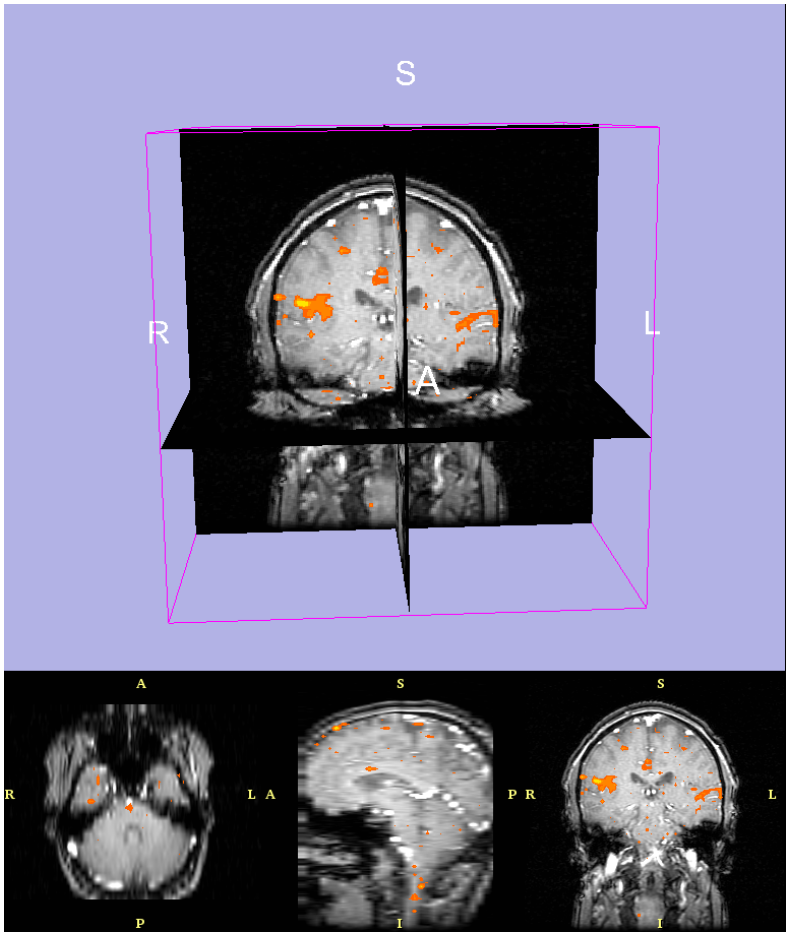
Interval browser and fMRIEngine

- Slicer tools for fMRI analysis and other multi-volume applications
- Separate general handling & processing of multi-volume data and more specialized application-specific processing
- Tools: Ibrowser, fMRIEngine (Slicer 2.4, early prototypes)
- Interoperate with Slicer's other multimodality visualization tools & with fBIRN processing pipeline.
- currently under development

