

Python's Role in VisIt

SciPy 2012 Presentation

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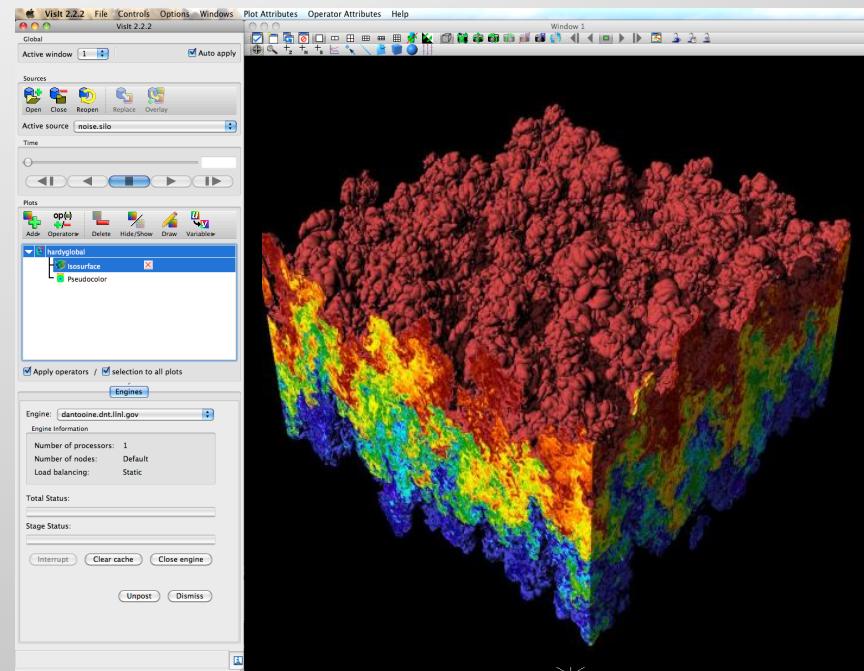
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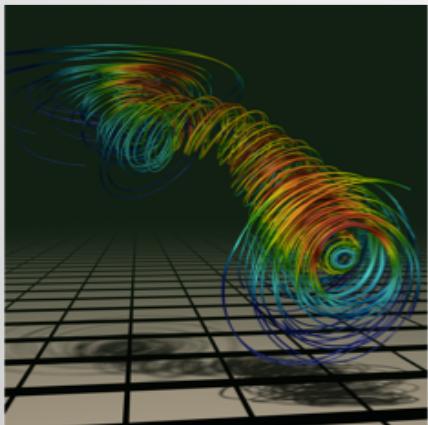
VisIt is an open source, turnkey application for data analysis and visualization of mesh-based data.

- Production end-user tool supporting scientific and engineering applications.
- Provides an infrastructure for parallel post-processing that scales from desktops to massive HPC clusters.
- Source released under a BSD style license.

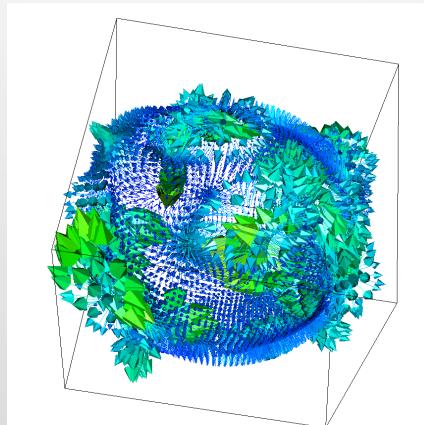


**Density Isovolum of a
3K³ (27 Bz) dataset**

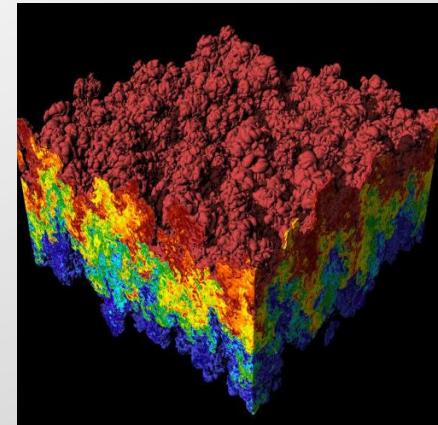
Examples of VisIt's visualization capabilities.



