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### 10th SPINE Meeting: 6-8 December 2005

# **SPIS-UI**

# Integrated Modelling Environment (EMI) for Space Modelling Final presentation CAD modelling and pre-processing

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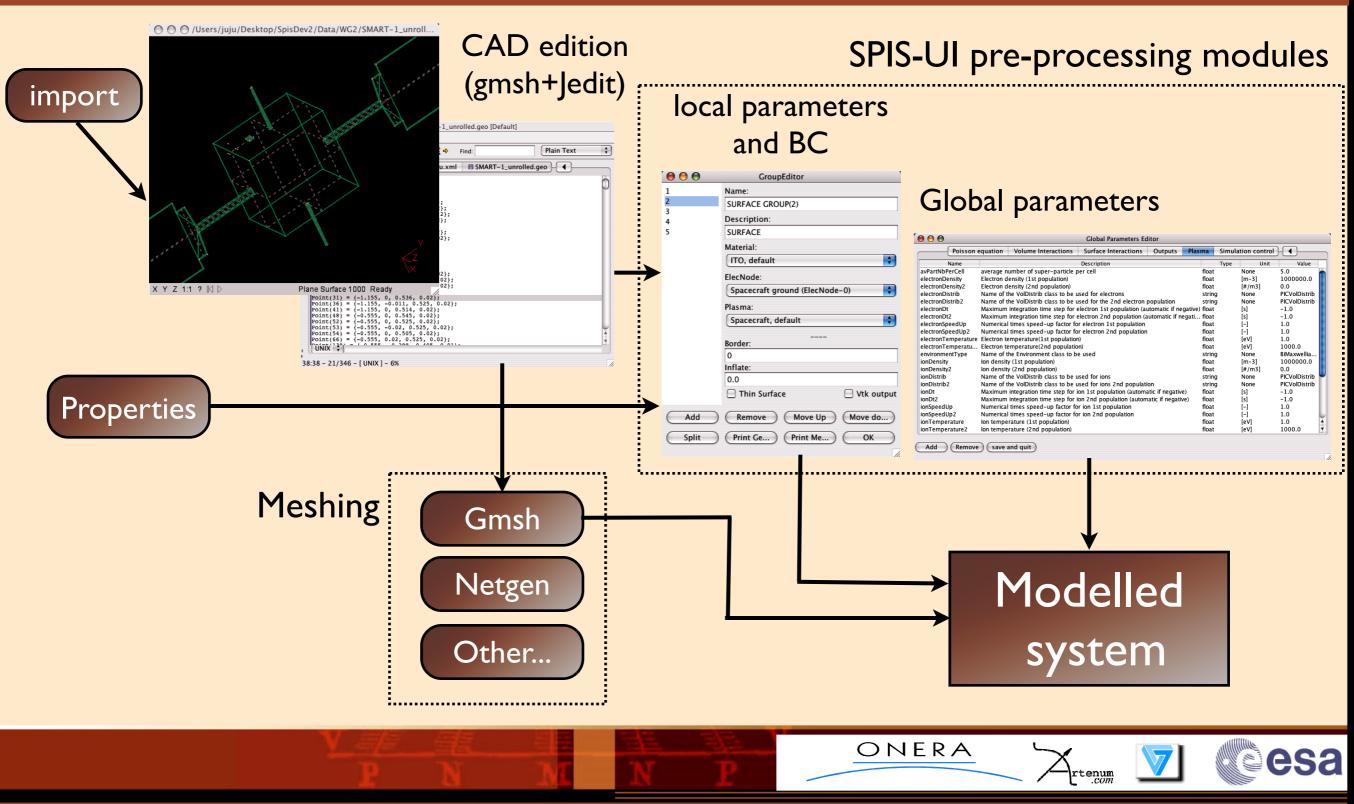
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#### System building

- Define the system (S/C + environment) to be modelled
  - Define the S/C geometry (CAD modelling)
  - Define the boundary and the initial conditions
    - Attribution of material properties
    - Attribution of "plasma model", i.e numerical properties
    - Attribution of electrical properties
- Deploy fields on the mesh(es) taking into account priority rules
- Convert for the "generic" structure to the solver one

