13th Summer School on SCIENTIFIC VISUALIZATION

Introduction to Paraview GUI

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OUTLINE

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- What is Paraview
- The GUI
- Sources
- Loading Data
- Text annotation
- Views management
- Save figures

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- Vectors visualization
- Streamlines
- Plotting over line
- Select data
- Create a custom filter
- Animations
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What is Paraview

ParaView is an open-source, multi-platform application designed to visualize data sets of varying sizes from small to very large. The goals of the ParaView project include developing an open-source, multi-platform visualization application that supports distributed computational models to process large data sets. It has an open, flexible, and intuitive user interface

(ref http://www.itk.org/Wiki/ParaView)

To date, ParaView has been demonstrated to process billions of unstructured cells and to process over a trillion structured cells. ParaView's parallel framework has run on over 100,000 processing cores.

ParaView's key features are:

- An open-source, scalable, multi-platform visualization application.
- Support for distributed computation models to process large data sets.
- An open, extensible, and intuitive user interface.
- An extensible, modular architecture based on open standards.
- A flexible BSD 3-clause license.
- Commercial maintenance and support.

PARAVIEW: a standard de-facto

ParaView is used by many academic, government, and commercial institutions all over the world.

ParaView runs on distributed and shared memory parallel as well as single processor systems and has been successfully tested on Windows, Linux, Mac OS X, IBM Blue Gene, Cray XT3 and various Unix workstations and clusters.

ParaView is downloaded roughly 100,000 times every year.

ParaView also won the HPCwire Readers' Choice Award and HPCwire Editors' Choice Award for Best HPC Visualization Product or Technology.

Obtaining Paraview & Official Resources

- **Main website:**
  http://www.paraview.org/
- **Download page:**
  http://www.paraview.org/paraview/resources/software.php
- **Resources (video):**
  http://www.paraview.org/paraview/resources/webinars.html
- **Resources (wiki):**
  http://www.paraview.org/Wiki/ParaView

The big picture

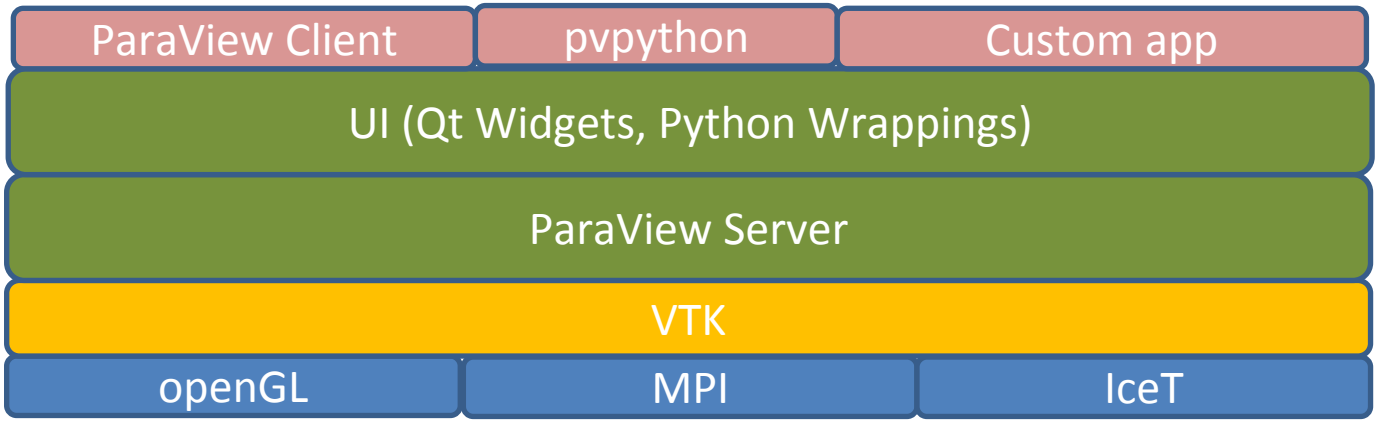
The application most people associate with ParaView is really just a small client application built on top of a tall stack of libraries that provide ParaView with its functionality.

Under the hood, ParaView uses the Visualization Toolkit as the data processing and rendering engine and has a user interface written using the Qt cross-platform application framework.

ParaView comes with a pvpython application that allows you to automate the visualization and post-processing with Python scripting.

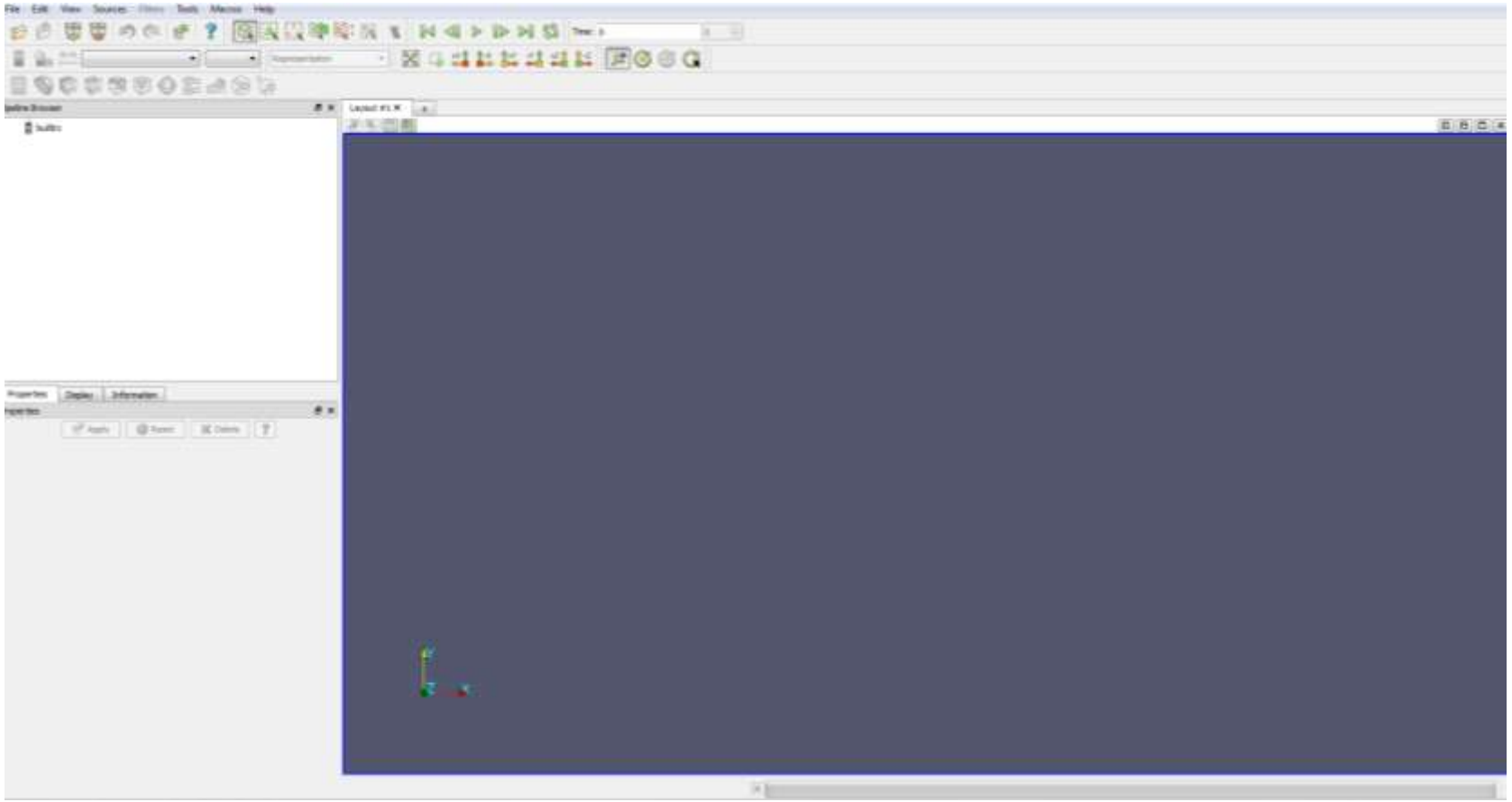
A ParaView Server library provides the abstraction layer necessary for running parallel, interactive visualization. It relieves the client application from most of the issues concerning if and how ParaView is running in parallel.

The Visualization Toolkit (VTK) provides the basic visualization and rendering algorithms.



GUI

Launch the Paraview application on your pc



GUI elements

http://www.paraview.org/Wiki/ParaView/Users_Guide/Introduction#User_Interface

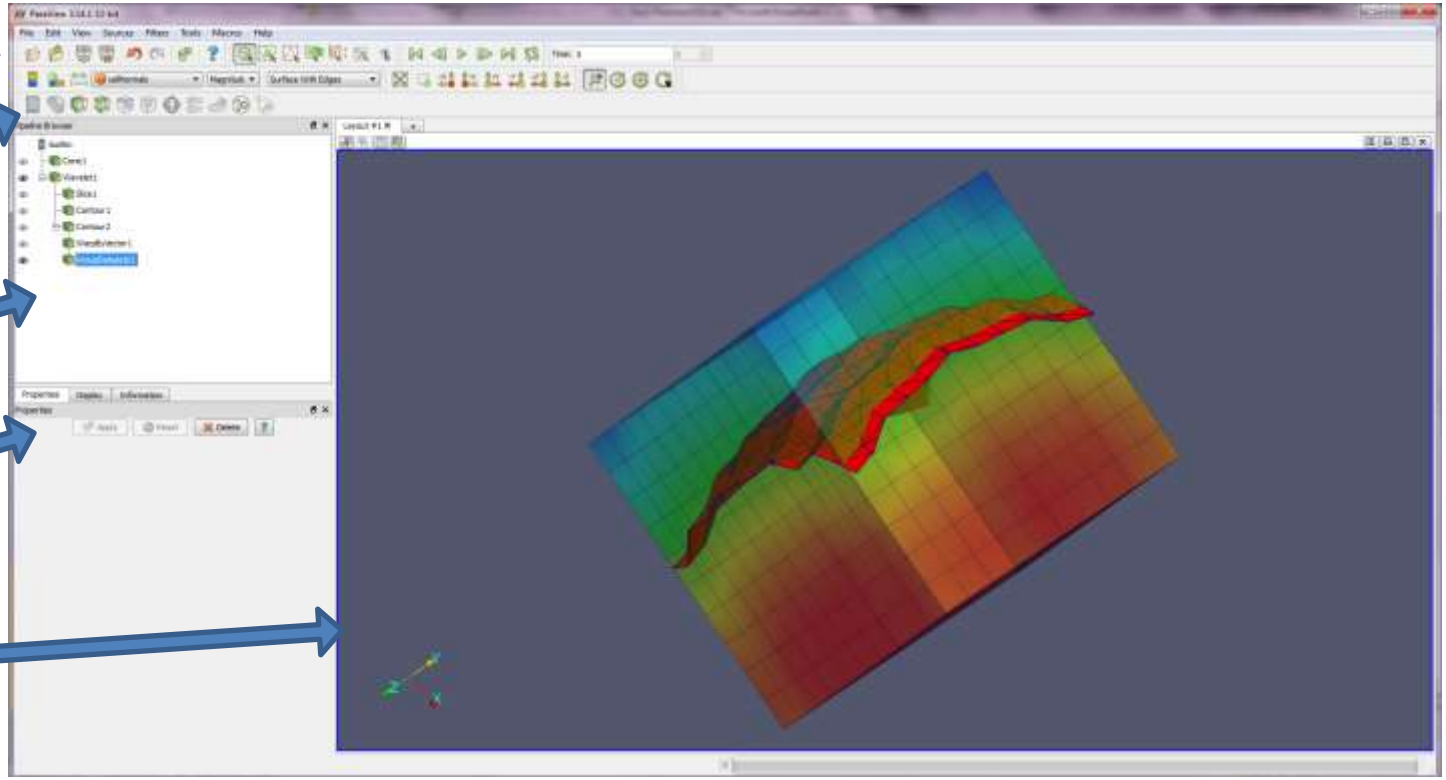
Menu Bar

Toolbars

Pipeline Browser
(we will look at this later on)

Properties Panel

3D View



One very important thing to keep in mind when using ParaView is that the GUI is very modal. At any given time you will have one "active" module within the visualization pipeline, one "active" view, and one "active" selection.

GUI elements definition

Menu Bar As with just about any other program, the menu bar allows you to access the majority of features.

Toolbars The toolbars provide quick access to the most commonly used features within ParaView.

