

# Lawrence Livermore National Laboratory

## Vacuum Seal R&D



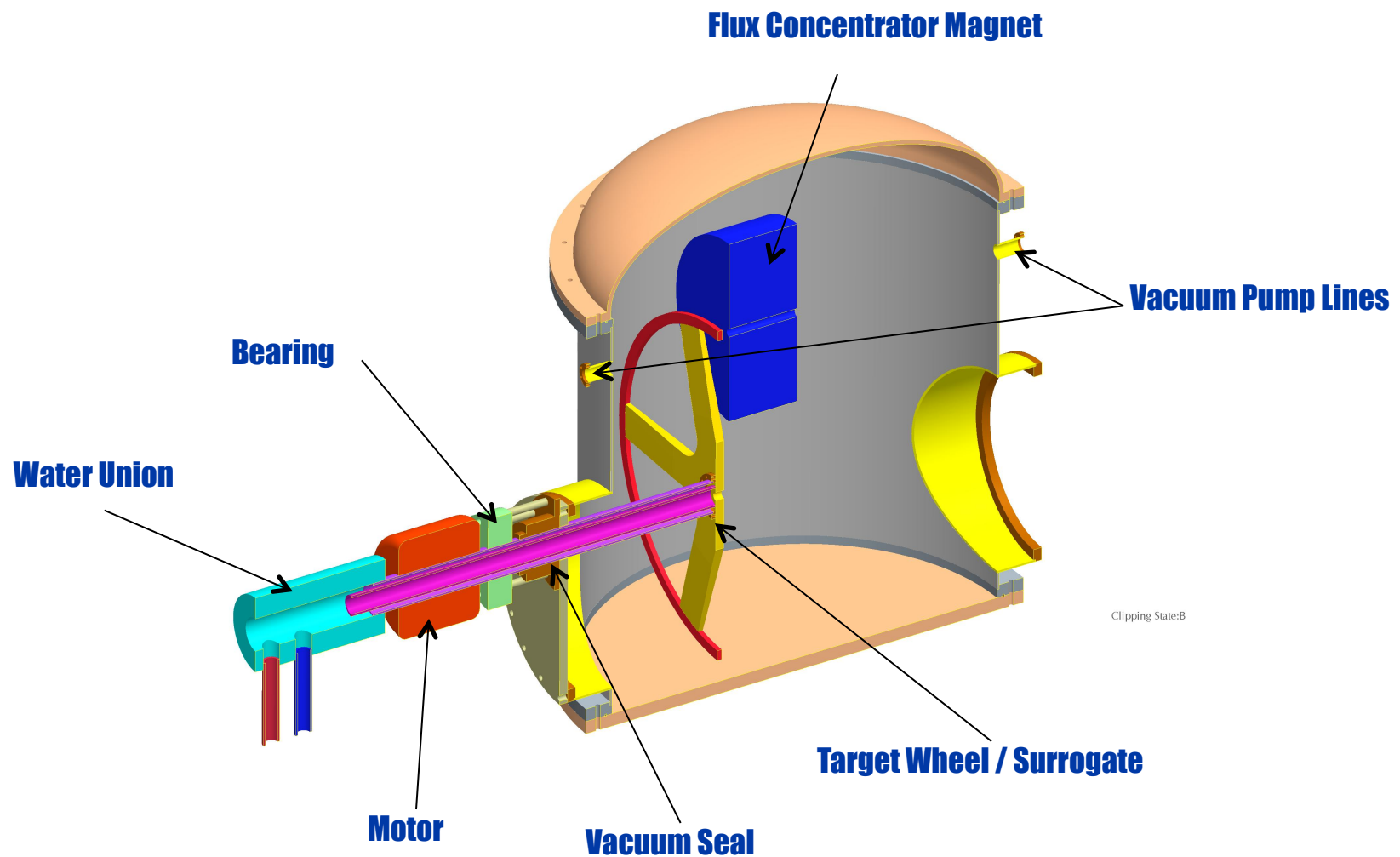
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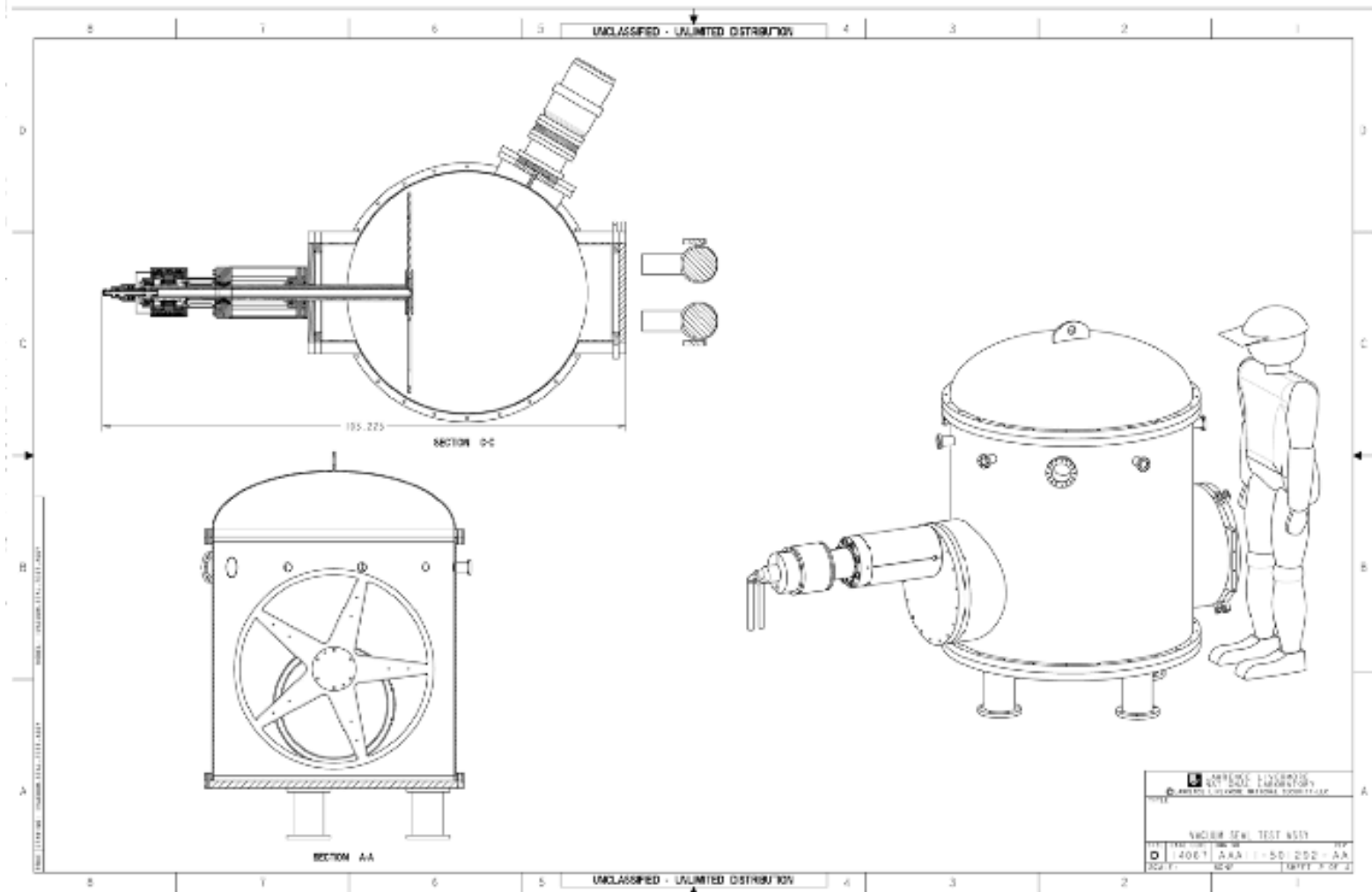
This work performed under the auspices of the U.S. Department of Energy by  
Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344

