OpenDX, abbreviated for CS 553

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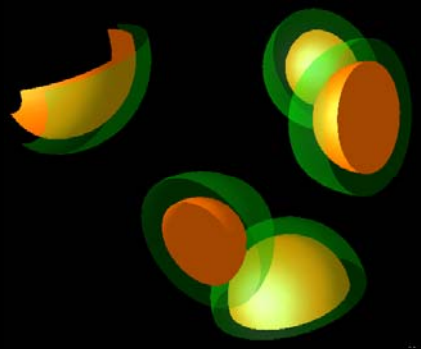
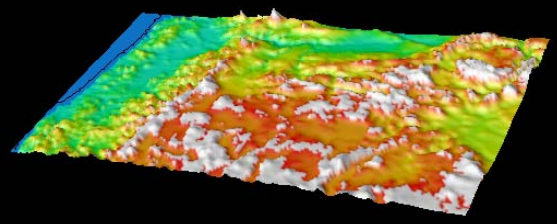
Oregon State University





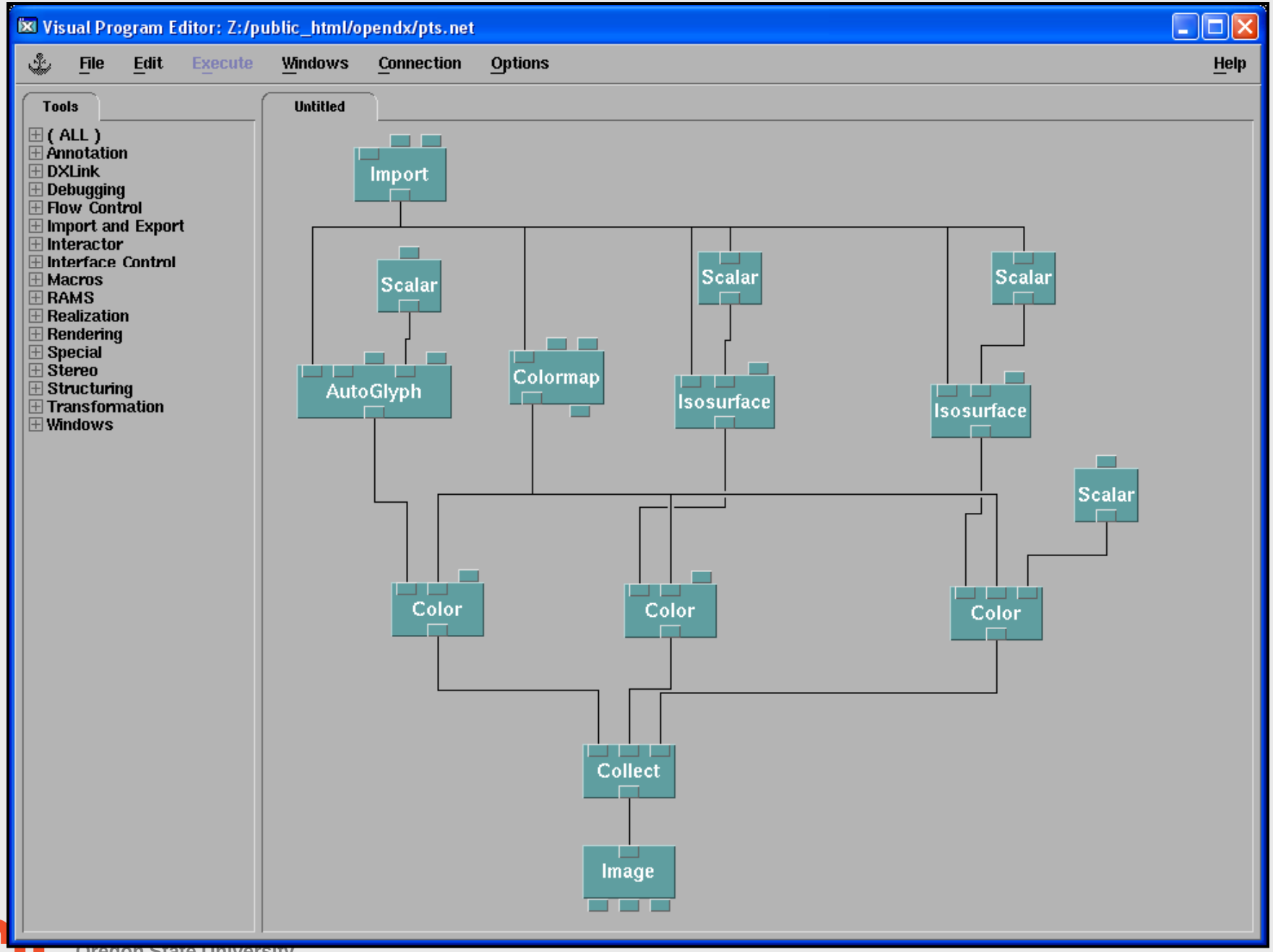
OpenDX

- Started out life as *IBM Visualization Data Explorer*
- When the product was cancelled, IBM put it into Open Source and renamed it *OpenDX*
- Basic premise is a series of interconnected modules, living together in an environment called the Visual Program Editor (VPE)
- There are lots of provided modules
- You can also write your own

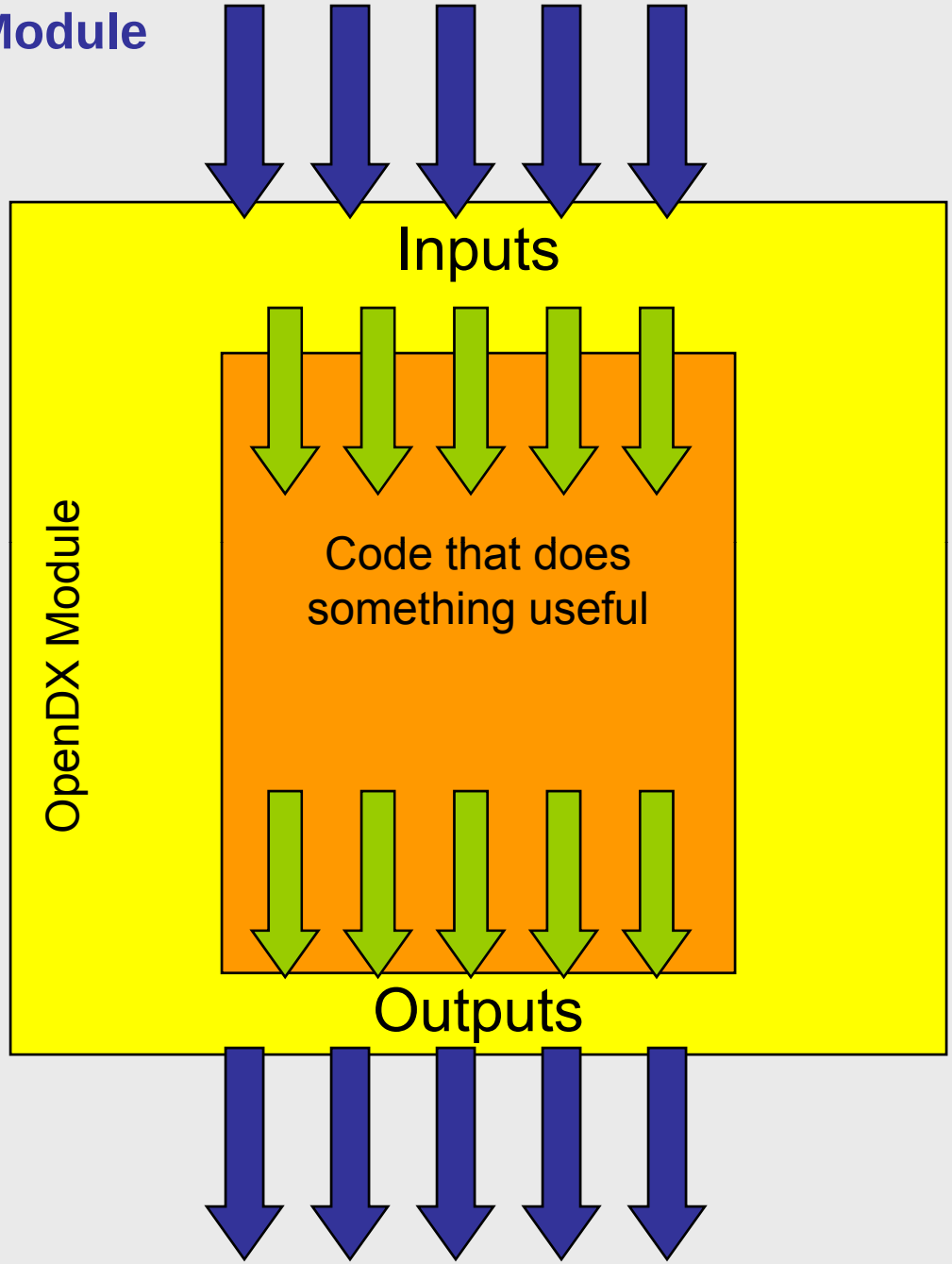
http://www.opendx.org

http://www.vizsolutions.com

http://cs.oregonstate.edu/~mjb/opendx


Visual Program Editor: Z:/public_html/opendx/pts.net
File
Edit
Execute
Windows
Connection
Options
Help
Tools
(ALL)
Annotation
DXLink
Debugging
Flow Control
Import and Export
Interactor
Interface Control
Macros
RAMS
Realization
Rendering
Special
Stereo
Structuring
Transformation
Windows
Untitled
Import
Scalar
Scalar
Scalar
AutoGlyph
Colormap
Isosurface
Isosurface
Scalar
Color
Color
Color
Collect
Image

The Structure of an OpenDX Module



Steps in Creating a Visualization

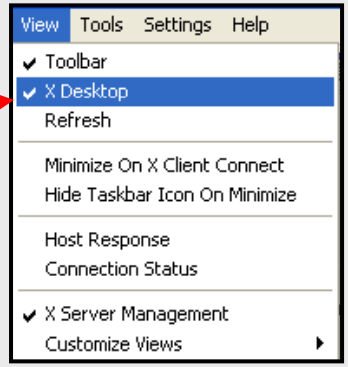
Seven Steps to Creating a Visualization

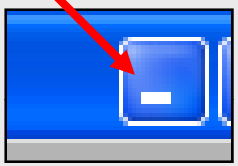
1. **Get the data**
2. **Formulate a scientific strategy. What do you want to show? How do you want to show it?**
3. **Import the data**
4. **Create a *simple* OpenDX network**
5. **Incrementally embellish the network. Save it often!**
6. **Choose what quantities you want to interact with. Change the Interactor styles to match the quantities being modified.**
7. **Create the output.**

Starting OpenDX in OSU's Computer Graphics Education Lab

Starting OpenDX on the OSU CGEL Systems

1. Start → All Programs → WRQ Reflection → Reflection X
2. In the *View* menu, click off *X Desktop*
3. Minimize the Reflection X window (the _ in the upper right corner)
4. Start → All Programs → OpenDX → DX



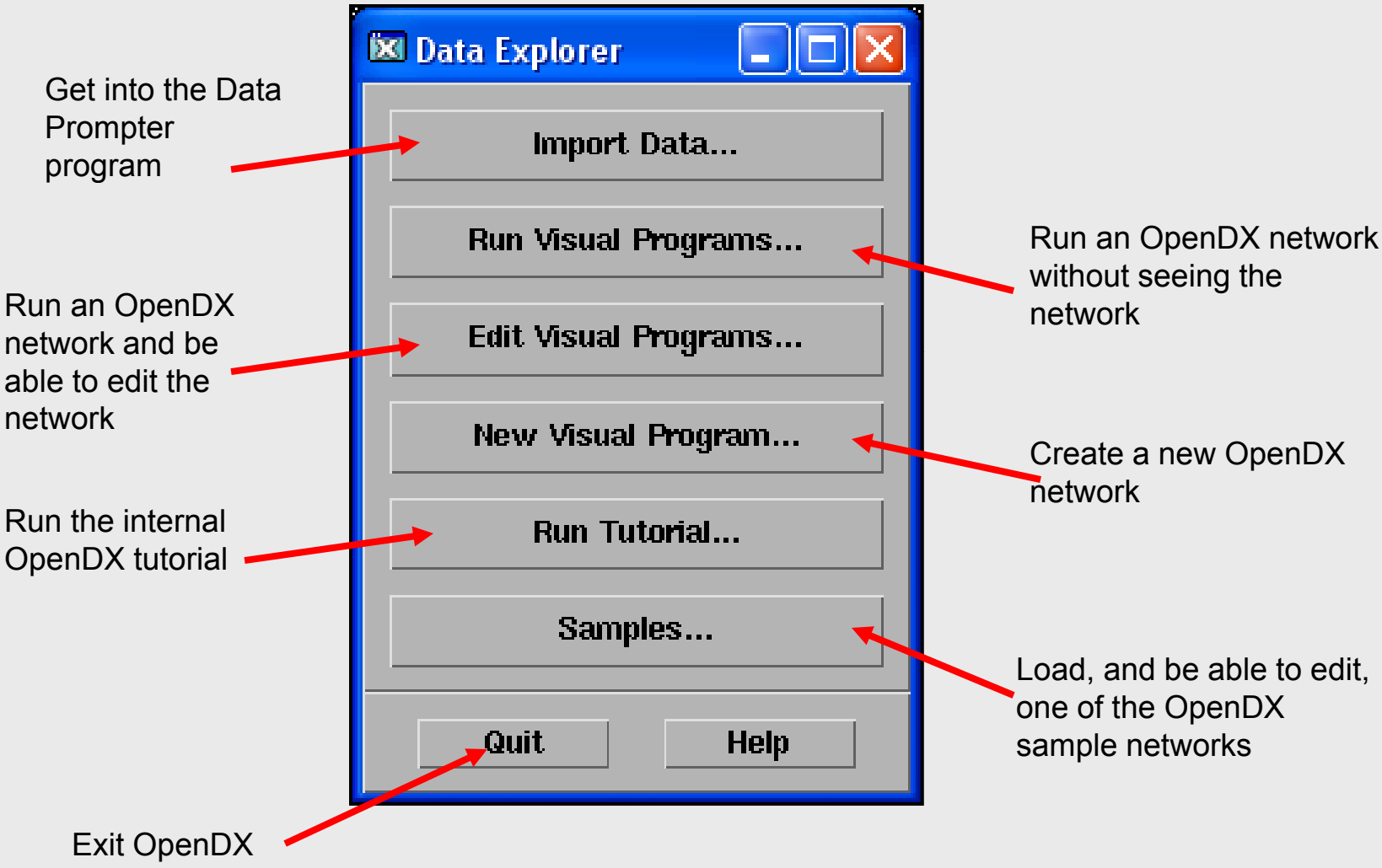


Quitting OpenDX on the OSU CGEL Systems

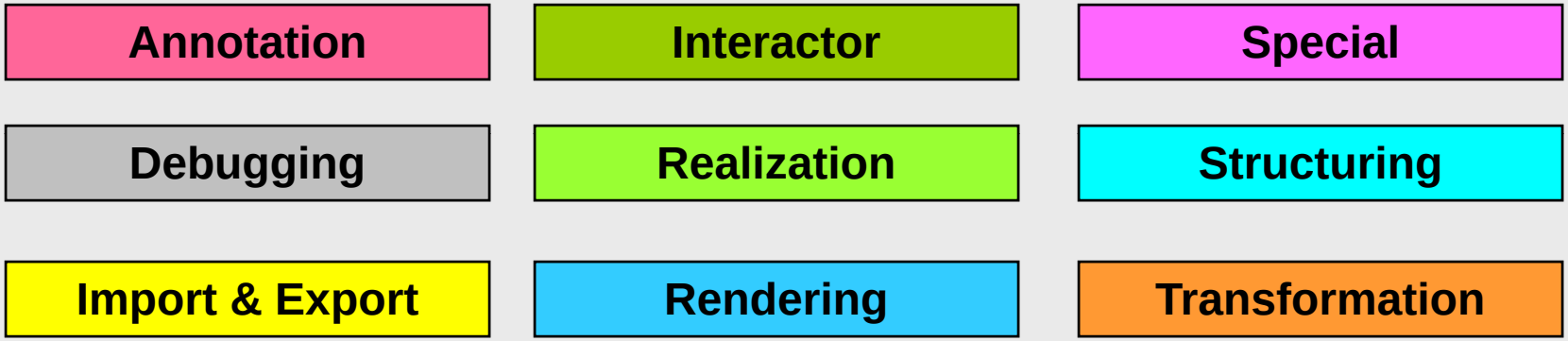
1. Select *Quit* from the OpenDX Main Menu
2. Maximize the Reflection X window by clicking here in the Task Bar
3. In the *File* menu, select *Exit*

