

# DTI Visualization using the Voreen Framework

Stefan Diepenbrock  
University of Münster  
diepenbrock@uni-muenster.de

Christian Schulte zu Berge  
University of Münster  
c.szb@uni-muenster.de

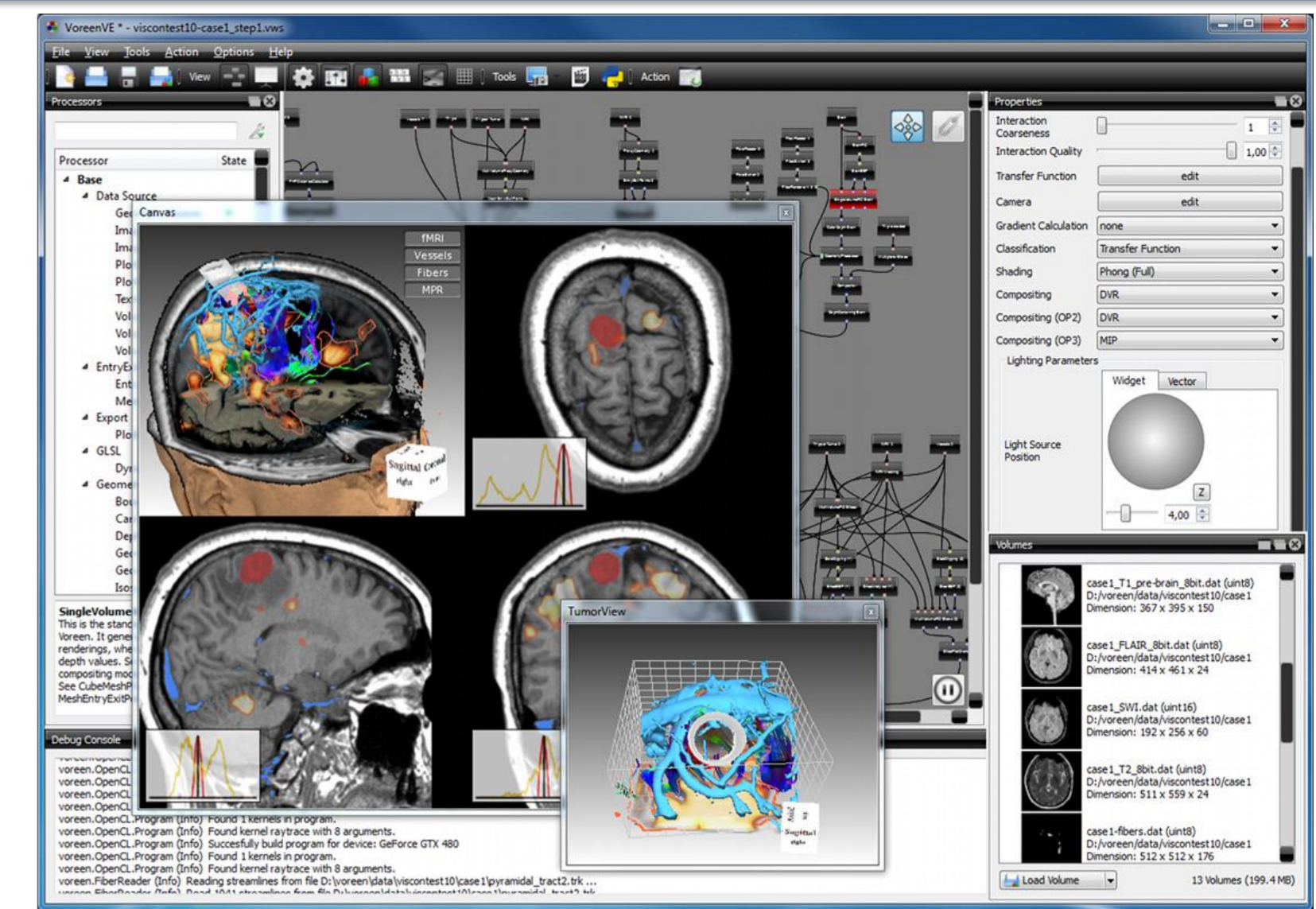
Klaus Hinrichs  
University of Münster  
khh@uni-muenster.de

Lydia Wachsmuth  
University Hospital Münster  
lydia.wachsmuth@uni-muenster.de

Cornelius Faber  
University Hospital Münster  
faberc@uni-muenster.de

- **Volume rendering engine** = Library + Applications
- Multiple linked views, state of the art multimodal visualization techniques, image and volume processing
- Applications are build by constructing *data flow networks* from building blocks called *processors* using a graphical editor (Rapid prototyping)
- Implemented in C++ using OpenGL, Open Source (GPL), easy to extend through modules
- Multi-platform: Windows, Linux, Mac
- Sophisticated animation tools
- The Voreen project has been initiated (in 2005) and is maintained by the Visualization and Computer Graphics Group at the Department of Computer Science at the University of Münster

## About Voreen



## DTI Module

We extended Voreen with functionality to process and visualize DTI data. Our application case is the visualization of small animal brain and spinal DTI scans. The implemented techniques can however be used for other applications. Our module extends Voreen by adding new processors for handling of DTI data and by providing readers for importing of datasets.

