Lossless Ion Trapping in Structures for Lossless Ion Manipulation (SLIM)

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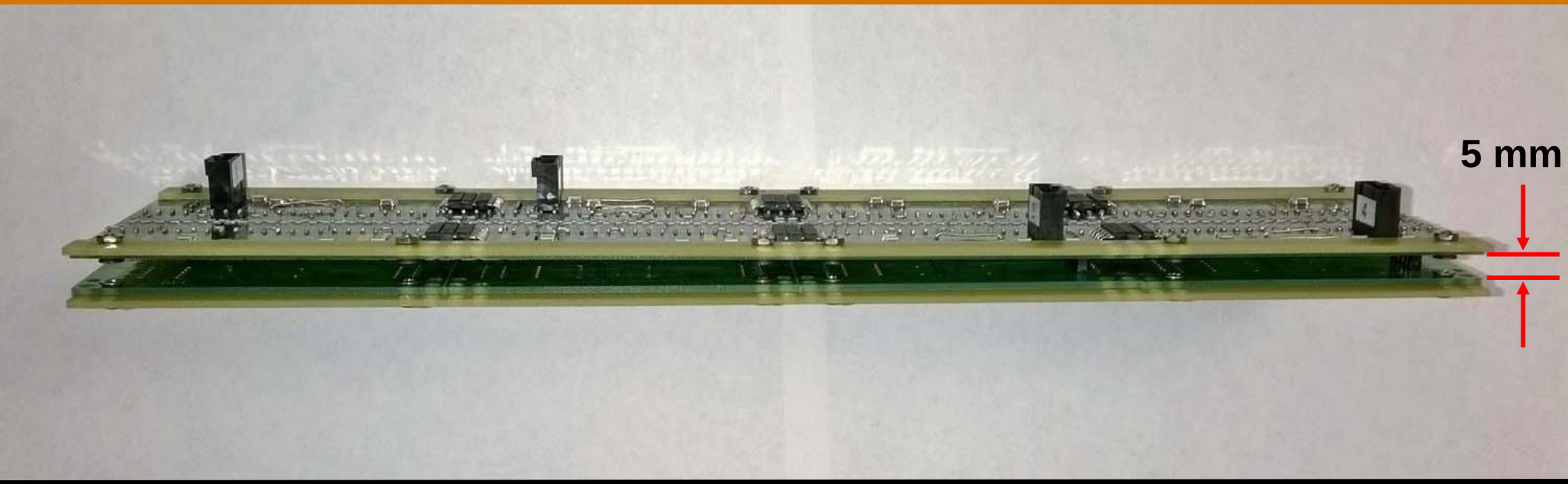
Basic Gas Phase Ion Manipulations

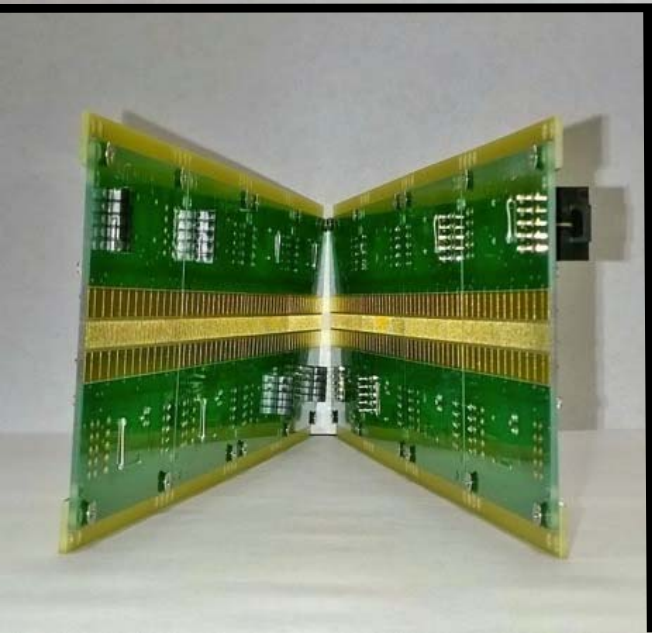
- Ion transport
- Ion trapping
- Ion-ion/ion-molecule reactions
- Ion mobility separations (IMS)

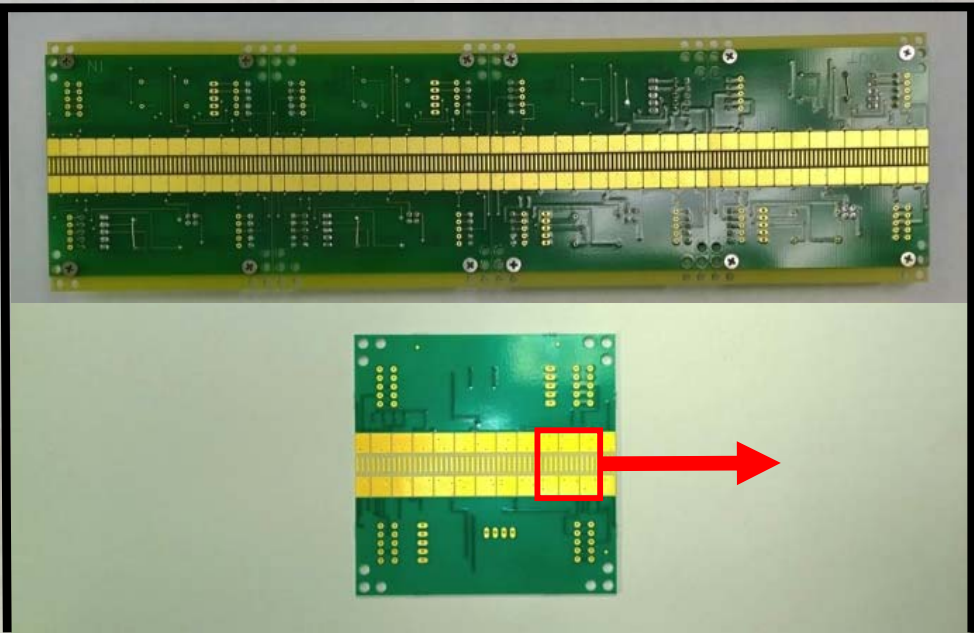
Ion Trapping in SLIM Explored at ~Torr Pressures

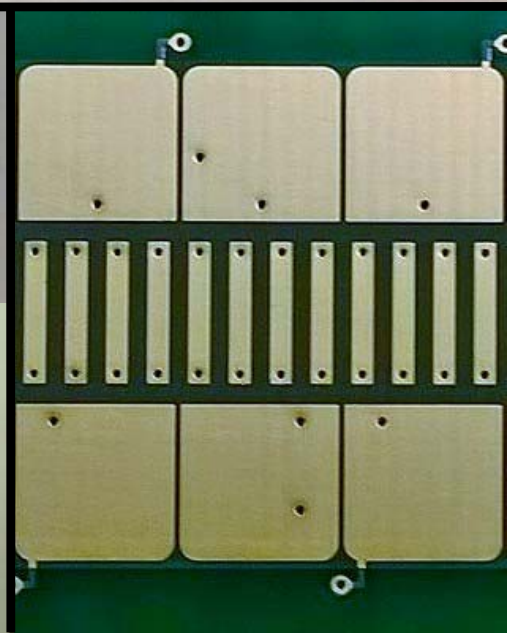
- Ion accumulation and charge capacity in a SLIM trap
- Ion release from a SLIM trap
- Ion storage for extended times to e.g. enable more efficient use of MS

Structures for Lossless Ion Manipulation









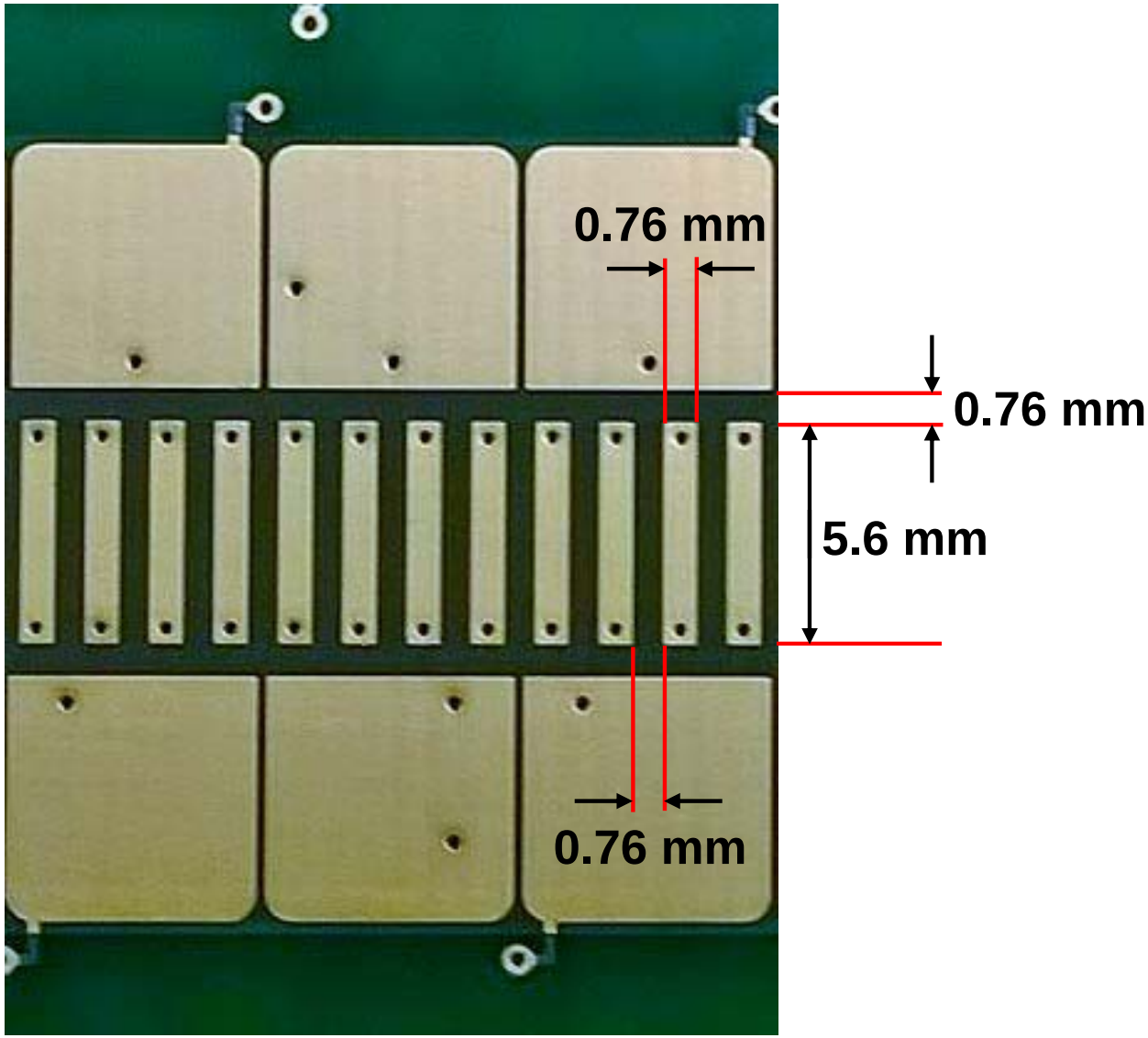
See Poster WP714 by Ian Webb *et al*., Jun 17

Slim Electrode Designs Used in This Study

Guard electrodes

Rung electrodes

Guard electrodes



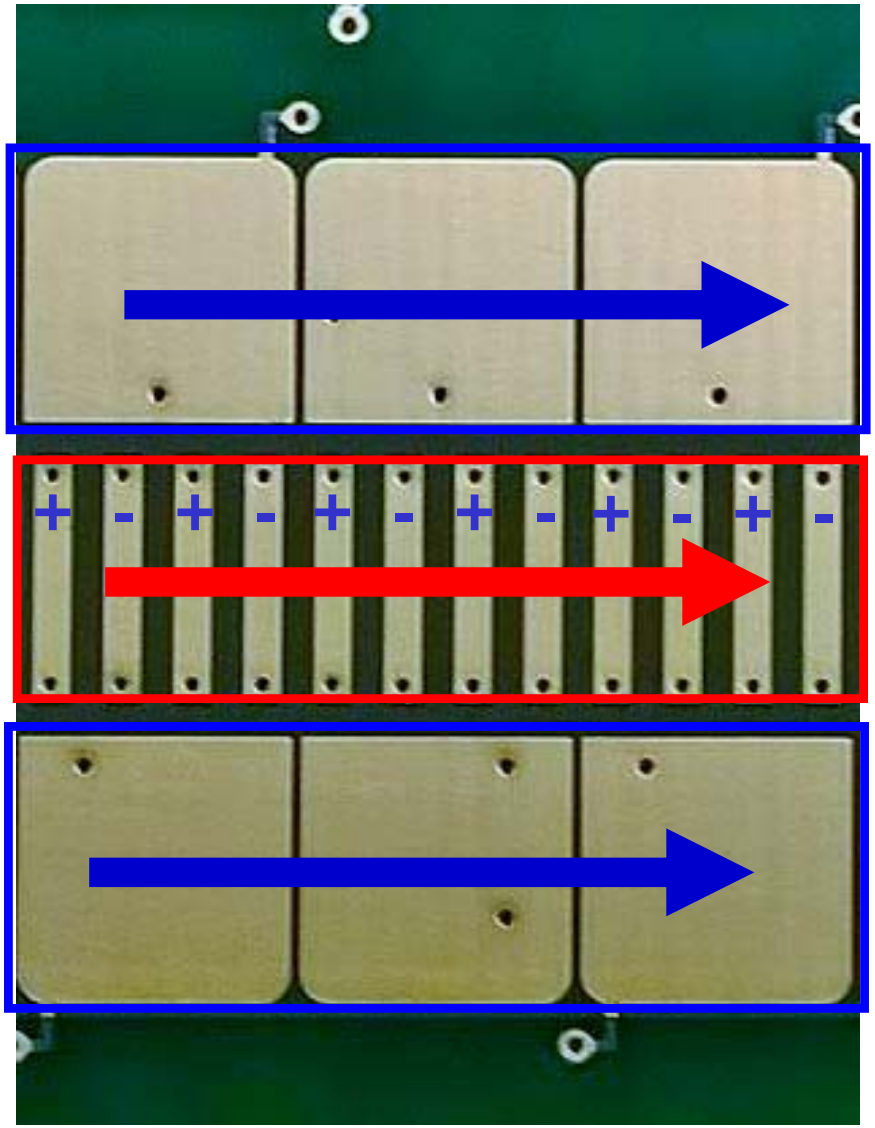
Comparable DC Voltages Used on Rung and Guard Electrodes to Facilitate Ion Confinement

