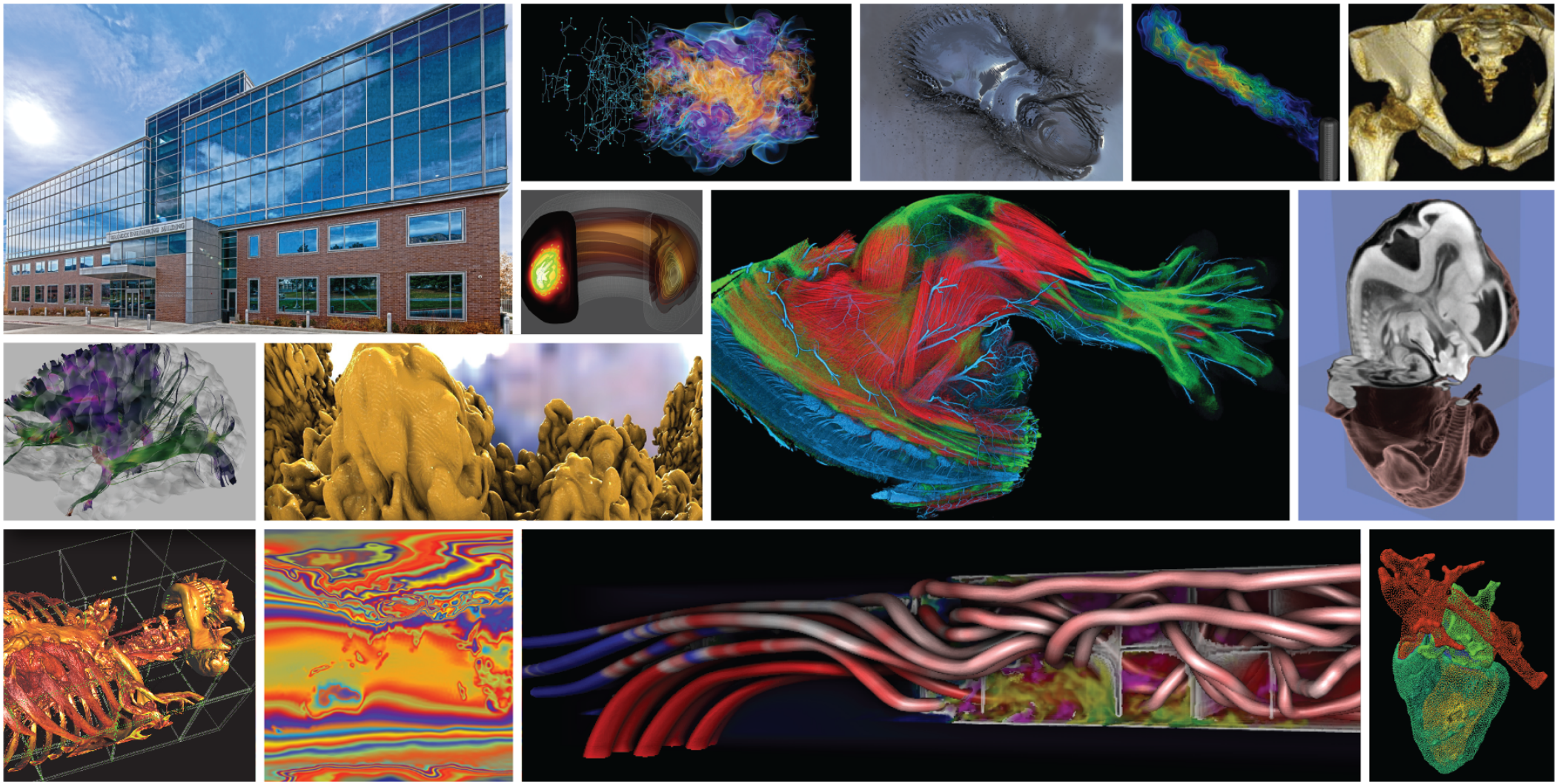
Visual Analysis for Discovery in Science



Chris Johnson
Scientific Computing and Imaging Institute
University of Utah

Brain Information Bandwidth

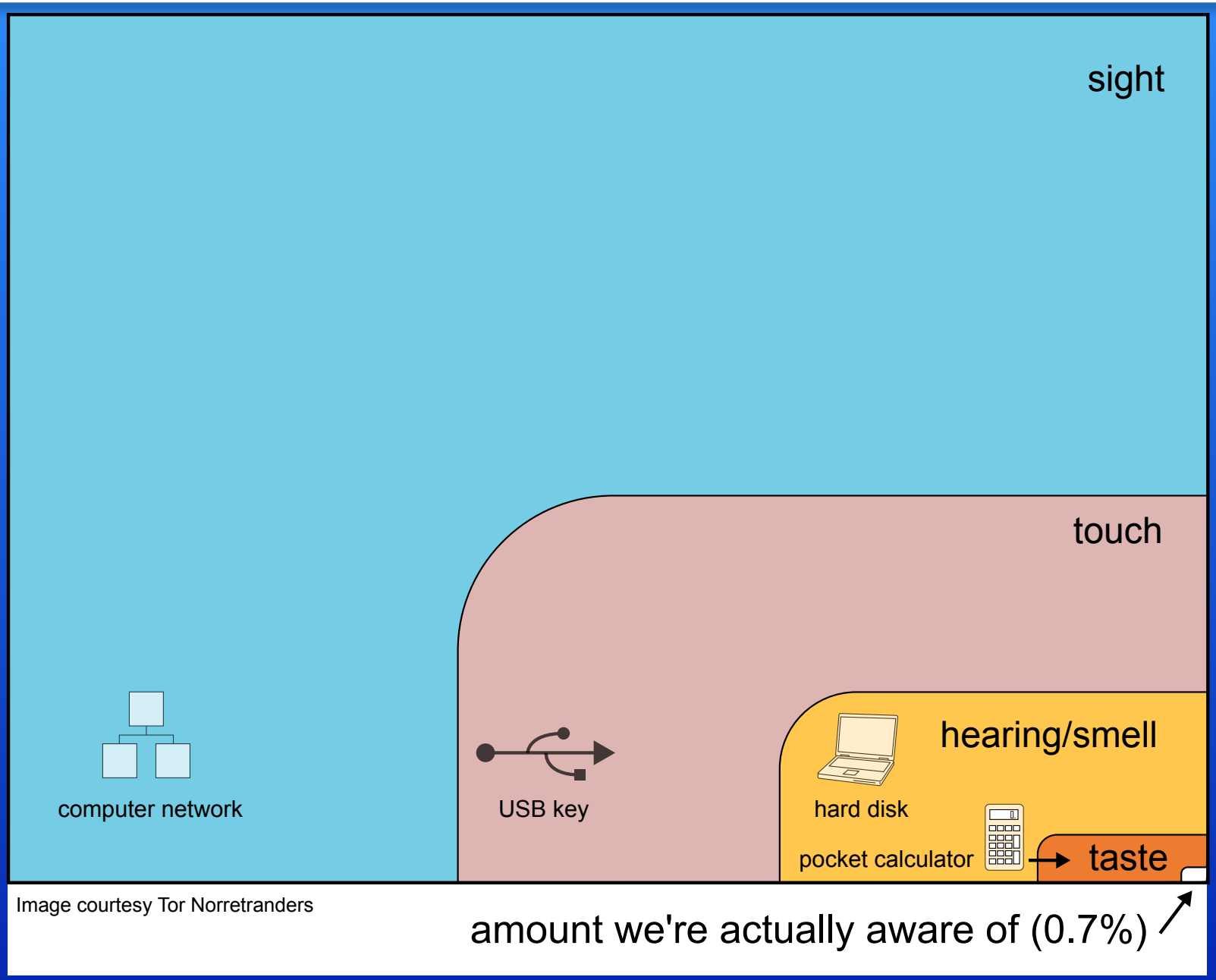
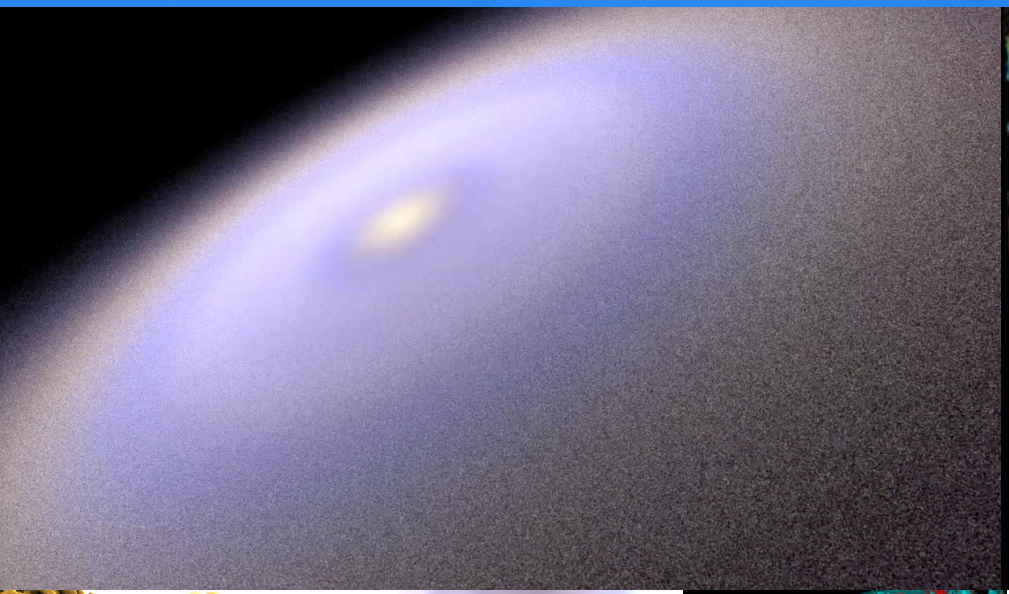
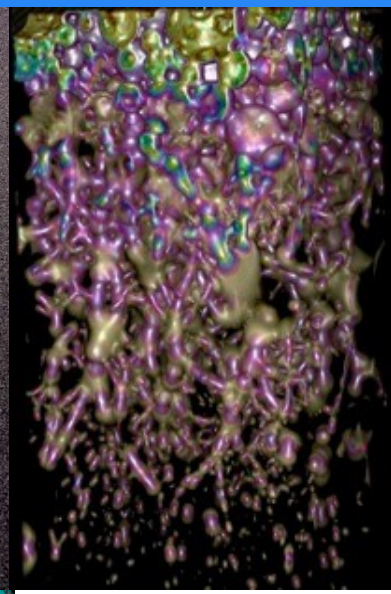
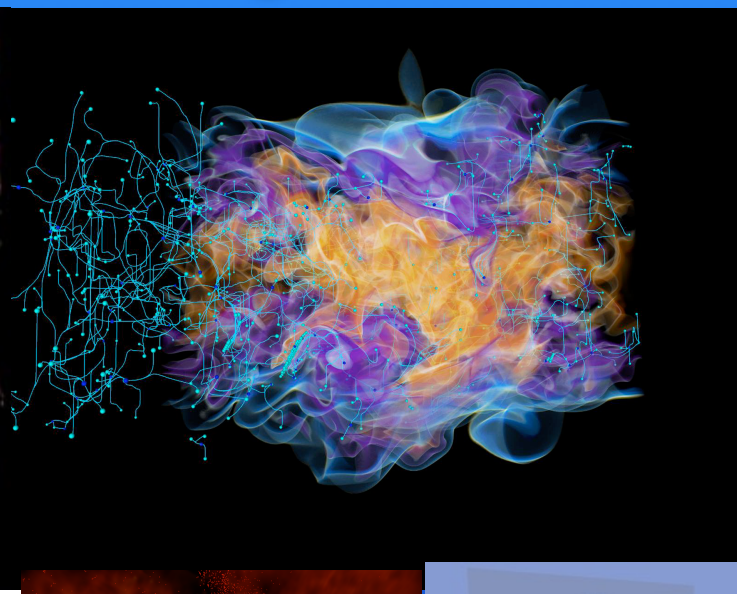
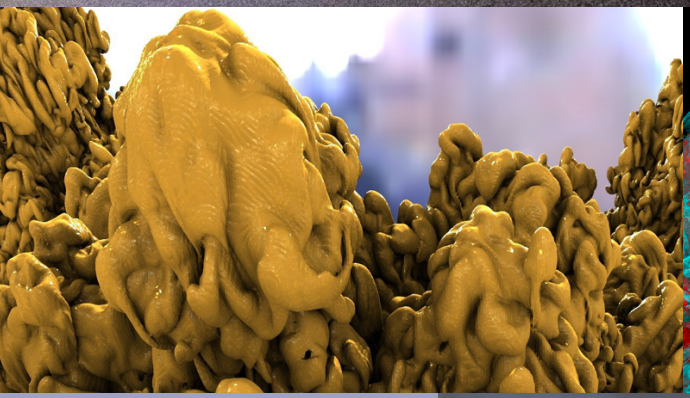
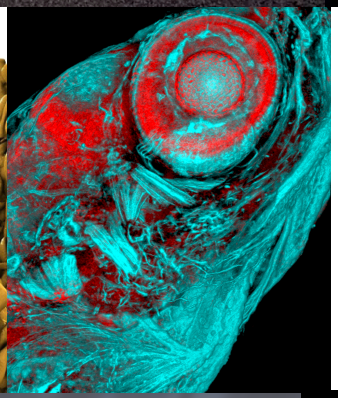
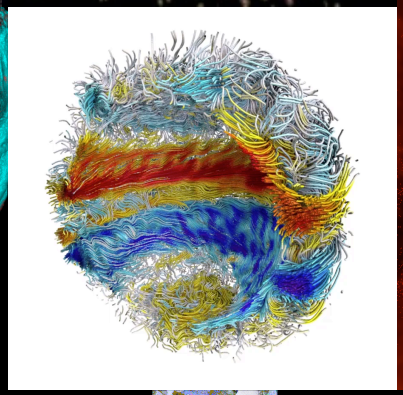
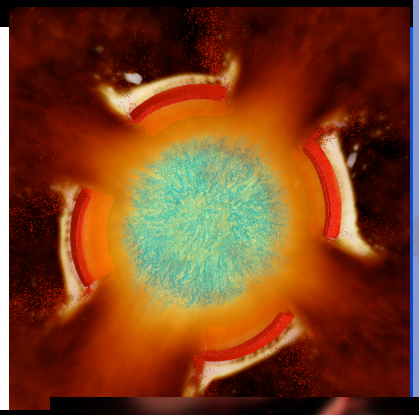
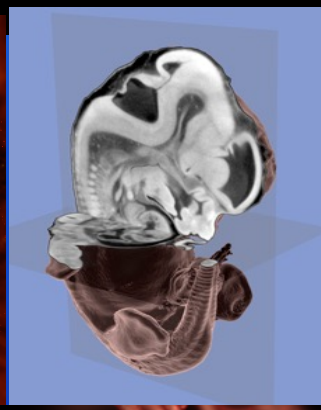
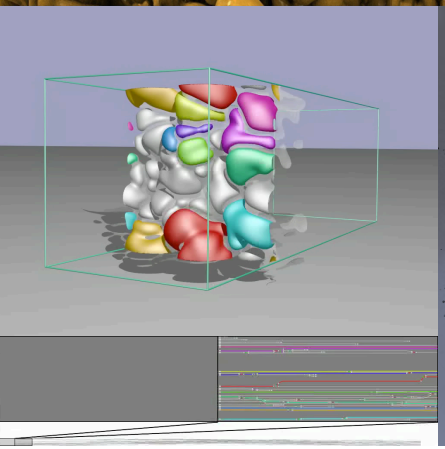
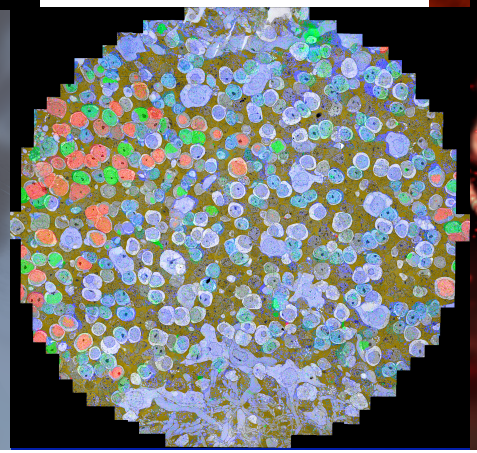
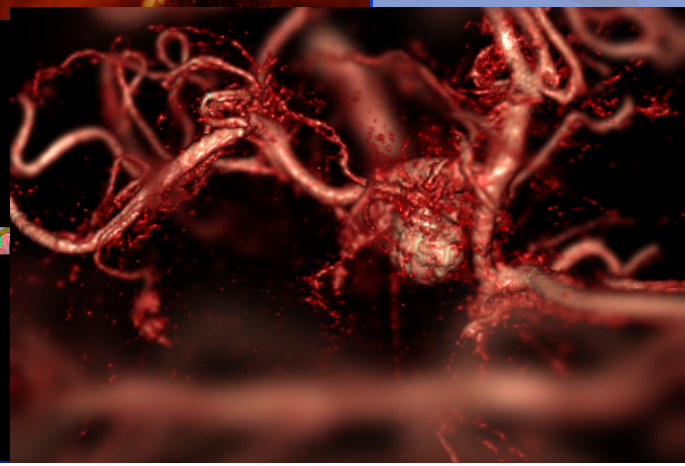
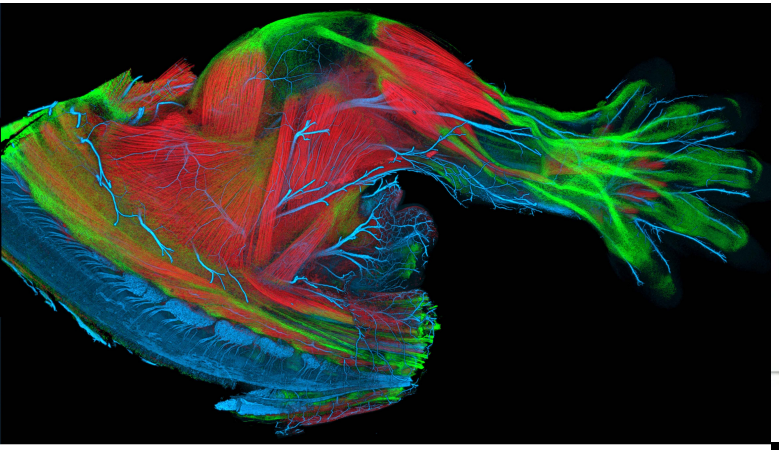
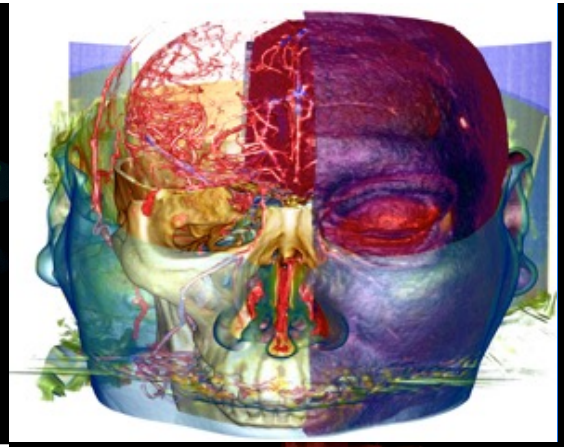
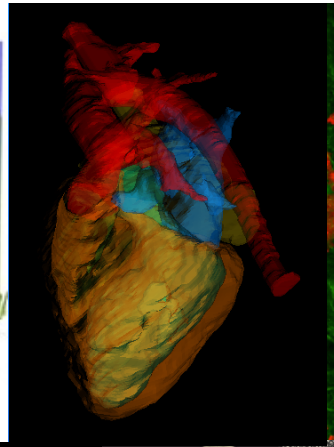
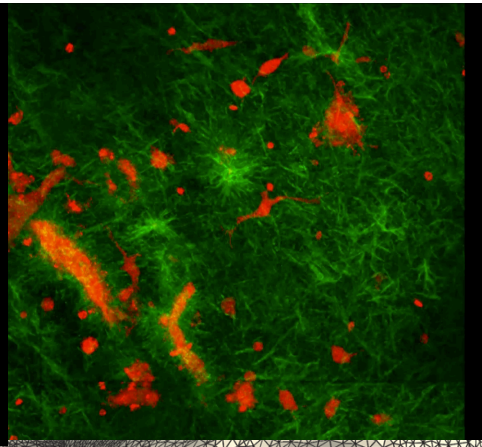
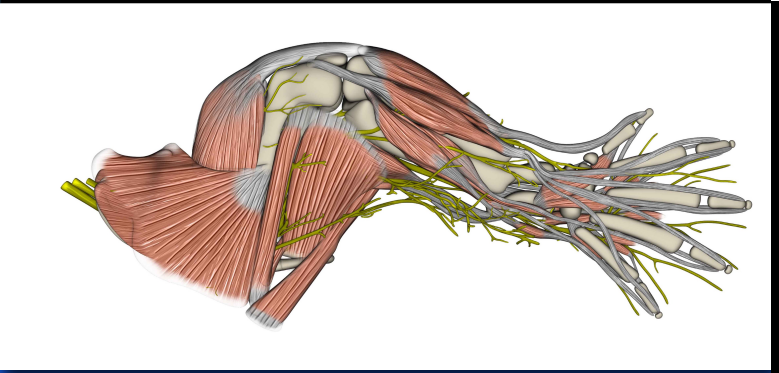
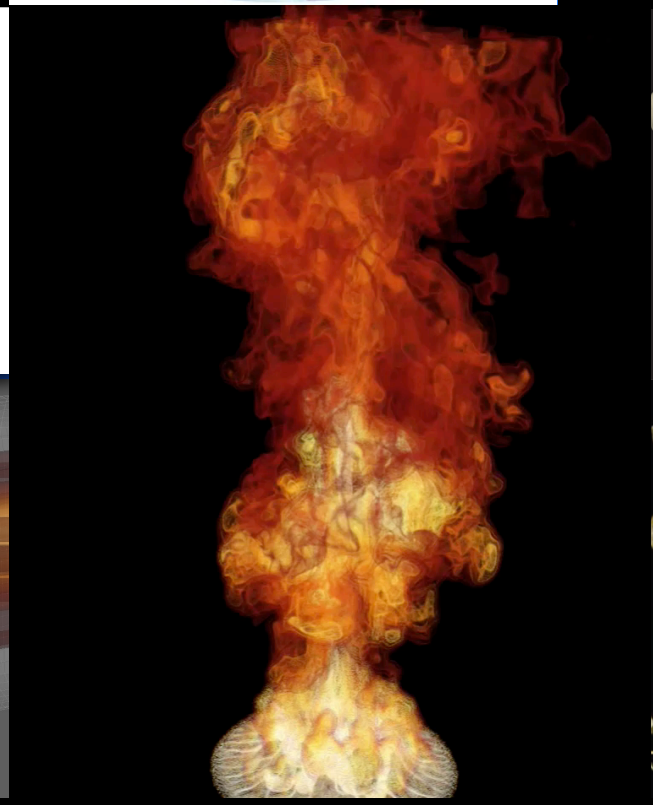
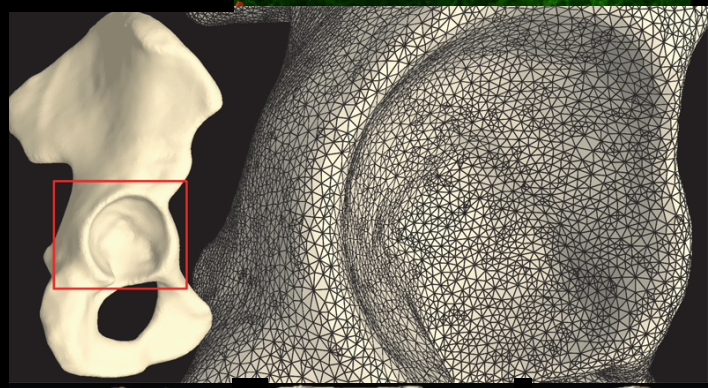
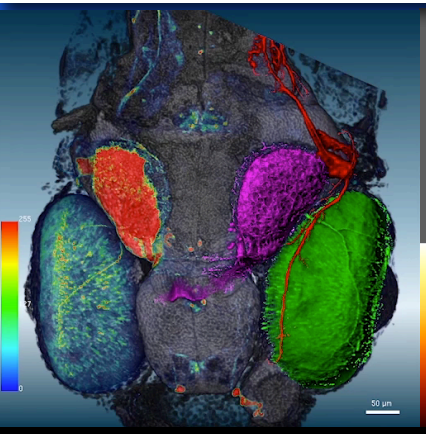


