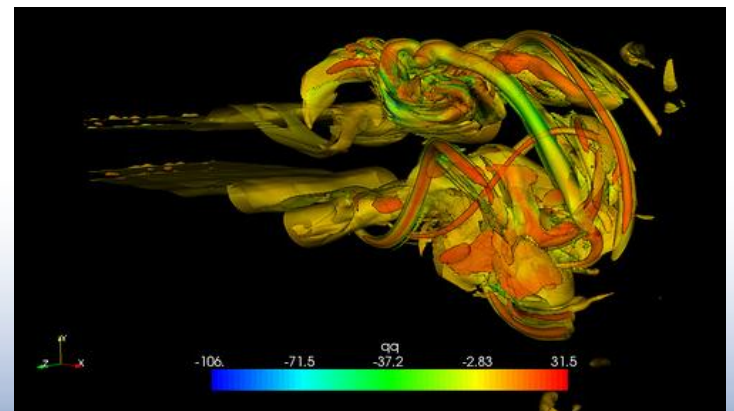




Open Source Tools for Large Scale Visualization and Image Analysis

OME Users Meeting – Paris 2011

Julien Jomier, Kitware
julien.jomier@kitware.com



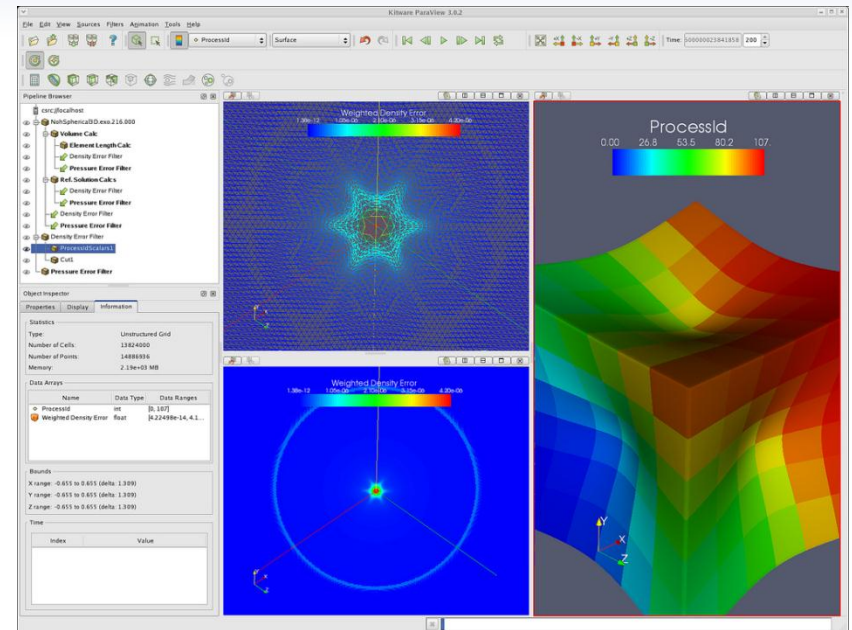
Kitware

- Founded in 1998
 - Support VTK (Visualization Toolkit) software
 - Revenue in 2011: \$20M
- 95+ employees
 - 70+ PhD and Masters
 - 31% growth in 2010
- Offices
 - Clifton Park, NY (USA)
 - Chapel Hill, NC (USA)
 - Lyon (France)
 - Bangalore (India)



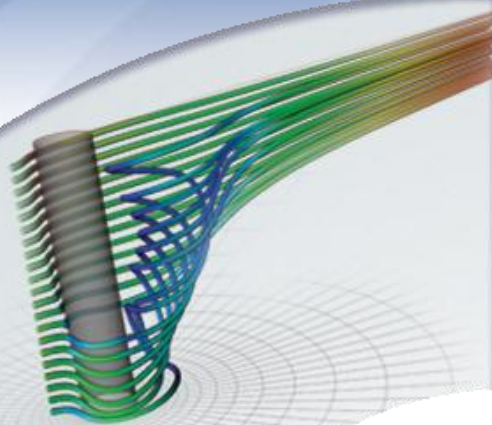
Business Model

- **Open source software**
 - Services and support
 - Consulting
 - Collaborative R&D
- **Commercial products**
 - Value-added products
 - Applications built on high quality, open source base
 - Custom (proprietary) software frameworks



SOFTWARE PROCESS

**SUPERCOMPUTING
VISUALIZATION**



**MEDICAL
IMAGING**



**COMPUTER
VISION**

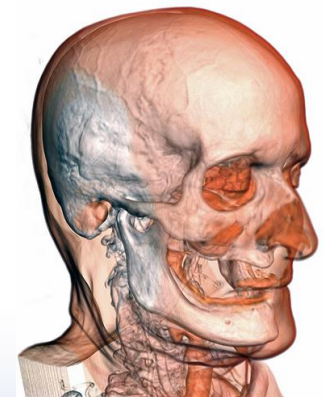
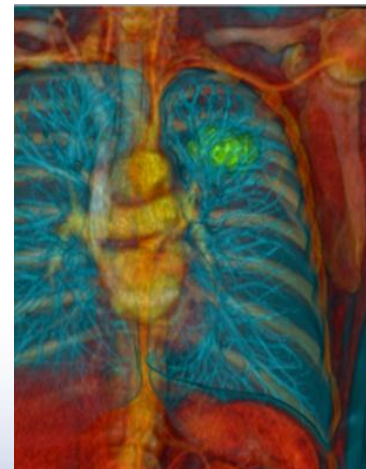
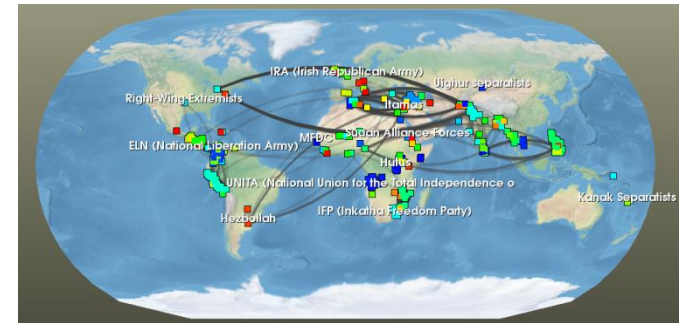
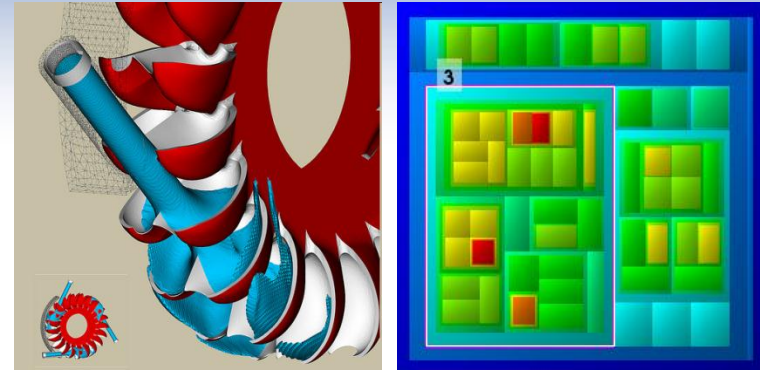


**DATA
MANAGEMENT**



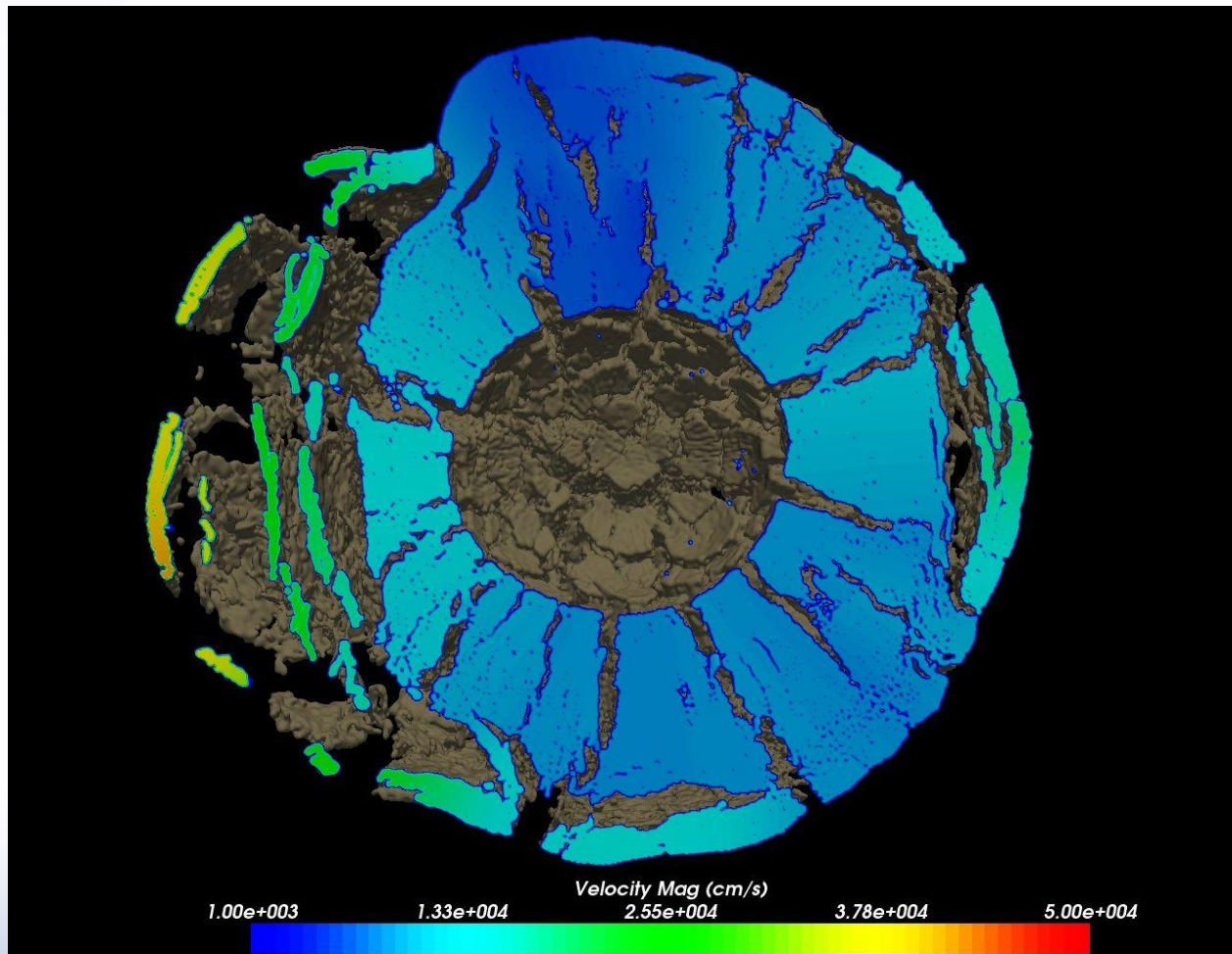
Open Source Systems

- **VTK** – Visualization Toolkit
- **ParaView** – Large data visualization
- **ITK** – Insight image analysis toolkit
- **CMake** – Cross-Platform Build
- **Titan** – Informatics Toolkit
- **3D Slicer** – Medical research platform
- **IGSTK, CTK, VXL, Avogadro**, more....