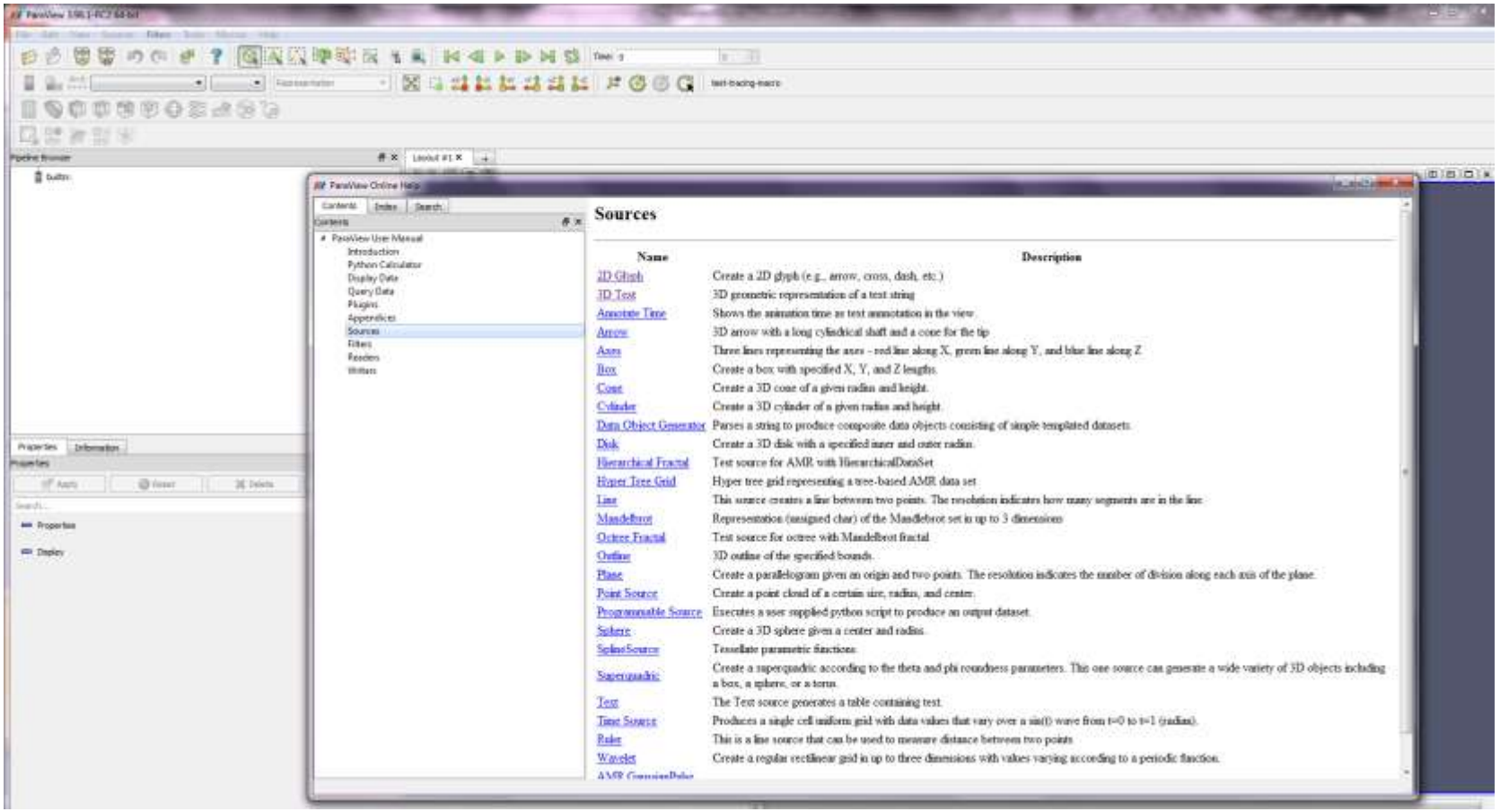
Pipeline Browser ParaView manages the reading and ltering of data with a pipeline. The pipeline browser allows you to view the pipeline structure and select pipeline objects. The pipeline browser provides a convenient list of pipeline objects with an indentation style that shows the pipeline structure. #The_Pipeline_Concept

Properties Panel The properties panel allows you to view and change the parameters of the current pipeline object. The properties are by default coupled with an Information tab that shows a basic summary of the data produced by the pipeline object.

3D View The remainder of the GUI is used to present data so that you

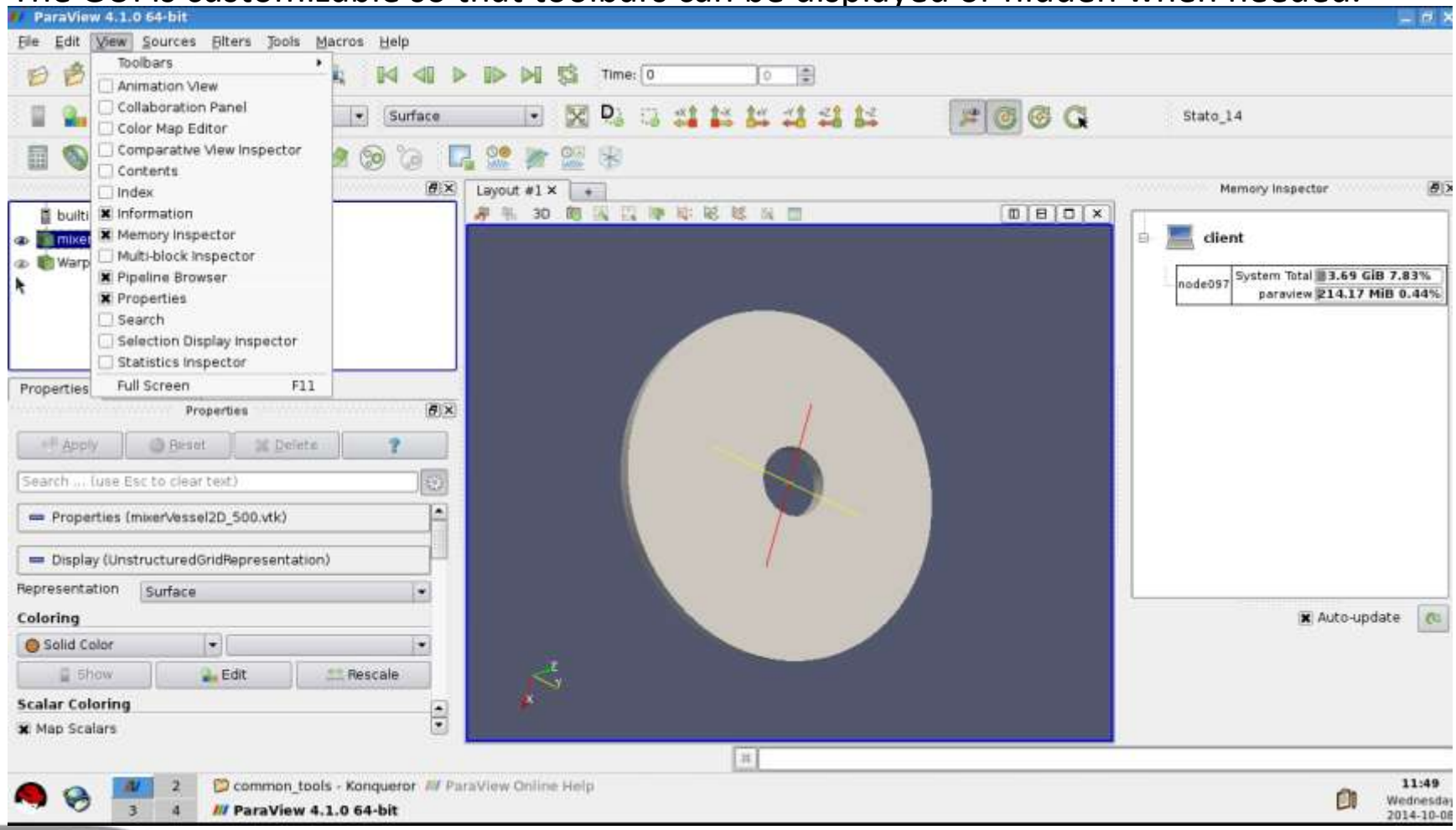
may view, interact with, and explore your data. This area is initially populated with a 3D view that will provide a geometric representation of the data.

/Menu-bar/help (!)



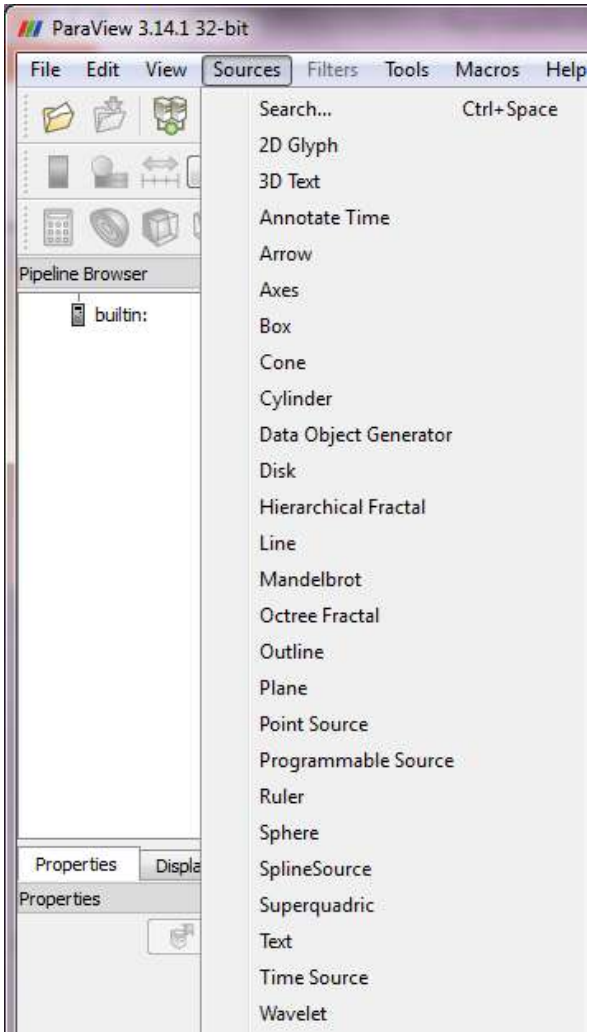
Personalize your GUI

The GUI is customizable so that toolbars can be displayed or hidden when needed.



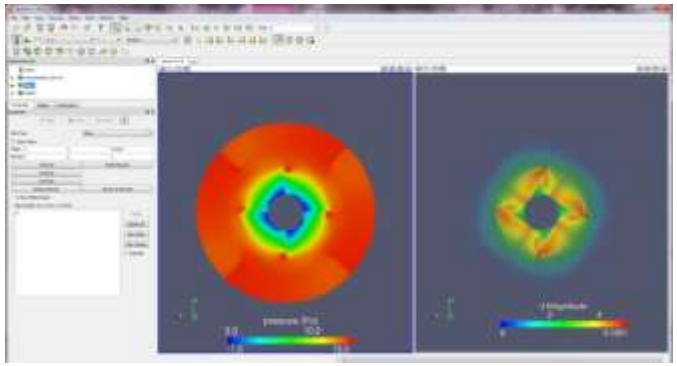
Sources

Data can be uploaded into ParaView 3D scene using VTK source objects or loading files (readers).

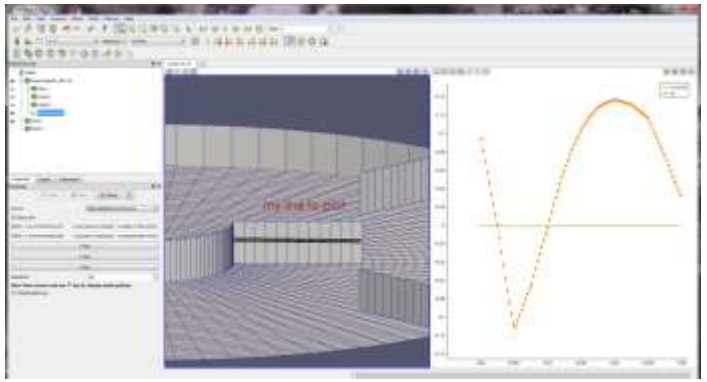


Multiple views

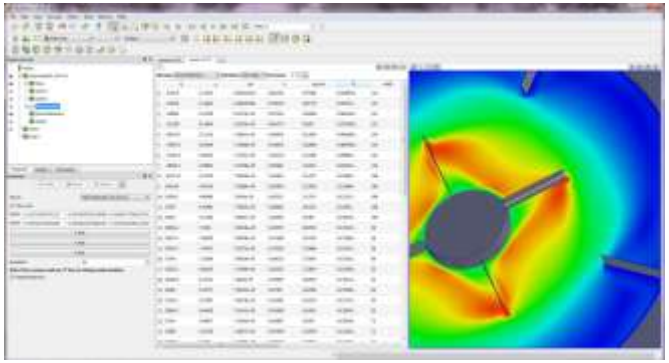
- 3d + 3d



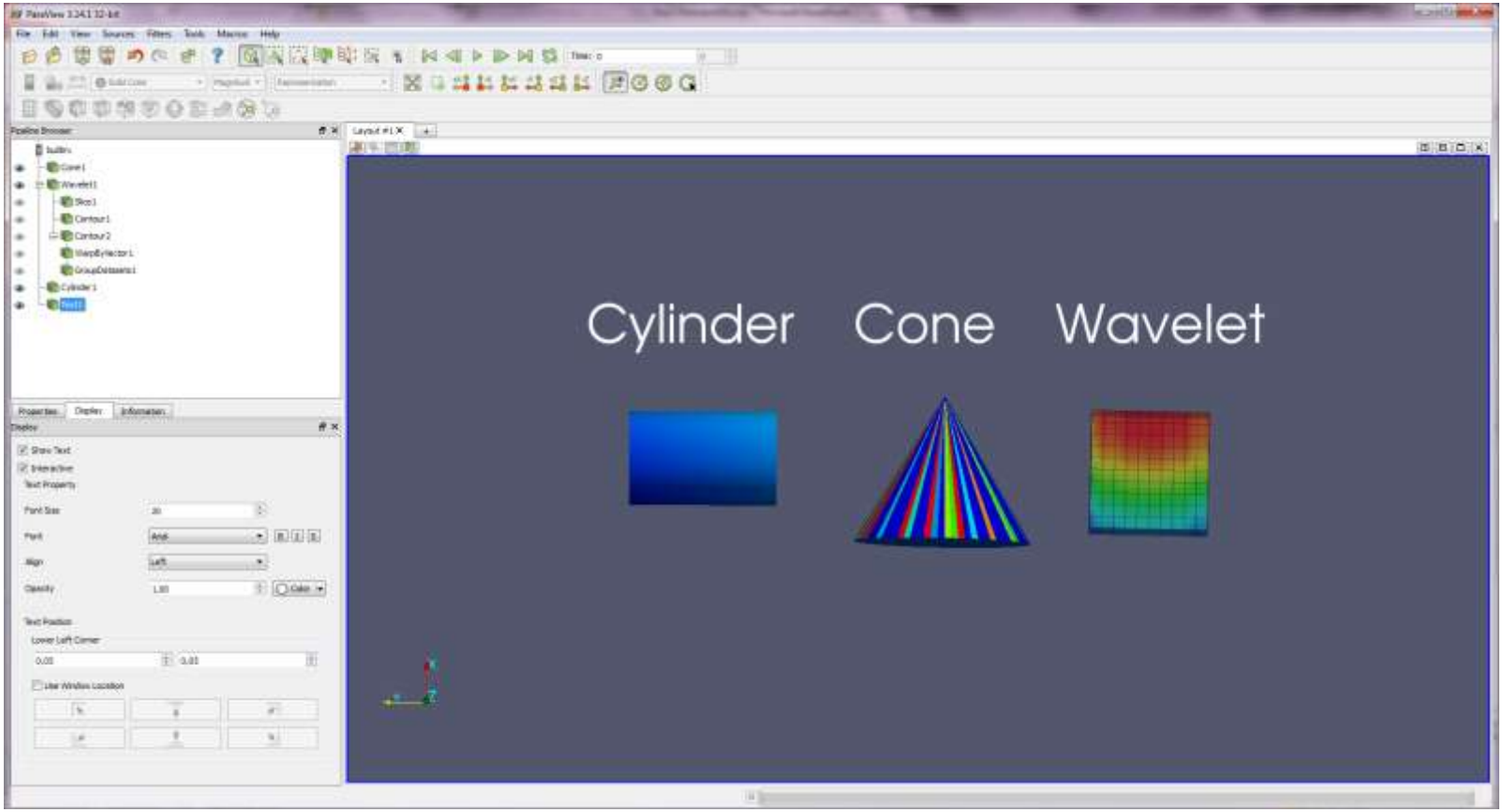
- 3d + 2d



- 3d + table



Sources



3D objects manipulations

Test the usage of your mouse buttons:

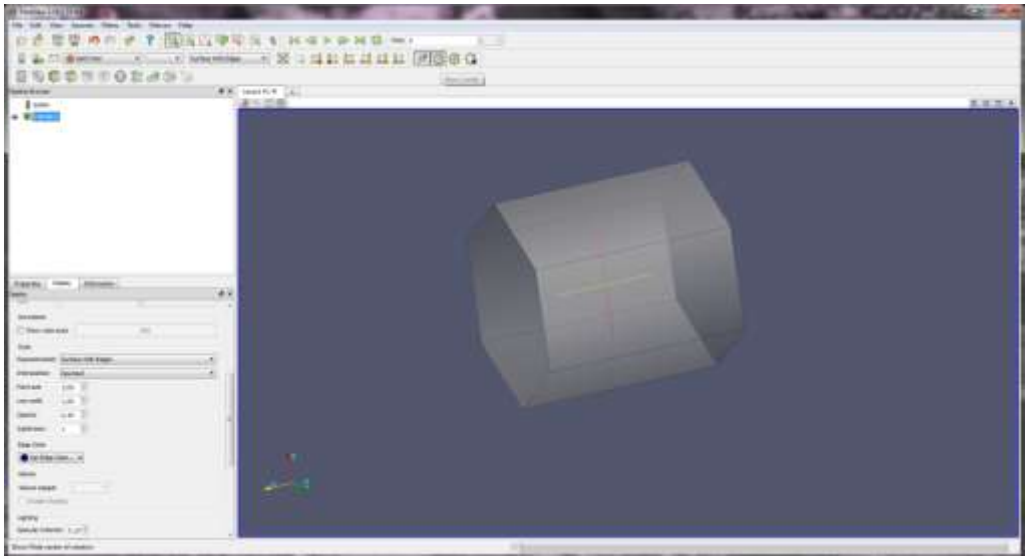
- **Left button:** rotation
- **Right button:** panning
- **Middle button:** zooming

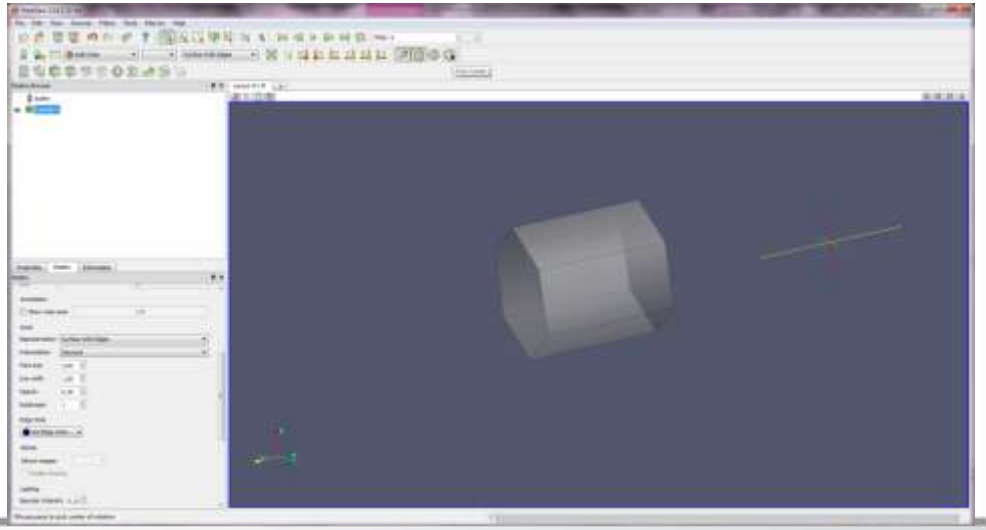
Camera control basics

Set camera location
Set zoom

Set view on/off for axis and center of rotation

Change center of rotation





Apply/Reset Undo/Redo

Apply: click on the apply button to 'sync' your data state.(Automatic apply of changes button), ParaView was designed to operate on large datasets, for which any given operation could take a long time to finish. In this situation you need the Apply button so that you have a chance to be confident of your change before it takes effect. The highlighted Apply button is a reminder that the parameters of one or more filters are out of sync with the data that you are viewing.

Making_Mistakes

Reset: click this button to restore the default configuration state.

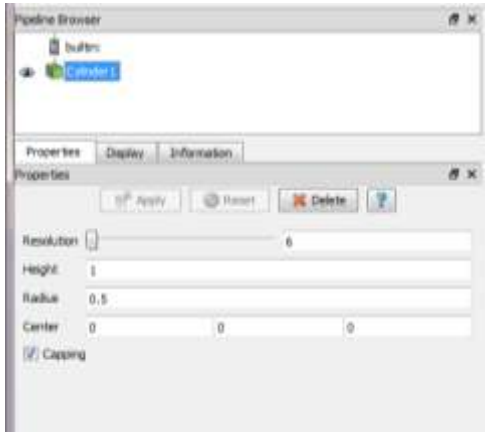
Undo: go back to the previous state

Redo: return to the state you changed back

Camera Undo: same as above but for camera views changes

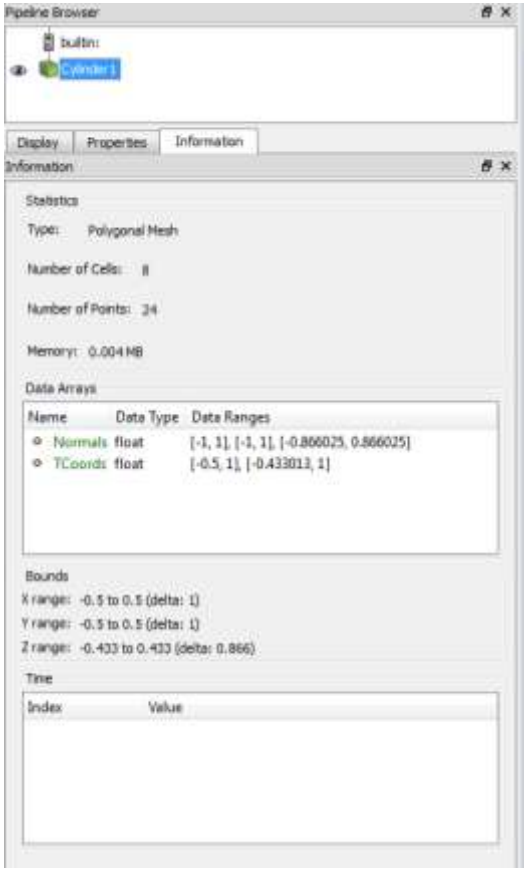
Camera Redo: same as above but for camera views changes

