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KERIDWEN
INTEGRATED MODELLING ENVIRONMENT

Collaborative modelling and concurrent scientific data analysis:

Application case in space plasma environment with the Keridwen/SPIS-GEO Integrated Modelling Environment

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Keridwen 2
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- Mesh editor
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- Simulation control and live monitoring
- Data mining and post-processing
- Automatic reporting

Conclusion and perspectives

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Introduction

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Introduction

New challenges in numerical modelling

Modelled systems are more and more complex and large

- Multi-physics / multi-scales / multi-models
  - ⇒ Require a large spectrum of expertise, often geographically spread
  - ⇒ Interoperability and integration into existing information systems
- Large systems highly demanding in terms of resources
  - ⇒ Parallel and/or distributed computations
  - ⇒ Remote control of the simulation loop(s) and live monitoring
- Complex to configure and model (3D geometry, properties attributions, numerical parameters settings)
  - ⇒ Need for simplified modelling process to reduce the learning curve and guide the users along the modelling chain
- Large amount of rich output data to process
  - ⇒ Necessity to share over the Web rich and complex data
  - ⇒ Necessity of a robust traceability of the input/results

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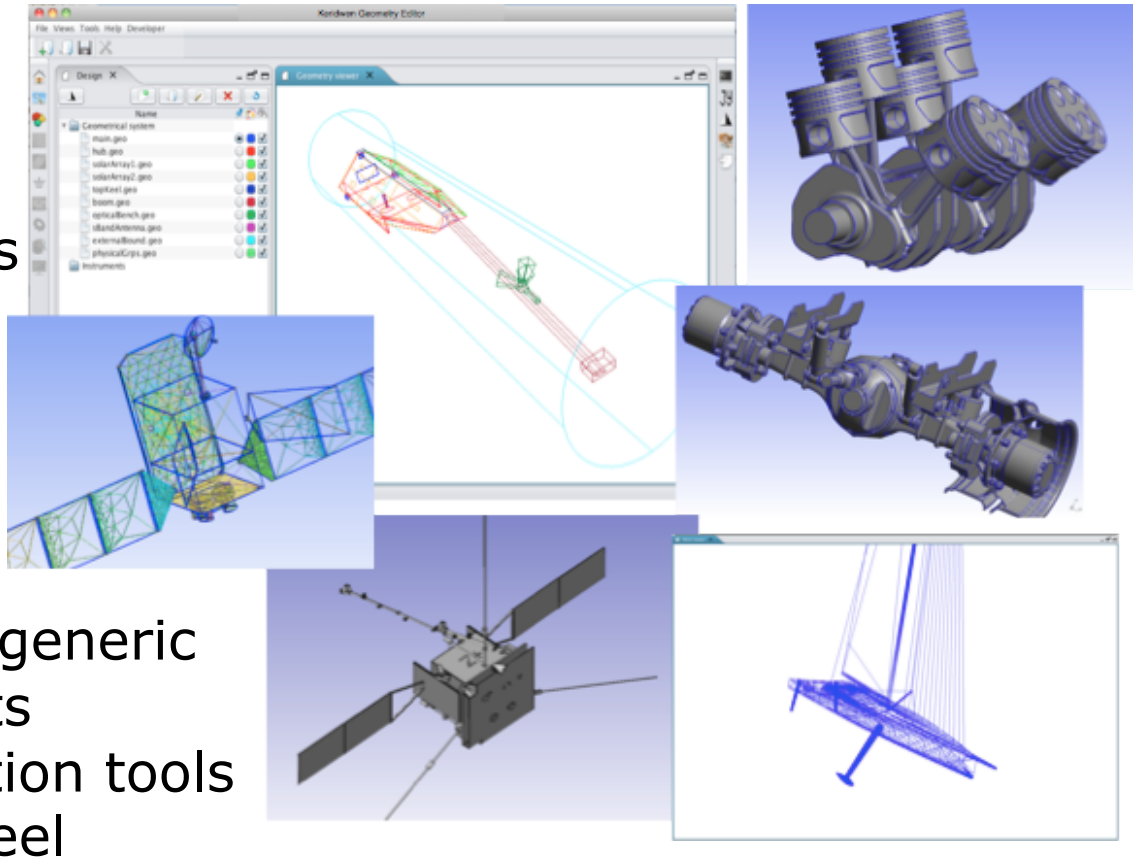
Introduction

Integrated Modelling Environments

- Provide tools common to most simulation environments
  - Possibility to integrate various numerical kernels
  - File formats converters
  - Distributed capabilities
  - Simulation monitoring and control
  - Tailored modelling chains
  - Sharing capabilities
  - Traceability and reporting



Objectives

- Simplify the integration of generic features in tailored contexts
- Easier to build new simulation tools without reinventing the wheel

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Keridwen 2

Integrated Modelling Environment

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Keridwen 2

Keridwen is an open-source modular toolbox gathering, through interoperable software modules, a structured set of key functions of the scientific software and to address the whole modelling process.

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Keridwen provides numerous generic modules like:

- Pre-processing, simulation control, post-processing
- CAD editors and 3D visualisation tools
- Fully written in Java and multi-threaded
- Based on industry standard OSGi modules system
- Robustness, performances and reliability
- High interoperability with other modeling tools
- Ready for future distributed architecture
- Generic data persistency and I/O capabilities
- Open-source: public release in the coming weeks

Keridwen aims to facilitate the conception and the development of tailored scientific applications, simulation software or data analysis tools.

The best basis to easily build the adapted Integrated Modelling Environment (IME) solutions

www.keridwen.org

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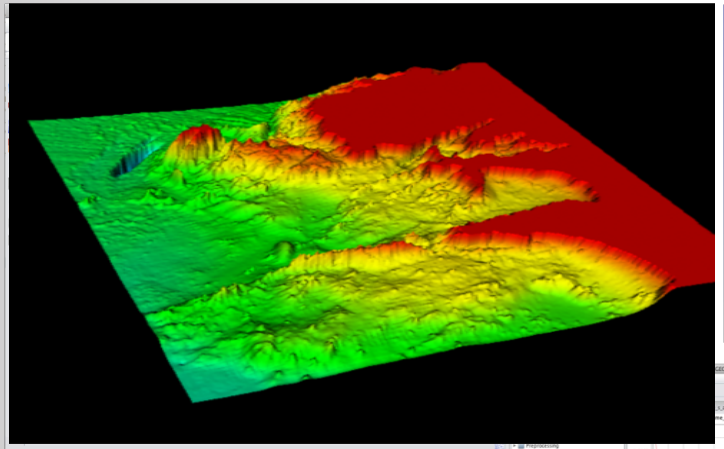
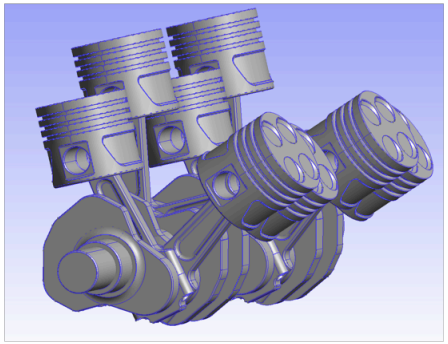
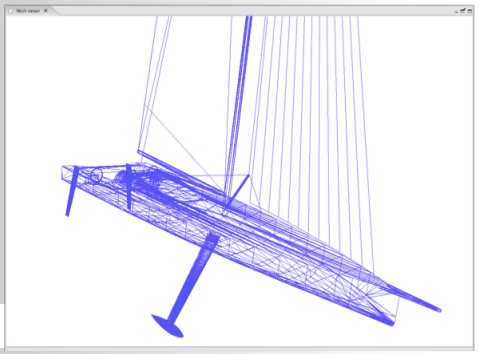
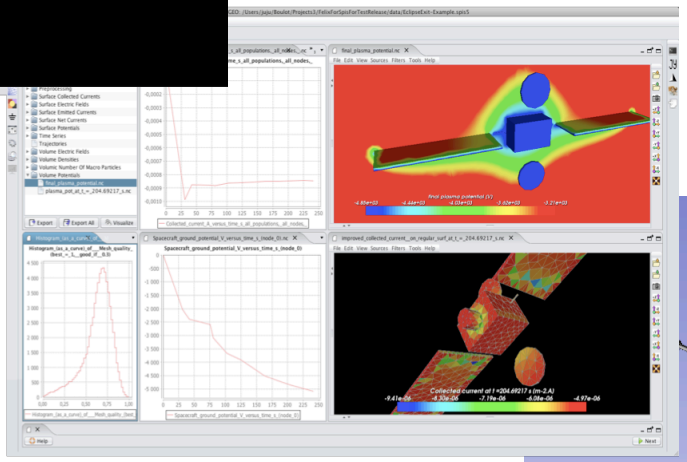
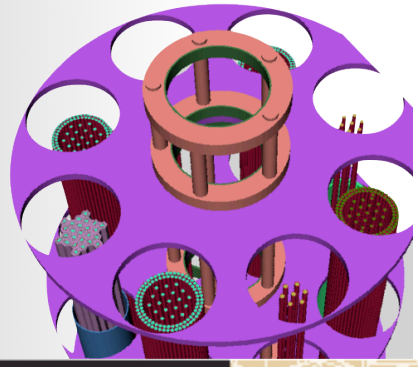
Keridwen 2