## DTI Workflow

### Data Import

#### DWI Volumes

- Bruker, DICOM (WIP), Analyze/Nifti

#### DTI Volumes

- Analyze/Nifti, nrrd

#### Fibers

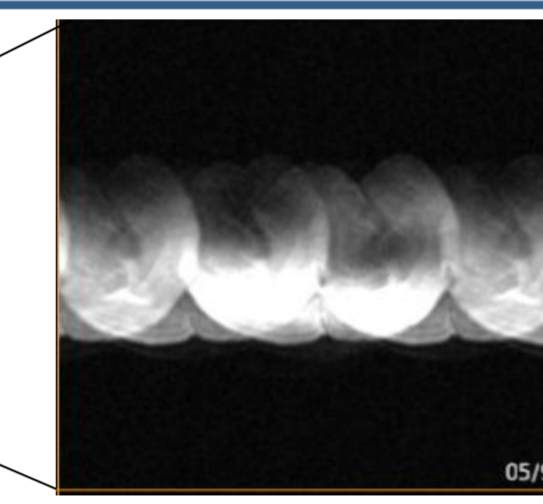
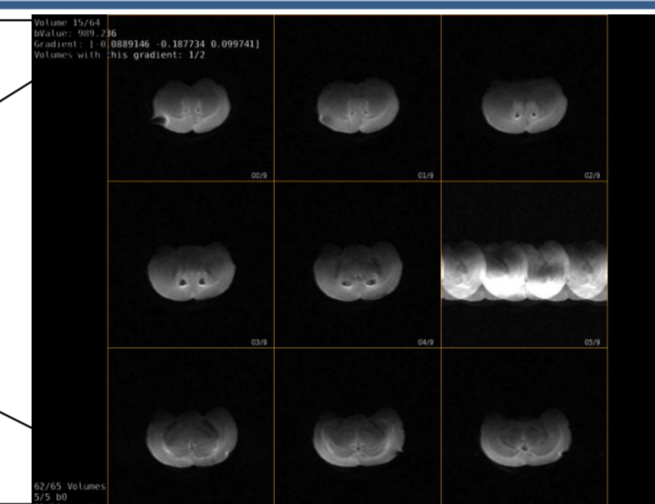
- TrackVis (.trk), DTIStudio (.dat)

### Gradient Direction Selection

Optional Step: Ignore low quality images (e.g., due to scanner problems)

Volume: 15/64  
bValue: 989.236  
Gradient: [ 0.0889146 -0.187734 0.099741]  
Volumes with this gradient: 1/2

62/65 Volumes  
5/5 b0  
29/30 gradients



### Tensor Estimation

- Dual tensor bases approach
- Using embedded metadata (Bruker, DICOM) or extra file to specify gradients

### DTI Processing

#### Derived Values:

- Eigenvalues, Eigenvectors
- Anisotropy (Fractional, Rational, Linear, ...)
- Diffusivity (Mean, Axial, Radial)
- Isotropy, Volume Ratio

