Visualization and Analysis of 2D and 3D Image Data With VisIt

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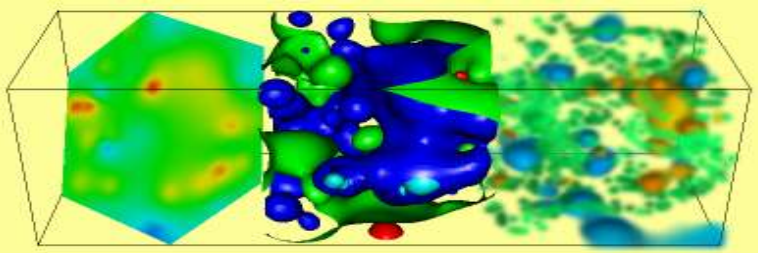
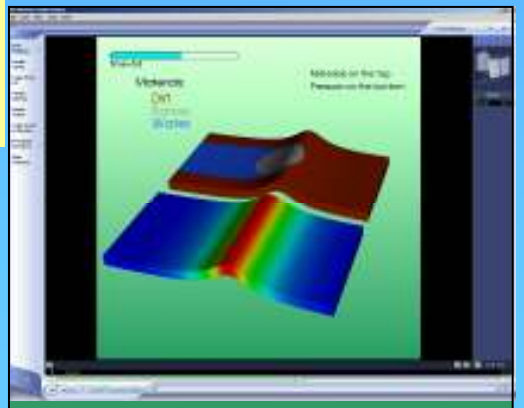
VisIt Background

- Viz/Analysis tool for simulated and experimental data
- Used by: physicists, engineers, code developers, vis experts.
- +300 users at LLNL, many users at other Academic/DOE sites
- Scalable architecture to 1000's of processors
- Open source, freely downloadable
  - Linux, Aix, Altix, Solaris, Tru64, Mac, Windows, Java
- http://www.llnl.gov/visit

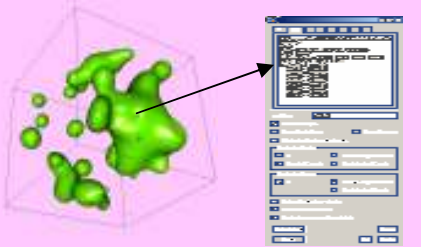


Data Exploration

Quantitative Analysis



Presentations



Debugging
Simulation
Codes

VisIt has support for common 2D and 3D Image Processing

- Reads LLNL CT data formats natively
  - Supports over 50 common file formats
  - Easy to write new reader plugins for different formats
- Handles size of typical CT data sets (500M-10B data points)
- Can define complex, run-time expressions
- Can export new data sets
  - VisIt can be used as part of a larger tool chain.

VisIt can read your data

- Reads over five dozen different database formats including
  - Many Image Formats
  - FITs
  - VTK
  - NETCDF
  - TecPlot
  - HDF5
  - Plot3D
  - GIS (ESRI Shapefile, DEM, many more)
  - FLUENT
  - Protein Databank
  - CGNS
  - NASTRAN
  - Silo
  - Exodus
  - Mili
  - SAMRAI
  - BoxLib
  - Ensight
- Database reader plug-ins can be developed for new formats

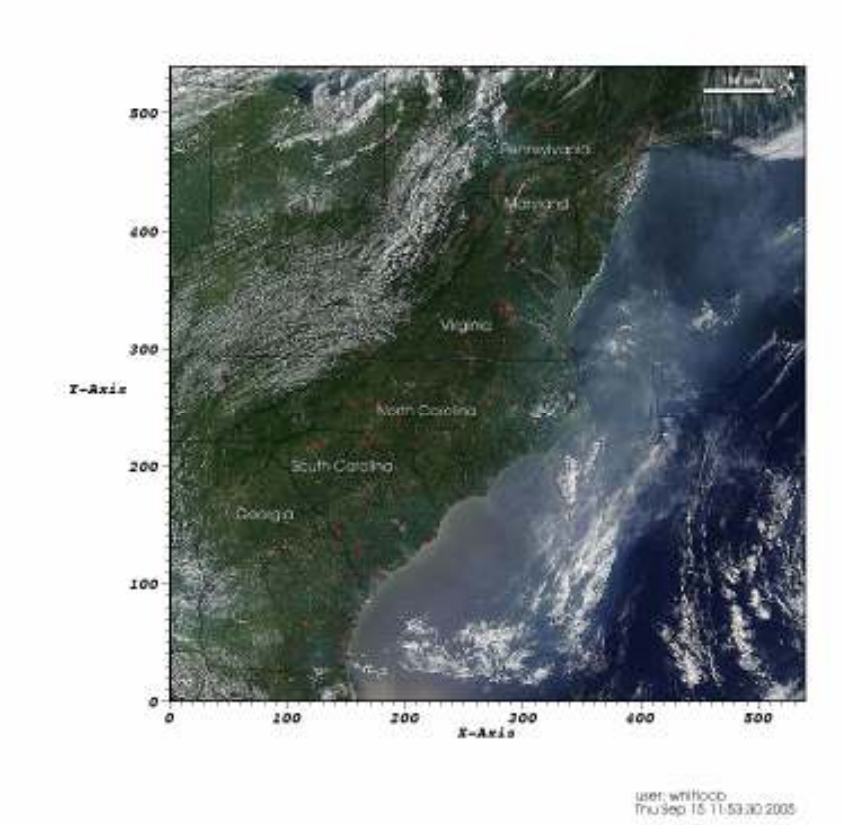
- Variable types
  - Scalar
  - Vector
  - Tensor
  - Arrays
  - Label
  - Material
  - Species
  - X,Y pairs

Various Plots Useful in 2D/3D Imaging Analyses

- Image (TrueColor) Plot
- Volume Plot
- Contour Plot
- Surface Plot
- Scatter Plot
- Streamline

