Appendix D

SYSTEMA/Thermica V4

Timothée Soriano
(Astrium, France)

SYSTEMA / Thermica V4

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Timothée SORIANO
Astrium
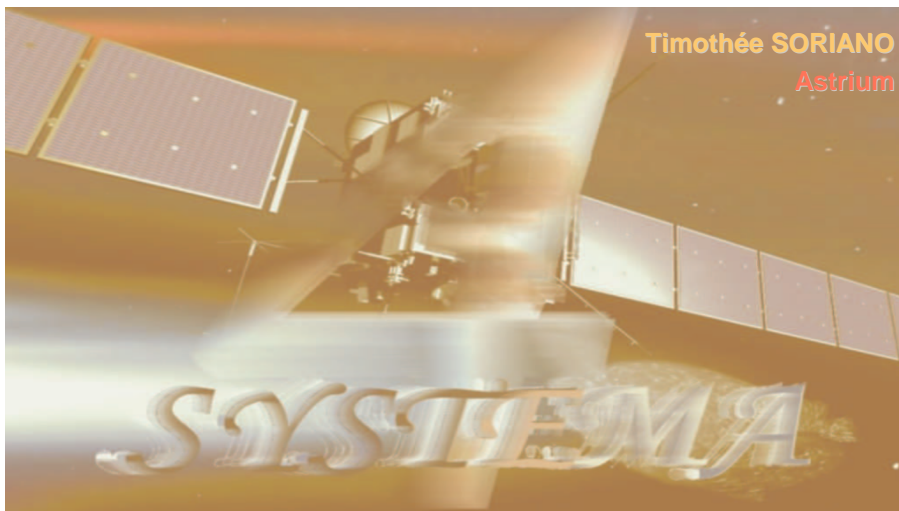
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Content

- **Overview**
- **Modeler**
- **Trajectory**
- **Kinematics**

- **Mission**
- **Processing**
- **Visualization tools**
- **Conclusion**

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Introduction

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❑ **Current release of THERMICA : v.3.2.30 (October 2006)**
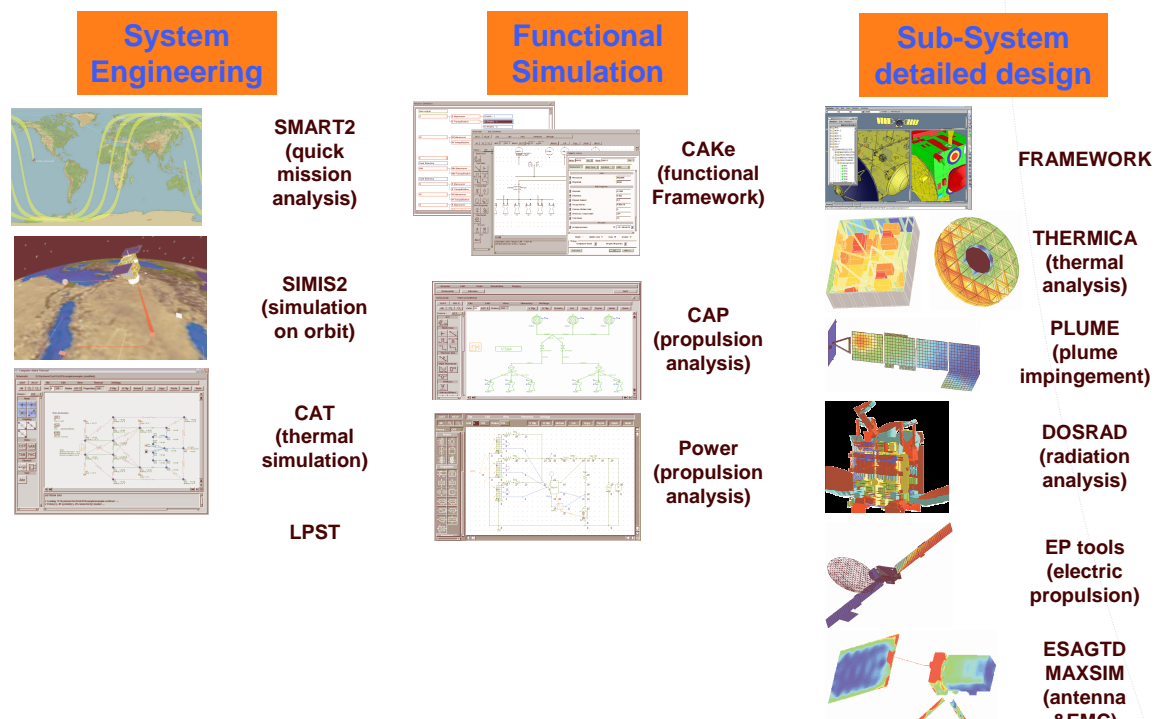
 ✓ **Unlimited radiation module**

