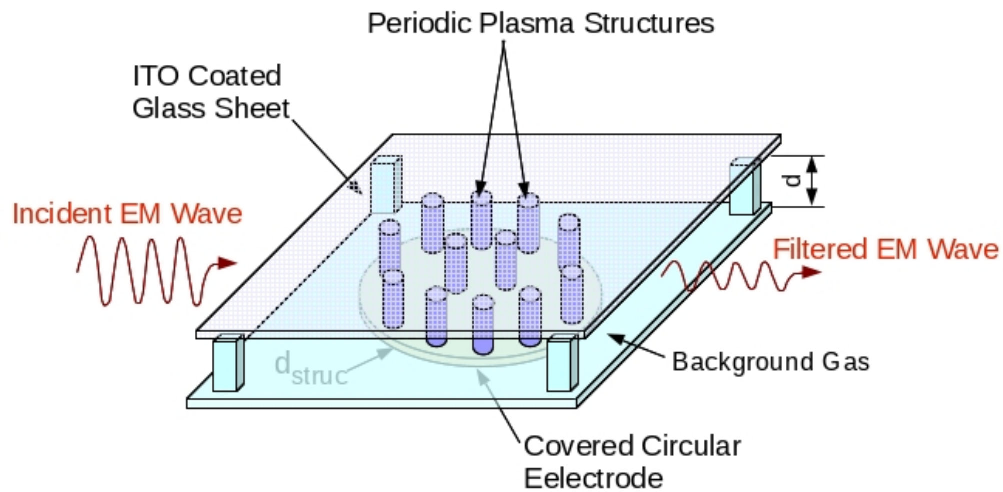
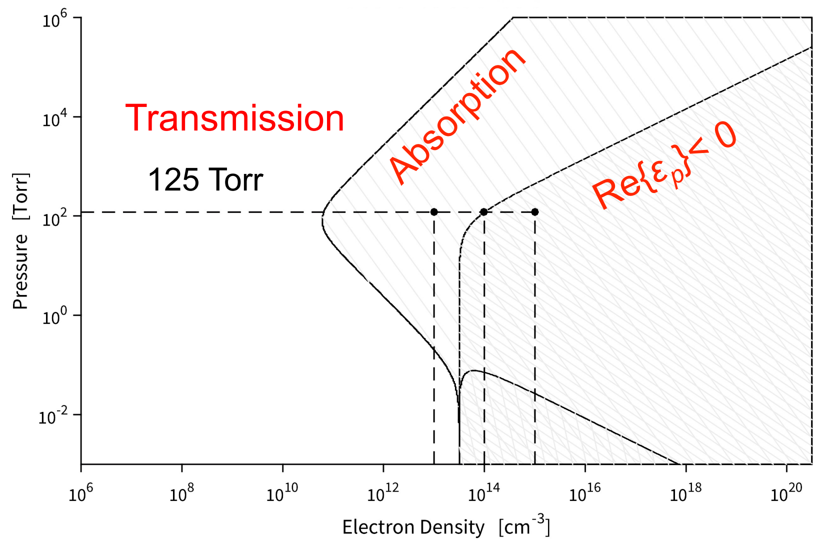
