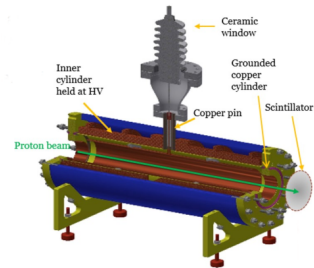


Summary of Gabor lens simulation

Titus Dascalu

October 1, 2020

Gabor lens - Previous prototype



Engineering drawing

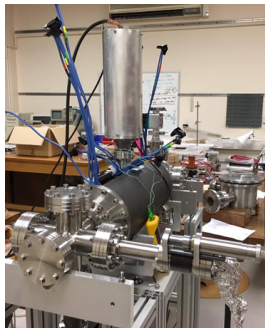
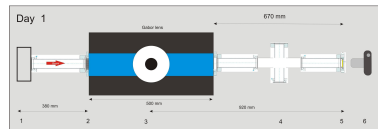


Photo of the setup



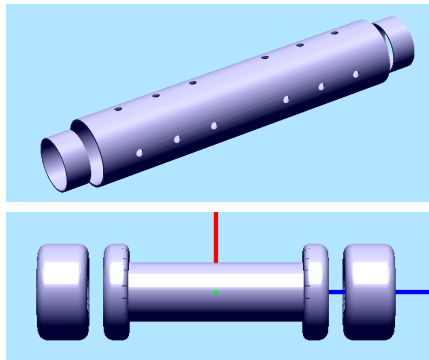
Experiment

- ▶ Simulate the dynamics of the confined electron plasma using a PIC code (VSim)
- ▶ Aim: understand the beam measurements done at Surrey and improve design

Main parameters of the lens

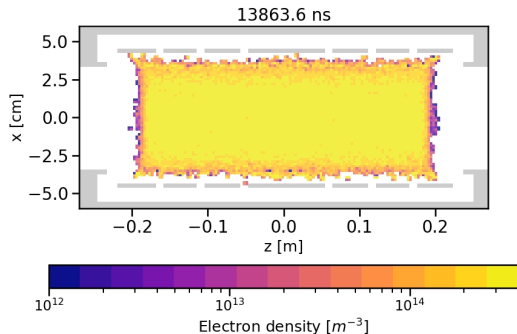
Parameter	Value
Electron density	$\sim 1 \times 10^{15} \text{ m}^{-3}$
Magnetic field	20 – 100 mT
Electrode voltage	10 – 60 kV
Simulation time	$\leq 10 \mu\text{s}$

- Initial condition for the plasma:
1. thermal equilibrium ($T \sim 100 \text{ eV}$)
 2. rigid rotor motion

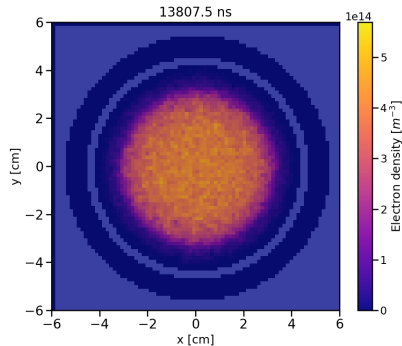


Electrode geometries visualised in VSim

Previous prototype - results



Longitudinal cross-section



Transverse cross-section

- ▶ The plasma column is stable for the simulated times (of order $10 \mu s$)
- ▶ The electron cloud is rotating around the central axis

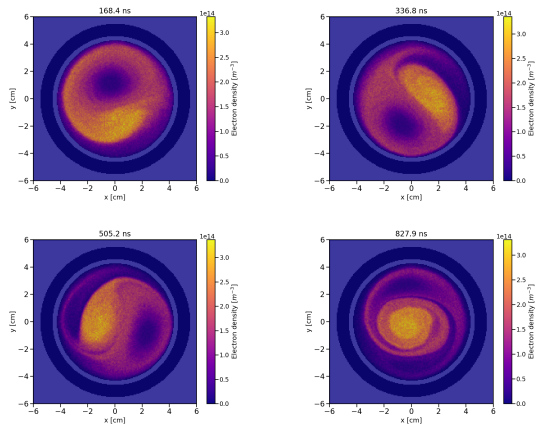
Previous prototype - results



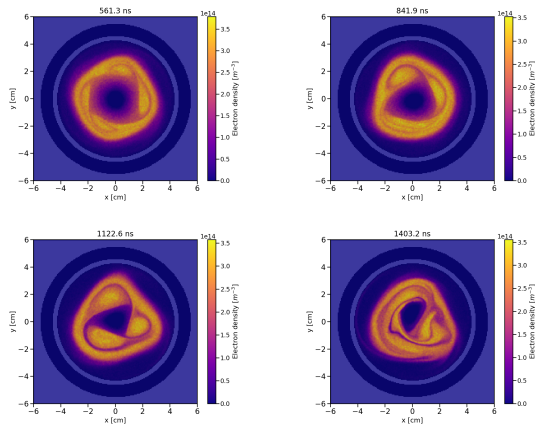
Longitudinally averaged electron density vs. transverse dimension

