A STUDY OF THE INTERACTION OF ROSETTA WITH THE COMETARY PLASMA AND ITS CONSEQUENCES ON ION MEASUREMENTS BY ROSINA/DFMS

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Objectives

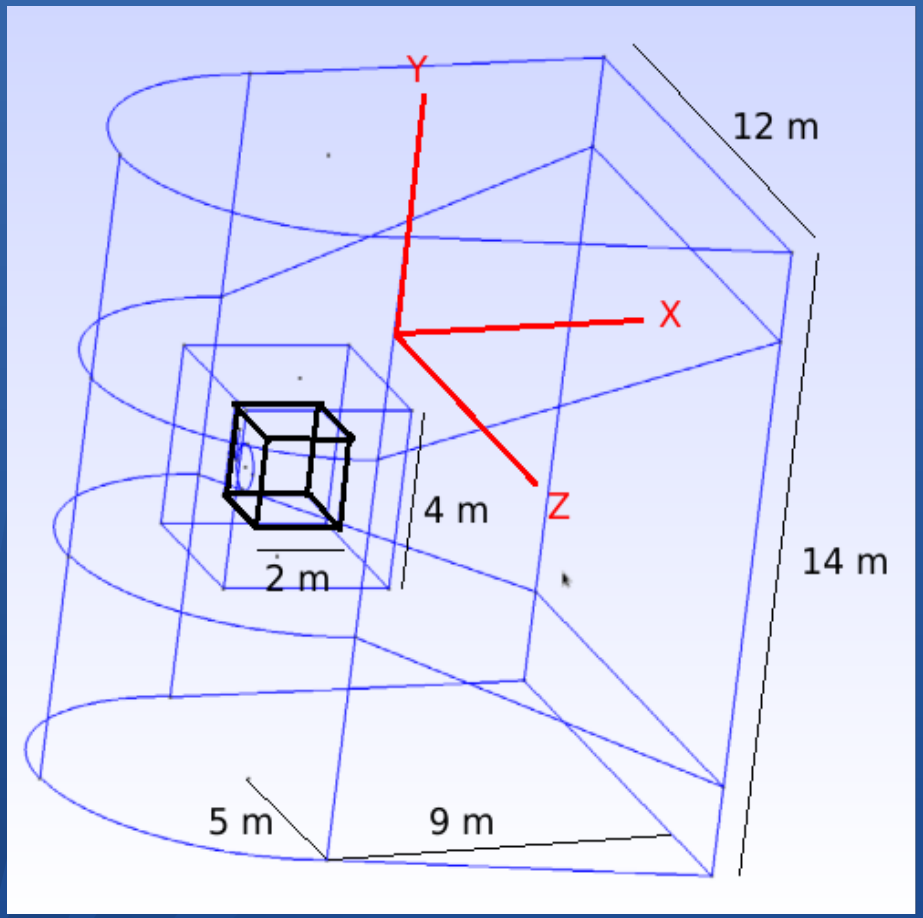
1- MODEL THE EQUILIBRIUM POTENTIAL OF ROSETTA AND ITS PLASMA SHEATH
(Ne AND Te TYPICAL VALUES KINDLY PROVIDED BY LAP TEAM)

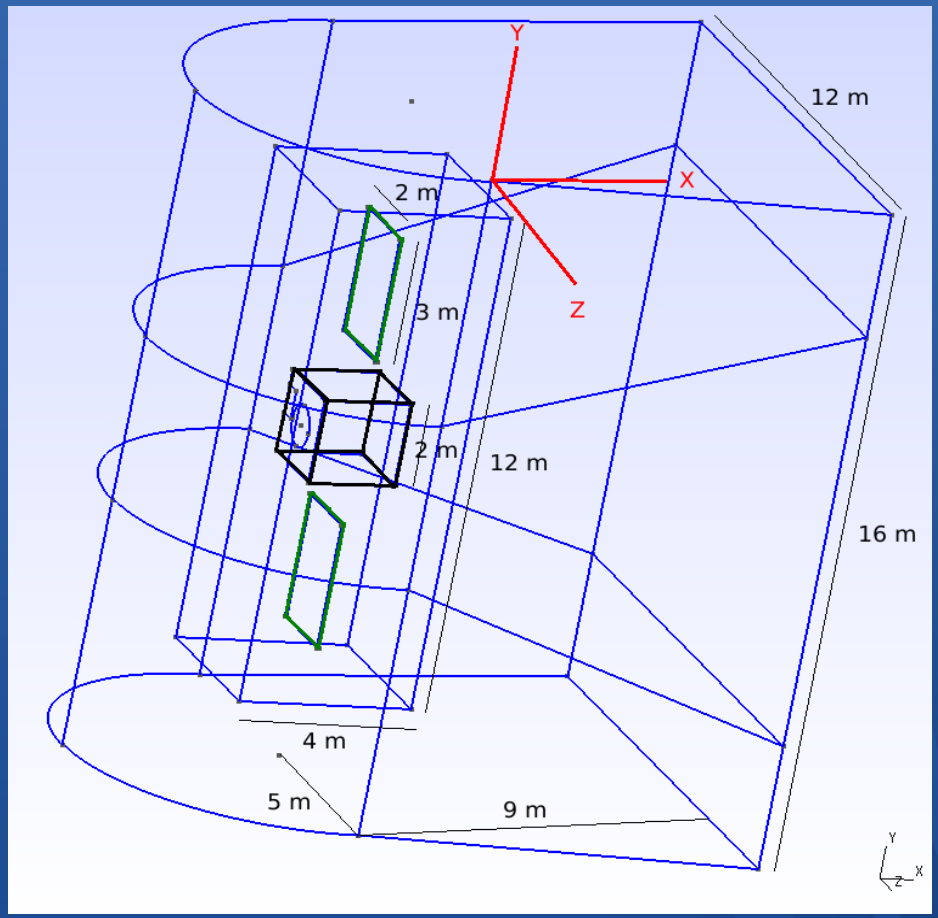
2A- STEP BY STEP EVOLUTION OF THE ROSETTA CONFIGURATION AND PLASMA CONDITIONS
- RECTANGULAR BOX, BOX + SOLAR PANELS, BOX + SOLAR PANEL + DFMS
- Ne, Te VARIATIONS
- PHOTO-ELECTRONS

2B- VARIATION OF THE MAIN PARAMETERS OF THE SIMULATION
MESH SIZE VS λD,
PIC/BOLTZMAN ALGORITHM
TO ASCERTAIN EFFECTS ON SIMULATION RESULTS AND DEFINE OPTIMAL SETTING

3- USE MODELLED ION TRAJECTORIES TO DETERMINE THE EFFECTIVE ANGULAR FIELD OF VIEW AND ENERGY WINDOW OF THE DFMS SPECTROMETER IN ION MODE (ON GOING)

