the low current test with the PTF power supplies







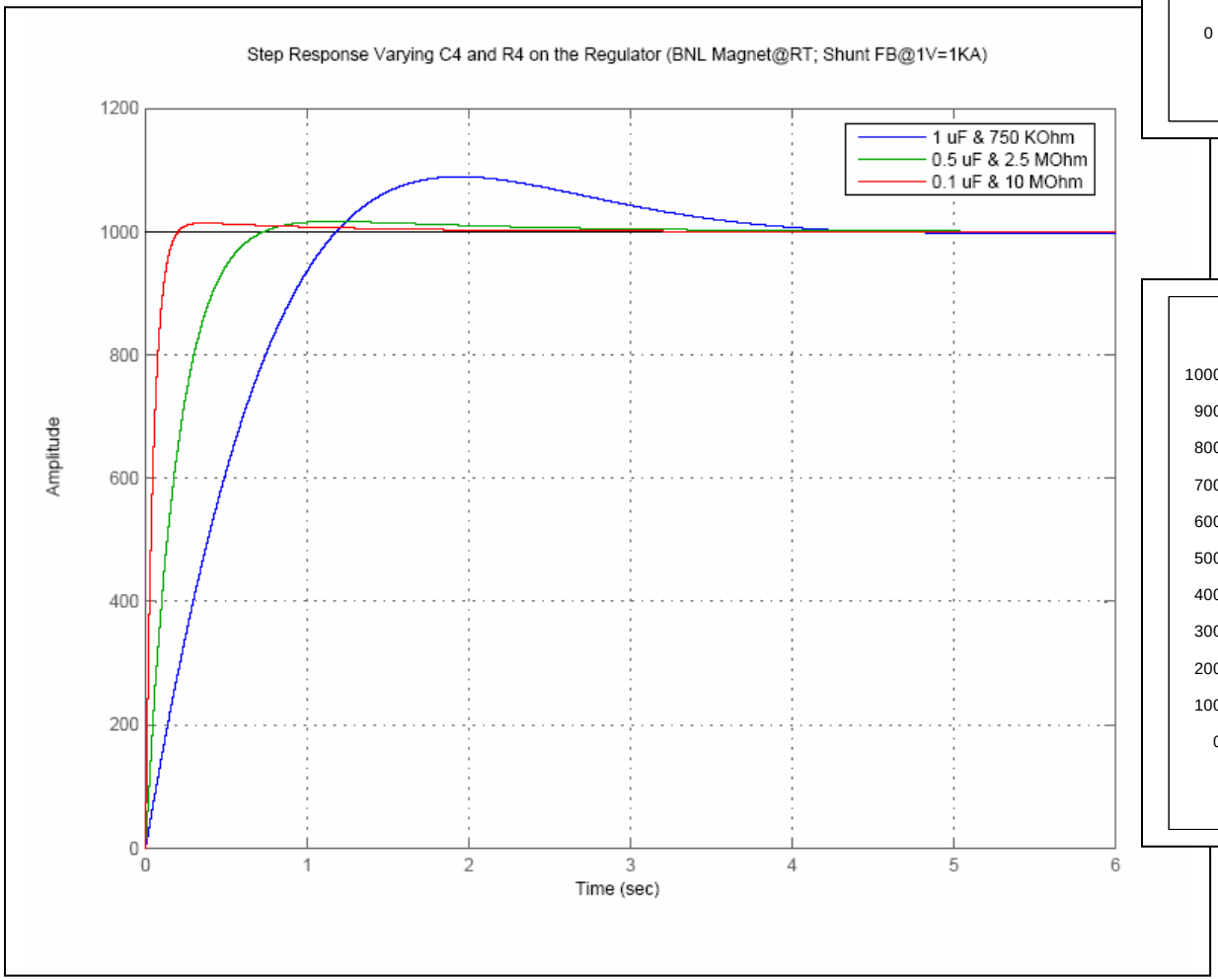
Power Connections,
Ground Fault Center Tap

