User Manual

Annex 1 - Spacecraft surface charging in GEO/MEO

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Presentation

Objectives

The objective of this document is to provide the user with the relevant information to understand how to simulate spacecraft surface charging in GEO and MEO with SPIS.

This UM is compliant with the version 5.0.1 of SPIS and is in its main User Manual in its version 2, revision 3 [RD0].

We remind that SPIS is an expert application. For this reason, the relevance of the results remains of the responsibility of the user.

Technical content summary

This document is divided in two main parts:

- The first part is an introduction to the spacecraft surface charging in GEO/MEO
- The second part explains the pre-defined settings used for GEO/MEO applications in basic mode.

Changes

Version	Revision	Date	Auteur / Observation
1	0	27/03/2013	Jean-Charles Matéo-Vélez / Document creation
1	1	10/04/2013	Julien Forest / References updates
1	2	26/06/2013	J.C. Matéo-Vélez / update for eclipse exit
1	3	05/07/2013	J.C. Matéo-Vélez
1	4	25/10/2013	J. C. Matéo-Vélez / Release of SPIS 5.1

Table of contents

1. Introduction

The present document constitutes an annex to the SPIS User Manual (UM) [RD0] dedicated to the use of SPIS in GEO/MEO orbits. This document arose from the SPIS-GEO activity (Software Requirements for the Simplified Standard MEO/GEO Tools for Spacecraft Charging (ITT ref. AO/1-6218/09/NL/AT, contract Nr 4000101174).

Section 2 presents some rationale of spacecraft surface charging in GEO/MEO

Section 3 describes the model-predefined settings used.

1.1. Reference documents

[RD0] SPIS User Manual, ESA-SPISGEO-D7-SUM-2012-08-002, version 3, revision 1, April 2013

[RD1] SPINE community Web site, www.spis.org

[RD2] Artenum's Kerdiwen Web site, http://www.artenum.com/EN/Products-Keridwen.html

[RD3] SPIS services Web site, http://www.spis-services.eu/

[RD4] Apache Felix OSGI runtime Web page, http://felix.apache.org/site/index.html

[RD7] ONERA, SPIS Project Documentation, *How to control NUM from UI*, 2013.

[RD8] ONERA, SPIS Project Documentation, *How to define spacecraft equivalent circuit*, 2012.

[RD9] Cassandra Web site, http://dev.artenum.com/projects/cassandra

[RD10] ONERA, SPIS-SCIENCE Software Design Document, 2013

1.2. Acronyms, abbreviations and definitions

- **ECSS:** European Cooperation for Space Standardization
- **GEO:** Geosynchronous orbit
- **MEO**: Middle Earth Orbit
- **SPIS**: Spacecraft Plasma Interaction Software
- **SPIS-NUM**: Spis Numerical kernel
- **SPIS-UI**: Spis User Interface

2. Rationale

Geosynchronous Earth Orbit (GEO) and Middle Earth Orbit have specific environments. The behaviour of spacecraft in non-quiet GEO environment (sub-storm) is of particular interest because it can lead to severe charging. This document summarises how SPIS-GEO has been specifically designed to model this situation. It also applies to Middle Earth Orbit charging simulations.

Non-quiet GEO environment is characterised by the presence of relatively high-energy electrons (10s of keV as far as surface charging is concerned) and the absence of significant low energy plasma (contrarily to the plasmasphere environment). The total plasma density is small (typically a few #/cm3). The physical consequences are:

- a large Debye length compared to spacecraft size
- currents collected from the plasma are usually smaller than the photoemission current: typically less than 1 nA/cm2 versus a few nA/cm2

The next consequences for charging are:

- the importance of photoemission (and secondary emission) and of its local variations results in differential charging (more positive where sunlit)
- the large Debye length makes long distance electrostatic influence effective
- this results in the well known situation of potential barrier in GEO and MEO (except for conductive spacecraft) depicted in the figures.
- the inverted voltage situation obtained on the solar panel is a risky situations since it can lead to severe electrostatic discharges

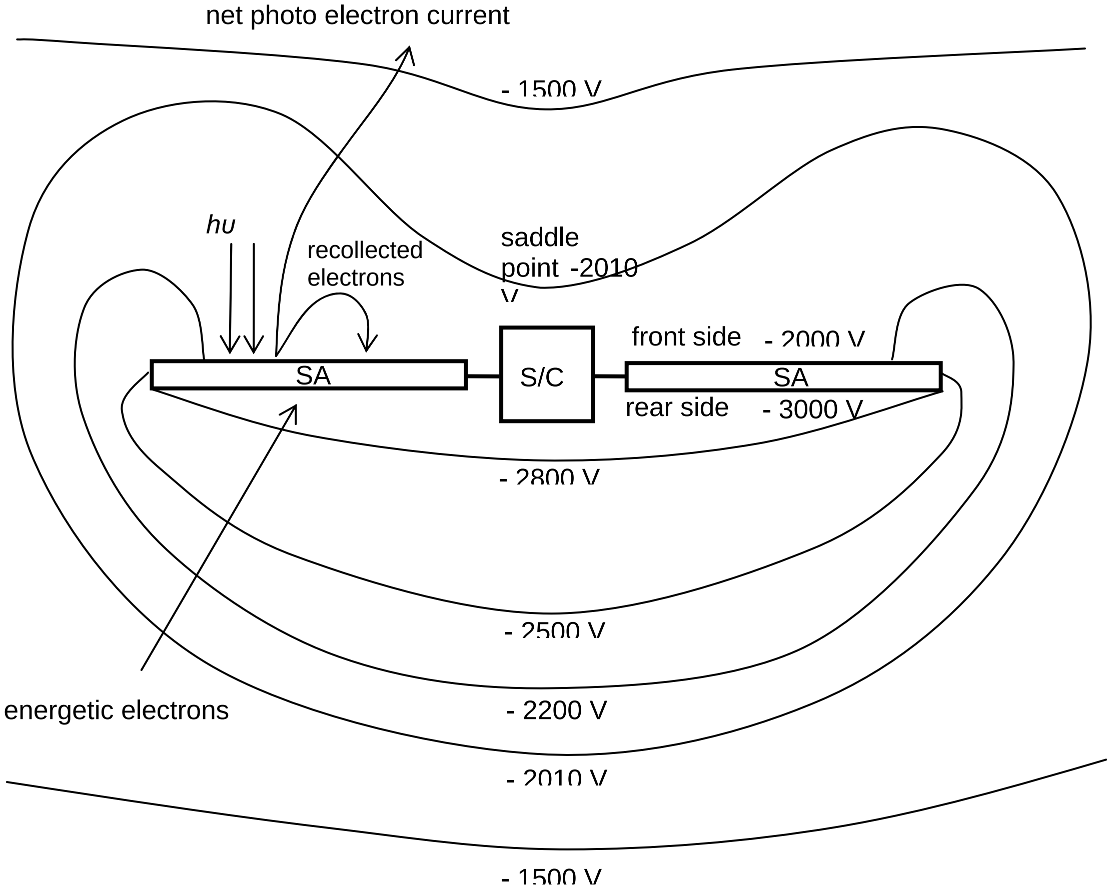


Figure 1 - Typical situation on a GEO spacecraft: inverted potential gradient (-2000V in sunlight and -3000V in shade on this example) and creation of a potential barrier blocking part of the photoemission

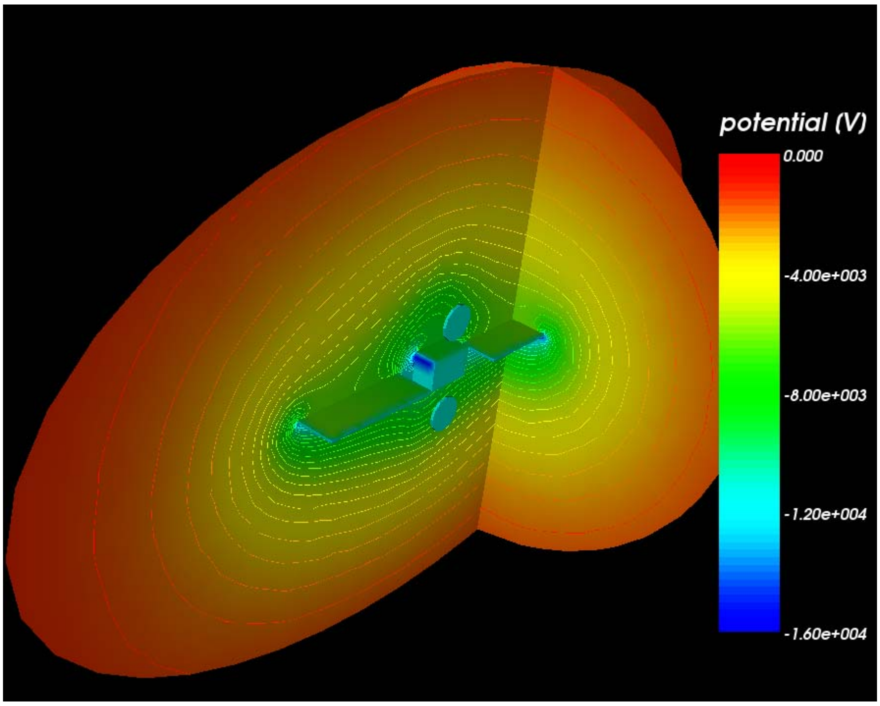


Figure 2 - Example of SPIS simulation of charging in GEO: local saddle points are visible (the main difference wih the previous chart is that in reality the potential is not uniform on the sunlit side here)

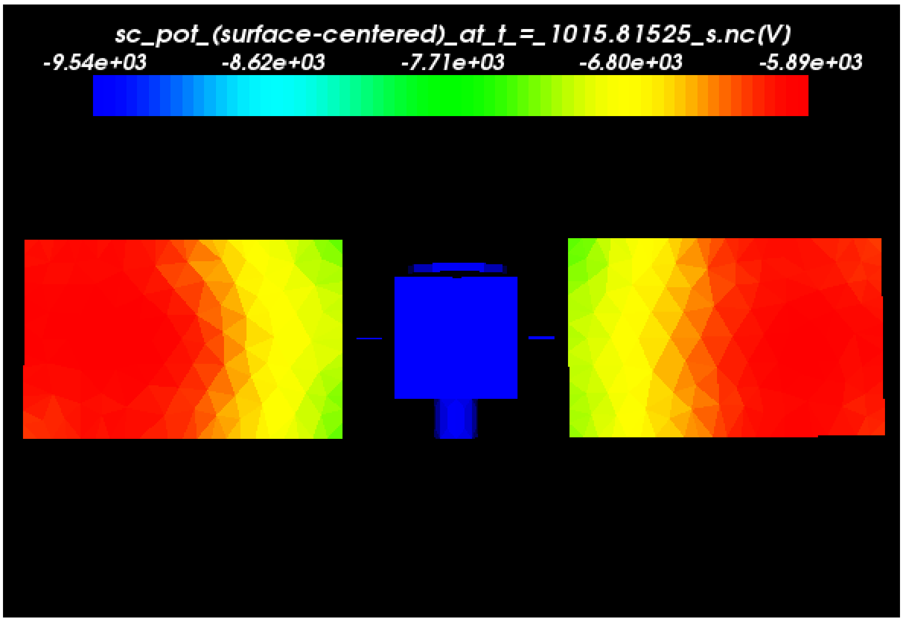


Figure 3 - Other example showing the surface potential of the same spacecraft (with different conditions)

This has mostly to do with steady state charging. Concerning time-dependent modelling the consequences are the following:

- Spacecraft capacitance is small while coating capacitance is large
- Absolute charging is thus fast while relative charging is slow
- Using the implicit circuit solver is thus needed to allow a large time step (automatic in SPIS v4, and ameliorated in SPIS-GEO).