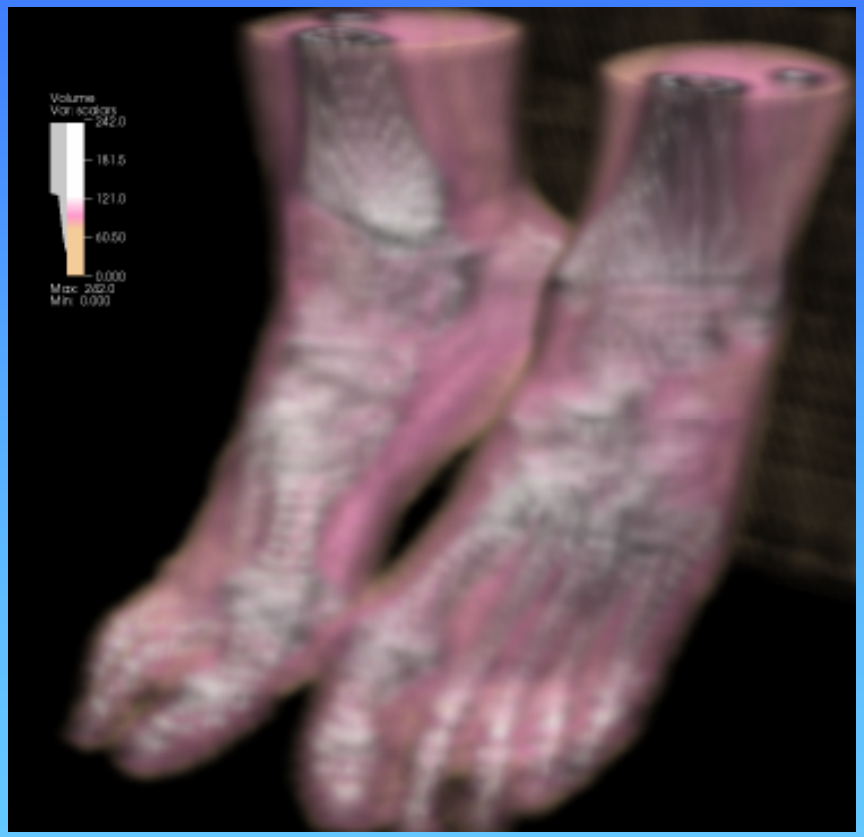
Truecolor plot

- The Truecolor plot lets you insert images or geometry that uses colors that are specified in the dataset
- Use the Truecolor plot to incorporate additional detail or to provide frame of reference for your visualization
- This plot accepts colors, which are represented as 4-tuple vectors with values in the range [0,255]



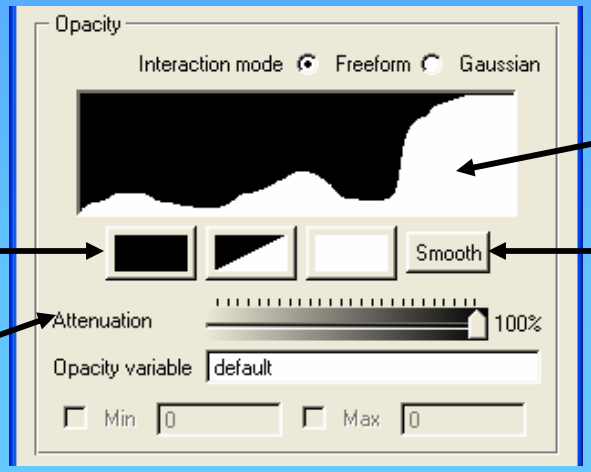
Volume plot

- This plot uses both color and transparency to visualize 3D scalar variables
- Use this plot when you want to look at internal features of a scalar variable while keeping all of the plot at least partially visible
- This plot accepts 3D scalar variables



Freeform opacity

- Draw the shape of the opacity curve and smooth it with the smooth button
- Clear the opacities, make them all fully opaque, or make a linear ramp



Freeform opacities

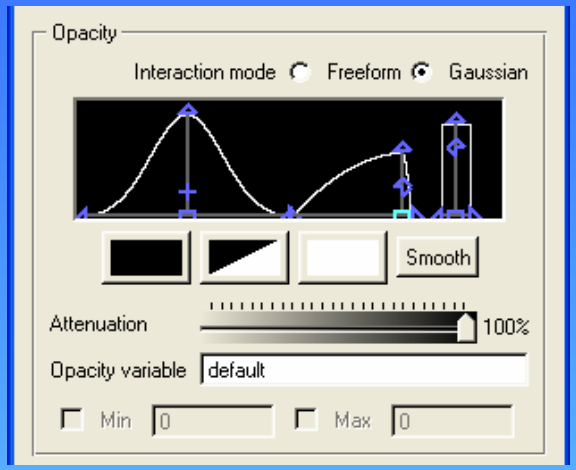
Preset opacity curves

Opacity attenuation

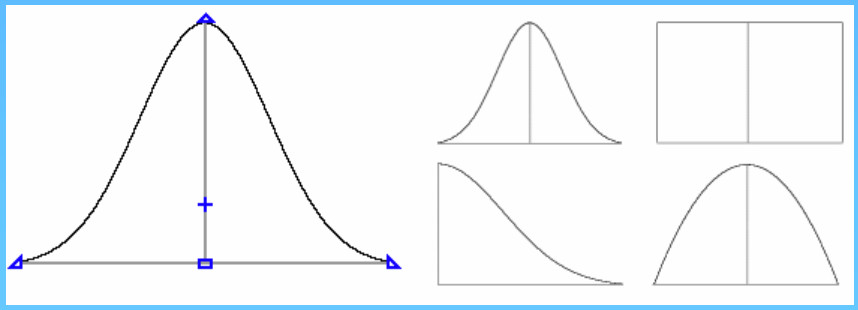
Smooth out opacity curve

Gaussian opacity

- Design opacity curve using a few opacity curves that can be modified by moving their control points
- Add a new curve by clicking in the curve area
- Remove a curve by right clicking on one of its control points



