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. Delonised water and alcohol rinsing. Drying in fume hood.
- High Pressure Rinsing with ultra-pure water in class-II 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. Delonised water, steam and alcohol rinsing. Drying in fume hood.
- High Pressure Rinsing with ultra-pure water in class-II 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 and 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)

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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