Highlights of LIMITS Work

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Outline

1. Calibrated the magnetic flow meter
2. Ran Flow tests without a magnetic field

   - Observed flow characteristics

   - Generate a pump speed flow curve.
3. Pump Problems and Fixes
4. Cleanup of the Vacuum Chamber, Tubing, and Pump.
5. Modifications to the system to make heating less complicated
6. Nozzle designing and testing is on going.

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Calibrated the magnetic flow meter

Presented at SOFE 2003

<u>Measurements of Lithium Flow with an EM Flow Meter in LIMITS</u>

Thomas J. Lutz, Richard E. Nygren, Tina J. Tanaka, Jimmie M. McDonald, Fred J. Bauer, Kenneth P. Troncosa, and Michael A. Ulrickson

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A simple electromagnetic flow meter was constructed and used in the one-inch thick-walled 316L stainless steel tubing (20.6 mm i.d.) of LIMITS. The flow meter uses a pair of NdFeB permanent magnets (57.2mmW x 48.3mmD x 76.2mmH) mounted on an iron yoke producing a field of about 0.5 Tesla. Initial calibration of the meter was done as lithium was moved using gas pressure from a transfer tank to the lithium furnace. In this calibration, we monitored the signal from the flow meter and the signal from a previously uncalibrated level meter in the lithium furnace. The reference for the calibration was the change in weight of the transfer tank, which we measured using a set of load cells under the sled supporting the tank. There was, as expected, some noise with the mV signal, but use of a running average essentially eliminated the noise. The signal was quite linear with flow as judged by the correspondence between the integrated flow signal and the weight of lithium transferred. Among the observed effects during the flow tests was a difficulty in interpreting the signal whenever vibration of stainless steel tubing occurred due to the (usually smooth running) pump or changes in the valve positions, for example, opening a valve with the pump running.

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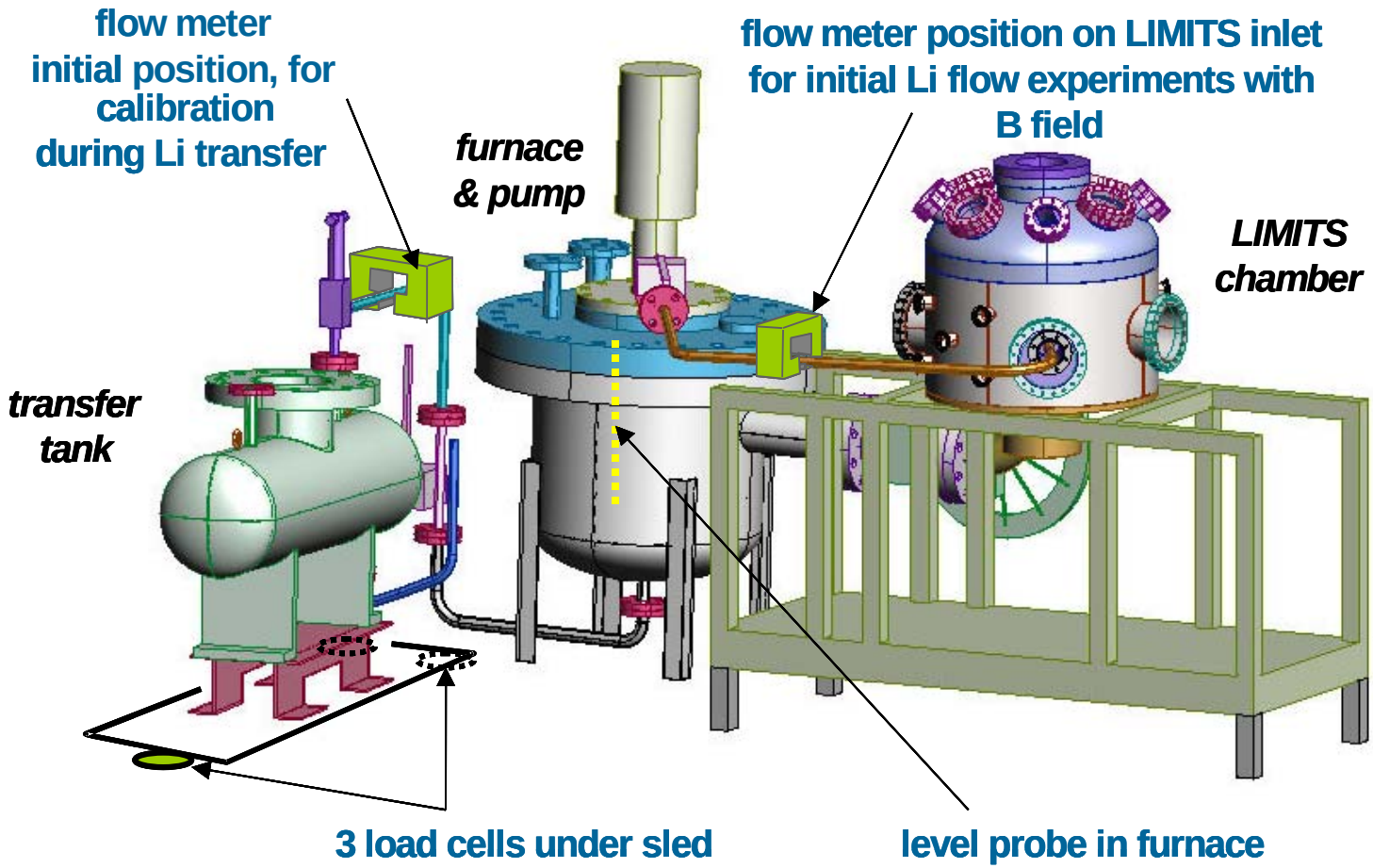
Calibrating the magnetic flow meter