Dynamic situations such as **exit from eclipse** are also very important to model since this transient phase may lead to dangerous inverted potential gradient situations.

Another purely numerical consequence from the large Debye length is the following:

- Modelling a population (ions or electrons) by a regular PIC method yields poor current statistics on spacecraft surfaces: too few of the particles injected at boundary of the large computation box hit the small spacecraft in it.
- This statistics can be improved by using back tracking, i. e. by initiating particle trajectories on the spacecraft and inverting time.

3. Practical parameterization of SPIS-GEO

This section describes the global parameters (defined in the SPIS 5 annex ***Controlling NUM from UI*** **[RD7]**) with their settings for SPIS-GEO. Most of the parameters are pre-defined and adapted to GEO/MEO situations in order to facilitate the SPIS usage in industrial context.

Different expertise levels are defined: low (basic settings), medium and advanced/expert. The basic expertise level permit to define the physical parameters and allow users to perform the simulations with SPIS-GEO automatic settings.

Higher level parameters may be modified with care by users.

Main numerical settings are pre-defined at medium and expert level considering:

- Maxwellian Boltzmann distribution for ambient electrons: this distribution is valid for negative potentials in the absence of a potential barrier, since it relies on the assumption of thermal equilibrium of a closed system.
- Vacuum conditions, which is justified because the Debye length is large compared to spacecraft dimensions. It leads to:
    - Ions are integrated using backtracking algorithm, i.e. which neglects particle space charge
    - Electric field boundary conditions on the external box mimic a 1/r decrease of the potential
- Surface interactions are turned on including:
    - electron emission under photon, electron and proton impact
    - volumic, surfacic and radiation induced conductivity
- Barrier of potential for secondary electrons as described in rationale
- Enhanced solver for the spacecraft circuit, permitting to reduce significantly the CPU time
- Multi-threading of PIC secondary electrons to save large CPU time

Most importantly is the capability to easily define exit from eclipse situations. One example of SPIS GEO eclipse exit is provided in the next figures.

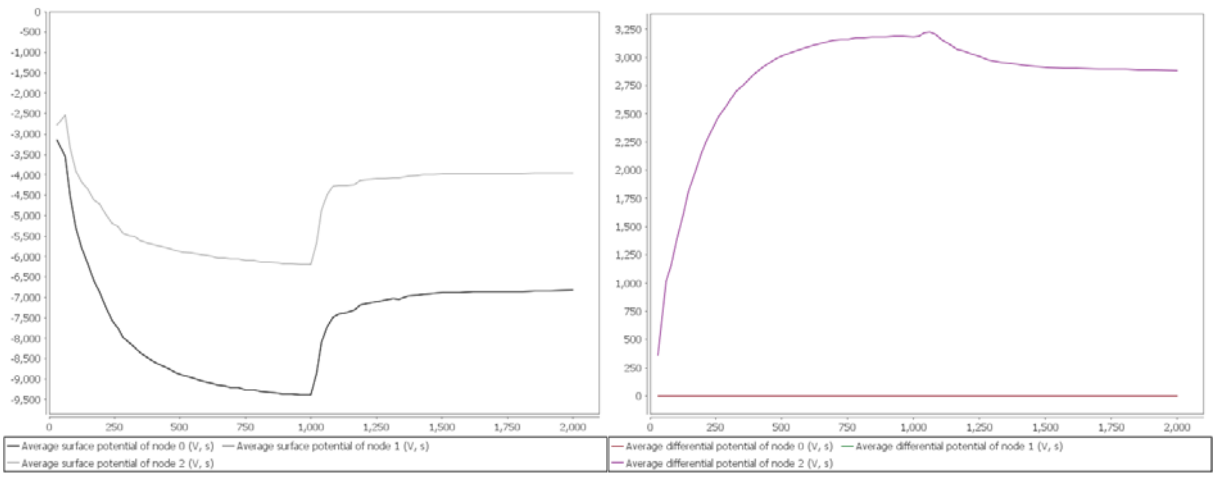


Figure 4 - Transient phase of eclipse exit. Node 2 refers to the solar panels of a GEO spacecraft. Exit from eclipse occurs at time t = 1000 s and lasts 60 s.

3.1. Overview of parameters

The 200 (and more) global parameters are classified in 3 levels of expertise (Low, Medium, Expert/Advanced) and in 7 domains (plasma, surface interactions, simulation control, spacecraft circuit, eclipse exit, magnetic field, outputs). In next section we present the 3 levels of expertise.

Pre-defined sets of XML global parameters as illustrated in Figure 5, in the corresponding “Predefined parameters box”. For a GEO/MEO application, the user will prefer to use the next files, instead of the generic *globalParam-5.1.0.xml* file :

- globalParameters-SPISGEO-ECSSGeoWorstCase.xml : file configurated for the ECSS GEO worst case environment, see Table 1.
- globalParameters-SPISGEO-ECSSGeoWorstCase-EclipseExit.xml: same but including eclipse exit. **Warning**: extra properties must be defined, see the corresponding paragraph below.
- globalParameters-SPISGEO-NASAWorstCase.xml: file configurated for the ECSS GEO worst case environment, see Table 2.

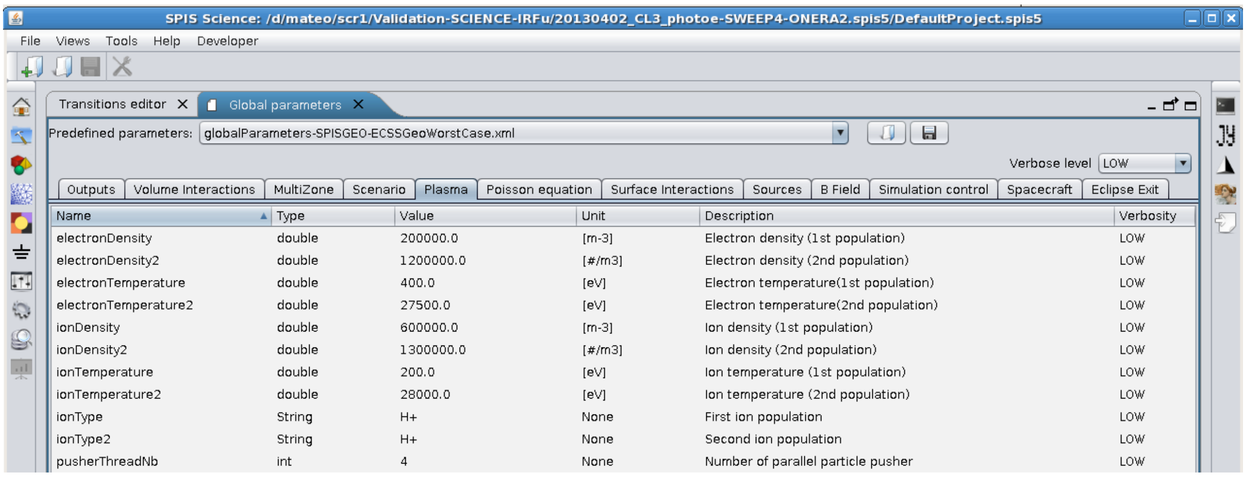


Figure 5 - Example of plasma parameters automatically set when using globalParameters-SPISGEO-ECSSGeoWorstCase.xml file

3.2. Basic settings (low expertise level)

The low expertise level consists of around 20 parameters. They consist in the main physical parameters to be set by users.

Plasma

Three sets of pre-defined parameters are provided for geosynchronous orbit in the SPIS-GEO release: European ECSS worst case *[ECSS-E-10-04A Space Environment, ESA-ESTEC, Nov 200*8], NASA guideline worst-case [*Design Guidelines for Assessing and Controlling Spacecraft Charging Effects, NASA Technical Paper 2361, Purvis, 1984*]. Here are presented the plasma environment of the ECSS worst-case. T

Table 1 - ECCS-E-10-04A Worst-case bi-Maxwellian plasma environment for outer magnetosphere

	Electron density (m-3)	Electron temperature (eV)	Proton density (m-3)	Proton temperature (eV)
Pop 1	2,00E+05	400	6,00E+05	200
Pop 2	1,20E+06	27500	1,30E+06	28000

Table 2 - NASA guideline (Purvis 1984) for GEO worst-case

Electron density (m-3)	Electron temperature (eV)	Proton density (m-3)	Proton temperature (eV)
1.12E+06	12000	2,36E+05	29500

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
electronDensity	double	200000	[m-3]	Electron density (1st population)	LOW	User defined
electronDensity2	double	1200000	[#/m3]	Electron density (2nd population)	LOW	User defined
electronTemperature	double	400	[eV]	Electron temperature(1st population)	LOW	User defined
electronTemperature2	double	27500	[eV]	Electron temperature(2nd population)	LOW	User defined
ionDensity	double	600000	[m-3]	Ion density (1st population)	LOW	User defined
ionDensity2	double	1300000	[#/m3]	Ion density (2nd population)	LOW	User defined
ionTemperature	double	200	[eV]	Ion temperature (1st population)	LOW	User defined
ionTemperature2	double	28000	[eV]	Ion temperature (2nd population)	LOW	User defined
ionType	String	H+	None	First ion population	LOW	User defined
ionType2	String	H+	None	Second ion population	LOW	User defined
pusherThreadNb	int	4	None	Number of parallel particle pusher	LOW	To be adapted to the operating system

Surface interactions

The orientation of the sun and the activation of the photoemission process are defined at low expertise level.

