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UNIVERSITÄT
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Vienna | Austria

Towards timing resolution in ion-solid interaction

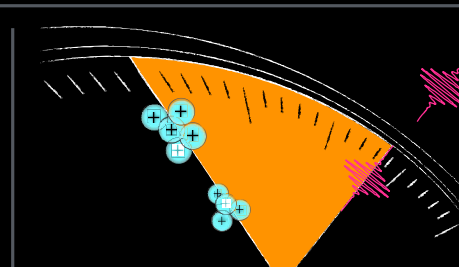
R.A. Wilhelm

TU Wien, Institute of Applied Physics

ANR
AGENCE
NATIONALE
DE LA
RECHERCHE

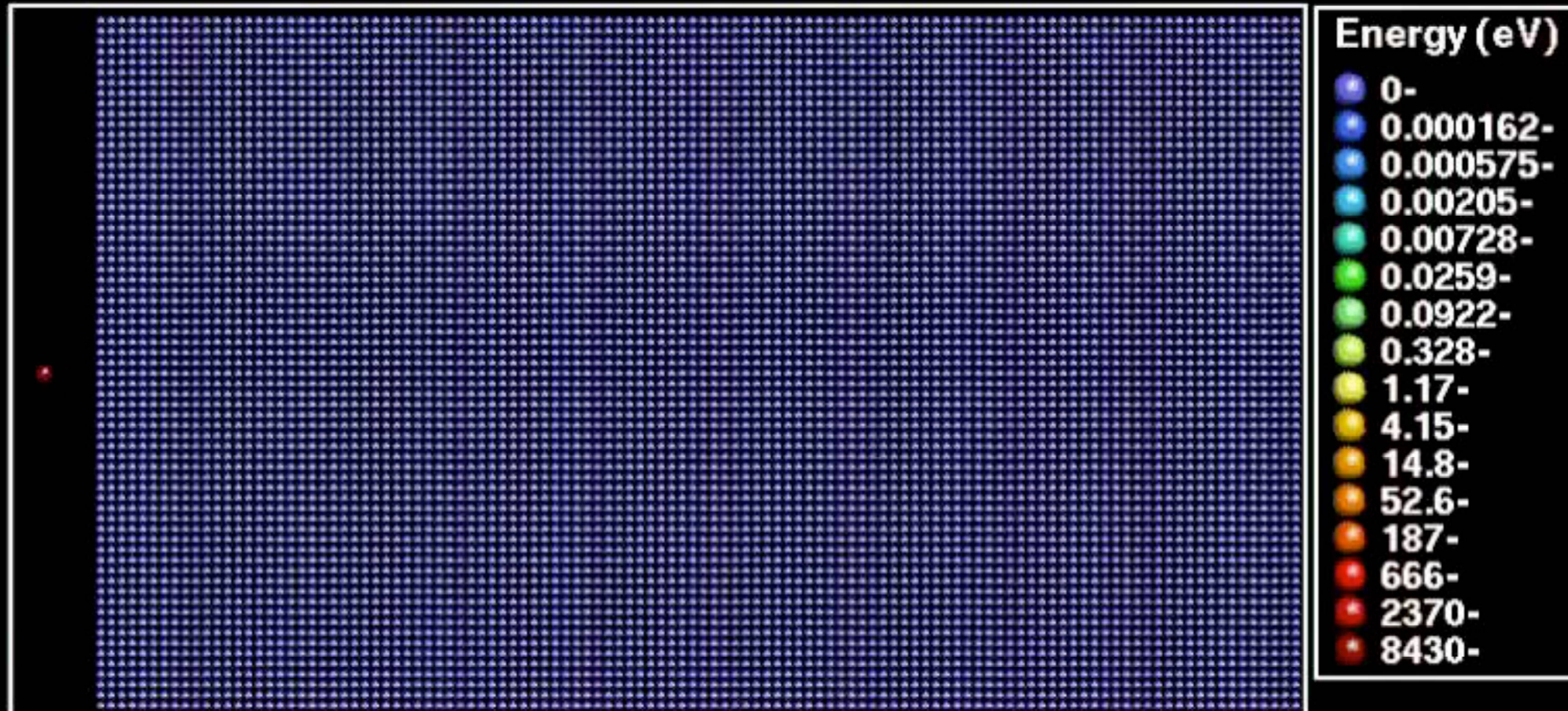
FWF

Der Wissenschaftsfonds.



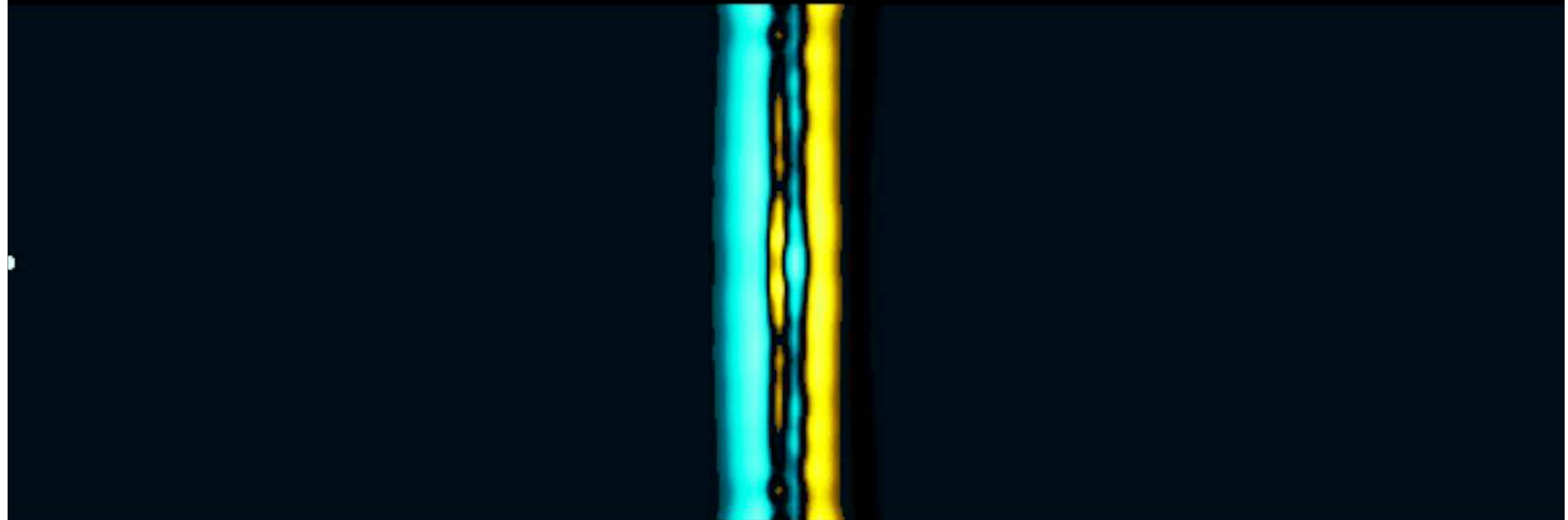
Maximum energy 30000.0 eV

time 0 ps



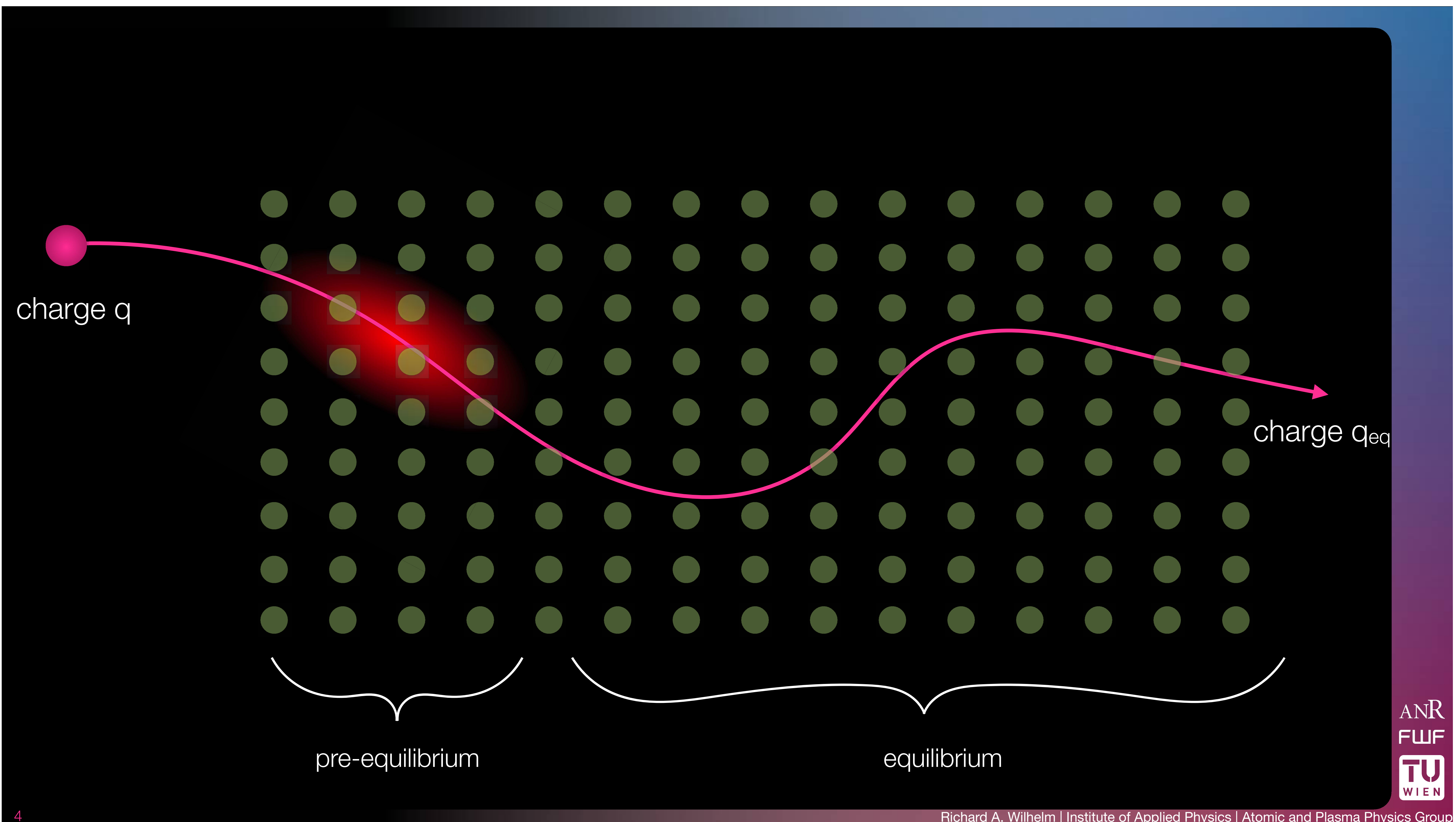
K. Nordlund, <http://www.acclab.helsinki.fi/~knordlun/anim.html>

