Currently, ICE features two plugins for visualizing and plotting simulation output data:

VisIt Tools - An interactive visualization tool for rendering data defined on 2D and 3D meshes.

CSV Plotting Tools - A customizable, 2D data plotting utility for data in CSV format.

1 Installation and Configuration

The CSV Plotting Tools require no additional software or preparation before use. The VisIt Tools need both a VisIt installation and a connection between ICE and a VisIt session.

1.1 VisIt Installation

Before preparing ICE, VisIt must be downloaded and installed. The ICE development team recommends using the latest version of VisIt but acknowledges that any version greater than or equal to 2.8.2 should work. VisIt does not need to be installed on the same machine where ICE is installed since ICE is capable of launching a VisIt session on a remote machine. Regardless of the host, make note of the directory where VisIt is installed as it will be necessary in the next step.

1.2 Configuring the VisIt Connection

Once VisIt is installed, ICE must connect to a running instance of VisIt in order to make use of its rendering capabilities. ICE provides two different tools that utilize VisIt, the Plot Editor and the Visualization Perspective. Both utilities provide slightly different functionality and are accessed through different means.

1.2.1 Connecting for the Plot Editor

The Plot Editor uses a default connection to VisIt established in the ICE Preferences page. This process only needs to be performed once. After initially creating the connection, ICE will launch and connect with VisIt upon each subsequent launch of ICE.

To set the connection, select Window → Preferences... in ICE's menu bar. (On Mac OS X, Preferences... is instead located under ICE in the menu bar.) Select Visualization → VisIt in the tree on the left side of the Preferences window.
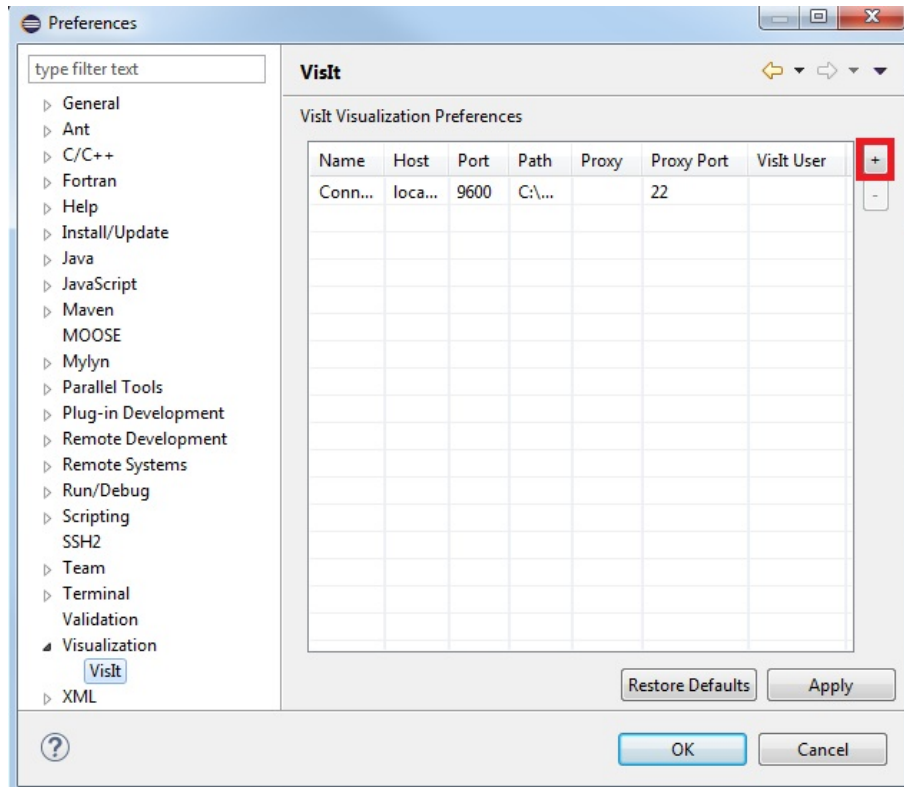
Press the button with a "+" symbol in the upper right (highlighted in the image above) to add a new row to the table. Click on cells in the new row to edit their values. The default values automatically supplied by ICE should be appropriate for most users. However, two fields may need to be changed:

Host: The default value of "localhost" allows for connections to VisIt installations on the same machine where ICE is running. To launch a remote VisIt connection, change this to the hostname of that machine.

Path: Enter the full path to the directory containing the VisIt executable, not the executable itself. The VisIt executable is named *visit* on Linux and Mac OS X. On Windows, *VisIt.exe* is the appropriate file.

Once finished editing the cells in the new row, press Apply, then OK. ICE will then launch an instance of VisIt and connect to it.

