



# An integrated developer-oriented OpenGL post-processor in Cast3m and VisualCast3m

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(contribution from A. Anthoine)

- Obsolescence of the graphical model of Cast3m
  - ⇒ Made for multiple devices including plotters
  - ⇒ Rendering (such as hidden line removal) by software
  - ⇒ Low level of interactivity
- Available standard for 3D rendering
  - ⇒ PC's available with powerful graphic cards (interactive games!)
  - ⇒ Hidden-surface removal, lighting, shading, etc... performed at hardware level
  - ⇒ Open source software: OpenGL + GLUT(GL Utility Toolkit)
- New developments for EUROPLEXUS...  
... but also for CAST3M!!
  - ⇒ Built-in graphic module
  - ⇒ Fortran 90 layer (modules and data structures)
  - ⇒ Possibility to interact with the development



# The rendering module: What is done at the moment

- Graphical capabilities
  - ⇒ Display geometries
  - ⇒ Display fields-by-point as vectors
  - ⇒ Display fields-by-point as isovalues
- Graphical modes
  - ⇒ On-screen interactive
  - ⇒ Off-screen for producing standard format bitmaps and animations

# The rendering module: viewing of the object

## Complete camera model

⇒ Eye location, camera orientation, field of view

- Basic navigation (On-screen)

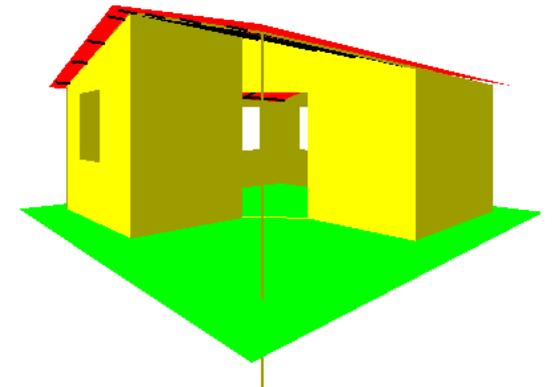
⇒ Translation and zoom of the camera by keystroke commands

⇒ Rotation by keystrokes or using the mouse (quaternion)

- Parametrized navigation (Off-screen)

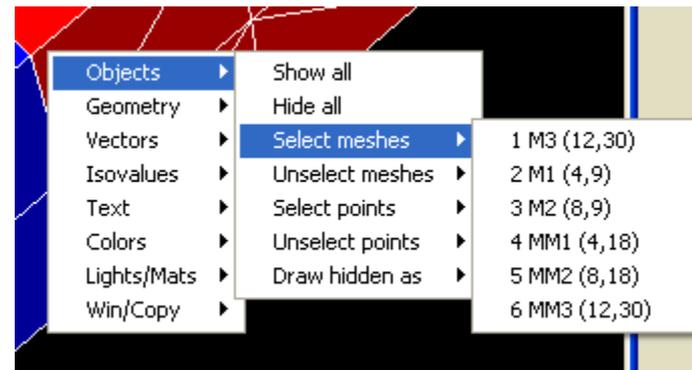
⇒ Specification of the camera (still image)

⇒ Circular or linear motion of the camera (animation)  
(SLERP object)



# The rendering module: On-line menu

- Hierarchical pop-up menus
  - ⇒ Only Graphical User Interface feature offered by GLUT
  - ⇒ Fully portable
- Basic menu level
  - ⇒ Objects
  - ⇒ Geometry
  - ⇒ Vectors
  - ⇒ Isovalues
  - ⇒ Text
  - ⇒ Colours
  - ⇒ Lights/Mats
  - ⇒ Win/Copy



# The rendering module: Off-line menu

- All the entries of the menu are modifying a SCENE object
- This object can be completely specified by a TABLE in Cast3m

```
tab4=table 'SCENE';  
*  
tab0=table 'OBJECTS';  
tab0 . 'SELECT_MESHES'=table 'LIST_OF_MESHES';  
tab0 . 'SELECT_MESHES' . 1=m1;  
tab0 . 'SELECT_POINTS'=table 'LIST_OF_POINTS';  
tab0 . 'SELECT_POINTS' . 1=p1;  
tab0 . 'SELECT_POINTS' . 2=p2;  
tab0 . 'DRAW_HIDDEN_AS'=MOT 'GREEN_GLASS';  
tab4 . 'OBJECTS'=tab0;  
*  
tab0=table 'GEOMETRY';  
tab0 . 'NAVIGATION'='FREE';  
tab0 . 'SHOW_CENTER'=vrai;  
tab0 . 'SHOW_INTERNAL_FACES'=vrai;  
tab0 . 'HIDE_ELEMENT_OUTLINES'=vrai;  
tab0 . 'SHOW_SHARP_CORNERS'=vrai;  
tab0 . 'POINTS_SHERES'=8.e0;  
tab0 . 'SHRINKAGE'=0.6e0;  
tab4 . 'GEOMETRY'=tab0;
```

```
tab0=table 'TEXT';  
tab0 . 'HIDE_INFO'=vrai;  
tab0 . 'SHOW_CAMERA_VALUES'=vrai;  
tab4 . 'TEXT'=tab0;  
*  
tab0=table 'COLORS';  
tab0 . 'CENTER'='JAUN';  
tab0 . 'SHARP_CORNER'='JAUN';  
tab0 . 'POINTS'='TURQ';  
tab4 . 'COLORS'=tab0;  
*  
tab0=table 'LIGHTS/MATS';  
tab0 . 'LIGHT_ON'=vrai;  
tab4 . 'LIGHTS/MATS'=tab0;
```



