Parallel Analysis and Visualization on Cray Compute Node Linux

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Overview

Challenges of analysis at the petascale

Scale

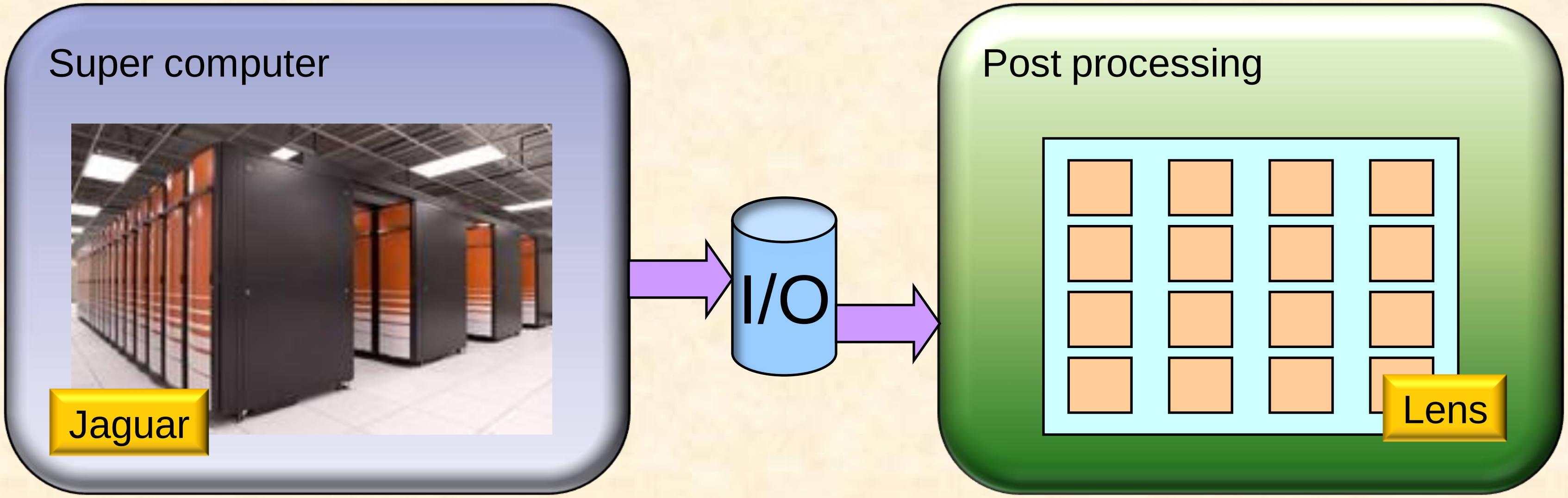
- Size
- Not compute bound
- Viz is always IO bound

Complexity

- More science, not (always) more resolution.
- Requires solutions beyond *pure parallelism.*
- New paradigms needed