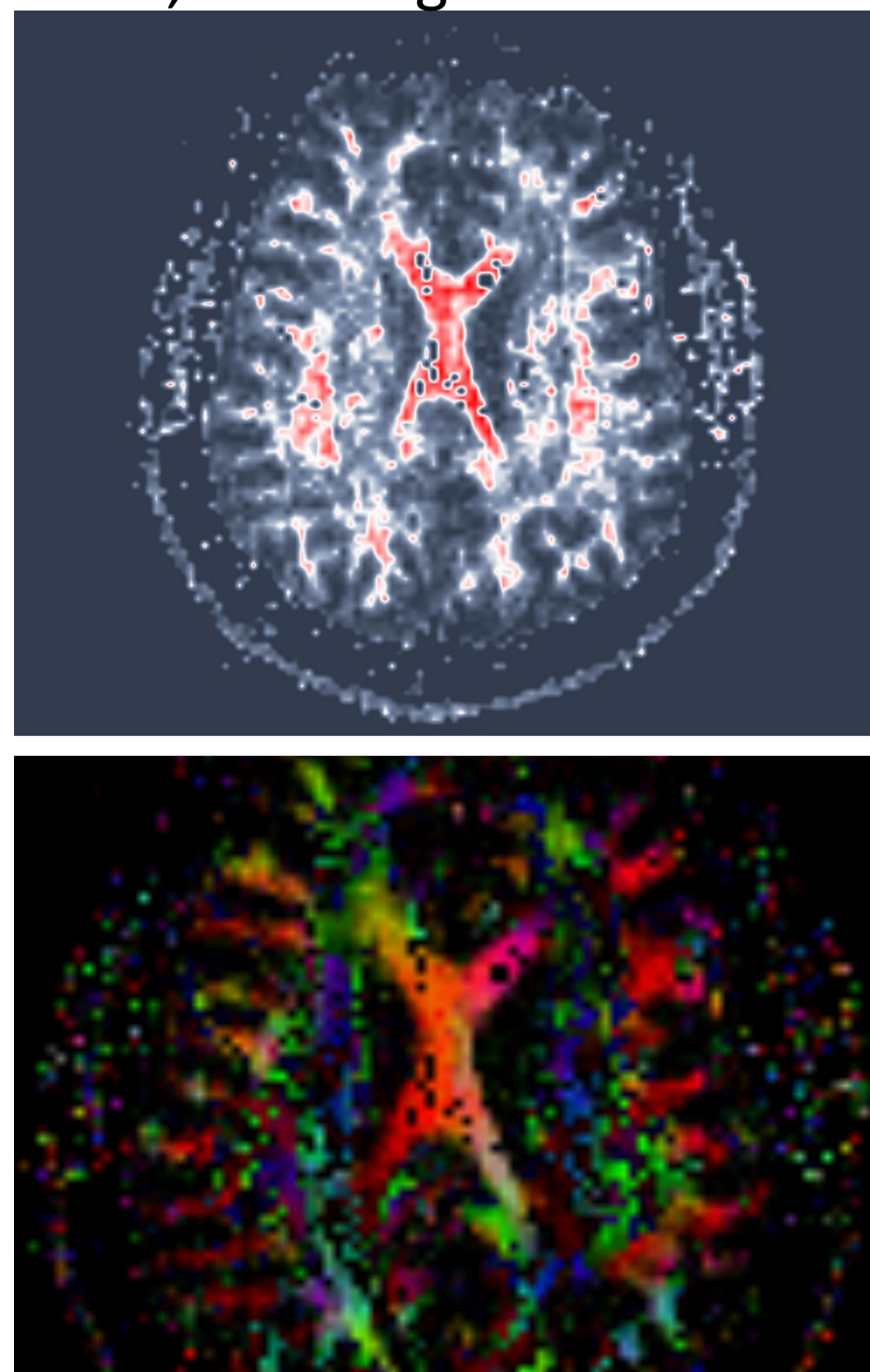
#### Fiber Tracking

- FACT
- TensorLine
- Fiber Clustering

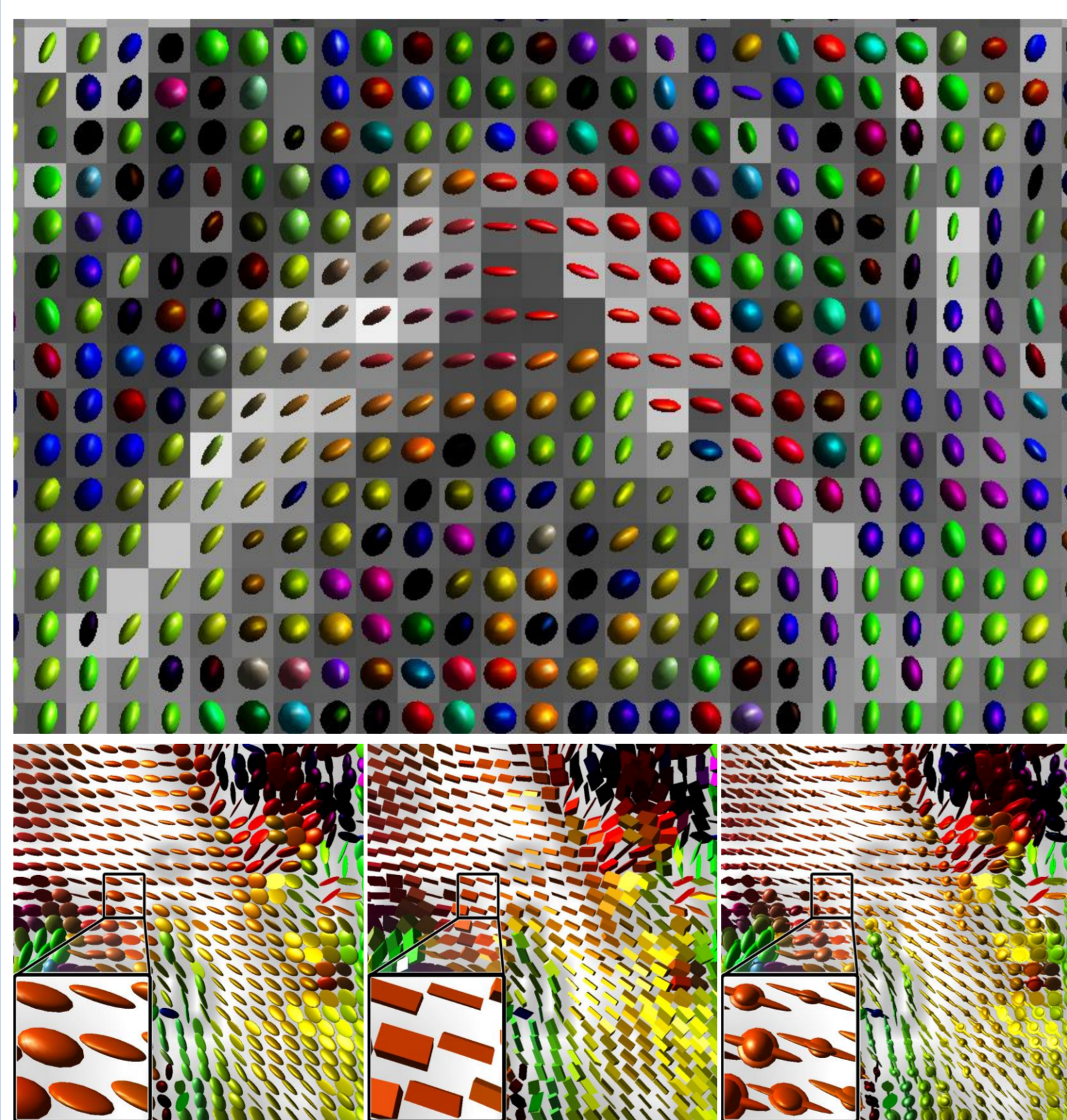
