Introduction to Scientific Visualization

CS 5630 / 6630

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School of Computing

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CS5630 / CS 6630

Scientific (and some Information) Visualization Techniques and Algorithms

Review the course syllabus

Book

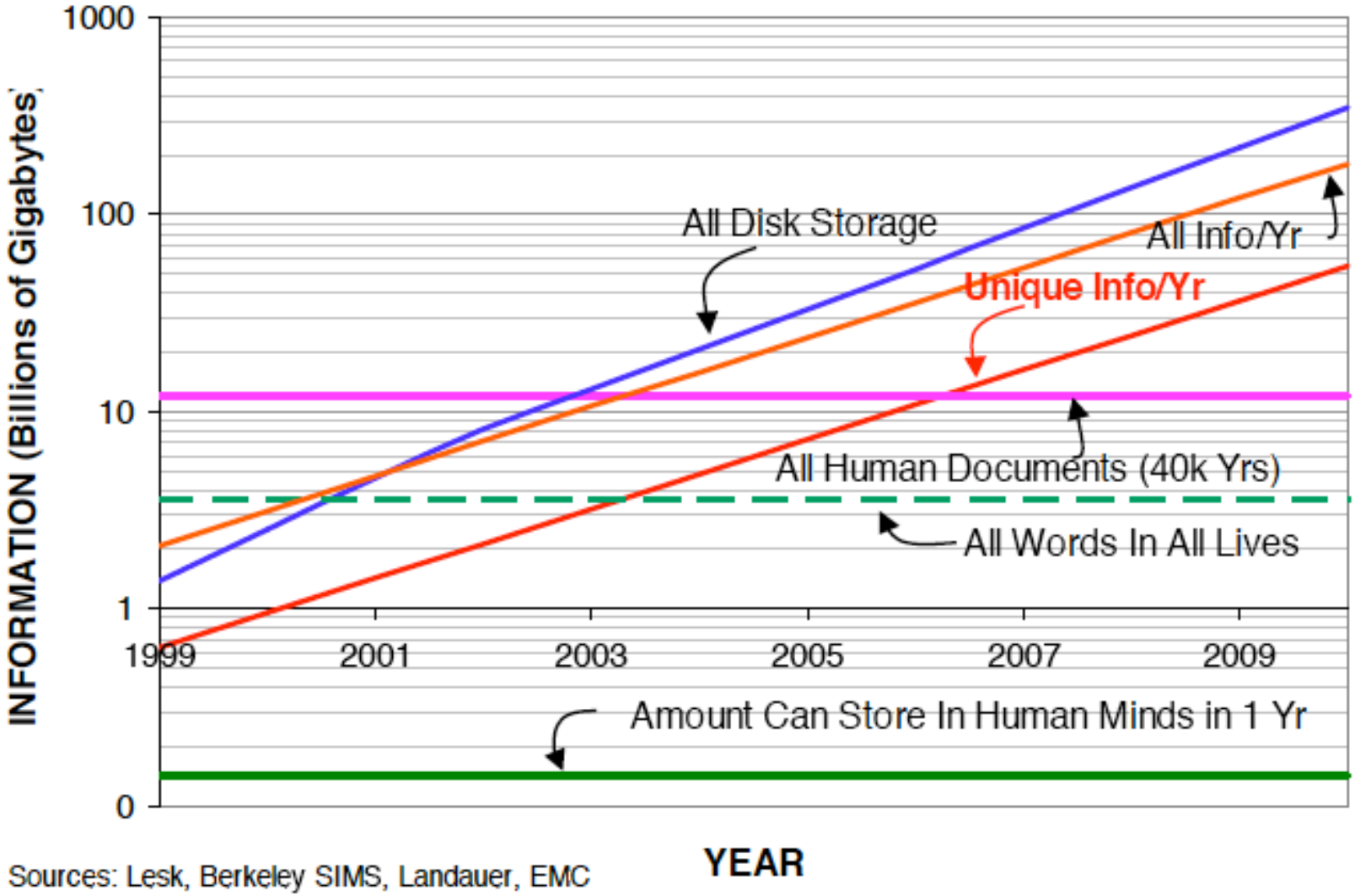
No Required Text

(notes distributed regularly)

Optional Text

Many books and papers!

Information Big Bang



What is Visualization?

A Hybrid Discipline

- Numerical analysis
- 2D and 3D graphics
- Image/signal processing and pattern recognition
- Art and Design
- Psychophysics
- Scientific computing
- …

Data Representation

Issues

- Dimension: *R*1, *R*2, *R*3, …
- Representation
- Topology

Representation

- Continuous — basis, e.g. polynomials
- Discrete — how sampled — structured vs unstructured
  - Sp. case — Cartesian grids, images, spacing, etc.
  - Unstructured, connectivity, spacing, primitives (e.g. simplexes)
  - Simple lists
- Hierarchies and multresolution
  - E.g. quadtrees for Cartesian grids

Topology

How are things connected (or not)?

- Discrete samples: neighborhoods, degree of connectivity, etc.
- Continuous: angles, manifolds in higher dimensional spaces.

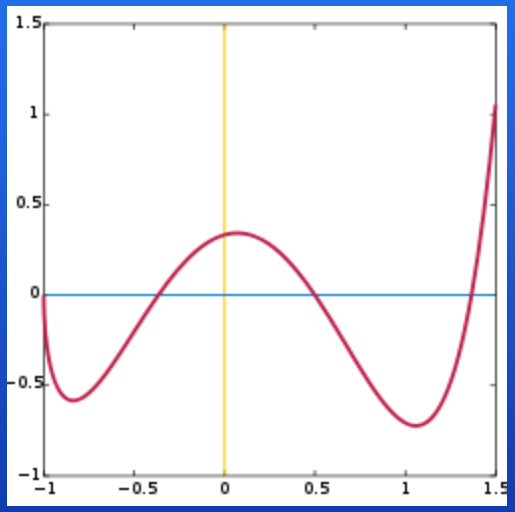
Examples

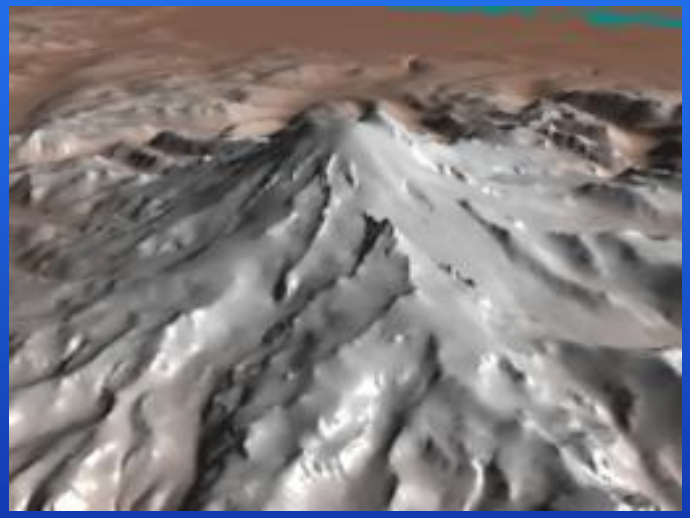
- Scalar fields (*N*D domain, 1D range)
  - 2D datasets / images
  - Density volumes
- Vector fields
  - Color images
  - Color video
  - Fluid flow field (+ time)
- Tensor fields
  - Diffusion imaging
  - Fluid flow field

