ISSC abstract:

When a spacecraft moves through a space plasma, different parts of it can develop large magnitude potentials relative to the ambient plasma due to a phenomenon called spacecraft charging. Historically, engineers have tried to mitigate this effect due to the negative consequences it can cause like electrical arcing and its unsolicited interactions with on board experiments and equipment. However, these large magnitude potentials also pose an opportunity for this effect to be exploited for energy harvesting from the space environment. Orbit-motion-limited models allow the analysis of this technique, but this model limits the studies to only be applicable to certain plasma regimes and spacecraft geometries. Therefore, this research aims to further explore this idea by using the Particle-in-Cell (PIC) method. As a first study in this research, we aim to build computational models for the analysis of spacecraft charging using WarpX, a highly optimized 3D electromagnetic PIC code. This paper presents the first results on the analysis of spacecraft charging using WarpX. The numerical algorithm in the WarpX solver is presented along with the algorithm used to compute the electric potential on the spacecraft. As a first step for verification, a simulation of a spherical spacecraft immersed in a static uniform plasma was carried out to compare against results from OML. Additionally, benchmark tests were also done for a CubeSat immersed in a flowing plasma with and without magnetic field, secondary electron emission and photoelectron emission. These initial tests are done to further study the feasibility of energy harvesting from spacecraft charging using simulations.