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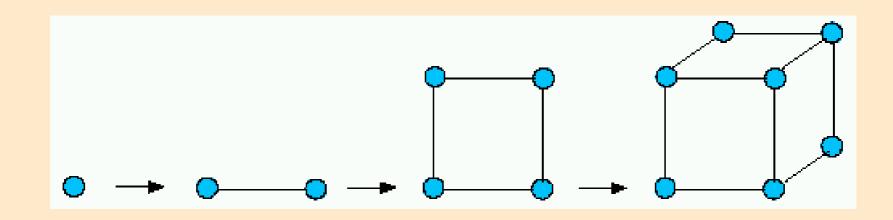
### Modelling process: pre-processing



# CAD modelling (I)

### Based on a BERPS approach (boundary)

- Optimizion of the base nodes
- building of the edges
- Close loop of edges to define surfaces
- Close loop of faces to define volume



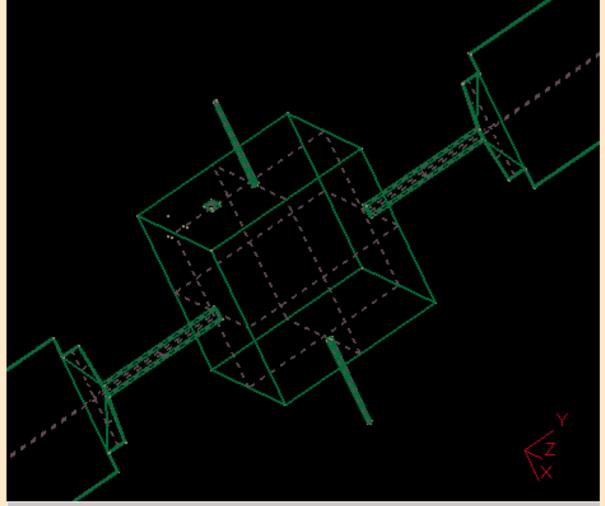
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## CAD modelling (2)

#### Gmsh based approach

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XYZ1:1 ? 🛛 🗅

Plane Surface 1000 Ready

// SC definition Point(1) = {0, 0, 0, 2.9}; Point(2) = {10, 0, 0, 2.9}; Point(3) = {0, 10, 0, 2.9}; Point(4) = {0, 0, 10, 2.9}; Point(5) = {10, 0, 10, 2.9}; Point(6) = {0, 10, 10, 2.9}; Point(7) = {10, 10, 0, 2.9};  $Point(8) = \{10, 10, 10, 2.9\};$ Line  $(1) = \{7, 2\};$ Line  $(2) = \{2, 5\};$ Line  $(3) = \{5, 8\};$ Line  $(4) = \{8, 7\};$ Line  $(5) = \{8, 6\};$ Line  $(6) = \{6, 3\};$ Line  $(7) = \{3, 7\};$ Line  $(8) = \{6, 4\};$ Line  $(9) = \{4, 5\};$ Line  $(10) = \{1, 4\};$ Line  $(11) = \{1, 2\};$ Line  $(12) = \{1, 3\};$ Line Loop  $(1) = \{7, 1, -11, 12\};$ Plane Surface (1) = {1}; Line Loop  $(2) = \{4, -7, -6, -5\};$ Plane Surface (2) = {2}; Line Loop  $(3) = \{6, -12, 10, -8\};$ Plane Surface (3) = {3}; Line Loop  $(4) = \{3, 4, 1, 2\};$ Plane Surface  $(4) = \{4\};$ Line Loop  $(5) = \{5, 8, 9, 3\};$ Plane Surface (5) = {5}; Line Loop  $(6) = \{9, -2, -11, 10\};$ 

//external boundary definition
Point(9) = {5, 5, 5, 0.5};
Point(10) = {6, 5, 5, 0.5};
Point(11) = {5, 6, 5, 0.5};
Point(12) = {5, 5, 6, 0.5};
Point(13) = {6, 5, 6, 0.5};
Point(14) = {5, 6, 6, 0.5};

Plane Surface  $(6) = \{6\};$ 

1.



