Elmer

Post-processing utilities

ElmerTeam
CSC – IT Center for Science

Visualization capabilities of Elmer suite

- ElmerPost is basically ok but has some limitations
  - Somewhat outdated look and feel
  - Output resolution same as window resolution
  - Only one view at a time
  - No parallel functionality
  - Limited feature list compared to Paraview
  - Currently building challenges
- VTK-widget in ElmerGUI
  - Minimalistic visualization mimicing ElmerPost functioality
- Visualization tools beyond Elmer suite as mainly used
  - Paraview!

Visualization tools – Poll (3/2014)

What visualization software do you use?

You may select up to **10** options

ElmerPost	☑	12	18%
ElmerGUI VTK postprocessor	☑	7	11%
Paraview	☑	27	41%
ViSit	☐	3	5%
Mayavi	☐	0	No votes
Gmsh	☐	2	3%
GiD	☐	1	2%
Matlab	☑	5	8%
gnuplot	☐	4	6%
Something else (please specify)	☐	5	8%

Total votes : 66

Submit vote

Exporting 2D/3D data: ResultOutputSolve

- Apart from saving the results in .ep format it is possible to use other postprocessing tools
- ResultOutputSolve offers several formats
  - vtk: Visualization tookit legacy format
  - vtu: Visualization tookit XML format
  - Gid: GiD software from CIMNE: http://gid.cimne.upc.es
  - Gmsh: Gmsh software: http://www.geuz.org/gmsh
  - Dx: OpenDx software
- **Vtu** is the recommended format!
  - offers parallel data handling capabilities
  - Has binary and single precision formats for saving disk space
  - Suffix **.vtu** in Post File does this automatically

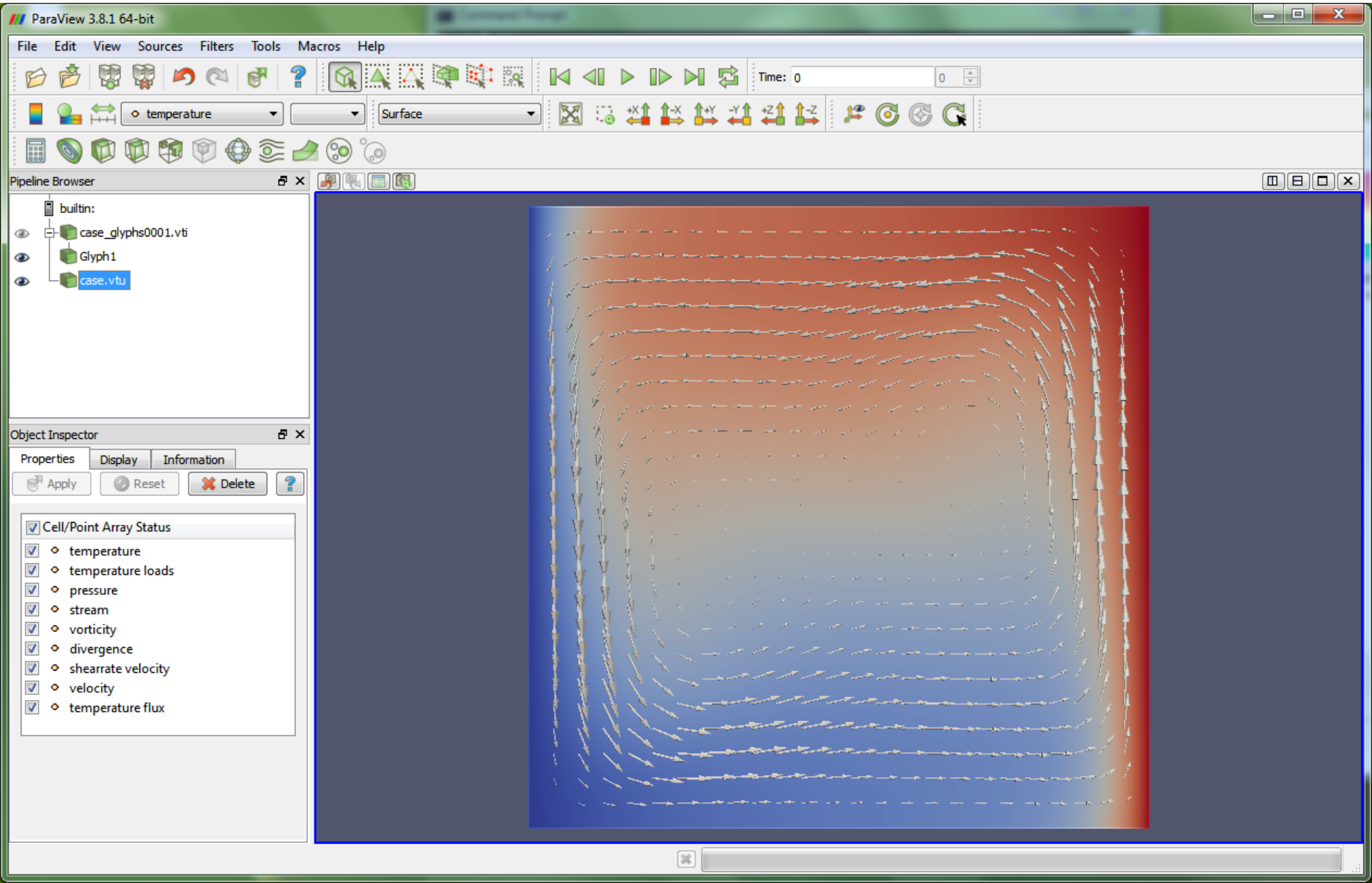
Exporting 2D/3D data: ResultOutputSolve

An example shows how to save data in unstructured XML VTK (.vtu) files to directory ”results” in single precision binary format.

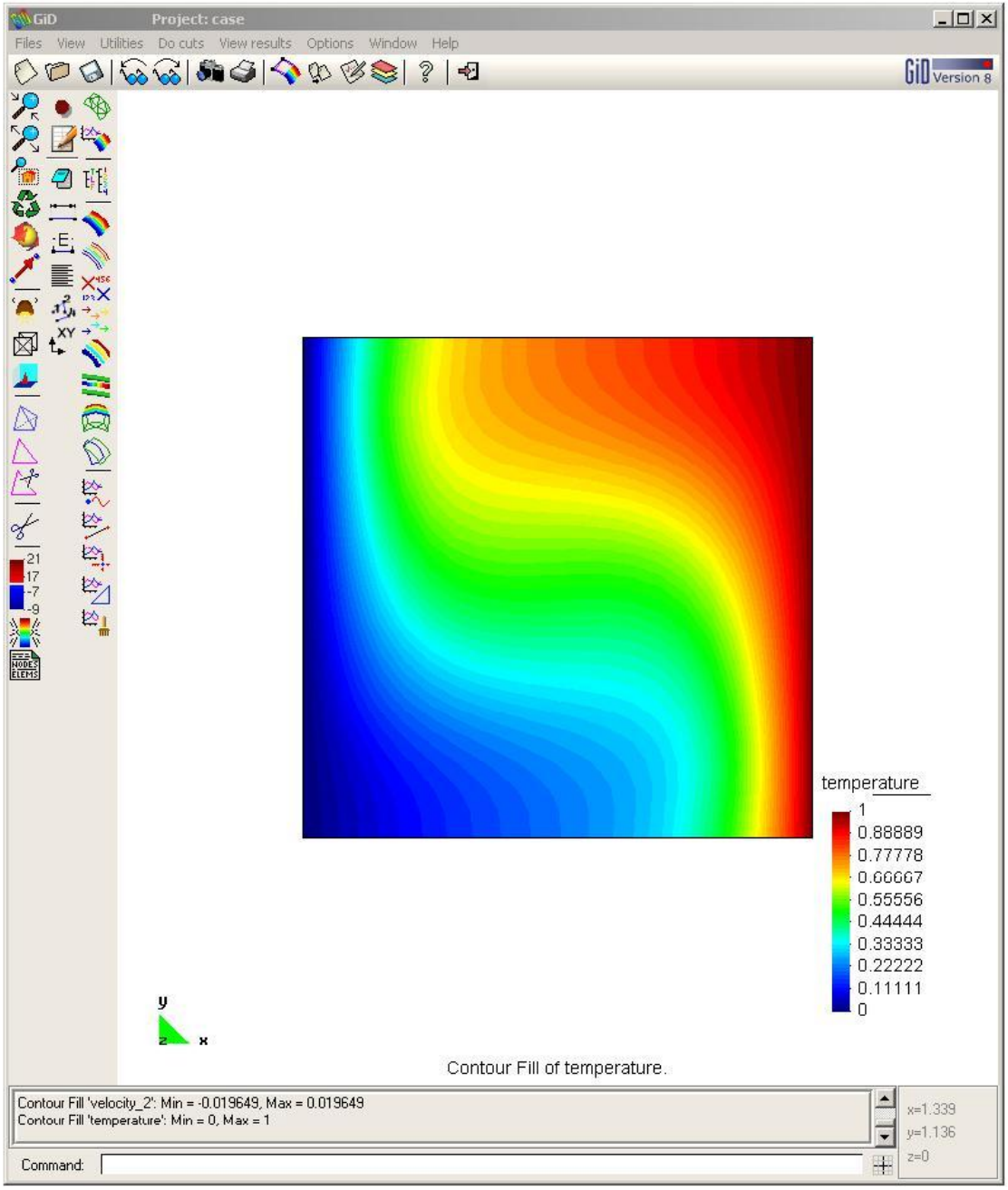
```
Solver n
  Exec Solver = after timestep
  Equation = "result output"
  Procedure = "ResultOutputSolve" "ResultOutputSolver"
  Output File Name = "case"
  Output Format = String ”vtu”
  Binary Output = True
  Single Precision = True
End
```

Basic functionality also just by adding suffix **.vtu** to the **Post File** in simulation section

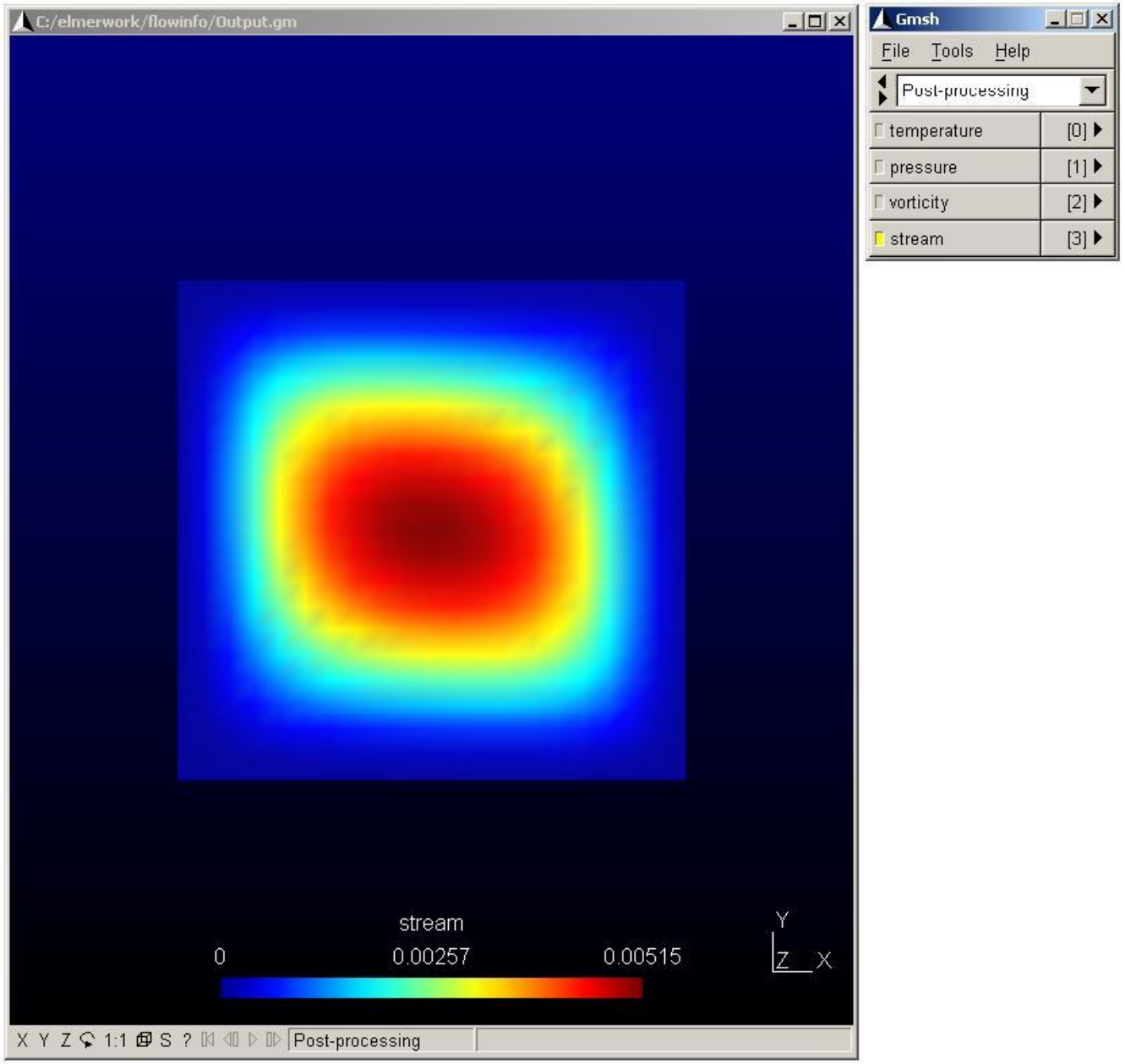
Case: View in Paraview



Example:
view in GiD



Example: view in Gmsh



Visualization with Paraview

Exporting 2D/3D data: ResultOutputSolve

By setting suffix for **`Post File`** to **`.vtu`** paraview format is saved automatically.

