About ParaView

CScADS : Scientific Data and Analytics for Petascale Computing Workshop

Outline

- About ParaView
- Short Tutorial
- Current Work in Progress

Kitware

History (http://www.paraview.org/Wiki/ParaView_Release_Notes

- 1999 LANL/Kitware project (via ASCI Views)
  - Build an end user tool from VTK
  - Make VTK scale
  - October 2002 first public release, version 0.6

- 2002-2005 Versions 0.6 through 2.6
  - Continued growth under DOE Tri Labs, Army Research Lab and various other partnerships

- September 2005 ParaQ project started
  - Sandia, Kitware and CSimSoft
  - Make ParaView easier to use
  - Add quantitative analysis
  - May 2007 version 3.0 released

- Continuing to evolve
  - 3.8 released May 2010 – release every 3 months

Community

Mailing Lists	Subscribers	Messages June 2010
Vtk-users	3412	620
Vtk-developers	400	95
Paraview-users	883	361
Paraview-developer	82	85

Community

- Downloads
  Jun 2010, 14772

+ Packagers:
  Debian, Ubuntu,
  Gentoo, Fedora,
  FreeBSD, Fink

+ source checkouts

| filename	downloads
ParaView-3.8.0-Win32-x86.exe	3024
ParaView-3.8.0.zip	2923
ParaViewData-3.8.0.zip	1651
ParaView-3.8.0.tar.gz	1430
ParaView-3.8.0-Linux-x86_64.tar.gz	1382
ParaView-3.8.0-Win64-x86.exe	1131
ParaView-3.8.0-Linux-i686.tar.gz	825
ParaView-3.8.0-Darwin-x86_64.dmg	547
ParaViewUsersGuide.PDF	352
ParaView-3.8.0-Darwin-Universal.dmg	300

Kitware

Very active development

June 2010 cvs -> git transition
now on 3 month release schedule
http://www.paraview.org/Wiki/ParaView_Release_Notes

Developers	2009-06 to 2010-06	June 2010
VTK	91	39
ParaView	85	19

http://www.ohloh.net/p/3249/analyses/latest

Codebase (LOC)	777,161
Effort (est.)	213 Person Years
Avg. Salary	$ 55000 year
	$ 11,731,047
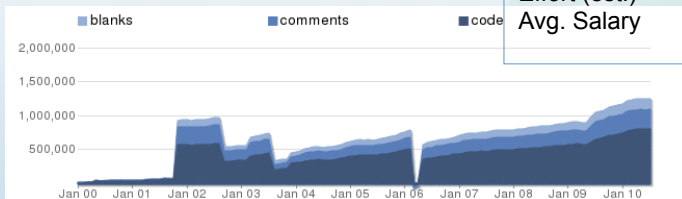
Kitware

What is ParaView?

An application and architecture for display and analysis of massive
scientific datasets.

What is ParaView?

An **application** and architecture for display and analysis of massive
scientific datasets.

- End User Visualization Tool
    - Do not have to be a programmer*
    - Wraps many of the important VTK filters into an Application**
    - Extensive searchable help
    - Undo/Redo
    - Configurable layout in preferences

    * Can even be a rocket scientist.
    ** Those not wrapped are easy to add

Processing and visualization

- File->Open
  - Read in structured (uniform rectilinear, non-uniform rectilinear, and curvilinear grids), unstructured, polygonal, image, multi-block, AMR and time varying data
- Filter->Choose Filter

Reader	→	Filter
Data		Data´

- Tune filter parameters via dialogs and 3D Widgets
- Repeat at Step 2 as desired
  - Build up arbitrary VTK pipelines that Isosurface, Clip, Warp,
  - Glyph, Streamline…
- Save in a variety of formats

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What is ParaView?

An application and **architecture** for display and analysis of massive scientific datasets.

- Open source (BSD license) and Cross Platform

- Extensible
  - At compile time via External Code Module Interface
  - At runtime via python scripting
  - At runtime via dynamically loaded C++ plugins
  - "Branding" infrastructure to makes new applications
    Pick and choose what parts you need
    Extend and customize as you see fit

Kitware

What is ParaView?

An application and architecture for **display** and analysis of massive scientific datasets.

- Each filter's output can be independently controlled
  - Points, Surface/Edges, Volume Rendering representations
  - Interactive Lookup Table(LUT) Editing/Saving
  - LUT per variable, per data set, per view
- Simultaneous display in multiple viewing windows
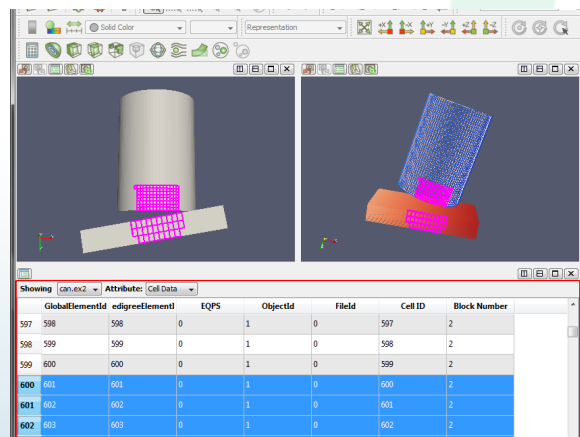- Augment view with a variety of Annotations
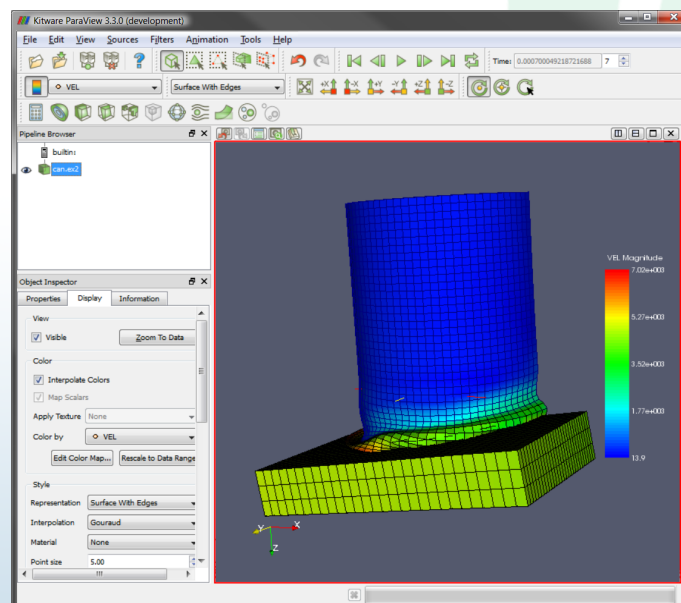
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What is ParaView?