Image courtesy Tor Norretranders

New Visual Analysis Techniques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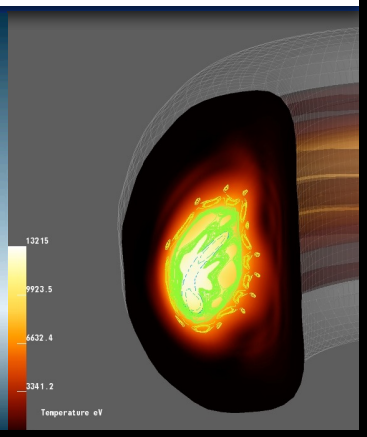
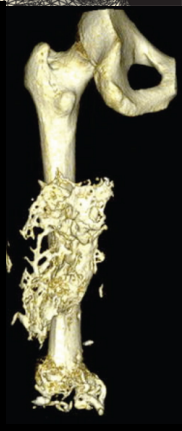
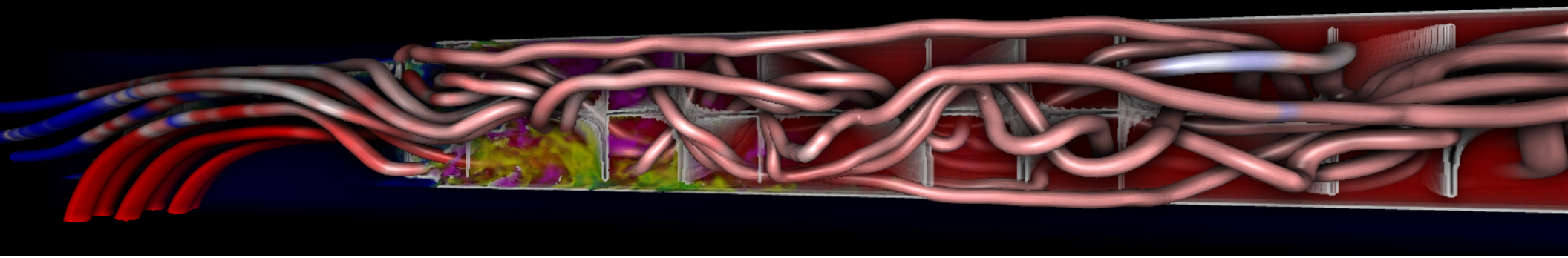
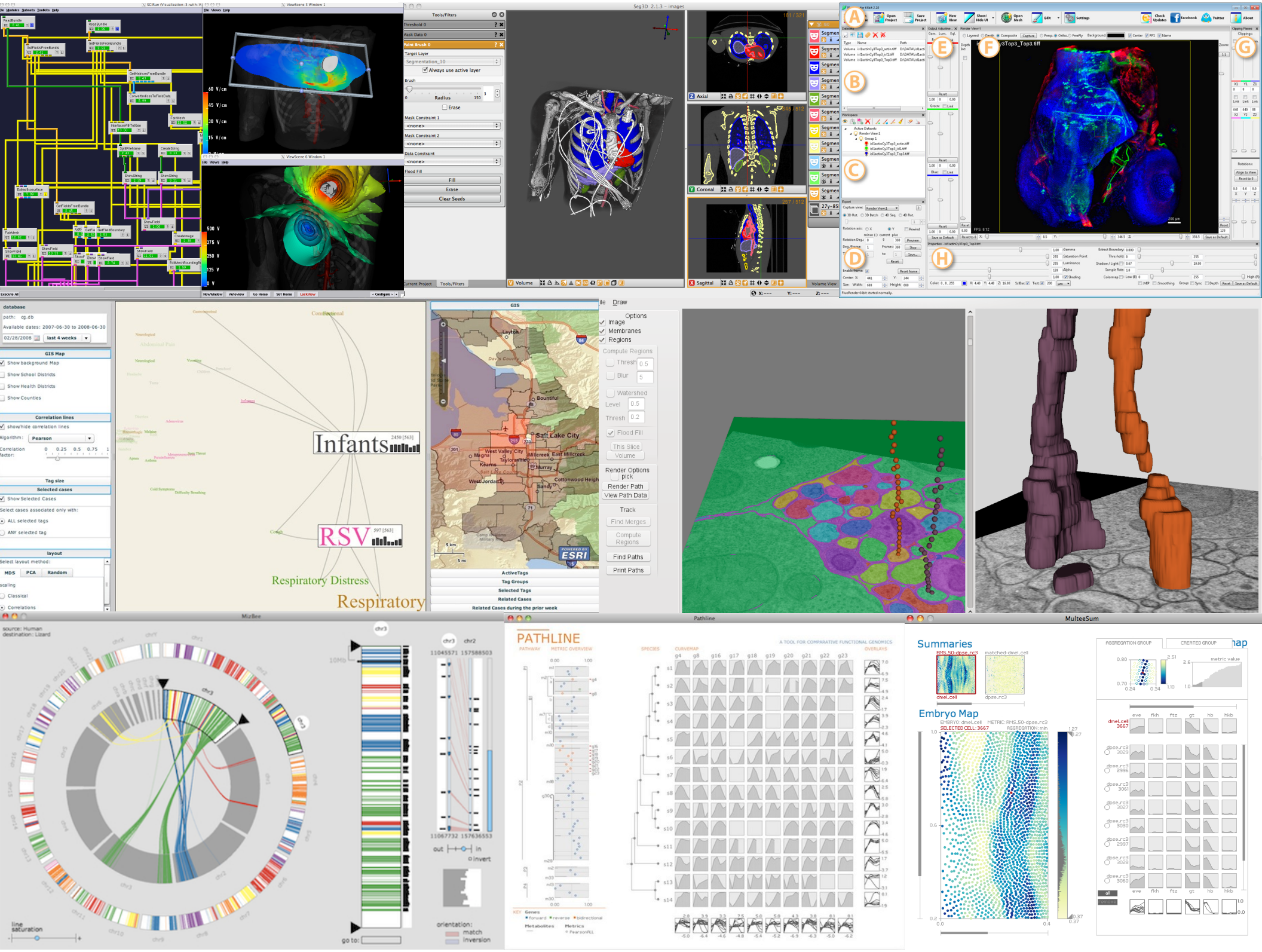
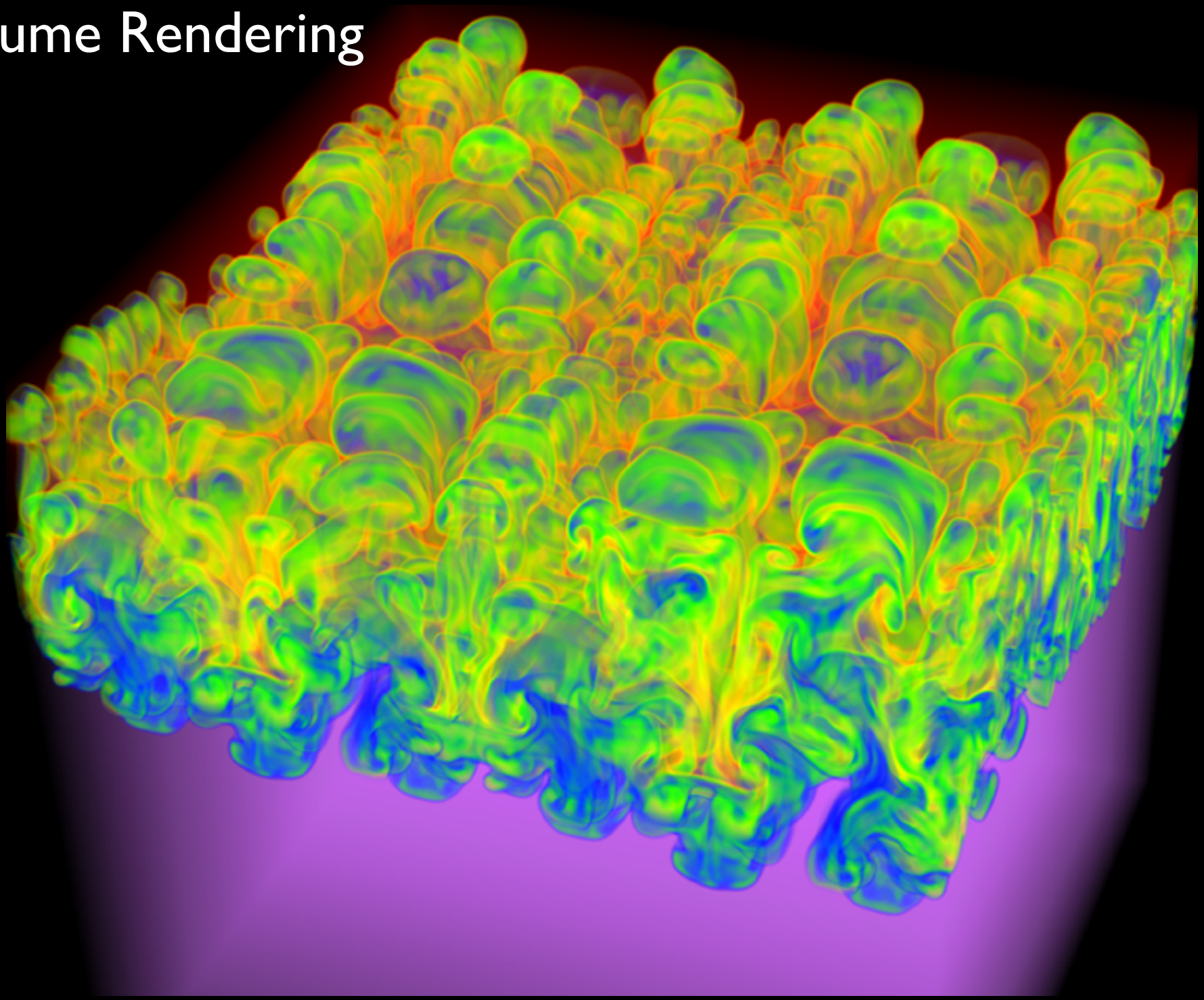

