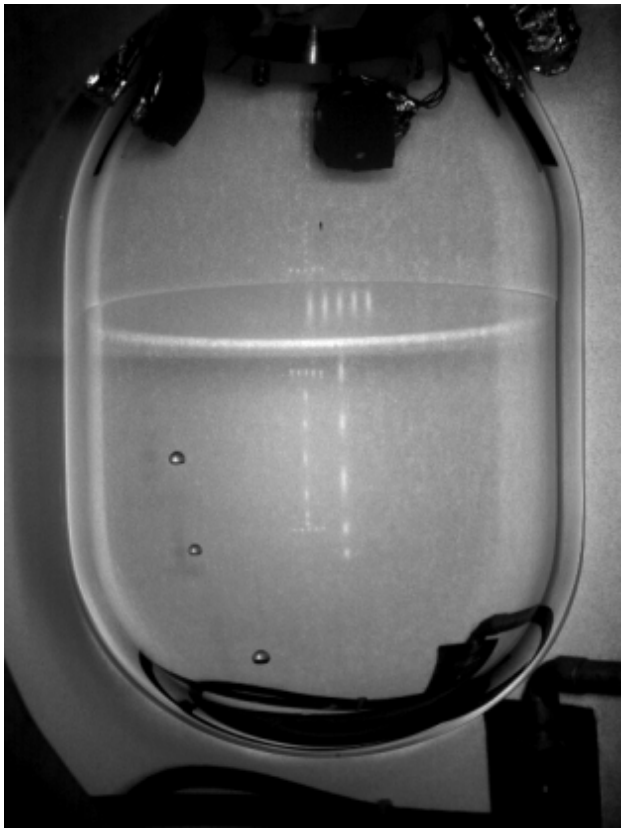
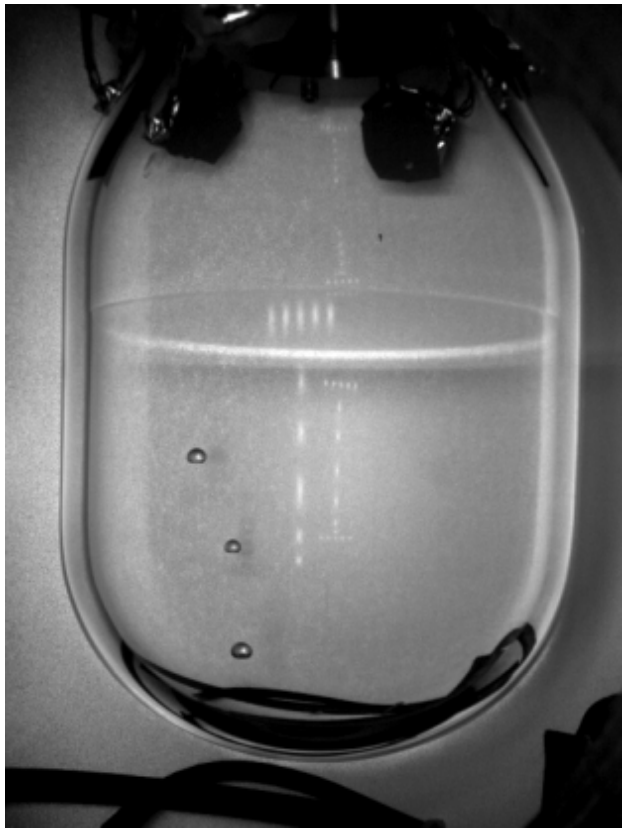
COUPP-2L Re-Deployment Plan