# The rendering module: Integration in Cast3m

- New directive TRAK
- Syntax (provisional!)

trak mail1 lchpo1 (mot1) (tab1) (tab2) (tab3);

mail1: type 'MAILLAGE' (mesh to be plotted)

lchpo1: type 'LISTCHPO' (fields-by-points to be represented)

mot1: 'NOSM' (NO Sub-Mesh option),  
'OFFS' (OFF-Screen option),  
'TEST' (TEST option)

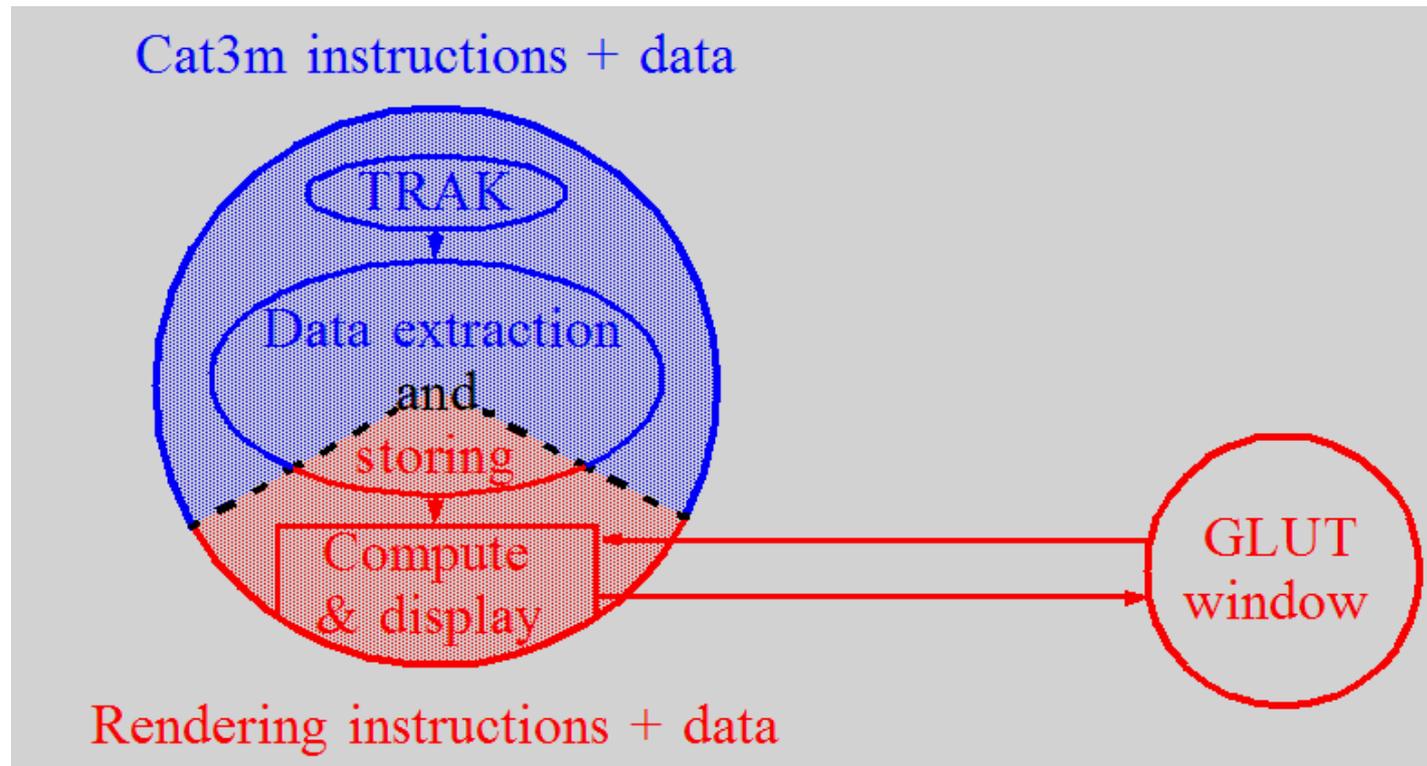
tab1: options for off-screen drawing

tab2: SLERP definition

tab3: SCENE definition

# The rendering module: Direct integration in Cast3m

How it works...





# The rendering module: Direct integration in Cast3m

... and limitations in Visual Cast3m (in the on-line case)

- The Glut window is not part of the Visual Cast3m workspace
- There is only one (inter)active graphical window with no persistent behaviour

... but convenient for other platforms...

