PERFORMANCE LIMITATION STUDIES on ISAC-II QWR's and e-linac elliptical cavities at TRIUMF

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Abstract

TRIUMF has been operating successfully for several years numerous 100MHz class superconducting quarter wave resonators on the ISAC-II heavy ion linac [1] and is now developing a 1.3 GHz activity to build the e-linac, a 50 MeV superconducting electron linac to produce radioisotopes by photofission [2]. Several studies on cavity treatments are ongoing to both enhance ISAC-II QWR performances and to meet the requirements on the e-linac elliptical cavities. This paper will summarize the main development efforts to understand performance limitations in these cavities.

Cavity preparation

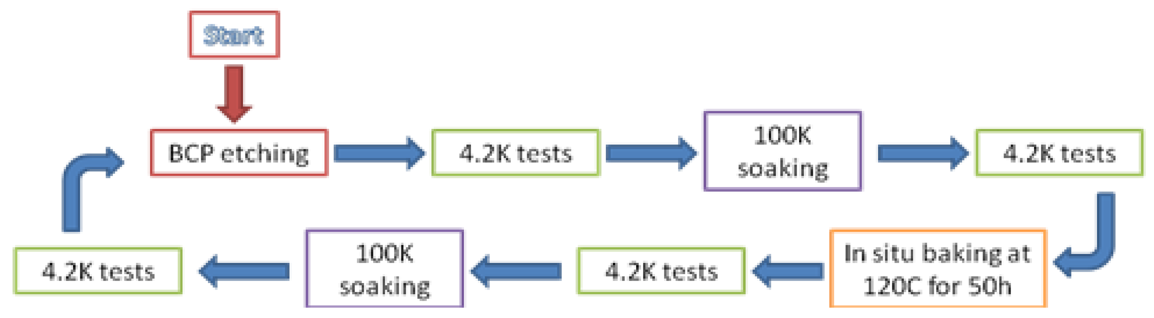
141 MHZ QWR PREPARATION :

- **BCP etching with slow agitation. Acid temperature is about 13C. Deionised water and alcohol rinsing. Drying in fume hood.**
- **High Pressure Rinsing with ultra-pure water in class-III clean room and alcohol rinsing. Cavity is left for drying for 12h.**
- **Cavity is loaded in cryostat and pumped down to 1E-6 torr.**
- **Cavity baking in situ at 120C during 48h or just dried up to 60C for 24h.**
- **Nitrogen shield pre-cooling down to 230K.**
- **Fast cool down with LHe. Cavity less than 30 minutes between 150K and 50K.**

1.3 GHZ SINGLE CELL PREPARATION :

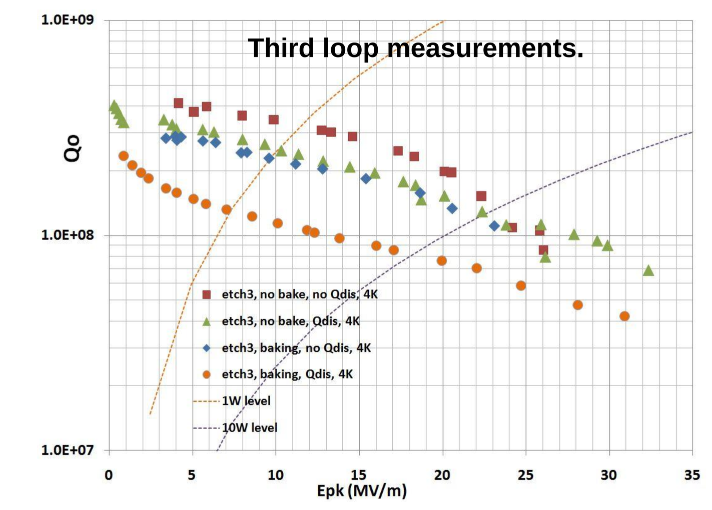
- **BCP etching with circulating acid. Acid temperature is about 13C. Deionised water, steam and alcohol rinsing. Drying in fume hood.**
- **High Pressure Rinsing with ultra-pure water in class-III clean room and alcohol rinsing. Cavity is left for drying for 12h.**
- **Cavity baking in situ at 120C during 48h**
- **Nitrogen shield pre-cooling down to 230K.**
- **Fast cool down with LHe. Cavity less than 30 minutes between 150K and 50K.**
- **Vacuum around 1E-7 torr when tested.**

