Modelling of multipactor effects in iris

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IRIS-SEY

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Context

- Radio Frequency (RF) signals power is constantly increasing inside satellites wave guides

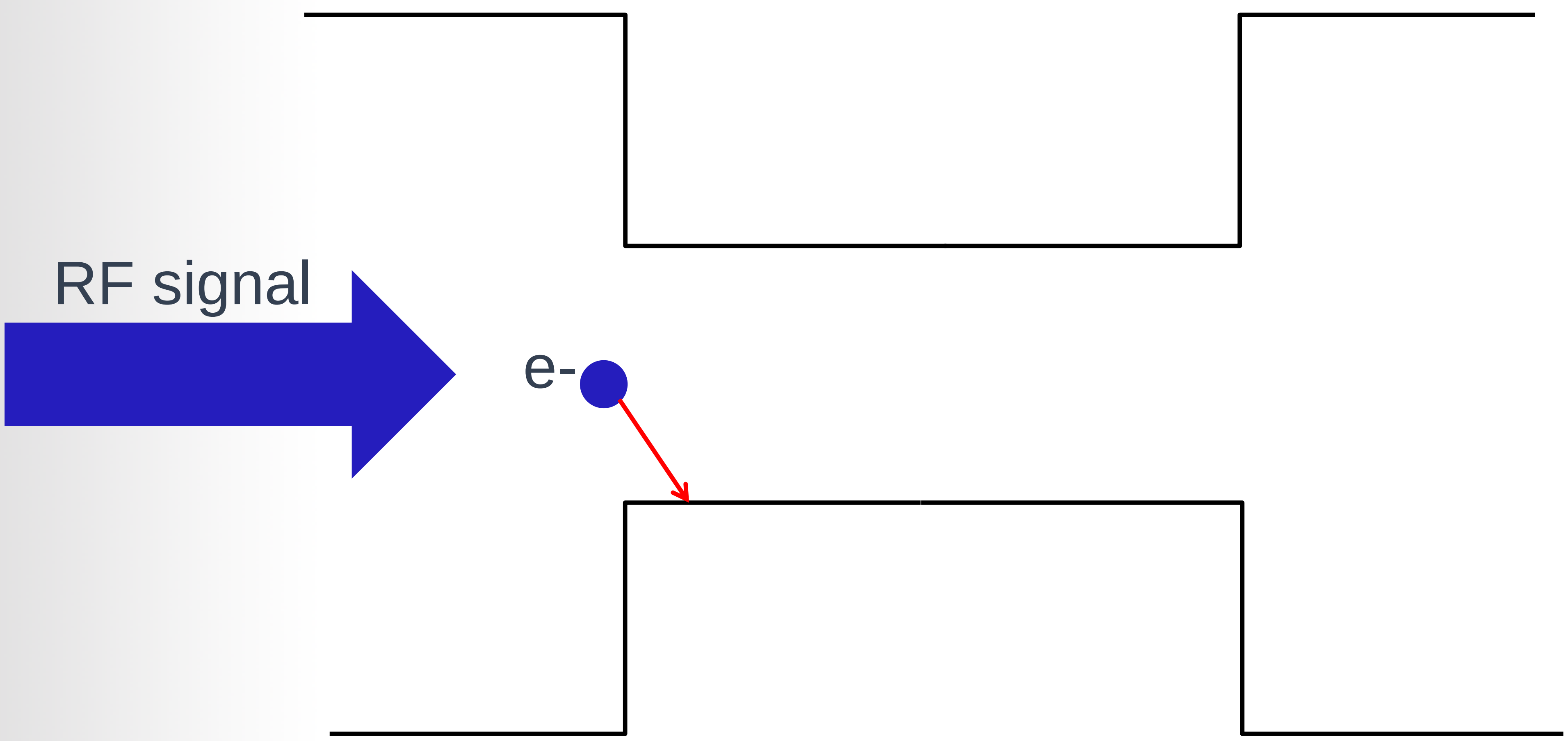
- Inside wave guides, there are irises filtering the RF signals