LLNL-PRES-495331

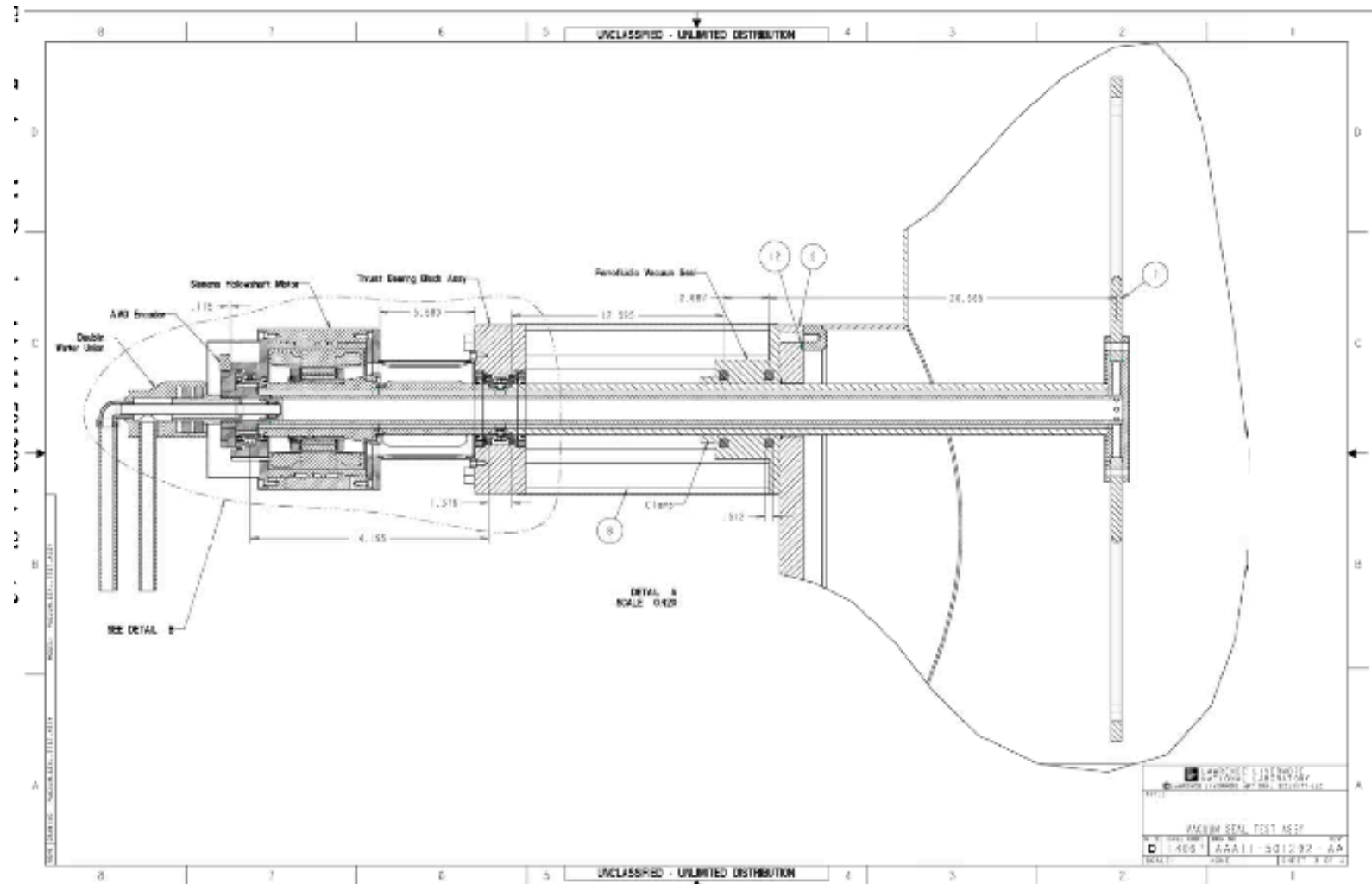
# We are prototyping the rotating vacuum seal and the pulsed flux concentrating magnet