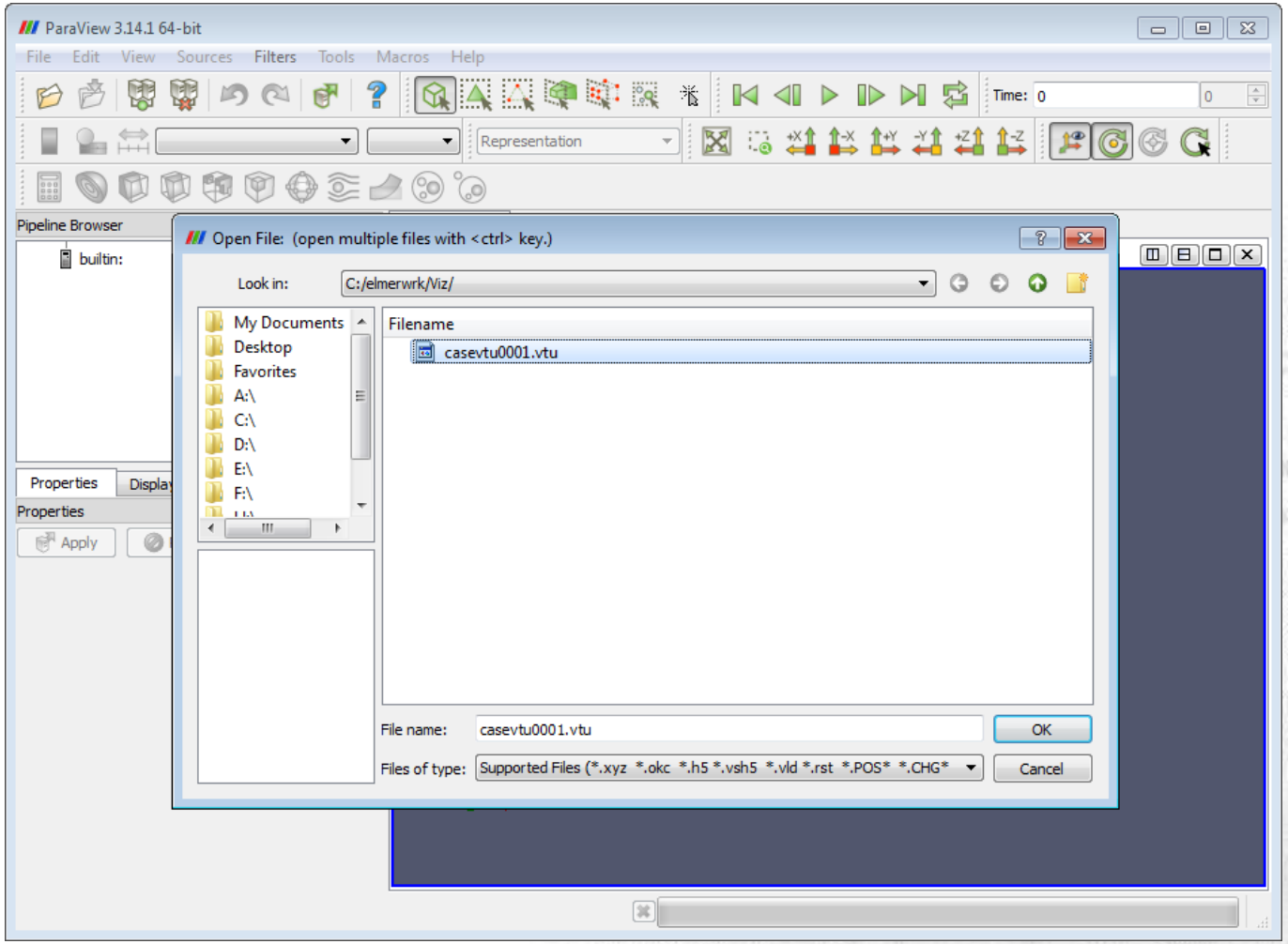
An example shows how to save data in unstructured XML VTK (.vtu) files to directory ”results” in single precision binary format.

```
Solver n
  Exec Solver = after timestep
  Equation = "result output"
  Procedure = "ResultOutputSolve" "ResultOutputSolver"
  Output File Name = "case"
  Output Format = String ”vtu”
  Binary Output = True
  Single Precision = True
  Save Geometry Ids = True
End
```

Filename conventions

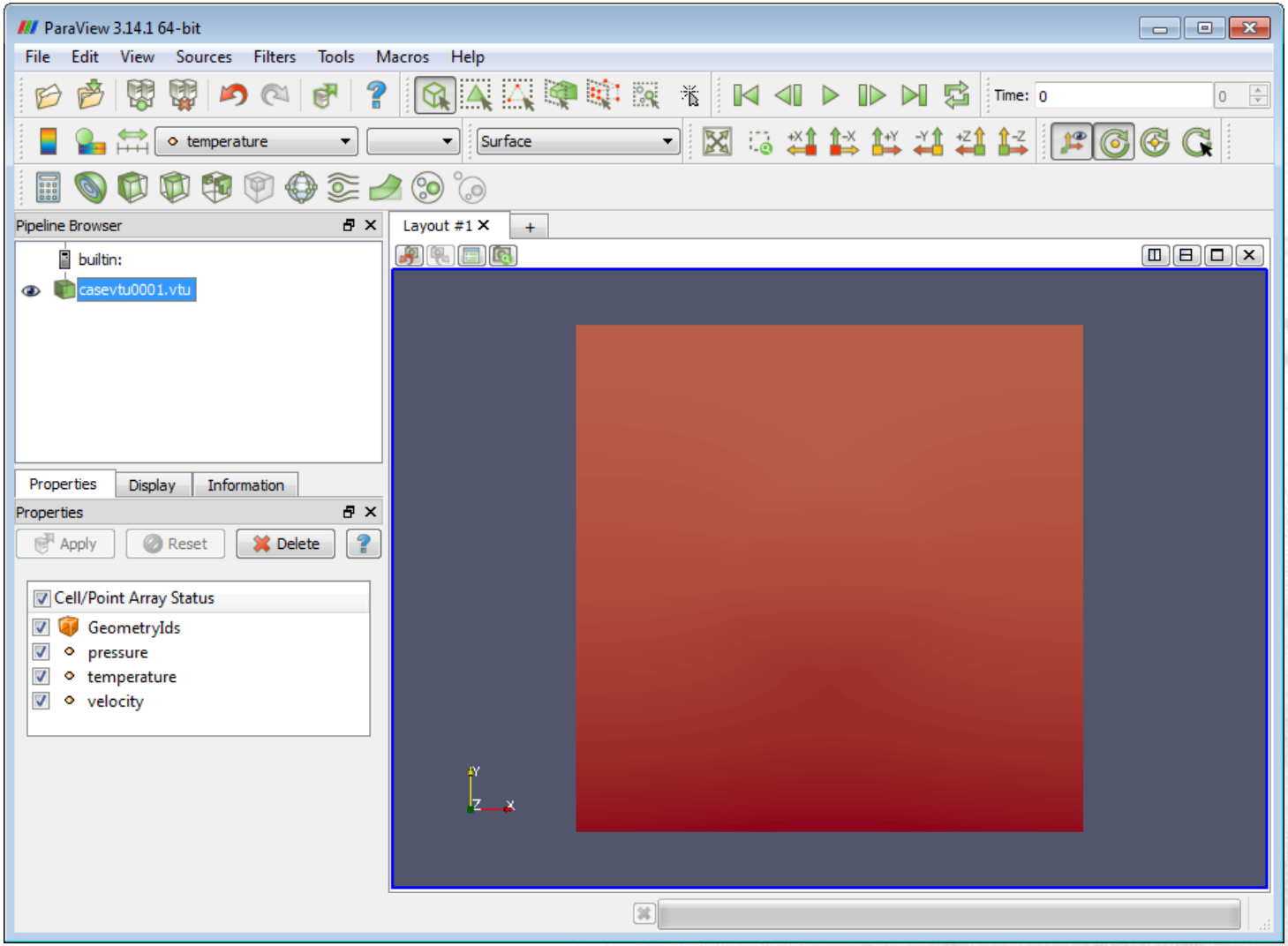
- Suffix of unstructured XML based VTU file is `.vtu`
- Timesteps numbered `#step`
- Partitions numbered with `#part`**par**`#step`
- Holder for vtu files in parallel is `.pvtu`

Loading data



Note: Paraview may have several datasets at the same time!

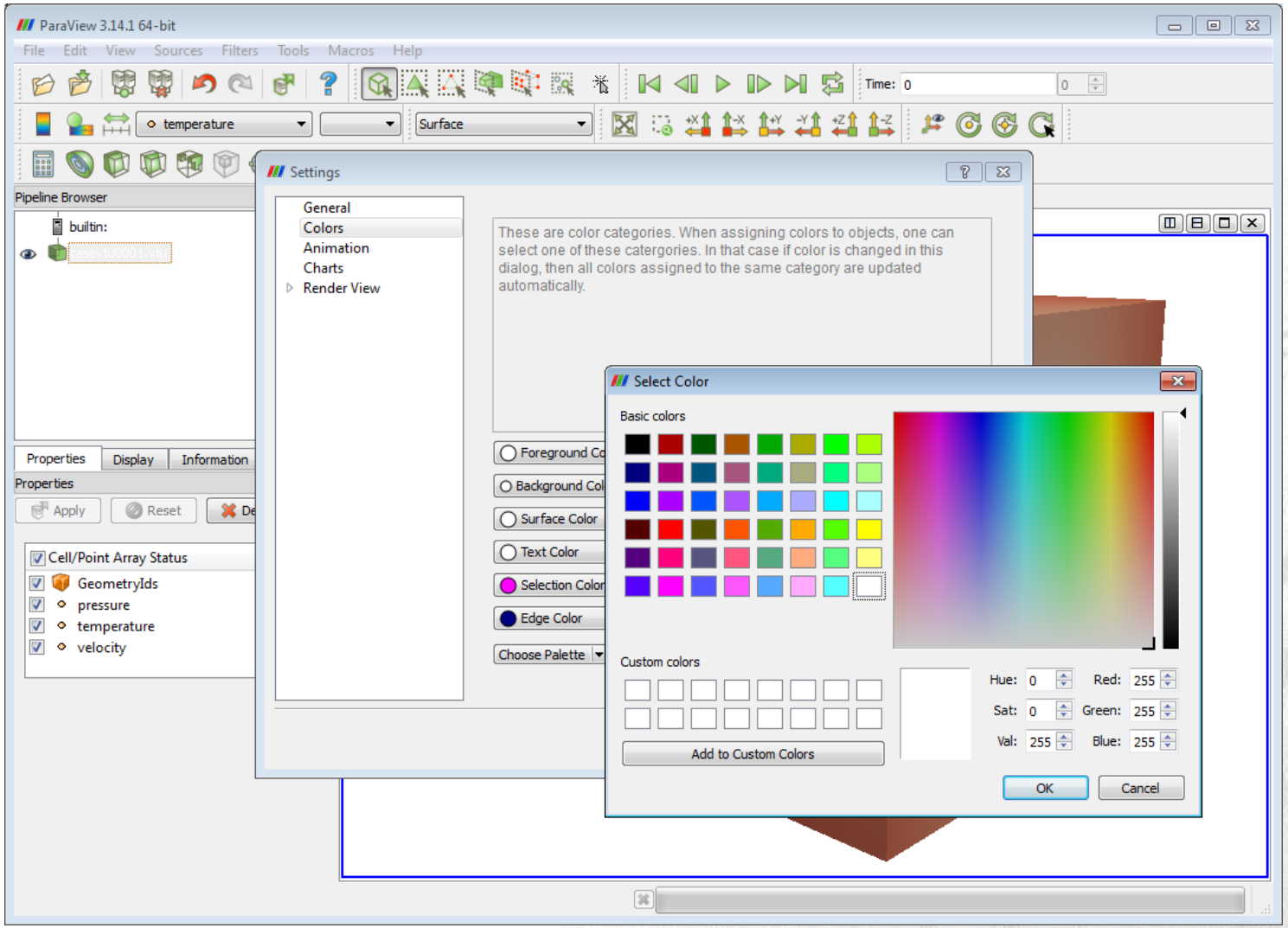
Solid color


ParaView 3.14.1 64-bit
File Edit View Sources Filters Tools Macros Help
Time: 0
temperature
Surface
Pipeline Browser
builtin:
casevtu0001.vtu
Properties Display Information
Properties
Apply Reset Delete
Cell/Point Array Status
GeometryIds
pressure
temperature
velocity
Layout #1

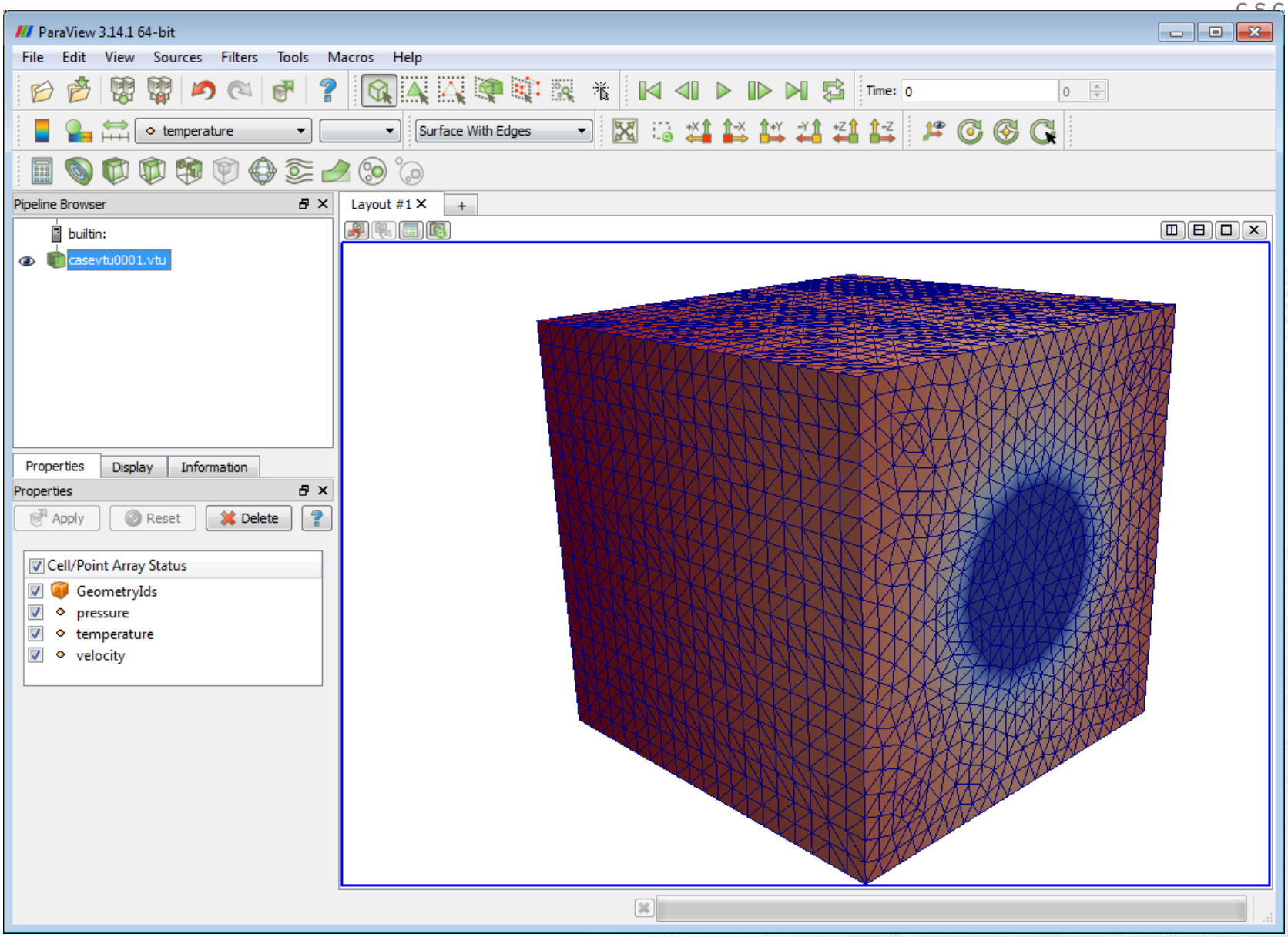
Moving object in Paraview

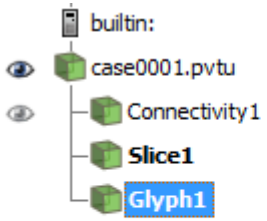
- Rotate
  - Mouse: Left bottom
- Scale
  - Mouse: Right bottom
- Translate
  - Mo*u*se: Center bottom

