TRIUMF

CANADA'S NATIONAL LABORATORY FOR PARTICLE AND NUCLEAR PHYSICS

Owned and operated as a joint venture by a consortium of Canadian universities via a contribution through the National Research Council Canada

An Electron Linac Photo-Fission Driver for the Rare Isotope Program at TRIUMF

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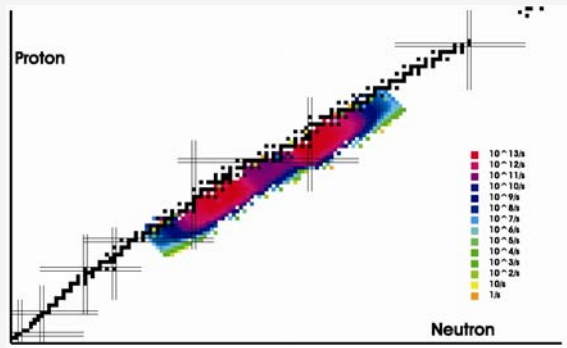


LABORATOIRE NATIONAL CANADIEN POUR LA RECHERCHE EN PHYSIQUE NUCLÉAIRE ET EN PHYSIQUE DES PARTICULES

Propriété d'un consortium d'universités canadiennes, géré en co-entreprise à partir d'une contribution administrée par le Conseil national de recherches Canada

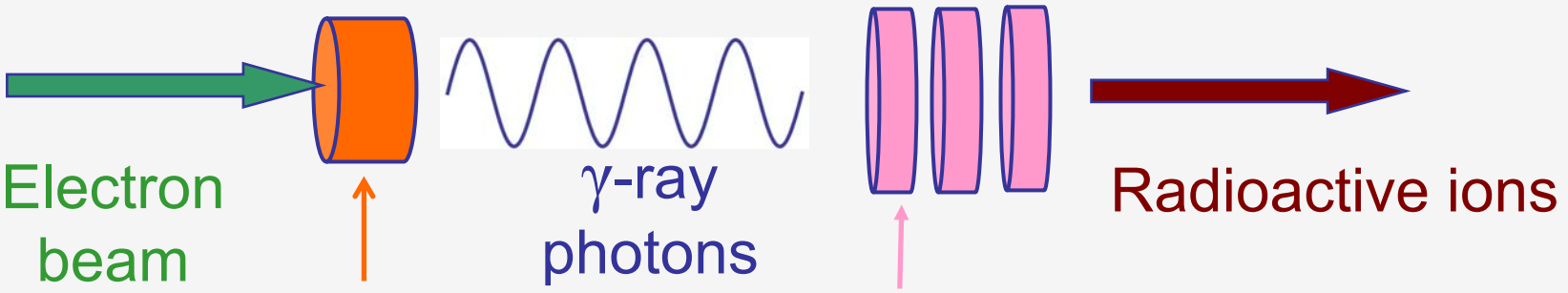
Outline

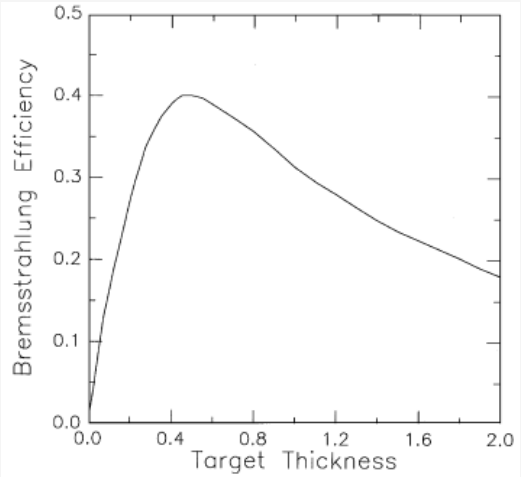
- Introduction
- Baseline design
- Beam dynamics study
- Schedule
- Summary

E-Linac Motivation/Impact

- New Science: Nuclear physics with neutron-rich RIBs
- Clean radioisotope beams
- Complementary & independent RIB driver
  - Enhanced science output: multiple beams to multiple users
  - Steady RIB production: staggered E-Linac & cyclotron shutdowns
- Leverages valuable existing infrastructure:
  - Proton Hall: available shielded vault with services
  - World-class RIB multiple experimental stations
  - Expands SCRF in-house expertise
- Prepares Canada for SCRF projects world-wide (ILC, CERN-SPL)
- Qualifies commercial partner (PAVAC) to build SCRF cavities.