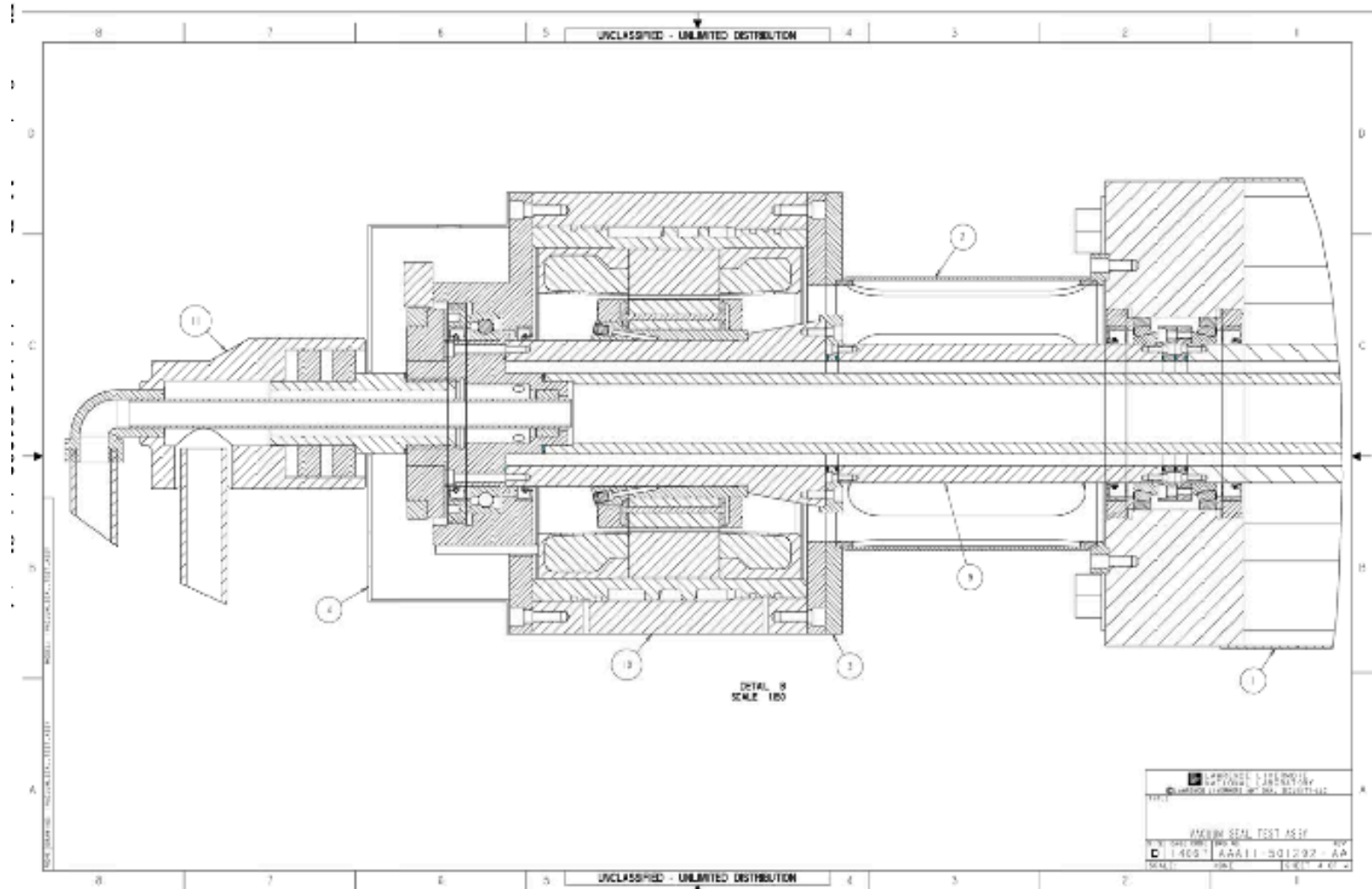
# We have acquired a vacuum tank large enough to accommodate the full size wheel



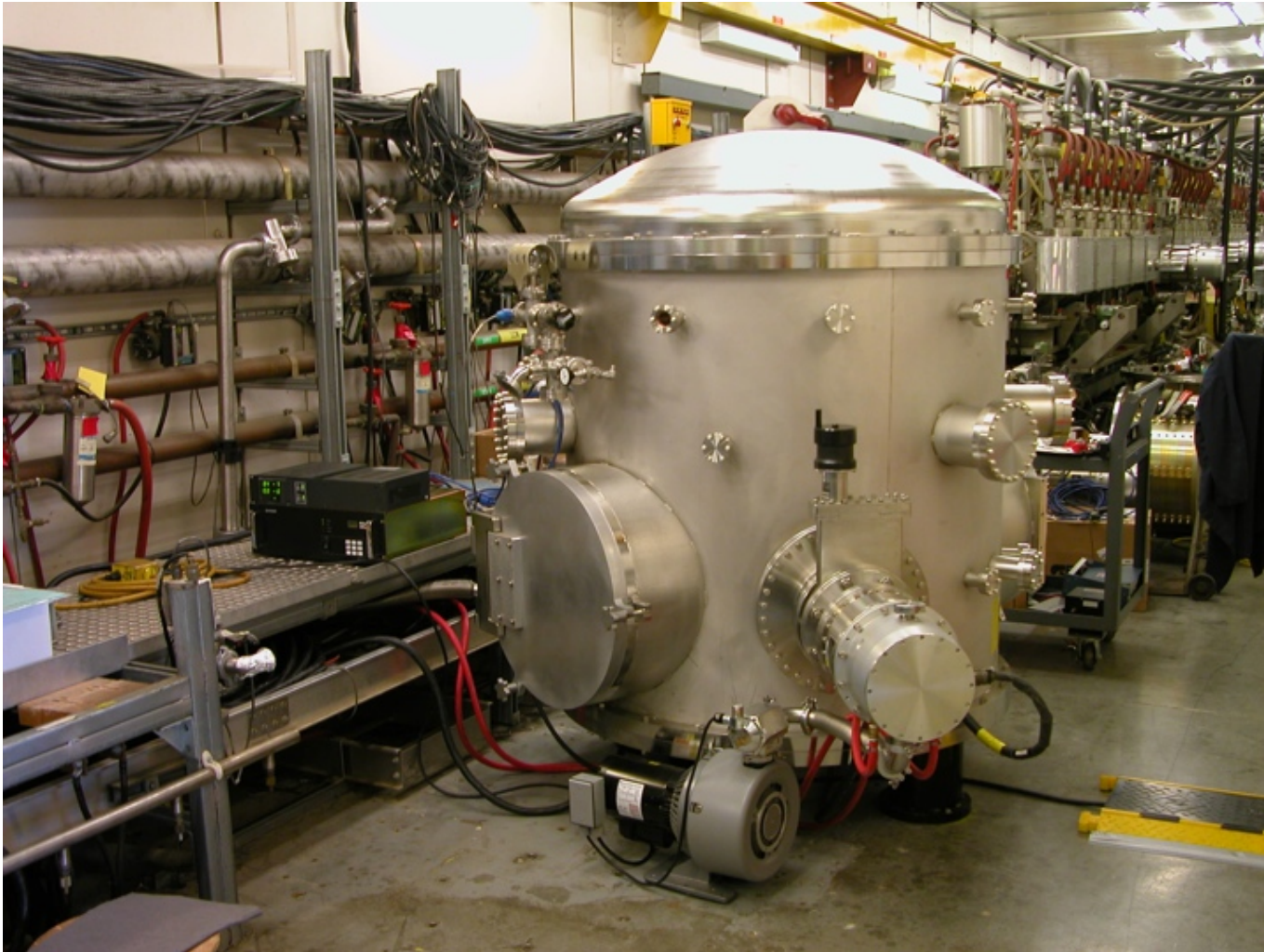
# Full mechanical drawings have been produced and parts have arrived



