Systema-Thermica

European Space Thermal Engineering Workshop 2023

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DEFENCE AND SPACE

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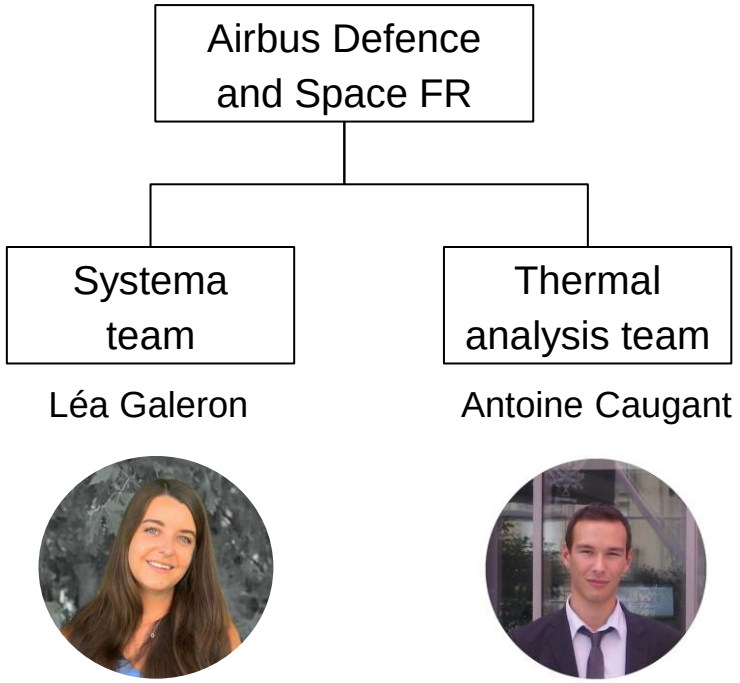
Agenda

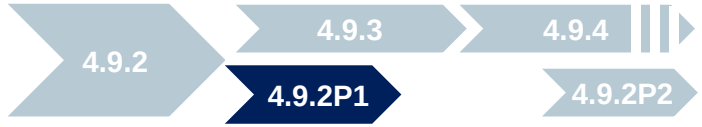
- Systema 4.9.2P1 Overview
- Systema 4.9.3 Overview
- Systema 4.9.2 Thermal validation
- Conclusion



Systema

Systema-4.9.2P1

Overview



Systema - Thermica LTS 4.9.2P1 April. 2023:

Systema-4.9.2P1 is the **maintenance version** of the current 4.9.2 Long Term Support (LTS) version.

Several bugfixes including:

- Kinematics : fixed the definition of ecliptic north pointing law with Orekit library
- Several corrections on the Python API, support of h5py python module on Linux, …
- Prevent scrolling up the edition panel when editing a field
- Wrong selected nodes on specific items after re-opening meshing fixed
- Specific item definition lost when modifying a shape fixed
- Step-Tas model exchange improved

Thermica/Thermisol:

- Added the possibility to export any real or integer user entities and Thermisol variables in h5 file
- Increased precision of geometrical position and normal export in nodal description output

And a new application **Airdrag** was released !

KEY MESSAGE
Do not hesitate to send us some feedbacks !

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Systema

Systema-4.9.2P1

New Airdrag

What

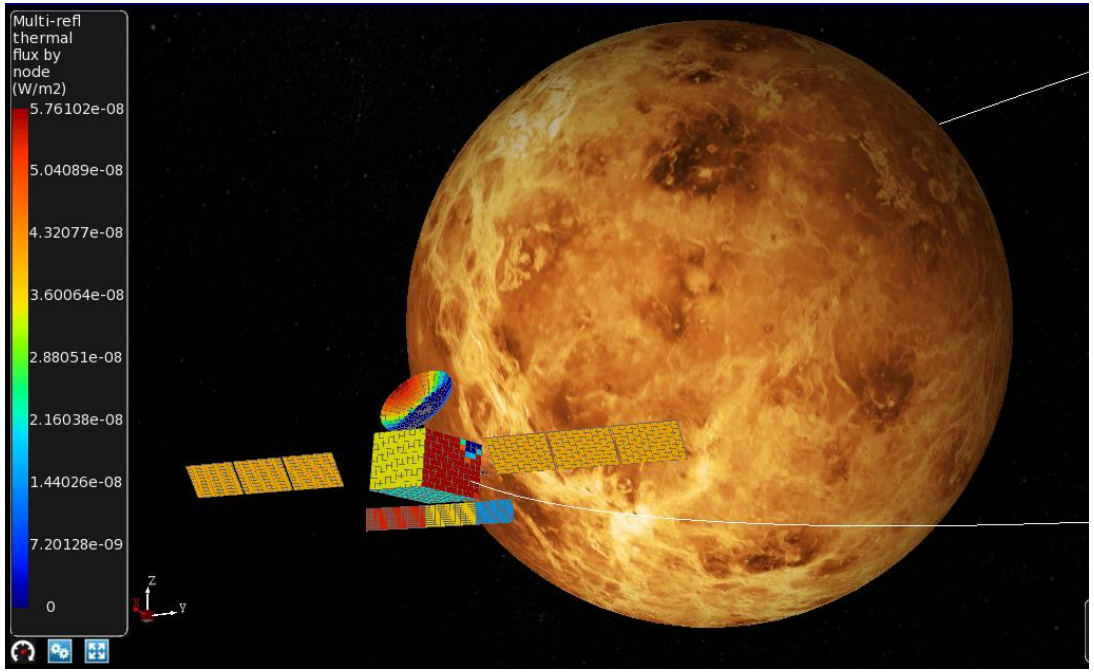
Modeling of main **forces** and **torques** and **thermal fluxes** induced by **residual atmosphere** for low orbiting spacecraft