What is photo fission?





Production efficiency: one γ-photon for three electrons (30 MeV)

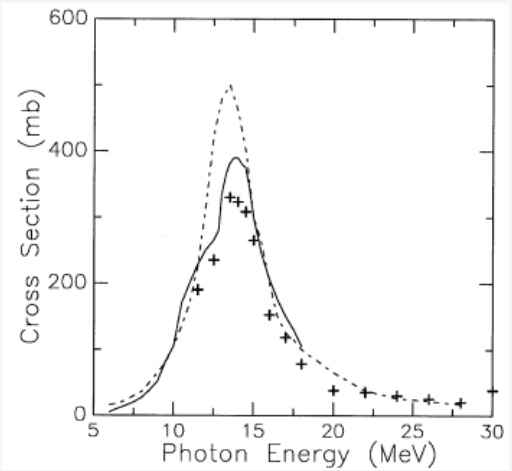


Photo-fission cross-section high for 15 MeV γ due to Giant Dipole Resonance

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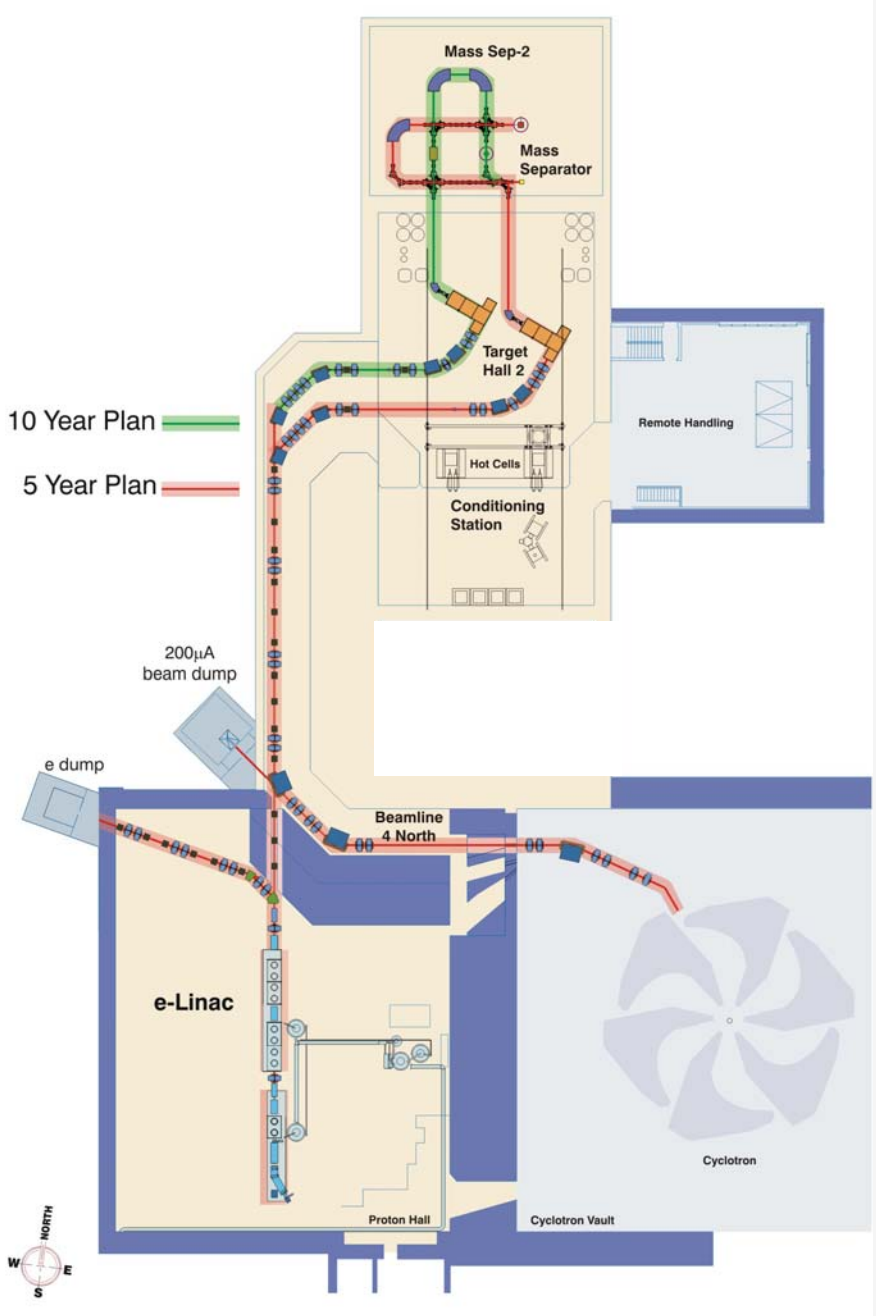
TRIUMF 5-year plan: ARIEL project – new isotope production facility for ISAC expansion



