Towards Better Modelling of Surface Emission in Caesiated Materials

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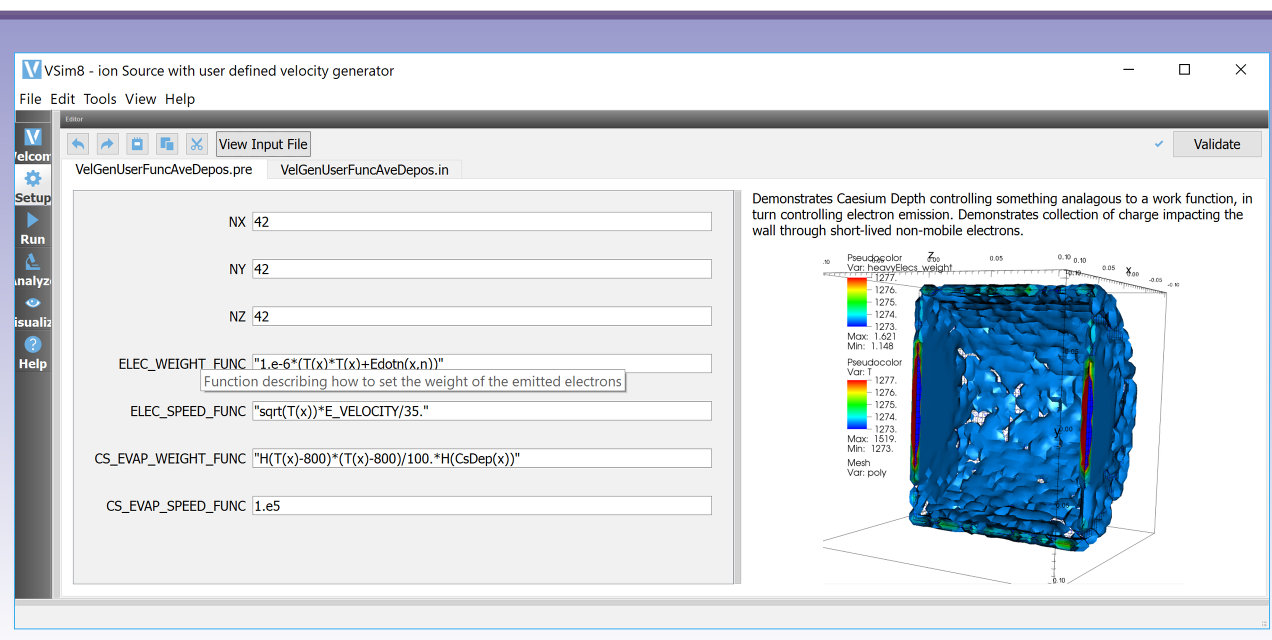
Abstract

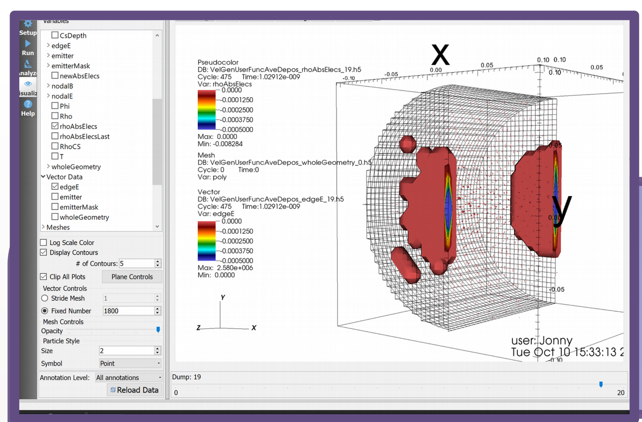
Models for surface interactions and emission in ion sources may be based on surface measurements taken with quite different nearby field strengths, particle spectra, charge densities, and connected to power supplies with different VI characteristics, or even different material composition to those in the device being simulated. Particularly, standard models available in many codes do not take into account the presence of Caesium, which is widely used to boost current in H- sources. We may only expect any description of a plasma to be as good as the models of the most important sources and sinks in the plasma. This paper describes some approaches towards improving models of the surface interaction in the hybrid PIC/fluid code VSim[1] for the case of Caesiated penning sources.

Objectives

- Provide reference implementation in the VSim Particle in Cell code for simulation code blocks used in ion source-like input file
- Demonstrate that complex details can be isolated from the physical models with which we are experimenting: expose models (see right)
- Use simplified geometry, simplified physics models, but advanced computational implementation



Reference Implementation



Fields

Magnetic Field

- Included in simulation. Affects particle motion

Electric Field

- Set using electrostatic (Poisson) solve using charge density, rho
- Local field used for particle motion (Boris update)
- Surface normal is computed. Used for particle emission.

