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Visual Spreadsheets in VisIt

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Motivation

The VACET team would like to add visual spreadsheeting capability to the visualization tool VisIt, to make it be a viable tool for current users of AMRVis and ChomboVis.

This document describes AMRVis' and ChomboVis' approaches to visual spreadsheets and describes a proposed visual spreadsheet mechanism for VisIt.

Existing implementations

ChomboVis

ChomboVis is a visualization tool developed at Lawrence Berkeley National Laboratory primarily for Adaptive Mesh Refinement (AMR) visualization. ChomboVis reads Chombo's HDF5 file format and processes data using the Visualization Toolkit (VTK).

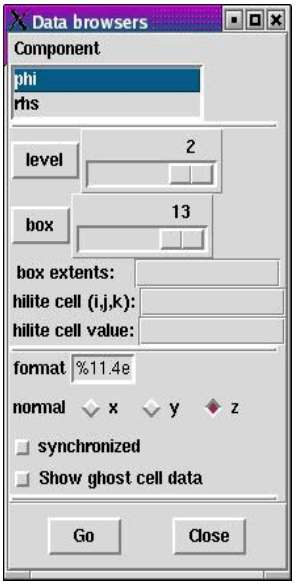
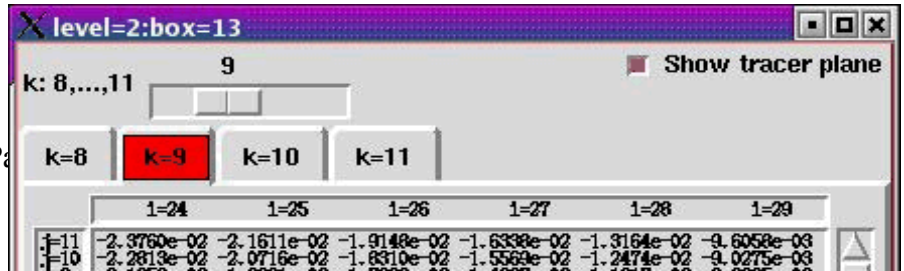


Figure 1 – ChomboVis data browser window

The visual spreadsheet in ChomboVis is actually another helper tool that reads in the HDF5 data and displays it in a visual spreadsheet window. When the user invokes the visual spreadsheet in ChomboVis, he must first select a variable to extract from the database as well as an AMR box and refinement level using the Data browser window shown in Figure-1. Restricting the data to be displayed in a spreadsheet is an important step because it is not feasible to expose very large datasets as spreadsheets. Large datasets displayed in their entirety would require a lot of resources and could become difficult to understand.
Once both the variable and AMR patch are chosen in the Data browser window, a new visual spreadsheet window, shown in Figure-2, is created showing all data for the selected AMR patch in a simple table. The table in a visual spreadsheet is inherently useful for displaying 2D data. 3D data are handled by creating tabs for each index in the 3rd dimension and a 2D spreadsheet is created on each tab. Using the cell indices on the tabs and around the edges of the spreadsheet, it is possible to quickly find the value for any database cell. The visual spreadsheet window also includes controls for numeric formatting, data display, and controls for selecting the active variable. Changing the active variable causes data for the new active variable on the currently selected AMR patch to be read from the database and displayed in the spreadsheet.



Since the visual spreadsheet in ChomboVis displays one AMR patch at a time, ChomboVis permits multiple visual spreadsheets to be active so data from multiple patches may be examined. Each visual spreadsheet also places a highlight box that outlines its AMR patch's extents into the main visualization window (*see Figure-3*). In 3D, the active tab in the visual spreadsheet window is highlighted in red. The active tab also indicates where in the 3D visualization's highlight box a highlighted plane will be drawn. The highlight plane indicates where, in the 3D visualization, one can find the data highlighted on the visual spreadsheet's active tab. Furthermore, as the active tab is changed in the visual spreadsheet, the highlight plane in the 3D visualization updates its location.