 ✓ **New conduction module (physical approach)**

 ✓ **Mapping module (to interface mechanical meshes)**

 ✓ **Sun at finite distance**

 ✓ **And all functionalities developed for the V3**
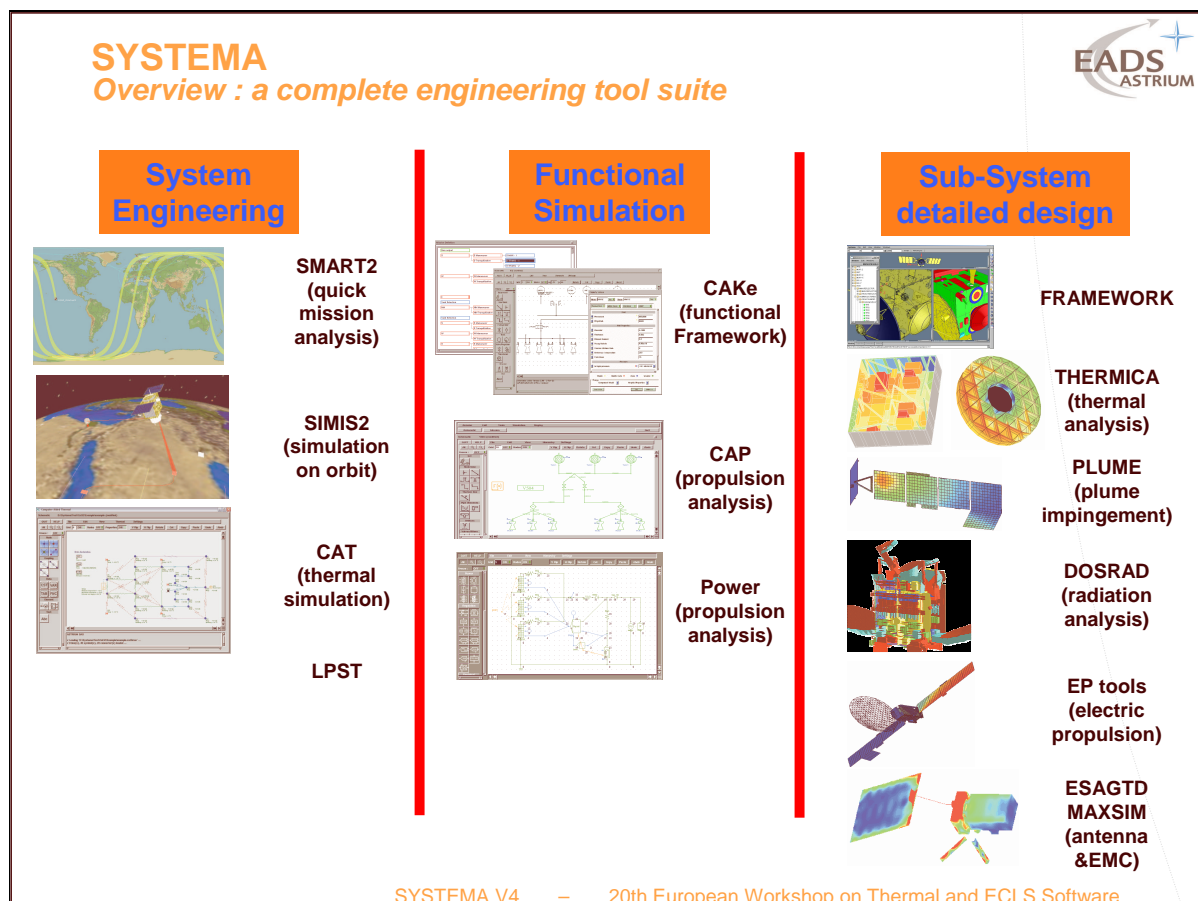
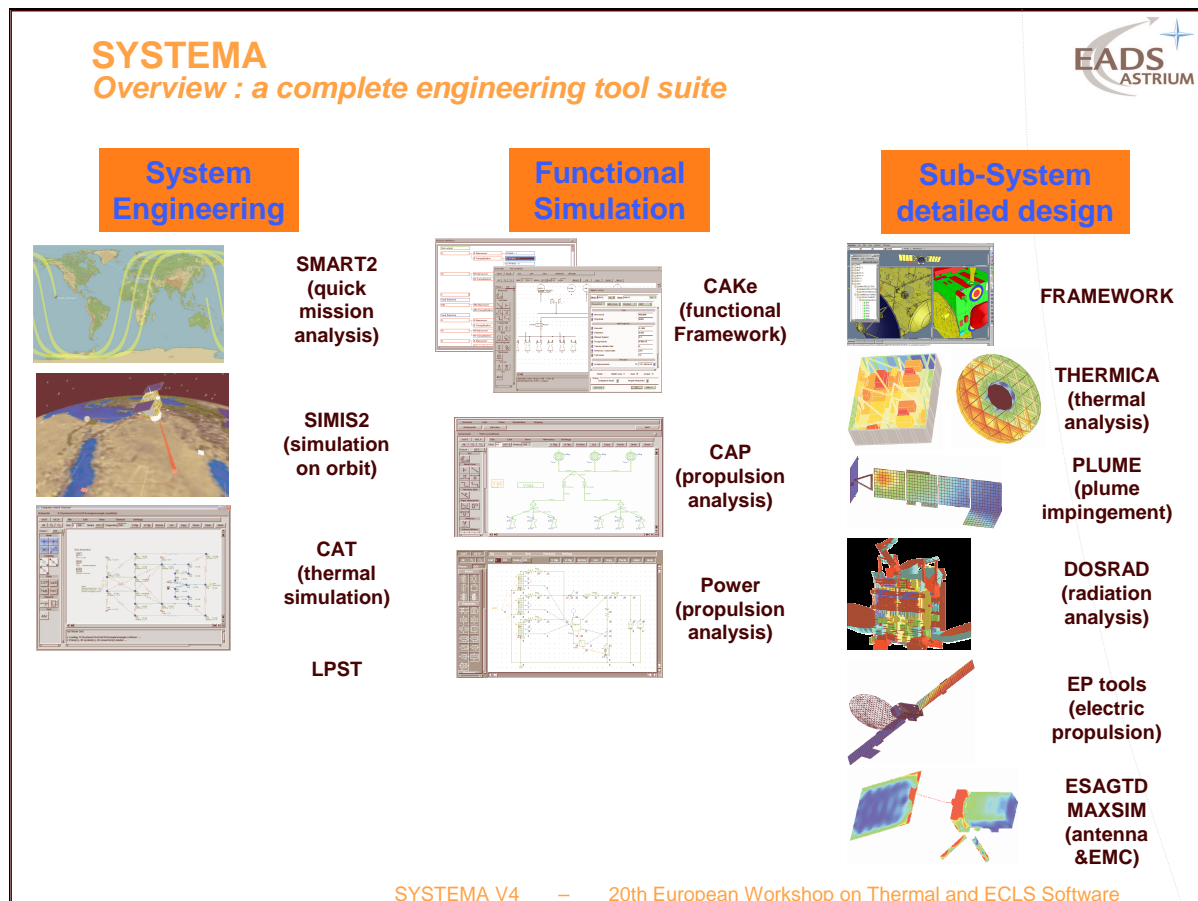❑ **SYSTEMA/THERMICA V4 release**