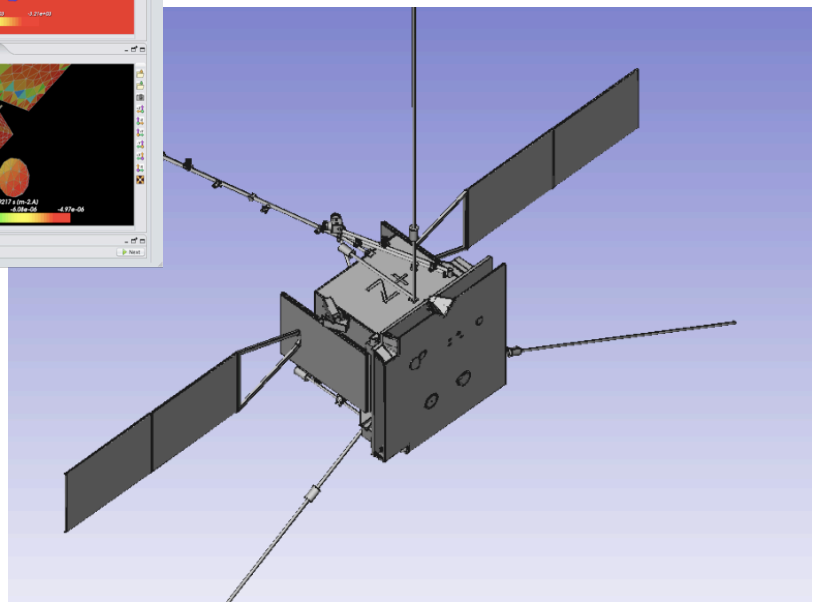












A wide scope of applications

- Space environment
- Radio protection
- Mechanics and CFD
- GIS
- Electronic circuit design

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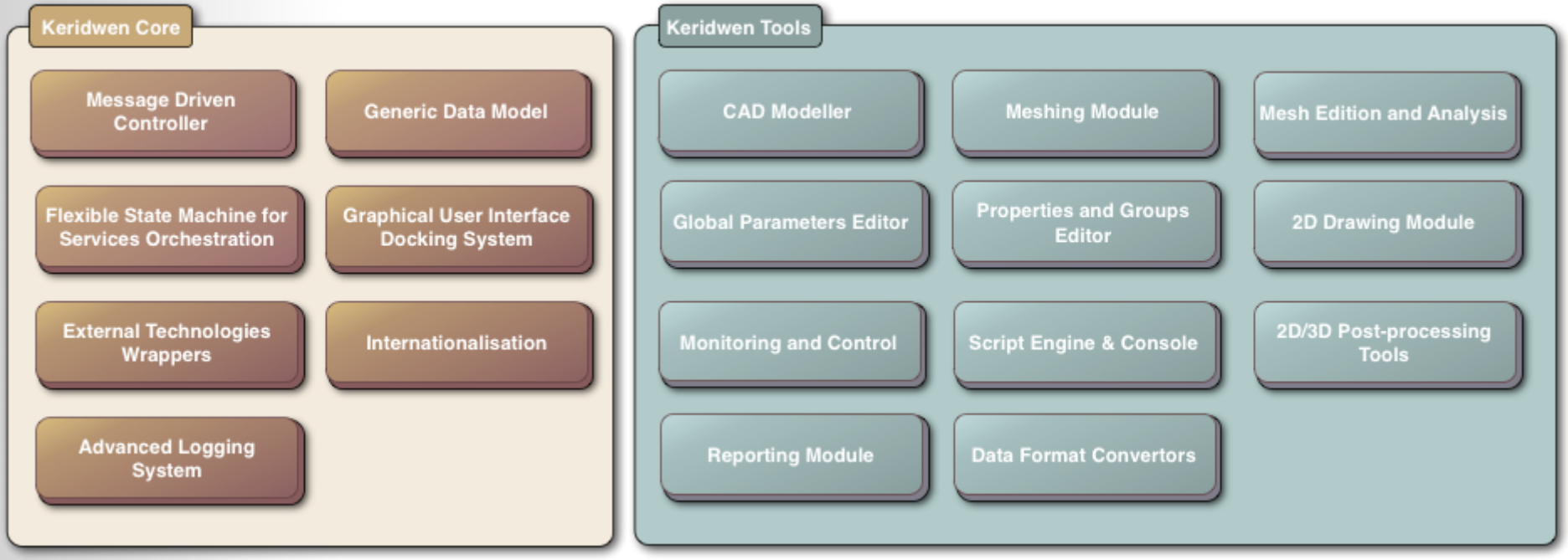
Keridwen 2

A modular system

- OSGi and normalised modules to easily build dedicated and adapted solutions
- Low level as well as top level functional modules
- Set a generic tools (mesher, viewer, auto-reporting, properties settings...)



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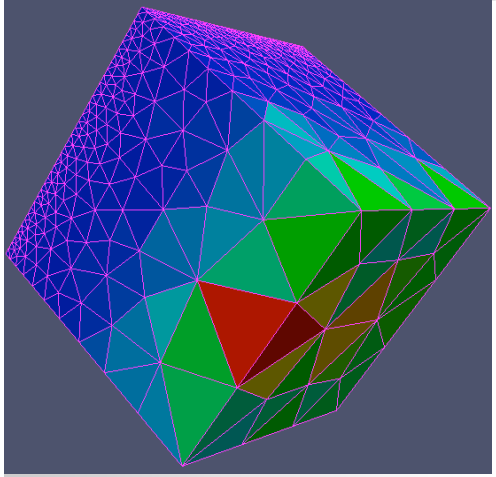
Keridwen 2



Underlying technologies

- Gmsh mesher
- VTK
- JFreeChart, 2D plotting library
- Open Cascade
- Penelope mesh library
  - Unstructured 3D meshing (tetrahedra)
  - Data fields (scalars, vectors, objects)
  - Mesh and data fields operators (splitting, mapping...)
  - Rich I/O capabilities: GMSH, XML, NetCDF, VTK...
- Frida, generic properties handling library
  - Handling of "Properties" being applied on CAD models, meshes or logical systems
  - Provide rich properties editions and mapping tools
- Cassandra, scientific 3D viewer and postprocessing tool

Penelope's Mesh Library

Frida, the painter

http://dev.artenum.com/projects/Penelope

http://dev.artenum.com/projects/frida

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Cassandra
Shared visions

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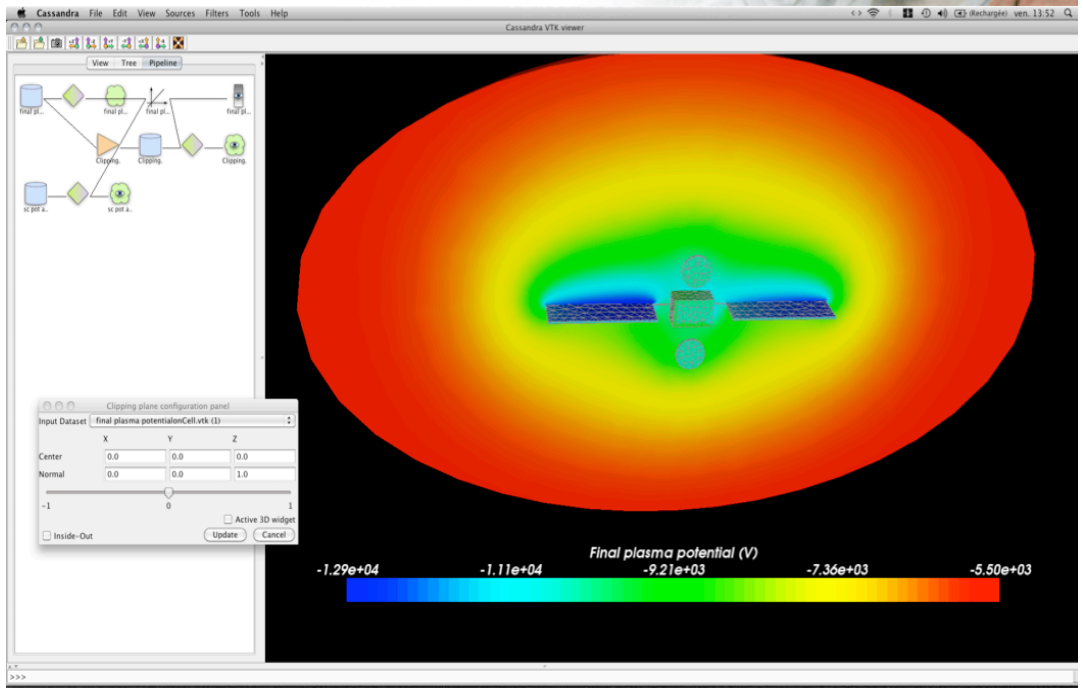
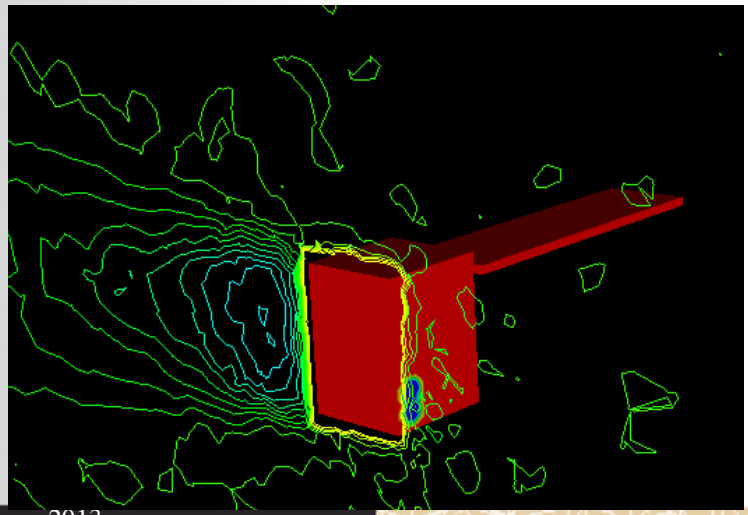
Cassandra, Shared visions