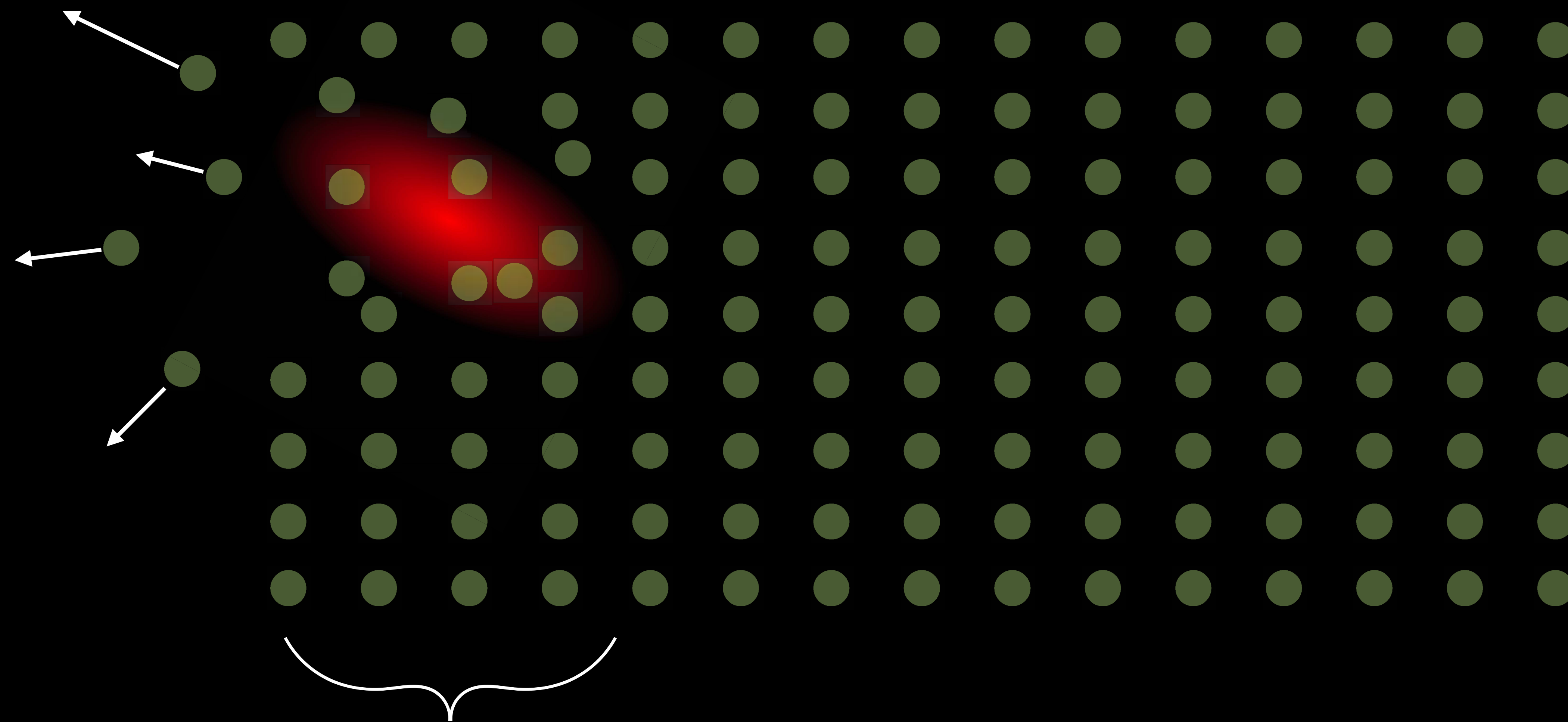
first 10fs



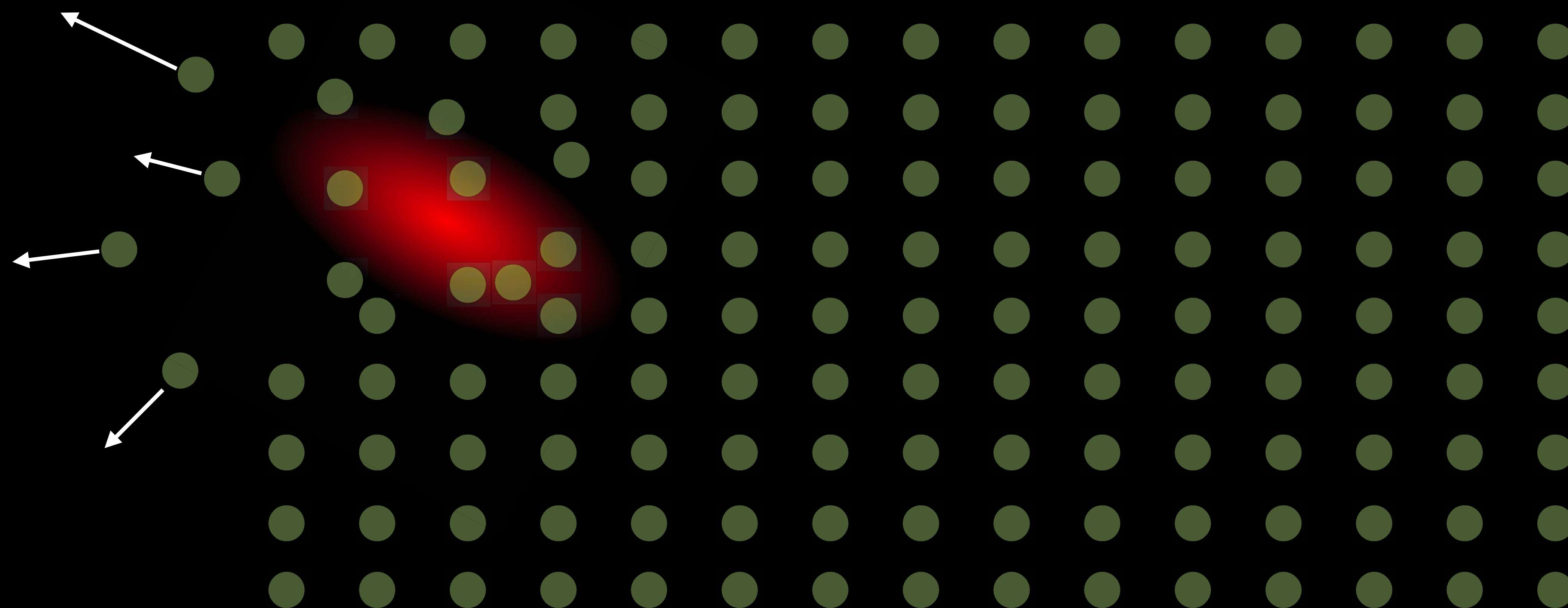
E. Gruber, R.A. Wilhelm et al., *Nat. Commun.* , 13948 (2016)

3



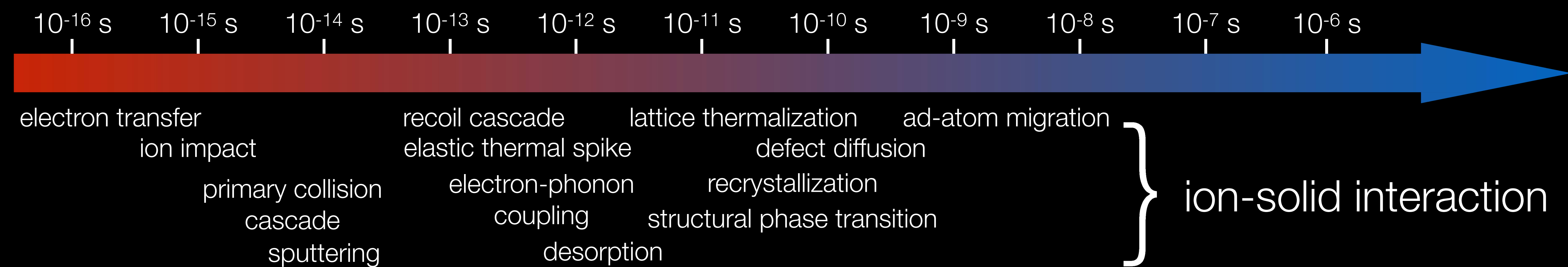


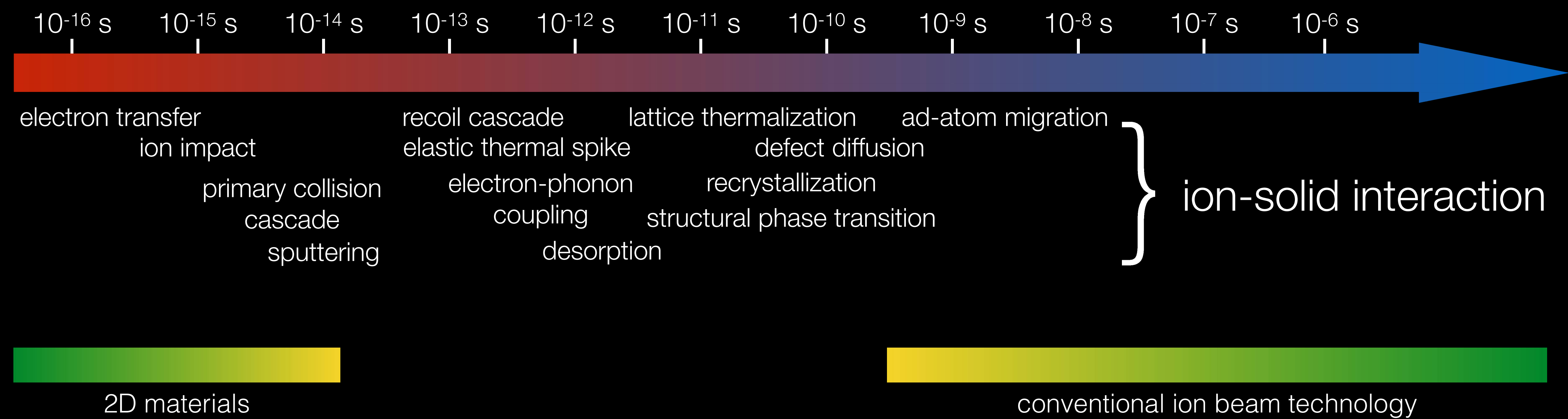
local melting / sublimation



local melting / sublimation

- | | |
|--|--------------|
| (1) Electronic excitation | 1 - 10 fs |
| (2) Lattice heating | 1 - 10ps |
| (3) Melting / Sublimation / Desorption | 10 - 100ps |
| (4) Nanostructures | ns - μ s |





charge exchange

electron / x-ray
emission

material modification

energy deposition

energy release

energy retention

time

Janine Schwestka -> RUAG Space

Matthias Werl -> active

Schwestka, J. et al. *NIM B* , 63 (2018)