- ▶ The electron cloud has a radial extension smaller than anode radius (dashed lines)
- ▶ Pseudo-flat plateau at $\sim 60\%$ of nominal electron density between ± 2 cm
- ▶ Negative radial gradient of the electron density is consistent with a stable plasma

Instabilities



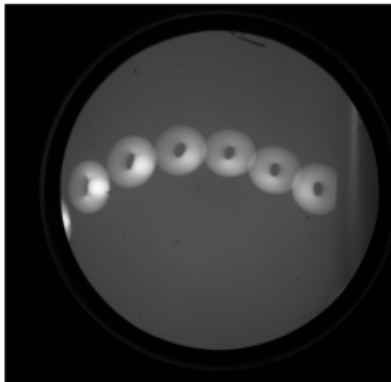
(1)



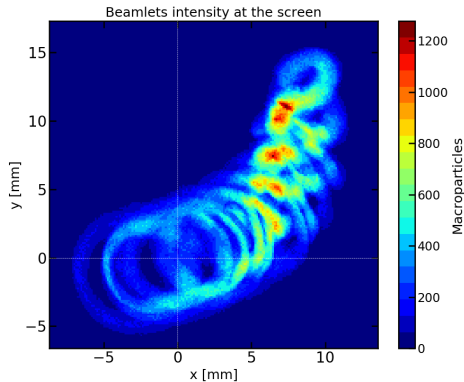
(2)

- Induced by the initial plasma distribution (radial gradient, rotation speed etc.)

Beamlets profile vs measurement

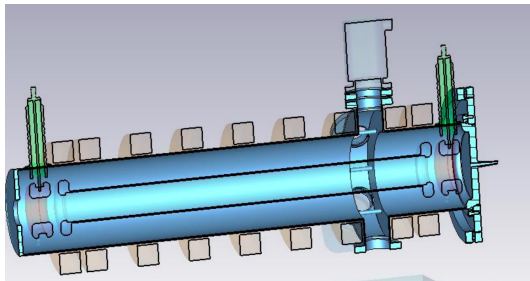


Measured beam intensity at 67cm downstream
of the Gabor lens

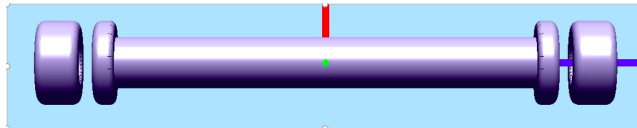


Beam intensity obtained with VSim for
instability (1)

Gabor lens - Current design

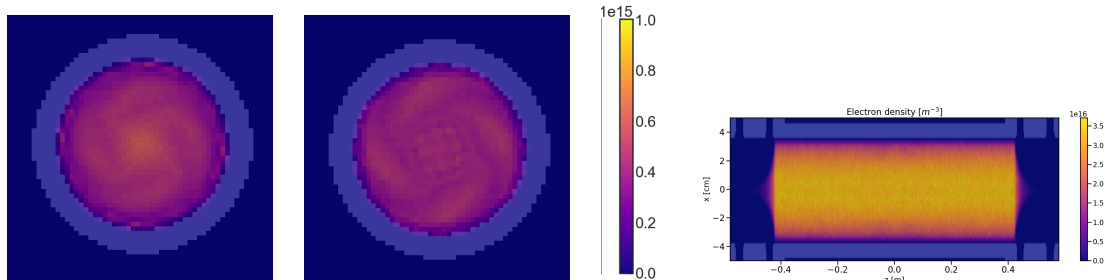


Updated drawing of the lens (from Colin Whyte)



Geometry visualised in VSim (central anode + lateral cathodes)

Current design - preliminary results



Transverse section through the plasma at 2 time frames

Longitudinal cross section

- ▶ Plasma column is rotating around central axis
- ▶ Periodic spiral-like patterns in the electron density distribution
- ▶ Longer simulation times are required to conclude whether instabilities occur