



Introduction to ParaView

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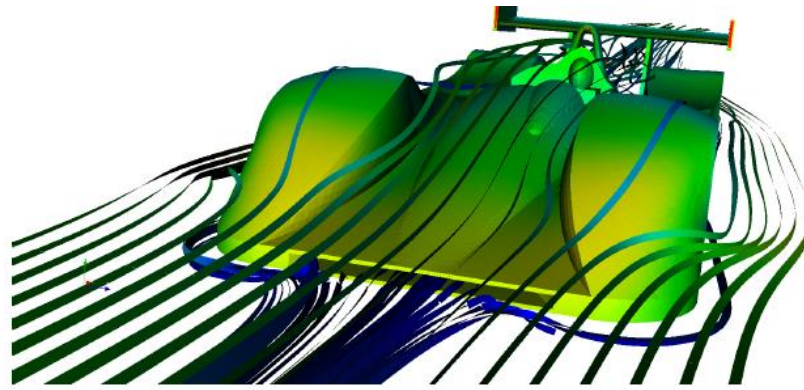
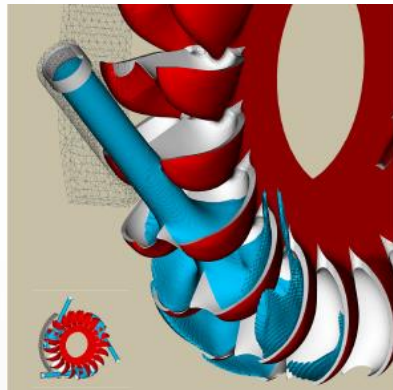
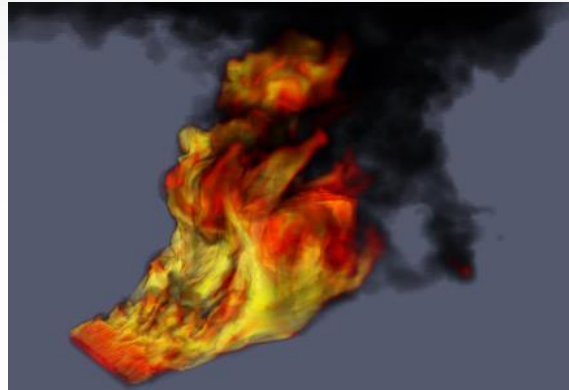
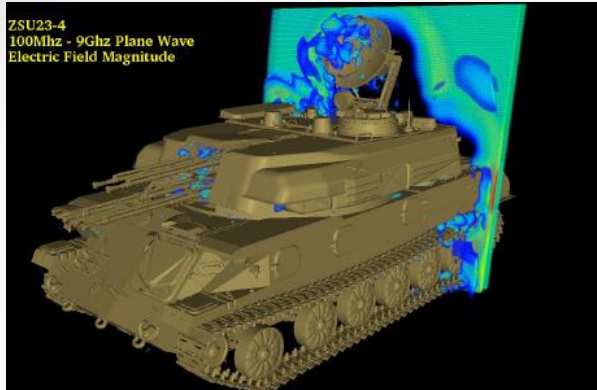
HPRC Short Course – Spring 2018



Introduction to ParaView

- What is ParaView
- The ParaView Architecture
- Hands-on: Basic Usage of ParaView
 - Getting Data
 - Interacting with 3D View
 - Representation and Field Coloring
 - Filter and Pipeline
 - Commonly used filters
 - contour, slice, clip, streamline, tube, glyph
 - Vector Visualization
 - Streamline, tube, glyph
 - Multiview
 - Volume Rendering

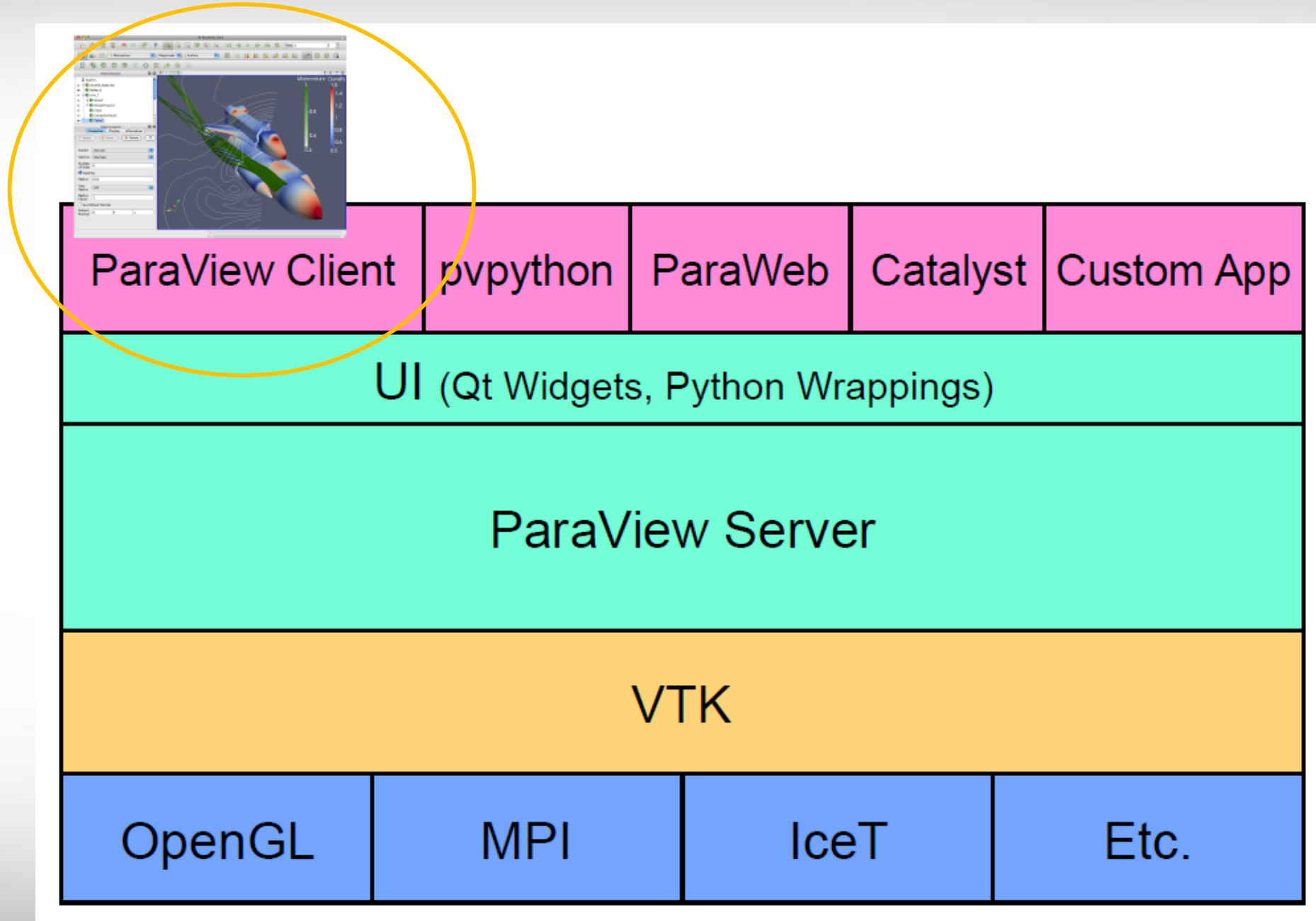
What is ParaView



- An open source visualization software for 2D/3D data sets
- Started in 2000 as a collaborative effort between Kitware Inc and Los Alamos National Laboratories
- Supports multi-platforms: Windows, Linux, MacOS
- Supports distributed computation for large data sets
- Has an open, flexible, and intuitive user interface
- Has an extensible and modular architecture based on open standard
- Free for non-commercial use

ParaView Architecture

Focus of this short course



Why Visualization

- A picture is worth a thousand words.

```
[pingluo@ada8 data]$ xxd disk_out_ref.ex2 |more
00000000: 4344 4601 0000 0001 0000 000a 0000 0019
00000010: 0000 000a 6c65 6e5f 7374 7269 6e67 0000
00000020: 0000 0021 0000 0008 6c65 6e5f 6c69 6e65
00000030: 0000 0051 0000 0004 666f 7572 0000 0004
00000040: 0000 0009 7469 6d65 5f73 7465 7000 0000
00000050: 0000 0000 0000 0007 6e75 6d5f 6469 6d00
00000060: 0000 0003 0000 0009 6e75 6d5f 6e6f 6465
00000070: 7300 0000 0000 2133 0000 0008 6e75 6d5f
00000080: 656c 656d 0000 1d30 0000 000a 6e75 6d5f
00000090: 656c 5f62 6c6b 0000 0000 0001 0000 000d
000000a0: 6e75 6d5f 6e6f 6465 5f73 6574 7300 0000
000000b0: 0000 0003 0000 000d 6e75 6d5f 7369 6465
000000c0: 5f73 6574 7300 0000 0000 0007 0000 000a
000000d0: 6e75 6d5f 7161 5f72 6563 0000 0000 0003
000000e0: 0000 0008 6e75 6d5f 696e 666f 0000 000a
000000f0: 0000 000e 6e75 6d5f 656c 5f69 6e5f 626c
00001000: 6b31 0000 0000 1d30 0000 000f 6e75 6d5f
00001010: 6e6f 645f 7065 725f 656c 3100 0000 0008
00001020: 0000 000b 6e75 6d5f 6e6f 645f 6e73 3100
00001030: 0000 0001 0000 000b 6e75 6d5f 6e6f 645f
00001040: 6e73 3200 0000 0001 0000 000b 6e75 6d5f
00001050: 6e6f 645f 6e73 3300 0000 0001 0000 000c
00001060: 6e75 6d5f 7369 6465 5f73 7331 0000 01a2
00001070: 0000 000c 6e75 6d5f 7369 6465 5f73 7332
00001080: 0000 006c 0000 000c 6e75 6d5f 7369 6465
00001090: 5f73 7333 0000 033c 0000 000c 6e75 6d5f
000010a0: 7369 6465 5f73 7334 0000 00d8 0000 000c
000010b0: 6e75 6d5f 7369 6465 5f73 7335 0000 00b4
000010c0: 0000 000c 6e75 6d5f 7369 6465 5f73 7336
000010d0: 0000 03c4 0000 000c 6e75 6d5f 7369 6465
```

