

## Supplementary Information

### Ultra-High Resolution Ion Mobility Separations Utilizing Traveling Waves in a 13-m Serpentine Path Length Structures for Lossless Ion Manipulations Module

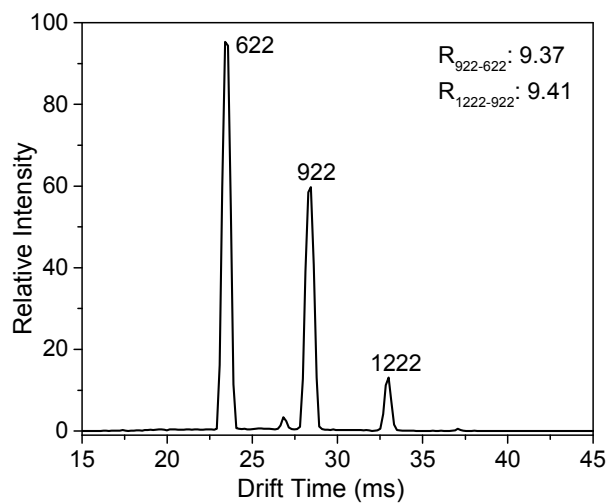
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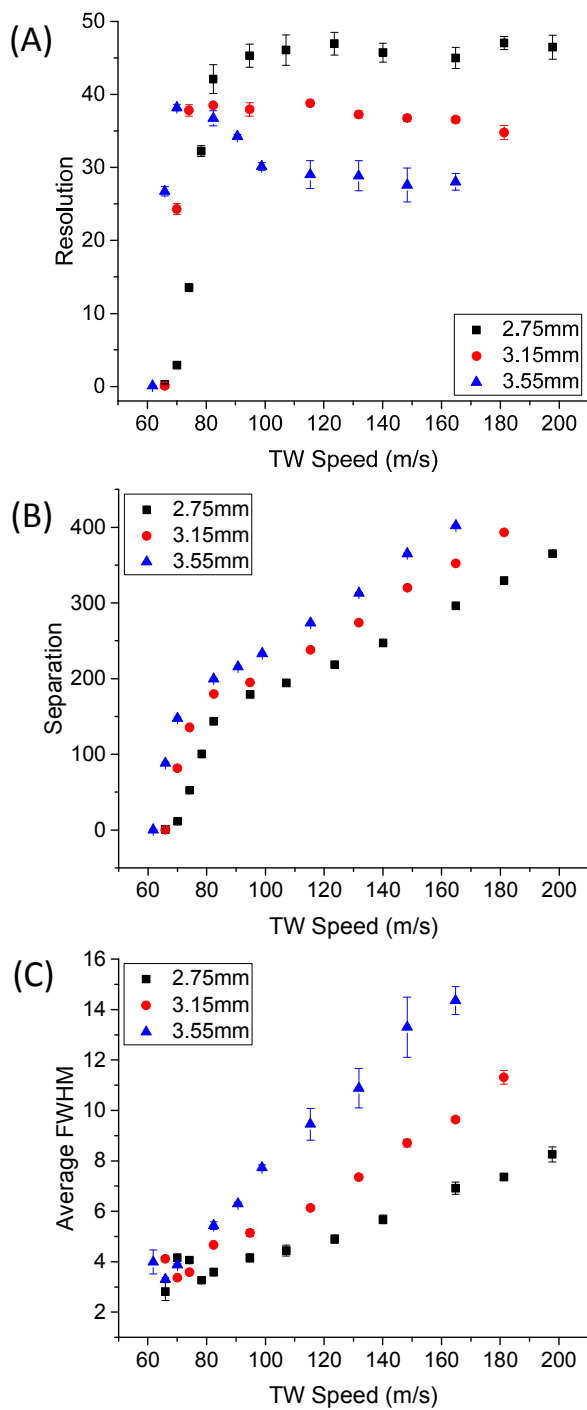
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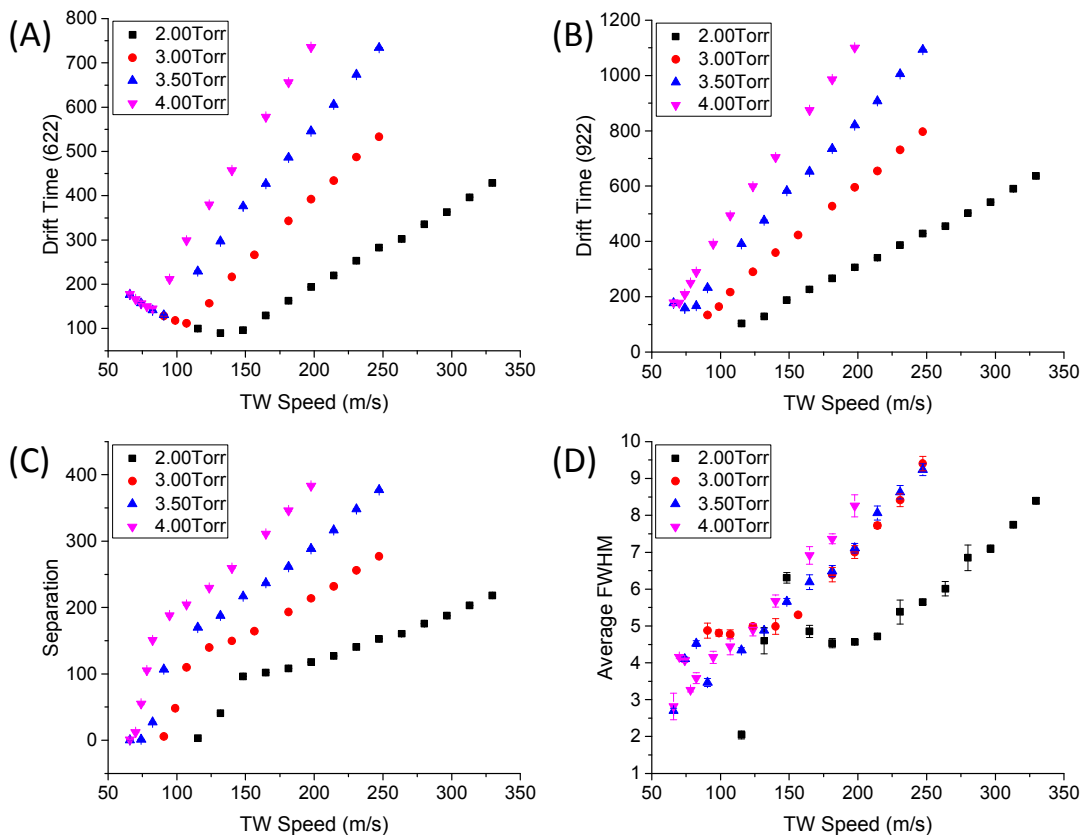
**Figure S-1.** Ion mobility spectrum of Agilent tuning mix using DT-IMS under 19 V/cm (90cm).