Production analysis and viz

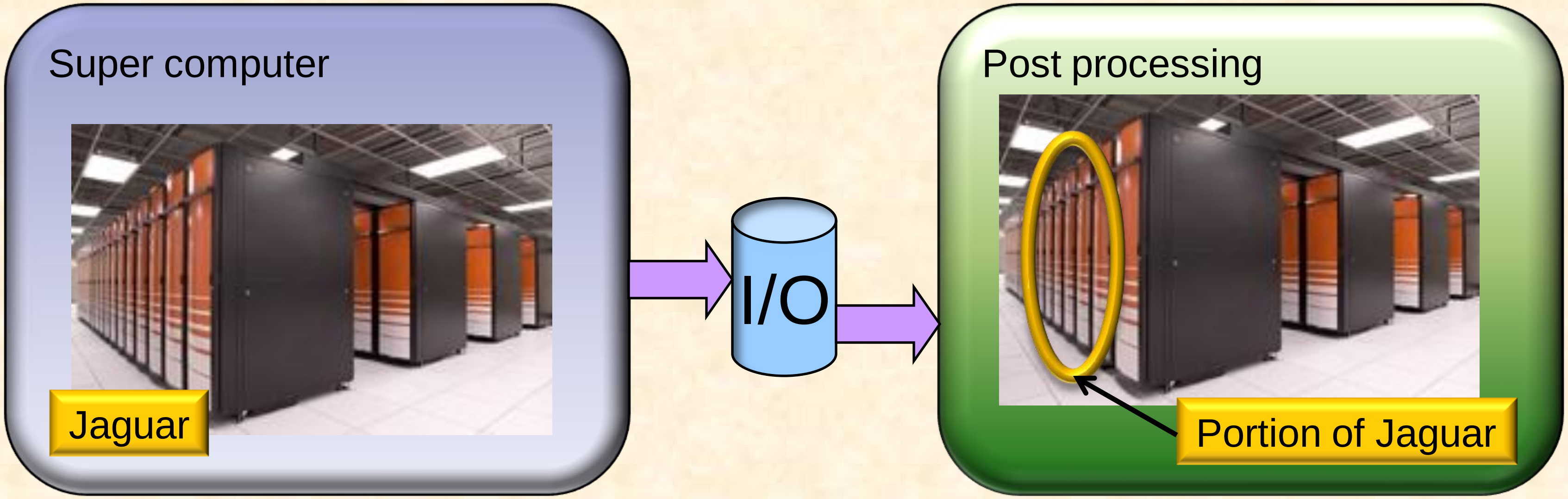
- **Method 1**



- **Shared disk (hopefully)**
- **Graphics cards**

Production analysis and viz

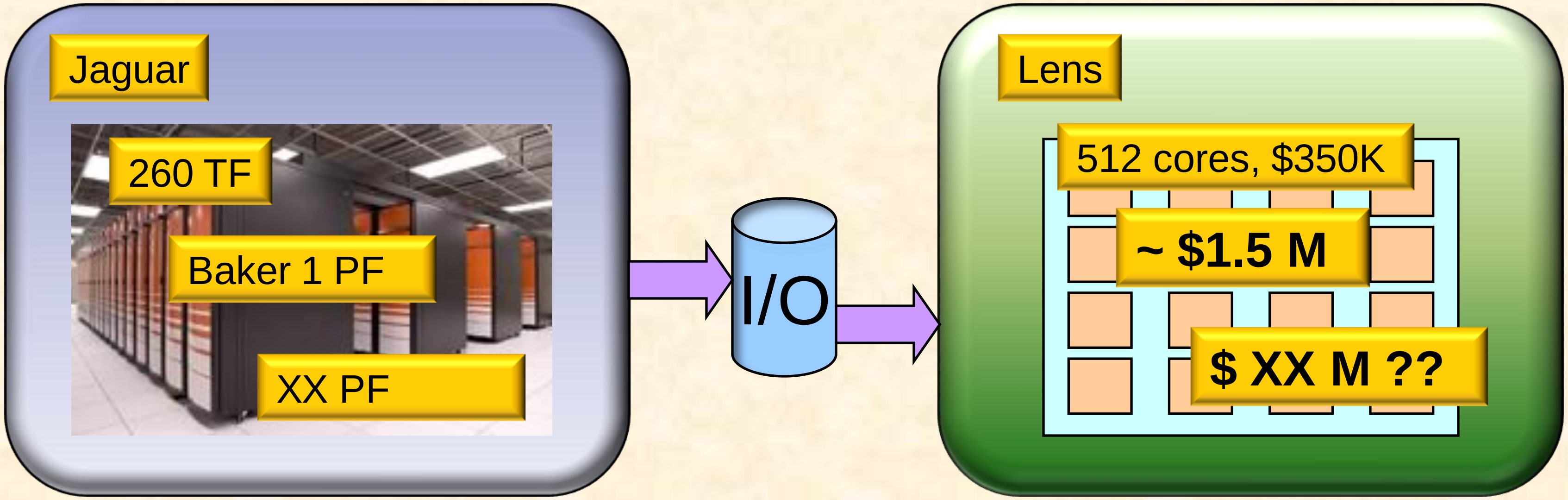
- **Method 2**



- **Computing, post processing both done on SC**
- **Simulation writes to disk, post processing reads from disk**
- **No graphics hardware**

Production analysis and viz

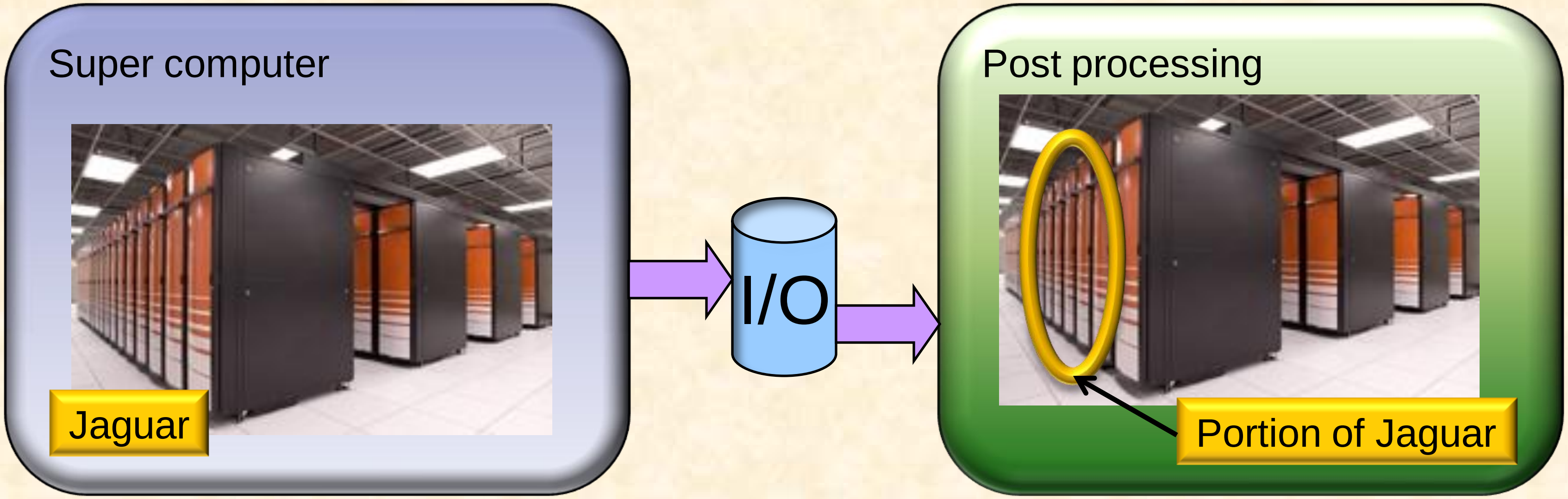
- **Method 1**



Will not scale

Production analysis and viz

- **Method 2**



Super computer

Jaguar

I/O

Post processing

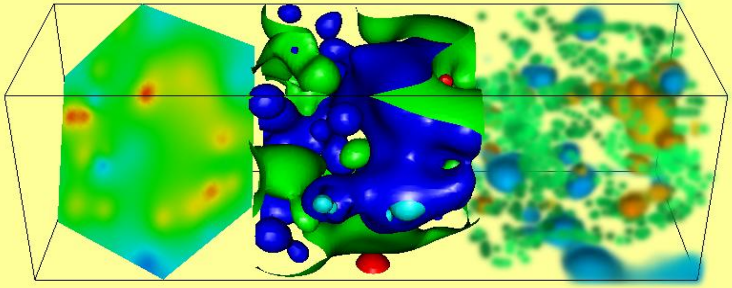
Portion of Jaguar

- **Lightweight OS on compute nodes**
- **Viz apps use a lot of full Linux**
- **No graphics cards**

