Surface Processing of Spoke Cavities for RIA

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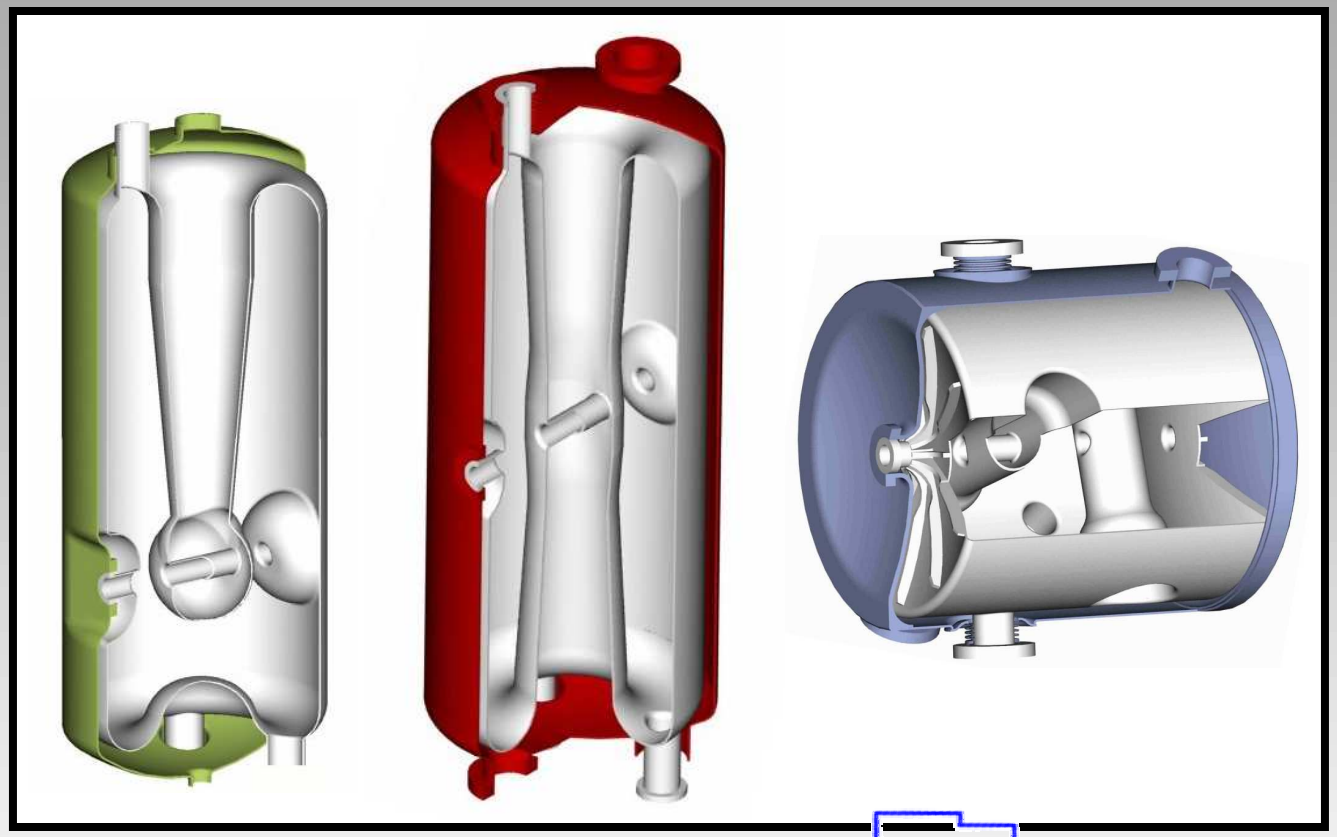
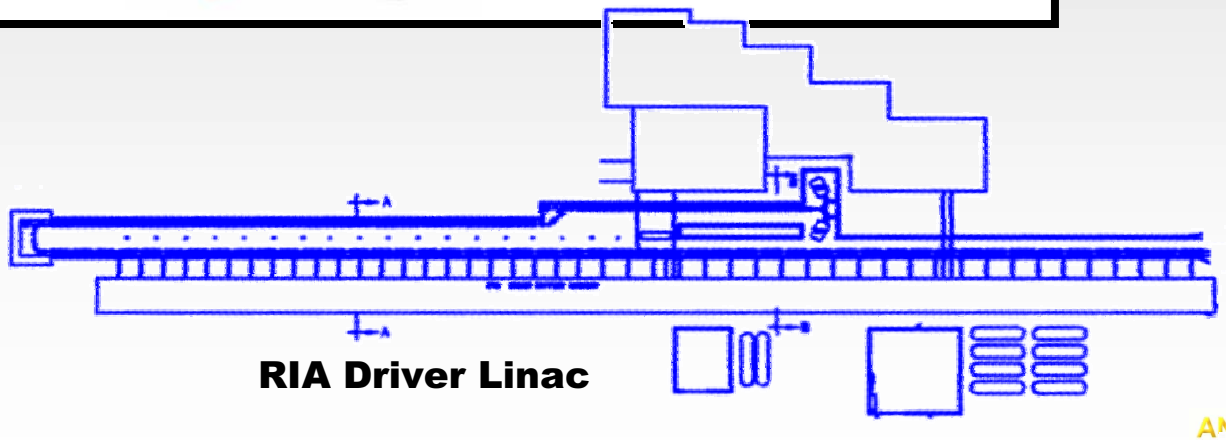
Higher gradients in drift-tube cavities for RIA

