



13th Summer School on **SCIENTIFIC VISUALIZATION**

Introduction to Paraview GUI

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OUTLINE

PART A

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

PART B

- Filters
- Vectors visualization
- Streamlines
- Plotting over line
- Select data
- Create a custom filter
- Animations
- Time dependent data



What is Paraview

ParaView is an open-source application for visualizing 2D/3D data.

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.



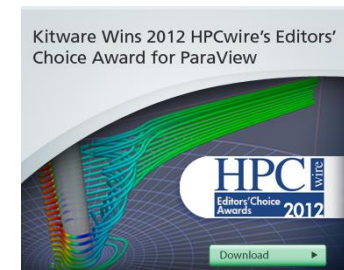


PARAVIEW: a standard de-facto

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

ParaView 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>



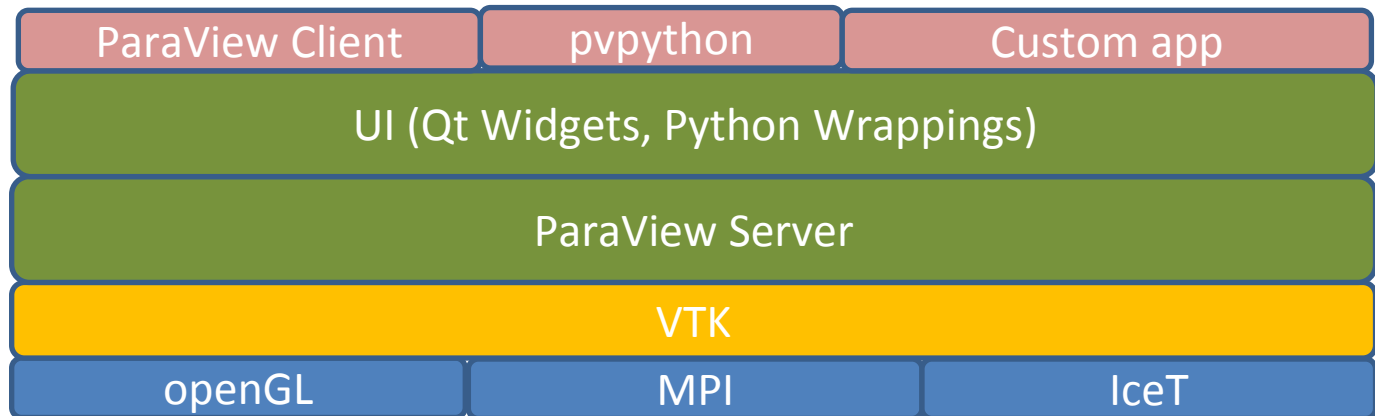
The big picture

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.

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.

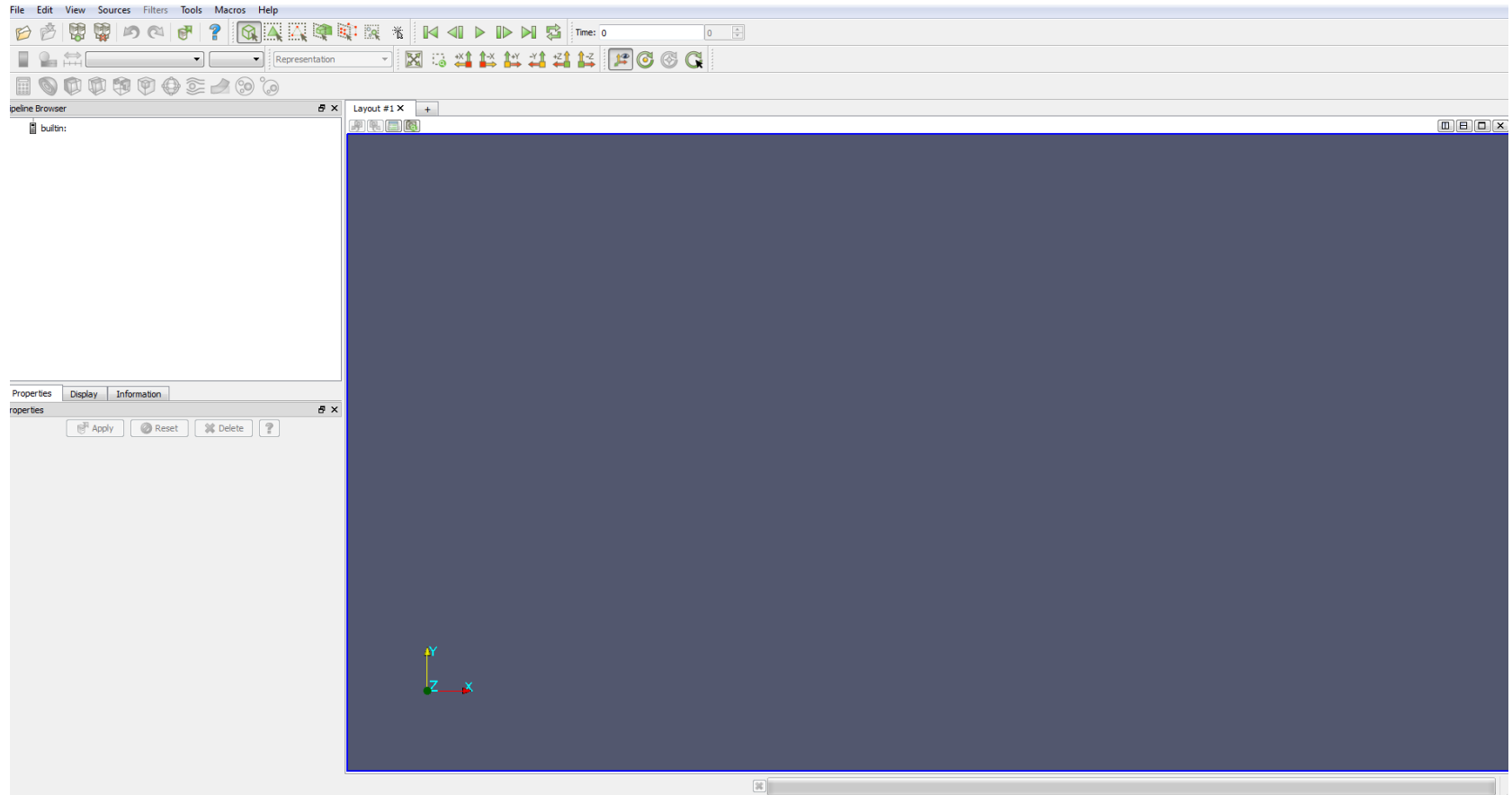
The Visualization Toolkit (VTK) provides the basic visualization and rendering algorithms.





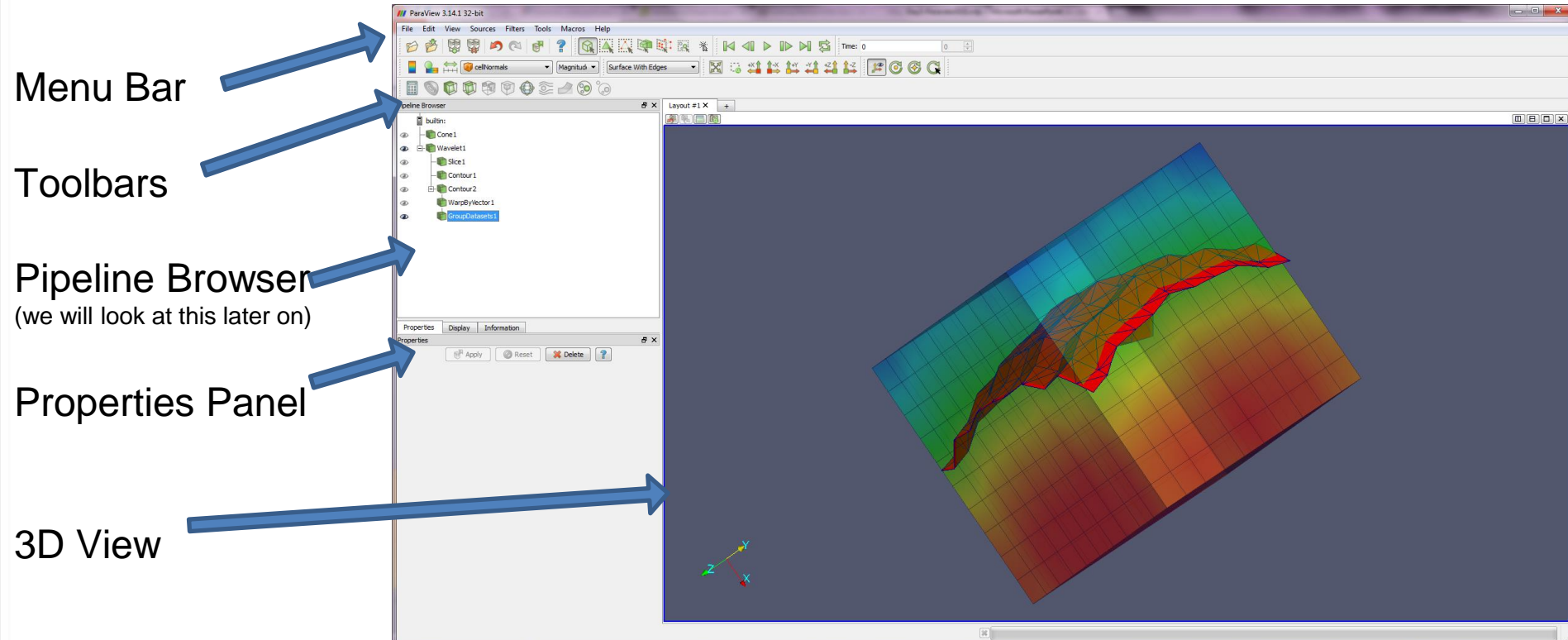
GUI

Launch the Paraview application on your pc





GUI elements





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 filtering 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.