Why

- In orbit control
- Attitude control
- Sizing of thrusters, momentum wheel, tank, …

How

- An accurate method based on Monte-Carlo Ray-tracing technique
- A fast algorithm for approximate computation based on integrated equations



What else

- Handle masking effects and multi-reflexion
- Thermal agitation also considered
- Includes Earth NRLMSISE-00 atmosphere and HWM07 wind model (possibility to replace it with constant values for other planets)

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Systema

Systema-4.9.3

Overview

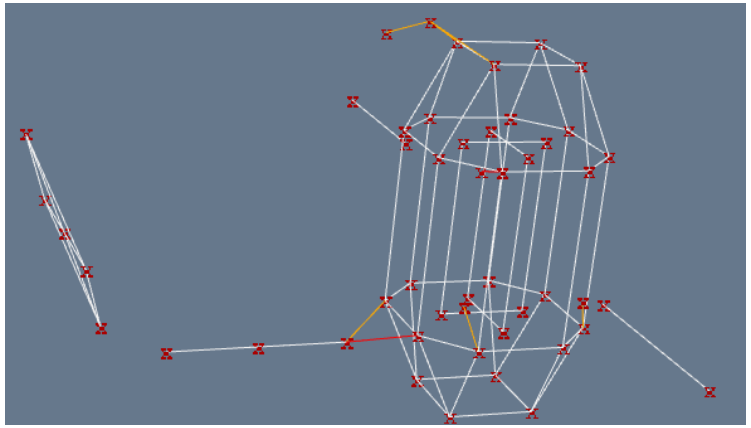
Systema - Thermica 4.9.3 Sept. 2023:

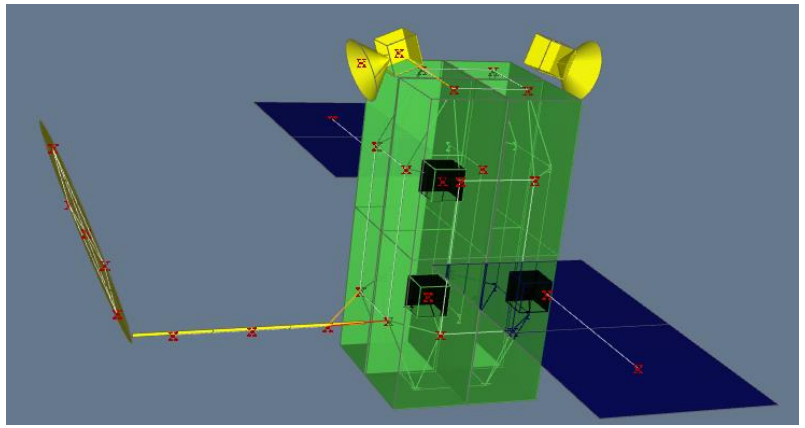
Focus on the robustification of Systema and the applications while working on the V5 specifications

Non-exhaustive feature list:

A faster dialog is used to select files

The color of help items can be set to ease screenshots





The precision of the calculation of orbital parameters has been improved to support you on your future interplanetary mission modelling

Several new methods were added to the Python API, and it now includes screenshot possibilities […]

DID YOU KNOW ?

In the “doc” directory of Systema installation folder you can find the release notes and know everything about the new versions ! You can also find them on our website !

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Systema-4.9.3 – Zoom on screenshot feature with the Python API