An application and architecture for display and **analysis** of massive scientific datasets.

- Chart, Plot and Spreadsheet View types
  - Probe along a curve and get 2D plot of values along the line
  - Display coordinates and data values as text in a spreadsheet, or on screen via Selection labels
- Drag mouse in View to visually select the important data
- Find Data queries
- Calculator and Programmable filters let you perform arbitrary data manipulation at runtime
- Import and export to .csv and many other formats

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Selection linking

- Selection is linked among all views (whenever possible)

- Make a selection in any View, it becomes the Active selection and is shown in all other views (whenever possible)

Kitware

What is ParaView?

An application and architecture for display and analysis of **massive** scientific datasets.

- Client/Server architecture lets it runs on variety of platforms
  - from netbooks
  - to the largest machines in the world
- Support for tile display and parallel rendering
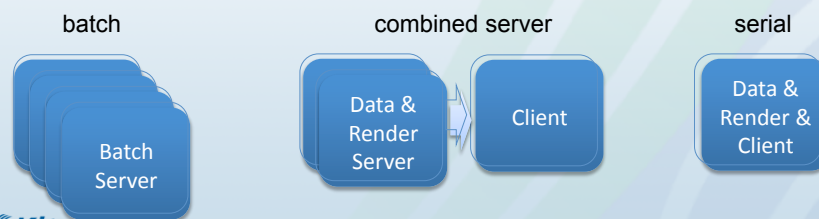- Level of detail techniques keep it interactive on huge data
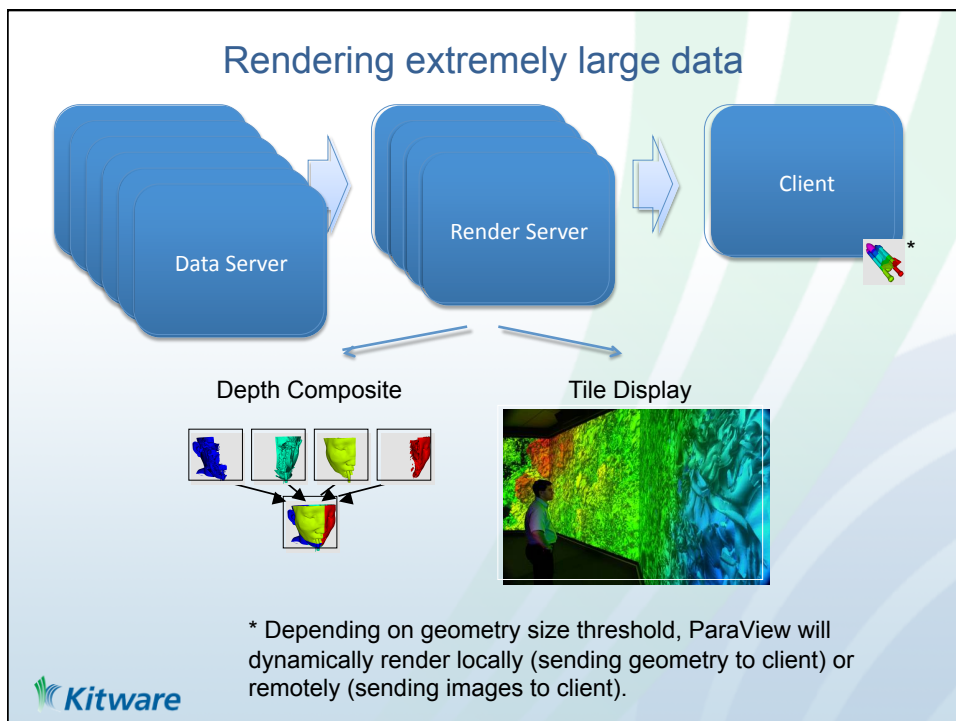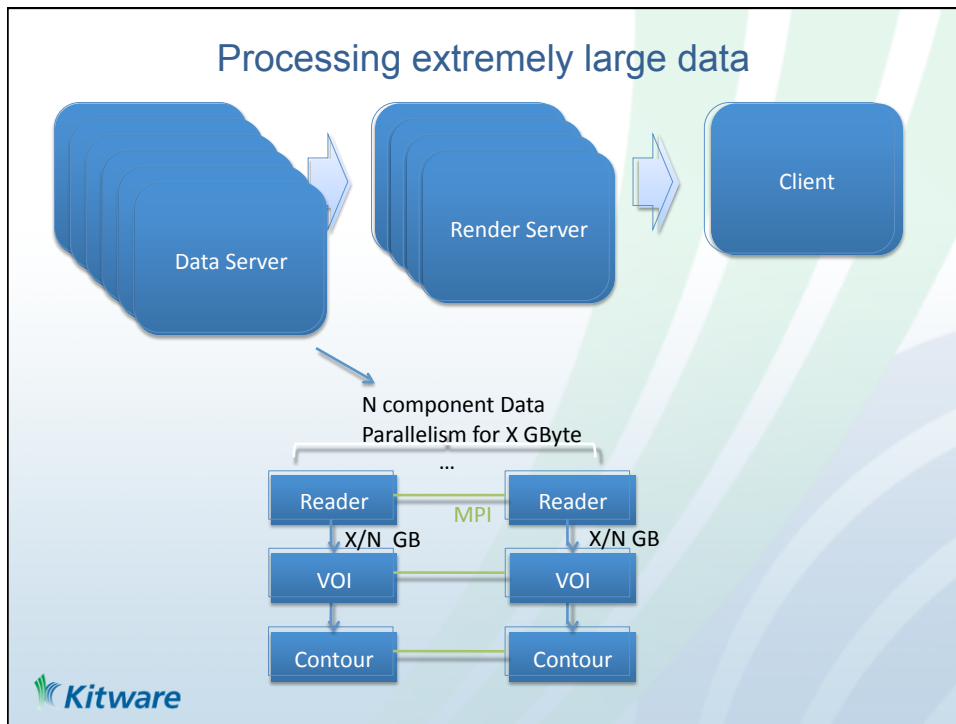
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Extremely large data