Main objects menu



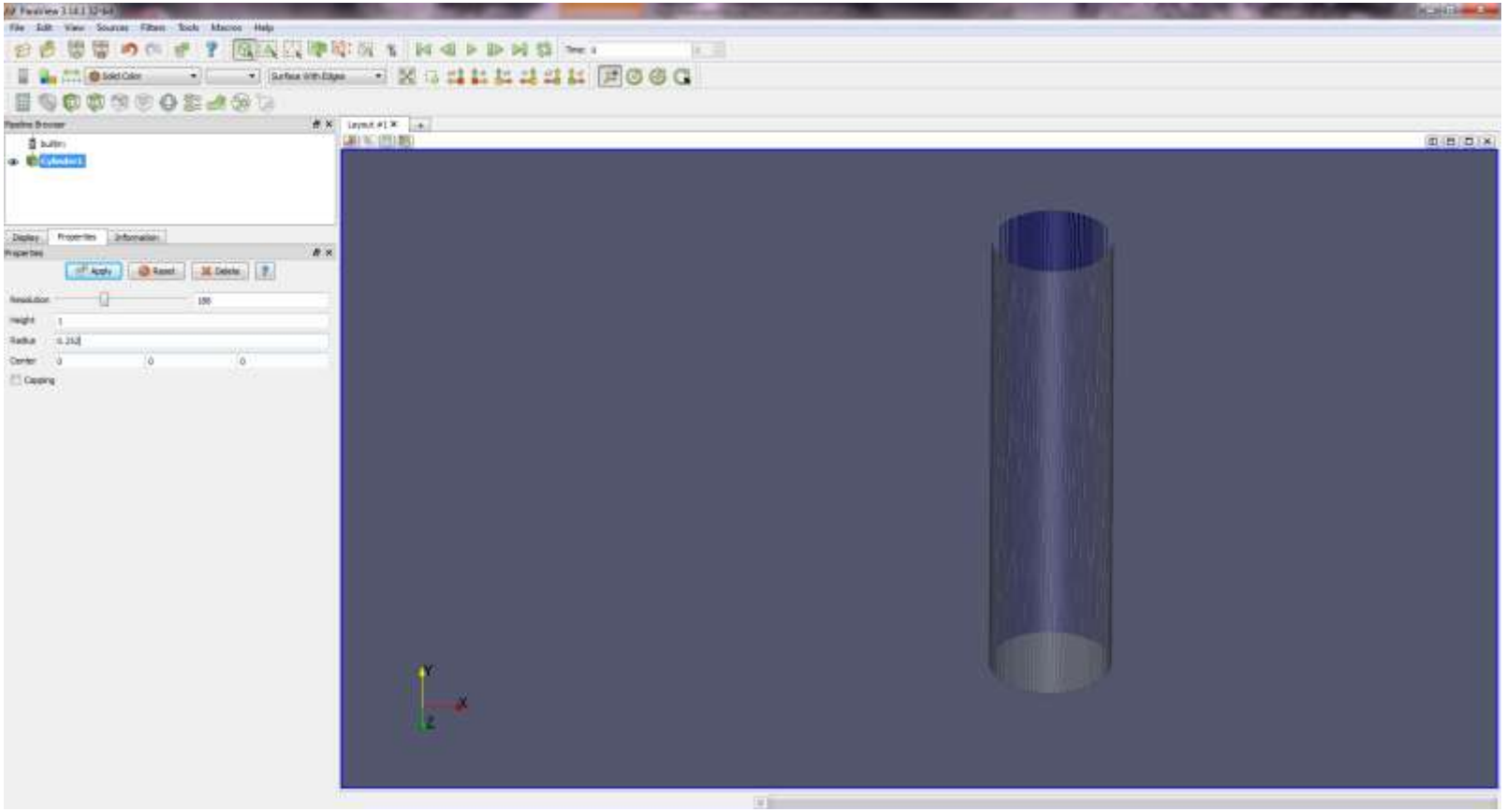
Properties

Display



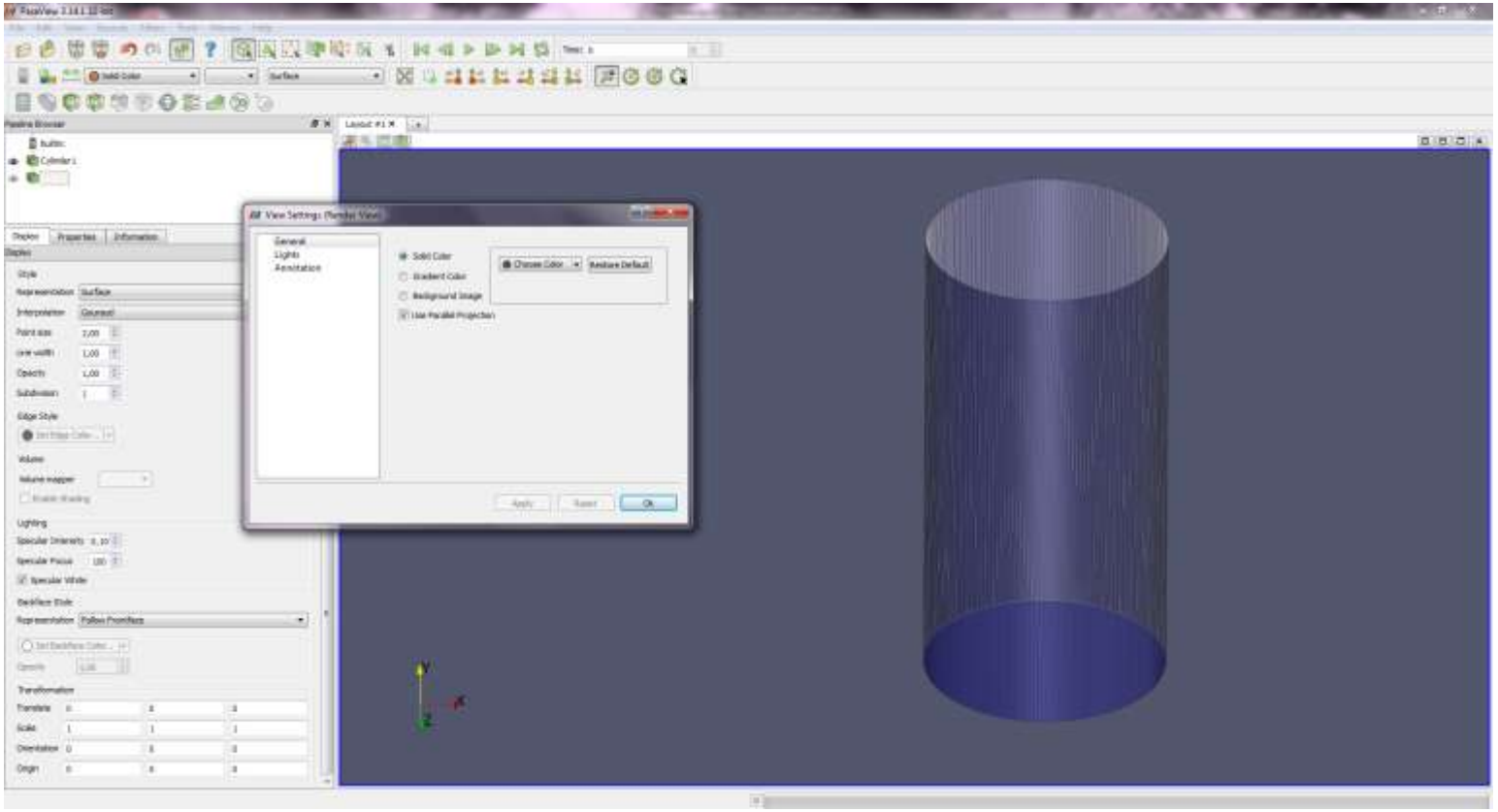
Informations

Change object properties

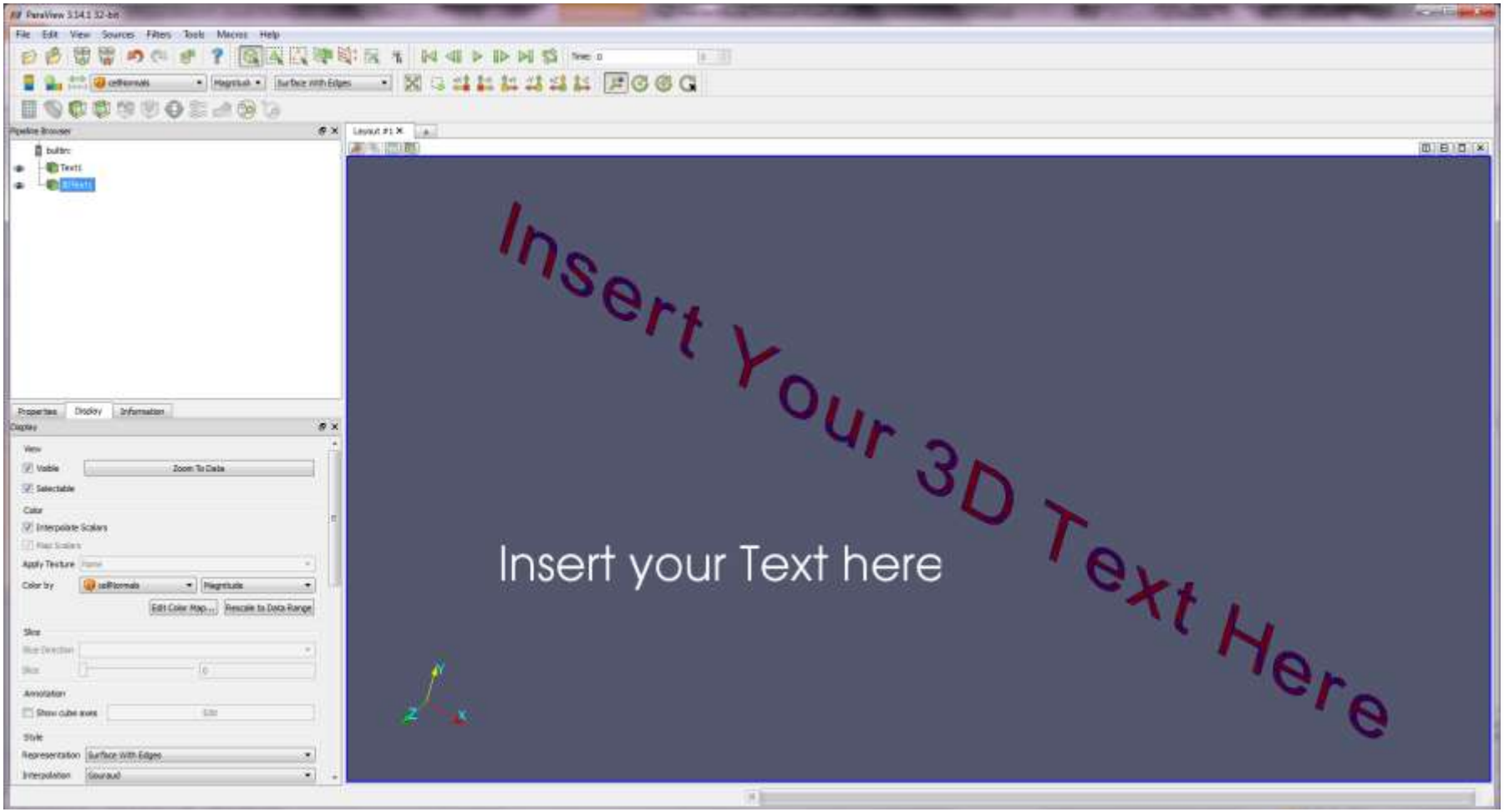


Display

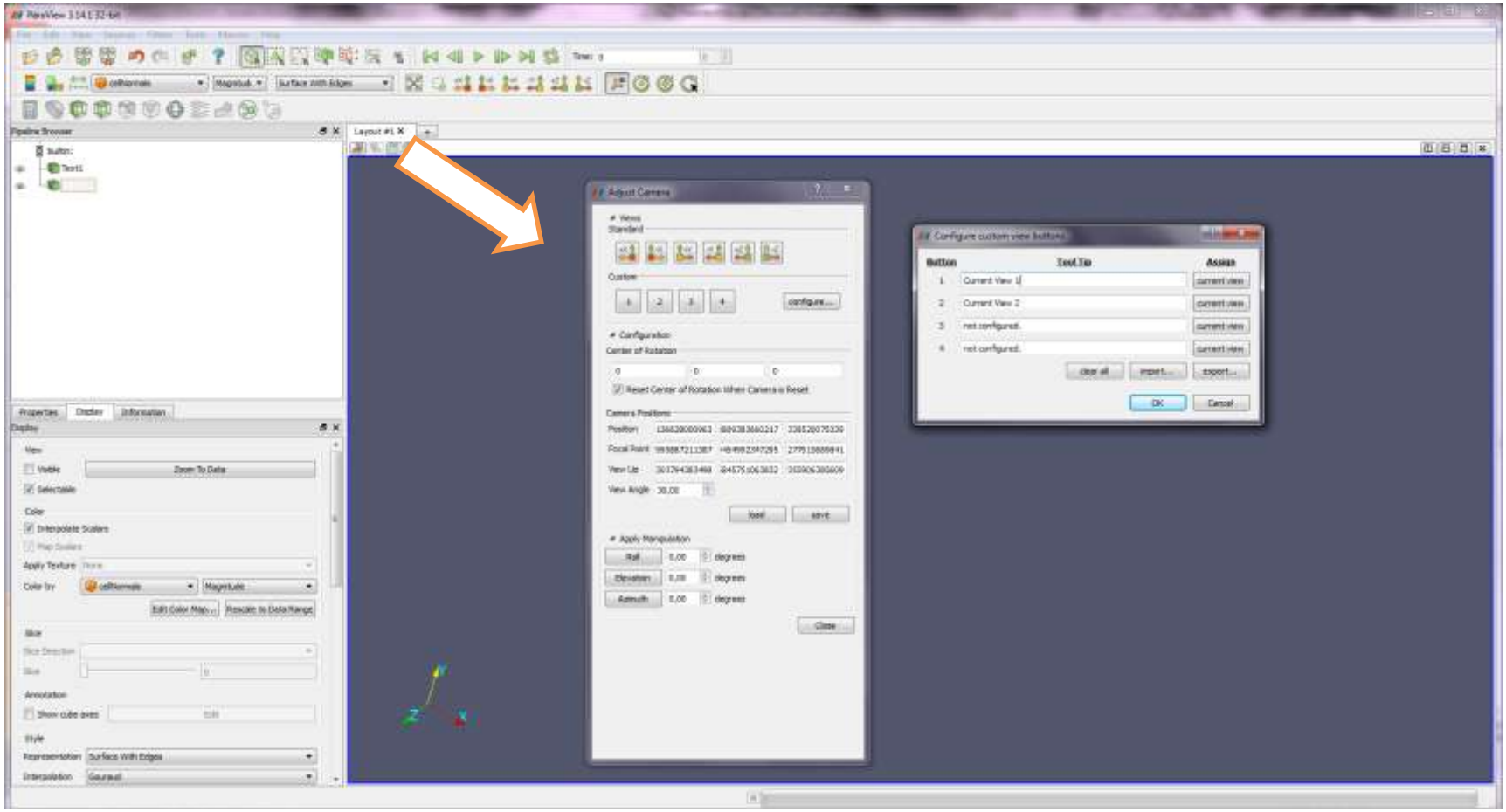
Play with different display options for this object.