Schwestka, J. et al. *J. Phys. Chem. Lett.* , 4805 (2019)

charge exchange

electron / x-ray
emission

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energy retention

Wilhelm, R. A. et al. *Phys. Rev. Lett.* , 153201 (2014)

Gruber, E. et al. *Nat. Commun.* , 13948 (2016)

Wilhelm, R. A. et al. *Phys. Rev. Lett.* , 103401 (2017)

Wilhelm, R. A. & Grande, P. L. *Commun. Phys.* , 89 (2019)

Creutzburg, S. et al. *Phys. Rev. B* , 045408 (2020)

Elisabeth Gruber -> Uni Innsbruck

Sascha Creutzburg -> to be finished

Anna Niggas -> active

Heller, R. et al. *Phys. Rev. Lett.* , 096102 (2008)

El-Said, A. S. et al. *Phys. Rev. Lett.* , 117602 (2012)

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Schwestka, J. et al. *ACS Nano* , 10536 (2020)

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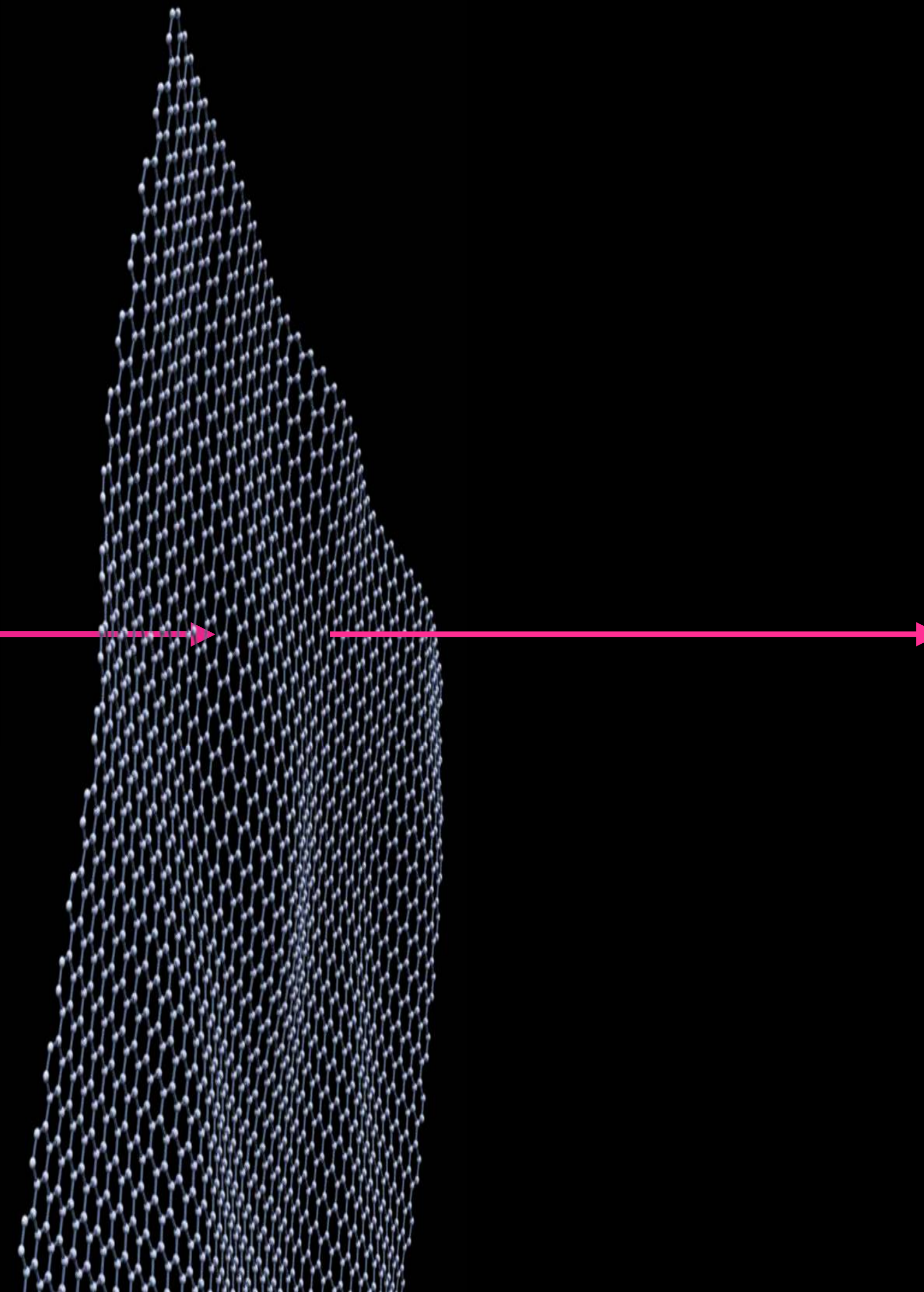
Heller, R. et al. *Phys. Rev. Lett.* , 096102 (2008)
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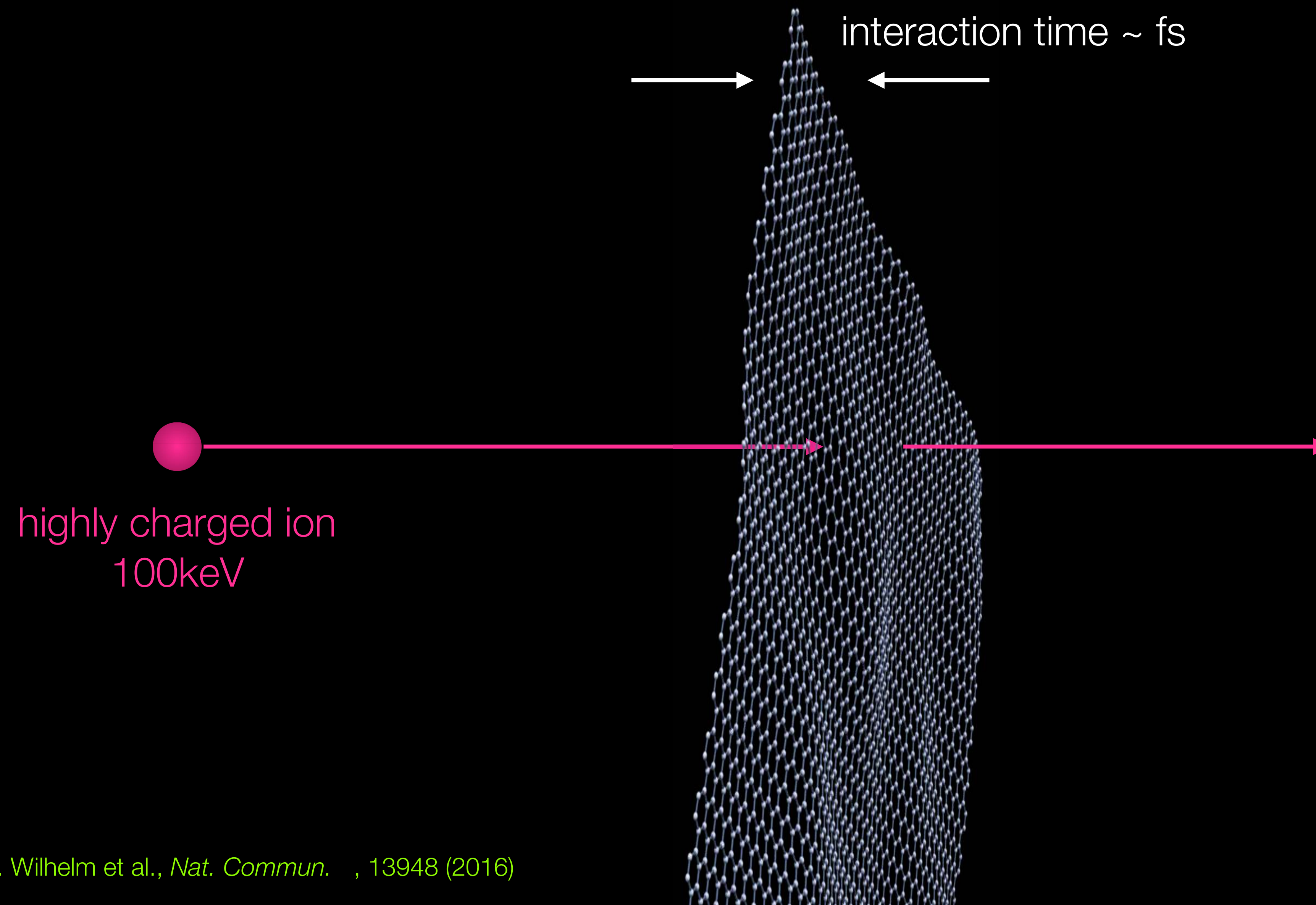


