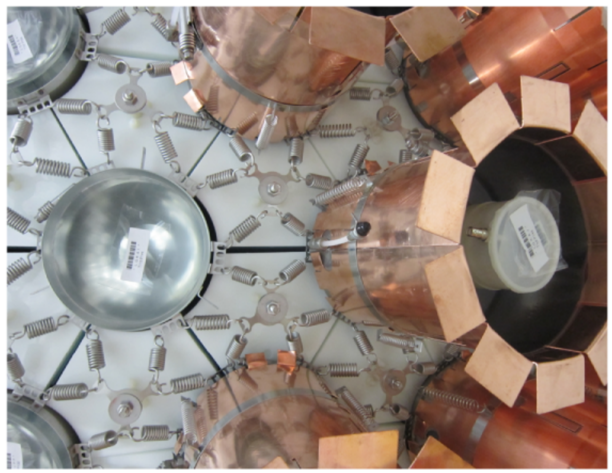
The DEAP-3600 Dark Matter Detector

Detector construction.



Detector overview.

The **neck** will allow access to the inner vessel for cleaning and liquid argon circulation.

Liquid argon at a total mass of 3600 kg (1000 kg after fiducial volume cut) serves as the WIMP target material. WIMPs interacting here create scintillation light.

The spherical inner **acrylic vessel** has a diameter of 170 cm. It holds the liquid argon.

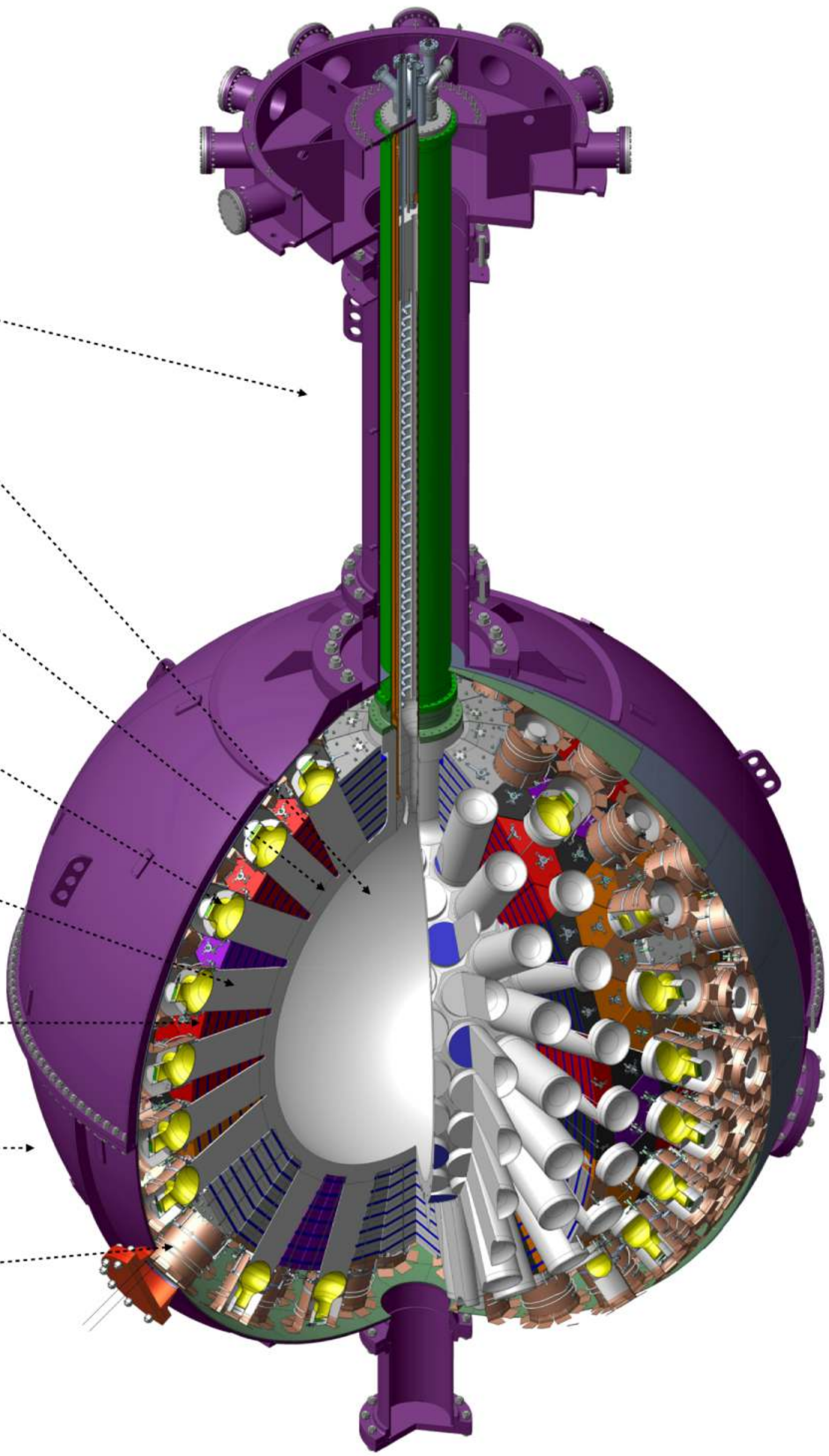
255 8” **photo-multiplier tubes (PMTs)** are optically coupled to the liquid argon volume by acrylic light guides. They detect the scintillation light.

The acrylic **light-guides** are long enough to absorb the neutrons emitted from the PMT glass and serve as thermal insulation, allowing the PMTs to be operated at near-room temperature.

Filler-blocks, made from HDPE sandwiched with foam, serve as additional neutron and thermal shielding.

The **stainless steel shell** isolates the detector from the water bath it is submerged in.

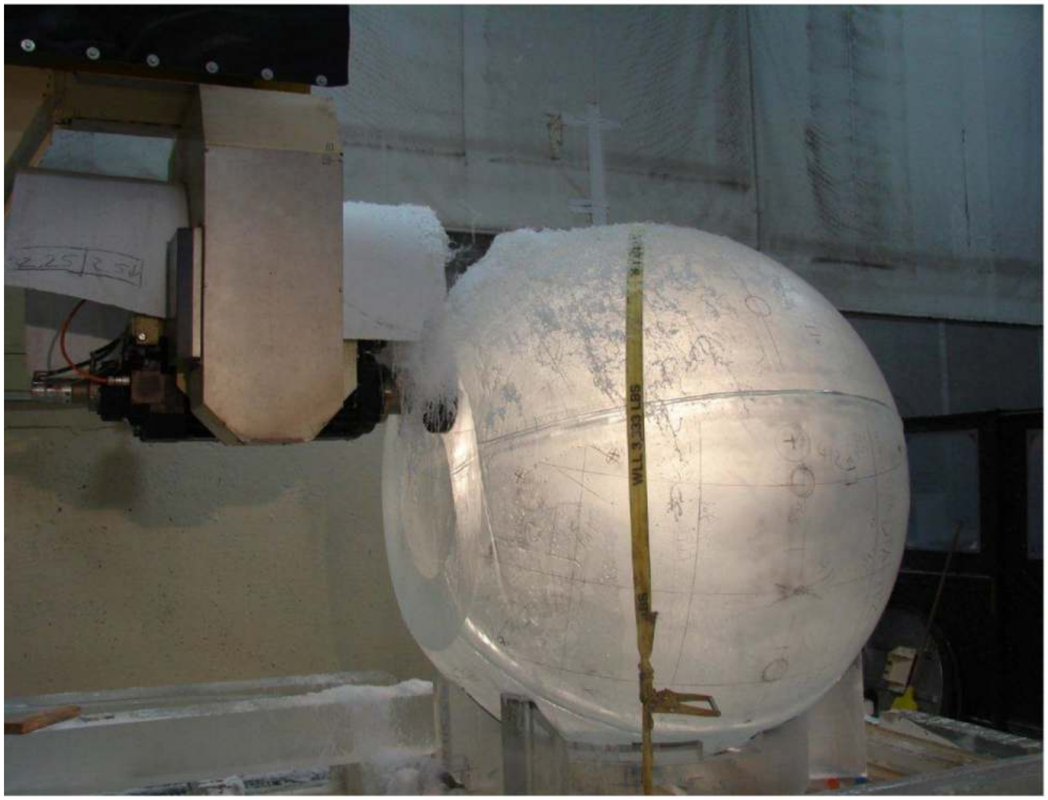
Copper **thermal shorts** keep the PMTs at their ideal operating temperature.



The journey of the acrylic vessel begins in Thailand, where acrylic sheets are poured from clean acrylic monomer.

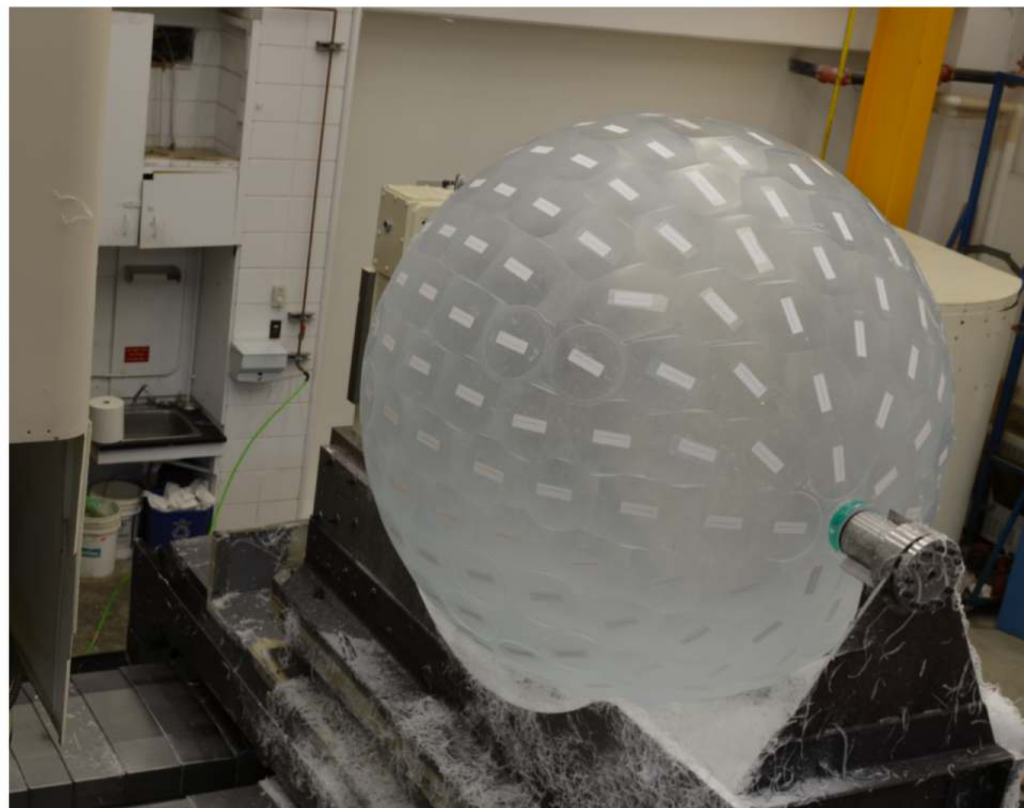
The sheets are thermoformed and machined into ‘orange slices’.

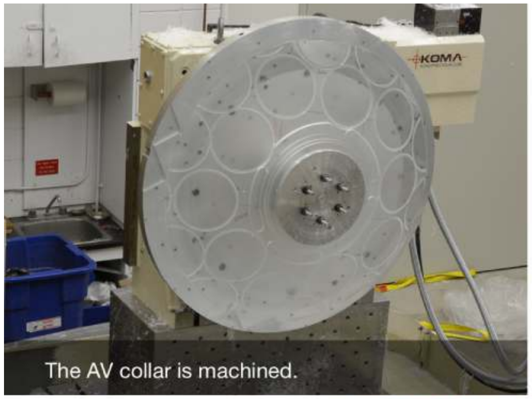
The ‘orange slices’ are dry-fit before being bonded together at Reynolds Polymer Technology, Inc.



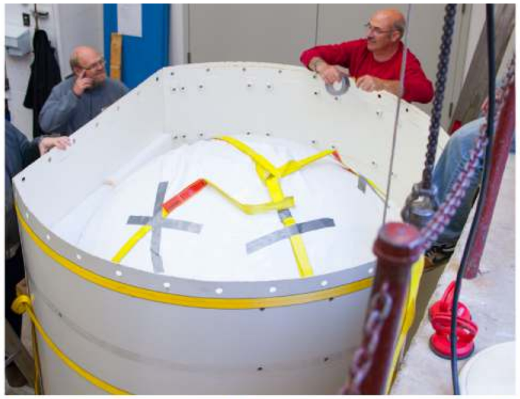
The main sphere of the acrylic vessel (AV) arrives at the University of Alberta.

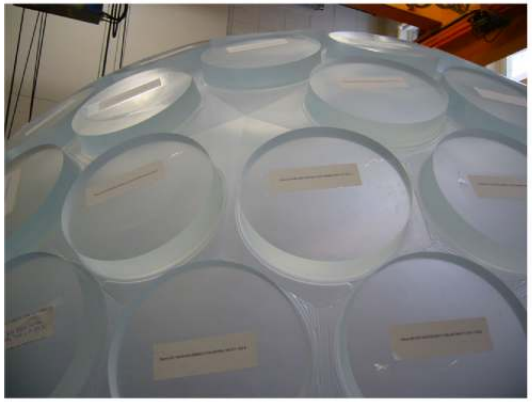
The AV is installed in the mill at the University of Alberta.

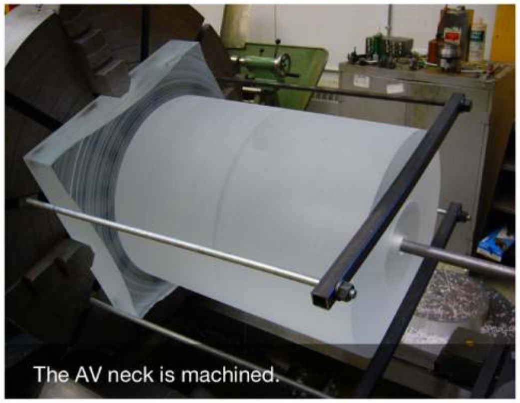


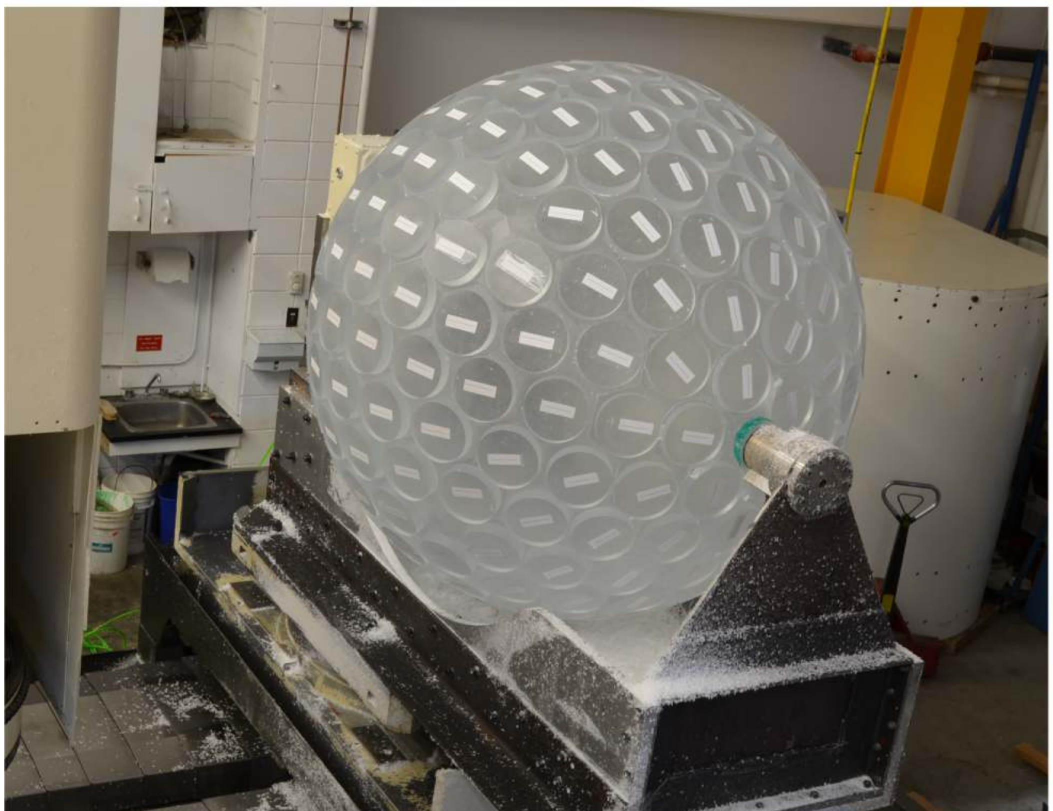


The AV collar is machined.






