

A collage of hand-drawn sketches on a light background. In the top left, a satellite with solar panels is shown. In the center, a water drop is depicted falling into a petri dish, creating ripples. To the right, a pencil is shown resting in a small cup. In the bottom right, a hand is shown holding a pen, ready to write on a piece of paper. The sketches are simple and illustrative.

Basic steps with SimpleGeo

Chris Theis

Overview

- 🍷 Approaches for geometry construction (CAD, CSG)
- 🍷 SimpleGeo – an interactive geometry modeler
- 🍷 Plugin concept

Current status

Current status

➔ Textual input

2D cuts (supplied by FLUKA via PLOTGEOM)

Goal

➔ **Combined interactive** modeling & 3D visualization & debugging which is independent of the syntax and format

Ways to go: CAD or CSG?

Why not use AutoCAD, etc...?

What is the difference between CAD & CSG?

C
A
D



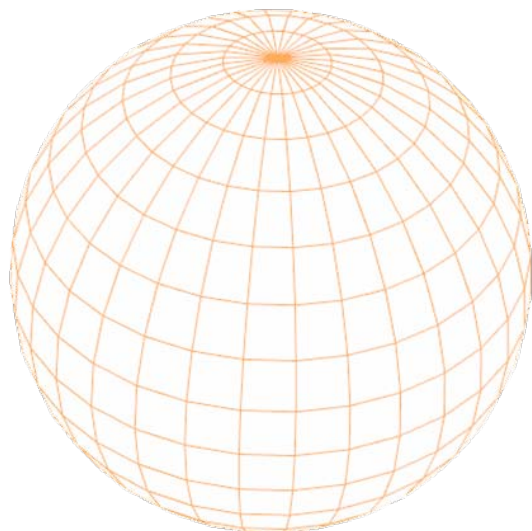
The “looks” must be correct

C
S
G

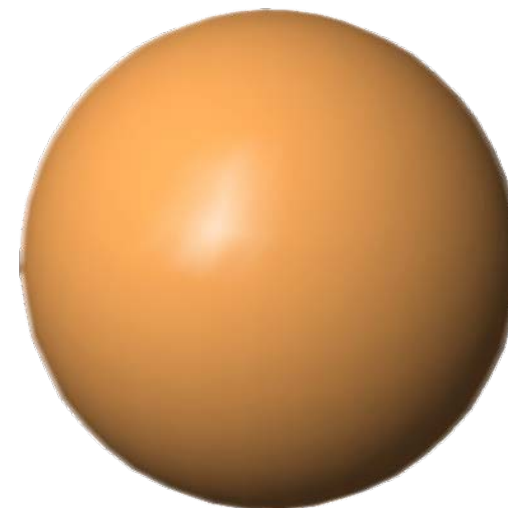


Mathematical properties
must be preserved!

Mathematical properties?



CAD



CSG

“So, what’s the big deal?”

Tracking



Point in polyhedron test with
Considering $N \times M$ faces

Solving $x^2 + y^2 + z^2 = R^2$

SimpleGeo - a hybrid solution

CAD

Can be rendered directly
with “ordinary” GFX - cards

CSG

Output for MC – codes
Hierarchical structure



SimpleGeo



Complex modeling algorithms
Numerical issues

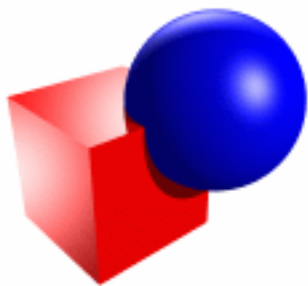
Constructive solid geometry

Basic idea

Solids are point sets (= primitives) that can be operated on

Geometry

Set of primitive solids combined with boolean operations



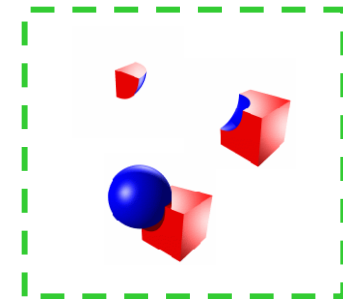
Union



Difference

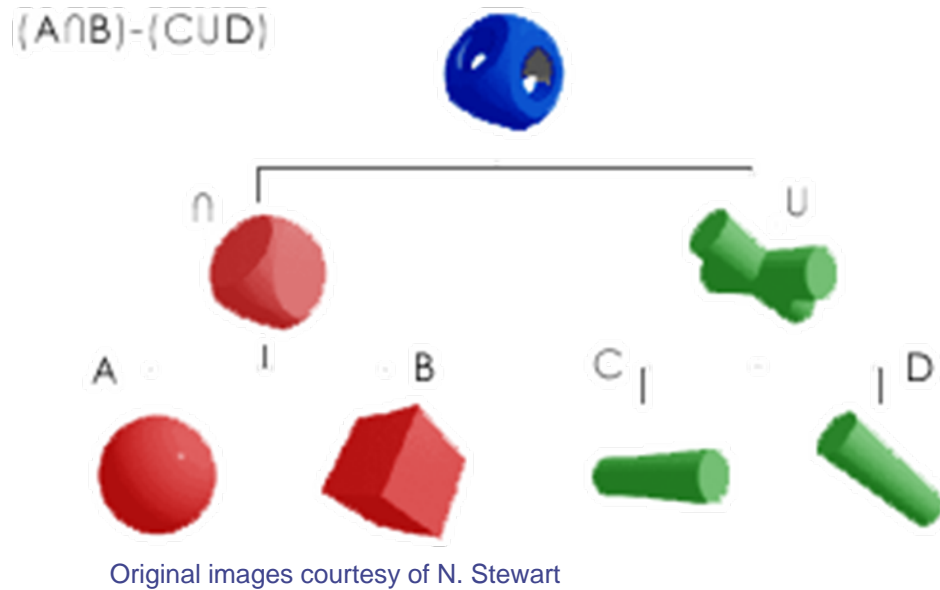


Intersection

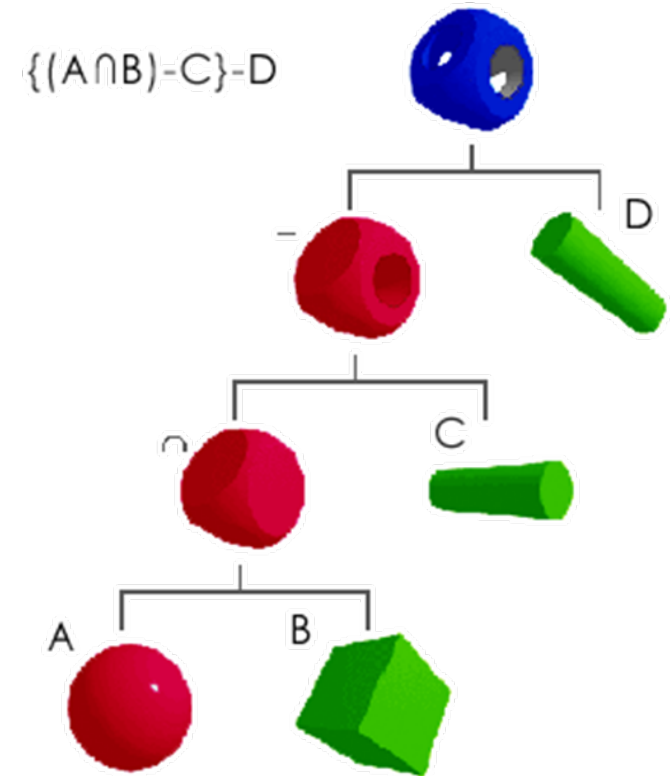


Group

Recursive CSG tree




Recursive CSG tree



Normalized CSG tree

CSG trees are **not unique**. Different constructions can yield the same result.

Loading a FLUKA input

1. Select "File" -> "Import"* and open the file named NeutronGenerator.inp located in the directory data\NeutronGen
2. If more than 10 regions are loaded the automatic build function is  disabled. You'll immediately be notified of this.
3. Press the automatic build button on the toolbar



4. Press the "Reset view" button.

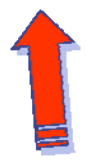
* Versions >2.0 support the new syntax with names as well as the old syntax with numbers. In view of the free format a delimiter (e.g. space) between the values is mandatory! If this is not present a warning will be displayed.



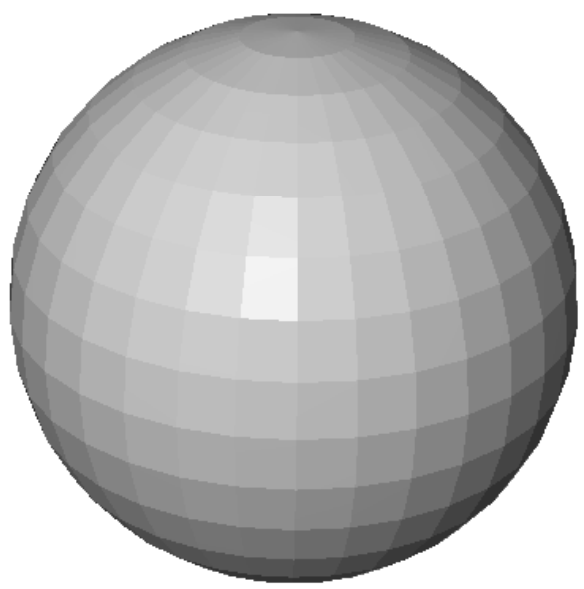
Authors: not specified -- Version: not specified -- Date: 24 02 2009 Hide

E:\MyProjects\SimpleGeo Delivery 4.0\demo data\Neutron-Generator.inp

- Root
 - 001_Diff
 - 002_Diff
 - 003_Diff
 - R_4
 - R_5
 - 006_Diff
 - 007_Int
 - R_7
 - 009_Diff
 - 010_Diff
 - 011_Diff
 - 012_Union
 - 013_Union



CSG tree



External void

General	
Name	Root
Type	Group
Comment	no comment
Importance	default
Position	
X-Rel.	0.00
Y-Rel.	0.00
Z-Rel.	0.00
Rot. X	0.00
Rot. Y	0.00
Rot. Z	0.00
Viz Attributes	
Contours	Yes
Contour color	Black
Contour style	Solid
Contour width	Normal
X-Ray mode	Off
Edge-Ray mode	Off
Exploded view	Off
Explosion factor	1.00
Visible to GI	Yes
Visible to AOC	Yes