Gaussian curve shapes



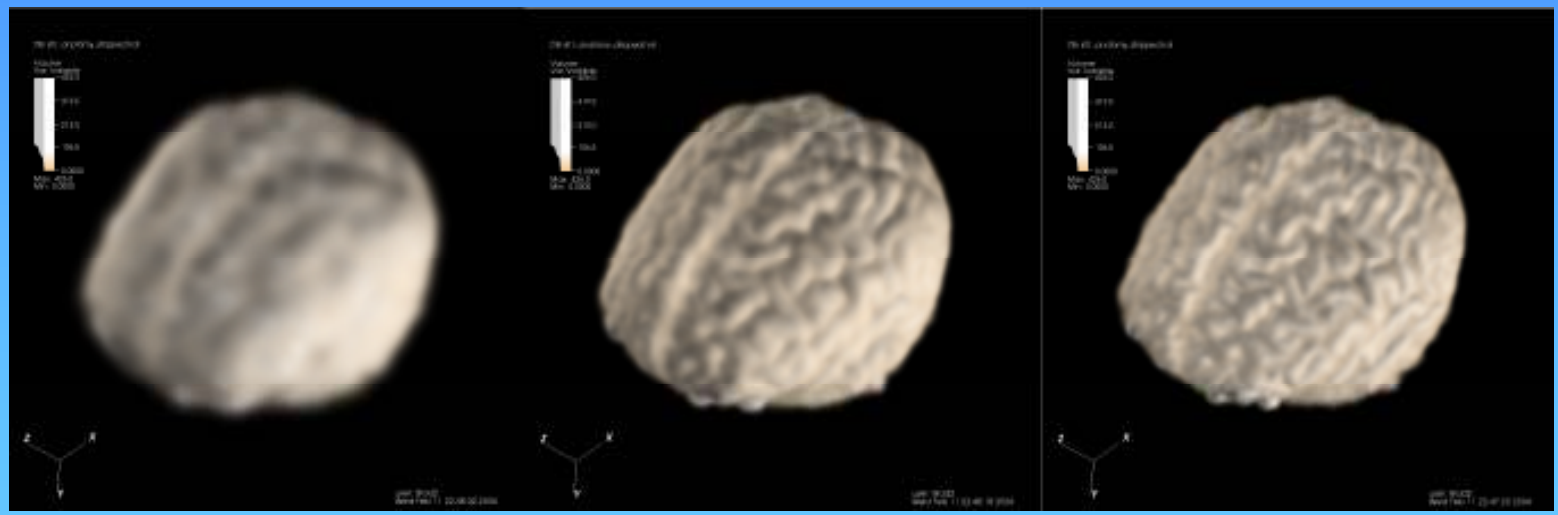
Number of samples

Brain dataset with 8,000,000 cells

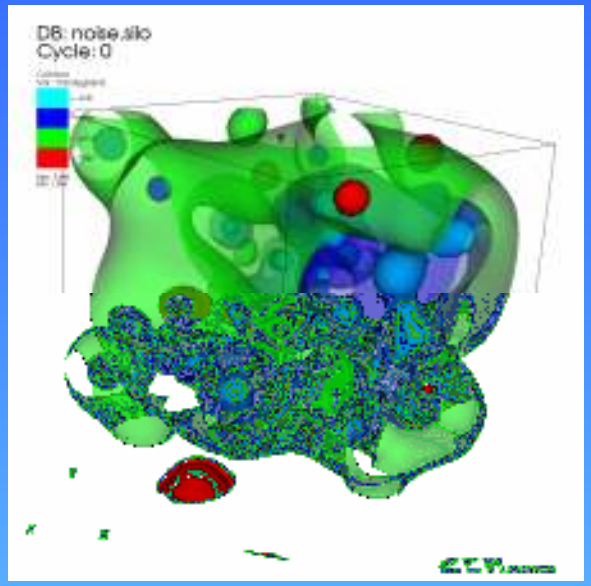
50,000 sample points

500,000 sample points

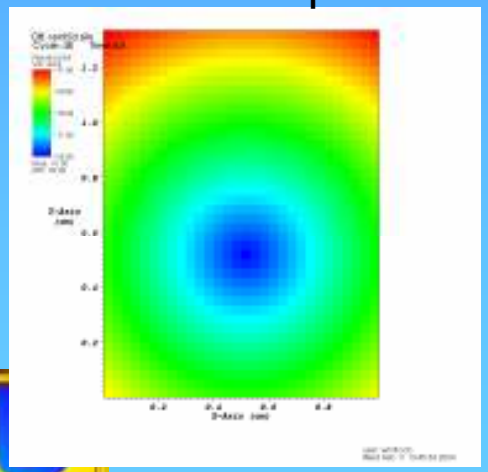
1,500,000 sample points



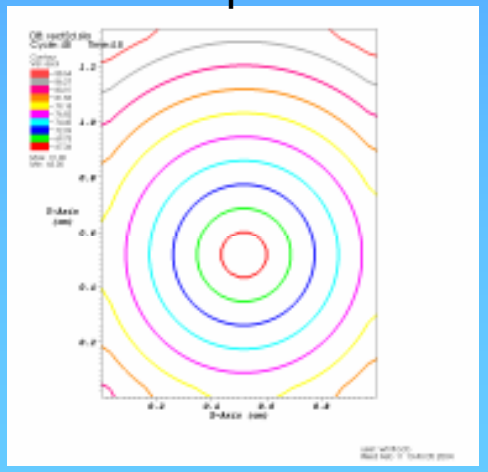
