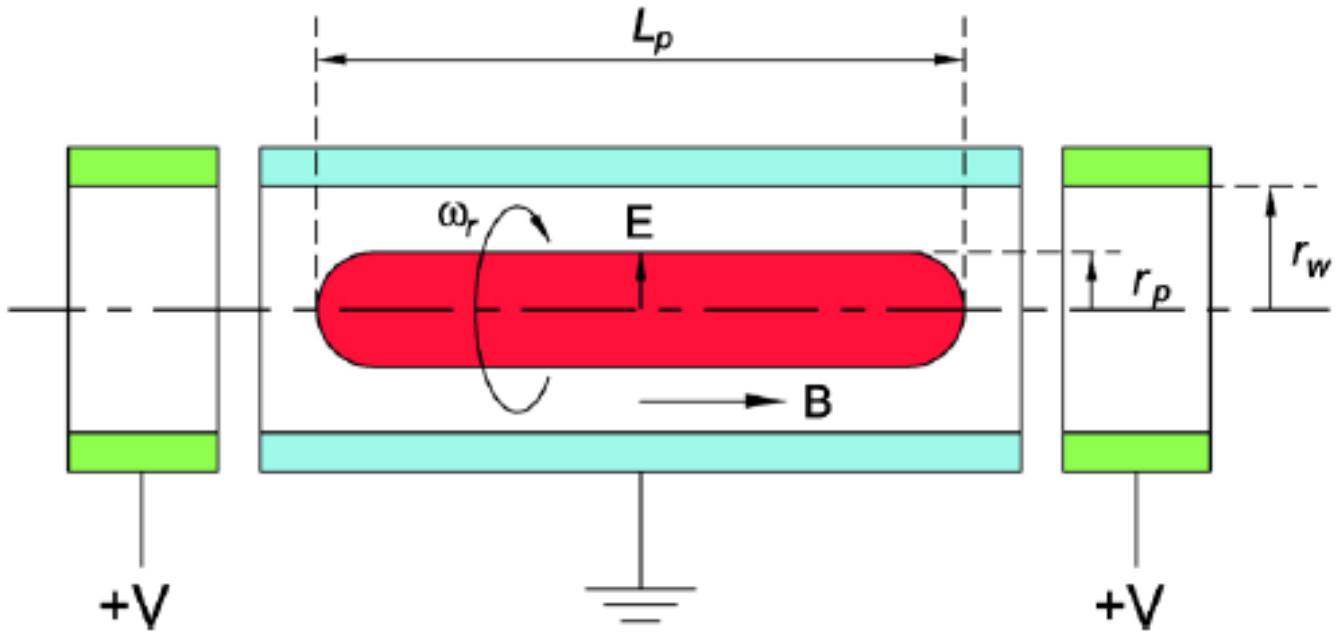
IC Locals Meeting

15th October 2021

Titus Dascalu

Penning-Malmberg trap



10.1103/RevModPhys.87.247

Aims of the proposed experiments at Swansea

A – Validation: confined electron plasmas **vs.** PIC simulations (VSim)

- Build models to predict results of existing diagnostics.
- Inform us on the suitability of the PIC code to do **predictions** on the confinement of an electron plasma in the **next design** iteration of the Gabor lens.

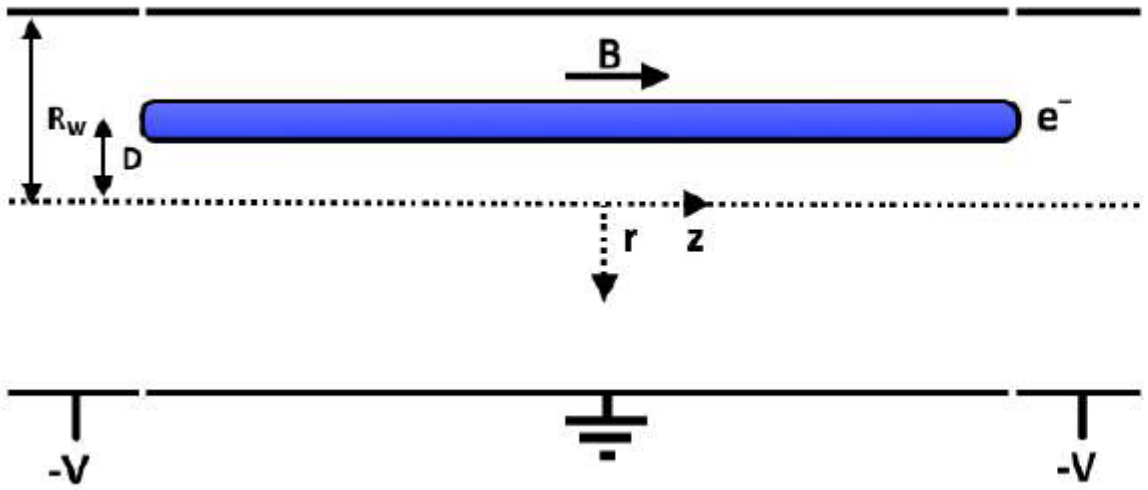
B – Development:

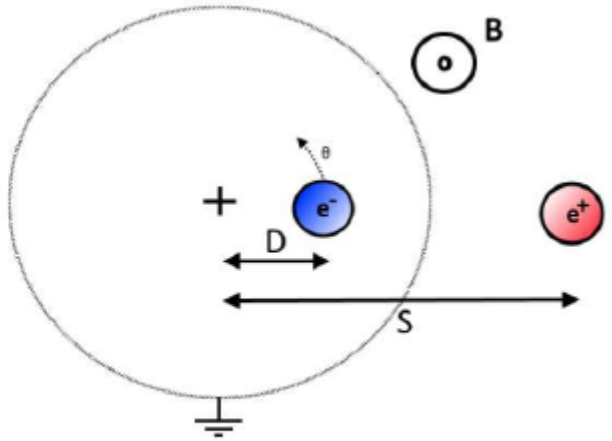
- Investigate the experimental limitations of the lens in relation to the focusing properties called for by the design of LhARA.

C – New measurements:

- Measure focusing of positron beam by electron cloud.

