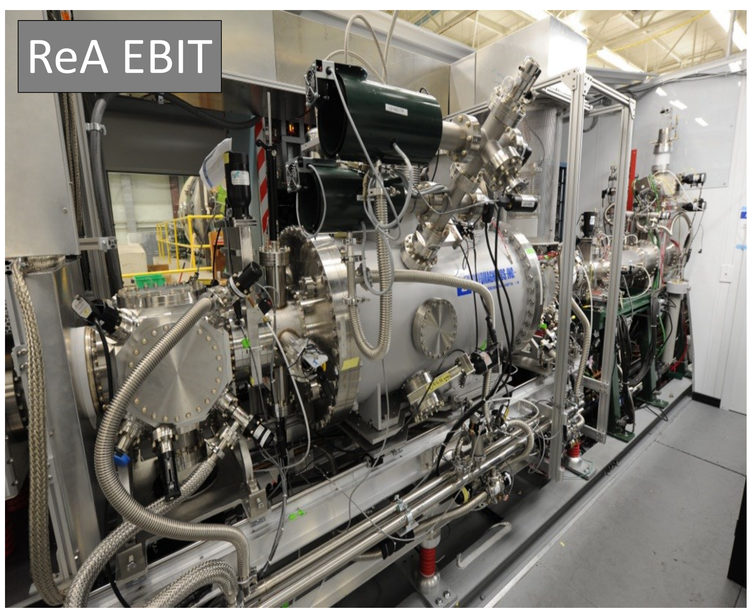
Simulations for a High-Current Electron Gun for the EBIT Charge Breeder of the ReA Post-Accelerator at FRIB

Hyock-Jun Son, Alain Lapierre, Antonio C.C. Villari, and Stefan Schwarz
Facility for Rare Isotope Beams, Michigan State University, 640 South Shaw Lane, East Lansing, MI 48824, USA

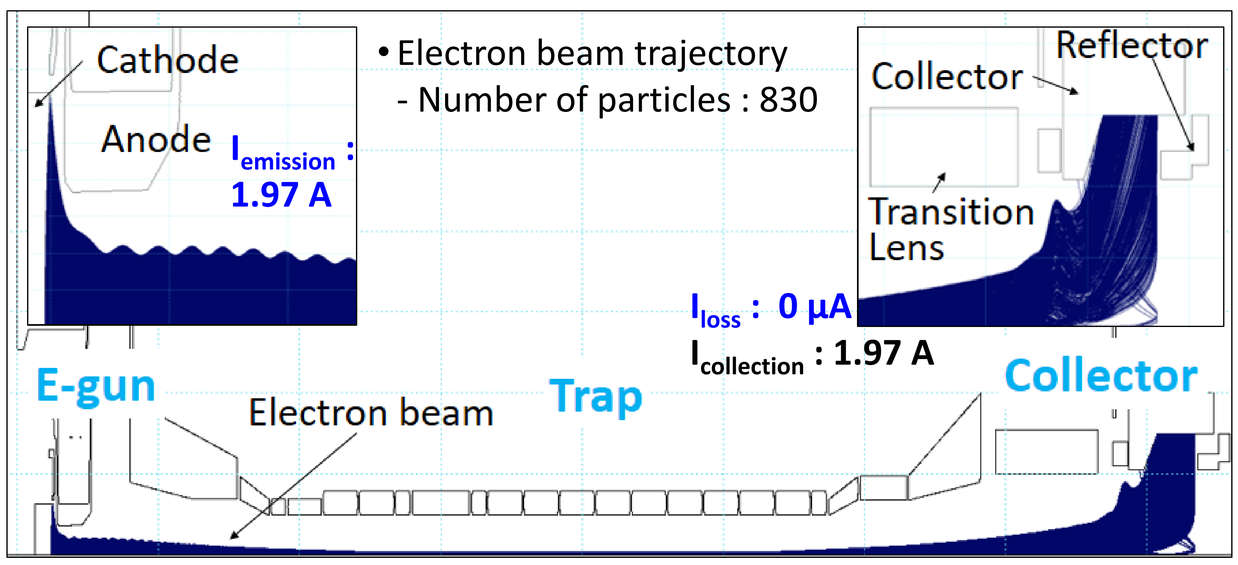
❑ Introduction

The Facility for Rare Isotope Beams (FRIB) at Michigan State University is nearing completion. In some cases, the RIB rates at FRIB are expected to exceed 10^{10} particles/s. The ReA EBIT charge breeder operates with an electron-beam current of 300 – 600 mA for a density of 170 – 340 A/cm^2. This current corresponds to a maximum capacity of 10^{10} elementary charges, which can be insufficient to handle high FRIB rates. To increase the EBIT electron-beam current and density, electron-beam simulations have been performed for a new electron-gun insert with a dispenser cathode having a larger emitting area. An electron beam of 2 A was the target current to reach a capacity of 5×10^{10} elementary charges. Parameter studies have been conducted to optimize beam transmission. A simulated current density at the trap was obtained to be 432 A/cm^2. The basic design of the insert and result of the simulations for the ReA EBIT will be presented.

