

The ParaView Coprocessing Library

**A Scalable, General Purpose *In Situ*
Visualization Library**

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Kitware Inc.

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University of Colorado at Boulder



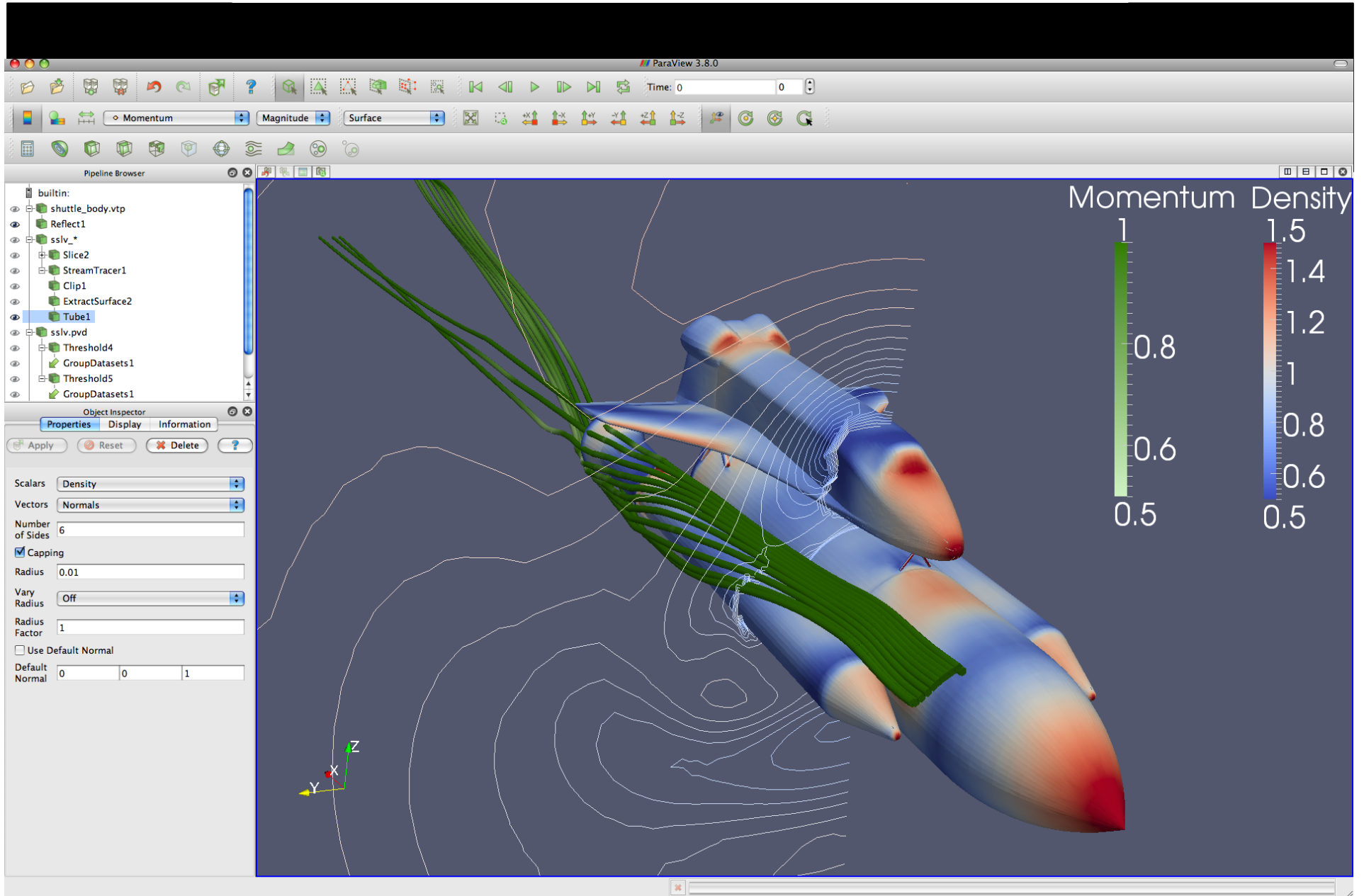
**Sandia
National
Laboratories**



**University of Colorado
Boulder**

LDAV 2011
SAND 2011-7859 C

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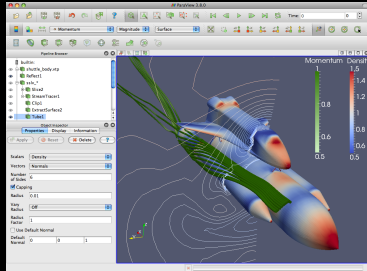


Current ParaView Usage

- Used by academic, government, and commercial institutions worldwide.
 - Downloaded ~3K times/month.
- Landmarks of SNL usage:
 - 6 billion structured cells (2005).
 - 250 million unstructured cells (2005).
 - Billions of AMR cells with 100's of thousands of blocks (2008).
 - Scaling test over 1 Trillion structured cells (2010).



ParaView Application Architecture



ParaView Client

pvpython

Coprocessing

Qt Controls

Python Wrappings

ParaView Server
Parallel Abstractions and Controls

VTK
Core Visualization and Analysis Algorithms

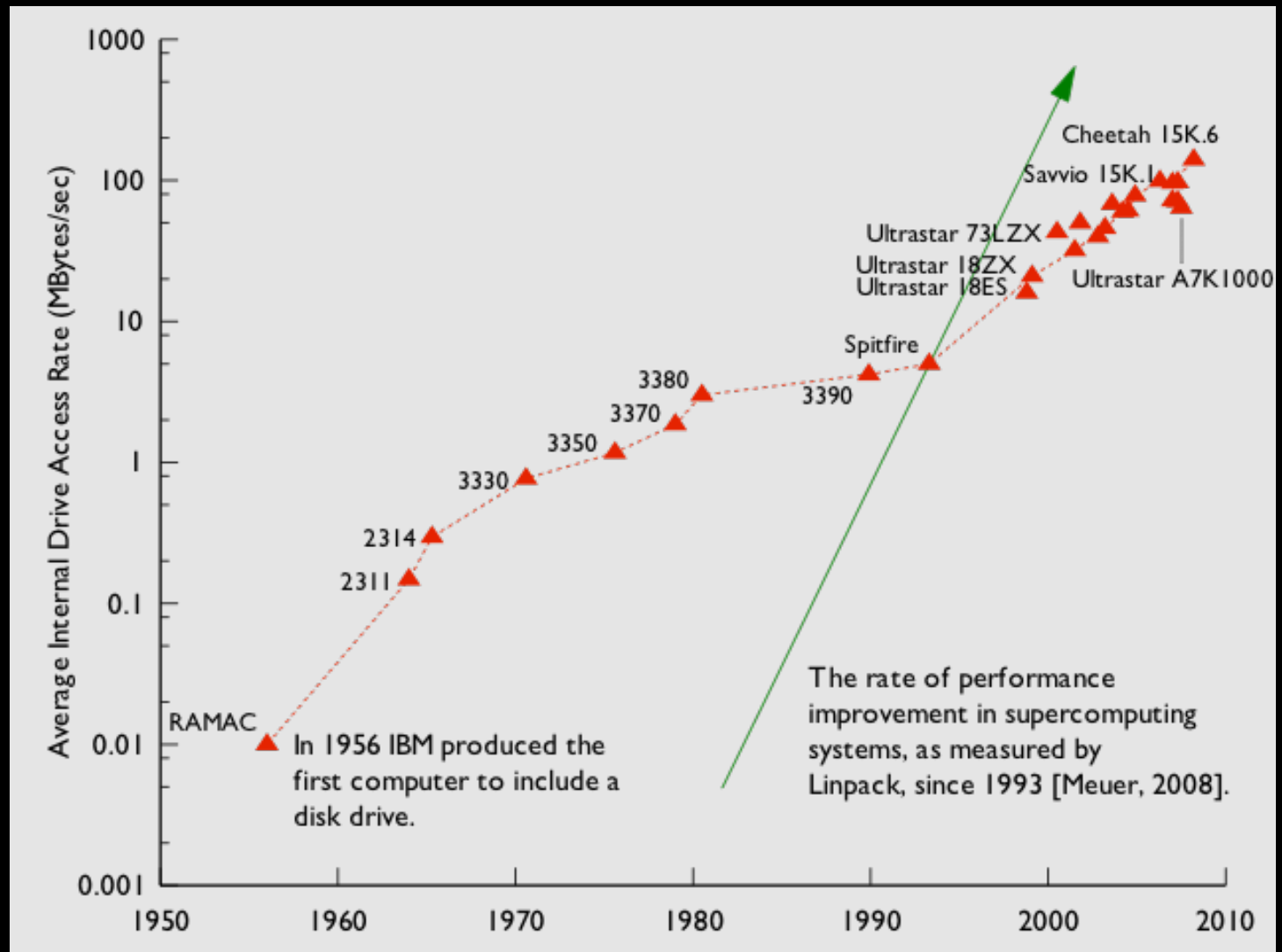
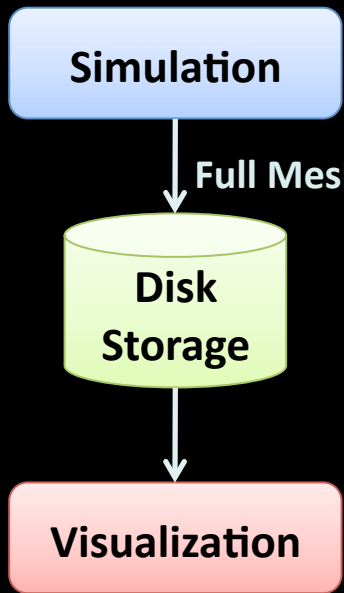
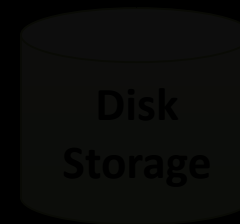
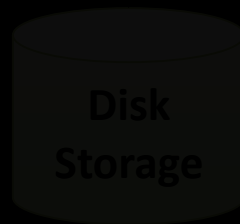
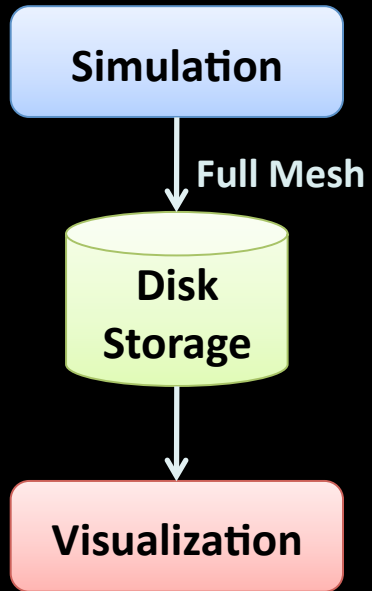
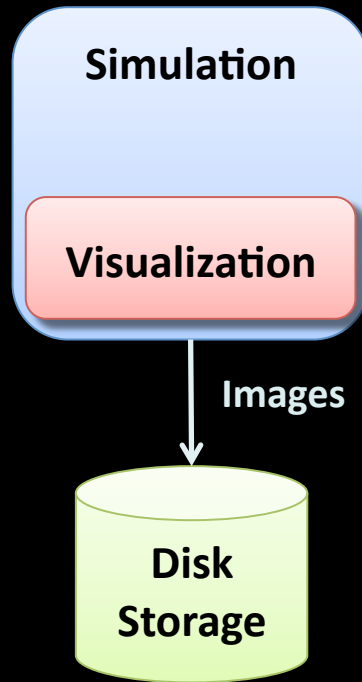
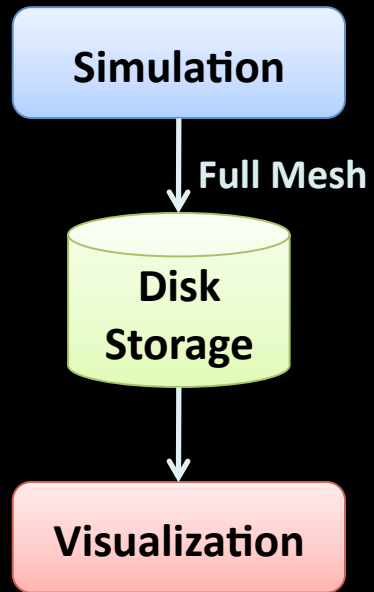
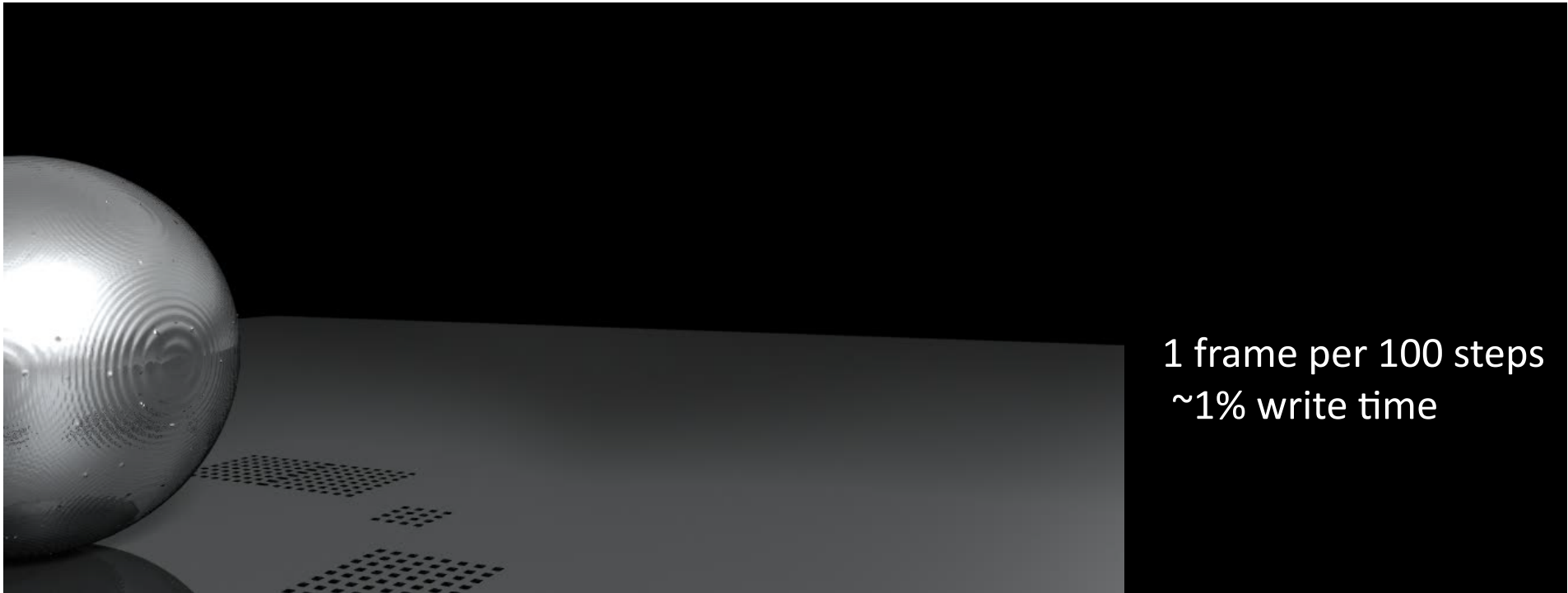