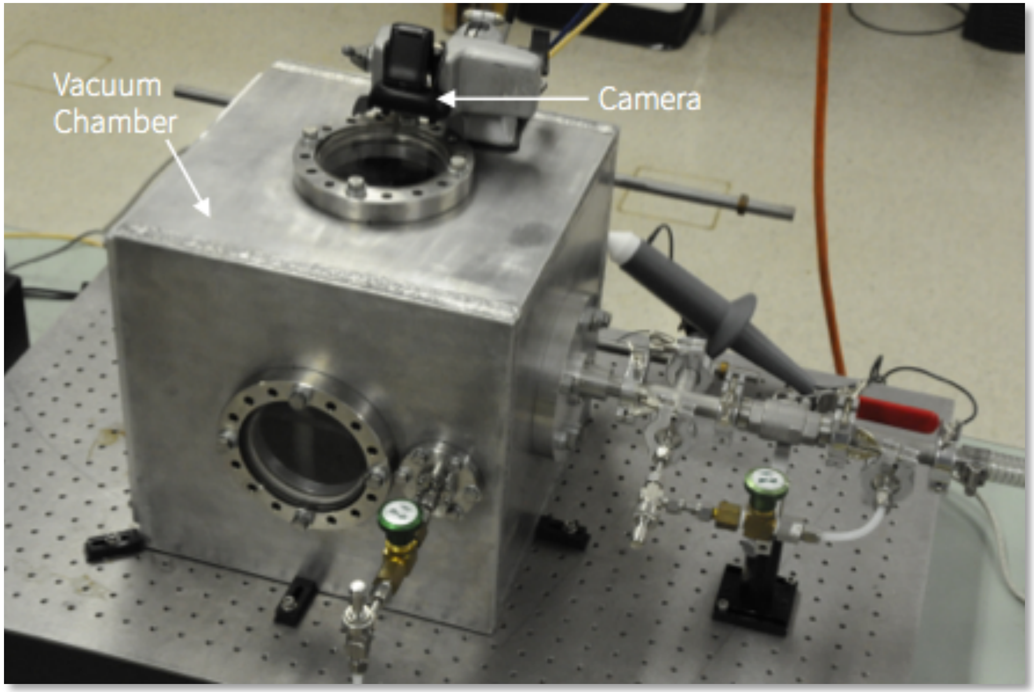
Research Objectives