... or for the off-screen drawing!



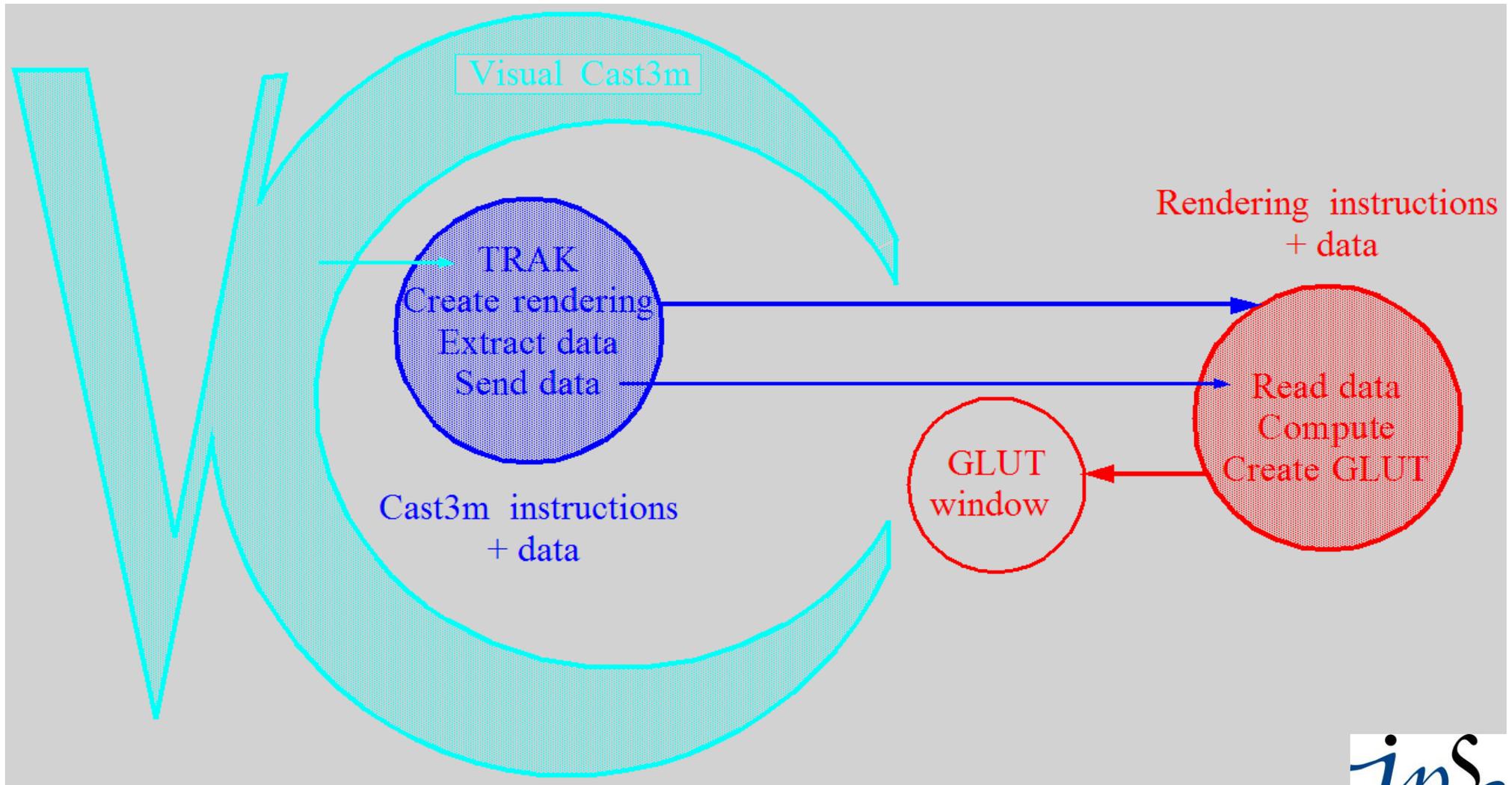
# The rendering module: Integration in Visual Cast3m

A parent/child/adoption scheme (in the on-line case)!

- Cast3m creates a new child rendering process, which creates in turn the Glut window
- The Glut window is adopted by Visual Cast3m
- The parent/child link is broken between Cast3m and the rendering process