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 (!)

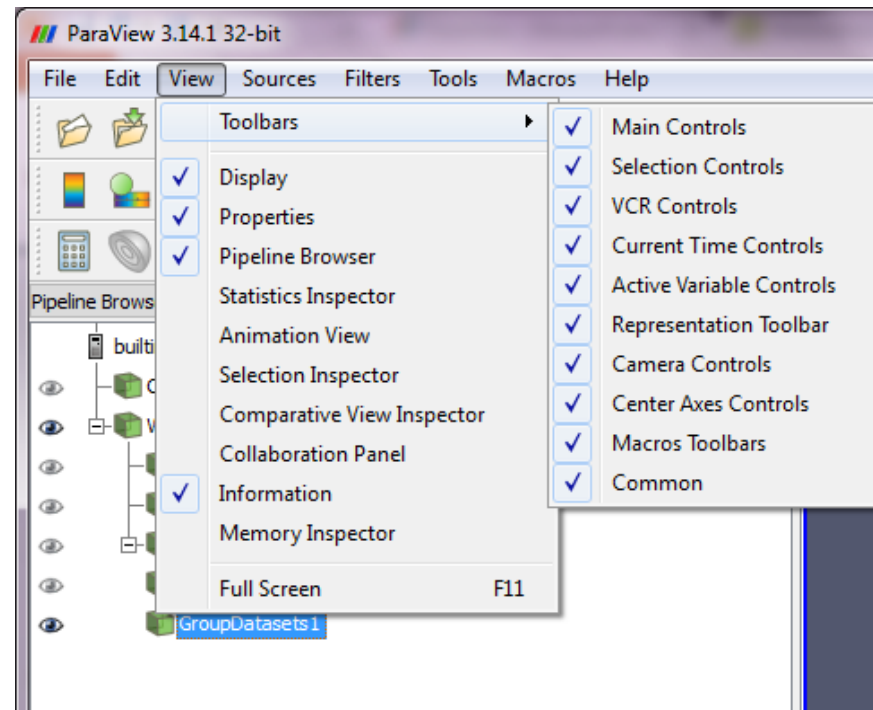
The screenshot shows the ParaView 3.98.1-RC2 64-bit application window. The main interface includes a menu bar (File, Edit, View, Sources, Filters, Tools, Macros, Help), a toolbar with various icons, and a Pipeline Browser on the left. A 'ParaView Online Help' window is open in the foreground, displaying a table of sources. The table has two columns: 'Name' and 'Description'. The 'Name' column lists various source types, and the 'Description' column provides a brief explanation of each. The 'Sources' section in the help window is expanded, showing a list of sources including 2D Glyph, 3D Text, Annotate Time, Arrow, Axes, Box, Cone, Cylinder, Data Object Generator, Disk, Hierarchical Fractal, Hyper Tree Grid, Line, Mandelbrot, Octree Fractal, Outline, Plane, Point Source, Programmable Source, Sphere, SplineSource, Superquadric, Text, Time Source, Ruler, Wavelet, and AMR GaussianPulse.

Name	Description
2D Glyph	Create a 2D glyph (e.g., arrow, cross, dash, etc.)
3D Text	3D geometric representation of a text string
Annotate Time	Shows the animation time as text annotation in the view.
Arrow	3D arrow with a long cylindrical shaft and a cone for the tip
Axes	Three lines representing the axes - red line along X, green line along Y, and blue line along Z
Box	Create a box with specified X, Y, and Z lengths.
Cone	Create a 3D cone of a given radius and height.
Cylinder	Create a 3D cylinder of a given radius and height.
Data Object Generator	Parses a string to produce composite data objects consisting of simple templated datasets.
Disk	Create a 3D disk with a specified inner and outer radius.
Hierarchical Fractal	Test source for AMR with HierarchicalDataSet
Hyper Tree Grid	Hyper tree grid representing a tree-based AMR data set
Line	This source creates a line between two points. The resolution indicates how many segments are in the line.
Mandelbrot	Representation (unsigned char) of the Mandelbrot set in up to 3 dimensions
Octree Fractal	Test source for octree with Mandelbrot fractal
Outline	3D outline of the specified bounds.
Plane	Create a parallelogram given an origin and two points. The resolution indicates the number of division along each axis of the plane.
Point Source	Create a point cloud of a certain size, radius, and center.
Programmable Source	Executes a user supplied python script to produce an output dataset.
Sphere	Create a 3D sphere given a center and radius.
SplineSource	Tessellate parametric functions.
Superquadric	Create a superquadric according to the theta and phi roundness parameters. This one source can generate a wide variety of 3D objects including a box, a sphere, or a torus.
Text	The Text source generates a table containing text.
Time Source	Produces a single cell uniform grid with data values that vary over a sin(t) wave from t=0 to t=1 (radian).
Ruler	This is a line source that can be used to measure distance between two points
Wavelet	Create a regular rectilinear grid in up to three dimensions with values varying according to a periodic function.
AMR GaussianPulse	



Personalize your GUI

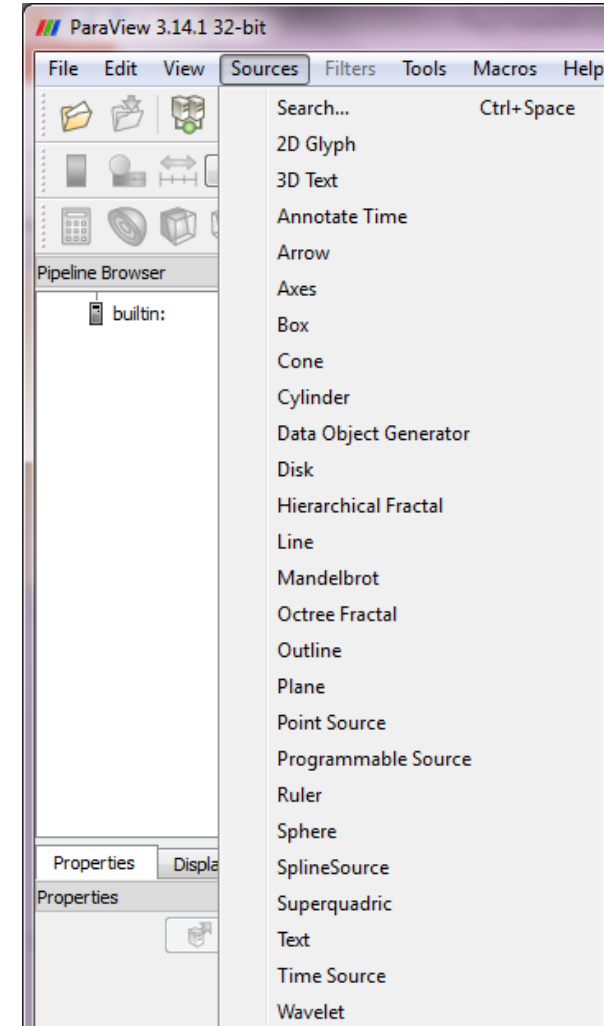
The GUI is customizable so that toolbars can be displayed or hidden when needed.