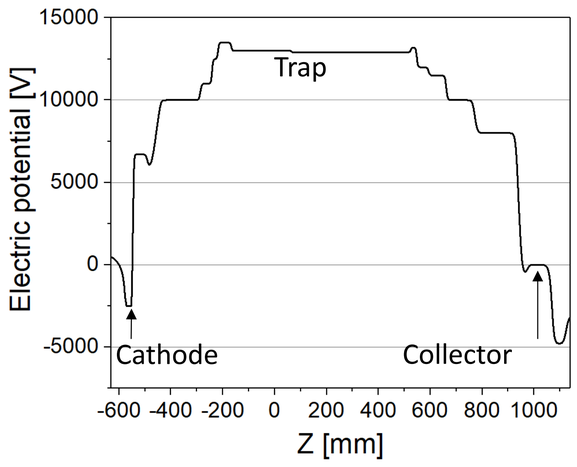
	Existing e-gun	New e-gun insert
Electron beam current	300 – 600 mA	2 A
Electron beam current density at trap	170 – 340 A/cm^2	432 A/cm^2
Capacity	10^{10} charges	5×10^{10} charges
Cathode	BaO dispenser cathode	
Cathode size	0.25” dia.	0.5” dia.
Maximum emission beam current	1.3 A	4 A