Experimental access to the fs-timescale

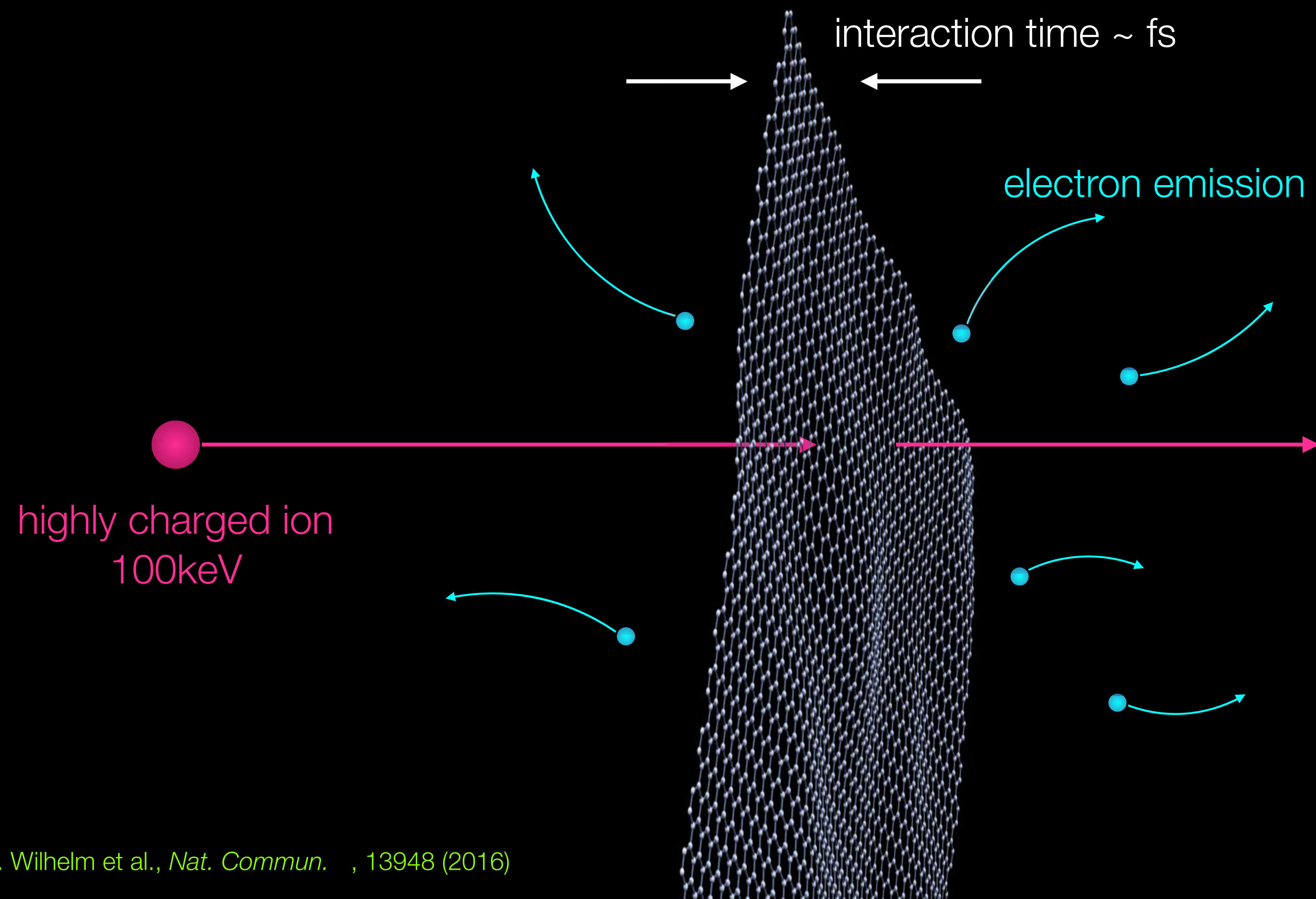
highly charged ion
100keV



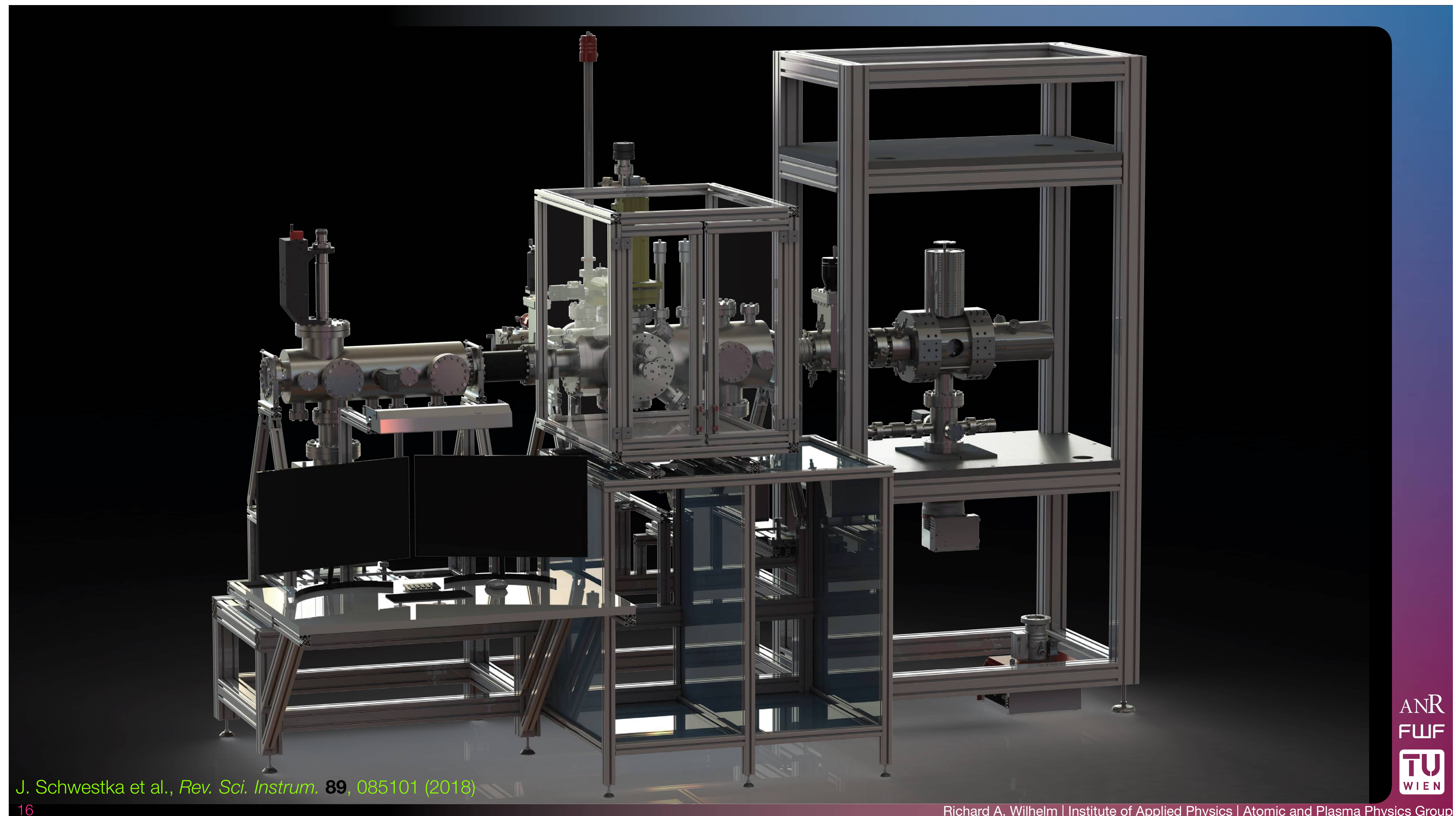
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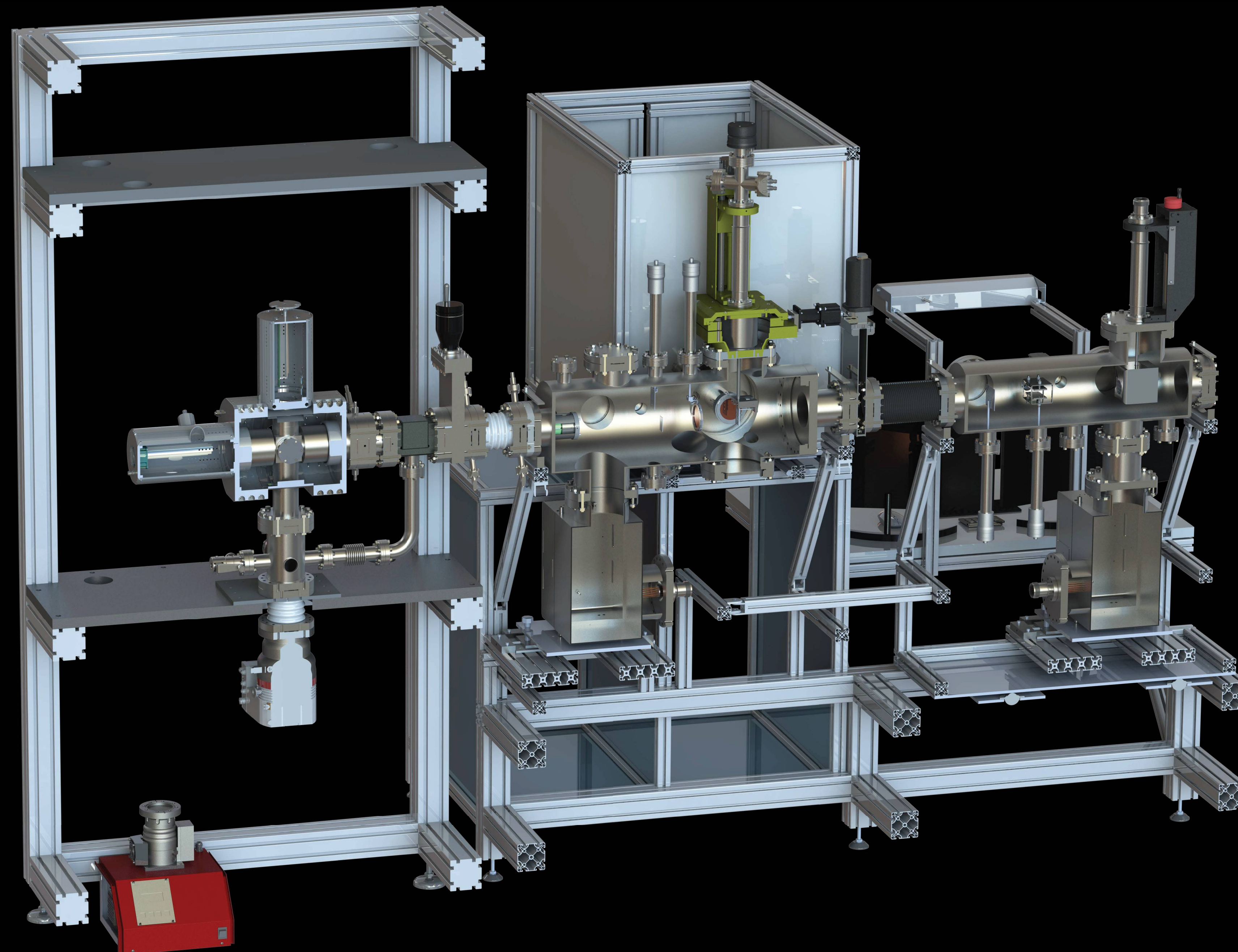
E. Gruber, R.A. Wilhelm et al., *Nat. Commun.* , 13948 (2016)