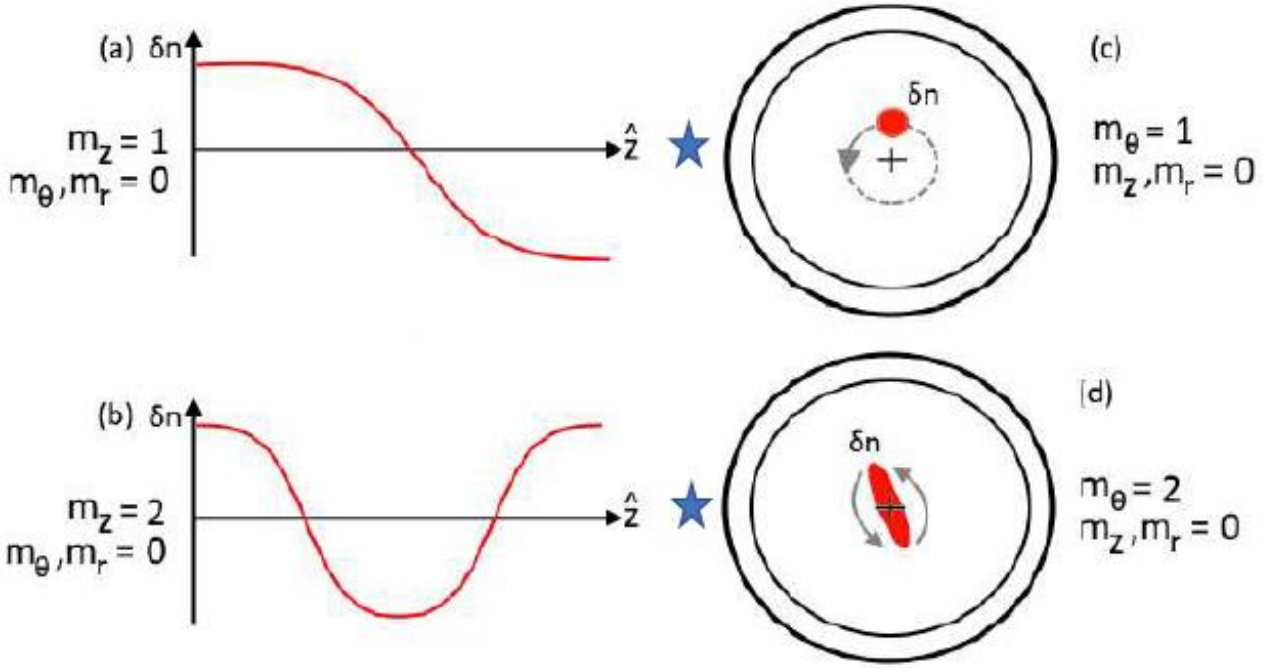
Diocotron drift





T. Savage, MRes Thesis, Swansea University, 2018

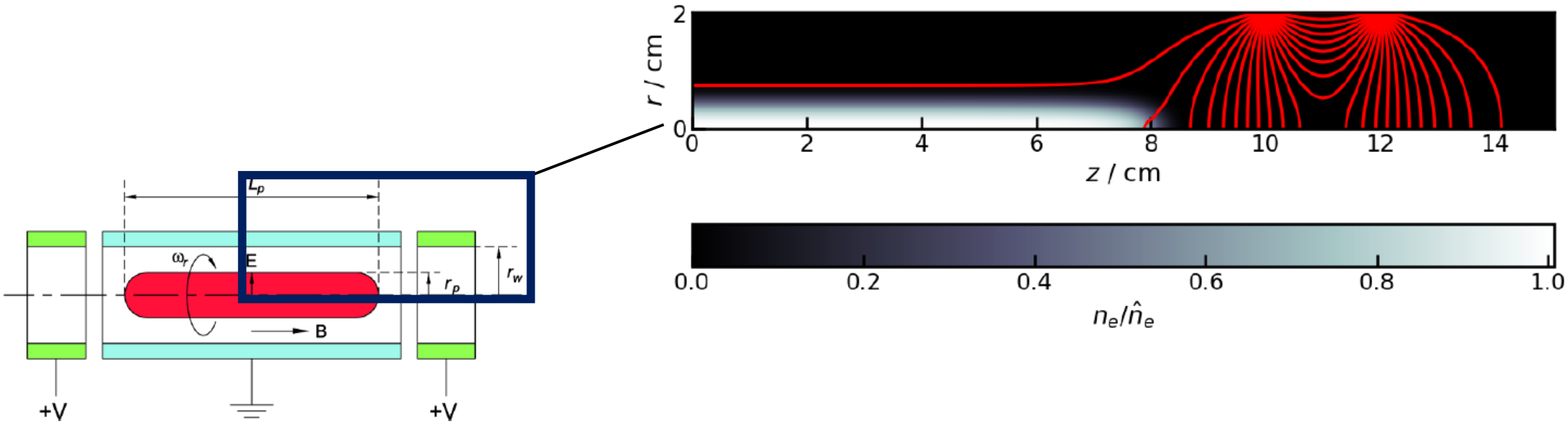
Diocotron drift



T. Savage, MRes Thesis, Swansea University, 2018

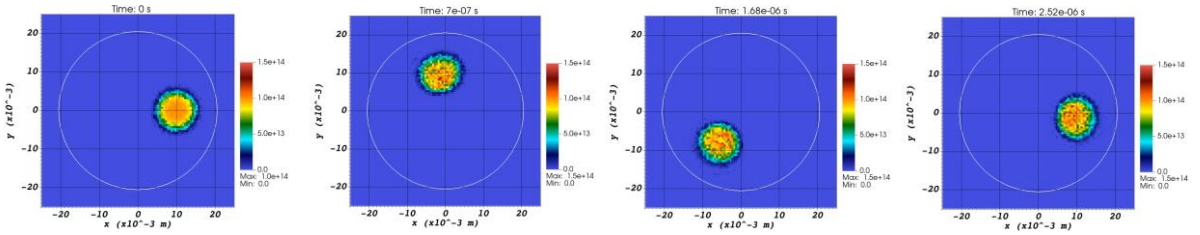
Diocotron drift

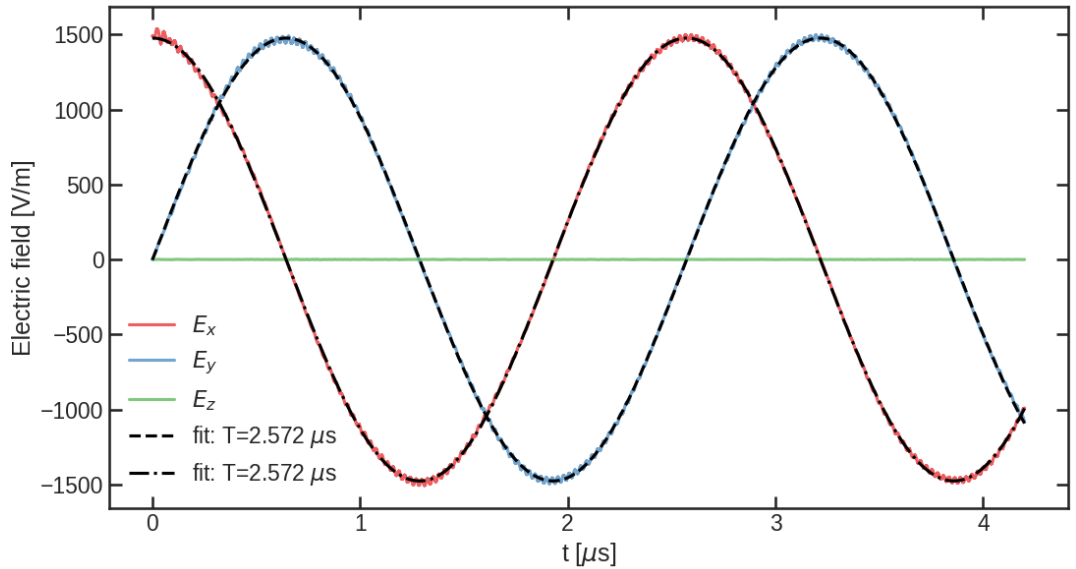
- Diocotron motion can be simulated with particle-in-cell (PIC) codes
  - Calculate equilibrium distribution of the confined plasma from 2D Poisson equation
  - Displace the plasma column radially and observe the motion



