



Large Scale Visualization with ParaView

Supercomputing 2015 Tutorial

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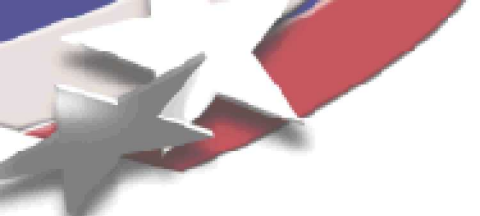
La-Ta Lo
Los Alamos National Laboratory

Joseph Insley
Argonne National Laboratory

Rich Cook
Lawrence Livermore National Laboratory

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SAND 2014-17514 PE

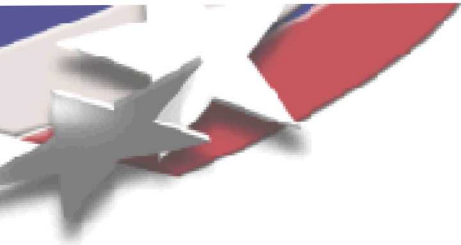
A decorative graphic in the top-left corner consisting of several overlapping stars in white, red, and blue.

Outline

- Introduction
- Basic Usage
- Batch Scripting
- Visualizing Large Models
- ParaView Cinema
- ParaViewWeb
- ParaView – Catalyst Integration
 - (Detailed Catalyst tutorial tomorrow morning.)

To Follow Along...

- Install ParaView 4.4.
 - <http://www.paraview.org> → Download
- Get example material.
 - http://www.paraview.org/Wiki/The_ParaView_Tutorial
- Data also available on thumb drives.
 - *Please don't steal the thumb drives.*
 - They are personal property volunteered by presenters.
 - They have never touched a Sandia computer.

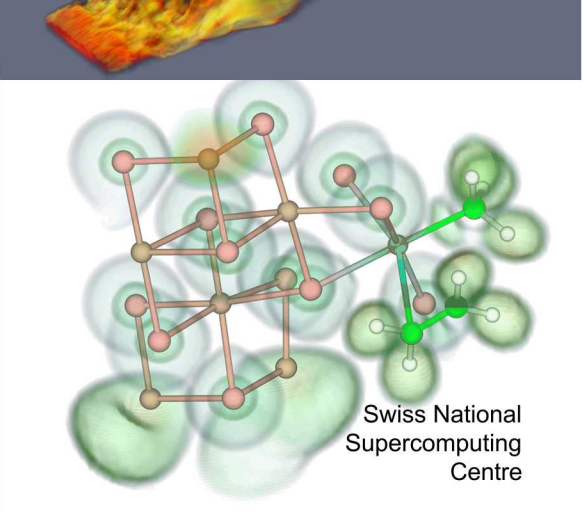
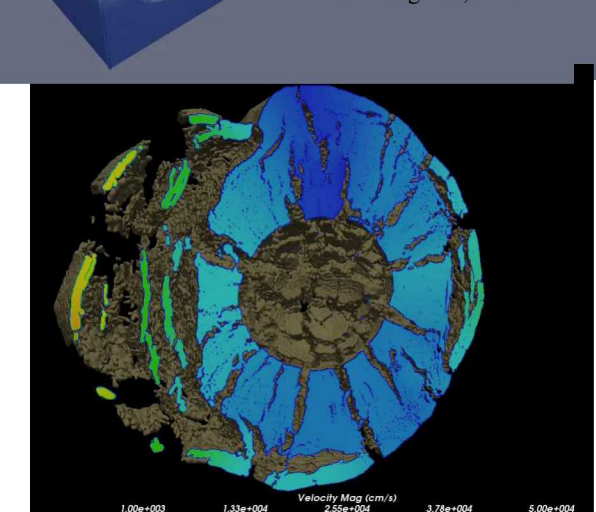
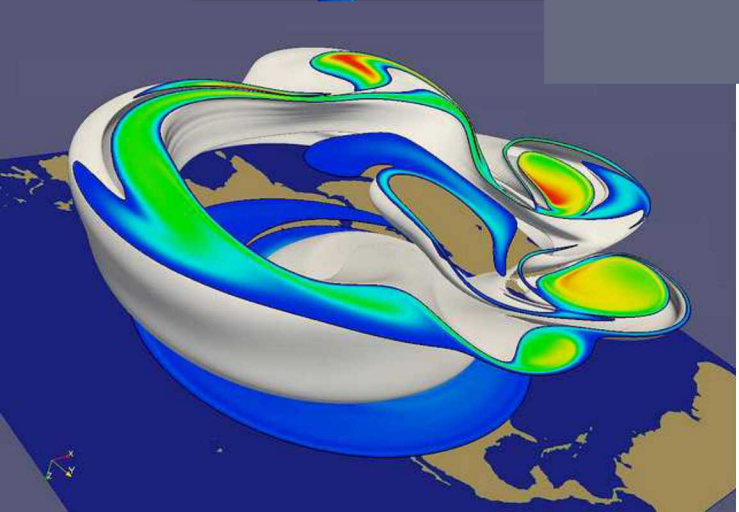
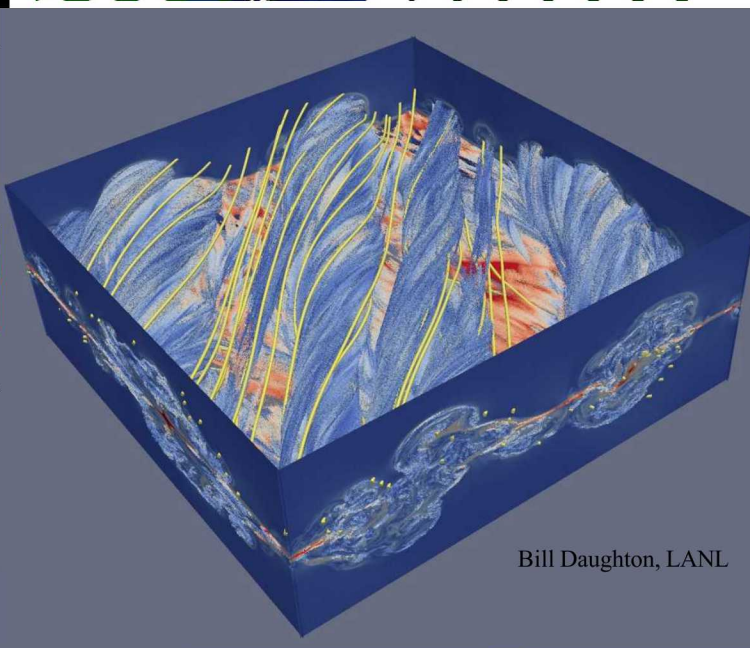
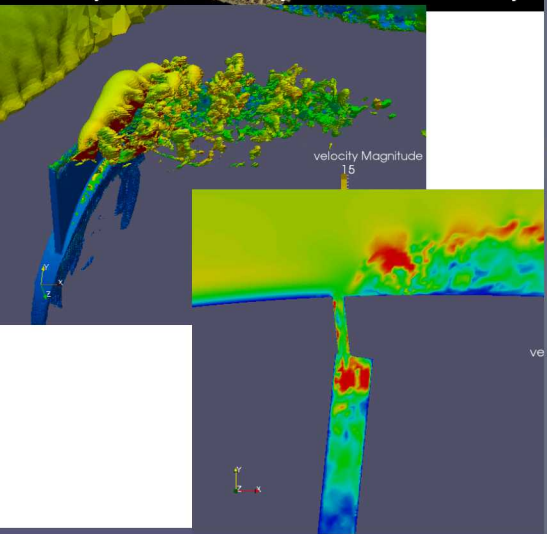
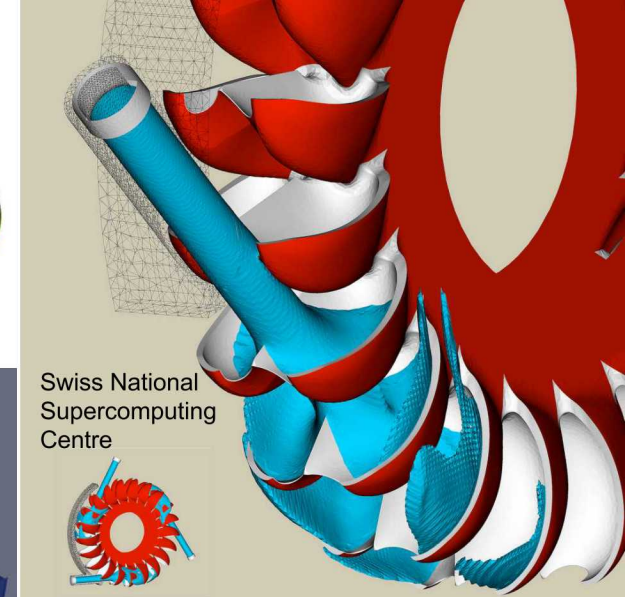
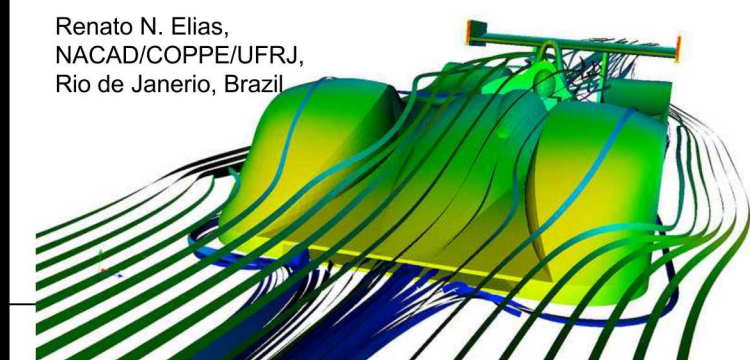
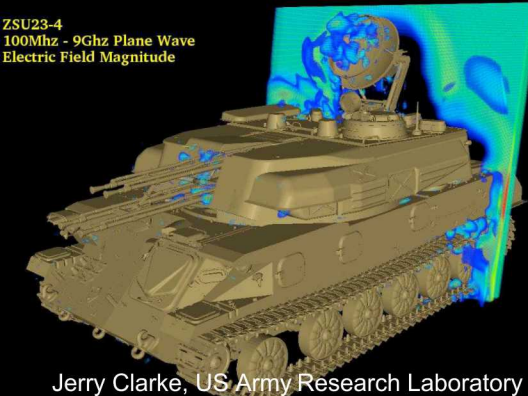


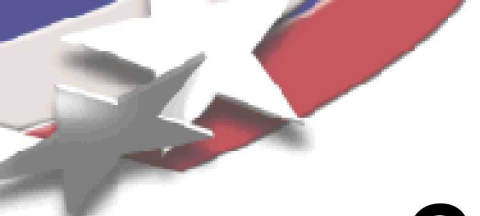
Introduction



What is ParaView?

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



In the top left corner, there are several overlapping stars in white, red, and blue, partially cut off by the edge of the slide.

Current ParaView Usage

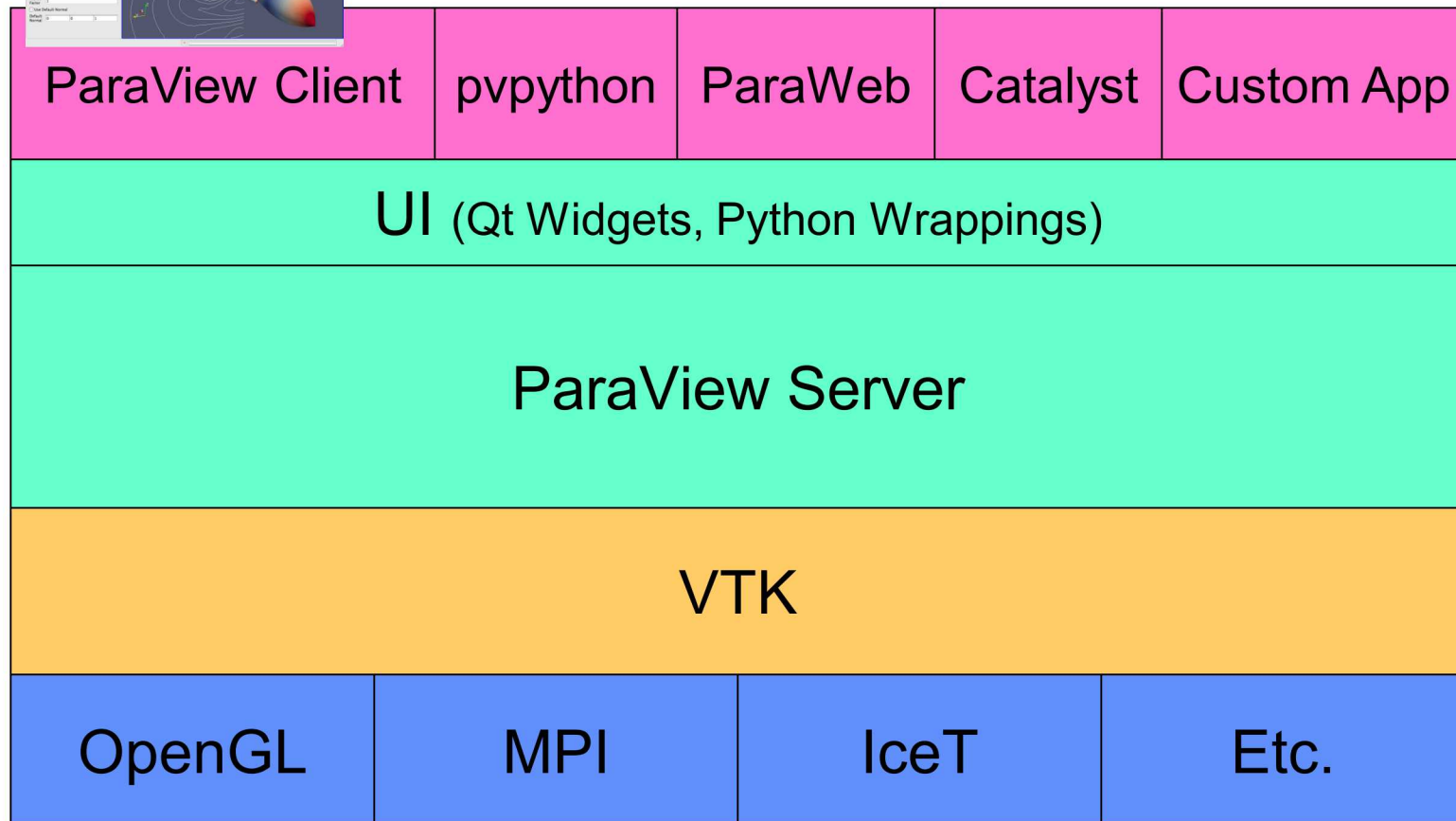
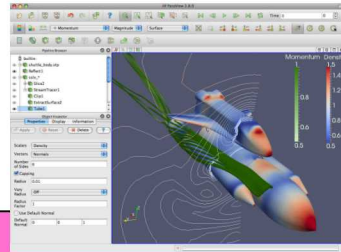
- Used by academic, government, and commercial institutions worldwide.
- Downloaded ~100K times per year.
- HPCwire Editors' Choice 2010 and HPCwire Readers' Choice 2010/2012 Awards for Best Visualization Product or Technology.



Data Ranges

- Used for all ranges of data size.
- Landmarks of SNL usage:
 - 6 billion structured cells (2005).
 - 250 million unstructured cells (2005).
 - Billions of AMR cells (2008).
 - Scaling test over 1 Trillion cells (2010).

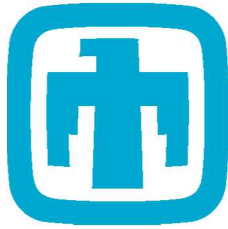
ParaView Application Architecture



ParaView Development

- Started in 2000 as collaborative effort between Los Alamos National Laboratories and Kitware Inc. (lead by James Ahrens).
 - ParaView 0.6 released October 2002.
- September 2005: collaborative effort between Sandia National Laboratories, Kitware Inc. and CSimSoft to rewrite user interface to be more user friendly and develop quantitative analysis framework.
 - ParaView 3.0 released in May 2007.
- ParaView 4.0 released in June 2013.

Current Funding



Sandia
National
Laboratories



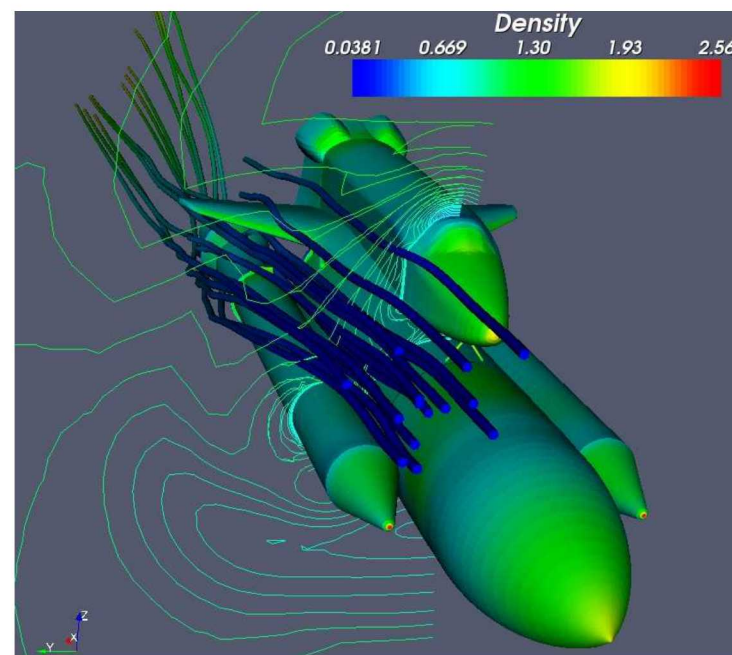
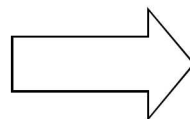
SDAV

- ARL
- ERDC
- US Army (SBIR)
- US Air Force (STTR)
- ONR
- Support Contracts
 - Electricity de France
 - Microsoft

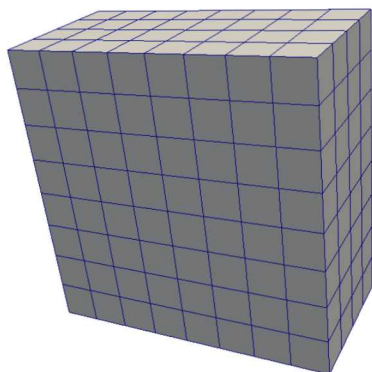
- Other contributors
 - Swiss National Supercomputing Centre
 - DOE SLAC
 - Ohio State
 - Mississippi State
 - RPI

