Plasma Measurement Simulations: Recent Uppsala Activities and Problems

T. Nilsson, IRF Uppsala
F. Johansson, IRF Uppsala

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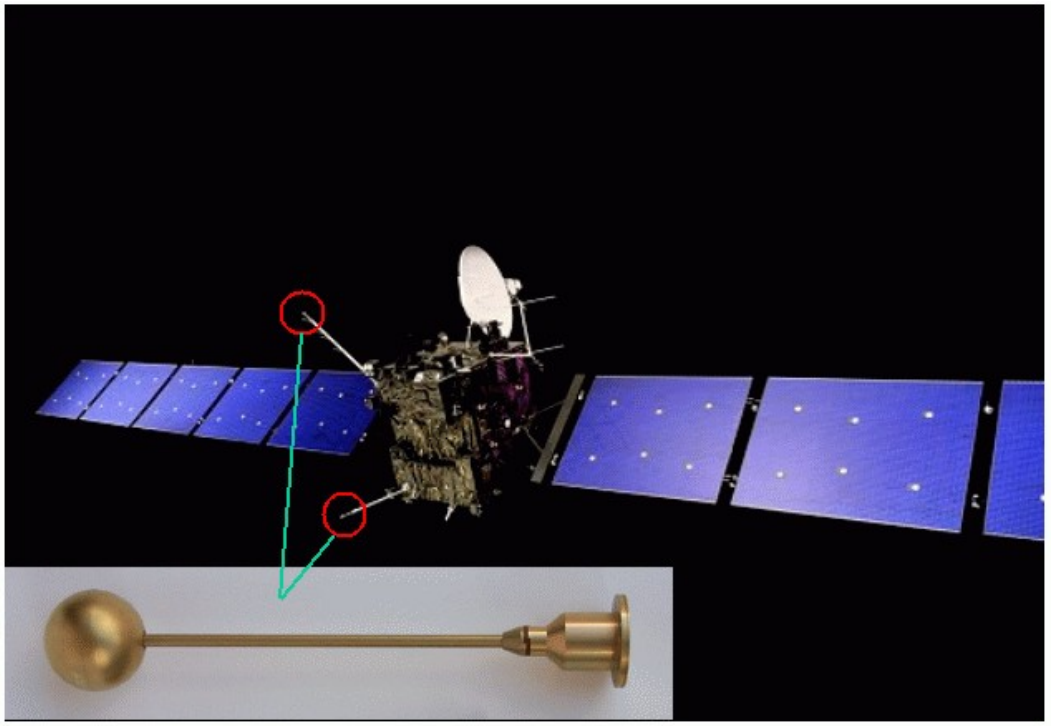
Outline of presentation

- Spacecrafts of interest
  - ESA’s Rosetta (with the RPC-LAP)
  - NASA’s MMS (with the FIELDS-SDP)
- SPIS bugs and issues
  - Or possible future improvements to SPIS

Rosetta RPC-LAP

- S/C & instrument overview
  - Launch 2004 to investigate 67P/Churyomov-Gerasimenko.
  - Arrived in 2014 and finally crashed on its surface 2016.

- Our instrument RPC-LAP consisted of two Langmuir probes.
  - TiN coated spheres of radius 5 cm on two booms.
  - The Langmuir probe sweep a bias voltage between probe and spacecraft and measuring the resulting current of electrons, ions, photoelectrons etc.