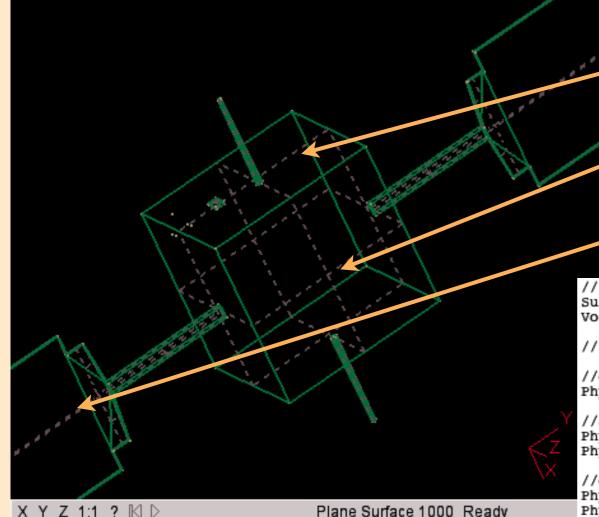
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## Attributes local properties (1)

#### Definition of sub-systems to applied local data

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Group or Physical I Group or Physical 2 Group or Physical XX...

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// conputationnal volume Surface Loop (1) = {2, 4, 5, 3, 6, 1, 8, 10, 11, 9, 12, 7}; Volume  $(1) = \{1\};$ 

//setting and attribution of physical (for groups setting)

//default group for nodes Physical Point (6) = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16};

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//sc

Physical Surface (1) = {7, 8, 10}; Physical Surface (2) = {11, 9, 12};

//external boundary Physical Surface  $(3) = \{1, 2, 4\};$ Physical Surface (4) = {5, 3, 6};

//comutationnal domaine Physical Volume (5) = {1};



#### Groups/Physical visualisation

000 Spacecraft Plasma Interaction System File Edit GEOM Mesh Properties Groups Fields Solver PostProcessing Tasks Data Bus Reporting Options Help Open Project Save Project Modeller Load GEOM Prop Edit Grps 2D Mesh 3D Mesh Convert Grps Fields Global Parameters UI to Num Run Solver DataField Manager 2D Plot JSynoptic 3D Plot Cassandra Spis Console JyConsole Pre-Processing Simulation Post-Processing Cassandra 2.1 VTK viewer File Edit View Sources Filters Tools Help Save image XY XZ YZ Reset view View Tree Pipeline Actor DEFAULT POINT GROUP (1) ☑ DEFAULT CURVE GROUP (2) DEFAULT SURFACE GROUP (3) SURFACE GROUP(11000343) (4) SURFACE GROUP(11000344) (5) SURFACE GROUP(11000345) (6) SURFACE GROUP(11000346) (7) SURFACE GROUP(11000347) (8) SURFACE GROUP(11000348) (9) SURFACE GROUP(11000349) (10) SURFACE GROUP(11000350) (11) SURFACE GROUP(11000351) (12) SURFACE GROUP(11000352) (13) V SURFACE GROUP(11000353) (14) ⊻ SURFACE GROUP(11000354) (15) SURFACE GROUP(11000355) (16)  $\checkmark$ SURFACE GROUP(11000356) (17) -Scalar bar-Text 🗹 Txt (1) Example of groups setting