13215
9923.5
6632.4
3341.2
Temperature eV

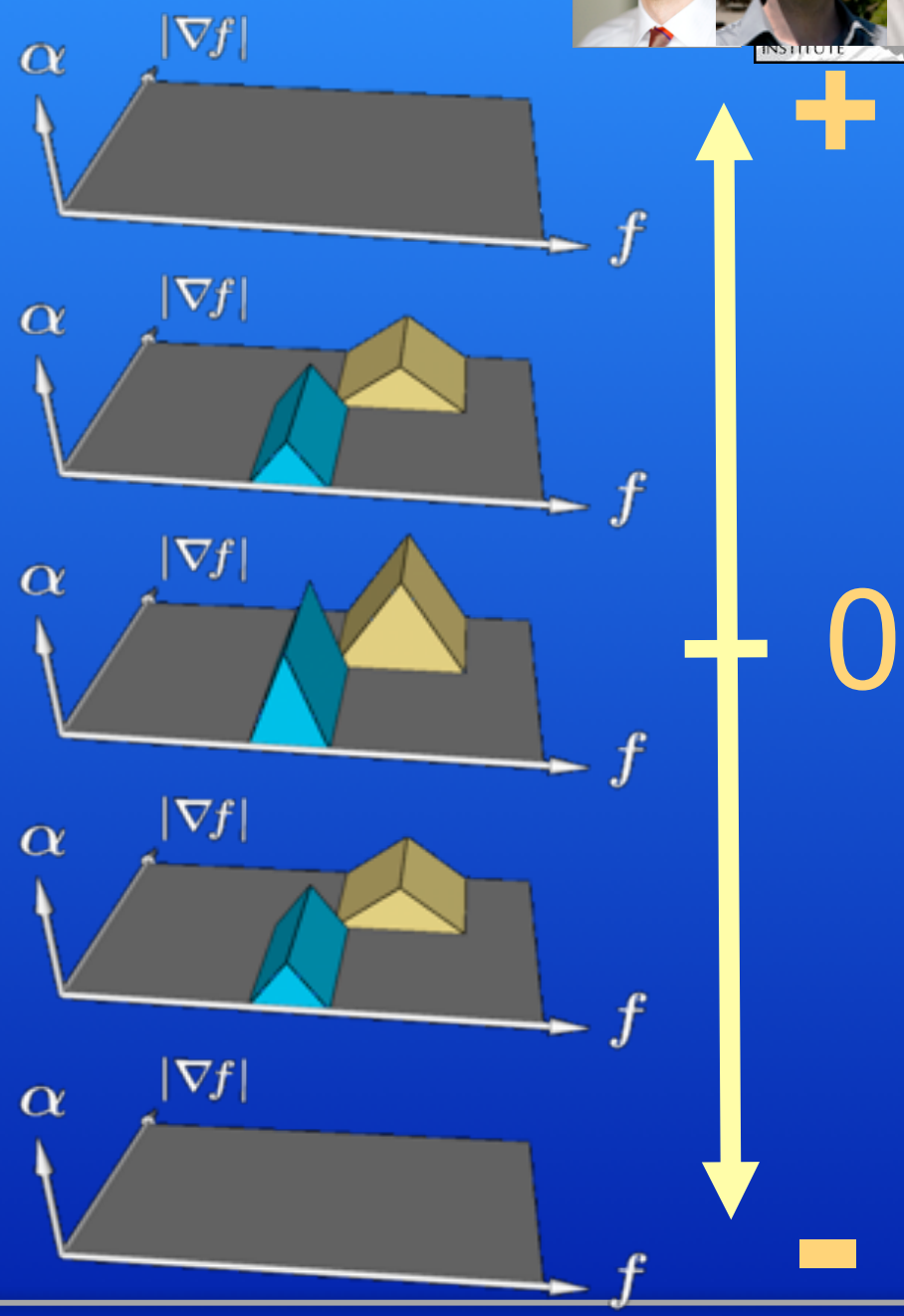




SCIRun (Visualization-3-with-V)
ViewScene 3 Window 1
ViewScene 6 Window 1
Seg3D 2.1.3 – images
Tools/Filters
Paint Brush 0
Fill
Erase
Clear Seeds
Axial
Coronal
Sagittal
Volume
database
path: cg.db
Available dates: 2007-06-30 to 2008-06-30
GIS Map
Show background Map
Show School Districts
Show Health Districts
Show Counties
Correlation lines
Pearson
Tag size
Selected cases
Show Selected Cases
layout
MDS
PCA
Random
Infants
RSV
Respiratory Distress
Respiratory
GIS
Salt Lake City
Bountiful
Options
Image
Membranes
Regions
Compute Regions
Watershed
Flood Fill
Render Options
Render Path
View Path Data
Track
Find Merges
Compute Regions
Find Paths
Print Paths
ActiveTags
Tag Groups
Selected Tags
Related Cases
Related Cases during the prior week
MizBee
Pathline
MulteeSum
PATHLINE
Summaries
Embryo Map

