

Modelling of multipactor effects in iris

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IRIS-SEY

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SPINE Meeting – April 4th-5th 2017

(1) Artenum Toulouse

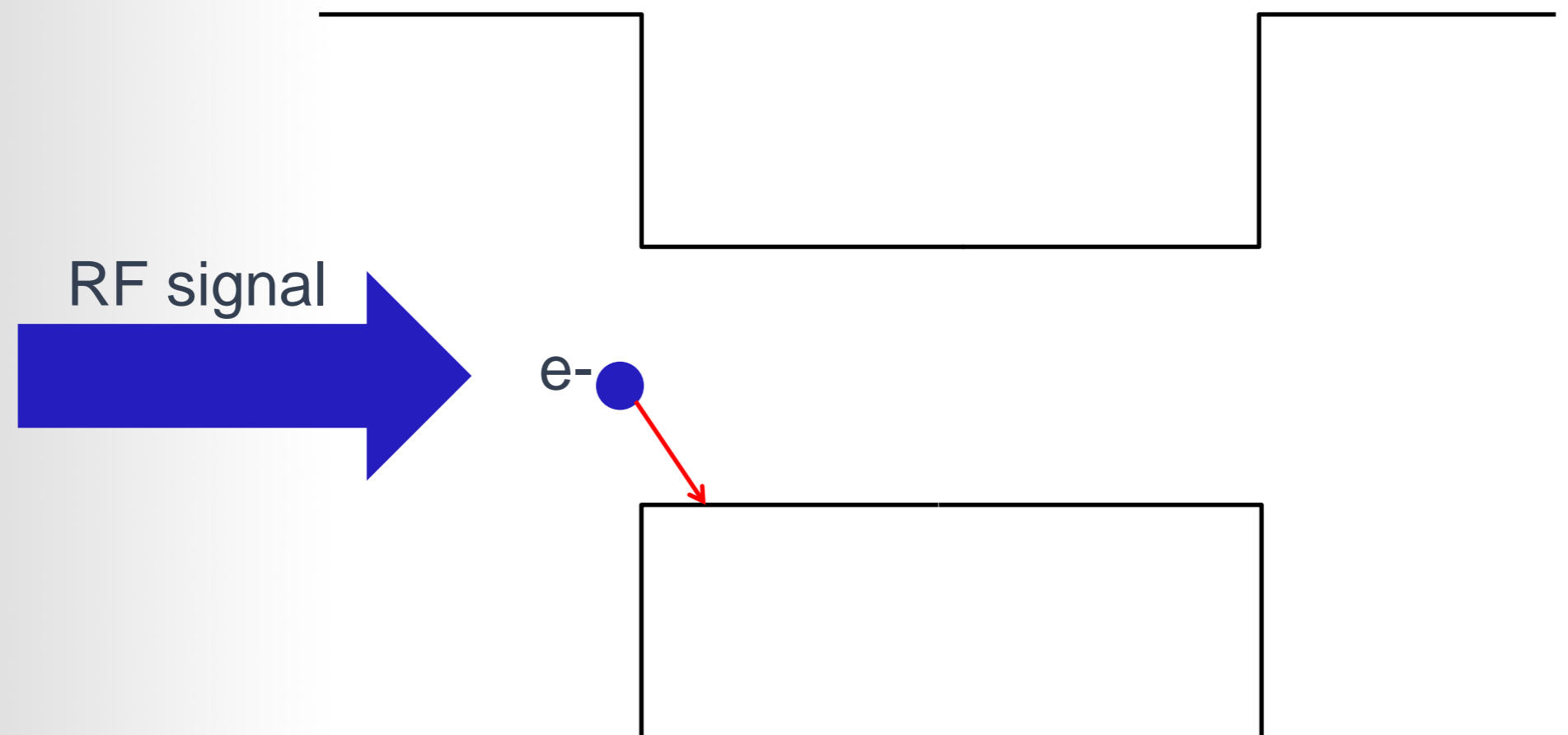
(2) CNES

(3) Artenum Paris/Lyon

- Radio Frequency (RF) signals power is constantly increasing inside satellites wave guides
- Inside wave guides, there are irises filtering the RF signals
- This power increase favours the appearing of the multipactor effect inside the irises
- Necessity to model the multipactor effect

