LhARA Capture Meeting

29th July 2021

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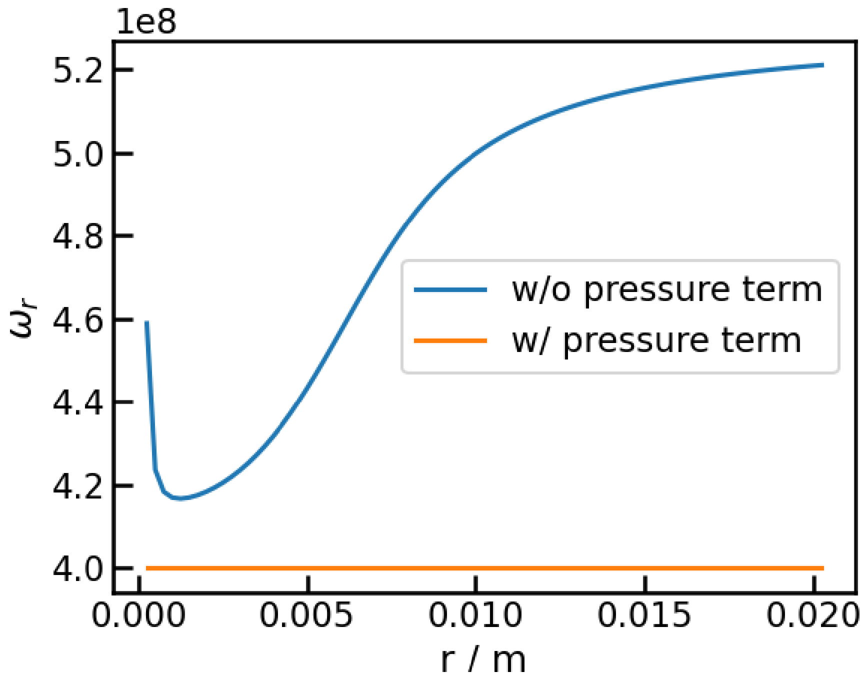
Diocotron motion

Electron plasma initial distribution

- From last week..

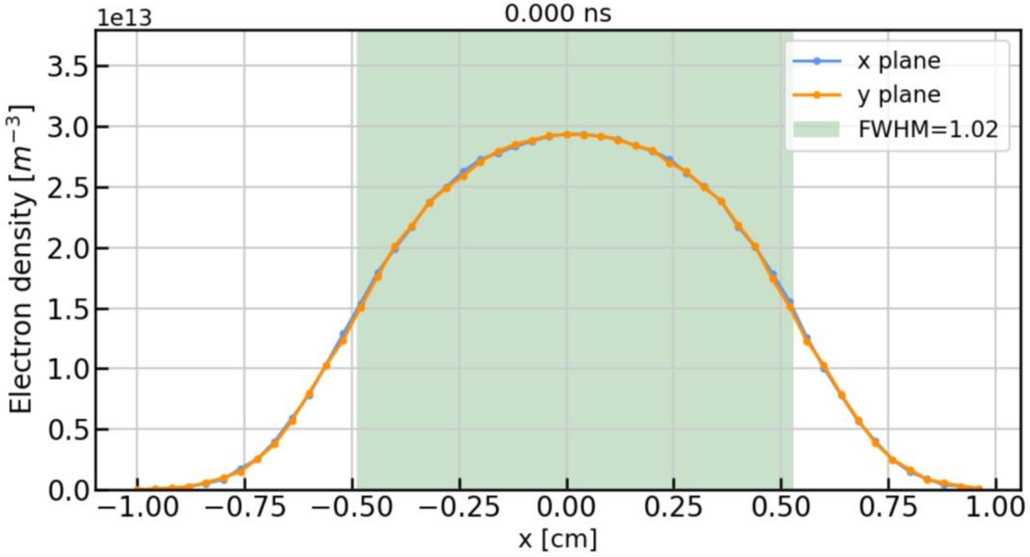
$$\omega_r = \frac{E_r}{Br} - \frac{k_B T}{qBrn}\frac{\partial n}{\partial r} + \frac{\omega_r^2}{\Omega_c}$$