Geometric models



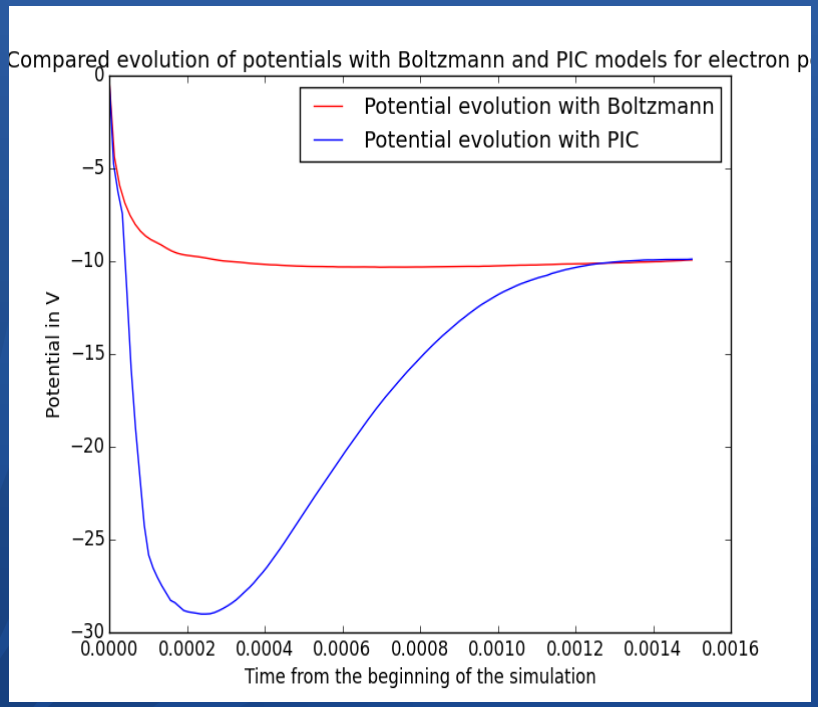


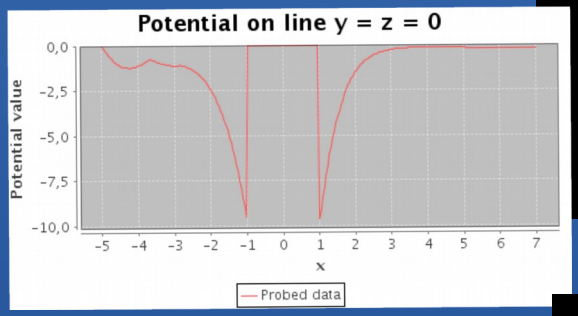
Common parameters

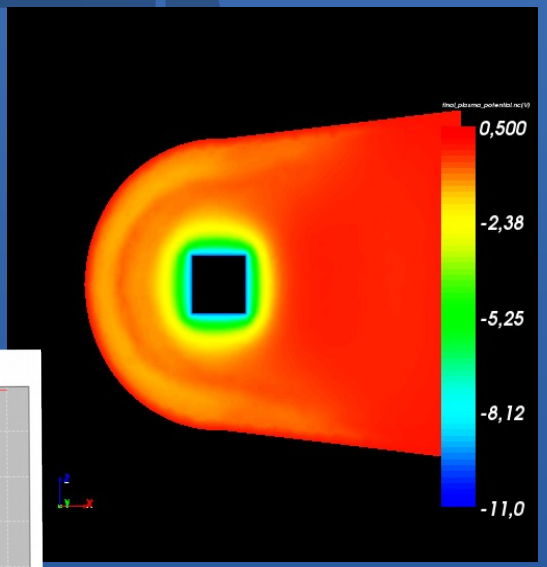
- Ions : H2O+, PIC model, Temperature 0,0087 eV
- Density 1,0E9 m**(-3), Temperature 2,7 eV : Debye Length 0,39 m
- Floating potential uniform on spacecraft with Csat 1 nF
- Cube surface aluminium, panel surface ITO for face sun
- Time steps for plasma and populations : 4,0E-7 s
- Simulation time step : 1,0E-6 s
- External boundary condition : Dirichlet 0 V
- Sun vector : +0,6 in x direction (relative to sun power at 1 UA)

Comparison between Particle In Cell and Maxwell-Boltzmann models for electron population

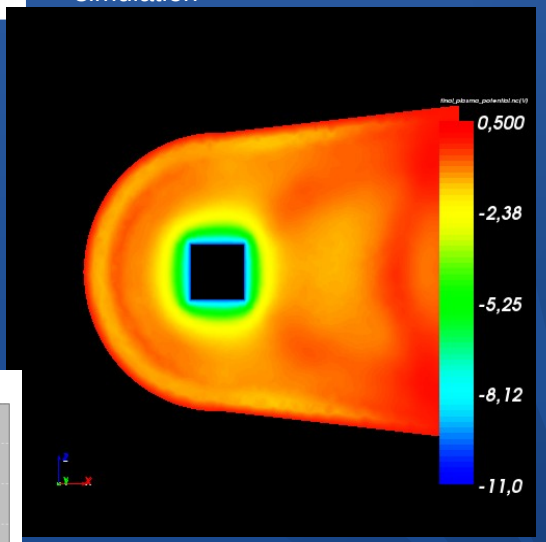
Objective: Check coherence between both model
In order to use faster Boltzmann model
Model : Simple cube, velocity +600m/s in x direction, No photoelectrons, internal resol 0,2 m, external 0,3 m (Debye 0,39 m)