DC for ion confinement and manipulation used in conjunction with RF confinement potentials applied to rung electrodes

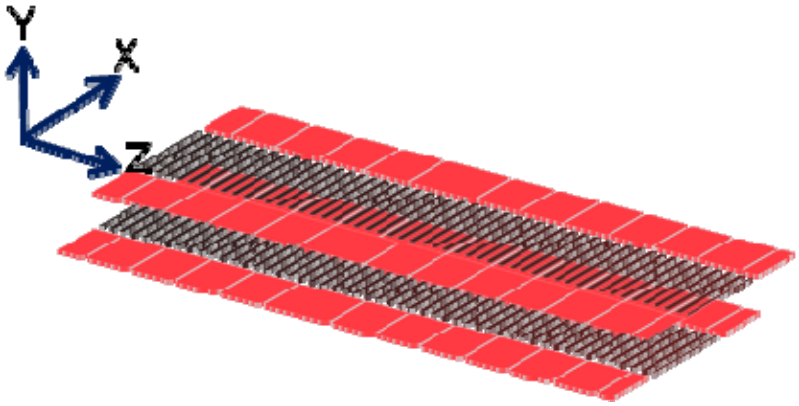
Guard gradient

DC Rung gradient

Guard gradient

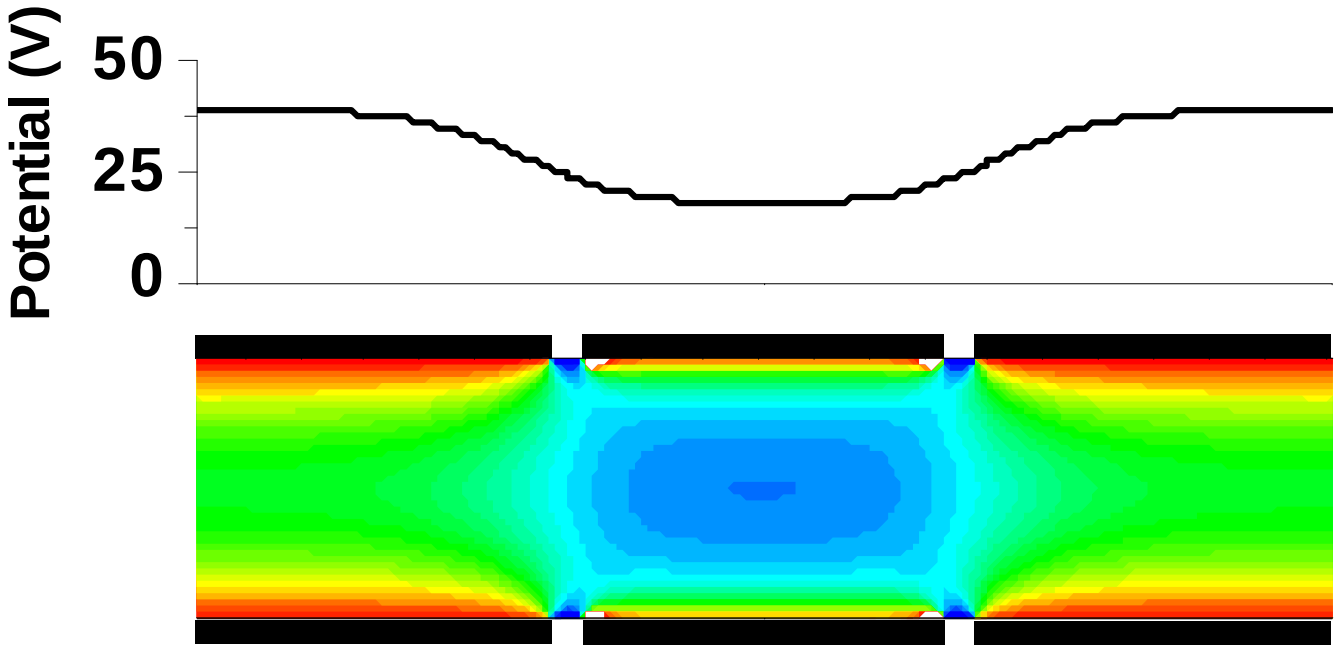


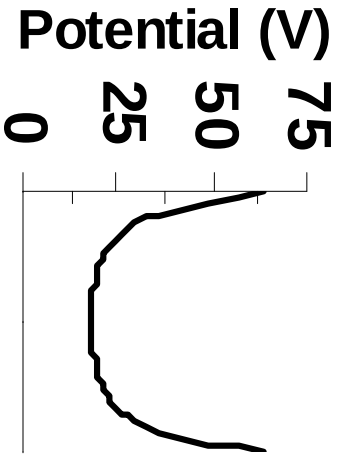
Pseudo Potential Well (Ion Confinement)

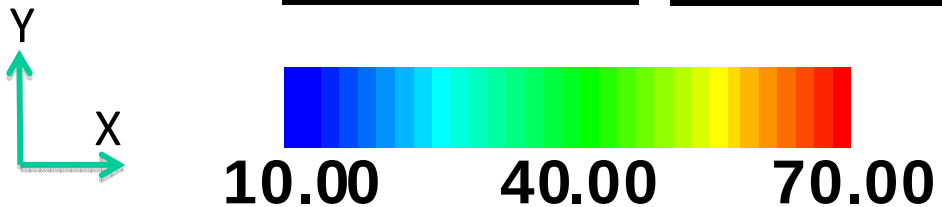


$$\varphi = \frac{q}{4m}\frac{|\nabla \emptyset_{RF}|^2}{\omega^2} + \emptyset_{DC}$$

Charge: 1+
Mass: 1000
RF: 200 $V_{p\text{-}p}$ at 800 kHz
Guard Bias: +5 V

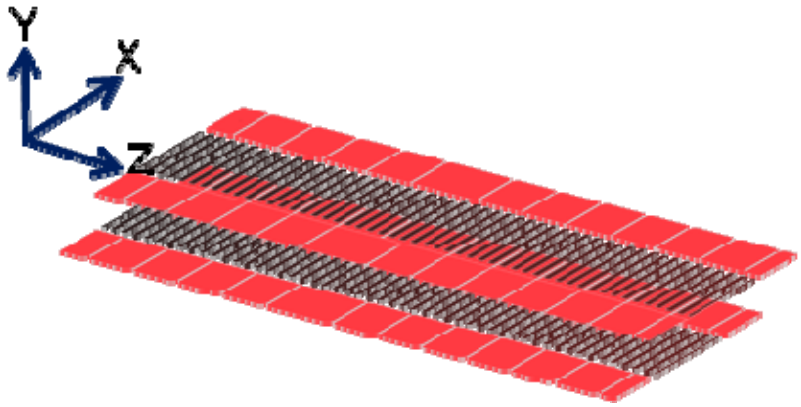


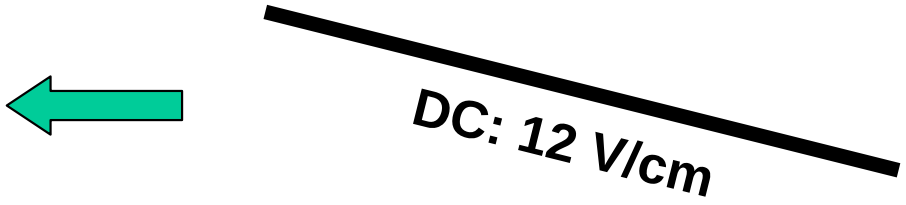


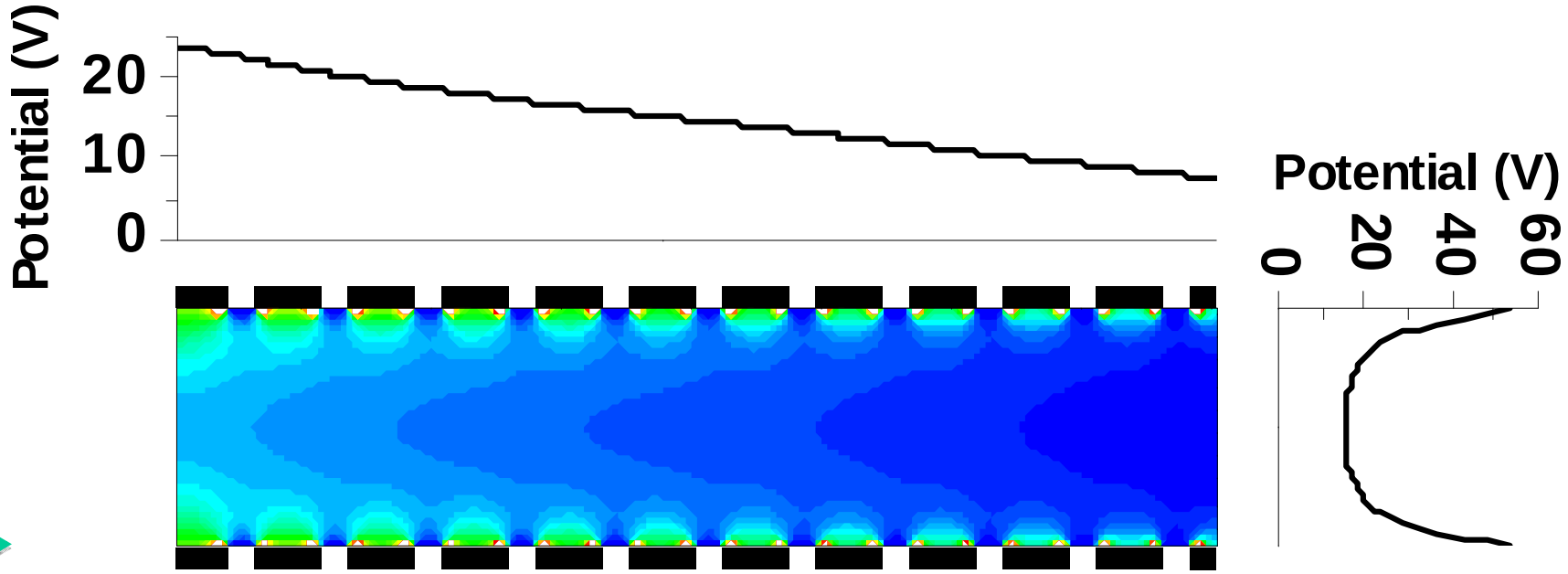


See Poster WP716 by Sandilya Garimella *et al.*, Jun 17

Pseudo Potential Well (Ion Transport)







