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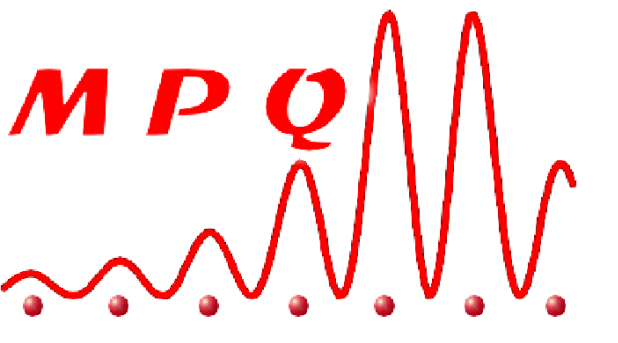
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Sympathetic cooling of ${}^9\text{Be}^+$ by ${}^{88}\text{Sr}^+$ Doppler cooled ions in large Coulomb crystals: an experimental study

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Motivation

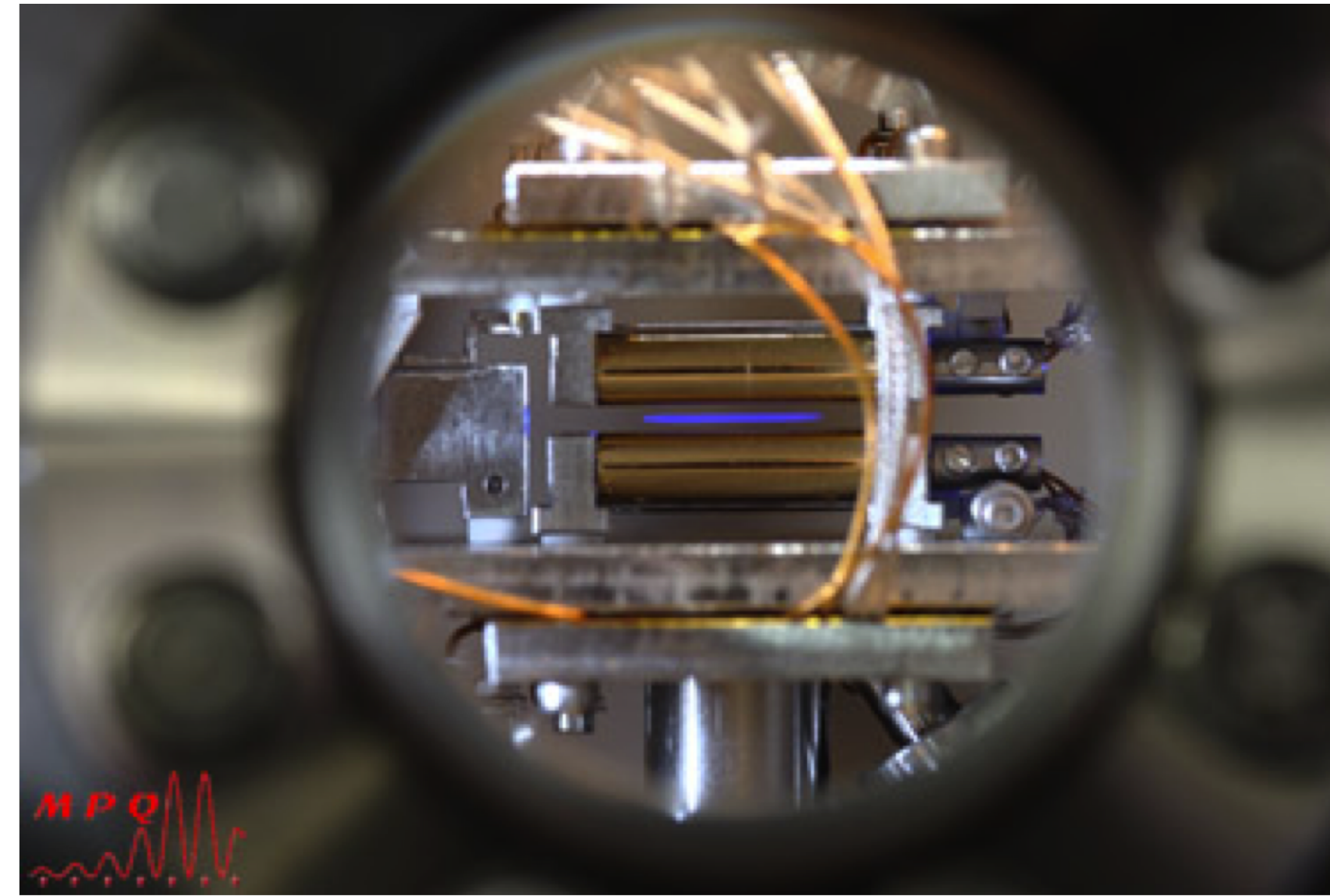
sympathetic cooling of light species by heavy coolants

- precision molecular spectroscopy
J. C. J. Koelemeij et al., Phys. Rev. Lett. **98**, 173002 (2007).
J. Biesheuvel et al., Nature Comm., **7**, 10385 (2016)

