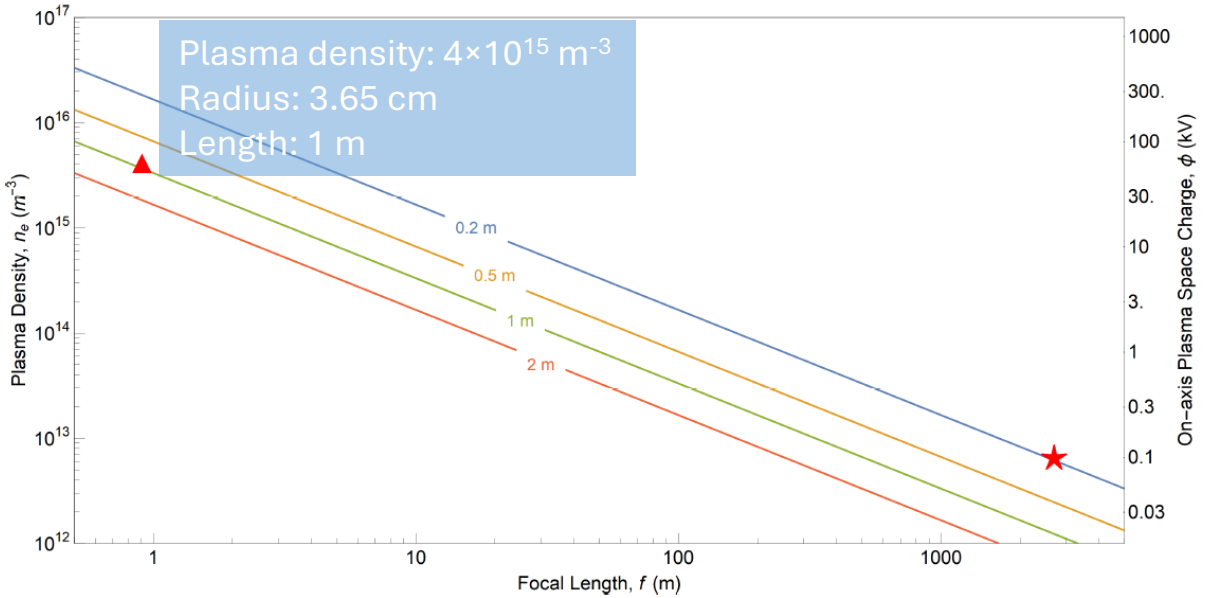
Proton and ion capture

Gabor lens

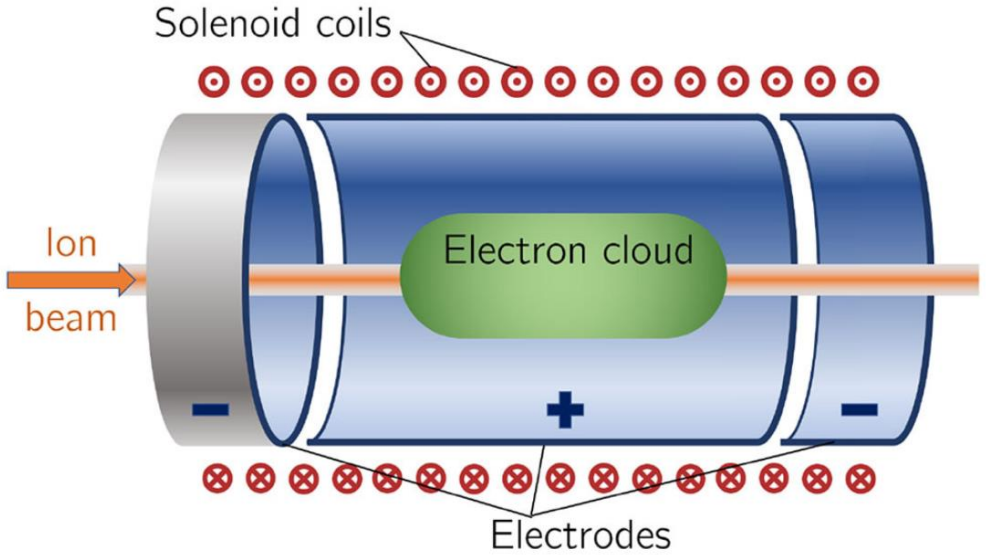
- **The focal length (f) of the Gabor lens:**

$$\frac{1}{f} = \frac{e^2 n_e l}{4\epsilon_0 U}$$

where e is electric charge of the electron
n_e is the plasma density
l is the length of the plasma
ϵ_0 is the permittivity of free space
U is the kinetic energy of the positively charge particle.

