SPIS-GEO/MEO

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Artenum, ONERA, OHB-Sweden, Astrium

Objectives of the project

Scope

- ESA/ESTEC contract
  - Technical Officer: David Rodgers
  - Partners: ATRIUM, ONERA, OHB-Sweden, ASTRIUM
- Adaptation to industrial needs and MEO/GEO orbits constraints :
  - Improvements based on the existing SPIS software
  - Implementation of the highest-priority requirements identified in User Requirement WP
  - Excludes: software parallelisation and development of new solvers

Objectives

- Provide a version of SPIS adapted to engineering applications
- Simplified User Interface (wizard-based approach and predefined models)
- Support of new file formats used in the industry (STEP and GDML)
- Physical models adapted to MEO/GEO orbits and commercial space platforms
- Tested software against in-flight observations and existing codes

Keep the compatibility of SPIS-GEO with the standard SPIS version

- A new user interface will be plugged into the existing SPIS-NUM library: SPIS-GEO will be a different “execution mode” of the same software
- SPIS-GEO projects will be compatible with the standard version of SPIS
- All changes will be reversed to the standard version of SPIS

UI and framework evolutions

Automated modelling steps:

- Geometry files import
- Simulation mesh size control
- Thin wires and plates support
- Automated selection of particle current models and solver attributes
- Generation of output plots and exports

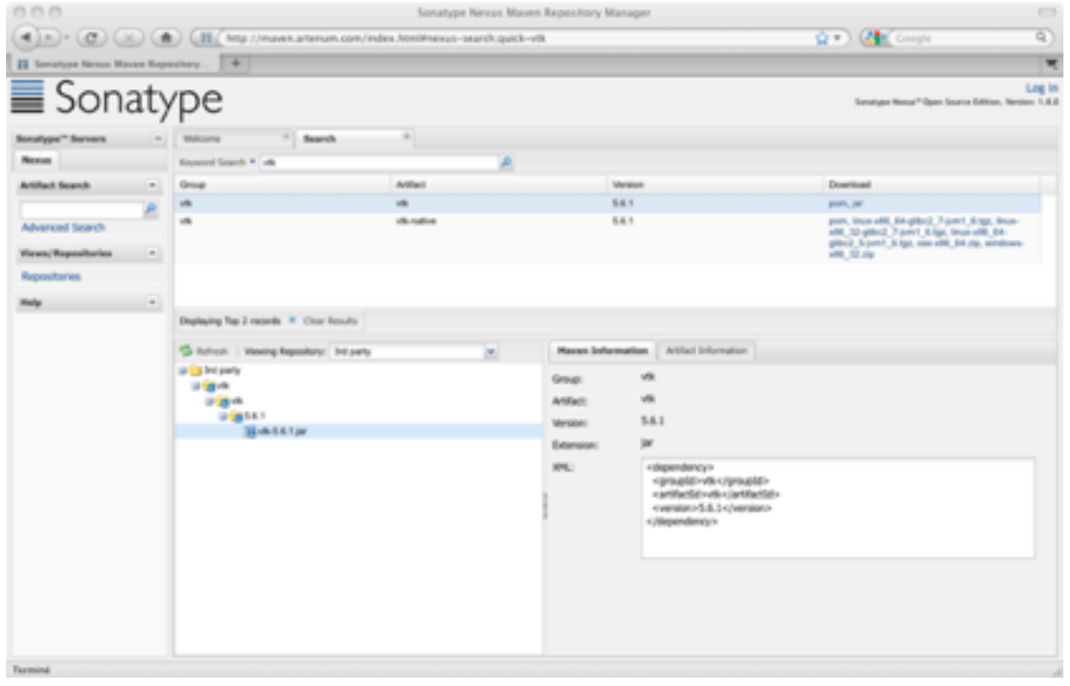
Simplified modelling steps:

- Standard materials and user-friendly definition of new ones
- Allocation of properties to groups
- Simplified plasma parameters definition and predefined worst cases
- Simplified definition of spacecraft circuit
- Solar array electrical behaviour
- Project saving, loading and batch running
- Introduction of wizards based approaches

Refactoring of the low level components

About 90% of the SPIS-UI framework components has been redeveloped

- Most of low level components fully redesigned
  - Following clean design paterns
- Fully Java based (no more Jython components at the low level)
  - Performences improvement
  - Better stability
  - More Homogenous
- Test-driven development chain based on a normalised continuous integration process (Maven, Hudson, Sonar)
  - Improved code quality and validation process
  - Simplify the software development process (including in the frame of the SPINE community)
  - Simplify the deployment (e.g dependencies management)
  - JUnit based regression tests chain
- Use of industrial standards
  - OSGI/D-OSGI
  - Felix Apache
  - VTK



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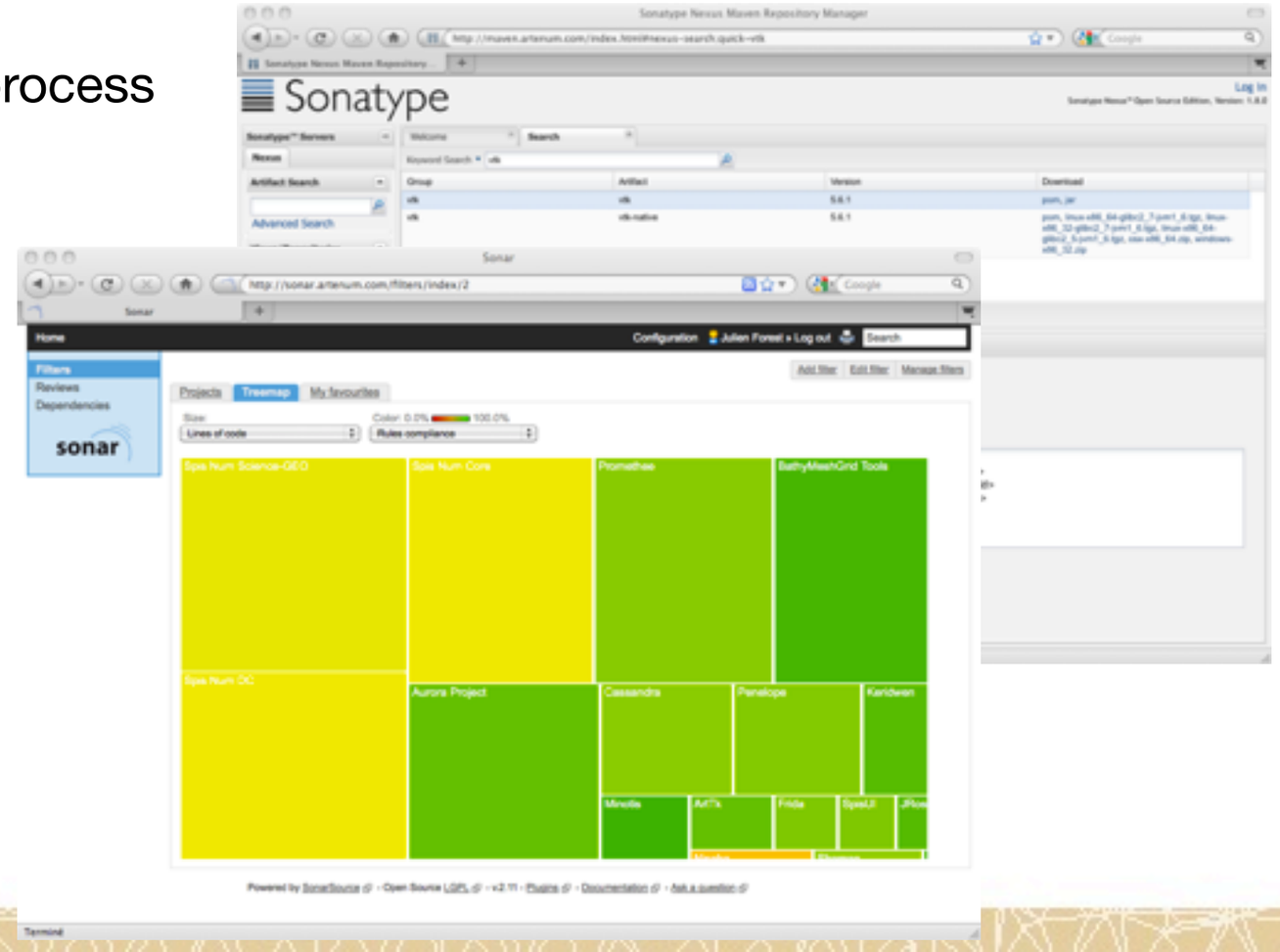

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Keridwen: a new framework

A new generic Artenum's Integrated Modelling Environment (IME)

- Modular (bundles replace Spis Tasks)
- Fully Java
- OSGI based (industrial standard)
  - For a better future inter-operability with other tools
    - G-Eclipse
    - ESA-Base
    - ...
  - For future distributed architecture (client/multi-servers) using D-OSGI
- Data model generation using XML model description
- Generic data storage & persistence
- Messaging system
- Evolutivity
- Integrated 3D meshing tools (Penelope, GMSH)
- Integrated visualization tools (Cassandra, VTK)
- 3D modelling tools (Open Cascade)
- Use of your business codes
- Find what your looking for easily (data mining tools)
- Multi-physics
  - Aperture toward other communities
  - Community critical mass increase for non tailored components

KERIDWEN
INTEGRATED MODELLING ENVIRONMENT

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New mesh capabilities

Introduction of Penelope

- Improved performances
  - Memory cost
  - I/O and processing time
- Dynamical management of mesh elements (needed for the mesh splitting/modification/ editio,n
- Full Java based support of DataFields / MeshMasks (i.e old Data/Fields mesh fields)
- Dynamical mesh structure extension/modification
- XML based persistence scheme (and in future NetCDF)
- Fully support of Gmsh file formats evolutions
  - Format V2.0
  - Support fields deployed on the mesh
  - Other mesh file formats
- Include a Java wrapping of Gmsh
  - Better data exchange
  - Better integration of Gmsh into Keridwen
  - Reversed to the Gmsh community -> part of the Gmsh dynamics

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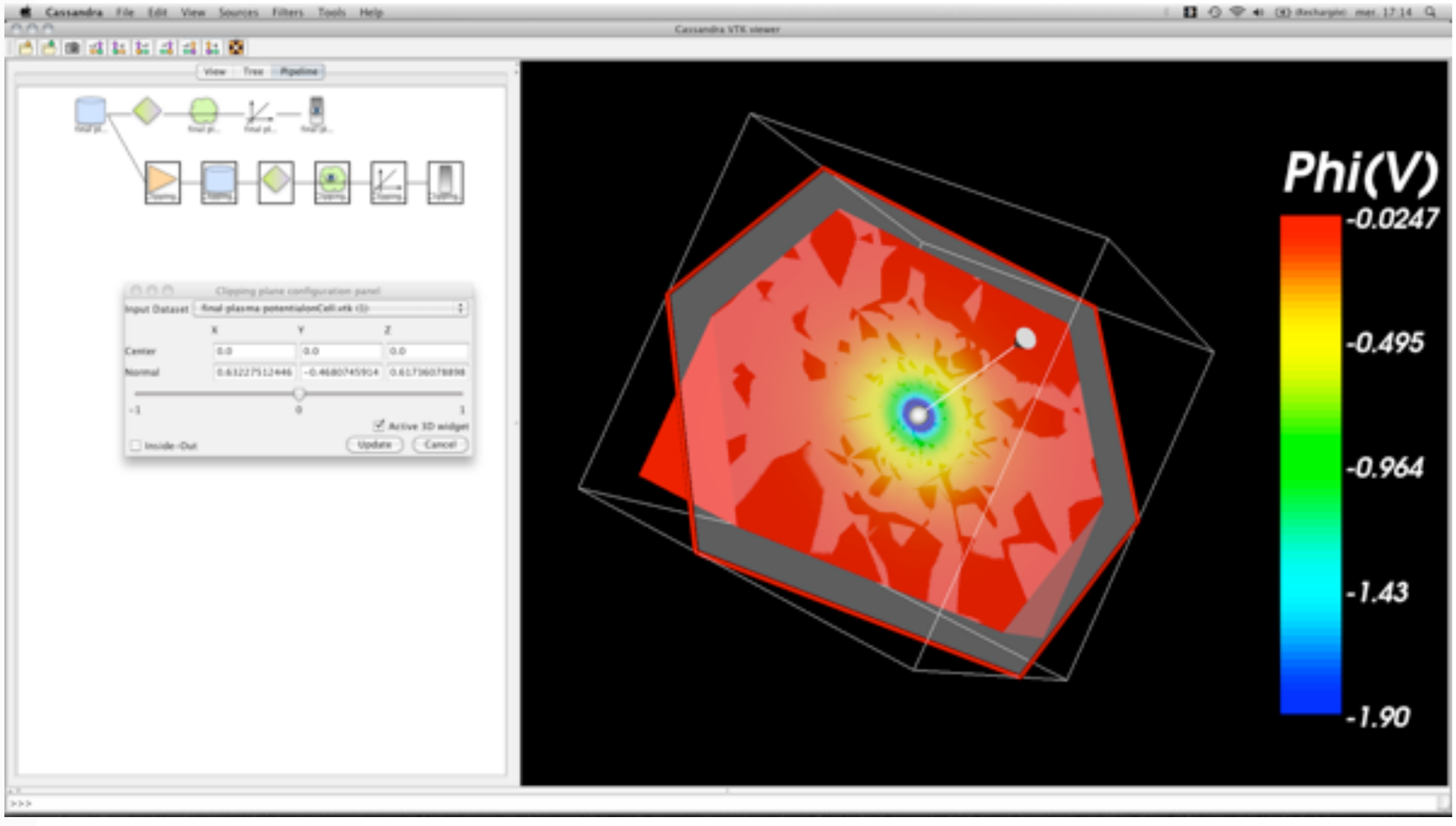
Post-processing: Cassandra