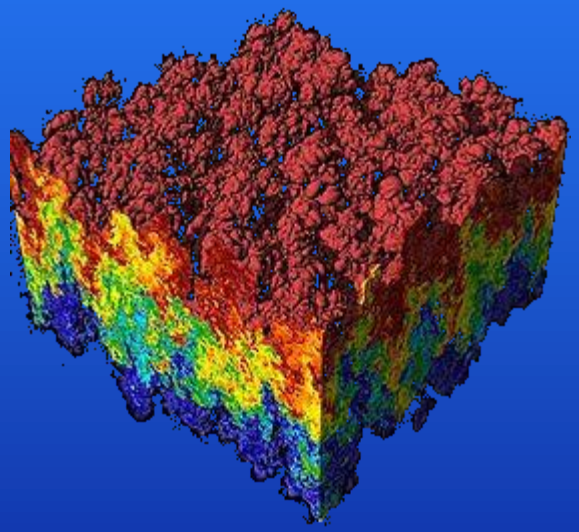
Scalar Fields

$$y=F(x)$$

Scalar Fields

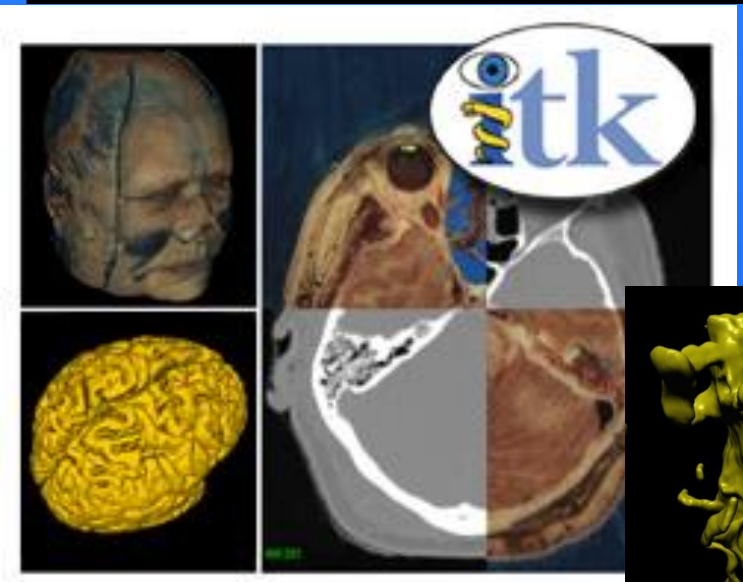


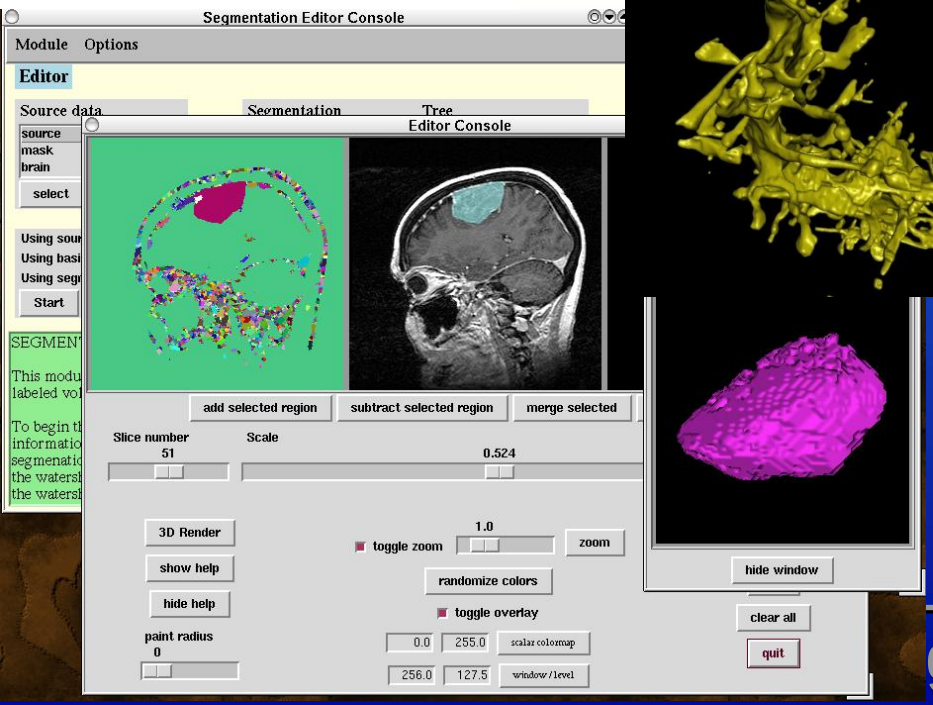


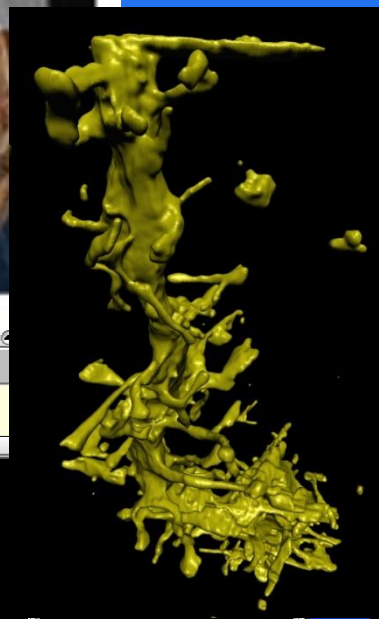


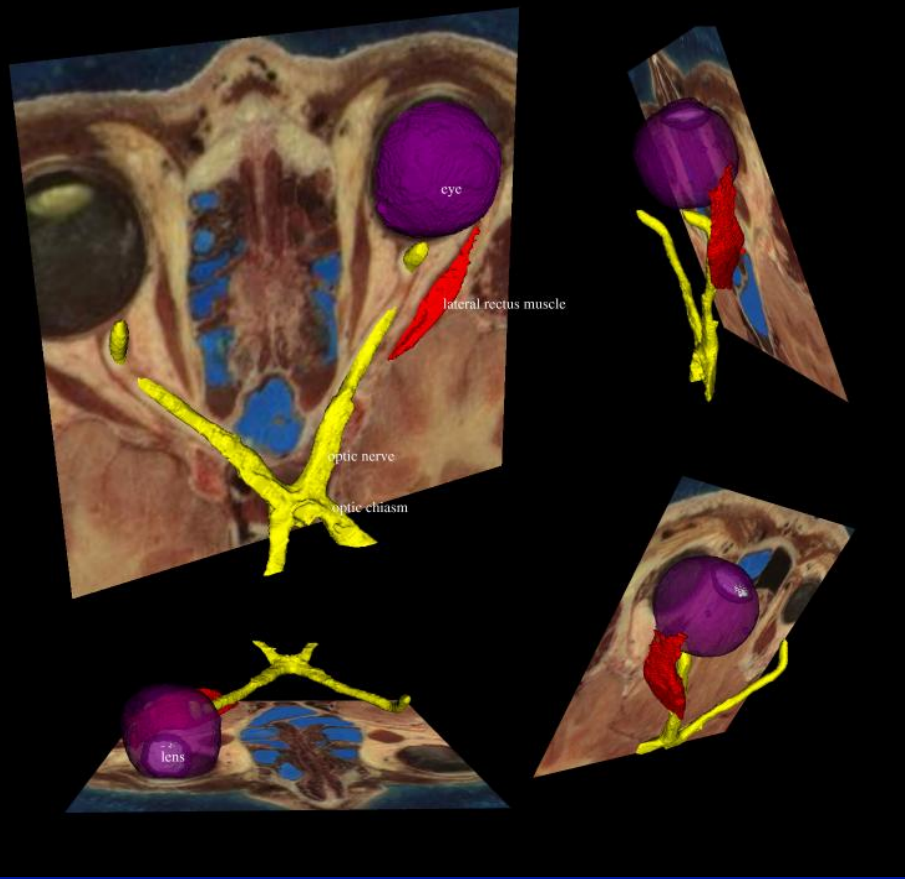
ITK: Insight Toolkit

www.itk.org

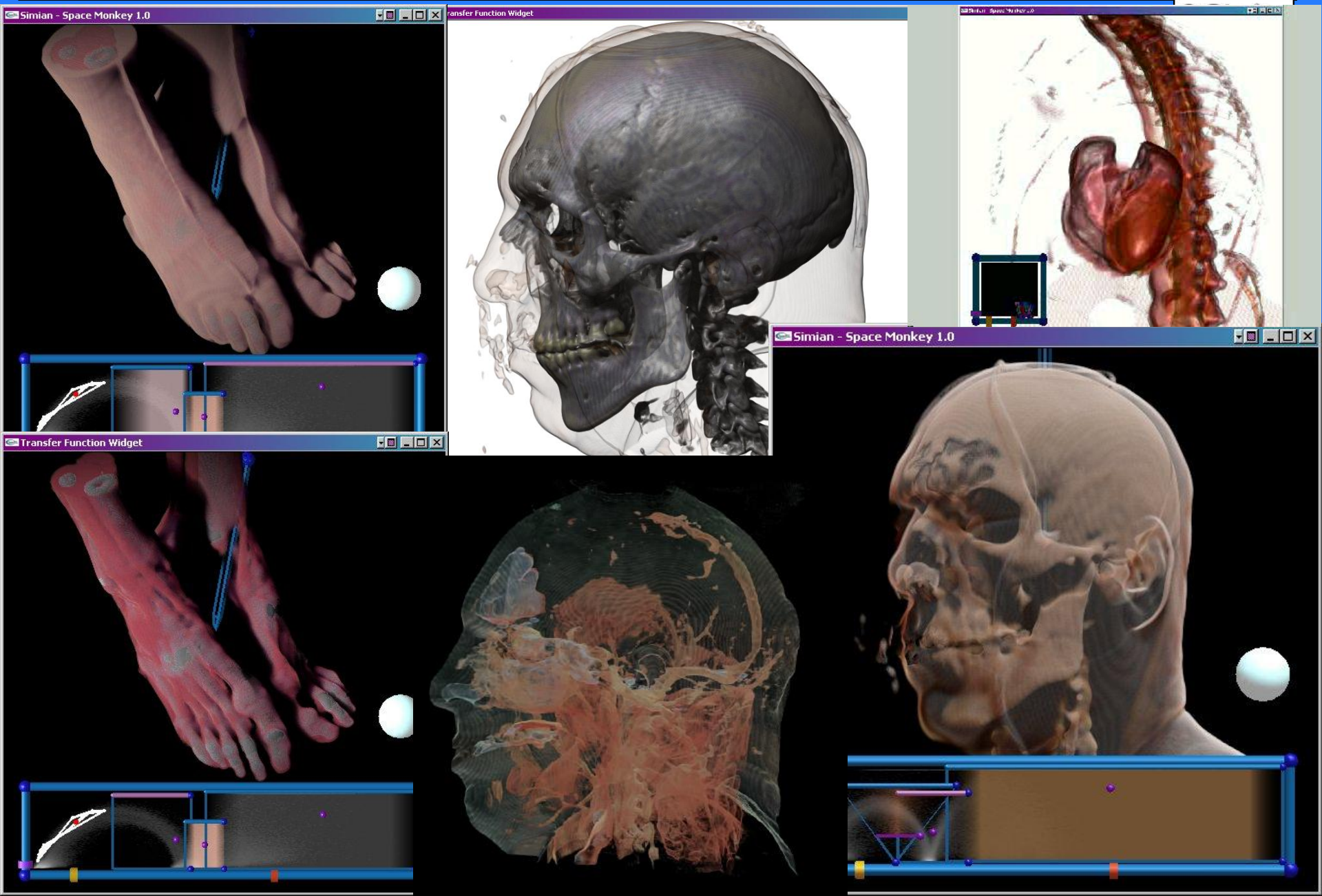




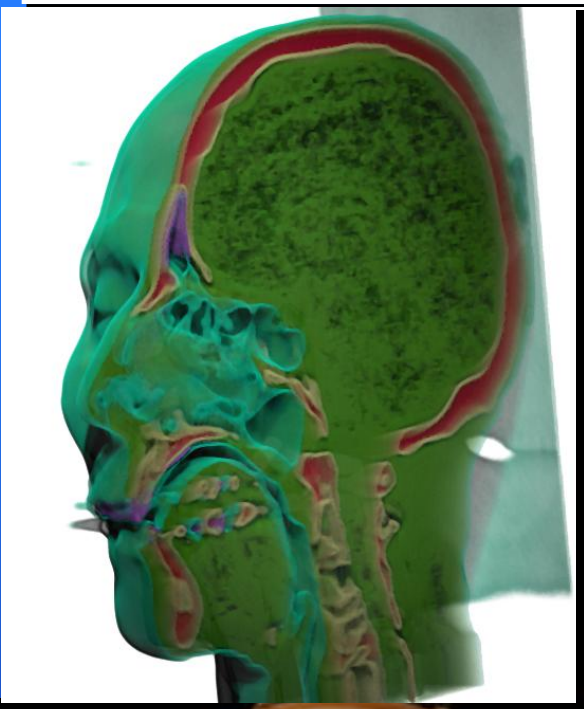


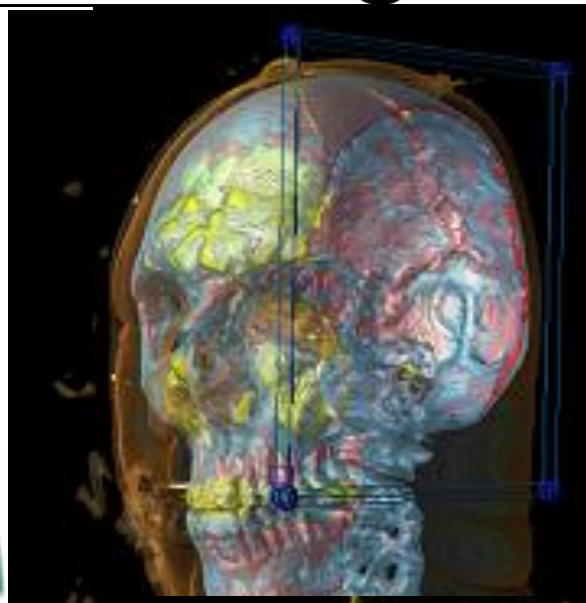


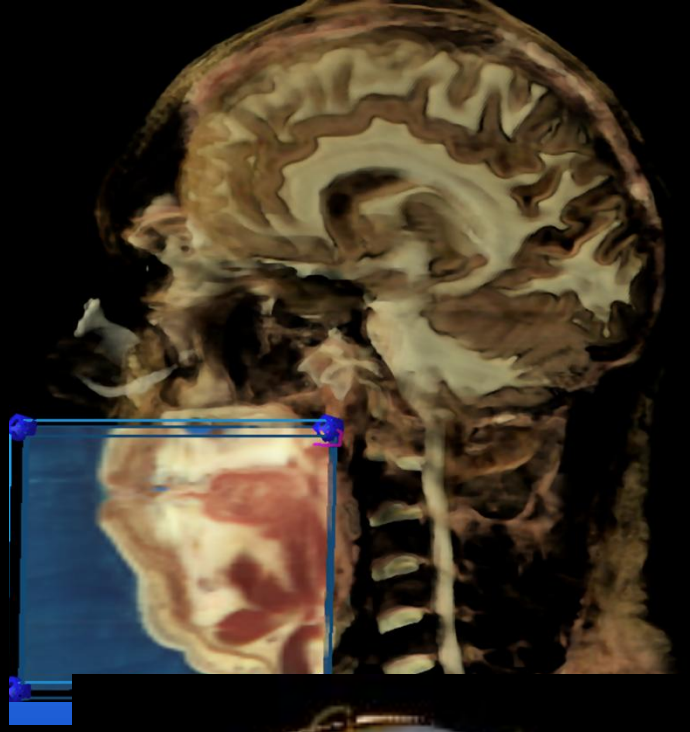