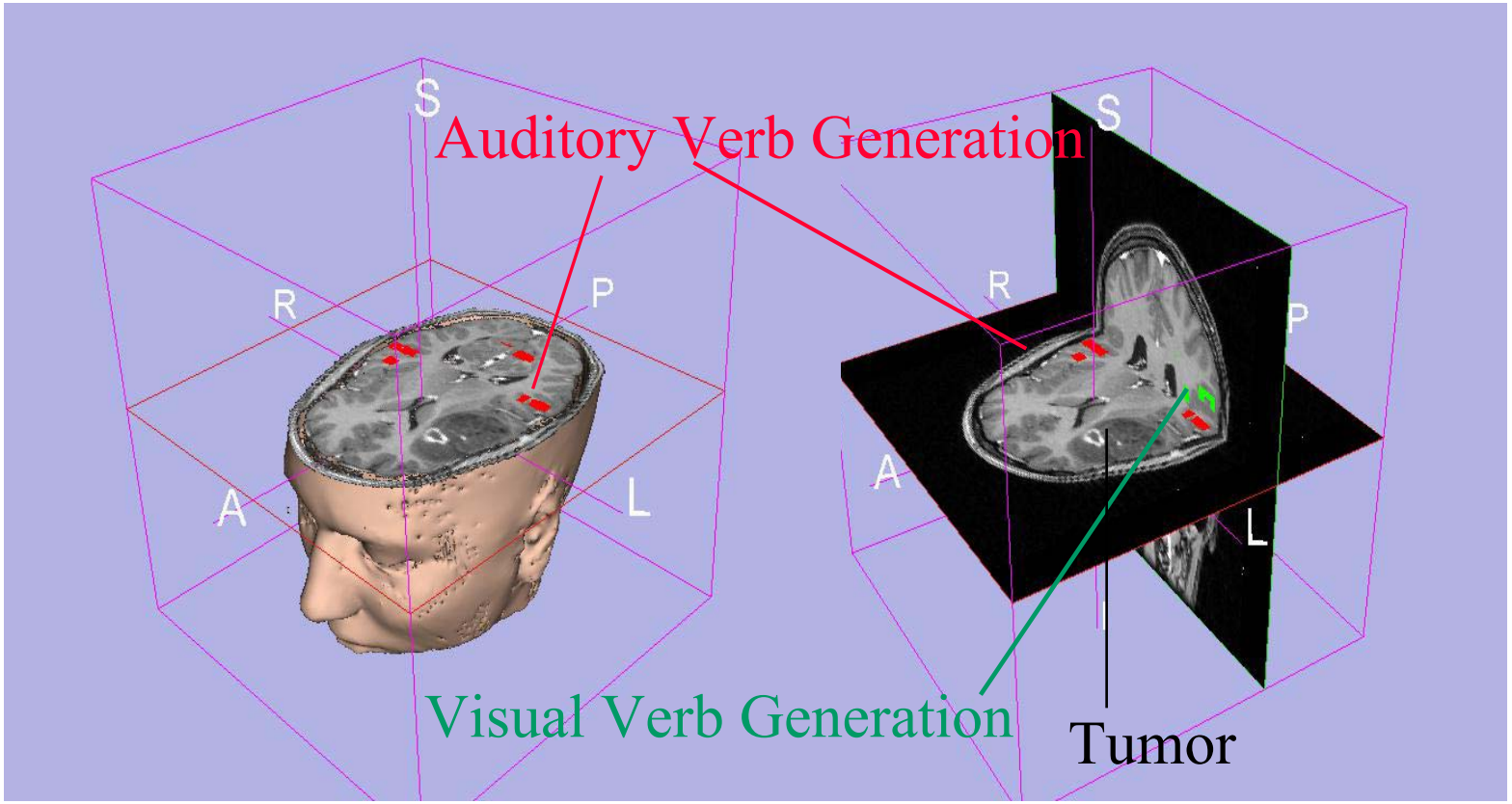


Wendy Plesniak
Haiying Liu
Steven Pieper
William Wells III
Cindy Wible

Interval browser and fMRIEngine

loading SPM activation volumes (Analyze format) in 3D Slicer:

neurosurgical case courtesy Cindy Wible (BWH)



Interval browser and fMRIEngine: Overview

- Ibrowser basic features (current)
- fMRIEngine basic features (current)
- motivation

- Ibrowser design goals
- Ibrowser: features under dev. & ongoing work

- fMRIEngine design goals
- fMRIEngine features under dev. & ongoing work

- Demo

Interval browser: Basic Features

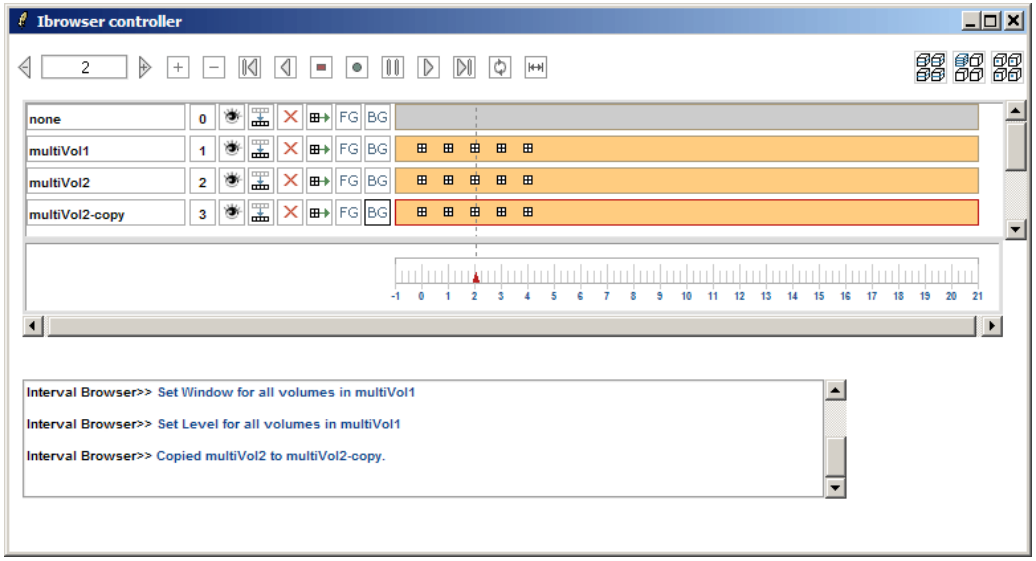
Loading: Analyze (3D and 4D), DICOM, BXH (BIAC XML Header) format data, (XCEDE soon);

Organization: persistent GUI organizes and indexes multi-volume data;

General processing: multi-volume window, level and threshold.

Animation: manual or automated animation over the interval; saving movies.

Shortcuts for manipulation and viewing: manual or automated animation over the interval.



fMRIEngine: Basic Features

- **Data loading:** Loads Analyze (3D and 4D), DICOM, BXH (BIAC XML Header) format data, (XCEDE soon); or imports from Interval Browser;

