Study of Ion Cooling and Ejection from Two Stage Linear Quadrupole Ion Trap consisted of RFQ ion guides

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Introduction

The primary objective of this work concerns linear quadrupole ion traps, which are commonly used to interface a continuous ion beam from an external source with a mass analyzer, requiring bunched or pulsed beams. We assume that the ions prepared for mass analysis, are well spatially shaped, and normalized by ion kinetic energy. (Slava, I don't understand the meaning of the previous sentence – I wrote it as I interpreted what you are saying – I may be all wrong) In our work, such a device was developed and built to interface a source of continuous ion beams and a Multireflection TOF separator [1] for nuclear physics applications.

Method

The system consists of a long cooler RFQ, and a short buncher RFQ and was developed and built according to requirements of the separator [1]. Ion transmission and ejection parameters were studied and optimized using a simulation program developed under SIMION 8. Auxiliary four flat electrodes were foreseen in each RFQ to form controlled longitudinal DC voltage drops along the RFQ axes. The buncher RFQ has additional short end sections with short RF electrodes, separated from the main buncher rods by a push ring electrode and followed by a pull ring electrode. The cooler and buncher assembly was enclosed in a vacuum chamber for experimental testing. A simple thermo-ion source was built and installed in front of the cooler RFQ, and a custom built MCP detector assembly was installed 3 cm downstream from the buncher exit aperture. Some features of the ion trap, designed by Saint – Petersburg group [2], were also used in our work.

Preliminary results

The cooler and buncher assembly enables one to transform a continuous ion beam with kinetic energy of ~10-100 eV into a sequence of short ion bunches. Tests were carried out using Cs+ ion beams produced by a thermo-ion source, installed in front of the cooler RFQ. The ion bunch time width, registered by MCP detector, was in the range of 8 – 100 nS. The ion bunch parameters were studied in the case when no push pulse was applied to the push electrode. The resulted bunch duration was in the range of 300-500 nS FWHM, while its width at the peak base was 700-1200 ns. Shortening of the bunch was achieved by time focusing on the MCP detector by properly adjusting DC voltage settings. The measured transmission efficiency of the buncher by varying multiple parameters was in the range 30% to 80%. Note that by adjusting DC voltages of the cooler and buncher electrodes, one can shape and move the longitudinal potential valley along the RFQ axis. This results in both transmission improvement, and/or variation of the bunch length. Energy spread of the accumulated ions was measured by varying retarding potential on the grid electrode, installed between the output buncher orifice, and MCP detector assembly. It was found that the energy spread is less than 1-1.5 eV in case of a sufficient ions' dwell time in the buncher. Note that even releasing ions softly, by minimizing DC voltage offset of the output orifice, one disturbs the additional (?) ions' energy spread of a few parts in 1eV.

References:

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Novel aspect

The designed device can be a useful converter of continuous beams into pulsed ones for high resolution TOF mass analyzers and separators.