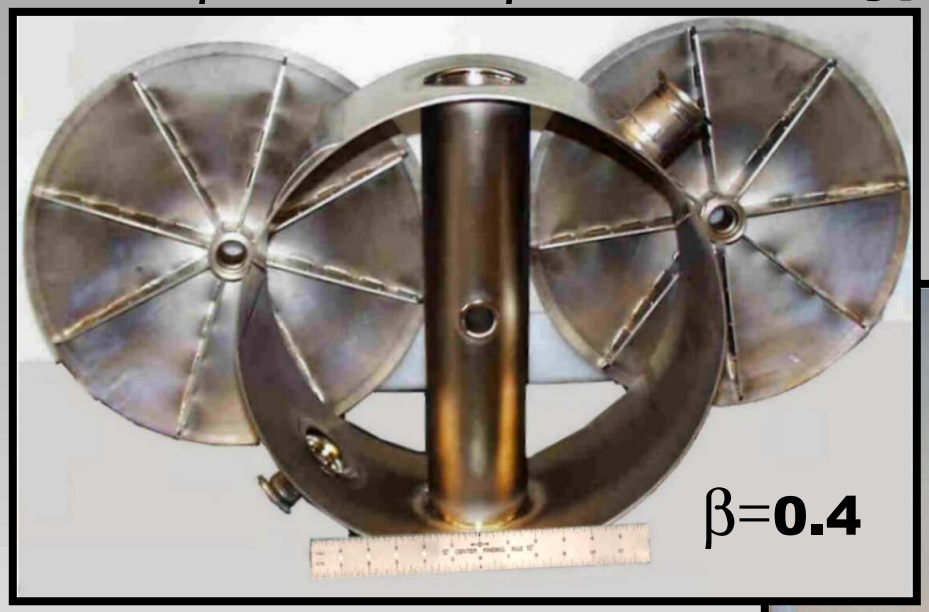


- Cost and Performance
- Clean processing techniques for drift-tube structures
- Developed for TESLA and at JLAB for elliptical cell cavities
- Recent progress related to drift-tube cavities



RIA Driver Linac

ANL β=0.3 and β=0.4 Prototype Spoke Cavities for RIA



- Constructed in 1996-97
- Single-cell 350 MHz solid niobium

- Electropolished
- Electron-beam welded
- Light chemical polish
- BCP and HPR

See Delayen et al, SRF 1993, for discussion of 805 MHz spoke

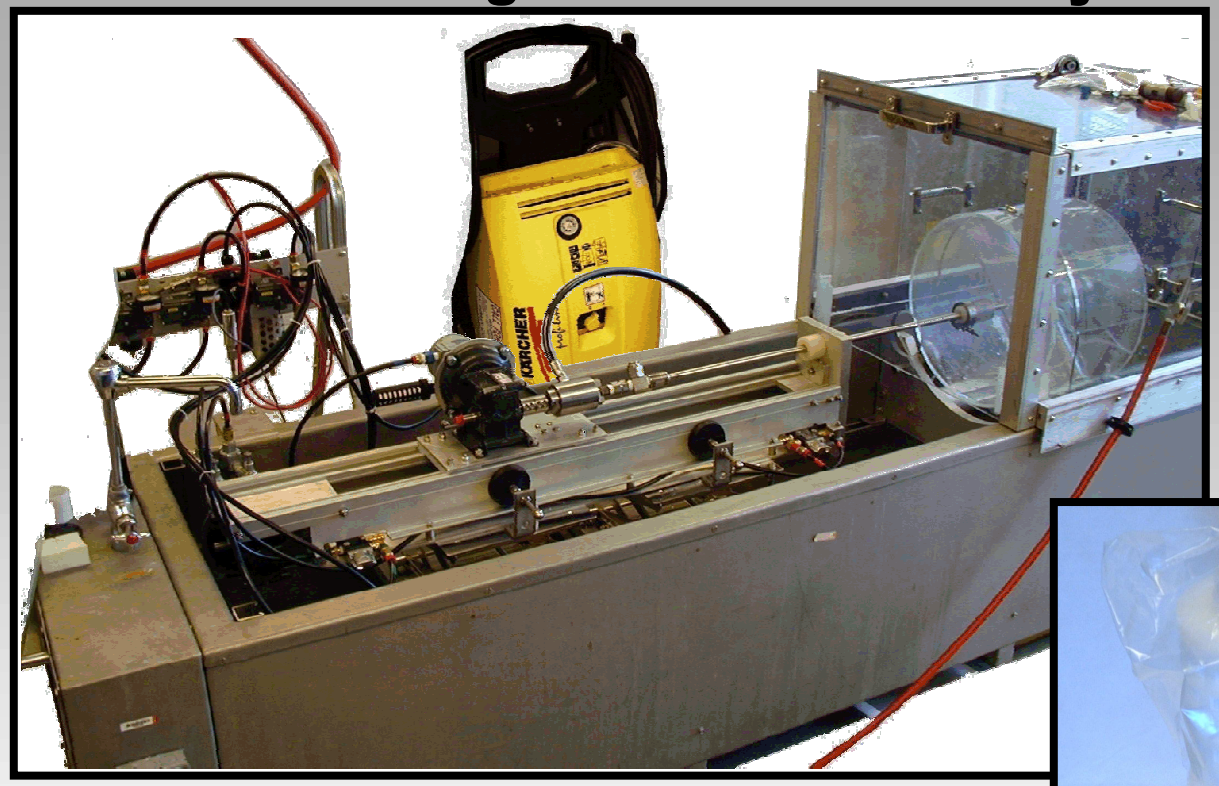
A Two-cell β=0.4 Spoke Cavity for RIA

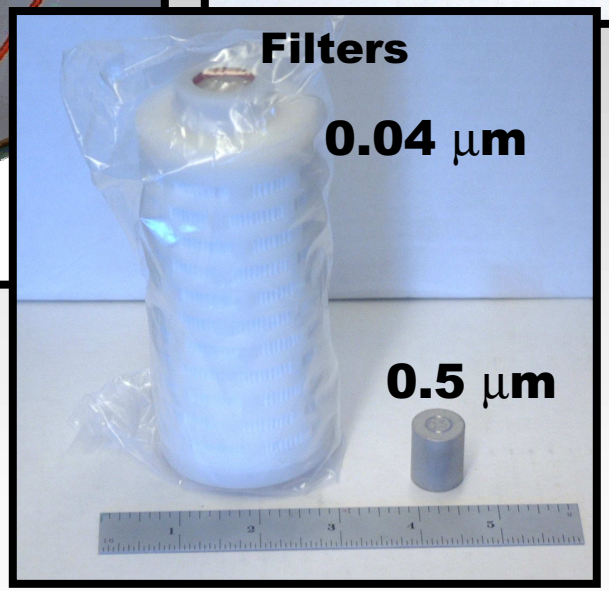
Completed: 100-200 μm removed

- 345 MHz
- Solid niobium, 3.175 mm RRR $\geq$250 sheet
- Plan for Surface for Treatment: Heavy EP, HPR, e-beam Closure Weld, Light BCP, and HPR

