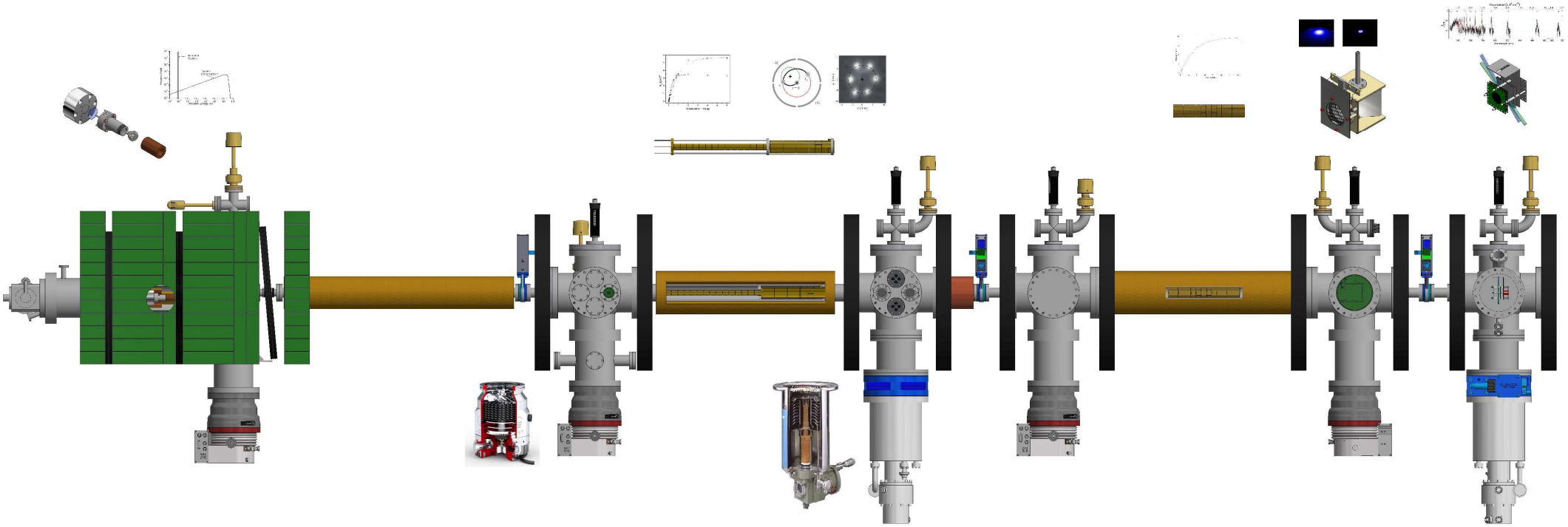
LhARA - Proton and ion capture Swansea Apparatus