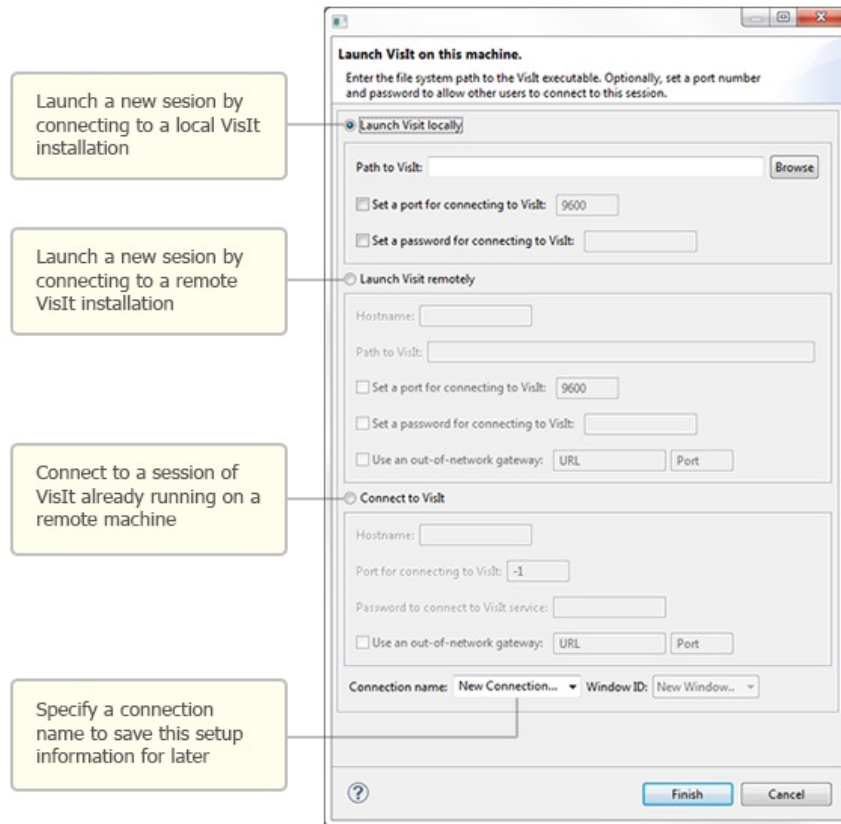### 1.2.2   Connecting for the Visualization Perspective

To establish a VisIt connection in the Visualization perspective, begin by opening this utility. In the main menu bar at the top of the window, select Window → Perspective → Open Perspective → Other.... Select Visualization in the dialog that appears and click OK. Alternatively, the same dialog may be accessed by clicking the Open Perspective button in the toolbar in the upper right-hand corner of the ICE workbench.
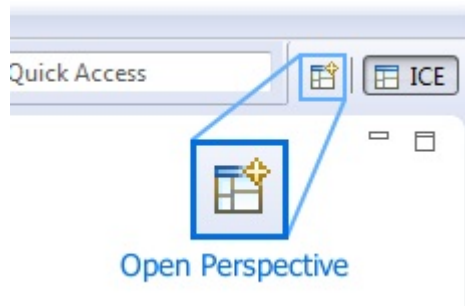
Click the Launch VisIt button in the tool bar to enter the VisIt connection parameters.

The resulting dialog offers three options for connecting to VisIt.

Launch a new sesion by connecting to a local VisIt installation

Launch a new sesion by connecting to a remote VisIt installation

Connect to a session of VisIt already running on a remote machine

Specify a connection name to save this setup information for later

1) Launch VisIt locally - This connection option will launch a new VisIt session on the machine running ICE. If VisIt in installed on this machine, use the Browse button to enter the directory containing the VisIt executable into the Path to VisIt field. Optionally, set a port number (default 9600) that VisIt will use to serve data to ICE, and if this VisIt session will be shared with multiple userd, set a password.

2) Launch VisIt remotely - Using this method of connecting will launch a new VisIt session on a machine other than the one used to run ICE. Specify the hostname and full path to the directory containing the VisIt executable. Optionally, enter a port number (default 9600), and if VisIt session will be shared with multiple users, enter a password. If access to the remote machine where VisIt is installed requires the use of an external gateway or proxy, specify its URL and port number, as well.

3) Connect to VisIt - To connect to a previously launched VisIt session, specify the hostname, port number, and password set on the lanuch of that

4

session. This information will need to be obtained from the person who initially launched the VisIt session. If access to the machine hosting the VisIt session requires the use of an external gateway or proxy, enter its URL and port number, as well.

For a reminder of where VisIt is installed on Windows, find a shortcut to VisIt on the desktop or in the start menu. Right-click the shortcut and open its Properties. The path to the VisIt executable's directoy will be shown next to Target.

Regardless of the method used to connect to VisIt, enter a Connection name at the bottom of the dialog.

When connecting to an existing session, specify a Window ID between 1 and 16. The Window ID used determines how ICE will connect to VisIt. If multiple users connect using the same Window ID, they will all see and be able to interact with the same VisIt view. However, if multiple users wish to each have their own unique session with its own controls, assign a unique Window ID to each user. The VisIt installation can support up to 16 unique window IDs at a time.

Once the required fields are complete, click the Finish button at the bottom, and ICE should begin connecting to VisIt.
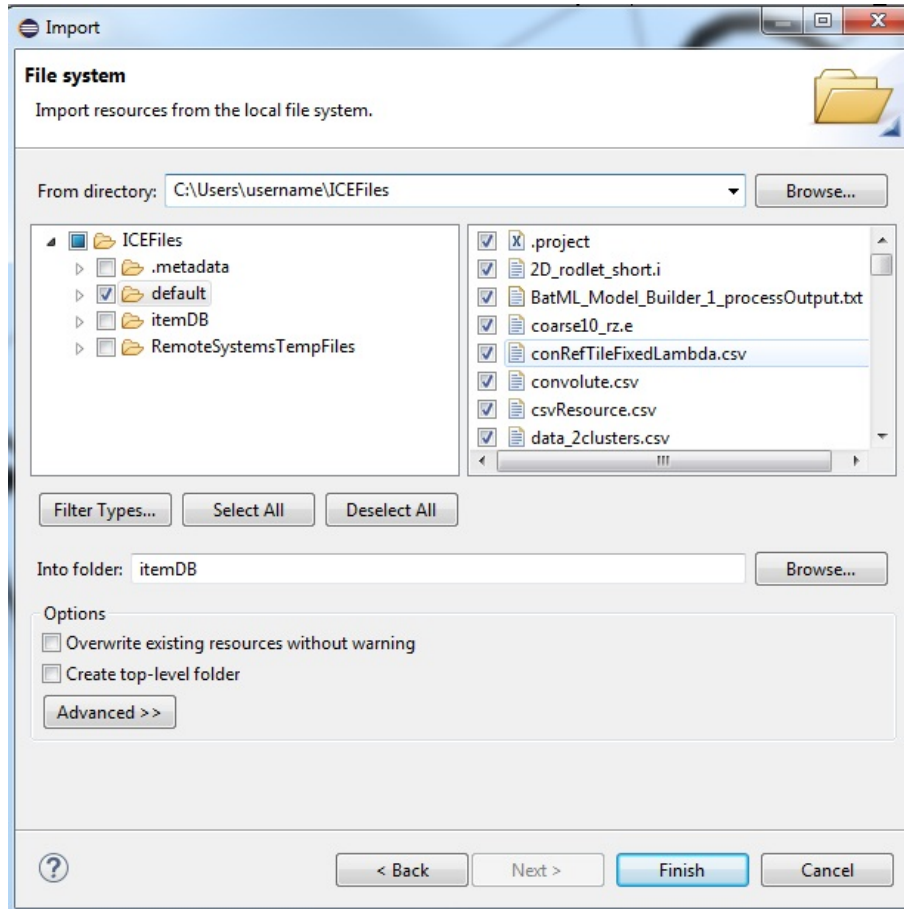
2 VisIt