As of Sept 20: 25 μm removed

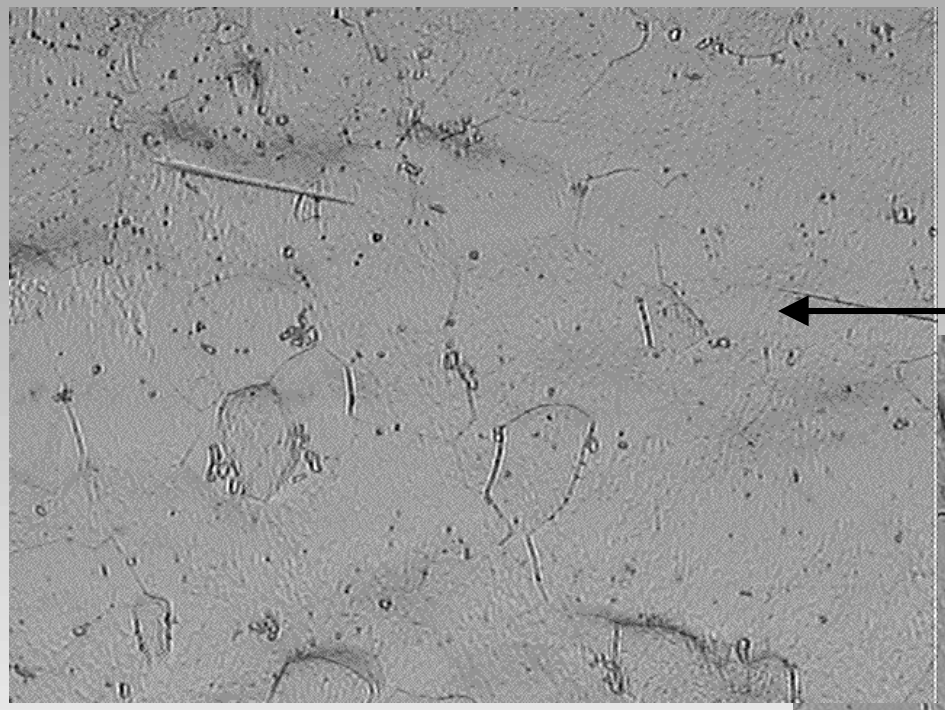
ANL Drift-Tube Cavity Surface Processing: An Automated High-Pressure Rinse System



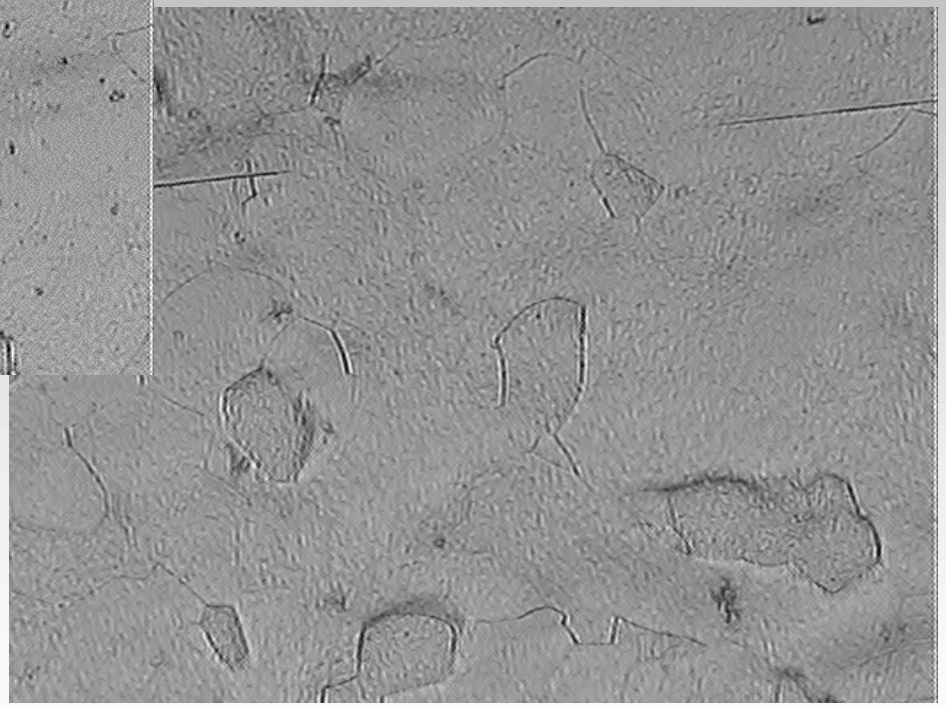


- PC controlled
- Ultra-pure DI water
- 20 l/m, up to 3000 PSI (1750 PSI)
- 0.04 μm filtration
- Curtained clean room area

Electropolished Nb surface Before and after HPR at 1750 PSI



240 μm



Cleaned with ethanol and Acetone, before HPR

After HPR

High-Pressure Rinse System: Manufacturers

High-pressure filtratration

- Domnick-Hunter PROPOR PES 0.04 μm, housing product #VIL01ABN-HP 4350 PSI
- Swagelok filter SF-8F-K4-05, housing SF-6TF2-LE
- Plumbing: Swagelok 8R nylon bore, 4000 PSI