Contour plot



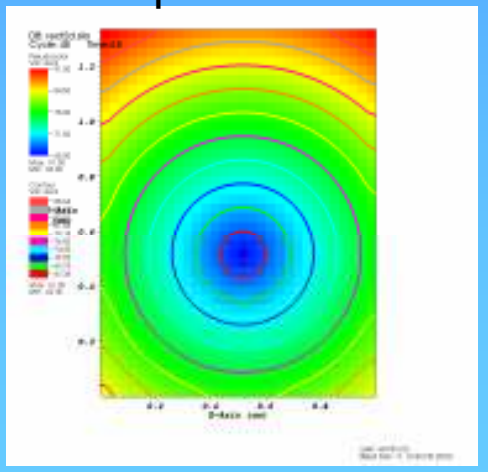
Pseudocolor plot



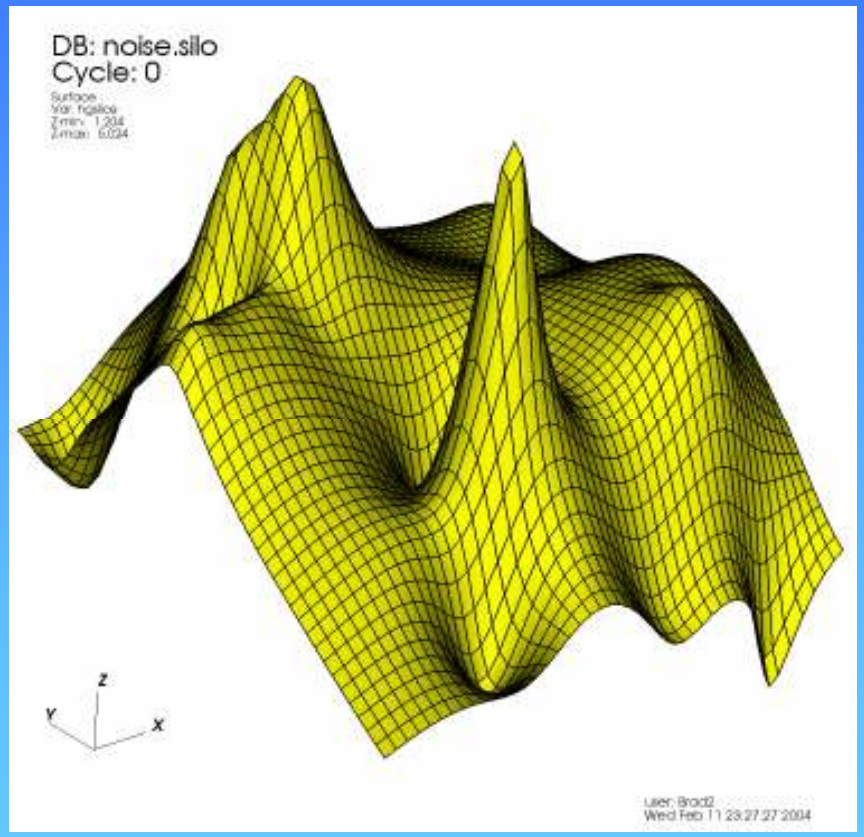
Contour plot

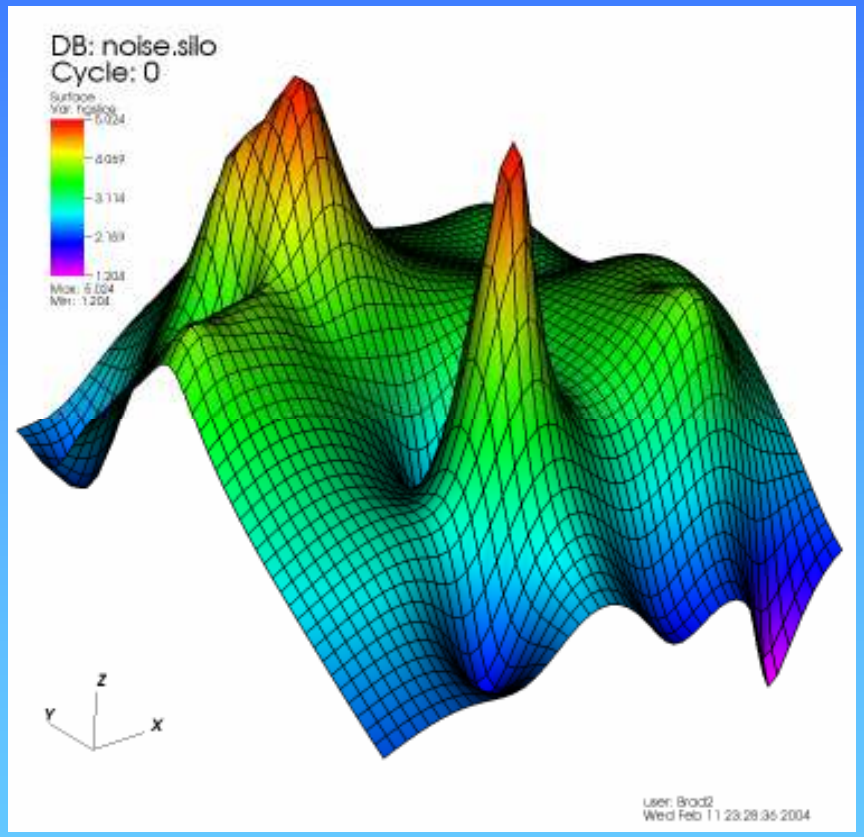


Both plots



Surface Plots



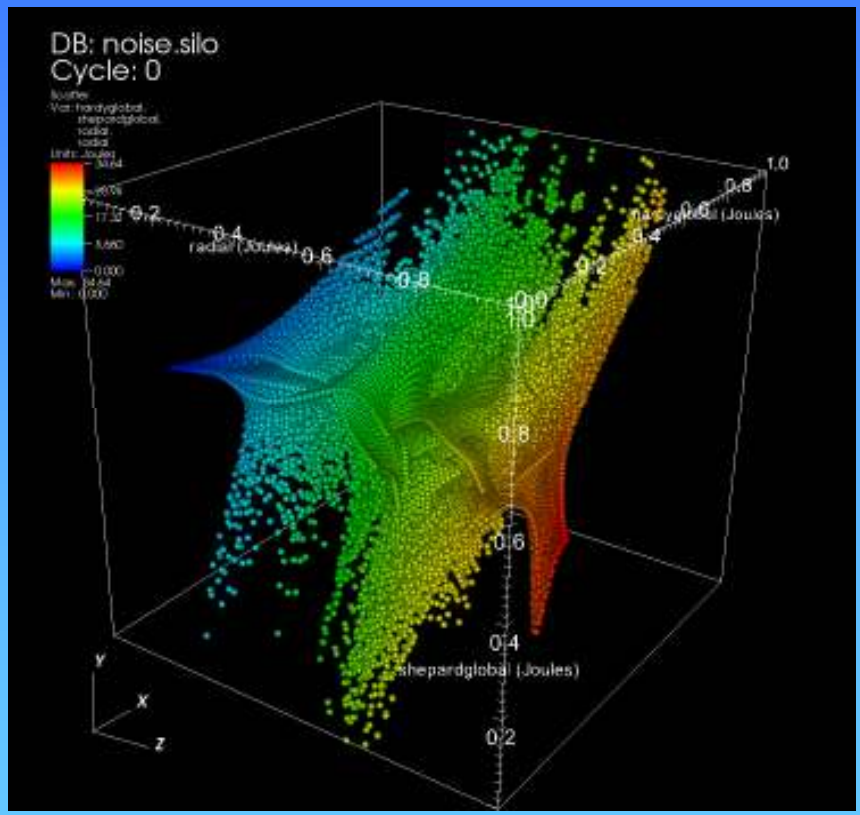


Constant colored surface