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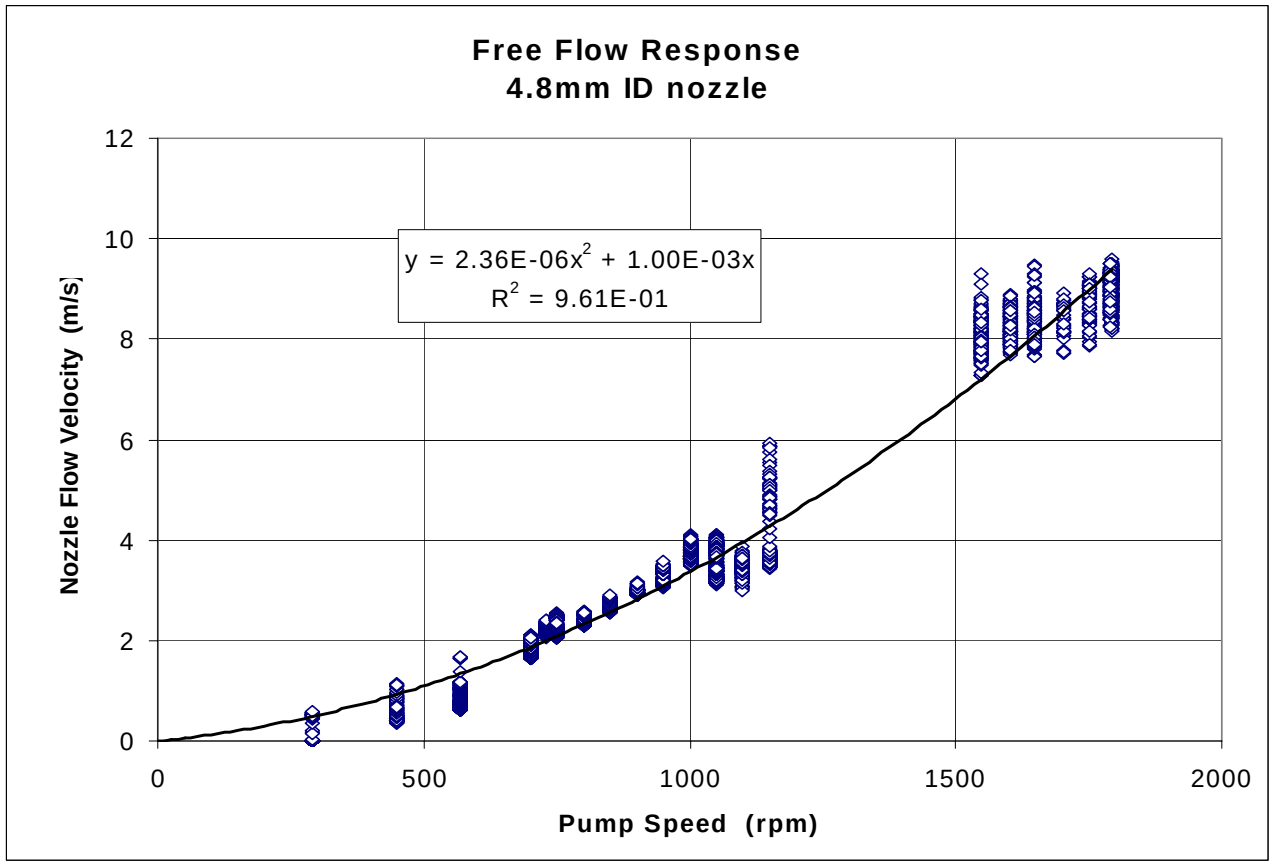
Generated a pump speed flow curve.



