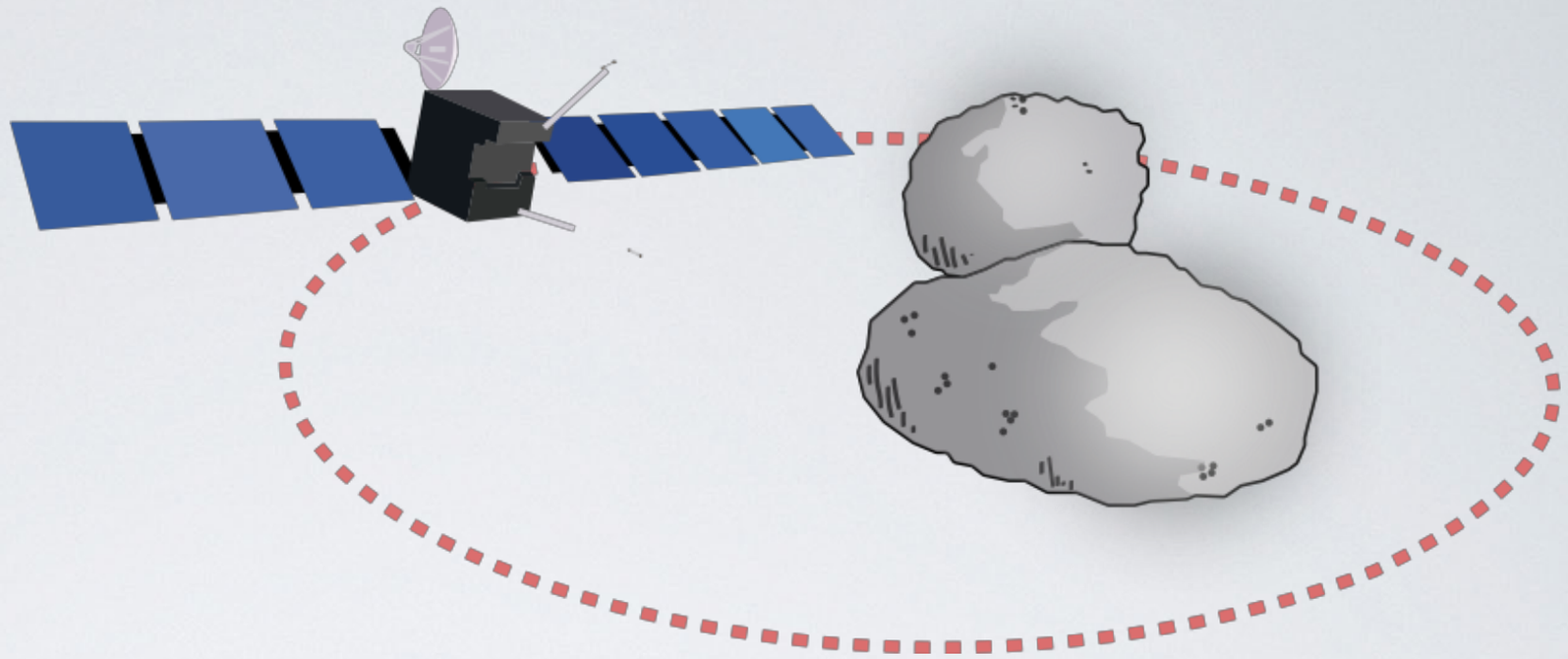
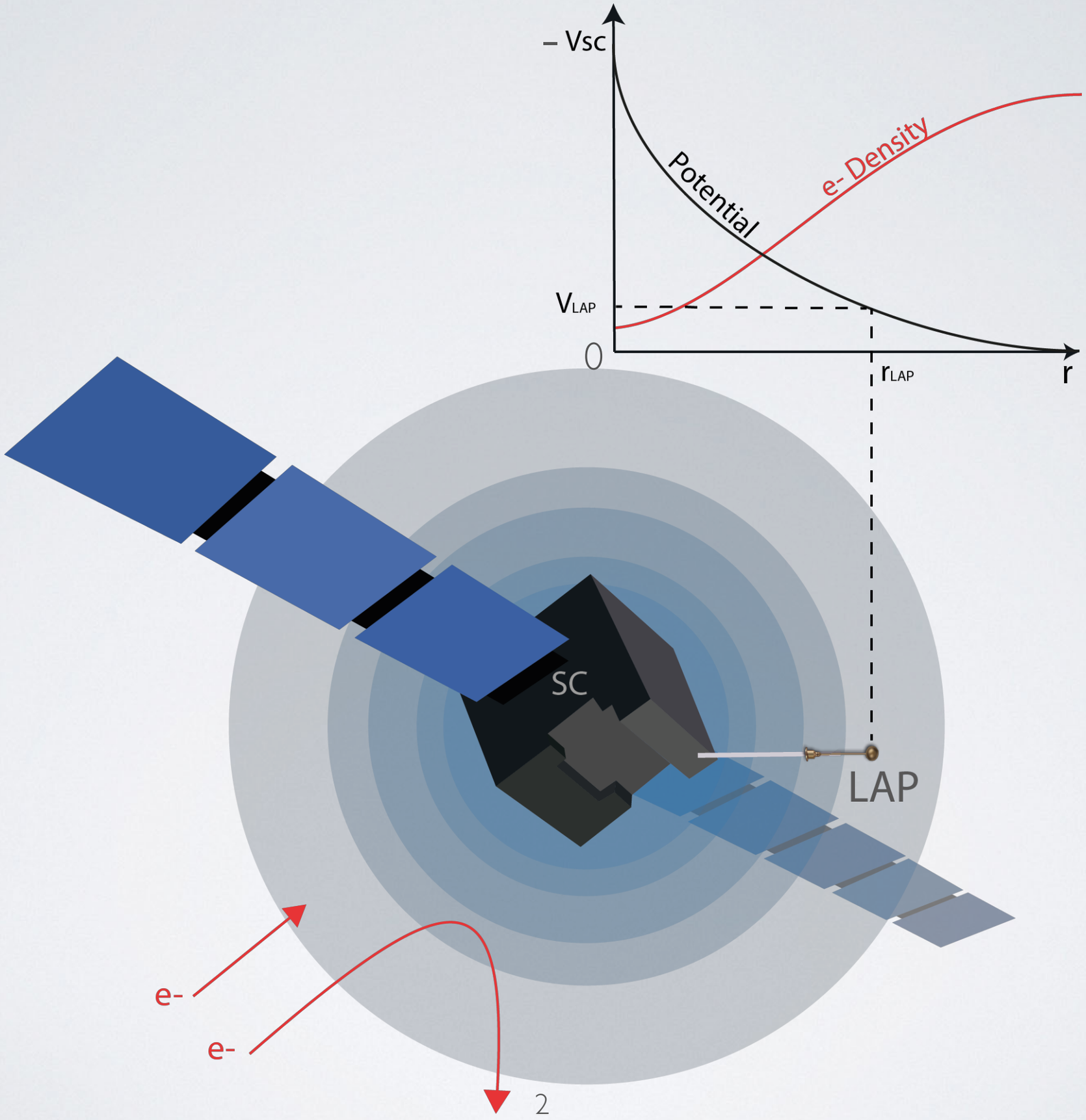