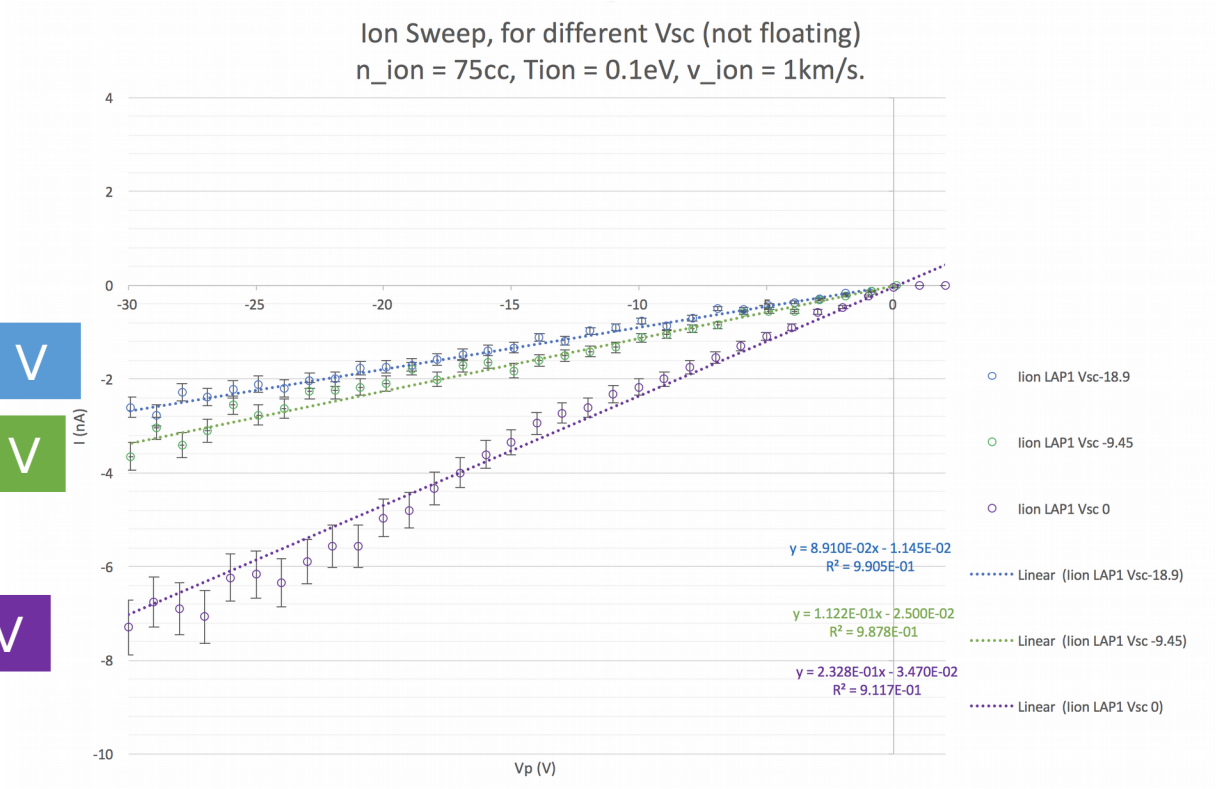


Rosetta RPC-LAP

Vsc= -18 V

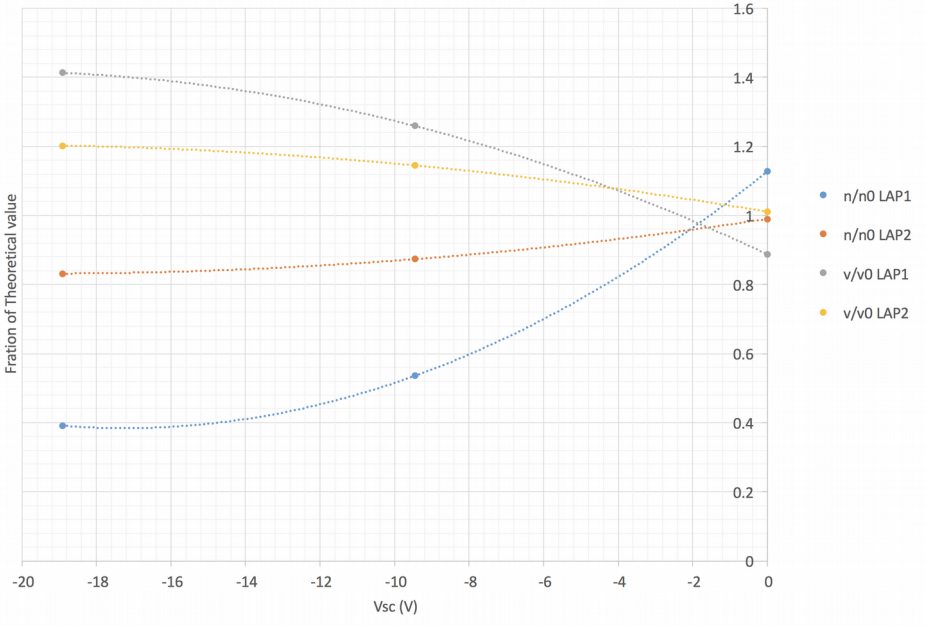
Vsc= -10 V

Vsc = 0 V

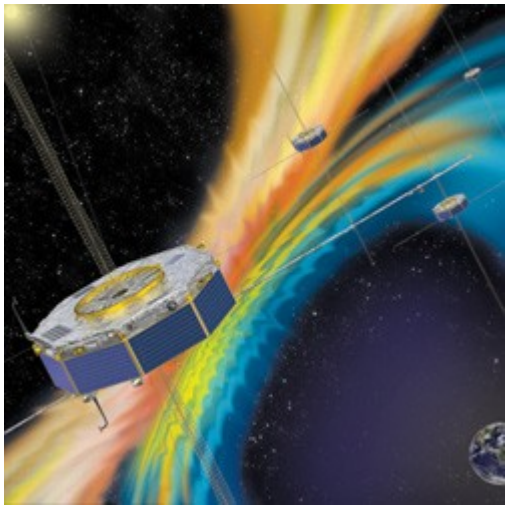


Ions accelerated to probe by spacecraft potential

Resulting in a smaller ion current slope and (potentially) higher velocity estimate in analysis