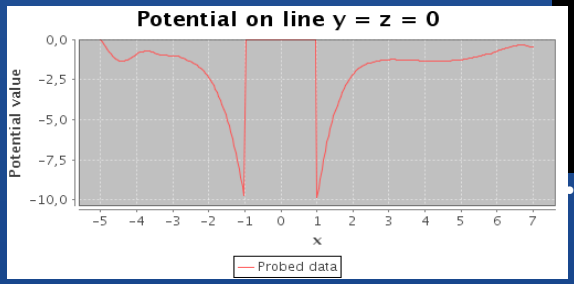






Potential cut normal Y Boltzmann simulation





- Potential cut normal Y PIC simulation
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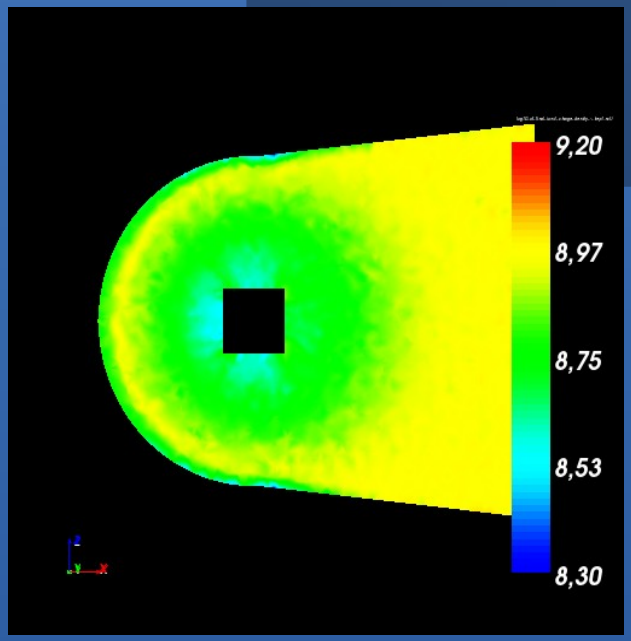
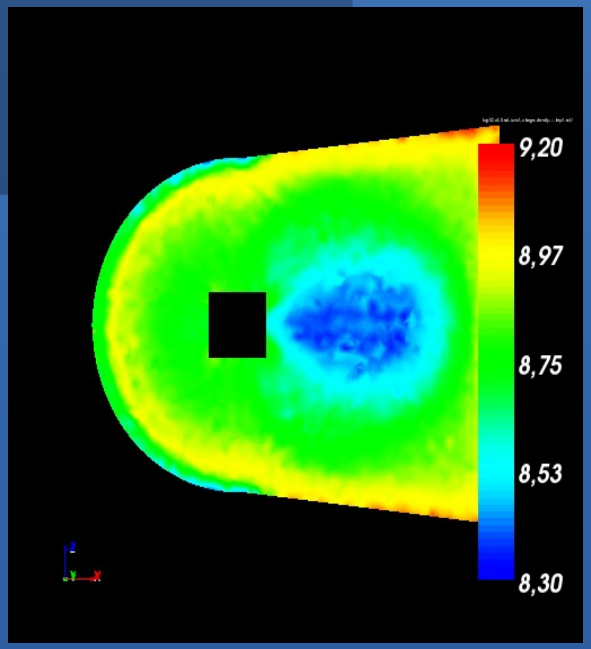
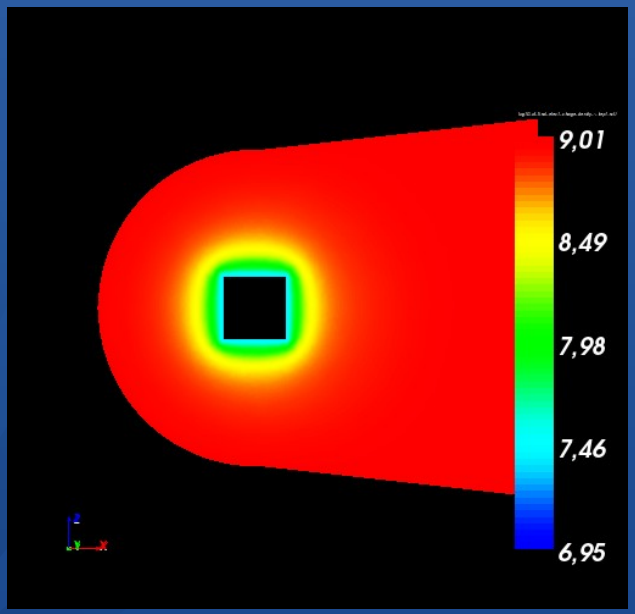


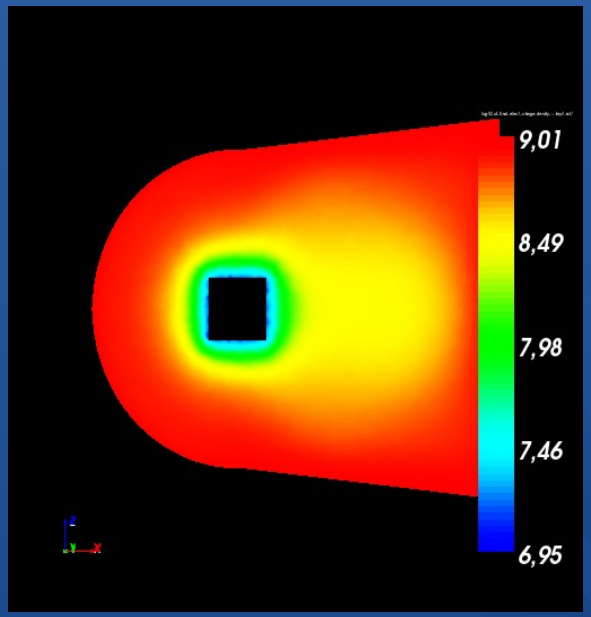
- Ion log density cut normal Y Boltzmann



- Ion log density cut normal Y PIC



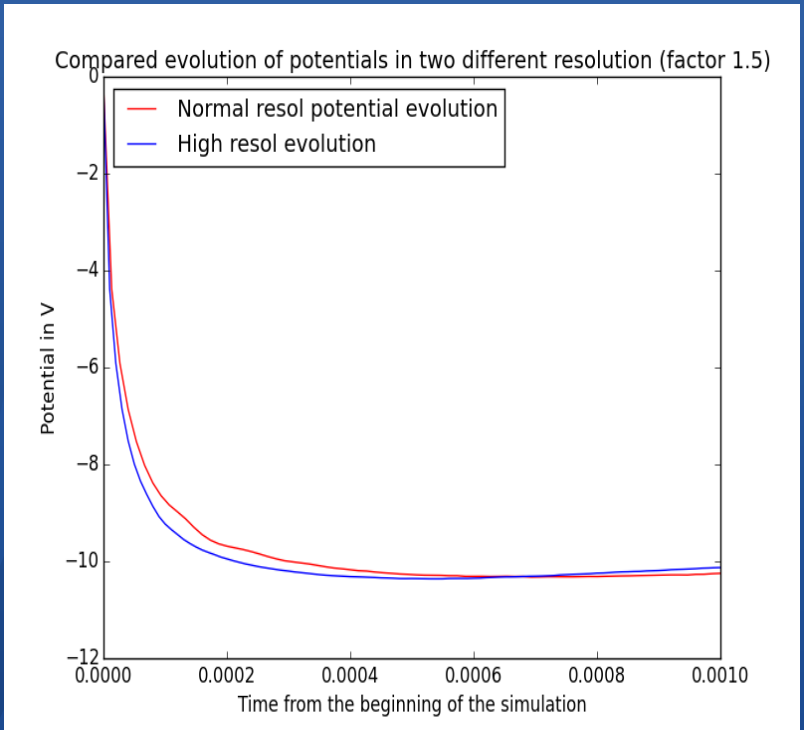
- Electron log density cut normal Y Boltzmann

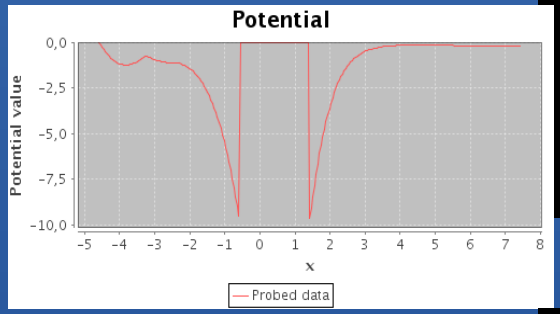


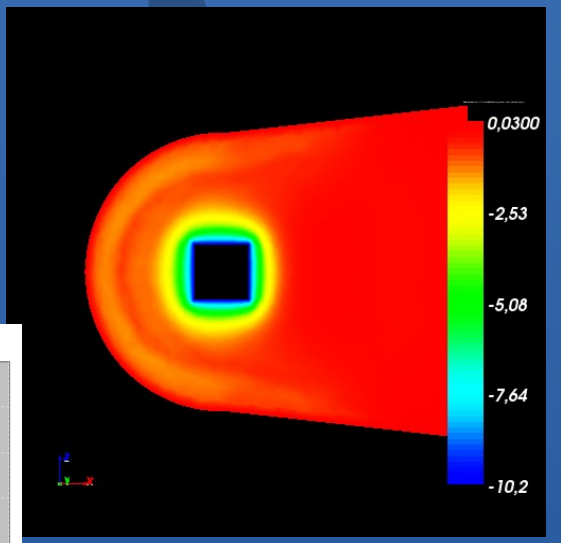
- Electron log density cut normal Y PIC

Influence of the mesh resolution on the results (res factor 1,5)