Basics of Visualization

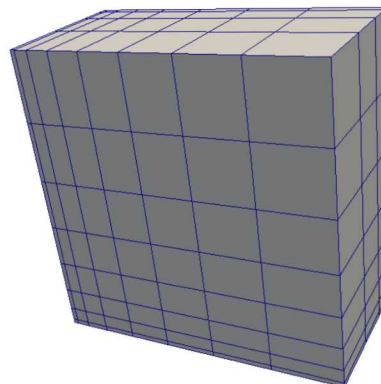
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0265720 134453 124327 176005 027034 107614 170774 073702 067274
0265740 072451 007735 147620 061064 157435 113057 155356 114603
0265760 107204 102316 171451 046040 120223 001774 030477 046573
0266000 171317 116055 155117 134444 167210 041405 147127 050505
0266020 004137 046472 124015 134360 173550 053517 044635 021135
0266040 070176 047705 113754 175477 105532 076515 177366 056333
0266060 041023 074017 127113 003214 037026 037640 066171 123424
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0266120 006716 071402 055672 132571 105645 170073 050376 072117
0266140 024451 007424 114200 077733 024434 012546 172404 102345
0266160 040223 050170 055164 164634 047154 126525 112514 032315
0266200 016041 176055 042766 025015 176314 017234 110060 014515
0266220 117156 030746 154234 125001 151144 163706 136237 164376
0266240 137055 062276 161755 115466 005322 132567 073216 002655
0266260 171466 126161 117155 065763 016177 014460 112765 055527
0266300 003767 175367 104754 036436 172172 150750 043643 145410
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0266400 020243 005602 004146 121574 124651 006634 071331 102070
0266420 157504 160307 166330 074251 024520 114433 167273 030635
0266440 133614 106171 144160 010652 007365 026416 160716 100413
0266460 026630 007210 000630 121224 076033 140764 000737 003276
0266500 114060 042647 104475 110537 066716 104754 075447 112254
0266520 030374 144251 077734 015157 002513 173526 035531 150003
0266540 146207 015135 024446 130101 072457 040764 165513 156412
0266560 166410 067251 156160 106406 136770 030516 064740 022032
0266600 142166 123707 175121 071170 076357 037233 031136 015232
0266620 075074 016744 044055 102230 110063 033350 052765 172463
```



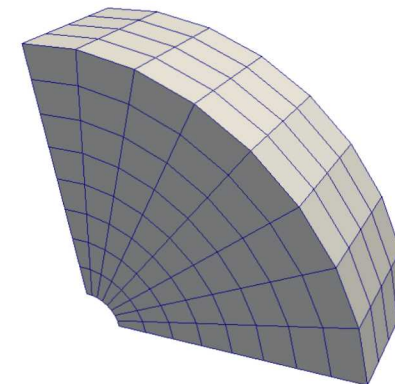
Data Types



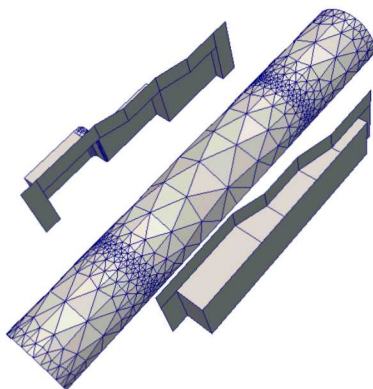
Uniform Rectilinear
(`vtkImageData`)



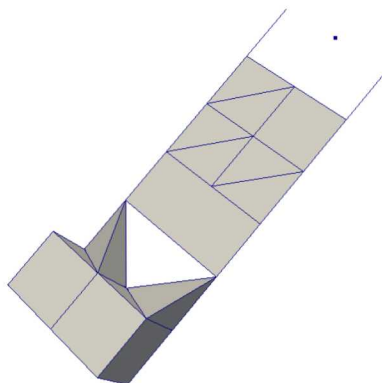
Non-Uniform Rectilinear
(`vtkRectilinearData`)



Curvilinear
(`vtkStructuredData`)



Polygonal
(`vtkPolyData`)



Unstructured Grid
(`vtkUnstructuredGrid`)

Multi-block

Hierarchical Adaptive
Mesh Refinement
(AMR)

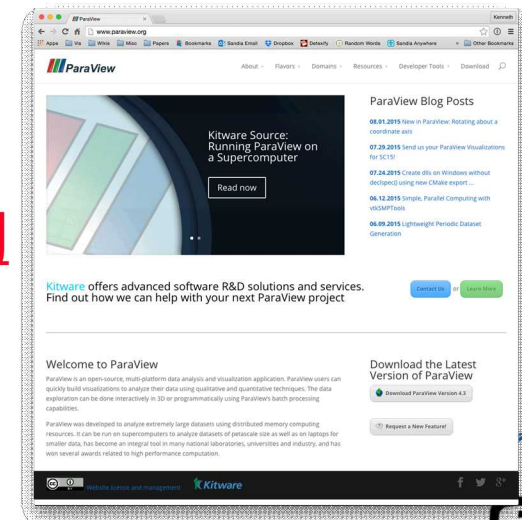
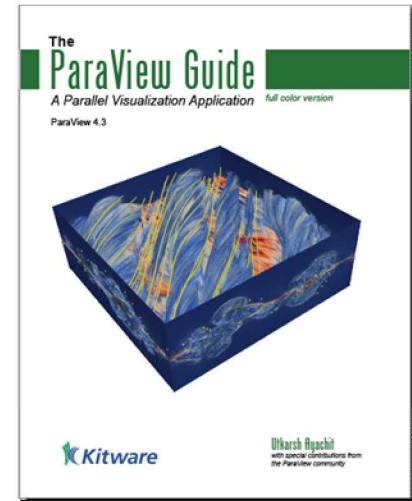
Hierarchical Uniform

AMR

Octree

More Information

- Online Help – F1 ?
- *The ParaView User's Guide*
 - <http://www.paraview.org/paraview-guide/>
- The ParaView web page
 - www.paraview.org
- ParaView mailing list
 - paraview@paraview.org





Basic Usage

User Interface

Menu Bar

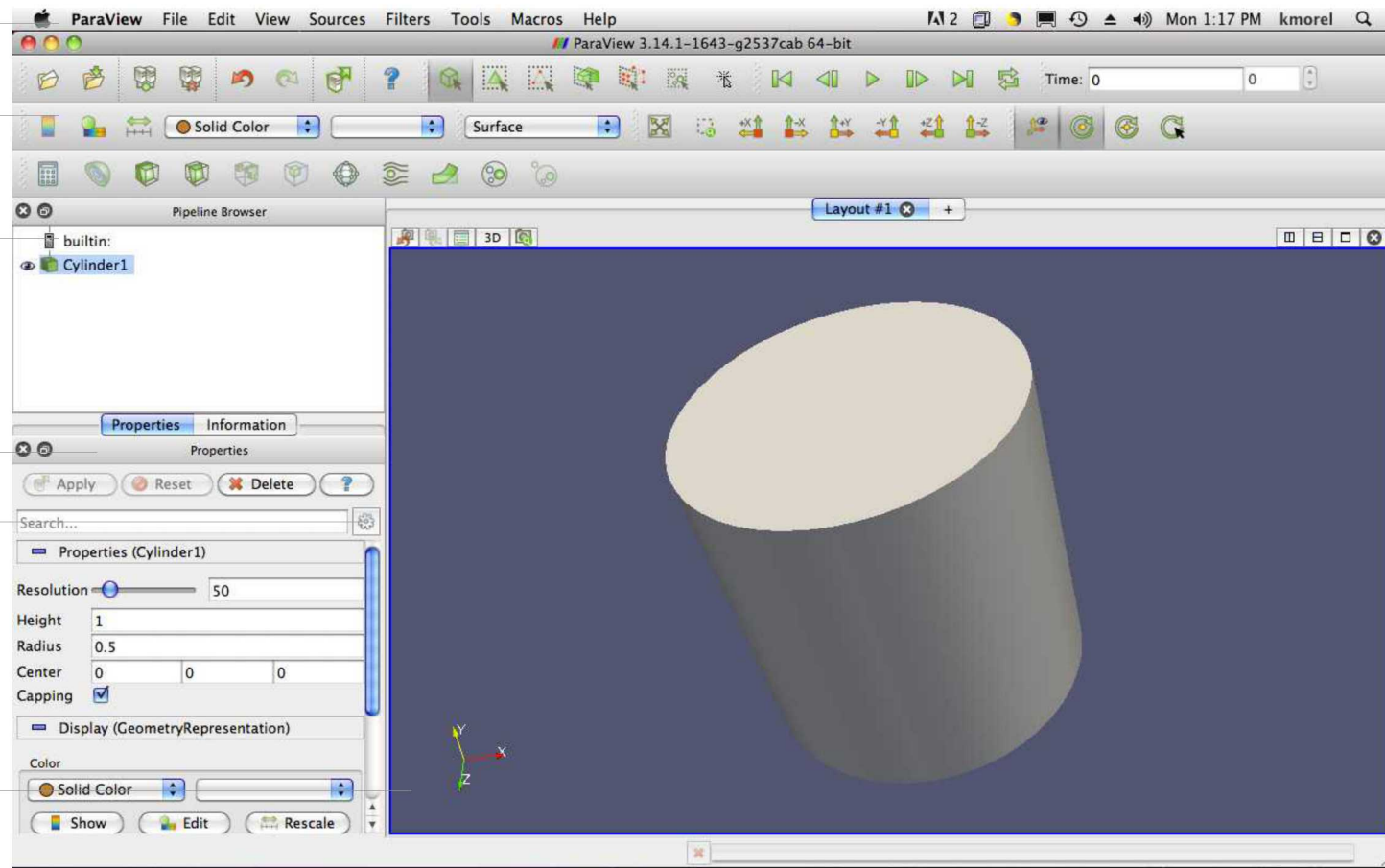
Toolbars

Pipeline Browser

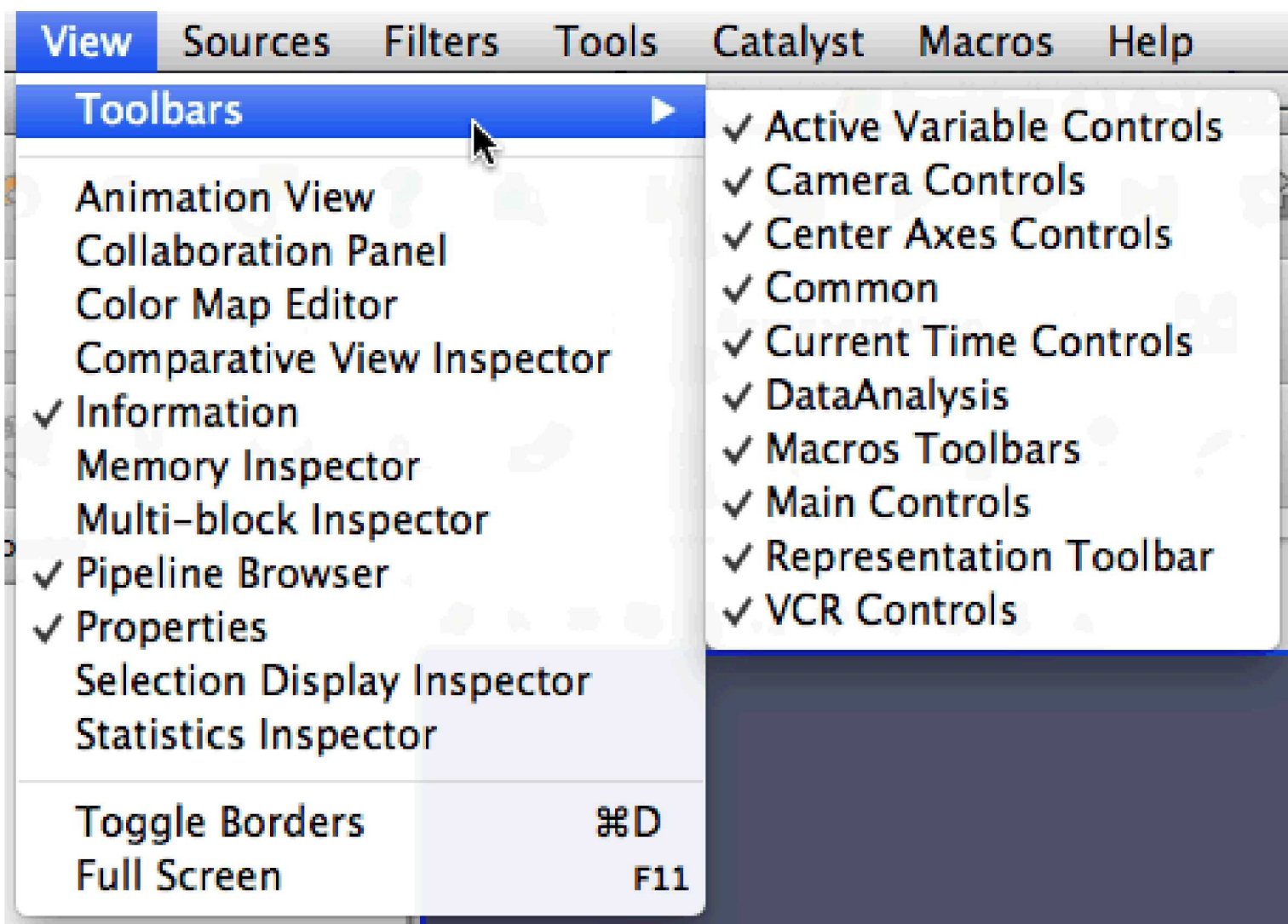
Properties Panel

Advanced Toggle

3D View



Getting Back GUI Components



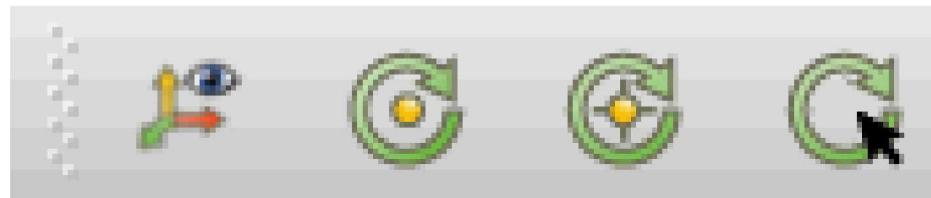
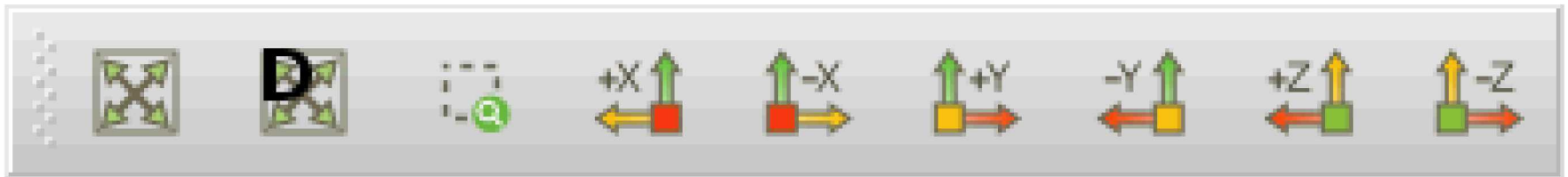
Creating a Cylinder Source

1. Go to the Source menu and select Cylinder.
2. Click the Apply button to accept the default parameters.



Simple Camera Manipulation

- Drag left, middle, right buttons for rotate, pan, zoom.
 - Also use Shift, Ctrl, Alt modifiers.



Creating a Cylinder Source

1. Go to the Source menu and select Cylinder.
2. Click the Apply button to accept the default parameters. 
3. Increase the Resolution parameter.

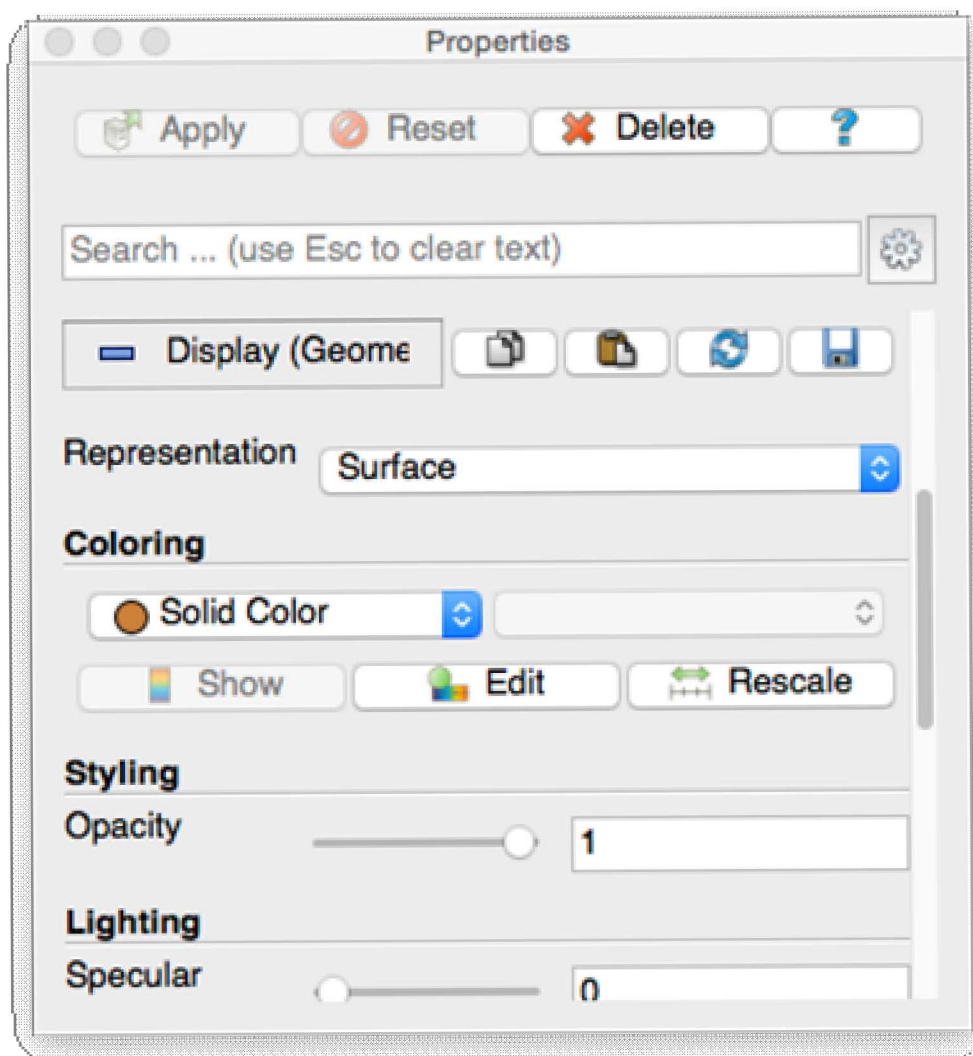


4. Click the  button again.

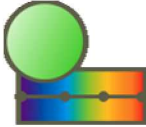
Pipeline Object Controls



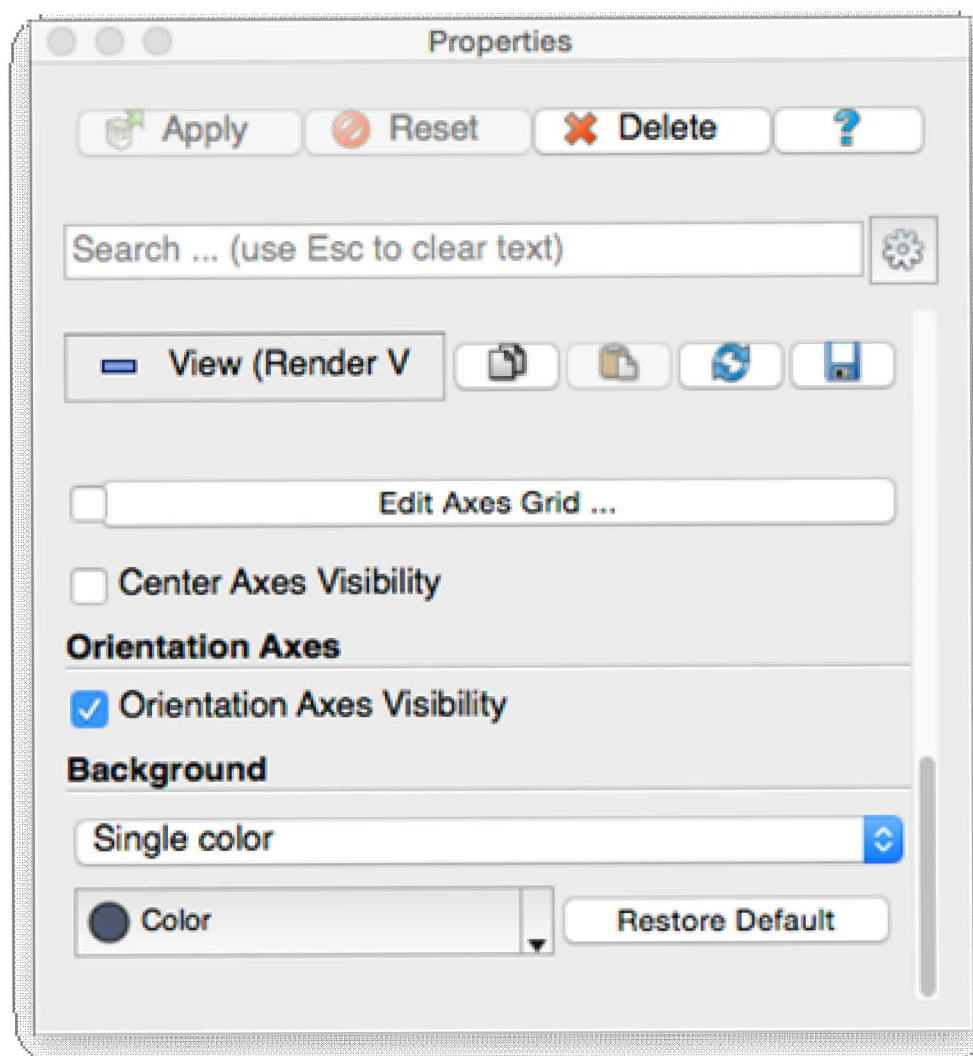
Display Properties



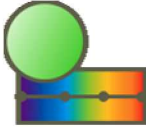
Change Render Properties

1. Scroll down to the Display group.
2. Click the  Edit button. (This button is replicated in the toolbar.)
3. Select a new color for the cylinder.

Render View Options

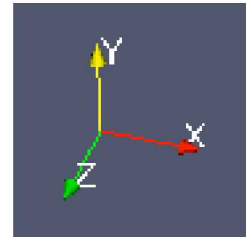


Change Render Properties

1. Scroll down to the Display group.
2. Click the  Edit button. (This button is replicated in the toolbar.)
3. Select a new color for the cylinder.
4. Scroll down to the View group.
5. Change the background from Single color to Gradient.

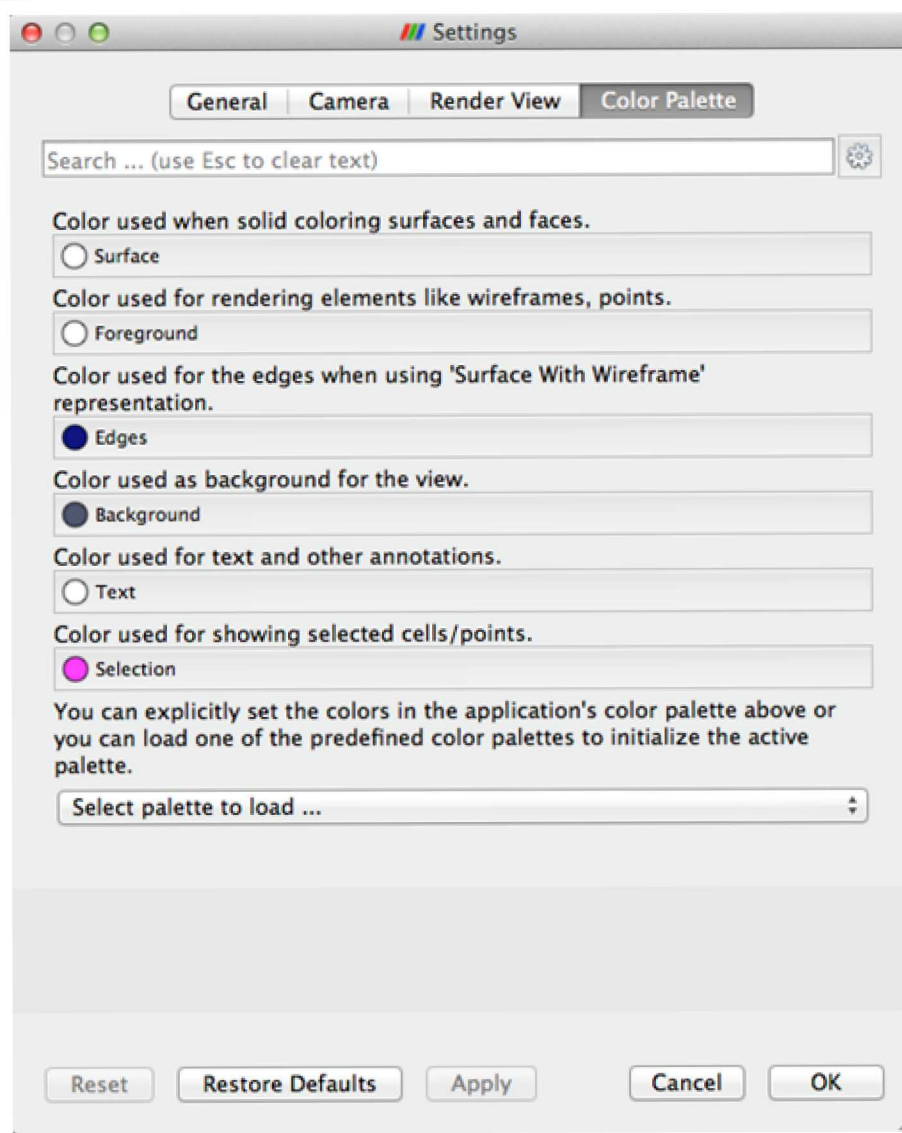
Changing the Color Palette

1. Make sure the orientation axes are visible in the lower left corner.



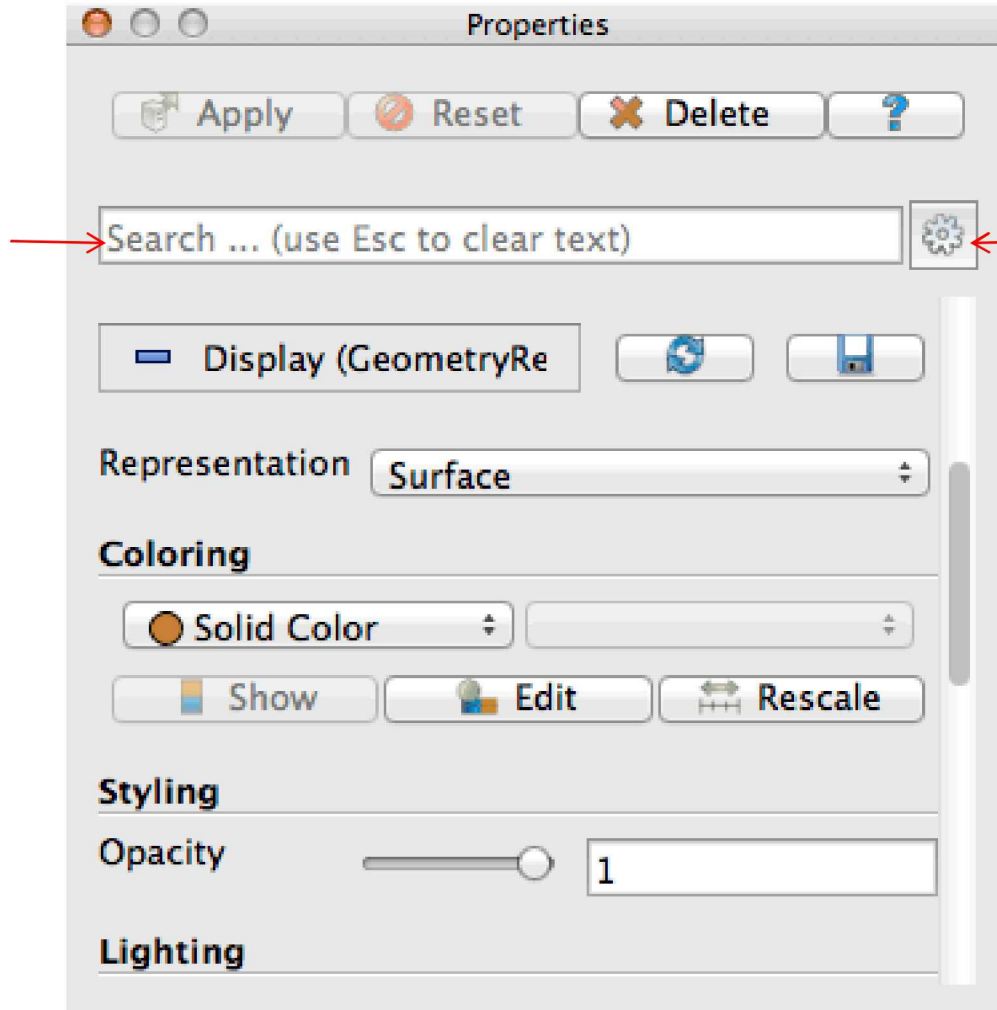
2. Click the color palette button  and change the colors.
3. Try several color palettes.

Color Palettes

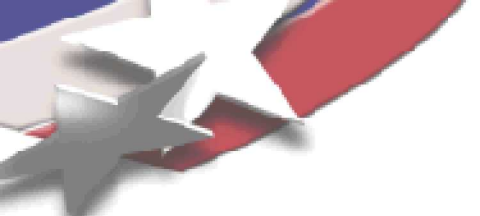


Advanced Properties

Search
Properties



Toggle
Advanced
Properties



Searching Properties

1. Type “specular” in the properties search box
2. Change Specular value to 1 (makes the cylinder shiny)

Searching Properties

1. Type “specular” in the properties search box
2. Change Specular value to 1 (makes the cylinder shiny)

Other interesting properties:

- Cube Axes
- Opacity
- Lights

Undo Redo



Undo



Redo



Camera
Undo



Camera
Redo

Creating a Cylinder Source

1. Go to the Source menu and select Cylinder.
2. Click the Apply button to accept the default parameters. 
3. Increase the Resolution parameter.



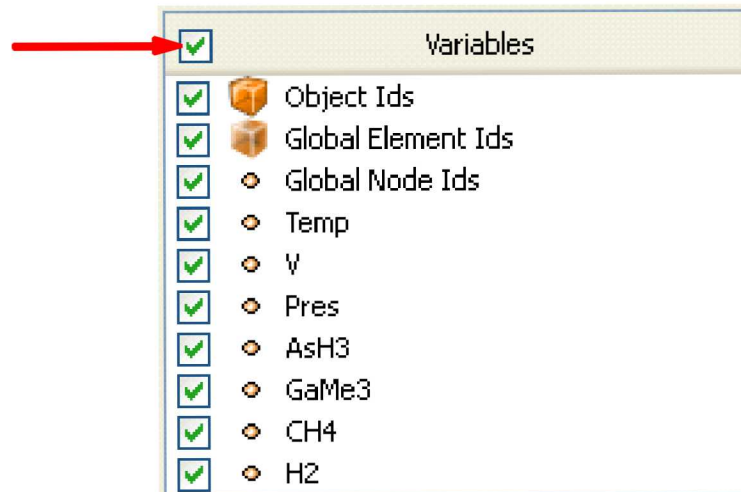
4. Click the  button again.
5. Delete the Cylinder. 

Supported Data Types

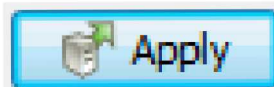
- ParaView Data (.pvd)
- VTK (.vtp, .vtu, .vti, .vts, .vtr)
- VTK Legacy (.vtk)
- VTK Multi Block (.vtm, .vtmb, .vtmg, .vthd, .vthb)
- Partitioned VTK (.pvту, .pvti, .pvts, .pvtr)
- ADAPT (.nc, .cdf, .elev, .ncd)
- ANALYZE (.img, .hdr)
- ANSYS (.inp)
- AVS UCD (.inp)
- BOV (.bov)
- BYU (.g)
- CAM NetCDF (.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, .gadget2)
- 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 files
- 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)
- M3DCI (.h5)
- MFIX Unstructured Grid (.RES)
- MM5 (.mm5)
- MPAS NetCDF (.nc, .ncdf)
- Meta Image (.mhd, .mha)
- Miranda (.mir, .raw)
- Multilevel 3d Plasma (.m3d, .h5)
- NASTRAN (.nas, .f06)
- Nek5000 Files
- Nrrd Raw Image (.nrrd, .nhdr)
- OpenFOAM Files (.foam)
- PATRAN (.neu)
- PFLOTTRAN (.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 files (.nrrd)
- 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 (.spherical, .sv)
- SpyPlot CTH
- SpyPlot (.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

Load disk_out_ref.ex2

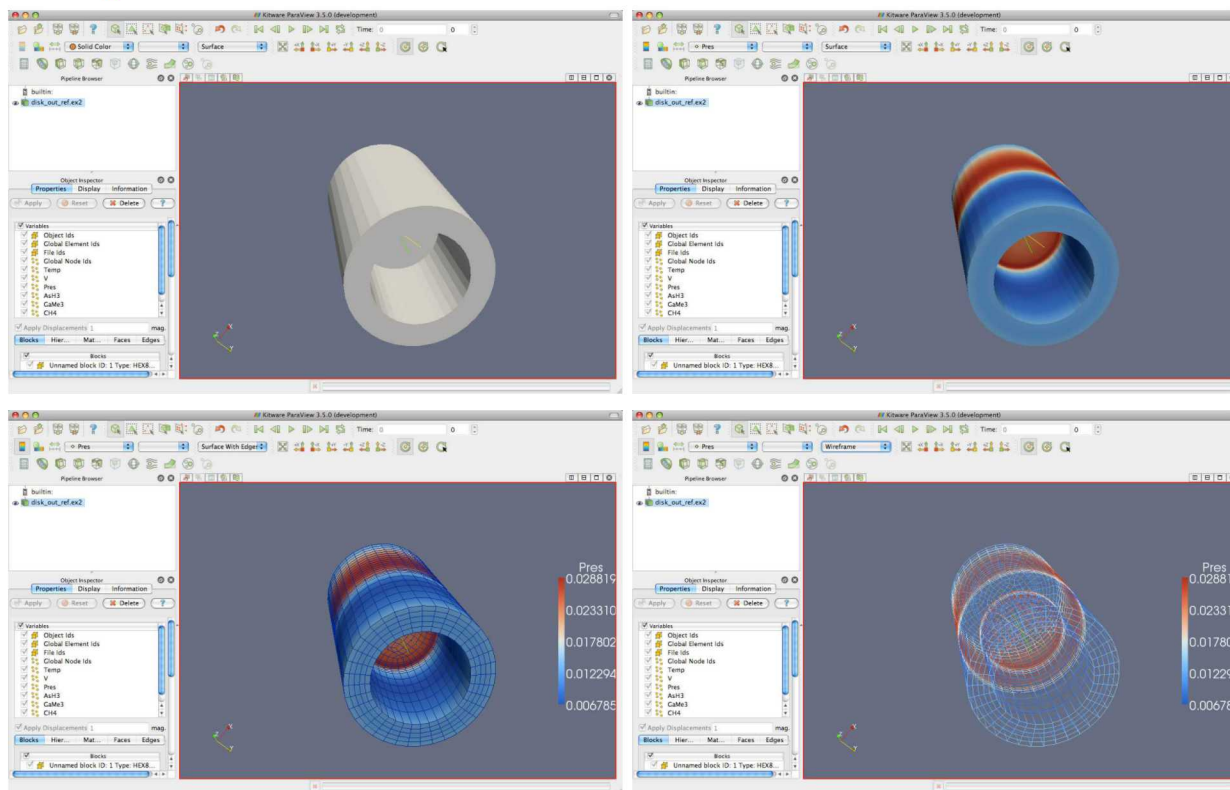
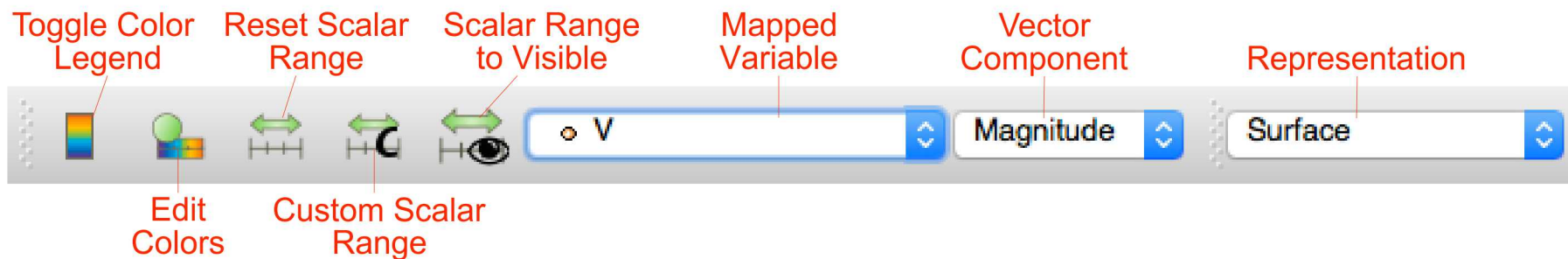
1. Open the file disk_out_ref.ex2.
2. Load all data variables.



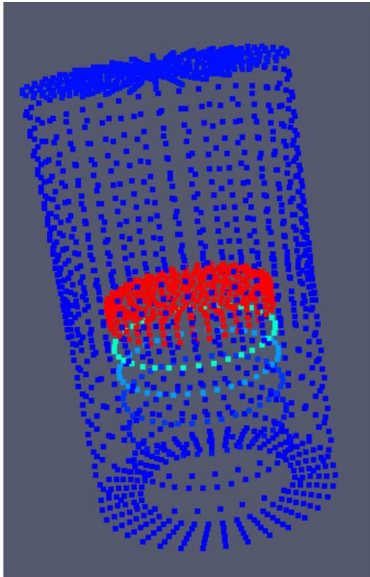
3. Click



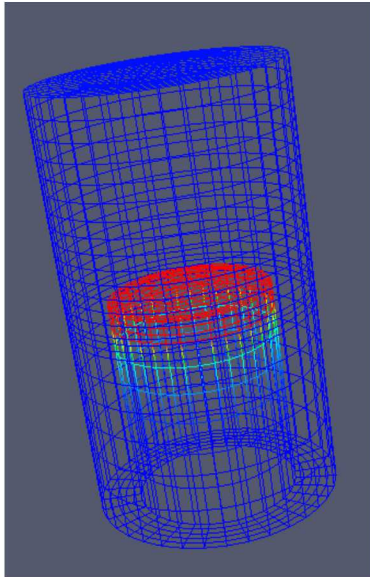
Data Representation



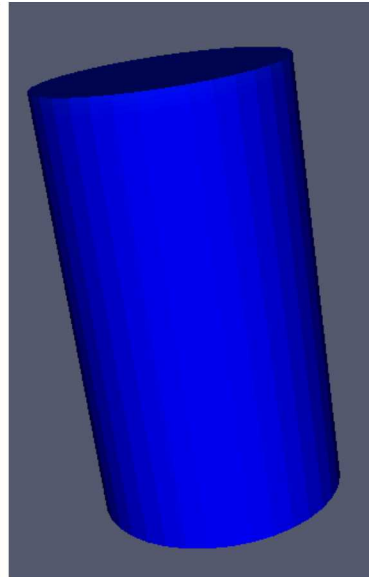
Geometry Representations



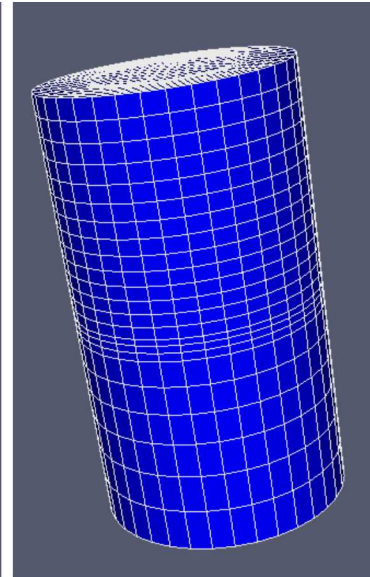
Points



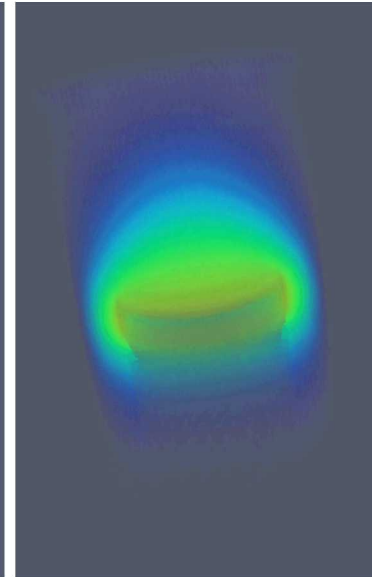
Wireframe



Surface



Surface
with Edges



Volume

Common Filters



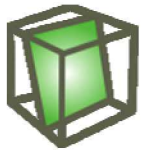
Calculator



Contour



Clip



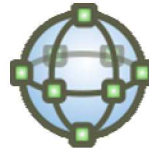
Slice



Threshold



Extract Subset



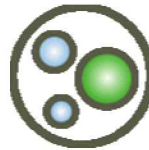
Glyph



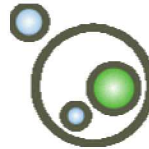
Stream Tracer



Warp (vector)

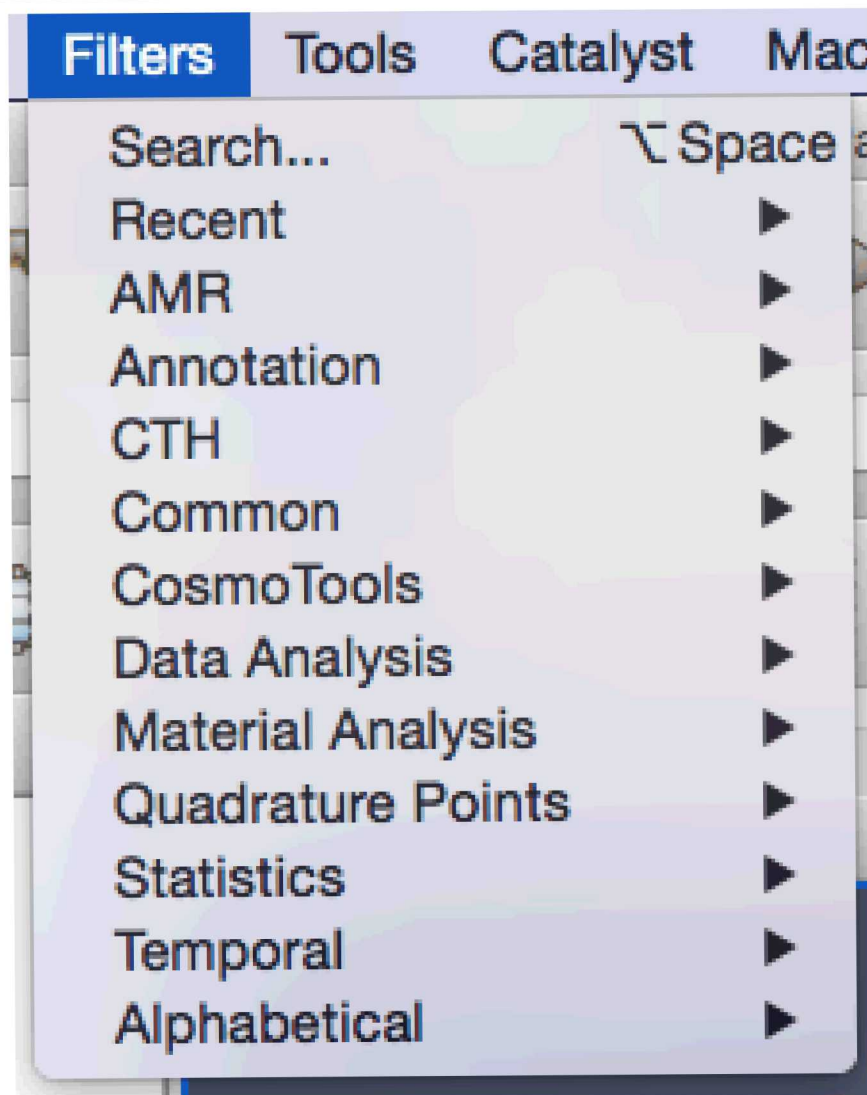


Group Datasets

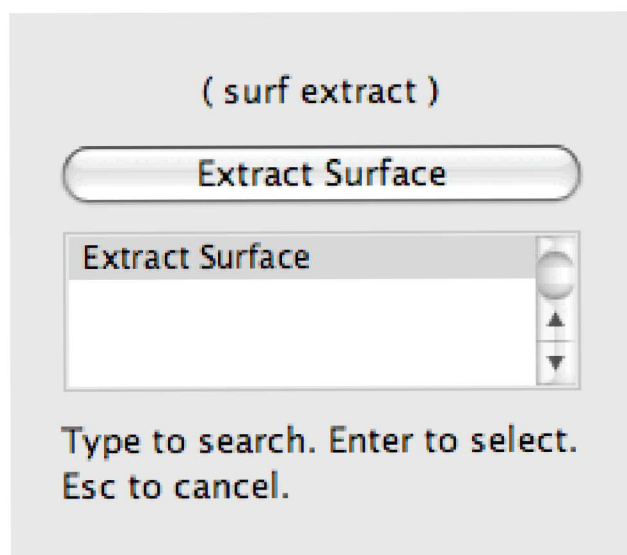


Extract Level

Filters Menu



Quick Launch



- Used for searching for filters by name
- Keyboard shortcut
 - Ctrl-space for Windows & Linux
 - Alt-space for Mac

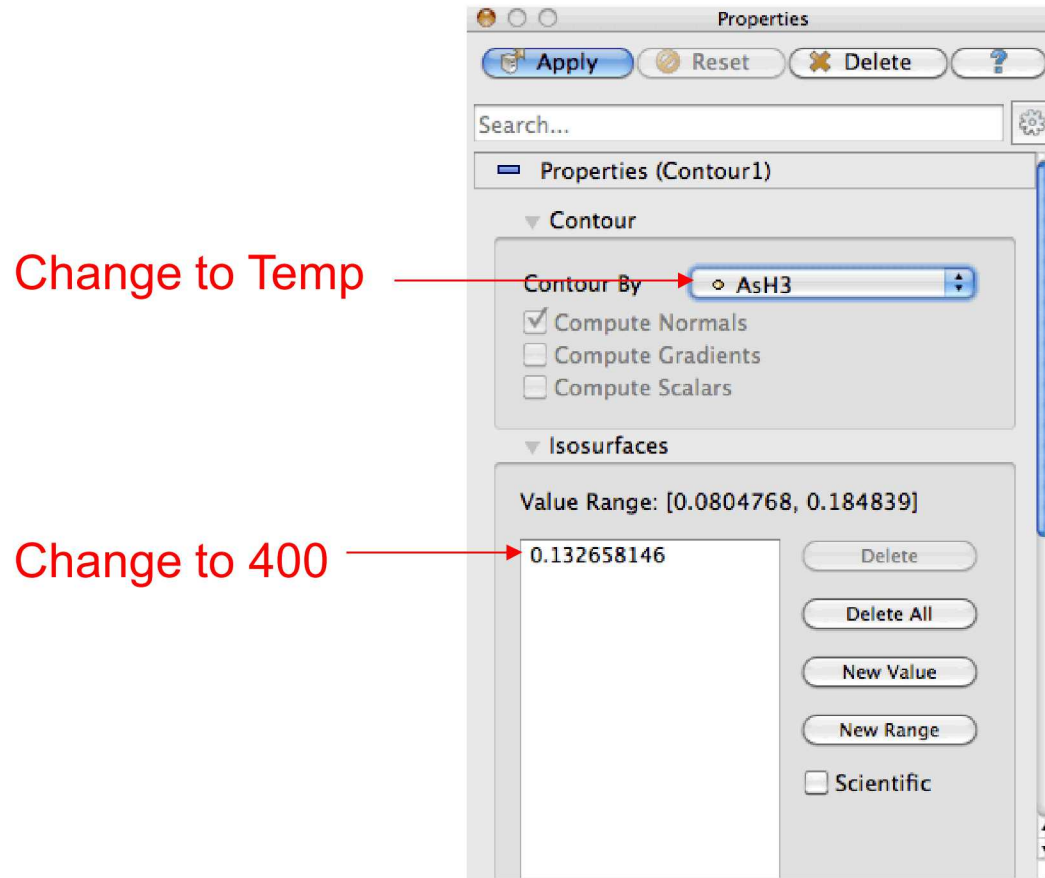
Apply a Filter

1. Make sure that disk_out_ref.ex2 is selected in the pipeline browser.
2. Select the contour filter.



Apply a Filter

3. Change parameters to create an isosurface at Temp = 400K.



Apply a Filter

1. Make sure that disk_out_ref.ex2 is selected in the pipeline browser.
2. Select the contour filter. 
3. Change parameters to create an isosurface at Temp = 400K.
4. 

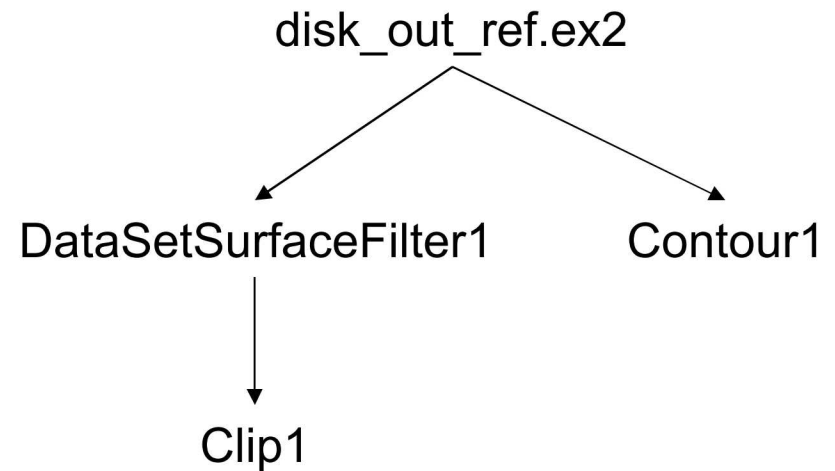
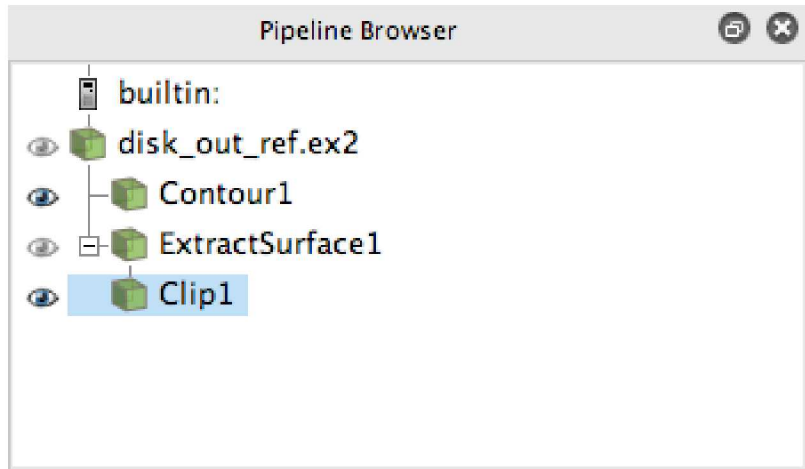
Create a Cutaway Surface

1. Select `disk_out_ref.ex2` in the pipeline browser.
2. From the quick launch, select Extract Surface.
3.  Apply

Create a Cutaway Surface

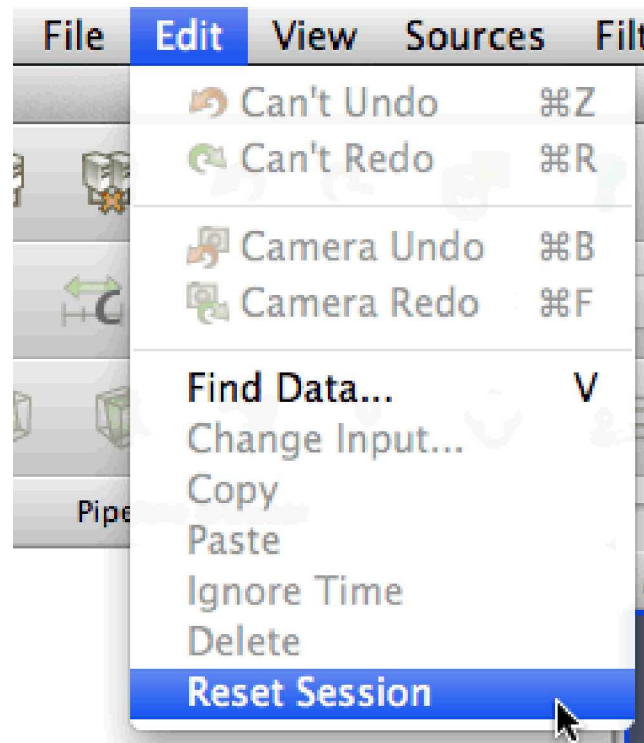
1. Select `disk_out_ref.ex2` in the pipeline browser.
2. From the quick launch, select Extract Surface.
3.  Apply
4. Create a clip filter. 
5. Uncheck Show Plane.  Show Plane
6.  Apply

Pipeline Browser Structure

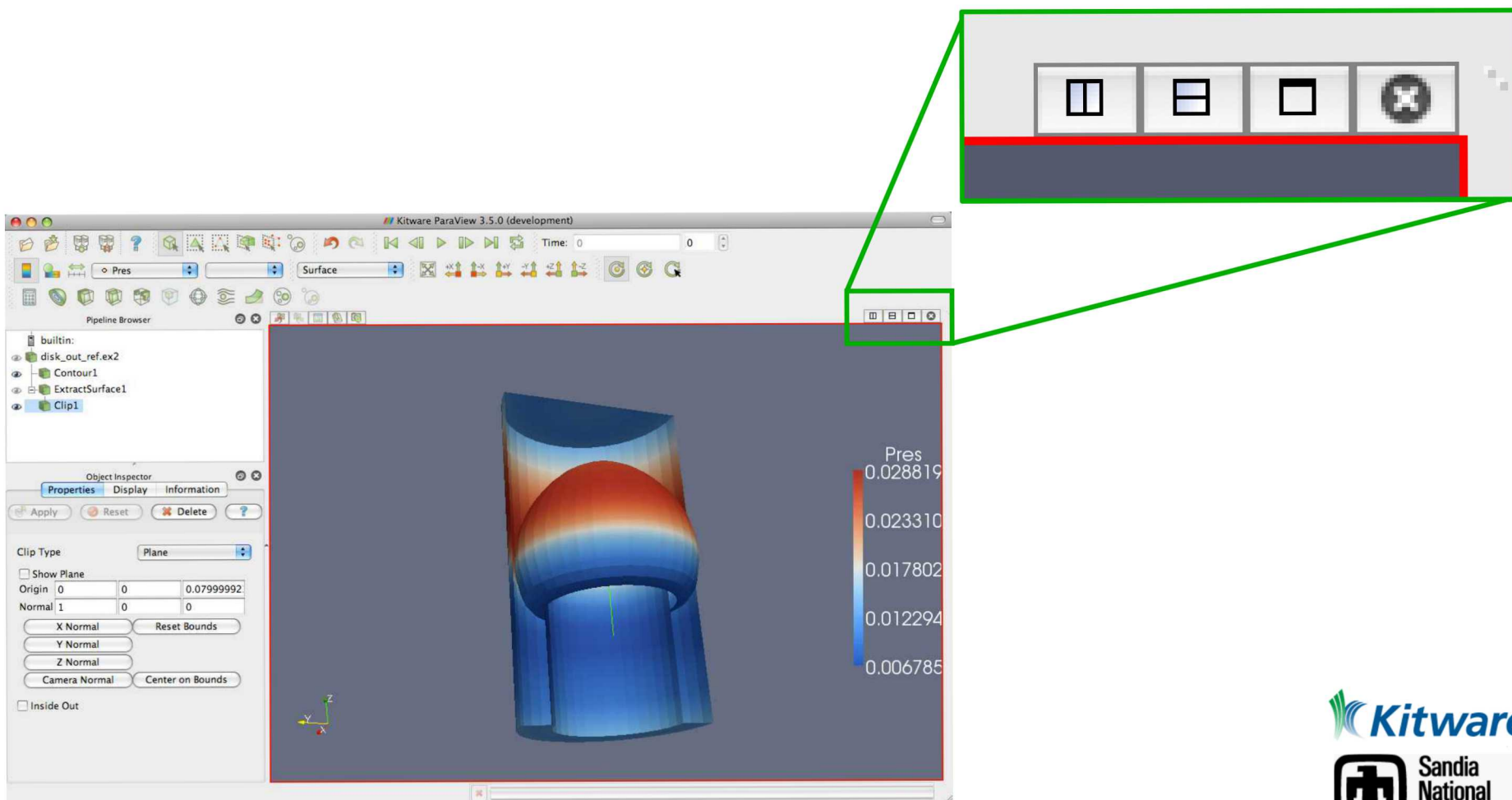


Reset ParaView

Edit → Reset Session



Multiview



Multiview

1. Open disk_out_ref.ex2. Load all variables. 
2. Add Clip filter. 
3. Uncheck Show Plane.  Show Plane
4. 
5. Color surface by Pres.

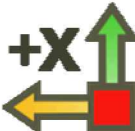
Multiview

6. Split the view horizontally. 
7. Make Clip1 visible. 
8. Color surface by Temp.

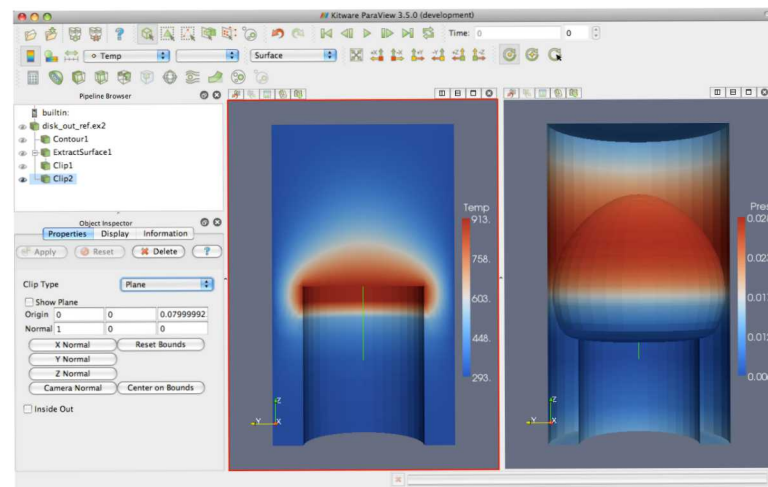
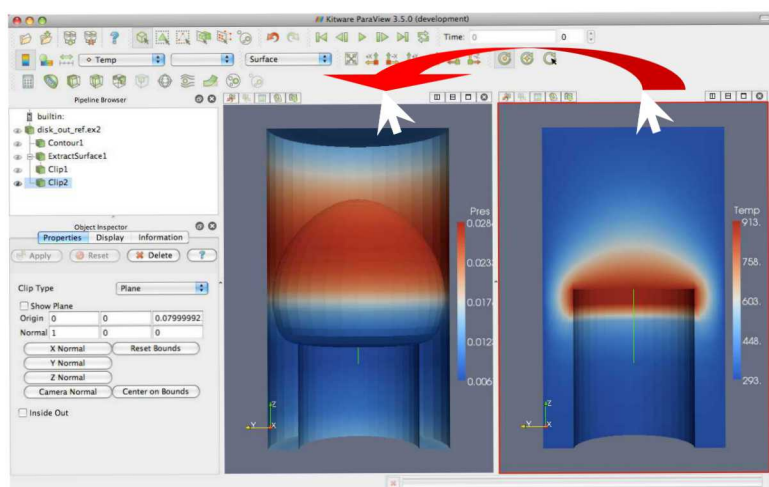
Multiview

6. Split the view horizontally. 
7. Make Clip1 visible. 
8. Color surface by Temp.
9. Right-click view, Link Camera...
10. Click other view.

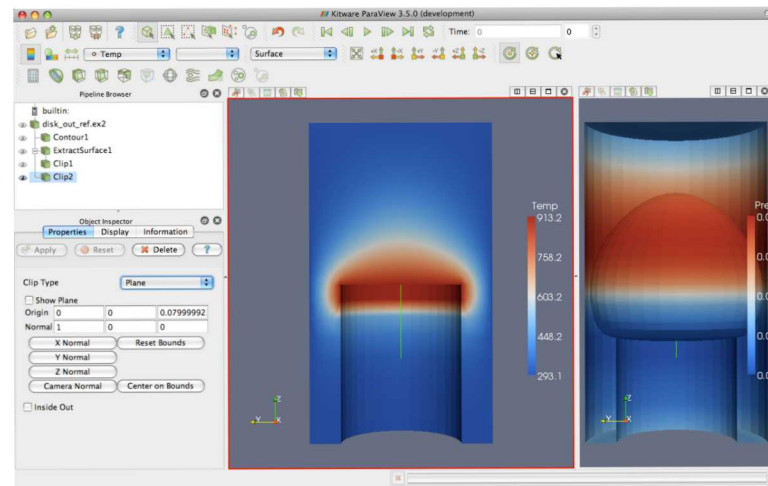
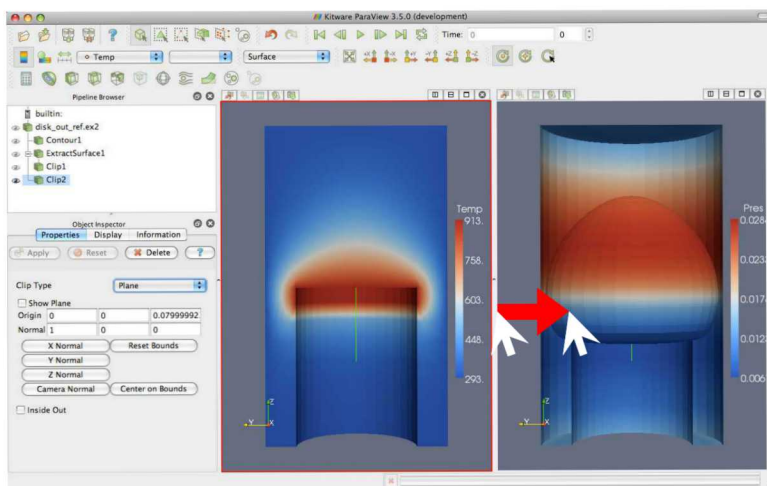
Multiview

6. Split the view horizontally. 
7. Make Clip1 visible. 
8. Color surface by Temp.
9. Right-click view, Link Camera...
10. Click other view.
11. Click 

Modifying Views

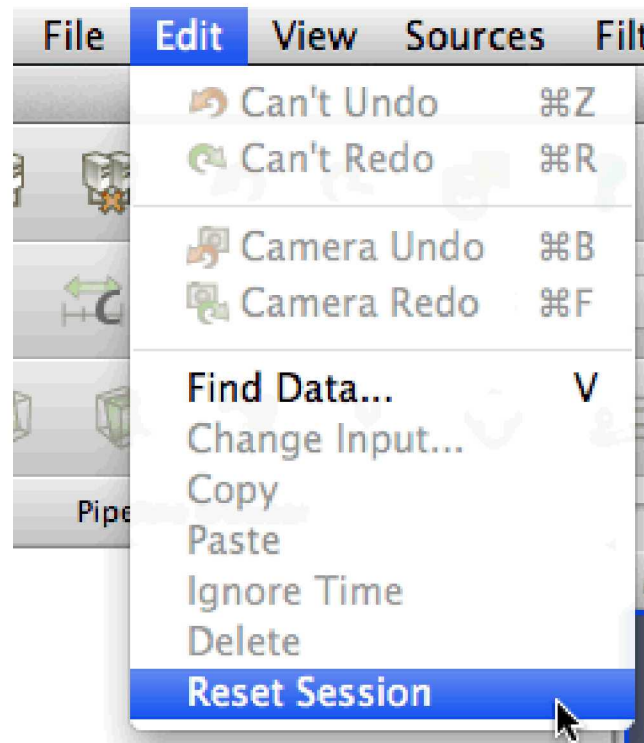


Modifying Views



Reset ParaView

Edit → Reset Session



Streamlines

1. Open disk_out_ref.ex2. Load all variables. 
2. Add Stream Tracer. 
3. 

Streamlines

1. Open disk_out_ref.ex2. Load all variables. 
2. Add Stream Tracer. 
3. 
4. From the quick launch, select Tube
5. 

Getting Fancy

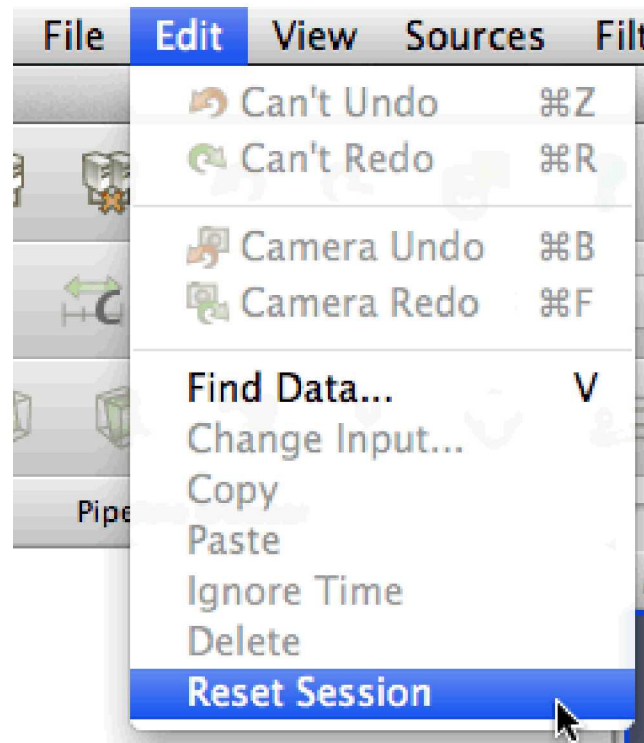
6. Select StreamTracer1.
7. Add Glyph filter.
8. Change Glyph Type to Cone.
9. Change Vectors to V.
10. Change Scale Mode to vector.
11. Click reset  next to Scale Factor.
12.  Apply
13. Color by Temp.

Getting Answers

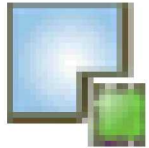
- Where is the air moving the fastest?
Near the disk or away from it? At the center of the disk or near its edges?
- Which way is the plate spinning?
- At the surface of the disk, is air moving toward the center or away from it?

Reset ParaView

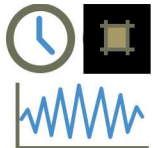
Edit → Reset Session