 ✓ **High interactivity level**

 ✓ **Improved 3D visualization and motion**
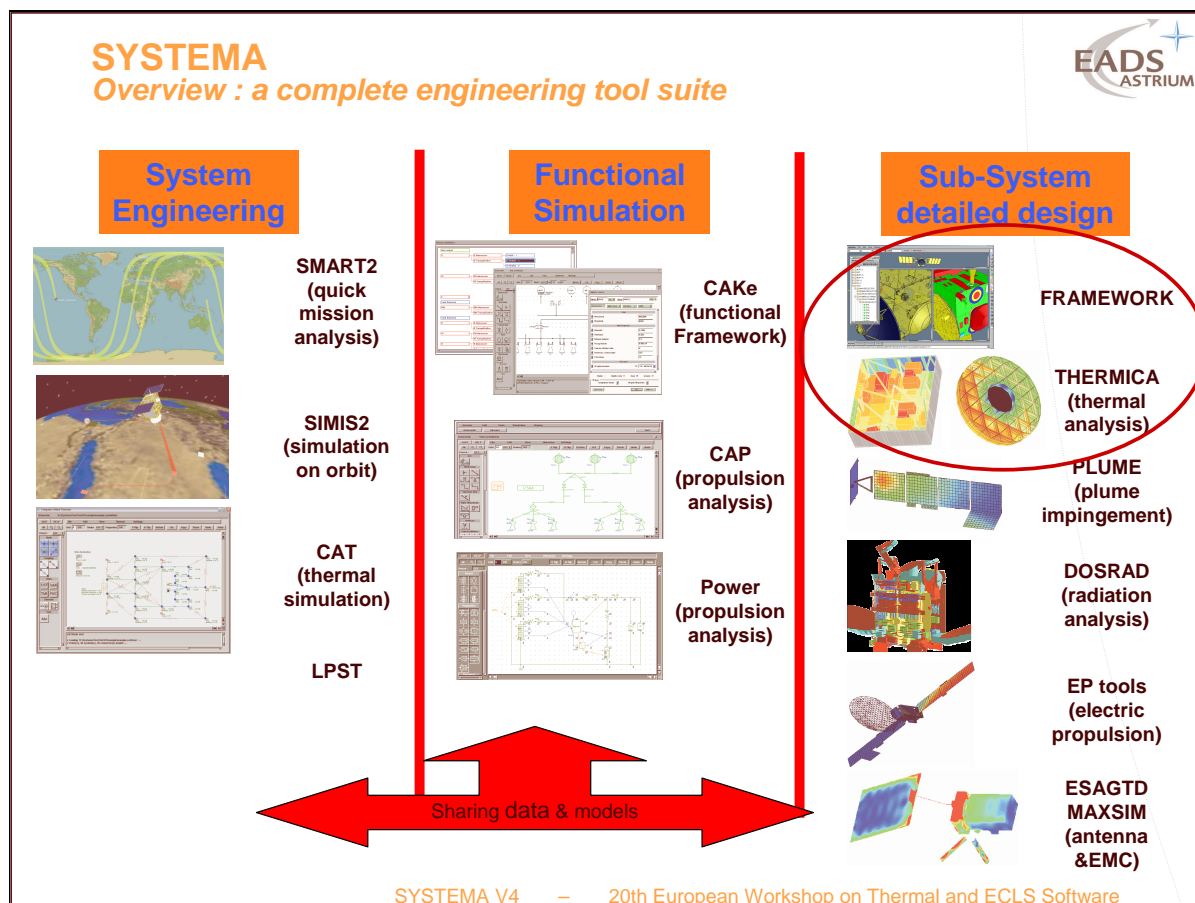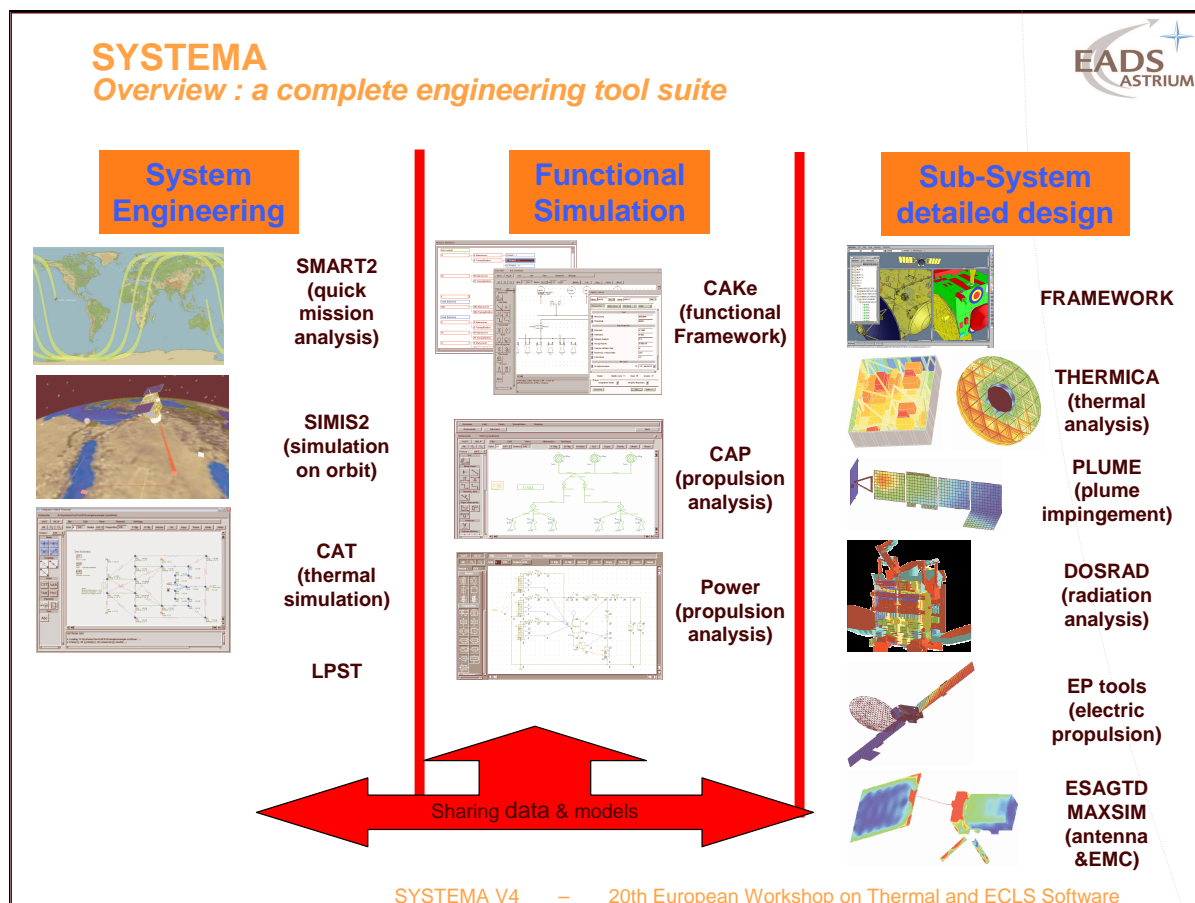
 ✓ **Plug-ins based application Management**

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SYSTEMA
Overview : a complete engineering tool suite

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System Engineering

Functional Simulation

Sub-System detailed design

SMART2 (quick mission analysis)

SIMIS2 (simulation on orbit)

CAT (thermal simulation)

LPST

CAKe (functional Framework)

CAP (propulsion analysis)

Power (propulsion analysis)

FRAMEWORK

THERMICA (thermal analysis)

PLUME (plume impingement)

DOSRAD (radiation analysis)

EP tools (electric propulsion)

ESAGTD MAXSIM (antenna &EMC)

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SYSTEMA V4
Overview : Main goals

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❑ **The goal of SYSTEMA V4 is to propose a large set of applications under the same environment :**