## Visualization

### Slice Rendering

FA, Main Eigenvector

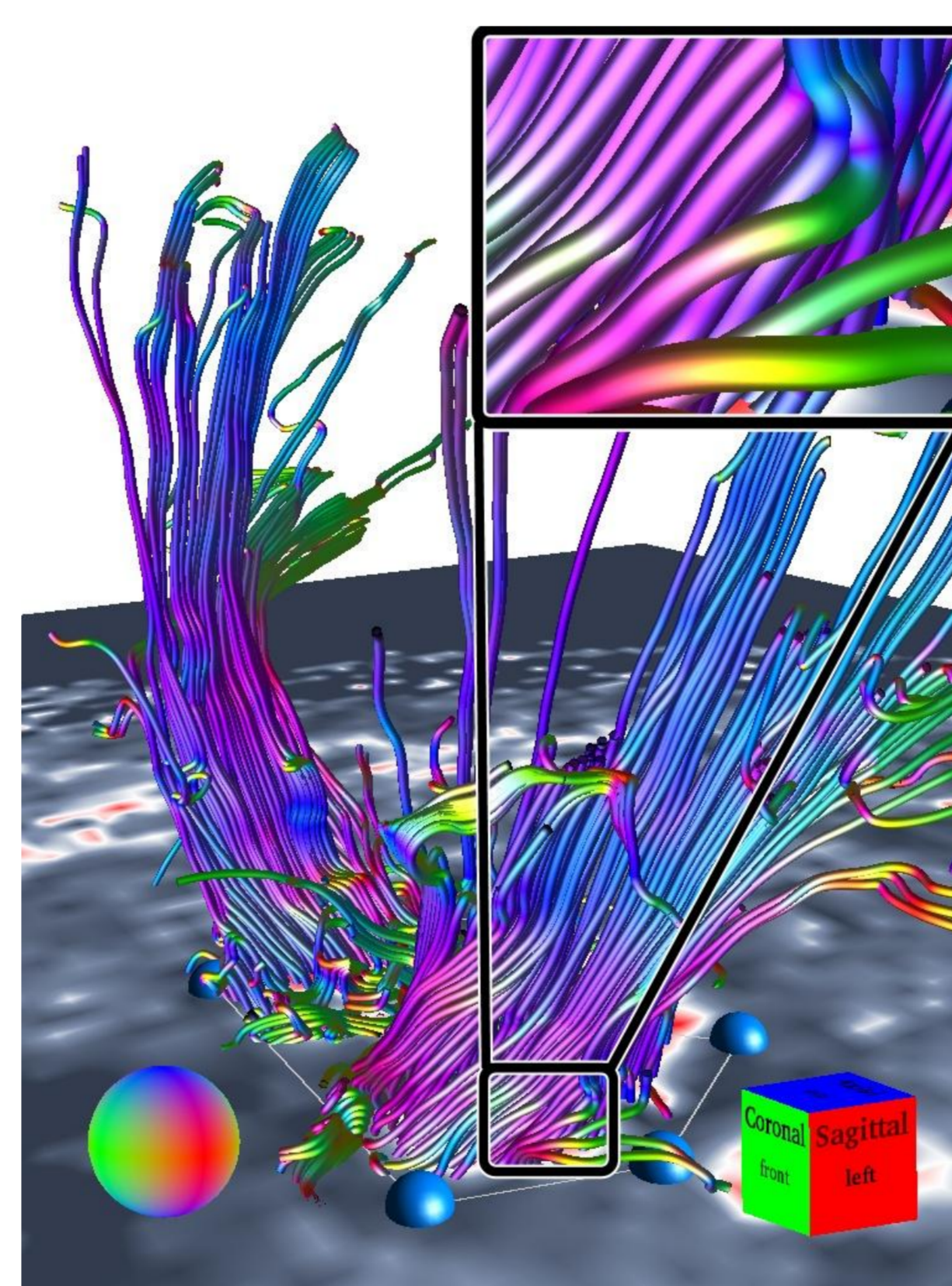