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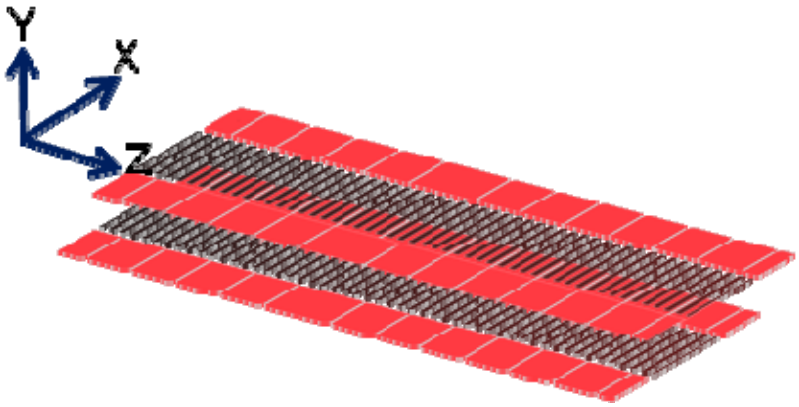
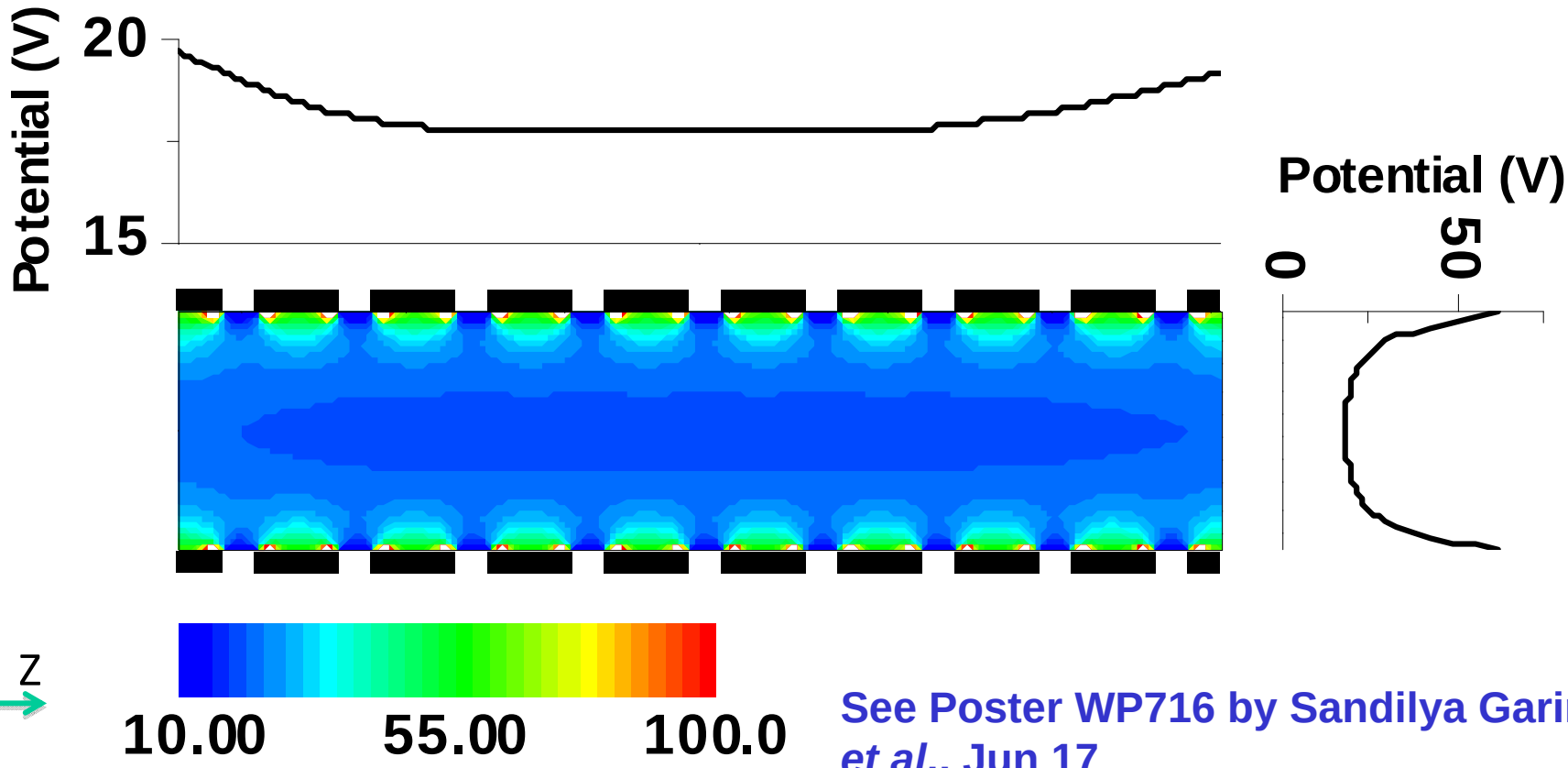
Pseudo Potential Well (Ion Trapping)



DC: 12 V/cm



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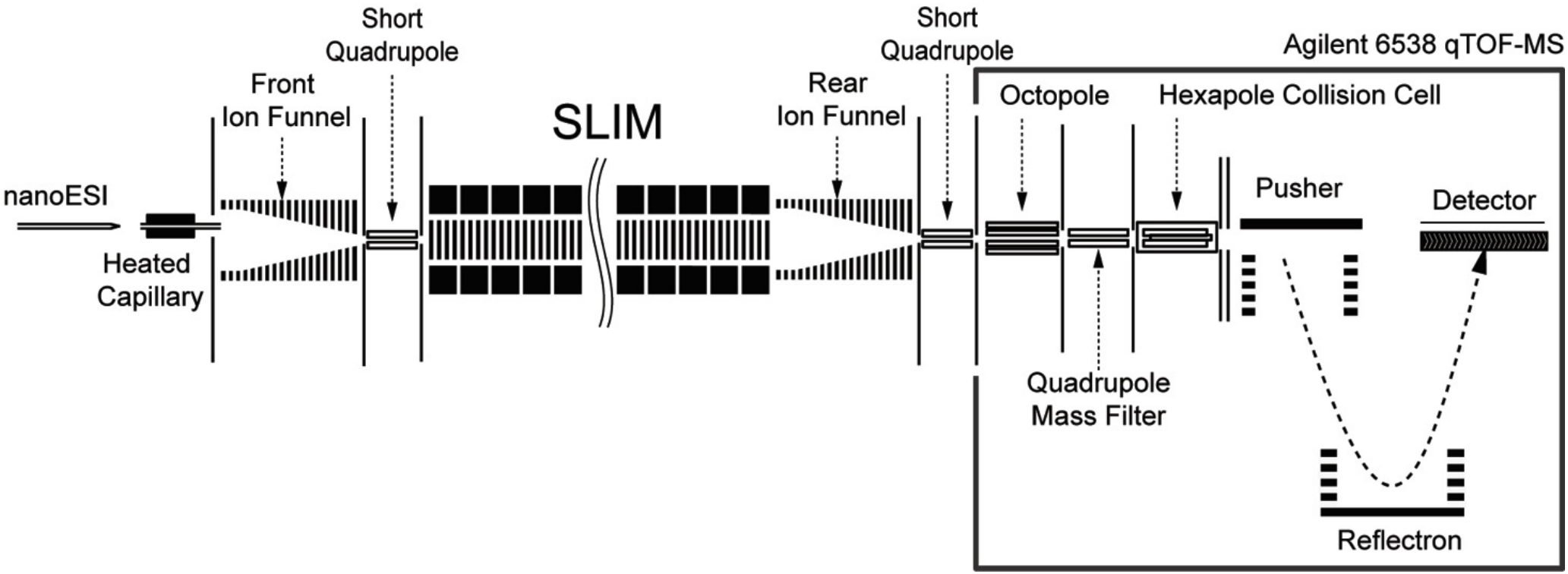
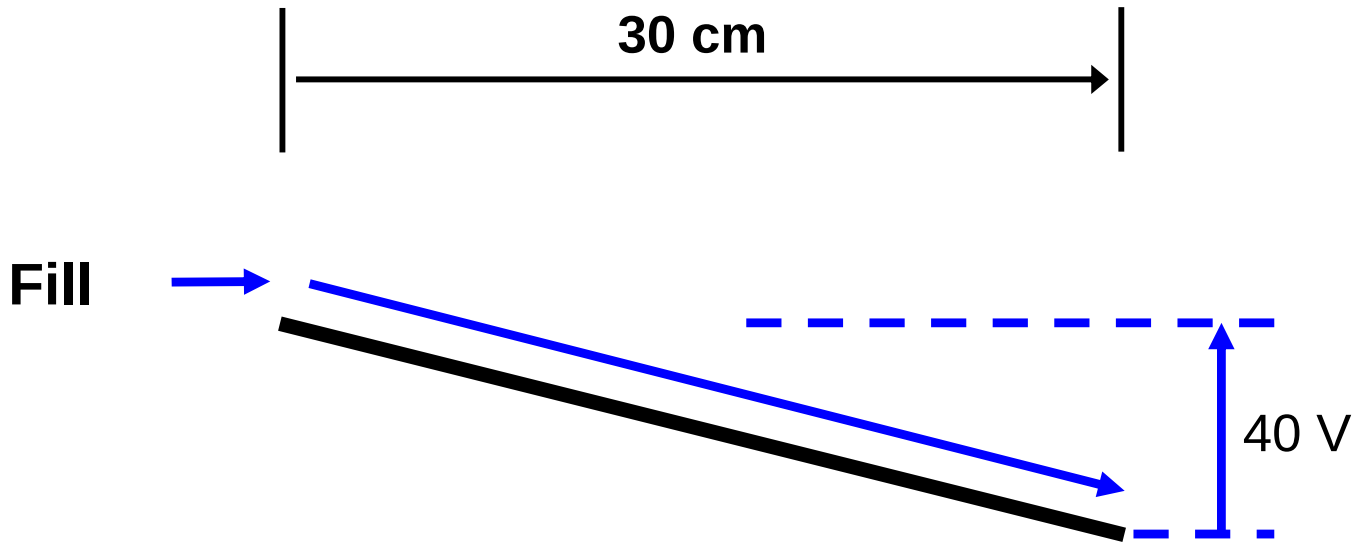
Instrumental Arrangement Used



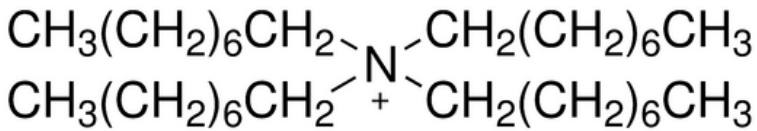
- Pressure: 4.3 torr (Nitrogen)
- RF: 165 $V_{p\text{-}p}$, 1.7 MHz

Continuous Mode (DC Gradient Arrangement)



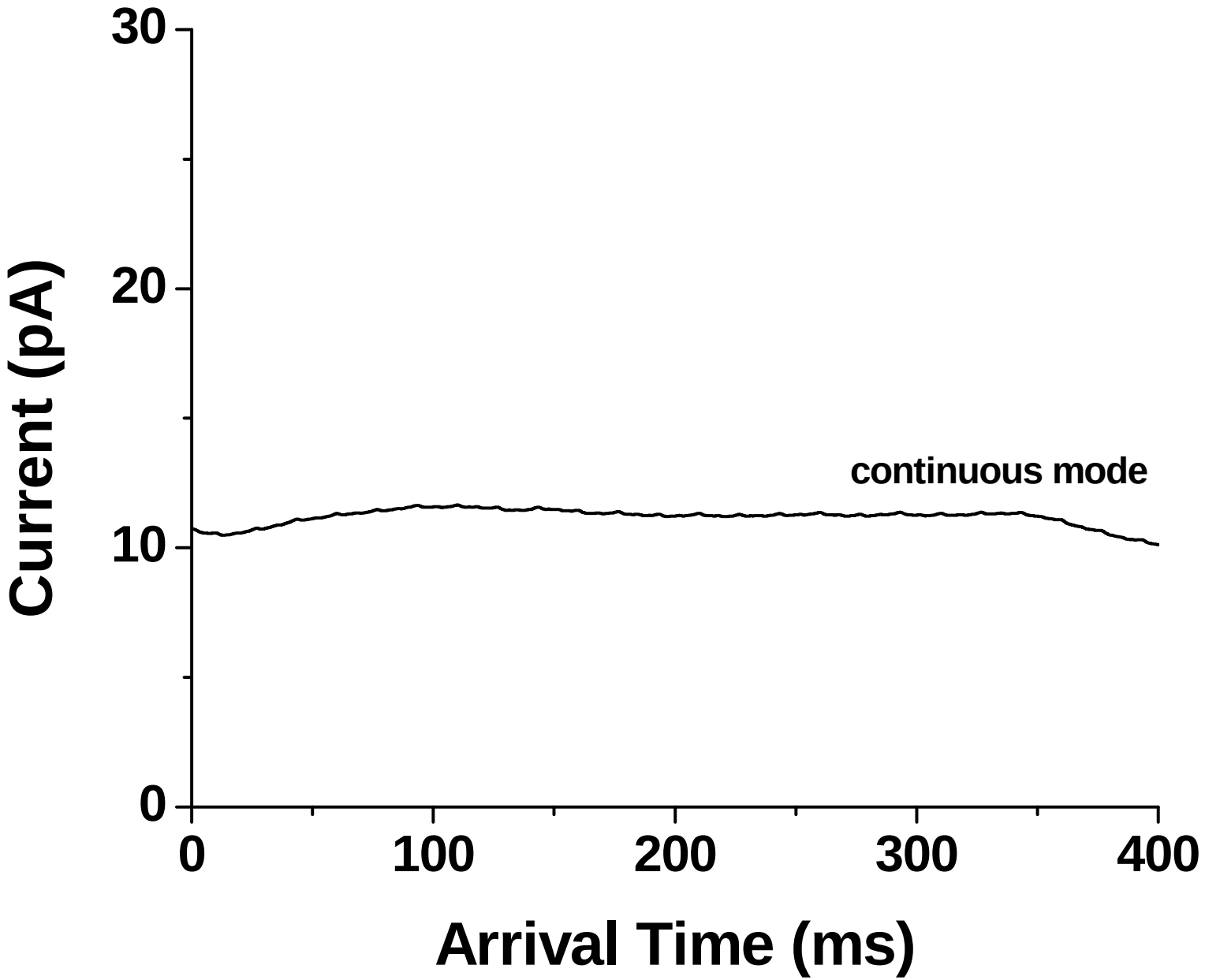
Sample Tetraoctylammonium Bromide

1 μ M in $CH_3CN/H_2O/CH_3COOH$ (75/24/1)