J. Schwestka et al., *Rev. Sci. Instrum.* **89**, 085101 (2018)

16

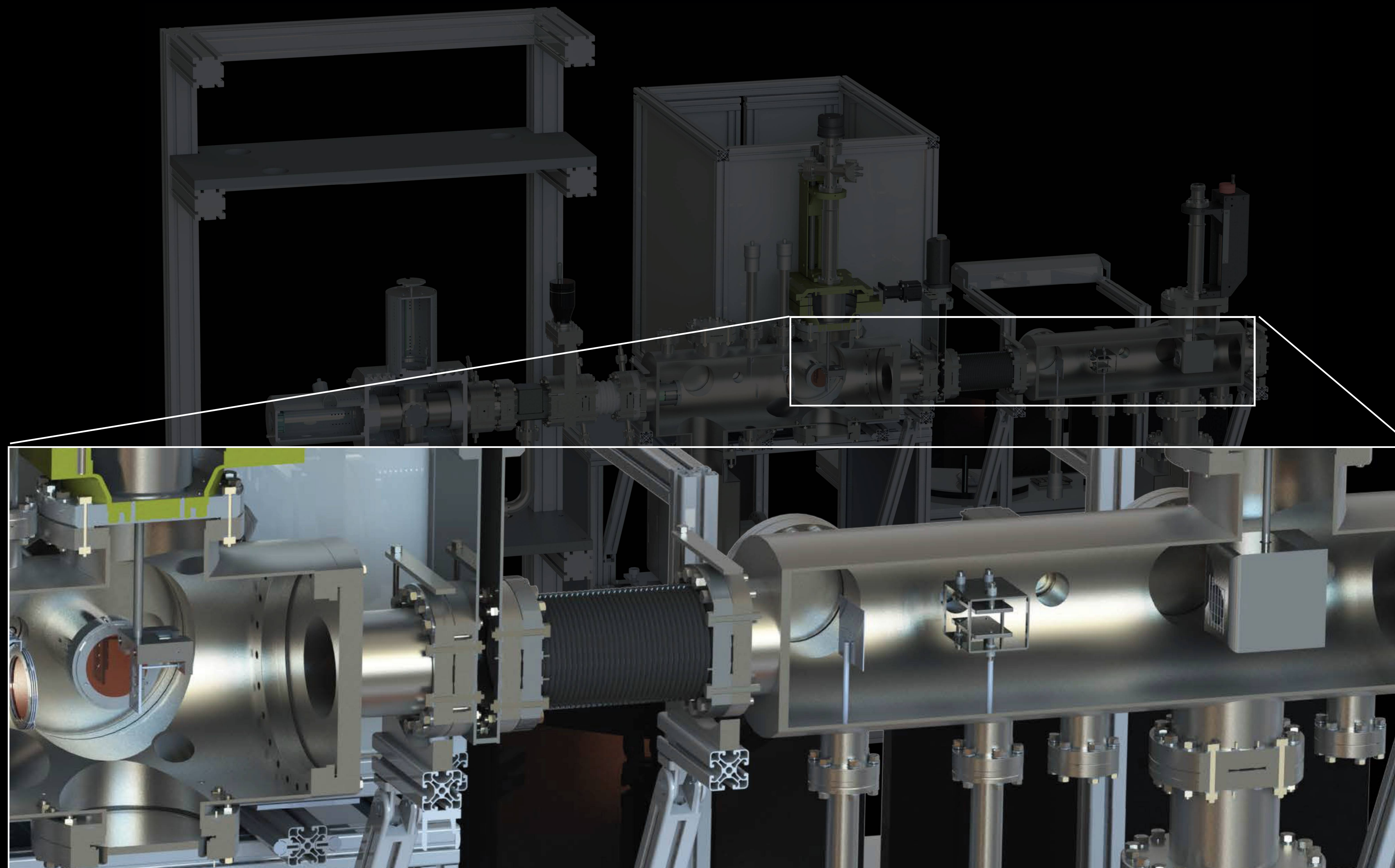
Richard A. Wilhelm | Institute of Applied Physics | Atomic and Plasma Physics Group



J. Schwestka et al., *Rev. Sci. Instrum.*, 085101 (2018)

17

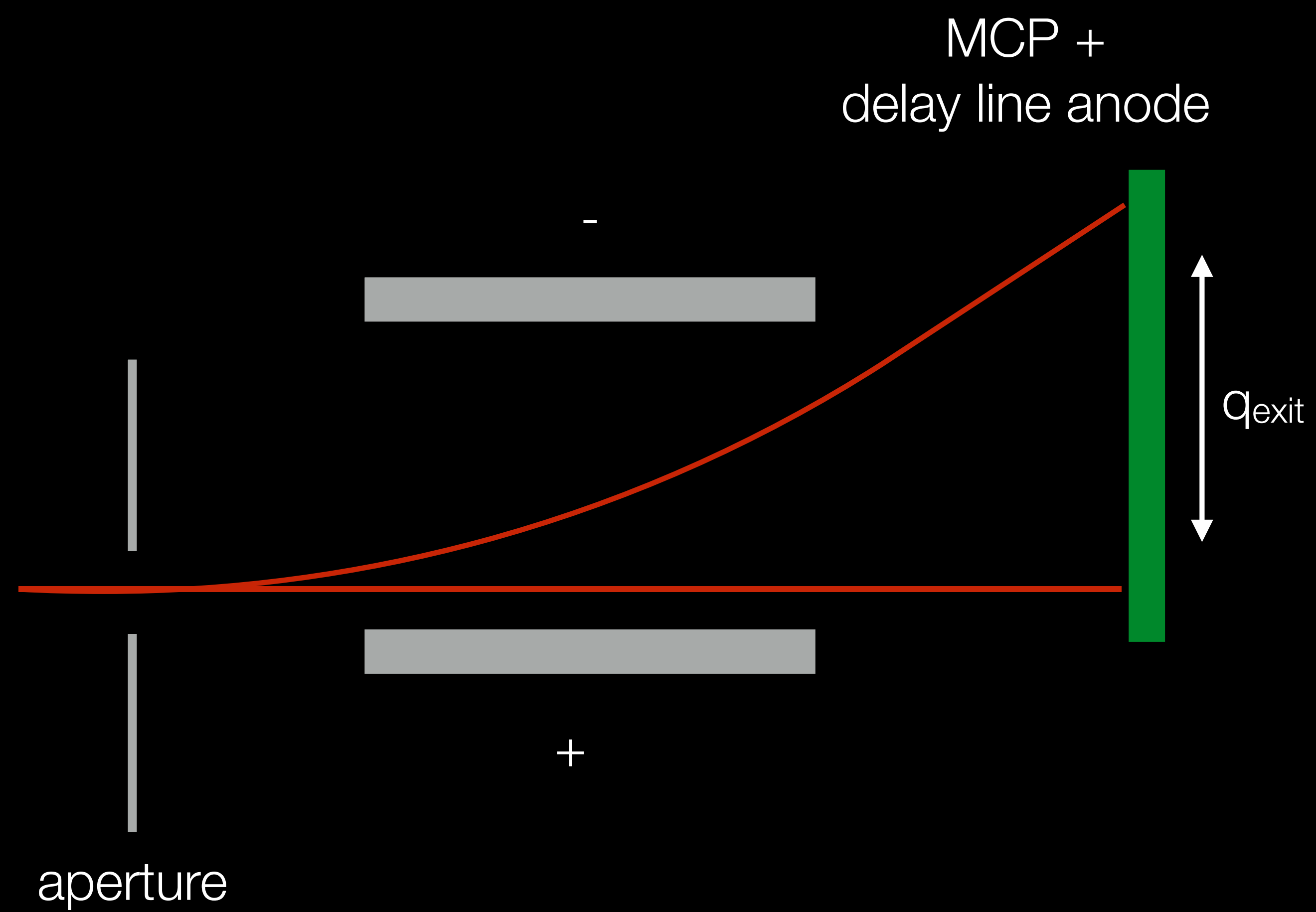
Richard A. Wilhelm | Institute of Applied Physics | Atomic and Plasma Physics Group