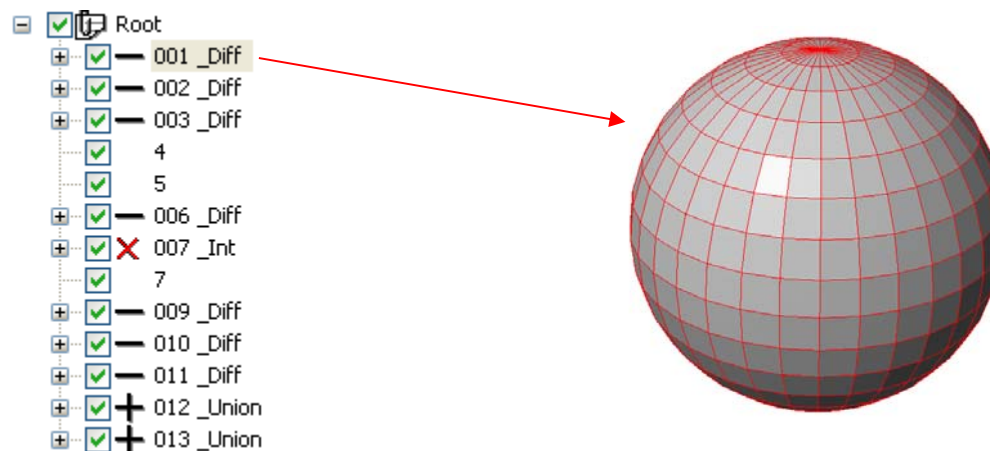
Properties

Next step –object identification

- Activate the “**identify**” function on the toolbar

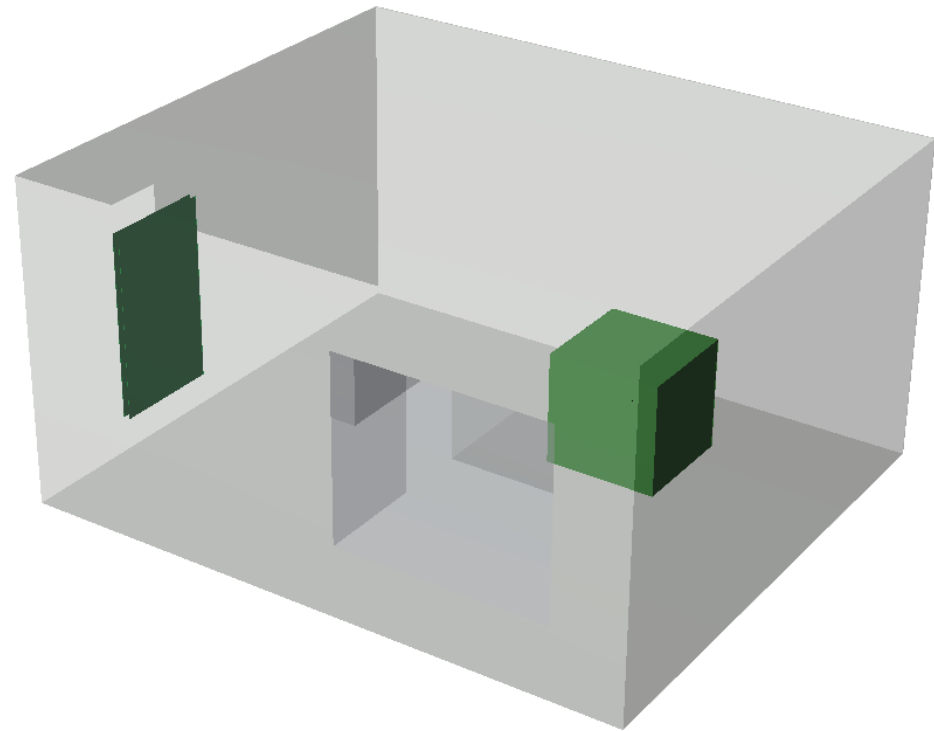


- Click on the gray sphere and the identified region will automatically be selected in the CSG tree. Selected (sub)regions are shown with red contours



Change visibility

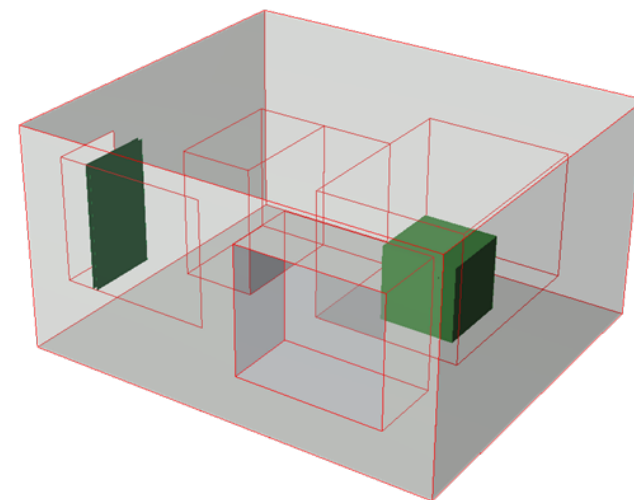
- Turn off the visibility of the surrounding blackhole by pressing **Space** or by clicking on the checkbox in the CSG tree.



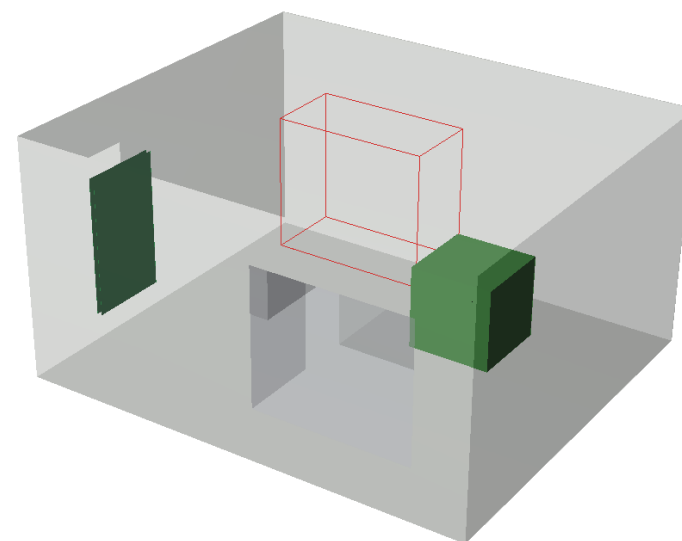
* More on visibility (saving, loading, ...) can be found in the manual's FAQ section 2.8 & 2.9

Checking regions/subregions

- Select region labeled "002_Diff"
The results of the selected region/subtree are marked in red.



- Select body number 4 of the region 002_Diff
Only this body/subregion is marked in red.



Camera control

- A number of predefined views are available from the “View” menu.

Front	F1
Back	F2
Left	F3
Right	F4
Top	F5
Bottom	F6
Arbitrary view	F7
Isometric views	

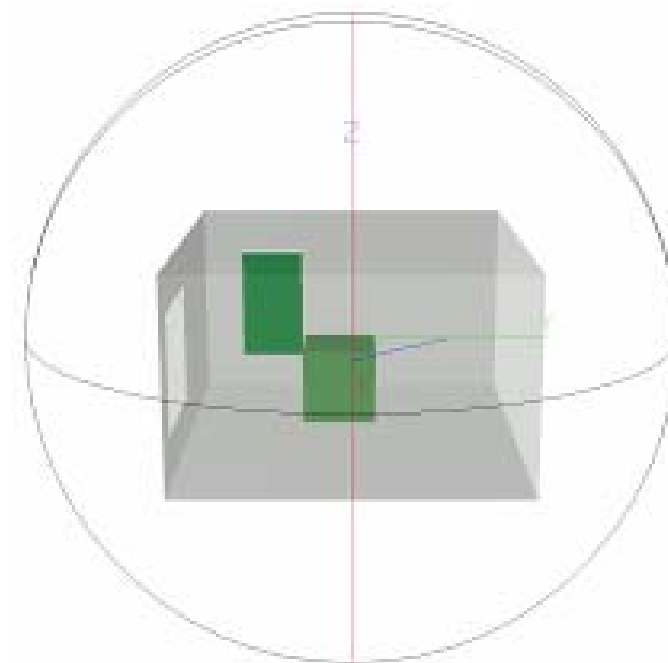
- Select one and move the mouse over the render view which will trigger a redraw with the selected perspective.

Camera control 2

- For dynamic and more flexible camera control active the **SpaceBall** on the toolbar.



- A ball with its 3 main arcs is drawn on top of the geometry. Moving the mouse near an arc will activate it. Any movement of the mouse with the left mouse button pressed will move the arc and thus, the camera.



Camera control 3

- For more flexibility you can grab the SpaceBall even at points that are not placed on an arc. For this you have to keep the **Shift key** pressed together with the left mouse button.
- On slow graphics cards this operation might slow down. Keeping the **Ctrl key** pressed in addition will reduce the level of detail shown during the movement!

Camera control 4

- If you want to zoom in you can do this with a mouse wheel while the SpaceBall is activated. Otherwise select the zoom function on the toolbar.



- Just draw a rectangle around the area you would like to zoom in on. To reset to the normal view use the “Reset View” button.



Visualization modes

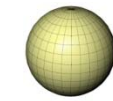
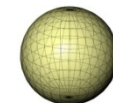
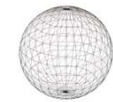
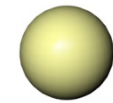
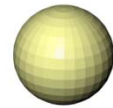
- Several different rendering options are available from the “**View**” menu.

✓ Flat shading	Shift + F1
Gouraud shading	Shift + F2
Wireframe	Shift + F3
Skeleton rendering	Shift + F4
Sketch rendering	Shift + F5
Overlay sketch	Shift + F6
Render contours	Shift + F7
Anti aliasing	▶
Shadows	▶

- Non shaded views allow for better performance, especially on slow graphics cards.