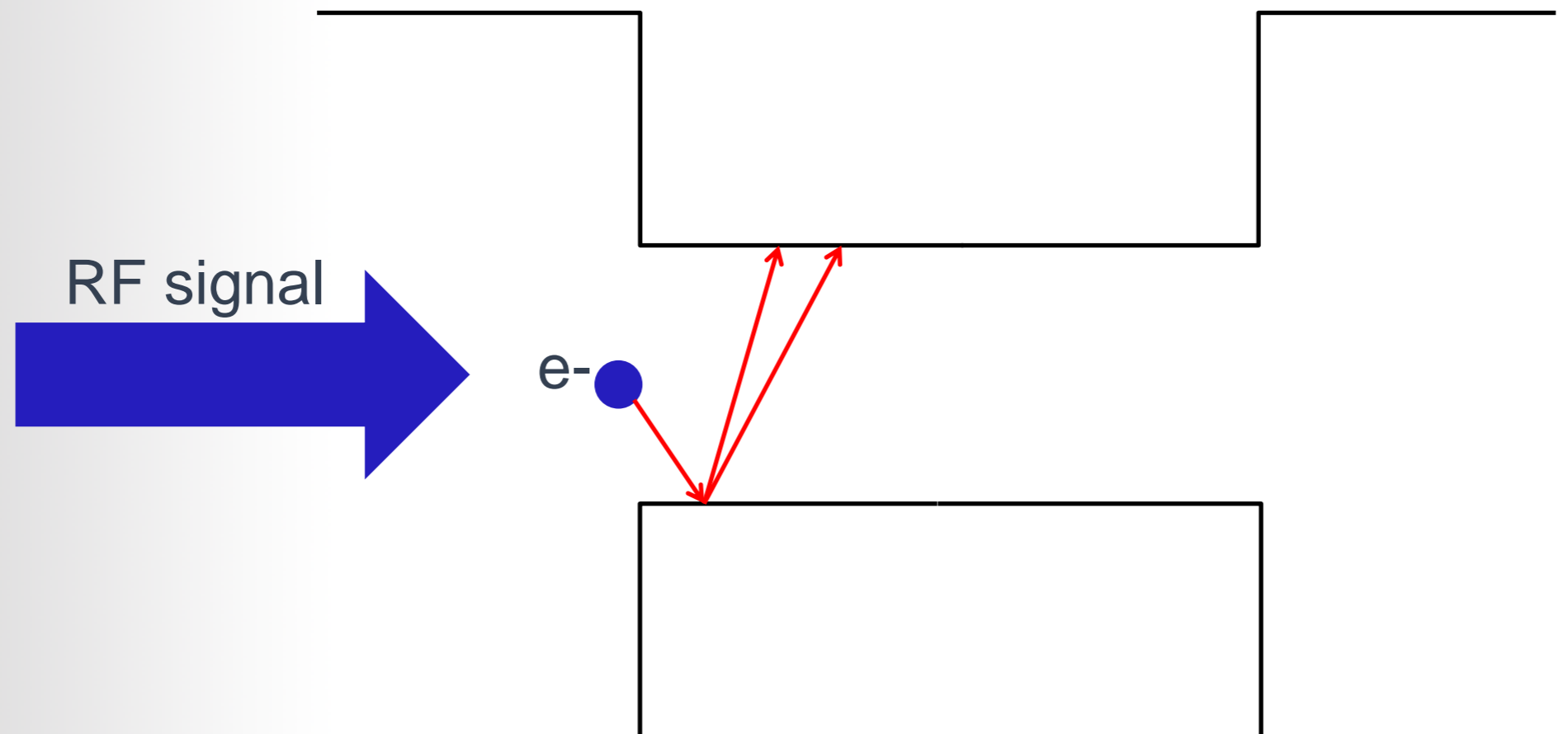
The multipactor effect

- Due to an electron impact on the surface
- Depending on the SEE properties of materials
- Creates electrons avalanche