An easier to use tool

- More filters
- 3D widgets to control filtres
- Better GUI interactivity



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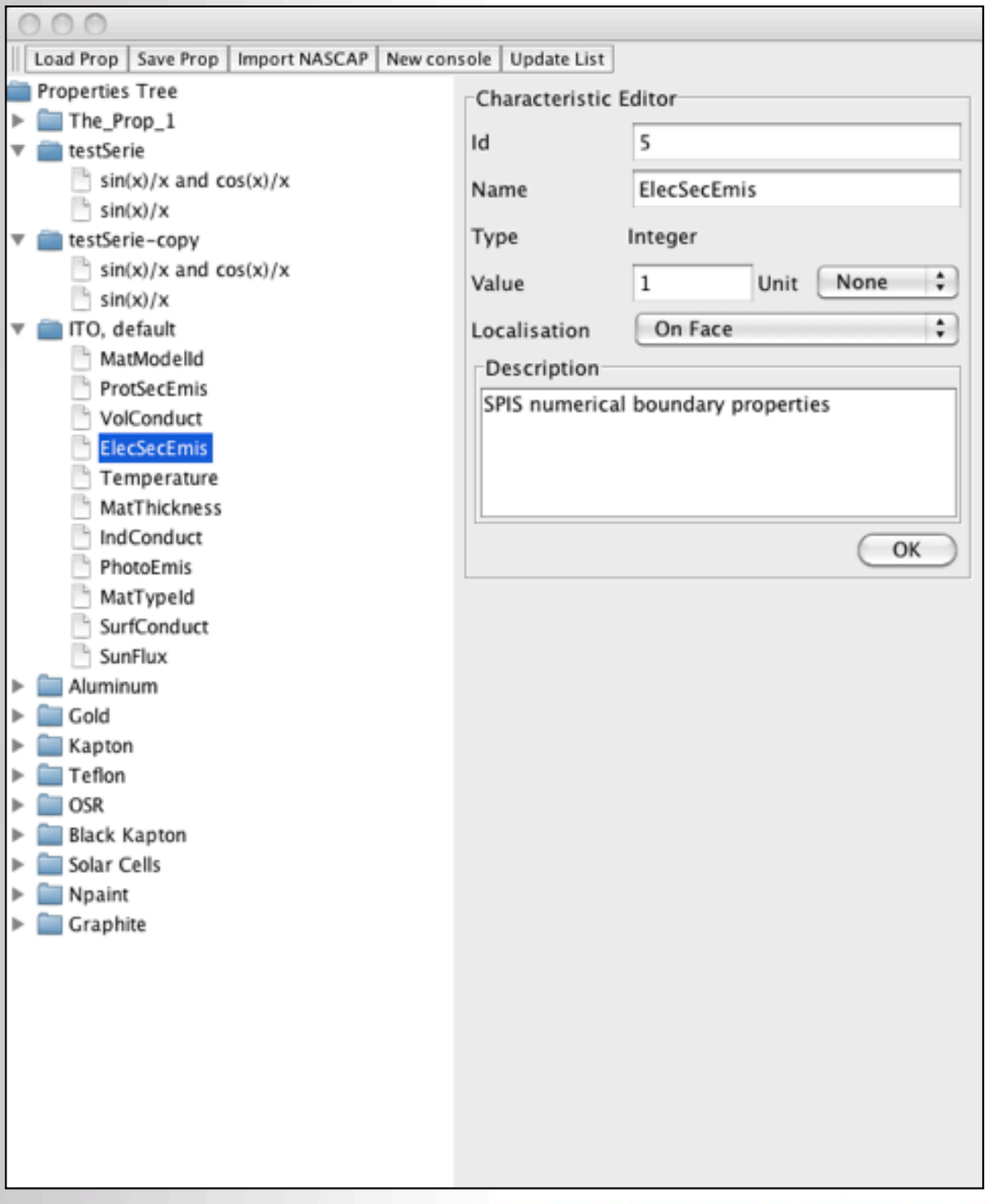
Frida: properties settings



Full new library for properties editions and settings

- More homogenous and self-consistence managment of properties
- Generic
- Easier to use: No more drama in the properties settings and groups editions in SPIS-UI!
- Fully XML based persistence Scheme
- Compliant with existing SPIS-UI and NASCAP material characteristic format
- More type of data supported, wit more physics
  - Tabulated data
  - Multi-dimensionnal data

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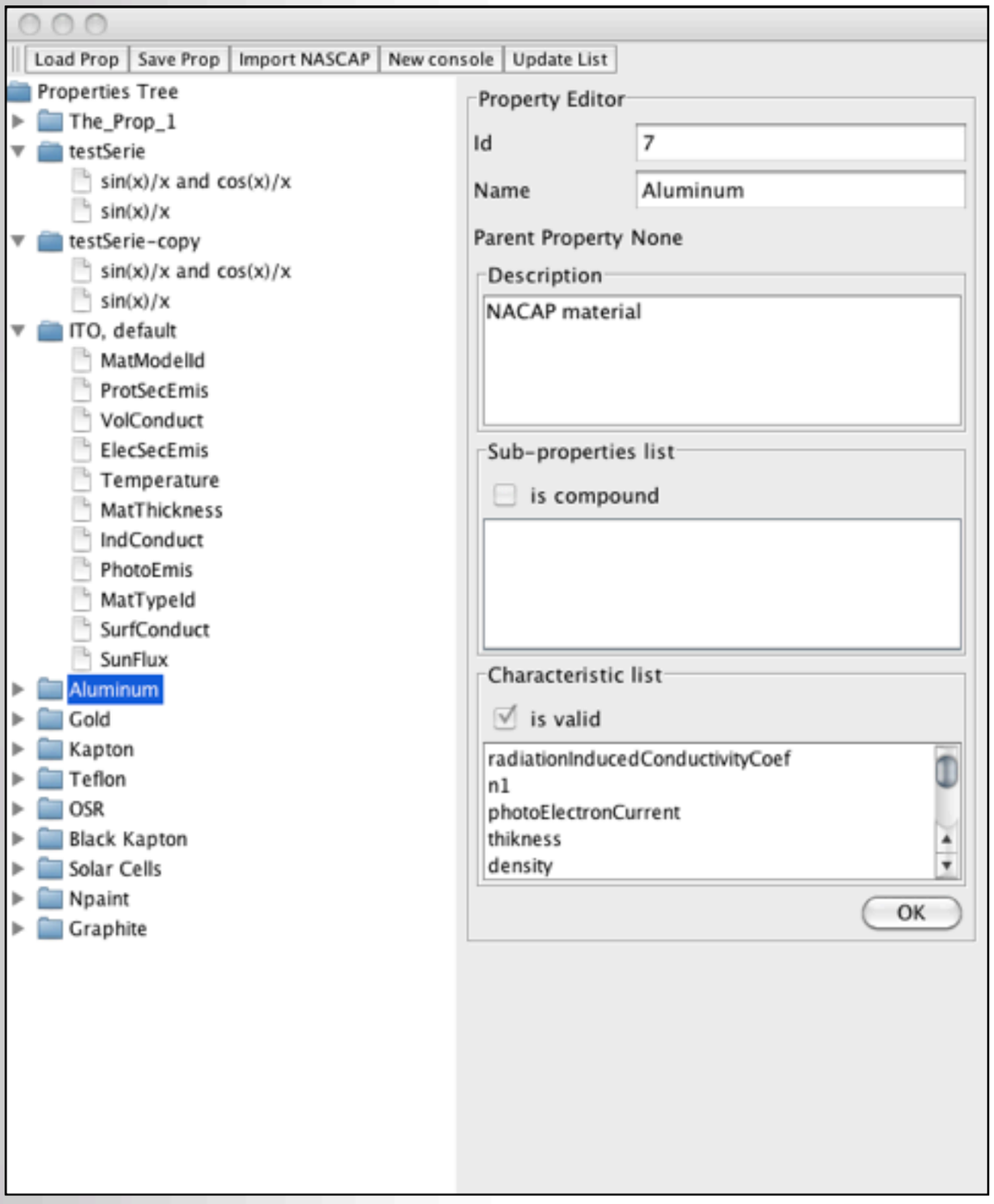

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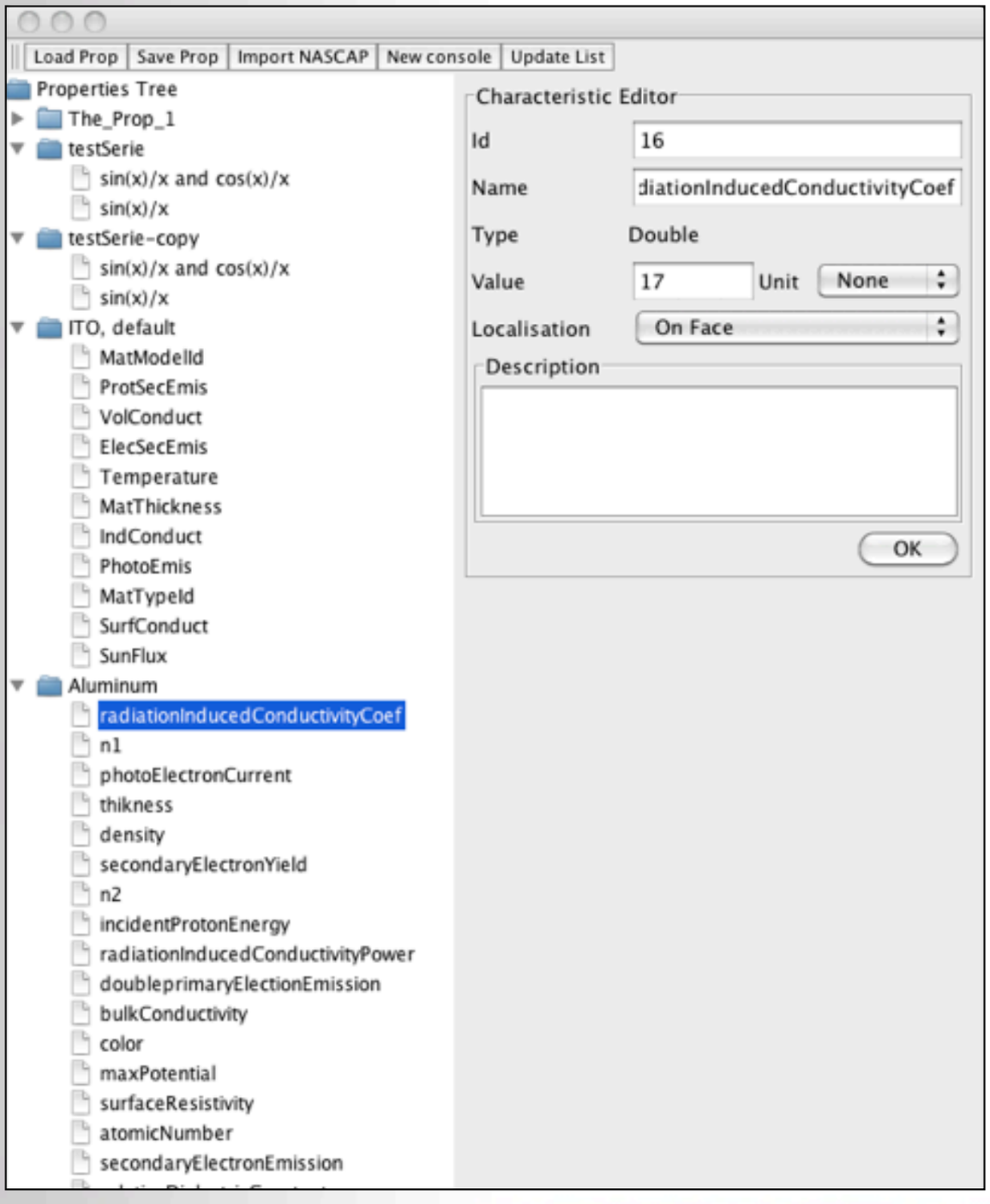