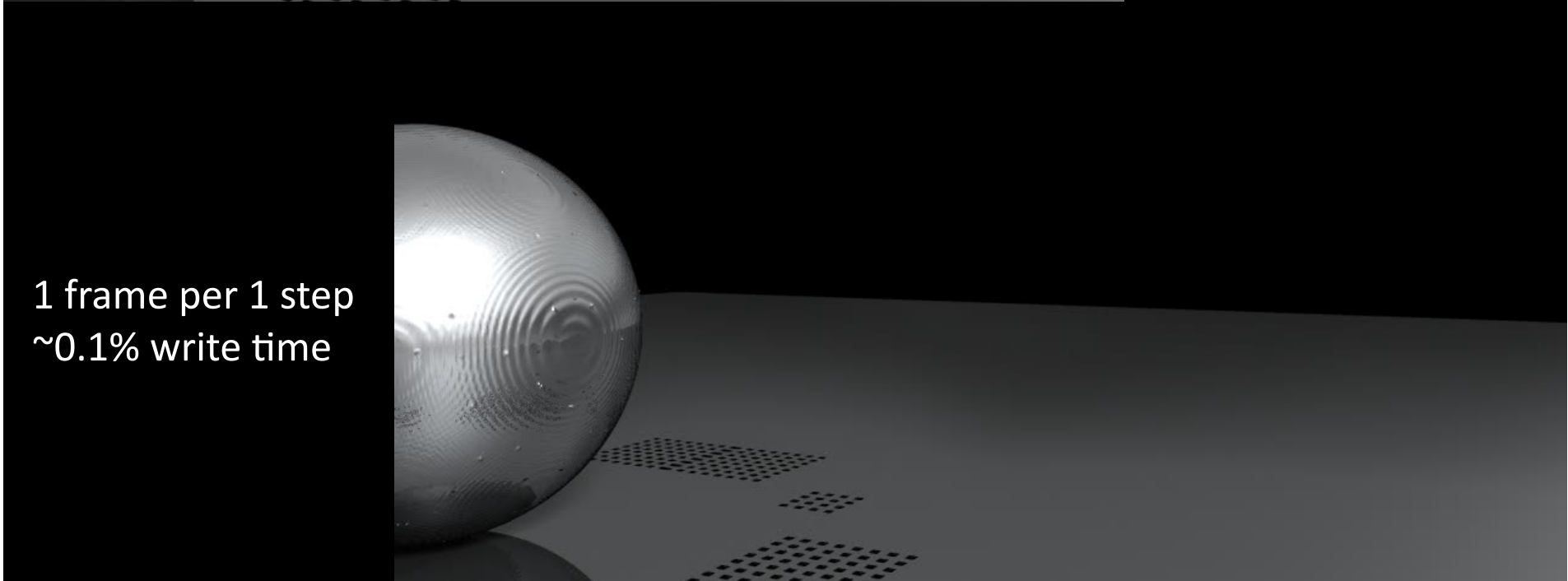
Image from Rob Ross, Argonne National Laboratory



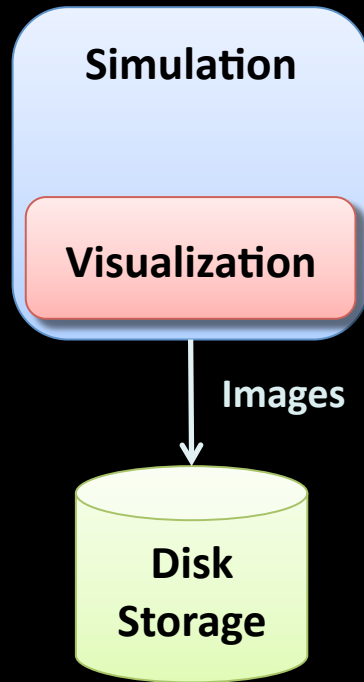
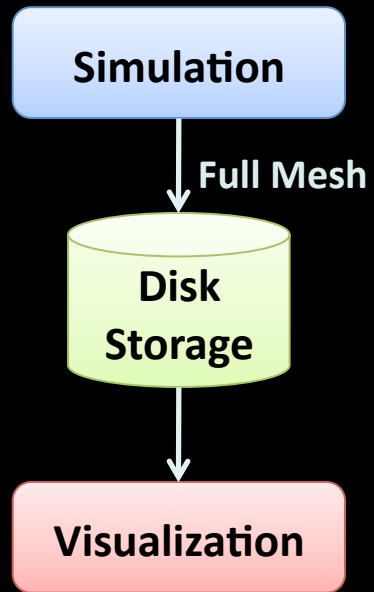