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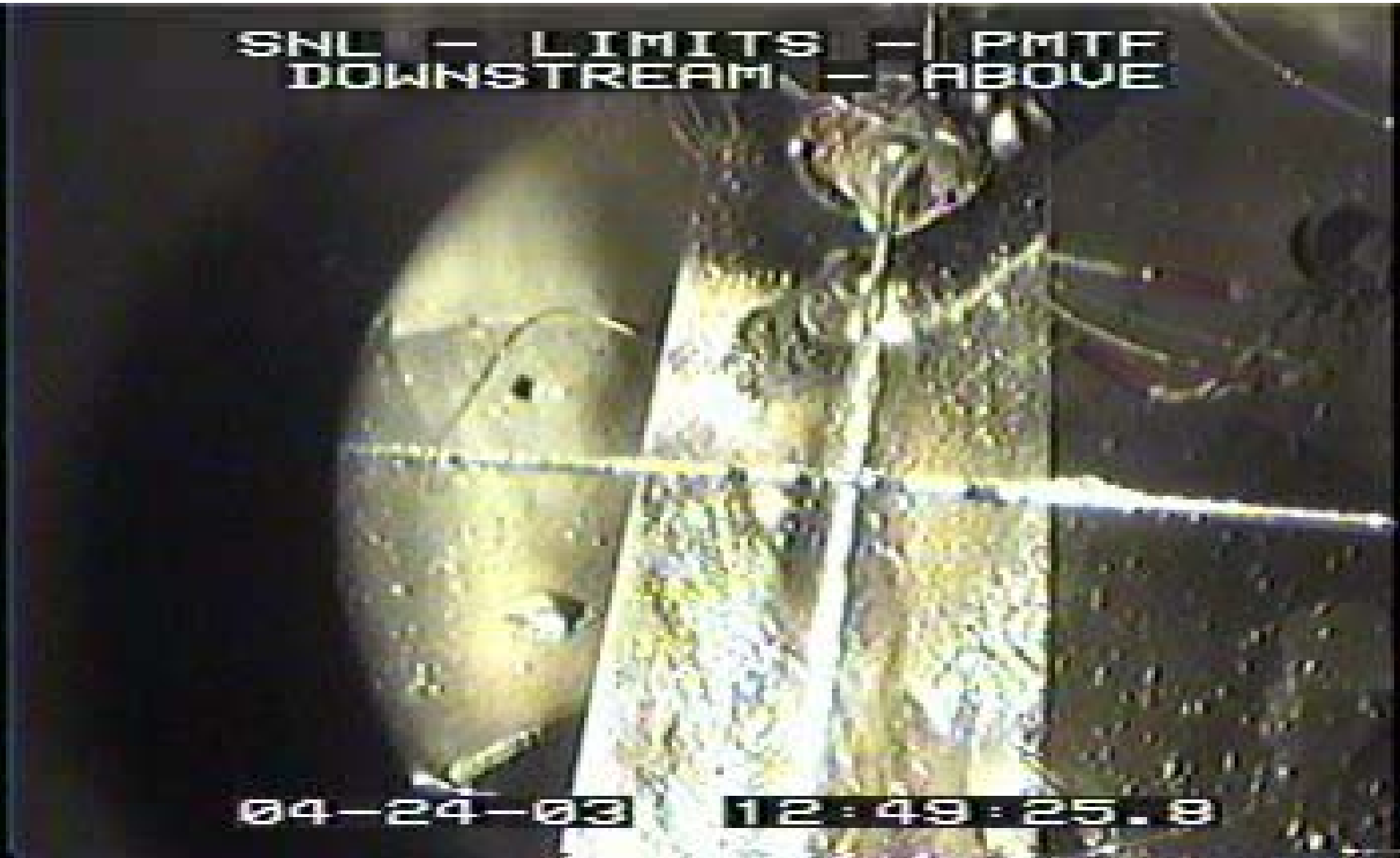
Ran Flow tests without a magnetic field
And Observed the flow characteristics