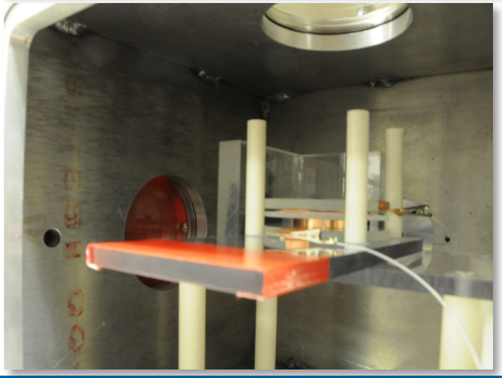
- Experimentally generate spatially periodic plasma structure gratings
  - Exploit charge instability between electrodes separated by a dielectric layer
- Demonstrate dynamic control of spacing of plasma structures
  - Depends on gas pressure (P_s), gap distance (d), and AC voltage (V_{AC})
- Incorporate experimentally derived plasma gratings into EM wave simulation to determine transmission characteristics
  - Probing frequency: 20 - 80GHz
  - Electron density: $10^{19} – 10^{21}$ m^{-3}
  - P_s=115 - 142 Torr

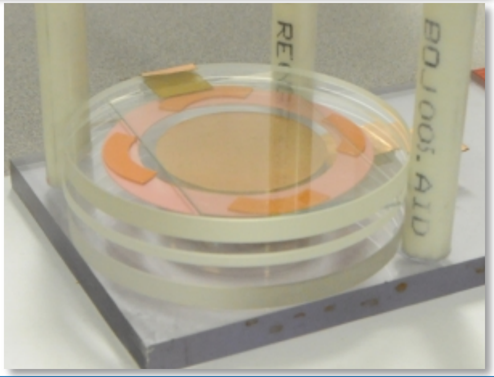


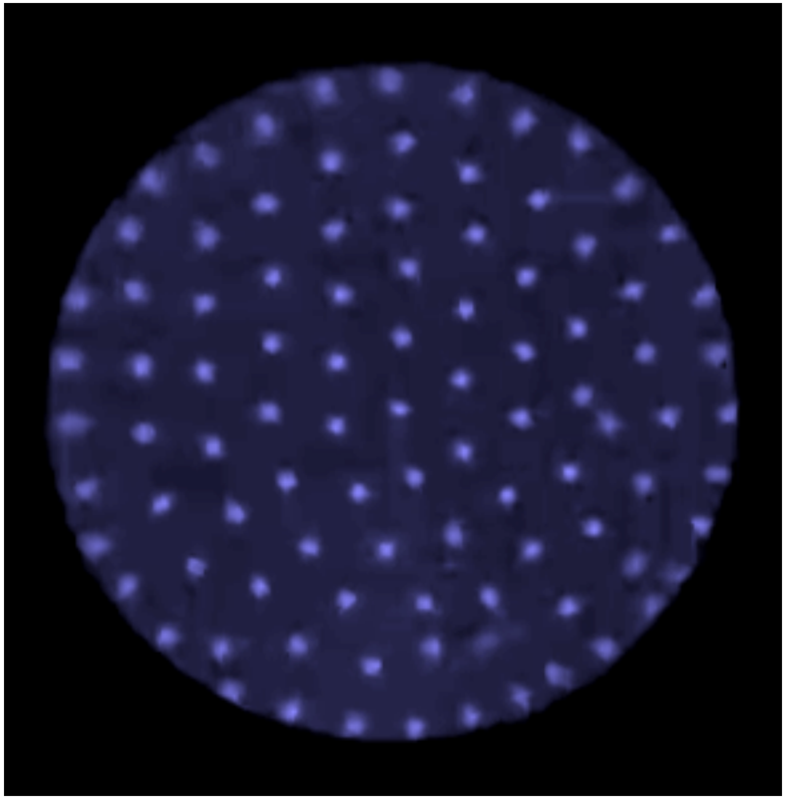


Experimental Setup

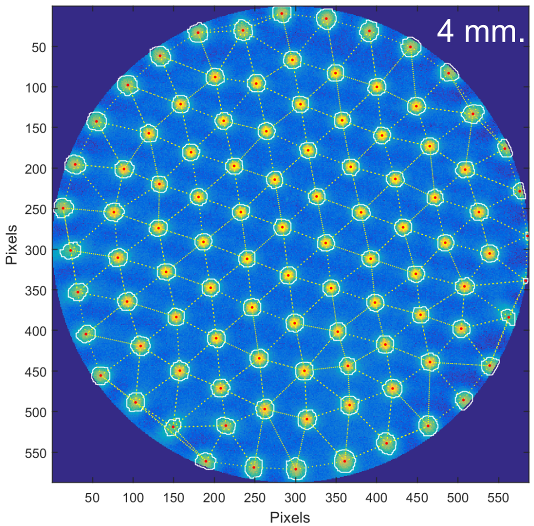


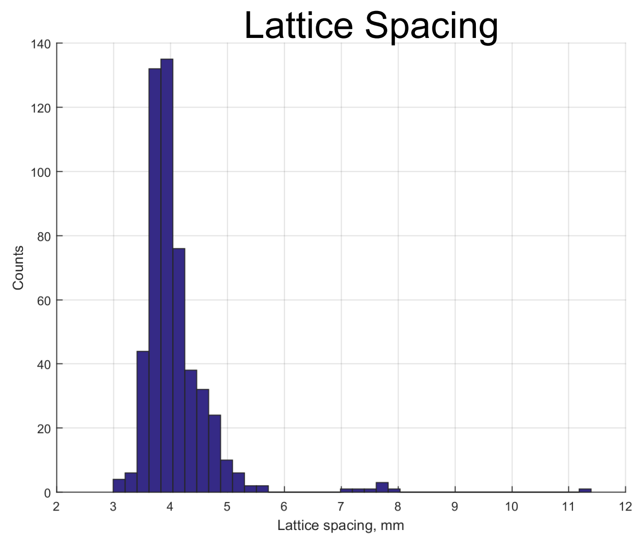


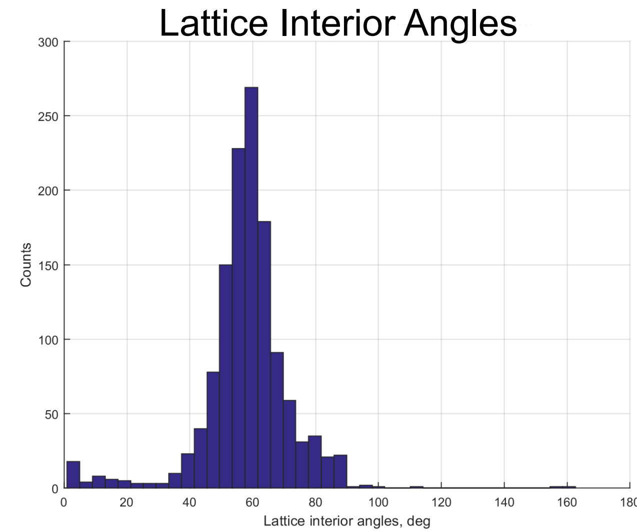


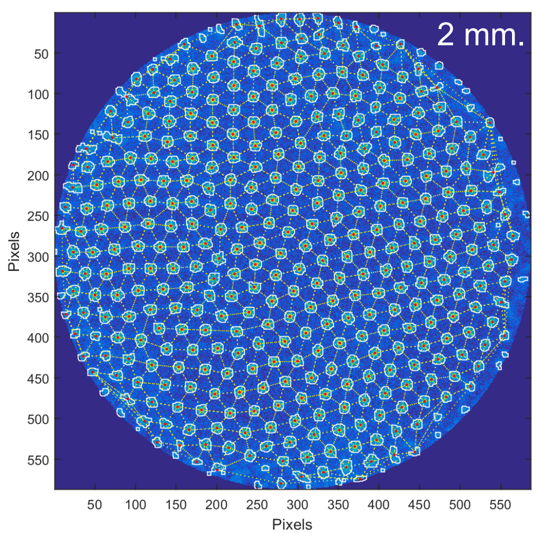


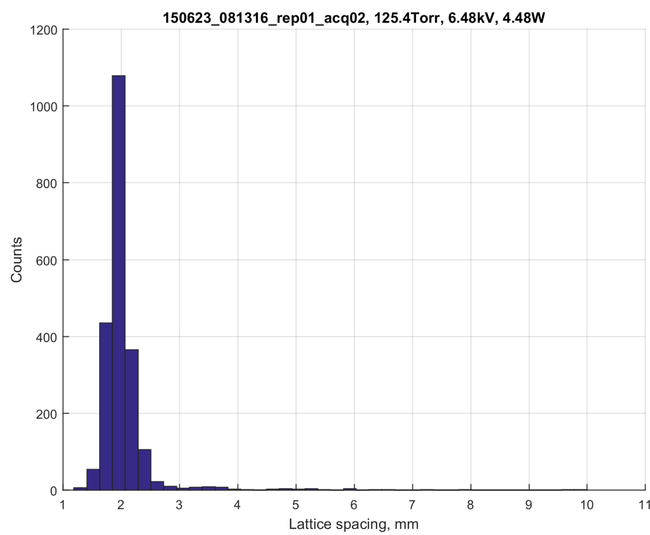
Lattice Analysis: Node Locations, Radii and Spacing