The AV neck is machined.




In several passes, stubs are precision machined out of the main AV sphere.

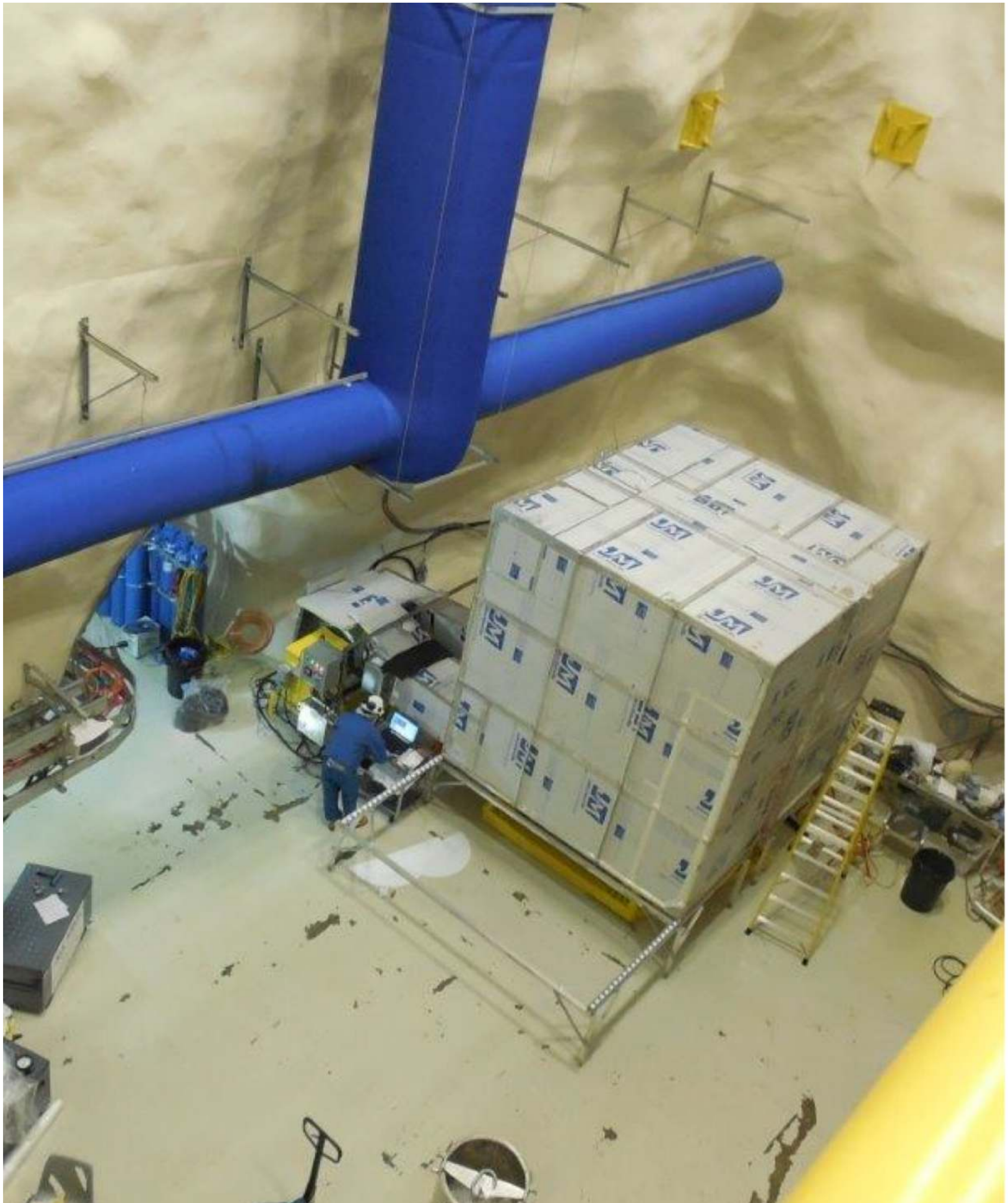
The sphere, the neck and the collar are slung to the bottom of the Cube Hall at SNOLAB.

The assembled AV would not have fit down the shaft into the mine.

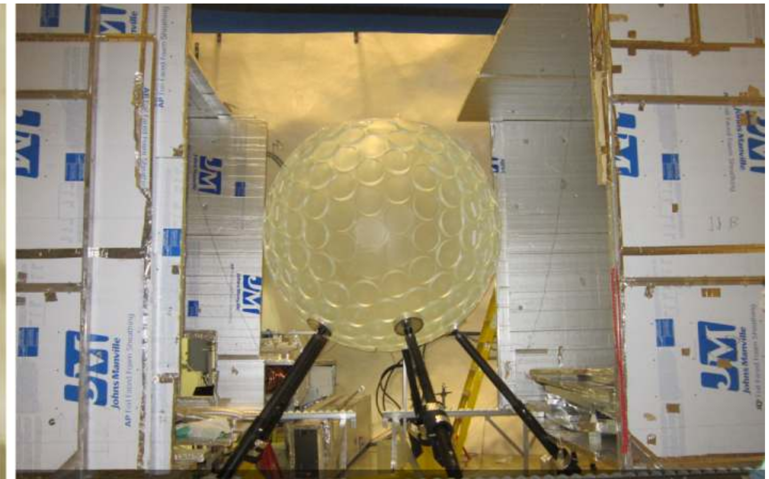
An RPT technician is preparing the AV for the collar bond.

RPT technicians pour the collar bond.

The AV neck is bonded to the AV.



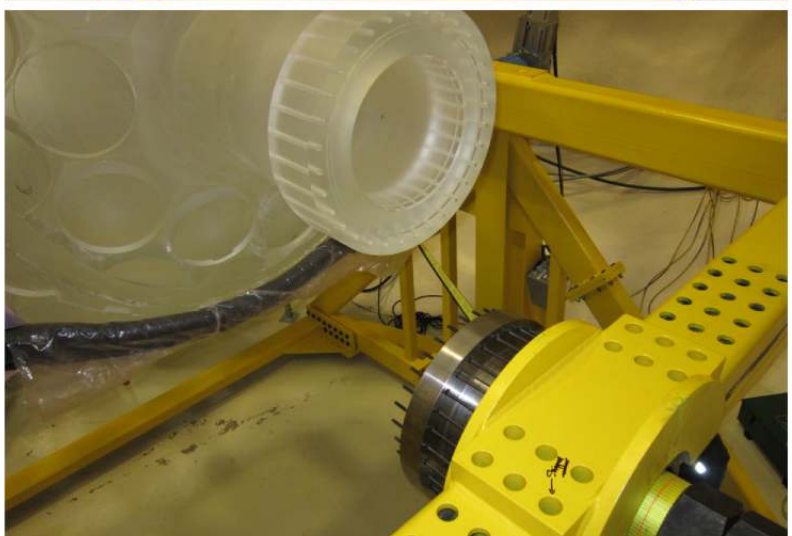
A physicist monitors the temperature inside the 10' x 10' x 10' oven in which the AV is heating up.



The oven was assembled around the AV a total of five times.

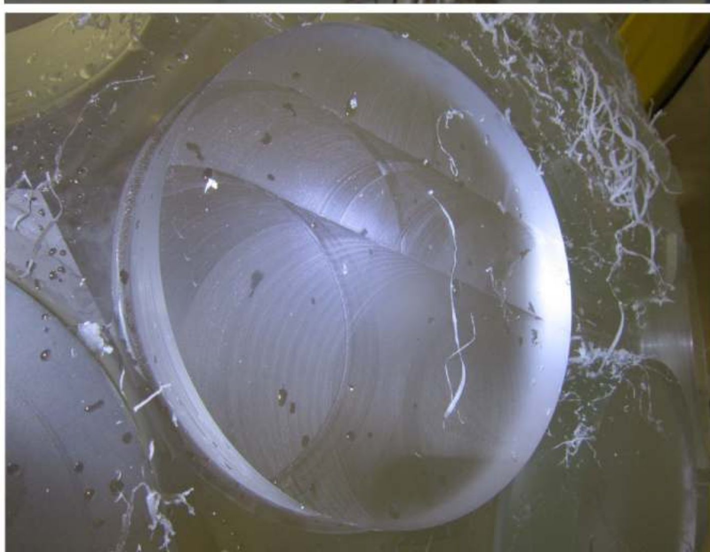
Heating the acrylic up to 85 C hardens the bonds and relieves stress.

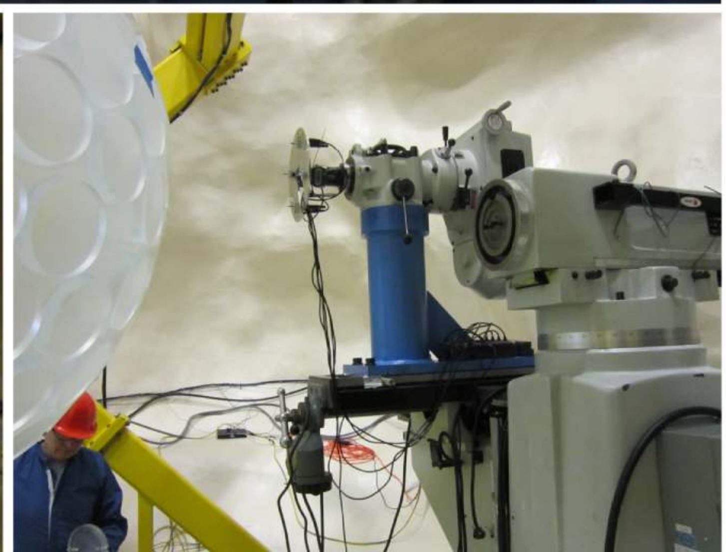
A full heating cycle takes about 6 days.



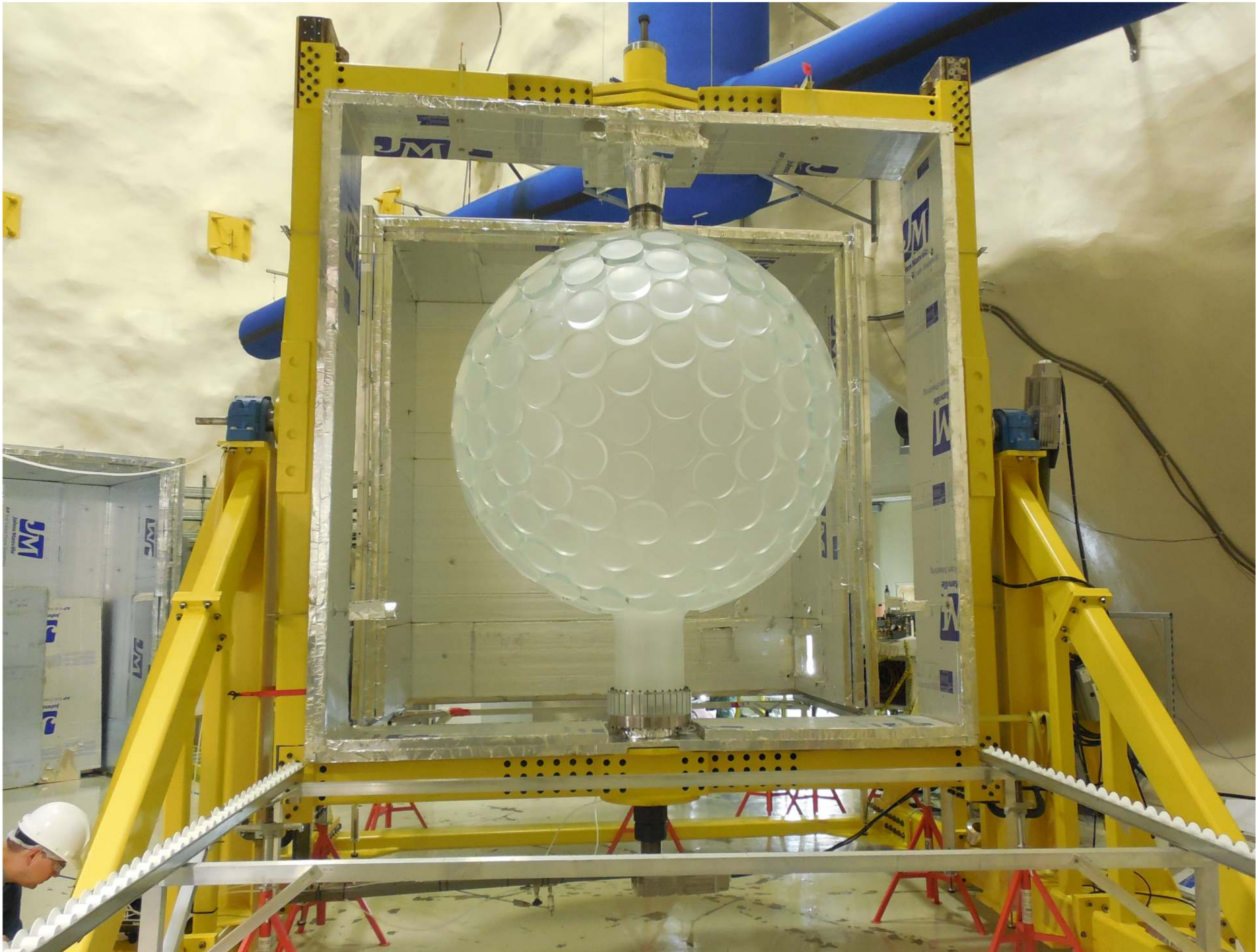
The AV is installed in the rotator.

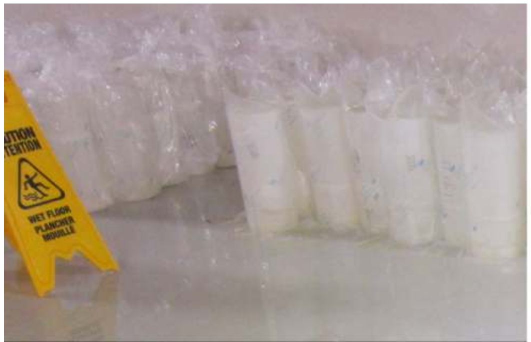

The stubs along the collar bond get touched up.





Oven modification to fit against the rotator frame.


The AV goes back into the oven.



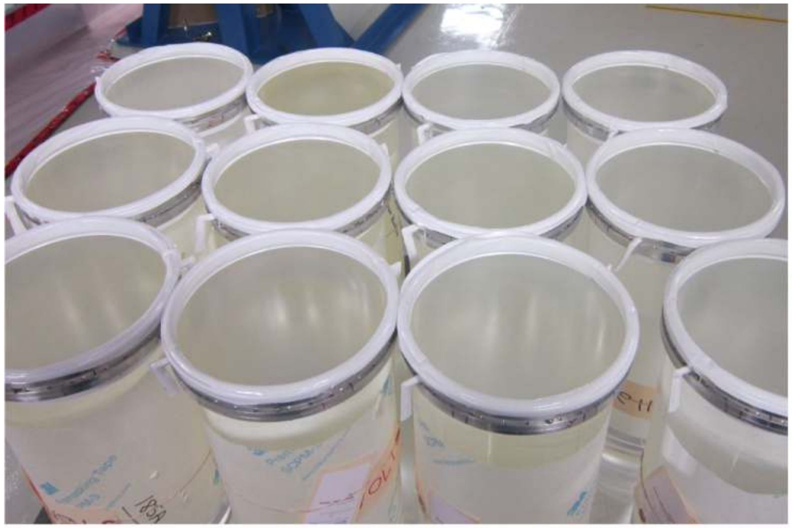
255 acrylic light guides were precision machined at TRIUMF

Once at SNOLAB, they are inspected, and the bonding surface is sanded.