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
photoEmission	int	3	None	if 0 no photo-emission, if 1 photo-emission turned on, if 3 turned on with photo-electron dynamics modelling, iF 4 more (hence 5 or 7) uses user-locally-defined sun flux instead of sun direction	LOW	Photoemission turned on in SPIS GEO
sunX	double	0	[-]	x-component of sun direction. The sun flux at 1 AU is multiplied by this factor.	LOW	User defined
sunY	double	0	[-]	y-component of sun direction. The sun flux at 1 AU is multiplied by this factor.	LOW	User-defined
sunZ	double	1	[-]	z-component of sun direction. The sun flux at 1 AU is multiplied by this factor.	LOW	User-defined

Simulation control

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
duration	double	2000	[s]	Duration of the simulation	LOW	The duration can be increased within the course of the simulation (using pause button)
simulationDt	double	100	[s]	Time step for global simulation dynamics (semi-automatic if 0: determined by lower level time step = plasmaDt, automatic if negative (-dt): increased as much as possible from the initial value dt)	LOW	This value should stay within a fraction of the total duration in order to simulate several time steps.

Spacecraft circuit

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
CSat	double	0.000001	[F]	absolute spacecraft capacitance	LOW	1 µF is larger than typical value for GEO spacecraft but it permit to fasten the simulation while keeping accurate final state and approximate transient phases.
electricCircuitFilename	String	circuit.txt	None	File name of extra electric devices (RLCV)	LOW	Nothing to do
validityRenormalisation	double	0.5	[-]	Scaling parameter to globally renormalise validity of scalable currents	LOW	Limiting the time step of the circuit. Increasing this parameter will fasten the simulation. But it can also generate imprecisions.

Eclipse exit

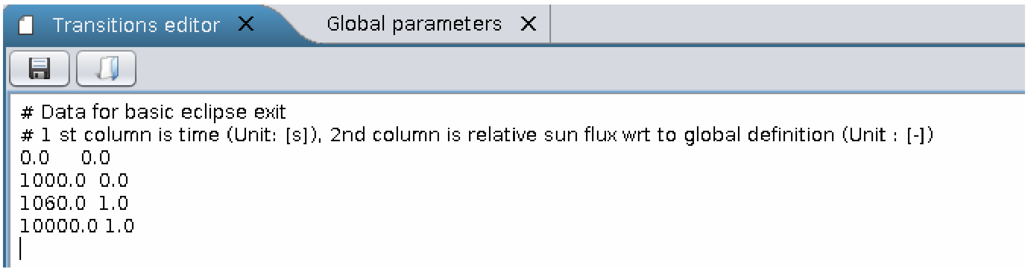
The exit from eclipse is a new important capability of SPIS-GEO. It provides a transition for the photoemission process and also for the evolution of conductivity (to mimic temperature evolution effect on dielectric conductivity).

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
transitionFlag1	double	1	None	flag for activating transition 1 (sun flux change) on the simulation configuration: 0 => none, 1.0 => yes	LOW	Time evolution of the sun flux is defined relatively to the sun flux sunX, sunY and sunZ. The BasicEclipseExt.txt file should contain: 1st column time in [s] and relative flux [-].
transitionFlag2	double	1	None	flag for activating transition 2 (conductivity change) on the simulation configuration: 0 => none, 1.0 => yes	LOW	Conductivity evolution vs time shall be defined at material property level. New property BUCT is a tabulated property with first column being the time in [s] and the second column the bulk conductivity in [ohm-1.m-1]

TRANSITION 1 = Evolution of photoemission flux Vs. Time

When selecting the transitionFlag1 = 1, the photoemission flux defined in the global parameters (SunX, Y, Z) is modified with respect to data defined in the Transition Editor (related to the NumKernel/Input/BasicEclipse.txt file which is used during the simulation).

In the example below, the relative sun flux is turned on linearly from 0 to 1 (i.e. the absolute sun flux varies from [0,0,0] to [SunX,SunY,SunZ] between t = 1000 s and t = 1060 s, and remains constant till the end of the simulation.

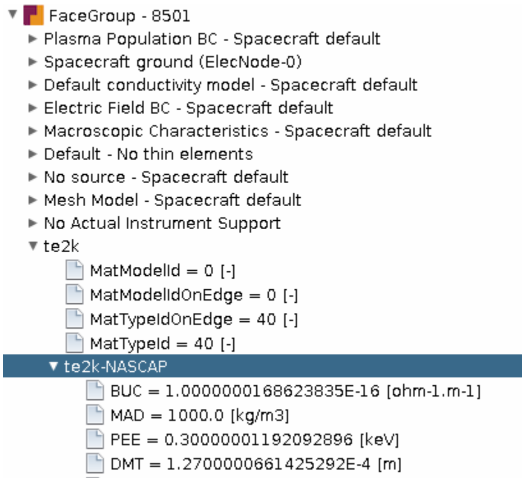


TRANSITION 2 = Evolution of bulk conductivity Vs. Time

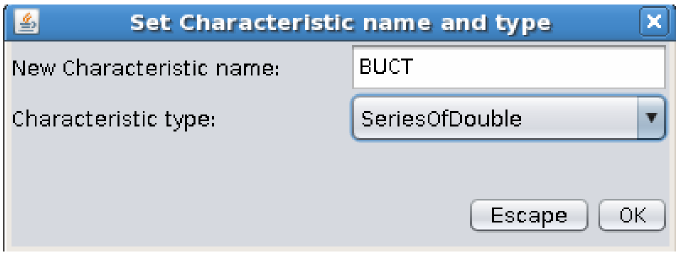
When selecting the transitionFlag2 = 1 (bulk conductivity versus time), at least one of the dielectric materials shall have the BUCT property.

To create this new Property, several approaches are possible. New properties files can be edited manually as all XML file. However, the simplest one is to use the advanced editor in the selection tree *Properties and Groups Editor* of the , as follow:

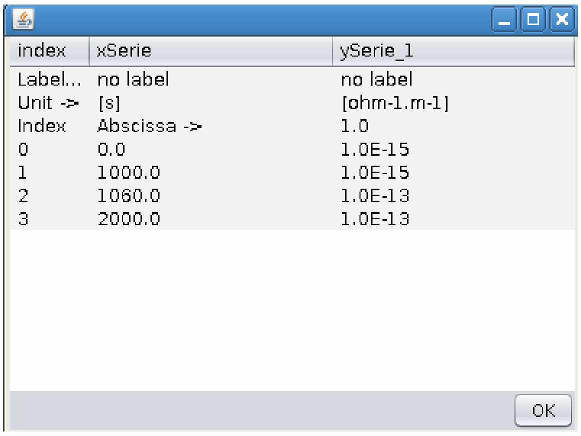
1. Select the group whose material (which shall be a dielectric) must be attributed the BUCT property;
2. On the selected Material, access to the contextual menu with a right-button click, add a new Empty Characteristics.



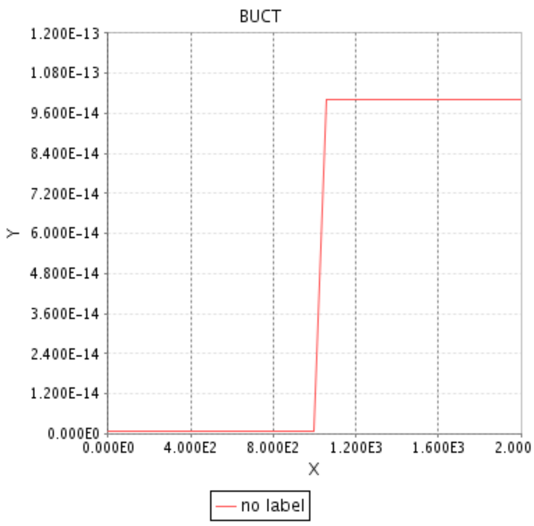
3. Select the new Characteristics of type SeriesOfDouble and call it BUCT, as illustrated in **Erreur ! Source du renvoi introuvable.**.



4. Set the number of series to 1 and the size N of the series (i.e. number of values by series);
5. Set the unit of BUCT to [ohm-1.m-1].
6. Click in the Edit button to set the values of series. An editor should appear as illustrated in next figure. Set the xSerie in unit [s] and define the N check point times. Set the ySerie in unit [ohm-1.m-1] and define the N values at check point times. SPIS will perform linear interpolation of BUCT between the check point times. Doing this, BUC (bulk conductivity) is replaced by BUCT.



7. By clicking on the plot button, series can be displayed as illustrated in next figure .



Magnetic field

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
Bx	double	0	[T]	x-component of the magnetic field (uniform over the computation box)	LOW	No effect of B field in GEO
By	double	0	[T]	y-component of the magnetic field	LOW	No effect of B field in GEO
Bz	double	0	[T]	z-component of the magnetic field	LOW	No effect of B field in GEO

Outputs

Remark : Automatic outputs are provided during the simulation in the form of ***Simulation Monitors***, independently of the setting of the following parameters.

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
currentMapMonitorStep	double	-10	[s]	time step for current density vectors monitoring (0 => none, -n => n times)	LOW	Default value
densitiesMapsMonitorStep	double	-10	[s]	time step for densities monitoring (0 => none, -n => n times)	LOW	Default value
energyMapMonitorStep	double	-10	[s]	time step for kinetic energy monitoring (0 => none, -n => n times)	LOW	Default value
finalCumulation	int	2	None	cumulate currents and densities at the end of simulation ? 0=no, 1or2=yes	LOW	Default value
finalCumulationStartTime	double	0.8	[s] or [-]	if finalCumulation=1 starting time for final dens-current cumulation, if finalCumulation=2 fraction of the simulation at which cumulation starts	LOW	Default value

materialPropertyPlots	int	1	None	flag for plotting material properties: 0=no, 1=yes	LOW	Default value
numericsMapsMonitorStep	double	-10	[s]	time step for numerical behaviour monitoring through 3D maps of superparticle numbers, one in #/element and one in #/node (0.0 => none, -n => n times)	LOW	Default value
numericsMonitorStep	double	-100	[s]	time step for numerical behaviour monitoring (0.0 => none, -n => n times)	LOW	Default value
plasmaElecFieldMapMonitorStep	double	-10	[s]	time step for plasma electric field monitoring (0 => none, -n => n times)	LOW	Default value
plasmaPotMapMonitorStep	double	-10	[s]	time step for plasma potential monitoring (0 => none, -n => n times)	LOW	Default value
scCurrentMapMonitorStep	double	-10	[s]	time step for spacecraft local currents monitoring (0 => none, -n => n times)	LOW	Default value
scElecFieldMapMonitorStep	double	-10	[s]	time step for spacecraft electric field monitoring (0 => none, -n => n times)	LOW	Default value
scPotMapMonitorStep	double	-10	[s]	time step for spacecraft local potential monitoring (0 => none, -n => n times)	LOW	Default value
scPotMonitorStep	double	-100	[s]	time step for spacecraft ground potential monitoring (0 => none, -n => n times)	LOW	Default value

3.3. Medium expertise settings

The low expertise level consists of around 40 parameters. They consist in parameters such as deactivating the SPIS-GEO mode and control time steps, deactivating some physical processes (such as secondary emission, conductivities), etc. In next tables we explain the choices made for GEO/MEO applications.