Volume Rendering - 3D Transfer Function

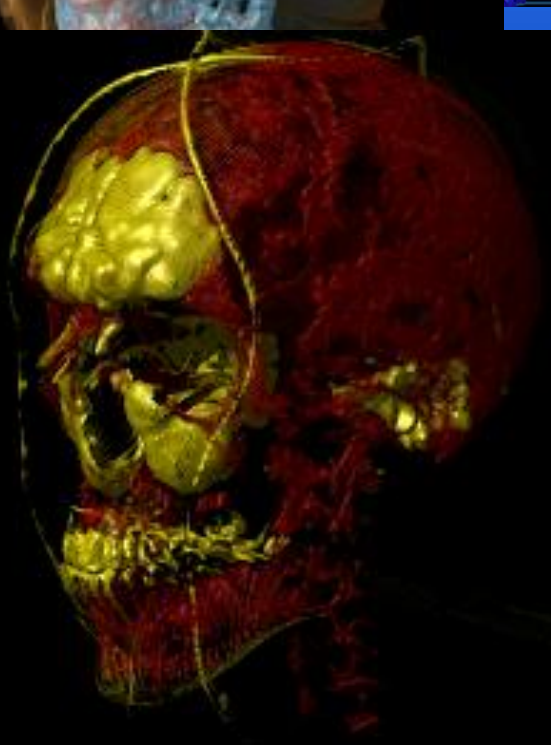


Volume Rendering

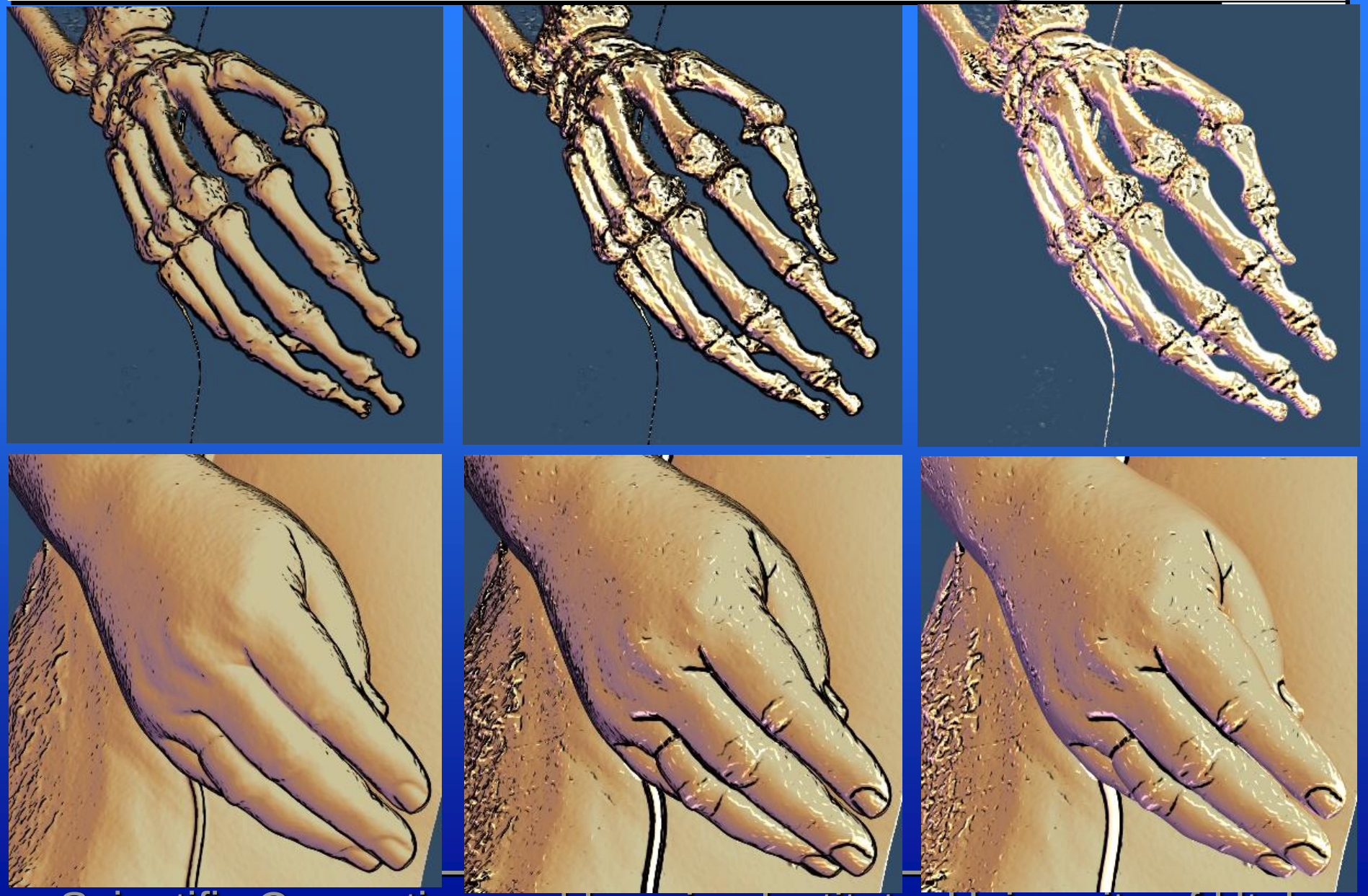




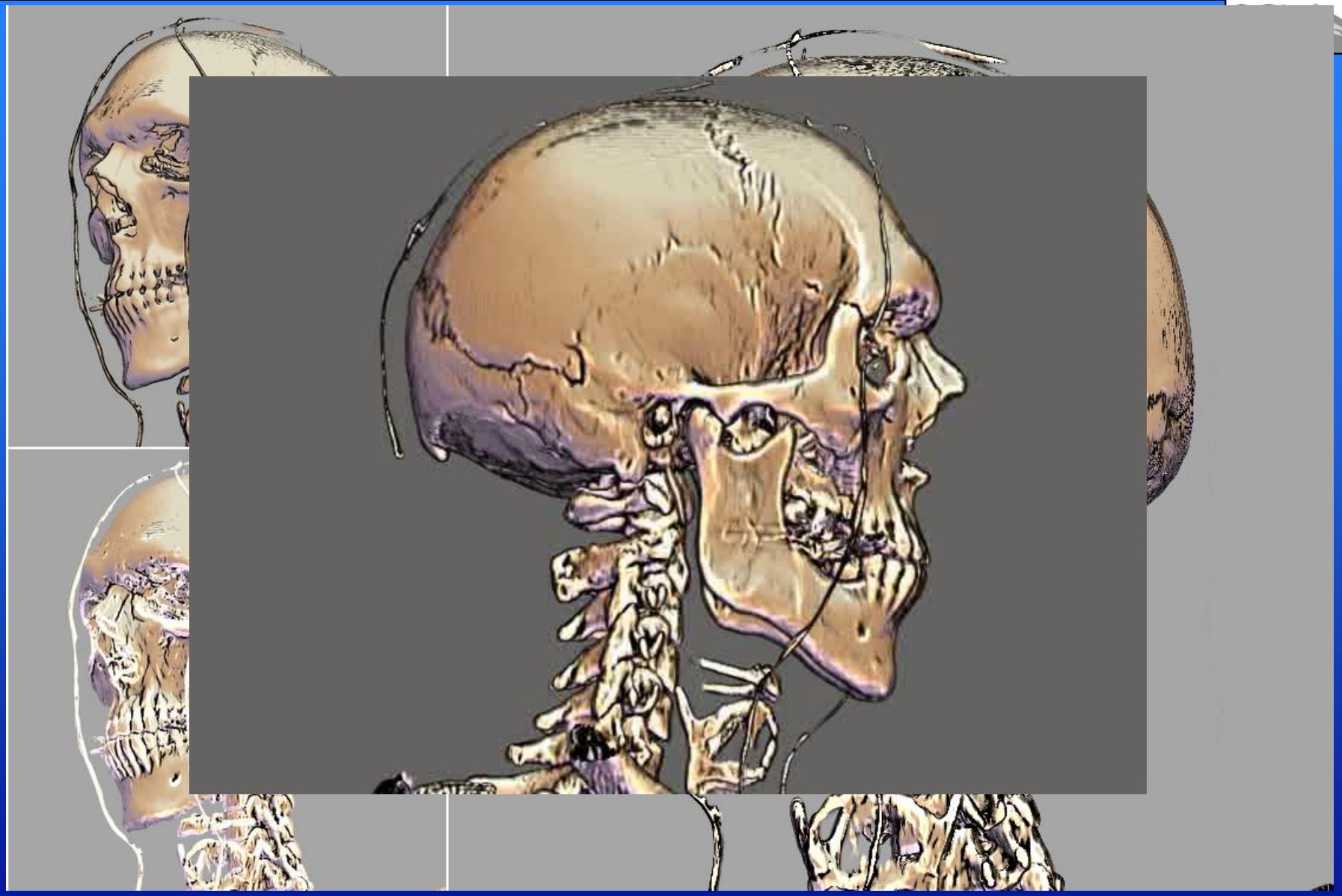




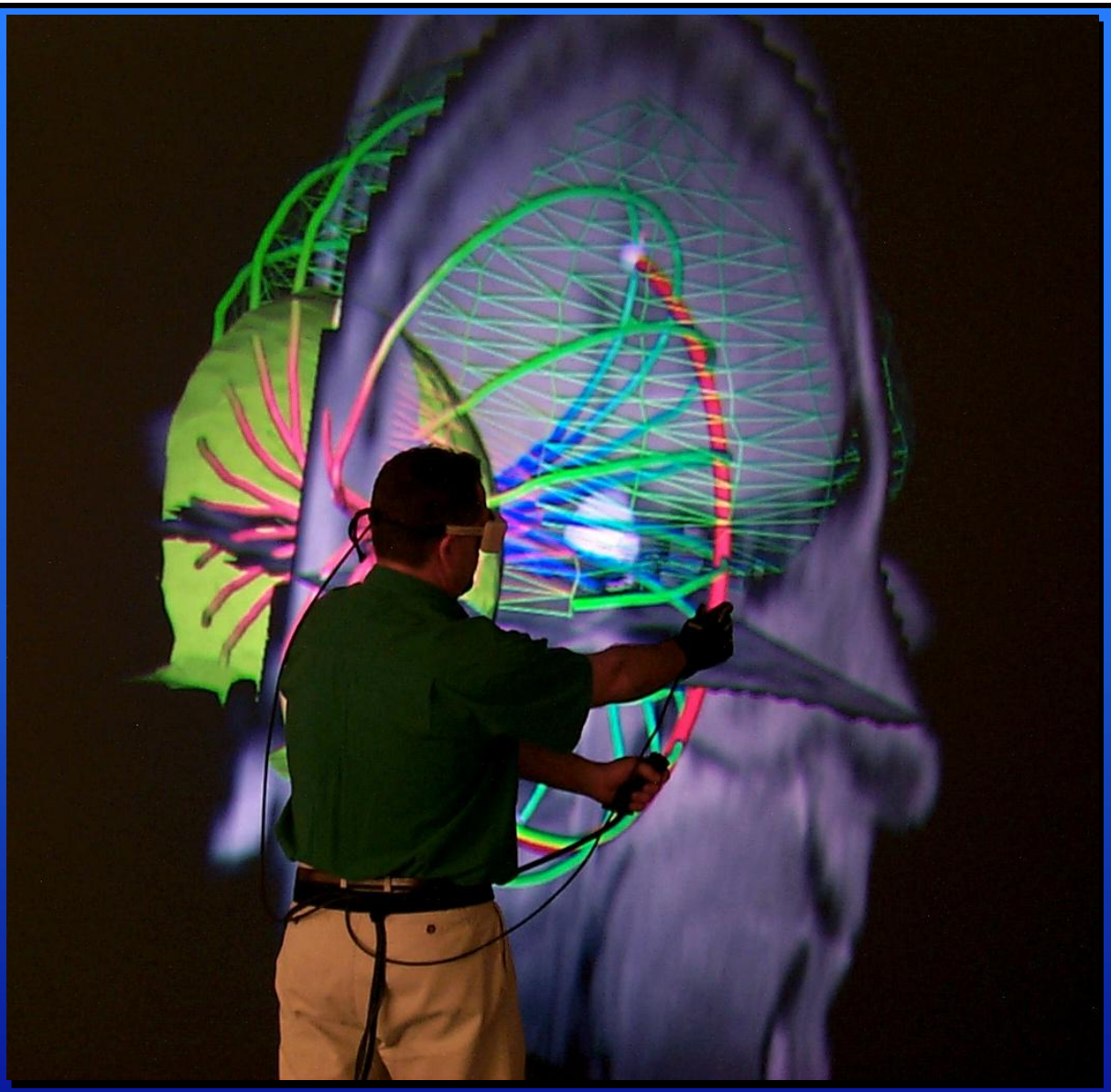
Curvature Based Rendering



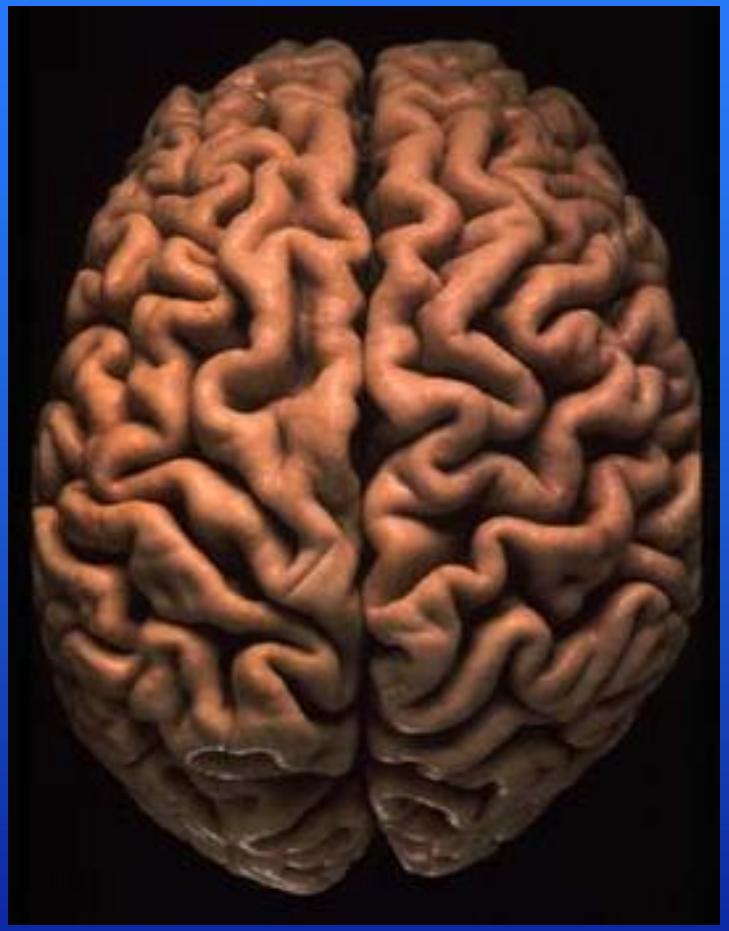
Non Photorealistic Rendering

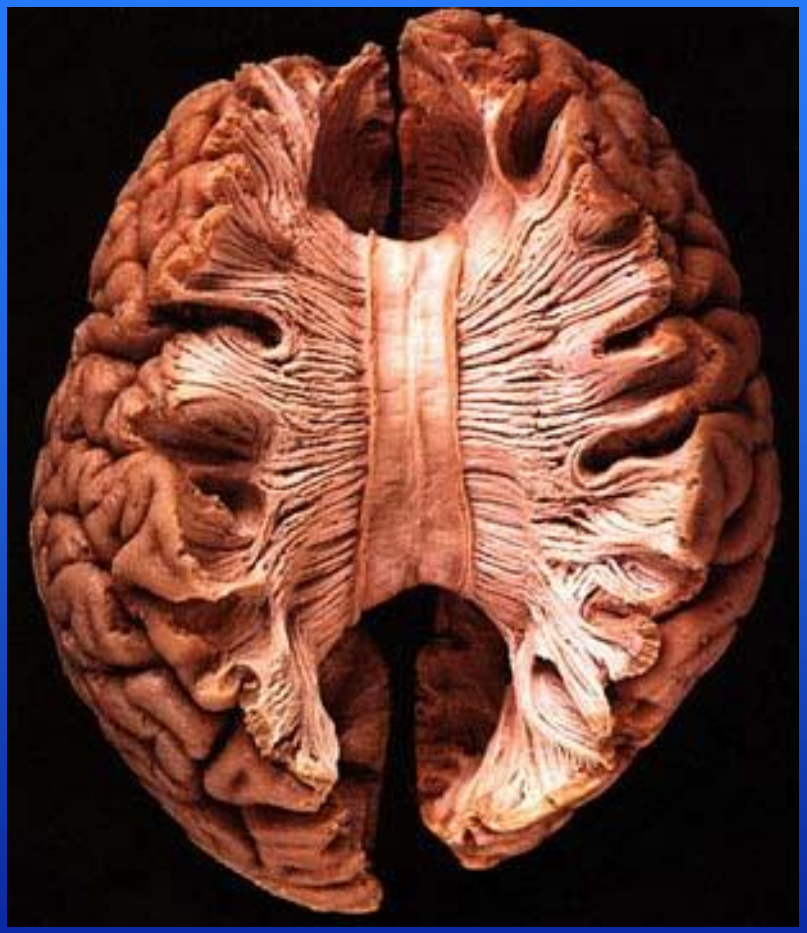


Vector Fields

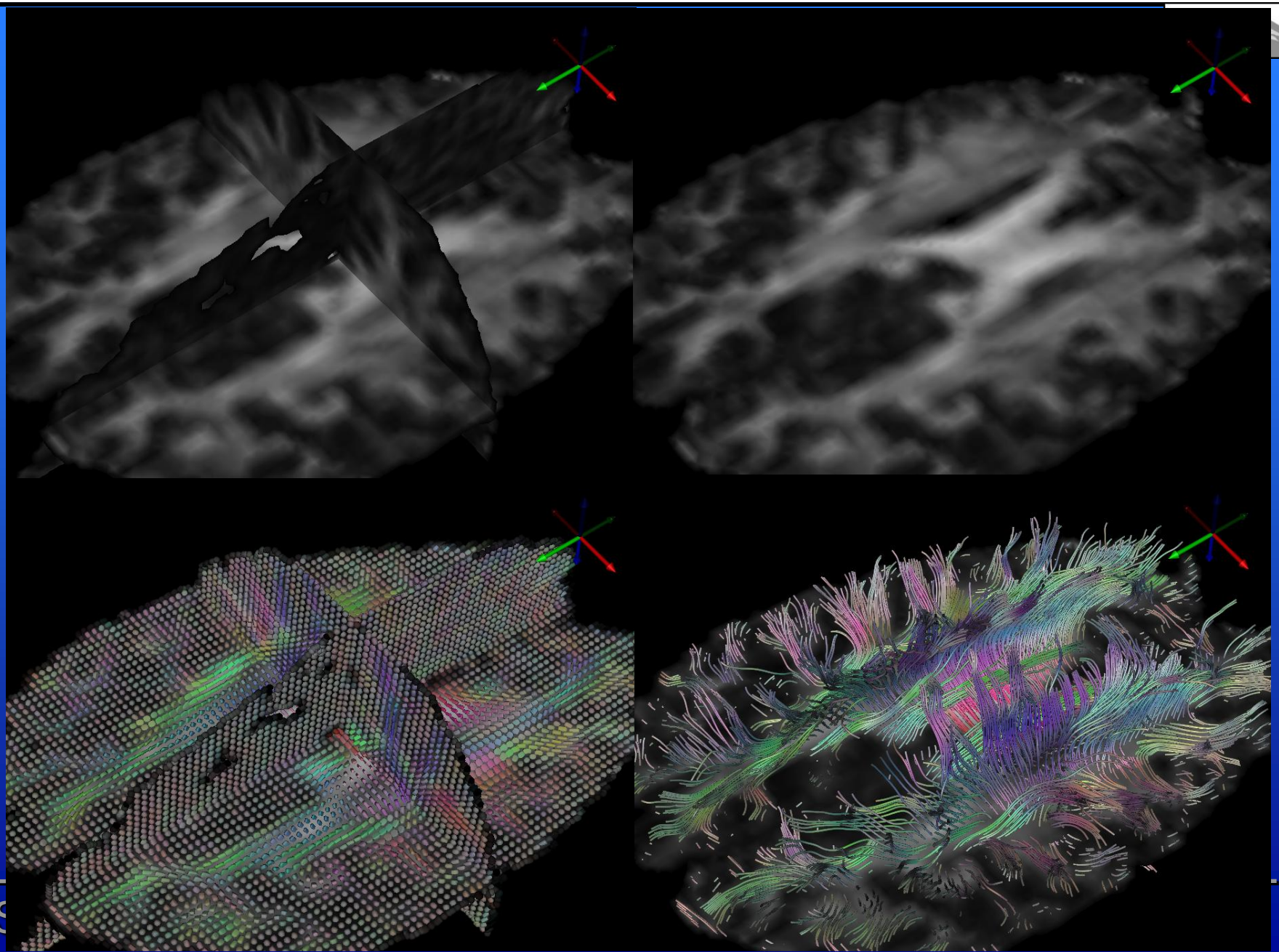