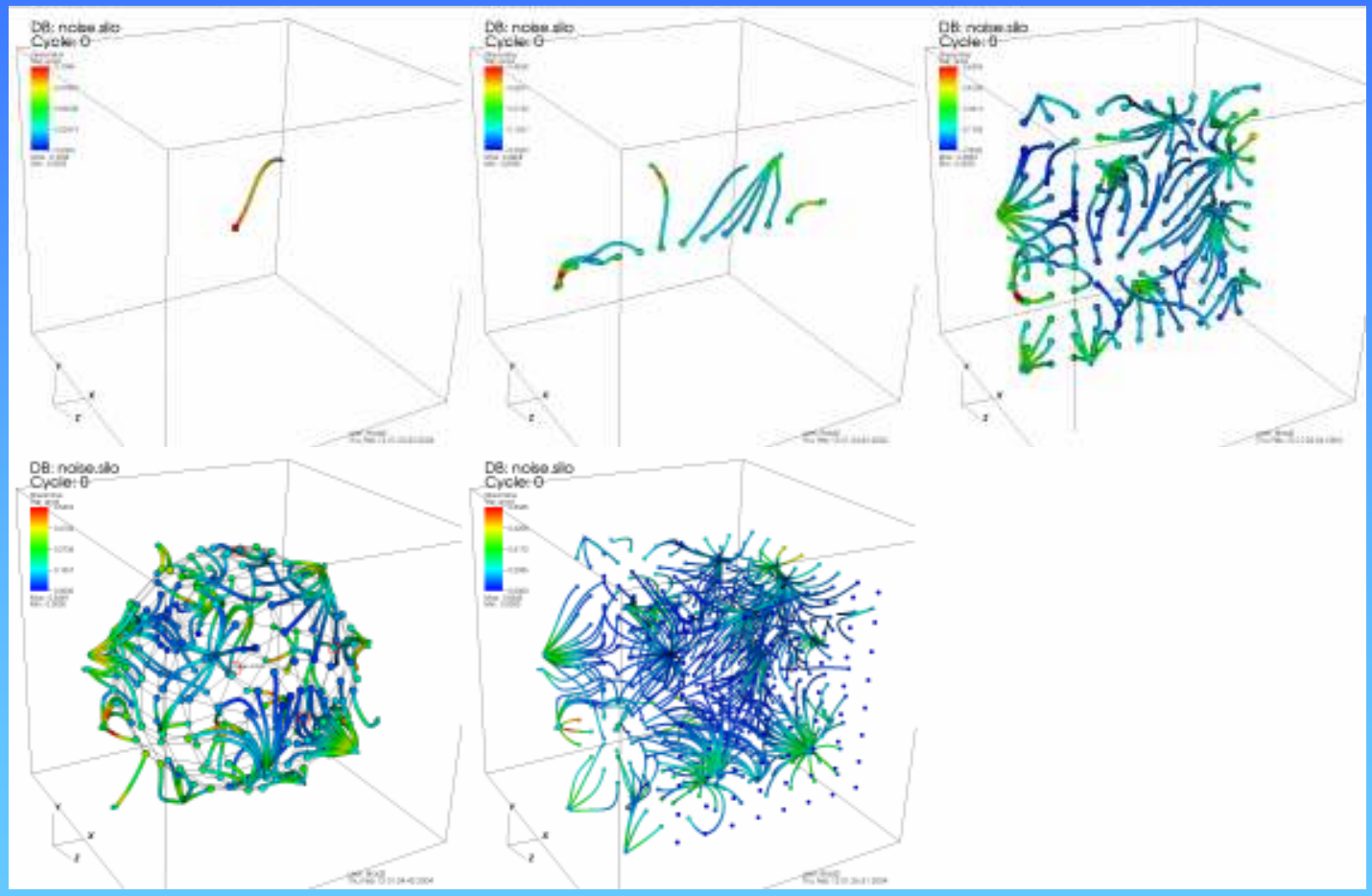
Z-value colored surface

Scatter plot

- The Scatter plot lets you use multiple scalar variables to create a point mesh, showing you relations between the variables
- 2 or 3 scalars can be used to create coordinates for points
- 1 additional scalar may be used to color the points