10th June 2021

Christopher Baker

Positron beamline overview



Source chamber

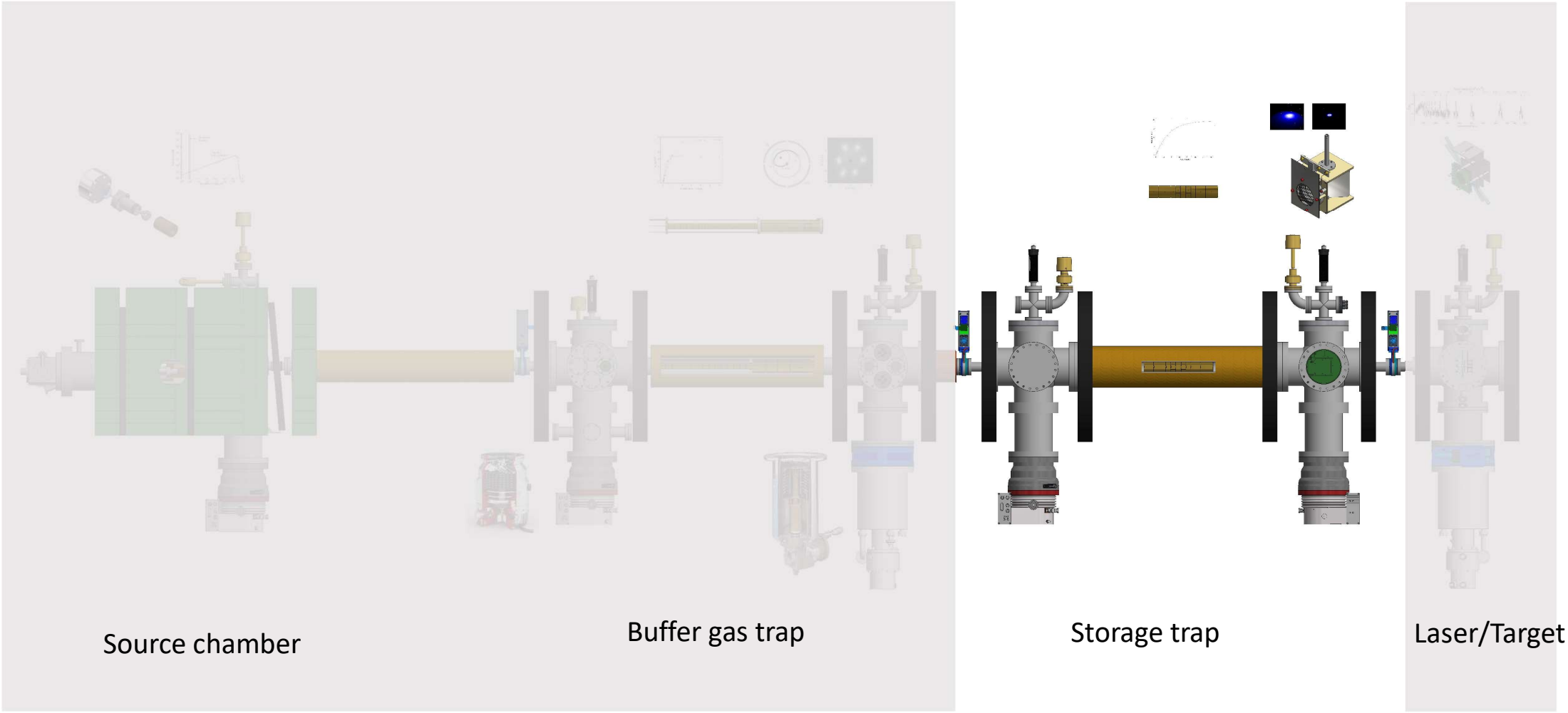
Buffer gas trap

Storage trap

Laser/Target

~ 6 m

Positron beamline overview



Source chamber

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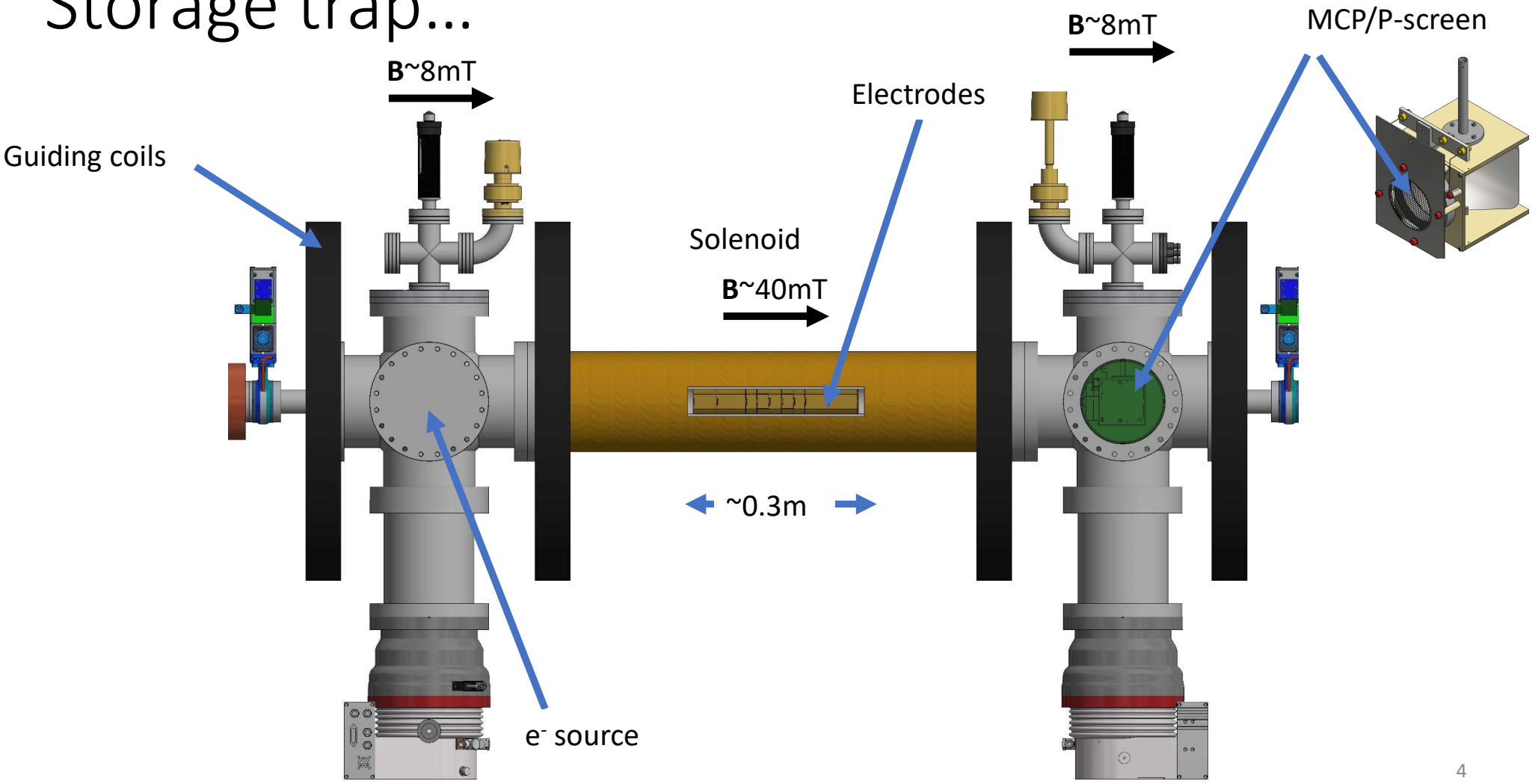
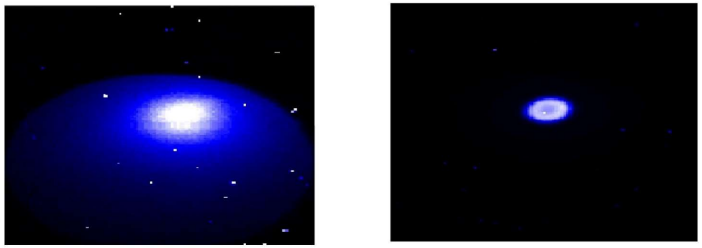
Laser/Target