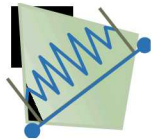
Common Data Analysis Filters



Extract Selection



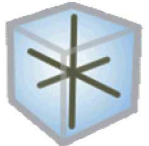
Plot Global Variables Over Time



Plot Over Line



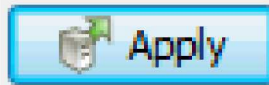
Plot Selection Over Time



Probe Location

Plotting

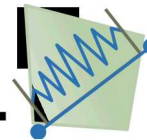
1. Open disk_out_ref.ex2. Load all variables.



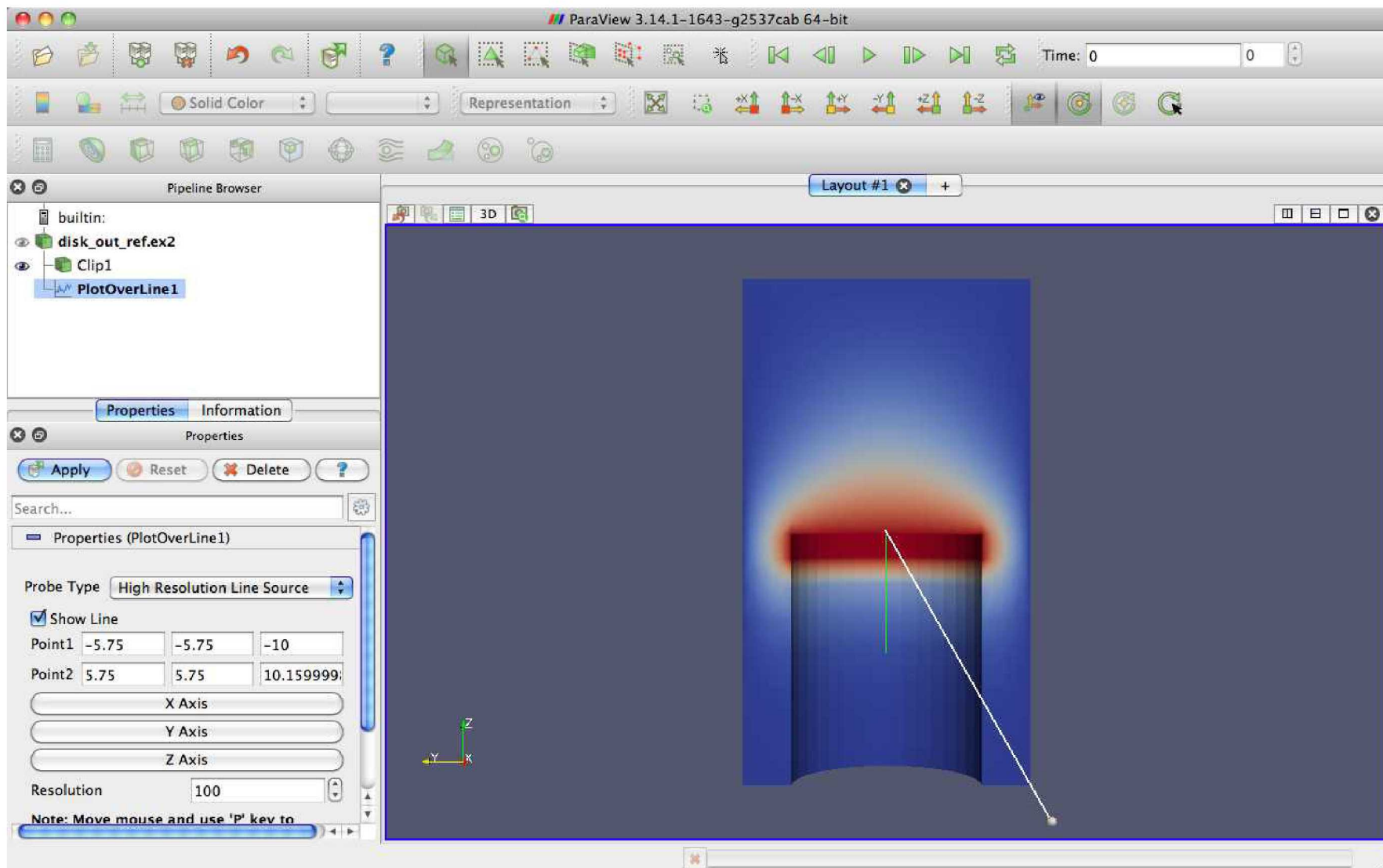
2. Clip, uncheck, ☒ Show Plane , 

3. Select disk_out_ref.ex2.

4. Add Plot Over Line filter.



3D Widgets

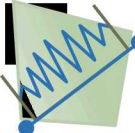


Plotting

1. Open disk_out_ref.ex2. Load all variables. 

2. Clip,  uncheck, ☒ Show Plane , 

3. Select disk_out_ref.ex2.

4. Add Plot Over Line filter. 

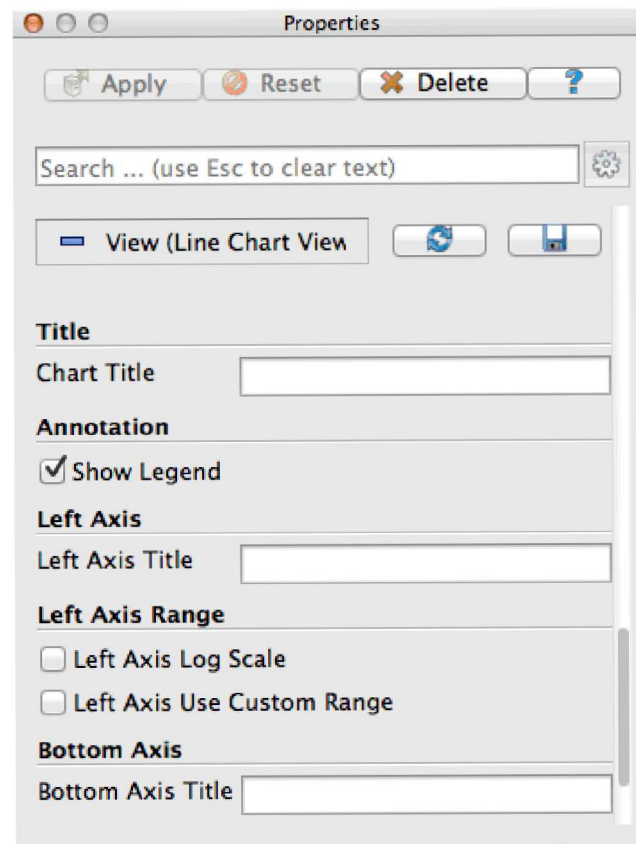
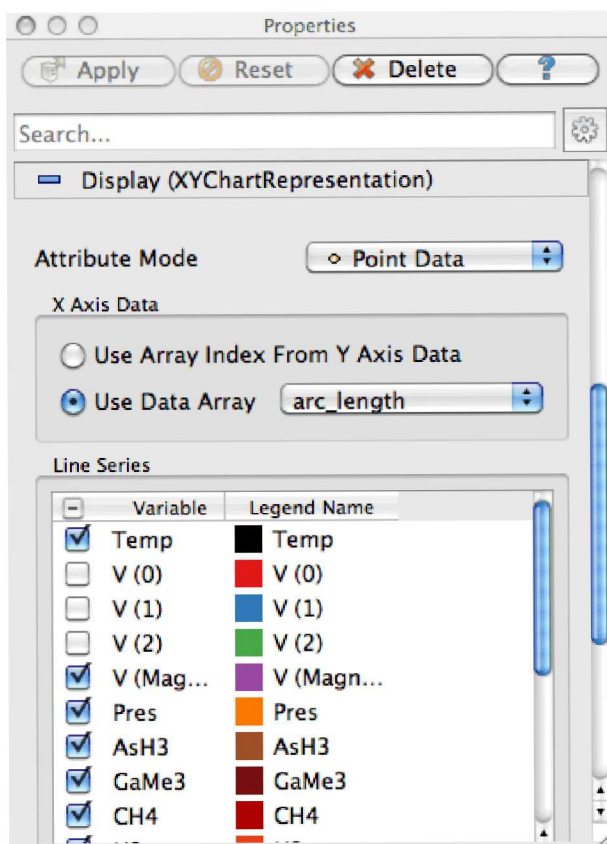
5. Once line is satisfactorily located, 

Interacting with Plots

- Left, middle, right buttons to pan, zoom.
- Mouse wheel to zoom.
- Reset view to plot ranges. 

Plots are Views

- Move them like Views.
- Save screenshots.

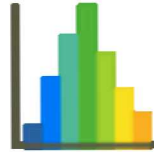


Adjusting Plots

1. In Display section of properties panel, turn off all variables except Temp and Pres.
2. Select Pres in the Display options.
3. Change Chart Axis to Bottom – Right.
4. Verify the relationship between temperature and pressure.

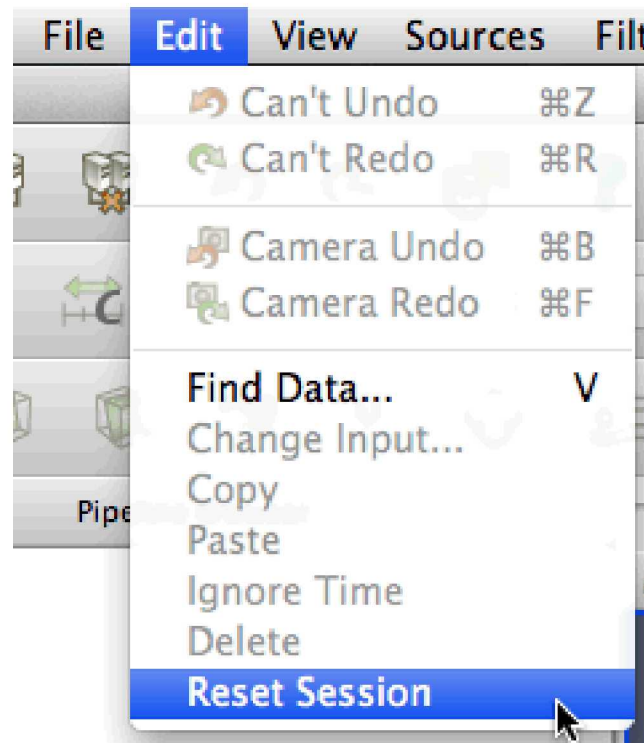
Histogram / Bar Chart

1. Select disk_out_ref.ex2.
2. Filters → Data Analysis → Histogram
3. Change ... to Temp.
4. 

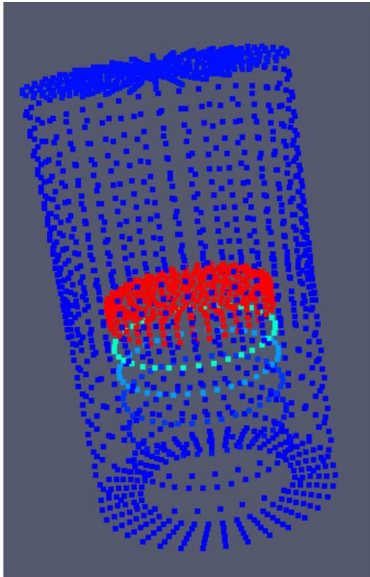


Reset ParaView

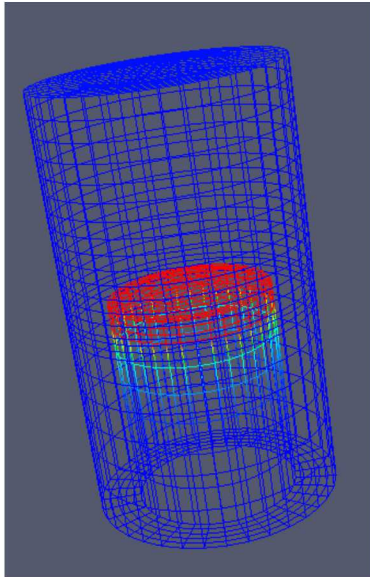
Edit → Reset Session



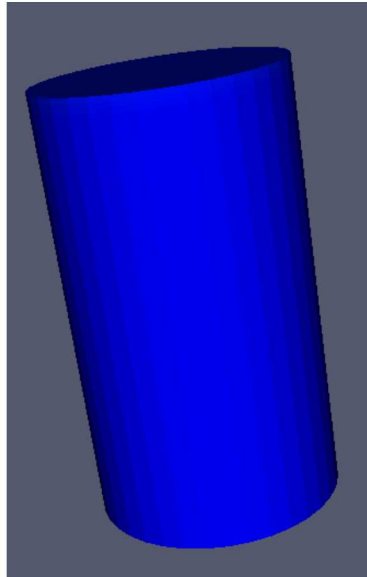
Geometry Representations



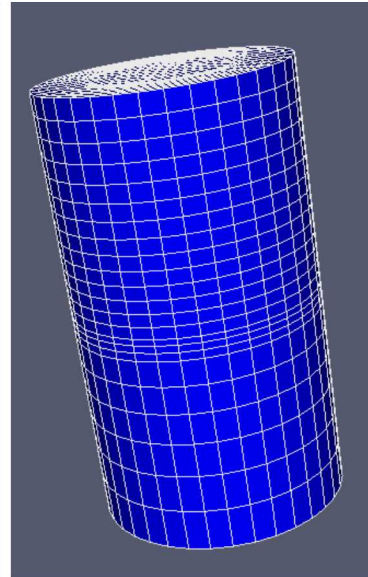
Points



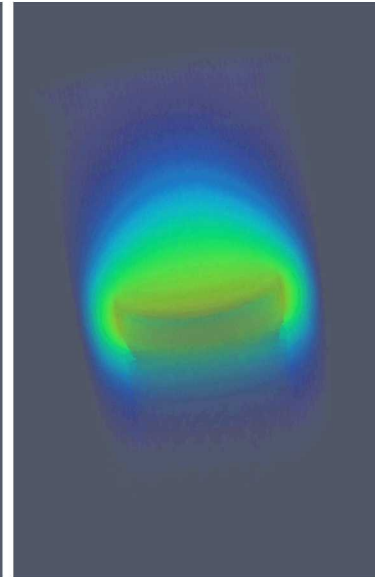
Wireframe



Surface



Surface
with Edges



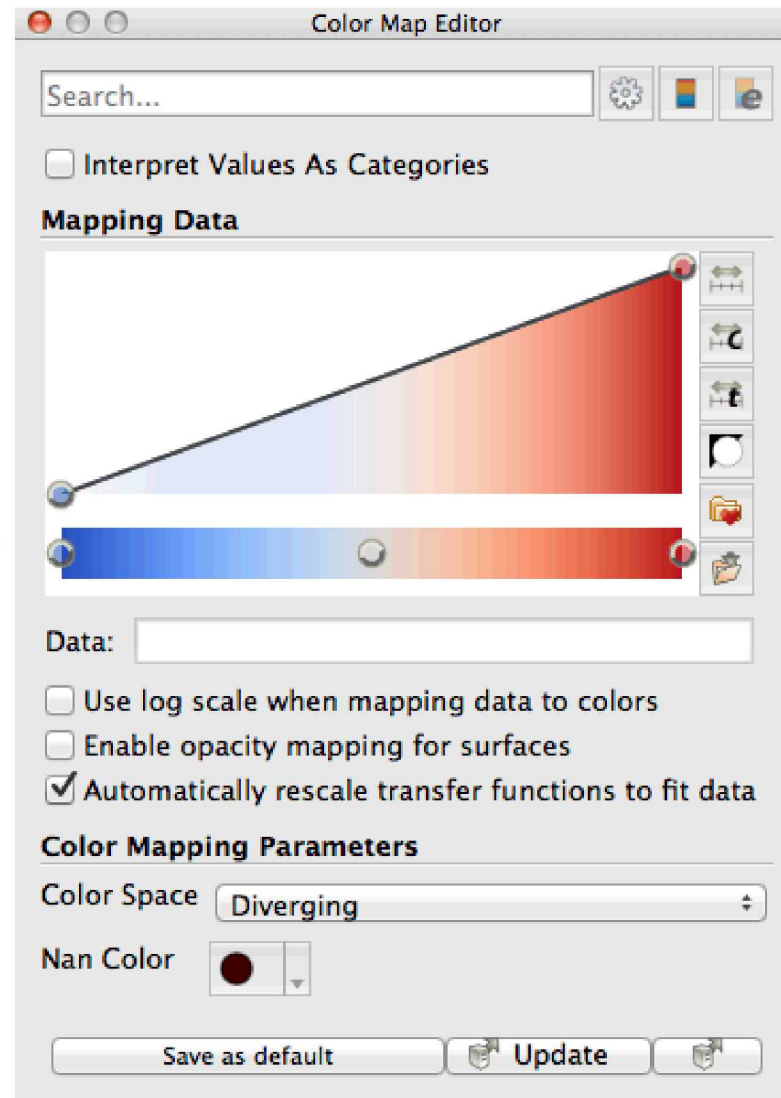
Volume



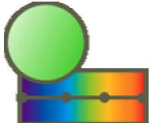
Volume Rendering + Surface Geometry

1. Open disk_out_ref.ex2. Load all variables. 
2. Change variable viewed to Temp.
3. Change representation to Volume.

Transfer Function Editor



Modify Transfer Function

1. Select disk_out_ref.ex2.
2. Click Edit Color Map  .
3. Click Choose preset  .
4. Select Black-Body Radiation.
Apply. Close.
5. Try adding and changing control points.

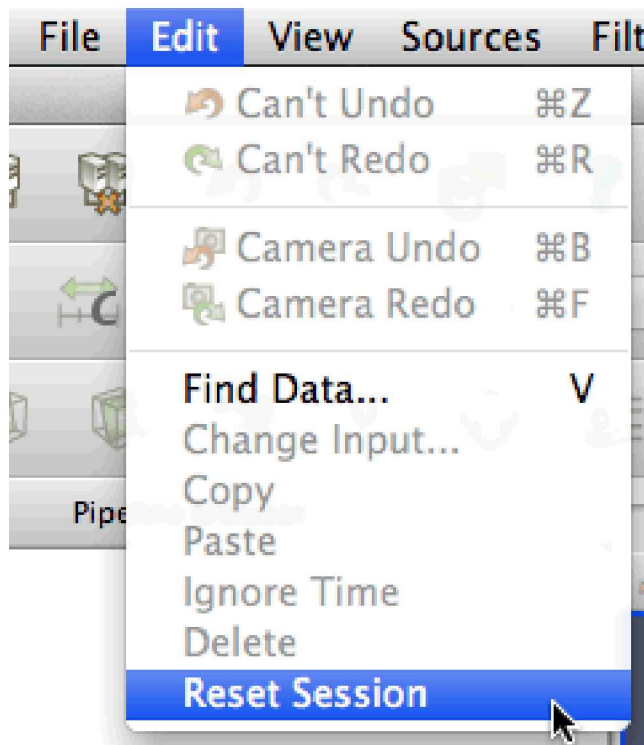


Volume Rendering + Surface Geometry

1. Open disk_out_ref.ex2. Load all variables. 
2. Change variable viewed to Temp.
3. Change representation to Volume.
4. Add Stream Tracer.  
5. Optional: Add Tubes and Glyphs.

Reset ParaView

Edit → Reset Session



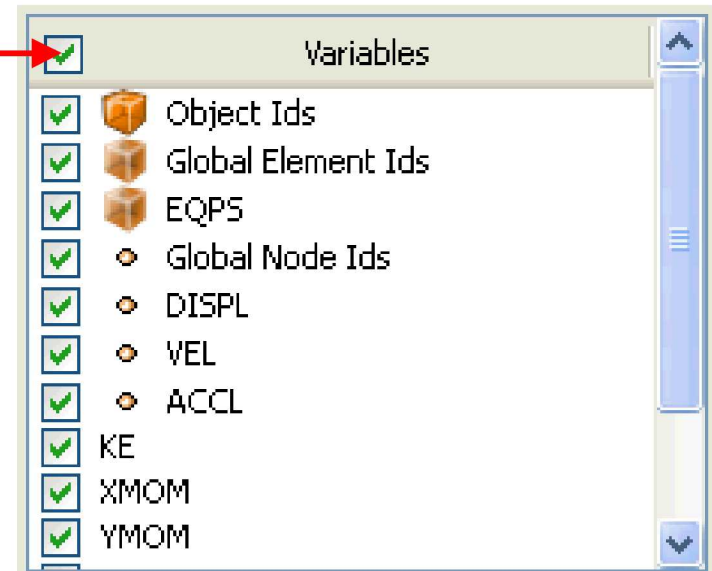
Loading Data with Time

1. Open the file can.ex2.
2. Select all variables.

3.  Apply

4. 

5. 



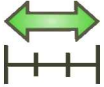
Animation Toolbar



Animation Pitfall

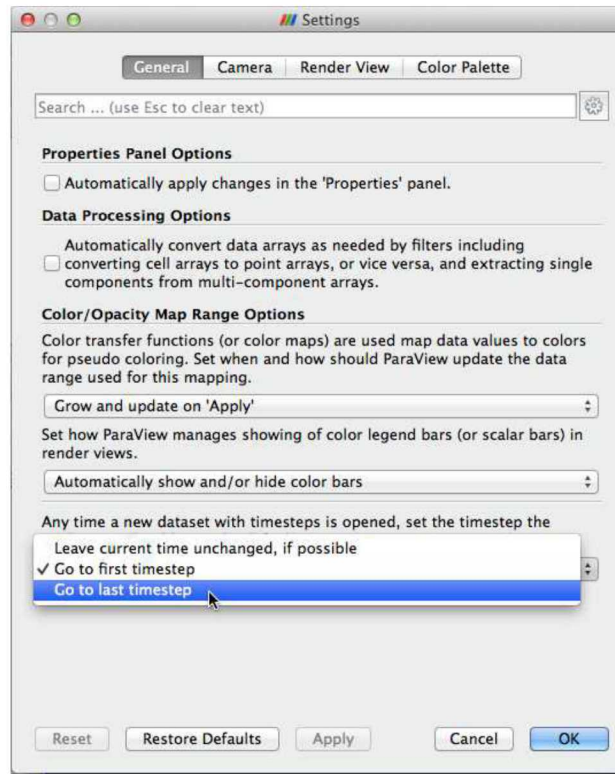
1. Go to first time step. ⏮
2. Color by EQPS variable.
3. Play ▶ (or skip to last time step ▶⏮).

Animation Pitfall

1. Go to first time step. 
2. Color by EQPS variable.
3. Play  (or skip to last time step ).
4. Fix with Rescale to Data Range. 

Data Range Workarounds

- Go to representative time and hit 
- In Settings change On File Open to Goto last timestep.

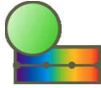


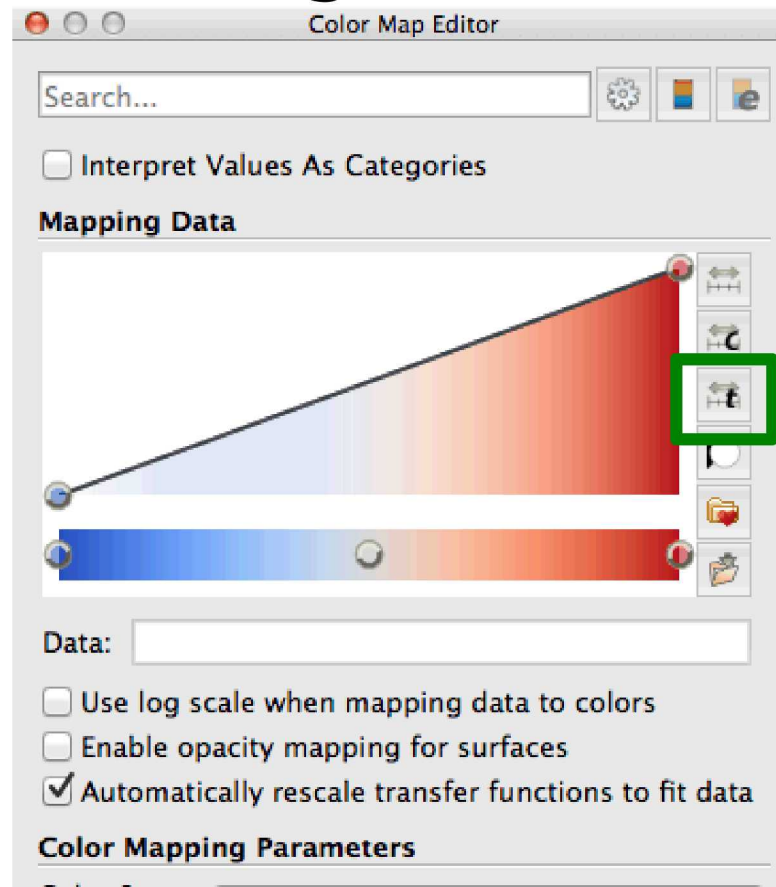
Data Range Workarounds

- Set a custom range.



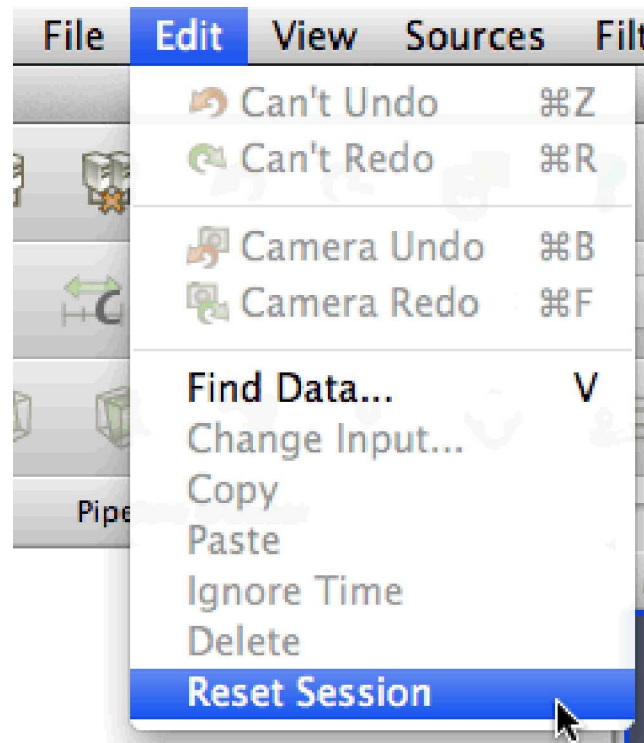
Data Range Workarounds

- Open color map editor dialog 
- Rescale to range over all timesteps



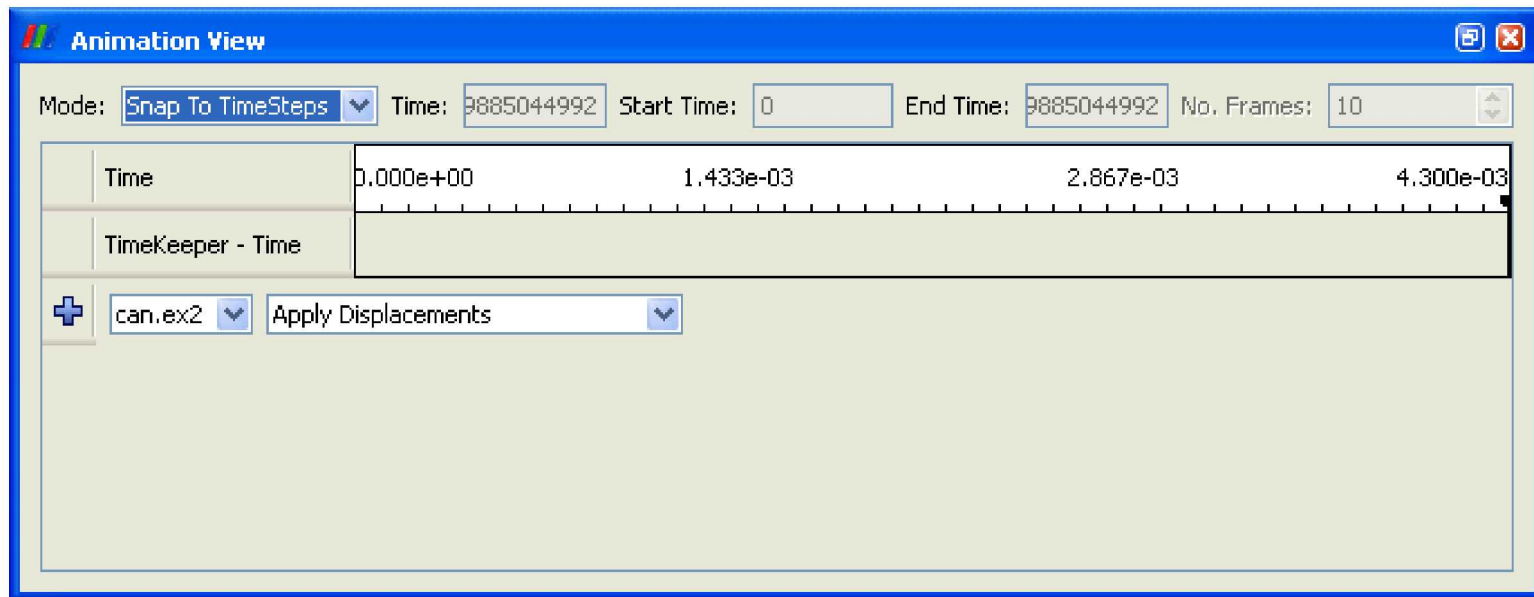
Reset ParaView

Edit → Reset Session



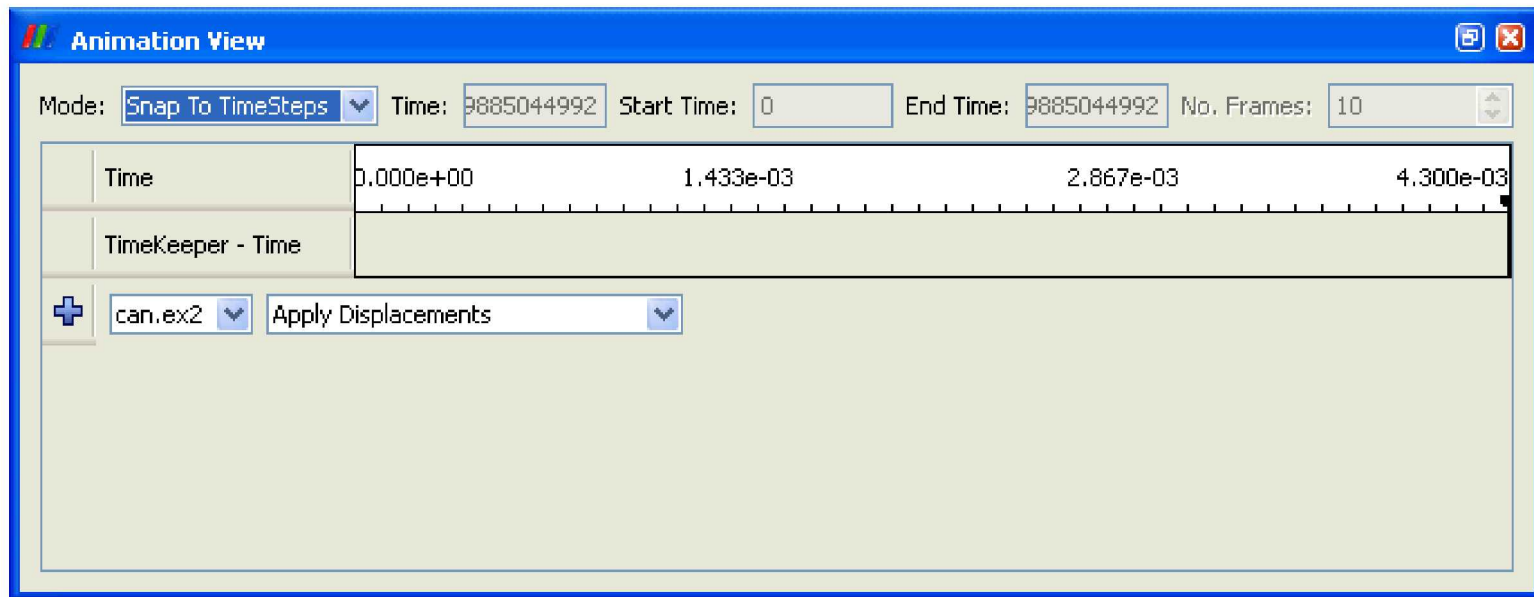
Animation View

View → Animation View



Animation View

View → Animation View



Animation Modes: Sequence, Real Time,
and Snap To TimeSteps

Changing Animation Timing

1. Open can.ex2. Load all variables. 
2. 
3. View → Animation View
4. Change Mode to Real Time.
 - Default animation duration is 10 sec.
5. 

Changing Animation Timing

1. Open can.ex2. Load all variables. 
2. 
3. View → Animation View
4. Change Mode to Real Time.
 - Default animation duration is 10 sec.
5. 
6. Change Duration to 60 sec.
7.  again.

Smoothing the Animation

1. Make sure can.ex2 highlighted.
2. From the quick launch, select Temporal Interpolator.
3.  Apply
4. Split view.  Show can.ex2 in one and TemporalInterpolator1 in the other. Link the cameras.
5. 

Adding Text Annotation

1. If you fell behind, you can reset ParaView and reload can.ex2.
2. Sources → Text
3. Type a message in text edit box
4. 

Text Position

Text Position

☒ Use Window Location

☐ Lower Left Corner

0.025267		0.010000	
			

Annotate Time

1. Sources → Annotate Time
2. 

Annotate Time

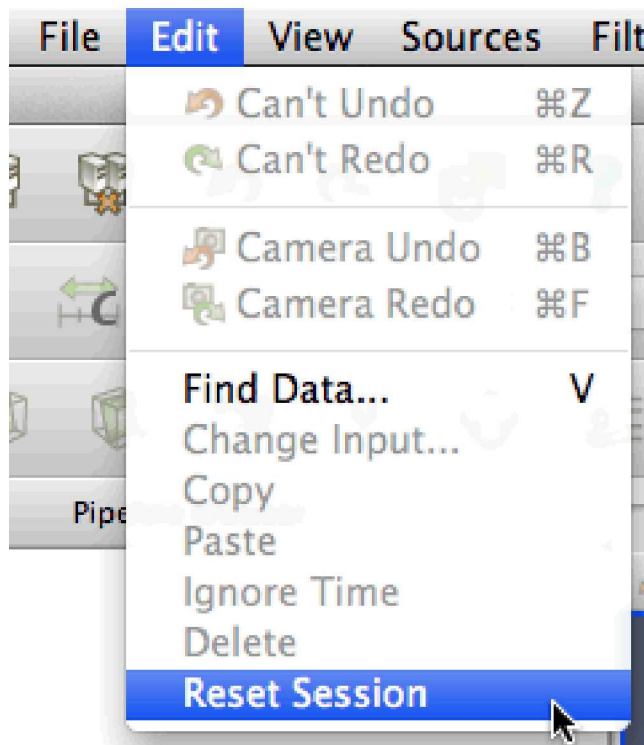
1. Sources → Annotate Time
2.  Apply
3. Select can.ex2
4. From quick dialog, select Annotate Time Filter
5.  Apply
6. Move annotation around.

Save Screenshot/Animation

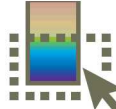
1. Choose File →  Save Screenshot
2. Complete the following dialogs.
3. Turn on Cube Axes around can.
4. Chose File → Export Scene
5. Complete the following dialogs.
6. Chose File →  Save Animation
7. Complete the following dialogs.

Reset ParaView

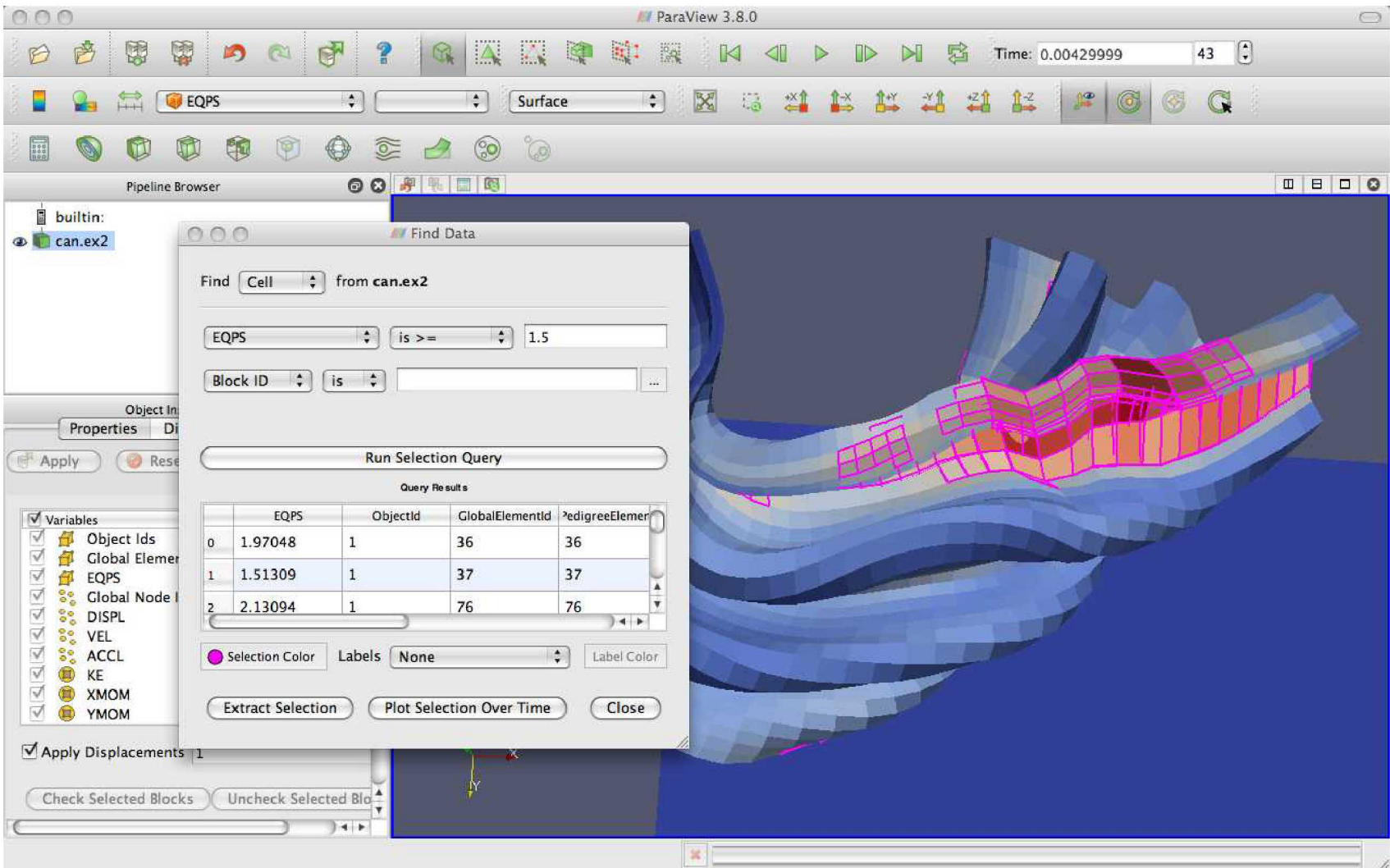
Edit → Reset Session



Query-Based Selection

1. Open can.ex2. All variables. 
2. Go to last time step. 
3. Edit → Find Data. 
4. Top combo box: find Cells.
5. Next row: EQPS, is $\geq$, and 1.5.
6. Click Run Selection Query.

Query-Based Selection



The image shows the ParaView 3.8.0 interface. The main window displays a 3D surface plot of a wavy, blue surface. A 'Find Data' dialog box is open, allowing for query-based selection. The dialog shows the following configuration:

- Find:** Cell from **can.ex2**
- EQPS:** is $\geq$ 1.5
- Block ID:** is

The **Run Selection Query** button has been clicked, resulting in the following **Query Results** table:

	EQPS	ObjectId	GlobalElementId	PedigreeElement
0	1.97048	1	36	36
1	1.51309	1	37	37
2	2.13094	1	76	76

Below the table, the **Selection Color** is set to a magenta color, and the **Labels** are set to **None**. The **Extract Selection** button is highlighted, indicating the next step in the process.

Brush Selection



Face Cell Selection
(shortcut: s)



Face Point Selection
(shortcut: d)



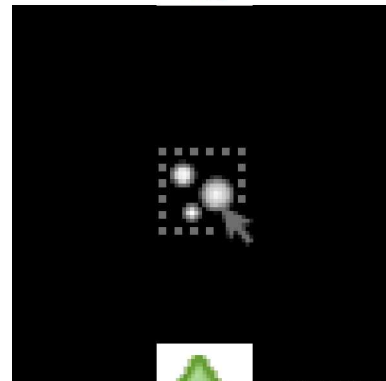
Through Cell Selection
(shortcut: f)



Through Point Selection
(shortcut: g)



Select Cells (polygon)



Select Points (polygon)

Block Selection
(shortcut: b)

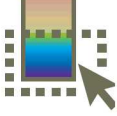


Interactively Select Cells

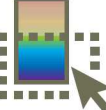
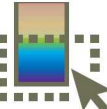


Interactively Select Points

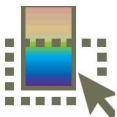
Selections

1. Open Find Data. 
2. Make various brush selections.
3. Observe results in the Find Data dialog box.
4. Play with the Invert Selection and Show Frustum options.

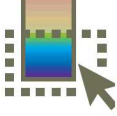
Frustum vs. Id Selections

1. Make a Select Cells Through 
2. Turn on Show Frustum in Find Data.  Rotate 3D view.
3. Play 
4. Hit Freeze Selection in Find Data. 
5. Play 

Adding Labels

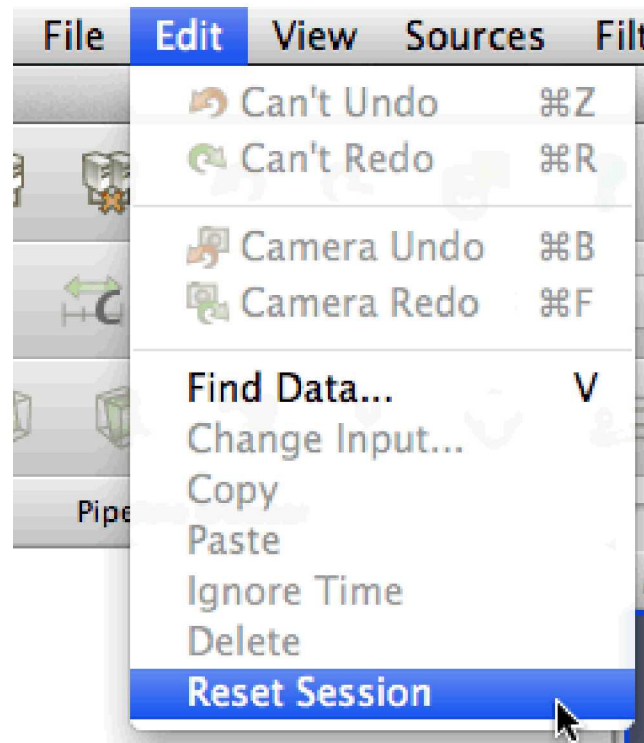
1. Go to the last time step. ▶▶
2. Open Find Data. 
3. Create query Global ID is min. Click Run Selection Query.
4. In the Cell Labels chooser, select EQPS.

Plot Selection Over Time

1. Open Find Data. 
2. Create query EQPS is max. Click Run Selection Query.
3. Click Plot Selection Over Time 
4. 

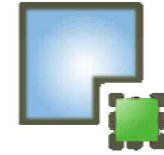
Reset ParaView

Edit → Reset Session



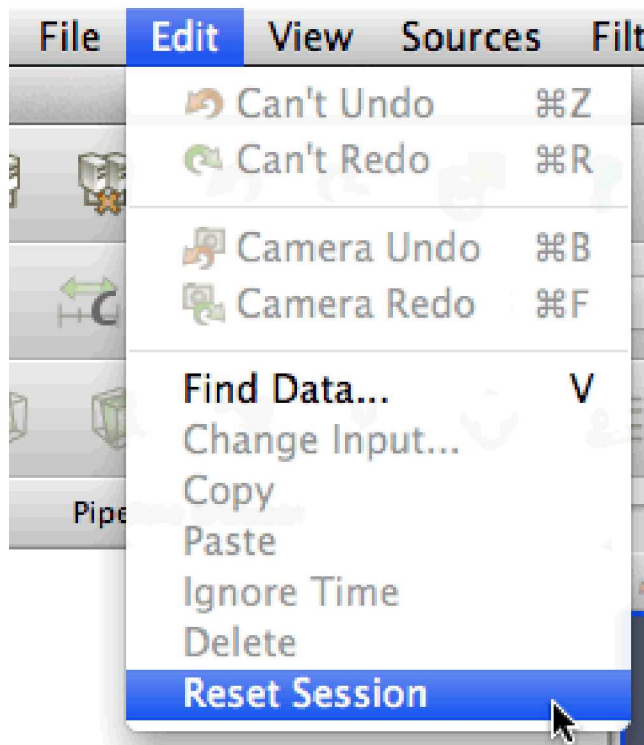
Extracting a Selection

1. Open can.ex2. Load all variables.
2. Perform a sizeable selection
3. Add the extract selection
- 4.



Reset ParaView

Edit → Reset Session



Make an Animation

1. Sources → Sphere, 
2. Make animation view visible.
3. Change No. Frames to 50.
4. Select Sphere1, Start Theta, press 

Make an Animation

1. Sources → Sphere, 
2. Make animation view visible.
3. Change No. Frames to 50.
4. Select Sphere1, Start Theta, press 
5. Double-click Sphere1 – Start Theta
6. Make New keyframe.
7. First keyframe value→360, second keyframe time→0.5 value→0.
8. Click OK.



Animating Two Properties

1. Open Sphere1 – Start Theta.
2. Delete the first keyframe (at time 0).
3. Click OK.
4. Select Sphere1 – End Theta, press .
5. Open Sphere1 – End Theta.
6. Change second key frame time to 0.5.

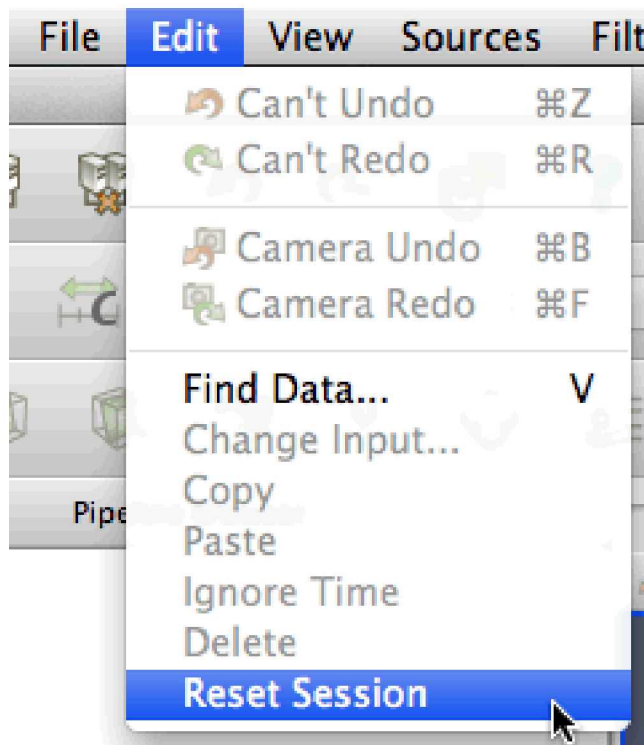


Camera Orbit

1. Place the camera where the orbit should start.
2. Make animation view visible.
3. Select Camera – Orbit, press 
4. Accept default values (click OK).
5. 

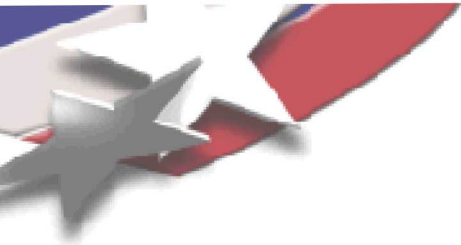
Reset ParaView

Edit → Reset Session



Following Data

1. Open can.ex2. Load all variables. 
2. 
3. Make animation view visible.
4. Select Camera – Follow Data, press 
5. 



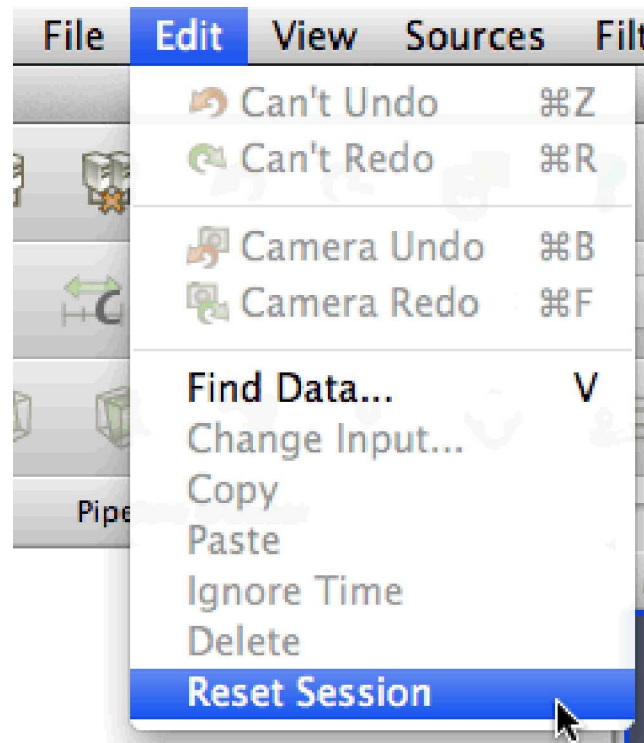
Batch Scripting

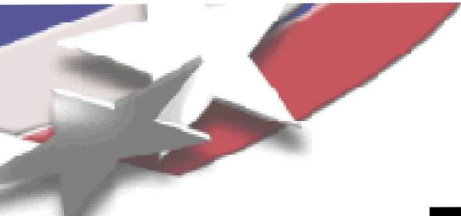
Python Batch Scripting

- Interpreter: Tools → Python Shell.
 - External programs pvpython and pvbatch.
 - Can add bindings to external interpreters.
- Run Python scripts or bind to macros.
- Can trace actions or capture state.
- (Batch scripting is a different set of bindings than programmable sources/filters.)

Reset ParaView

Edit → Reset Session

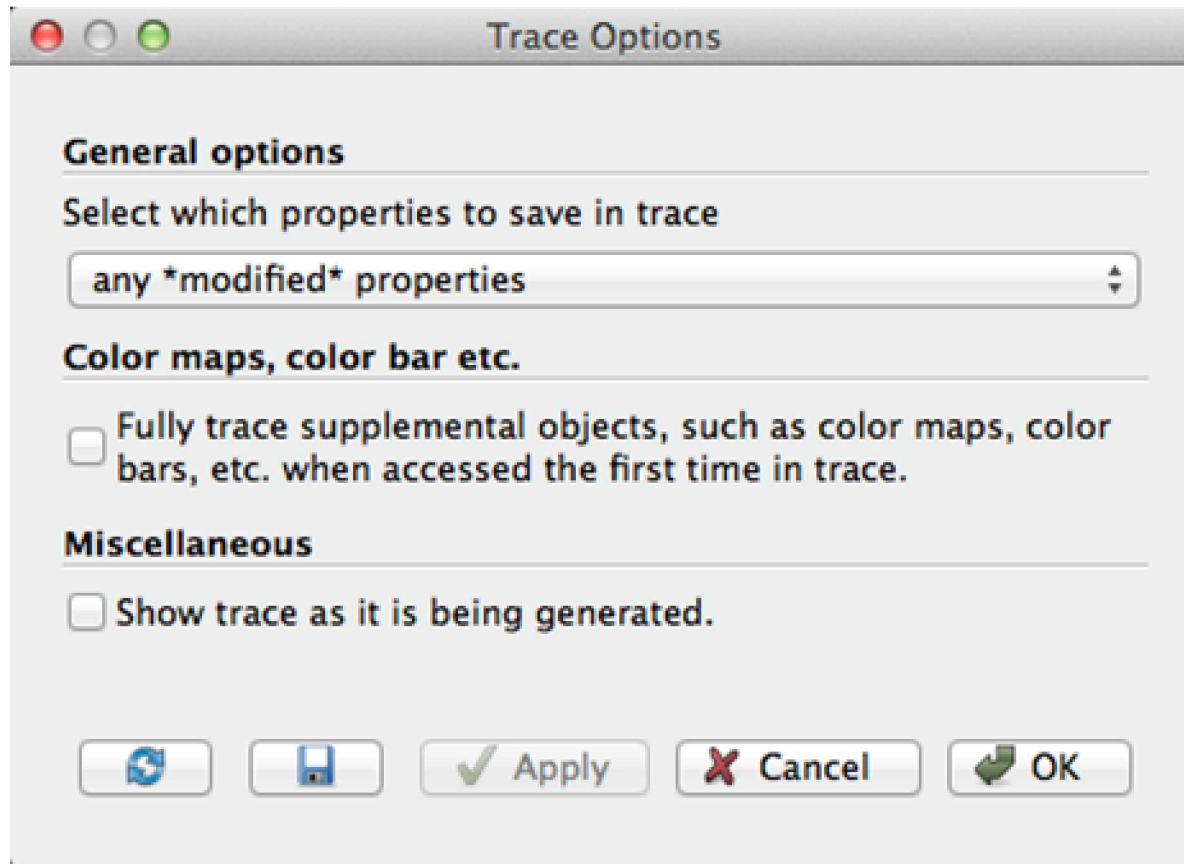


Three overlapping stars in white, red, and blue are located in the top-left corner of the slide.

Tracing ParaView State

1. Select Tools → Start Trace.

Python Tracing Options



Tracing ParaView State

1. Select Tools → Start Trace.
2. Accept defaults (click OK).
3. Build a simple pipeline (e.g. create a sphere source and clip it).
4. Select Tools → Stop Trace.
5. An editing window will open.

Adding a Macro

1. In Python edit window menu, select File → Save As Macro...
2. Chose a descriptive name. Save in directory provided.
3. Close Python edit window.
4. Select Edit → Reset Session.
5. Activate your macro (on toolbar or Macros menu).

Creating a Pipeline

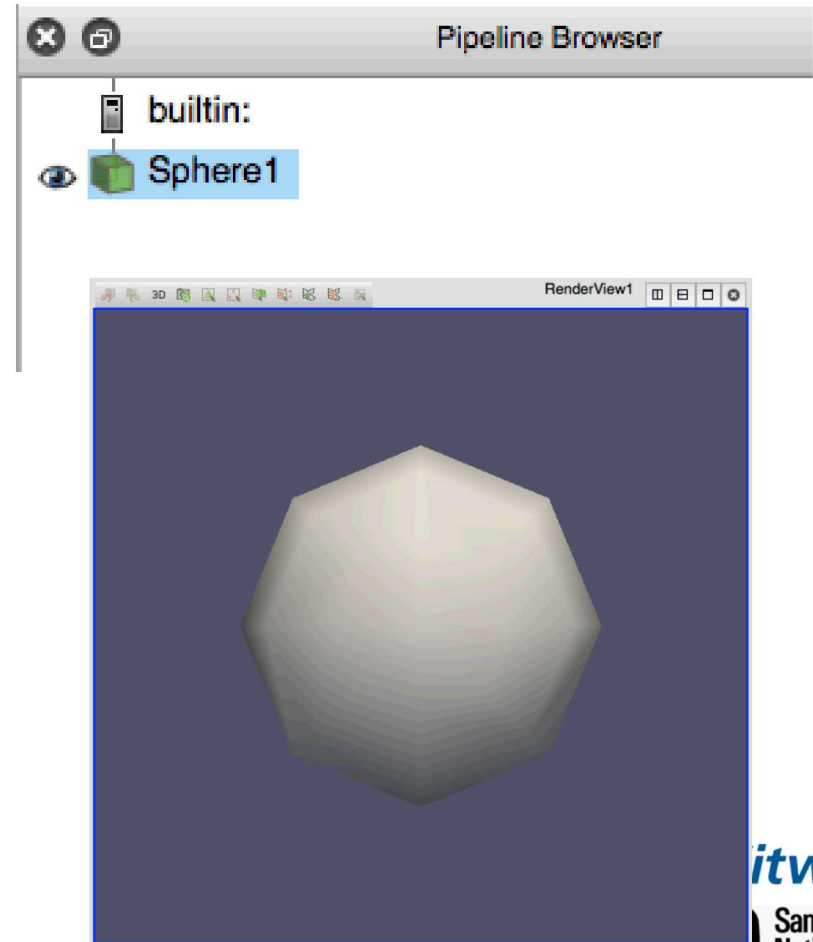
- In Python Shell create a source

