TRIUMF
Canada's national laboratory for particle and nuclear physics
Laboratoire national canadien pour la recherche en physique nucléaire
et en physique des particules

SRF Developments at TRIUMF

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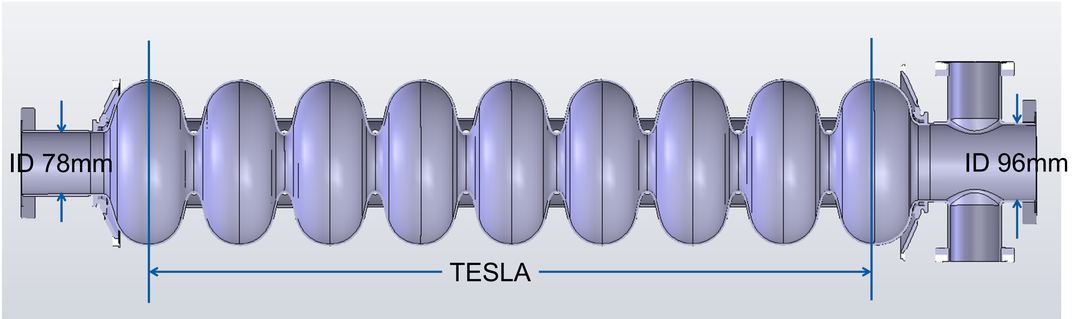
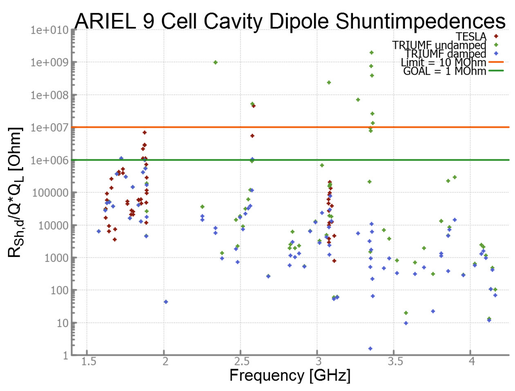
ARIEL SRF 1.3GHz Cavity



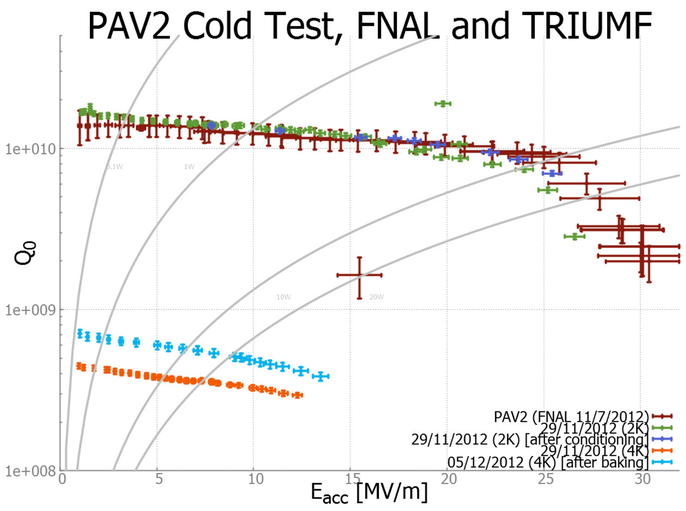


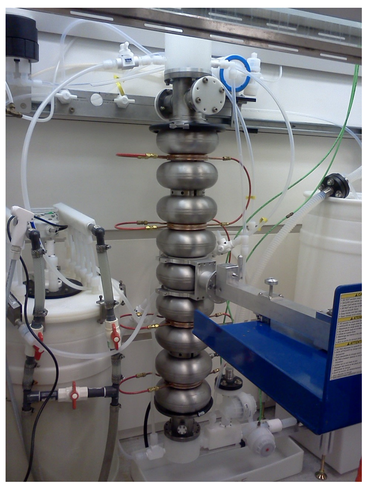
Dipole Shunt Impedances

The ARIEL nine cell cavity has been designed with HOM in mind. Future plans to upgrade the eLINAC to an ERL requires dipole shunt impedances to be below 10^7 Ω to prevent multi-pass beam break-up. This goal is achieved by modifications to the cavity end groups and the use of beam line absorbers instead of HOM couplers.