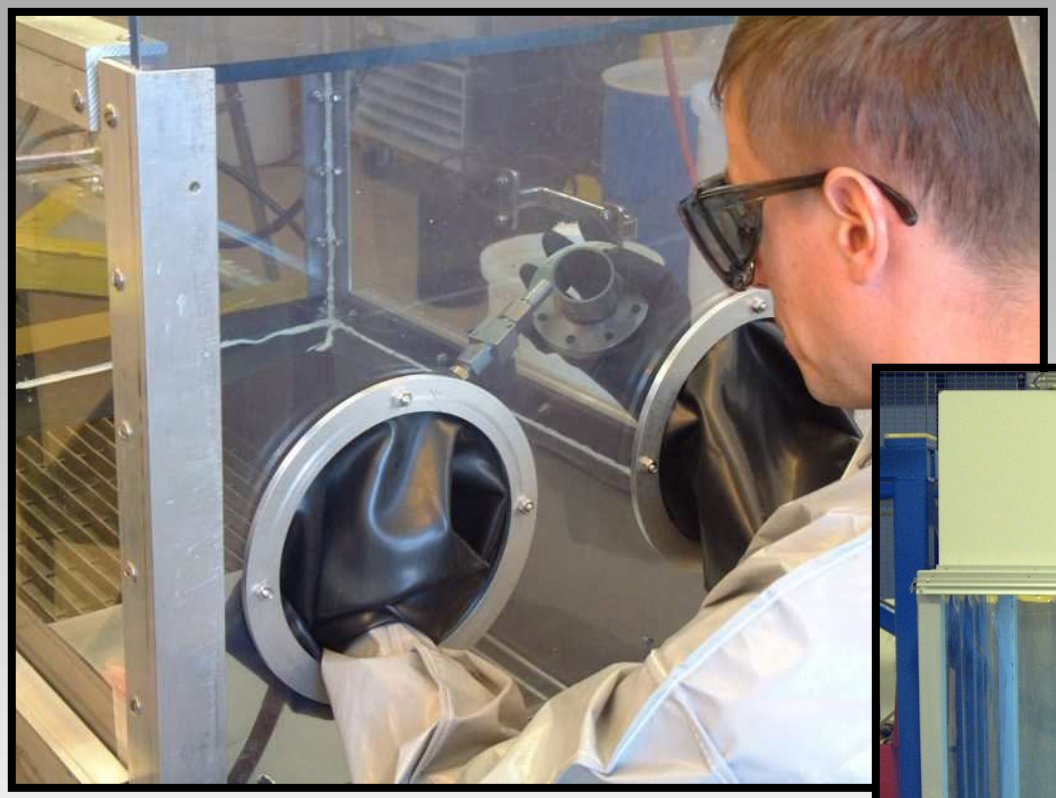
High-pressure Pump

- Karcher HD1090 3000 PSI, 4 GPM

Translation carriage, nozzles:

- StoneAge Waterjet Tools (CAVQ custom lancing system)
- Nozzles TD-010-P4

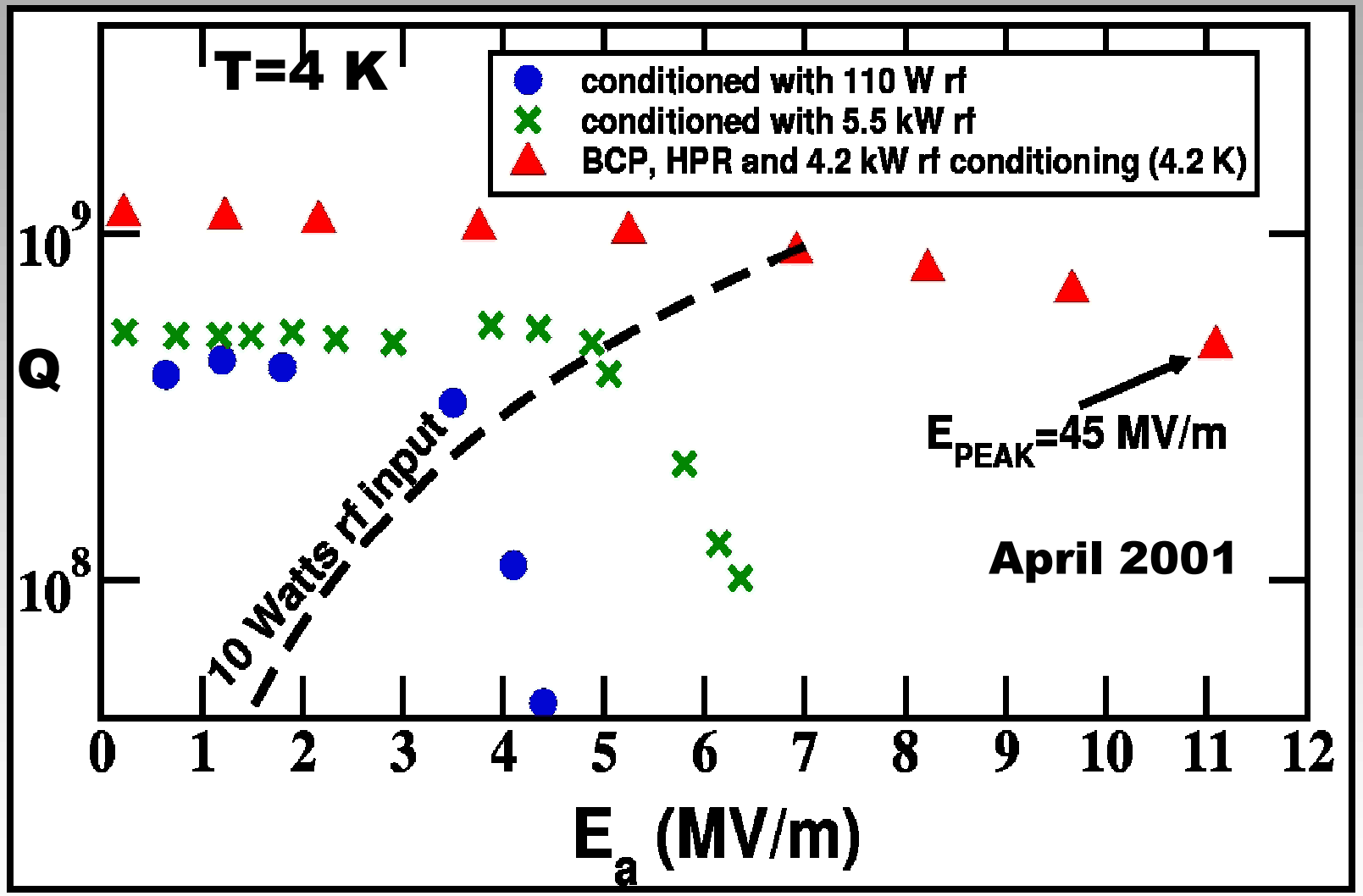
A Manual High-Pressure Rinse



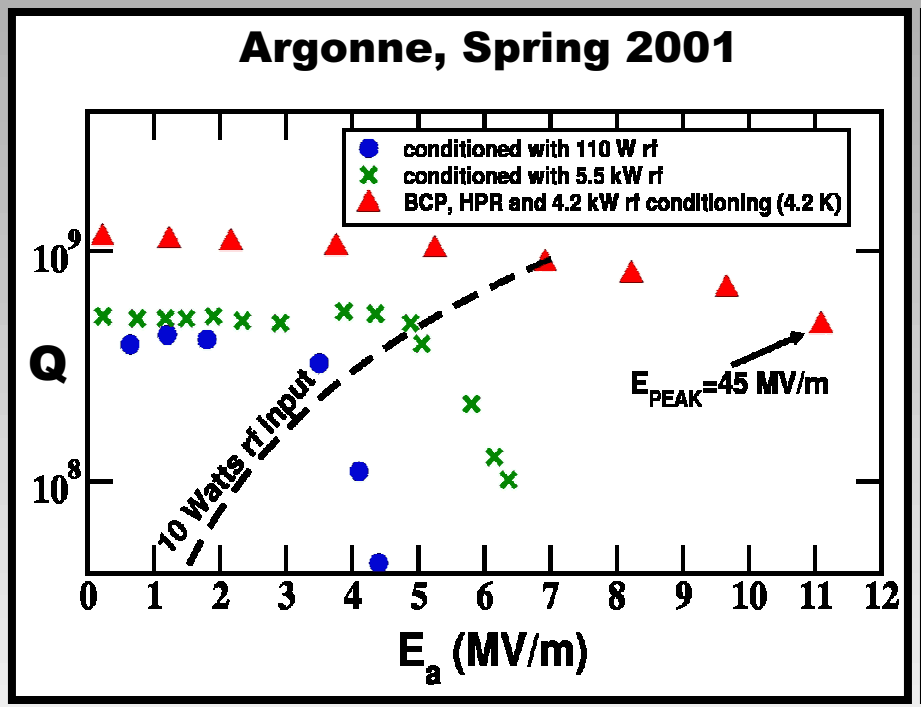
Used for:

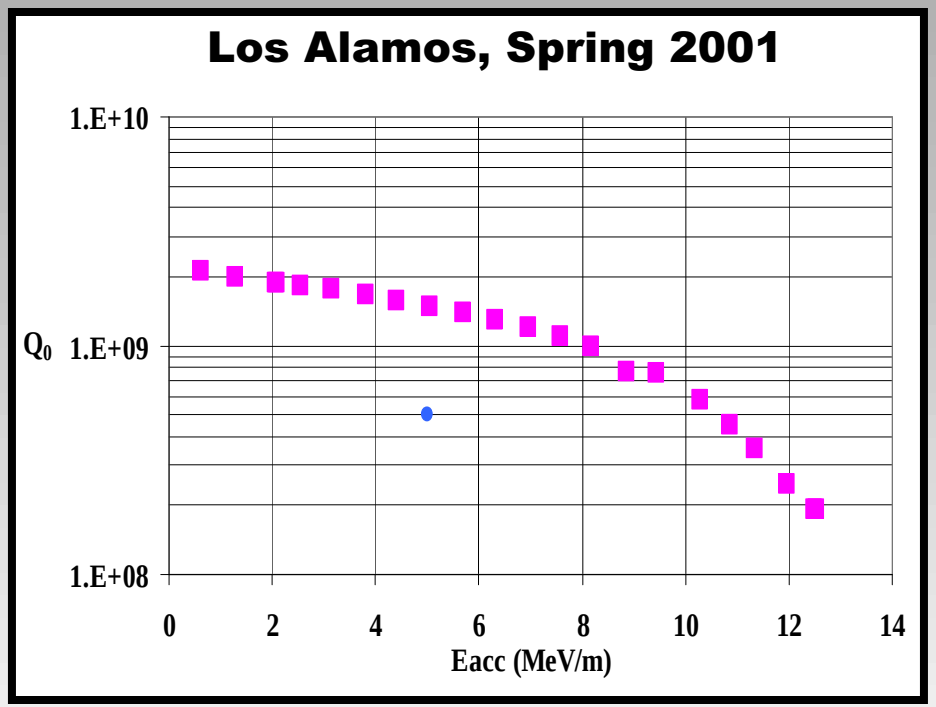
- **Cleaning after EP**
- **Prior to e-beam weld**
- **Coupler parts, bagged and assembled downstairs**

