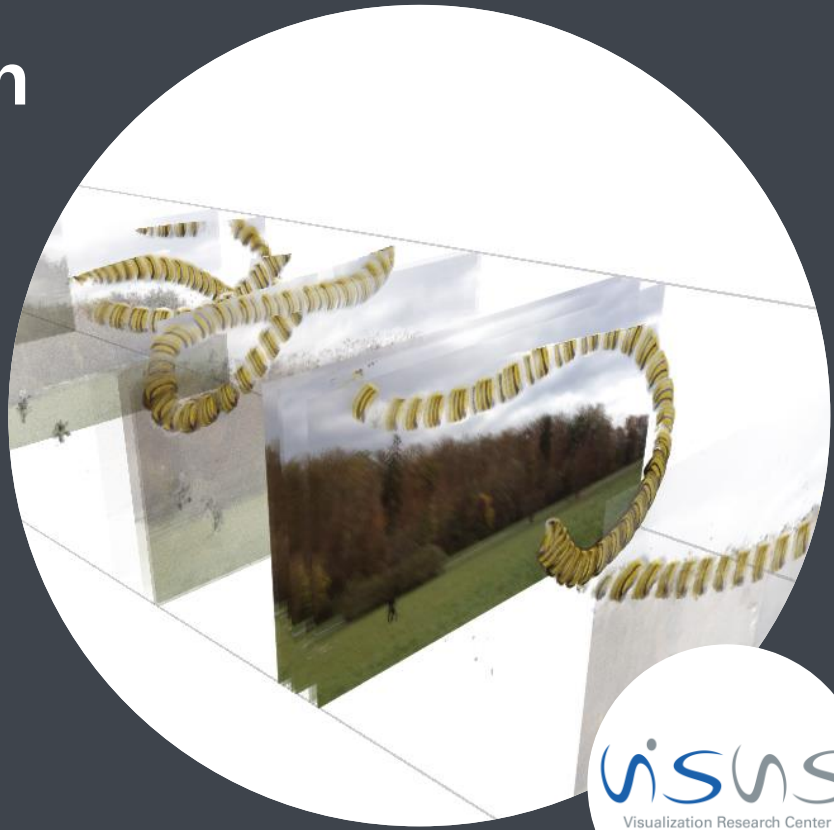
Space-Time Volume Visualization of Gaze and Stimulus



Valentin Bruder, Kuno Kurzhals, Steffen Frey,
Daniel Weiskopf, and Thomas Ertl

23-Jul-19

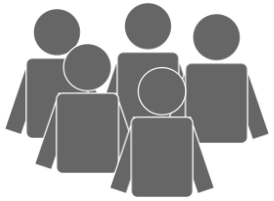
Visualization Research Center
University of Stuttgart

ETH zürich

Motivation

Scenario

1 video



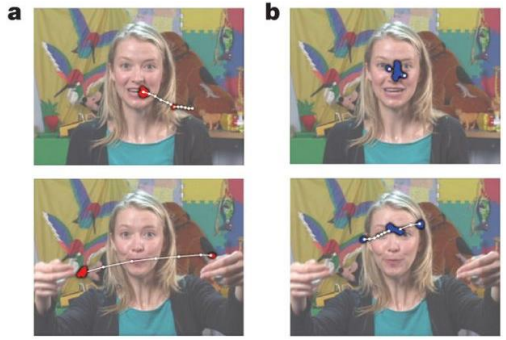
multiple participants

https://www.youtube.com/watch?v=ujKgs-VyeIk

Advertising & product placement, psychology

Questions

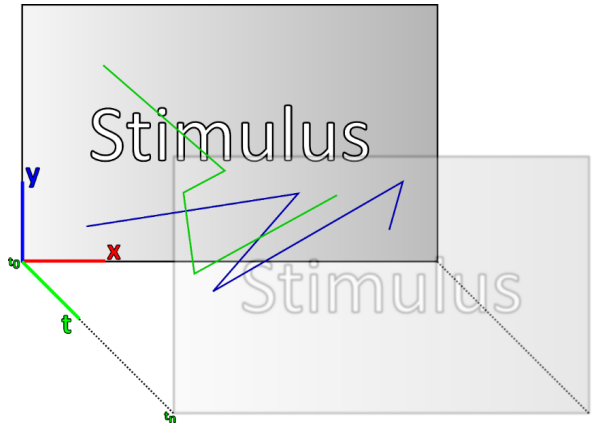
- **Where** and **when** did participants look at the same region?
- **What** did they look at?

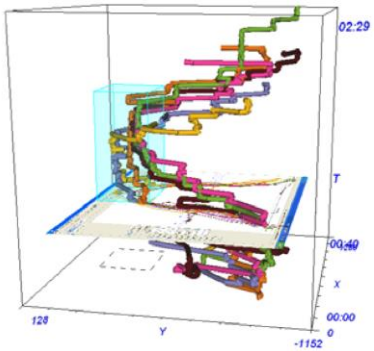


Research on autism spectrum disorders (ASDs)
Jones & Klin., [Nature 2013]

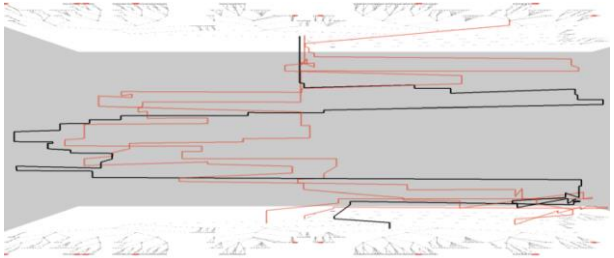
Static spatio-temporal overview

Space-Time Cube





Li et al., [GIScience 2010]



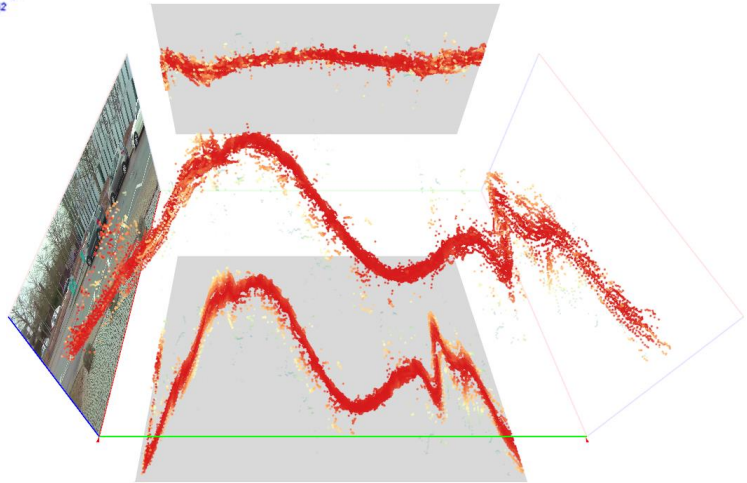
Andrienko et al., [TVCG 2012]

Problem

- Stimulus underrepresented

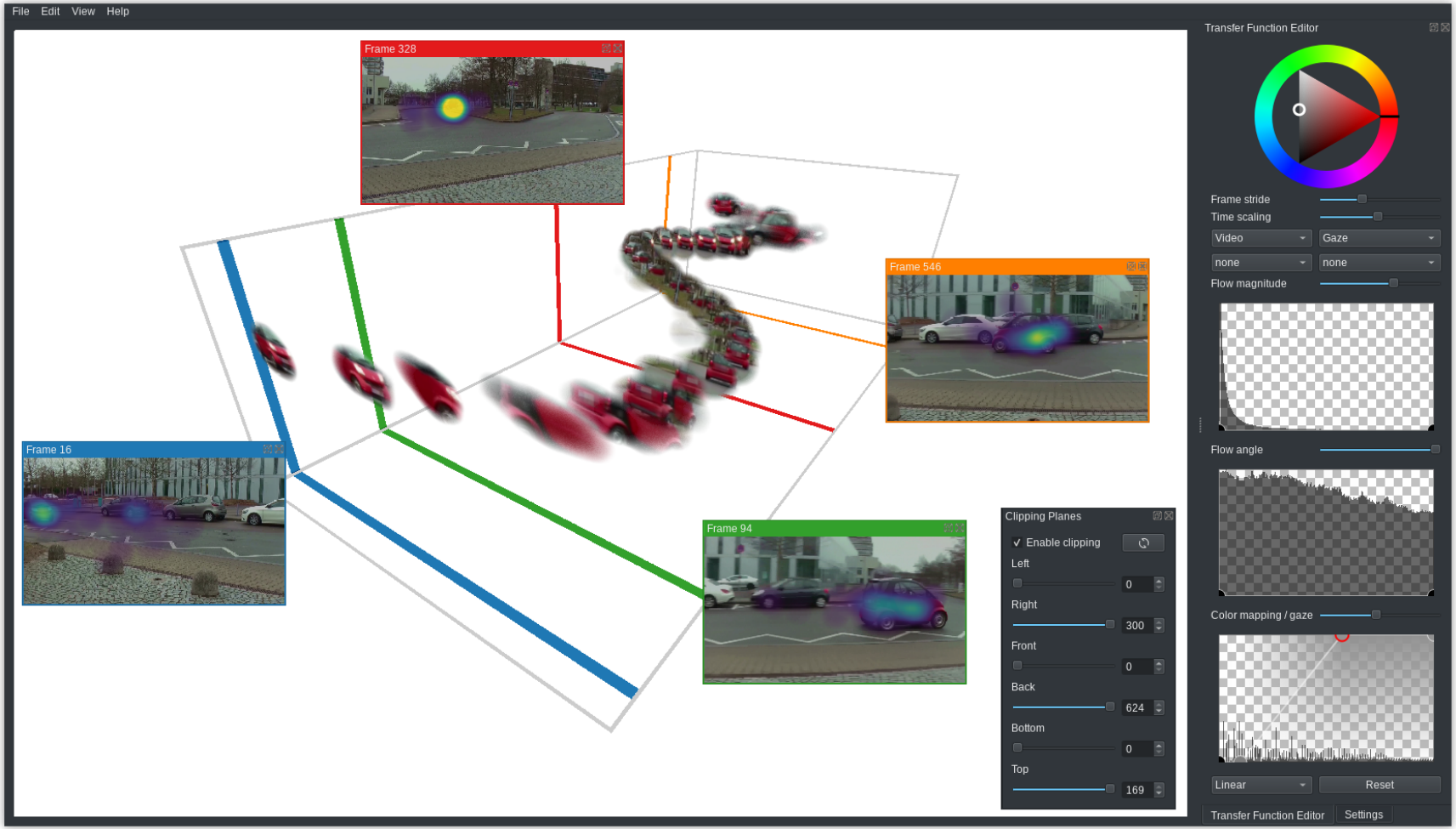
Idea

- STC eye tracking data + STC video data
- Volume rendering to combine data sources
- No AOIs necessary