Dedicated to
create and modify data

Now

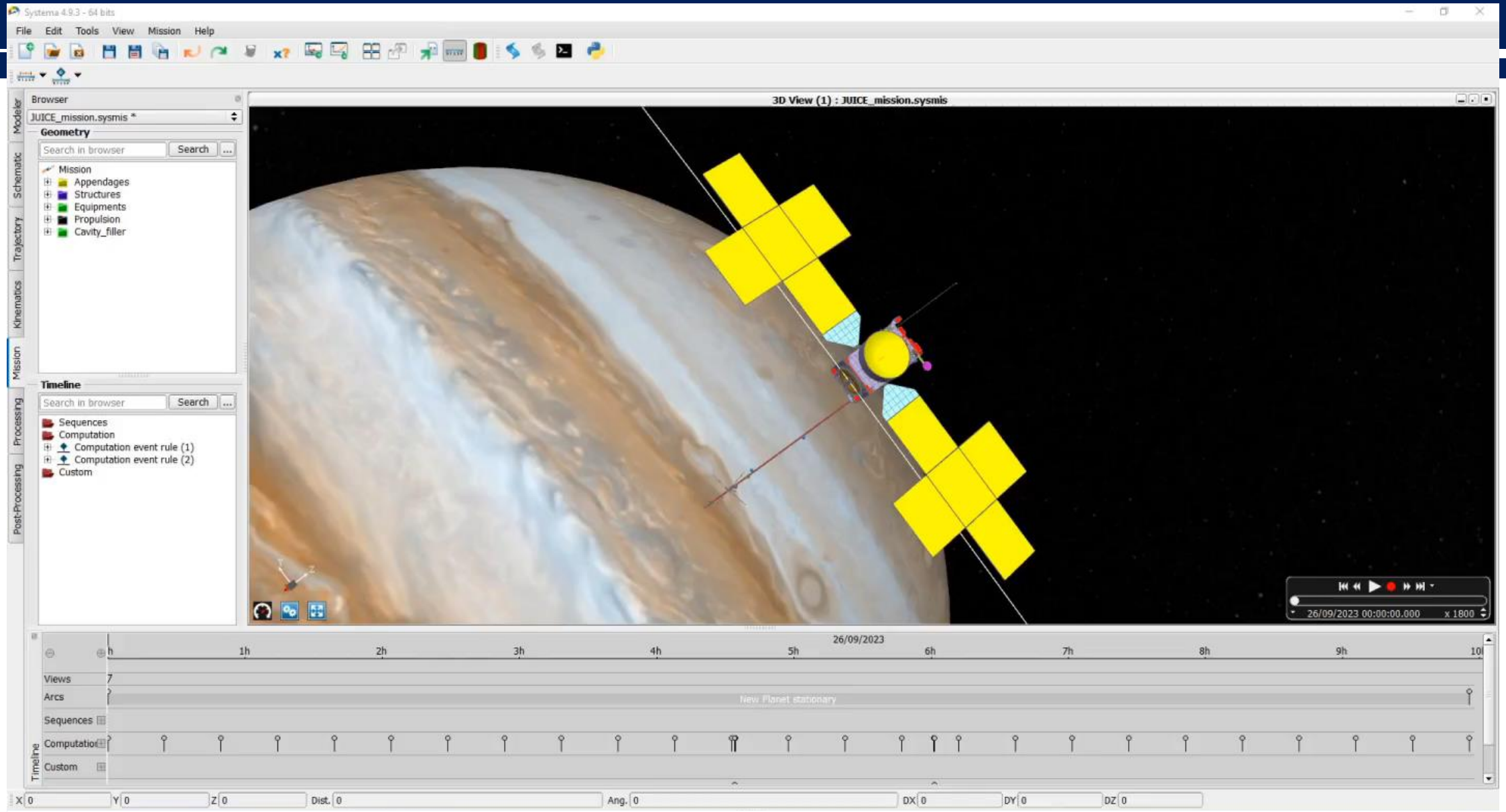
Also **create and tune 3D views:**

- Set the entity to display
- Add textual information
- Move the camera
- Manage the player
- Change the background color

All of this using Python API to allow you to automatize sceenshots of 3D views

KEY MESSAGE
Systema Python API is now reaching a high degree of maturity

Systema-4.9.3 – Zoom on screenshot feature with the Python API



Systema

What's next ?

4.9.4

- Oriented on technical applications, for example: improvements on the solar lamp to allow ambient tests
- No major improvement on graphical user interface
- Scope will be defined according to your needs and feedbacks

4.9.2P2

- Maintenance version of the current Long Term Support (LTS) version
- On user demand if blocking issue

5.0

Current activities

- Definition and specifications
- Redesign of our development environment with more modern and more efficient technologies

Developments will start next year !

Objectives

- Better visualization tools
- Model comparison
- Post-processing
- Facilitate parametric analysis
- Modularity
- Maintainability
- Easy migration V4 → V5
- …

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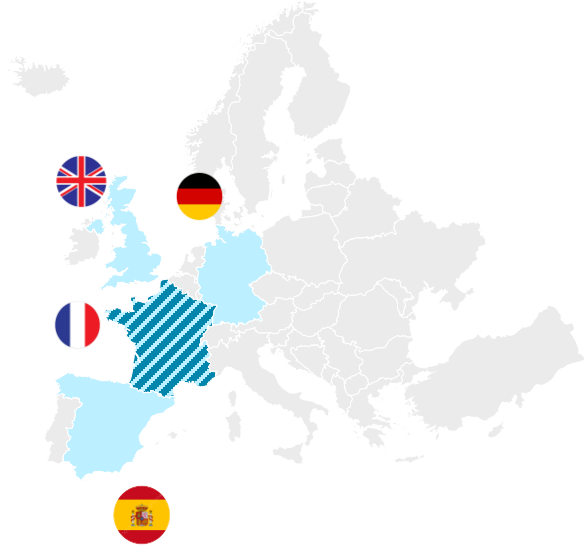
Systema 4.9.2