Cassandra 2.5, 3D Scientific Data Viewer

- Graphic visualisation pipeline editor for complex and tailored post-processing
- Simpler to use (improved LAF, 3D widgets)
- Based on Java and VTK
- Open-source
- Large set of filters
- Rich data conversion capabilities
- CAD import capabilities (STEP, Iges,Brep...)
- Collaborative capabilities with Cassandra Cloud





http://www.artenum.com/EN/Products-Cassandra.html

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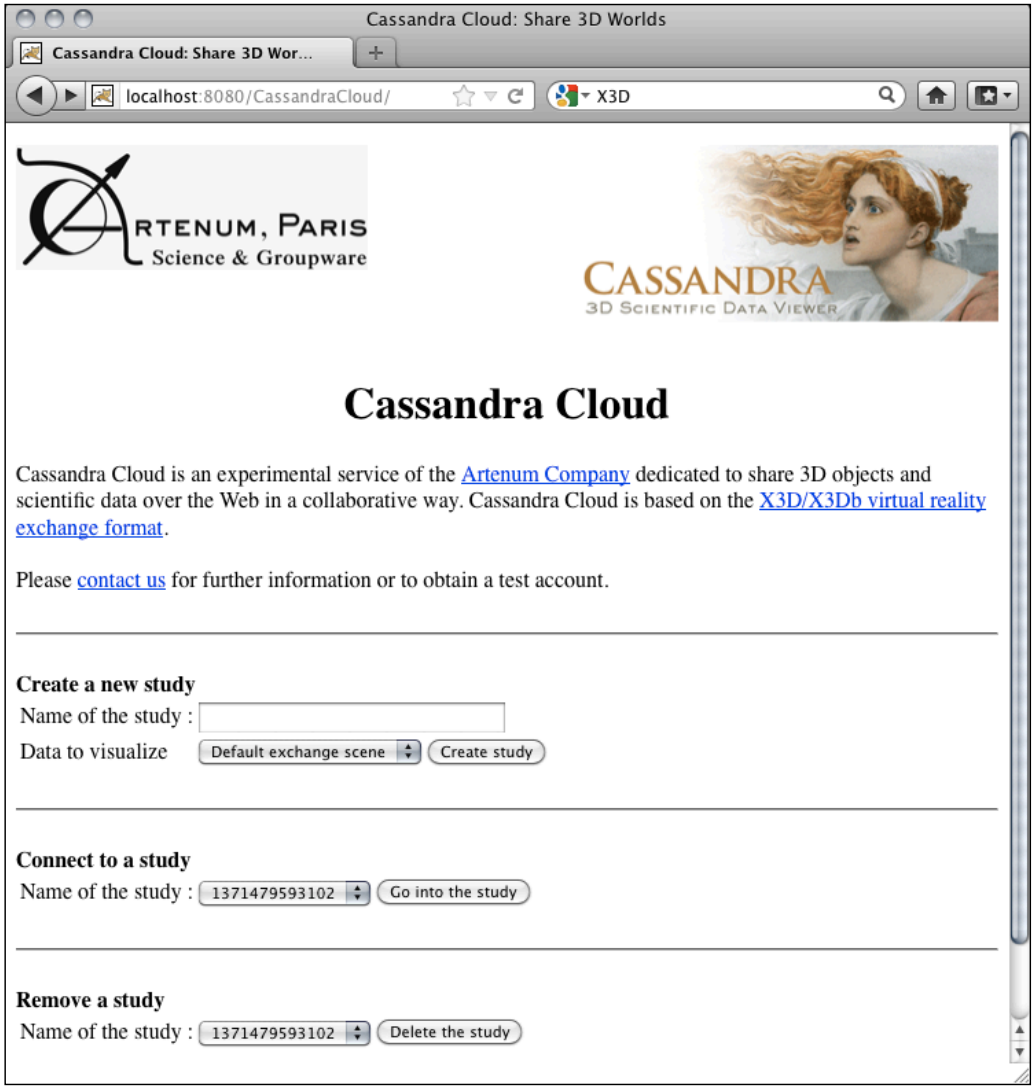
Cassandra, Shared visions

Cassandra Cloud Service

- Experimental Web service
- Share over the Web
  - Processed 3D scientific data
  - CAD models
  - Meshes
- Interactive collaboration
- Data exchange based on X3Db files
- Fine integration into Keridwen (through Cassandra) to share:
  - CAD models
  - Mesh quality evaluation
  - Local properties settings
  - Simulation 3D post-processing



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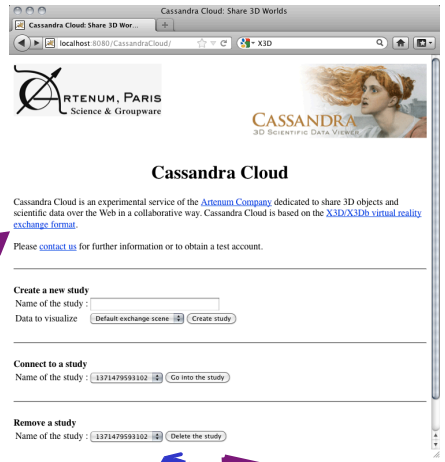
Cassandra, Shared visions

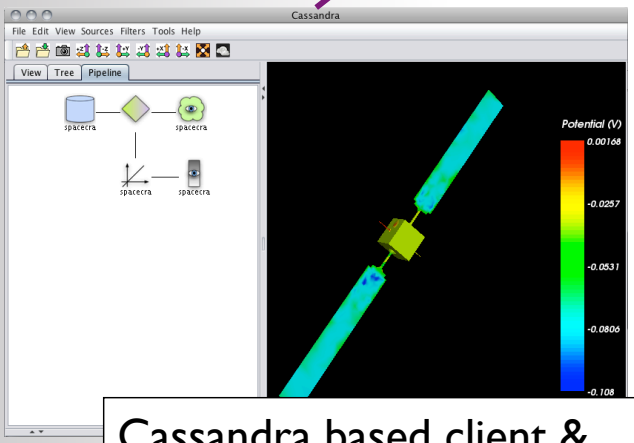
Cassandra Cloud Service

- Data fields and CAD models
- Publication in X3Db format
- Share actions and points of view though Comet based notifications
- Based on ShareX3D (S. Jourdain, Web3D 2009)

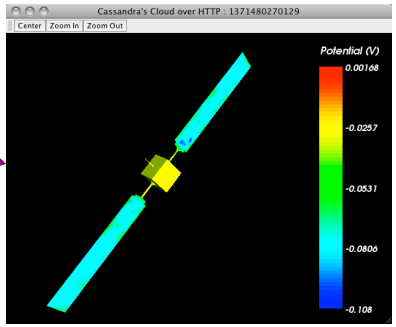


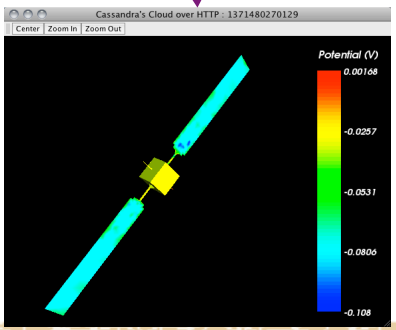
Light weight sharing server

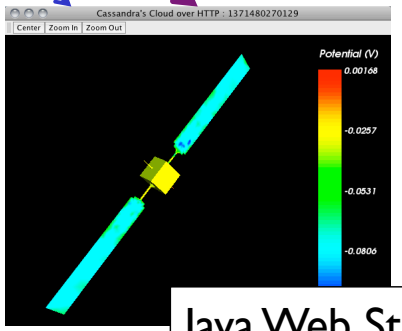
Comet based notifications



Cassandra based client & scientific data analysis tool







Java Web Start & XJ3D light visualisation client

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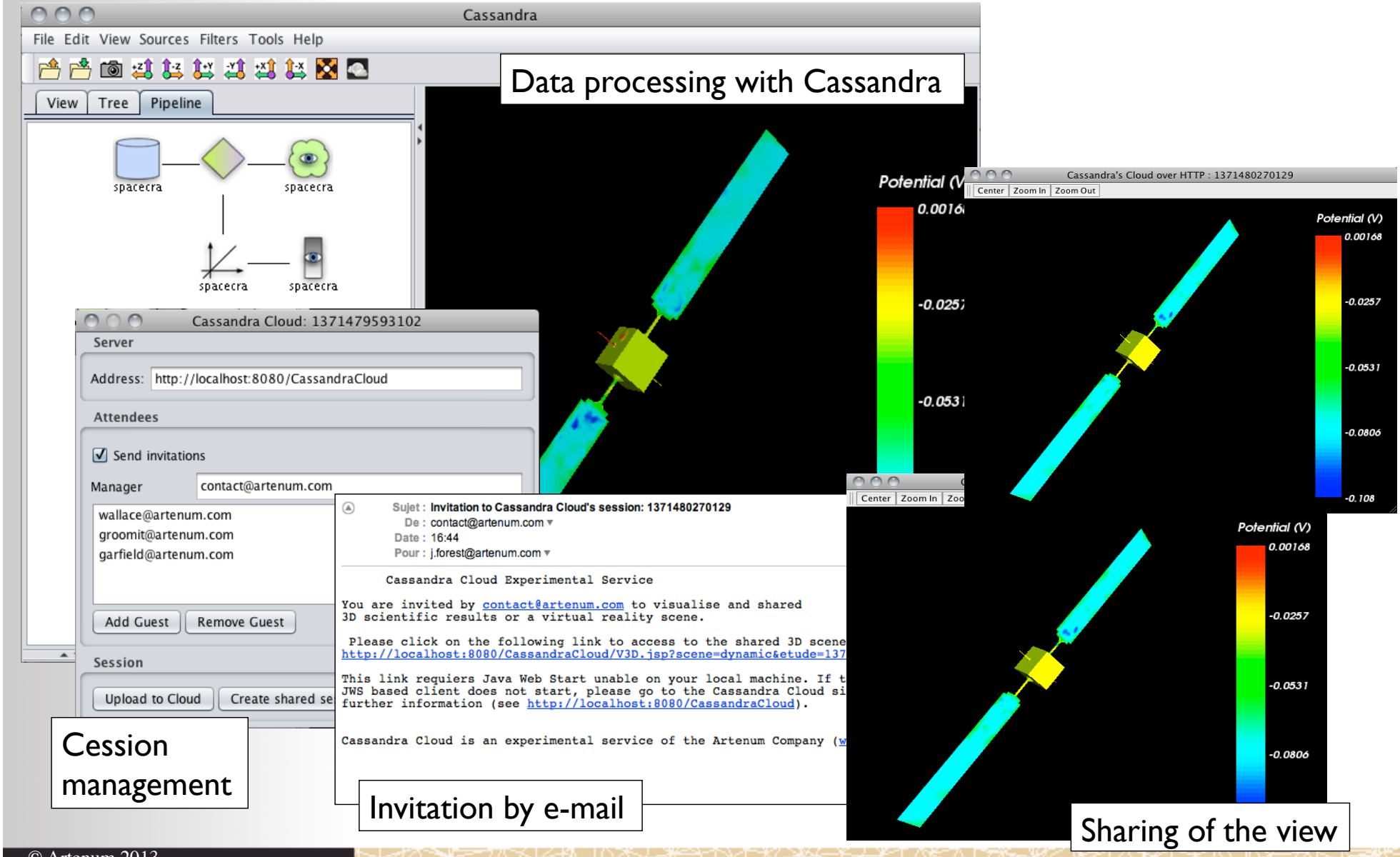
Cassandra, Shared visions