```
sphere = Sphere()
```

```
Show()
```

```
Render()
```

```
ResetCamera()
```



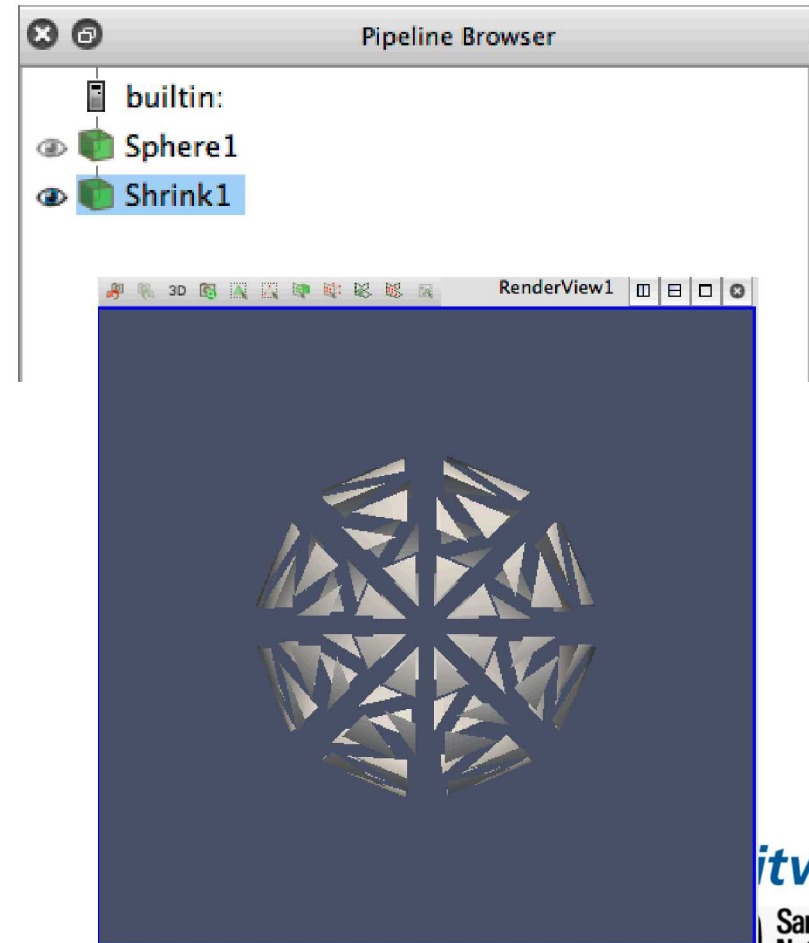
Creating a Pipeline

- In Python Shell create a source

```
sphere = Sphere()  
Show()  
Render()  
ResetCamera()
```

- Then feed that into a filter

```
Hide()  
shrink = Shrink()  
Show()  
Render()
```



Changing Properties

- Get listing of sphere's properties

```
dir(sphere)
```

- Examine and then change one

```
print sphere.ThetaResolution
```

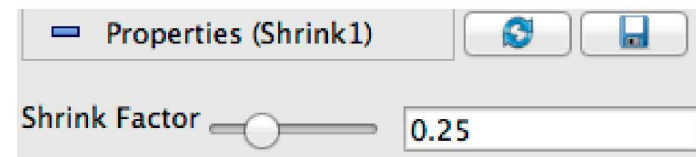
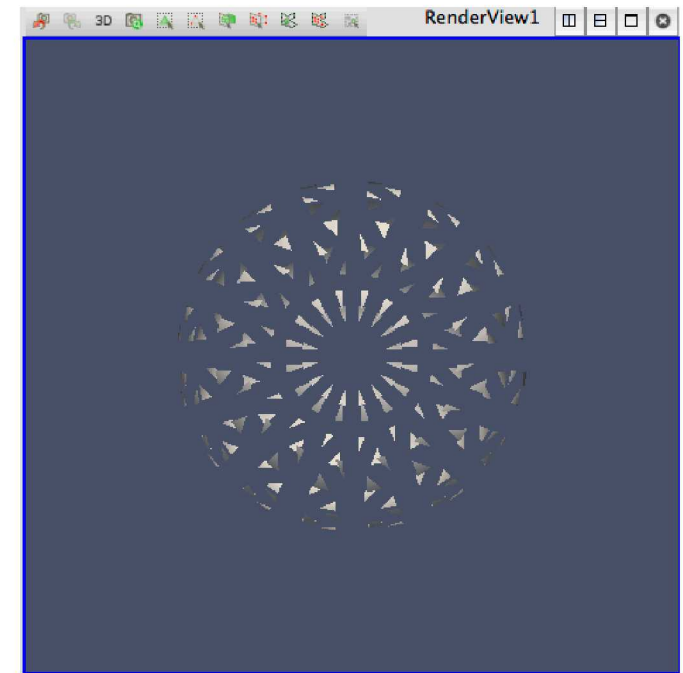
```
sphere.ThetaResolution = 16
```

```
Render()
```

- Change a different filter

```
shrink.ShrinkFactor = 0.25
```

```
Render()
```



Branching and Merging Pipeline

- Feed sphere's output into a second filter

```
wireframe = ExtractEdges(  
    Input=sphere)
```

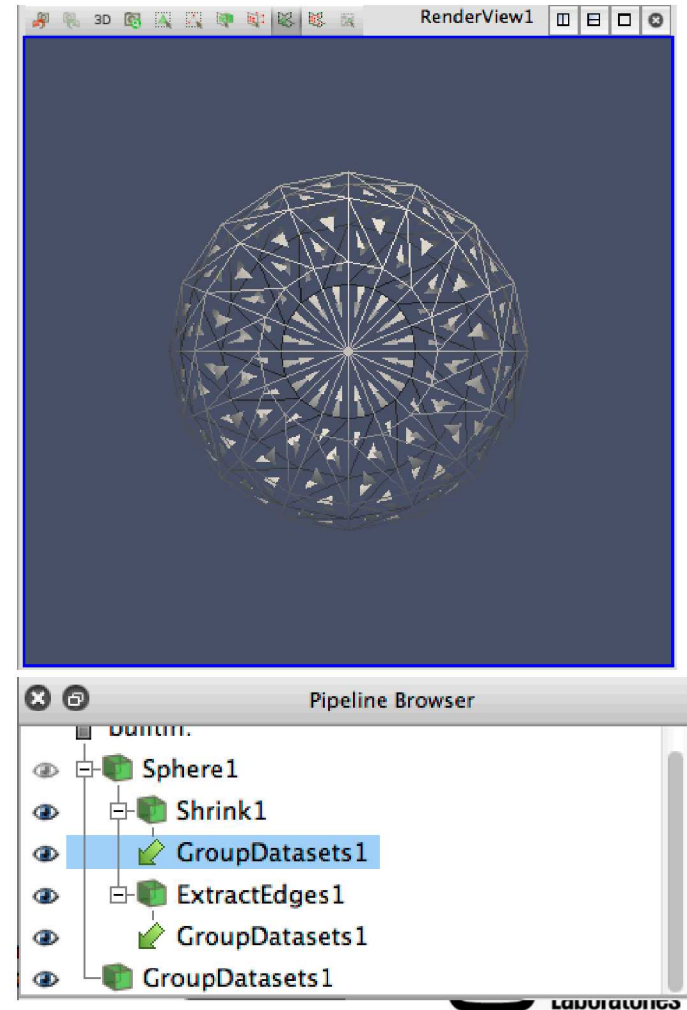
```
Show()
```

```
Render()
```

- Feed two filters into one

```
group = GroupDatasets(  
    Input=[shrink,wireframe])
```

```
Show()
```

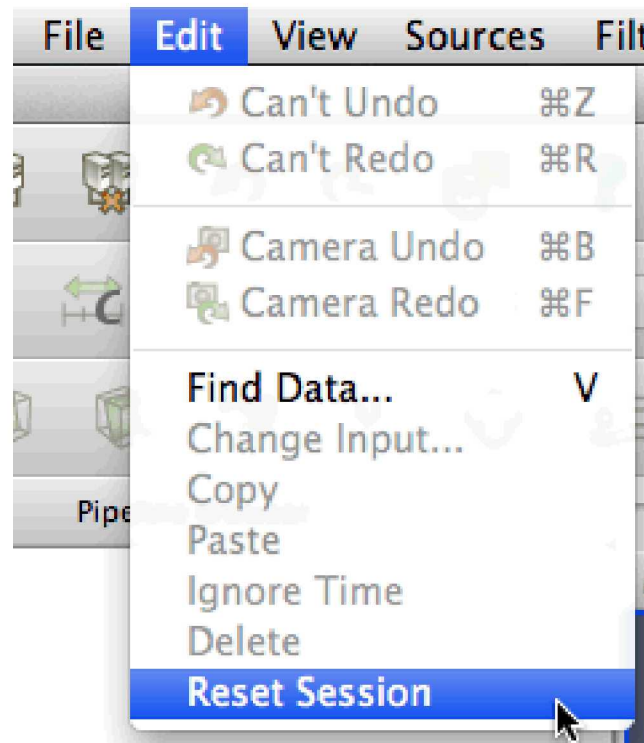


Finding Pipeline Objects

- `GetSources()` Returns a list of objects listed in the Pipeline Browser
- `GetActiveSource()` Returns the object selected in the Pipeline Browser
- `SetActiveSource()` Sets the object selected in the Pipeline Browser to the given object

Reset ParaView

Edit → Reset Session



Reading Files

- Open a dataset

```
reader = OpenDataFile(  
    '<path>/disk_out_ref.ex2')  
  
Show()  
Render()  
ResetCamera()
```


Querying Attributes

- Examine all point data ranges

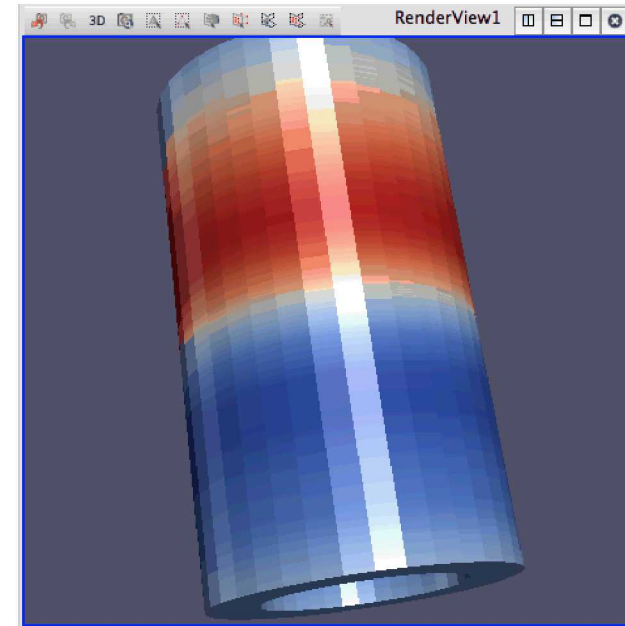
```
pd = reader.GetPointData()
for ai in pd.values():
...     print ai.GetName(),
...     ai.GetNumberOfComponents(),
...     for i in xrange(ai.GetNumberOfComponents()):
...         print ai.GetRange(i),
...     print
```

```
AsH3 1 (0.08047682046890259, 0.18483947217464447)
CH4 1 (0.0, 0.0011702391784638166)
GaMe3 1 (0.00022284436272457242, 0.007213925942778587)
GlobalNodeId 1 (1.0, 8499.0)
H2 1 (0.8076131343841553, 0.9176878929138184)
PedigreeNodeId 1 (1.0, 8499.0)
Pres 1 (0.006785521749407053, 0.028818512335419655)
Temp 1 (293.1499938964844, 913.1500244140625)
V 3 (-19.949113845825195, 19.949113845825195) (-19.949113845825195, 19.949113845825195)
(-21.1259765625, 6.7119011878967285)
```


Coloring Data

- Get a hold of and manipulate display properties

