University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Doctor of Philosophy

of

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BSc (University of Winnipeg, 2007)
BAEM (University of Minnesota, 2009)
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"A Superconducting RF Deflecting Cavity for the ARIEL e-Linac Separator"

Department of Physics and Astronomy

Wednesday, March 7, 2018
9:00 A.M.
Clearihue Building
Room B017

Supervisory Committee:
Dr. Dean Karlen, Department of Physics and Astronomy, University of Victoria (Co-Supervisor)
Dr. Lia Merminga, Department of Physics and Astronomy, UVic (Co-Supervisor)
Dr. Robert Laxdal, Department of Physics and Astronomy, UVic (Member)
Dr. Jens Bornemann, Department of Computer Science, Uvic (Outside Member)

External Examiner:
Dr. Jean Delayen, Department of Physics, Old Dominion University

Chair of Oral Examination:
Dr. Francis Lau, School of Health Information Science, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

The ARIEL electron linac is a 0.3MW accelerator that will drive the production of rare isotopes in TRIUMF's new ARIEL facility. A planned upgrade will allow a second beam to be accelerated in the linac simultaneously, driving a Free Electron Laser while operating as an energy recovery linac. To not disrupt beam delivery to the ARIEL facility, an RF beam separator is required to separate the interleaved beams after they exit the accelerating cavities. A 650MHz superconducting RF deflecting mode cavity has been designed, built, and tested for providing the required 0.3MV transverse deecting voltage to separate the interleaved beams. The cavity operates in a TE-like mode, and has been optimized through the use of simulation tools for high shunt impedance with minimal longitudinal footprint.

The design process and details about the resulting electromagnetic and mechanical design will be presented, covering the cavity's RF performance, coupling to the operating and higher order modes, multipacting susceptibility, and the physical design. The low power dissipation on the cavity walls at the required deflecting field has allowed for the cavity to be fabricated using non-conventional techniques. These include fabricating from bulk, low purity niobium and the use of TIG welding for joining the cavity parts. A method for TIG welding niobium has been developed that achieves minimal degradation in purity of the weld joint while using widely available fabrication equipment. Applying these methods to the fabrication of the separator cavity has made this the first SRF cavity to be built at TRIUMF.

The results of cryogenic RF tests of the separator cavity at temperatures down to 2K will be presented. At the operating temperature of 4.2 K, the cavity achieved a quality factor of 4×10^8 at the design deflecting voltage of 0.3 MV. A maximum deflecting voltage of 0.82MV was reached at 4.2 K, with peak surface fields of 26MV/m and 33mT. The cavity's performance has exceeded the goal deflecting voltage and quality factor required for operation.