Thermal validation

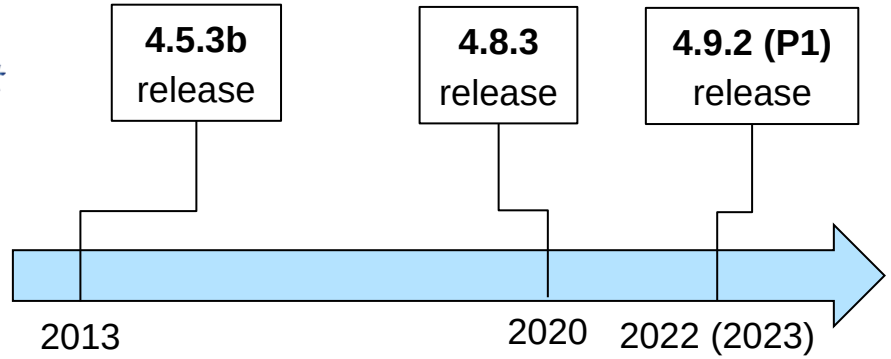
Motivations & challenges



- **Systema-Thermica at ADS:**
  - More than 100 internal users (90% in thermal)
  - Across 4 different countries
  - Mainly using **L**ong **T**erm **S**upport versions (LTS)

- **Thermal users validation is required to:**
  - Verify compliance with current IT environment
  - Check industrial cases non-regression

- **4.9.2 LTS motivations:**
  - Future interplanetary missions modelling
  - Performances optimizations (Thermisol & GUI)
  - Scripting API improvements (Python)
  - Model exchanges with Step-TAS checker



- **Validation challenges:**
  - Transnational coordination in parallel of S/C projects
  - Tests coverage must be as exhaustive as possible at low cost

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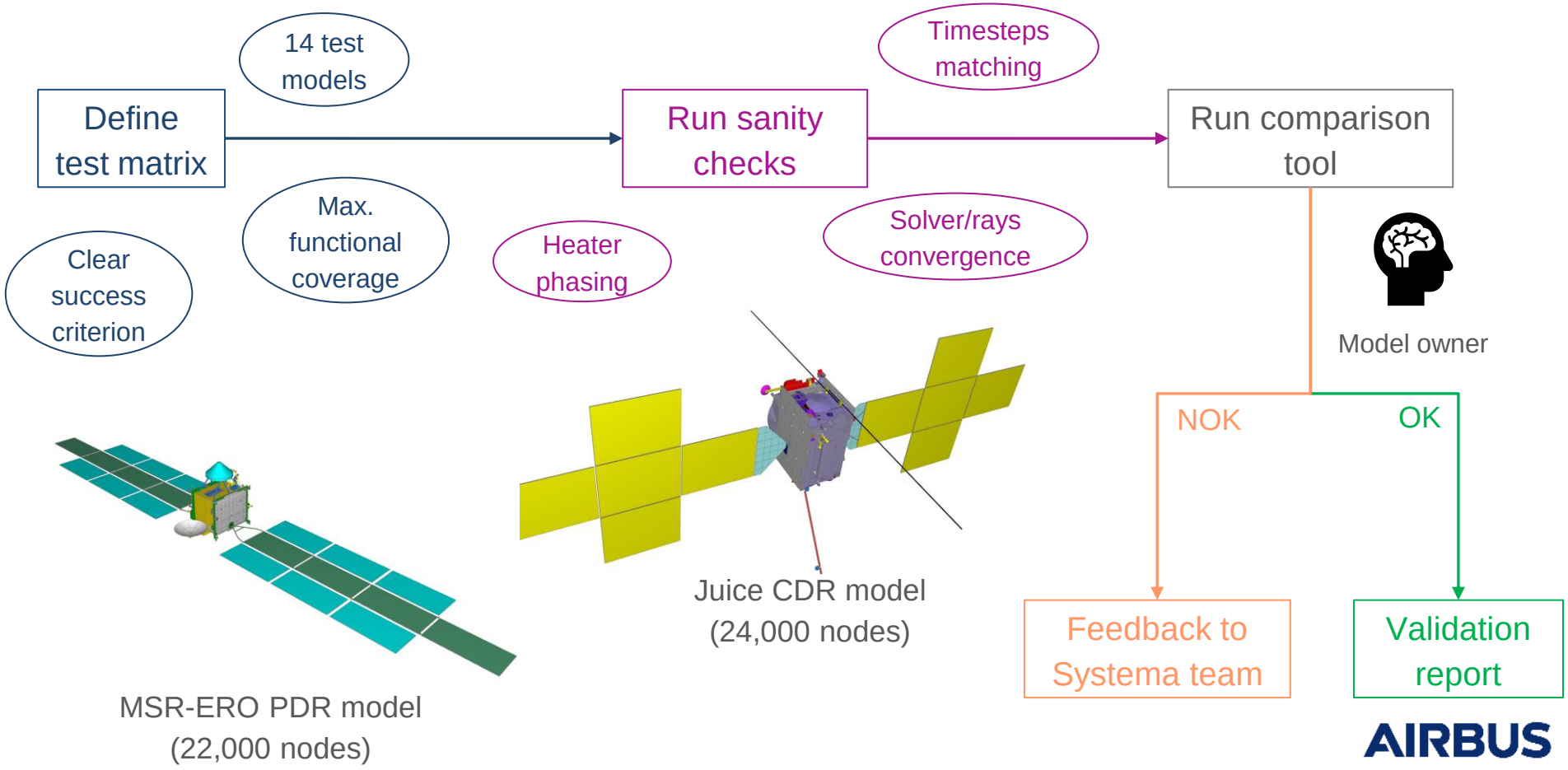
Systema 4.9.2