```
readerRep = GetRepresentation()  
readerRep.DiffuseColor = [0, 0, 1]  
readerRep.SpecularColor = [1, 1, 1]  
readerRep.SpecularPower = 128  
readerRep.Specular = 1  
Render()
```



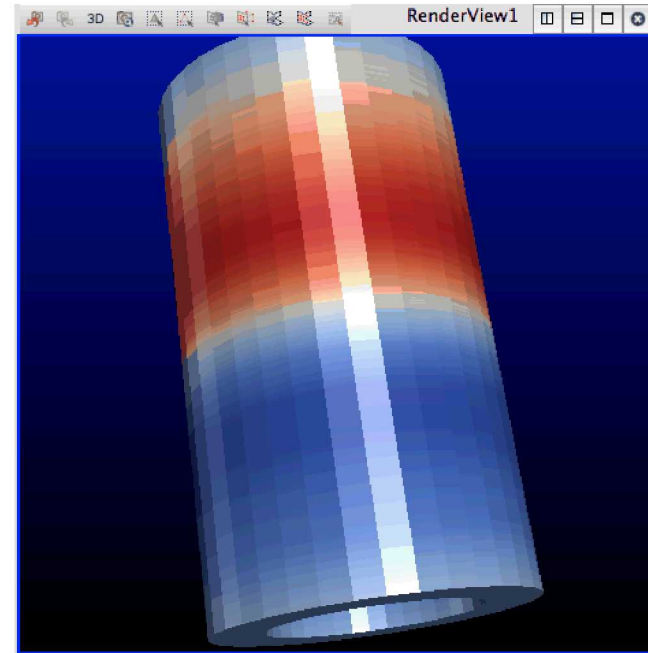
- Now assign a color transfer function

```
readerRep.ColorArrayName = 'Pres'  
readerRep.LookupTable = \  
... AssignLookupTable(reader.PointData['Pres'],  
... 'Cool to Warm')  
Render()
```

Controlling the View

Get a hold of, then manipulate view properties

```
view = GetActiveView()  
view.Background = [0, 0, 0]  
view.Background2 = [0, 0, 0.6]  
view.UseGradientBackground = True  
Render()
```



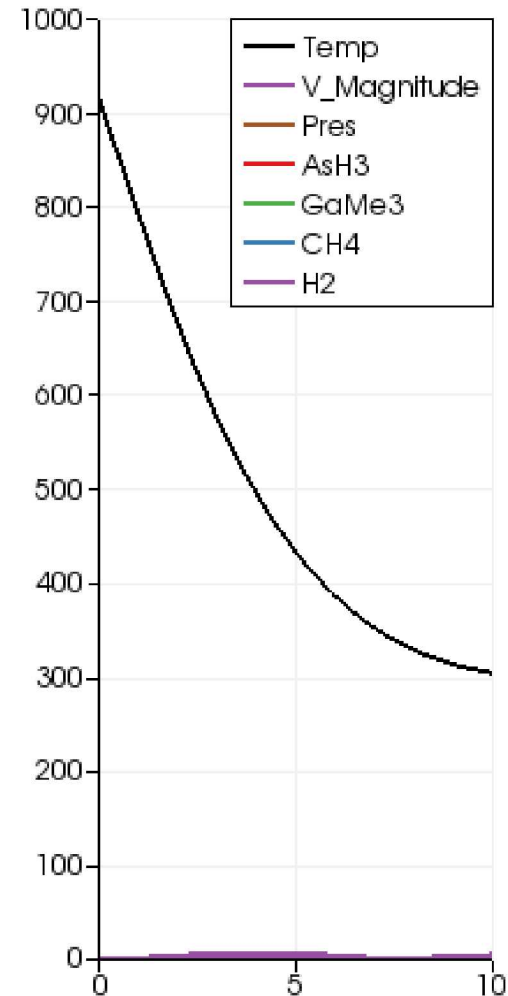
Save Results

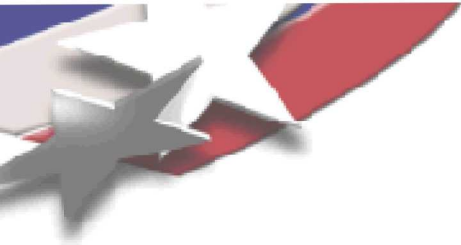
Save Data

```
plot = PlotOverLine()
plot.Source.Point1 = [0,0,0]
plot.Source.Point2 = [0,0,10]
writer = CreateWriter('\<path>/plot.csv')
writer.UpdatePipeline()
```

Then save screen capture of plot