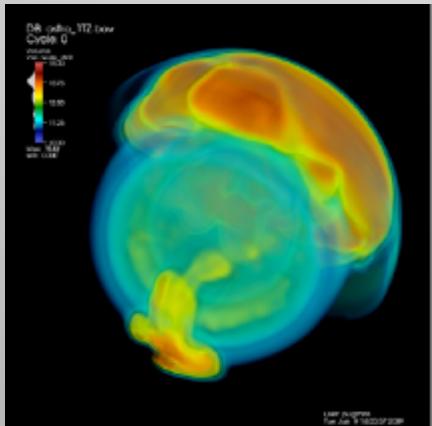
Streamlines



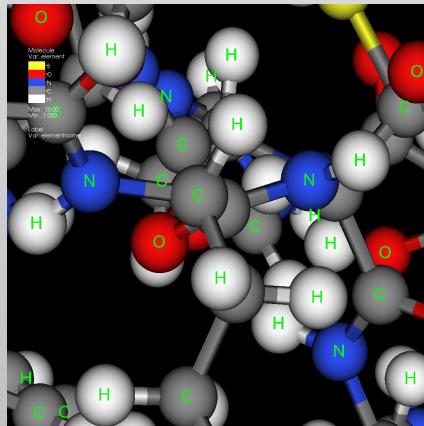
Vector / Tensor Glyphs



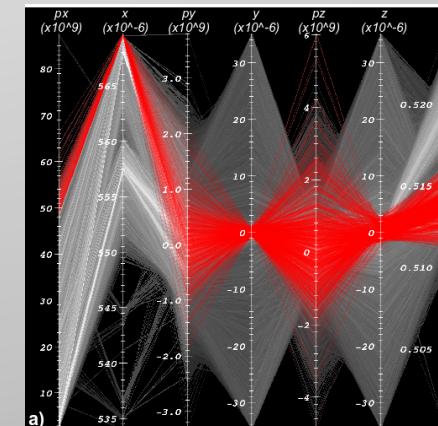
Pseudocolor Rendering



Volume Rendering

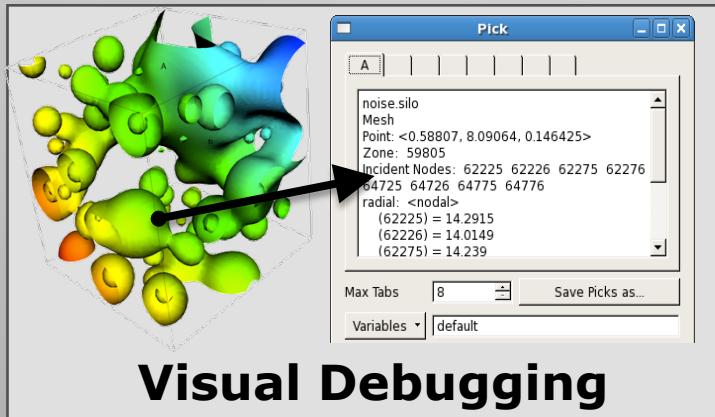
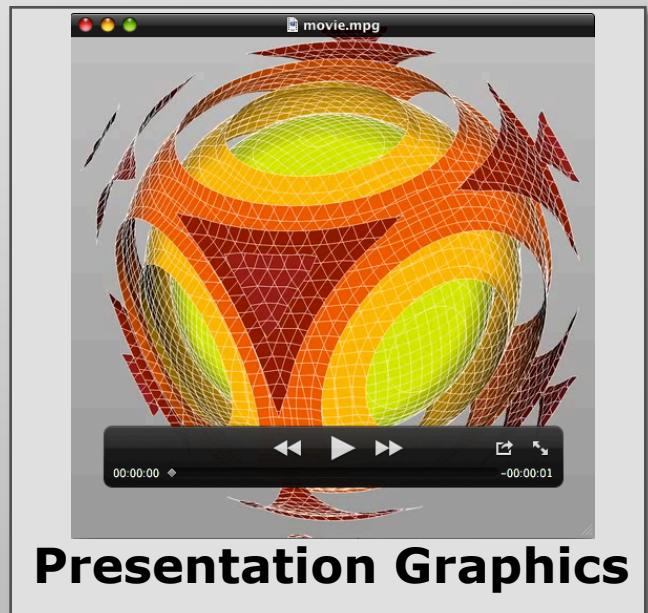
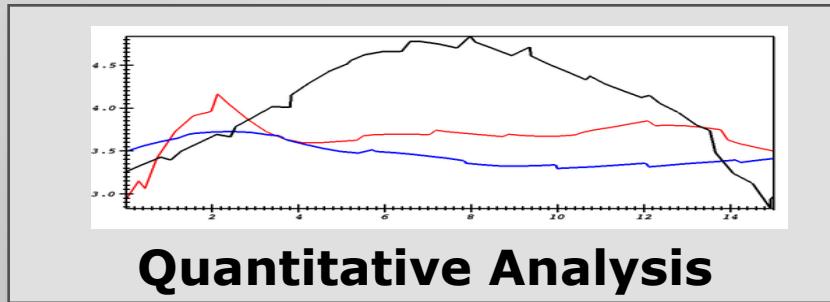
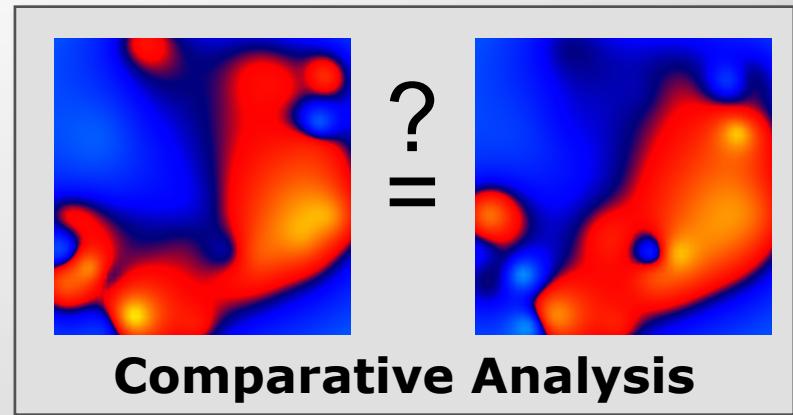
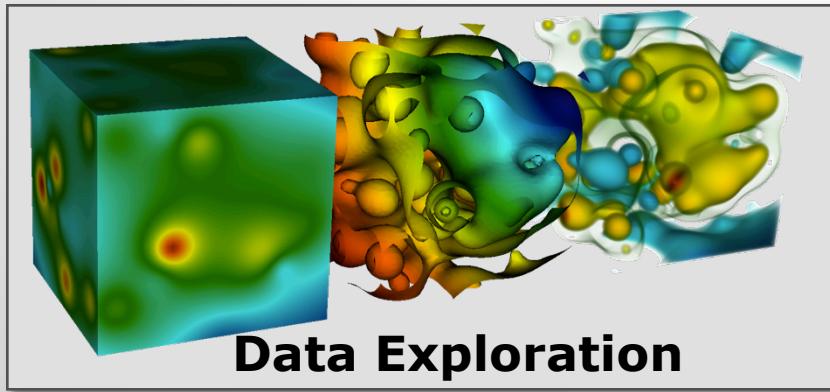


Molecular Visualization



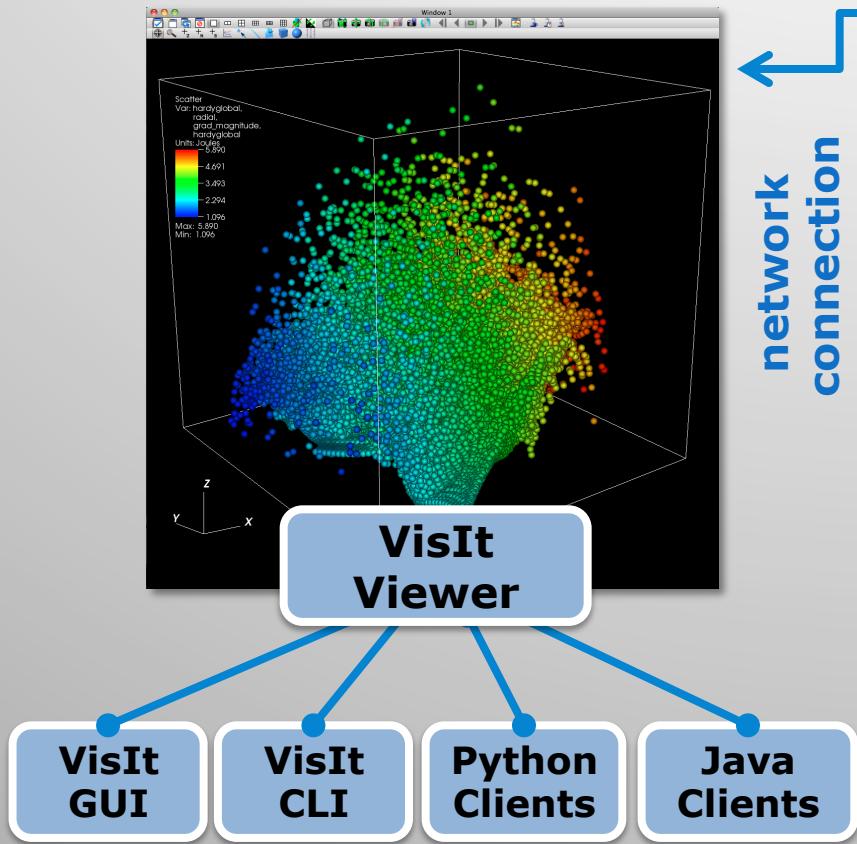
Parallel Coordinates

VisIt supports a wide range of use cases.