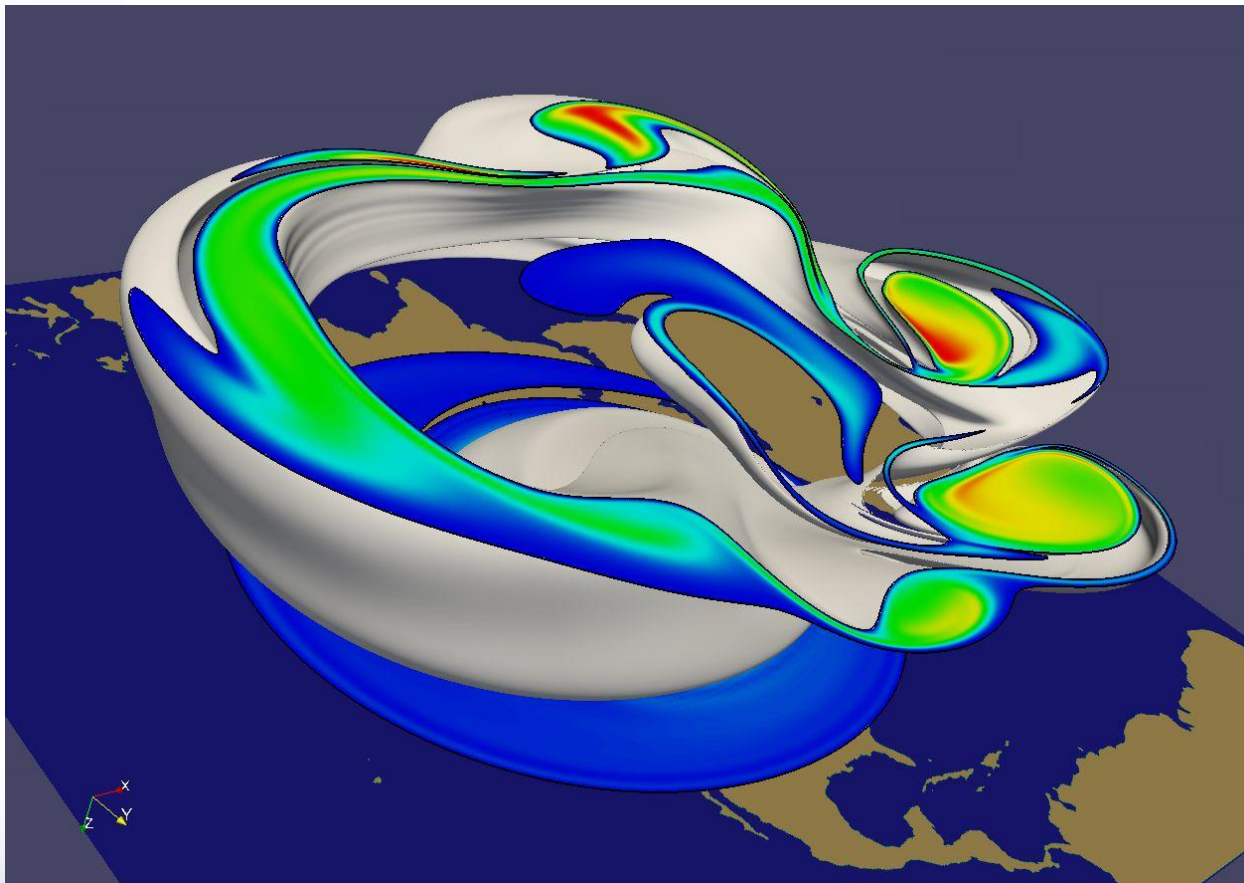
Golevka asteroid vs. 10 megaton explosion

- CTH shock physics, over 1 billion cells



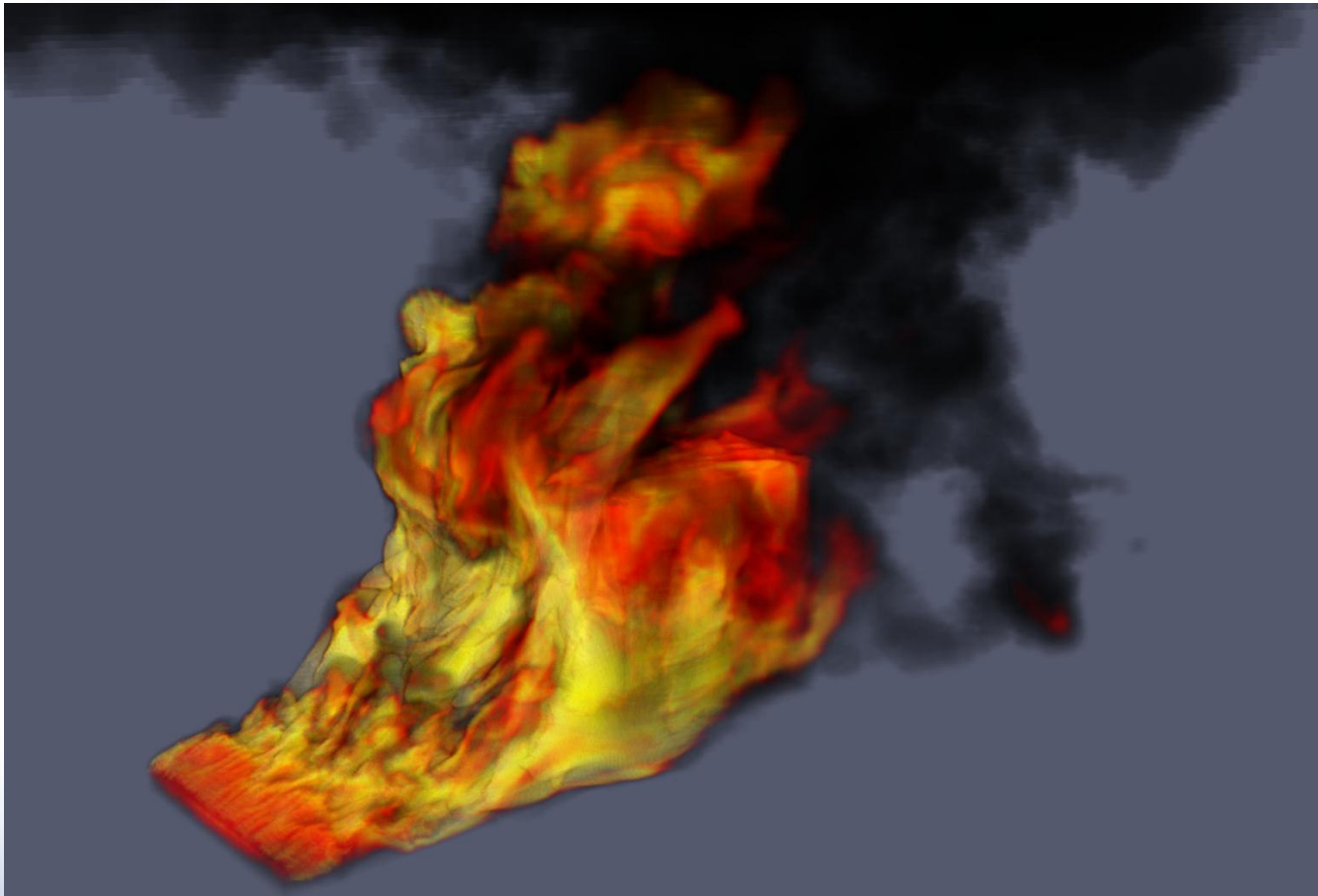
Polar vortex breakdown

- SEAM Climate Modeling, 1 billion cells (500 million cells visualized).



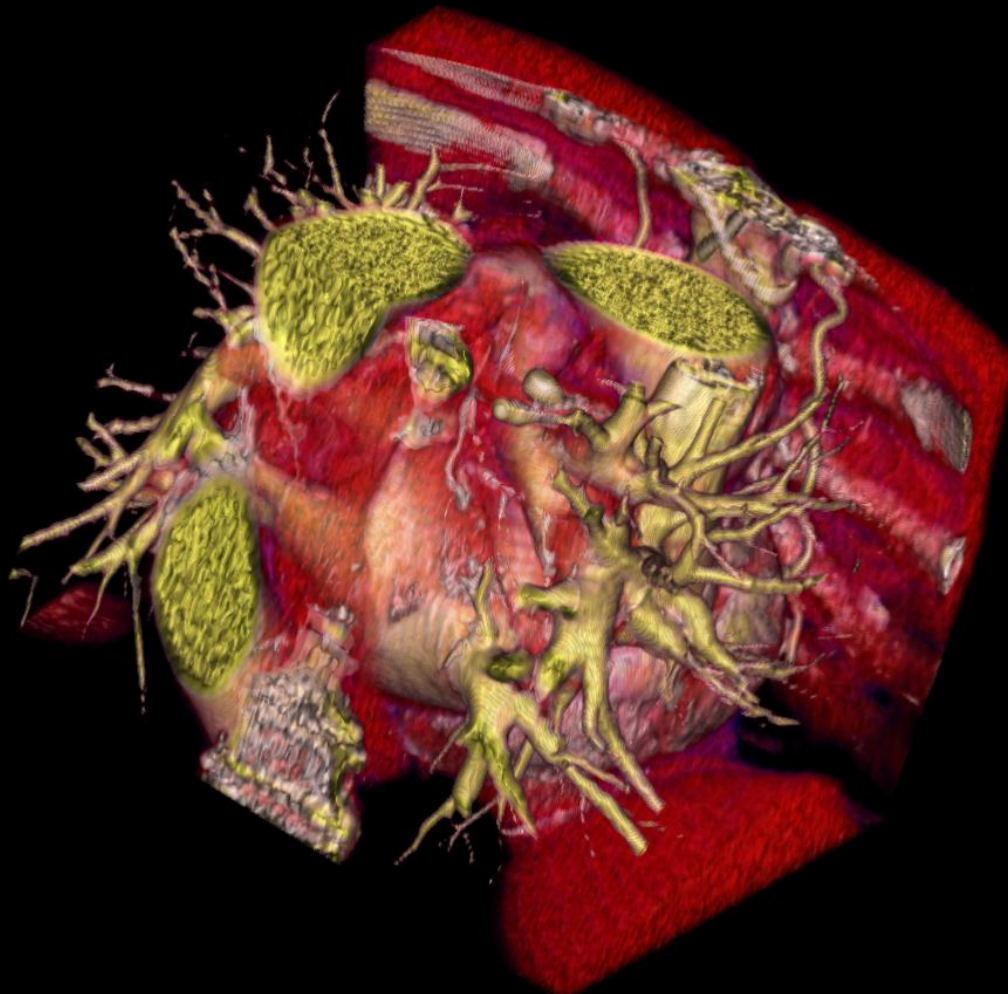
Objects-in-Crosswind fire

- Coupled SIERRA/Fuego/Syrinx/Calore, 10 million unstructured hexahedra



Volume
CT GE MEDICAL SYSTEMS Discovery CT750 HD
Exam: 71
Series: 3 (SSEG 75-75%)