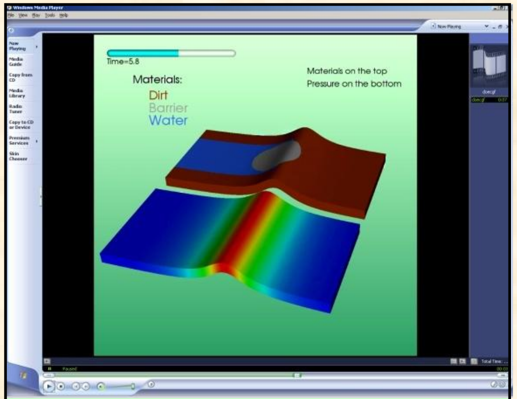
VisIt Overview

- VisIt is an open source, end user visualization and analysis tool
  - Used by: physicists, engineers, code developers, vis experts
  - 50 > simulation codes < 100
  - ~1000 users at LLNL, ORNL, LBL, others…
  - >100K downloads on web
  - Developers at LLNL, ORNL, LBL, UCDavis, others……

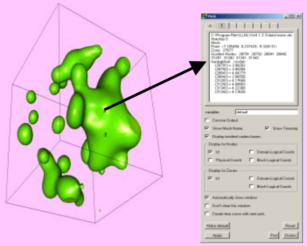
Use cases include…



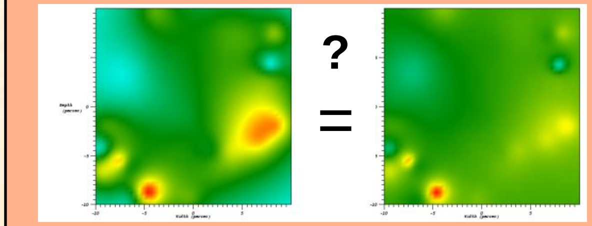
Data Exploration



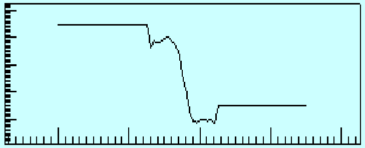
Presentations



Visual Debugging

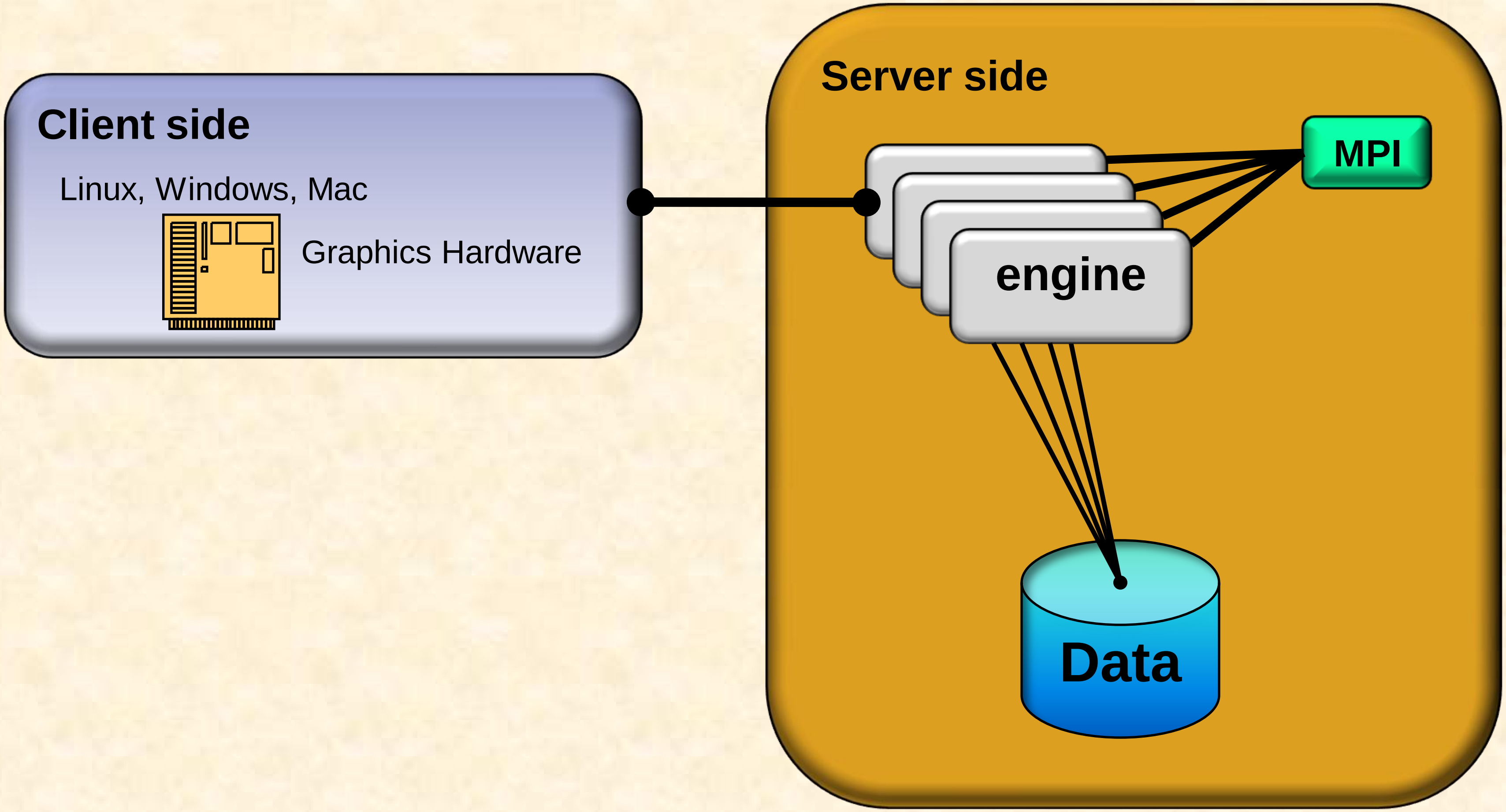