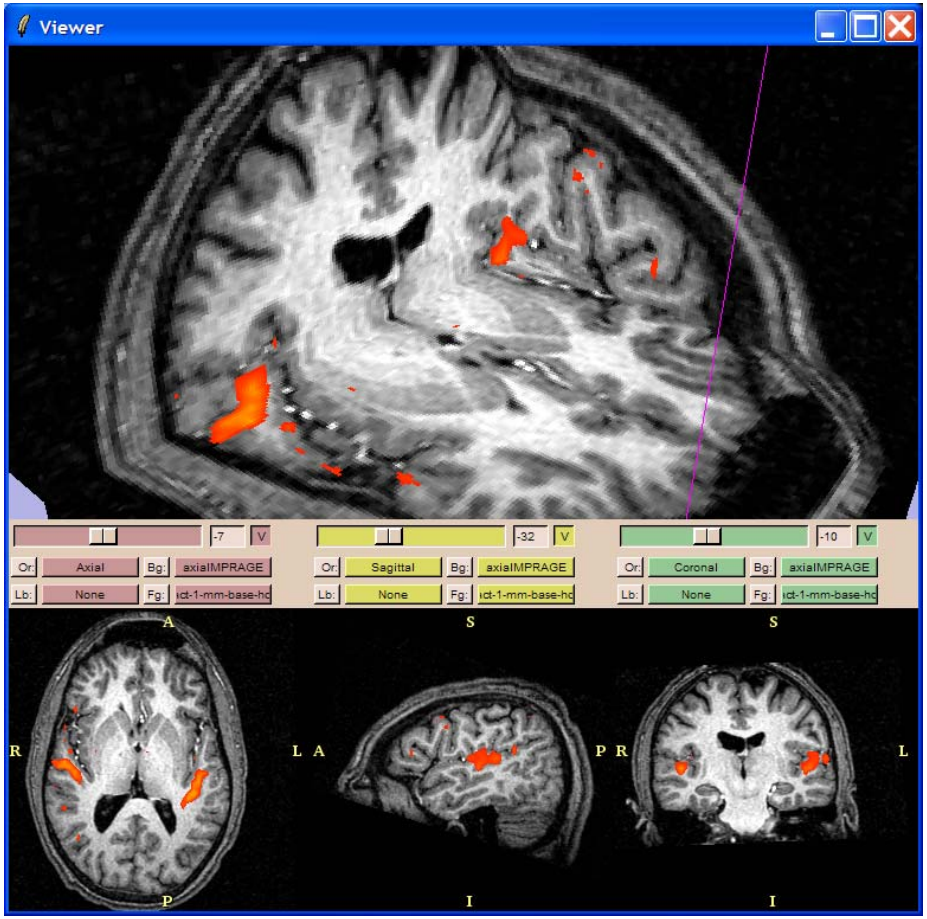
- **Protocol specification:** input blocked design, event-related or mixed design via GUI or load/save in text file;

- **Activation computing:** specify contrasts, detection by basic GLM; generates color-coded parametric map of activation

- **3D visualization** of activation in the context of subject's own anatomy (no standardized morphological space yet);

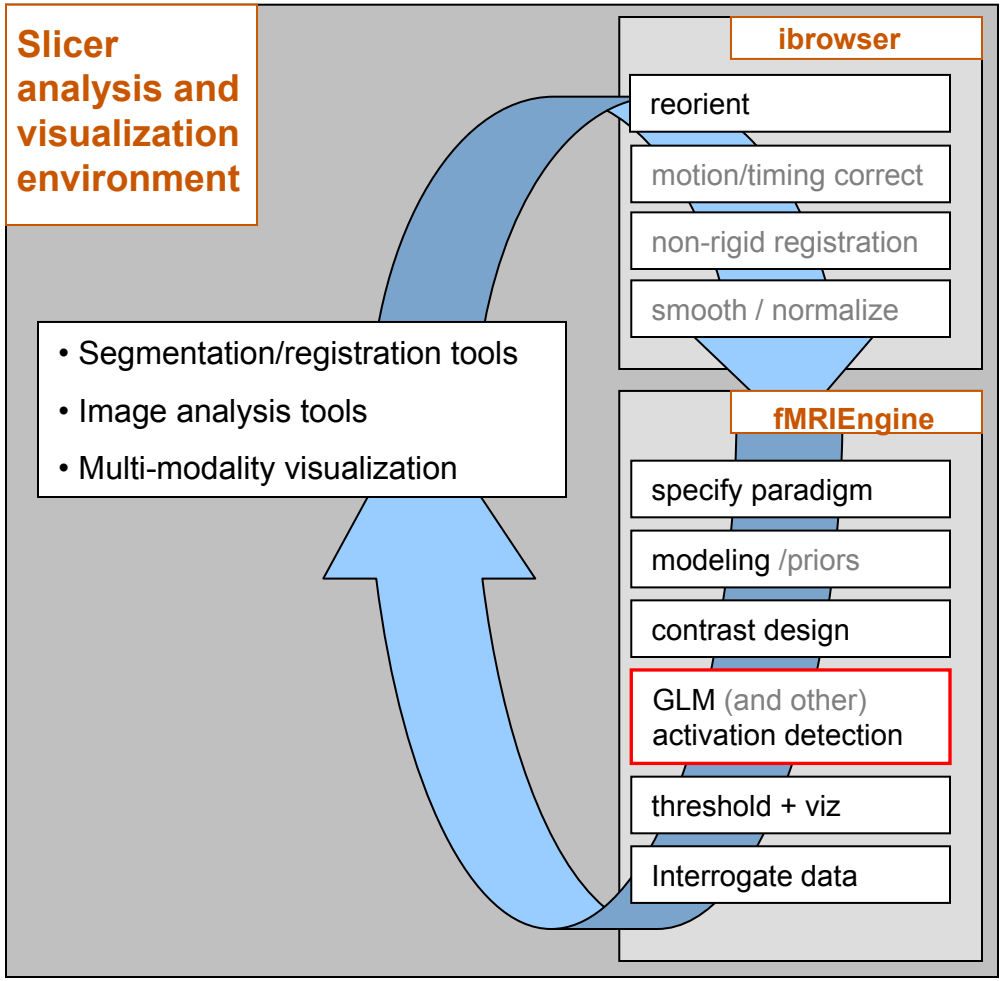
- **interactive** thresholding and voxel timecourse plotting.