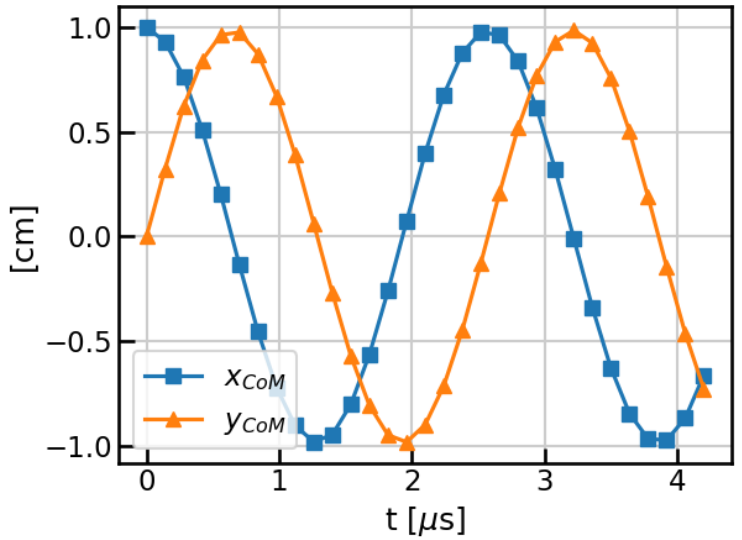
Diocotron drift

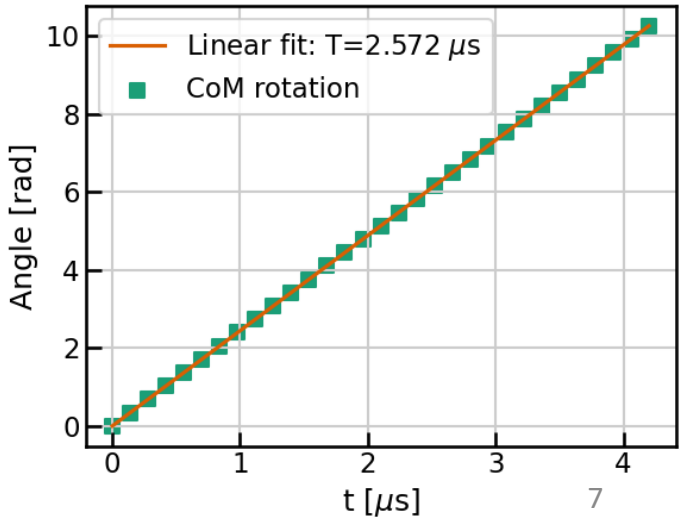
- Extract period from:
  a) Variation of the electric field at the centre of the trap





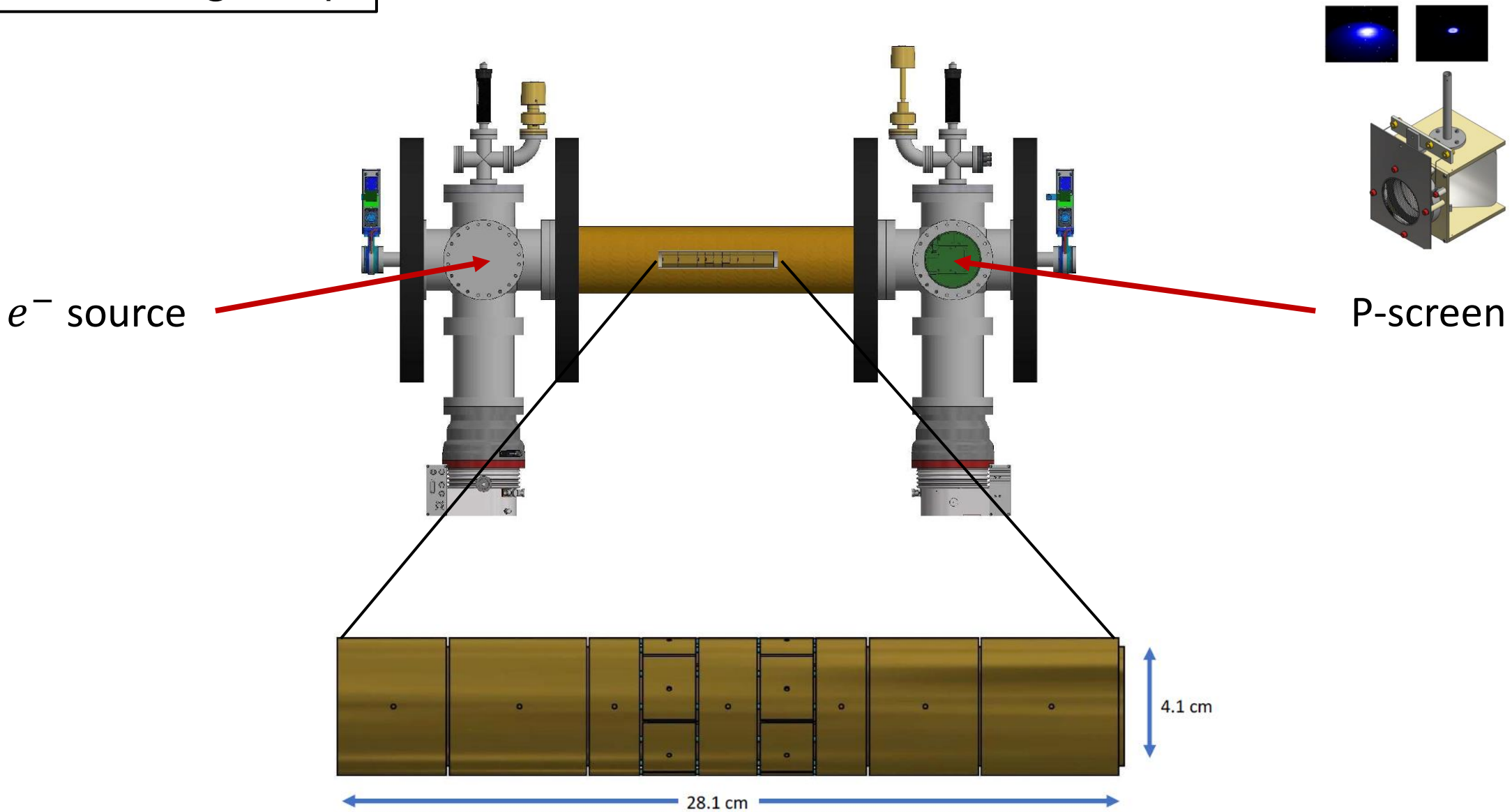
  b) Motion of the centre of mass of the plasma