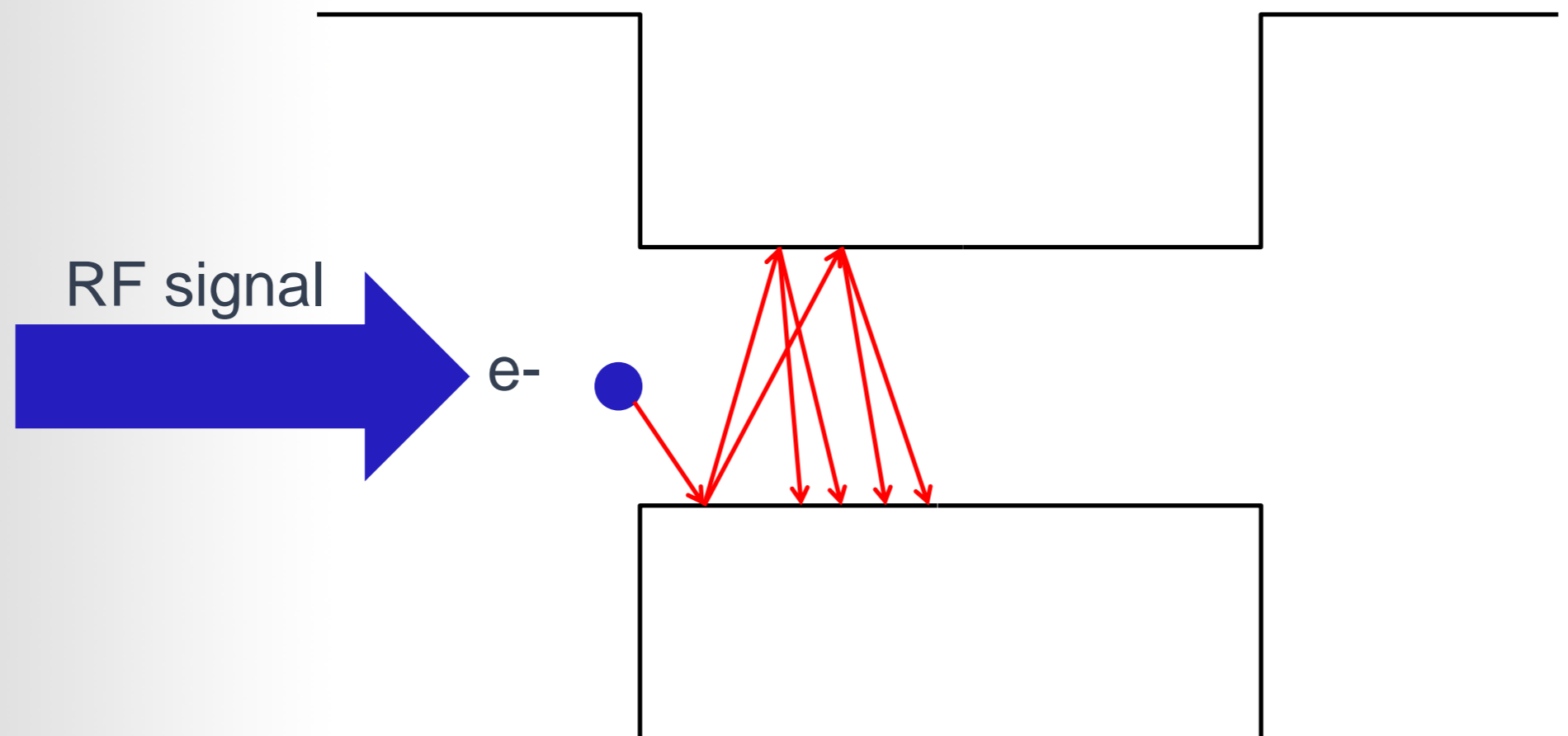
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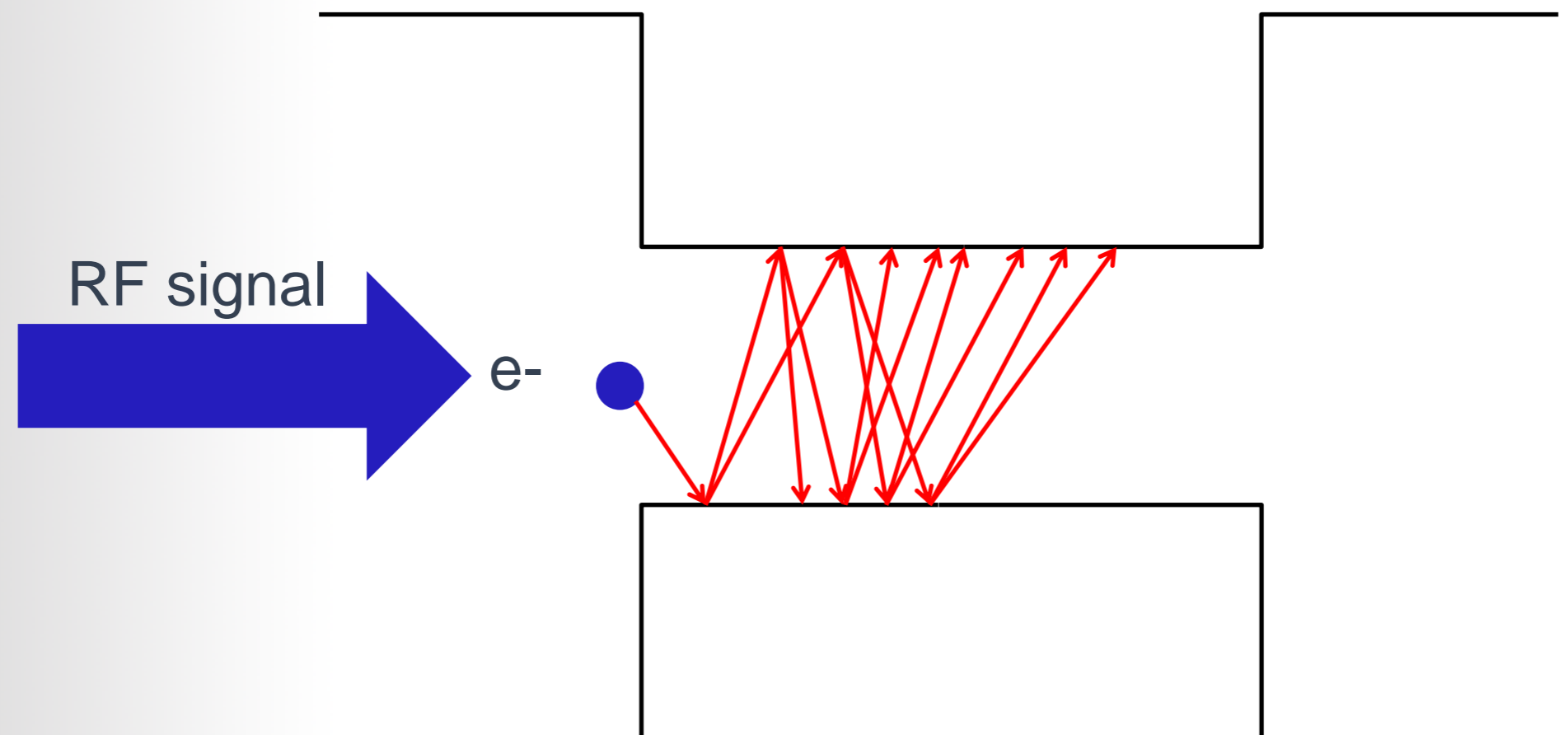
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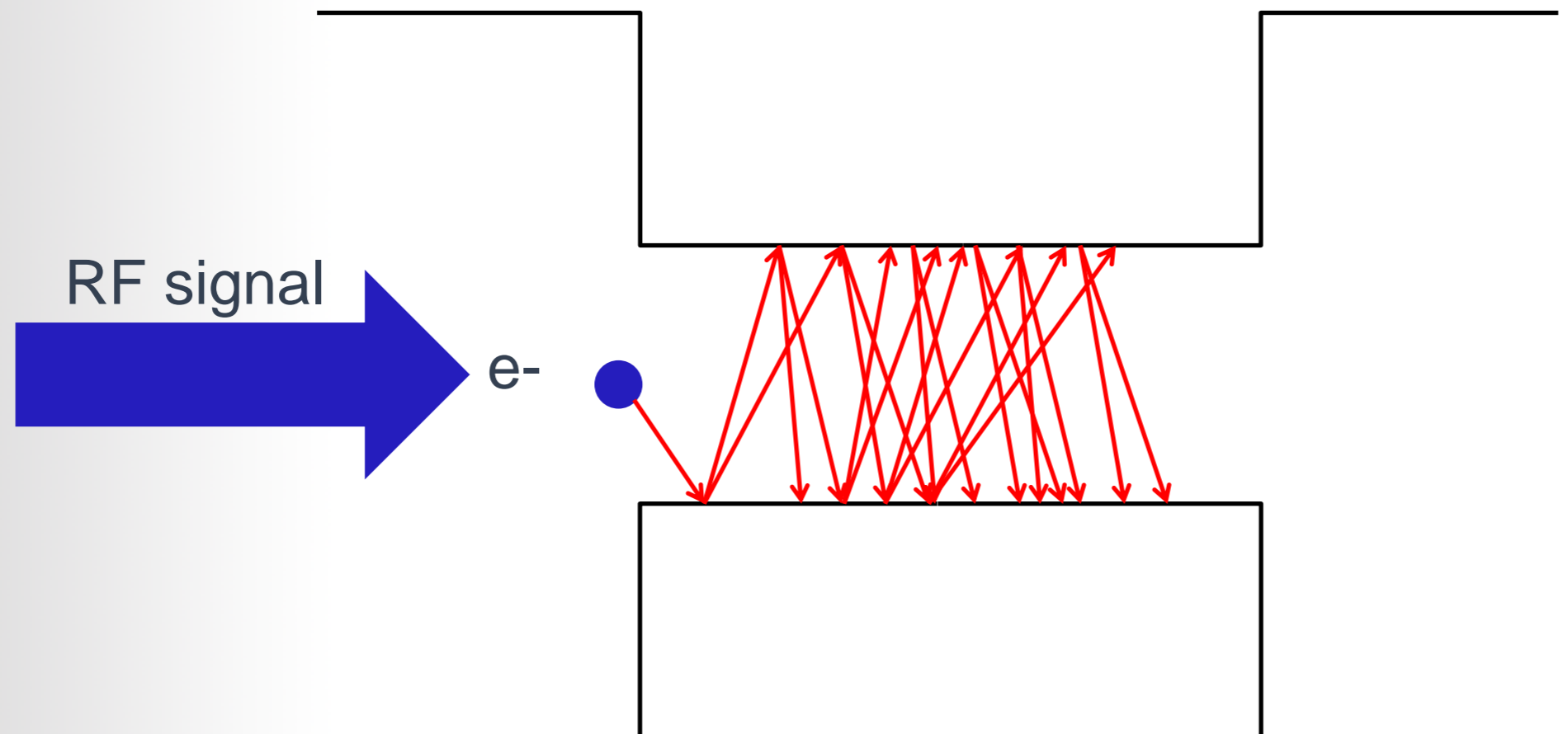
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- The presence of charges inside the wave guides can cause parasites:
 - Impedance changes:
 - Reduction or shifting of the RF signals frequency
 - Sending back part of the RF power to the emitter → destruction or overheating risks
 - Appearing of ESD → arching which can be critical for dielectric materials