Tones vs. Rest: results courtesy Cindy Wible (BWH)



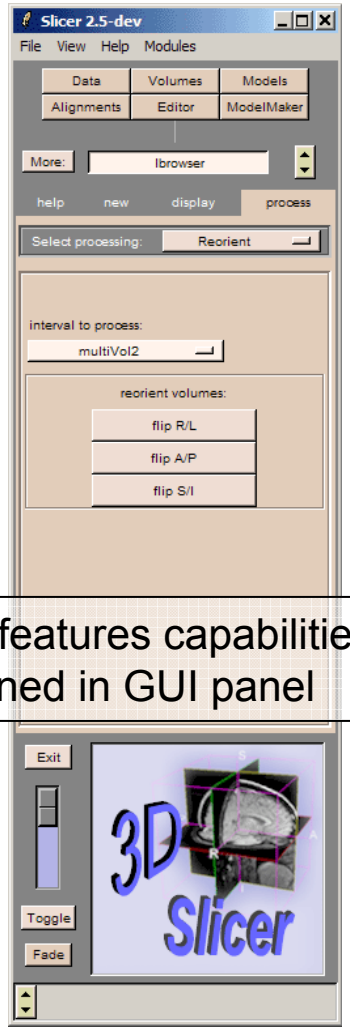
Interval browser and fMRIEngine: combined workflow

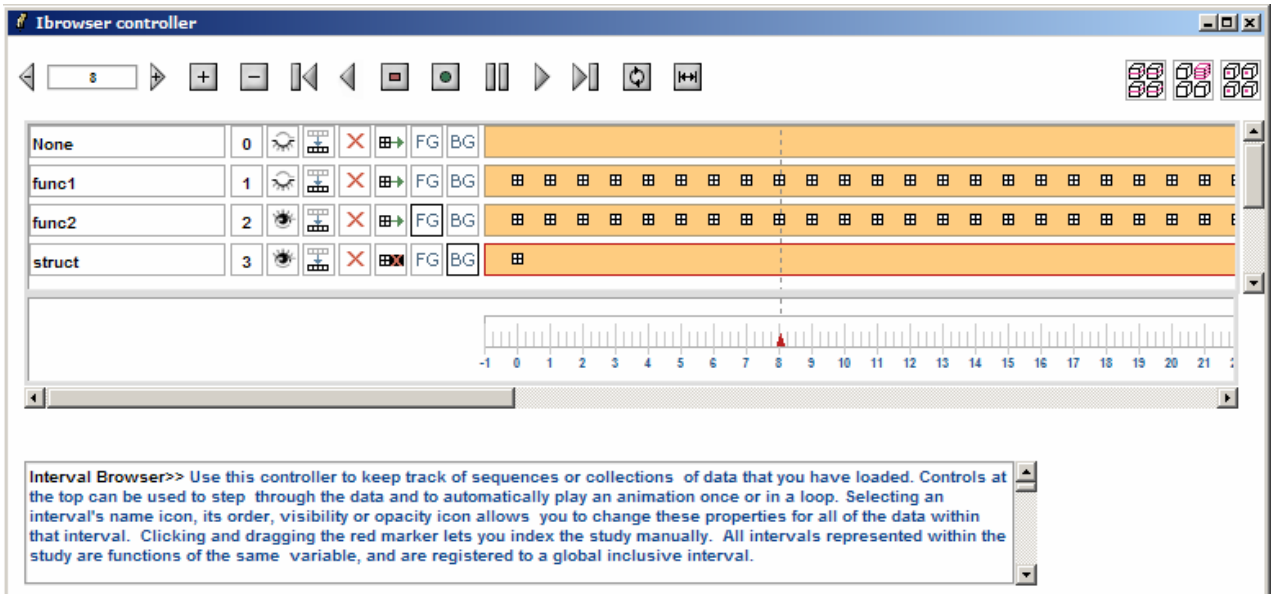
Goal: fMRI and multi-volume tools interoperate with Slicer's other modules