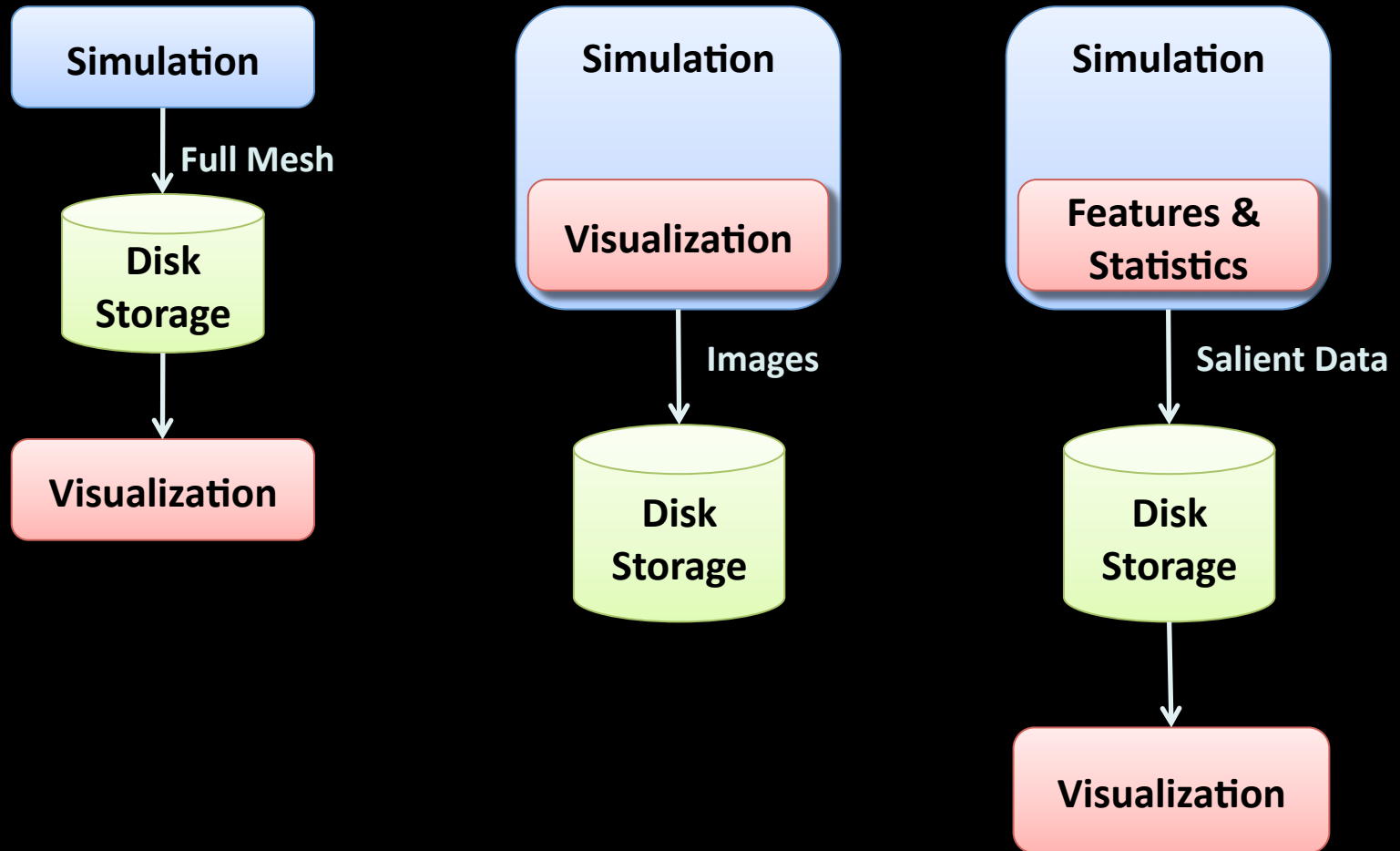


1 frame per 100 steps
~1% write time



1 frame per 1 step
~0.1% write time

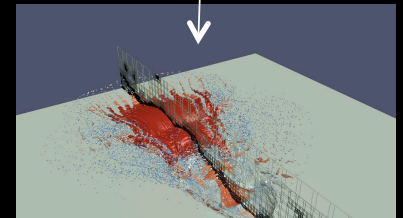




Simulation

**ParaView
Coprocesing**

Output
Processed
Data



Rendered Images

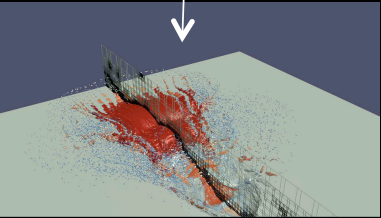
Simulation

**ParaView
Coprorocessing**

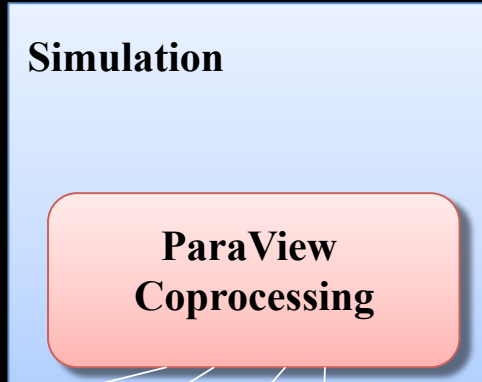
Output
Processed
Data



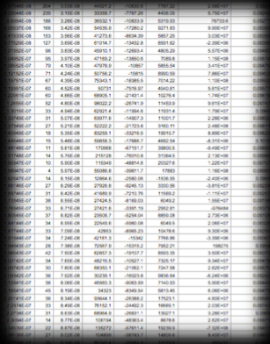
Polygonal Surfaces



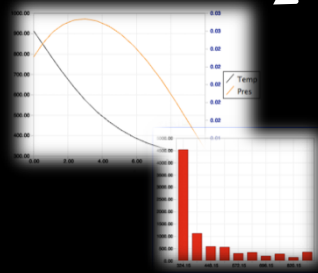
Rendered Images



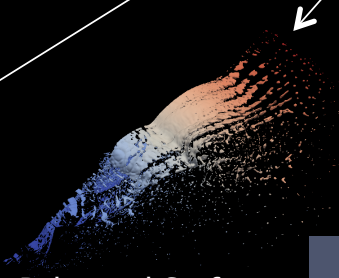
Output
Processed
Data



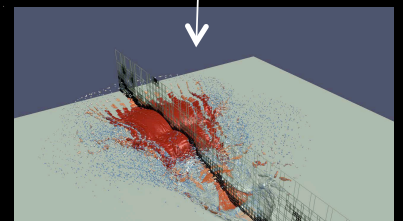
Statistics



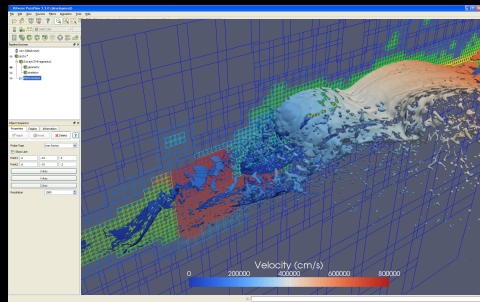
Charts



Polygonal Surfaces



Rendered Images



Script Export

```
# Create the reader and set the filename.  
reader = servermanager.sources.Reader(FileNames=path)  
view = servermanager.CreateRenderView()  
repr = servermanager.CreateRepresentation(reader, view)  
reader.UpdatePipeline()  
dataInfo = reader.GetDataInformation()  
pDInfo = dataInfo.GetPointDataInformation()  
arrayInfo = pDInfo.GetArrayInformation("displacement9")  
if arrayInfo:  
# get the range for the magnitude of displacement9  
range = arrayInfo.GetComponentRange(-1)  
lut = servermanager.rendering.PVLookupTable()  
lut.RGBPoints = [range[0], 0.0, 0.0, 1.0,  
                 range[1], 1.0, 0.0, 0.0]  
lut.VectorMode = "Magnitude"  
repr.LookupTable = lut  
repr.ColorArrayName = "displacement9"  
repr.ColorAttributeType = "POINT_DATA"
```

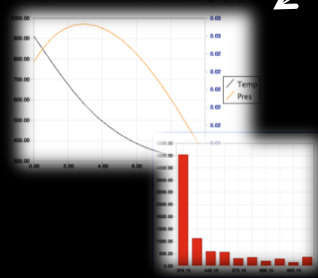
Augmented script in input deck.

Simulation

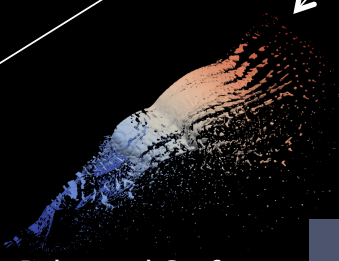
ParaView Coprocessing

Output Processed Data

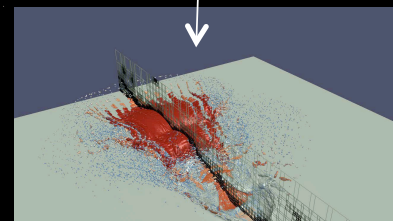
Statistics



Charts



Polygonal Surfaces



Rendered Images

Simulation

function
calls

Adaptor

function
calls

Coprocessing
API

ParaView
Server

INITIALIZE()
ADDPipeline(*in pipeline*)

REQUESTDATADESCRIPTION(*in time, out fields*)
COPROCESS(*in vtkDataSet*)

FINALIZE()

Example Problem Sets

- Ignition/extinction events in burning fuel
- Fragment detection of exploding pipe bomb
- Jet flow over full wing

Example Problem Sets

- **Ignition/extinction events in burning fuel**
 - S3D, Sandia California
- Fragment detection of exploding pipe bomb
- Jet flow over full wing

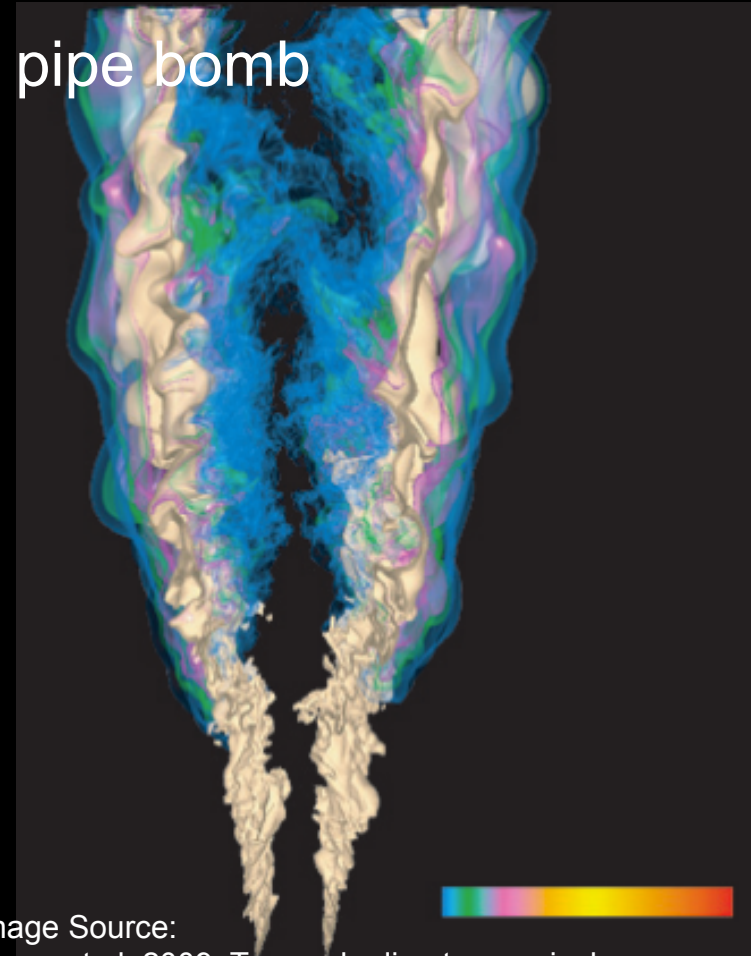
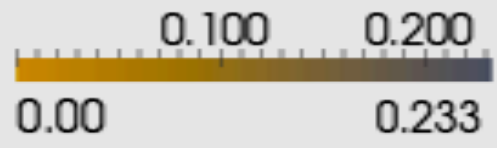


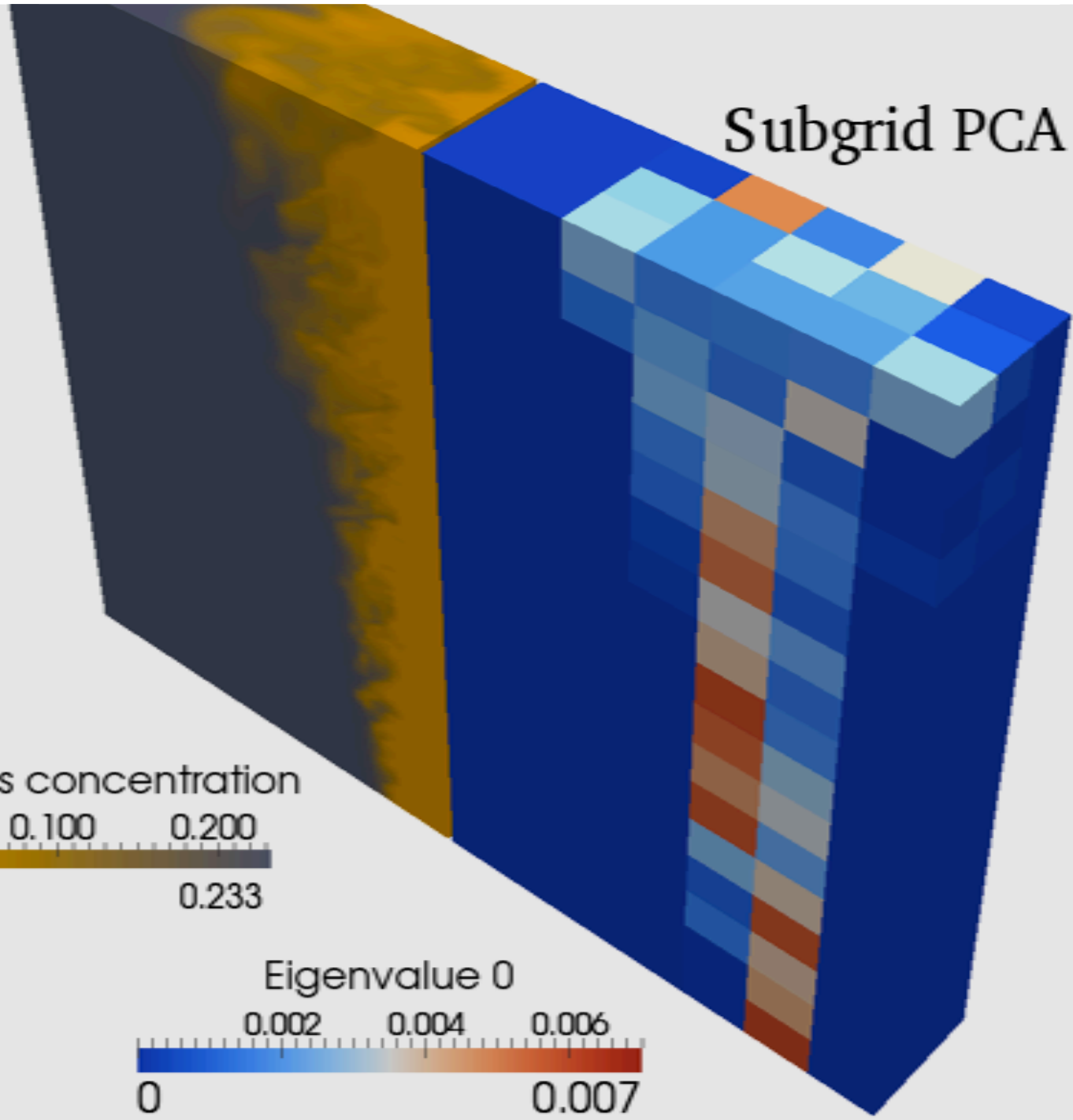
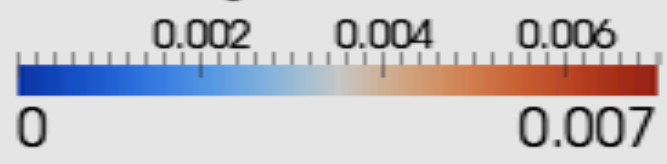
Image Source:
Chen, et al. 2009. Terascale direct numerical
simulations of turbulent combustion using S3D.