2.1 Opening a VisIt File

2.1.1 Opening a Plot Editor

To open a Plot Editor, a file that uses this editor must first be placed in the Project Explorer. This view lists files imported into ICE. To access the Project Explorer, use the the menu bar at the top of the window and navigate to Window → Show View → Project Explorer. Depending on the active Eclipse perspective, opening this view may require selecting Other... and finding the Project Explorer in the dialog under the General category in the tree.

By default, the Project Explorer should automatically import the ICE-Files/default and ICEFiles/itemDB folders. If it does not, or if you want to import a different folder into ICE, right click in the Project Explorer and select Import... from the context menu. Then, select General → File System from the tree, and press the Next button. Select directories and/or files to import into the Project Explorer, and enter which folder they should be imported into, as

shown below.

Once a file is in the Project Explorer, simply double click on it to open it in VisIt.

### 2.1.2 Opening in the Visualization Perspective
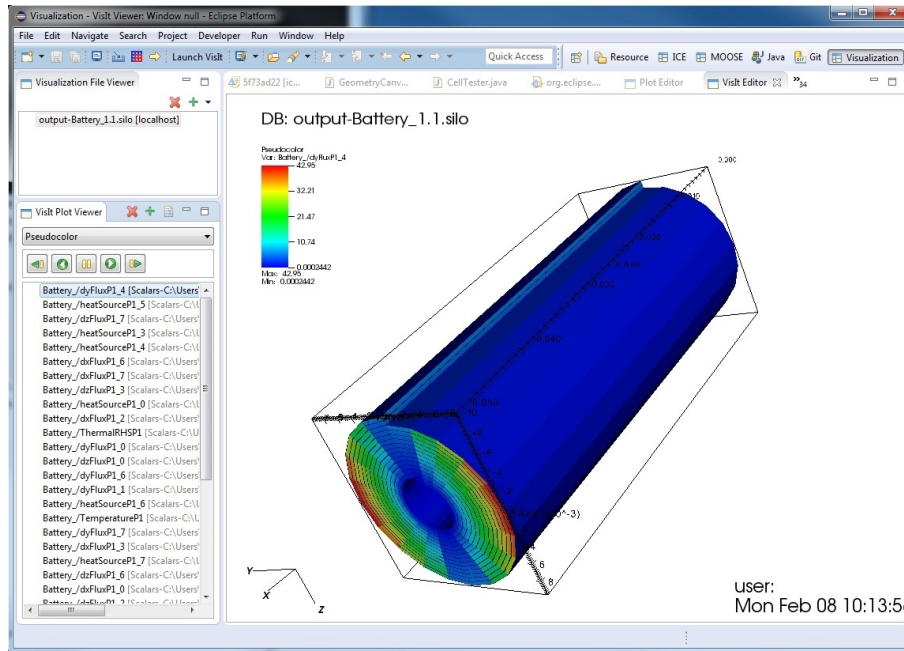
To open a file in the Visualization Perspective, first import the file into the Visualization File Viewer, located in the upper left of the screen. Click the Open a File button (green plus sign icon). The resulting dialog allows for the selection of local files to import.
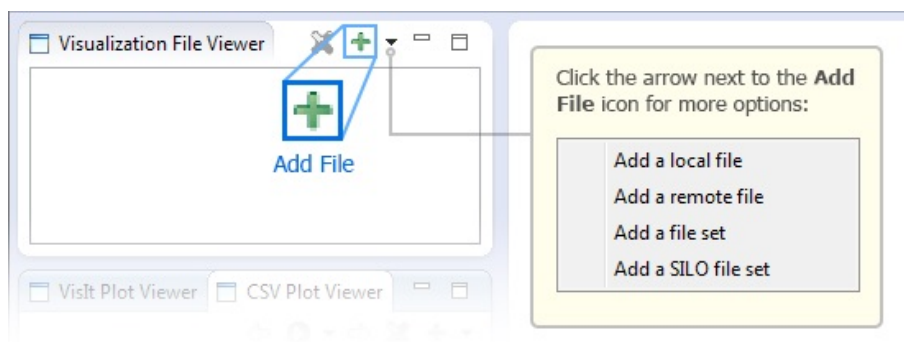