- ✓ **PC / Unix native, compliant with the standard engineer tools,**
- ✓ **Fully interactive, up to date framework capabilities,**
- ✓ **Open for evolution aiming at minimizing the maintenance costs,**
- ✓ **CAD & FEM interface for efficient model generation,**
- ✓ **Based on standard formats for interface (Step , XML, HDF5),**
- ✓ **Common geometry description, compatibility between applications,**
- ✓ **Common definition of trajectory, pointing and kinematics,**
- ✓ **Common use of visualization and pre / post processing tools,**
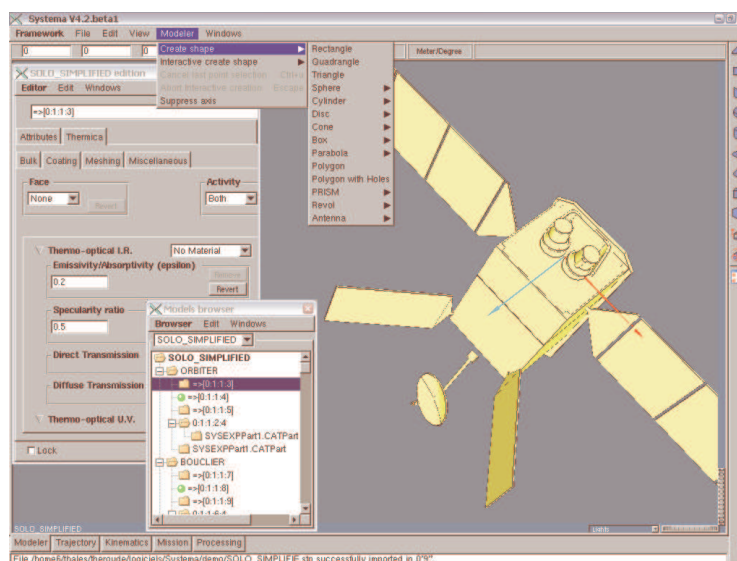- ✓ **Integration of the applications based on a functional description**

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SYSTEMA V4
Overview : Main concepts

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❑ **The user interacts with a desktop where he can access to all the data (geometry, trajectory, kinematics, mission…) in parallel to the applications:**
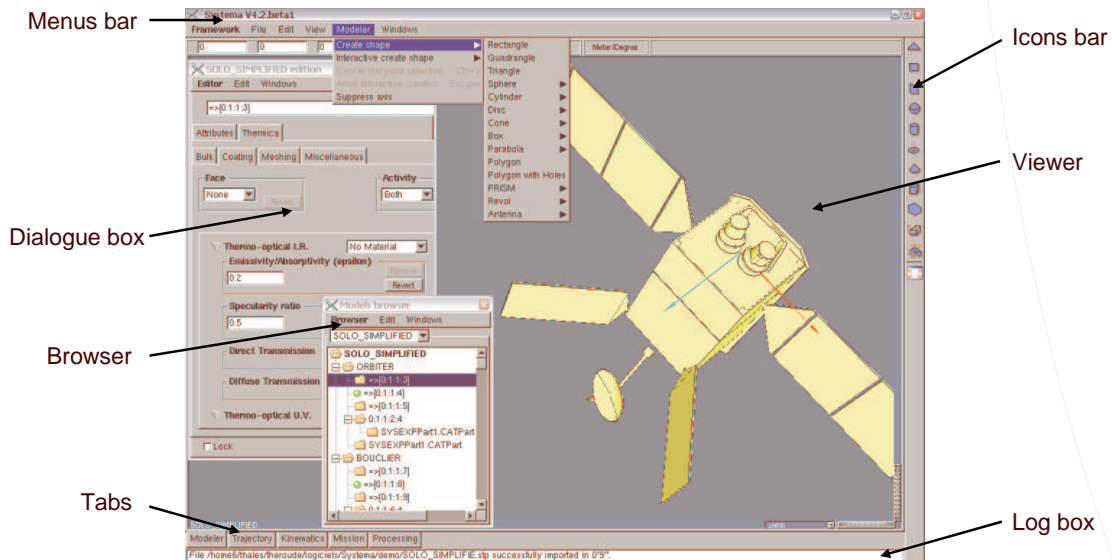

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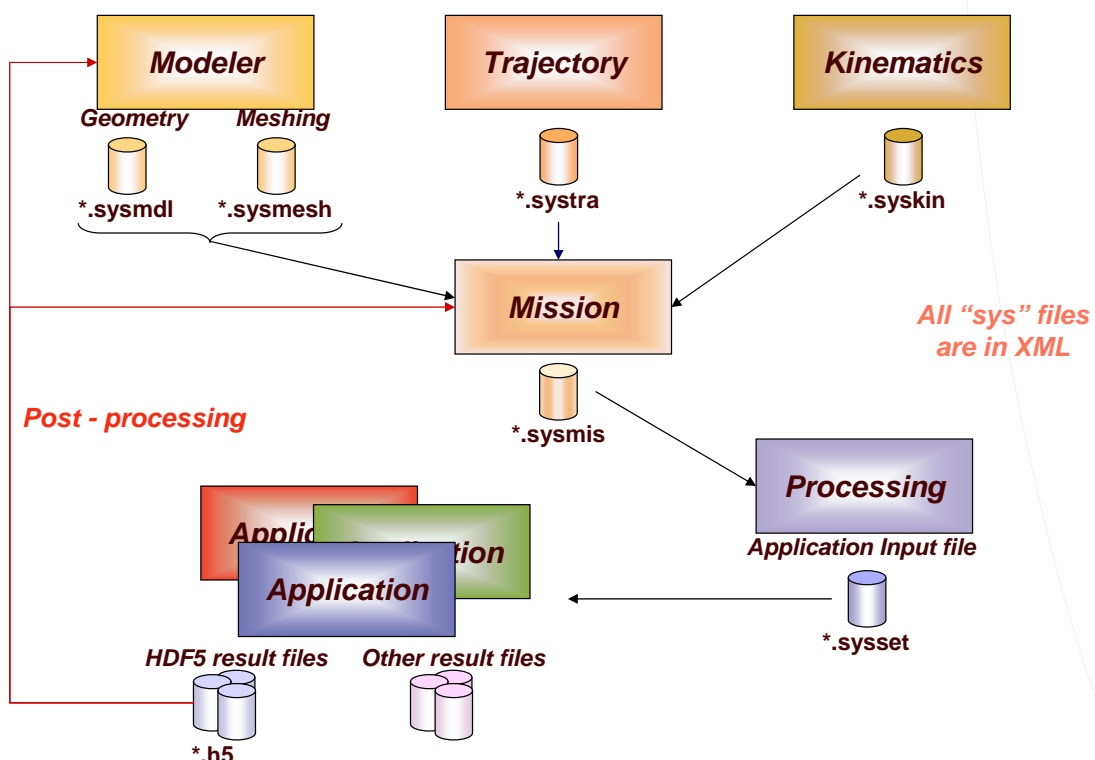
SYSTEMA V4
Overview : Main concepts

❑ **The user interacts with a desktop where he can access to all the data (geometry, trajectory, kinematics, mission…) in parallel to the applications:**

Menus bar

Dialogue box

Browser

Tabs

Icons bar

Viewer

Log box

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SYSTEMA V4
Overview : an open framework

Modeler

Geometry *Meshing*

*.sysmdl *.sysmesh

Trajectory

*.systra

Kinematics

*.syskin

Mission

All "sys" files are in XML

*.sysmis

Post - processing

Processing

Application Input file

Application

Application

*.sysset

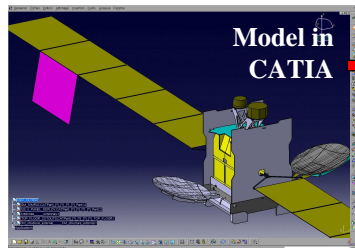**HDF5 result files** **Other result files**