E-Linac Beam Specification

Practical considerations (beam diagnostics) motivate bunch rep rate

Bunch charge (pC)	16
Bunch repetition rate (GHz)	0.65
Radio frequency (GHz)	1.3
Average current (mA)	10
Kinetic energy (MeV)	50
Beam power (MW)	0.5
Duty Factor	100%

The requirement: 50 MeV × 10 mA = ½ MW beam power

Bunch vital statistics	inject	eject
Normalized emittance (μm)	<30π	<100π
Longitudinal emittance (eV.ns)	<20π	<40π
Bunch length (FW), inject (ps)	<170	<30
Energy spread (FW)	<1 keV	<1%

Not critical; beam dumped on target

HP RF building block for e-linac

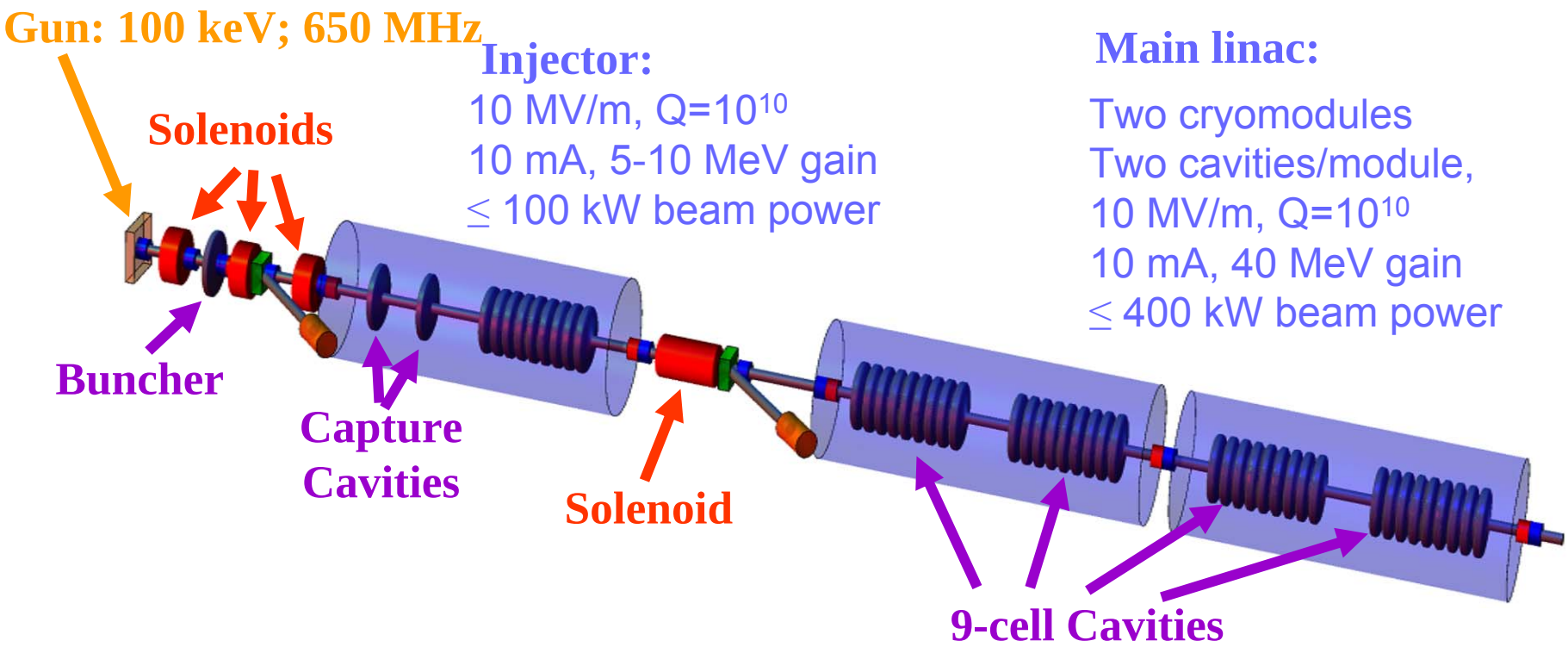
130 kW klystron

50 kW coupler

50 kW coupler

E-linac RF unit = 100 kW/cavity

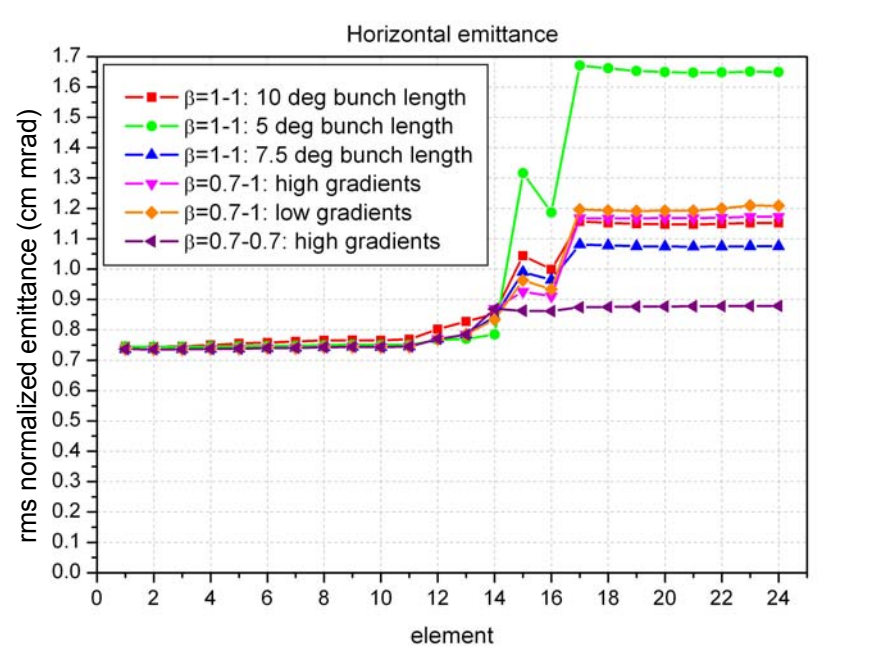
E-linac layout

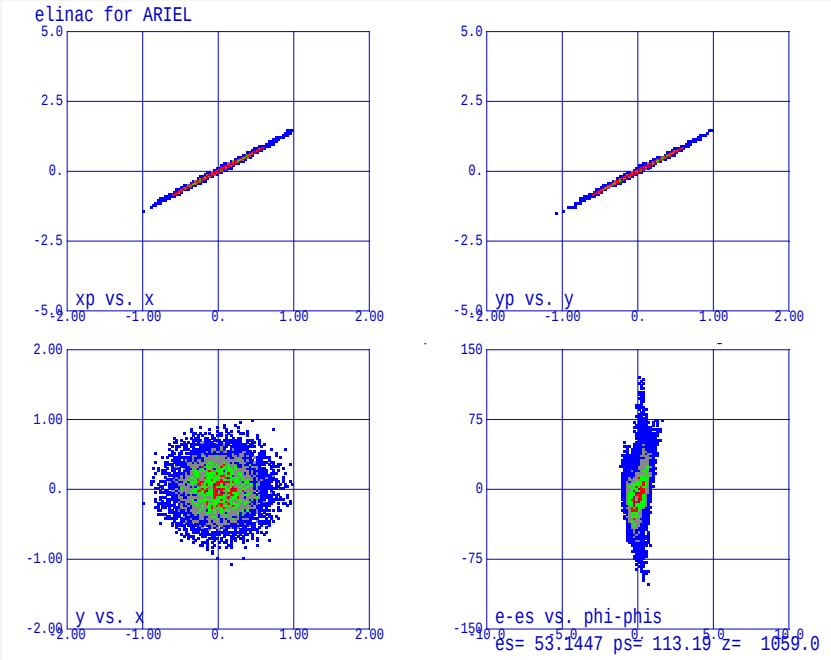


Division into injector & main linacs allows:

- Possible expansion for:
  - Energy Recovery Linac (ERL) – e.g. 10 mA, 80 MeV
  - Recirculating Linear Accelerator (RLA) – e.g. 2 mA, 160 MeV