### Tensor Glyph Visualization



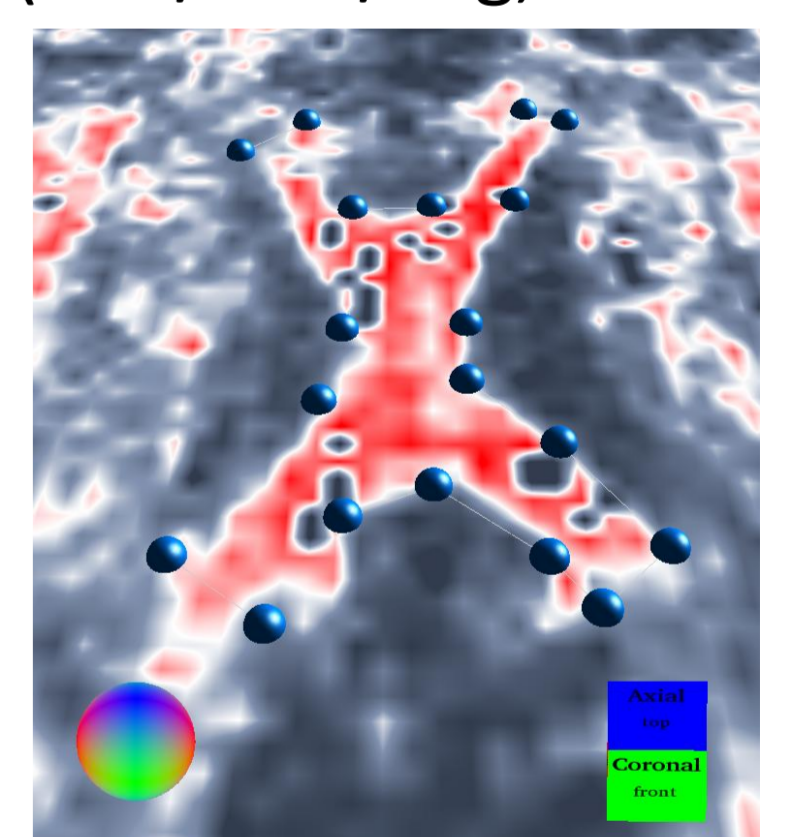
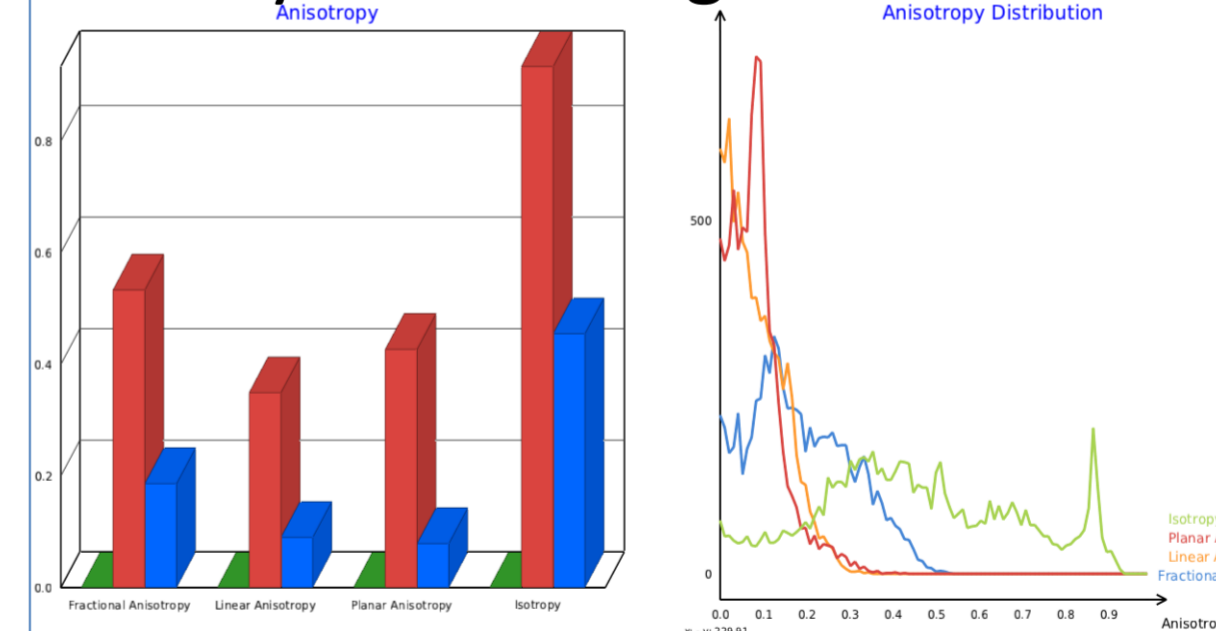
### Fiber Rendering