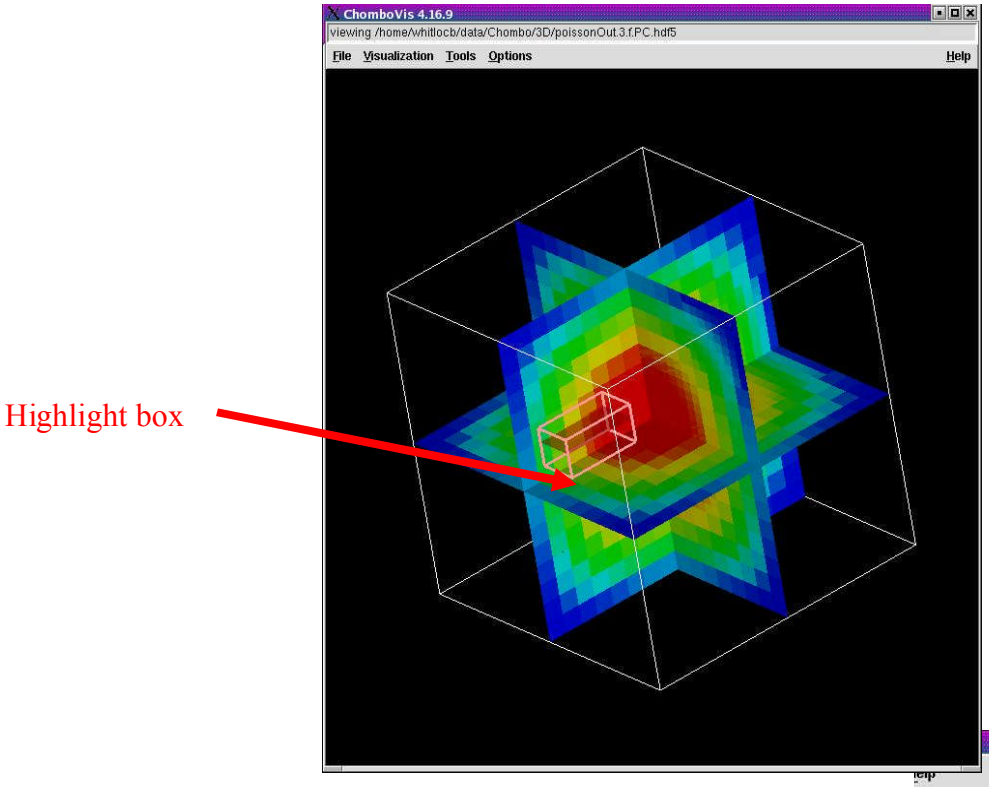


Figure 3 – The highlight box in a 3D ChomboVis visualization.

AMR Vis

AMR Vis is a visualization and data analysis tool, developed at LBL, for examining data files generated by AMR algorithms. AMRVis provides a visualization window, shown in Figure-4, that can display scalar AMR data mapped to color. The boundaries of each AMR patch are also drawn on top of the scalar data. The user can pick on the plot in the main visualization window reveal information such as the coordinates of the pick, the AMR level and patch of the pick, and the value and cell indices of the cell that contains the pick point.

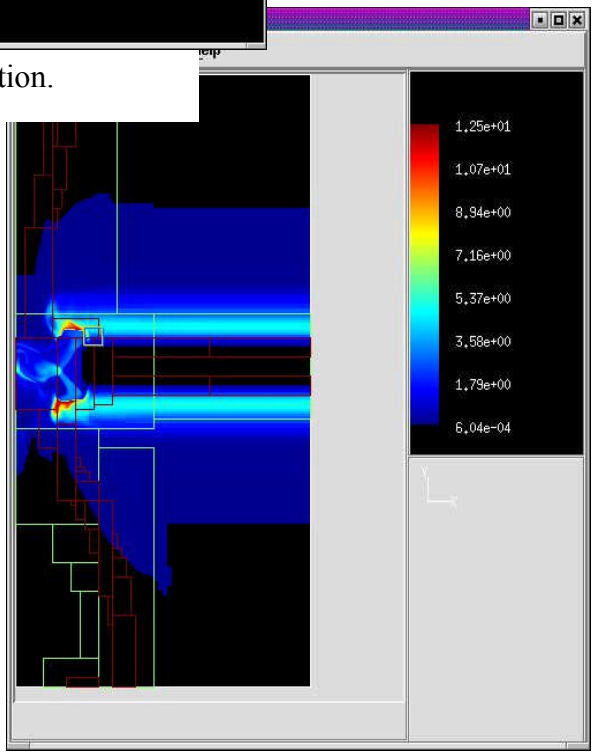


Figure-4 – AmrVis main window

In addition to plotting AMR datasets AMRVis provides a visual spreadsheet for displaying the numeric data used to create the plotted image in a tabular form. Data is selected for the visual spreadsheet using a rectangular selection tool that allows the user to highlight a region on

the screen where data extraction will take place. Once the user sweeps out a region of interest, it is possible to activate the visual spreadsheet to display data from the AMR cells that exist within the specified bounds. The AMRVis visual spreadsheet, seen in Figure-5, displays data for only the selected region, which may contain several AMR patches, and uses its knowledge of the AMR data to represent the data in the spreadsheet in cells showing the AMR structure. The AMRVis visual spreadsheet surpasses conventional spreadsheets because the data are displayed in a format that resembles a labeled plot of the AMR mesh, including the mesh boundaries. In addition to showing the mesh structure and the values within each cell, the spreadsheet provides special axis annotations that show the levels of AMR nesting as well as the indices used to address cells within each AMR level. The AMRVis visual spreadsheet also contains optional controls for coloring the text using the displayed data values and also accepts input controlling numeric format.