3 functional components, 2 are parallel mpi enabled

Data Server

Render Server

Client
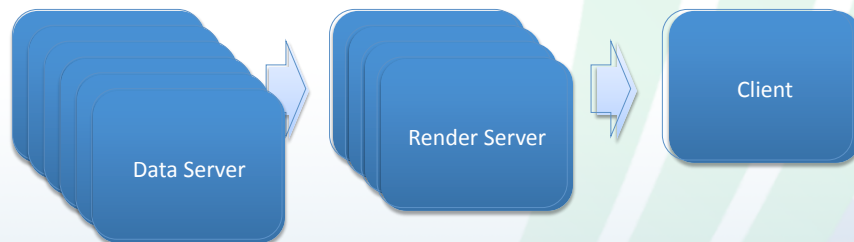
several configurations, 3 most common are

batch

combined server

serial

Batch Server

Data & Render Server

Client

Data & Render & Client

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Processing extremely large data

Rendering extremely large data

* Depending on geometry size threshold, ParaView will dynamically render locally (sending geometry to client) or remotely (sending images to client).

Golevka asteroid vs.10 megaton explosion
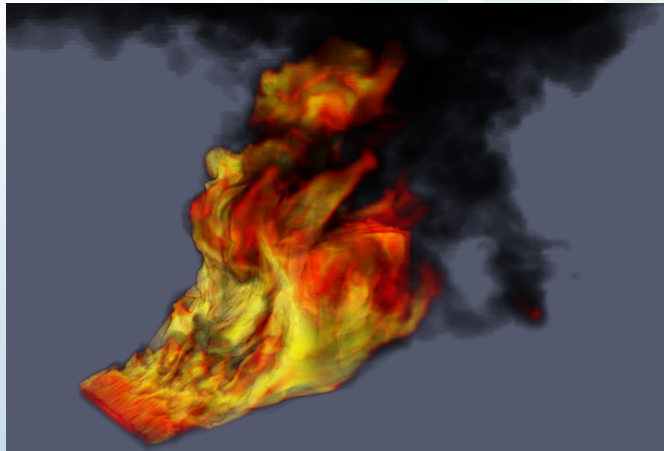
- CTH shock physics, over 1 billion cells
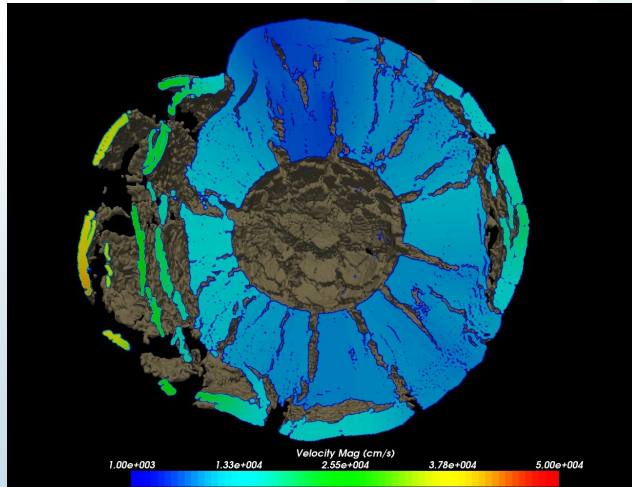
Polar vortex breakdown

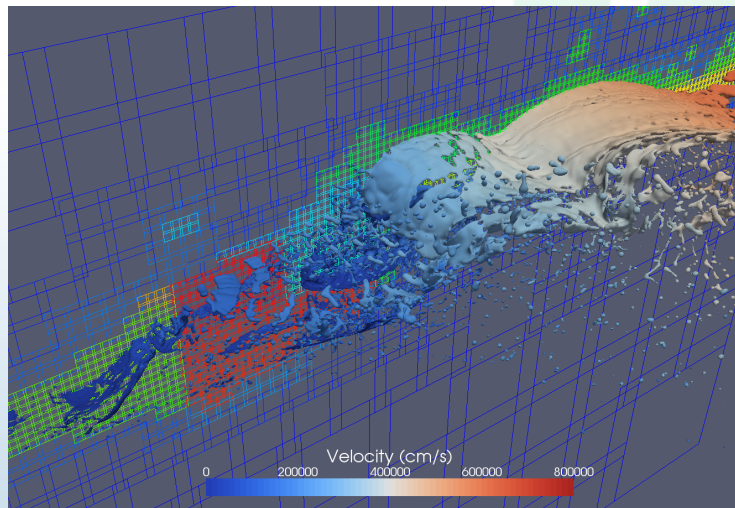- SEAM Climate Modeling, 1 billion cells (500 million cells visualized).
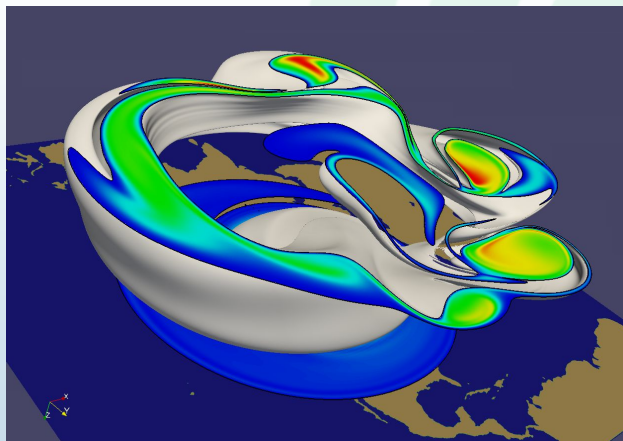
Objects-in-Crosswind fire