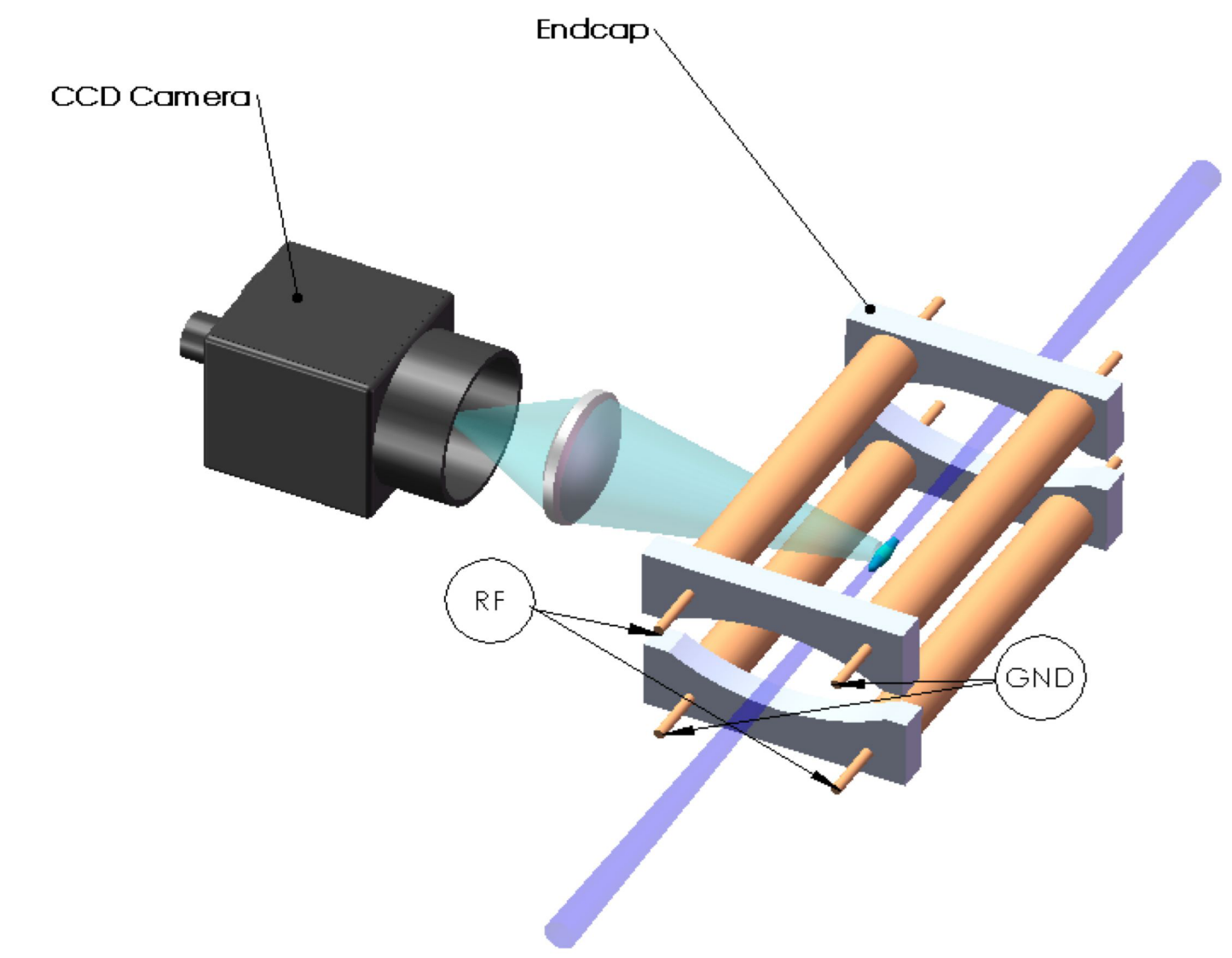
- multicharged ions
L. Schmoeger et al., Science, **347**, 1233 (2015)

- GBAR experiment
P. Perez and Y. Sacquin, Classical and Quantum Gravity, **29**, 18 (2012)

- experiments test for molecular dynamics simulations
N. Sillitoe et al., arXiv:1705.03347 [physics.comp-ph]