Subgrid PCA

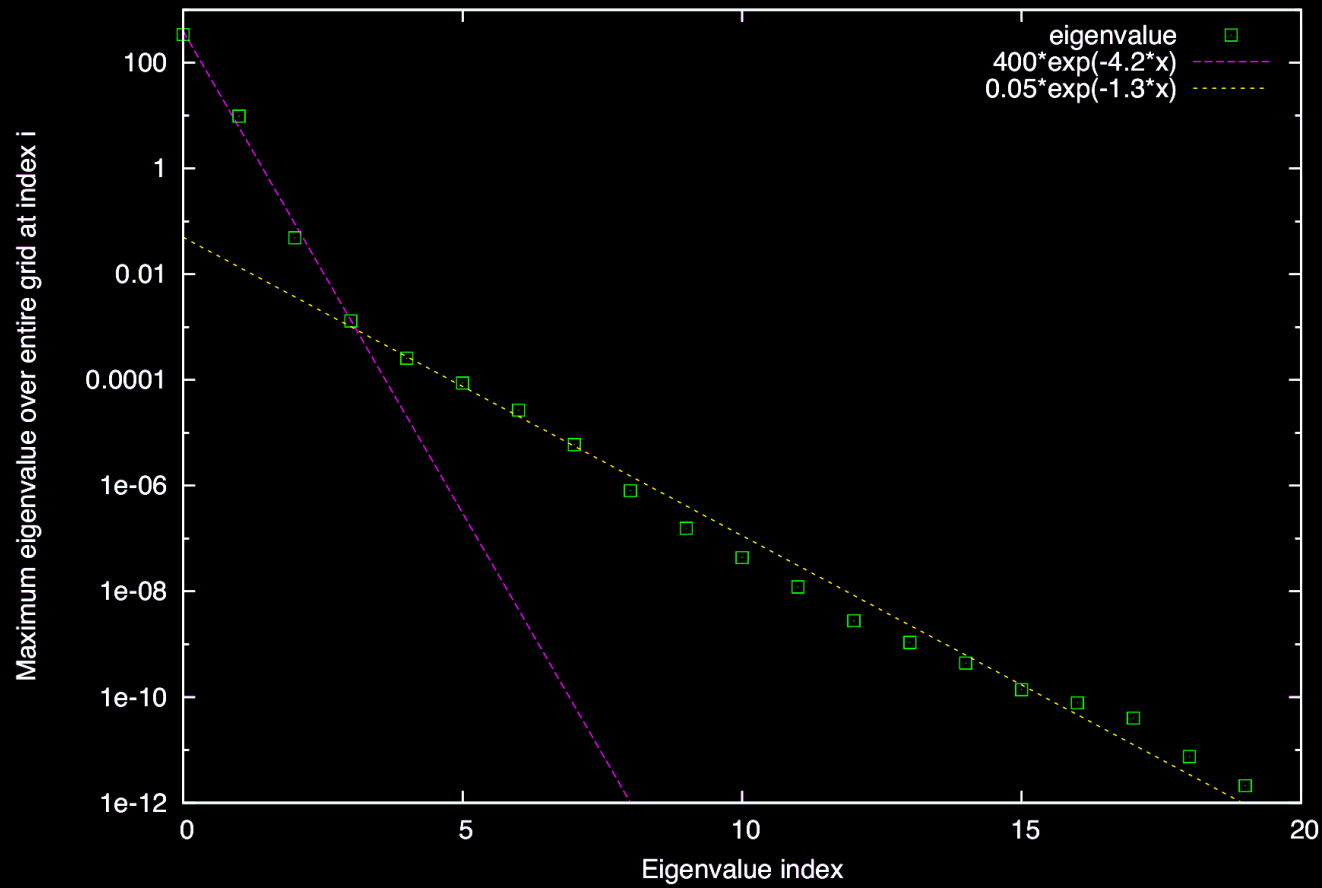
Species concentration



Eigenvalue 0



Eigenvalue magnitude vs. eigenvalue index

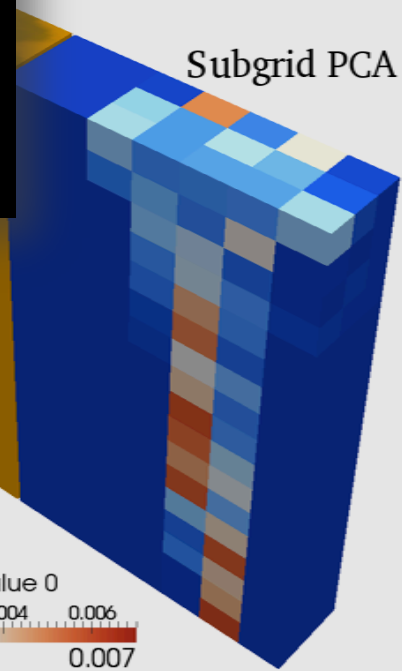
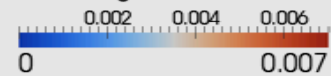


Subgrid PCA

Species concentration



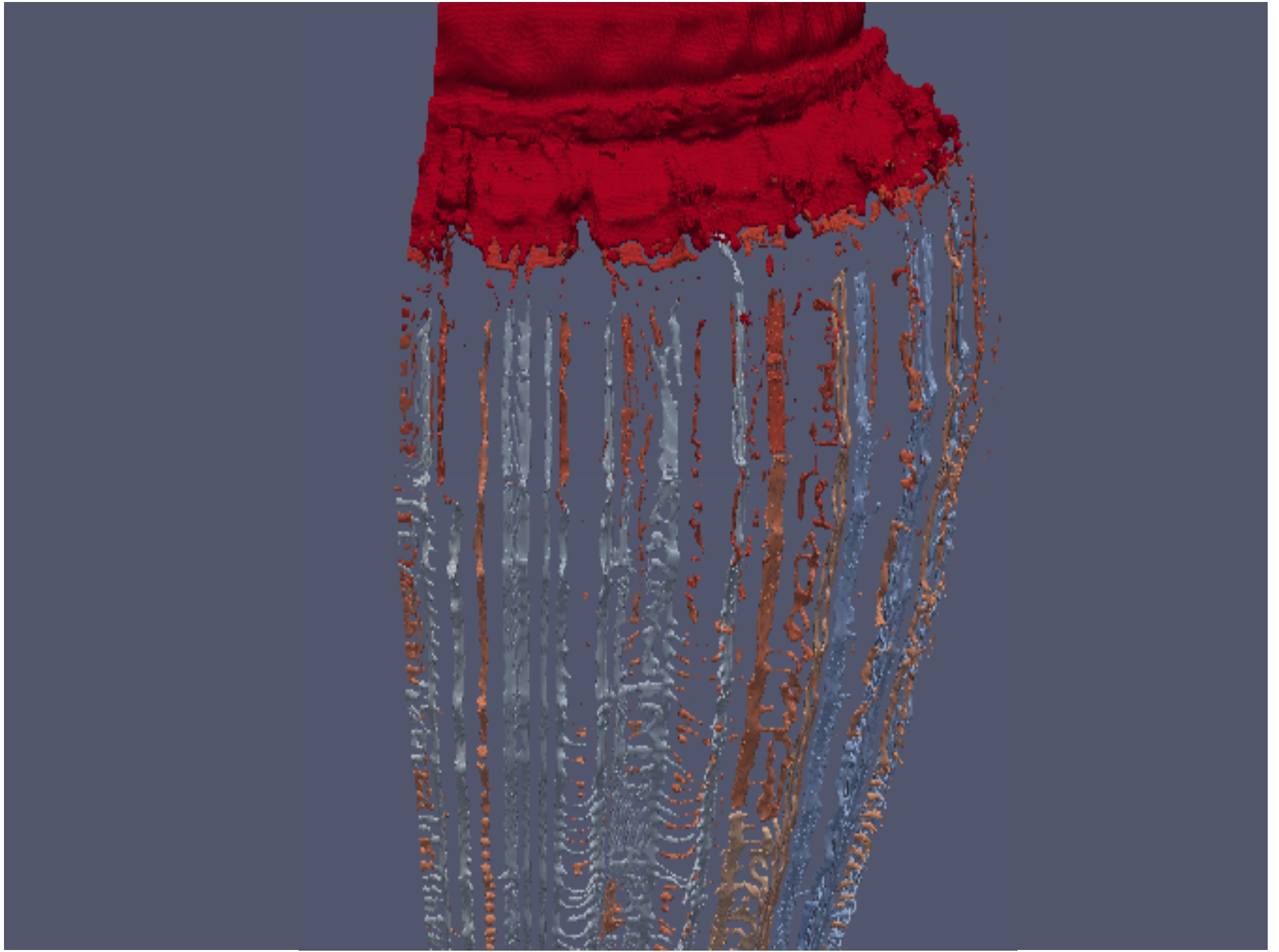
Eigenvalue 0

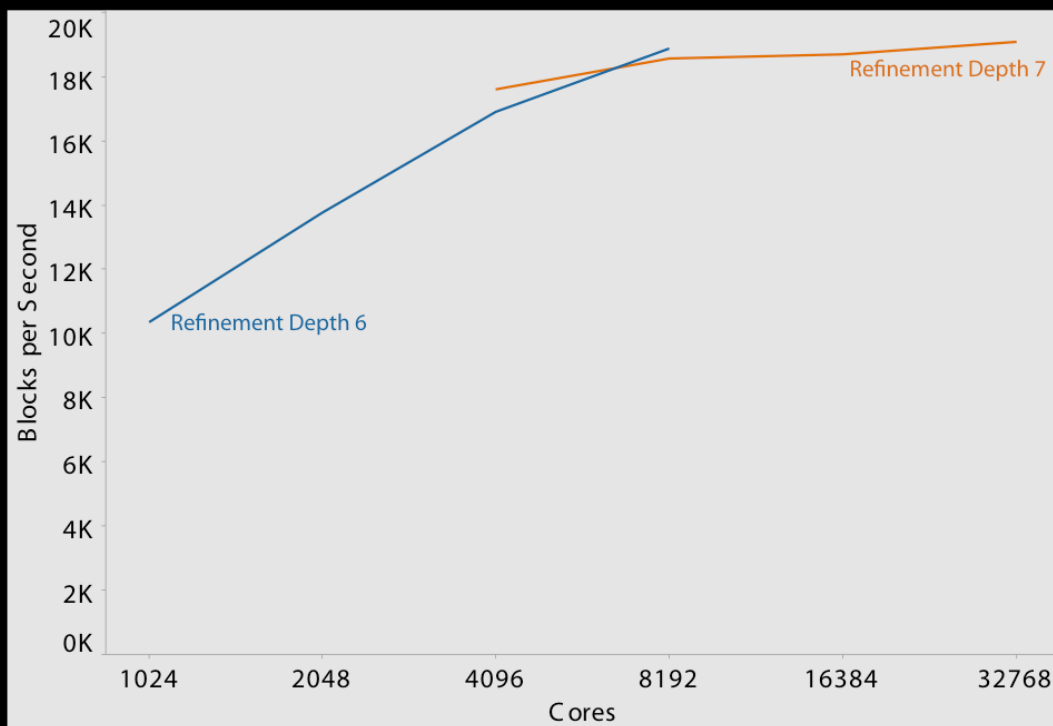
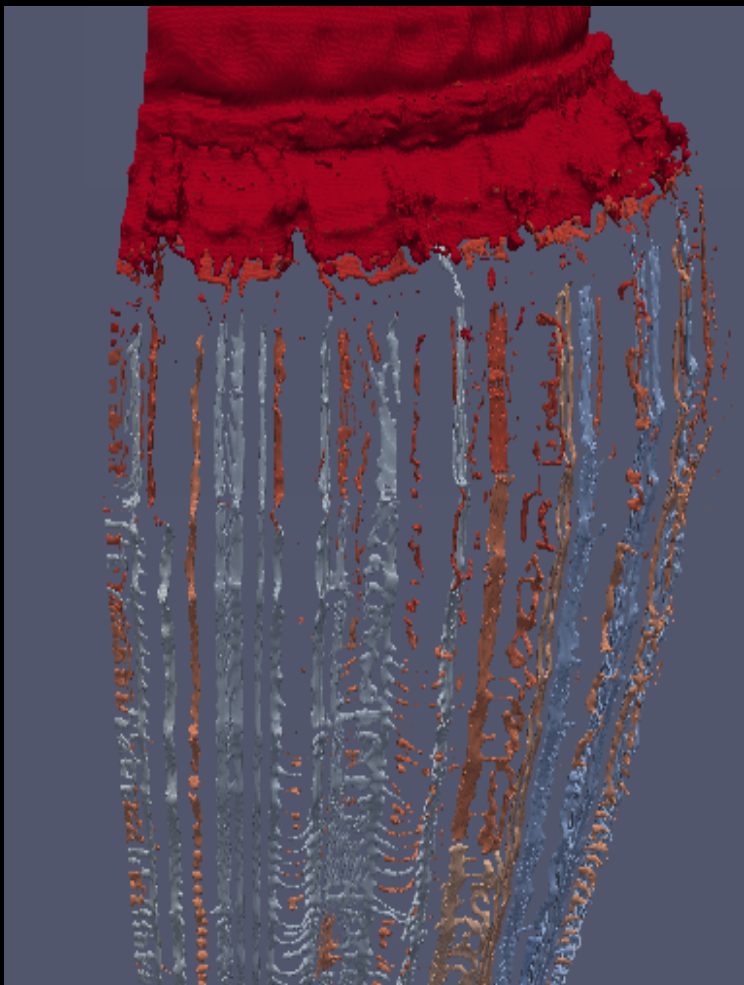