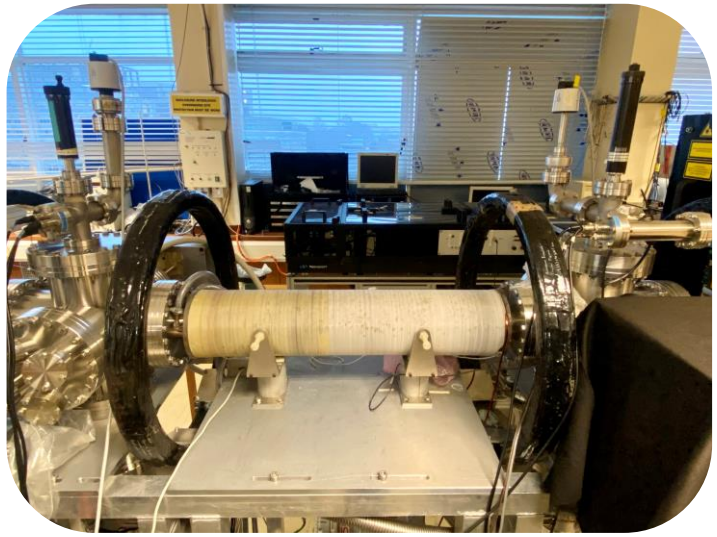


- **Penning-Malmberg trap**

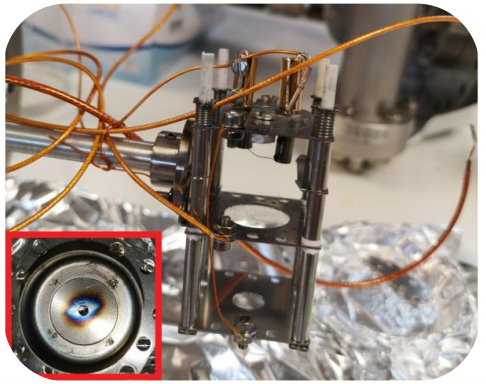


Aymar, G., Becker, T., Boogert, S., Borghesi, M., Bingham, R., Brenner, C., ... & Xiao, R. (2020). LhARA: the laser-hybrid accelerator for radiobiological applications. Frontiers in Physics, 8, 567738.