# Drive motor and rotating cooling water coupling will mount directly on the shaft



# The vacuum tank is setup and under vacuum



# All parts are at LLNL except the Daresbury target wheel

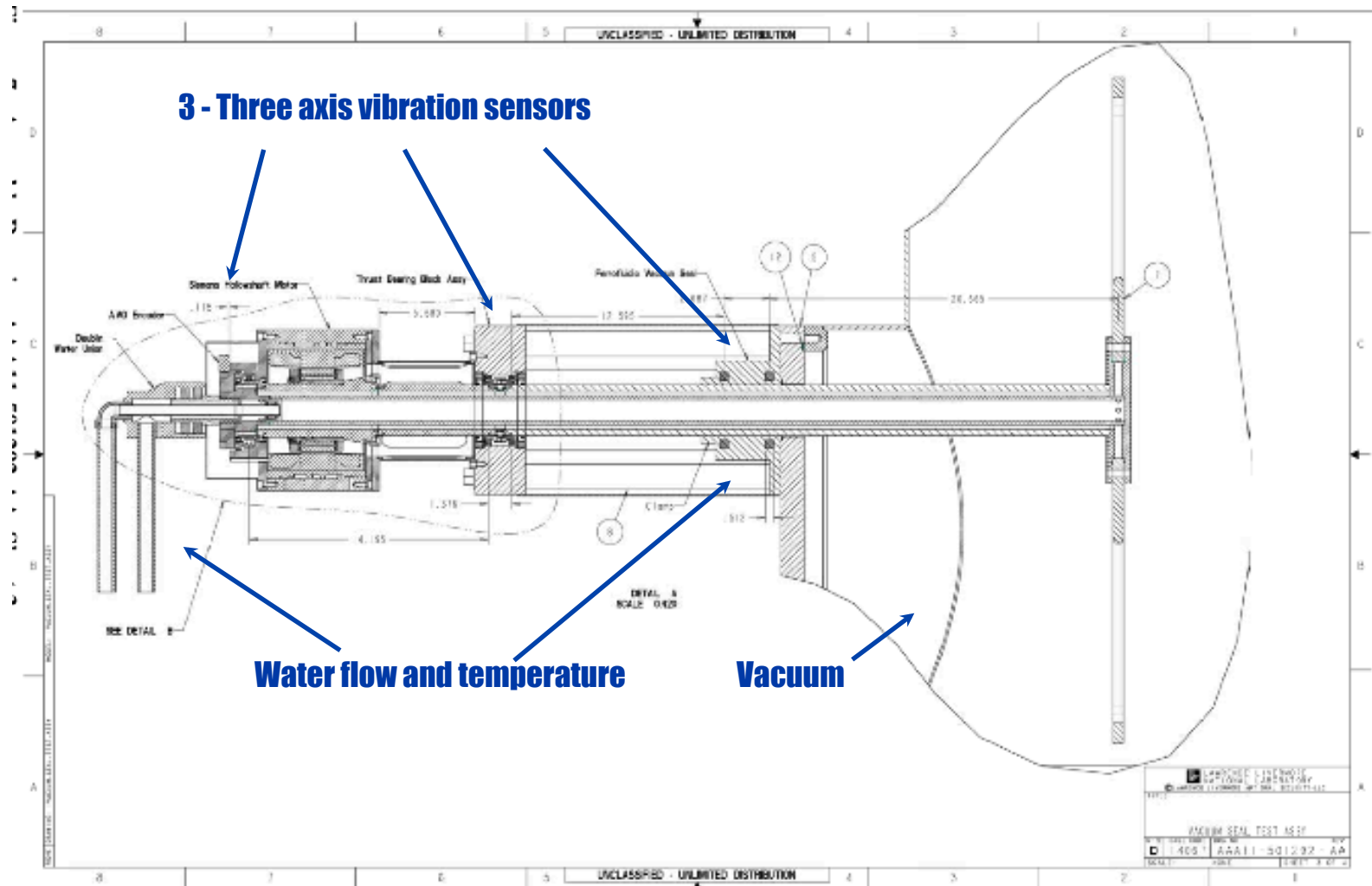


# Siemens hollow shaft motor is ready for mounting

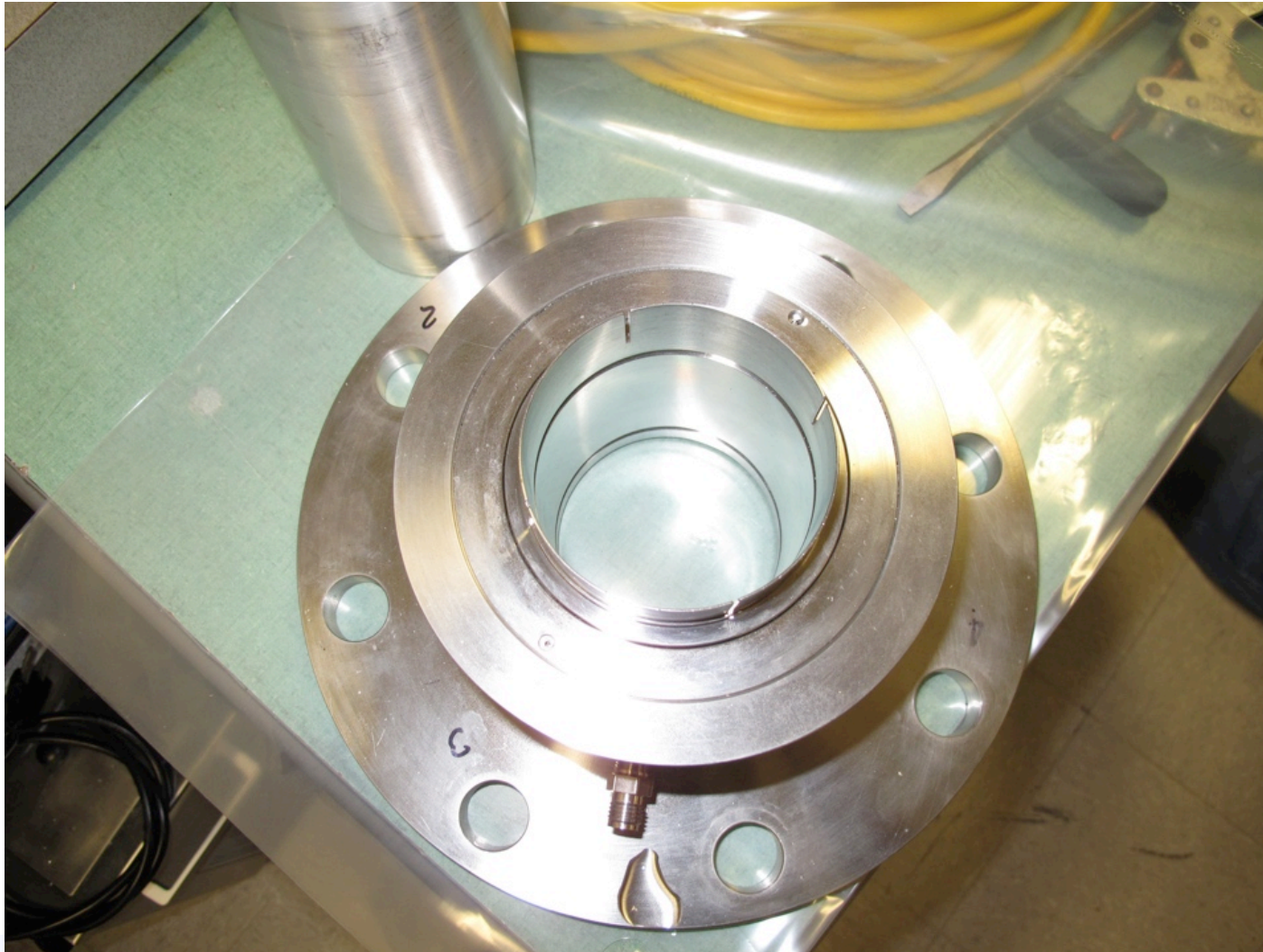




# The shaft will be constantly monitored during operation



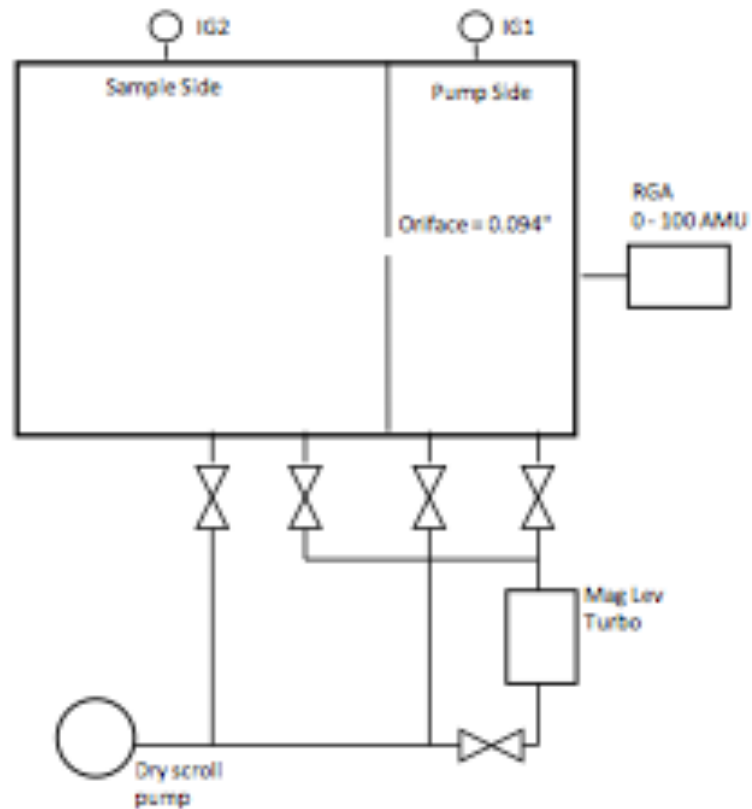