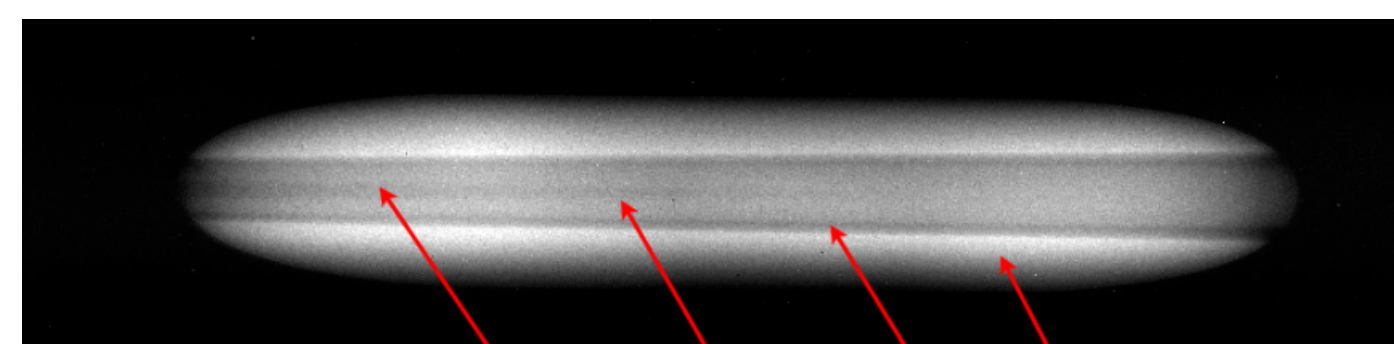
Trap features



- inner radius $R = 3.4$ mm
- length $Z_I = 30$ mm
- radio-frequency 7.6 MHz
- amplitudes V_{RF} 50 - 800 V

- axial motional frequency (${}^{88}\text{Sr}^+$): 10 - 30 kHz
- typical stability parameter (${}^{88}\text{Sr}^+$) $q < 0.005$

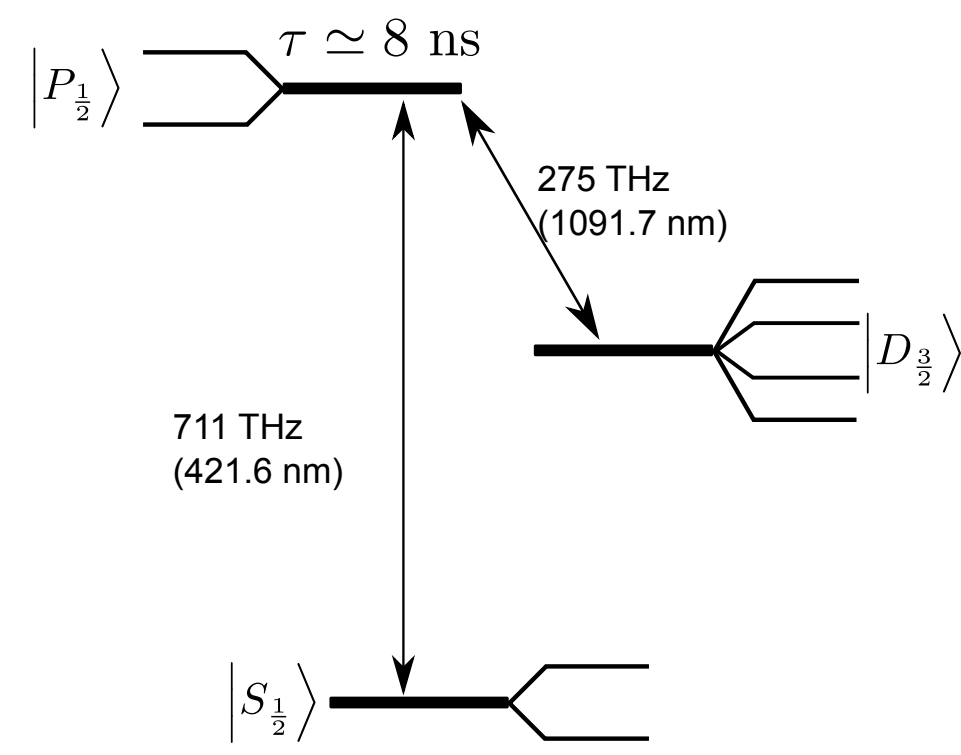
Sympathetic cooling of Sr^+ isotopes



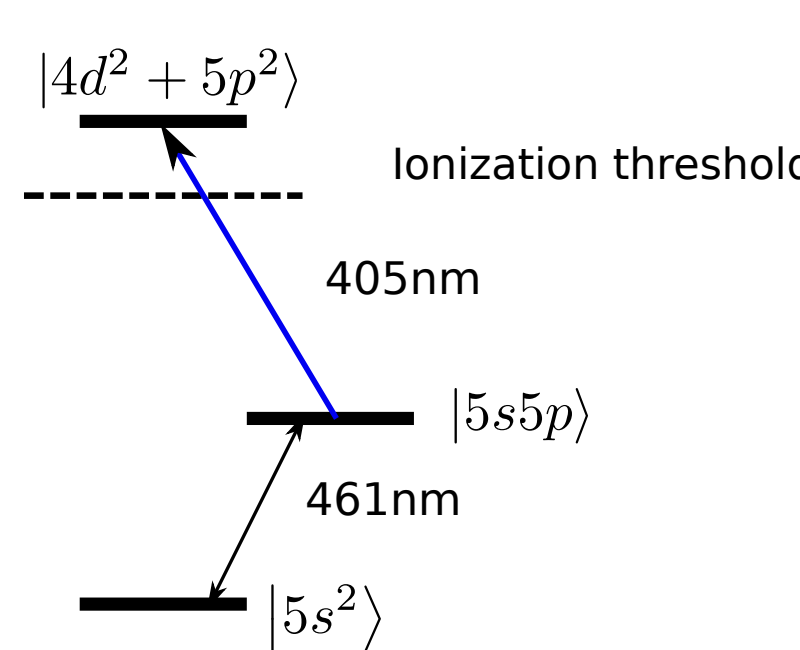
${}^{84}\text{Sr}^+$ 0,56%
 ${}^{86}\text{Sr}^+$ 9,86%
 ${}^{87}\text{Sr}^+$ 7%
 ${}^{88}\text{Sr}^+$ 82,58%