Brain Structure - Fiber Tracks





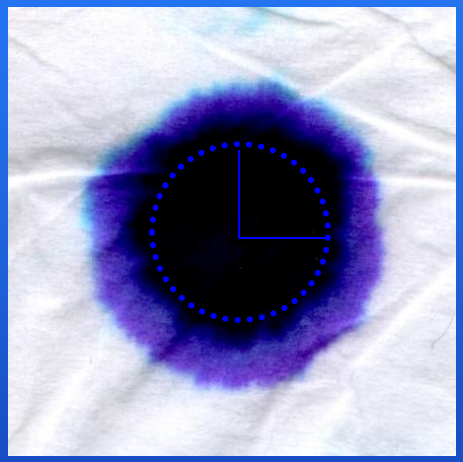
DT MRI Visualization



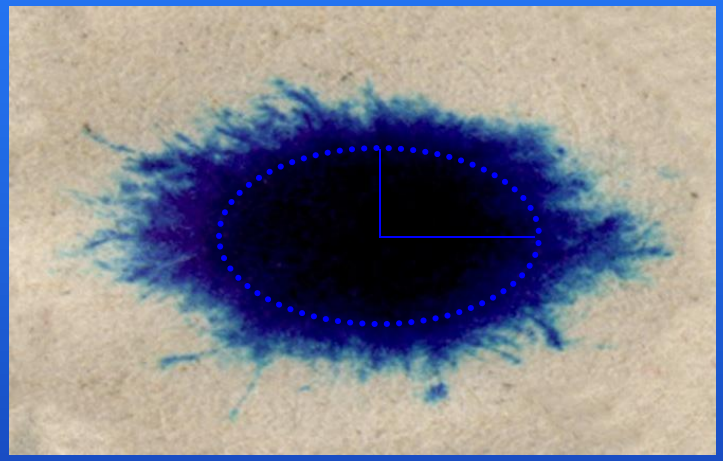
Diffusion in Biological Tissue

Motion of water through tissue

Faster in some directions than others

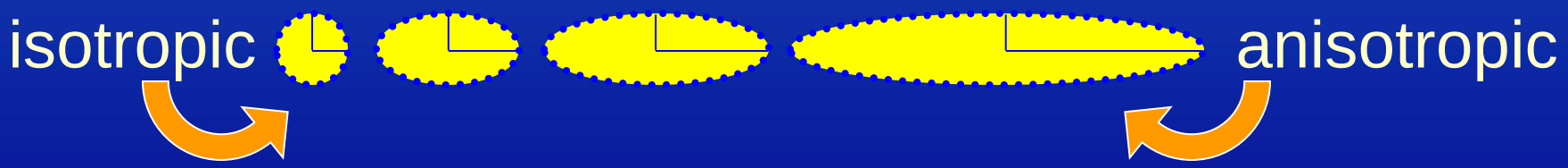


Kleenex



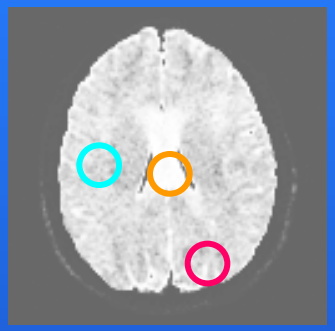
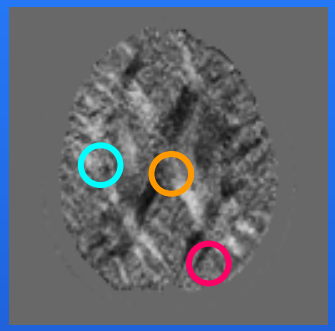
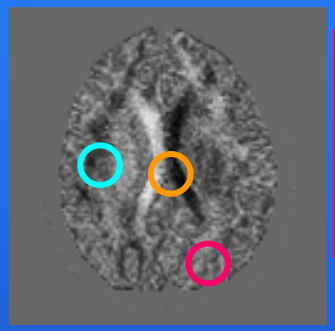
Newspaper