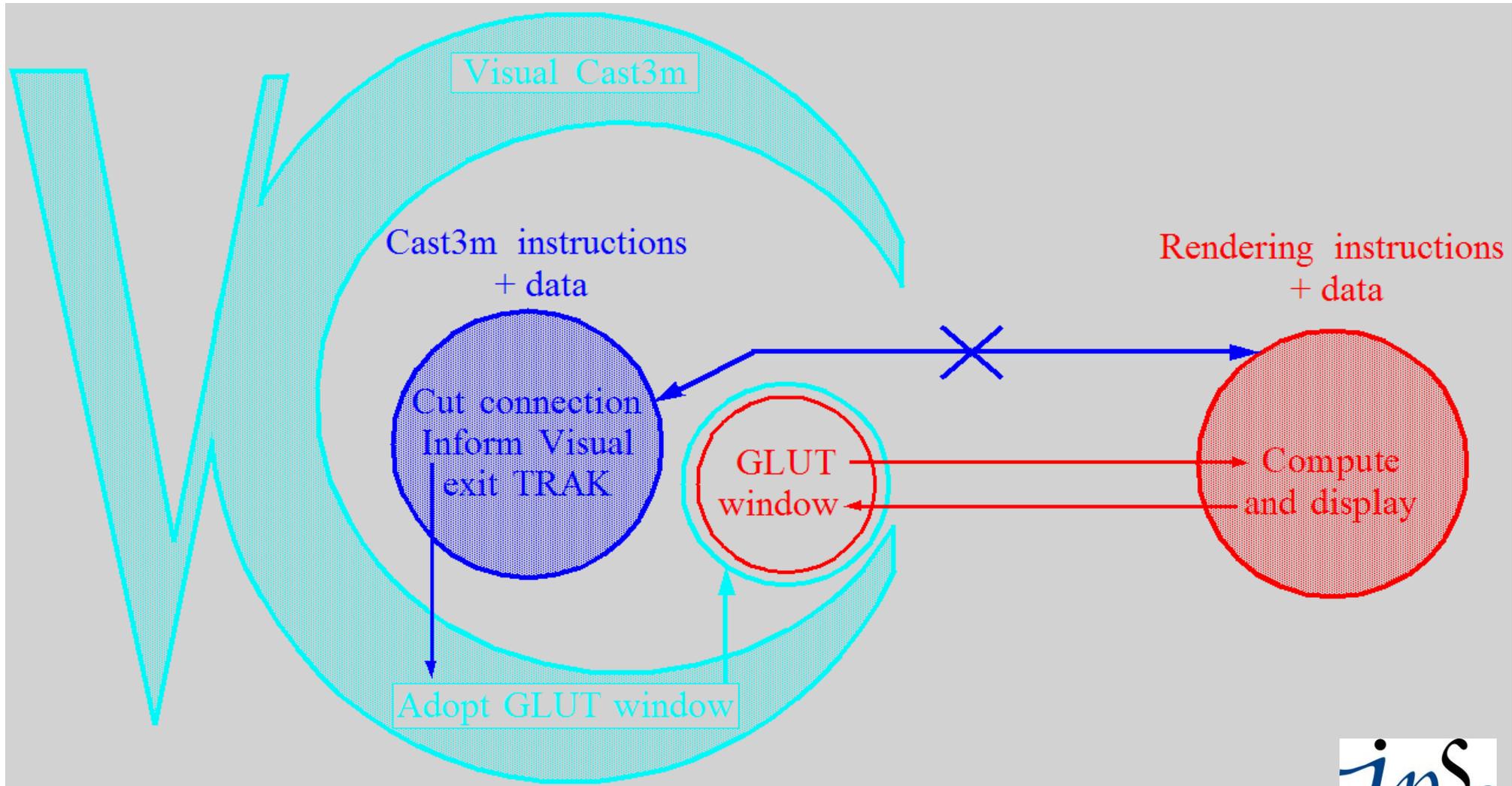
# The rendering module: Integration in Visual Cast3m

## The parent/child phase



# The rendering module: Integration in Visual Cast3m

The orphanization and adoption phase





# The rendering module: What will be done in the future

- Display fields-by-elements (almost ready)
- Advanced navigation for on-screen mode
- Use of SLERP and SCENE for on-screen drawing
- Smooth scene transition for animation
- ...
- ... and user feedback/requests!!!!!!!!!!



# The rendering module: Portability on Linux and other platforms

- This development is working on Windows NT4, 2000 and XP
- OpenGL is not installed by default on all Linux platform

**BUT...**

- OpenGL is available freely (dependance on the graphic card)
- Glut part works under Linux (all features available except direct production of AVI animation files)
- The direct interface for on-line drawing still exists!