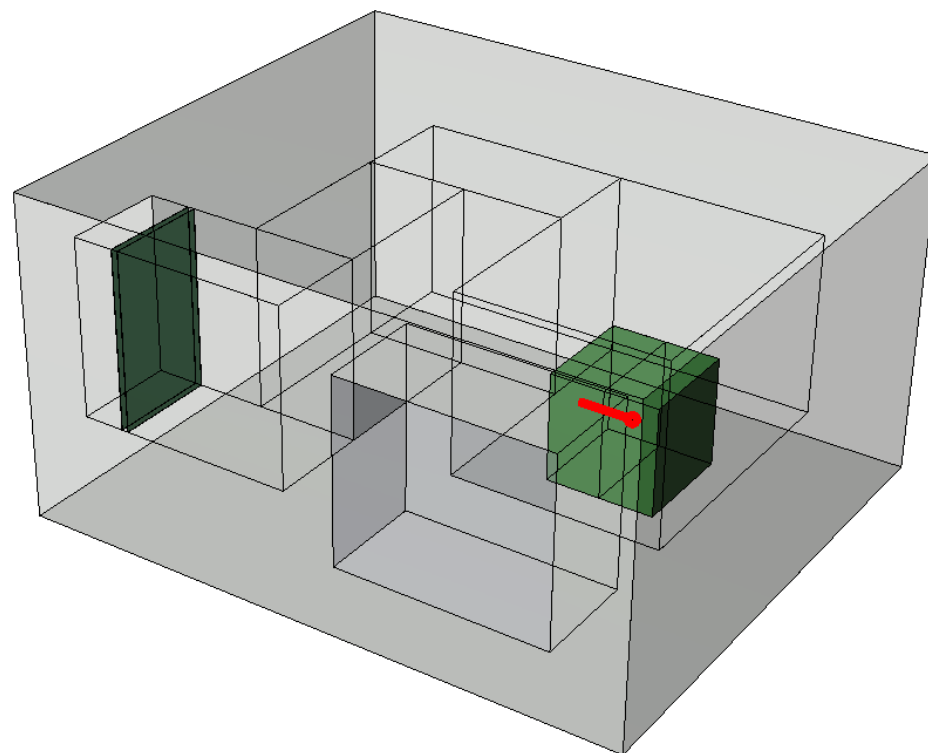
Visualization modes

- **Flat shading**
 - Default mode
- **Gouraud shading**
 - More complex shading supporting shiny high-lights
- **Wireframe**
 - Triangulated wireframe mode
- **Skeleton rendering**
 - Colored wireframe mode
- **Sketch rendering**
 - Black & white triangulated wireframe mode
- **Overlay sketch**
 - Can be combined with Flat or Gouraud shading. Allows for inspecting regions that are located inside other regions.
- **Render contours**
 - Can be combined with Flat or Gouraud shading. Only the outermost contours are drawn
- **Render hard contours**
 - Only hard edges will be drawn which is useful, for example, for cylindrical bodies.



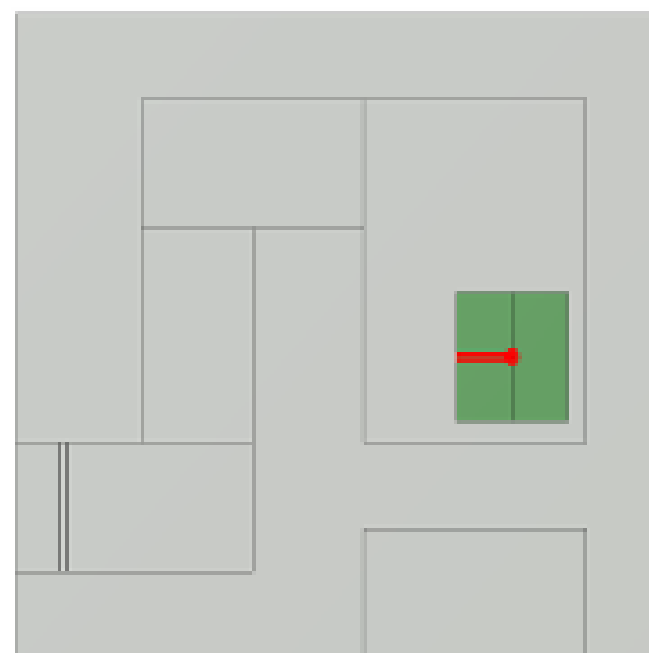
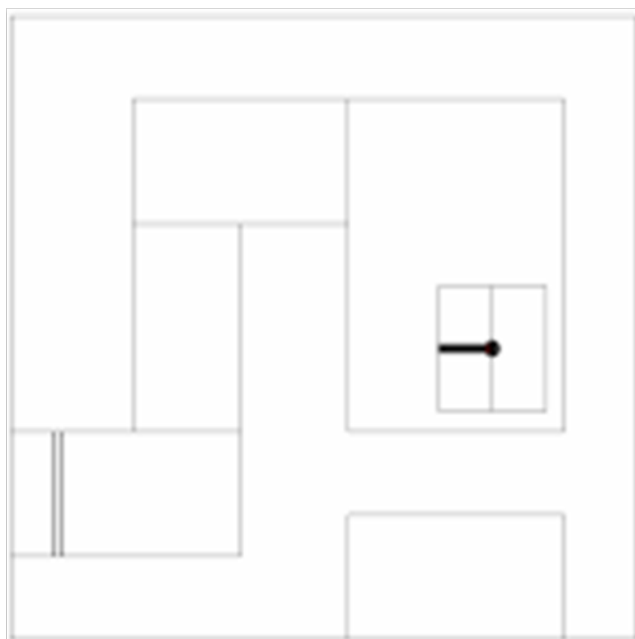
Visualization modes

- Try to combine “Flat” shading with “Render contours”.
- Try to combine “Flat” shading with “Overlay sketch”. This will allow you to see inside the surrounding air and show you the maze.



More on rendering options

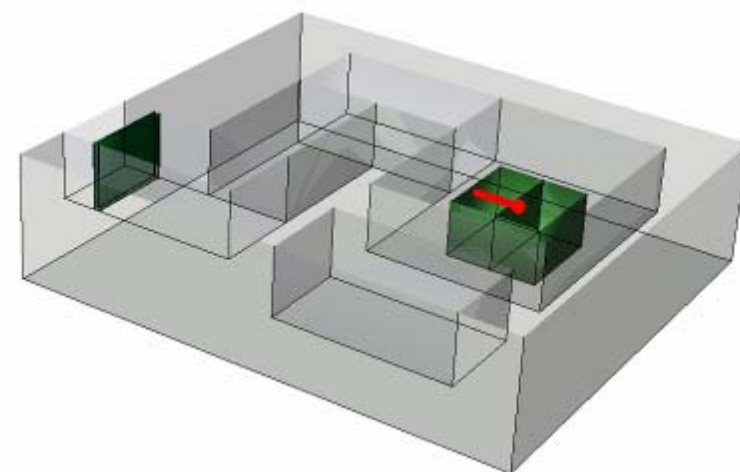
- There are several other rendering options:
 - Aliasing: Softening of jagged contour lines. High-end gfx cards can do this “on-the-fly” to some extent.
 - Parallel projection, allows you to obtain flat looking images. The look is similar to 2D sections if the camera is set to the correct position.



Clipping planes

- Clipping planes remove everything on one side of the plane. You can select various predefined planes from the “View” - “Clipping planes” menu.

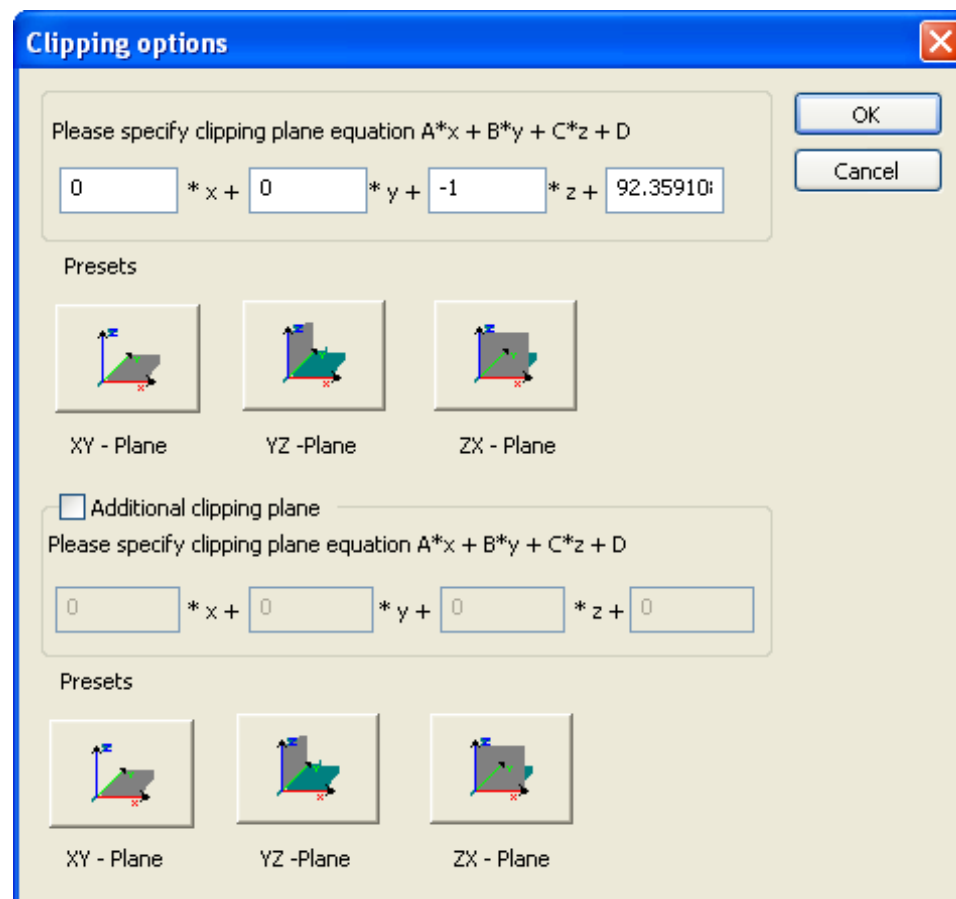
Activating the Identify function from the toolbar you can interactively change the position of the clipping plane while moving the mouse with the left button pressed.



