Implementation of Array of Traps and Ion Elevators in Structures for Lossless Ion Manipulations (SLIM)

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Overview

- Demonstration of array of traps and an ion elevator to enable multi-level SLIM.
- Utilizes the previous demonstration of extended path lengths and switching.
- Array of traps enables storing ions of interest in separate traps.
- Ion elevator enables moving ions between different levels of a multi-level SLIM device and expanding the path length and resolution.

Introduction

- SLIM are constructed from arrays of electrodes patterned on two parallel surfaces. It uses RF and DC potentials to confine and move the ions at few Torr pressure [1].
- Previously, a SLIM ion “switch” was developed to control ions motion into different directions [2].
- SLIM trap utilized a switch to selectively trap the ion species by suitably timing the switching.
- To construct the SLIM elevator, an orifice is introduced between two SLIM layers, with the orifice width equal to the inter-surface gap [3].
- A suitably arranged traveling wave, RF and DC potentials move the ions through the elevator to the next level.

Methods

Array of Traps

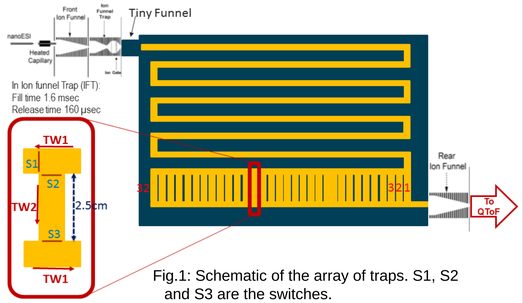

Fig.1: Schematic of the array of traps. S1, S2 and S3 are the switches.

- 32 traps are arranged in a single surface.
- The total path length excluding the array of trap is approximately 4 m.
- Each trap is 2.5 cm long.
- The SLIM utilized an array of 6 RF electrodes interleaved with 5 TW electrodes (each 1 mm long).
- Two traveling waves (TW1 and TW2) are used, TW1 for the mobility separation and TW2 for the trap region.

Elevator

Fig.2: The elevator configuration

Results

Array of traps

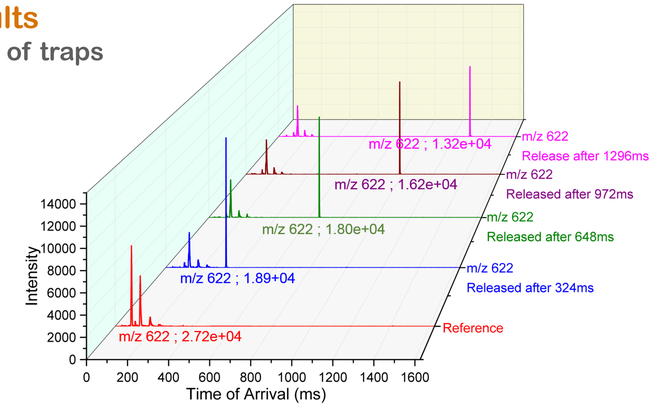

Fig. 3: The spectra show the trapping and delayed release of the m/z 622 peak after different periods.

- Agilent tune mix is used to evaluate both array of traps and elevator performance.
- Speed of TW1 = TW2 = 150 m/s and square wave.
- Improved transmission was observed at lower TW2 amplitude is because at higher TW2 amplitude, the ions are continuously pushed against the blocking potential which may in turn cause loss of ions.

Elevator

- No loss of ions has been observed in separation mode.
- No loss of mobility resolution was observed when ion packets move through the elevator.

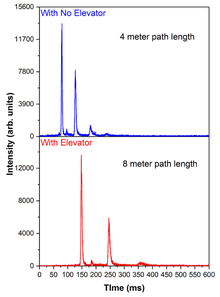

Fig.4: Mobility spectra recorded with No elevator (top) and with elevator (bottom)

Conclusions

- A SLIM array of traps has been developed and initially demonstrated experimentally.
- The amplitude of the traveling wave in the trapping region should be lowered while trapping ions to minimize the loss of ions.
- SLIM elevator was demonstrated and the performance was studied.
- It has been shown that efficient switching of ions through the elevator can be accomplished with only two DC electrodes, with a voltage equal to or slightly lower than the traveling wave amplitude.
- No significant loss of ions or resolution was observed in the elevator region when appropriately tuned.

Acknowledgements

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