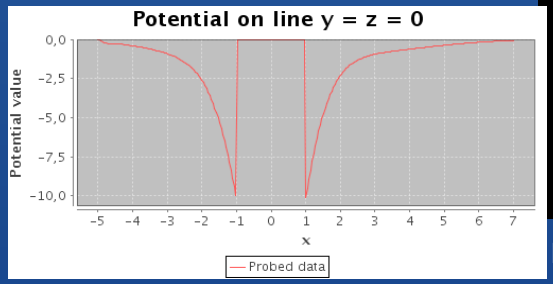
Objective : Check if resolution is accurate enough to get reliable results
Model : Simple cube, Boltzmann, No photoelectrons, Velocity +600 m/s in x direction (0,034 eV for ions).

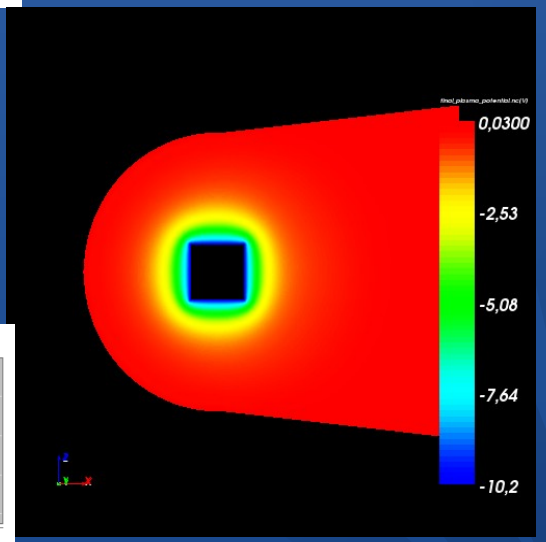






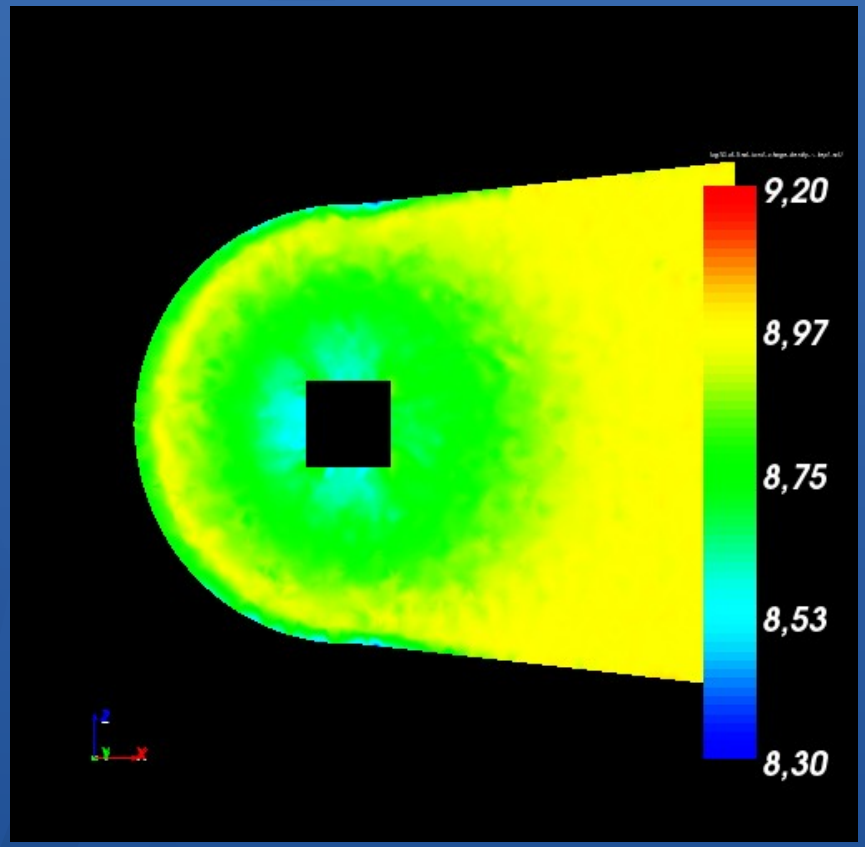
Potential cut normal Y normal resolution