The dam will keep the glue from flowing away.

Dam and clamps in place, ready for bonding.

Dams and clamps are installed on the light guides (LGs). The clamps seal the dam against the acrylic of the LG and later the stub, confining the bonding syrup to the gap between them until it hardens.



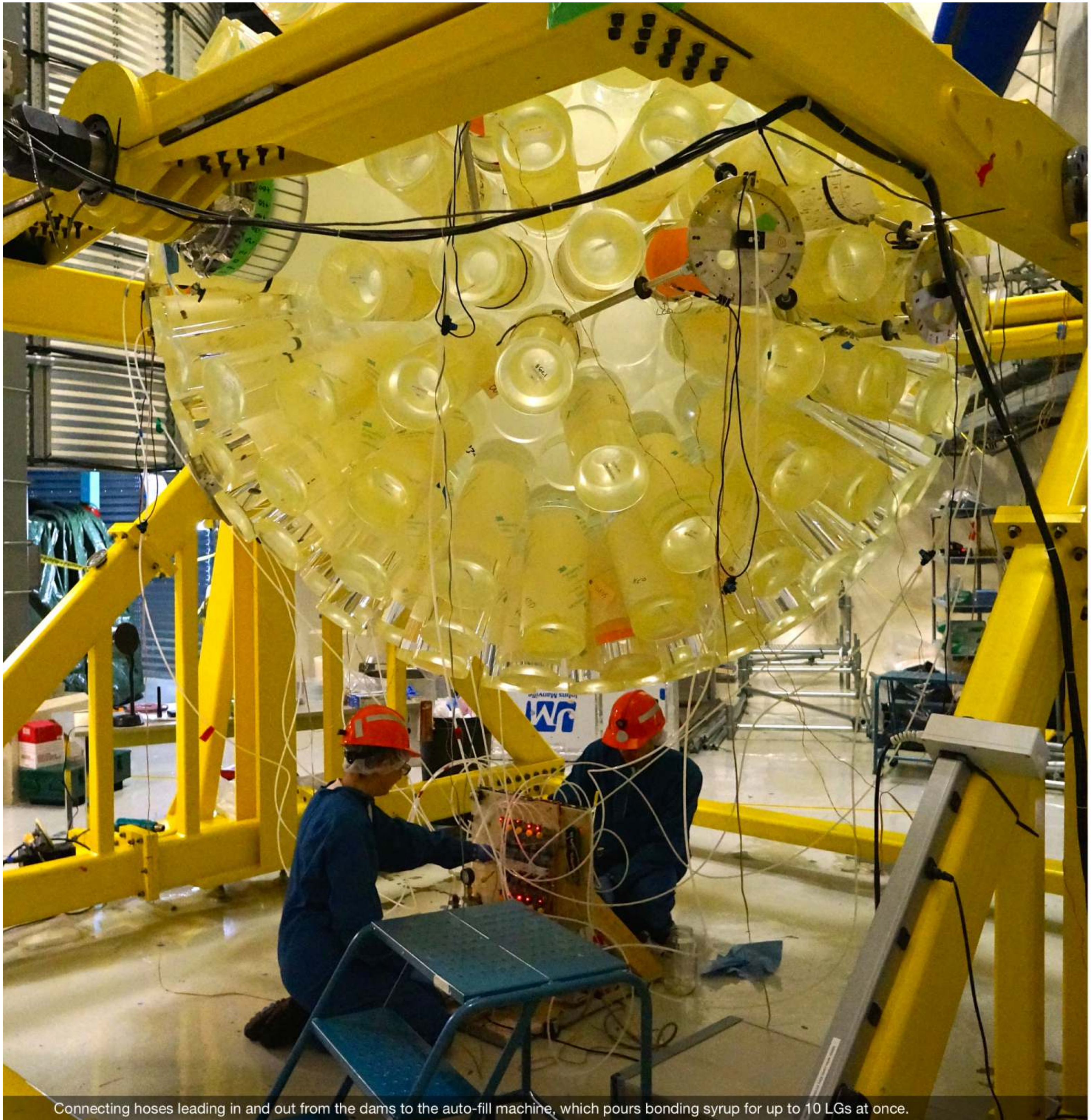
A custom alignment platform keeps all parts straight.

A stub is cleaned in preparation for bonding.

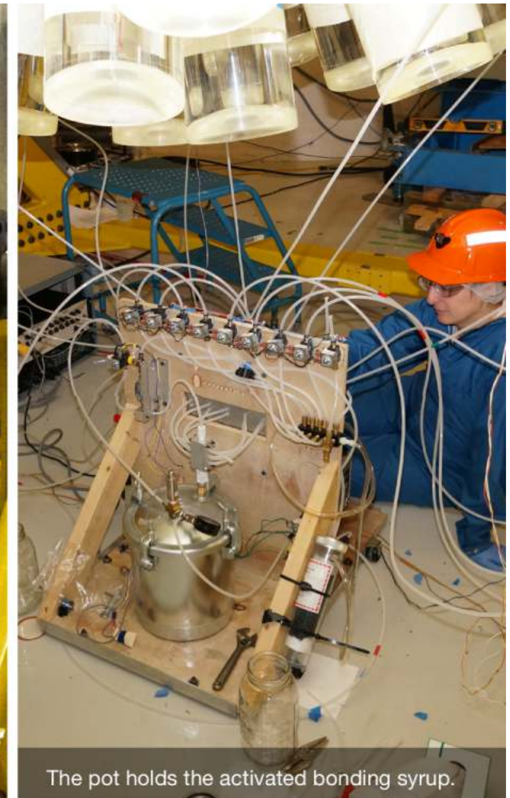
Aligning the tripod which keeps the LG parallel to its stub.

Tightening the clamp on the stub.

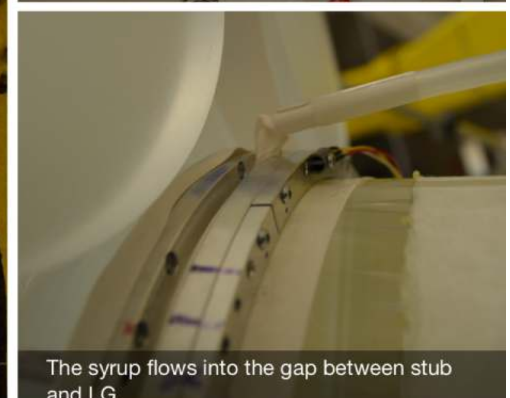
LG in place, parallel to and exactly 2 mm away from its stub.



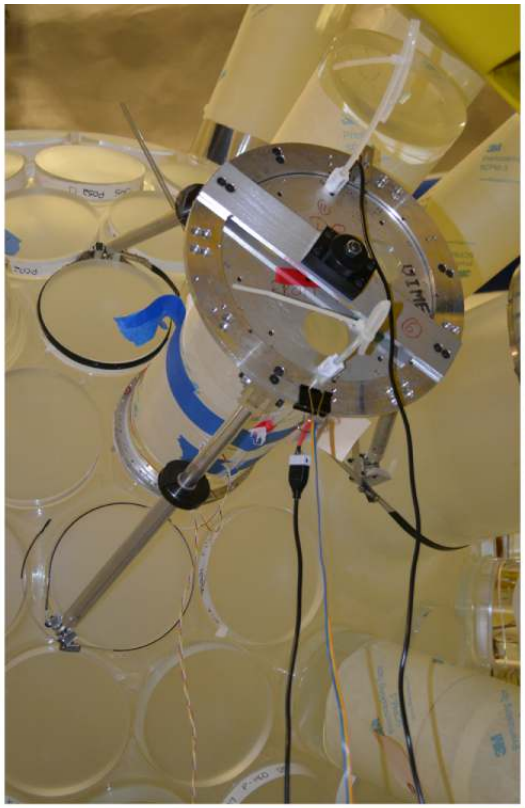
Connecting hoses leading in and out from the dams to the auto-fill machine, which pours bonding syrup for up to 10 LGs at once.

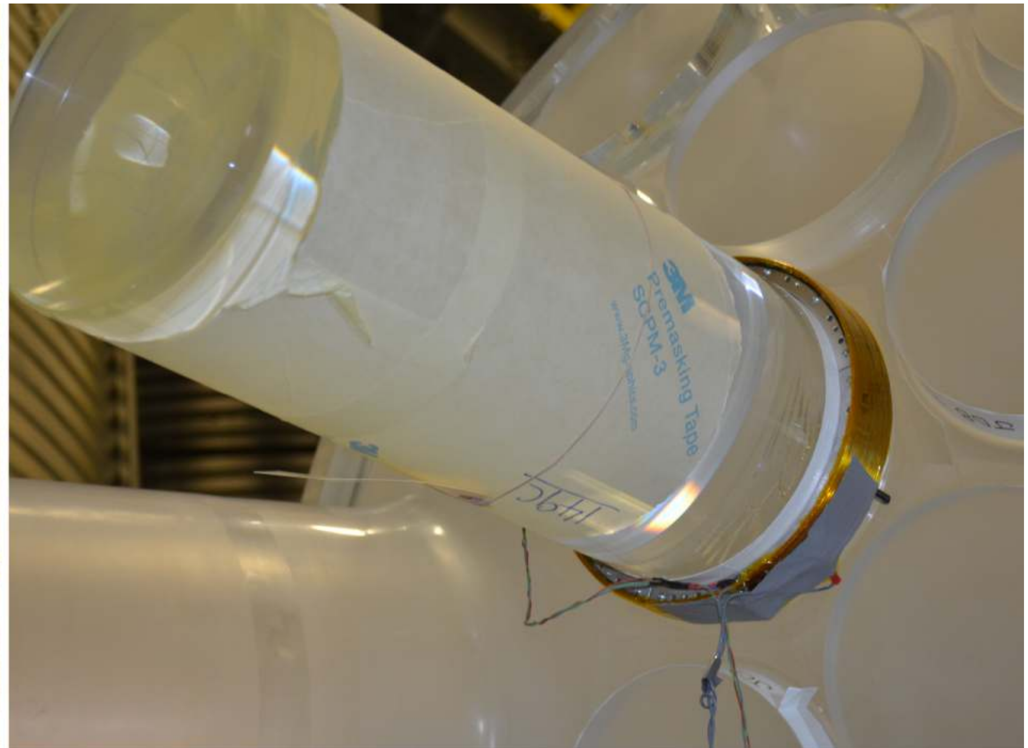


The pot holds the activated bonding syrup.

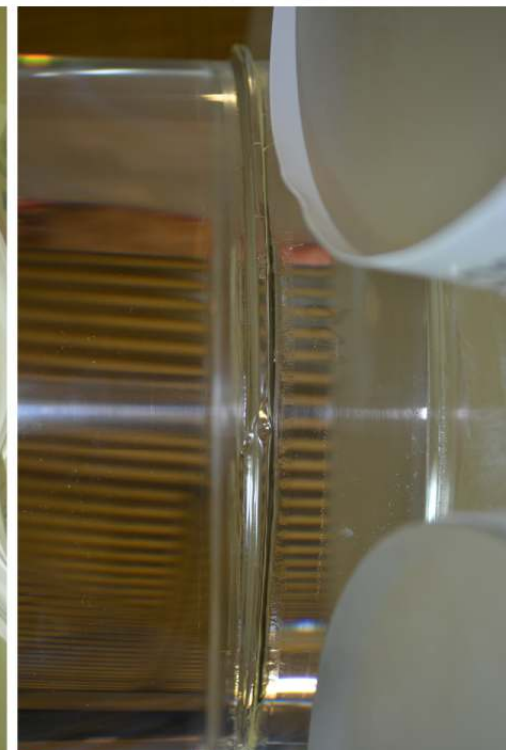


The syrup flows into the gap between stub and LG.

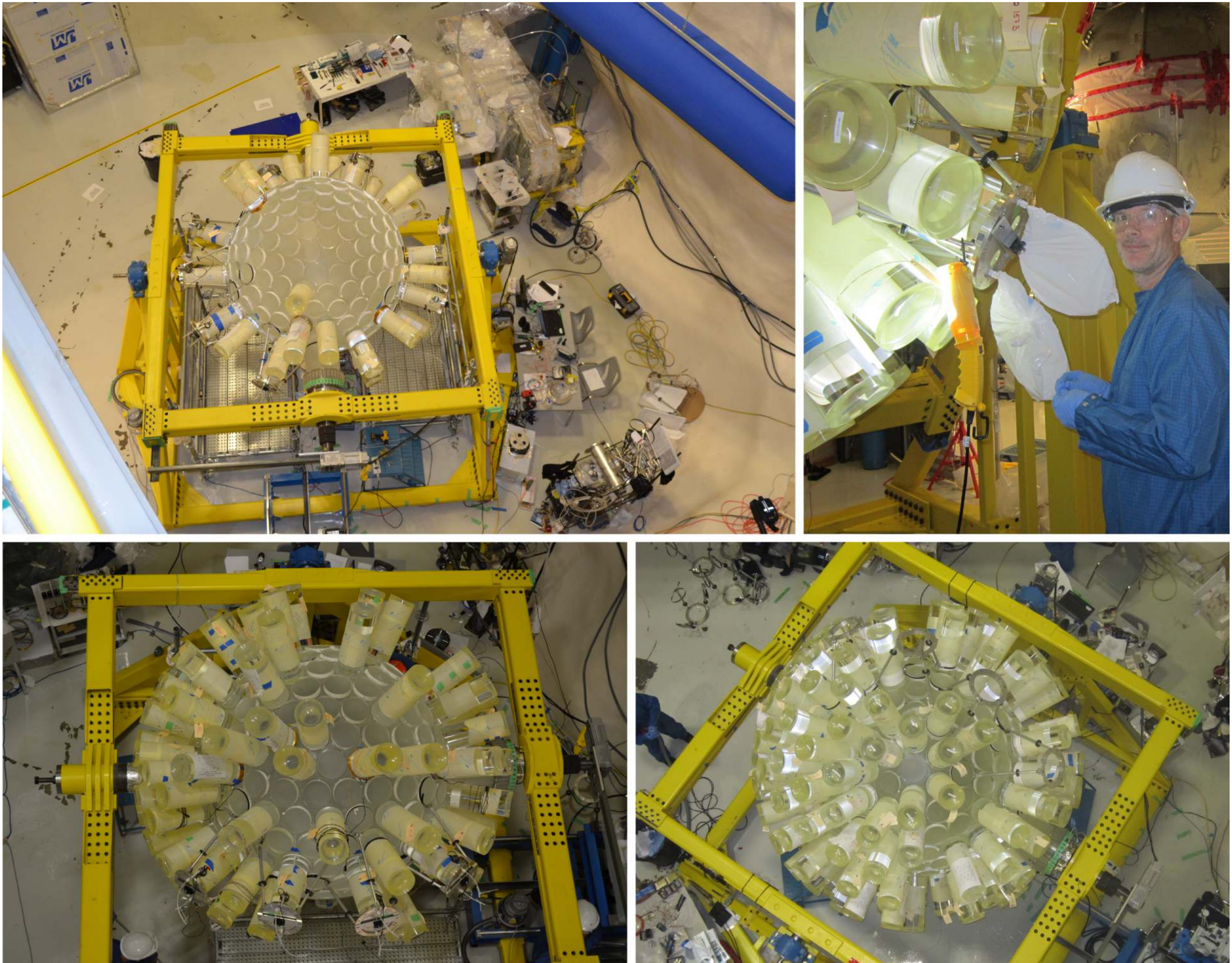




After the bonding syrup is polymerized, the bond is locally heated to harden it.