1. Contractual context
2. IRIS-SEY presentation
3. Notion of material properties in the multipactor context
4. Conclusion

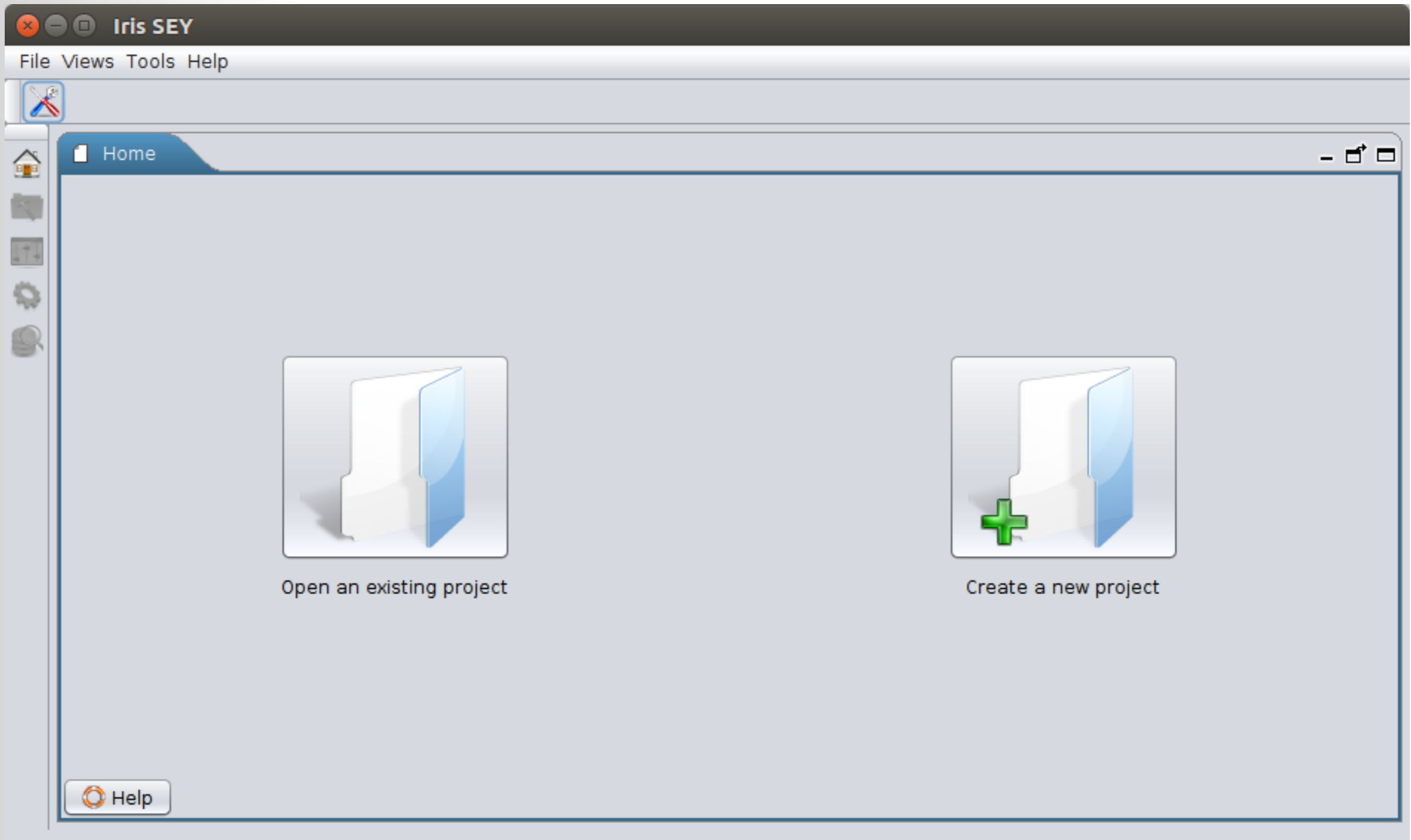
- CNES study to create a code allowing the modelling of the multipactor effect inside an iris
 - Creation of the IRIS-SEY software, focused on the modelling of irises devices
 - Development of the whole numerical core based on a publication:
 - “Conformal mapping analysis of multipactor breakdown in waveguide irises”
 - Published in Physics of plasmas 15, 033501 2008
 - Published by V. E. Semenov, E. Rakova, R. Udiljak, D. Anderson, M. Lisak, J. Puech
- IRIS-SEY aims to be an Open Source software
 - Not existing in the multipactor community
 - SPINE community = model of an Open Source community which is recognized outside of the surface charging → has pushed CNES to come close to this community model for the multipactor effects:
 - Development of a set of Open Source codes
 - Initiation of an open scientific and industrial community
 - Creation of a collaboration web platform

- To create the Open Source IRIS-SEY:
 - Use as much as possible pre-existing Open Source components
 - Sharing with other several thematic scientific communities of non tailored components:
 - Share and reduce the validation cost with other space projects of the SPIS approach
 - Validation and indirect improvement of the community version of SPIS
 - Extend non tailored components (GUI, IME, post-processing tools, ...)