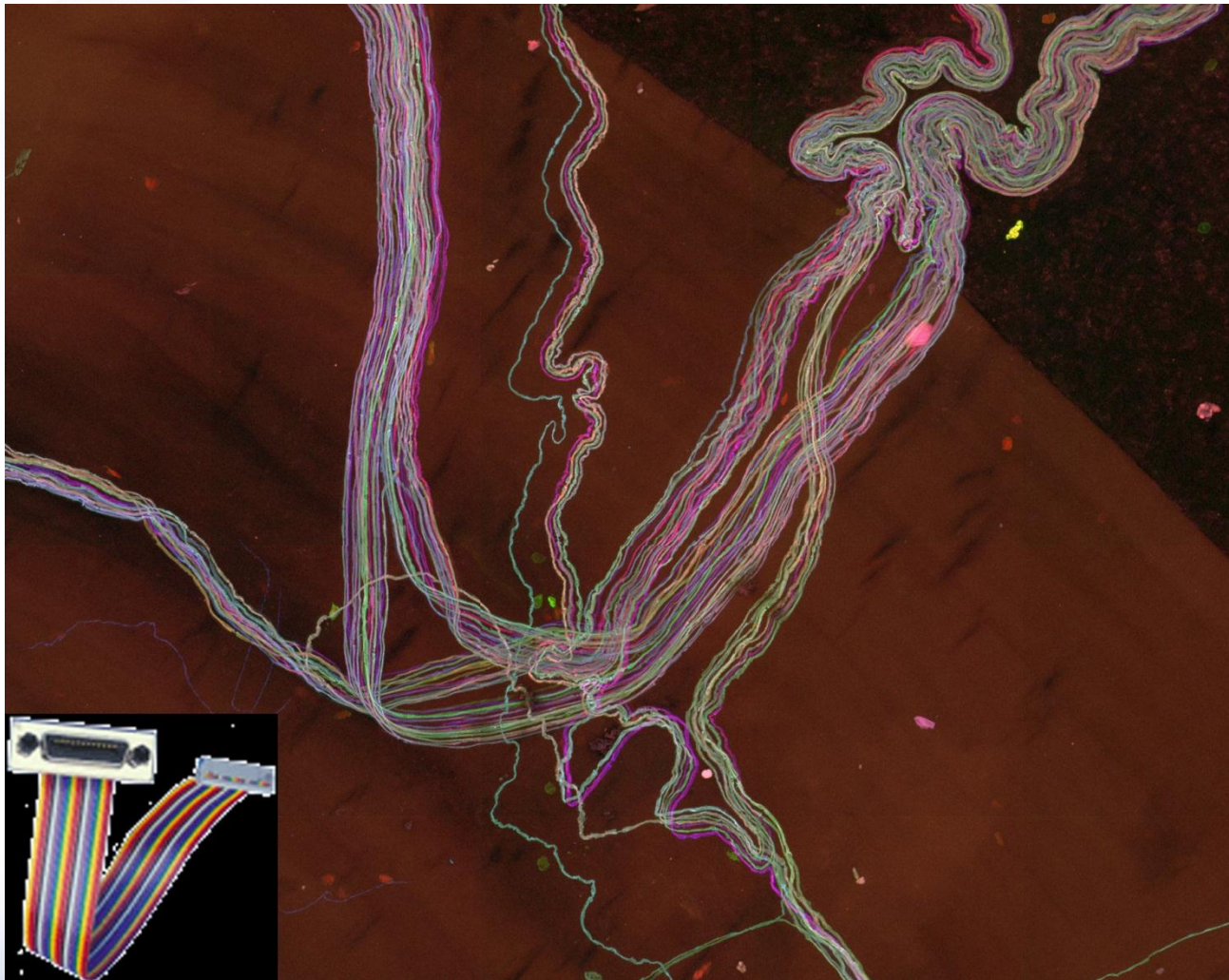
IMS
University of Michigan Hospital
CT750-HD CHEST 71 JB
ID: AW248044413.774.1233589876
71 year(s) M
01/14/09 11:20:42



mA: 438
kVp: 120
Thick: 2.5 mm
Kernel: STANDARD
VolView 3.2



What's Big Now: Case Study: Connectome Mapping Neural Circuitry



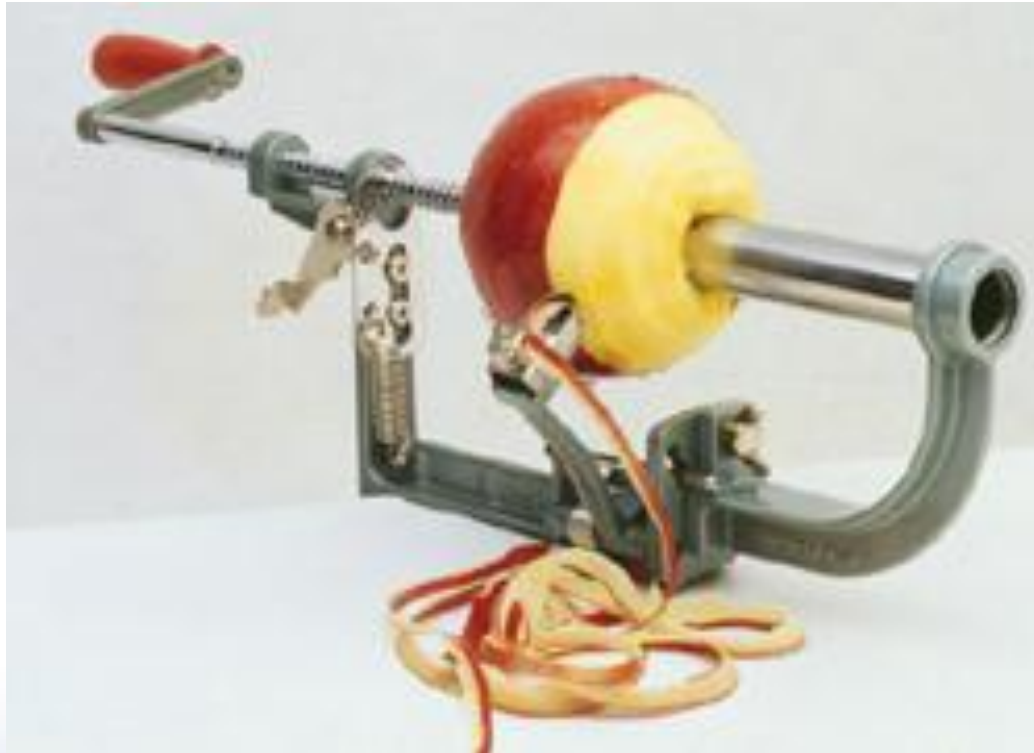
What's Big Now (2008)

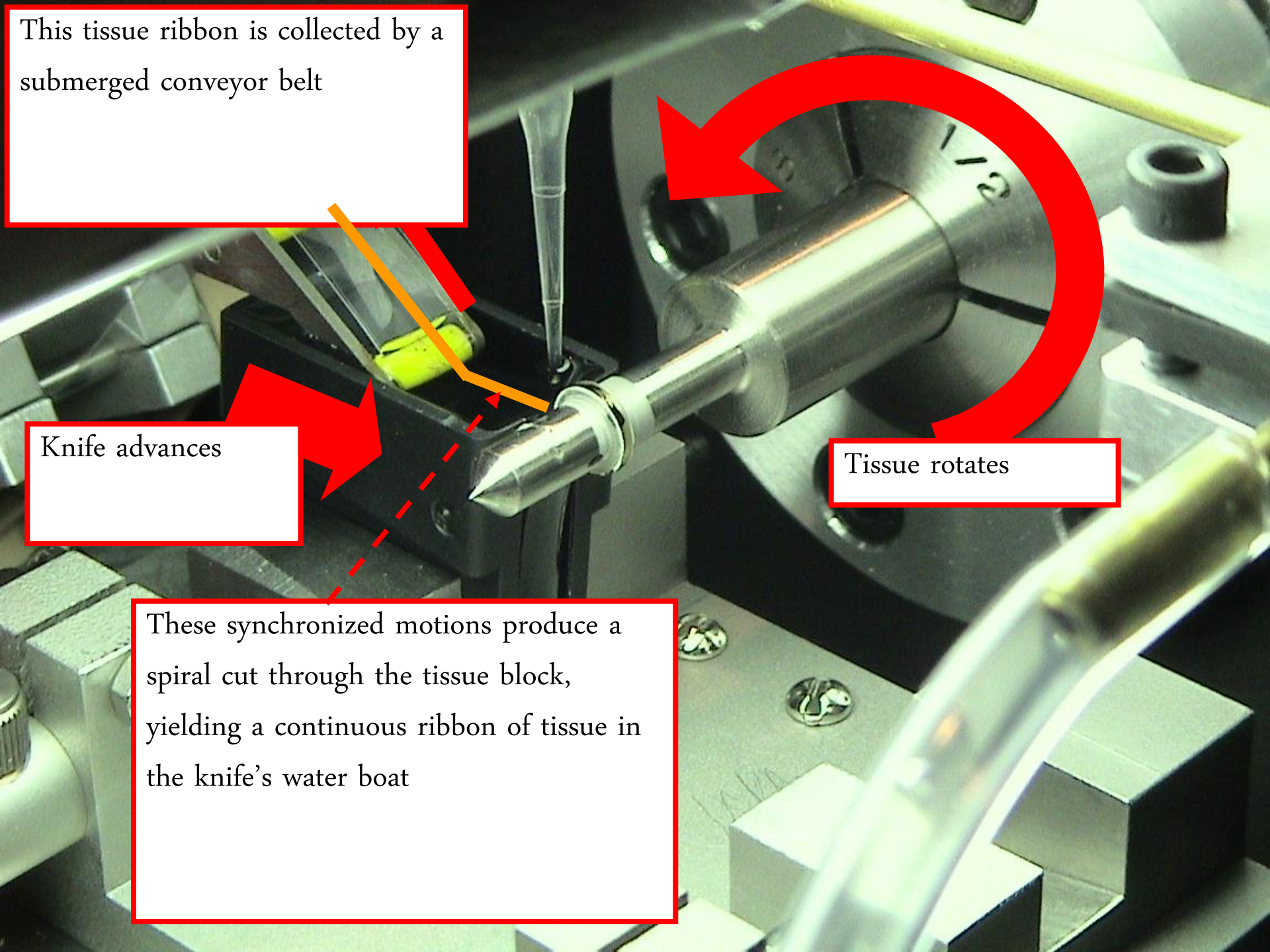
- Harvard Center for Brain Science Connectome Project
 - Jeff Lichtman (FAS/Molecular & Cellular Biology, Center for Brain Science, Harvard) and Clay Reid (HMS/Neurobiology, Center for Brain Science, Harvard)
 - Mapping connectivity of neural systems (e.g., mice)
 - Use electron microscopy to image tissue samples
 - ~25 μm resolution
 - 100,000 x 100,000 x 40,000 images
 - Each of the 20,000 images is 10 gigabytes
 - Total size is for one dataset: terabytes