Setting background color



Color mesh with surface + edges

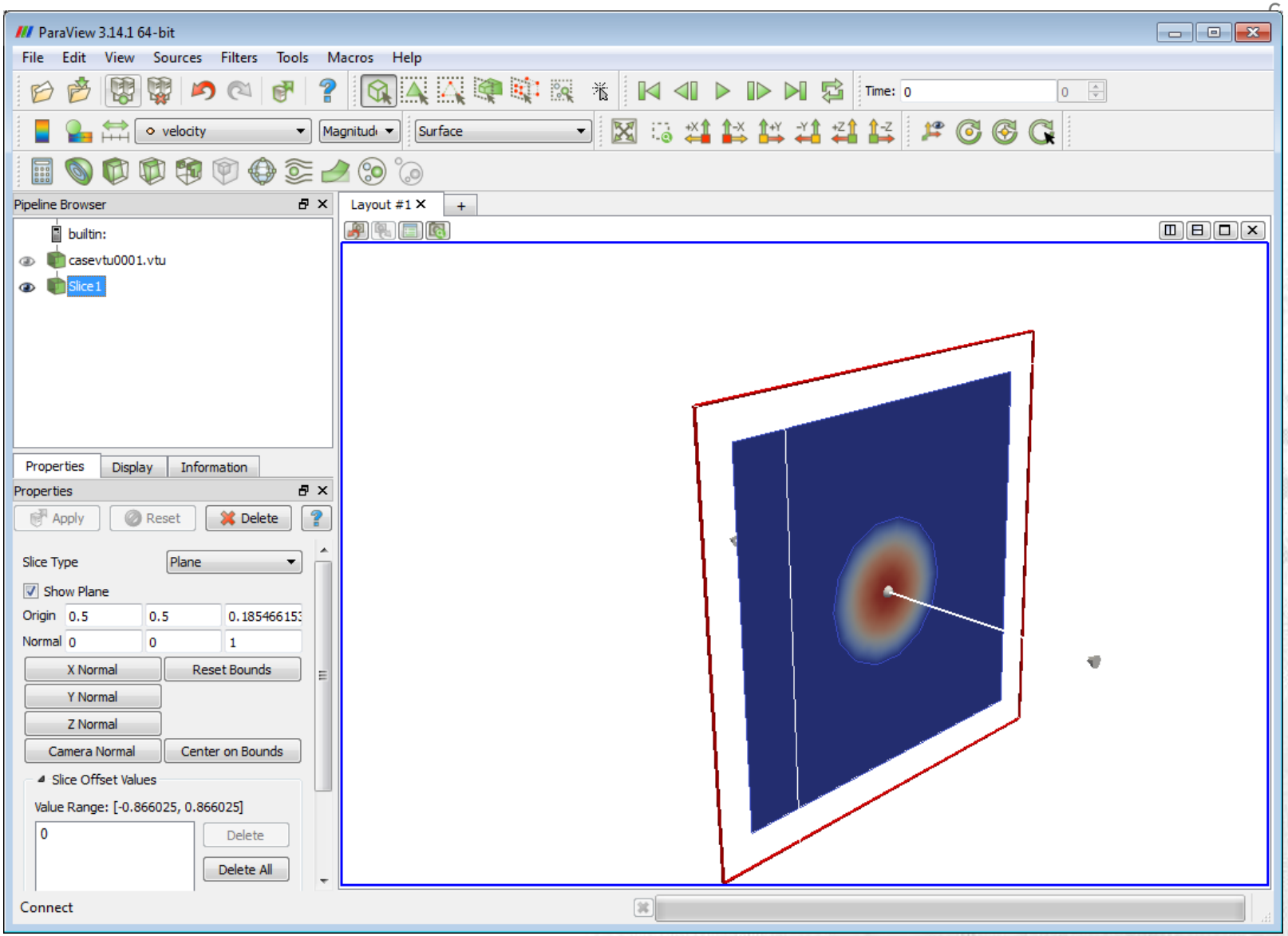




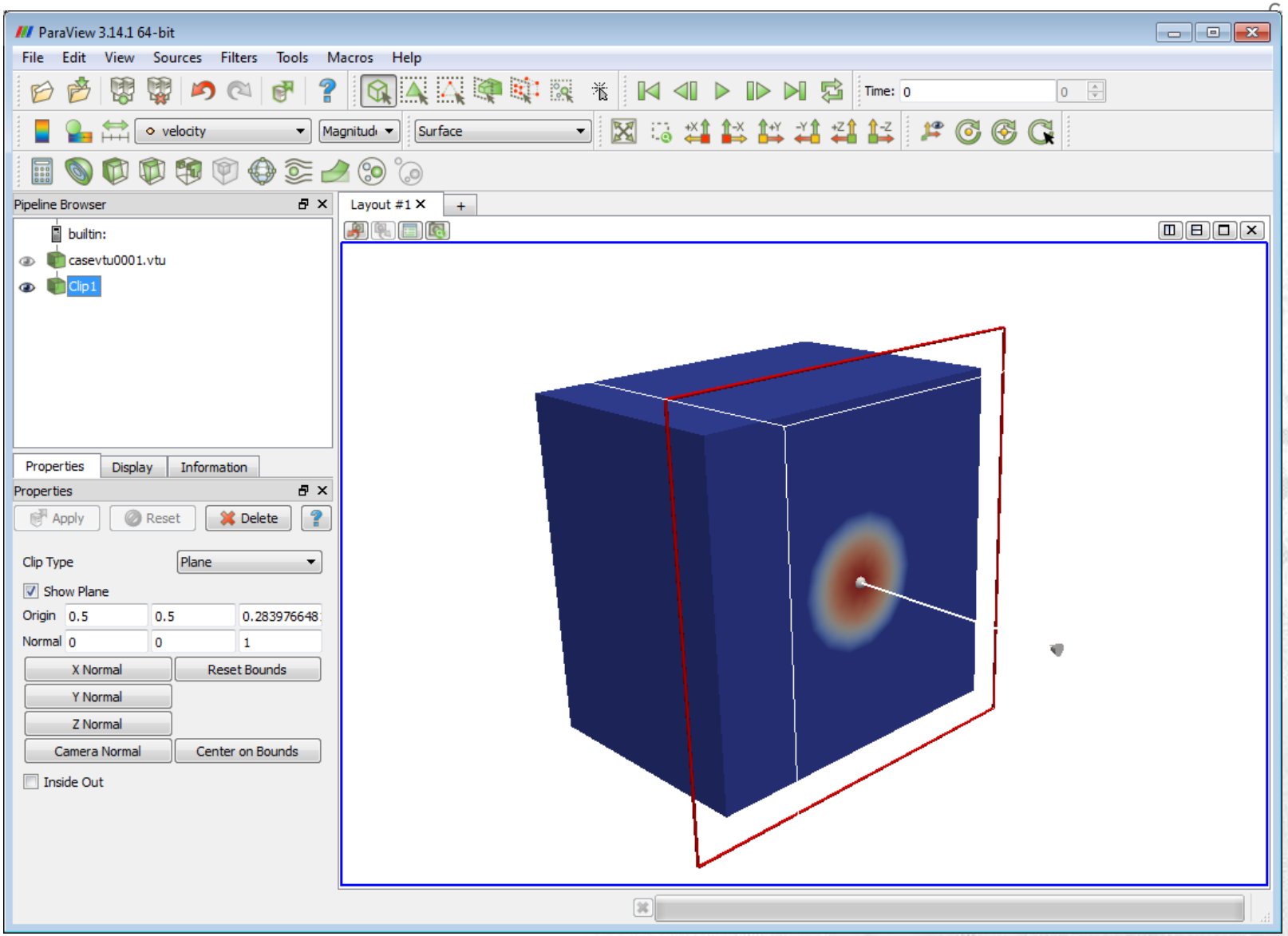
CSC

- Paraview uses extensively *filters* to create new datasets
- Filters and datasets may be set active or passive by clicking the eye
- Several datasets may be visualized at the same time