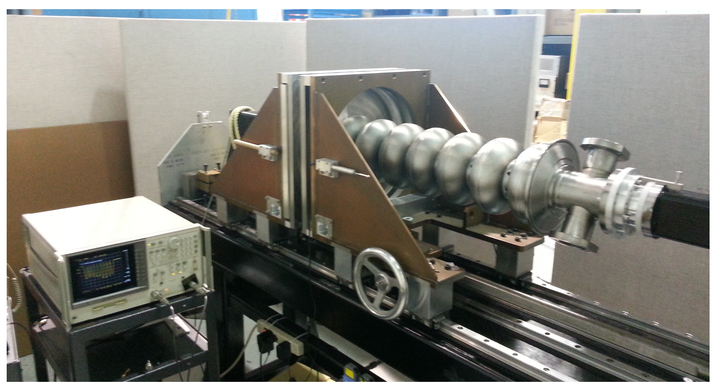
Single Cell Cavity Testing

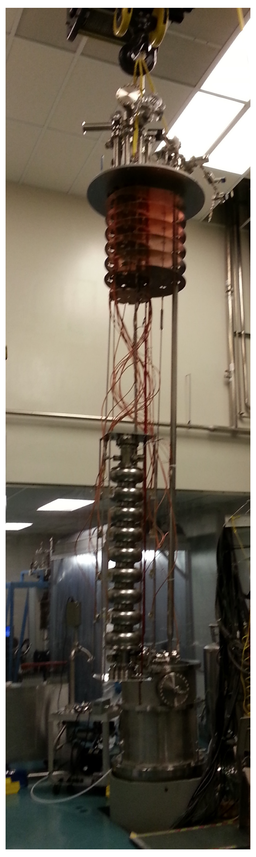
Single cell 1.3 GHz cavity test have been done to qualify our cavity treatment procedures before moving to production nine cell cavities. This has been successfully done in collaboration with Fermi National Accelerator Laboratory. Both 2K tests of one cavity tested at FNAL and TRIUMF match very well, qualifying processing at TRIUMF and exceed goal performance for ARIEL of Q ≥ 10^{10} at 10 MV/m and 2K.