Swansea positron beamline

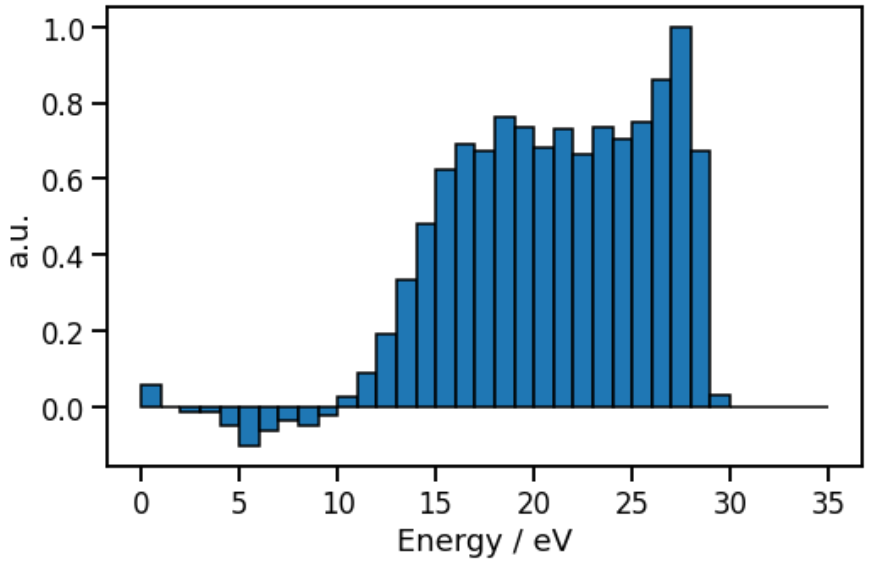
Swansea storage trap

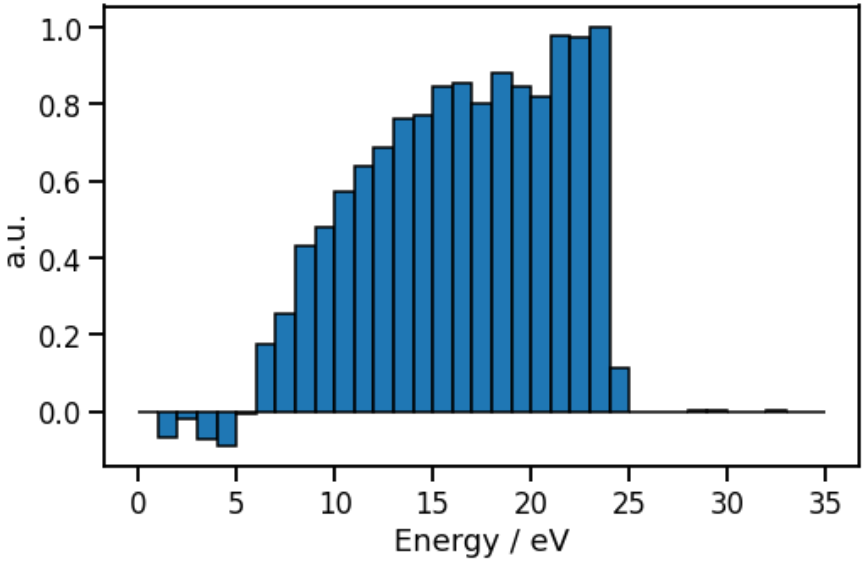


(Images from C. Baker)

Electron source

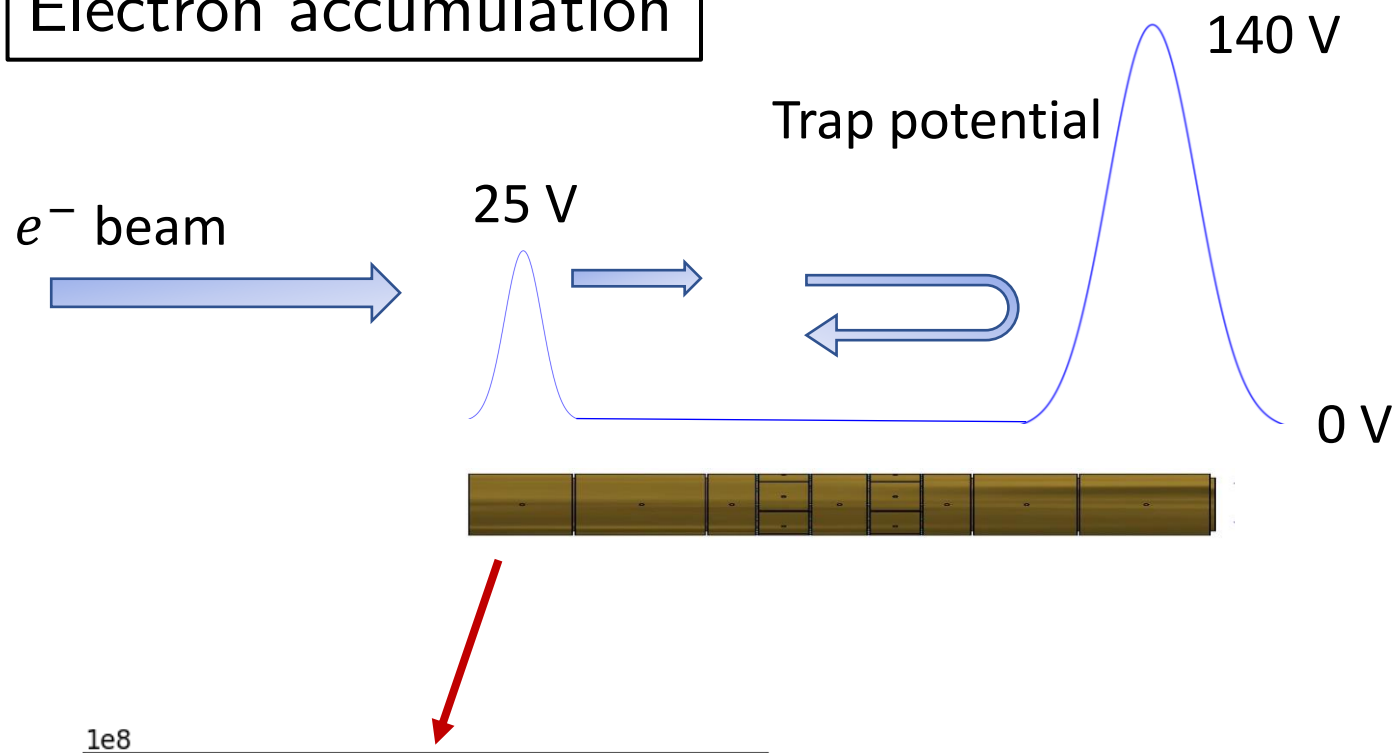
- W-filament on manipulator
- Beam currents typically 1-2 uA
- Relatively wide beam energy spread