The OpenDX Main Menu and Categories of Modules

The OpenDX Main Menu



Nine Categories of OpenDX Modules



Annotation OpenDX Modules

- AutoAxes – creates an axis box for whatever data you are plotting
- AutoGlyph – designs and produces glyphs for the data based on the data values
- Caption – creates caption text for an image
- ColorBar -- creates a colorbar to be displayed
- Format – creates a string from a number (used to create file names)
- Glyph – produces an identical glyph for every point in the data
- Legend – produces a legend to be displayed
- Plot – creates a 2D plot
- Ribbon – creates a flow field ribbon
- Text – displays text in 3D space
- Tube – creates a flowfield tube

Debugging OpenDX Modules

- Describe – describes an object
- Print – prints information about a field to the Message Window

Import & Export OpenDX Modules

- Export – writes data from OpenDX into a file
- Import – reads data into OpenDX from a file
- ImportSpreadsheet – reads data into OpenDX from a tabular file
- Include – includes or excludes points in a field based on their data values
- ReadImage – reads an image into OpenDX from a file
- Reduce – filters and resamples a field into a lower resolution
- Refine – interpolates a field into a higher resolution
- Slab – takes a positional subset of the data
- Slice – takes a positional slice through the data
- WriteImage – writes an image from OpenDX into a file

Interactor OpenDX Modules

- FileSelector – presents a dialog box to let you select a file
- Integer – allows the user to input an integer number
- Scalar – allows the user to input a floating point number
- Selector – allows the user to select one of a number of options
- String – allows the user to input a string
- Toggle – allows the user to select one of two options
- Vector – allows the user to input a vector

Realization OpenDX Modules

- AutoGrid – maps a set of scattered points onto a grid
- Band – divides a field into bands
- Connect – creates triangle connections for scattered data points in a field
- IsoSurface – creates surfaces or lines of constant data value
- MapToPlane – projects a data field onto an arbitrary plane
- RubberSheet – deforms a surface field by the amount of the data value at each point
- ShowBox – creates a bounding box for display
- ShowConnections – displays the outline of connectivity elements in a field
- ShowPositions – displays the positions in a field
- Streakline – computes an advection path through a changing flow field
- Streamline – computes a path through a non-changing flow field

Rendering OpenDX Modules

- AmbientLight – specifies the ambient light
- Arrange – creates a single side-by-side image from a collection of images
- AutoCamera – selects a good camera view of the data
- Camera – specifies a camera view
- Display – a more elaborate image-rendering system than Image
- Image – renders and displays field data
- Light – specifies a distant (parallel) light source
- Normals – compute point or face normals for shading a surface
- Render – renders a field and creates an image
- Rotate – rotates field data
- Scale – scales field data
- Shade – specifies object-shading parameters
- Transform – performs a general matrix transform of an object
- Translate – translates field data

Special OpenDX Modules

Colormap – presents an interactive tool for specifiying color vs. data value

Receiver – receives the output of a Transmitter

Sequencer – creates an animation “VCR” display

Transmitter – “wirelessly” connects a network to a receiver

Structuring OpenDX Modules

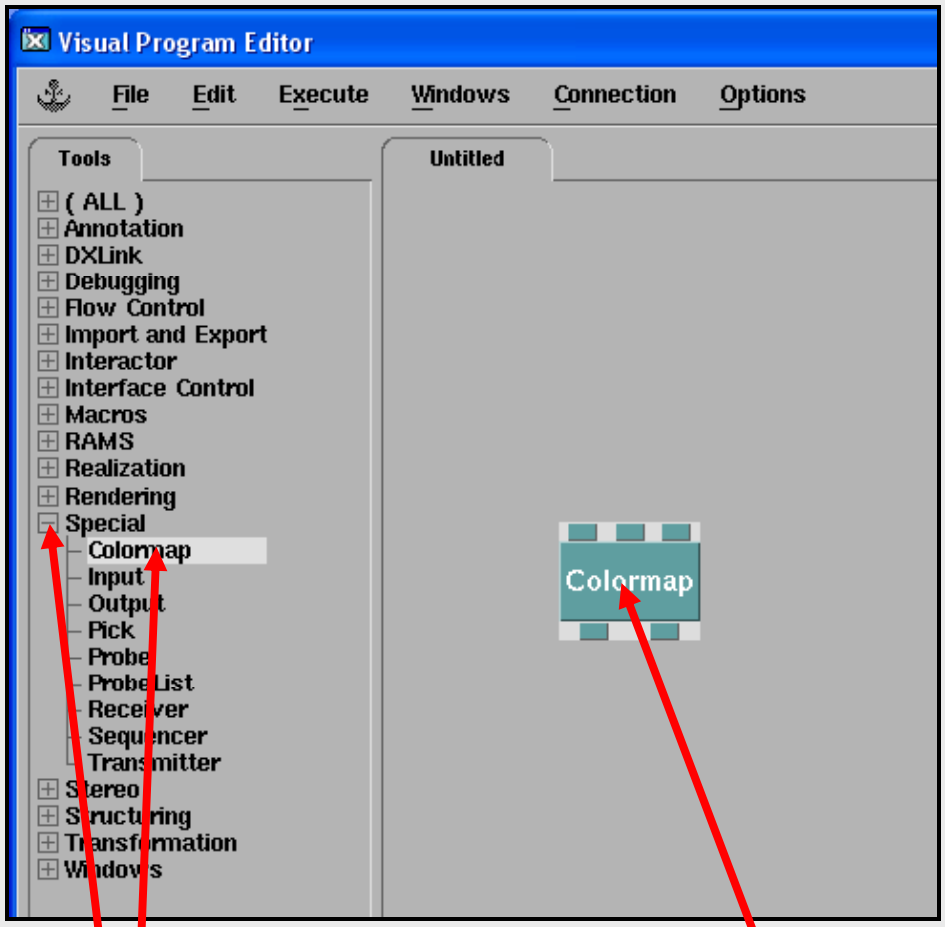
- Collect – collects objects into a group
- Inquire – returns information about a field
- Mark – marks a new field component as “data” (e.g., for Compute)
- Remove – removes a specified component from a field
- Rename – renames a specified component in a field
- Unmark – undoes the effects of Mark

Transformation OpenDX Modules

- AutoColor – automatically color a data field (blue→green →red)
- Color – assign a color by name of by RGB values
- Compute – perform point-by-point arithmetic on a field's "data" component
- DivCurl – computes the divergence and curl of a flow field
- Equalize – apply histogram equalization to a field
- Gradient – computes the gradient of a scalar field
- Histogram – creates a histogram that can be rendered with Plot
- Map – projects one field's data onto another field's geometry
- Measure – calculates surface area and volume of a geometry (e.g., isosurface)
- SimplifySurface – reduces the size of the triangular mesh
- Statistics – computes the mean, standard deviation, variance, minimum, and maximum of a field's data

Adding and Connecting Modules

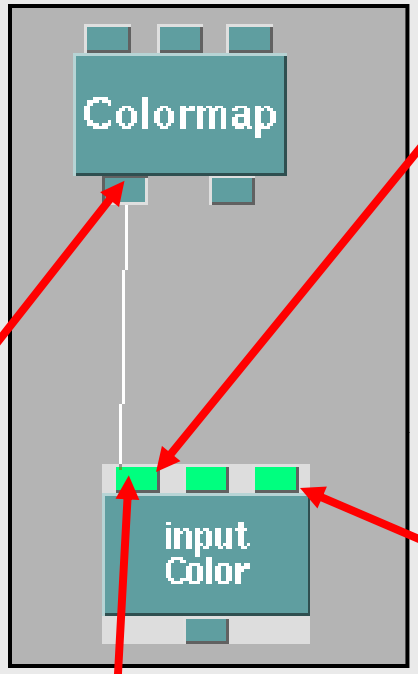
Adding a Module into the Visual Editing Area



It's not drag-and-drop, it's click-and-click

1. Left-click on the module category to list its modules.
2. Left-click on the module you want to add
3. Move the cursor into the Editing Area and left-click

Connecting Modules in the Visual Editing Area



If an input tab is in the "up" position, you are allowed to try to connect to it.

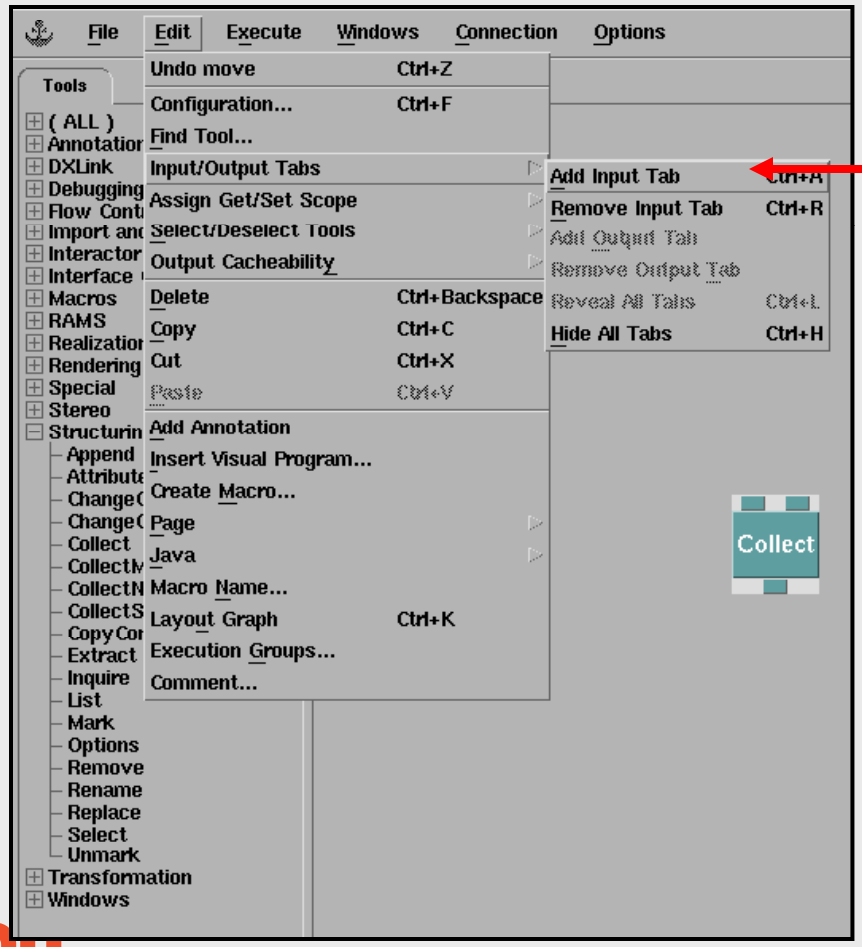
If an input tab is "down", then it has already been set to a constant within the module itself, and cannot take an external connection until that constant has been un-set.

Just because an input tab is up, however, doesn't mean that this input is data-compatible with the output you are trying to connect to it. Data-compatability is indicated by the input tab(s) turning bright green.

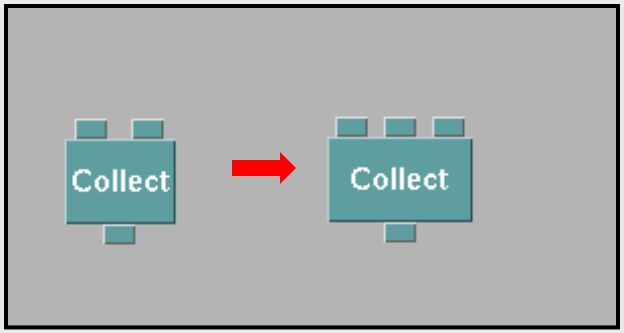
This, however, still doesn't imply that the connection makes logical sense. ☺

1. Left-click on the output tab of the module you are connecting from
2. Keeping the left button down, drag to the input tab of the module you are connecting to
3. When you get close, the tabs to which a connection make sense will highlight in green
4. Move the cursor on top of the tab you want to connect to, and release the left mouse button
5. To disconnect, reverse the process. Click on the input tab and drag back to the output tab.