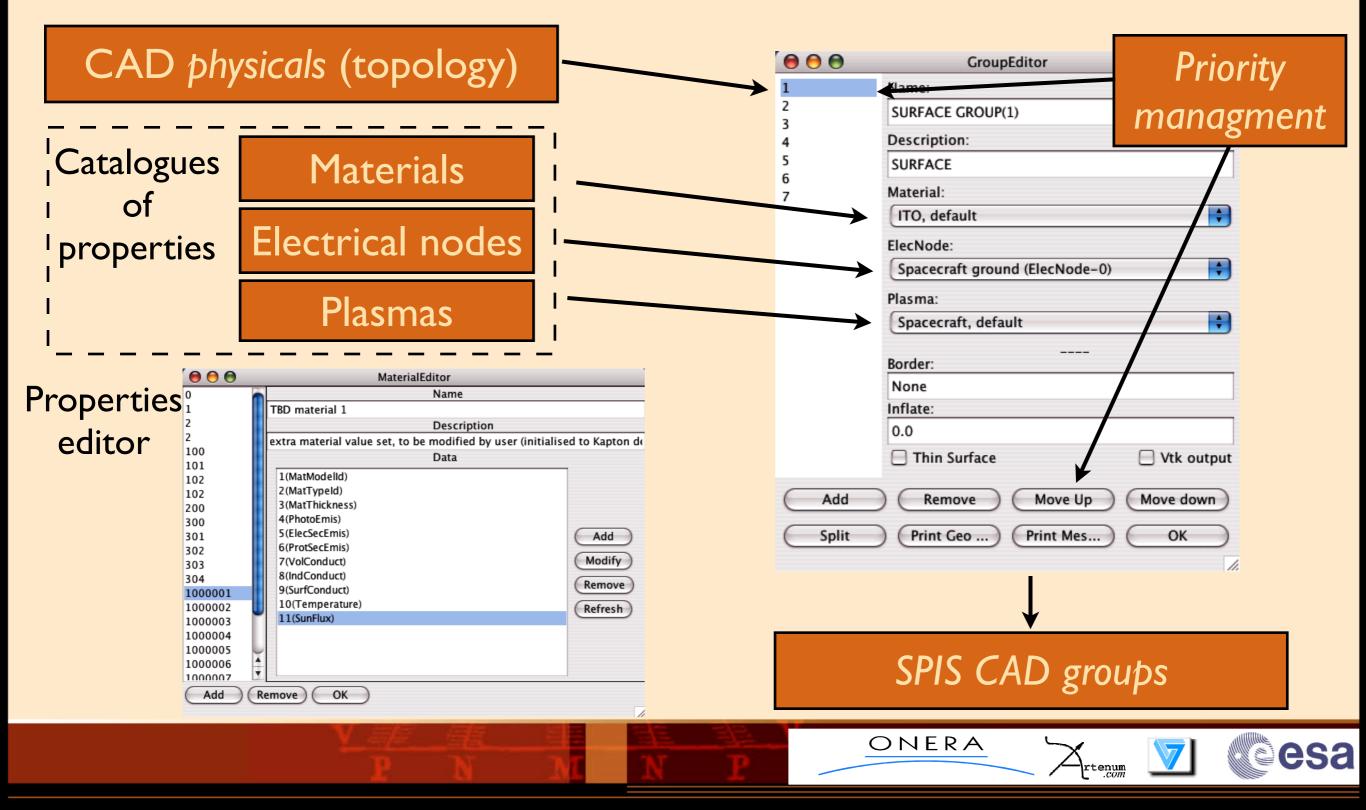








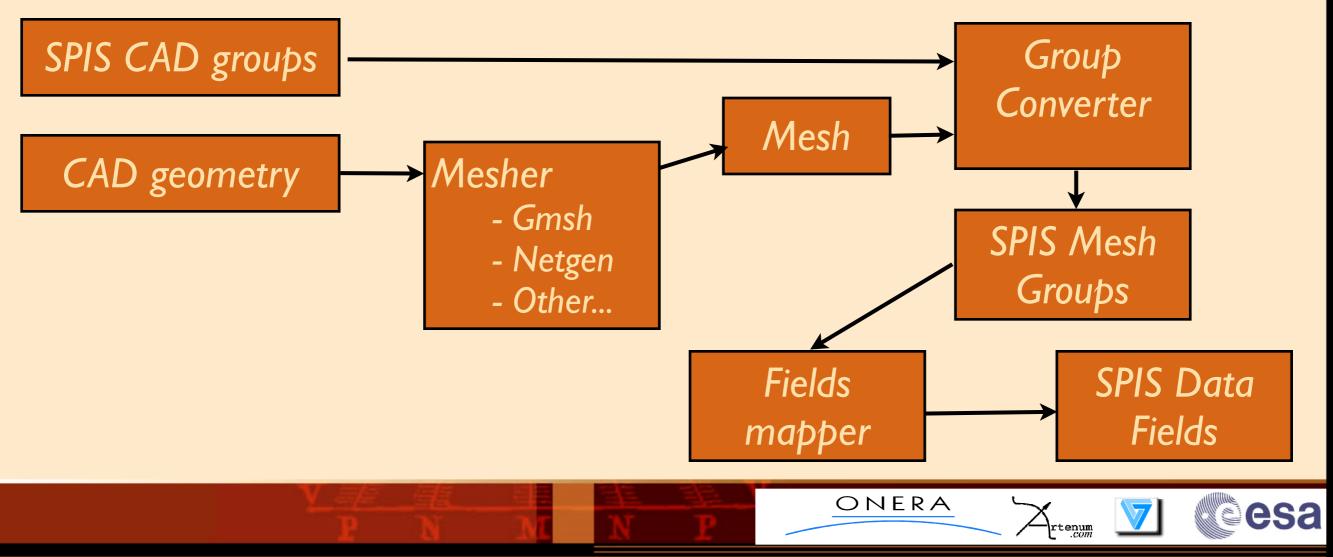
### Groups Manager: link CAD physical and