```
plotView = CreateView('XYChartView')
Show(plot)
Render()
SaveScreenshot ('\<path>/plot.png')
```





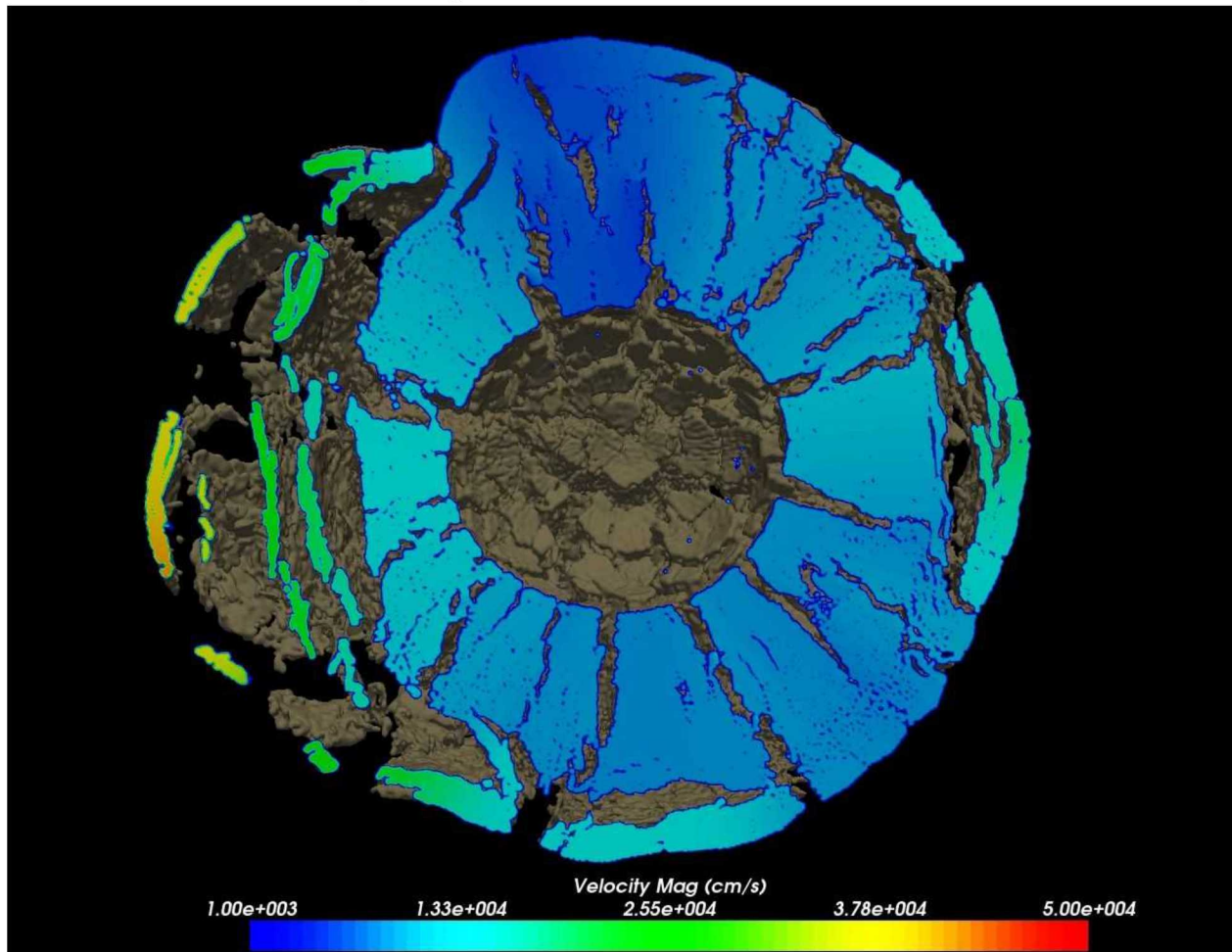
Visualizing Large Models



Golevka Asteroid vs. 10 Megaton Explosion

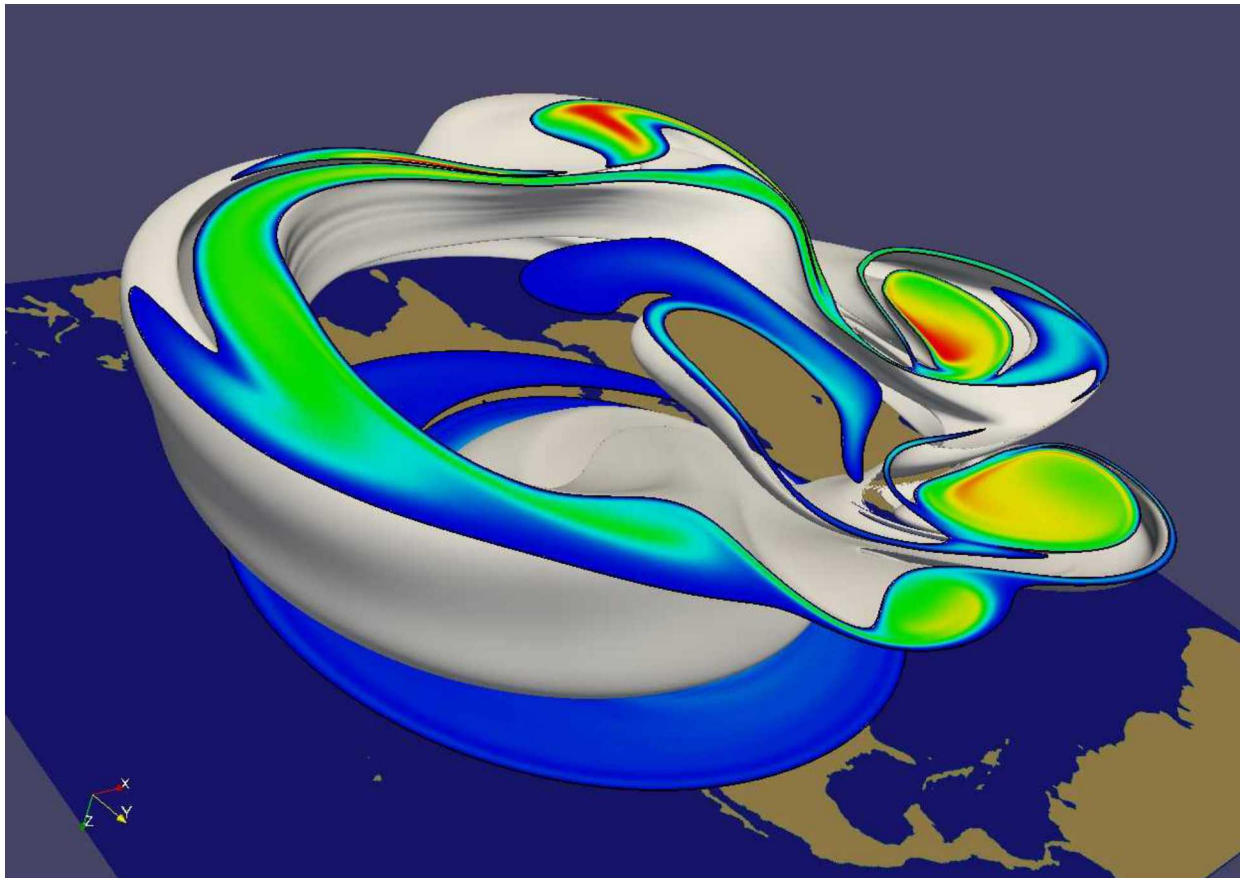


- CTH shock physics, over 1 billion cells



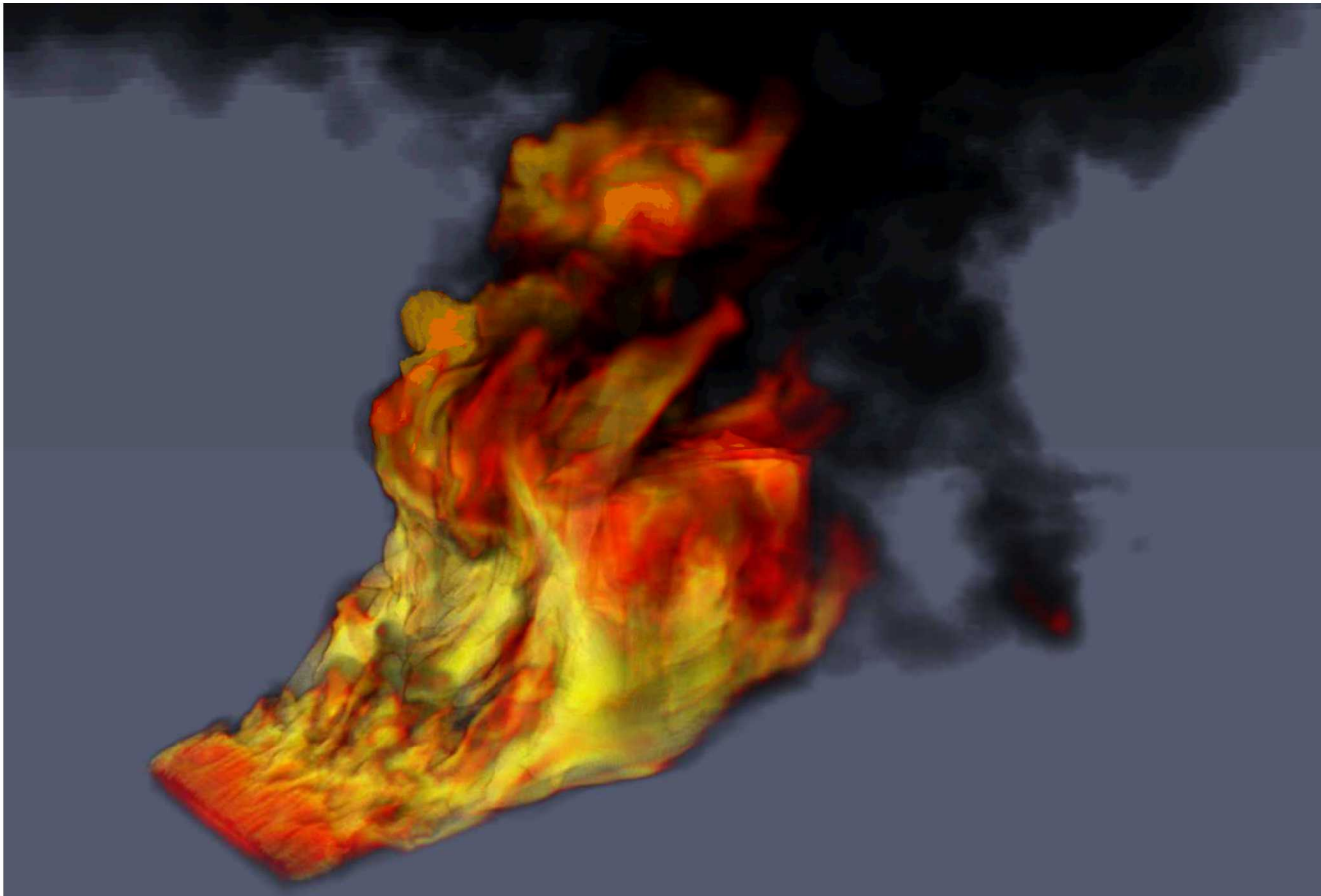
Polar Vortex Breakdown

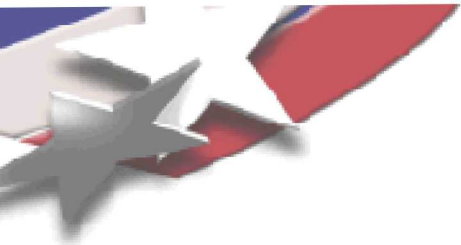
- SEAM Climate Modeling, 1 billion cells (500 million cells visualized).



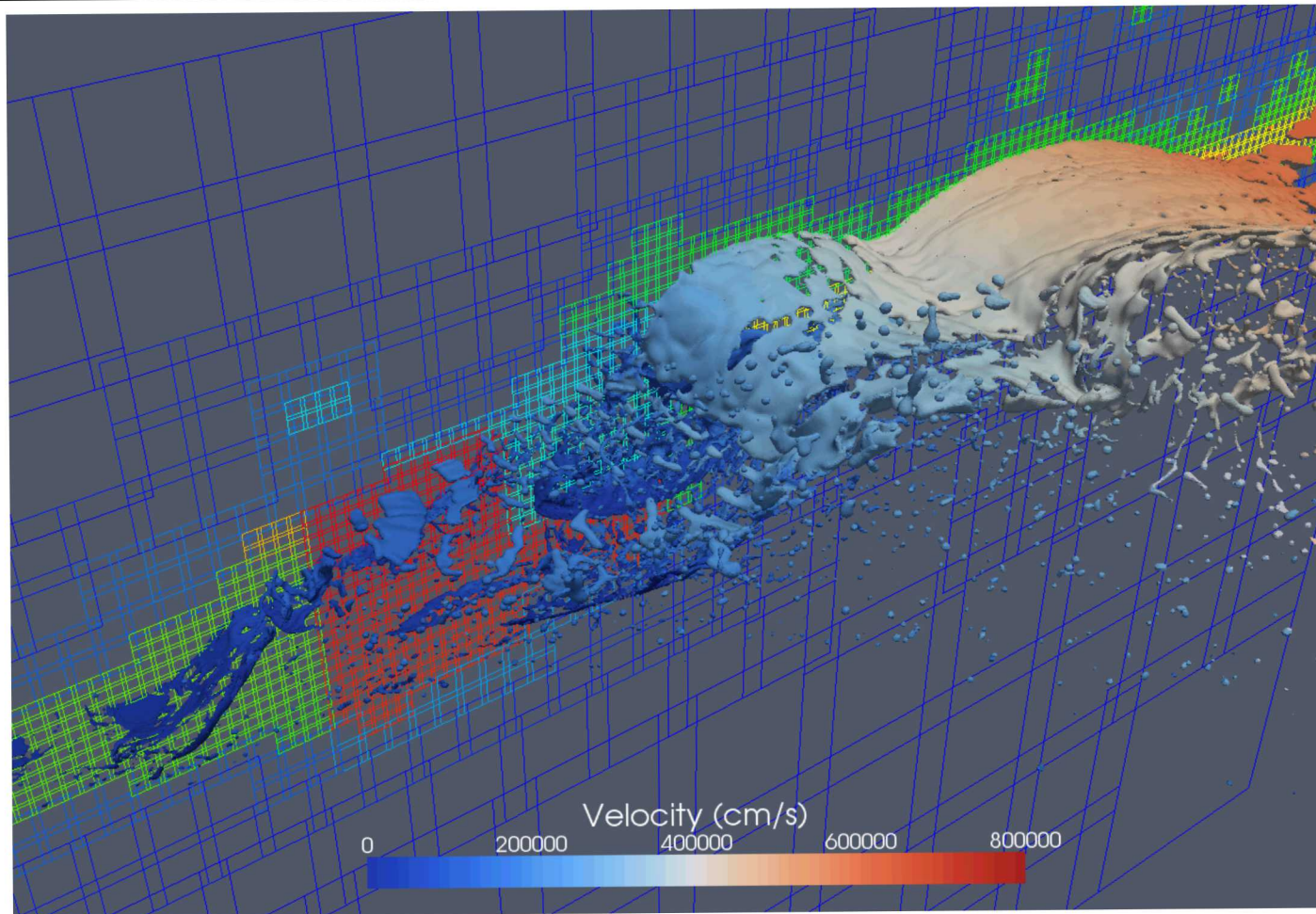
Objects-in-Crosswind Fire

- Coupled SIERRA/Fuego/Syrinx/Calore, 10 million unstructured hexahedra

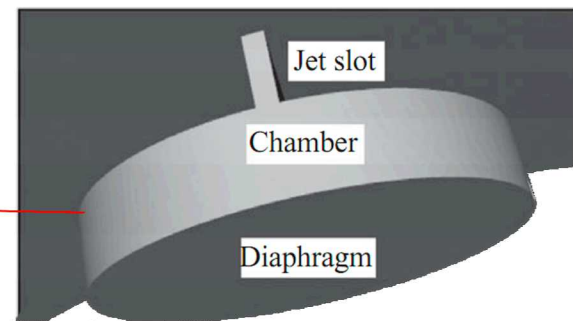
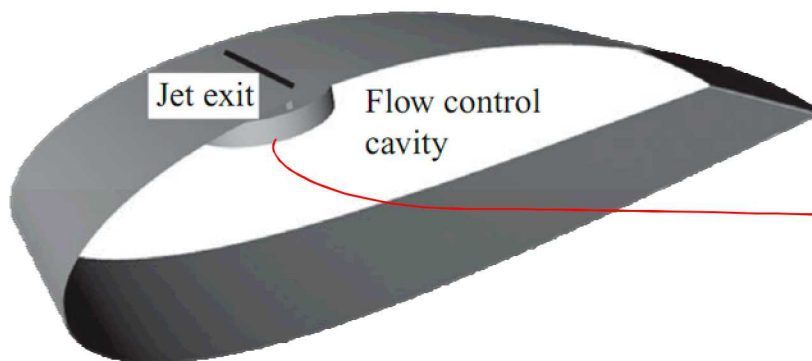
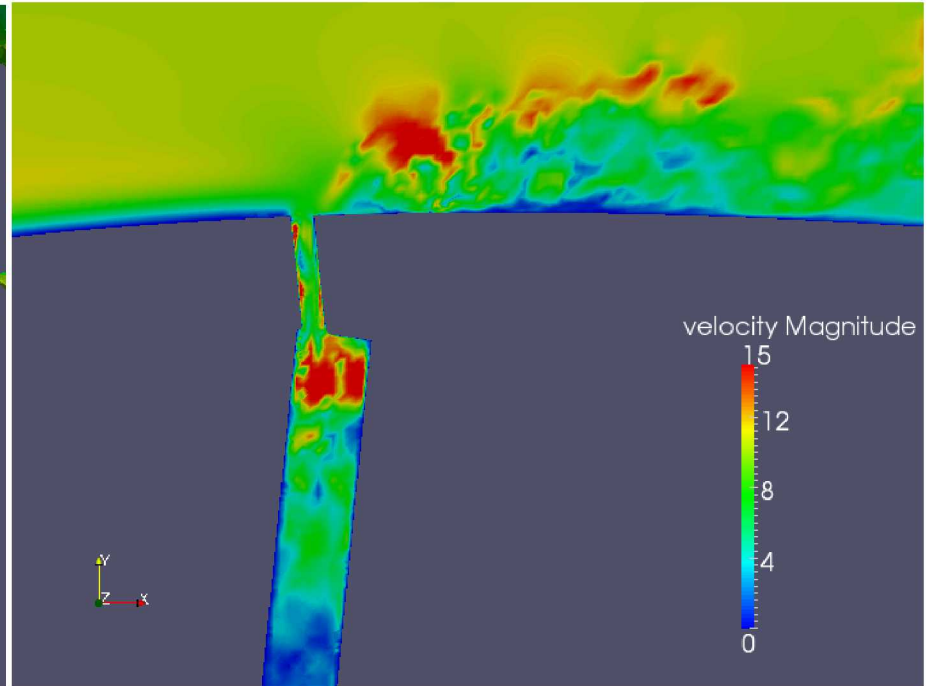
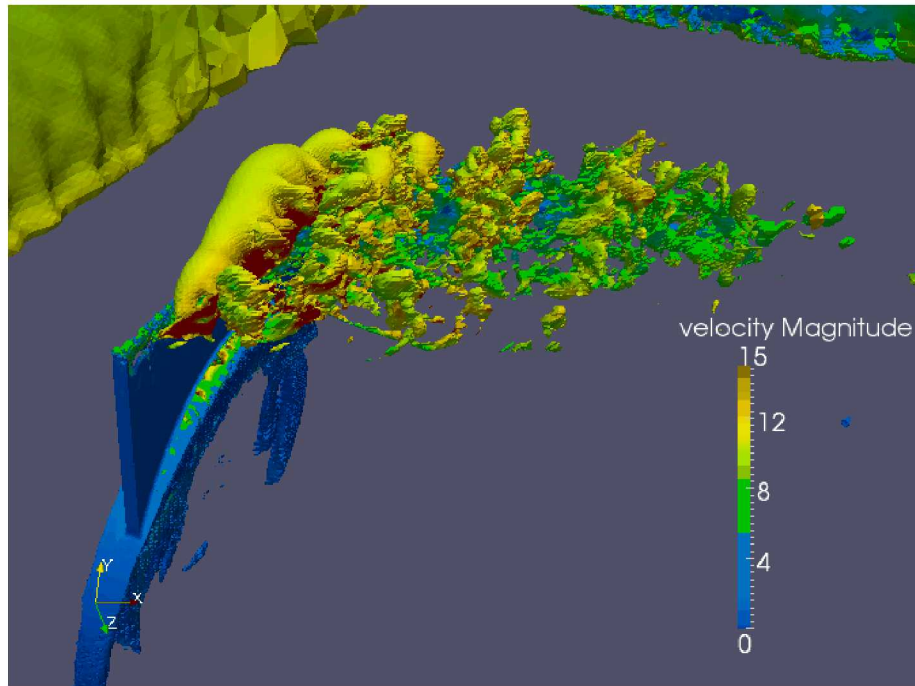




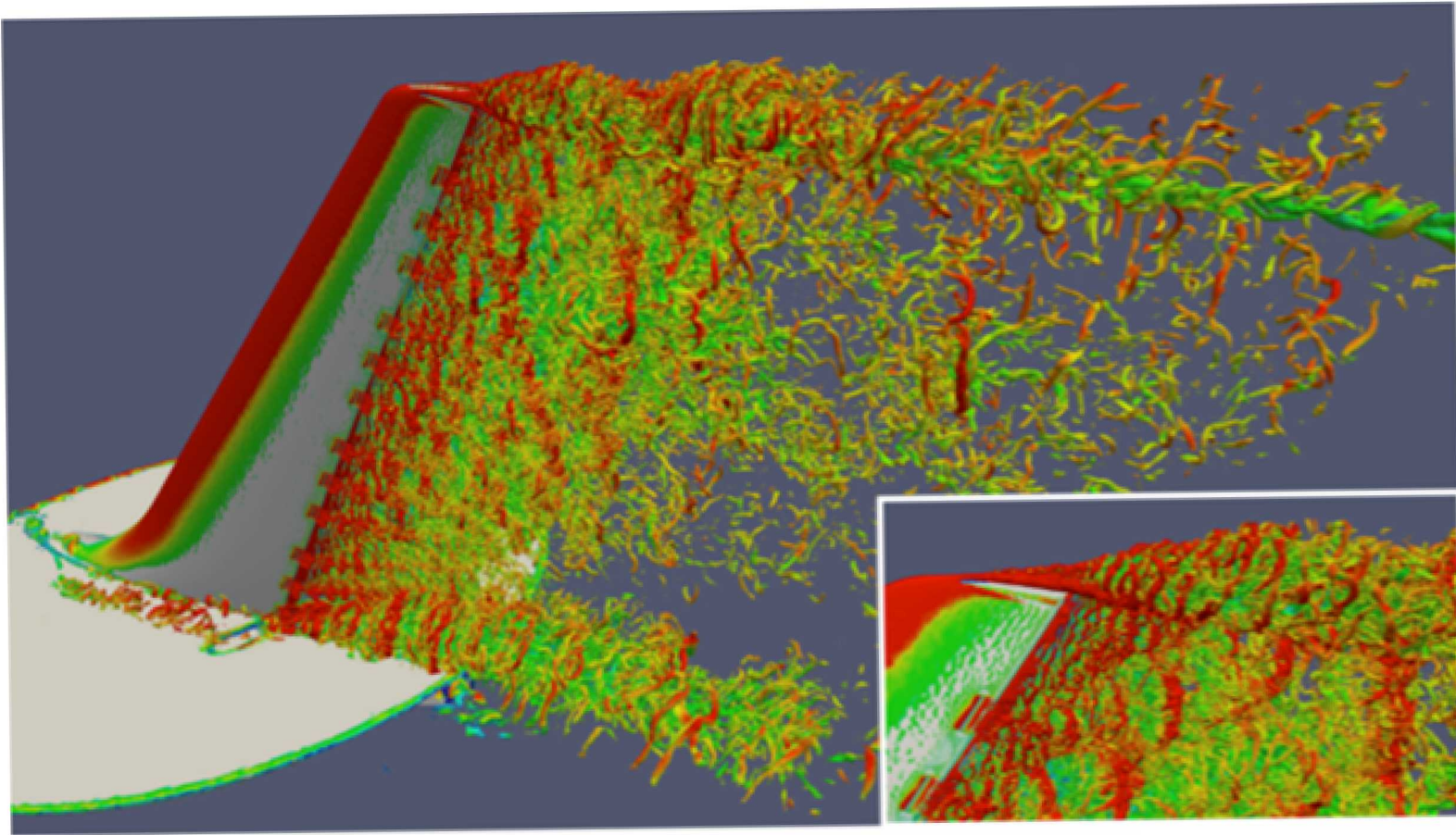
Large Scale AMR

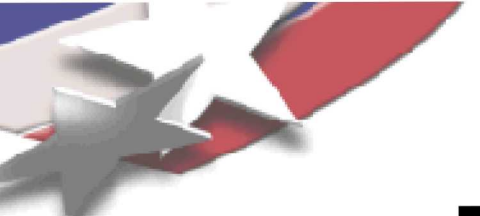


Wing with Unsteady Crossflow from Synthetic Jet (3.3B tet)



Wake of Deflected Wing Flap

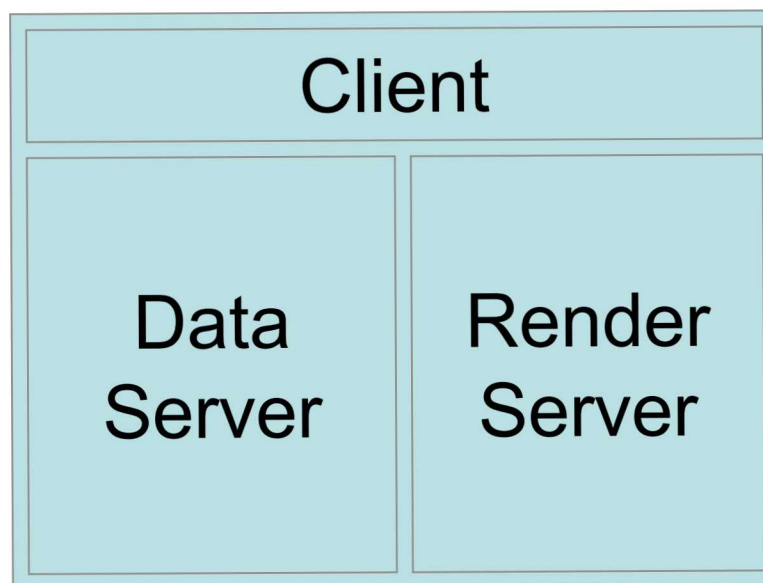


Three stylized stars in white, red, and blue, arranged in a cluster in the top-left corner.

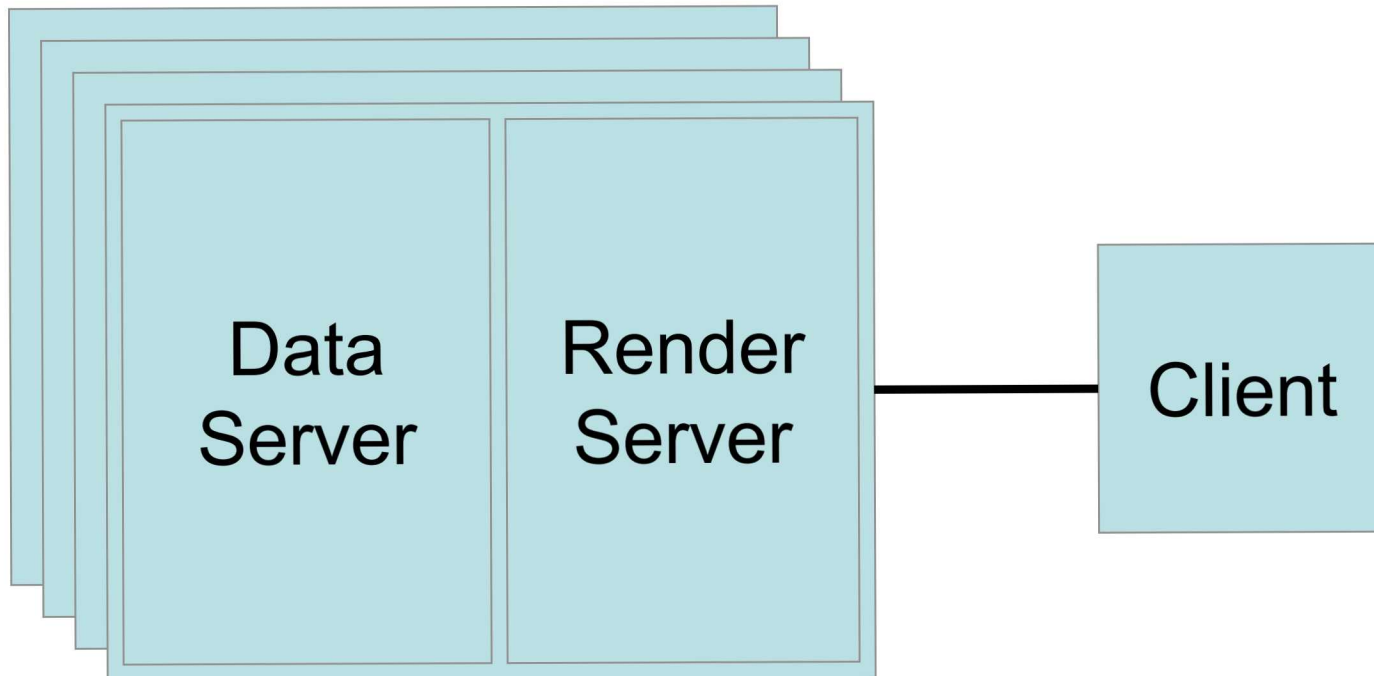
ParaView Architecture

- Three tier
 - Data Server
 - Render Server
 - Client

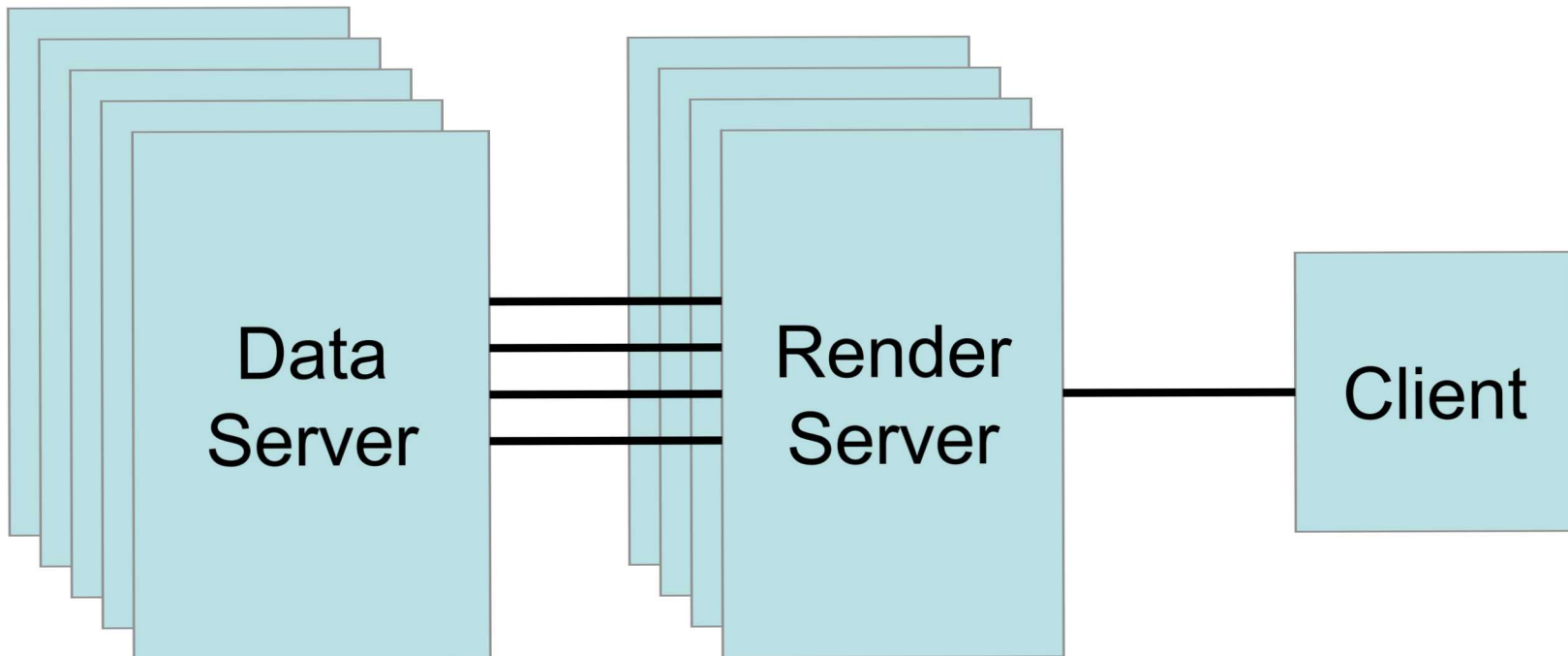
Standalone

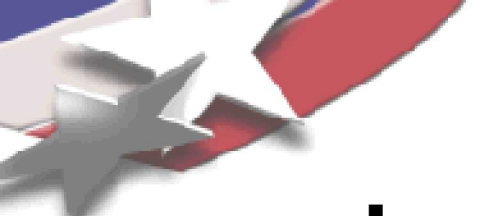


Client-Server



Client-Render Server-Data Server



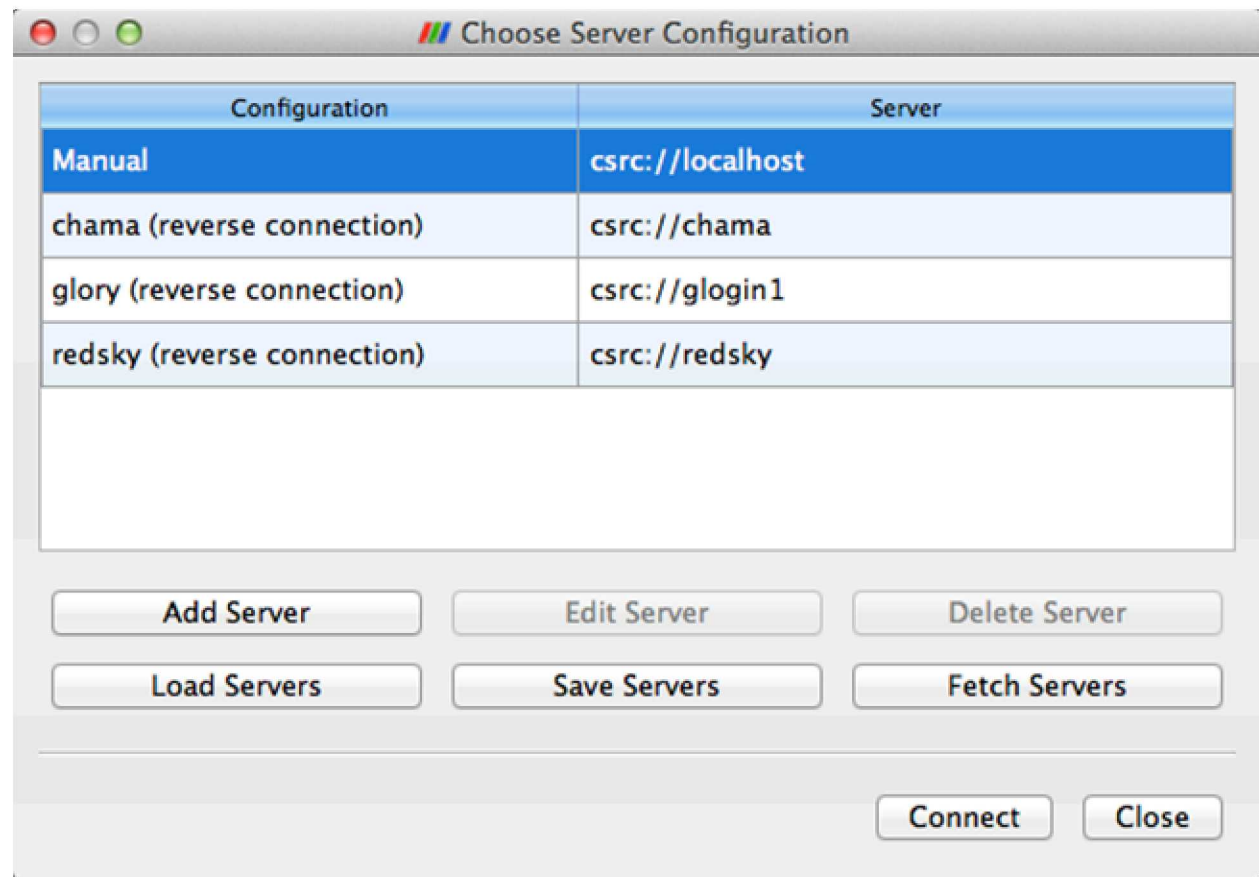
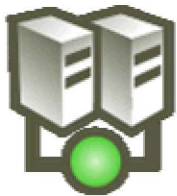


Requirements for Installing ParaView Server



- C++
- CMake (www.cmake.org)
- MPI
- OpenGL (or Mesa3D www.mesa3d.org)
- Qt 4.7 (optional)
- Python + NumPy + Matplotlib (optional)
- http://www.paraview.org/Wiki/Setting_up_a_ParaView_Server#Compiling

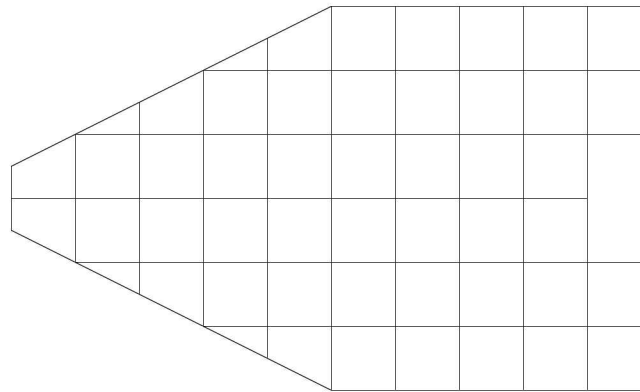
Connecting to a ParaView Server



http://www.paraview.org/Wiki/Setting_up_a_ParaView_Server#Running_the_Server

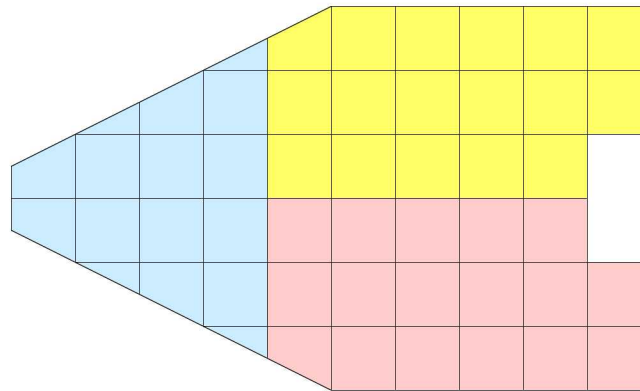
Data Parallel Pipelines

- Duplicate pipelines run independently on different partitions of data.



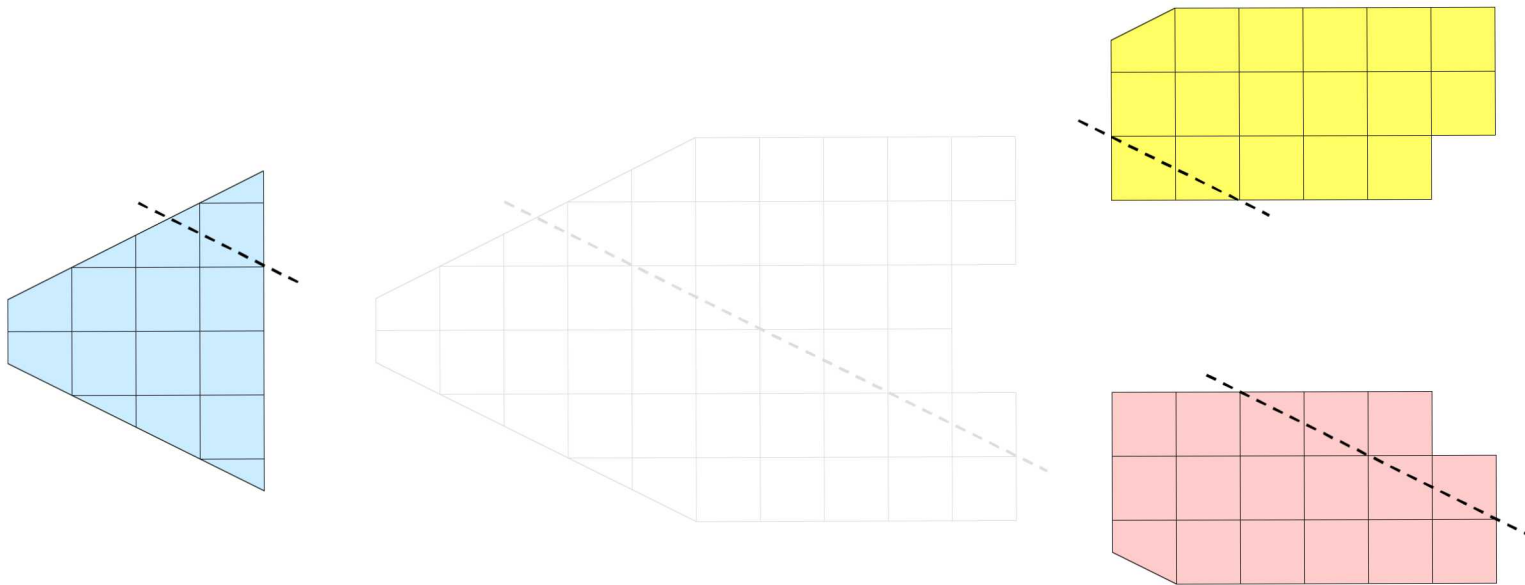
Data Parallel Pipelines

- Duplicate pipelines run independently on different partitions of data.



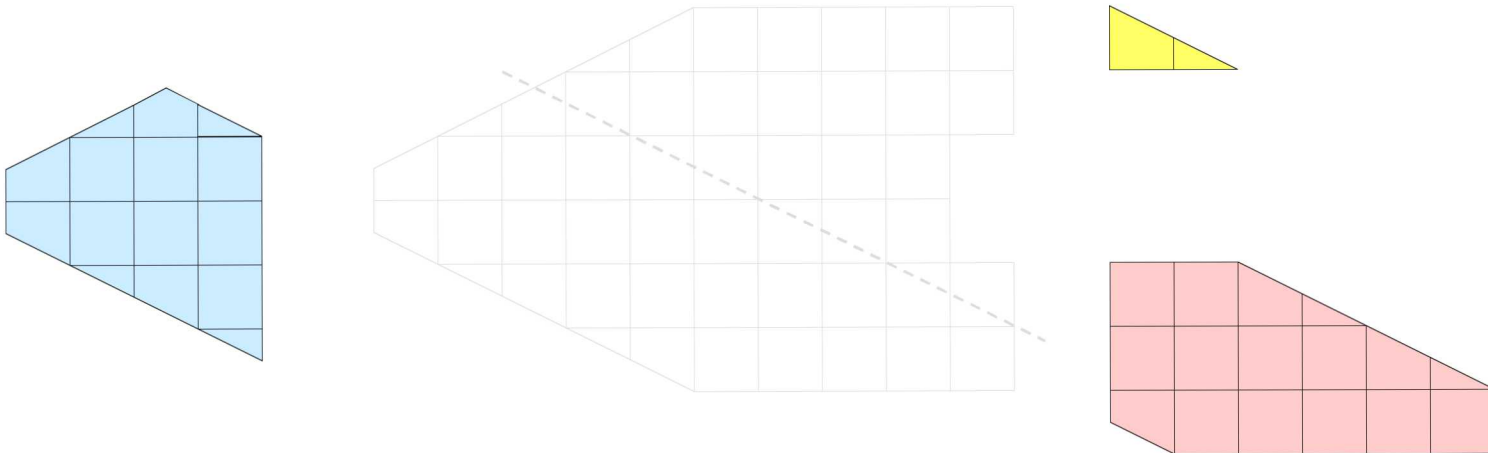
Data Parallel Pipelines

- Some operations will work regardless.
 - Example: Clipping.



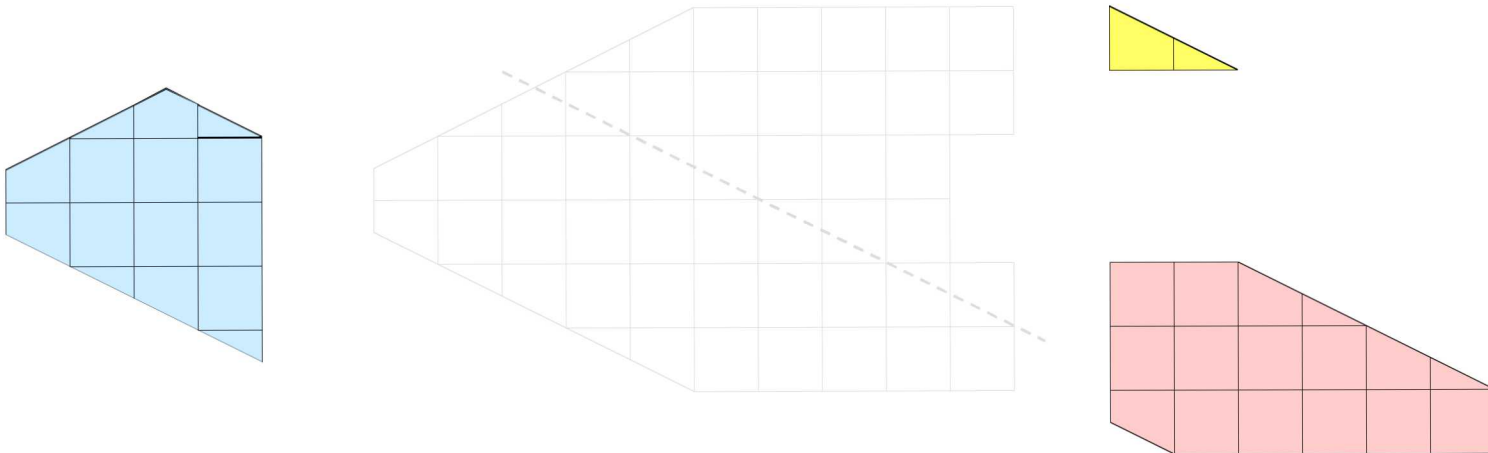
Data Parallel Pipelines

- Some operations will work regardless.
 - Example: Clipping.



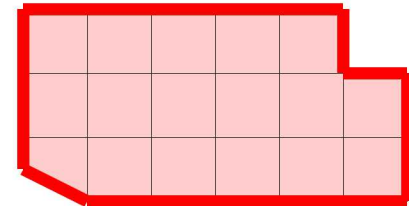
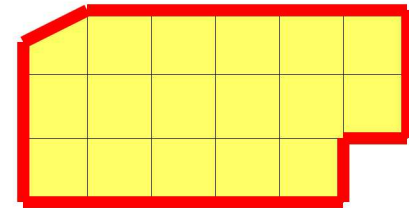
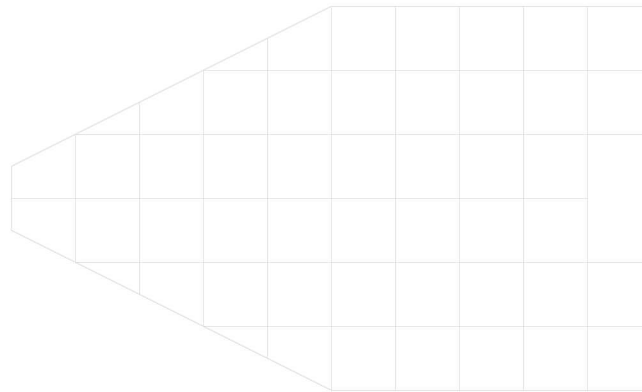
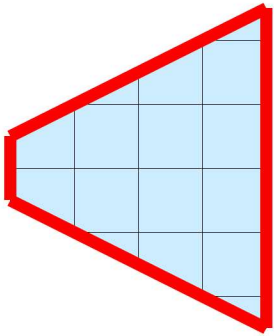
Data Parallel Pipelines

- Some operations will work regardless.
 - Example: Clipping.



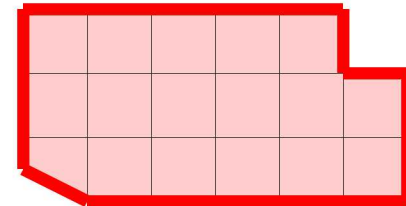
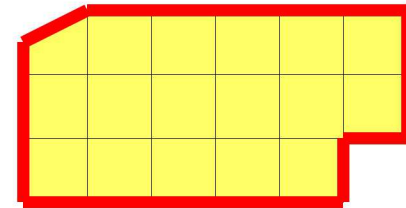
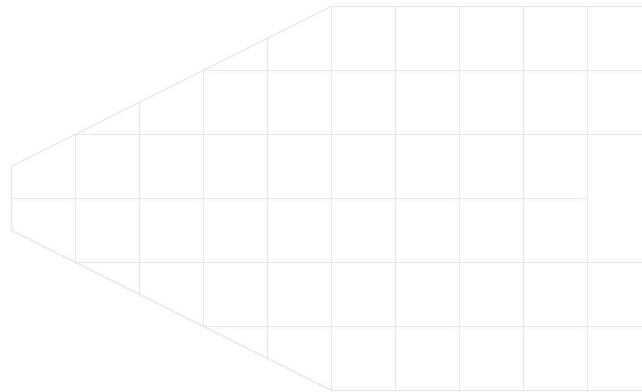
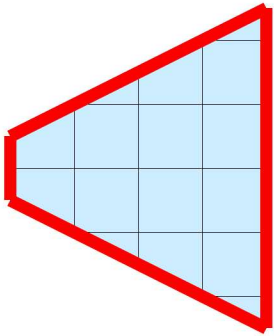
Data Parallel Pipelines

- Some operations will have problems.
 - Example: External Faces



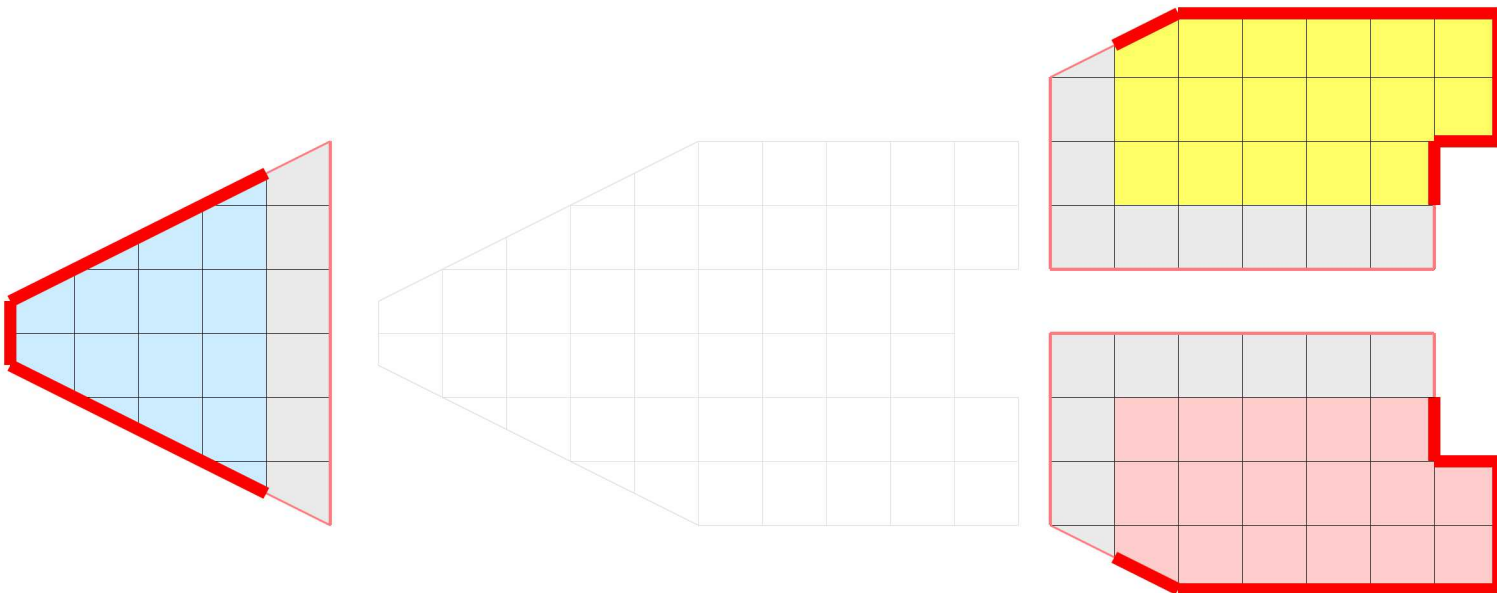
Data Parallel Pipelines

- Some operations will have problems.
 - Example: External Faces



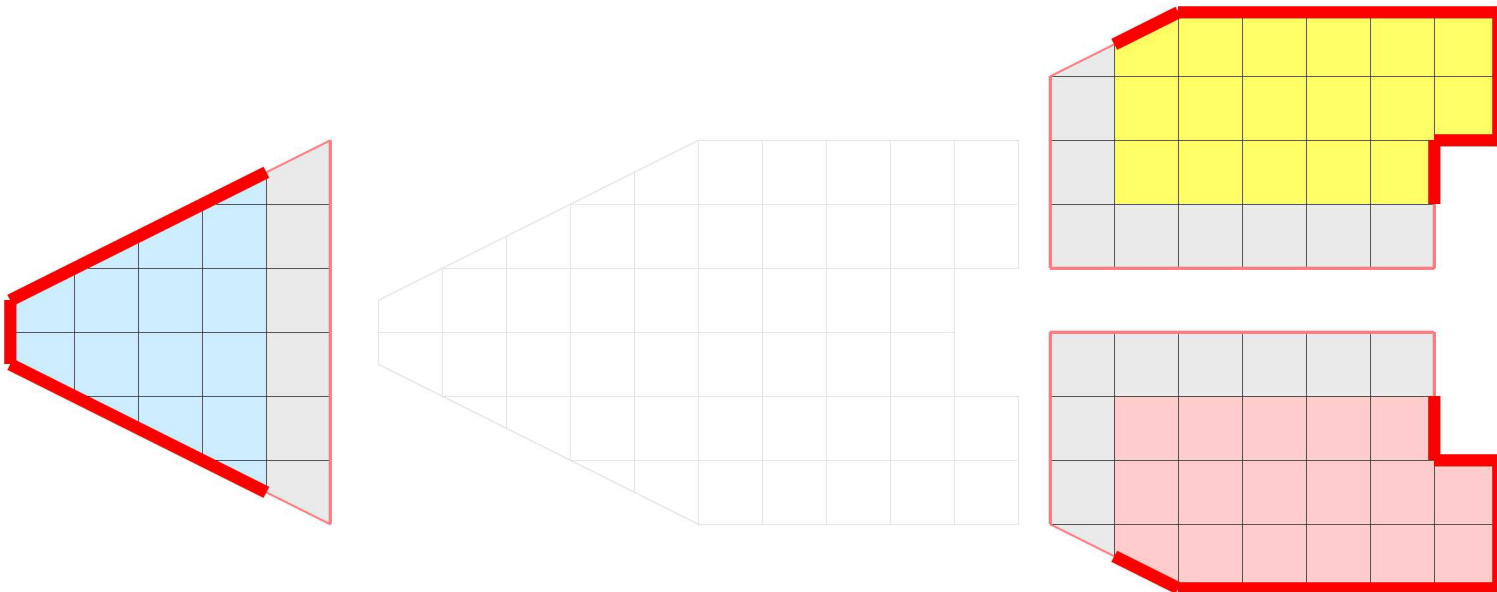
Data Parallel Pipelines

- Ghost cells can solve most of these problems.



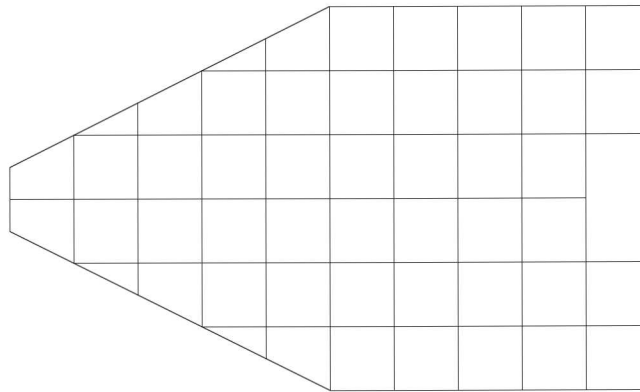
Data Parallel Pipelines

- Ghost cells can solve most of these problems.



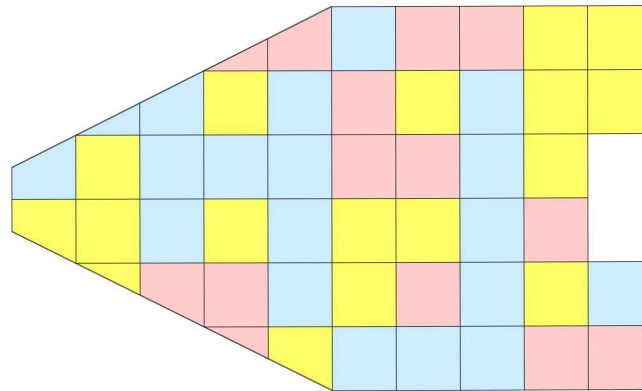
Data Partitioning

- Partitions should be load balanced and spatially coherent.



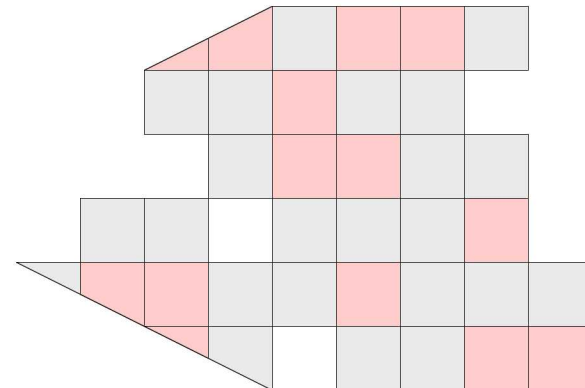
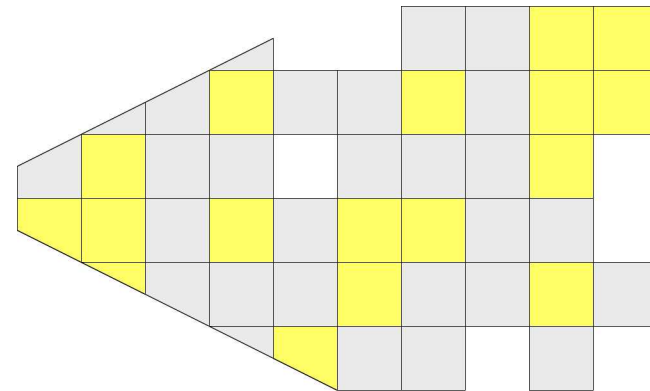
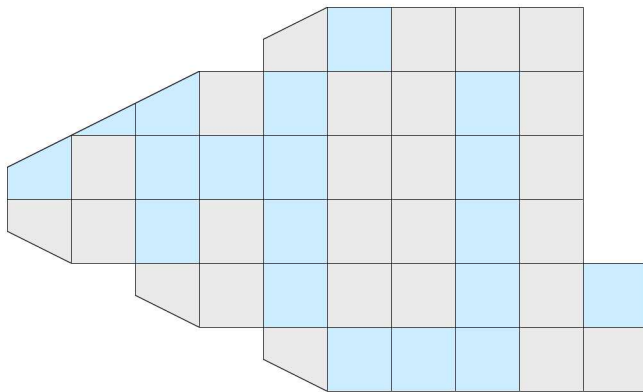
Data Partitioning

- Partitions should be load balanced and spatially coherent.



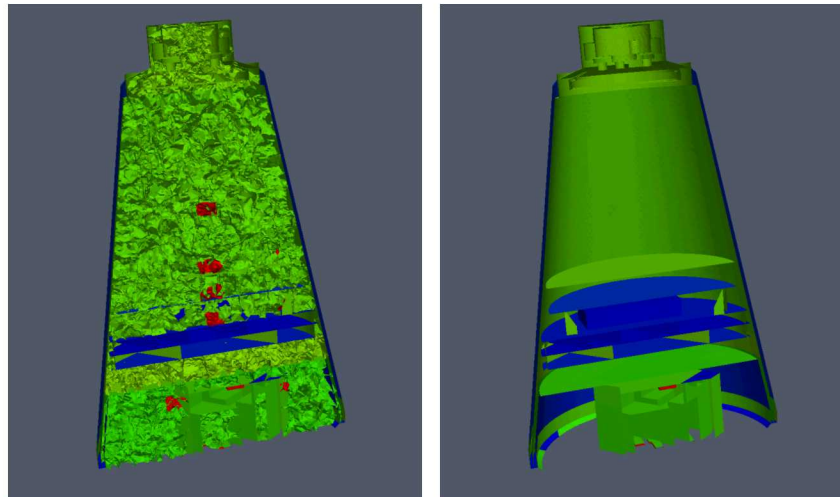
Data Partitioning

- Partitions should be load balanced and spatially coherent.



Load Balancing/Ghost Cells

- Automatic for Structured Meshes.
- Partitioning/ghost cells for unstructured is “manual.”
- Use the D3 filter for unstructured
 - (Filters → Alphabetical → D3)

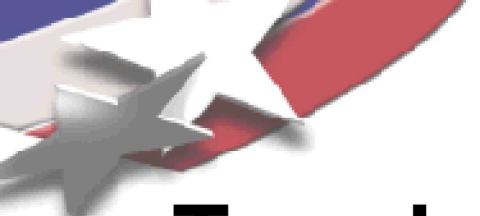


Job Size Rules of Thumb

- Structured Data
 - Try for max 20 M cell/processor.
 - Shoot for 5 – 10 M cell/processor.
- Unstructured Data
 - Try for max 1 M cell/processor.
 - Shoot for 250 – 500 K cell/processor.

Avoiding Data Explosion

- Pipeline may cause data to be copied, created, converted.
- This advice **only for dealing with very large amounts of data.**
 - Remaining available memory is low.



Topology Changing, No Reduction

- Append Datasets
- Append Geometry
- Clean
- Clean to Grid
- Connectivity
- D3
- Delaunay 2D/3D
- Extract Edges
- Linear Extrusion
- Loop Subdivision
- Reflect
- Rotational Extrusion
- Shrink
- Smooth
- Subdivide
- Tessellate
- Tetrahedralize
- Triangle Strips
- Triangulate



Topology Changing, Moderate Reduction

- Clip

- Decimate

- Extract Cells by
Region

- Extract Selec

- Quadric Clustering

- Threshold

Similar: Extract Subset

Topology Changing, Dimension Reduction



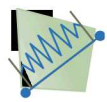
- Cell Centers
- Contour A small icon representing a contour, showing a green circle with a blue center and a white ring.
- Extract CTH Fragments
- Extract CTH Parts
- Extract Surface
- Feature Edges
- Mask Points
- Outline (curvilinear)
- Slice A small icon representing a slice, showing a green cube with a white outline.
- Stream Tracer A small icon representing a stream tracer, showing a green circle with a white outline and a green dot in the center.

Adds Field Data

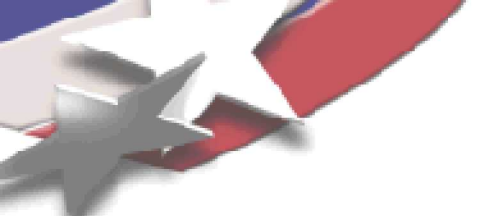
- Block Scalars
- Calculator 
- Cell Data to Point Data
- Compute Derivatives
- Curvature
- Elevation
- Generate Ids
- Gen. Surface Normals
- Gradient
- Level Scalars
- Median
- Mesh Quality
- Octree Depth Limit
- Octree Depth Scalars
- Point Data to Cell Data
- Process Id Scalars
- Random Vectors
- Resample with dataset
- Surface Flow
- Surface Vectors
- Texture Map to...
- Transform
- Warp (scalar)
- Warp (vector) 

Total Shallow Copy or Output Independent of Input



- Annotate Time
- Append Attributes
- Extract Block
- Extract Datasets
- Extract Level 
- Glyph 
- Group Datasets 
- Histogram 
- Integrate Variables
- Normal Glyphs
- Outline
- Outline Corners
- Plot Global Variables Over Time
- Plot Over Line 
- Plot Selection Over Time 
- Probe Location 
- Temporal Shift Scale
- Temporal Snap-to-Time-Steps
- Temporal Statistics

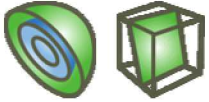




Special Cases

- Temporal Filters
 - Temporal Interpolator
 - Particle Tracer
 - Temporal Cache
- Programmable Filter {...}

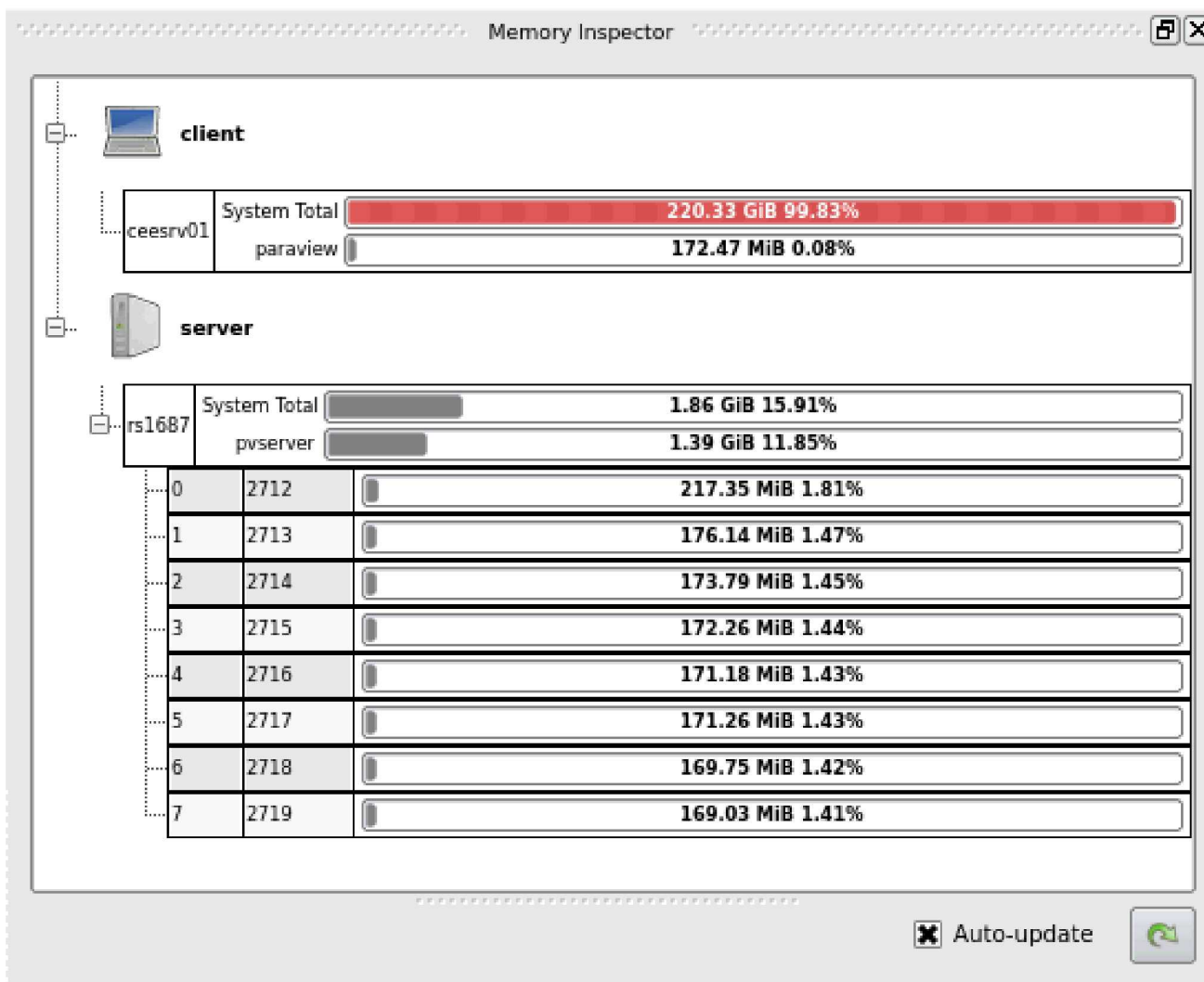
Culling Data

- Reduce dimensionality early. 
 - Contour and slice “see” inside volumes.
- Prefer data reduction over extraction.
 - Slice instead of Clip.
 - Contour instead of Threshold.
- Only extract when reducing an order of magnitude or more.
 - Can still run into troubles.

Culling Data

- Experiment with subsampled data.
 - Extract Subset
- Use caution.
 - Subsampled data may be lacking.
 - Use full data to draw final conclusions.

Memory Inspector

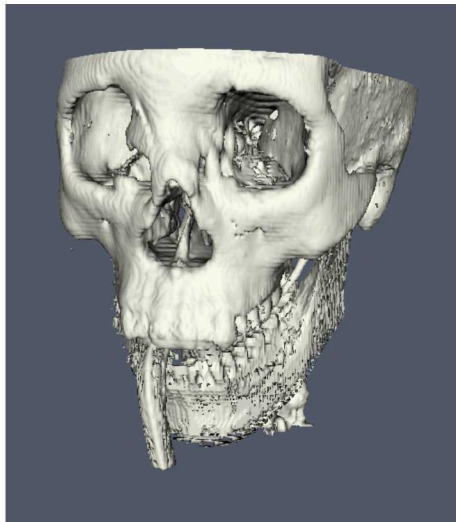


Rendering Modes

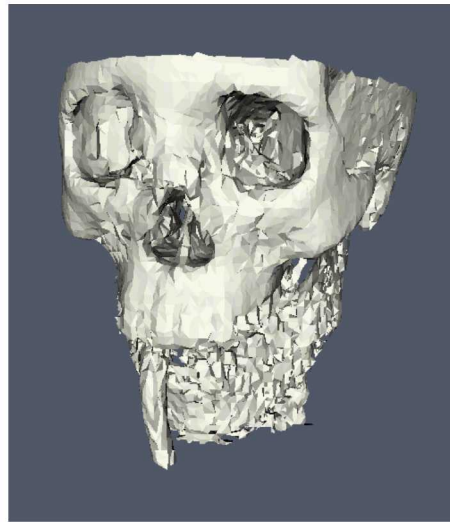
- Still Render
 - Full detail render.
- Interactive Render
 - Sacrifices detail for speed.
 - Provides quick rendering rate.
 - Used when interacting with 3D view.

Level of Detail (LOD)

- Geometric decimation
- Used only with Interactive Render



Original Data



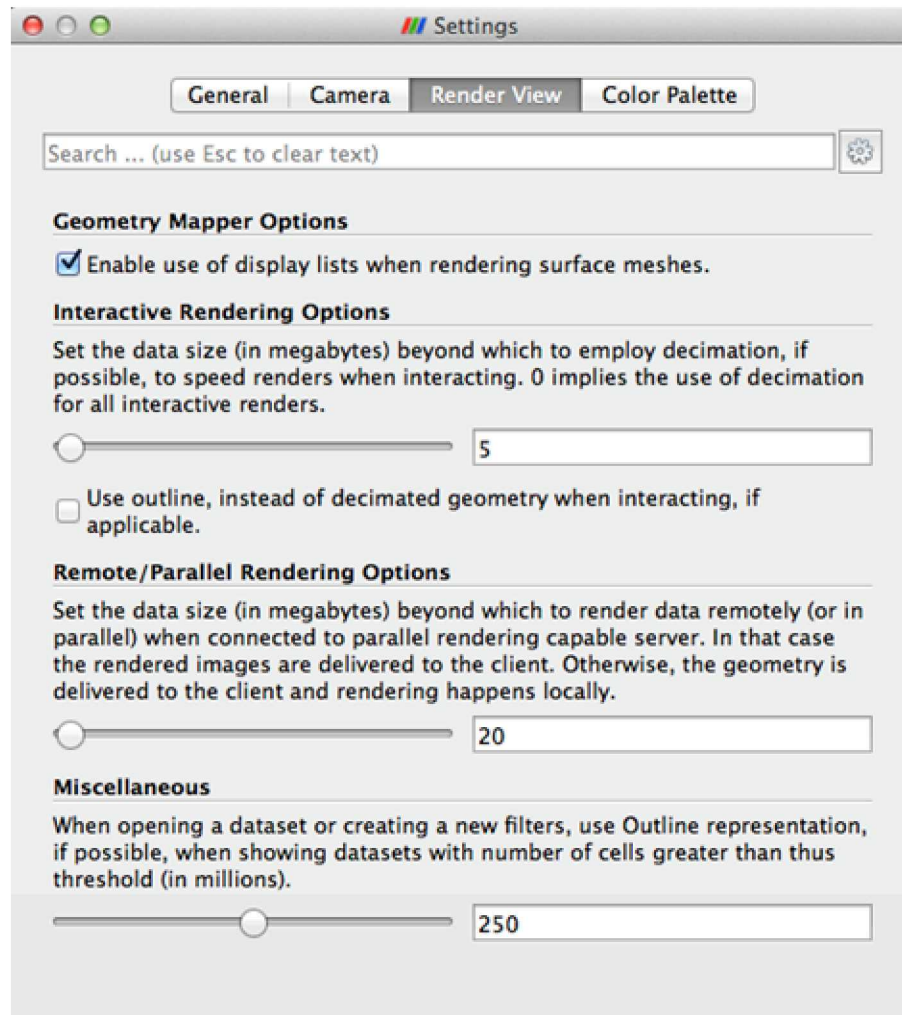
Default Decimation



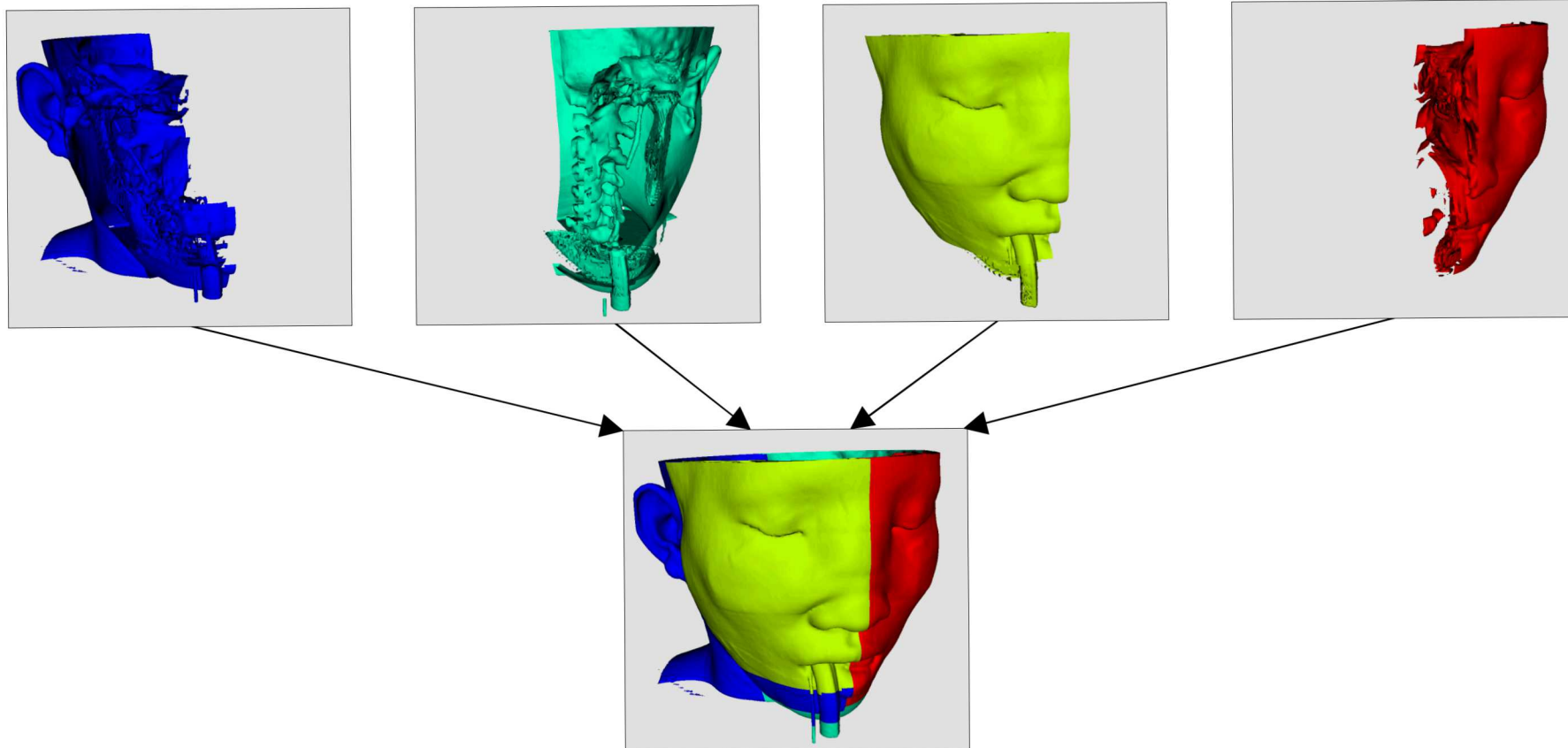
Maximum Decimation

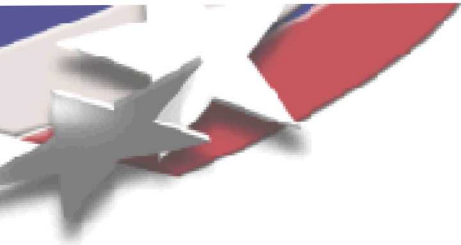
3D Rendering Parameters

Edit → Settings, Render View

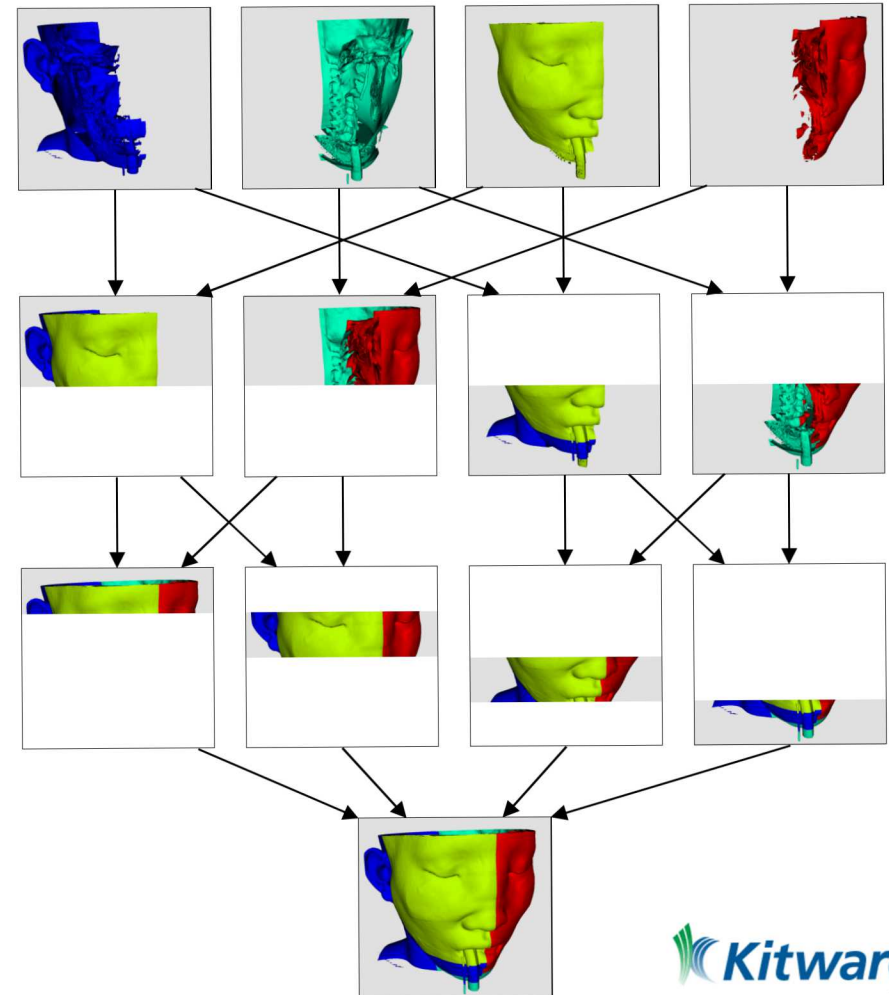
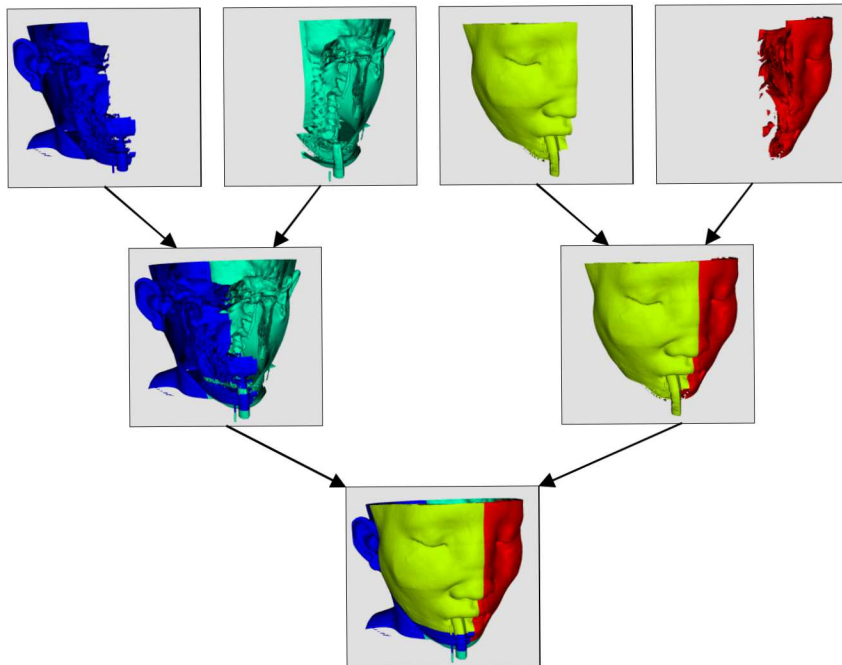


Parallel Rendering





Parallel Rendering



Tiled Displays

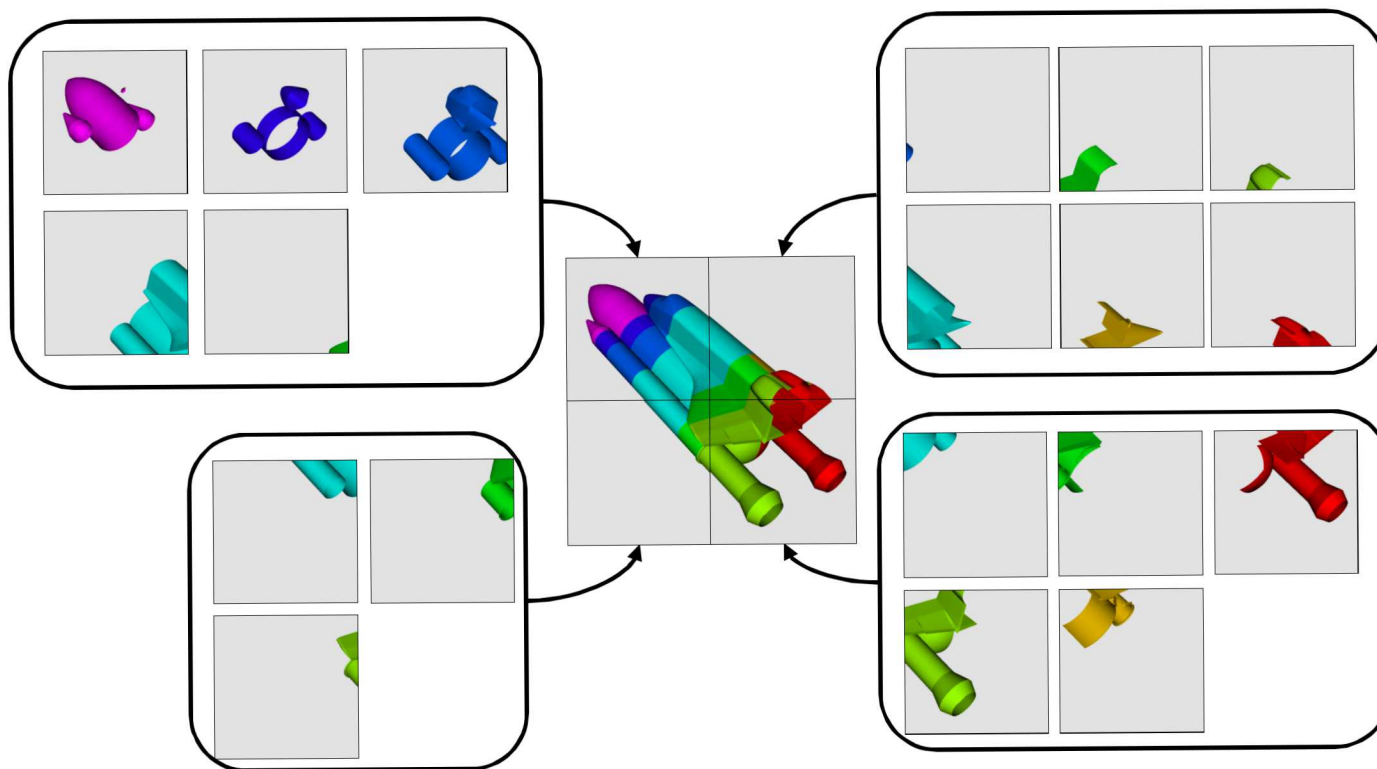
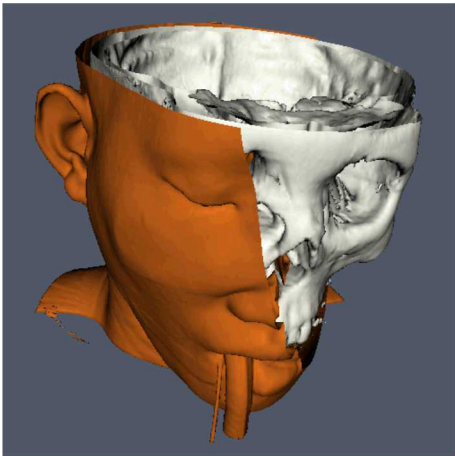
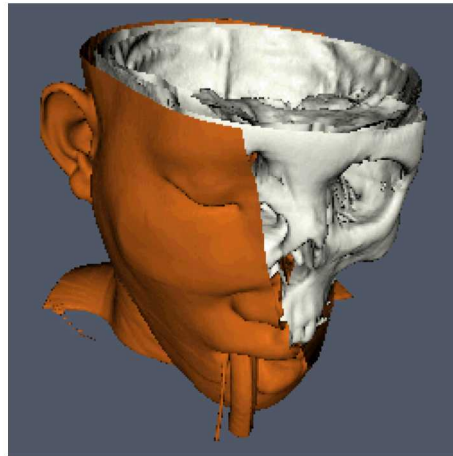


Image Size LOD

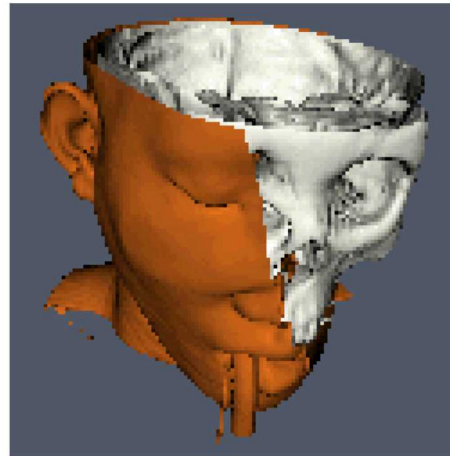
- ParaView's parallel rendering overhead proportional to image size.
- Can use smaller images for interactive rendering.



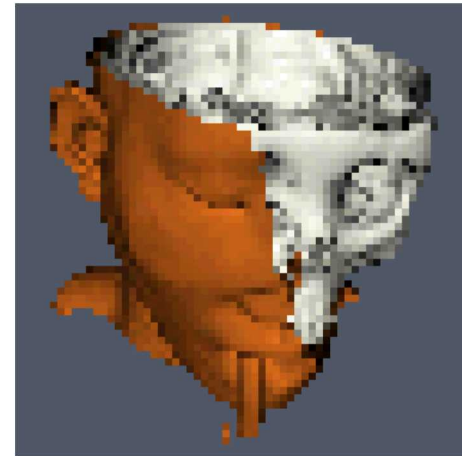
Original Data



Subsample Rate: 2 pixels



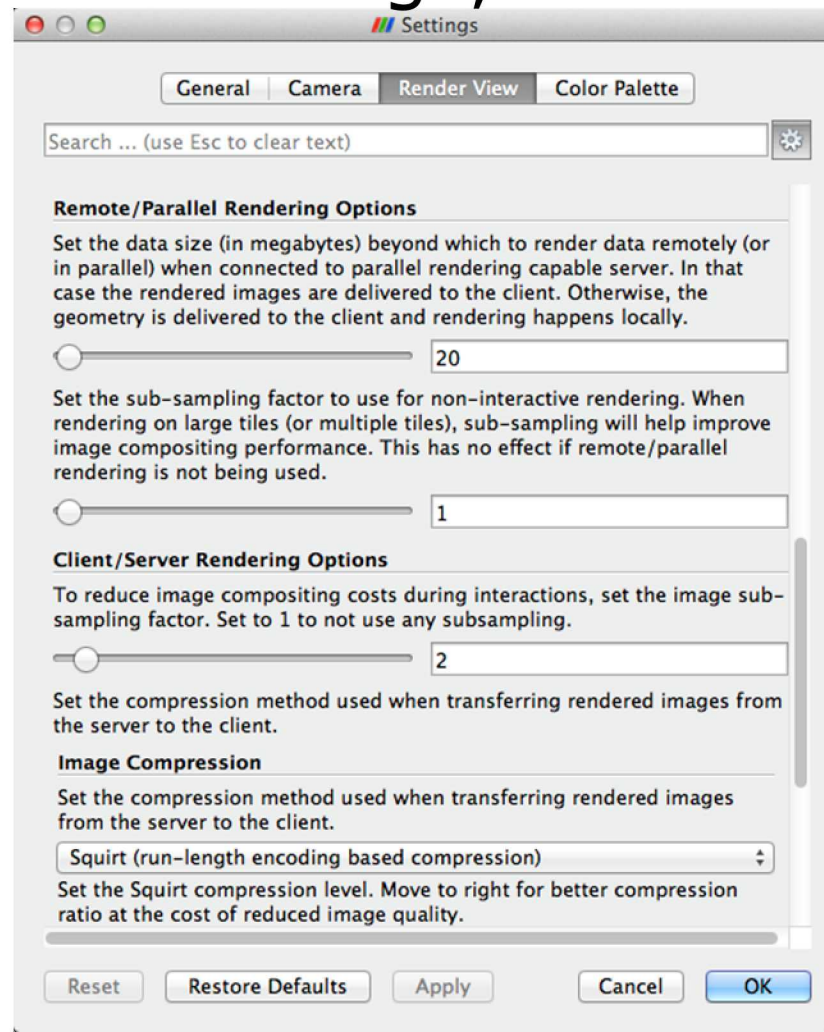
Subsample Rate: 4 pixels



Subsample Rate: 8 pixels

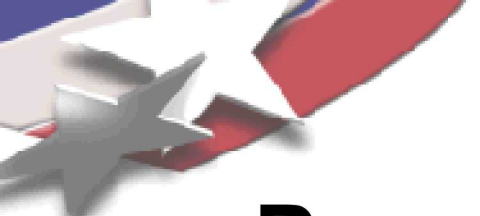
Parallel Rendering Parameters

Edit → Settings, Render View



Parameters for Large Data

- Use display lists for GPU, off for CPU.
- Try outline instead of decimated geometry.
 - Also try lowering decimation factor.
- Avoid shipping large data back to client.
- Turn on subsampling.
- Image Compression on.

 In the top-left corner, there are several overlapping stars in white and red, some with a 3D effect.

Parameters for Low Bandwidth

- Try larger subsampling rates.
- Try Zlib compression and fewer bits.

Parameters for High Latency