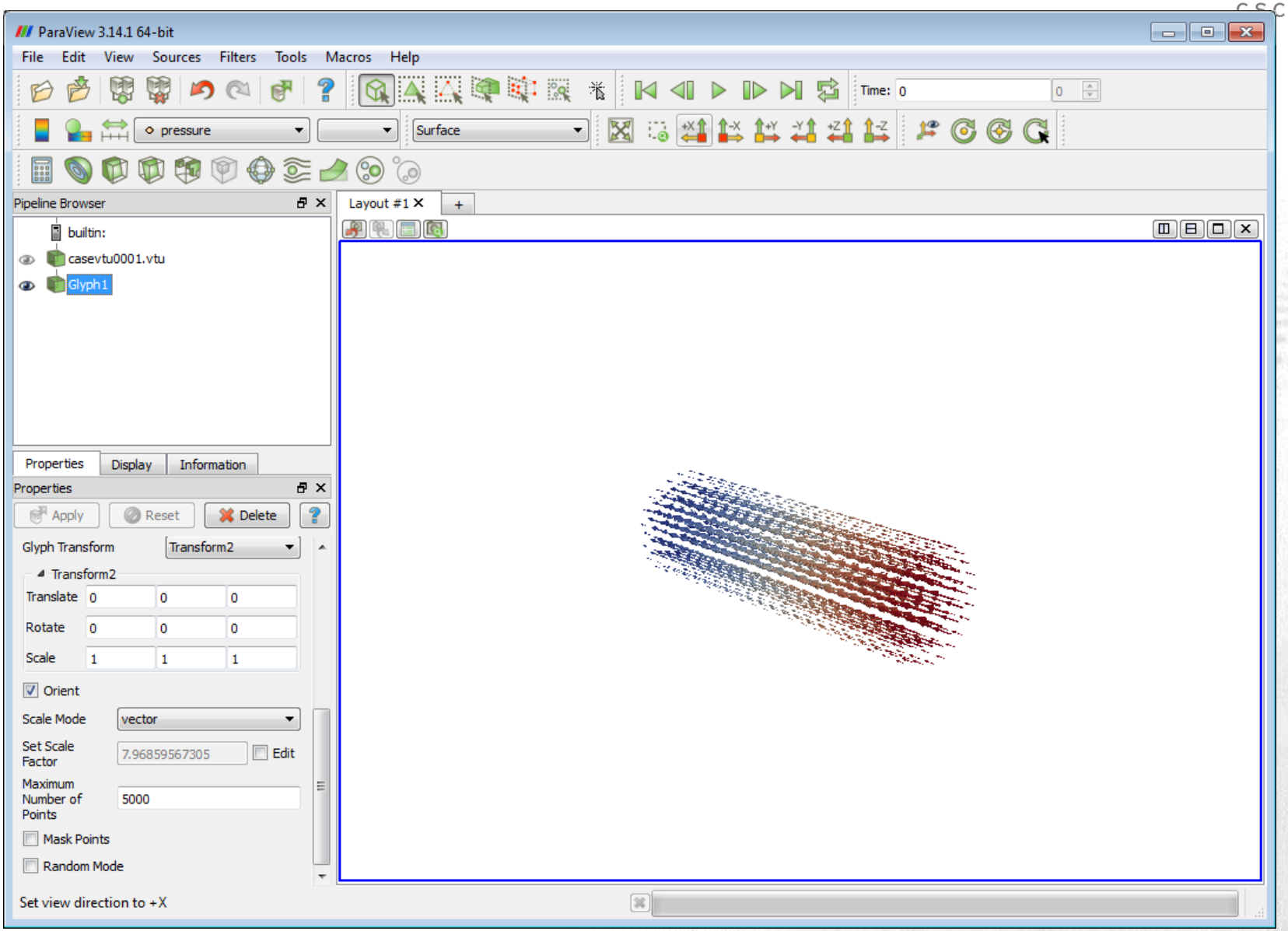
Plotting a slice



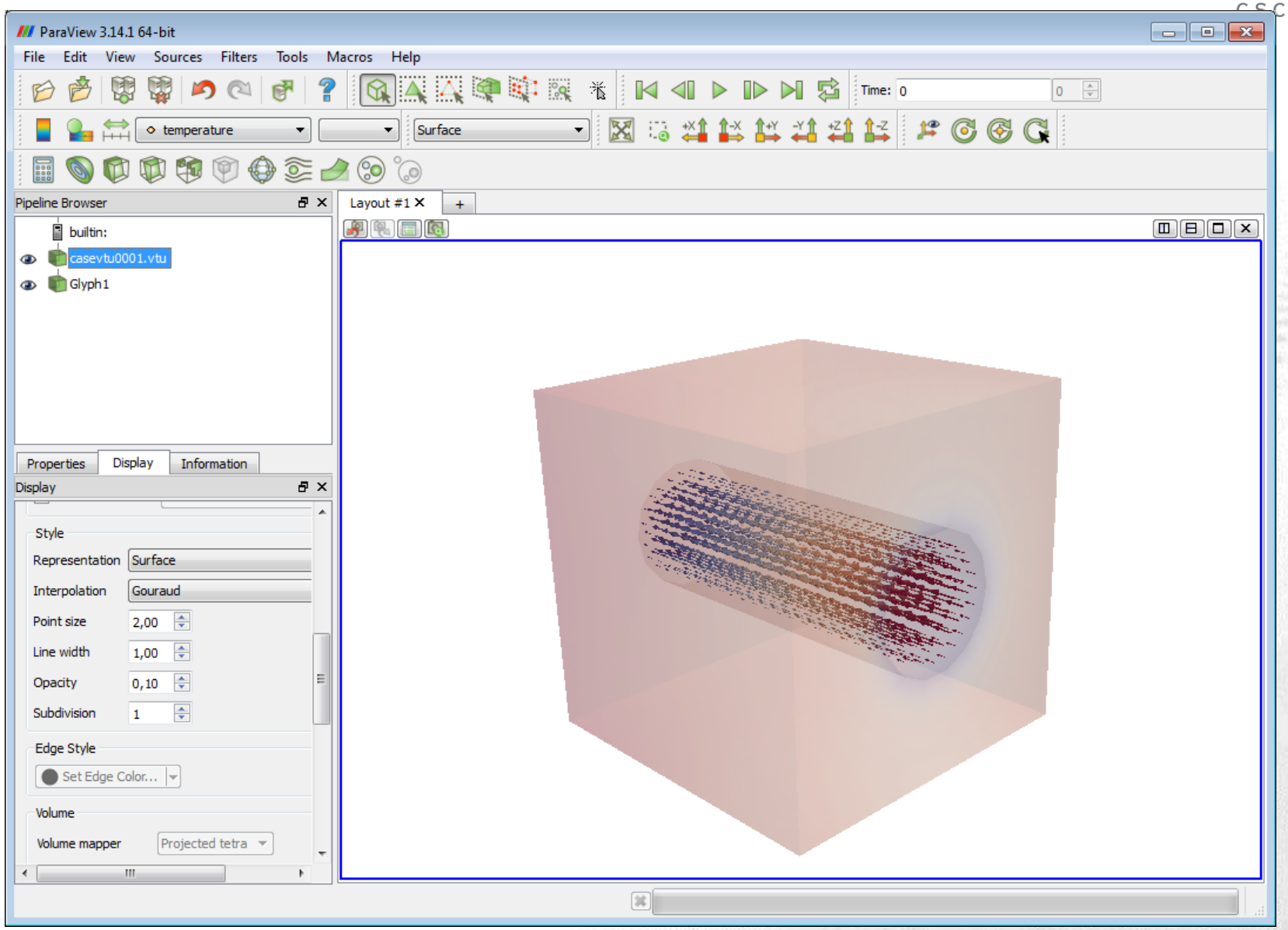
Plotting a clip



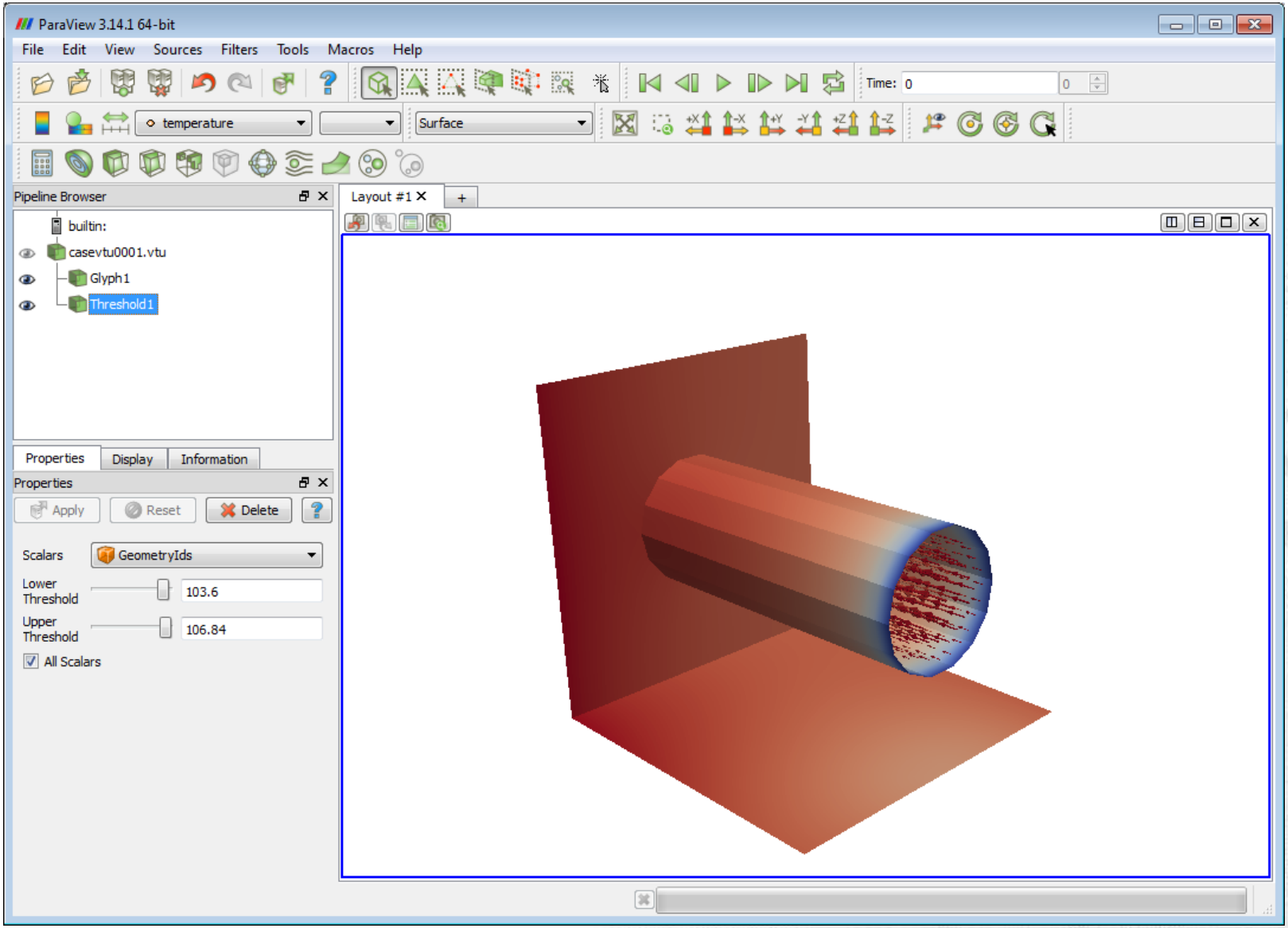
Vector plot


ParaView 3.14.1 64-bit
File Edit View Sources Filters Tools Macros Help
Time: 0
pressure
Surface
Pipeline Browser
builtin:
casevtu0001.vtu
Glyph1
Layout #1
Properties Display Information
Properties
Apply Reset Delete
Glyph Transform Transform2
Transform2
Translate 0 0 0
Rotate 0 0 0
Scale 1 1 1
Orient
Scale Mode vector
Set Scale Factor 7.96859567305 Edit
Maximum Number of Points 5000
Mask Points
Random Mode
Set view direction to +X

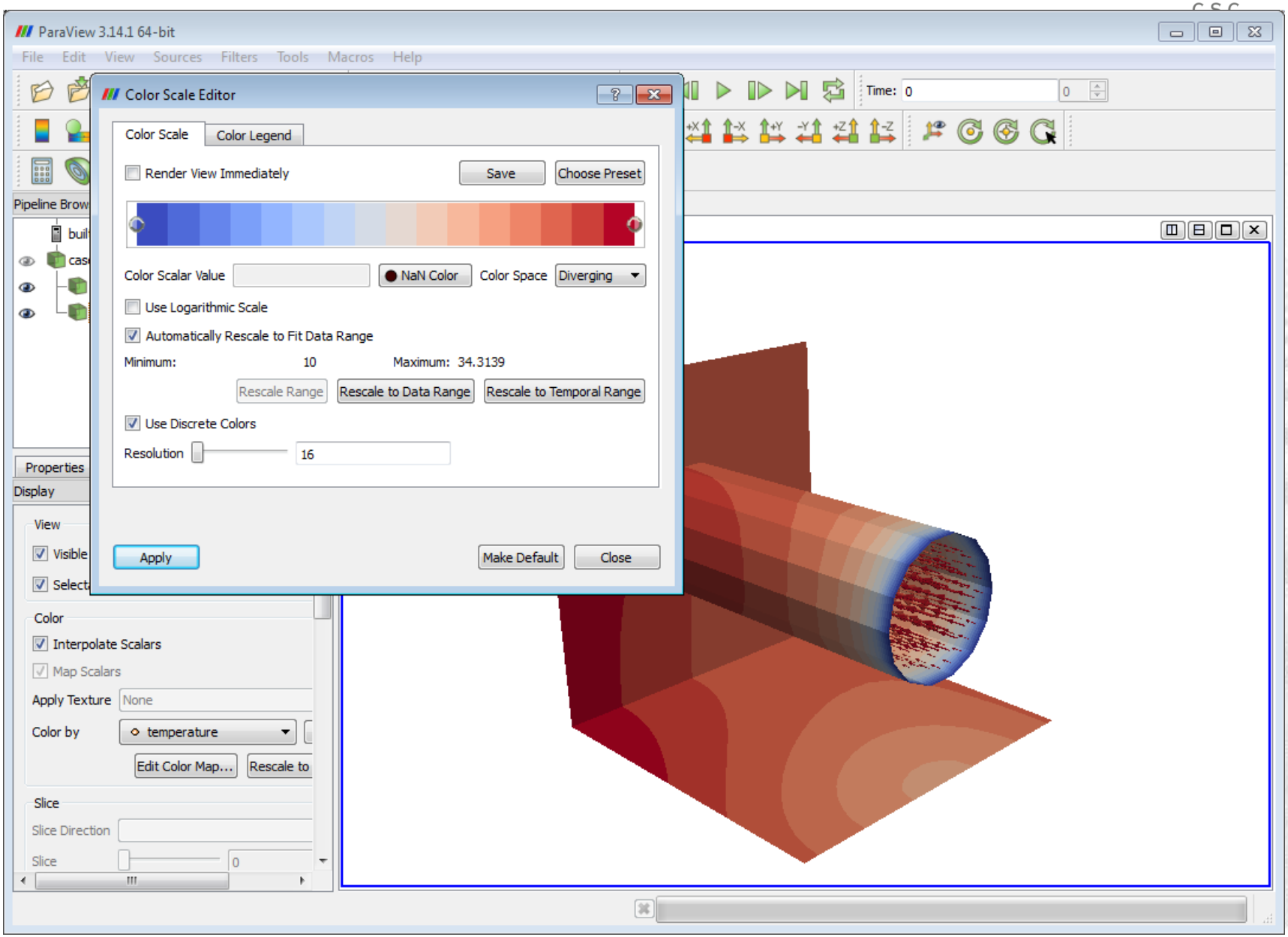
Vector plot + opaque solid surface



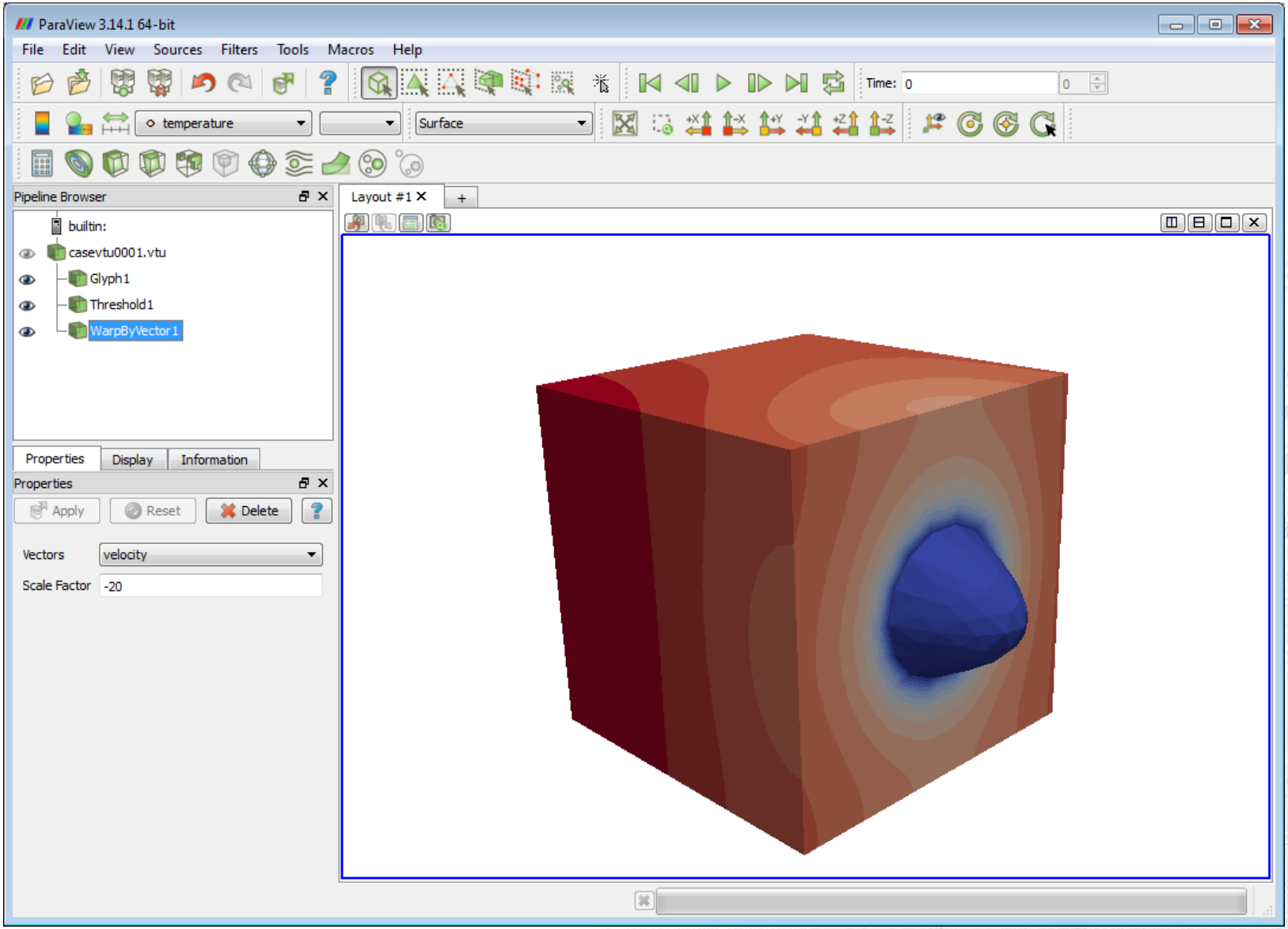
Vector plot + solid surface with Id treshold