# We have begun initial vacuum testing of the Rigaku Ferrofluidic Seal in a separate test stand



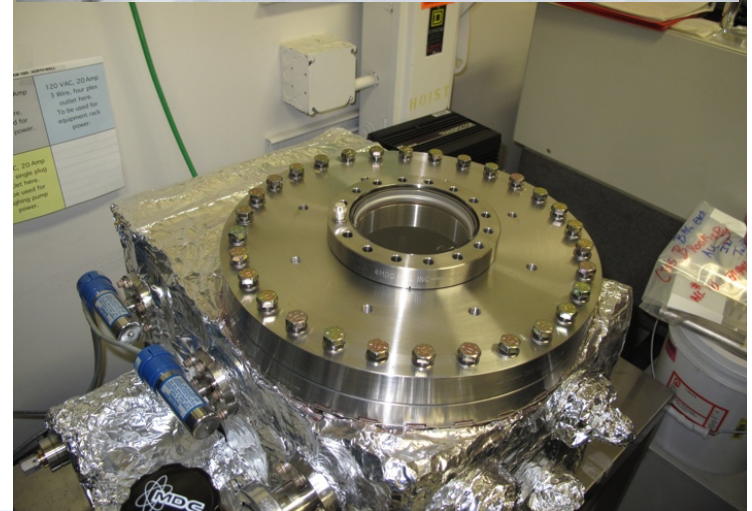
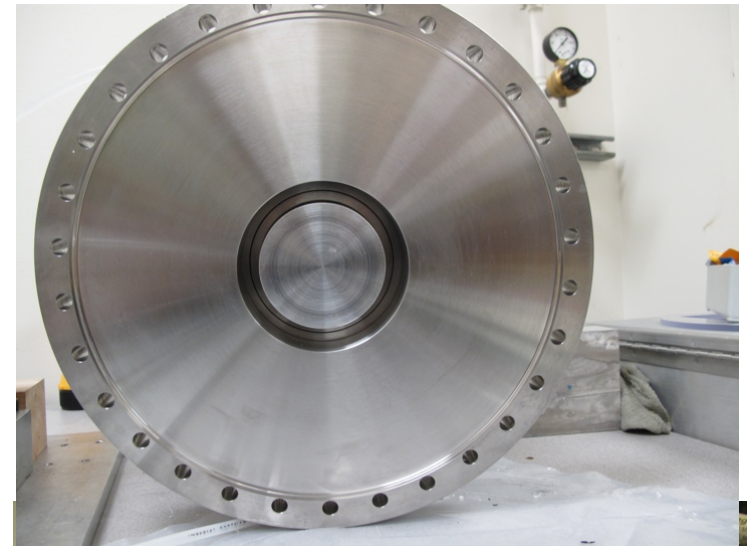
# We have an existing outgassing test stand that we have modified to test the Rigaku seal

## Vacuum Sciences and Engineering Lab Outgassing Measurement Test Stand

Sample Side Volume = 216 Cu. in.  
Sample Side Surface Area = 5,575 cm<sup>2</sup>  
Conductance = 0.52 L/s for air at 20C  
 $Q = C(P_{IG2} - P_{IG1})$