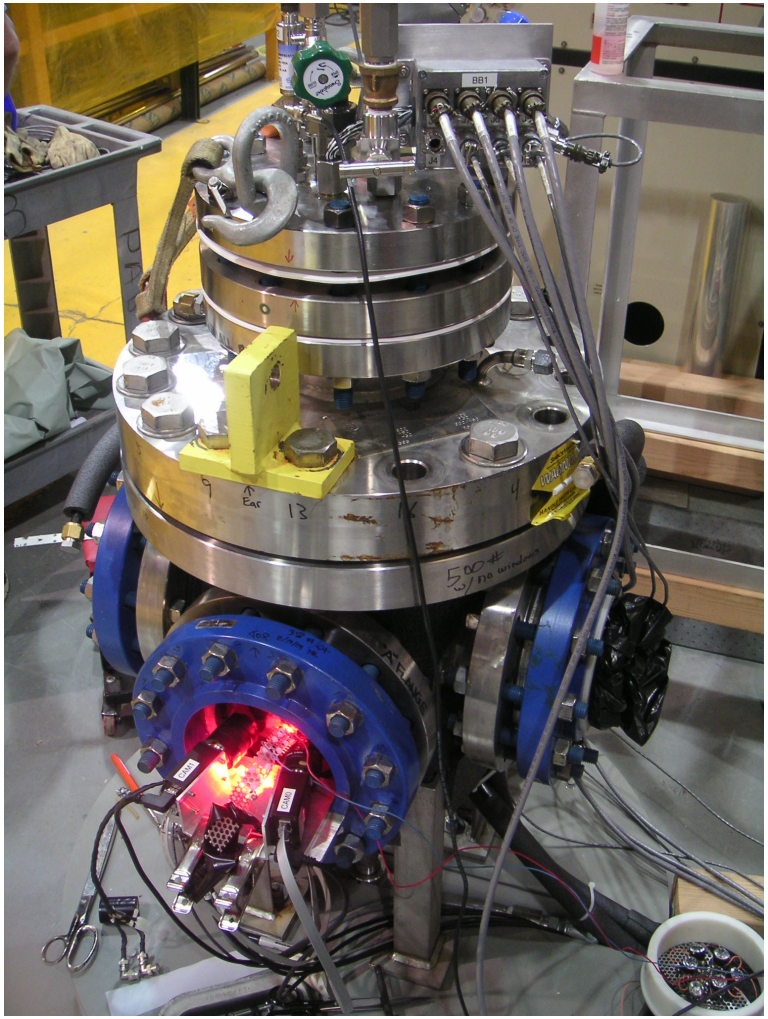




The Work We Need To Do:

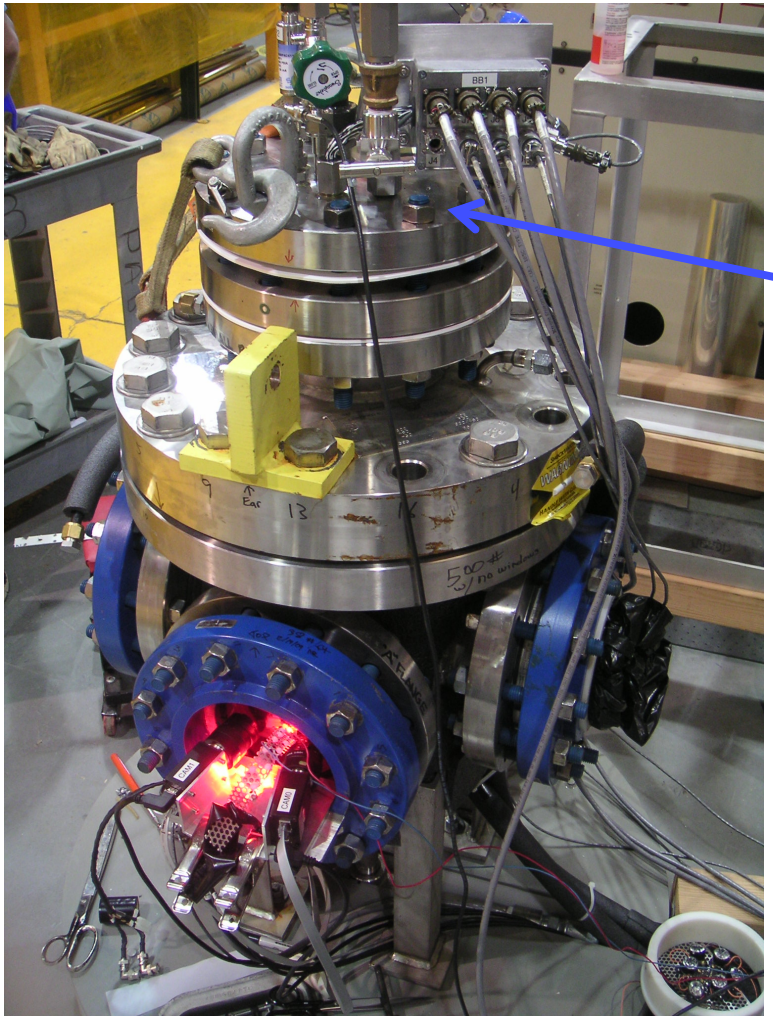
1) Repair the chamber
2) Install new acoustic sensors
3) Upgrade Hydraulic Cart Piping
4) Modify the DAQ/Controls software (and some hardware)
5) Complete Engineering Documentation
6) Complete a formal failure modes analysis

The Work We Need To Do:



1) Open the chamber:

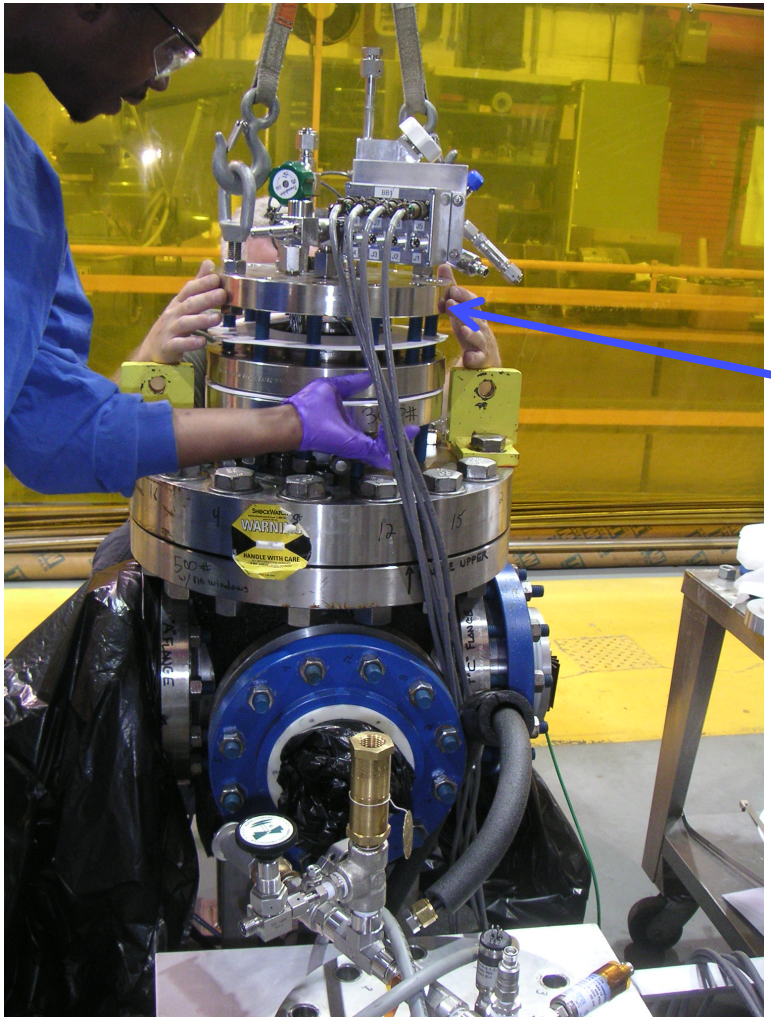
The Work We Need To Do:



1) Open the chamber:

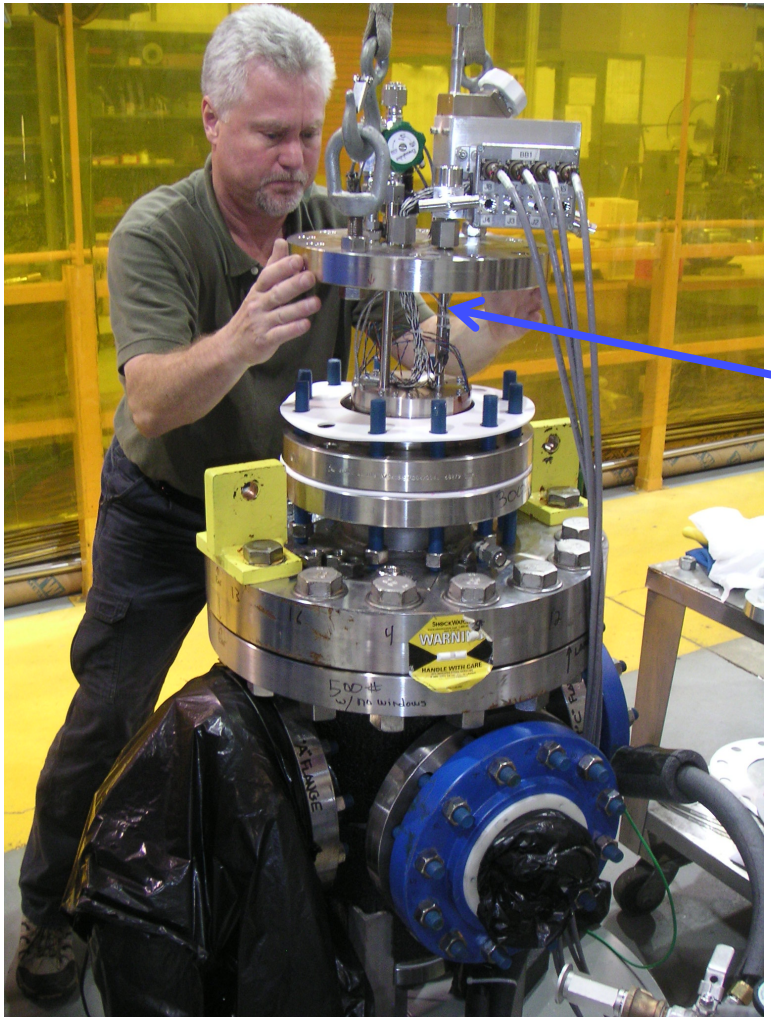
open the top flange seal

The Work We Need To Do:



1) Open the chamber:
   a) open the top flange seal

The Work We Need To Do:



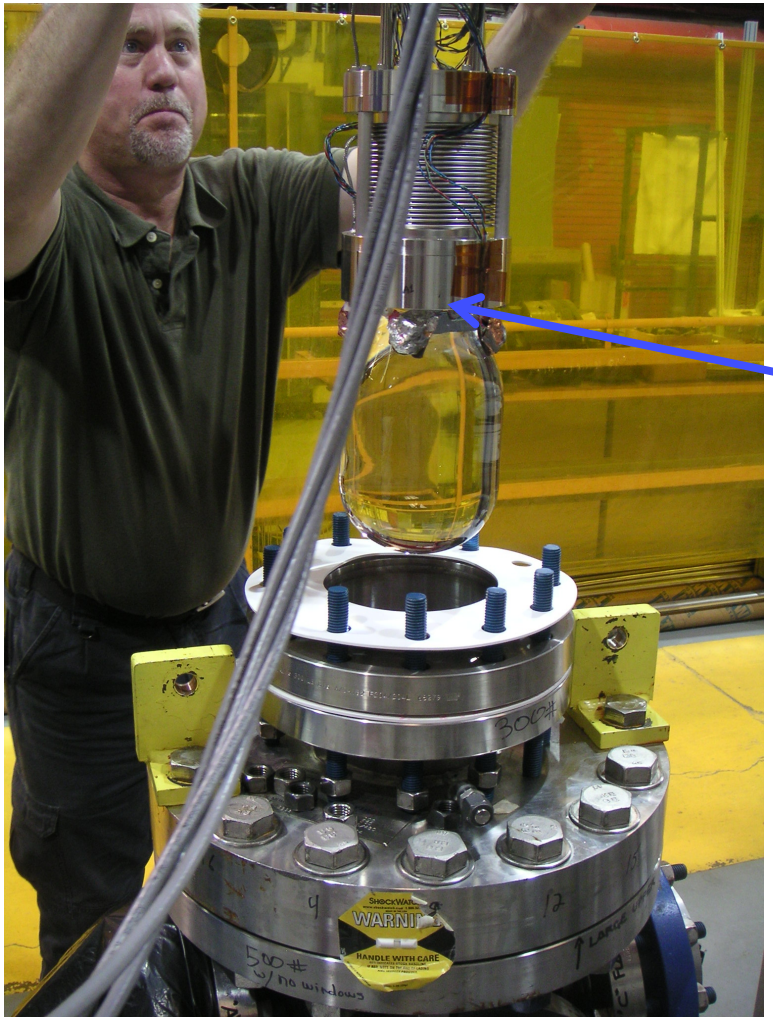
1) Open the chamber:
   a) open the top flange seal

The Work We Need To Do:

1) Open the chamber:
   a) open the top flange seal

extract the inner vessel assembly

The Work We Need To Do:



1) Open the chamber:
   a) open the top flange seal

The Work We Need To Do:

1) Open the chamber:
   a) open the top flange seal
   b) extract the inner vessel assembly

2) Disassemble the Bellows seals top and bottom
   a) cut acoustic sensor wires
   b) extract the old bellows and the jar
   c) strip top flange plumbing.

The Work We Need To Do:

3) Clean the parts
   a) Bag the pieces
   b) Transport to A-0
   c) Ultrasonic clean, bag

4) Re-assemble
   a) Re-assemble the bellows & jar
   b) Replace plumbing, valves, and instrumentation

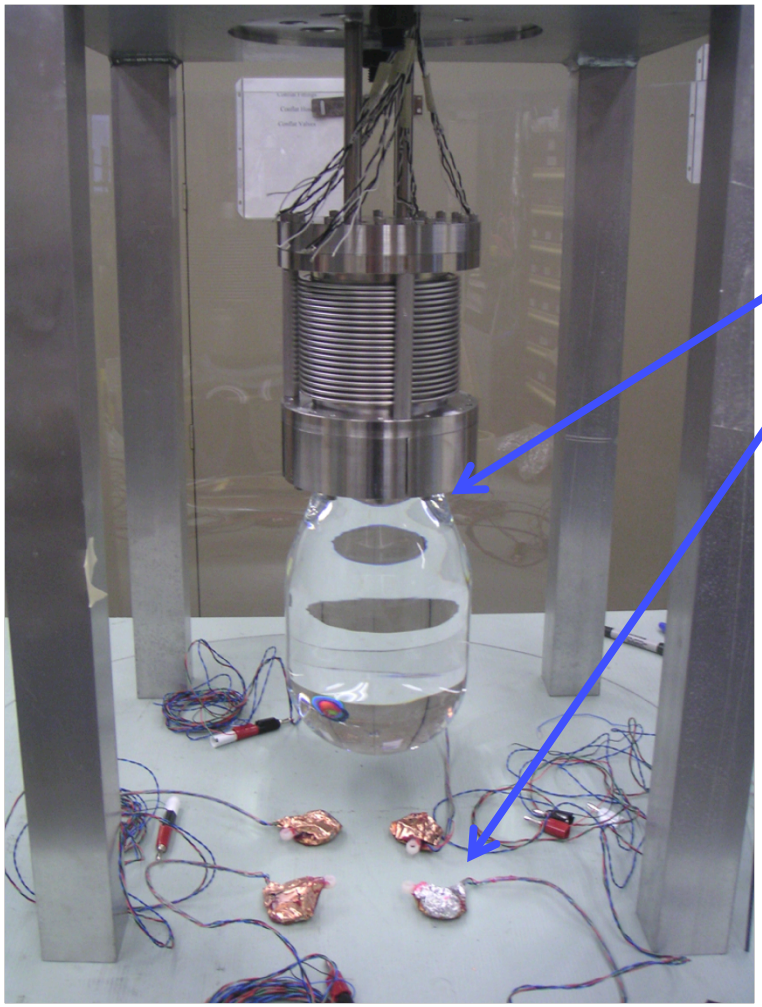
5) Vacuum Leak Check

The Work We Need To Do:

6) Water Distillation
   a) Mobilization of distillation apparatus
   b) Setup in Lab-3
   c) Complete the Water fill of the chamber.