Properties Information

Information

Statistics

Type: Multi-block Dataset

Number of Cells: 7472

Number of Points: 8499

Memory: 2 MB

Data Arrays

Current data time: 0

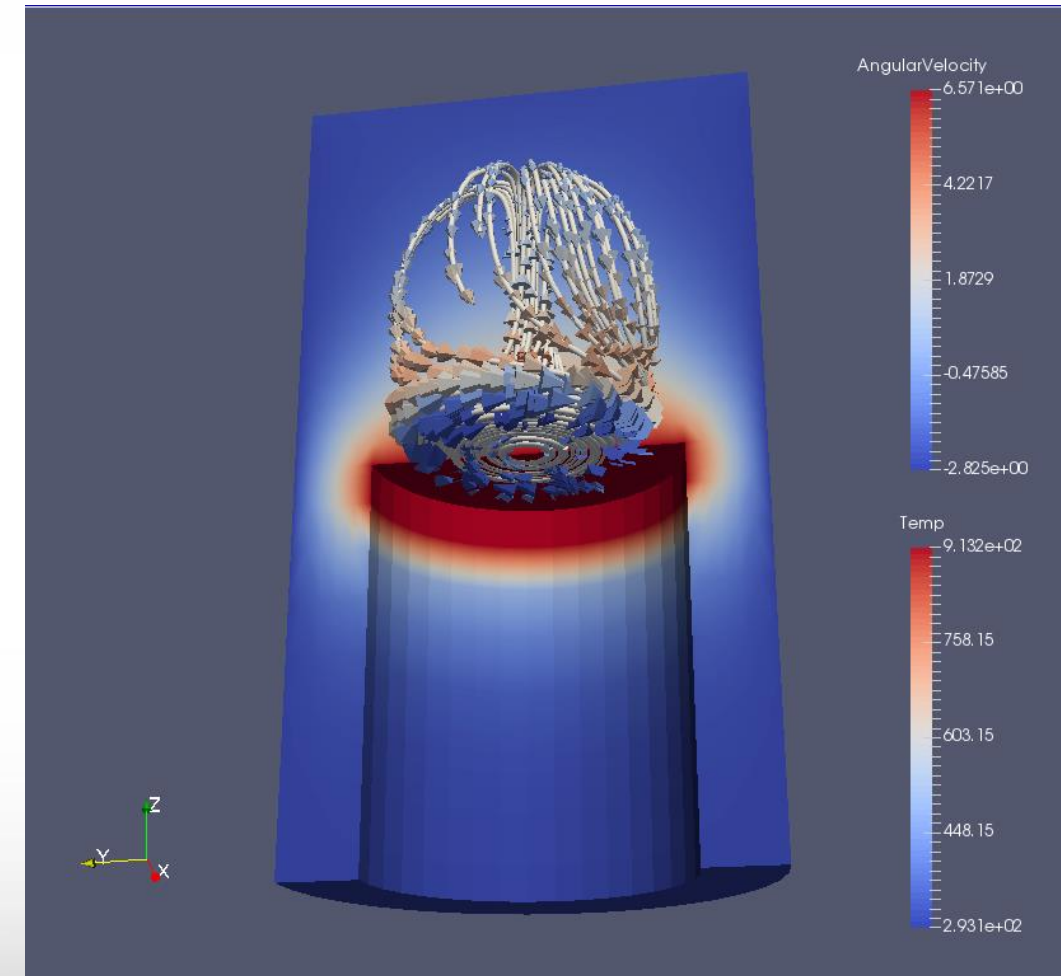
| Name | Data Type | Data Ranges |
|-----------------|-----------|-----------------------------|
| AsH3 | double | [0.0804768, 0.184839] |
| CH4 | double | [0, 0.00117024] |
| GaMe3 | double | [0.000222844, 0.007213...] |
| GlobalNodeId | idtype | [1, 8499] |
| H2 | double | [0.807613, 0.917688] |
| PedigreeNodeId | idtype | [1, 8499] |
| Pres | double | [0.00678552, 0.0288185] |
| Temp | double | [293.15, 913.15] |
| V | double | [-19.9491, 19.9491], [-1... |
| GlobalElementId | idtype | [1, 7472] |

Bounds

X range: -5.75 to 5.75 (delta: 11.5)

Y range: -5.75 to 5.75 (delta: 11.5)

Z range: -10 to 10.2 (delta: 20.2)



ParaView User Interface

Menu bar

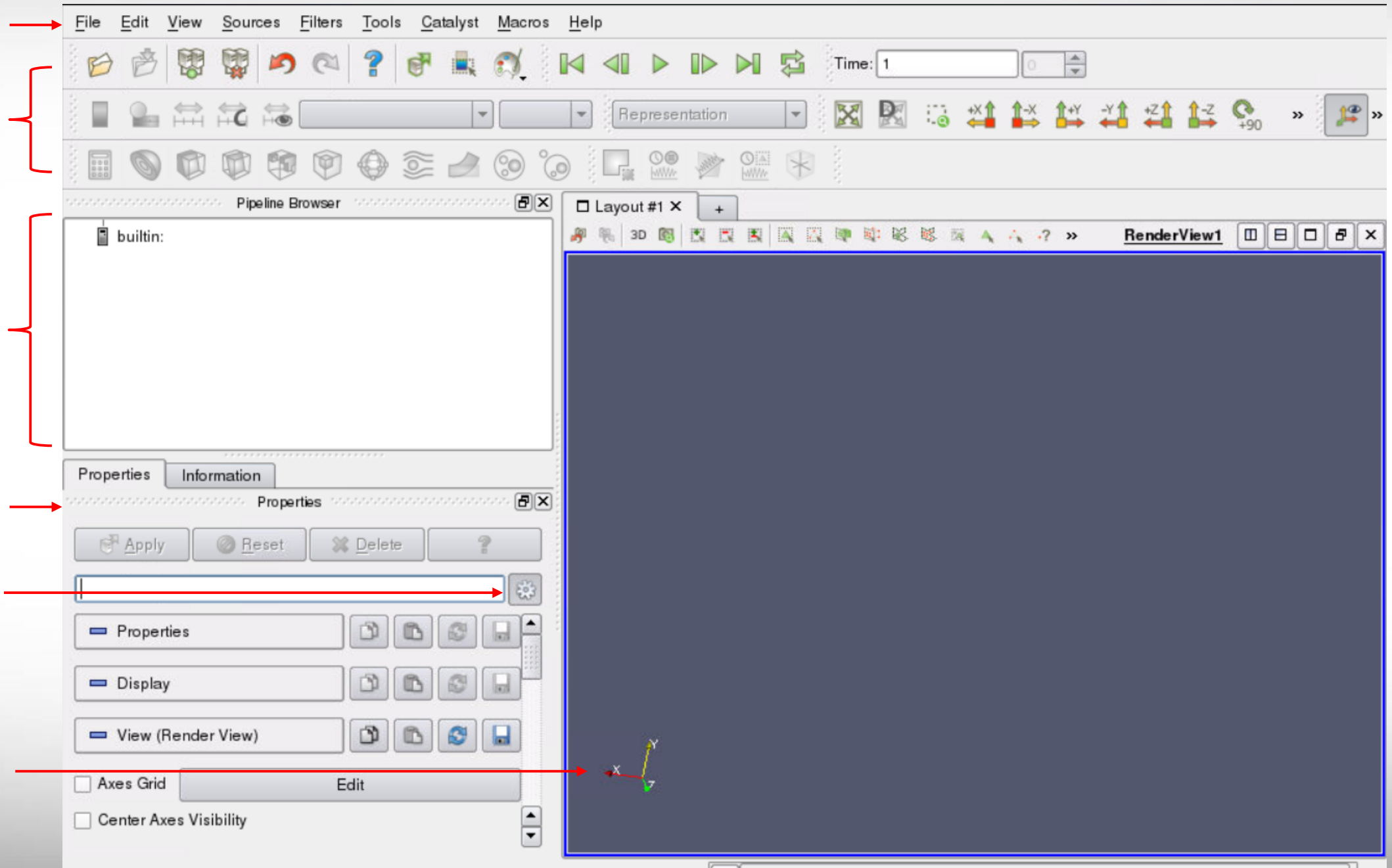
Toolbars

Pipeline browser

Property panel

Advanced toggle

3D view



Getting Data

- Creating a source from the menu Sources
- Loading from a file

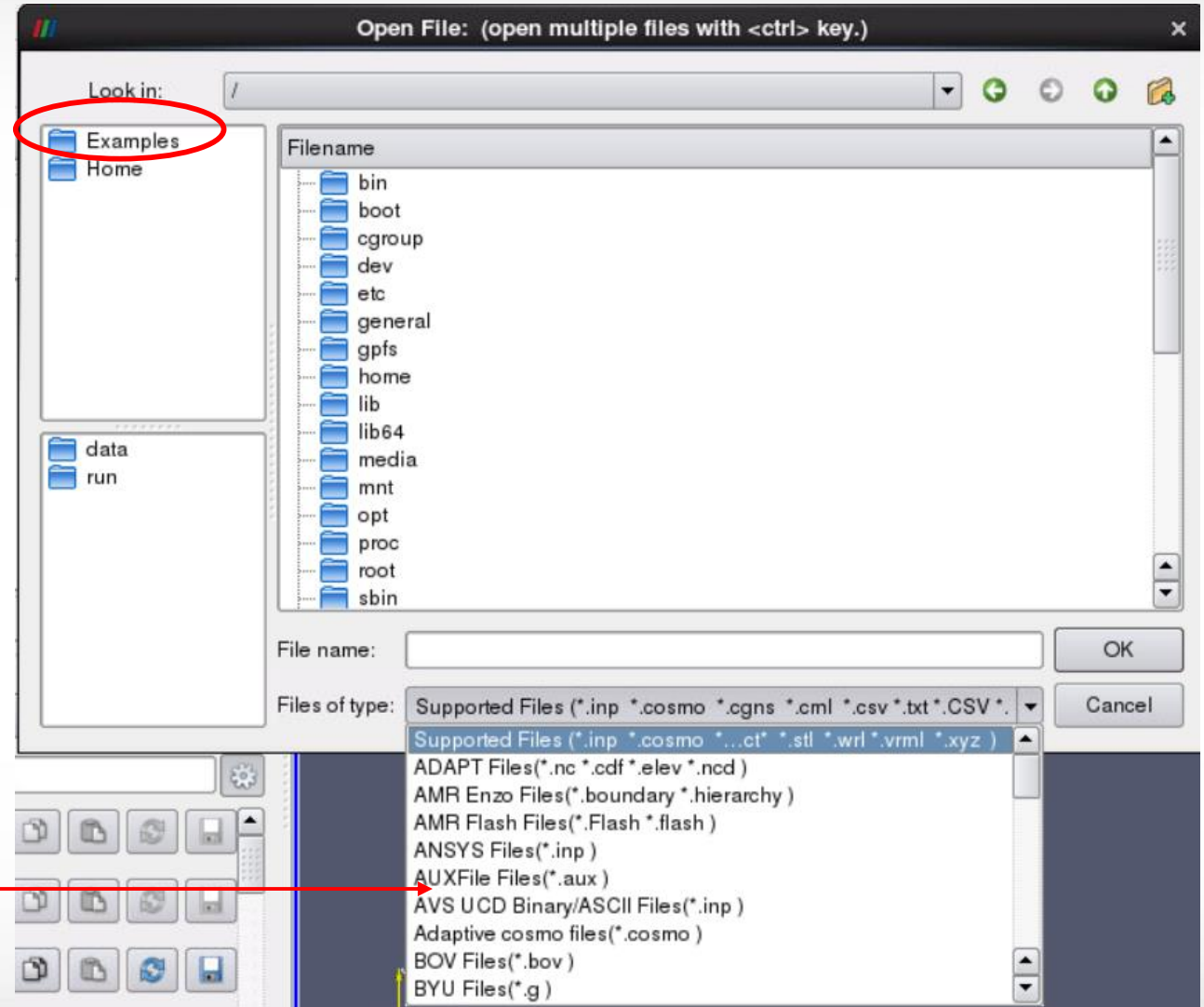
Interacting with a 3D View

- Create a Source: Sources -> Cylinder
- Change parameters: resolution -> 80
- Play with camera controls
- Play with center access controls