Thermal validation

Methodology

- **Systema-4.8.3 validation retex**
  - The validation work should be supervised by model owners in each domains/sites
  - Need for common process and tools to support model owners
- **Validation methodology**



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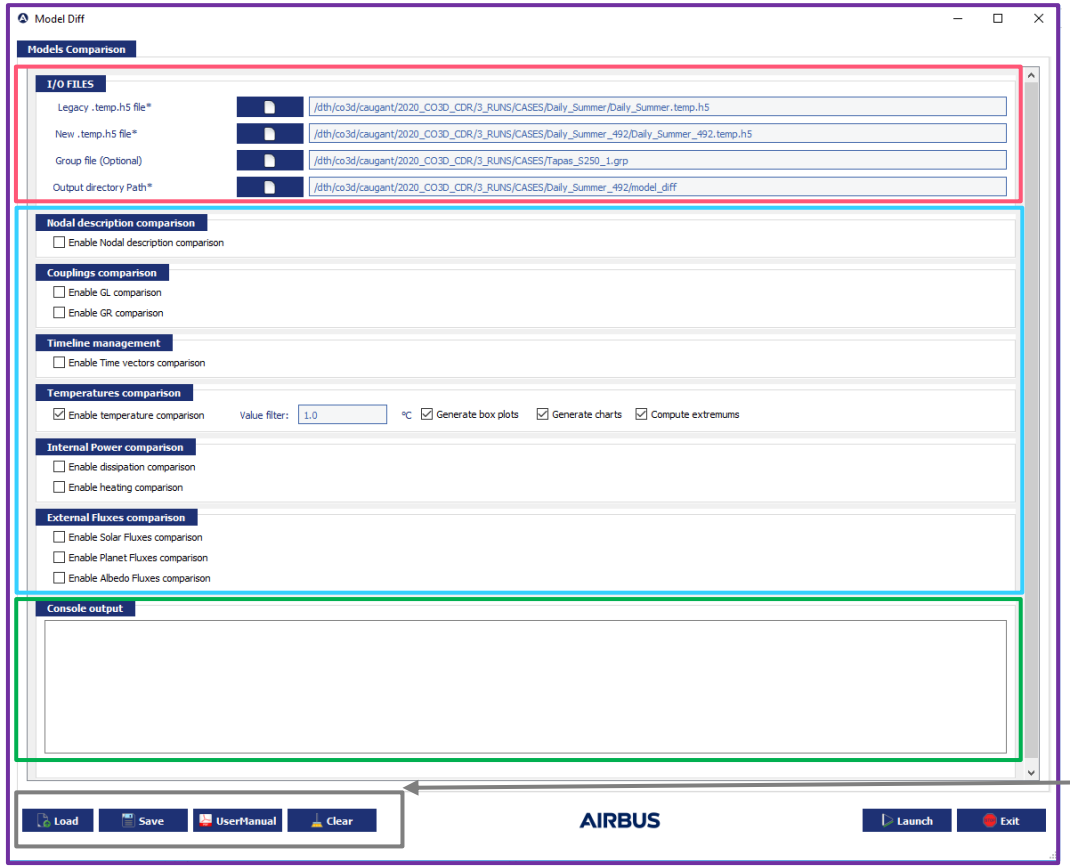
Model Diff tool