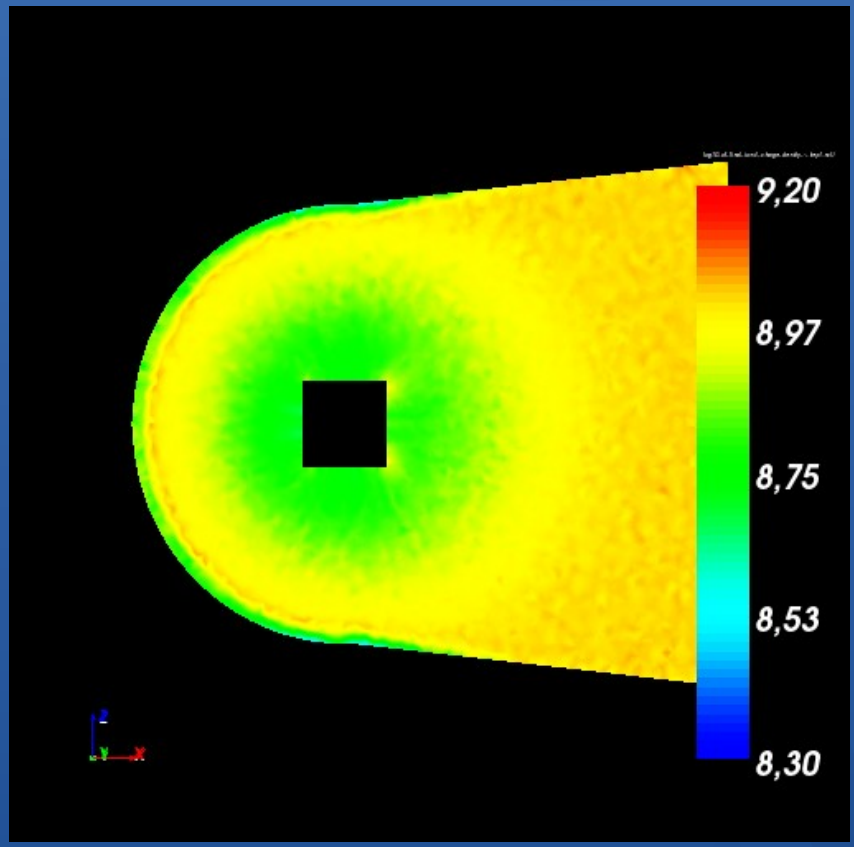


Potential cut normal Y high resolution

Instability effect on ion density map at high resolution



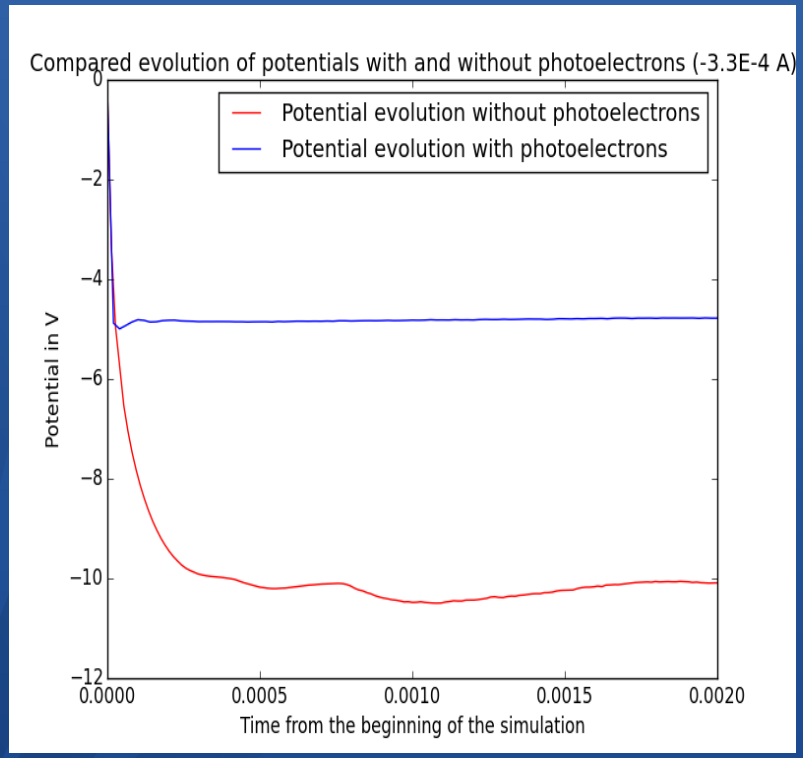
- Ion log density cut normal Y normal resolution

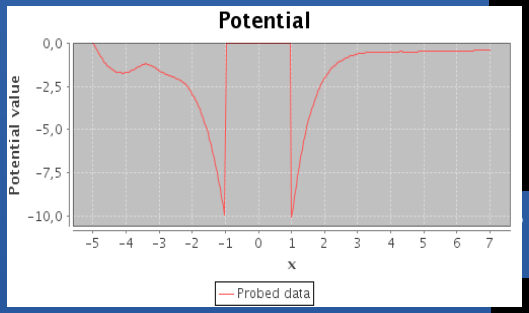


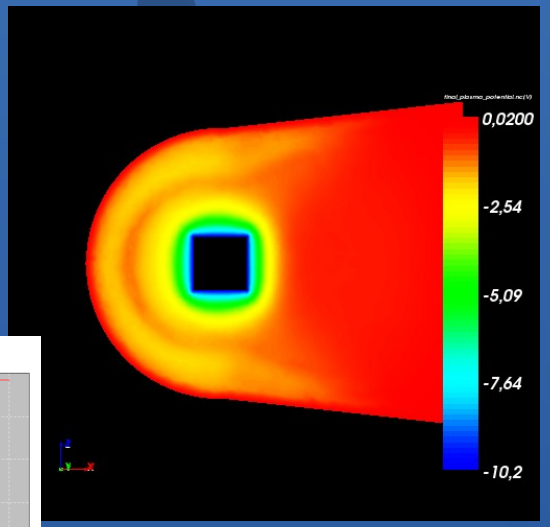
- Ion log density cut normal Y high resolution

Influence of photoelectrons on model with panels

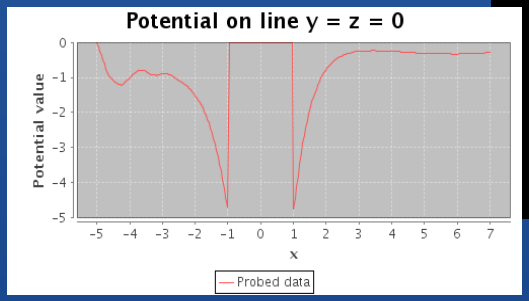
Objective: Make sure of the stability of the convergence
While introducing the additional population
Model : With panels, internal resol 0,2 m, external 0,3 m (Debye 0,39 m)
Boltzmann, Velocity +600m/s in x direction (0,034 eV for ions)