- Turn up Remote Render Threshold.
 - Allow more data to go to client.
- Play with the LOD Threshold and LOD Resolution to control geometry sent to client.
- Turn on Use outline for LOD rendering if decimated geometry too big for client.
- Try turning on interactive render delay.



ParaView **Catalyst**

Why *In Situ*?

System Parameter	2011	“2018”		Factor Change
System peak	2 PF	1 EF		500
Power	6 MW	≤20 MW		3
System Memory	0.3 PB	32-64 PB		33
Node Performance	0.125 Tf/s	1 TF	10 TF	8-80
Node Concurrency	12	1,000	10,000	83-830
Network BW	1.5 GB/s	100 GB/s	1,000 GB/s	66-660
System Size (nodes)	18,700	1M	100k	33
Total Concurrency	225 K	10 B	100 B	40K-400K
Storage Capacity	15 PB	300-1,000 PB		20-67
I/O BW	0.2 TB/s	20-60 TB/s		100-300

In Situ



Augmented
script in
input deck.

ParaView Catalyst



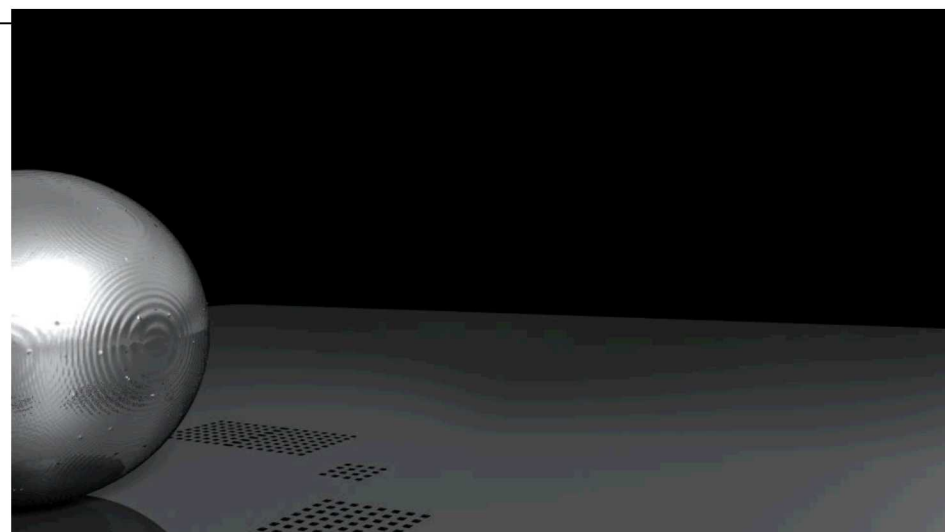
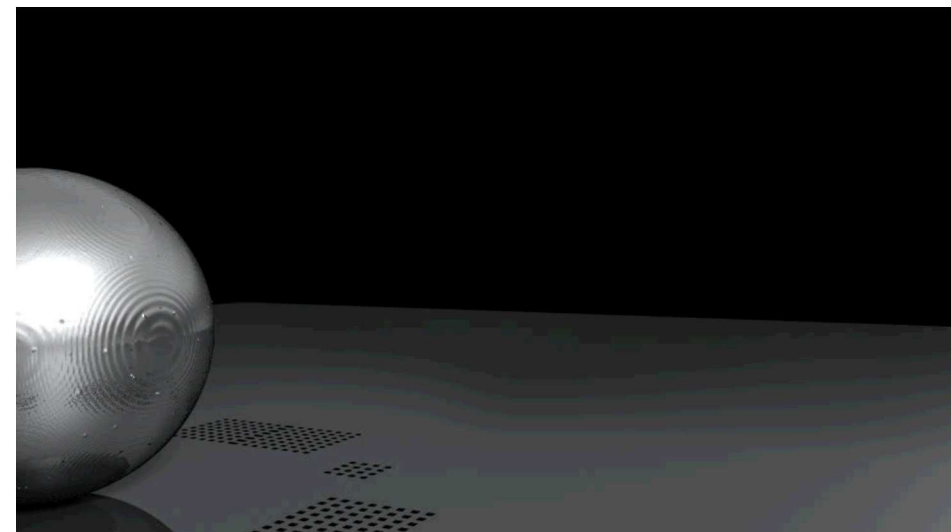
A 3D visualization of a crack in a concrete slab. The crack is represented by a dark, elongated feature. The surrounding area is colored in red and blue, indicating different stress or strain fields. The slab is shown in a perspective view, with a grid pattern on its surface.

Year	Age	Sex	Height (cm)	Weight (kg)	Body Fat (%)	Lean Body Mass (kg)	Max Heart Rate (b/min)	Max Oxygen Consumption (L/min)	Max Power (W)	Max Speed (m/s)	Max Acceleration (m/s ²)	Max Deceleration (m/s ²)	Max Force (N)	Max Torque (Nm)	Max Moment (Nm)	Max Energy (J)	Max Power (W)	Max Speed (m/s)	Max Acceleration (m/s ²)	Max Deceleration (m/s ²)	Max Force (N)	Max Torque (Nm)	Max Moment (Nm)	Max Energy (J)	Max Power (W)	Max Speed (m/s)	Max Acceleration (m/s ²)	Max Deceleration (m/s ²)	Max Force (N)	Max Torque (Nm)	Max Moment (Nm)	Max Energy (J)
1970	18	M	178	75	15	63.75	190	3.5	1200	1.5	1.5	1.5	1200	1.5	1.5	1.5	1200	1.5	1.5	1.5	1200	1.5	1.5	1.5	1200	1.5	1.5	1.5	1200	1.5	1.5	1.5
1970	19	M	180	78	16	66.24	192	3.6	1220	1.55	1.55	1.55	1220	1.55	1.55	1.55	1220	1.55	1.55	1.55	1220	1.55	1.55	1.55	1220	1.55	1.55	1.55	1220	1.55	1.55	1.55
1970	20	M	182	81	17	68.73	194	3.7	1240	1.6	1.6	1.6	1240	1.6	1.6	1.6	1240	1.6	1.6	1.6	1240	1.6	1.6	1.6	1240	1.6	1.6	1.6	1240	1.6	1.6	1.6
1970	21	M	184	84	18	71.22	196	3.8	1260	1.65	1.65	1.65	1260	1.65	1.65	1.65	1260	1.65	1.65	1.65	1260	1.65	1.65	1.65	1260	1.65	1.65	1.65	1260	1.65	1.65	1.65
1970	22	M	186	87	19	73.71	198	3.9	1280	1.7	1.7	1.7	1280	1.7	1.7	1.7	1280	1.7	1.7	1.7	1280	1.7	1.7	1.7	1280	1.7	1.7	1.7	1280	1.7	1.7	1.7
1970	23	M	188	90	20	76.20	200	4.0	1300	1.75	1.75	1.75	1300	1.75	1.75	1.75	1300	1.75	1.75	1.75	1300	1.75	1.75	1.75	1300	1.75	1.75	1.75	1300	1.75	1.75	1.75
1970	24	M	190	93	21	78.69	202	4.1	1320	1.8	1.8	1.8	1320	1.8	1.8	1.8	1320	1.8	1.8	1.8	1320	1.8	1.8	1.8	1320	1.8	1.8	1.8	1320	1.8	1.8	1.8
1970	25	M	192	96	22	81.18	204	4.2	1340	1.85	1.85	1.85	1340	1.85	1.85	1.85	1340	1.85	1.85	1.85	1340	1.85	1.85	1.85	1340	1.85	1.85	1.85	1340	1.85	1.85	1.85
1970	26	M	194	99	23	83.67	206	4.3	1360	1.9	1.9	1.9	1360	1.9	1.9	1.9	1360	1.9	1.9	1.9	1360	1.9	1.9	1.9	1360	1.9	1.9	1.9	1360	1.9	1.9	1.9
1970	27	M	196	102	24	86.16	208	4.4	1380	1.95	1.95	1.95	1380	1.95	1.95	1.95	1380	1.95	1.95	1.95	1380	1.95	1.95	1.95	1380	1.95	1.95	1.95	1380	1.95	1.95	1.95
1970	28	M	198	105	25	88.65	210	4.5	1400	2.0	2.0	2.0	1400	2.0	2.0	2.0	1400	2.0	2.0	2.0	1400	2.0	2.0	2.0	1400	2.0	2.0	2.0	1400	2.0	2.0	2.0
1970	29	M	200	108	26	91.14	212	4.6	1420	2.05	2.05	2.05	1420	2.05	2.05	2.05	1420	2.05	2.05	2.05	1420	2.05	2.05	2.05	1420	2.05	2.05	2.05	1420	2.05	2.05	2.05
1970	30	M	202	111	27	93.63	214	4.7	1440	2.1	2.1	2.1	1440	2.1	2.1	2.1	1440	2.1	2.1	2.1	1440	2.1	2.1	2.1	1440	2.1	2.1	2.1	1440	2.1	2.1	2.1
1970	31	M	204	114	28	96.12	216	4.8																								



In Situ

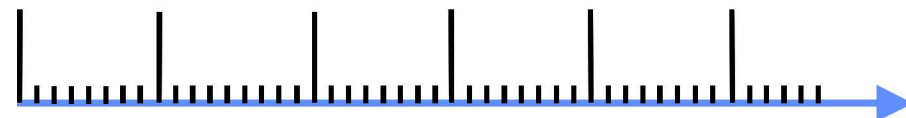
Access to More Data



Dump
Times



Post-processing



In situ processing

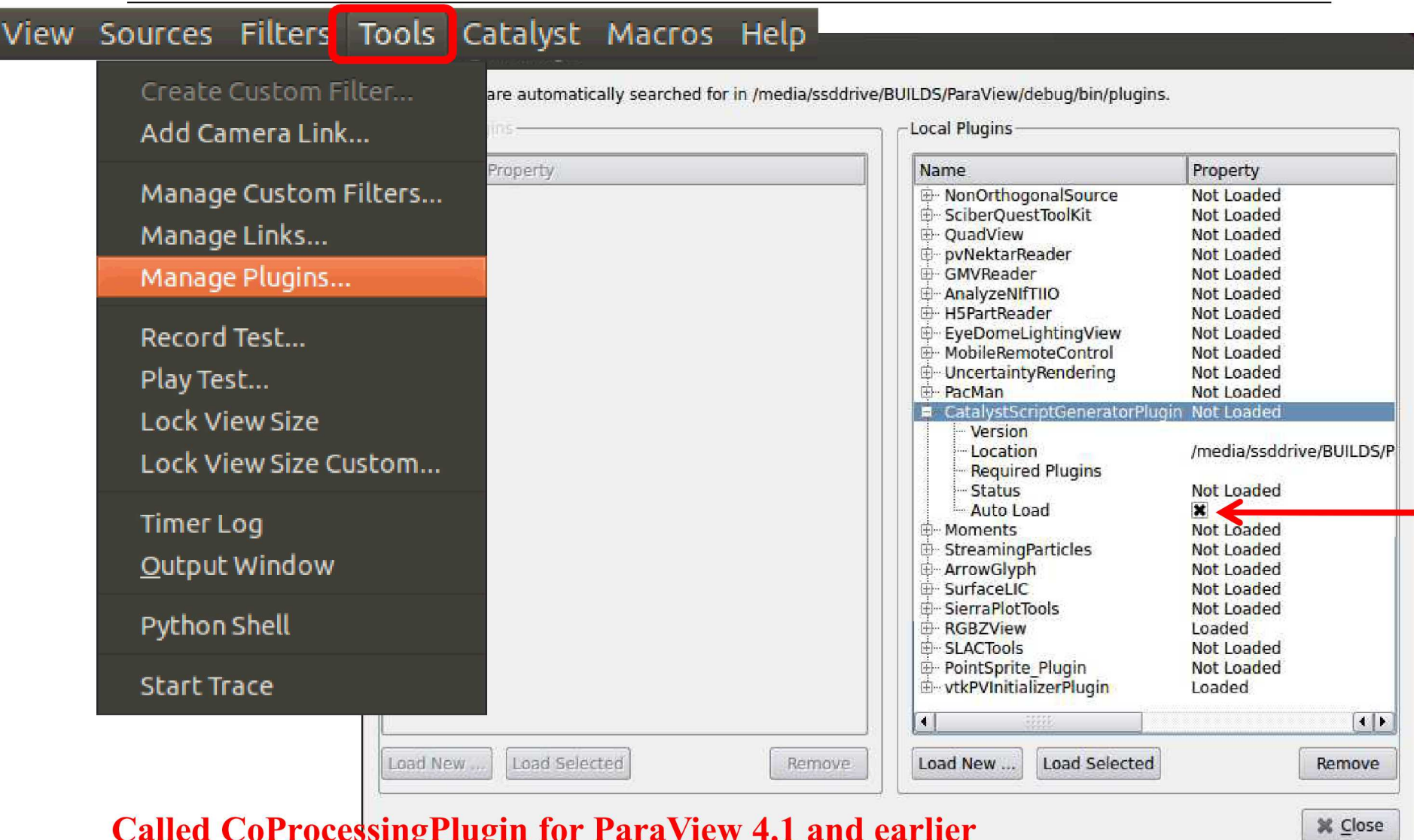
CTH (Sandia) simulation with roughly equal data stored at simulation time

Reflections and shadows added in post-processing for both examples

ParaView GUI Plugin

- Creates Catalyst scripts to use with simulation runs
- Similar to using ParaView interactively
 - Setup desired pipelines
 - Ideally, start with a representative data set from the simulation
- Extra pipeline information to tell what to output during simulation run
 - Add in data extract writers
 - Create screenshots to output
 - Both require file name and write frequency

In Situ Demo – Load Plugin Step



The screenshot shows the ParaView interface. The **Tools** menu is open, and **Manage Plugins...** is selected. The **Local Plugins** dialog is displayed, showing a list of plugins and their status. A red arrow points to the **Auto Load** checkbox for the **CatalystScriptGeneratorPlugin**, which is currently unchecked.

Name	Property
NonOrthogonalSource	Not Loaded
SciberQuestToolKit	Not Loaded
QuadView	Not Loaded
pvNektarReader	Not Loaded
GMVReader	Not Loaded
AnalyzeNIFTIIO	Not Loaded
H5PartReader	Not Loaded
EyeDomeLightingView	Not Loaded
MobileRemoteControl	Not Loaded
UncertaintyRendering	Not Loaded
PacMan	Not Loaded
CatalystScriptGeneratorPlugin	Not Loaded
Version	
Location	/media/ssddrive/BUILDS/P
Required Plugins	
Status	Not Loaded
Auto Load	☐
Moments	Not Loaded
StreamingParticles	Not Loaded
ArrowGlyph	Not Loaded
SurfaceLIC	Not Loaded
SierraPlotTools	Not Loaded
RGBZView	Loaded
SLACTools	Not Loaded
PointSprite_Plugin	Not Loaded
vtkPVInitializerPlugin	Loaded

Buttons at the bottom of the dialog: Load New ..., Load Selected, Remove, Close.

Called CoProcessingPlugin for ParaView 4.1 and earlier

In Situ Demo – New Plugin Menus

CoProcessor Writers

Export State

Parallel Hierarchical Box Data Writer

Parallel MultiBlockDataSet Writer

Parallel Image Data Writer

Parallel PolyData Writer

Parallel Rectilinear Grid Writer

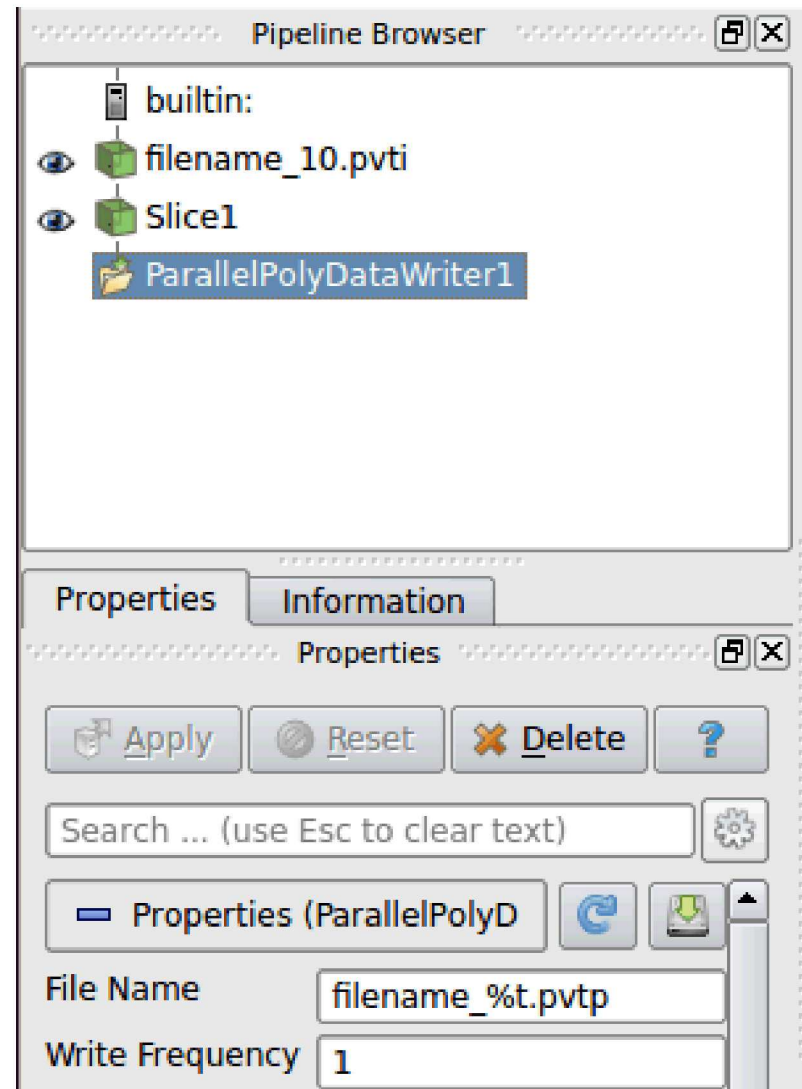
Parallel Structured Grid Writer

Parallel UnstructuredGrid Writer

In Situ Demo – Adding in Writers

- Only valid writers available in Writers menu
- Parameters:
 - File Name – %t gets replaced with time step
 - Write Frequency

Parallel Hierarchical Box Data Writer
 Parallel MultiBlockDataSet Writer
 Parallel Image Data Writer
Parallel PolyData Writer
 Parallel Rectilinear Grid Writer
 Parallel Structured Grid Writer
 Parallel UnstructuredGrid Writer

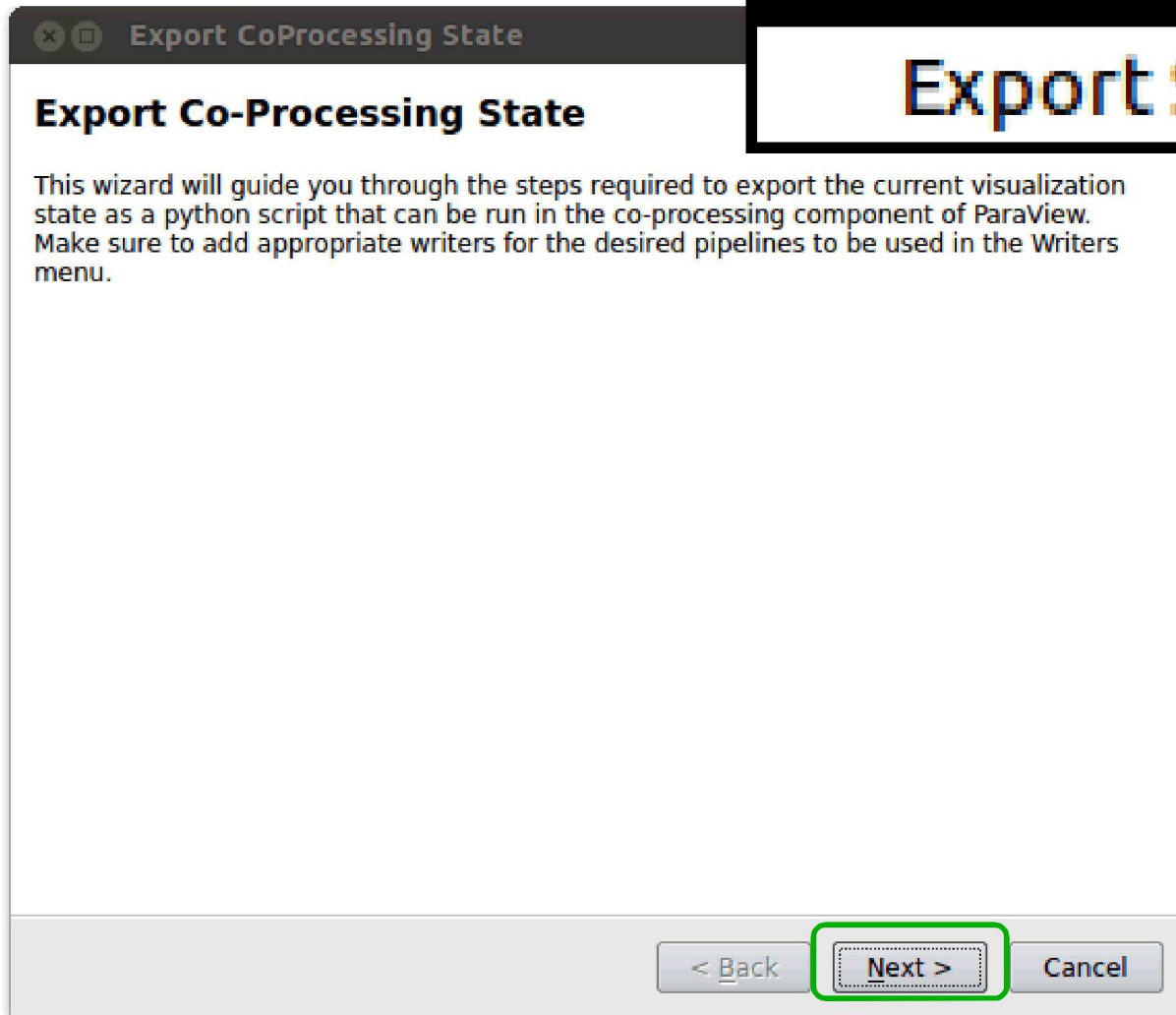


In Situ Demo – Exporting the Script



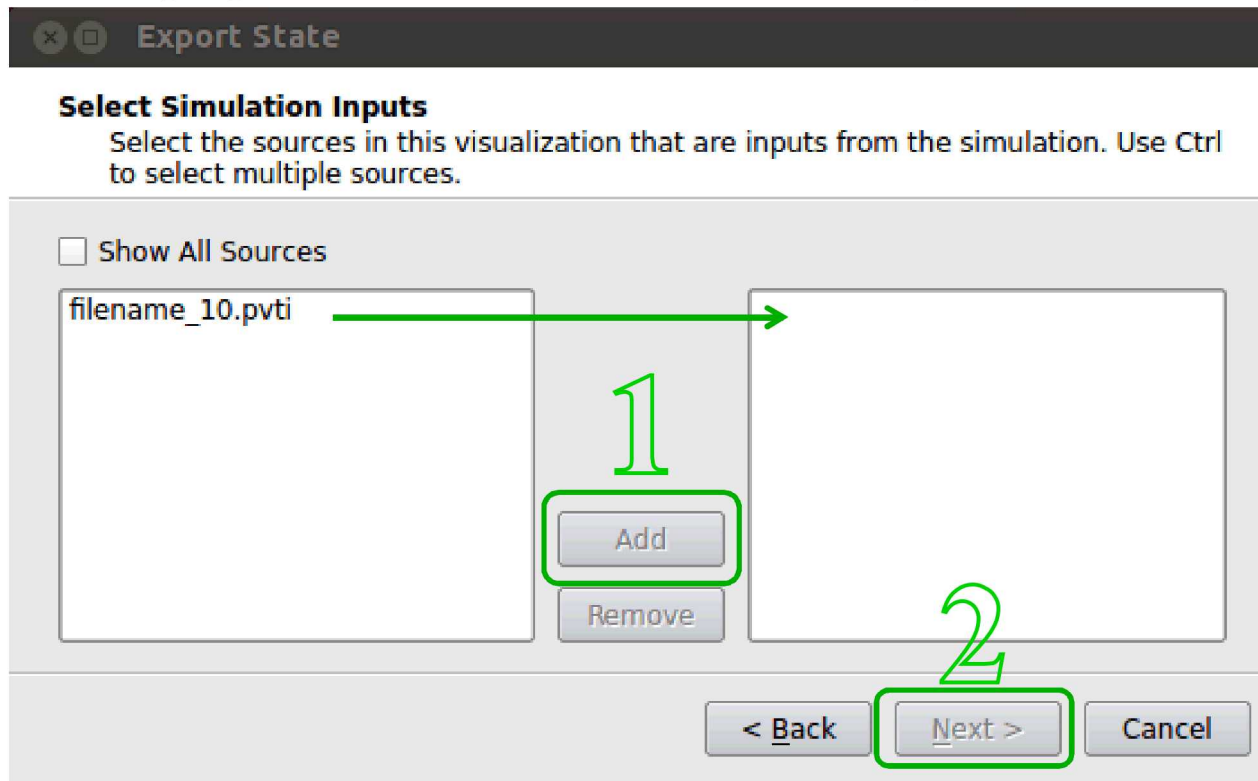
CoProcessor

Export State



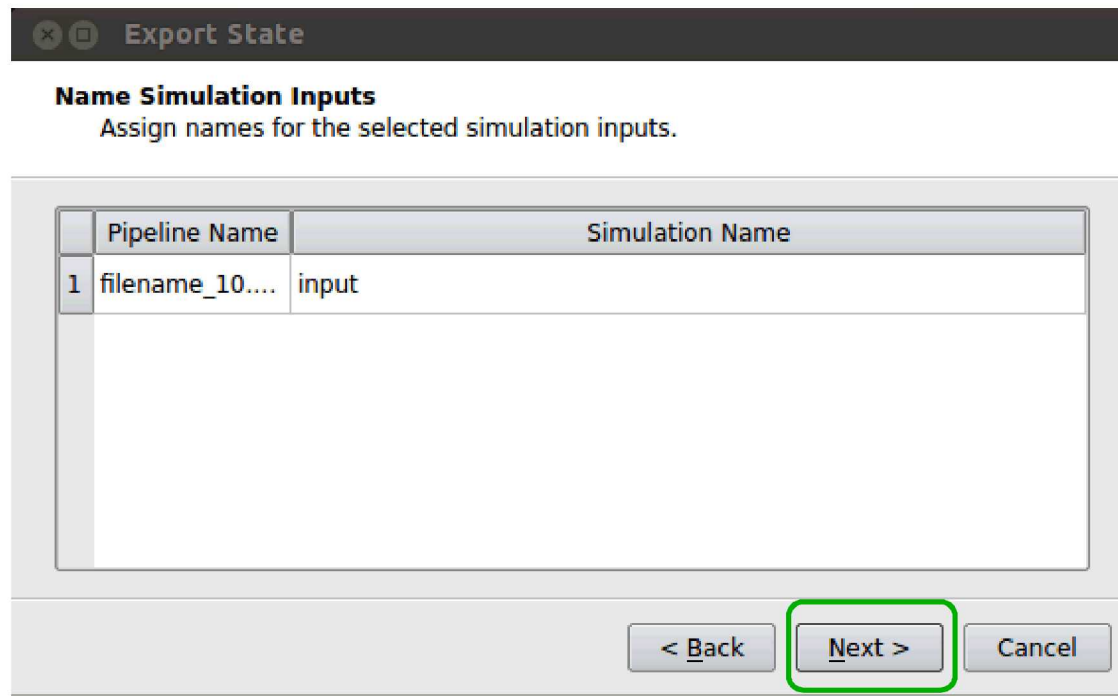
In Situ Demo – Select Inputs

- Usually only a single input but can have multiple inputs
- Each pipeline source is a potential input



In Situ Demo – Match Up Inputs

- Source name (e.g. “filename_10.pvti”) needs to be matched with string key in adaptor (e.g. “input” which is the default for single inputs)



Export State

Name Simulation Inputs
Assign names for the selected simulation inputs.

	Pipeline Name	Simulation Name
1	filename_10....	input

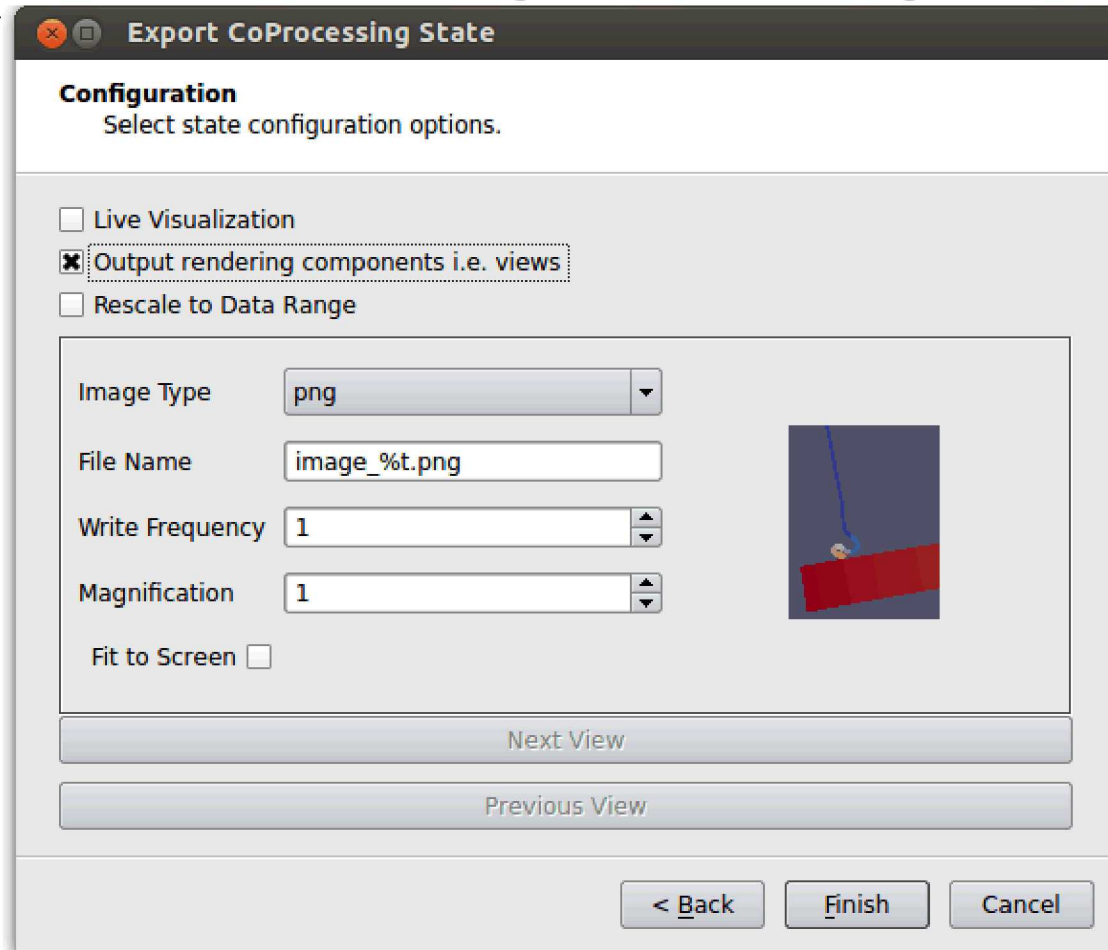
< Back **Next >** Cancel

In Situ Demo – Generating an Image

- Parameters/Options:

- Live visualization
- Rescale to Data Range (all images)
- Individual images
 - Image Type
 - File Name
 - Write Frequency
 - Magnification
 - Fit to Screen

- %t gets replaced with time step



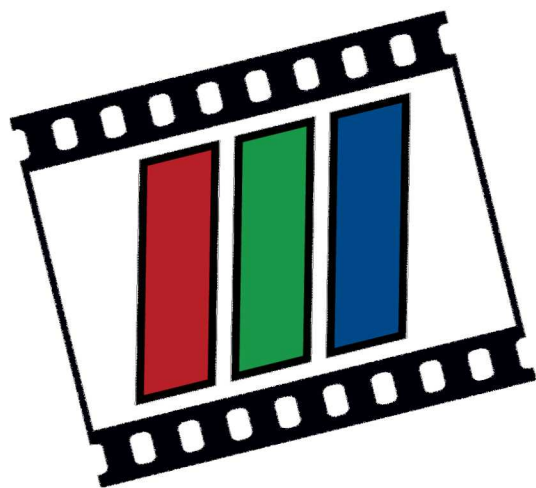
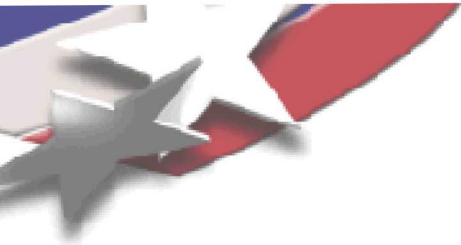
ParaView Catalyst Modes

- Batch – executes the script pipelines without any user interaction
- Interactive – connect the ParaView GUI to the running simulation to observe the output and modify pipelines
 - Can either pause the simulation at a specific point in the simulation or have the GUI update the Catalyst pipelines when convenient
- Can switch between interactive and batch modes during the run

In the top left corner, there are several overlapping stars in white and red, partially cut off by the edge of the slide.

Want to Learn More?

- SC14 Tutorial:
 - In Situ Data Analysis and Visualization with ParaView Catalyst
 - November 17th, 8:30am-12pm, room 394
- Catalyst User's Guide:
 - <http://paraview.org/Wiki/images/4/48/CatalystUsersGuide.pdf>
- Website:
 - <http://catalyst.paraview.org>
- Examples:
 - <https://github.com/acbauer/CatalystExampleCode>

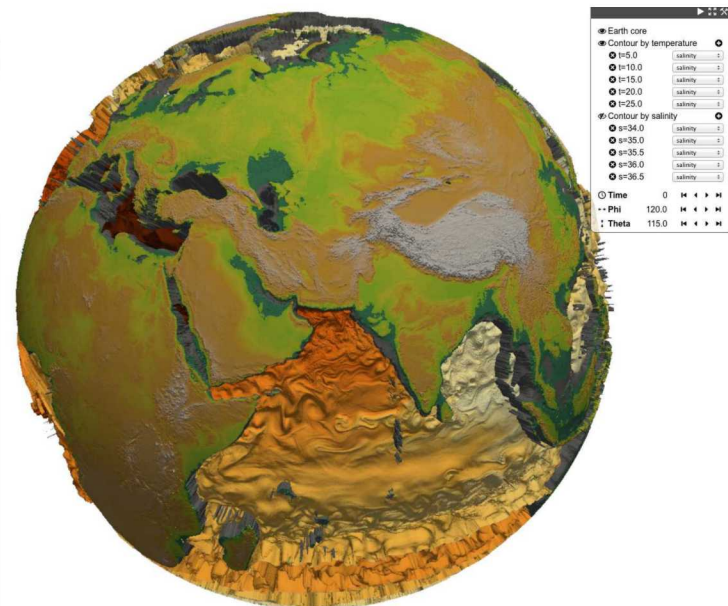
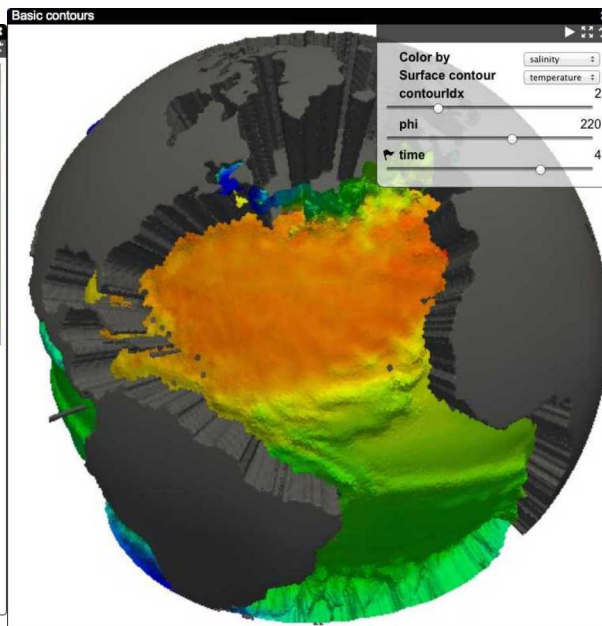
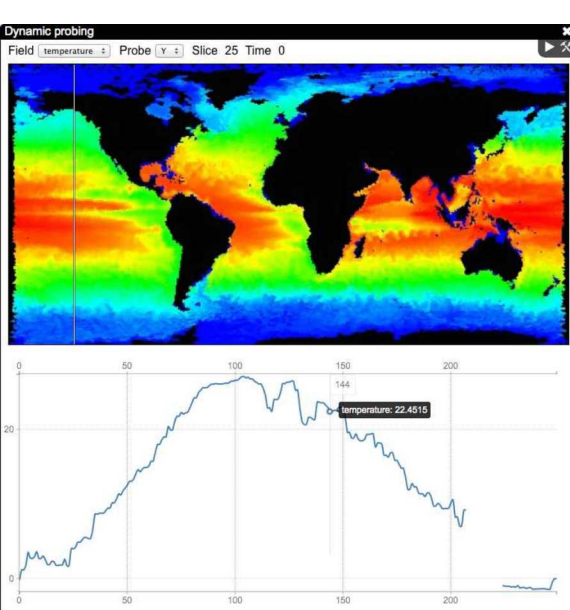
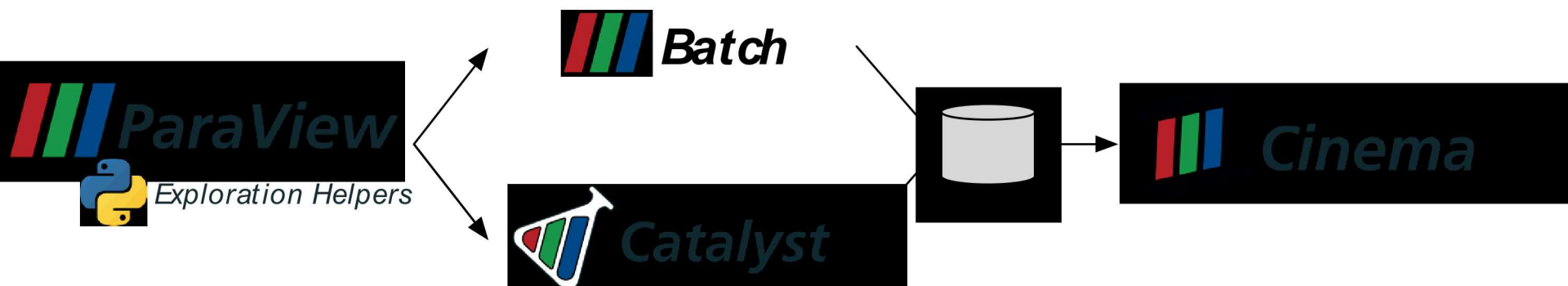


ParaView **Cinema**

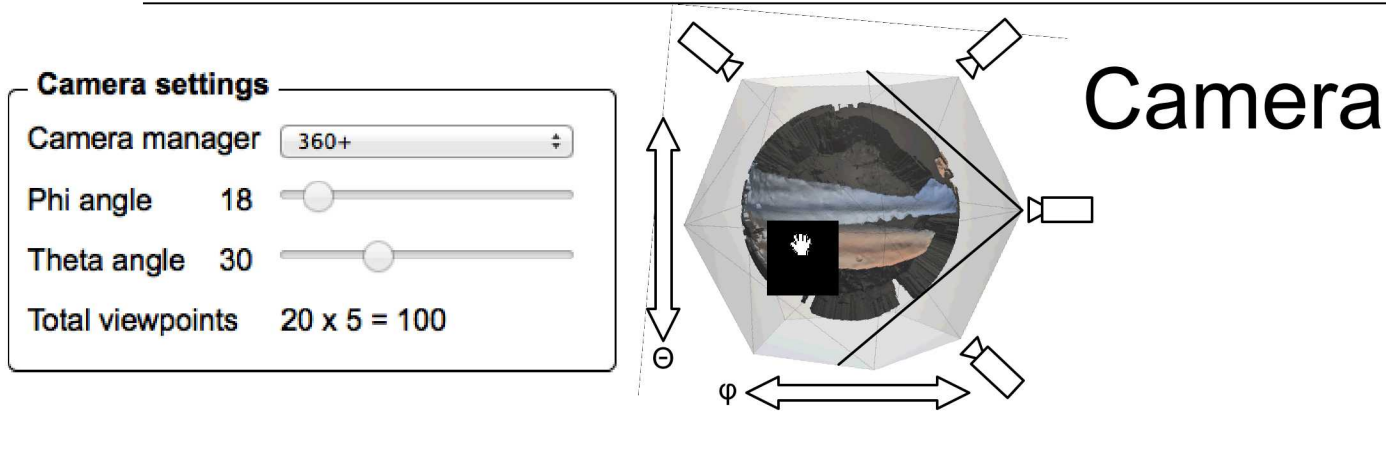
Extract an Interactive Picture

- Non interactive job (in situ/batch) for interactive exploration.
- Image based techniques (single vs. composite).
- Data reduction / subsampling (various formats)
- Lightweight client for exploration
 - Web browser
 - Easier to share results

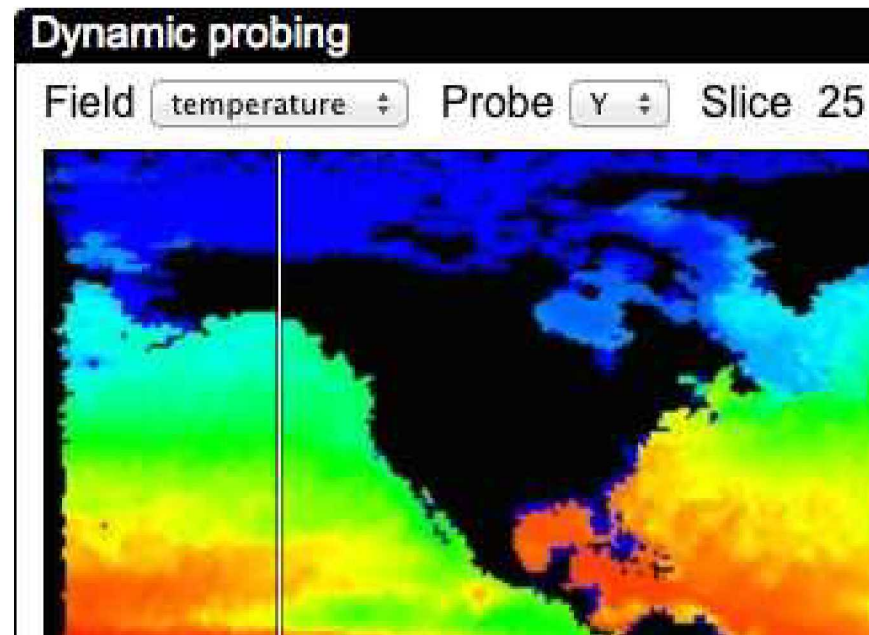
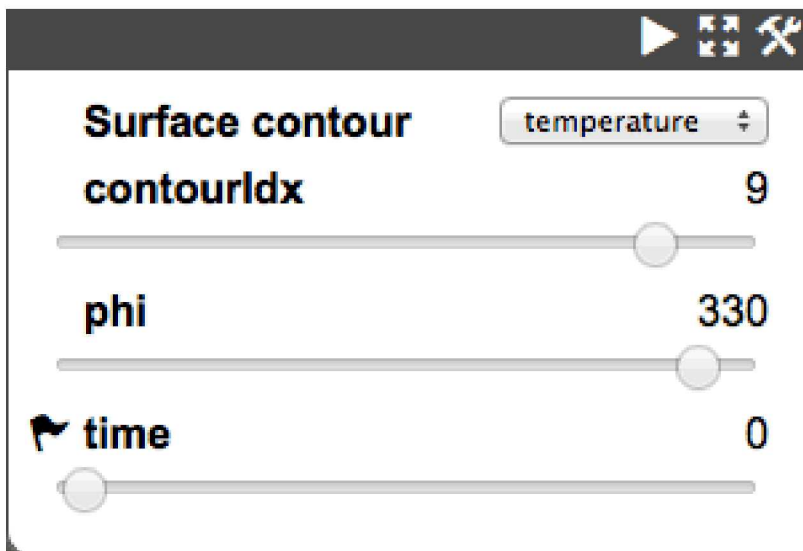
What Can Be Done?



Interactive on What?



Filter Parameter



How to Use It?