*.h5

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Modeler
Setting the geometry : Import from CAD Models

❑ **Import from CAD Models**

Model in **CATIA** → **STEP Files** → Import in **THERMICA**
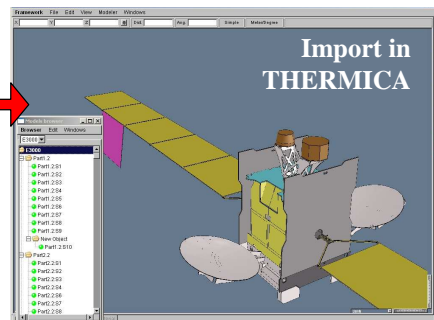
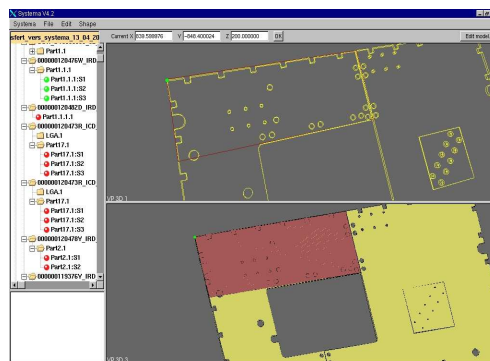❑ **Semi-automatic simplification**

➢ CAD geometry is used as a <u>layer</u> which gives specific points

➢ Pick on specific points to build Thermica shapes

Interactive creation of a Thermica rectangle from the CAD layer

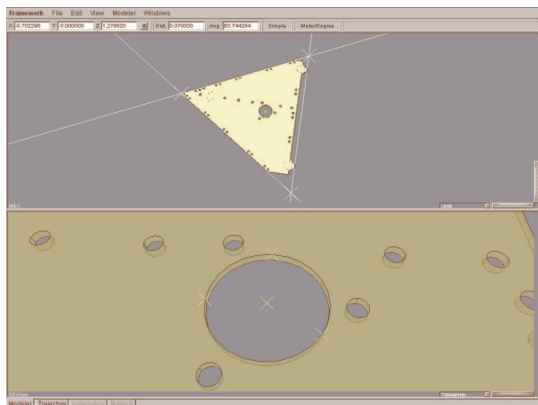SYSTEMA V4 – 20th European Workshop on Thermal and ECLS Software

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Modeler
## *Setting the geometry : User-oriented model construction*

❑ **Multi way point construction**

✓ **3D direct selection**

✓ **Manual edition**

✓ **Virtual point using Helps items**

➢ Grids

➢ Lines to create intersection points

➢ Curve centre with 3 points

➢ Middle of a segment

❑ **Quick shape construction**

✓ Step-by-step interactive construction (by picking points)

✓ Smart construction points (height and width computed with projections if necessary)
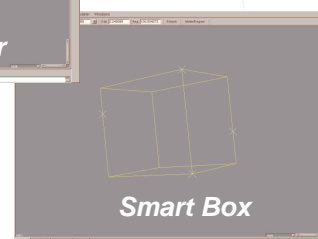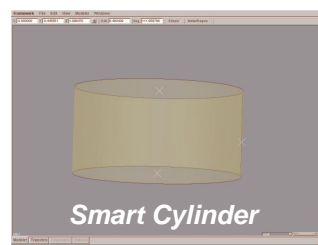
Smart Cylinder

Smart Box

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Modeler
Setting the geometry : Advanced visualization features

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❑ **Easy 3D manipulation**
- ✓ Standard mouse zoom, pan, rotate actions
- ✓ Fit all or only selected

❑ **Multi-viewers management**
- ✓ Easy management
  - ➤ Creation/Deletion, Resizing/Masking
- ✓ Simultaneous points of view over a model
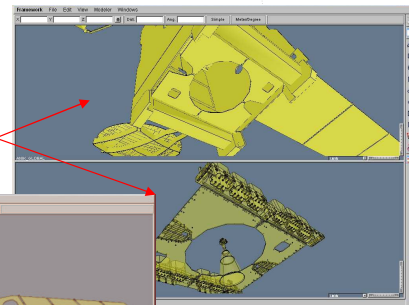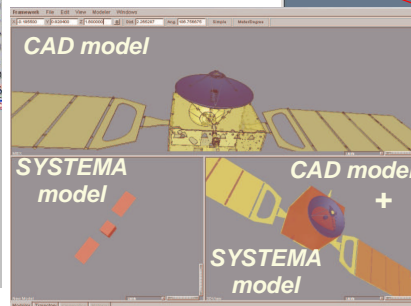
❑ **Full representation features**
- ✓ Multi representation : wire frame, solid, both
- ✓ Transparency / Lights orientation management
- ✓ Model frame enabling / disabling

❑ **Multi-models management**
- ✓ Several models can be loaded in T4STAR
  - ➤ For comparison
  - ➤ For assembly
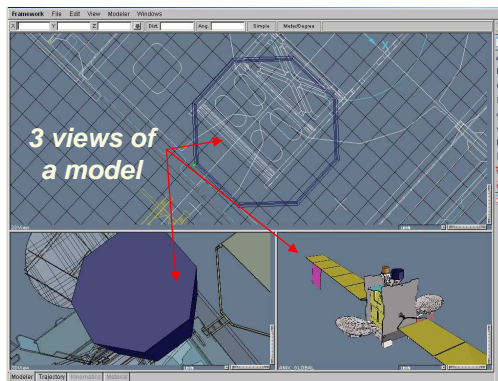
3 views of a model

2 parts of a system

CAD model

SYSTEMA model

CAD model + SYSTEMA model

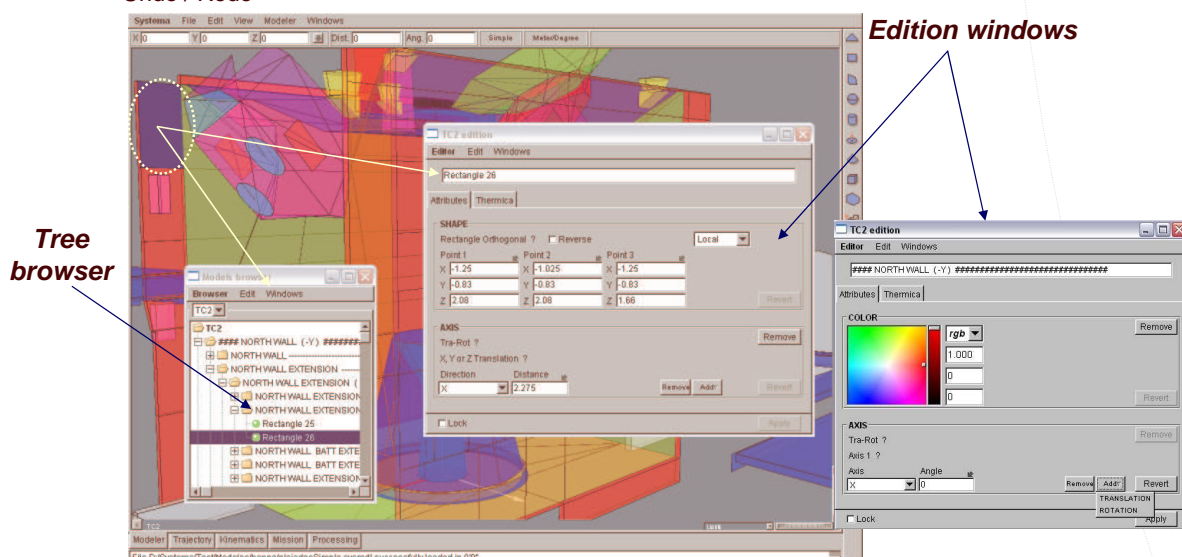SYSTEMA V4　　–　　20th European Workshop on Thermal and ECLS Software