ANL β=0.4 Prototype Spoke Cavity Test Results



ANL β=0.3 and β=0.4 Prototype Spoke Cavity Results

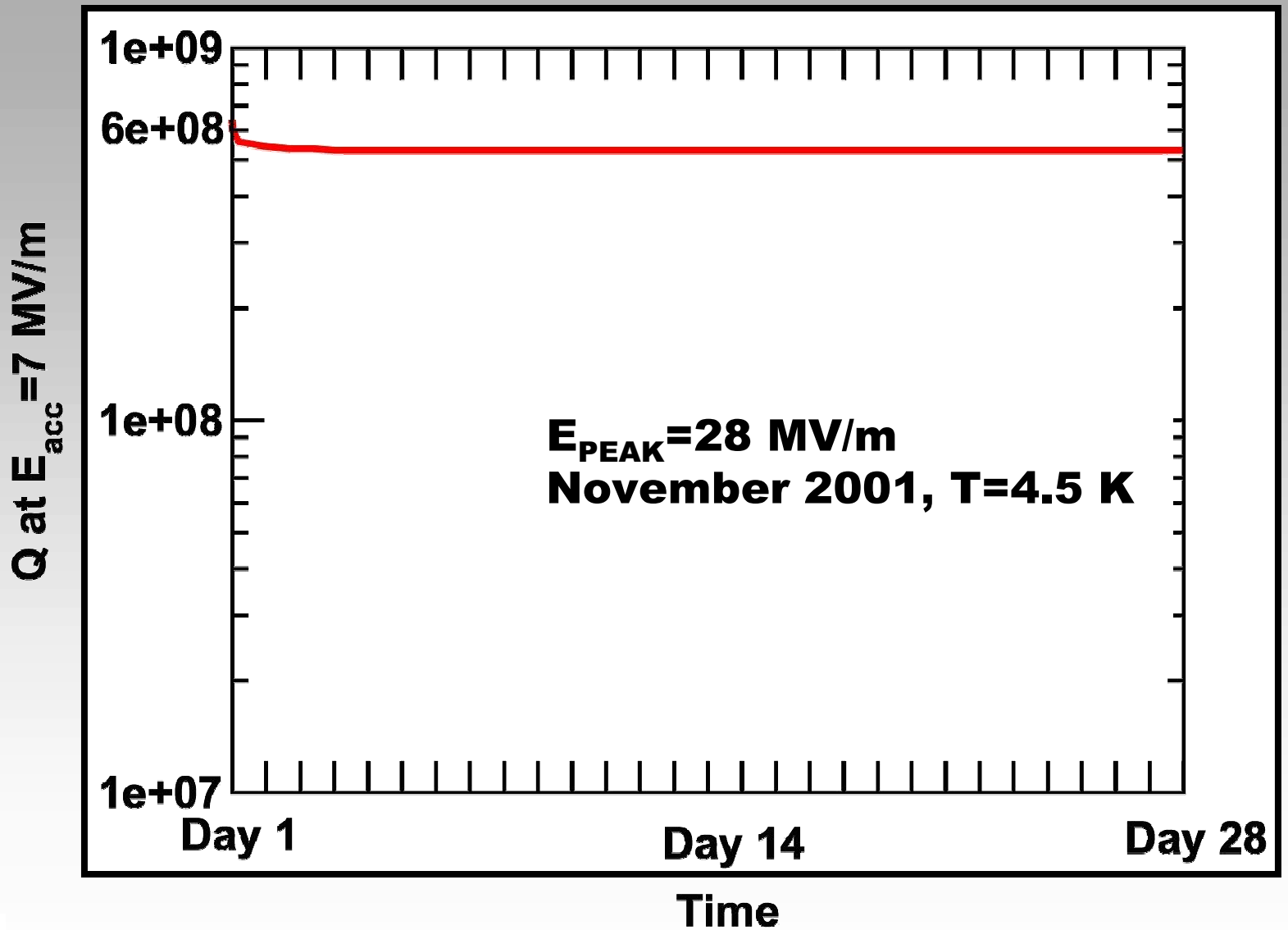




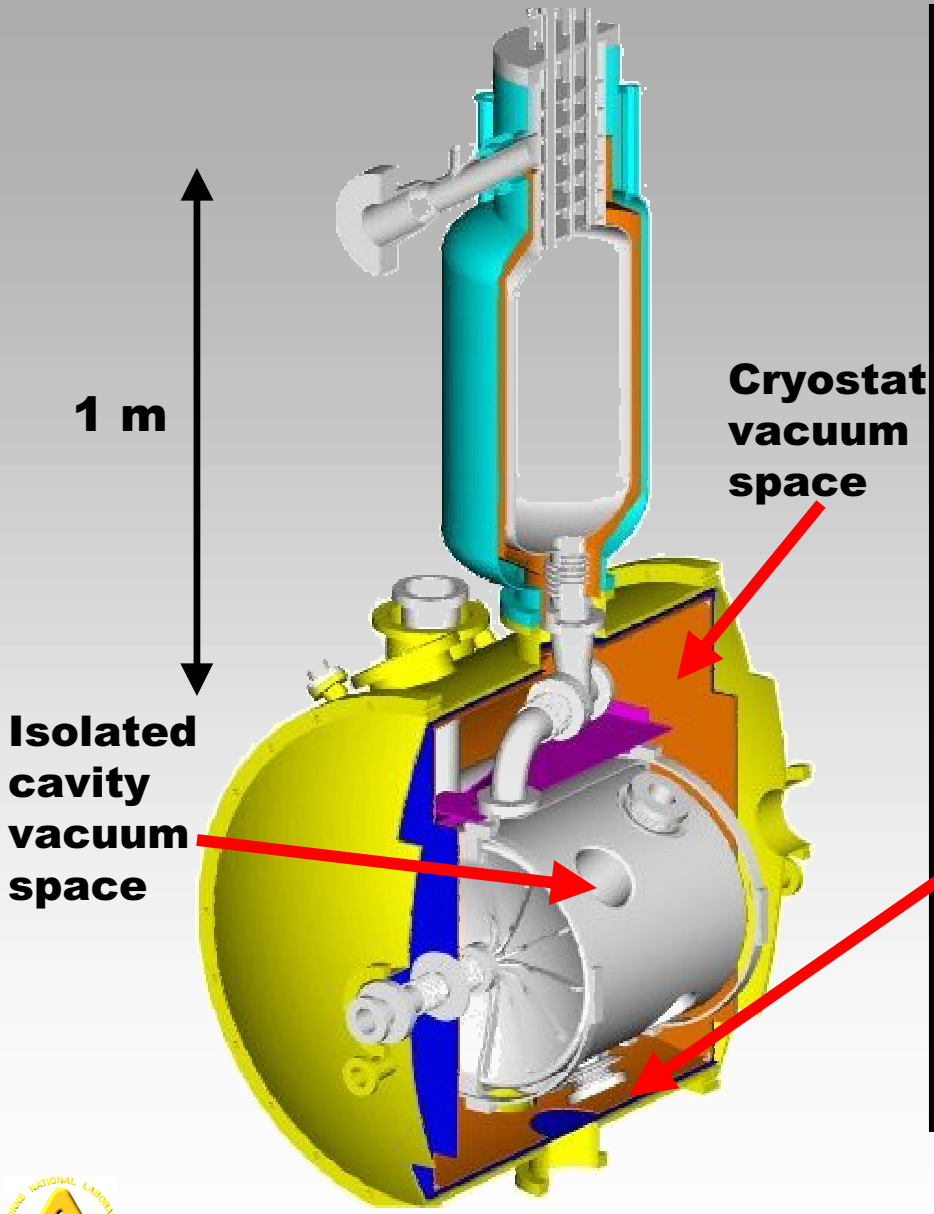
Argonne Result β=0.4 cavity

Los Alamos Result β=0.3 cavity

ANL β=0.4 Spoke Cavity at 7 MV/m for One Month

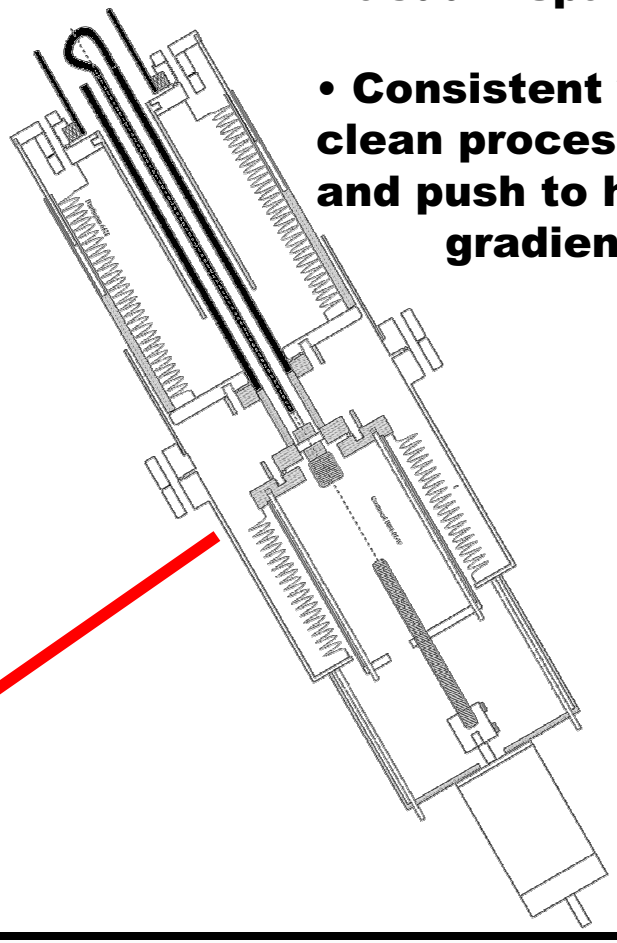


Tests of 345 MHz Two-cell Spoke Cavity



Power Coupler

- Separate vacuum space
- Consistent with clean processing and push to higher gradients.



Tests of 345 MHz Two-cell Spoke Cavity

- Cavity space sealed in clean area
- ATLAS refrigerator for long-term tests
- New rf coupler, phase stabilize
- Vibration damping mount

Surface Processing of Two-cell Spoke Cavity: Electropolish

Siemens
- 89.5% by vol. of H_2SO_4 (96% conc. by weight)
- 10.5% by vol. of HF (40% conc. by weight)

- 76 liters - housing, 15 liters - end plate 50-100 cycles
- Power supply voltage: 19 V
- Power Supply On/Off → 60 sec./90 sec. ("one cycle")
- Acid Temperature: 31.5°C +/- 0.25°C
- <u>Recirculate acid only during Off time</u>
  20 liters/min pumped

