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BioHPC

Visualization on BioHPC

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Updated for 2021-07-14

Outline

- What is Visualization
  - Scientific visualization
  - Workflow examples

- Visualization on BioHPC
  - Storage and management of image
    BioHPC cluster & Lamella cloud storage
    BioHPC OMERO (Open Microscopy Environment Remote Objects)

  - Image processing/Analyzing with HPC

  - Visualization (3D volume rendering)
    Concepts and examples of different type of volume rendering
    GPU rendering v.s. CPU rendering

Why is data visualization important?

Data visualization, or "data viz," is becoming largely important as the amount of data generated is increasing and big data tools are helping to create meaning behind all of that data.

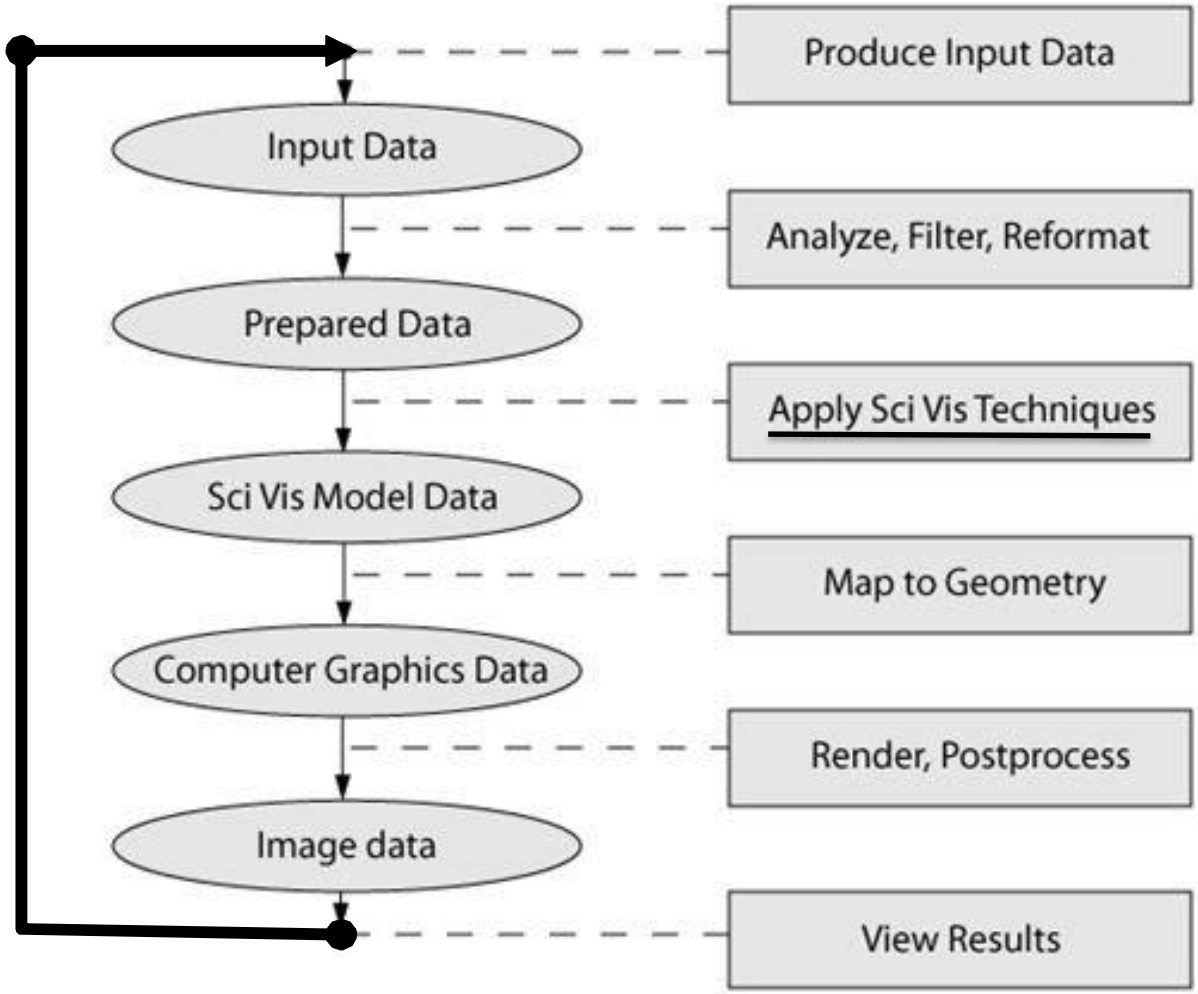
Courtesy of Amit Amritkar, Ph.D., Computer Scientist, BioHPC