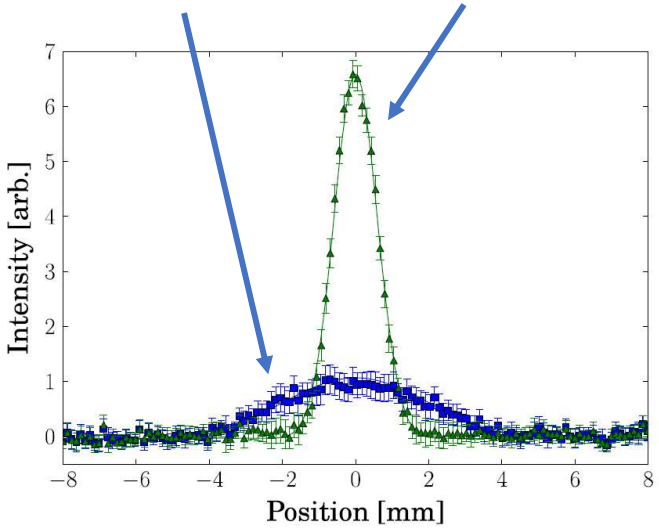
Storage trap…

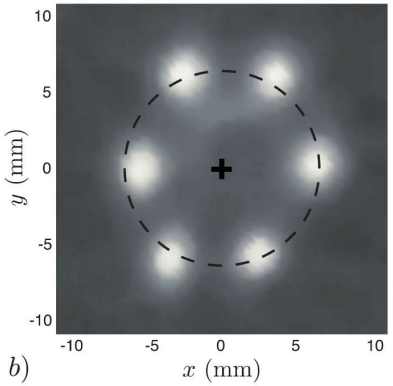


Destructive diagnostics using MCP/P-screen

Optical imaging of P-screen fluorescence allows provides positional information (right) & line integrated densities (below) to be determined.