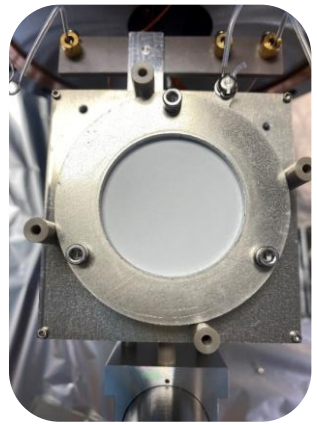
Swansea Penning-Malmberg trap

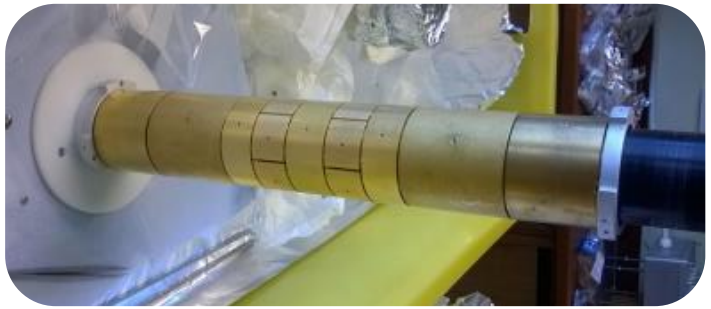


Electron source



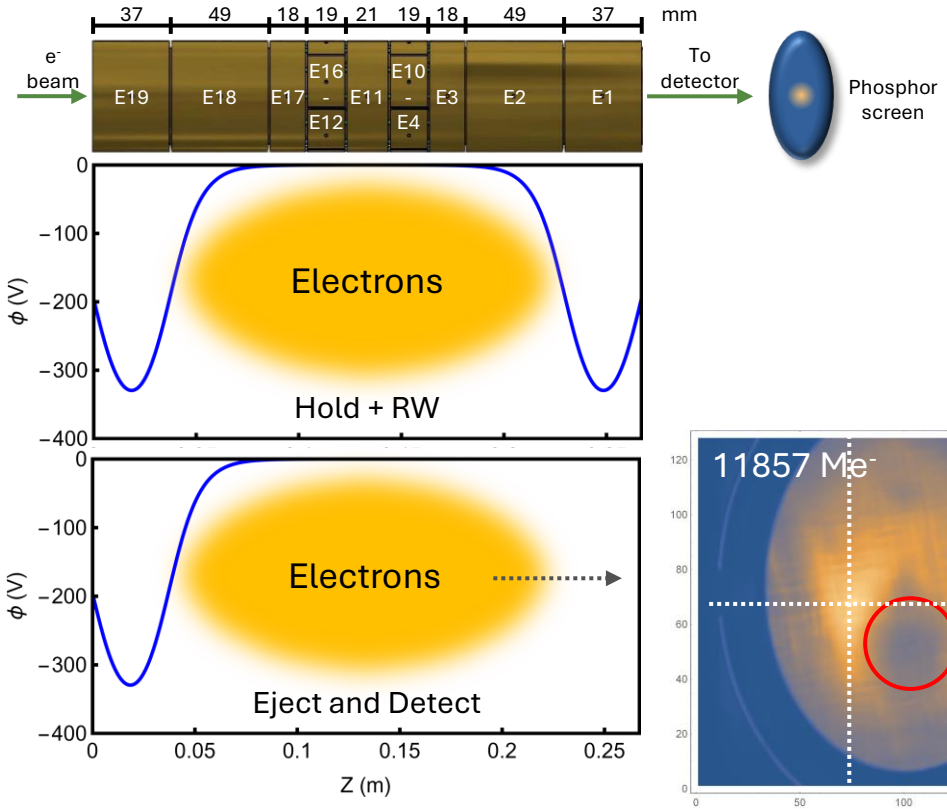
Phosphor screen





Trapping e⁻ plasmas

- **Rotating wall + Cooling gas (CO_2)**

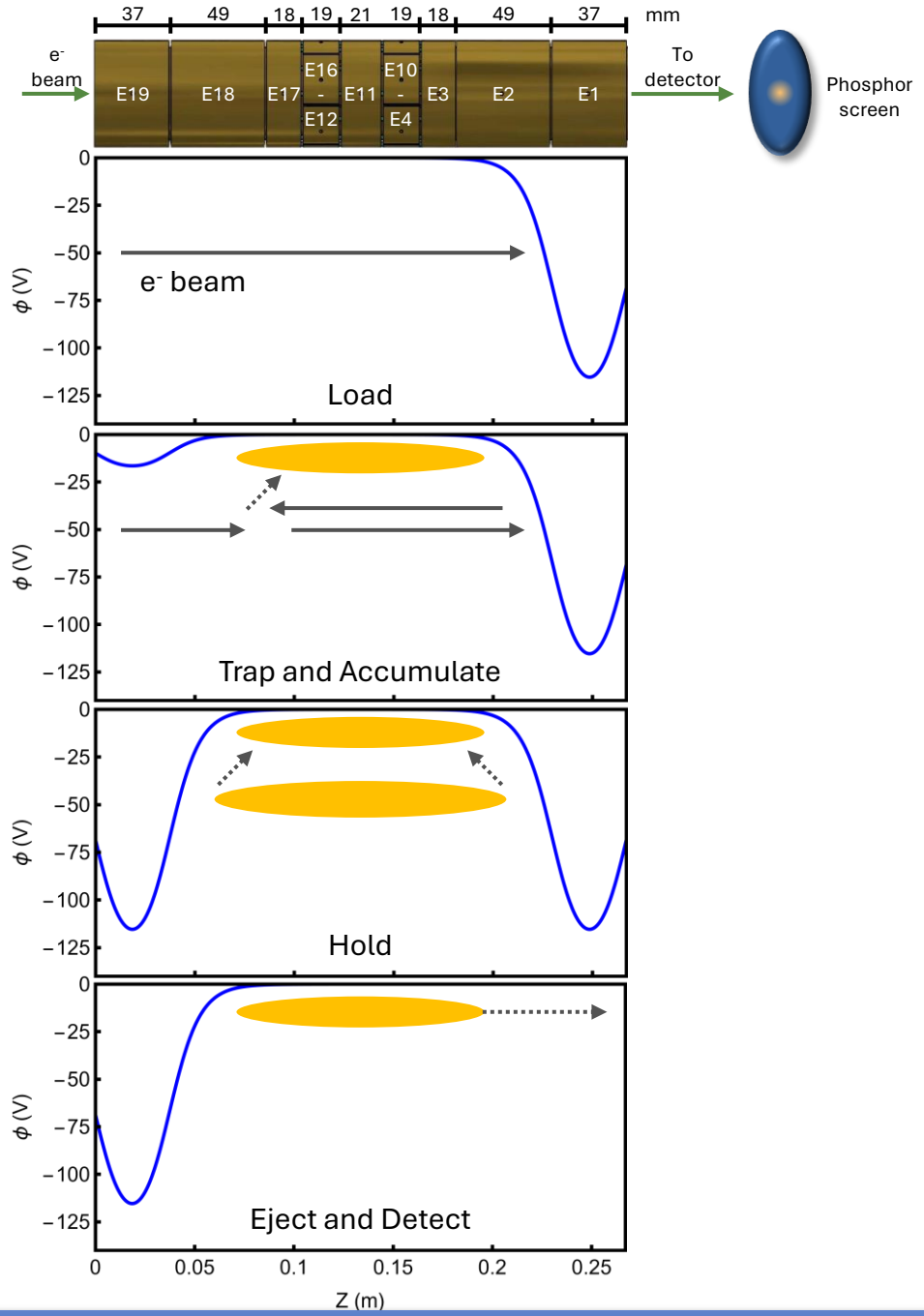


September 2024:

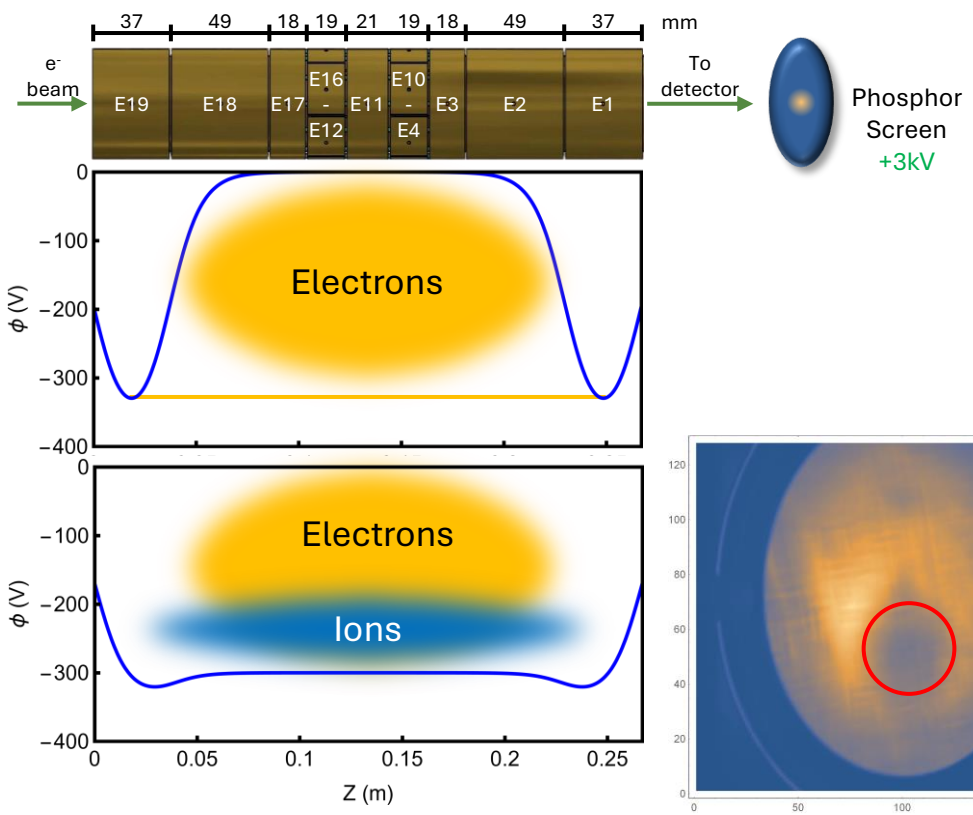
Trap potential: -400V

Peak density: 1.1×10^{15} m^{-3}

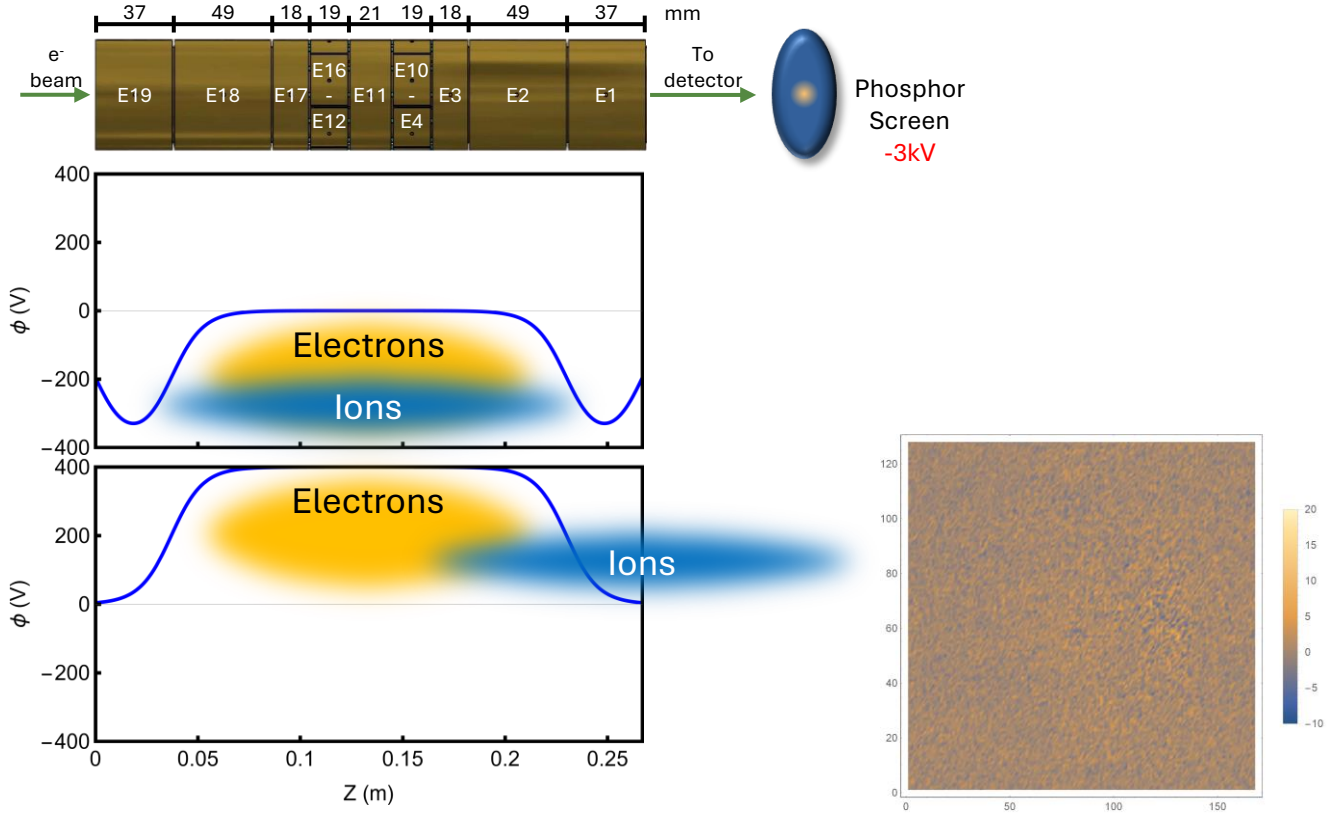
Radius: ~5 mm



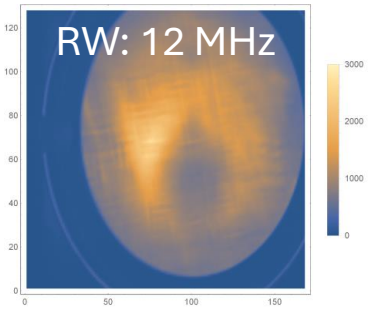
Ions in the trap

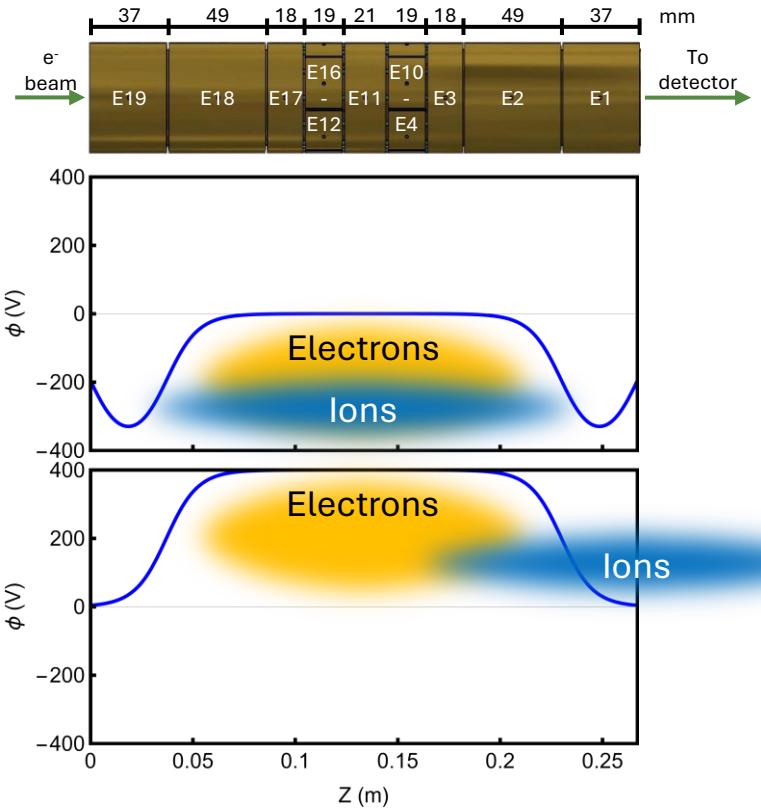