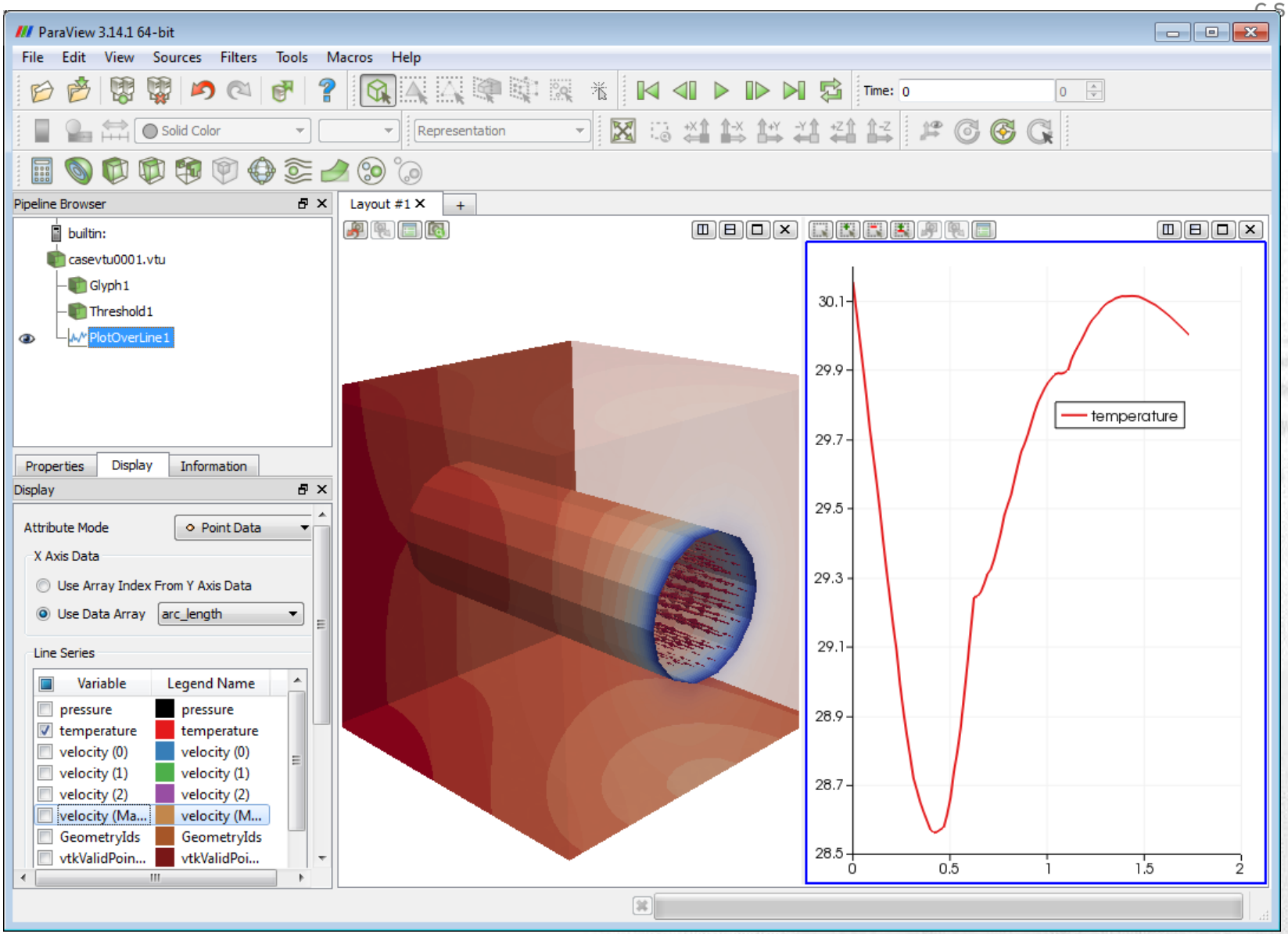
Change of colormap



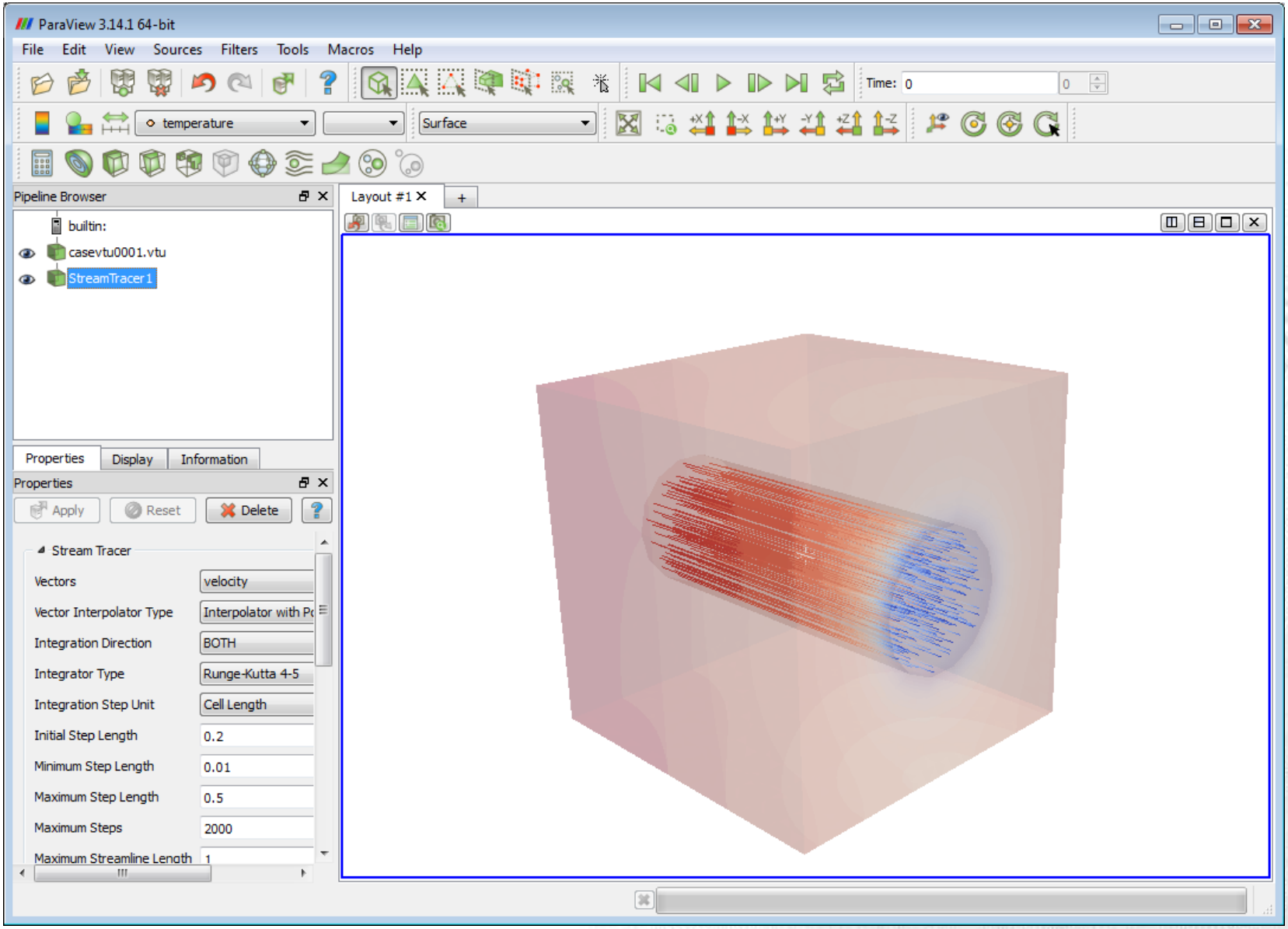
Deformation – WarpByVector filter



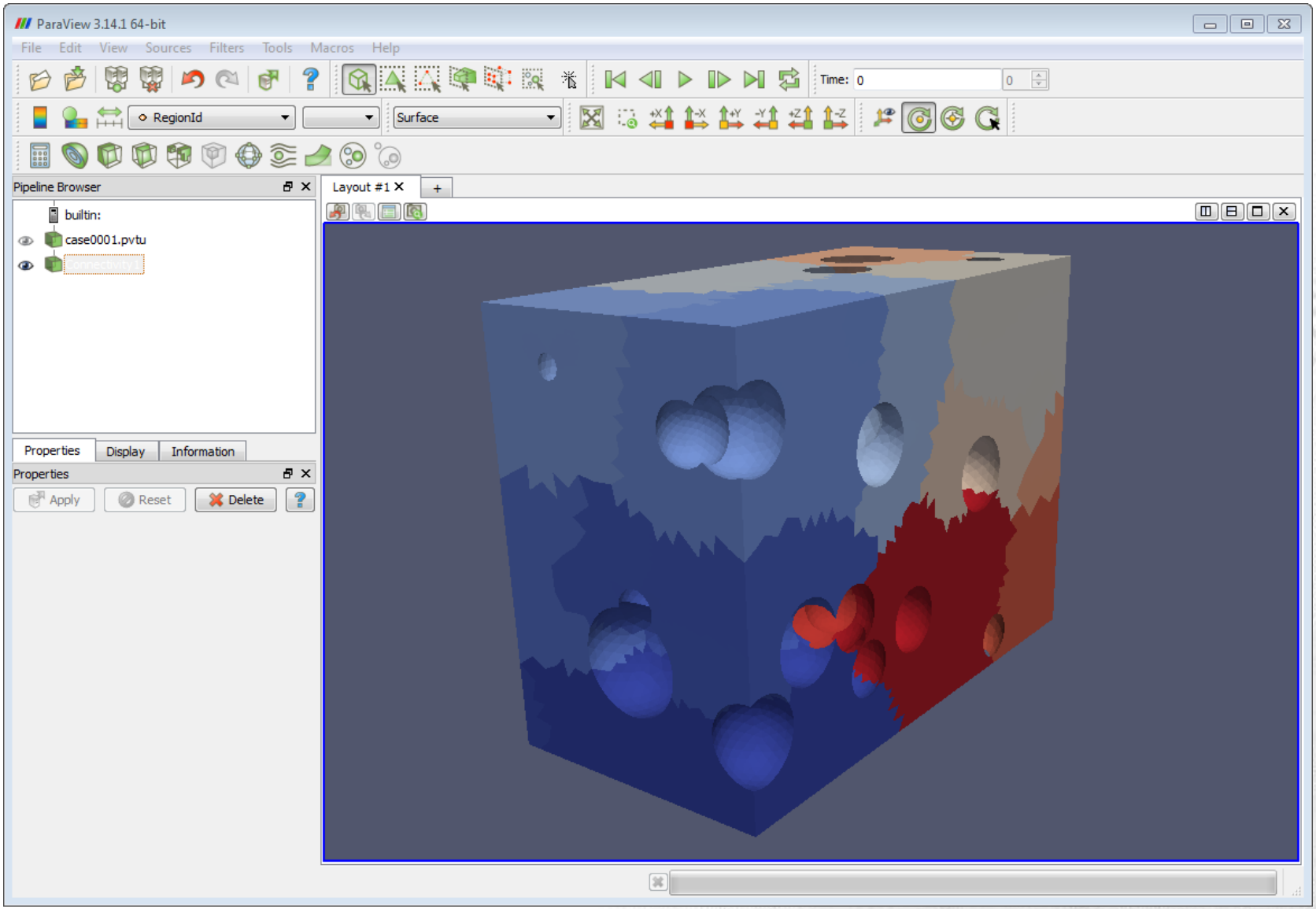
Plot line – PlotOverLine filter



Streamlines – Filter StreamTracer



Partitioning – Connectivity filter

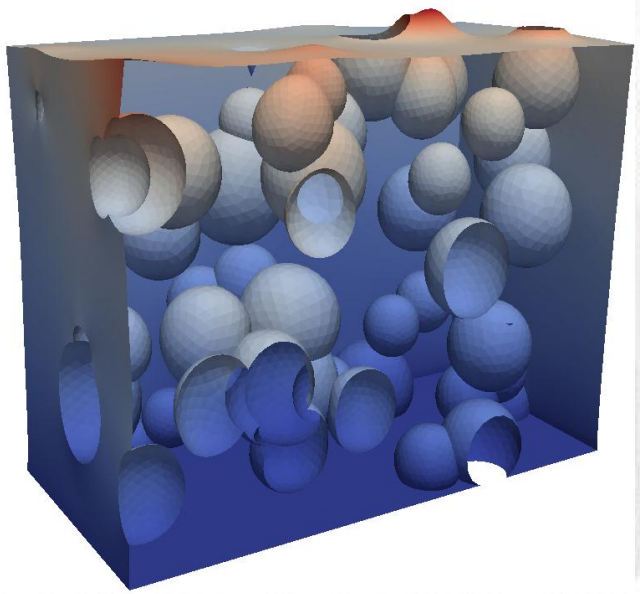


File size in Paraview output

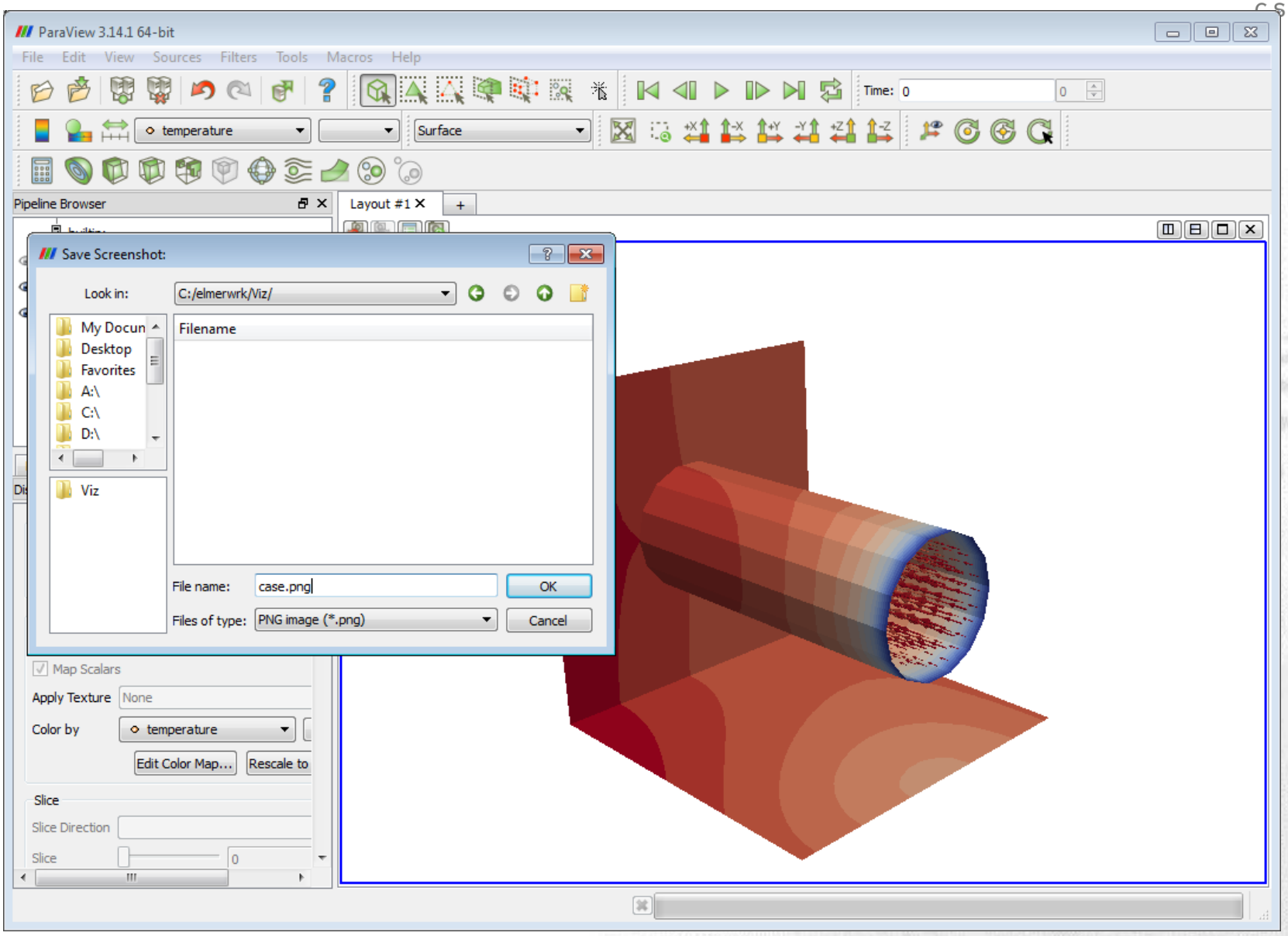
- Memory consumption of vtu-files (for Paraview) was studied in the ”swiss cheese” case
- Saving just boundaries in single precision binary format may save over 90% in files size compared to full data in ascii
- With larger problem sizes the benefits are amplified

Binary output	Single Prec.	Only bound.	Bytes/ node
-	X	-	376.0
X	-	-	236.5
X	X	-	184.5
X	-	X	67.2
X	X	X	38.5

Simulation Peter Råback, CSC, 2012.



Saving figures



Saving animations with Paraview

- The only packing method that comes with Paraview by default is motion AVI
- It is advicable to save the animation as separate files
- You may use ElmerClips to make mpg animations of the separate png figures