- Lines, Triangle Strips, Streamtubes
- Mapping of scalars (e.g., Anisotropy) to width, transparency, ...



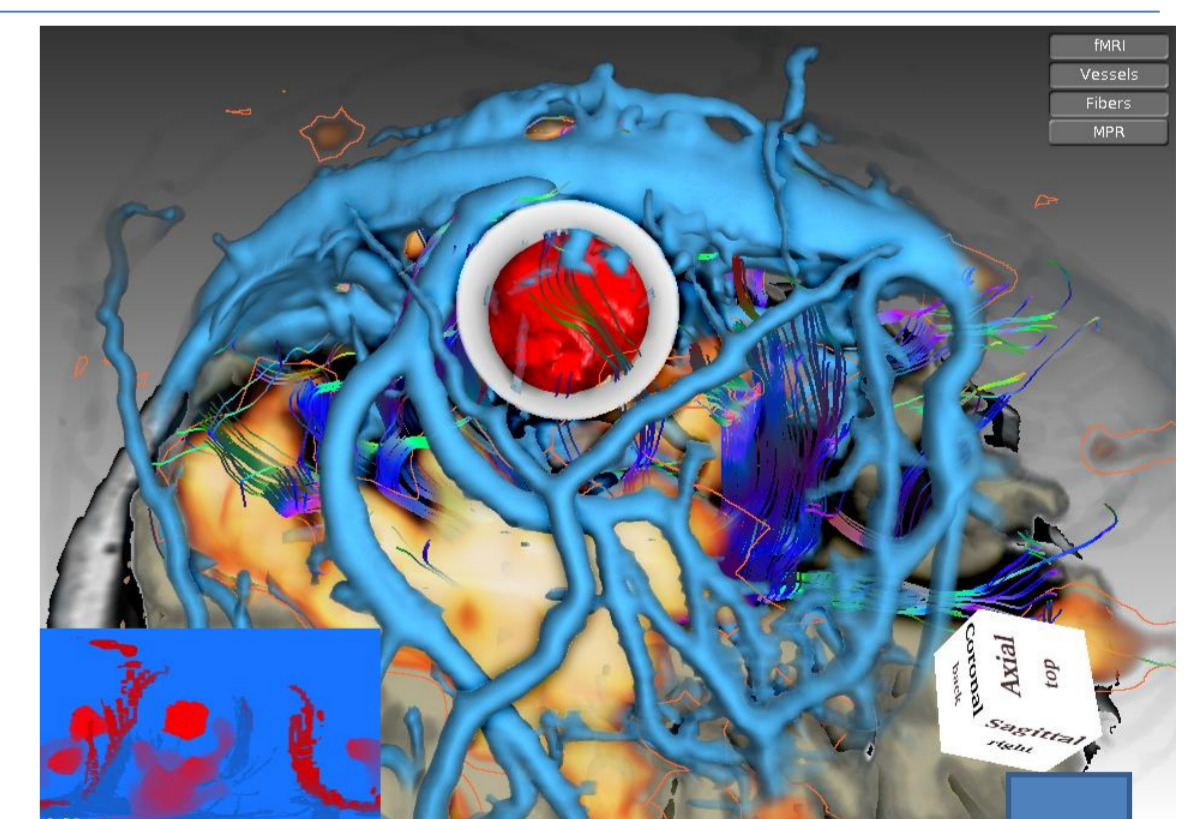
### Interactive Analysis

- ROI definition: Arbitrary polygons, multiple layers
  - Seed fibers/glyphs
  - Analyze and plot values in ROI (Min/Max/Avg, Histogram)
- Analyze fiber length distribution