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

Large scale AMR

Using ParaView a tutorial
(see also http://www.paraview.org/Wiki/The_ParaView_Tutorial)

- UI and Help
- Load data, Inspect it
- Show the Data: representations, color map, multiview, animate
- Query the Data
- Work with the Data
  - Slice, warp, streamline/tube, histogram, plot, temporal interpolate, python programmable filter
- Save the Results
- Script it

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User interface

Menu Bar

Toolbars

Pipeline Browser

Object Inspector

View(s)
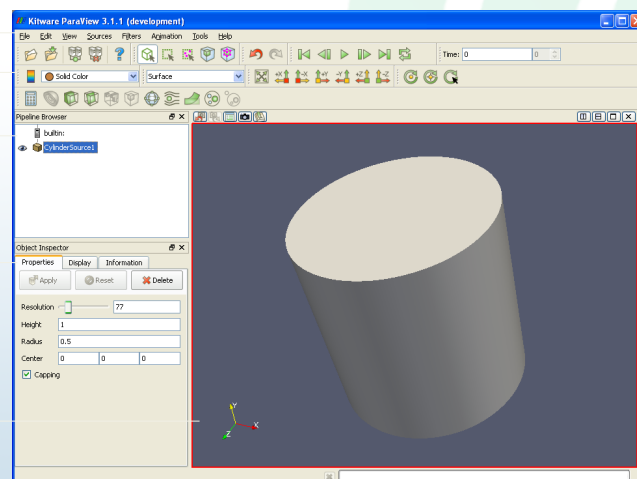
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Online help

- Searchable help system
- Authored pages
- Generated pages
  - for every accessible method
    of every reader, source, filter and writer
- Duplicated online
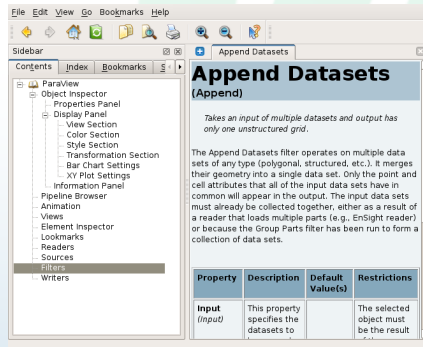
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Load data : file formats

- Kitware formats: (.vtk, .pvd, .vt?, pvt*)
- Exodus
- Xdmf annotated hdf5 (.xmf, .xdmf)
- SpyPlot CTH
- EnSight (.case, .sos)
- netCDF CF (.ncdf, .nc)
- Protein Data Bank (.pdb)
- XMol Molecule
- PLOT3D
- LS-DYNA

- SESAME Tables
- POP Ocean Files
- AVS UCD (.inp)
- Digital Elevation Map (.dem)
- VRML (.wrl)
- Phasta Files (.pht)
- MFIX (.RES)
- Tecplot ASCII (.tec, .tp)
- Fluent Case Files (.cas)
- OpenFOAM Files (.foam
- Flash multiblock files

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More file formats

- Enzo boundary and hierarchy
- Gaussian Cube File (.cube)
- Facet Polygonal Data
- LANL cosmology data (.cosmo)
- LANL windbade (.wind)
- LANL VPIC (.vpc)
- SLAC netCDF mesh, mode and particle data
- Stereo Lithography (.stl)
- Meta Image (.mhd, .mha)

- BYU (.g)
- Stanford Polygonal (.ply)
- Wavefront Polygonal Data (.obj)
- PNG Image Files
- TIFF Image Files
- Raw Image Files
- NRRD image files (.nrrd)

- Comma Separated Values (.csv)
- Python scripted readers

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More file formats

Via Plugins
- NIH Analyze/Nifti
- H5part HDF5 Particle files
- .tlp tulip graphs
- .xml tree structures
- netdmf
- sql table interface
- prism sesame files

Coming soon
- visit formats: enzo, fluent, miranda, pixie, netcdf, pdb, samrai, silo*, tertrad, +visit extensions
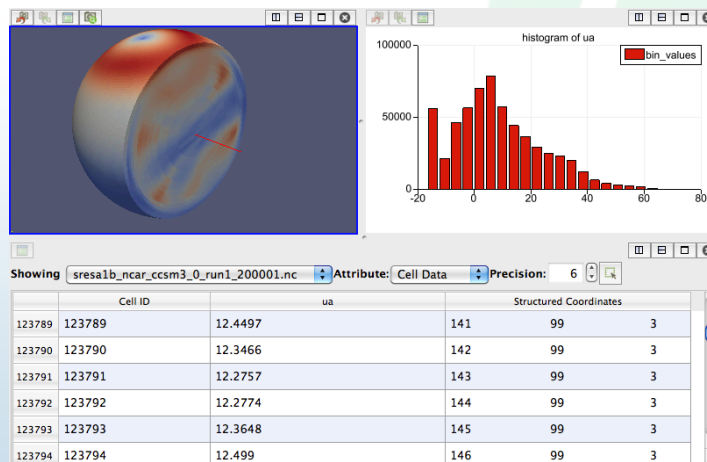- NCAR vapor data format