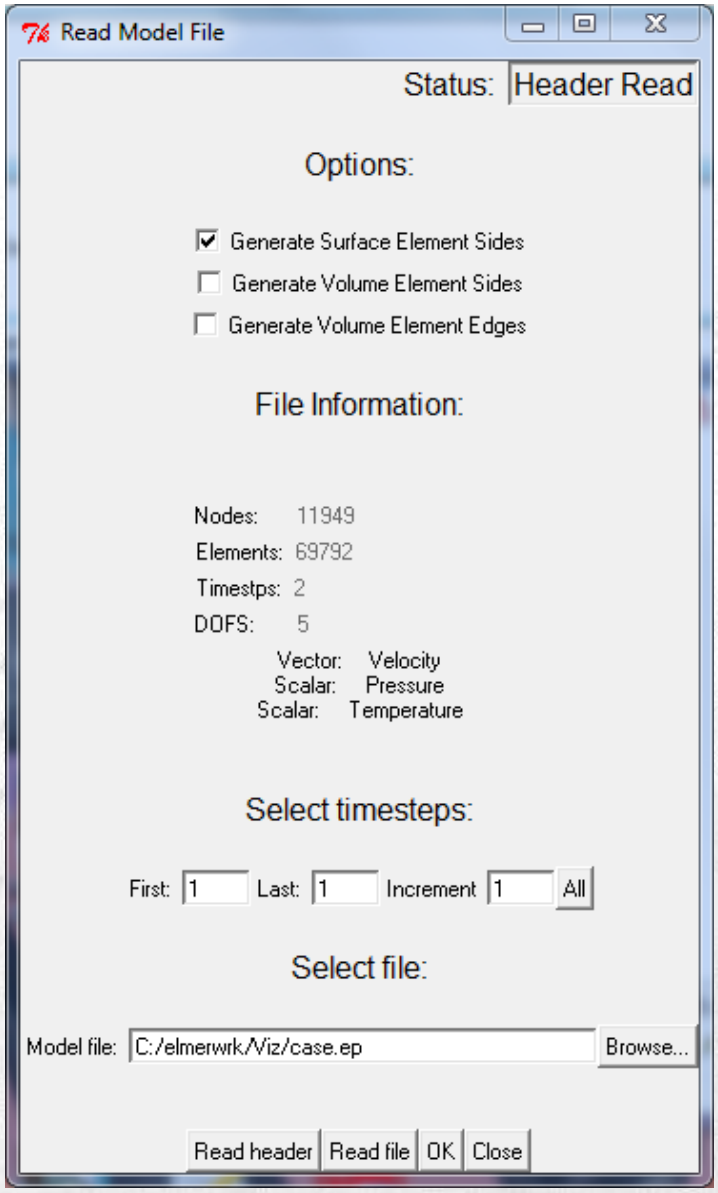
Visualization with ElmerPost

How to write files for ElmerPost

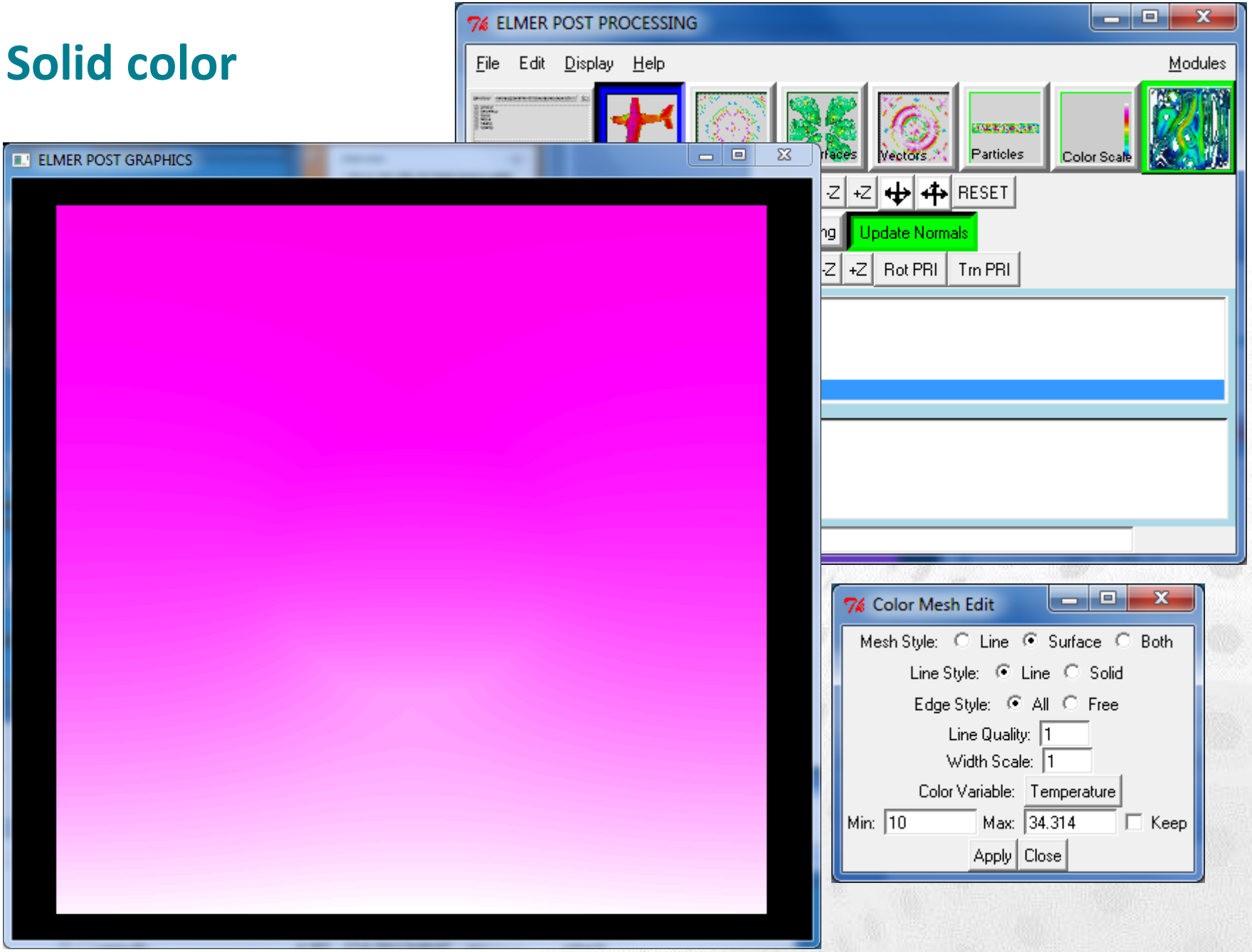
- Default suffix is `.ep`
- May be requested in Simulation section
  `Post File = case.ep`
- Or using ResultOutputSolver with
  `Output format = ElmerPost`

Loading data

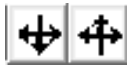
- Assume data in case.ep
- `File -> Open -> case.ep`
- Here the timesteps are chosen
- If element edges or sides are not defined for BCs they may have to be created here



Solid color

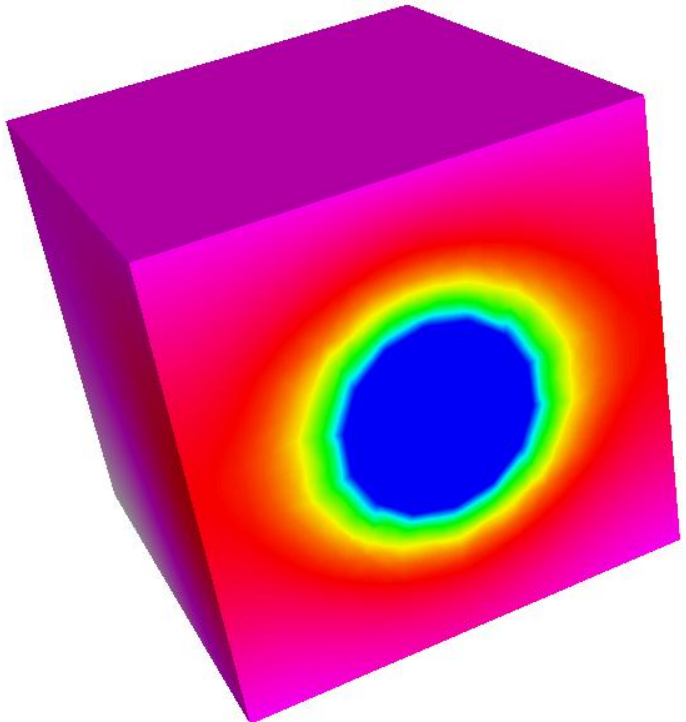

ELMER POST PROCESSING
File
Edit
Display
Help
Modules
Vectors
Particles
Color Scale
RESET
Update Normals
Rot PRI
Trn PRI
ELMER POST GRAPHICS
Color Mesh Edit
Mesh Style: Line Surface Both
Line Style: Line Solid
Edge Style: All Free
Line Quality: 1
Width Scale: 1
Color Variable: Temperature
Min: 10
Max: 34.314
Keep
Apply
Close

Moving object in ElmerPost

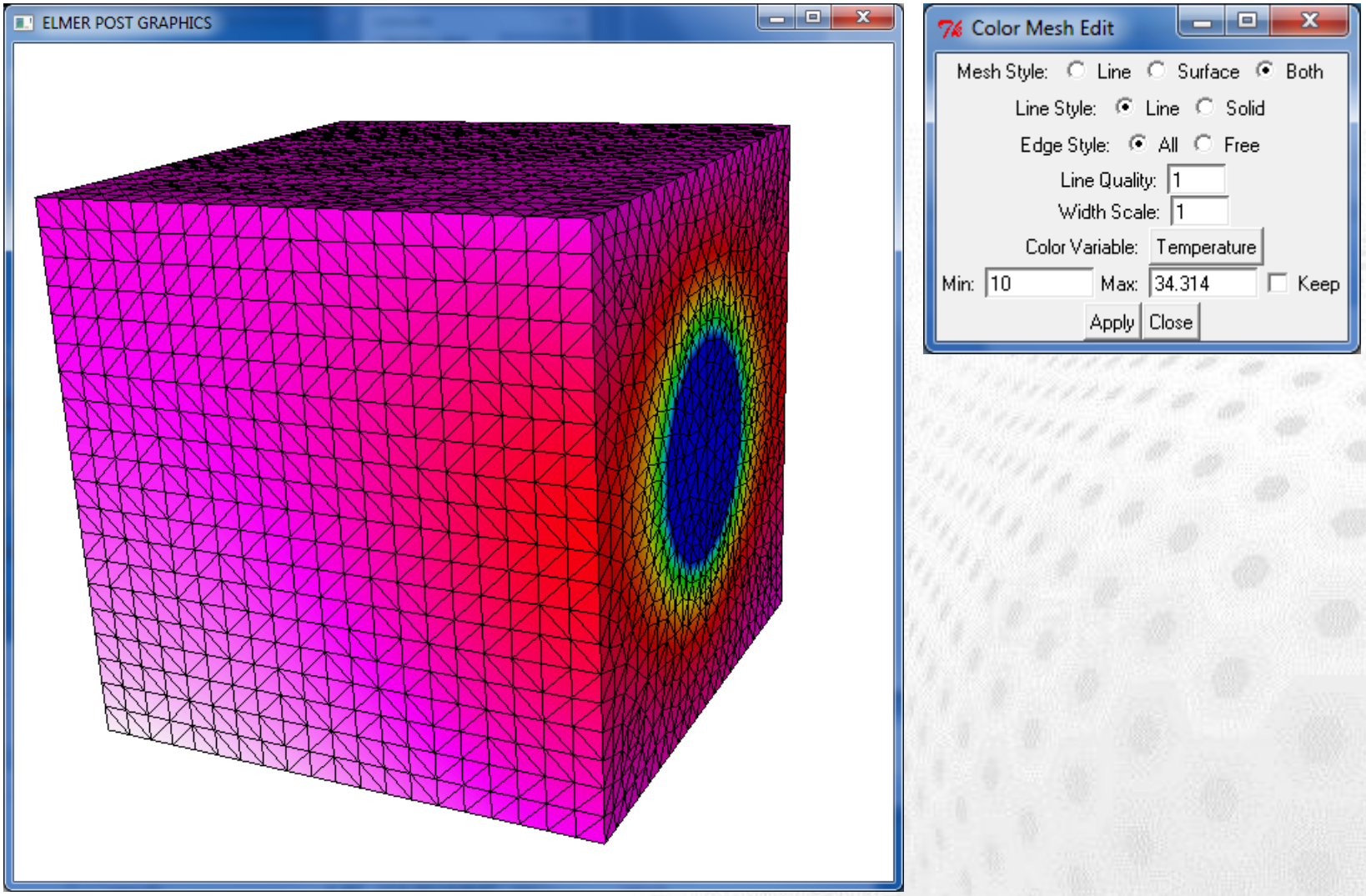
- Rotate
  - Mouse: Right bottom
  - Click: 
  - Command line, e.g.: `rotate 30 45 60`
- Scale
  - Mouse: Both bottoms
  - Click: 
  - Command line: `scale 1 10 1`
- Translate
  - Mouse: Left bottom
  - Click: 
  - Command line: `translate 1 2 3`

Setting background color

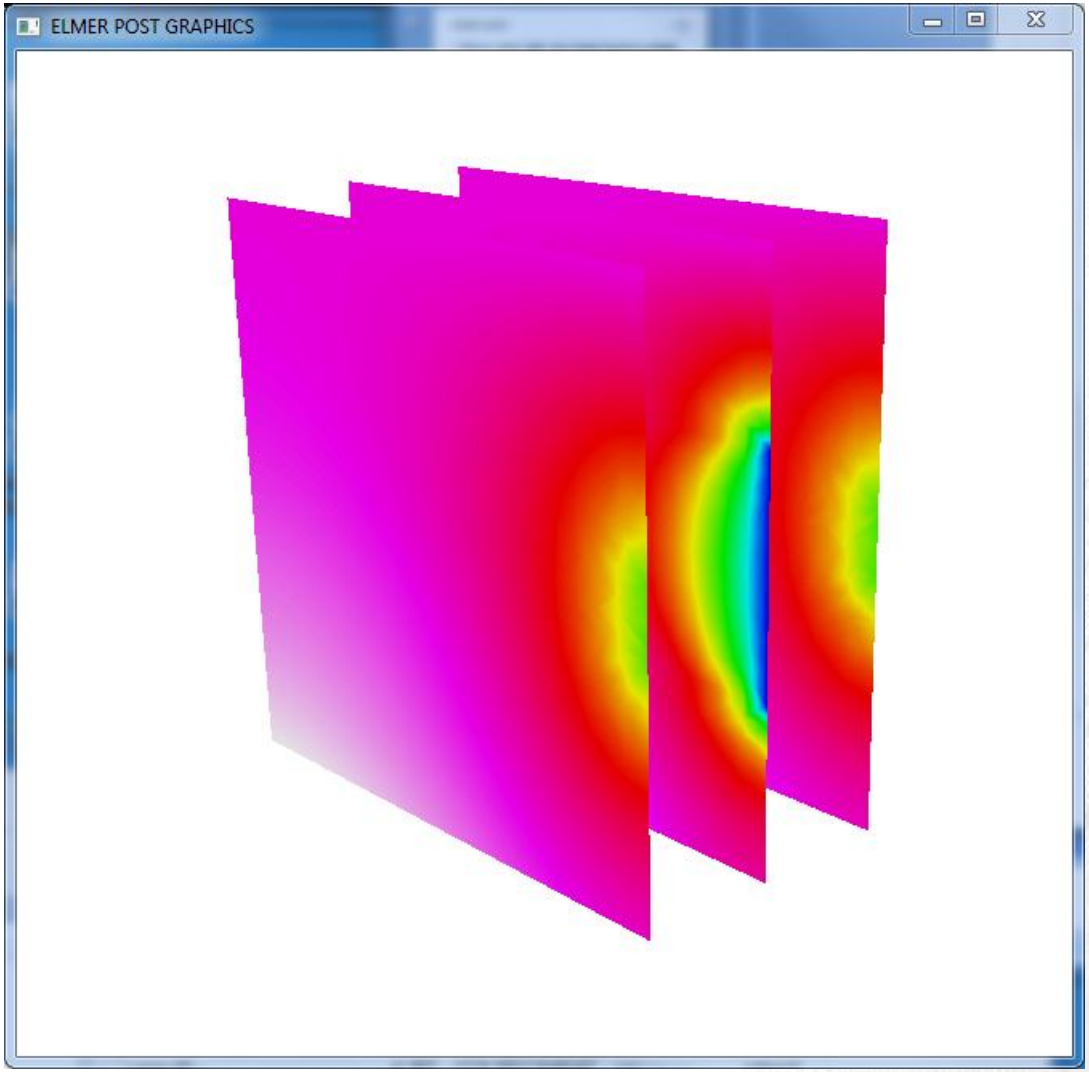
- Click:
  - Edit -> Background
  - Set 100.0 100.0 100.0 for white
- Command line
  - `background 100 100 100`