Experimental setup

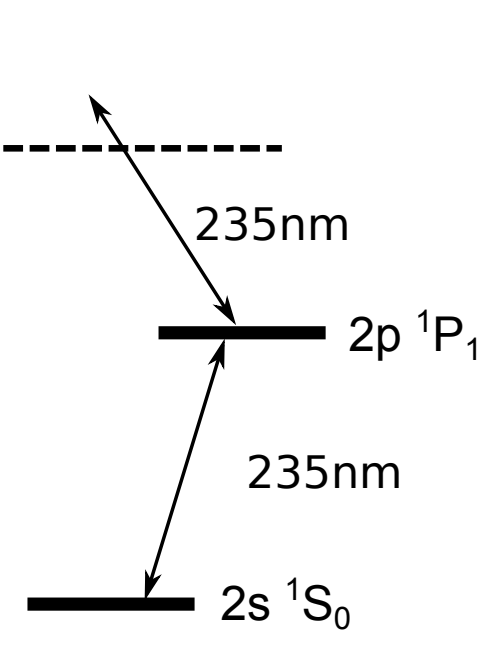
Doppler cooling of Sr^+



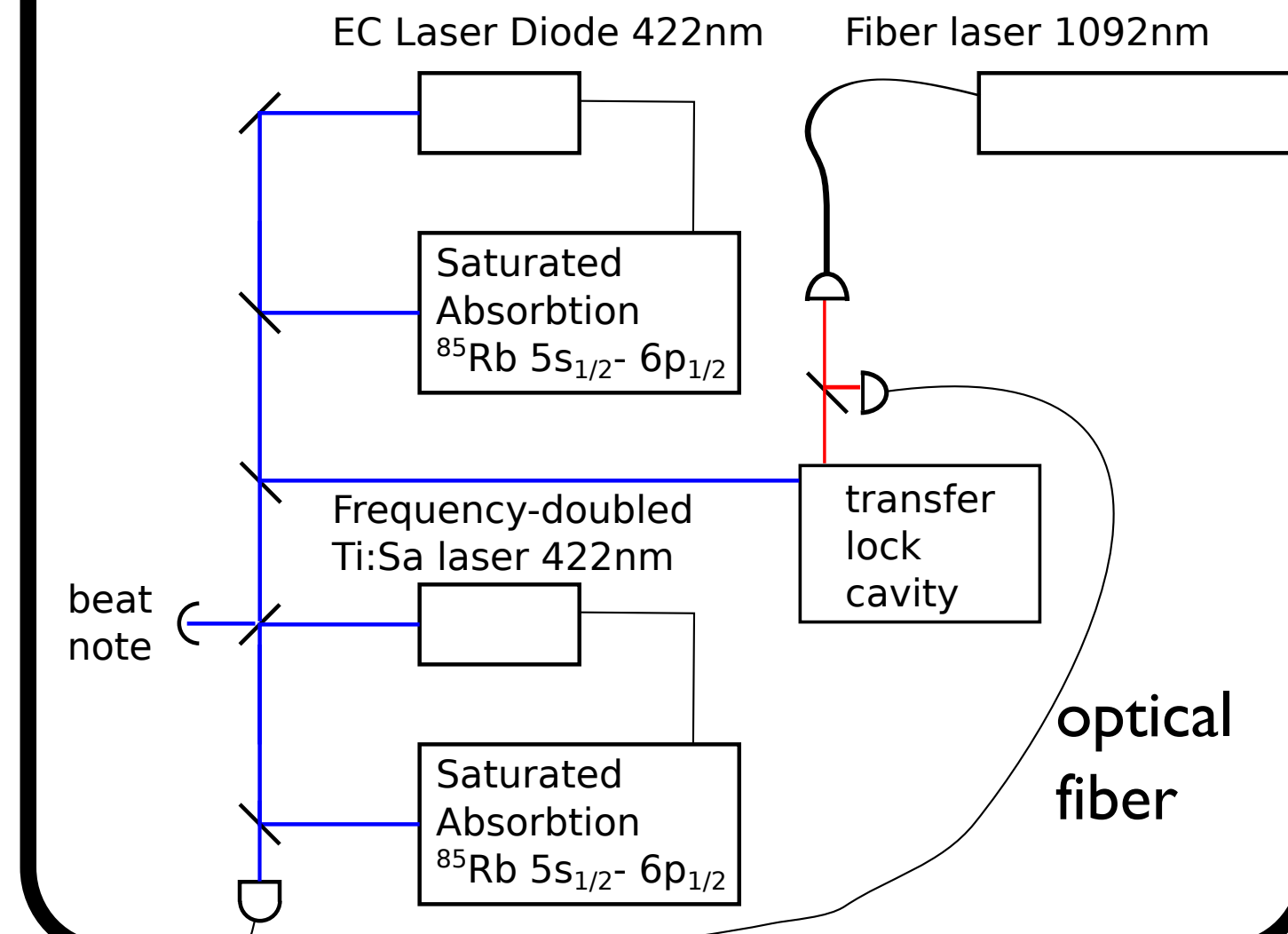
Photoionization of Sr



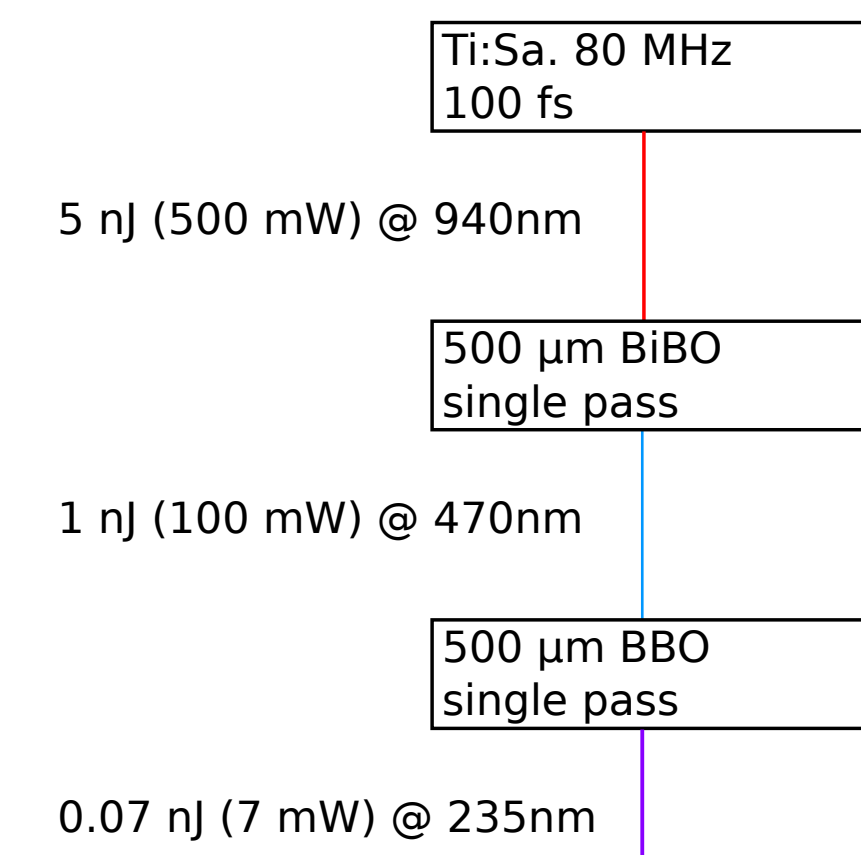
Photoionization of Be