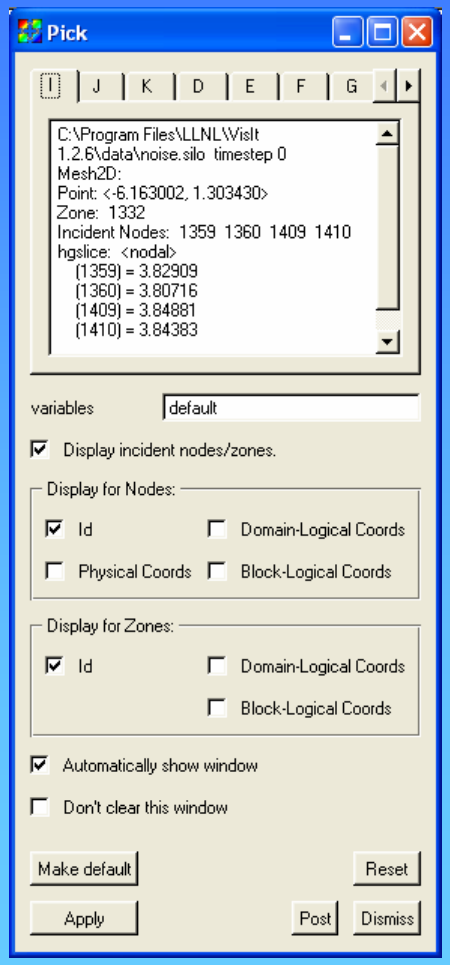


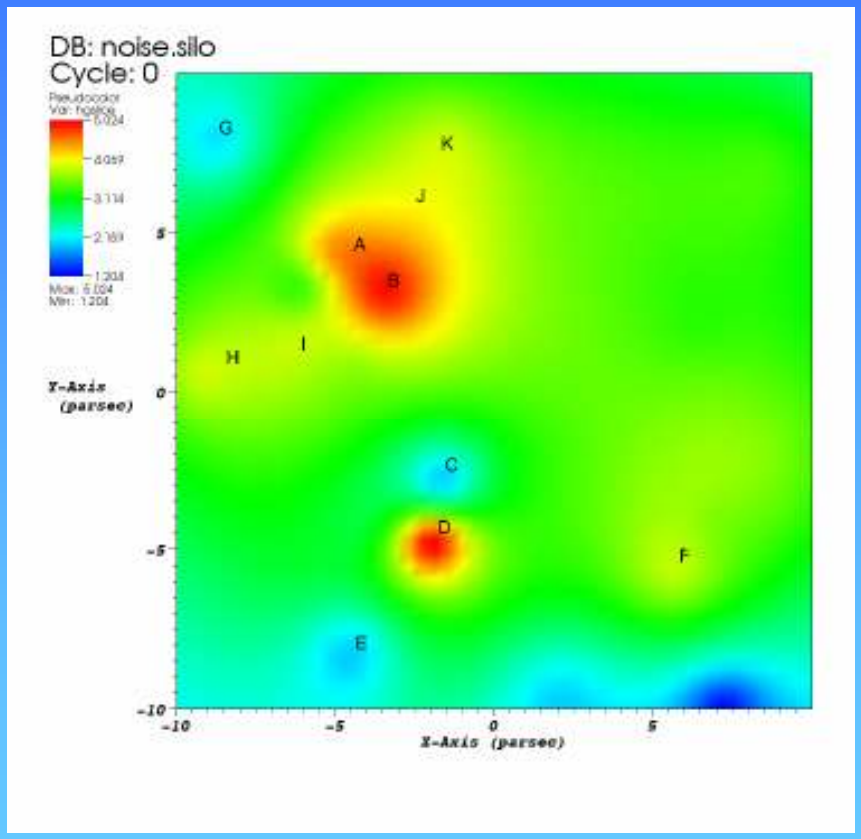
Streamline Plots



Pick

Each pick point leaves a marker that you can use to match with the pick information displayed in the Pick window





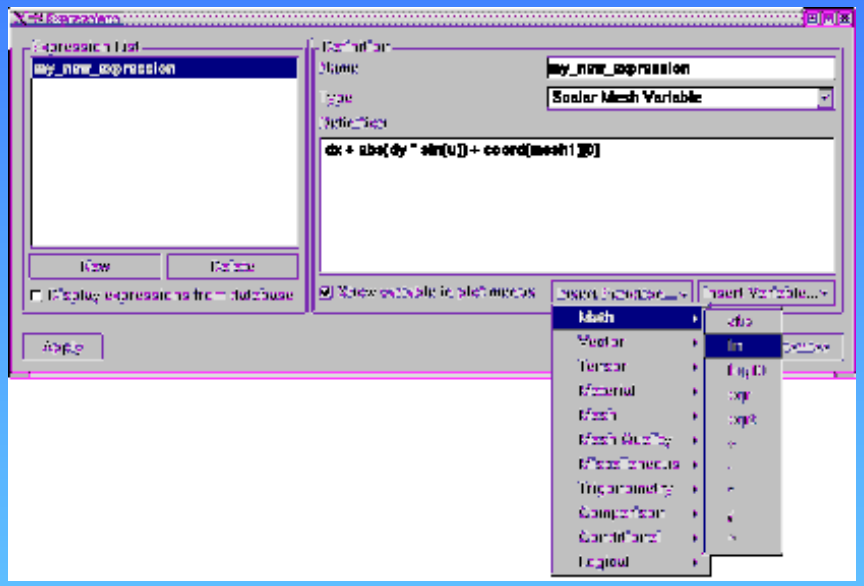
Queries

- VisIt provides queries so you can compute values about
  - An entire database
  - A plot
  - A point in a database
  - A linear path through a database
- Pick and Lineout are queries
  - Use Query window to precisely specify pick point or lineout endpoints
  - Lineout query can create curves for 3D data