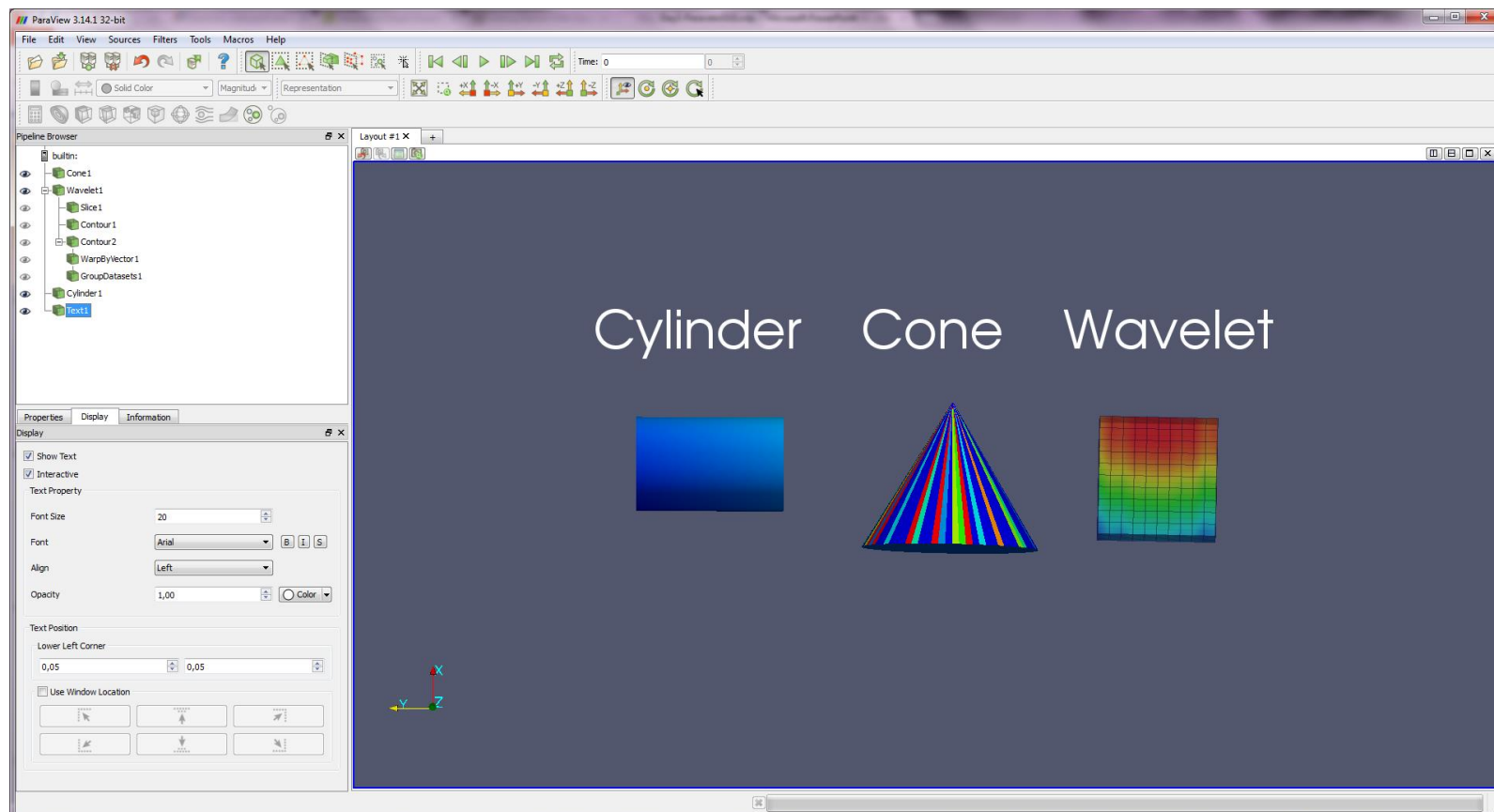


Sources

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



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

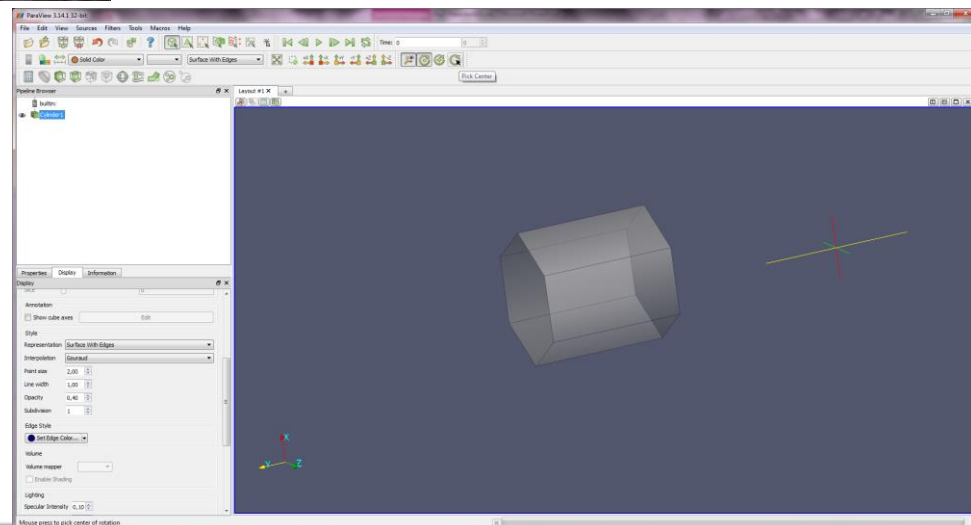
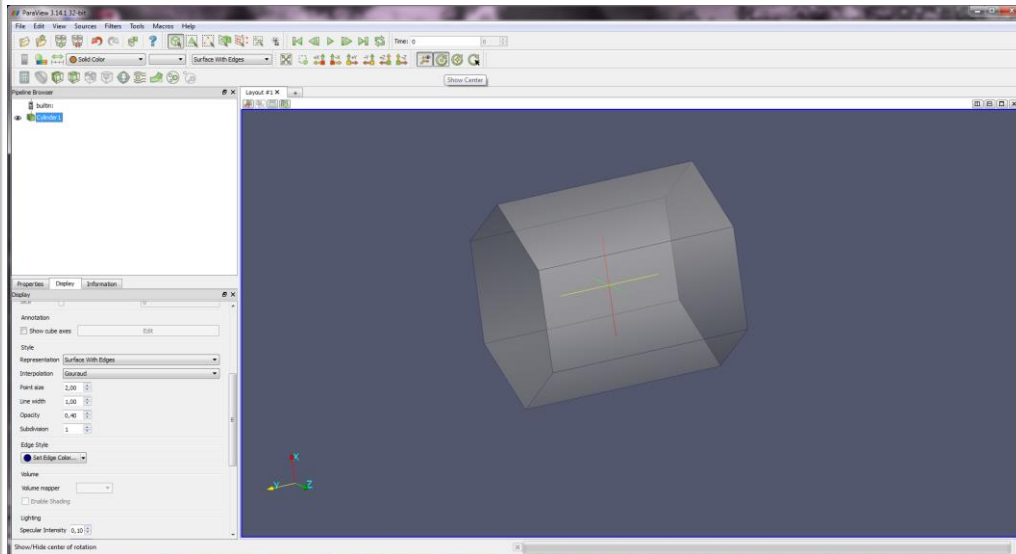


Set view on/off for
axis and center of
rotation





Change center of rotation





Apply/Reset Undo/Redo

Apply: click on the apply button to 'sync' your data state. (Automatic apply of changes button )

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

Undo: go back to the previous state

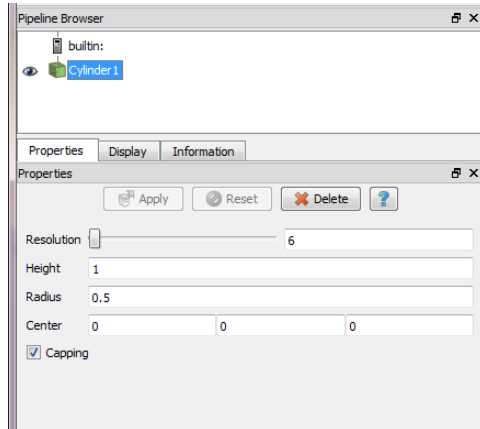
Redo: return to the state you changed back

Camera Undo: same as above but for camera views changes

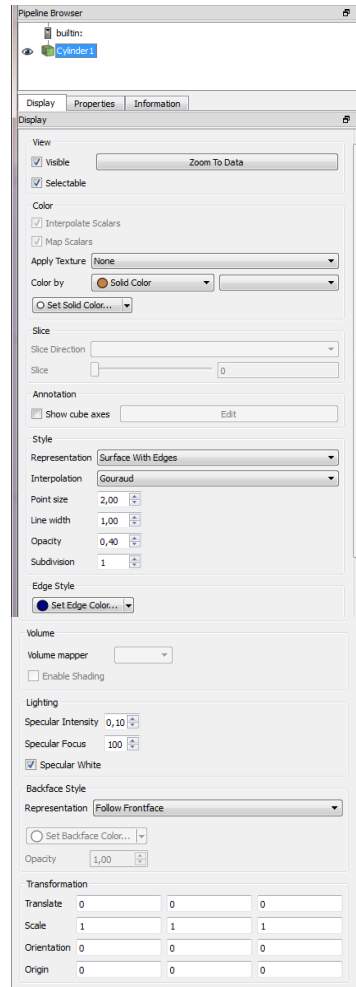
Camera Redo: same as above but for camera views changes