Value of data visualization

- Two basic types
  - Exploration: find a story the data is telling you
  - Explanation: tell a story to audience
- Represent large quantities of data coherently
- Help the user to discern relationship in the data
- Does not distort what the data has to say
- Takes into account your audience's expectations

https://www.slideshare.net/idigdata/data-visualization-best-practices-2013/5-The_Value_of_Data_Visualization

Scientific visualization pipeline



Courtesy of Amit Amritkar, Ph.D., Computer Scientist, BioHPC

Designing visualization

- Chart Choosers
  - http://labs.juiceanalytics.com/chartchooser/index.html
  - http://www.datavizcatalogue.com/
  - http://extremepresentation.typepad.com/blog/2006/09/choosing_a_good.html
- Trifecta check
  - What is the practical QUESTION?
  - What does the DATA say?
  - What does the VISUAL say?
  - Ideally, the results of all three investigations are one and the same.

Courtesy of Amit Amritkar, Ph.D., Computer Scientist, BioHPC

Audience considerations - Color palettes

Color Simulation Controls
(or switch to the color selection controls)

Simulate colors as percieved by a user with
normal trichromatic color vision
and a PC color monitor.

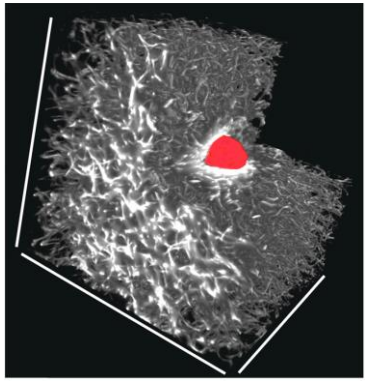
clear simulation settings

(Open a new window with more information about color blindness or gamma values.)

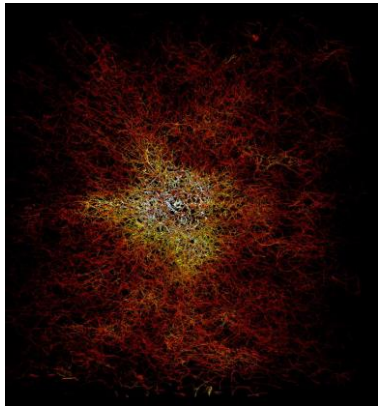
Courtesy of Amit Amritkar, Ph.D., Computer Scientist, BioHPC

Scientific Visualization : from single image/view to multiple datasets

Finding collagen fibers

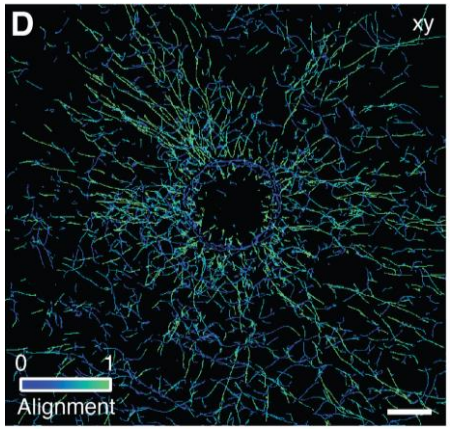


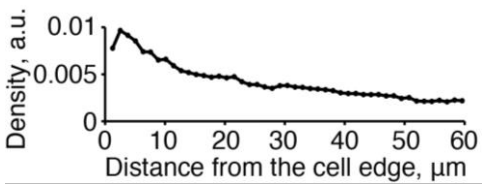
raw image produced by
light-sheet microscopes

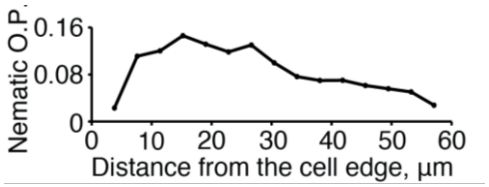


3D rendering

Fiber Alignment







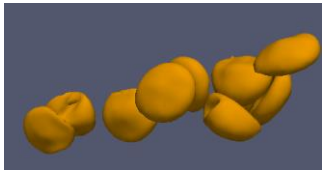
Fiji Is Just ImageJ

MATLAB

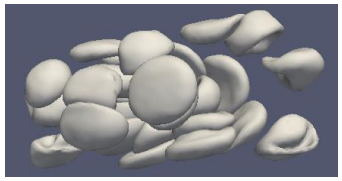
* Example provided by Dr. Meghan Driscoll From Dr. Danuser lab