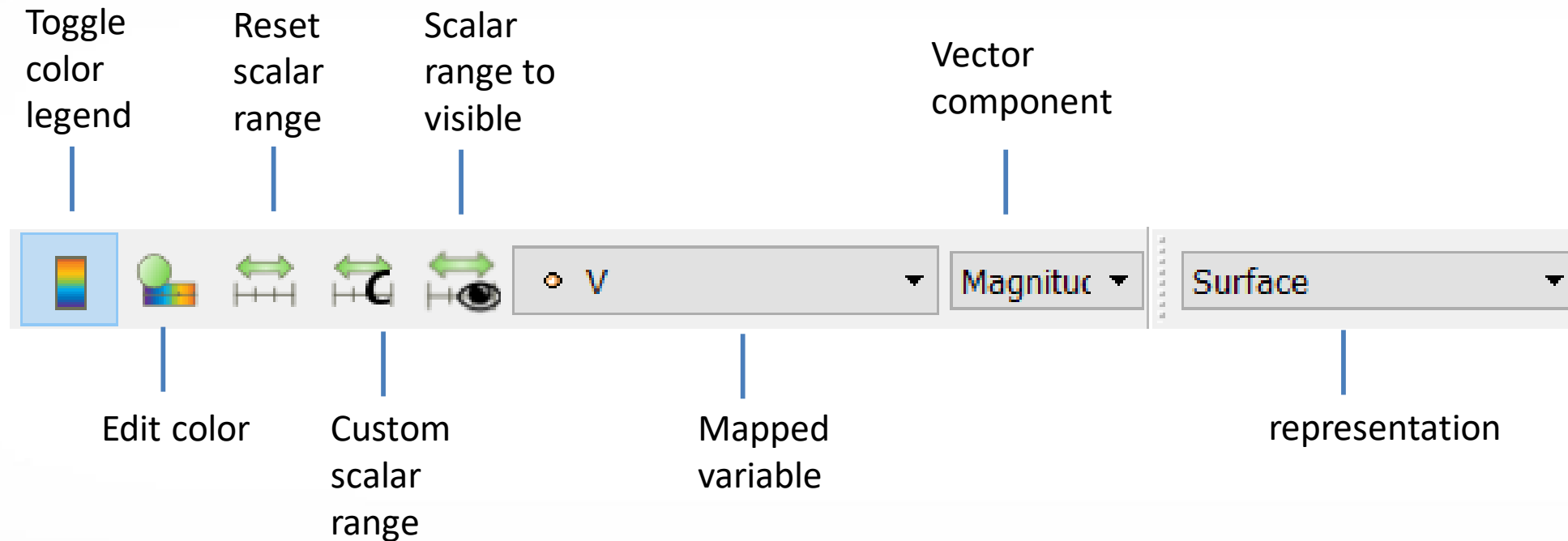


Loading from a File

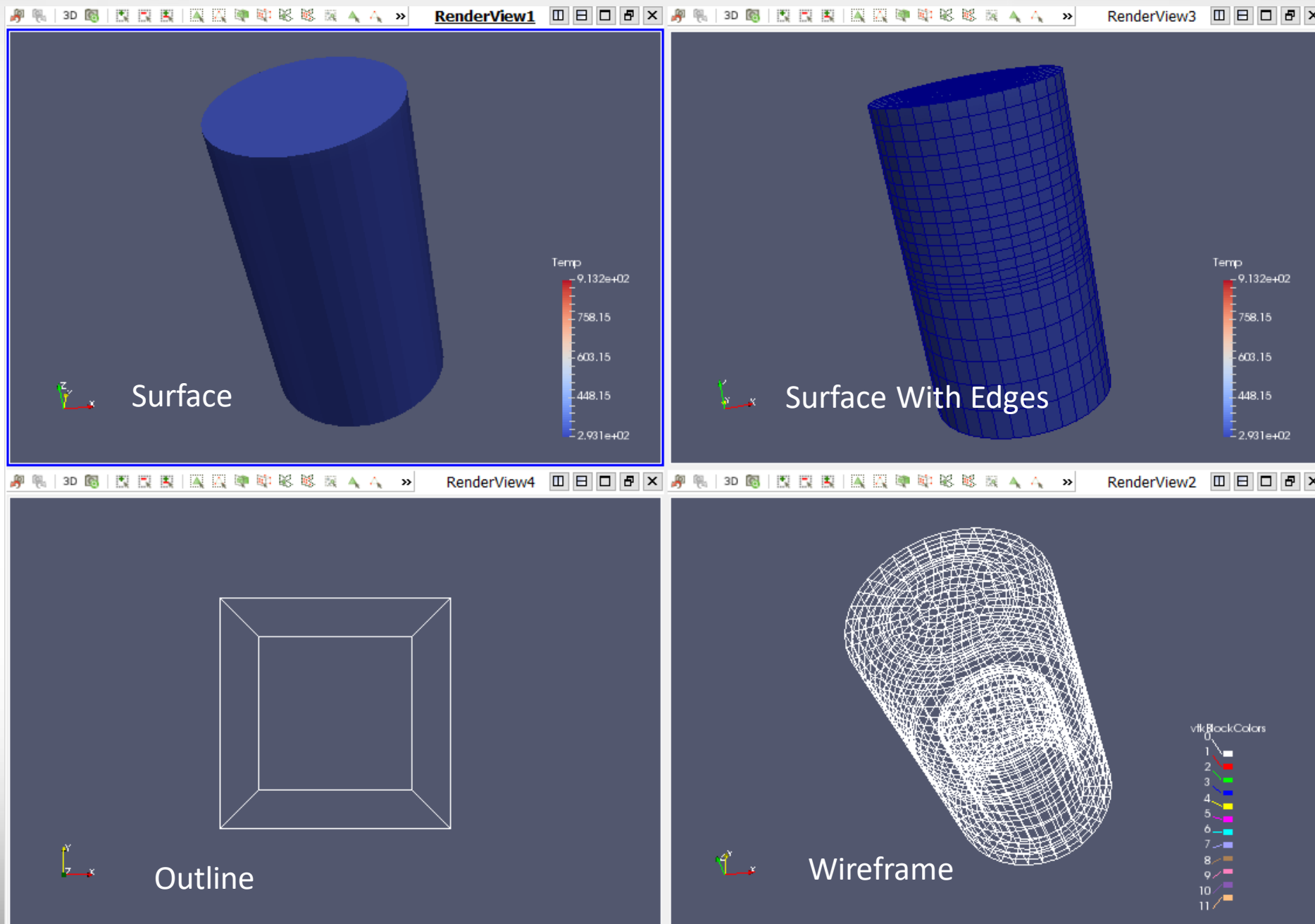
- ParaView provides different readers to read different types of input files.
- File -> Open -> Examples -> disk_out_ref.ex2
- To view the file, click the eye next to disk_out_ref.ex2 in the pipeline browser.




Representation and Active Variable Controls

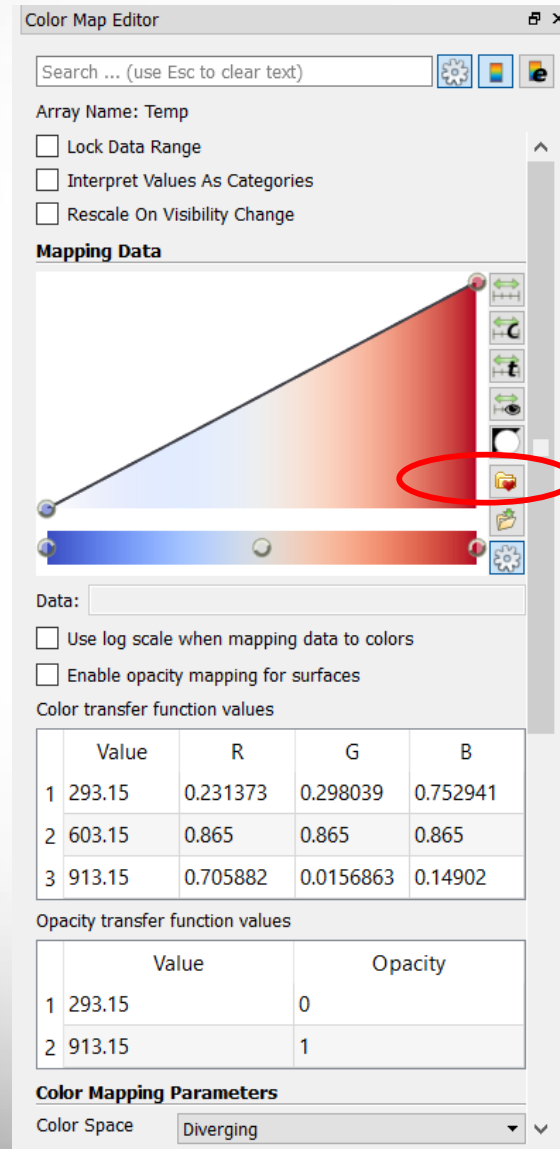


Representation



Change Color Map

- Edit Color Map -> Choose Preset  -> Black Body Radiation -> Apply



Color Map Editor

Search ... (use Esc to clear text)

Array Name: Temp

Lock Data Range

Interpret Values As Categories

Rescale On Visibility Change

Mapping Data

Data:

Use log scale when mapping data to colors

Enable opacity mapping for surfaces

Color transfer function values

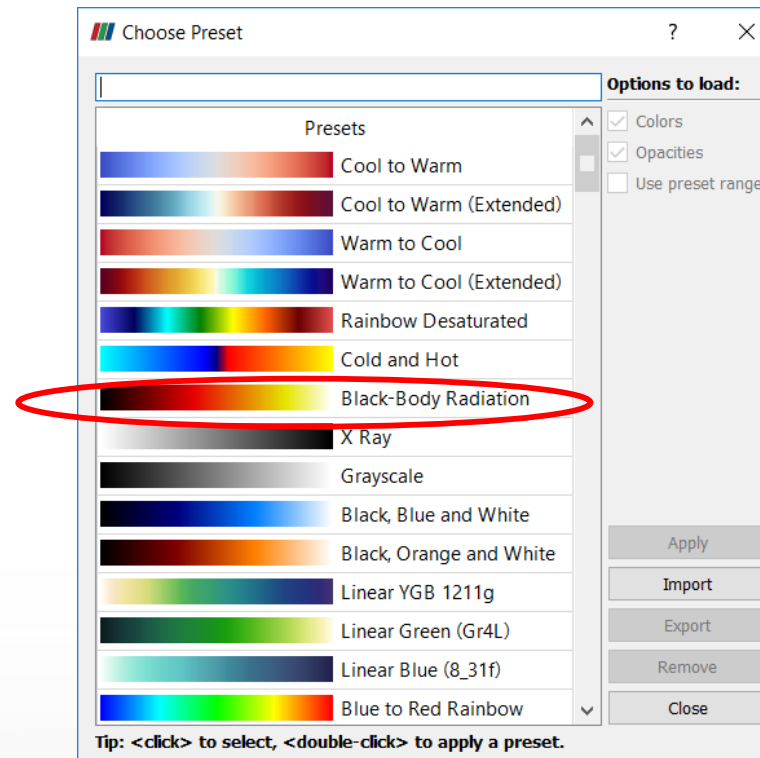
| | Value | R | G | B |
|---|--------|----------|-----------|----------|
| 1 | 293.15 | 0.231373 | 0.298039 | 0.752941 |
| 2 | 603.15 | 0.865 | 0.865 | 0.865 |
| 3 | 913.15 | 0.705882 | 0.0156863 | 0.14902 |

Opacity transfer function values

| | Value | Opacity |
|---|--------|---------|
| 1 | 293.15 | 0 |
| 2 | 913.15 | 1 |

Color Mapping Parameters

Color Space: Diverging



Choose Preset

Options to load:

Colors

Opacities

Use preset range

Presets

- Cool to Warm
- Cool to Warm (Extended)
- Warm to Cool
- Warm to Cool (Extended)
- Rainbow Desaturated
- Cold and Hot
- Black-Body Radiation**
- X Ray
- Grayscale
- Black, Blue and White
- Black, Orange and White
- Linear YGB 1211g
- Linear Green (Gr4L)
- Linear Blue (8_31f)
- Blue to Red Rainbow

Apply

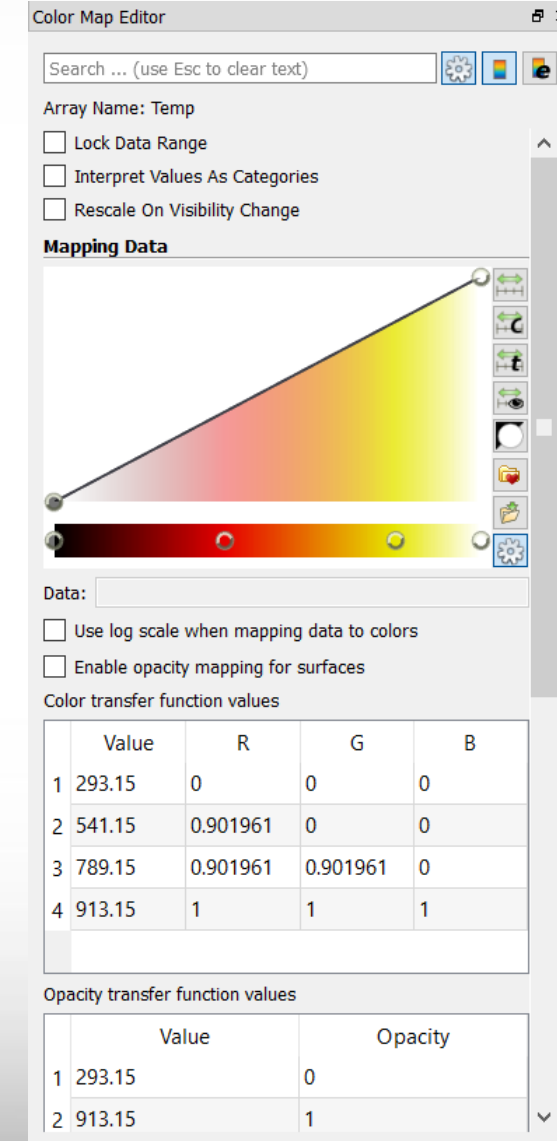
Import

Export

Remove

Close

Tip: <click> to select, <double-click> to apply a preset.



Color Map Editor

Search ... (use Esc to clear text)

Array Name: Temp

Lock Data Range

Interpret Values As Categories

Rescale On Visibility Change

Mapping Data

Data:

Use log scale when mapping data to colors

Enable opacity mapping for surfaces

Color transfer function values

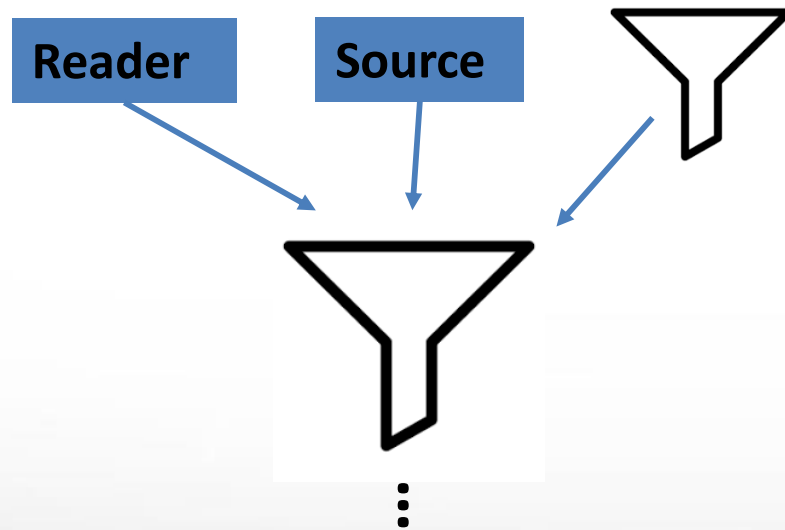
| | Value | R | G | B |
|---|--------|----------|----------|---|
| 1 | 293.15 | 0 | 0 | 0 |
| 2 | 541.15 | 0.901961 | 0 | 0 |
| 3 | 789.15 | 0.901961 | 0.901961 | 0 |
| 4 | 913.15 | 1 | 1 | 1 |

Opacity transfer function values

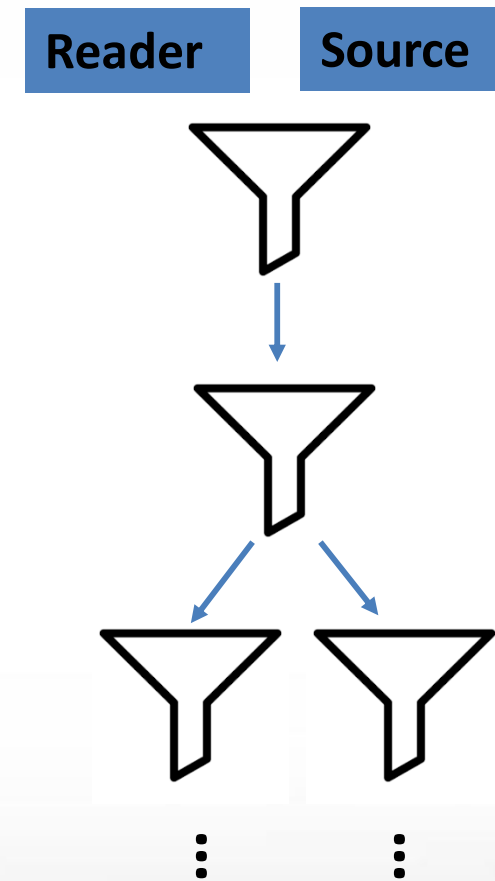
| | Value | Opacity |
|---|--------|---------|
| 1 | 293.15 | 0 |
| 2 | 913.15 | 1 |

Filter and Pipeline

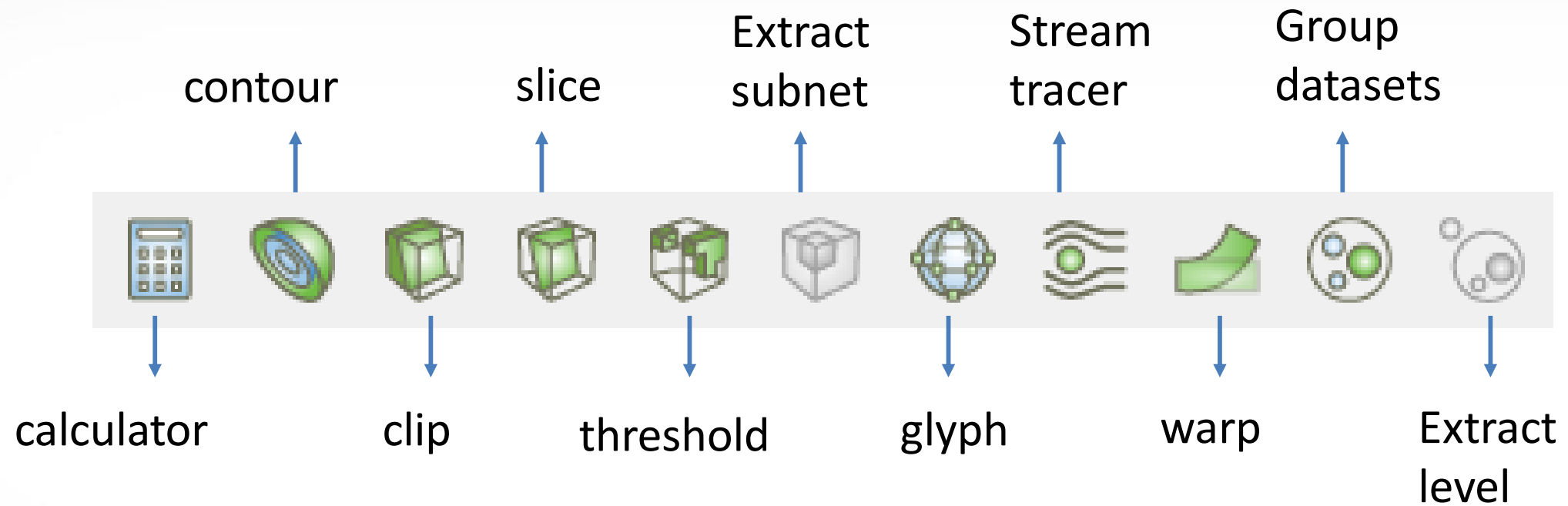
- **Filter:** a functional unit that processes the data to generate, extract, or derive features from the data.



