NUMERICAL SIMULATIONS OF MAGNETICALLY CONFINED PLASMAS

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This poster presents the results of an innovative fully 3D numerical code, developed by the INFN ion source group in a MatLab environment, able to reproduce the beam-plasma interaction and its subsequent ionization, as well as electrons dynamics under magnetostatic and electromagnetic fields. The code implements a formalism based on the Langevin equation to describe the Spitzer collisions, while ionizations are calculated by using the Lotz formula and included with a MonteCarlo approach. This work have been carried out in the framework of the PANDORA PROJECT

NUMERICAL APPROACH

SPITEZR COLLISIONS: LANGEVIN EQUATION

$\Delta v_{Lang} = v(t+1) - v(t) = -v_1 v(t) * Tstep + v_{rand}$

Slowing Down

Random Diffusion

Dynamical Friction

Parallel and Perpendicular Diffusion

ELECTRONS DYNAMICS: SELF-CONSISTENT LOOP

Electrons Dynamics without collisions → Density and Temperature Maps

Electromagnetic Calculations ← Density Map ← Electrons Dynamics with collisions

Fully 3D Dielectric Tensor for the calculation of electromagnetic field

CHARACTERISTICS

- Boris method
- Relativistic effects for electrons motion
- N=10000 simulated particles
- T_{step}=10^{-10} s
- T_{span}= 500 μs

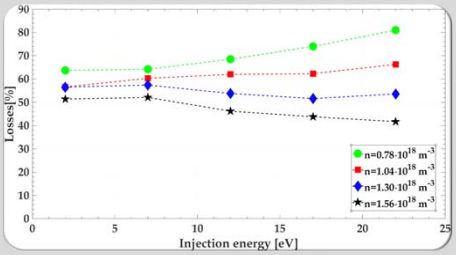
IONS

- N=40000 simulated particles
- T_{step}=10^{-12} s
- T_{span} = 40 μs

ELECTRONS

- Ionizations= LOTZ formula + MonteCarlo

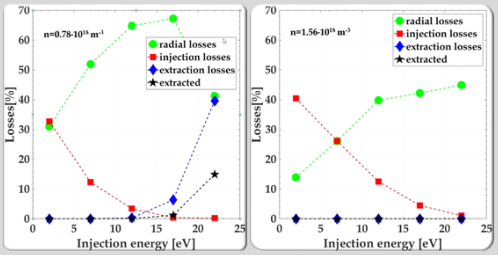
$^{85}Rb^{1+}$ BEAM-PLASMA INTERACTION

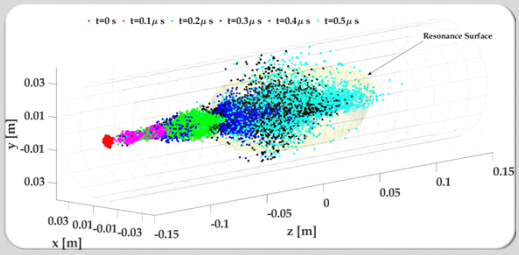


Ions losses as a function of the injection energy for different plasma densities and KT_i=0.5 eV

INFLUENCE OF PLASMA PARAMETERS ON IONS CAPTURE

Ions losses in different directions as a function of the injection energy for two plasma densities and KT_i=0.5 eV

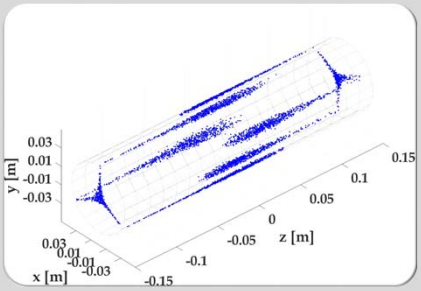




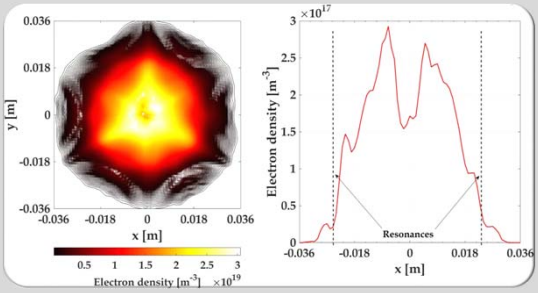
Ions trajectories at different time steps for E=7 eV and ΔE=2 eV

PRECISE TRACKING OF THE INJECTED PARTICLES

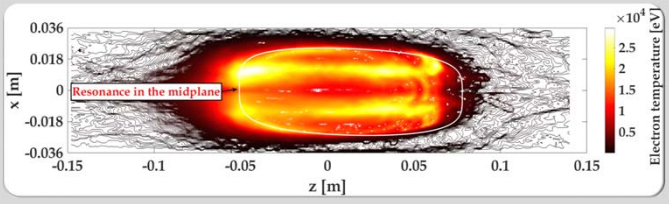
Distribution of ions losses on th eplasma chamber walls and end plates



ELECTRONS DYNAMICS



PLASMOID/HALO MODEL CONFIRMED!
DENSITY FINE STRUCTURE



ELECTRONS TEMPERATURE SPATIAL DISTRIBUTION

THE HIGHEST TEMPERATURE IS DISTRIBUTED AROUND THE RESONANCE SURFACE