properties



## Meshing and fields deployement

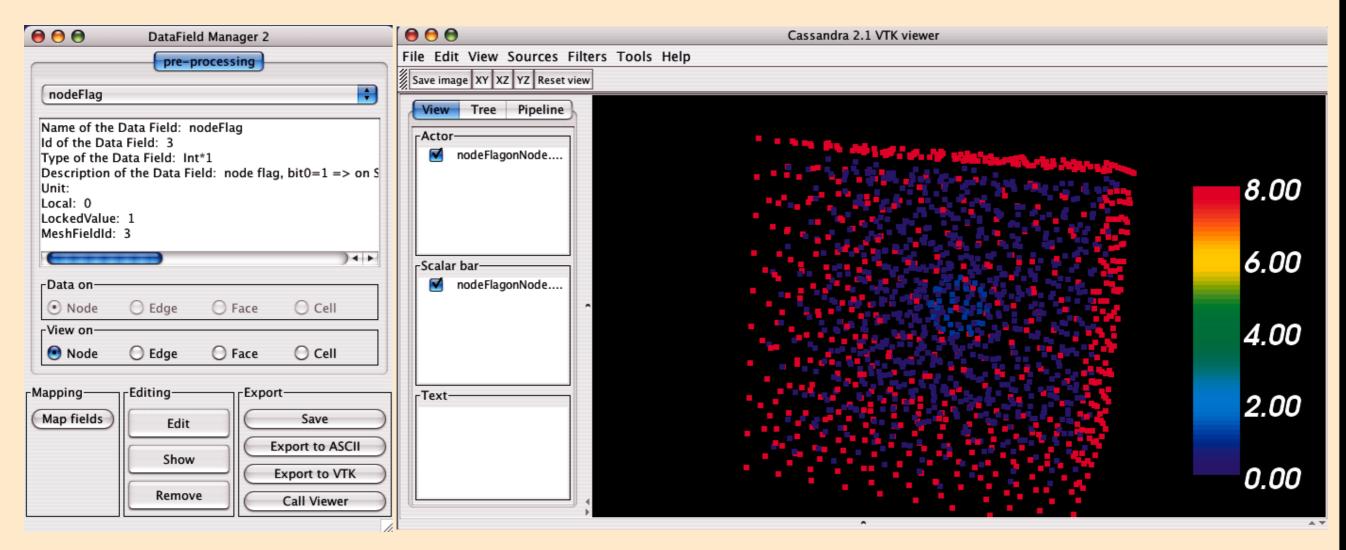
Solvers understand fields deployed on mesh only