Currently, ICE can only open files in VisIt on the same machine that is running the VisIt session. For a connection to a remote VisIt installation, click the arrow beside the Open a File button, and select "Add a remote file" from

the drop down menu. The resulting dialog box allows the user to browse the file system of the remote machine hosting the VisIt session.
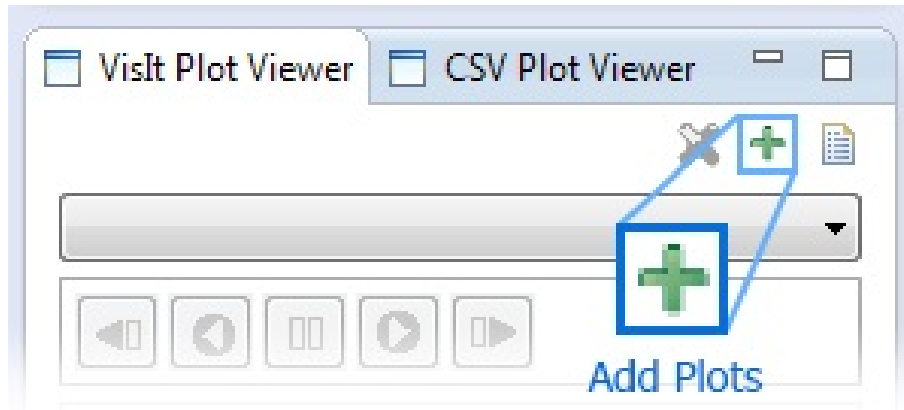
Once a file is in the Visualization File Viewer, create a plot by selecting the file, and then clicking the Add a Plot to the List button located in the VisIt Plot Viewer in the lower part of the column on the left side of the workbench. The resulting dialog allows the user to select plots from the file to view. After mading a selection or selctions and pressing OK, these plots will be placed in the VisIt Plot Viewer.
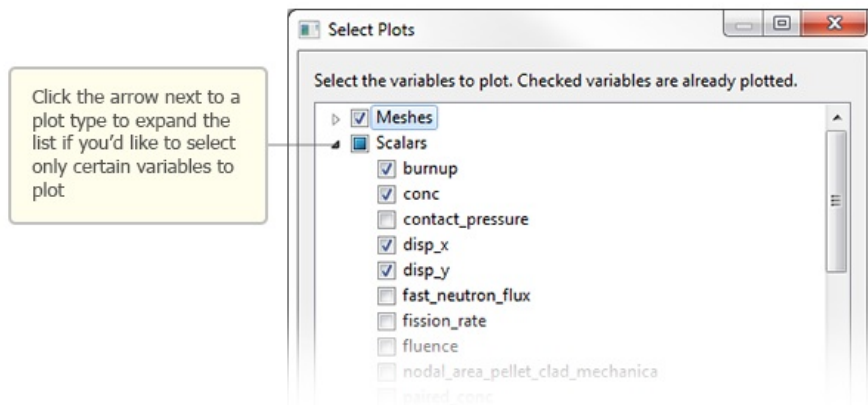
Finally, double click a plot in the VisIt Plot Viewer to render the data to the screen.

2.2   Using VisIt

Both the Plot Editor and the Visualization Perspective allow the user to rotate the model by clicking and dragging inside the display area or adjust the zoom by scrolling the mouse wheel. Other commands vary slightly between the two utilities.

2.2.1   Selecting the Plot

In the Plot Editor, pressing the Select Series... button will open a dialog which lists the various plots in the opened file. Simply select one and click OK to open it.
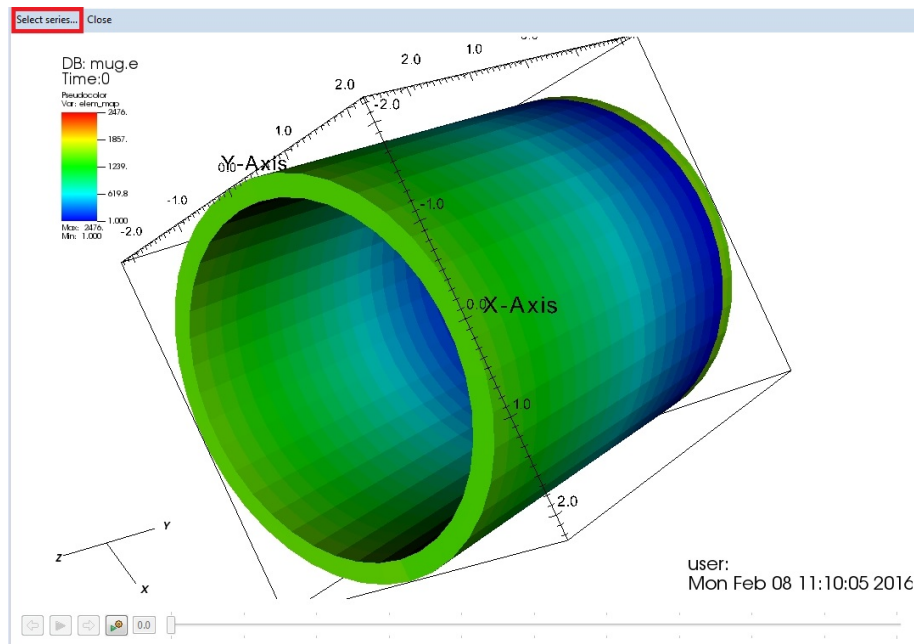

In the Visualization Perspective, the opened plots will be listed in the VisIt Plot Viewer. Double click on one to open it.

2.2.2   Setting the Plot Representation

VisIt is capable of displaying plots in several different representations, such as pseudocolor, contour, or volume.

To switch between plot types in the Plot Editor, right click inside the display area and select one of the listed options under the Representation category in the context menu.