```
exporter = ThreeSixtyImageStackExporter( \
    fng, \
    view, \
    center_of_rotation, \
    distance, \
    rotation_axis, \
    angle_steps)

# Explore
for iso in iso_values:
    countourFilter.Isosurfaces = <iso>
    fng.update_active_arguments(iso=<iso>)
    exporter.UpdatePipeline()
```

What's Next?

- More types of data exploration classes.
- More client components.
- Integrated environment for data management and results sharing.

 SC 14 – Big Data Analysis Paper
Decorative stars in the top left corner: a large white star and a smaller red star.

Wednesday, November 19th, 11:30 @ 391-92

An Image-Based Approach to Extreme Scale In Situ Visualization and Analysis

James Ahrens, Sebastien Jourdain, Patrick O'Leary, John Patchett,
David Rogers, Mark Petersen

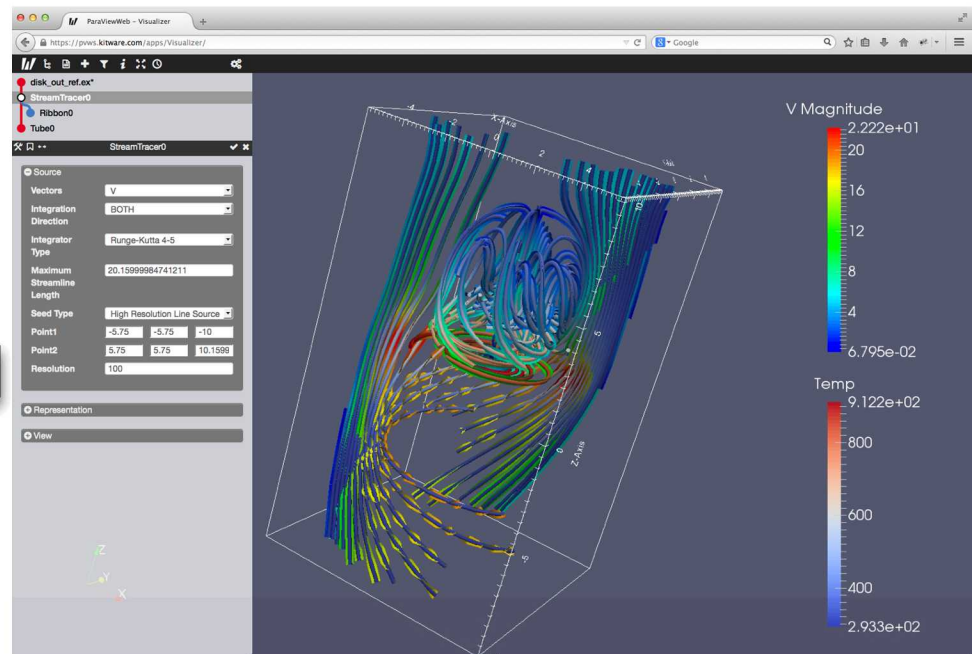
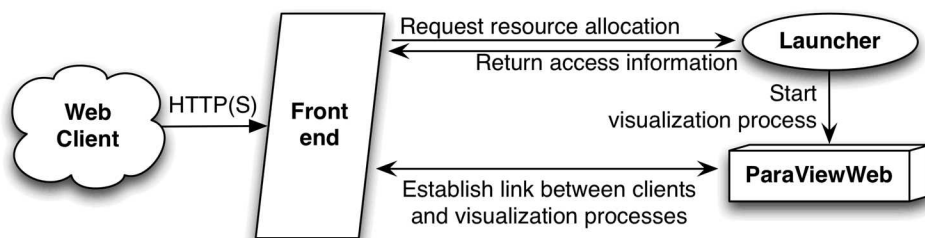


ParaView Web



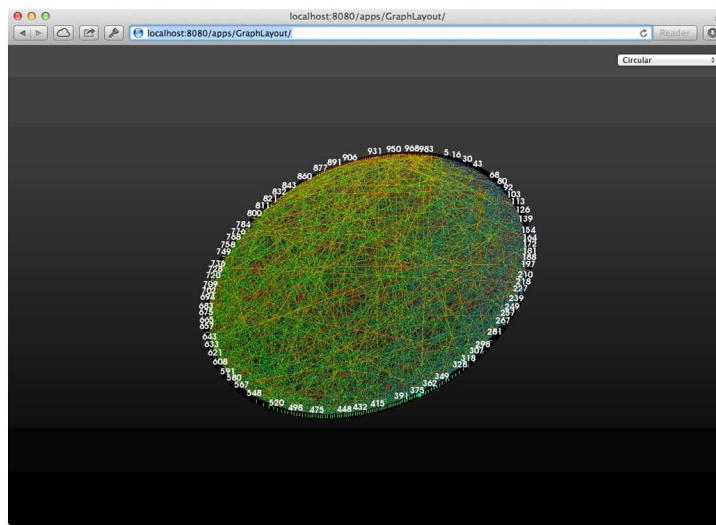
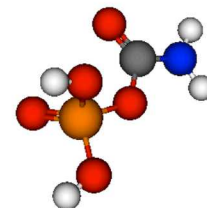
What's That?

- Web remote visualization framework.
- ParaView client on the web.



What Can I Do With It?

- Ease access to your resources for visualization (Cluster, Cloud...)
- No client/server visualization mismatch.
- Custom client application.
- Collaboration.



Q formula=CH*

Query syntax

The query syntax is as follows

There are six comparison operators:

- = - string or numeric equals in the case of string equals * can be used as a wildcard.
- != - string or numeric not equals.
- > - numeric greater than, has no meaning for strings.
- >= - numeric greater than or equal, has no meaning for strings.
- < - numeric less than, has no meaning for strings.
- <= - numeric less than or equal, has no meaning for strings.

The comparison operators can be using with the follow string fields:

- inchi
- inchikey
- name
- formula

or the following numeric fields:

- mass
- atomCount

The comparison operators can be combine using the following two boolean operator, precedence is left to right:

- | - logical OR
- & - logical AND

HS — CH₃

HO — CH₃

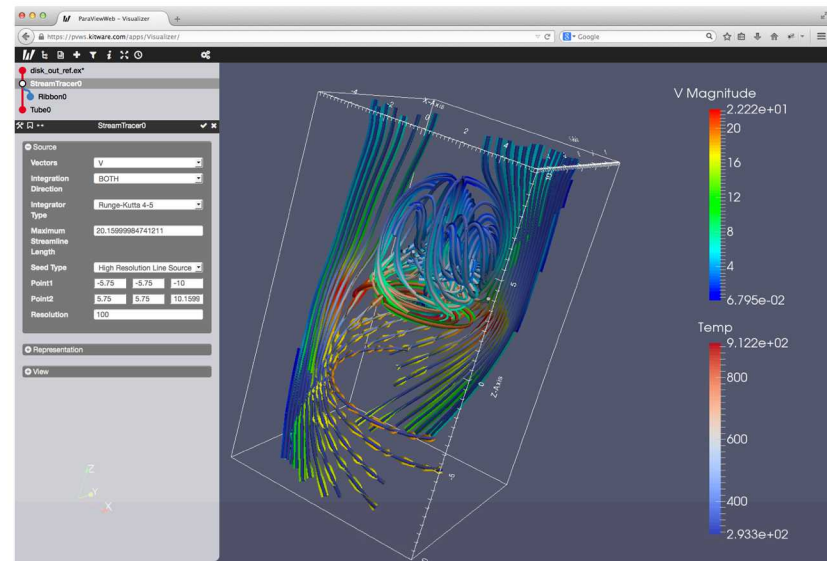
H₂N — NH
|
OH

Where Can I Get It?

- You already have it!
 - It is in the ParaView binaries.

```
$ pvpython \
  ./lib/site-packages/paraview/web/pv_web_visualizer.py \
  --content ./www \
  --port 8080 \
  --data-dir /home/user
```

```
$ open http://localhost:8080/apps/Visualizer/
```



Guides and Documentation

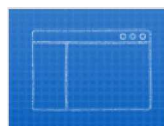
ParaViewWeb

<http://www.paraview.org/documentation>

- ▼ Startup guides
 - Quick start
 - Architecture
 - ParaViewWeb inside iPython
- ▼ Deployment Guide
 - Ubuntu 14.04 LTS
 - Amazon EC2 AMI Instance
 - Using Apache < 2.4 (Deprecate)
 - VirtualGL and TurboVNC
 - Parallel Visualization
- ▼ Session managers
 - Jetty launcher
 - Python Launcher
- ▼ Compilation guides
 - Configure and build VTK
 - Configure and build Paraview
 - Offscreen OSMesa Paraview
- ▼ Developer corner
 - Code Style Guidelines
 - Setting up a machine for Web
 - Automatic deployment and up

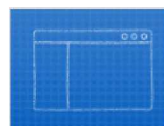
Guides

Startup guides



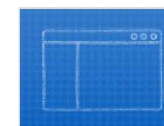
Quick start

This quick start guide show how to test quickly ParaViewWeb locally.



Architecture

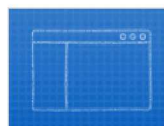
This guide go through the design evolution while explaining why we made the choices that we made.



ParaViewWeb inside iPython

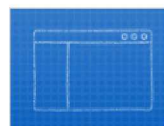
This documentation explain how to setup iPython/notebook along ParaViewWeb with distributed MPI engines and live visualization.

Deployment Guide



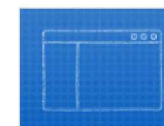
Ubuntu 14.04 LTS

This document explains how to setup a ParaViewWeb server on Ubuntu 14.04 LTS Desktop.



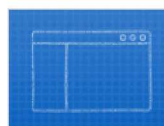
Amazon EC2 AMI Instance

This document explains how to set up an Amazon EC2 AMI instance with Apache, Jetty and ParaViewWeb using Apache 2.4+.



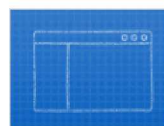
Using Apache < 2.4 (Deprecated)

This document explains how to use Apache as the front-end for ParaViewWeb.



VirtualGL and TurboVNC

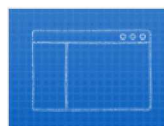
This document explains how to set up ParaViewWeb to do hardware-accelerated, offscreen rendering.



Parallel Visualization

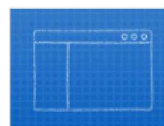
This document explains how to set up the Parallel Web application in order to load data on a visualization cluster.

Session managers



Jetty launcher

This document explains how to use the Jetty Session Manager for ParaViewWeb.



Python Launcher

This document explains how to use the provided Python Launcher for ParaViewWeb.

Compilation guides



Configure and build VTK

This document explains how to configure and build



Configure and build Paraview

This document explains how to configure and build



Offscreen OSMesa ParaviewWeb

This document explains

Further Reading

- ParaView's documentation page.
 - <http://www.paraview.org/documentation>
- *The ParaView User's Guide*
- <http://www.paraview.org/Wiki/ParaView>
- http://www.paraview.org/Wiki/Setting_up_a_ParaView_Server



Further Reading

Visualization and Customization

- Will Schroeder, Ken Martin, and Bill Lorensen. *The Visualization Toolkit*. Kitware, Inc., fourth edition, 2006.
- Kitware Inc. *The VTK User's Guide*. Kitware, Inc., 2006.
- Jasmin Blanchette and Mark Summerfield. *C++ GUI Programming with Qt 4*. Prentice Hall, 2006.



Further Reading

Parallel VTK Topics

- Kenneth Moreland. “A Survey of Visualization Pipelines.” *IEEE Transactions on Visualization and Computer Graphics*, 19(3), March 2013. DOI 10.1109/TVCG.2012.133.
- James Ahrens, Charles Law, Will Schroeder, Ken Martin, and Michael Papka. “A Parallel Approach for Efficiently Visualizing Extremely Large, Time-Varying Datasets.” Technical Report #LAUR-00-1620, Los Alamos National Laboratory, 2000.
- James Ahrens, Kristi Brislawn, Ken Martin, Berk Geveci, C. Charles Law, and Michael Papka. “Large-Scale Data Visualization Using Parallel Data Streaming.” *IEEE Computer Graphics and Applications*, 21(4): 34–41, July/August 2001.



Further Reading

Advanced Pipeline Execution

- Andy Cedilnik, Berk Geveci, Kenneth Moreland, James Ahrens, and Jean Farve. “Remote Large Data Visualization in the ParaView Framework.” *Eurographics Parallel Graphics and Visualization 2006*, pg. 163–170, May 2006.
- James P. Ahrens, Nehal Desai, Patrick S. McCormic, Ken Martin, and Jonathan Woodring. “A Modular, Extensible Visualization System Architecture for Culled, Prioritized Data Streaming.” *Visualization and Data Analysis 2007, Proceedings of SPIE-IS&T Electronic Imaging*, pg 64950I-1–12, January 2007.
- John Biddiscombe, Berk Geveci, Ken Martin, Kenneth Moreland, and David Thompson. “Time Dependent Processing in a Parallel Pipeline Architecture.” *IEEE Visualization 2007*. October 2007.



Further Reading

Parallel Rendering

- Kenneth Moreland, Brian Wylie, and Constantine Pavlakos. “Sort-Last Parallel Rendering for Viewing Extremely Large Data Sets on Tile Displays.” *Proceedings of IEEE 2001 Symposium on Parallel and Large-Data Visualization and Graphics*, pg. 85–92, October 2001.
- Kenneth Moreland and David Thompson. “From Cluster to Wall with VTK.” *Proceedings of IEEE 2003 Symposium on Parallel and Large-Data Visualization and Graphics*, pg. 25–31, October 2003.
- Kenneth Moreland, Lisa Avila, and Lee Ann Fisk. “Parallel Unstructured Volume Rendering in ParaView.” *Visualization and Data Analysis 2007, Proceedings of SPIE-IS&T Electronic Imaging*, pg. 64950F-1–12, January 2007.