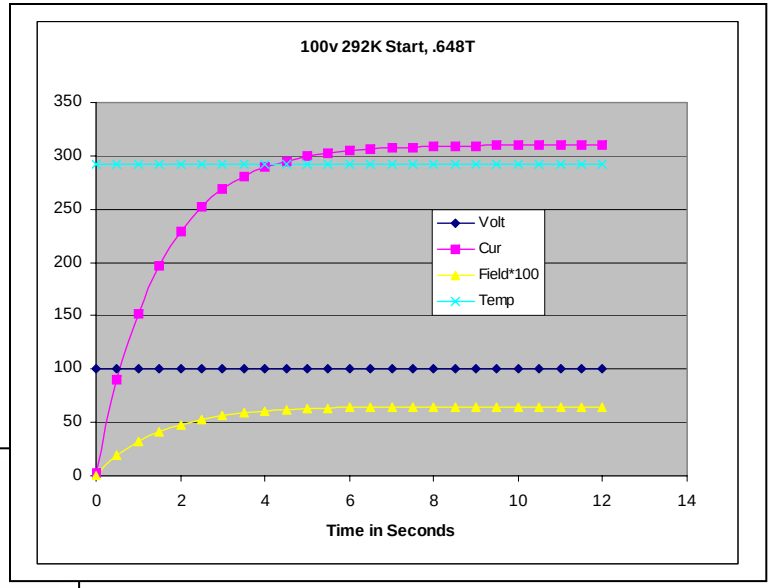


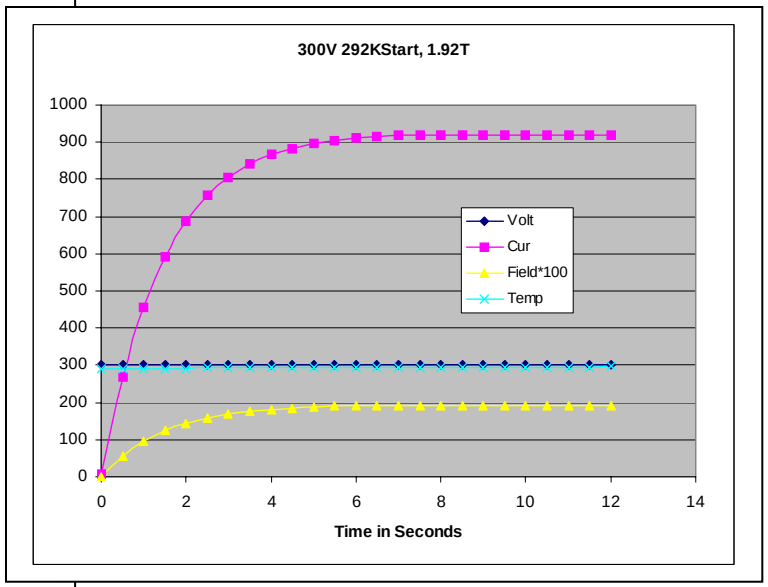
Phil,

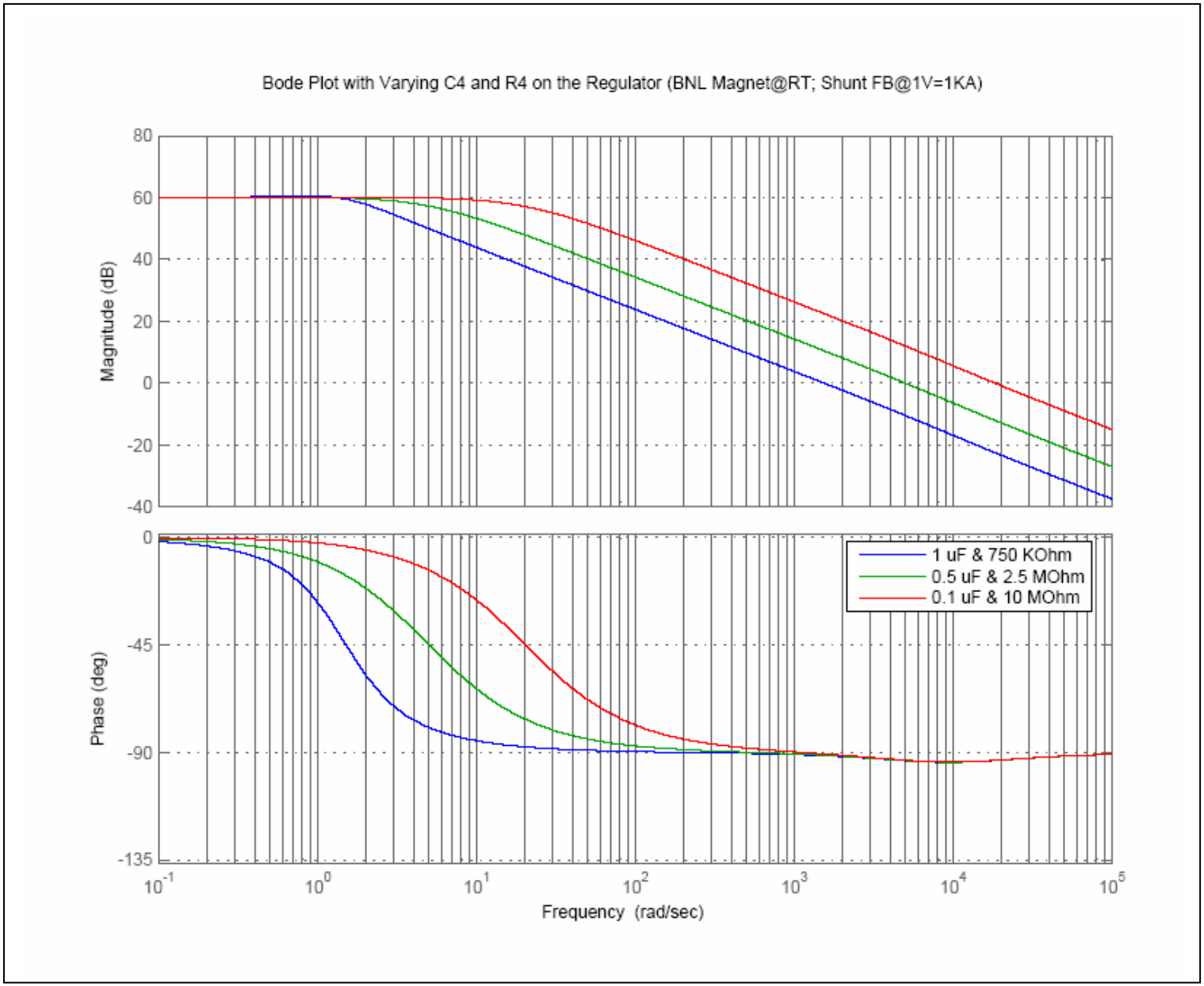
Attached are the step and bode plot responses for the BNL magnet at room temperature with the feedback changed to 1V = 1 KA. Basically, for the room temperature tests at the current transformer taps, the simulation shows that the integrator R and C values can remain 750 kOhms and 1 uF.

Gary L. Dekow, Operations & Engineering Coordinator,
Plasma Science and Fusion Center, MIT.



