

# Blood Flow Aneurysm Tutorial Calculating Flux

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## Description of Simulation Data

This tutorial uses the **aneurysm** dataset -- available at: [http://www.visitusers.org/index.php?title=Tutorial\\_Data](http://www.visitusers.org/index.php?title=Tutorial_Data)

## Calculating the flux of a Velocity Field through a surface

To calculate a flux, we will need the original velocity vector, the normal vector of the surface, and VisIt's Flux Operator. We will calculate the flux through a cross-slice located at  $Y=3$ , at the beginning of the artery. We are assuming that you have open the datafile series, and that you start with a blank page.

### Creating the slice and showing velocity glyphs

First we will directly plot the velocity vectors that exist on the slice through the 3D mesh.

- Add a **Vector** plot of **velocity**
- Open the **Vector** plot attributes
- On the 1st tab (Vectors), set the **Fixed number** to 40
- On the 3rd tab (Glyphs)
  - Set **Arrow body** to **Cylinder**
  - Set **Geometry Quality** to **High**

**Vector plot attributes**

Vectors Data **Glyphs**

**Scale**

Scale  ☒ Scale by magnitude ☒ Auto scale

**Style**

Glyph type  ☒ Draw head Size

Arrow body  Width

Vector origin ☐ Head ☐ Middle ☒ Tail

**Rendering**

Geometry Quality ☐ Fast ☒ High

Make default Load Save Reset

Apply Post Dismiss

- Click Apply and Dismiss
- Add a **Slice** operator
- Open the **Slice** operator attributes
  - Set **Normal** to **Arbitrary** and to **0 1 0**
  - Set **Origin** to **Intercept** and to **3**
  - Set **Up Axis: Project to 2D** to **OFF**
- Click Make default, Apply and Dismiss
- Click Draw

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Slice operator attributes

Normal

Orthogonal

☐ X Axis
 ☐ Y Axis
 ☐ Z Axis

☐ flip

Arbitrary

☒

0 1 0

Theta-Phi

☐

180 0

Origin

☐ Point
 ☒ Intercept
 ☐ Percent
 ☐ Zone
 ☐ Node

Intercept

3

Up Axis

☐ Project to 2D

Direction

0 0 1

☒ Interactive

Make default

Load

Save

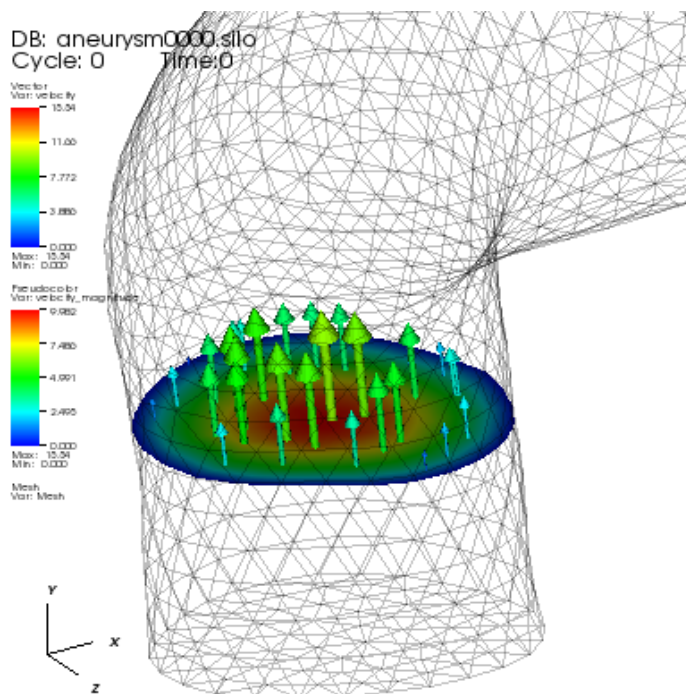
Reset

Apply

Post

Dismiss

- Zoom in to explore the plot results.