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Cassandra, Shared visions

A lightweight approach

- Server side successfully runs on light Raspberry Pi based solution
  - ARM based
  - 256Mo RAM
  - ADSL internet connection

- Why such tests?
  - Check the relevance of the whole approach
    - X3Db based data exchange
    - Band-width & latency
    - Server needed resources
  - Explore possibilities of simple and intranet exchange points
    - Easy to install
    - Easy to use
    - Low cost and low consumption

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Application Case
The SPIS Project

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SPIS

Overview

- Spacecraft Plasma Interactions Software
- Funded by ESA and CNES
- 9 major releases since 2003
- More than 6 500 downloads
- New SPIS generation
  - SPIS-GEO
  - SPIS-Science
  - AISEPS for plasma propulsion
  - SPIS Dust
- http://dev.spis.org
- More than 800 registered members (and around 2 new registrations a week)
- About 20 active contributors (including SMEs, major industrial actors and academics)

SPIS-GEO project

- International consortium:
  - Artenum
  - ONERA
  - Astrium
  - OHB-Sweden
- Objectives:
  - Simplified user interface
  - Support of standard file formats (STEP, NetCDF, VTK, XML, etc.)
  - Improved robustness and overall quality

⇒ **Full redevelopment based on Keridwen 2**

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SPIS

A complex and rich modelling process

- A long path to follow:
  - From the system definition to the post-processing
  - Control the simulation (monitoring)
  - Simplify the reporting and data traceability
- Data may have to be shared at various steps:

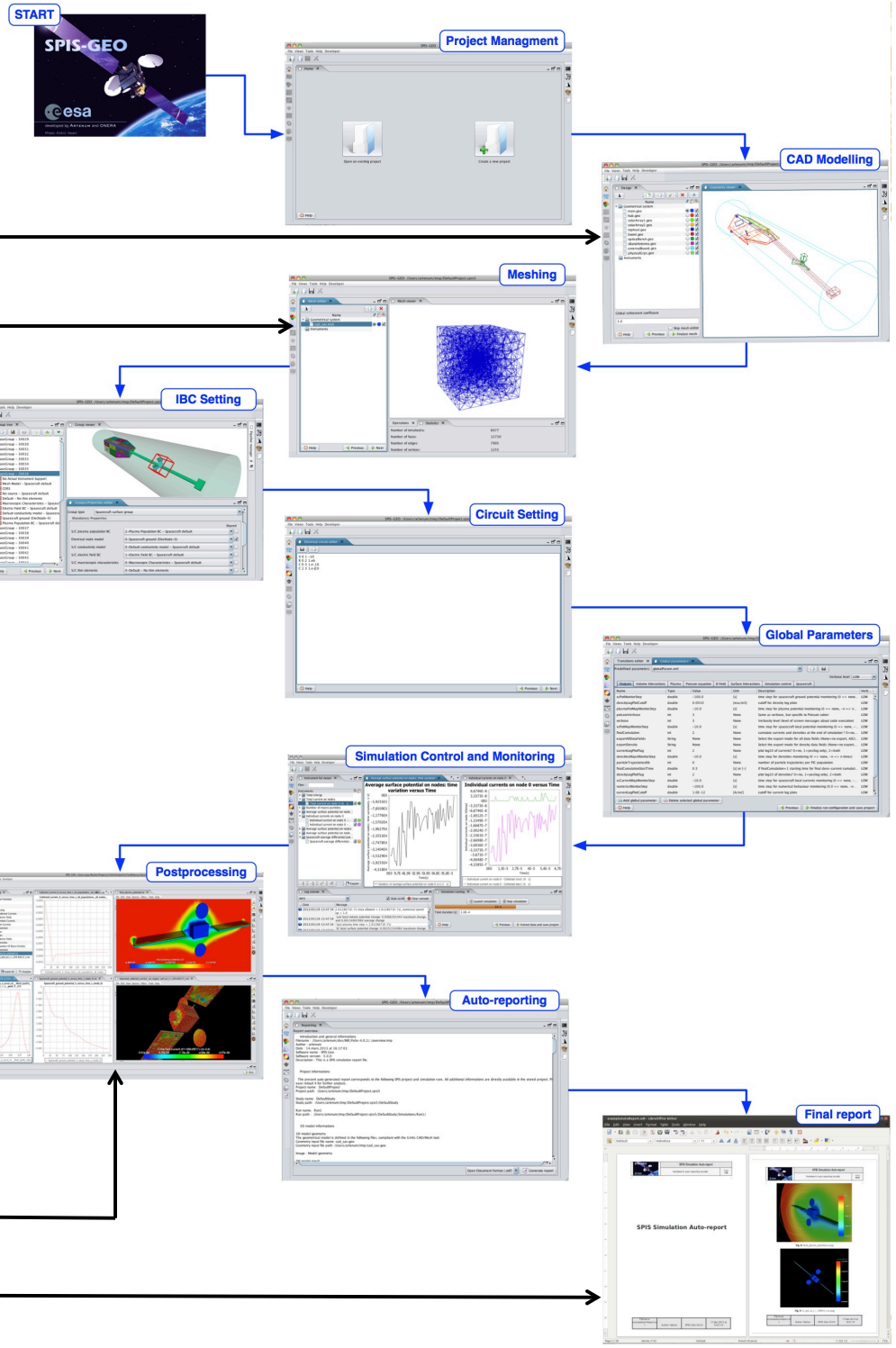
CAD models

Meshes

Properties setting

3D results

Final report



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SPIS

Data may have to be shared over a network at several points along the modelling process

- Whole project persistency scheme:
  - Saving on a central server
  - Should allow a remote access (files paths defined as URIs)
  - Should allow a distributed persistency scheme
- Centralised material database
- Share and/or visualise CAD models
  - Visualisation
  - Concurrent design
  - Centralised CAD sub-systems
- Share and/or visualise Initial and Boundary Conditions settings
- Share and/or visualise produced result data
- Share and centralised simulation reports

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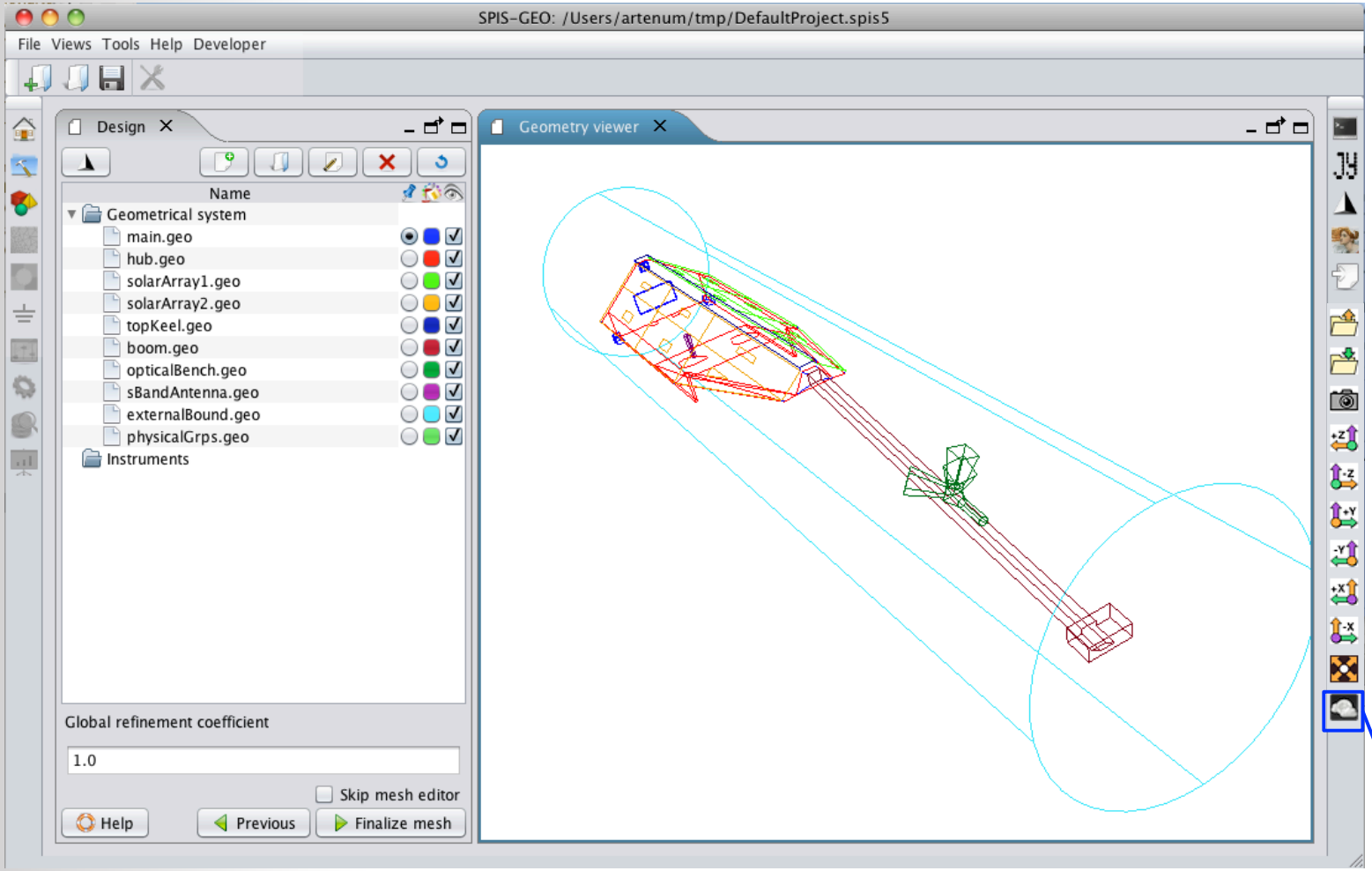
Geometry and CAD editor