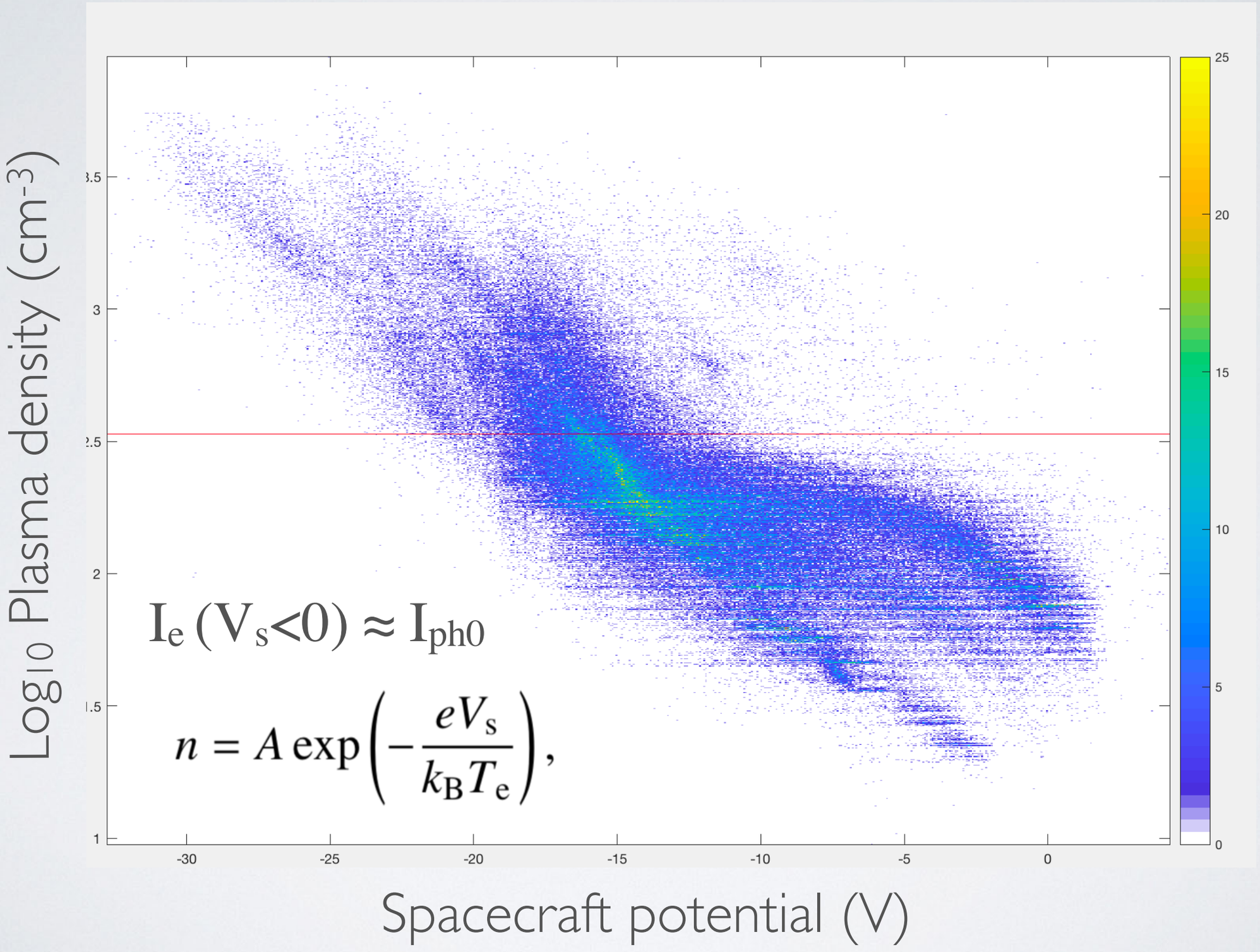
EXPOSED BUS BARS ON ROSETTA SOLAR PANELS