Modeler
Setting the geometry : Browser and edition windows

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❑ **Full interactivity between the browser and the geometry**
- ✓ Multiple selection in the browser / graphical window
- ✓ Ability to hide / show surfaces
- ✓ Undo / Redo

Edition windows

Tree browser

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Modeler
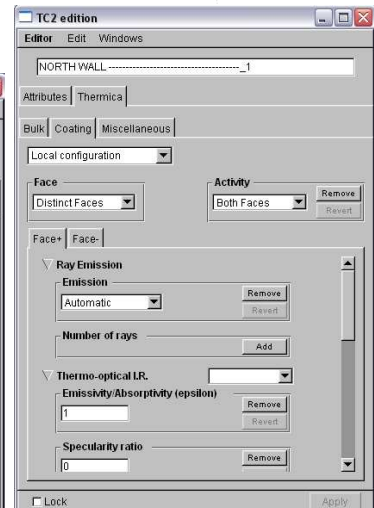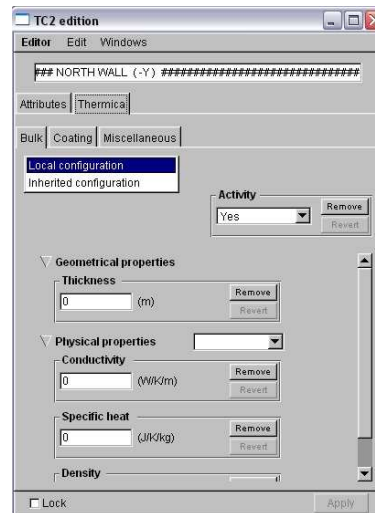### Setting the properties : addition of physical properties

❑ **Physical properties are classified by**

  ✓ **Application** (THERMICA, OUTGASSING, PERTUBATION, DOSRAD…)

  ✓ **Container**

   (for example Bulk and Coatings in THERMICA)

❑ **Container features**

  ✓ **Inheritance management**

  ✓ **Face and activity management**

  ✓ **Material management**

THERMICA physical properties

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Modeler
Setting the properties : addition of meshing and numbering

❑ **Meshing and Numbering independent from the geometry**

  ✓ **Meshing/Numbering algorithms provided by applications**

  ✓ **Multi-meshing/numbering support for one Model**

  ✓ **Improved numbering management**

The meshing tool is designed for applications that require a nodal break-down of the model (like THERMICA) or if a sub-meshing of some shapes is necessary.
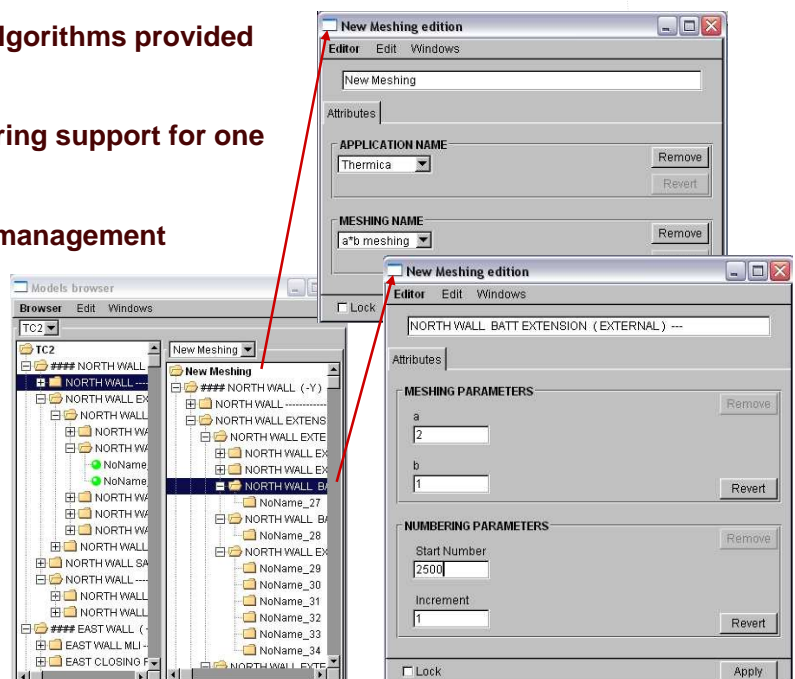
SYSTEMA V4 – 20th European Workshop on Thermal and ECLS Software
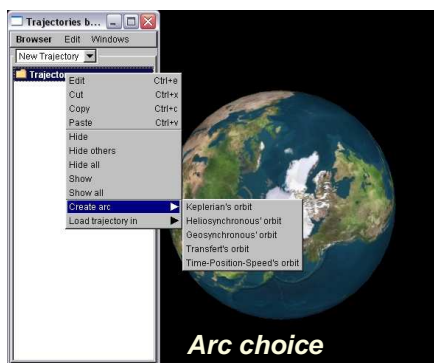
Trajectory
Creation of arcs

❑ **Customization of the trajectory**

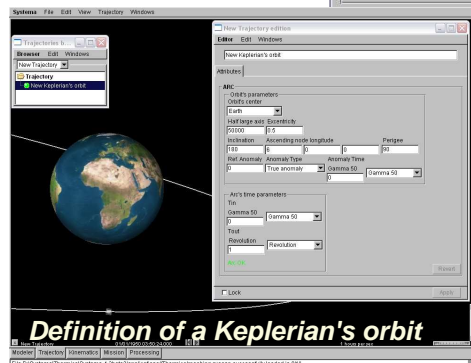   ✓ **Management of every planets of the Solar System, Sun and Moon with the real ephemerid :**

   ➢ Arcs around any planet or the Sun
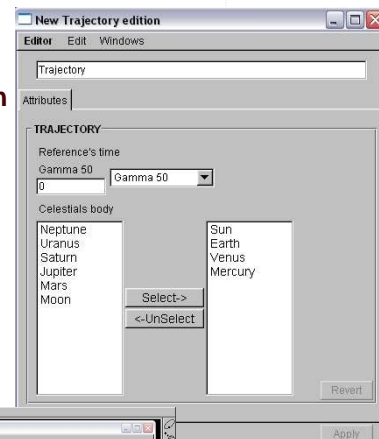
   ➢ Interplanetary arcs