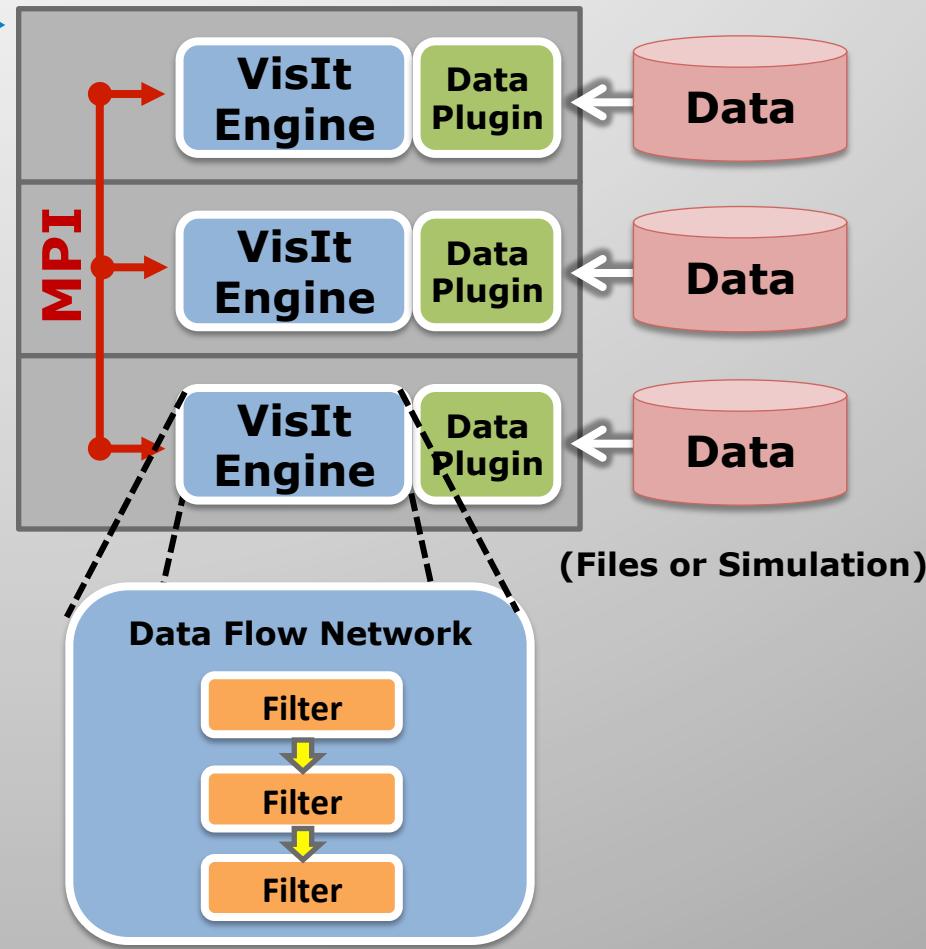


VisIt employs a parallelized client-server architecture.

Local Components

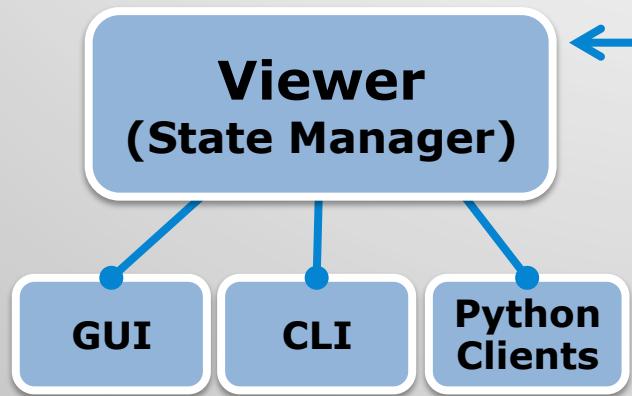


Parallel Cluster

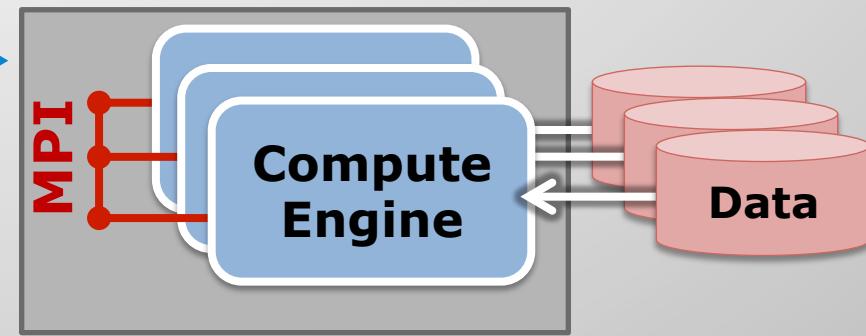


VisIt provides Python interfaces for state control and data manipulation.

Local Components



Parallel Cluster



**Python Client Interface
(State Control)**

**Python Filter Runtime
(Direct Mesh Manipulation)**

VisIt provides Python interfaces for state control and data manipulation.

