

LhARA Meeting

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August 11, 2020

Knowledge/Progress Since Pre-CDR on Laser Source Simulations

- 2D simulations may need a correction factor to better match to experiments
 - Simulations appear to give a cutoff energy of about 30 MeV, whereas given similar parameters only about 17 MeV is measured experimentally.

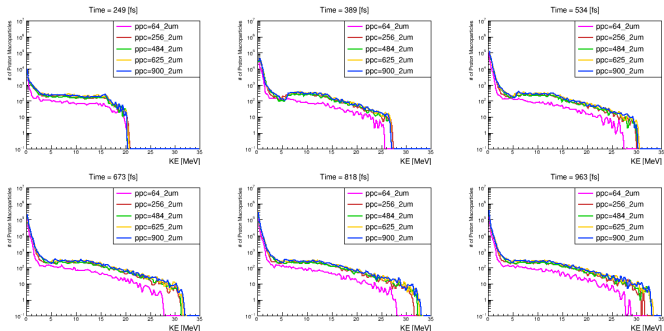


Figure: Convergence testing by varying the particle per cell (PPC).

- We may want to have a higher cutoff energy than necessary in order for 15 MeV to be located within the plateau region

Knowledge/Progress Since Pre-CDR on Laser Source Simulations

3 There is a spray of high energy electrons at the start (look at 280 fs plot)

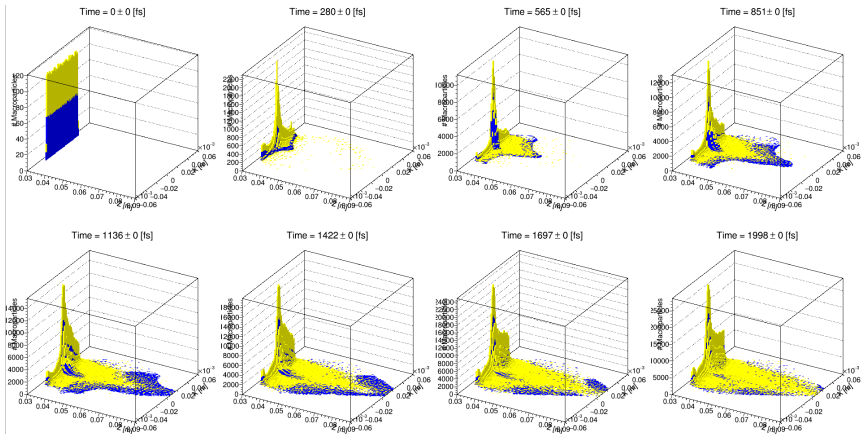


Figure: Distribution of electron (yellow) and protons (blue) overlaid.

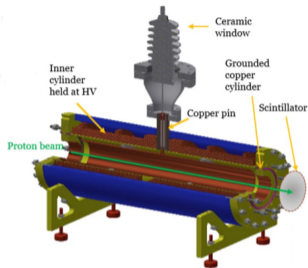
- ④ Likely will need a thin foil target (few microns or less)
- ⑤ Particle tracking in SMILEI potentially allows for a slightly more realistic simulated beam from source
 - EPOCH beam used in Pre-CDR had positions derived from Gaussian beam assumptions without longitudinal spread

Progress Since the Pre-CDR on Capture Simulations

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August 11, 2020

Gabor lens - Previous prototype



Engineering drawing

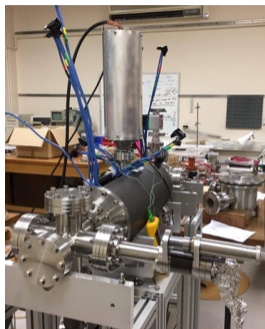
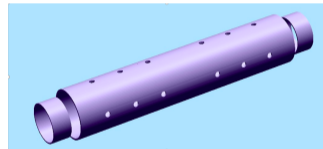