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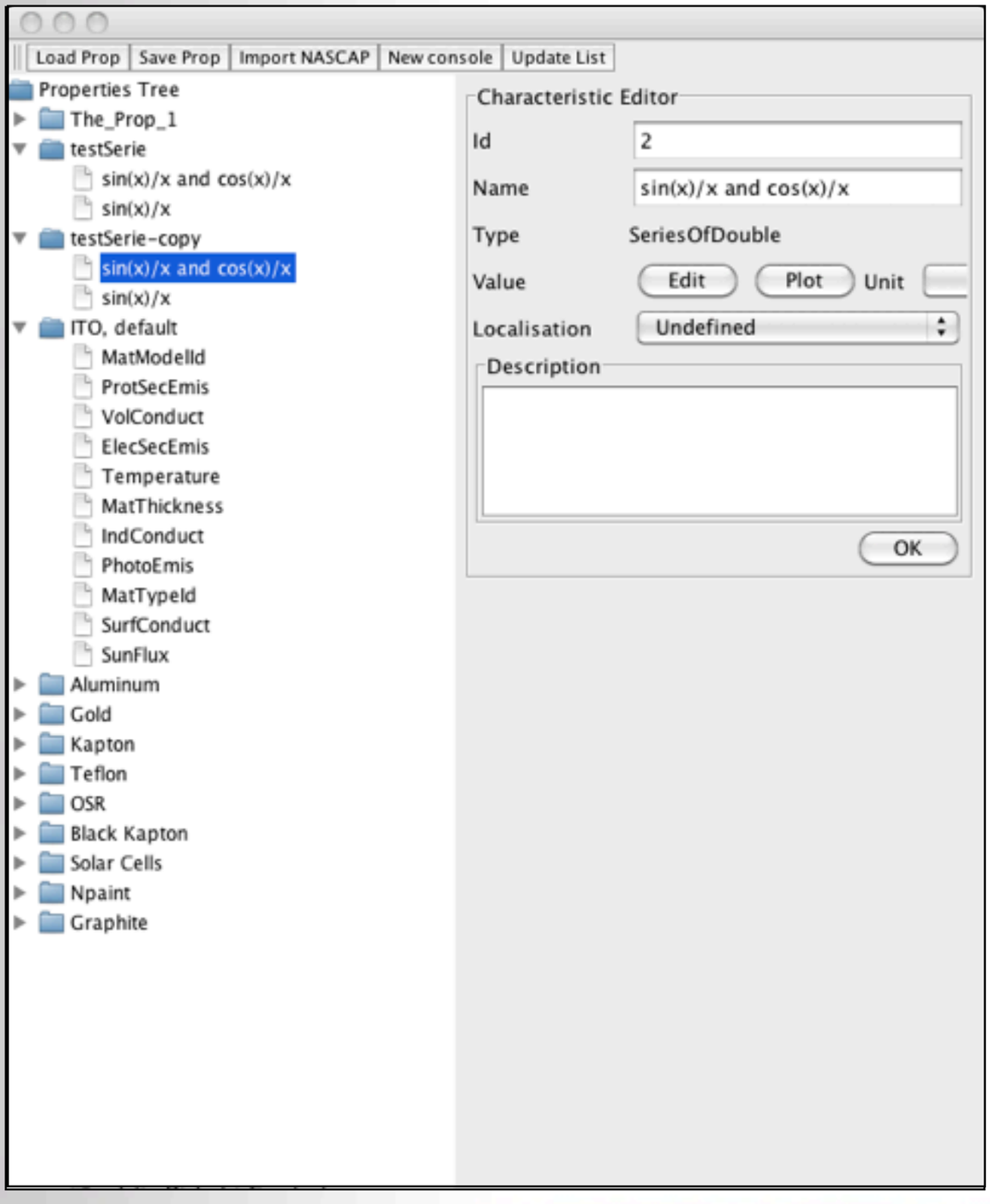

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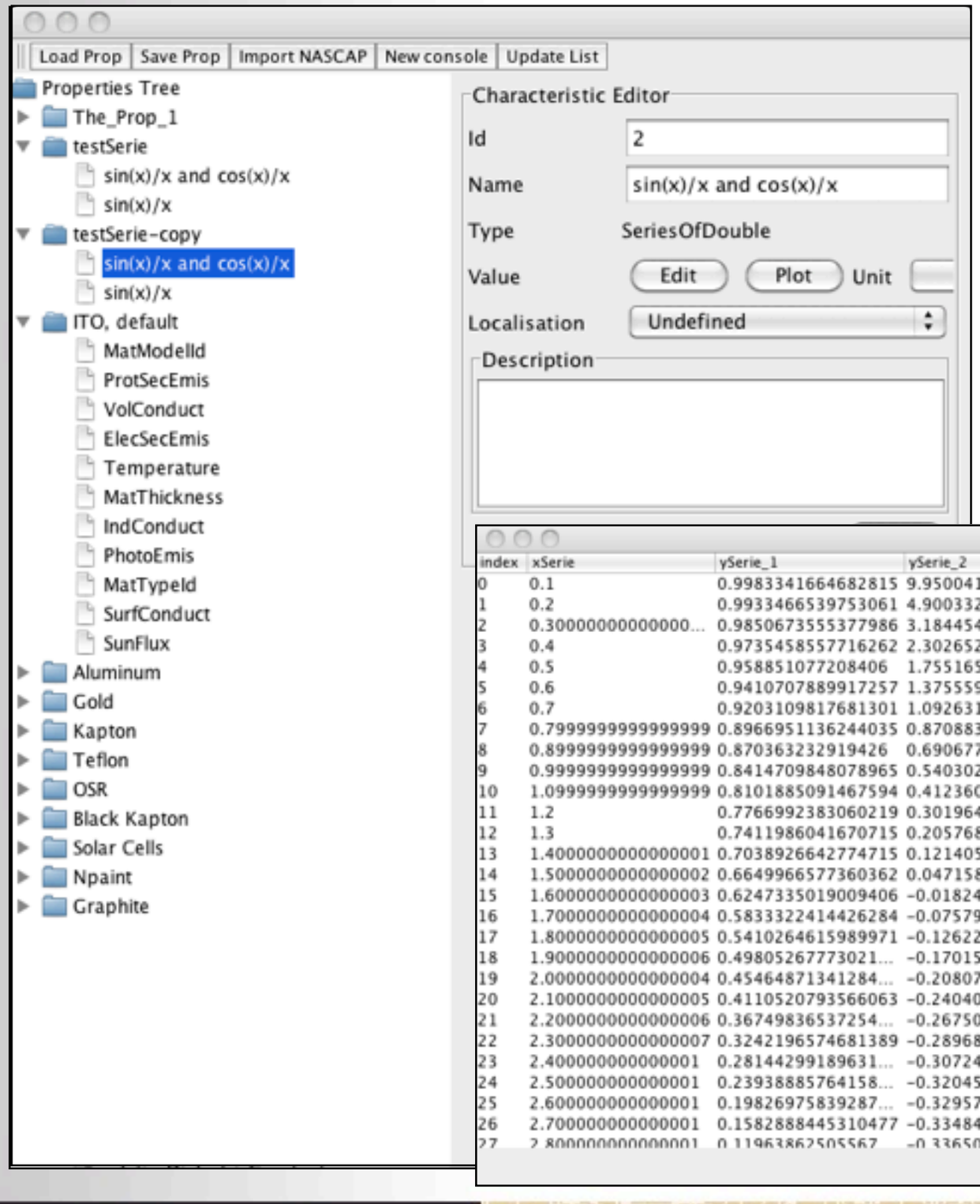

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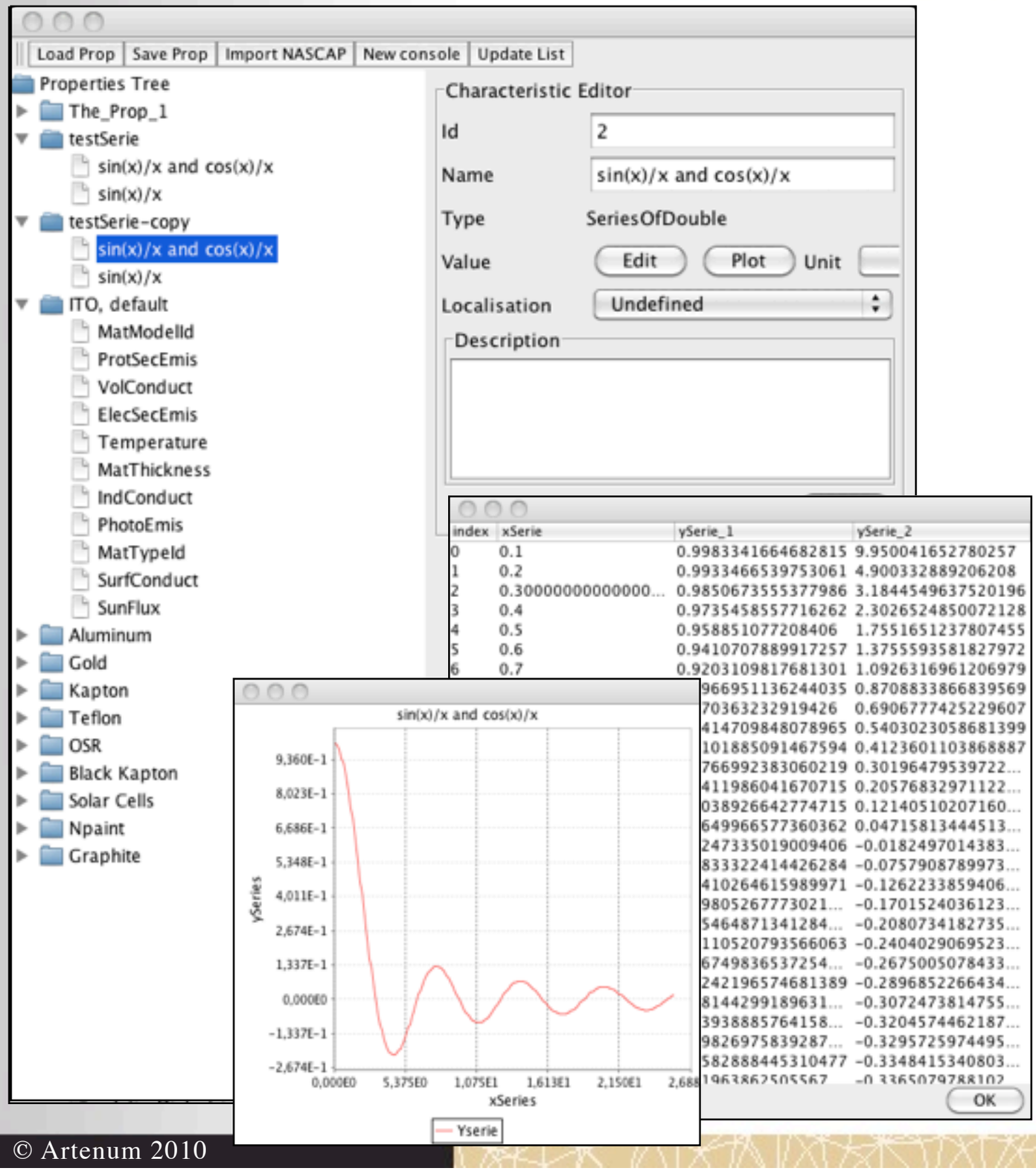