Some Modules Can Have Variable Numbers of Tabs



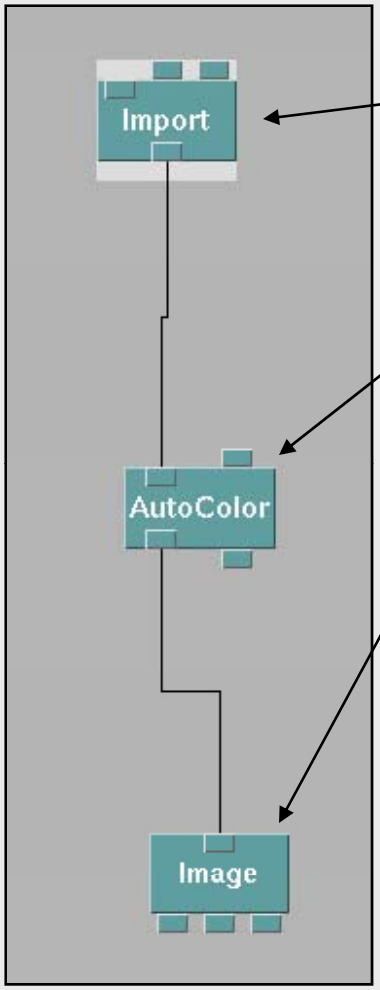
Edit→Input/Output Tabs→Add Input Tab



Collect **and** ***Compute*** **are two common modules that work this way**

Terrain Visualization

Terrain Visualization

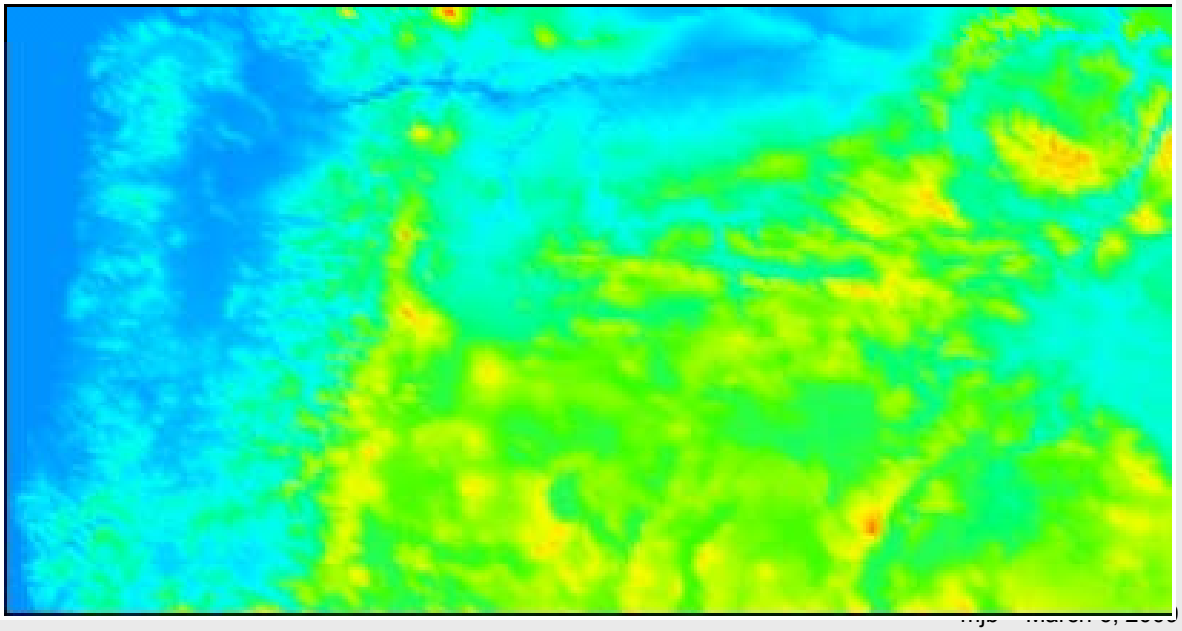


Import/Export

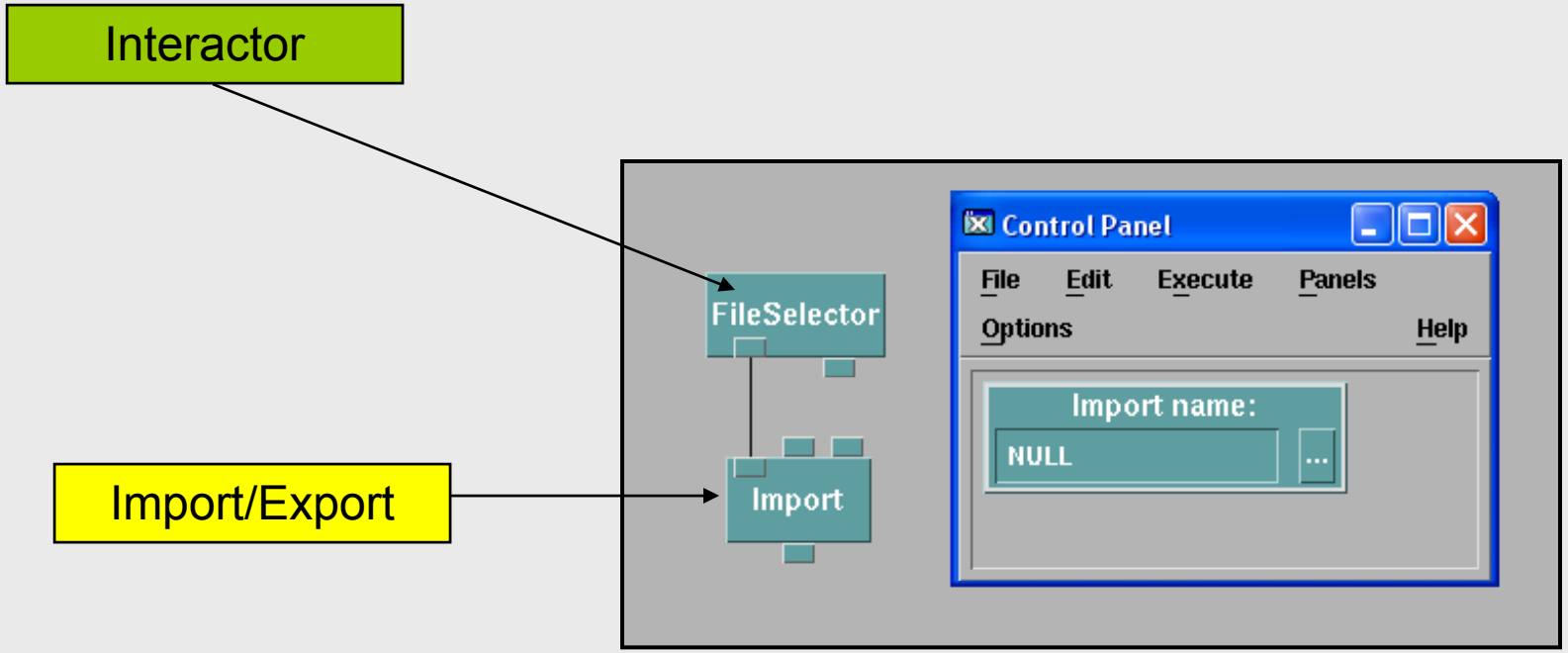
Transformation

Rendering

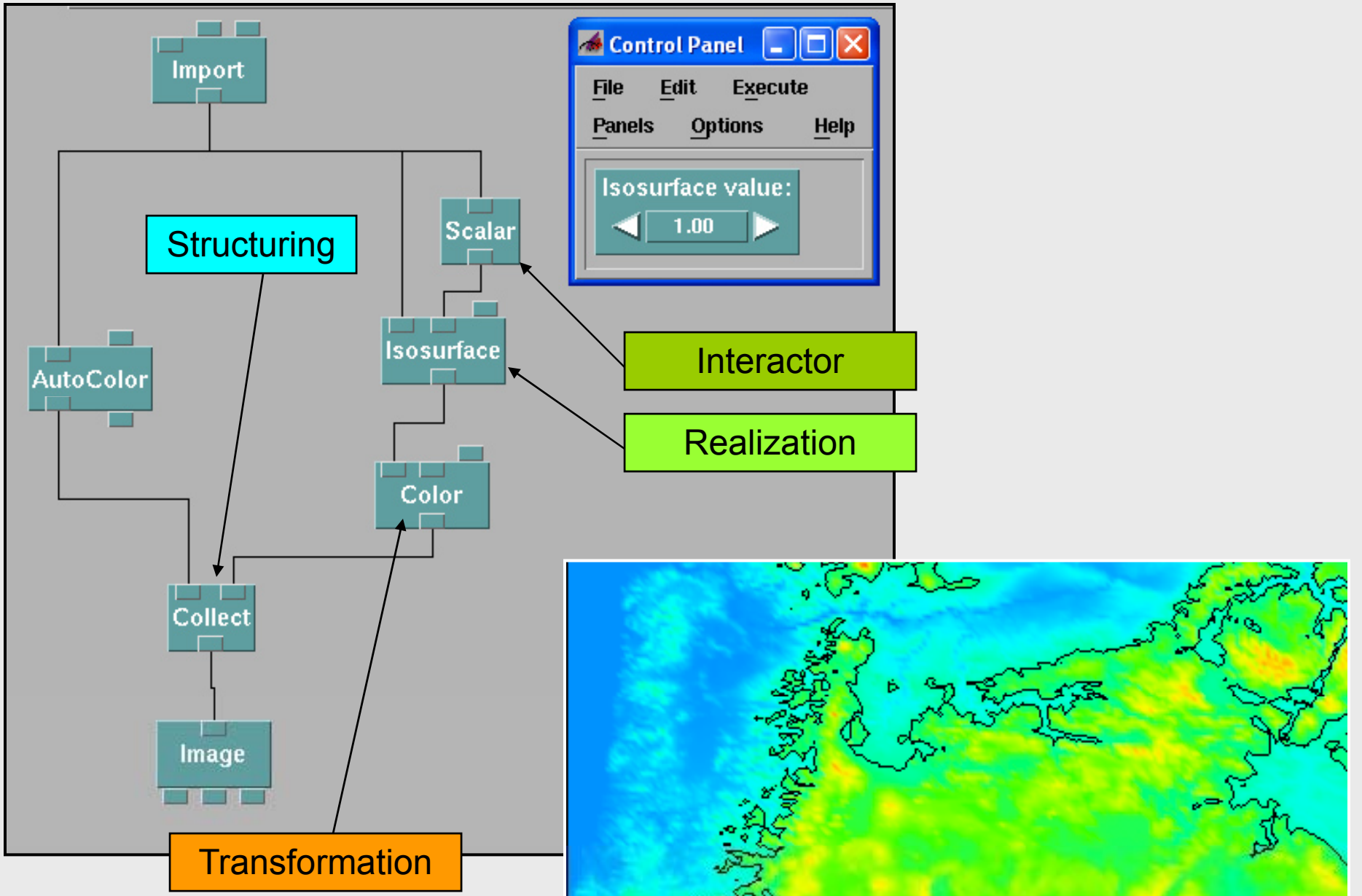
Start simply, then embellish !



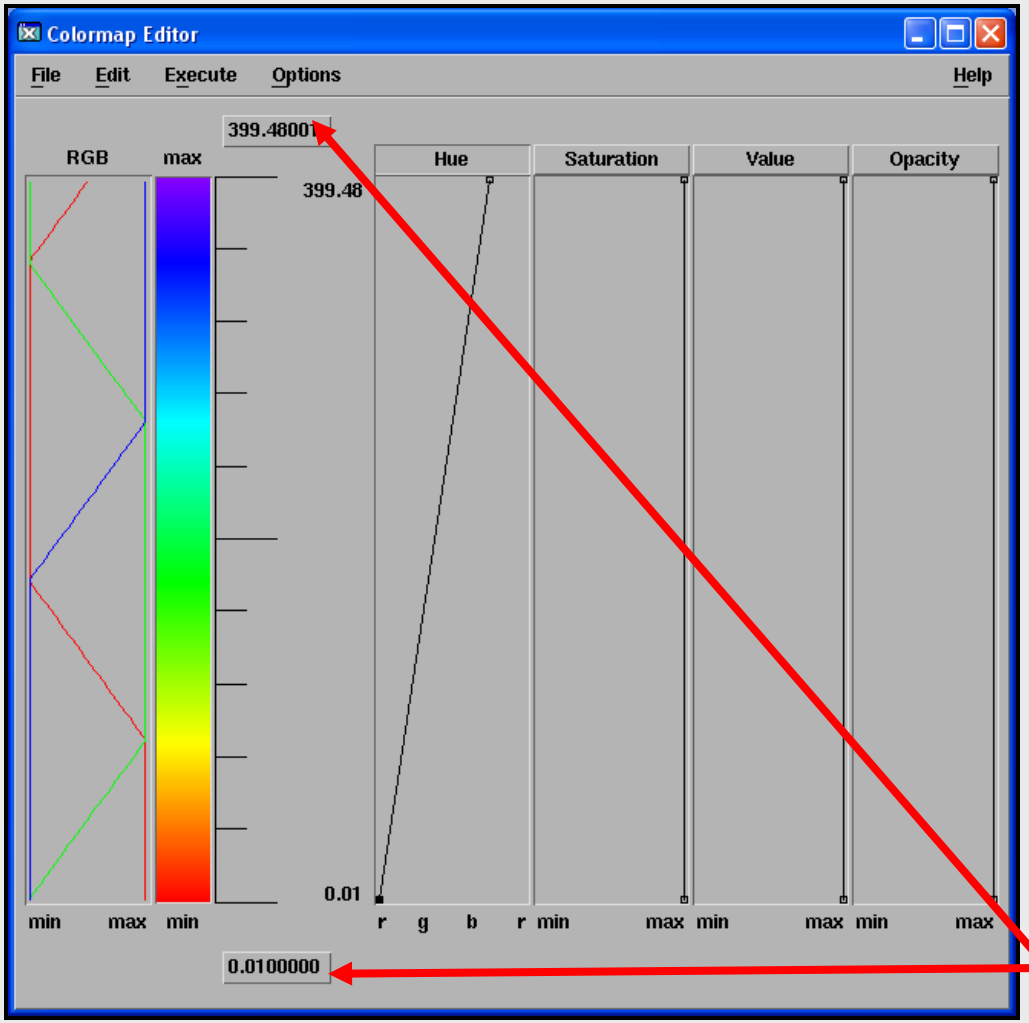
The Import and FileSelector Modules

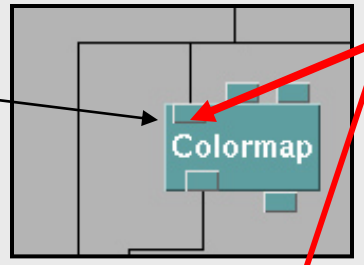


You can type a filename into the Import module, but hooking in a FileSelector module makes it way easier and friendlier


Import
Control Panel
File
Edit
Execute
Panels
Options
Help
Isosurface value:
1.00
Structuring
Scalar
Isosurface
AutoColor
Interactor
Realization
Color
Collect
Image
Transformation