and the bittersweet implications on LAP

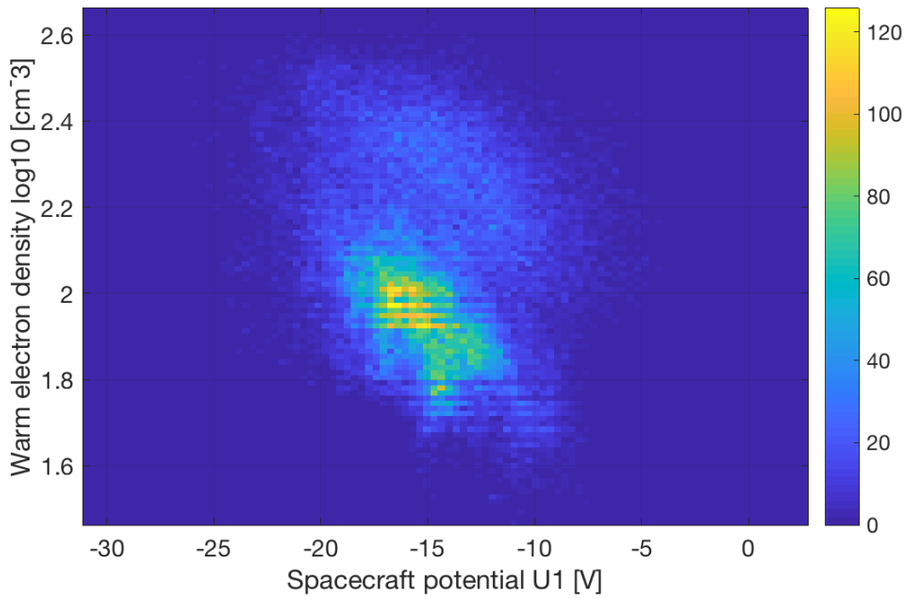
Fredrik Leffe Johansson frejon@irfu.se

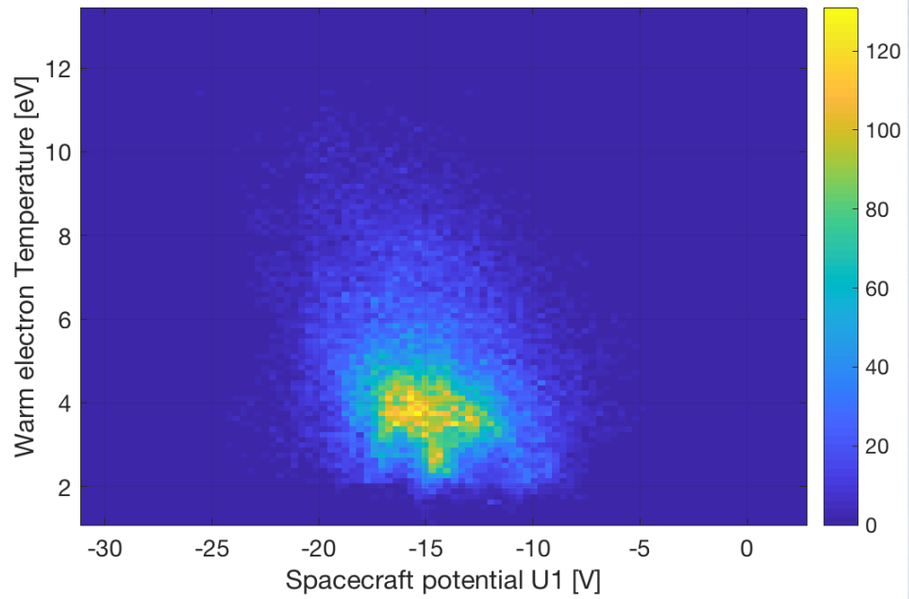

– Vsc
Potential
e- Density
VLAP
0
rLAP
r
SC
LAP
e-
e-

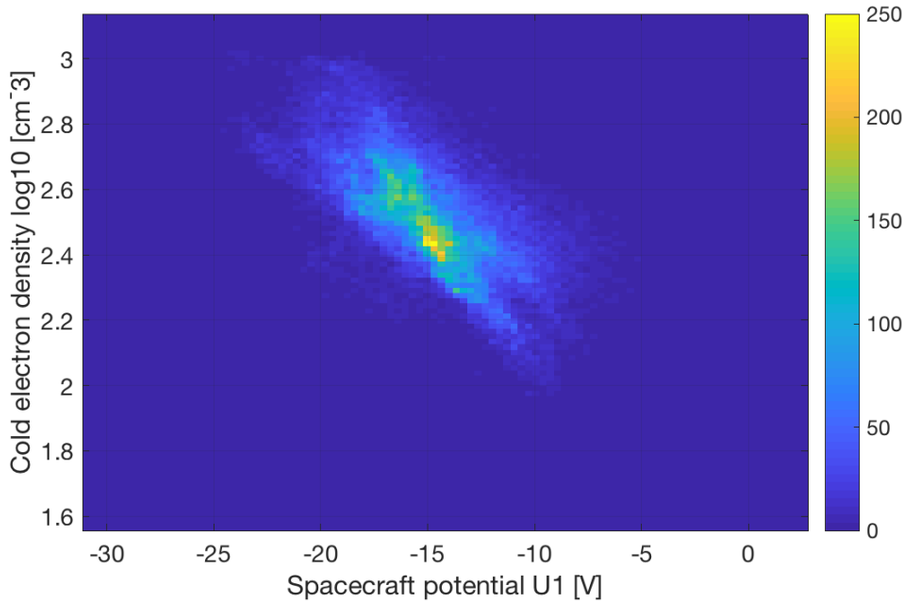
MOTIVATION -XCAL

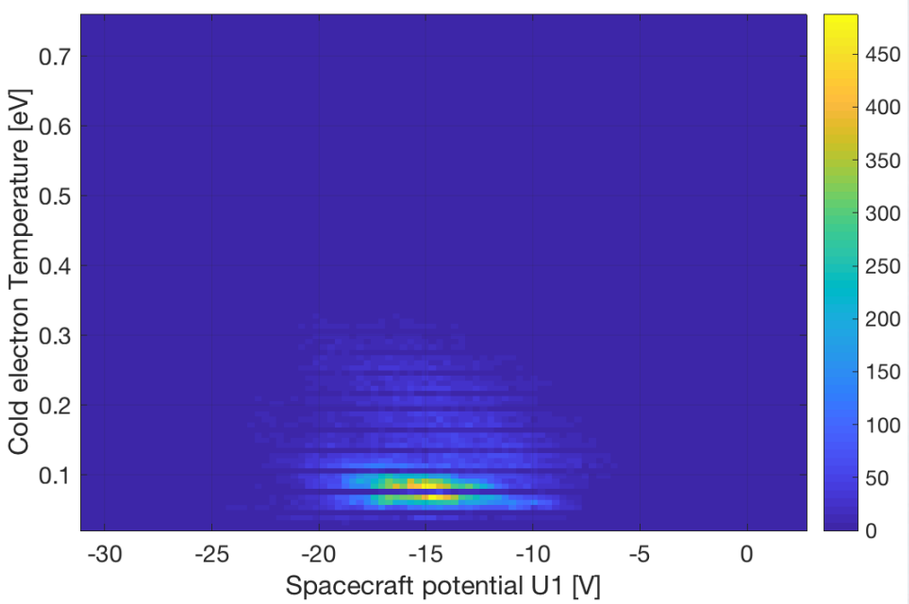


MOTIVATION -NEW RESULTS