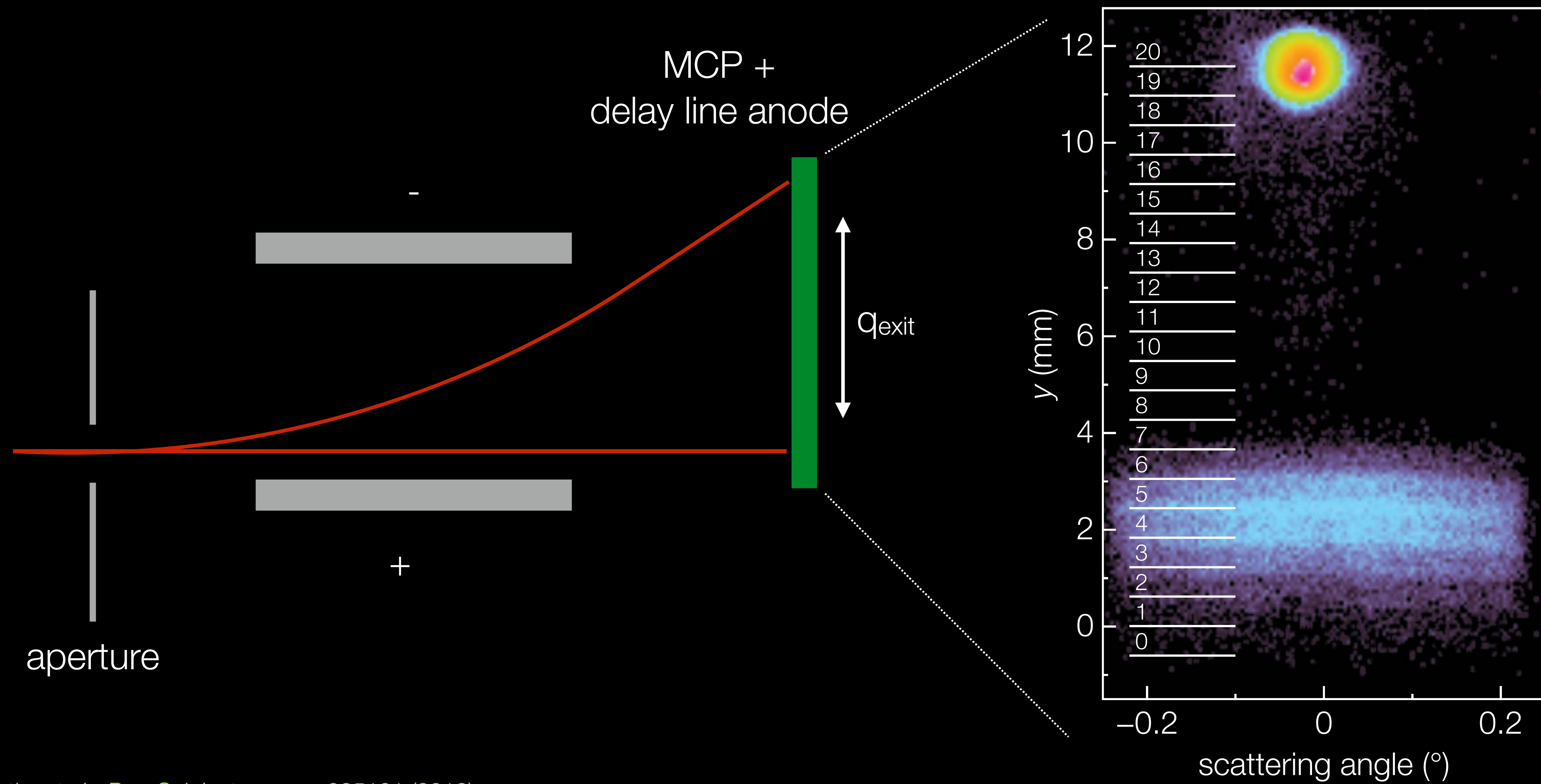


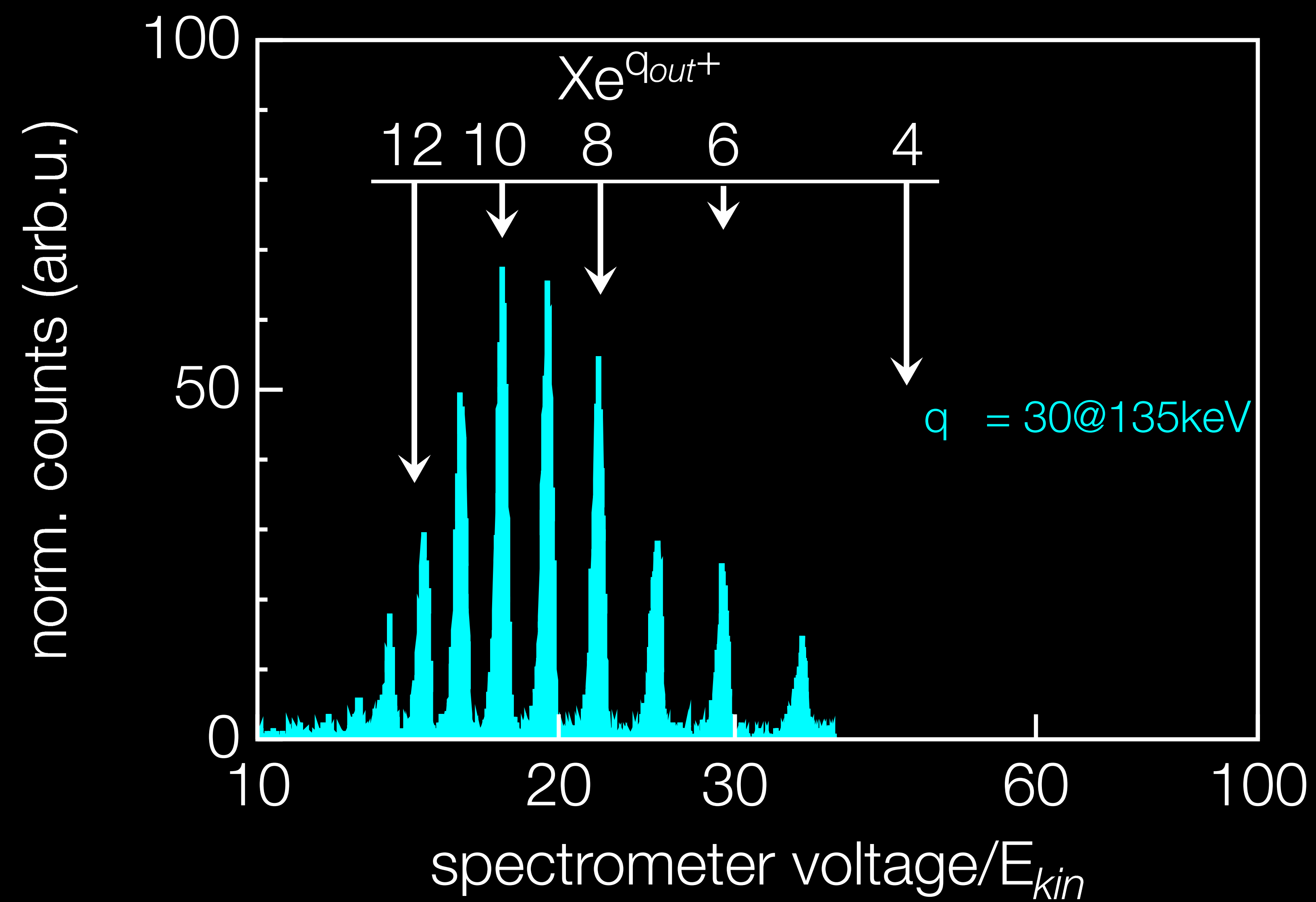
J. Schwestka et al., *Rev. Sci. Instrum.*, 085101 (2018)

18

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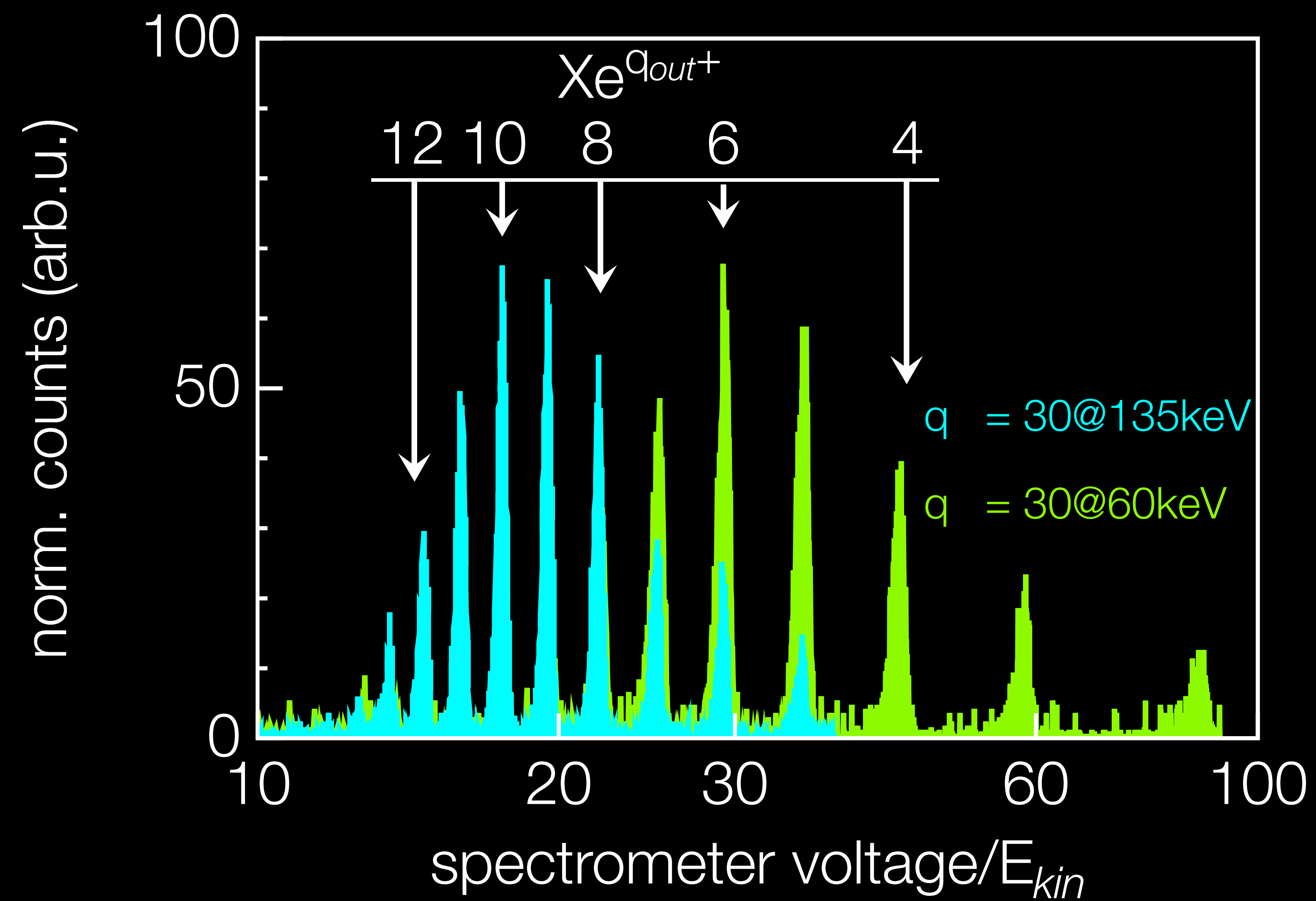