Volume Rendering

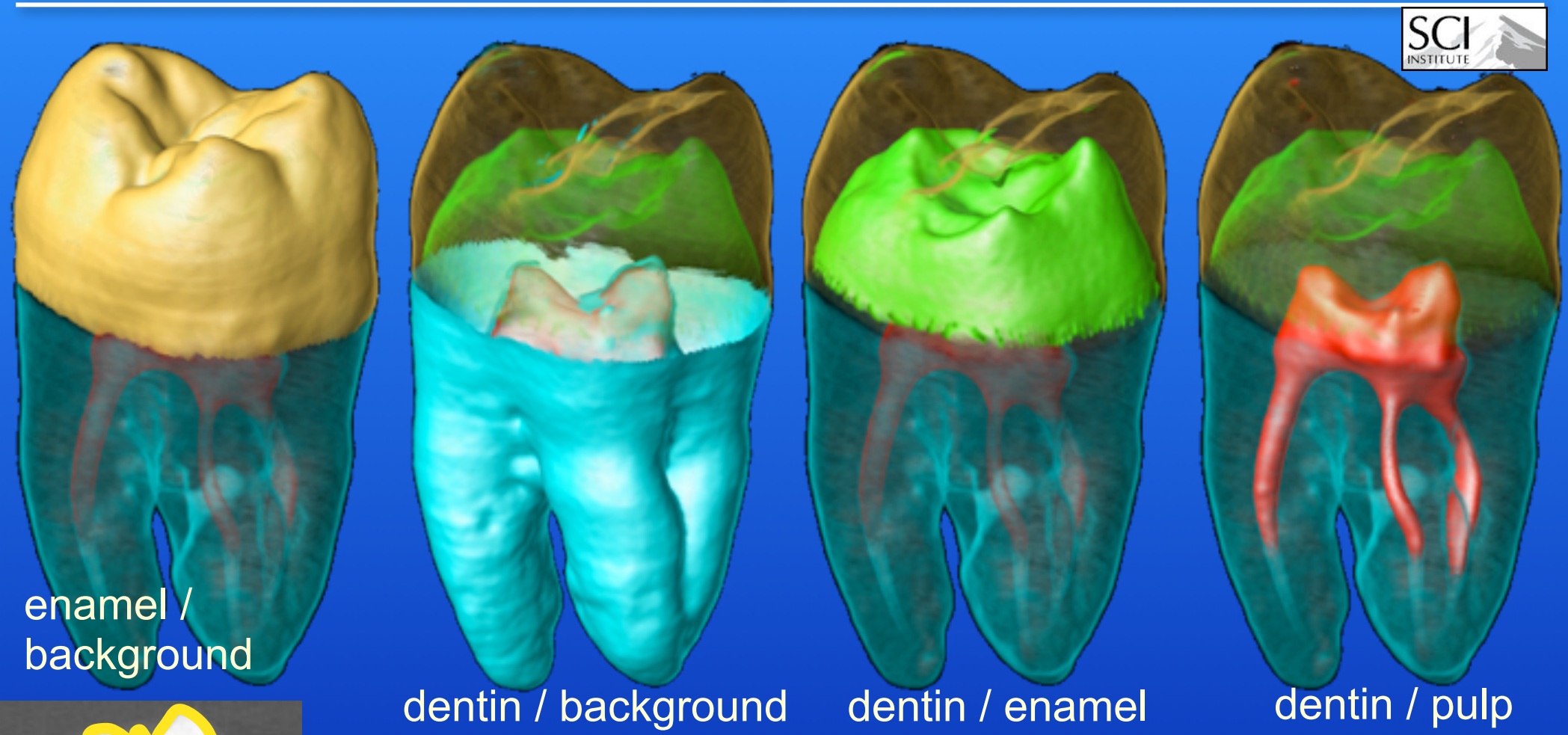


Multi-Dimensional Transfer Function



RGB $\alpha(f, |\nabla f|, D^2_{\widehat{\nabla f}} f)$

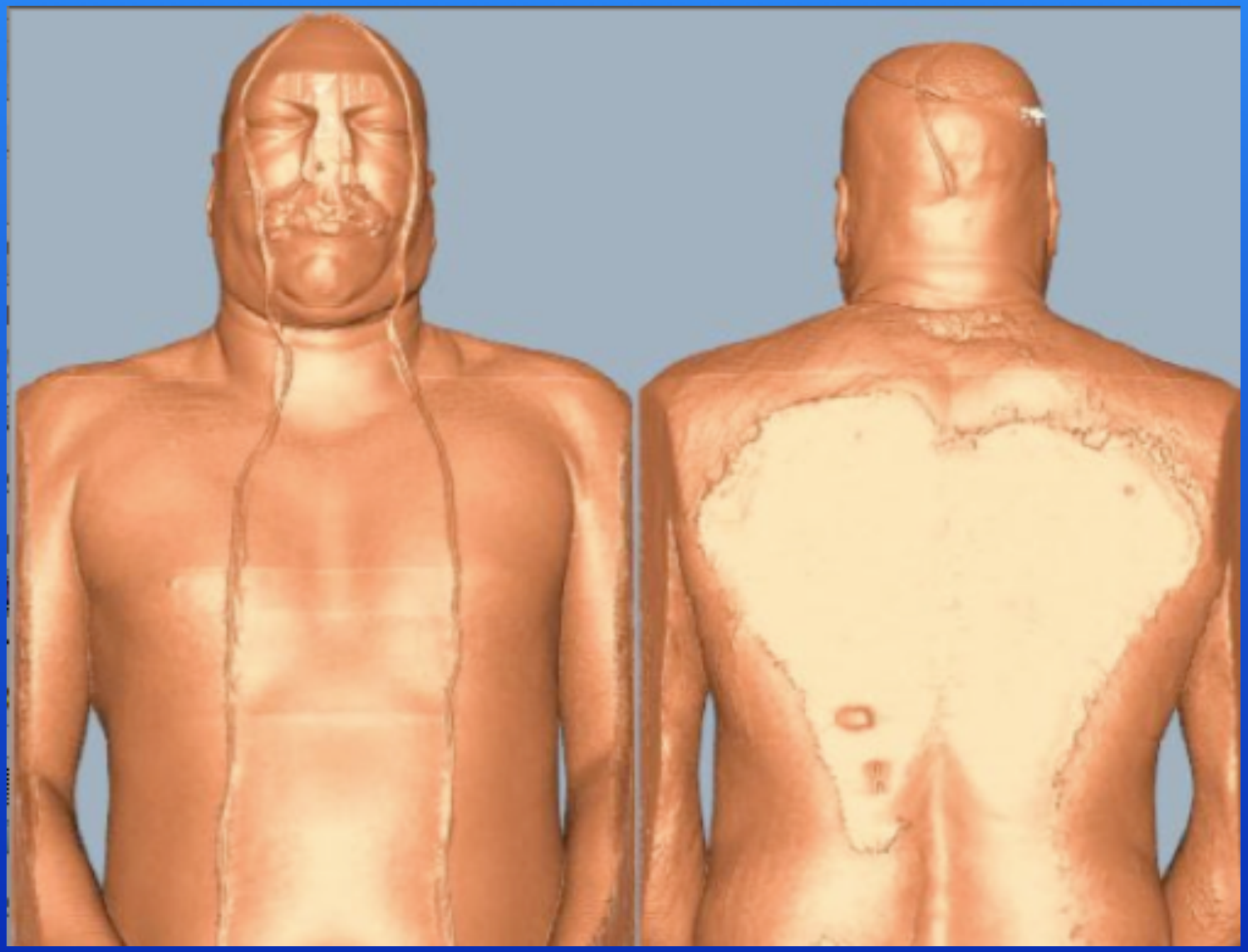
Volume Rendering



1D: not possible

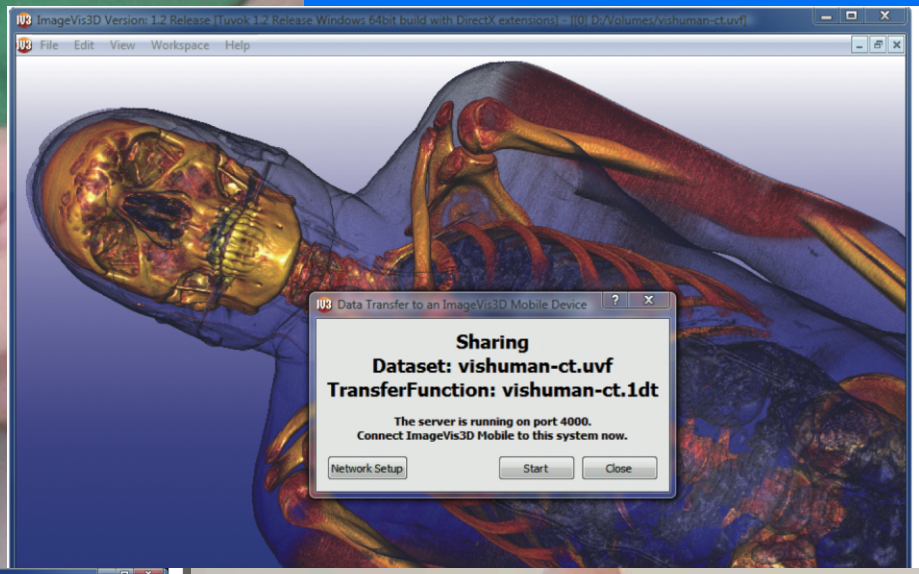
2D: specificity not as good

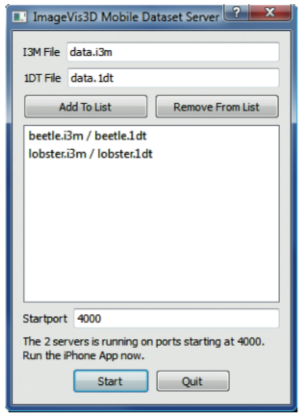
NIH Visible Male

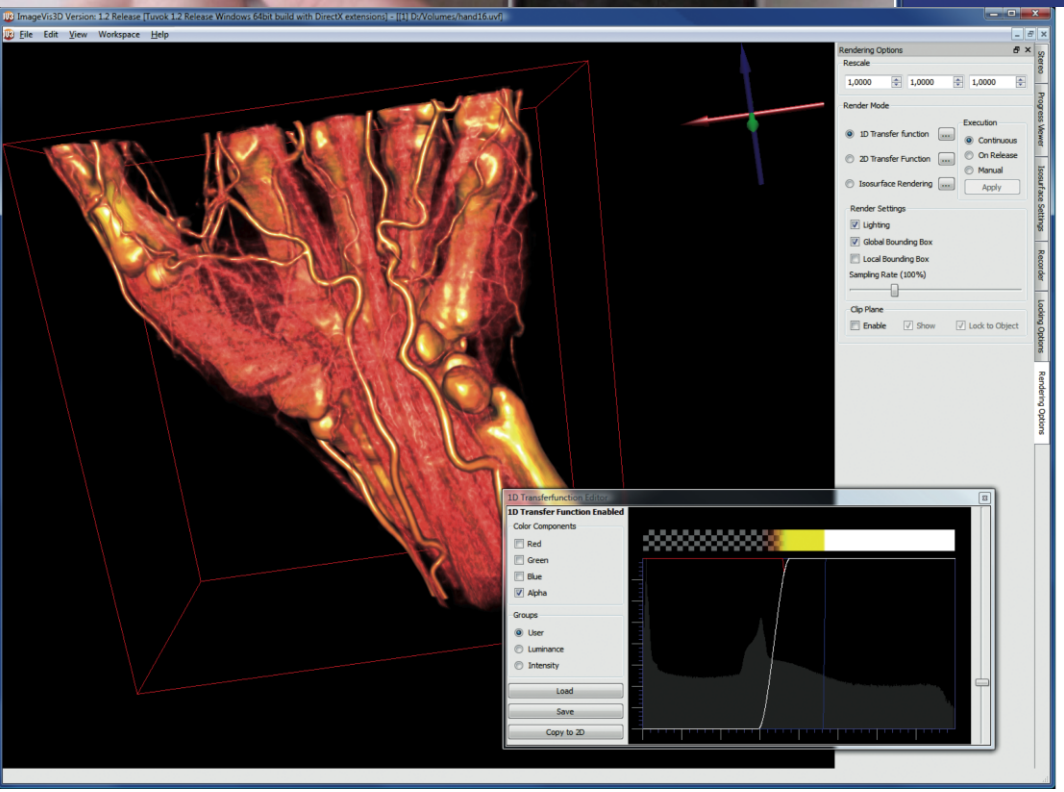


Visible Human - High Resolution

ImageVis3D - Mobile



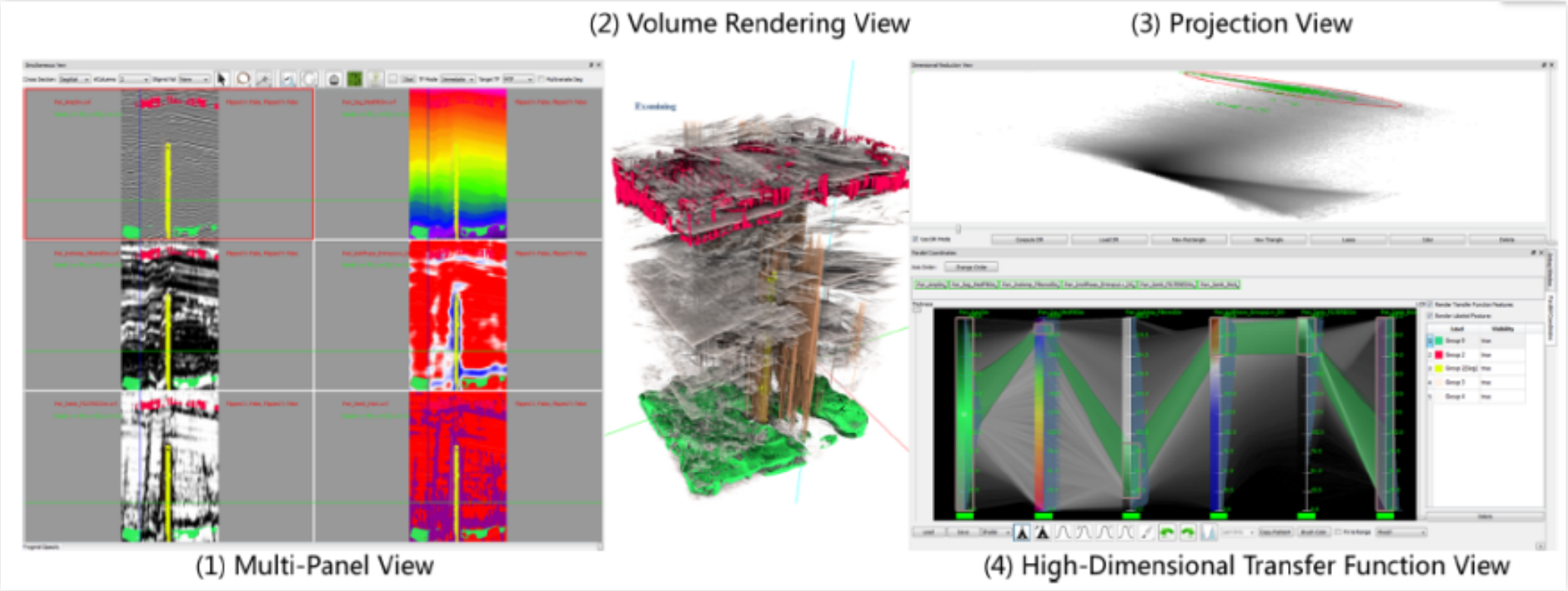




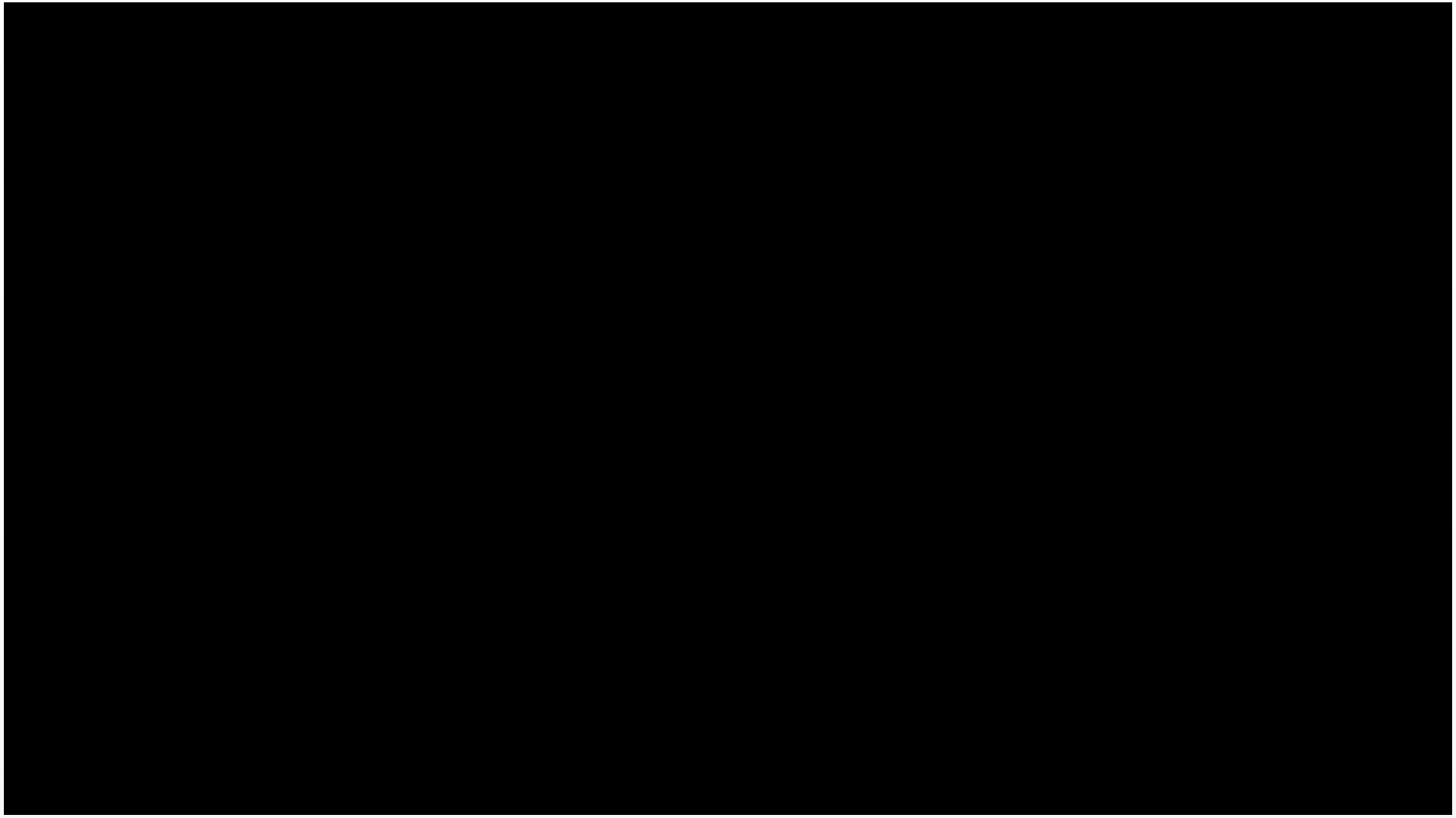
High Dimensional Transfer Functions

Create Transfer Functions (TFs) from user selected samples in spatial domain and error/uncertainty.

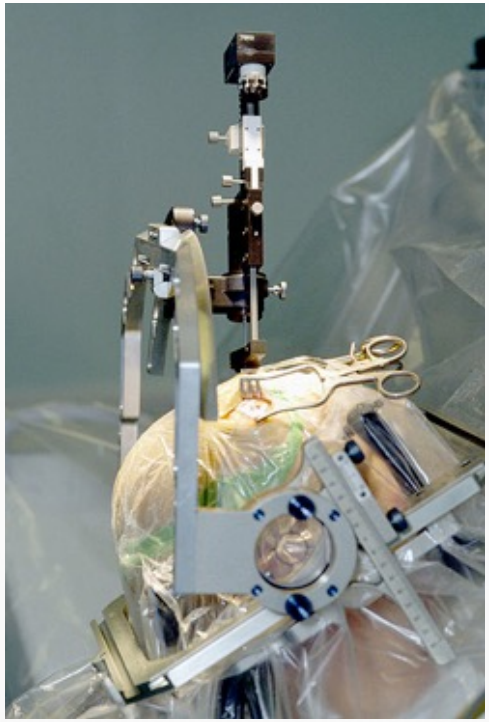
Multiple linked views.



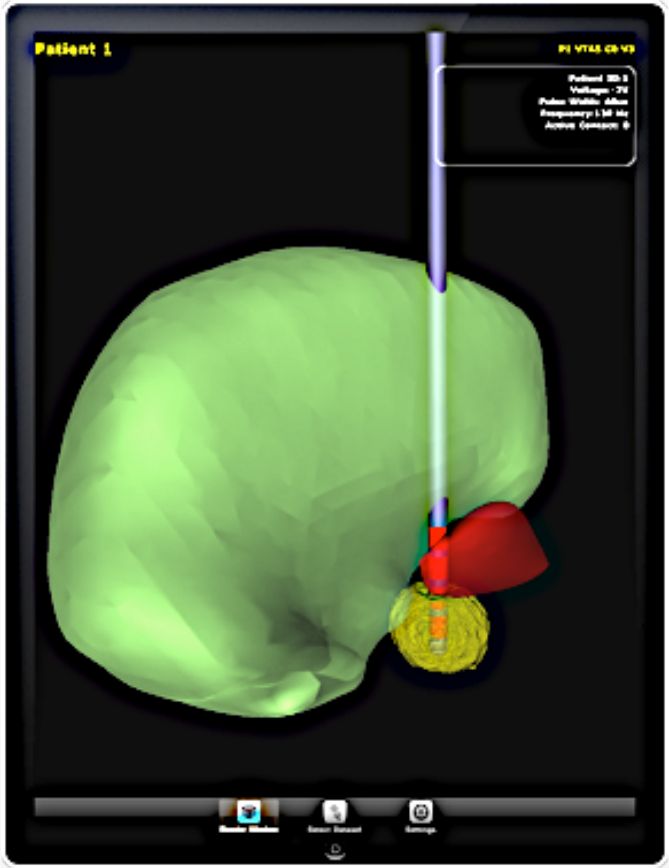
Deep Brain Stimulation



ImageVis3D Mobile DBS App

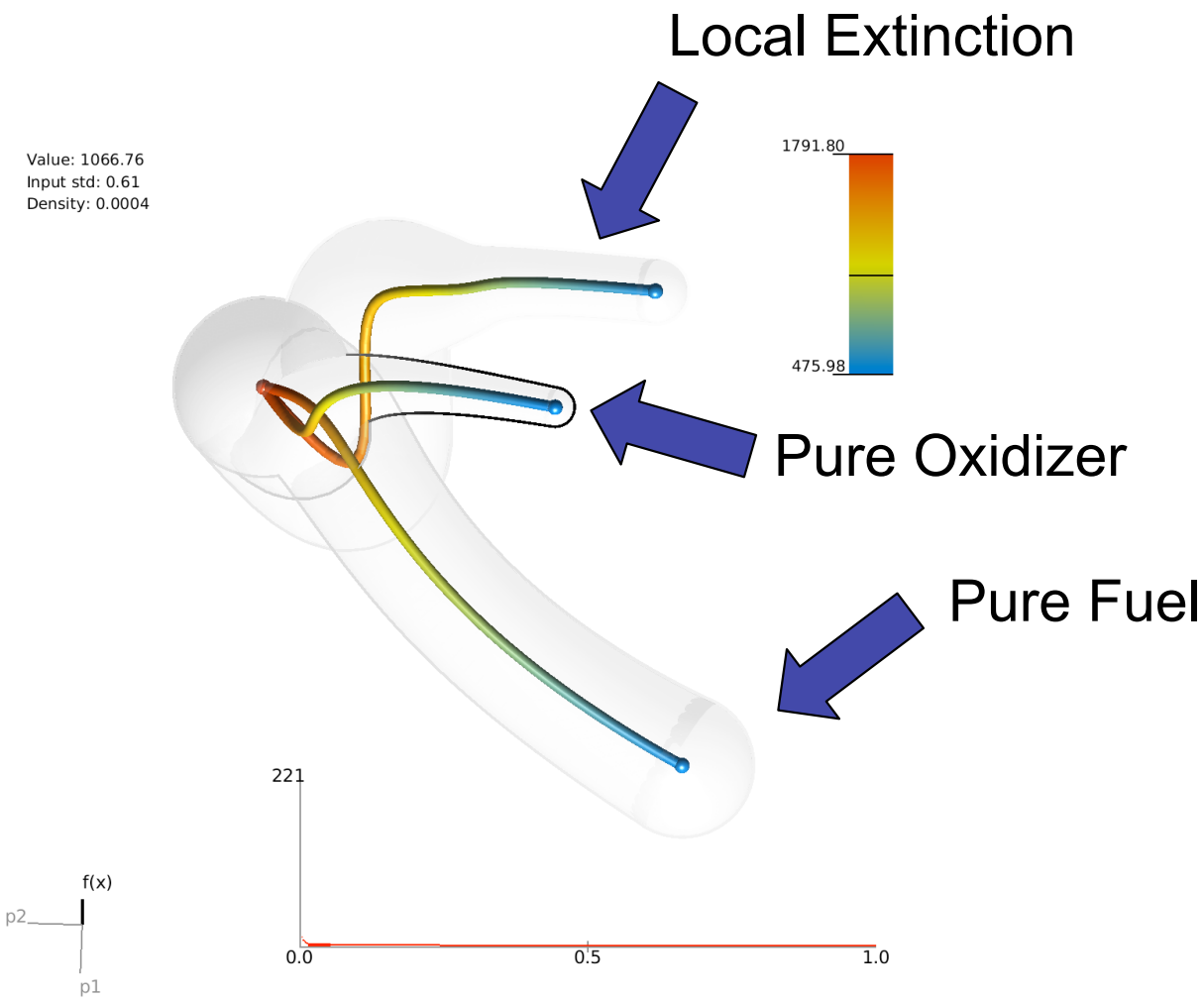


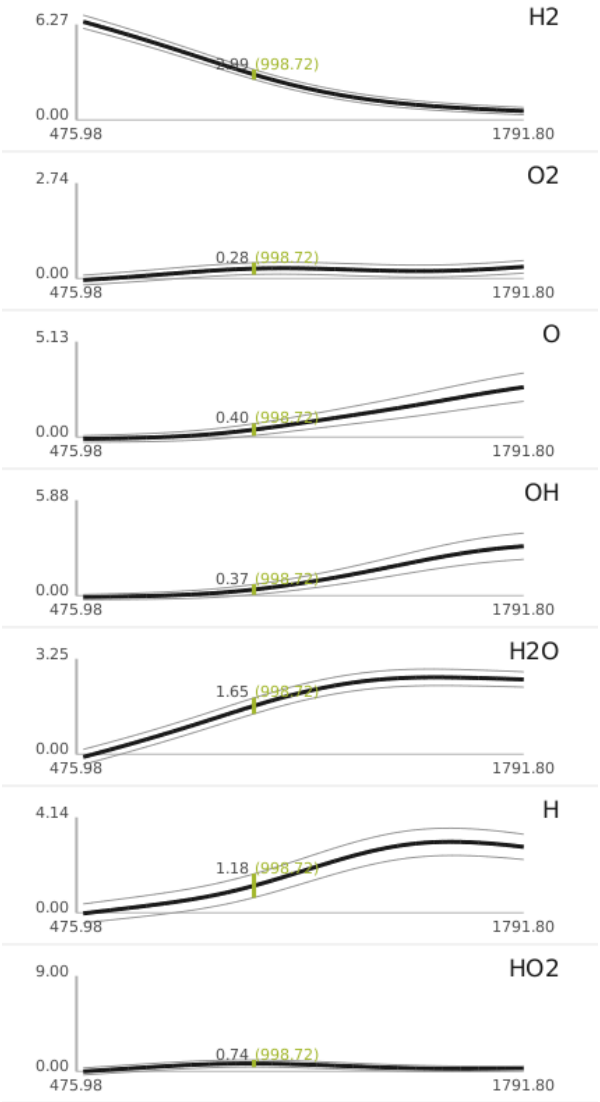
Deep Brain Stimulation
DBP: Chris Butson