Local Components | Parallel Cluster

Walkthrough Topics:

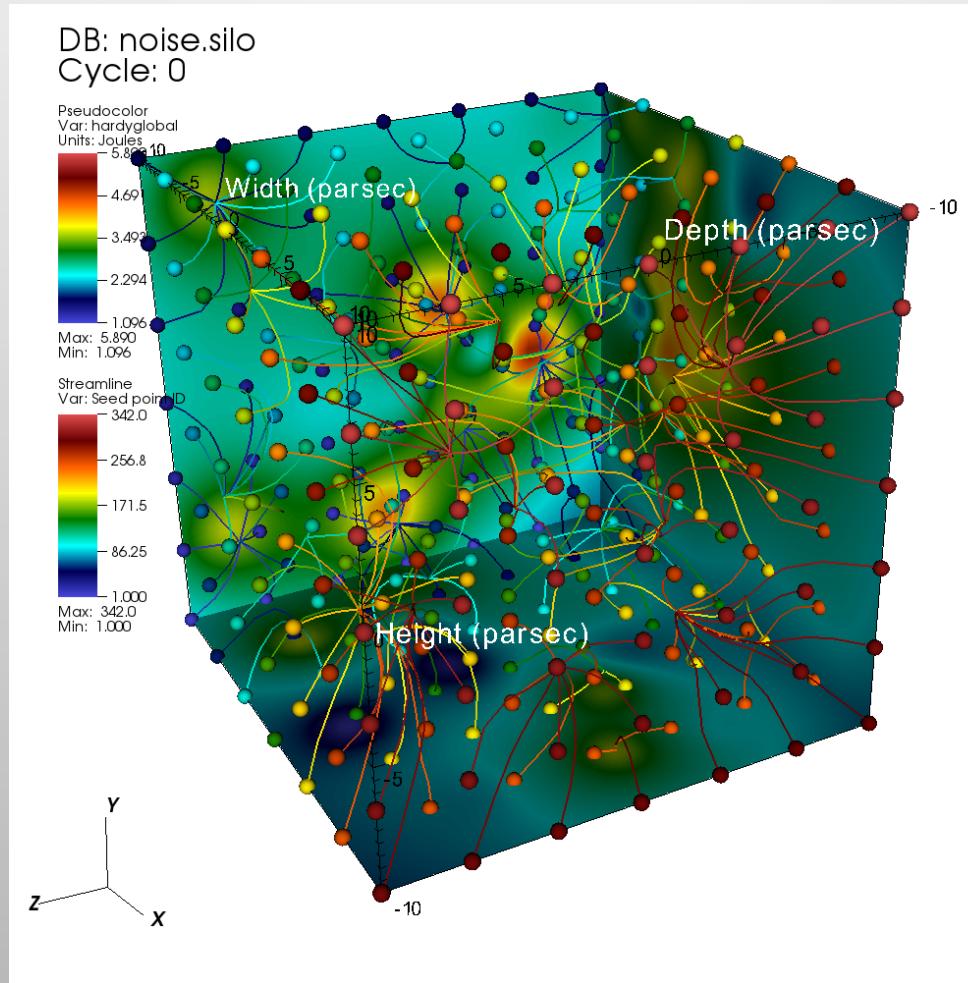
- Python Client Interface
- Custom Python UIs
- Python Filter Runtime

Python Client Interface
(State Control)

Python Filter Runtime
(Direct Mesh Manipulation)

Python Client Interface

Python Client Interface Example Script: Using VisIt's Building Blocks



There are several ways to access VisIt's Python Client Interface.

- Launch VisIt's CLI binary:
 - >visit -cli
- Launch for windowless batch processing:
 - >visit -nowin -cli -s <script_file.py>
- Control VisIt from a Python interpreter:
 - `import visit`
 - http://visitusers.org/index.php?title=Python_Module_Support
- Record GUI actions in to Python snippets:
 - Macro Recording provides a quick path to learn VisIt's Python API.

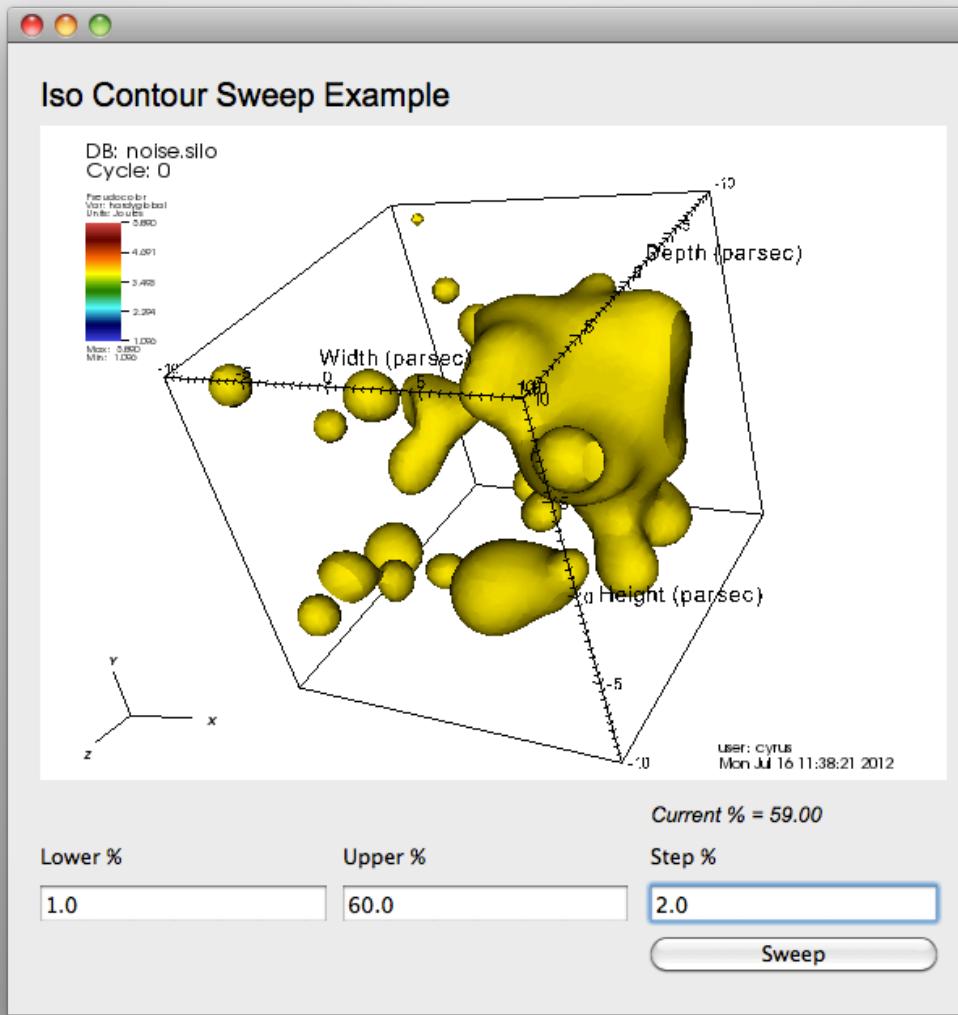
Custom Python UIs

We extended VisIt's core C++ infrastructure to support Python custom UIs.

