

Scientific Visualization Suites: Visit

2022 International HPC Summer School

Marcelo Ponce



June 2022 - Athens, Greece

- 1 Scientific Visualization
 - 2D/3D Visualization Generalities
 - Visualization Pipeline
- 2 VisIt
 - Generalities
 - Viz. Pipelines Basics
 - Movies Generation
 - Remote Visualization
 - Scripting
- 3 Summary
- 4 Further Resources
 - References

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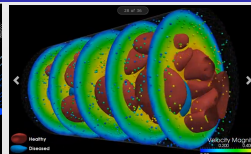
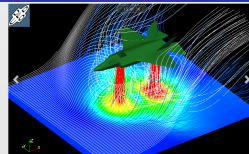
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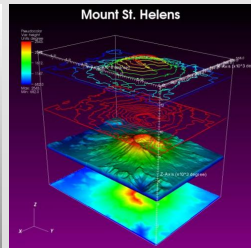
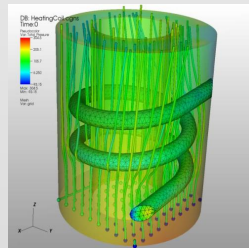
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- **Visualization** is the process of mapping scientific data into “*visual form*”
- Much easier to understand images than a large set of numbers
- For interactive data exploration, debugging, communication with peers



ParaView



VisIt 2.6 Patch 2

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SciNet
SCIENTIFIC RESEARCH COMPUTING AT THE UNIVERSITY OF TORONTO

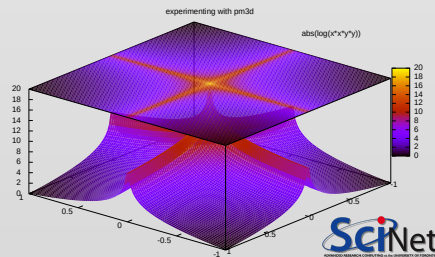
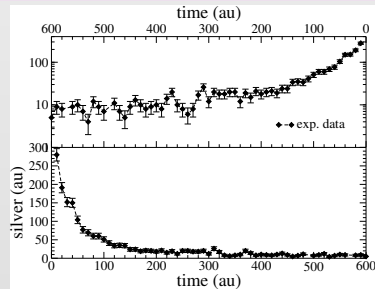
1D plotting vs. 2D/3D visualization

➔ 1D plotting

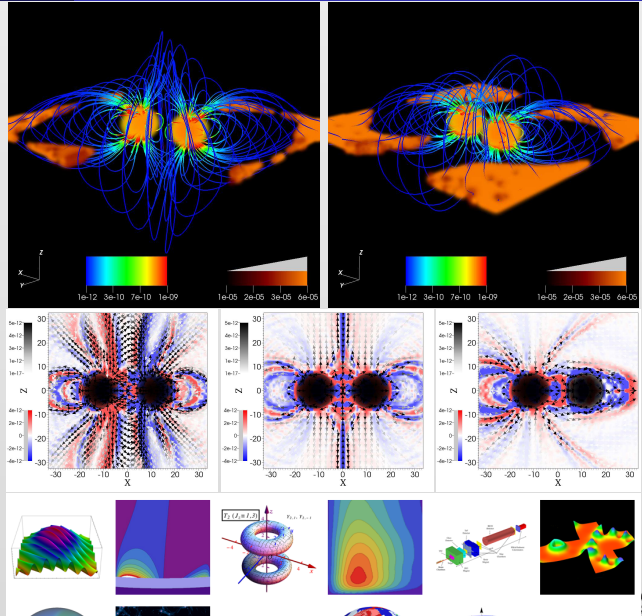
plotting functions of one variable, 1D tabulated data (eg. `gnuplot`, `xmgr`, or Python's `matplotlib` library)

➔ 2D/3D visualization

displaying multi-dimensional datasets, typically data on 2D/3D structured grids or on unstructured meshes (that have some topology in 2D/3D)



- represent data
- plotting
- visualization techniques
- analyze/explore
- communicate
(publications/talks)
- make it look nice?



2D/3D visualization packages

- ➔ **gnuplot**: command-driven interactive 2d and 3d plotting program
- ➔ **GraphViz**: represent structural information as diagrams of abstract graphs and networks
- ➔ **HDFview**: visual tool for browsing and editing HDF4 and HDF5 files
- ➔ **ImageMagick**: manipulation of image
- ➔ **Molden**: pre/post-processing for molecular and electronic structures
- ➔ **OpenCV**: library for real time computer vision
- ➔ **ParaView**: Parallel visualization application

- ➔ **SciLab**: open source platform for numerical computation
- ➔ **VisIt**: Visualization Tool for HPC
- ➔ **XCrysDen**: Crystalline and Molecular Structure Visualization
- ➔ **yt**: python-based package for visualization of AMR datasets
- ➔ **VMD**: Visualization for Molecular Dynamics
- ➔ **openDX**: very old, not maintained package, but really nice approach to visualization process (modules)
- ➔ **blender**: aimed mostly to animations (a little bit more focus on “artistic” viz.)
- ➔ **tecPlot**: CFD viz. (oil & gas, geoscience, combustion, ...)

2D/3D visualization packages

General Features

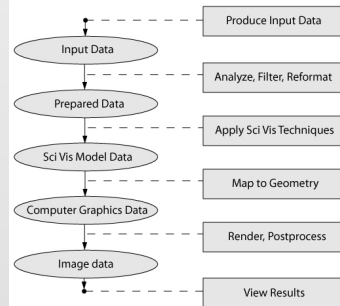
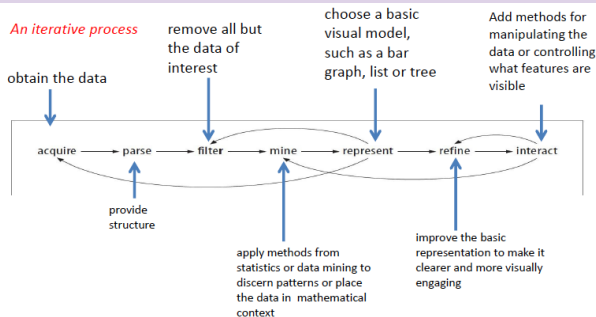
- visualize **scalar** and **vector** fields
- **structured** and **unstructured meshes** in 2D and 3D, particle data, polygonal data, irregular topologies
- ability to handle very **large datasets** (GBs to TBs)
- ability to scale to large ($10^3 - 10^5$ cores) computing facilities
- **interactive** manipulation
- support for **scripting**, **common data formats**, **parallel I/O**
- open-source, **multi-platform**, and **general-purpose**



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► Data Visualization Process



► Scientific Visualization Techniques

▢ contours/isosurfaces, clips, thresholds, glyphs, streamlines, pseudocolors, ...

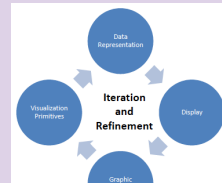
► Map to Geometry

▢ scalars, vectors, tensors

▢ 1D, 2D, 3D

▢ mesh/grid

► Render/PostProcess



Visualization Toolkit (VTK)

- Open source, multiplatform
- Supports distributed computation models
- Extensible modular architecture
- Available for 3D computer graphics, image processing and visualization
- Collection of C++ libraries
- Leveraged by many applications
- Divided into logical areas
 - Filtering
 - Information Visualization
 - Volume Rendering
- Cross platform, using OpenGL
- Wrapped in Python, Tool Command Language (Tcl) and Java

▶ **ParaView** and **Visit** are end-user applications with support:

- ➡ *parallel* Data Archiving/Reading/Processing/Rendering
- ➡ single node, *Client-Server*, *MPI Cluster* Rendering

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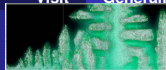
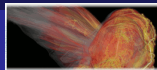
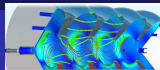
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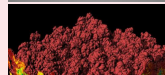
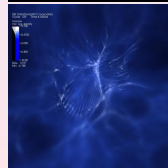
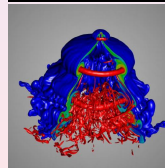
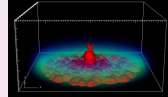
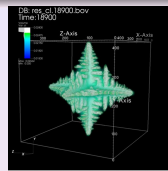
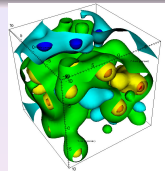
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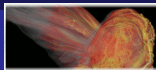
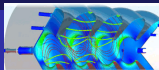
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<https://wci.llnl.gov/simulation/computer-codes/visit>

- Developed by the *DOE Advanced Simulation and Computing Initiative*, to visualize results of terascale simulations, first release fall of 2002 – maintained by *LLNL*
- For this class, **you can use ver $\geq$ v2.12.x** available as source and binary for [Linux/Mac/Windows](#)
- Latest version available is **3.2.2**
- Over 80 visualization features (contour, mesh, slice, volume, molecule, ...)
- Reads over 130 different file formats
- Interfaces with C++, Python, and Java
- Uses MPI for [distributed-memory parallelism](#) on HPC clusters





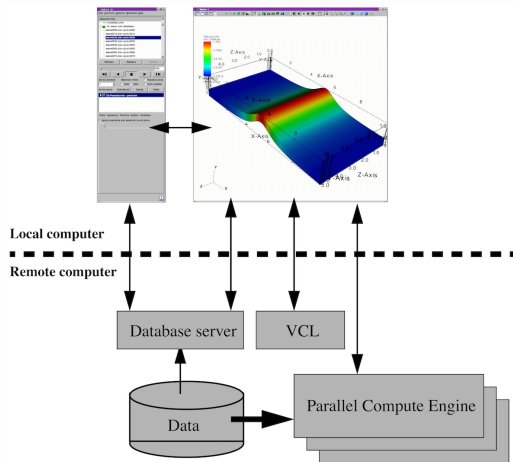
- can run: locally, remotely, client/server mode
- interface pretty much looks the same on each platform
- can read over a 100 different data formats
- new database plugin readers can be developed

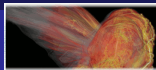
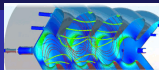
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➤ 1D Curves

➤ 2D/3D meshes: Rectilinear, Curvilinear, Unstructured, Points, AMR, Molecular, CSG

➤ VisIt Architecture





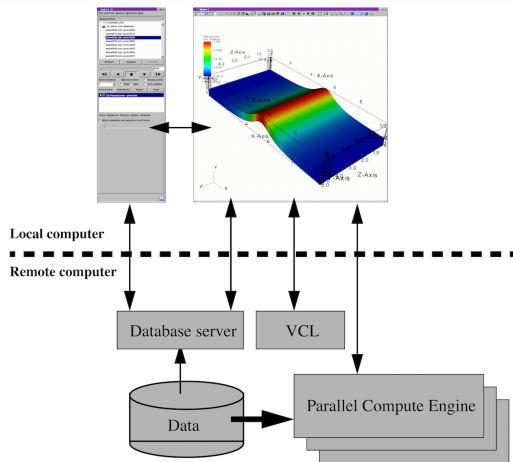
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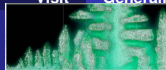
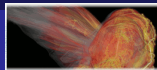
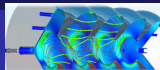
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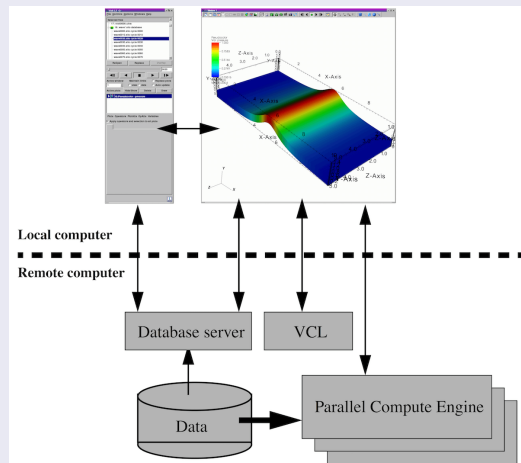
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➡ VisIt Architecture





VisIt: Multiple Interfaces

- GUI (graphical user interface)
- Python programming interface
- Java programming interface
- C++ programming interface

► Use multiple interfaces simultaneously
➡ Use VisIt as an application or a library
➡ C++, Python, Java interfaces allow other applications to control VisIt

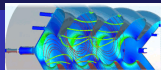


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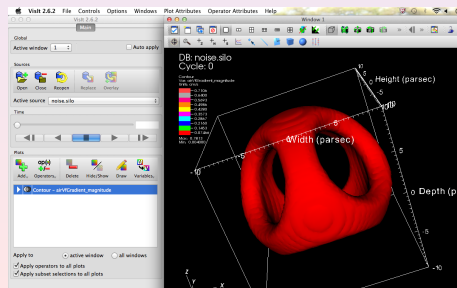
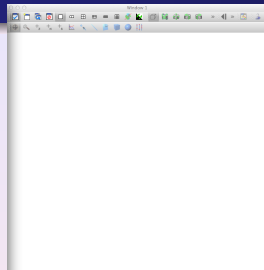
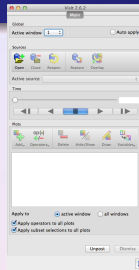
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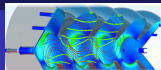
➔ GUI

- ➔ Select files to visualize
- ➔ Create and manage plots
- ➔ Set plot attributes
- ➔ Add operators
- ➔ Set look and props. for visualization

➔ Viewer

- ➔ display all of the data being visualized
- ➔ Mouse navigation
- ➔ up to 16 vis windows
- ➔ Popup menu
- ➔ Toolbars





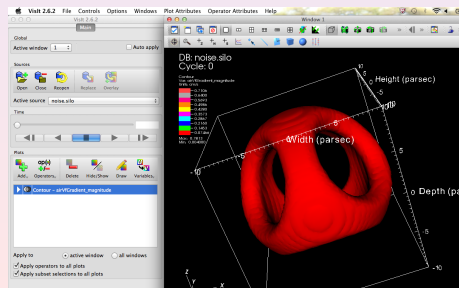
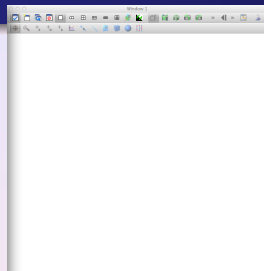
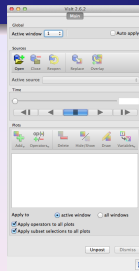
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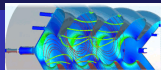
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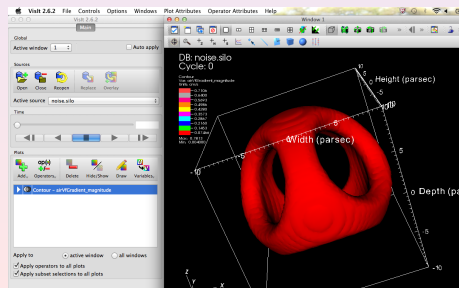
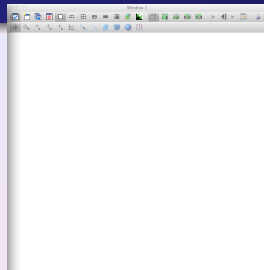
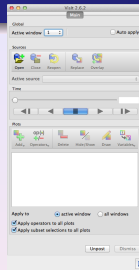
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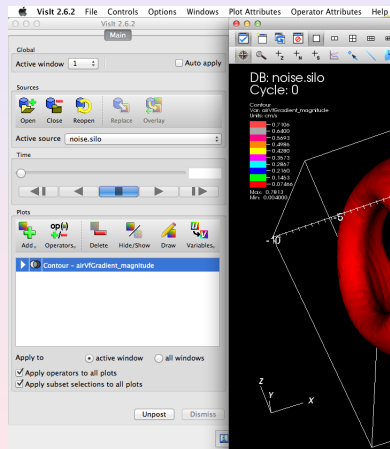
Visit: GUIs