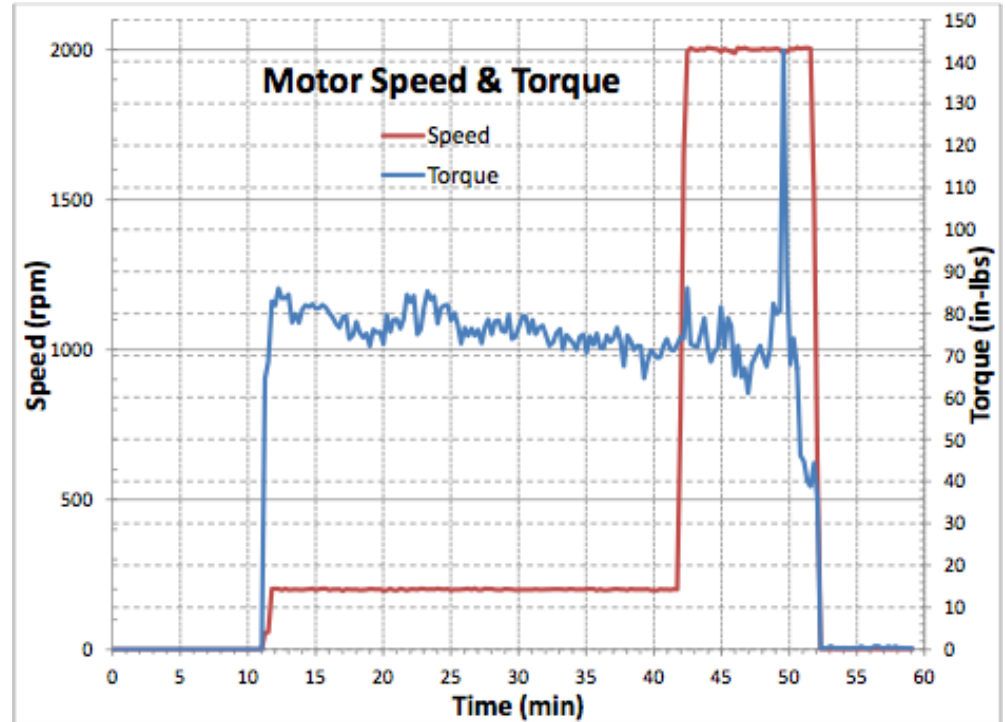


# The test stand allows us to rotate the seal up to 2000 RPM with pressure and outgassing measurements



# October 3rd we did our first full test of the Rigaku seal

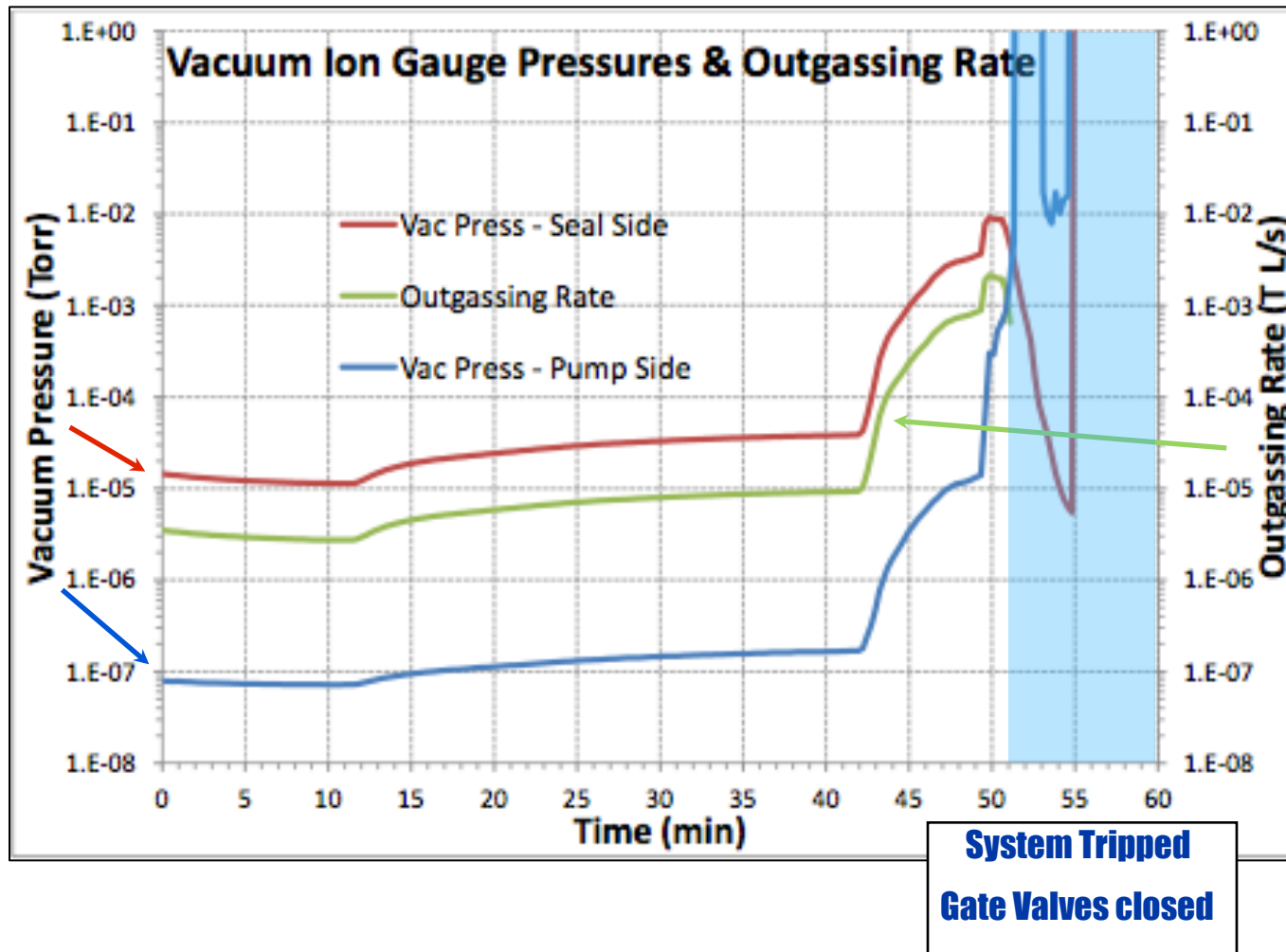
Scan #	Time	Time	Speed	
	H:M:S	min	rpm	Comments
1	10:32	0	0	started data recording
17	10:35	3	0	took full RGA Scan
20	10:36	4	0	took full RGA Scan
40	10:41	9.2	0	took full RGA Scan
43	10:42	10.2	0	took full RGA Scan
47	10:43	11.2	200	
123	11:03	30.5	200	took full RGA Scan
162	11:13	40.5	200	took full RGA Scan
168	11:14	42	2000	
191	11:20	48	2000	took full RGA Scan
197	11:22	49.6	2000	Torque ramped up & vacuum leak occurred
208	11:24	52.3	0	Stopped motor
235	11:31	59.1	0	Ended data recording



... and we killed it.

