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Numerical Simulations of Plasma Dynamics in ECRIS Afterglow

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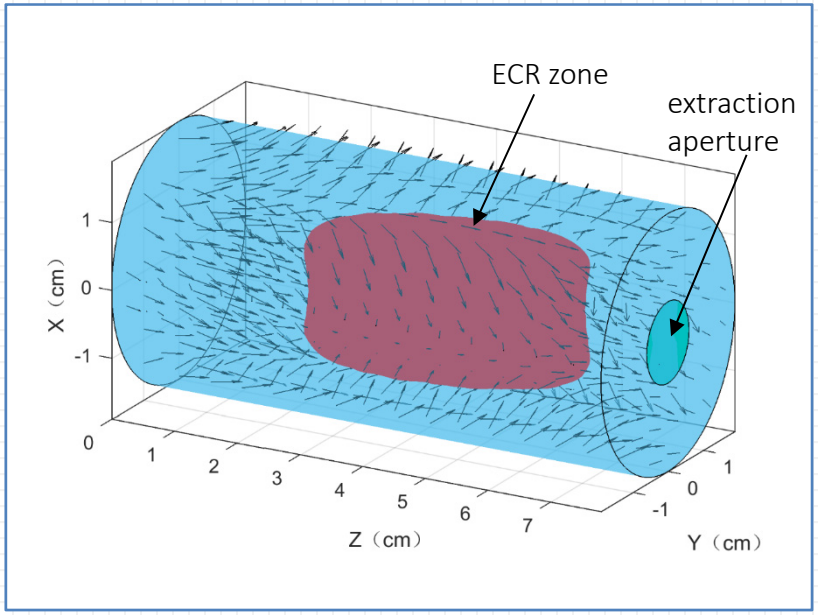
ECRIS Set-up

Layout of LAPECR1U



Critical Parameters

Cavity Radius	19 mm
Cavity Length	78 mm
Aperture Radius	6 mm
MW Mode	$TE_{1,1}$
MW Frequency	14.5 GHz
MW Power	500 W
ECR Magnetic Field	0.518 T
Plasma Species	Argon
Plasma Density	10^{12} cm^{-3}

Simulation Scheme

Two-Step Simulation for A Stable Operation

Energetic Electrons

Single Particle Simulation

- Electrons (~10 eV) uniformly distributed at first
- Coulomb Collision is considered with constant scattering factor
- Rejoin system as new particles when out of bounds
- Electrons are heated till average energy reaches 10 keV
- Distributions of the electrons are sent to the 2nd step as initiation

ECRIS Operation

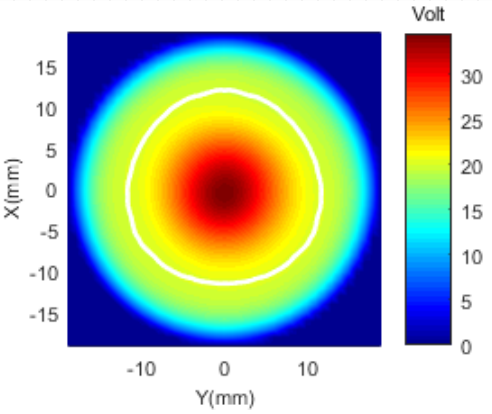
Implicit Particle-in-cell Simulation

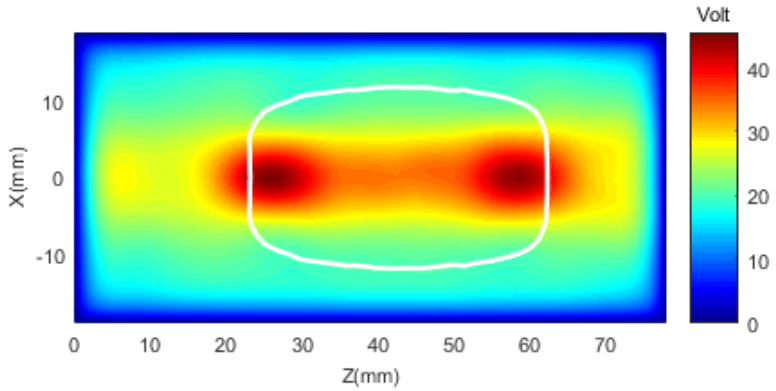
- Cold Electrons (~10 eV) uniformly distributed at first
- Ions (~1 eV) distributed due to quasi-neutrality
- Coulomb Collision is considered with computed local plasma density
- Secondary emission for electrons and absorption for ions when out of bounds
- Ionization is omitted, and in stead new particles are manually created