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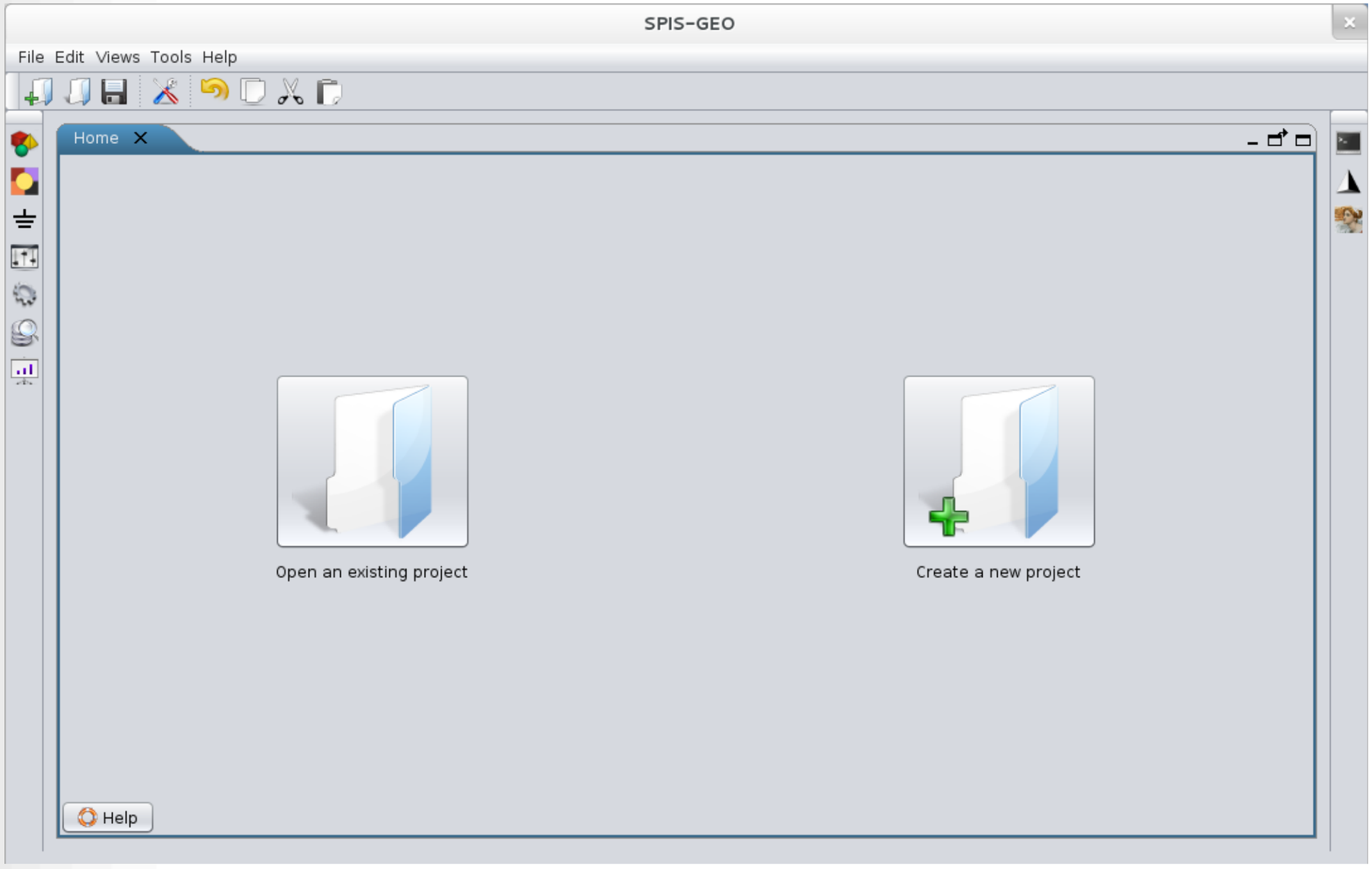
A first integration

A wizard and project based simplified GUI



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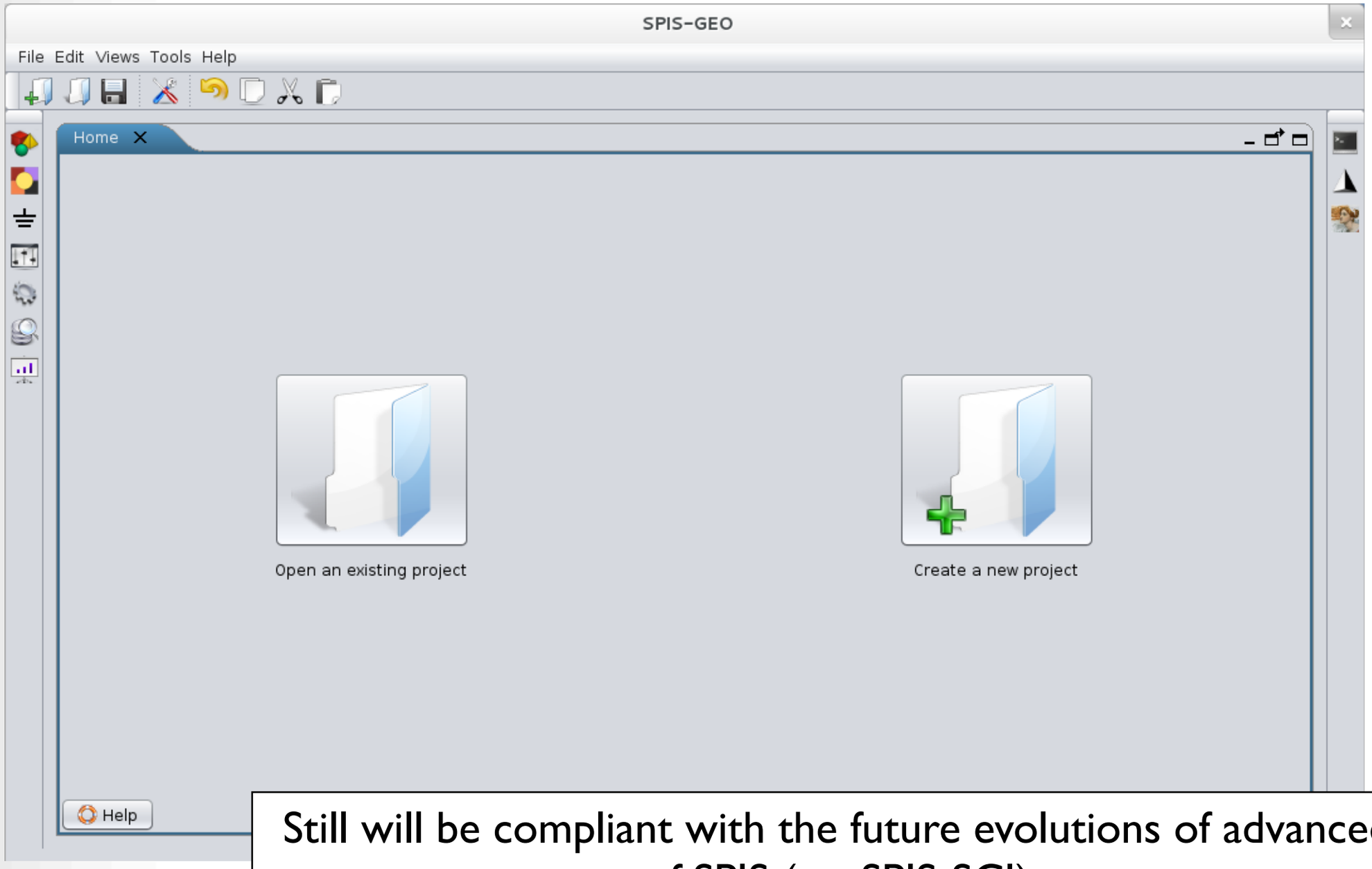
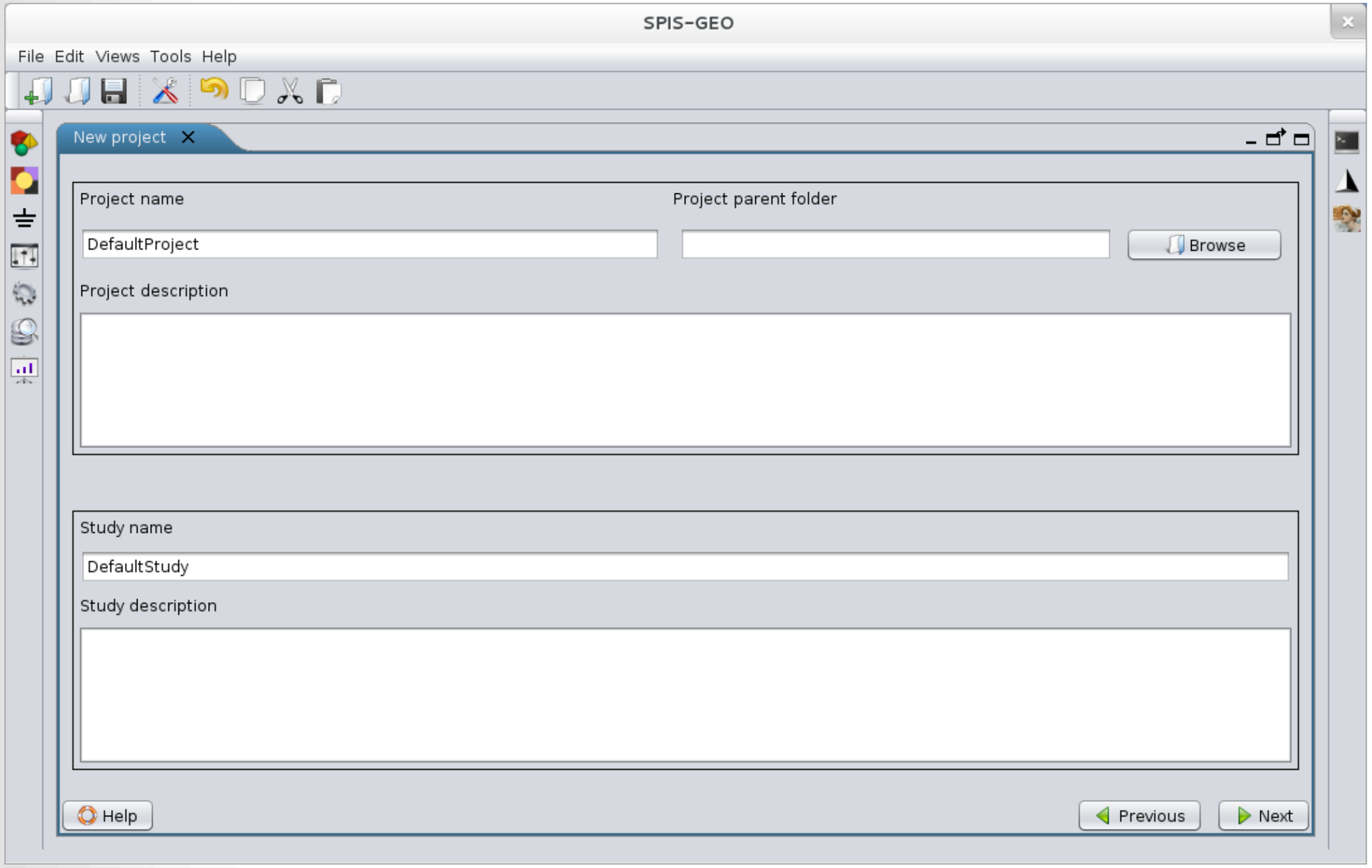


Still will be compliant with the future evolutions of advanced of SPIS (e.g SPIS-SCI)