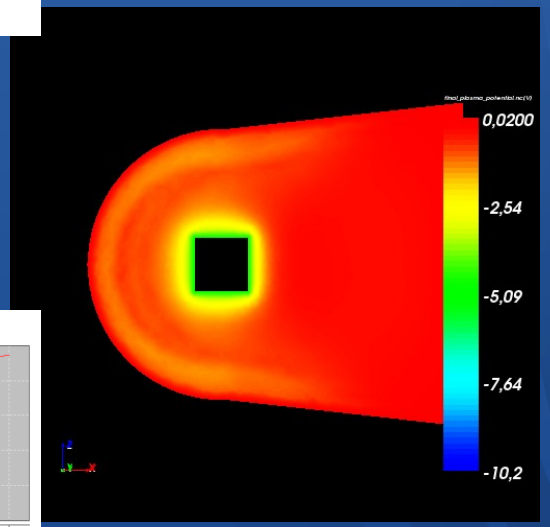




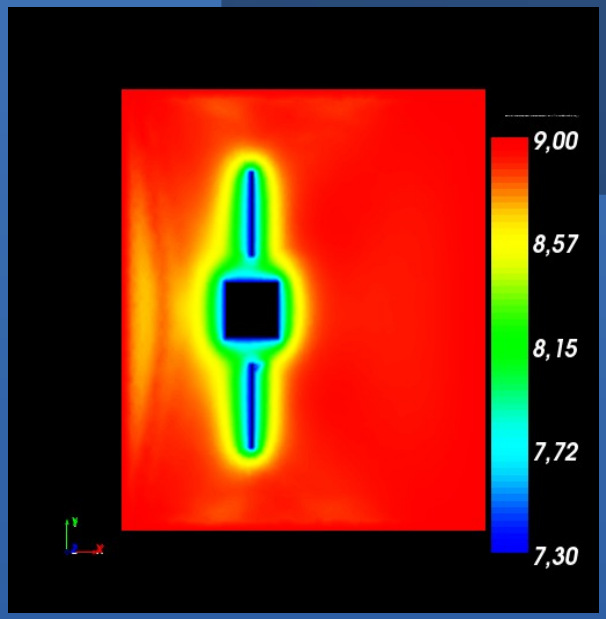


Potential cut normal Y without photoelectrons

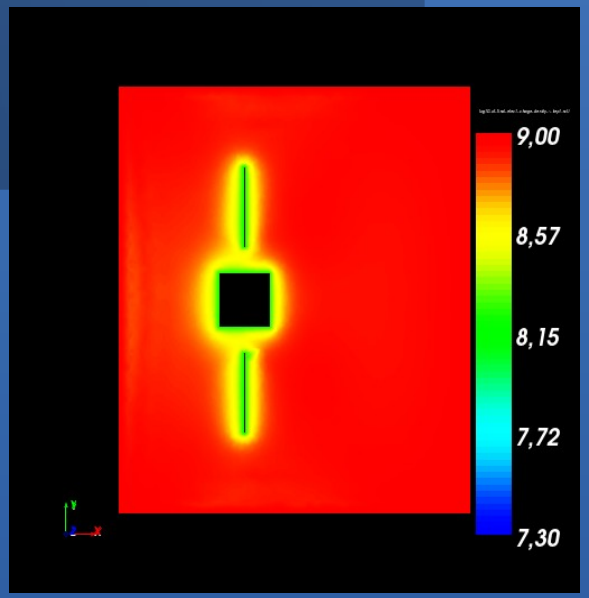




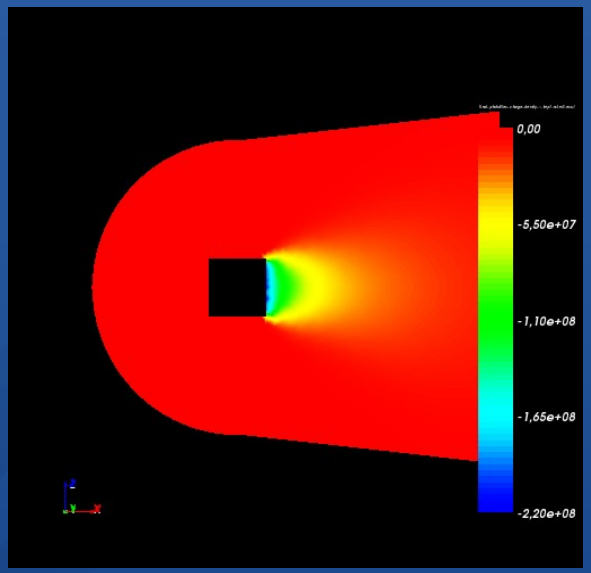
Potential cut normal Y with photoelectrons



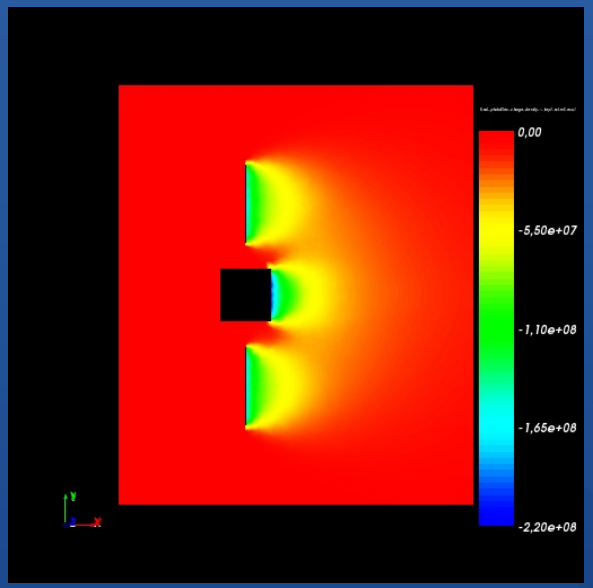
- Plasma potential cut normal Z without photoelectrons



- Plasma potential cut normal Z with photoelectrons



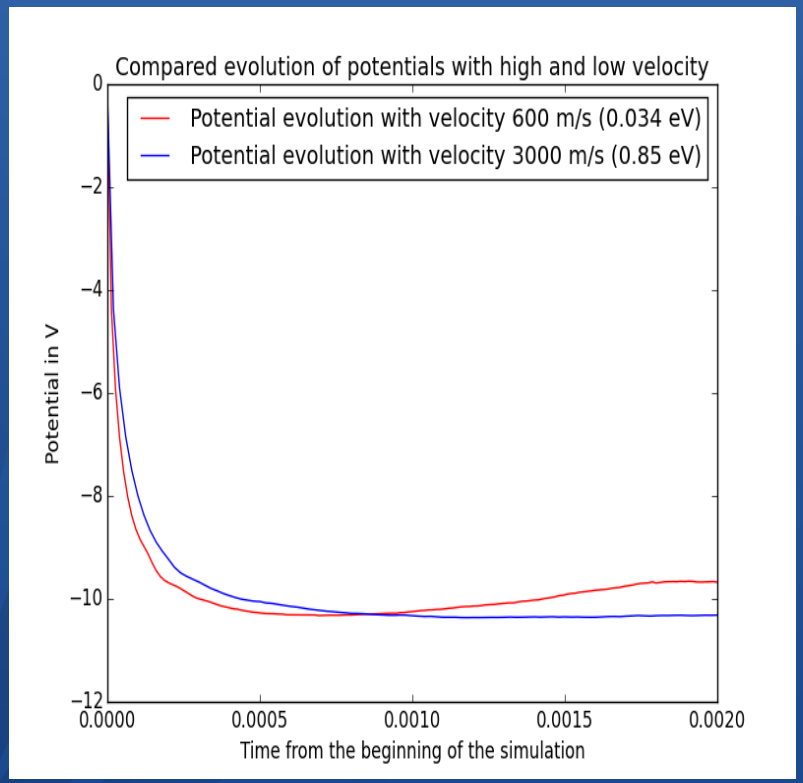
- Photoelectron density cut normal Y

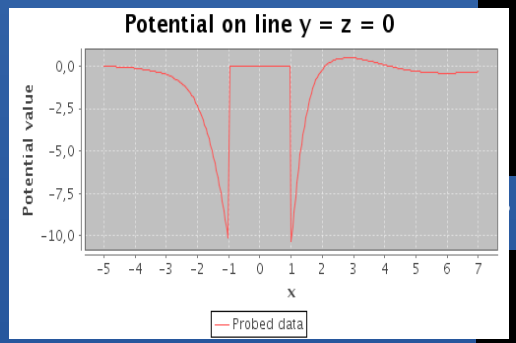


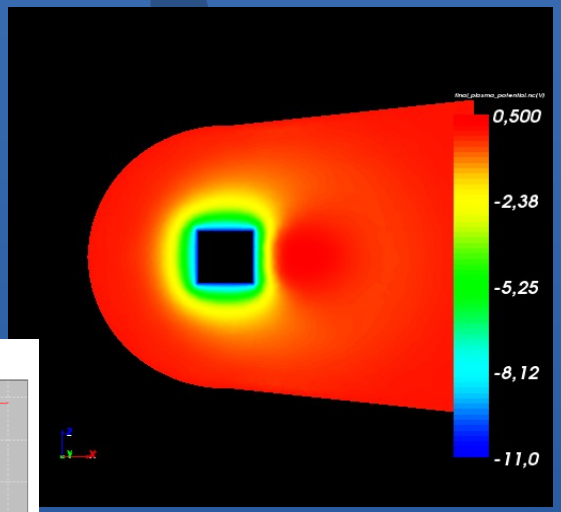
- Photoelectron density cut normal Z

Influence of the plasma velocity

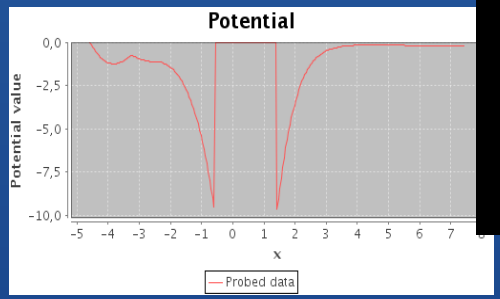
Objective : Determine the influence of the plasma Velocity, with a velocity of 3000 m/s (0,85 eV for ions)
Model : Simple cube, Boltzmann, No photoelectrons
Internal resol 0,2m, external 0,3 m (Debye 0,39 m)