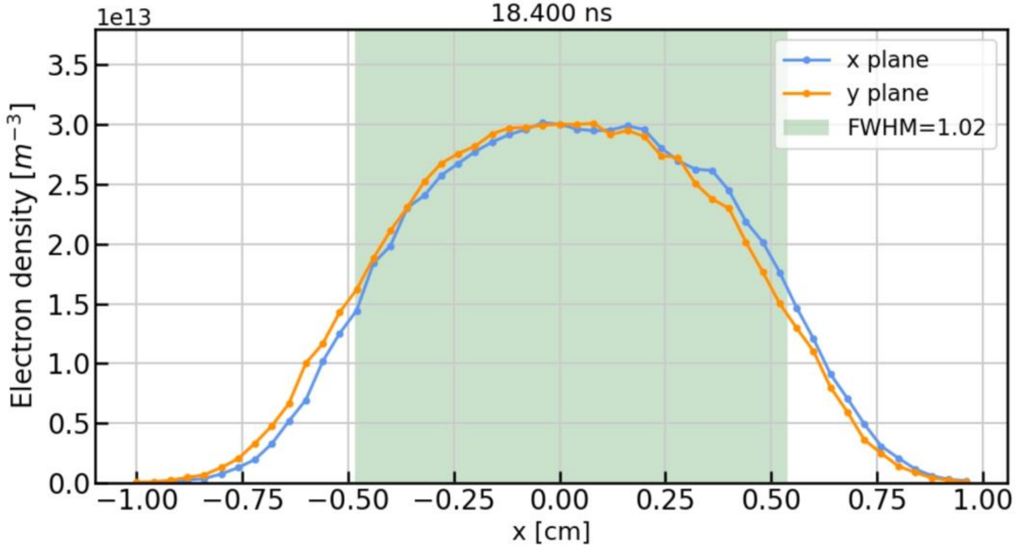
thermal pressure term



Electron plasma initial evolution

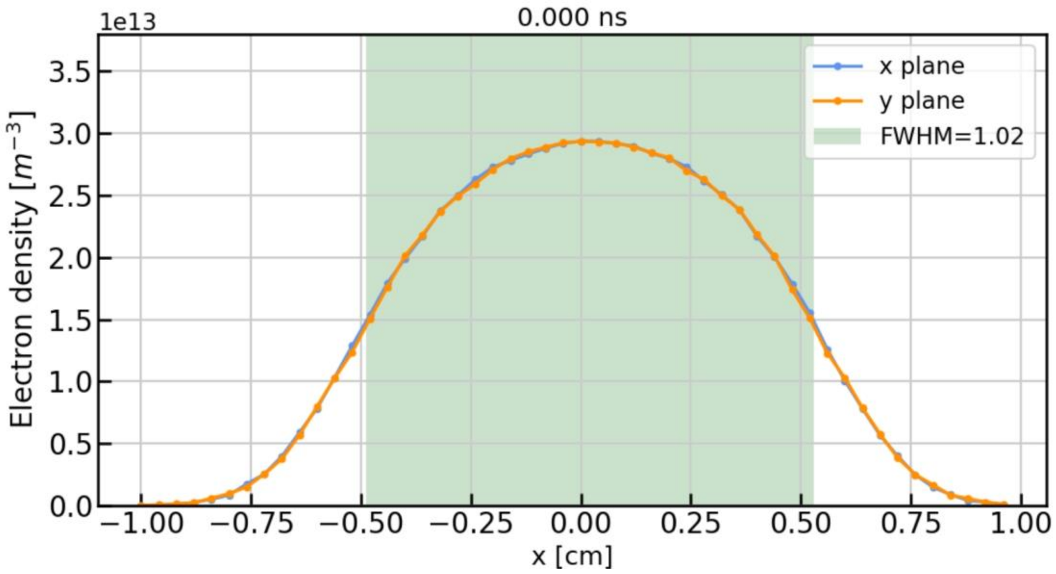
- Local ω_r initialised according to no pressure model
- Plasma temperature set to $T = 0$ eV in the rotating frame

