

# Enhanced ion utilization efficiency in IMS-TOFMS using a novel gate-free traveling wave ion guide

Zhekun Wang<sup>a, b</sup>, Zhongjun Zhao<sup>a, b</sup>, Zhihao He<sup>a</sup>, Xiaoqin Jiang<sup>a, b</sup>, Yanting Yang<sup>c</sup>,  
Jianxiong Dai<sup>c</sup>, Ziqiu Su<sup>c</sup>, Xing Guo<sup>a, b\*</sup>, Yixiang Duan<sup>a</sup>

<sup>a</sup>School of Mechanical Engineering, <sup>b</sup>Research Center of Analytical Instrumentation,

Sichuan University,

Chengdu 610064, P.R. China;

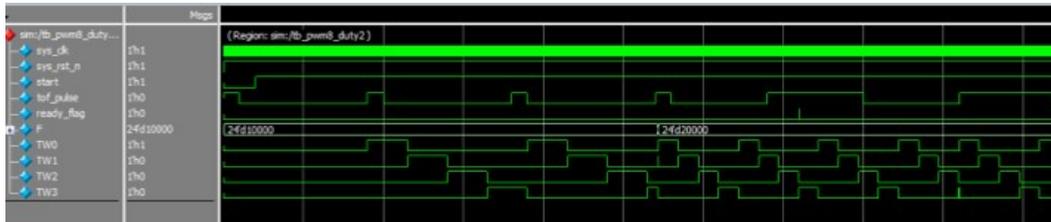
<sup>c</sup>Aliben Science and Technology Company Limited,

Chengdu 610064, P.R. China;

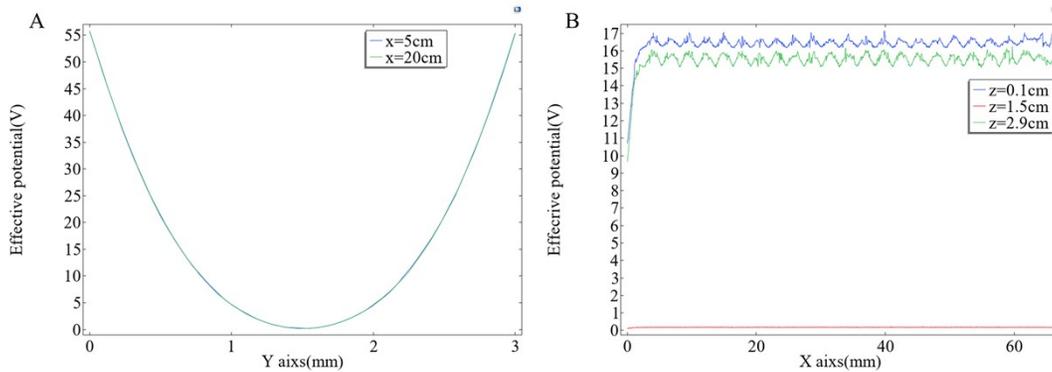
\* Address correspondence to:

Dr. Xing Guo, School of Mechanical Engineering, Sichuan University, 29 Wangjiang Road, Chengdu 610064,  
P.R. China; E-mail: [guoxing@scu.edu.cn](mailto:guoxing@scu.edu.cn).

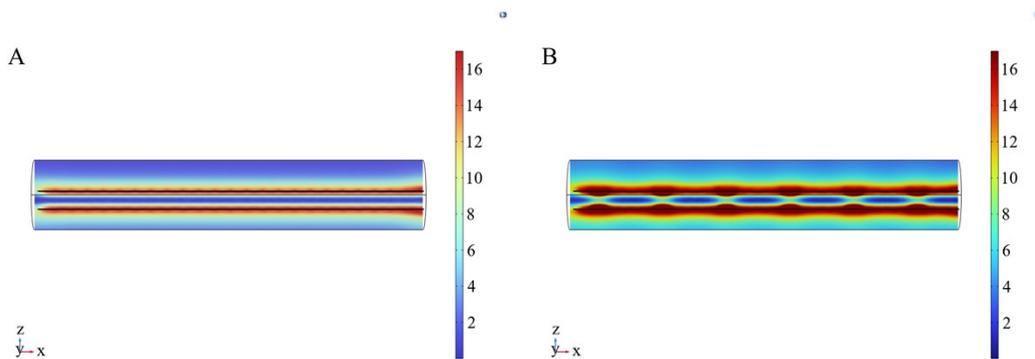
**Traveling wave synchronized generation mode.** The traveling wave is triggered by the rising edge of the TOF pusher pulse and subsequently remains synchronized with it (phase-locked). Each set of four traveling waves exhibits complementary phases with a duty cycle of 1/4. Upon a change in the traveling wave frequency, the TW automatically resynchronizes to the rising edge of the next repeller pulse. After generation, the traveling wave passes through a phase-shift system that enables continuous adjustment of its phase, allowing the pusher pulse to scan the entire traveling wave cycle. By setting different delay time, comprehensive ion information within a single traveling wave period can be acquired.