### Multiple Modalities

- Easy combination with other modalities and rendering techniques provided by Voreen



### Export

#### Analysis Results

- as CSV, XML, HTML

#### Images & Videos

- Standard File Formats (jpg, png, mpeg)

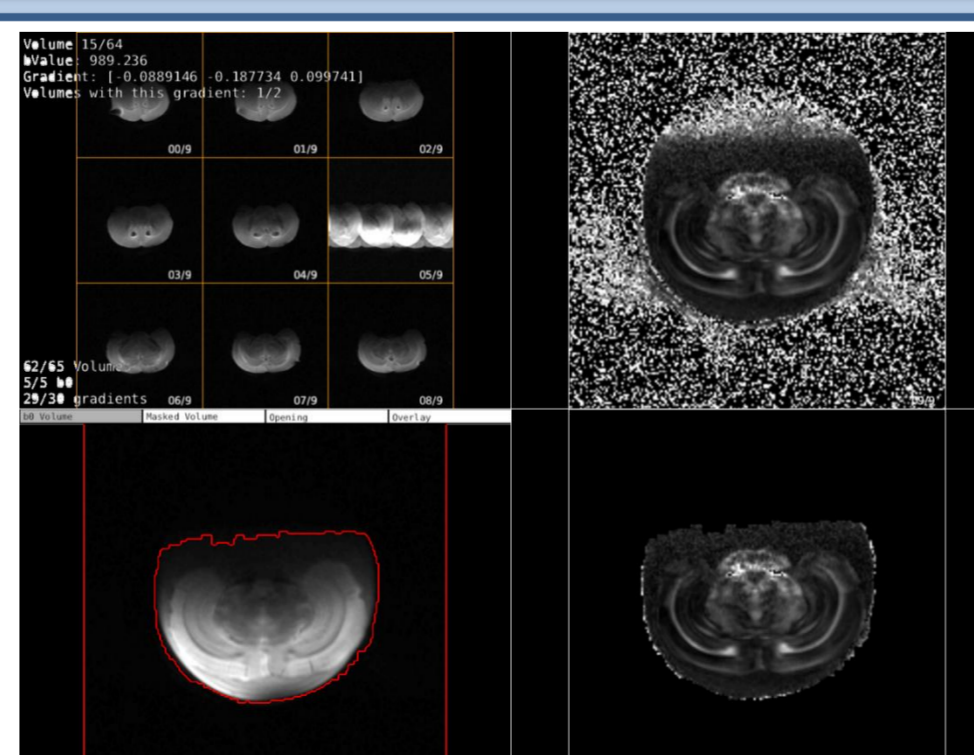
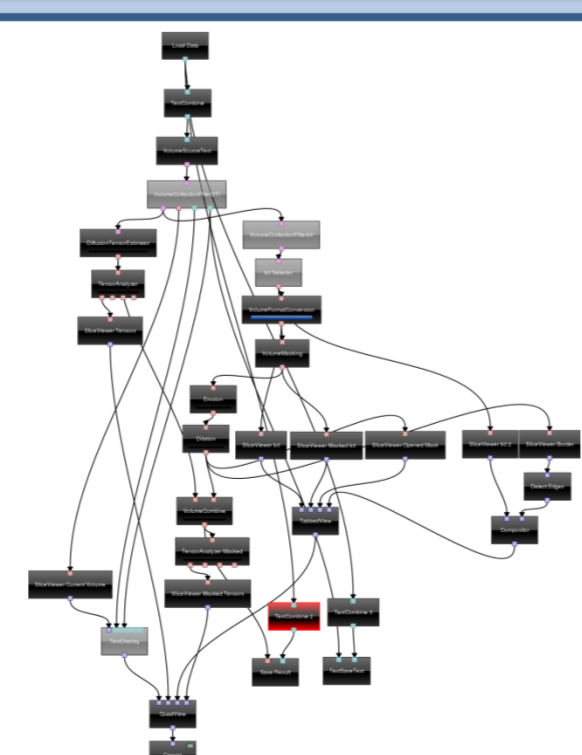
#### Volumes and Fibers

