Simulations for a new electron gun for the TITAN EBIT

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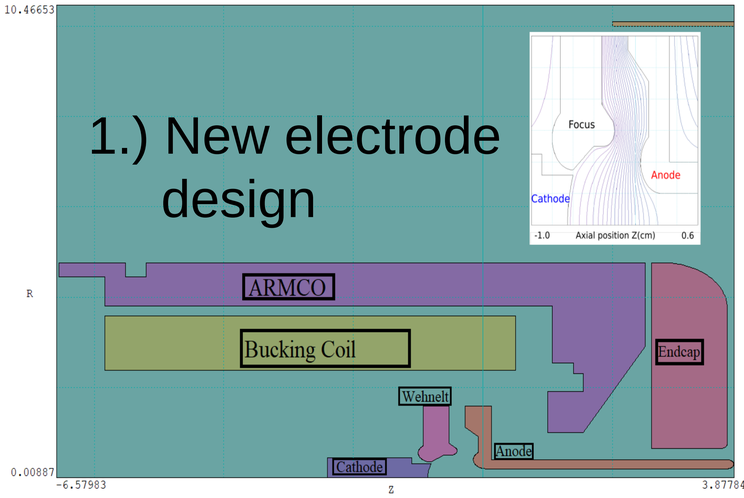
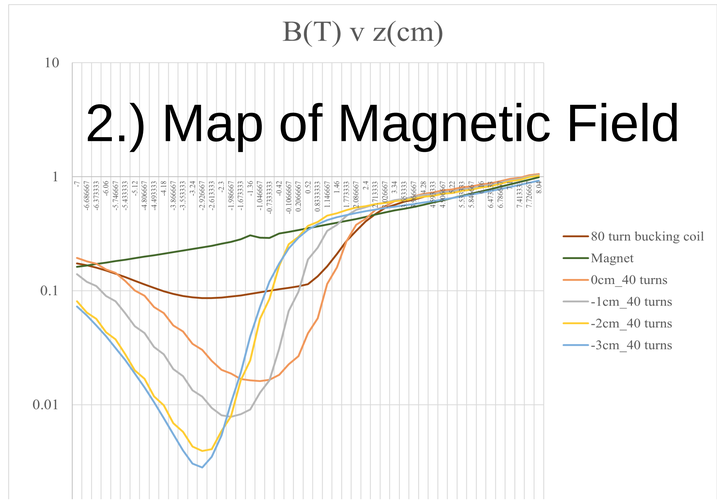
TRIUMF's Ion Trap for Atomic and Nuclear Science (TITAN) aim is to study the bounds of nuclear structure. To achieve that goal, TITAN performs high precision mass measurements with the Measurement Penning Trap (MPET). Highly charged ions improve the uncertainty of MPET mass measurements; thus, the focus of TITAN Electron Beam Ion Trap (EBIT) is to charge breed short lived radioactive isotopes for use in Penning trap mass spectrometry. The ability of the current TITAN EBIT gun to control and compress the electron beam is insufficient, so a new electron gun with different electrode geometry capable of greater compression and control of the electron beam has been designed and simulated.

1.) New electrode design



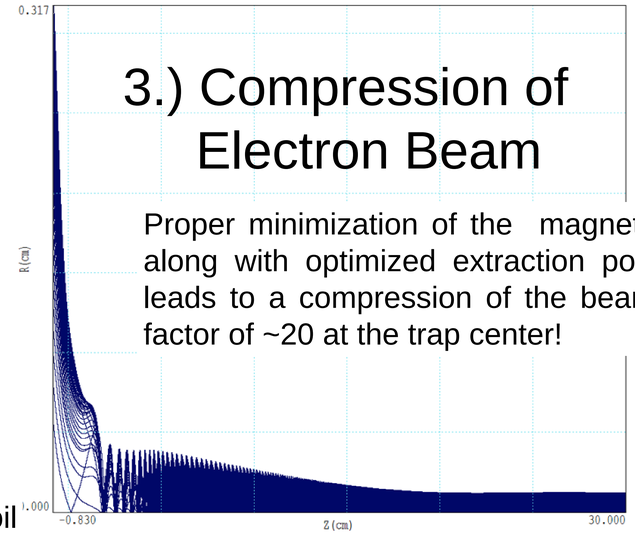
A new Wehnelt-Anode pairing was designed for this gun. Extraction potentials were optimized for this electrode design.

2.) Map of Magnetic Field



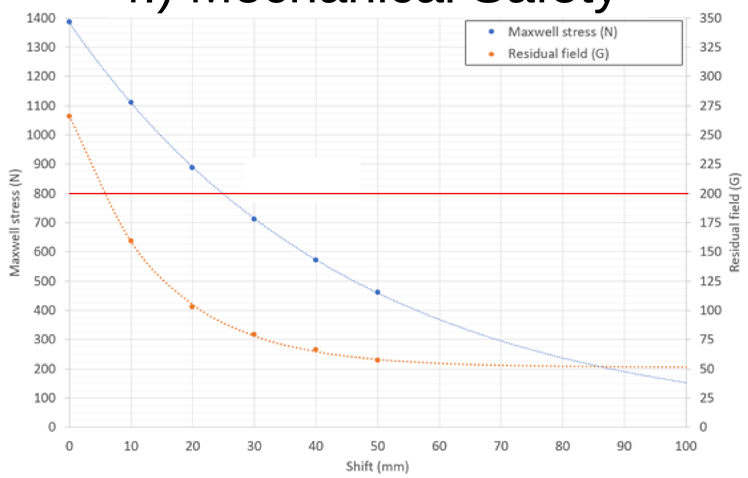
Simulations of the fringe field from the superconducting coil showed a minima of the field at the cathode surface.

3.) Compression of Electron Beam



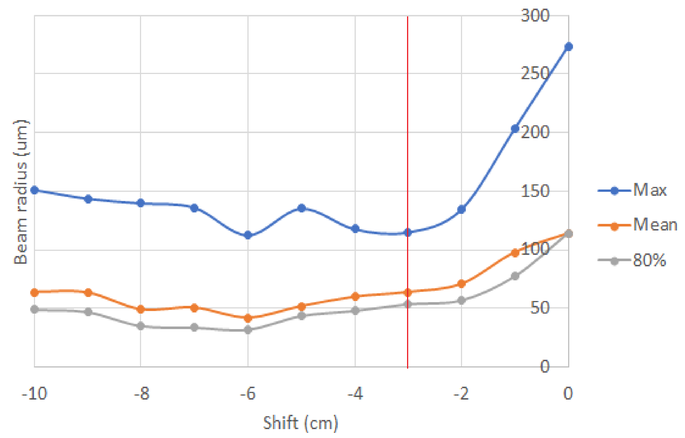
Proper minimization of the magnetic field along with optimized extraction potentials leads to a compression of the beam by a factor of ~20 at the trap center!

4.) Mechanical Safety



The gun induces a magnetic force on the magnet struts. Shifting the gun position was able to minimize the force to less than the 800N limit.

5.) Electron beam radius



Displacement of the gun did not negatively affect the beam compression!

In order to improve the control and compression of the electron beam in the TITAN EBIT a new gun has gone into development. The compression of the electron beam was found to be substantial, even after dealing with the mechanical constraints of the EBIT. Final checks of the mechanical design are underway, then the gun will go be machined at TRIUMF. Installation and testing to begin in March 2022, and first online experimental use expected in summer 2022.

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