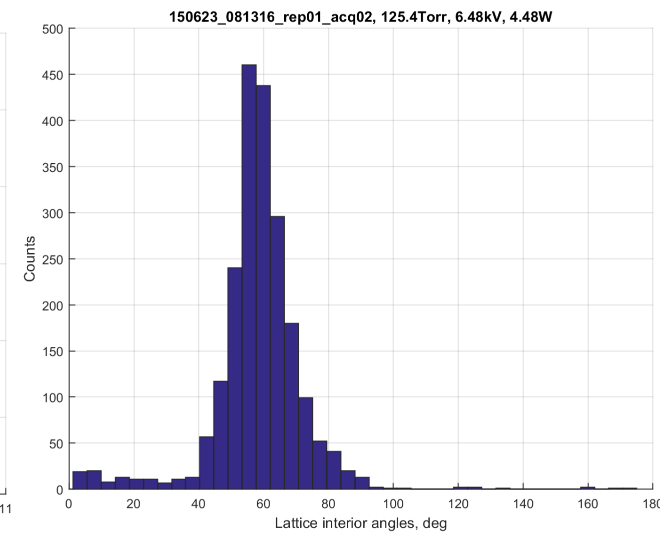






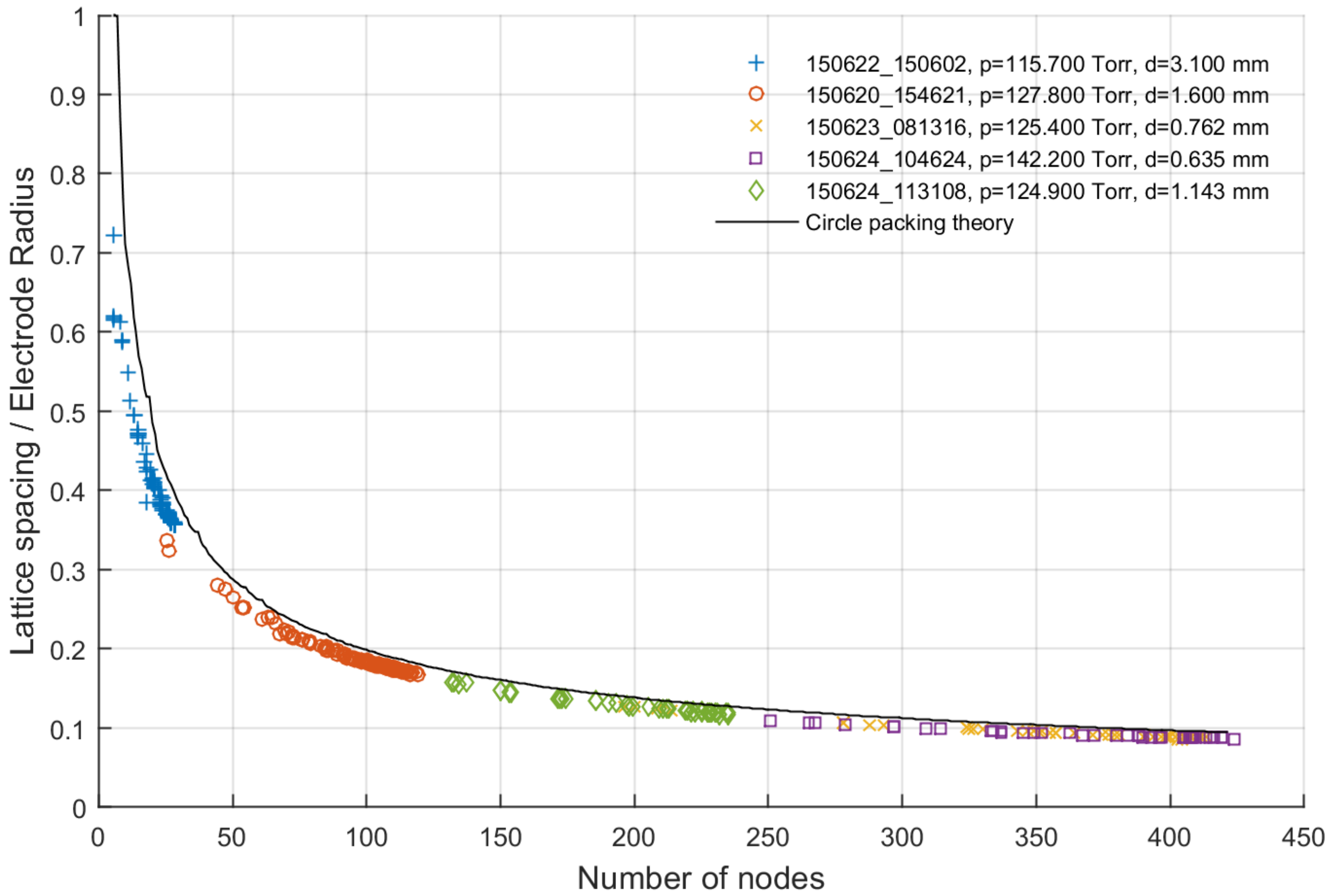






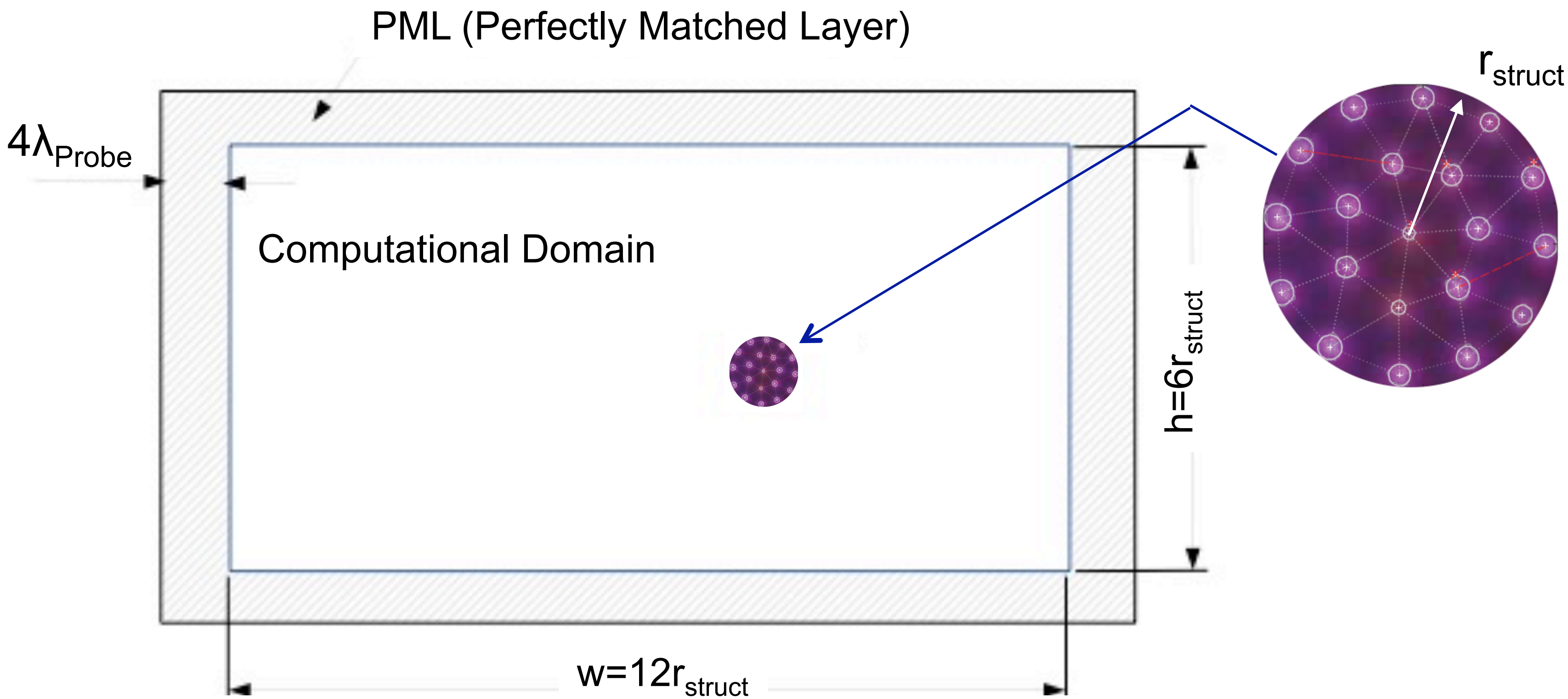
Predictive Plasma Structure Control

Follows Circle Packing Theory

