HOM Cavity Design for the TRIUMF eLINAC

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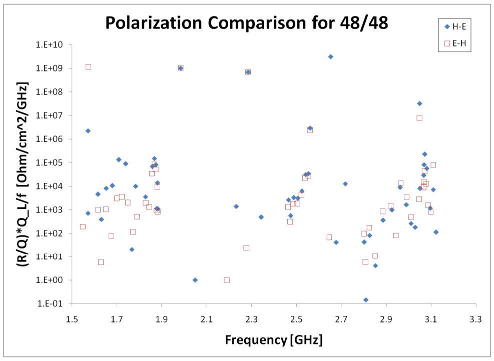
The TRIUMF eLINAC, currently in its design phase, is a 50 MeV electron linear accelerator and will be used for photo-fission to produce rare isotopes for experiments. Future upgrade plans include an option to go to a recirculating LINAC to provide higher energies. This brings up the need to calculate the shunt impedances of higher order modes (HOM) to avoid beam instabilities and beam break up (BBU). The cavity design for a 9 cell cavity has to account for the limitations given by the desired beam current of 10mA and the layout of the recirculating path to create a high enough BBU limit.

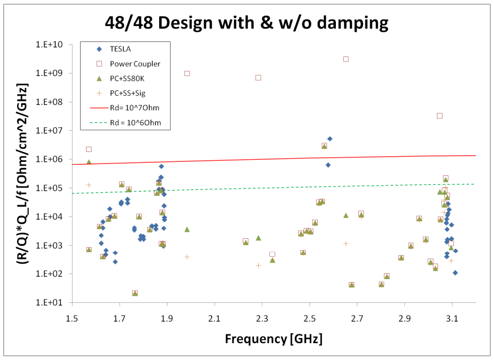
Work on the cavity design to accommodate for those requirements will be presented as well as a way to reduce the shunt impedance by the use of ring dampers will be discussed.

The TRIUMF e-Linac consists of five nine-cell cavities. Each cavity is supposed to provide 10MV of accelerating voltage at 1.3 GHz and a Q0 ≥10^10. The linac is divided into one injector cryomodule (ICM) with one cavity and two accelerating cyromodules (ACM) with each two cavities. The ACM section of the linac is under consideration to be extended to an energy recovery Linac (ERL) or recirculating linac. This future upgrade requires attention to the HOMs of the cavity. Modes with a high shunt impedance will cause BBU and too much dissipated power in the cavity, especially if one of the mode is on a beam repetition rate harmonic. One of the goals is to come up with a cavity design that does not rely on active HOM couplers to work within the given limit. The baseline for the cavity design is the TESLA 9 cell cavity.

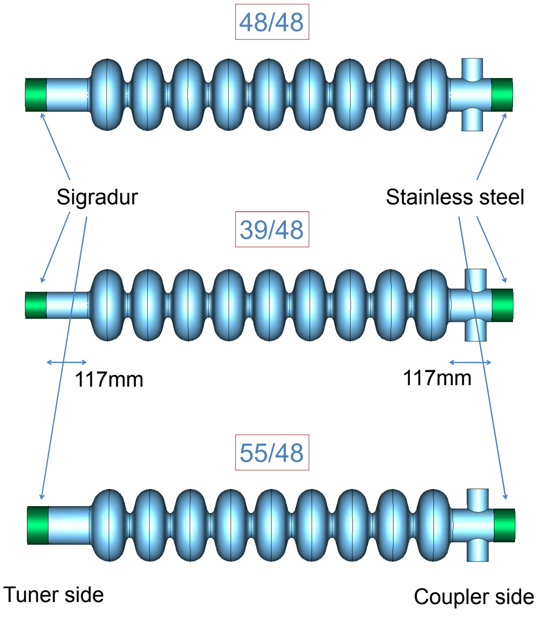
Threshold for BBU from beam dynamics is *Rd/Q*QL* ≤ 10^7 Ω. On top of that a safety margin from fabrication tolerances reduces the desired limit in shunt impedance to ≤ 10^6 Ω.

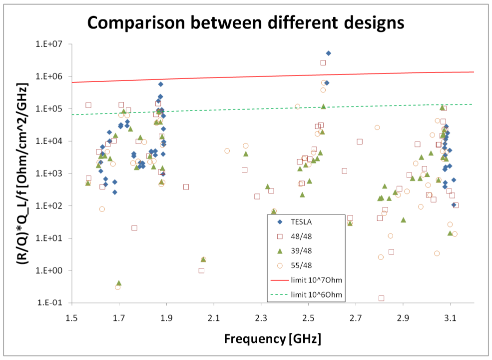


Simulation results of a symmetric cavity for the polarization of dipole modes. It was found that the vertical polarization of electric field is more dangerous that the horizontal.

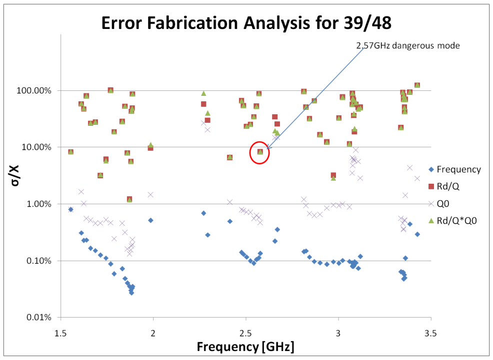


Dipole spectrum of symmetric 48/48 cavity design with damping rings made of SS or Sigradur. Trapped mode at 2.56 GHz and strong mode at 1.57Ghz.





Different cavity designs with different beam pipe diameter on the tuner side compared to each other with damping rings made of stainless steel (coupler side) and Sigradur (tuner side).



Variation of all half cell geometry parameters of all 18 half cells within ±.5mm leads to small a small spread in frequencies (≤ 1%) and bigger spread in shunt impedances (≤100%) for 60 dipole modes with a sample size of 60 cavities.

Sigradur

- Glassy Carbon

- Electrical conductivity: ~20 kS/m

-Thermal conductivity : 5 W/mK [300K]

(picture courtesy of htw-germany.com)

Conclusions

An asymmetric cavity design has been developed that fulfills the requirements for BBU of dipole mode with Rd ≤10^7Ω with out any HOM couplers. Further investigations on fabrication tolerances reduced the threshold shunt impedance to Rd ≤10^6Ω to give enough safety margin. This criterion will be met with the proposed damping strategy, including Sigradur, a glassy carbon. Passive damping strategies are being studied at TRIUMF