- **Visualization Pipeline**

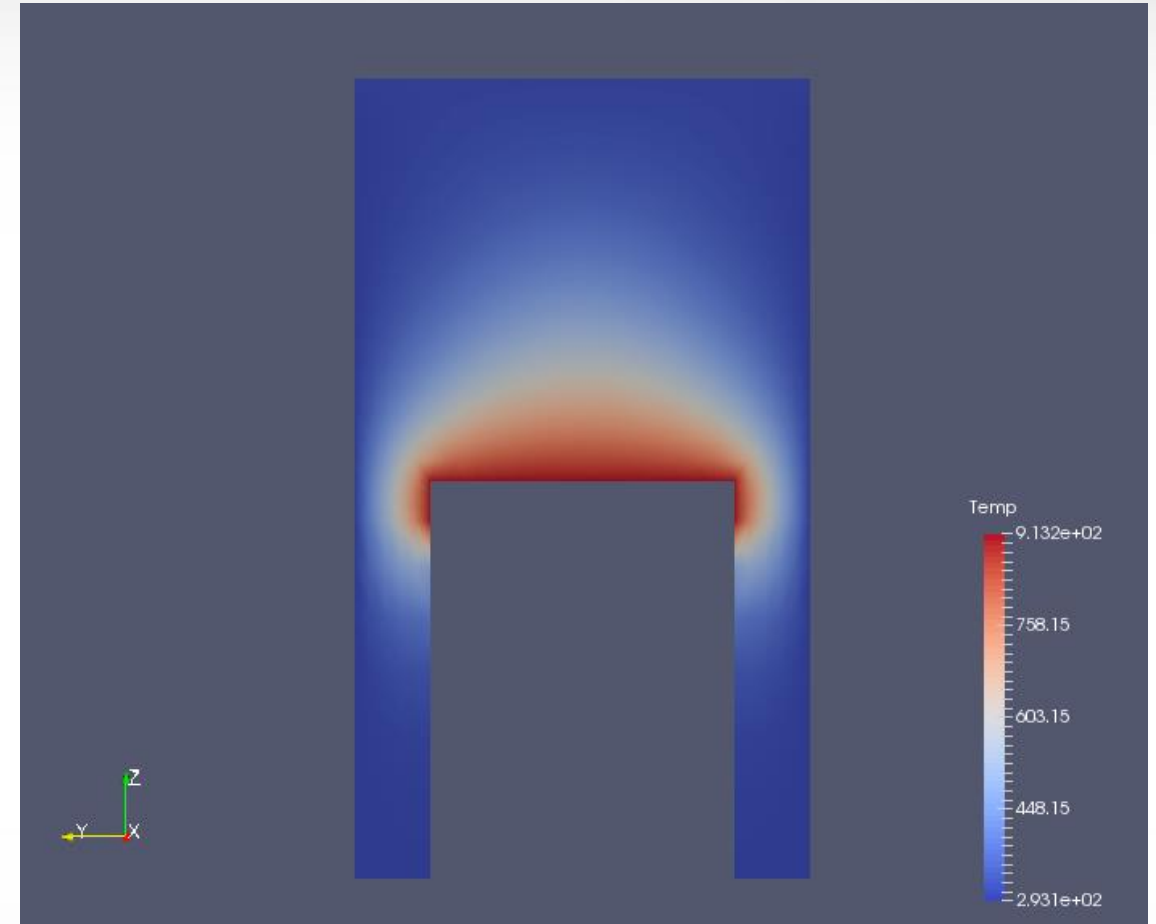


Commonly Used Filters



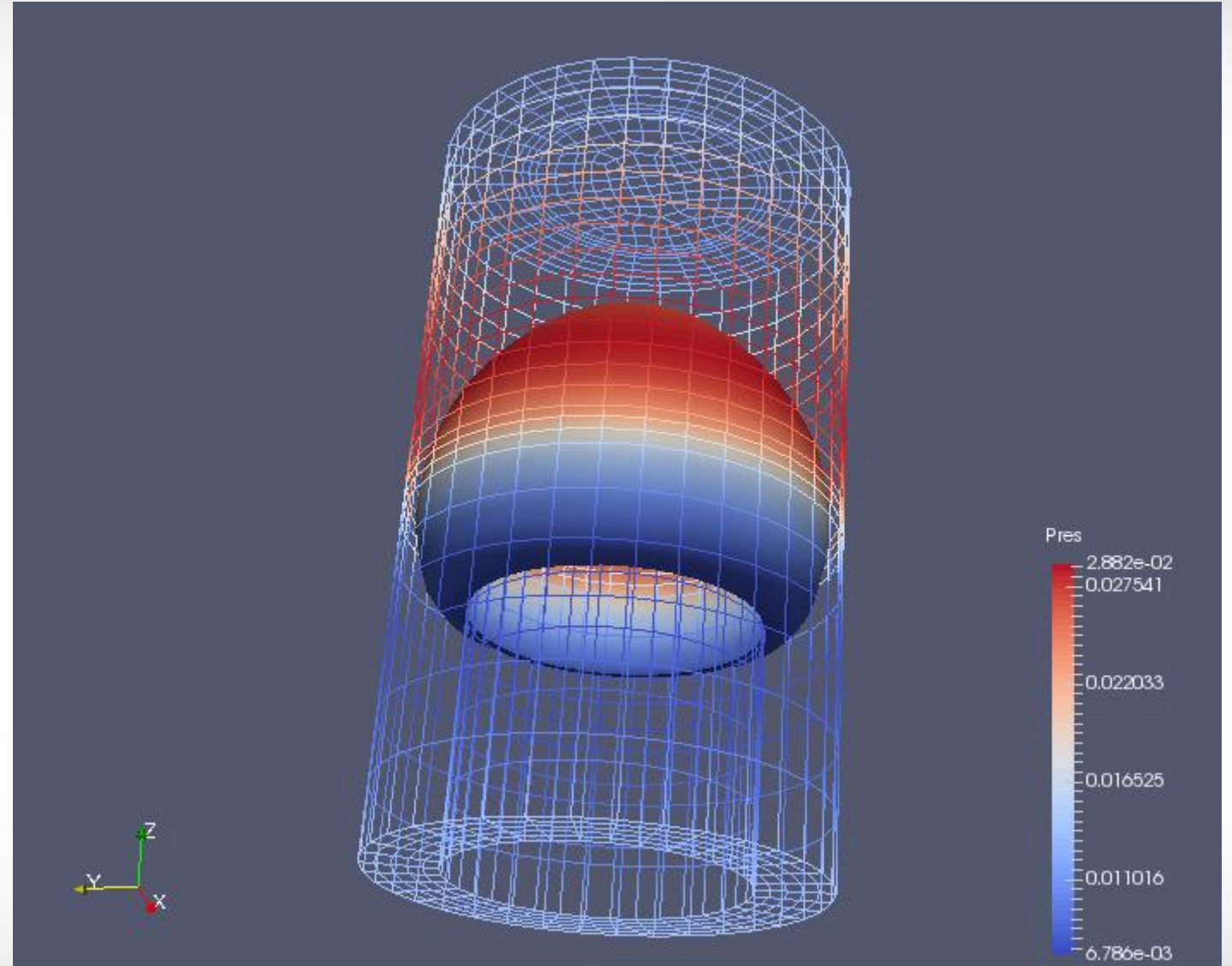
Slice

- Make sure `disk_out_ref.ex2` is loaded
- Click “slice” -> uncheck “show plane” in **Plane Parameters** -> **Apply**
- Change active variable to “temp”
- Set view direction to **+X**
- Rotate the slice to view from different angles



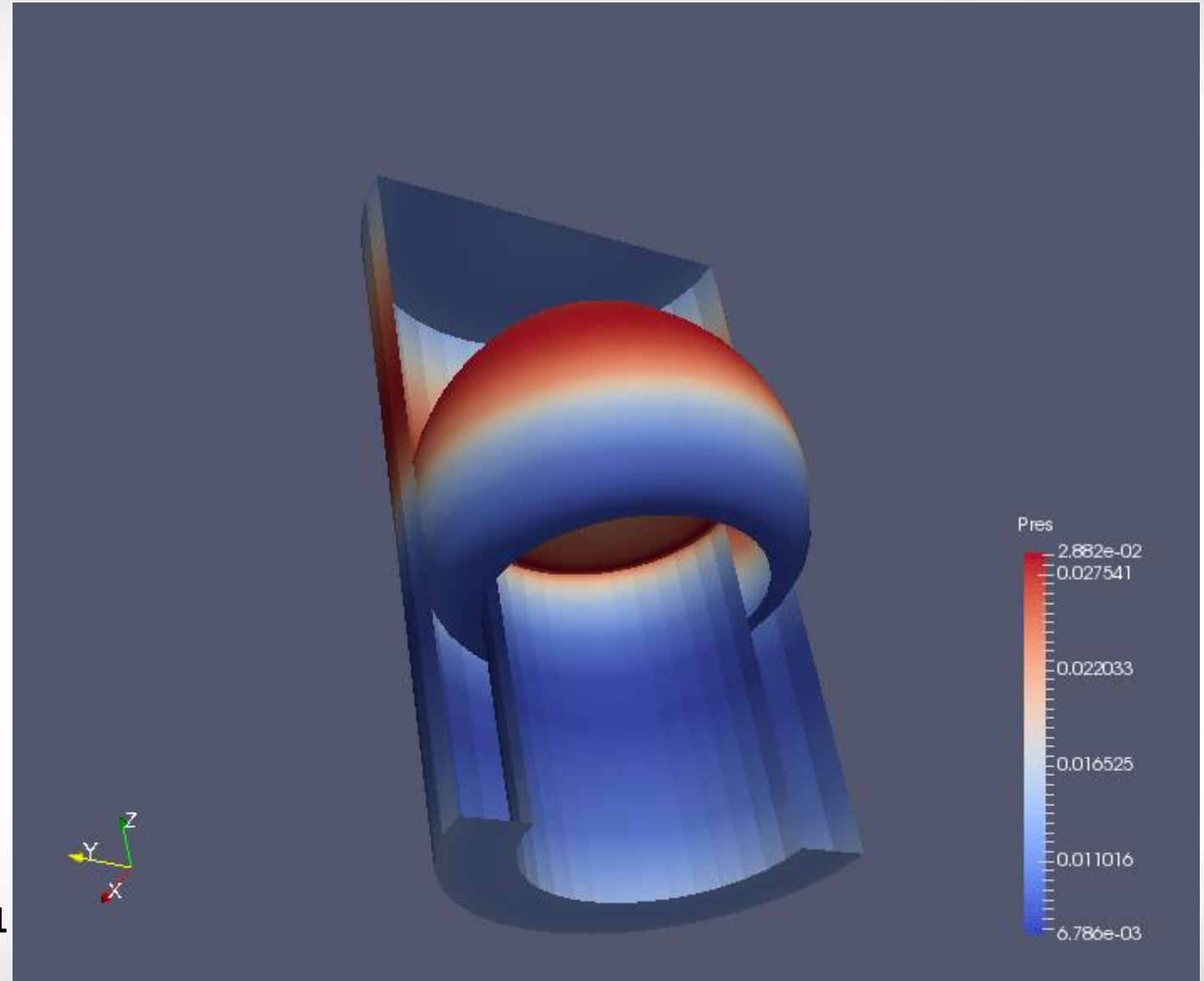
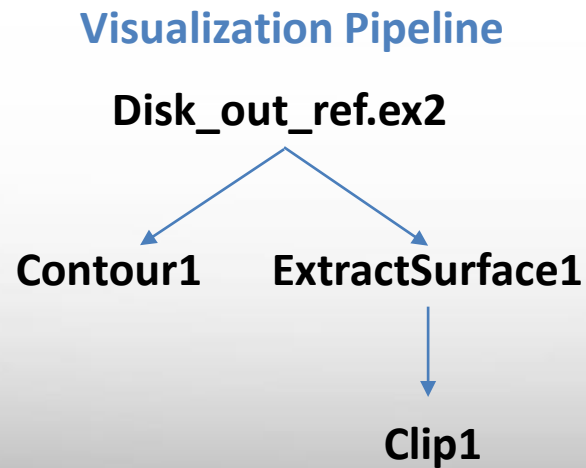
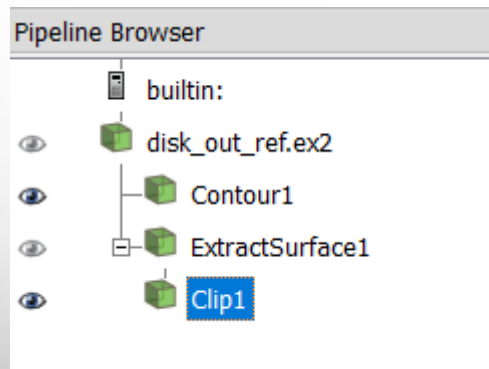
Contour