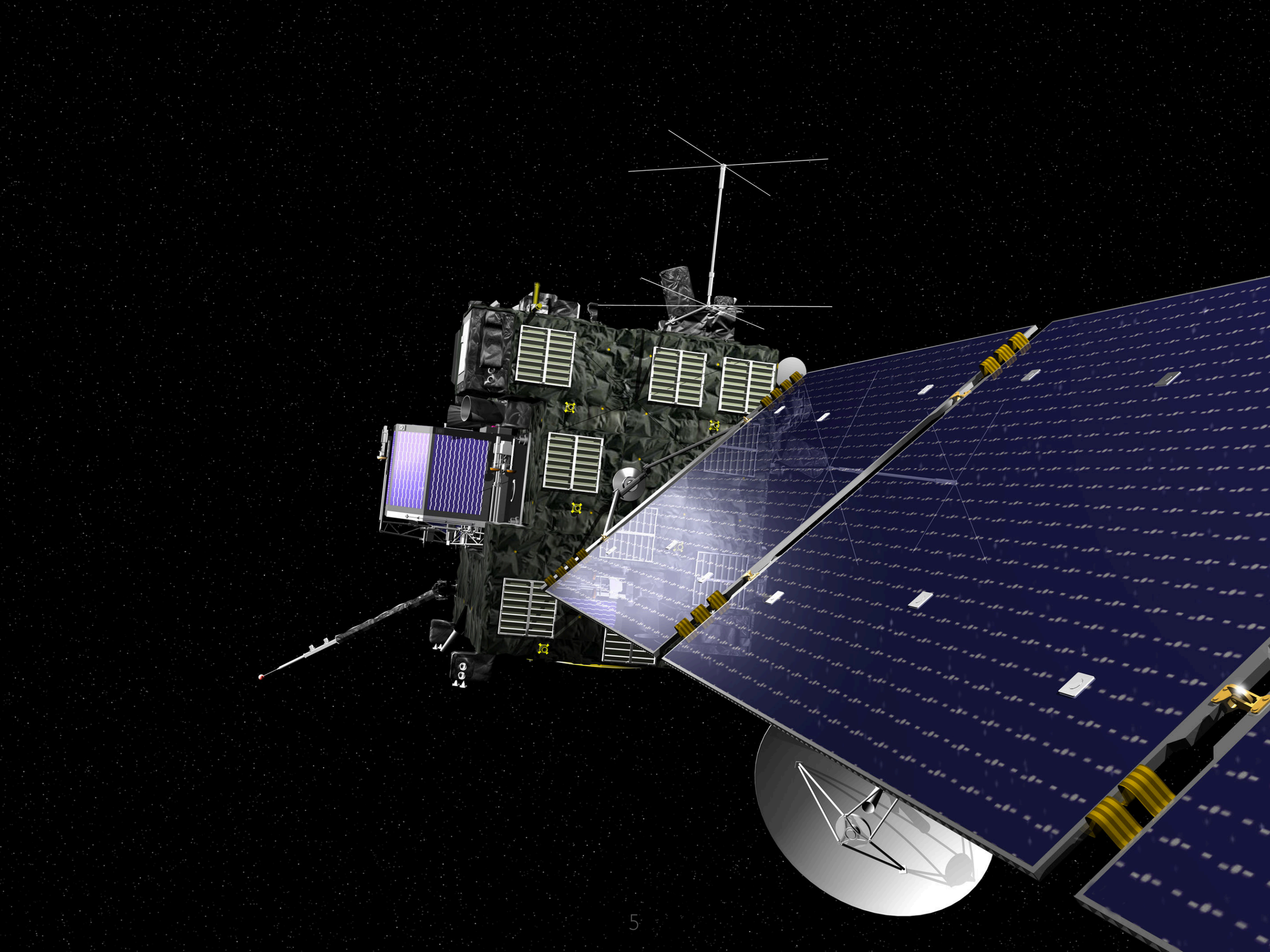


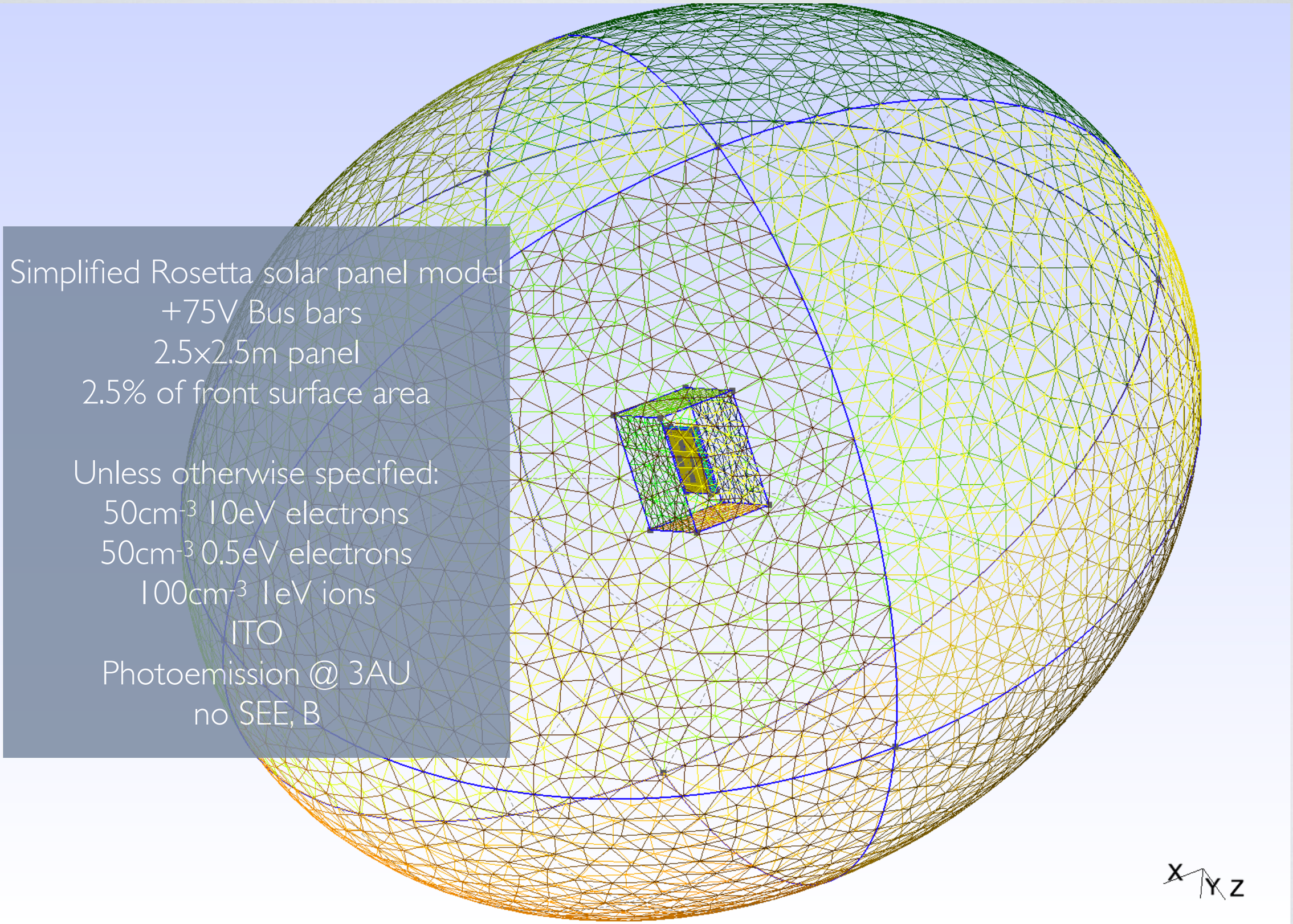




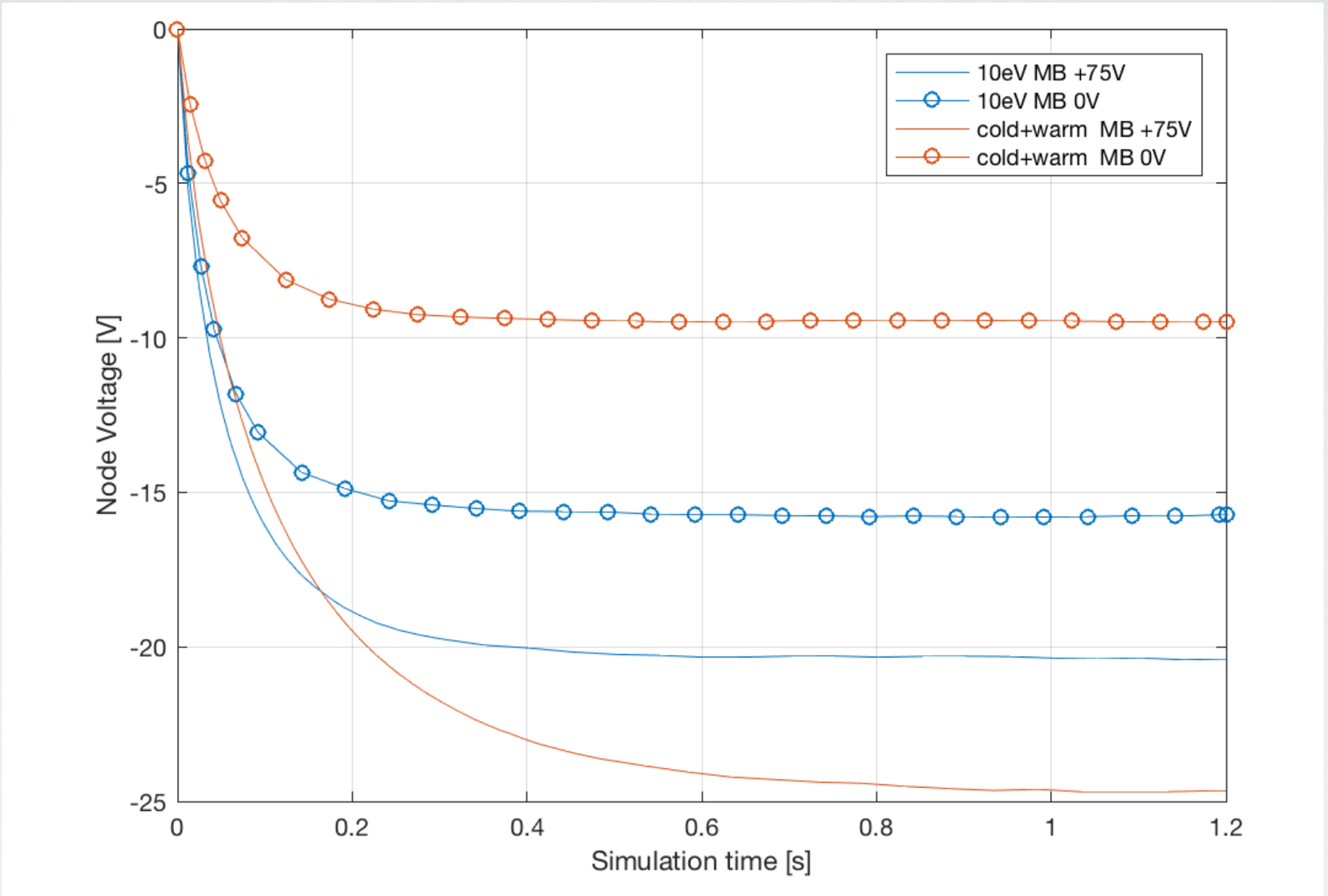


Spacecraft potential has a linear-log relationship with density, especially clear with the cold electron population (0.1eV), even though 0.1eV electrons cannot contribute a current to a uniformly charged -15 V body. How can this be