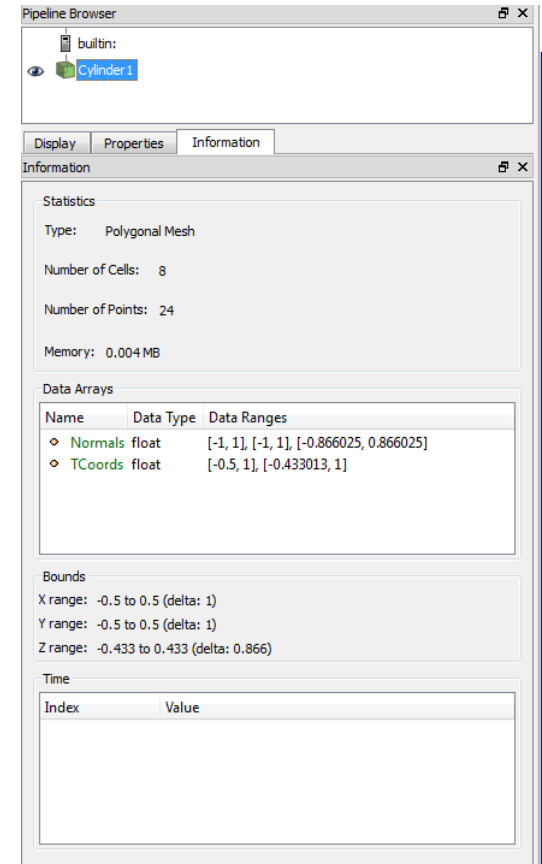
Main objects menu



Properties



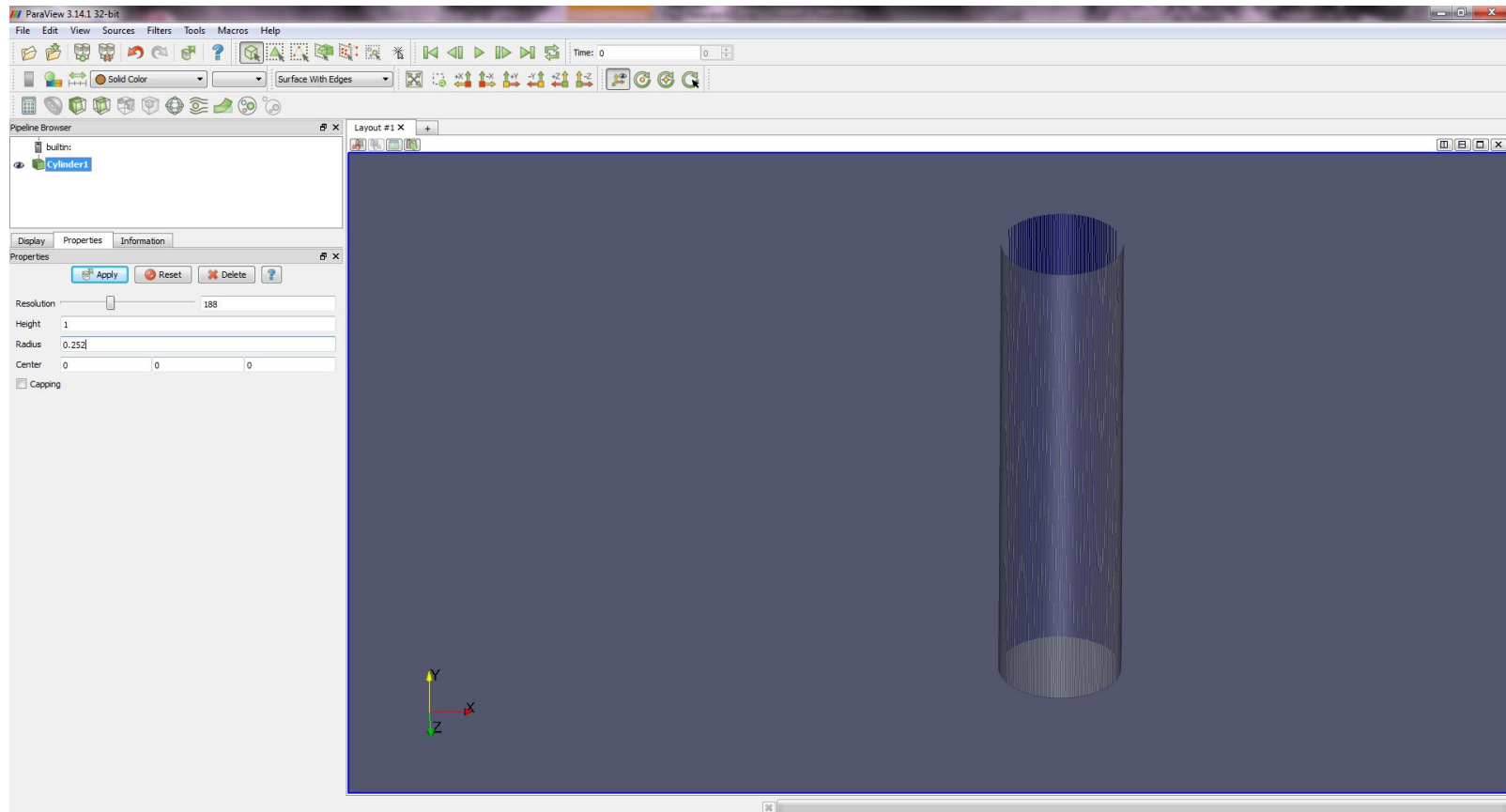
Display



Informations



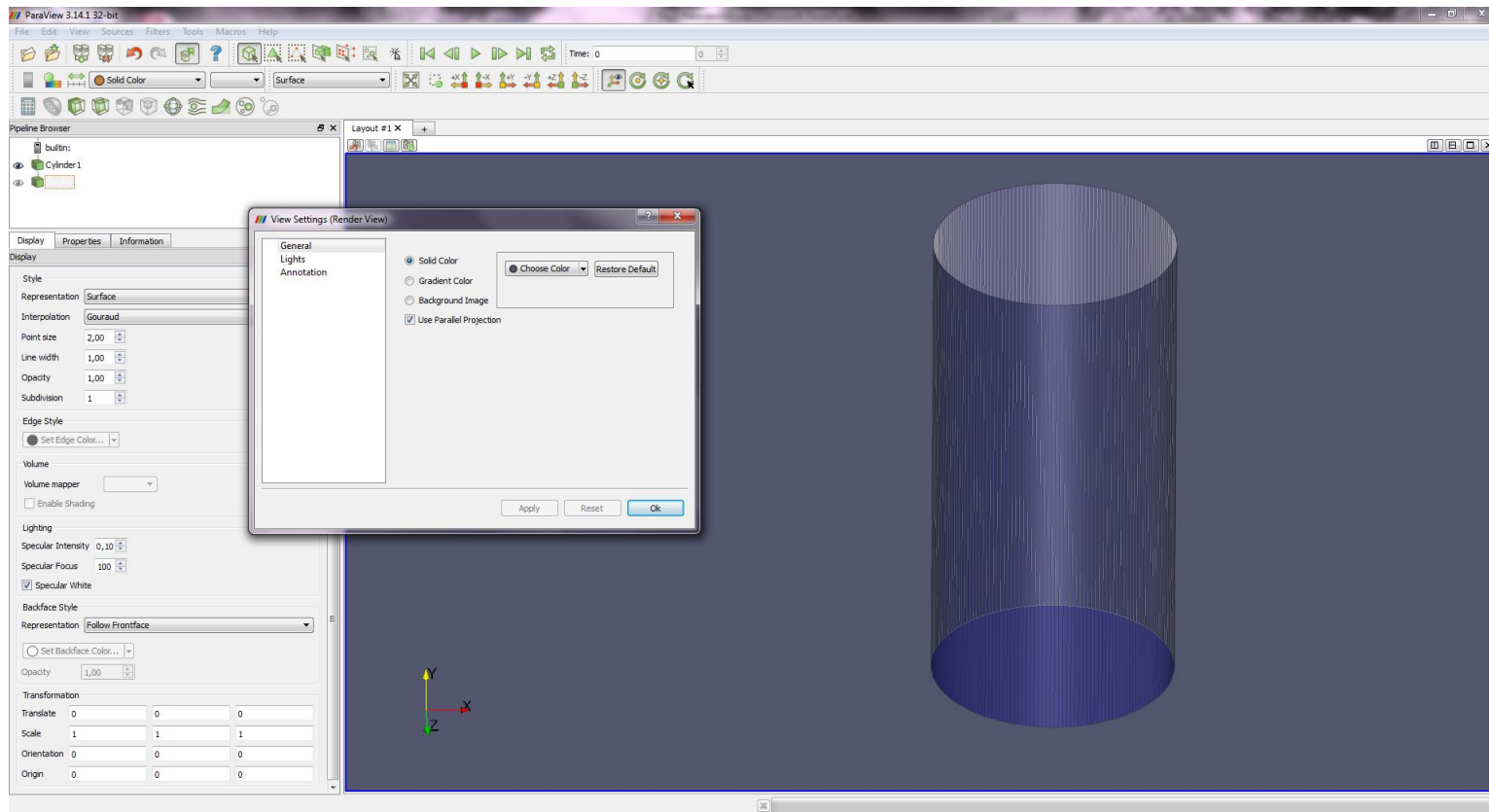
Change object properties





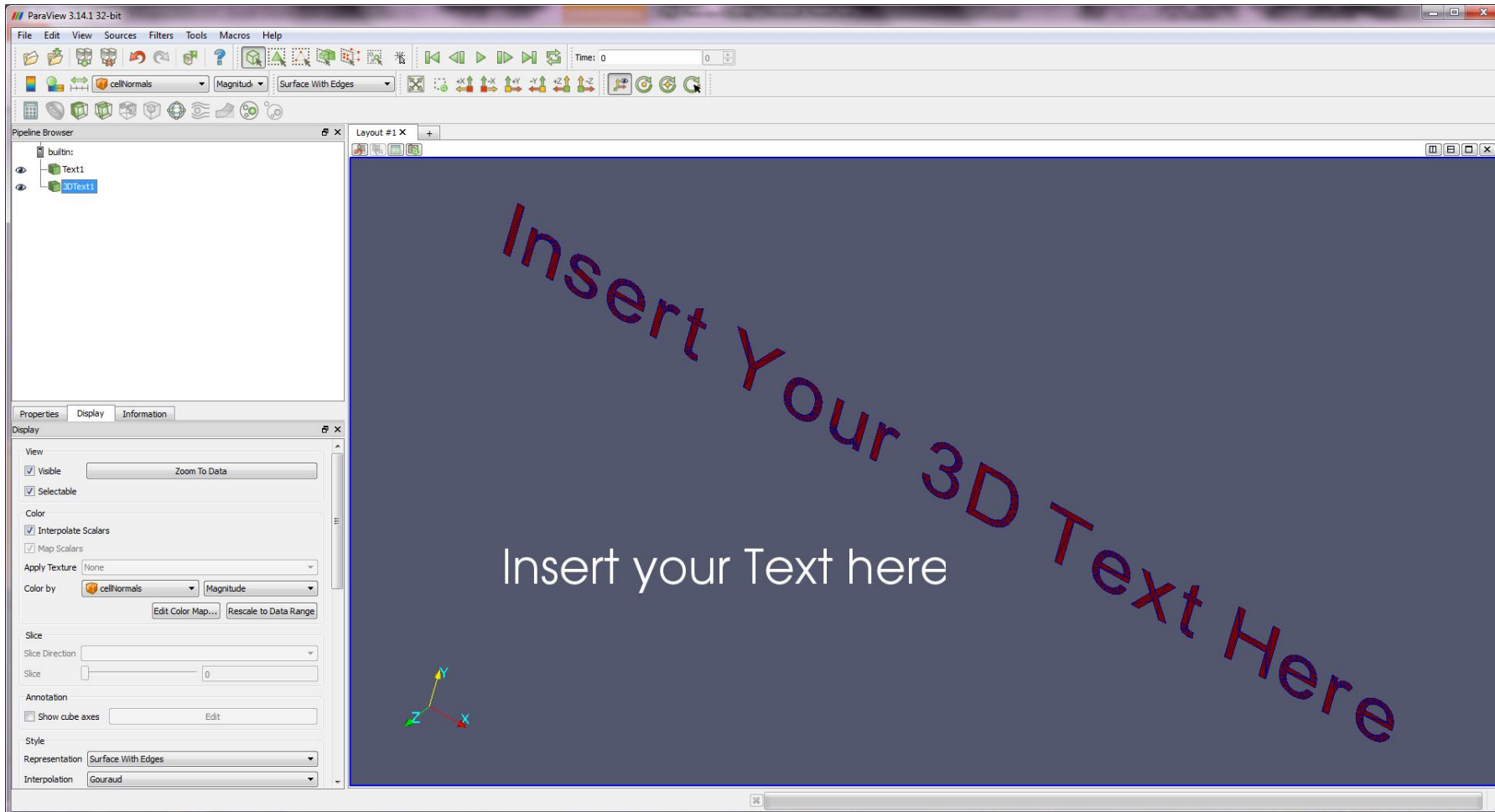
Display

Play with different display options for this object.





Text annotation





Views Management

The screenshot displays the ParaView 3.14.1 32-bit interface. The main window shows a 3D visualization of a cube with a coordinate system (X, Y, Z). The interface includes a Pipeline Browser on the left, a Properties panel at the bottom left, and two configuration dialog boxes in the center.

Adjust Camera Dialog:

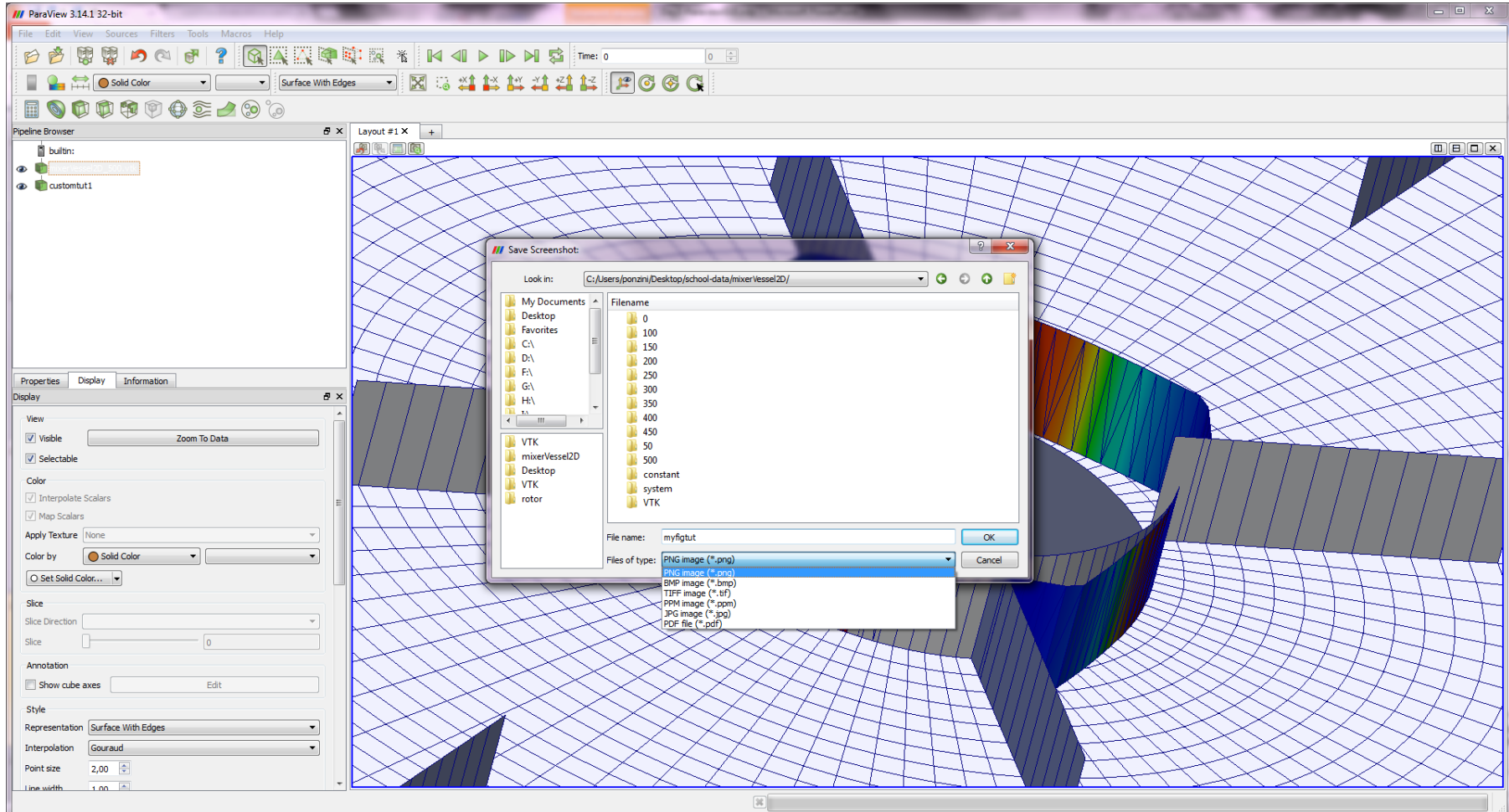
- Views:** Standard and Custom views.
- Configuration:** Center of Rotation (0, 0, 0), Reset Center of Rotation When Camera is Reset.
- Camera Positions:** Position (136628000963, 1809383660217, 339520075339), Focal Point (995887211387, +454992347295, 277915689841), View Up (303794383498, -1845751063832, 355906385609), View Angle 30,00.