More on clipping planes

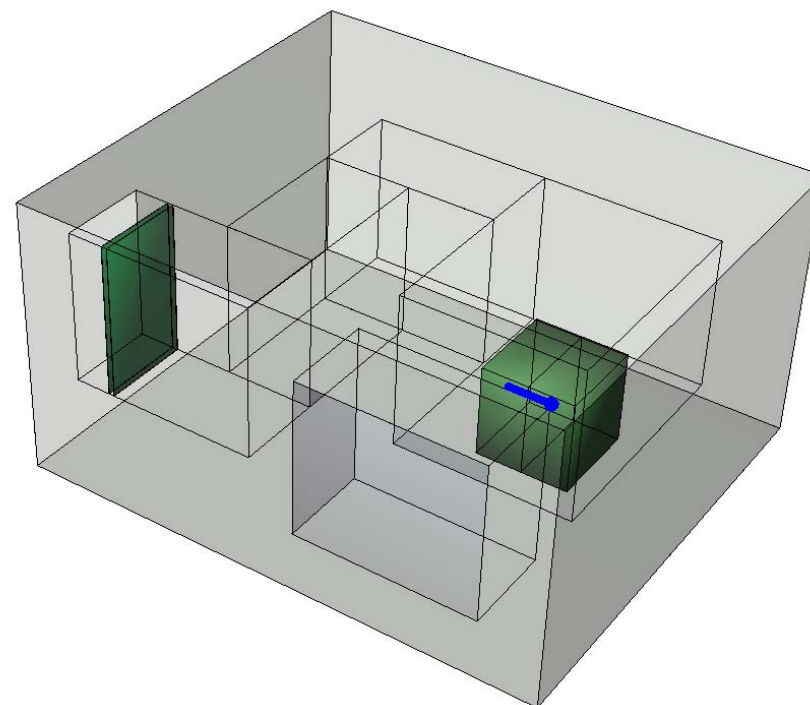
The options (plane equation) of the clipping planes are available under the “Clipping planes” – “Settings...” item. There you can define the type, position and orientation.

The orientation can be flipped by changing the sign for example.



Emphasizing an object

If you want to emphasize an object you can select different options (color, line style, line width) for this one region only. First select the region and then choose the visualization attributes in the property view.

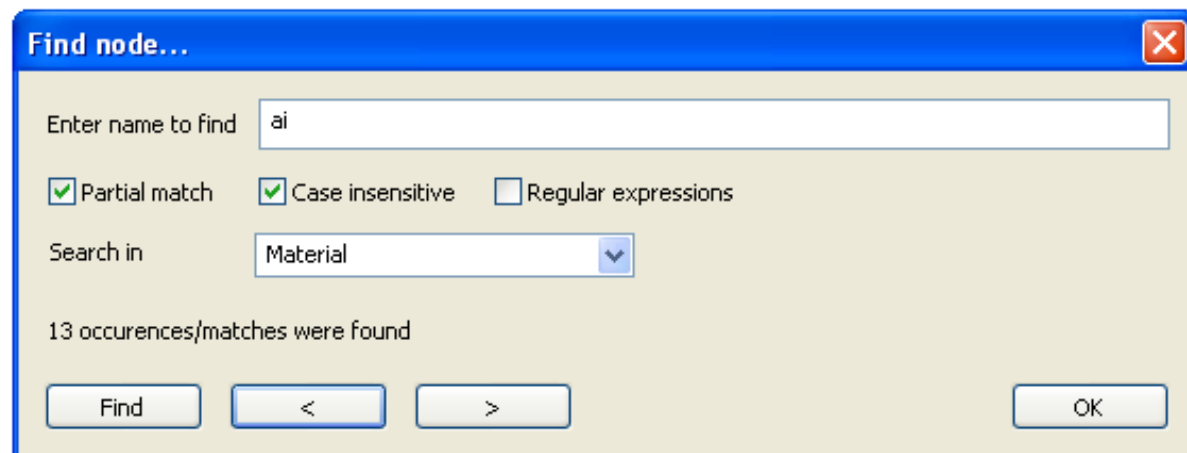


These settings will be effective in any rendering mode where contours are shown.

Navigation in the CSG tree

- You can immediately jump to a region number X by choosing “Go to region...” from the “Edit” menu or by pressing Ctrl + G.
- To find regions choose “Find node” from the “Edit” menu or press Ctrl + F.
 - Various search criterions like name, comments, materials and type are available.

Searching in the CSG tree



Several search refinements options are available. The options given above will find every node which has a material assignment that partially matches “ai” in its name. In our case we will find all nodes with a material assignment of “Air”. Pressing the < and > key automatically jumps to the respective node in the CSG tree.

If requested regular expressions are available for more complex searches.

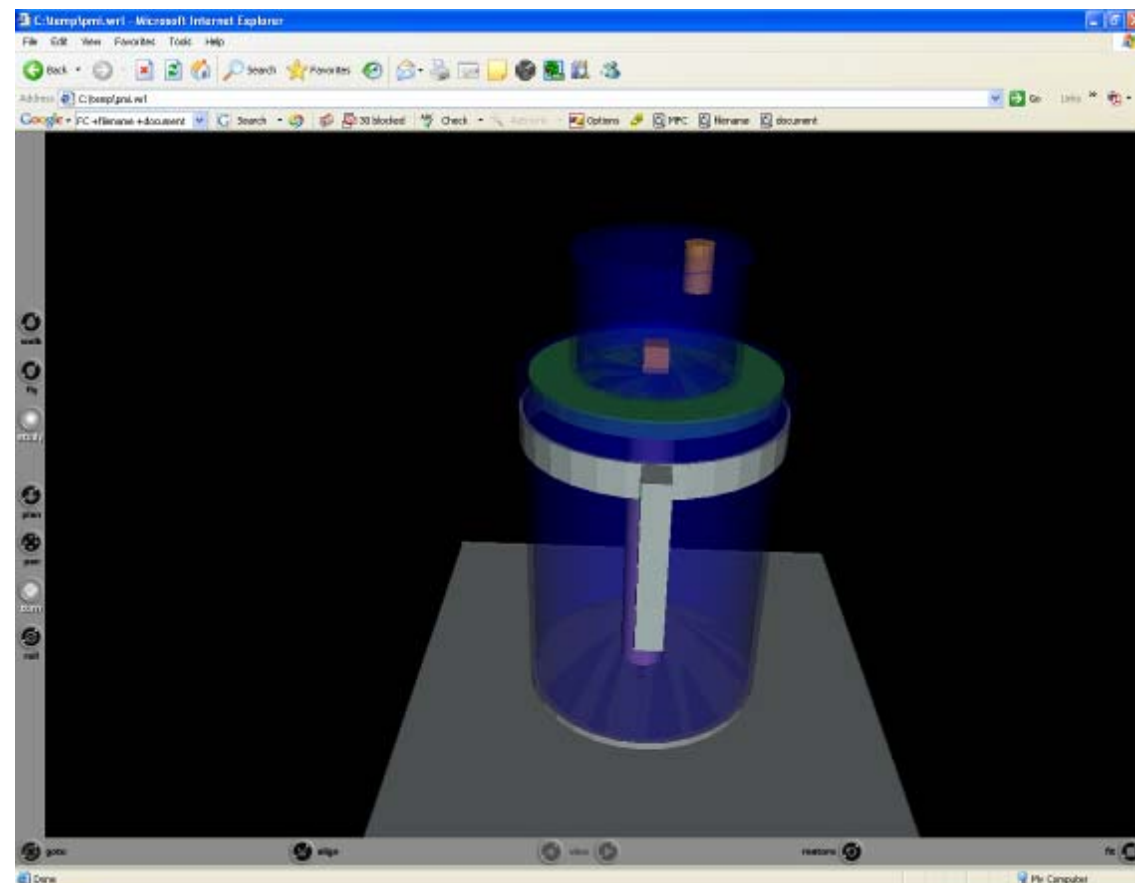
Saving images & geometries...

- The currently visible geometry can be saved to an image by selecting “Save Image” from the “File” menu, or it can be copied to the clipboard via “Edit” – “Copy to clipboard” for immediate insertion in other Windows applications.
- The geometry can be exported to different raytracing packages via “File” - “Export” - “3D objects”. These packages do not support interactivity but supply photorealistic images.

Saving images & geometries...

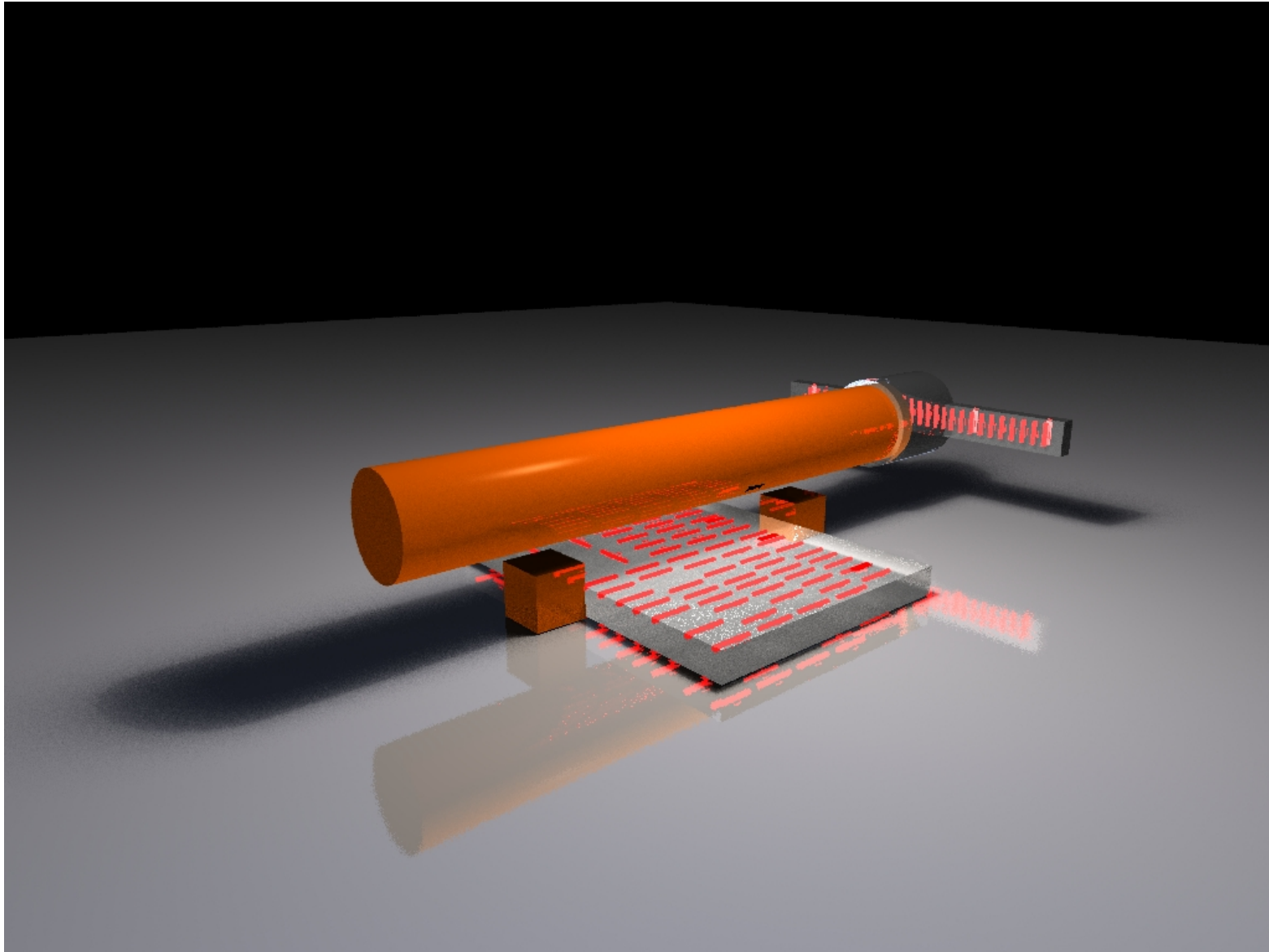
One supported file format is VRML. You can pass these files on to collaborators who can inspect them in a web browser using any freely available VRML plugin. (e.g. CORTONA). They do not need SimpleGeo!