Comparative Analysis



Quantitative Analysis

VisIt Architecture



Port to Catamount

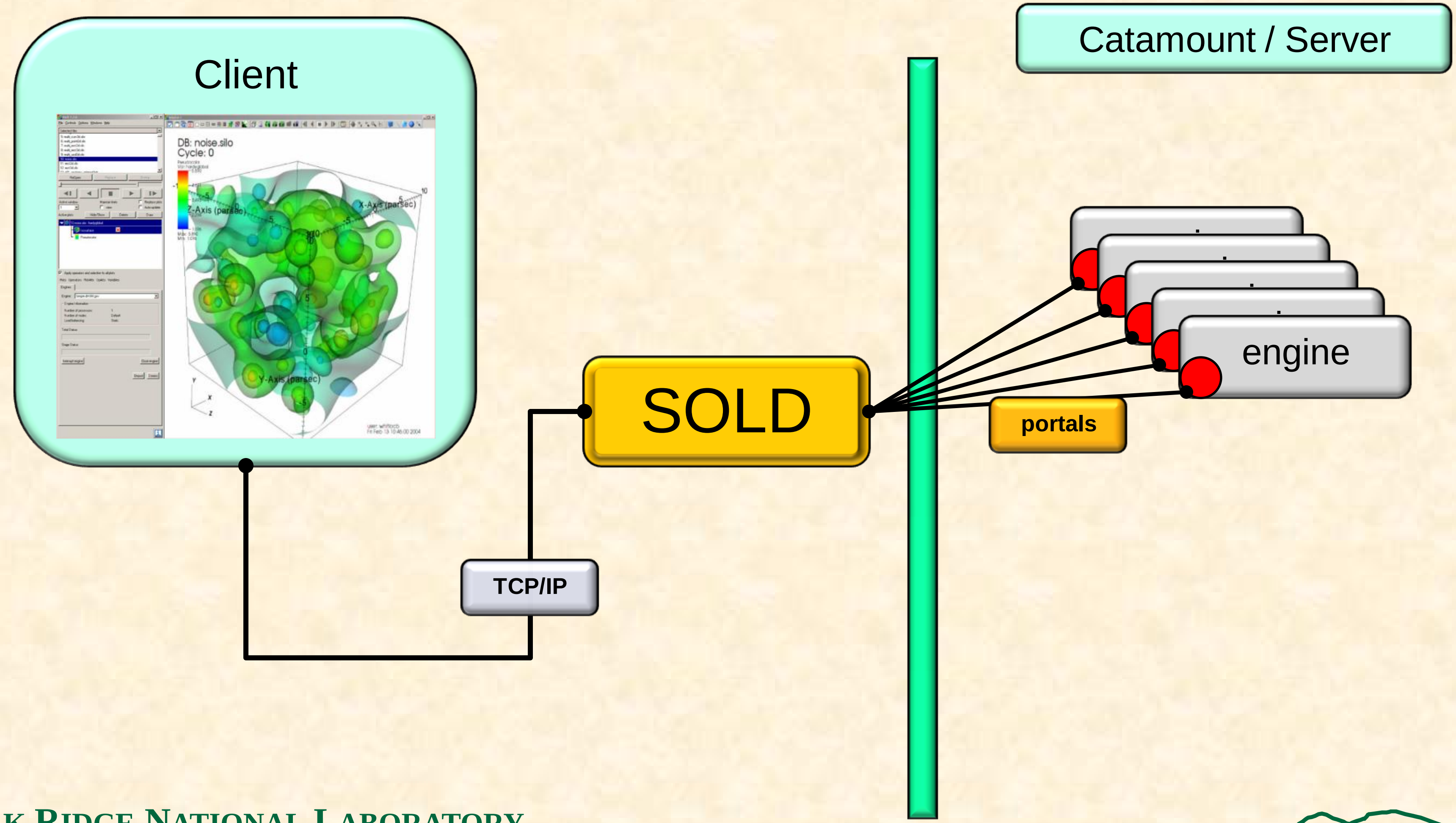
Kevin Thomas, CUG 2007

Catamount: Light kernel

Issues	Solutions
Static link only	• Static build of VisIt • Limit plugin set
No sockets	**S**ocket **O**ffload **L**ibrary **D**

Port to Catamount

Kevin Thomas, CUG 2007



Port to CNL

CNL: Less restrictive light kernel

Issues	Solutions
Everything on lustre	• Install VisIt → /lustre/…. • cp /usr/lib64/* /lustre/….
Shared libs. *Limited* support	Engine wrapper

Engine wrapper:

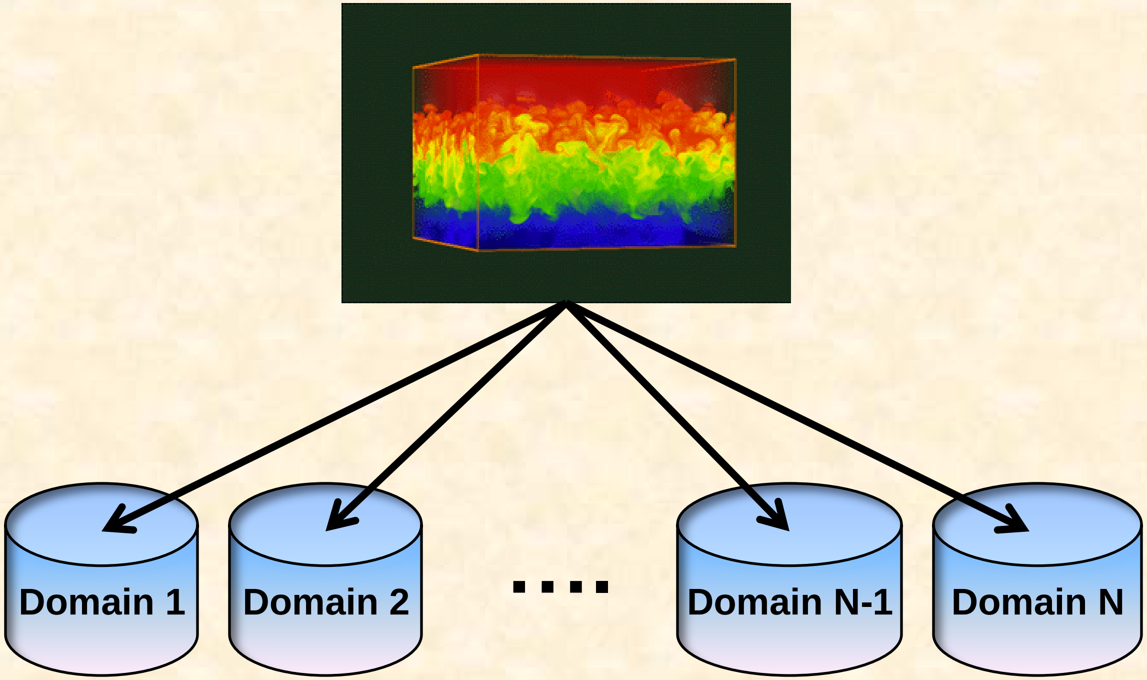
```
int main( int argc, char **argv )
{
    setenv( "LD_LIBRARY_PATH", "/usr/lib64:/lustre/scratch/…. ", 1 );

    char *eng = "/lustre/scratch/pugmire/visit/1.8.0/linux-x86_64/bin/engine_par_exe";

    char cmd[100000];
    sprintf( cmd, “%s”, eng );
    for ( int i = 1; i < argc; i++ )
         sprintf( cmd, "%s %s", cmd, argv[i] );

     system( cmd );
    return 0;
}
```

Test Data



Domain 1

Domain 2

....

Domain N-1

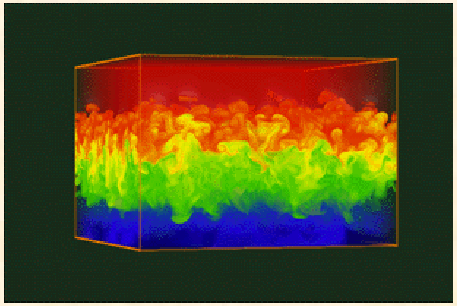
Domain N

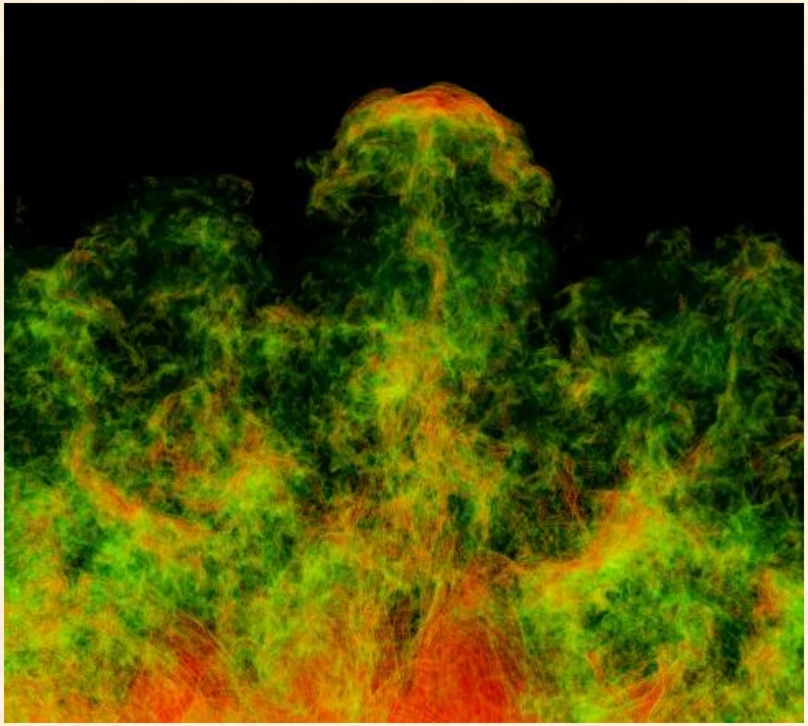
- Load *N* domains into memory
- Apply viz algorithms
- Display result