# Demonstrations

- On-screen capabilities
- Off-screen capabilities



```

opti titr 'Ma cabane a El Salvador';
opti elem cub8;
ter0 = (3.5 3.5 0.) d 1 (-3.5 3.5 0.) tran 1 (0. -7. 0.) coul vert;
boit1 = ter0 moin (0 0 1) volu tran 1 (0 0 1);
boit2 = ter0 moin (0 0 1) volu tran 1 (0 0 2);
boit3 = ter0 moin (0 0 1) volu tran 1 (0 0 3.2);
mesh1 = tabl;
mesh1 . 1 = rcf0 et rct0 et (rcc0 incl boit1 'VOLU' 'STRI');
mesh1 . 2 = mesh1 . 1 et ((vb3 et vb4) incl boit2 'VOLU' 'STRI');
mesh1 . 3 = mesh1 . 2 et fun0;
mesh1 . 4 = mesh1 . 3 et sul;
mesh1 . 5 = mesh1 . 4 et wall et (hb2 incl boit2 'VOLU' 'STRI');
mesh1 . 6 = mesh1 . 5 et su2;
mesh1 . 7 = mesh1 . 6 et ((vb3 et vb4) incl boit3 'VOLU' 'STRI');
mesh1 . 8 = mesh1 . 7 et wal2 et (hb2 incl boit3 'VOLU' 'STRI');
mesh1 . 9 = mesh1 . 8 et su3;
mesh1 . 10 = mesh1 . 9 et (vb3 et vb4);
mesh1 . 11 = mesh1 . 10 et wal3 et wal4 et hb2;
mesh1 . 12 = mesh1 . 11 et su4;
mesh1 . 13 = mesh1 . 12 et rcc0 et rcb0;
mesh1 . 14 = mesh1 . 13 et do0;
mesh1 . 15 = mesh1 . 14 et po0;
mesh1 . 16 = mesh1 . 15 et te3;
mesh1 . 17 = mesh1 . 16 et ro0;
mesh1 . 18 = mesh1 . 17 et ter0;
*
tscenel = tabl 'SCENE';
*
tab0 = tabl 'GEOMETRY';
tab0 . 'NAVIGATION'='FREE';
tab0 . 'SHOW_BACK_FACES' = vrai;
tab0 . 'HIDE_ELEMENT_OUTLINES' = vrai;
tab0 . 'ANTIALIAS_LINES' = vrai;
tscenel . 'GEOMETRY' = tab0;
*
tab0 = tabl 'TEXT';
tab0 . 'SHOW_CAMERA_VALUES' = faux;
tscenel . 'TEXT' = tab0;
*
tab0 = tabl 'COLORS';
tab0 . 'BACKGROUND' = 'BLAN';
tscenel . 'COLORS' = tab0;
*
tab0 = tabl 'LIGHTS/MATS';
tab0 . 'LIGHT_ON' = vrai;
tscenel . 'LIGHTS/MATS' = tab0;
  
```

Construction of  
 “Ma cabane a El Salvador”

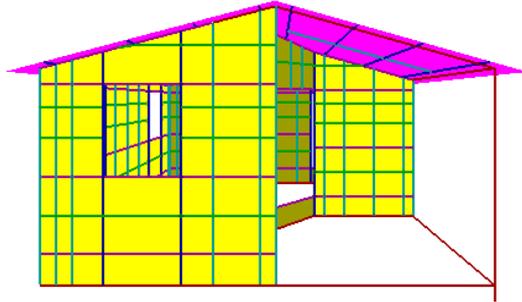
```

dis0 = 8.; alt0 = 1.5; ver0 = -0.005; fovy = 80; tcam0 = tabl;
num0 = 18;
theta0 = -360./num0;
repe i0 num0;
  thetai0 = theta0*&i0;
  cthi0 = (cos thetai0)*dis0;
  sthi0 = (sin thetai0)*dis0;
  tcam0.&i0 = tabl 'CAMERA';
  tcam0.&i0.'EYE' = prog cthi0 sthi0 (ver0*thetai0+alt0);
  tcam0.&i0.'VIEW' = prog (-1.*cthi0) (-1.*sthi0) 0.;
  tcam0.&i0.'RIGHT' = prog (-1.*sthi0) cthi0 0.;
  tcam0.&i0.'UP' = prog 0. 0. 1.;
  tcam0.&i0.'FIELD_OF_VIEW'= fovy;
fin i0;
*
tslerpl=tabl 'SLERP';
tslerpl.'CAMERA_1'=tcam0 . 1;
tslerpl.'CAMERA_2'=tcam0 . 2;
tslerpl.'CENTRE'=prog 0. 0. (ver0*theta0*3/2.+alt0);
tslerpl.'NB_FRAMES'=360/num0;
*
ttrakl=tabl 'TRAK';
ttrakl.'OUTPUT'='AVI';
ttrakl.'MODALITY'='NEW&OPEN';
ttrakl.'NB_FRAMES'=360;
ttrakl.'FRAMES_PER_SECOND'=15;
ttrakl.'COMPRESSION'=-1;
ttrakl.'KEY_FRAME'=10;
ttrakl.'BASE'='U:\VisualK2000\Trash\ani-con';
trak mesh1 . 1 'NOSM' 'OFFS' ttrakl tslerpl tscenel;
*
ttrakl.'MODALITY'='OLD&OPEN';
enle ttrakl 'NB_FRAMES';
repe i0 (num0 - 2);
  tslerpl.'CAMERA_1'=tcam0.(&i0 + 1);
  tslerpl.'CAMERA_2'=tcam0.(&i0 + 2);
  tslerpl.'CENTRE'=prog 0. 0. (ver0*theta0*(2*&i0+3)/2.+alt0);
  trak mesh1.(&i0 + 1) 'NOSM' 'OFFS' ttrakl tslerpl tscenel;
fin i0;
*
ttrakl.'MODALITY'='OLD&CLOSE';
tslerpl.'CAMERA_1'=tcam0 . 18;
tslerpl.'CAMERA_2'=tcam0 . 1;
tslerpl.'CENTRE'=prog 0. 0. (ver0*theta0*19/2.+alt0);
trak mesh1 . 18 'NOSM' 'OFFS' ttrakl tslerpl tscenel;
  