Scientific Visualization : from multiple datasets to a single image/view

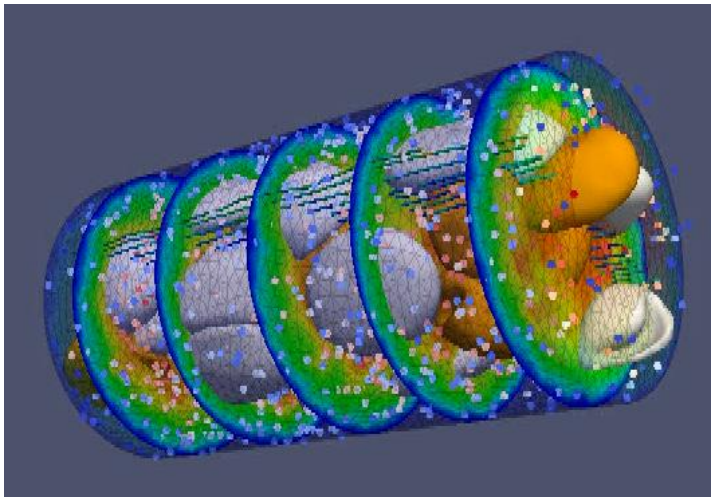
Red blood cell

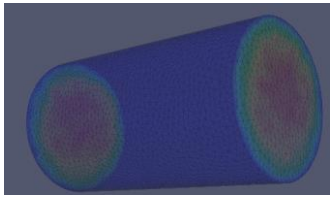


diseased cell

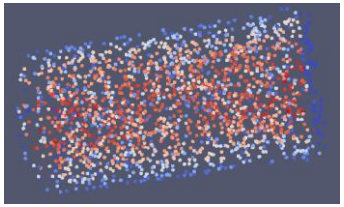


healthy cell

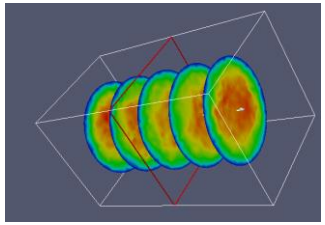




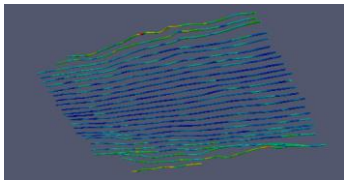
unstructured mesh



particles



xy-plane slice (based on velocity)