- Apply Manipulation:** Roll (0,00 degrees), Elevation (0,00 degrees), Azimuth (0,00 degrees).

Configure custom view buttons Dialog:

Button	Tool Tip	Assign
1	Current View 1	current view
2	Current View 2	current view
3	not configured.	current view
4	not configured.	current view



Save figure





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)

DCCMD (.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 Unstructured 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)

Spherical (.spherical, .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, .nhrd)

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)



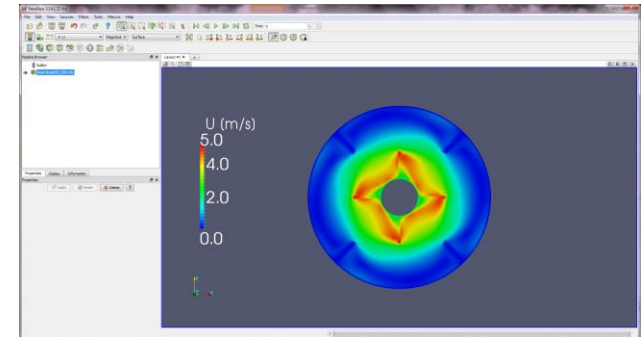
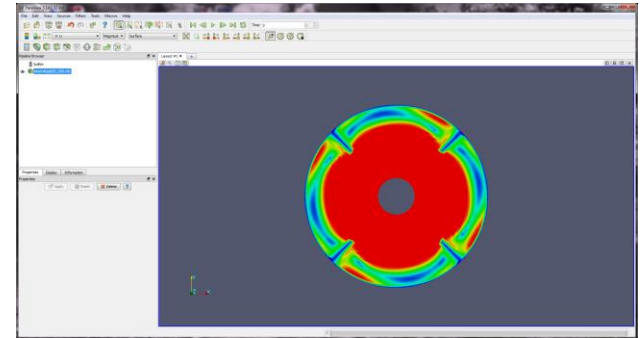
Loading your data (no filtering)

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



U 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





END OF PART A



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.

