Vertical Electropolish @ Cornell

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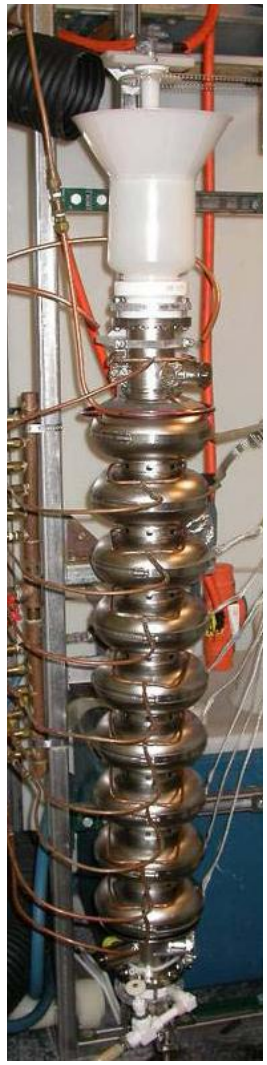


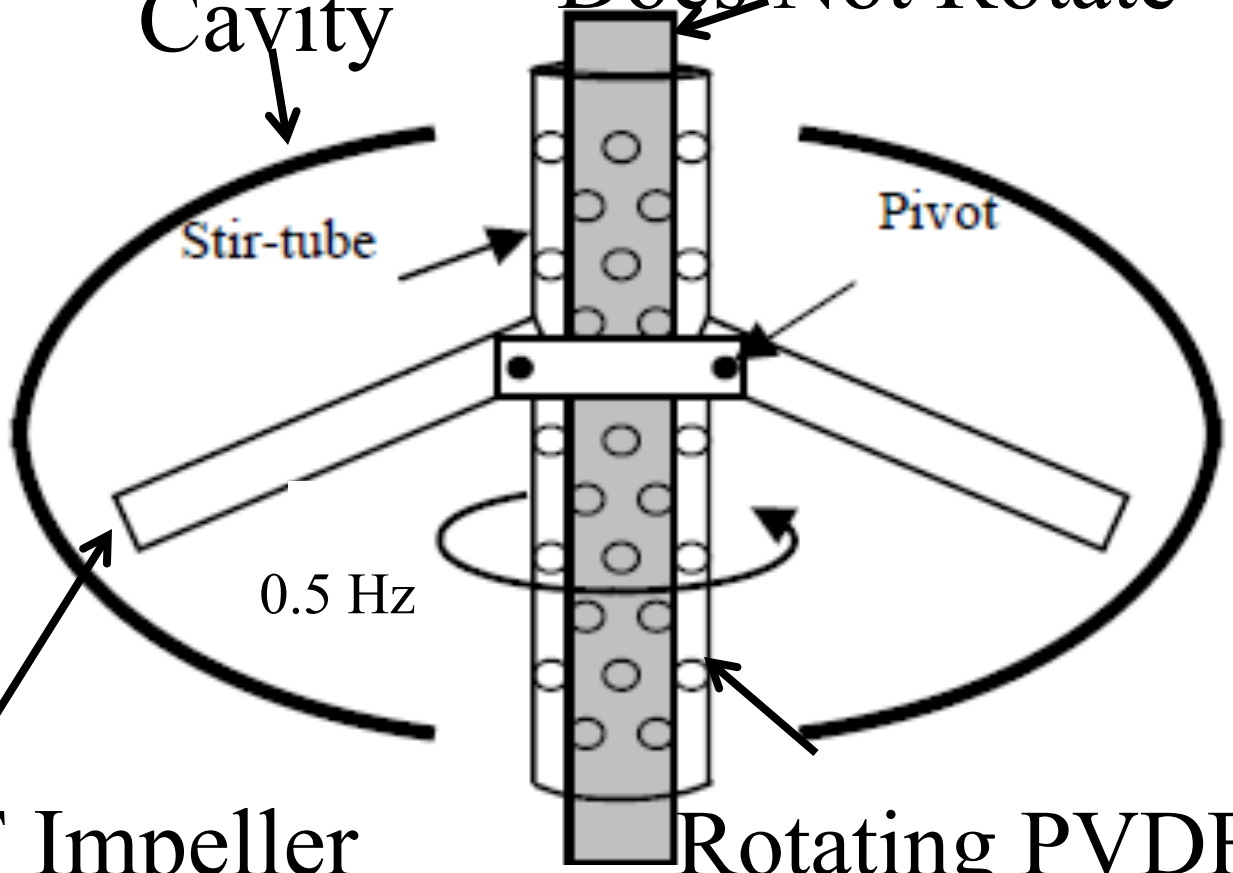
Vertical Electropolish at Cornell

- Outline
  - What is Vertical Electropolish? How does it work?
  - Why use vertical electropolishing?
  - The status of vertical electropolishing 9-cell cavities @ Cornell.
  - Summary and Plans

- Collaborators:
  - Hasan Padamsee
  - Curtis Crawford

What is Vertical Electropolish?