For ray-tracing packages only regions that are currently visible are saved to avoid cluttering.



Images can be saved in various formats or directly exported to other Windows programs via the clipboard.

Ray-traced geometry



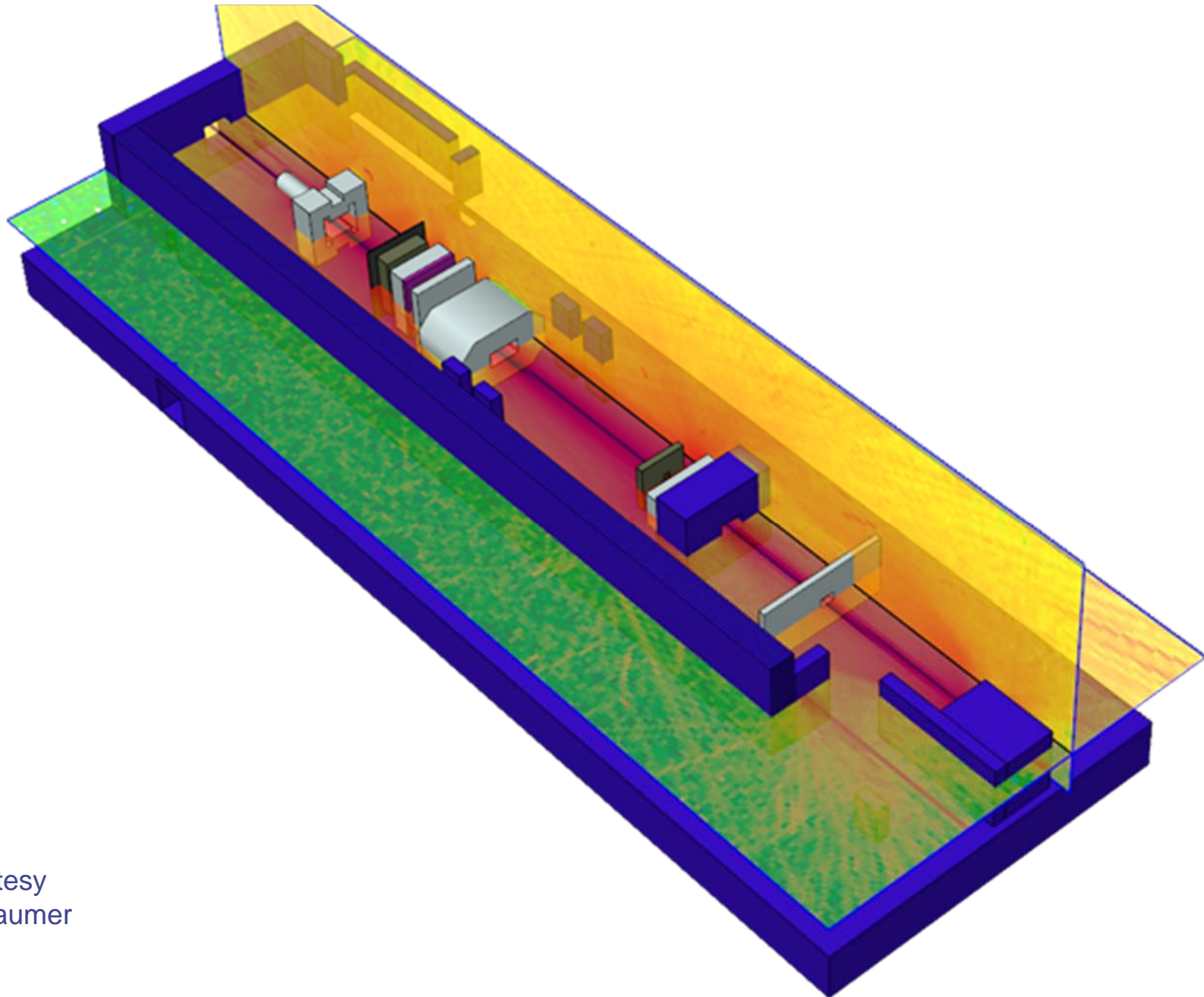
Geometry courtesy
of M. Fuerstner

Key features

- ✓ Interactive **creation** & **modification** of a geometry via **drag & drop**
- ✓ Import of FLUKA, ALIFE, WAVEFRONT, PLY
- ✓ Export to FLUKA, MCNP(X), PHITS*
- ✓ Export to various 3D raytracing packages
- ✓ Arbitrary camera viewpoints
- ✓ VB-Script like macro language
- ✓ Relative coordinate frames of nodes
- ✓ Undo/Redo functionality
- ✓ Volume & mass calculation of regions

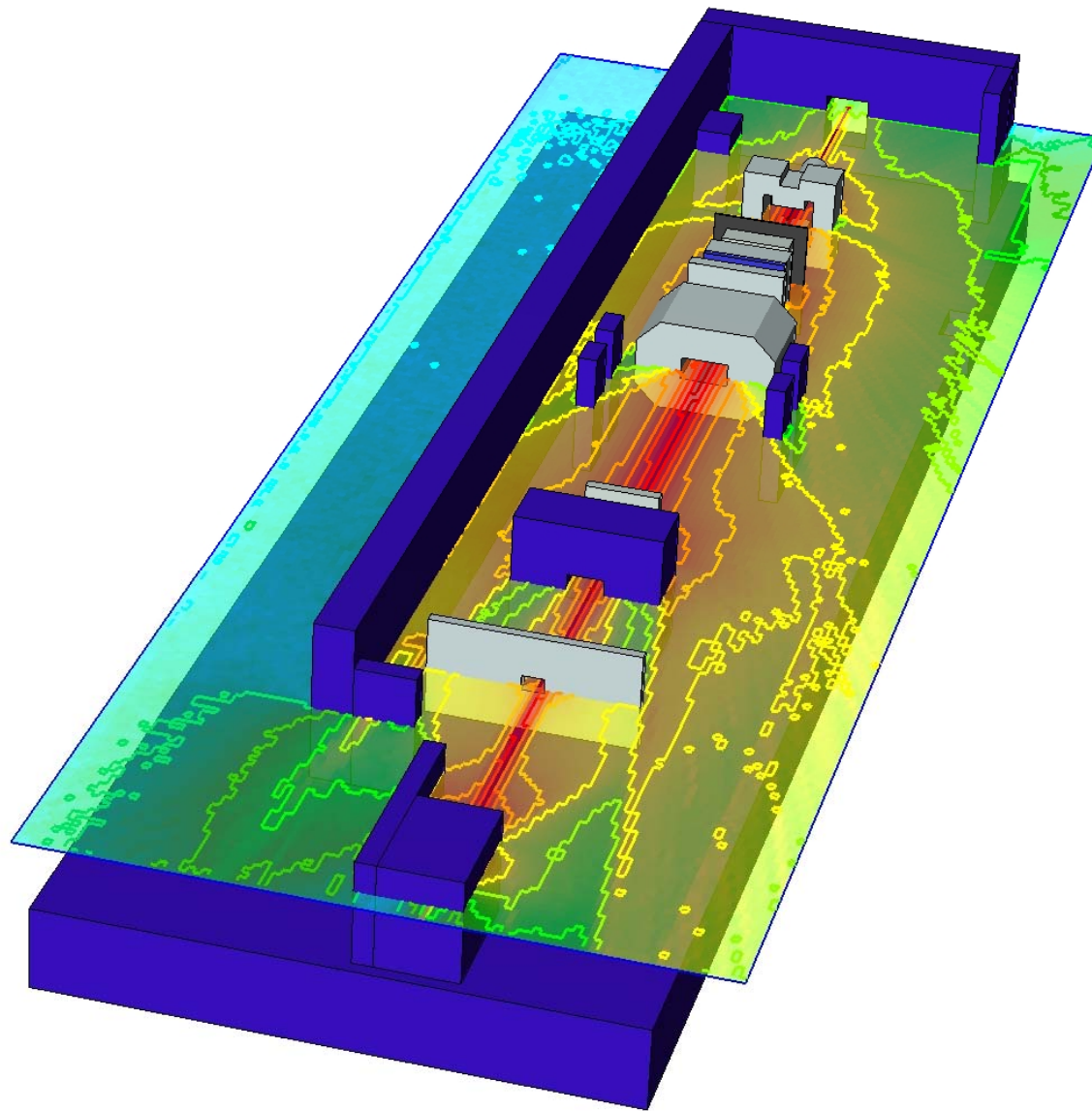
* This exporter is currently in beta state