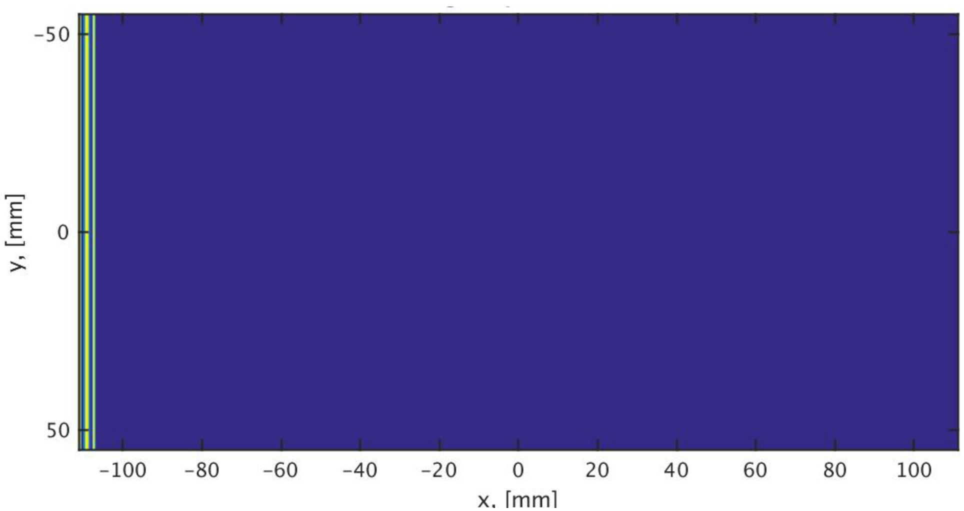


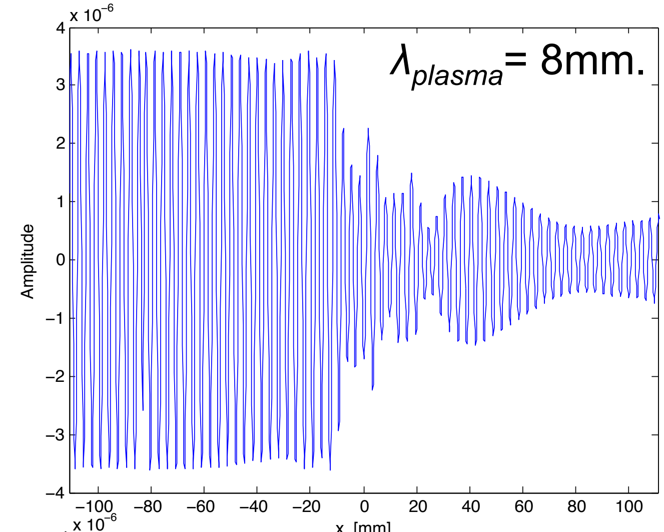
EM Wave Simulation

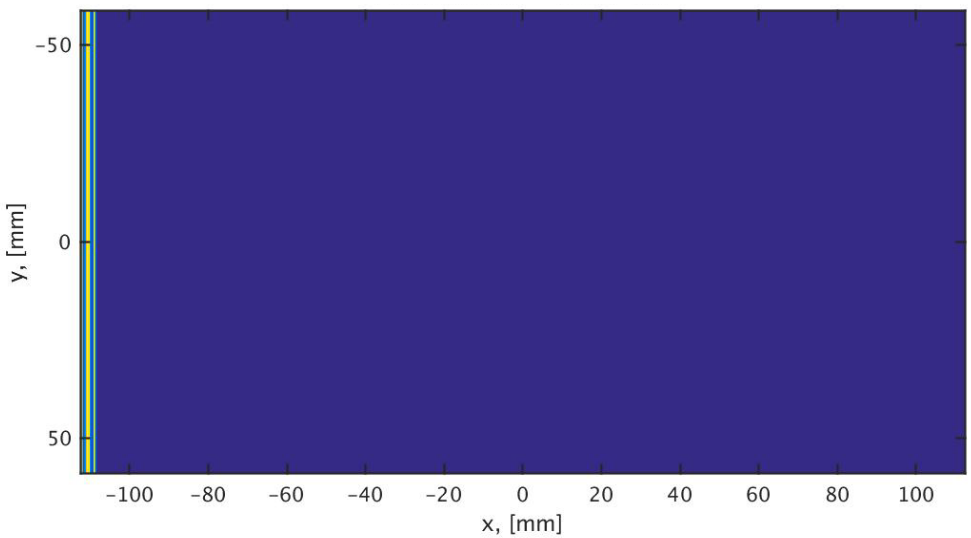
- Utilized MIT open-source (Meep) software that solves Maxwell's equations at each time step to realize the electromagnetic field at discrete spatial locations.
- Dispersive materials are defined in Meep using a Lorentz-Drude model, which we adapted to allow for plasma permittivity.