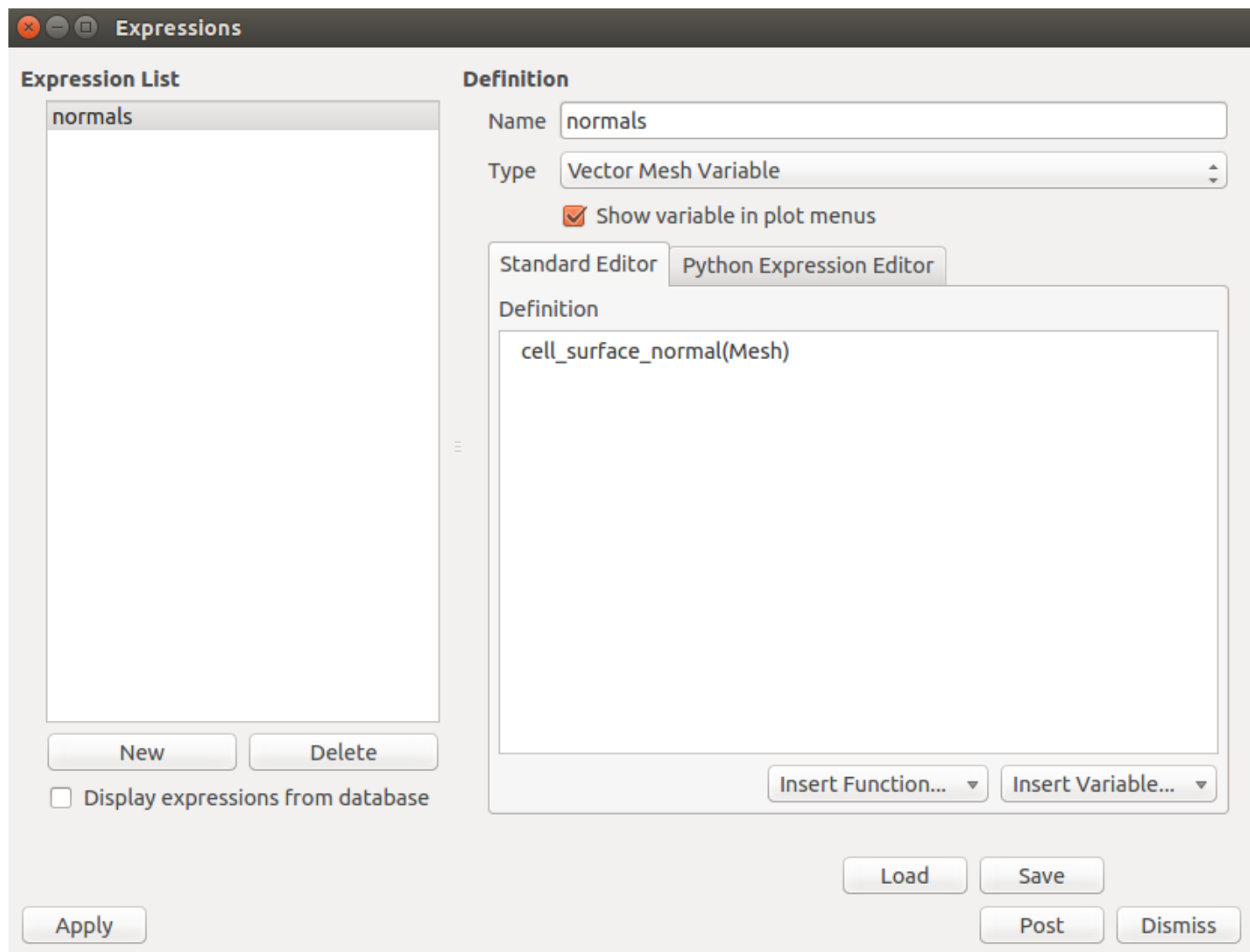


The vector plot uses glyphs to draw portions of the instantaneous vector field. The arrows are colored according to the speed at each point (the magnitude of the velocity vector). Next we create an expression to evaluate the vectors normal to the Slice. These normals should all point in the Y direction.

### Creating a vector expression and using the Defer Expression operator

We will use VisIt's pre-defined expression to evaluate the normals on a cell-by-cell basis.