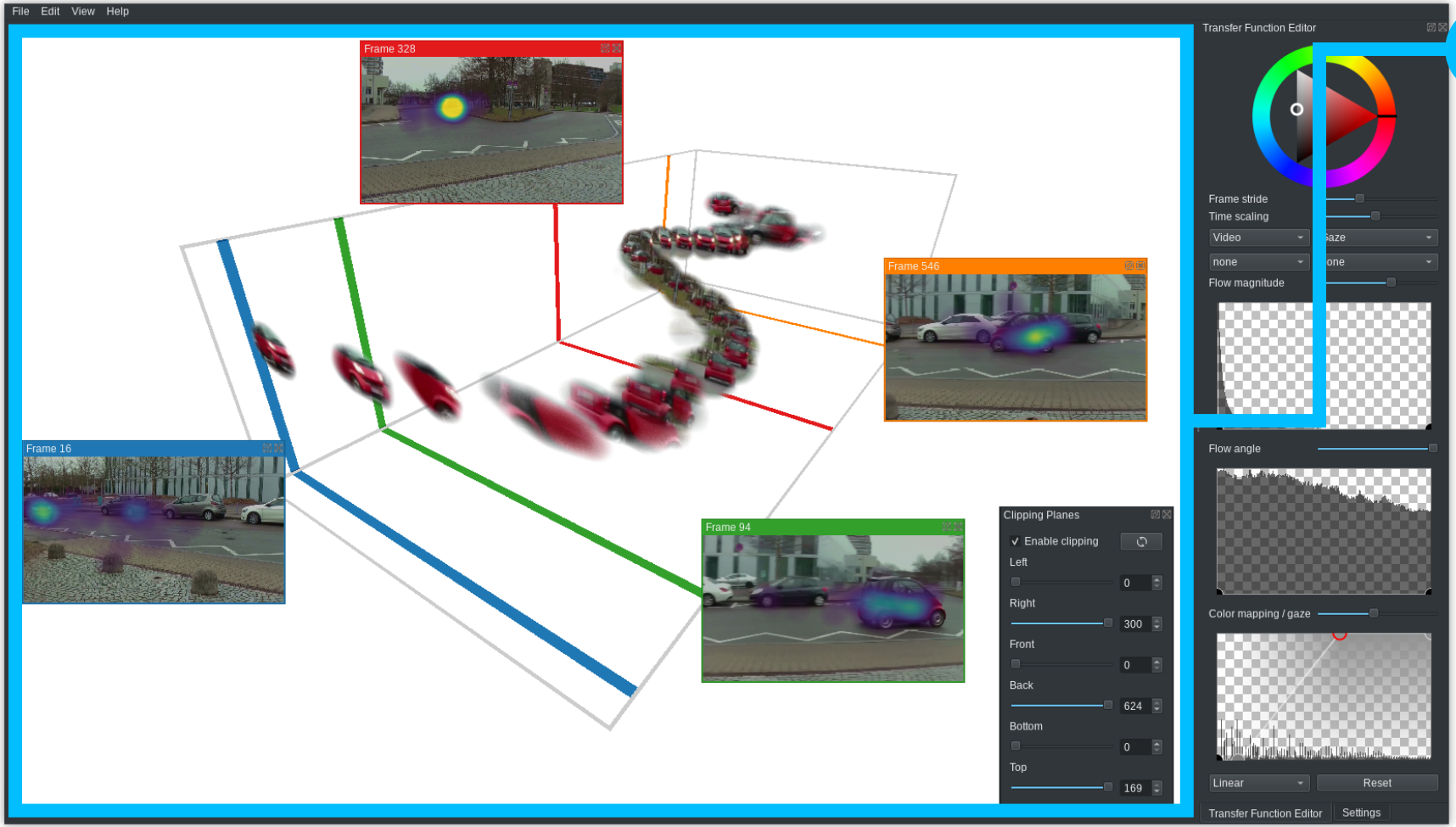


Kurzhals et al., [ETRA 2014]

Visual Design

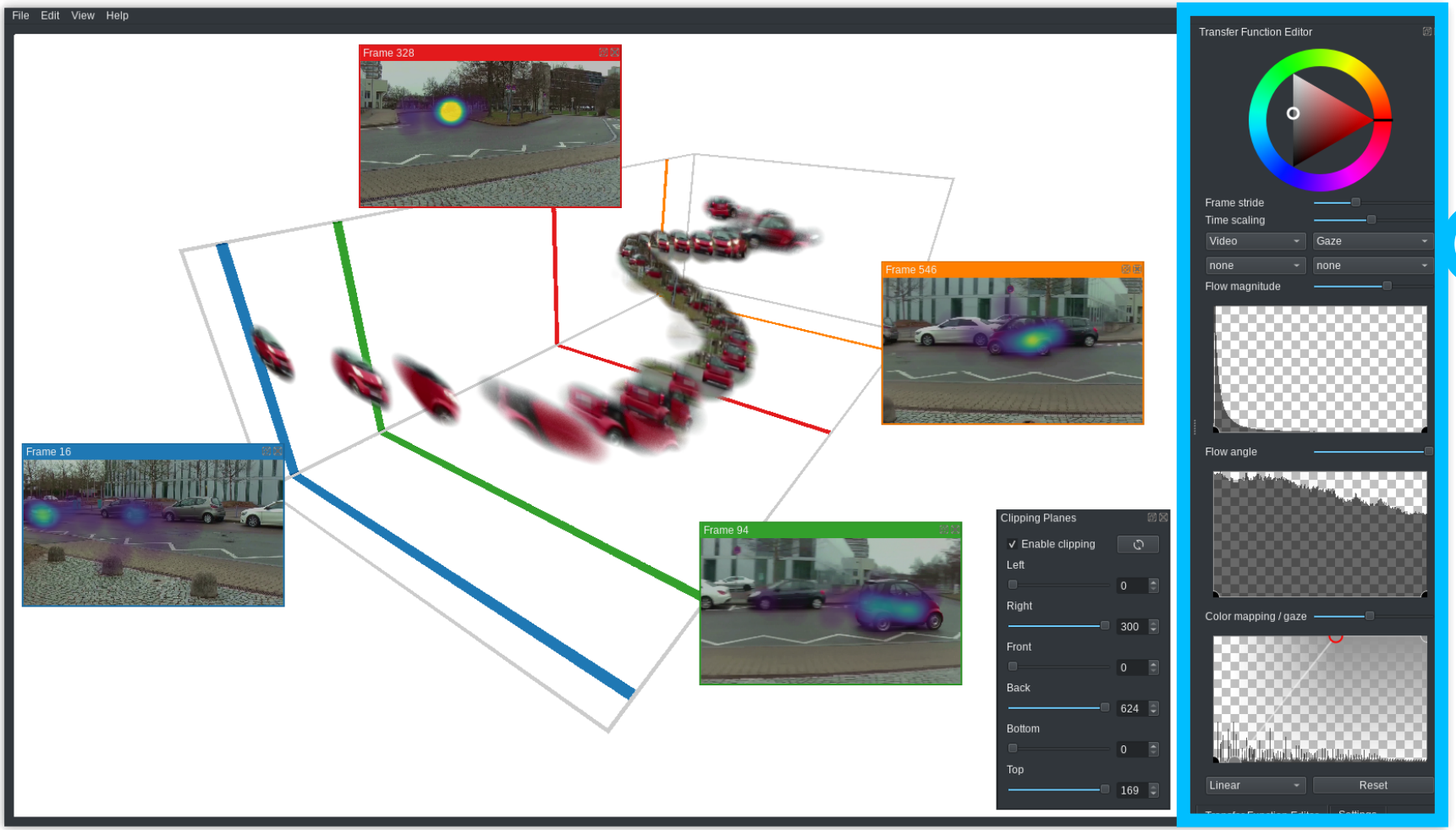


Visual Design



A. Main view (STC)

Visual Design



A. Main view (STC)

B. Transfer function editor

Visual Design

A. Main view (STC)

B. Transfer function editor

C. Clipping

Visual Design

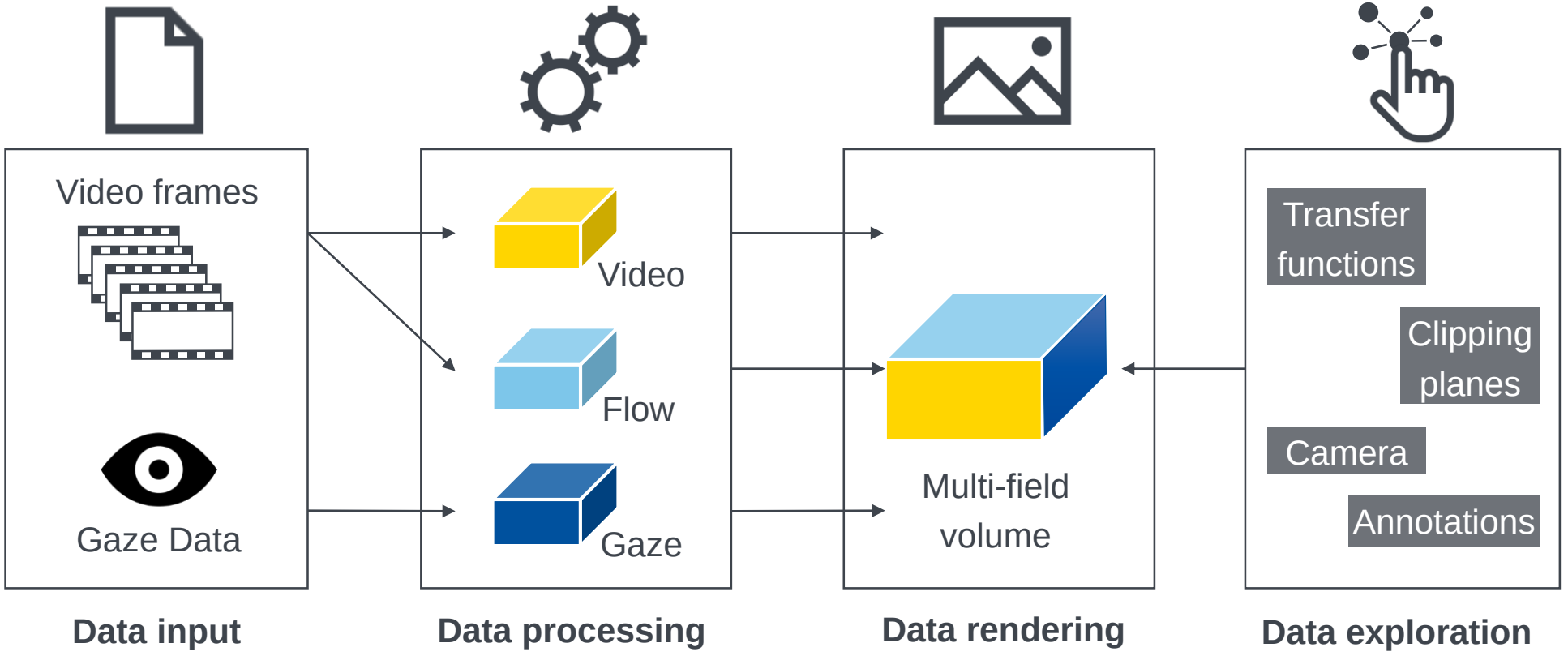
A. Main view (STC)

B. Transfer function editor

C. Clipping

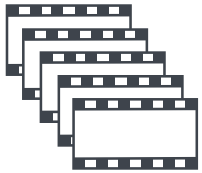
D. Annotations (heat map)

Technique

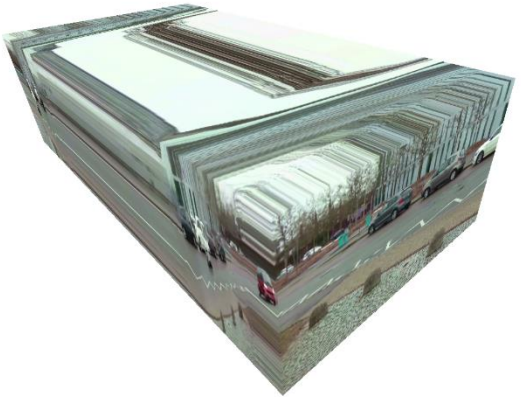

Video frames
Gaze Data
Video
Flow
Gaze
Multi-field volume
Transfer functions
Clipping planes
Camera
Annotations
Data input
Data processing
Data rendering
Data exploration