Parameters for VEP	
Cathode	Aluminum > 99.5%
Stir-Tube	PVDF
Paddles	PVDF
Seals	Viton
End Groups	PTFE, HDPE
Electrolyte	24 Liters/9 -Cell
Electrolyte Composition	9:1 (H2SO4:HF)+8ml of HNO3 per Gallon
Maximum Use	9 g/l dissolved Nb
Current	250 Amperes
Voltage	14.5 Volts
Temperature	20 to 23^0 C
Stir-Tube Transparency	>50%
Stir Frequency	0.5 to 2 Hz
EP Rate at Equator	0.5 μm/min
Ratio EP Rate iris/equator	~1.5



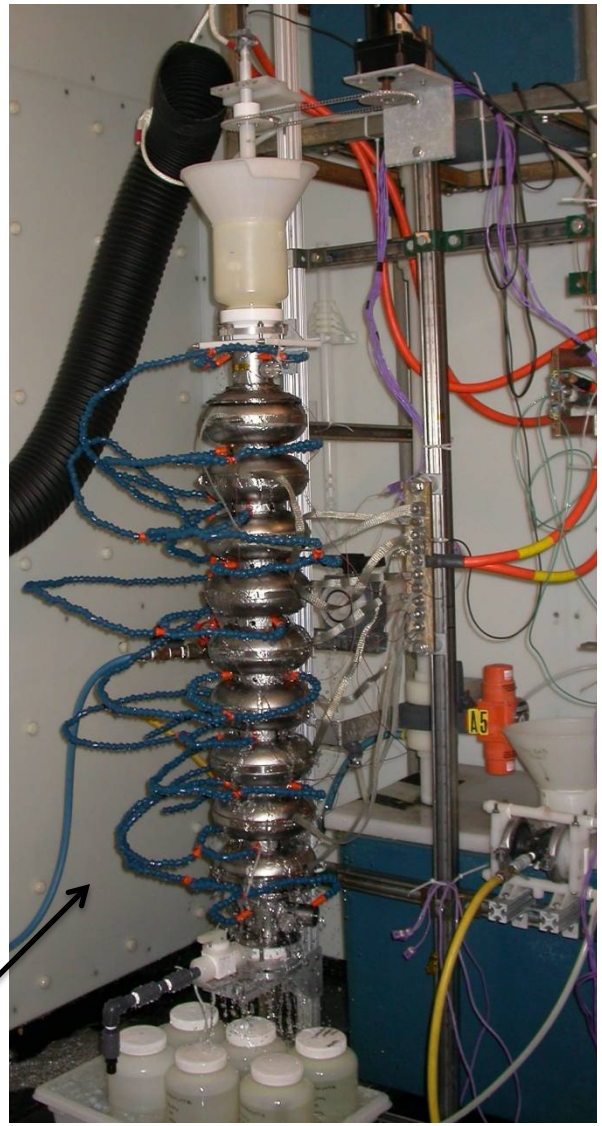
H. Padamsee & A.C. Crawford, PAC07, WEPMS009

What is vertical Electropolish?