❑ **Available arcs are**
   ➢ Keplerian's orbit
   ➢ Heliosynchronous' orbit

   ➢ Geosynchronous' orbit
   ➢ Transfert's orbit
   ➢ Time-Position-Speed file

Planet choice

Arc choice

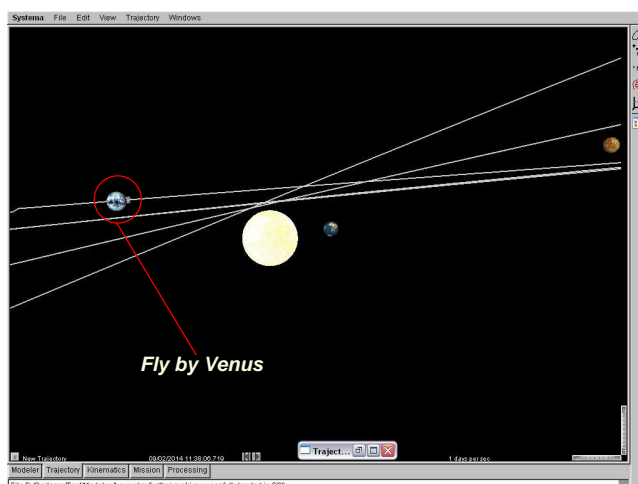*Definition of a Keplerian's orbit*

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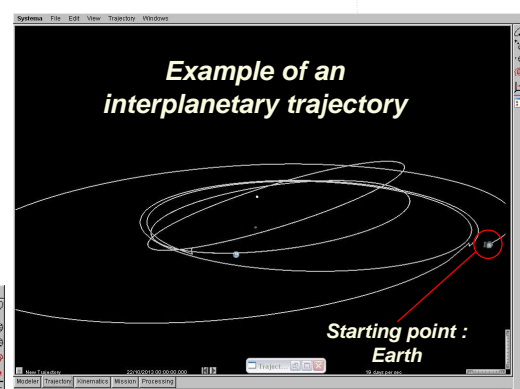
Trajectory
Visualization

❑ **3D visualization of the trajectory**

   ✓ **The user can play/stop the trajectory**

   ✓ **Variable time scale**

   ✓ **Zoom / Pan / Rotate interactivity**

Example of an interplanetary trajectory

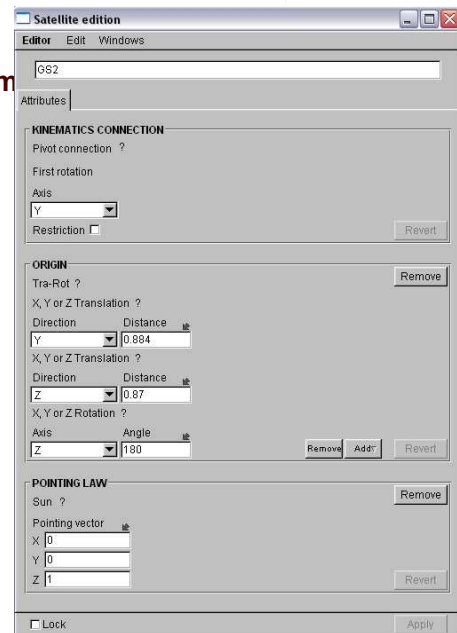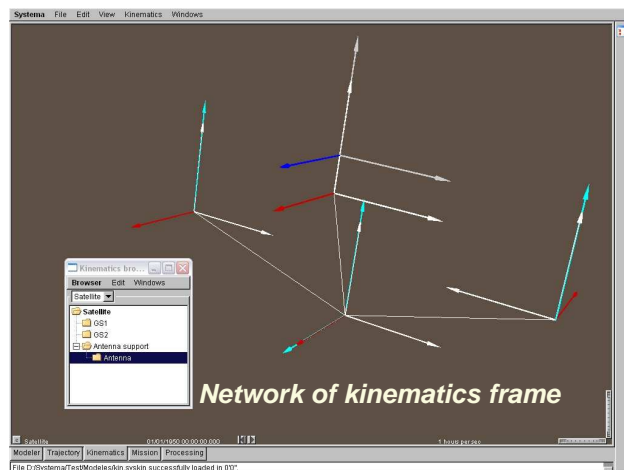*Starting point : Earth*

Fly by Venus
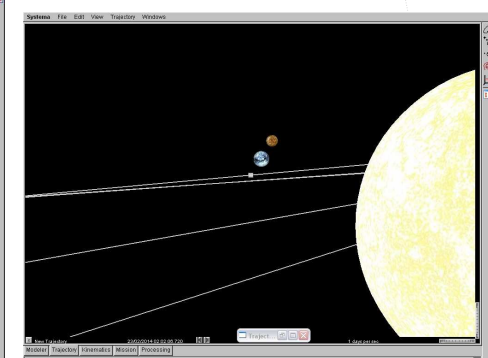
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Kinematics
Principles

❑ **Independent from the geometry**

    ✓ **Tree of rigid bodies linked by degrees of freedom**

    ✓ **Definition of pointing / general kinematics laws**

    ✓ **Visualization of the kinematics of bodies**

      Inspired form Mechanics standards

Network of kinematics frame

Kinematics parameters edition

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Kinematics
Setting Pointing and Moving Bodies