Sharing with Cassandra Cloud

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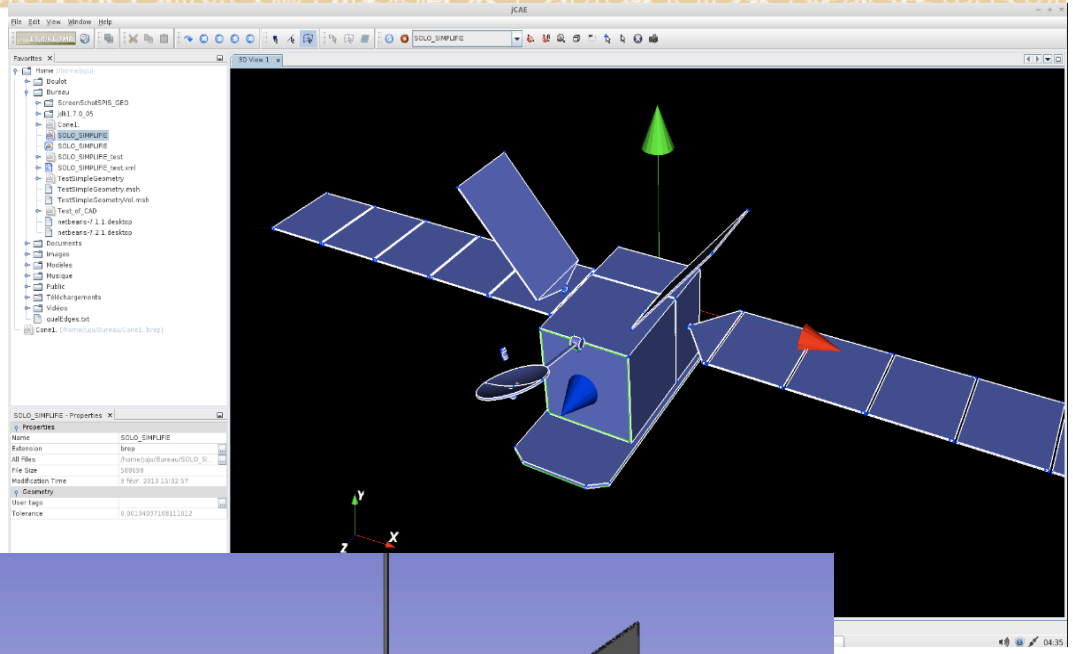
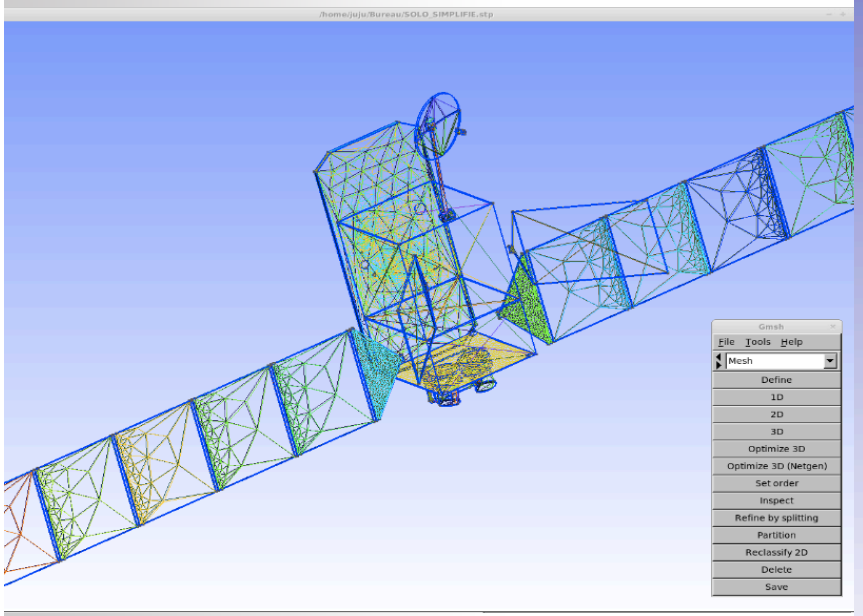
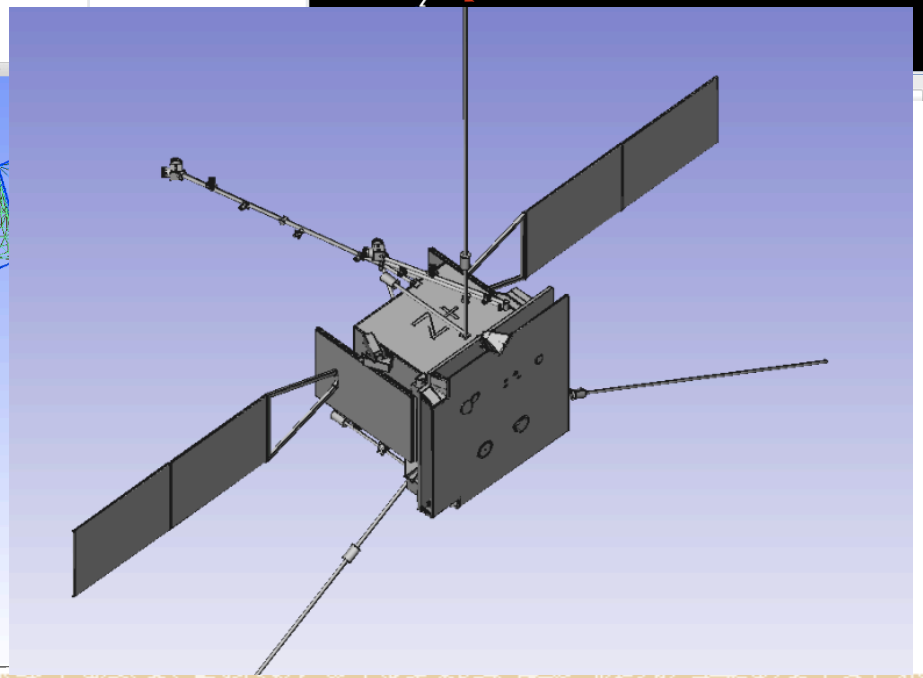
SPIS

CAD Interoperability

- STEP importer through Gmsh (OpenCascade based)
- Tessellated geometries importer (Penelope)
- Interfacing with external CAD tools (e.g. JCAE, FreeCAD, CATIA...)