Acquiring Data

- Embed tissue samples in cylindrical polymer
- Produce continuous ribbon of material at high data rates
- Image (SEM) ribbon as it streams off



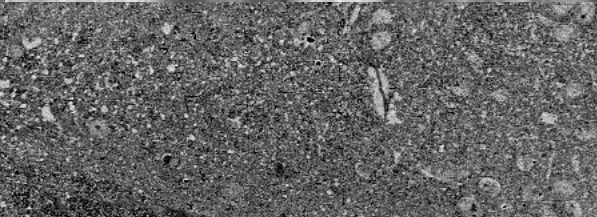
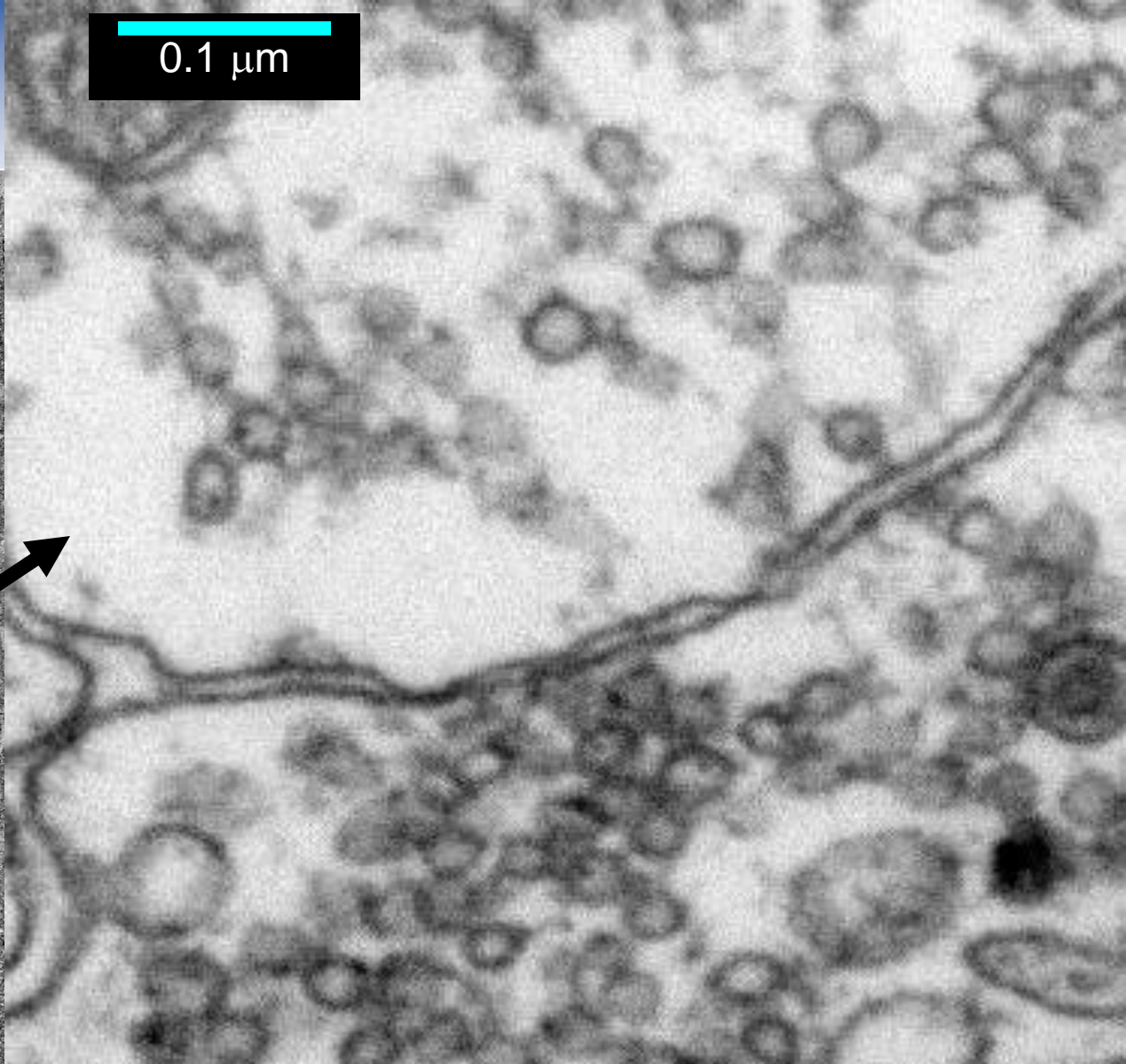
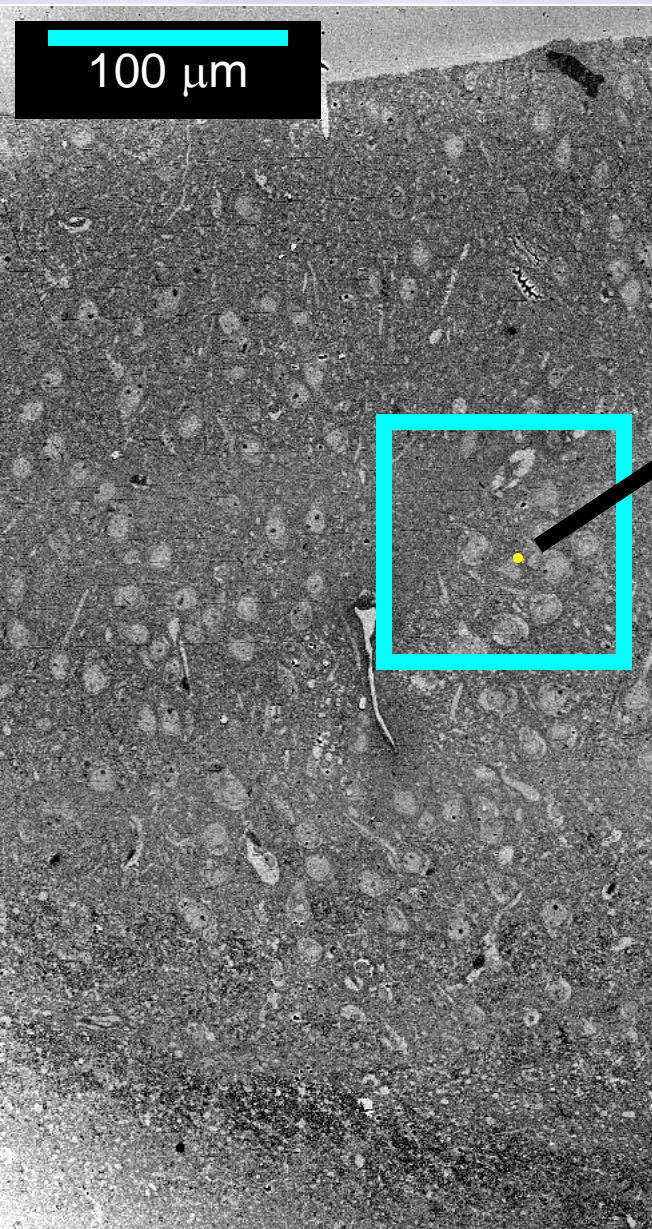


This tissue ribbon is collected by a submerged conveyor belt

Knife advances

Tissue rotates

These synchronized motions produce a spiral cut through the tissue block, yielding a continuous ribbon of tissue in the knife's water boat

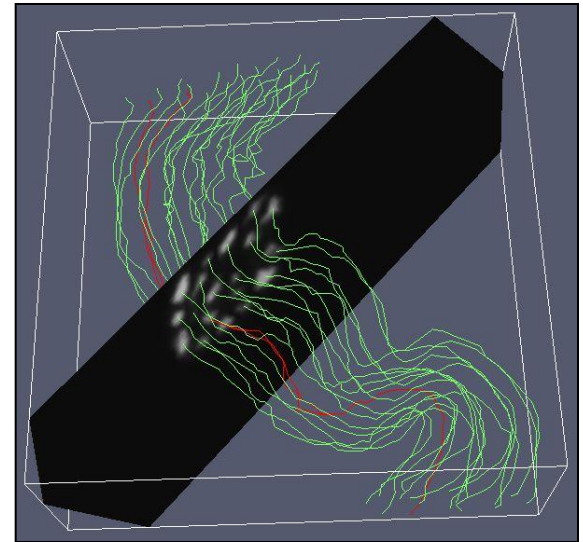


40,000 of
images like this
per volume



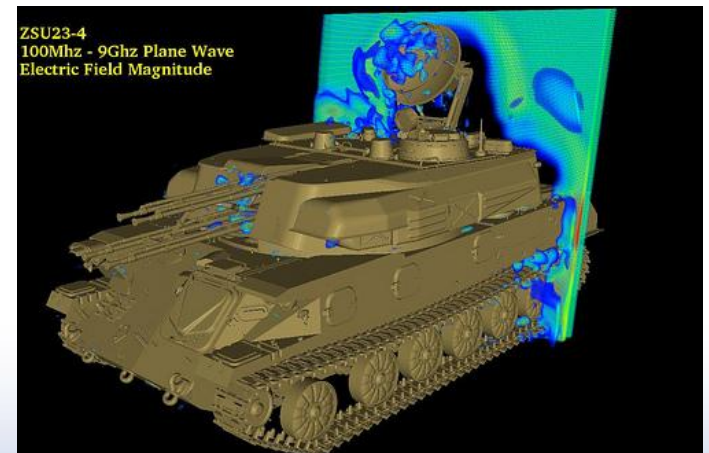
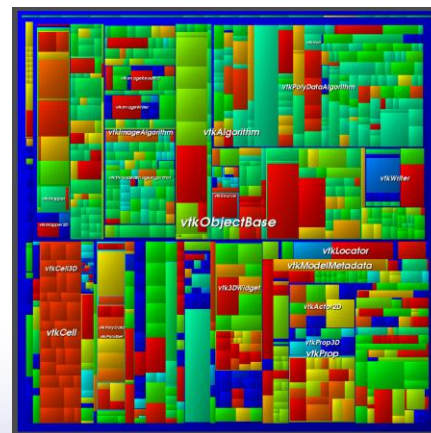
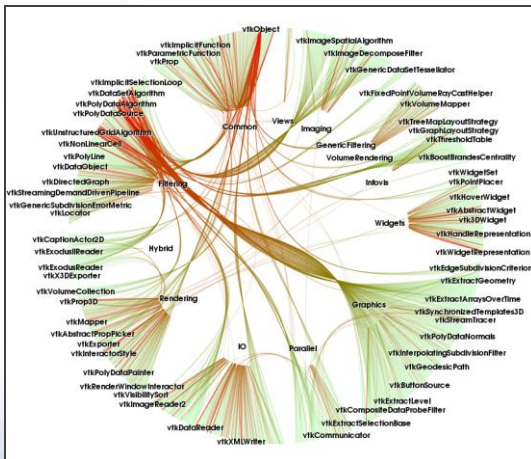
Viewing Large Data

