Long Range Digital Neural Circuit Reconstruction

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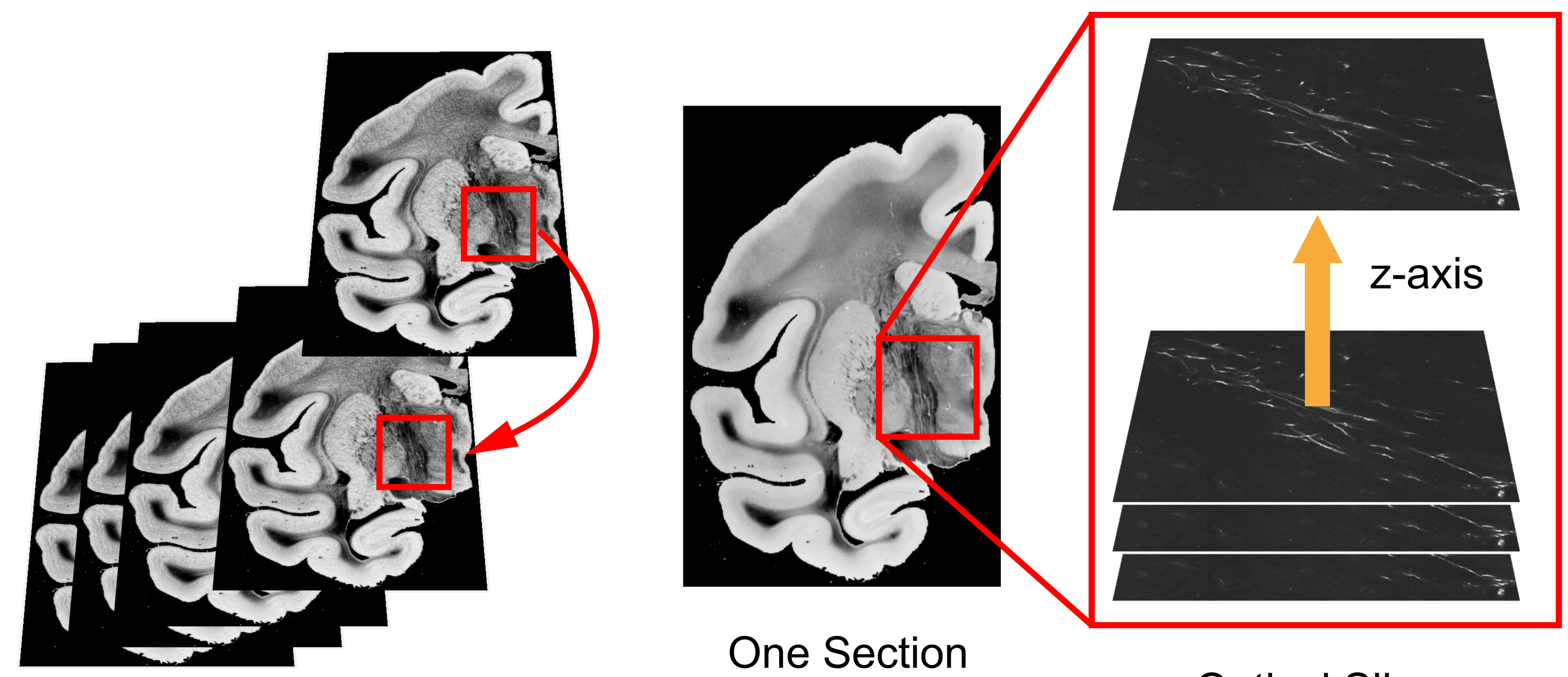
This work is in collaboration with the Center for Integrated Neuroscience and Human Behavior at the Brain Institute, University of Utah.
We would like to thank Li Dai, PhD, and Michael Bridge, PhD for their help.