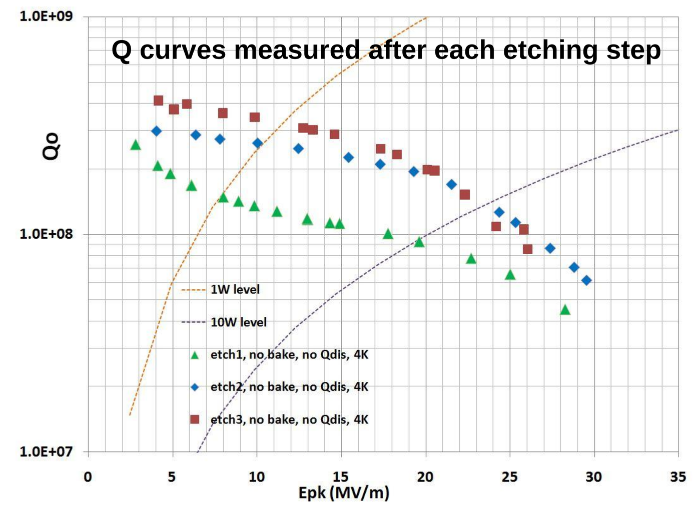
141 MHz Quarter-Wave Resonator study

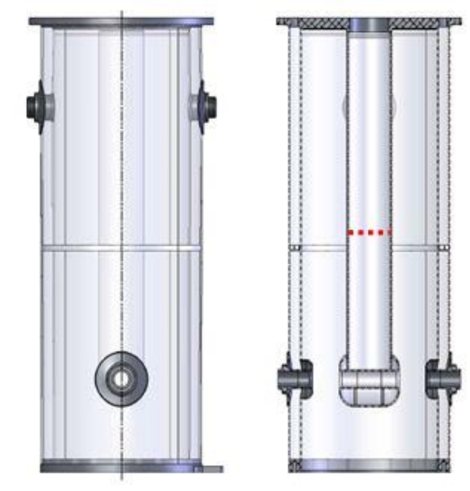


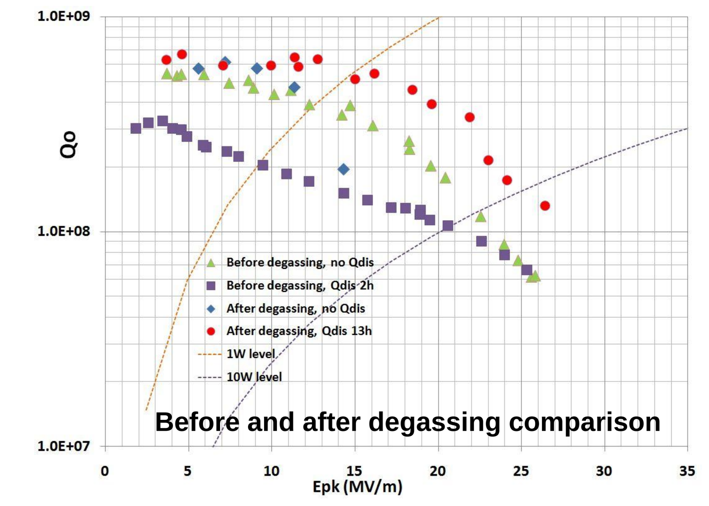
- **Aim was to enhance the performances of ISAC-II QWR and highlight any dependency between etching depth, baking and Q-disease.**
- **Study done on a spare repaired cavity after leak problem. (Additional welding on inner conductor done)**
- **Custom etching to reach the correct operating frequency after three loops. (80 µm on the 'root' end first and 20 µm overall).**
- **No real improvement of cavity between second and third loop => No need to etch more than 160 µm**
- **In third loop, no recovery of Q-diseased cavity after 120C baking? (No explanation for the moment)**

- **We expected a better quality factor (1E9) after a total removal of 240 µm (86+74+78) in high magnetic field region and 65 µm close to the beam tube. First suspect was Hydrogen.**
- **After 10h degassing at 600C + 30 µm etching , no real improvement of base Qo but less Q-slope and no Q-disease.**
- **Need more investigation to understand the origin of such low Qo. Due to additional welding on inner conductor ?**