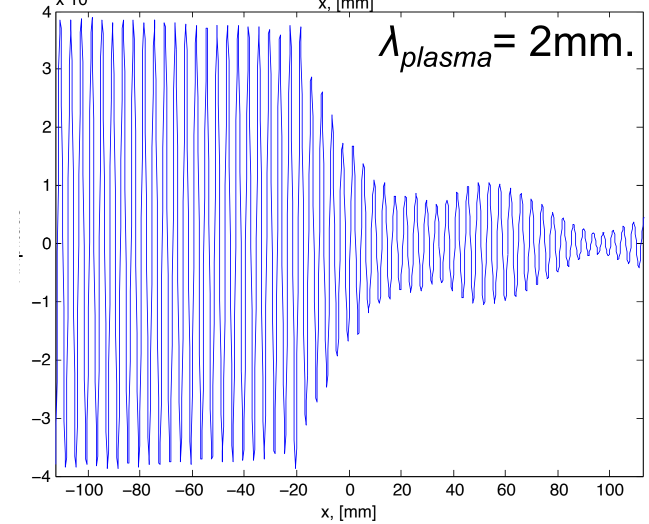


Meep Simulations: p_{air}=125 Torr, n_e=1.3e^{20}m^{-3}, $f_{probing}$=70GHz



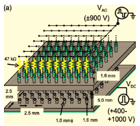




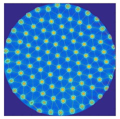


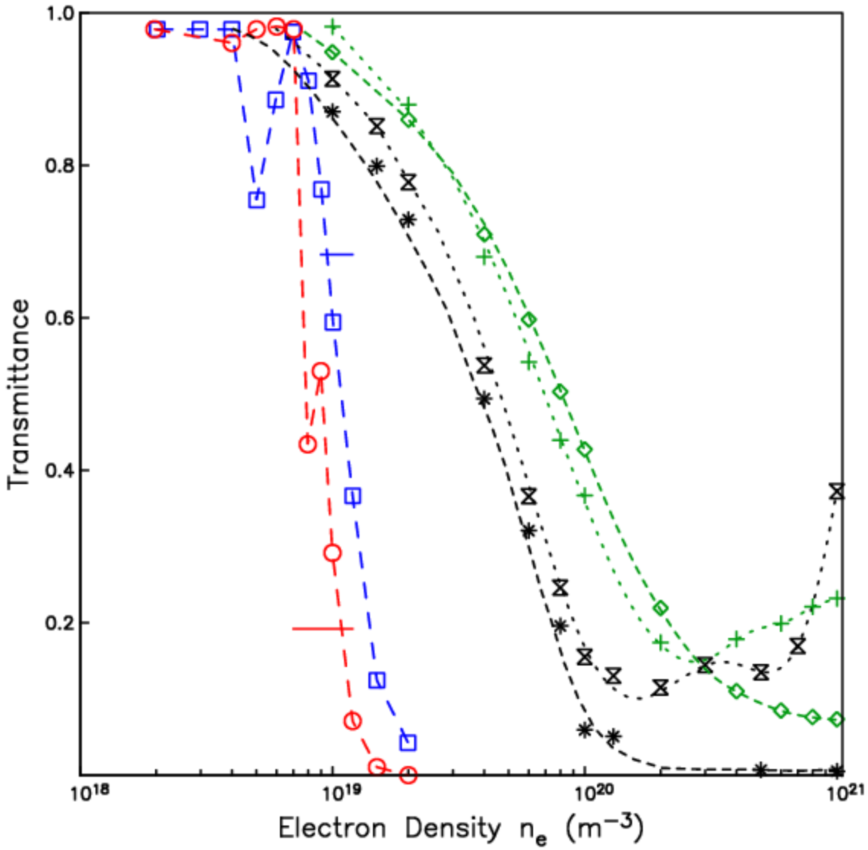
Effect of Electron Density and Probing Frequency

Effect of Electron Density



□ Sakagushi 17rows
○ Sakagushi 30rows
✱ 2mm, 70 GHz ND
⧖ 2mm, 30 GHz ND
◇ 8mm, 70 GHz ND
+ 8mm, 30 GHz ND





Effect of Probing Frequency

□ Sakagushi 17rows
○ Sakagushi 30rows
◇ ND 2mm., 1E19
+ ND 2mm., 1E20
✱ ND 2mm., 1E21
× ND 8mm., 1.3E20