Centrifugal Pump Problems and Fixes

- Lithium heating
- Pump impeller friction

Lithium does not provide lubrication

- –Stainless Steel rubbing on stainless steel causes friction welding
- –Molybdenum plasma sprayed coating cracked and unbonded.
- –We have designed a cobalt alloy ring and have a contract with a shop to modify the impeller. This could lead to a patentable liquid metal centrifugal pump.

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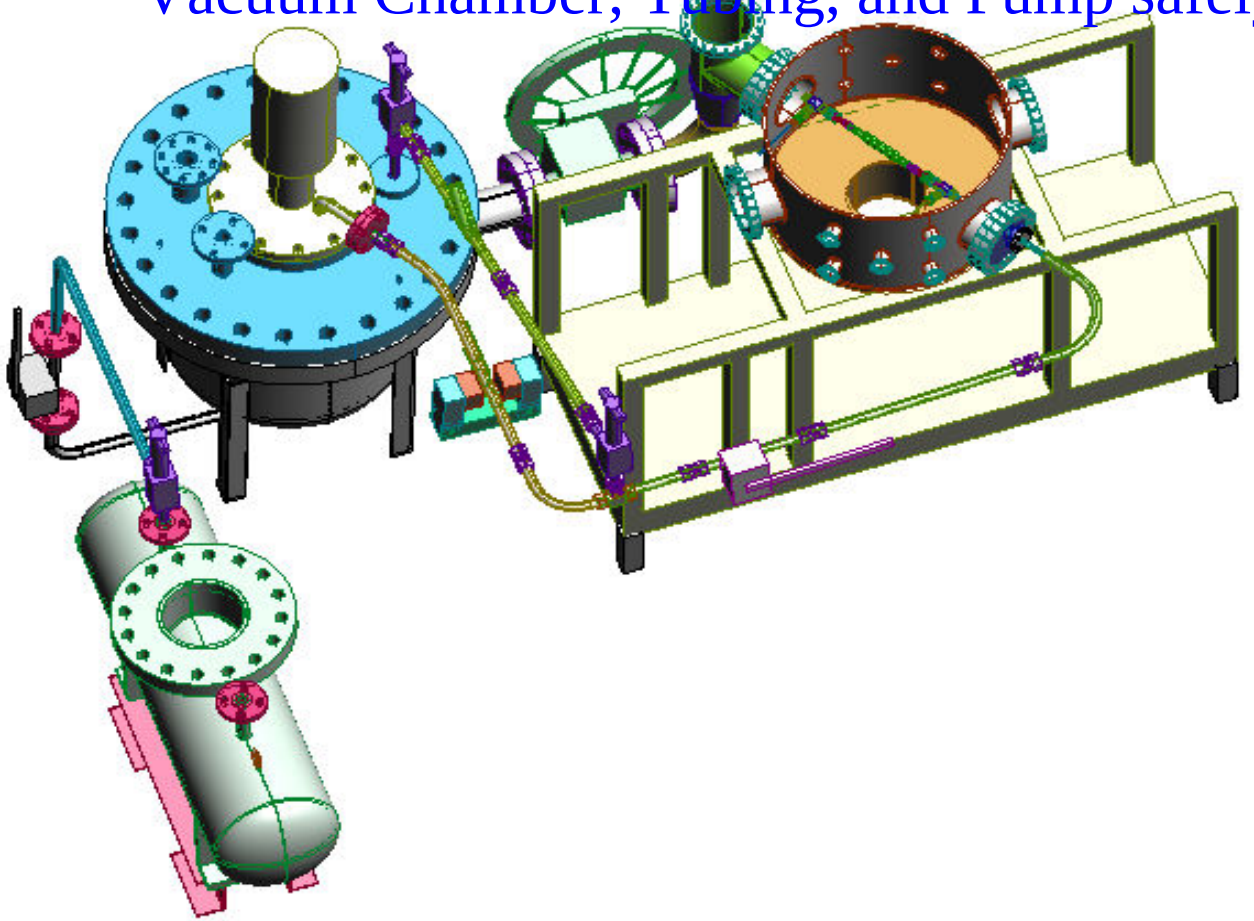
Proven we can perform Lithium cleanup of the Vacuum Chamber, Tubing, and Pump safely!