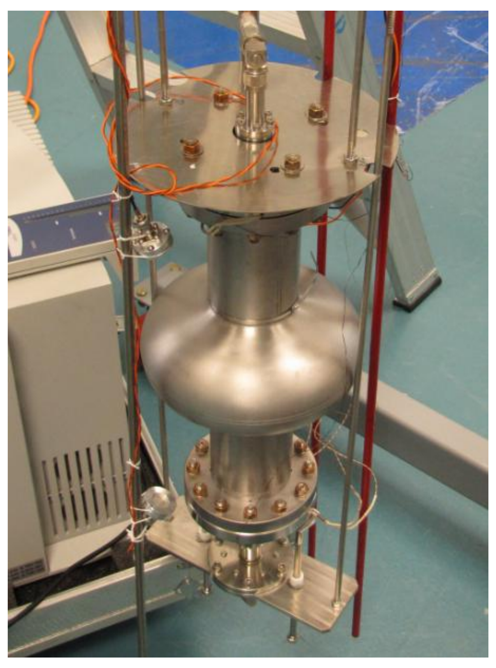


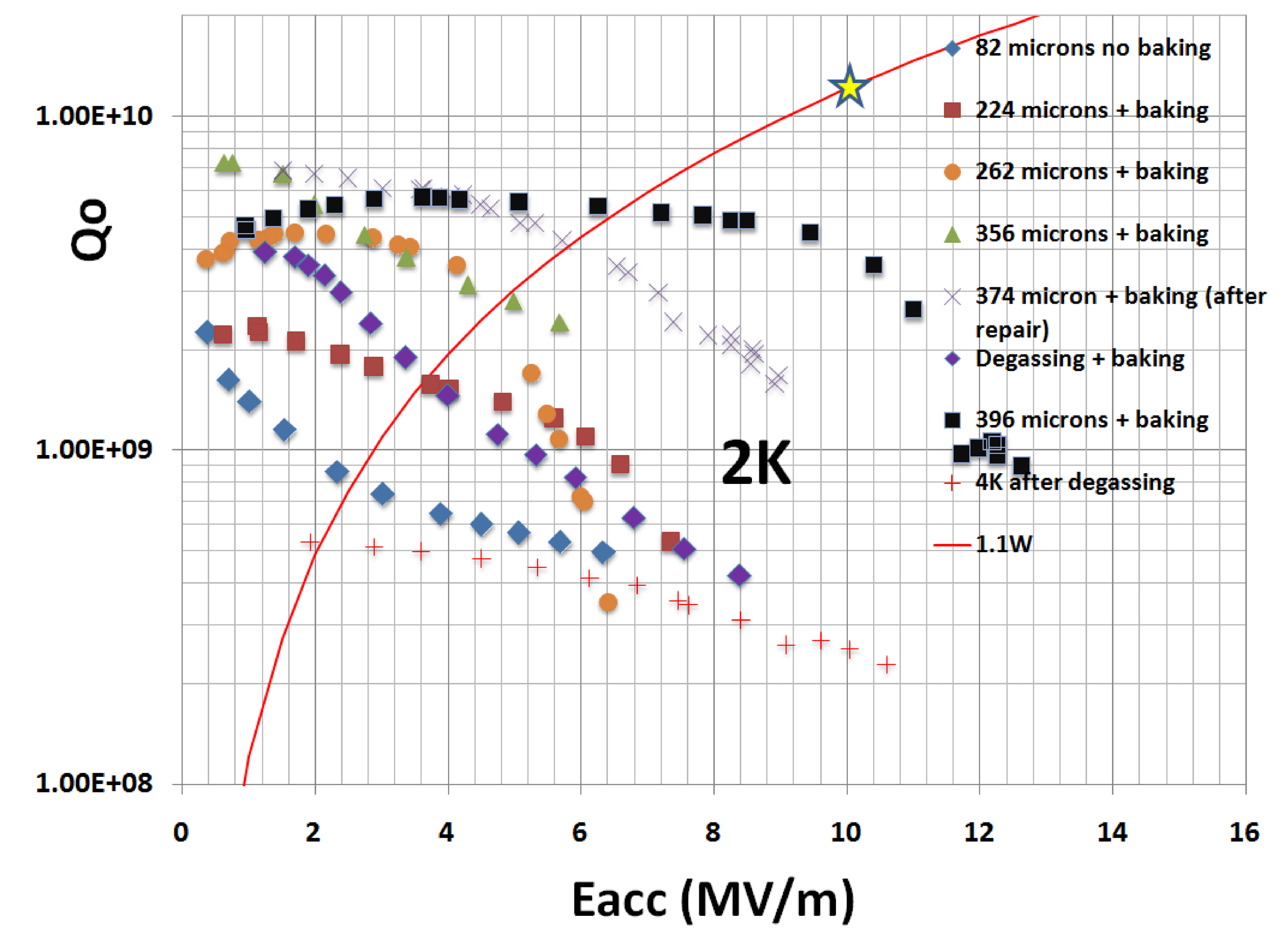


1.3 GHz 1-cell cavity progress

- **So far more than 300 µm removed with BCP but still not achieving a good Qo and strong Q-slope.**
- **Cavities of the same series have been tested at FNAL with high performances.**
- **Had problems of leak opening during etching (improper etching procedure) and glow discharges in coupler cable connector on warm side. Solved with isolation chamber for connector.**
- **After degassing at 800C for 2 hours, strong Q-slope (see purple diamonds).**
- **Additional 20 µm etching improved a lot. No real improvement of base Qo but no Q-slope (before field emission started, see black square)**
- **Hydrogen removed, no Q-disease symptoms even after more than 10h soaking at 90K. => Hydrogen is not responsible for low base Qo.**

- **Next improvements to be done :**
  - **Magnetic field has to be checked more carefully inside the cryostat.**
  - **Some improvements to be done on cavity preparation and vacuum quality.**





References

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[3] D. Longuevergne, "Experimental study of the surface resistance of the 141 MHz quarter-wave resonator at Triumf", LINAC10, Tsukuba, Japan, September 2010.
[4] S. Koscielniak, "ARIEL and the Triumf e-linac initiative , a 0.5 MW electron linac for the rare isotope beam production", LINAC08, Victoria, Canada, September 2008.
[5] http://www.pavac.com/

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