- Distant visualization
 - Leave data in place
 - Build Client / Server solutions
 - More efficient than transferring data
- Connectome Example
 - Interactive (>10 fps) through 100,000 x 100,000 x 40,000 volume
 - Oblique slice view through volumetric data
 - Enable tracing of neural circuitry

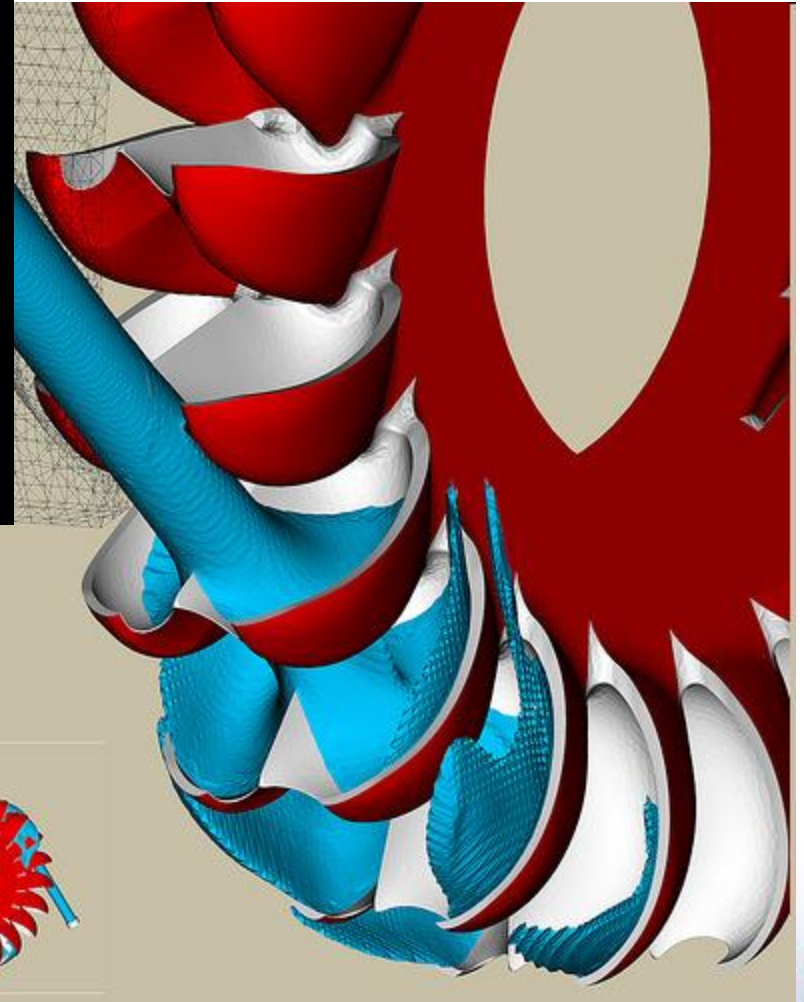
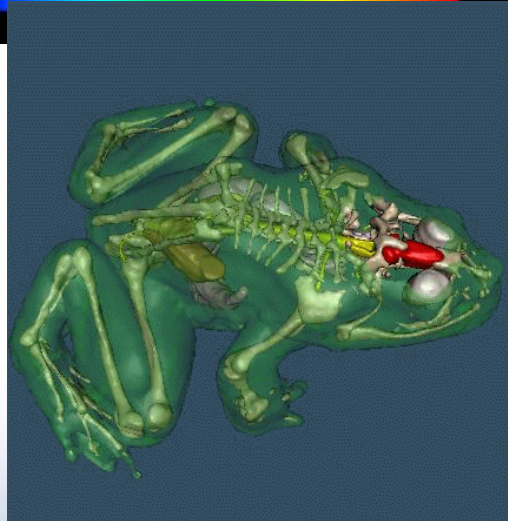
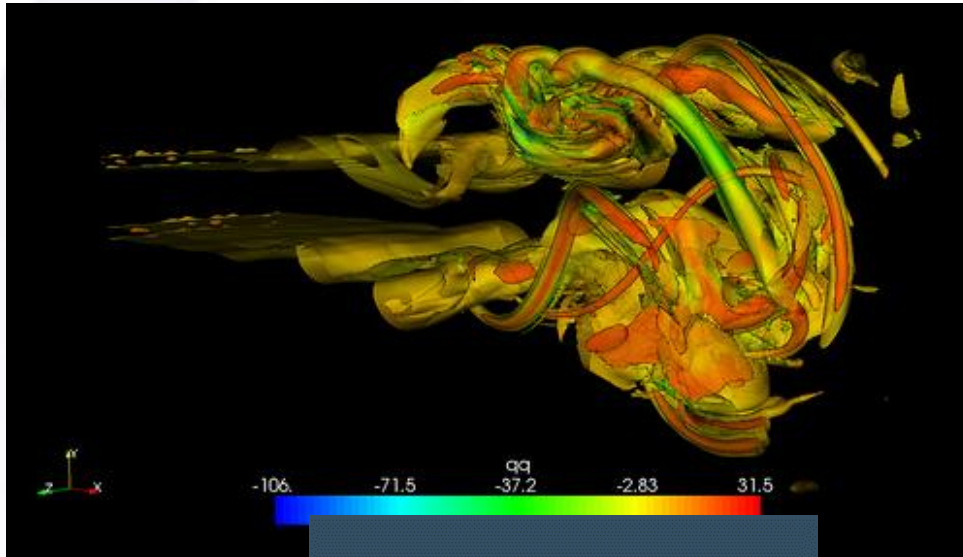


The Visualization Toolkit (VTK)

- www.vtk.org
- Started in 1993 at GE
- Visualization Library
 - Written in C++ (+5.5 million LOC)
 - Automatic binding for Java, TCL, Python
 - Portable by design: Linux, Windows, Mac OSX, Solaris...
- Very active community: 4000+ users

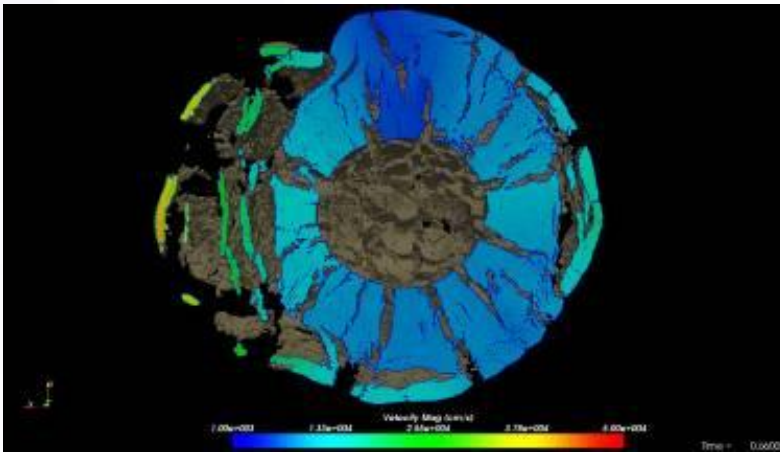


The Visualization Toolkit (VTK)

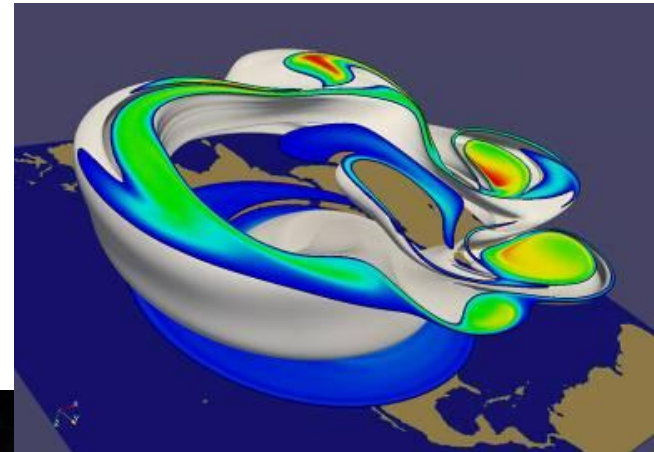


ParaView

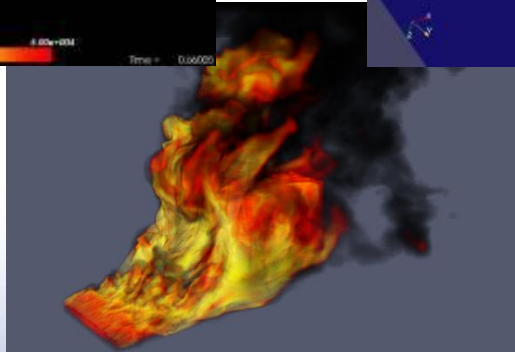
- www.paraview.org
- An **application** and a **framework** for visualization and analysis of scientific datasets
- End-user visualization tool