➔ 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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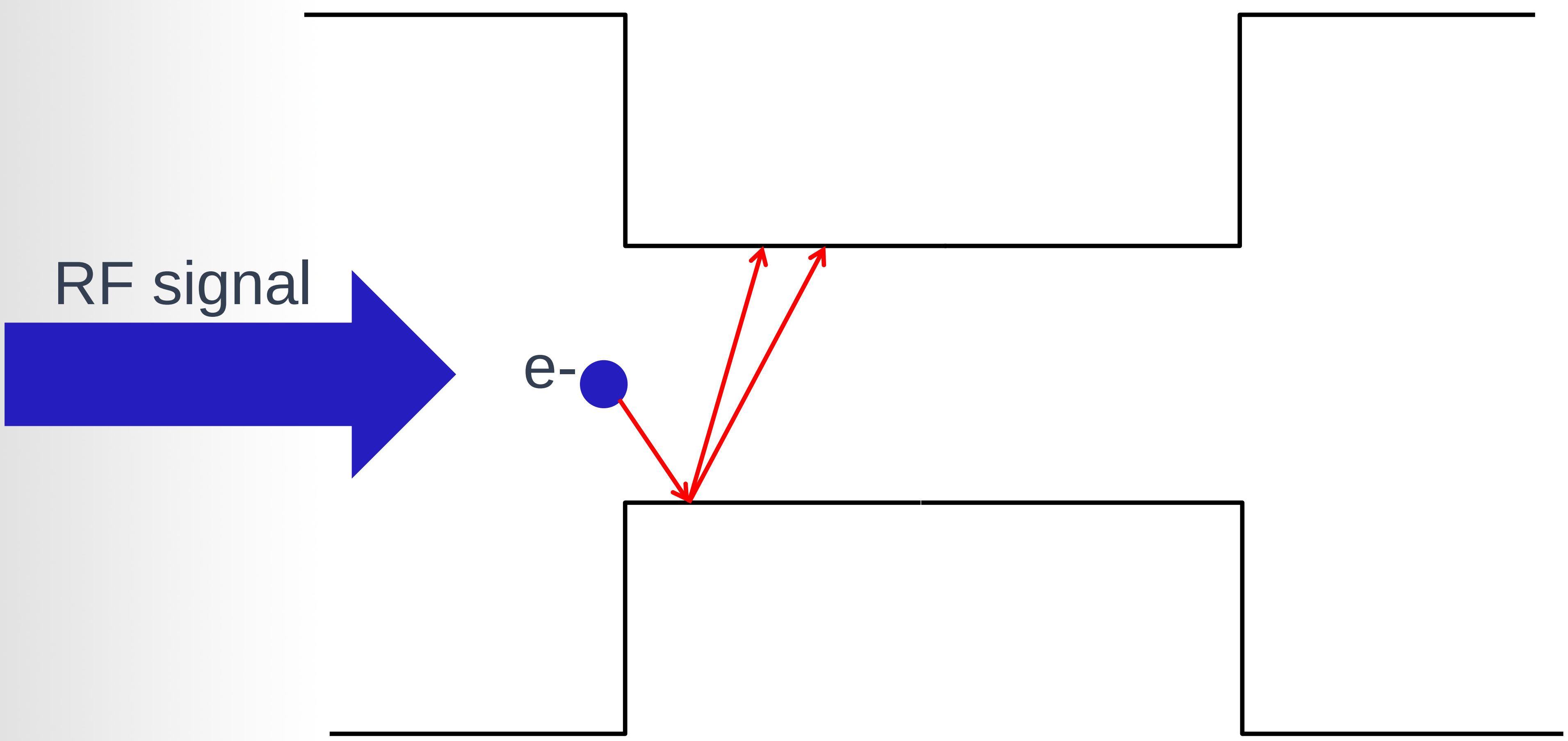

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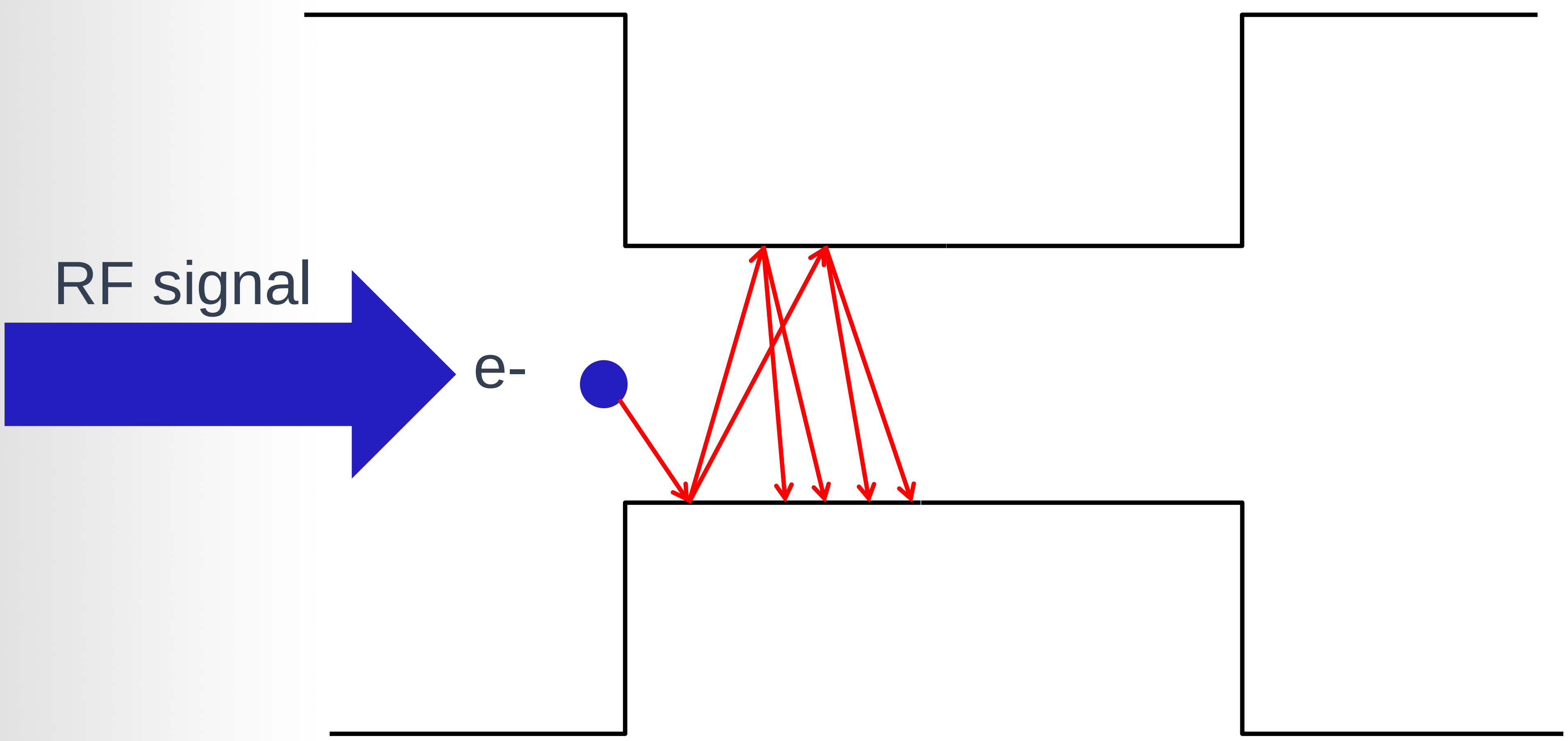