- Anisotropy: diffusion rate depends on direction

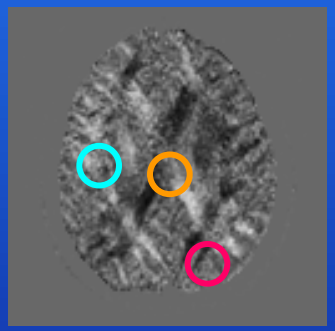
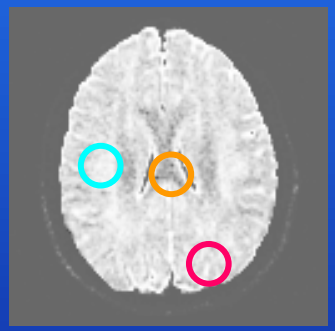
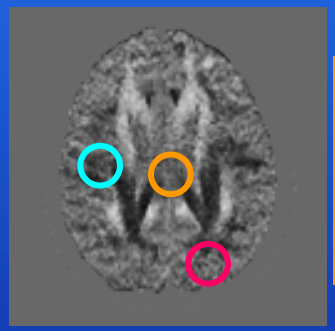


Diffusion MRI of the Brain

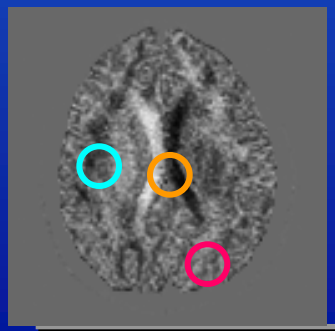
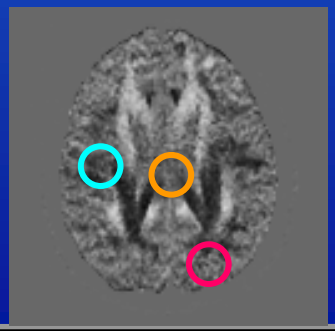
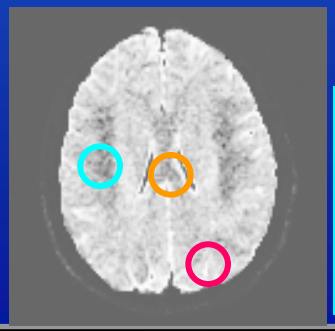
Anisotropy high along white matter fiber tracts

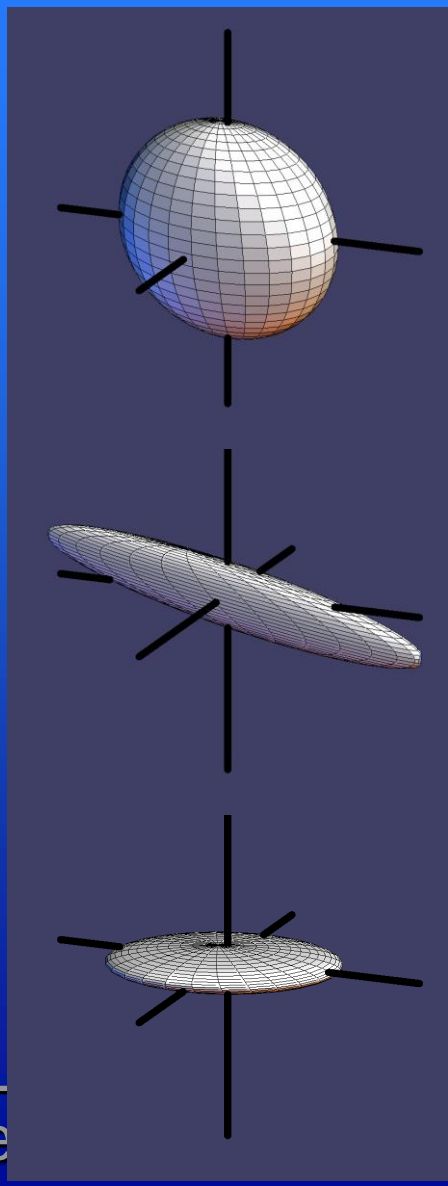
2.1	-0.1	-0.2
-0.1	2.0	-0.0
-0.2	-0.0	2.1