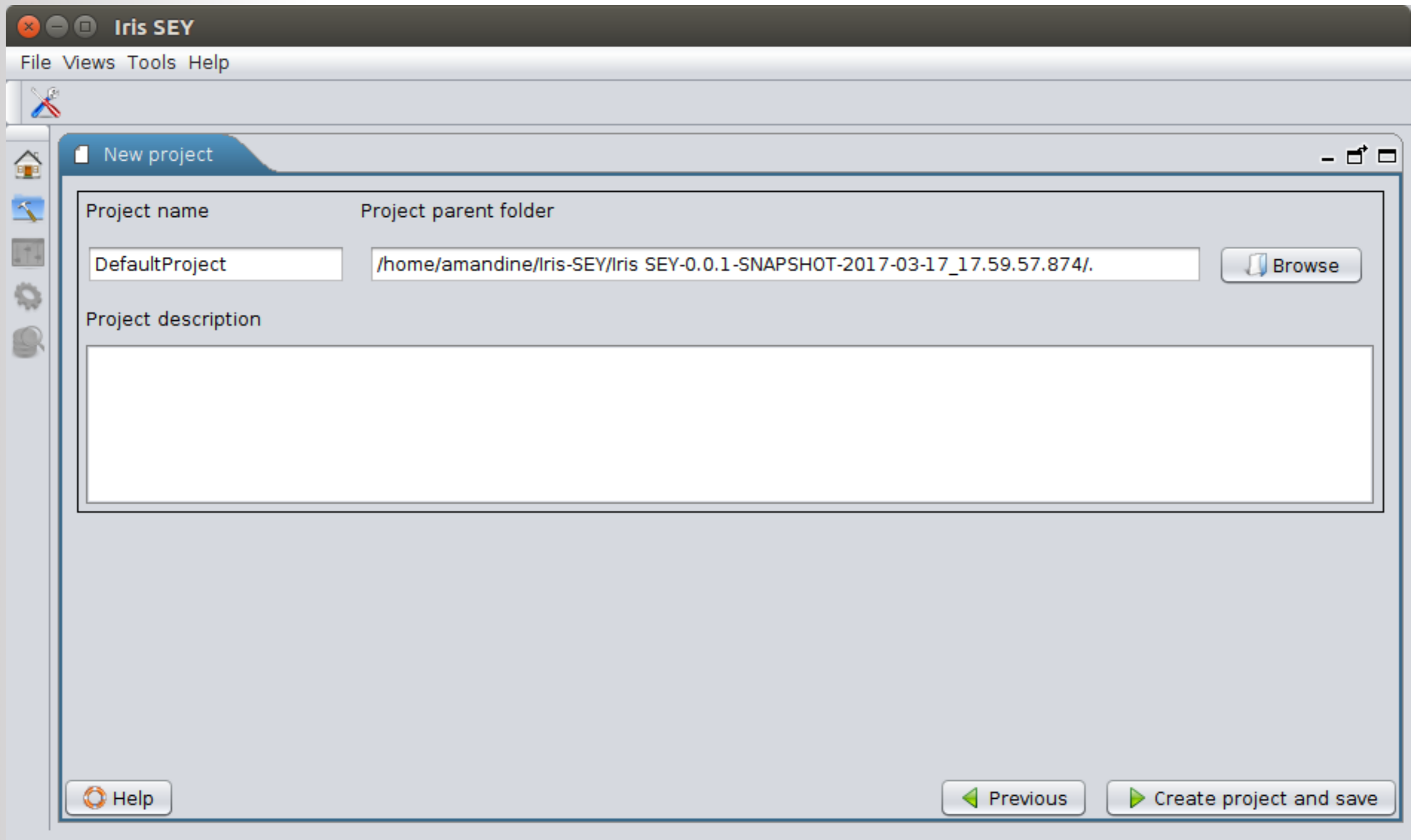
- New unique software called IRIS-SEY:
 - “User-friendly” user interface
 - Thanks to the user interface, possibility to set the simulation inputs
 - Java language
 - Multi-modular approach (OSGi)
 - Based on the Keridwen IME used in several scientific computing projects (SPIS, Prométhée, EDGE, Robbie ...)
 - Persistence projects able to be re-loaded and saved
 - Multi-platform:
 - Linux 64 bits;
 - Windows7 32 bits;
 - Windows7 64 bits;
 - Visualization of results
 - User manual packaged with the software
- Validation effort → soon to be finished

IRIS-SEY overview

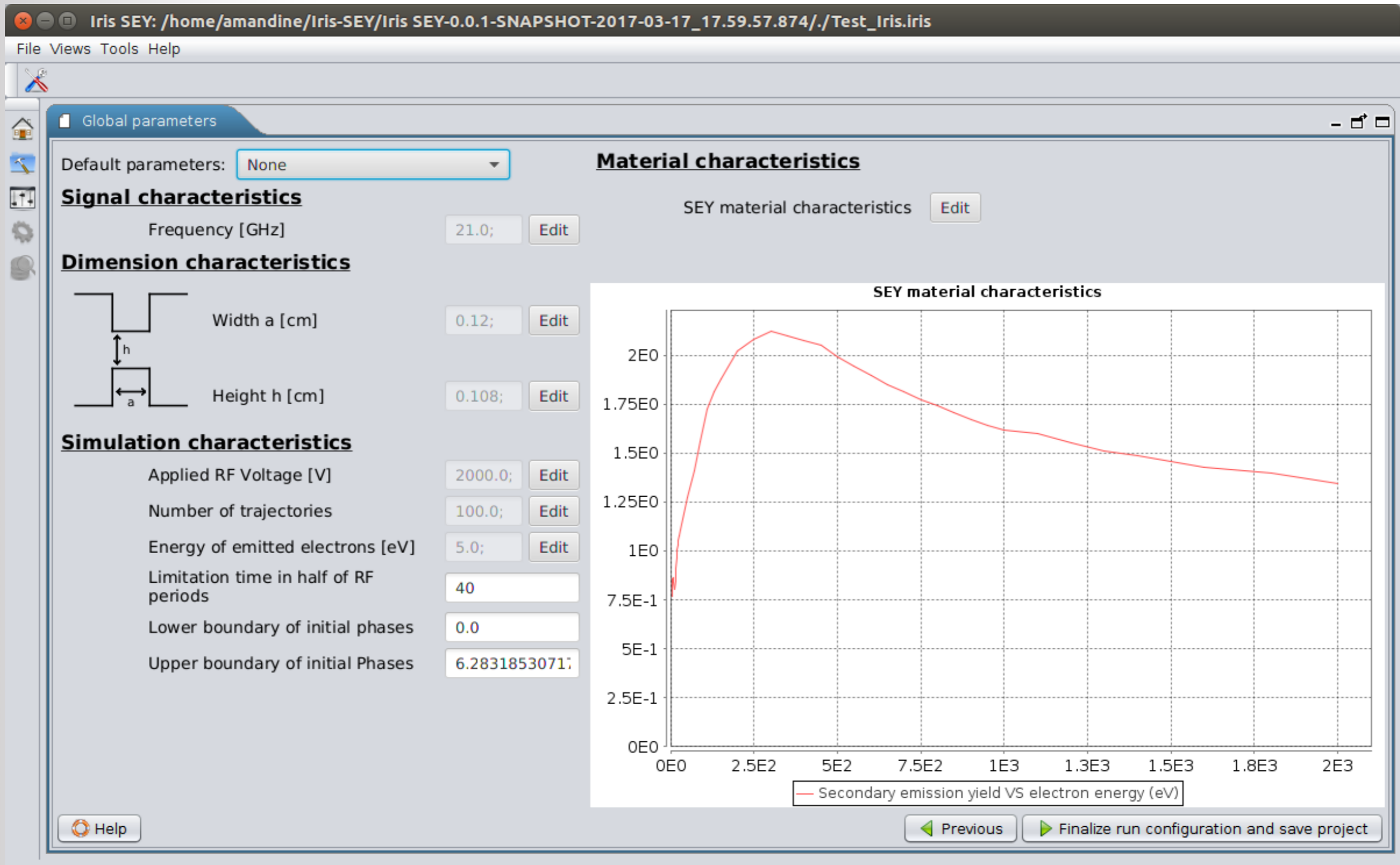
Main view perspective:
Create a new project OR load an existing one