- Ineed to mesh
- need to convert CAD groups to groups of mesh
- Ineed to "map" or "deploy" fields on the mesh



## Deployed fields

#### Same tools for pre and post-processing



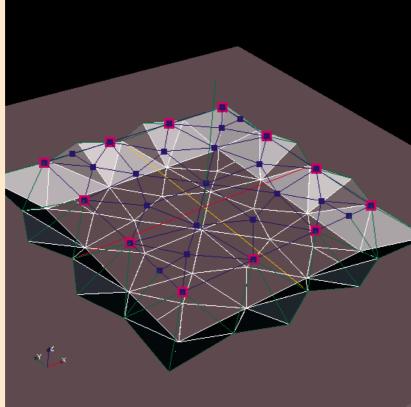
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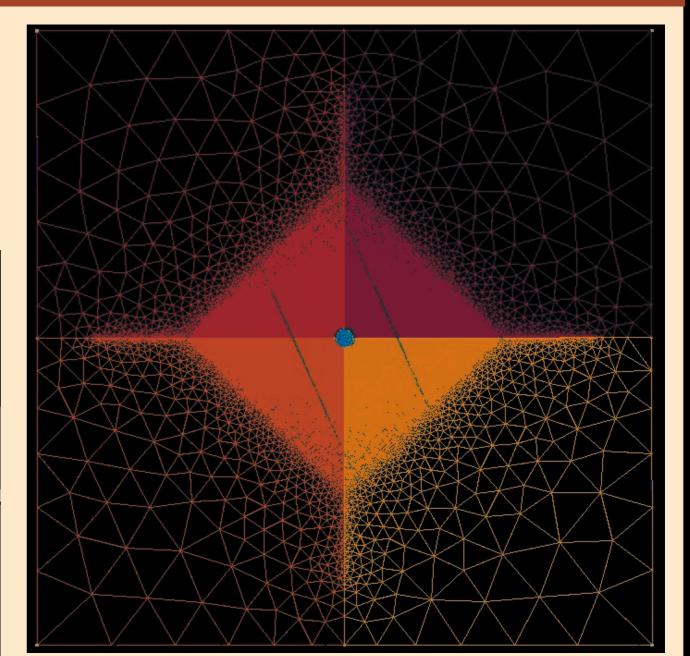
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## Meshing and refinement

- Possibility of mesh refinement
- Mesh pre-processing for singularities (i.e 2D thin surfaces)