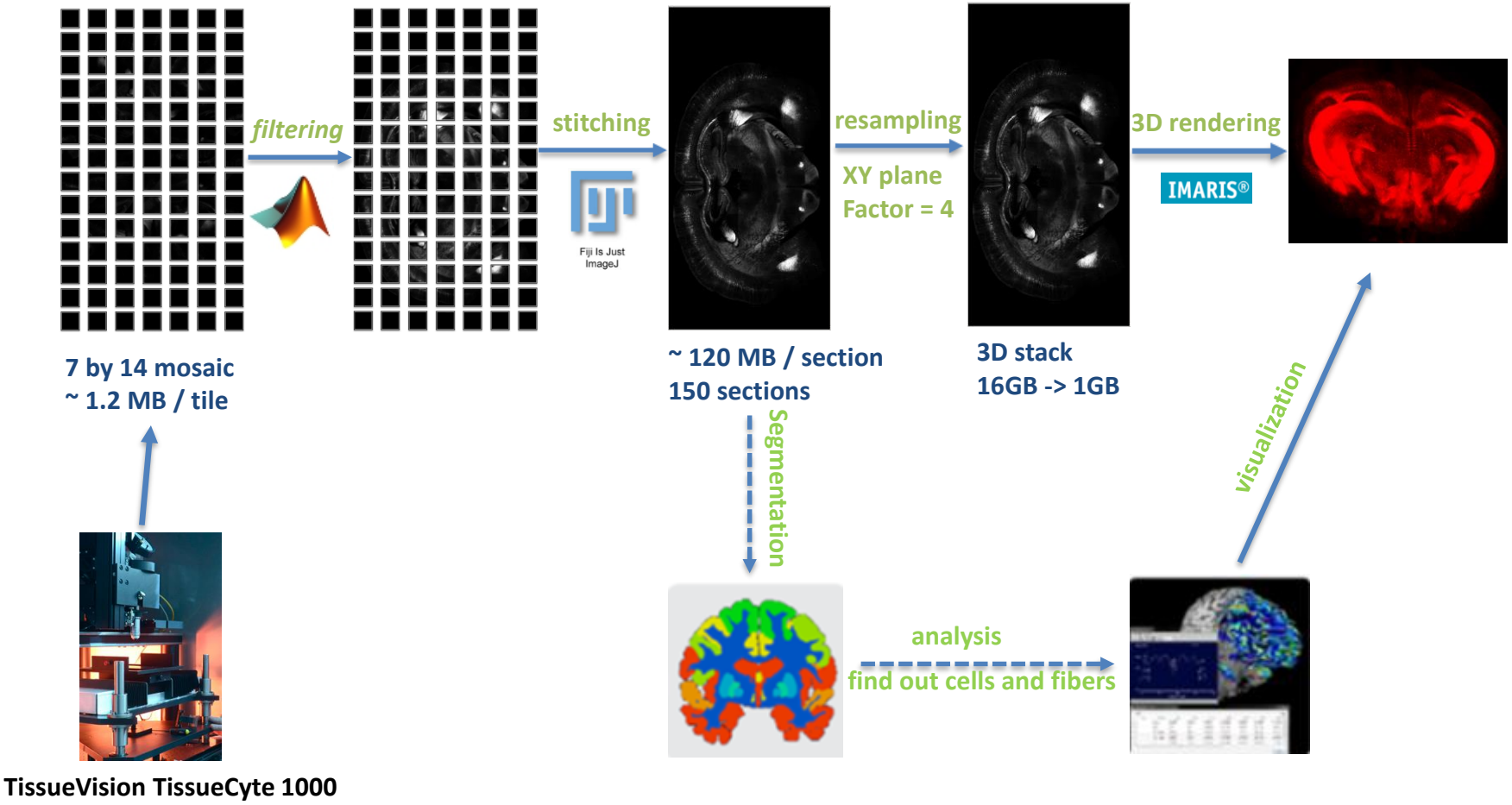


streamline (velocity)

https://www.alcf.anl.gov/user-guides/vis-paraview-red-blood-cell-tutorial

ParaView
Parallel Visualization Application

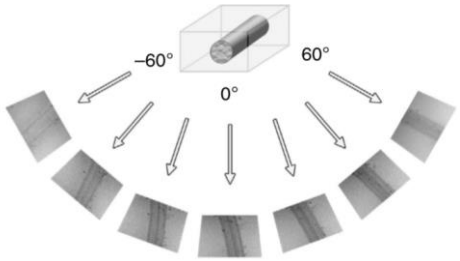
From image to understanding – workflow of whole brain image analysis



* Images and workflow were provided by Dr. Denise Ramirez from WBMF

From image to understanding – workflow of visualizing the native ultrastructure of motile cilia