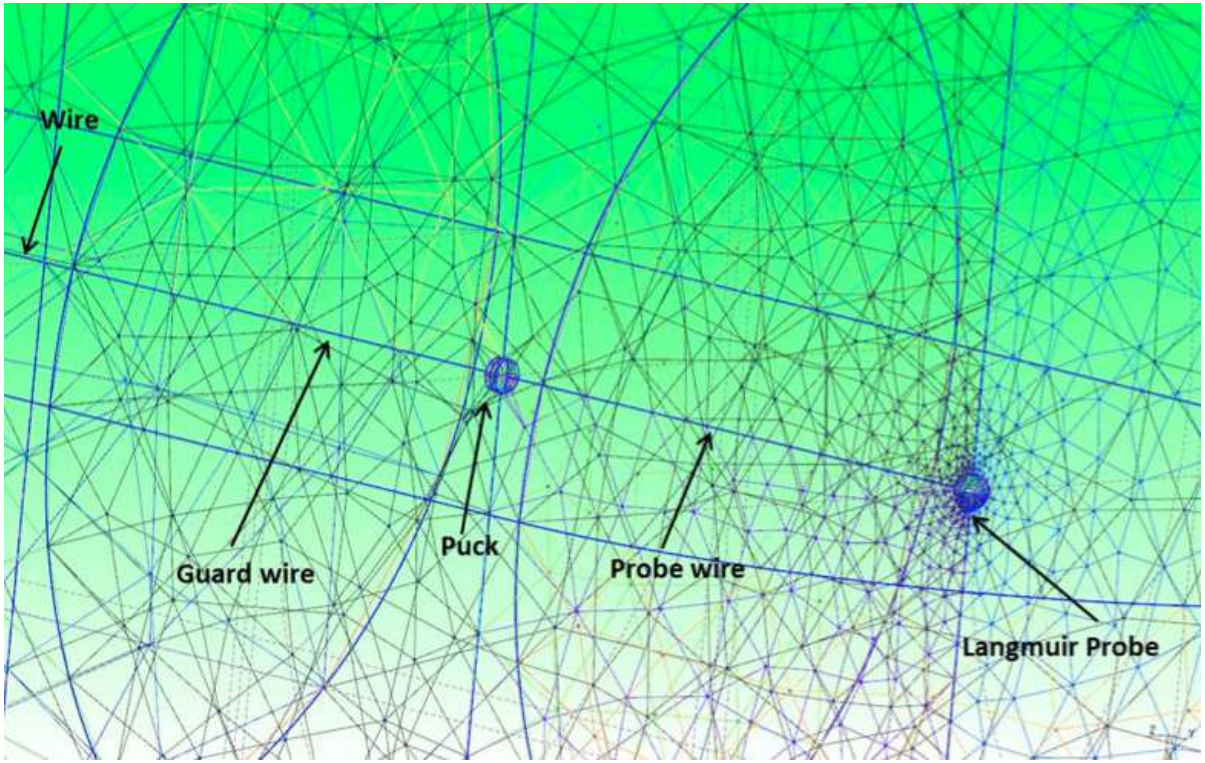
MMS FIELDS EDP



- S/C and instrument overview
  - NASA mission launched in march of 2015, into Earth orbit.
  - Goal: investigate magnetic reconnection in the dayside magnetopause and nightside magnetotail.
  - Consists of 4 octagonally shaped spinning spacecrafts
    - About 3 m diameter
    - Nominal spin rate 3 rpm
    - Flown in a tetrahedral configuration.
  - UNH/KTH/IRFU: Spin-plane double probe, (SDP), is part of Electric field double probes, (EDP).
    - Probe spheres of radius 8 cm coated with TiN at the end of about 60 m booms, making it 120 m tip-to-tip.
    - Applies a bias current and measure the resulting voltage
      - (difference between two probes provide the electric field).