Results

- Interactive exploration of Richtmyer-Meshkoff simulation

- Mesh: 2048x2048x1920
- 960 domains
- Interactive ray casting session

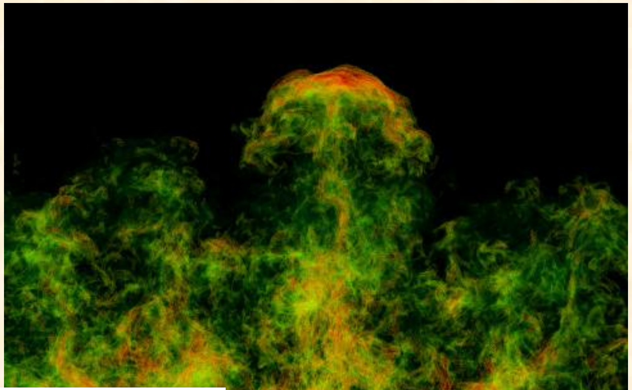


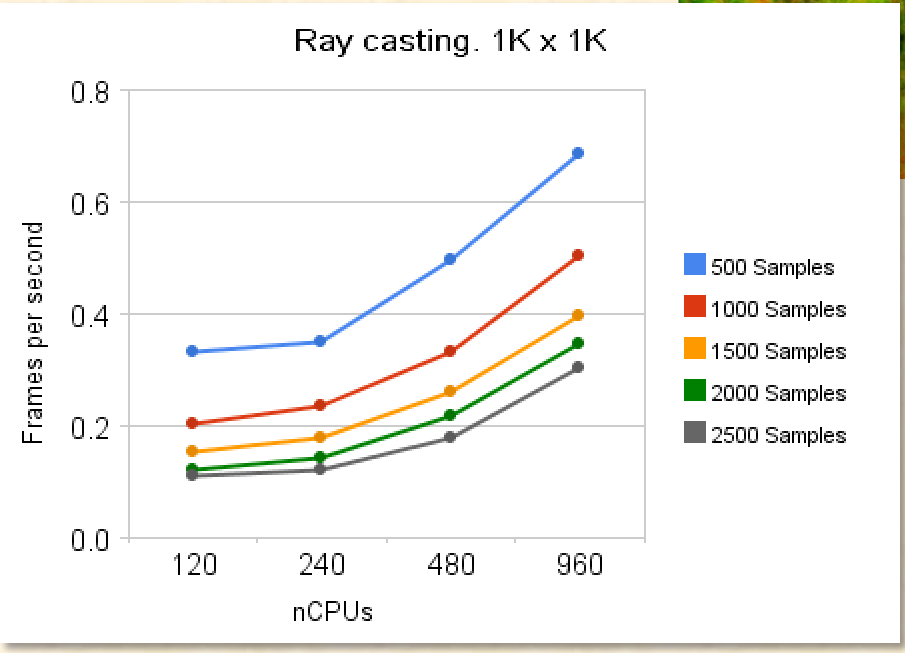


Results

Interactive exploration.

Ray casting 1024x1024 image

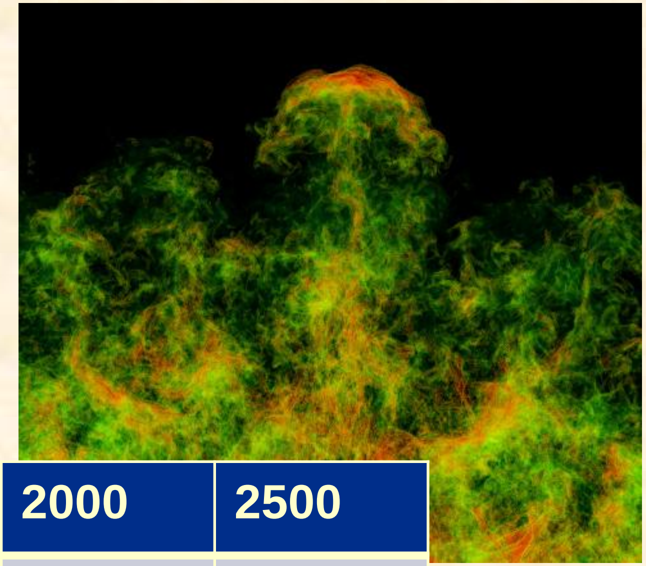




Results

Interactive exploration.

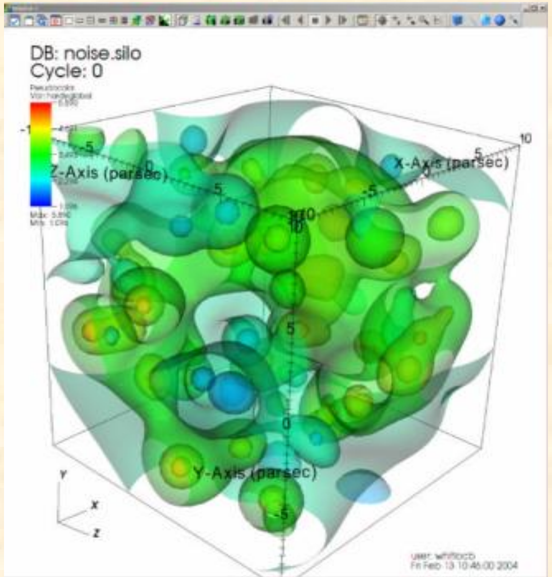
Ray casting 1024x1024 image



nCPUs	500	1000	1500	2000	2500
120	0.331	0.205	0.153	0.123	0.110
240	0.350	0.236	0.178	0.144	0.121
480	0.497	0.332	0.262	0.218	0.177
960	0.687	0.505	0.396	0.345	0.305

Results

- Isocontour of interpolated *noise* data set
  - 1 billion zones, 1000 domains
  - 10 billion zones, 1000, 2744 domains