Goal

Track selectively stained axons across many slices of tissue to establish brain connectivity over large distances

Data

- Brain tissue is cut into many thin slices, called sections, approximately 30 μm thick
- Sections are independently stained, mounted on microscope slides, and imaged using confocal fluorescence microscopy techniques
- Our target is to follow axons through more than 400 sections
- Each sequence of section images is composed of optical slices
- The part of the axon in focus is visible in a given slice



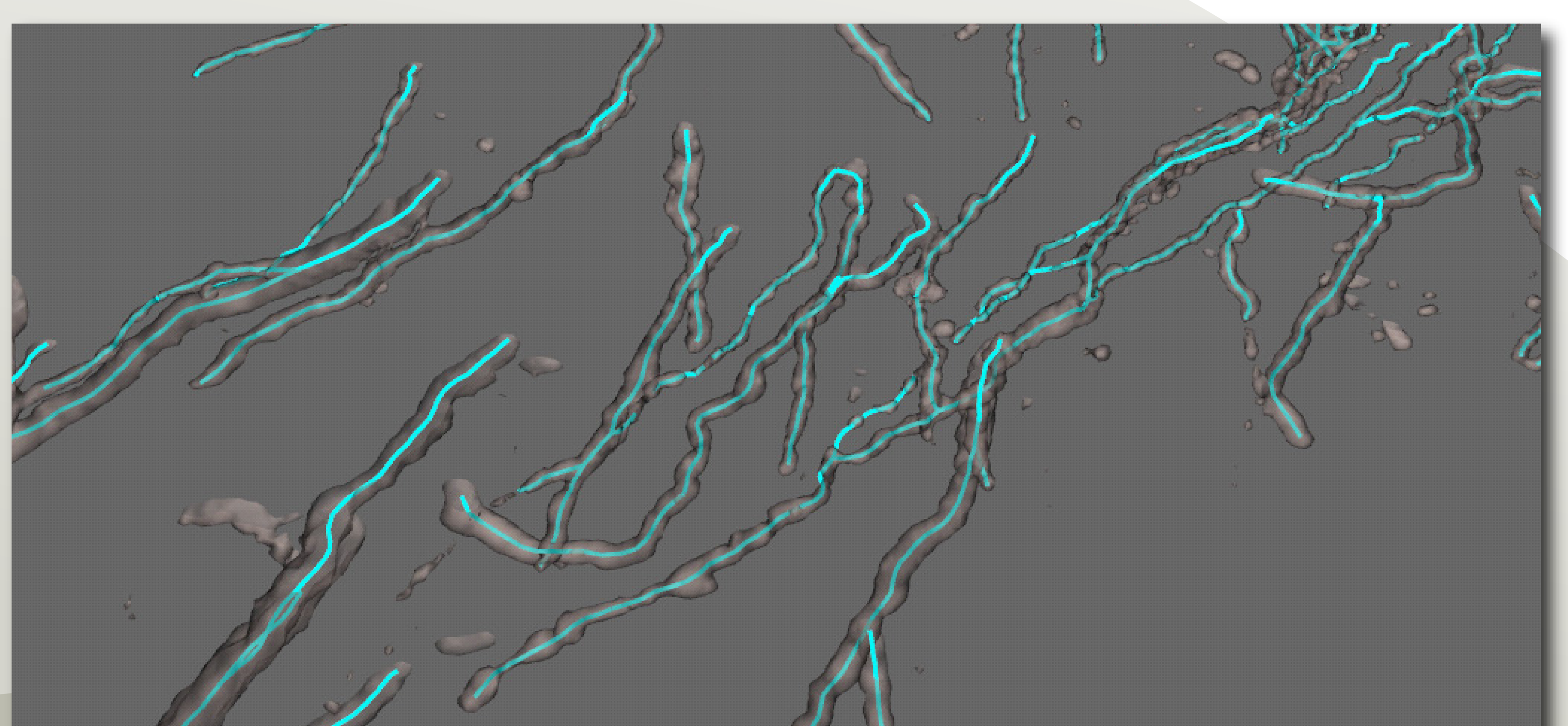
Sections

One Section

Optical Slices

Task: Trace Axons

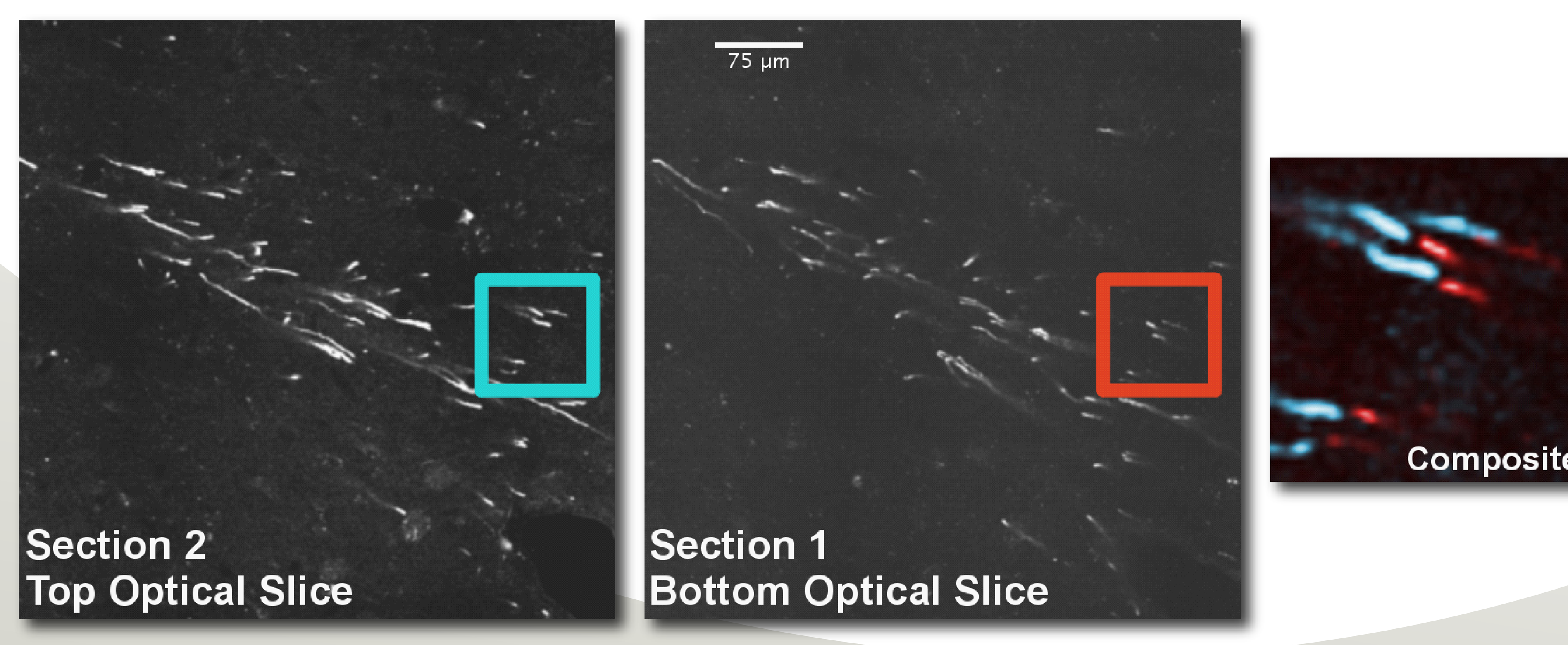
Extracting axon centerlines allows individual projections to be tracked



Axon centerlines

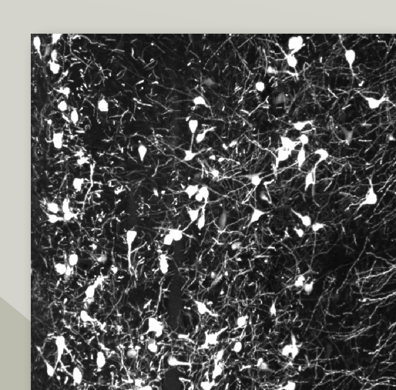
Task: Align Sections

- Sections must be aligned for restoring axon continuity
- Axon endpoints can be matched at section boundaries