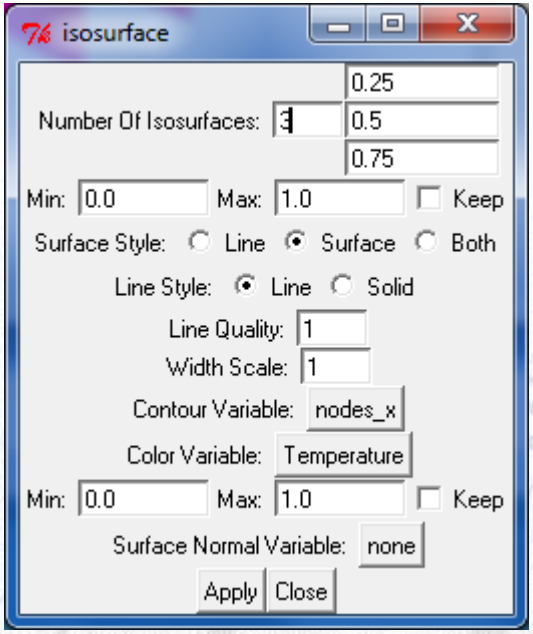


Color mesh with surface + edges

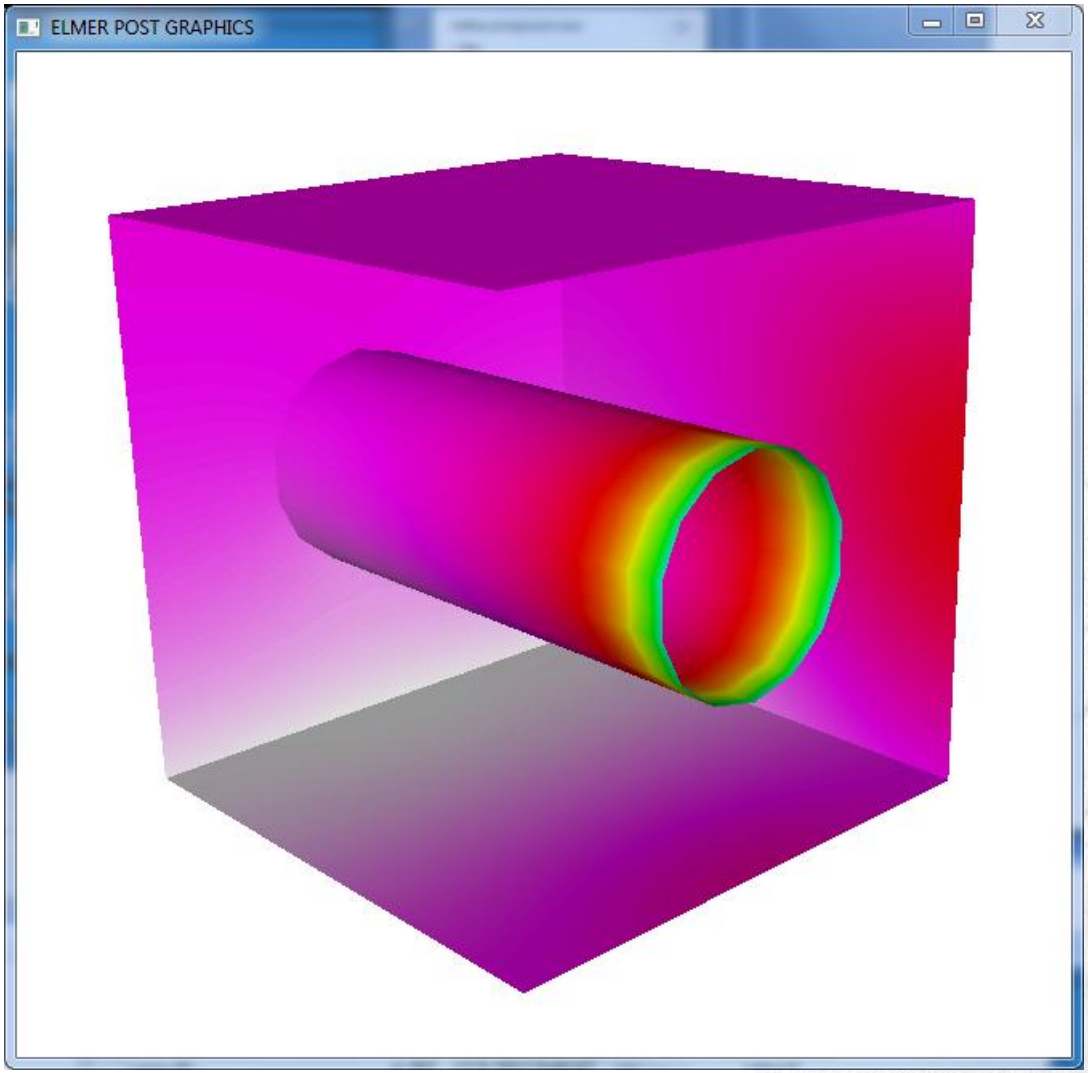


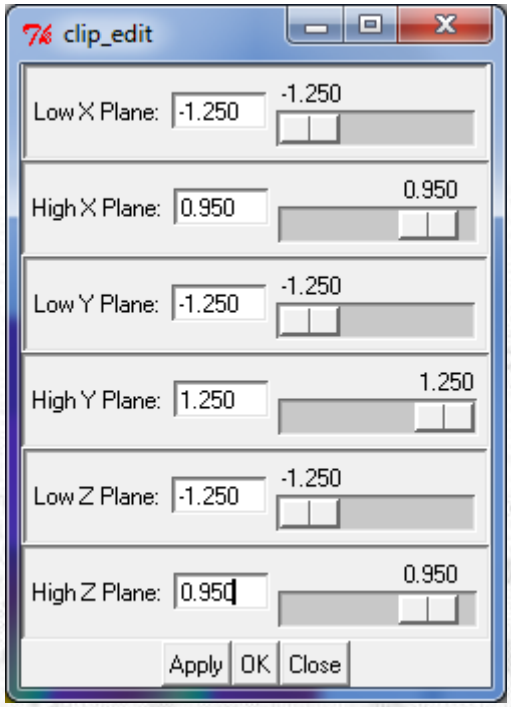
Plotting isosurfaces



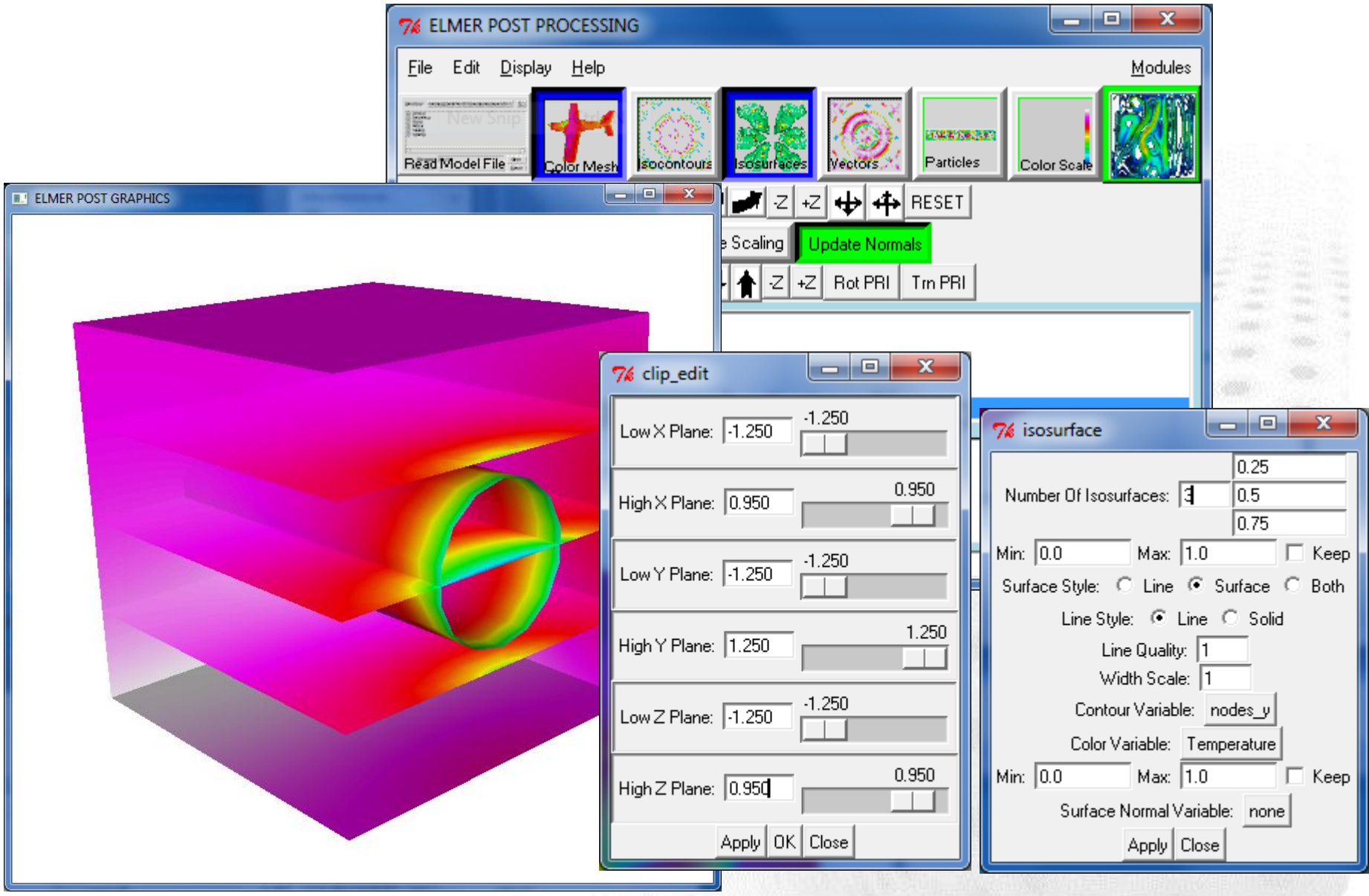


Using clip planes

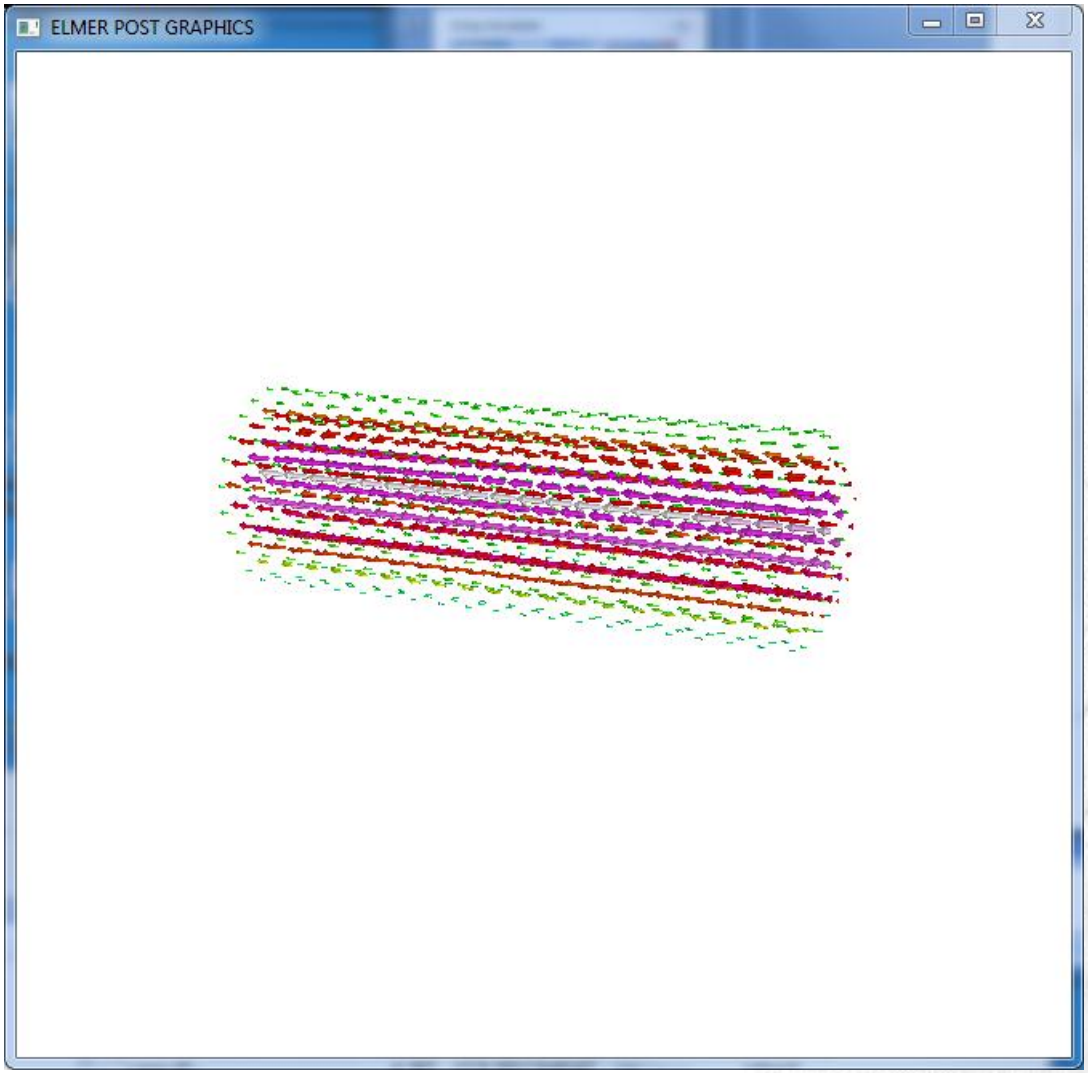


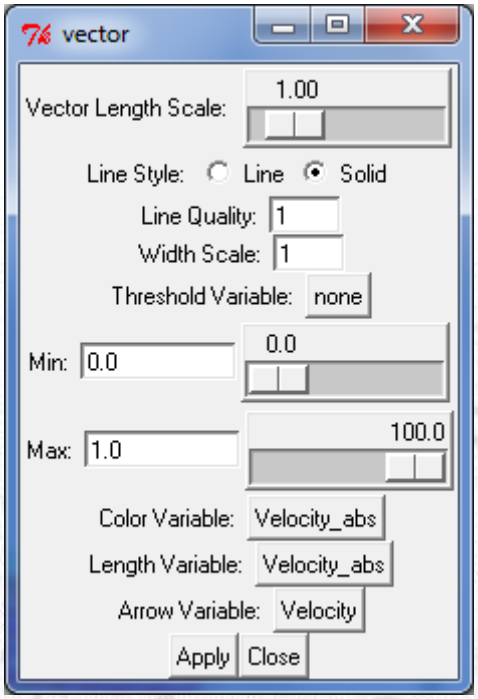


Isosurface + surface plot + clip planes

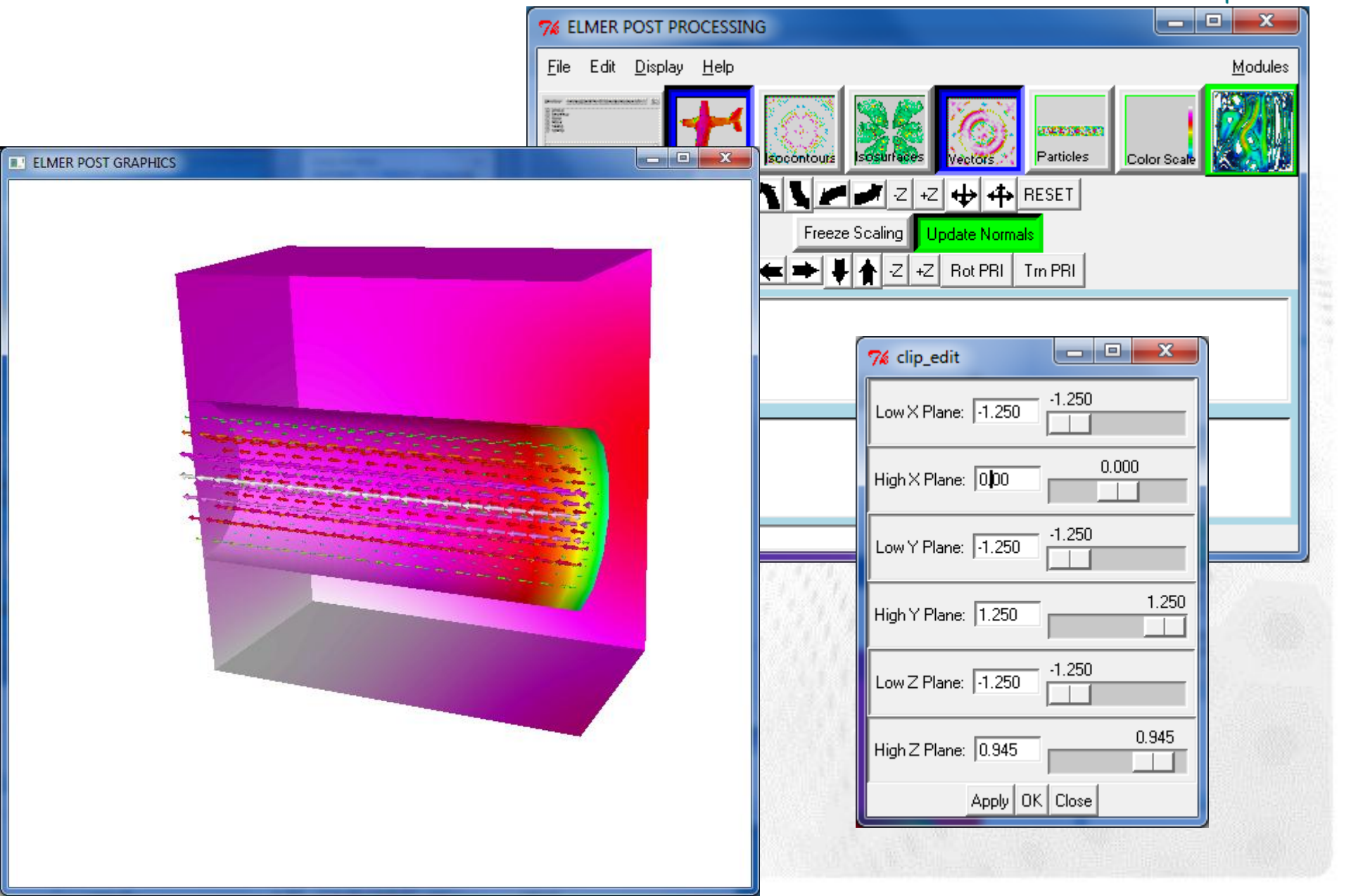


Vector plots

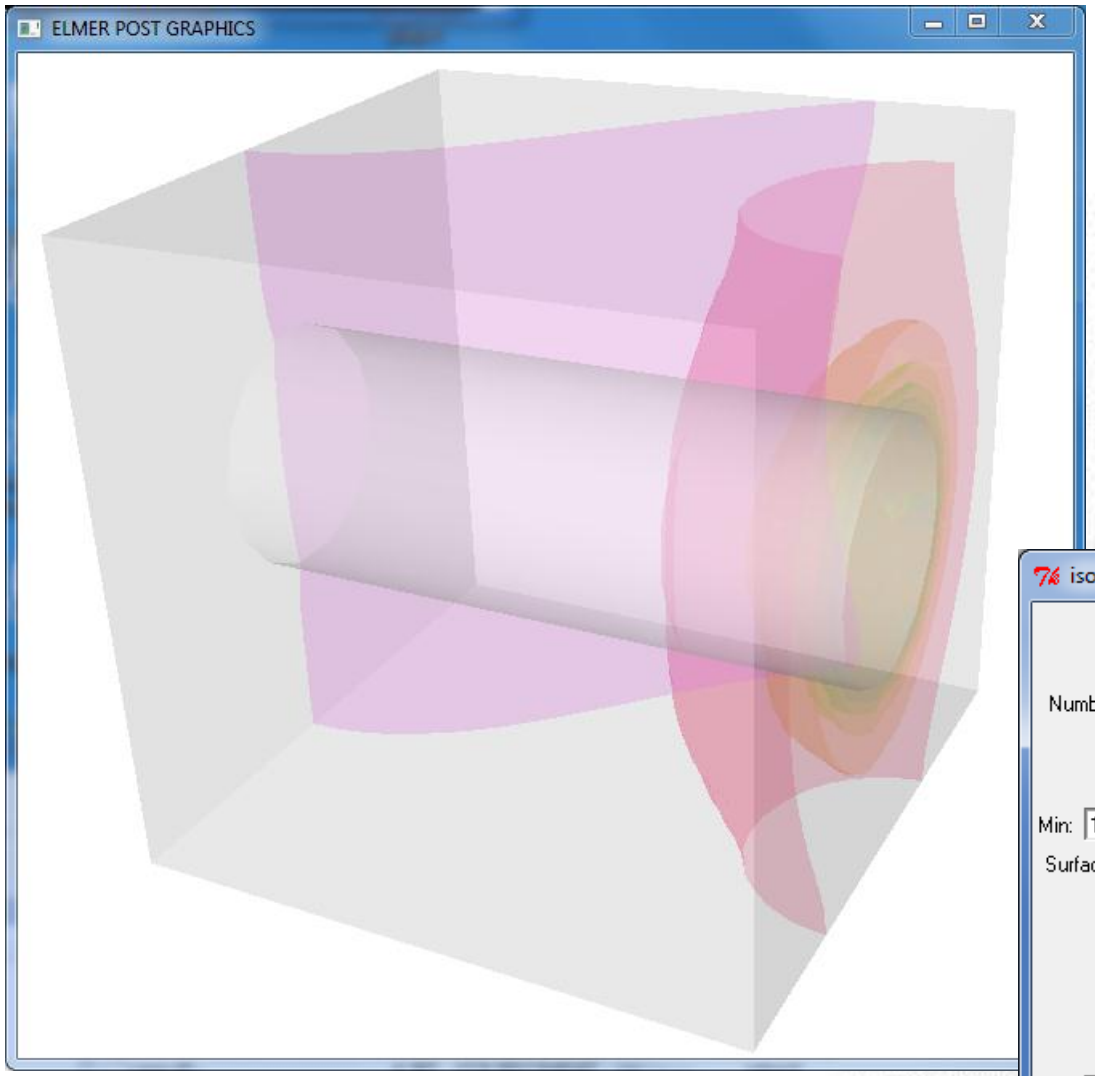


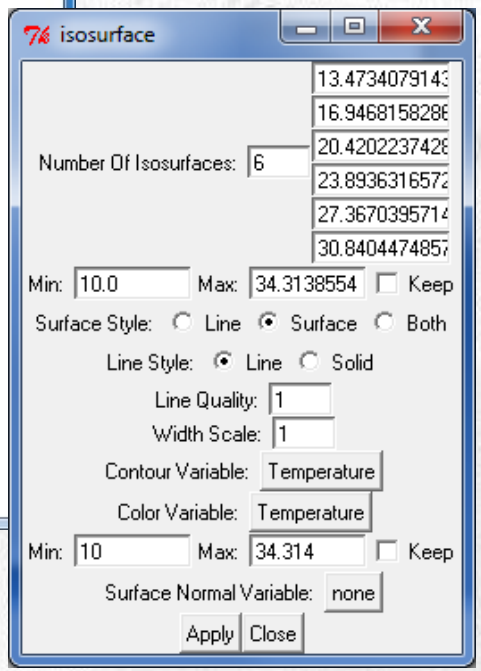


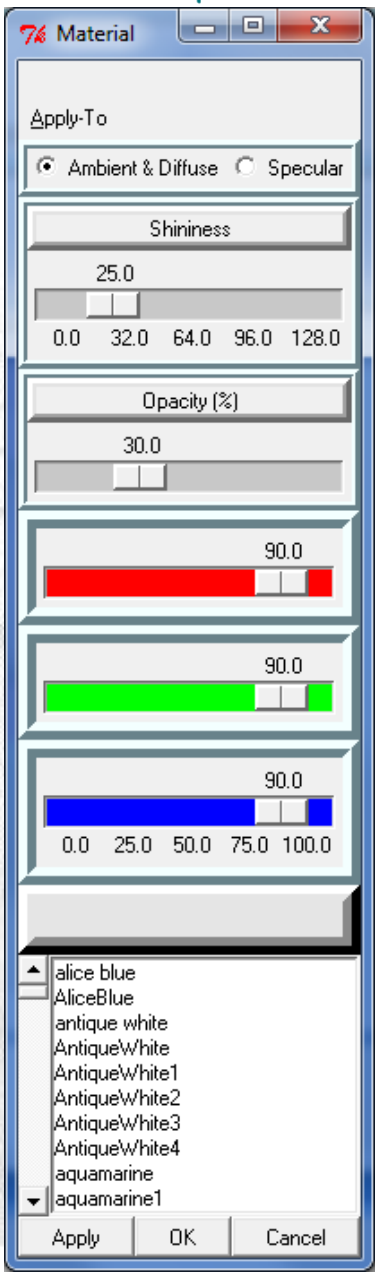