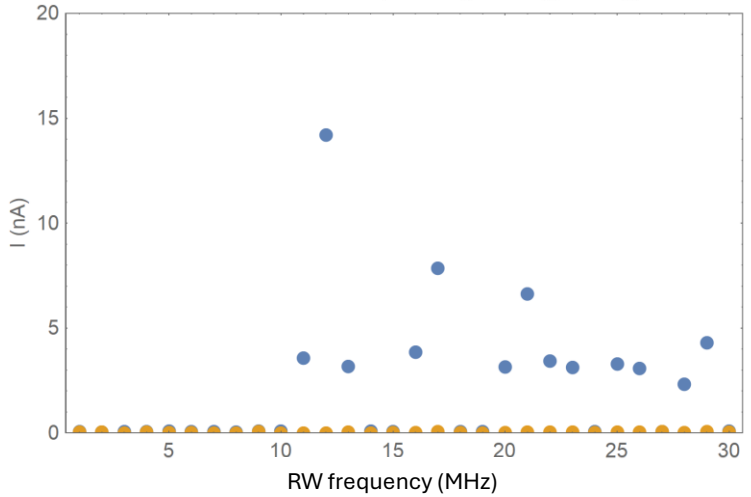
Imaging ions in the trap

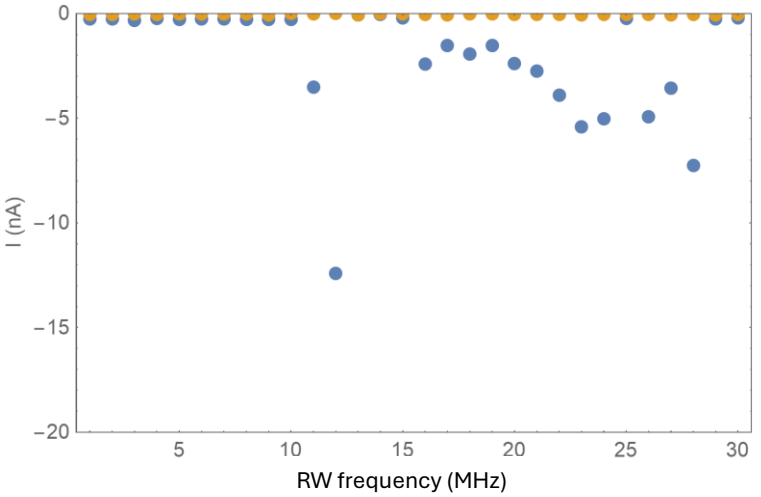


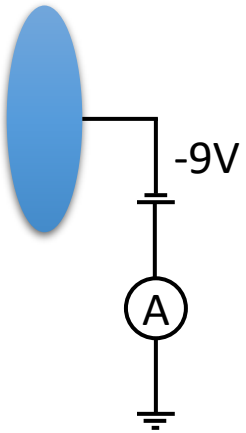
Measure current of the trapped ions

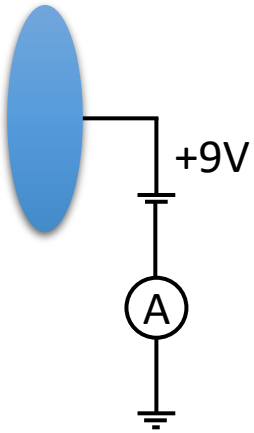




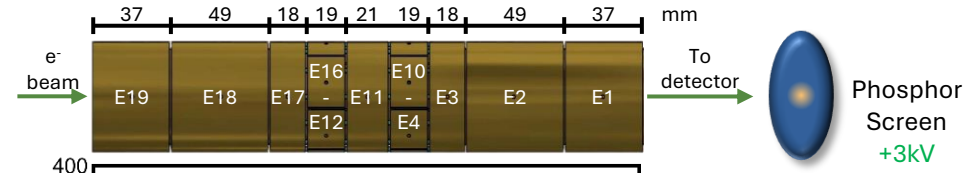


