Controlled Ion Ejection from an External Trap for Extended *m/z* Range in FT-ICR Mass Spectrometry

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Results and Discussion

An auxiliary rf waveform of the same amplitude and phase applied to all the rods of an ion accumulation multipole creates an *m/z*-dependent axial pseudo potential. Controlled decrease of the auxiliary rf amplitude releases ions from the accumulation multipole sequentially from high to low *m/z*. The slope of the auxiliary rf voltage ramp is adjusted so that ions of different *m/z* reach the center of the ICR cell at the same time point, which mitigates the typical time dispersion observed in external source FT-ICR and extends the observable mass range for a single data acquisition by 2- to 3-fold. For complex mixture analysis, twice the number of elemental compositions are assigned when the auxiliary rf ejection is applied compared with the standard gated trapping.

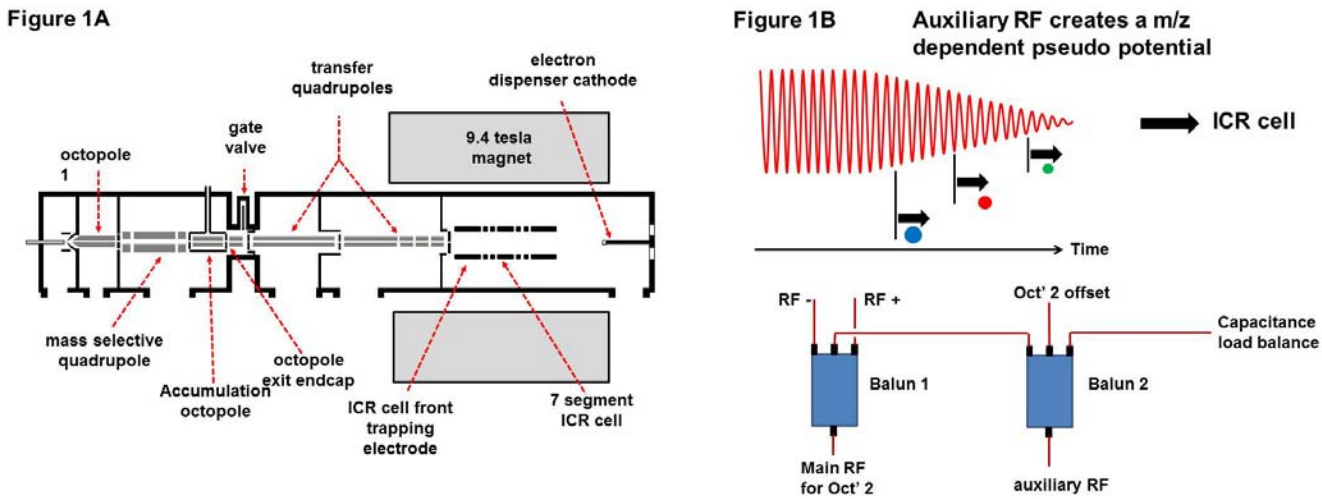

Figure 1. (a) Schematic of the custom built 9.4 T FT-ICR mass spectrometer. (b) Schematic for application of the auxiliary rf. The auxiliary rf is applied to the center tap of the balun for the main rf drive of the accumulation octopole trap, and thus an auxiliary rf waveform of the same phase and voltage is applied to all the multipole rods. Ions are released from the accumulation multipole toward the ICR cell sequentially from high to low m/z as the auxiliary rf amplitude is ramped down. The ion accumulation period in a modified rf octopole (2.0 MHz, 200 Vp-p) was between 0.3 and 2.0 s.The octopole is 160 mm in length with eight tilted gold-coated tungsten wires (100 μm in diameter) inter-digitated between the octopole rods (1.6 mm rod diameter with an inscribed diameter of 4.8 mm). The pressure in the accumulation octopole was set with a variable leak valve and optimized for ion accumulation, which is estimated at approximately 1×10^{-3} Torr, and kept constant throughout the entire experiment. The distance from the exit of the accumulation octopole to magnetic field center is 1.4 m. Application of an auxiliary rf waveform of the same amplitude and phase to all rods of an accumulation multipole creates an m/z-dependent axial pseudo potential. A schematic wiring diagram is shown in Figure 1b. After ion accumulation, an extraction voltage of 5–45 V is applied to the tilted wires, which creates an axial voltage gradient within the accumulation multipole. The voltage gradient forces the ions toward the exit and shortens the time period required for ions to exit the device. An auxiliary rf voltage (150–400 $V_{p\text{-}p}$) is applied to create the axial pseudo potential between the rods of the accumulation octopole and the octopole endcaps.

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References

[1] Kaiser, N.K. *et al.*, J. Am. Soc. Mass Spectrom., **25**, 943-949 (2014)