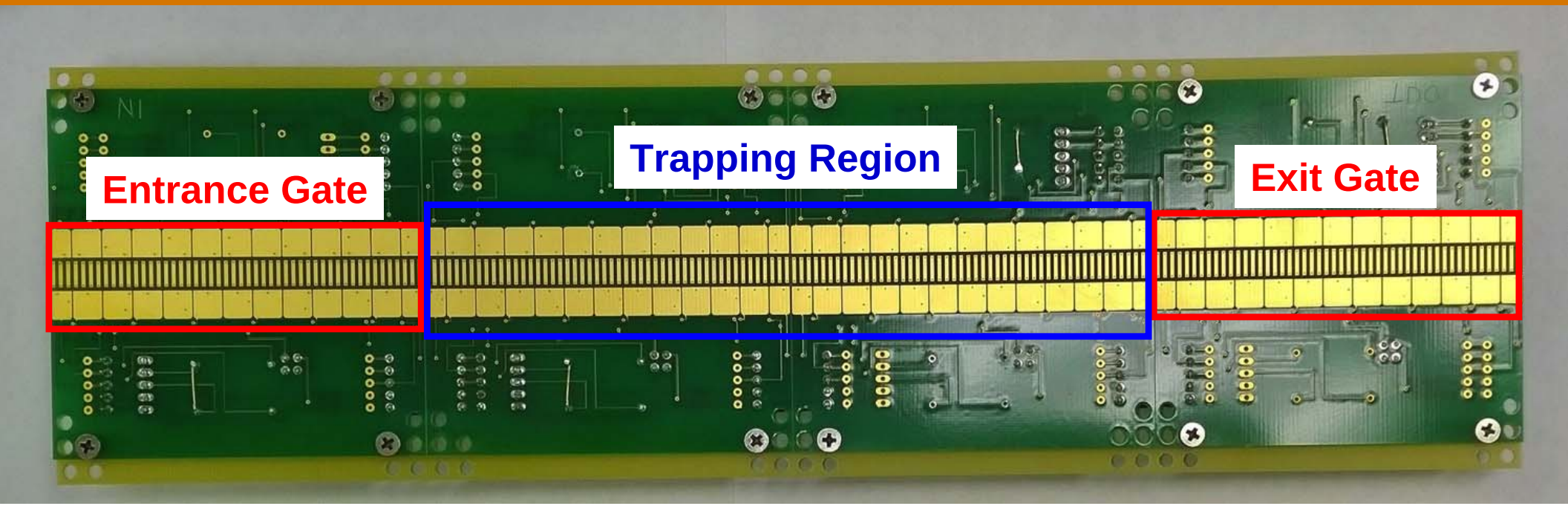


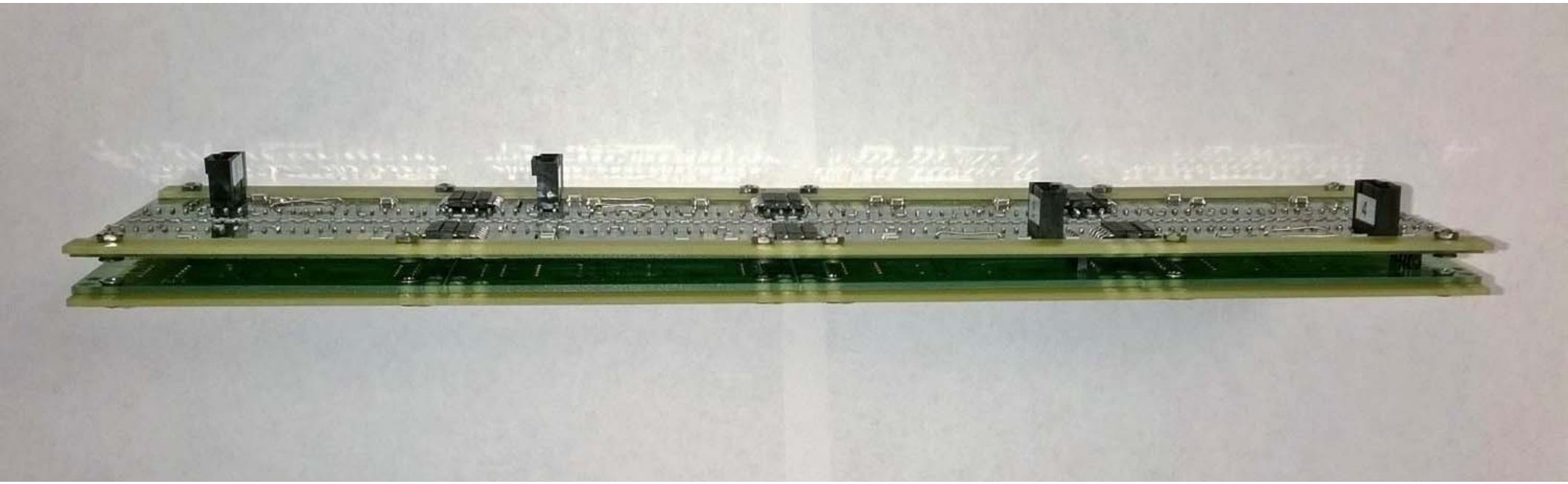
m/z: 466.3

Continuous Mode (Current Measurements)