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Inspect the data

- Information about the Active Filter's output
- DataObject structure
- Size (Bytes, #points, #cells)
- Geometric bounds
- Structured bounds
- Arrays:
  - Name
  - Association (point, cell)
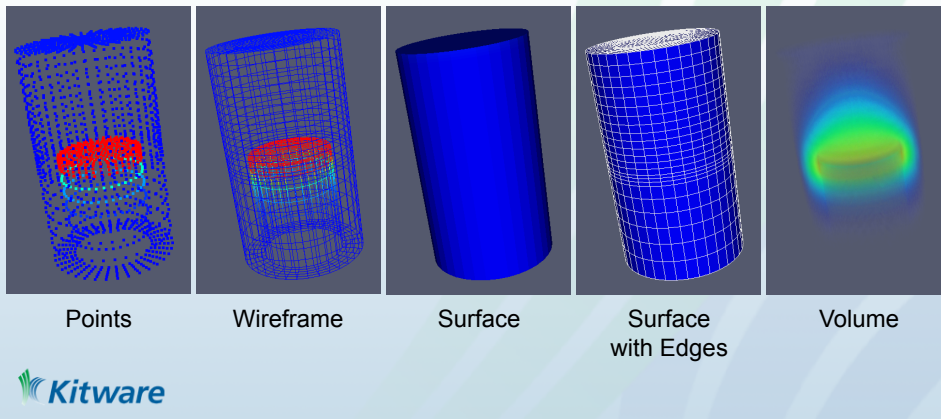 - Data Type
  - Value Ranges
- Temporal Domain

Kitware
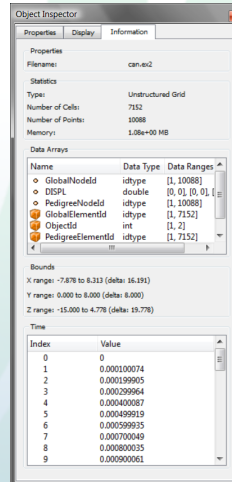
Display the data

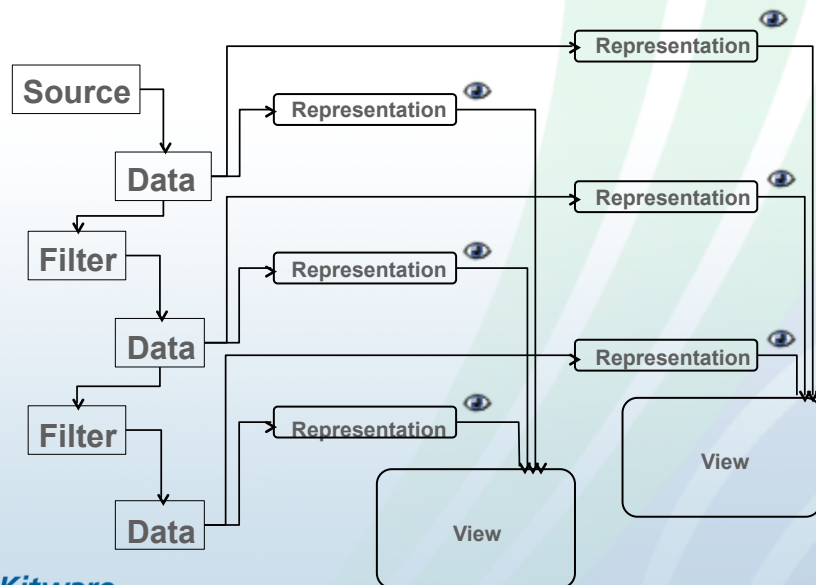- Views – Windows onto one or more data sets

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Display the data

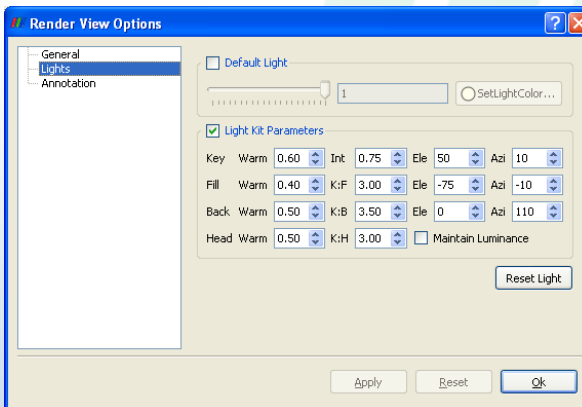- Representations (aka Displays) – visual characteristics of one particular data set in one particular view

| Points | Wireframe | Surface | Surface with Edges | Volume |

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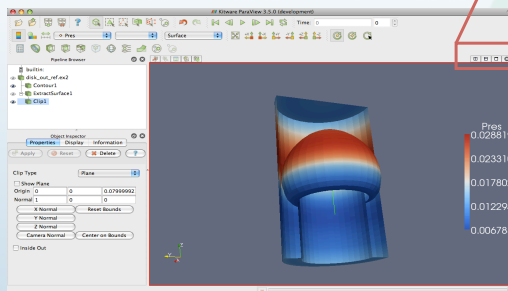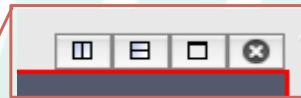## MultiView visualization pipeline

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View controls

- Accessible on toolbar above each view
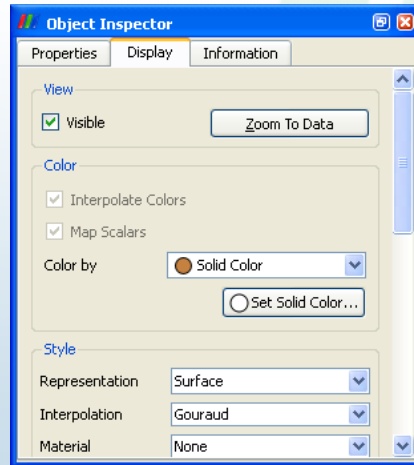- As are camera and multiview controls

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Multiview

- Split, maximize, and close buttons on top right
- Click in a view to make it active then rest of application (view controls, display tab etc) pertain to it
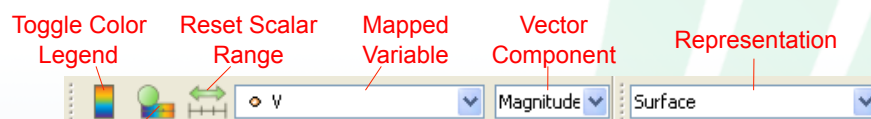- CTRL->Right Mouse to link cameras