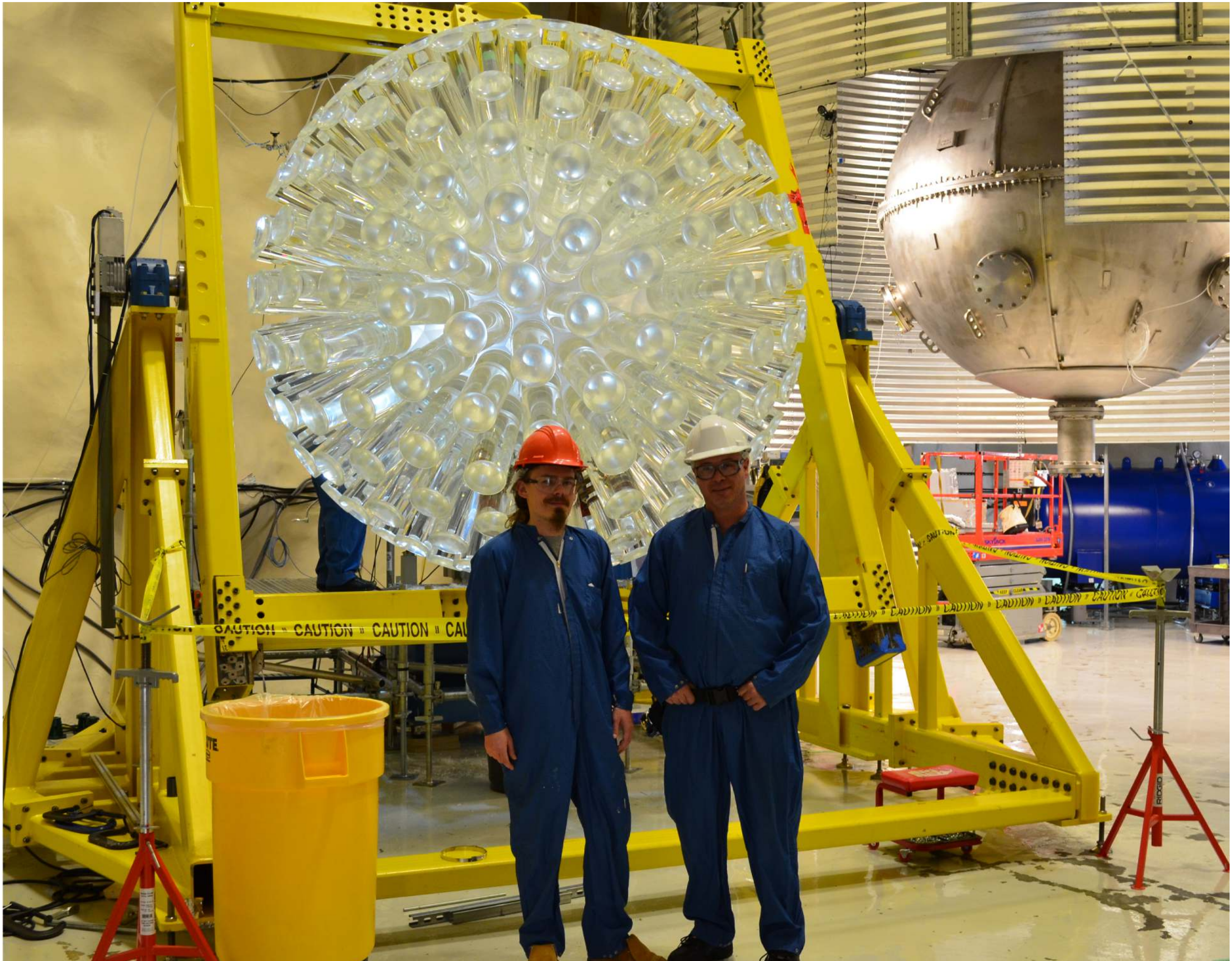
The dam is removed, leaving a 'bulge' of extra acrylic, at which any stresses accumulate.








FEATHERLITE

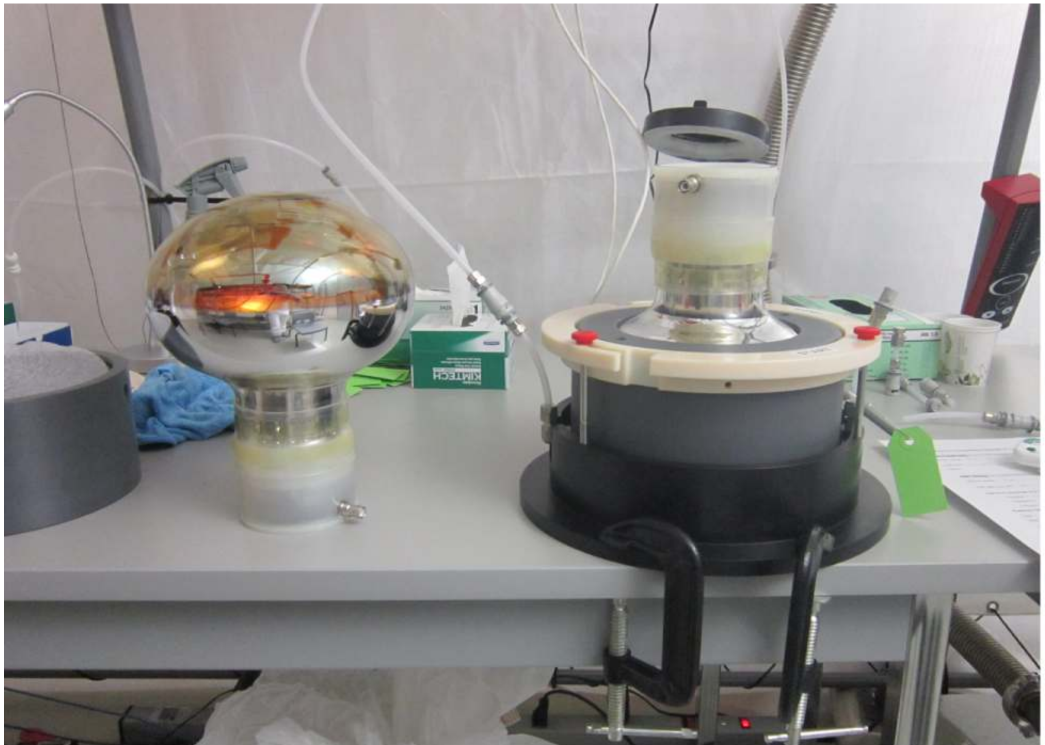

CAUTION
CAUTION
CAUTION
RIDGID

The AV is heated up for the fifth time to harden and relieve stress in the LG bonds.

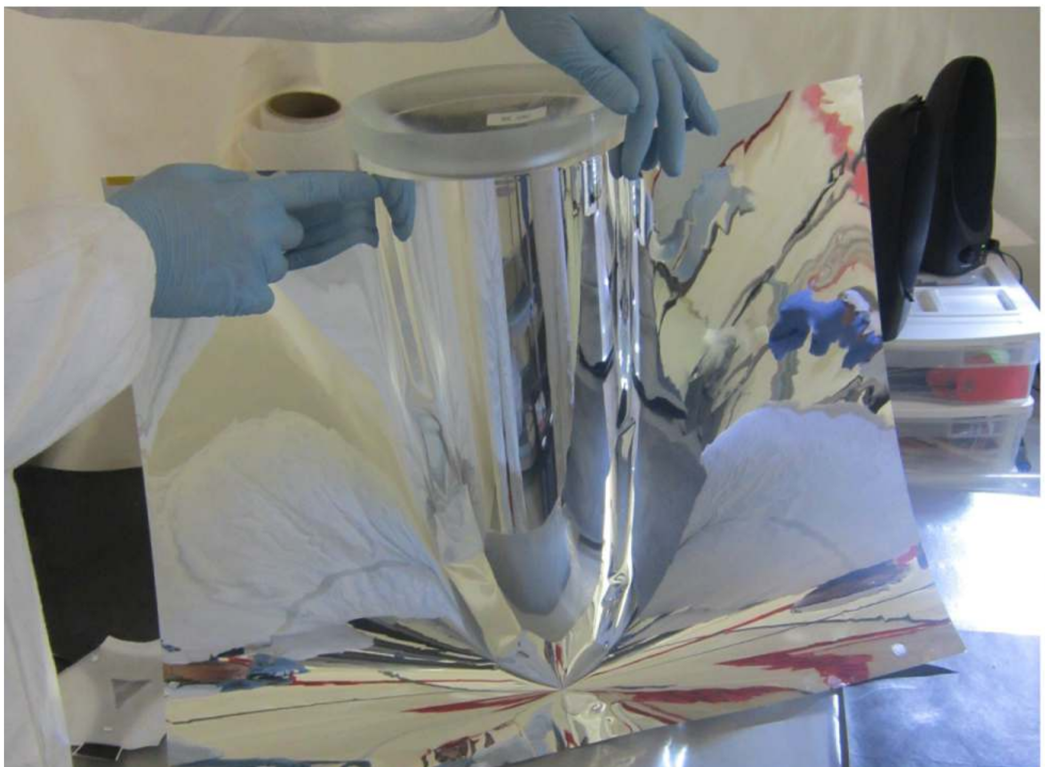
All bulges are machined off.

Blemishes are polished.

All bonds are inspected.



Naked PMT (left) and mounted PMT (right).



Dry-fit of specular reflector.

Over 19000 custom-made parts come together to accessorize the AV.

Mount gets o-ring and oil couplings.

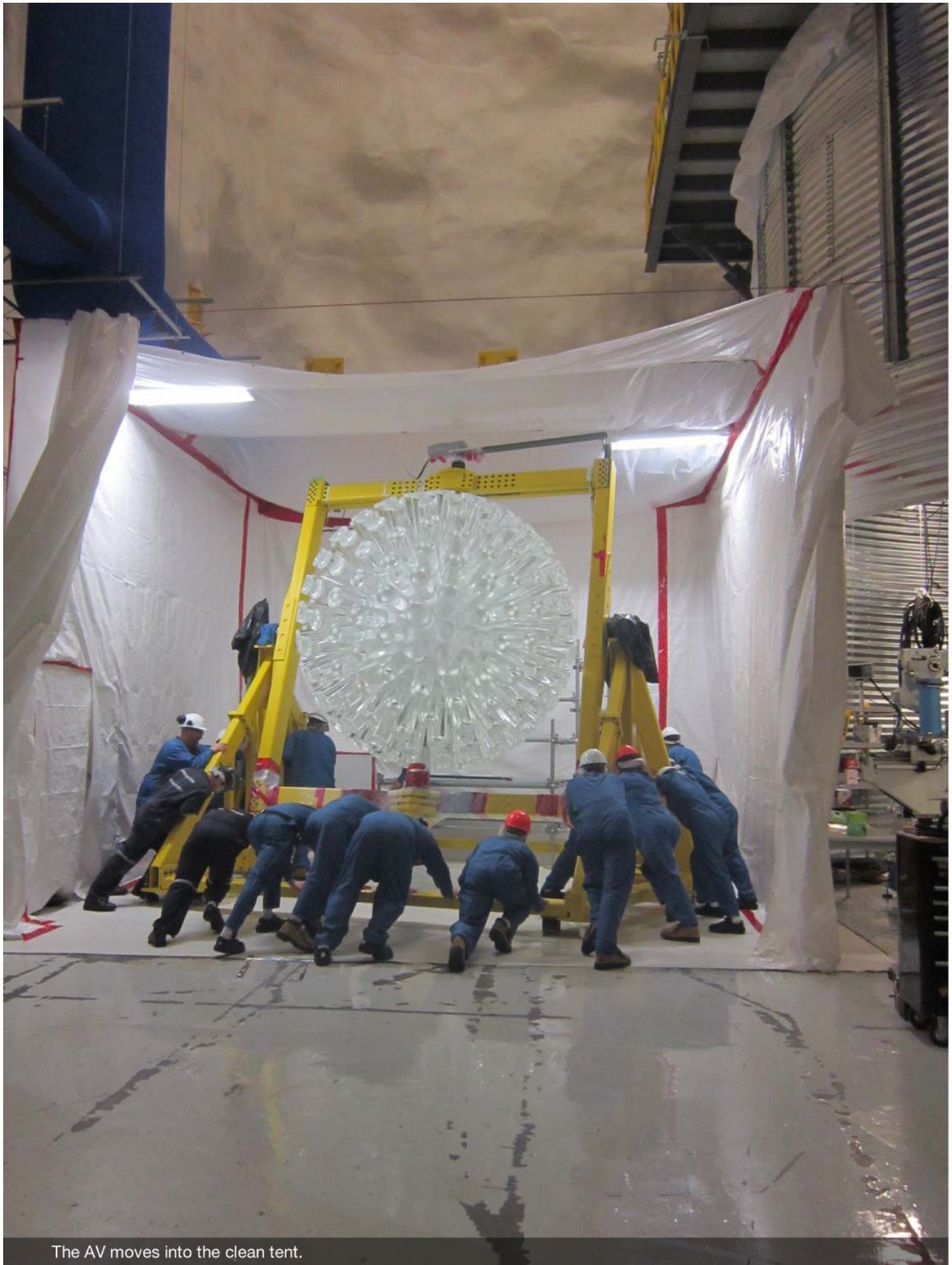
PMT bulb is measured.

PMT goes into its mount …

… and is locked in place.

Fully mounted PMT. Two green tags indicate it passed the pressure and the Helium leak test.

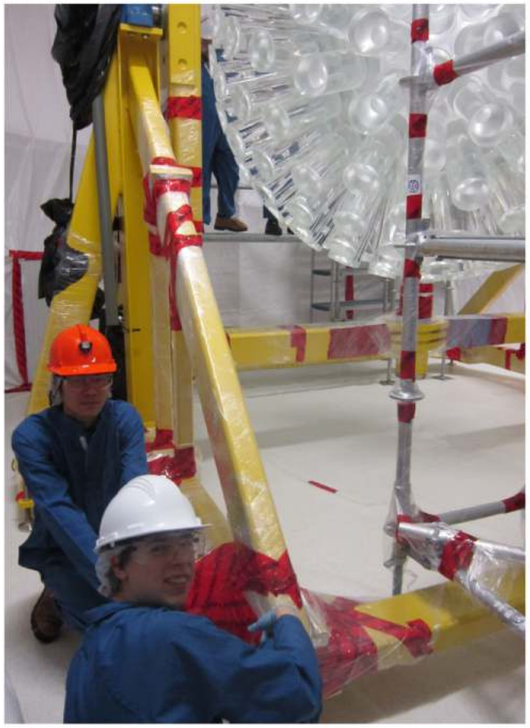
$500.000 of PMTs, 2 deep on 4 racks.