Main window in GUI

- ➡ Access other important windows
- ➡ Open files
- ➡ Set animation time state
- ➡ Set active window
- ➡ Create and manage filters (pipeline)
- ➡ Displays progress from compute engine

➡ Really useful ones

➡ Apply to... check-boxes





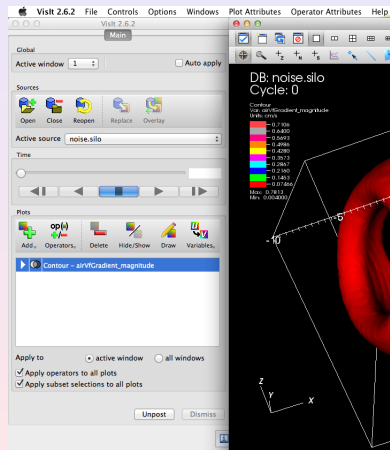
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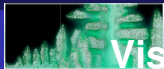
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Visit: GUIs

File



Controls



Options



Windows



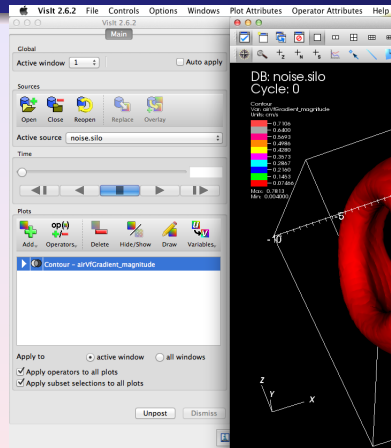
Plot Attributes

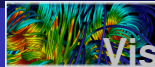


Operator Attributes



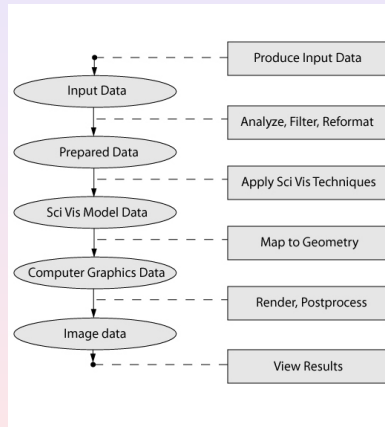
Help





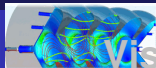
Visit: Visualization Pipeline

- 1 Open database (or file)
- 2 Create a plot
- 3 Set plot attributes
- 4 Apply operators to plot to modify data
- 5 Set operator attributes
- 6 Compute engine generates plot
- 7 Plot displayed in vis window
- 8 iterate//repeat...



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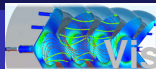
VisIt: Import Data

- ▶ **File** → **Open file...**
↳ choose data file ("noise.silo")

▶ Become available

- ▶ Active source: "noise.silo"
- ▶ Add button

- ▶ **File** → **File information...**



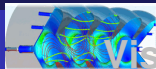
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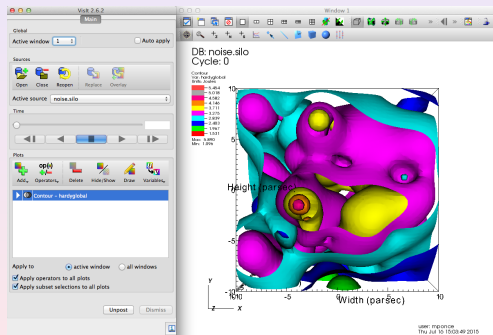
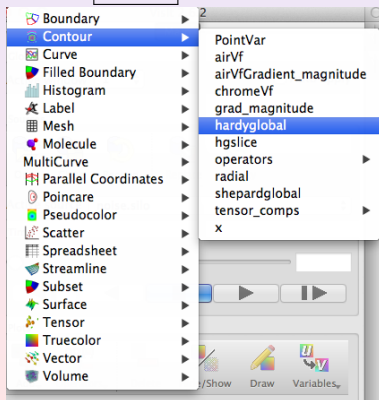


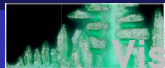
Visit: Contours

► Add → Contours

→ *hardyglobal*

→ Draw





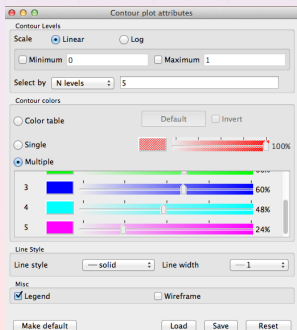
Visit: Contours

double-click on
Contour-hardyglobal

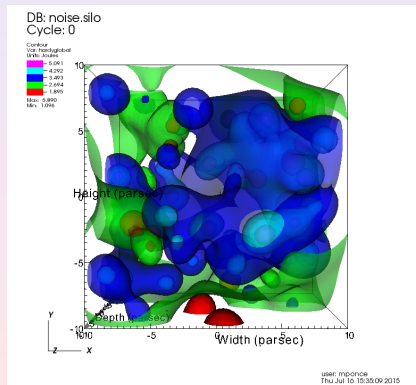
under Select by, choose

N levels = 5 Enter

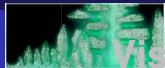
Change opacity levels, eg:
100%, 60%, 60%, 48%, 24%



Apply & Dismiss



Hide/Show or Delete

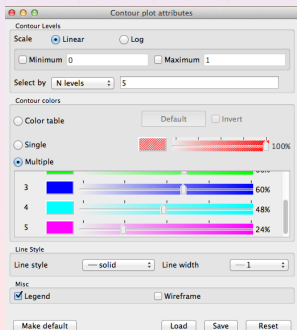


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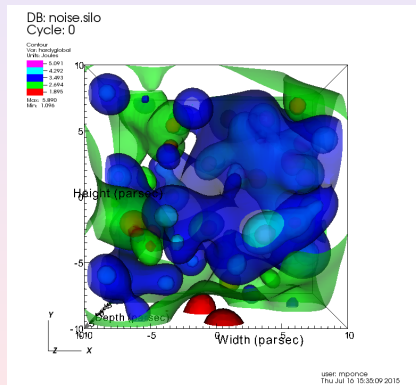
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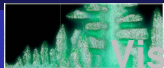
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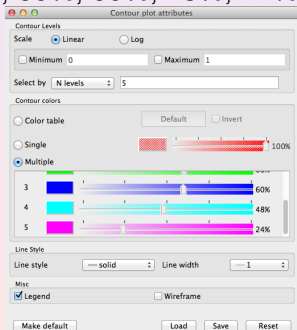


Hide/Show or Delete

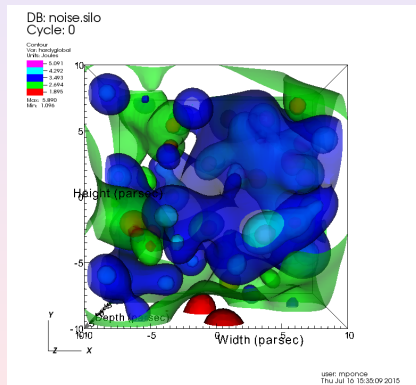


Visit: Contours

- double-click on **Contour-hardyglobal**
- under **Select by**, choose **N levels** = 5 **Enter**
- Change **opacity levels**, eg: 100%, 60%, 60%, 48%, 24%

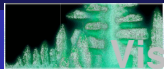


Apply & Dismiss



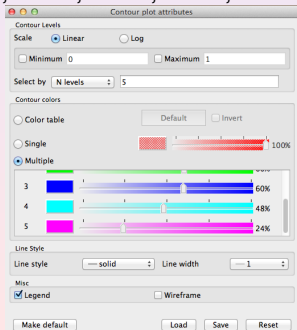
user: mponce
Thu Jul 16 15:35:09 2015

Hide/Show or Delete

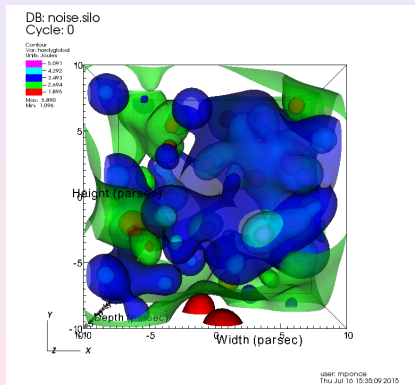


Visit: Contours

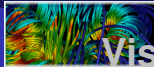
- double-click on **Contour-hardyglobal**
- under **Select by**, choose **N levels** = 5 **Enter**
- Change **opacity levels**, eg: 100%, 60%, 60%, 48%, 24%



Apply & Dismiss



Hide/Show or Delete



VisIt: PseudoColor & IsoSurfaces



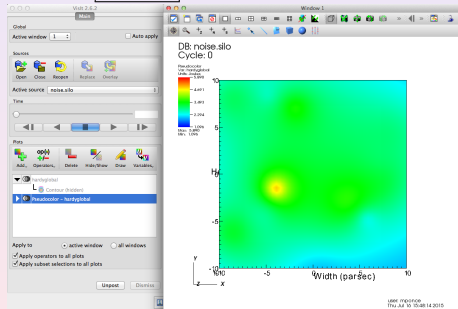
Add



Pseudocolor


hardyglobal


Draw



Operators



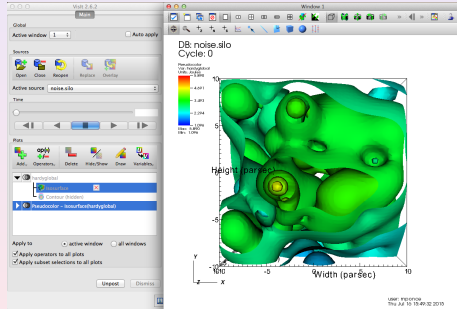
Slicing



Isosurface



Draw

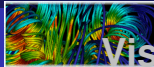


click ► to expand, double click on [Isosurface]

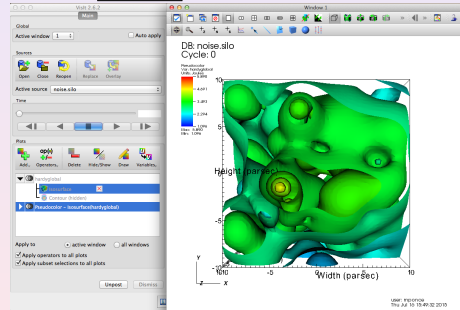
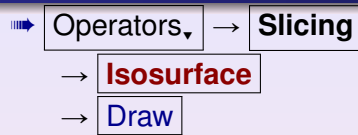
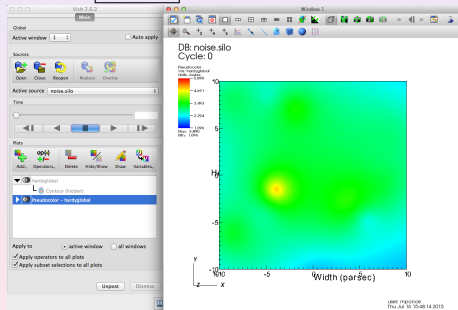
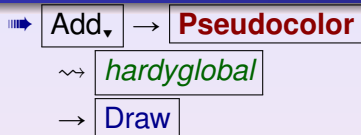
→ under Select by, choose Percent (s) = 50

Enter

Dismiss



Visit: PseudoColor & IsoSurfaces



click ► to expand, double click on [Isosurface]

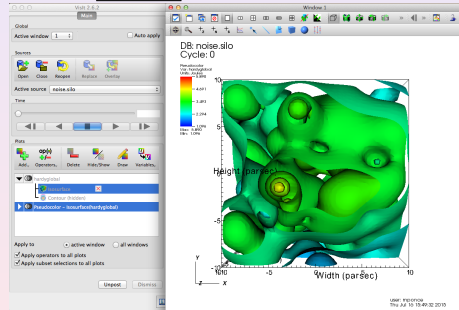
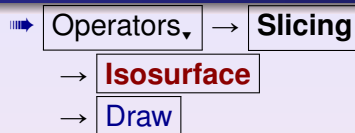
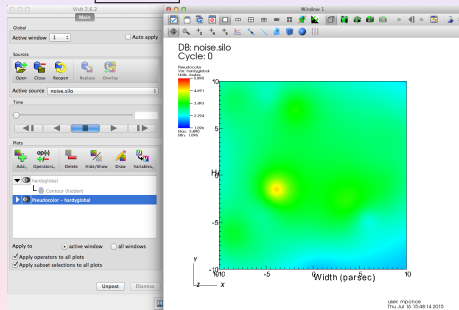
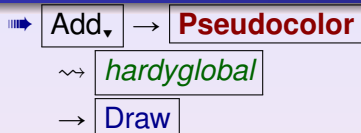
→ under Select by, choose **Percent (s)** = 50

Enter

Dismiss



Visit: PseudoColor & IsoSurfaces

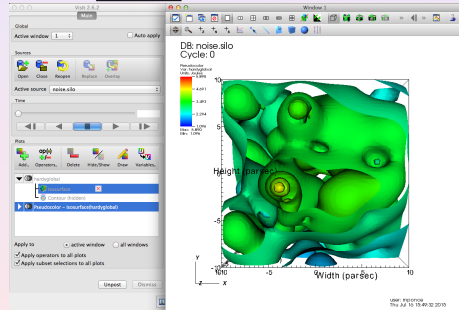
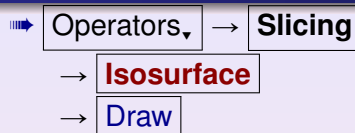
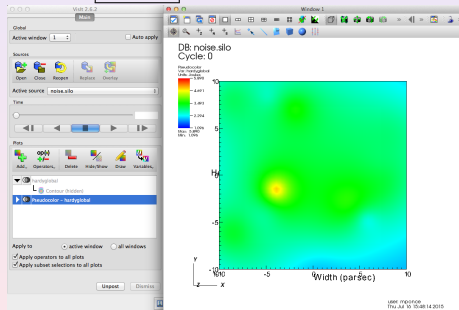
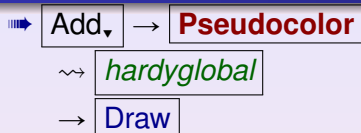



 click ► to expand, double click on [Isosurface]


 under **Select by**, choose **Percent (s)** = 50 **Enter** & **Dismiss**



Visit: PseudoColor & IsoSurfaces

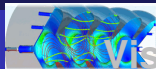



 click ► to expand, double click on [Isosurface]

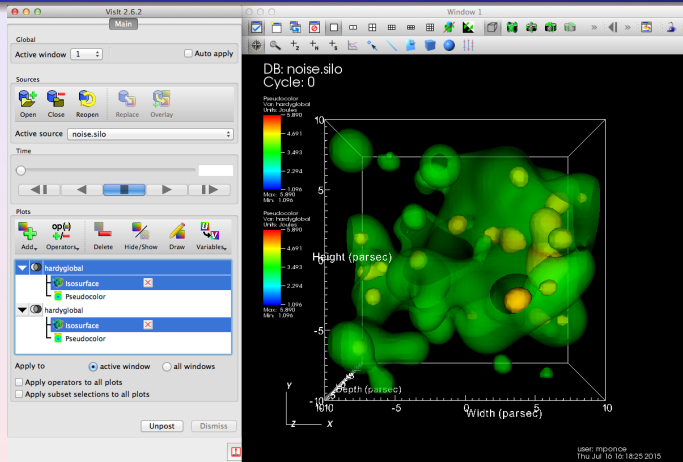

 under **Select by**, choose **Percent (s)** = 50



Dismiss



Visit: PseudoColor & IsoSurfaces

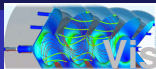


→ unselect the
[Apply...]
check-boxes

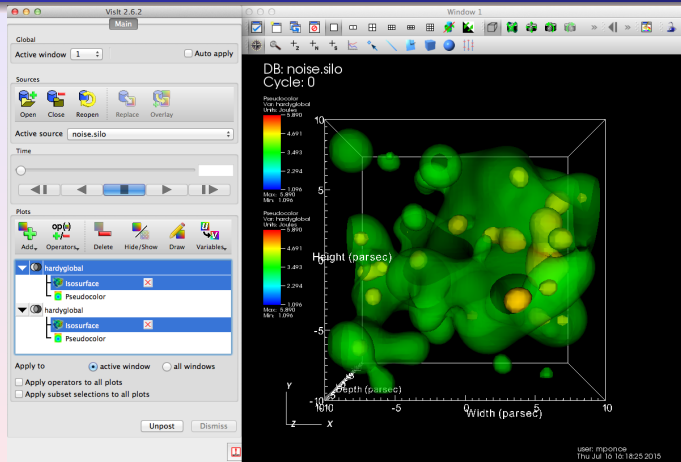
→ add 1 more
Pseudocolor
+ IsoSurface,
w/Percent(s)=80
& adjust its
opacity