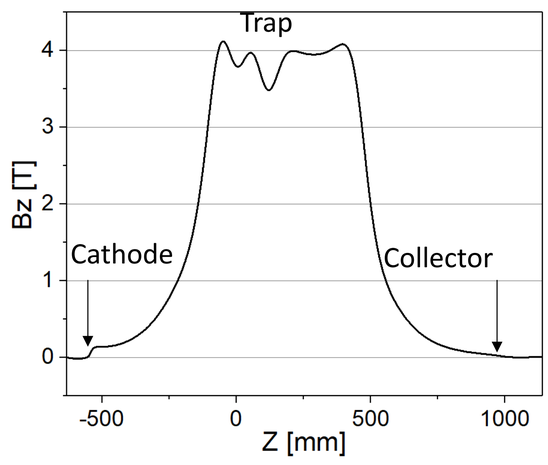
❑ Optimized Electron Beam Transport



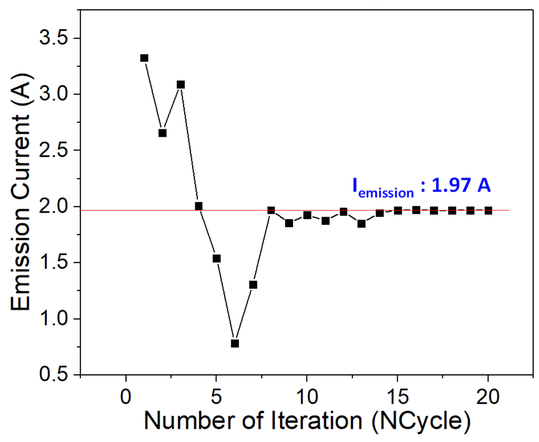
• Electric potential distribution



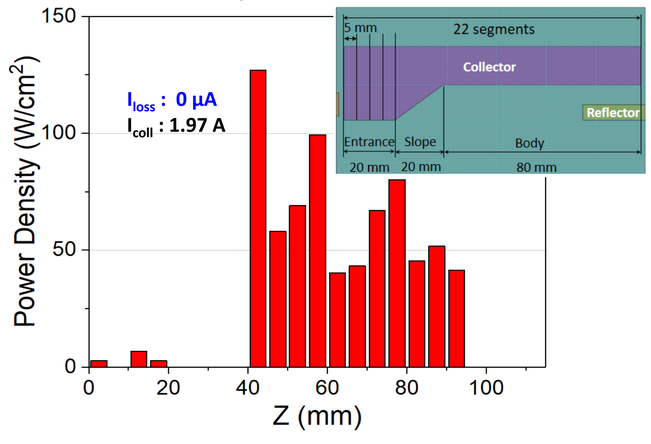
• Magnetic field distribution



• Emission current convergence

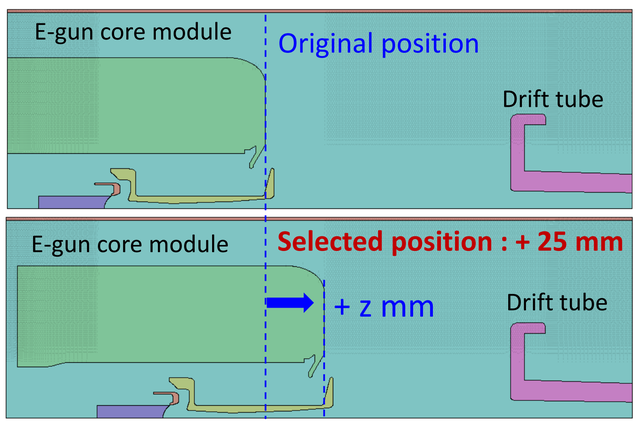


• Power dissipation on the collector

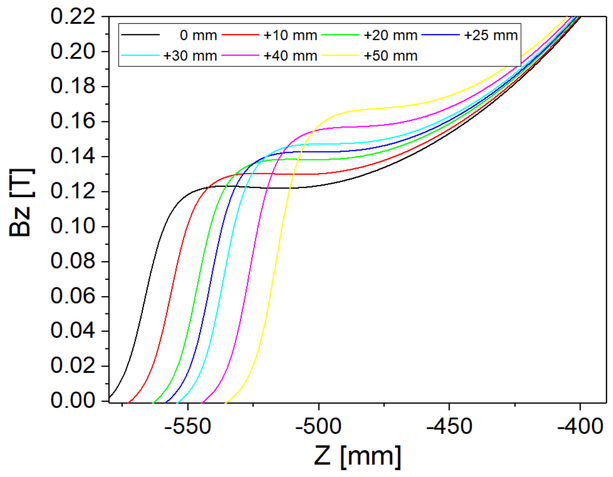


❑ Electron gun position study

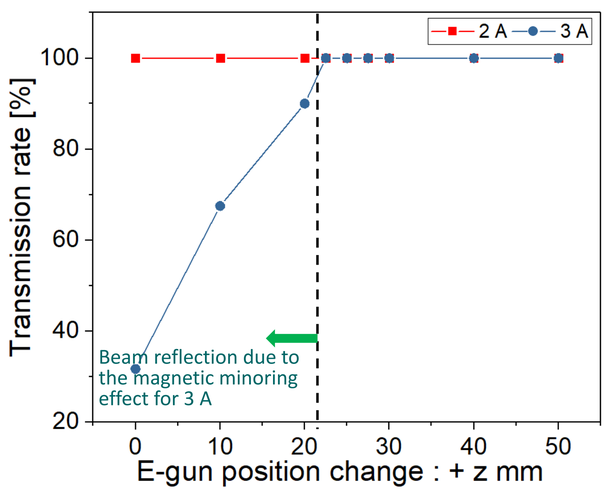
• Electron gun position change



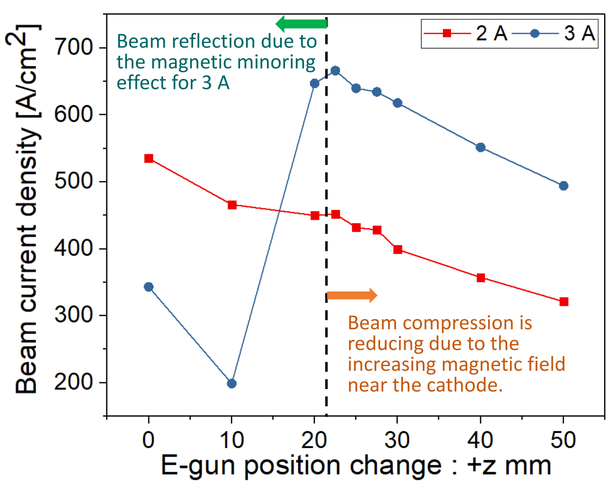
• Magnetic field near the cathode



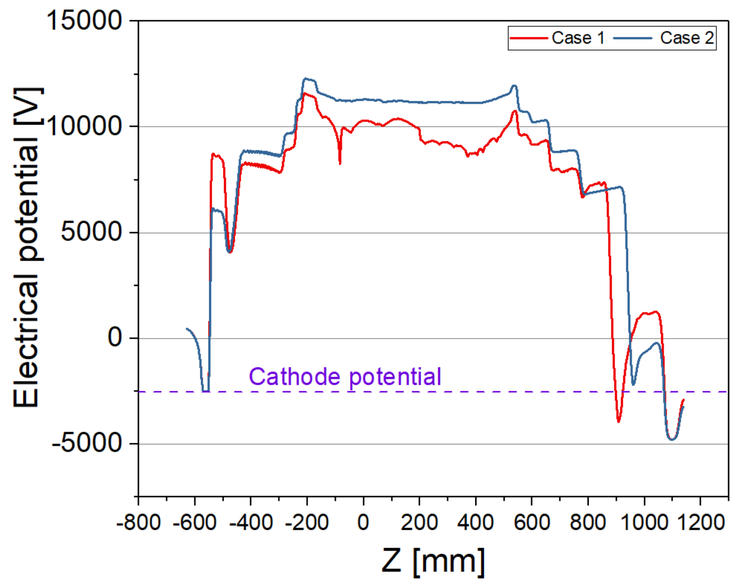