Data Processing

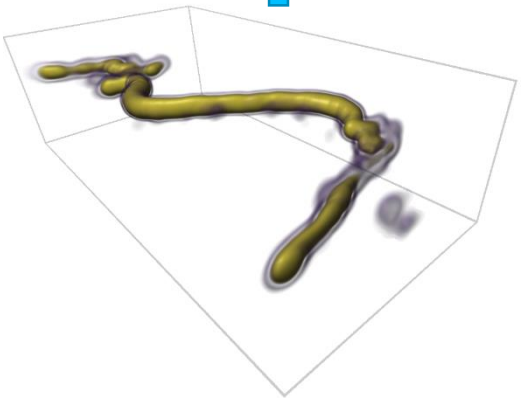
Data Processing

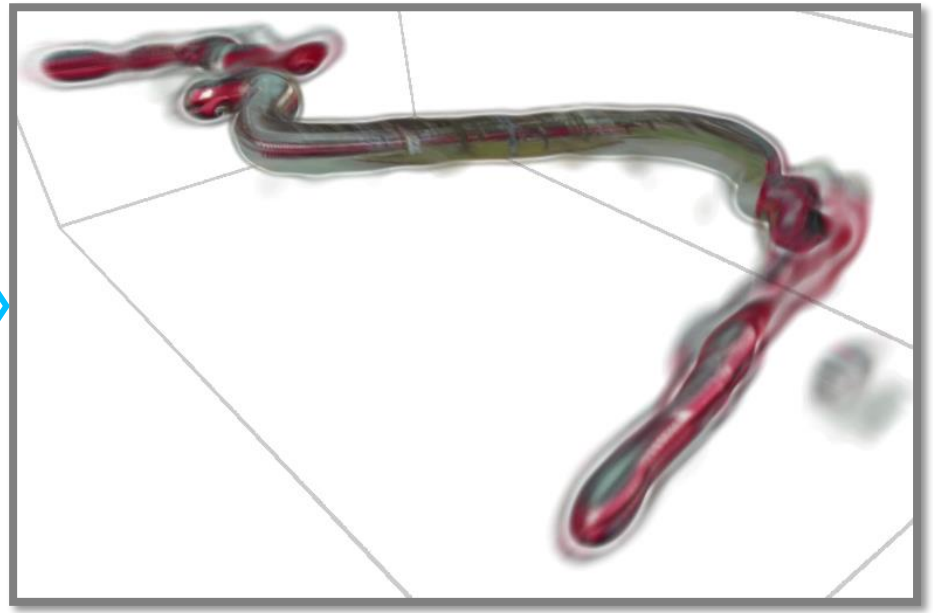


Video data



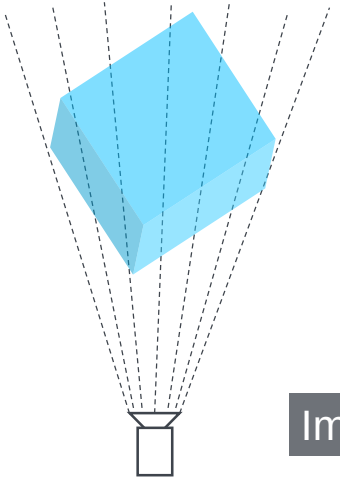
Gaze data





Data Rendering

Ray casting



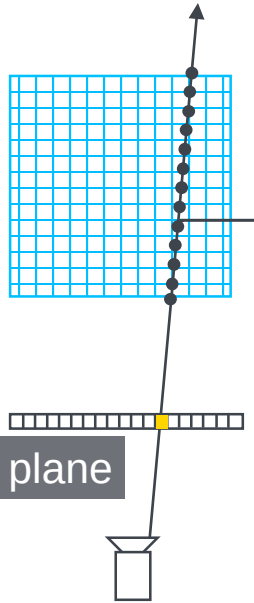
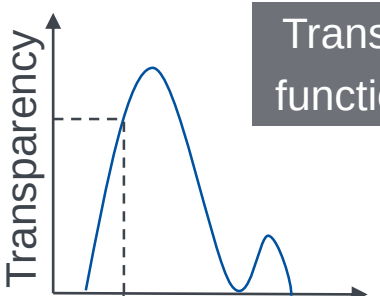


Image plane

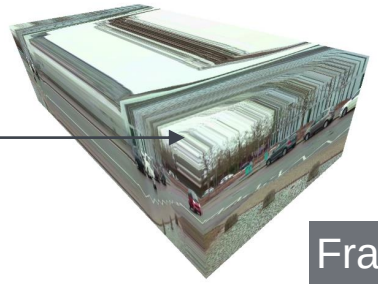
∀ Samples

Opacity (α)



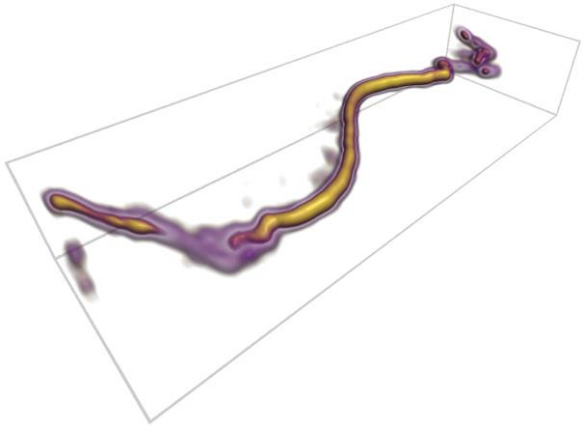
Transfer functions

Color (RGB)



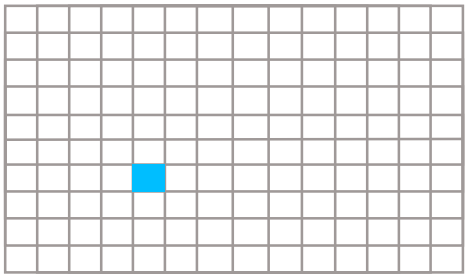
Frame data

Multi-Field Data



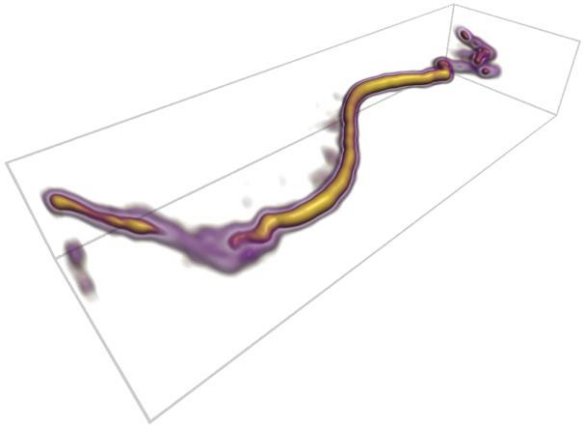
Gaze density

Flow data:



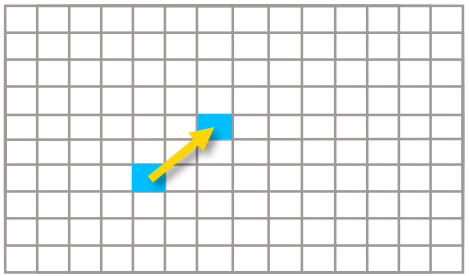
Frame 1

Multi-Field Data



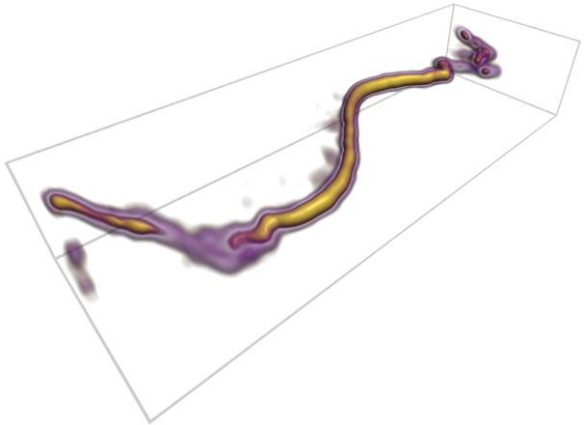
Gaze density

Flow data:



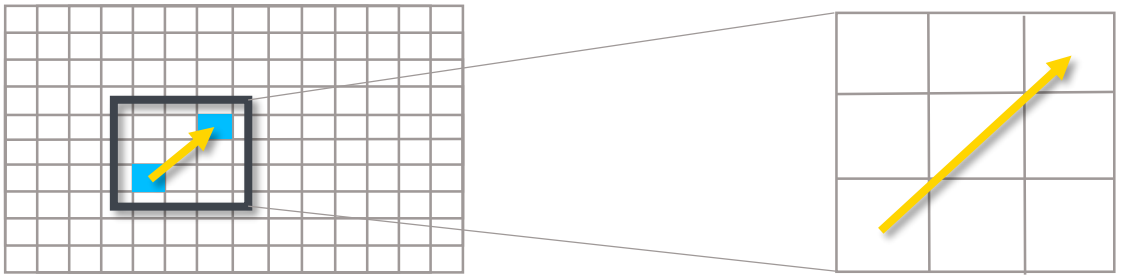
Frame 2

Multi-Field Data



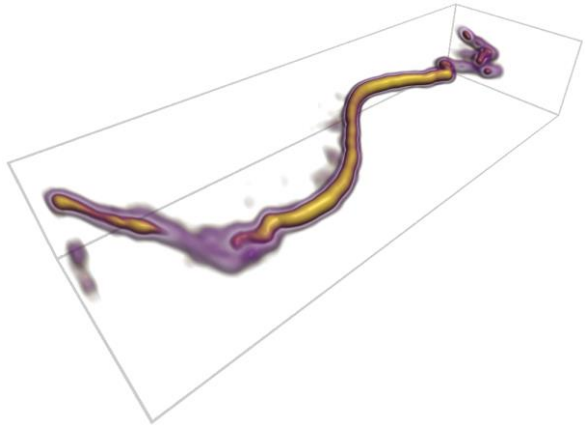
Gaze density

Flow data:

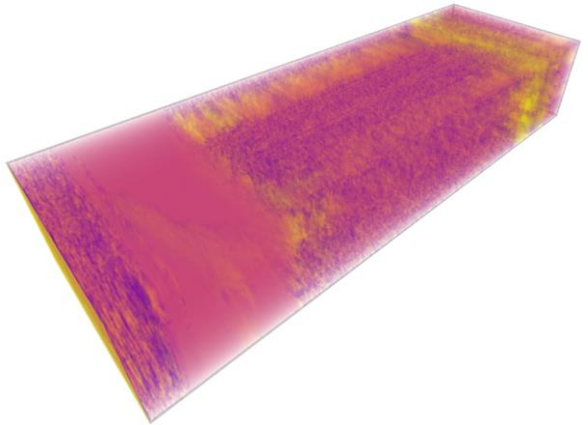


Frame 2

Multi-Field Data

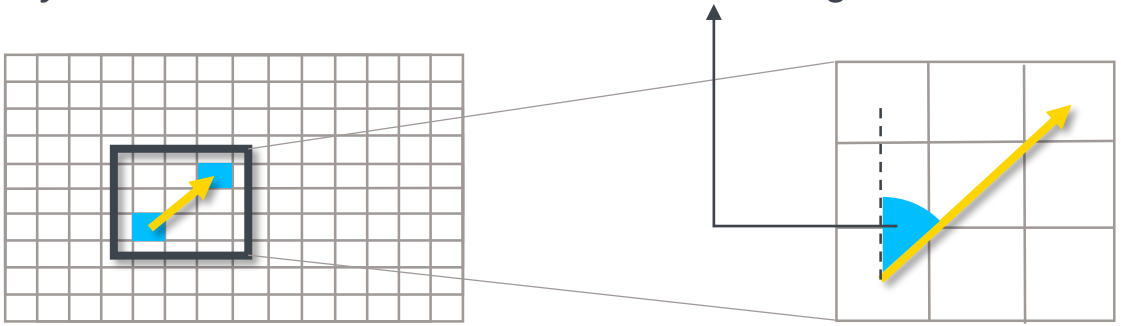


Gaze density



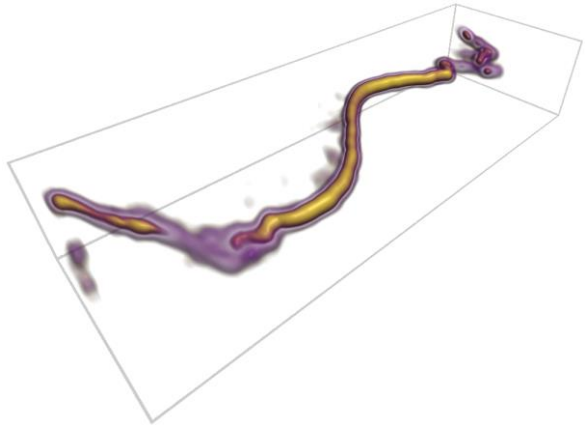
Flow vector angle

Flow data:

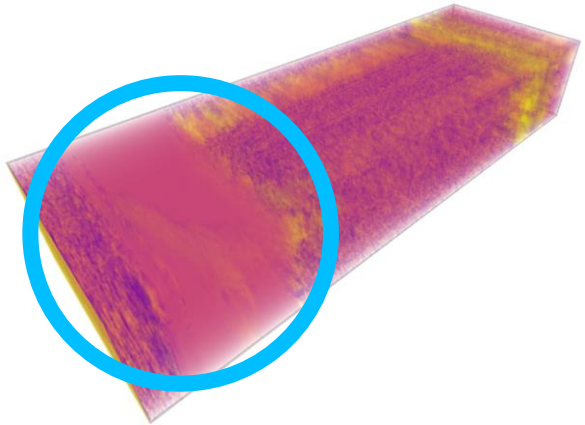


Frame 2

Multi-Field Data

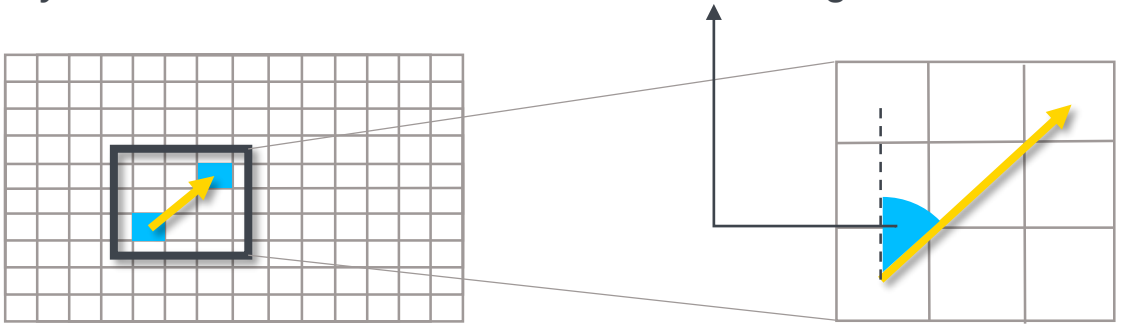


Gaze density



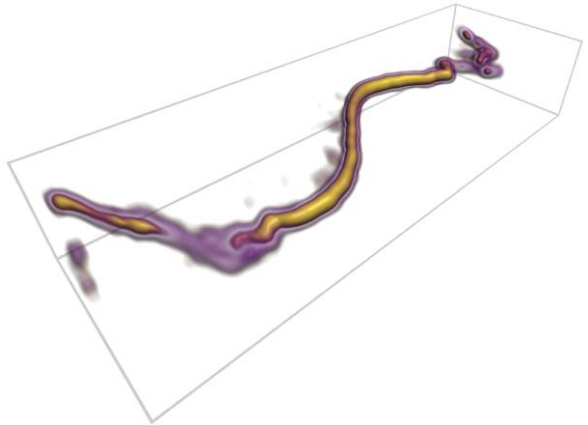
Flow vector angle

Flow data:

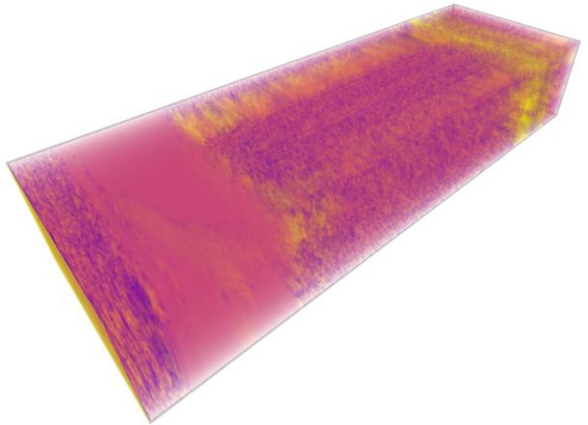


Frame 2

Multi-Field Data

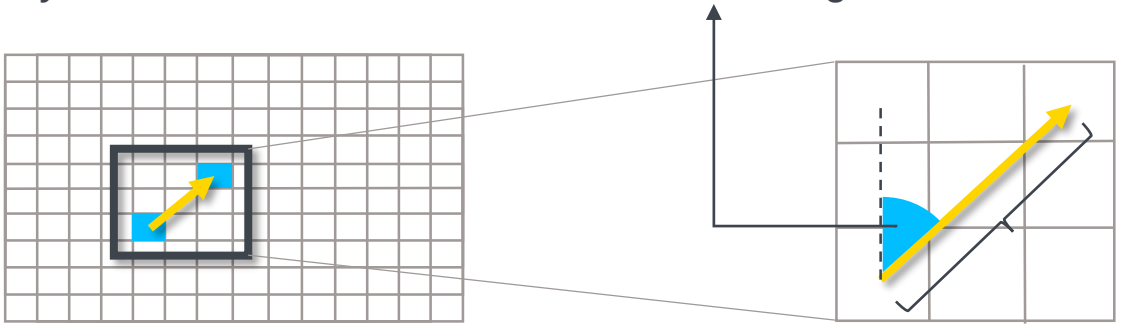


Gaze density



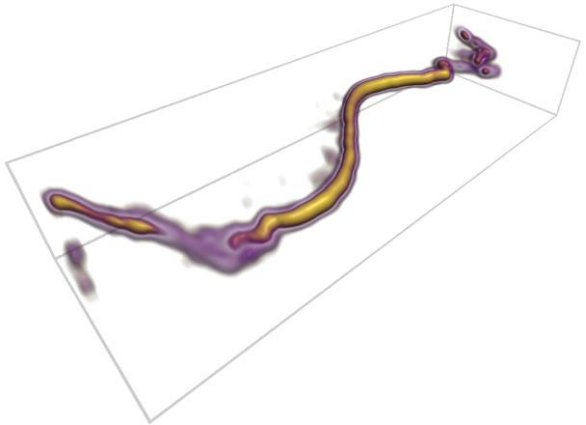
Flow vector angle

Flow data:

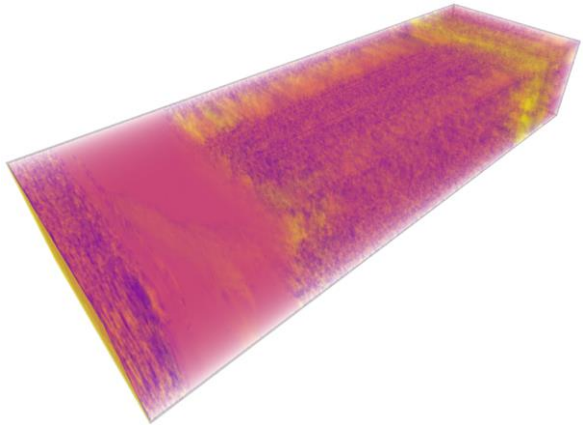


Frame 2

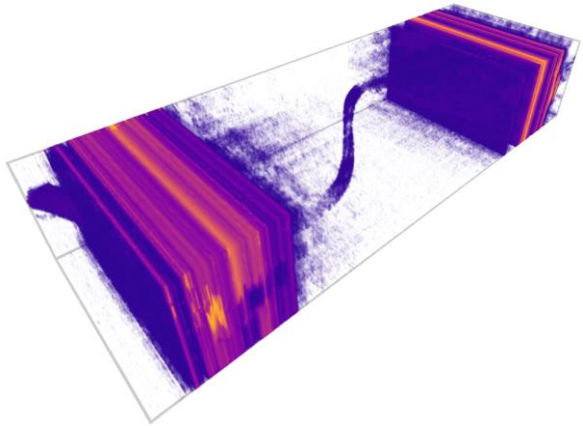
Multi-Field Data



Gaze density

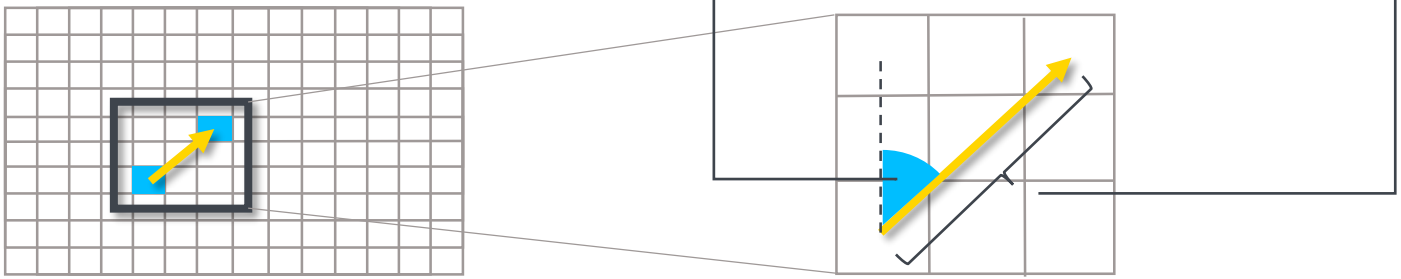


Flow vector angle



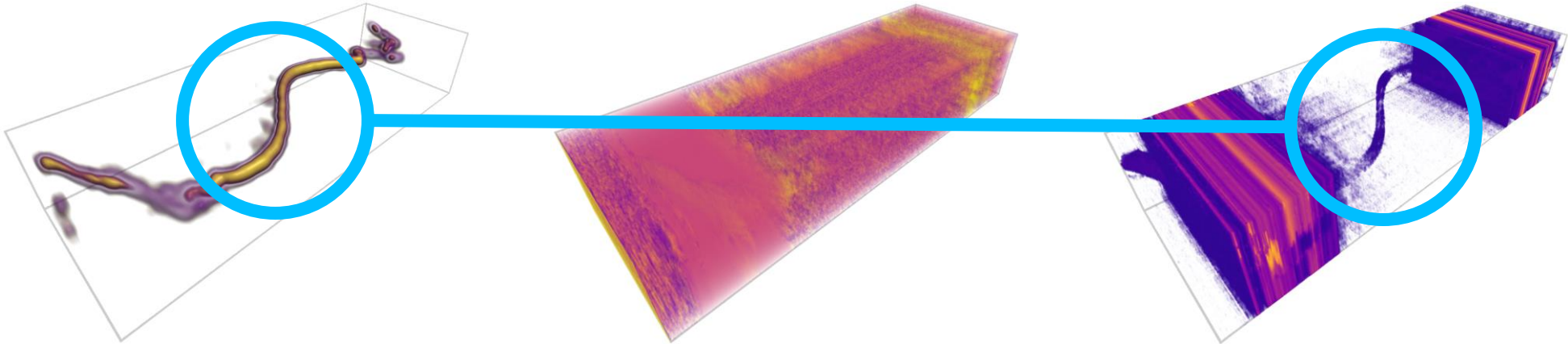
Flow vector magnitude

Flow data:



Frame 2

Multi-Field Data

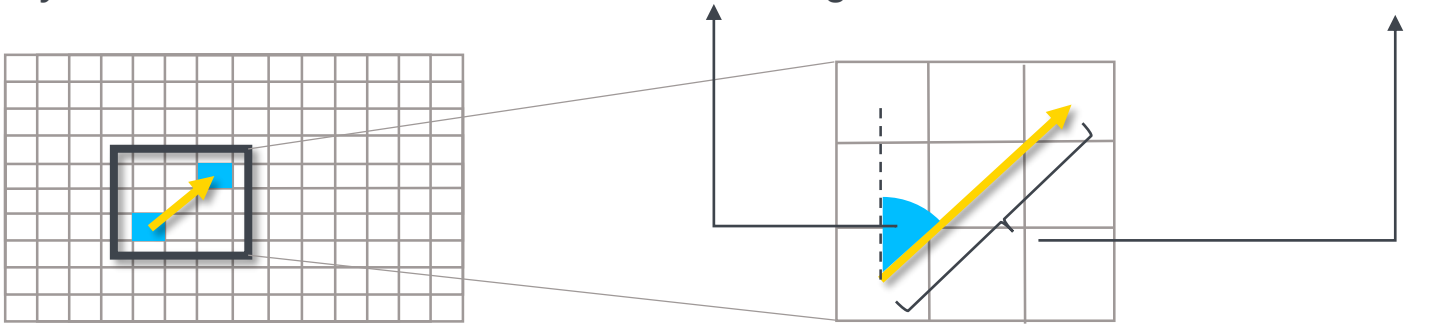


Gaze density

Flow vector angle

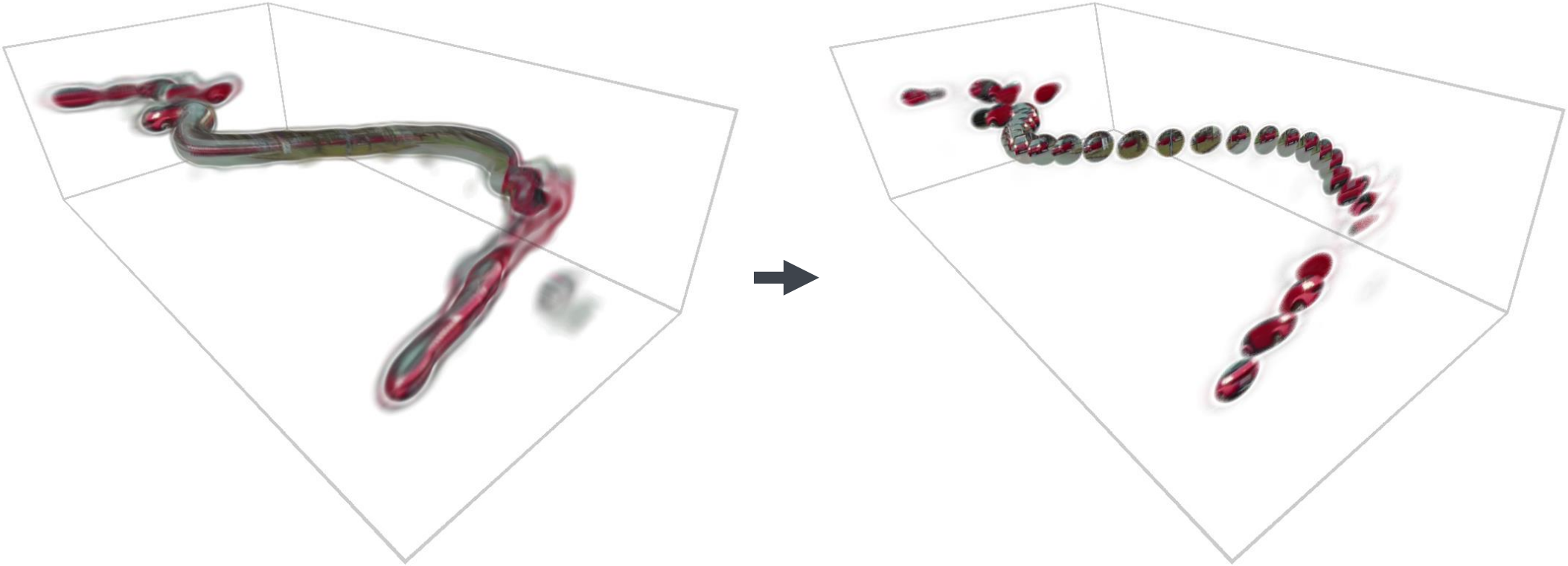
Flow vector magnitude

Flow data:

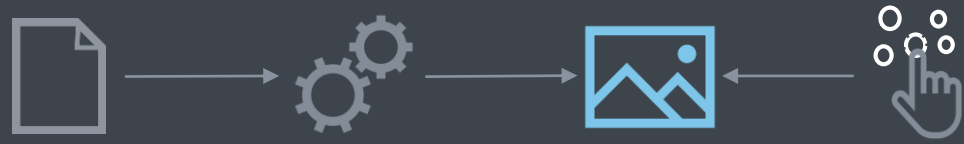


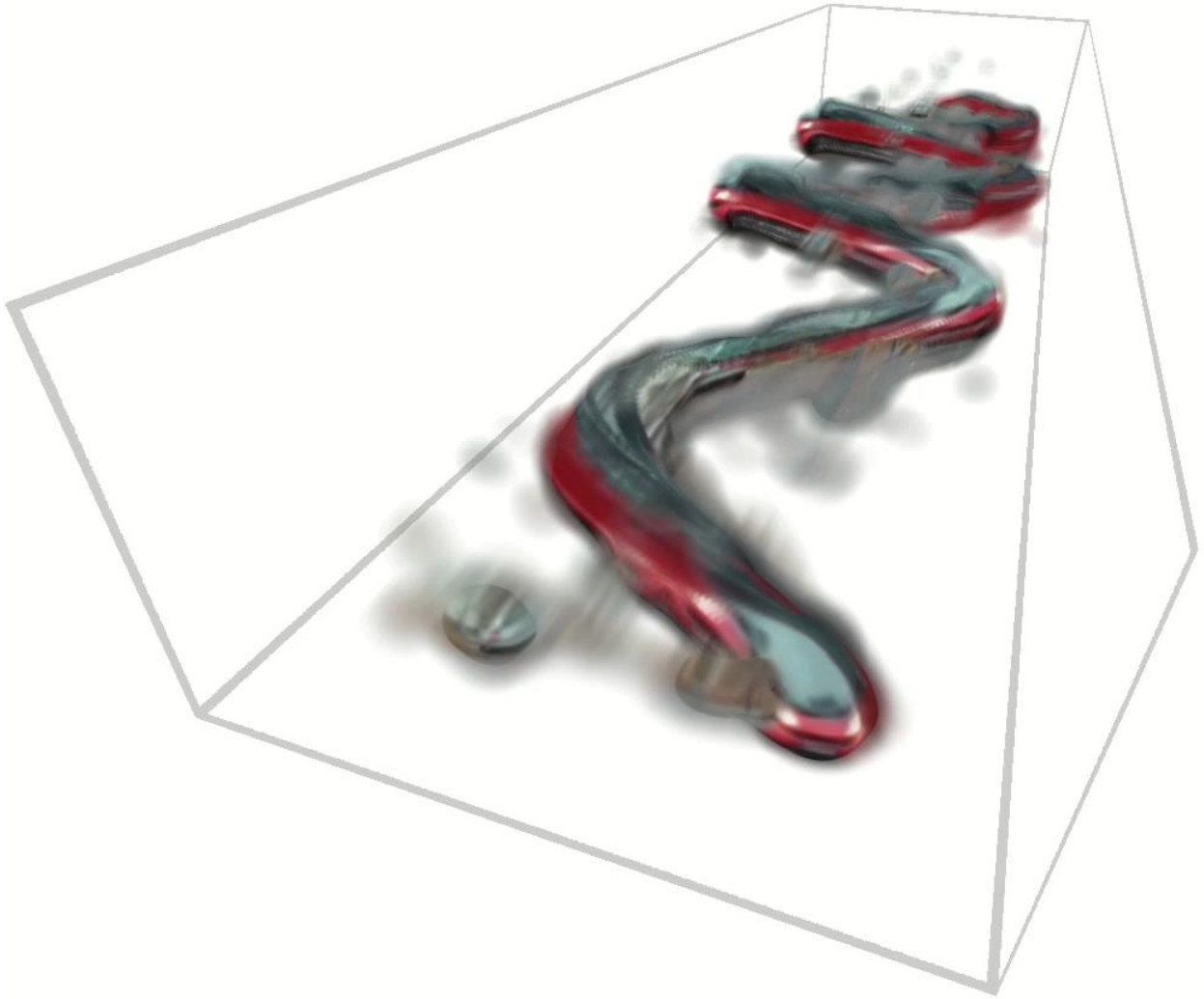
Frame 2

Volume Slices



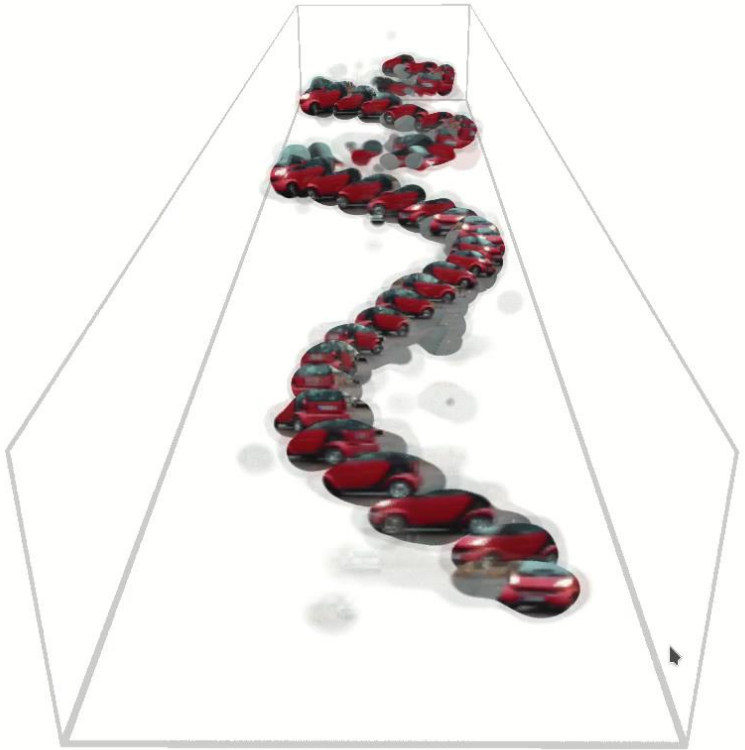
Volume Slices



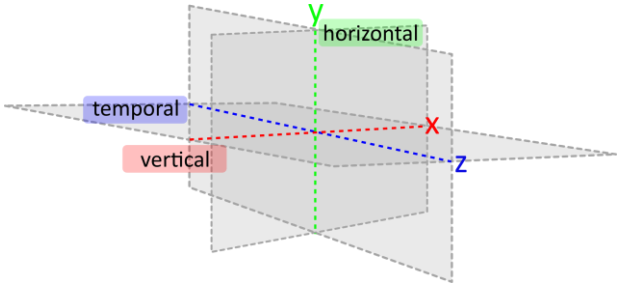


Data Exploration

Camera



Clipping Planes



Clipping planes

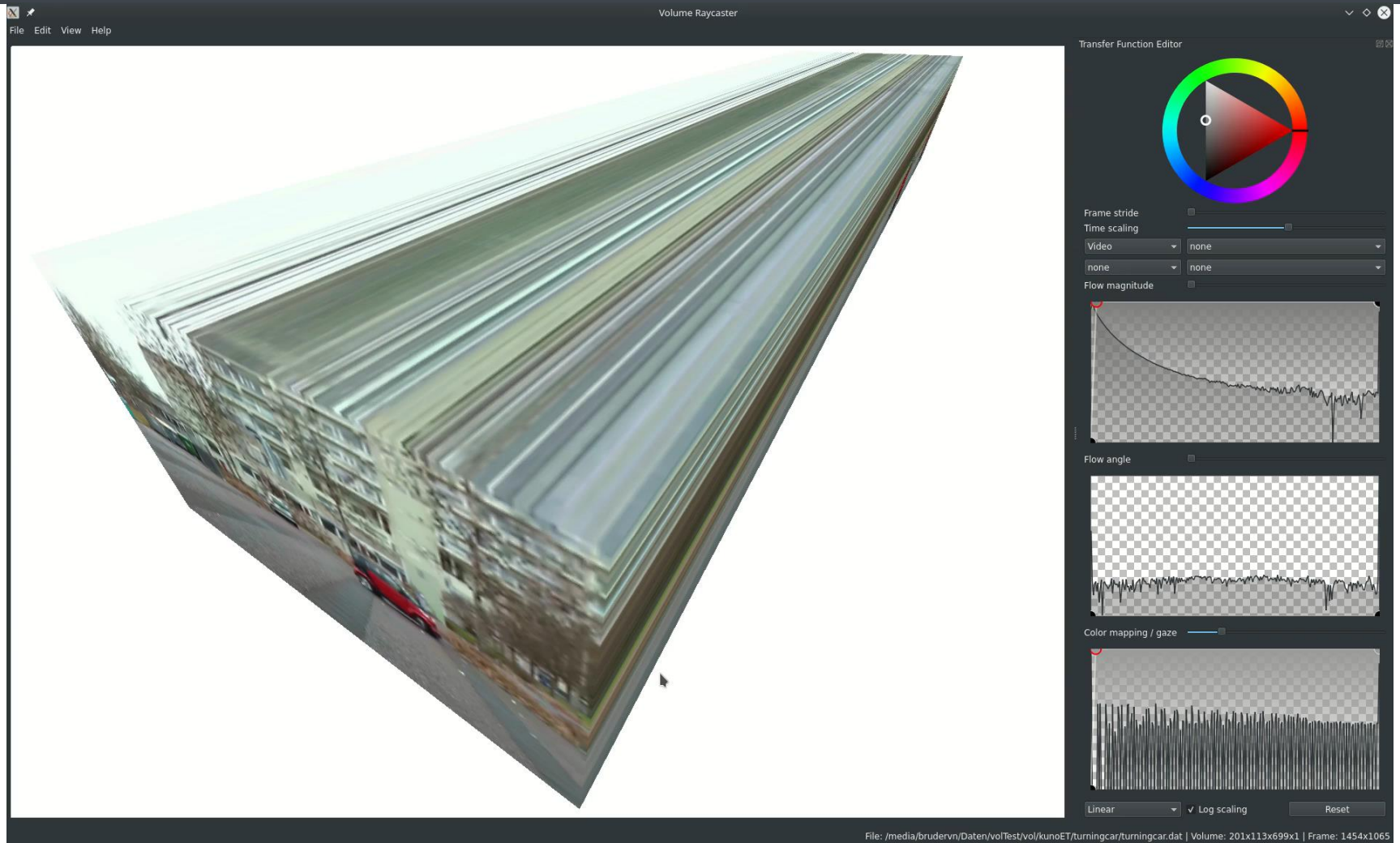
Front (Z)