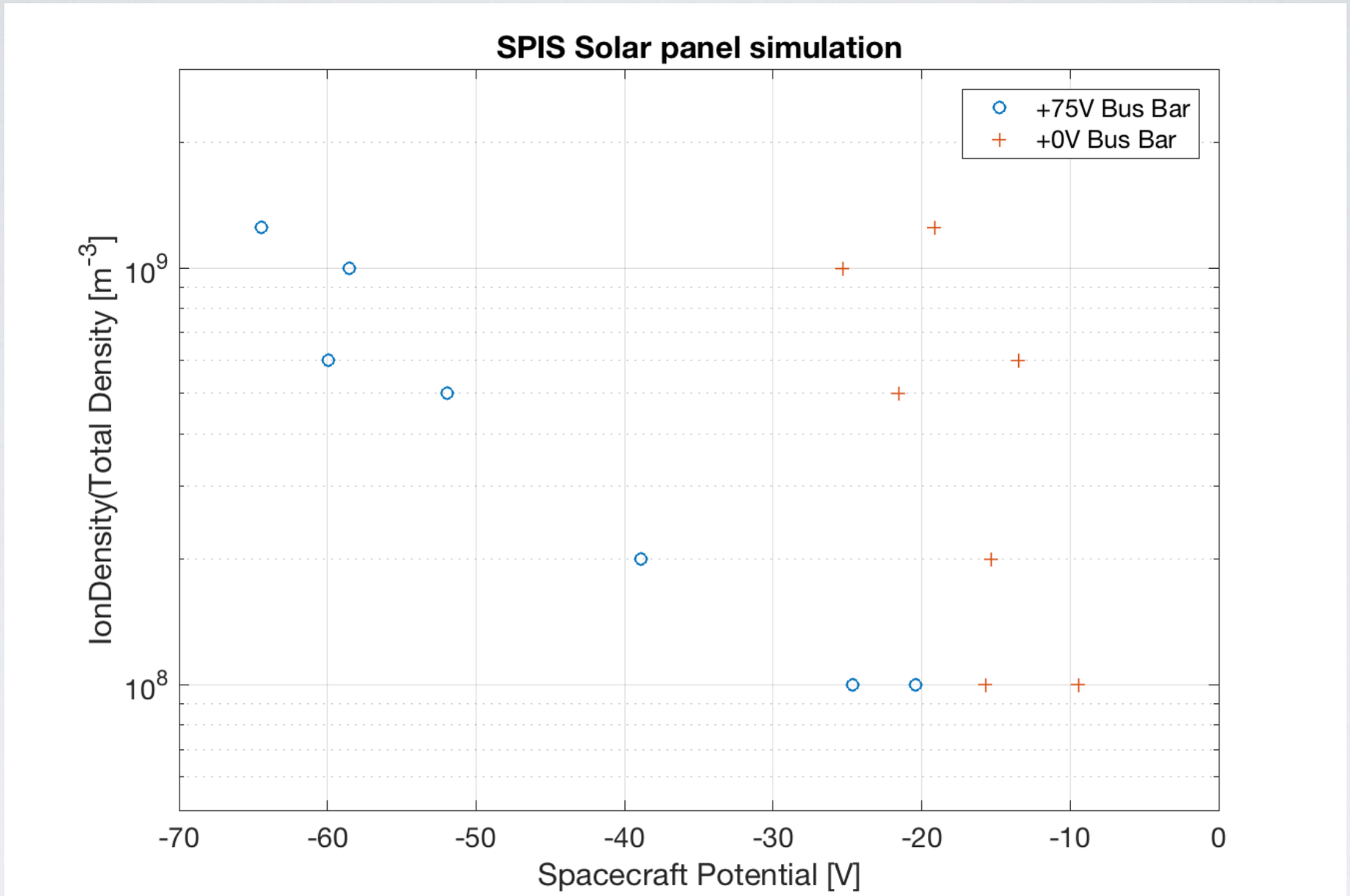



Simplified Rosetta solar panel model
+75V Bus bars
2.5x2.5m panel
2.5% of front surface area
Unless otherwise specified:
50cm-3 10eV electrons
50cm-3 0.5eV electrons
100cm-3 1eV ions
ITO
Photoemission @ 3AU
no SEE, B
X
Y
Z

RESULTS

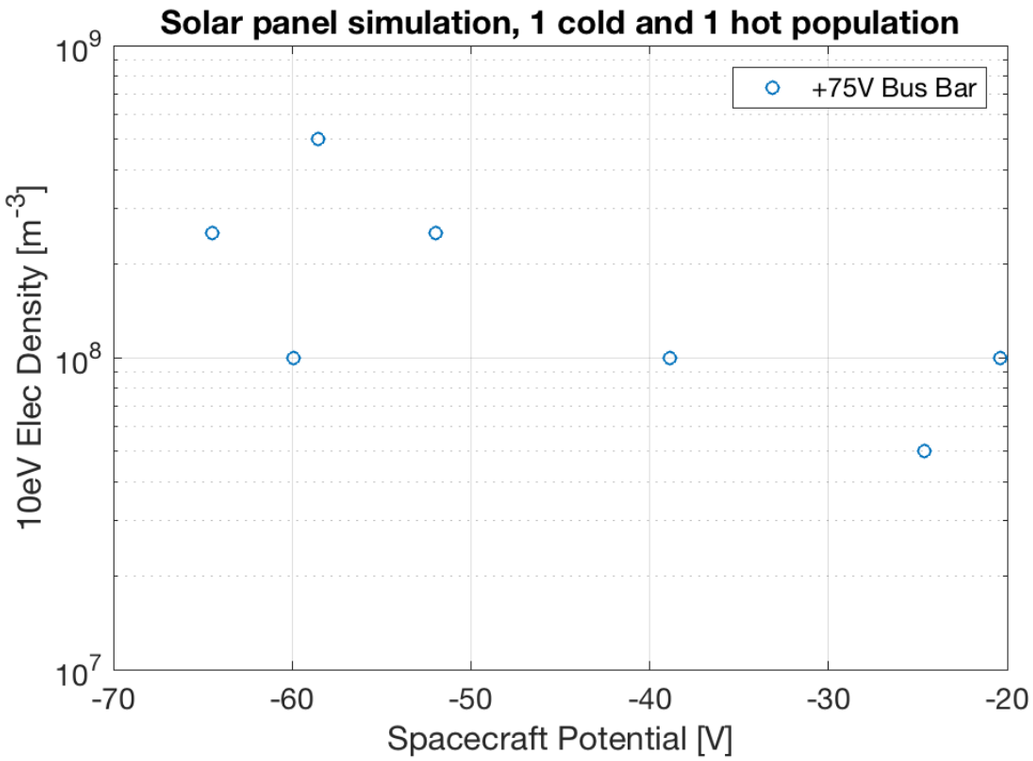


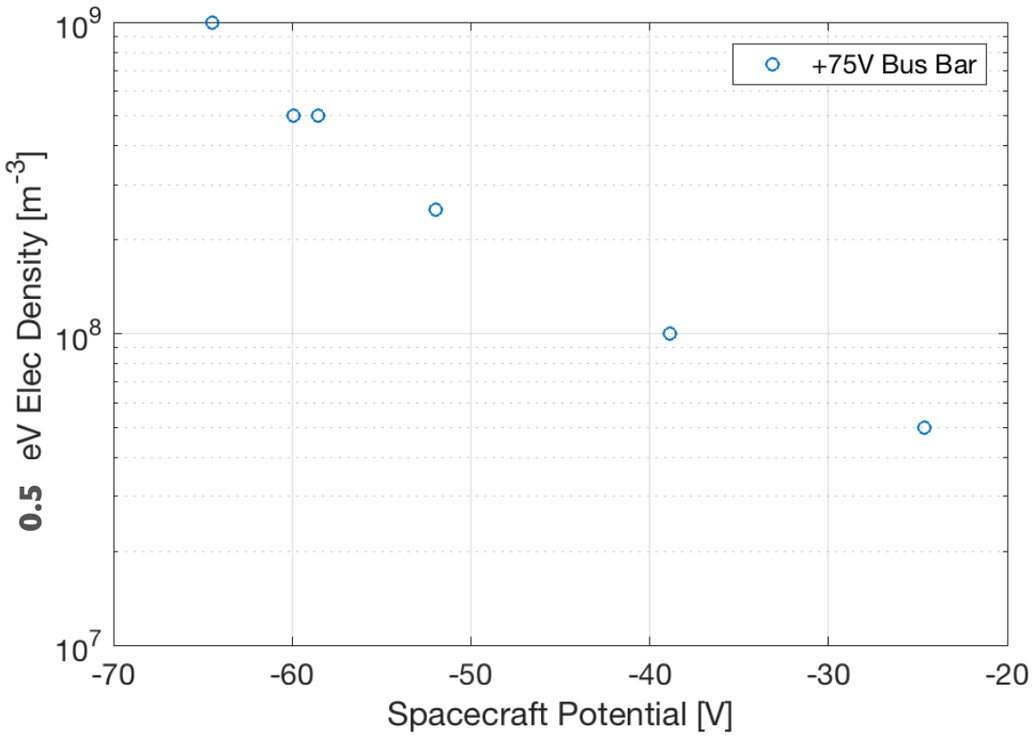
- The small exposed positive elements attracts significant current, enough to change the floating potential of the system (and spacecraft).
- When there is a cold (0.5eV) electron population present, this effect is even more noticeable.
- Note(!) Maxwell-Boltzmann fluid approximation for electrons. On-going PIC-PIC Simulations agree for the 0V case, but show slightly less severe charging with elements at +75V.



- 7 simulations of environments with various electron energy distribution. Clear and significant charging with exposed +75V elements

- Clear dependence on cold electron density, less clear response with 10 eV electron population.