Plasma

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
chargeDepositDuringIntegrationFlag	int	1	[-]	flag for setting charge deposit in volume of PIC distribution during instead of after the trajectory integration; 0: after ; 1: during	MEDIUM	For PIC populations: particles crossing several cells during a time step deposit their charge on each cell. It increases volume statistics.
electronVx	double	0	[m/s]	electron drift velocity along x axis (1st population)	MEDIUM	To be used if relevant
electronVx2	double	0	[m/s]	electron drift velocity along x axis (2nd population)	MEDIUM	To be used if relevant
electronVy	double	0	[m/s]	electron drift velocity along y axis (1st population)	MEDIUM	To be used if relevant
electronVy2	double	0	[m/s]	electron drift velocity along y axis (2nd population)	MEDIUM	To be used if relevant
electronVz	double	0	[m/s]	electron drift velocity along z axis (1st population)	MEDIUM	To be used if relevant
electronVz2	double	0	[m/s]	electron drift velocity along z axis (2nd population)	MEDIUM	To be used if relevant
ionVx	double	0	[m/s]	Ion drift velocity along x axis (1st population)	MEDIUM	To be used if relevant
ionVx2	double	0	[m/s]	Ion drift velocity along x axis (2nd population)	MEDIUM	To be used if relevant
ionVy	double	0	[m/s]	Ion drift velocity along y axis (1st population)	MEDIUM	To be used if relevant
ionVy2	double	0	[m/s]	Ion drift velocity along y axis (2nd population)	MEDIUM	To be used if relevant
ionVz	double	0	[m/s]	Ion drift velocity along z axis (1st population)	MEDIUM	To be used if relevant
ionVz2	double	0	[m/s]	Ion drift velocity along z axis (2nd population)	MEDIUM	To be used if relevant

Surface interactions

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
electronSecondaryDensification	double	0.05	[-]	densification coefficient for secondary electron superparticles (from electron impact)	MEDIUM	The injection of secondary electron super particles is a good compromise between accuracy and CPU time cost.
electronSecondaryEmission	int	3	None	bits go by groups of 3 (bit0=on/off, bit1=simulate_secondary_elec_dynamics/don t, bit2=allow_secondaries_of-secondaries/don t), while groups of 3 bits are for ambient population 1, ambient population 2, source 1, source 2, source 3 and source 4 resp.	MEDIUM	Electron emission under electron impact is turned on
electronSecondaryTemperature	double	2	[eV]	secondary electron temperature (from electron impact)	MEDIUM	2eV temperature is the commonly admitted value for secondary electrons
inducedConductivity	int	1	None	if 0 no induced conductivity, if 1 induced conductivity turned on	MEDIUM	Conductivity induced by radiation is turned on
photoElectronDensification	double	1	[-]	densification coefficient for photo electron superparticles	MEDIUM	The injection of secondary electron super particles is a good compromise between accuracy and CPU time cost.
photoElectronTemperature	double	2	[eV]	photo-electron temperature	MEDIUM	2eV temperature is the commonly admitted value for photo electrons
protonSecondaryDensification	double	0.05	[-]	densification coefficient for secondary electron superparticles (from proton impact)	MEDIUM	The injection of secondary electron super particles is a good compromise between accuracy and CPU time cost.
protonSecondaryEmission	int	3	None	if 0, no secondary emission, if 1, secondary emission turned on	MEDIUM	Electron emission under proton impact is turned on
protonSecondaryTemperature	double	2	[eV]	secondary electron temperature (from proton impact)	MEDIUM	2eV temperature is the commonly admitted value for secondary electrons

surfaceConductivity	int	1	None	if 0 no surface conductivity, if 1 surface conductivity turned on	MEDIUM	Surface conductivity is turned on
volumeConductivity	int	1	None	if 0 no volume conductivity, if 1 volume conductivity turned on	MEDIUM	Volumic conductivity is turned on

Simulation control

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
plasmaDt	double	-1.0	[s]	Time step for global plasma dynamics (semi-automatic if 0: determined by lower level time step = smallest matter dt)	MEDIUM	Not used because spisGEO = 1
plasmaDuration	double	0.0	[s]	Integration duration of the plasma dynamics (automatic if 0: plasma dynamics is only integrated over a fraction 1/plasmaSpeedUp of actual physical time)	MEDIUM	Not used because spisGEO = 1
simulationDtInit	double	0.0001	[s]	initial time step for global simulation dynamics (only used if automatic)	MEDIUM	Initial time step of the simulation typically leads to small variations of potential at start (~1 Volt)
spisGEO	int	1	None	flag to define SPIS-GEO automatic settings (1: activated)	MEDIUM	Settings for plasma integration and population integration (time steps and duration) are automatically calculated so as to ensure that populations cross teh bow at each population dynamics integration loop.

Spacecraft circuit

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
electricCircuitIntegrate	int	1	None	SC electric circuit integration: 0=no change, 1=floating	MEDIUM	Electrical circuit is turned on to simulate surface potential evolution
initPot	double	0	[V]	initial potential	MEDIUM	Initial voltage is zero
initPotFlag	int	1	None	flag to define initial pot: 0 => set to 0, 1 => set to global initPot, 2 => set to local potential defined as SC Dirichlet condition	MEDIUM	Initial voltage is zero everywhere

Eclipse exit

transitionDt1	double	0.01	[s]	maximal time step when the transition 1 evolves	MEDIUM	This value aims at limiting the time step for sudden photoemission activation at eclipse exit, hence limiting undesirable numerical effects such as overshoots.
transitionDt2	double	0.01	[s]	maximal time step when the transition 2 evolves	MEDIUM	This value aims at limiting the time step for sudden chnage in conductivity, hence limiting undesirable numerical effects such as overshoots
transitionNb	int	2	None	number of transitions	MEDIUM	Combination of two transitions: photoemission and conductivity.

Magnetic field

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
magnetizedPlasmaFlag	int	1	[T]	flag for taking account the effect of the magnetic field and of the magnetically induced electric field (due to spacecraft motion) on particle trajectories. 1: yes; 0: no (un-magnetized plasma)	MEDIUM	In case magentic field is turned ion by user, particles will be considered as magnetized

3.4. Advanced and expert settings

More than 140 settings remain advanced or expert parameters that should be carefully modified by users. Their pre-defined settings for Geo/MEO applications is explained in next tables.

Plasma

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
avPartNbPerCell	double	5	None	average number of super-particle per cell	ADVANCED	Not used since no PIC population of ambient
BFieldIterativePusher	int	1	None	flag for particle pusher method used in case of magnetic field (0: RKCK algorithm from spis 4.3; 1: Dichotomy method from spis 5)	ADVANCED	In case of B field
btPartNbPerSurf	int	20	None	number of super-particle generated per surface element for back tracking	ADVANCED	Accurate backtracking.
electronDensityCutoff	double	0	[m-3]	truncation of elec density in case of fluid model	ADVANCED	
electronDistrib	String	GlobalMaxwell BoltzmannVolDistrib	None	Name of the VolDistrib class to be used for electrons	ADVANCED	Negative potential and no negative barrier of potentials are assumed for ambient electrons. Hence MB distribution is valid.
electronDistrib2	String	GlobalMaxwell BoltzmannVolDistrib	None	Name of the VolDistrib class to be used for the 2nd electron population	ADVANCED	Negative potential and no negative barrier of potentials are assumed for ambient electrons. Hence MB distribution is valid.
electronDt	double	-1	[s]	Maximum integration time step for electron 1st population (automatic if negative)	ADVANCED	Not used with MB
electronDt2	double	-1	[s]	Maximum integration time step for electron 2nd population (automatic if negative)	ADVANCED	Not used with MB
electronDuration	double	0	[s]	Maximum integration duration for electron 1st population (automatic if 0)	ADVANCED	Not used with MB

electronDuration2	double	0	[s]	Maximum integration duration for electron 2nd population (automatic if 0)	ADVANCED	Not used with MB
electronSpeedUp	double	1	[-]	Numerical times speed-up factor for electron 1st population	EXPERT	Not used with MB
electronSpeedUp2	double	1	[-]	Numerical times speed-up factor for electron 2nd population	EXPERT	Not used with MB
electronTrajFlag1	int	0	[-]	Plot ambient electron (1st population) trajectory? 0=no, 1=yes	ADVANCED	Not used with MB
electronTrajFlag2	int	0	[-]	Plot ambient electron (2nd population) trajectory? 0=no, 1=yes	ADVANCED	Not used with MB
environmentType	String	BiMaxwellianEnvironment	None	Name of the Environment class to be used	ADVANCED	Bi-maxwellian environment type is set by default as in spacecraft charging guidelines
ExtendedPopNbr	int	0	None	number of extended populations	ADVANCED	Use it if you want to add new populations
ionDistrib	String	BackTrackingVolDistrib	None	Name of the VolDistrib class to be used for ions	ADVANCED	Ions are backtracked from the spacecraft to increase statistics. No PIC model necessary because the space charge is small in GEO (Debye length very large compared to spacecraft dimensions)
ionDistrib2	String	BackTrackingVolDistrib	None	Name of the VolDistrib class to be used for ions 2nd population	ADVANCED	idem
ionDt	double	-1	[s]	Maximum integration time step for ion 1st population (automatic if negative)	ADVANCED	Not used in BT
ionDt2	double	-1	[s]	Maximum integration time step for ion 2nd population (automatic if negative)	ADVANCED	Not used in BT