The Colormap Editor Module

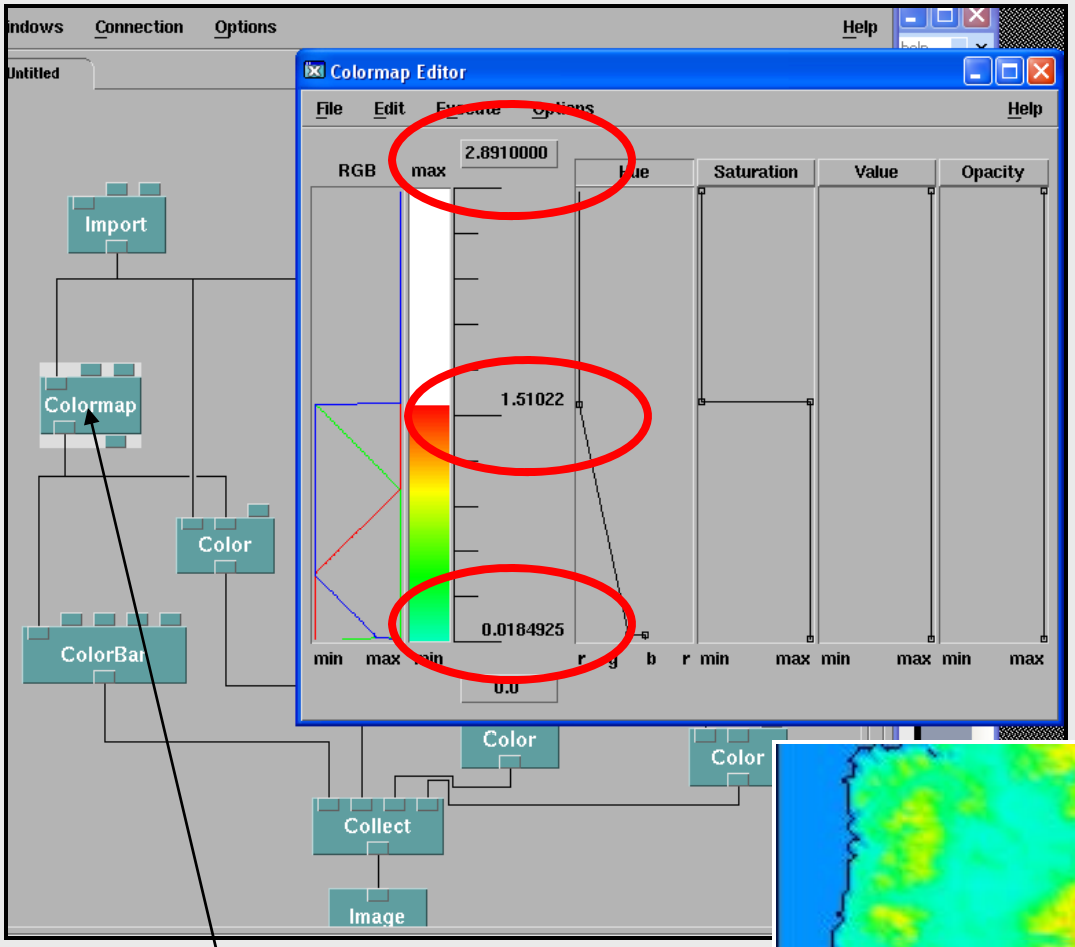


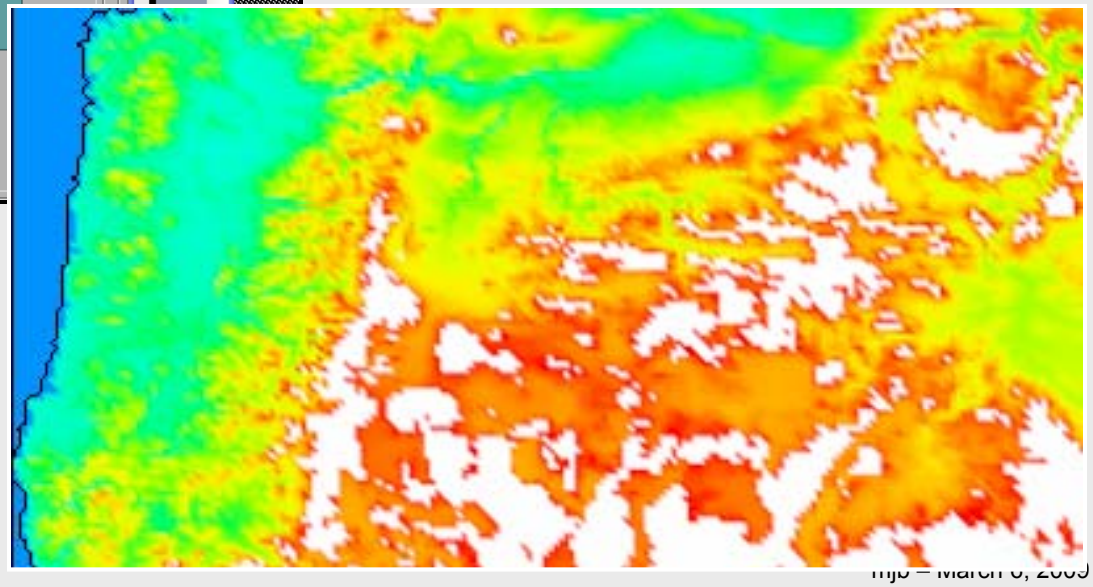


- The first input "tab" is the field input.
- Click on the Hue, Saturation, Value, or Opacity labels to edit that curve.
- Double-click on a line to add a control point there.
- Click on a control point to select it.
- Sweep a box over several control points to select them all.
- Hold down the left mouse button on a control point to move it. If several are currently selected, all will move together,
- Edit → Delete to remove selected control point(s).

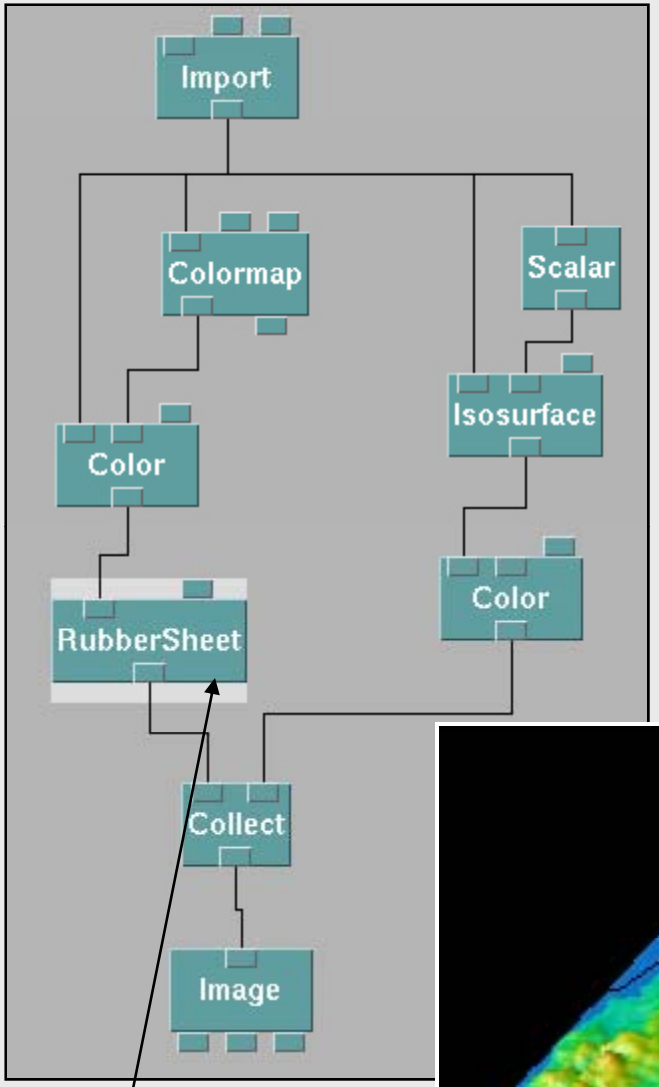
The data value range over which the colors apply is determined by scanning the data itself.

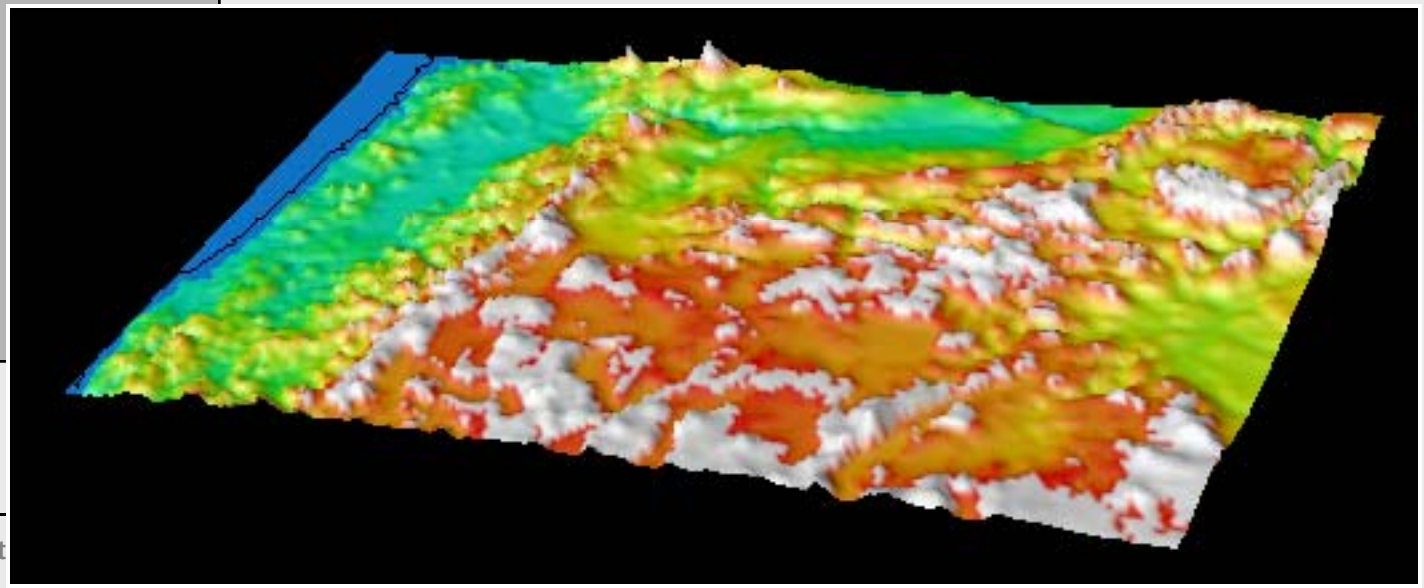
The Colormap Editor in Action





Rubbersheeting the Terrain Surface





The Image Window

Image Window Options

The *AutoAxes* option has many ways to embellish the visualization with axes, labels, grids, etc.

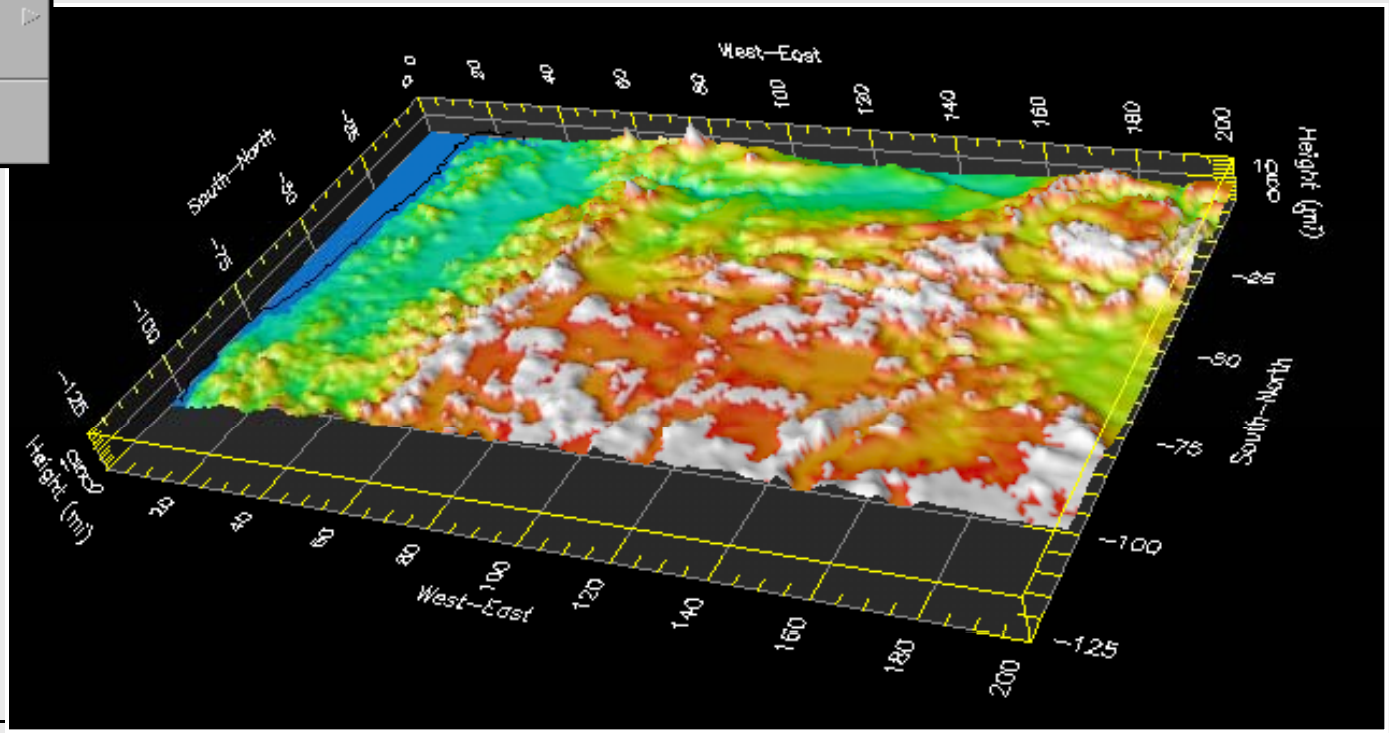


Image Window Options

The *Mode* option lets you set what scene transformation the mouse will perform.