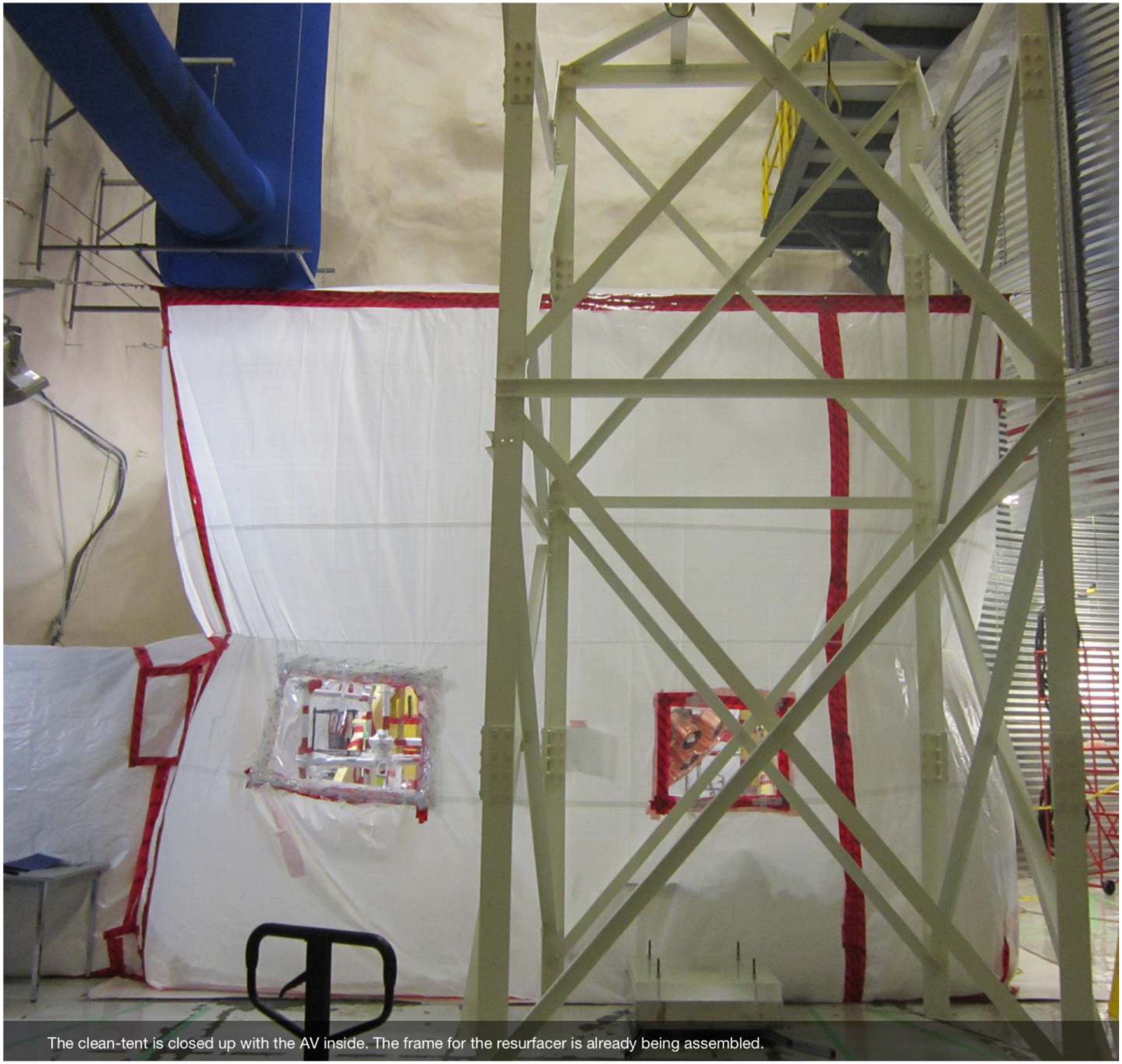
The AV moves into the clean tent.

The AV is scrubbed …

… and scrubbed some more.



Entryway into the clean-tent.



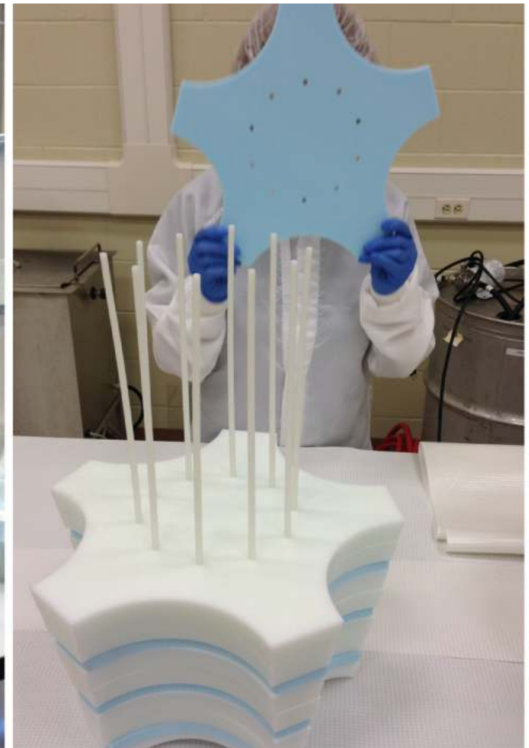
The clean-tent is closed up with the AV inside. The frame for the resurfacer is already being assembled.


Specular reflector and magnetic shielding are wrapped around the LGs.

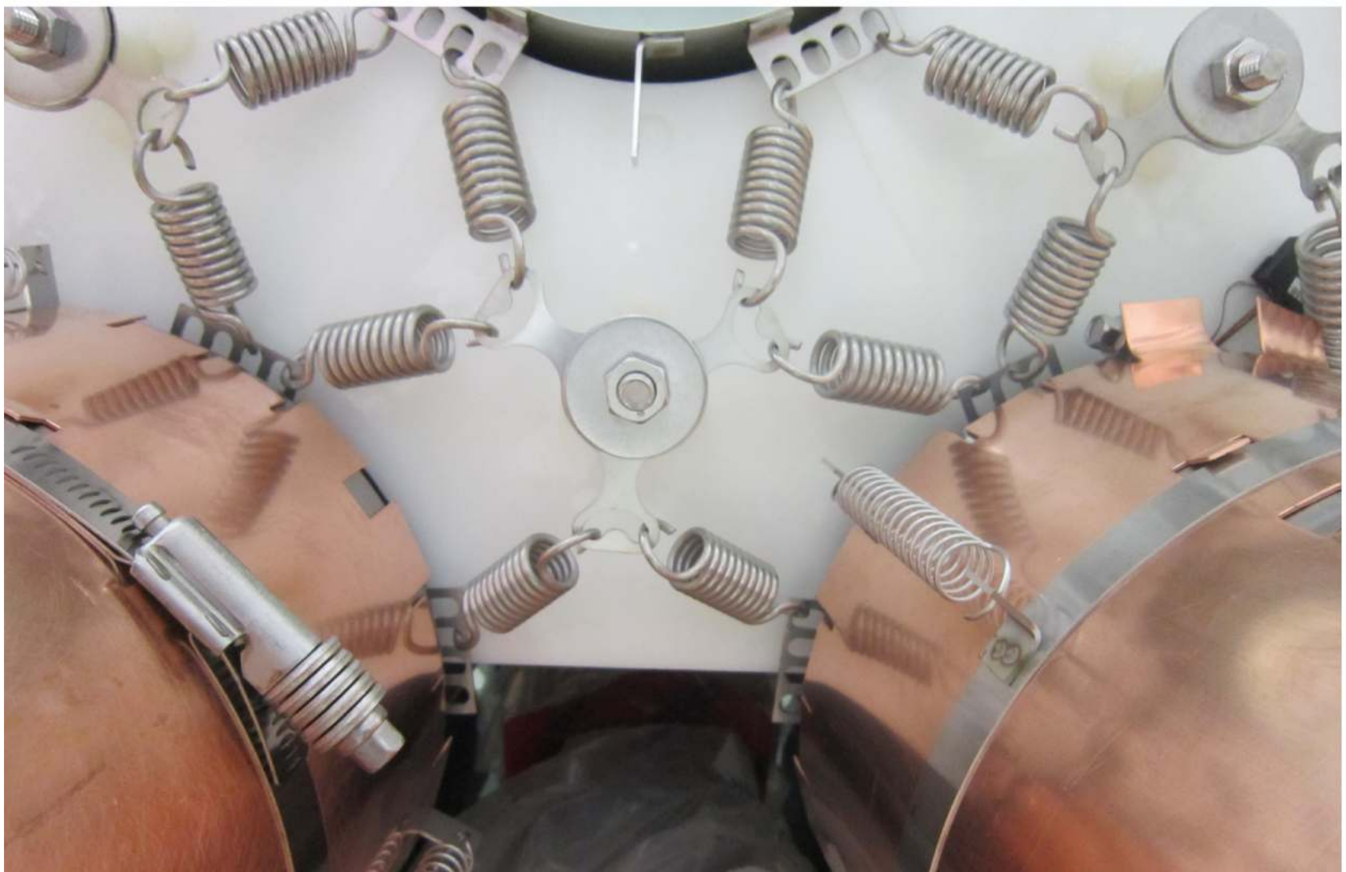

Five stitch-guns were harmed in the making of this detector.


Diffuse reflector pieces are sittched together to cover the facets between the LGs.



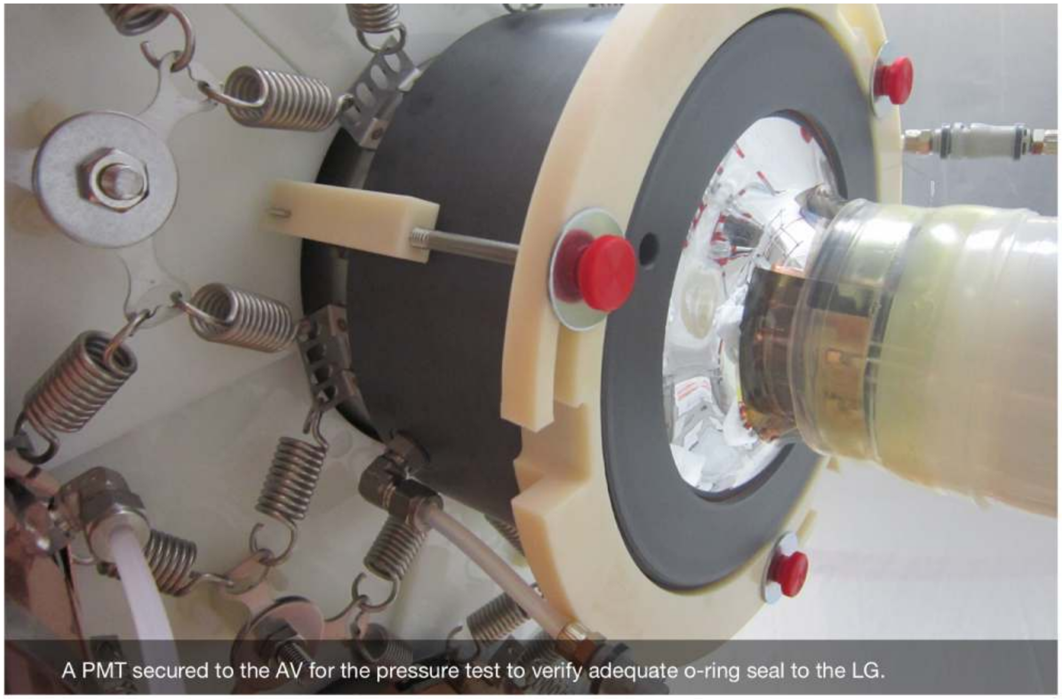



Fillerblocks, made from layers of blue foam and HDPE plastic, are pre-assembled on surface and shipped underground. They shield against neutrons and provide insulation.

Spring keeps filler blocks in place while allowing them to move during cool-down.

Not a tool used in dentistry, but a spring stretcher.



A PMT secured to the AV for the pressure test to verify adequate o-ring seal to the LG.

PMTs in their mounts are attached to their LGs.

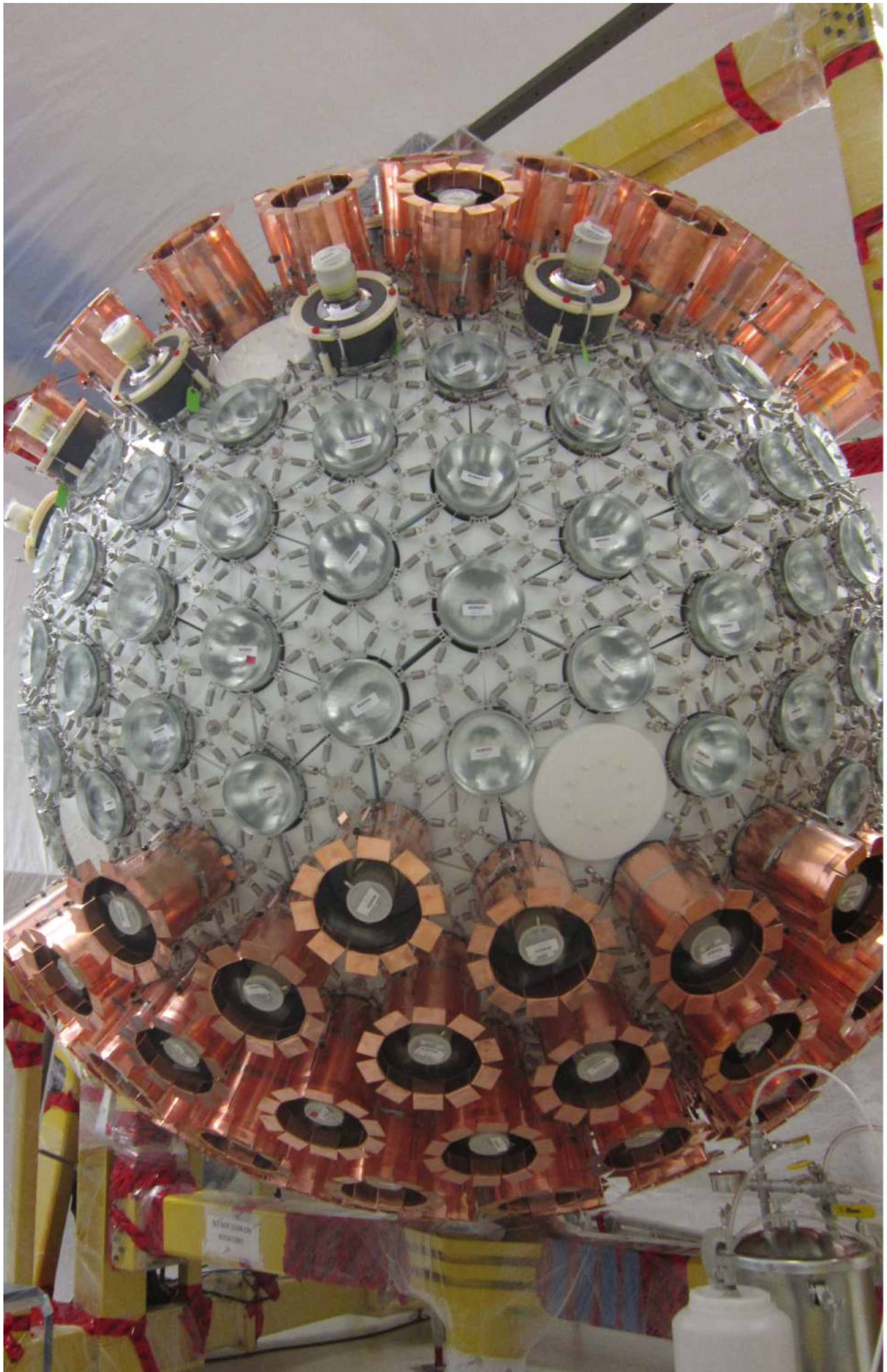
Oil is filled into the 2-5 mm gap between the PMT glass and the LG.