- Edit -> Reset Session
- Load `disk_out_ref.ex2` -> check all variables -> apply
- Active variable -> `pres`
- Representation -> Wireframe
- Contour -> In Properties tab click “temp” for “Contour by”
- Change “Isosurfaces” value to “400” -> apply



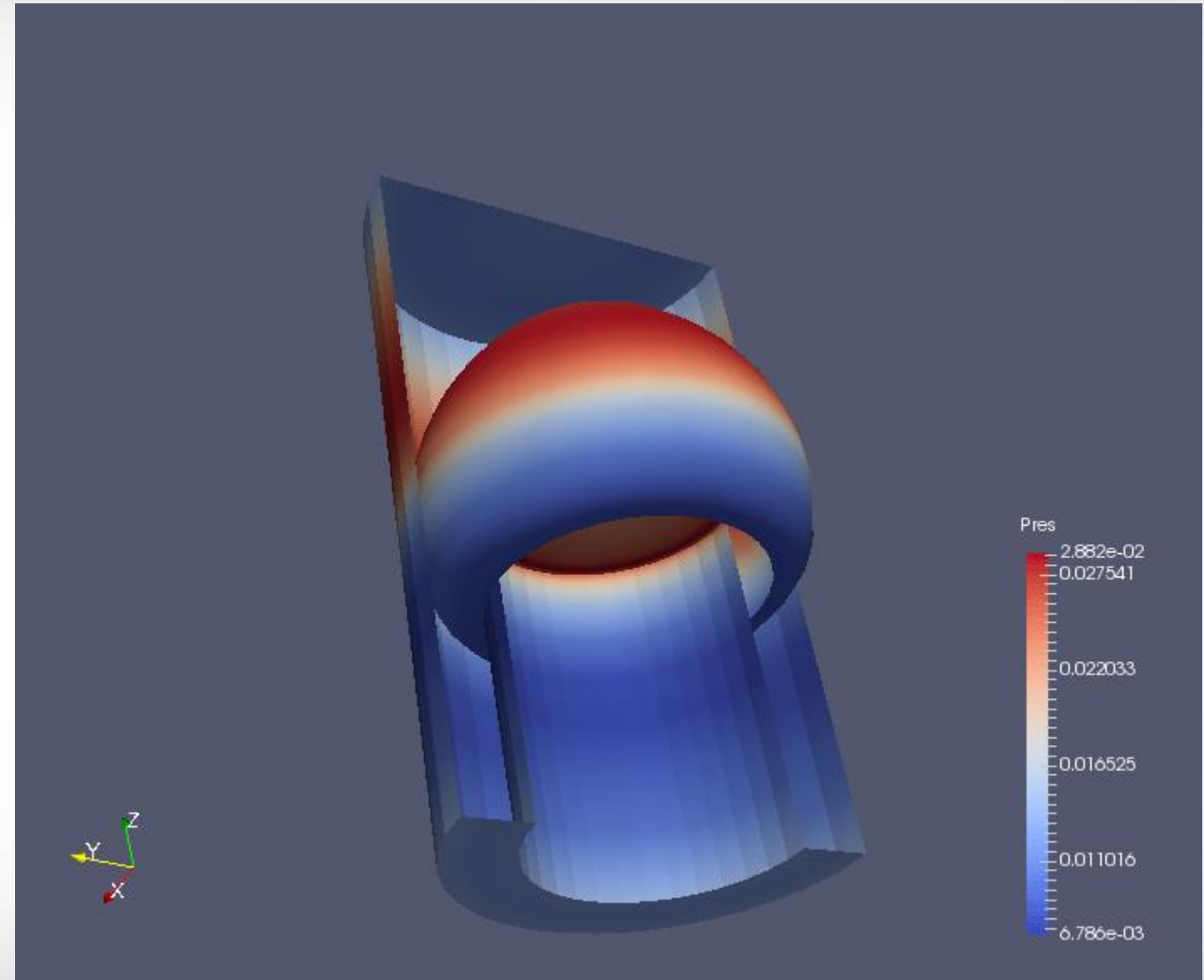
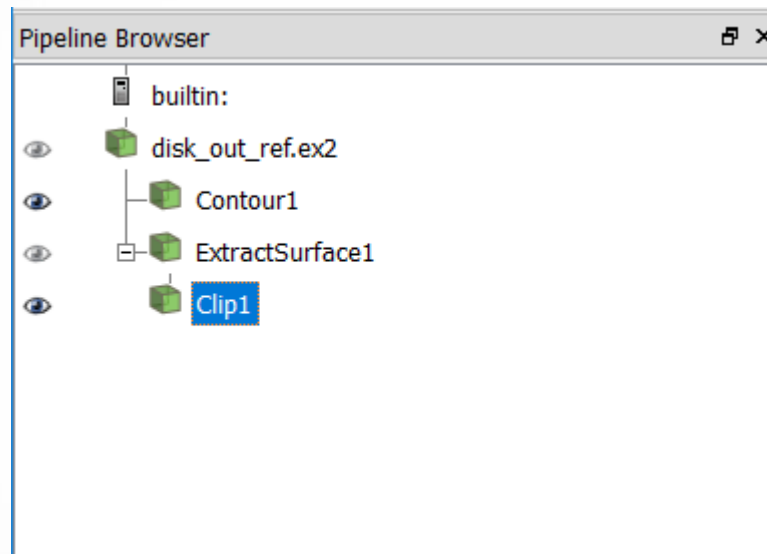
Extract Surface

- Continue from previous slide
- Representation -> Surface
- Filters -> Alphabetical -> Extract Surface -> apply
- Select “ExtractSurface1” -> Clip -> uncheck “show plane” in “Plane Properties” -> Apply




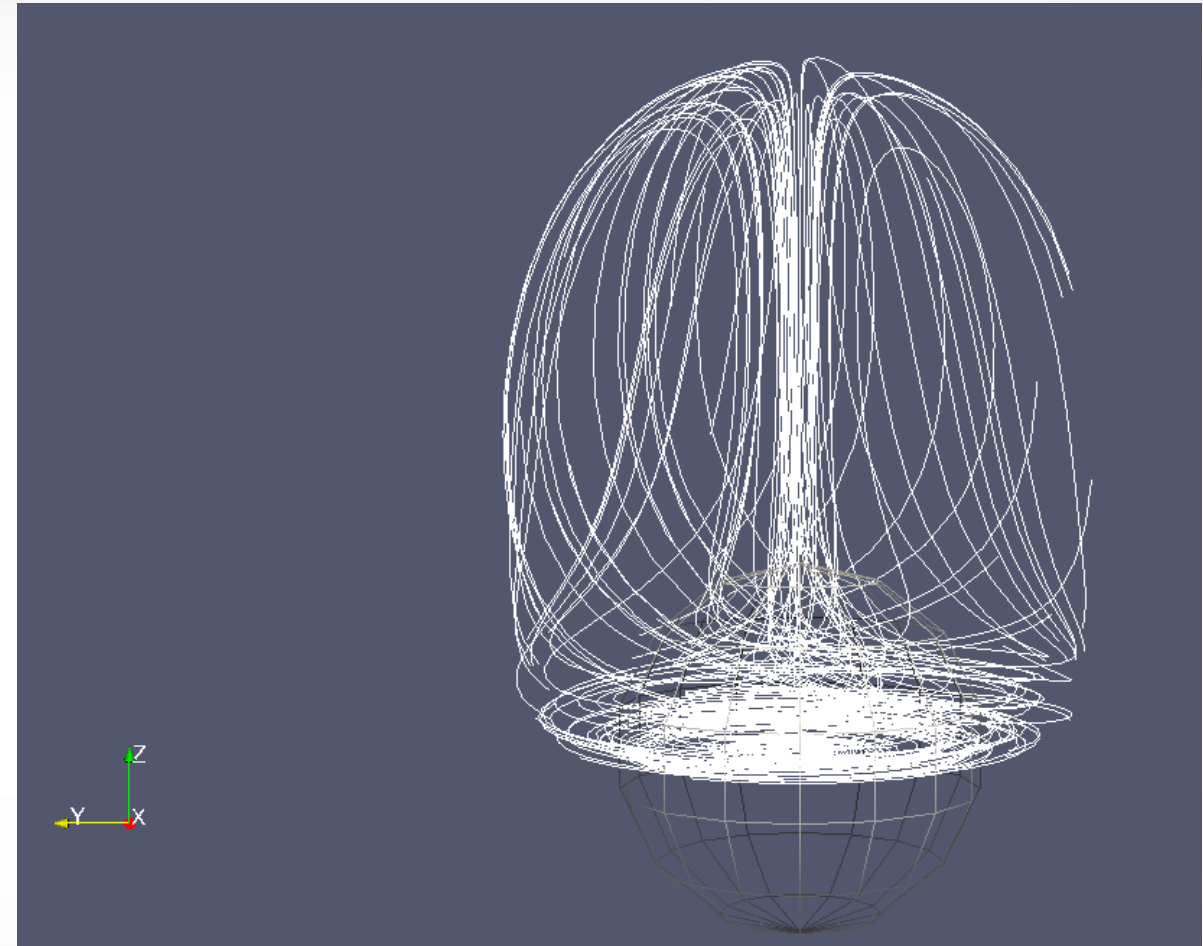
Save/Load State

- File -> Save State
- File -> Load State



Vector Visualization - Streamlines

- The data set has a velocity field describing the movement of the air over the heated rotating disk.
- The filter **Stream Tracer** can be used to determine the currents in the air.
- Click  **Stream Tracer** from common filters -> **Apply**