Queries	
Zonepick	Revolved volume
Nodepick	Revolved surface area
Lineout	Surface area
Eulerian	Volume
Compactness	WorldPick
Cycle	WorldNodePick
Time	Variable by zone
L2Norm	Plot MinMax
Integrate	Spatial extents
L2Norm between curves	PickByZone
Area between curves	PickByNode

Creating expressions

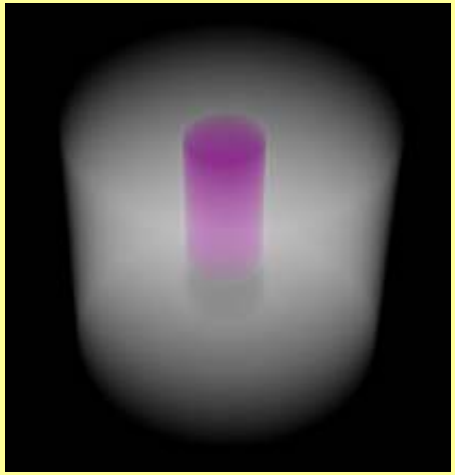
Expression	Description	Example
-	Unary negation	-a
+	Addition	A + b
-	Subtraction	A – b
*	Multiplication	A * b
/	Division	A / b
^	Exponentiation	a ^ b
sin	Sine	sin(a)
cos	Cosine	cos(a)
tan	Tangent	tan(a)
deviatoric_stress	Deviatorc stress	deviatoric_stress(a)
asin	Arcsine	asin(a)
acos	Arccosine	acos(a)
abs	Absolute value	abs(a)
ln	Natural log	ln(a)
log, log10	Log_{10}	log(a)
sq, sqr	Square	sqr(a)
sqrt	Square root	sqrt(a)