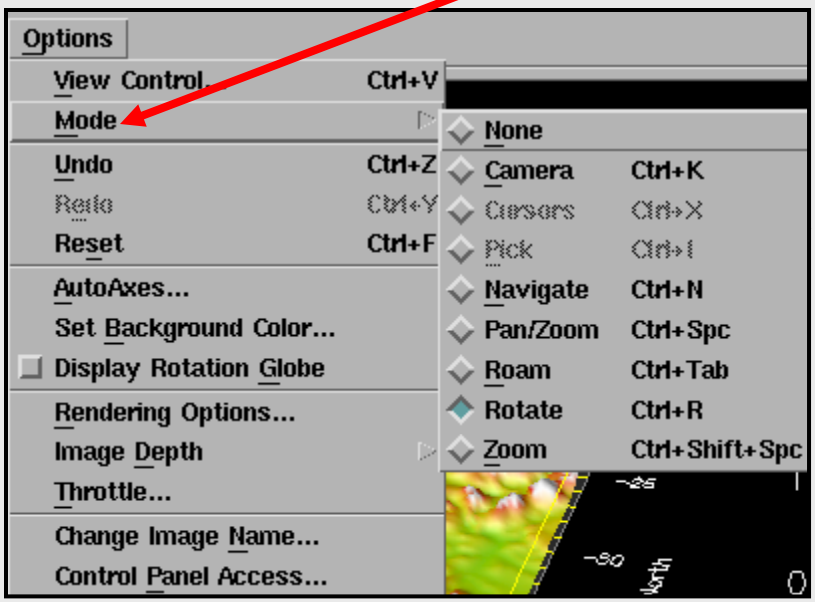
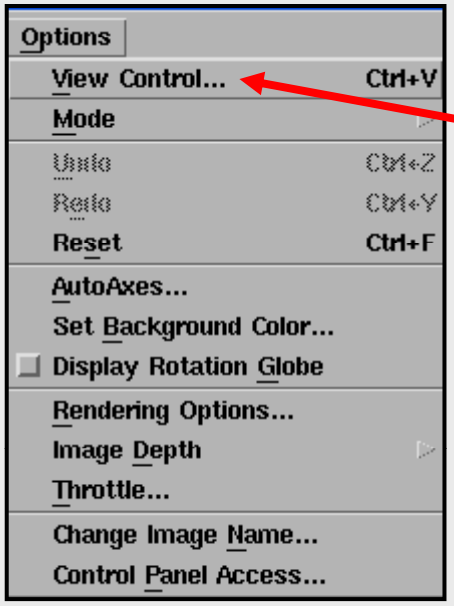
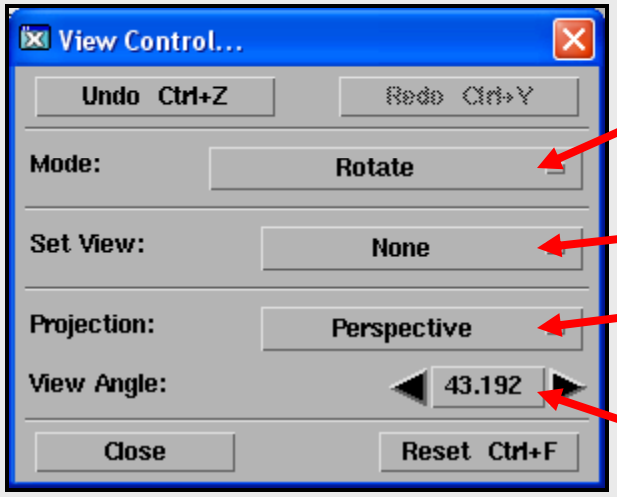


Image Window Options



The *View Control* option lets you set various aspects of how the scene will appear.



Same as the *Mode* option

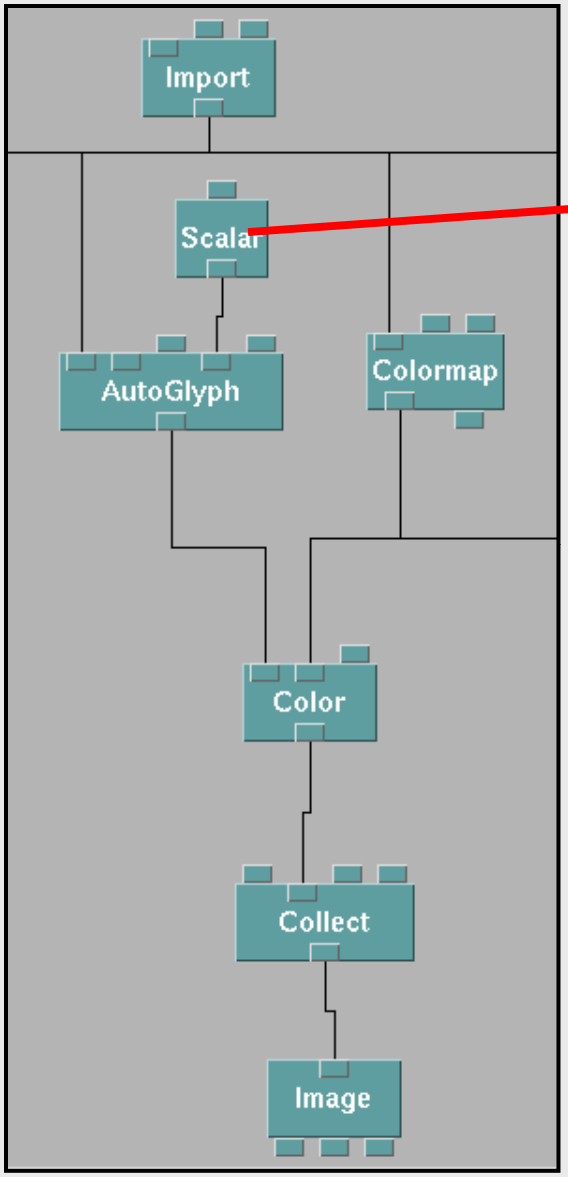
Set a pre-defined view

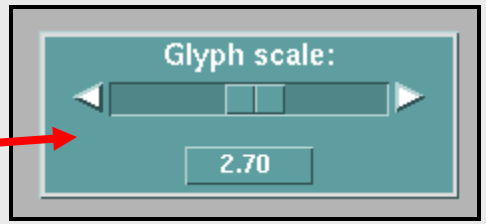
Specify Perspective or Orthographic 3D projection

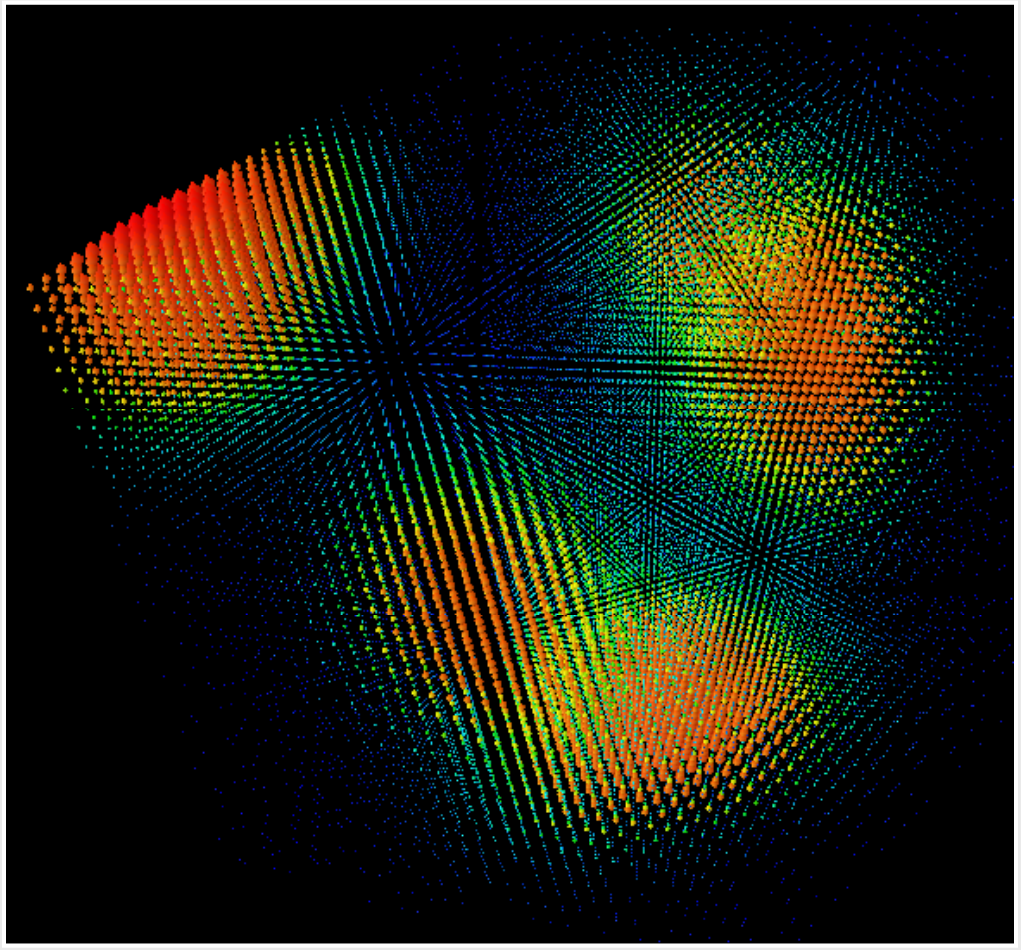
If using Perspective, this specifies the field-of-view angle. The larger this number, the more severe the perspective will be.

Scalar Visualization

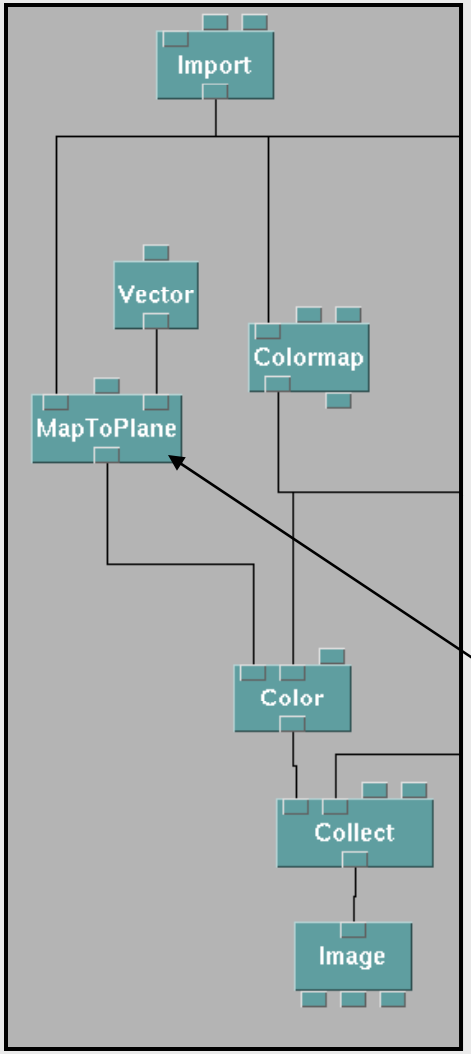
Glyphs


Import
Scalar
AutoGlyph
Colormap
Color
Collect
Image


Glyph scale:
2.70

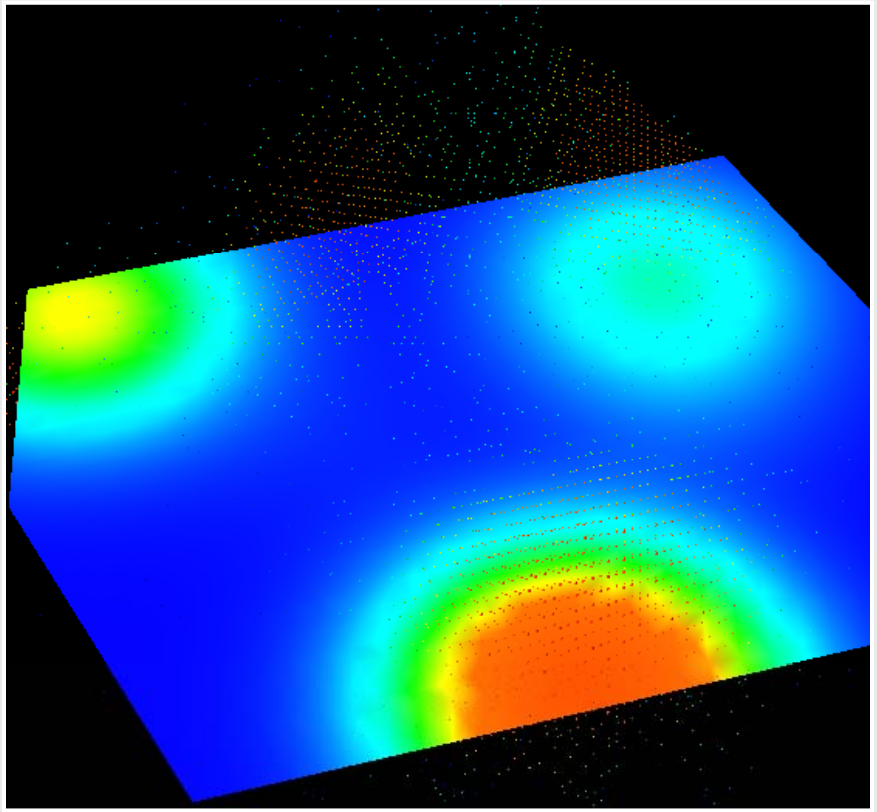


3D Cutting Plane – Interpolated Colors

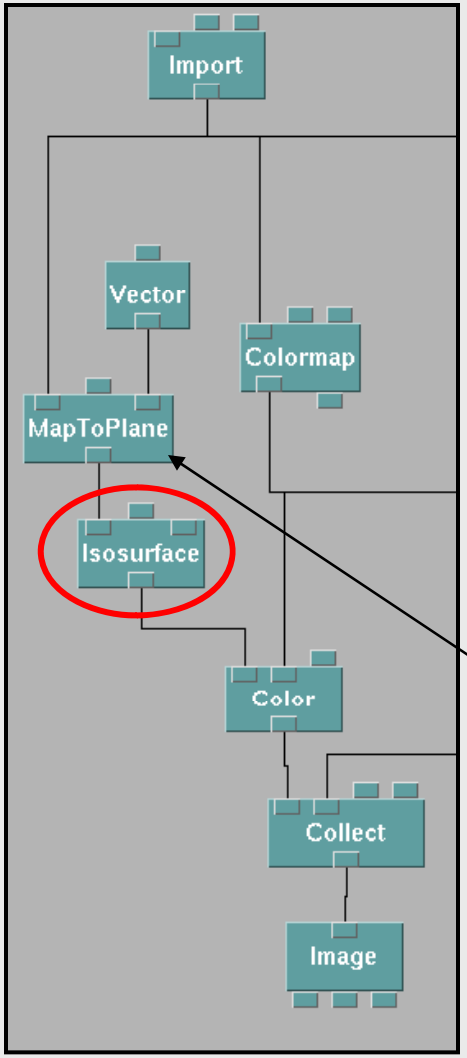


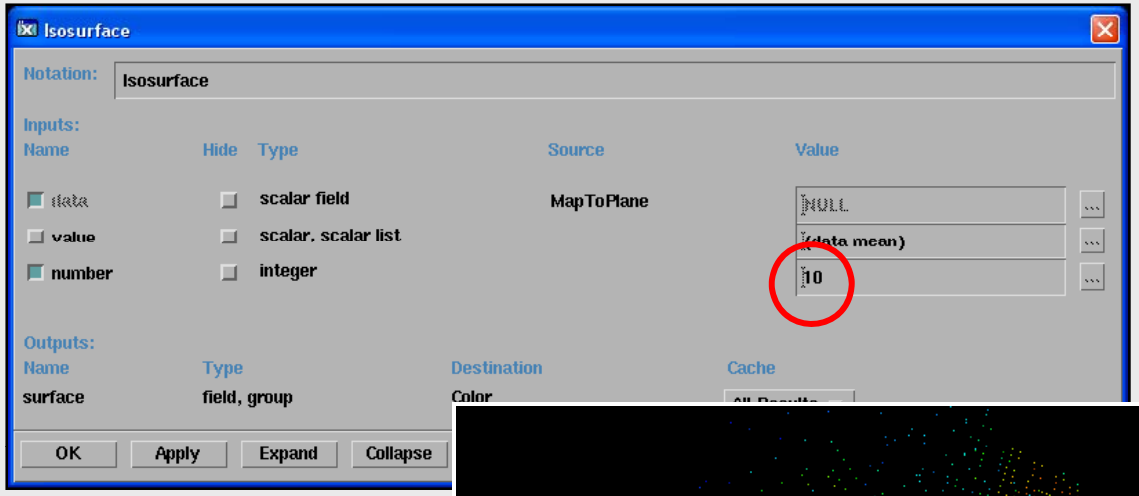
Realization

MapToPlane interpolates the 3D field onto the given plane. The first argument is the field, the second is a 3D point on the plane, and the third argument is a 3D normal to the plane.