1 billion cell asteroid
detonation simulation



1/2 billion cell
weather simulation

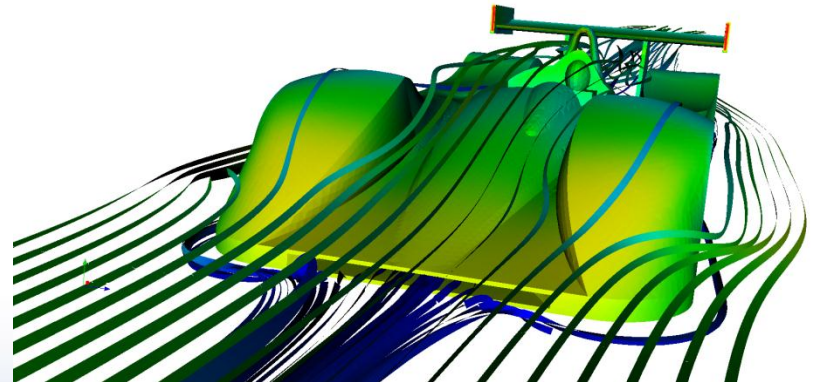


Fire simulation

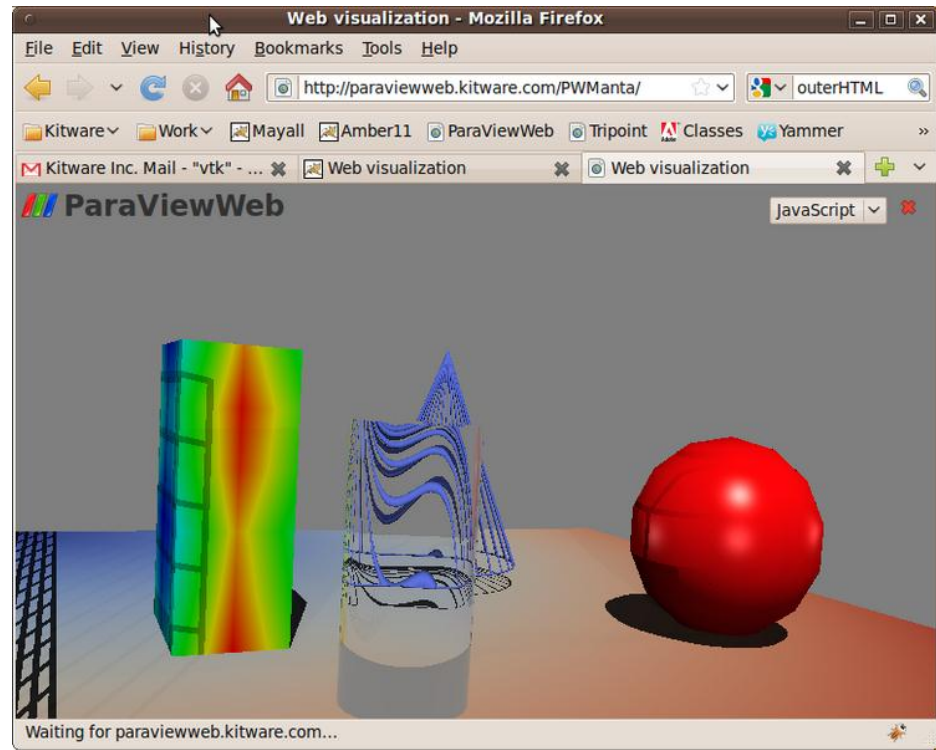
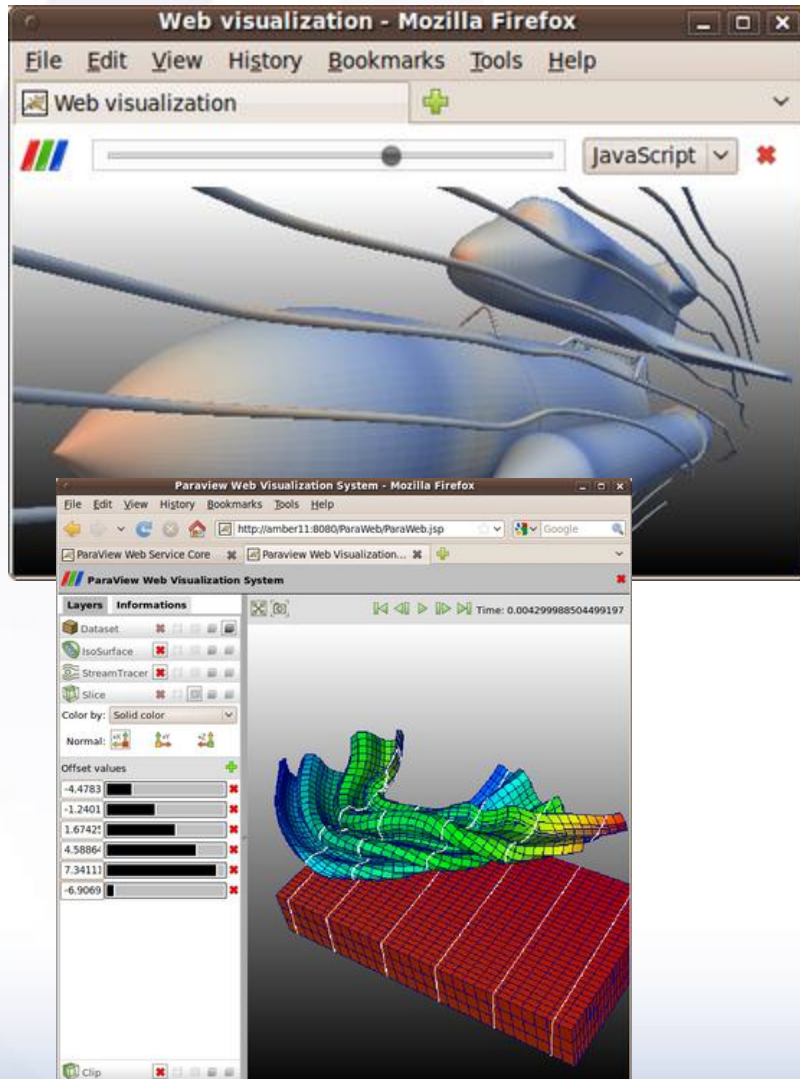


ParaView

- OpenSource (BSD)
- Based on VTK
- C++/Qt
- Python support
- Very active community (HPC wire award)
- Multi-core support (MPI)
- Co-Processing (in-situ)
- More than 50 news readers
- Visit plugins are supported
- User's guide online



ParaViewWeb



<http://www.webviz.org>



Server Site



Network Storage
(Parallel File System)



Compute server



Web Server



Visualization Cluster



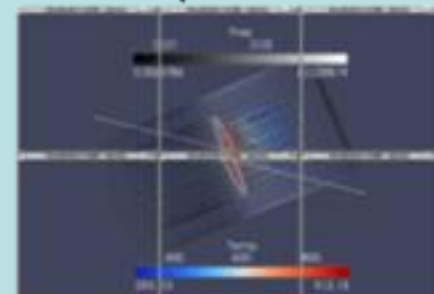
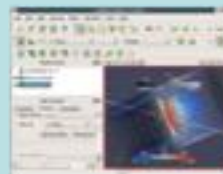
Web Client



