Application cases of space modelling software based on the open-source Integrated Modelling Environment Keridwen

KERIDWEN
INTEGRATED MODELLING ENVIRONMENT
www.keridwen.org

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Open Source Initiative

Introduction: Modelling complex systems needs several steps, from pre-processing – to define studied systems – to post-processing – to analyse results. Multi-physics or multi-scales simulations improve such complexity. Integrated Modelling Environments (IME) aims to reduce this complexity by offering adapted and homogeneous tools to users.

Last released in September 2017, Keridwen is an open-source set of tools – developed in Java/OSGi – that aims to help the creation of tailored IME. Beyond decreasing tailored application developing time, sharing common tools improves software quality and helps maintenance and evolution along.

Keridwen generic functions:

① Define 3D geometric description

Keridwen CAD modules aims to help the user to define its geometry, from scratch or by using conversion from industrial geometry formats.

Depending on the modelled physic, needs in terms of geometry are different. From precise geometry to more abstract representations, Keridwen aims to handle them through its various editors.

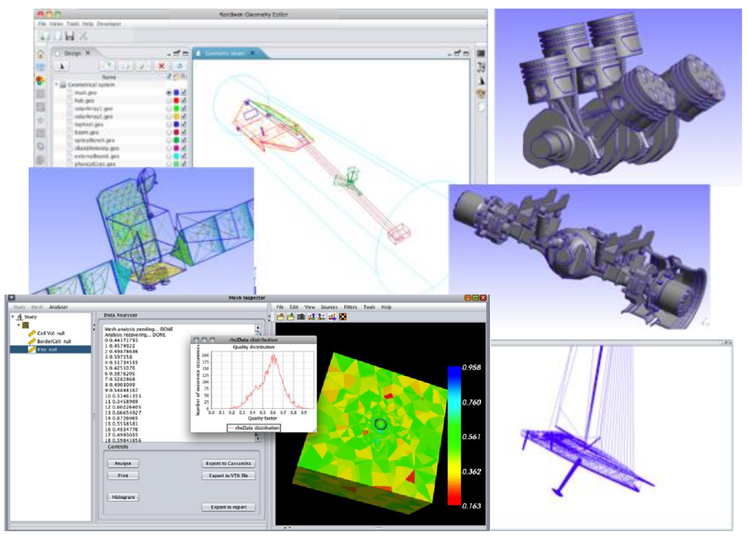
Some 3D model may need a precise mesh description. Keridwen can produce such meshes using the Gmsh software or can directly import them into the framework.

B-Rep
STEP AP 203-214, GEO, STL, UNV

CSG
GDML

→ Keridwen CAD Editors
Easy creation/ modification of geometry

→ Simulation kernels compatible geometry / mesh formats



② Apply properties on geometry

Keridwen group editor allows creating generic properties and attributing them to geometric descriptions. Such properties can represent:

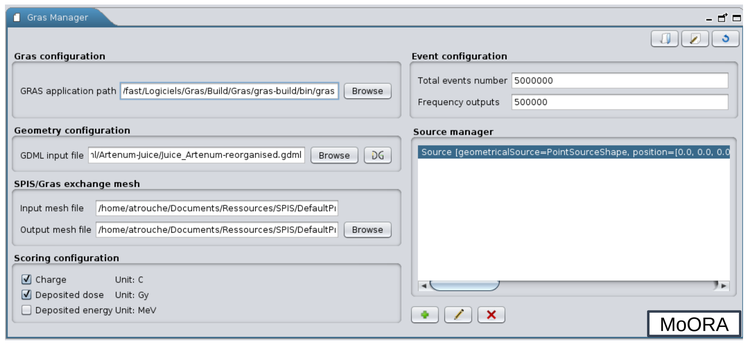
- Initial and/or Boundary Conditions
- Material properties
- Local parameters

Such properties can then be attributed to different sub-systems or the whole system.

③ Define simulation parameters

Define the various global simulation parameters using generic editors or dedicated graphical user interfaces to guide more precisely the user.