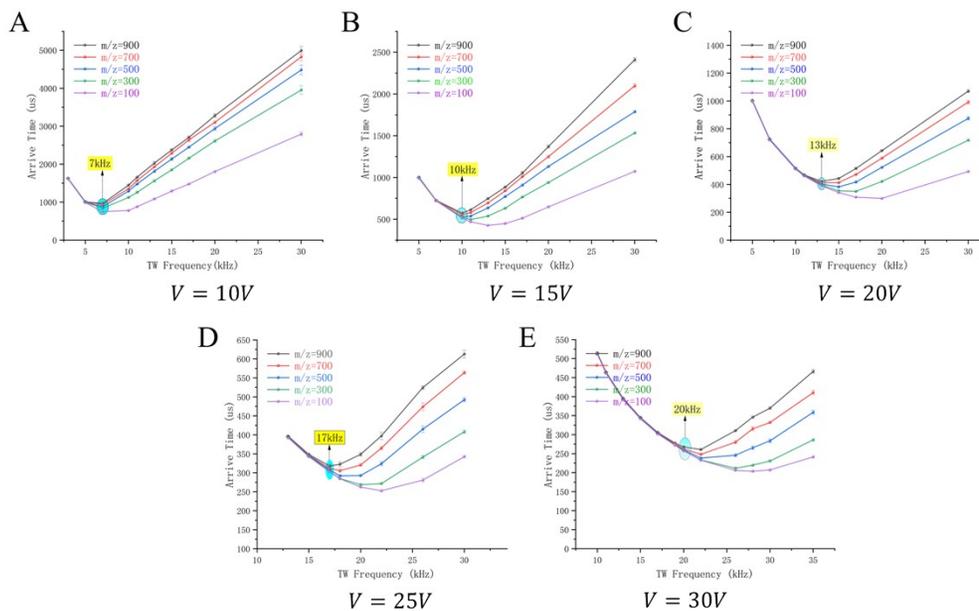
**Figure S1.** Traveling wave synchronized with the tof-pusher pulse.



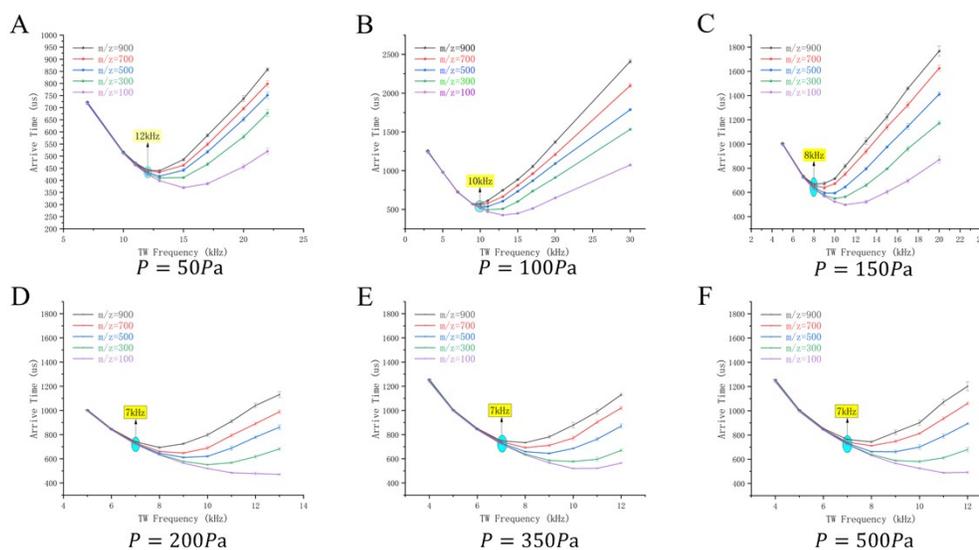
**Figure S2.** (A) The effective potential value along the y-axis at  $z = 1.5$  cm under rf excitation, (B) The effective potential value along the x-axis under the combined action of tw and rf fields;