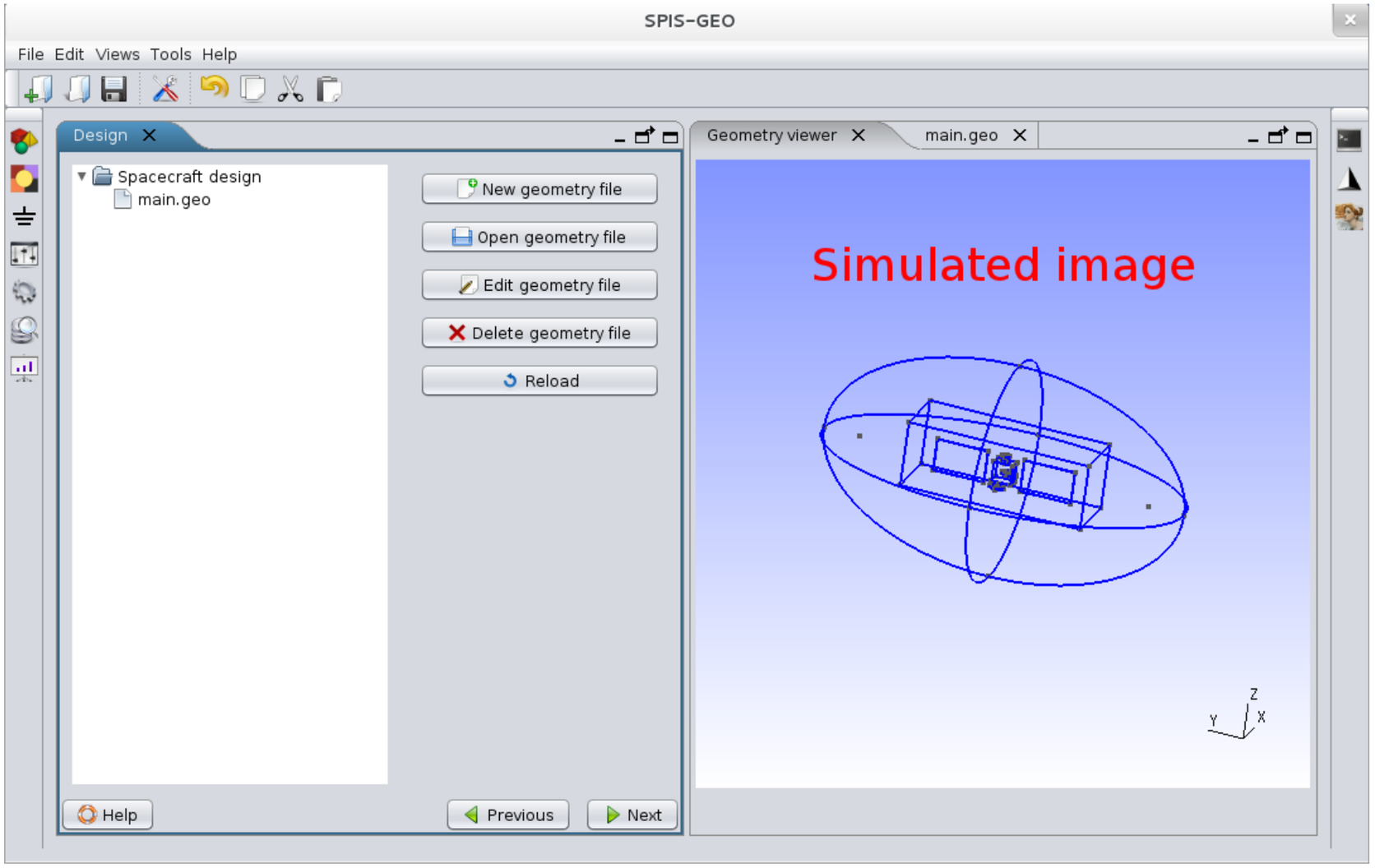
A simplified GUI



Better CAD tools integration

Better integration of CAD tools and groups edition

- A lot of intermediate processing and non-tailored steps hided
  - groups conversion
  - fields mapping
  - ...
- Better integration of Gmsh
- Better WISIWIG approach
- Better control of the meshing tool
- Basic STEP file format import facilities (Gmsh OCC plugin)



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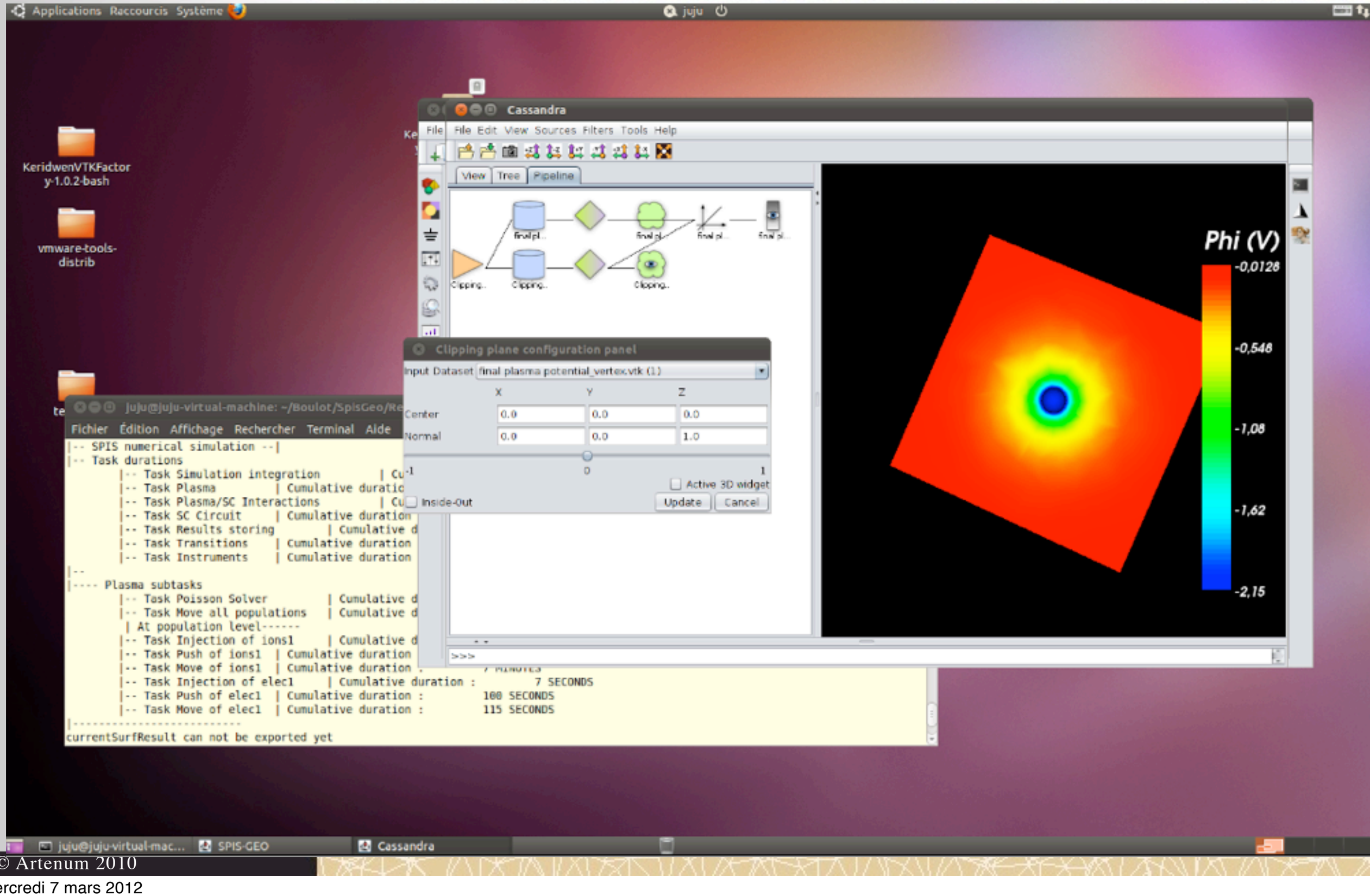
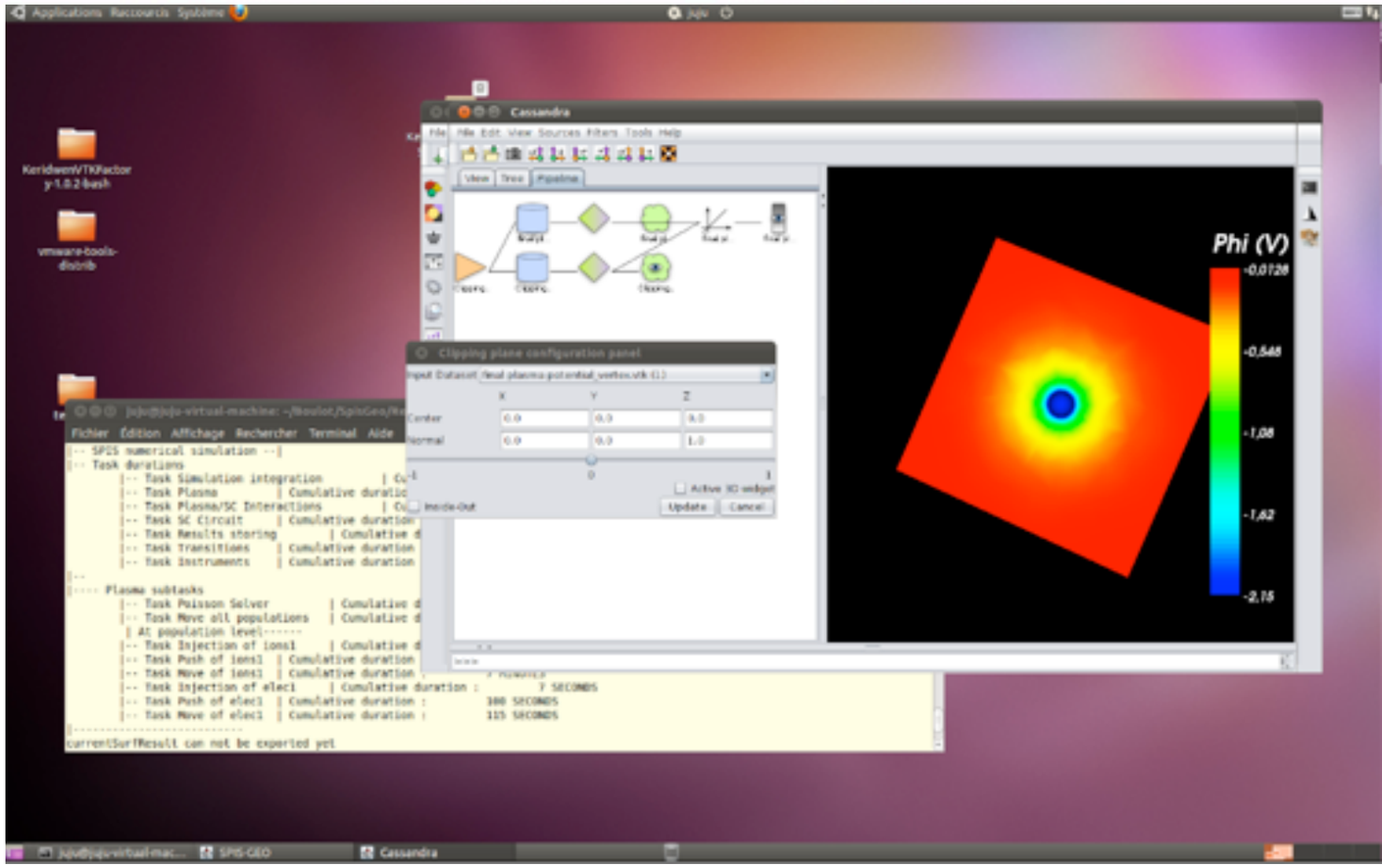
Kernel integration



Kernel integration

Last version of SPIS-NUM kernel has been integrated

- Full compliance with Penelope
- Input/output DataField
- Possibility to import existing projects (through DataField)
- Simulation output recovering
  - Improved performances
    - Faster data extraction and conversion
  - Improved data-mining in replacement of the current «DataField Manager» (under integration)
- Improved interfacing with SPIS-NUM
  - better control
  - better monitoring (not done yet)
  - Allow the introduction

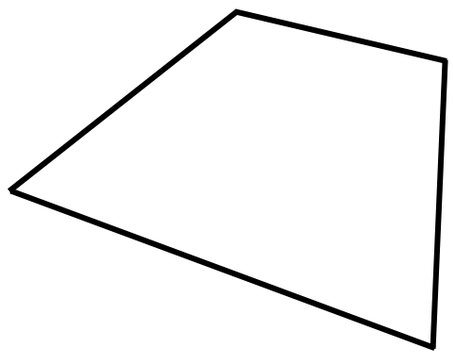


New features: mesh splitting

Mesh splitting

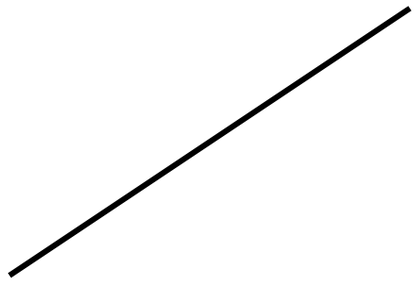
- Needed to model with good performances
  - solar panels
  - antennas
  - instruments (SPIS-SCI)
- Specific pre-processing needed to use dedicate SpisNum models
- Necessity to introduce hypothesis and models to pass from «3D» to «thin 2D» models
- Necessity to modify the mesh by «crack it» in order to split the mesh elements corresponding to the thin elements
  - Deep modification of the mesh library: JFreeMesh -> Penelope