Examples



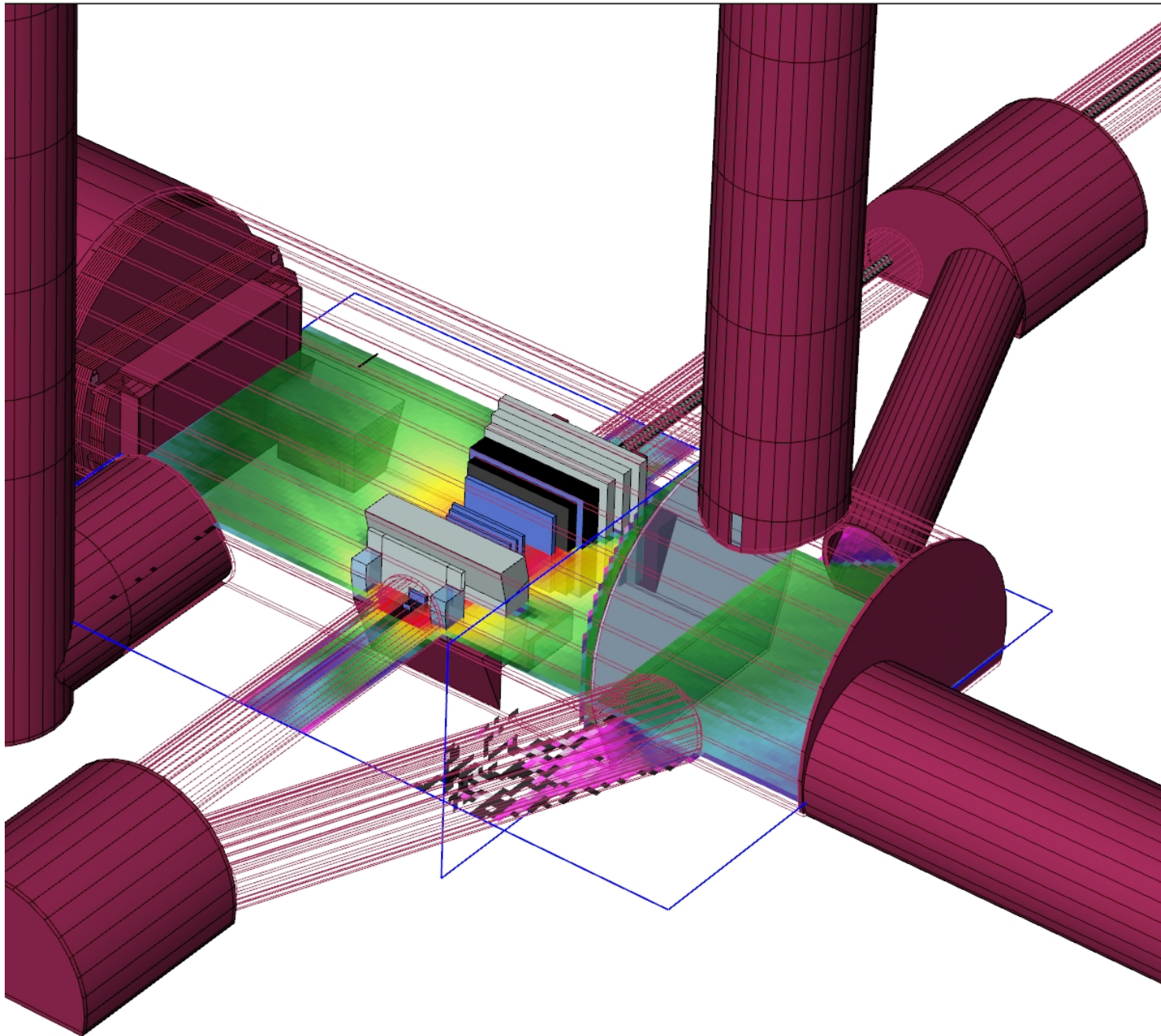
Model courtesy
of E. Feldbaumer

Examples

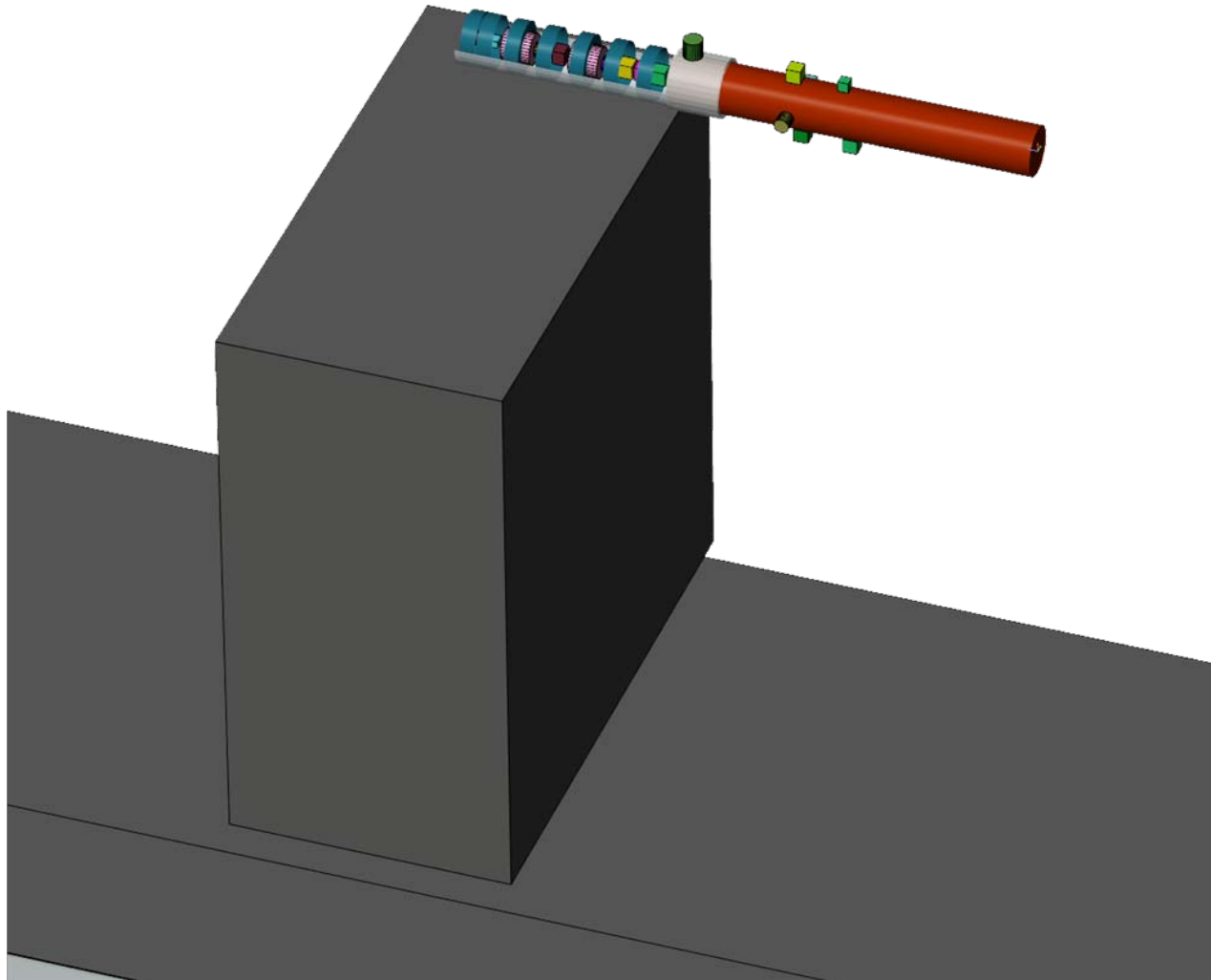


Model courtesy
of E. Feldbaumer

Examples

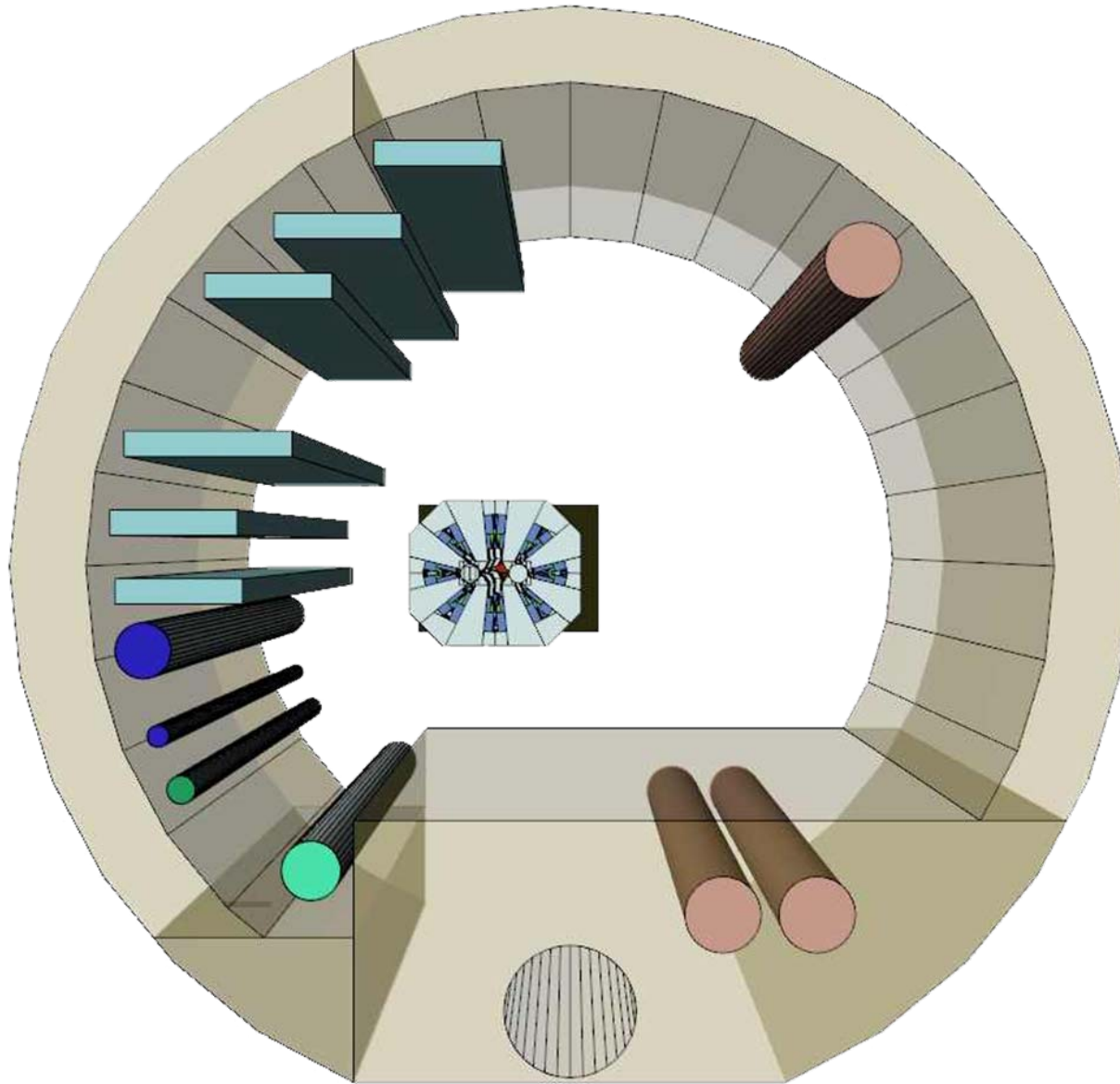


Examples



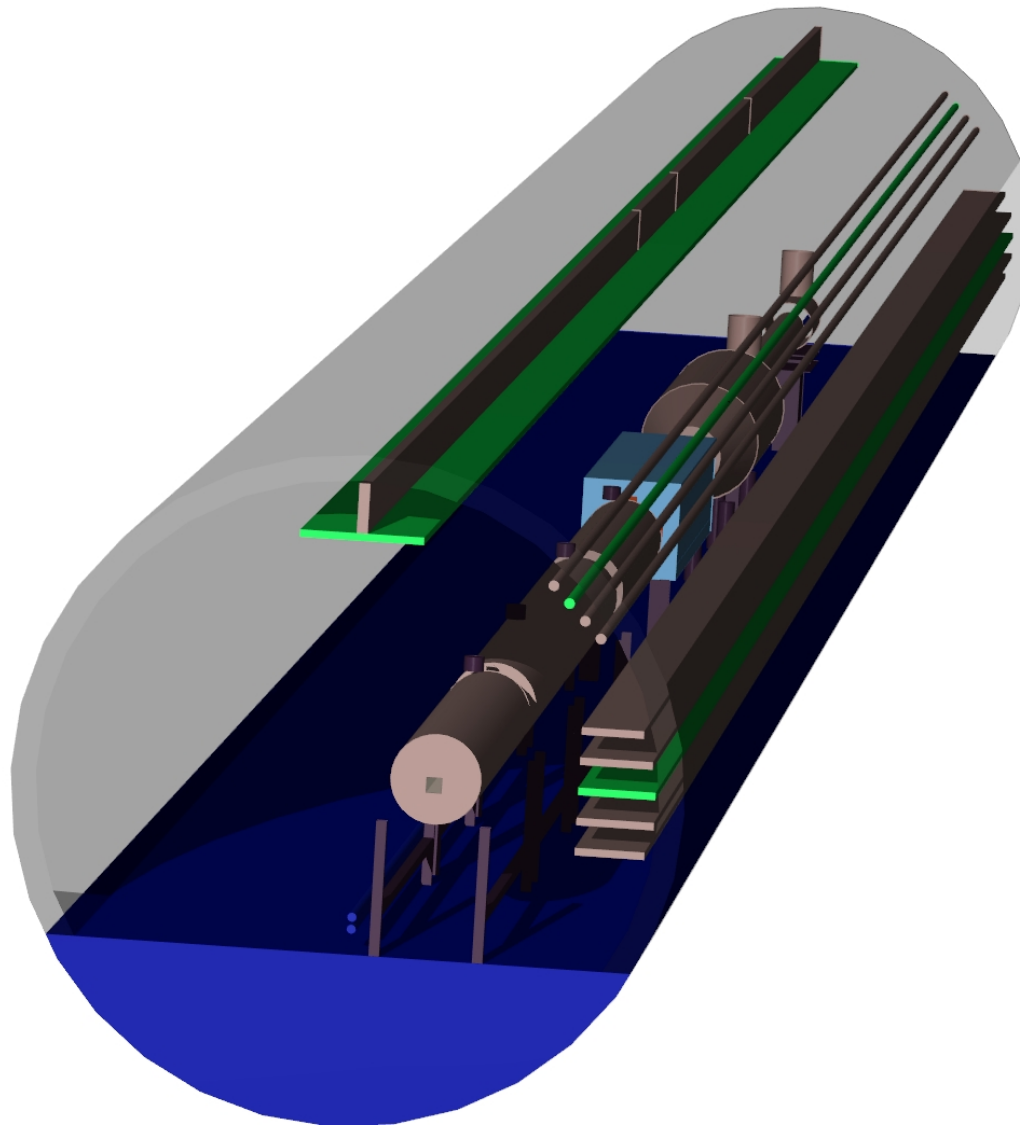
Model courtesy
of M. Brugger &
S. Roesler