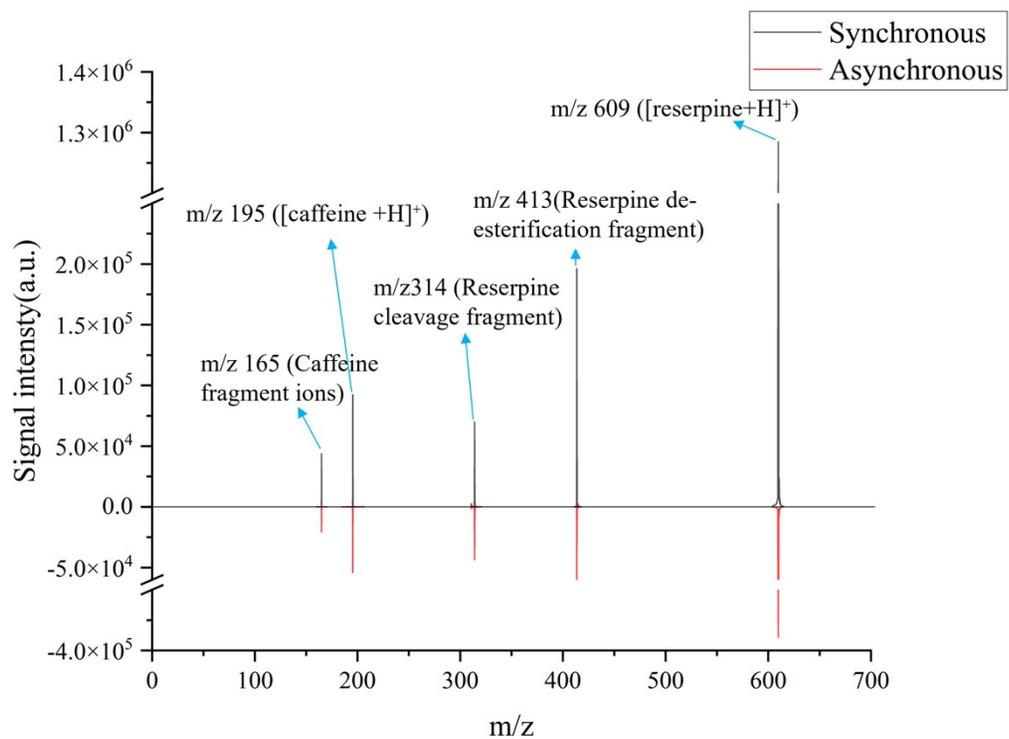
**Figure S3.** (A) Pseudopotential confinement along the z-axis under RF-only conditions; (B) Optimized pseudopotential confinement with applied TW and bias voltage;



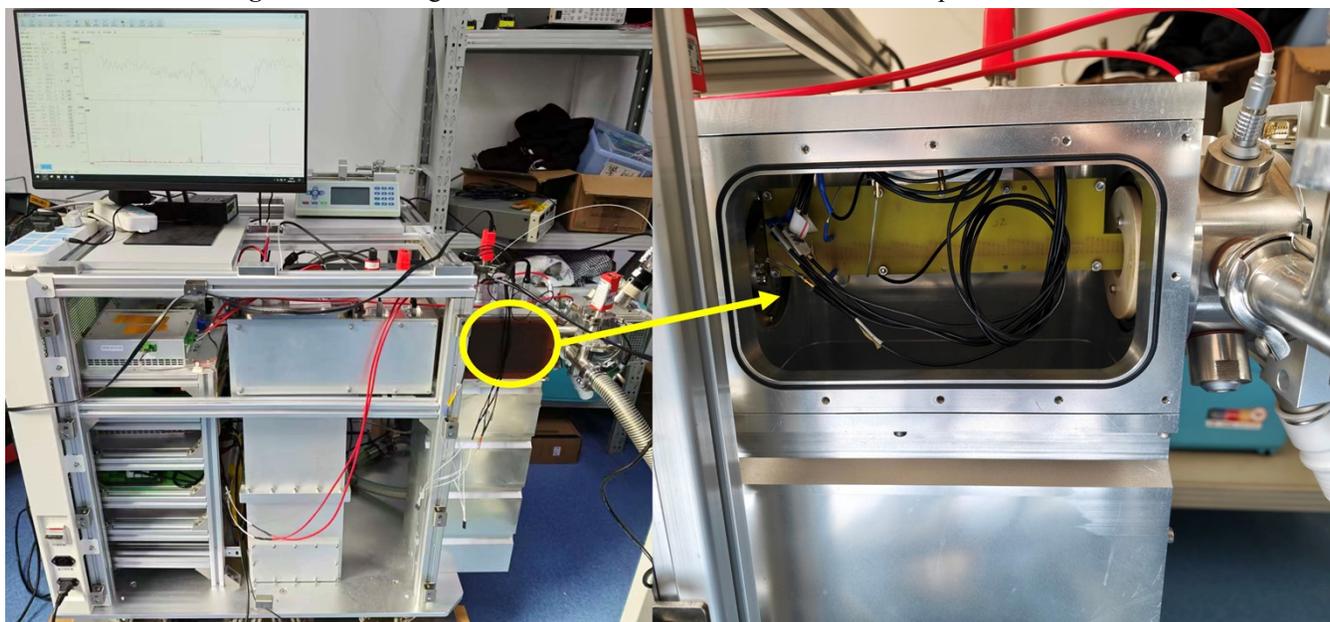
**Figure S4.** Under varying voltages: Arrival time versus TW frequency for different ions at 100 Pa pressure, (A) : 10 V; (B) : 15 V; (C) : 20 V; (D) : 25 V; (E) : 30 V;



**Figure S5.** Under varying pressure: Arrival time versus TW frequency for different ions at 15V TW amplitude, (A) : 50 Pa; (B) : 100 Pa; (C) : 150 Pa; (D) : 200 Pa; (E) : 350 Pa; (F) : 500 Pa;



**Figure S6.** Mass signal intensities of different ions under the two operational modes



**Figure S7.** Photograph of the instrument structure.