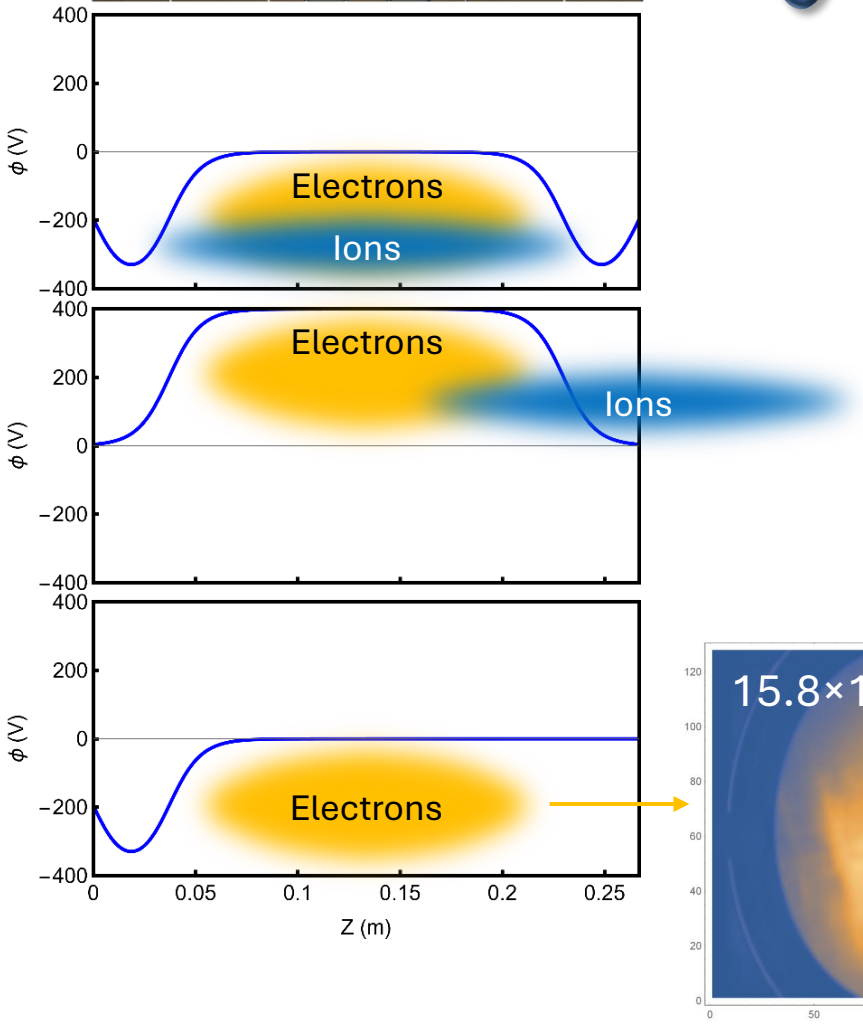


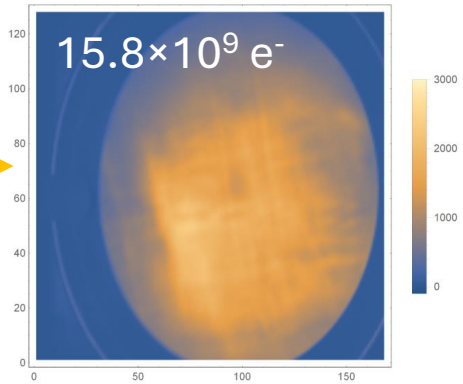




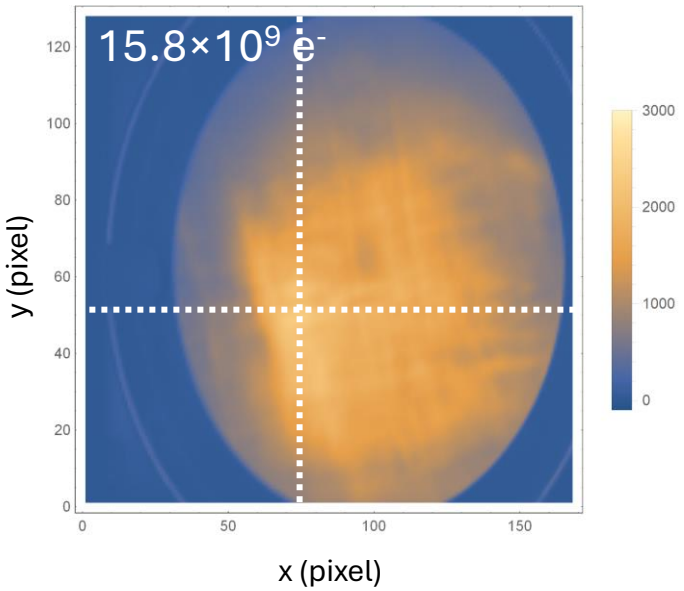
Eliminate the ions

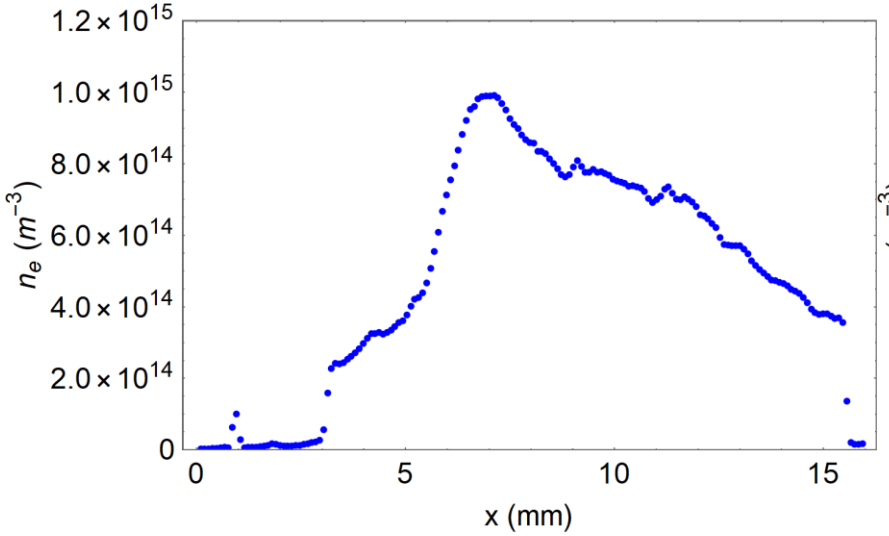


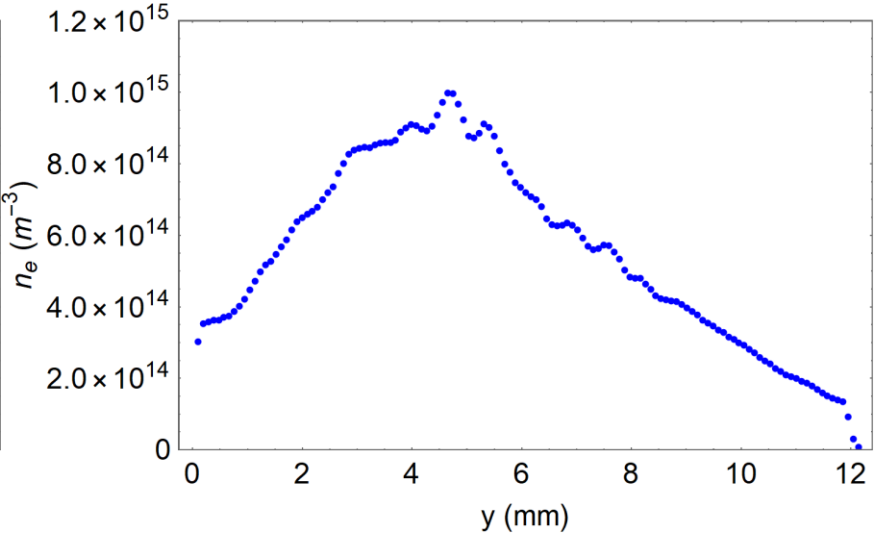




Peak density



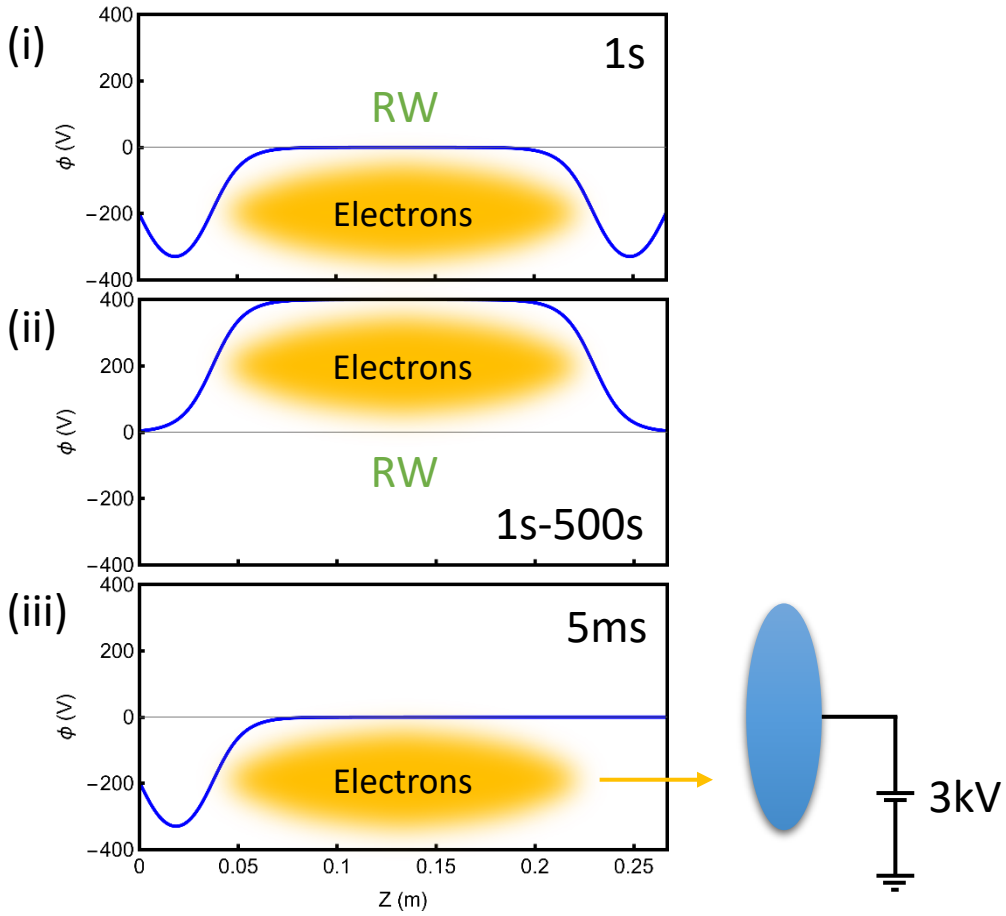