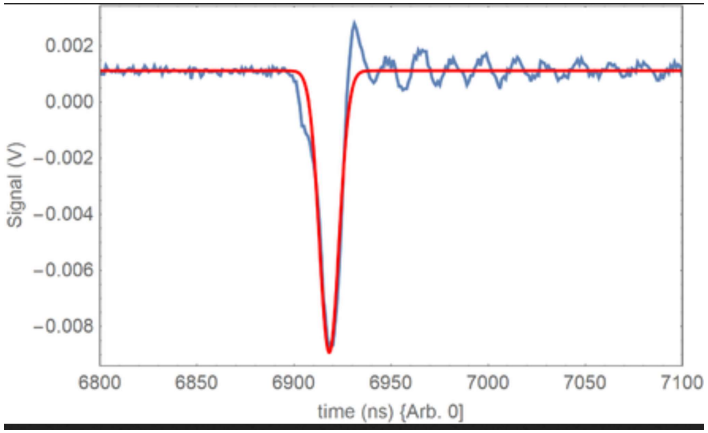




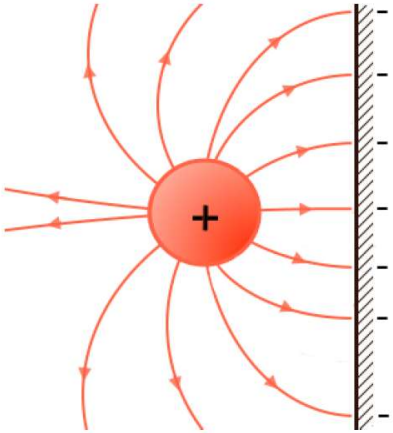
In principle, the e.g. plasma temperature information is also available in optical measurements (untried at Swansea)

P-screen can be used as anode to collect MCP amplified electron signal.
This signal can be configured for

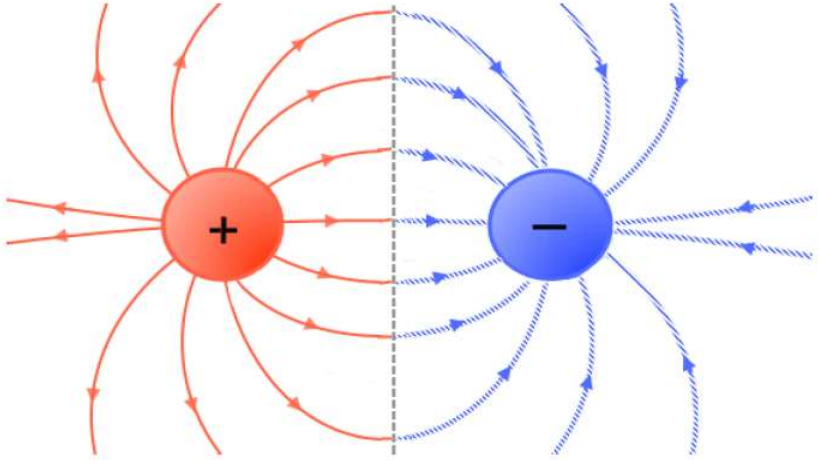
- timing information (as below) or
- integrated charge (ideal for plasma temperature diagnostics)



Non-destructive diagnostics (image charge)



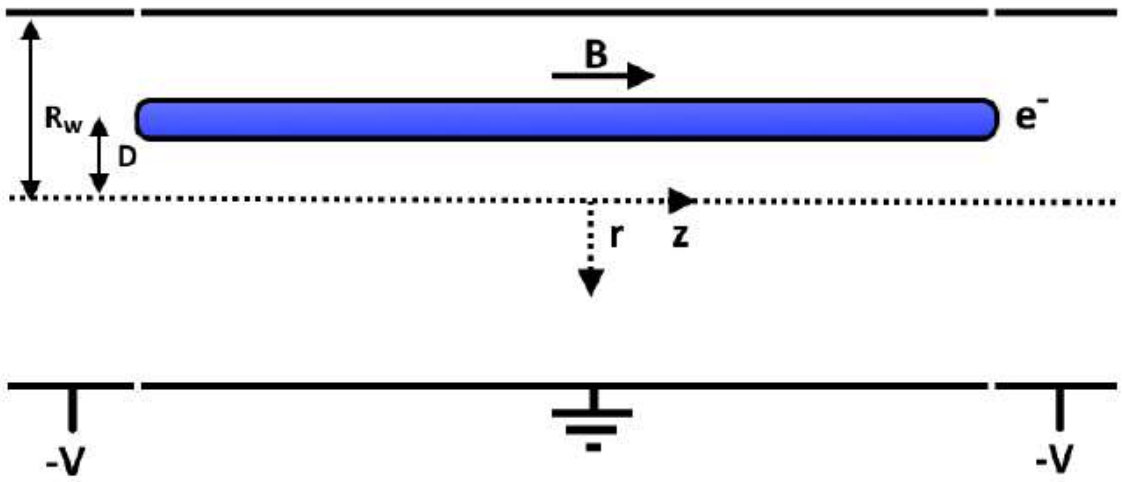
A positive charge of magnitude +Q next to a conducting plane (black line) held at ground. Negative charges are induced on the opposing side of the conductor by the positive electric field lines, maintaining a null potential on the surface of the conductor.