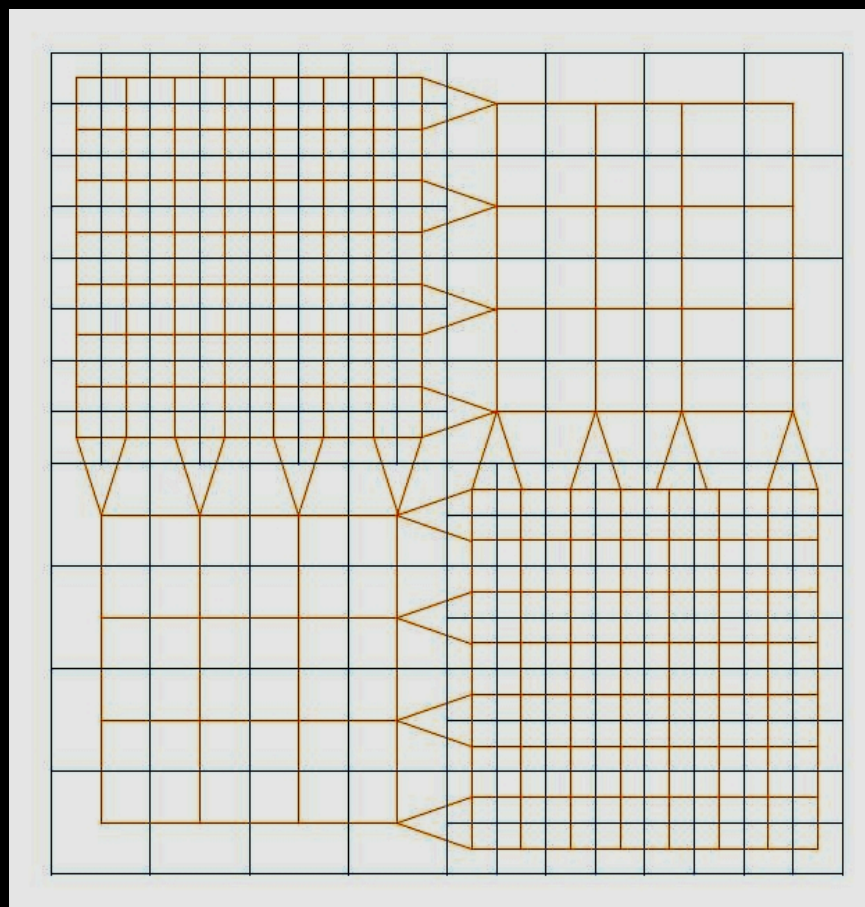
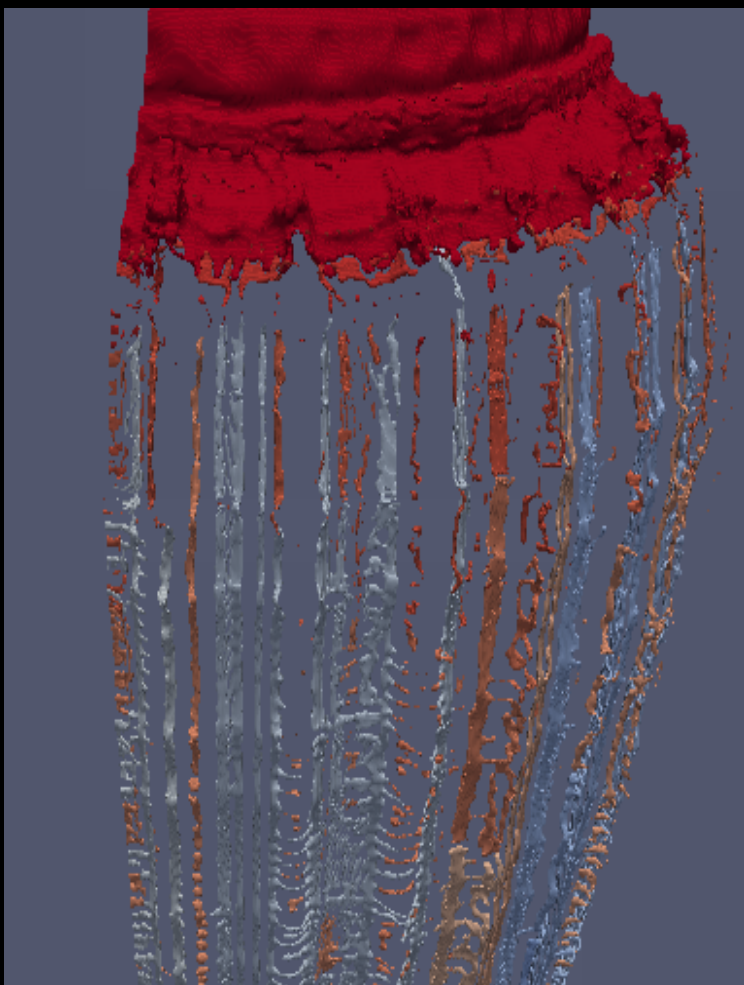
Example Problem Sets

- Ignition/extinction events in burning fuel
- **Fragment detection of exploding pipe bomb**
 - CTH, Sandia New Mexico
- Jet flow over full wing