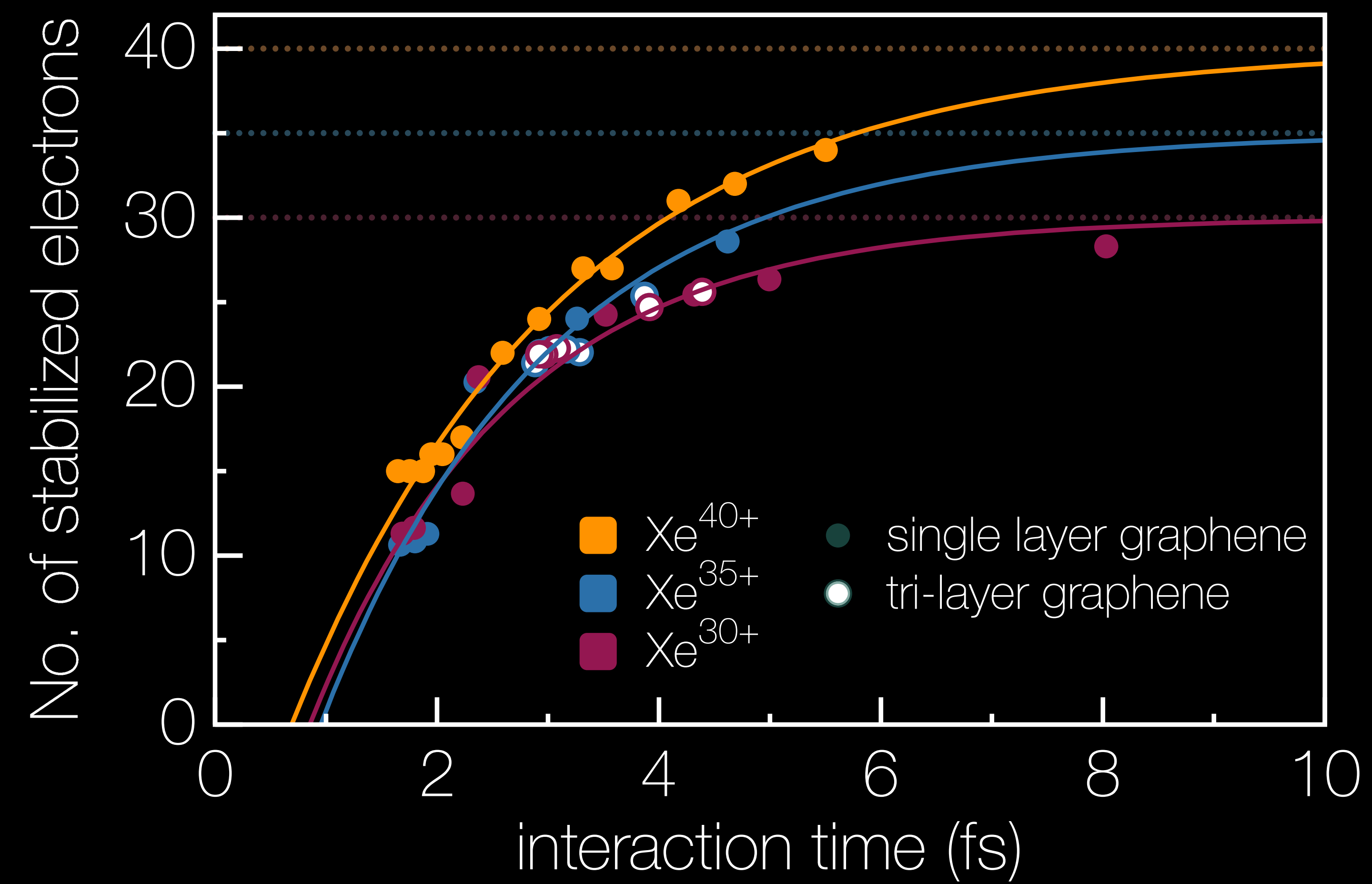


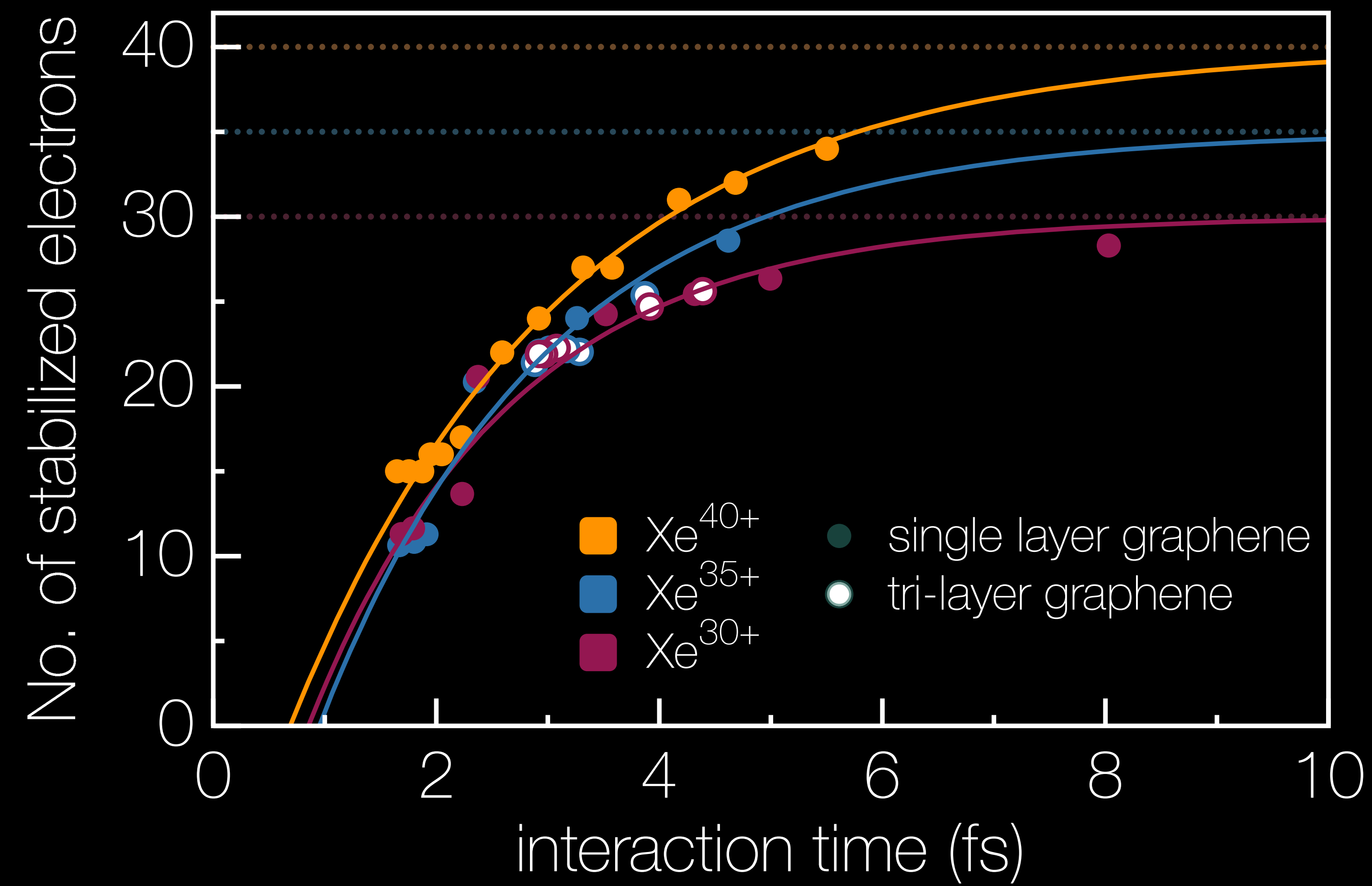
E. Gruber *et al.*, *Nat. Commun.*, 13948 (2016)