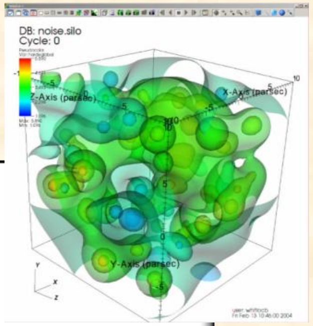
- Load data

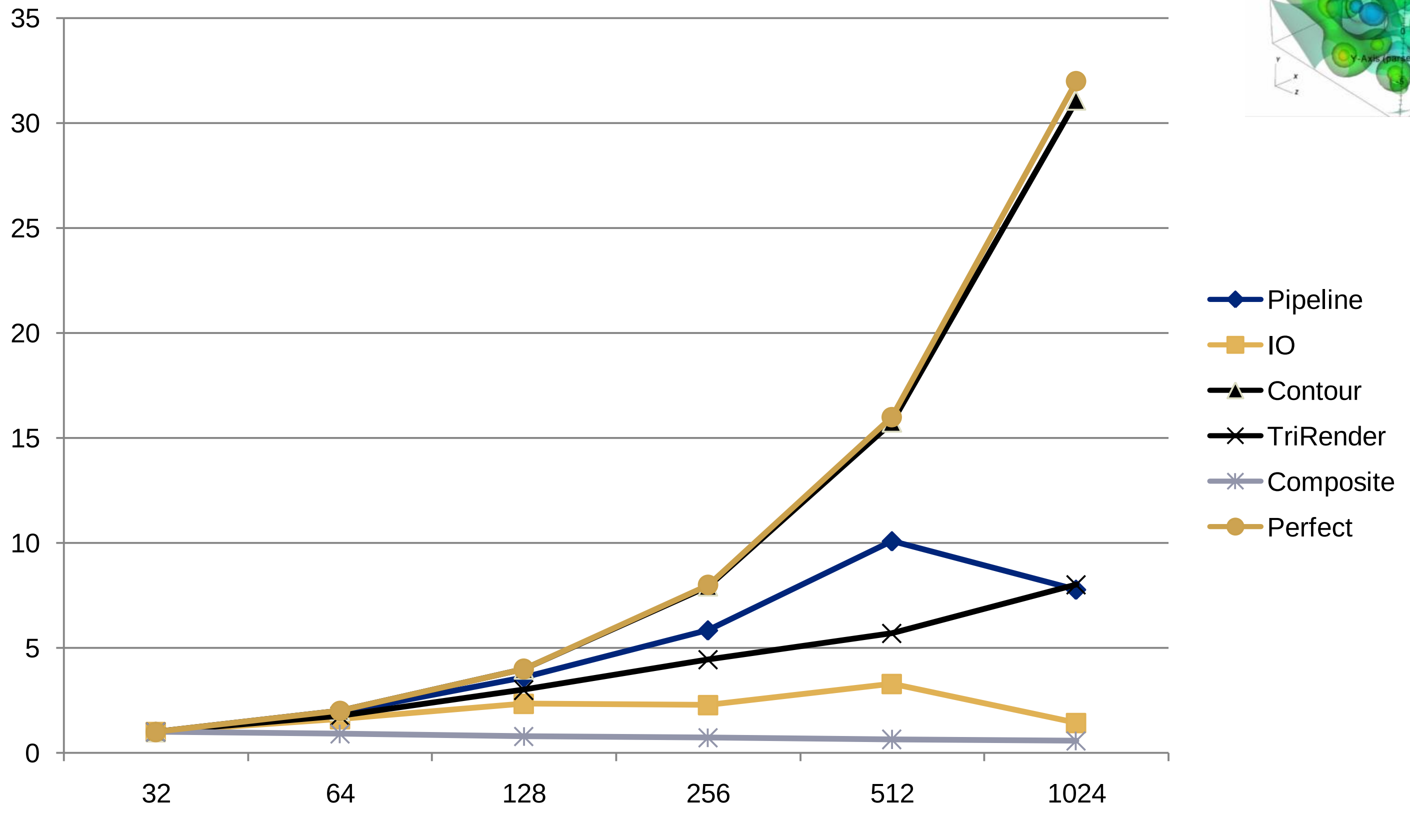
- Compute 10 iso contours

- Draw

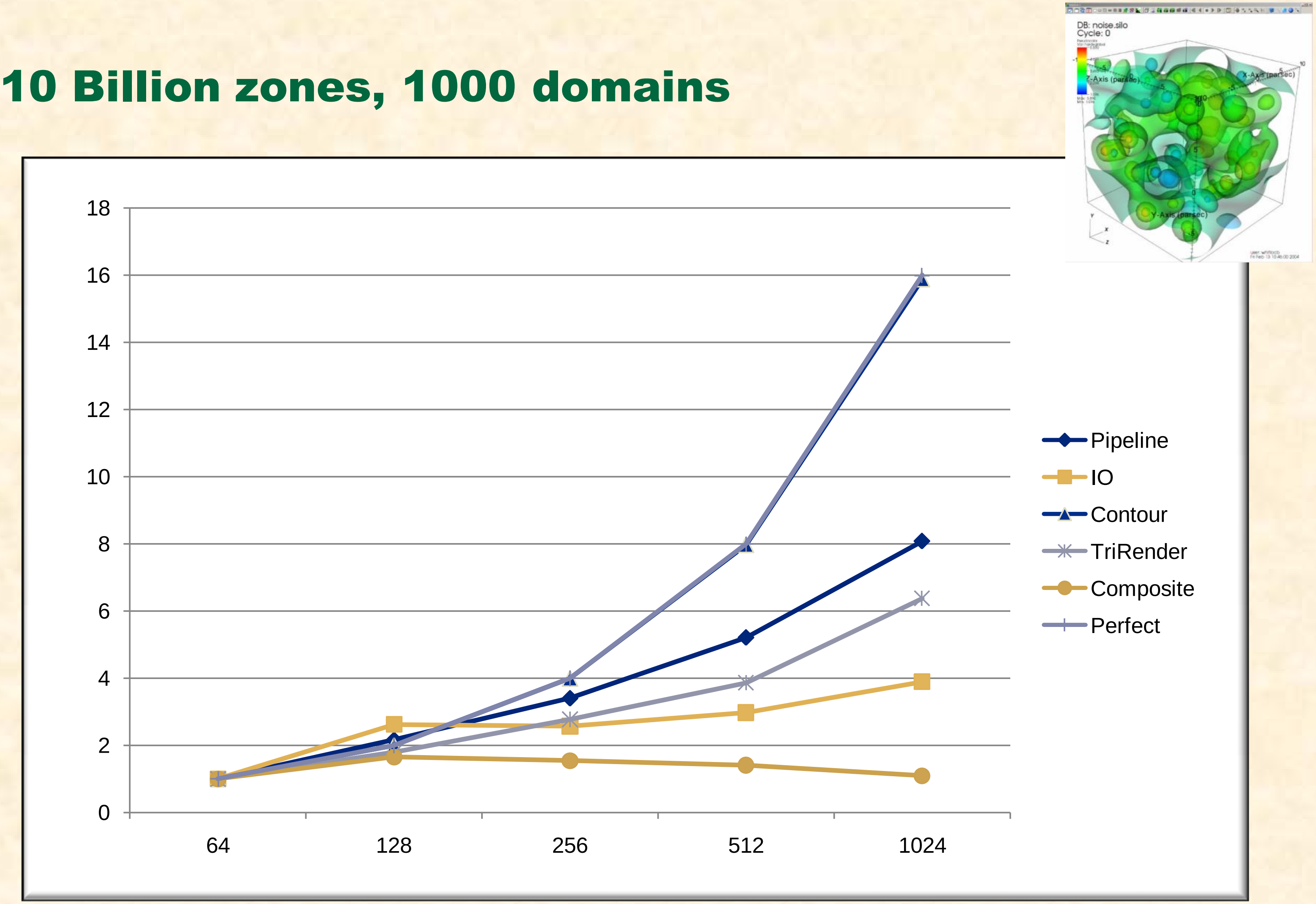
  1. Render triangles
  2. Composite sub-images (** Not expected to scale)
  3. Display result

1 Billion zones, 1000 domains

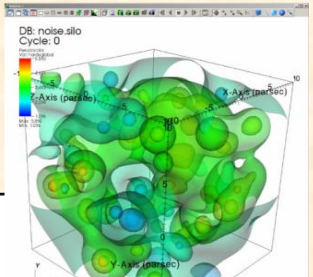