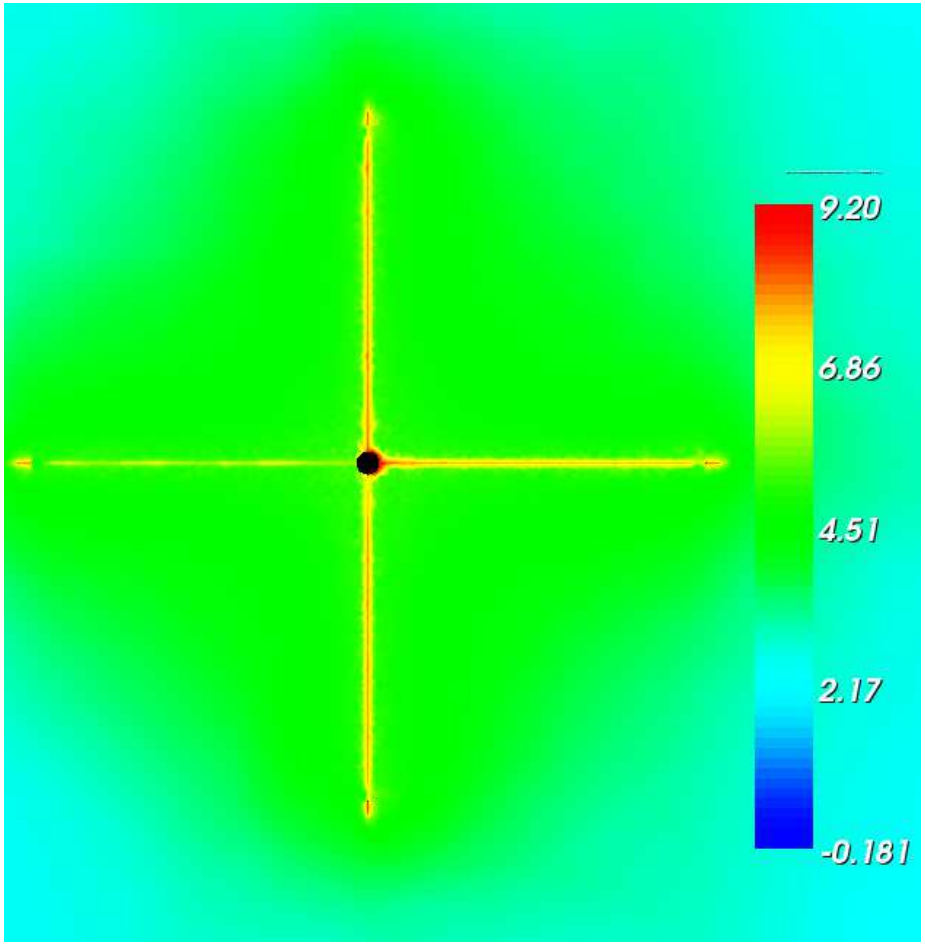
MMS FIELDS EDP

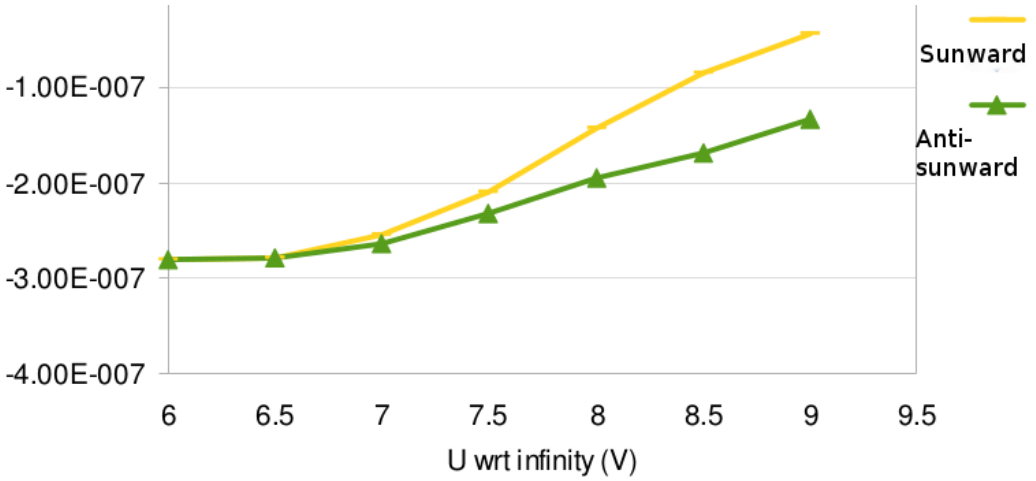
- Main wire is kept at S/c potential.
- Guard elements bias -4 and -8V respectively to minimize disturbance from spacecraft and wire itself.
- Probe wire and sphere is kept at biased current (around -100nA).
- (Setup is very similar to ESA's Cluster EFW)
- To get accurate probe measurements (voltage at a specific bias current) we use SPIS Langmuir Probes (currents at varying bias voltages).



Quick recap from a previous Cluster simulation (vacuum)

- We would expect an asymmetry in sun direction, just because of the sun.
- Below shows Langmuir probe currents (net current of photoelec) simulated by SPIS to the spherical probes.