Vector plot + solid surface



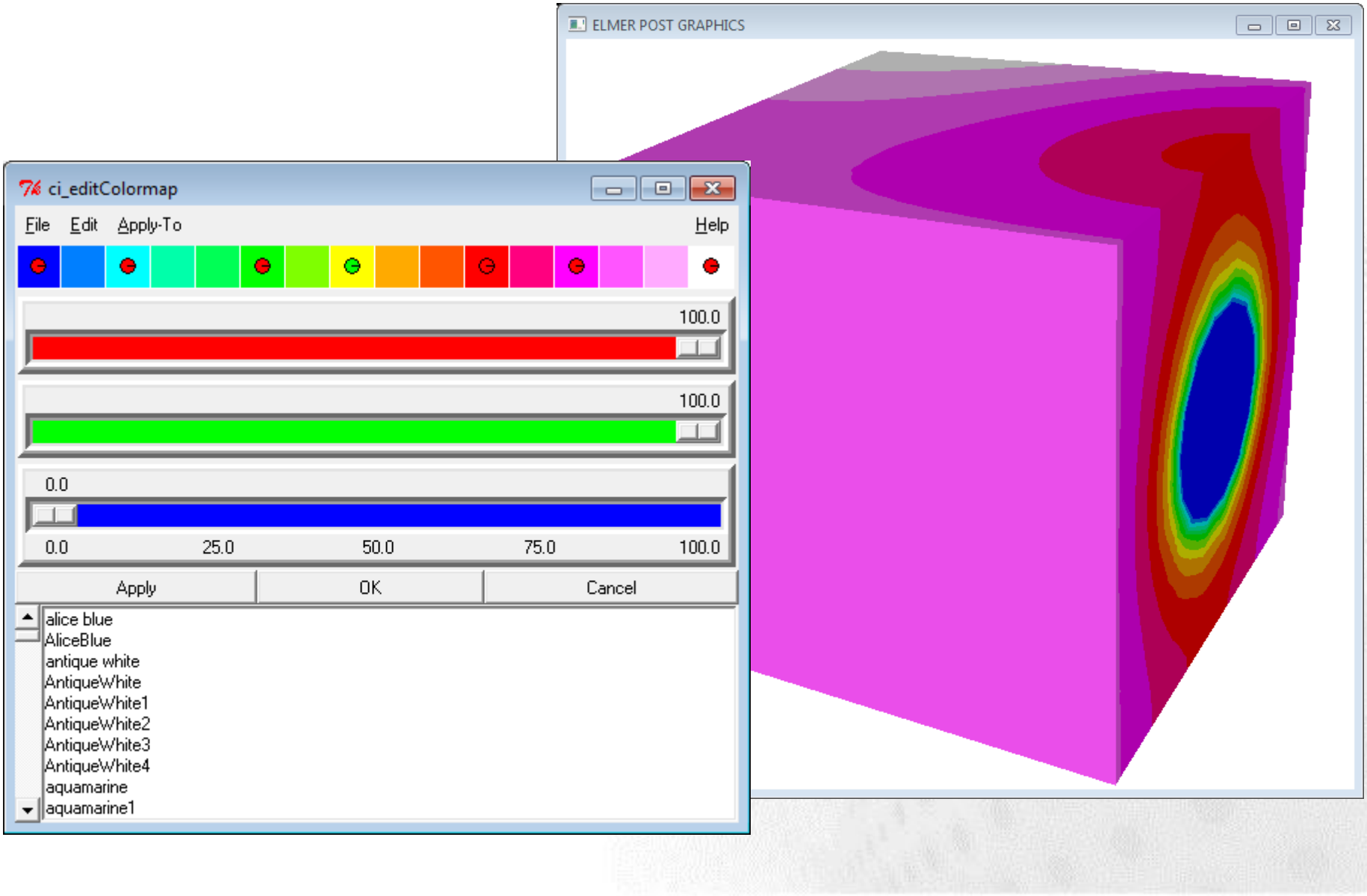
Surface plot + Isosurfaces + Opaque



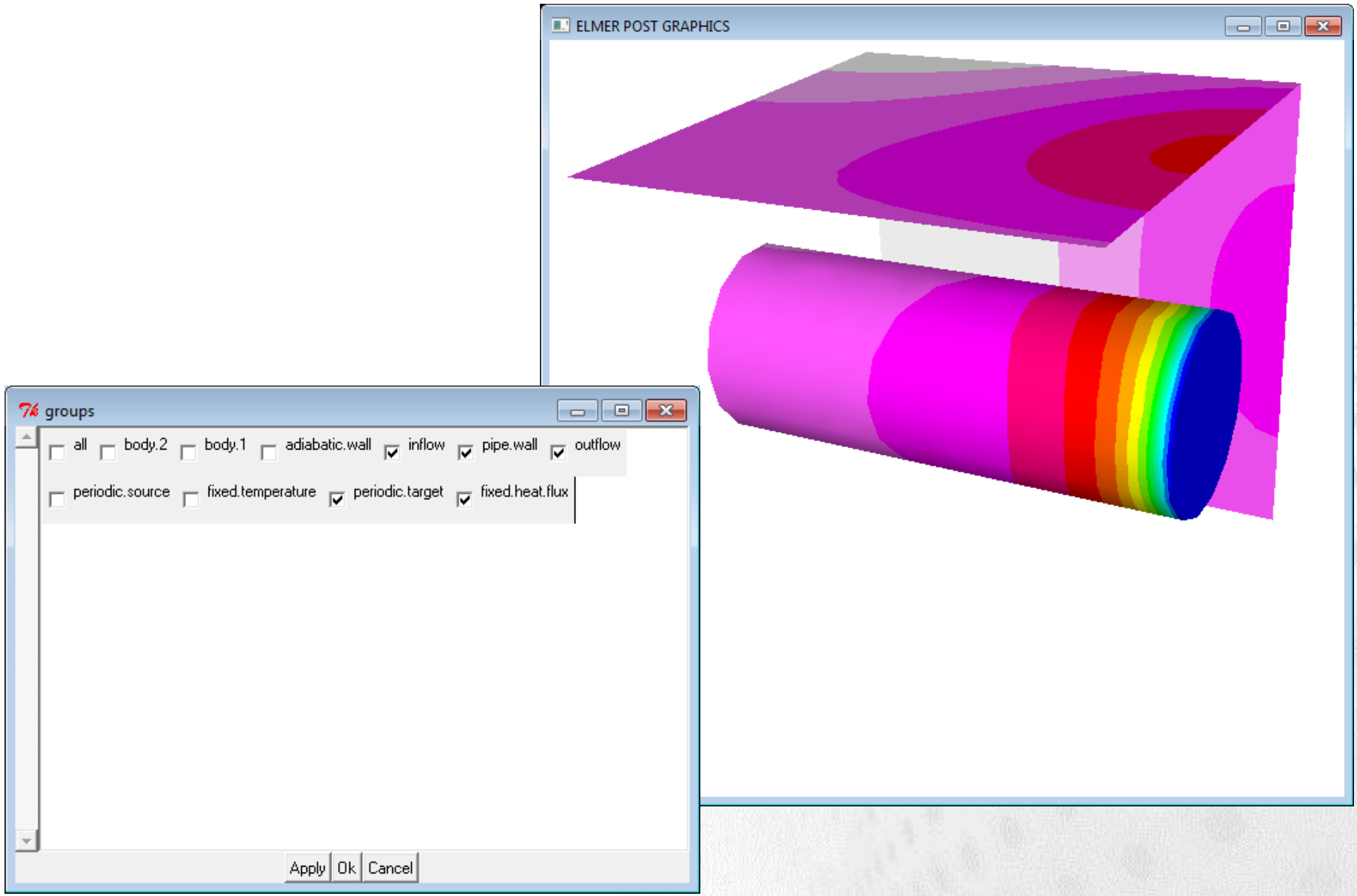




Change of colormap

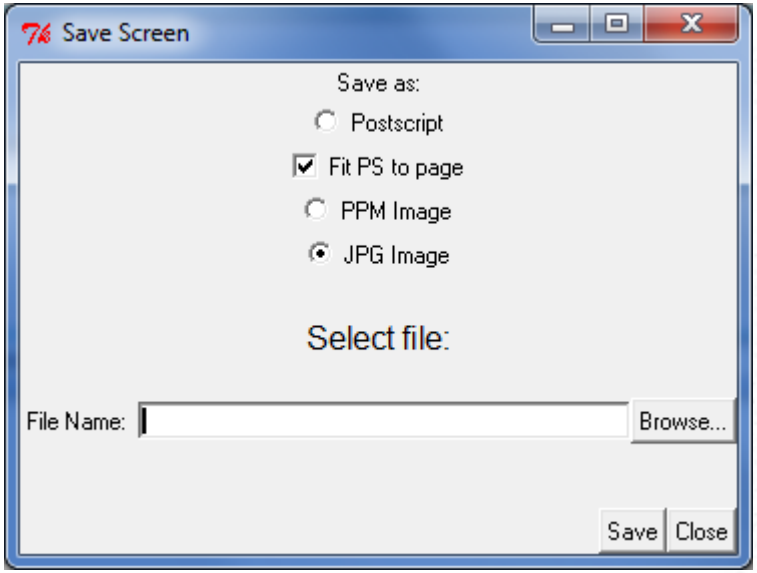


Selecting active geometric entities



Saving figures

- File -> Save Image -> jpg



Deformation in geometry

- Assume displacement field in variable
  `”Displacement”`
- Set in command windows:

```
math n0=nodes
math nodes=n0+Displacement
```

- Replot

Conclusions

- Use Paraview and VTU format
- For large visualizations ViSiT could be an option