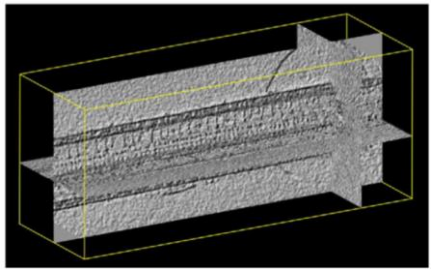
Tecnai G2 F30
Cryo-electron tomography



66 tile series

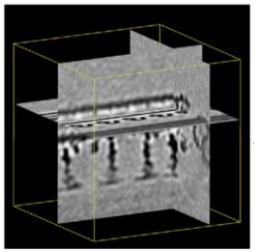
IMOD

Image alignment and calculation of 3D tomogram

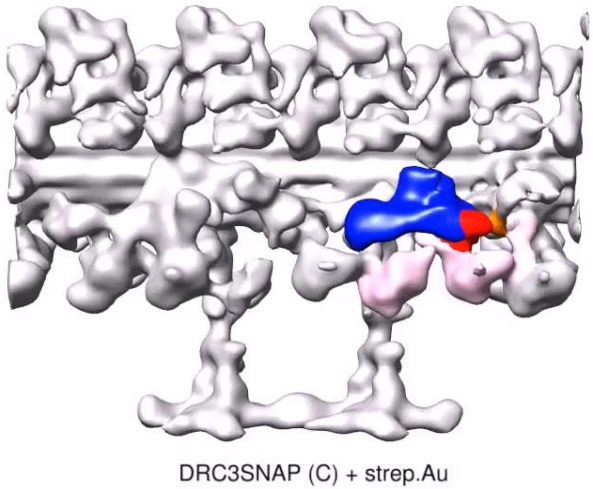


PEET

3D subtomogram averaging of axonemal repeats



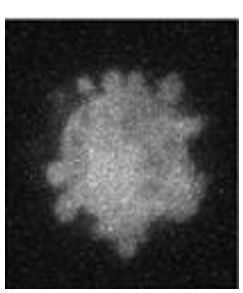
CHIMERA



Native 3D structure of axonemal repeat

* Images and workflow were provided by Dr. Kangkang Song from Dr. Nicastro Lab

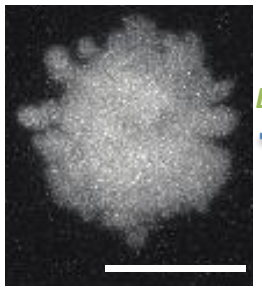
From image to understanding – workflow of bleb detection and tracking



~ 18.2 KB / slice
160 slice

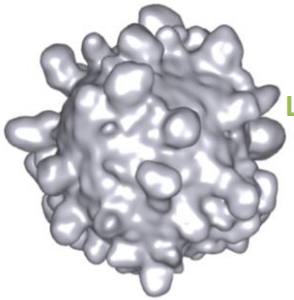
3D rendering

Fiji Is Just ImageJ

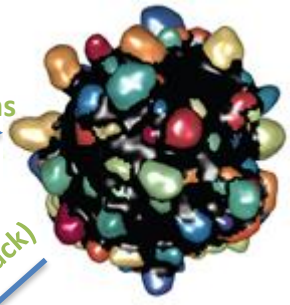


~ 13.8 MB

Extract Surface

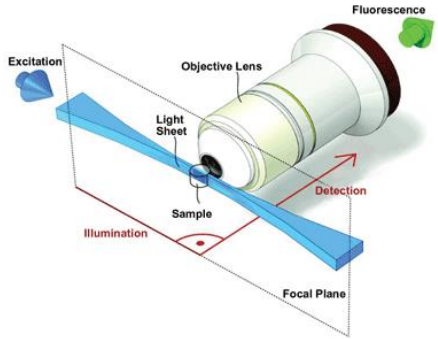


Segmentation
Locating Protrusions



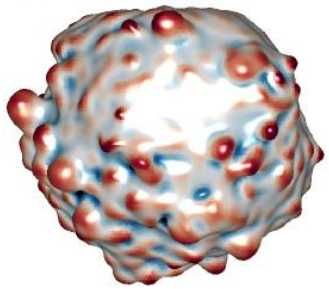
tracking blebs (U-track)

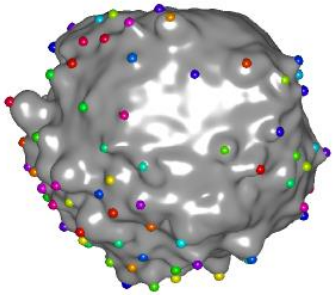
preprocessing



MESPIM
2-photon Bessel Beam Light Sheet Microscope

0.00 sec





- Images were taken by Reto Fiolka, Kevin Dean, and Erik Welf from Dr. Danuser Lab
- Bleb detection and tracking were processed by Meghan Driscoll from Dr. Danuser Lab