Side (X)

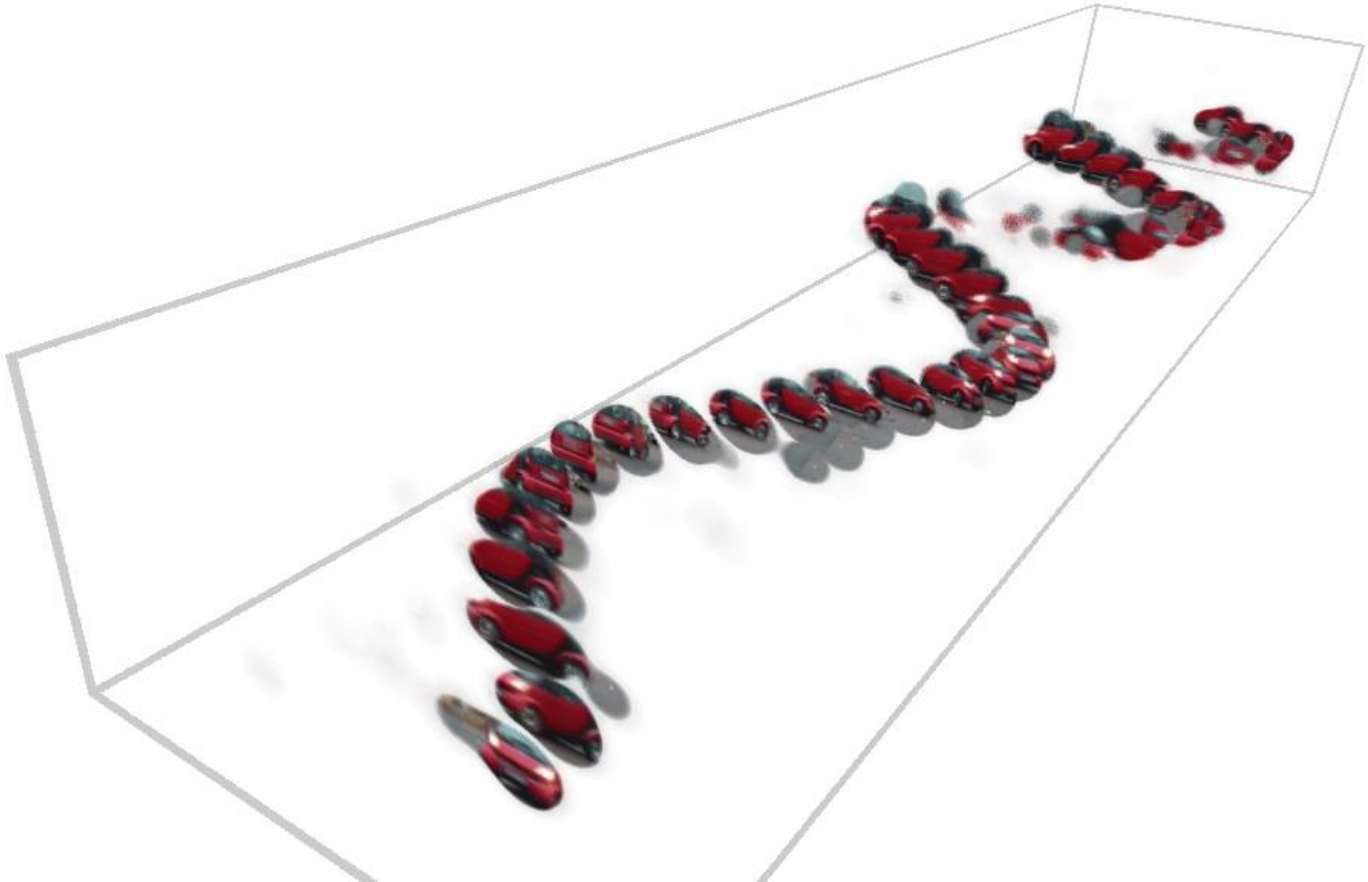
Koch et al., [ETRA 2018]

Top (Y)