- implemented functionality
- planned functionality

Interval browser: Design Goals



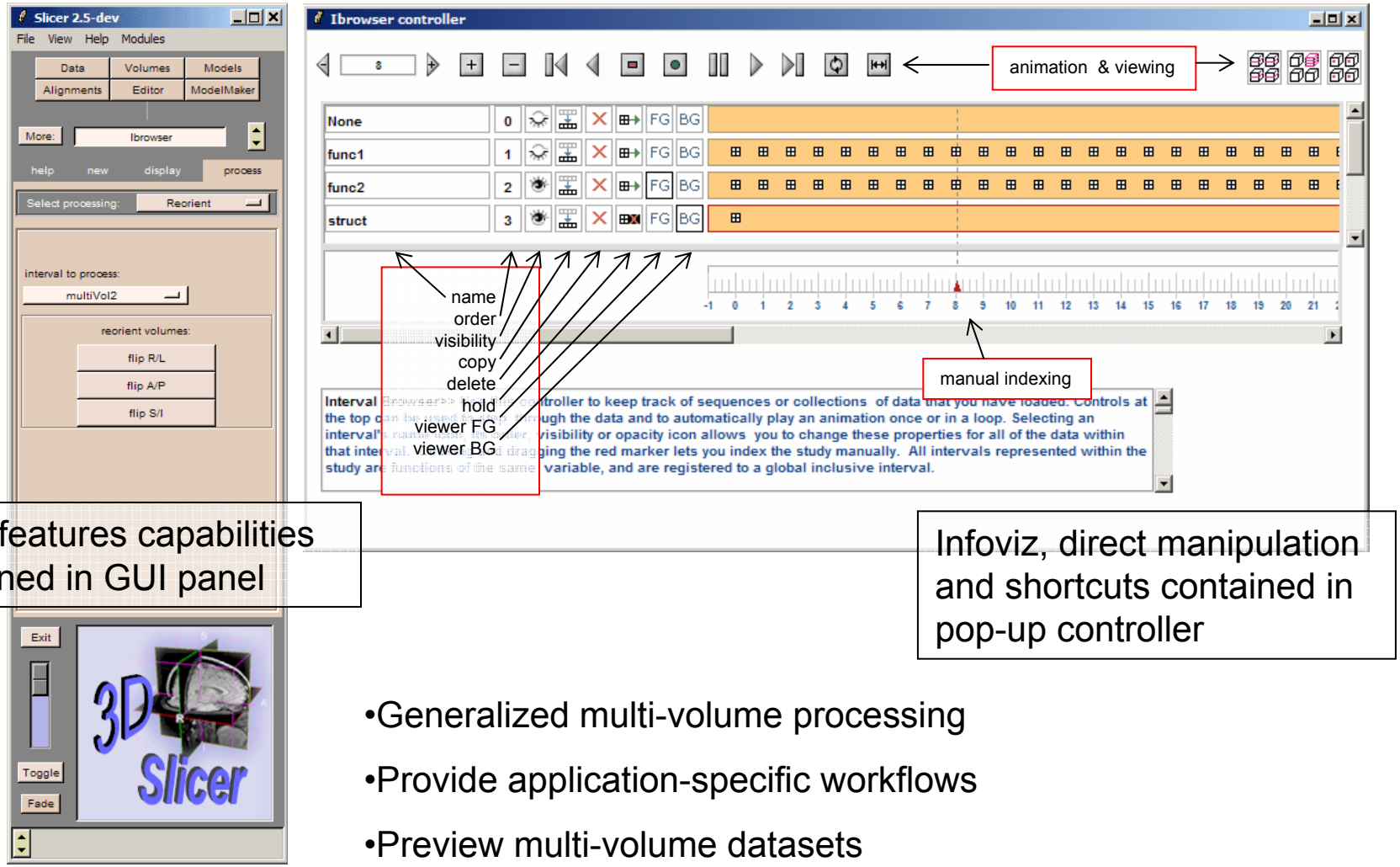


Basic features capabilities contained in GUI panel

Infoviz, direct manipulation and shortcuts contained in pop-up controller

- Generalized multi-volume processing
- Provide application-specific workflows
- Preview multi-volume datasets
- Organize and manipulate large multi-volume datasets