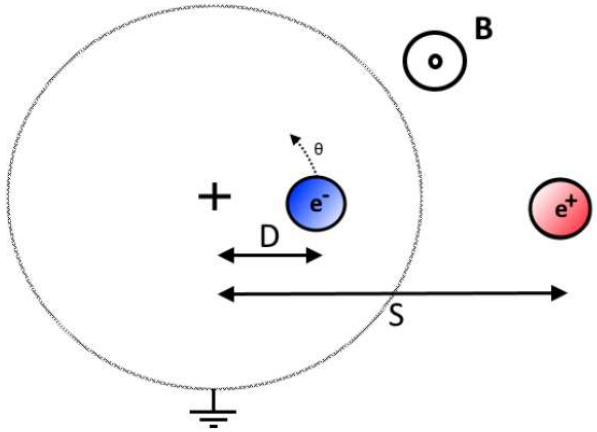


Equivalently: The conducting plane has been removed (grey line) and replaced by a negative charge of equal but opposite magnitude to the positive charge.

T. Savage, MRes Thesis, Swansea University, 2018

Non-destructive diagnostics (image charge)





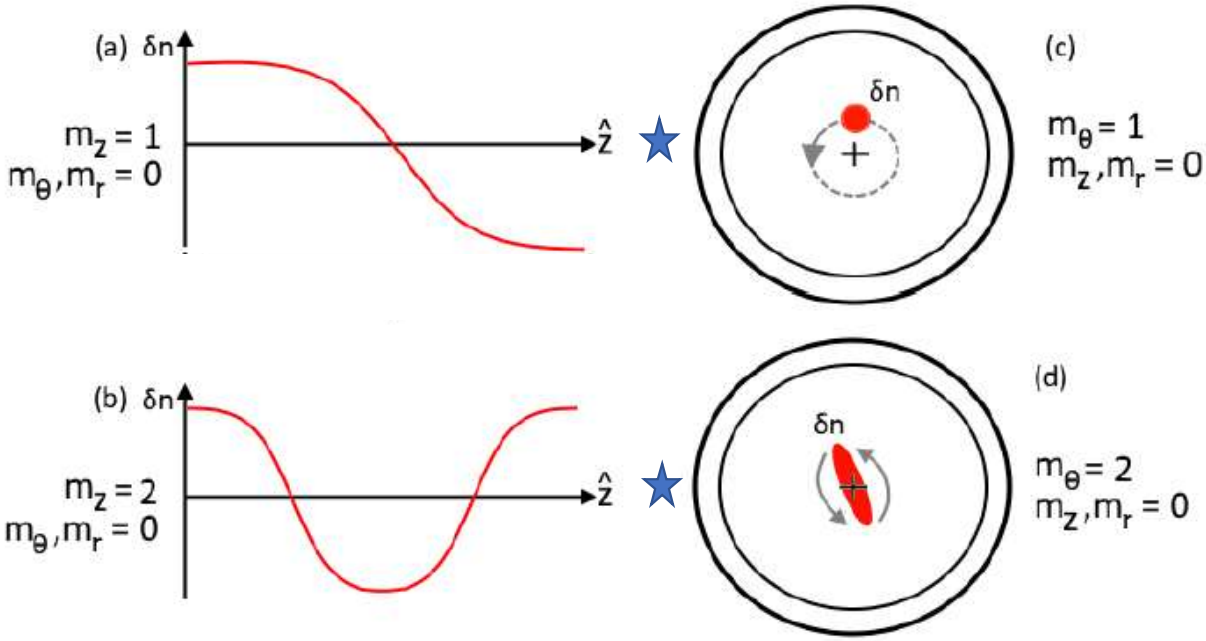
If a charge (-Q) confined in a Penning-Malmberg trap is located away from the central axis at distance D, there will be a defined image charge 'location' at distance S (+Q)

T. Savage, MRes Thesis, Swansea University, 2018

Non-destructive diagnostics (image charge)