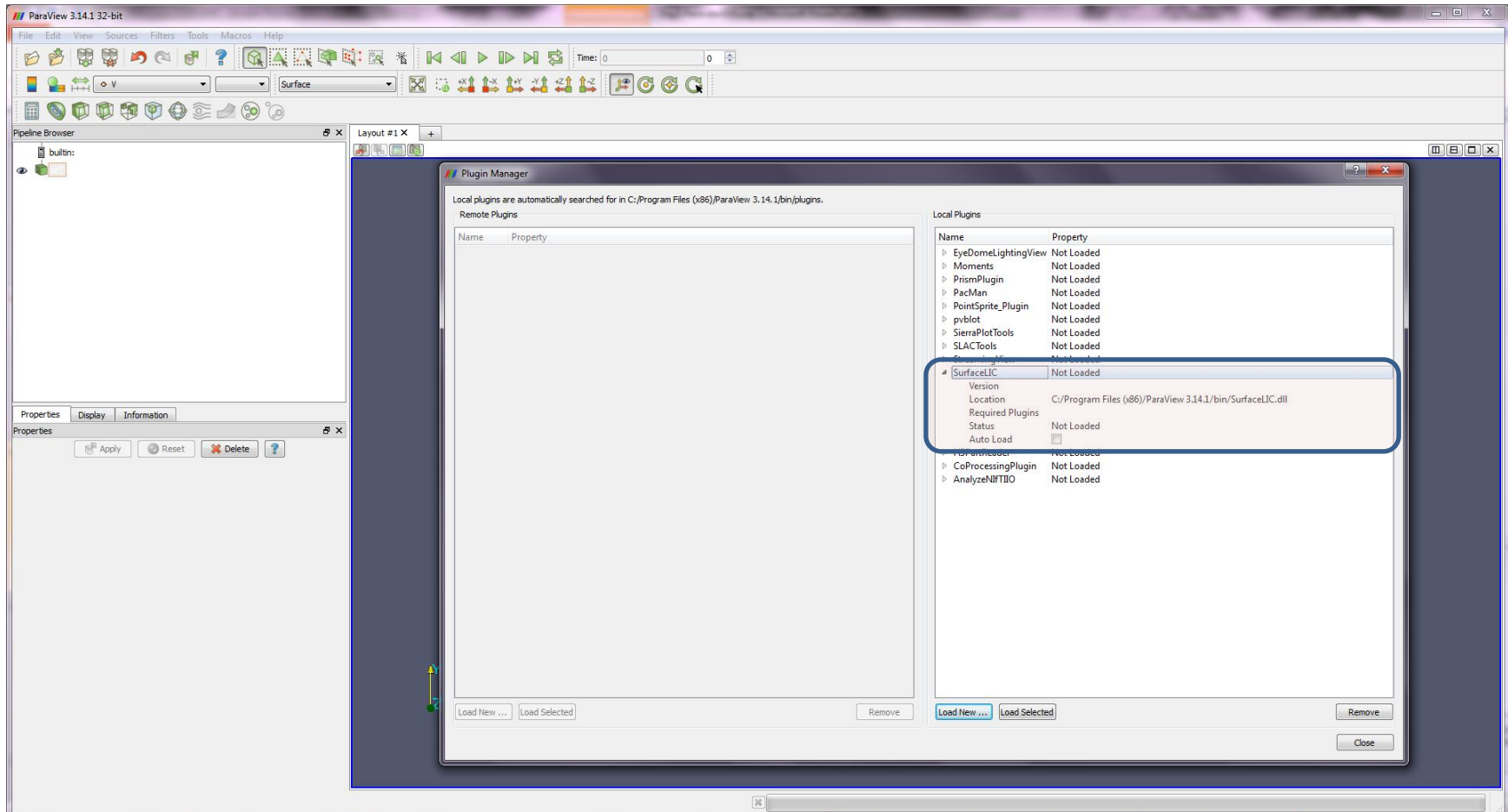
Alphabetical An alphabetical listing of all the filters available. If you are not sure where to find a particular filter, this list is guaranteed to have it. There are also many filters that are not listed anywhere but in this list.

Other Filters

The screenshot displays a software interface with a search menu on the left and a list of filters on the right. The search menu includes options like 'Recent', 'Common', 'Cosmology', 'Data Analysis', 'Material Analysis', 'Statistics', 'Temporal', and 'Alphabetical'. The filter list is organized into columns and includes various tools such as 'AMR Contour', 'Gradient', 'Scatter Plot', 'Shrink', 'Slice', 'Smooth', 'Stream Tracer', 'Surface Flow', 'Surface Vectors', 'Table To Points', 'Table To Structured Grid', 'Temporal Cache', 'Temporal Interpolator', 'Temporal Shift Scale', 'Temporal Snap-to-Time-Step', 'Temporal Statistics', 'Tessellate', 'Tetrahedralize', 'Texture Map to Cylinder', 'Texture Map to Plane', 'Texture Map to Sphere', 'Threshold', 'Transform', 'Triangle Strips', 'Triangulate', 'Tube', 'Warp By Scalar', 'Warp By Vector', 'Youngs Material Interface', and 'box-and-del-and-iso-and-smooth'.



Other customized filters



You will get an example of usage of the SurfaceLIC filter during the school



Working with filters over data

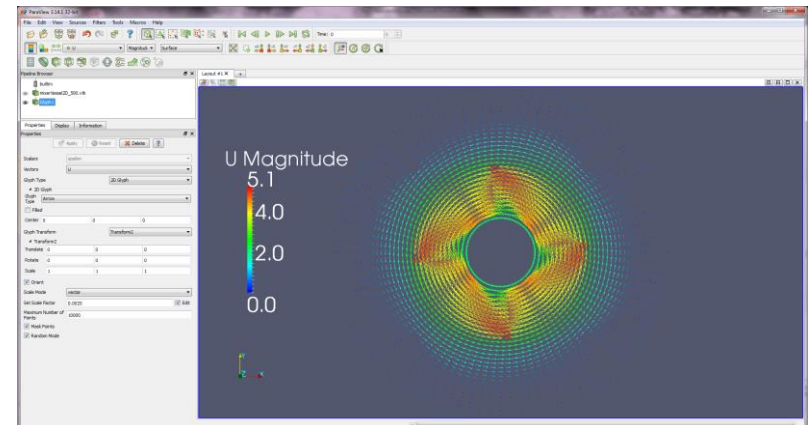
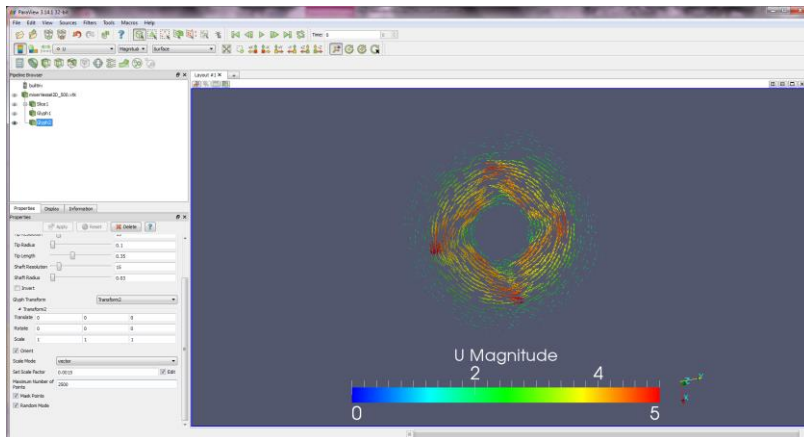
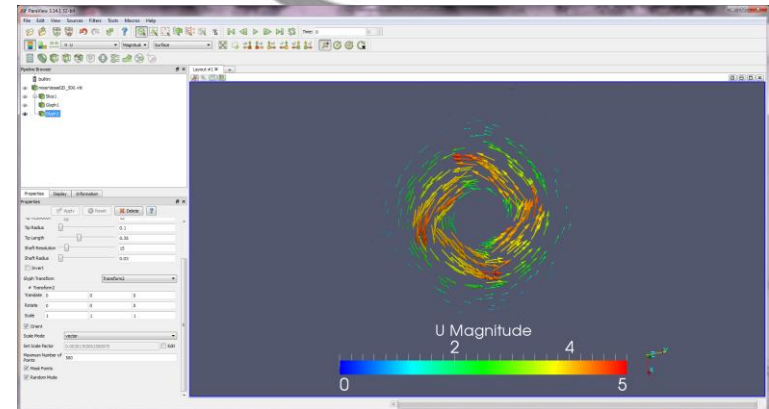
Perform basic filtering on the data provided for the school

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



Vectors Visualization

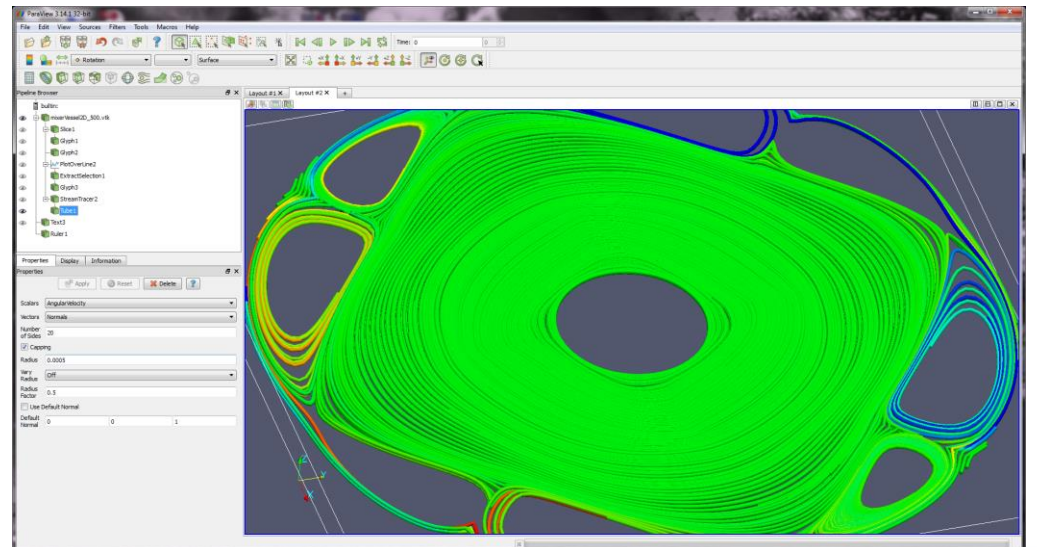
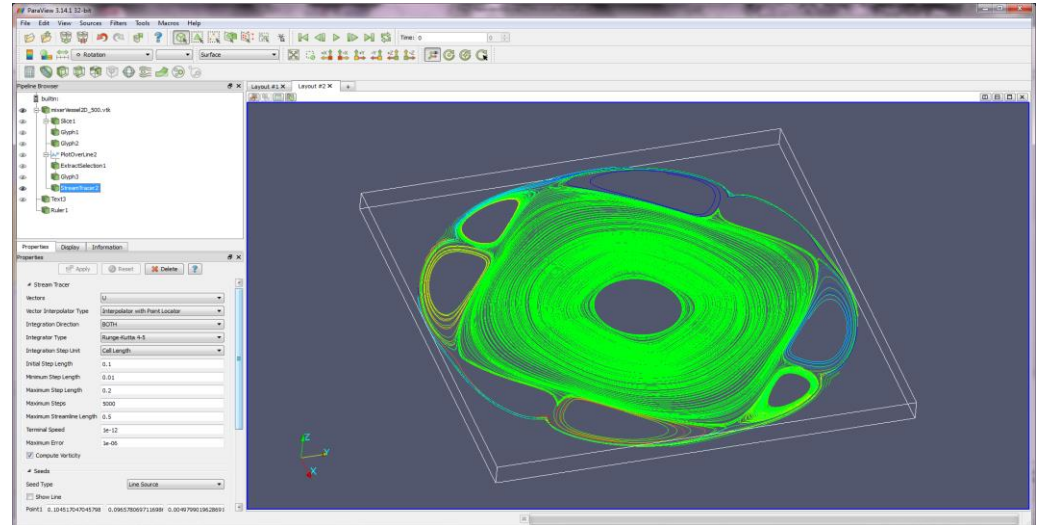
- Select filter for 3d vectors
- Select a slice normal to z axis
- Select 2d vectors on the slice
- Modify vectors aspects