- We chose PySide, a LGPL Python Qt wrapper, as the primary UI framework.
- Current support includes the ability to:
 - *Embed VisIt's render windows.*
 - *Reuse VisIt's existing GUI widgets.*
 - *Design UIs via Qt Designer.*
- Full UI integration required combining ***client*** (CLI, GUI) and ***viewer*** processes.

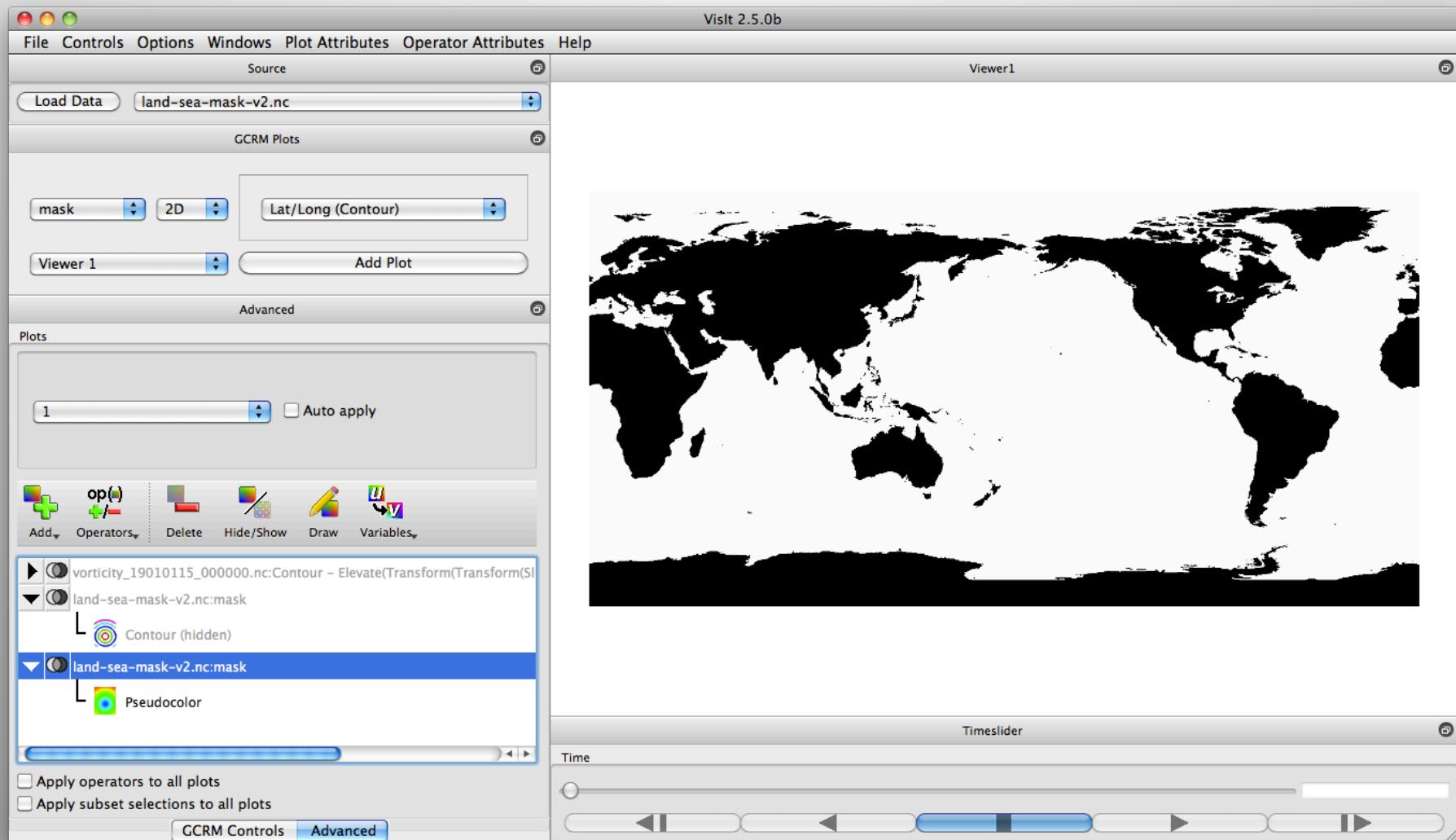


Custom Python UI Example Script: Isosurface Sweep



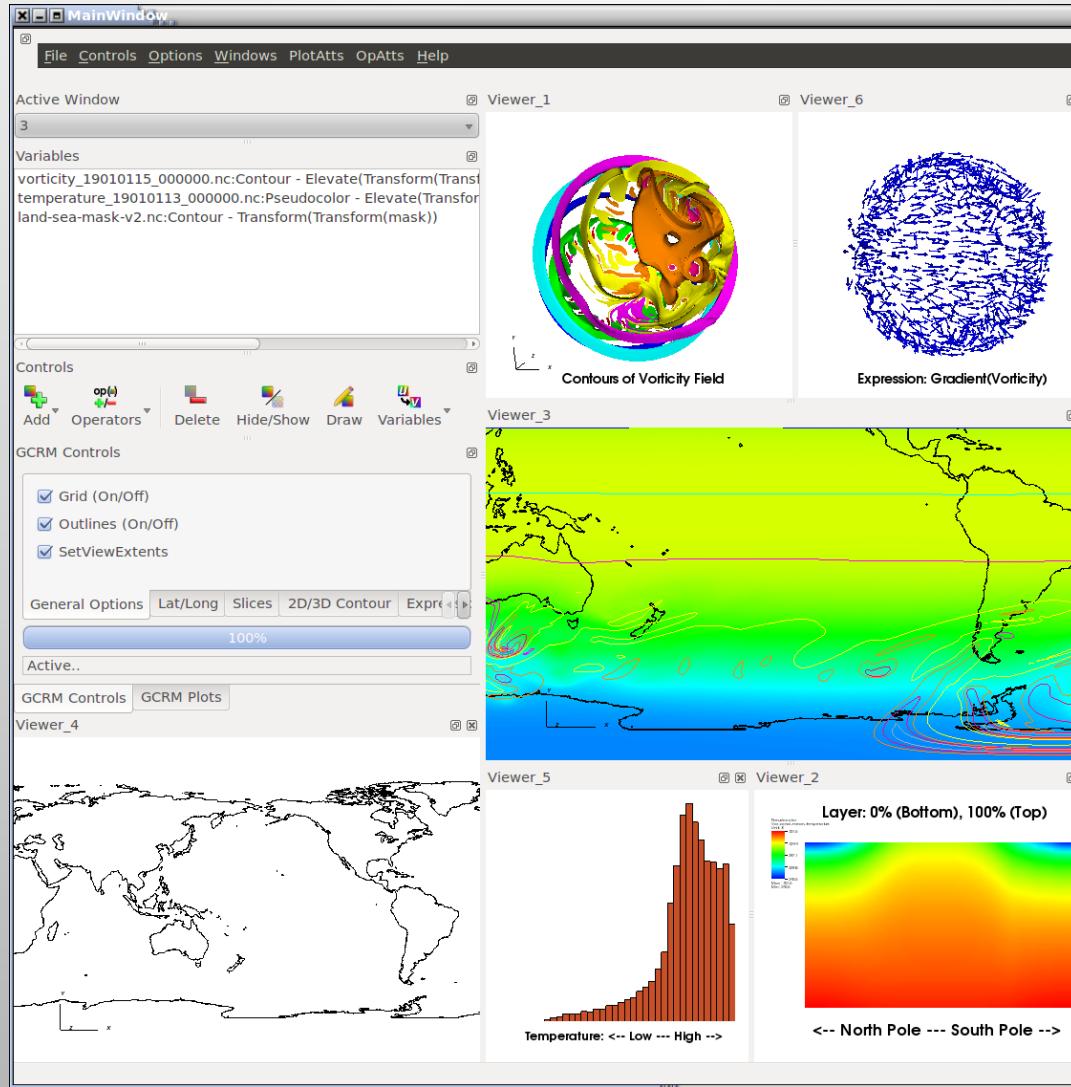
Custom UI Example: GCRM

Global Cloud Resolving Model Viewer



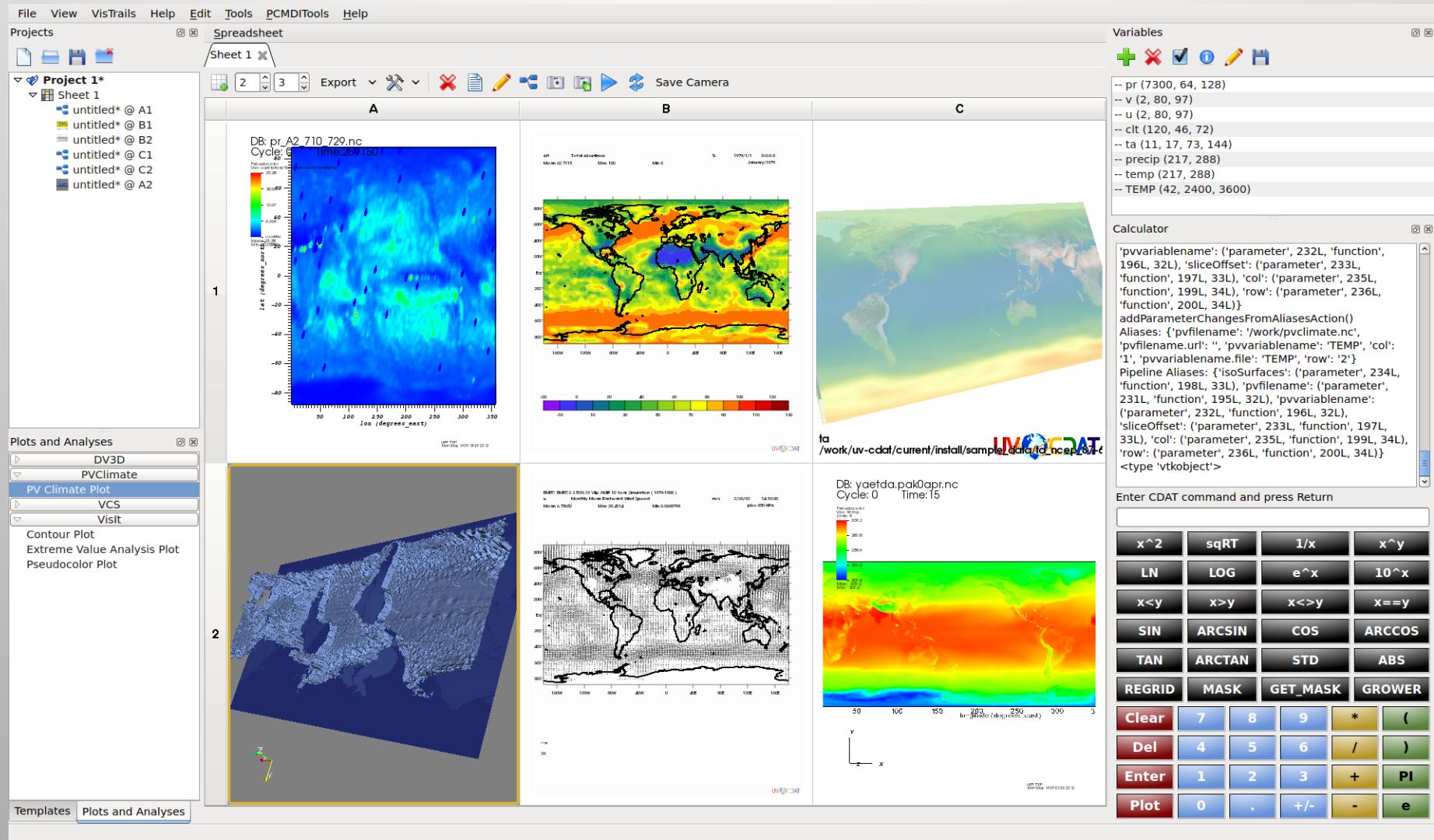
Custom UI Example: GCRM

Global Cloud Resolving Model Viewer



Custom UI Example: UV-CDAT

Ultrascale Visualization – Climate Data Analysis Tools



Custom UI Example: UV-CDAT

Ultrascale Visualization – Climate Data Analysis Tools

File View VisTrails Help Edit Tools PCMDITools Help

Projects

- Project 1*
 - untitled* @ A1
 - untitled* @ B1
 - untitled* @ B2
 - untitled* @ C1
 - untitled* @ C2
 - untitled* @ A2

Spreadsheet

Sheet 1

A **B** **C**

1 **2**

Variables

Calculator

```
-- pr (7300, 64, 128)
-- v (2, 80, 97)
-- u (2, 80, 97)
-- cld (120, 46, 72)
-- ta (11, 17, 73, 144)
-- precip (217, 288)
-- temp (217, 288)
-- TEMP (42, 2400, 3600)
```