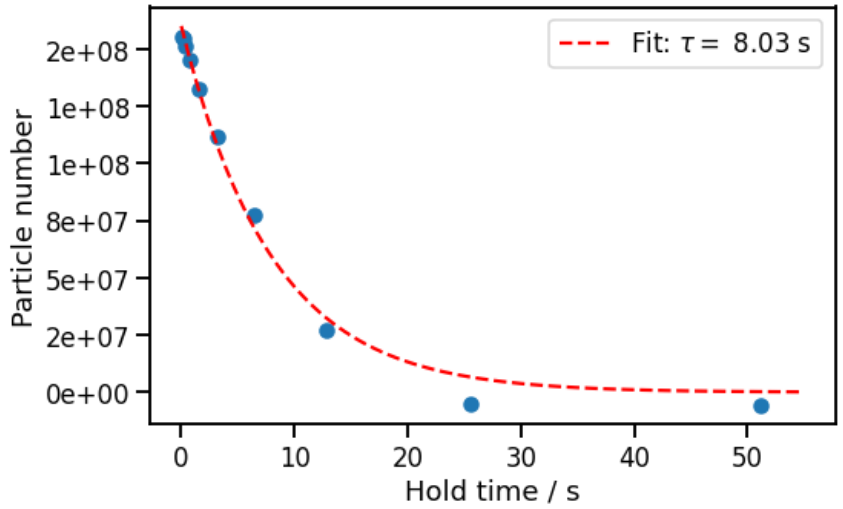


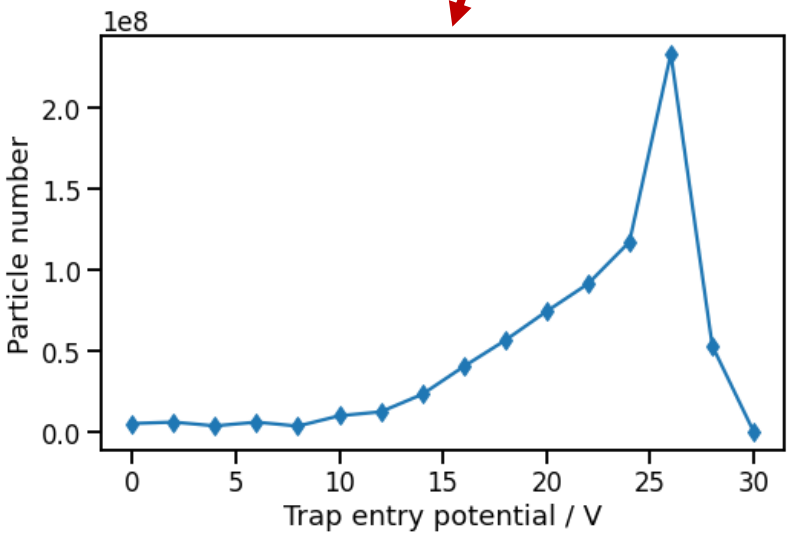


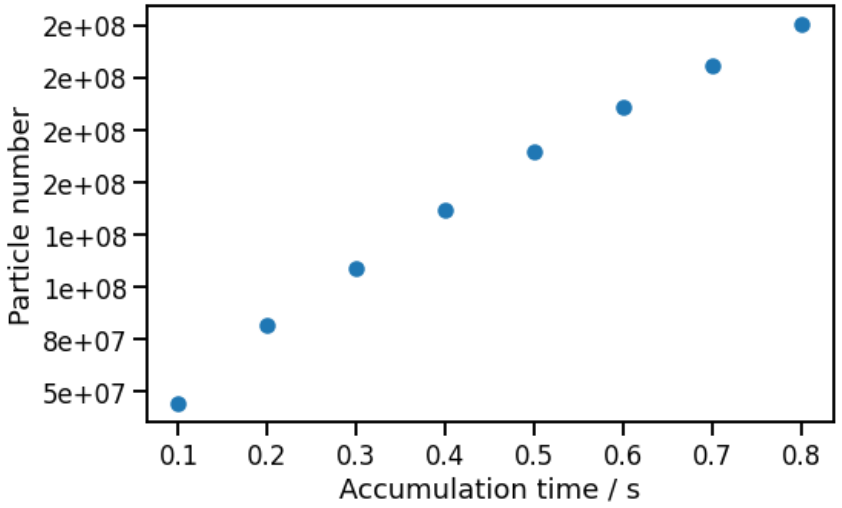
Accelerating voltage
difference applied to source: 30 V 25 V