Text annotation

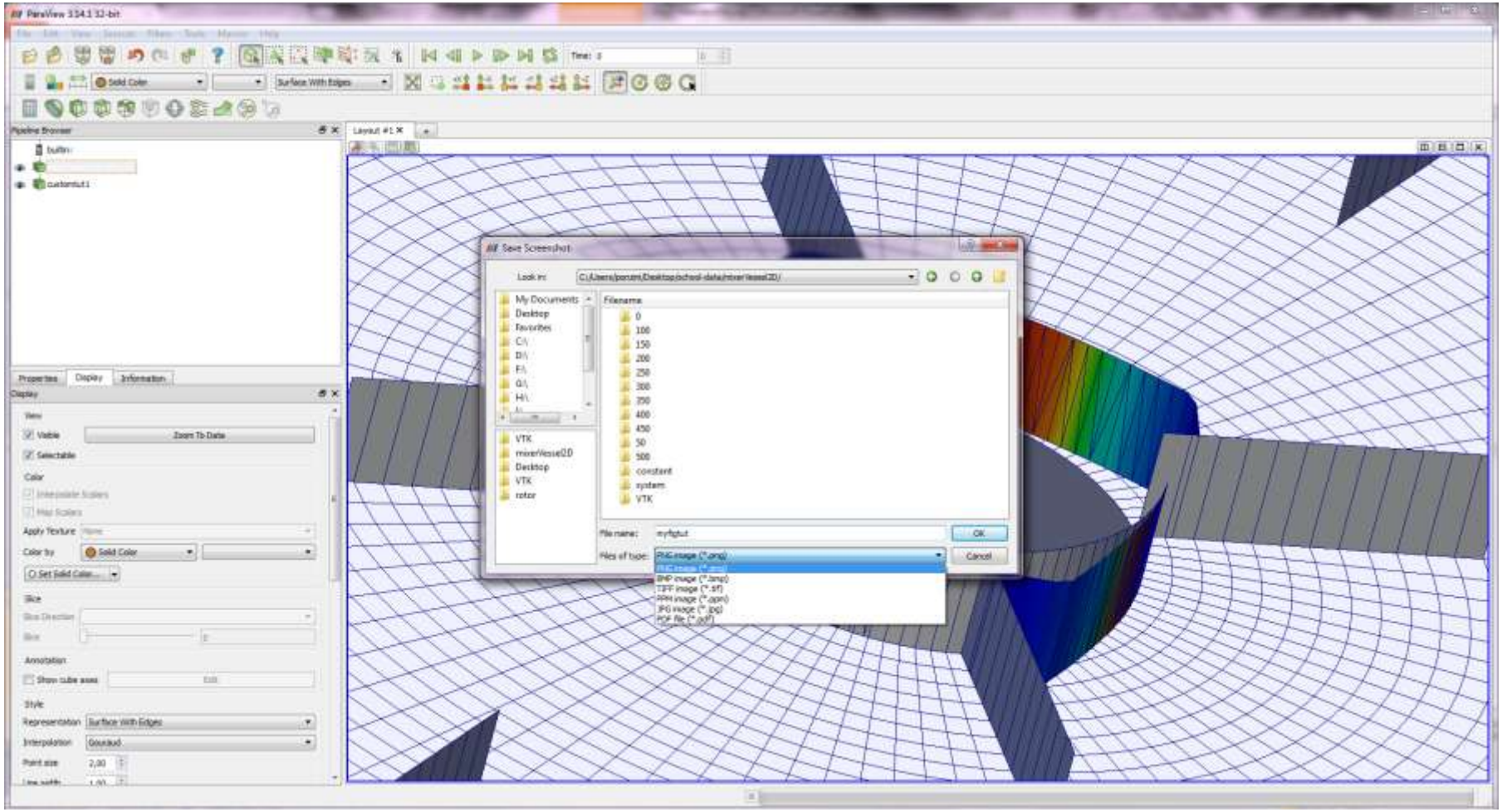


Views Management



Save figure

http://www.paraview.org/Wiki/ParaView/Users_Guide/Saving_Data



Loading data

http://www.paraview.org/Wiki/ParaView/Users_Guide/Loading_Data

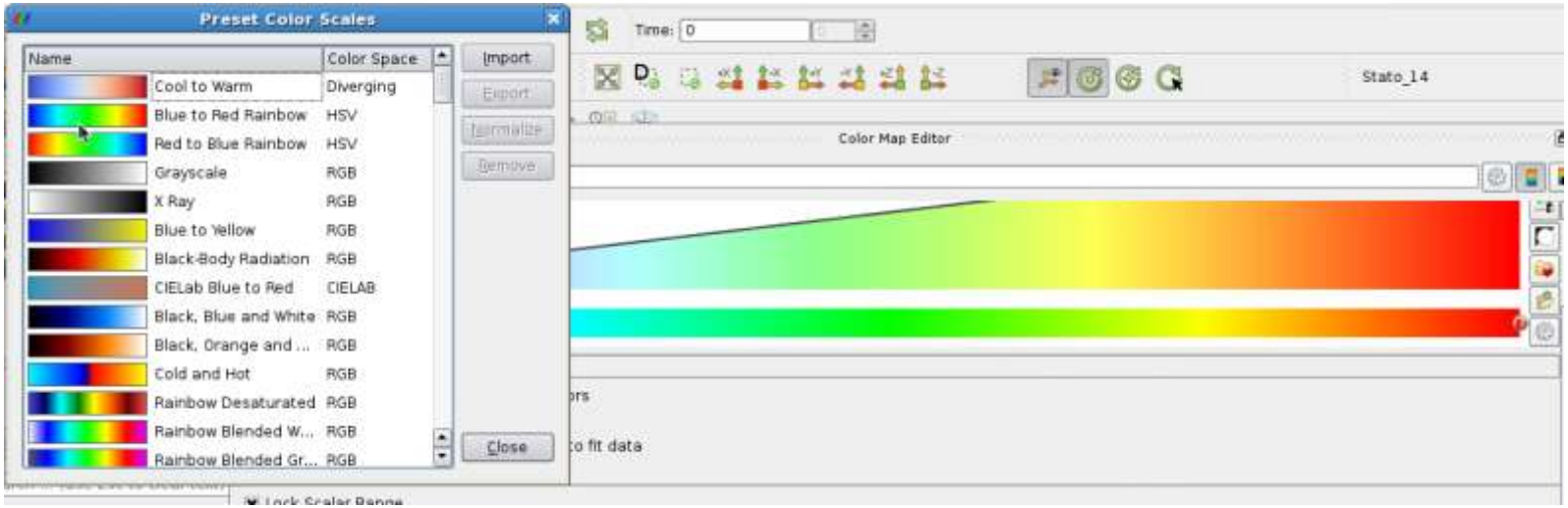
- ParaView Data (.pvd)
- VTK (.vtp, .vtu, .vti, .vts, .vtr)
- VTK Legacy (.vtk)
- VTK Multi Block (.vtm, .vtmb,.vtmg, .vthd, .vthb)
- Partitioned VTK (.pvtu, .pvti, .pvts, .pvtr)
- ADAPT (.nc, .cdf, .elev, .ncd)
- ANALYZE (.img, .hdr)
- ANSYS (.inp)
- AVS UCD (.inp)
- BOV (.bov)
- BYU (.g)
- CAM NetCDF (.nc, .ncdf)
- CCSM MTSD (.nc, .cdf, .elev, .ncd)
- CCSM STSD (.nc, .cdf, .elev, .ncd)
- CEAucd (.ucd, .inp)
- CMAT (.cmat)
- CML (.cml)
- CTRL (.ctrl)
- Chombo (.hdf5, .h5)
- Claw (.claw)
- Comma Separated Values (.csv)
- Cosmology Files (.cosmo, .gad-get2)
- Curve2D (.curve, .ultra, .ult,.u)
- DDCMD (.ddcmd)
- Digital Elevation Map (.dem)
- Dyna3D(.dyn)
- EnSight (.case, .sos)
- Enzo boundary and hierarchy
- ExodusII (.g, .e, .exe, .ex2,.ex2v.., etc)
- ExtrudedVol (.exvol)
- FVCOM (MTMD, MTSD, Particle, STSD)
- Facet Polygonal Data
- Flash multiblock les
- Fluent Case Files (.cas)
- GGCM (.3df, .mer)
- GTC (.h5)
- GULP (.trg)
- Gadget (.gadget)
- Gaussian Cube File (.cube)
- JPEG Image (.jpg, .jpeg)
- LAMPPS Dump (.dump)
- LAMPPS Structure Files
- LODI (.nc, .cdf, .elev, .ncd)
- LODI Particle (.nc, .cdf, .elev,.ncd)
- LS-DYNA (.k, .lsdyna, .d3plot,d3plot)
- M3DCl (.h5)
- MFIX Unstructred Grid (.RES)
- MM5 (.mm5)
- MPAS NetCDF (.nc, .ncdf)
- Meta Image (.mhd, .mha)
- Miranda (.mir, .raw)
- Multilevel 3d Plasma (.m3d,.h5)
- SAMRAI (.samrai)
- SAR (.SAR, .sar)
- SAS (.sasgeom, .sas, .sasdata)
- SESAME Tables
- SLAC netCDF mesh and mode data
- SLAC netCDF particle data
- Silo (.silo, .pdb)
- Spheral (.spheral, .sv)
- SpyPlot CTH
- SpyPlot Case (.case)
- SpyPlot History (.hscth)
- Stereo Lithography (.stl)
- TFT Files
- TIFF Image Files
- TSurf Files
- Tecplot ASCII (.tec, .tp)
- Tecplot Binary (.plt)
- Tetrad (.hdf5, .h5)
- UNIC (.h5)
- VASP CHGCA (.CHG)
- VASP OUT (.OUT)
- VASP POSTCAR (.POS)
- VPIC (.vpc)
- VRML (.wrl)
- Velodyne (.vld, .rst)
- VizSchema (.h5, .vsh5)
- Wavefront Polygonal Data (.obj)
- WindBlade (.wind)
- XDMF and hdf5 (.xmf, .xdmf)
- XMol Molecule
- NASTRAN (.nas, .f06)
- Nek5000 Files
- Nrrd Raw Image (.nrrd, .nhdr)
- OpenFOAM Files (.foam)
- PATRAN (.neu)
- PFLOTRAN (.h5)
- PLOT2D (.p2d)
- PLOT3D (.xyz, .q, .x, .vp3d)
- PLY Polygonal File Format
- PNG Image Files
- POP Ocean Files
- ParaDIS Files
- Phasta Files (.pht)
- Pixie Files (.h5)
- ProSTAR (.cel, .vrt)
- Protein Data Bank (.pdb, .ent,.pdb)
- Raw Image Files
- Raw NRRD image les (.nrrd)

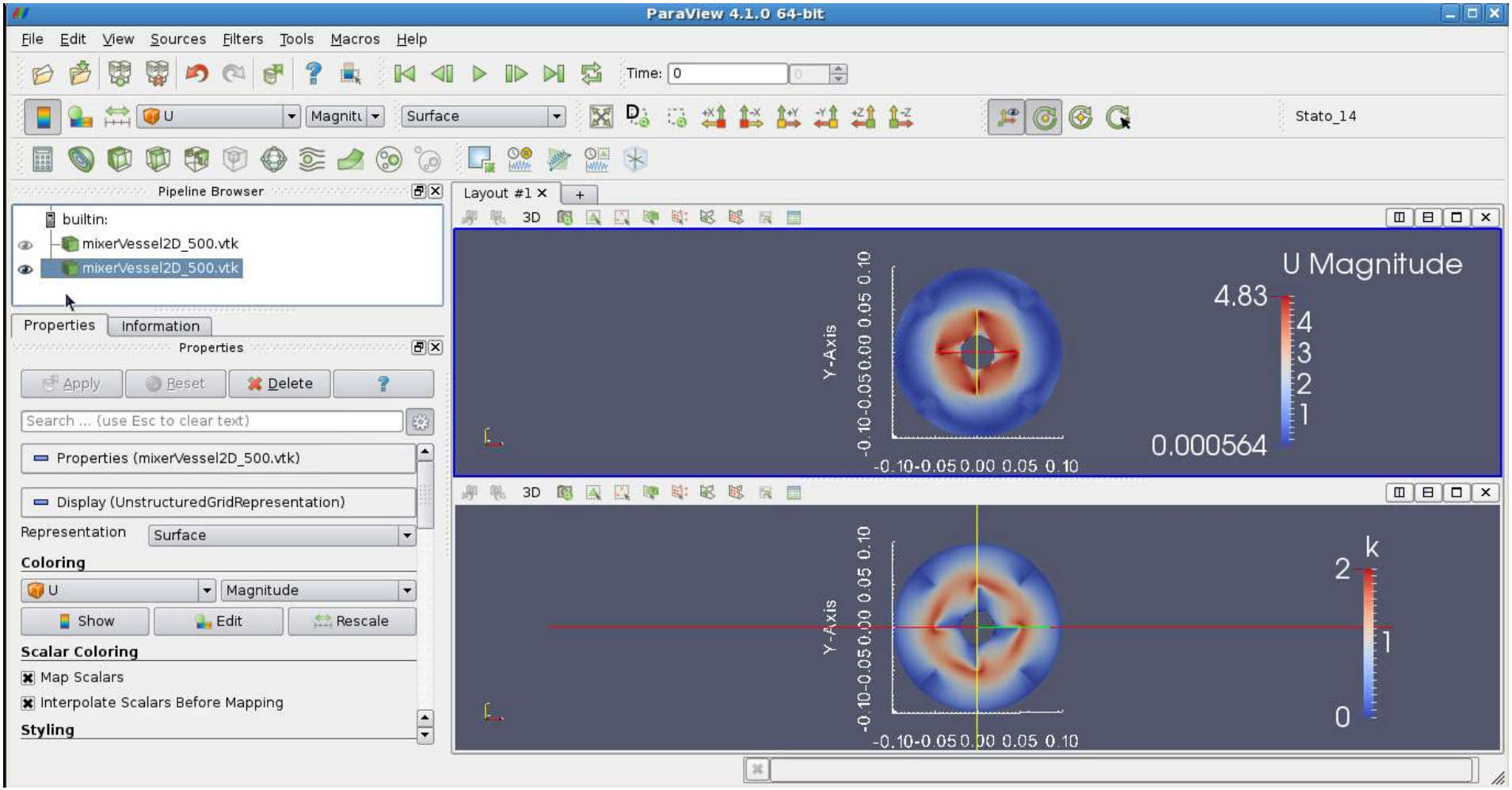
Loading your data (no filtering)

- Load the data file provided for the school. (mixerVessel2D_500.vtk)
- Inspect available variables and ranges.
- Adjust view and display settings as learned above.
- Adjust representation and coloring
- Adjust text and legend

U + k field

- Select surface view + U magnitude
- Scale the data range
- Show label and colorbar
- Add a text to your scene and manage
- Change legend dimensions, format, position and range
- Save an image
- Redo the same for k value
- Choose your preset color scale (Blue to Red Rainbow in the example)




ParaView 4.1.0 64-bit
File Edit View Sources Filters Tools Macros Help
Time: 0
U
Magnitu
Surface
Stato_14
Pipeline Browser
builtin:
mixerVessel2D_500.vtk
mixerVessel2D_500.vtk
Properties
Information
Properties
Apply
Reset
Delete
Search ... (use Esc to clear text)
Properties (mixerVessel2D_500.vtk)
Display (UnstructuredGridRepresentation)
Representation
Surface
Coloring
U
Magnitude
Show
Edit
Rescale
Scalar Coloring
Map Scalars
Interpolate Scalars Before Mapping
Styling
Layout #1
3D
Y-Axis
-0.10 -0.05 0.00 0.05 0.10
U Magnitude
4.83
4
3
2
1
0.000564
3D
Y-Axis
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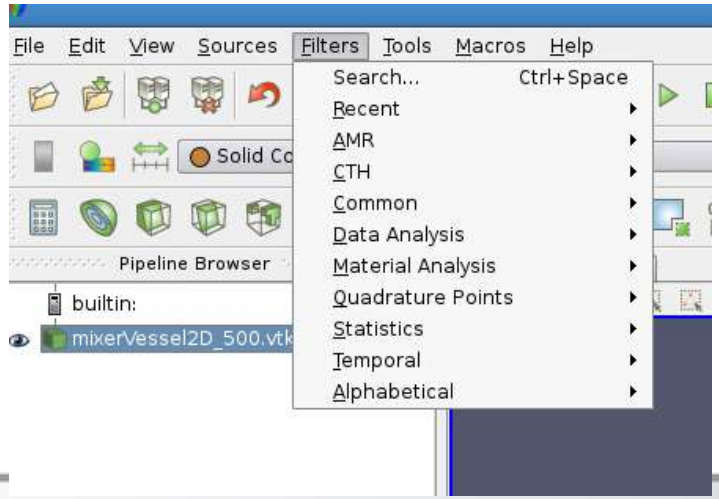
END OF PART A

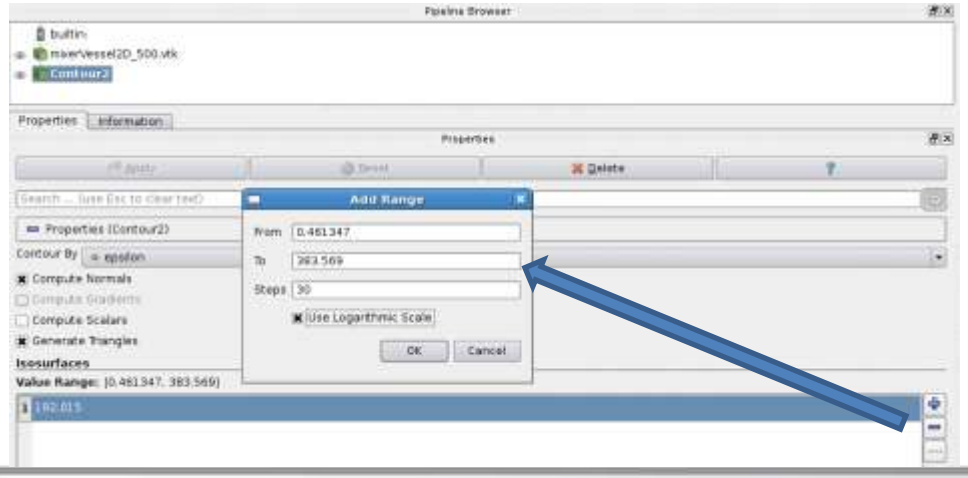
Filtering in Paraview / Manipulating Data

- It is often necessary to process the raw data in various ways. Examples include slicing into the data to make the interior visible, extracting regions that have particular qualities, and computing statistical measurements from the data.
- All of these operations involving taking in some original data and using it to compute some derived quantities.
- A **filter** is the basic tool that you use to manipulate data
- If data is a noun, then a filter is the verb that operates on the data. Filters operate by ingesting some data, processing it and producing some other data.
- ParaView creates **filters** when you open data files and instantiate new filters form the Filters menu.
- The set of filters you create becomes your visualization pipeline, and that pipeline is shown in ParaView's Pipeline Browser.



Filtering parameters and properties

- Each time a dataset is opened from a file, a source is selected, a filter is applied, or an existing reader, source, or filter is selected in the Pipeline Browser
- ParaView updates the Object Inspector for the corresponding output dataset
- From **the Properties** tab you modify the parameters of the filter, fine tuning what it produces from its input (if any)
- The specific controls and information provided on the tab then are specific to the particular vtkAlgorithm you are working with, but all filters have at least the Apply, Reset, Delete and ? (help) controls.
- The help button brings up the documentation for the filter in ParaView's help system in which the input restrictions to the filter, output type generated by the filter, and descriptions of each parameter are listed.
- The Delete button removes this filter from the pipeline. The delete button is only enabled when there are no filters further down the pipeline that depend on this filter's output.
- Managing the Pipeline



List of common filters

Calculator Evaluates a user-defined expression on a per-point or per-cell basis.

Contour Extracts the points, curves, or surfaces where a scalar field is equal to a user-defined value. This surface is often also called an iso-surface.

Clip Intersects the geometry with a half space. The effect is to remove all the geometry on one side of a user-defined plane.

Slice Intersects the geometry with a plane. The effect is similar to clipping except that all that remains is the geometry where the plane is located.

Threshold Extracts cells that lie within a specified range of a scalar-field.

Extract Subset Extracts a subset of a grid by defining either a volume of interest or a sampling rate.

Glyph Places a glyph, a simple shape, on each point in a mesh. The glyphs may be oriented by a vector and scaled by a vector or scalar.

Stream Tracer Seeds a vector field with points and then traces those seed points through the (steady state) vector field.

Warp (vector) Displaces each point in a mesh by a given vector field.

Group Datasets Combines the output of several pipeline objects into a single multi-block data set.

Extract Level Extract one or more items from a multi block data set.

Other Filters

Recent The list of most recently used filters sorted with the most recently used filters on top.

AMR A set of filters designed specifically for data in an adaptive mesh refinement (AMR) structure.

CTH Filters used to process results from a CTH simulation.

Common The most common filters. This is the same list of filters available in the filters toolbar and listed previously.

Cosmology This contains filters developed at LANL for cosmology research.