→ clipping → select/check the [Apply...] boxes

→ Operators → Selection → Clip



Visit: PseudoColor & IsoSurfaces

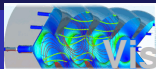


unselect the
[Apply ...]
check-boxes

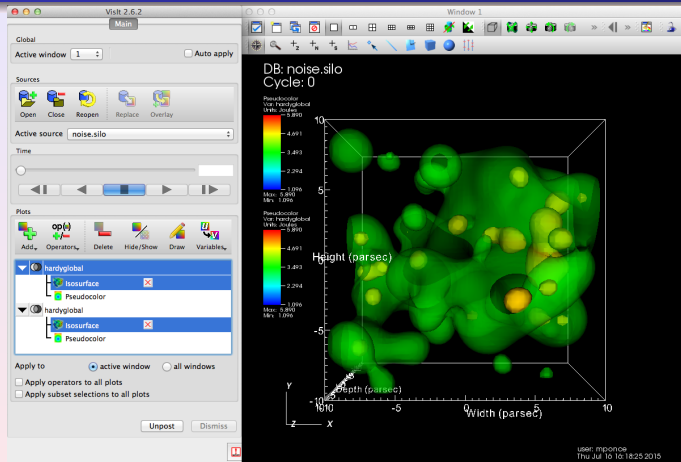
add 1 more
Pseudocolor
+ **IsoSurface**,
w/Percent(s)=80
& adjust its
opacity

clipping → select/check the [Apply...] boxes

Operators, → Selection → Clip



Visit: PseudoColor & IsoSurfaces



unselect the
[Apply ...]
check-boxes

add 1 more
Pseudocolor
+ **IsoSurface**,
w/Percent(s)=80
& adjust its
opacity

clipping → select/check the [Apply...] boxes

Operators → **Selection** → **Clip**



Visit: General Remarks

- ▶ operators/plots can be removed **Delete** –or– hidden **Hide/Show**
- ▶ save your work **frequently**: **File** → **Save session...**

* Restoring a previous session

- ▶ **File** → **Restore session...**

loads the previous state of the given session (**that needs to be specifically saved**)

- ▶ **File** → **Restore session w/sources...**

extremely useful for re-identifying datasets that could have been moved or renamed

Be aware, that Visit, by default won't save your work (session) nor ask you when you try to exit the program!



VisIt: General Remarks

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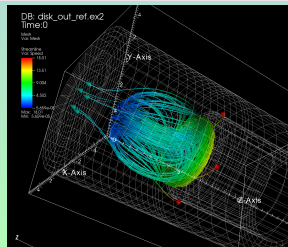
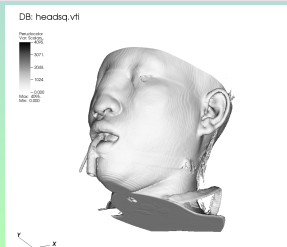
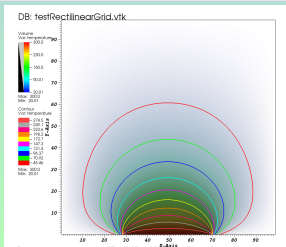
Be aware, that VisIt, by default won't save your work (session) nor ask you when you try to exit the program!



Visit: Intermesso i

Hands-on...

- ▶ Load some of the other datasets: [eg. "testRectilinearGrid.vtk", "headsq.vtk", "disk_out_ref.ex2", ...] –or– *your own data!!*
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- ▶ If you have used other visualization packages, compare how easy and whether it is possible or not, to obtain similar results, let's say, with ParaView or VAPOR for instance...
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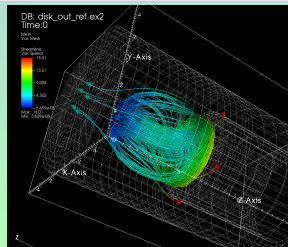
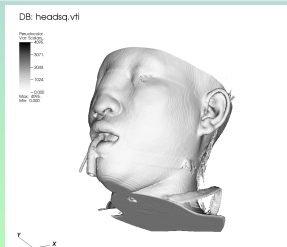
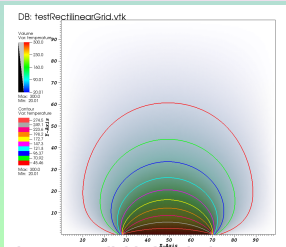
More datasets available for playing, at: http://www.visitusers.org/index.php?title=Tutorial_Data



Visit: Intermesso i

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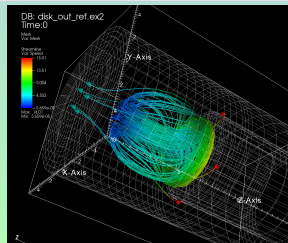
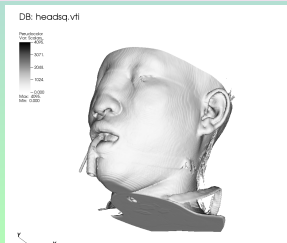
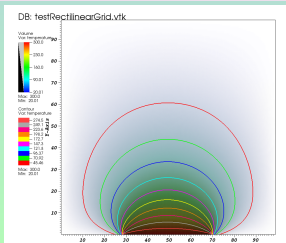
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Visit: Intermesso i

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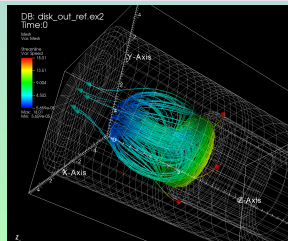
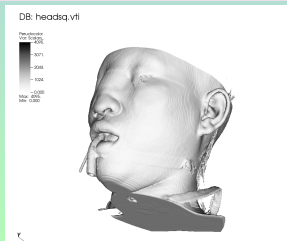
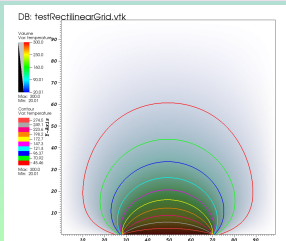
More datasets available for playing, at: http://www.visitusers.org/index.php?title=Tutorial_data



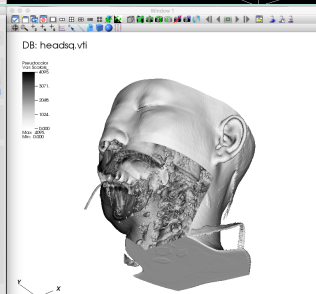
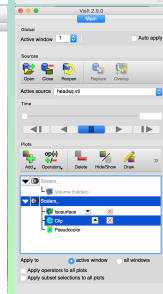
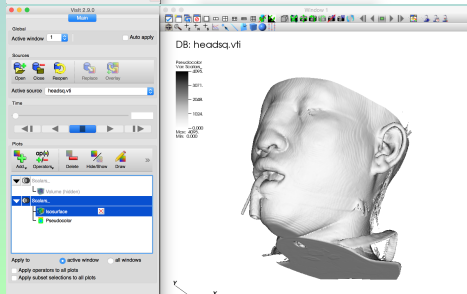
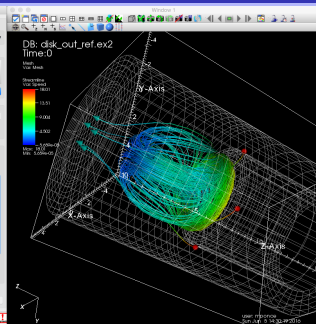
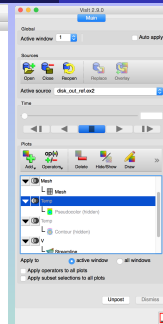
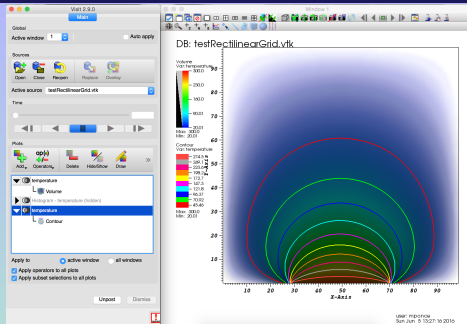
Visit: Intermesso i

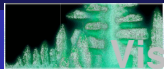
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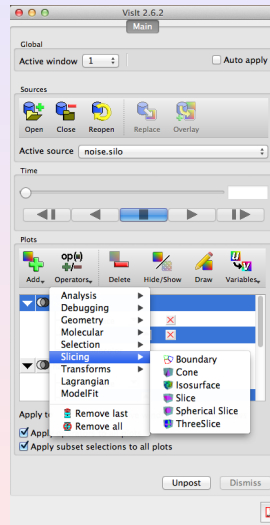




Visit: Slices

Slicing Isosurfaces

- ➡ Operators ▾ → **Slicing** → **Slice**
- ➡ double-click on [Slice]
 - ➡ try choosing different **axes** & **Project to 2D**
 - ➡ try also the other types of slices





VisIt: Vector Field representations – Glyphs

➡ Glyphs

➡ Add ▾ → **Vector** ~→ *airVfGradient*

➡ Apply & Dismiss

➡ double-click on [**Vector**]

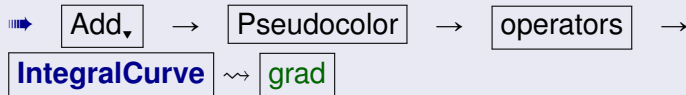
➡ set **Vector amount** ~→ 1000

➡ more *properties* in [**Data**] & [**Glyph**]



VisIt: Vector Field representations – Streamlines

➤ Streamlines



➤ double-click on [IntegralCurve]

➤ set Source type ~> plane

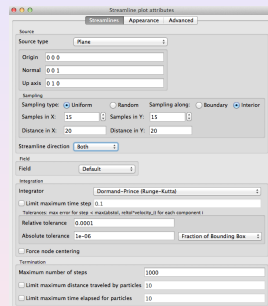
➤ increase samples/distance along axes ~> 15/20

➤ Integration direction ~> both

➤ double-click on [Pseudocolor]

➤ in [Geometry], Line type ~> Tubes, w/Radius ~> 0.005

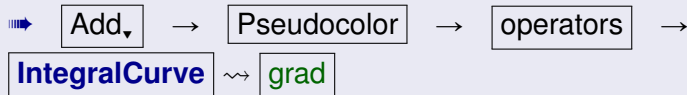
➤ [Data] ~> bluehot ➤ Apply





VisIt: Vector Field representations – Streamlines

➡ Streamlines



➡ double-click on [IntegralCurve]

➡ set Source type ~~~ plane

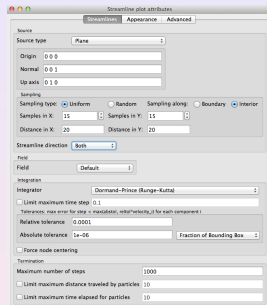
➡ increase samples/distance along axes ~~~ 15/20

➡ Integration direction ~~~ both

➡ double-click on [Pseudocolor]

➡ in [Geometry], Line type ~~~ Tubes, w/Radius ~~~ 0.005

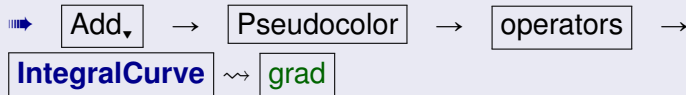
➡ [Data] ~~~ bluehot ➡ Apply





VisIt: Vector Field representations – Streamlines

➤ Streamlines



➤ double-click on [IntegralCurve]

➡ set Source type $\rightsquigarrow$ plane

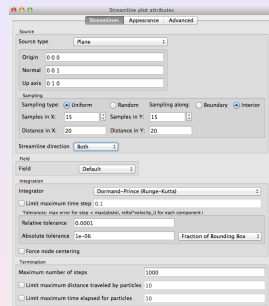
➡ increase samples/distance along axes $\rightsquigarrow$ 15/20

➡ Integration direction $\rightsquigarrow$ both

➤ double-click on [Pseudocolor]

➡ in [Geometry], Line type $\rightsquigarrow$ Tubes, w/Radius $\rightsquigarrow$ 0.005

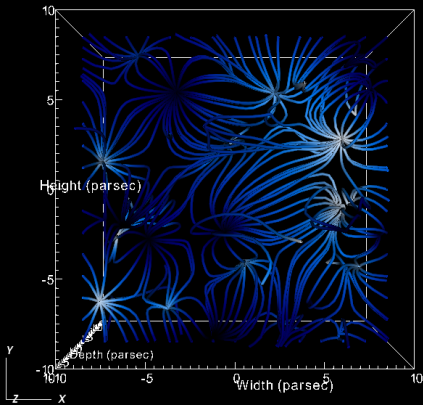
➡ [Data] $\rightsquigarrow$ bluehot ➡ Apply





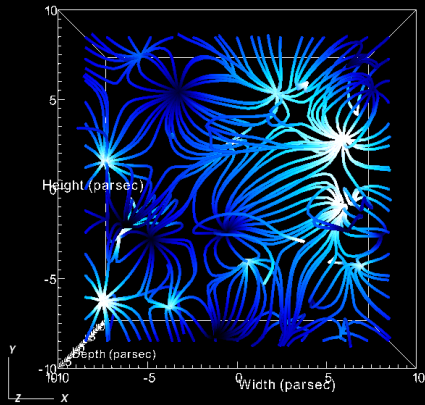
Visit: Vector Field representations – Streamlines

DB: noise.silo
Cycle: 0



user: mponce
Thu Jul 16 23:01:43 2015

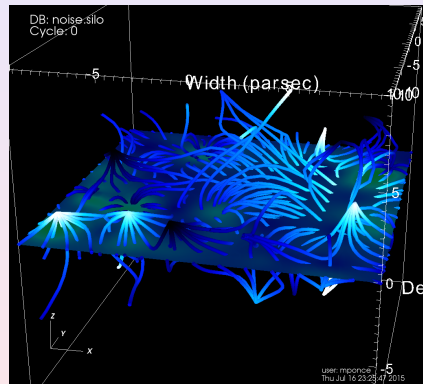
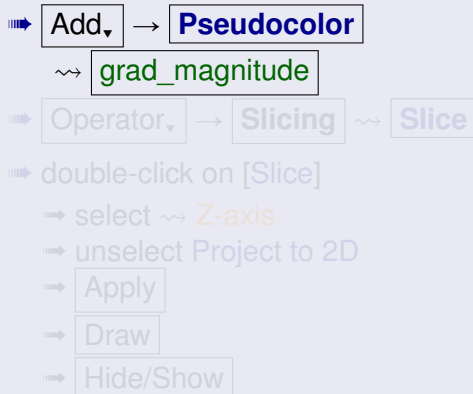
DB: noise.silo
Cycle: 0



user: mponce
Thu Jul 16 23:01:57 2015

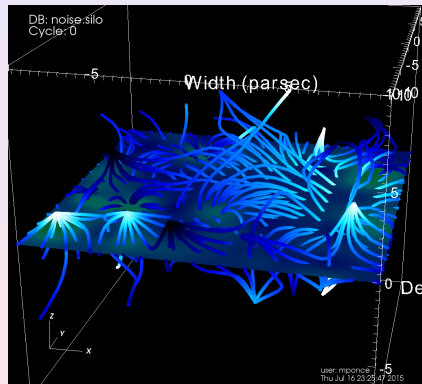
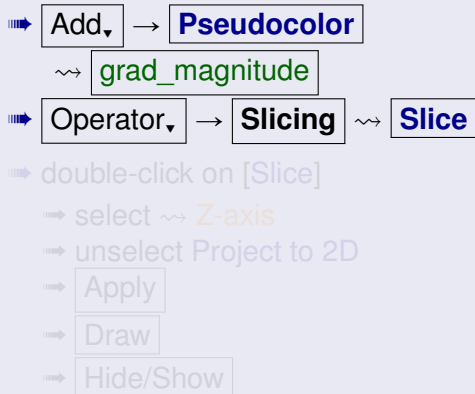


