A Low Energy Beam Transport to Match a Multicusp Ion Source to RFQ

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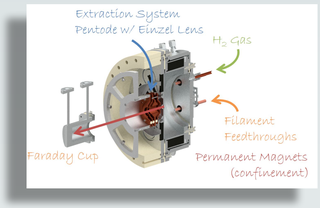
The RadioFrequency Quadrupole Direct Injection Project (RFQ-DIP) uses a filament-driven multicusp ion source to produce H2+. A Low Energy Beam Transport (LEBT) injects the beam from the ion source into the RFQ. The LEBT shapes the beam to the optimum input Twiss parameters for transmission through the RFQ while minimizing the emittance. The LEBT system has been designed using the accelerator codes IBSimu and WARP. To ensure the accuracy of the simulations, a series of diagnostic tools to assess the beam quality have been integrated into the LEBT design. The LEBT also integrates a beam chopper for machine protection and duty factor control, as well as steering capability to compensate for small misalignments. Presented here are the beam dynamics simulations as well as the design of the LEBT and matching to the RFQ.

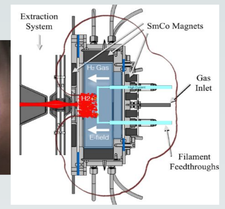
Introduction

- Enables highly compact design
- Eliminates unwanted ion species
- Preaccelerates with >90% transmission efficiency
- Increases Phase Aceeptance

Ion Source

- Multicusp, filament-driven, short plasma, modular
- Will produce 10 mA of H2+
- 80% H2+ to 20% H+
- Use of H2+ reduces space charge

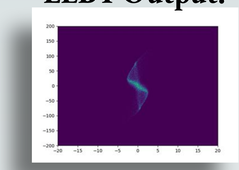




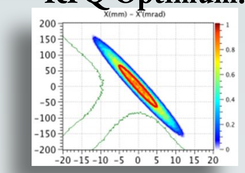
Beam Dynamics

- Modeled using PIC codes IBSimu and WARP
- Optimized to match RFQ input

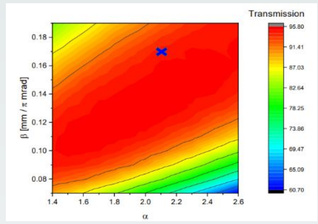
LEBT Output:



RFQ Optimum:

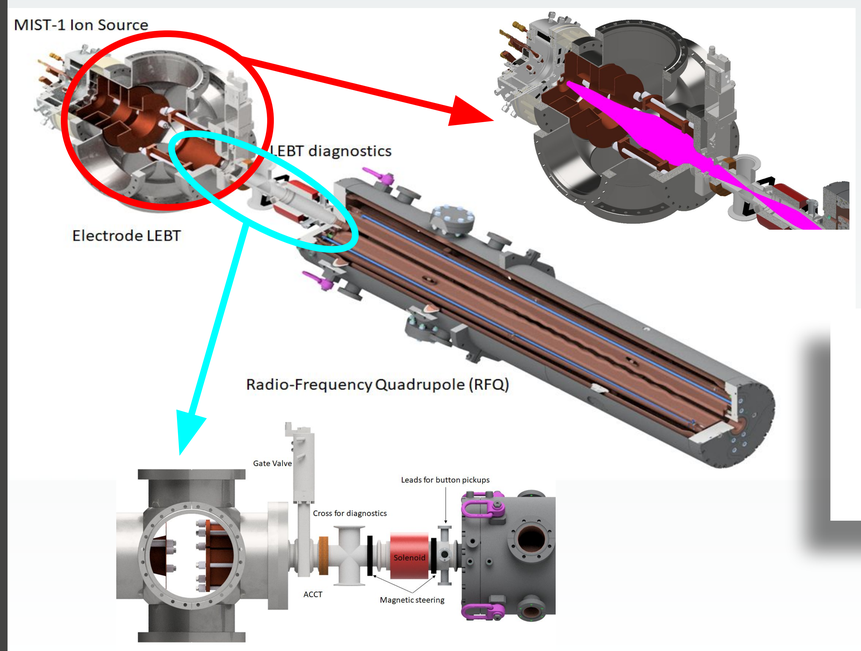


Beam Parameter	LEBT Simulation Output	PARMTEQ Optimum
Norm. 1 RMS Emit. (mm mrad)	0.157	0.3
Alpha	2.1	2.1
Beta (mm mrad)	.17	.13



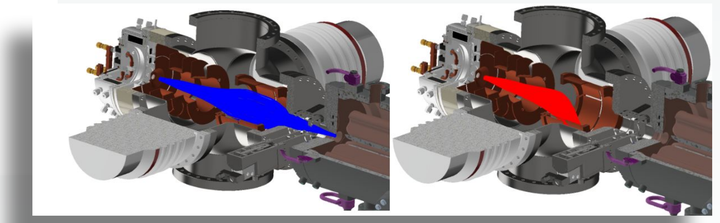
RFQ Overview

- An H_2^+ Ion source with electrode LEBT to match RFQ
- Initial shaping of beam and focusing into RFQ, control of beam and diagnostics
- Ensures high transmission through beamline



Design Constraints

- Output energy of the LEBT must be 15 KeV.
- The electrodes be far apart to prevent sparking.
- The electrodes should be within the 6-way cross
- Diagnostics section which includes:
- - 4 button pickups
- - ACCT, Faraday cup
- - Additional port for pumping.
- Separated by a gate valve.
- Small degree steering for alignment
- LEBT must be able to be run in pulsed mode using a chopper.



Conclusion

The LEBT is well matched to the RFQ, while also fitting the design constraints of the system. It provides steering and diagnostics for the beam going into the RFQ.