Instant Messenger
Client

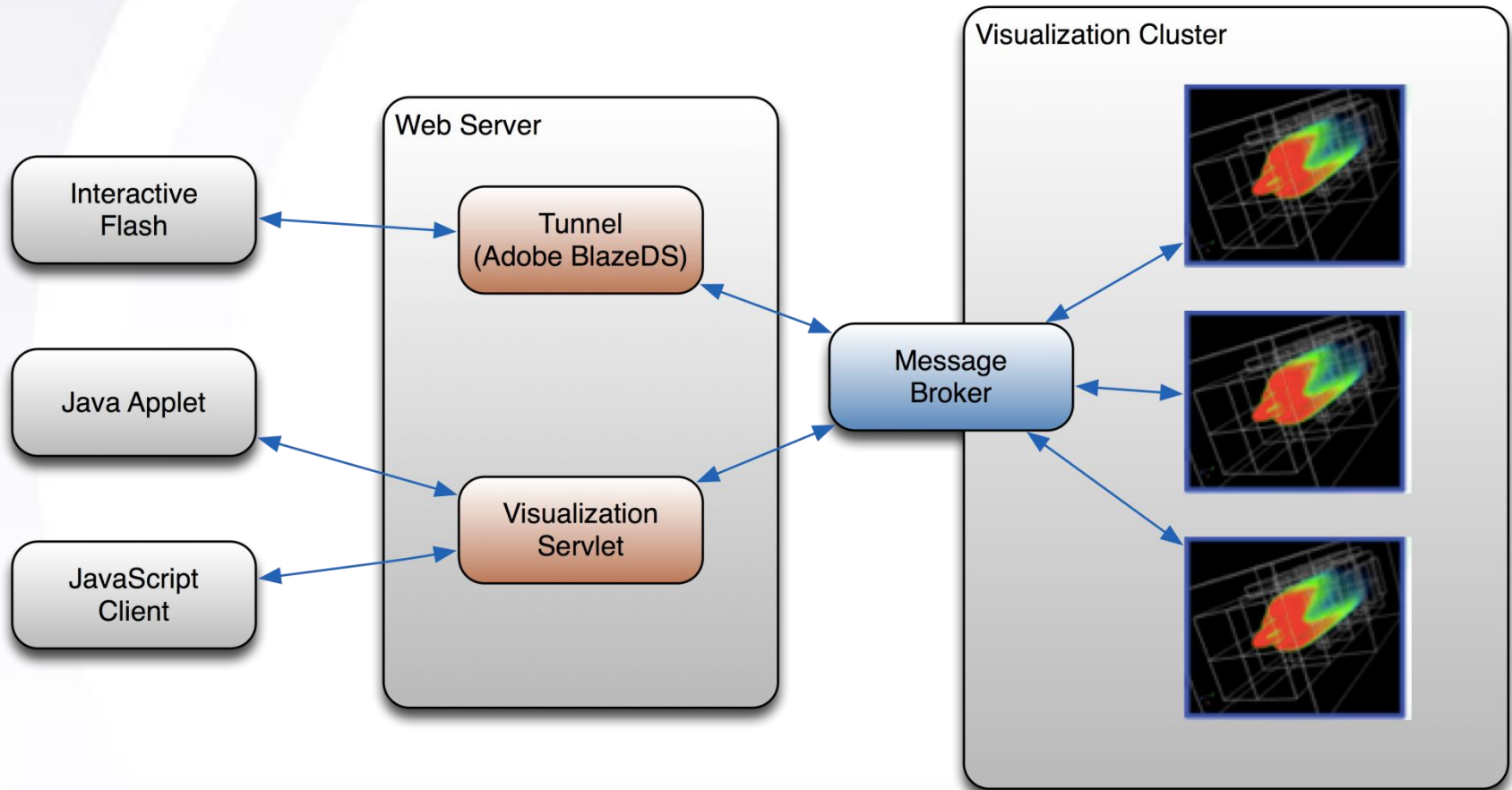


Desktop Client



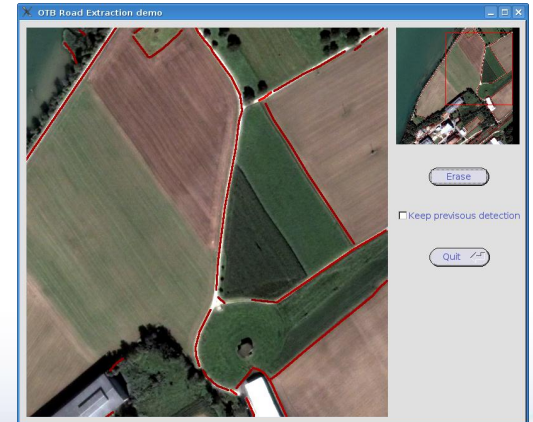
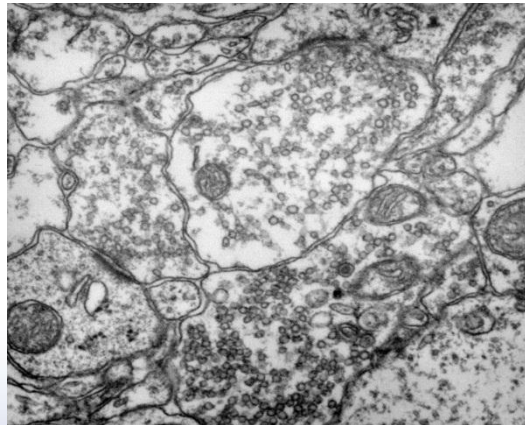
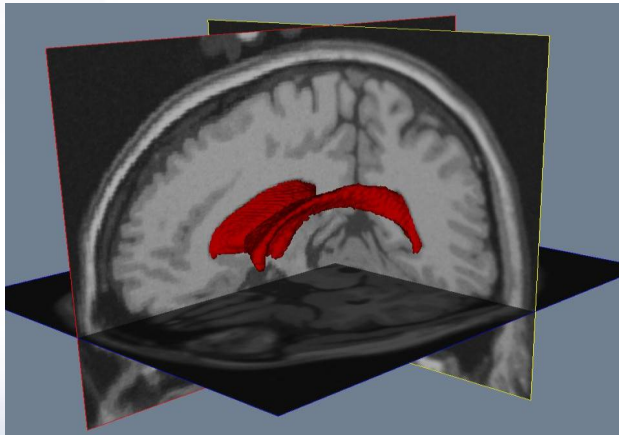
Tiled Display
Client

ParaView Web



The Insight Toolkit (ITK)

- www.itk.org
- Started in 2000 from the NLM
- Image Processing Library
 - Written in C++ (+2.1 million LOC)
 - Automatic binding for Java, TCL, Python
 - Portable by design: Linux, Windows, Mac OSX, Solaris...
- Very active community: 2000+ users



Insight Toolkit

- Segmentation/Registration
- Filtering
- Image analysis
- Image-Guided Surgery
- Simulation: haptic devices
- No Visualization
- No GUI

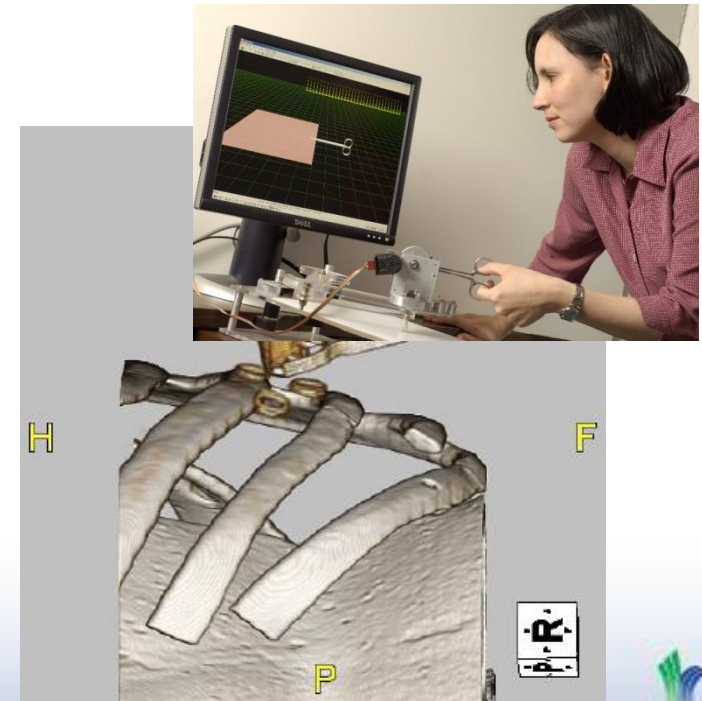
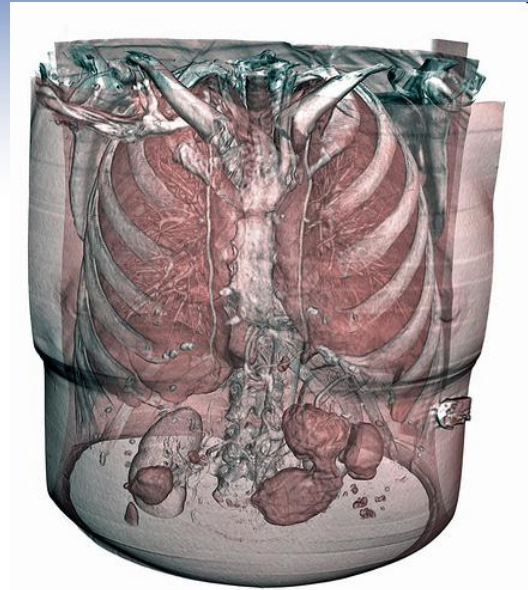
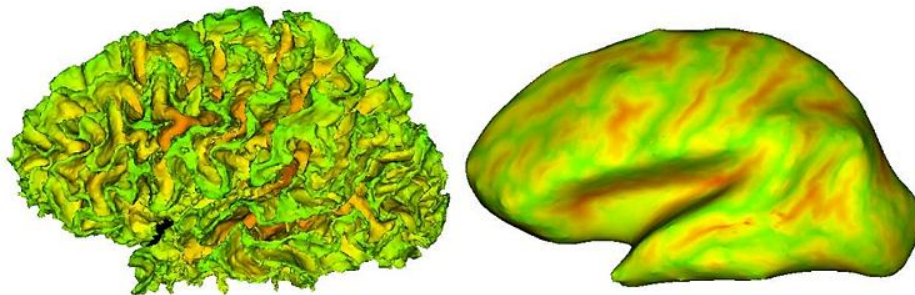