Data Analysis The filters designed to retrieve quantitative values from the data. These filters compute data on the mesh, extract elements from the mesh, or plot data.

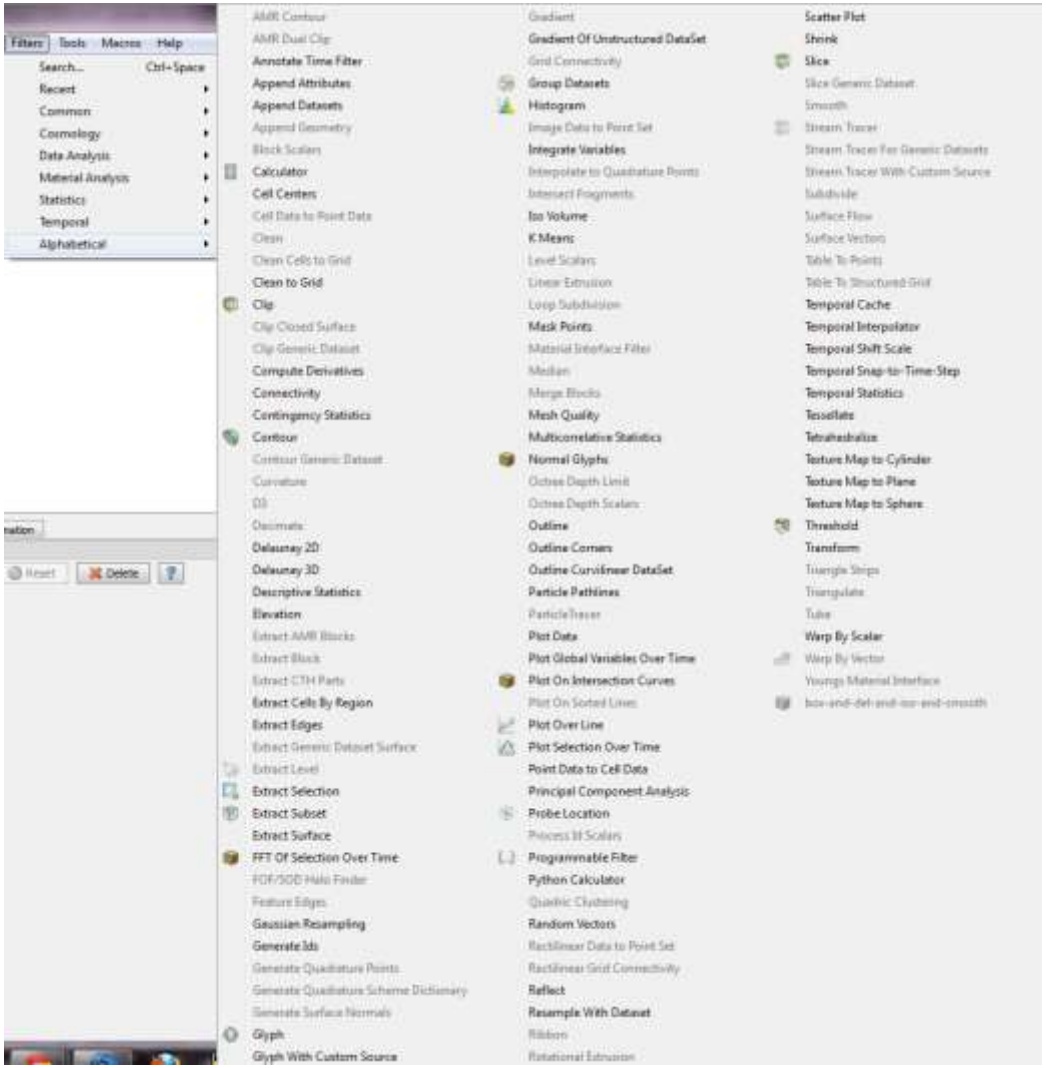
Material Analysis Filters for processing data from volume fractions of materials.

Statistics This contains filters that provide descriptive statistics of data, primarily in tabular form.

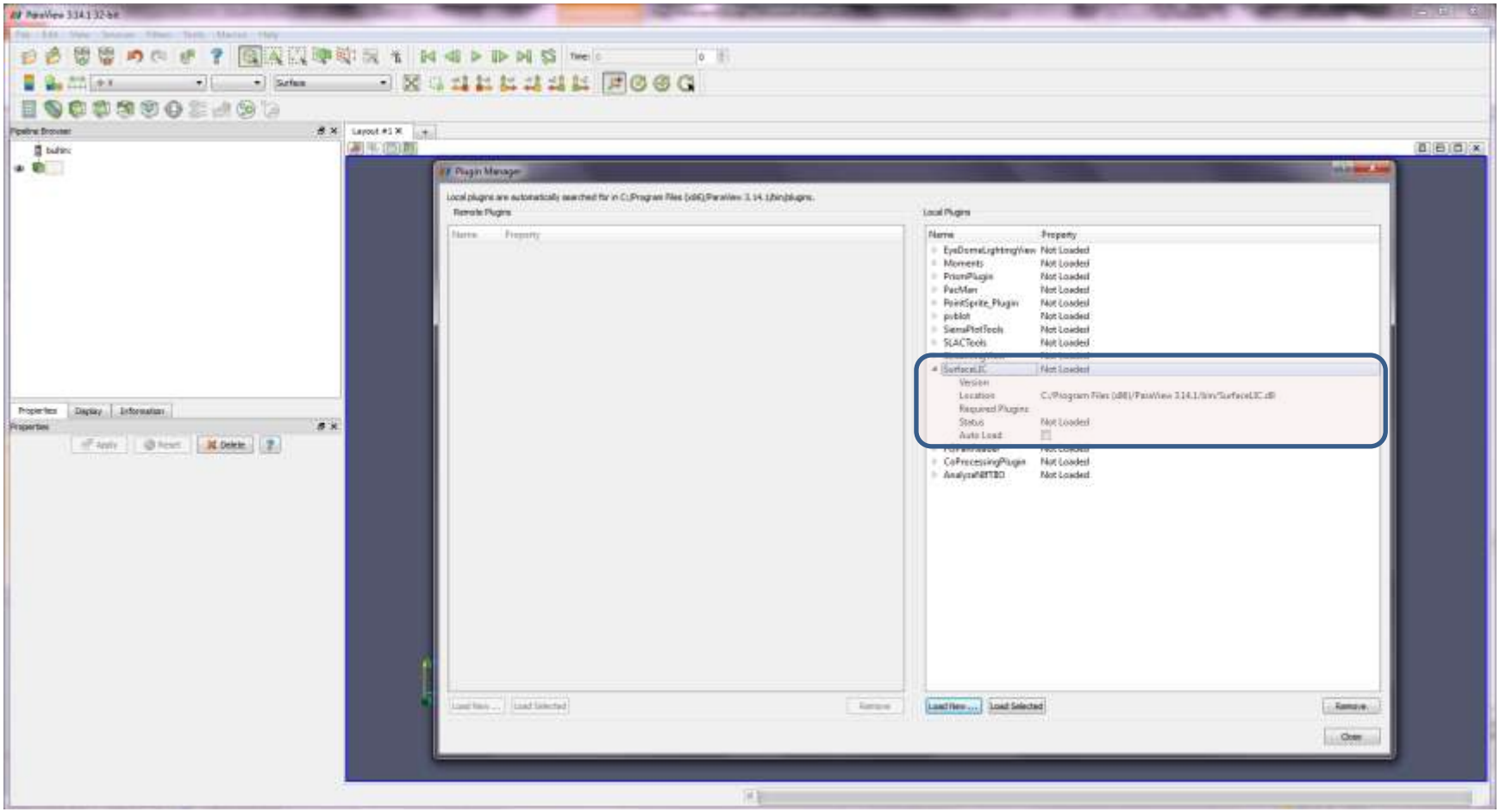
Temporal Filters that analyze or modify data that changes over time. All filters can work on data that changes over time because they are executed on each time snapshot. However, filters in this category will introspect the available time extents and examine how data changes over time.

Alphabetical An alphabetical listing of all the filters available. If you are not sure where to find a particular filter, this list is guaranteed to have it. There are also many filters that are not listed anywhere but in this list.

Other Filters



Other customized filters



Working with filters over data

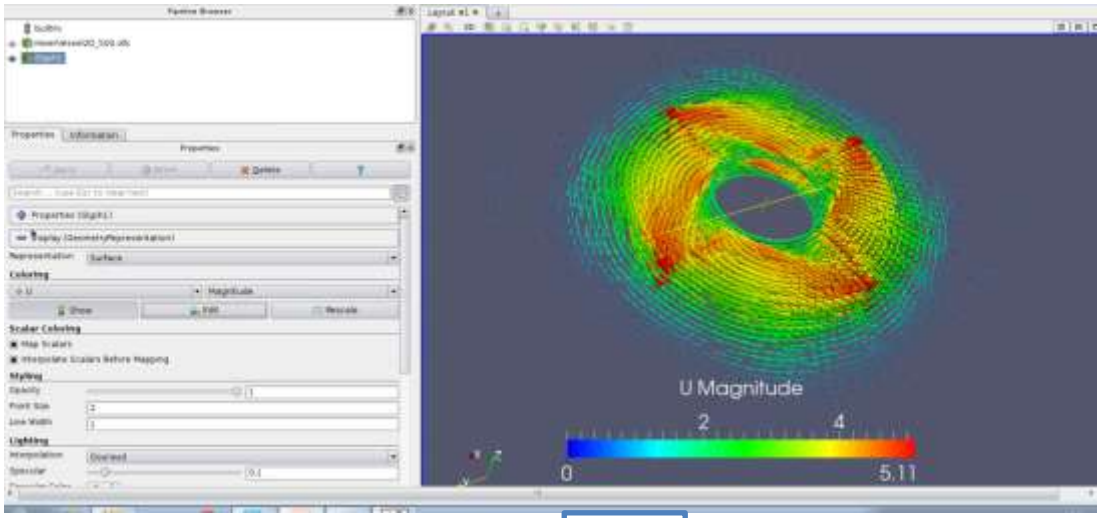
Perform basic filtering on the data provided for the school

- Slicing
- Iso-surface
- Extract surface
- Clipping
- Vectors
- Streamlines

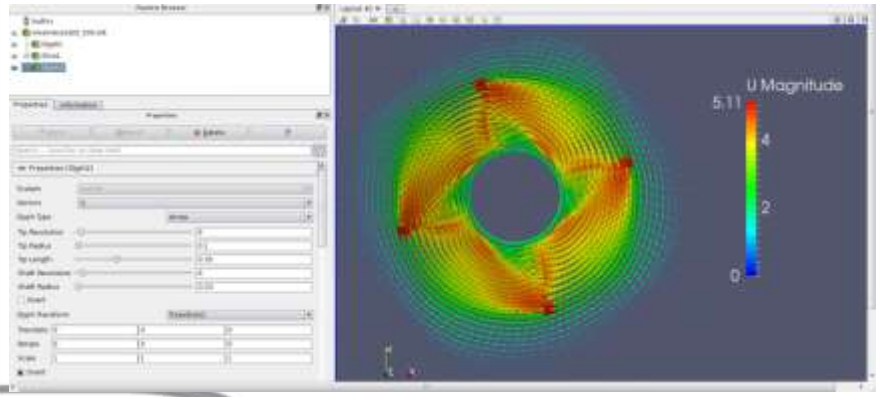
Vectors Visualization, glyph filter

- Select filter for 3d vectors, 1)
- Select a slice normal to z axis
- Select 2d vectors on the slice 2)
- Modify vectors aspects 3)

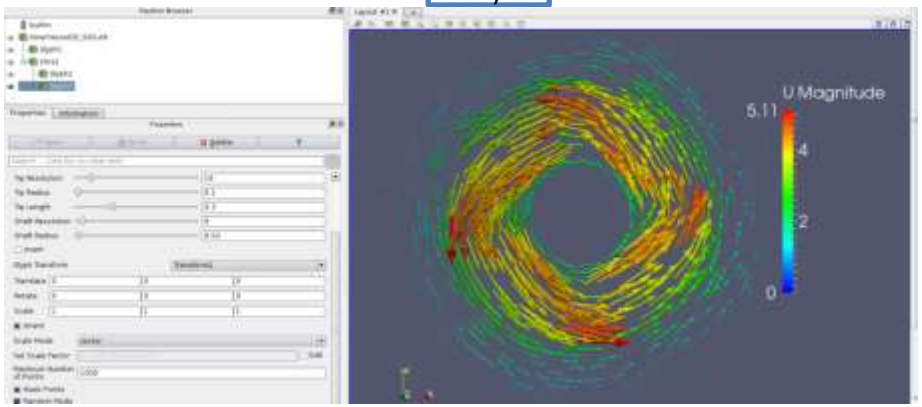
1)



2)



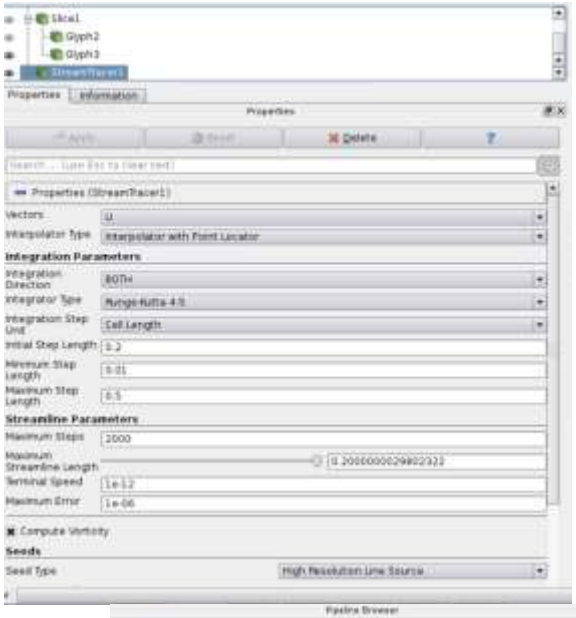
3)