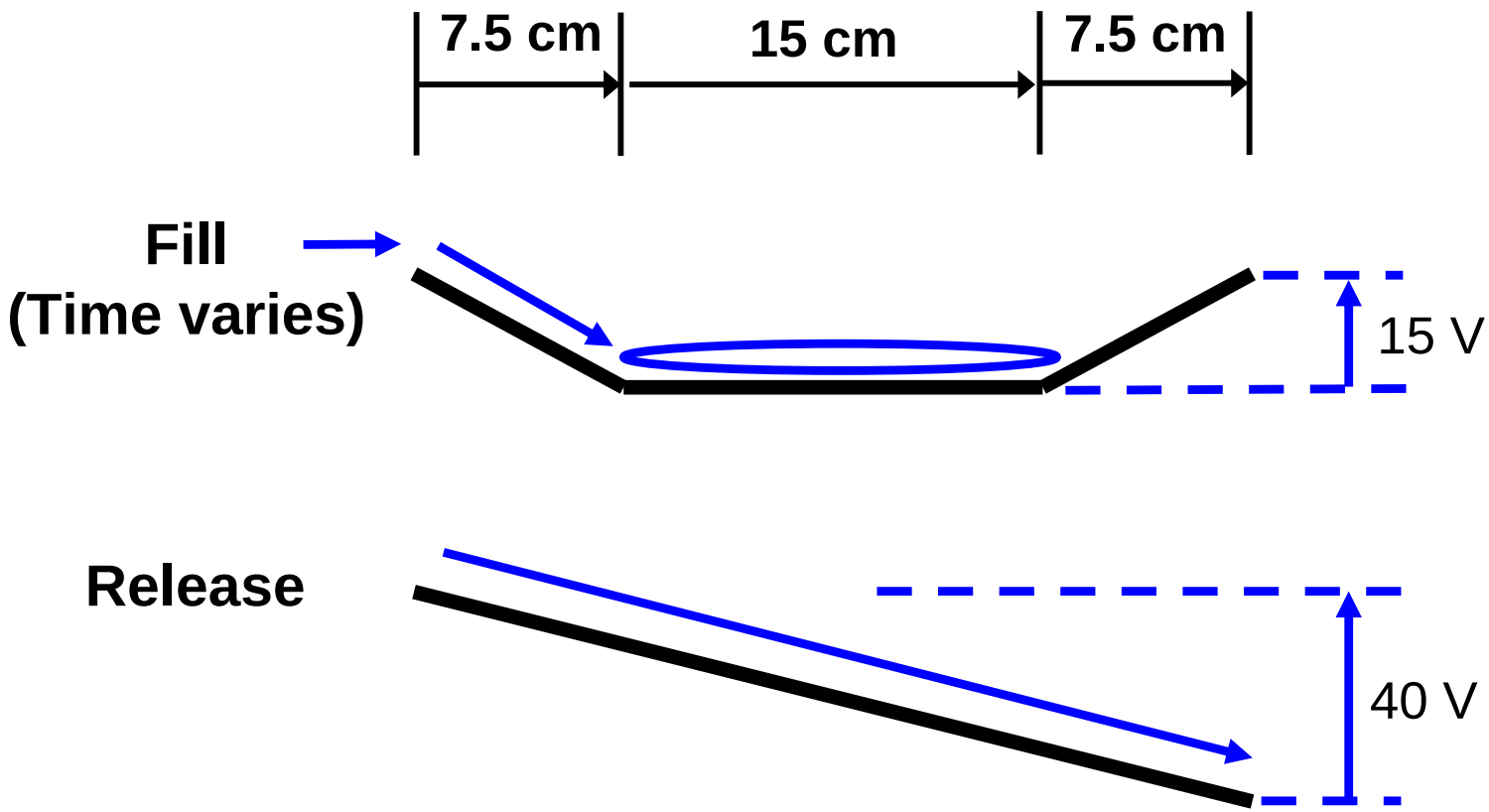


SLIM Used for the Charge Capacity Study

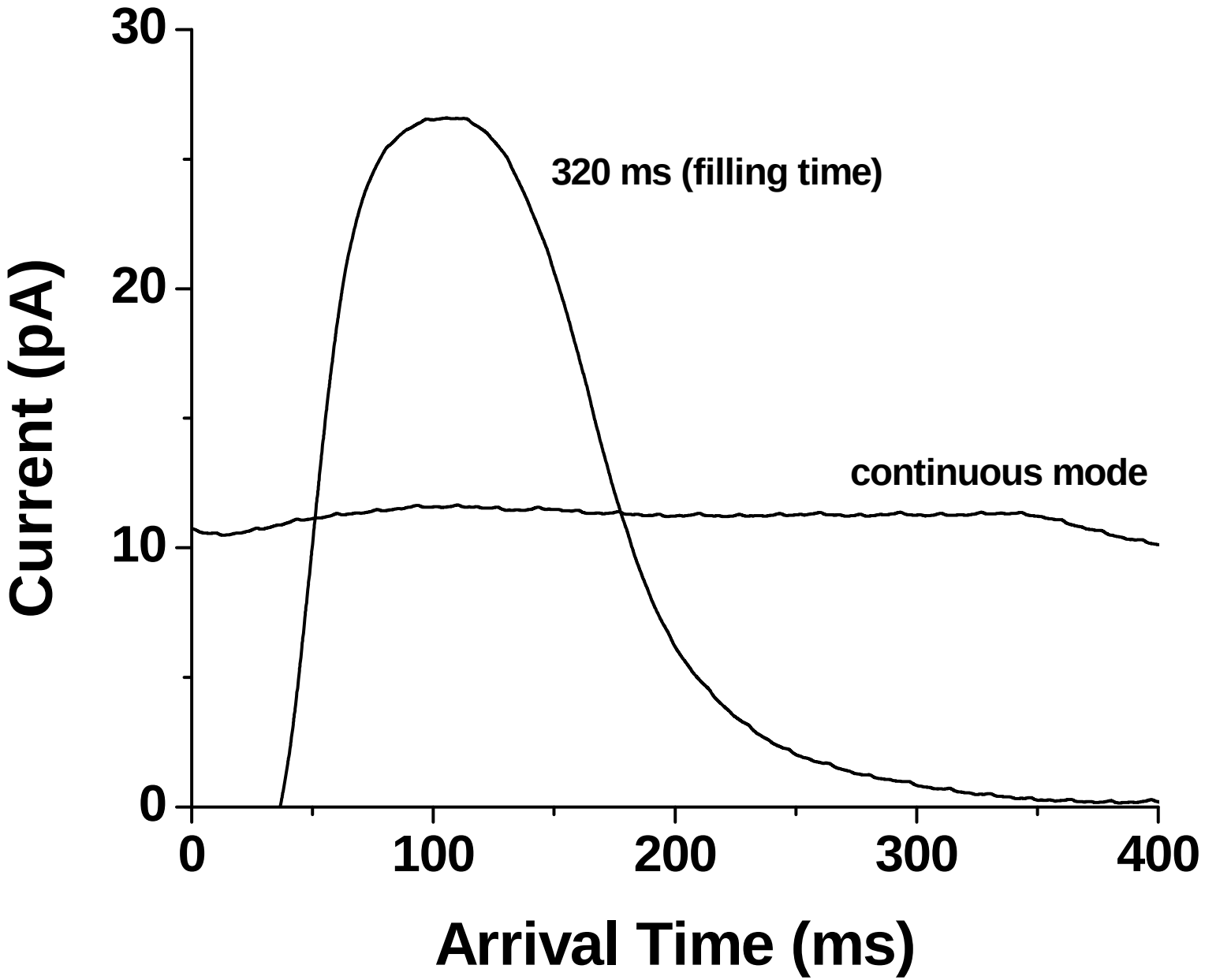




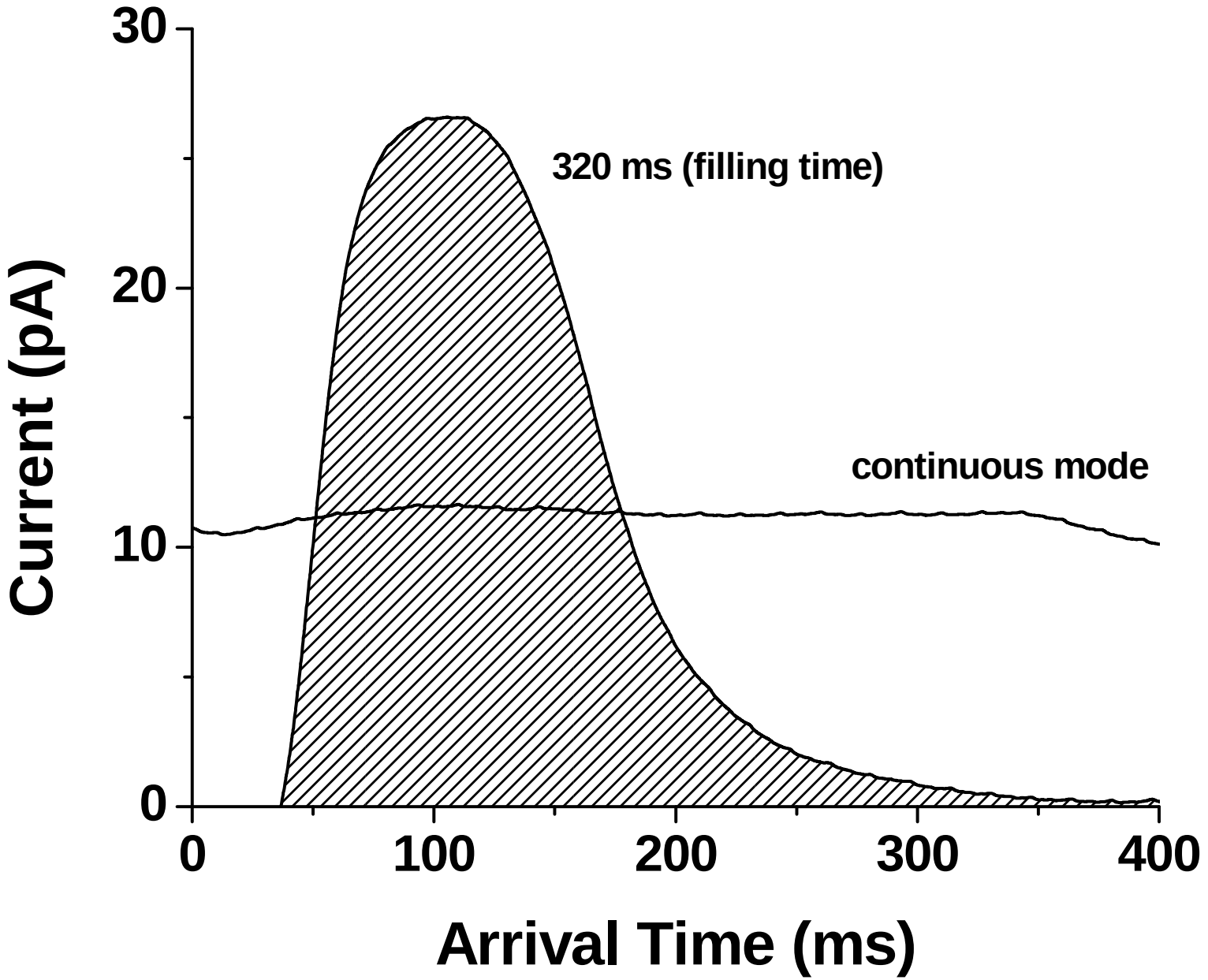
Charge Capacity (DC Gradient Arrangement)



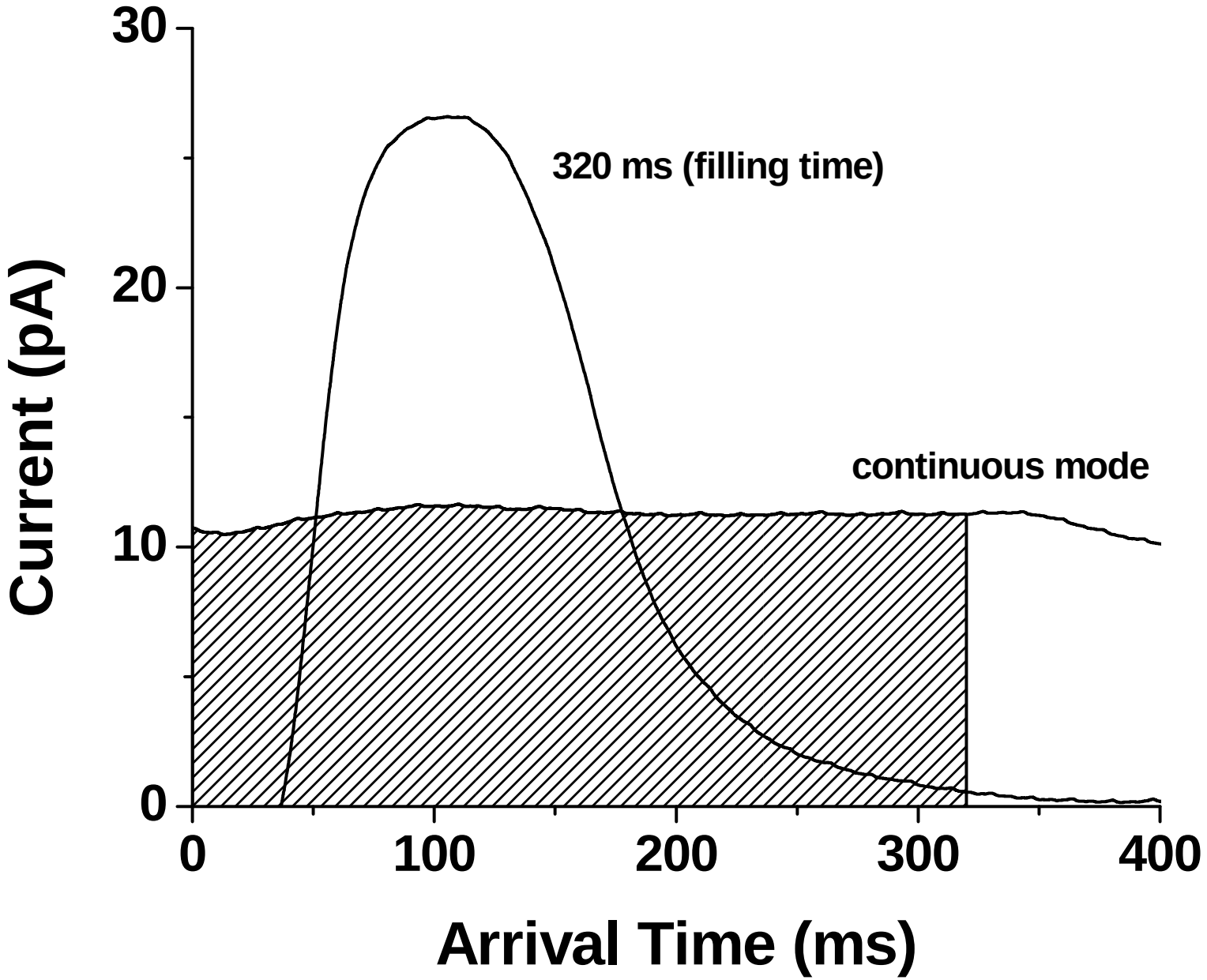
Charge Capacity (Current Measurements)