Beam dynamics: 100 kV - 50 MeV low charge (16pC)





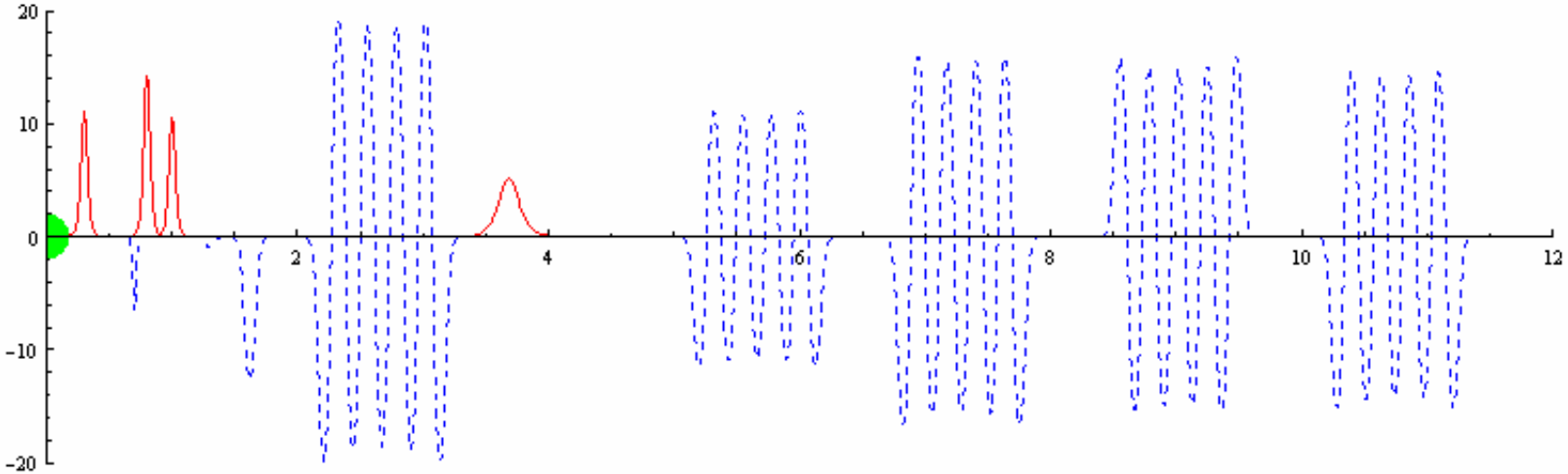
Curves represent results of capture section optimization

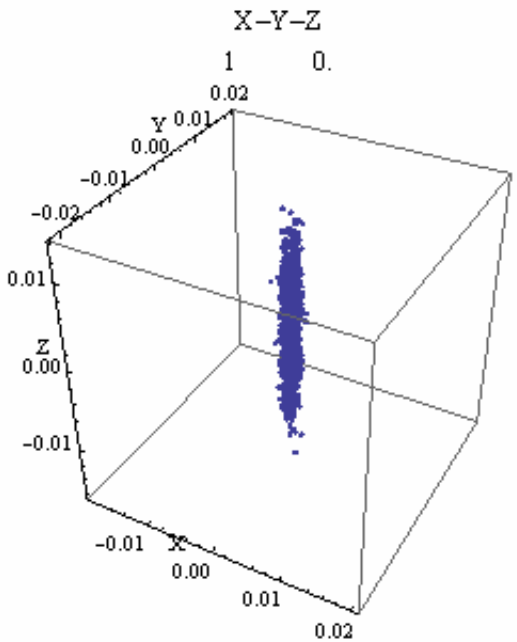
Beam portraits at the linac exit

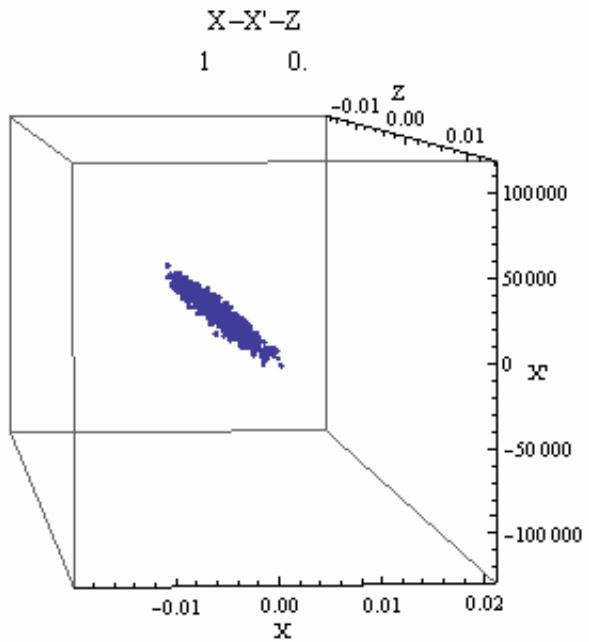
Energy spread (3 rms): 0.32%
Bunch length (3 rms): 6.4 ps