```

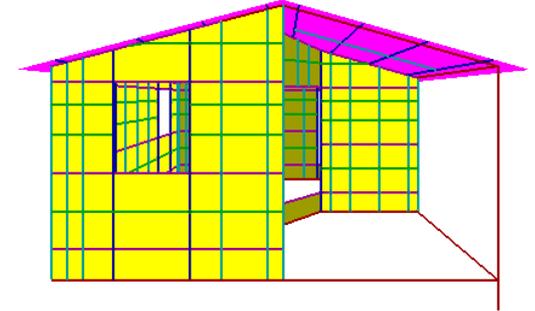
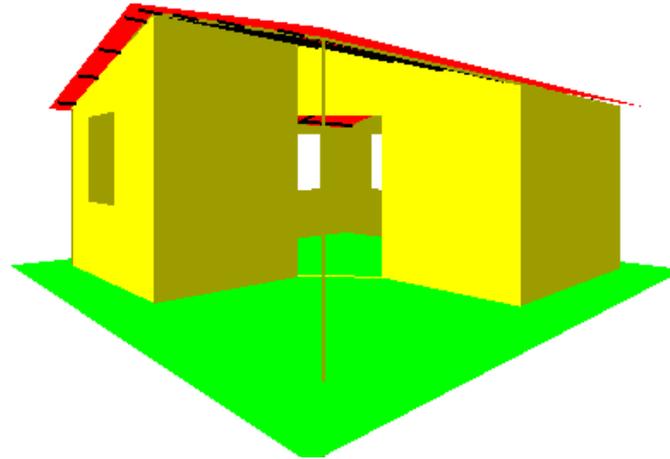


# Demonstrations

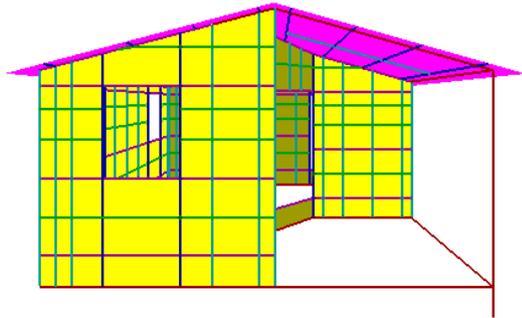
## Shape modes of “Ma cabane a El Salvador”