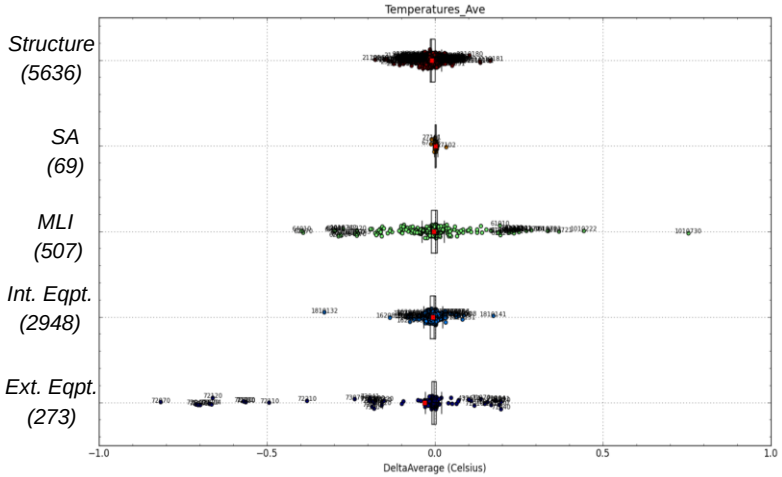
Model Diff user interface

Inputs definition (H5 files, groups file, output folder)

Comparison options (nodal desc., GL/GR, results, …)

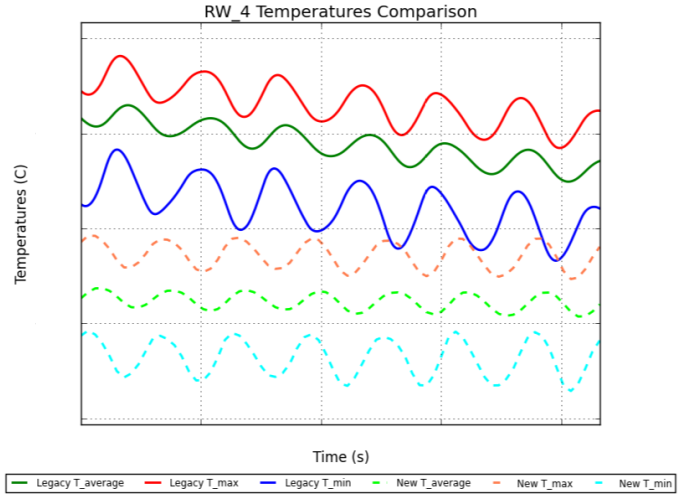
Outputs console

Parameters saving / loading (for batch comparisons)



Box plots

Excel report



2D curves

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Systema 4.9.2

Thermal validation

Validation first results

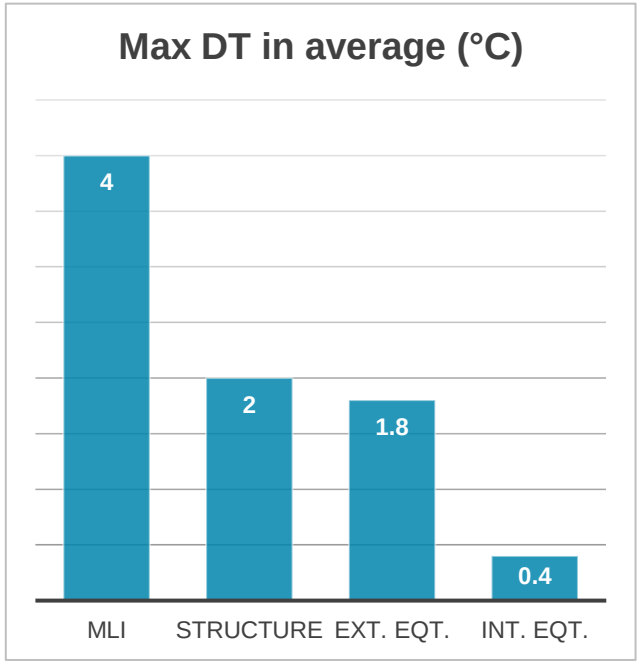
- Overall validation should be finished by the end of the year (FR part already finished)

- Slight changes in orbital calculations but neglectable impact on external fluxes
  - Eclipse dates are changed but Δduration < 0,5%
  - Sun distance/incidence are changed but ΔCs < 0,03W/m2 around Earth and Δincidence < 1°

- Some reference frames are changed:
  - Sun (now has an intrinsic rotation)
  - Moon and custom moons (Ganymede, Phobos, …)

- Blocking bugs were corrected in 4.9.2P1 patch
  - Wrong definition of ecliptic north pointing law
  - …

- Temperature differences are acceptable without time-consuming model updates



Global results of FR validation (8 cases)