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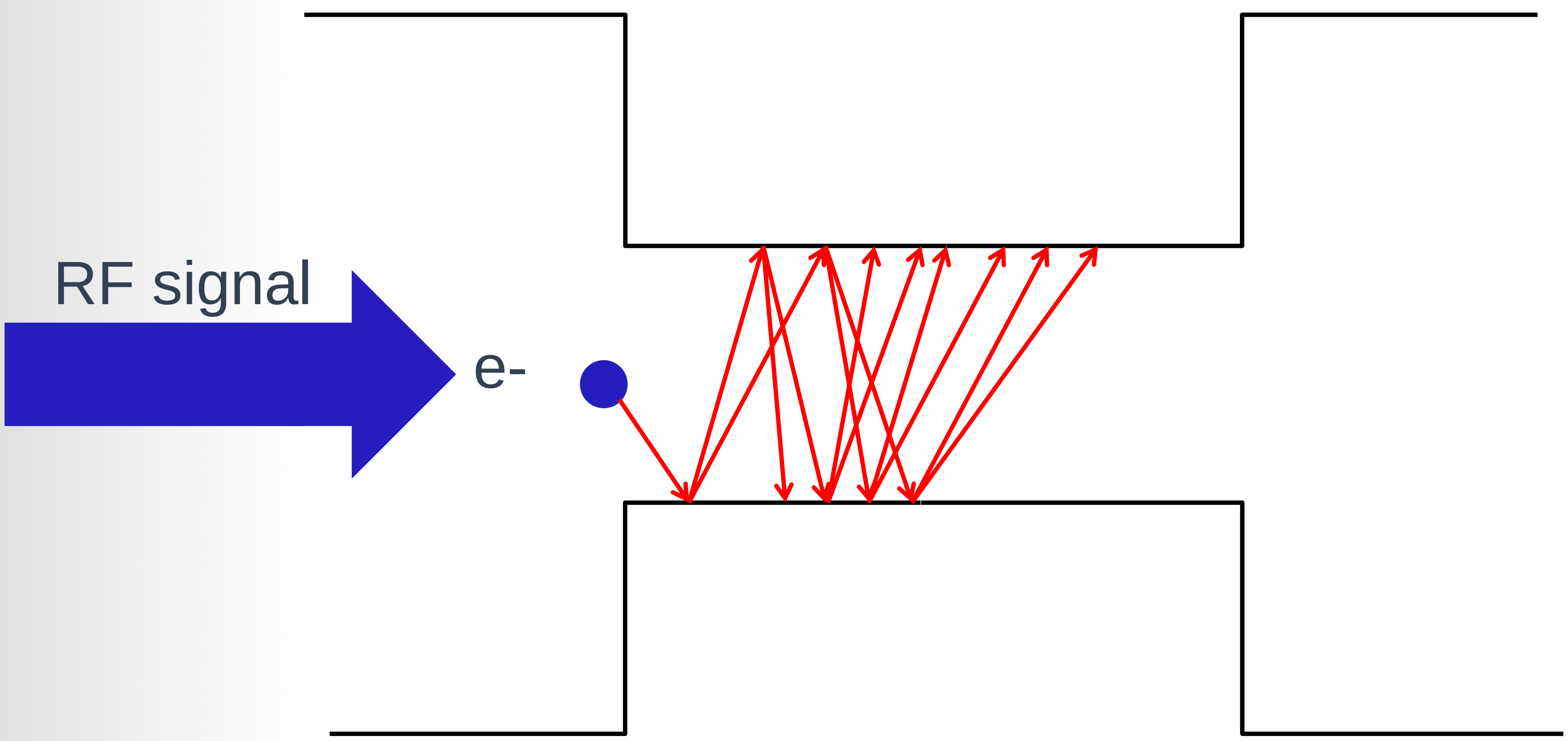

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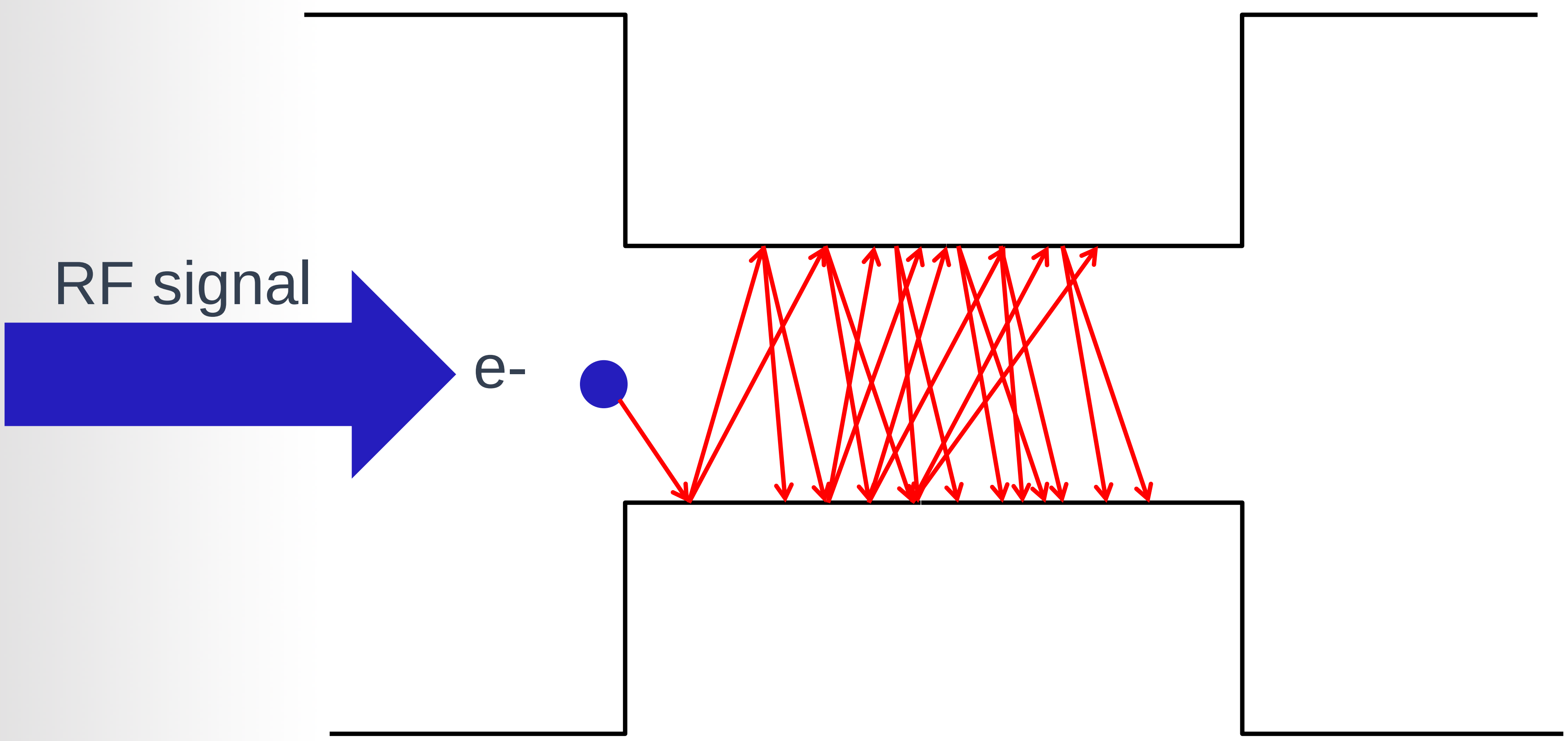