Image Segmentation

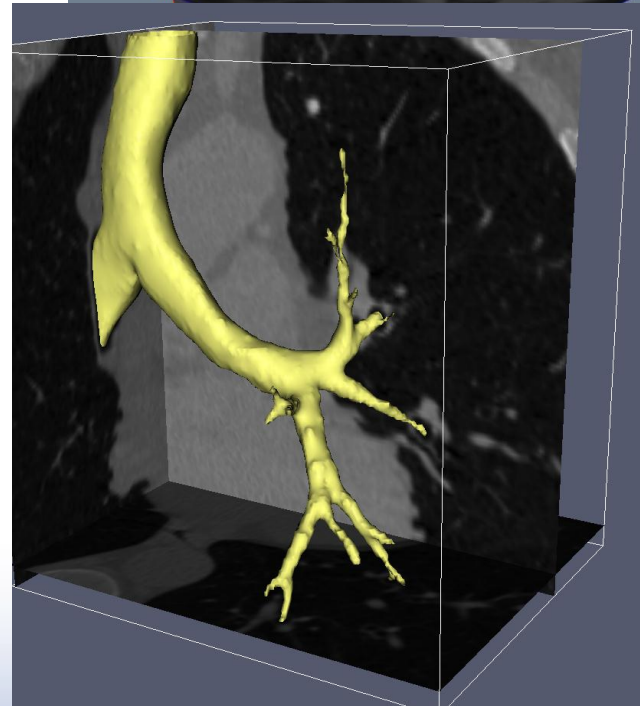
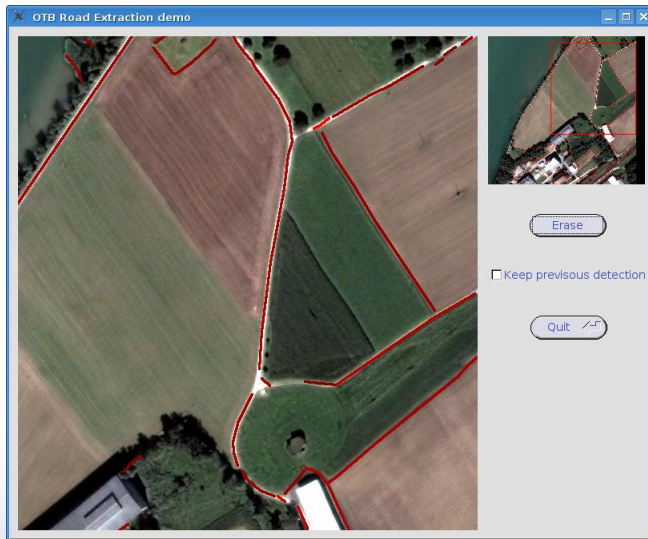
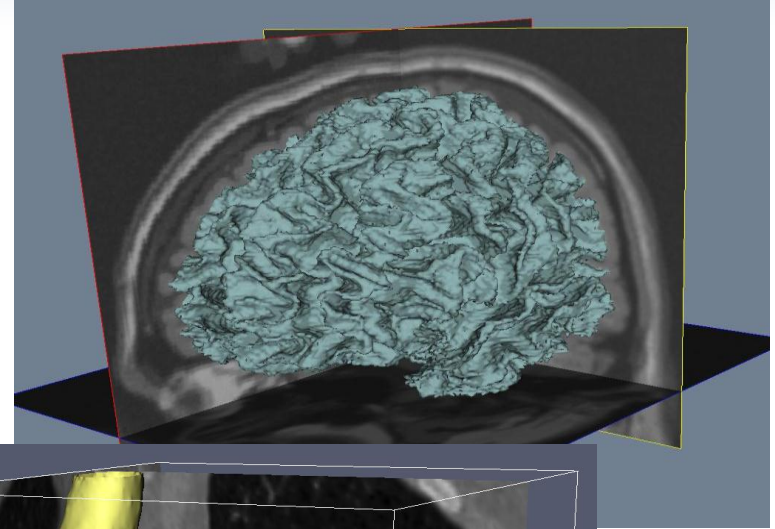
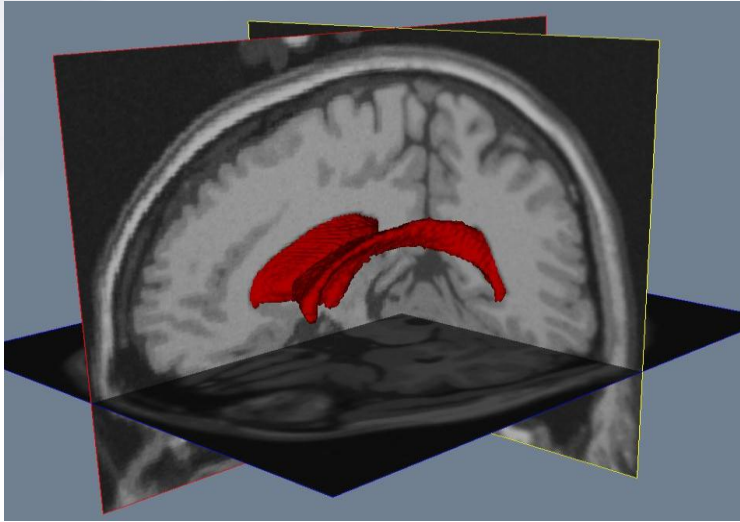
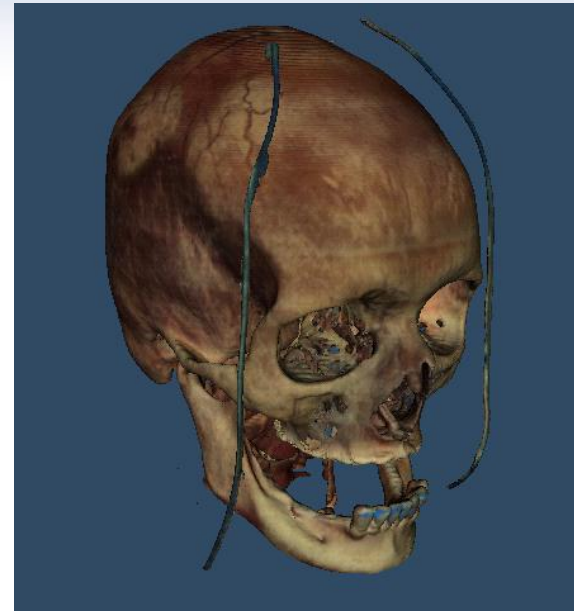
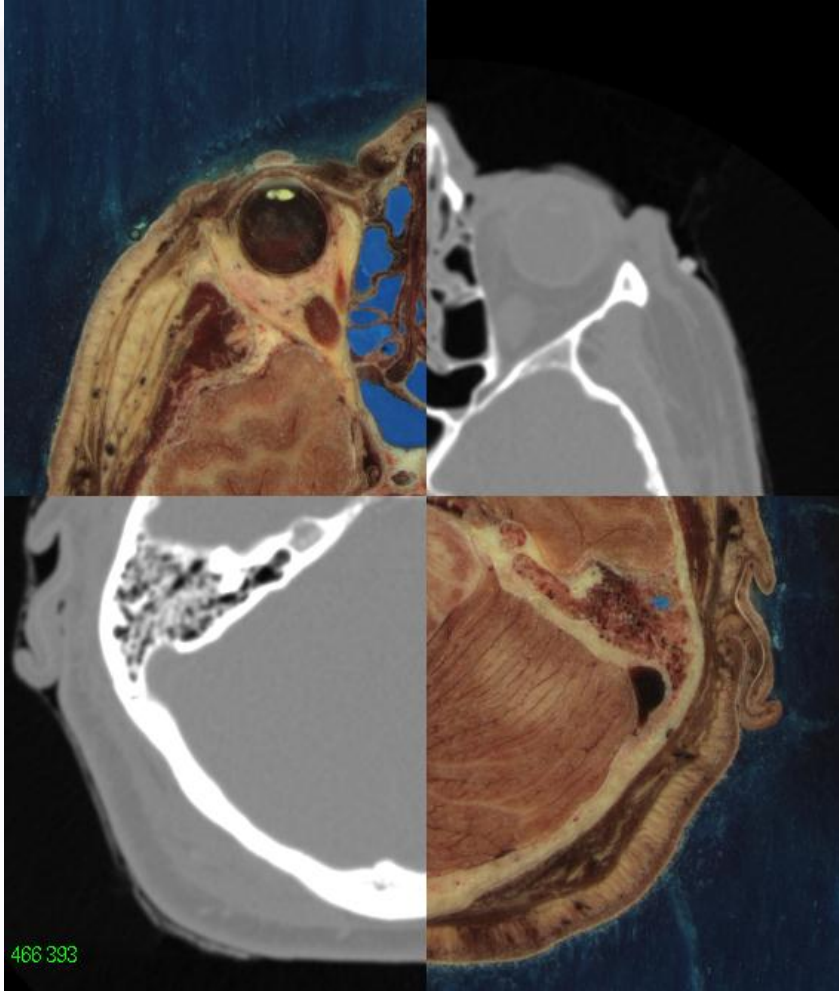
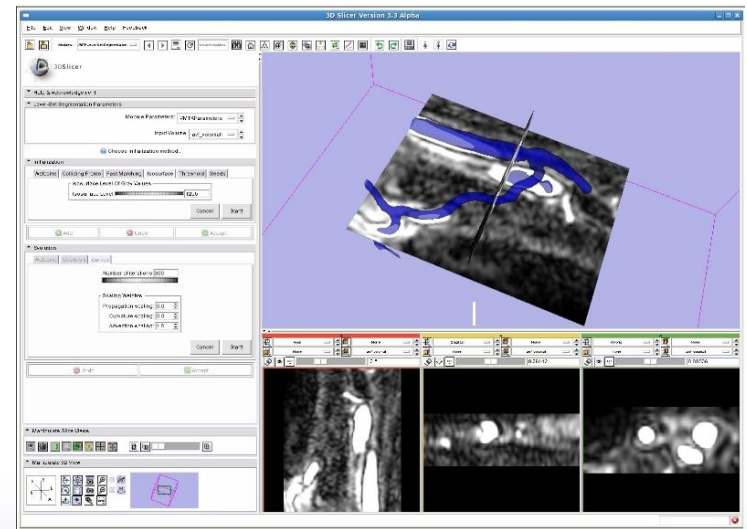
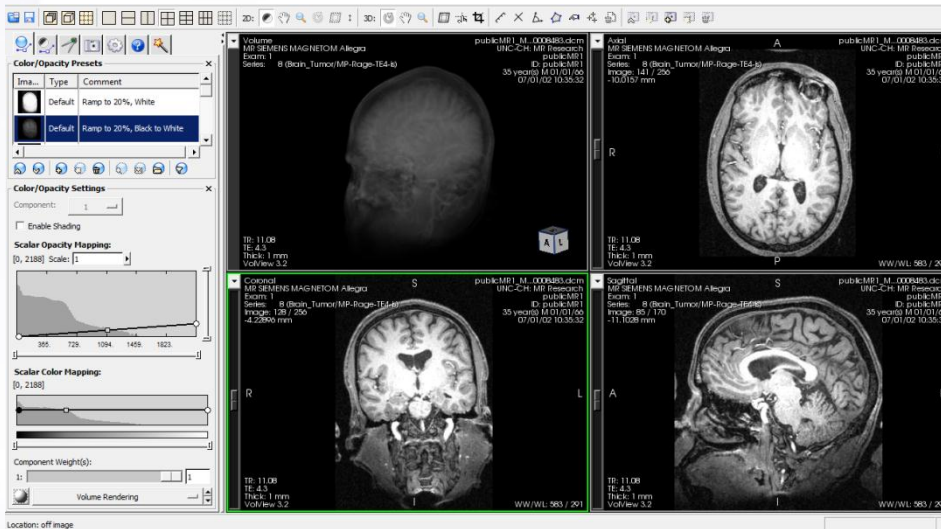


Image Registration



Open-source Tools and Libraries

- **Implementation** of algorithms for dissemination
- **Prototyping** of new technologies
- **Dissemination** of research
- **Modularization** of applications



The Insight Toolkit v4

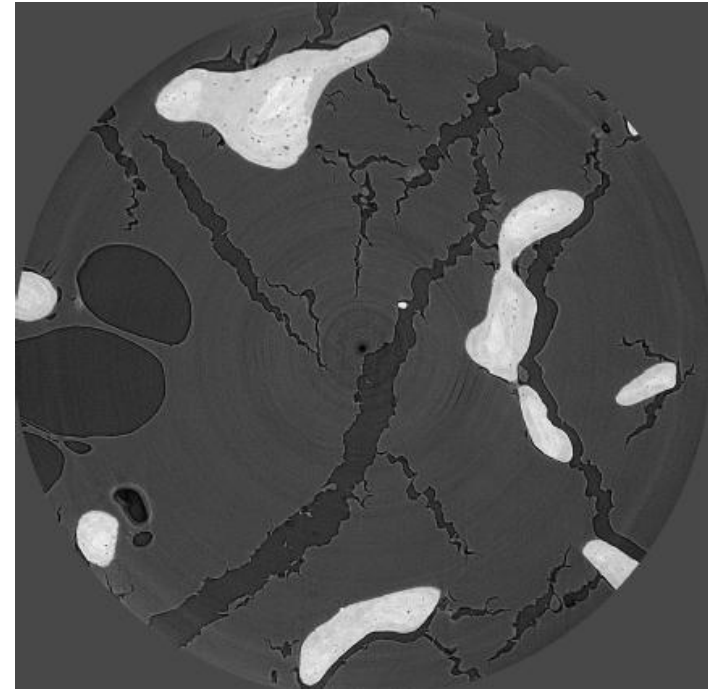
- Beta release this summer
- Simple ITK (no template)
- Better wrapping mechanism
- Support for video processing
- GPU accelerated algorithms
- Modularity
- Support for data management (MIDAS)
- Migration support



ITK v4 - Microscopy

Improving Support for

- Large images (> 4Gb)
- Multi-Channel processing
- Multi-Resolution
- File formats
 - JPEG 2000
 - TIFF 4.0 / BigTiff
 - MRC
 - Interfacing with Bio-Formats



Micro-calcifications - MicroCT

ITK v4 - Microscopy Features

- Deconvolution
- Noise Reduction
- Classification Algorithms
- Feature detection
- Colocalization
- Nuclei segmentation
- Color correction
- 3D registration (rigid and non-rigid)



Customers and Collaborators



Let's work together!

- **Bring ITK/VTK to the Microscopy community**
- **Collaboration**
 - Research Grants
- **Support** on ITK, VTK, ParaView, CMake, MIDAS.
- **Consulting**
 - Software development
 - Infrastructure development
- **Training**
 - Courses off/on-site
 - Books (amazon.co.uk)





Open Source Tools for Large Scale Visualization and Image Analysis

Julien Jomier, Kitware
julien.jomier@kitware.com