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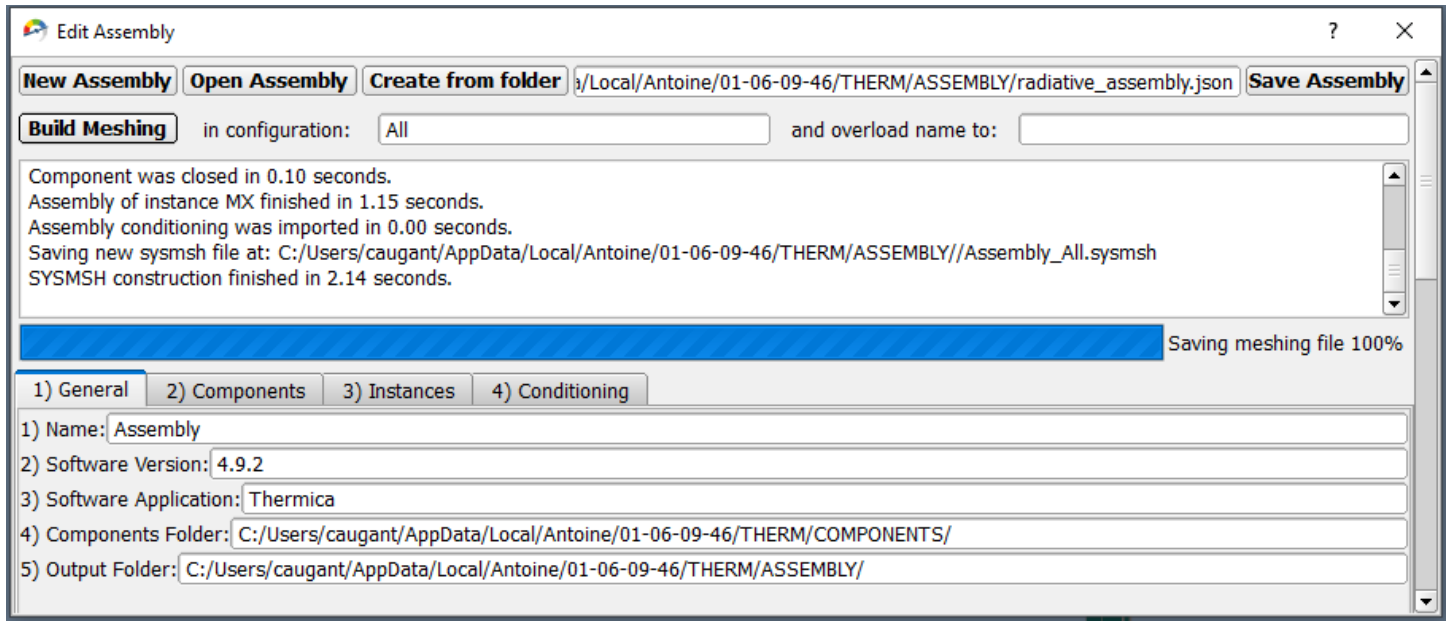
Benefits of migration

- **Performances improvement**
  - Thermisol run durations reduced up to -40%
  - Model saving duration on network drive reduced by 95%

- **User-defined PyQt4 GUI for:**
  - Geometrical model optimization
  - Assembly of geometrical sub-models



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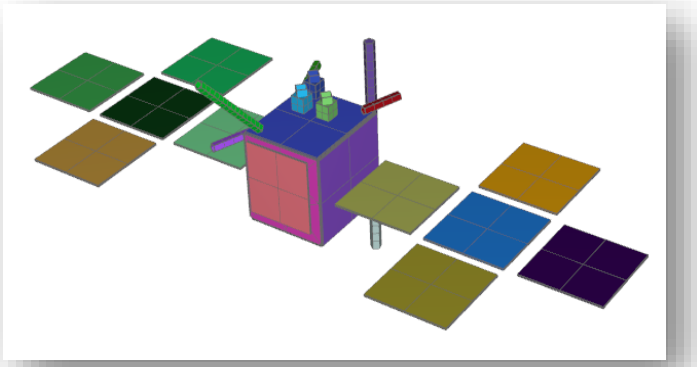
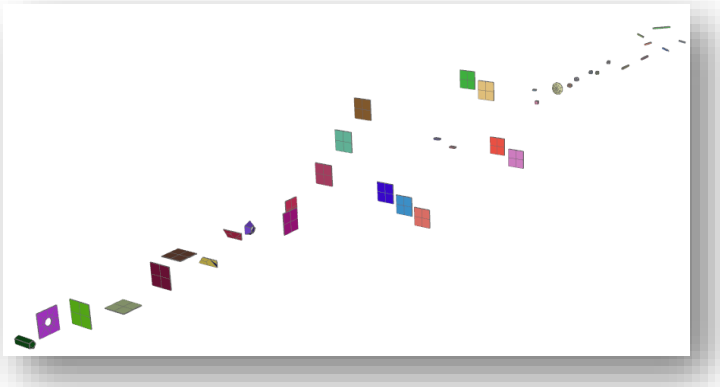