Enhanced Streamlines

- Stream Tracer draws 1d lines that has no thickness.
 - No shading
 - No direction
- Can be enhanced with other filters
 - **ctrl+space** (quick search) -> **Tube** -> **Apply**
 - **Glyph** -> **Apply**

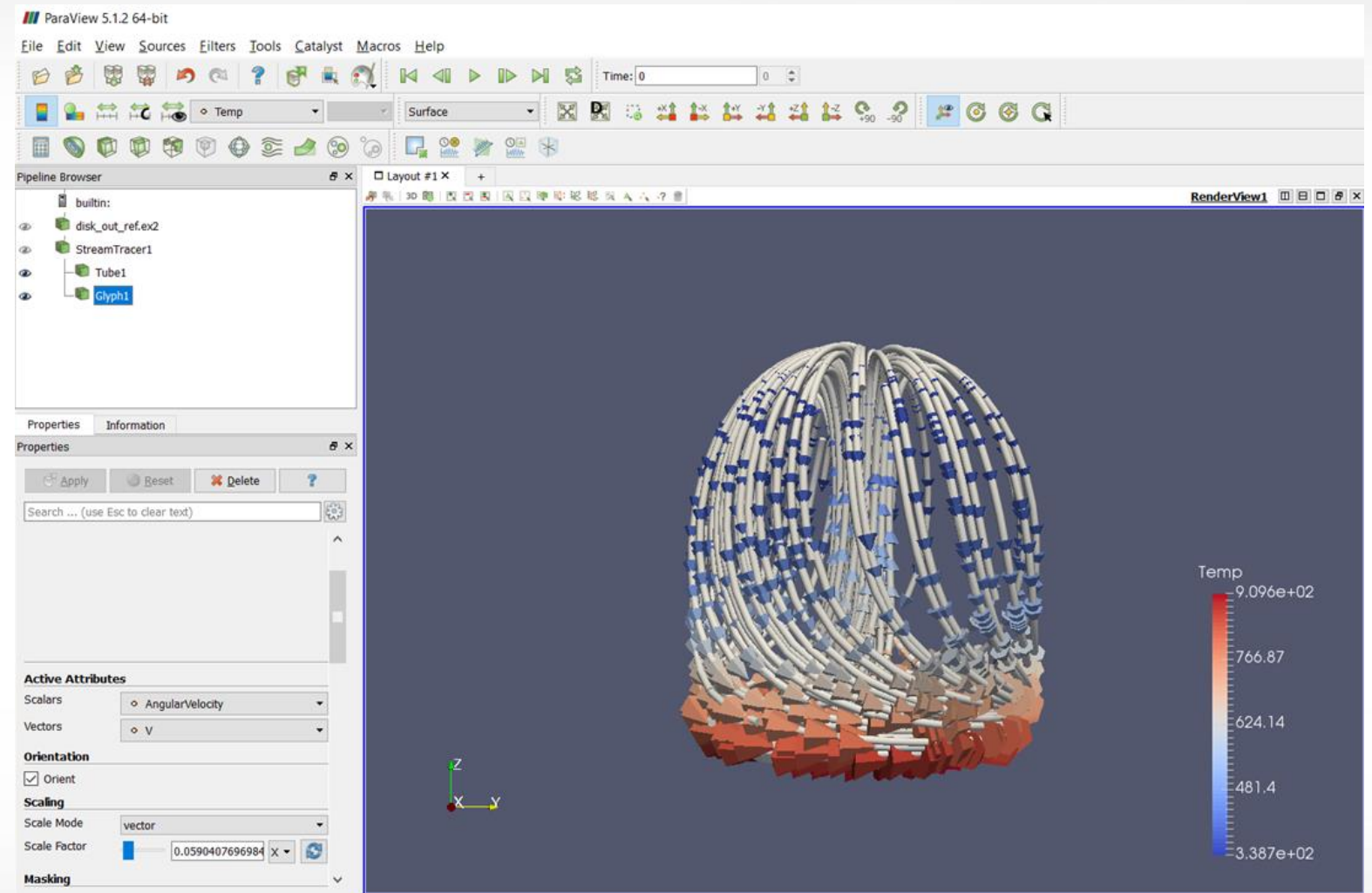
Glyph Properties:

Glyph Source: Glyph Type = cone

Active Attributes: Vectors = V

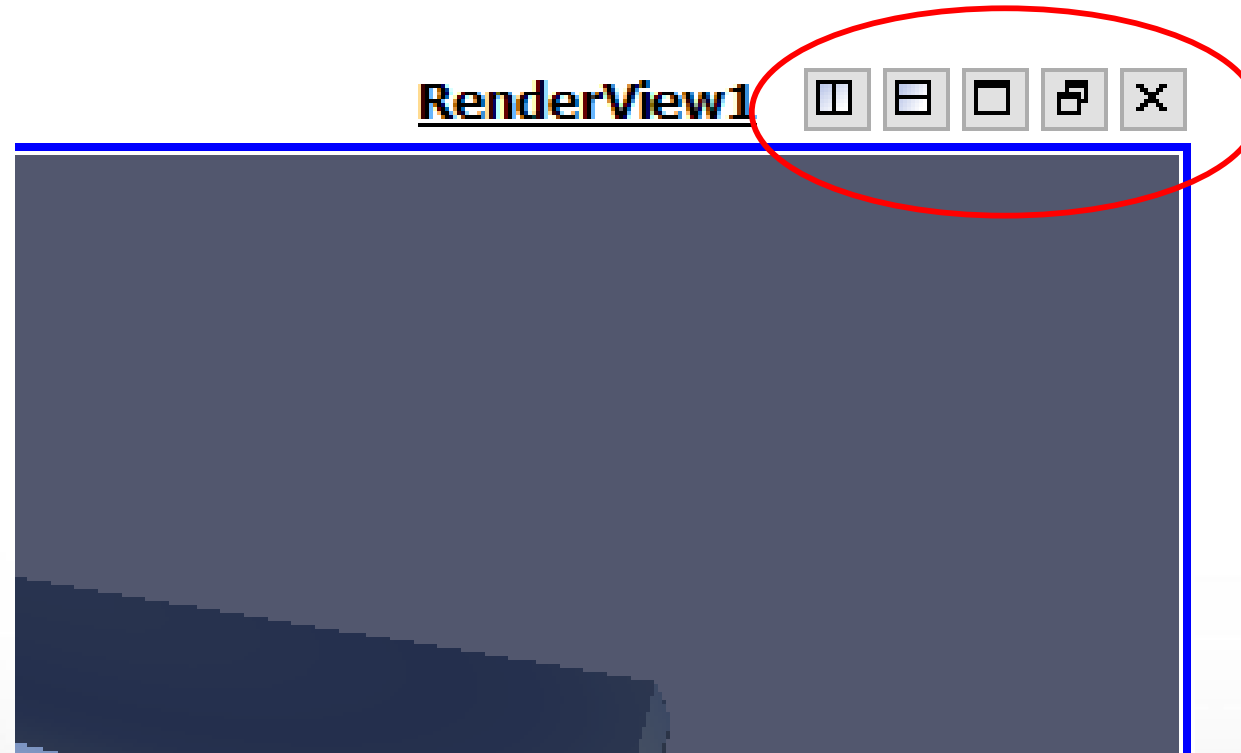
Scaling: Scale Mode = vector

Scale Factor = 0.5904.. (click  to set the value)