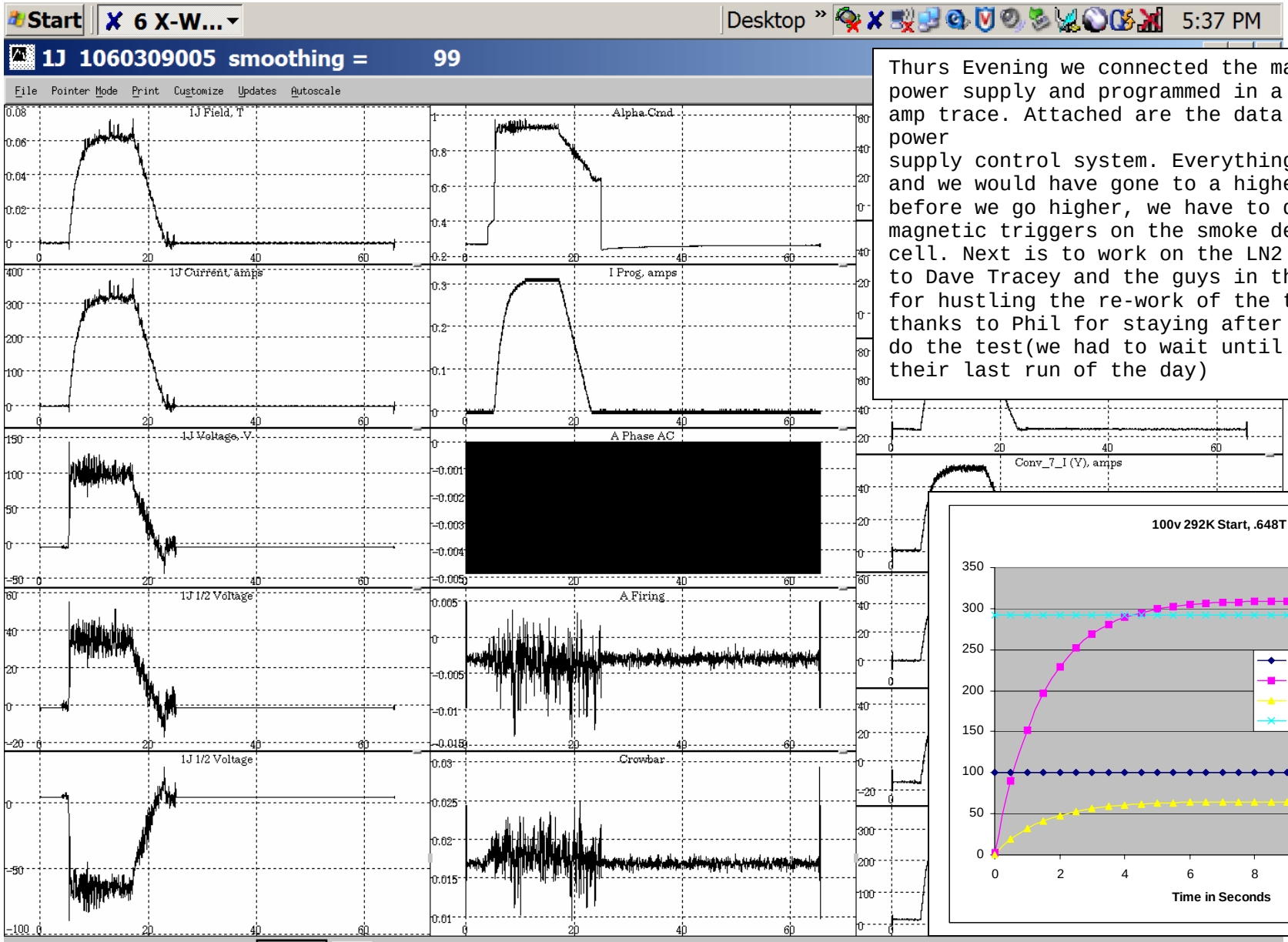





Bode Plot with Varying C4 and R4 on the Regulator (BNL Magnet@RT; Shunt FB@1V=1KA)
Magnitude (dB)
80
60
40
20
0
-20
-40
Phase (deg)
0
-45
-90
-135
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
10^{5}
Frequency (rad/sec)
1 uF & 750 KOhm
0.5 uF & 2.5 MOhm
0.1 uF & 10 MOhm

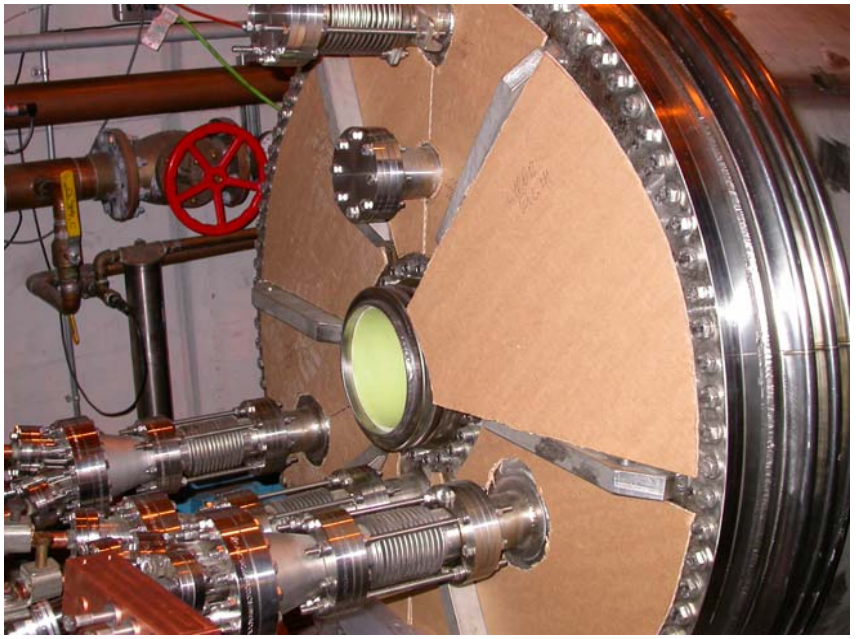
Initial Connection to PTF Power Supply, Thursday March 9 2006

