

# Electropolishing at ANL/FNAL

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ANL Electropolishing parameters for 9-cell cavities	
Pre-cleaning	Ultrasonic, 1% Liquinox, 1 hour, 50 °C
Electrical connection	Copper braid on cells 2, 5, 8
Cavity rotation speed	1 rpm
Acid reservoir/inlet temperature	20 °C
Acid outlet temperature	30-35 °C
Heat exchanger capacity	10 kW
Heat exchanger material	3003-O Aluminum
Acid flow rate	8 liter/minute
Air flow rate	9 liters/minute
Cathode geometry	3.3 cm OD Al tube
Cathode masking	Teflon tape w/ 40mm openings at cell location
Cathode holes	One 6 mm hole downward into each cell
Electrolyte	9:1 of 96% sulfuric, 48% HF
Volume of rinse water	200 liters
Final pH	5
Post-cleaning	Ultrasonic, 1% Liquinox, 1 hour, 50 °C

Table 1. Electropolishing parameters used at ANL for nine-cell cavity electropolishing

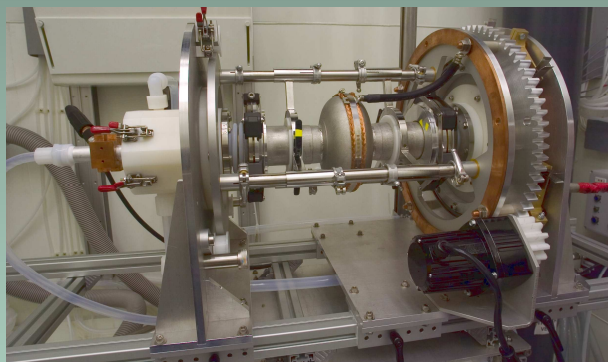


Figure 1. The EP hardware configured for a 1.3 GHz single-cell cavity

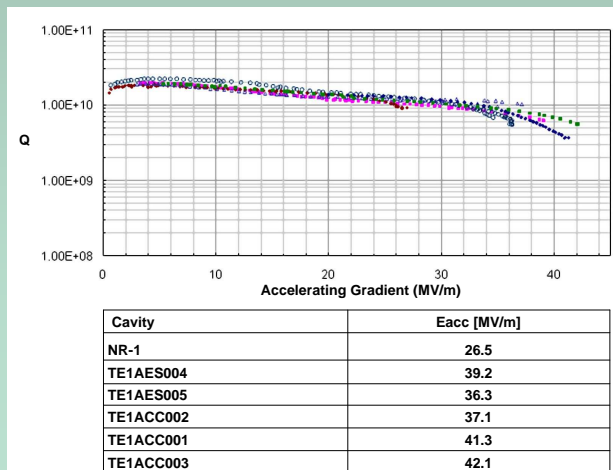


Figure 2. Single-cell cavity cold test results measured at FNAL after electropolishing, high-pressure water rinsing and assembly at the joint ANL/FNAL facility.

## ABSTRACT

A system for electropolishing of 1.3 GHz elliptical single- and nine-cell cavities is in operation at the joint ANL/FNAL cavity processing facility located at Argonne. The system is one piece of a larger 200 m<sup>2</sup> complete single cavity processing and assembly facility which also includes clean rooms and high-pressure water rinsing. Recently, the electropolishing system has been used to process a series of single and nine-cell cavities. For single cell cavities a good set of EP parameters has been demonstrated based on more than a half dozen complete processing and cold test cycles at ANL/FNAL. The latest six single cell cavities each exceed  $E_{acc}=35$  MV/m and, at this gradient, have Q in the range  $6 \times 10^9 - 1 \times 10^{10}$ . The first nine cell cavities electropolished at ANL have not yet reached similar fields (~23-26 MV/m) and ongoing activities are focused on demonstrating 30 MV/m or better in these cavities. Suitable nine cell EP parameters using the ANL/FNAL EP system including acid/water temperatures, flow rates, current, voltage, air flow etc. are all substantially different than for single-cell cavities and are discussed here.