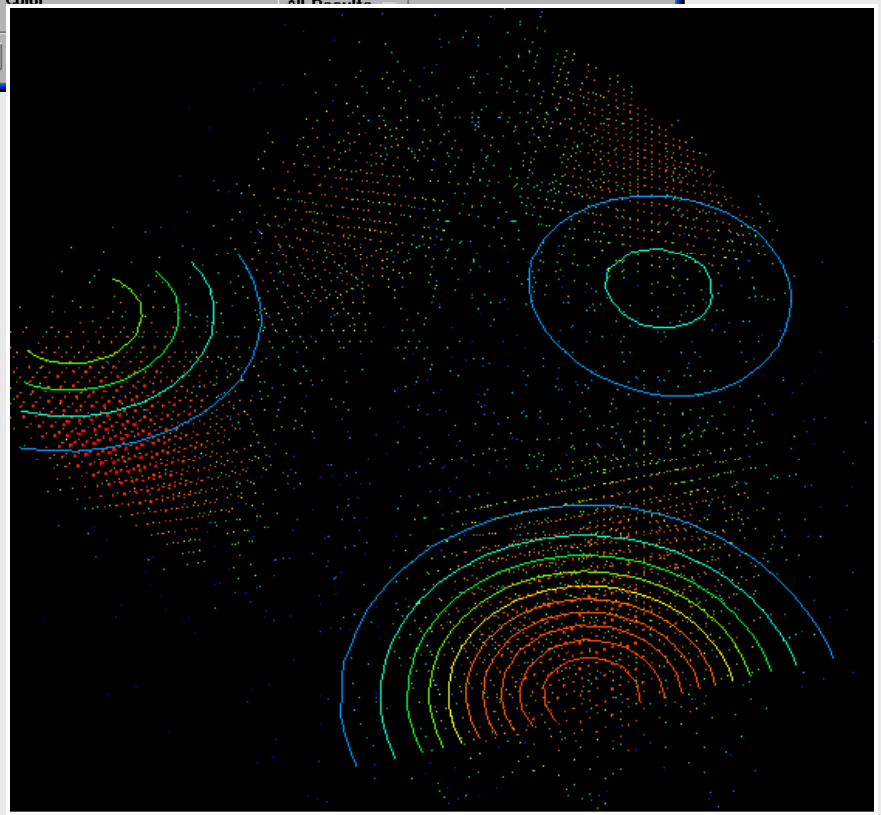


3D Cutting Plane – Contours

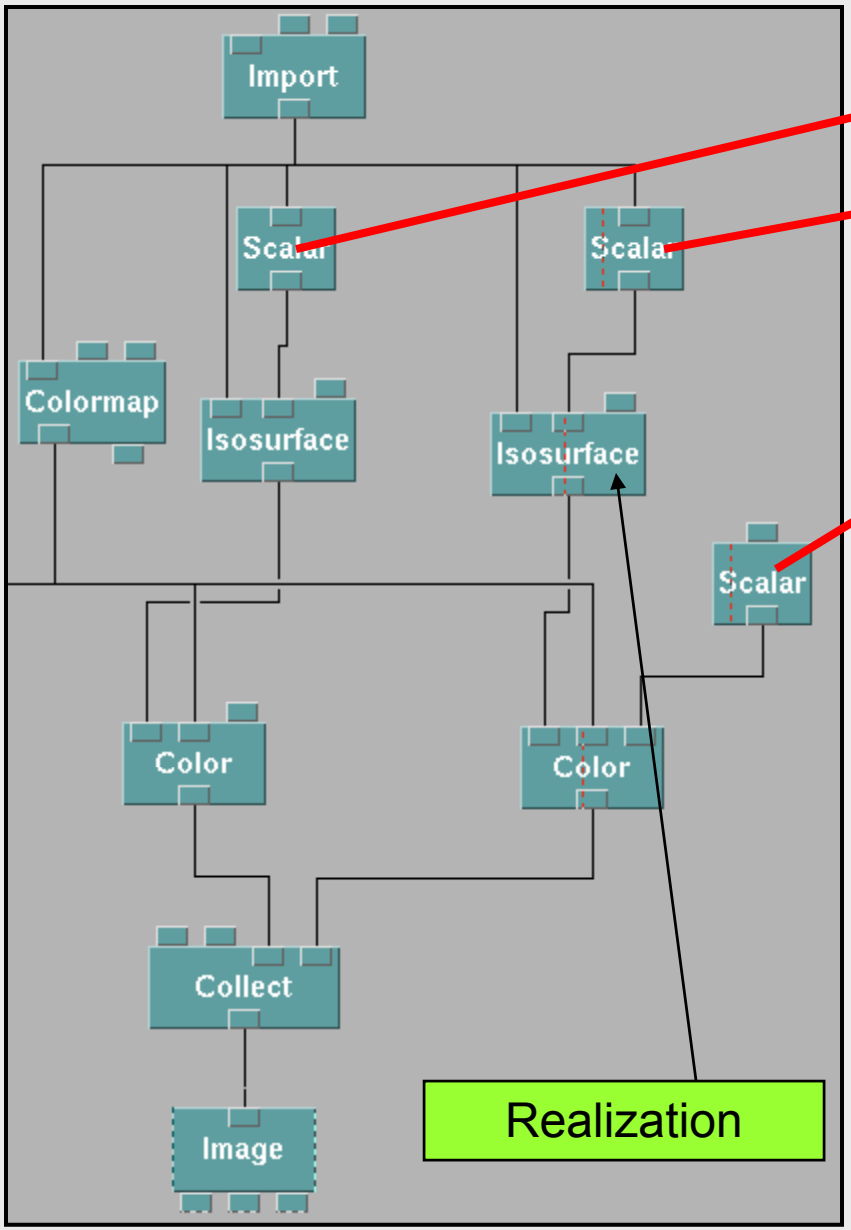


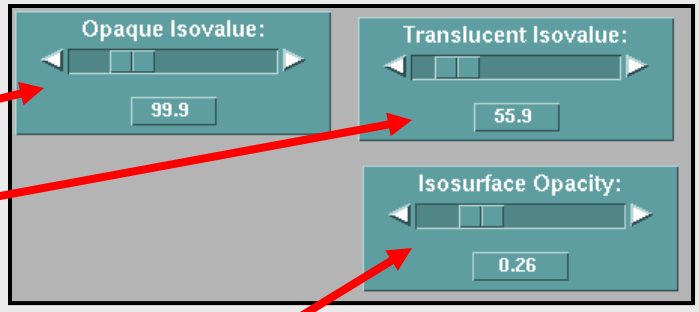


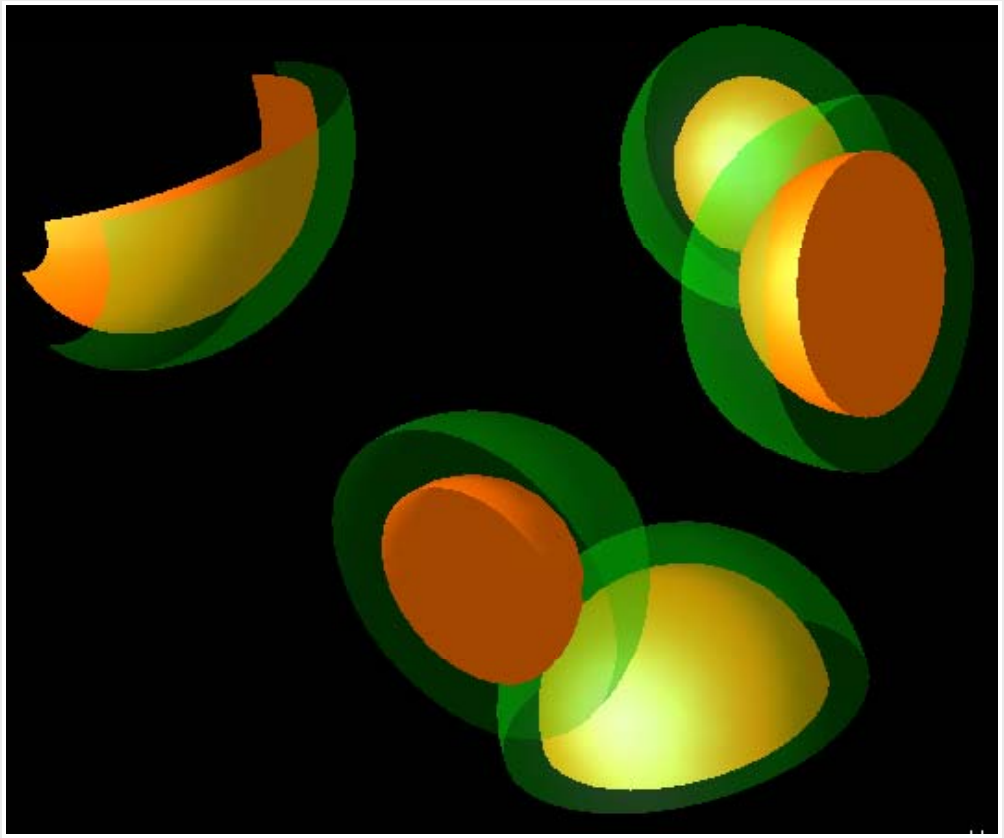
Realization



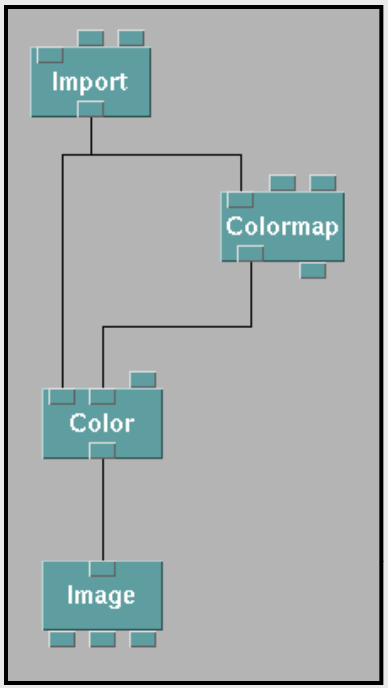
Isosurfaces







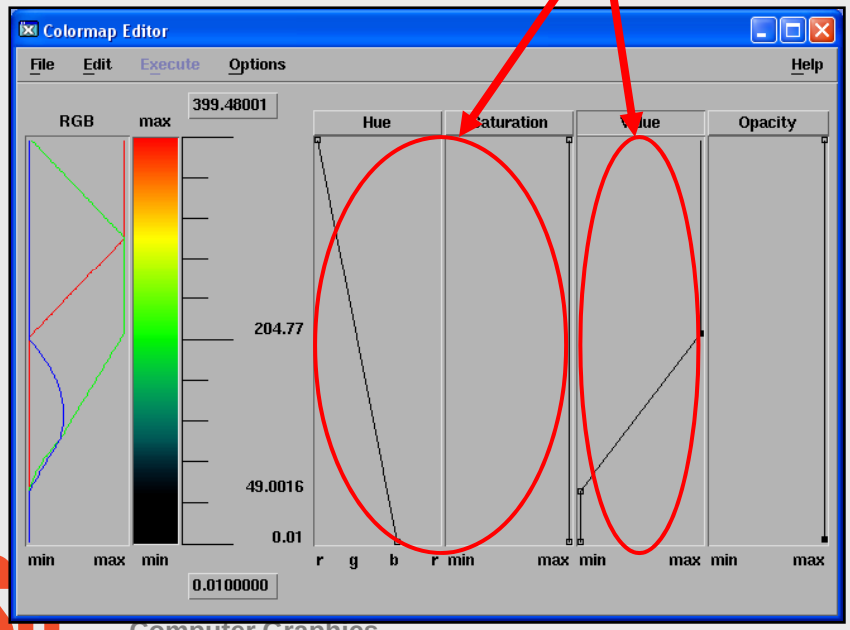
Direct Volume Rendering

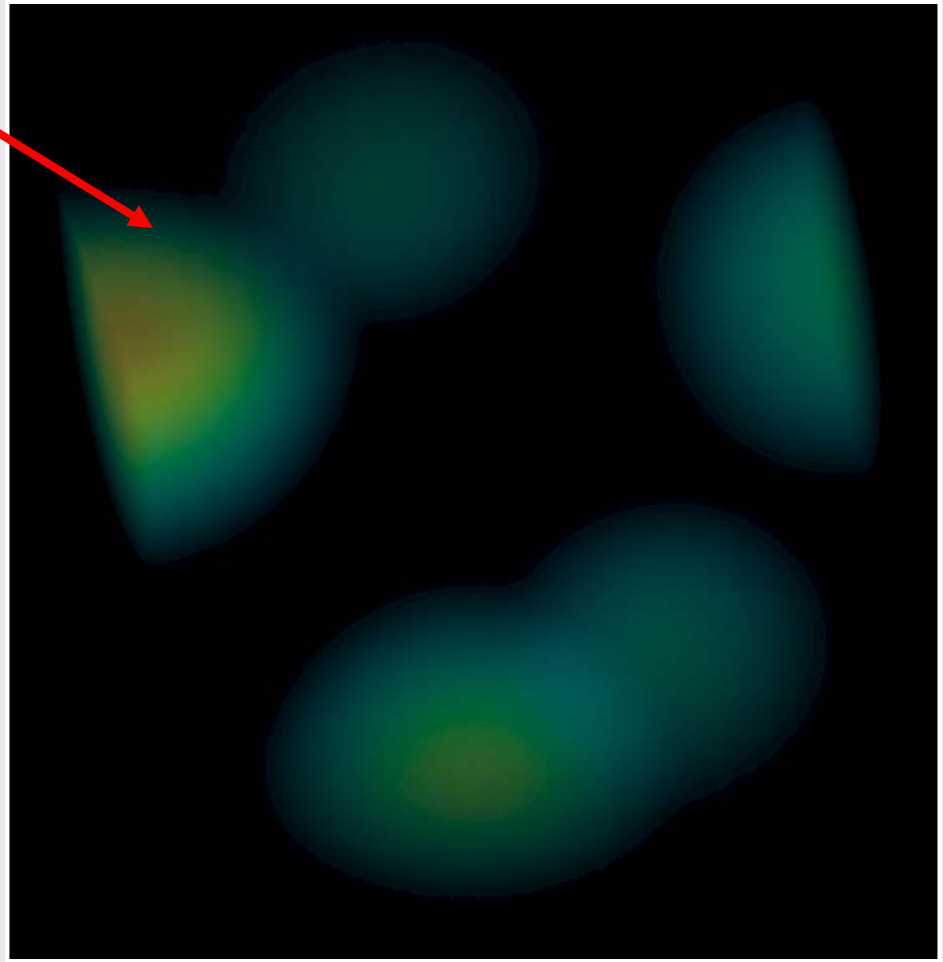


A Volume Rendering "Transfer Function" relates data scalar value to its corresponding color and opacity. For volume rendering, OpenDX uses the color *Value* as the opacity, not the color Opacity.