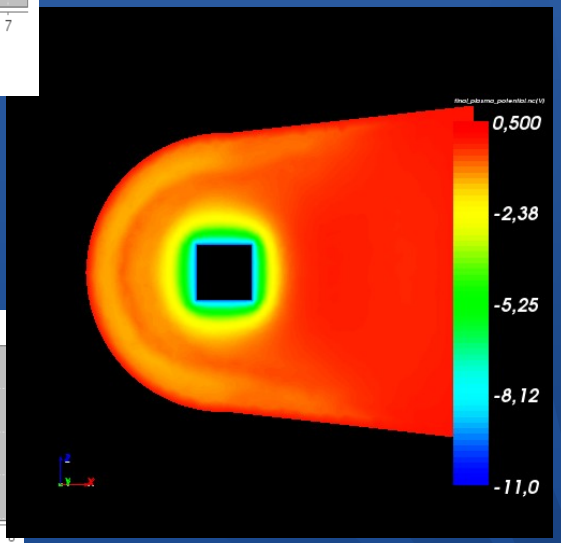






- Potential cut normal Y 3000 m/s

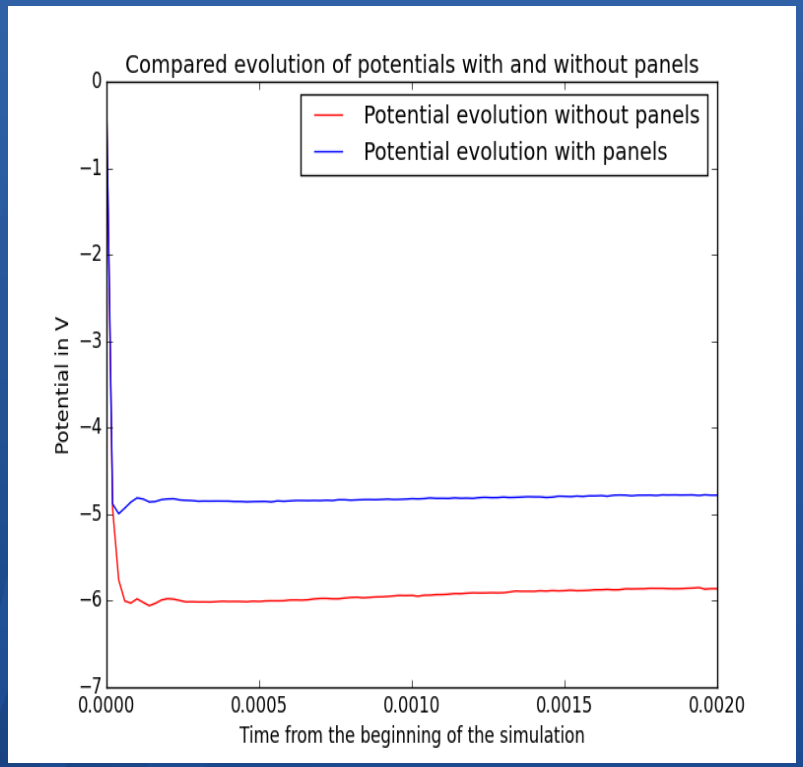


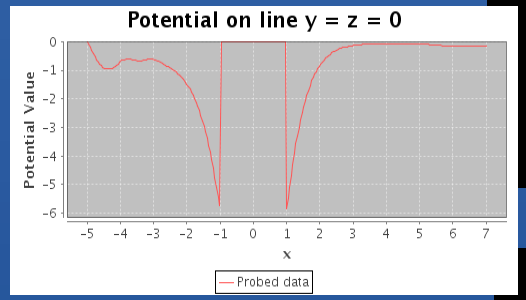


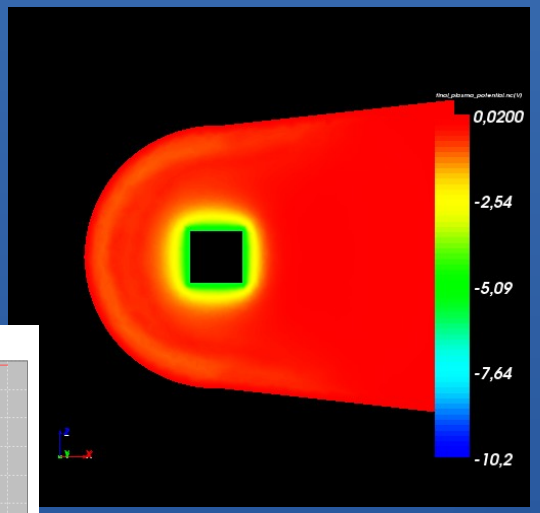
- Potential cut normal Y 600 m/s

Influence of the solar panels when photoelectrons are simulated

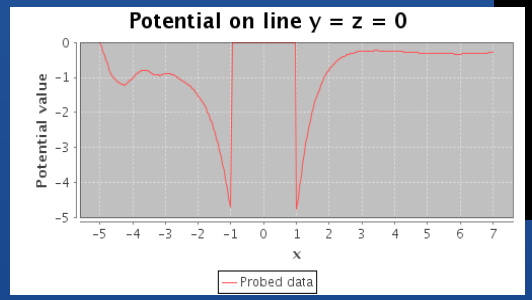
Model : Boltzmann, internal resol 0,2 m, external 0,3m (Debye 0,39 m), Velocity +600m/s in x direction (0,034 eV for ions), With photoelectrons