Representation controls

- Choose a filter in the pipeline browser
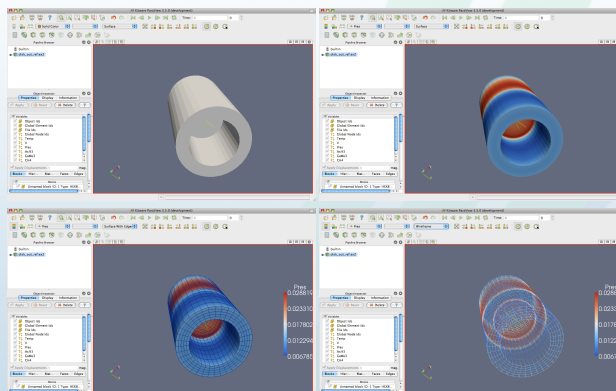- Object Inspector's Display tab controls how it's data will look in the active view
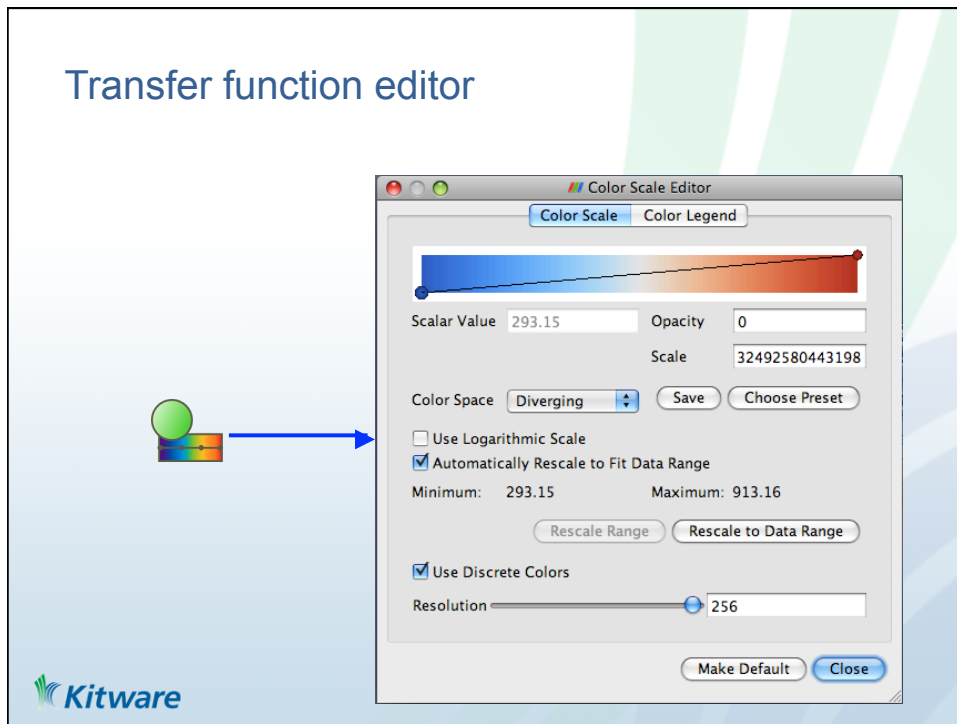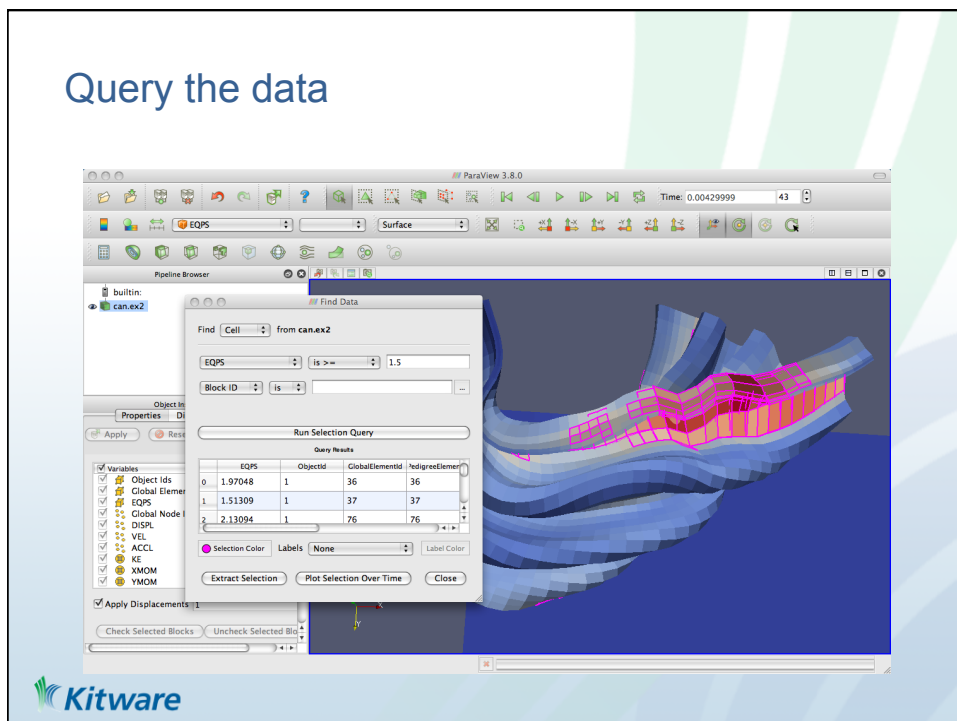
Transfer function editor