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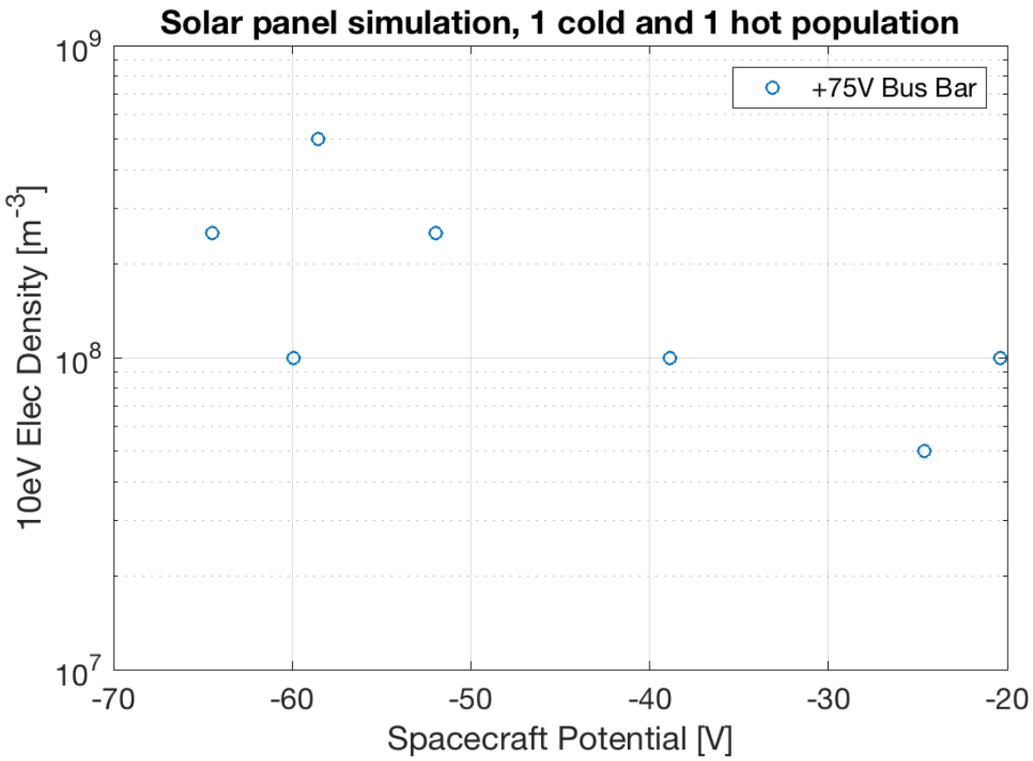
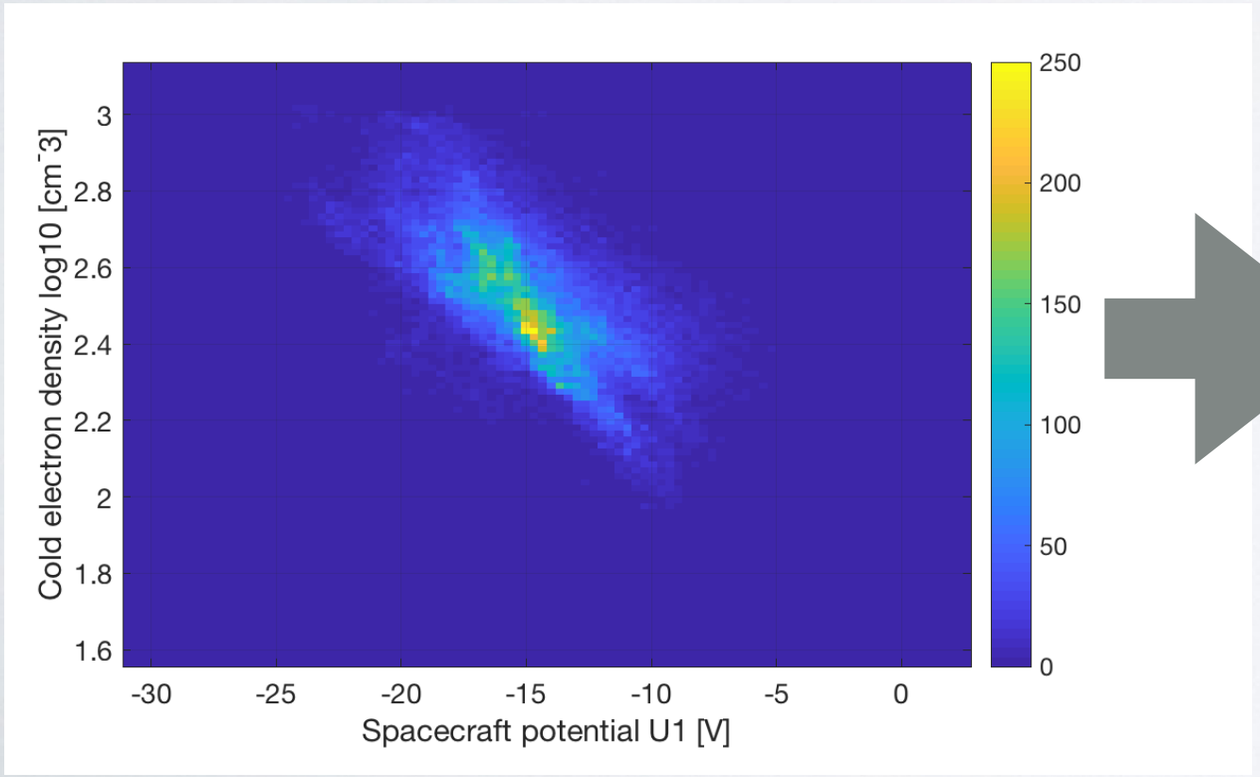
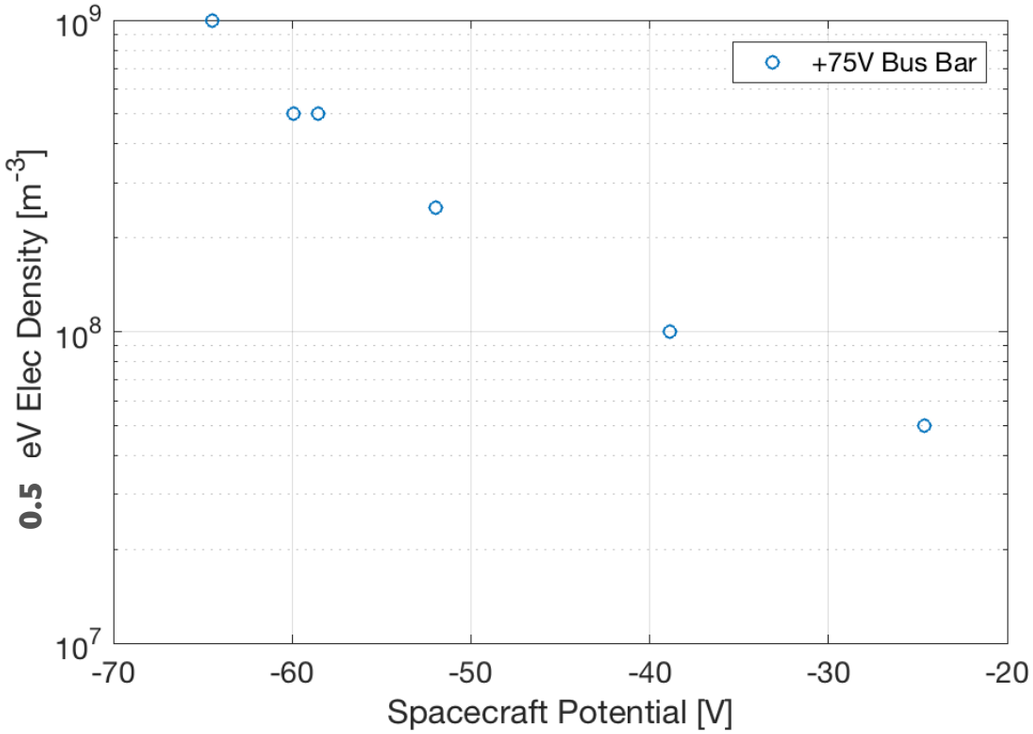
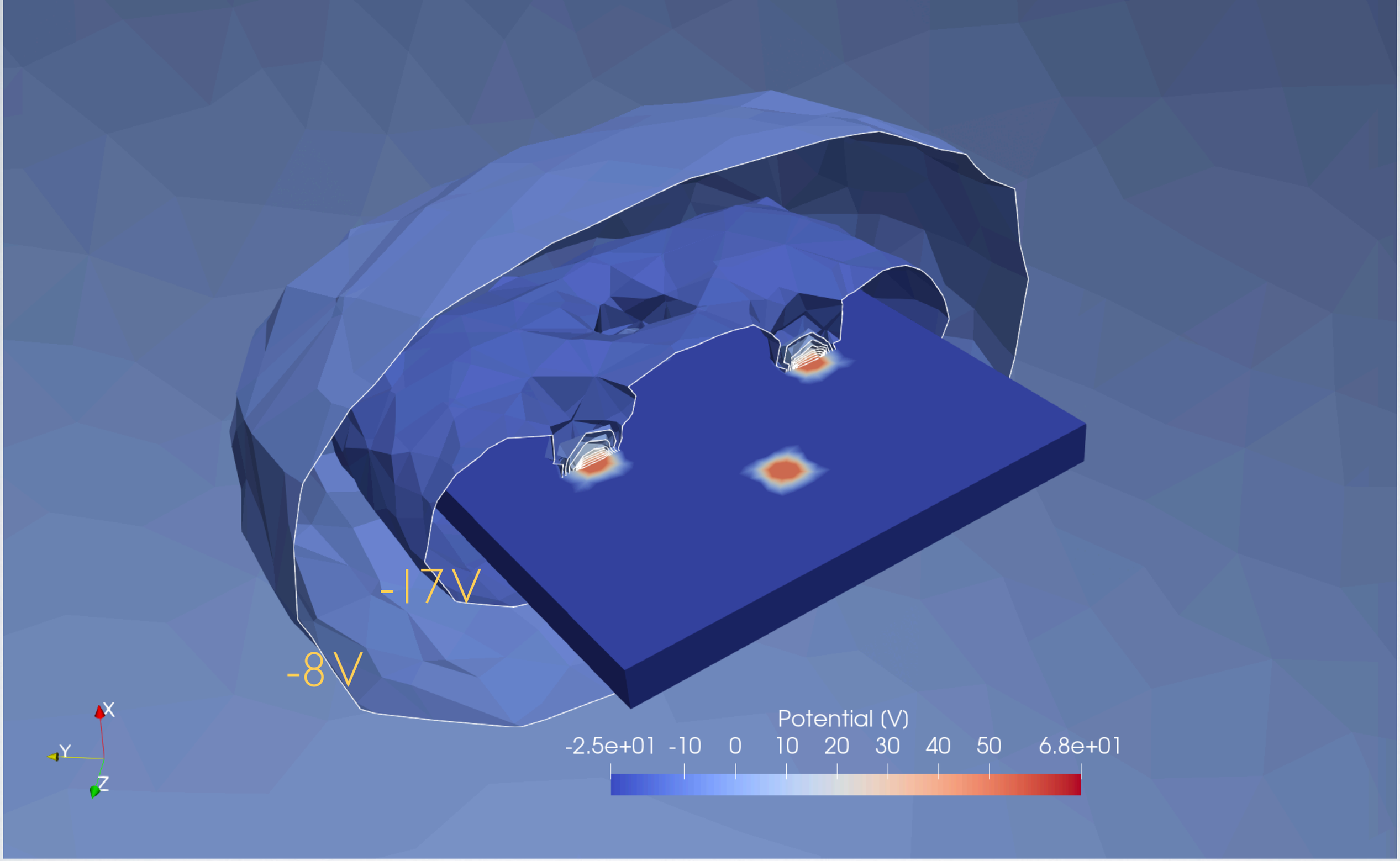