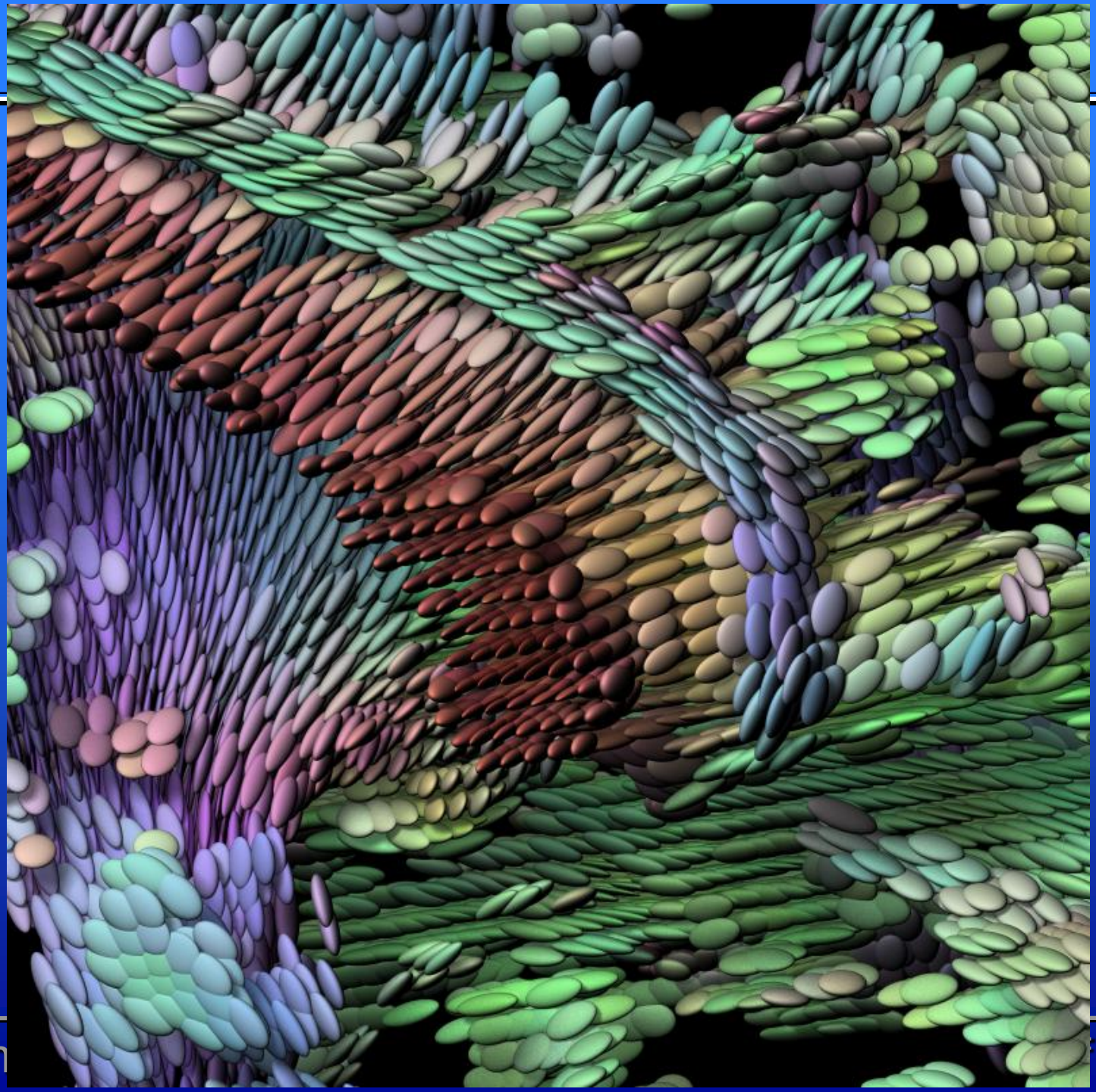




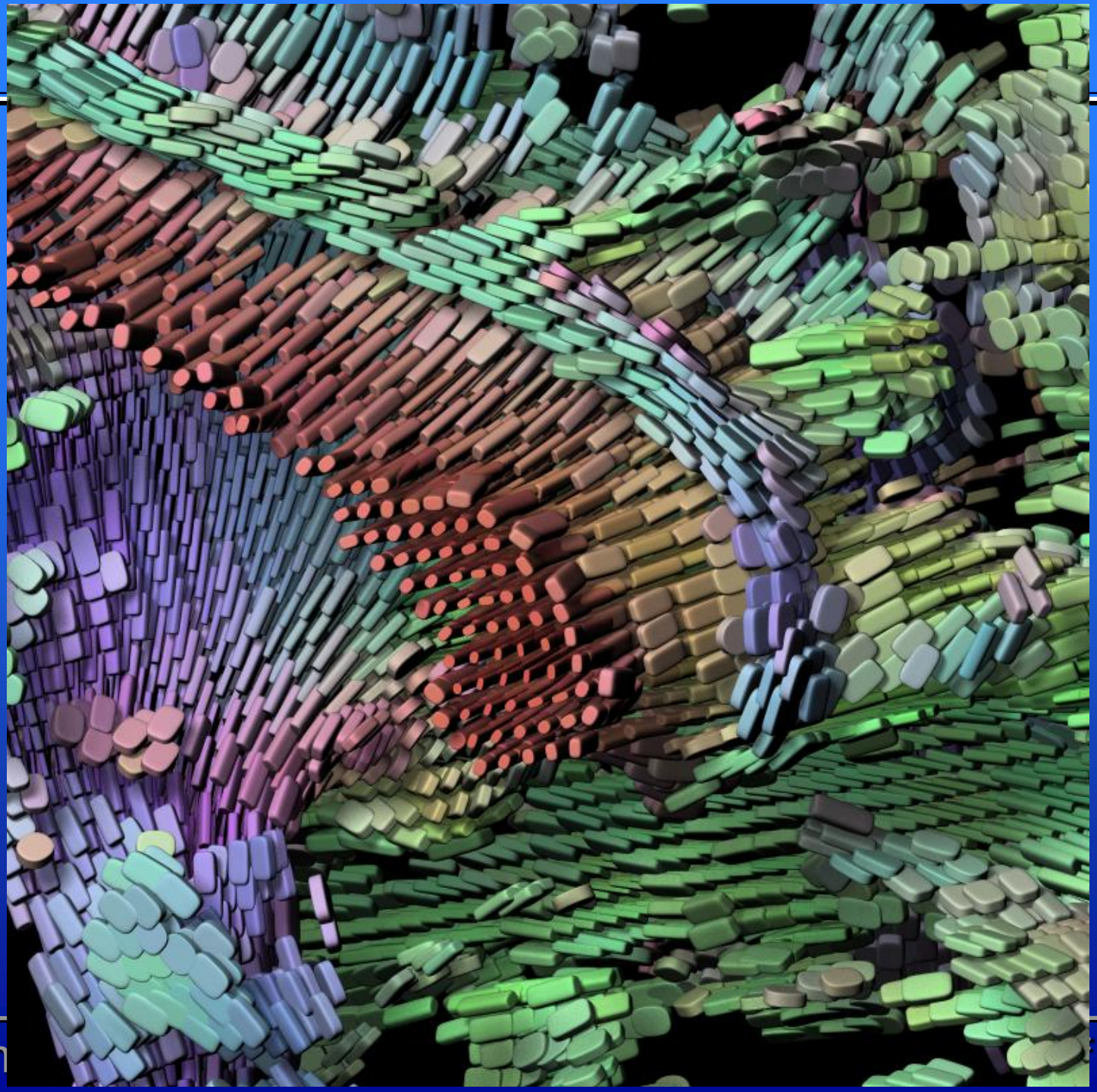
3.7	0.3	-0.8
0.3	0.6	-0.1
-0.8	-0.1	0.8

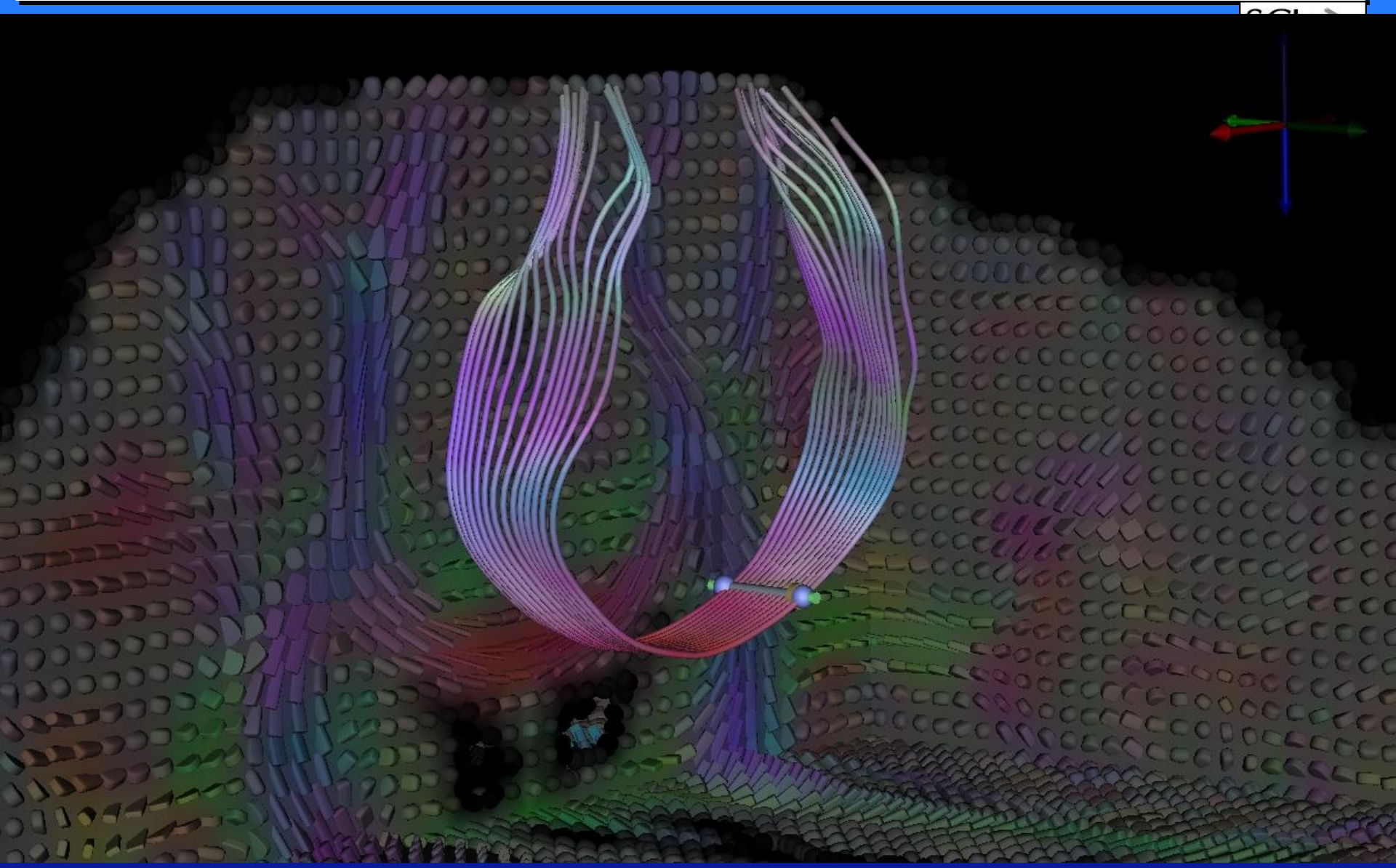
1.7	0.1	-0.1
0.1	2.3	-0.3
-0.1	-0.3	0.3



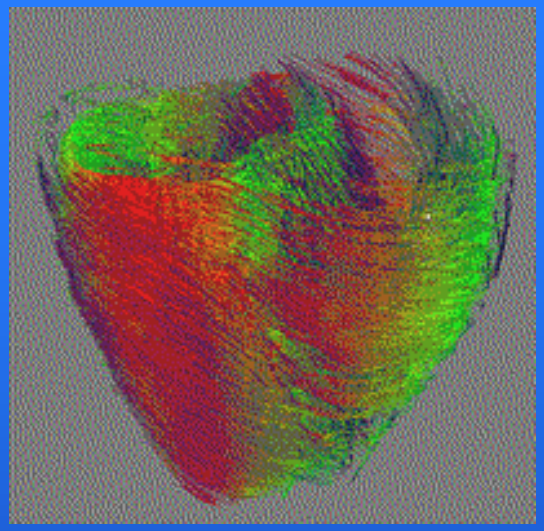


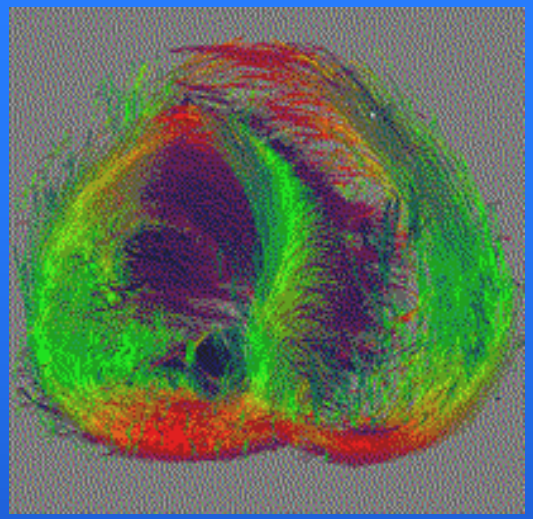


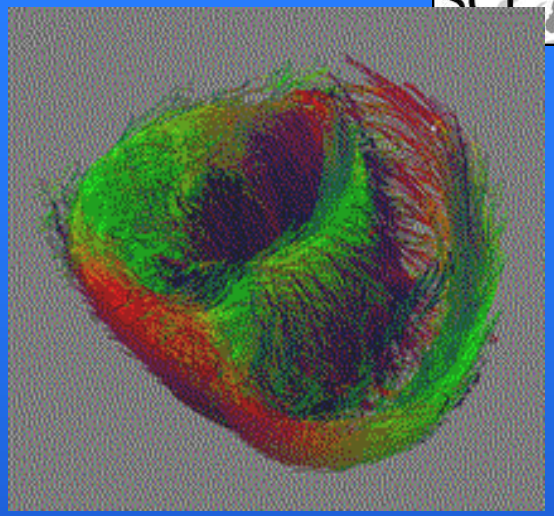
Diffusion Tensor Visualization

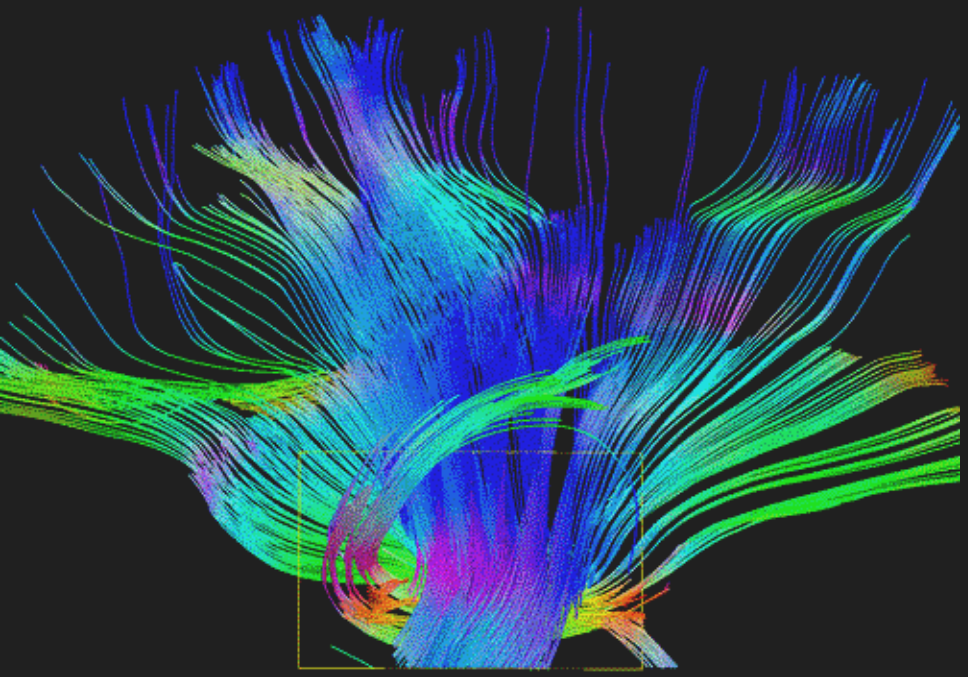