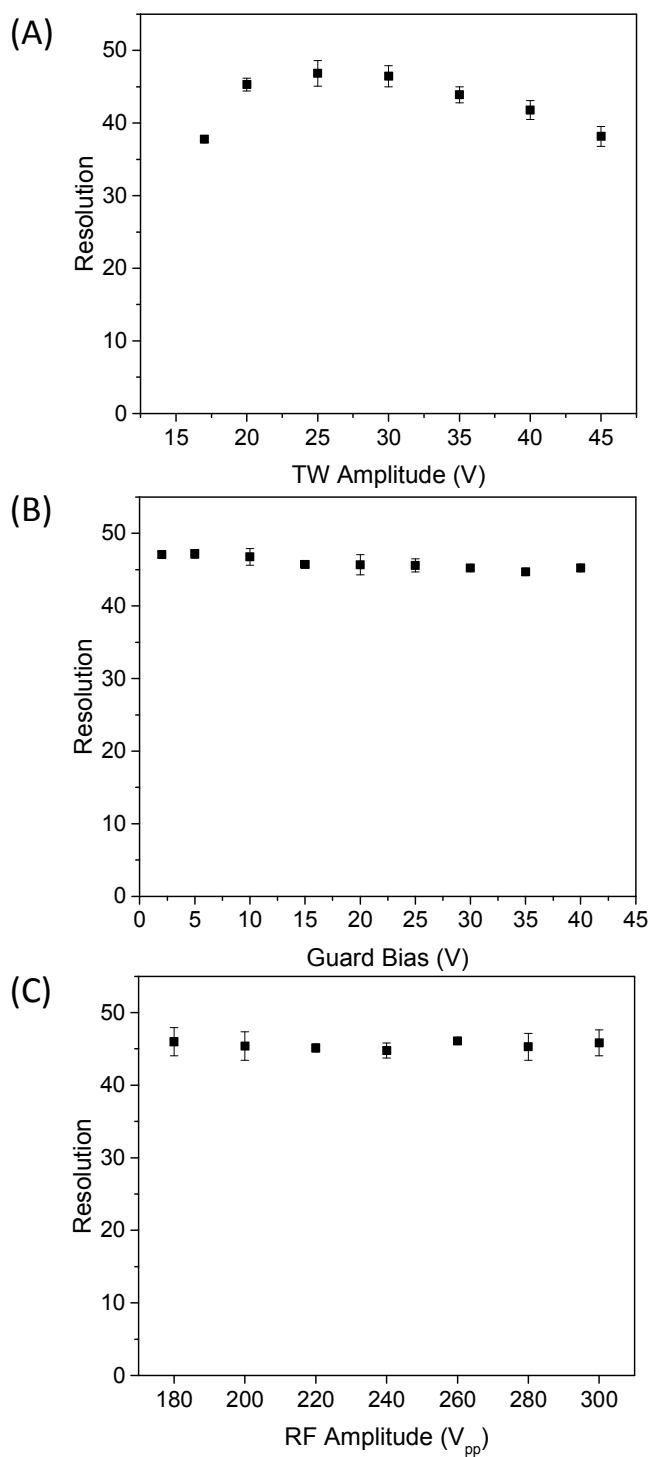
**Figure S-2.** (A) Resolution, (B) Separation and (C) Averaged peak width (FWHM) for the  $m/z$  622 and 922 peaks were measured as a function of traveling wave speed at different gaps between two surfaces at 4.00 Torr  $N_2$  using the settings: traveling wave with amplitude of 30V, guard bias of 5V, and RF amplitude of 220  $V_{pp}$  at 650 kHz.