The direct volume rendering part of the Image module will only work in Orthographic projection.

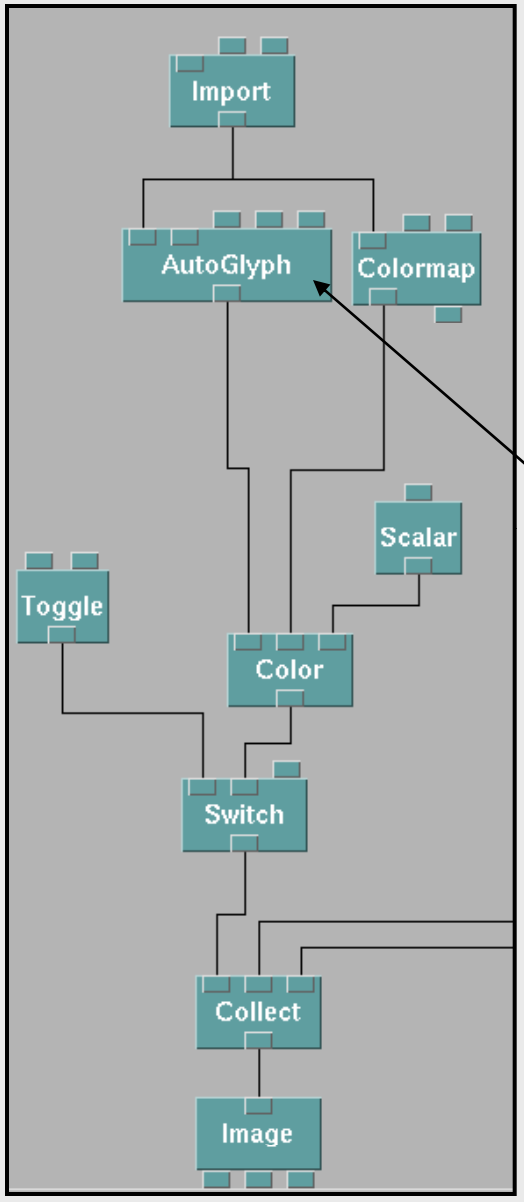
These are the "Transfer Function"



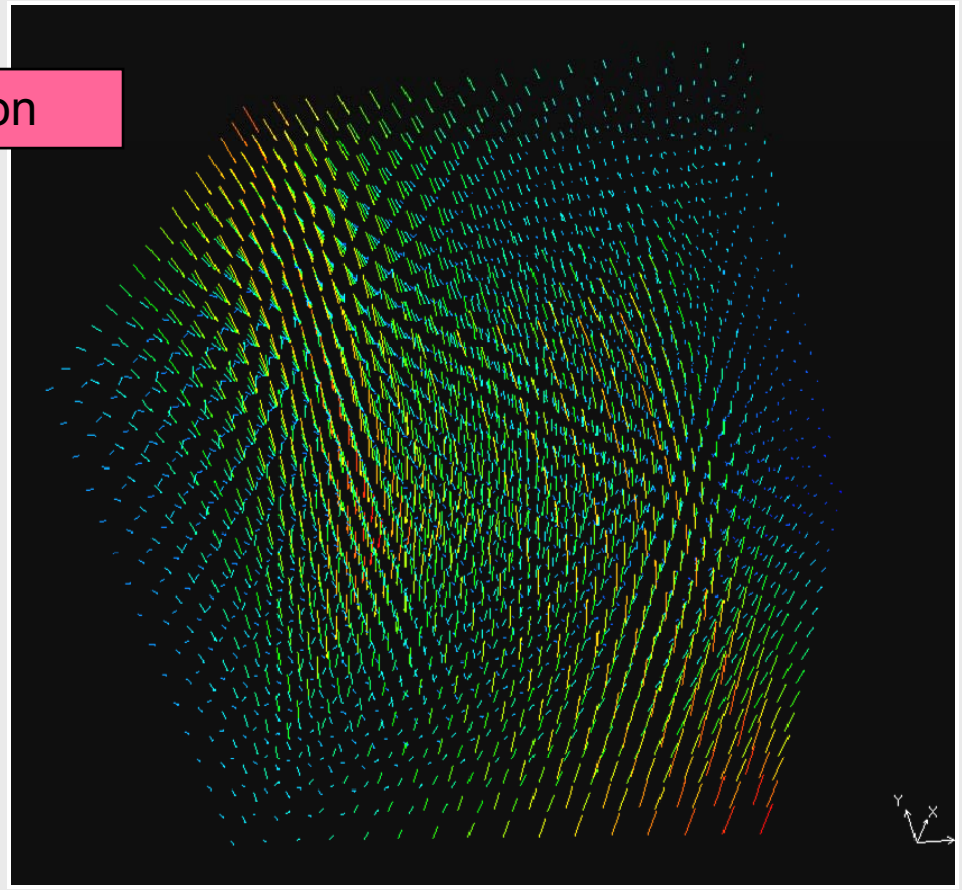


Vector Visualization

Vector Cloud



Annotation



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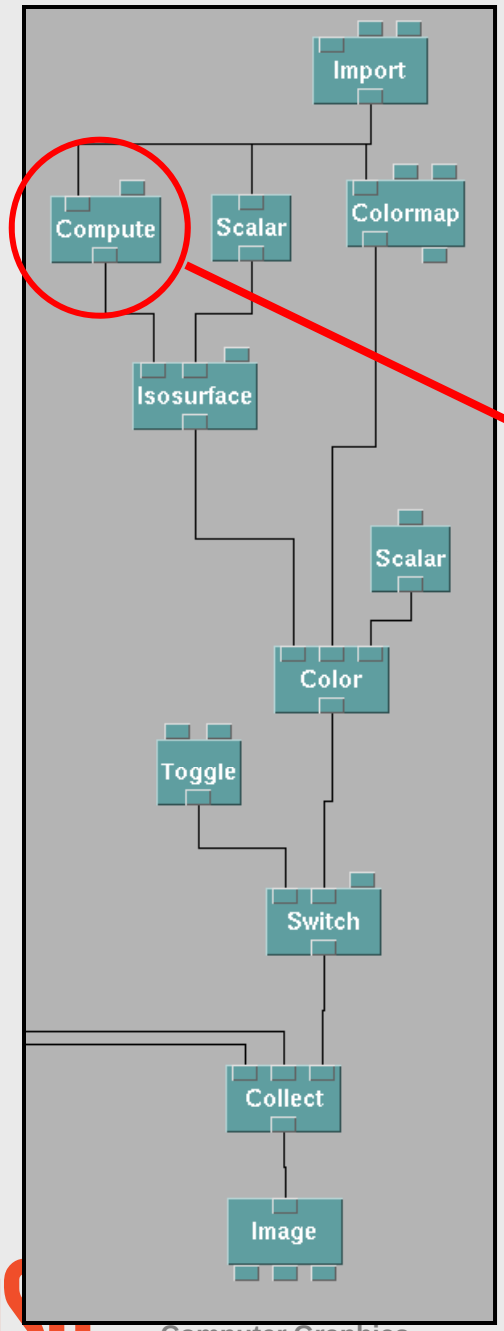
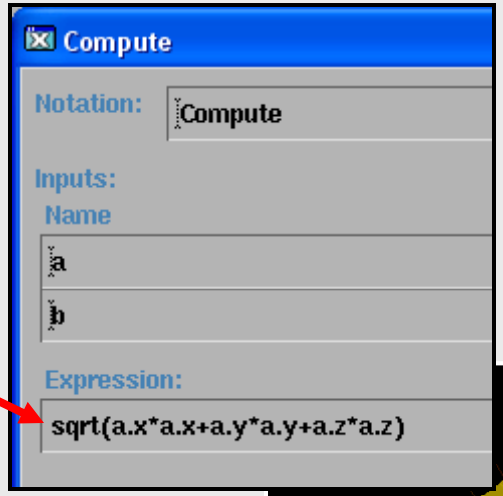
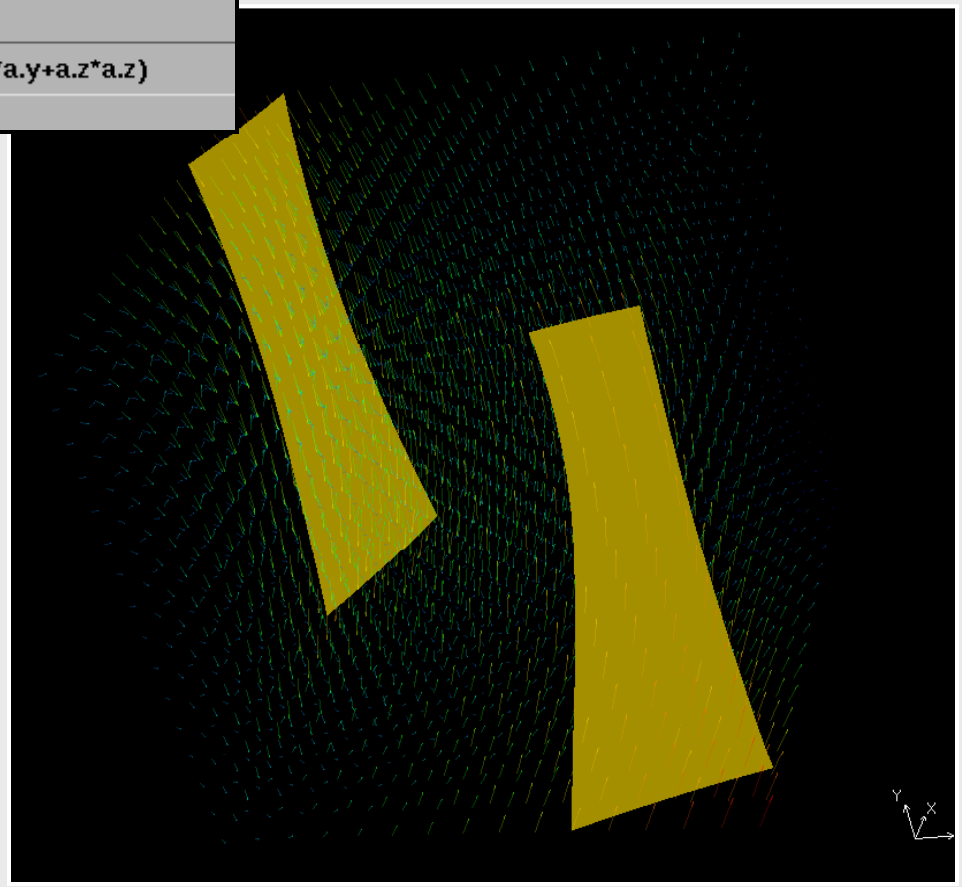
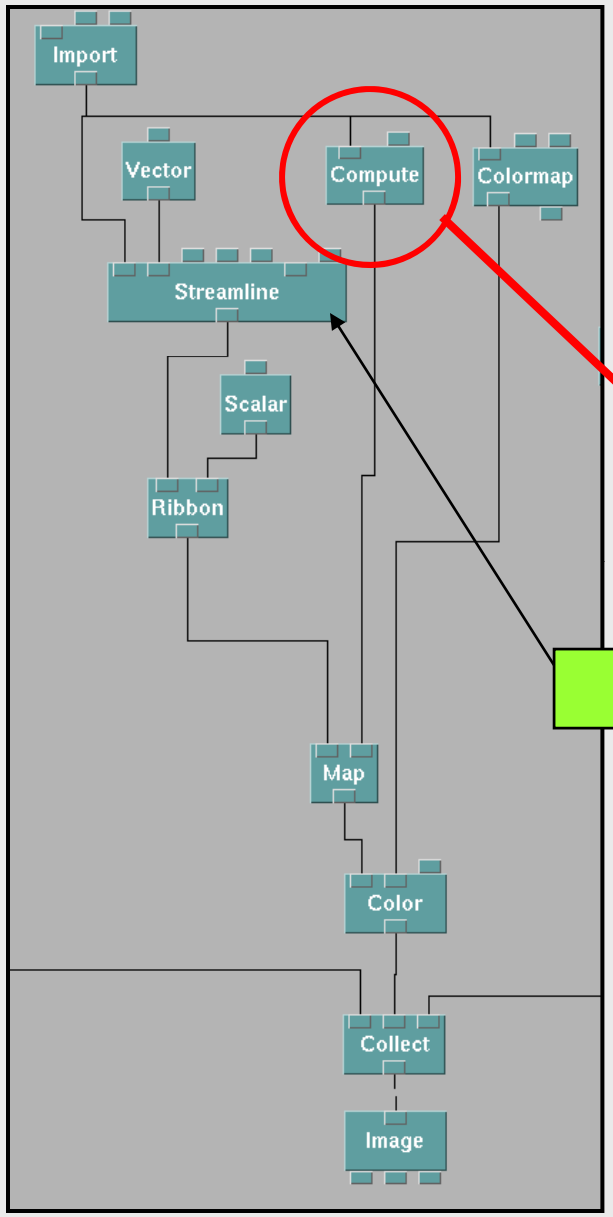
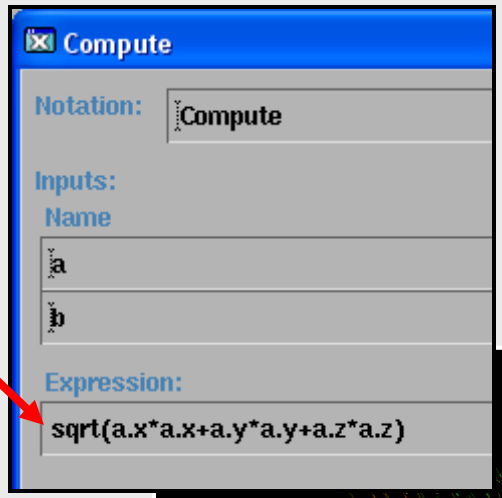