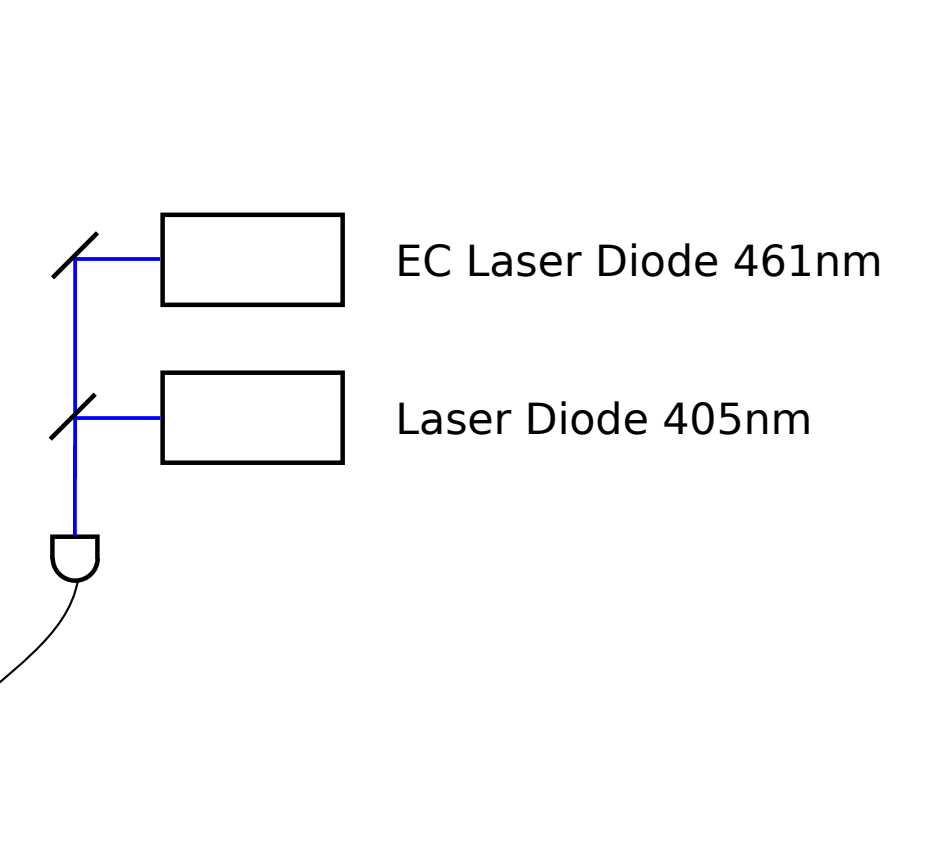
Sr^+ cooling lasers and stabilization



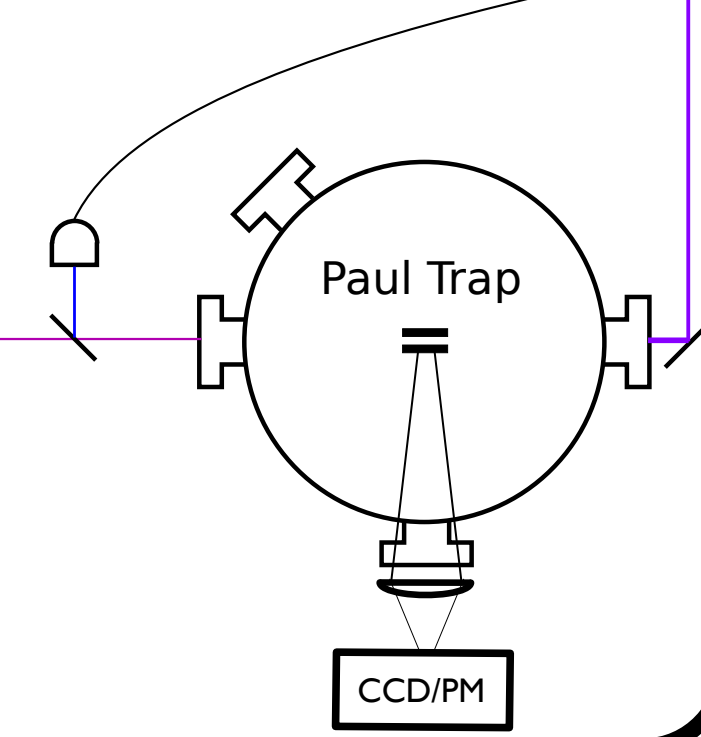
${}^9\text{Be}$ photo-ionization



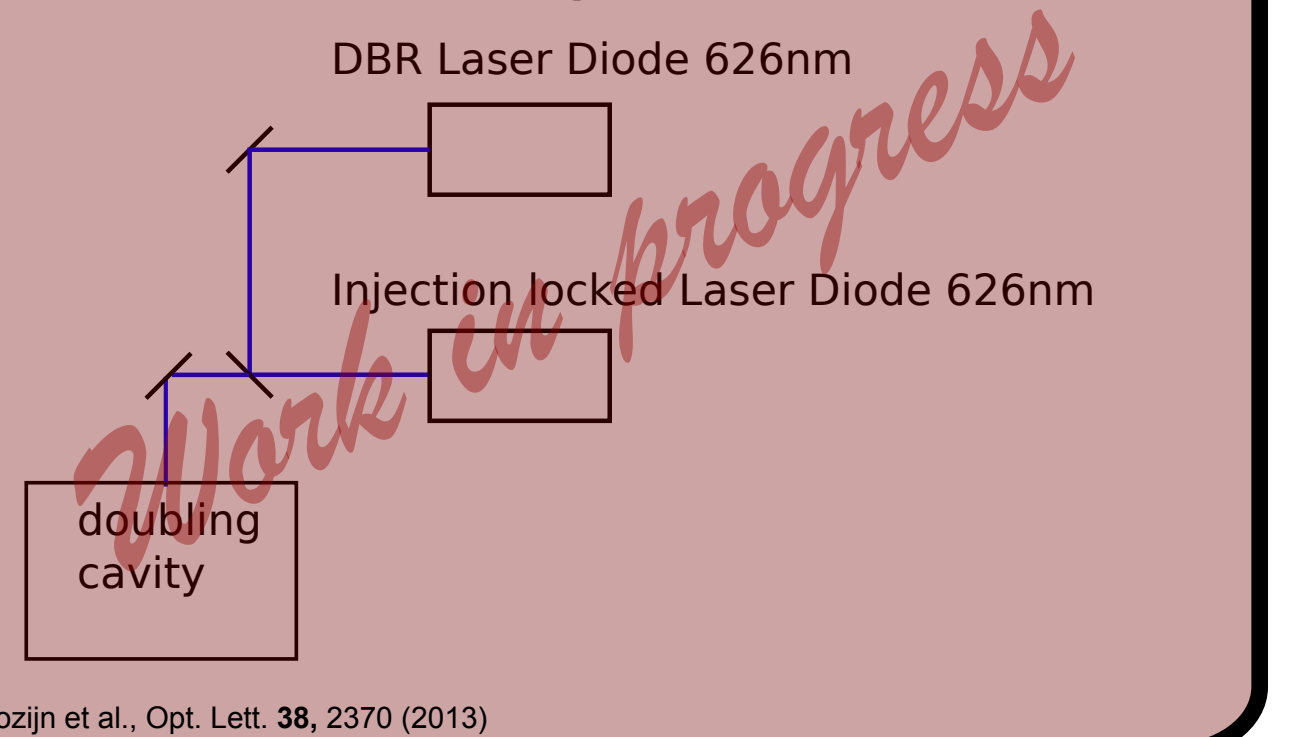
${}^{88}\text{Sr}$ photo-ionization



Vacuum chamber