Examples



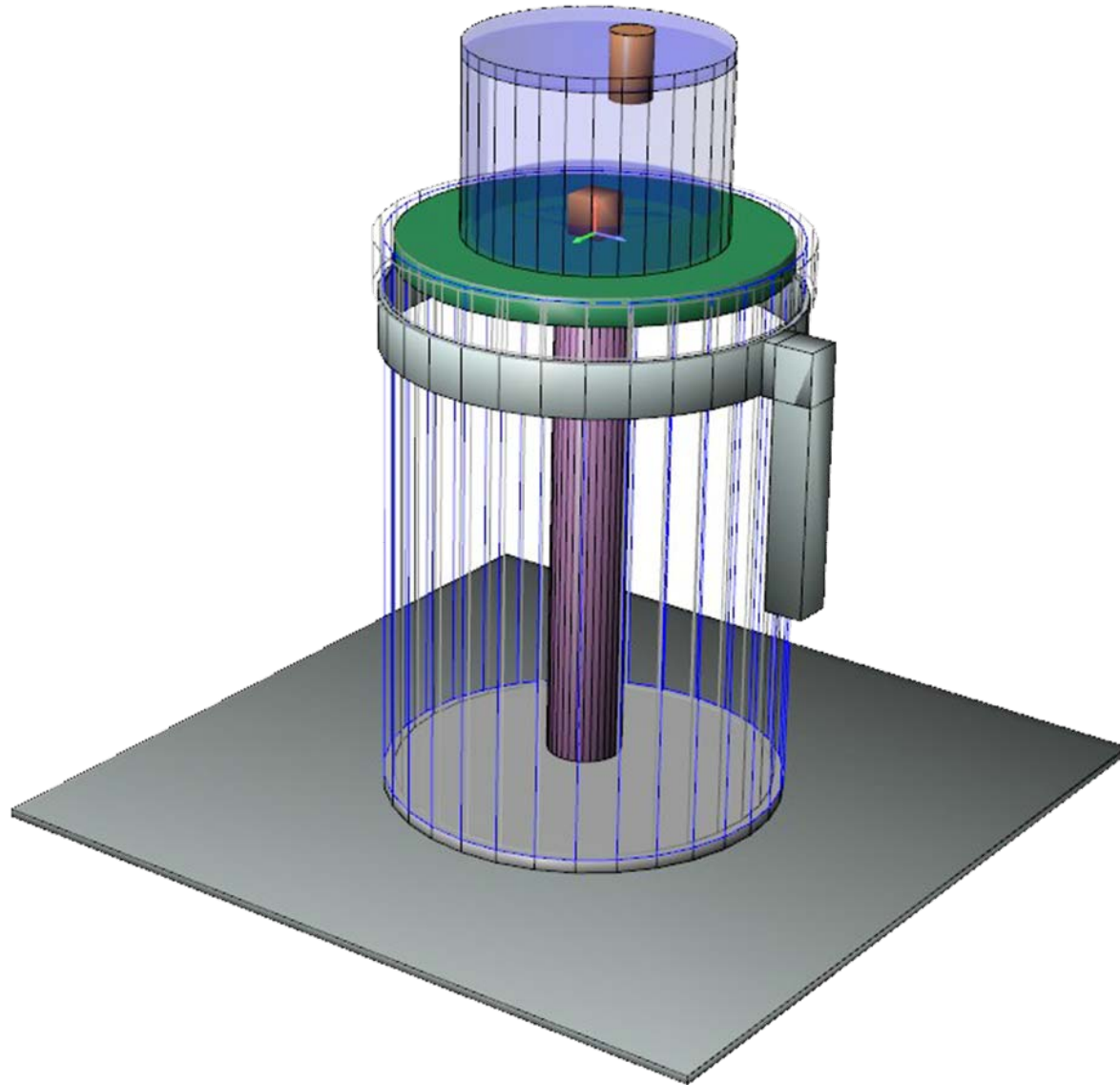
Model courtesy
of H. Vincke

Examples



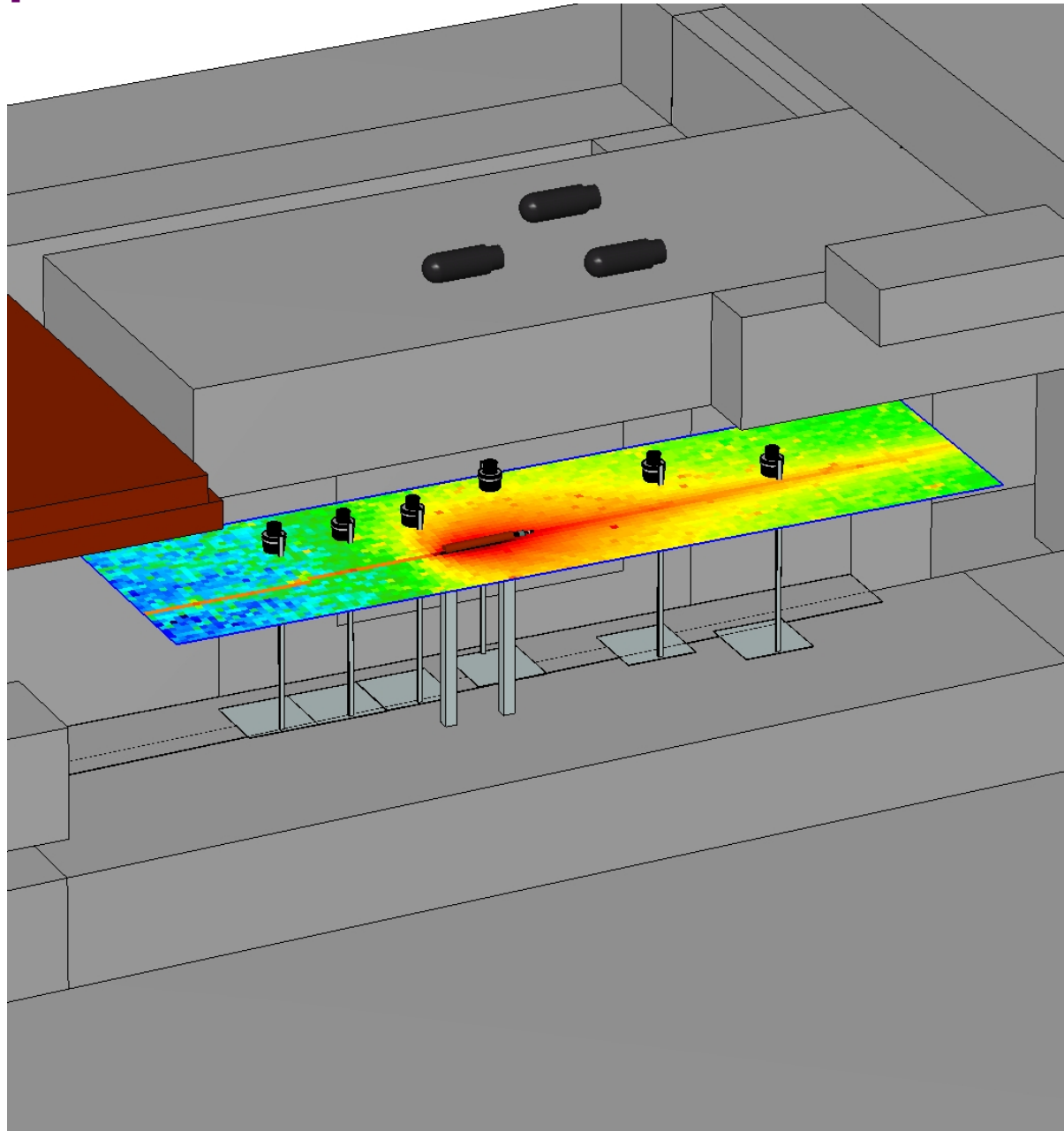
Model courtesy
of L. Nicolas

Examples



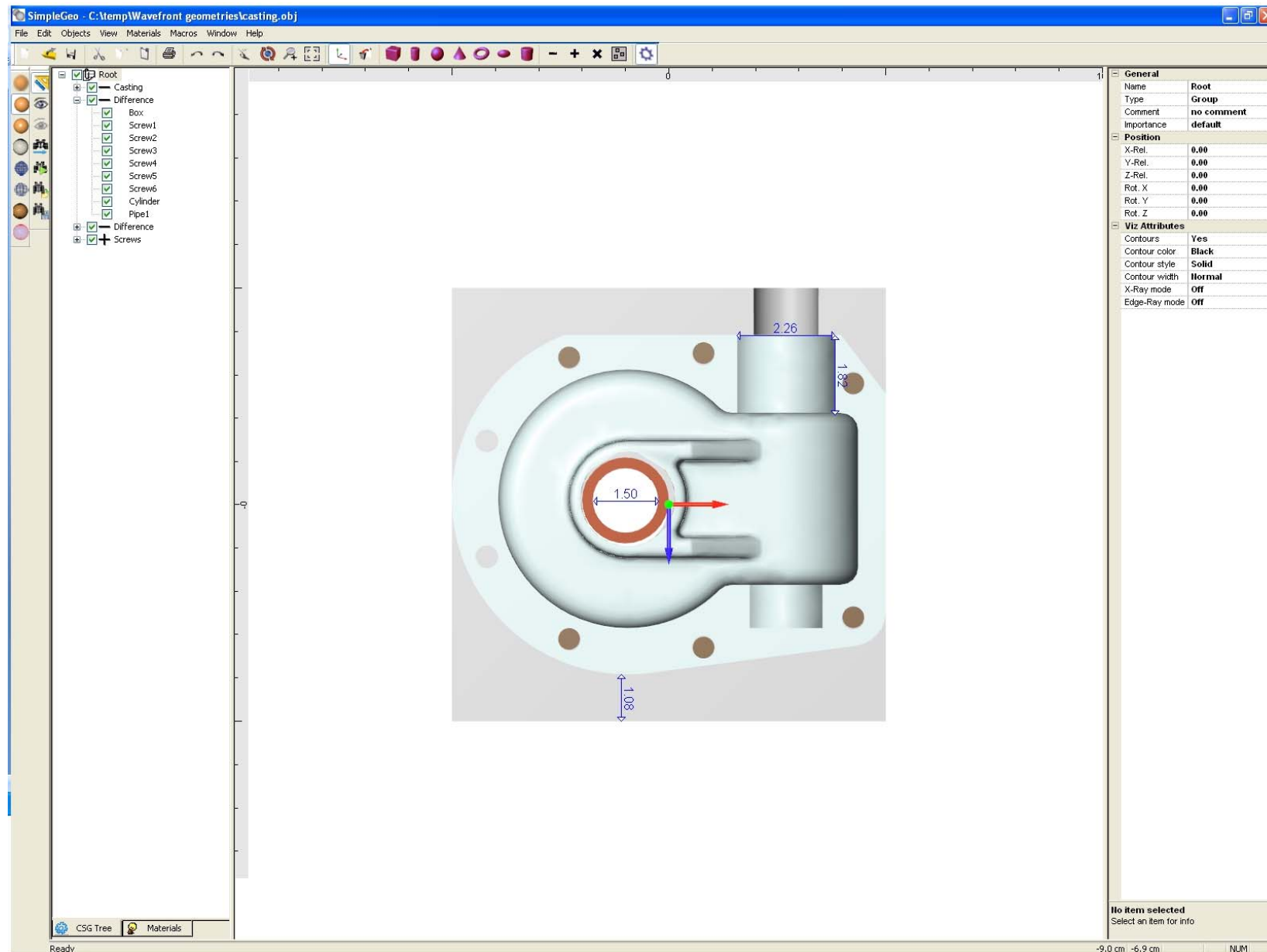
Model courtesy
of H. Vincke