The Visualization Perspective features a drop down menu at the top of the VisIt Plot Viewer which allows for switching between the available representations.
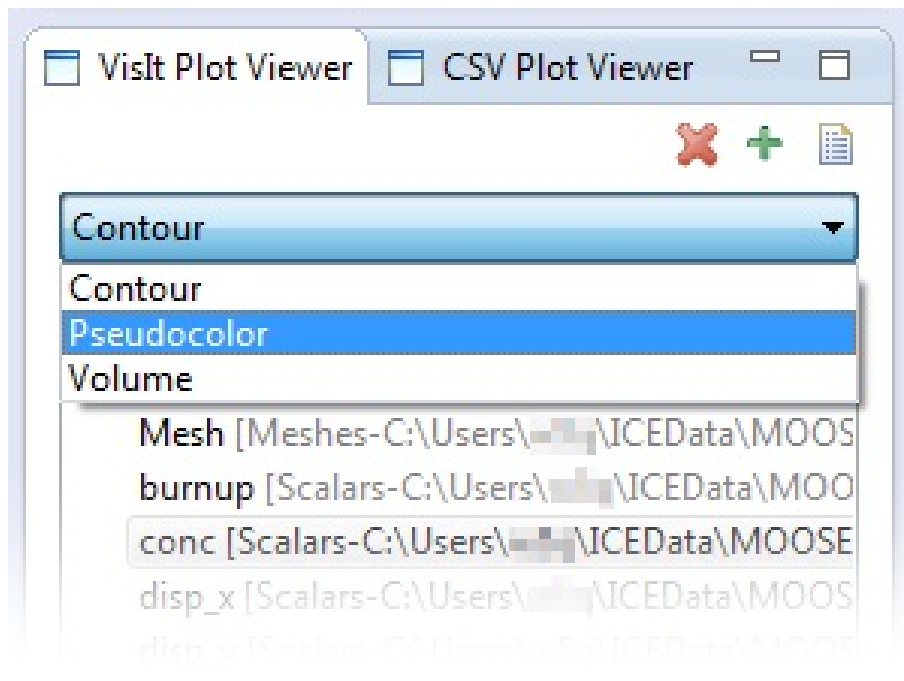
2.2.3   Animation and Time Data

The Plot Editor features a time slider widget at the bottom of the screen.

The controls, in order of left to right, are:

1) Return to the previous time step.

2) Automatically play the plot as an animation by displaying the time steps sequentially.

3) Advance to the next time step.

4) Opens an options menu that allows the user to set the playback speed, toggle whether the animation should loop when it reaches the end, and set the plot to the first or last time step.

5) A display for the current time step. It can be edited to set the plot to an arbitrary time step.

6) A slider that shows the current time step's position on the timeline. The slider can be dragged around the timeline, setting the plot's time step accordingly.

In the Visualization Perspective, the Visit Plot Viewer has a similiar set of controls.
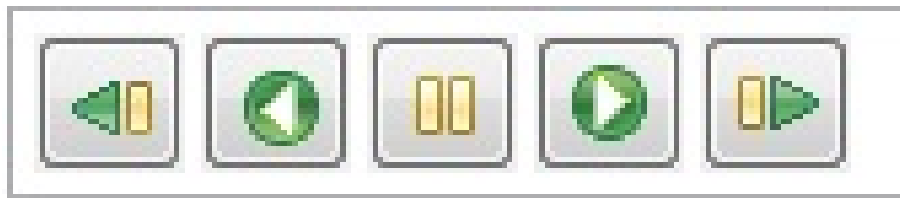
The buttons, in order of left to right, are:

1) Return to the previous time step.

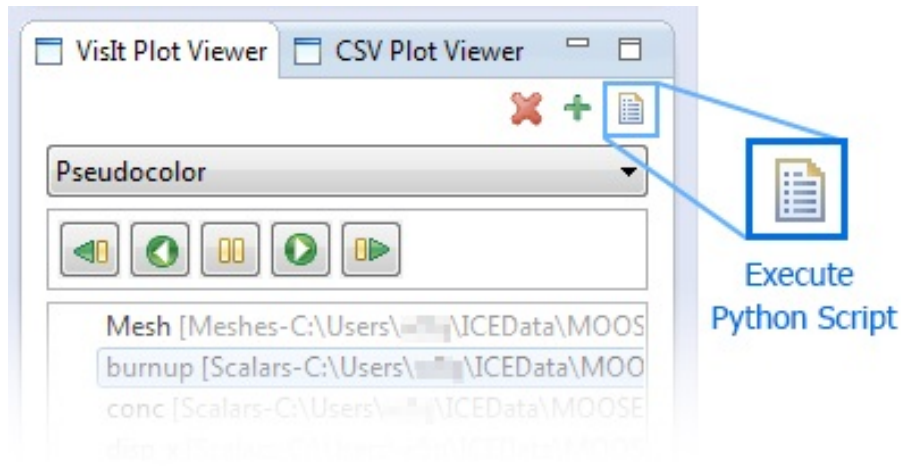2) Automatically play the plot as an animation backwards, going through the time steps in reverse order.

3) Pause the animation.

4) Automatically play the plot as an animation by displaying the time steps sequentially.

5) Advance to the next time step.

2.2.4 Sending VisIt Python Commands

This functionality is only available in the Visualization Perspective.

The Execute Python Script button in the upper right of the VisIt Plot Viewer will open a new window with a Python shell. Commands entered into this shell will be sent to the instance of VisIt.

Python code can be written into the shell directly, but the Load from File button will import an existing .py script into the console. Once done, hit the Execute button to send the python command(s) to VisIt.

Writing Python scripts for VisIt is beyond the scope of this tutorial. Please refer to the VisIt Python Interface Manual provided by the VisIt development team at Lawrence Livermore National Laboratory for information on Python commands for VisIt.

3 CSV Plot Viewer

ICE offers functionality for the viewing of CSV files.

3.1 Opening a CSV File

CSV files are opened in Plot Editors through the Project Explorer. Open the Project Explorer with Window → Show View → Project Explorer and import the file by right clicking and selecting import. Once the file is in the Project Explorer, double click to open it.

ICE expects CSV files to be in an [m x n] format, with no row holding empty

values. The first row in the file will be used to name a series, with the series data being specified by the column of values beneath it.