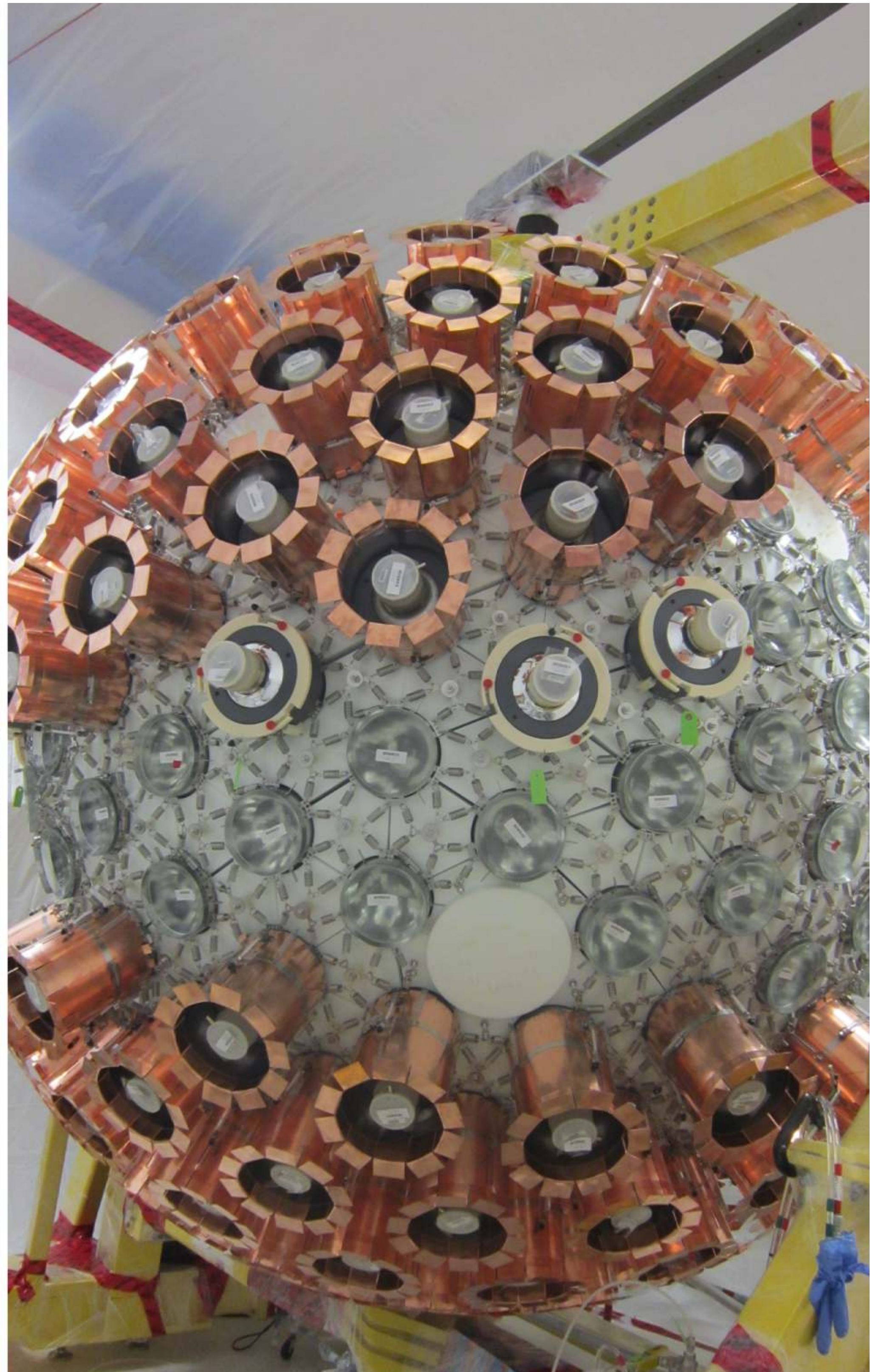
Oil-fill station.

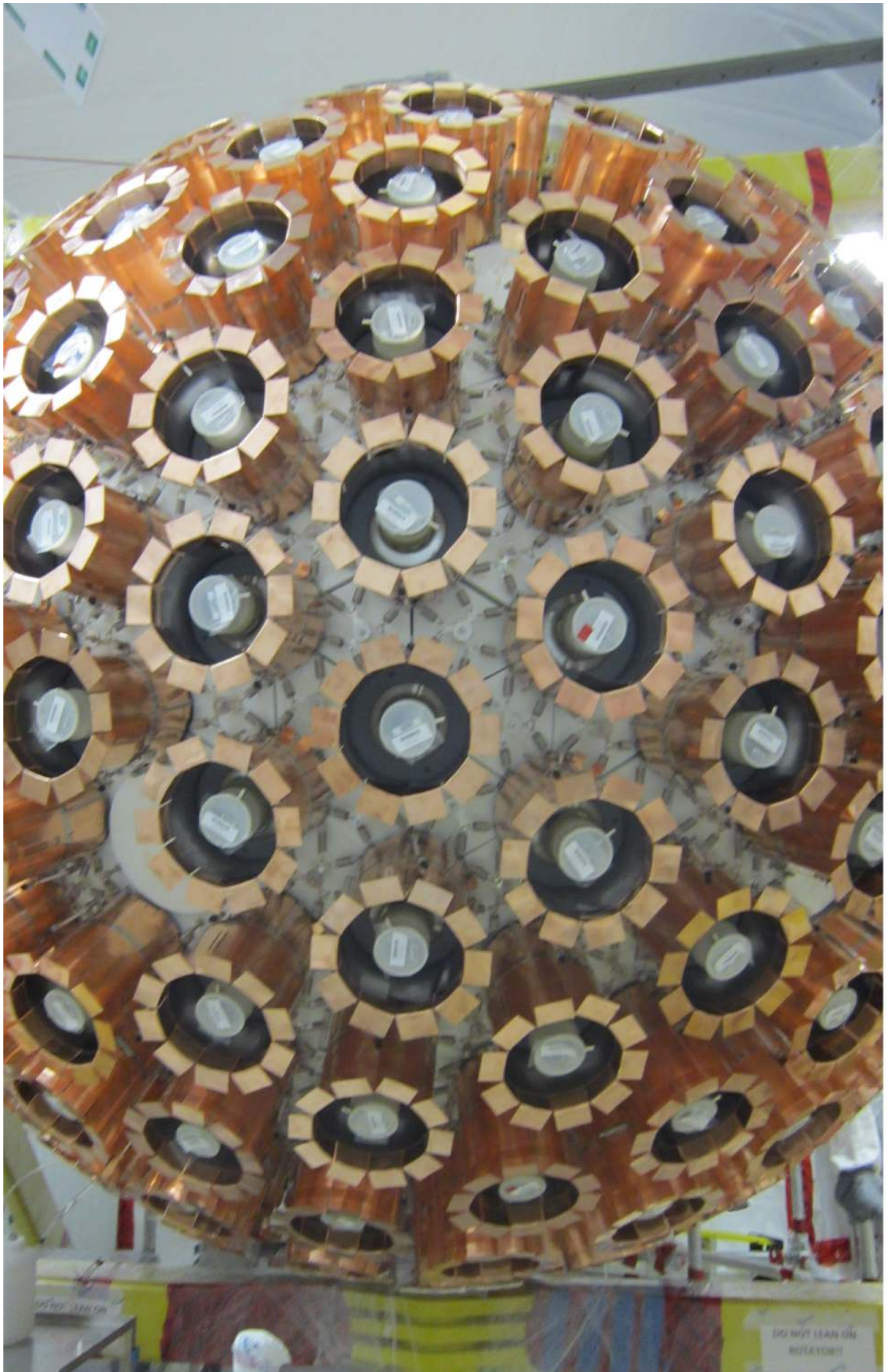
Copper thermal shorts keep the PMTs at the right temp.


Tyvek


DO NOT LEAN ON ROTATOR!!

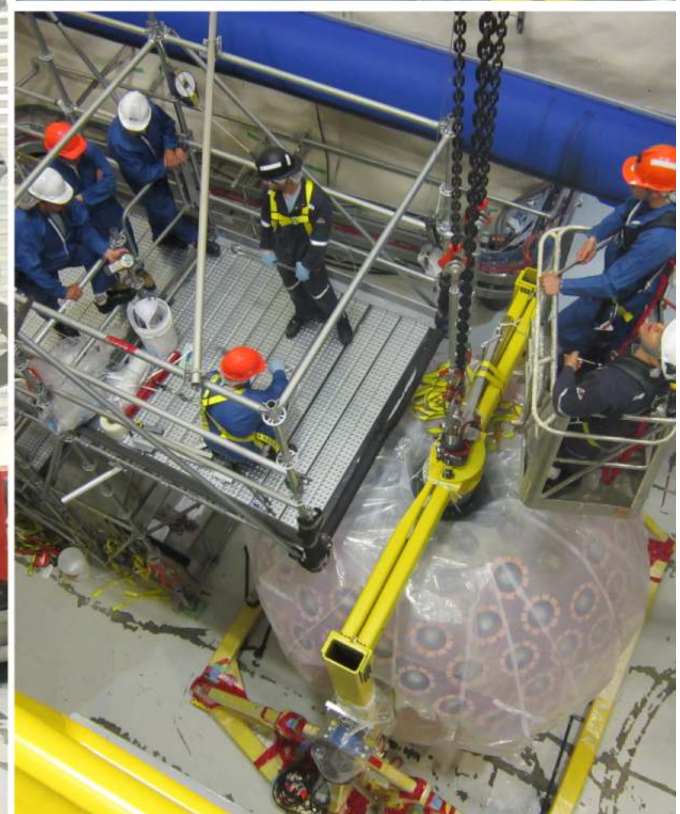


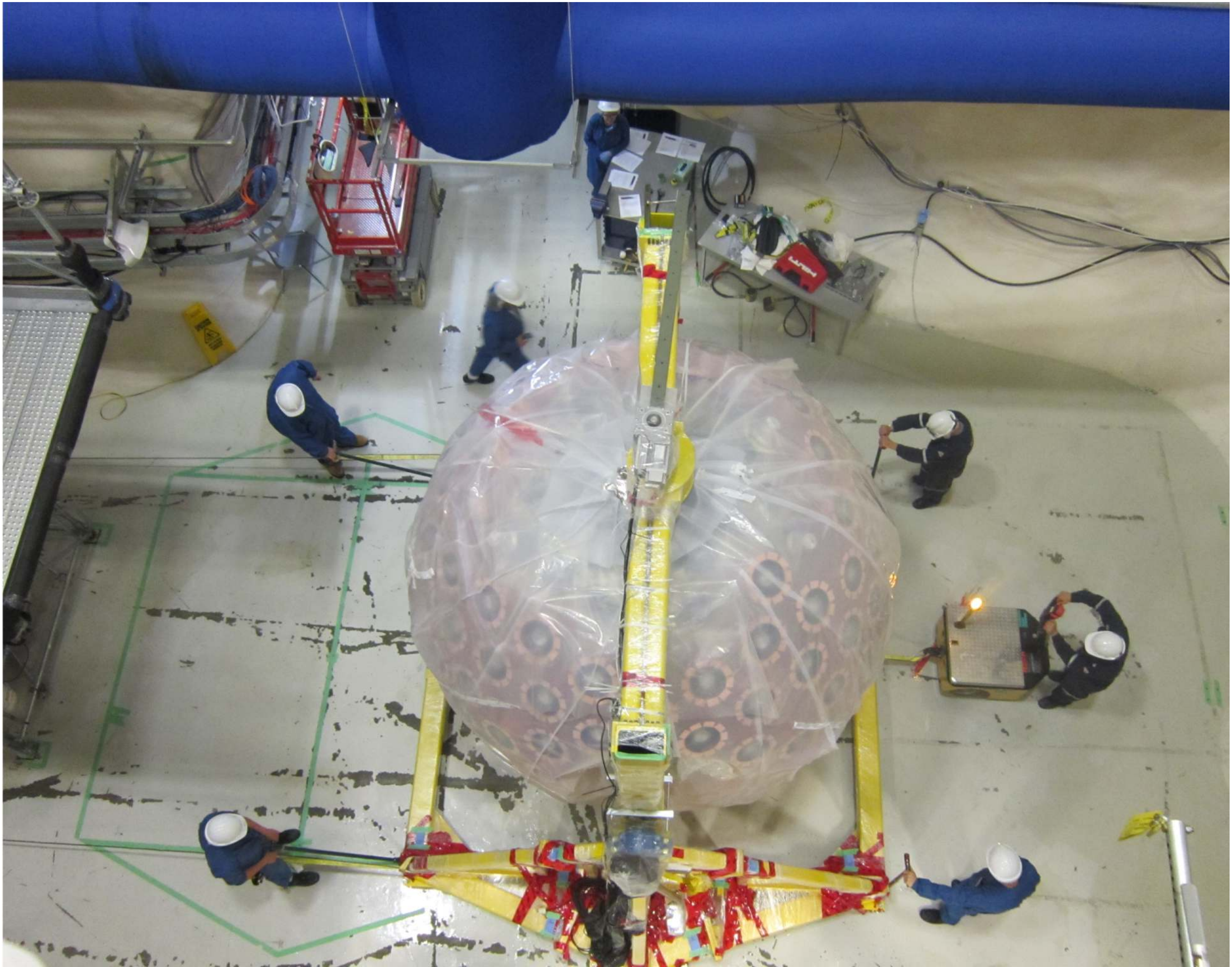


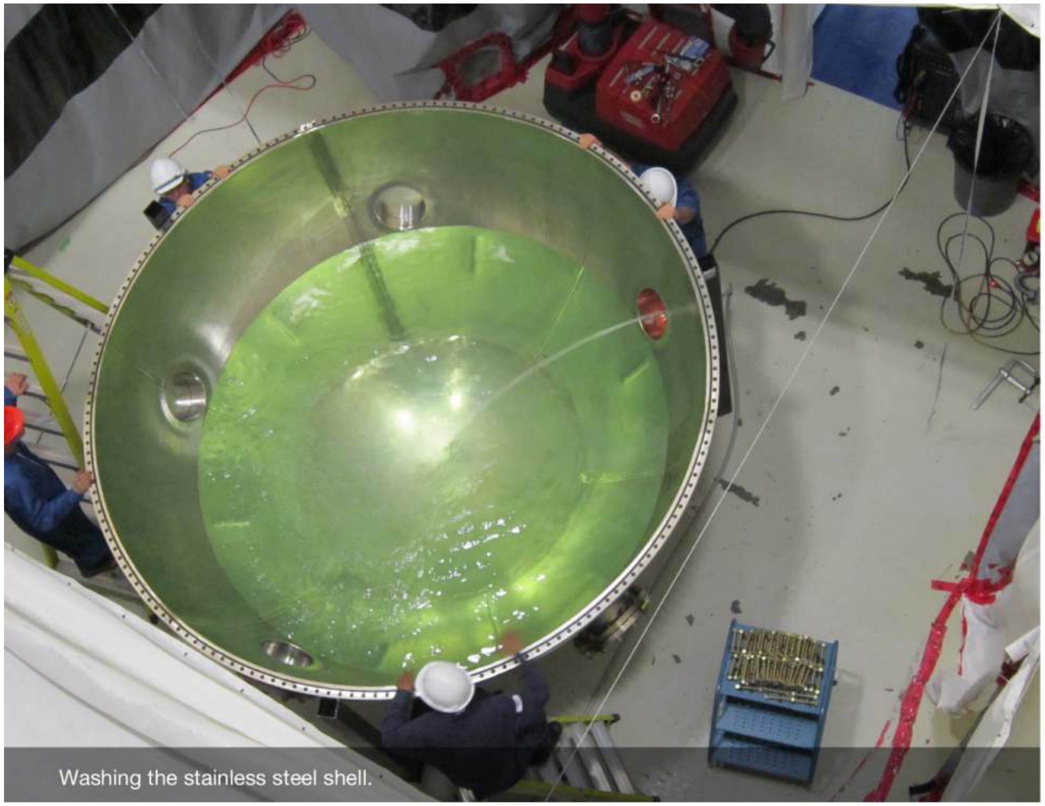


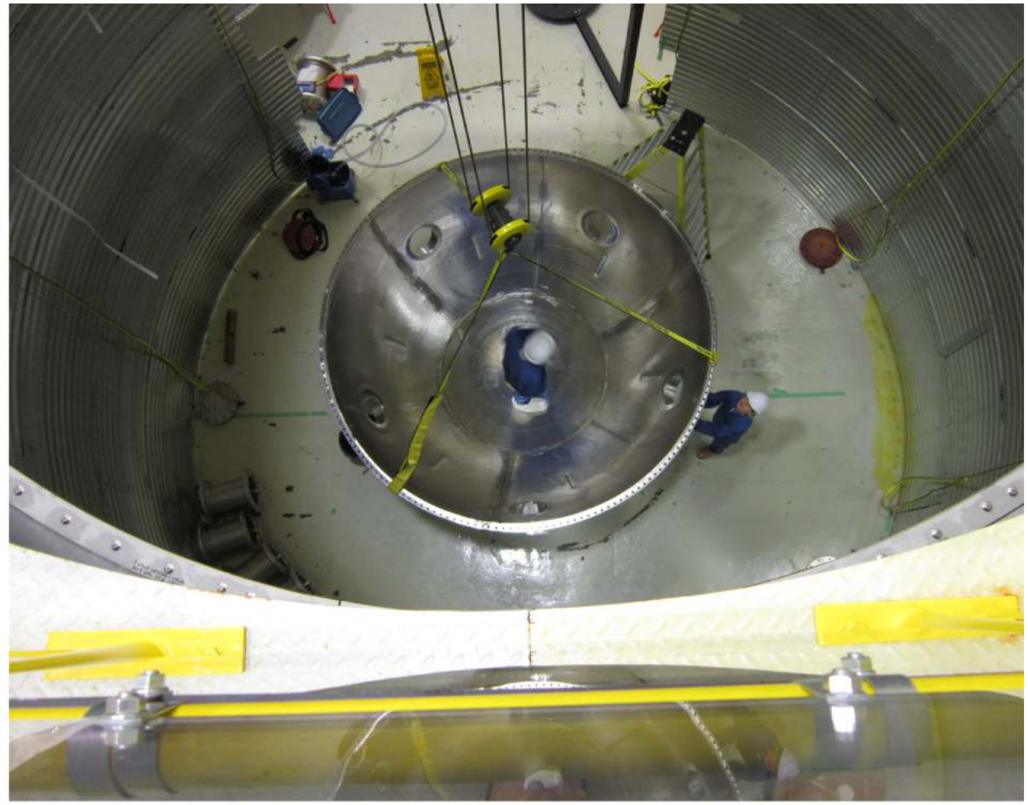
The AV is bagged up in preparation for the move into its final position inside the shield tank.


