Ion mobility-selected trapping and enrichment in Structures for Lossless Ion Manipulations

Overview
- This work presents an apparatus and a method using SLIM technologies to switch, trap and accumulate mobility-selected ions at 4 Torr nitrogen.
- Key operations and the optimization of the SLIM-Trap are described.
- The successful ion enrichment of the standard TOF tuning mixture and the low concentration peptides are demonstrated.

Introduction
The ability to select and accumulate ions based upon a new dimension of the ion mobility separation can benefit many MS applications. Consequently, enriching the low concentration spiked targets from complex matrices with high concentration components, and the separation of isobaric species which typically require ultrahigh mass-resolved spectra.

In this work we show that specific ions can be easily targeted for trapping and enrichments by utilizing linear and tee modules of SLIM. The first linear SLIM module was for initial ion separation. A following SLIM tee was used to redirect selected ions into a second linear SLIM module (SLIM-Trap) positioned orthogonal to the instrument direction. By repeating cycles of selection and trapping, ion population inside the SLIM-Trap can be significantly increased.

Methods
Ion mobility-selected trapping

(a) Ion introduction
(b) Redirection
(c) Accumulation
(d) Release

Figure 2 Selected-mobility trapping by a SLIM-Trap. (a) Ions transferred into a linear SLIM module were initially separated by their mobility. (b) A SLIM tee, was used to direct selected ions into the SLIM-Trap. (c) After 100 accumulation of the selected target ions, (d) the trap releases the ion pack to a TOF-MS for the mass detection.

Results
Optimization of the SLIM-Trap

(a) in no trapping, (b) switching, and (c) trapping mode.

Conclusions
- The switching and trapping of the mobility-selected ion at 4 Torr was demonstrated using a SLIM-Trap.
- Studies on ion switching potentials show that 25-30 V, lower than the potentials in the "allpass" mode, are optimal for the SW-Rung.
- Higher trapping efficiency of the SLIM-Trap was obtained for lower DC gradients in the trapping region.
- The results of the ion releasing efficiency of the SLIM-Trap indicates that the lower DC gradient during the ion ejection results in higher ion numbers while it increases the peak widths of the trapped ion pack.
- Ion accumulation applications of heparin (2,2-difluoroethoxy) phosphazene and Melittin show that the SLIM-Trap can store and accumulate selected ions until the ion number reaches to the maximum trapping capacity of the trap.

Acknowledgements
Portions of this work were supported by the National Institutes of Health (NIH) NIGMS grant P41 GM103493, the Laboratory Directed Research and Development (LDRD) program at Pacific Northwest National Laboratory, and by the Department of Energy Office of Biological and Environmental Research Genome Sciences Program under the Panomics project. Experiments were performed in the Environmental Molecular Science Laboratory (EMSL), a U.S. Department of Energy (DOE) national scientific user facility at Pacific Northwest National Laboratory (PNNL) operated by Battelle for the DOE under contract DE-AC05-76RL01830.