C. Butson, G. Tamm, S. Jain, T. Fogal and J. Krüger "Evaluation of Interactive Visualization on Mobile Computing Platforms for Selection of Deep Brain Stimulation Parameters" *IEEE Transactions on Visualization and Computer Graphics, 2012 (in press).*

Visualization of 10D Combustion Simulation of Jet CO/H2-Air Flames





10 dimensional data set describing the heat release wrt. to various chemical species in a combustion simulation

Analysis of Combustion Simulations

Combustion Simulation of Jet CO/H2-Air Flames

Input: Composition of 10 chemical species

Output: Temperature

Michelangelos David

Michelangelos David - Part 2

Gigapixel David - iTunes App

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GigapixelDavid

Valerio Pascucci ›

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Free

This app is designed for both iPhone and iPad

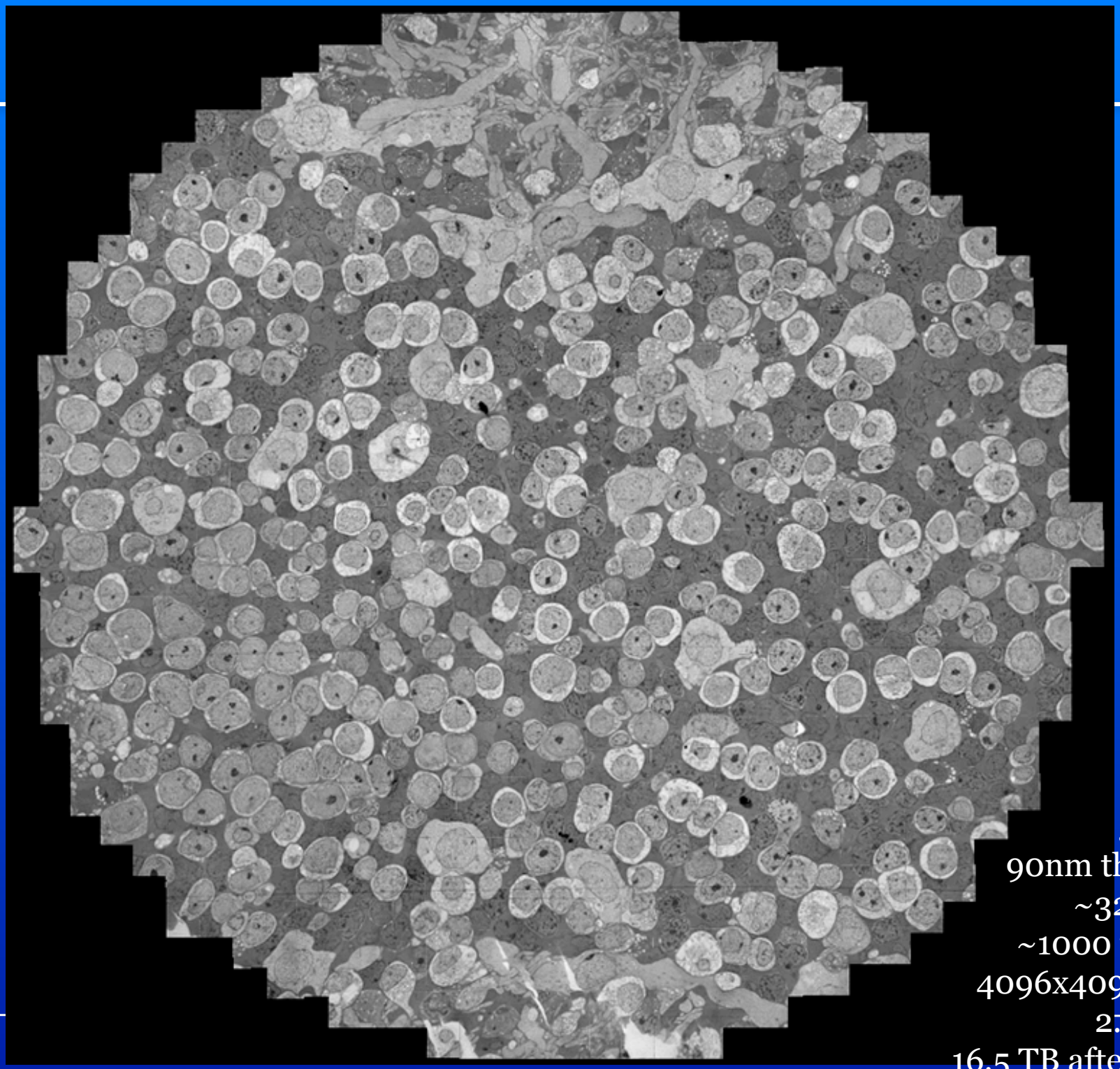
No Ratings
Rated 17+

LINKS

Privacy Policy
Developer Website

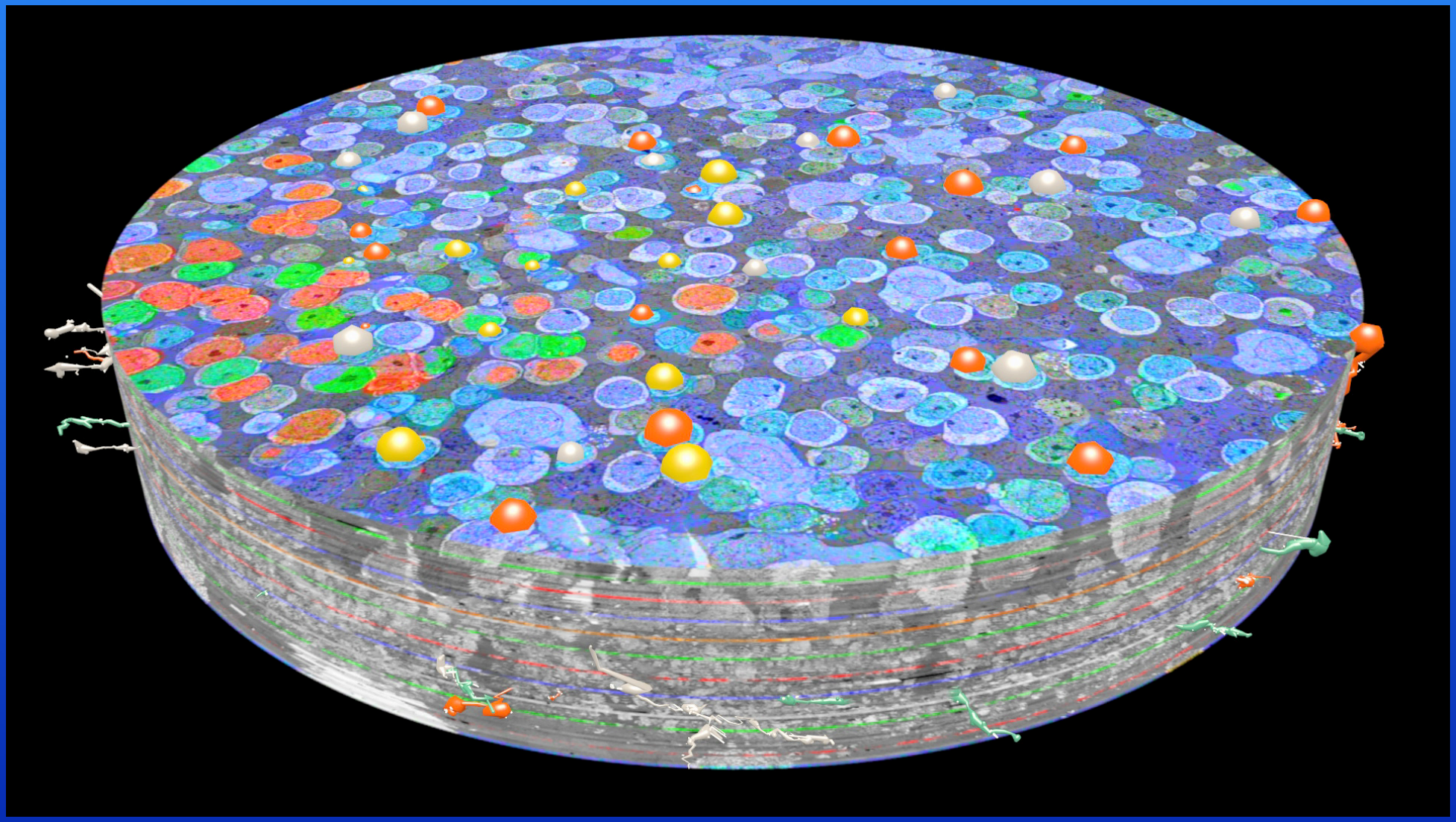
© VISUS

Screenshots | iPhone | iPad



341 Sections
90nm thick sections
~32GB/Section
~1000 tiles/section
4096x4096 pixels/tile
2.18 nm/Pixel
16.5 TB after processing

Connectome

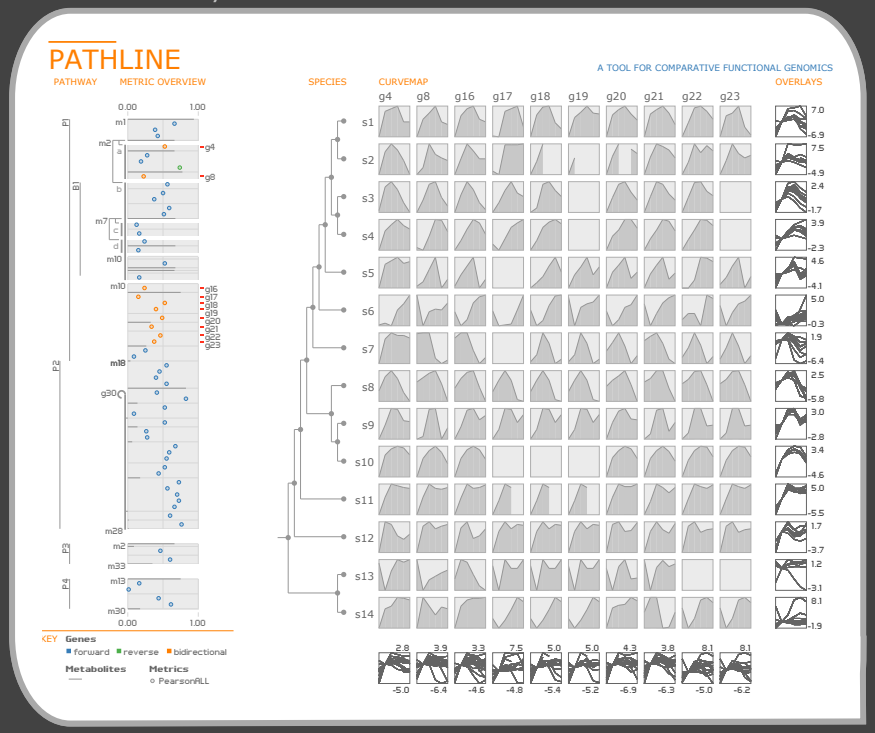


PROBLEM-DRIVEN VISUALIZATION RESEARCH *for biological data*

- target specific biological problems
- close collaboration with biologists
- rapid, iterative prototyping
- focus on genomic and molecular data

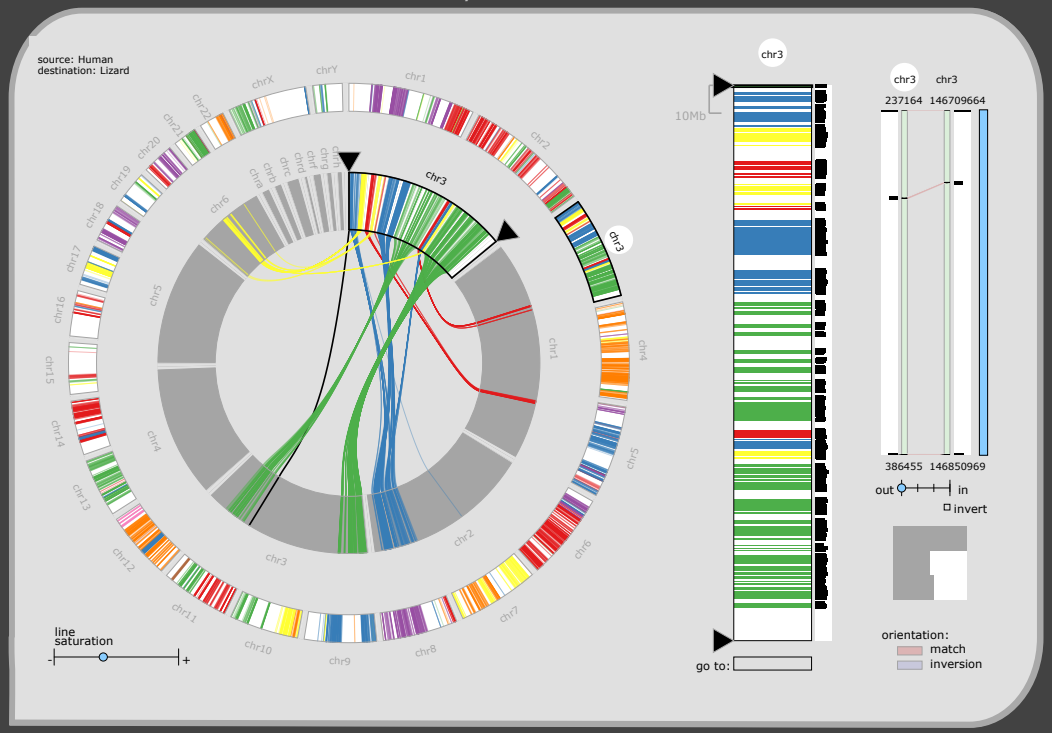
M. Meyer et al., EuroVis 2010.