ECRIS Potential at CW Operation

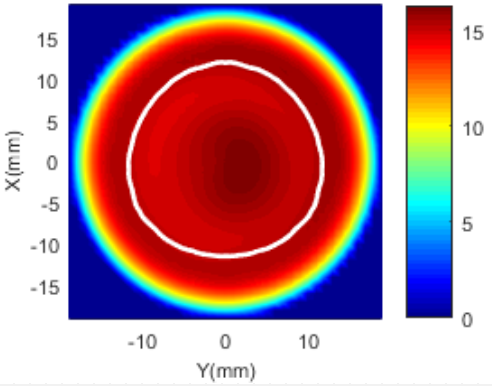
Energetic electrons (well-confined) as backgrounds instead of being tracked

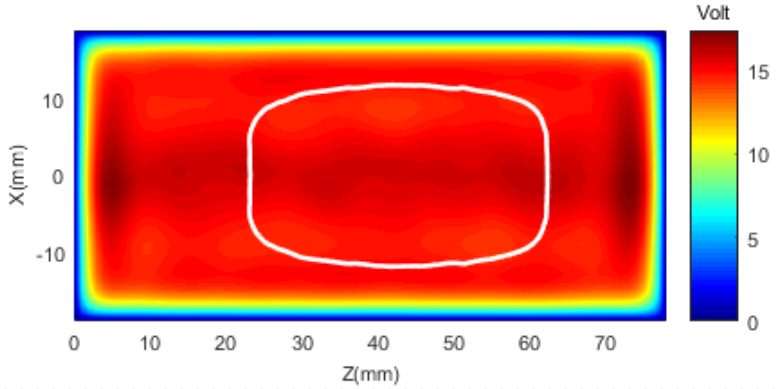
With MW Power





Without MW Power

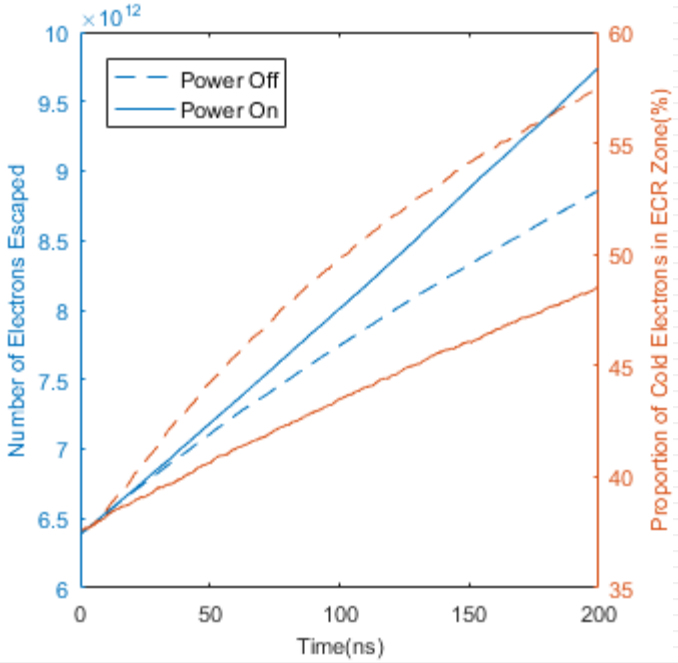


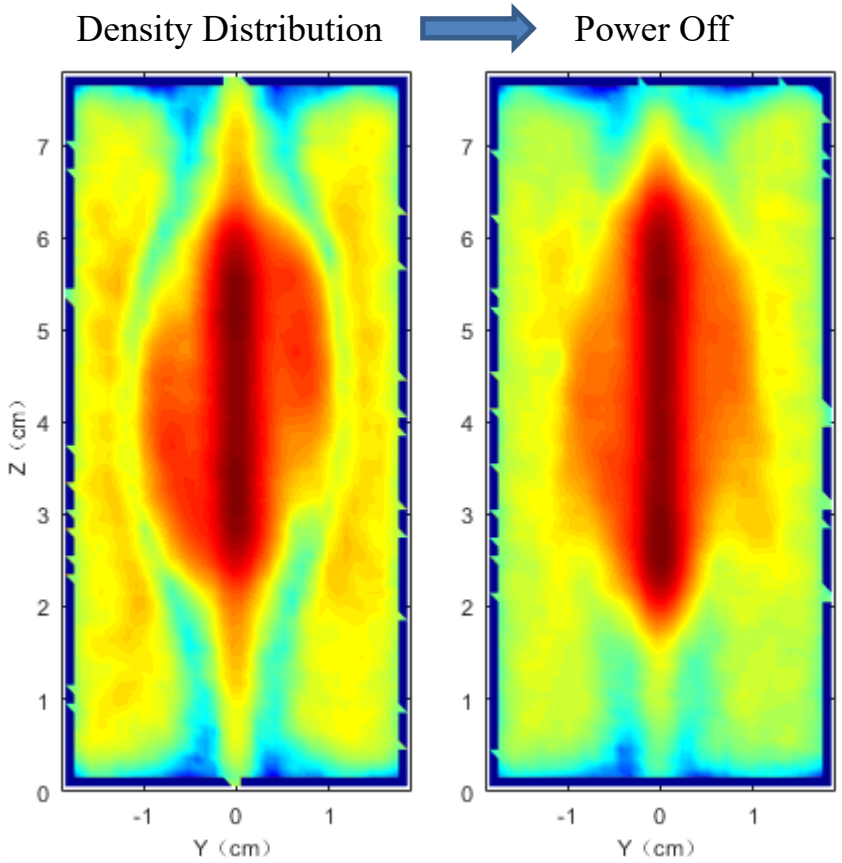


MW power is critical to the formation of the potential dip.

Cold Electrons at Power-off

assuming that the energetic electron distribution still remain unchanged

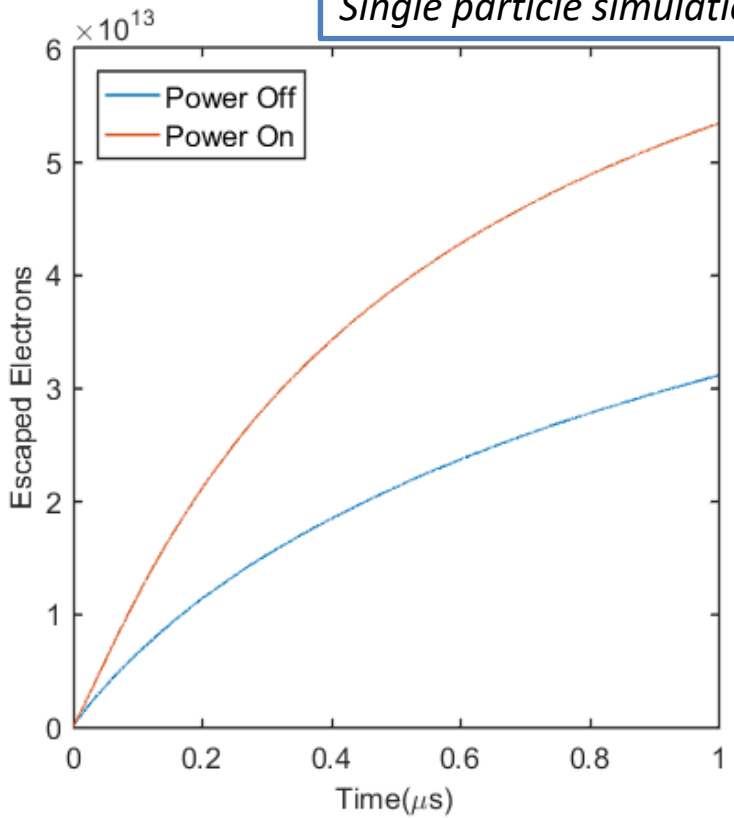


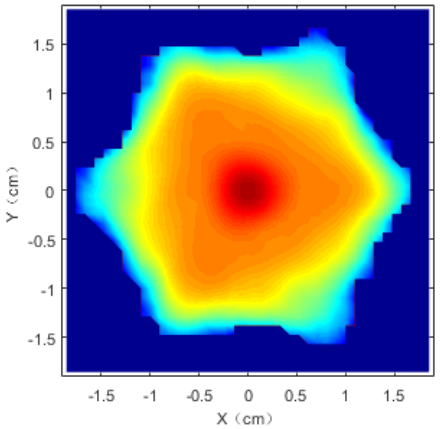


Cold electrons by itself may not contribute much to the ECRIS afterglow.

Energetic Electrons at Power-off

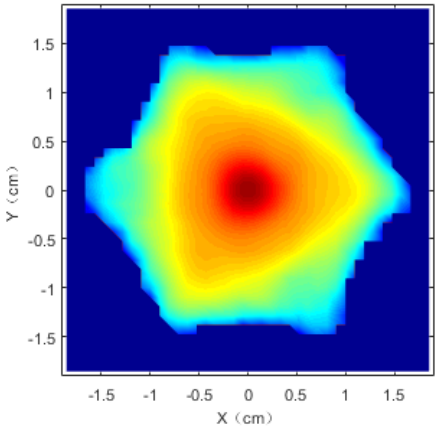
Single particle simulation





Density Distribution

Power Off



Energetic electrons are less confined at power-on due to RF diffusion.

Summary

Next Works:

I. Track energetic electrons in the simulation once an appropriate velocity distribution has been calculated.

II. Consider multi charge state ions and step-wise ionization.

III. Extend simulation time for diagnostics of ion dynamics.

Thanks for your attention!