Visit: Slices





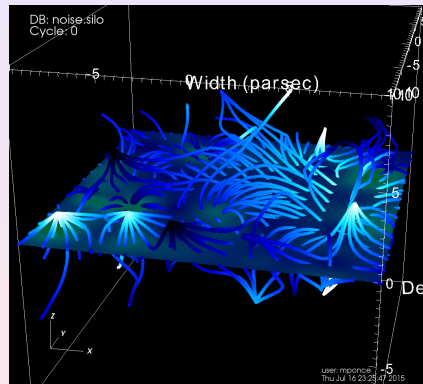
Visit: Slices

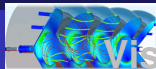




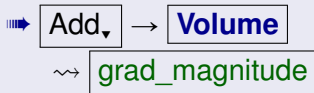
Visit: Slices

- ➡ Add ▾ → **Pseudocolor**
 - ↪ grad_magnitude
- ➡ Operator ▾ → **Slicing** ↪ **Slice**
- ➡ double-click on [Slice]
 - ➡ select ↪ Z-axis
 - ➡ unselect Project to 2D
 - ➡ Apply
 - ➡ Draw
 - ➡ Hide/Show

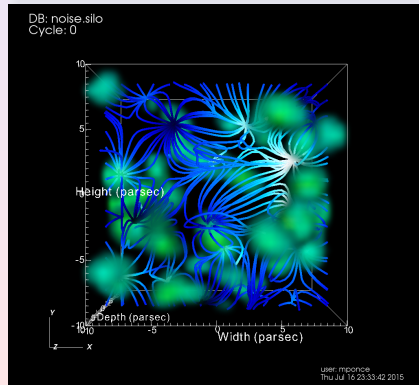
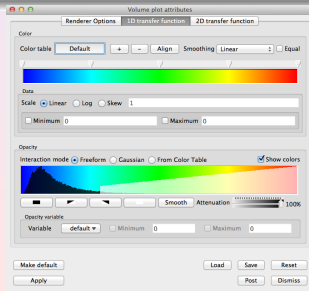




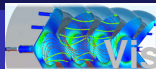
Visit: Volume Rendering



- double-click on [Volume]
- click on 1D Transfer Function
- change Transfer Fn/Opacity



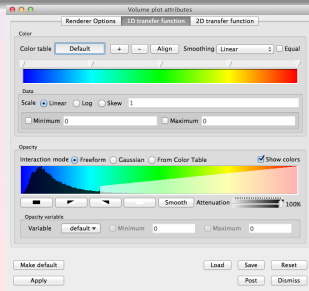
user: mponce
Thu Jul 16 23:33:42 2015



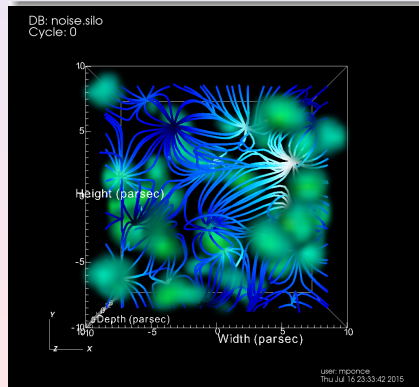
VisIt: Volume Rendering

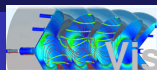
➡ Add → **Volume**
 ~→ **grad_magnitude**

➡ double-click on [Volume]
 ➡ click on **1D Transfer Function**
 ➡ change **Transfer Fn/Opacity**



➡ **Apply**
 ➡ **Draw**





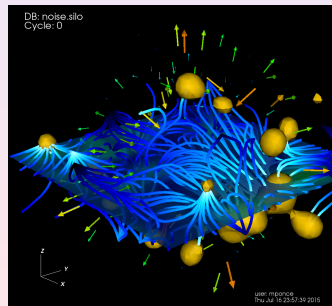
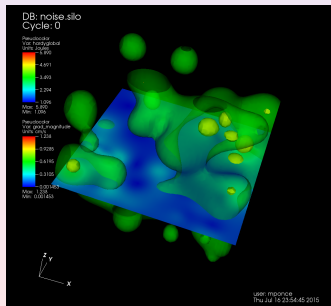
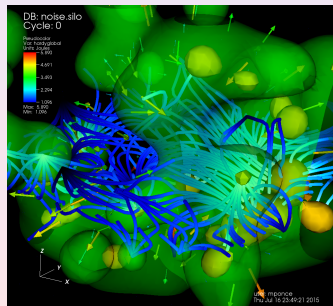
VisIt: Aesthetics & Final Products

➡ Legends, axes, ...

➡ Controls → **Annotation...**

➡ “hard-copies”: images, ...

➡ File → **Save Window**



Outline

- 1 Scientific Visualization
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- 2 **Visit**
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Movie Generation

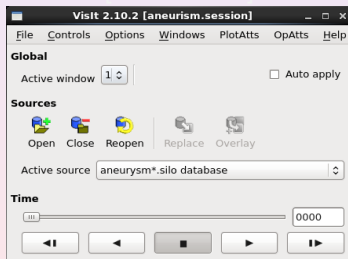
Movies & Animations

- ➡ sequence in time (*evolution*)
- ➡ motion through space (usually done through *scripting*)

Basic *timestep* Animation

- Simplest case: “static animation”, in which only the *database timestep* changes
- Allows database behaviour over time to be quickly inspected (without the complexity of scripting)
- Controlled through [VCR]-type of buttons on the *time-framming* panel of the main windows

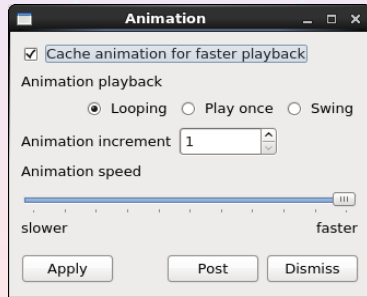
[Time Slider]



[Main Window]



[Animation Window]

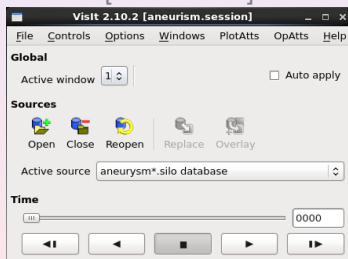


→ Controls → Animation...

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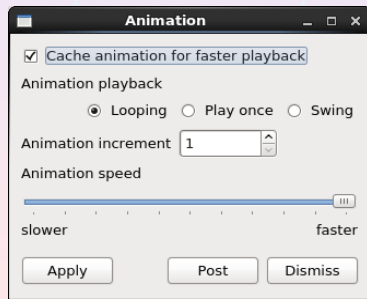
[Time Slider]



[Main Window]

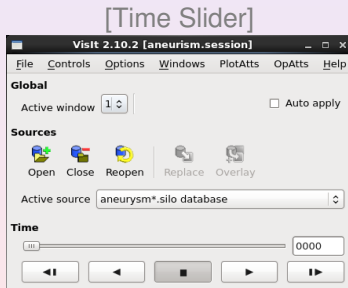


[Animation Window]

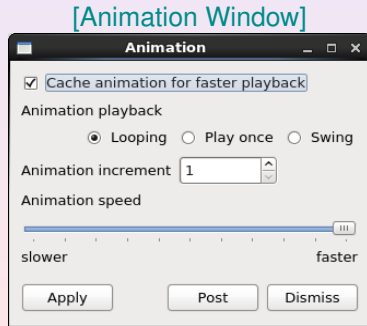


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[Main Window]



Controls



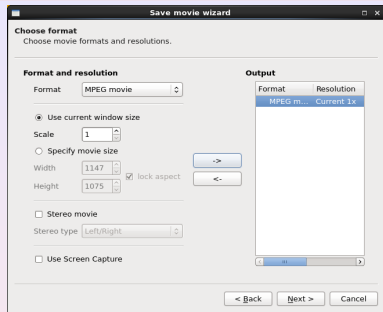
Animation...

Movie Wizard

File → Save Movie...

Guided Movie Generation

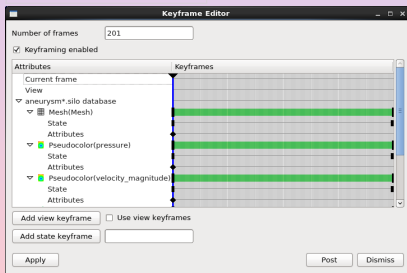
- Produce several formats and resolutions, at the same time
- Stereo movies
- Can handle currently allocated processors or spawn another VisIt session for movie-generation
- Can use movie templates to assemble complex sequence of frames



Keyframing

- Advanced form of animation, that allows attributes to change as the animation progresses
- Attributes that can be keyframed: Plots attributes, Database states, View
- Eg. make a plot fade out as the animation progresses, make view slowly change, ...

→ Controls →
Keyframing...



→ [time slider]: "Keyframing Animation"

→ Choose the desired active time slider from the pull-down menu

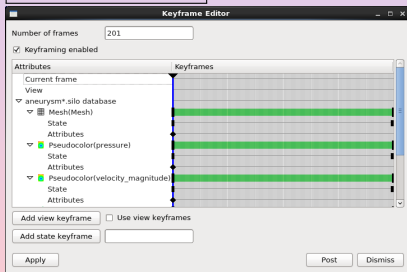
- Enable "keyframing mode"
- Adjust number of frames
- a keyframe is created for each plot attrib.
- Plot attribs. are calculated for each frame
- Using the keyframe indicators *, set the time range for each attribute

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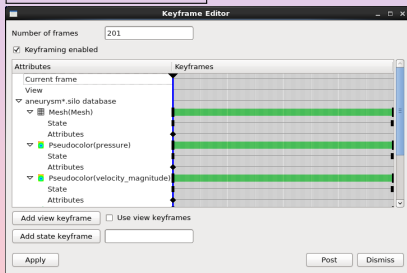
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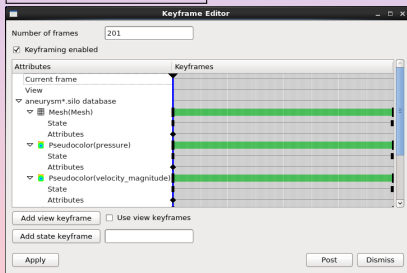
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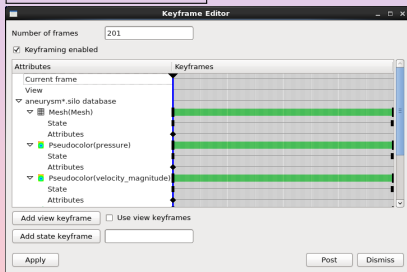
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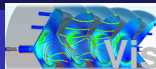
- a keyframe is created for each plot attrib.

- Plot attribs. are calculated for each frame

➡ Using the keyframe indicators ♦, set the time range for each attribute

➡ [time slider]: “Keyframing Animation”

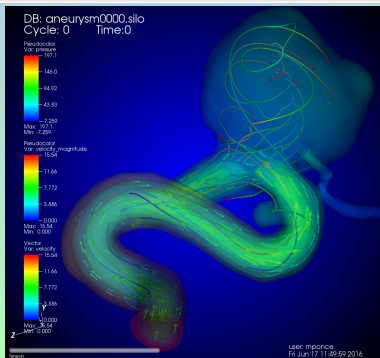
➡ Choose the desired **active time slider** from the pull-down menu

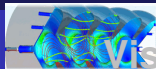


Visit: Intermesso ii

Hands-on...

- ▶ Using the “aneurysm” dataset –or– *your own data*, generate a time sequence movie
- ▶ Experiment with keyframing, lighting, ... or any of the other techniques we have been discussing

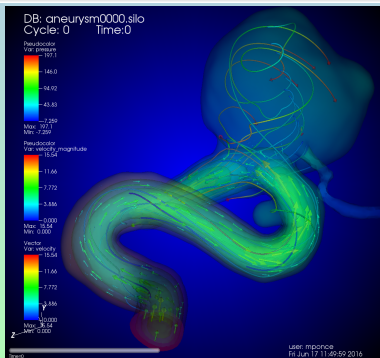


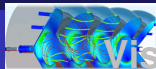


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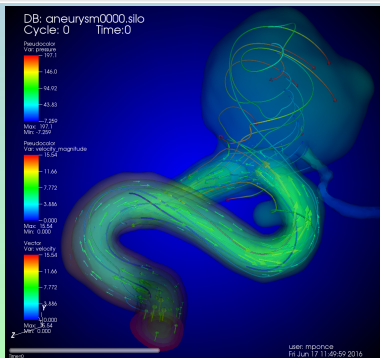


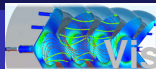


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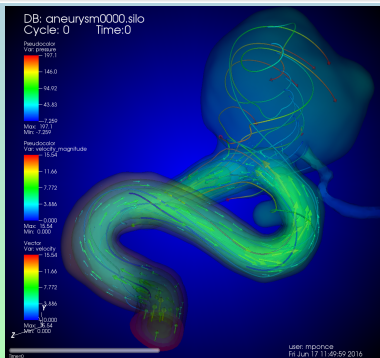




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Remote Visualization

There may be different reasons why one would want to visualize data remotely:

- data locality: data is located in a remote site, eg. cluster
- the remote server is more powerful and can generate more demanding visualizations
- ...

Ways to Visualize Remotely

- X-forwarding
- VNC
- Server-Client protocol, natively provided by the Viz.Suite

X-forwarding

- the viz. software will run on the remote host
- all the graphics are forwarded to the local computer
- it is usually slow! Alternatively one could use VNC instead...

```
ssh -X USERNAME@bridges2.psc.edu
```

```
module load visit  
visit  
# for executing in parallel with 28  
processors  
module load intel  
visit -np 28
```

Try running,
`visit -help`
`visit -fullhelp`
for more command line
arguments...

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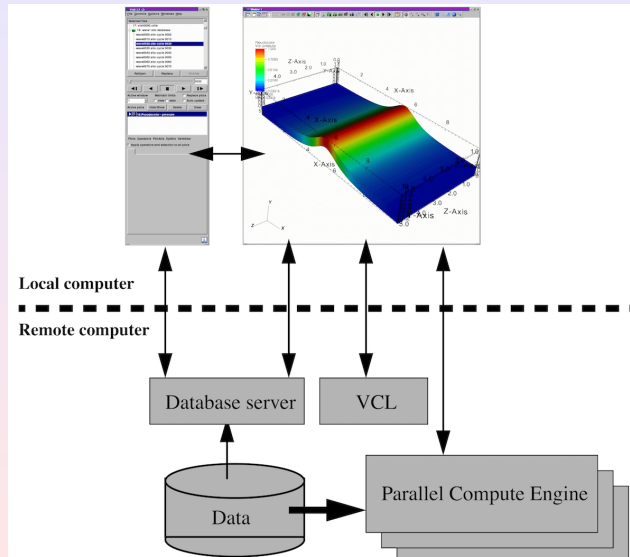
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Client-Server Protocol



Remote Visualization – Client-Server Mode

VisIt supports “remote visualization” protocols, which includes:

- accessing data remotely, ie. stored on the cluster
- rendering visualizations using the compute nodes as rendering engines
- or both

For allowing VisIt connect to the Bridges cluster you need to set up a "Host Configuration"

- 1 use the Bridges Host configuration file: https://cmsweb.utsc.utoronto.ca/marcelo-ponce/teaching/ihpcss_2022/viz/config/host_bridges2.xml
- 2 configure the host manually

* OBS: VisIt requires to use the same version in both the local client and the remote host!