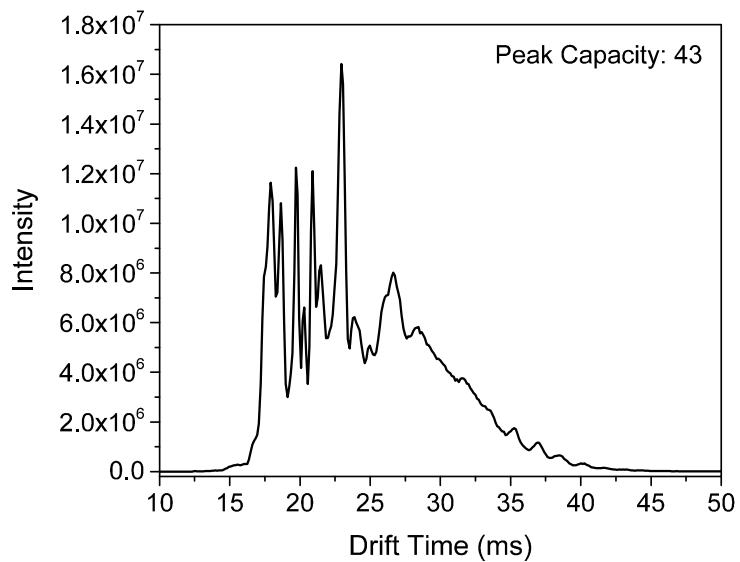
**Figure S-3.** Drift time of (A)  $m/z$  622; (B)  $m/z$  922; (C) Separation and (D) Average peak width (FWHM) for the  $m/z$  622 and 922 peaks was measured as a function of traveling wave speed at various pressures from 2.00 Torr to 4.00 Torr  $N_2$  with the following conditions: traveling wave with amplitude of 30V, guard bias of 5V, and RF amplitude of 220  $V_{pp}$  at 650 kHz with 2.75 mm gap.



**Figure S-4.** Resolution for the  $m/z$  622 and 922 peaks was measured at 123.6 m/s as a function of (A) Traveling wave amplitude under conditions of guard bias of 5V, RF amplitude of  $220V_{pp}$  at 650 kHz, and 2.75 mm gap at 4.00 Torr  $N_2$ ; (B) Guard bias with the following settings: amplitude of 30 V, RF amplitude of  $220 V_{pp}$  at 650 kHz, and 2.75 mm gap at 4.00 Torr  $N_2$ ; (C) RF amplitude at 650 kHz using traveling wave amplitude of 30 V, guard bias was set to be 5 V, and 2.75 mm gap at 4.00 Torr  $N_2$ .



**Figure S-5.** Ion mobility spectrum of the 9 peptide and Ultramark mixture sample was obtained by DT-IMS at following conditions: 19 V/cm, 90 cm and 4.00 Torr. The peak capacity was calculated using the same peaks showing in Table S-1.



**Table S-1.** The m/z, drift time and FWHM of all peaks observed in Figure 4 and calculated peak capacity and peak generation rate by eq 2 and 3 (blue colored data points were used for calculating the peak capacity and peak generation rate).

m/z	Drift Time(ms)	FWHM(ms)	Peak Capacity	Peak Generation Rate (s <sup>-1</sup> )
530.72	154.93	1.62		
541.59	130.88	1.45		
558.24	161.63	5.81		
578.77	188.40	1.63		
614.79	203.35	1.69		
671.32	234.50	1.59		
674.28	239.71	2.10		
685.27	235.87	1.91		
712.35	214.13	1.60		
724.80	248.58	2.84		
727.85	273.75	1.99		
763.37	299.90	2.26		
768.74	255.68	2.48		
811.89	337.53	2.79		
836.84	299.09	2.71		
	304.51	2.53		
876.17	493.66	5.88	245.5	368.8
	523.73	5.02		
892.76	351.90	2.22		
897.42	389.81	2.28		
921.87	396.43	2.02		
949.45	394.27	2.77		
956.78	400.34	2.34		
1021.85	448.99	2.78		
1121.83	504.71	3.67		
	509.53	3.32		
1221.80	561.25	4.74		
	566.43	4.64		
1321.78	621.04	4.82		
	629.13	4.04		
1421.75	678.61	4.19		
	684.42	5.27		
1521.72	739.32	7.51		
1621.71	796.59	8.14		