3.2 Using the CSV Plot Viewer
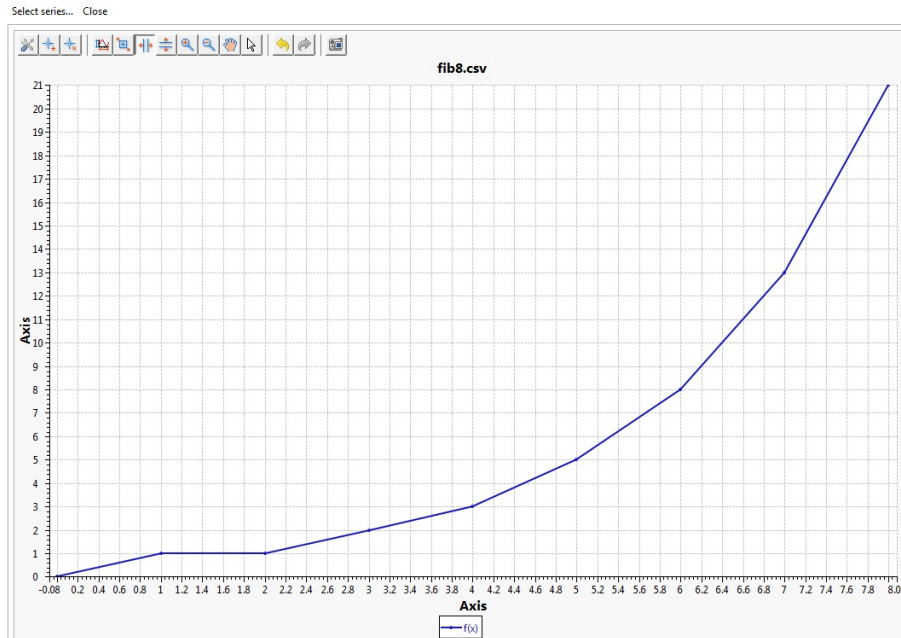
3.2.1 Controlling the Graphics

The row of buttons at the top of the viewer provide basic graph editing capabilities.

The first button allows the user to edit a variety of basic graph attributes, such as font, axis titles and scales, line colors, etc.

The next two buttons allow for the addition and removal of annotations for specific data points.

The central grouping of buttons allow the user to zoom and pan the camera in a variety of ways.

The two yellow arrow buttons will undo/redo changes made to the graph.

The final button will export a screenshot of the graph.

3.2.2 Setting the Independent Series

By default, the first column in the file will serve as the independent series setting the graph's x axis. By right clicking the Plot Viewer and selecting Set Independent Series. . . , the user can set the independent series to any other series in the file.

3.2.3 Setting the Dependent Series

When first opened, only the series defined by the second column in the file will be displayed. There are several ways to change this.

The Select series. . . button in the upper left hand corner will display a list of all the series in the file. Selecting one and pressing OK will graph that series and removing all others.

Right clicking and choosing Select series. . . from the context menu will open a dialog in which any of the available series may be selected. All selected series will be graphed at once with deselected series removed.

Finally, the Remove all series option in the context menu will completely clear the graph.

3.2.4 Viewing the Data

At the bottom of the editor is a series of tabs.
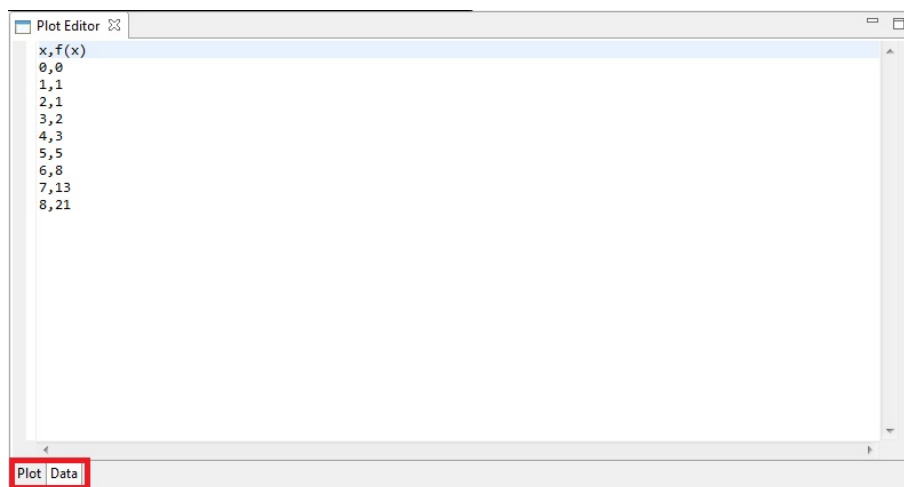
The Plot tab contains the graph described thus far. The Data tab will display the raw numerical source data in a text editor.

4   MOOSE Embedded Visualization

MOOSE Workflow Items allow for easy visualization of their associated files, making use of the VisIt and CSV Plot Editors described previously.