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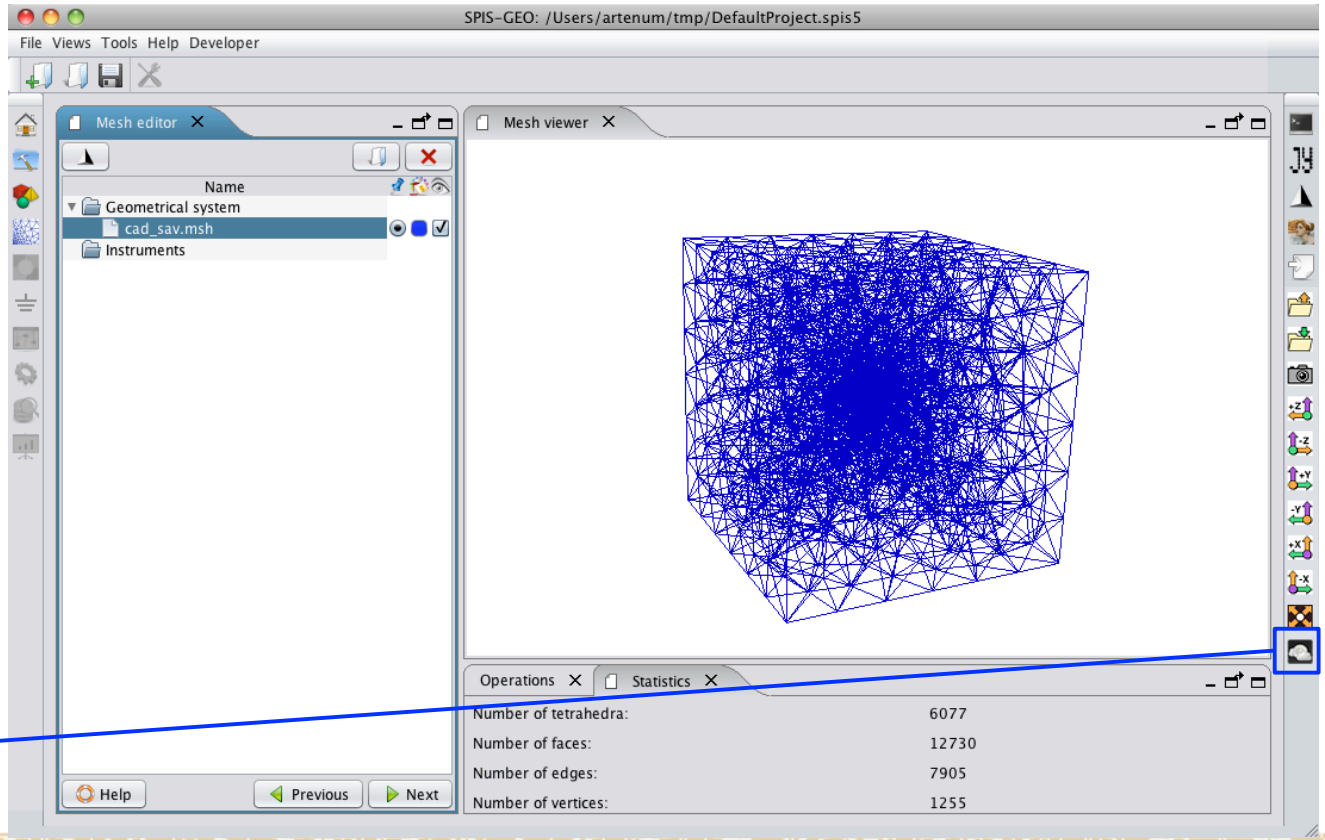
User interface overview – Mesh editor

- Mesh statistics
- Possibility to directly import existing mesh files in various formats (gmsh, STL, UNV...)
- Mesh operations mechanisms: currently, one operator provided to change the orientation of mesh faces (used for 2D thin elements)
- Mesh statistics information



Sharing with Cassandra Cloud

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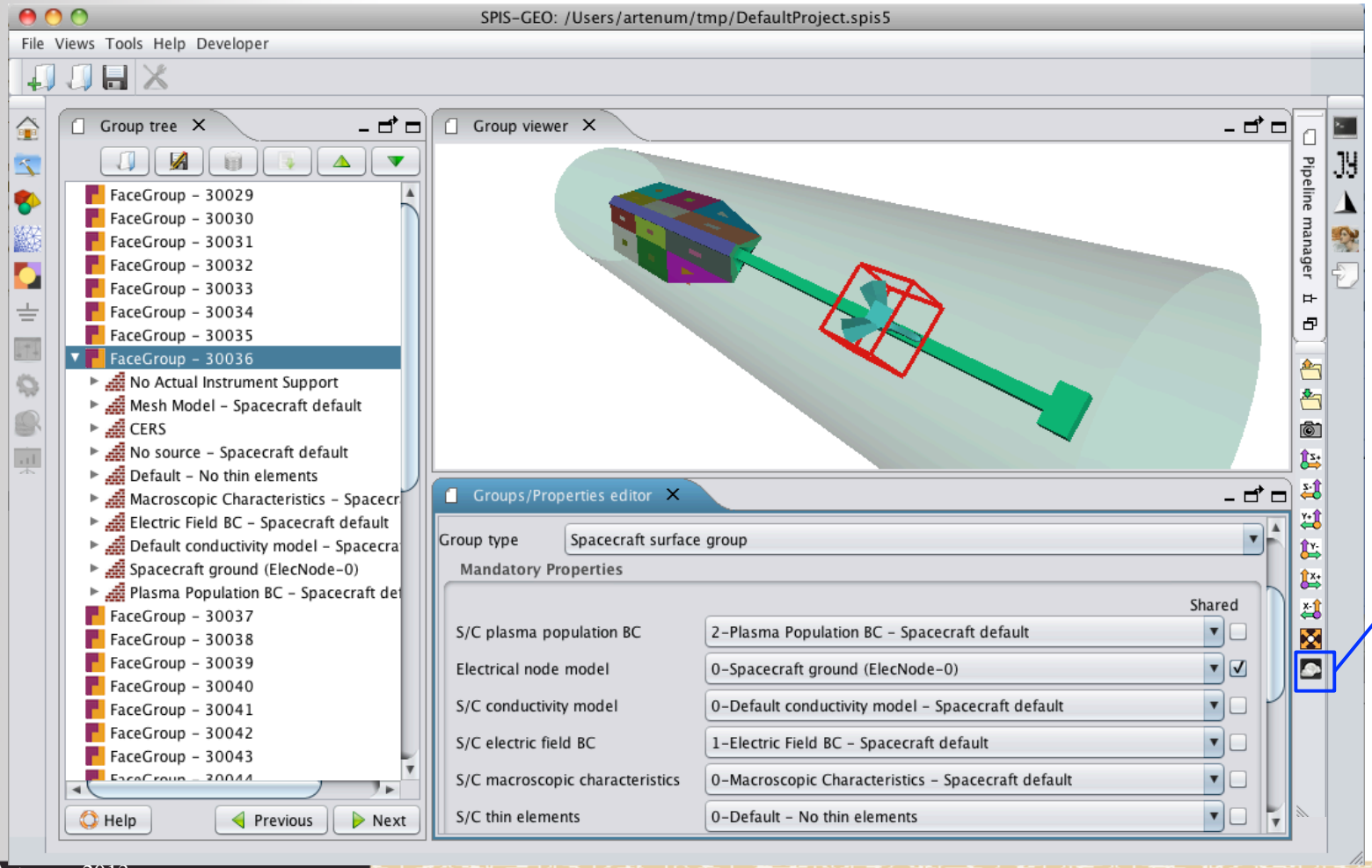
Properties and Groups editor

- Simplified edition of the group properties allocation and edition
- Based on the Frida library



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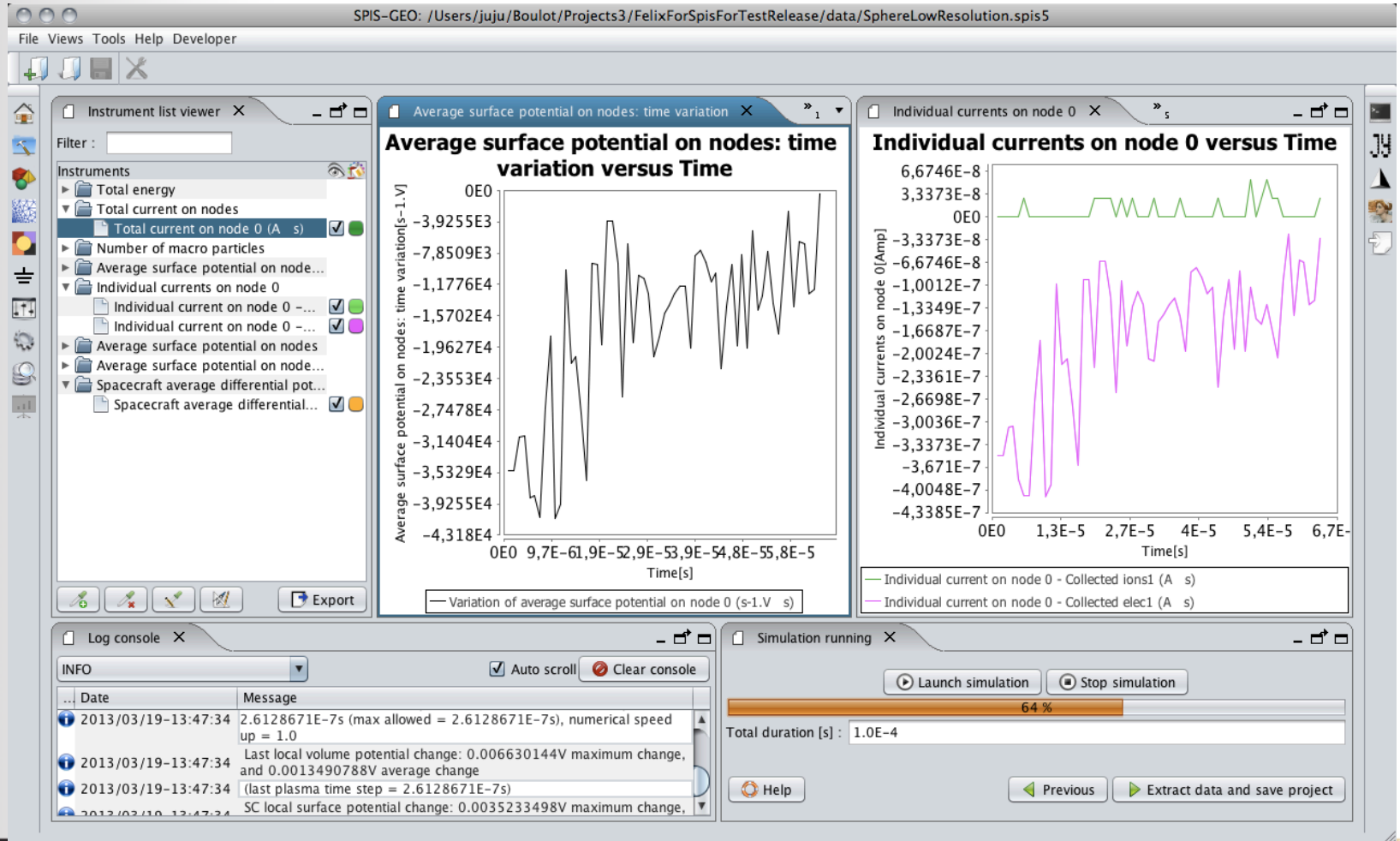
User interface overview – Simulation control & monitoring