❑ **Kinematic bodies : types of link**

    ➢ Pivot connection   1 rotation of freedom

    ➢ Ball pivot   2 rotations of freedom

    ➢ Ball joint   3 rotations of freedom

    ➢ Free connection   3 rotations + 3 translations of freedom

    ✓ **Possibility of constraints on any degree of freedom**

❑ **Pointing and Attitude laws**

    ➢ Orbit regular momentum   ➢ Equatorial projection of Sun

    ➢ Orbit velocity vector   ➢ Sun

    ➢ Orbit center   ➢ Ecliptic north pole

    ➢ Planet   ➢ Regular spin around vector

    ➢ Planet north pole   ➢ Transformation defined in a file

    ➢ Planet vernal point

    ✓ **Possibility of combining two laws on the same kinematic body**

    ✓ **Possibility of defining "fast-moving" bodies (fast-spin)**

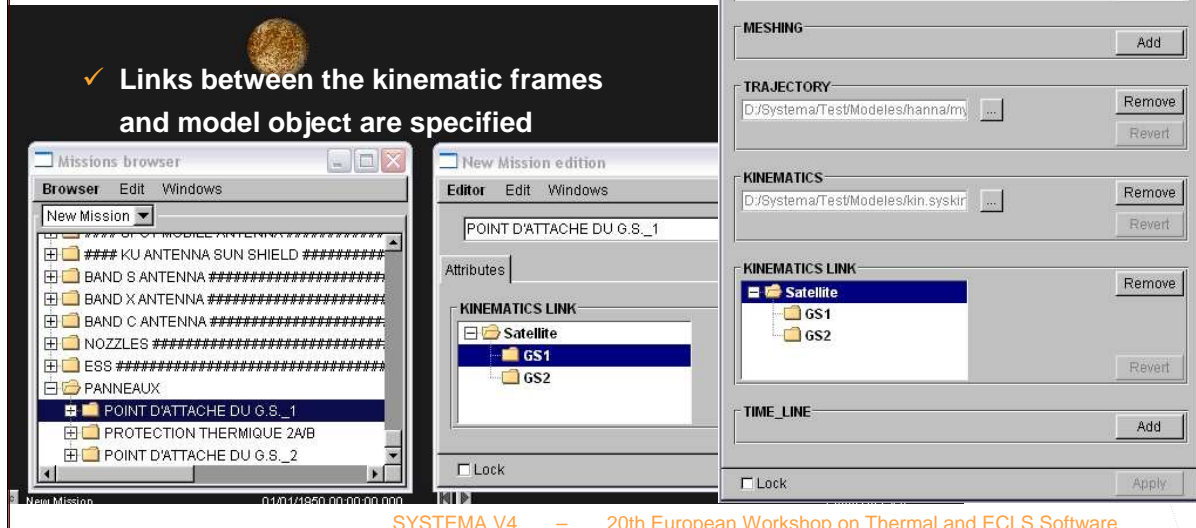SYSTEMA V4   –   20th European Workshop on Thermal and ECLS Software

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Mission
Building the complete system

✓ **All bricks built in the modeller, trajectory and kinematics modules are combined in the mission**

✓ **Links between the kinematic frames and model object are specified**

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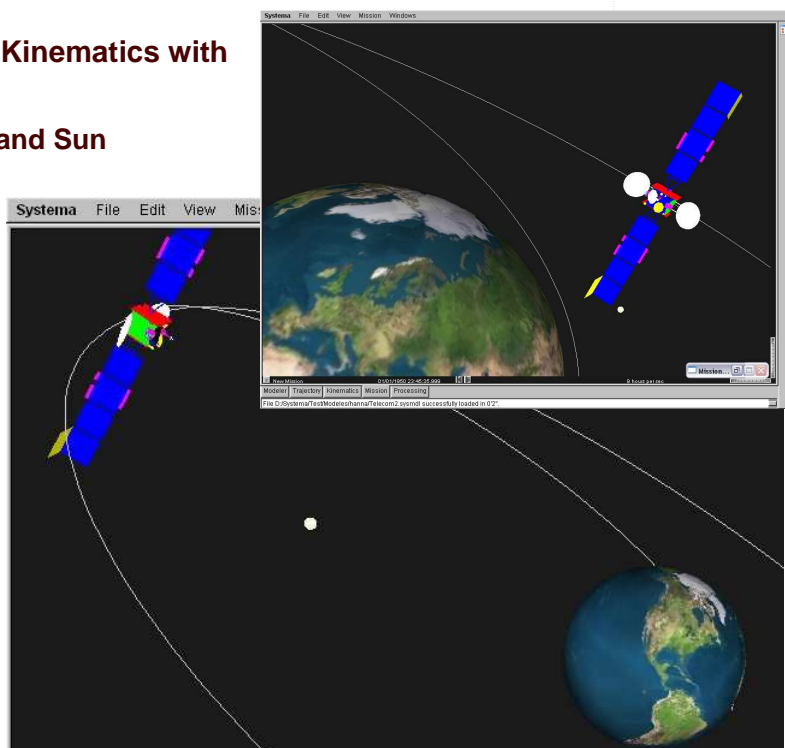
Mission
3D motion

❑ **3D model + Trajectory + Kinematics with**

✓ **Position of the planets and Sun**

✓ **Position of the satellite with pointing**

✓ **Kinematic bodies with motion**

✓ **Zoom / Pan / Rotate interactivity**

✓ **Play / Stop**

✓ **Variable time scale**

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Processing
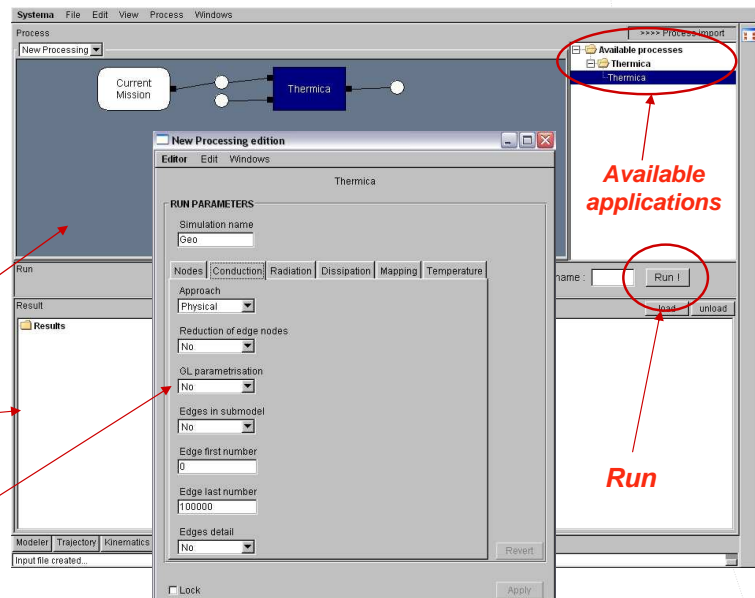## *Setting the applications*

❑ **Interactive processing**

  ✓ **Sets the applications and their properties, their input/output files…**

  ✓ **A processing schematic is created**

  ✓ **Any mission can be chosen from this module**

  ✓ **Results management**

  Process management

  Result management

  Application properties

  Available applications

  Run

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Visualization tools
Properties and results display

❑ **3D visualization of properties or results**

  ✓ **In static mode**   (modeller tab)   **or in dynamic mode**   (mission tab)

  ➢ Colour bar management and scale management (min, max, gamma…)

  ➢ Animation management (play / stop)

❑ **2D Curves**

  ➢ High interactivity between result selection and curve displays

❑ **And more display tools…**   (ray display, coupling display…)

❑ **Result management**

  ➢ Generic : allows post-processing tools to create any results that can be displayed

  ➢ High interactivity level : easy results selection and management

  ➢ Parametric results management

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Conclusion
Roadmap

- **SYSTEMA / THERMICA V4 beta release :**   **Q1 *2007***
    - For evaluation

- **SYSTEMA / THERMICA V4 full release**   **Q2 *2007***
    - Full THERMICA with all modules

- **Future evolutions (2007-2009) :**
    - ✓ **Increase the capacity in terms of visualization / animation**
    - ✓ **Management of model assembly**
    - ✓ **Management of Timeline, events…**
    - ✓ **Improved conduction module (edge and resistance contact management)**
    - ✓ **Schematic**
    - ✓ **…**

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