4.1   Creating a MOOSE Workflow

First open the MOOSE Perspective, either through Window $\rightarrow$ Perspective $\rightarrow$ Open Perspective $\rightarrow$ Other... and selecting MOOSE, or by clicking the Open Perspective button in the top right corner and selecting MOOSE.
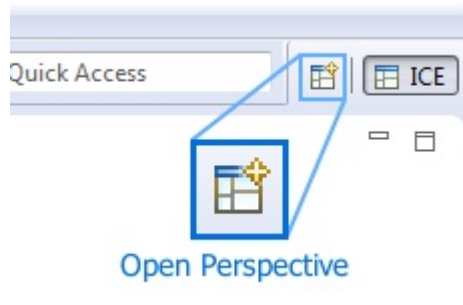
Next, you must open a MOOSE Workflow. The two buttons outlined in red below will create Items. The upper one will import a .i file, while the bottom button will create a new workflow. In either case, select MOOSE Workflow from the menu and hit OK.
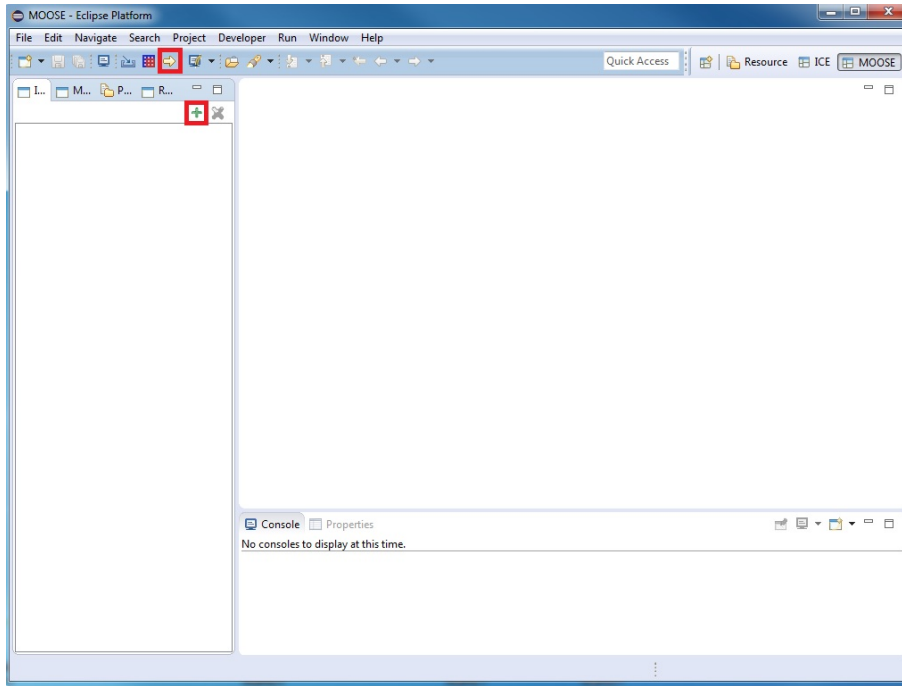
You must now choose the MOOSE application which will run the file. The Browse... button under MOOSE-Based Application in the upper left hand corner will open a menu asking if the application is on the local machine or on a remote one. For local applications, you will simply need to select it from a dialog.
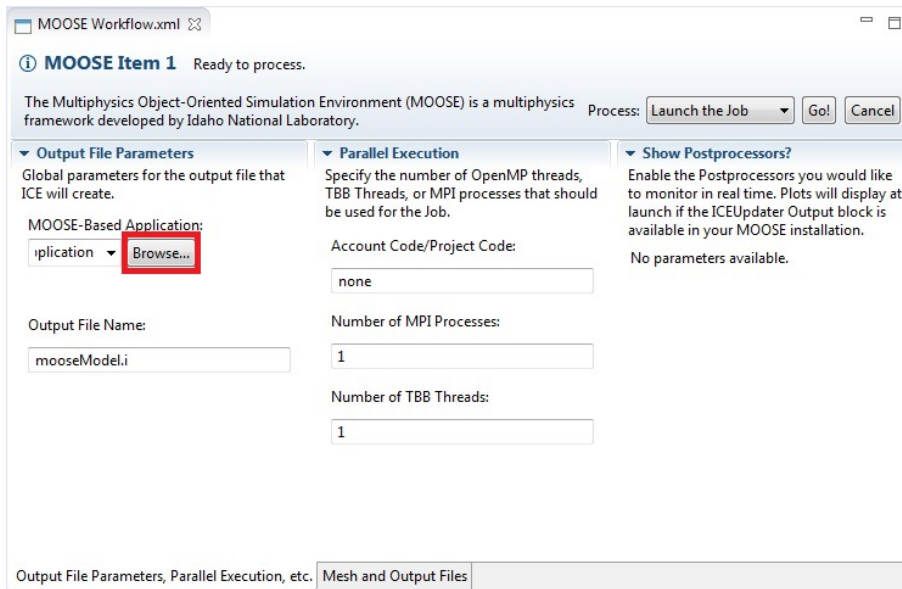
If the application is remote, a new dialog will open. At the top, press the New button to set up your connection.

You must set the Host to the computer containing the MOOSE application, and User and Password to the username and password for your account on that machine. You may also optionally set the Port number, timemout, and proxy settings. Once done, click Finish. You will automatically be shown the file system for your new connection. Select the MOOSE application from it and click OK.

Save the form. If you imported a file, there will still be unsaved changes after a single save. You can save again and skip the next section.