Surface Processing of Two-cell Spoke Cavity: Electropolish

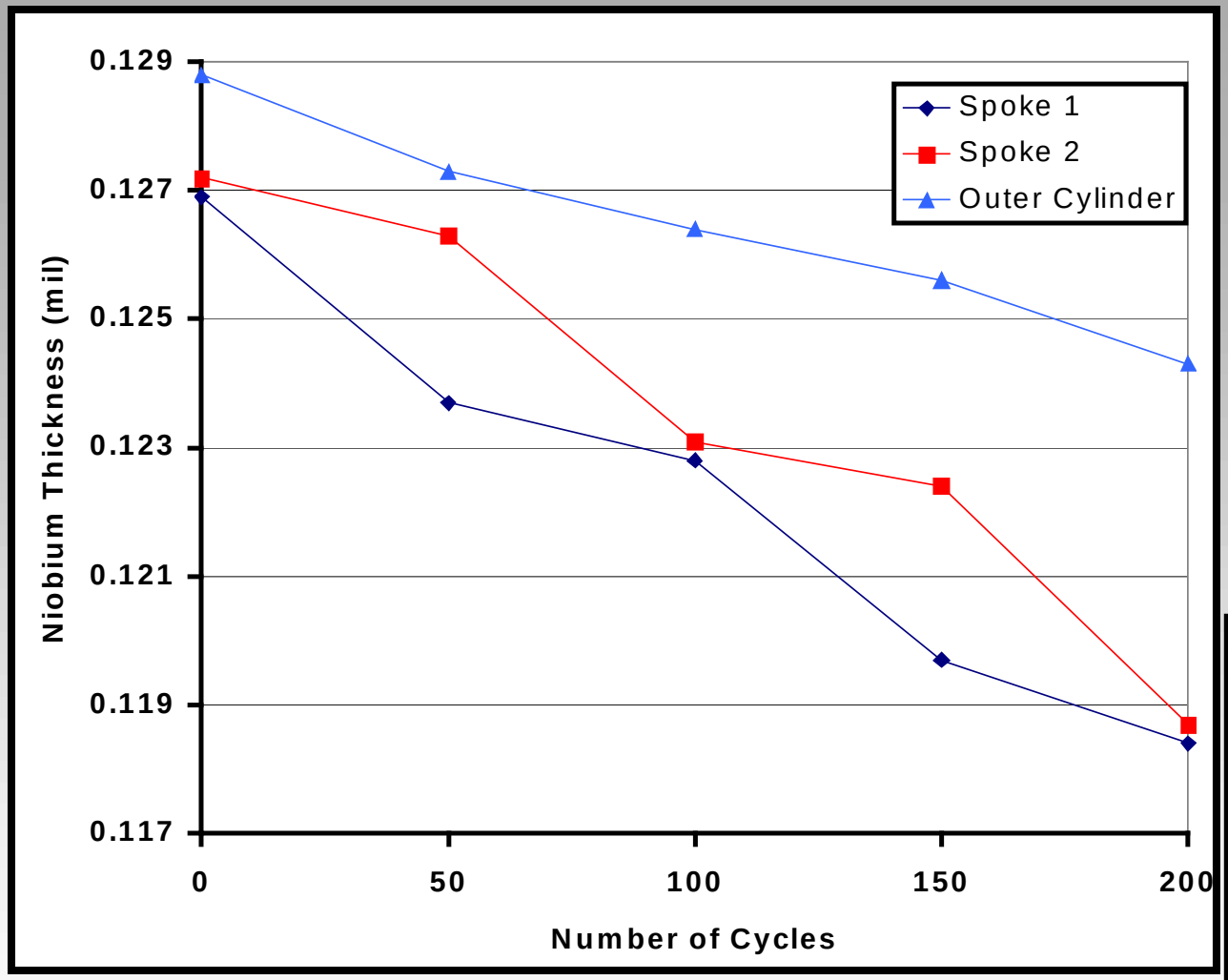
Housing Electrode

3/8” 3003 Al tubing

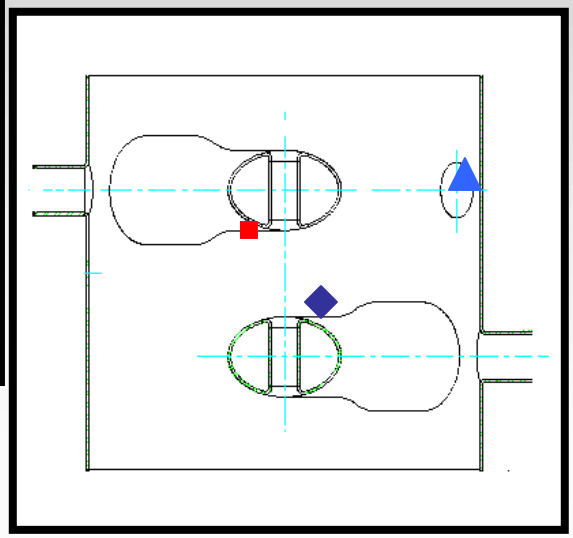
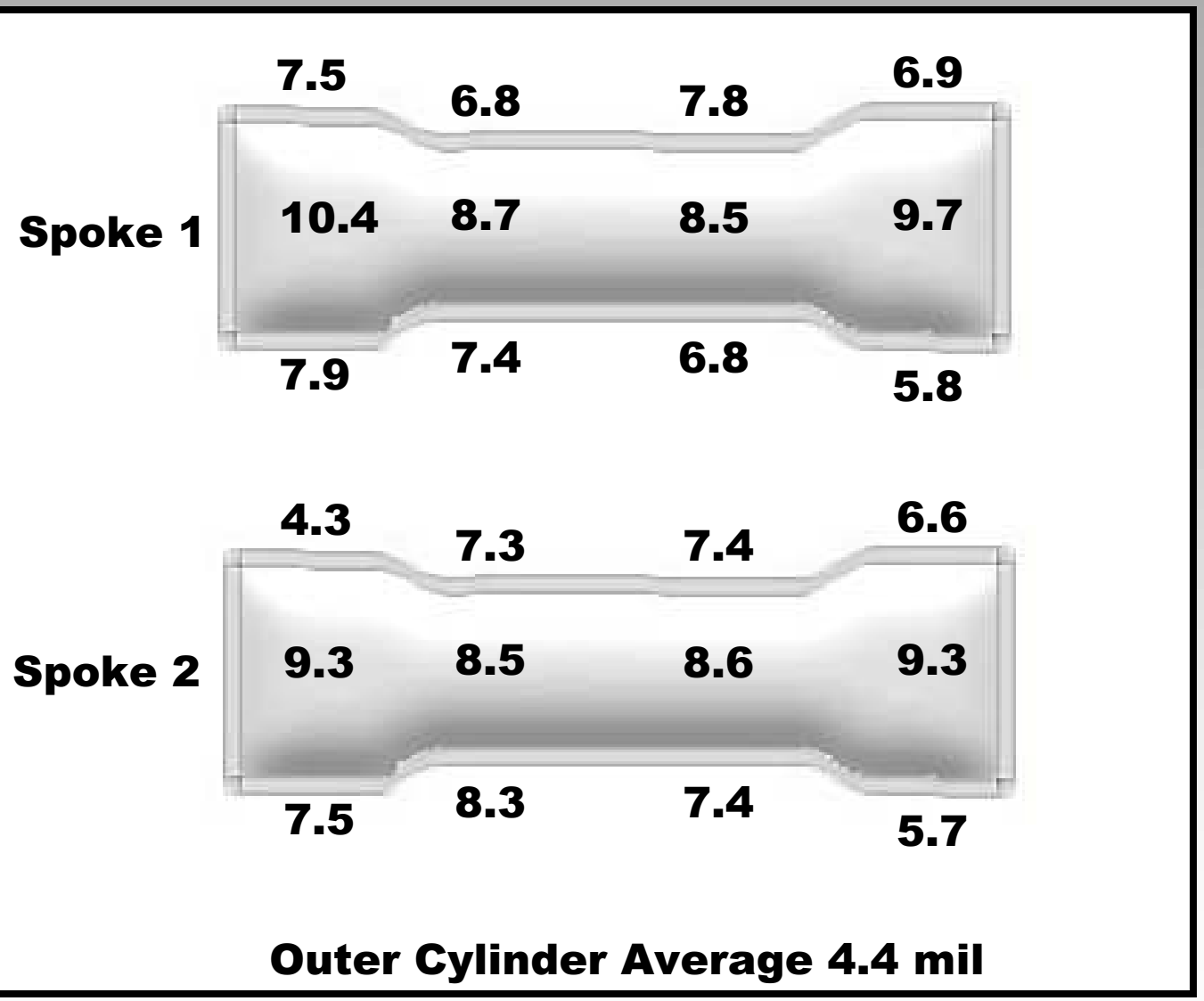
- **Housing area: 8600 cm^2**
  Cathode area: 4300 cm^2
- **Endplate area: 1650 cm^2**
  Cathode area: 2110 cm^2

End Plate Electrode

Surface Removal Rates on the Spokes and Outer Housing



- **Housing flipped after each 50 cycles**
- **Clear difference between upward and downward facing surfaces**



Total Thickness Niobium Removed (mil)