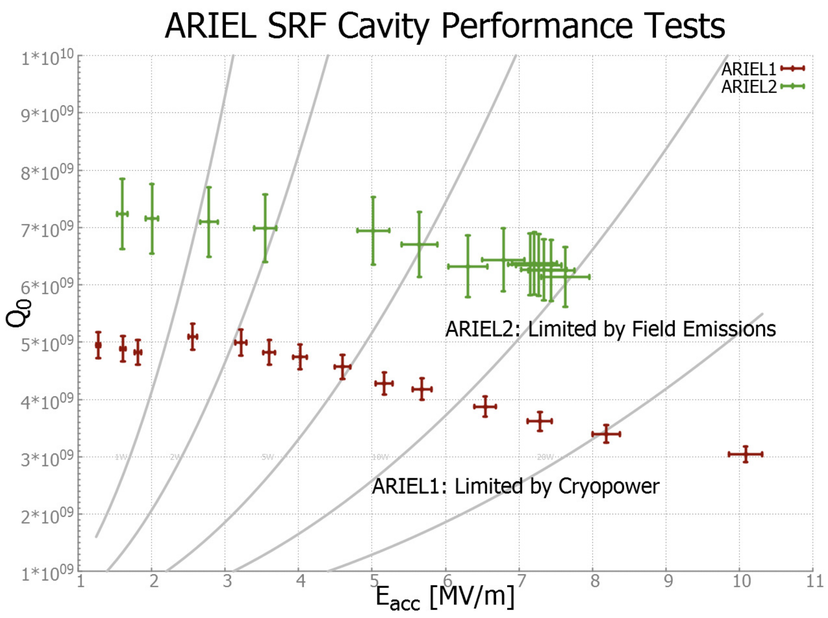




Nine Cell Cavity Testing



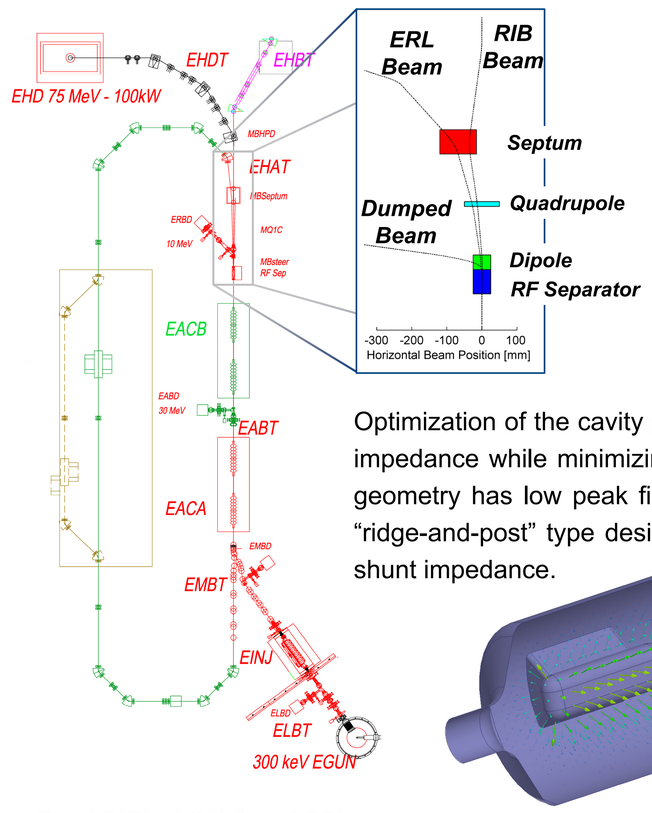




The first two cavities for the ARIEL eLINAC have gone through multiple preparation stages including, chemical etching, warm frequency and field tuning, cleaning and vertical RF test at 2K. ARIEL1 is highly q-diseased and shipped to FNAL for 800C degassing, but reaches goal gradient without problems. ARIEL2 was limited by strong field emissions at its first test.

Future Developments

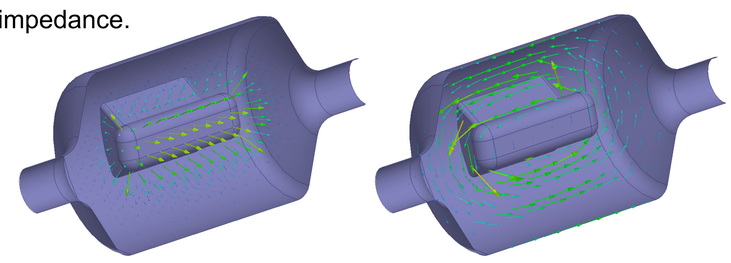
SRF Separator for the ARIEL ERL



The ARIEL eLINAC and ERL layout

A future extension to the ARIEL eLINAC will be the addition of a recirculation path for an Energy Recovery Linac (ERL), the driver for a light source. ERL operation is designed to occur simultaneously with RIB delivery requiring RF separation at the end of the main linac. An SRF separator cavity is being designed based on the RF-dipole geometry to separate the ERL and RIB beams at a frequency of 650 MHz.