ionDuration	double	0	[s]	Maximum integration duration for ion 1st population (automatic if 0)	ADVANCED	Not used in BT
ionDuration2	double	0	[s]	Maximum integration duration for ion 2nd population (automatic if 0)	ADVANCED	Not used in BT
ionSpeedUp	double	1	[-]	Numerical times speed-up factor for ion 1st population	EXPERT	Not used in BT
ionSpeedUp2	double	1	[-]	Numerical times speed-up factor for ion 2nd population	EXPERT	Not used in BT
ionTrajFlag1	int	0	[-]	Plot ambient ion (1st population) trajectory? 0=no, 1=yes	ADVANCED	Not used in BT
ionTrajFlag2	int	0	[-]	Plot ambient ion (2nd population) trajectory? 0=no, 1=yes	ADVANCED	Not used in BT
iterativePusherAbsTolPos	double	0.00001	[m]	precision of iterative particle pusher (RKCK method): absolute tolerance position	EXPERT	
iterativePusherAbsTolVelo	double	1E+12	[m/s]	precision of iterative particle pusher (RKCK method): absolute tolerance velocity	EXPERT	
iterativePusherRelTolPos	double	0.001	None	precision of iterative particle pusher (either RKCK or dichotomy method): relative tolerance position	EXPERT	
iterativePusherRelTolVelo	double	0.001	None	precision of iterative particle pusher (RKCK method): relative tolerance velocity	EXPERT	
lmvdSubType	String	uniform	None	sub-type of the LocalMaxellVolDistrib if an ion/elec distrib is declared LocalMaxellVolDistrib	EXPERT	
maxwellEnergy SamplerFactor	double	1.3	None	spacing geometric factor of the maxwellian energy sampler	ADVANCED	The maxwellian velocity sampler is well reproduced with these settings

maxwellEnergy SamplerPointNb	int	100	None	number of points of the maxwellian energy sampler	ADVANCED	The maxwellian velocity sampler is well reproduced with these settings
maxwellEnergy SamplerSpacing	double	0.01	None	first spacing of the maxwellian energy sampler [eV]	ADVANCED	The maxwellian velocity sampler is well reproduced with these settings
pop1Density	double	0	[m-3]	Population density	ADVANCED	Extended population setting
pop1DF_FileName	String	None	[-]	name of the file describing the population distribution function in the environment	ADVANCED	Extended population setting
pop1DFBasis_Vect1_X	double	1	[-]	x coordinate of Vect1 defining the basis of the population distribution function	ADVANCED	Extended population setting
pop1DFBasis_Vect1_Y	double	0	[-]	y coordinate of Vect1 defining the basis of the population distribution function	ADVANCED	Extended population setting
pop1DFBasis_Vect1_Z	double	0	[-]	z coordinate of Vect1 defining the basis of the population distribution function	ADVANCED	Extended population setting
pop1DFBasis_Vect2_X	double	0	[-]	x coordinate of Vect2 defining the basis of the population distribution function	ADVANCED	Extended population setting
pop1DFBasis_Vect2_Y	double	1	[-]	y coordinate of Vect2 defining the basis of the population distribution function	ADVANCED	Extended population setting
pop1DFBasis_Vect2_Z	double	0	[-]	z coordinate of Vect2 defining the basis of the population distribution function	ADVANCED	Extended population setting
pop1Distrib	String	PICVolDistrib	[-]	distribution type of 1st extended population	ADVANCED	Extended population setting
pop1Dt	double	-1	[s]	Maximum integration time step for 1st extended population	ADVANCED	Extended population setting
pop1Duration	double	0	[s]	Maximum integration duration for 1st extended population	ADVANCED	Extended population setting

pop1EnvironmentDF	String	IsotropicMaxwellianDF	[-]	Population distribution function in the environment	ADVANCED	Extended population setting
pop1Kappa	double	9	[-]	Population kappa parameter (if kappa distribution)	ADVANCED	Extended population setting
pop1Optimization	double	0	[-]	optimize population statistics by injecting new particles. Example: if 0.5 => add 50 % of optimized particles to the original list	ADVANCED	Extended population setting
pop1OptimizationMode	double	1	[-]	if pop1Optimization is positive, mode of statistics collection ? 1 : after particle integration; 2 : during particle integration	ADVANCED	Extended population setting
pop1SEEFlag	int	0	[-]	secondary Emission Flag Under Electron or Proton Impact: bits go by groups of 3 (bit0=on/off, bit1=simulate_secondary_elec_dynamics/don't, bit2=allow_secondaries_of-secondaries/don't)	ADVANCED	Extended population setting
pop1SpeedUp	double	1	[-]	Numerical times speed-up factor for population	ADVANCED	Extended population setting
pop1Temperature	double	1	[eV]	Population temperature (if isotropic)	ADVANCED	Extended population setting
pop1TrajFlag	int	0	[-]	plot population trajectory ? 0=no, 1=yes	ADVANCED	Extended population setting
pop1Type	String	electron	[-]	Population Type	ADVANCED	Extended population setting
pop1Tx	double	0	[eV]	Population temperature along x axis	ADVANCED	Extended population setting
pop1Ty	double	0	[eV]	Population temperature along y axis	ADVANCED	Extended population setting
pop1Tz	double	0	[eV]	Population temperature along z axis	ADVANCED	Extended population setting
pop1Vx	double	0	[m/s]	Population drift velocity along x axis	ADVANCED	Extended population setting
pop1Vy	double	0	[m/s]	Population drift velocity along y axis	ADVANCED	Extended population setting
pop1Vz	double	0	[m/s]	Population drift velocity along z axis	ADVANCED	Extended population setting

pusherRKCKAbsTolPos	double	0.00001	[-]	RK Cash-Karp pusher precision: absolute tolerance position	ADVANCED	
pusherRKCKAbsTolVelo	double	1E+12	[-]	RK Cash-Karp pusher precision: absolute tolerance velocity	EXPERT	
pusherRKCKRelTolPos	double	0.001	[-]	RK Cash-Karp pusher precision: relative tolerance position	ADVANCED	
pusherRKCKRelTolVelo	double	0.001	[-]	RK Cash-Karp pusher precision: relative tolerance velocity	ADVANCED	

Surface interactions

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
barrierCSFlag	int	1	[-]	flag for the current scaler specific to GEO potential barrier phenomenon for photo/secondary electron recollection (0 = off, 1 = on)	ADVANCED	Barrier of potential is turned on for GEO cases
bcsGlobalFactor	double	10	[-]	global temperature factor for the current scaler specific to GEO potential barrier phenomenon (BarrierCurrentScaler) for photo/secondary electron recollection (for expert users only)	EXPERT	Barrier of potential default settings
bcsLocalFactor	double	1	[-]	local temperature factor for the current scaler specific to GEO potential barrier phenomenon (BarrierCurrentScaler) for photo/secondary electron recollection (for expert users only)	EXPERT	Barrier of potential default settings
bcsRelValid	double	200	[-]	relative validity (relative to temp*bcsLocalFactor) for the current scaler specific to GEO potential barrier phenomenon (BarrierCurrentScaler) for photo/secondary electron recollection (for expert users only)	EXPERT	Barrier of potential default settings
bcsSmoothdIdV	int	30	[-]	number of smoothing steps (each step => nearest elements) for dI/dV of recollected electrons when the barrier current scaler is on (for expert users only)	EXPERT	Barrier of potential default settings
bcsSmoothI	int	0	[-]	number of smoothing steps (each step => nearest elements) for the collected intensity when the barrier current scaler is on (for expert users only)	EXPERT	Barrier of potential default settings
bcsSmoothPot	int	10	[-]	number of smoothing steps (each step => nearest elements) for the potential when the barrier current scaler is on (for expert users only)	EXPERT	Barrier of potential default settings
electronSecondaryEmissionTrajFlag	int	0	None		ADVANCED	Trajectory may be plotted

erosion	int	0	None	bits go by groups of 3 (bit0=on/off, bit1=eroded_products_dynamics/don t, bit2=unused), while groups of 3 bits are for ambient population 1, ambient population 2, source 1, source 2, source 3 and source 4 resp.	EXPERT	Erosion not simulated in basic simulations
erosionProductDensification	double	1	[-]	densification coefficient for erosion product superparticles	EXPERT	Erosion not simulated in basic simulations
erosionProductDt	double	-1	[s]	Maximum integration time step for erosion products (automatic if negative)	EXPERT	Erosion not simulated in basic simulations
erosionProductDuration	double	0	[s]	Maximum integration duration for erosion products (automatic if 0)	EXPERT	Erosion not simulated in basic simulations
erosionProductSpeedUp	double	1	[-]	Numerical times speed-up factor erosion products	EXPERT	Erosion not simulated in basic simulations
erosionProductsTrajFlag	int	0	None	plot erosion products trajectory? 0=no, 1=yes	EXPERT	Erosion not simulated in basic simulations
interactorDt1	double	-1	[s]	Maximum integration time step for particles from first interactor on SC (automatic if negative)	EXPERT	Generic interactor other than SEEE, SEEP, erosion and photoemission)
interactorDuration1	double	0	[s]	Maximum integration duration for particles from first interactor on SC (automatic if 0)	EXPERT	Generic interactor other than SEEE, SEEP, erosion and photoemission)
interactorFlag1	double	0	[-]	flag for defining a first generic interactor on the spacecraft: 0 => none, 1 => yes, x => number of super-particles densified by x if relevant	EXPERT	Generic interactor other than SEEE, SEEP, erosion and photoemission)
interactorNb	int	0	None	number of interactors	EXPERT	Generic interactor other than SEEE, SEEP, erosion and photoemission)
interactorParticleType1	String	O+	None	Type of particles emitted by the first interactor if it is an emitter	EXPERT	Generic interactor other than SEEE, SEEP, erosion and photoemission)

interactorPopSource1	String	electrons1	None	volume population to be used as source of the interaction of this first interactor (must be one of the predefined volume population names ions1, elec1, source1, photoElec...)	EXPERT	Generic interactor other than SEEE, SEEP, erosion and photoemission)
interactorSpeedUp1	double	1	[-]	Numerical times speed-up factor for particles from first artificial interactor on SC	EXPERT	Generic interactor other than SEEE, SEEP, erosion and photoemission)
interactorType1	String	CathodeSpot	None	Name of the first Interactor class to be used for an interactor on the spacecraft	EXPERT	Generic interactor other than SEEE, SEEP, erosion and photoemission)
photoElectronTrajFlag	int	0	None	plot photo electron trajectory? 0=no, 1=yes	ADVANCED	Plot of photo electron trajectory not activated here
secondaryDt	double	-1	[s]	Maximum integration time step for all types of secondary electrons (automatic if negative)	EXPERT	Not used in the SPIS-GEO mode (spisGEO =1)
secondaryDuration	double	0	[s]	Maximum integration duration for all types of secondary electrons (automatic if 0)	EXPERT	Not used in the SPIS-GEO mode (spisGEO =1)
secondarySpeedUp	double	1	[-]	Numerical times speed-up factor for all types of secondary electrons	EXPERT	Not used in the SPIS-GEO mode (spisGEO =1)

Simulation control

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
dimensionality	int	3	[-]	Physical dimensionality of the assumptions done in code	ADVANCED	Only 3D simulations are considered here
fixedDt	int	0	[-]	flag to have fixed integration duration dt of all populations (if yes, durations will be each population dtMax) (0=no, 1=yes)	EXPERT	No used if spisGEO = 1
fixedSimulationDtFlag	int	0	None	flag to define the time step evolution mode: 0 => automatic calculation (as a function of the validity: maximum time step equal simulationDt), 1 => fixed time step equal to SimulationDt (Infinite validity for the current scalers - if activated)	EXPERT	No used if spisGEO = 1
noCurrentScalerFlag	int	0	None	flag to desactivate the dI/dV calculation: 0 => activated, 1 => disactivated (zero current variation asumed in the implicit circuit solver)	EXPERT	No used if spisGEO = 1
plasmaSpeedUp	double	1	[-]	Numerical times speed-up factor for plasma (plasma dynamics is only integrated over a fraction 1/plasmaSpeedUp of actual physical time)	EXPERT	No used if spisGEO = 1
plasmaUnderRelaxTimeCstt	double	0	[s]	under-relaxation time constant for plasma (default=0 => no under-relaxation)	EXPERT	No used if spisGEO = 1
scenario	String	Scenario	None	(possible) scenario for the simulation	EXPERT	Not used
simulationDtMaxFactor	double	2	[s]	maximum amplification factor of the global simulation dynamics time step	ADVANCED	The increase of the simulation time step at the end of each loop is limited to a factor 2. It limits unexpected overshots with reasonable CPU time.