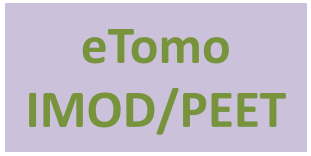
Resources on BioHPC

1. **Storage and management of images**

Lamella Cloud Storage

2. **Analyzing images**

EMAN2



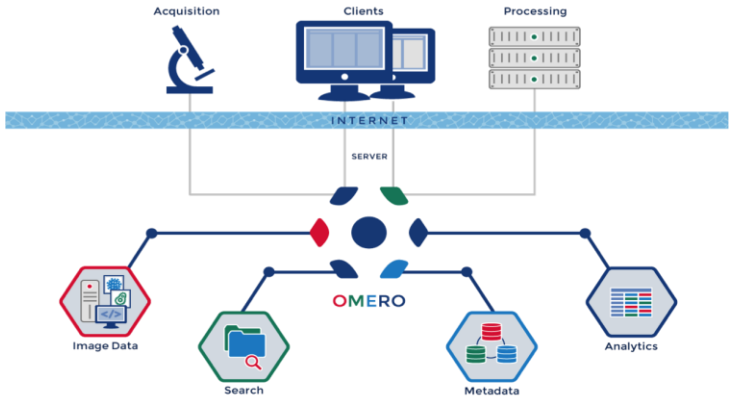
Fiji Is Just ImageJ

G'MIK

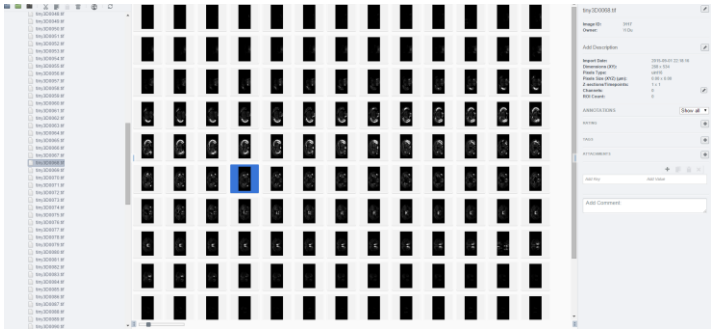
3. **Scientific Visualization (3D volume rendering)**

Storage and management of images -- OMERO

Open **M**icroscopy **E**nvironment **R**emote **O**bjects



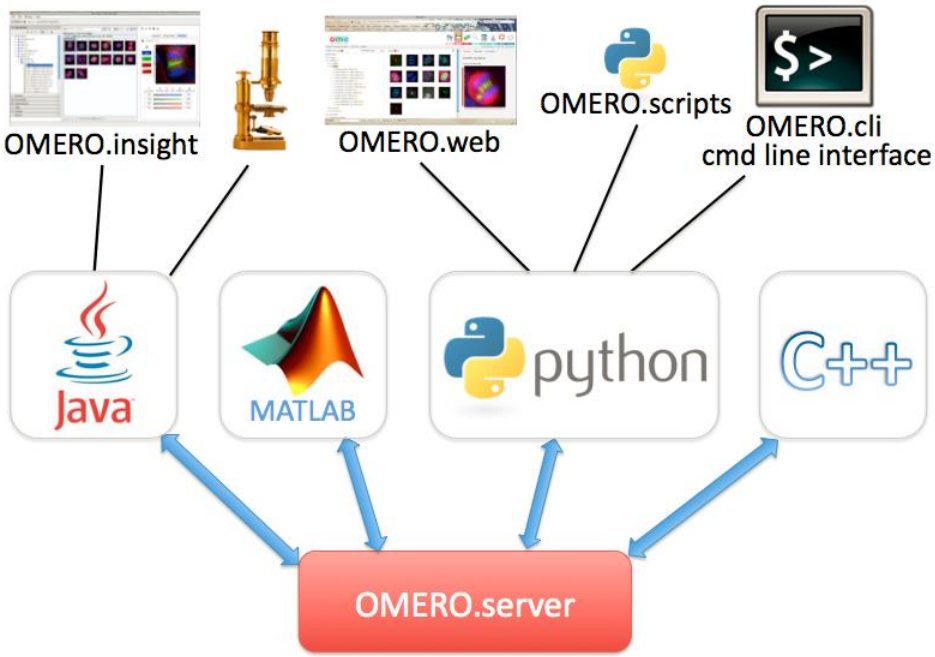
BioHPC OMERO Sever Web application:
https://imagebank.biohpc.swmed.edu



Client

- Download and install the OMERO desktop client from:
  https://www.openmicroscopy.org/omero/downloads/

Storage and management of images -- Benefits of using BioHPC OMERO



OMERO lets you keep your images well organized and more!