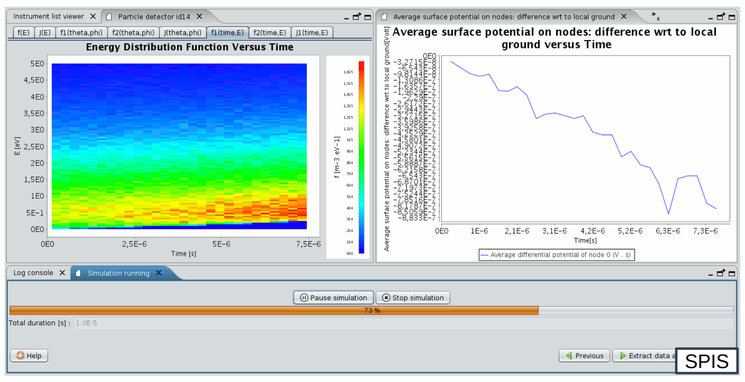
Both approaches rely on the Keridwen global parameter format that simplifies loading and saving such parameters to and from the disk.



④ Follow numerical kernel evolution

Dynamic control of on-going simulation main characteristics via `F(x)=y` type plots and `F(x,y)=z` type 2D map visualisation.

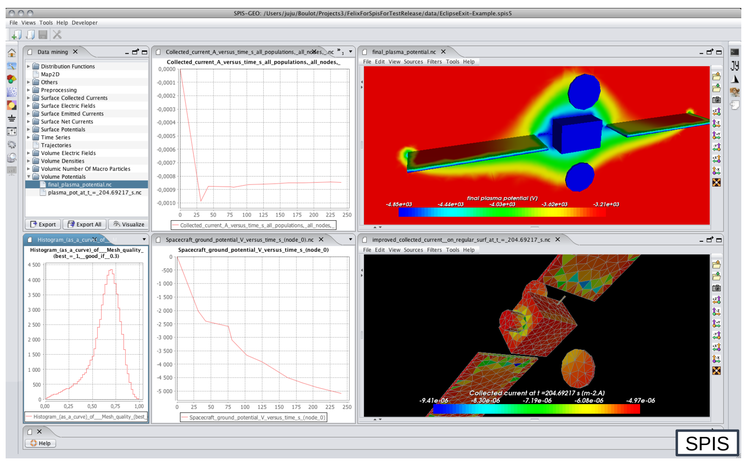
It is possible to update those visualisations following the simulation evolution, depending on the simulation kernel capabilities.



⑤ Extract data from simulation results

Keridwen features advanced post-processing 2D/3D functions :

- 2D plots data visualisation
- 3D plots data visualisation and post-processing (operations such as clipping, cutting plane, obtain values along an axis, etc.)
- Large export possibilities (NetCDF, XML, CSV, VTK, X3D, etc.)



Keridwen generic functions

Throughout the modelling step, some generic functions are needed. Keridwen offers:

- A generic hierarchical data model with various readers/writers to load/save from/to disk
- A dynamic logging system
- Internationalisation features to facilitate the translation of software
- Generic common **G**raphical **U**ser **I**nterface (GUI) elements to centralise developments
- A complete set of tools to help create applications with several modelling steps. It goes from the definition of the various step in configuration files to a generic docking system based on the DockingFrames framework.

For more information, see http://keridwen.org

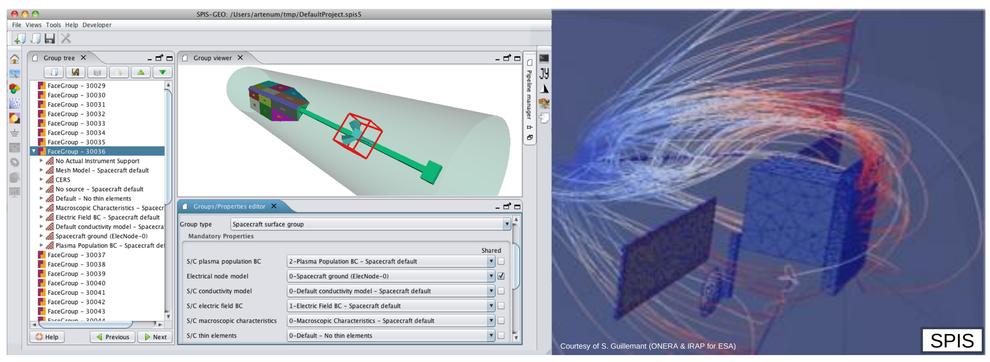
Space applications based on Keridwen:

Modelling spacecraft charging : SPIS

Initiated by ESA and CNES, developed by ONERA and Artenum and maintained by the SPINE community, SPIS (for **S**pacecraft **P**lasma **I**nteraction **S**ystem) aims to model interactions between spacecraft and surrounding plasma, and more particularly space-craft charging. The SPIS-NUM numerical core is an electrostatic 3D PIC model mainly developed by ONERA.

① B-Rep 3D CAD editor and Gmsh mesh → ② Generic group properties editor → ③ Simulation editor with pre-defined settings → ④ Real-time data visualisation → ⑤ 2D and 3D data visualisation

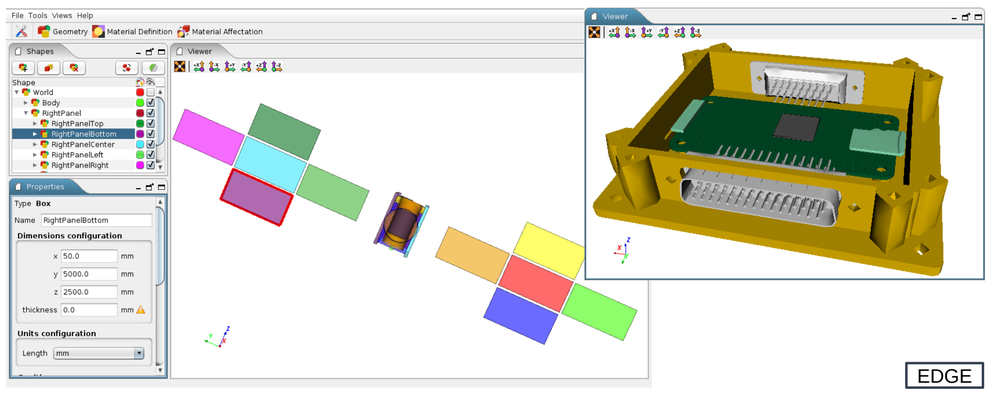
For more information, see http://spis.org



Defining geometry : Edge

EDGE, or ExtendeD Gdml Editor, is a WYSIWYG CAD GDML editor. EDGE spares the users time consuming manual editions they had to perform. EDGE features user-friendly properties editors, a real-time 3D viewer and a complete material editor.

For more information, see http://space-suite.com/edge/



Modelling radiations effects : MoORa

Initiated and developed by Artenum, MoORa, for **Mo**delling **O**f **Ra**diations aims to provide a integrated solution to drive radiations effects analysis end-to-end,
MoORa simulation relies on ESA tool GRAS, a fully operational 3D Monte-Carlo radiation effects analysis tool based on GEANT4.

① EDGE (see details above) → ② → ③ Dedicated GUI for radiation simulation setting → ④ Display progress following GRAS log outputs → ⑤ 2D and 3D data visualisation

Input .mac file → GRAS → Outputs files

For more information, see http://space-suite.com

Modelling multipactor effect in Iris : IRIS-SEY

Funded by CNES, the French agency, and developed by Artenum, IRIS-SEY models the multipactor effect in irises inside RF components and wave-guides. IRIS-SEY consists of a Java 2D model integrated into a dedicated IME.

③ Dedicated GUI for simulation setting → ④ Follow the simulation evolution → ⑤ 2D plots and 2D map summary visualisation

Software to be released soon (open-source).

Conclusion : Keridwen has been successfully used to create several complex system modelling software (SPIS, Edge, MoORa, IRIS-SEY, …). Keridwen being used by several tools, its components are more and more validated by their various uses in tailored applications. The last released version (2.0.20 in September 2017) of Keridwen benefits from the latest improvements.
The various space applications of Keridwen has shown the relevance of Keridwen, and of the IME concept more generally. But Keridwen is not limited to space-related thematics and can be extended to various scientific domains : for example, Keridwen has already been used in robotics.