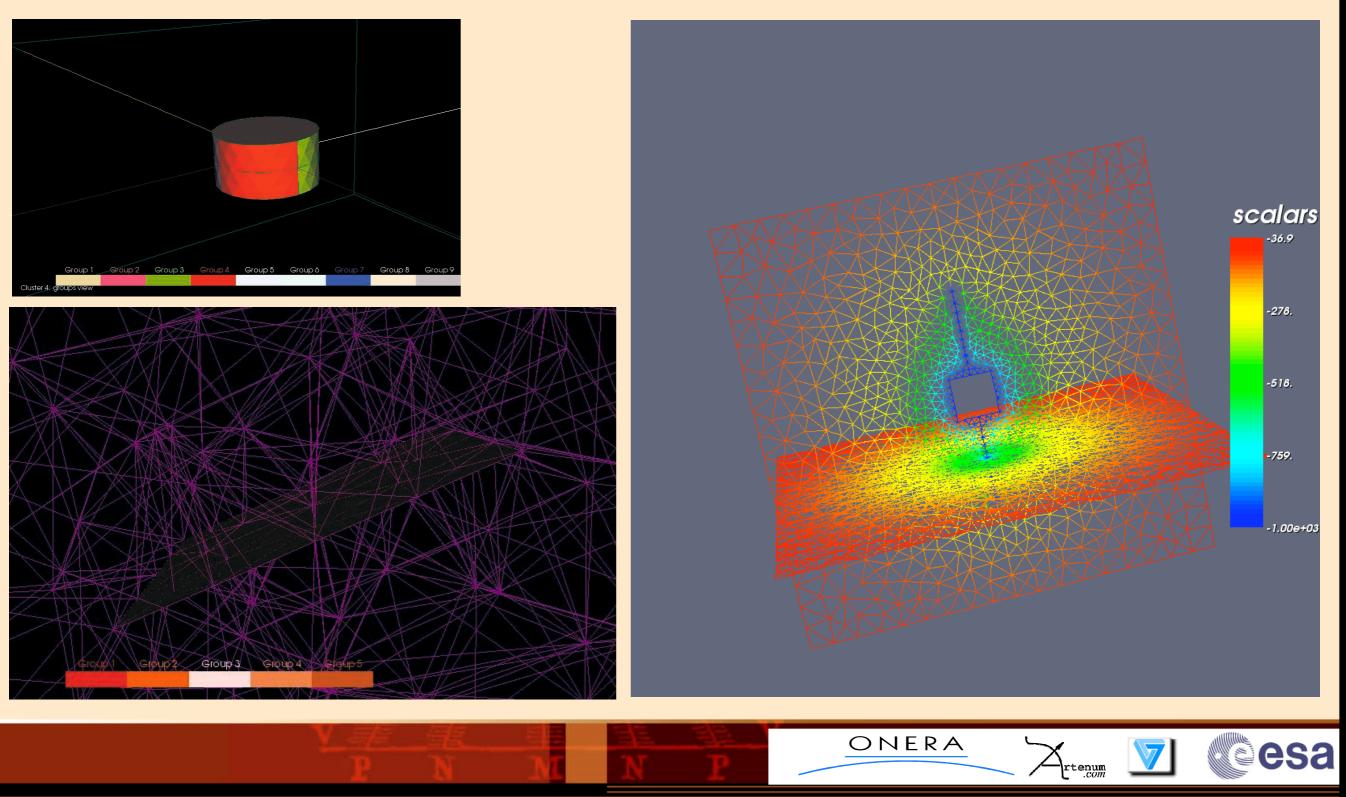




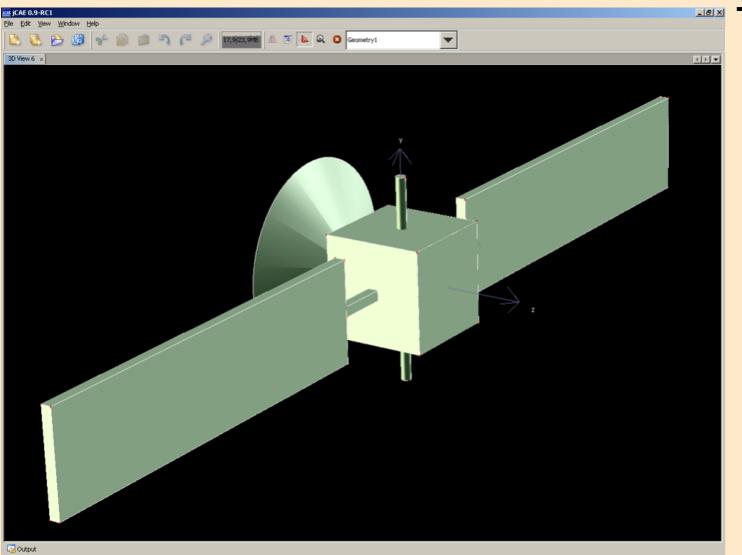
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#### ID and 2D thin elements



## CAD modelling tomorrow



#### The Artenum R&d effort:

 Study of integration of an OpenCascade based CAD module with <u>JCAE projecrt</u>

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- Possibility of CSG and BREP approaches
- Possibility of import of industrial formats (IGES, STEP...)

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## Conclusion on CAD modelling

- Possibility to model complex and realistic 3D models
- Possibility of detailed properties attribution
- Possibility of 2D/3D meshing with refinement capabilities
- Still CAD modelling rough and long due to the strict BREPS approach
- Still limitations in the import of industrial formats (IGES, STEP, MED...)
- Improvements expected in a near future with the possible of the integration of JCAE, OpenCasade based CAD modeller

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