Horizontal Electropolish
FNAL/ANL Joint Processing Center

M.P. Kelly et al, LINAC08, Pg. 839, THP026

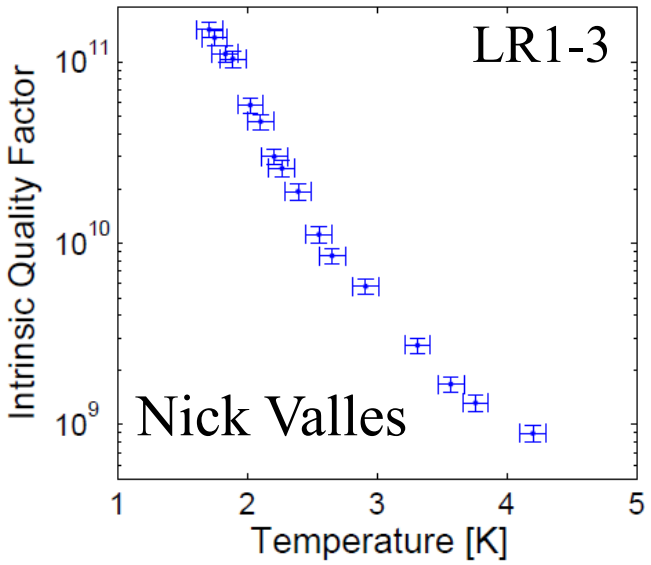
Vertical Electropolish

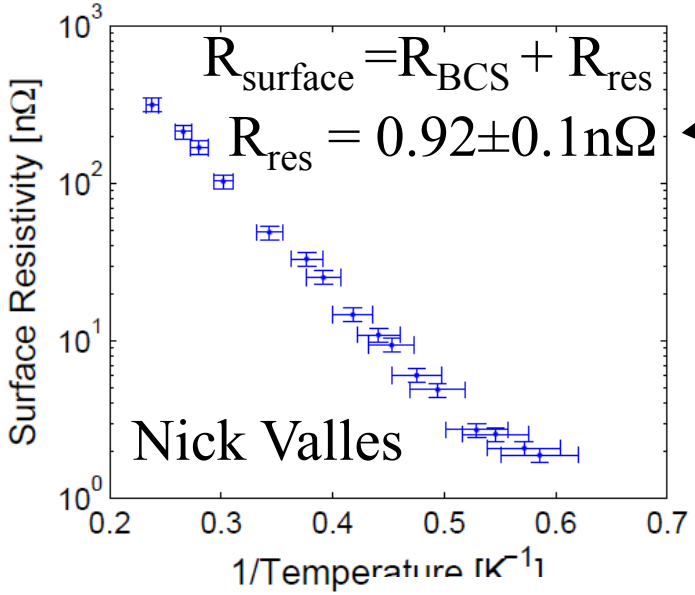


Why Vertical Electropolish?

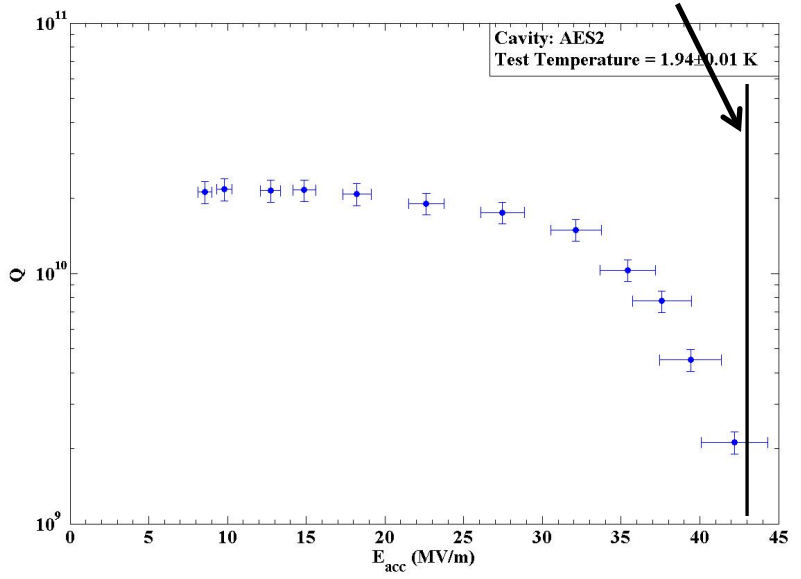
- Vertical electropolishing has the following benefits when compared to horizontal electropolishing
  - Eliminates rotary acid seals
  - Eliminates sliding electrical contact
  - Eliminates the cavity vertical/horizontal position control fixtures
  - Simplifies the acid plumbing/containment, eliminates the acid storage barrels and recirculation systems
  - The outside of the cavity is actively cooled, providing better temperature control of the polishing reaction.
  - Flexible, thin walled or heat treated, cavities do not sag during polishing
  - Acid is only used once, prohibits accumulation of contaminats
  - Lower capital equipment costs
  - Fewer parts reduces the risk of Sulfur and other contaminants building-up in the system, which may cross contaminate the cavities resulting in field emission or other RF losses.
- But the electrolyte must be changed more frequently (after about 100 microns of material removal).
- For large amounts (e.g. 200 microns) of material removal the cavity orientation must be rotated periodically, to balance the up-down polishing asymmetry.
- Vertical electropolishing has produced several high performance single-cell and one 5-cell cavity.

Why Vertical Electropolish?





- Extremely low residual resistances
- CW field performance approaches theoretical limit of 43 MV/m