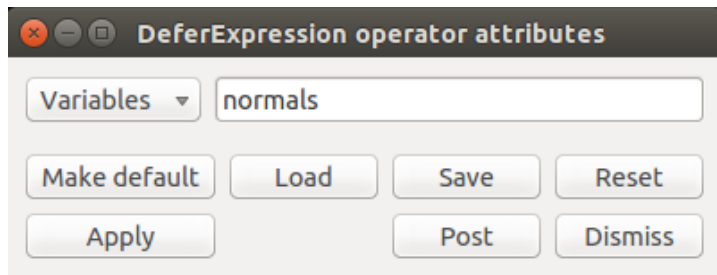
- Select the **Controls** and **Expressions** menu
- click **New**
- Change the name to **normals** and the **Type** to **Vector Mesh Variable**
- Edit the definition by selecting **Insert Function**, going to the **Miscellaneous** category and selecting **cell\_surface\_normal**. You then need to add the name of the mesh **Mesh** inside the parentheses.



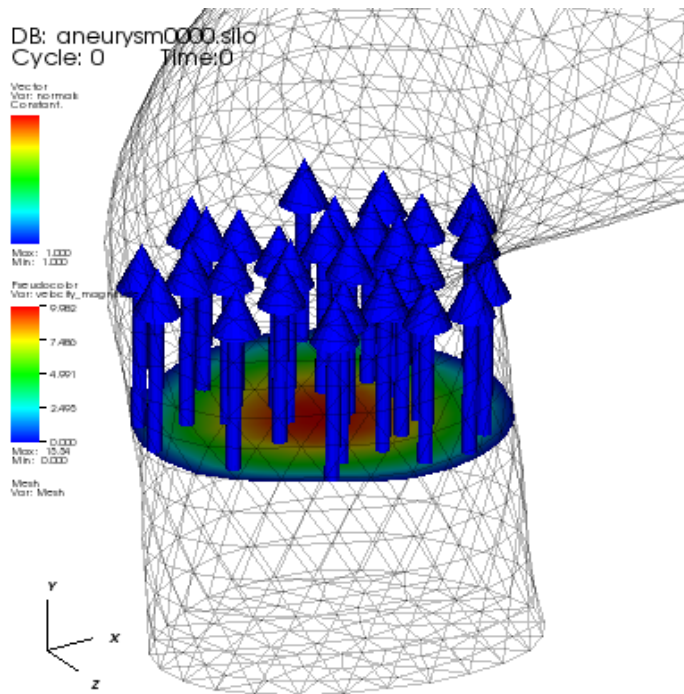
- Click Apply and Dismiss

Return to the Vector plot and change its variable to **normals**

- you will most probably be greeted with an error message saying: *The 'normals' expression failed because The Surface normal expression can only be calculated on surfaces. Use the ExternalSurface operator to generate the external surface of this object. You must also use the DeferExpression operator to defer the evaluation of this expression until after the external surface operator.*
- in fact, VisIt cannot use the name **Mesh** which refers to the original 3D mesh. It needs to defer the evaluation, until after the Slice operator is applied. Thus, we add the **Defer Expression** operator (from the Analysis group).
- Open the **DeferExpression** operator attributes
- Add the name **normals** to the Variables list



- Click Apply and Dismiss
- Click Draw

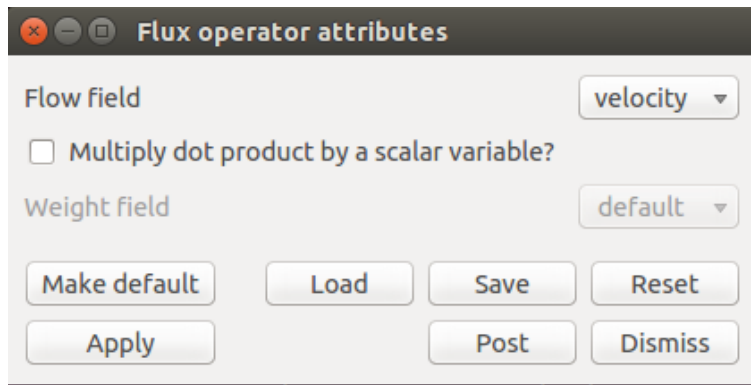


- Verify that all your normals point in the up (Y) direction.