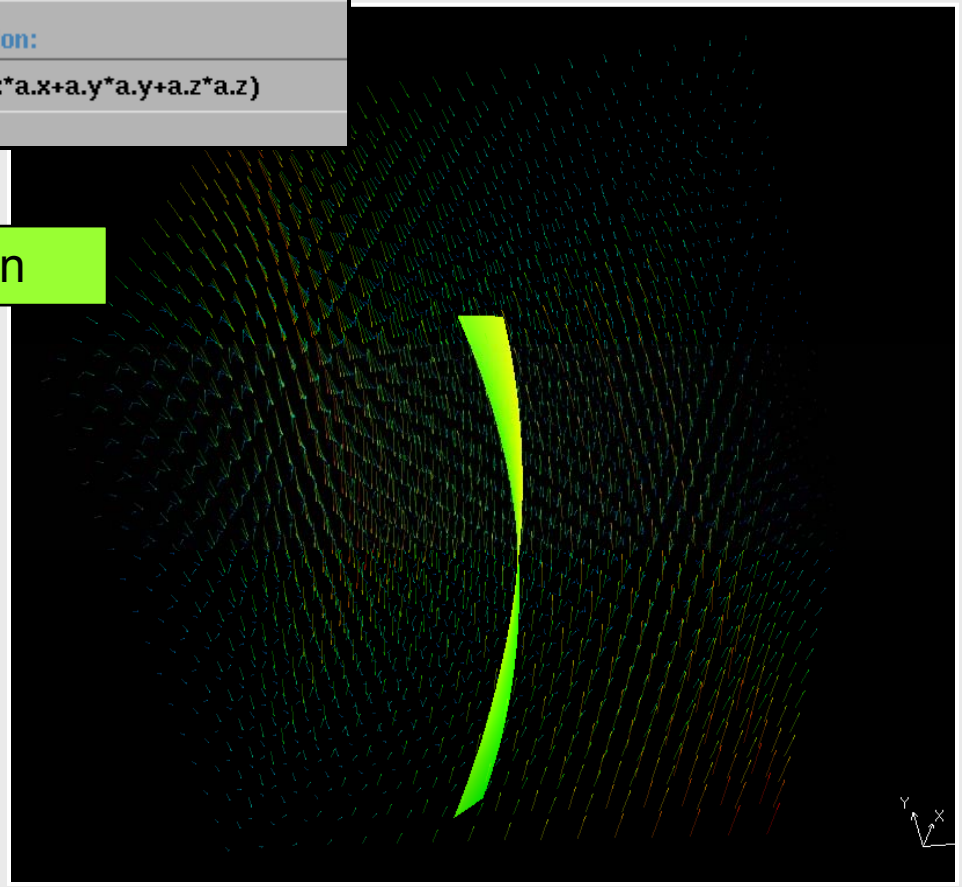


Streamline Ribbon

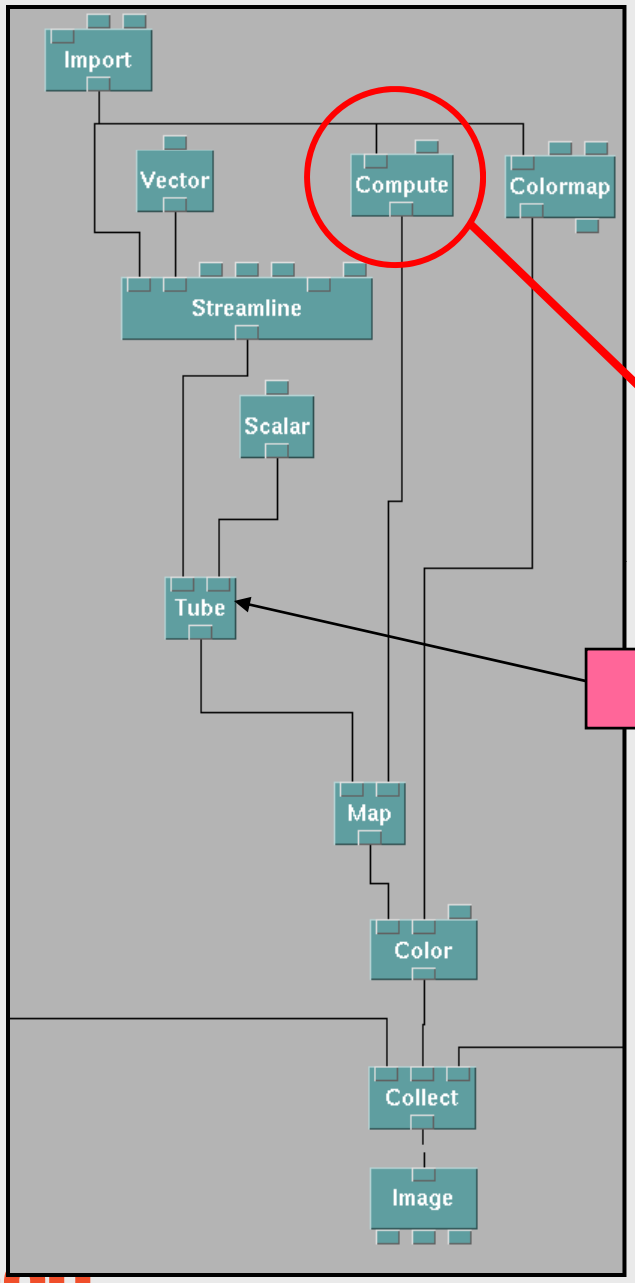


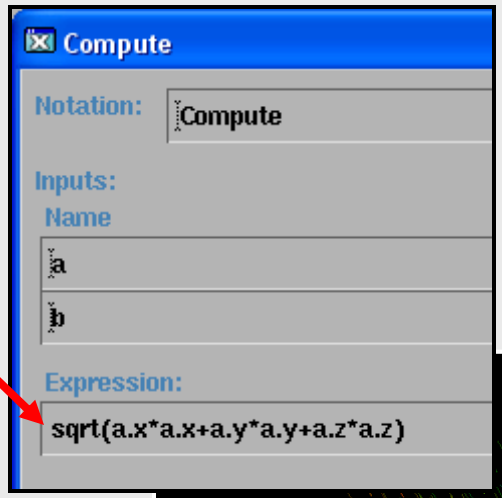


Realization

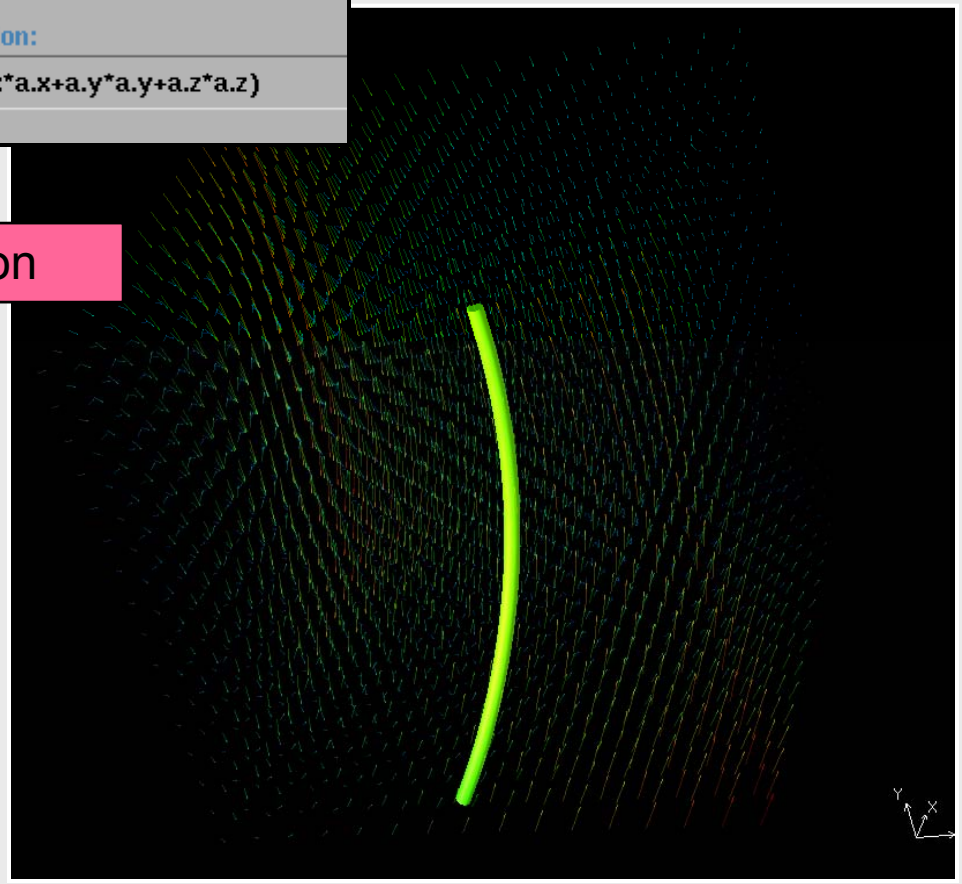


Streamline Tube





Annotation



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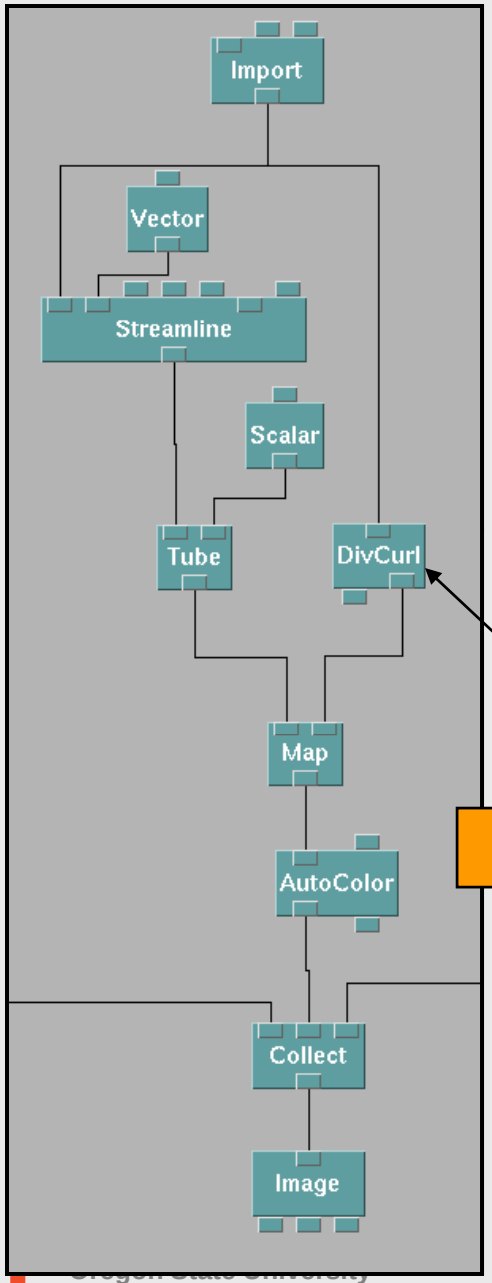
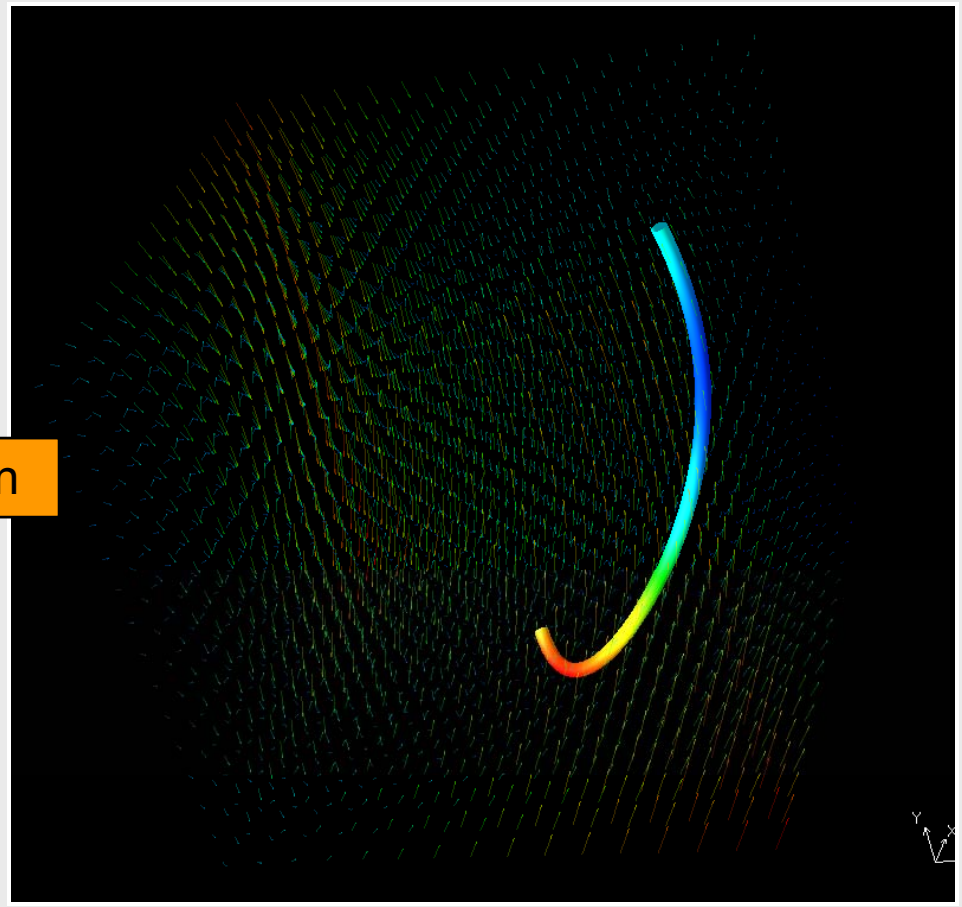
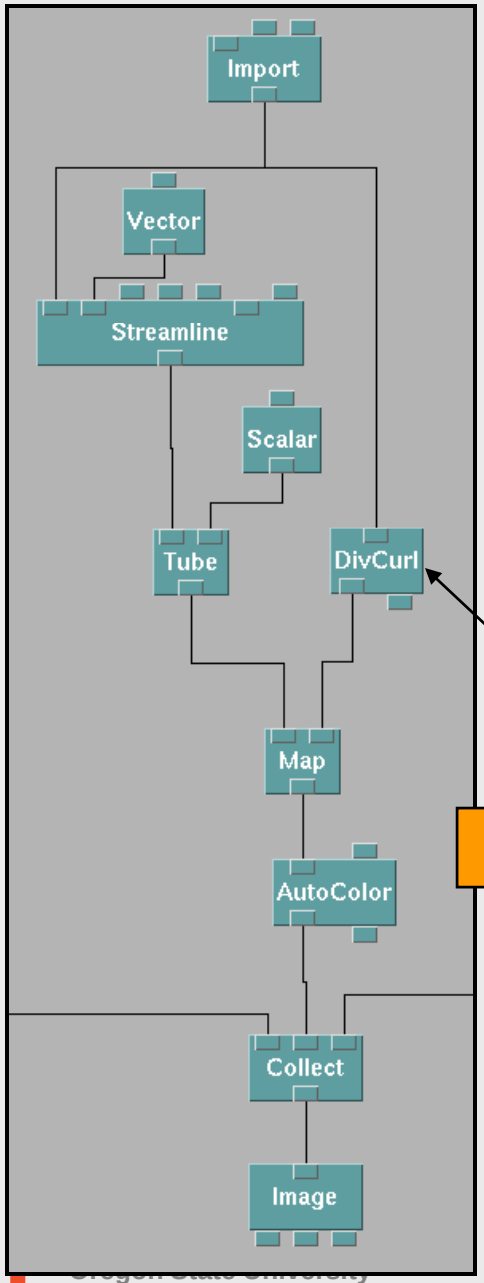


Transformation



Divergence



Transformation