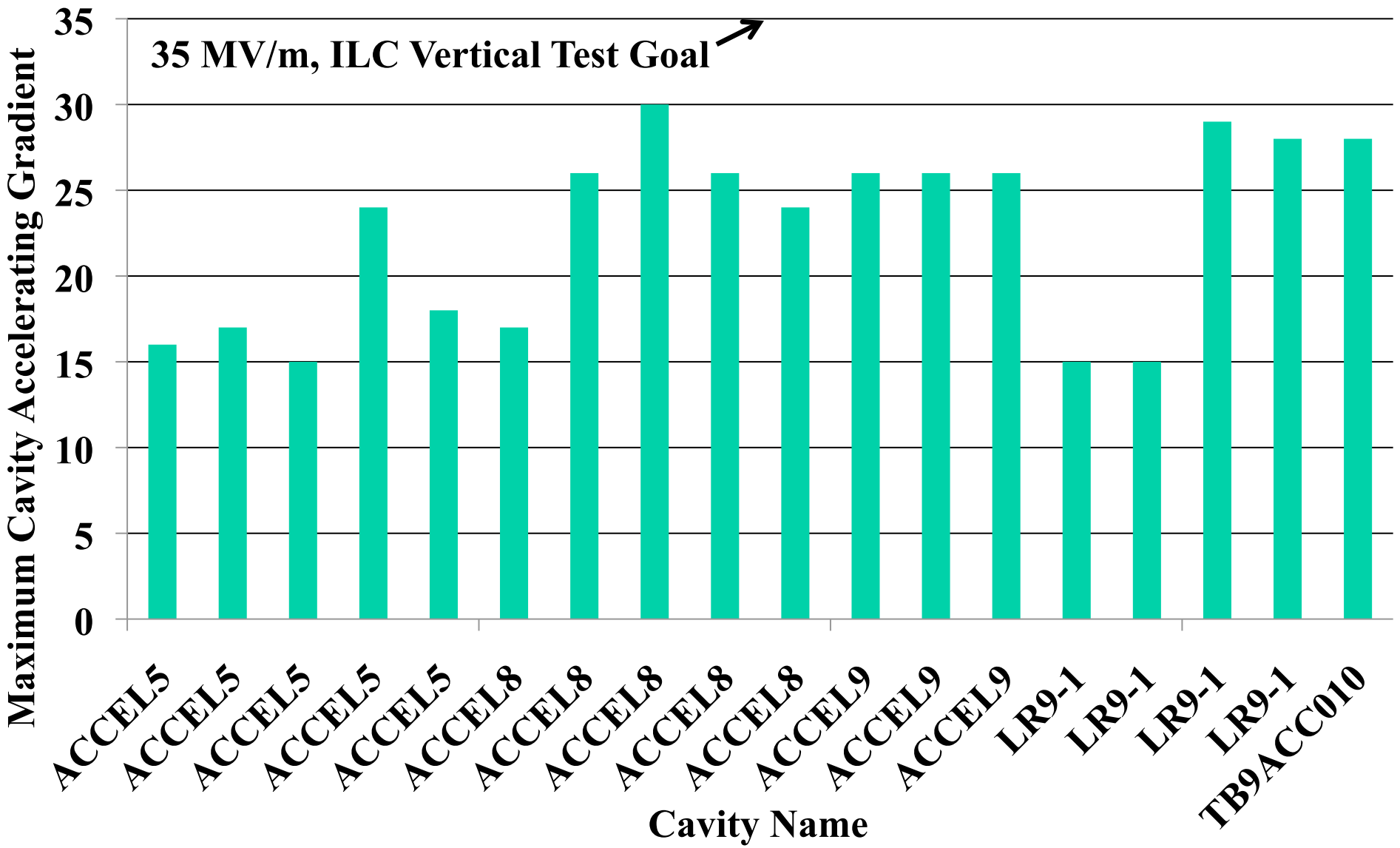
- We reduced the temperature at which we polish to 20-25 C, was 30-40 C.
- We reduced the agitation of the electrolyte during the polish.
- We have had several good single cell results

9-Cell VEP Status

- We have processed and tested 5 different 9-cell cavities with vertical electropolish. Sometimes more than once.

- We are working toward a procedure which will meet the ILC vertical test specifications of 35 MV/m with a Q of 1E10 in 9-cell cavities.
  - So far we have been limited to gradients below 30 MV/m by surface defects
  - We are working on a technique to remove these defects via barrel rolling with vertical electropolishing providing the final surface polishing
  - This technique was successfully employed with a 9-cell reentrant cavity

9-Cell VEP Status



Summary of VEP Results

- 1-cell, 1.3 GHz cavity , World record Eacc, high Q
  - Re-entrant shape
  - TESLA-like shape (Niowave and AES)
- 5-cell, 1.3 GHz, Eacc = 37 MV/m
  - TESLA-like shape
- 9-cell ILC cavity, Eacc 25 – 30 MV/m
  - Quench limited, i.e. by defect
  - Individual cells reach 37 MV/m (also quench)
- Thermometry in near future (being prepared by Dave Meidlinger and Eric Chojnacki)

Summary and Plans

- Vertical electropolish is effective in small cavities.
- We are now tweaking the procedure to optimize for 9-cell ILC cavities.
- We have made significant progress after:
  - Lowering the process temperature
  - Reducing the electrolyte agitation during the procedure
- We are now working on
  - Optimizing the amount of electrolyte agitation (e.g. stirring) during cavity polishing
  - Ultrasonic agitation
  - Optimization of temperature
  - Improving our process control, e.g. rotation speed for agitation, current and voltage monitoring, etc.

9-Cell VEP Status
As Time Goes On…