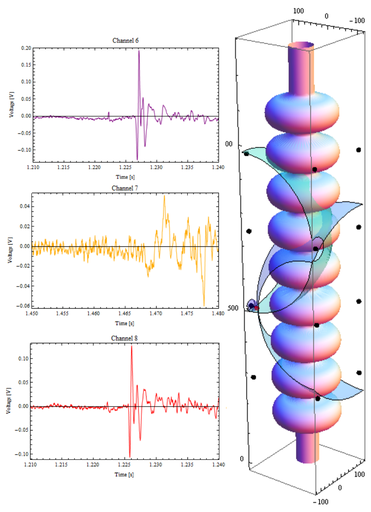
Optimization of the cavity geometry was performed to maximise shunt impedance while minimizing peak surface fields. Since the RF-dipole geometry has low peak fields, modified cavity geometries such as a "ridge-and-post" type design are being investigated to provide higher shunt impedance.



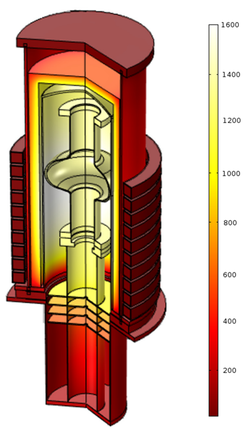
Electric and magnetic transverse deflecting fields

Second Sound Quench Detection

During vertical tests of SRF cavities, second sound transducers detect quench of the Nb cavity. Multiple sensors, made at the University of Toronto, are used to localize the origin of the quench via time-of-flight measurements. Complimentary to second sound, UoT is working on a temperature mapping system to localize the defect more precisely after the relatively imprecise second sound measurements.
This second sound Quench detection system is already in place and the data processing is being optimized.

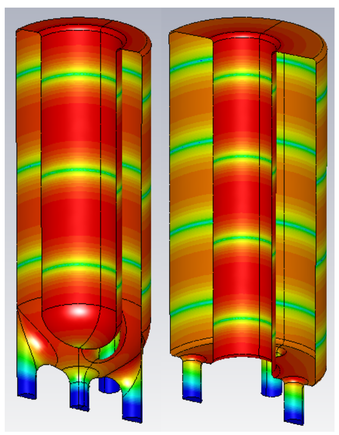


RF Induction Oven



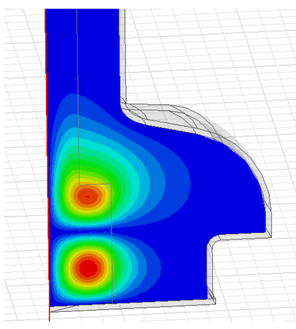
An RF induction UHV heat treatment oven for the heat treatment up to 1400ºC of samples and cavities (sized for 1.3GHz single cell cavities) in UHV conditions for R&D towards high Q operation.

Multimode Resonator



TEM multi-mode SRF Quarter Wave and Half Wave Resonators for measuring the RF surface resistance as a function of frequency, RF magnetic field and temperature.
Designed to fit in the induction furnace.

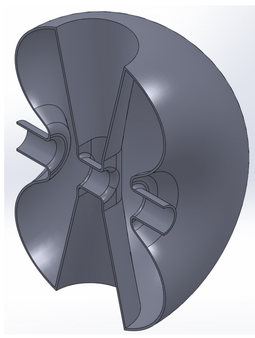
Mushroom Cavity for Sample Studies



A superconducting Nb *mushroom shaped* cavity will be used as a sample host to characterize the superconducting RF resistance and maximum magnetic surface fields of treated niobium and novel superconducting materials at high RF fields and frequencies < 2 GHz. This type of cavity focuses the peak magnetic field on a sample at the root of the mushroom. Diagnostics can include calorimetric measurements via T-mapping as well as Q perturbation.

Balloon Spoke Design Study

Cavity design study on a 325 MHz Spoke cavity shows promising improvements on multipacting suppression by using a balloon shape. At the same time this cavity seems to be less sensitive to Helium pressure fluctuations and mechanical vibrations with a simpler stiffening system compared to other spoke cavities. RF efficiency is also improved while maintaining similar peak fields. Preliminary fabrication considerations show a reduced number of steps compared to more rectangular spoke cavities.



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