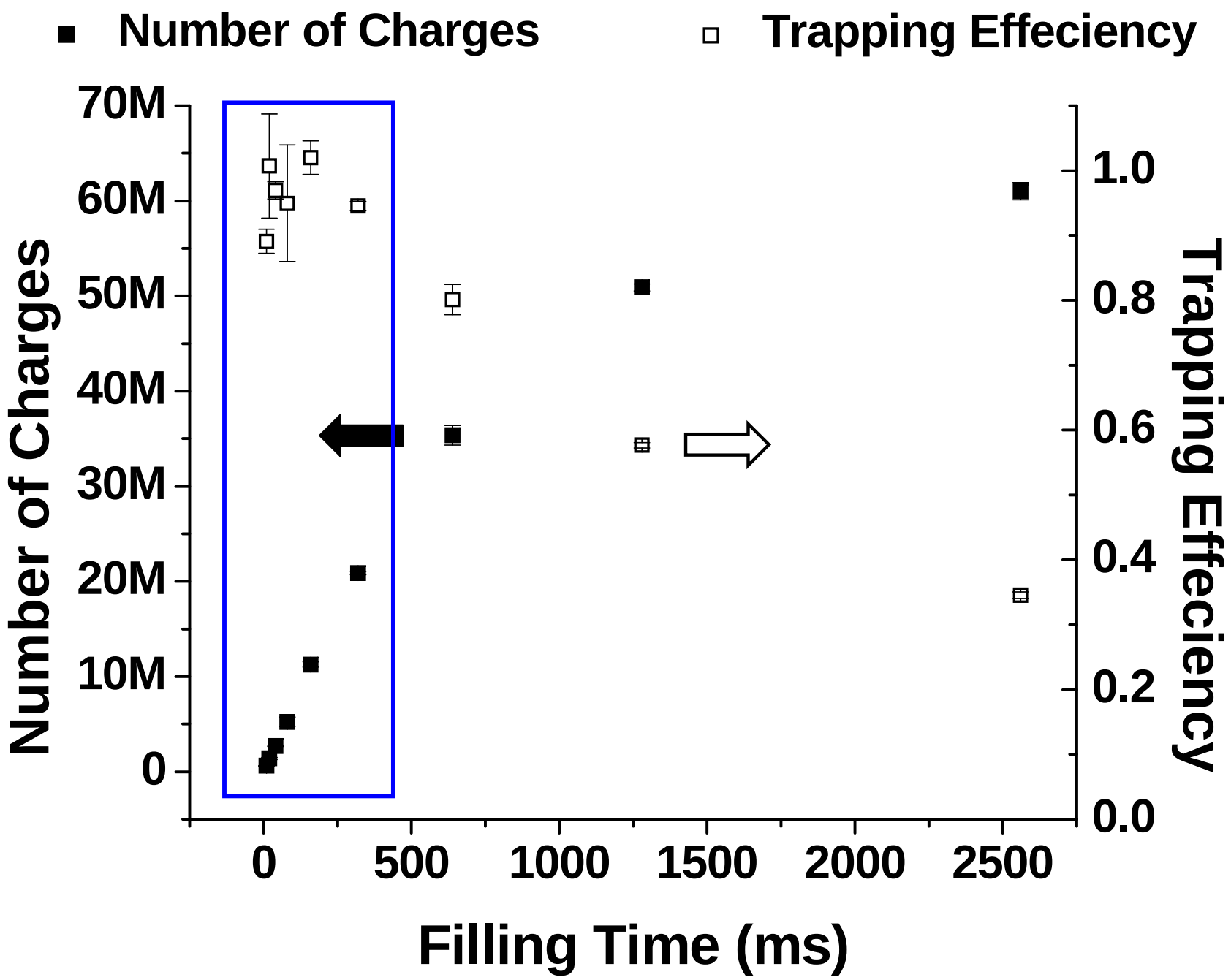
Charge Capacity Measurements



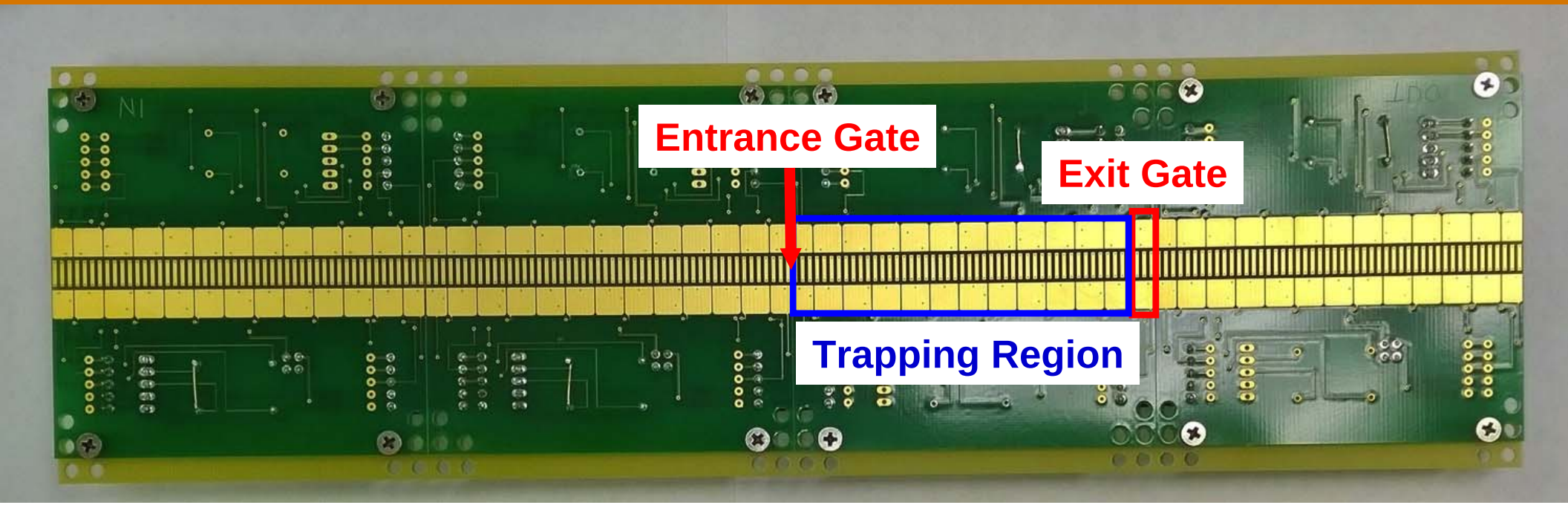
Charge Capacity Measurements

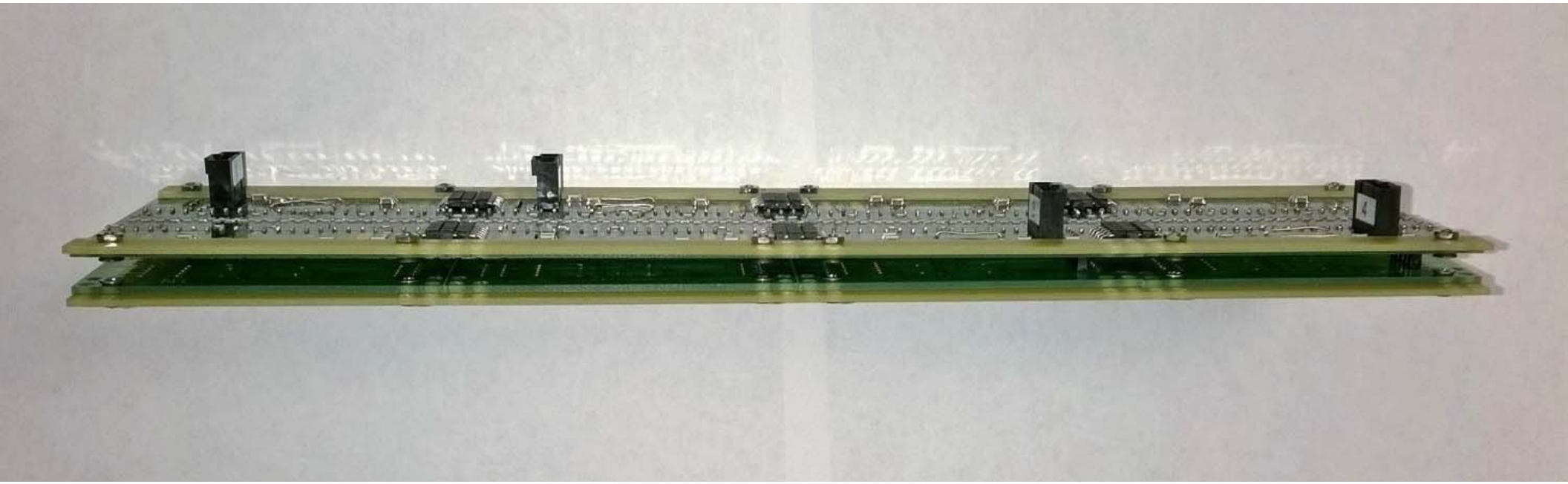


SLIM Charge Capacity

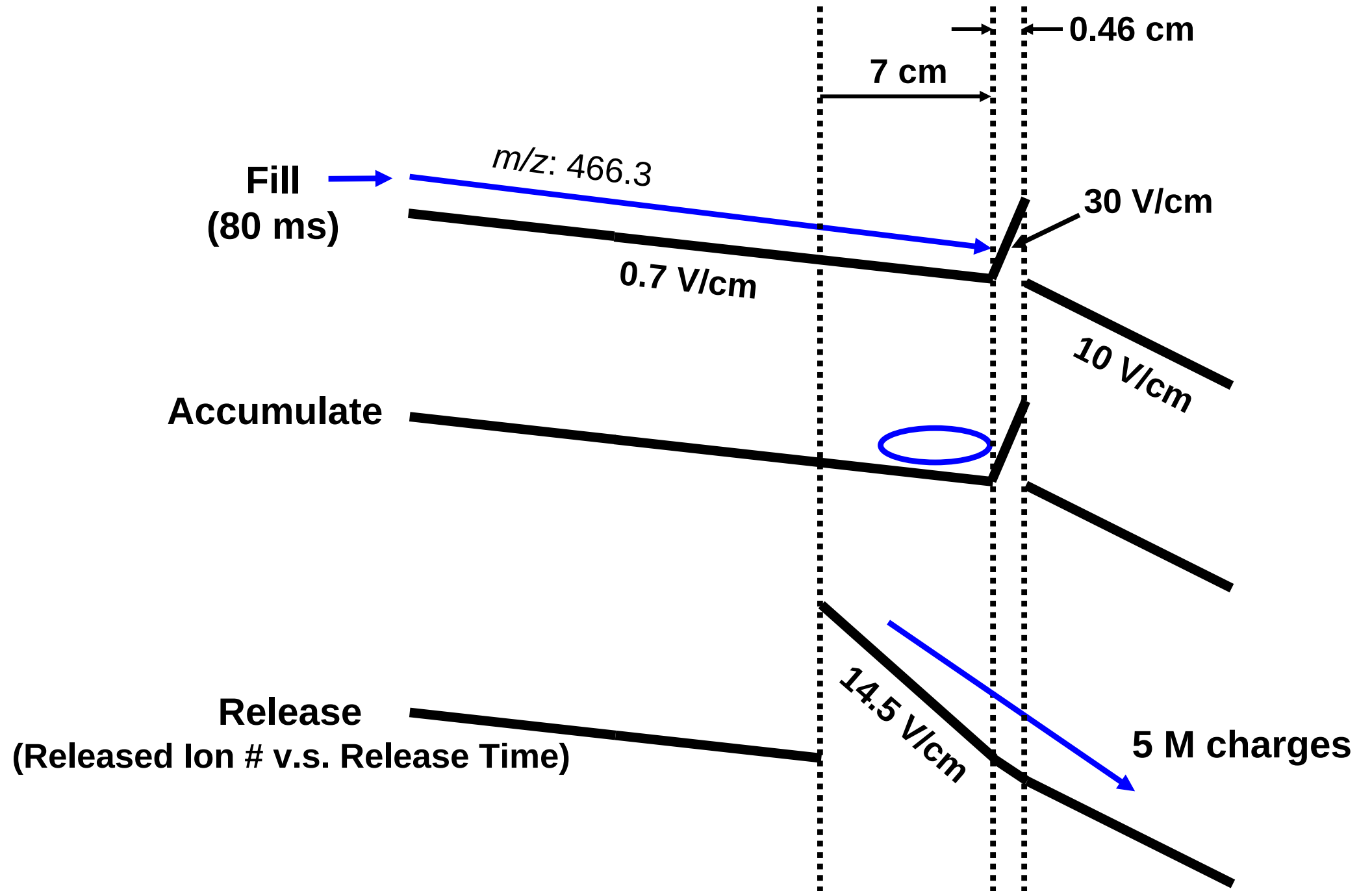


SLIM Used for the Release Time Study

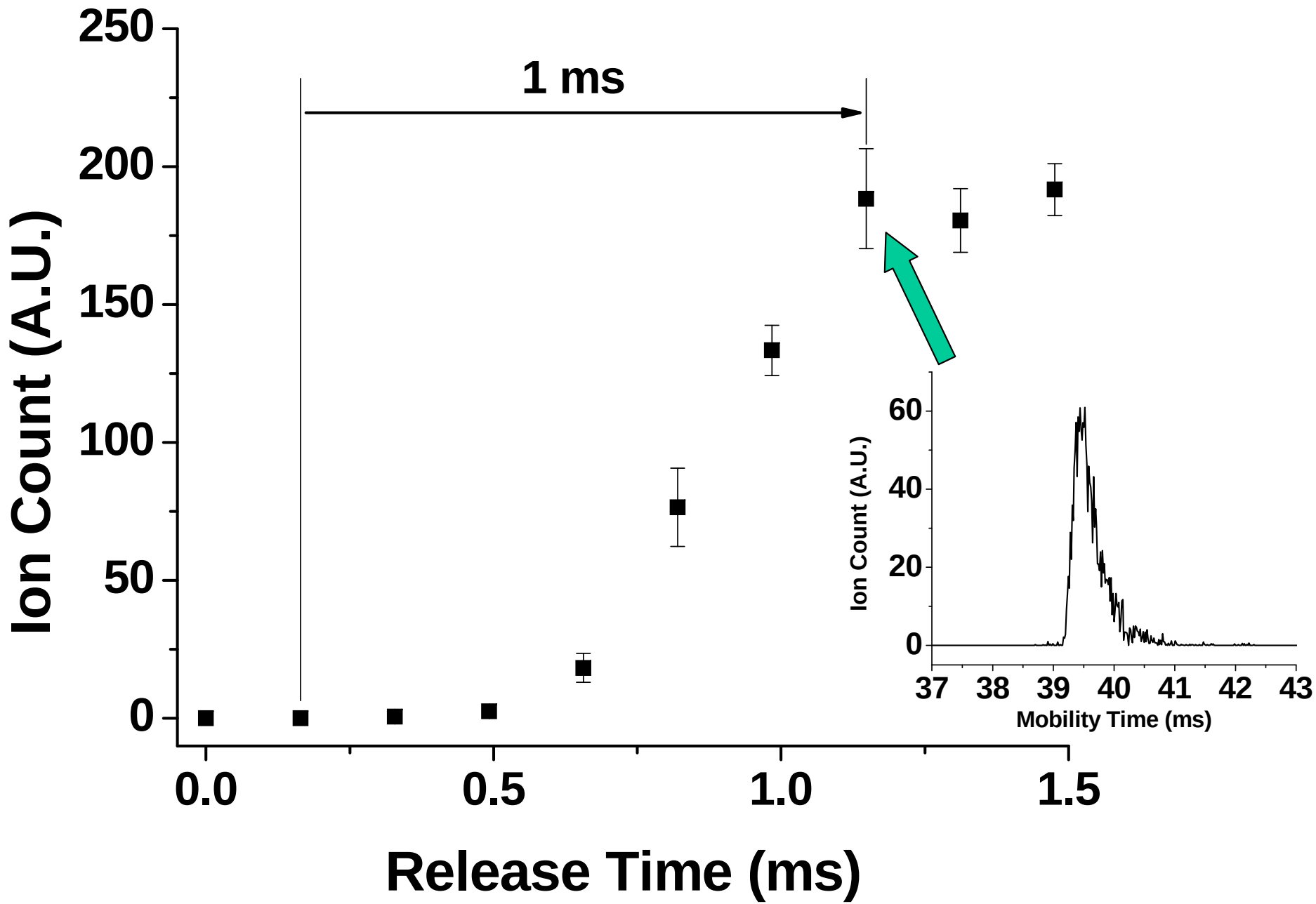




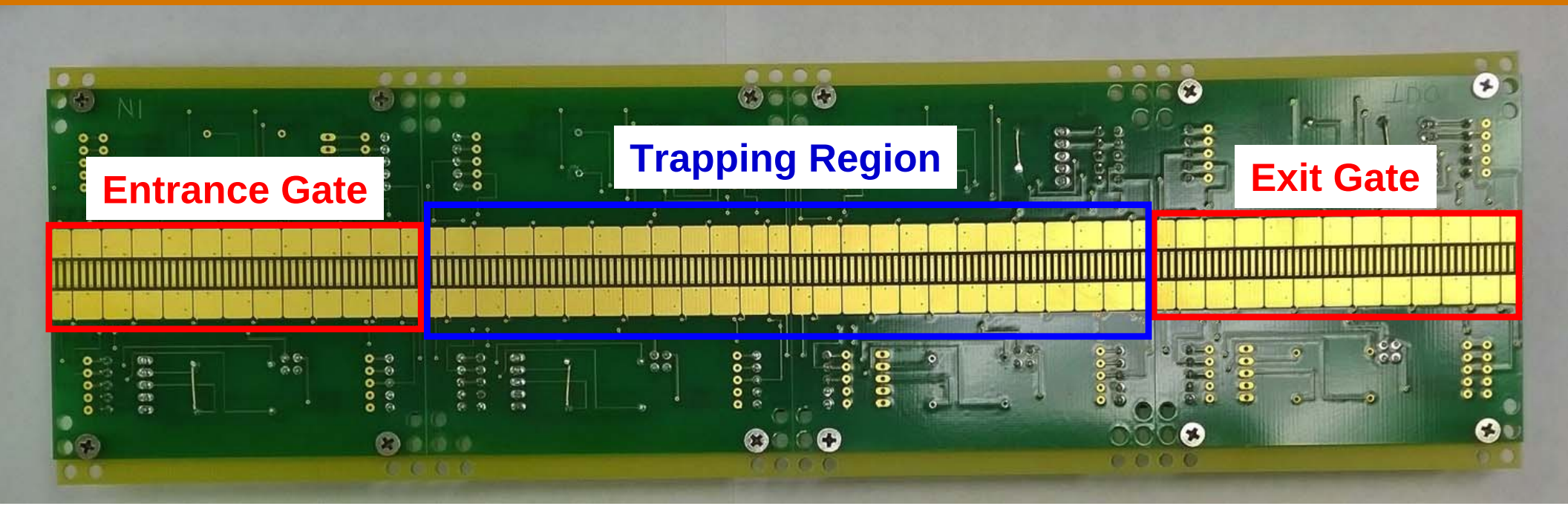
Release Time (DC Gradient Arrangement)