Define where to save the project, its name and its description



Define the simulation input characteristics



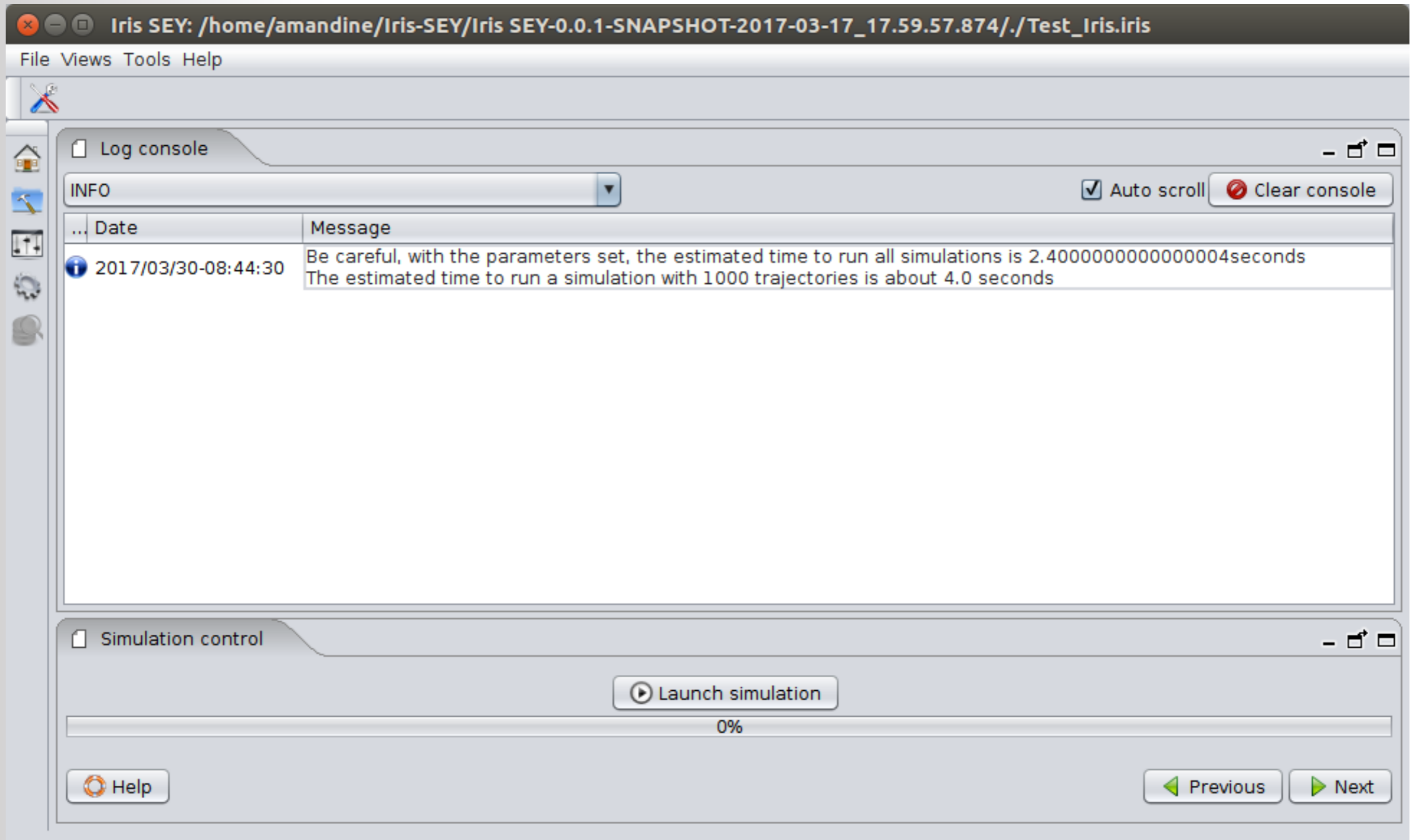
The screenshot displays the Iris SEY software interface. The window title is "Iris SEY: /home/amandine/Iris-SEY/Iris SEY-0.0.1-SNAPSHOT-2017-03-17_17.59.57.874/./Test_Iris.iris". The interface is divided into several sections:

- Global parameters:** Default parameters: None
- Signal characteristics:** Frequency [GHz]: 21.0; Edit
- Dimension characteristics:**
 - Width a [cm]: 0.12; Edit
 - Height h [cm]: 0.108; Edit
- Simulation characteristics:**
 - Applied RF Voltage [V]: 2000.0; Edit
 - Number of trajectories: 100.0; Edit
 - Energy of emitted electrons [eV]: 5.0; Edit
 - Limitation time in half of RF periods: 40
 - Lower boundary of initial phases: 0.0
 - Upper boundary of initial Phases: 6.2831853071
- Material characteristics:** SEY material characteristics Edit

The graph on the right, titled "SEY material characteristics", plots the Secondary emission yield (SEY) against electron energy (eV). The x-axis ranges from 0E0 to 2E3 eV, and the y-axis ranges from 0E0 to 2E0. The curve shows a peak yield of approximately 2.1 at 300 eV, followed by a gradual decline.