Thurs Evening we connected the magnet to the PTF power supply and programmed in a 100 volt 300 amp trace. Attached are the data traces from the power
supply control system. Everything seemed fine and we would have gone to a higher current but before we go higher, we have to disable the magnetic triggers on the smoke detectors in the cell. Next is to work on the LN2 cooling. Thanks to Dave Tracey and the guys in the machine shop for hustling the re-work of the terminals, and thanks to Phil for staying after hours to do the test(we had to wait until C-Mod finished their last run of the day)

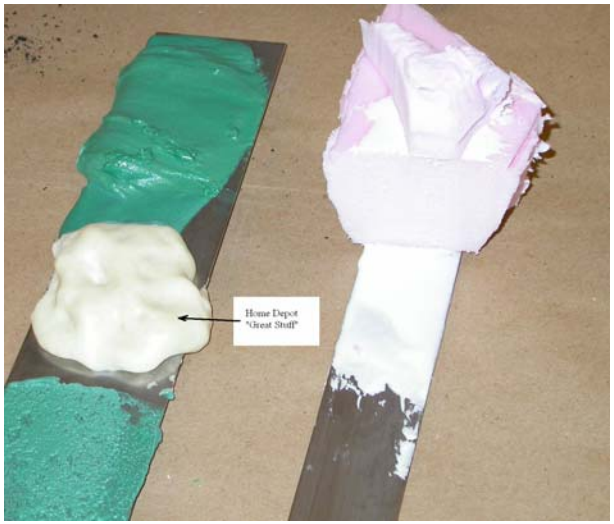


Insulation Tests

CTD materials slump badly on vertical surfaces – They would be almost impossible to apply to the cover. We plan to use Pittsburgh-Corning FoamGlas. It is a closed cell foam that survived dunk tests well. The cells have H2S and would be flammable, but the dunk test produced little damage to the foam cell structure (as measured by a “smell” test.



Templates are prepared to cut sections of foam glass to apply to the cover.



“Great Stuff” Home insulation foam survived the dunk tests very well. The white CTD material, applied in a thick coat lost it’s bond after a dunk test but behaved well as an adhesive. “Great Stuff” is flamable

Glass foam survived dunk tests well. Green is the CTD material. Blue is Stycast We still haven’t dunked this sample.

Cover Insulation Has Been Received. Application to the Cover Planned for This Week

Instrumentation

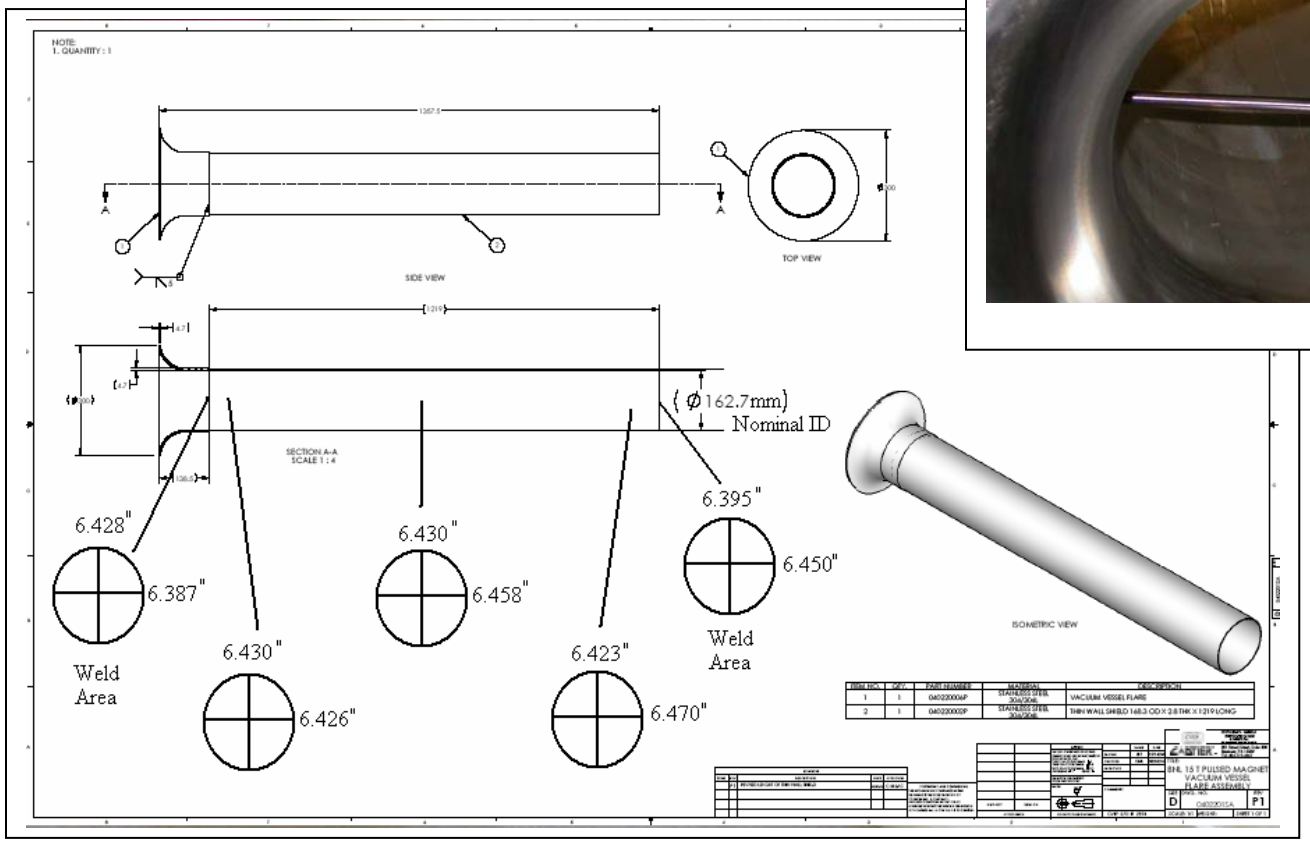
Cables for Instrumentation have been Purchased. Terminal Plugs are being soldered on.