Solar panel



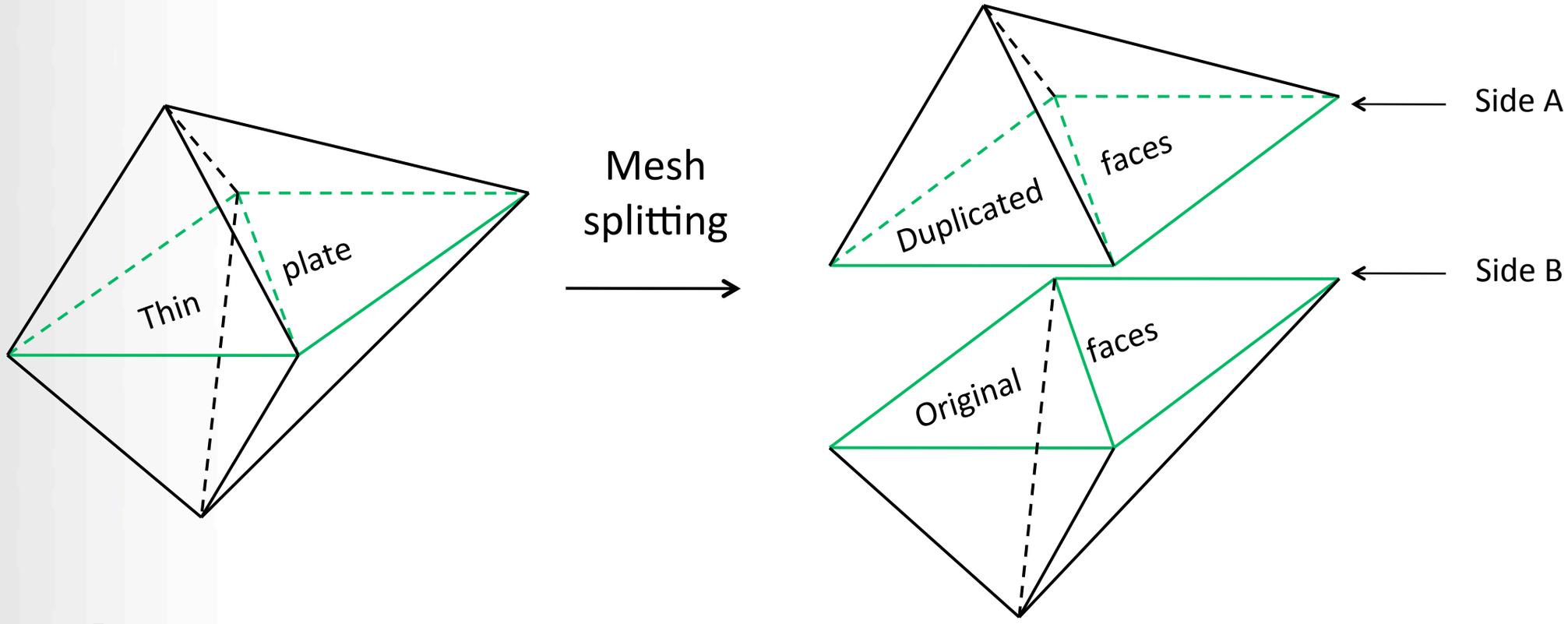
Thin plate

Antenna



Wire

Mesh splitting principle

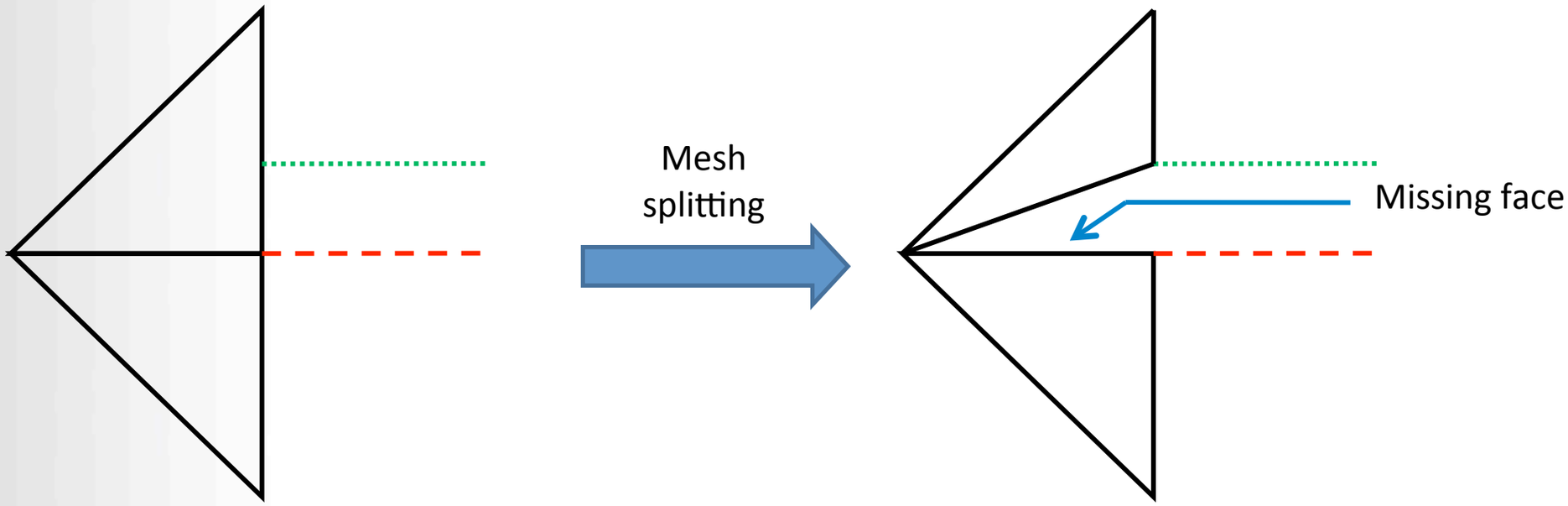


Requires to:

- Identify the elements being split, i.e the thin surface
- Identify both sides
- Duplicate elements on the thin surface
- Re-build the connectivity for elements belonging on the split elements
- Identify and re-build on the boundaries of the surface
- Deploy identification fields and tags needed by SPIS-NUM