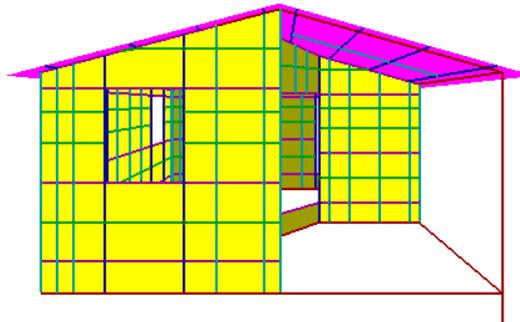
1rst mode



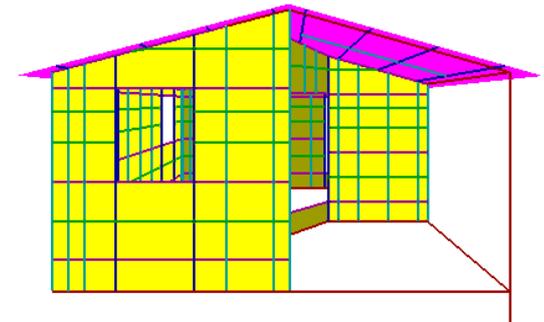
5th mode



2nd mode

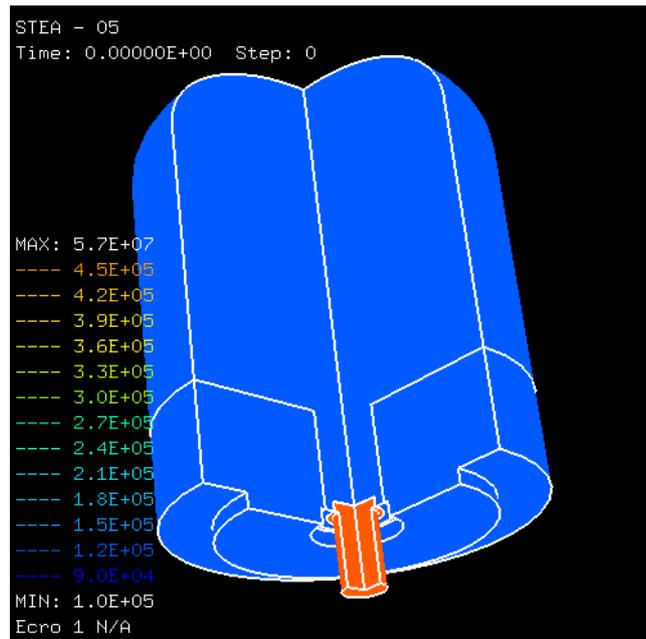


3rd mode

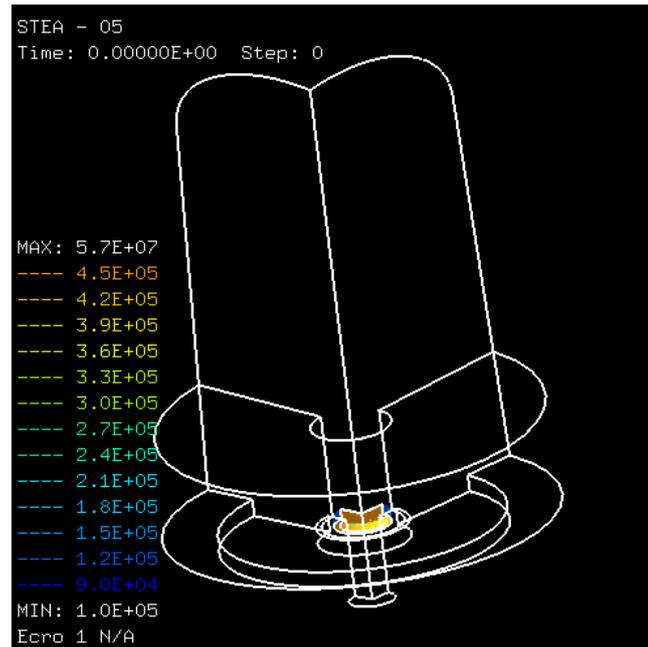


4th mode

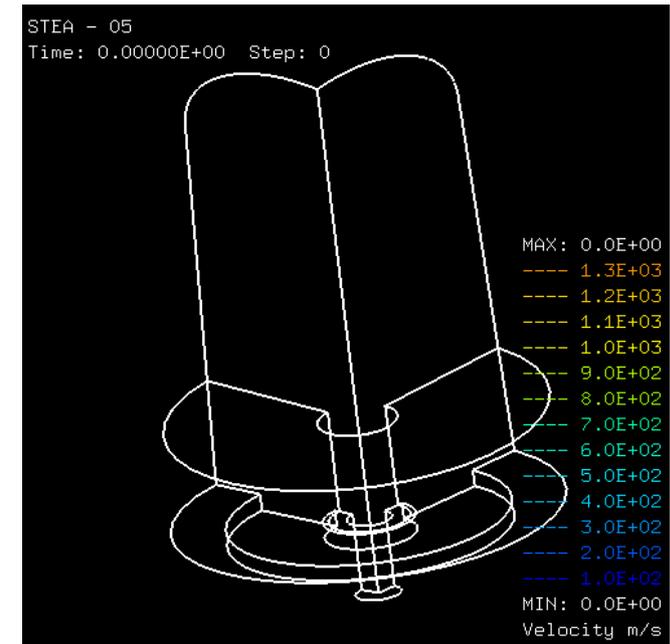
## Core explosion in the secondary container of a nuclear reactor



Pressure (iso-fill)



Pressure (iso-surface)