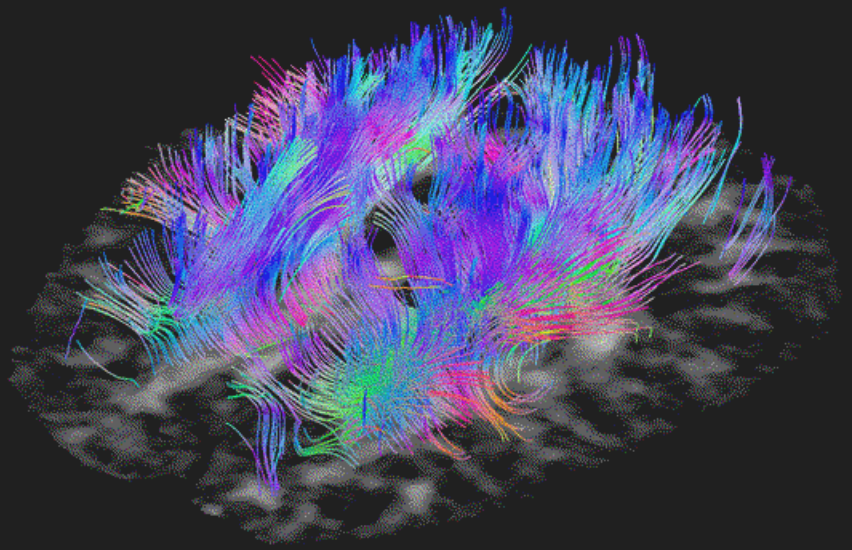
Fiber Tracking – Leonid Zhukov



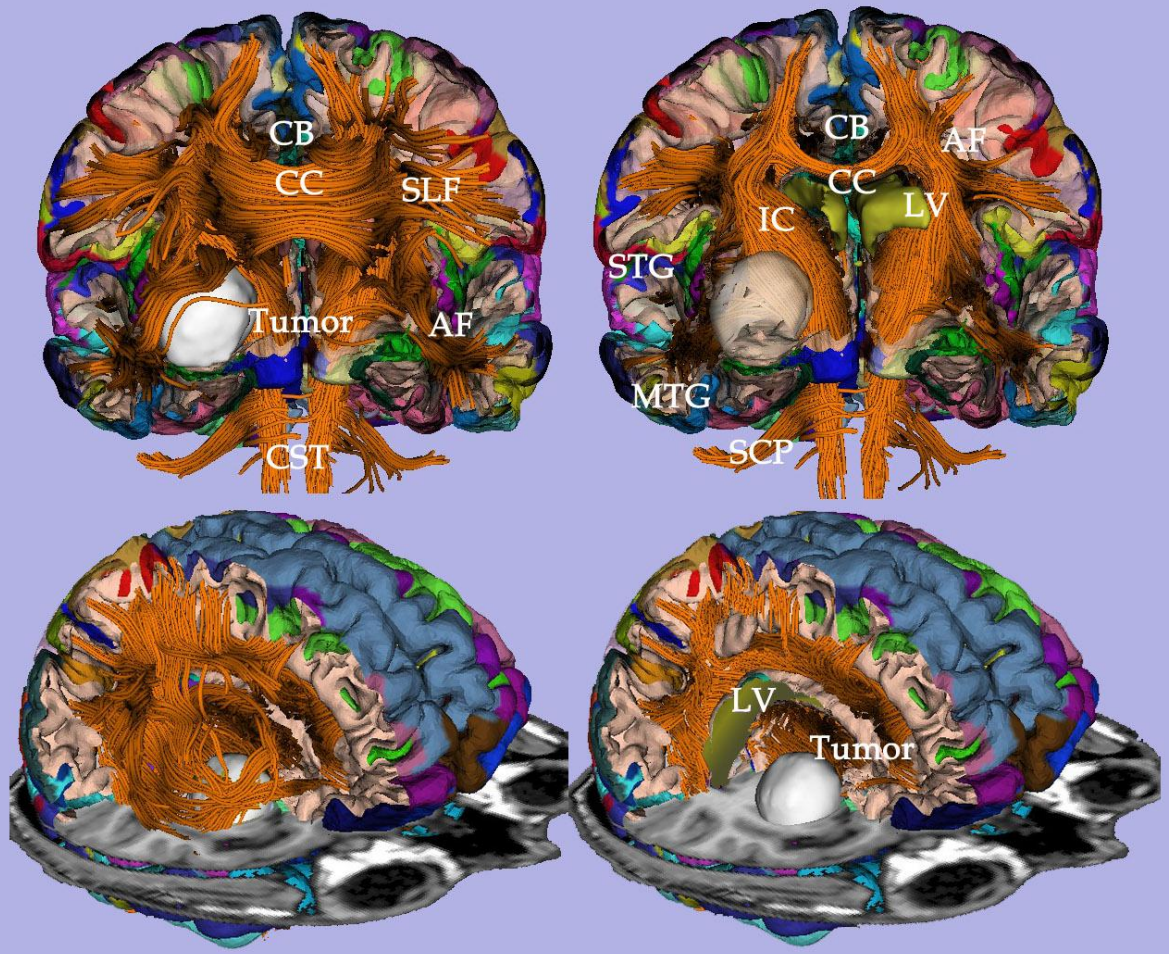






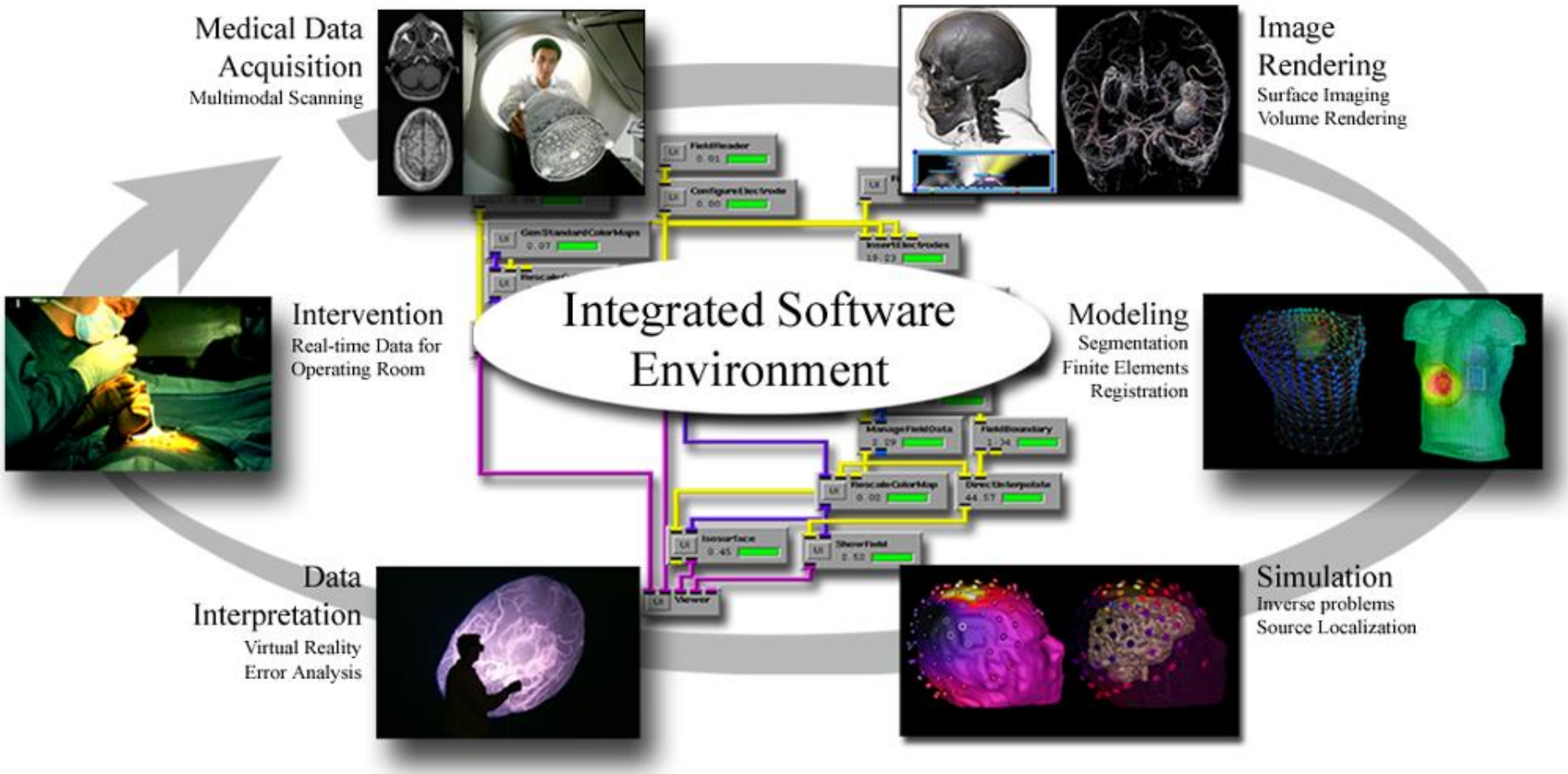


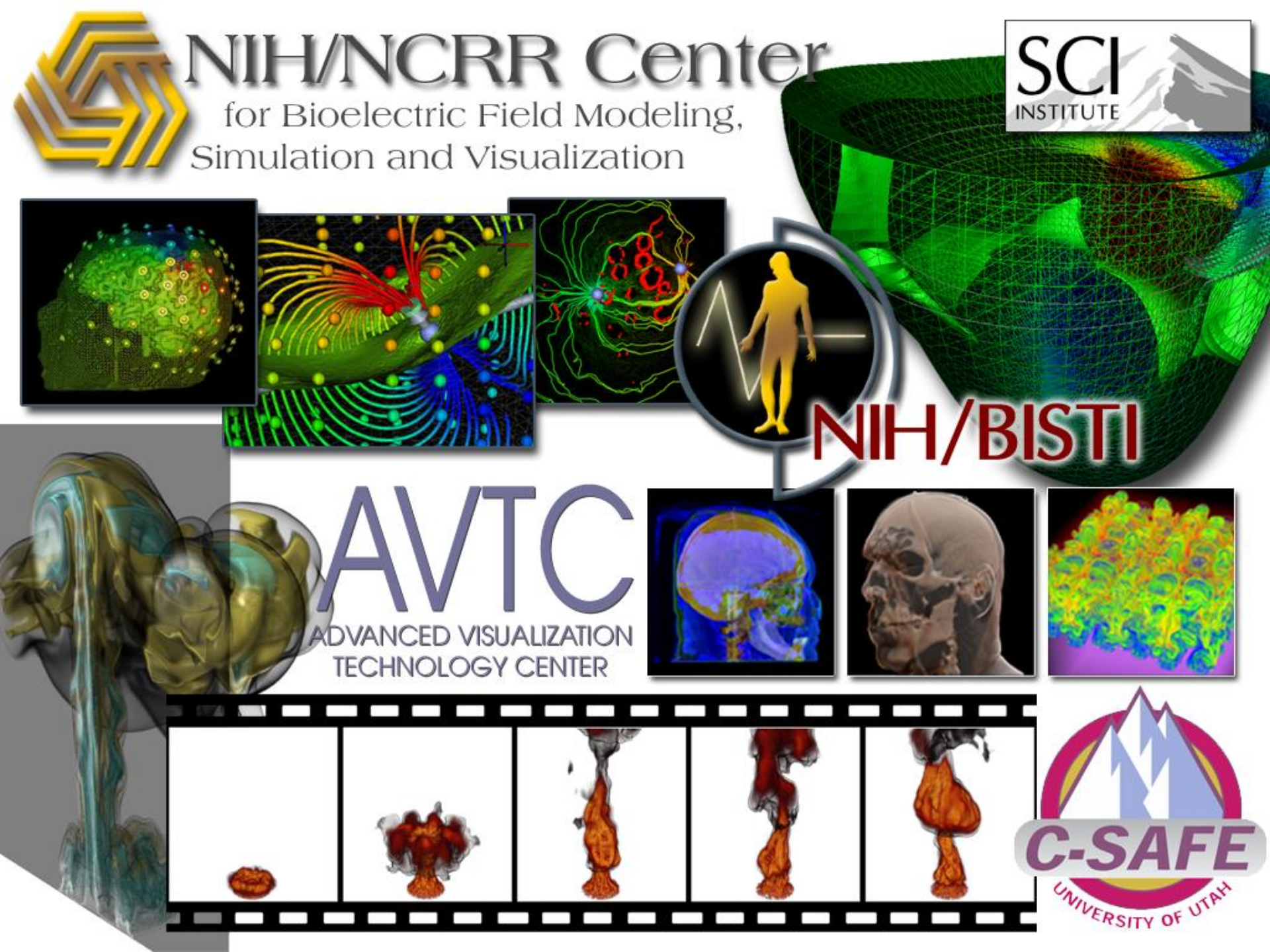
White Matter Tracts



Hae-Jeong Park, Ph.D., 2003

Park, Westin, and Kikinis, BWH, Harvard Medical School, 2003


Medical Data Acquisition
Multimodal Scanning
Image Rendering
Surface Imaging
Volume Rendering
Intervention
Real-time Data for Operating Room
Integrated Software Environment
Modeling
Segmentation
Finite Elements
Registration
Data Interpretation
Virtual Reality
Error Analysis
Simulation
Inverse problems
Source Localization


NIH/NCRR Center
for Bioelectric Field Modeling,
Simulation and Visualization
SCI
INSTITUTE
NIH/BISTI
AVTC
ADVANCED VISUALIZATION
TECHNOLOGY CENTER
C-SAFE
UNIVERSITY OF UTAH

Lots More to Come!