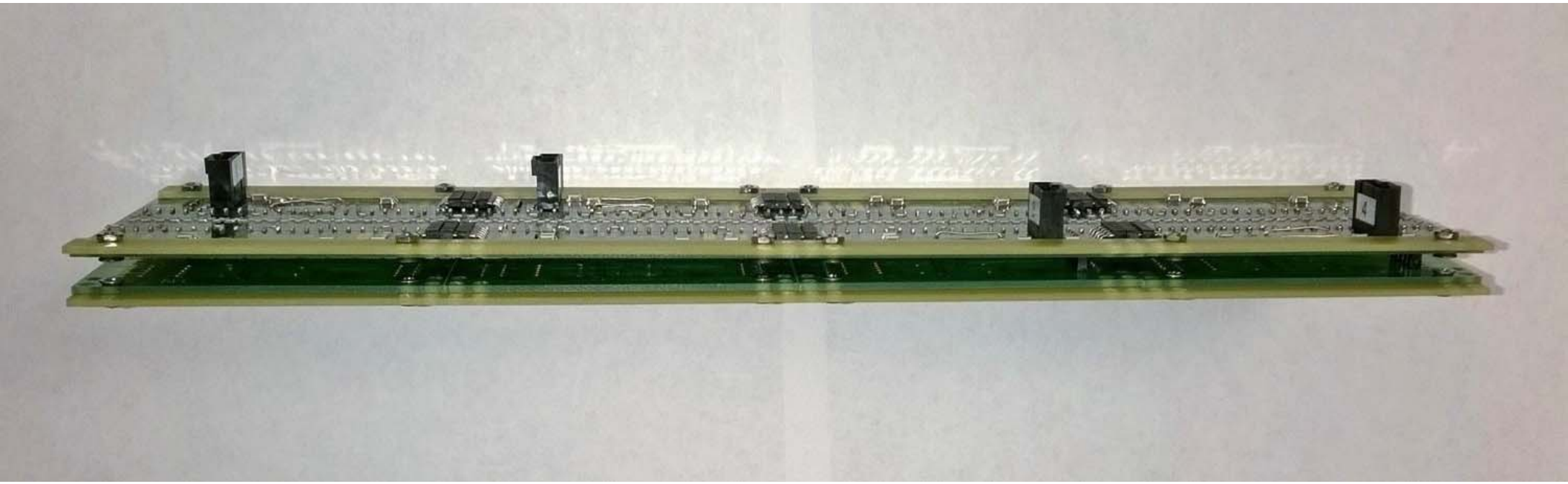


SLIM Release Time

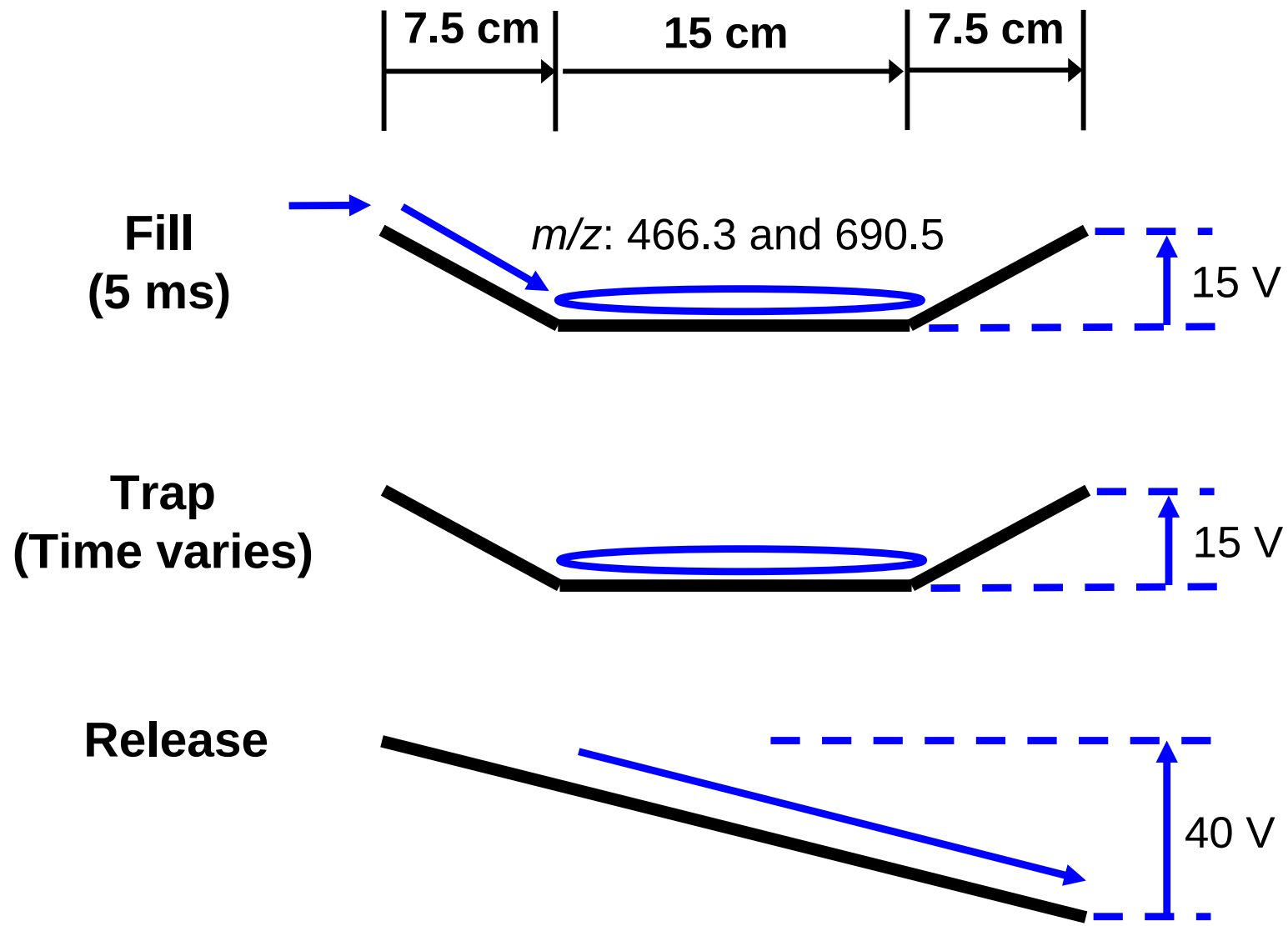


SLIM Used for the Storage Time Study





Storage Time (DC Gradient Arrangement)



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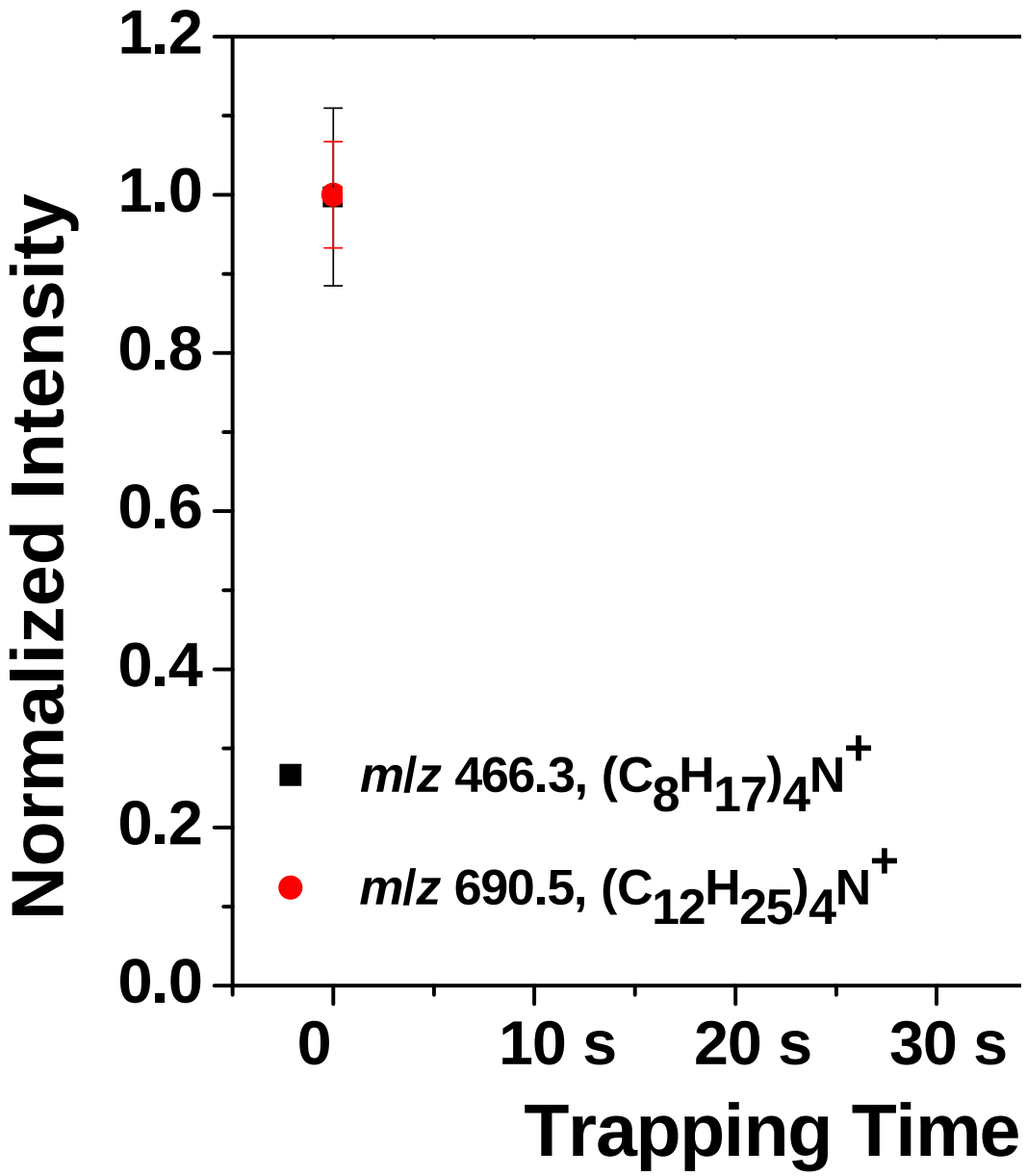
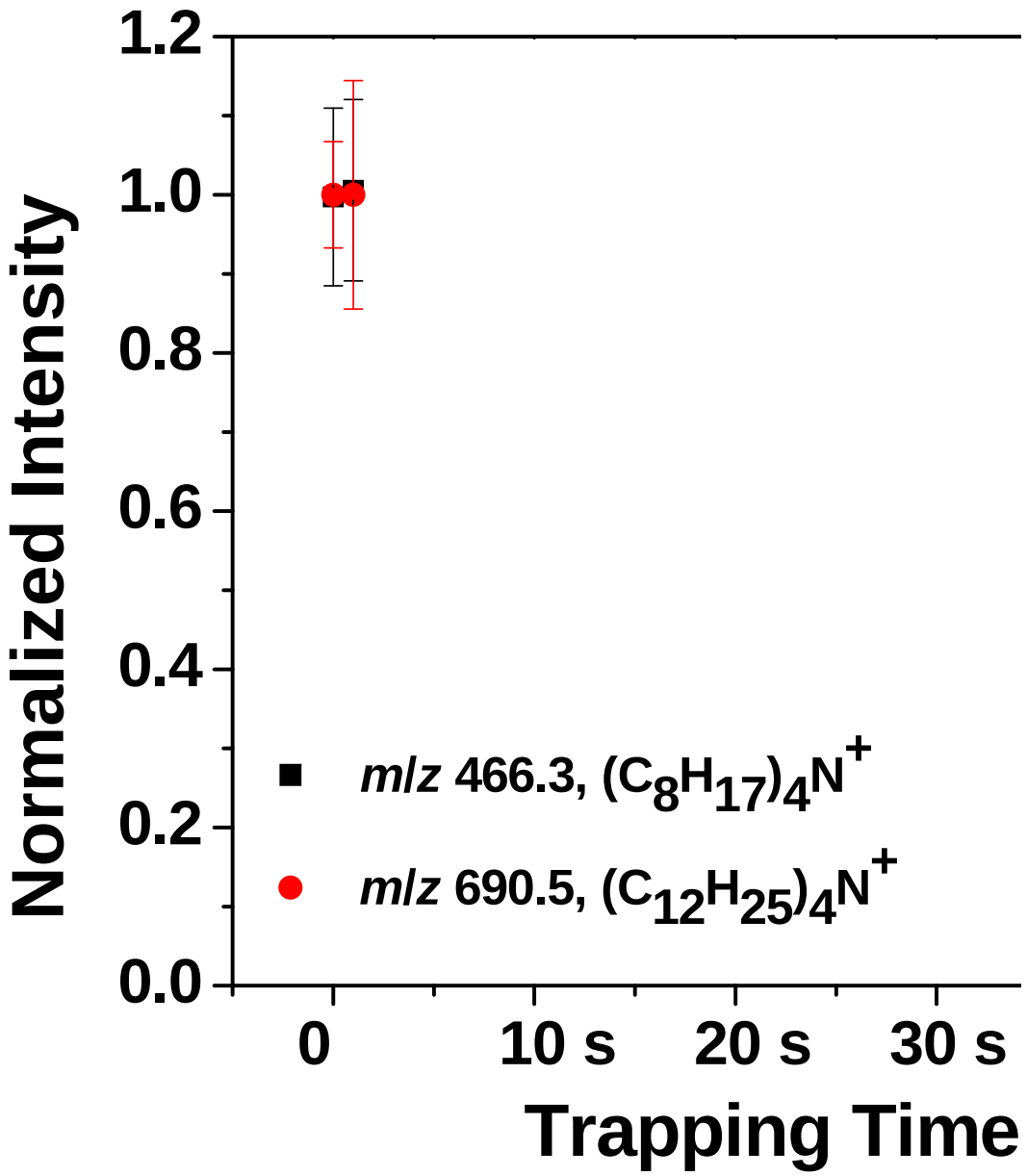
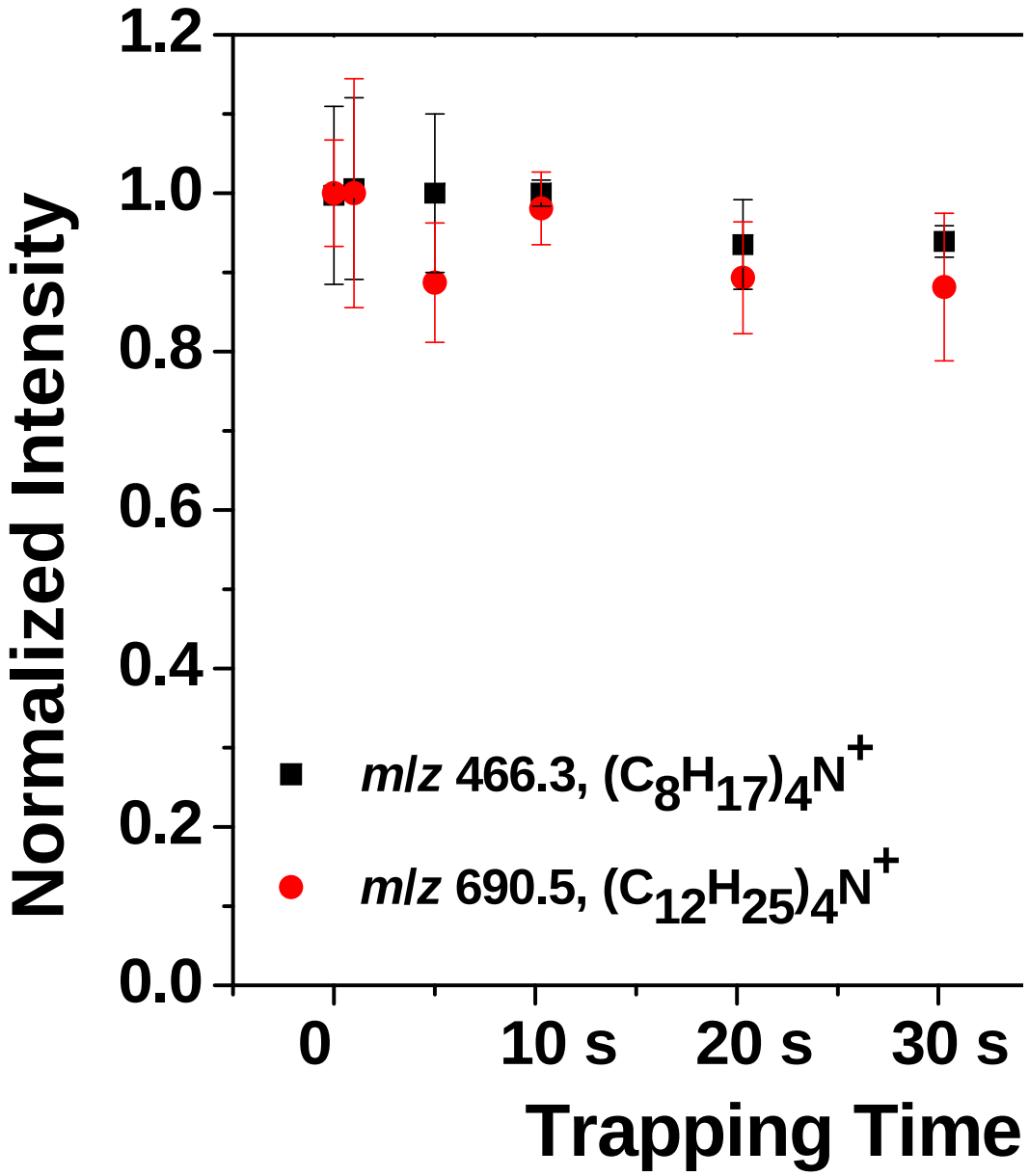