Interval browser: Basic and developing features



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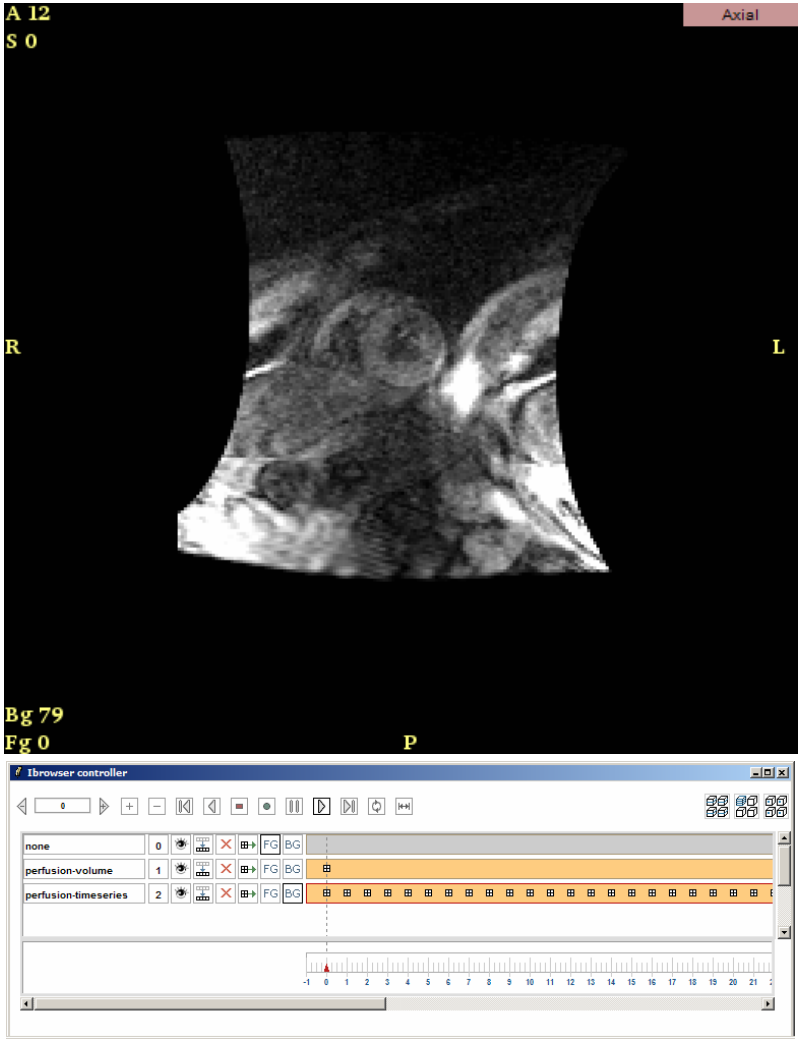
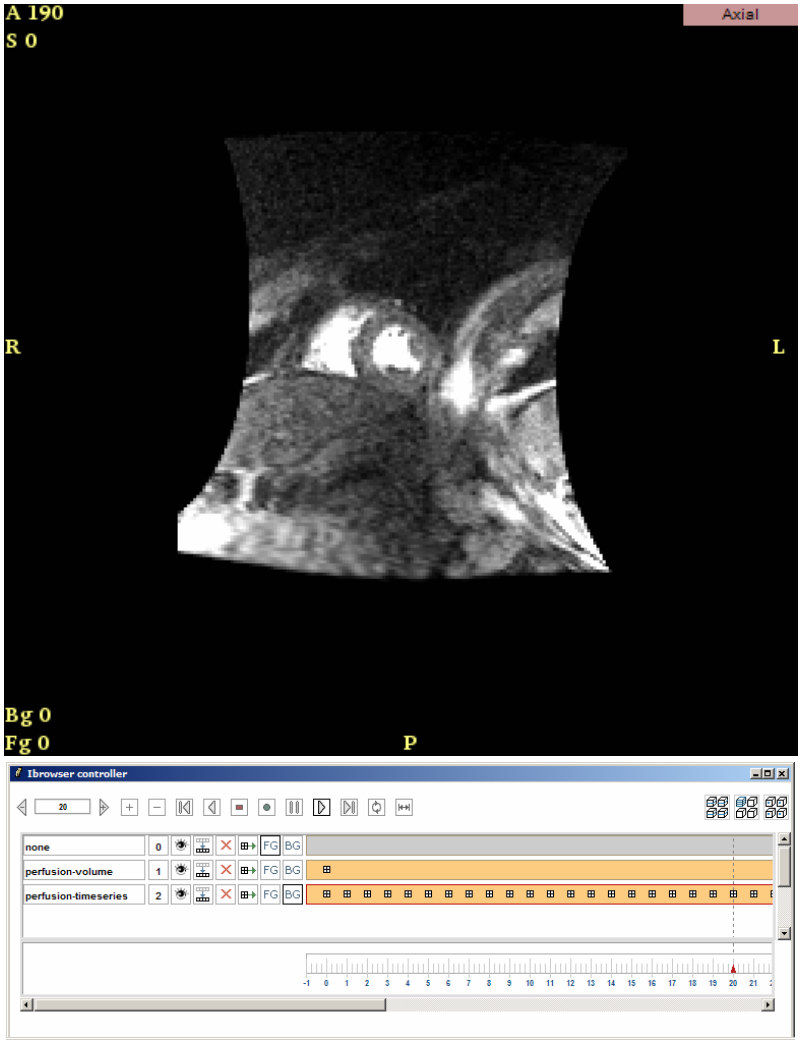




visualizing animated cardiac perfusion study courtesy Raymond Kwong (BWH)

Interval browser: Features under development

Loading: XCEDE, MINC…

Representation: MRMLIntervalData, MRMLVolumeGroups, MRML3

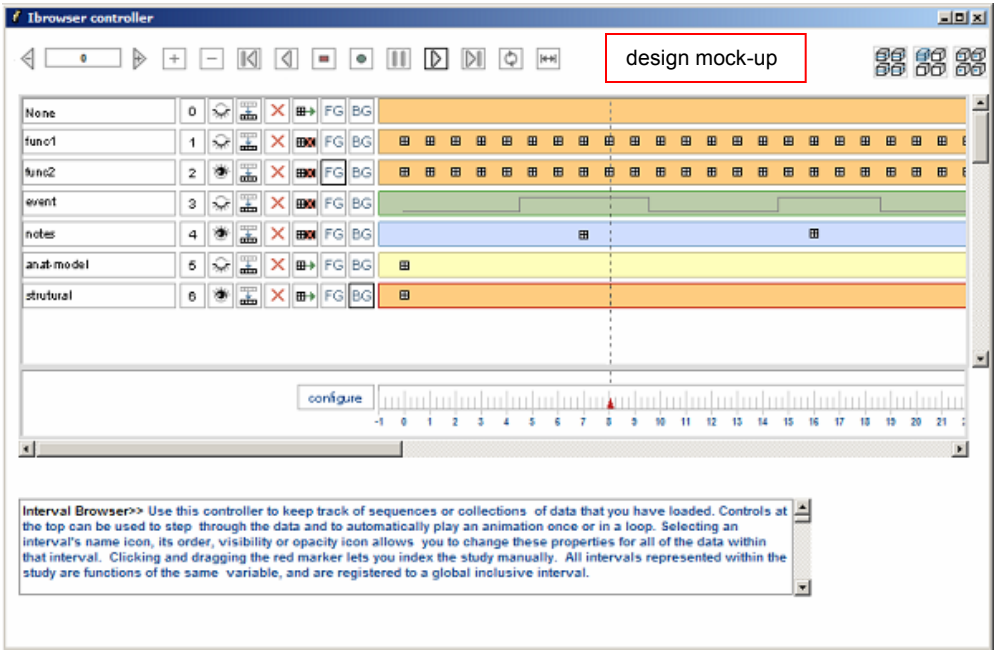
General processing: workflow for fMRI preprocessing; non-rigid registration tools; normalized morphological space…

Viewing: lightbox views.