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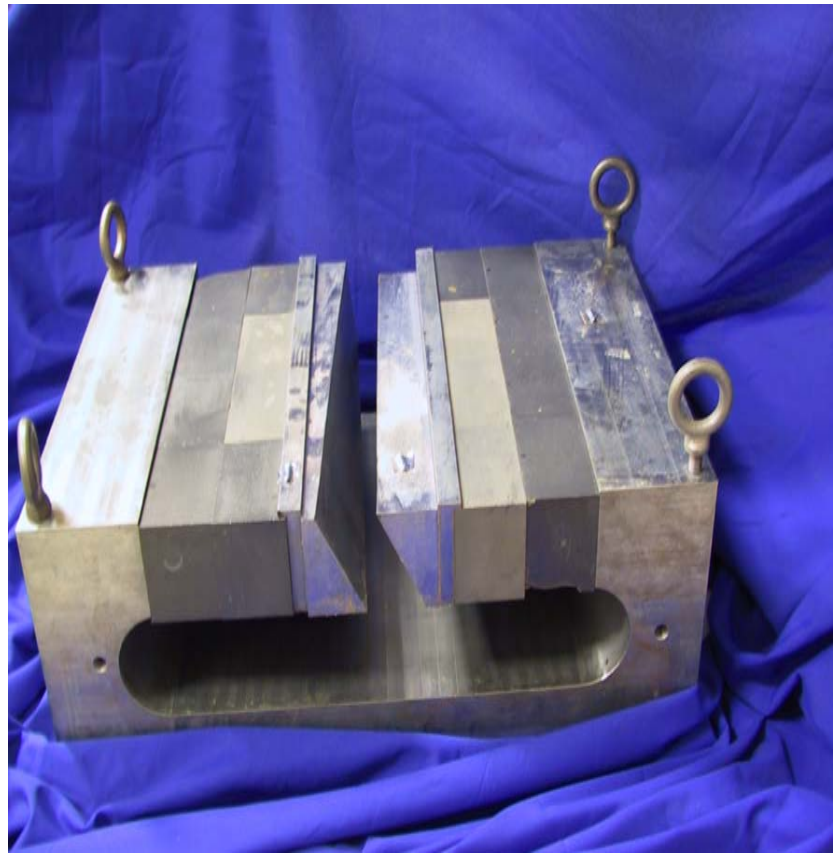
Magnet filled with Li