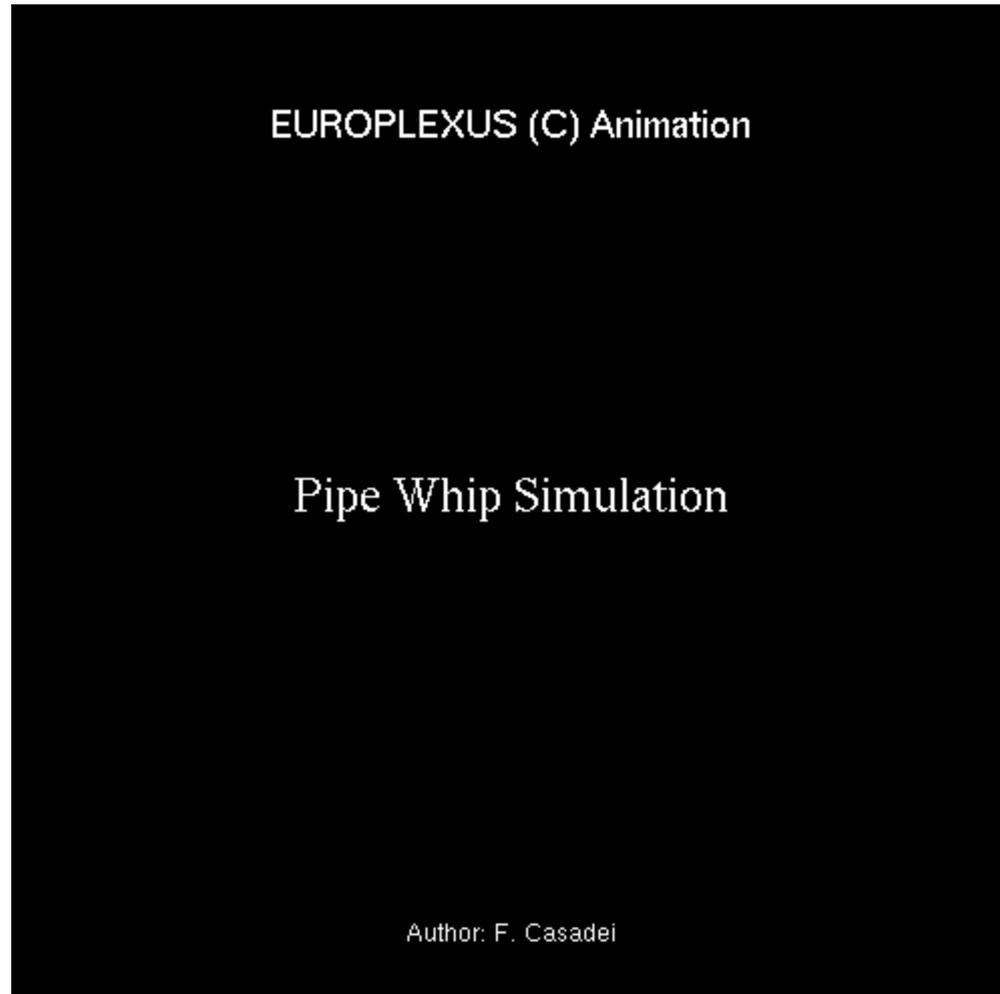


Fluid velocities



# Demonstrations

## Rupture of a pressurized tube



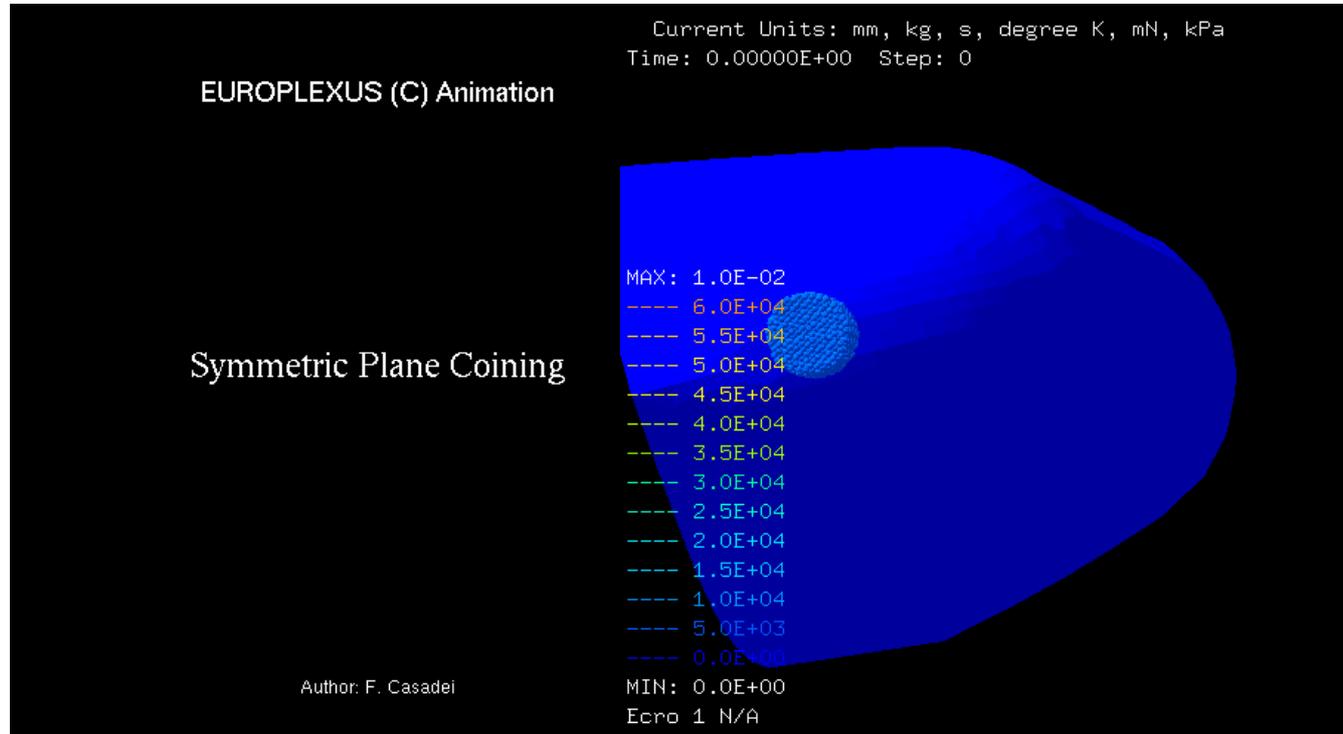
Pressure (iso-surface)





# Demonstrations

- On-screen capabilities
- Off-screen capabilities



EUROPLEXUS (C) Animation

Cable Impact

Author: F. Casadei

Current yield stress

Vmis of the membrane  
stress in the shells

Configuration