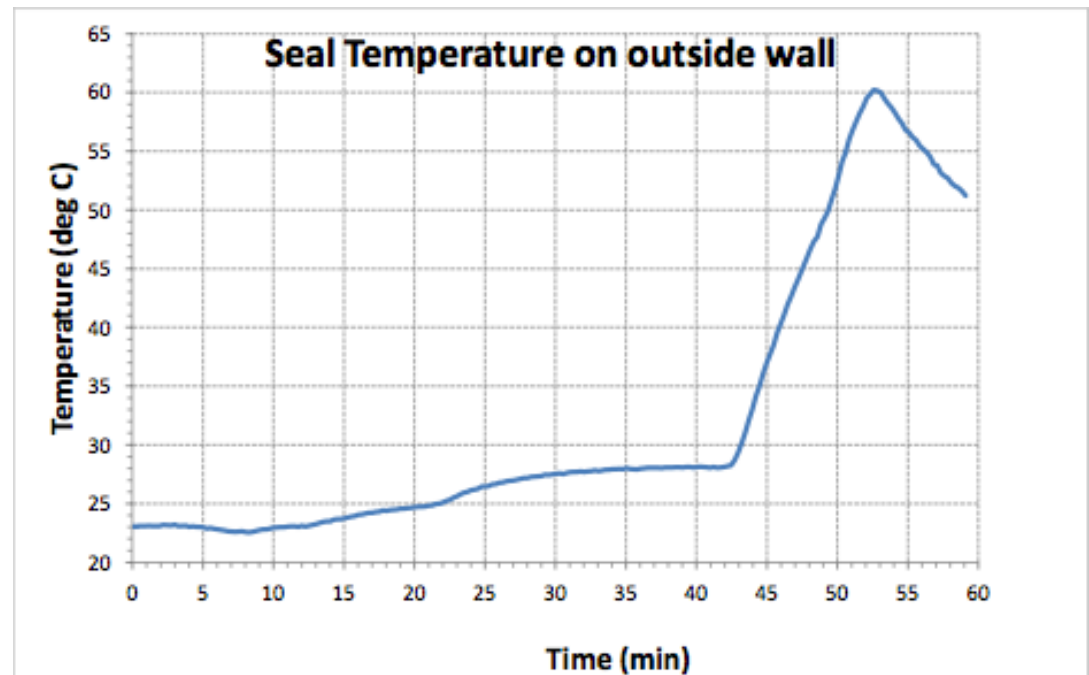


# Outgassing looked like it was stabilizing when the seal failed

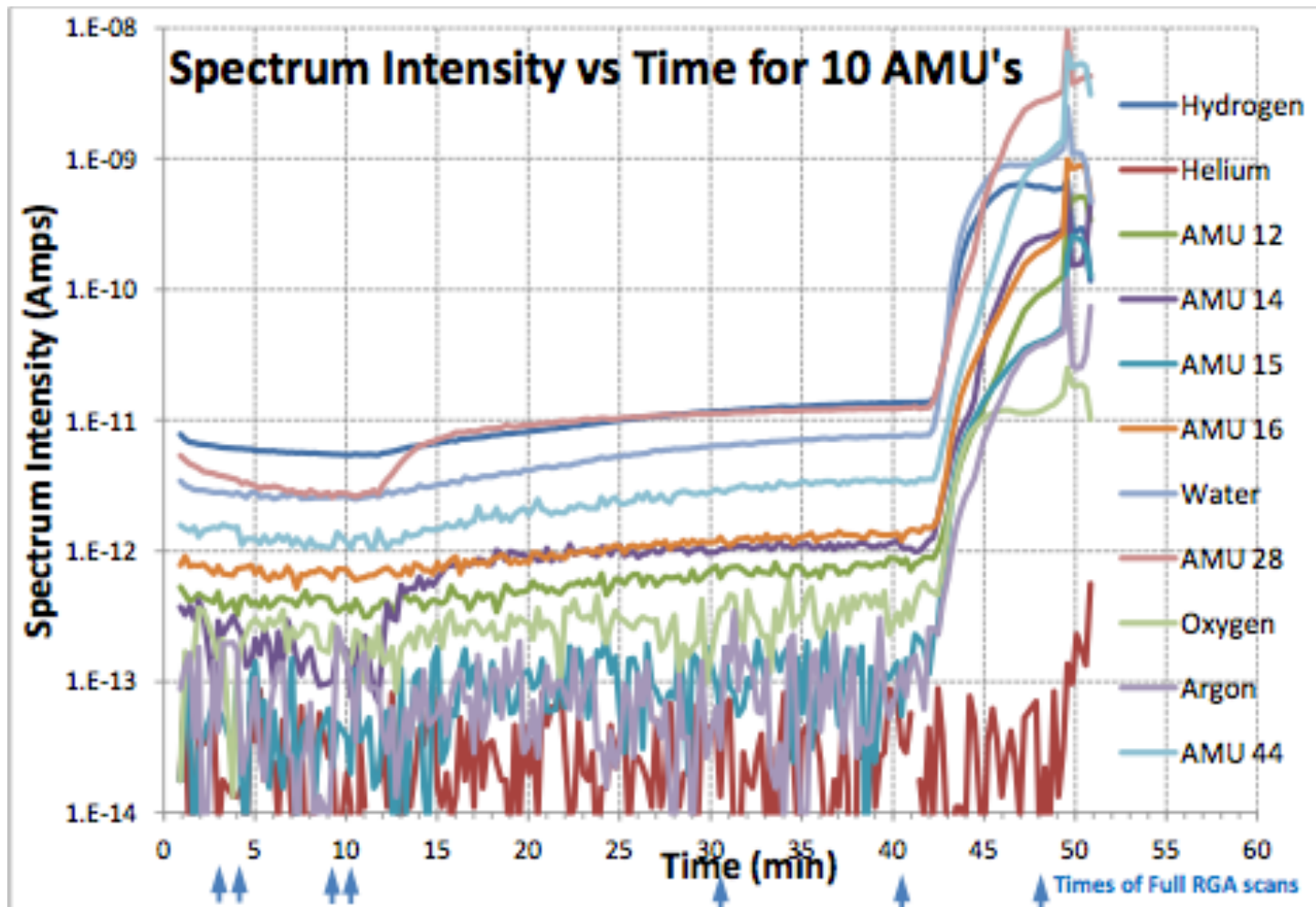


# Temperature data showed no sign of plateauing

- Rigaku reports running at 55 °C without problems
- Temperature was still rising when we turned it off



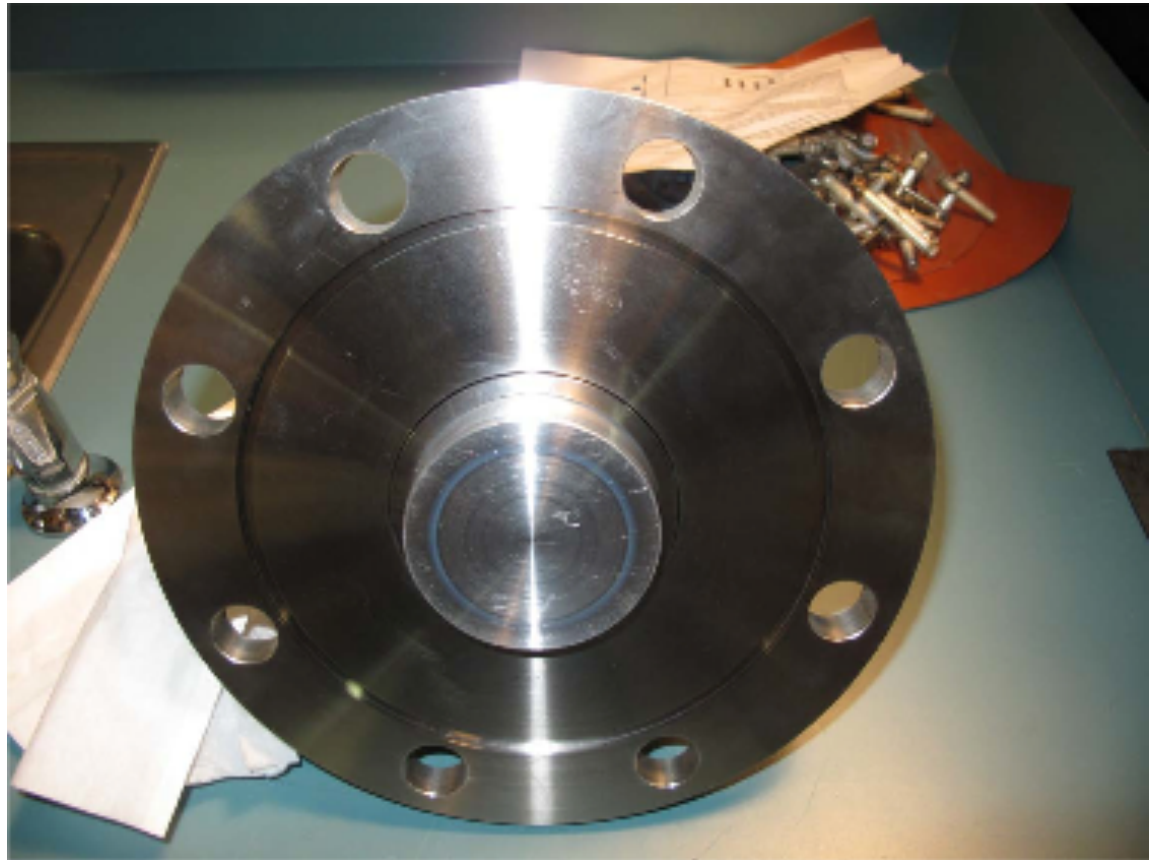
# Residual Gas Analyzer output showed a spike