Electron accumulation

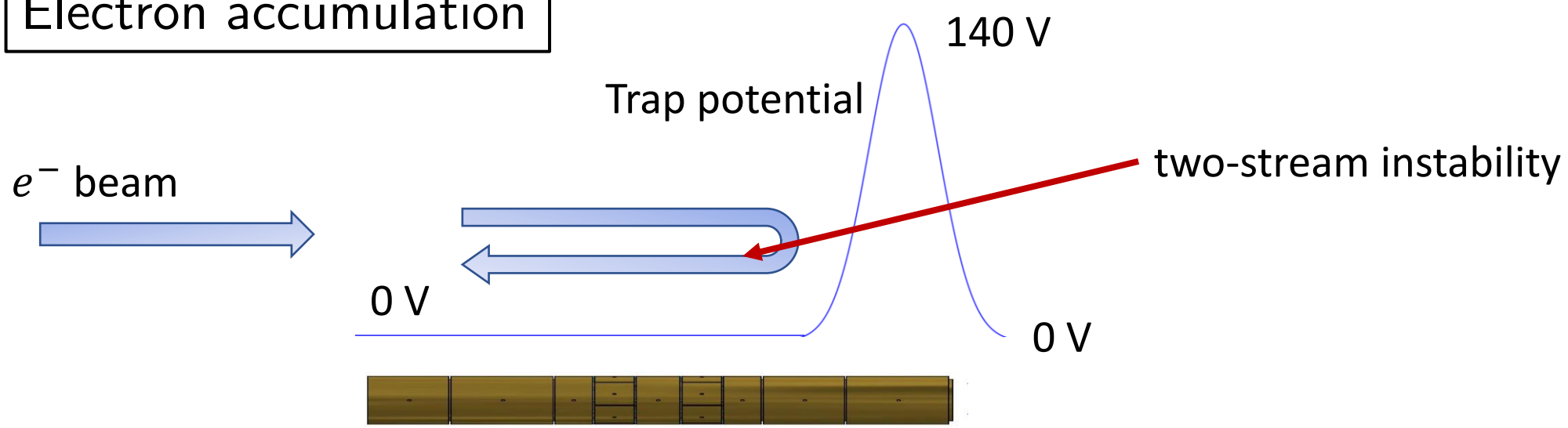


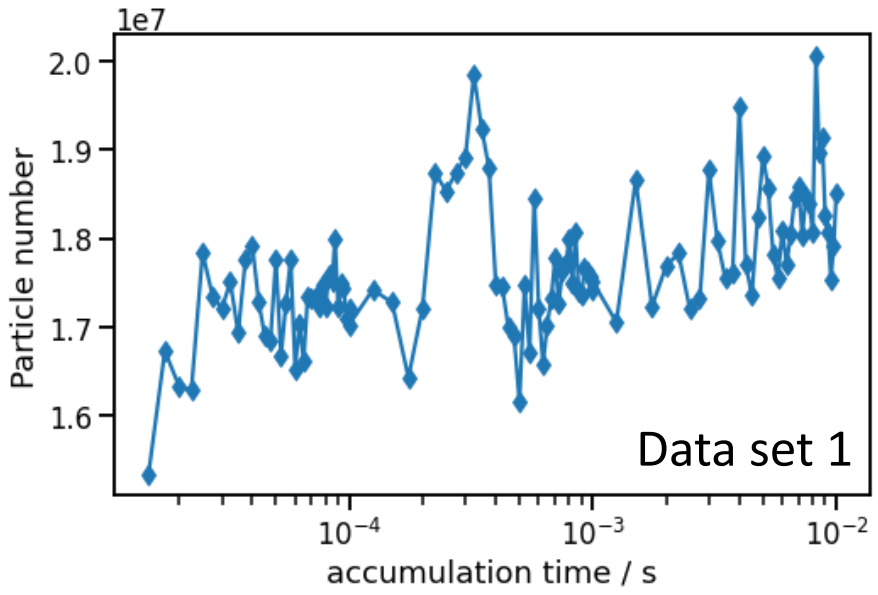


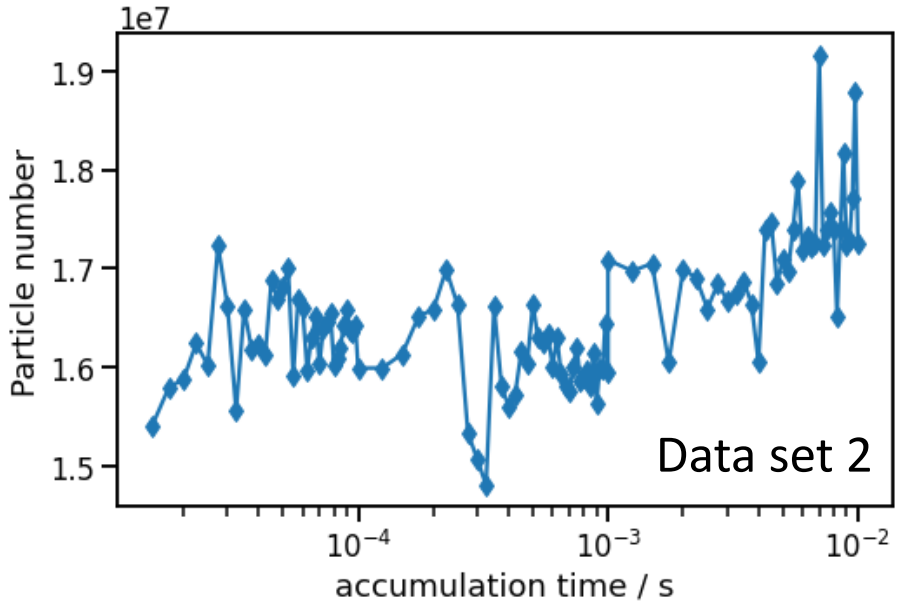




Electron accumulation

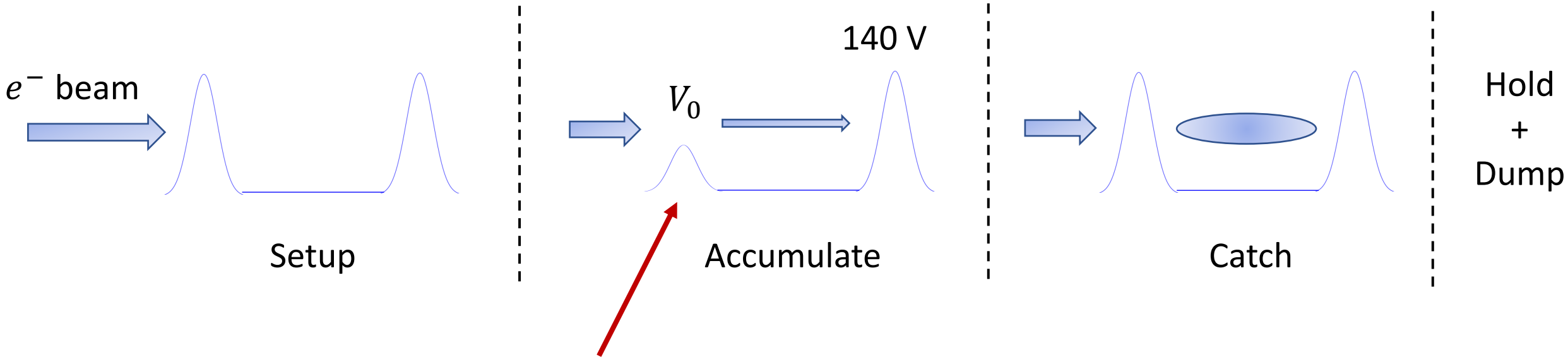






Beam catching

- Used for studying the diocotron motion

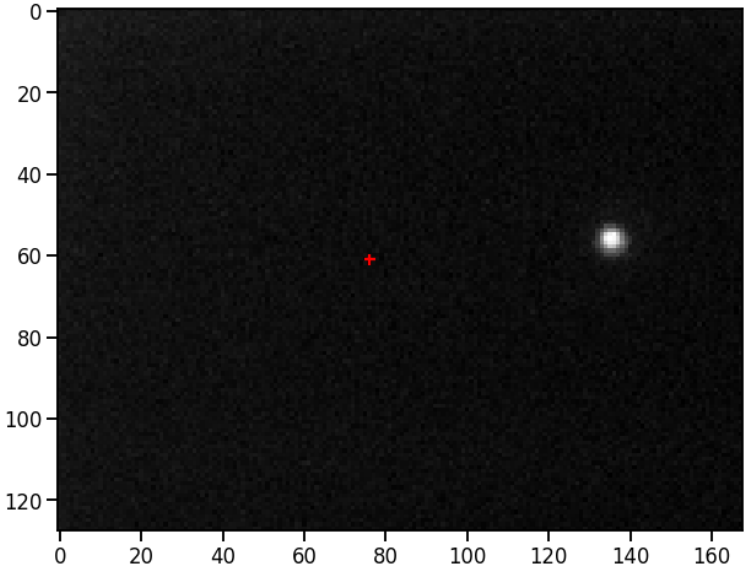


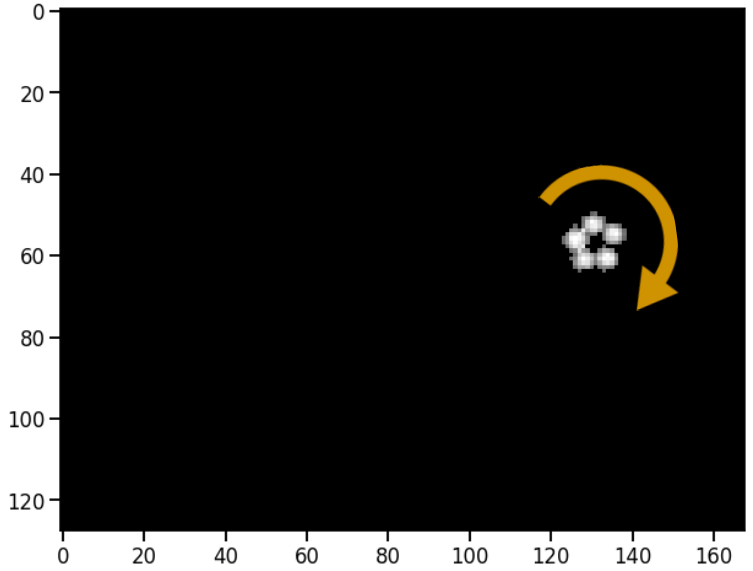
Time required for gate to
"open&close" limited to ~30 μs

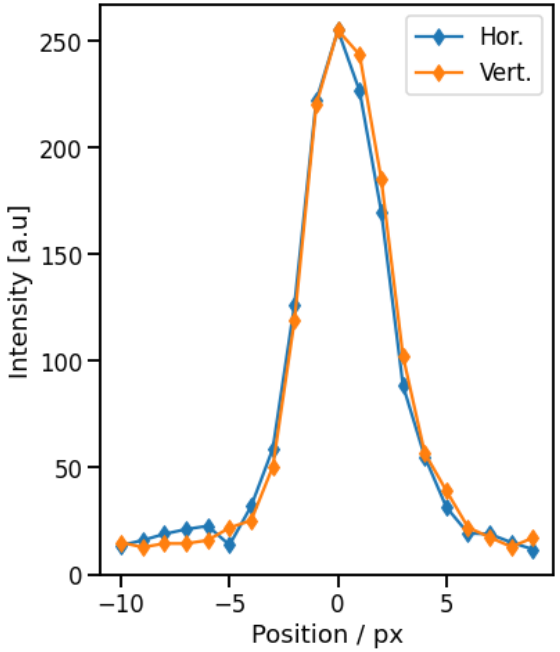
Diocotron motion

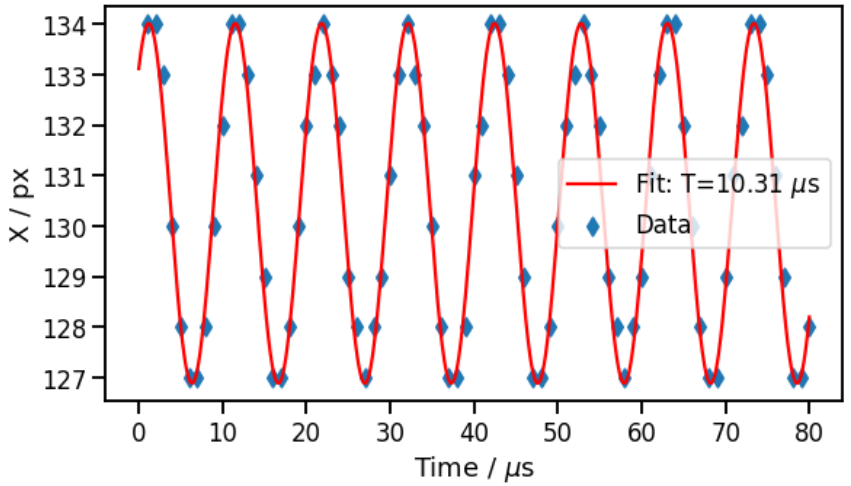
- Thin plasma column
- Low charge (V_0 = 20V)
- Small amplitude