Other data types: representing events, model geometry, annotations.

Saving: currently no way to save multi-volume data as a scene.

…



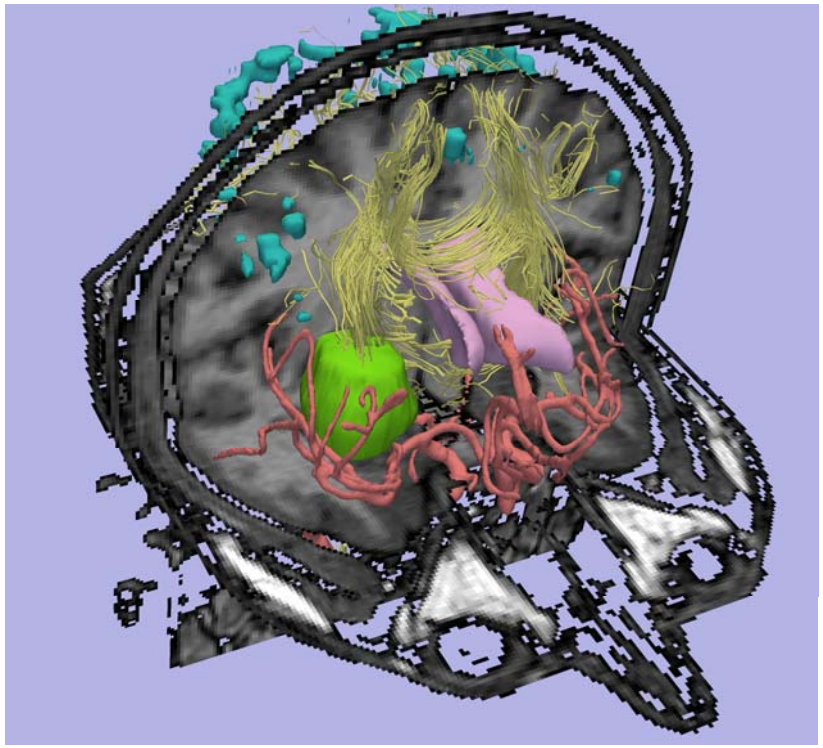
fMRIEngine: motivation

Goals: Provide an extensible suite of activation detection algorithms for fMRI analysis; easy to drop in to

•the software,

•the interface, and

•the workflow;



- fMRI statistical parametric maps +
- Structural: MRI Tumor Segmentation
- DTI
- MEG
- Anatomy Atlas: “Textbook” Information…

fMRIEngine: Design Goals

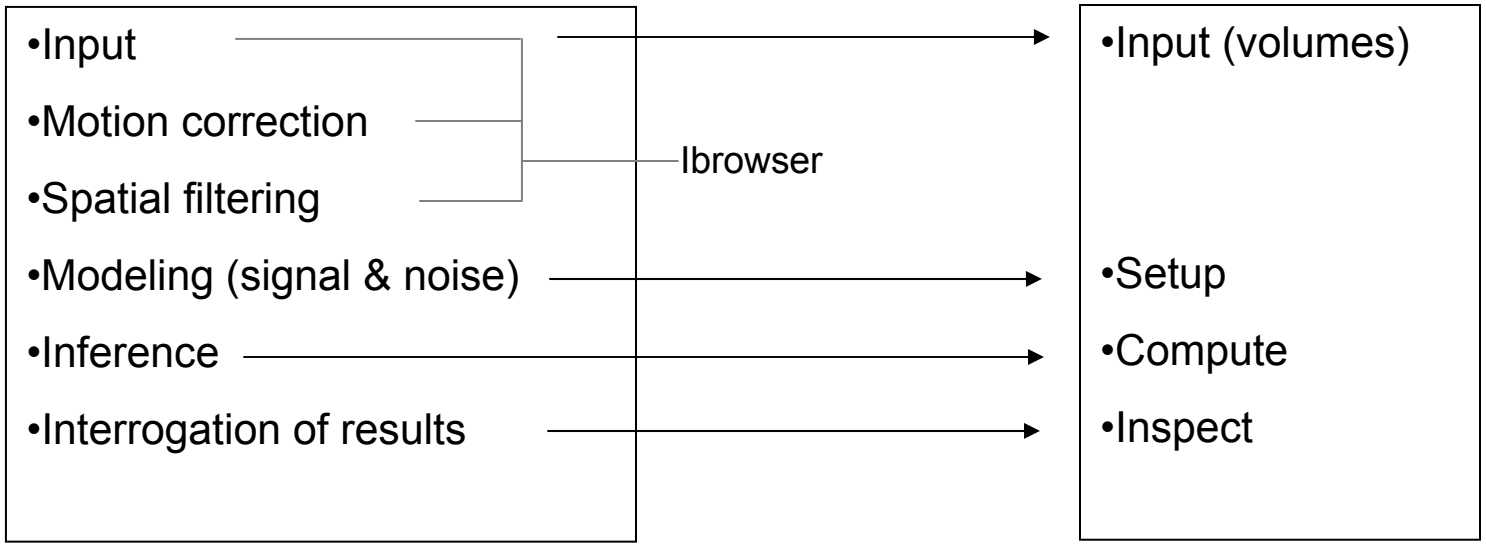
Interfaces for fMRI analysis packages tend to be complicated.