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Using the Bridges Host configuration file

- 1 Download the Bridges Host configuration file, from the following link
https://cmsweb.uts.utoronto.ca/marcelo-ponce/teaching/ihpcss_2022/viz/config/host_bridges2.xml
- 2 Depending on the OS you are using on your local machine:
 - on a **Linux/Mac OS** place this file in `~/.visit/hosts/`
 - on a **Windows** machine, place the file in `My Documents\VisIt 3.1.x\hosts\`
- 3 Restart Visit and check that the bridges profile should be available in your hosts [Options] ➡ Host Profiles...

Manual Host Configuration

- 1 [Options] ➡ "Host profiles...", click on 'New Host' and select:

Host nickname = `bridges`

Remote host name = `bridges.psc.edu`

Username = `YOURusername`

Path to VisIt installation =
`/opt/packages/Visit/`

- 2 Click on the "Tunnel data connections through SSH", and then hit Apply!

The screenshot shows a 'Host profiles' window with a sidebar on the left containing 'Hosts' and 'Remote Profiles'. The 'Hosts' list contains one entry, 'bridges'. The main panel is titled 'Host Settings' and contains the following fields and options:

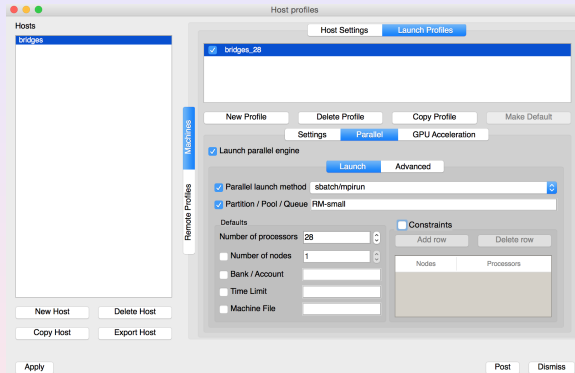
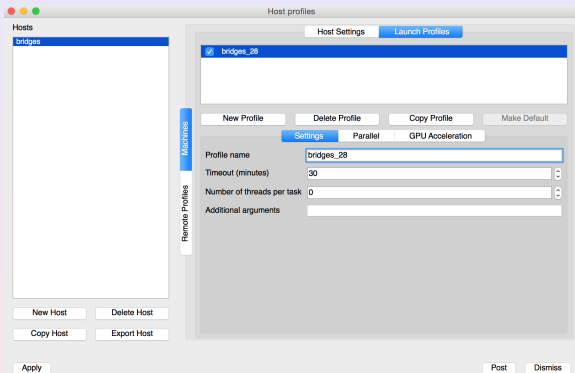
- Machine**
 - Host nickname: `bridges`
 - Remote host name: `bridges.psc.edu`
 - Host name aliases: (empty)
- Maximum nodes**: 1
- Maximum processors**: 1
- Path to VisIt installation**: `/opt/packages/Visit/visit2.12.3/src`
- Account**
 - Username: `mponce`
- Connection**
 - ☐ Share batch job with Metadata Server
 - ☒ Tunnel data connections through SSH
 - Method used to determine local host name when not tunneling:
 - ☐ Use local machine name
 - ☐ Parse from SSH_CLIENT environment variable
 - ☐ Specify manually: (empty)
 - ☐ SSH command: `ssh`
 - ☒ SSH port: `2222`
 - ☐ Use gateway: (empty)

At the bottom of the window, there are buttons for 'New Host', 'Delete Host', 'Copy Host', 'Export Host', 'Apply', 'Post', and 'Dismiss'.

Manual Host Configuration (cont.)

- 3 On the top of the window click on 'Launch Profiles' tab.
You will have to create a profile:
 - Profile name: `bridges_28`
- 4 Then click on the Parallel tab and set the "Launch parallel engine"
 - Parallel launch method: `sbatch/mpirun`
 - Partition/Pool/Queue: `RM-small`
 - Number of processors: `28`
- 5 Don't forget to select Options/Save Settings!

Manual Host Configuration (cont.)



- 6 Finally, go to the "Options" menu and select "Save settings", so that your changes are saved and available next time you relaunch Visit.

Accessing Remote Hosts...

- [File] ➡ Open file... ~→ click on "Host ▼"
- A list possible hosts should display, including "bridges2" – select it!
- You will be asked to enter your password, check that the username is correct! Otherwise, click on [Change Username]!
- If the connection was successful, the window should be displaying the remote File System, eg. Path: /home/USERNAME

• ssh into bridges: `ssh USERNAME@bridges2.psc.edu`

• Try copying the datasets, either directly from the internet, `curl -L -O`

`https://monitor.scineta.utoronto.ca/gitlab/teaching/ihpcss-2021\_sciviz/-/raw/main/data-tutorials/aneurysm\_tutorial\_data.tar.gz`

or copy it from my homedir, `cp -rv /home/mjponce/visit-examples -`

• uncompress your datafiles: `tar -xvzf datasets.tar.gz`

• Hit [Refresh] in Visit's file browser window

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Python scripting in VisIt I

- It is possible to run Python scripts in VisIt, from the command line without the GUI

```
$ /path/to/VisIt -nowin -cli -s YOURscript.py
```

it can be very useful for running batch rendering jobs on a supercomputer

- VisIt has a built-in Python 2.7 shell

Controls → Launch CLI...

It'll start VisIt's Python interpreter in a terminal

- Alternatively,

Controls → Command...

provides a text editor with Python syntax highlighting and an Execute button that tells VisIt to execute the script;

- GUI translation tool into Python code:

Controls → Command...

lets you record your GUI actions into Python code that you can use in your scripts

Python scripting in VisIt II

- In addition, you can use Python in

Controls → Expressions... → Python Expression Editor

- Also,

Controls → Query → Python Query Editor

Python Scripting: creating plots

Let's start from scratch...

- 1 launch a Python shell

Controls → Launch CLI...

- 2 type the following commands (YOU NEED TO ADJUST THE PATH!):

```
1 # this opens the datafile, "noise.silo"  
2 OpenDatabase("PATHtoDATA/noise.silo")  
3 # this defines which type of plot we want to add  
4 AddPlot("Pseudocolor", "hardyglobal")  
5 # this last command "draws" the plot, like pressing the draw button  
6 DrawPlots()
```

Controlling Plots Attributes

- Each plot in VisIt has a number of attributes that control the appearance of the plot
- To access them, first create a plot attributes object by calling a function `PlotNameAttributes()`, e.g., `PseudocolorAttributes()`, or `VolumeAttributes()`
- If changing attributes, pass the object to the `SetPlotOptions()`
- If setting new defaults, pass the object to `SetDefaultPlotOptions`

```
p = PseudocolorAttributes()
p # will print out all attributes

p.min, p.max = 1, 3 # colour map range
p.minFlag, p.maxFlag = 1, 1 # turn it on
SetPlotOptions(p) # set active plot attributes

help(SetPlotOptions)
```

```
#Revert to the original colour map range:
p.minFlag, p.maxFlag = 0,0 # turn it off
SetPlotOptions(p)

#Pick a different colour map:
p.colorTableName = "Greens" # new colour map
SetPlotOptions(p)
```

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```

Running scripts from inside the GUI

- Option 1: paste the code into the command window (**Controls** → **Command...**) and click **Execute**
- inside the Python shell, change to the directory containing the scripts and run the script(s)

```
os.getcwd()    # get the current directory}

os.chdir("/Users/marcelo/Downloads/datasets/scripts")

# os.chdir("C:\Users\marcelo\Desktop\datasets")    # Windows example

Source("scriptName.py")
```

Some examples...

We will assume that "noise.silo" is open!

```
1 # this is scratch.py
2 DeleteAllPlots()
3 AddPlot("Pseudocolor", "hardyglobal")
4 p = PseudocolorAttributes()
5 p.colorTableName = "Oranges"
6 SetPlotOptions(p)
7 DrawPlots()
```

```
>>> Source("scratch.py")
```

```
1 # this is addOperator.py
2 DeleteAllPlots()
3 AddPlot("Pseudocolor", "hardyglobal")
4 AddOperator("Isosurface")
5 isoAtts = IsosurfaceAttributes()
6 isoAtts.contourMethod = isoAtts.Value # contour by
    value(s)
7 isoAtts.variable = "hardyglobal"
8 DrawPlots()
9 print isoAtts # default is 10 isosurface levels
```

```
>>> Source("addOperator.py")
```

```
1 # this is threeSurfaces.py
2 for i in range(3):
3     isoAtts.contourValue = 2. + i*1.5
4     SetOperatorOptions(isoAtts)
```

```
>>> Source("threeSurfaces.py")
```

```
1 # this is saveSurfaces.py
2 s = SaveWindowAttributes()
3 s.format, s.fileName = s.PNG, 'iso'
4 s.outputToCurrentDirectory = 0
5 s.outputDirectory = "."
6 SetSaveWindowAttributes(s)
7 for i in range(3):
8     isoAtts.contourValue = 2. + i*1.5
9     SetOperatorOptions(isoAtts)
10    name = SaveWindow()
```

```
>>> Source("saveSurfaces.py")
```

Some examples...

We will assume that "noise.silo" is open!

```
1 # this is scratch.py
2 DeleteAllPlots()
3 AddPlot("Pseudocolor", "hardyglobal")
4 p = PseudocolorAttributes()
5 p.colorTableName = "Oranges"
6 SetPlotOptions(p)
7 DrawPlots()
```

```
>>> Source("scratch.py")
```

```
1 # this is addOperator.py
2 DeleteAllPlots()
3 AddPlot("Pseudocolor", "hardyglobal")
4 AddOperator("Isosurface")
5 isoAtts = IsosurfaceAttributes()
6 isoAtts.contourMethod = isoAtts.Value # contour by
    value(s)
7 isoAtts.variable = "hardyglobal"
8 DrawPlots()
9 print isoAtts # default is 10 isosurface levels
```

```
>>> Source("addOperator.py")
```

```
1 # this is threeSurfaces.py
2 for i in range(3):
3     isoAtts.contourValue = 2. + i*1.5
4     SetOperatorOptions(isoAtts)
```

```
>>> Source("threeSurfaces.py")
```

```
1 # this is saveSurfaces.py
2 s = SaveWindowAttributes()
3 s.format, s.fileName = s.PNG, 'iso'
4 s.outputToCurrentDirectory = 0
5 s.outputDirectory = "."
6 SetSaveWindowAttributes(s)
7 for i in range(3):
8     isoAtts.contourValue = 2. + i*1.5
9     SetOperatorOptions(isoAtts)
10    name = SaveWindow()
```

```
>>> Source("saveSurfaces.py")
```

Some examples...

We will assume that "noise.silo" is open!

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Some examples... Camera Motion

```

1 # this is printView.py
2 print GetView3D() # print all its attributes of the
  current view
3 # GetView3D().viewNormal # can also print a single
  attribute

>>> Source("printView.py")

```

```

1 # this is setControlPoint.py
2 from math import *
3 c0 = View3DAttributes()
4 phi = 0 # 0 <= phi <= 2*pi
5 theta = 0 # -pi/2 <= theta <= pi/2
6 c0.viewNormal = (cos(theta)*cos(phi), cos(theta)*sin(
  phi), sin(theta))
7 c0.focus = (0, 0, 0)
8 c0.viewUp = (0, 0, 1)
9 c0.viewAngle = 30
10 c0.parallelScale = 17.3205
11 c0.nearPlane = -34.641
12 c0.farPlane = 34.641
13 c0.perspective = 1
14 SetView3D(c0)

>>> Source("setControlPoint.py")

```

```

1 # this is rotateAroundVertical.py
2 nsteps = 300
3 for i in range(nsteps):
4     phi = float(i)/float(nsteps-1)*2.*pi
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6                     sin(theta))
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```

>>> Source("rotateAroundVertical.py")

```

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2 nsteps = 100
3 xfirst = 0
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5 for i in range(nsteps):
6     x = xfirst + float(i)/float(nsteps-1)*(xlast-
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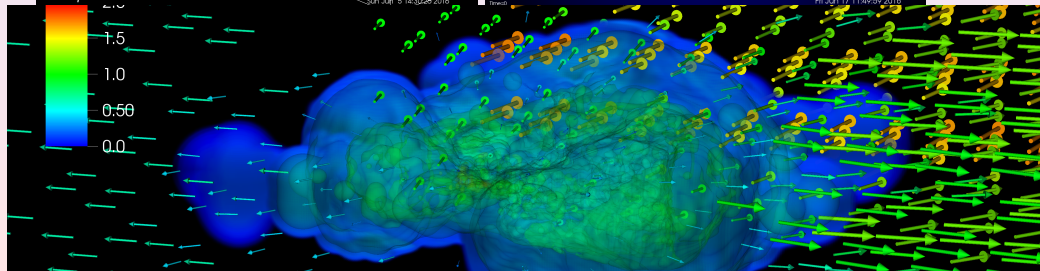
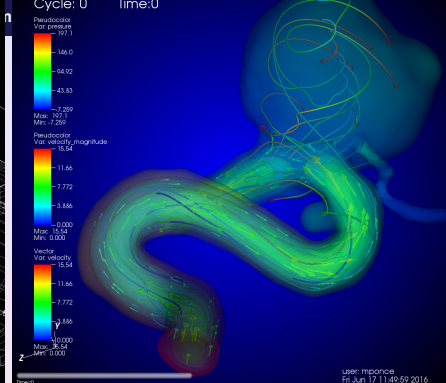
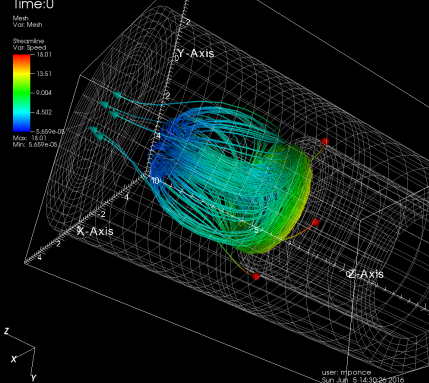
```

»» Source("flyInOut.py")

- 1 Scientific Visualization
 - 2D/3D Visualization Generalities
 - Visualization Pipeline
- 2 VisIt
 - Generalities
 - Viz. Pipelines Basics
 - Movies Generation
 - Remote Visualization
 - Scripting
- 3 Summary
- 4 Further Resources
 - References

Section 3

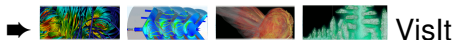
Summary



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Visit

➡ Website:

<https://wci.llnl.gov/simulation/computer-codes/visit/>

<https://wci.llnl.gov/codes/visit/>

➡ Documentation:

<https://wci.llnl.gov/simulation/computer-codes/visit/manuals>

➡ Visit User Manual: <http://visit-sphinx-user-manual.readthedocs.io>

➡ Gallery: <https://wci.llnl.gov/simulation/computer-codes/visit/gallery>

➡ Visit Users wiki: <http://www.visitusers.org>

➡ Tutorials: http://www.visitusers.org/index.php?title=VisIt_Tutorial

➡ Examples Datasets: http://www.visitusers.org/index.php?title=Tutorial_Data

➡ ParaView Tutorial

➡ http://www.paraview.org/Wiki/The_ParaView_Tutorial

➡ CI-Tutor: Cyber Infrastructure Tutor

➡ <http://www.citutor.org> “Introduction to Visualization”

➡ specifics or general questions about viz...

➡ courses_AT_scinet.utoronto.ca

➡ support_AT_scinet.utoronto.ca

5 Additional Material

- VTK Format
- Blood Aneurism – tutorial
- Dataset Exploration
- Vector Fields Visualizations
- High Quality Plots
- Professional Quality Plots

Outline

5 Additional Material

- VTK Format
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VTK legacy format

➡ in the shell, try

```
$ file testRectilinearGrid.vtk
```

testRectilinearGrid.vtk: ASCII C program text, with very long lines, with CLRF line terminators

➡ ASCII file ...

➡ try to look at it...