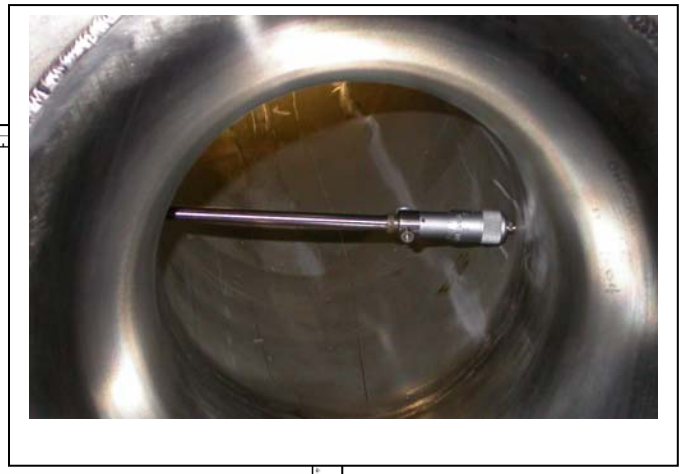
Monday 2-20 06 email:

```
Hello Peter.
>
>Here is all the documentation about the level
sensors.
>For the little problem of sensitivity, it can
be adjusting using >potentiometer P1 on the
card. Only one potentiometer on each card for 5
>diodes. But sensitivity need to be adjust when
you cool down the diode by approaching it from
the liquid, and not by tanking it out because
it take a time to warm up.
>If when using P1 you are not able to adjust
the sensitivity because you are at the end of
the potentiometer, you can move the strap SW21
from it >position and coming completely
backward with P1 . This will change the
>polarity of the reference on the amplifier.
But normally you will not >move the strap until
you have 100m of cable. See  EDA-00279-
V2_sch.pdf for schematic of the card.
Hope this will be helpful for you.
>
>Regarding,
>
>Jean-Marc Quetsch
```

Feb 9 2006 test of the discrete level sensor – It did not seem to be able to detect when the diode was immersed or when it was in cold N2 gas just above the liquid. Voltage changed about 1mV out of 30 mV

Bore As-Built – A "Go Gauge" is planned





This Week's Plans:

Finish Magnet Insulation and N2 Vent in preparation for Cooldown.

We will need a "modest" shot at cold temperatures - about 2 T for the MIT safety officer to measure the stray field outside the building and to checkout procedures to lock out smoke detector remote signals.

Fix things – Add additional insulation?

Next week 5T 10T 15T?