21

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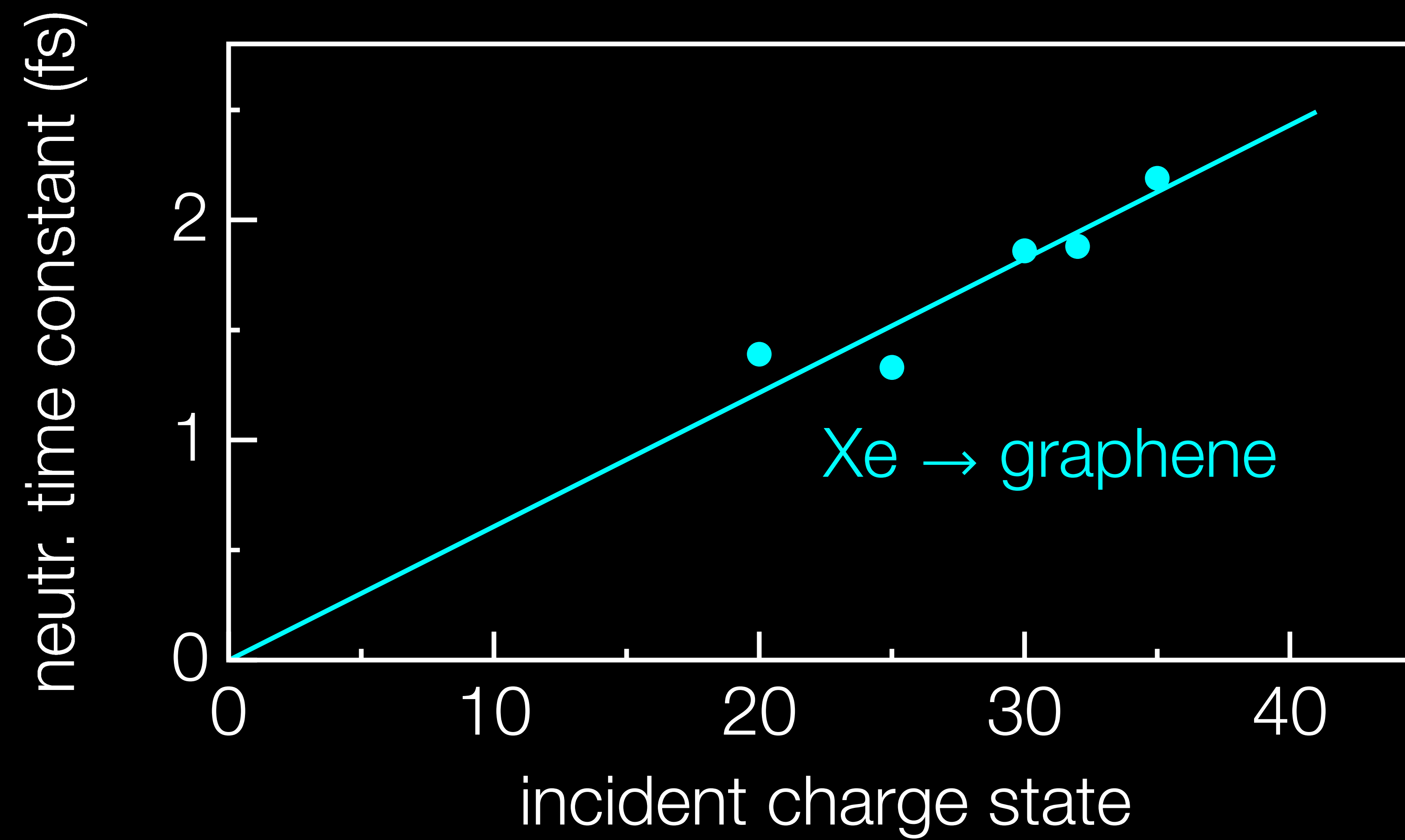






$$\bar{N}_{stab} = q_{in} - \bar{q}_{out} = q_{in} \left(1 - e^{\frac{-t}{\tau(q_{in})}} \right)$$

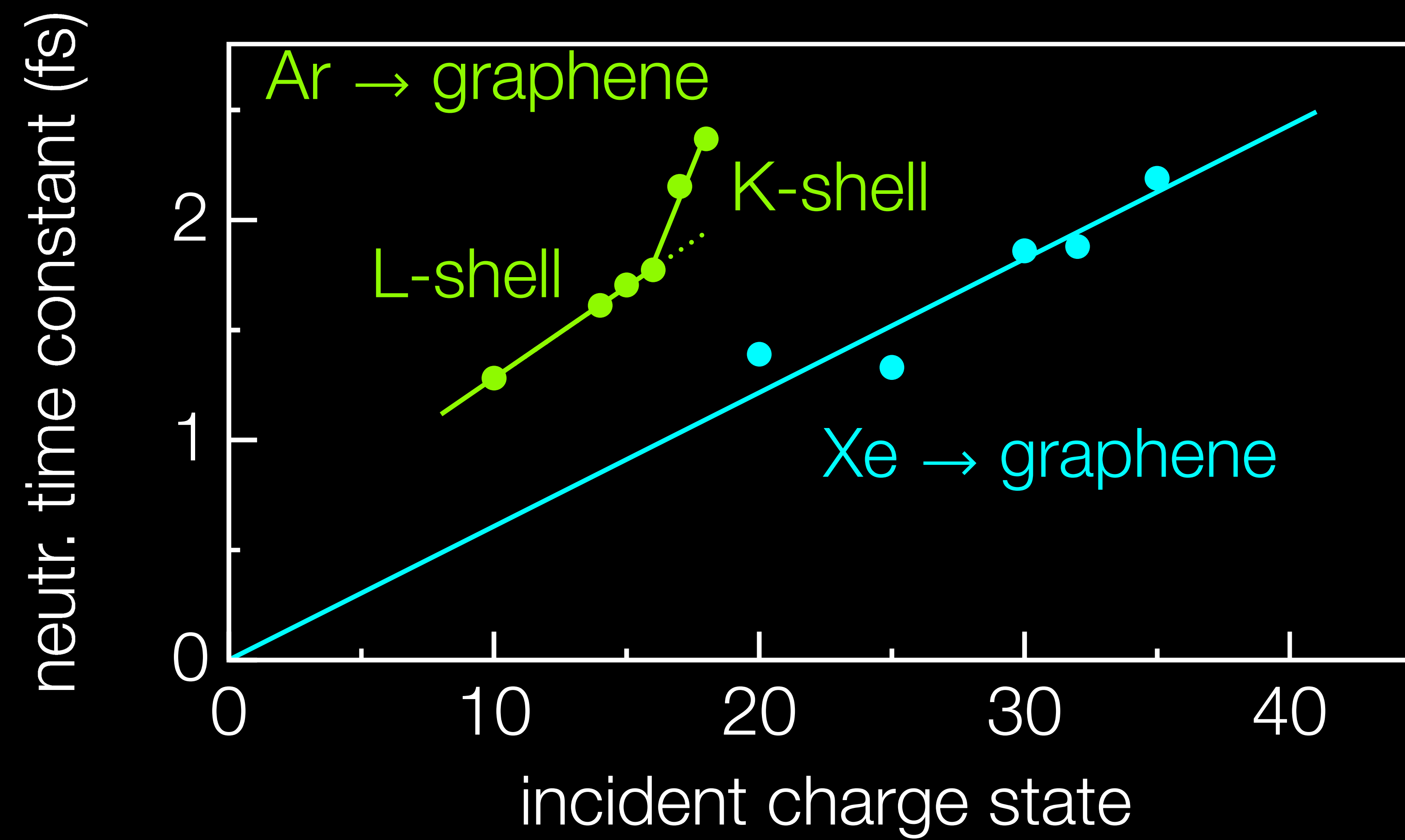
Hollow atom lifetime



E. Gruber, R.A. Wilhelm et al., Nat. Commun. 7, 13948 (2016)

R.A. Wilhelm et al., Phys. Rev. Lett. 119, 103401 (2017)

Hollow atom lifetime

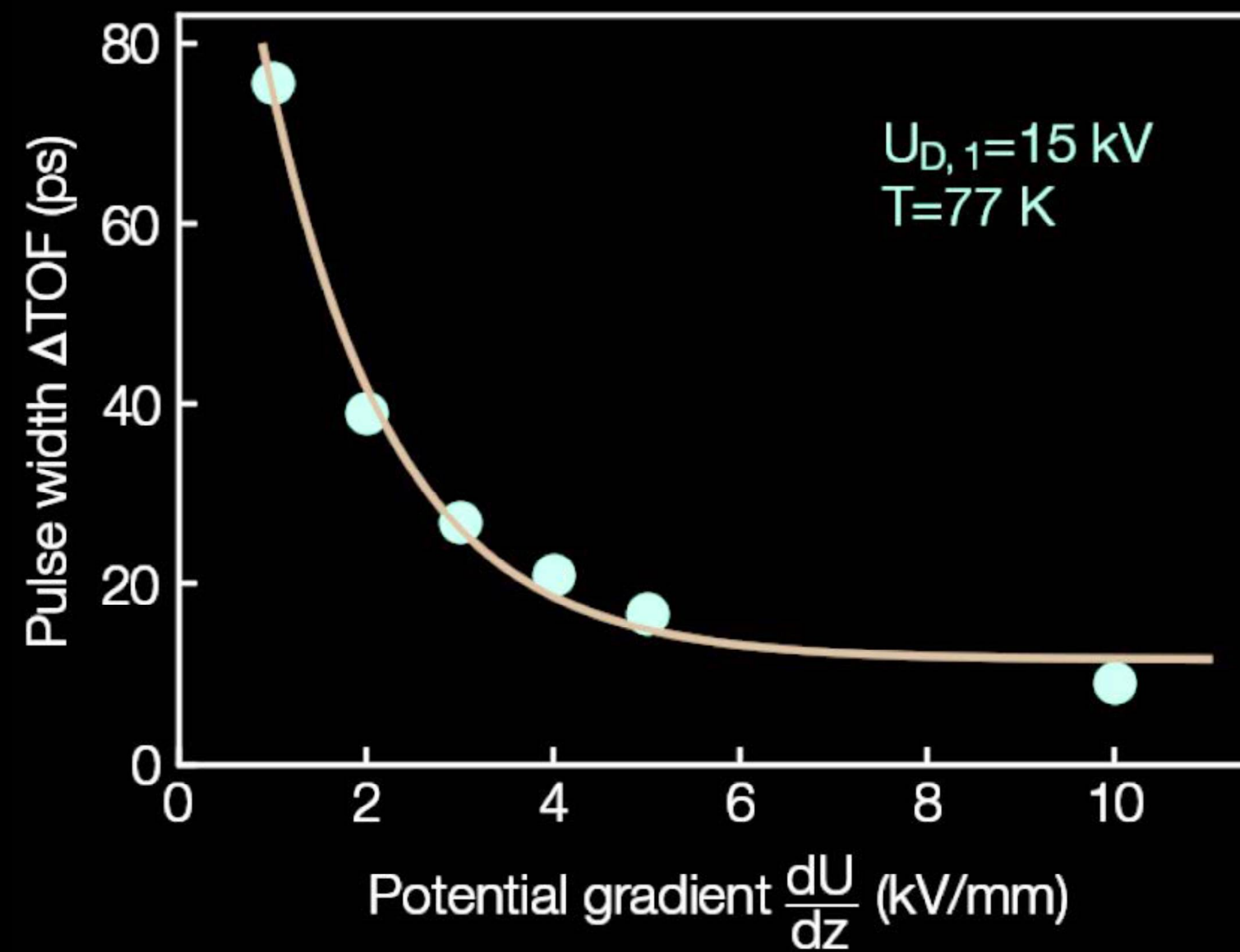


E. Gruber, R.A. Wilhelm et al., Nat. Commun. 7, 13948 (2016)
R.A. Wilhelm et al., Phys. Rev. Lett. 119, 103401 (2017)

Where to go from here?

Are truly time-resolved experiments possible?

Challenges ahead



Challenges ahead