```
$ more testRectilinearGrid.vtk
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VTK legacy format

```

1 # vtk DataFile Version 2.0
2 Rectilinear grid of temperature values
3 ASCII
4 DATASET RECTILINEAR_GRID
5 DIMENSIONS 100 100 1
6 X_COORDINATES 100 float
7 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
   23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38
   39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54
   55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70
   71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
   87 88 89 90 91 92 93 94 95 96 97 98 99
8 Y_COORDINATES 100 float
9 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
   23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38
   39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54
   55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70
   71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
   87 88 89 90 91 92 93 94 95 96 97 98 99
10 Z_COORDINATES 1 float
11 0
12 POINT_DATA 10000
13 SCALARS temperature float
14 LOOKUP_TABLE default
15 20.18 20.36 20.54 20.73 20.93 21.13 21.35 21.58 21.82 22.09 22.38 22.70
   23.06 23.46 23.92 24.44 25.05 25.77 26.63 27.68 28.99 30.68
   32.90 35.99 40.50 47.61 60.00 84.65 142.03 300.00 300.00 300.00
   300.00 300.00 300.00 300.00 300.00 300.00 300.00 300.00 300.00

```

- (1) header
- (2) title (upto 256 characters)
- (3) Data type:
ASCII or Binary
- (4) Geometry/Topology,
5 types:
STRUCTURED_POINTS,
STRUCTURED_GRID,
UNSTRUCTURED_GRID,
POLYDATA,
RECTILINEAR_GRID,
FIELD
- (5) Dataset attributes:
data

Outline

5

Additional Material

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Outline

5

Additional Material

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VisIt: Aneurism DataSet

This tutorial uses the **aneurysm dataset**

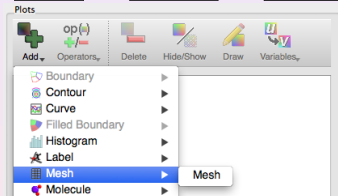
- ▶ Launch VisIt
- ▶ In VisIt's GUI, under the **Sources** section, click **Open**
- ▶ Navigate your file system to select the “aneurysm.visit” file.
- ▶ Alternatively, navigate into the aneurism directory and load all the “*.silo” files.



Visit: Plotting Mesh Topology

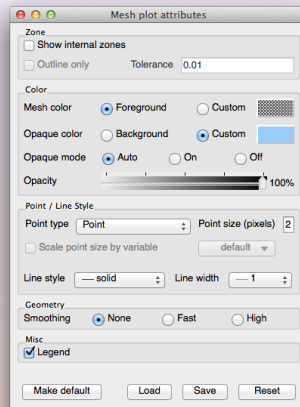
- First we will examine the finite element mesh used in the blood flow simulation.

► Add → Mesh → Mesh



► click draw

- Expand the Mesh plot object and double click to open the Mesh Plot Attributes Window

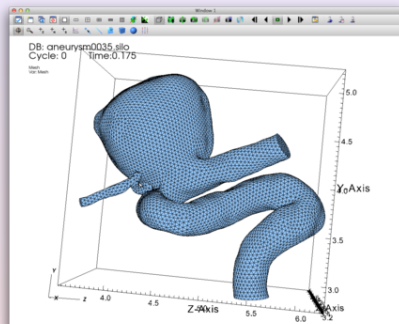




Visit: Plotting Mesh Topology

Experiment with settings for:

- ▶ Mesh color
- ▶ Opaque color
- ▶ Opaque mode
- ▶ Show internal zones
- ▶ You will need to click **Apply** to commit the settings to your plot.





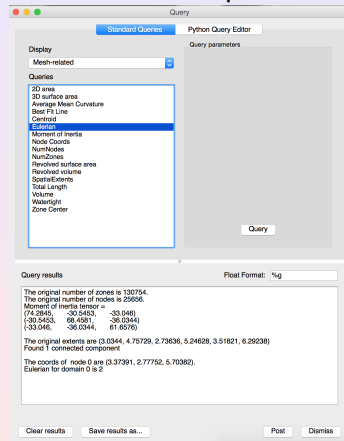
VisIt: Query Mesh Properties

VisIt's Query interface provides several quantitative data summarization operations.

- ▶ [Controls Menu] → Query
- ▶ Select NumZones and click Query
 ➡ **number of elements** in the mesh
- ▶ Select NumNodes and click Query
 ➡ **number of vertices** in the mesh

Pop quiz

- ▶ How many elements are used to construct the mesh?
- ▶ How many vertices are used to construct the mesh?





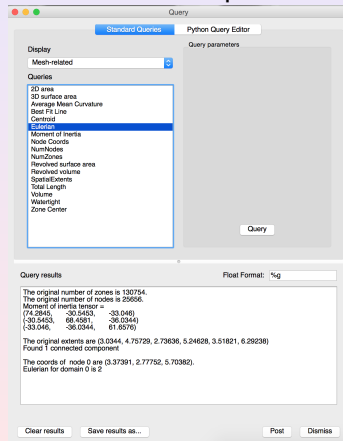
VisIt: Query Mesh Properties

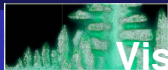
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VisIt: Examining and Identifying Data Fields

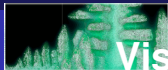
In addition to the mesh topology, this dataset provides two mesh fields:

- ▶ A *scalar field* **pressure**, associated with the mesh vertices.
- ▶ A *vector field* **velocity**, associated with the mesh vertices.

▶ [File Menu] → File information...

VisIt automatically defines an expression that allows us to use the *magnitude of the velocity vector field* as a *scalar field* on the mesh

⇒ the result of the expression is a new field named **velocity_magnitude**



VisIt: Examining and Identifying Data Fields

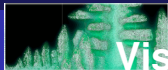
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- ▶ [File Menu] → File information...

VisIt automatically defines an expression that allows us to use the *magnitude of the velocity vector field as a scalar field* on the mesh

⇒ the result of the expression is a new field named **velocity_magnitude**



VisIt: Examining and Identifying Data Fields

In addition to the mesh topology, this dataset provides two mesh fields:

- ▶ A *scalar field* **pressure**, associated with the mesh vertices.
- ▶ A *vector field* **velocity**, associated with the mesh vertices.
- ▶ [File Menu] → File information...

VisIt automatically defines an expression that allows us to use the *magnitude of the velocity vector field as a scalar field* on the mesh

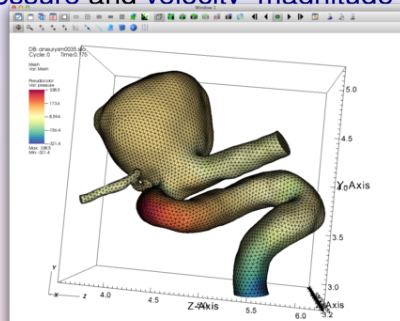
⇒ the result of the expression is a new field named **velocity_magnitude**



Visit: Visualizing Scalar Fields

We will use **Pseudocolor Plots** to examine the **pressure** and **velocity magnitude** fields.

- Add → Pseudocolor → Pressure
- Expand the Pseudocolor plot and double click to bring up the Pseudocolor Plot Attributes Window.
- Change the color table to **Spectral** and check the **Invert** button
- Click **Apply**
- [Plot List] click **Draw**
- [Time Slider] click **Play** / **Stop**



Experiment with:

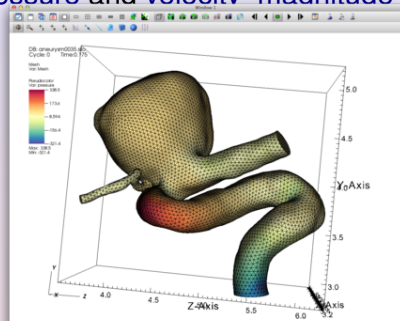
- ▶ setting the Pseudocolor plot limits
- ▶ hiding/showing the Mesh plot



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Experiment with:

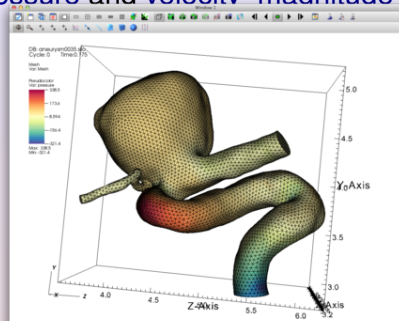
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Experiment with:

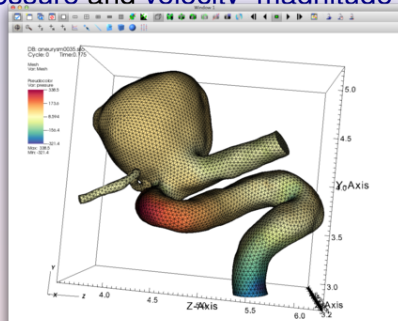
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- ▶ hiding/showing the Mesh plot



Visit: Analyzing Scalar Fields

Query the Maximum Pressure Over Time

We can use the pressure field to extract the heart beat signal.

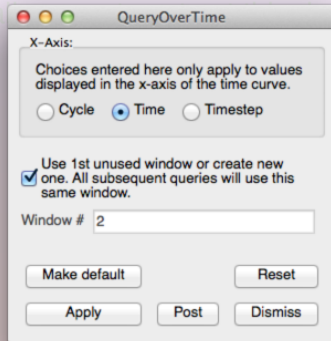
We want to find the maximum pressure value across the mesh elements at each time step of our dataset.

⇒ Visit provides a **Query over time** mechanism that allows us to:

- First, we need to set our query options to use time as the independent variable for our query: [Controls Menu] →

Query over time options

- Select **time**
- click **Apply** and dismiss the window





Visit: Analyzing Scalar Fields

Query the Maximum Pressure Over Time

We can use the pressure field to extract the heart beat signal.

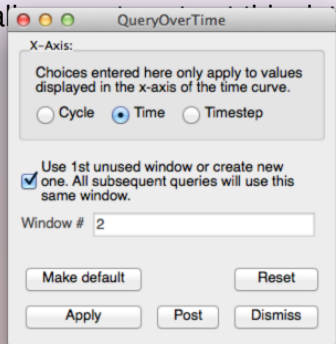
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VisIt: Analyzing Scalar Fields

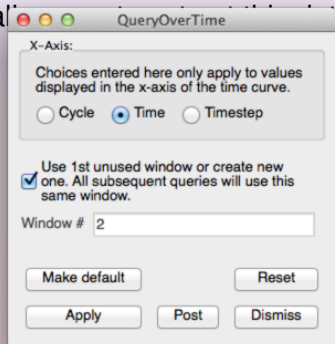
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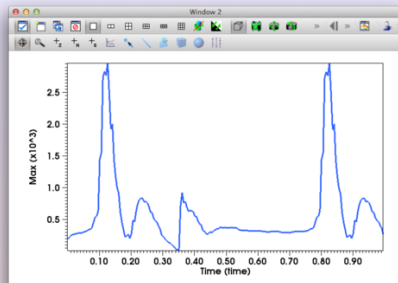


Visit: Analyzing Scalar Fields

Now we can execute the **Max query** on all the time steps and collect the results into a curve.

- [Plot List] Click to make sure the **Pseudocolor plot** is active
- [Controls Menu] → **Queries**
- Select **Max**
- check **Do Time Query**

This will process the simulation output files and create a new window with a curve that contains the maximum pressure value at each time.



Exercises

- ▶ How many heart beats does this dataset cover?
- ▶ Estimate the number of beats per minute of the simulated heart.

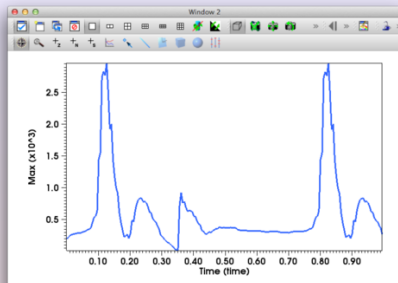


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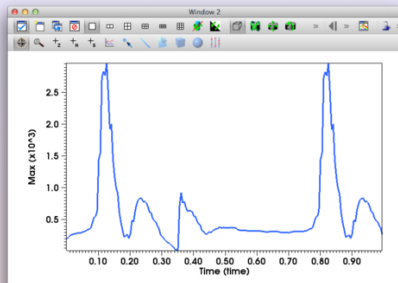


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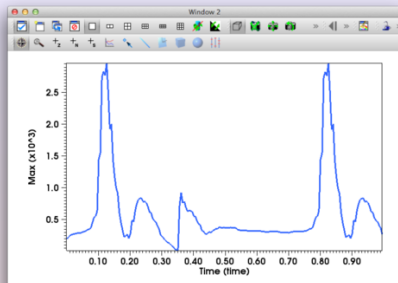


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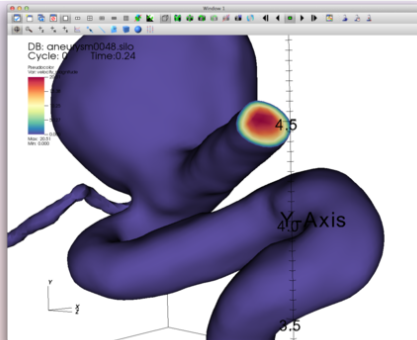


Visit: Analyzing Scalar Fields

Contours and Sub-volumes of High Velocity

Next, we will create a **Pseudocolor plot** to look at the *magnitude of the velocity vector field*.

- First, **Hide** / **Delete** previous plots
- Add a **Pseudocolor Plot** of the *velocity_magnitude*: [Plot List] → **Add** → **Pseudocolor** → *velocity_magnitude*
- Open (double-click) **Pseudocolor Plot Attributes Window**, and set the color table options as before
- [Plot List] → **Draw**



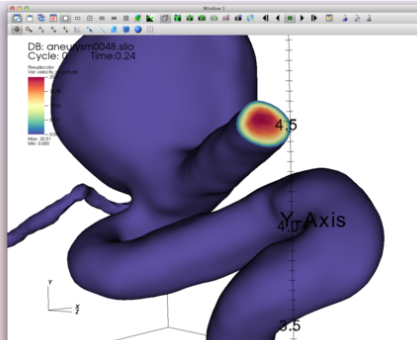


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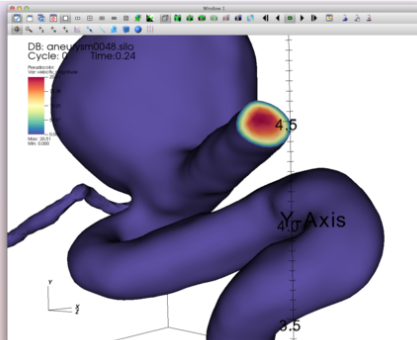


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Visit: Analyzing Scalar Fields

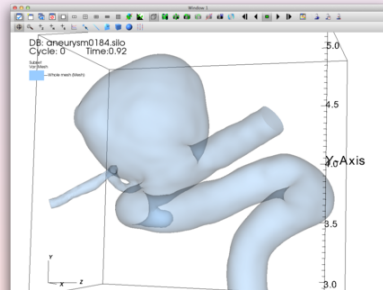
Notice that the velocity at the surface of the mesh is **zero**. To get a better understanding of the flow inside the mesh, we will use operators to extract regions of *high blood flow*.

Creating a Semi-Transparent Exterior Mesh Plot

When looking at features inside the mesh, it helps to have a partially transparent view of the whole mesh boundary for reference.

We will add a Subset plot to create this view of the mesh boundary.