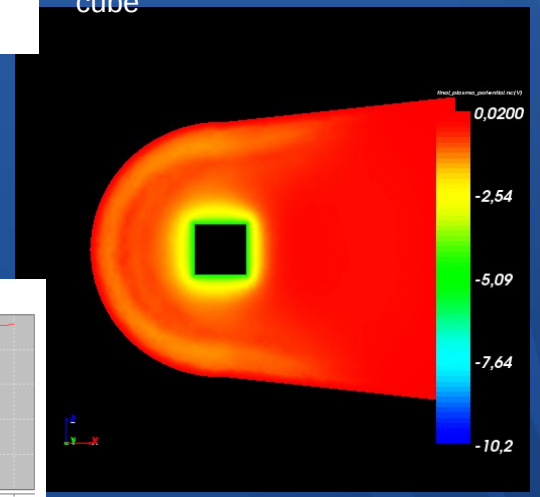






Potential cut normal Y simple cube



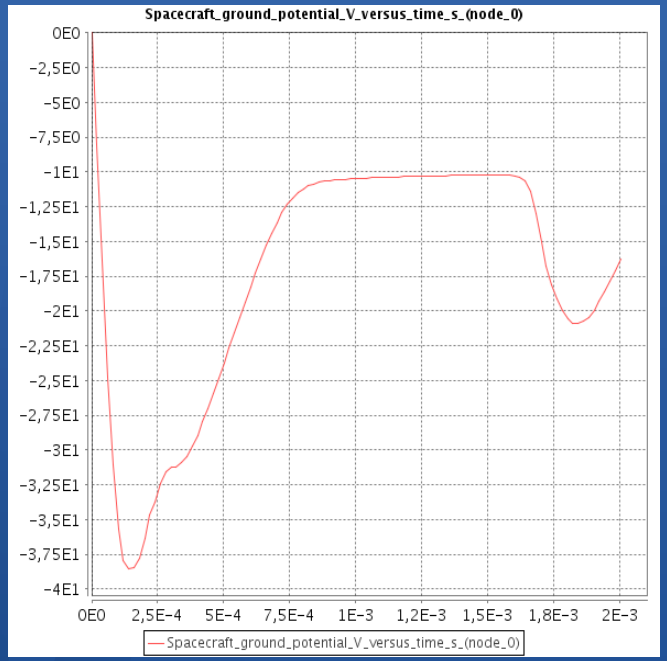


Potential cut normal Y with panels

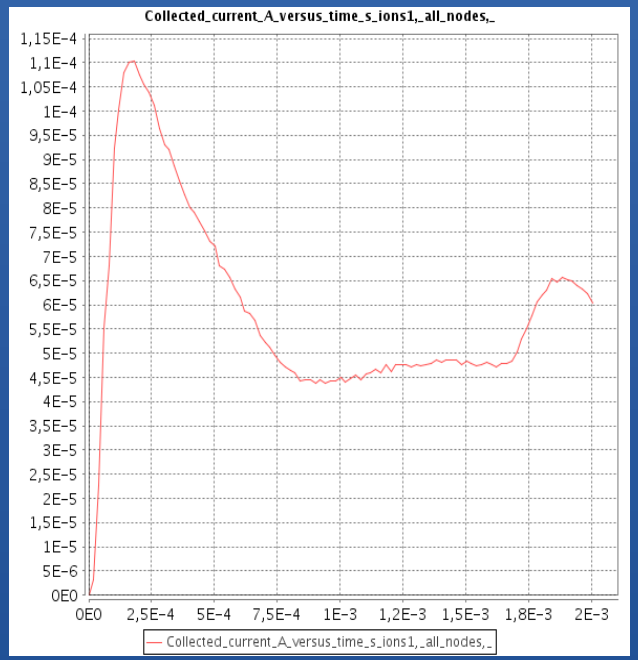
Summary of results

- PIC and BOLTZMANN: general good agreement (excepted some details?)
- MESH RESOLUTION
- PHOTO-ELECTRONS: effect moderate
- WAKE: effect noticeable at high velocities (probably not so significant at smaller, observed velocities)
- SOLAR PANELS : The potential becomes less negative because of photoelectric effect

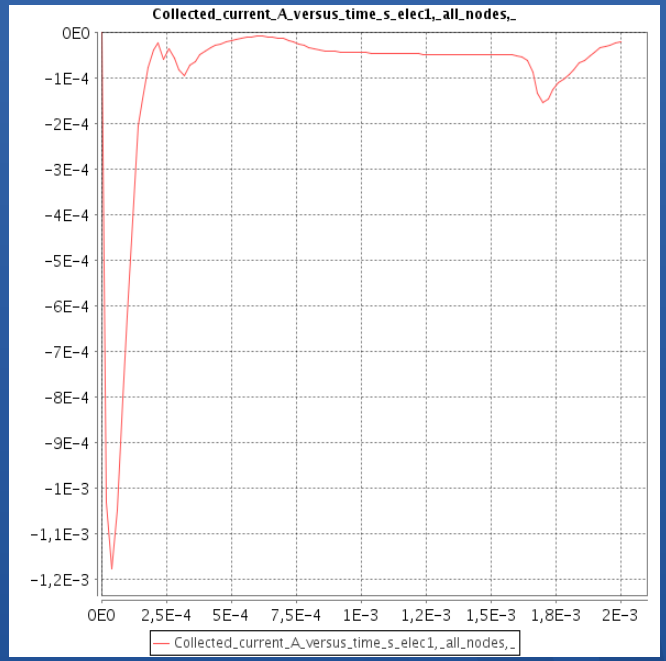
Questions : trusting PIC simulation



- Potential evolution



- Ion current evolution



- Electron current evolution

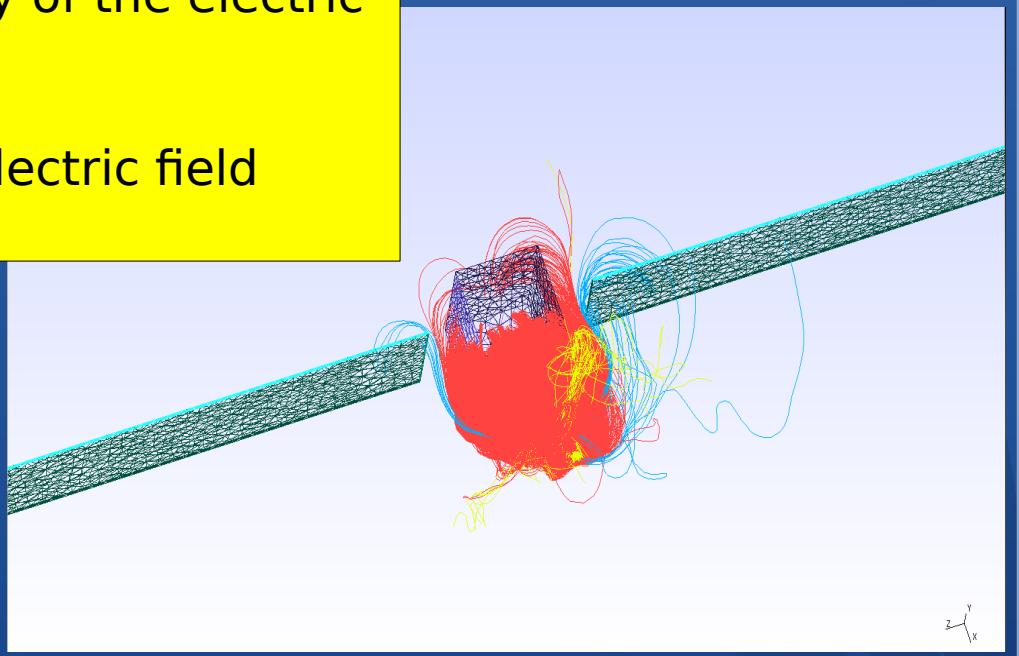
Plotting ion trajectories using output potential maps

- Objective : plot trajectories by backtracking to find The effective field of view of ROSINA instrument

- Realisation : A program for computing and plotting 10000 trajectories from a same end point with different end velocities.

- Problem : Trajectories with close final velocities can be very different because of the discontinuity of the electric field.

- Question : How to model a continuous electric field from a SPIS potential map ?



Questions

- Why does the potential falls that low in PIC simulation ?
- Why do we observe artefacts in densities when using high resolution ?
- Which model should we believe most in which cases, between PIC and Boltzmann ?
- Increasing the number of computing core does not speed up the calculations much ?
- In which cases is it interesting to choose other types of boundary conditions than Dirichlet ?