Spacecraft circuit

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
circuitSolverMode	int	0	None	flag to define the circuit solver mode: 0 => implicit solver, 1 => explicit solver	EXPERT	Implicit solver for spacecraft circuit, which permit to adapt time step consistently with plasma behaviour.
exactCSat	double	0	[-]	exact computation of CSat if > 0	ADVANCED	Not used in basic mode.
implicitCircuitSolver	int	0	None	type of linear system solver used in case of implicit circuit solver; 1: Gauss method; 0: Conjugate Gradient Squared (recommended)	ADVANCED	Conjugate Gradient Square method is used to solve circuit solver linear system. Saves CPU cost with respect to Gauss method
scVeloCrossBFlag	int	1	[-]	flag to take account the effect induced by the spacecraft drift on the spacecraft surface potential (in the reference frame of the plasma)	ADVANCED	If magnetic field and drifting spacecraft, then the electric field induced by the motion of the spacecraft is turned on.
scVeloX	double	0	[m/s]	x-component of the spacecraft velocity in the reference frame of the plasma at rest	ADVANCED	Spacecraft velocity is negligible wrt to population velocity in GEO
scVeloY	double	0	[m/s]	y-component of the spacecraft velocity in the reference frame of the plasma at rest	ADVANCED	Spacecraft velocity is negligible wrt to population velocity in GEO
scVeloZ	double	0	[m/s]	z-component of the spacecraft velocity in the reference frame of the plasma at rest	ADVANCED	Spacecraft velocity is negligible wrt to population velocity in GEO
smoothingI	double	0	None	strength of spacecraft surface intensity smoothing at each step (1.0 => 1 step on nearest elements, can be smaller or larger than 1.0)	ADVANCED	Not used
smoothingPot	double	0	[-]	strength of spacecraft surface potential smoothing at each step	ADVANCED	Not used
validityRenormalisation	double	0.5	[-]	Scaling parameter to globally renormalise validity of scalable currents	ADVANCED	Limiting the time step of the circuit.

Eclipse exit

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
transitionType1	String	BasicEclipseExit	None	Name of the Transition class to be used for transition 1 on the simulation	ADVANCED	Photoemission progressive activation
transitionType2	String	ConductivityEvolution	None	Name of the Transition class to be used for transition 2 on the simulation	ADVANCED	Bulk conductivity progressive change

Poisson equation

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
iterGradient	int	1000	None	Maximum iteration number for conjugate gradient Poisson Solver	EXPERT	Not used
iterGradientNl	int	1000	None	Maximum iteration number for conjugate gradient non-linear Poisson Solver	EXPERT	Good compromise between accuracy and CPU time
iterLinearSys	int	10000	None	Maximum iteration number for linear system solver (used for capacitance matrix inversion)	EXPERT	Not used
iterNewton	int	100	None	Maximum iteration number for Newton algorithm in non-linear Poisson solving	EXPERT	Good compromise between accuracy and CPU time
linearPoisson	int	0	None	if 1 linear Poisson solver, if 0 non-linear	ADVANCED	Non-linear solver is used to solve implicitly the Poisson equation with MB ambient electrons
neutrality	int	0	None	neutrality switch, 0=off => regular Poisson computation, 1=on => imposes neutrality instead of solving Poisson	EXPERT	Not used

poissonBCParameter1	double	0	[varies]	Parameter that can be used by some BC types (e.g. 1/rn exponent)	ADVANCED	Not used
poissonBCParameter2	double	0	[varies]	2nd parameter that can be used by some BC types	ADVANCED	Not used
poissonBCType	int	1	None	Poisson boundary conditions type, see documentation	ADVANCED	Vacuum conditions are assumed
tolGradient	double	0.0001	[-]	Tolerance for conjugate gradient Poisson Solver	EXPERT	Not used
tolGradientNl	double	0.000001	[-]	Tolerance for conjugate gradient Poisson Solver when non-linear solving	EXPERT	Good compromise between accuracy and CPU time.
tolLinearSys	double	0.00000001	[-]	Tolerance for linear system solver (used for capacitance matrix inversion)	EXPERT	Not used
tolNewton	double	0.02	[-]	Tolerance for Newton algorithm loop in non-linear Poisson solving	EXPERT	Good compromise between accuracy and CPU time
vacuum	int	0	None	flag for vacuum computation (0=off, 1=on), if on and linearPoisson is on solves Laplace equation, if on and linearPoisson is off only sets ion space charge to zero in Poisson eq.	EXPERT	Not used
variableTe	int	0	None	flag to use a variable Te in Boltzmann equation (physically meaningless), 0=off, 1=on	EXPERT	Not used
variableTeConstant	double	1	[-]	constant in the variable Te law	EXPERT	Not used
variableTeGamma	double	1.1	[-]	gamma adiabatic exponent in the variable Te law	EXPERT	Not used

Outputs

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
cumulateBetweenSteps	int	1	None	cumulate currents and densities between monitoring steps for improved statistics (0=no, 1=yes(improved only), 2=both)?	ADVANCED	Default value
currentLogPlotCutoff	double	1E-12	[A/m2]	cutoff for current log plots	ADVANCED	Default value
currentLogPlotFlag	int	2	None	plot log10 of currents? 0=no, 1=yes(log only), 2=both	ADVANCED	Default value
densityChargeState	int	4	None	control of output density type, either amu/m3 or #/m3, 1=amu, 2=#, 4=automatic (from known particle type)	ADVANCED	Default value
densityLogPlotCutoff	double	0.001	[ecu/m3]	cutoff for density log plots	ADVANCED	Default value
densityLogPlotFlag	int	2	None	plot log10 of densities? 0=no, 1=yes(log only), 2=both	ADVANCED	Default value
exportAllDataFields	String	None	None	Select the export mode for all data fields (None=no export, ASCII=ASCII multi-files)	ADVANCED	Default value
exportDensity	String	None	None	Select the export mode for density data fields (None=no export, ASCII=ASCII multi-files)	ADVANCED	Default value
exportPotential	String	None	None	Select the export mode for potential data fields (None=no export, ASCII=ASCII multi-files)	ADVANCED	Default value
fluxChargeState	int	4	None	control of output collected fluxes type, either C/m2/s = A/m2 (i.e. a current) or #/m2/s (i.e. a flux), 1=currents, 2=fluxes, 4=automatic (from known particle type)	ADVANCED	Default value
particleTrajectoriesNb	int	0	None	number of particle trajectories per PIC population	ADVANCED	Default value

particleTrajectoriesPeriod	int	1000	None	Probability to follow a particle trajectory = one over particleTrajectoriesPeriod	ADVANCED	Default value
poissonVerbose	int	3	None	Same as verbose, but specific to Poisson solver	ADVANCED	Default value
taskDurationVerbose	int	3	None	Same as verbose, but specific to CPU monitoring	ADVANCED	Default value
verbose	int	3	None	Verbosity level (level of screen messages about code execution)	ADVANCED	Default value

Volume interactions

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
crossSectionVolInteract1	String	1.0e-18	[m2] or None	Cross section for 1st volume interaction, either a float (its value [m2]) or the name of the file describing sigma(E)	ADVANCED	see [RD7]
crossSectionVolInteract2	String	1.0e-18	[m2] or None	Cross section for 2nd volume interaction, either a float (its value [m2]) or the name of the file describing sigma(E)	ADVANCED	see [RD7]
inPart1VolInteract1	String	Xe+	None	Type of particles for first interacting population of 1st volume reaction	ADVANCED	see [RD7]
inPart1VolInteract2	String	Xe+	None	Type of particles for first interacting population of 2nd volume reaction	ADVANCED	see [RD7]
inPart2VolInteract1	String	Xe	None	Type of particles for second interacting population of 1st volume reaction	ADVANCED	see [RD7]
inPart2VolInteract2	String	Xe	None	Type of particles for second interacting population of 2nd volume reaction	ADVANCED	see [RD7]
inPop1VolInteract1	String	source1	None	Defines first interacting population of 1st volume reaction (e.g. ions for CEX), must be one of ions1, ions2, elec1, elec2, source1... source4, photoElec, secondElec	ADVANCED	see [RD7]
inPop1VolInteract2	String	source1	None	Defines first interacting population of 2nd volume reaction (e.g. ions for CEX), must be one of ions1, ions2, elec1, elec2, source1... source4, photoElec, secondElec	ADVANCED	see [RD7]

inPop2VolInteract1	String	fractionOf FirstPopSource	None	Defines second interacting population of 1st volume reaction(e.g. neutrals for CEX), must be one of ions1, ions2, elec1, elec2, source1... source4, photoElec, secondElec	ADVANCED	see [RD7]
inPop2VolInteract2	String	fractionOf FirstPopSource	None	Defines second interacting population of 2nd volume reaction(e.g. neutrals for CEX), must be one of ions1, ions2, elec1, elec2, source1... source4, photoElec, secondElec	ADVANCED	see [RD7]
outPart1VolInteract1	String	Xe+	None	Type of particles for first population produced in 1st volume interaction	ADVANCED	see [RD7]
outPart1VolInteract2	String	Xe+	None	Type of particles for first population produced in 2nd volume interaction	ADVANCED	see [RD7]
outPart2VolInteract1	String	Xe	None	Type of particles for second population produced in 1st volume interaction	ADVANCED	see [RD7]
outPart2VolInteract2	String	Xe	None	Type of particles for second population produced in 2nd volume interaction	ADVANCED	see [RD7]
outPop1DtVolInteract1	double	-1	[s]	Maximum integration time step for first population produced in 1st volume interaction (automatic if negative)	ADVANCED	see [RD7]
outPop1DtVolInteract2	double	-1	[s]	Maximum integration time step for first population produced in 2nd volume interaction (automatic if negative)	ADVANCED	see [RD7]
outPop1DurationVolInteract1	double	0	[s]	Maximum integration duration for first population produced in 1st volume interaction (automatic if 0)	ADVANCED	see [RD7]
outPop1DurationVolInteract2	double	0	[s]	Maximum integration duration for first population produced in 2nd volume interaction (automatic if 0)	ADVANCED	see [RD7]