Query the data

Selection

- Visually select interesting data
- shown in all compatible views
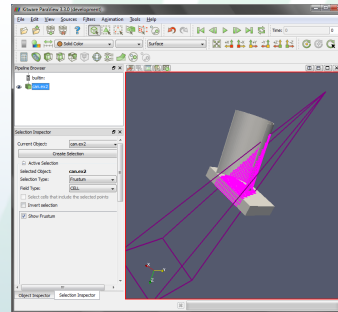- can then label, extract etc
  - 'Select Cells On' to get nearest cells

  - Select Points On' to get nearest points

  - 'Select Cells Through' to get all cells intersecting a frustum

  - 'Select Points Through' for selecting points inside a frustum

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Manipulate the data

- Filters Menu
  - Recent
  - Common
  - Data Analysis
  - Statistical
  - Temporal
  - Alphabetical
- Quick Launch
  - PC/Linux CTRL-Space
  - Mac   ALT-Space
- Apply Undo/Redo

Calculator

Contour

Clip

Slice

Threshold

Extract Subset

Glyph

Stream Tracer

Warp (vector)

Group Datasets

Extract Group

Kitware
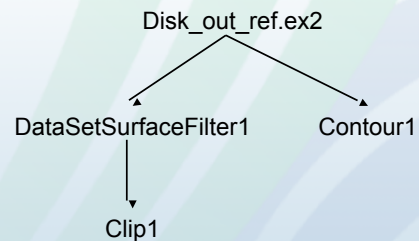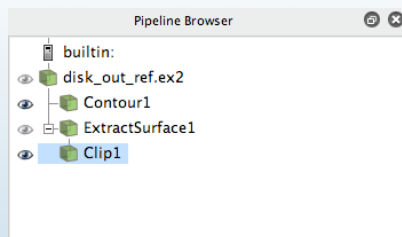
Pipeline Browser : condensed pipeline graph
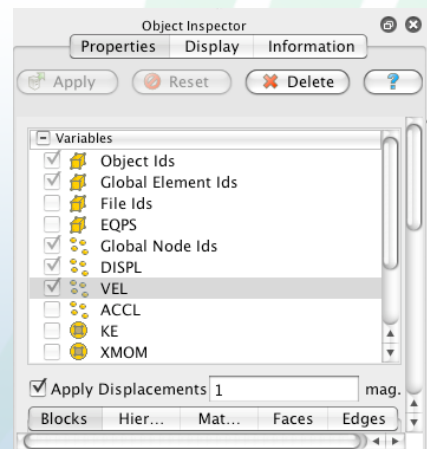
- Use pipeline browser to navigate the graph
- Select a reader/filter to make it active, then object inspector, information tab and display tab pertain to it

Kitware

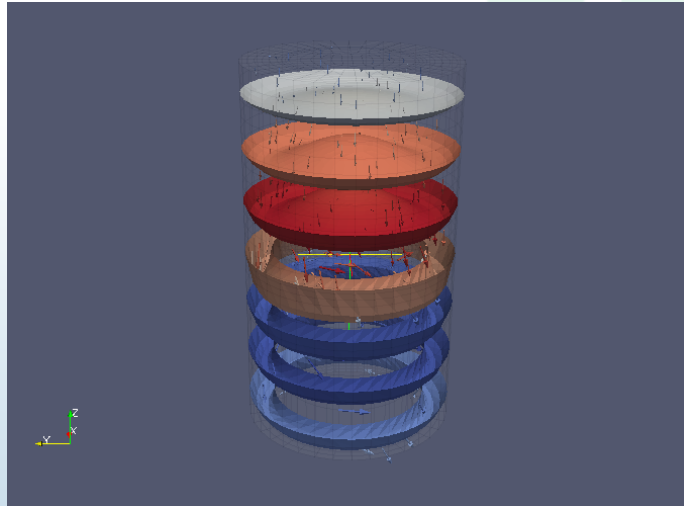## Filter parameters

- Properties Tab of Object Inspector
- Text controls <-> 3D Widgets
- Reset
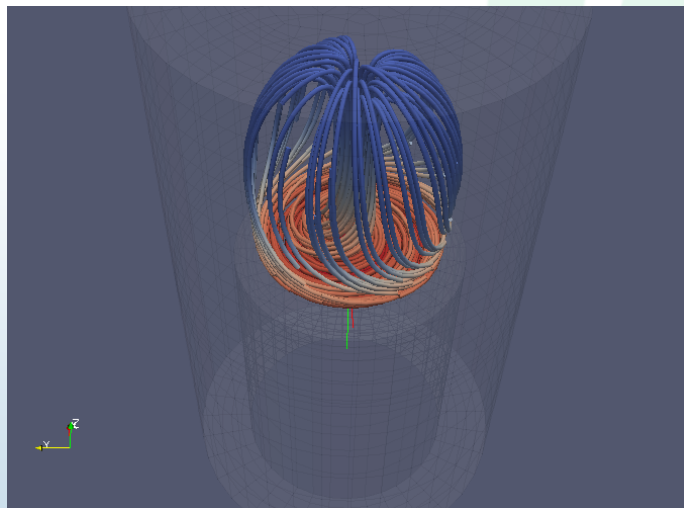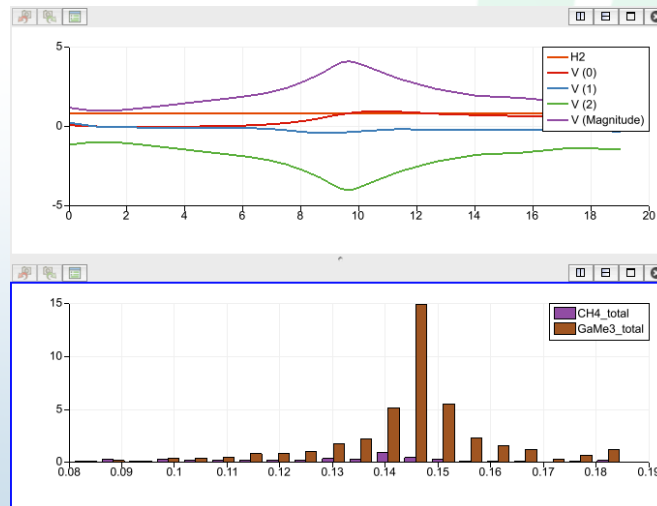- Apply
- Help
- Delete