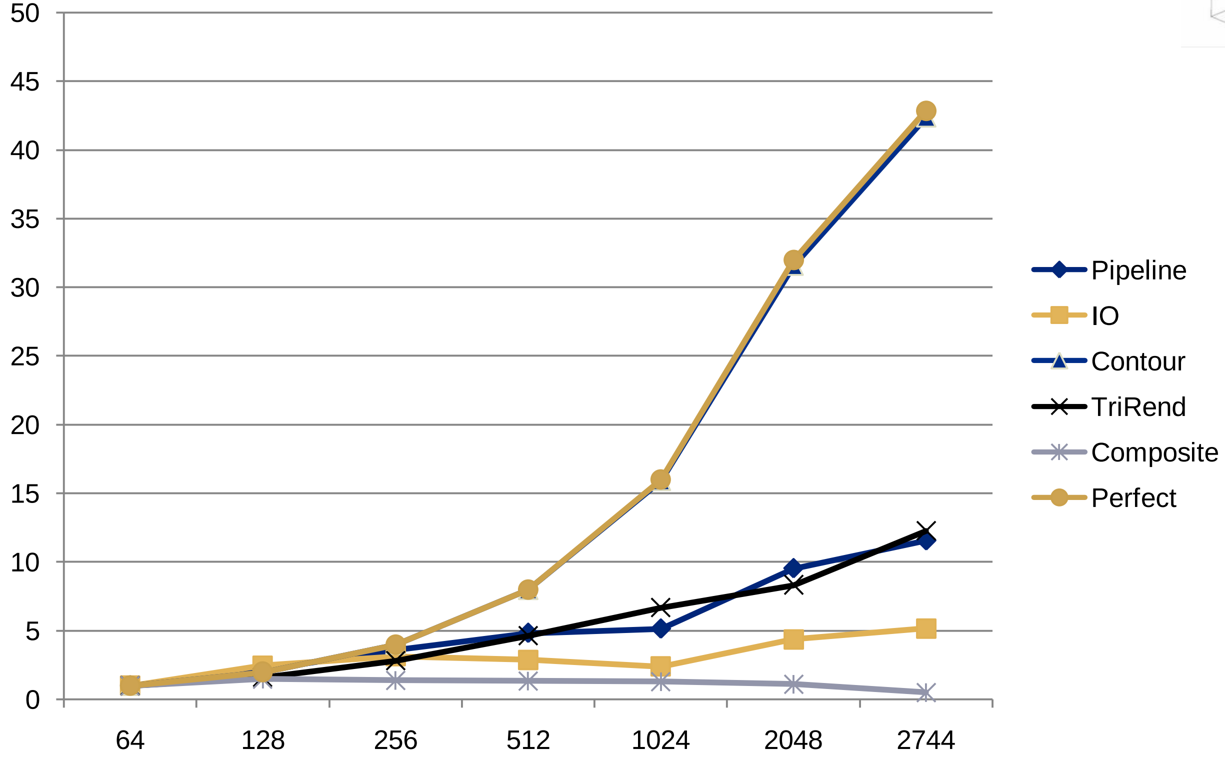
10 Billion zones, 1000 domains



10 Billion zones, 2744 domains



DB: noise.silo
Cycle: 0



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Conclusions

- Viable way to do analysis and visualization
- Valuable insight into tool behavior at scale
- More scaling studies needed