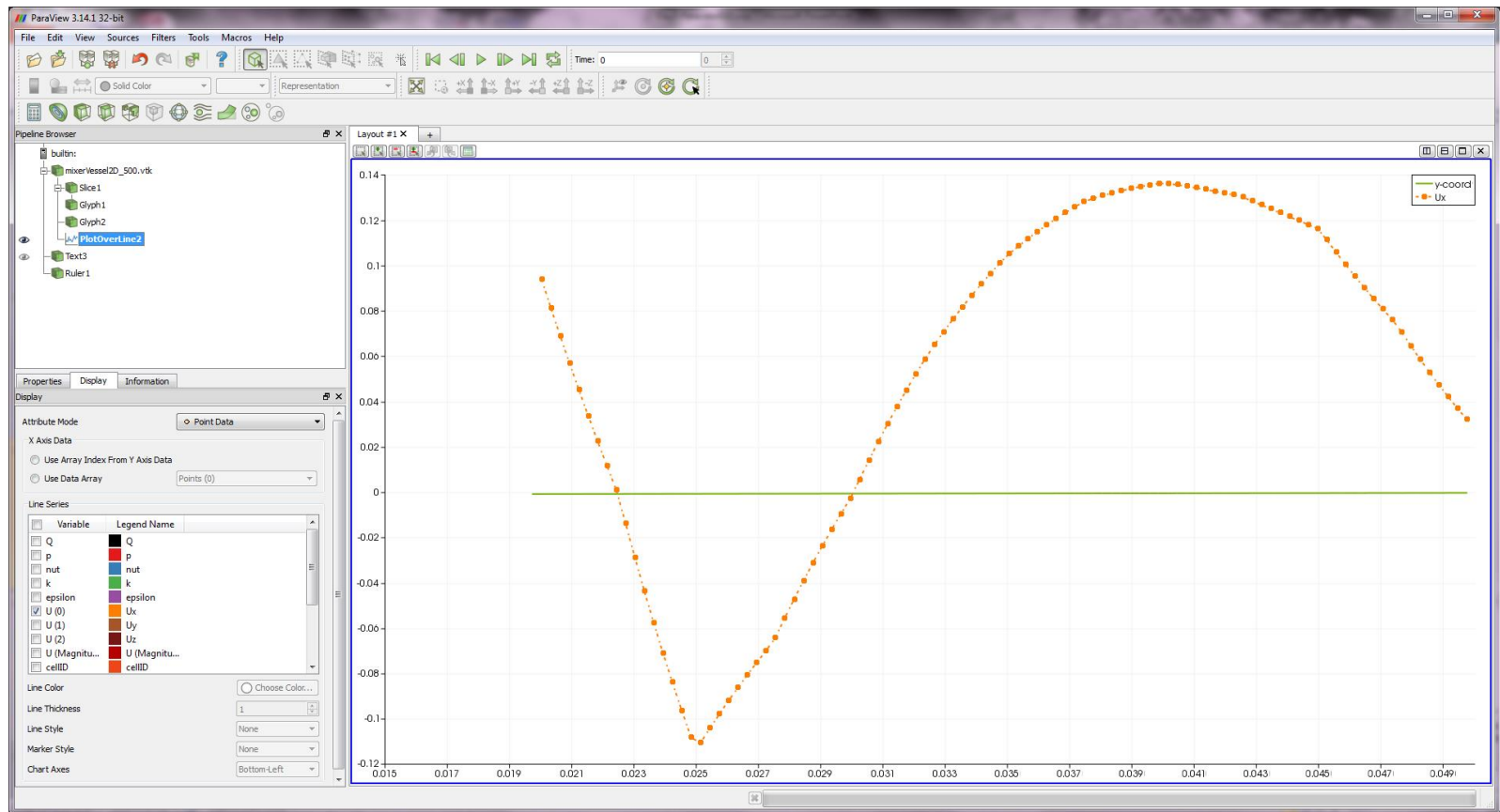


Streamlines

- Insert streamlines by line
- Change stream properties
- Color by rotation
- Enhance streams using tubes