### Calculating the flux on the slice

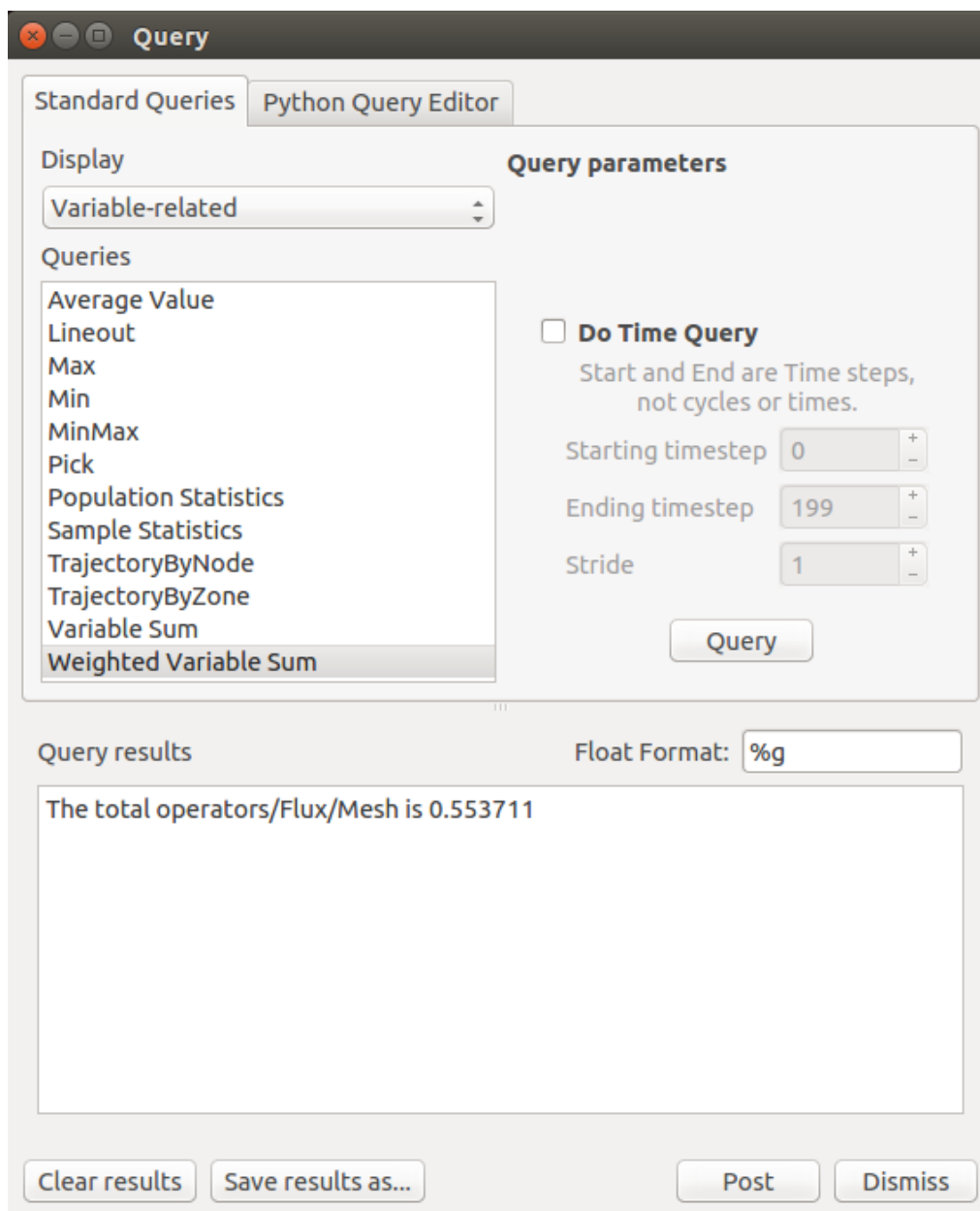
We are now ready for the final draw.