4.1.1 Configuring the MOOSE Input Data
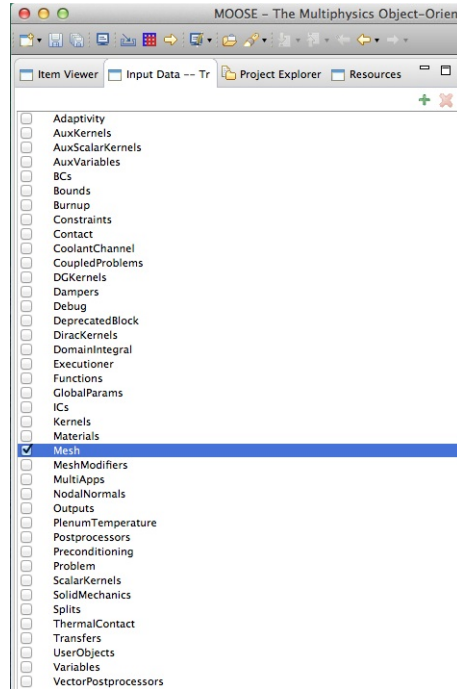
If you did not import a pre-written MOOSE file, some setup will be required before the job can create visualizations. Switch to the Input Data – Tree View tab on the left of the screen. Here you will see a list of MOOSE data categories. Click Mesh and switch to the Properties tab at the bottom.
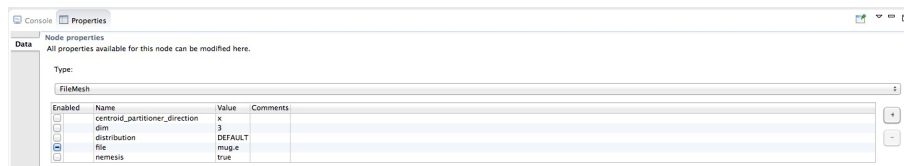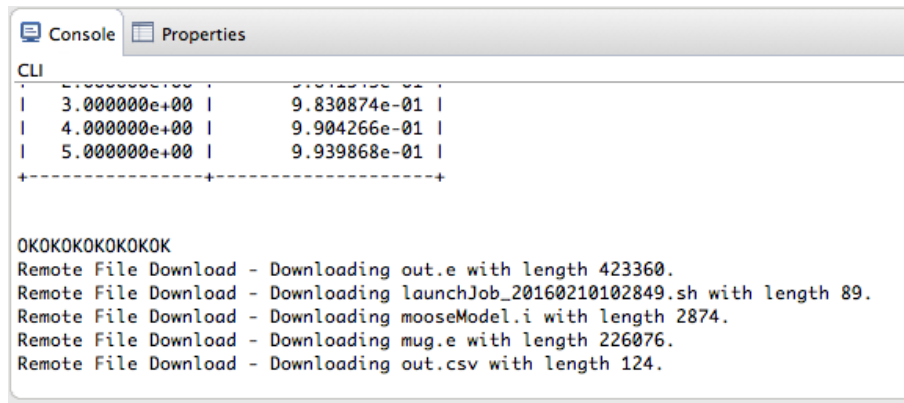

The Properties tab will display the properties of the Mesh variable. At the top will be drop down menu labeled Type. Select FileMesh from it and the table below it will be populated. In the table, select the file line and place the file containing the mesh you want to work with in it, as mug.e is in the example above.

If there are any variables you want to graph from the job, you will have to specify them as Variables and create PostProcessors which point to them,

similar to how you just set the Mesh.

## 4.2 Viewing the Embedded Visualizations

Once your MOOSE Workflow is set up, make sure the Process control is set to "Launch the Job", and click the Go! button in the upper right hand corner. Wait until the console shows that the output files are finished downloading, similar to what is seen here:


```
🖥 Console  ▦ Properties
CLI
|   3.000000e+00 |        9.830874e-01 |
|   4.000000e+00 |        9.904266e-01 |
|   5.000000e+00 |        9.939868e-01 |
+----------------+--------------------+


OKOKOKOKOKOKOK
Remote File Download - Downloading out.e with length 423360.
Remote File Download - Downloading launchJob_20160210102849.sh with length 89.
Remote File Download - Downloading mooseModel.i with length 2874.
Remote File Download - Downloading mug.e with length 226076.
Remote File Download - Downloading out.csv with length 124.
```

You can now change to the Resources tab on the left. This will list all the output files produced by the MOOSE job. Double clicking on one will open a Plot Editor inside the MOOSE Item's Mesh and Output Files tab. The visualization can be controlled normally, as described in previous sections.

Multiple resources can be opened at once. At the top of the screen are controls for the number of rows and columns making up the grid. These can be changed to set the layout for the various plots, as demonstrated below.
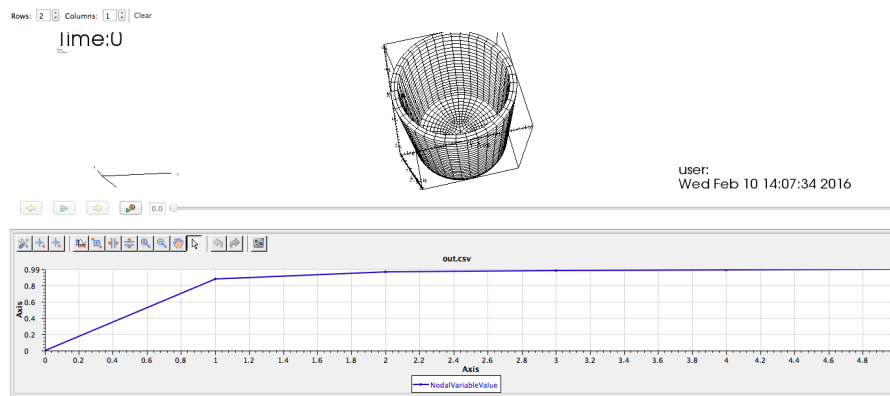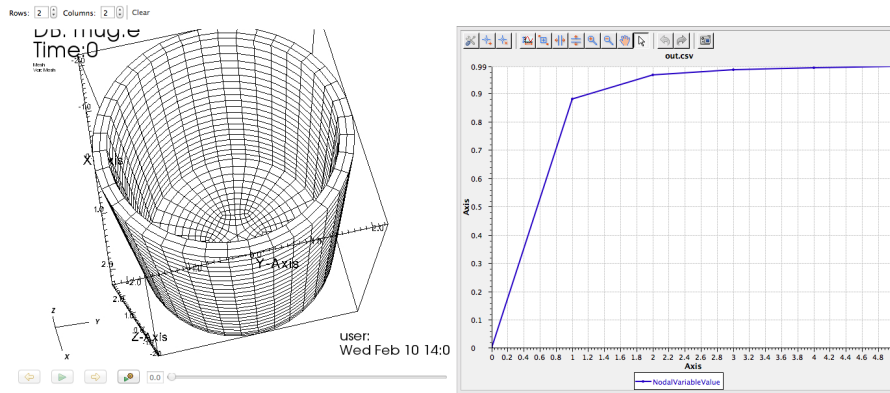
Be careful when reducing the number of rows or columns, as any plots which no longer fit in the grid will be closed.

If you hover over a plot, a button will appear in the upper left hand corner. Clicking it will close that plot.

Alternatively, the Clear button next to the controls for the number of rows and columns will close all the plots.