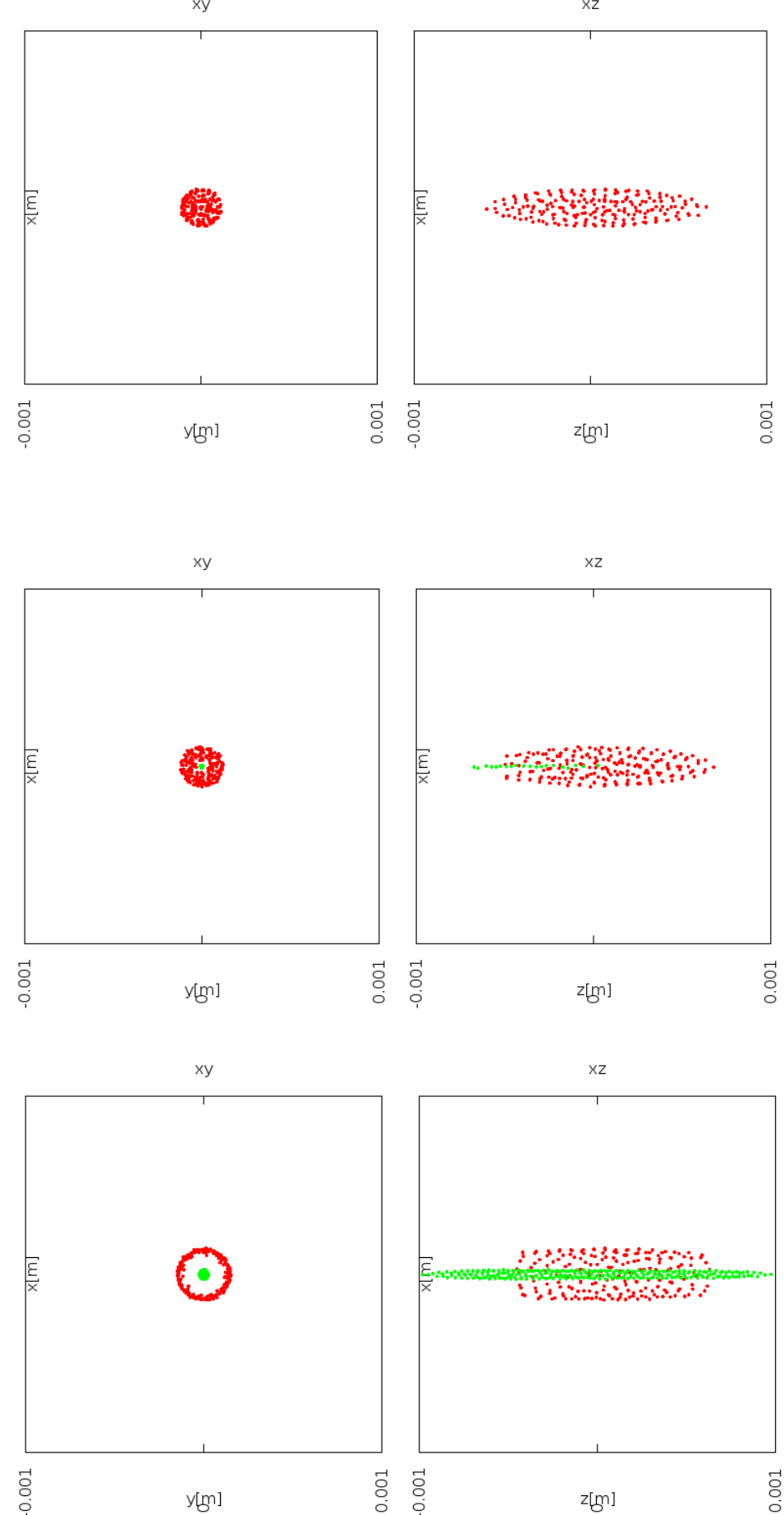


Be^+ probing laser



Preliminary results

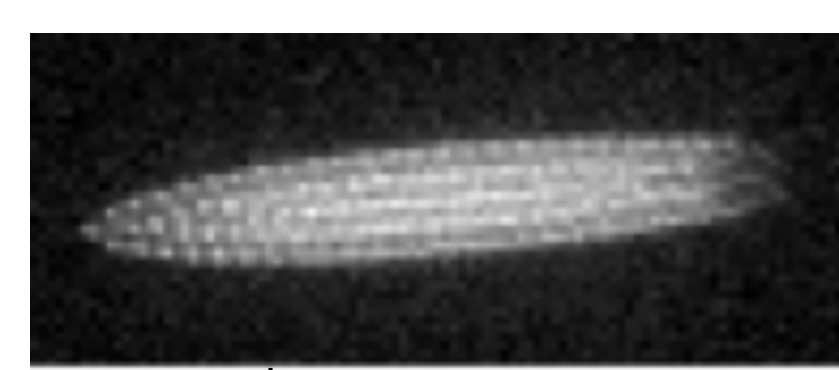
numerical simulations of steady-state



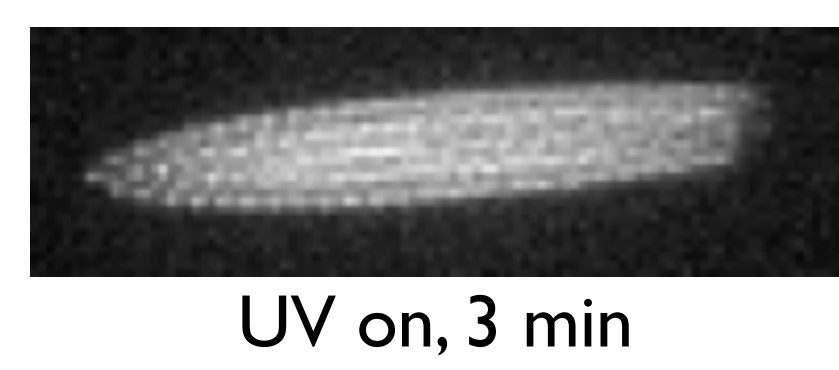
pure Sr^+ $N=200$