Enter CDAT command and press Return

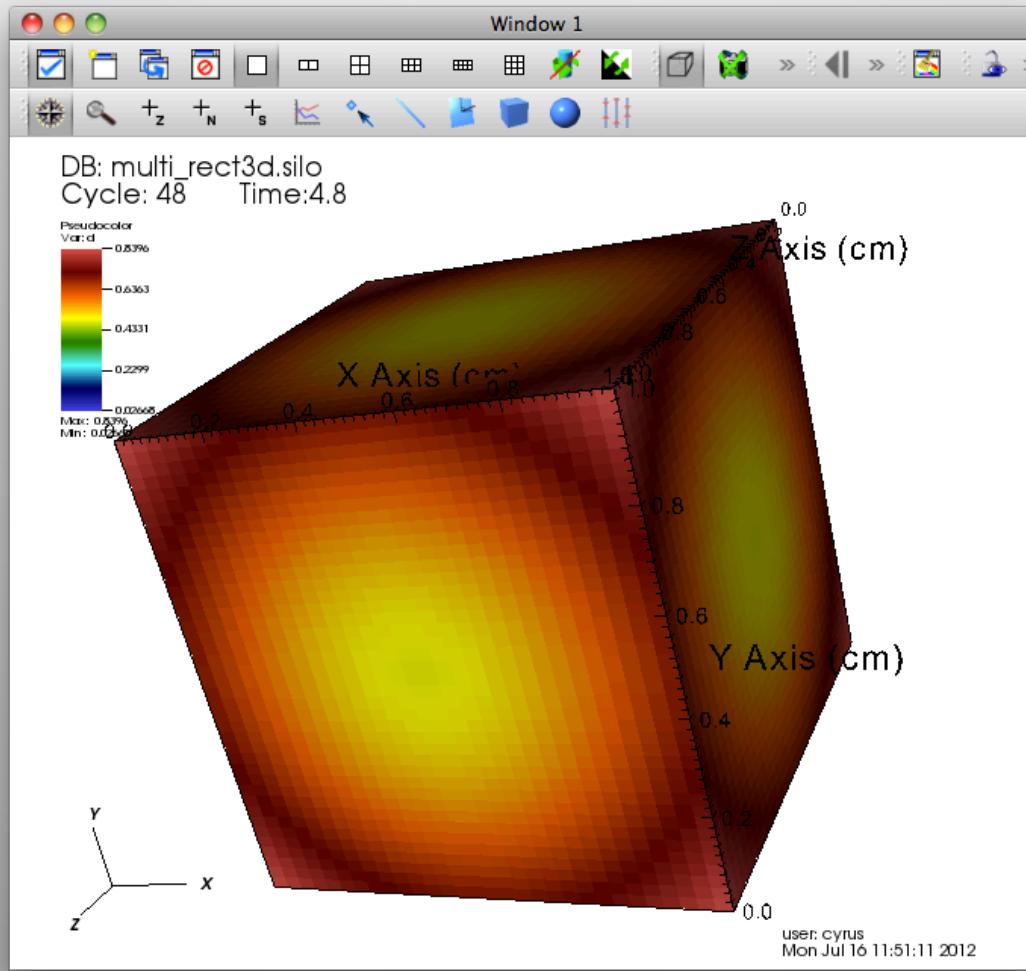
x^2	sqrt	1/x	x^y
LN	LOG	e^x	10^x
x<y	x>y	x<>y	x==y
SIN	ARCSIN	COS	ARCCOS
TAN	ARCTAN	STD	ABS
REGRID	MASK	GET_MASK	GROWER
Clear	7	8	9
Del	4	5	6
Enter	1	2	3
Plot	0	.	+/-
			-
			e

Python Filter Runtime

A Python Filter Runtime provides access to low-level mesh data structures.

- VisIt embeds a Python interpreter in each ***compute engine*** MPI process.
- C++/Python data exchanges utilize VTK's Python wrapper module.
 - Nice path to *numpy* and *scipy*.
- Parallel communication is provided via a simple MPI wrapper, named '*mpicom*'.
- We currently support Python Filters for VisIt's ***Expression*** and ***Query*** building blocks.

Python Filter Runtime Example Script: Cell Average Query



Python Filter Runtime Example: OpenCL Expression Framework Research

```

du = grad(vx,dims,x,y,z)
dv = grad(vy,dims,x,y,z)
dw = grad(vz,dims,x,y,z)

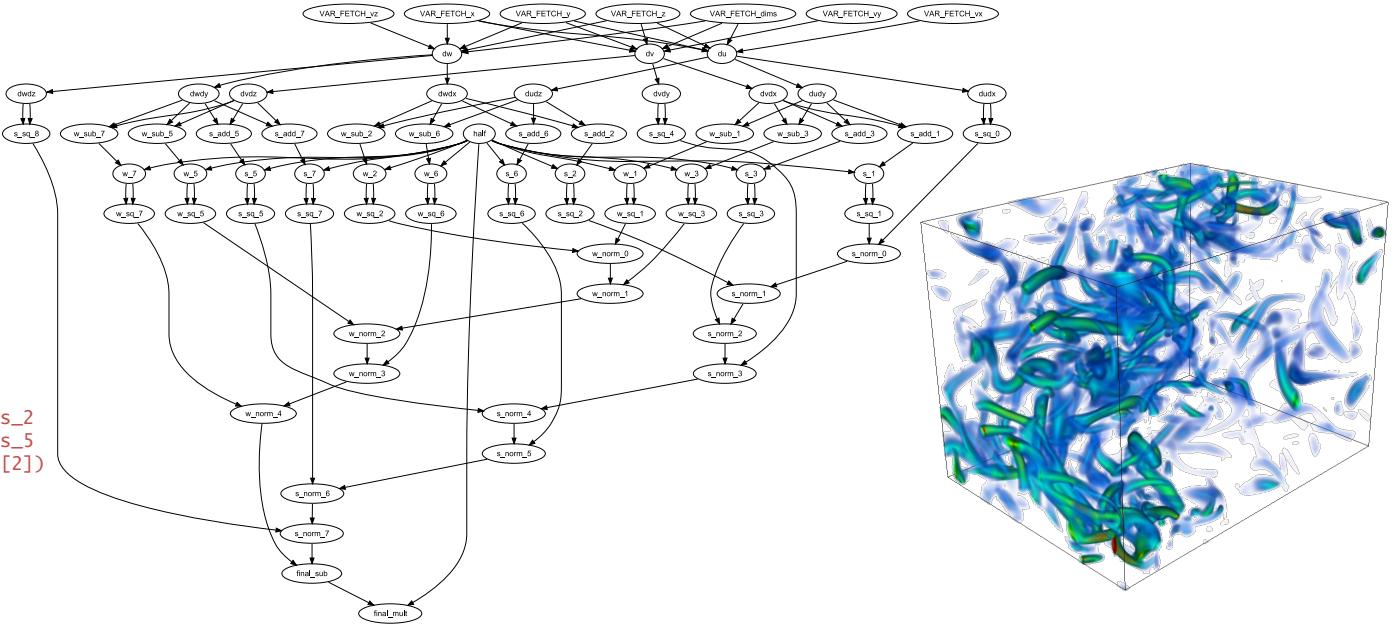
s_1 = (.5 * (du[1] + dv[0]))
s_2 = (.5 * (du[2] + dw[0]))
s_3 = (.5 * (dv[0] + du[1]))
s_5 = (.5 * (dv[2] + dw[1]))
s_6 = (.5 * (dw[0] + du[2]))
s_7 = (.5 * (dw[1] + dv[2]))
w_1 = (.5 * (du[1] - dv[0]))
w_2 = (.5 * (du[2] - dw[0]))
w_3 = (.5 * (dv[0] - du[1]))
w_5 = (.5 * (dv[2] - dw[1]))
w_6 = (.5 * (dw[0] - du[2]))
w_7 = (.5 * (dw[1] - dv[2]))

s_norm = (du[0]*du[0] + s_1*s_1 + s_2*s_2
          + s_3*s_3 + dv[1]*dv[1] + s_5*s_5
          + s_6*s_6 + s_7*s_7 + dw[2]*dw[2])

w_norm = (w_1*w_1 + w_2*w_2
          + w_3*w_3 + w_5*w_5
          + w_6*w_6 + w_7*w_7)

q_crit = (.5 * (w_norm - s_norm))