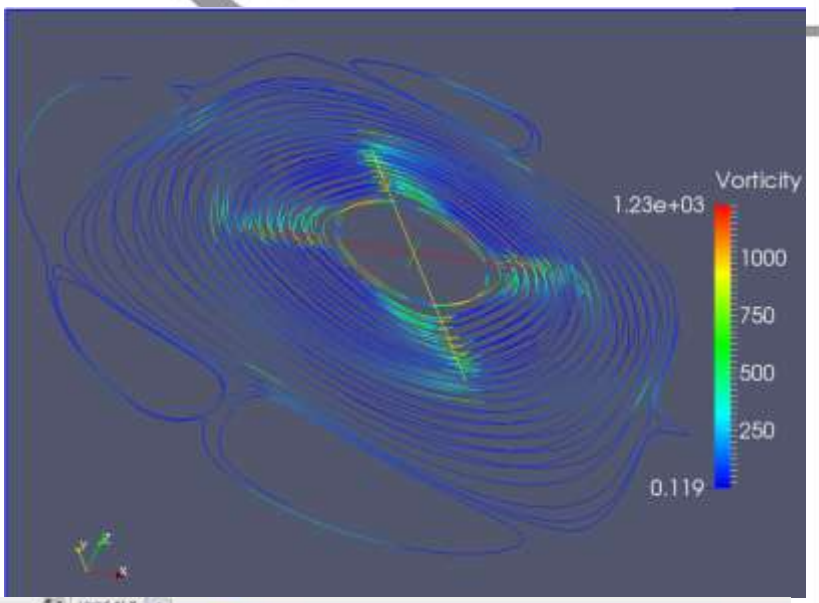


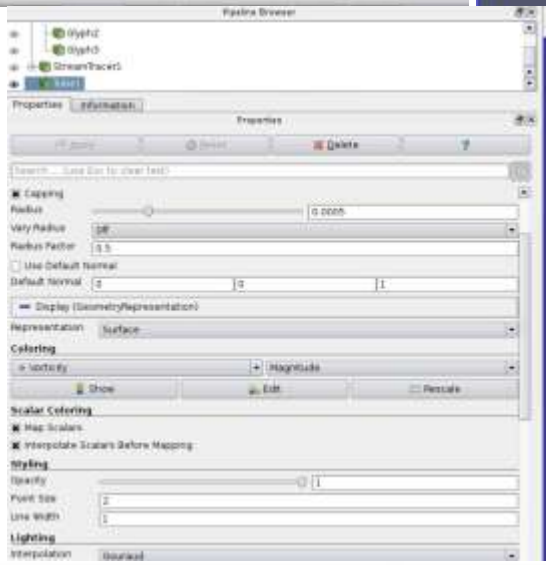
Streamlines

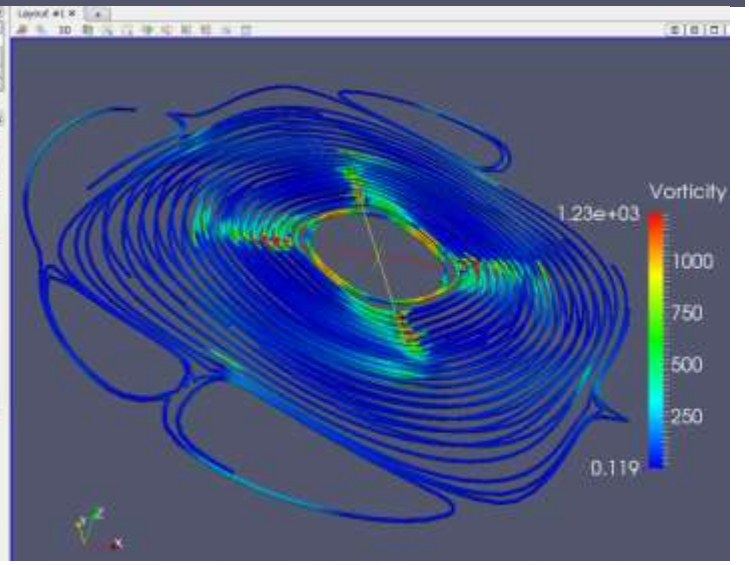
Integrate streamlines in a vector field

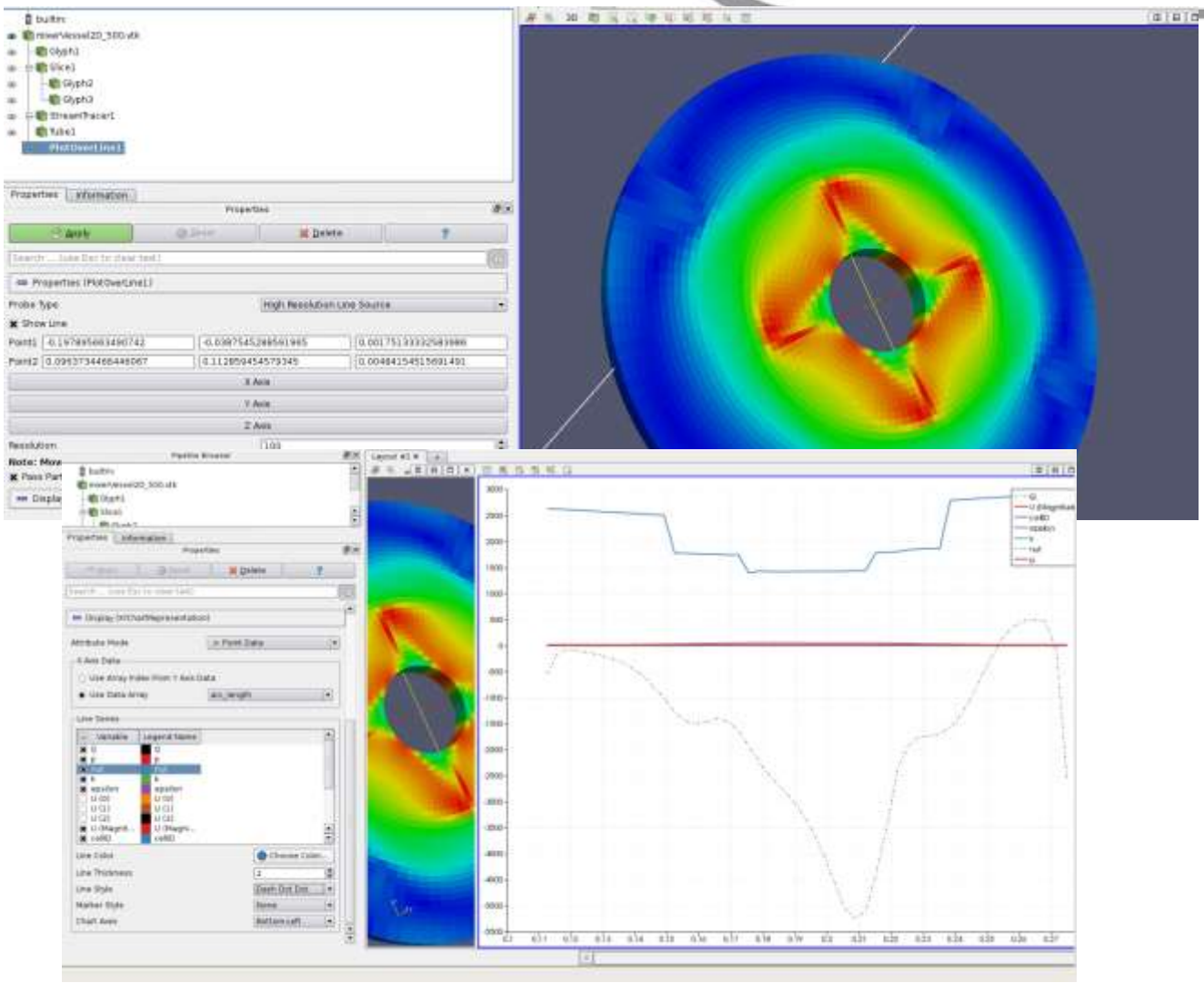
- Insert streamlines by line
- The input is given by the the vtkDataSet, that is the mixervessel*.vtk
- Use the default value with seed Type High Res. Line source
- Change stream properties
- Color by rotation
- Enhance streams using tubes
- Properties for streamlines





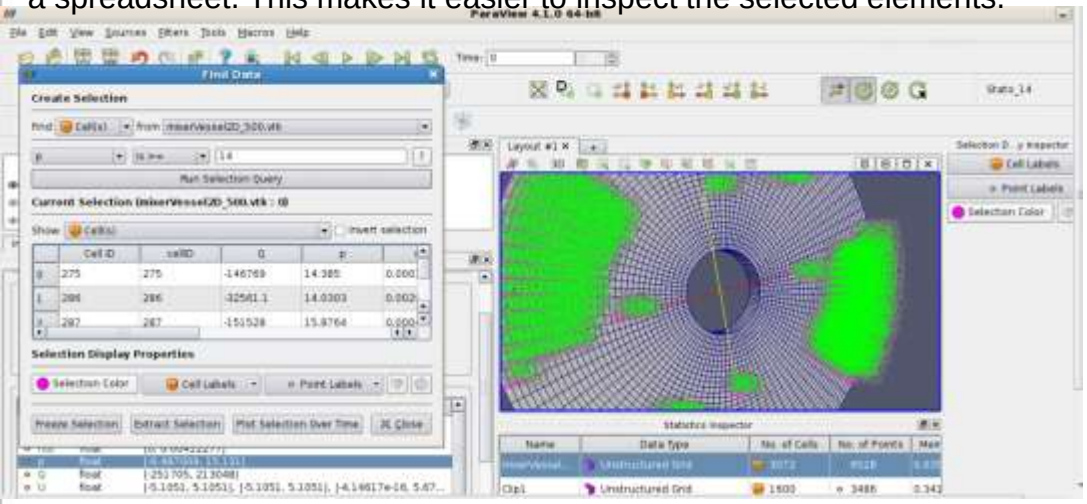


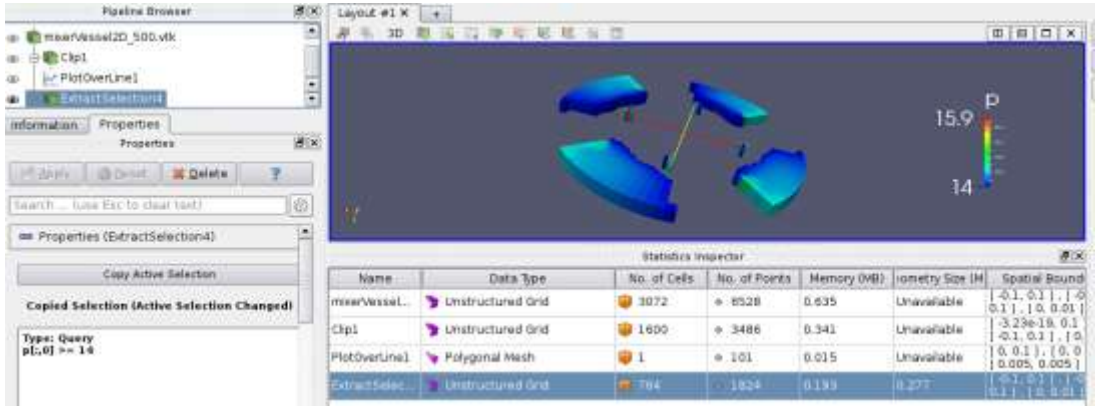



Properties
Information
Apply
Delete
Probe Type
High Resolution Line Source
Show Line
X Axis
Y Axis
Z Axis
Resolution

Data selection

Another mechanism for creating selections is by specifying a selection criteria. For example, suppose you want to select all cells where the pressure value is between a certain threshold. In such cases, you can use the Find Data dialog. The Find Data dialog performs a dual role: not only does it enable specifying the selection criteria but also show details of the selected elements in a spreadsheet. This makes it easier to inspect the selected elements.