- [Plot List] → Uncheck
Apply operators to all plots
- Add a Subset Plot of the *mesh*: [Plot List] → Add → Subset → Mesh
- Open (double-click) Subset Plot
Attributes Window: change color to LightBlue, Opacity ~ 25%, hit Apply





Visit: Analyzing Scalar Fields

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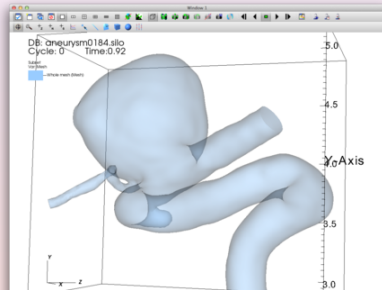
 →

Subset

 →

Mesh
- ▶ Open (double-click) **Subset Plot**
Attributes Window: change color to **LightBlue**, **Opacity** ~ 25%, hit

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Visit: Analyzing Scalar Fields

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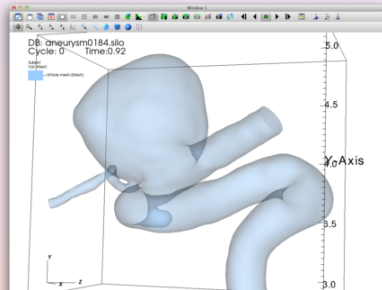
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 →

Mesh
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Apply





Visit: Analyzing Scalar Fields

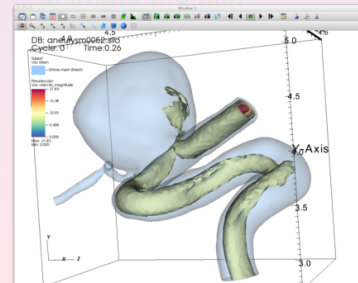
Contours of High Velocity

Now we will extract **contour surfaces** at *high velocity* values using the **IsoSurface Operator**

- [Plot List] → Click to select the Pseudocolor Plot
- Add an **IsoSurface Operator**:
[Plot List] → Operators → Slicing → **IsoSurface**
- Open (double-click) **IsoSurface Operator Attributes Window**:
set **Select by** to **Value**, and use **10 15 20**;
click **Apply** and dismiss the window

[Plot List] → Draw

- use the [Time Slider] to animate the plot





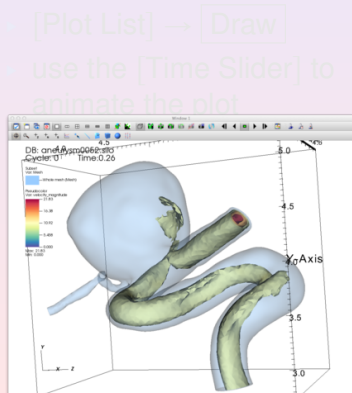
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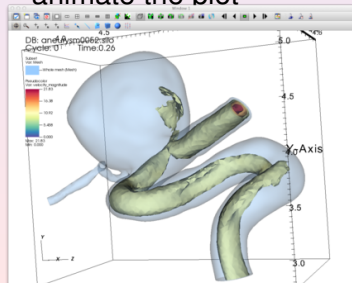
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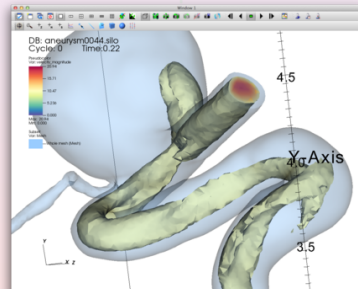
Visit: Analyzing Scalar Fields

Sub-Volumes of High Velocity

As an alternative to *contours*, we can also extract the **sub-volume** between two scalar values using the **IsoVolume Operator**

- Remove / Hide the 'IsoSurface Operator'
- Add an **IsoVolume Operator**:
[Plot List] → Operators → Selection
→ **IsoVolume**
- Open (double-click) **IsoVolume Operator Attributes Window**:
set the **Lower Bound** ~10, and
Upper Bound ~20;
click **Apply** and dismiss the window

- [Plot List] → Draw
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Visit: Analyzing Scalar Fields

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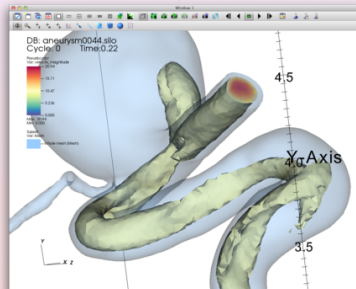
set the **Lower Bound** ~10, and

Upper Bound ~20;

click **Apply** and dismiss the window

[Plot List] → Draw

- ▶ use the [Time Slider] to animate the plot





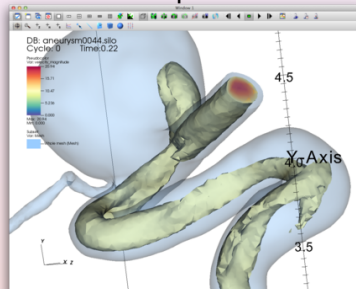
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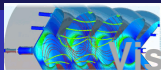


Outline

5

Additional Material

- VTK Format
- Blood Aneurism – tutorial
- Dataset Exploration
- **Vector Fields Visualizations**
- High Quality Plots
- Professional Quality Plots



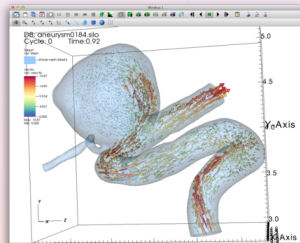
VisIt: Vector Fields Visualization

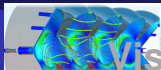
Plotting the Vector Field Directly with Glyphs

VisIt's vector plot renders a vector field at each time step as a collection of Arrow Glyphs. This allows us to see the direction of the vectors as well as their magnitude.

- Add a **Vector Plot** of *velocity*:
[Plot List]: **Add** → **Vector** → **velocity**
- Open **Vector Plot Attribute Window**:
[Vector Tab] set **Stride** ~5,
[Data Tab] set **Color** ~ **Spectrum+Inv.**,
[Glyphs Tab] set **Scale** ~0.5,
Arrow Body ~ **cylinder**,
Geometry Quality ~ **High**
click **Apply** and dismiss the window

- [Plot List] → **Draw**
- use the [Time Slider] to animate the plot





VisIt: Vector Fields Visualization

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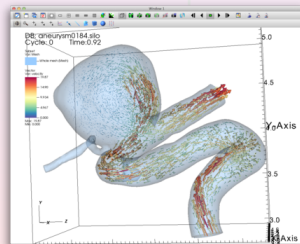
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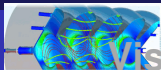
Arrow Body ~cylinder,

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 animate the plot





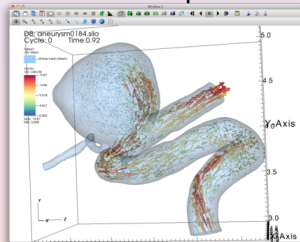
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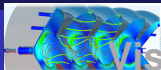
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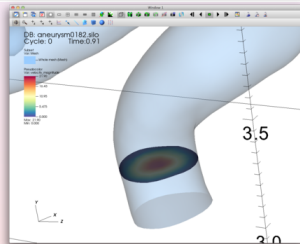
Visit: Vector Fields Viz – streamlines

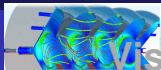
Examining features of the Flow Field with Streamlines

To explore the flow field further we will seed and advect a set of streamlines near the inflow of the artery.

Streamlines show the path massless tracer particles would take if advected by a static vector field. To construct Streamlines, the first step is selecting a set of spatial locations that can serve as the initial seed points.

We want to center our seed points around the peak velocity value on a slice near the inflow of the artery. To find this location, we query a sliced pseudocolor plot of the velocity_magnitude

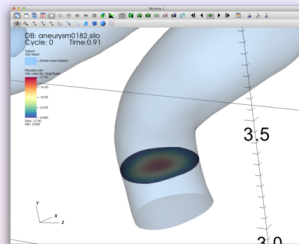


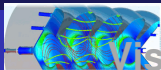


VisIt: Vector Fields Viz – streamlines

Slicing the blood flow:

- Add a **Pseudocolor Plot** of *velocity_magnitude*:
[Plot List]:
Add → **Pseudocolor** → *velocity_magnitude*
- Open **Pseudocolor Plot Attributes Window**:
[Data Tab] set **Color** ~> **Spectral**
- Add a **Slice Operator**:
[Plot List]: **Operators** → **Slicing** → *slice*
- ▶ Open **Slice Operator Attributes Window**:
[Normal] set **Orthogonal** ~> **Y axis**,
[Origin] set **Point** ~> **3 3 3**,
[Up Axis] uncheck **Project to 2D** click **Apply** and dismiss the window





VisIt: Vector Fields Viz – streamlines

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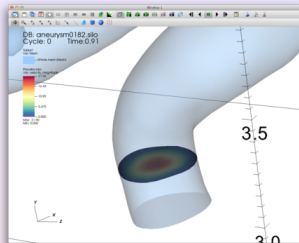
[Plot List]: **Operators** → **Slicing** → **slice**

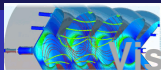
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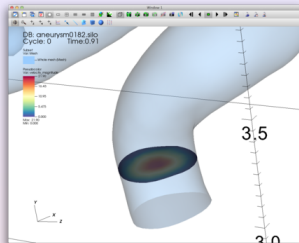
[Plot List]: **Operators** → **Slicing** → slice

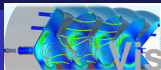
- ▶ Open **Slice Operator Attributes Window**:

[Normal] set **Orthogonal** → **Y axis**,

[Origin] set **Point** → **3 3 3**,

[Up Axis] uncheck **Project to 2D** click **Apply** and dismiss the window





VisIt: Vector Fields Viz – streamlines

Slicing the blood flow:

- ▶ Add a **Pseudocolor Plot** of *velocity_magnitude*:

[Plot List]:

Add → **Pseudocolor** → *velocity_magnitude*

- ▶ Open **Pseudocolor Plot Attributes Window**:

[Data Tab] set **Color** → **Spectral**

- ▶ Add a **Slice Operator**:

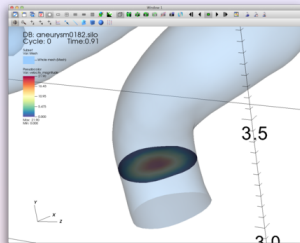
[Plot List]: **Operators** → **Slicing** → *slice*

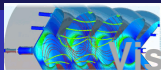
- ▶ Open **Slice Operator Attributes Window**:

[Normal] set **Orthogonal** → **Y axis**,

[Origin] set **Point** → **3 3 3**,

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VisIt: Vector Fields Viz – streamlines

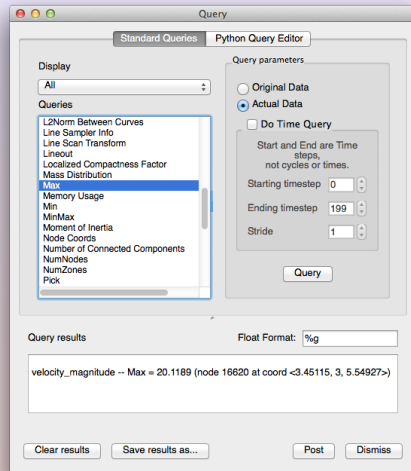
Query to find the Maximum Velocity on the Slice

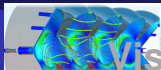
[Plot List]: click on the pseudocolor
velocity_magnitude to make it
active

Go to the **Controls Menu**:
[Max] select **Actual Data** → **Query**

→ This will return the *maximum scalar value on the slice* and the x,y,z coordinates of the node associated with this value.

→ We will use the x,y,z coordinates of this node to seed a set of streamlines.





VisIt: Vector Fields Viz – streamlines

Query to find the Maximum Velocity on the Slice

- [Plot List]: click on the pseudocolor

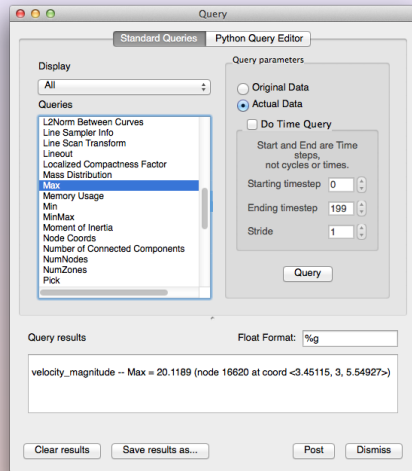
`velocity_magnitude` to make is

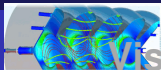
active

- Go to the **Controls Menu**:
[Max] select `Actual Data` → **Query**

- This will return the *maximum scalar value on the slice* and the *x, y, z coordinates of the node associated with this value*.

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VisIt: Vector Fields Viz – streamlines

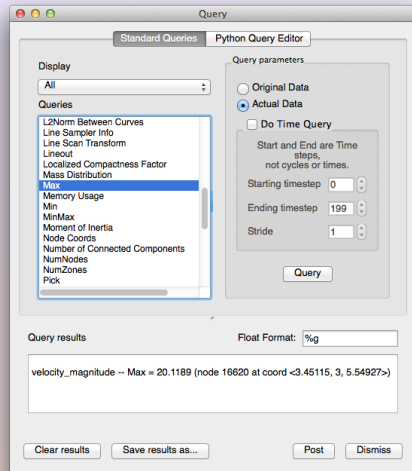
Query to find the Maximum Velocity on the Slice

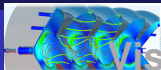
- ▶ [Plot List]: click on the pseudocolor `velocity_magnitude` to make is **active**

- ▶ Go to the **Controls Menu**:
[Max] select **Actual Data** → **Query**

→ This will return the *maximum scalar value on the slice* and the *x, y, z coordinates of the node associated with this value*.

→ We will use the *x, y, z coordinates of this node to seed a set of streamlines*.





Visit: Vector Fields Viz – streamlines

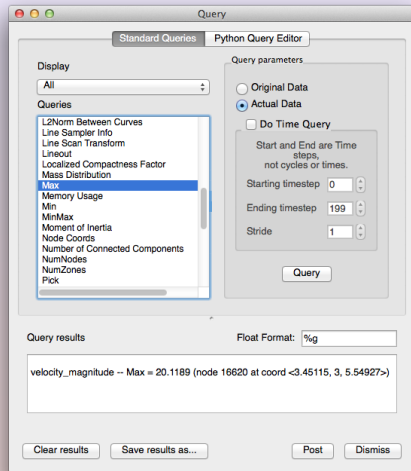
Query to find the Maximum Velocity on the Slice

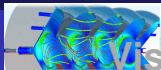
- ▶ [Plot List]: click on the pseudocolor `velocity_magnitude` to make it **active**

- ▶ Go to the **Controls Menu**:
[Max] select `Actual Data` → **Query**

➡ This will return the *maximum scalar value on the slice* and the x, y, z coordinates of the node associated with this value.

➡ We will use the x, y, z coordinates of this node to seed a set of streamlines.