Examples

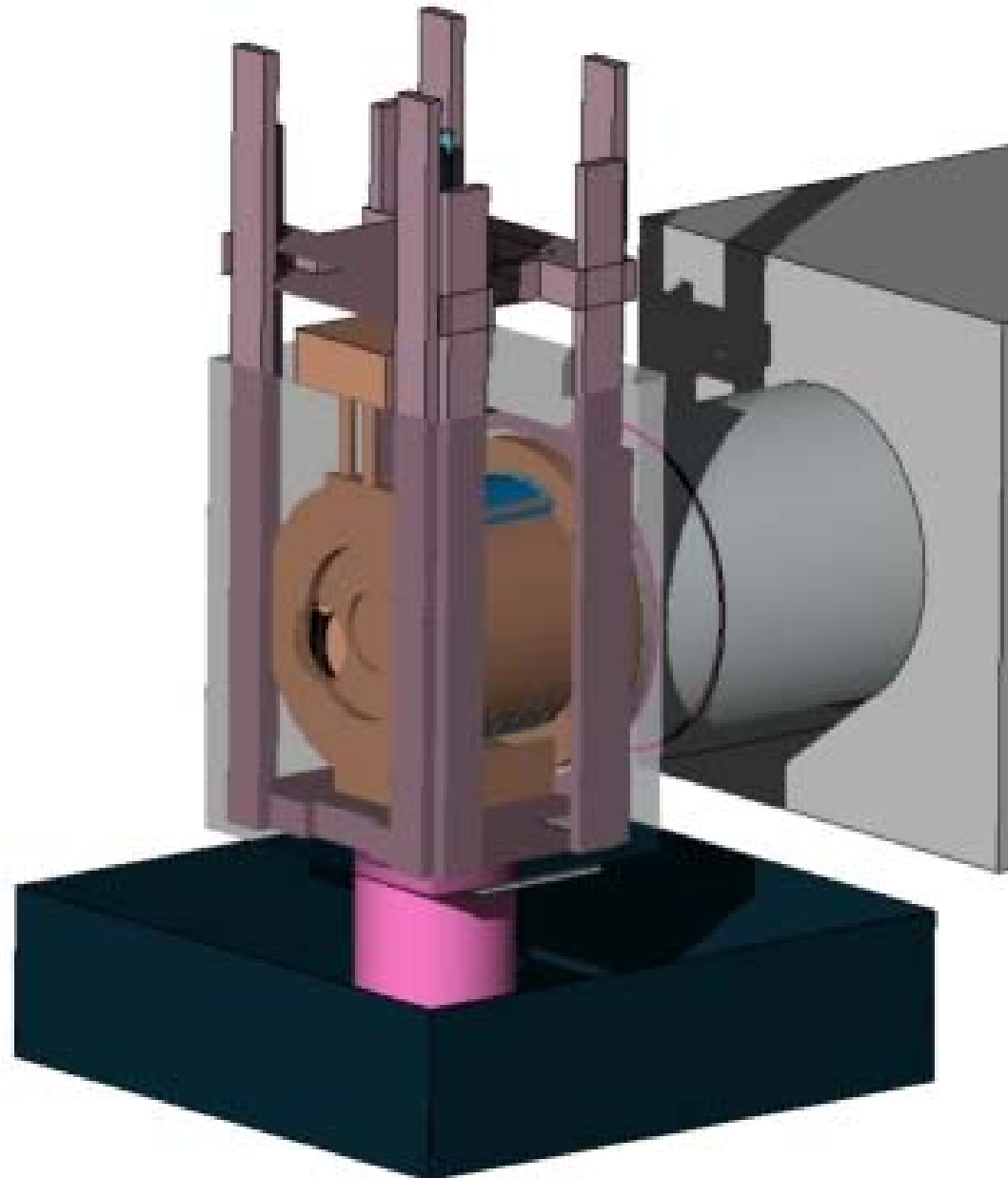


Model courtesy
of H. Vincke

Examples – 2D measures



Examples



Model courtesy
of E. Lebbos

Thank you for your attention



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