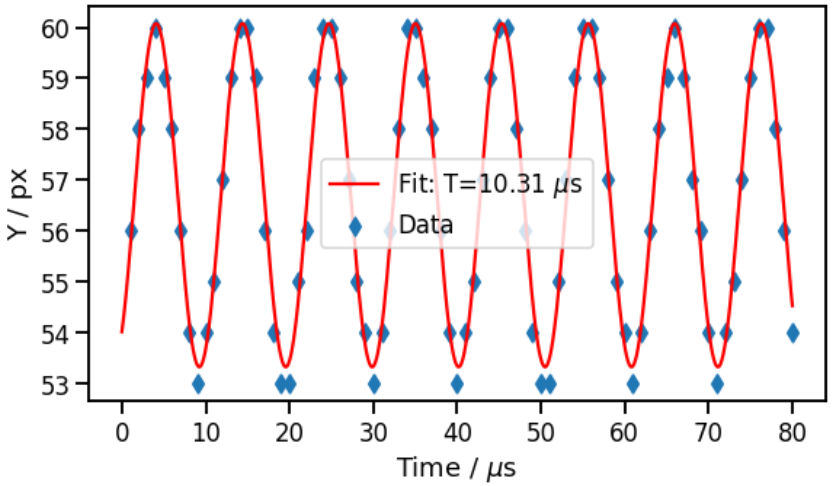
P-screen image







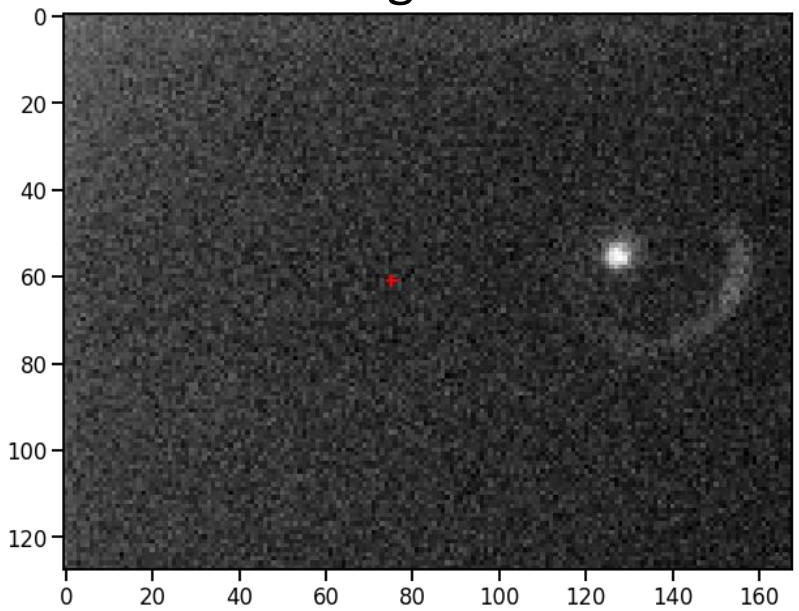


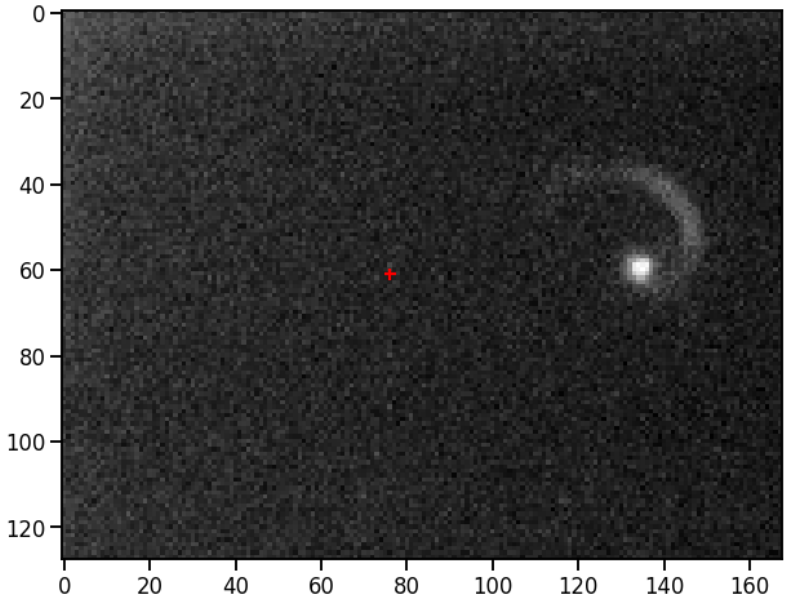


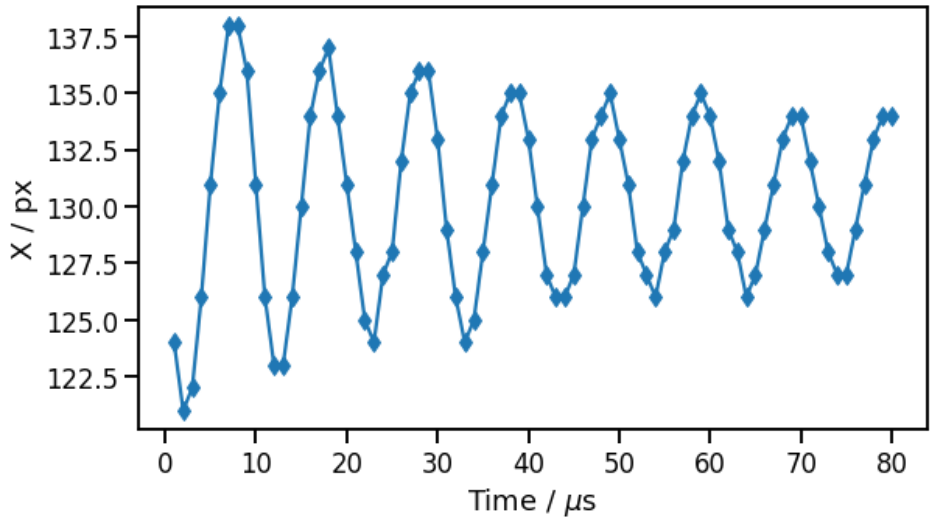
Diocotron motion

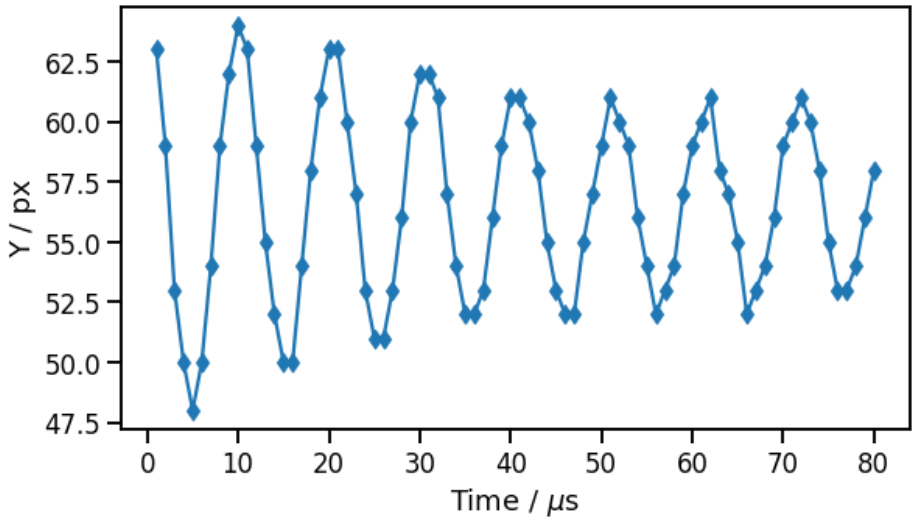
- Larger amplitudes lead to formation of a ‘tail’