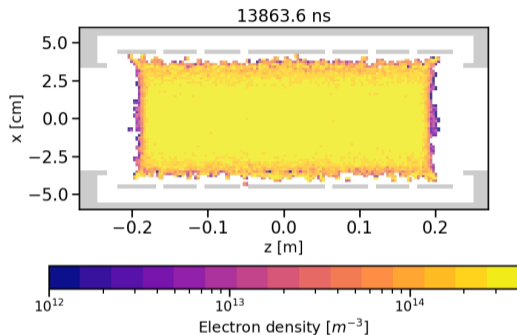
Photo of the setup



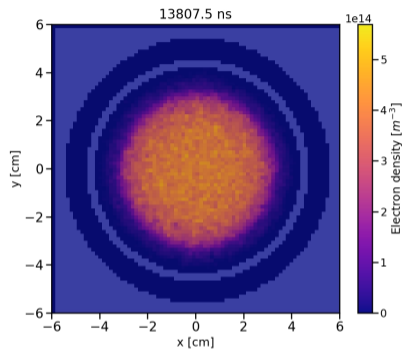
Geometry built in VSim

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

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
- ▶ The distribution of the focusing field can be extracted for use in beam tracking

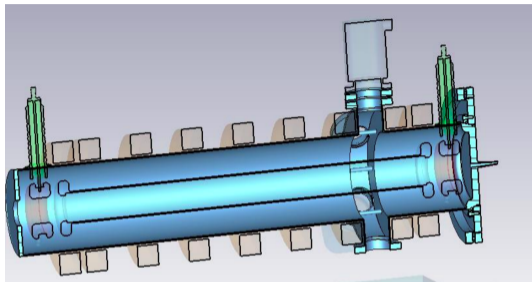
Previous prototype - results



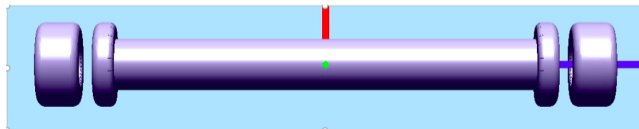
Longitudinally averaged electron density vs. transverse dimension

- ▶ 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

Gabor lens - Current design

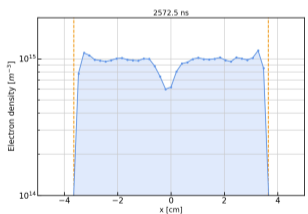
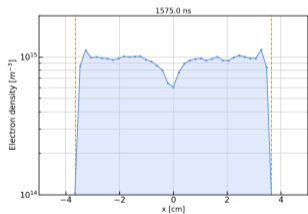
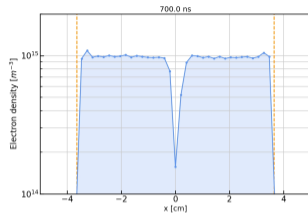
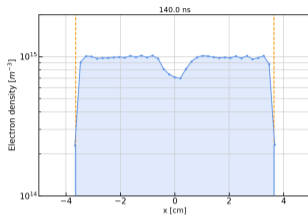


Updated drawing of the lens (from Colin Whyte)



Geometry visualised in VSim (central anode + lateral cathodes)

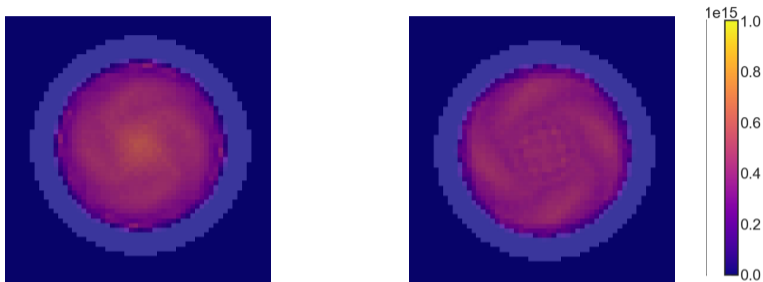
Current design - preliminary results



Longitudinally averaged electron density vs. transverse dimension

- ▶ Electrons are lost longitudinally from the region near the central axis

Current design - preliminary results



Transverse section through the plasma column and anode at two different time frames

- ▶ 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