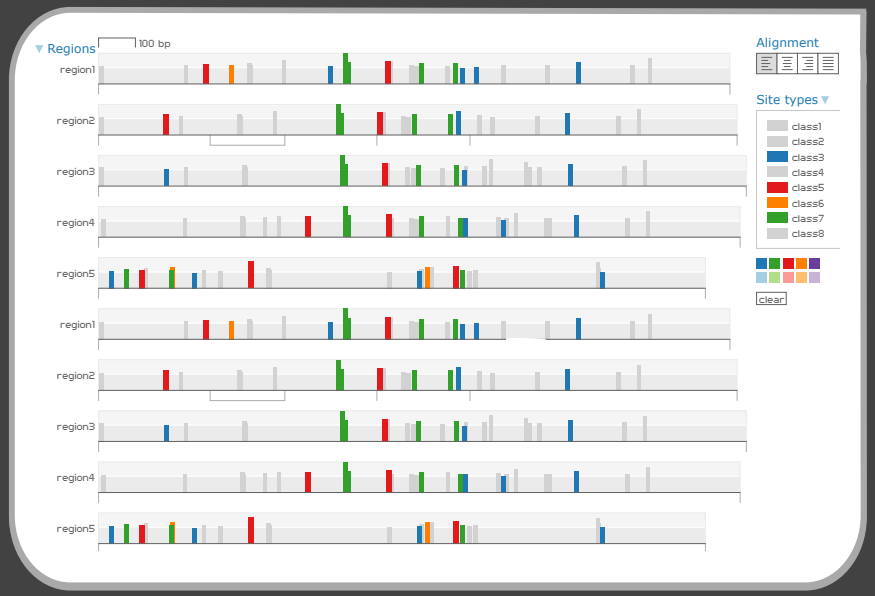
Pathline



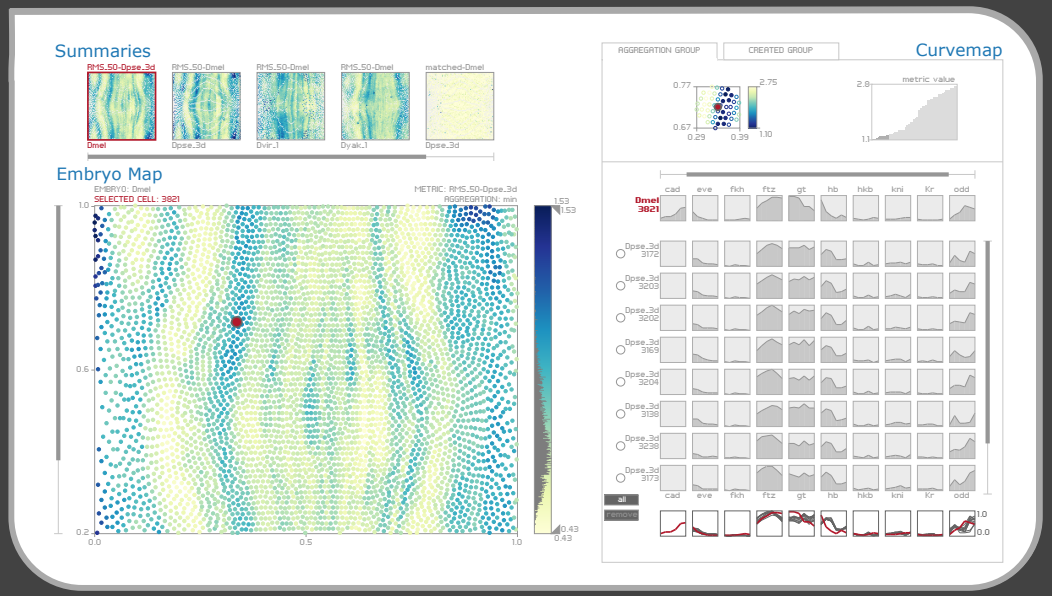
MizBee

M. Meyer et al., InfoVis 2009.



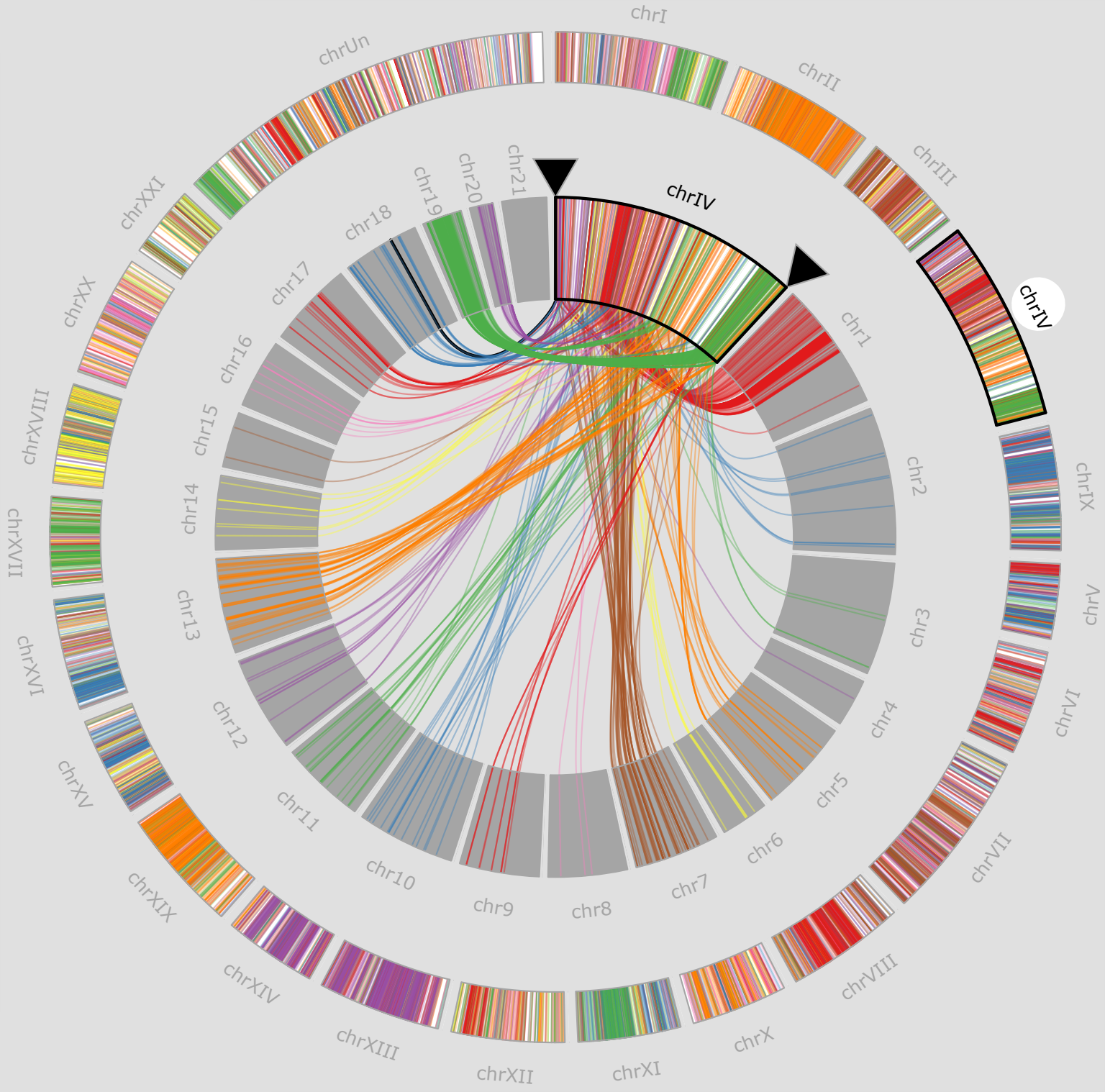


InSite



MulteeSum

M. Meyer et al., InfoVis 2010.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chrIII
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chrV
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chrVII
chrVIII
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chrXI
chrXII
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chrXIX
chrXV
chrXVI
chrXVII
chrXVIII
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chrXXI
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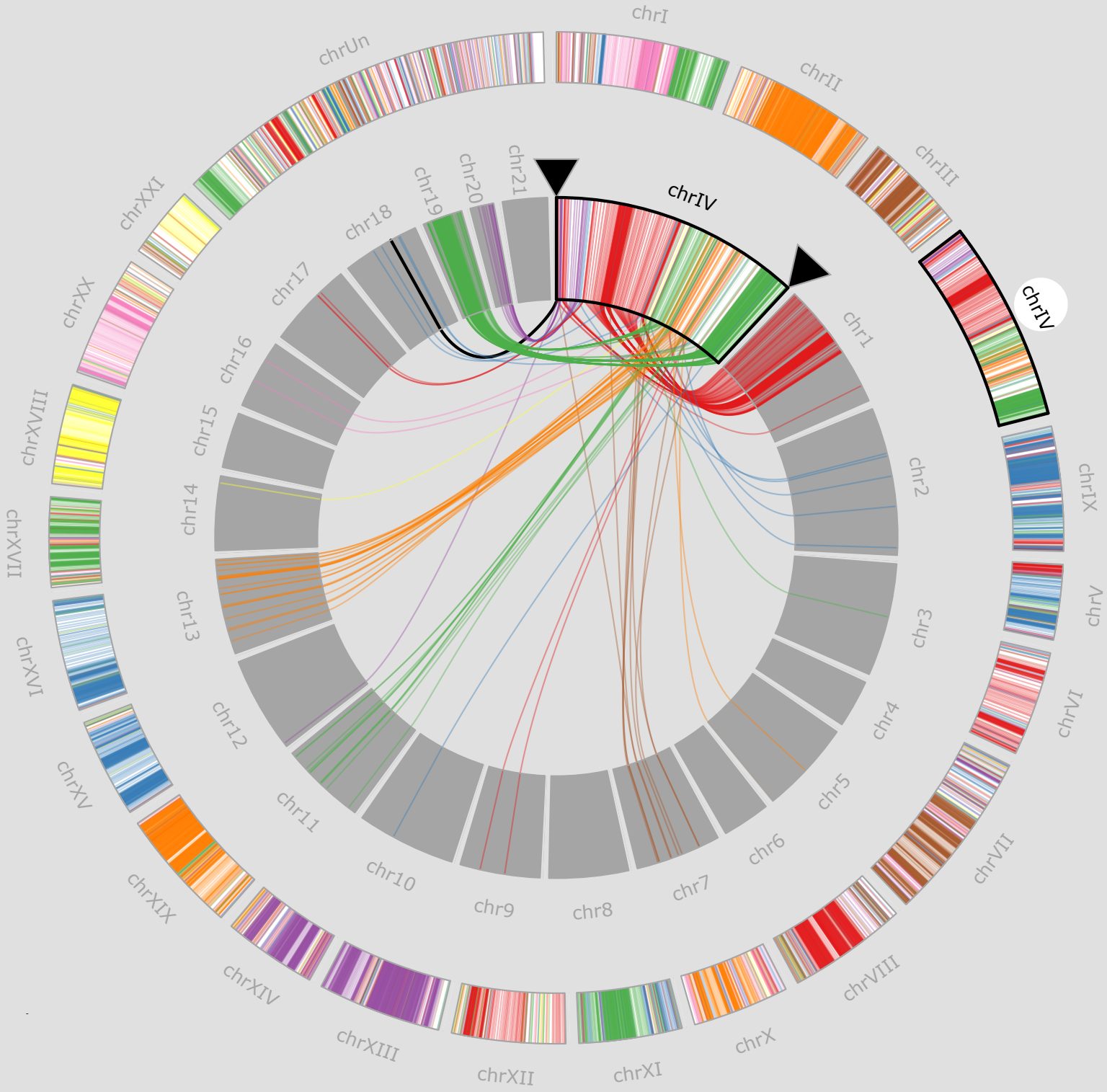
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chrXV
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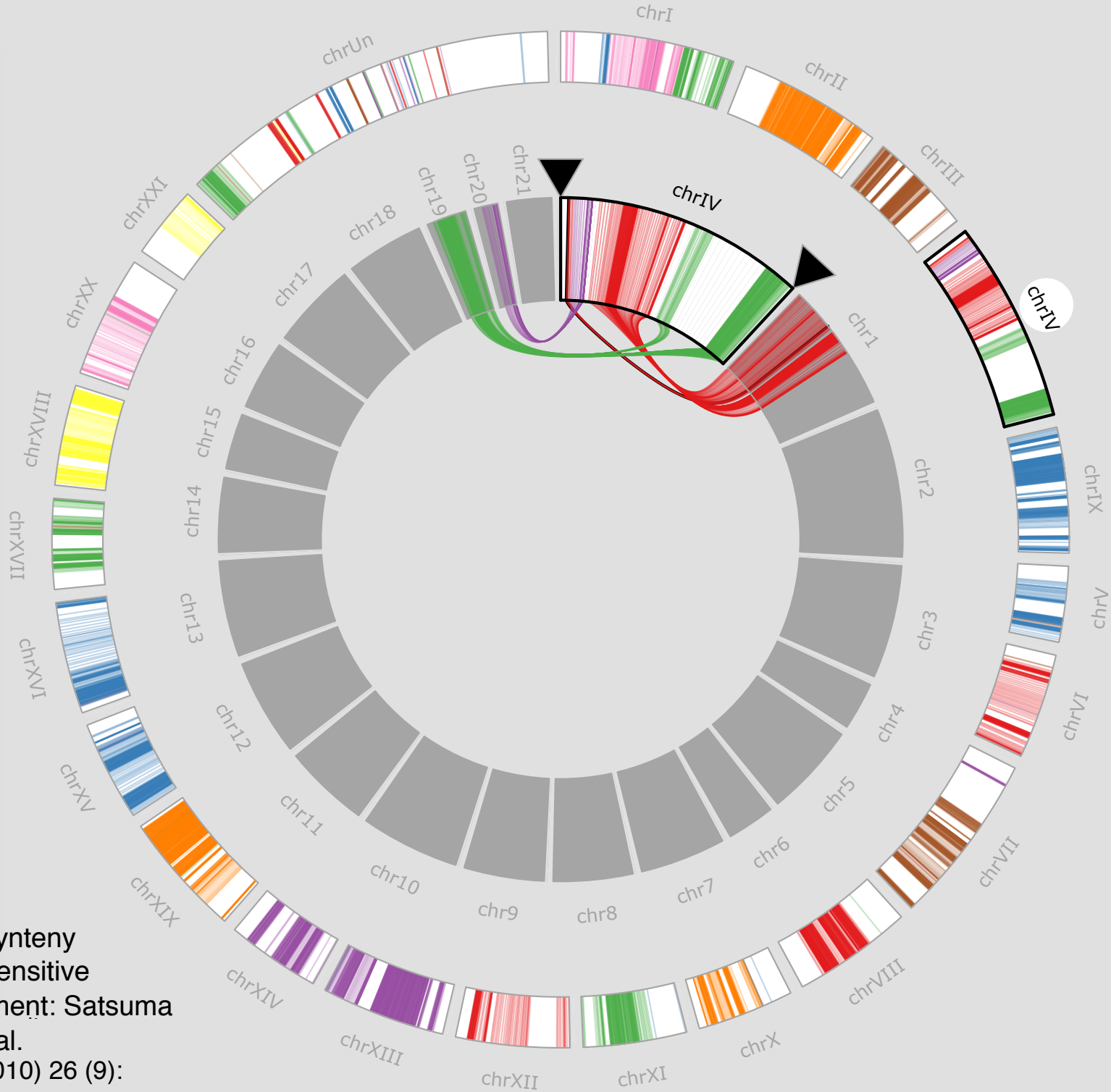


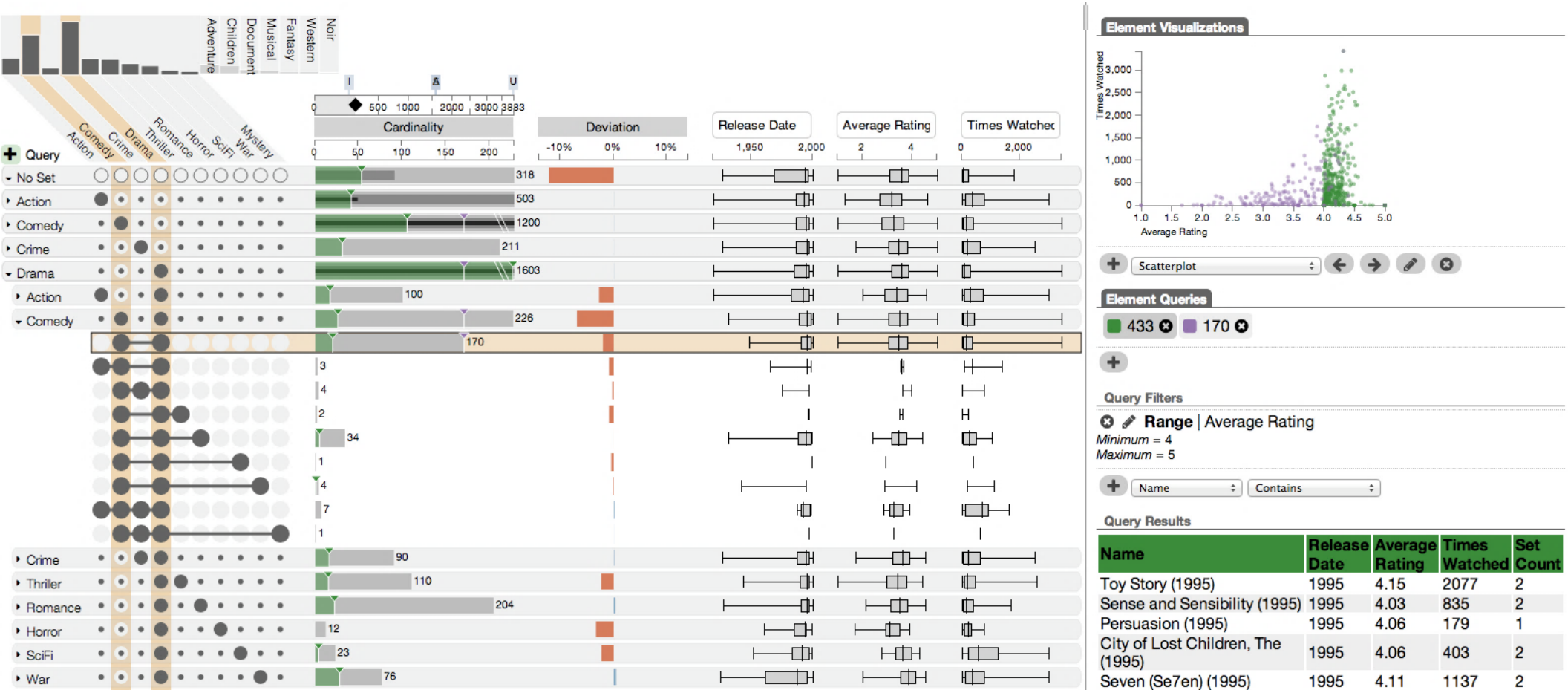
Genome-wide synteny through highly sensitive sequence alignment: Satsuma
M. Grabherr, et al.
Bioinformatics (2010) 26 (9): 1145-1151.