- Raw Data, .trk (TrackVis)

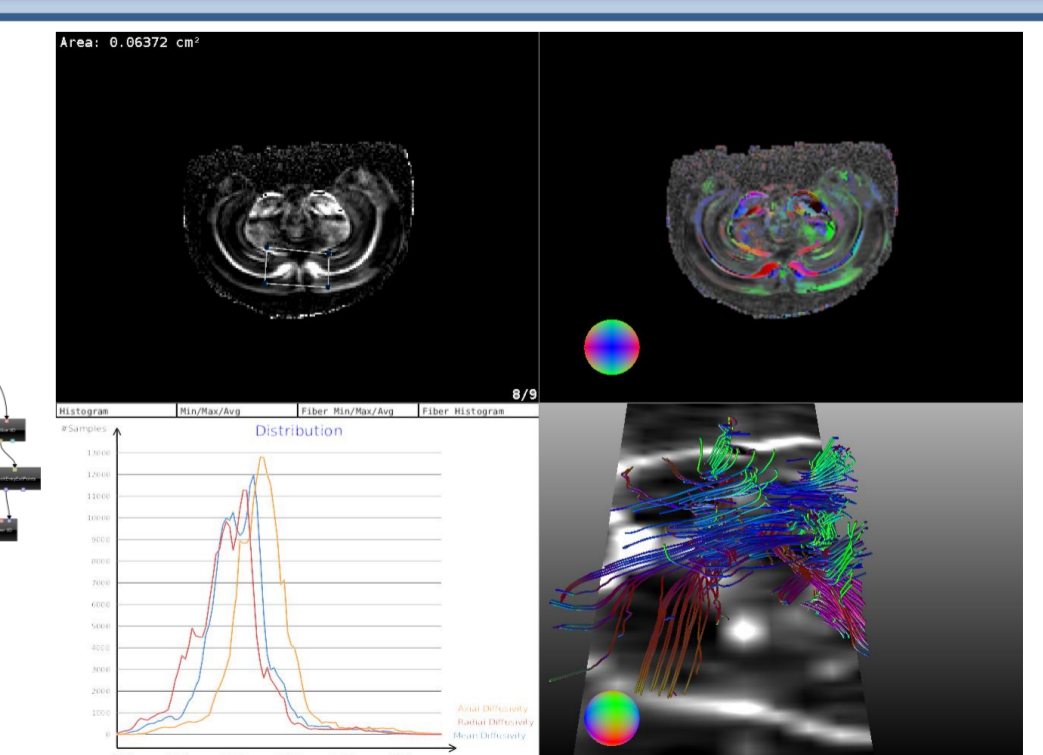
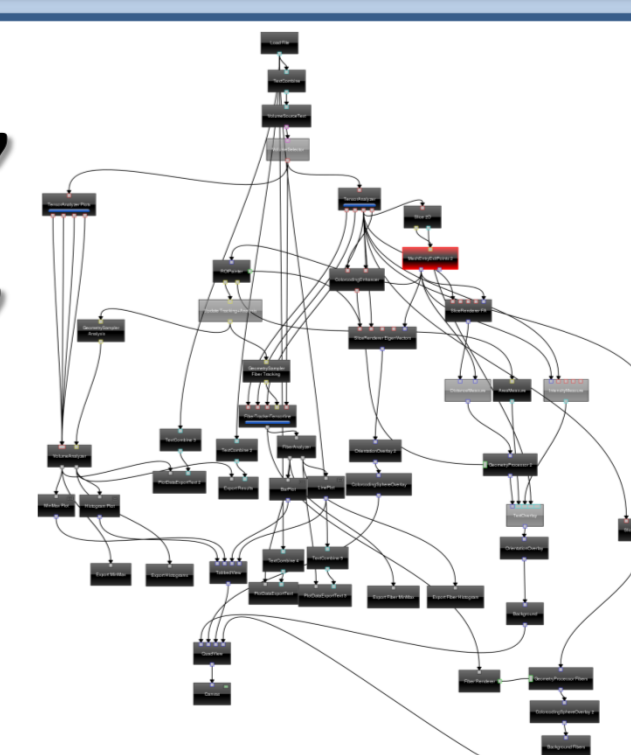
### Example Networks

These are the dataflow networks (with resulting screenshots) for the two-step workflow we used in our application case.

#### Gradient Direction Selection & Masking



#### ROI Definition, Fiber Tracking, Analysis



Accompanying poster: High-resolution separation of adjacent fibre bundles by accelerated in vivo DTI-EPI of the mouse brain