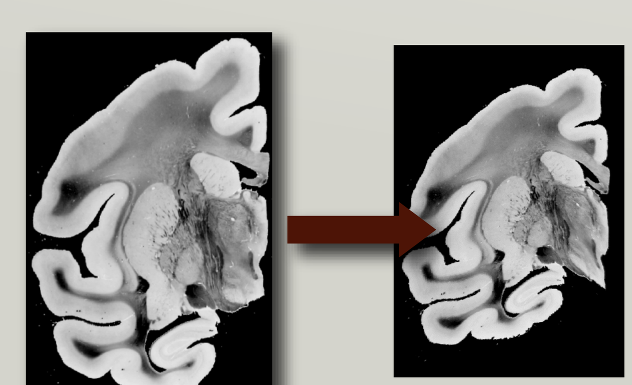


Challenges

- Imperfections in the microscope slides
- Tracing axons in dense regions and in areas with weak signal
- Reconnecting axons in the presence of section deformations and tears



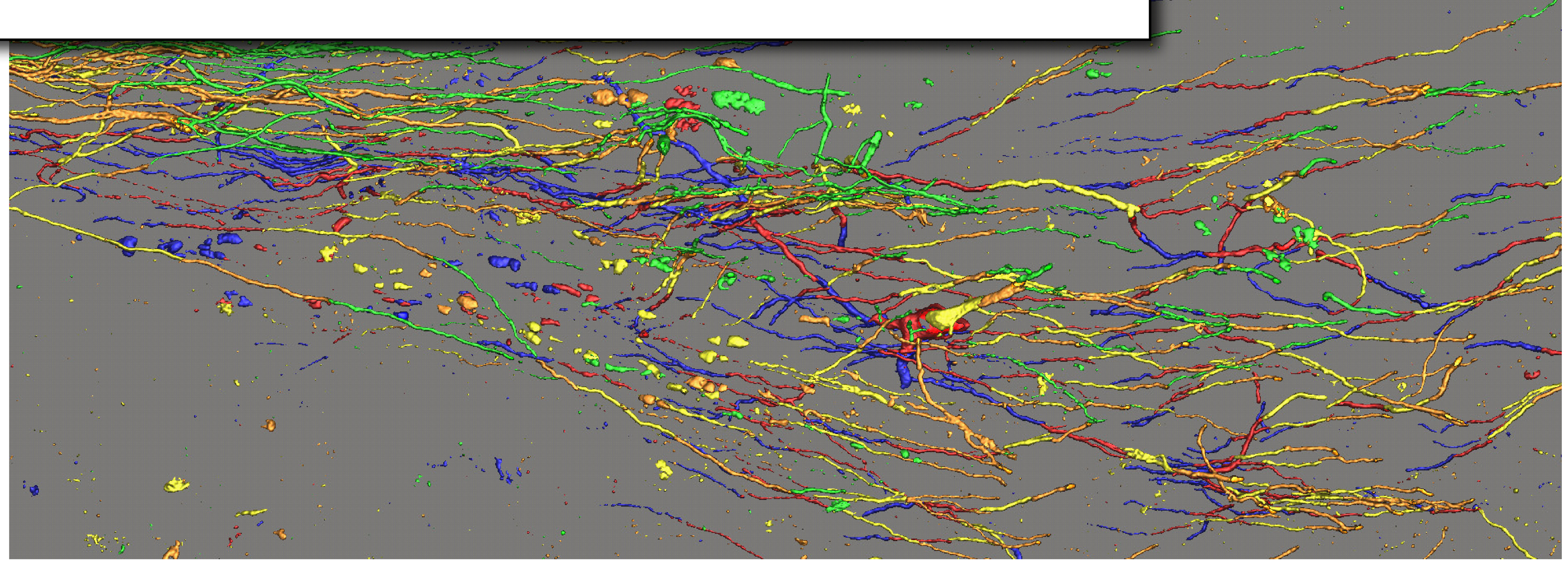
Dense Region

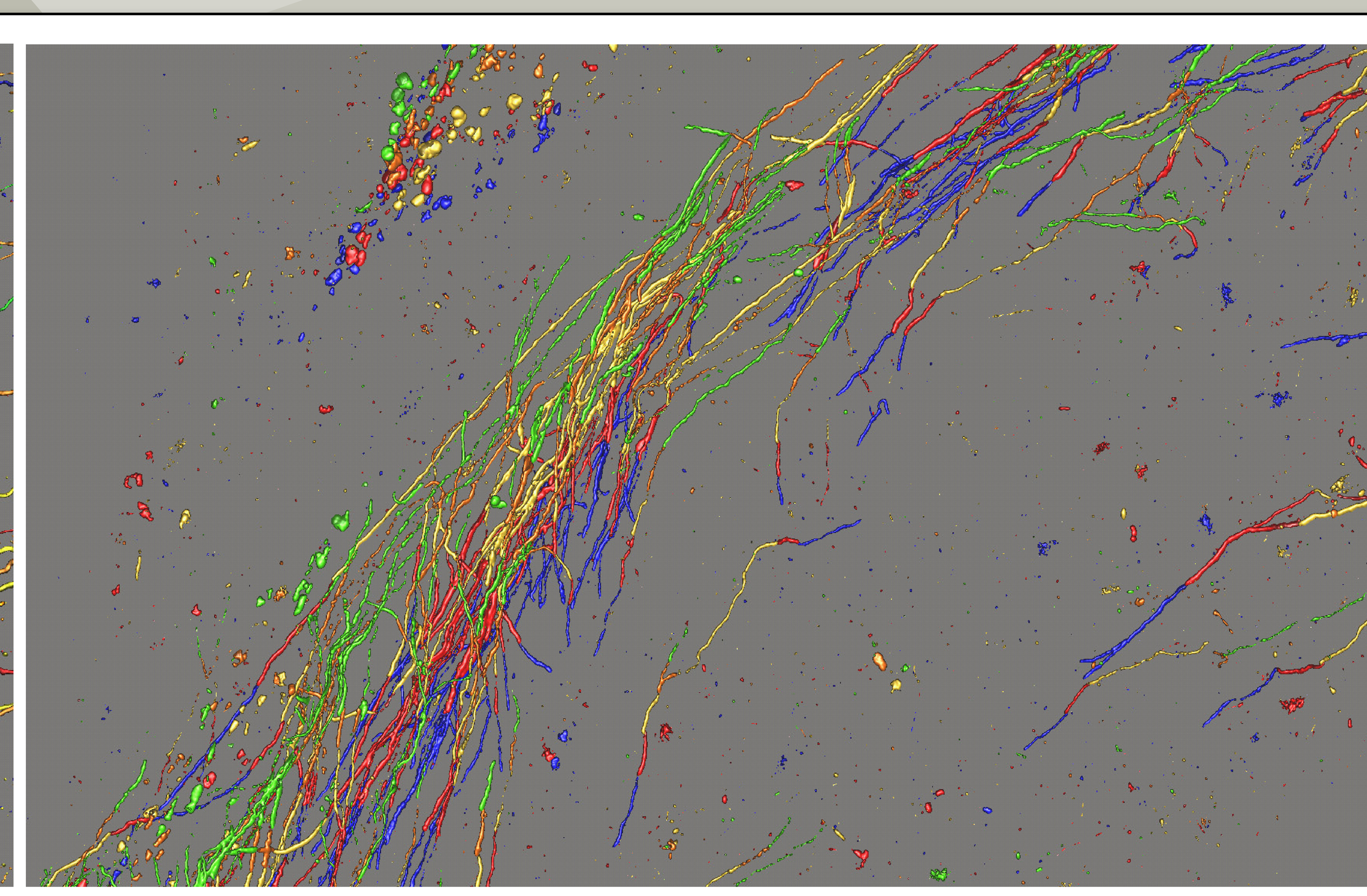


Section Distortion

Digital Reconstructions

- Use automated methods to trace axons and align sections
- Visualize aligned sections
- Make manual corrections where necessary
- Analyze pathways (origins, destinations, path lengths, etc.)





Visualizations of five sections of aligned axons. Each section is represented by a different color.