Consequences of the multipactor effect

- 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

Outline

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

Contractual context

- 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 plateform

Contractual context

- 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, …)

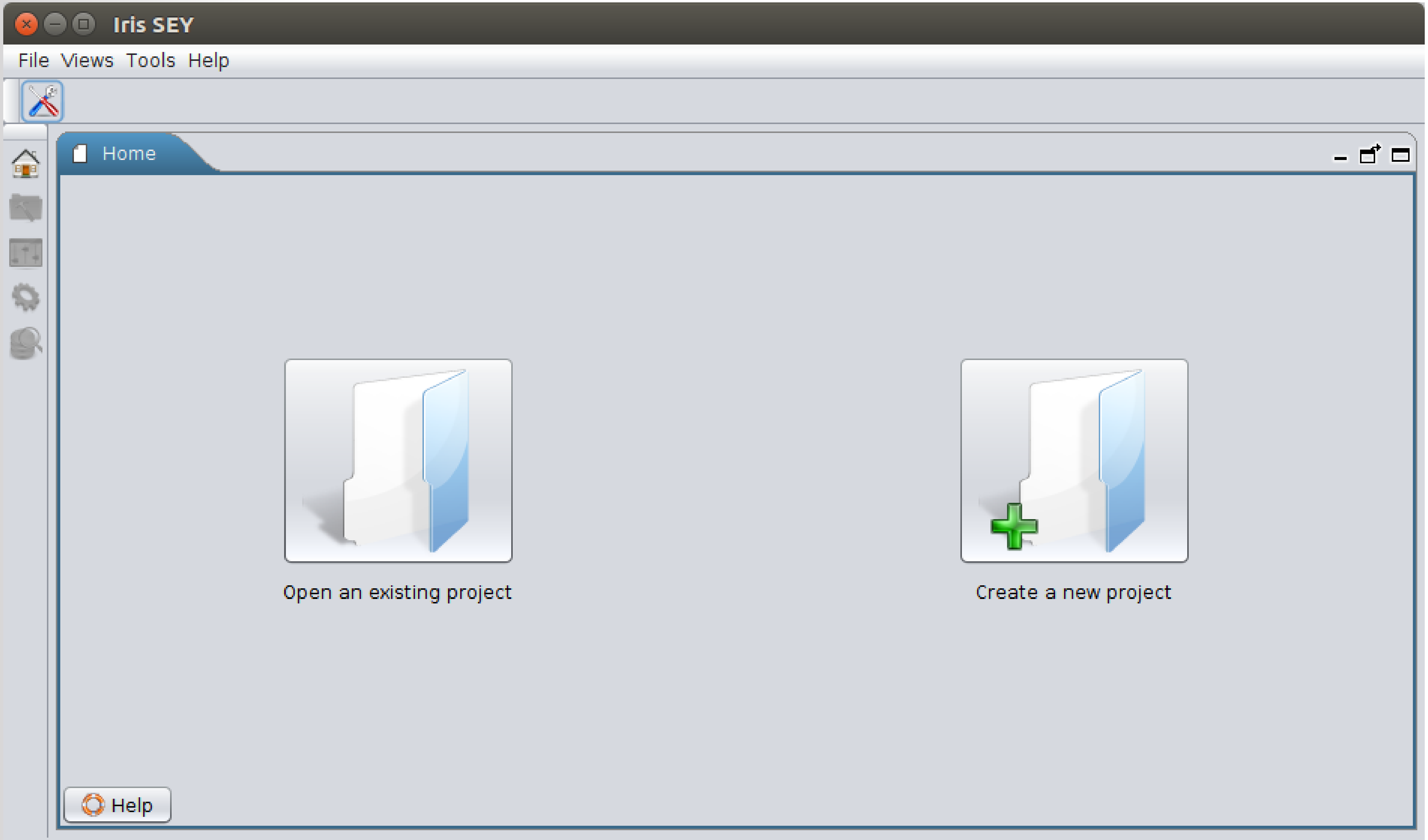
IRIS-SEY overview

- 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

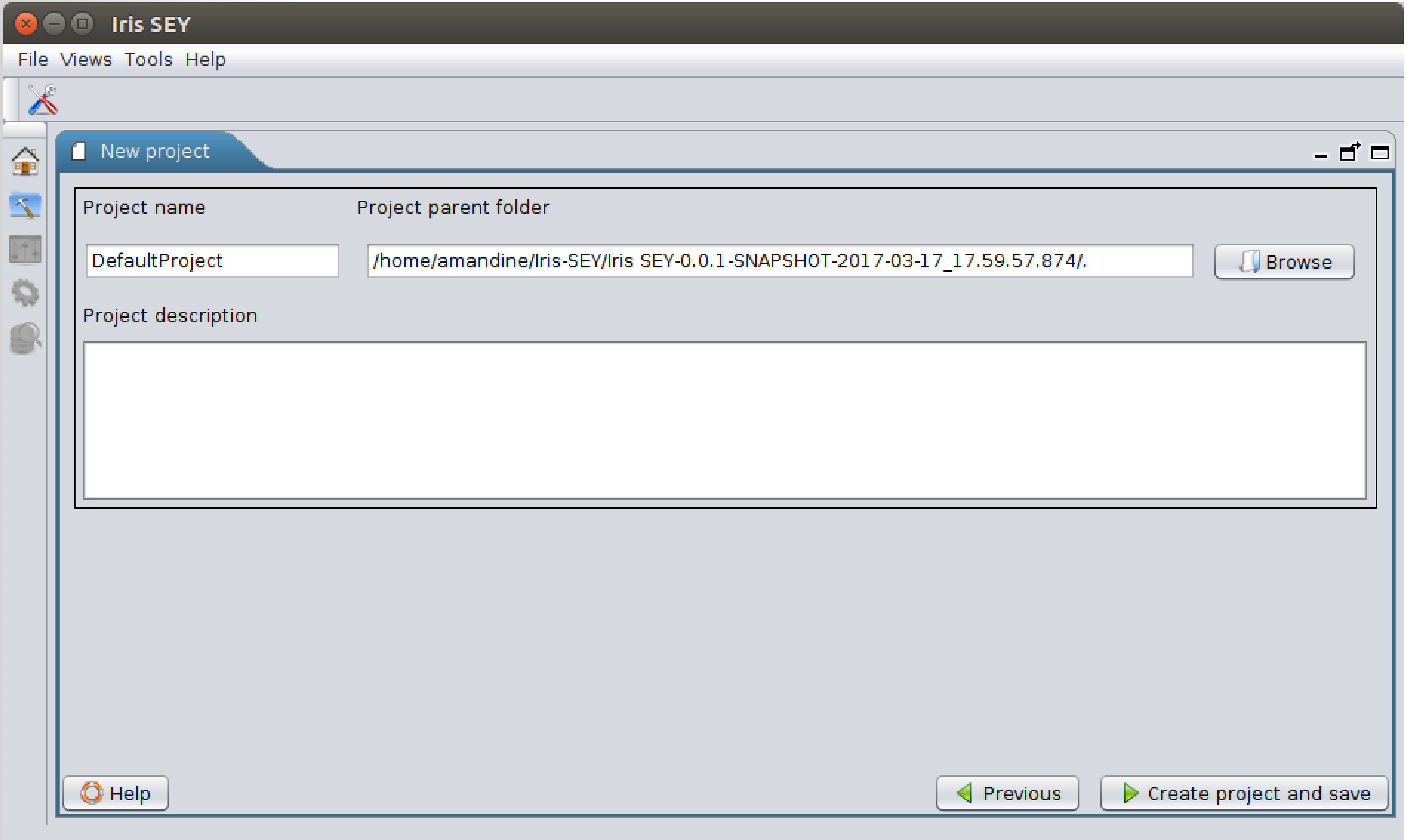
Main view perspective:

Create a new project OR load an existing one



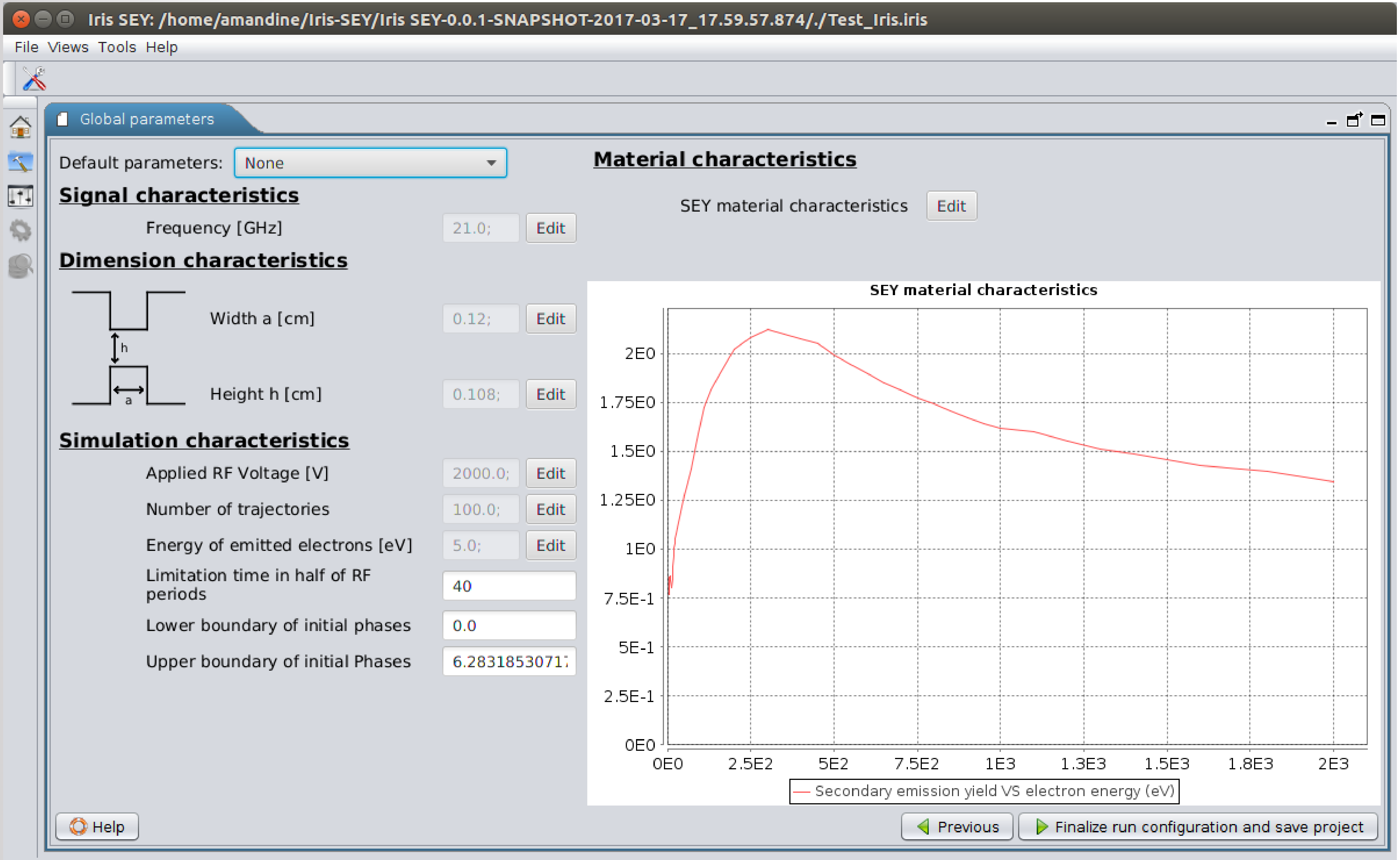
IRIS-SEY overview

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



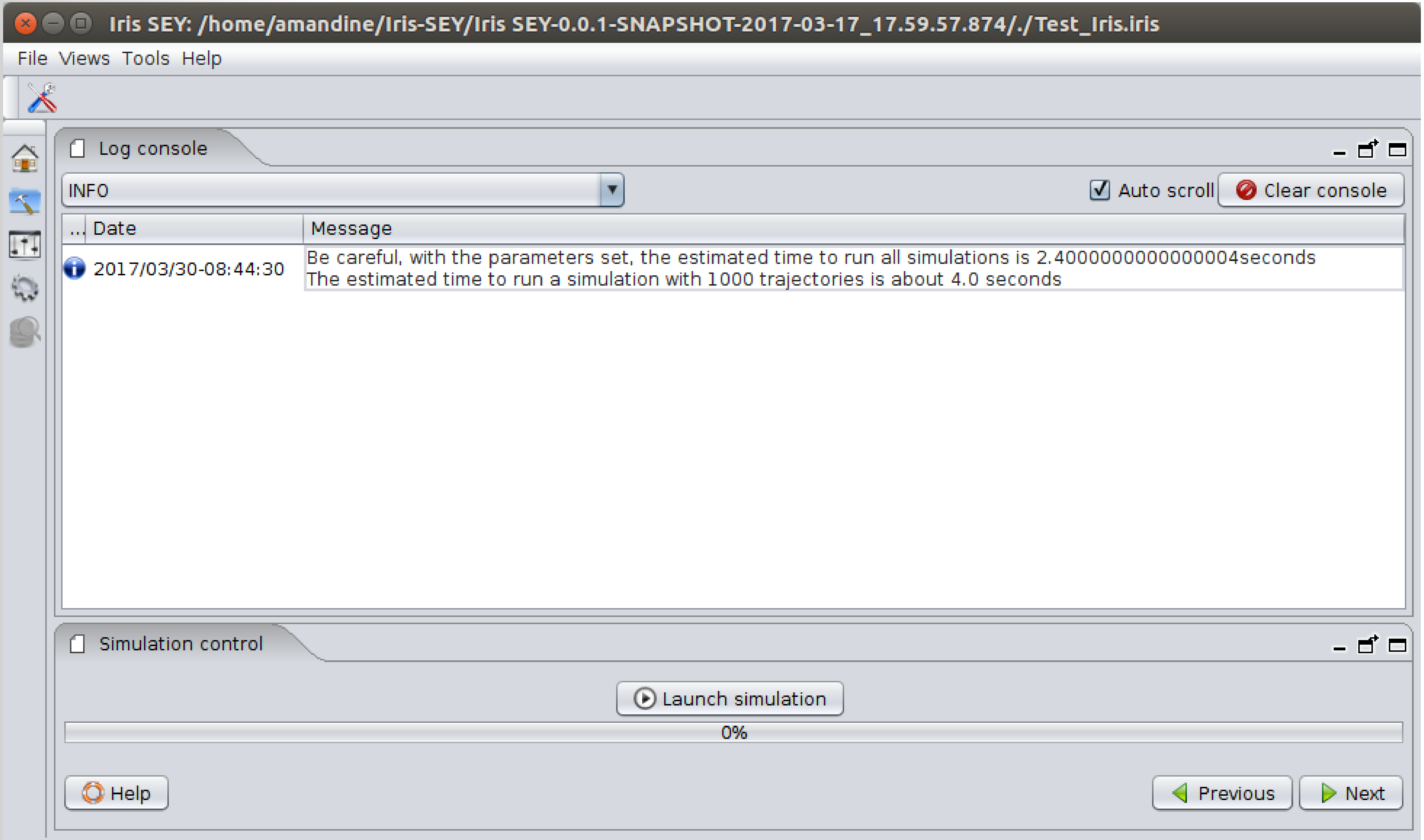