SKYJACK
KEEP
CLEAR
SKYJACK



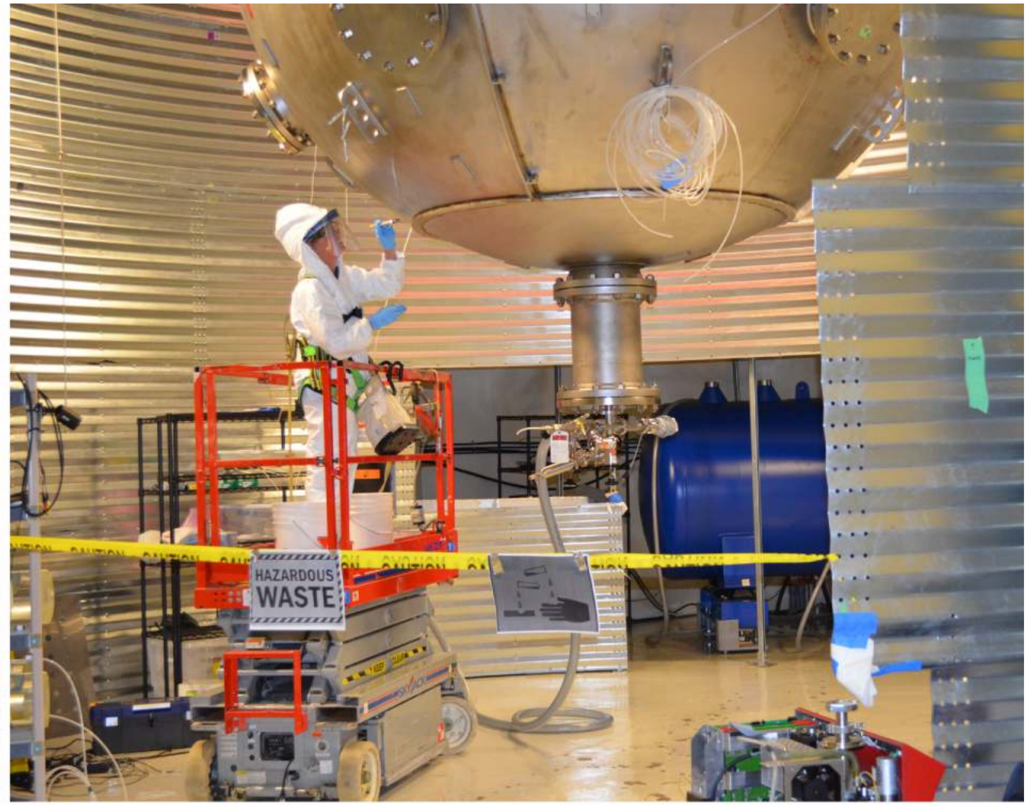



Washing the stainless steel shell.

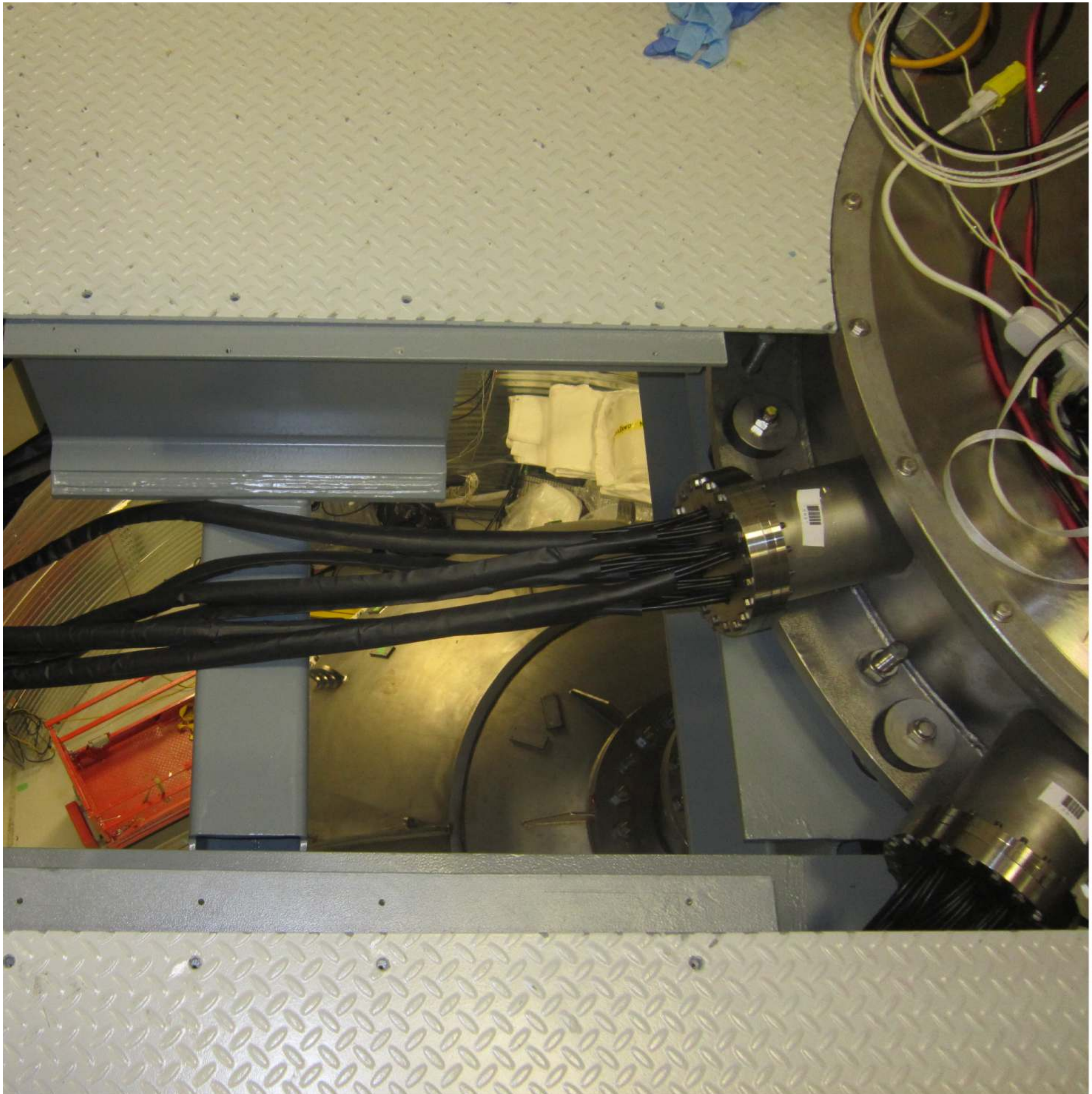


The stainless steel shell ready for leak testing.


SKYJACK
SJIII 3219

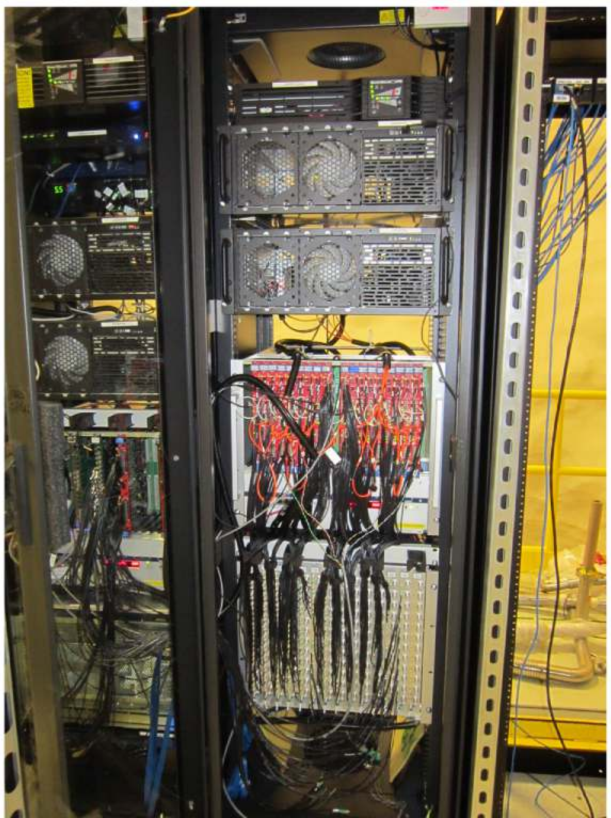

HAZARDOUS
WASTE

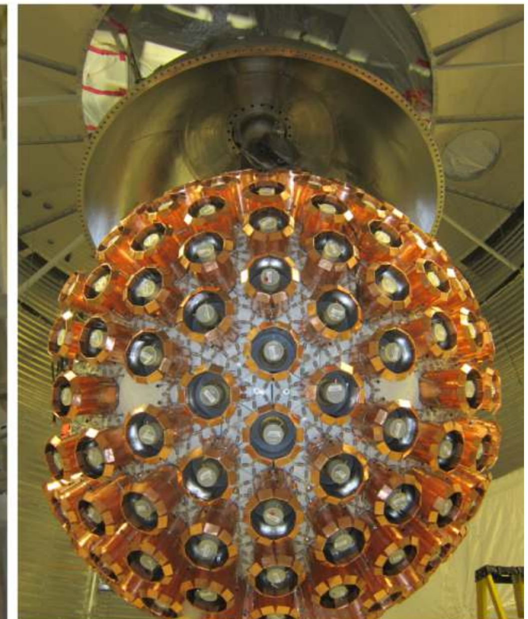
PMT and instrumentation cables strung through the neck.



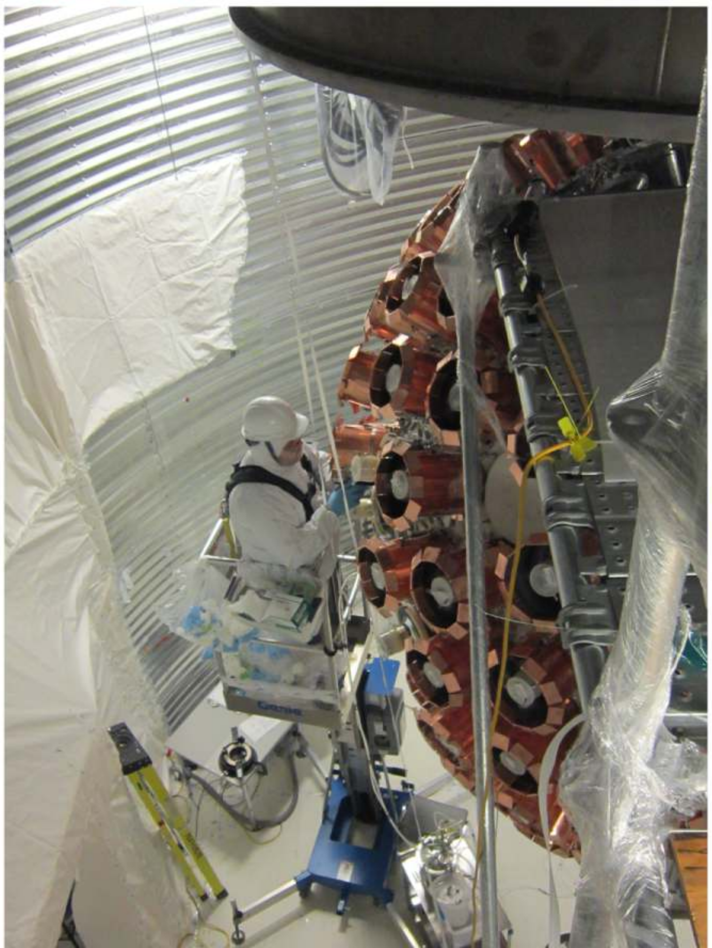
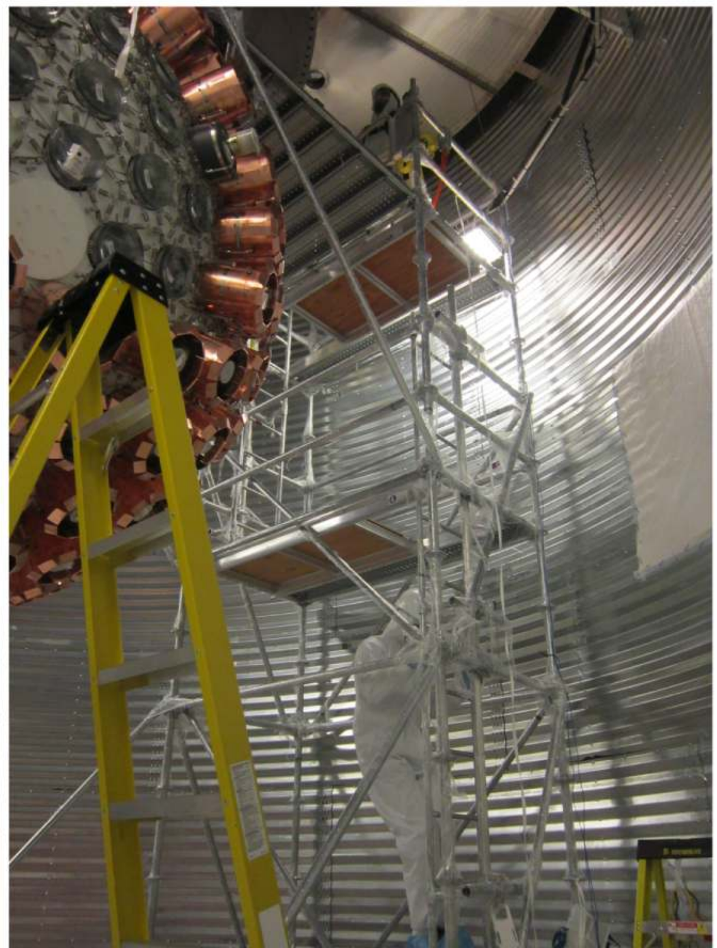
Cables have to be carefully routed up the neck, through a vacuum feed-through, and under the deck plates to the DAQ racks.