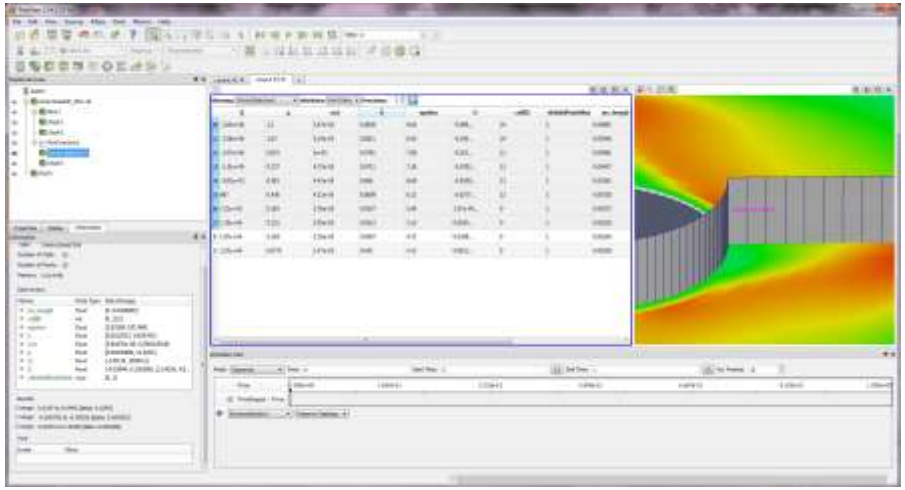


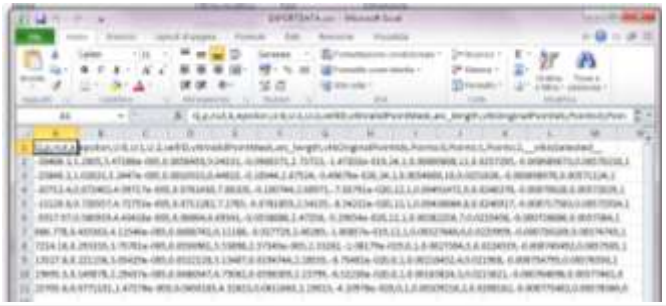


Data saving

http://www.paraview.org/Wiki/ParaView/Users_Guide/Selection

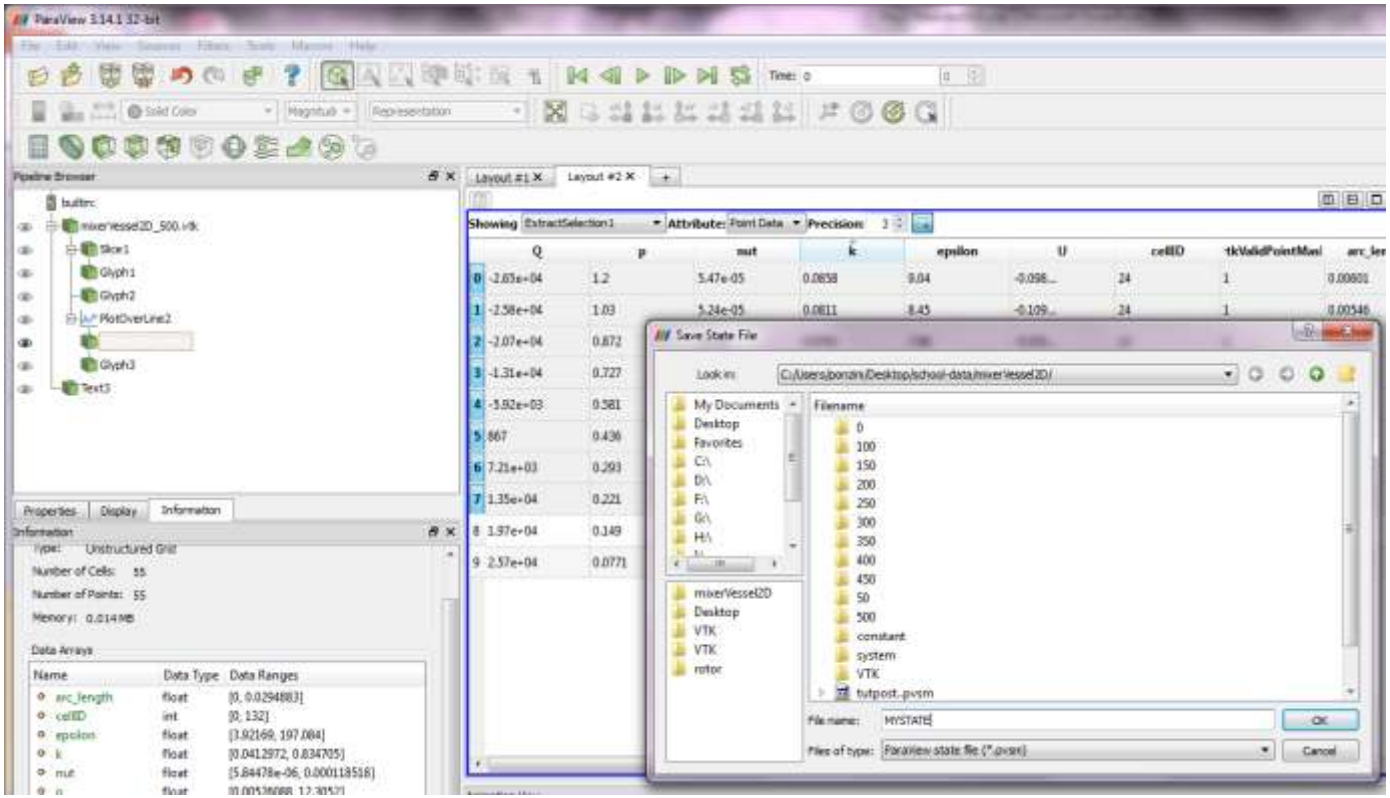
- Select your data





Save a pipeline as a scene

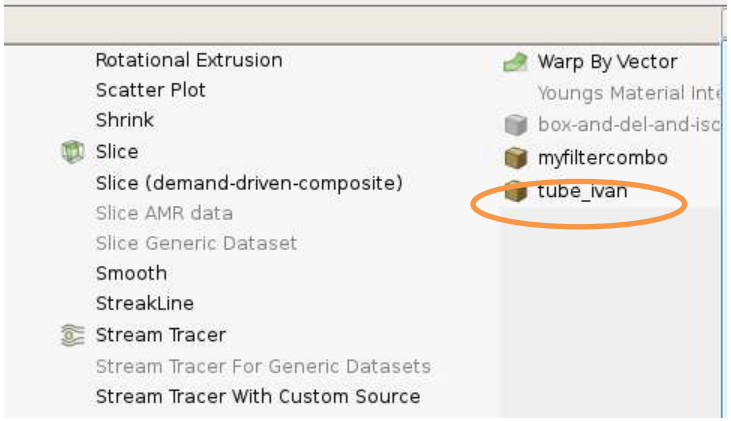
Save the obtained pipeline a PV scene for future processing by loading the scene back into ParaView.

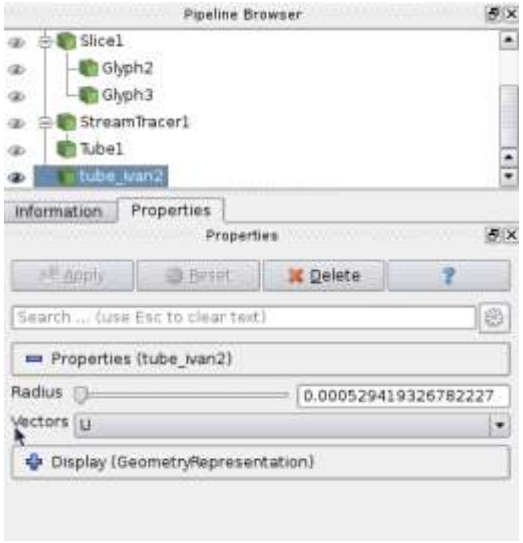


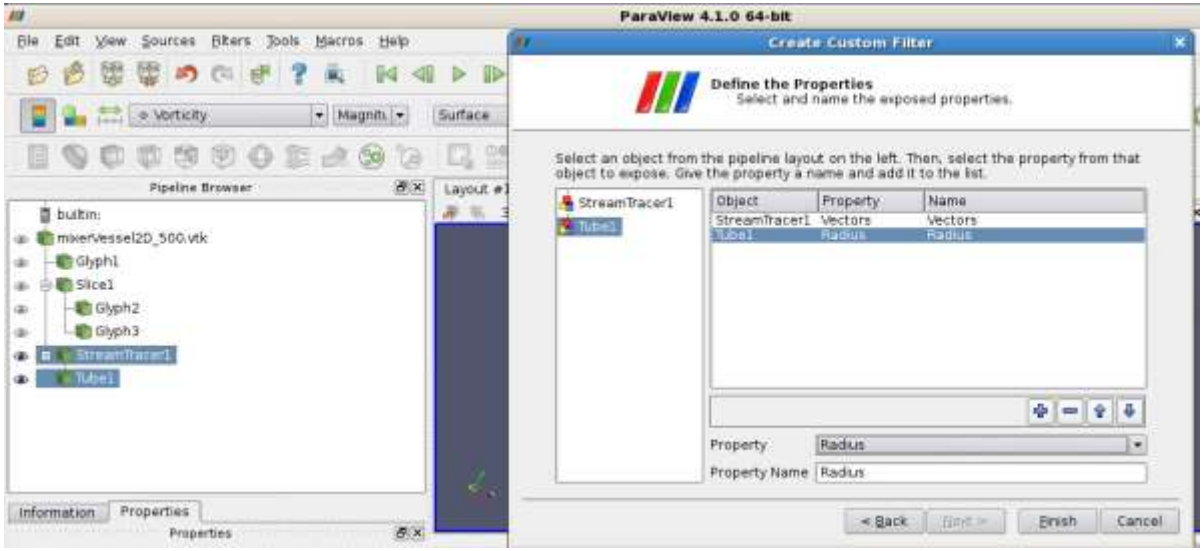
Build and use a new filter from a pipeline

http://www.paraview.org/Wiki/ParaView/Custom_Filters

- Create a custom filter by grouping a pipeline
- Save the filter
- Close and re-load your custom filter

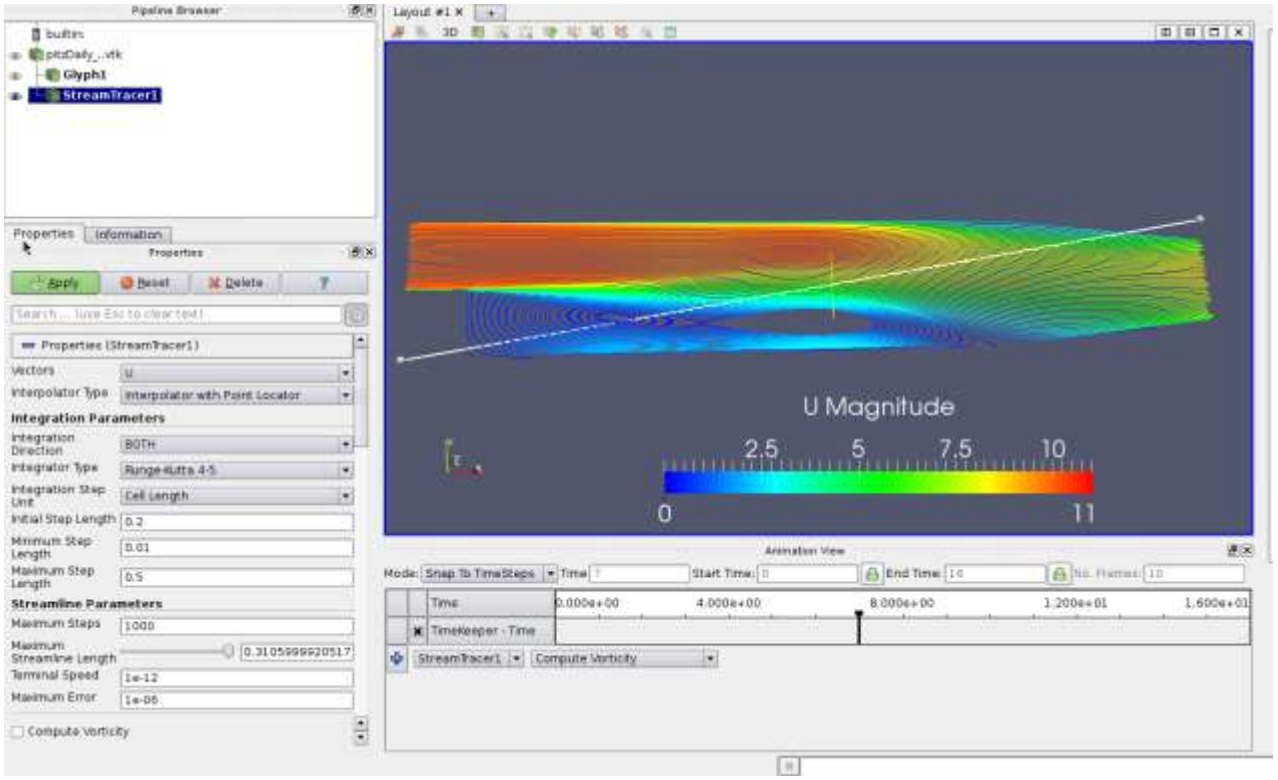


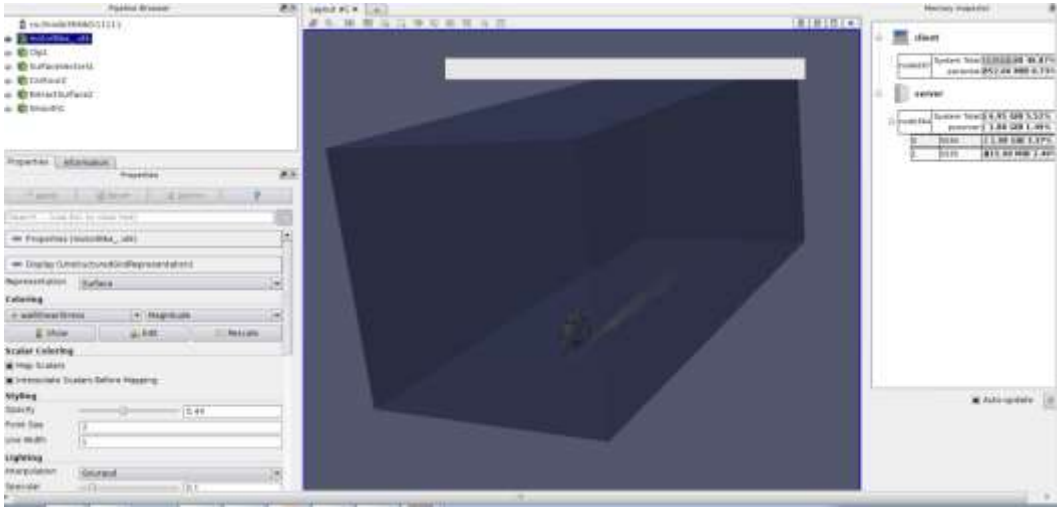
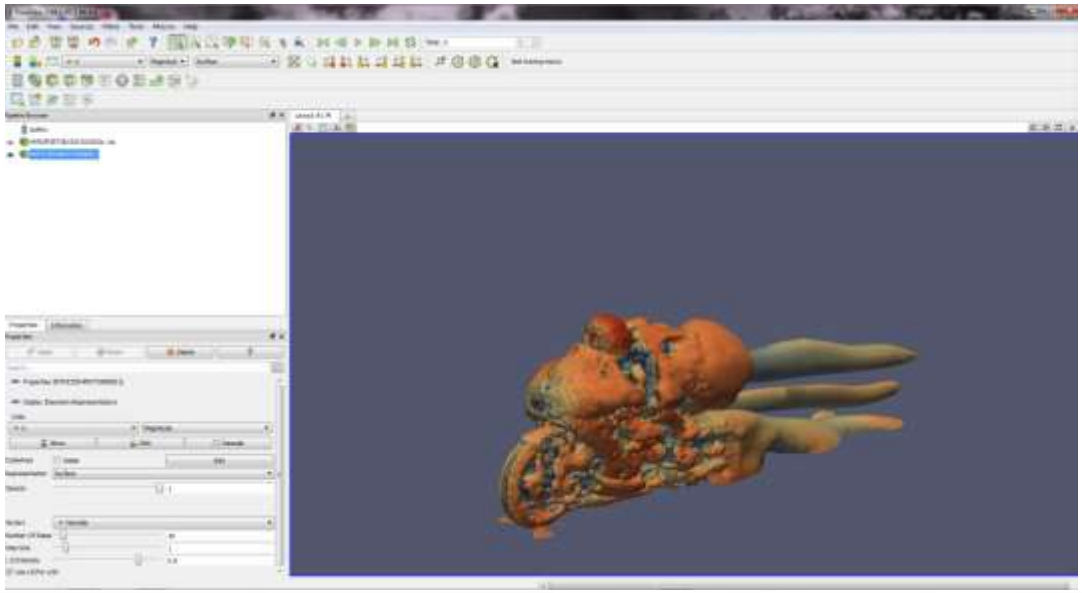




Tutorial1

- Load the data provided for the tutorial
- Process the data to obtain:
  - ✓ Glyph of U
  - ✓ StreamTrace of U
  - ✓ Animate over time
  - ✓ Save the animation



Tutorial2

- Load the data provided for the tutorial
- Process the data to obtain:
  - ✓ Smaller dataset to process (by clipping)
  - ✓ Contour plot of iso-Q
  - ✓ Extract the isosurface
  - ✓ Smooth
  - ✓ Save the surface for future visualization
  - ✓ Color by velocity or pressure or both and compare
  - ✓ Build a filter that will do all the work in a single click
  - ✓ Add text and colorbar
  - ✓ Save meaningful visualizations