P-screen image





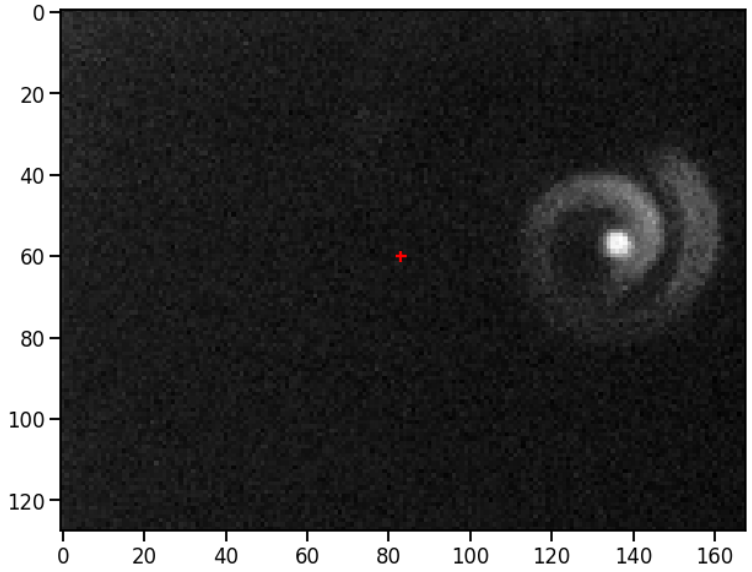


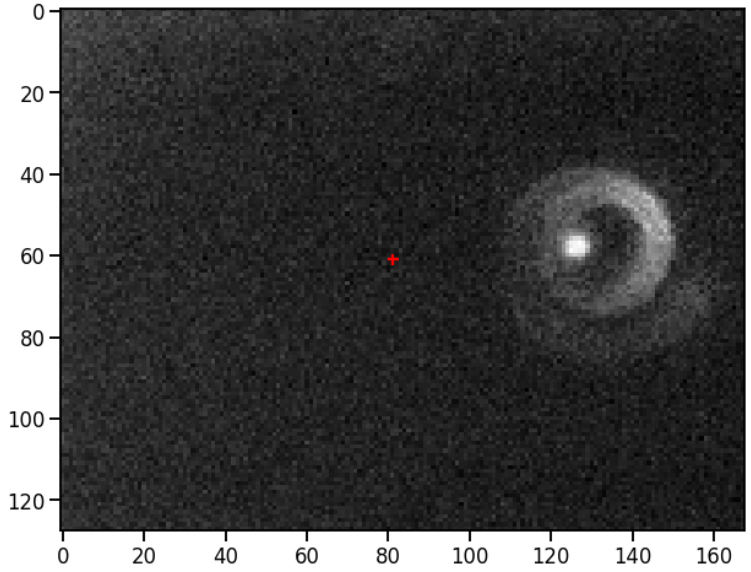


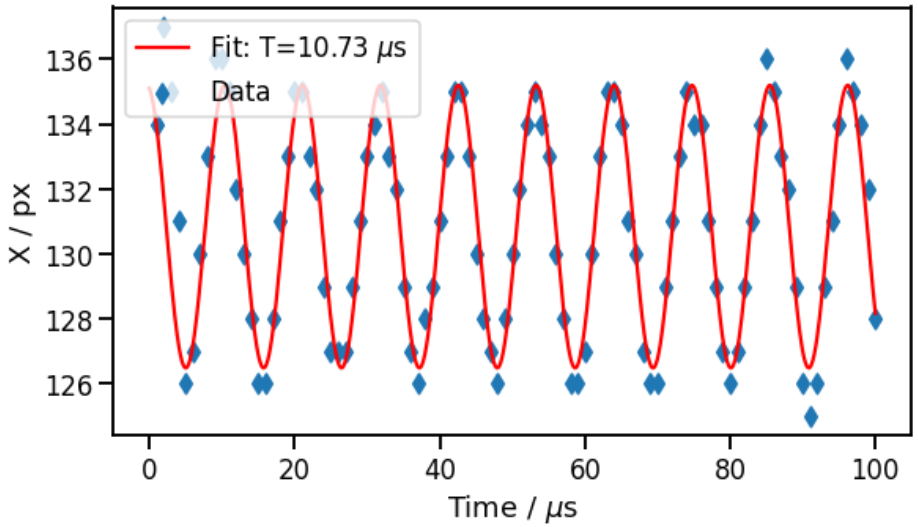
Diocotron motion

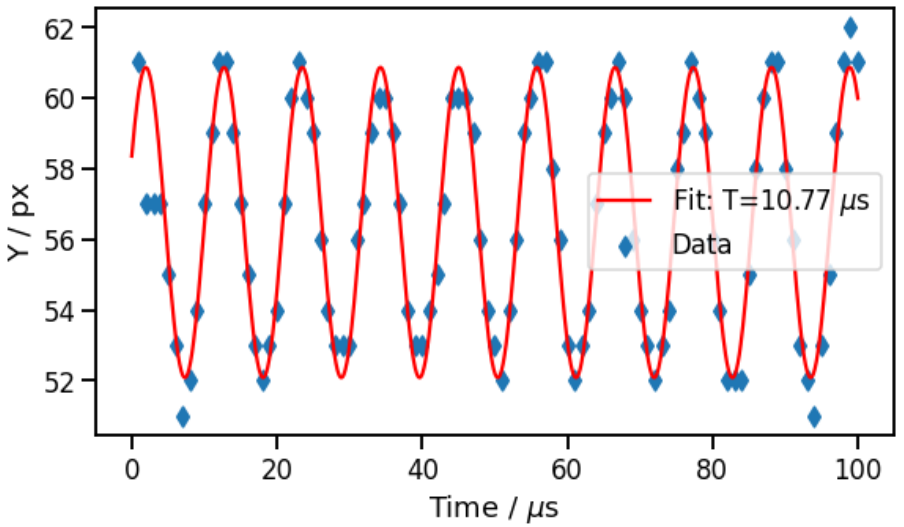
- Higher charge (V_0 = 0V)
  - ~ 4 times higher
- Small amplitude

P-screen image









Further observations

- ‘Tails’ start to appear for higher space-charge when
  - The beam current increases
  - Gate potential V_0 decreases

- Gate response time is comparable with the diocotron period
  - Captured electrons start to rotate while beam is still injected into the trap

- Next step:
  - Capture and accumulate beam on-axis + kick the plasma column radially