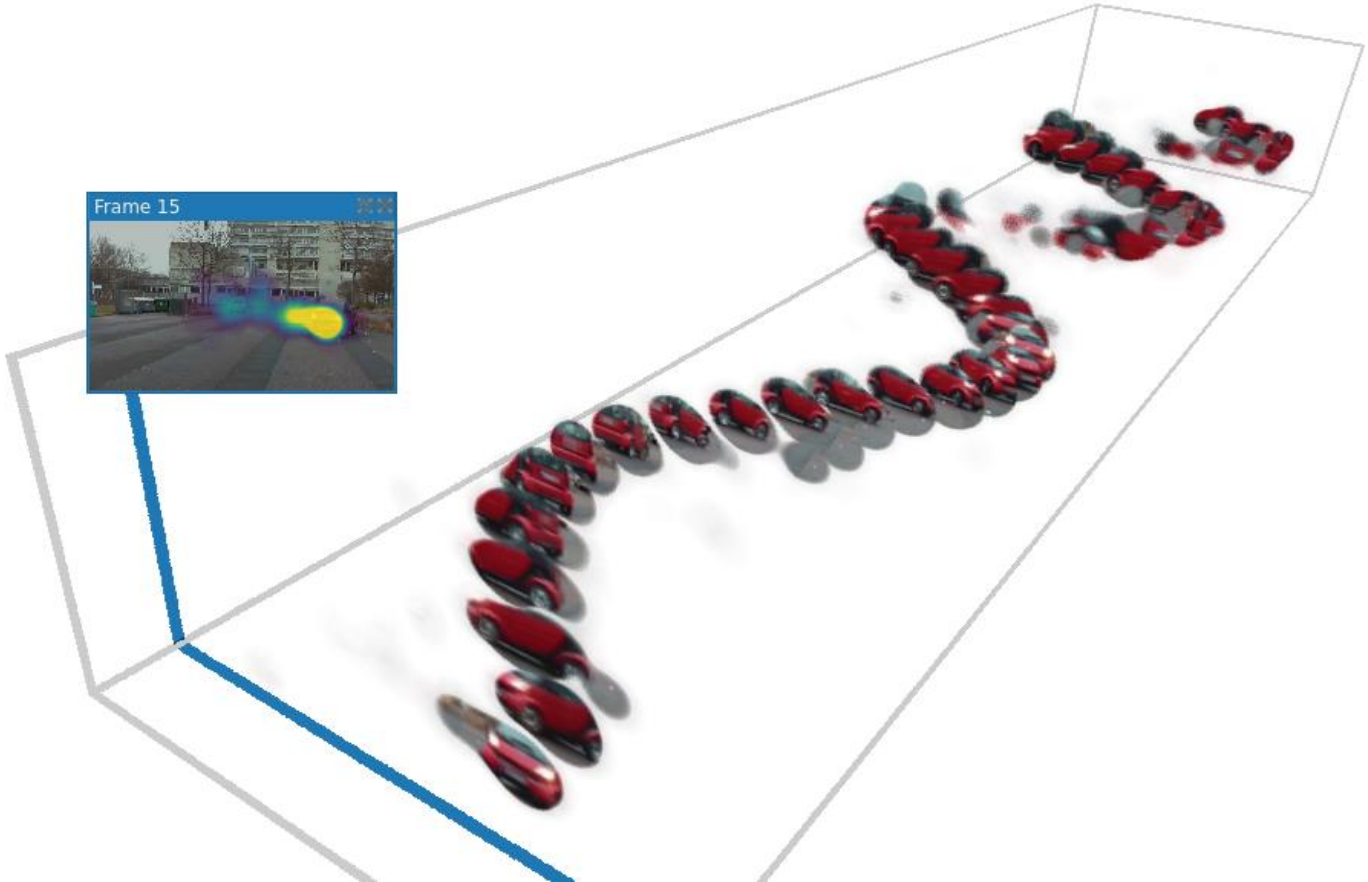
Transfer Functions



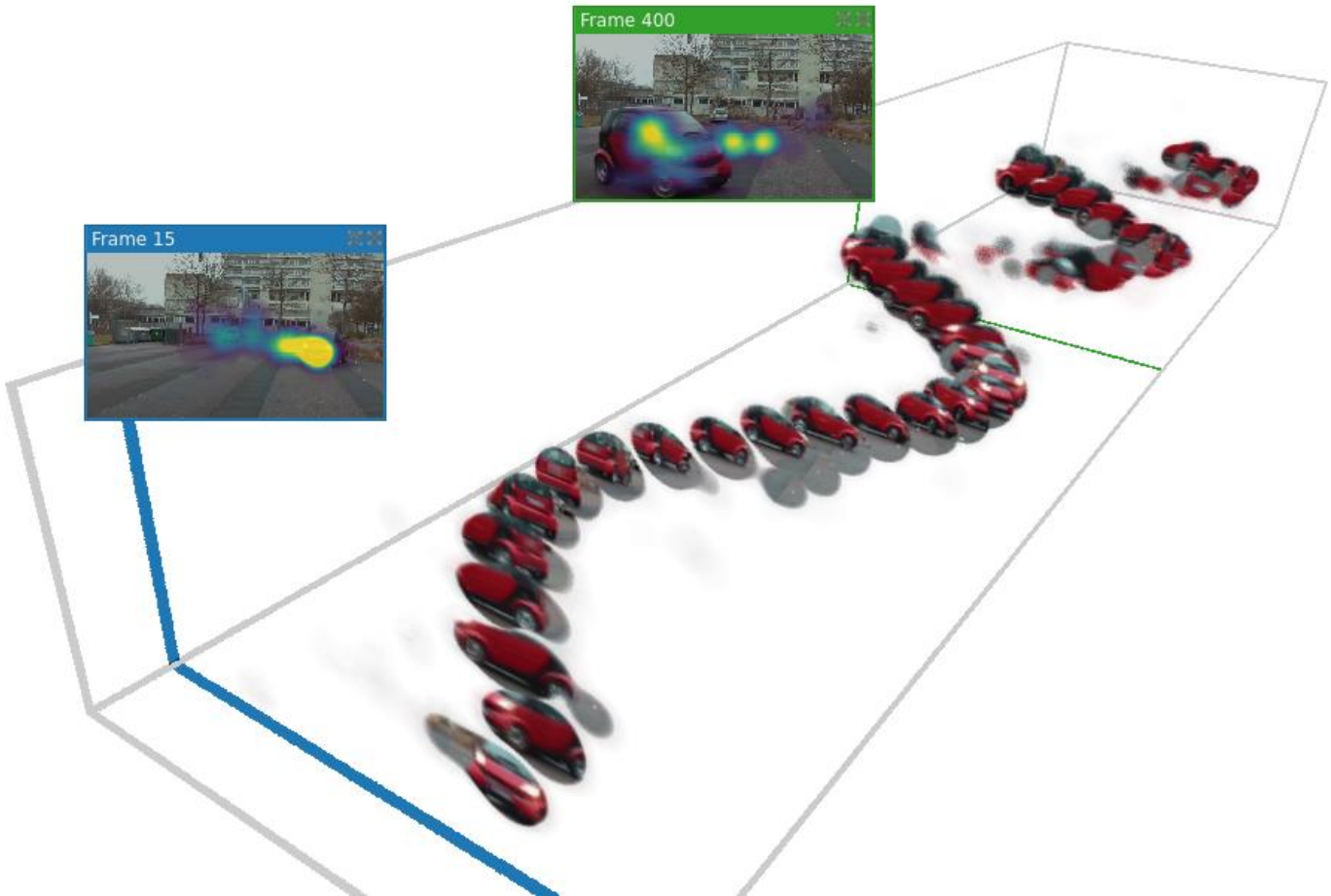
Annotations



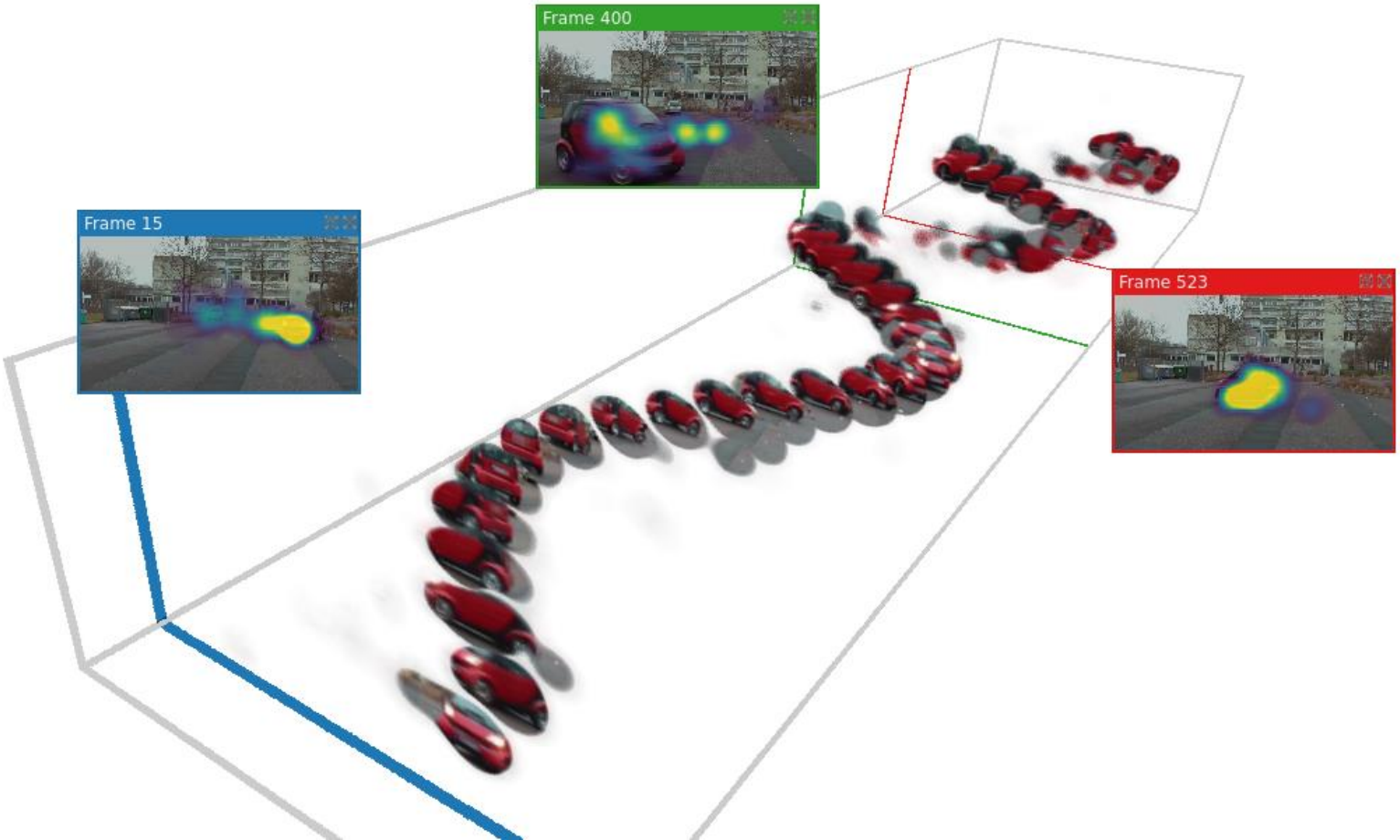
Annotations



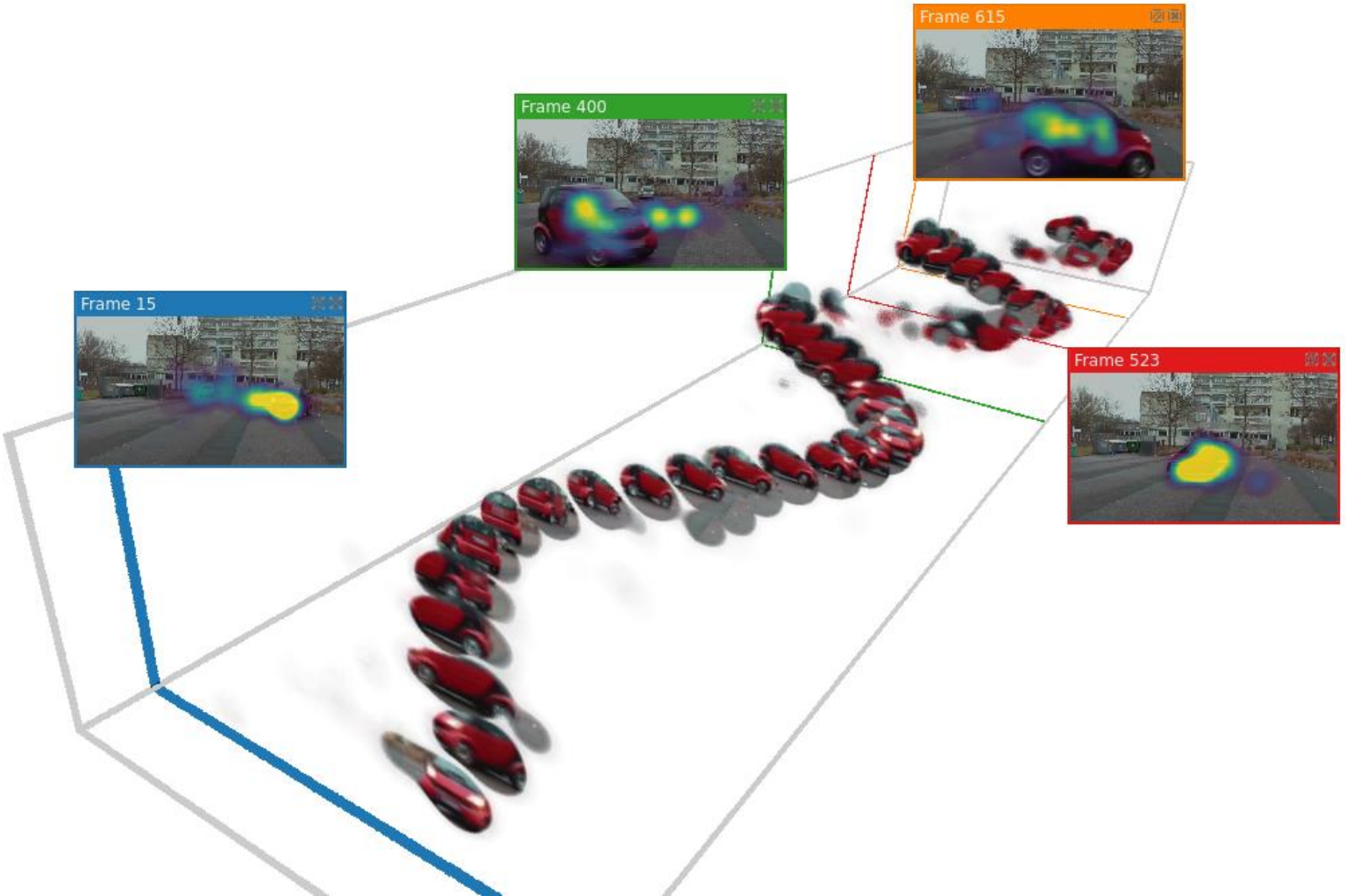
Annotations



Annotations

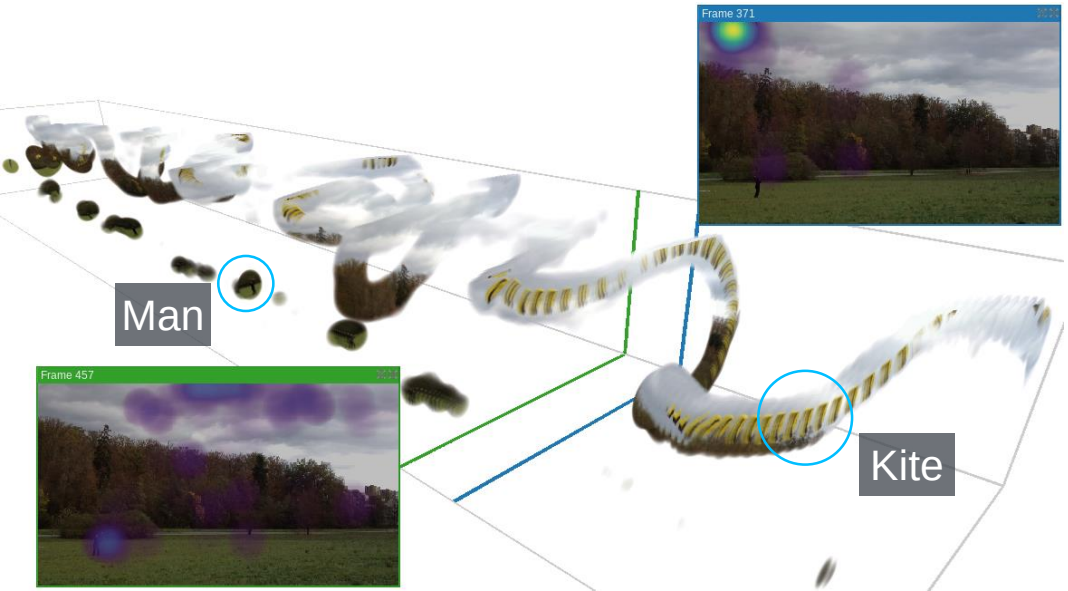


Annotations

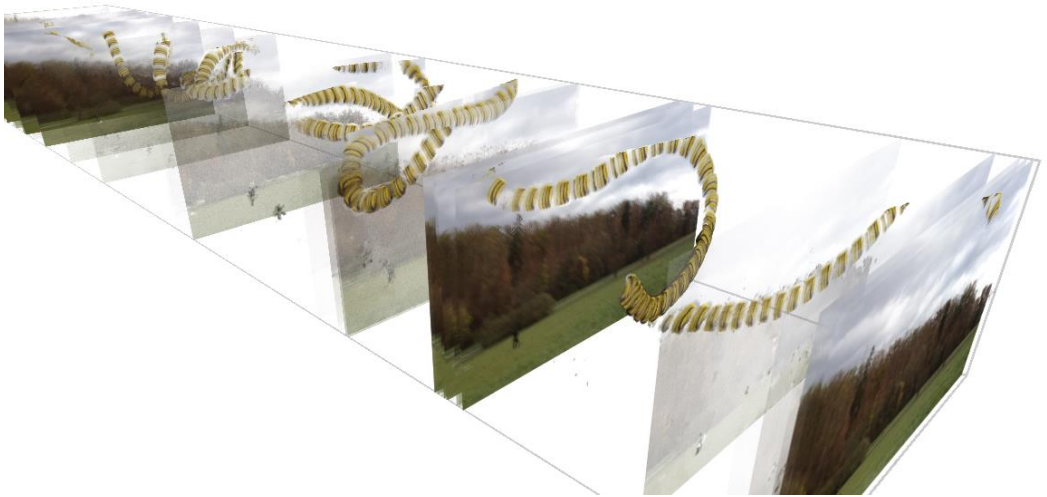


Examples

Example: Man Steering a Yellow Kite

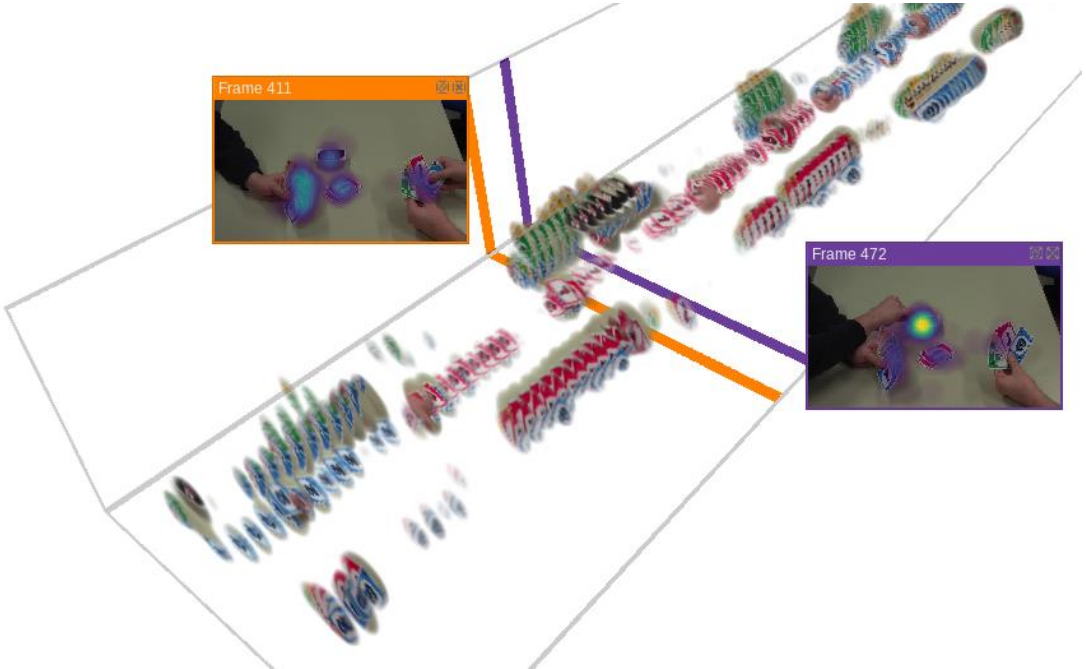


Filtered by gaze



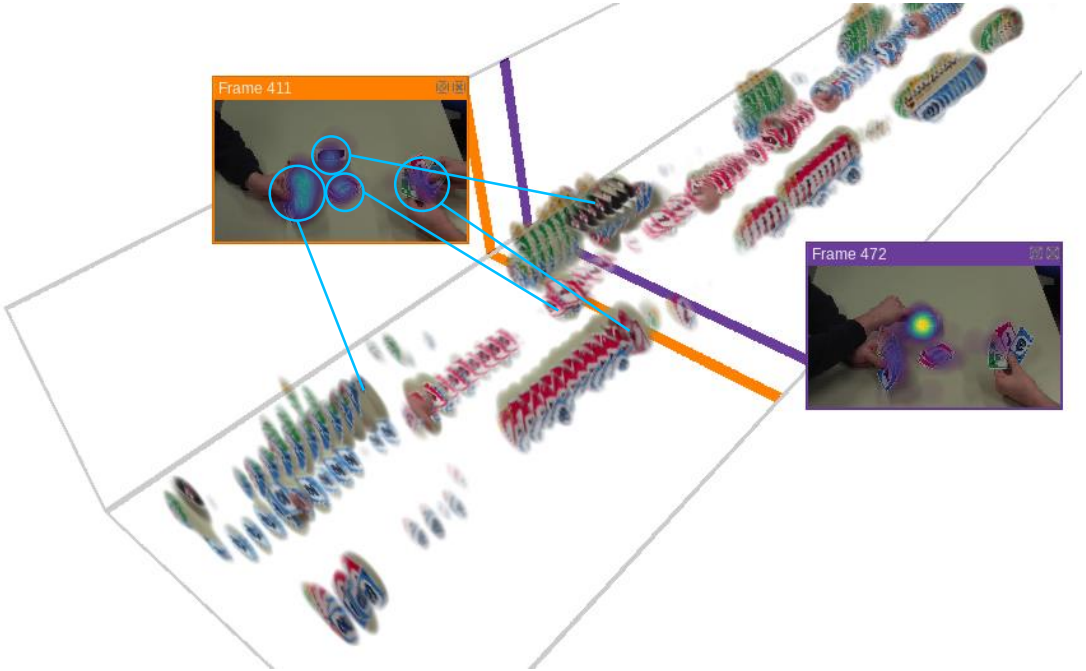
Filtered by flow

Example: UNO Card Game



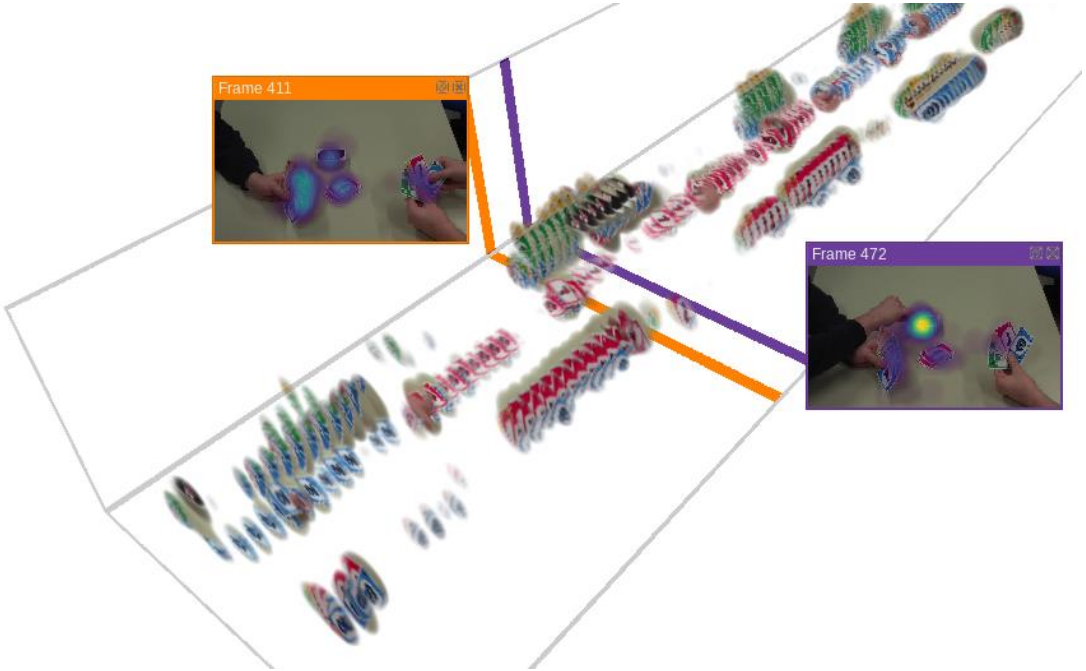
Filtered by gaze

Example: UNO Card Game

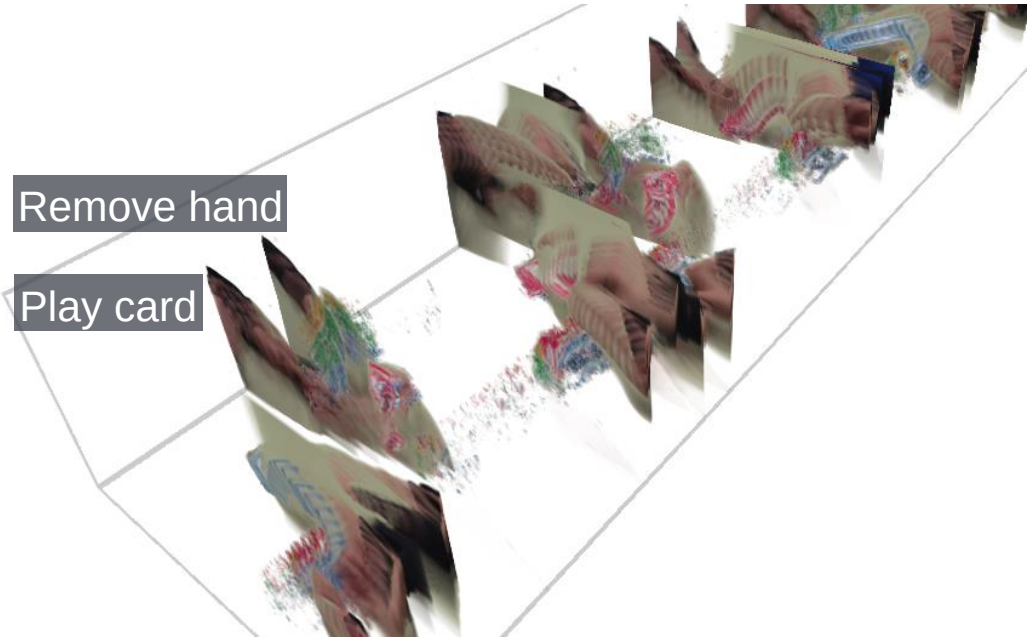