Compare with Rosetta measurements







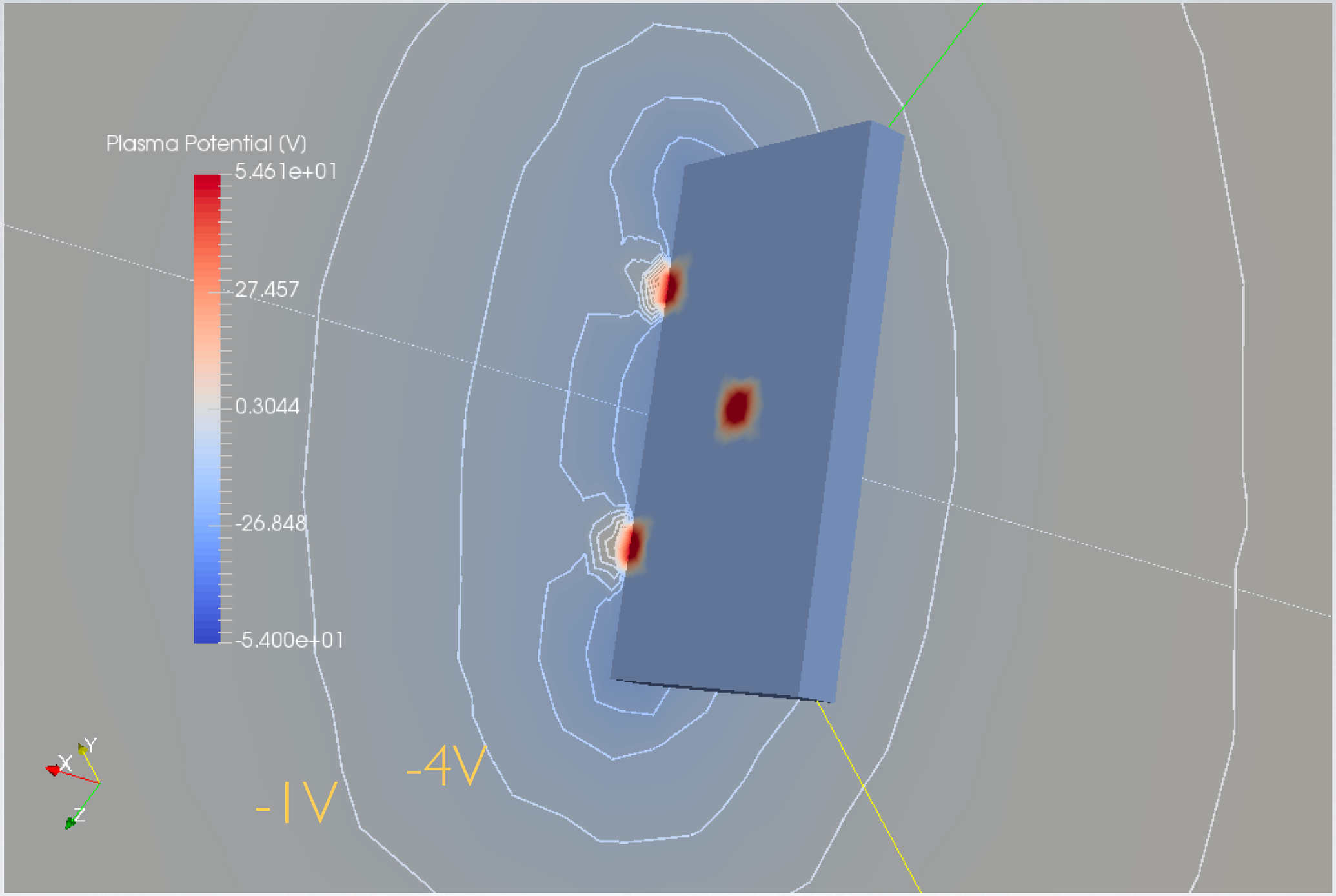
Potential Structure
10eV electron simulation

CONCLUSIONS

- A small, conductive and biased surface such as solar array bus bars is consistent with the significant negative charging of the Rosetta Spacecraft.
- For $\mathbf{U/T_e < 1}$, or if the cold electron density is small, the effect is very limited.
- This changes our interpretation on the cometary electron environment as published by Odelstad+2015 JGR, Odelstad+2017 MNRAS, although the conclusions made are still believed to generally true.
- The highly negative spacecraft potential, the short booms for the Langmuir Probes and the uncertainties in the electron energy distribution disturbs the measured electron current, and is currently no longer used in the analysis.
- However, the same root cause enables a cross-calibration exercise that increased the dynamical range and the temporal resolution (from ≈ 0.5-1hz to 60 hz) of the estimated plasma density with great precision.