• Beam transmission rate study

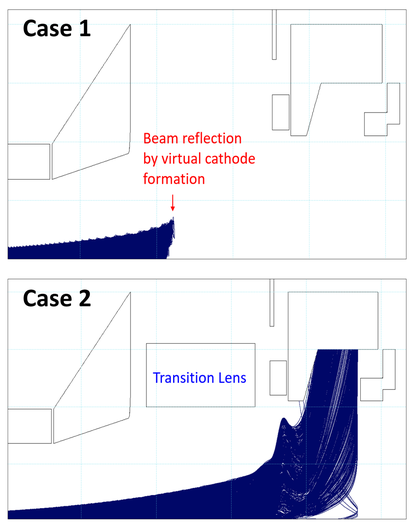


• Current density study (at Trap)

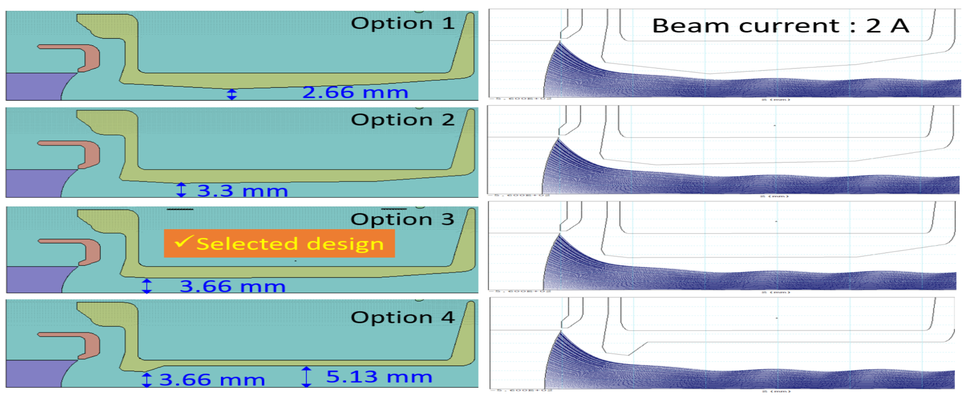


❑ Virtual cathode formation

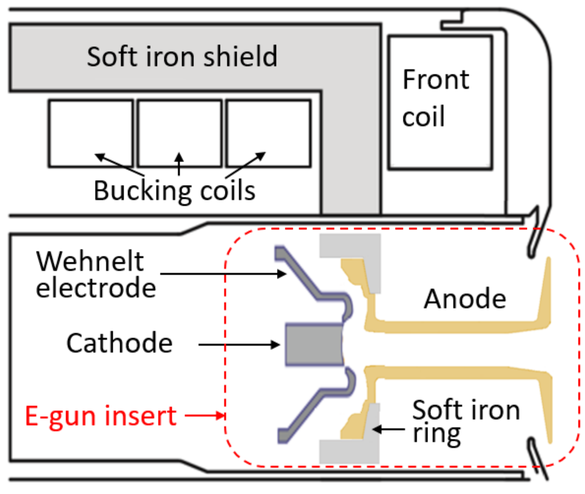


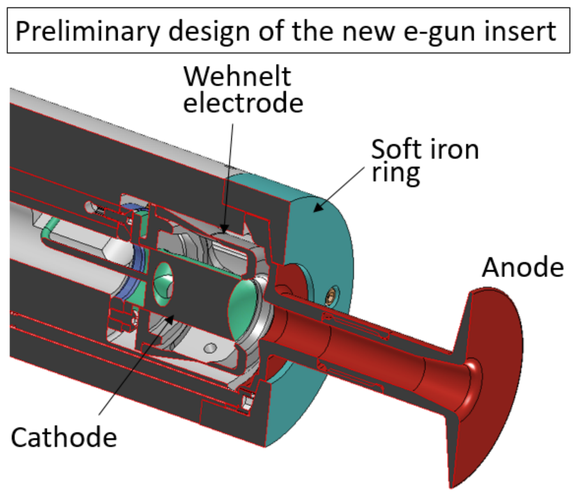


❑ Anode design modification



❑ Electron gun structure and New insert





U.S. Department of Energy Office of Science
National Science Foundation
Michigan State University

19th International Conference on Ion Sources –ICIS’21
September 20-24, 2021

※ Work supported by National Science Foundation, under contract No. PHY-1565546