Figure 3. Electropolishing system for 1.3 GHz single and nine-cell elliptical cavities. The system is shown loaded with a nine cell cavity in the horizontal orientation as is the case, for example, during the electropolishing procedure.



Figure 4. Electropolishing system shown in the horizontal orientation (left panel) as during the procedure and the same system shown rotated into the vertical orientation (right panel) as required for dumping the acid at the end of the procedure and for loading and unloading of the cathode.

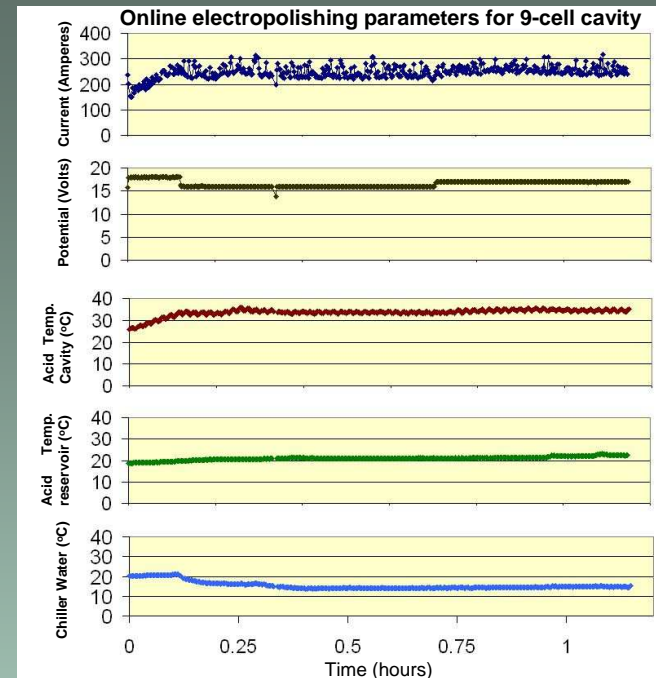


Figure 5. Parameters for electropolishing of a standard ILC-type nine-cell cavity. The removal rate has been measured to be very close to the nominal 0.3 microns/minute, or just over 20 dmicrons for this procedure. The only parameters adjusted during EP are the applied anode/cathode potential (2<sup>nd</sup> panel from top) and the temperature of the chiller water (bottom panel) circulated through a heat exchanger in the external acid reservoir.

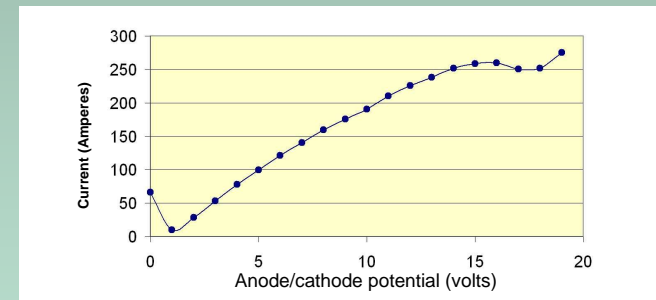


Figure 6. Measured current versus voltage (I-V) curve measured about 20 minutes into the procedure described above in Figure 5. The data clearly shows the plateau corresponding to the 'electropolishing region' between about 15 to 18 volts. Most of this procedure was performed at 16-17 volts anode/cathode potential.

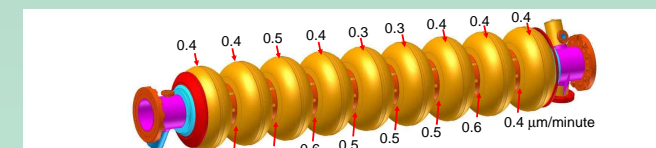


Figure 7. Measured removal rate in microns/minute near the equator and iris regions as determined using a hand held ultrasonic thickness gauge.