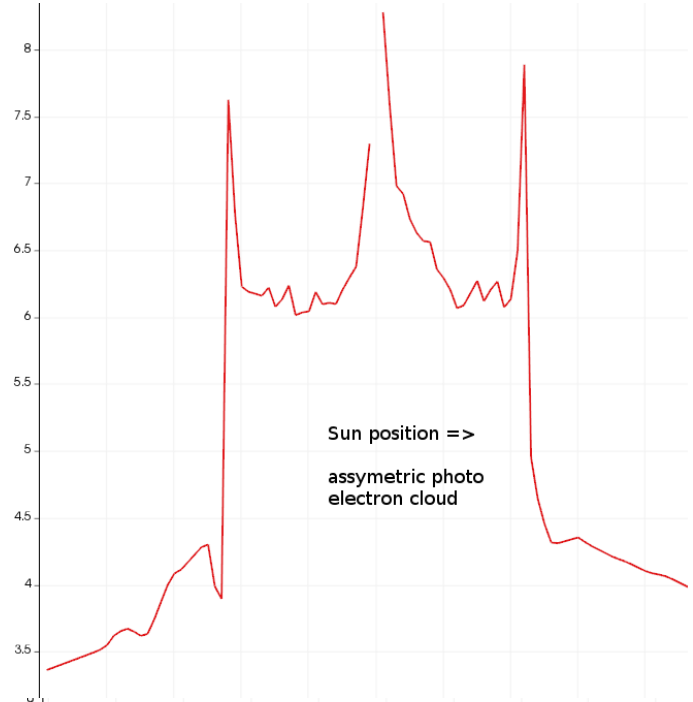


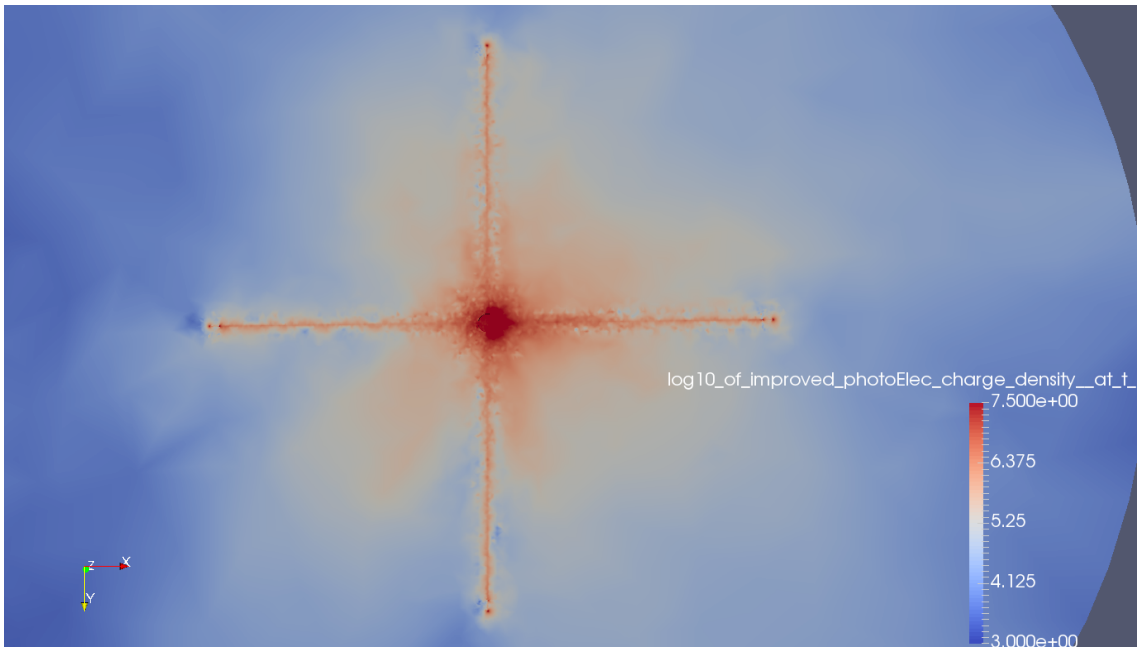


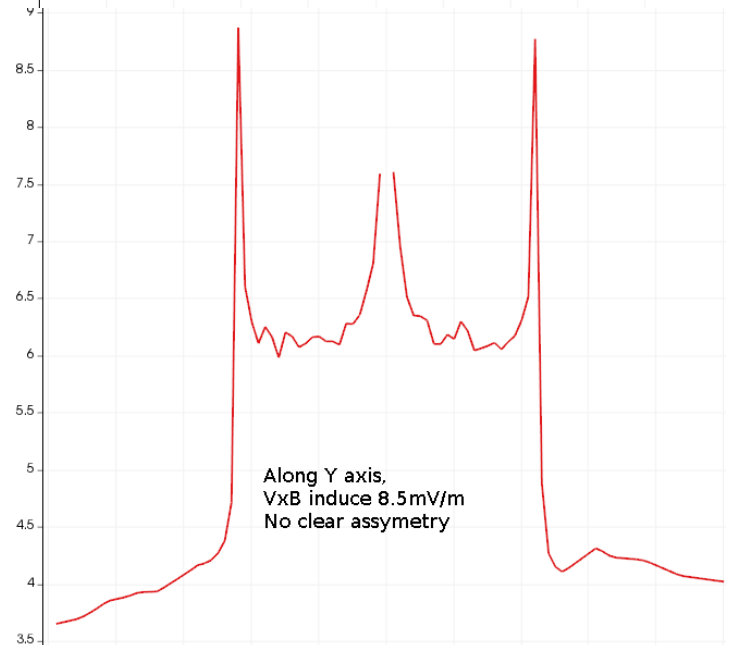
MMS FIELDS EDP

- Environment is rather varying in the MMS orbit but we focus on one instance, based on MMS1 2016/02/25.
  - Ne = Ni = 50 cm^-3.
  - Te = 20 eV, Ti = 80 eV (PIC H+).
  - Vx = -170 km/s (X points towards the sun).
  - Bz = 50 nT, inducing a field (VxB) of 8.5 mV/m.
  - ASPOC (“active spacecraft potential control”) emitting zero current.