outPop1SpeedUpVolInteract1	double	1	[-]	Numerical times speed-up factor for first population produced in 1st volume interaction	ADVANCED	see [RD7]
outPop1SpeedUpVolInteract2	double	1	[-]	Numerical times speed-up factor for first population produced in 2nd volume interaction	ADVANCED	see [RD7]
outPop1VolInteractTrajFlag	int	0	None	plot 1st produced population trajectory? 0=no, 1=yes	ADVANCED	see [RD7]
outPop2DtVolInteract1	double	-1	[s]	Maximum integration time step for first population produced in 1st volume interaction (automatic if negative)	ADVANCED	see [RD7]
outPop2DtVolInteract2	double	-1	[s]	Maximum integration time step for first population produced in 2nd volume interaction (automatic if negative)	ADVANCED	see [RD7]
outPop2DurationVolInteract1	double	0	[s]	Maximum integration duration for 2nd population produced in 1st volume interaction (automatic if 0)	ADVANCED	see [RD7]
outPop2DurationVolInteract2	double	0	[s]	Maximum integration duration for 2nd population produced in 2nd volume interaction (automatic if 0)	ADVANCED	see [RD7]
outPop2SpeedUpVolInteract1	double	1	[-]	Numerical times speed-up factor for first population produced in 1st volume interaction	ADVANCED	see [RD7]
outPop2SpeedUpVolInteract2	double	1	[-]	Numerical times speed-up factor for first population produced in 2nd volume interaction	ADVANCED	see [RD7]
outPop2VolInteractTrajFlag	int	0	None	plot 2nd produced population trajectory? 0=no, 1=yes	ADVANCED	see [RD7]
parameter1VolInteract1	double	0.05	[variable]	1st parameter of 1st volume interactor	ADVANCED	see [RD7]
parameter1VolInteract2	double	0.05	[variable]	1st parameter of 2nd volume interactor	ADVANCED	see [RD7]

parameter2VolInteract1	double	0.1	[variable]	2nd parameter of 1st volume interactor	ADVANCED	see [RD7]
parameter2VolInteract2	double	0.1	[variable]	2nd parameter of 2nd volume interactor	ADVANCED	see [RD7]
parameter3VolInteract1	double	0	[variable]	3rd parameter of 1st volume interactor	ADVANCED	see [RD7]
parameter3VolInteract2	double	0	[variable]	3rd parameter of 2nd volume interactor	ADVANCED	see [RD7]
parameter4VolInteract1	double	0	[variable]	4th parameter of 1st volume interactor	ADVANCED	see [RD7]
parameter4VolInteract2	double	0	[variable]	4th parameter of 2nd volume interactor	ADVANCED	see [RD7]
volInteract1	double	0	None	Flag to turn on 1st volume interaction : 0 => off, 1 => on, x>0 => on, superparticles densified by x	ADVANCED	see [RD7]
volInteract2	double	0	None	Flag to turn on 2nd volume interaction: 0 => off, 1 => on, x>0 => on, superparticles densified by x	ADVANCED	see [RD7]
volInteractNb	int	2	None	Number of volume interactors : not to be modified in UI, but only in defaultGlobalParam.py if the number of sources is modified in defaultGlobalParam.py	ADVANCED	see [RD7]
volInteractType1	String	CEXInteractor	None	Type of 1st volume interaction, UI-buildable class name derived from VolInteract	ADVANCED	see [RD7]
volInteractType2	String	CEXInteractor	None	Type of 2nd volume interaction, UI-buildable class name derived from VolInteract	ADVANCED	see [RD7]

MultiZone

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
hmzvdPoissonVlasovLoopNb	int	3	None	number of Poisson-Vlasov loops within each jCL factor adjusting iteration in a HybridMZVolDistrib	EXPERT	see [RD7]
jclfAdjustLoopNb	int	3	None	number of loops for adjusting jCL factor within a HybridMZVolDistrib	EXPERT	see [RD7]
jclfCVSpeed	double	1	None	convergence speed for jCL factor	EXPERT	see [RD7]
jclfExtractingFieldWeight	double	1	None	weighing factor for the presence of an extracting electric field at boundary between zones, which leads to a jCLfact increase	EXPERT	see [RD7]
jclfLowerBound	double	0.01	None	lower bound for jCL factor	EXPERT	see [RD7]
jclfPosChargeWeight	double	1	None	weighing factor for the presence of positive space charge in a positive sheath, which leads to jCLfact reduction to avoid instabilities	EXPERT	see [RD7]
jclfReattractingFieldWeight	double	1	None	weighing factor for the presence of a re-attracting electric field at boundary between zones, which leads to a jCLfact reduction	EXPERT	see [RD7]
jclfSmoothing	double	1	None	smoothing strengh for jCL factor at each iteration	EXPERT	see [RD7]
jclfUpperBound	double	100	None	upper bound for jCL factor	EXPERT	see [RD7]
neLowerBoundCoeff	double	1	None	coefficient ruling the lower boundary on Ne estimate for jTh computation: small => less constraint, big => ne close to ni	EXPERT	see [RD7]

zoneBdElecDensification	double	1	None	densification coefficient (increases superparticle number, decreasing their weight) for PIC electrons emitted at zone boundary	EXPERT	see [RD7]

Scenario

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
scenarioParameter4	double	0.000002	[s]	If PotentialSweep: Duration of first IV step	ADVANCED	see [RD7]
scenarioParameter5	double	0.000001	[s]	If PotentialSweep: Duration of other steps	ADVANCED	see [RD7]
scenarioParameter15	double	1	[V]	If PotentialSweep: Final potential of 1st node	ADVANCED	see [RD7]
scenarioParameter18	double	1	[V]	If PotentialSweep: Final potential of 2nd node	ADVANCED	see [RD7]
scenarioParameter21	double	1	[V]	If PotentialSweep: Final potential of 3rd node	ADVANCED	see [RD7]
scenarioParameter24	double	1	[V]	If PotentialSweep: Final potential of 4th node	ADVANCED	see [RD7]
scenarioParameter27	double	1	[V]	If PotentialSweep: Final potential of 5th node	ADVANCED	see [RD7]
scenarioParameter30	double	1	[V]	If PotentialSweep: Final potential of 6th node	ADVANCED	see [RD7]
scenarioParameter3	double	1	[V]	If PotentialSweep: Final voltage (used for monitoring, not to define node potentials)	ADVANCED	see [RD7]
scenarioParameter8	int	-1	[-]	If PotentialSweep: Flag for nodes monitored (-1: all nodes; else: minimum and maximum nodes Id to be defined)	ADVANCED	see [RD7]
scenarioParameter7	int	-1	[-]	If PotentialSweep: Flag for populations monitored (9 bits used for all/elec1/elec2/ions1/ions2/source1/s2/s3/S4, -1 all	ADVANCED	see [RD7]

				separately)		
scenarioParameter11	int	0	[-]	If PotentialSweep: Flag for type of current monitored (0=all, 1=collected, 2=emitted)	ADVANCED	see [RD7]
scenarioParameter6	double	0.5	[-]	If PotentialSweep: Fraction of step duration used for IV sweeps results	ADVANCED	see [RD7]
scenarioParameter13	int	0	[-]	If PotentialSweep: Id of 1st node with pot change	ADVANCED	see [RD7]
scenarioParameter16	int	0	[-]	If PotentialSweep: Id of 2nd node with pot change	ADVANCED	see [RD7]
scenarioParameter19	int	0	[-]	If PotentialSweep: Id of 3rd node with pot change	ADVANCED	see [RD7]
scenarioParameter22	int	0	[-]	If PotentialSweep: Id of 4th node with pot change	ADVANCED	see [RD7]
scenarioParameter25	int	0	[-]	If PotentialSweep: Id of 5th node with pot change	ADVANCED	see [RD7]
scenarioParameter28	int	0	[-]	If PotentialSweep: Id of 6th node with pot change	ADVANCED	see [RD7]
scenarioParameter14	double	0	[V]	If PotentialSweep: Initial potential of 1st node	ADVANCED	see [RD7]
scenarioParameter17	double	0	[V]	If PotentialSweep: Initial potential of 2nd node	ADVANCED	see [RD7]
scenarioParameter20	double	0	[V]	If PotentialSweep: Initial potential of 3rd node	ADVANCED	see [RD7]
scenarioParameter23	double	0	[V]	If PotentialSweep: Initial potential of 4th node	ADVANCED	see [RD7]
scenarioParameter26	double	0	[V]	If PotentialSweep: Initial potential of 5th node	ADVANCED	see [RD7]
scenarioParameter29	double	0	[V]	If PotentialSweep: Initial potential of 6th node	ADVANCED	see [RD7]
scenarioParameter10	int	0	[-]	If PotentialSweep: Maximal Id node number	ADVANCED	see [RD7]
scenarioParameter9	int	0	[-]	If PotentialSweep: Minimal Id node number	ADVANCED	see [RD7]

scenarioParameter12	int	0	[-]	If PotentialSweep: Number of nodes whose potential changes	ADVANCED	see [RD7]
scenarioParameter1	int	0	[-]	If PotentialSweep: Number of steps of the potential sweep	ADVANCED	see [RD7]
scenarioParameter2	double	0	[V]		ADVANCED	see [RD7]