Filtered by gaze

Example: UNO Card Game



Filtered by gaze



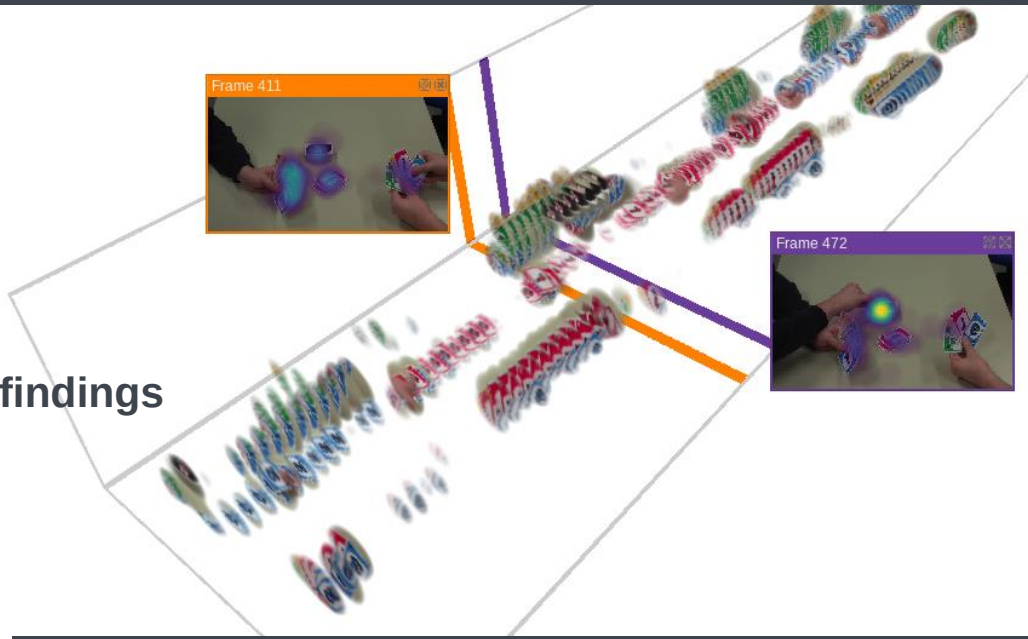
Filtered by flow

Conclusion and Future Work

Space-time volume with multiple fields

- Video, gaze, optical flow
- Interactive navigation and filtering
- Annotations

Exploration, support statistics, dissemination of findings



Future work

- Transfer functions with presets
- Encode additional information, e.g. AOI labels
- Placement of annotation frames

DFG

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Quantitative Methods for Visual Computing
Transregional Collaborative Research Center

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