Magnet after cleaning



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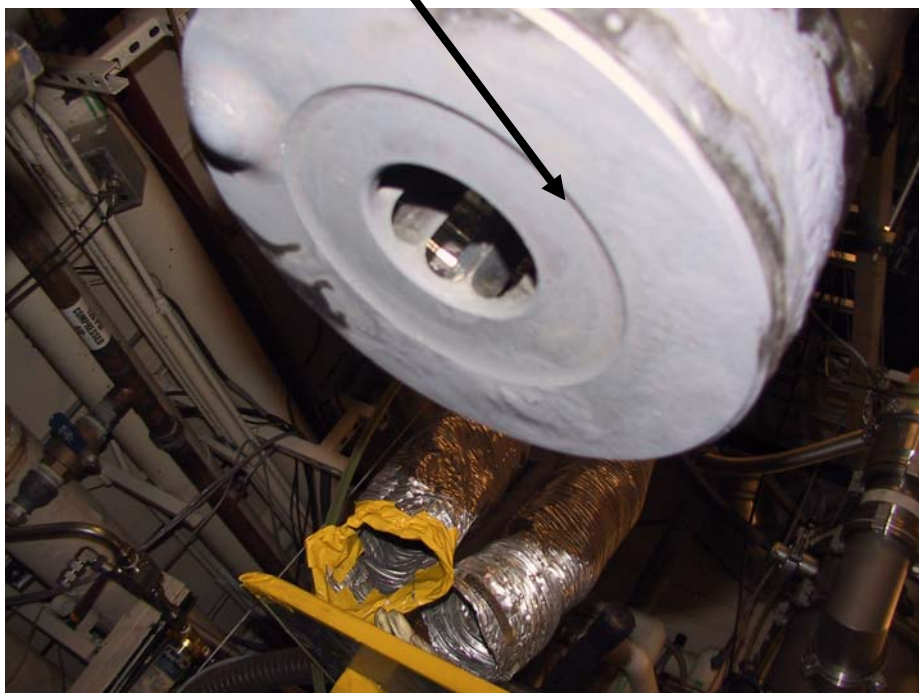
Pump impeller with Li



Pump impeller being cleaned in ultra pure water bath

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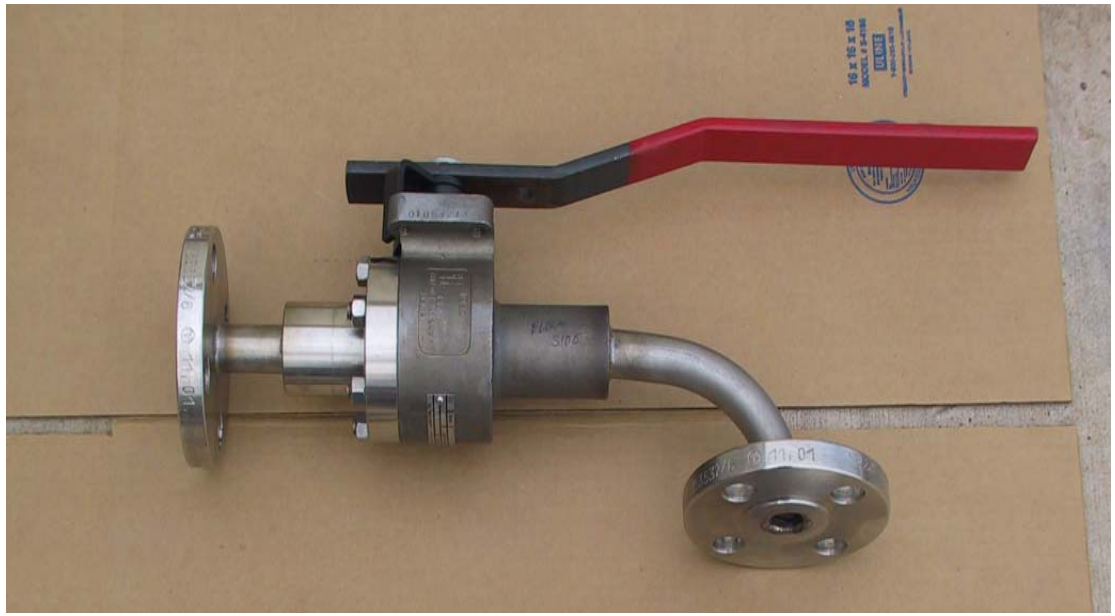
Modifications to the system to make heating less complicated

- **Lithium heating**
  - **Large flanges and small tubes are hard to heat evenly.**
  - **We now replacing, where possible, the flanges with Swagelok fittings.**



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Nozzle designing and testing is on going.

- **Flat streams are needed for high-heat flux testing**

- **10 m/s flow is desired, but this is most likely a turbulent flow region**

- **Water is used to simulate lithium flow**

- **This promising nozzle has a vertical slot, but forms a horizontal flat stream**

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Questions?

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