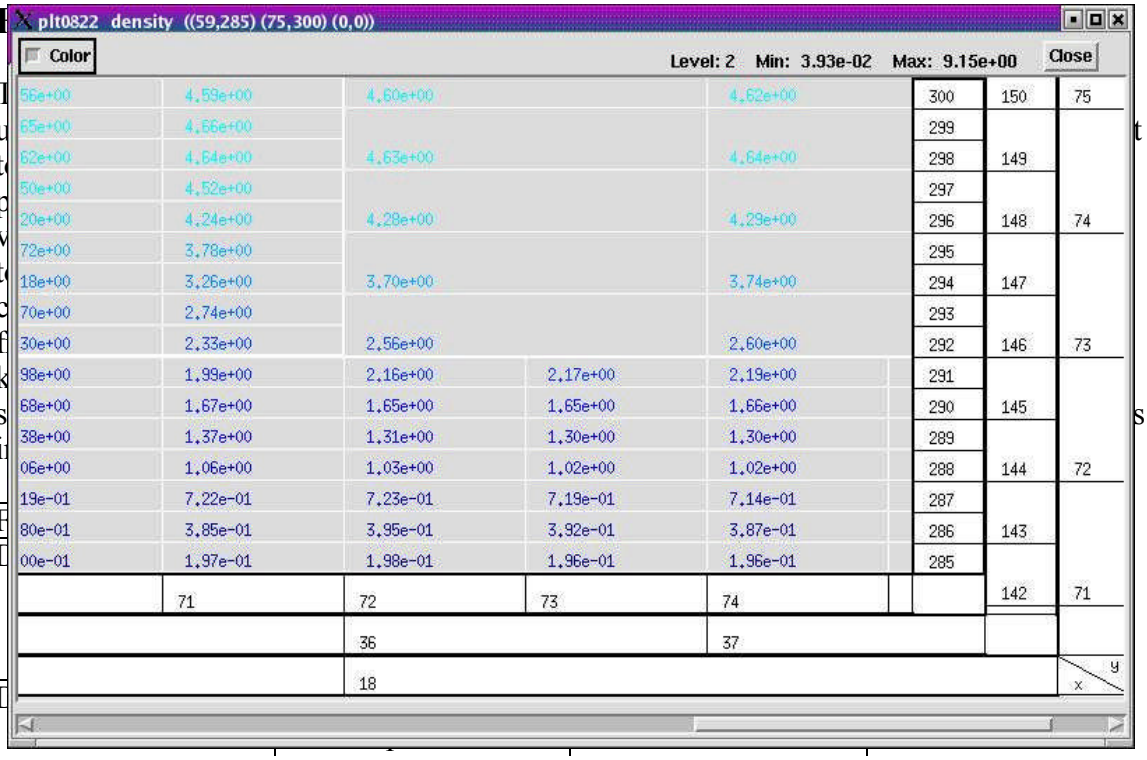


Figure-5 – AMRVis visual spreadsheet

	grid that surrounds the patch. Cell indices and cell values.	structure and has additional AMR nesting context in the form of specialized axes
Color text by data	No	Yes
Set text format	Yes	Yes

Highlights original plot	Yes – via explicit highlight of patch bounds with extra plane highlight in 3D	Yes – via rectangular selection tool
Spreadsheet shows AMR context	No	Yes – using AMR mesh and special axes
Multiple spreadsheet windows	Yes	No
Spreadsheet can be used stand-alone	Yes	No

Points to consider

1) The existing formats (Chombo HDF5 and Boxlib) only store scalars, and they store vectors as multiple scalars. Since the visual spreadsheets will also be applicable to VisIt's other customers, we should consider data types beyond scalars as well. Do the existing stakeholders have opinions about this? Beyond vectors, there is also material information. Another issue is point-centered data, which may be an issue for your mapped grids.
2) A data selection scheme that chooses a region of the grid can easily overwhelm memory. Is it intended that users will choose large regions of data with this scheme? (As opposed to the ChomboVis scheme which chooses a single patch to operate on.)

Possible requirements (unification of differences)

- Multiple spreadsheet windows
- How to select data for visual spreadsheet? Select domain vs. Select box – or both?
- Highlight of plot data to relate the data in a visual spreadsheet to the data in a plot.
- Export to visual spreadsheet data to file
- Format number display
- Display of AMR data as well as non-AMR data such as VisIt's material data
- AMR-aware axes and mesh display in spreadsheet?
- Color numbers by scalar value
- Use spreadsheet or some form of it as stand-alone data viewer

Proposed solution

It would be highly desirable to have a unified solution.
However:

1) the AMRVis style spreadsheet, where a 2D subregion of the grid (that may span many patches), requires VisIt to have the option of using its parallel processing for large data sets.
2) The ChomboVis style spreadsheet, where a user can very quickly vary which 2D subregion of a single patch, requires an implementation with tabs and quick interaction.

Given the makeup of VisIt, these two goals seem somewhat incongruent. As such, a possible outcome is two implementations, both of which would be available to the ANAG and CCSE code teams.

The current pathforward is to have a single plot for spreadsheets, which can have two dramatically different appearances. One will appear like the ChomboVis style spreadsheet and enable quick interactivity for a single patch. The other will appear like AMRVis and leverage VisIt's scalable rendering mode (when necessary).