ON-GOING WORK

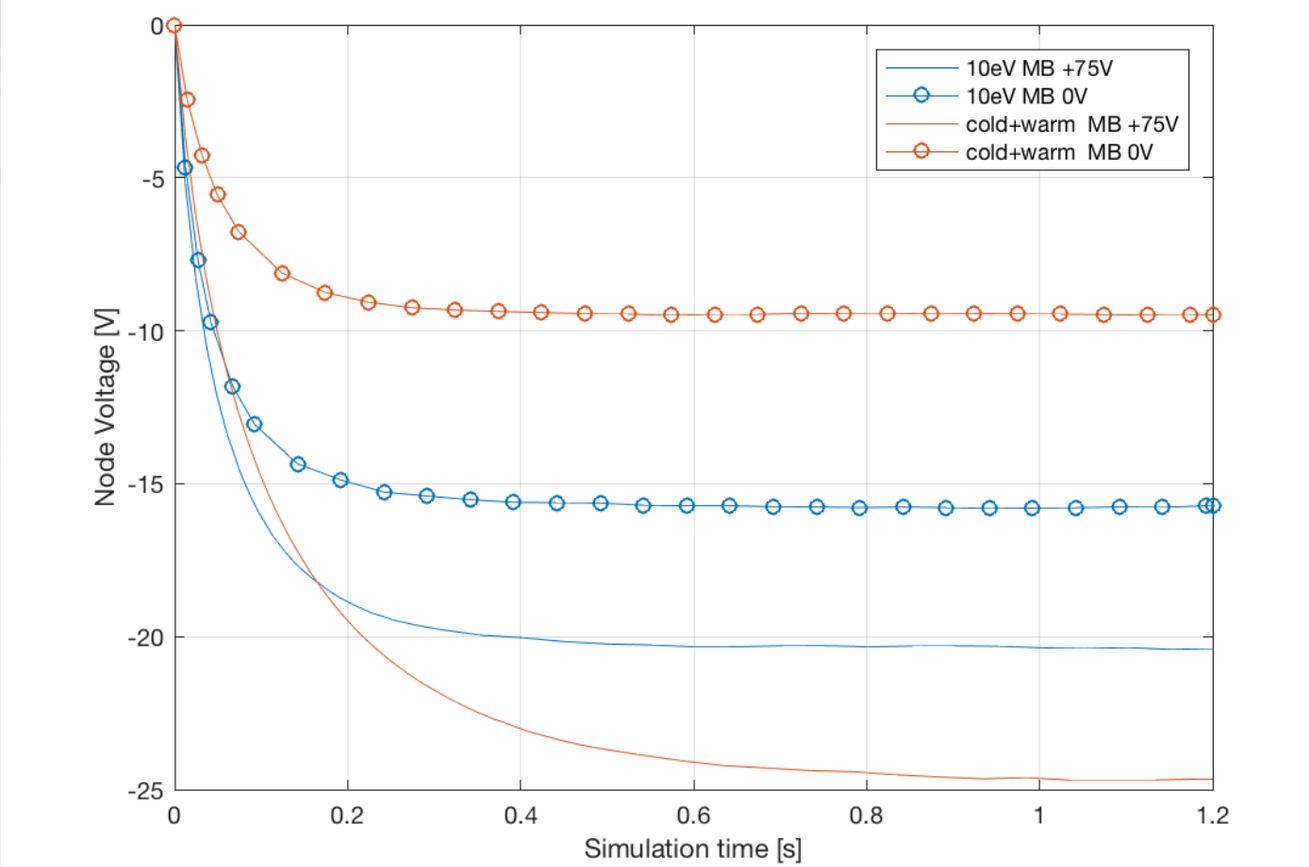
- PIC PIC simulations underway
- New SPIS version enabled environmentType "TimeDependentEnvironment", but I haven't gotten that to work
- Compare simulation results with OML, apply to more realistic version model of Rosetta solar array panels



Potential Structure

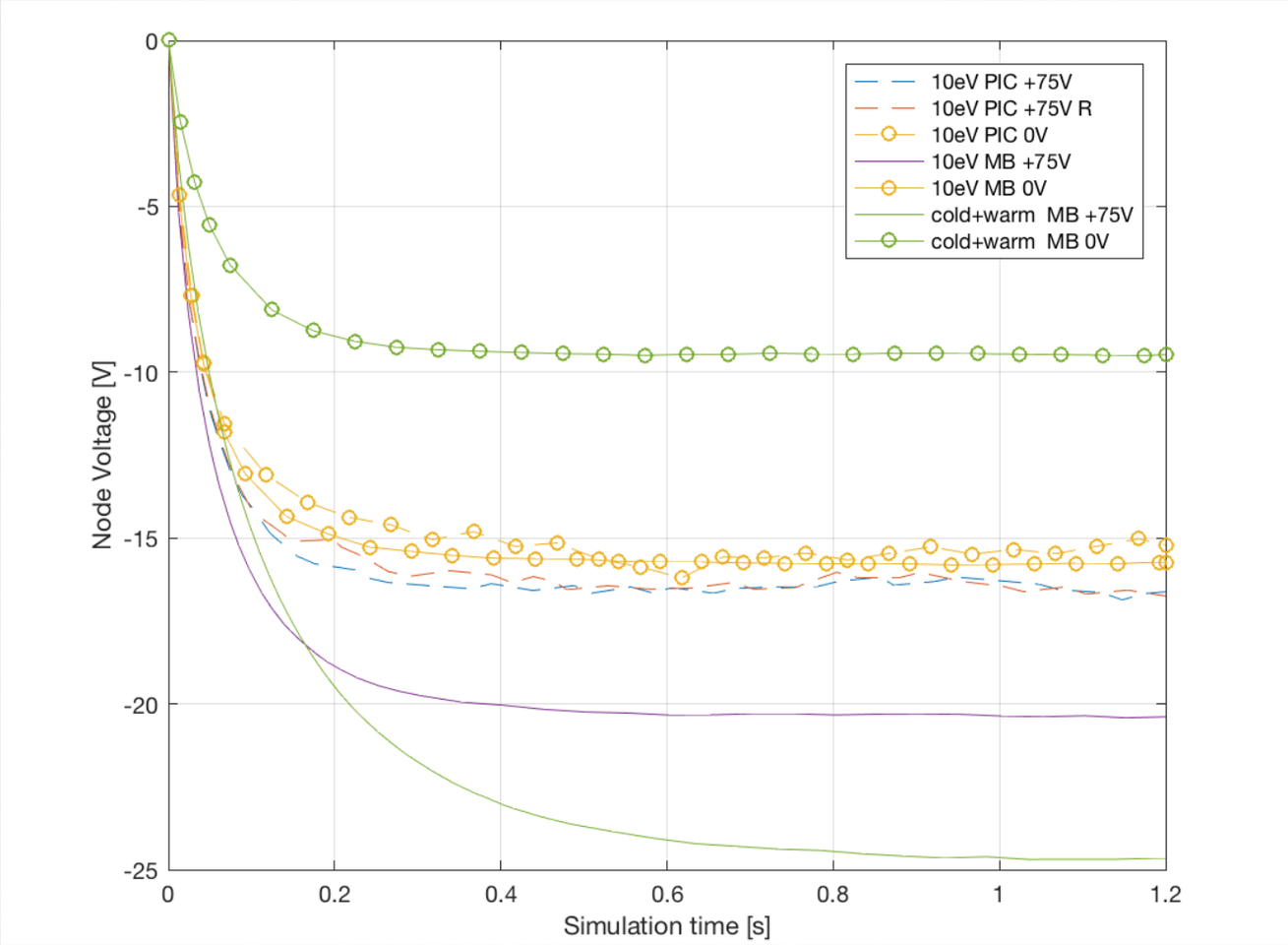
×

RESULTS



- As expected, the small (16% area) attracts significant current, enough to change the floating potential of the system (and spacecraft).
- When there is a cold electron population present, this effect is even more noticeable.
- The maxwell-boltzmann approximation is dubious. However, PIC simulation confirm the trends, but the spacecraft charging is slightly less severe in the +75 V simulations. (dV≈2V). The PIC simulations with +0V bus bars are identical (but noisier)

RESULTS



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