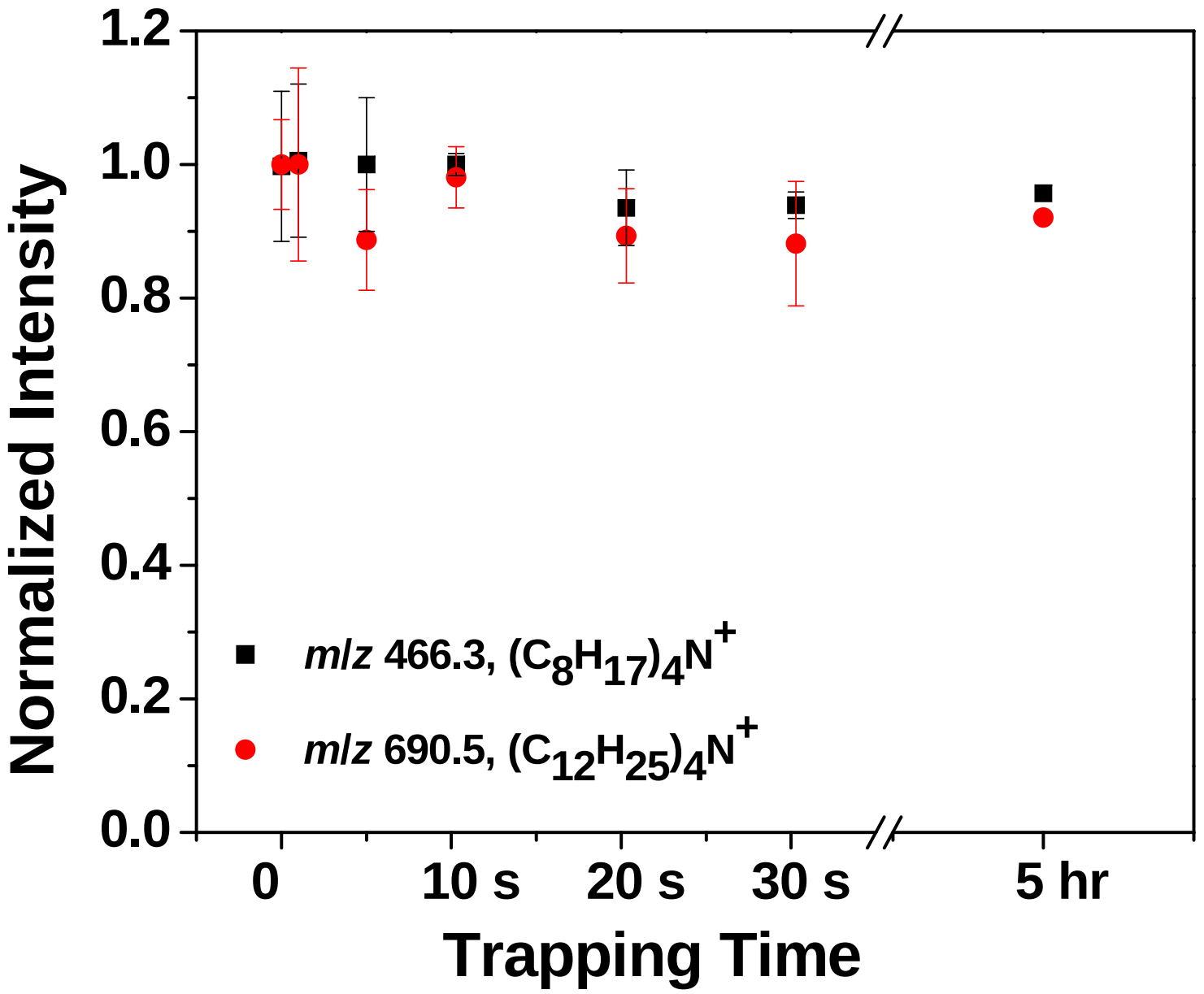
SLIM Storage Time



SLIM Storage Time

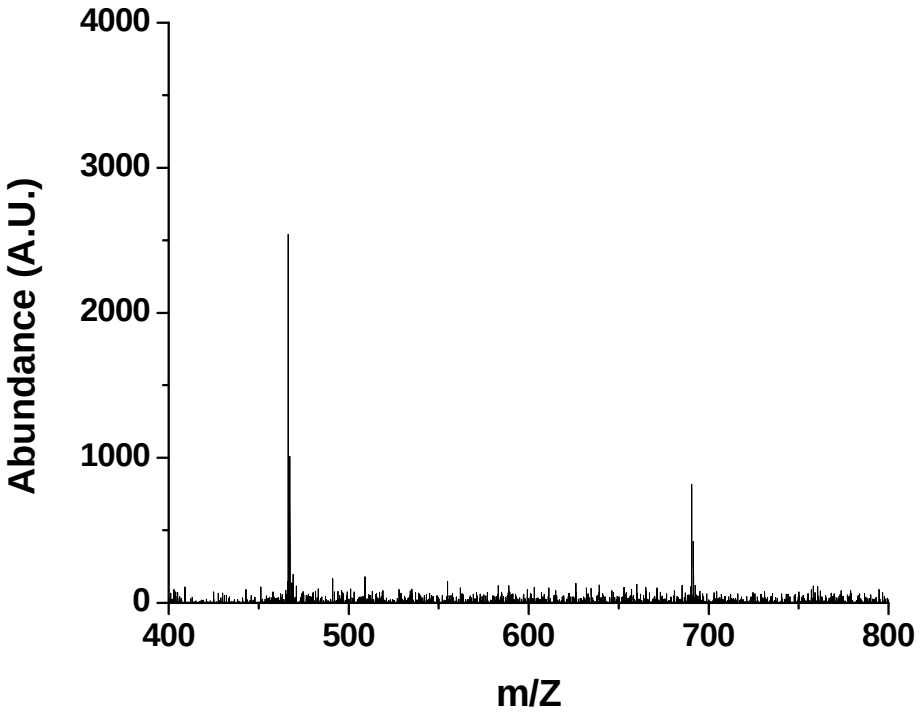


SLIM Storage Time

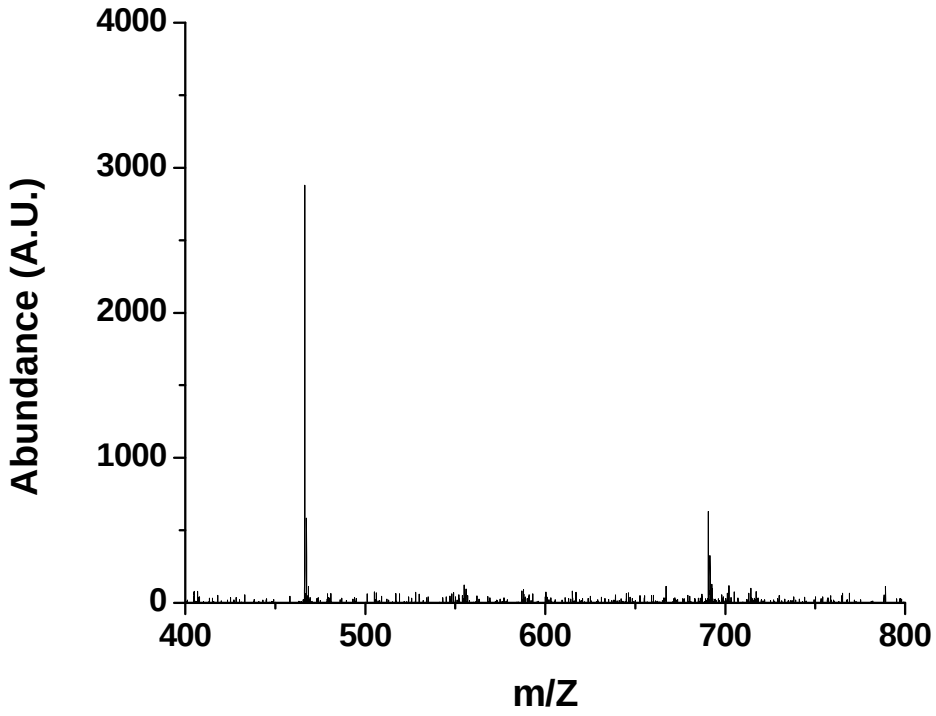


SLIM Storage Time

Trapping for 1 s



Trapping for 5 hours



Conclusions

Initial research has demonstrated:

- Effective pseudo potential wells in SLIM
- The construction and application of a number of SLIM arrangements
- Defined charge capacity of a SLIM trap
- Ion release from a SLIM trap
- Lossless ion trapping at Torr for hours in SLIM

Acknowledgements

NIH National Institute of General Medical Sciences
Biomedical Technology Research Resource

DOE Office of Biological and Environmental Research

PNNL Laboratory Directed R&D