```



User Expression

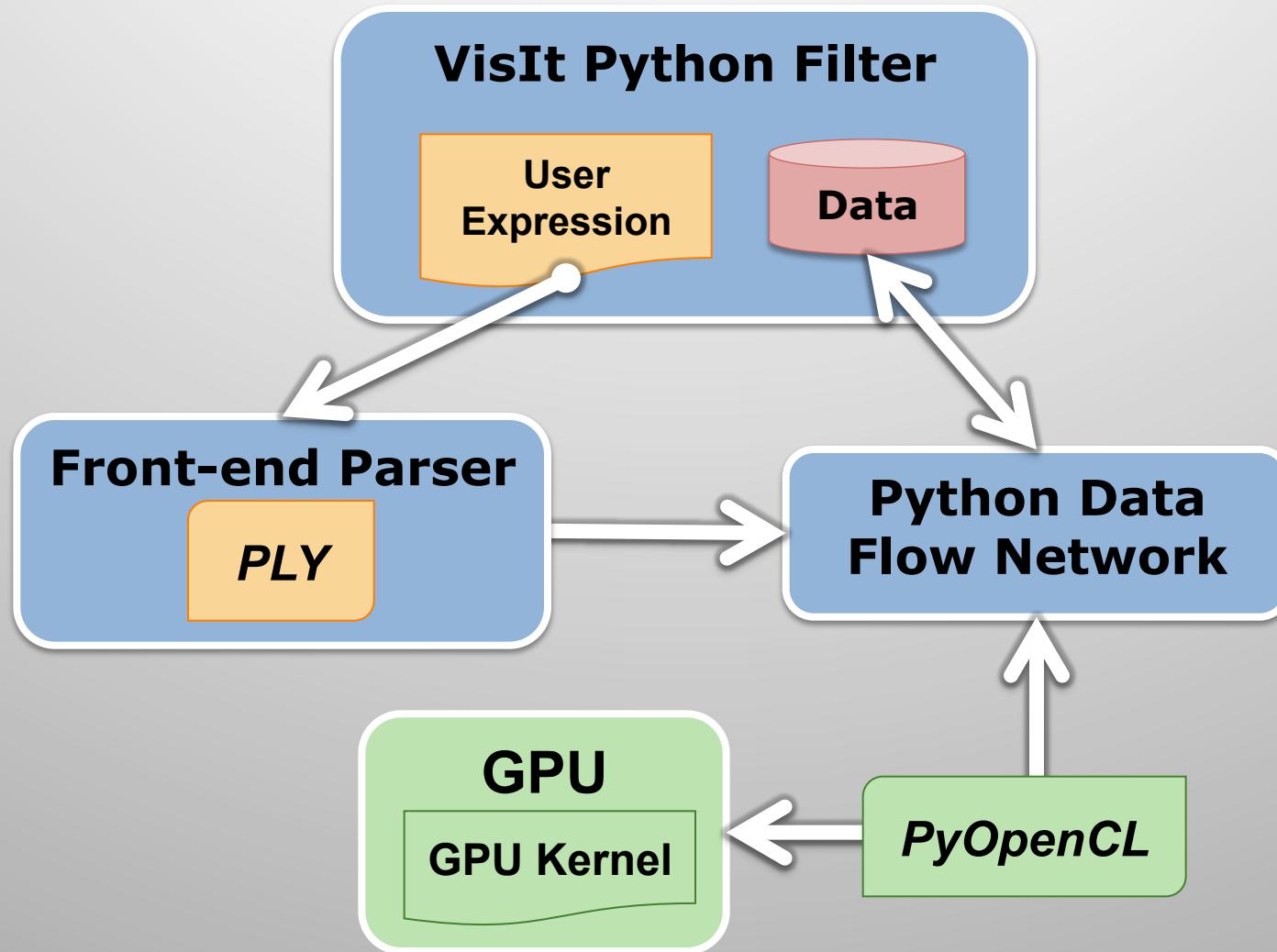
Data Flow Network

Volume Rendering
of GPU Result

Joint research with M. Moussalem (UT-Austin), P. Navrátil, (TACC) and M. Jiang (LLNL)

Illustration of the OpenCL GPU expression framework executing a user defined Q-criterion expression, used for vortex core detection.

Python Filter Runtime Example: OpenCL Expression Framework Research



The End ...

- **Future Work:**

- Stronger, faster, smarter Python support.

- **Thanks to:**

- VisIt Team
 - GCRM, UV-CDAT, and TACC Researchers

- **Code Examples:**

- https://github.com/cyrush/scipy_proceedings/tree/2012/papers/krishnan_harrison

- **VisIt Project Resources:**

- VisIt Website: <https://wci.llnl.gov/codes/visit/>
 - VisIt Users Wiki: <http://visitusers.org/>
 - VisIt Mailing Lists: visit-users, visit-developers
 - Python Reference Manual:
<http://portal.nersc.gov/svn/visit/trunk/releases/2.3.0/VisItPythonManual.pdf>

- **Questions?**