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Slice -> Warp

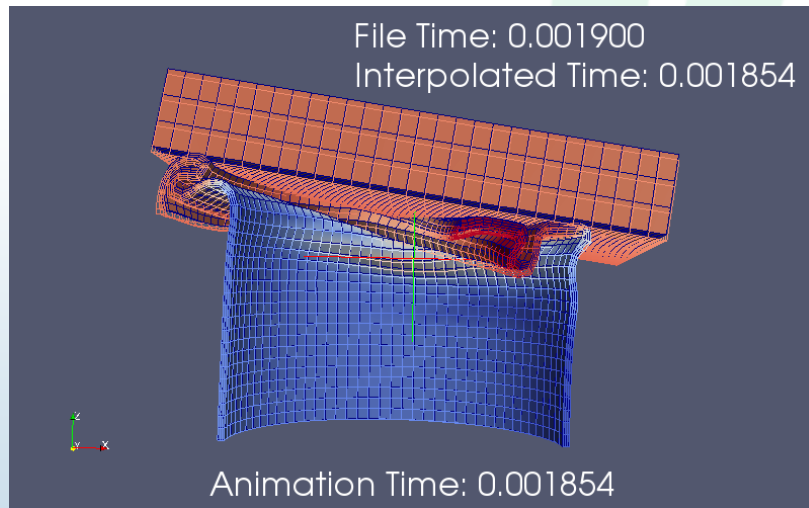Kitware

Streamline -> Tube

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Plot Over Line, Histogram

Temporal Interpolate

Python Filter - a whitebox filter

{...}

```
Data      ?      Data
In               Out
      <your code here>
```
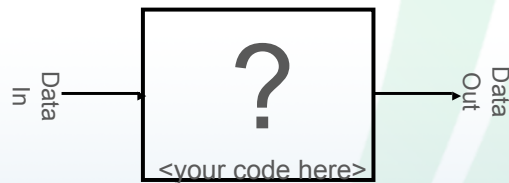
- Write python wrapped VTK code on the server at runtime
- Examples at:
  http://www.paraview.org/Wiki/Python_Programmable_Filter

- Python Calculator variant uses simple (numpy) array syntax
- Programmable source variant is an easy path to data import

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Python scripting

- Control over the entire pipeline, not just inside one filter
- API mimics GUI
- Within or without GUI
  - In GUI (Tools->Python Shell)
    - Create "Macros" that you can call from GUI buttons
    - Synched with GUI
    - tab completion and help browsing
    - "Trace" records GUI actions as scripts
  - Outside (pvpython, pvbatch, or standard python shell with paths)
    - No Qt/ParaQ overhead
    - Batch processing

Kitware

Exporting data, images, sessions

- File->Save *
  - Active filter's data, prompted for file format

  - Screen shot, either selected view or all

  - Movie
    - Image sequence, avi, ogg, ffmpeg->avi

  - State – for restoring ParaView session later

Kitware

What is ParaView?

- An application and architecture for display and analysis of massive scientific datasets. **Which is rapidly evolving.**

- ParaView's distinguishing feature is that it is highly extensible and reusable.

Kitware

Recent/Ongoing work

- * SLAC plugin (3.6)
  - Collection of tools for Stanford Linear Accelerator Center users
- * Branding infrastructure (3.8)
  - Modular Qt GUI infrastructure to enable more derived applications
- * ERDC tools (3.6)
  - ParaView as Pre-Processor, model builder
  - Generate input files for Army's Engineering Research and Development Center FEM simulation tools
- Visit Databases Plugin (3.6.1)
  - Adapter for Visit Database enabled file formats
  - 3.10 brings second incarnation
- Vistrails Plugin (3.6.2)
  - Vistrails connects to ParaView accept and undo redo to give graphical representation of provenance and interface to make use of it

Kitware

Recent/Ongoing work

- Python Trace (3.6.2)
  - Record actions taken in GUI as human readable python scripts
- CVS->Git transition
  - Improve releases and involve more contributors
- * Adaptive Streaming ParaView (3.8)
  - Multiresolution visualization, skipping unimportant portions of data
- Development Binaries (3.8)
  - Develop plugins that work with Kitware binaries
- LIC rendering (3.8), Manta Ray Tracer (3.8), GPU Glyphs (3.10)
  - New rendering techniques

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Recent/Ongoing work

- * ParaviewWeb (3.8)
  – Collaborative web interface to ParaView service
  – http://paraviewweb.kitware.com/PW/
  – http://www.paraview.org/Wiki/ParaViewWeb
- Improved 2D VTK charting components (3.8)
  – Parallel coordinates view (3.10)
- Vapor Plugin (3.10)
  – Interface to NCAR Vapor Data Format wavelet compressed data
- Coprocessing, Live Data and Computational Steering (3.10)
  – Visualize what is being produced, as it is being produced

Kitware

Recent/Ongoing work

- 4.0 major overhauls are in progress
  – Streamlined GUI to be more intuitive
  – Lightweight server control constructs
  – Modular rendering classes
  – Composable VTK/ParaView libraries

Kitware

http://www.paraview.org

portal to all things paraview

- Wiki Page
  - http://www.paraview.org/Wiki/ParaView
- Mailing List
  - Sign up->http://public.kitware.com/mailman/listinfo/paraview
  - Search ->http://markmail.org/search/?q=list:paraview
- User Voice
  - Feature request voting
- Bug Tracker
  - http://www.paraview.org/Bug/my_view_page.php
  - Project:-> ParaView3
- Source Code Documentation
  - http://www.paraview.org/ParaView3/Doc/Nightly/html/classes.html
- Regression Testing
  - http://www.cdash.org/CDash/index.php?project=ParaView3

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