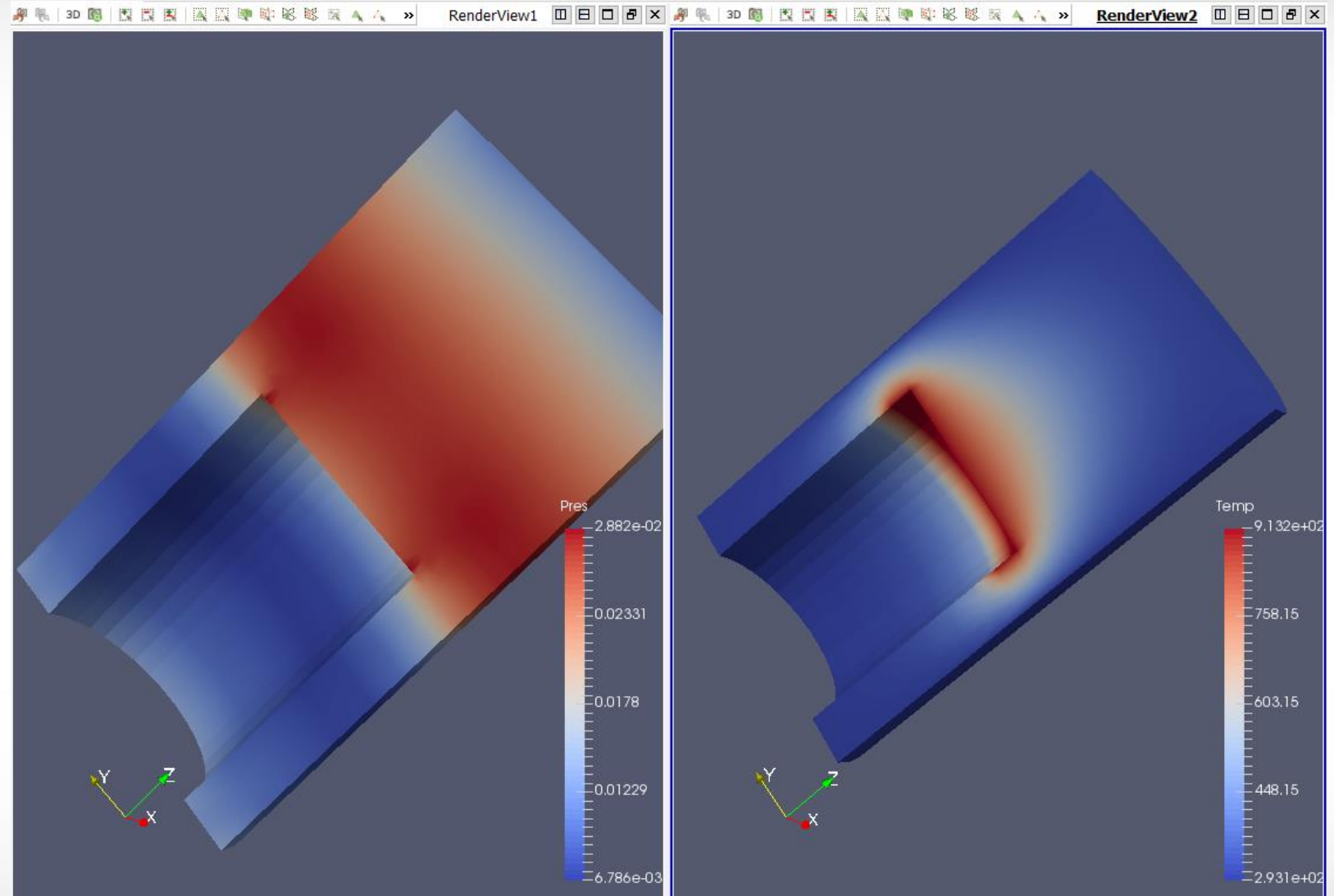
Multiview

- On top right of 'view', there are buttons for splitting, resizing, and deleting views.



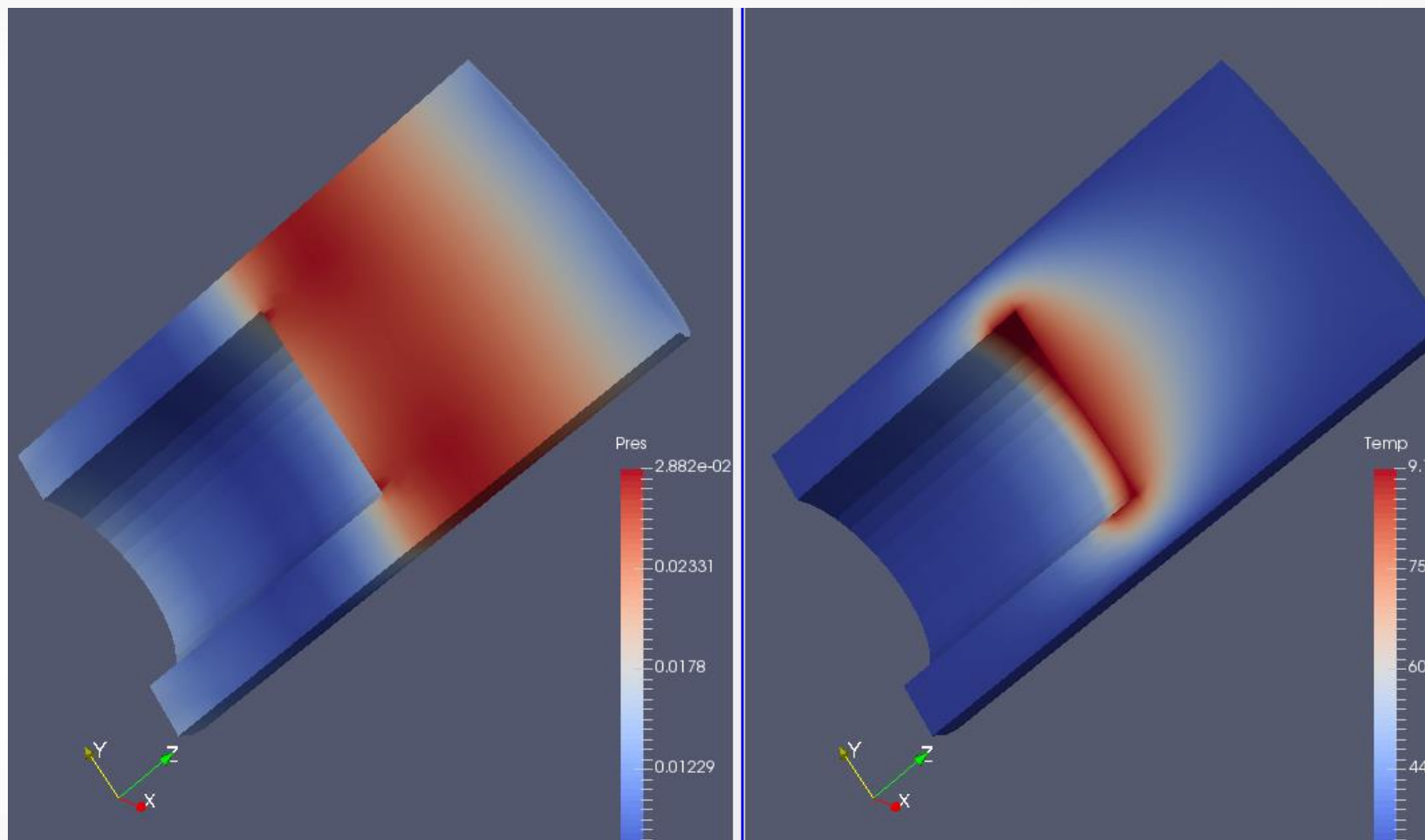
Using Multiview

- Edit -> Reset Session
- File -> Recent File -> disk_out_ref.ex2
- Clip -> color by Pres
- Split Vertically
- Click the right view
- Clip -> color by Temp



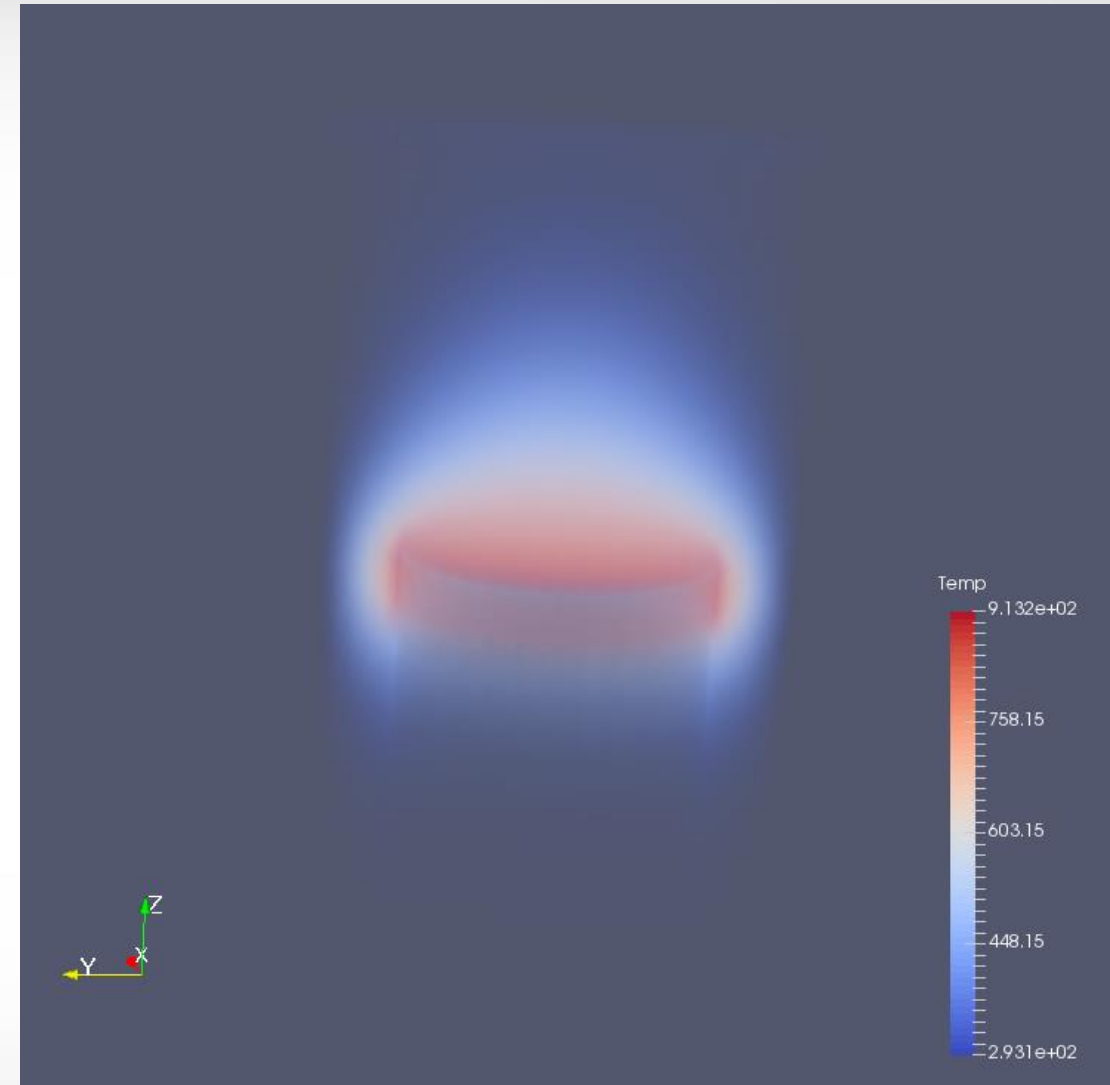
Linking Camera

- Right click one view
- Select “Linking Camera”
- Click the other view
- The two views are now using the same camera – rotating one view causes the other view to rotate in the same direction. Very convenient for viewing the value of different variables at the same location.



Volume Rendering

- A solid mesh is rendered as a translucent cloud, with the scalar field determining the color and density at every point in the cloud.
- The benefit is to see features all the way through a volume
- Filters -> Data Analysis -> Histogram -> Apply



Exercise 1

- Do volume rendering in Multiview with temperature and pressure respectively.

Exercise 2

- Start with a new session.
- Add a streamline augmented with tube and glyph to the volume rendering with temperature.
- Change the transfer function to “Black-Body Radiation”.

Further Reading

- ParaView tutorial

https://www.paraview.org/Wiki/The_ParaView_Tutorial

- ParaView user guide

<https://www.paraview.org/paraview-guide/>

- Sandia National Lab ParaView tutorials

https://www.paraview.org/Wiki/SNL_ParaView_4_Tutorials