- Simulation control: start / pause / stop
- Real-time monitoring: displays key parameters of the simulation



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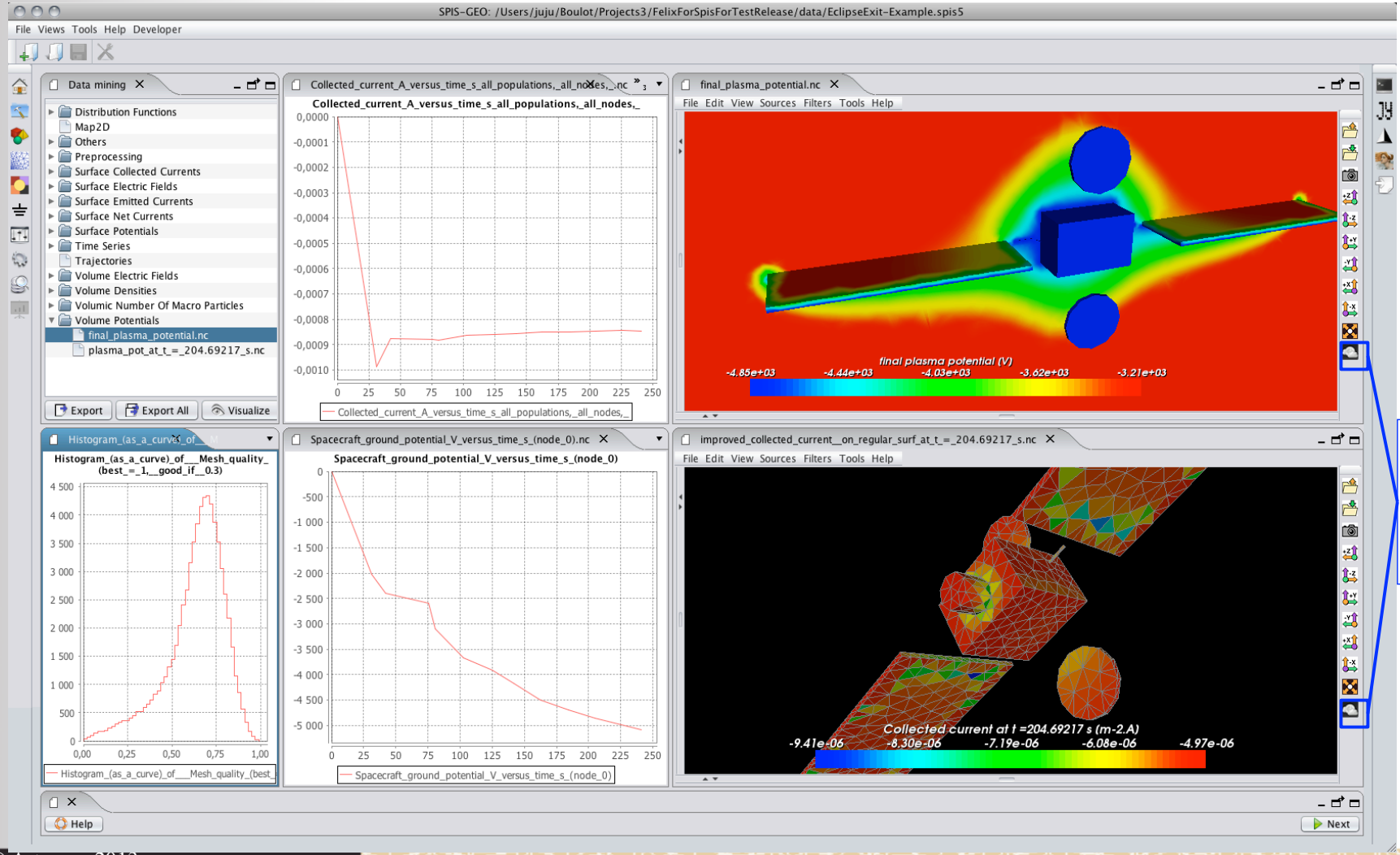
Post-processing

- Rich 2D/3D post-processing tools



Sharing with Cassandra Cloud

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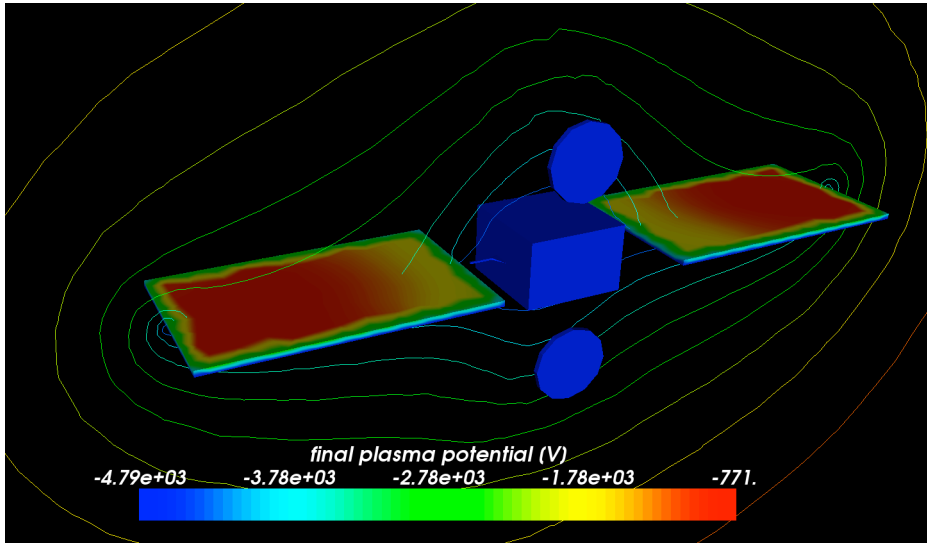
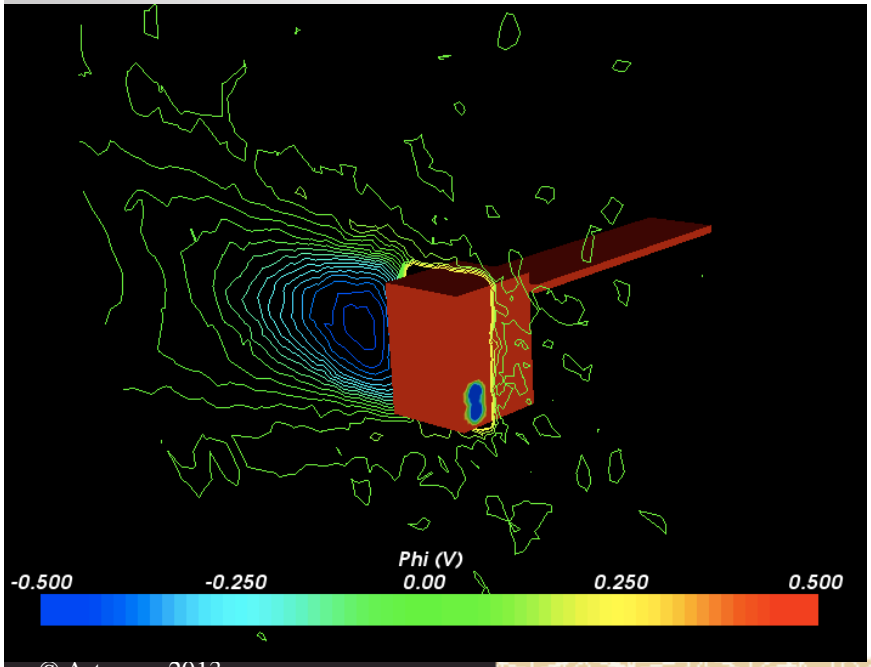
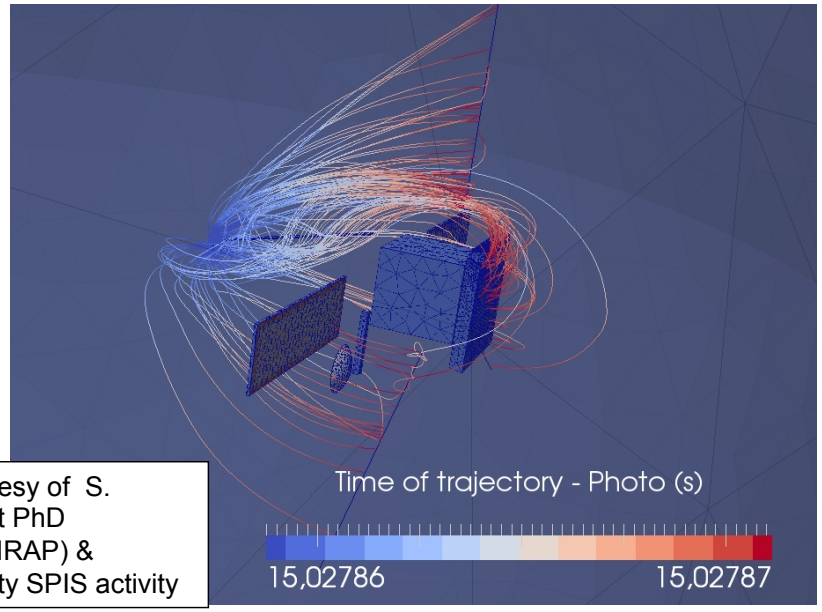
SPIS

3D Post-processing

- Multi-data analysis and filtering
- Rich post-processing pipeline
- Sharing over the Web with Cassandra Cloud Service







