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Summary of the 3D machine descriptions WS in Garching 18th March 2010

Participants:
Rui Coelho, David Coster, Christian Konz, Fabio Subba, Tilmann Lunt, Maurizio Palumbo, Simppa Jämsä (remote), David (georgian coll.) + another one of the edge modellers (IPP?!)

Agenda

09h30 - 10h00 - Welcoming and Overview of the ITM datastructure on machine descriptions and CfP (***R.Coelho+C.Konz***)
10h00 - 10h30 - 3D defeaturing tool and use cases (***T.Lunt***)
10h45 - 11h15 - Wall meshing in CarMa(CARIDDI) - from CAD to physics code (***M. Palumbo***)
11h15 - 12h00 - GRID CPO concept (***F. Subba***)
12h00-12h30 - Joint discussion (***challenges, short-medium plans***)

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13h45 - 15h00 - Interfacing 3D grids in the GRID CPO (***joint discussion and plans***)
15h30 - 17h00 - Joint discussion with input from edge codes requirements/plans

A. ITM datastructure, machine descriptions and 3D related effort

An overview of ITM-TF datastructure and machine descriptions (v4.07b) was presented (see ***ITM datastructure MD and heading to 3D.ppt***) with special emphasis on the CPOs that are directly related to plasma facing components, i.e. limiter and vessel. Diagrams of JET and AUG device cross sections evidenced the present limitations of the limiter and wall descriptions and the opportunities and requirements for improvement were identified. Among others, non contiguous plasma facing limiters (e.g. ferritic inserts) must be allowed for in the geometry and the CPOs should be extended to encompass the material characterization (mechanical, thermal, chemical, electrical,…). The underlying motivation for adopting a GRID CPO was highlighted and the several obstacles in defeaturing CAD drawings of tokamak devices were raised, driven by competing requirements of physics modules, e.g gas tight device for MC transport codes and realistic device geometry with ports for RWM codes.

B. Preliminary Reporting on WP10-EDRG-ACT3

Reporting on the progress of EDRG-ACT3, dedicated to the testing of a numerical tool for the defeaturing of the first wall of a tokamak device directly imported from CAD drawings in STL format was presented (see ***3D_wall_lunt_jamsa.ppt***). Defeaturing, within the concept of the developed tool, is achieved by appropriately choosing bundles of rays with user defined resolution directed to the wall and interpolating the resultant mesh. Examples taken from the AUG device were shown in the framework of gas tight 3D transport codes. Flexible defeaturing with on-demand rasterization detail can be achieved, assisted by 1D or 2D interpolation methods and the output can be saved in STL format.

C. Wall meshing in CARIDDI/CarMa code

An overview of the methodology adopted for the assembly of the wall meshing for the CARIDDI code was presented (see ***MFP_Garching.ppt***). CAD defeaturing within

CATIA commercial software of the fully detailed device is performed, noticeably easier when the drawing is formatted in multiple layers. A finite volume meshing of the 3D volume, (with deformable hexahedrals) bounded by a given reference meshed surface, is then performed using the AVL-FIRE commercial software. An Element-node incidence matrix (9 lines, first 8 for node id and 9^{th} for tagging the type of material) and the full matrix of (x,y,z) coordinates of all nodes is required as input.

D. GRID CPO concept

A review of the current proposal for the structure of a generic GRID CPO was presented, emphasizing on the notion of spaces, nodes, edges, faces, periodicity on the grid and casting additional information on the grid datastructure. Several illustrative examples were presented.

E. Joint discussion

1. **CAD defeaturing** : It was agreed that it is essential for reducing the enormous amount of information that an original CAD drawing has with respect to what most codes require. However, since different codes have different requirements, e.g. it was noted that particle codes probing divertor physics might require the least defeaturing, the ITM should foresee the storage of a very detailed 3D wall and plasma facing components for each device.

2. **Defeaturing tool** : the tool is flexible enough for the user to decide the defeaturing level. The STL I/O ascii format consists basically of the sequence of 3 coordinates of the triangles building up the mesh, thereby facilitating to some extent the mapping to the GRID CPO.

3. **Finite volume meshing** : Since the defeaturing tool can natively output to STL format, it can be used to do a first defeaturing of the wall surface that is then piped to a finite volume mesher from the reference surface.

4. **Mesh storage** : Since the GRID CPO should suit any grid, an attempt to store both wall surface meshes and 3D finite volume wall meshes needs to be pursued.

5. **Proposed actions** :

    a. Jointly perform a test on realistic CAD sectors of an arbitrary device (ITER, JET,…) on defeaturing with the tool with some guidelines targeting RWM code requirements (Tilmann/Simppa and Maurizio Palumbo).
    b. From the defeatured wall surface arising from the previous action, build in manual mode the corresponding finite volume mesh in AVL-FIRE and assess its validity (Maurizio Palumbo).
    c. Create first examples of GRID CPO casting presently used vessel geometry and extension to multi segment-like wall (Rui)
    d. From quadrangular wall surface meshes in an ASCOT sector, provide the equivalent mesh cast under the GRID CPO (Simppa Jämsä with assistance from Fabio Subba)
    e. Building on the previous action, target storage under the GRID CPO of the triangular surface mesh from **action a.** and the finite volume mesh from **action b.** (Tilmann/Maurizio/Fabio/Simppa/Rui)