- Add a **Pseudocolor** plot of variable **operator->Flux->Mesh**
- Add a **Slice** operator and verify that the default values previously saved are used.
- Move the **Slice** operator up, above the **Flux** operator
- Add a **Defer Expression** operator as before
- Move the **Defer Expression** operator up, above the **Flux** operator, and below the **Slice**
- Open the **Flux** operator attributes
- Change the Flow field name from **default** to **velocity**

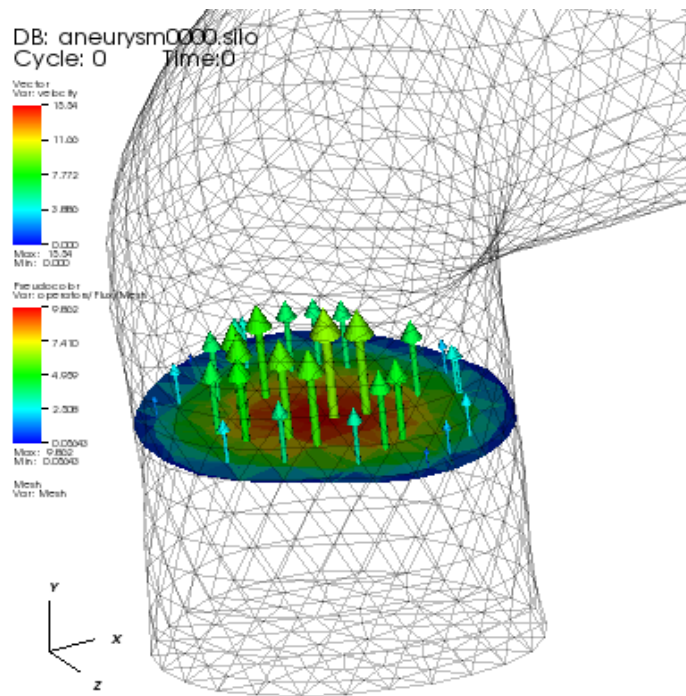


The 'Flux operator attributes' dialog box has a title bar with standard window controls. It contains a 'Flow field' dropdown menu set to 'velocity'. Below it is a checkbox labeled 'Multiply dot product by a scalar variable?' which is unchecked. Underneath is a 'Weight field' dropdown menu set to 'default'. At the bottom, there are two rows of buttons: the first row contains 'Make default', 'Load', 'Save', and 'Reset'; the second row contains 'Apply', 'Post', and 'Dismiss'.

- Click Apply and Dismiss
- Click Draw
- Verify that you have a display that is cell-centered, and that will vary with the Time slider
- Get the numerical value of the flux by query-ing for the **Weighted Variable Sum**



The 'Query' dialog box has a title bar with standard window controls. It features two tabs: 'Standard Queries' and 'Python Query Editor'. The 'Standard Queries' tab is active. On the left, under the 'Display' section, is a dropdown menu set to 'Variable-related'. Below this is a list of query types: 'Average Value', 'Lineout', 'Max', 'Min', 'MinMax', 'Pick', 'Population Statistics', 'Sample Statistics', 'TrajectoryByNode', 'TrajectoryByZone', 'Variable Sum', and 'Weighted Variable Sum' (which is highlighted). To the right of this list, under 'Query parameters', is an unchecked checkbox for 'Do Time Query' with the text 'Start and End are Time steps, not cycles or times.' Below this are three input fields: 'Starting timestep' (0), 'Ending timestep' (199), and 'Stride' (1), each with increment and decrement buttons. A 'Query' button is located below these fields. At the bottom of the dialog, there is a 'Query results' section with a 'Float Format' dropdown set to '%g'. Below this is a large text area containing the result: 'The total operators/Flux/Mesh is 0.553711'. At the very bottom, there are four buttons: 'Clear results', 'Save results as...', 'Post', and 'Dismiss'.



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