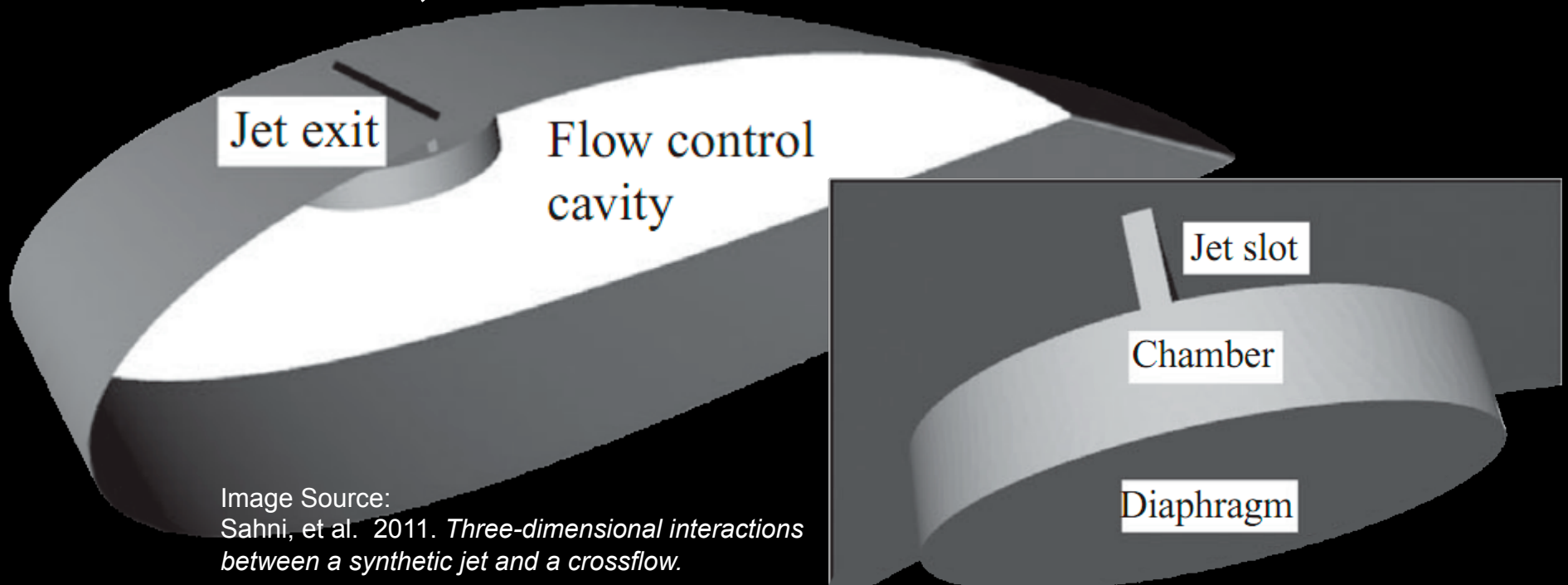






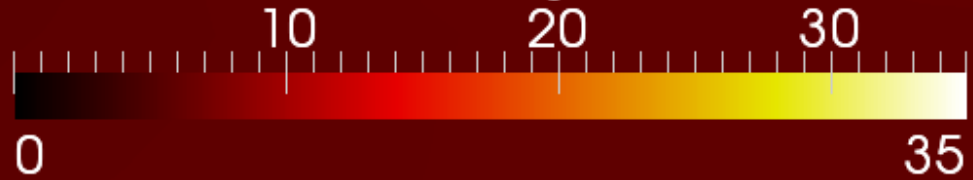
Example Problem Sets

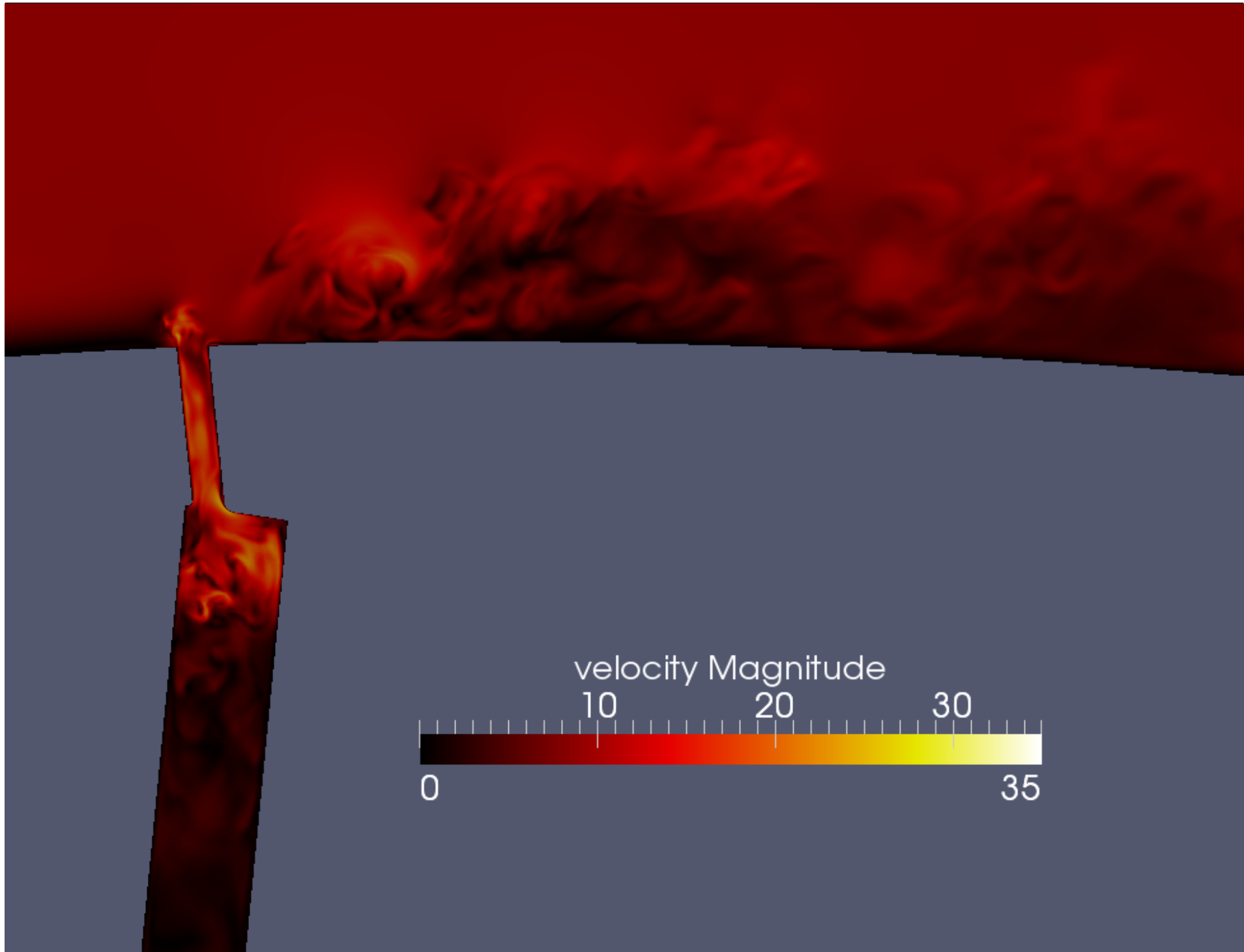
- Ignition/extinction events in burning fuel
- Fragment detection of exploding pipe bomb
- **Jet flow over full wing**
 - Phasta, UC Boulder and Kitware

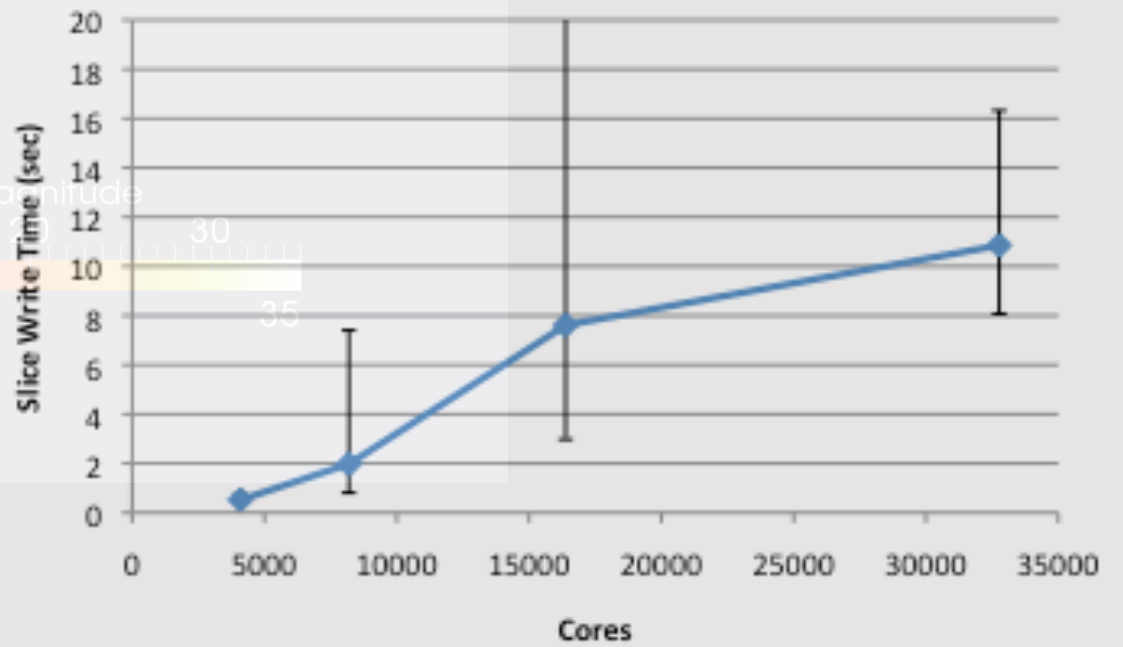
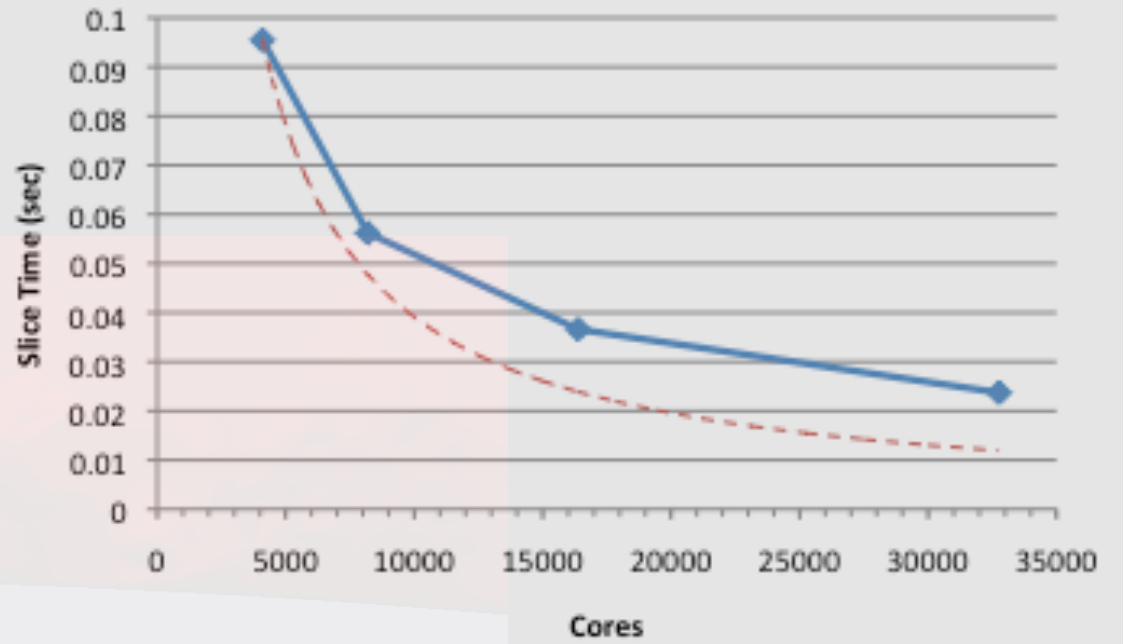
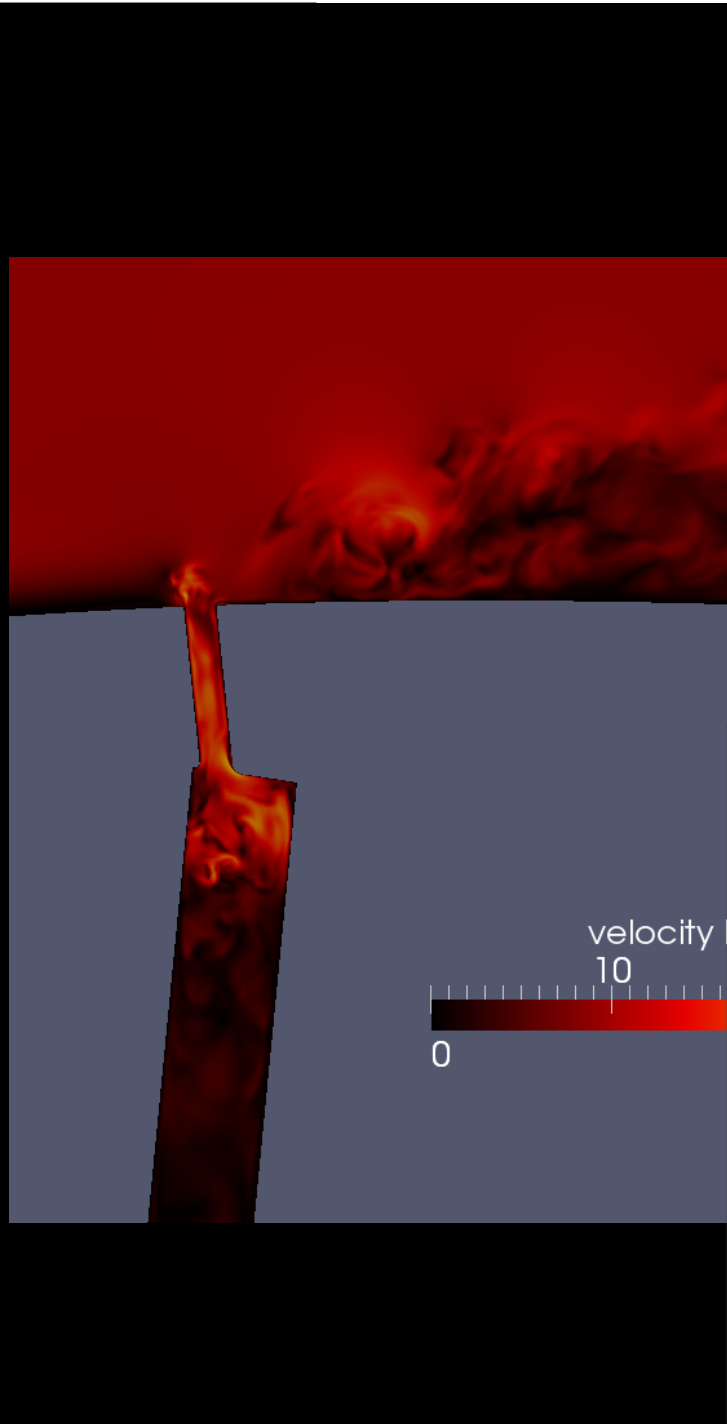