Electron Energy [eV]	Secondary Emission Yield
0	0.8
100	1.5
200	1.9
300	2.1
400	2.0
500	1.9
750	1.7
1000	1.5
1500	1.3
2000	1.2

Launch the simulation, access to log messages, monitor simulation progress

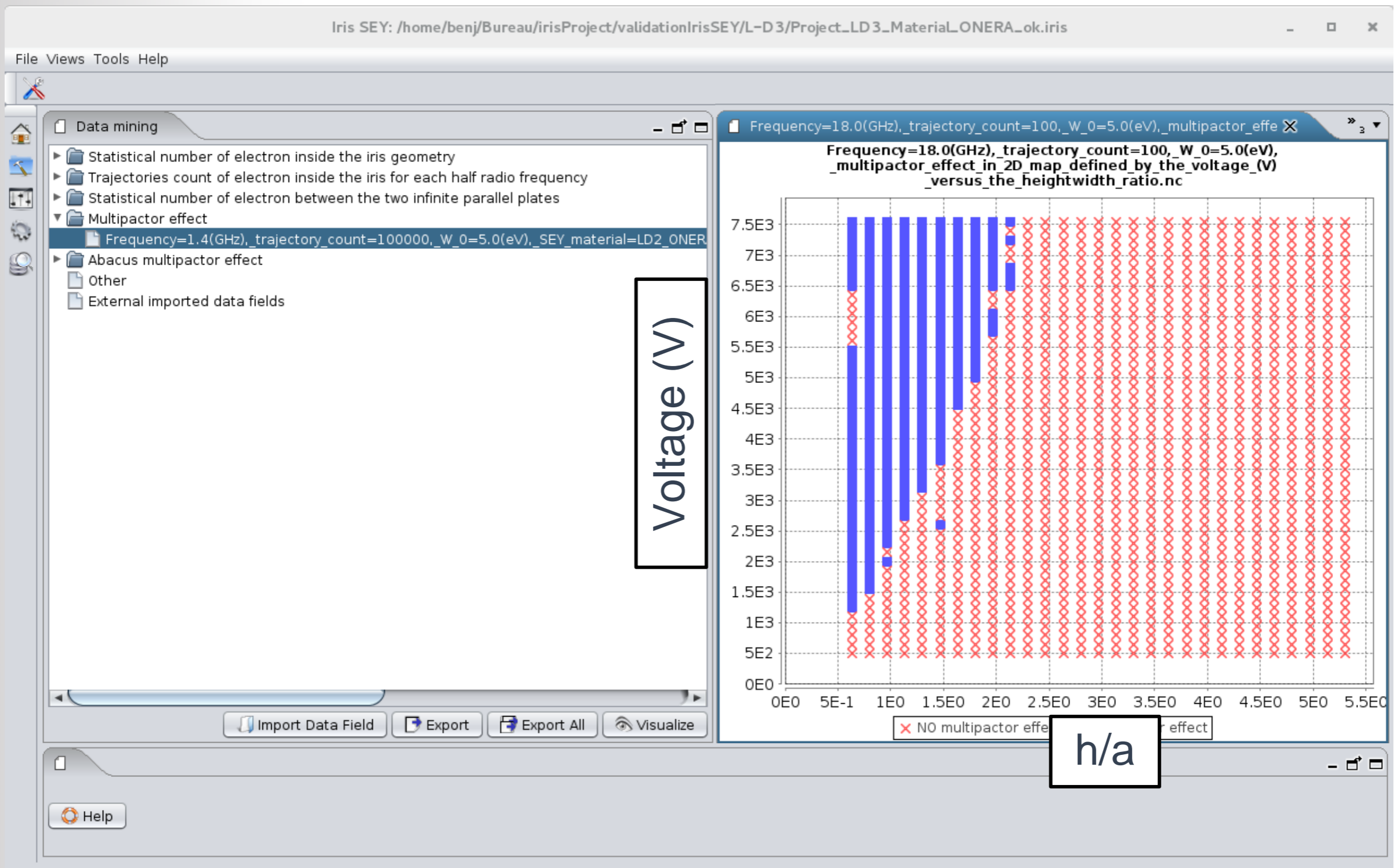


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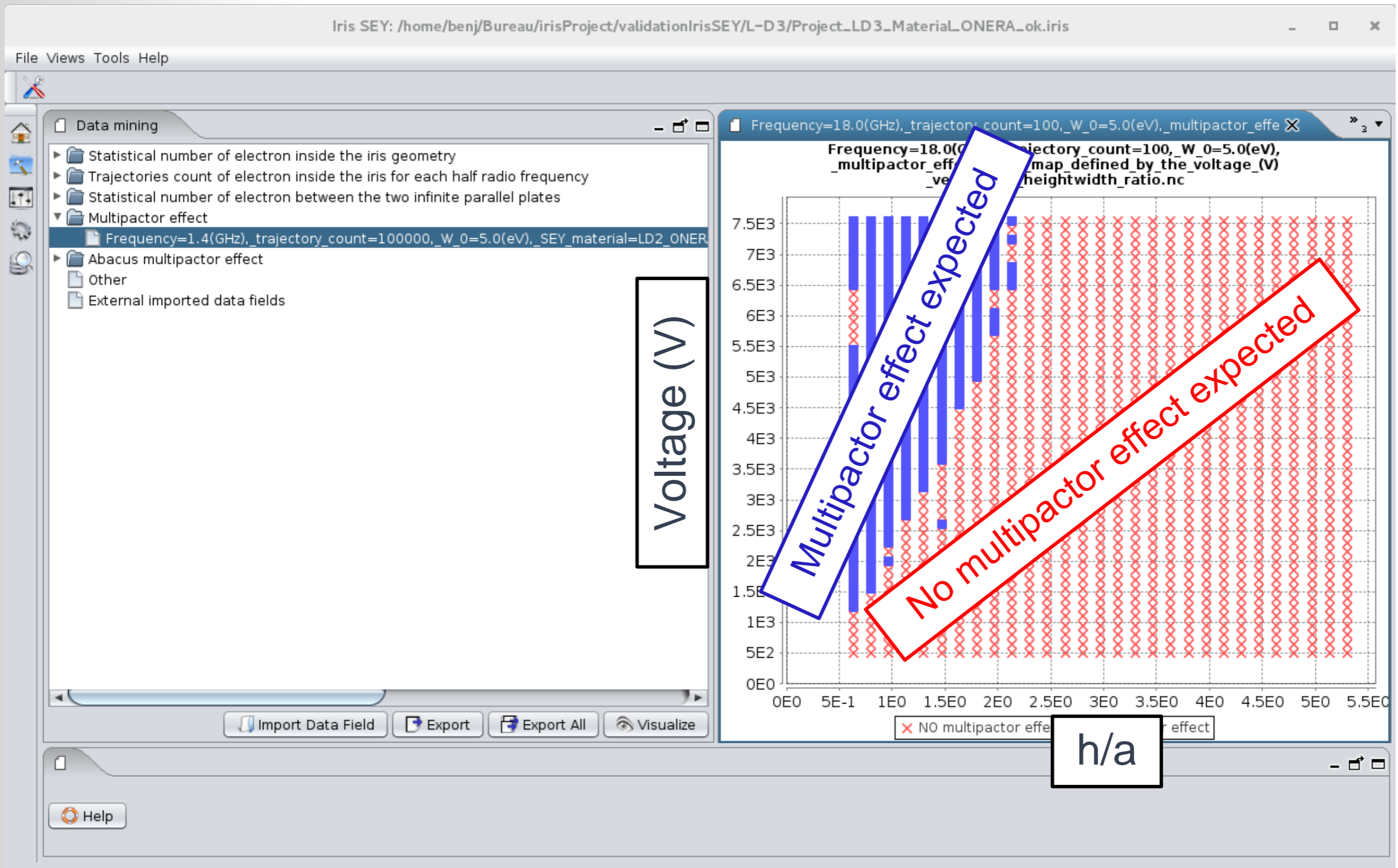
- Log console:** A panel with a dropdown menu set to "INFO", a checked "Auto scroll" checkbox, and a "Clear console" button. It contains a table with the following data:

Date	Message
2017/03/30-08:44:30	Be careful, with the parameters set, the estimated time to run all simulations is 2.4000000000000004seconds The estimated time to run a simulation with 1000 trajectories is about 4.0 seconds
- Simulation control:** A panel featuring a "Launch simulation" button, a progress bar at 0%, a "Help" button, and "Previous" and "Next" navigation buttons.

Visualization of simulation results

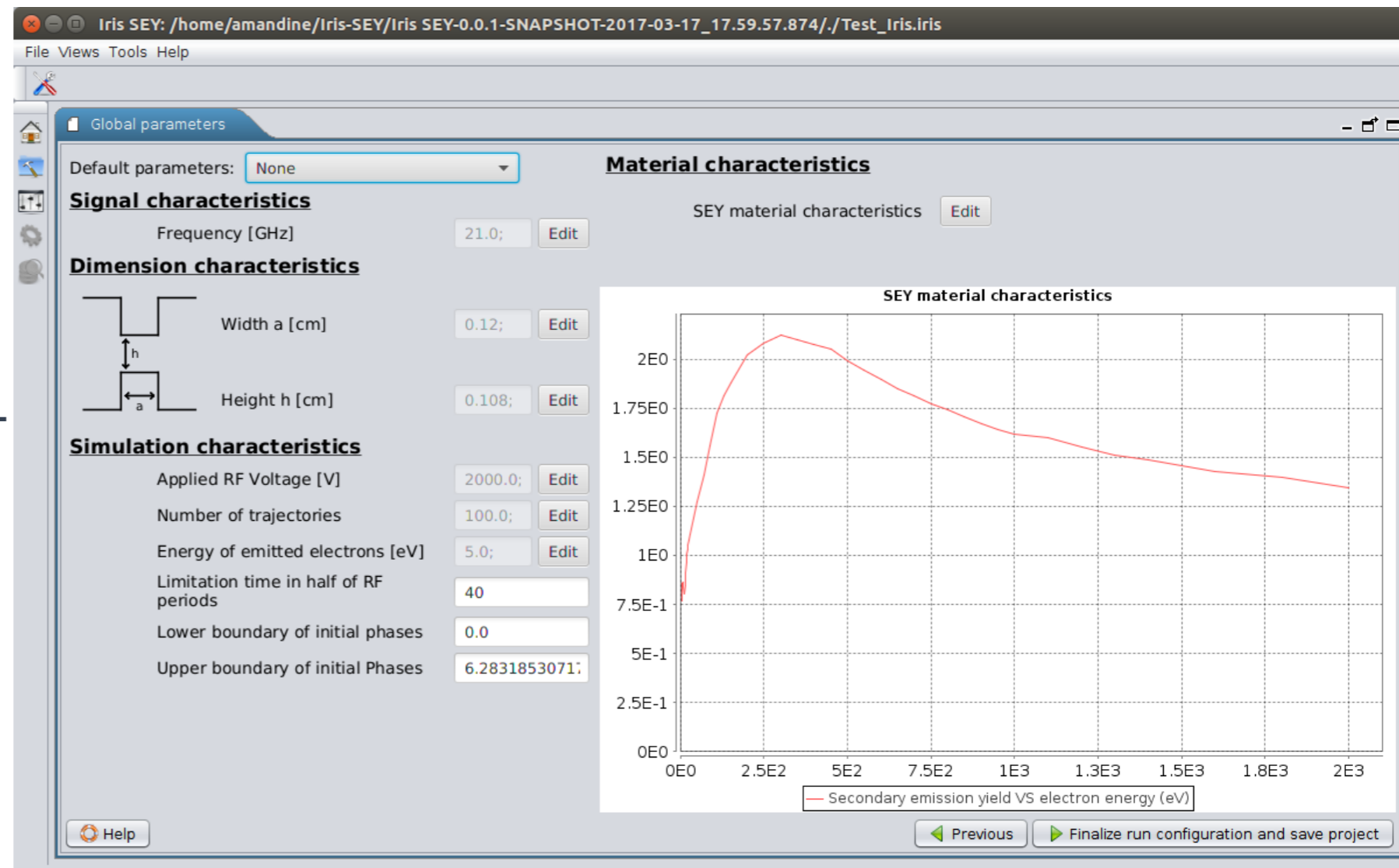


Visualization of simulation results



- In IRIS-SEY, secondary emission properties defined by a tabulated distribution function
- But, there are several way to model secondary emission properties:
 - How to defined these models ?
 - How to normalize them ?
 - How to share them with other communities (including surface charging) ?

→ Interesting to mutualize the material properties needs between surface charging and other communities (cf CNES/MATREX R&T by D. Payan)



- CNES study to create a numerical code modelling the multipactor effect inside an iris
- Future Open Source software: IRIS-SEY
 - Good example of the use of shared Open Source components over several communities (like Keridwen)
 - Through non tailored components, indirect validation and improvement of the community version of SPIS
- Will to create a community around the multipactor effect and based on the same model as the SPINE community
- Release by the end of the year
- Continuation of the project in Open Source