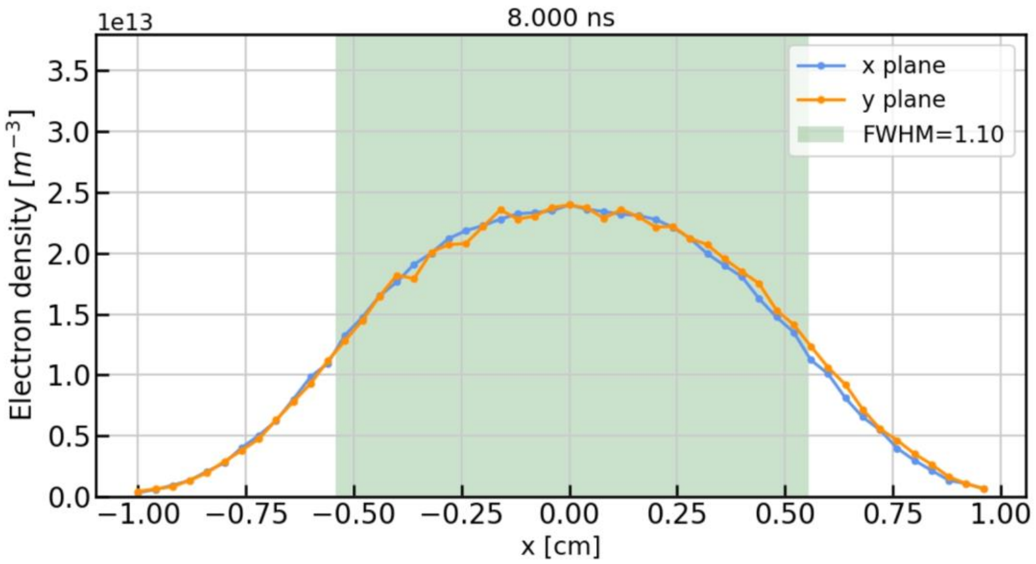




Electron plasma initial evolution

- Local ω_r initialised according to no pressure model
- Plasma temperature set to $T = 1$ eV in the rotating frame





Plasma initialisation scheme

Assumptions

- The diocotron frequency is mostly determined by spatial profile of the plasma column
- The profile of the electron cloud does not change significantly from the equilibrium distribution in either
  - Offsetting the plasma from the axis
  - Beam capture

Plasma initialisation scheme

$T_e \sim$ 0.1 eV – 1.0 eV (close to values from experiment)

ω_r set to generate a radial profile close to experiment (plasma uniform up to radius $\approx$ 1 mm)

Calculate the 2D (r,z) plasma profile by solving full Poisson equation for electron plasma in thermal equlibirum at T_e

Load the axisymmetric 2D profile into VSim

- set local ω_r according to the equilibrium equation in the absence of pressure ($T = 0$ eV) to avoid radial expansion of plasma and drop in density
- in the z-direction sample velocities from Gaussian with temperature T_e

Set the grid size as a fraction of the Debye length $\lambda_D(T_e)$

Couple of checks throughout the simulation

- check velocity distribution to make sure macroparticles satisfy CFL condition
- calculate local T and λ_D in each cell and compare latter to max. grid dimension

Diocotron simulation – Parameter Set 1

Main constraints:

$$f_\infty = \frac{cNe}{\pi B R_w^2}$$ → required total simulation time

$$\lambda_D = \sqrt{\left(\frac{\varepsilon_0 k_B T}{n_0 e^2}\right)}$$ → grid spacing

ω_r, T → time step (from CFL condition)

Parameter	**Value**
n_e [m^{-3}]	1×10^{15}
B [T]	0.03
V_{gate} [V]	100
r_p [mm]	1.5
L_p [cm]	≈ 2
d [cm]	1
T [eV]	~ 1
Estimated T_{dioc} [μs]	≈ 3