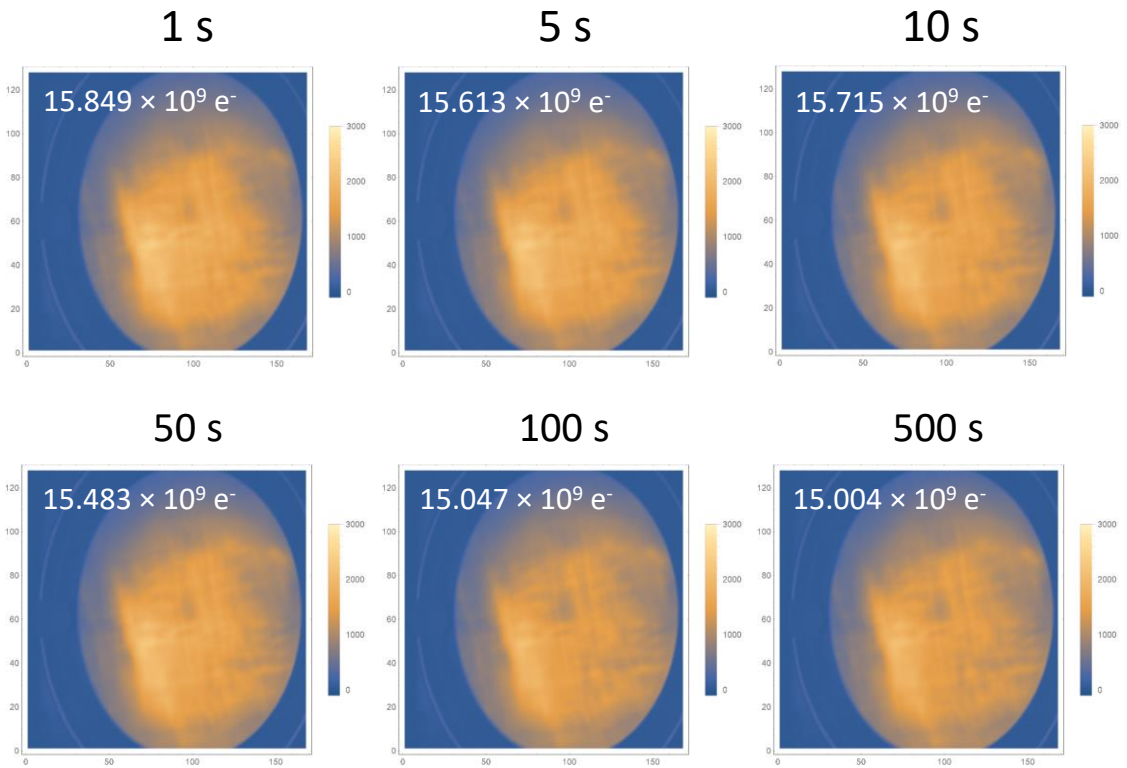


Peak density = 1×10^{15} m^{-3}

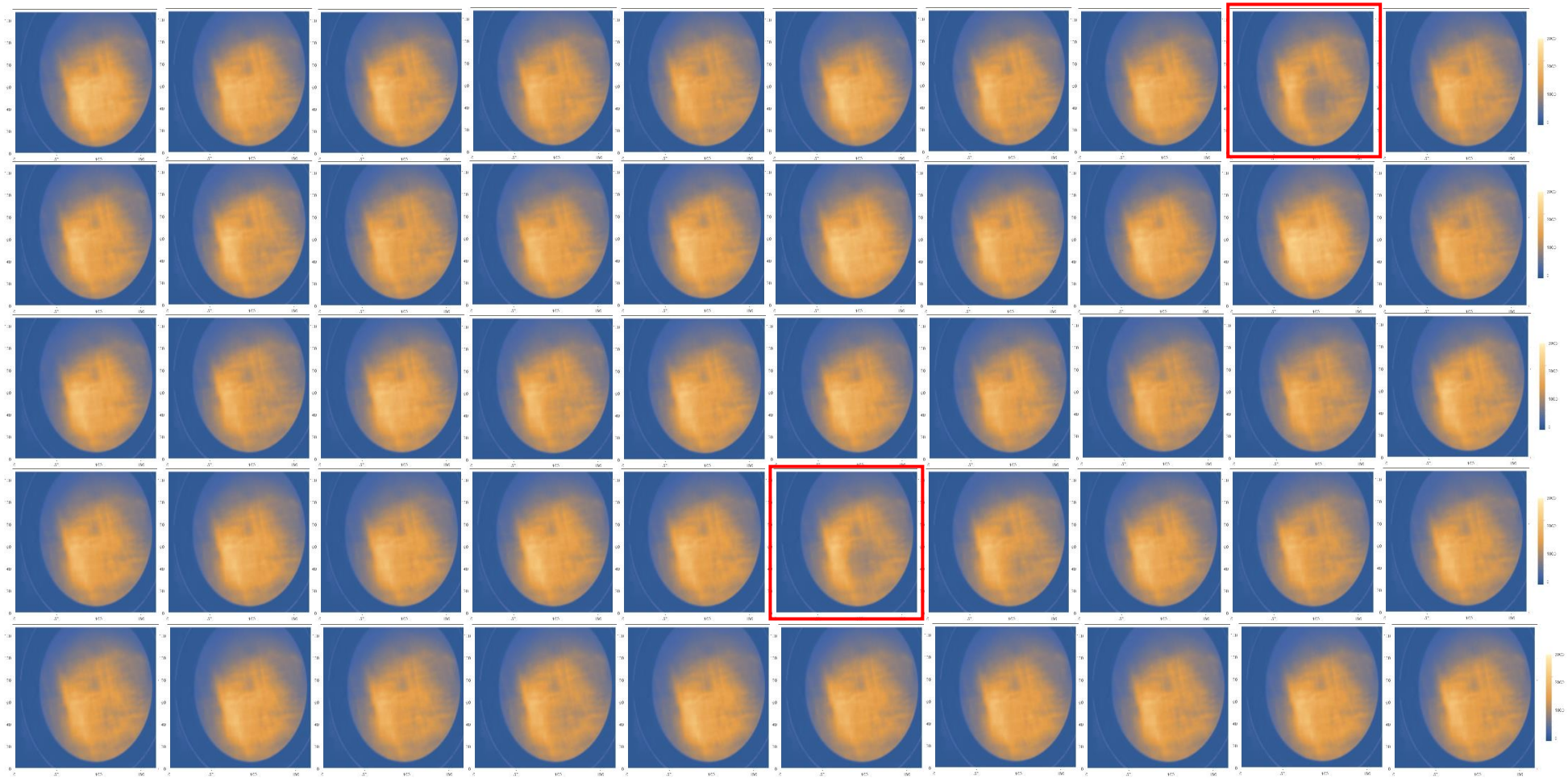
Lifetime of the plasma

(in the raised trap)





Reproducibility and stability



Conclusion and outlook

Density

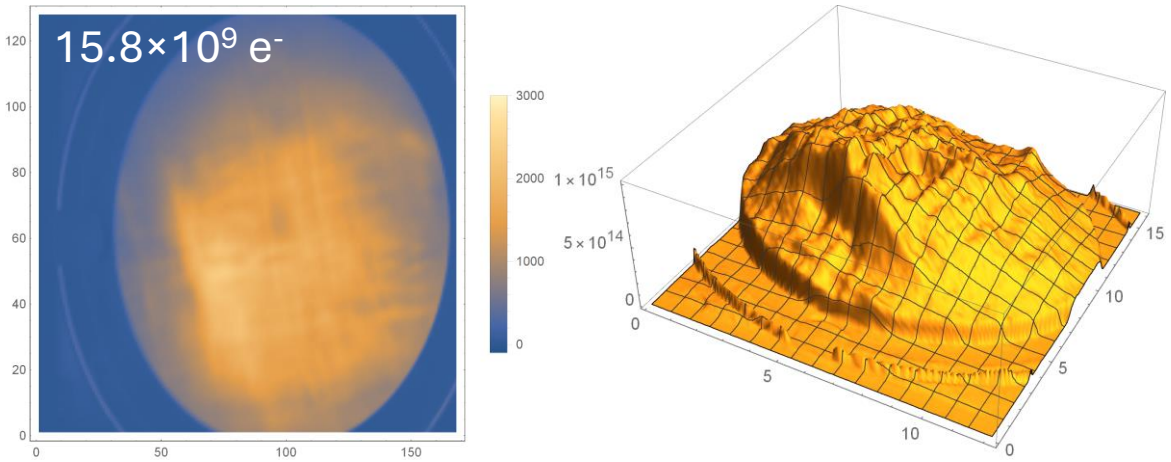
- The peak density of the plasma is 1×10^{15} m^{-3}.

Radius

- ~ 5 mm.

Lifetime

- As long as the RW is applied, the plasma remains stable.



Next steps ...

- Investigate and improve the plasma profile.

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