IRIS-SEY overview

Define the simulation input characteristics



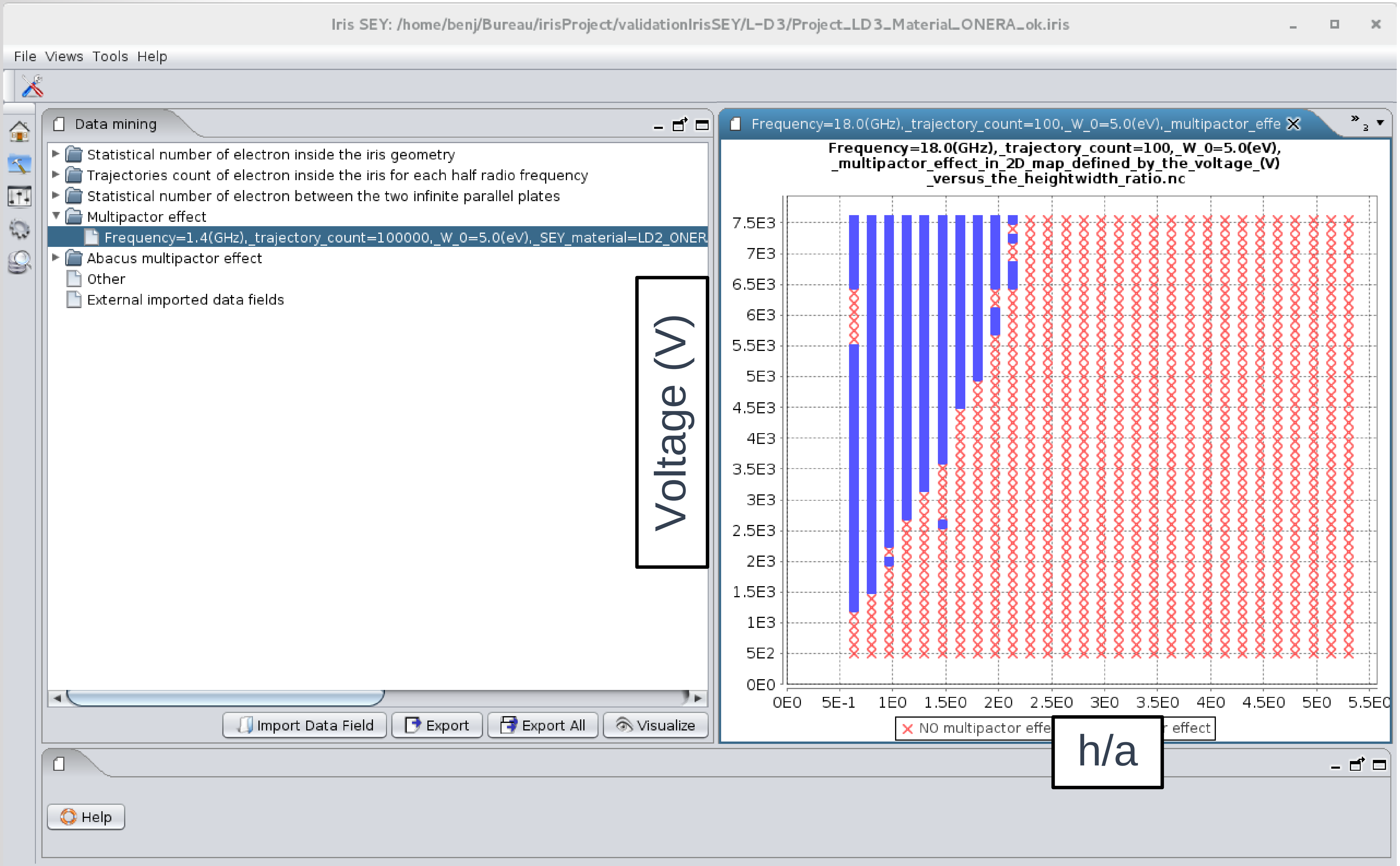
IRIS-SEY overview

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