Expression window

VisIt in Recent As-Built Modeling Analysis

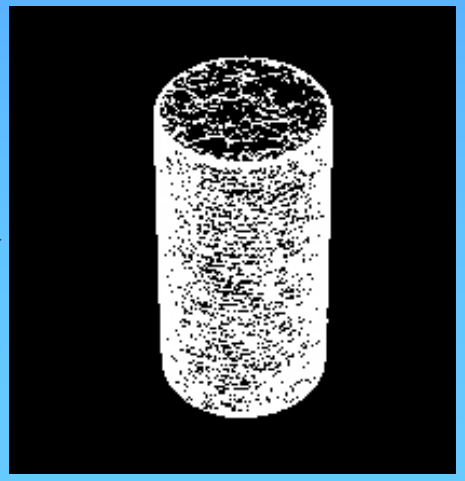
CT data



Segmentation

Extracting boundaries

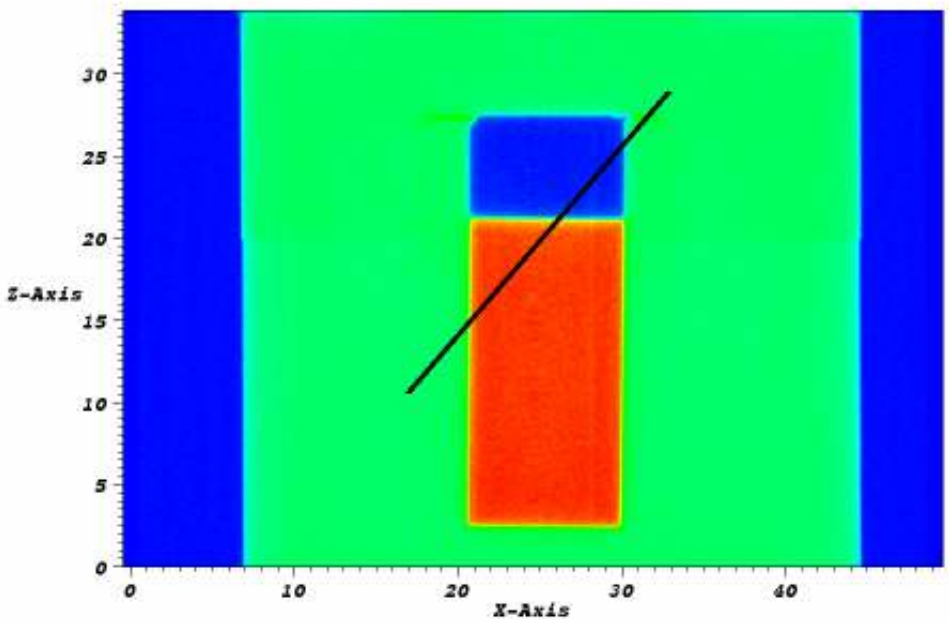
Smoothing & Decimation



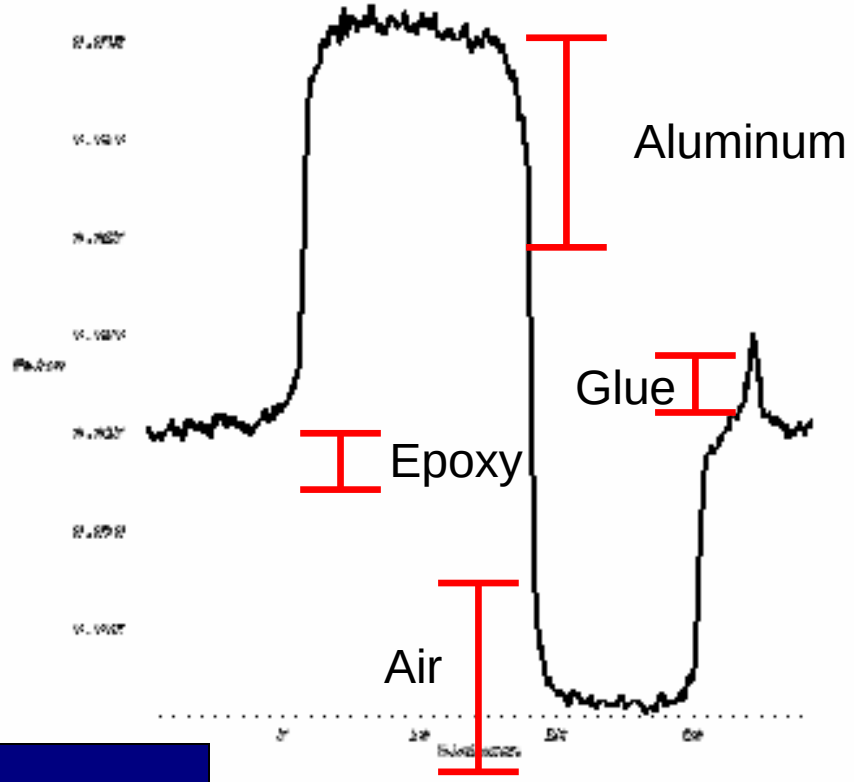
Mesh Generation

Segmentation using spatial & data ranges.

- First step is to identify data ranges for each material.
- Bounding box needed to isolate air inside epoxy.



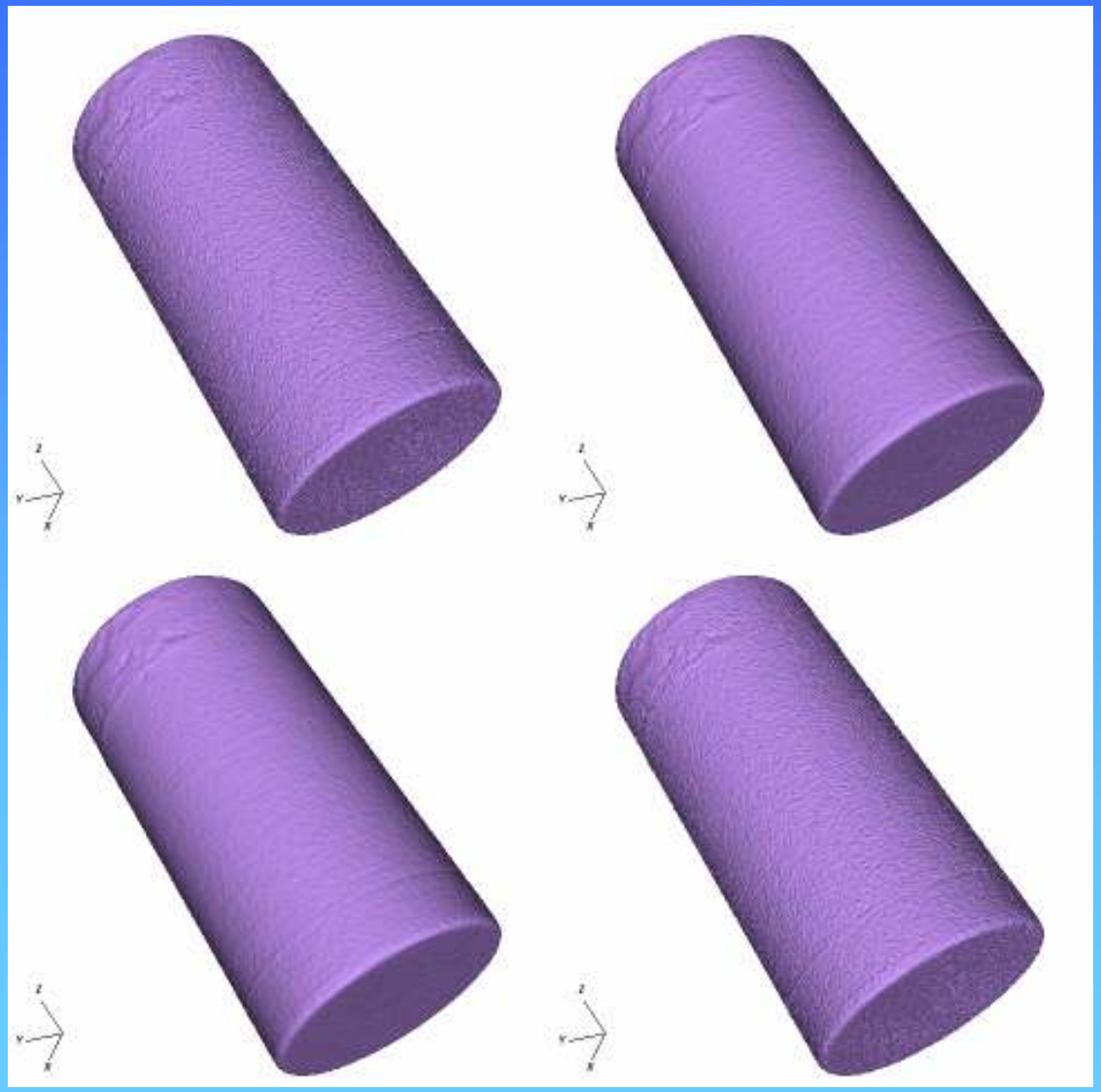
Plotting cross section of volume



Epoxy and Cellulose are indistinguishable using CT data.

Examples of Some of VisIt's Image Processing Filters

Conservative Smoothing



Median Filter

Mean Filter

No Smoothing

Summary

- Open Source Visualization & Analysis Tool
- Reads many formats & easily extended
- Many features for 2D/3D Image Data
- http:www.llnl.gov/visit