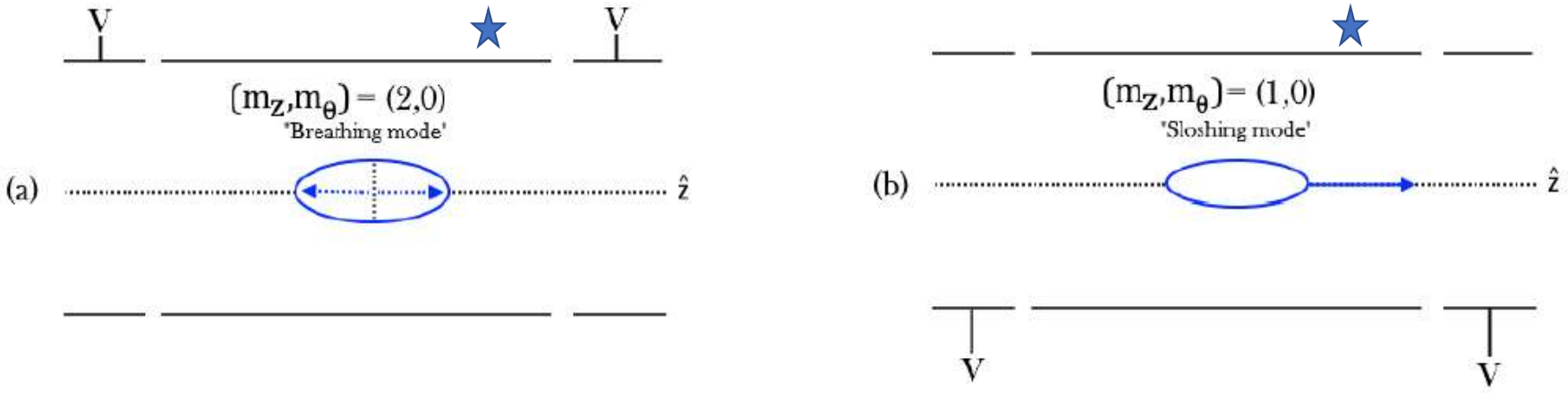
If the induced image charge is somehow probed at a specific location (e.g. azimuthally at ★) , a signal can be recorded.

This signal can be compared to theory & plasma parameters determined.



T. Savage, MRes Thesis, Swansea University, 2018

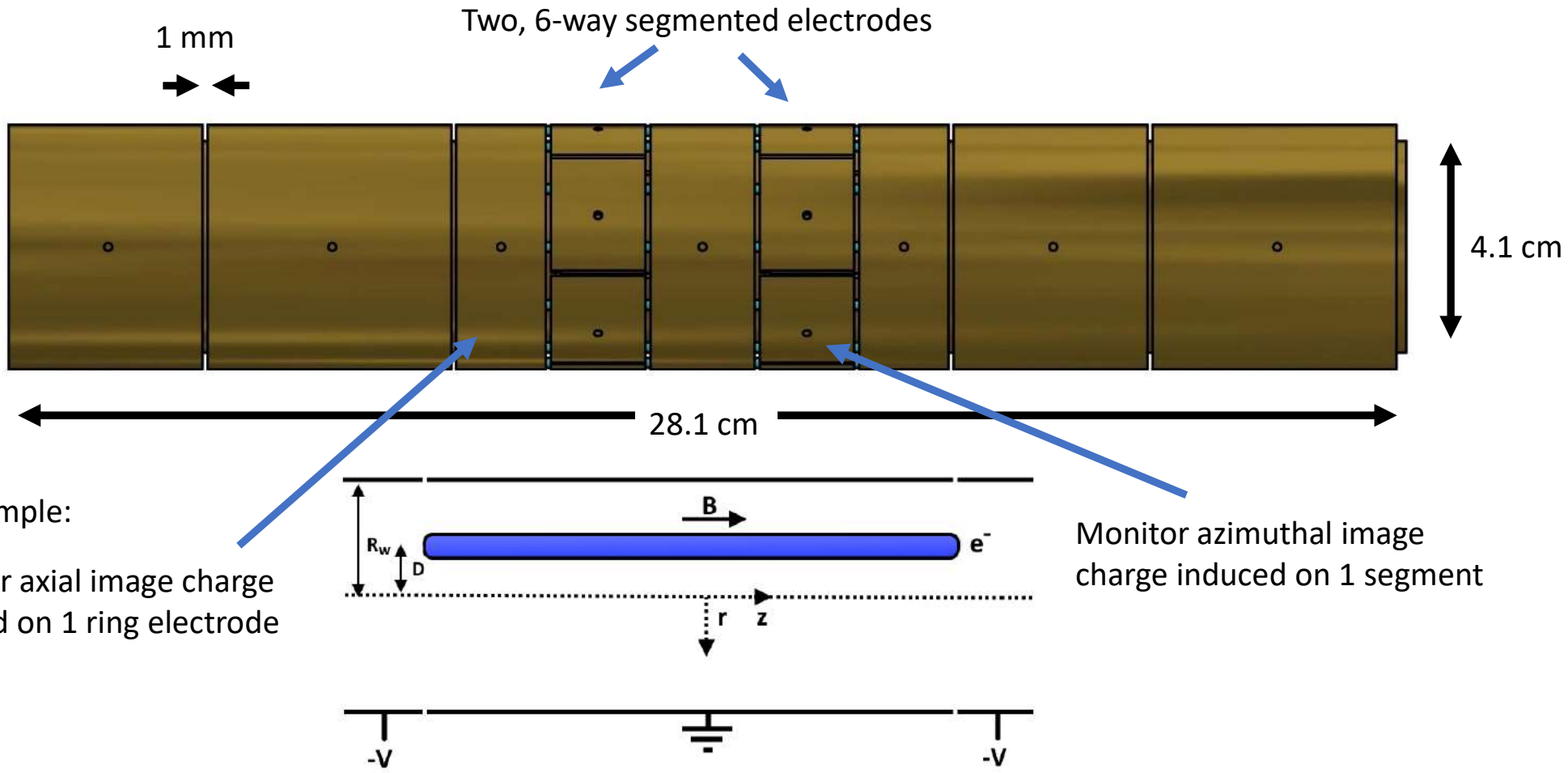
Non-destructive diagnostics (image charge)