Storage and management of images – Live demo

BioHPC Tutorials

- Parallel Programming in Matlab on BioHPC(MDCS and parallel tool box)

- Python on BioHPC

Online Tutorials

eTomo
IMOD/PEET

http://bio3d.colorado.edu/imod/doc/etomoTutorial.html
http://bio3d.colorado.edu/PEET/PEETmanual.html

RELION

http://www2.mrc-lmb.cam.ac.uk/groups/scheres/relion13_tutorial.pdf

NCMI National Center for Macromolecular Imaging

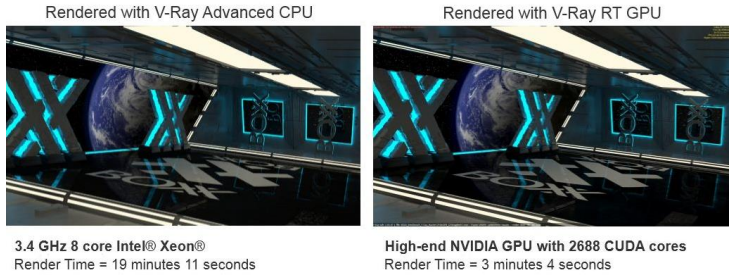
EMAN2

http://blake.bcm.edu/emanwiki/EMAN2/Tutorials

Scientific Visualization (3D volume rendering)

How much faster is GPU rendering as compared to CPU rendering?

Benchmarking (with the same image quality)



many slower cores v.s. few fast cores

BioHPC GPU resources

Partition Name	Number of Nodes	GPU Type	GPU memory
GPU	8	Tesla K20/K40/K6000	>=5GB
GPUp4	16	Tesla P4	8GB
GPUp40	16	Tesla P40	24GB
GPUp100	12	2x Tesla P100	16GB/device
GPUv100s	32	Tesla V100	32GB
GPU4v100	12	4x Tesla V100	32GB/device
GPUA100	16	Ampere A100	40GB

http://blog.boxxtech.com/2014/10/02/gpu-rendering-vs-cpu-rendering-a-method-to-compare-render-times-with-empirical-benchmarks/

Scientific Visualization (3D volume rendering)

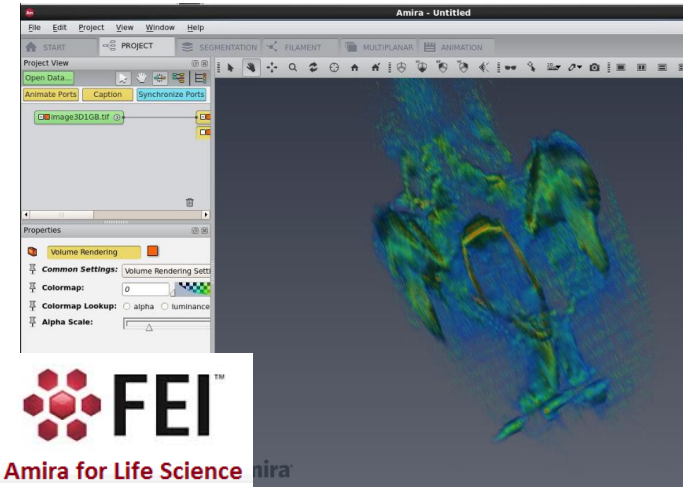
Web based visualization access: https://portal.biohpc.swmed.edu/terminal/webgui/

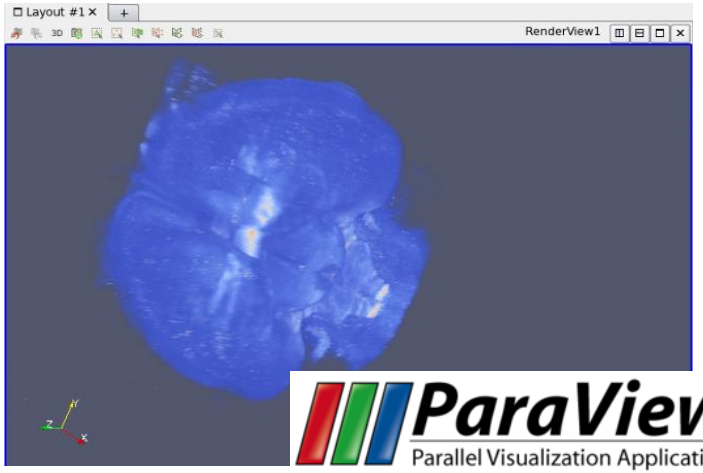
- **WebGUI**
  reserve a CPU node

- **WebGPU**
  reserve a GPU node, good for ImageJ, Amira, stand-alone paraview or compile your CUDA code
  step 1: add visualization software as a module: **`module load <software name>`**
  step 2: **`vglrun <software name>`**

Web based visualization server access: https://portal.biohpc.swmed.edu/terminal/webdesktop/

Scientific Visualization (3D volume rendering)