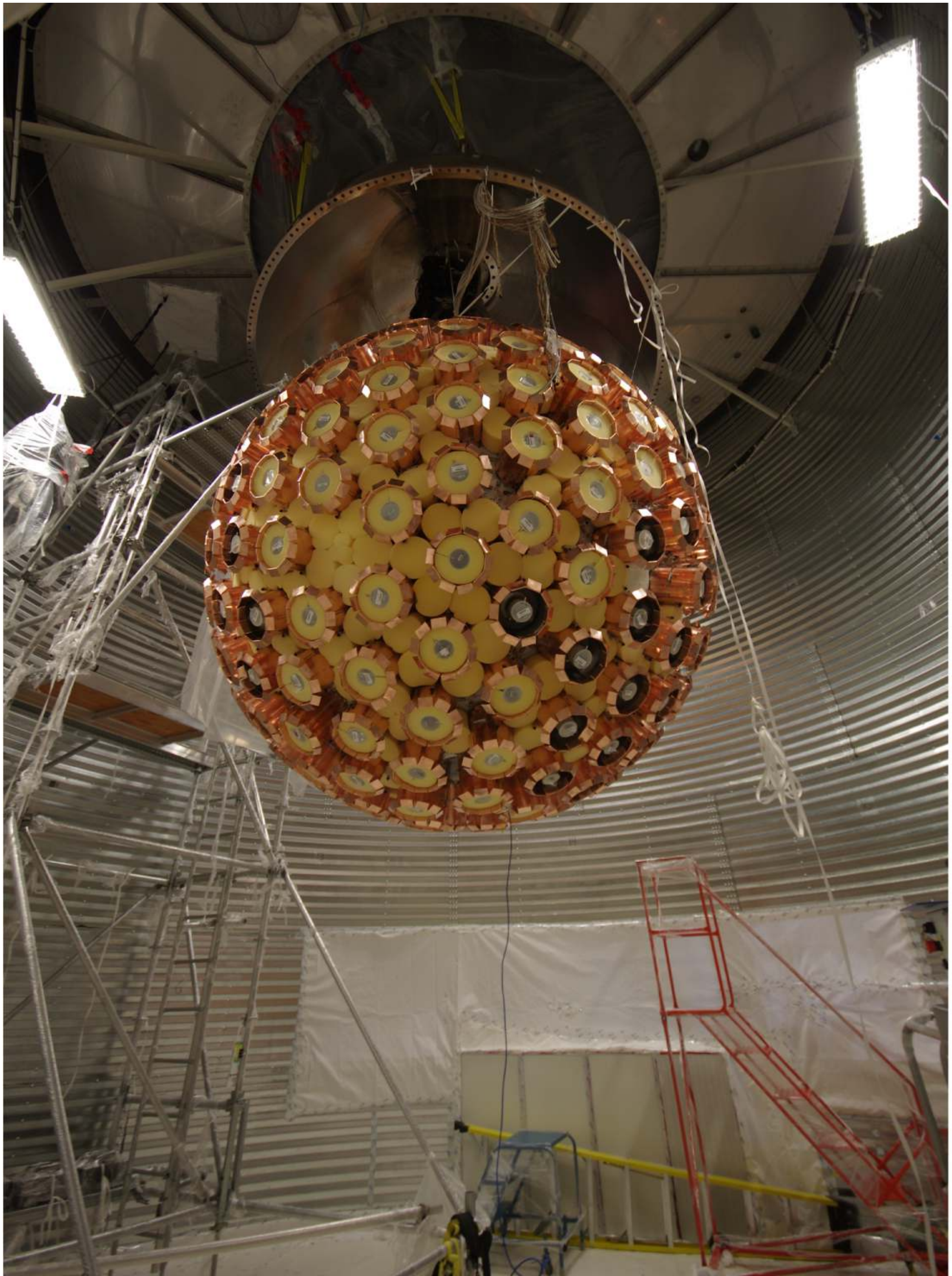
Three DAQ racks hold the data-taking electronics.



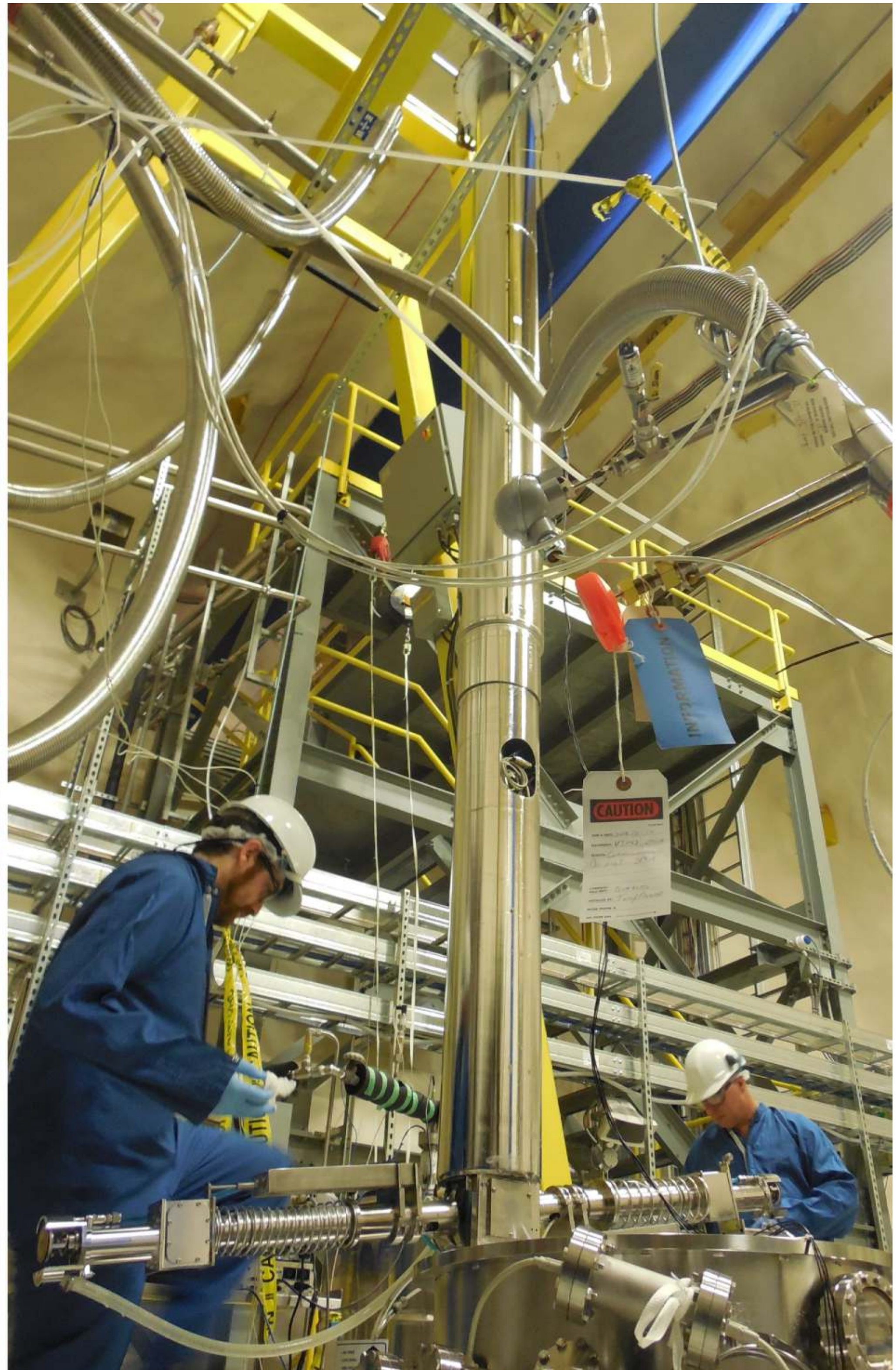




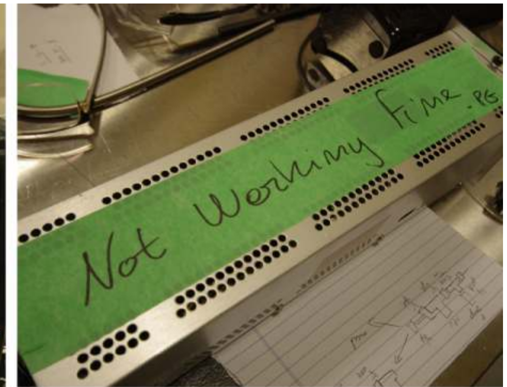


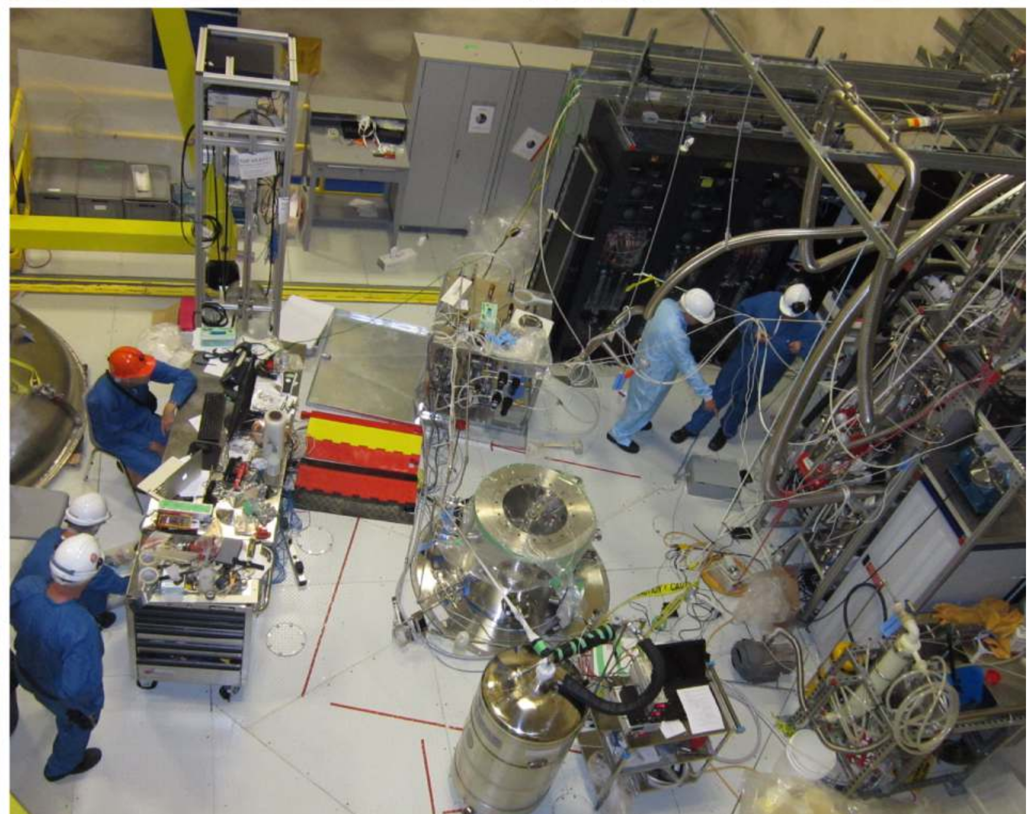
One of the two resurfacer sanding-heads, sanding an acrylic test-plate.

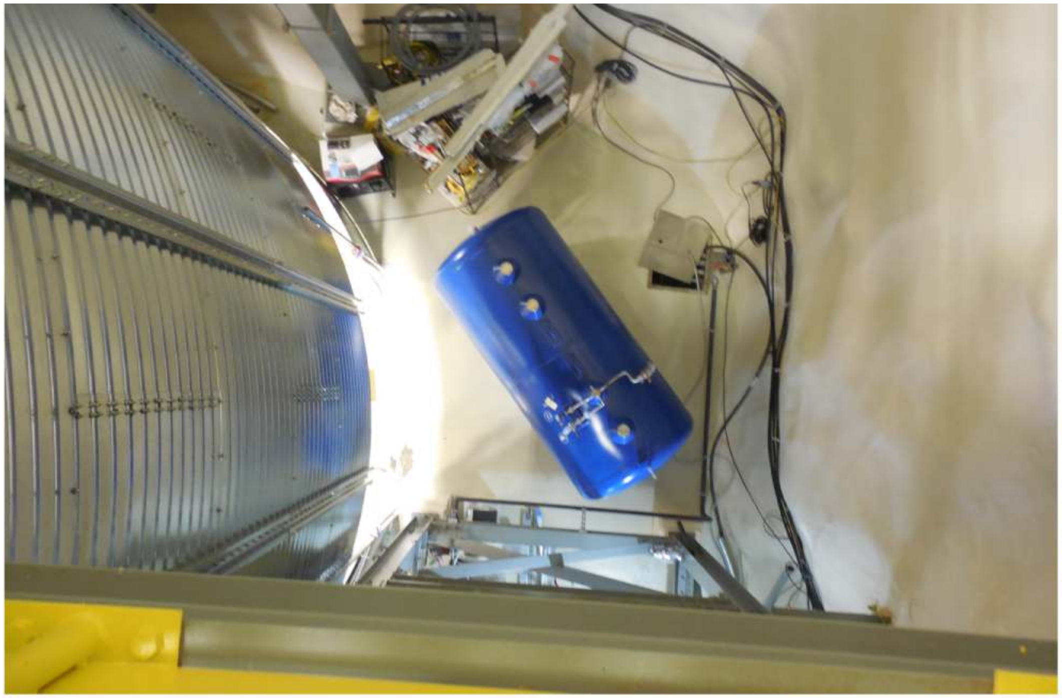


The two arms of the resurfacer before deployment into the AV.

The resurfacer control-station.

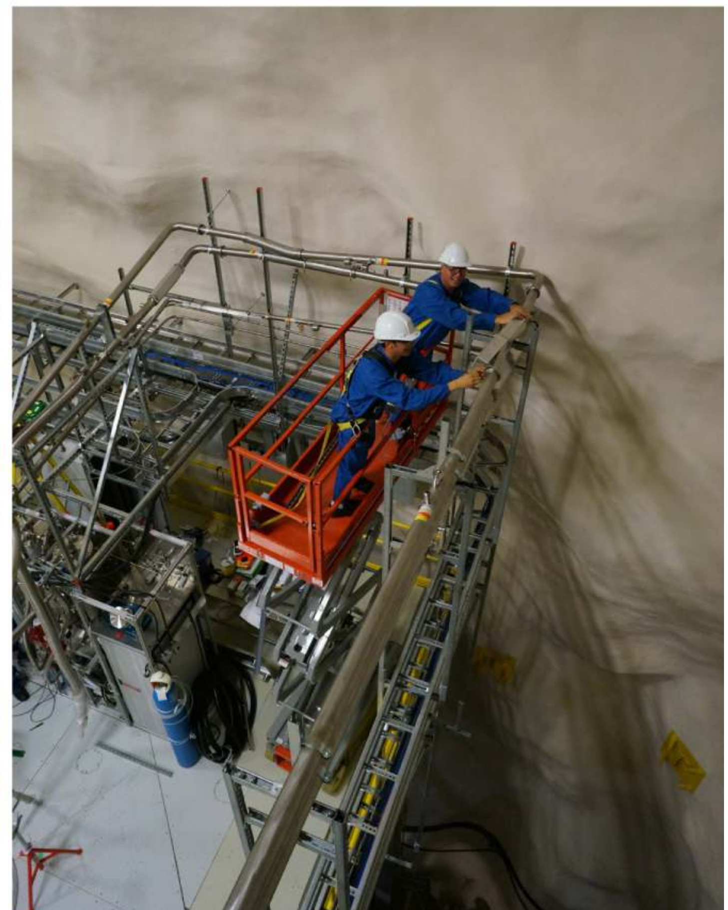


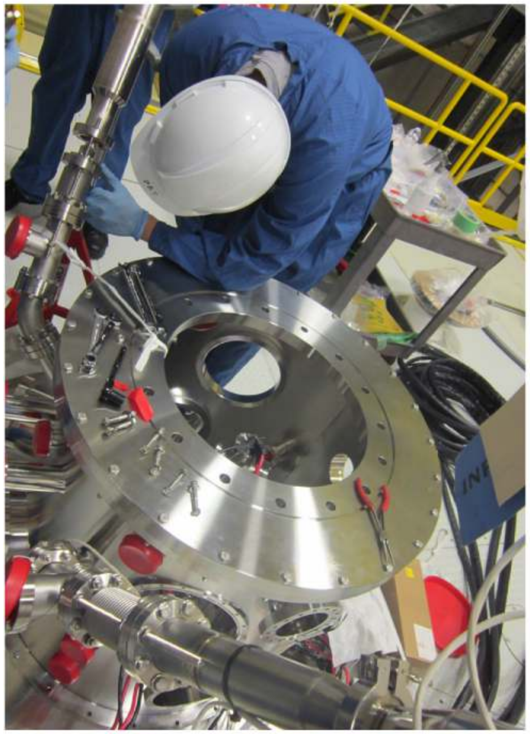





DANGER
OPEN HOLE


Yale






DANGER
OPEN
HOLE


LEE COOPER 1908

Detector construction at SNOLAB
Sudbury, Ontario, Canada
2012-2014

Created by Tina Pollmann for the DEAP collaboration.