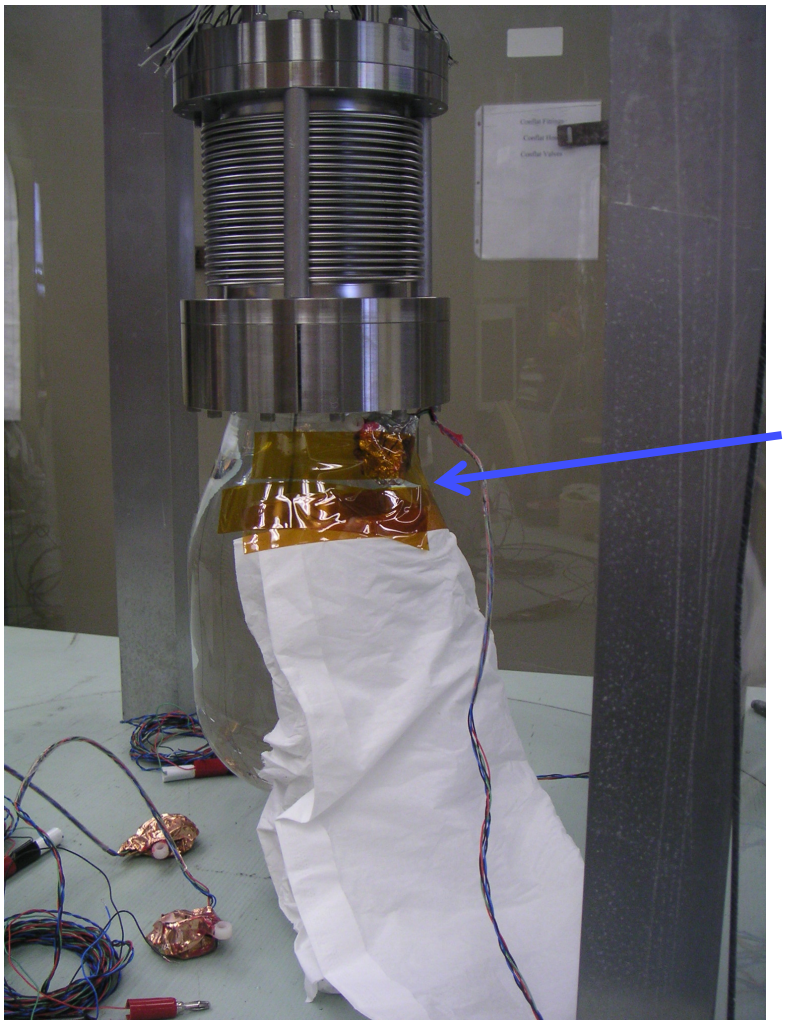
7) Expand Process Flow Diagram to include Fill Configurations.
   a) Water
   b) CF3I
   c) Glycol

The Work We Need To Do:



1) Prep for Acoustic Sensor Installation
   a) Clean the sensors and surfaces.

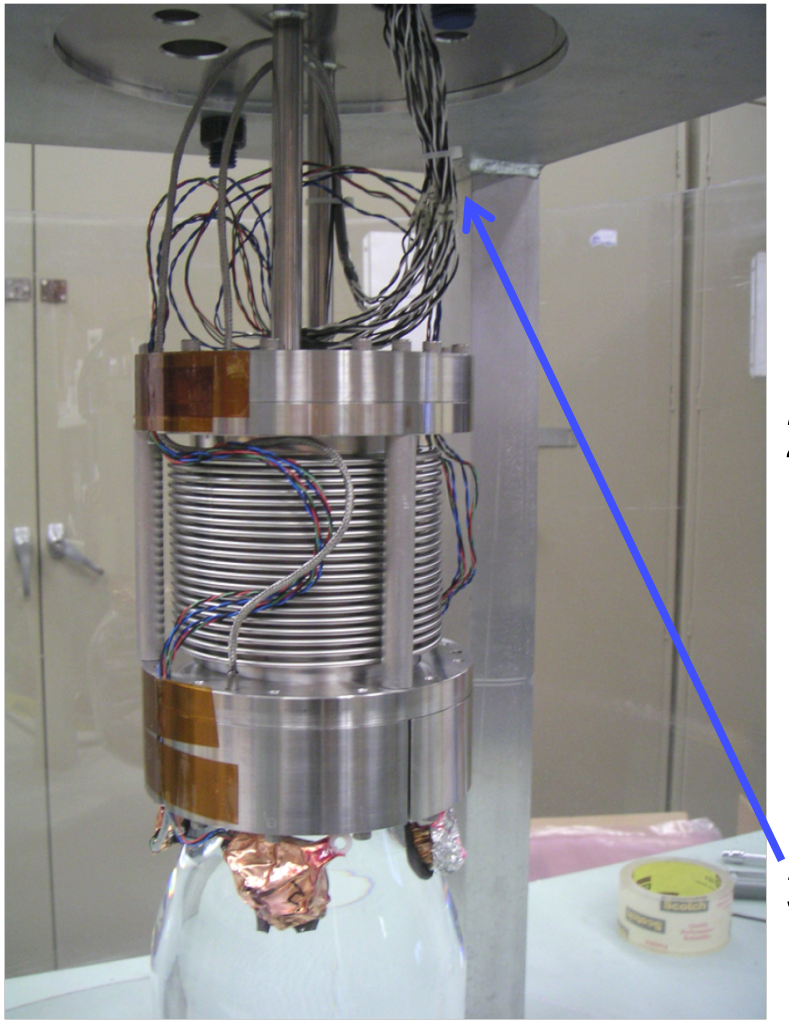
The Work We Need To Do:



1) Prep for Acoustic Sensor Installation
   a) Clean the sensors and surfaces.

2) Glue on the Sensors
   a) Mask bond area with Kapton tape
   b) Bond with JBWeld epoxy

The Work We Need To Do:



1) Prep for Acoustic Sensor Installation
   a) Clean the sensors and surfaces.

2) Glue on the Sensors
   a) Mask bond area with Kapton tape
   b) Bond with JBWeld epoxy

3) Reconnect internal wiring, test.

The Work We Need To Do:

1) Hydraulic Cart Plumbing Tune-Up

   a) Eliminate brass fittings

   b) Eliminate unused components

Our Controls Failure

1) Video driver hung with no errors.
   a) Always returned the same stale frames
   b) All DAQ loops index to camera frame acquisition
   c) Cycle period dropped to ~2 msec instead of 10
   d) dP/dt is really dP/(fixed value10msec)
2) Therefore we had no video trigger and a significantly desensitized pressure trigger.
3) The run control loop continued to allow expansions
4) The Hydraulic Cart PID loop continued to regulate the pressure
5) The bellows was stretched.
6) NEED IMPROVED DAQ ERROR HANDLING
7) Link to Failure Analysis Report:
   http://coupp-docdb.fnal.gov:8080/cgi-bin/ShowDocument?docid=151

The Work We Need To Do:

1) Add protections to DAQ code
   a) Expansion Permit – subject to good status
      i. Check frame counter
      ii. Check measured δt
      iii. Check absolute timestamp advance
      iv. Check Hydraulic Ram position
      v. Check Pneumatic Ram position
      vi. Check Temperatures

   b) Eliminate Temperature PID loop in top level DAQ
      i. Add a separate temperature sensor so that we can use the native PID on the NESLAB
      ii. Other solution?

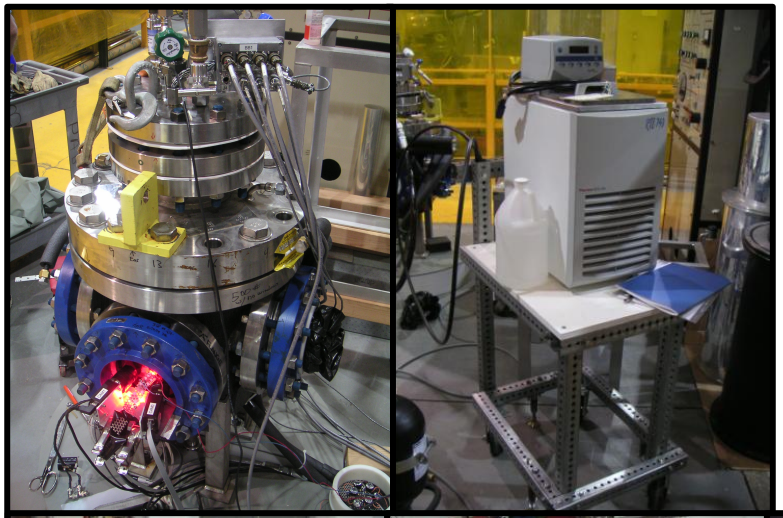
The Work We Need To Do:

a) Eliminate Temperature PID loop in top level DAQ

   i. Add a separate temperature sensor so that we can use the native PID on the NESLAB

   ii. Other solution?

The Work We Need To Do:



a) Prep for Shipment
   a) Chamber vessel
   b) Hydraulic cart
   c) Relay Rack
   d) NESLAB unit
   e) Inner vessel assy.
   f) Fluid handling

Site Prep:

Resource Requirements Summary:

Footprint: 8 feet x (12-18 feet) = 96-144 square feet.

Network Connection: needs spec.

Electrical: 2-3 60Hz, 110V, 20A circuits.
We may choose to provide a UPS for the DAQ rack.