MMS FIELDS EDP

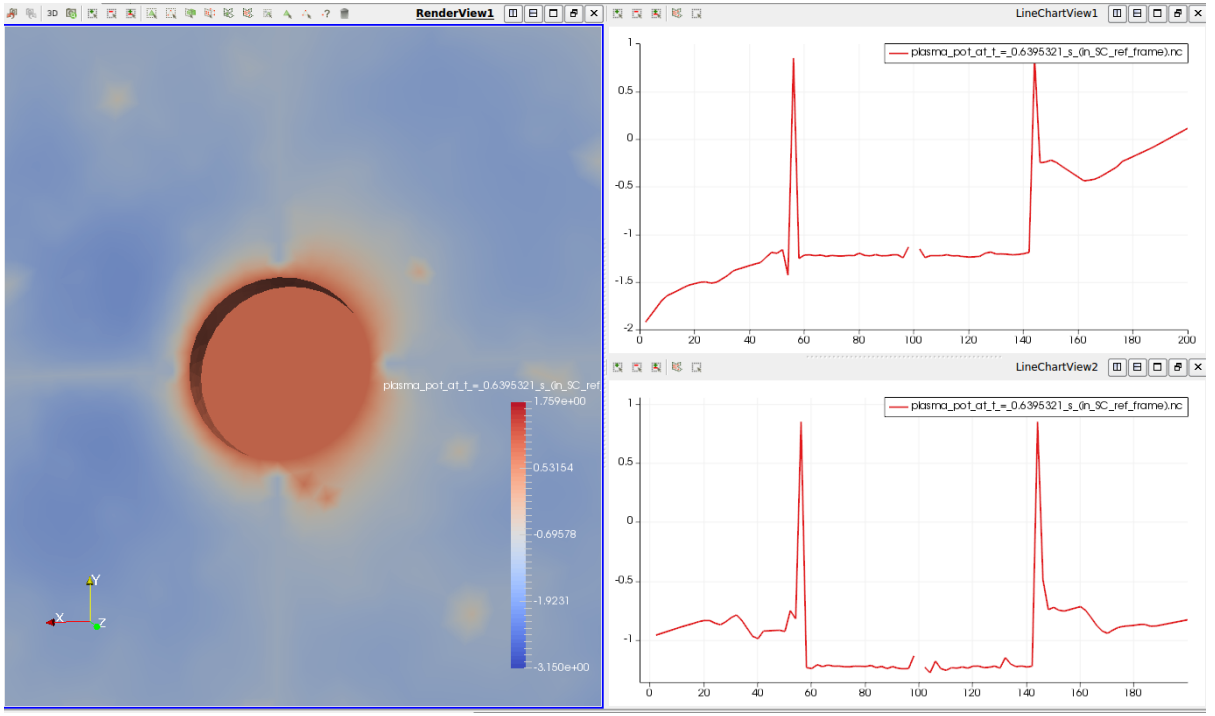






Open question: Potential at thin wires?

- Strange potential picture around thin wires close to s/c body.
- Both S/c body and thin wires are Node-0.
- These thin wires should be at same potential (+1.7V) but appears negative (-1.2V)?



SPIS Bugs/issues and possible improvements

- SPIS Bug #336. Photo e- and thin wires.
  - When the simulated sun is in the exact direction of a thin wire NO photoemission takes place.
  - This in not only true for the thin wire but the entire spacecraft which can lead to drastically incorrect potentials.
  - One workaround found is having the sun at very a slight angle away from the thin wire direction.
- SPIS Bug #330. Possible improvement to the SPIS instrument “Langmuir probe”.
  - Presently each SPIS “Langmuir probe” is specified to only do backtracking of one particle population at a time and changing the bias as it steps through the sweep.
  - Would it be possible, in the future, to have SPIS do backtracking of multiple populations but having only one sweeping action (i.e. changing bias and then do backtrack of “elec1”, “ions1”, etc., followed by the next step)?
  - For our instruments we are mainly interested in an accurate value of the nett current (to/from the probe).