IRIS-SEY overview

Visualization of simulation results



IRIS-SEY overview

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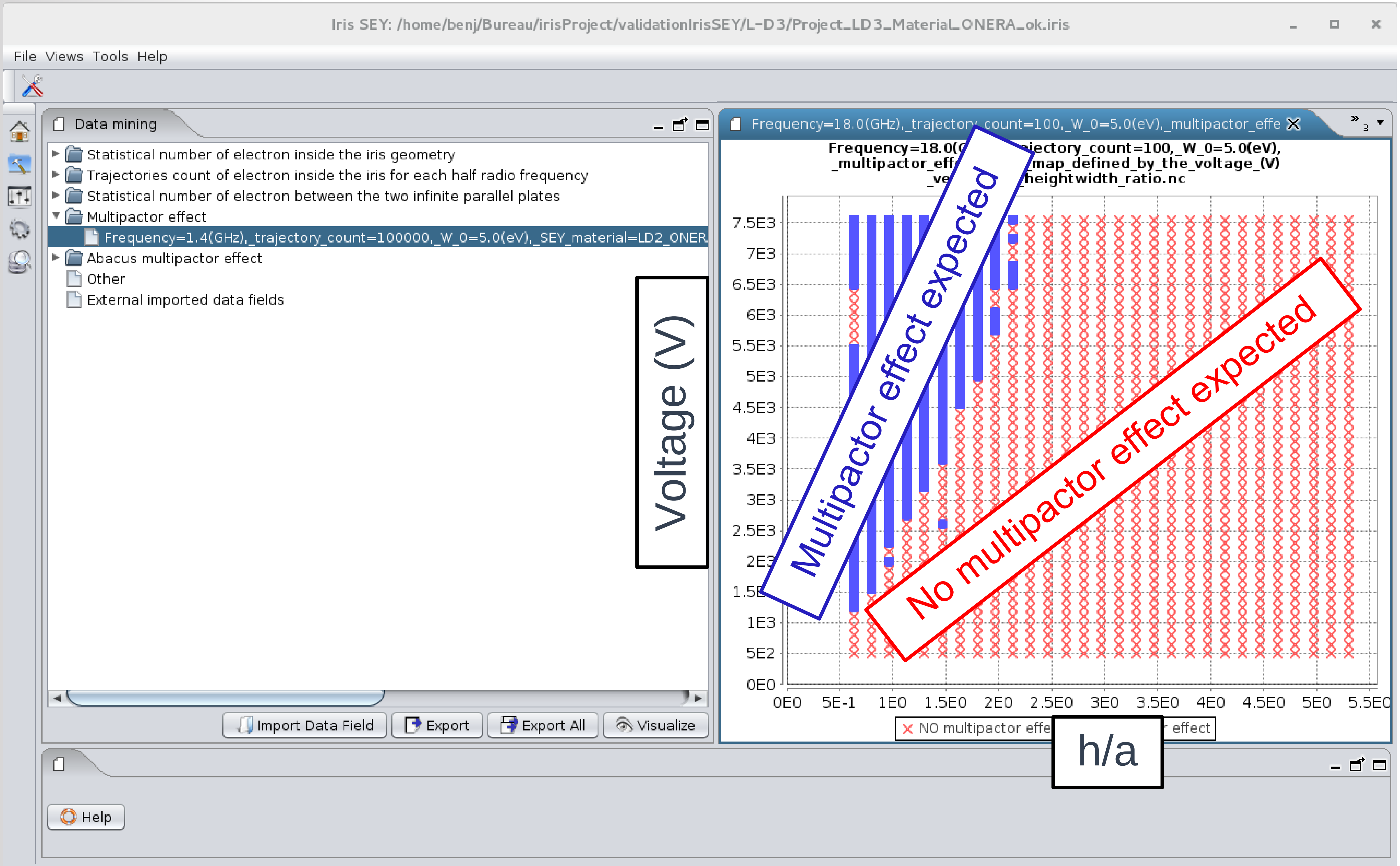
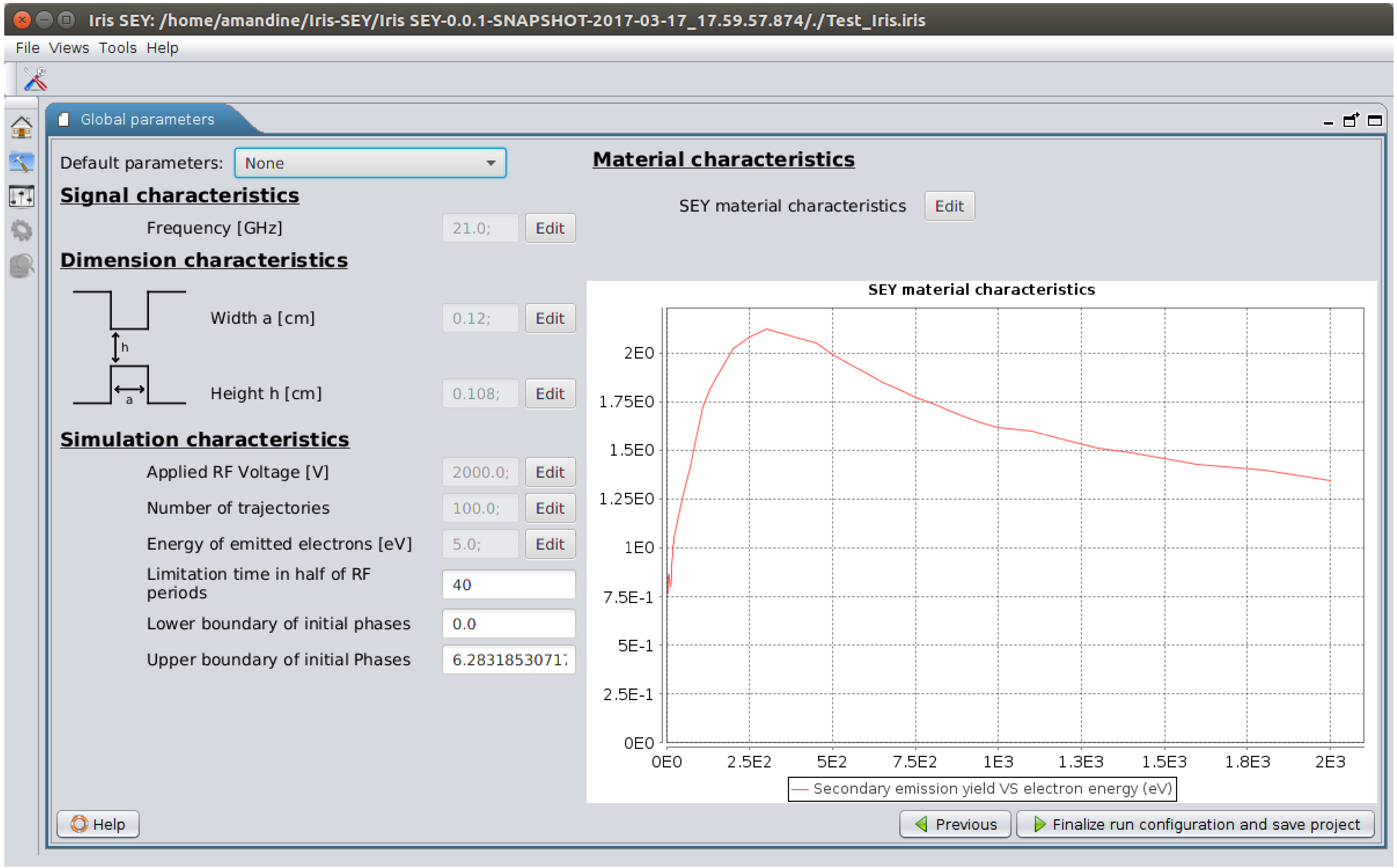


Notion of material properties in the multipactor context

- 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)



Conclusion

- 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