Compressed Air: <10 SCF/day @ >50 psig

Hoist (need ~15 feet below the hook for water tank shield)

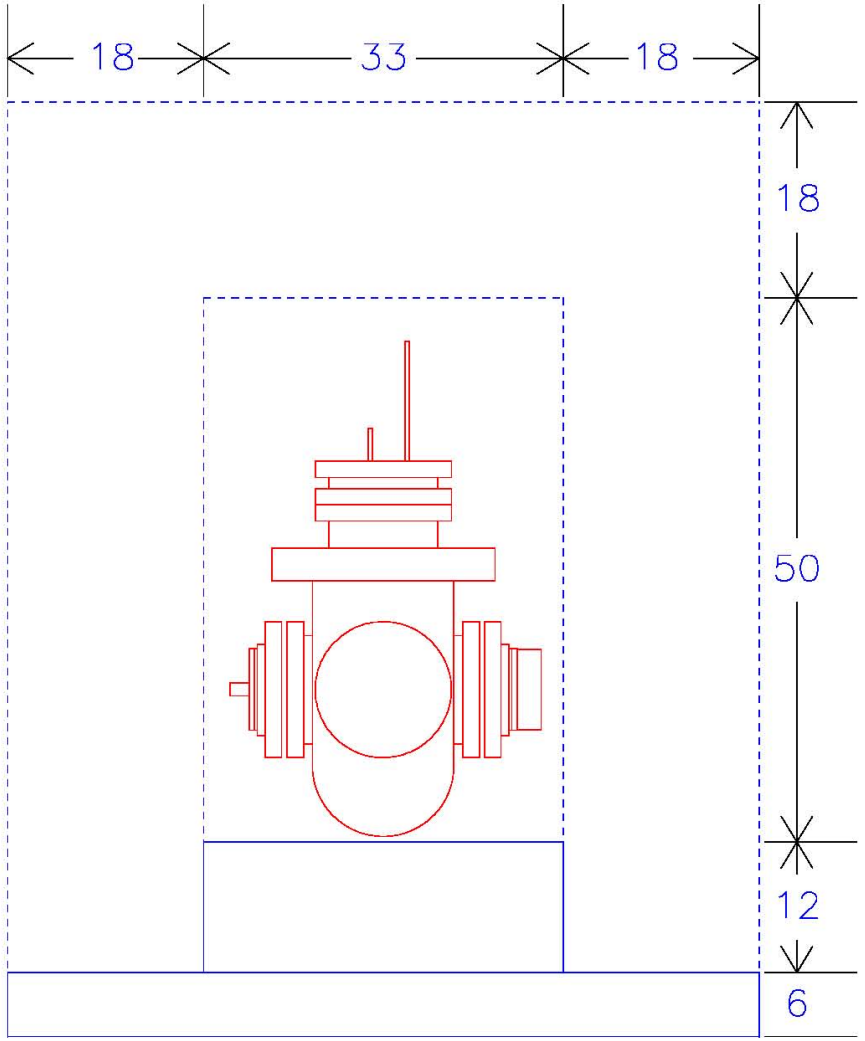
Provisions for use of radioactive sources?

Site Prep:

a) Nominal Shielding Requirement
   i. 18 inches water or poly
   ii. Recycled poly shielding material is OK

b) Baseline Solution
   i. is recycled poly from U.C. (Collar)

c) Fallback
   i. FNAL Recycled poly
   ii. Water tank



Resources Required (People)

1) Mark Ruschman [senior technician]
   1) Vessel extraction
   2) Inner vessel disassembly, clean, reassembly, vacuum leak check
   3) Water distillation setup
   4) *1-2 weeks over the next 6 weeks plus 1 week in June.*

2) Mike Crisler [senior scientist]
   1) Preparation of engineering materials and documentation.
   2) Update Operations Written Procedures.
   3) Improvements to DAQ and controls code.
   4) Instrumentation wiring, testing.
   5) Acoustic Transducer installation and testing.
   6) Commissioning tests of overall system.

Resources Required (People)

3) Jeter Hall [FNAL research associate]
   1) Write PRL for 2009 run.
   2) Improvements to DAQ & controls code.
   3) Improvements to analysis code.
   4) Preparations for Installation, Operations
   5) Coordinate Installation, commissioning at SNOLAB

4) Eric Dahl* [UC Kavli Institute Fellow]
   1) Improvements to DAQ & controls code.
   2) Improvements to analysis code.
   3) Update Operations Procedures
   4) Installation, commissioning at SNOLAB
   5) Operations Coordination at SNOLAB

*also ops coordinator for 60-kg

Resources Required (People)

5) Engineer TBD
   1) Checking drawings and procedures
   2) Possible analysis of shipping preparations
   3) 1-2 days of effort over the next 6 weeks.