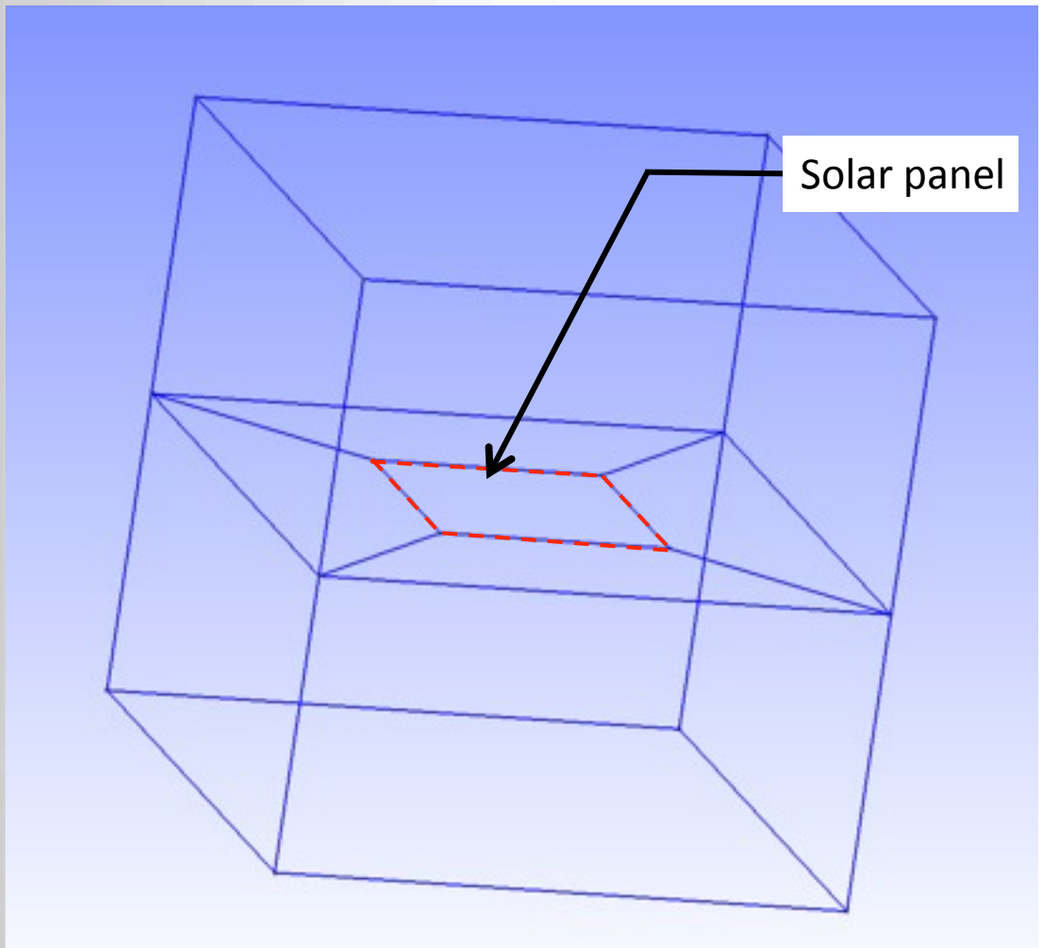
Mesh splitting

Specific case of boundary elements

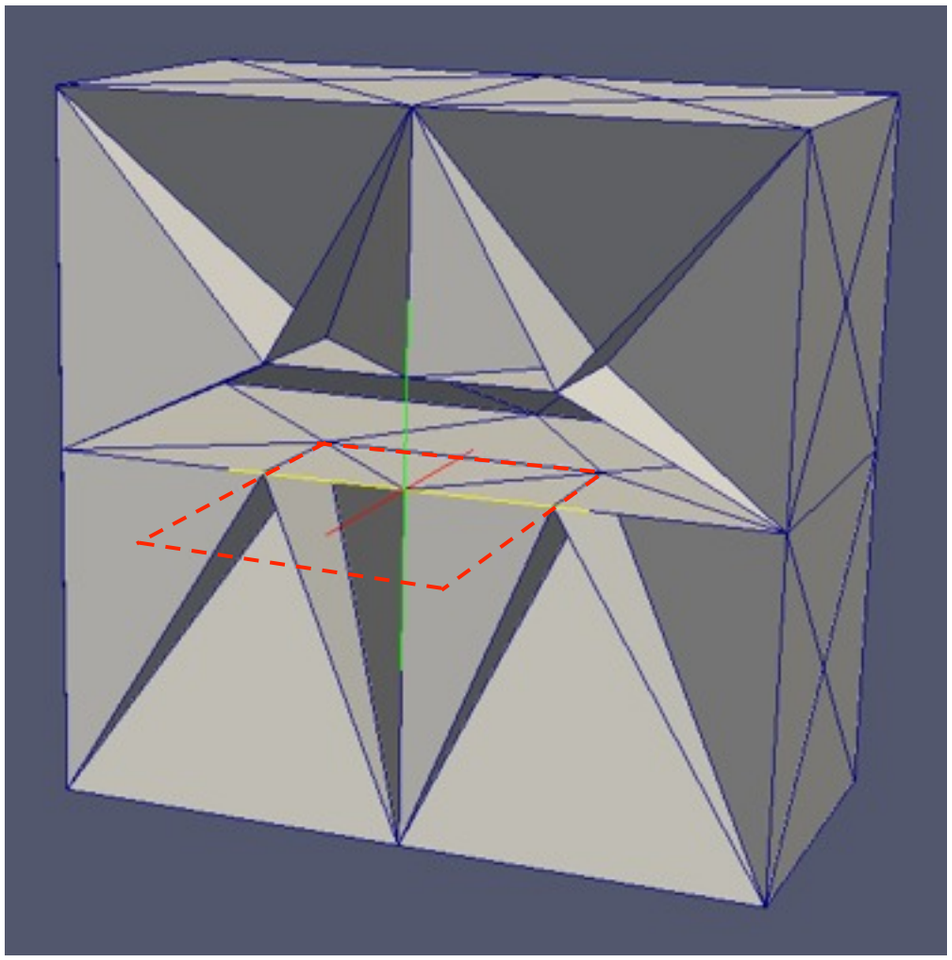


Duplicated thin plate

Original thin plate

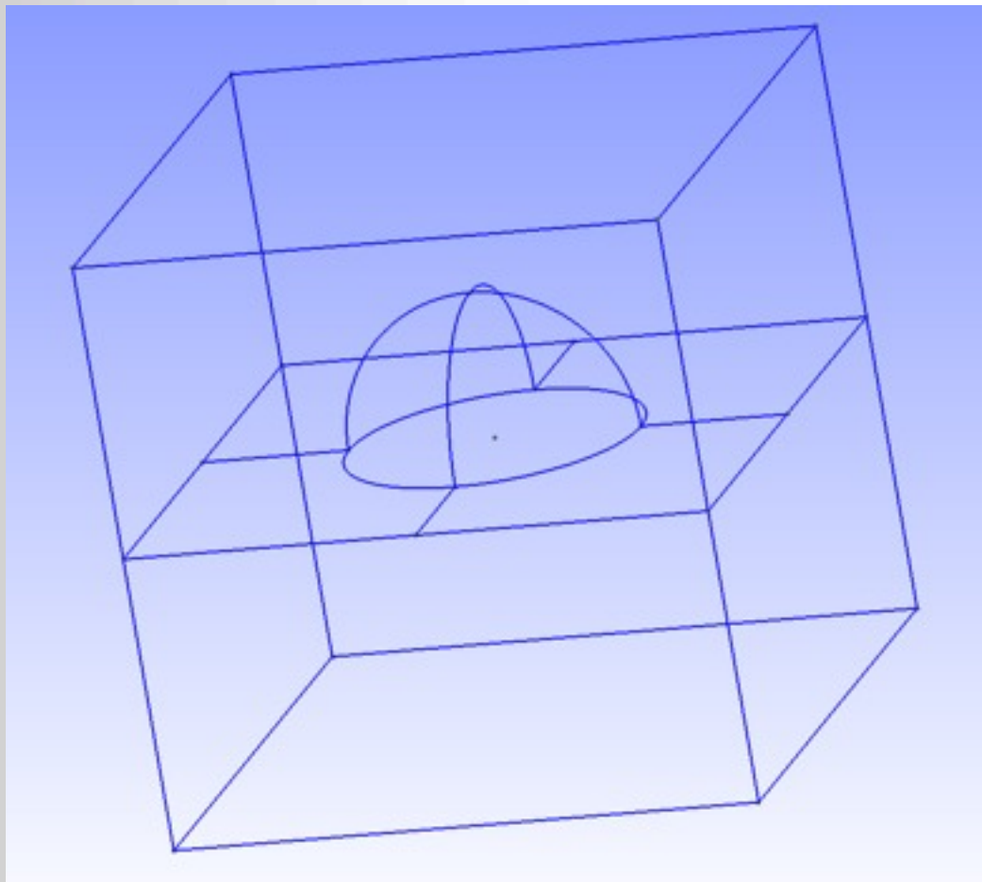


Mesh
Splitting
+
clipping

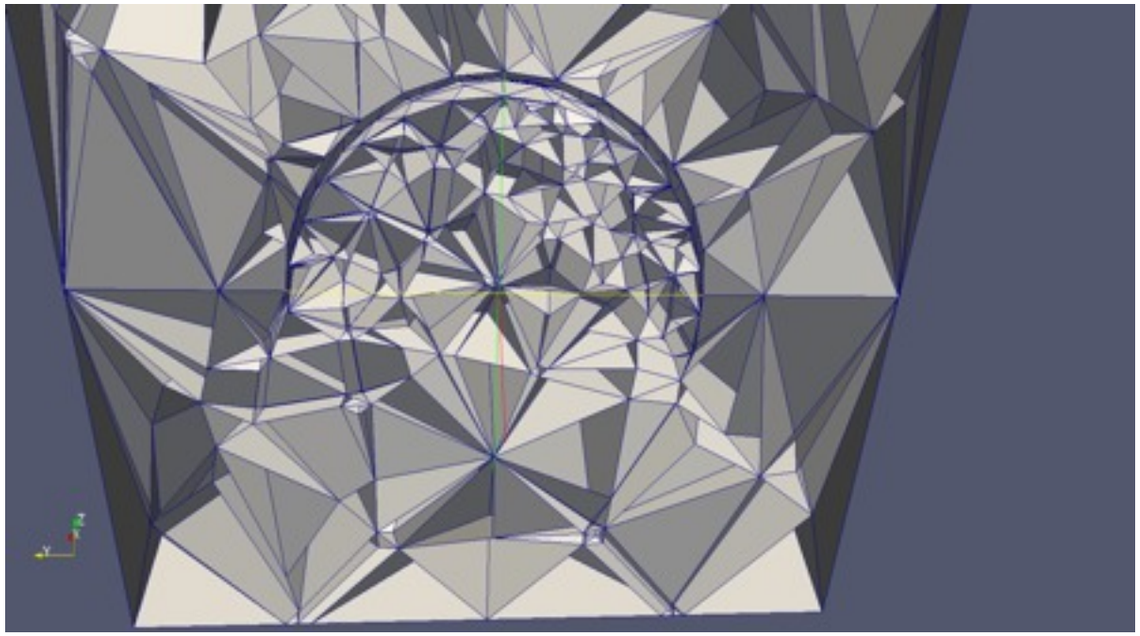


Original thin plate

Results 2/2



Mesh Splitting + clipping



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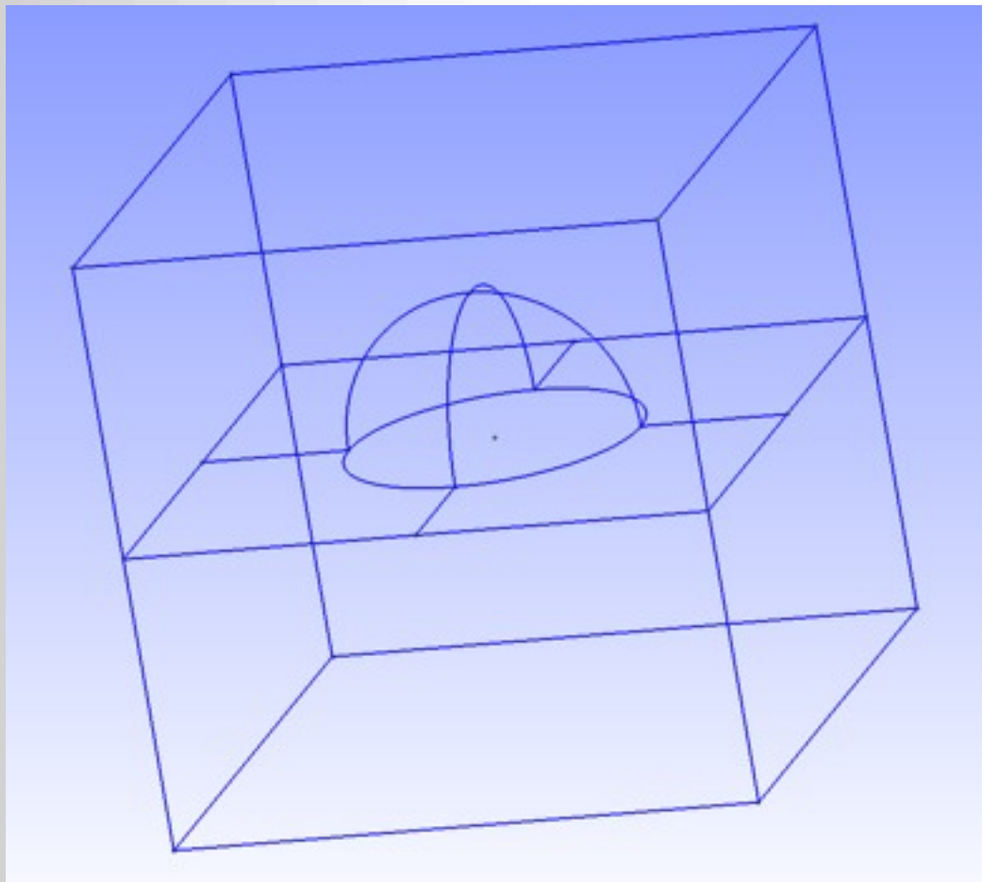
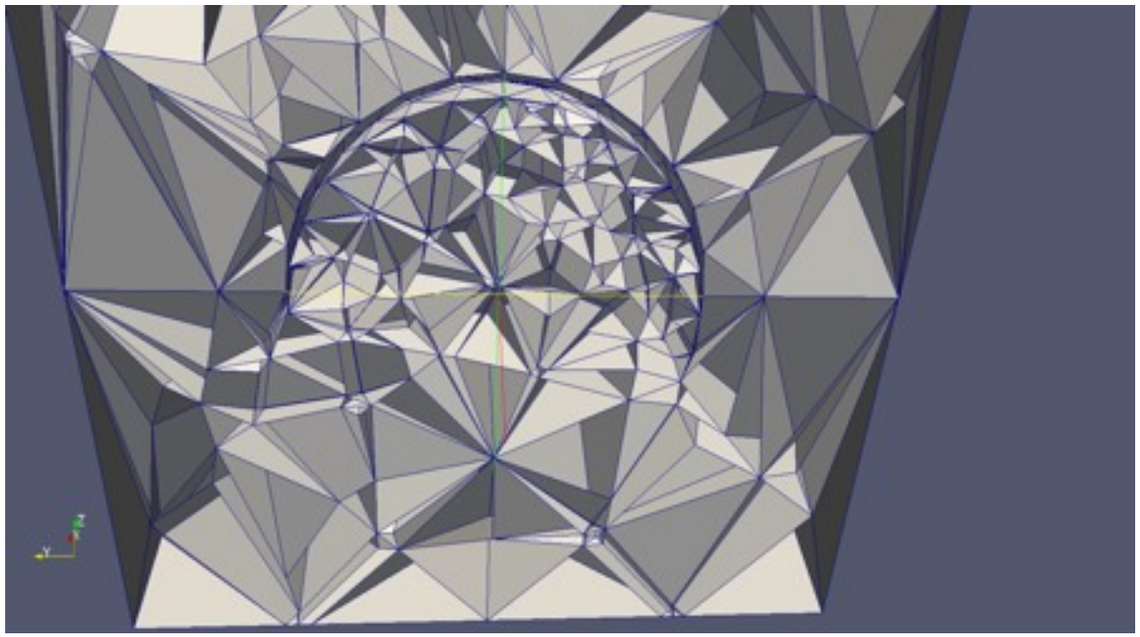


Mesh Splitting + clipping



Operational in Penelope, but some fields needs to be defined to make it fully operational in SPIS-NUM

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SPIS-NUM Kernel evolutions

Several improvements

- Improved models (in synergy with SPIS-SCI developments)
  - transitions managements (e.g eclipse exit)
  - 2D thin elements
  - Self-shadowing for a better control of the Pe emission
- Better monitoring and simulation control (in synergy with SPIS-SCI)
  - stop/resume
  - instruments

Robustness, precision and efficiency of the code

Convergence criteria and diagnostic parameters monitoring

- Convergence and diagnostic parameters:
- Large sensitivity analysis of results to physical and numerical parameters and good comparison to analytical model -> Most of pre-defined settings identified
- Real-time monitoring
- Multi-threading of the particle pusher -> Gain of efficiency on multi-proc OS