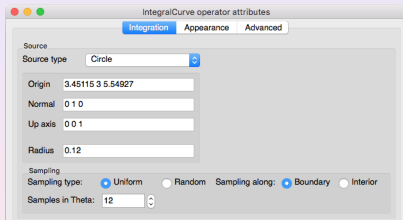




VisIt: Vector Fields Viz – streamlines

Plotting Streamlines of Velocity

[Plot List]: Add → Pseudocolor → operators/IntegralCurve/velocity



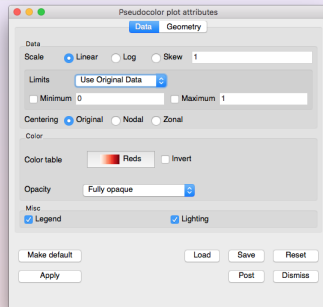
► [Geometry tab]

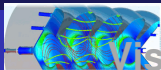
Line type ~ Tubes, Tail ~ Sphere,

Head ~ Cone,

Head/Tail Radius ~ 0.02

► [Apply / Draw] → [Time Slider] click [Play / Stop]

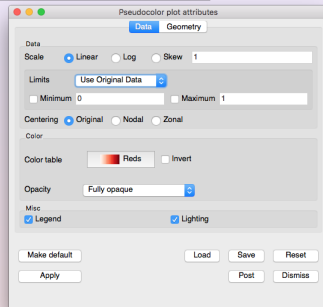
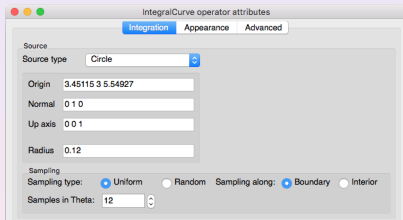




VisIt: Vector Fields Viz – streamlines

Plotting Streamlines of Velocity

[Plot List]: **Add** → **Pseudocolor** → operators/IntergralCurve/velocity



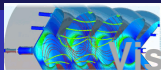
► [Geometry tab]

Line type ~ Tubes, Tail ~ Sphere,

Head ~ Cone,

Head/Tail Radius ~ 0.02

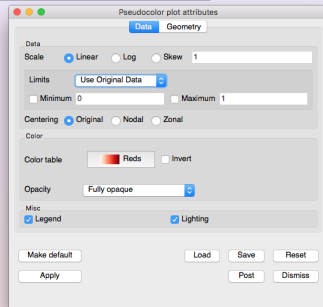
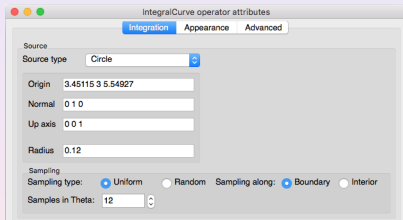
► [Apply / Draw] → [Time Slider] click [Play / Stop]



VisIt: Vector Fields Viz – streamlines

Plotting Streamlines of Velocity

[Plot List]: **Add** → **Pseudocolor** → operators/IntegralCurve/velocity



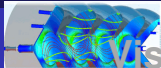
► [Geometry tab]

Line type ~ Tubes, Tail ~ Sphere,

Head ~ Cone,

Head/Tail Radius ~ 0.02

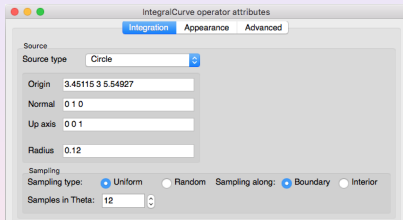
► Apply / Draw → [Time Slider] click Play / Stop



VisIt: Vector Fields Viz – streamlines

Plotting Streamlines of Velocity

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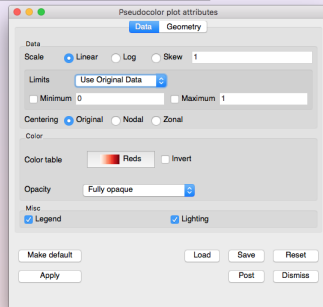


► [Geometry tab]

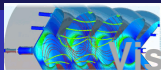
Line type ⇨ **Tubes**, Tail ⇨ **Sphere**,

Head ⇨ **Cone**,

Head/Tail Radius ⇨ **0.02**



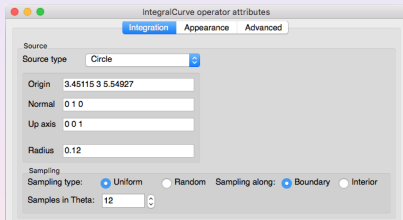
► Apply / Draw → [Time Slider] click Play / Stop



Visit: Vector Fields Viz – streamlines

Plotting Streamlines of Velocity

[Plot List]: **Add** → **Pseudocolor** → operators/IntegralCurve/velocity



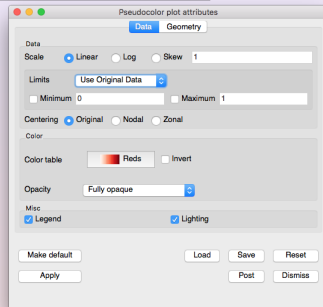
► [Geometry tab]

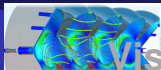
Line type ⇨ **Tubes**, Tail ⇨ **Sphere**,

Head ⇨ **Cone**,

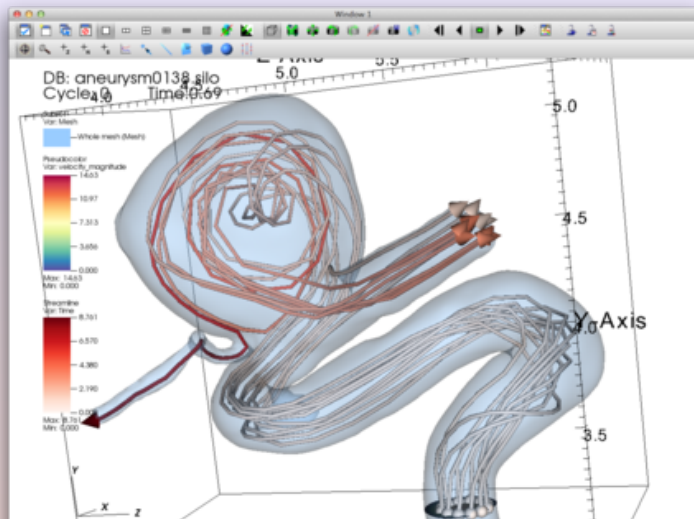
Head/Tail Radius ⇨ **0.02**

► **Apply** / **Draw** ⇨ [Time Slider] click **Play** / **Stop**





VisIt: Vector Fields Viz – streamlines



Outline

5

Additional Material

- VTK Format
- Blood Aneurism – tutorial
- Dataset Exploration
- Vector Fields Visualizations
- **High Quality Plots**
- Professional Quality Plots

Outline

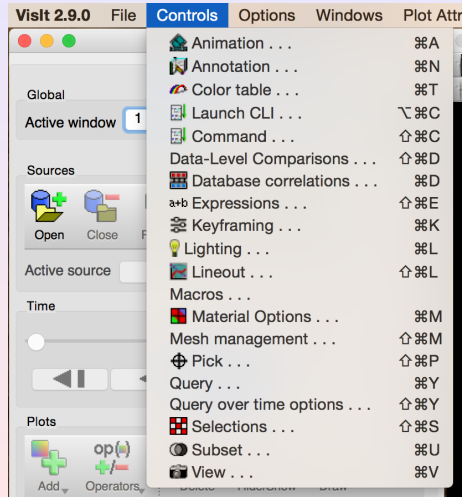
5

Additional Material

- VTK Format
- Blood Aneurism – tutorial
- Dataset Exploration
- Vector Fields Visualizations
- High Quality Plots
- Professional Quality Plots

Professional Quality Plots

- Annotations
- Colors
- Lighting
- Views



Annotations

Annotations

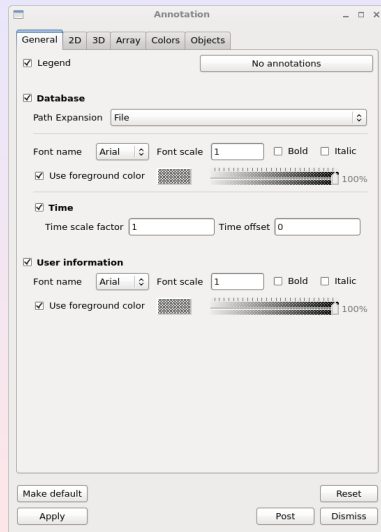
- objects in the viz-window that convey information about the plots
- make clear what is being visualized and make the visualization appear more polished

Types of Annotations

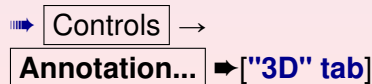
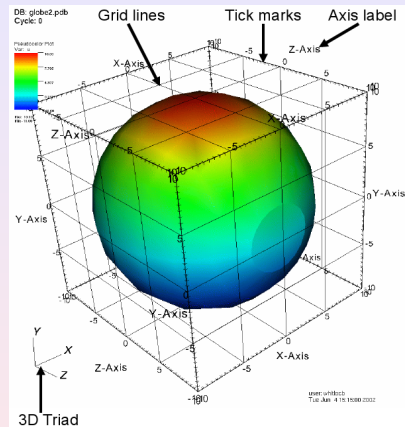
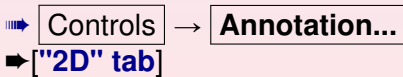
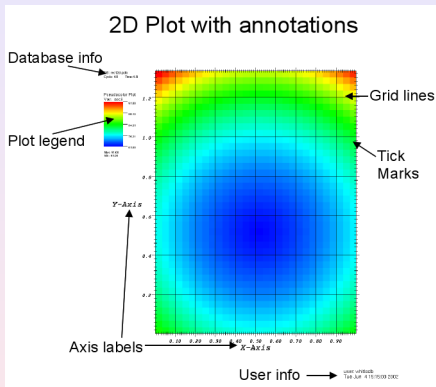
- Database name
- User name
- plot legends
- plot axes and labels (2d & 3d)
- 3d triad
- 2d, 3d text
- time slider
- images
- line and arrows

Annotation Window

- General annotations
- 2D axes settings
- 3D axes settings
- Array axis settings
- Color and Backgrounds
- Objects (legend, time slider, ...)



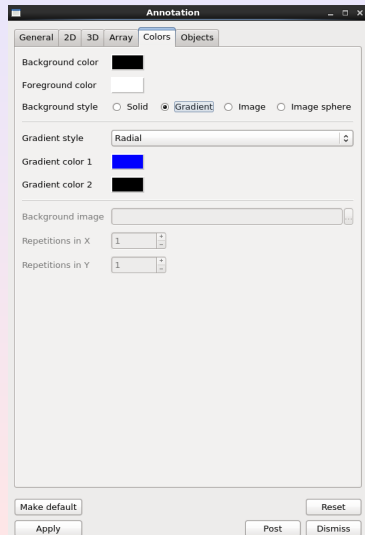
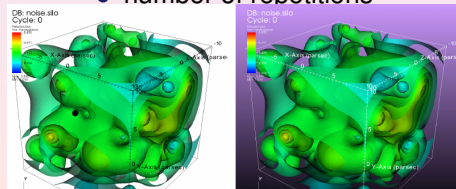
2D & 3D Annotations



Colors and Backgrounds

➡ Controls → Annotation...
 ➡ ["Colors" tab]

- set background/foreground
- Background styles:
 - solid
 - gradient
 - image (flat image)
 - image sphere (warped image, that rotates with the view)
 - number of repetitions

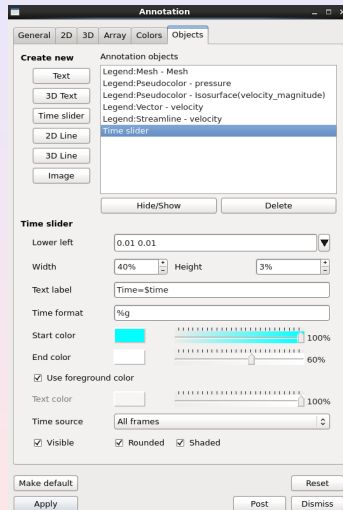
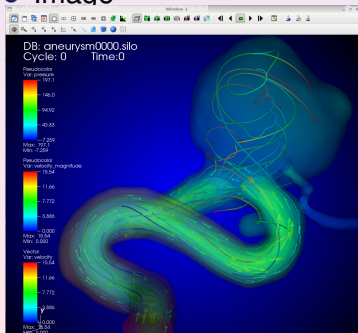


Annotation Objects

➡ Controls → Annotation...

➡ ["Objects" tab]

- 2D/3D Text
- 2D/3D Lines
- Time Slider
- Image

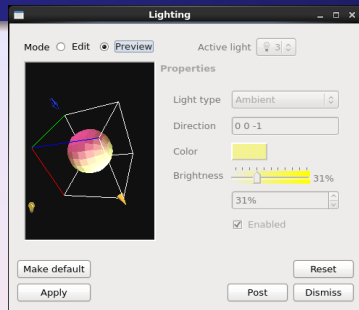
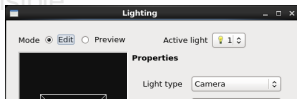


Lighting

- Lighting affects the brightness of plots
- 3D visualizations may require multiple *light sources*
- VisIt allows up to 8 light sources
- Each light source can be positioned and colored

→ Controls → Lighting...

- [Edit]: configure light sources
- [Preview]: all sources are visible



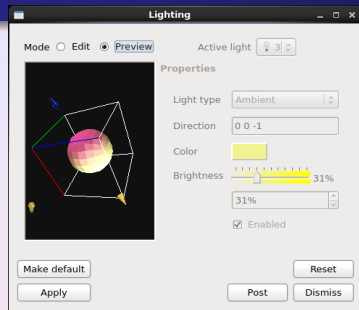
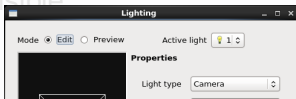
- only the active light can be modified
- once a light has been selected, you can change its props.
- Types of lights: Ambient, Camera, Object Light

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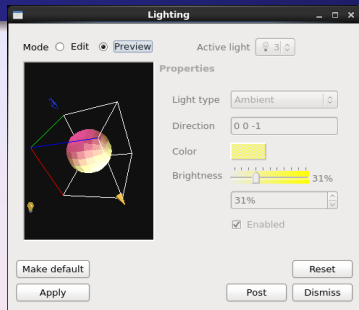
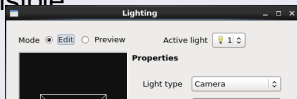
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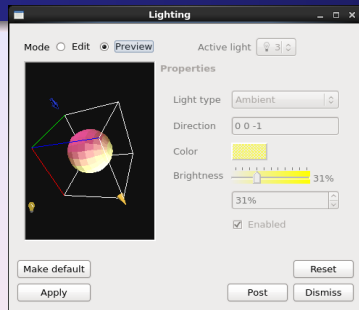
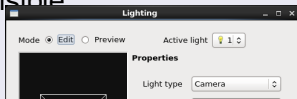
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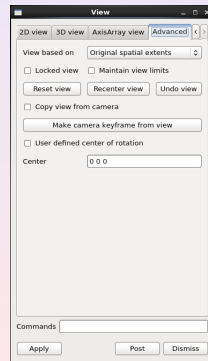
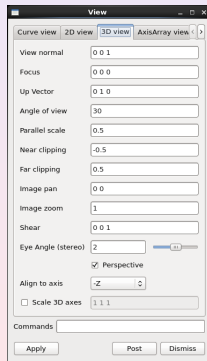
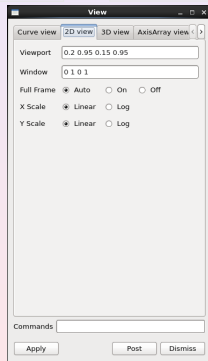
- [Edit]: configure light sources
- [Preview]: all sources are visible



- only the active light can be modified
- once a light has been selected, you can change its props.
- Types of lights: Ambient, Camera, Object Light

View

- the “view” can be set *interactively* in the viz-window (click and drag, ...)
- or using a “View Window”, to specify exactly the configuration view



“Locked view”: when the view changes in any locked window, all other locked windows readjust to it

View

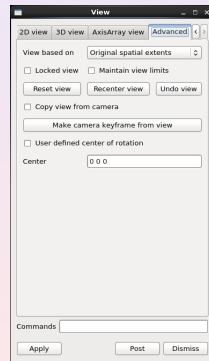
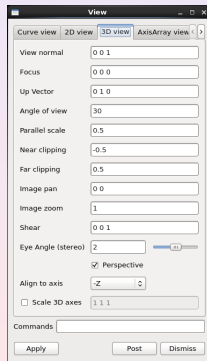
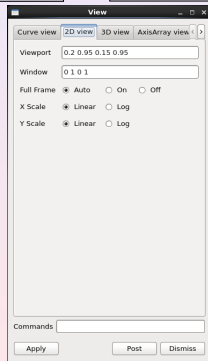
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Controls



View...



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Generating “hardcopies”, aka plotting images and figures

Generating Hardcopies: Figures

1



File →

Set Save option...

Allows you to control the properties of the image: file type, resolution, naming convention, etc...

2

File → **Save window**

Generates the image/file of the currently displayed window.