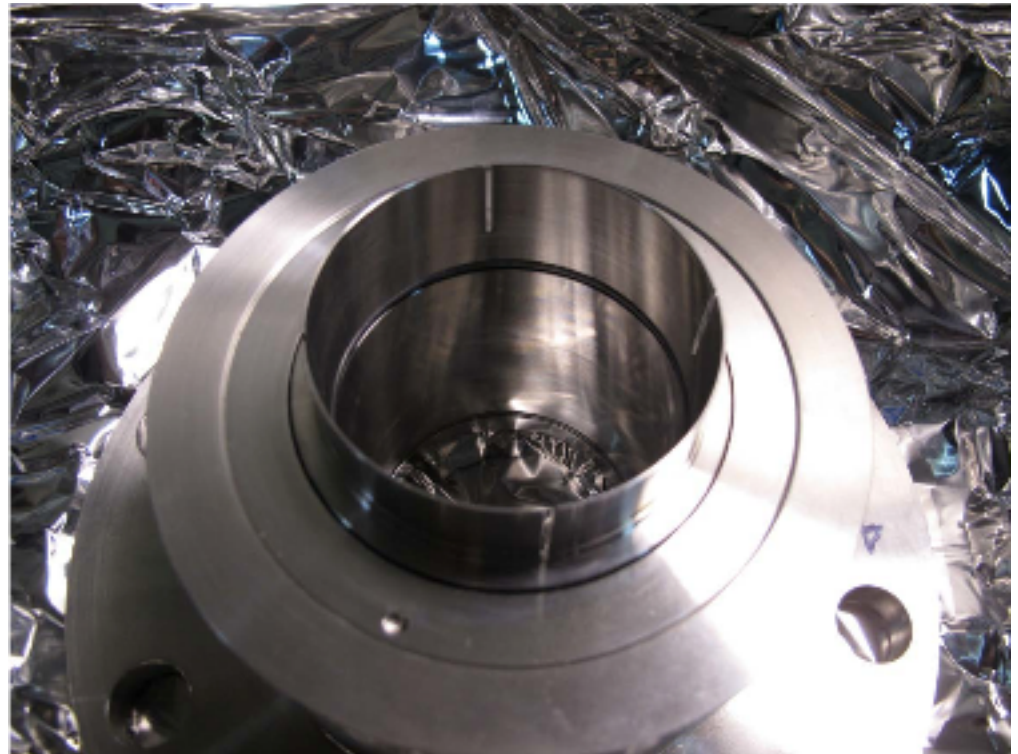
# Seal inspected after failure

- No visual signs of failure or residue
- No signs of residue inside the chamber



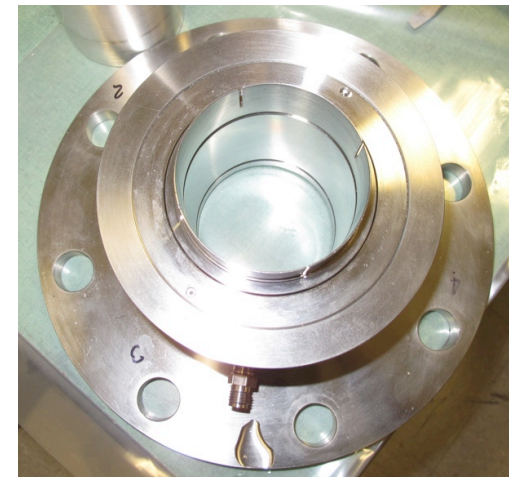
# Checked whether there was a problem on the shaft seal

- O-rings were good.
- No sign of slipping
- No indication of any problem here



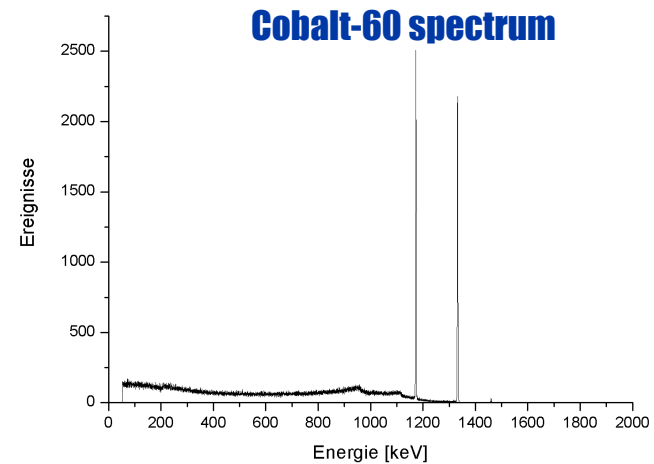
# Status

- Both Ferrotech and Rigaku assert that these seals should run at 2000 RPM as long as there is cooling water flow
- We are acquiring a plug compatible replacement from Ferrotech
- The Rigaku seal will be returned to Rigaku for post-mortem and repair
- We will continue with assembly of the prototype shaft
  - but we will wait to mount the new seal until after it runs successfully on the test stand



# Possible Radiation Damage Testing using the Test Stand

- Ferrofluid is an oil with suspended magnetic particles
- Radiation damage is a concern
- Cobalt-60 Irradiation facilities exist
  - Only  $de/dx$
  - Below photoneutron threshold – no activation



- Propose to acquire second seal for destructive testing
- Facilities exist that can provide 300kGy/hour