Visualization of Biological Data

MizBee

Browser that enables analysis of comparative genomics data through visualization across multiple scales.

UpSet - Set Visualization - InfoVis `14



Name	Release Date	Average Rating	Times Watched	Set Count
Toy Story (1995)	1995	4.15	2077	2
Sense and Sensibility (1995)	1995	4.03	835	2
Persuasion (1995)	1995	4.06	179	1
City of Lost Children, The (1995)	1995	4.06	403	2
Seven (Se7en) (1995)	1995	4.11	1137	2

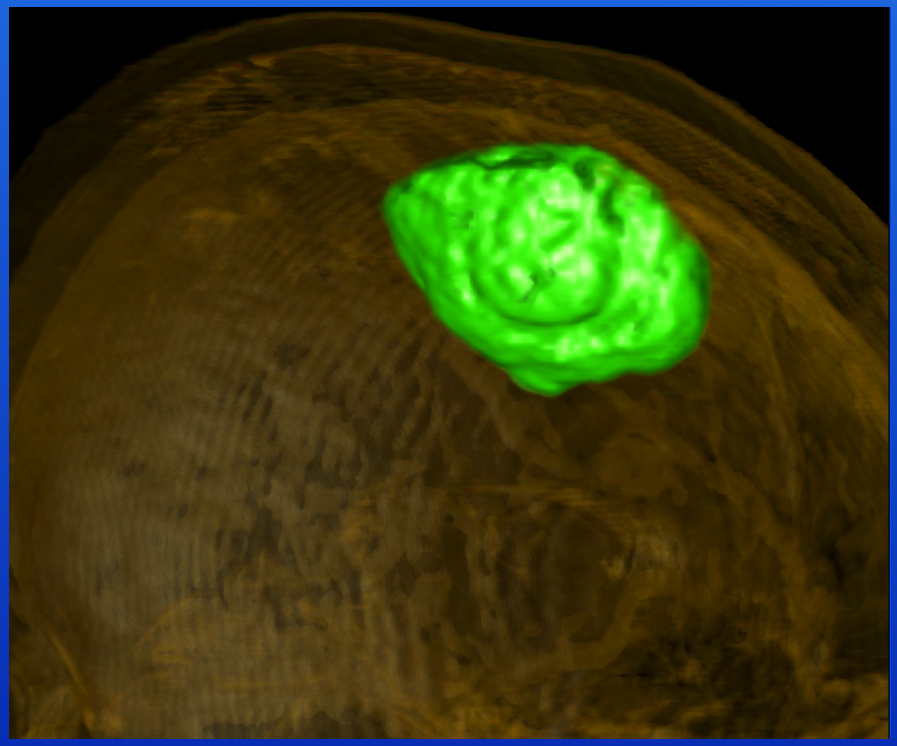
Visualizing attributes and elements

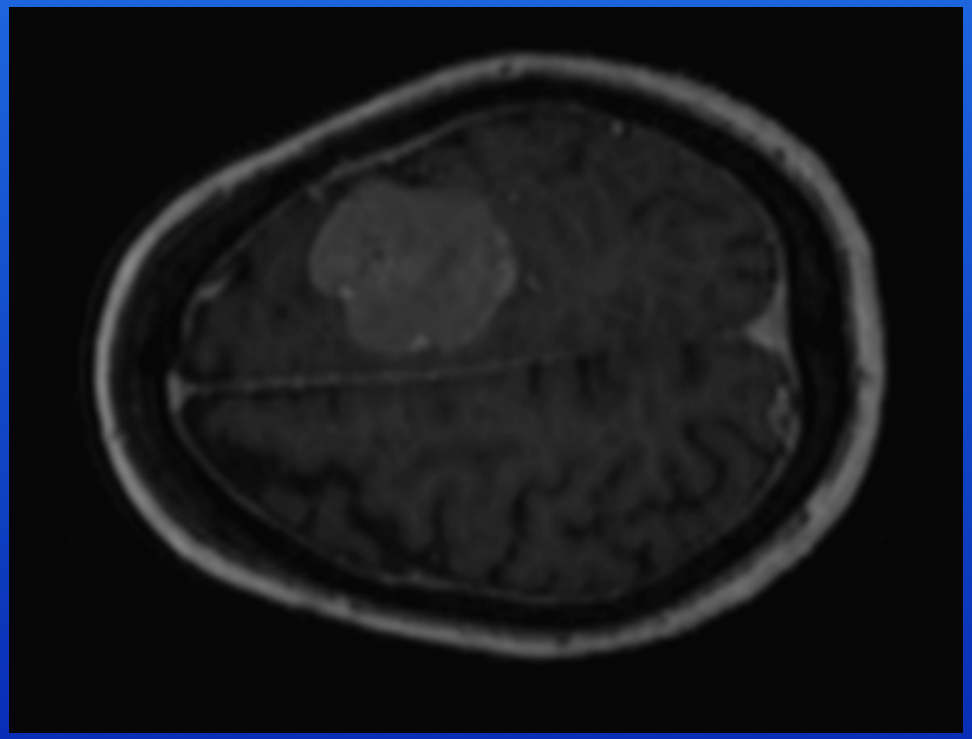
Pathfinder: Visual Analysis of Paths in Graphs

C. Partl, S. Gratzl, M. Streit, A.M. Wassermann,
H. Pfister, D. Schmalstieg, and A. Lex

Uncertainty Visualization

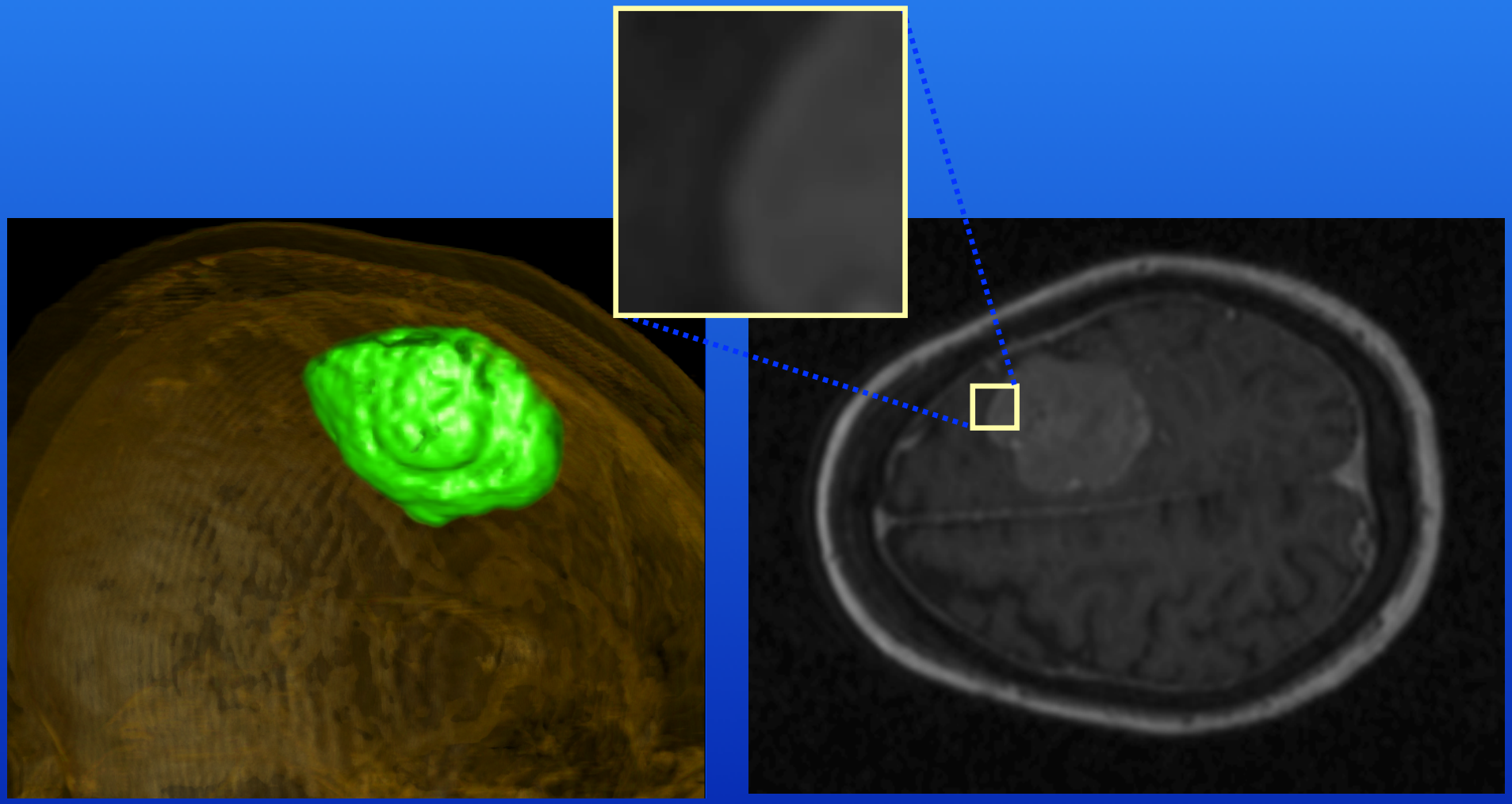
When is the last time you've seen an error bar in a 3D visualization?





Uncertainty Visualization

Surfaces imply certainty



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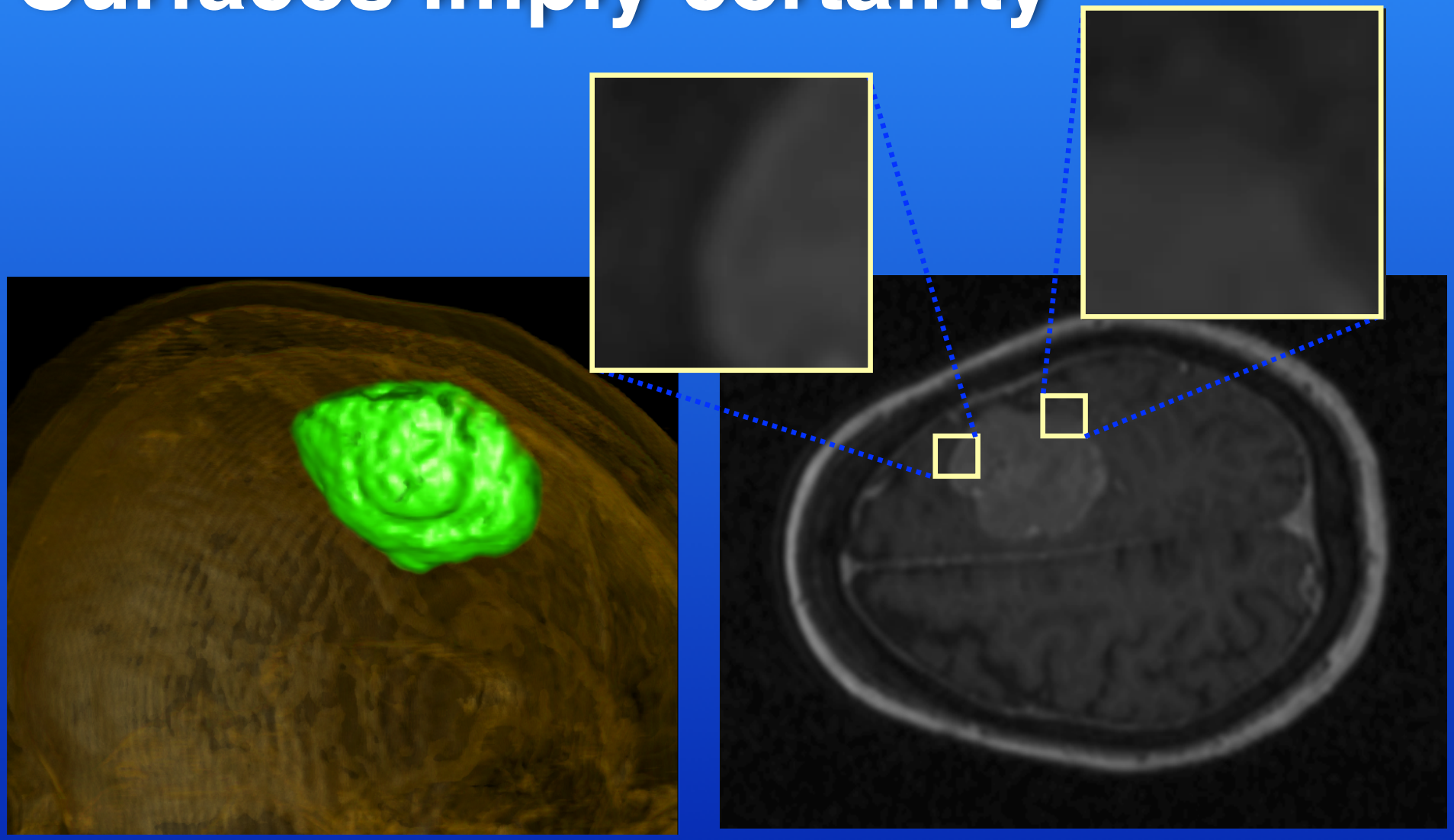
Surfaces imply certainty