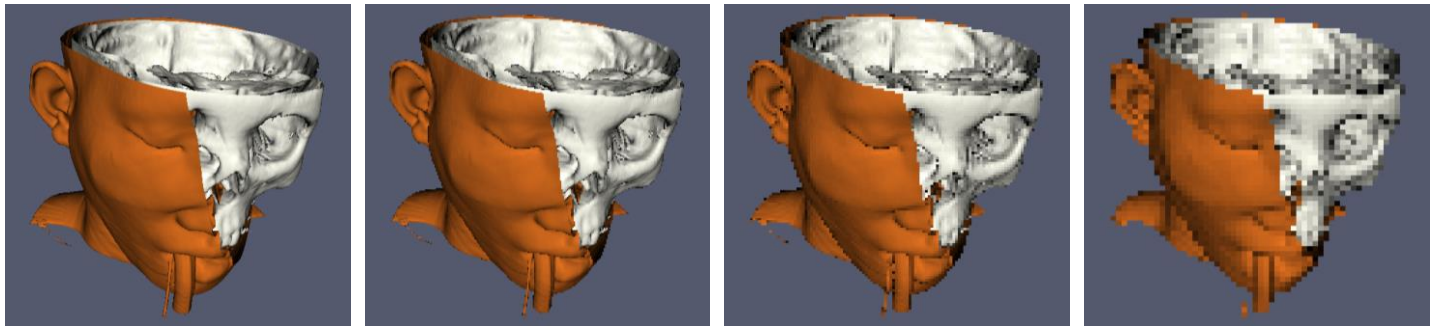




Scientific Visualization (3D volume rendering) -- Big Data Visualization

How to interactively manage visually overwhelming amounts of data

Option A: Resampling on original dataset



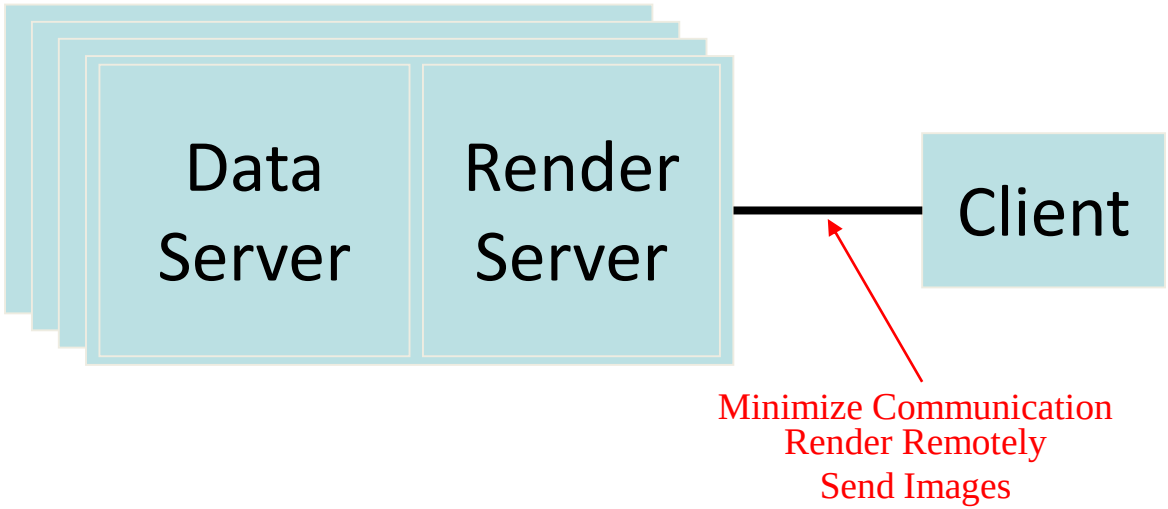
Original Data | Subsample Rate: 2 pixels | Subsample Rate: 4 pixels | Subsample Rate: 8 pixels

Option B: Parallel visualization
e.g, paraview for Interactive Remote Parallel Visualization

- Allocate multiple nodes for visualization, each node/process will process one part of the image

Scientific Visualization (3D volume rendering) -- Big Data Visualization

Client-Server mode of ParaView (remote visualization)



1. Start the remote server
2. Configuring a server connection
3. Connect to the remote server

The ParaView Guide, p. 191: https://www.mn.uio.no/astro/english/services/it/help/visualization/paraview/paraviewguide-5.6.0.pdf

BioHPC can help

- Let us know if there is any specific visualization software that you want us to install
- Any problems with current visualization softwares?
- For questions and comments please email the ticket system: biohpc-help@utsouthwestern.edu