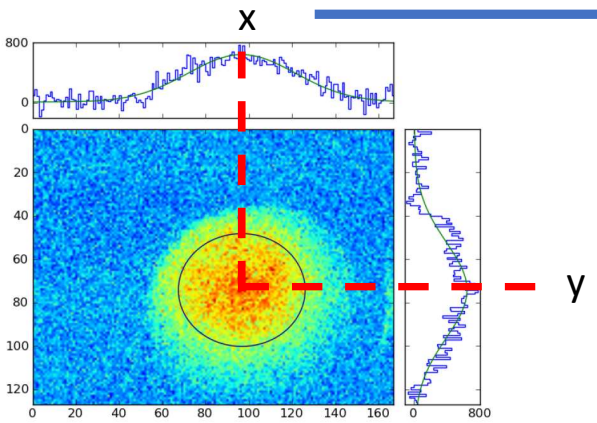
Similarly, if the motion is axial, (instead of radial) the induced image charge could somehow probed at a specific axial location (e.g. ★) so that a signal can be recorded. This signal can also be compared to theory & plasma parameters determined.

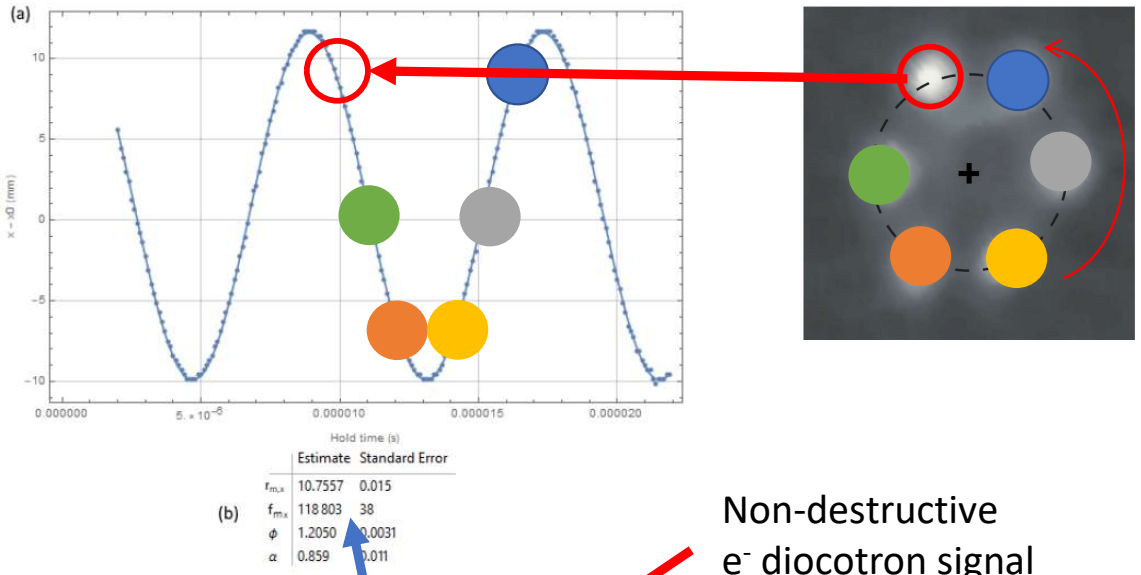
T. Savage, MRes Thesis, Swansea University, 2018