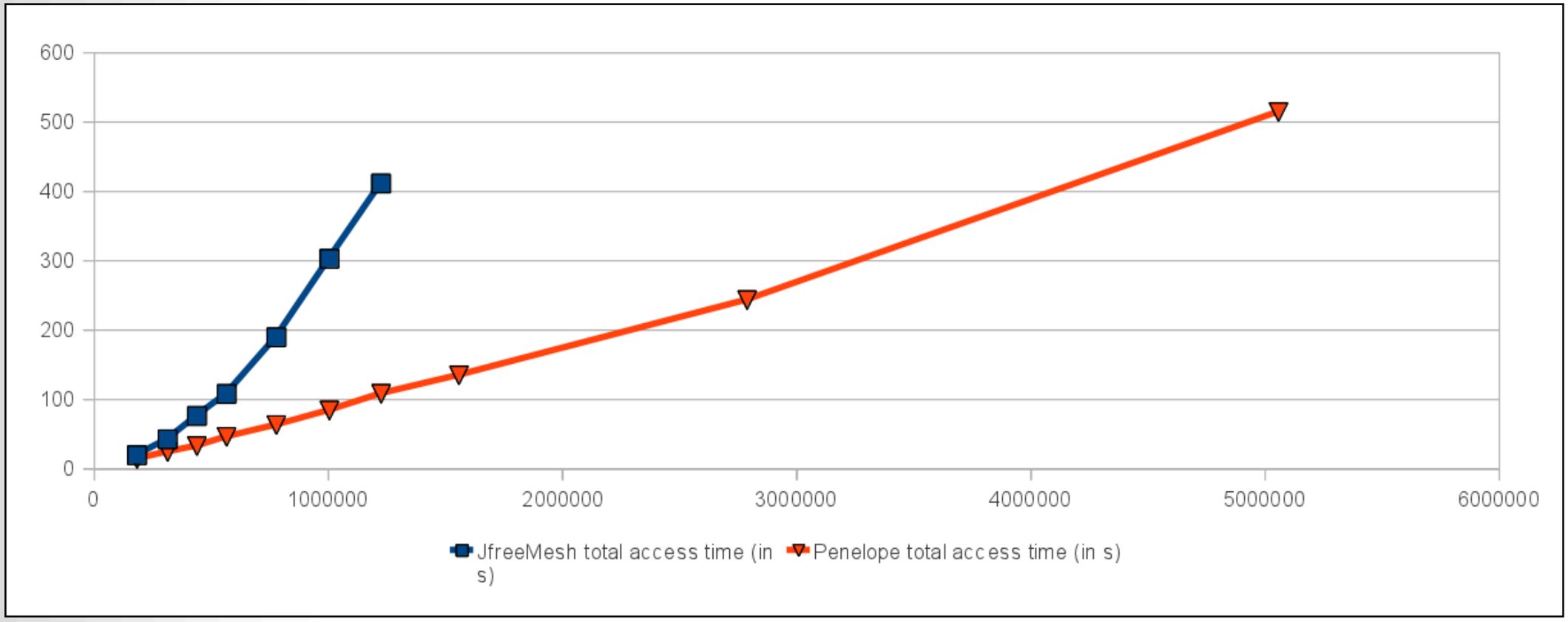
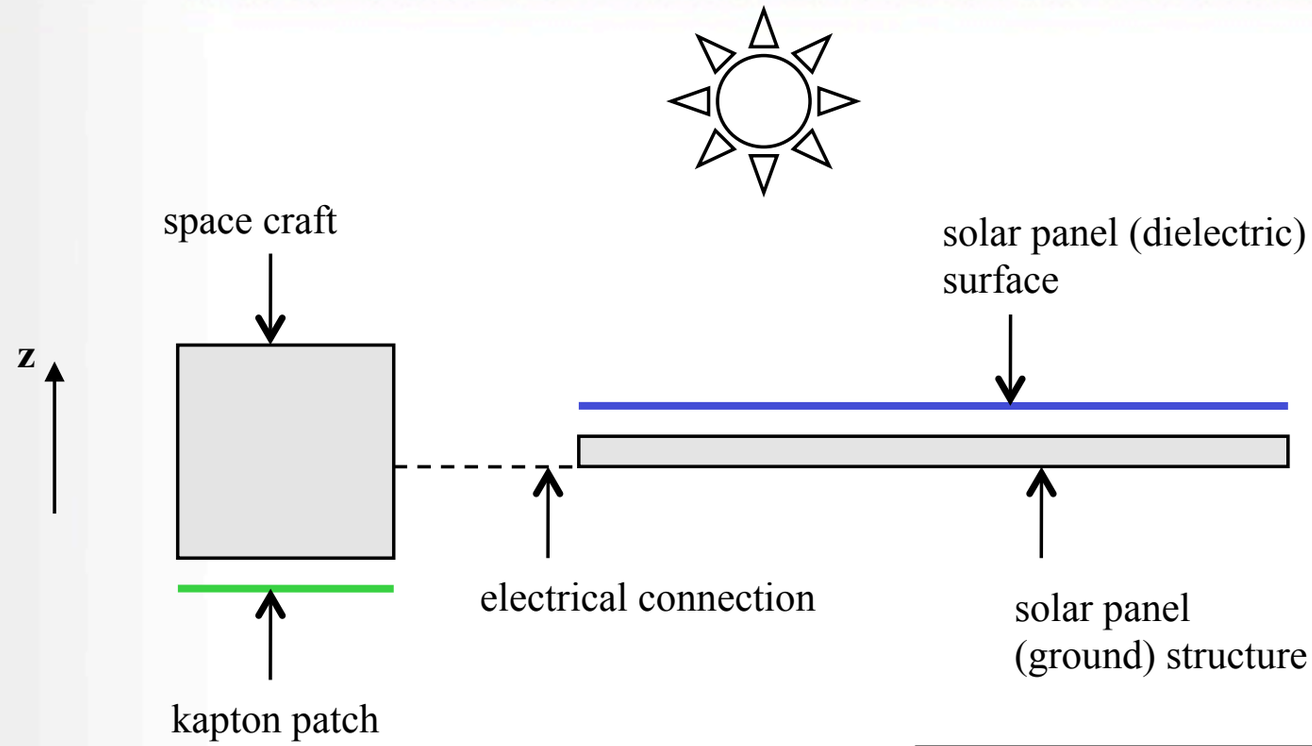


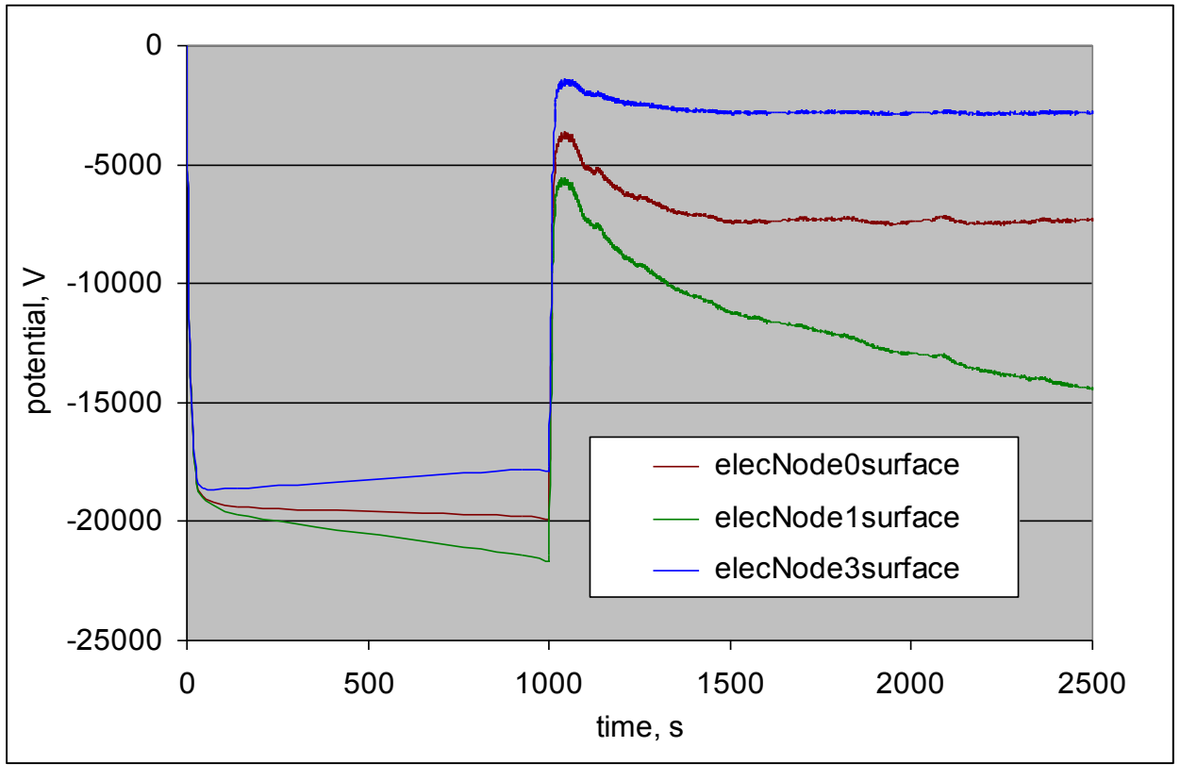
Figure: Access performance comparison between JFreeMesh (in blue) and Penelope (in red). Total access time in seconds for increasing number of tetrahedra (lower is better)

Robustness, precision and efficiency of the code



- ECSS worst case environment
- Eclipse exit with change in sun flux and material conductivity

time [s]	Sun flux (1.0 @ 1 A.U)	CERS bulk conductivity [ohm-1.m-1]	kapton bulk conductivity [ohm-1.m-1]
0	0	1e-15	1e-15
1000	0	1e-15	1e-15
1100	1.0	1e-14	1e-15
2000	1.0	1e-13	1e-15



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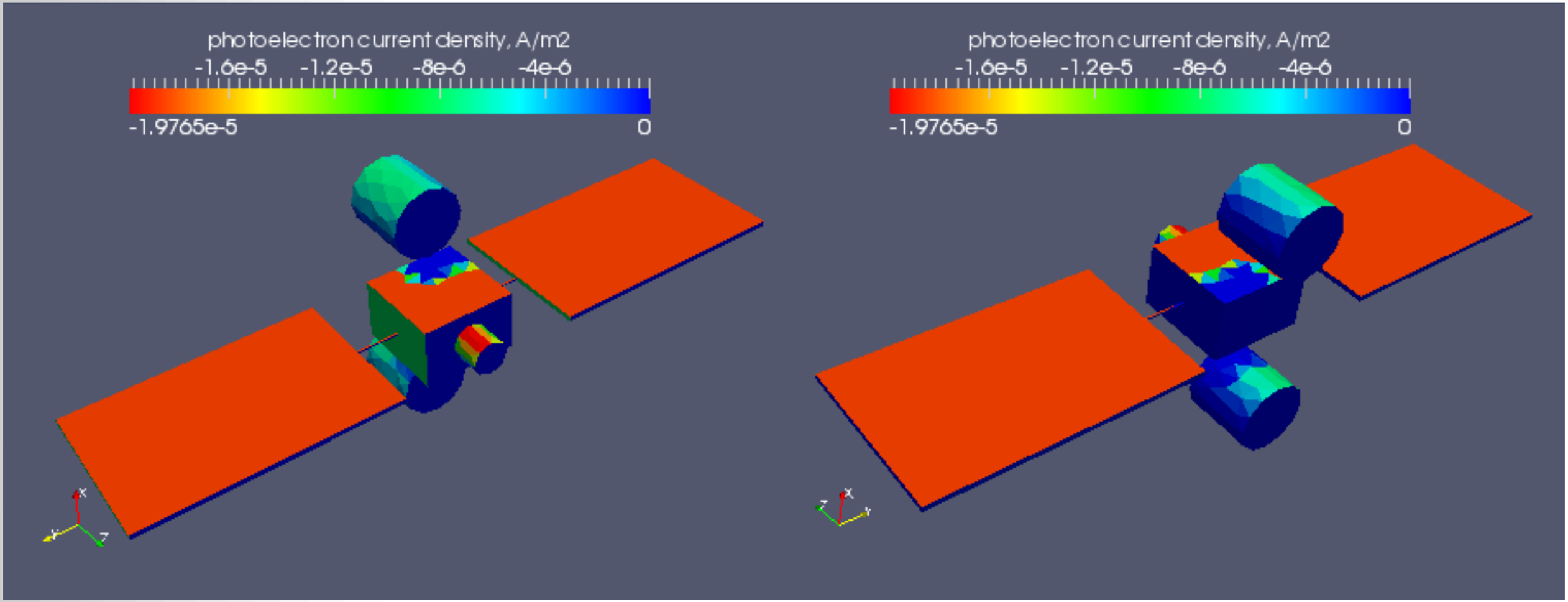
Self-Shadowing



Expected schedule

We are late… SPIS's users are waiting for SPIS-GEO

- Synergy / synchronisation with other projects (SPIS-SCI, ElShield...)
- Strong (actually larger than expected) refactoring of low level components of SPIS-UI
- Longer than expected validation phase

Current «pre-release» is still a development version

- Only for the develop team and ESA for now, being
  - Under integration
  - To be validated
  - Based on a fully redeveloped and validated framework
  - All needed elements of the both pre and both processing chain are ready
  - Some of them still need to be integrated into the framework

Large validation campaign will be performed by the industrial partners (OHB, Astrium), in order to:

- Validate the tools from an physical point of view
- Validate the global ergonomie of the tools as an «industrial user point of view»

First stable release expected for end of may 2012

- For the next SCTC 2012.... Welcome to Japan!