Uncertainty Visualization

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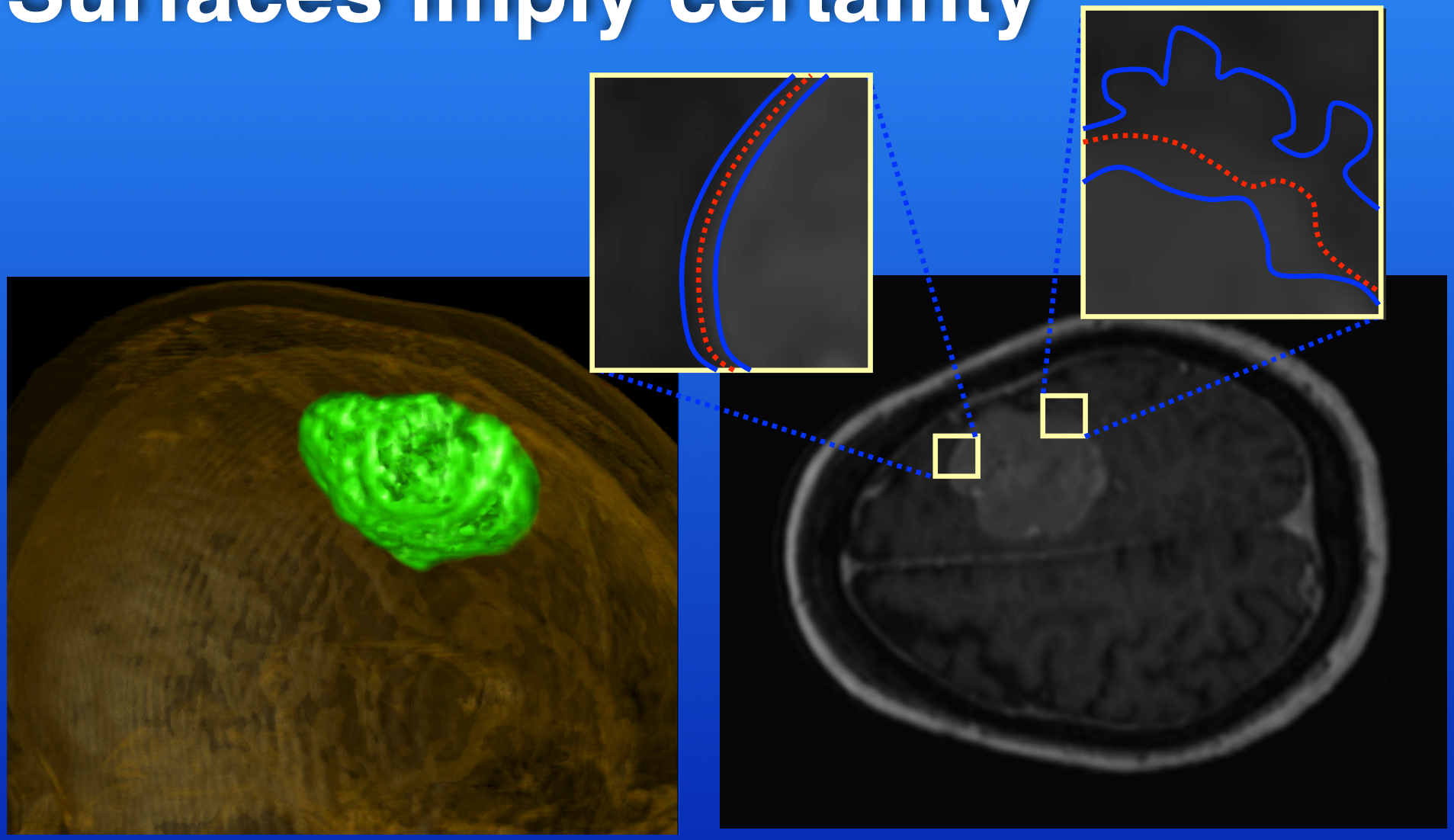
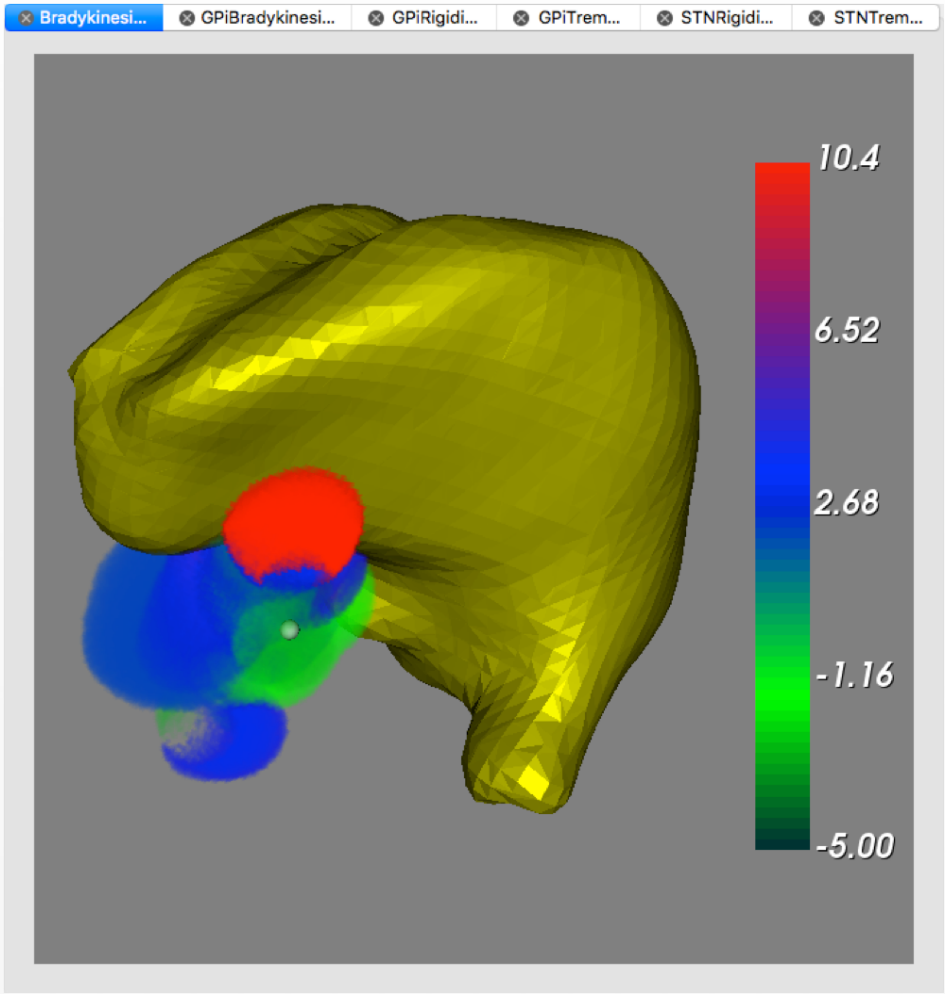
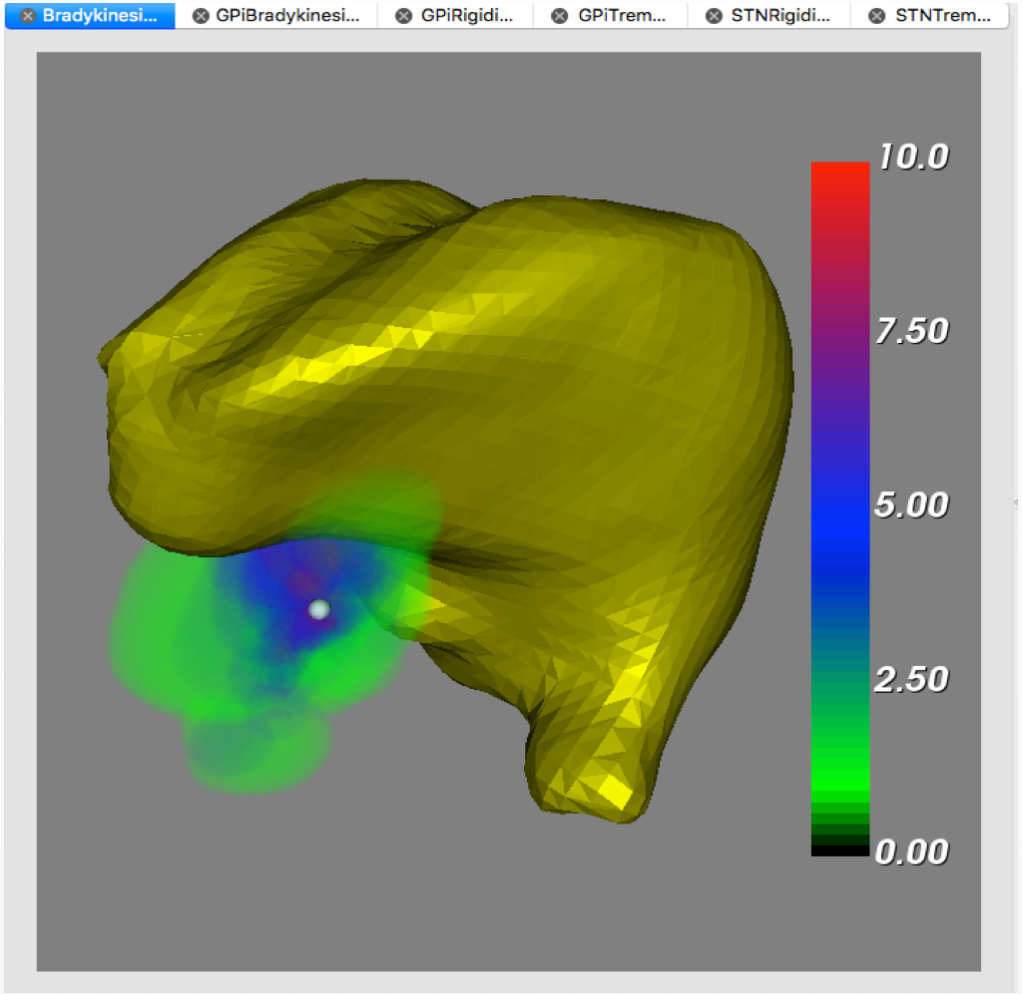


Deep Brain Stimulation Uncertainty



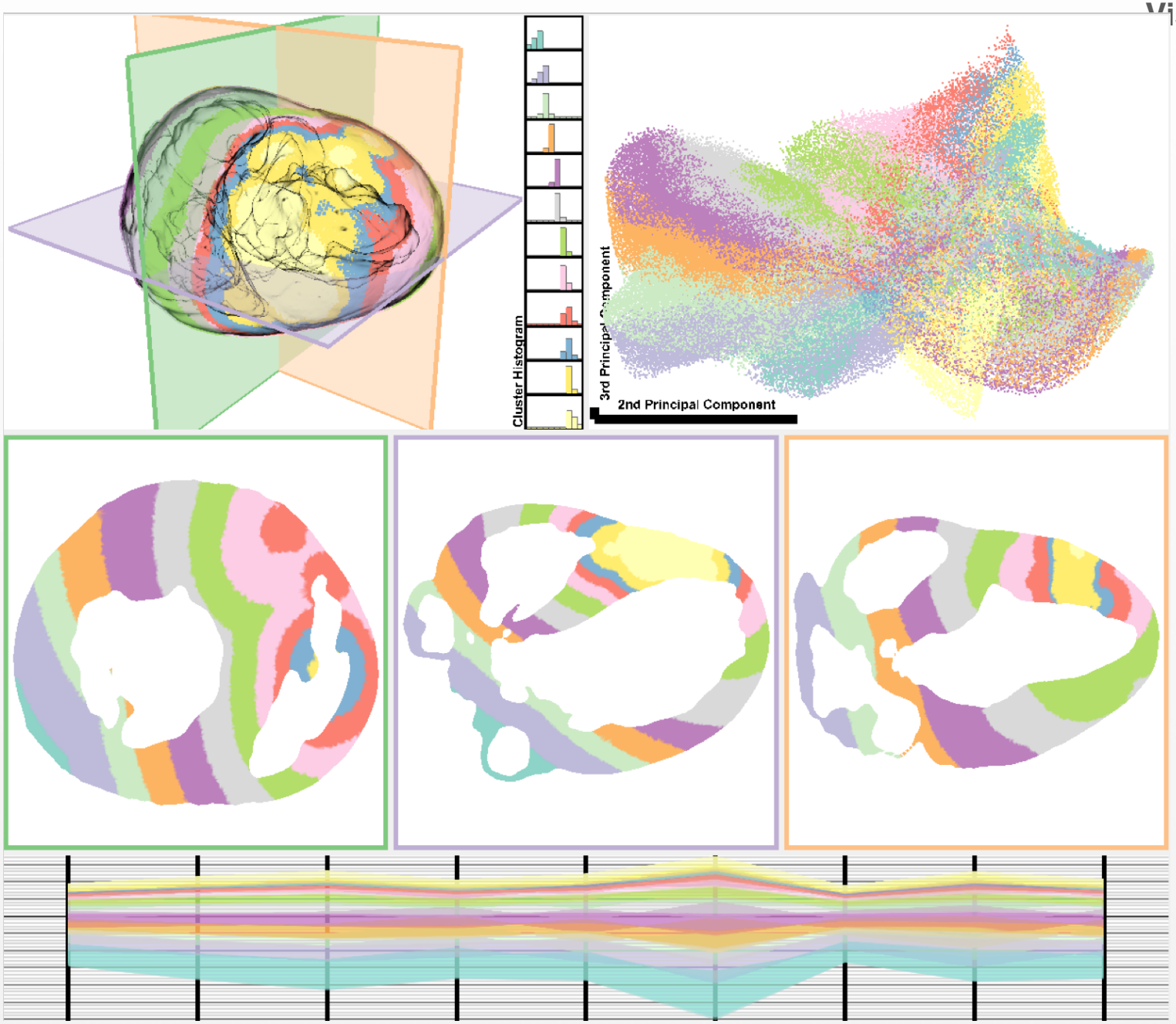
Mean



Variance

μView Visualization Framework

Visualization



Ensemble-Vis: A Framework for the Statistical Visualization of Ensemble Data

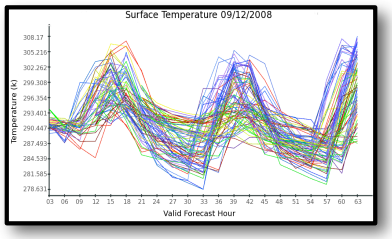
What is ensemble data?

Collection of data sets generated by computational simulations.

Used to simulate complex systems, mitigate uncertainty, unknowns in initial conditions, and parameter sensitivity.

These data sets are:

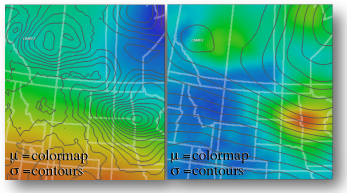
- Multidimensional
- Multivariate
- Multivalued



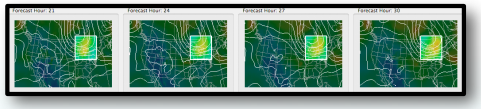
Ensemble-Vis Workflow

- User-driven
- Component-based

Ensemble Overviews

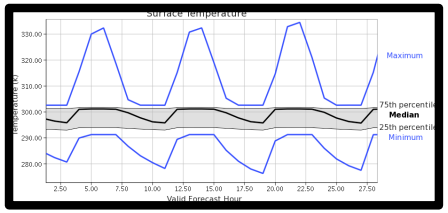


Spatial Overviews:
Mean and standard deviation encoded through colormaps and contours.

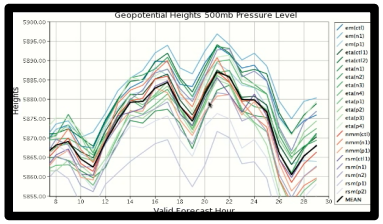


Temporal Overviews:
Filmstrip and animation.
Show evolution through time.
Small multiples show every time step. User can select desired temporal location.

Trend Charts

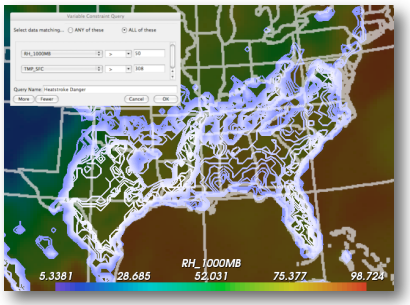


Quartile Charts:
Show minimum and maximum, innerquartile range.



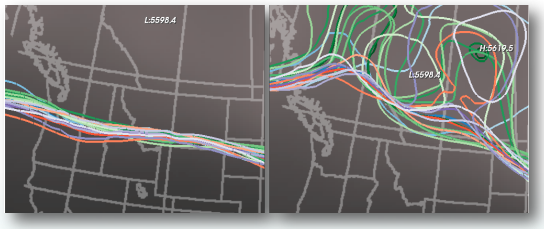
Plume Charts:
Show every member and mean.
Color coded based on model.
Deselect members to hide.
Drill-down to direct data display.

Query Contours



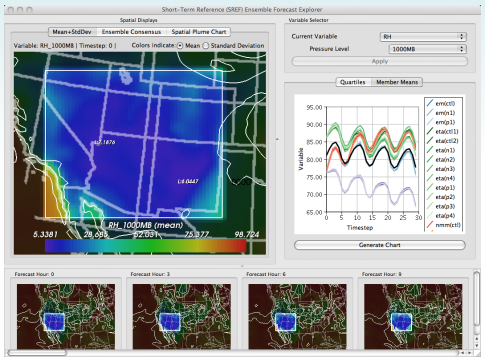
* User-driven query
* Select subset based on conditions
* Returns % of satisfying members
* Displayed as nested contours

Spaghetti Charts



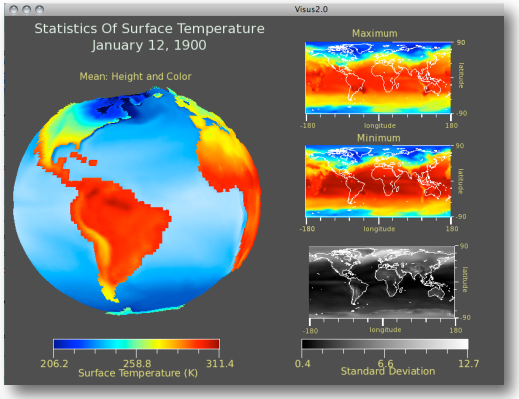
* Show variation across space
* User chosen contour value
* Isocontour for each desired member
* Highlights outliers and divergence

Implementation



SREF Weather Explorer

- VTK filters, Qt Widgets
- Relational database:
  - MySQL/ Netezza



ViSUS

- Climate Data Analysis Tools (CDAT) integration
- C++, python, FLTK
- Out-of-core, streaming

Interactive Streamline Exploration and Manipulation using Deformation

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Han-Wei Shen[1], Chris R. Johnson[2], Pak Chung Wong[3]
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