Sources

KeyName	ValueType	Value	Unit	Description	VerbosityLevel	Comment
fieldFactor	double	1	[-]	field factor enhancement for Fowler-Nordheim sources (usually named beta)	ADVANCED	see [RD7]
sourceCurrentFactor1.1	double	1	None	Multiplication factor defining the current of sub source No 1 of source No 1 with respect to source No 1	ADVANCED	see [RD7]
sourceCurrentFactor1.2	double	1	None	Multiplication factor defining the current of sub source No 2 of source No 1 with respect to source No 1	ADVANCED	see [RD7]
sourceCurrentFactor1.3	double	1	None	Multiplication factor defining the current of sub source No 1 of source No 1 with respect to source No 1	ADVANCED	see [RD7]
sourceCurrentFactor1.4	double	1	None	Multiplication factor defining the current of sub source No 2 of source No 1 with respect to source No 1	ADVANCED	see [RD7]
sourceDt1	double	-1	[s]	Maximum integration time step for particles from 1st source (automatic if negative)	ADVANCED	see [RD7]
sourceDt1.1	double	-1	[s]	Maximum integration time step for particles from sub source No 1 of source No 1 (automatic if negative)	ADVANCED	see [RD7]

sourceDt1.2	double	-1	[s]	Maximum integration time step for particles from sub source No 2 of source No 1 (automatic if negative)	ADVANCED	see [RD7]
sourceDt1.3	double	-1	[s]	Maximum integration time step for particles from sub source No 1 of source No 1 (automatic if negative)	ADVANCED	see [RD7]
sourceDt1.4	double	-1	[s]	Maximum integration time step for particles from sub source No 2 of source No 1 (automatic if negative)	ADVANCED	see [RD7]
sourceDt2	double	-1	[s]	Maximum integration time step for particles from 2nd source (automatic if negative)	ADVANCED	see [RD7]
sourceDt3	double	-1	[s]	Maximum integration time step for particles from 3rd source (automatic if negative)	ADVANCED	see [RD7]
sourceDt4	double	-1	[s]	Maximum integration time step for particles from 4th source (automatic if negative)	ADVANCED	see [RD7]
sourceDuration1	double	0	[s]	Maximum integration duration for particles from 1st source (automatic if 0)	ADVANCED	see [RD7]
sourceDuration1.1	double	0	[s]	Maximum integration duration for particles from sub source No 1 of source No 1 (automatic if 0)	ADVANCED	see [RD7]
sourceDuration1.2	double	0	[s]	Maximum integration duration for particles from sub source No 2 of source No 1 (automatic if 0)	ADVANCED	see [RD7]
sourceDuration1.3	double	0	[s]	Maximum integration duration for particles from sub source No 1 of source No 1 (automatic if 0)	ADVANCED	see [RD7]
sourceDuration1.4	double	0	[s]	Maximum integration duration for particles from sub source No 2 of source No 1 (automatic if 0)	ADVANCED	see [RD7]
sourceDuration2	double	0	[s]	Maximum integration duration for particles from 2nd source (automatic if 0)	ADVANCED	see [RD7]

sourceDuration3	double	0	[s]	Maximum integration duration for particles from 3rd source (automatic if 0)	ADVANCED	see [RD7]
sourceDuration4	double	0	[s]	Maximum integration duration for particles from 4th source (automatic if 0)	ADVANCED	see [RD7]
sourceFlag1	double	0	[-]	Flag for defining artificial source No 1 on the spacecraft: 0 => none, 1 => yes, x => number of super-particles densified by x	ADVANCED	see [RD7]
sourceFlag1.1	double	0	[-]	Flag for defining artificial sub source No 1 of source No 1 on the spacecraft (source1.1): 0 => none, 1 => yes, x => number of super-particles densified by x	ADVANCED	see [RD7]
sourceFlag1.2	double	0	[-]	Flag for defining artificial sub source No 2 of source No 1 on the spacecraft (source1.2): 0 => none, 1 => yes, x => number of super-particles densified by x	ADVANCED	see [RD7]
sourceFlag1.3	double	0	[-]	Flag for defining artificial sub source No 3 of source No 1 on the spacecraft (source1.1): 0 => none, 1 => yes, x => number of super-particles densified by x	ADVANCED	see [RD7]
sourceFlag1.4	double	0	[-]	Flag for defining artificial sub source No 4 of source No 1 on the spacecraft (source1.2): 0 => none, 1 => yes, x => number of super-particles densified by x	ADVANCED	see [RD7]
sourceFlag2	double	0	[-]	Flag for defining artificial source No 2 on the spacecraft: 0 => none, 1 => yes, x => number of super-particles densified by x	ADVANCED	see [RD7]
sourceFlag3	double	0	[-]	Flag for defining artificial source No 3 on the spacecraft: 0 => none, 1 => yes, x => number of super-particles densified by x	ADVANCED	see [RD7]

sourceFlag4	double	0	[-]	Flag for defining artificial source No 4 on the spacecraft: 0 => none, 1 => yes, x => number of super-particles densified by x	ADVANCED	see [RD7]
sourceMachFactor1.1	double	1	None	Multiplication factor defining the mach number of sub source No 1 of source No 1 with respect to source No 1	ADVANCED	see [RD7]
sourceMachFactor1.2	double	1	None	Multiplication factor defining the mach number of sub source No 2 of source No 1 with respect to source No 1	ADVANCED	see [RD7]
sourceMachFactor1.3	double	1	None	Multiplication factor defining the mach number of sub source No 1 of source No 1 with respect to source No 1	ADVANCED	see [RD7]
sourceMachFactor1.4	double	1	None	Multiplication factor defining the mach number of sub source No 2 of source No 1 with respect to source No 1	ADVANCED	see [RD7]
sourceNb	int	4	None	Number of particle sources: not to be modified in UI, but only in defaultGlobalParam.py if the number of sources is modified in defaultGlobalParam.py	ADVANCED	see [RD7]
sourceNb1	int	0	None	Number of particles sources of the multi-source 1 (if source 1 is a MultipleSurfDistrib). Nb: create extra parameters for these sub sources	ADVANCED	see [RD7]
sourceNb2	int	0	None	Number of particles sources of the multi-source 2 (if source 2 is a MultipleSurfDistrib). Nb: create extra parameters for these sub sources	ADVANCED	see [RD7]
sourceNb3	int	0	None	Number of particles sources of the multi-source 3 (if source 3 is a MultipleSurfDistrib). Nb: create extra parameters for these sub sources	ADVANCED	see [RD7]

sourceNb4	int	0	None	Number of particles sources of the multi-source 4 (if source 4 is a MultipleSurfDistrib). Nb: create extra parameters for these sub sources	ADVANCED	see [RD7]
sourceParticleType1	String	Xe+	None	Type of particles emitted by source 1	ADVANCED	see [RD7]
sourceParticleType1.1	String	electron	None	Type of particles emitted by sub source No 1 of source No 1	ADVANCED	see [RD7]
sourceParticleType1.2	String	electron	None		ADVANCED	see [RD7]
sourceParticleType1.3	String	electron	None	Type of particles emitted by sub source No 3 of source No 1	ADVANCED	see [RD7]
sourceParticleType1.4	String	electron	None	Type of particles emitted by sub source No 4 of source No 1	ADVANCED	see [RD7]
sourceParticleType2	String	electron	None	Type of particles emitted by source 2	ADVANCED	see [RD7]
sourceParticleType3	String	Cs+	None	Type of particles emitted by source 3	ADVANCED	see [RD7]
sourceParticleType4	String	In+	None	Type of particles emitted by source 4	ADVANCED	see [RD7]
sourceSpeedUp1	double	1	[-]	Numerical times speed-up factor for 1st source population	ADVANCED	see [RD7]
sourceSpeedUp1.1	double	1	[-]	Numerical times speed-up factor for sub source No 1 of source No 1	ADVANCED	see [RD7]
sourceSpeedUp1.2	double	1	[-]	Numerical times speed-up factor for sub source No 1 of source No 1	ADVANCED	see [RD7]
sourceSpeedUp1.3	double	1	[-]	Numerical times speed-up factor for sub source No 1 of source No 1	ADVANCED	see [RD7]
sourceSpeedUp1.4	double	1	[-]	Numerical times speed-up factor for sub source No 1	ADVANCED	see [RD7]

				of source No 1		
sourceSpeedUp2	double	1	[-]	Numerical times speed-up factor for 2nd source population	ADVANCED	see [RD7]
sourceSpeedUp3	double	1	[-]	Numerical times speed-up factor for 3rd source population	ADVANCED	see [RD7]
sourceSpeedUp4	double	1	[-]	Numerical times speed-up factor for 4th source population	ADVANCED	see [RD7]
sourceTempFactor1.1	double	1	None	Multiplication factor defining the temperature of sub source No 1 of source No 1 with respect to source No 1	ADVANCED	see [RD7]
sourceTempFactor1.2	double	1	None	Multiplication factor defining the temperature of sub source No 2 of source No 1 with respect to source No 1	ADVANCED	see [RD7]
sourceTempFactor1.3	double	1	None	Multiplication factor defining the temperature of sub source No 1 of source No 1 with respect to source No 1	ADVANCED	see [RD7]
sourceTempFactor1.4	double	1	None	Multiplication factor defining the temperature of sub source No 2 of source No 1 with respect to source No 1	ADVANCED	see [RD7]
sourceTrajFlag1	int	0	None	plot source 1 trajectory (and sub sources if any)? 0=no, 1=yes	ADVANCED	see [RD7]
sourceTrajFlag2	int	0	None	plot source 2 trajectory (and sub sources if any)? 0=no, 1=yes	ADVANCED	see [RD7]
sourceTrajFlag3	int	0	None	plot source 3 trajectory (and sub sources if any)? 0=no, 1=yes	ADVANCED	see [RD7]

sourceTrajFlag4	int	0	None	plot source 4 trajectory (and sub sources if any)? 0=no, 1=yes	ADVANCED	see [RD7]
sourceType1	String	LocalMaxwell SurfDistrib	None	Name of the SurfDistrib class to be used on the spacecraft as source No 1	ADVANCED	see [RD7]
sourceType1.1	String	LocalMaxwell SurfDistrib	None	Name of the SurfDistrib class to be used on the spacecraft as sub source No 1 of source No 1	ADVANCED	see [RD7]
sourceType1.2	String	LocalMaxwell SurfDistrib	None	Name of the SurfDistrib class to be used on the spacecraft as sub source No 2 of source No 1	ADVANCED	see [RD7]
sourceType1.3	String	LocalMaxwell SurfDistrib	None	Name of the SurfDistrib class to be used on the spacecraft as sub source No 3 of source No 1	ADVANCED	see [RD7]
sourceType1.4	String	LocalMaxwell SurfDistrib	None	Name of the SurfDistrib class to be used on the spacecraft as sub source No 4 of source No 1	ADVANCED	see [RD7]
sourceType2	String	MaxwellianThruster	None	Name of the SurfDistrib class to be used on the spacecraft as source No 2	ADVANCED	see [RD7]
sourceType3	String	LocalMaxwell SurfDistrib	None	Name of the SurfDistrib class to be used on the spacecraft as source No 3	ADVANCED	see [RD7]
sourceType4	String	LocalMaxwell SurfDistrib	None	Name of the SurfDistrib class to be used on the spacecraft as source No 4	ADVANCED	see [RD7]