6) Sten Hansen*
   1) Ongoing development of acoustic transducer readout
   2) Coordinate readout board fabrication and assembly
   3) Few days of effort

7) Electronics Assembly Tech*
   1) Transducer board assembly
   2) Few days of effort

*off-project in that this is an ongoing R&D activity

Resources Required (People)

8) Ilan Levine, Ed Behnke, et.al at IUSB*
   1) Ongoing development of acoustic transducer fabrication
   2) Need to fabricate a special batch for COUPP-2L
   3) Few days of effort

*off-project in that this is an ongoing R&D activity

Resources Required ($)

1) Bellows Replacement
    1) $3K

2) Miscellaneous Plumbing
    1) Miscellaneous fittings to replace brass on hydraulic cart
    2) Additional Temperature or Pressure Transducers
    3) Call it $2K

3) DAQ Upgrade*
    1) Replace 2-core processor with 4-core
    2) Use multiple and Faster DAQ cards for Instrument I/O
    3) This could add up to $10K

*off-project Kavli Institute R&D effort

Resources Required ($)

4) Infrastructure Costs at SNOLAB
   1) Power, lighting, compressed air, network connection
   2) I really have no idea what this costs.
   3) Call if $15K

5) Additional Shielding Costs
   1) We'll likely use (re-)recycled polyethylene
   2) We may need additional material or some structural elements
   3) Call it $10K

6) Travel Costs
   1) Installation nominally 1 week, three people. Call it 3x$2k = $6k
   2) Emergency trips, routine maintenance.
      i. This is very hard to estimate at this time.
      ii. Depends on SNOLAB, and it will merge with 60kg preparations.
      iii. Imagine 2 people travelling per month. 3 months x 2 x 2k = $12k

*This could be U of C or SNOLAB

Resources Required Summary

1) TOTAL $ COSTS
   1) Something less than $10k nominal cost to repair the detector
   2) Something or order $10k optional DAQ upgrade
   3) Something like $25k site preparation costs including shielding.
   4) Something like $20k in travel costs for installation and maintenance.
   5) I'll call this $10k (+$10k) [+$25k] {+$6k}
   6) The code is
      $necessary (+optional) [+not well understood site costs] {+travel}

2) The ONLY critical personnel resource issue is M.R.
   1) Can PPD make Mark available for ~two weeks out of the next six?

3) Three possible funding sources:
   1) DOE at Fermilab
   2) NSF at U of C
   3) Some SNOLAB support may be available for site work
   4) COUPP does not propose to resolve this issue now.

Scientific and Technical Merit:

- A run of the 4 kg in a deep site will significantly advance the state of the art of bubble chambers for WIMP searches
  - Continue testing acoustic discrimination in a device that has demonstrated excellent performance
  - Develop alpha source techniques for bubble chambers
- The science goals are significant enough to warrant operation of the 4 kg in a deep site
  - World class sensitivity to both spin-dependent and spin-independent WIMP-nucleon couplings
- There are significant synergies between the operation of the 4 kg and 60 kg chambers
  - In-situ alpha sources are required for a dark matter discovery in all future bubble chambers
  - A world class science result will cement bubble chambers as a (the) leading technology for the direct detection of dark matter
  - Building relationships with SNOLAB and Canadian colleagues will strengthen the COUPP collaboration
  - Developing operations expertise and experience in SNOLAB will accelerate that transition for the 60 kg

Technical preparedness:

- Is the 4kg chamber sufficiently well documented to be reviewable with respect to electrical and mechanical engineering and ES&H?
  - *We think yes. There is work to do, but we're in pretty good shape.*

- Have the controls and DAQ problems encountered in December 2009 been satisfactorily resolved?
  - *Yes. We ran four months with little intervention. We need only a modest improvement in the Mean Time to Failure. The improvements we've outlined should provide a significant improvement. More than enough for our needs at SNOLAB.*

- Is the system robust enough for extended operation in a remote location?
  - *Yes. We only need a modest improvement over what we saw in our MINOS run.*

Resource requirements:

- Does the proposed plan cover all of the steps likely to be required for this deployment?
  - Yes
- What labor (scientific, engineering and technician) and M&S resources will be needed? Are the estimates reasonable and well justified?
  - Yes
- Are the resource estimates consistent with past experience with the 4kg chamber?
  - Yes
- Are there areas that are likely to require contingency beyond the estimates?
  - Not much. M&S is well understood. Site Prep isn't well understood, but will not affect Fermilab. Travel is complicated, partly "off project." The numbers provided are generous.

Resource requirements:

- What is the plan for operating the 4kg chamber at SNOLAB, in light of the need to simultaneously operate the 60 kg chamber in the NUMI tunnel? Evaluate the manpower and travel required to accomplish this.
  - The plan is to install the chamber, turn it on, and leave it. We're not planning to man the chamber continuously. A detailed understanding depends on working with SNOLAB, and we can't yet do that.
- Will work on the 4kg deployment by technicians, engineers or scientists incur any significant delays in commissioning the 60kg chamber in the MINOS underground area?
  - No
- How does COUPP propose to fund this effort?
  - We do not propose to resolve that at this time.

Summary

This is fantastic Physics for a very modest price.

- World Best spin-dependent WIMP limits sensitivity
- World Competitive in spin-independent WIMP sensitivity
- Evaluation of α-rejection vital to future program