Radiative model



Conductive model

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Systema 4.9.2

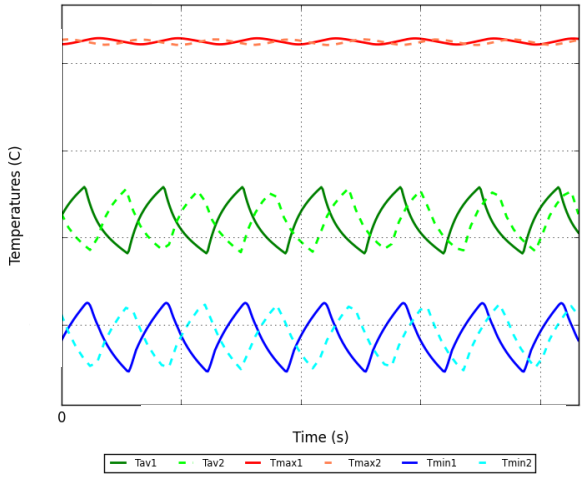
Thermal validation

Model Diff re-use applications

- **ESATAN / THERMISOL comparison of JUICE model**
  - Conversion .TMD → .temp.h5 (Python script)
  - Input: analysis groups

  → Overall deltas are acceptable

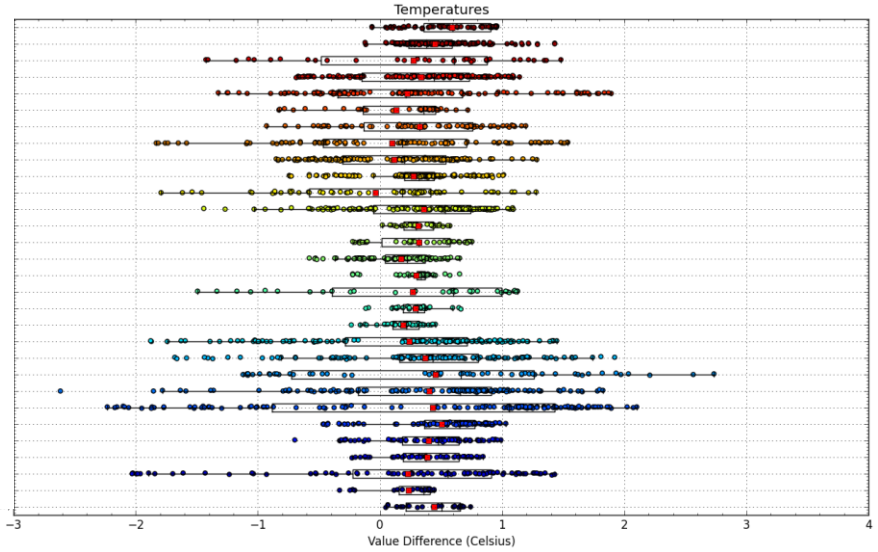
  → Differences in heating law modelling were detected



ESATAN vs Thermisol curve comparison

- **Detailed vs Reduced model comparison for Coupled Launcher Analysis**
  - Input: Reduced-Detailed nodes mapping

  → ECSS compliance is demonstrated



Max deviations for each reduced node (entire timeline)
Detailed vs Reduced model (CLA activity)

- **Validation of simulator models**
  - Comparison between physical model results and operations simulator outputs

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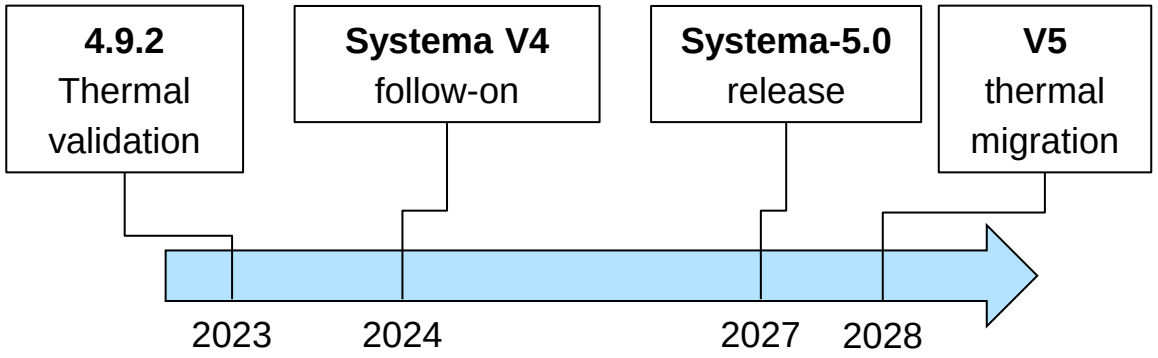
Conclusions & way forwards

- **Systema-4.9.2P1 L**ong **T**erm **S**upport Version (LTS) was released in April 2023
  - It includes a new application called **Airdrag**
  - Its thermal validation should be finished by the end of 2023
  - Very good feedback from the ADS thermal analysis teams
- **Systema-4.9.3** has been released on September 29th
- **Systema-4.9.4** and **5.0** developments are starting soon

- Migrating from one software (version) to another is way easier
  - Model diff tool is shared within the ADS thermal community
  - The thermal validation process should be applicable to V4→V5 migration
  - Systema team could include user models in their validation (under NDA)



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