With courtesy of S. Guillemant PhD (ONERA, IRAP) & ESA activity SPIS activity

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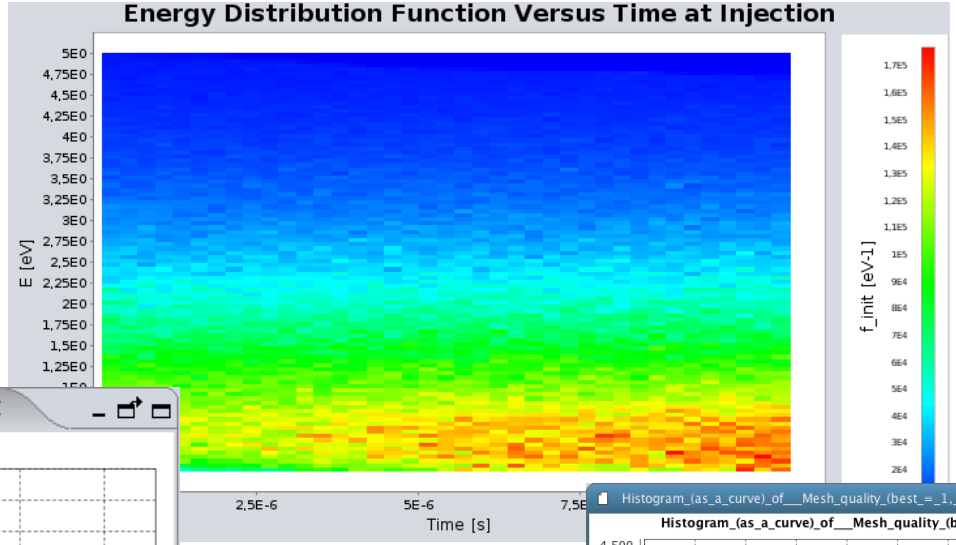
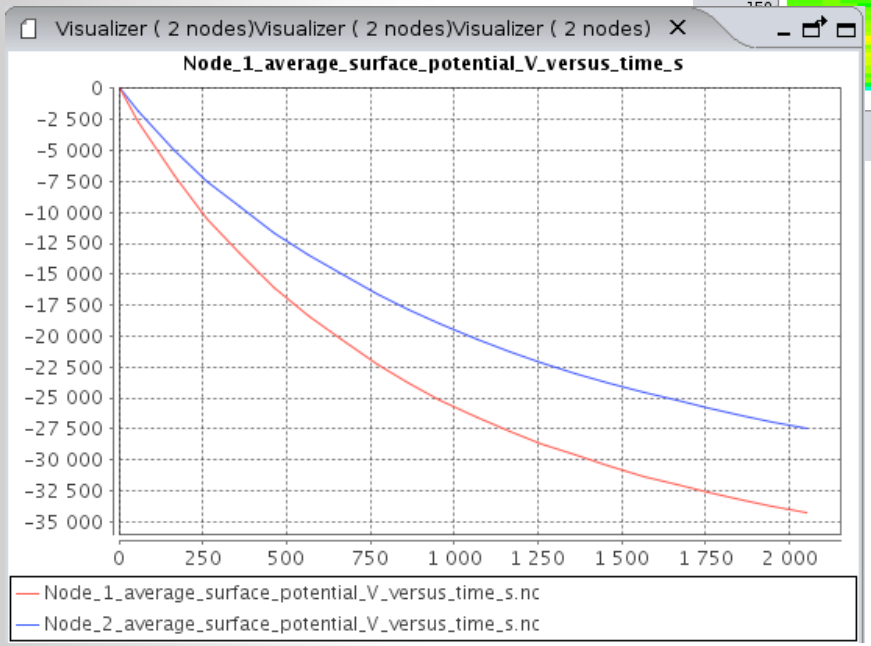
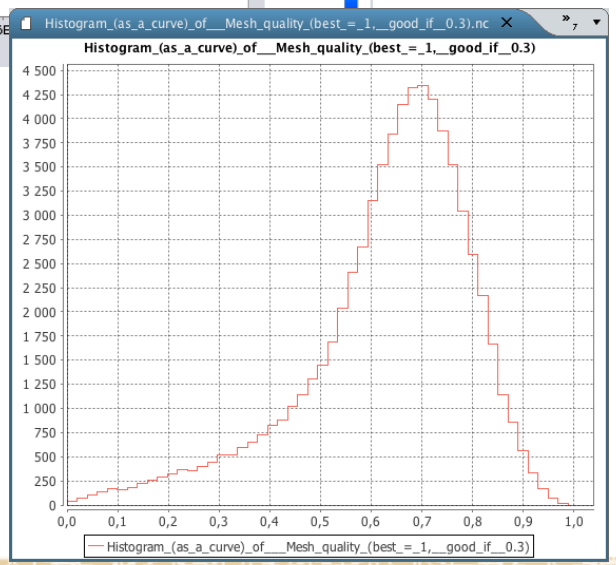
2D Post-processing

- Rich 2D post-processing capabilities, based on JFreeChart 2D plotting functions
  - times series
  - histograms







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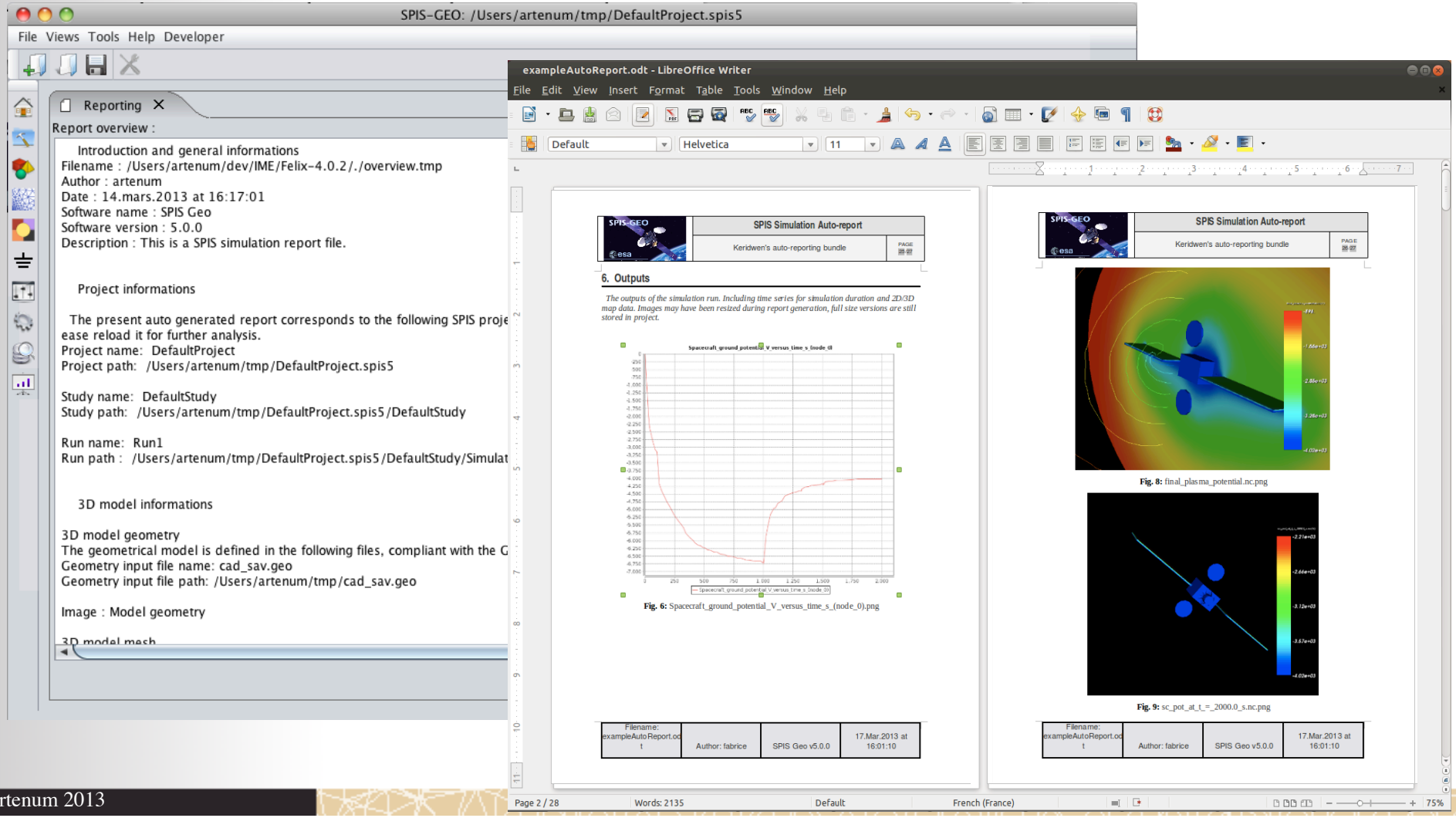
Auto-reporting

- Automatically generated OpenOffice reports



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Conclusion and perspectives

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Conclusion & perspectives

- New modelled systems, new needs in the modelling process
- As an IME solution, **Keridwen** aims to address them
  - Lightweight and modular solution
  - Adaptable
  - Based on industrial standards
- Need of data sharing and visualisation over the Web appears at several levels along the modelling chain
- The **Cassandra Cloud** service, based on X3D, has demonstrated the possibility to exchange data/visualisation in an efficient way.
- **Keridwen** and **Cassandra Cloud** have been successfully tested on a real-life use case **SPIS**.

- Other applications currently under investigation
  - Remote HPC: simple data extraction and visualisation
  - Remote non-regression test suite: simple data extraction and visualisation
- Cassandra Cloud is still experimental and should be further improved/tested

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More info

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