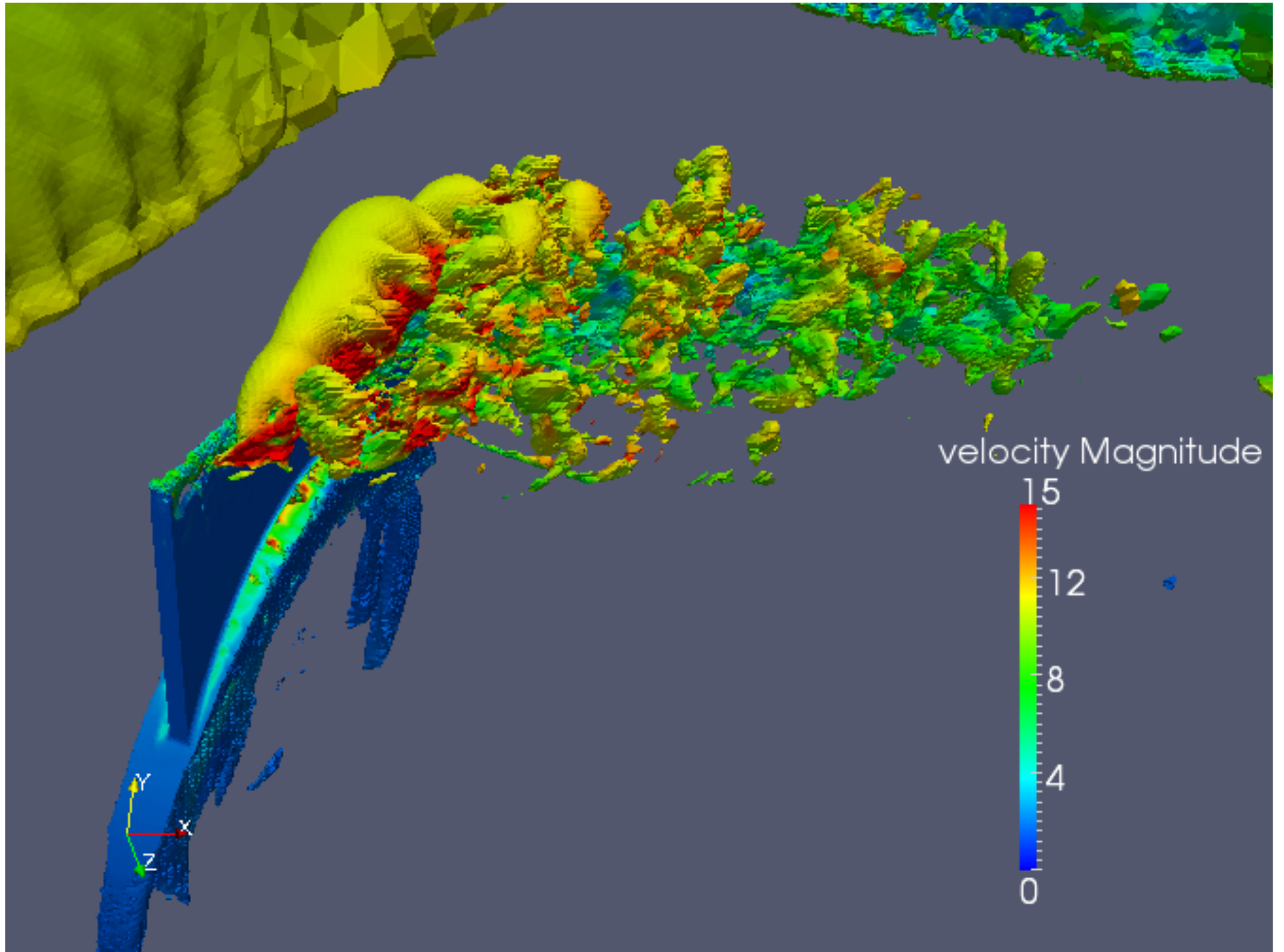


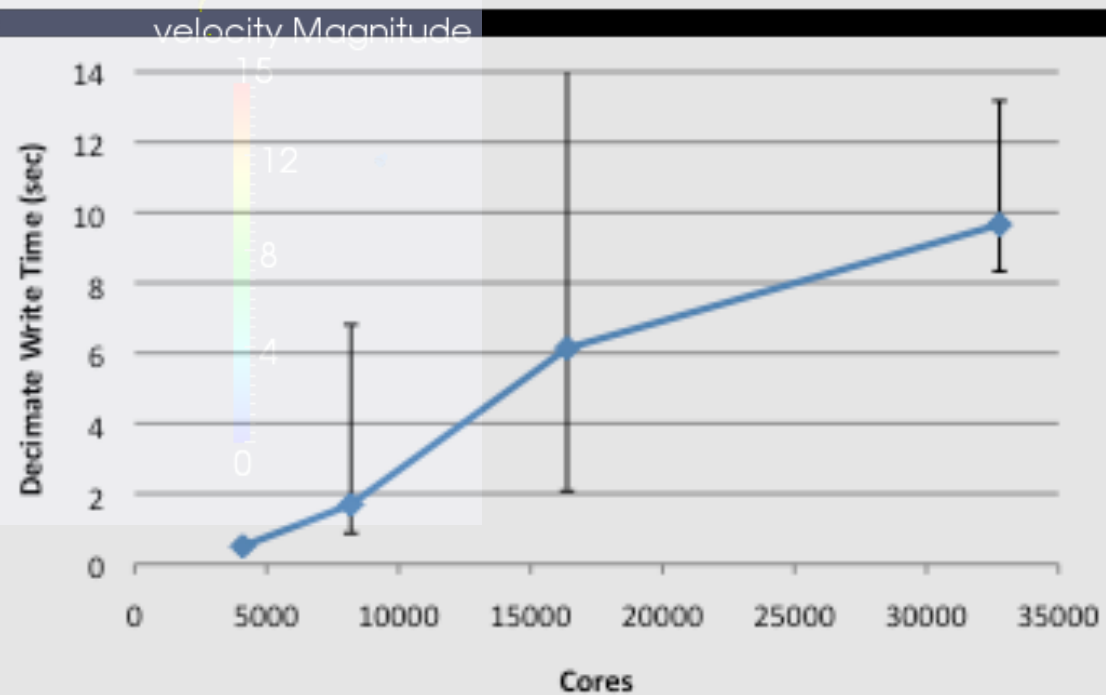
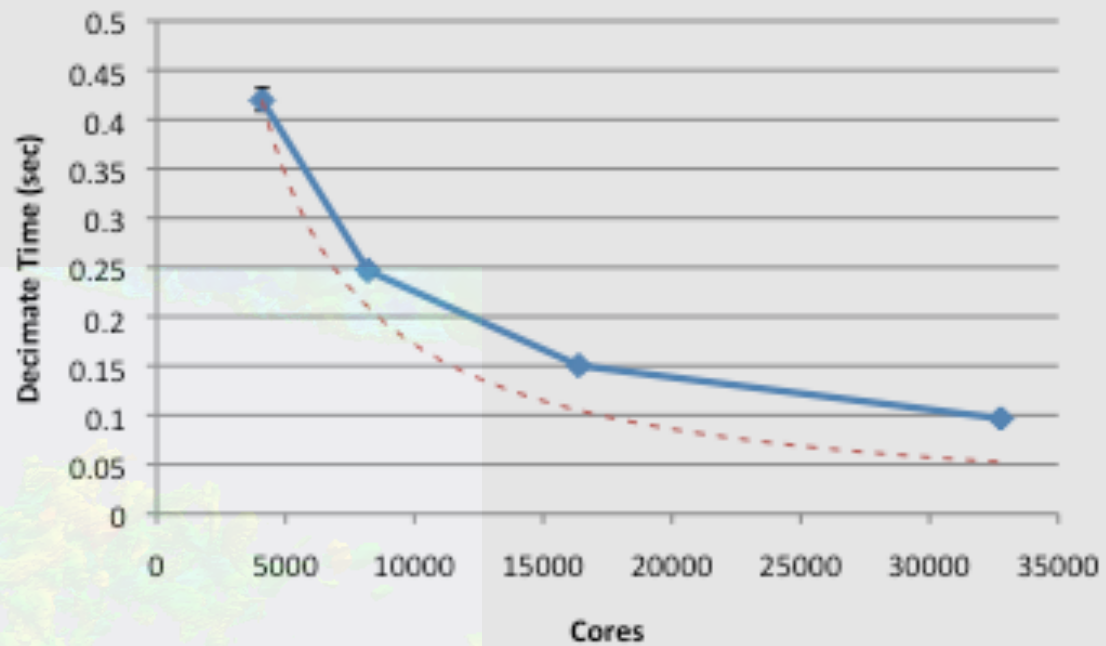
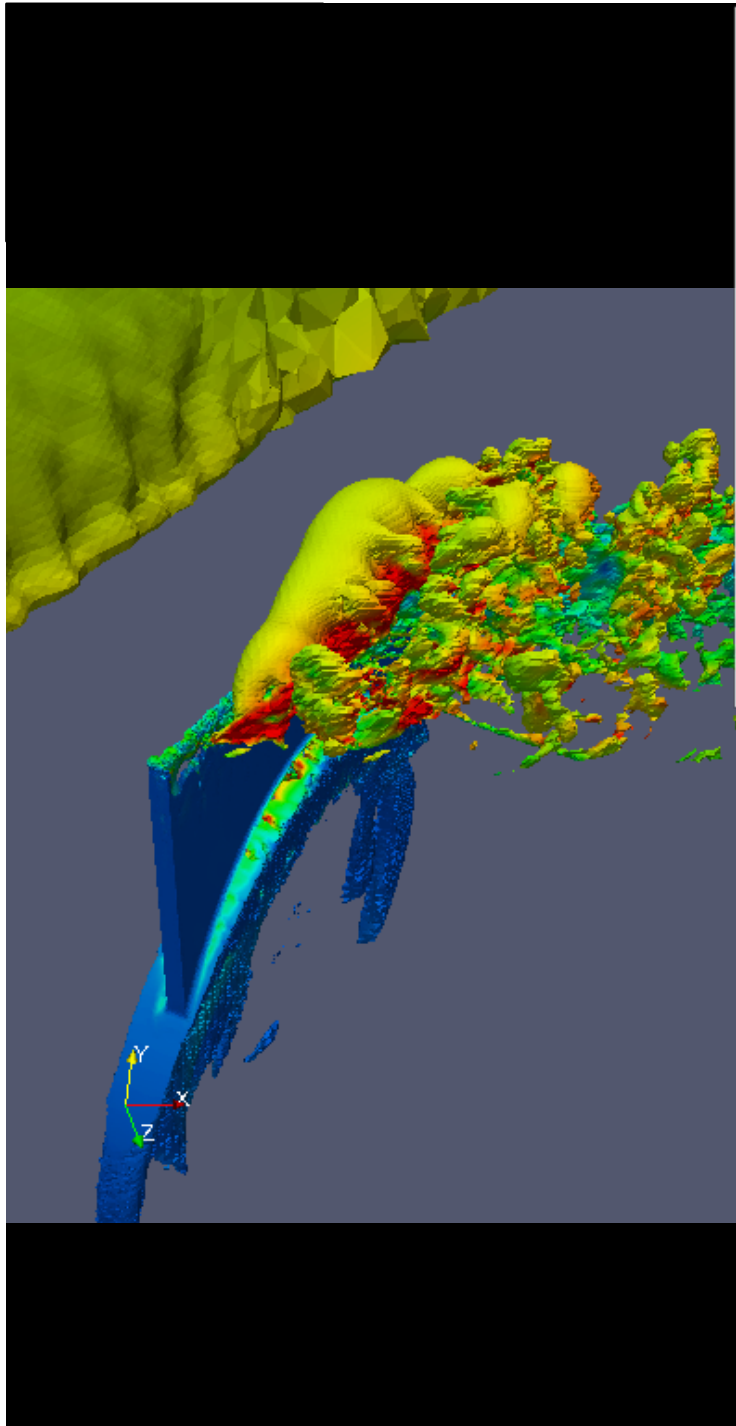
velocity Magnitude