$N=200 \text{ Sr}^+ ; N=100 \text{ Be}^+$

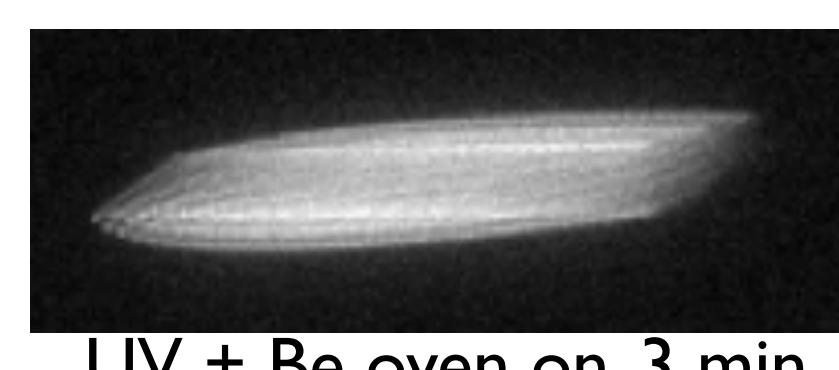
$N=200 \text{ Sr}^+ ; N=250 \text{ Be}^+$



Sr^+ initial crystal



UV on, 3 min

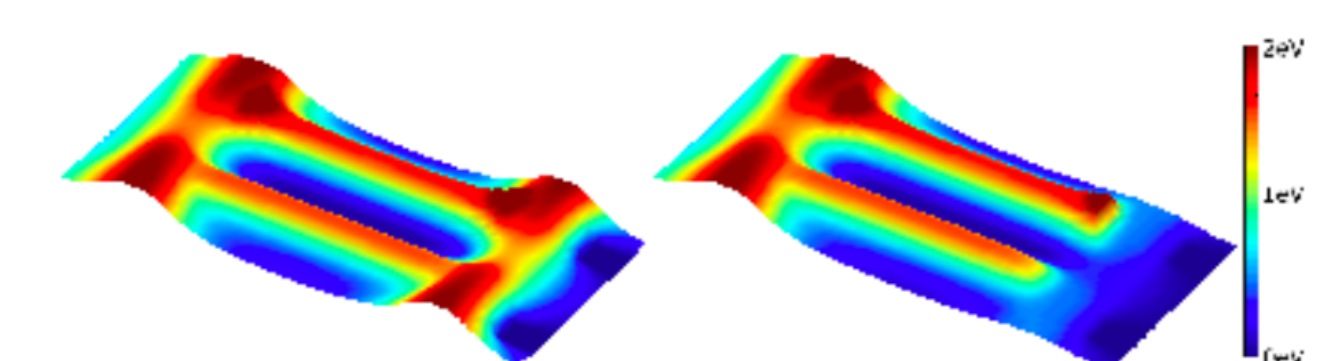


UV + Be oven on, 3 min

- qualitatively long (> 10 s) cooling dynamics
- independent of loading order
- tickle confirmation of mass ratio

Next steps

${}^{88}\text{Sr}^+$ isotope selection



probing ${}^9\text{Be}^+$ for diagnostics

study of sympathetic cooling dynamics