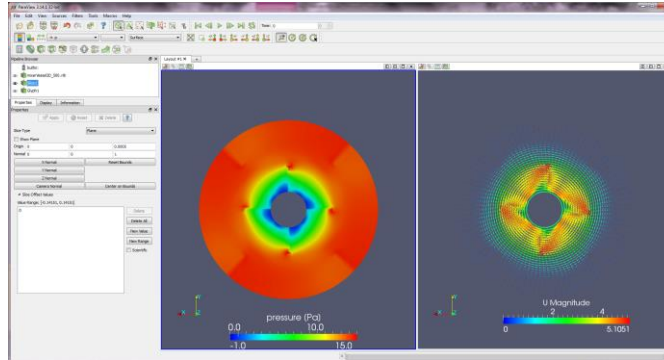
Plotting



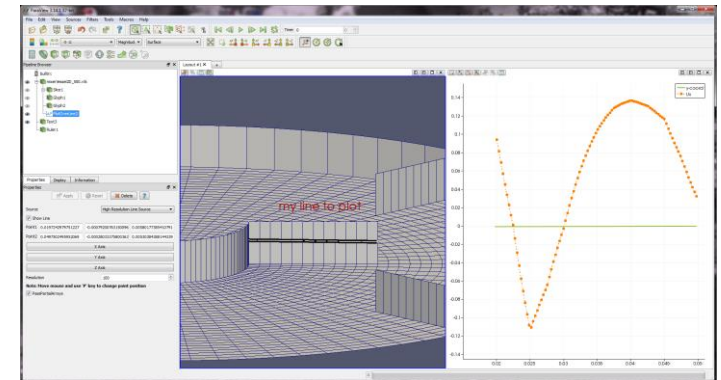


Multiple views

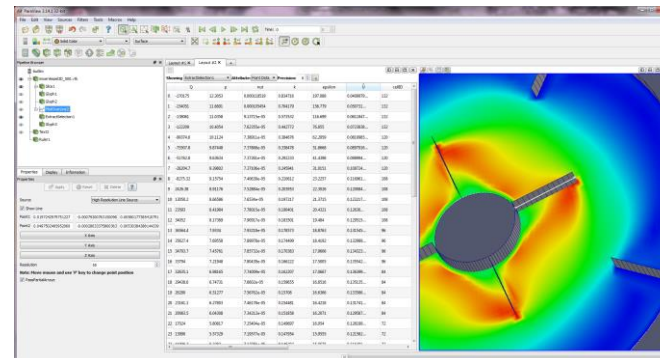
- 3d + 3d



- 3d + 2d



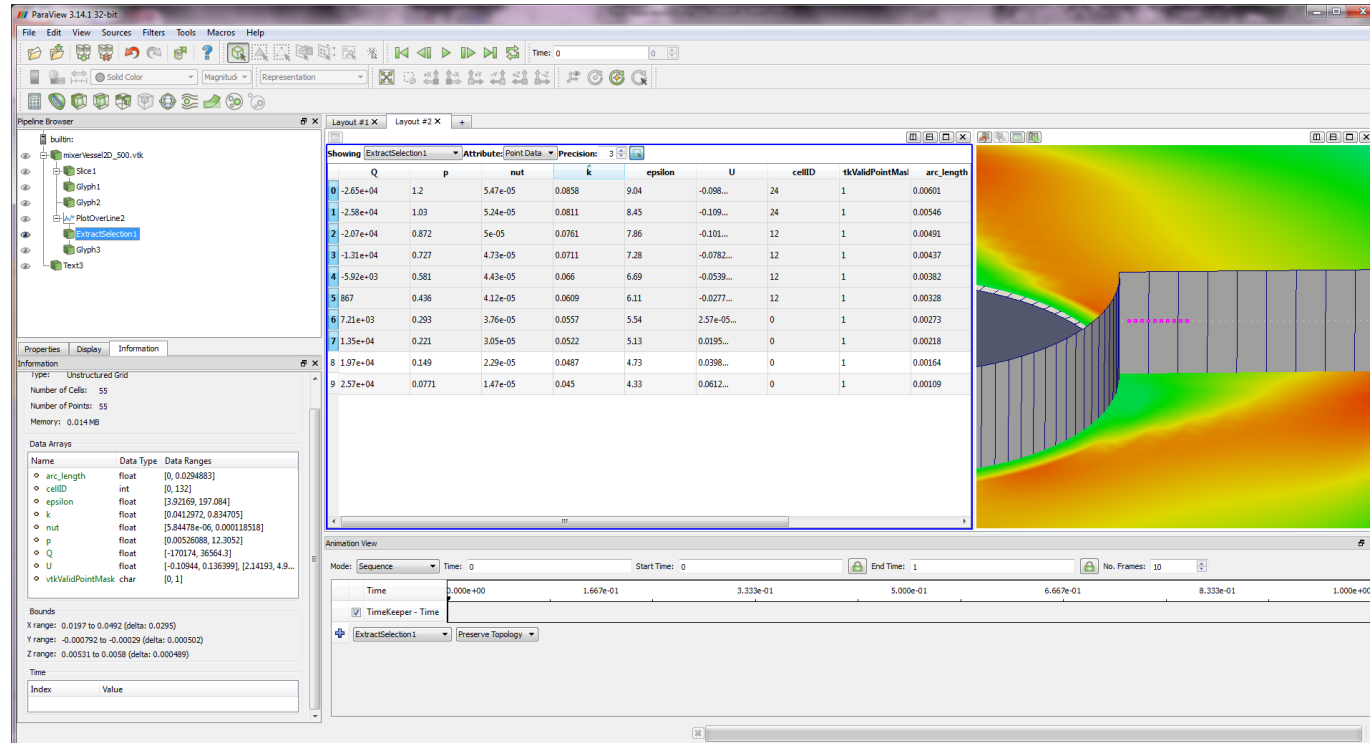
- 3d + table



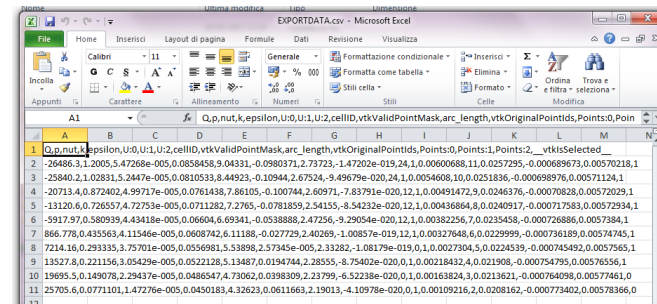
Data selection/saving



- Select your data



- Save as csv





Save a pipeline as a scene

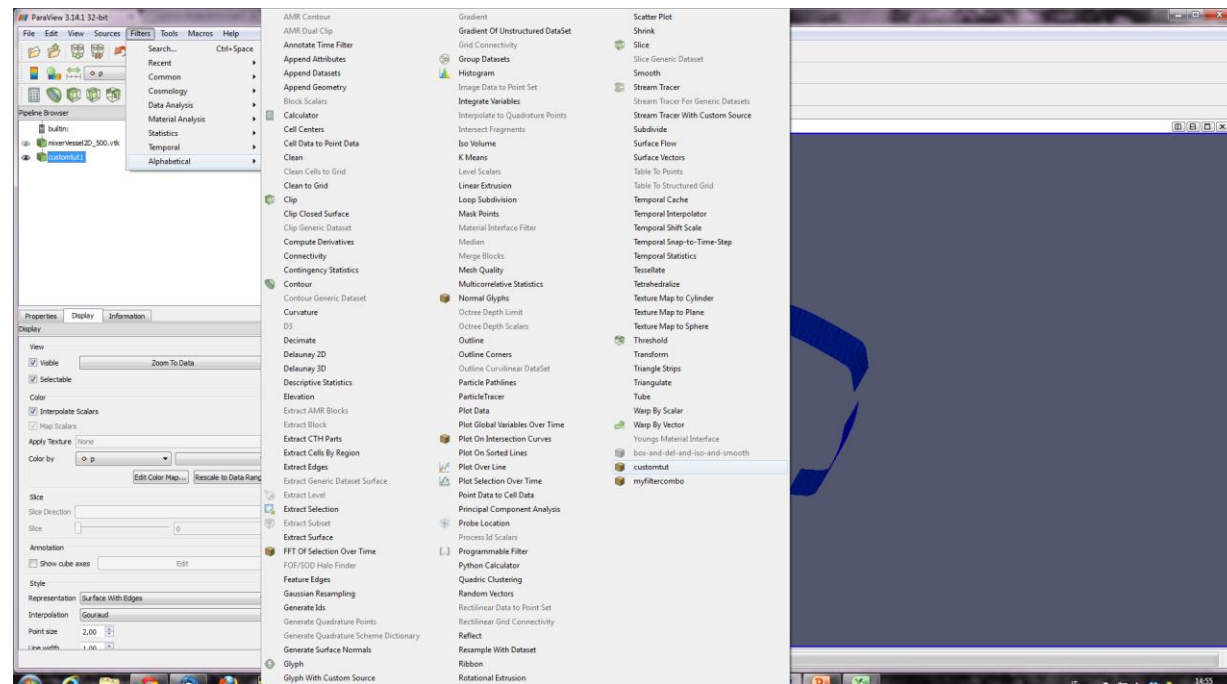
Save the obtained pipeline a PV scene for future processing by loading the scene back into ParaView.

The screenshot shows the ParaView 3.14.1 32-bit interface. The Pipeline Browser on the left shows a pipeline starting with 'builtin:' followed by 'mixerVessel2D_500.vtk', which is sliced and visualized with glyphs and a plot over line. The 'Information' panel at the bottom left shows details for the selected 'PlotOverLine2' object, including its type (Unstructured Grid), number of cells and points (55), and memory usage (0.014 MB). The 'Data Arrays' table lists variables like arc_length, cellID, epsilon, k, nut, and p with their data ranges.

Q	p	nut	k	epsilon	U	cellID	tkValidPointMas	arc_ler
0	-2.65e+04	1.2	5.47e-05	0.0858	9.04	-0.098...	24	0.00601
1	-2.58e+04	1.03	5.24e-05	0.0811	8.45	-0.109...	24	0.00546
2	-2.07e+04	0.872						
3	-1.31e+04	0.727						
4	-5.92e+03	0.581						
5	867	0.436						
6	7.21e+03	0.293						
7	1.35e+04	0.221						
8	1.97e+04	0.149						
9	2.57e+04	0.0771						

The 'Save State File' dialog box is open, showing the file path 'C:/Users/ponzini/Desktop/school-data/mixerVessel2D/'. The file name is 'MYSTATE' and the file type is 'ParaView state file (*.pvsm)'. The dialog also shows a file browser view of the directory contents, including folders like 'My Documents', 'Desktop', and 'mixerVessel2D'.

Build and use a new filter from a pipeline

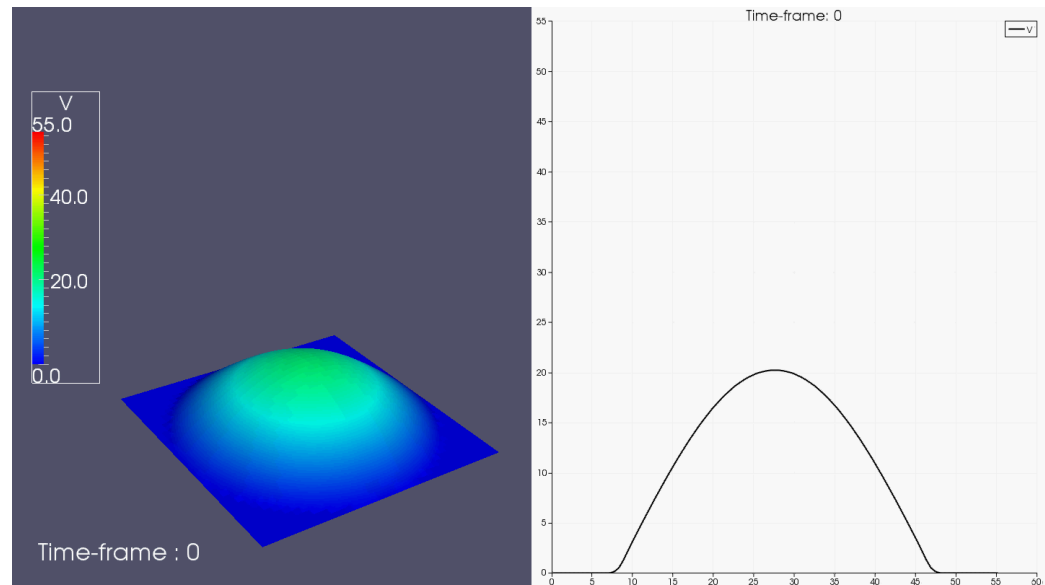


- Create a custom filter by grouping a pipeline
- Save the filter
- Close and re-load your custom filter



Tutorial1

- Load the data provided for the tutorial
- Process the data to obtain:
 - ✓ Slice info
 - ✓ Contour plot
 - ✓ Warp on scalar
 - ✓ 2d lineplot
 - ✓ Animate over time
 - ✓ Save the animation





Tutorial2

- Load the data provided for the tutorial
- Process the data to obtain:
 - ✓ Smaller dataset to process
 - ✓ 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