Temperature Field

- set by impacts of particles
- sets outgoing particle velocities and weights/currents
- various updaters to set:
  - full solution of the heat transport equation, or
  - damping towards prescribed equilibrium temp

Caesium Depth Field

- in principle space and time dependent
- sets outgoing particle velocities and weights/currents
- various updaters to internal solved
  - damping according to prescribed equilibrium temp
  - full solution of the heat transport equation.

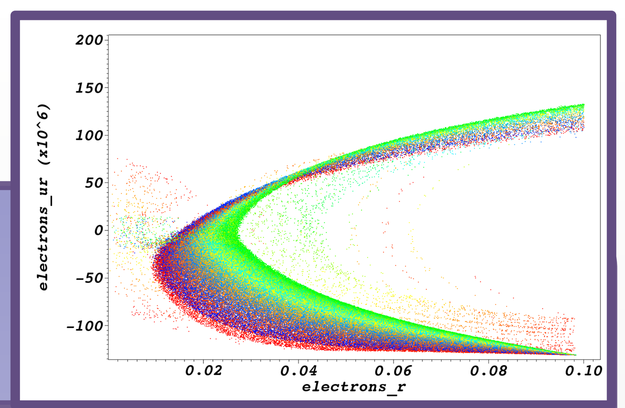
Charge density (rho)

- Set by all moving kinetic species within the simulation
- Used to determine electrostatic potential, so E field

Absorbed charge density (rhoAbs)

- Set by “heavy particles”
- Used to determine change in temperature and Cs Depth

Particles



Electrons

- Respond to Electric and magnetic fields
- Emission only from specific areas controlled by mask
- Emission velocity determined by Cs Depth, Temperature and local E field
- Each macroparticle represents different number of physical particles
- Emission macroparticle weight (so current) set from local Cs Depth, E, T fields
- Switched to heavy electrons when absorbed on geometry, but able to use for secondary emission.

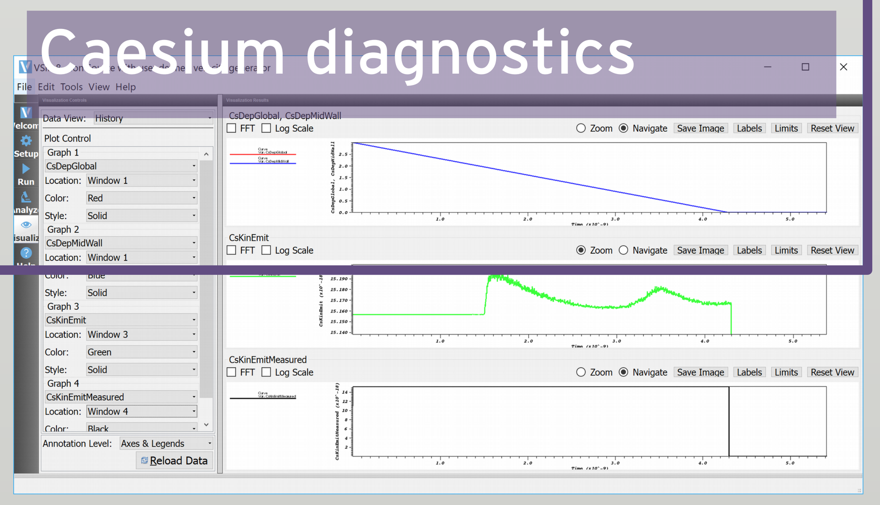
Caesium Ions

- Emitted with velocity and weight dependent on same things as electrons, but different functional dependence. Switches off when Cs fully depleted
- Analogue between depth and work function could be included.
- Diagnostics included for absorbtion and emission.

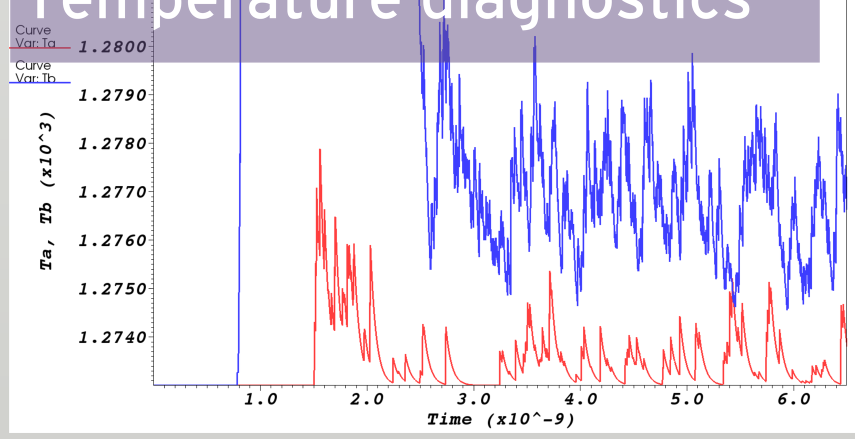
Heavy Electrons

- Non moving species - initiated by collisions with walls
- Deposits charge only into special field used for update of other fields

Caesium diagnostics



Temperature diagnostics



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References

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