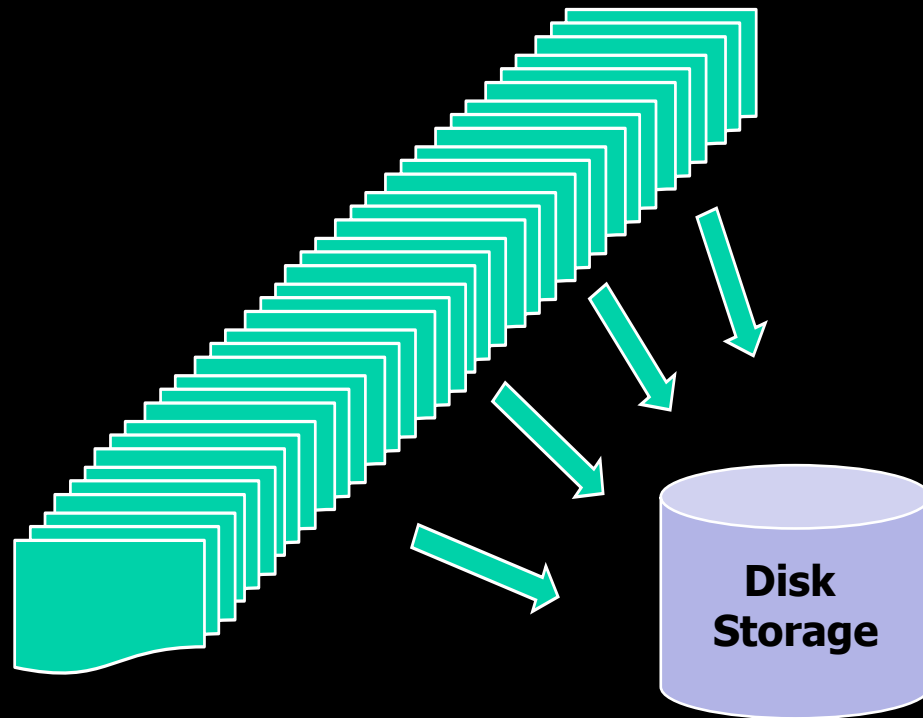






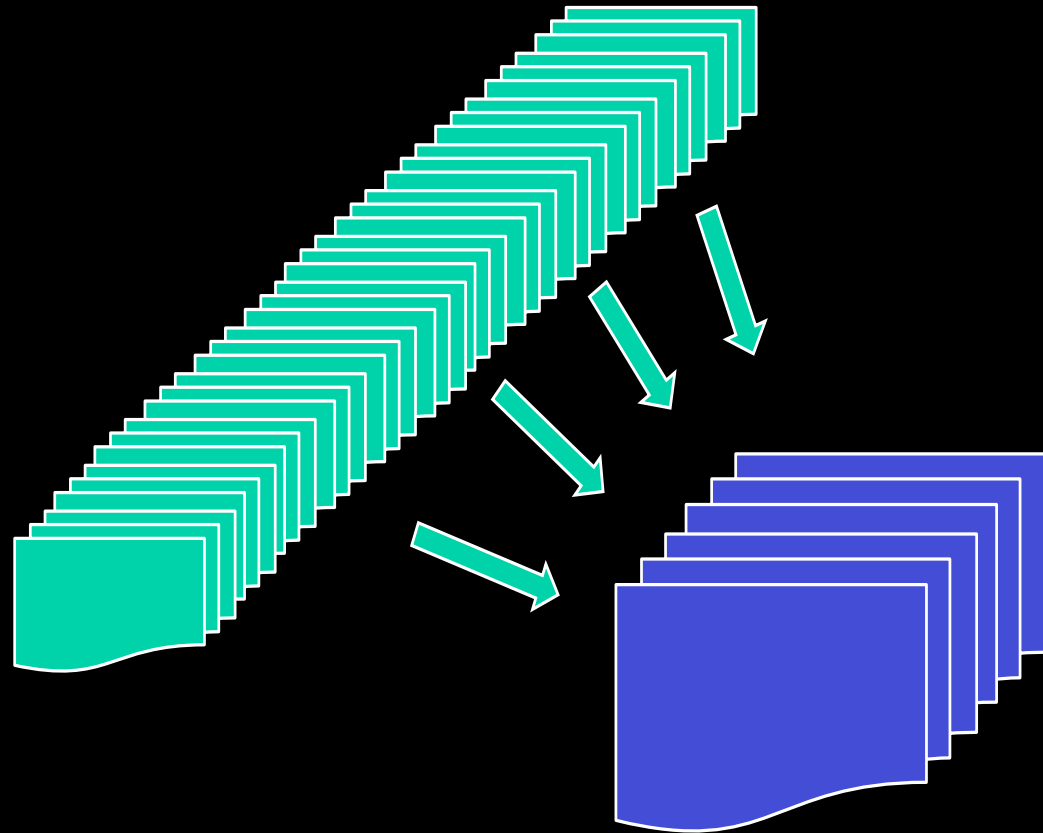


In Transit Visualization



Full scale
Simulation
w/ In situ

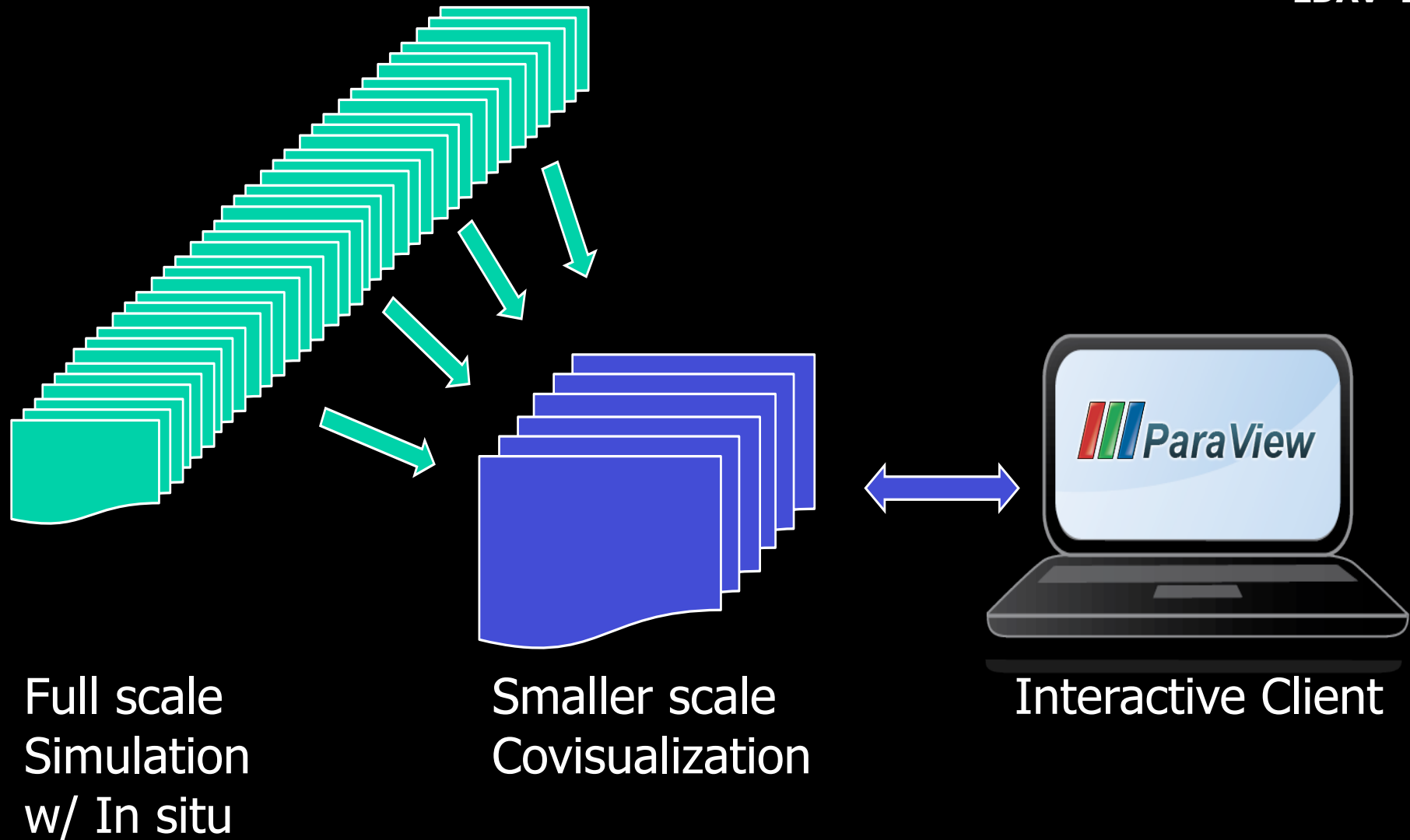
In Transit Visualization

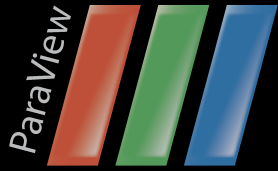


Full scale
Simulation
w/ In situ

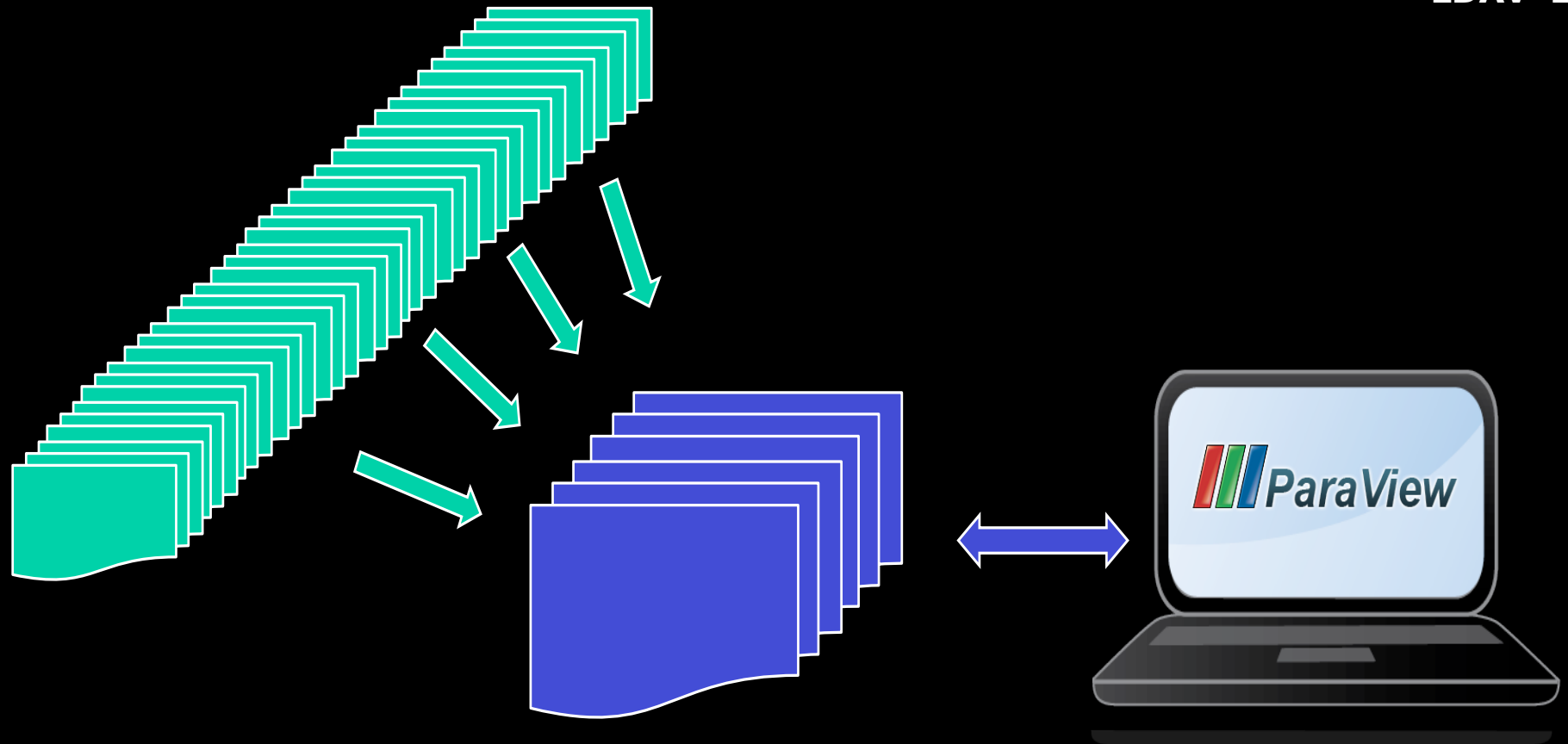
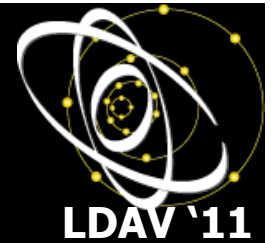
Smaller scale
Covisualization

In Transit Visualization





In Transit Visualization



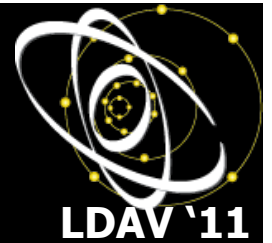
16k cores
IBM BG/P

10 Viz Nodes

~1 Step/Sec
80% simulation
20% visualization



Thanks for your attention



Nathan Fabian, ndfabia@sandia.gov

- <http://paraview.org/paraview/resources/software.html>
 - Latest version: 3.12.0-RC2
- **“Large Scale Visualization with ParaView”**
 - Date: Sun Nov 13
 - Time: 8:30am – 12:00pm
- **“In-Situ Visualization with ParaView”**
 - Date: Sun Nov 13
 - Time: 1:30pm – 5:00pm