Storage trap assembly - current

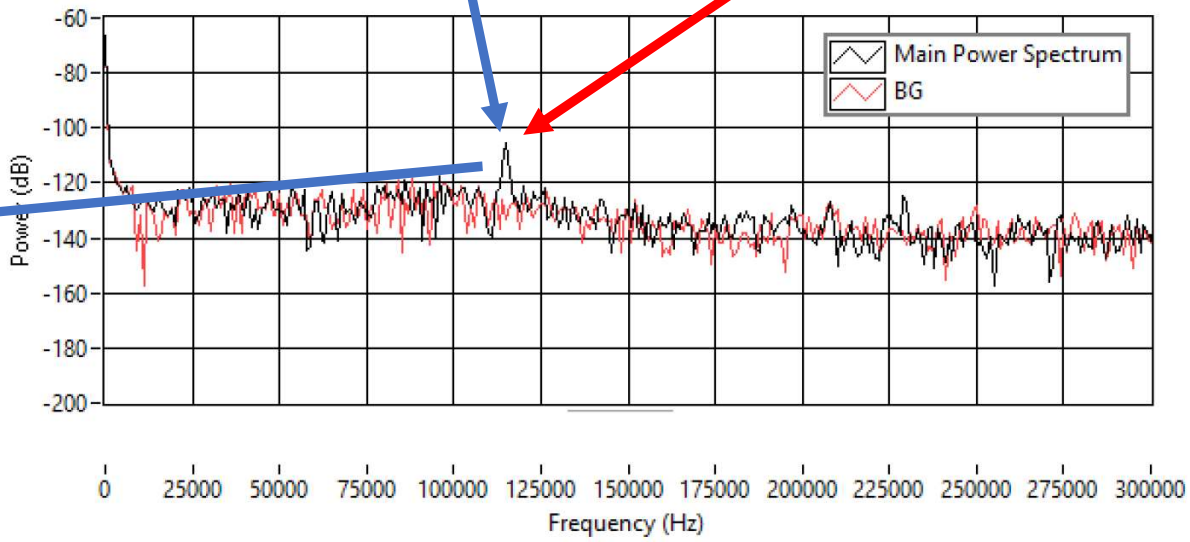


e⁻ Diagnostics….





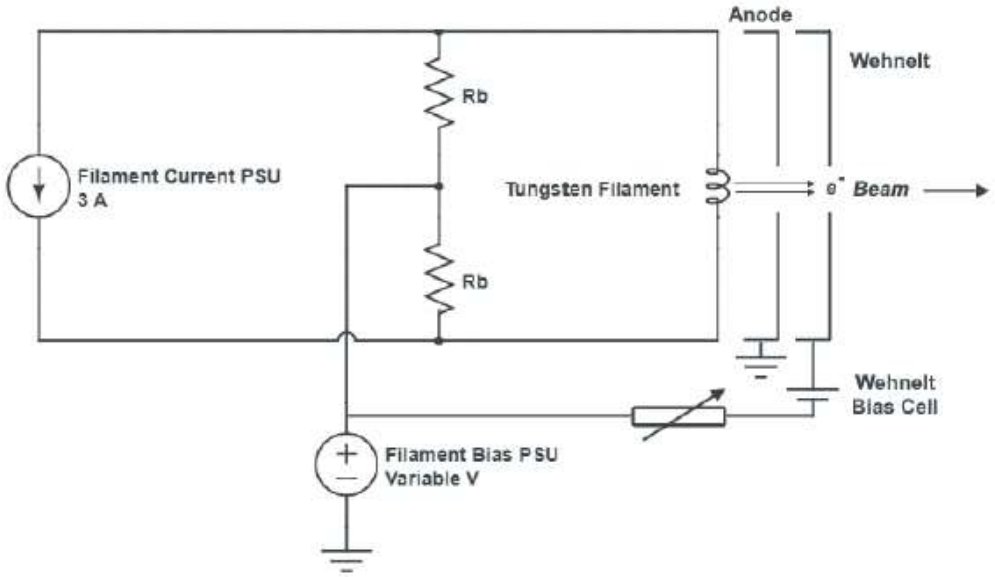
Non-destructive
e⁻ diocotron signal



$$f_1 = \frac{eN}{4\pi^2 \epsilon_0 L_p B r_w^2}$$

N ~ 1.5x10^7, σ_r ~ 1 mm, L_p ~ 1 cm
ρ ~ 10^{15} m^{-3} ϕ~15 V

Electron source



- 90W home-wound W-filament on manipulator (radial positioning)
- Typically 25uA at 30 V with 1-2 eV spread
- r ~ 0.5 – 1 mm in trap
- Simple beam capture $N_z \sim 10^6$ cm^{-1}
- Other loading techniques trap more

Planned Experiments at Swansea

- Titus Dascalu