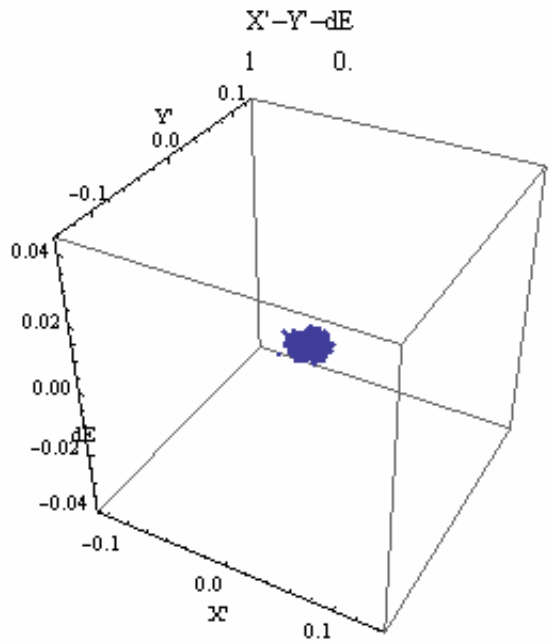
Beam dynamics posters: Thursday: TH6PFP097; Friday: FR5PFP075

Beam dynamics (continued)









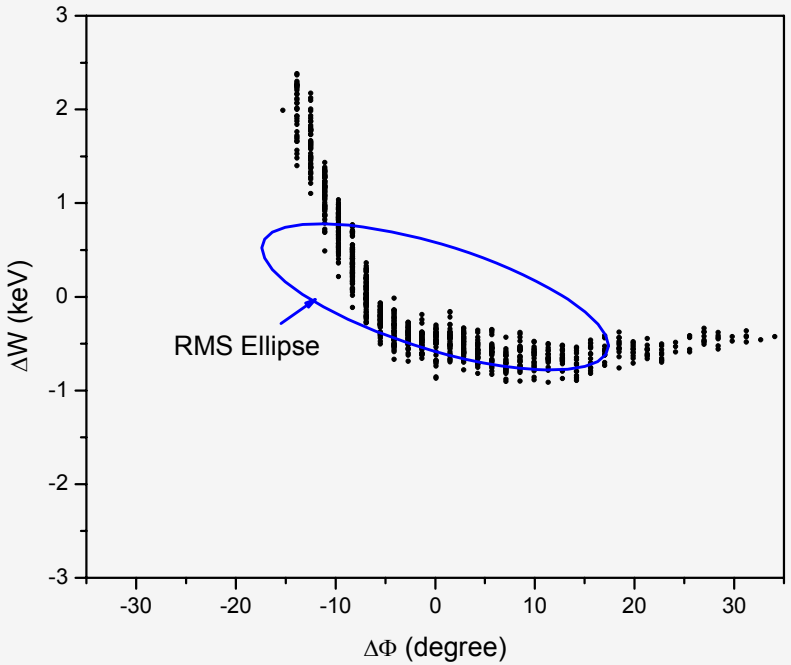
Electron Source

Thermionic gun – inexpensive, simple, low maintenance

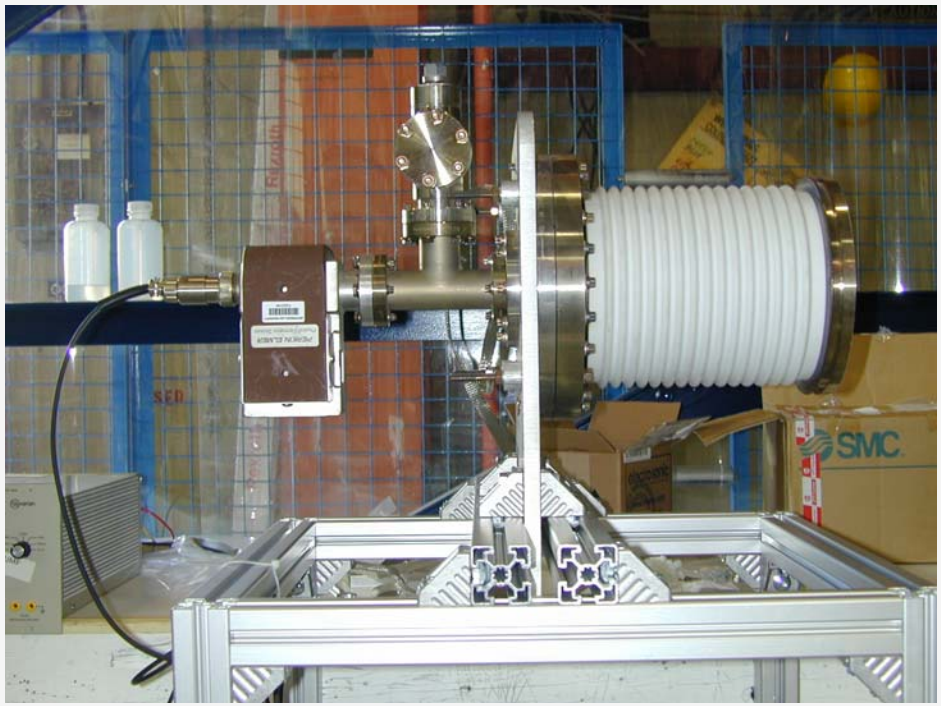
NIST/JLab electron gun was donated to TRIUMF

Being converted from diode to triode

RF modulated gun avoids chopping and high power beam dump at linac start



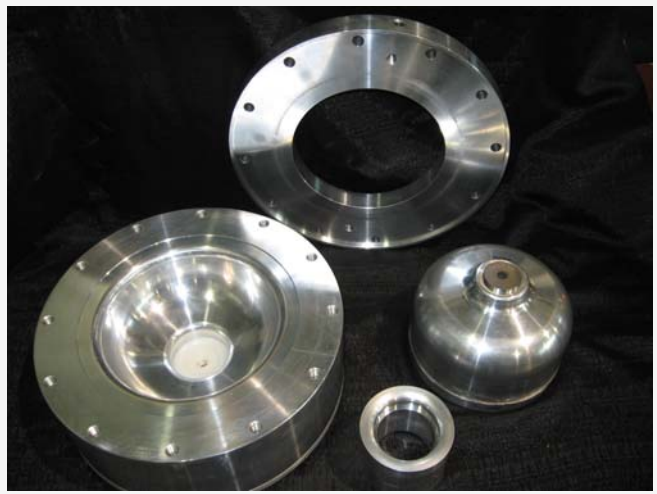
Longitudinal emittance simulation (SIMION 3D) at the gun exit



Electron gun development stand

Cavity Development with PAVAC

- PAVAC is a local company with EBW expertise
  - Now produces 20 QW 141MHz cavities for ISAC-II
- PAVAC to produce two single cells by summer 2009
  - Dies sourced from FNAL/RRCAT
  - Forming and welding tests underway (in copper and Nb)



Collaboration with VECC*

- Same goal: build electron linac for RIB
- Share resources
- Signed MOU in 2008

- Scope: build and test with beam at TRIUMF

two Injector Cryo-Modules (ICM) at 10MeV/50kW

* VECC=Variable Energy Cyclotron Centre (Kolcata, India)

TRIUMF/VECC collaboration poster: MO6RFP090

The Schedule

- July 2009
  - Conceptual design
  - Single cavity of beta=1 prototyping and test
- December 2009
  - ICM design
- November 2010
  - Assemble ICM1
- May 2011
  - Beam test with ICM1 in ISAC-II
  - Build e-linac infrastructure in Proton Hall
- December 2011
  - Test ICM2 in Proton Hall
- July 2013
  - E-linac beam test at 25 MeV
- November 2013
  - Ready for RIB production
- 2017
  - E-linac beam test at full energy and full power

Summary

- E-linac is a major new RIB source, complementary to cyclotron
- Opens new science horizons with neutron-rich RIB
- L-band SCRF cost effective MW-class fission driver
- Capitalization on world-wide SRF R&D
- Light source technology test bed
- Allows participation in other SRF projects (e.g. SPL, ILC etc.)