Design goals for GUI:

- Easily adaptable for new activation detectors
- Simple to compare detectors
- Support users' workflow
- Provide help & info where appropriate

fMRIEngine: Design Goals

fMRI analysis: GUI reflects common workflow (needs assessment)

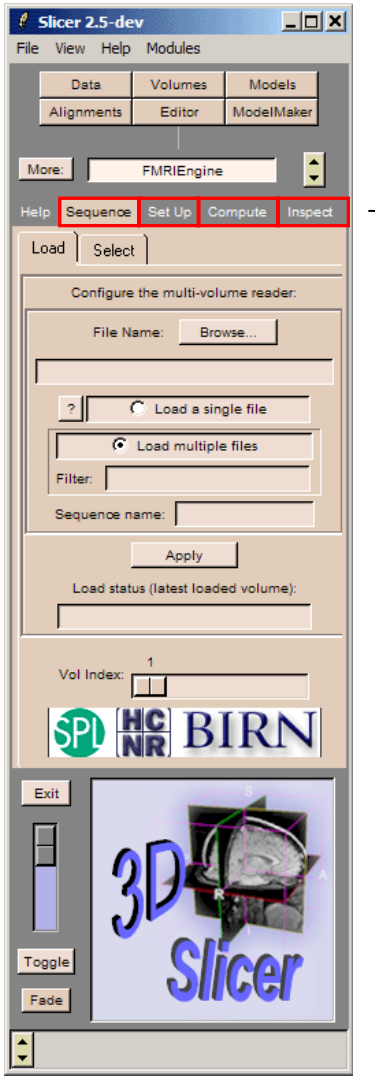


Lai, Gollub, Hoge, Greve, Vangel, Poldrack, Greenberg, Teaching Statistical Analysis of fMRI Data *Proc ASEE*, 2003

(simulation for teaching statistical analysis of fMRI data)

fMRIEngine: Design Goals

fMRI analysis: GUI top level tabs reflect these basic steps



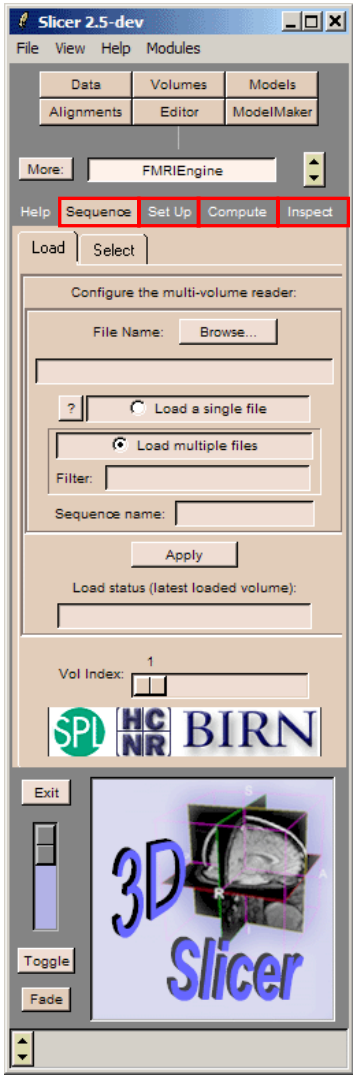
- Input (volumes)
- Set Up
- Compute
- Inspect

fMRIEngine: Design Goals

fMRI analysis: GUI top level tabs reflect these basic steps

Top-level flow:

1. Sequence: data loading or selection
2. Set up: Detector Selection, Paradigm specification, modeling, contrast definition, model viewing
3. Compute: generate activation volumes
4. Inspect: visualization, statistical inference, and interactive interrogation of results

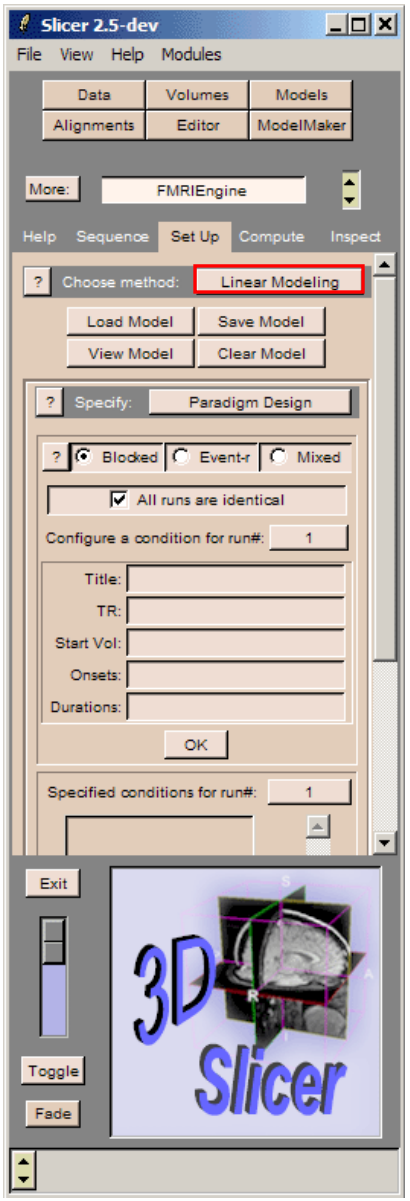


fMRIEngine: Basic and developing features

Gui consistency to simplify user's experience:

Set up frame: choose a detector

Only Set up frame changes depending on detection method selected



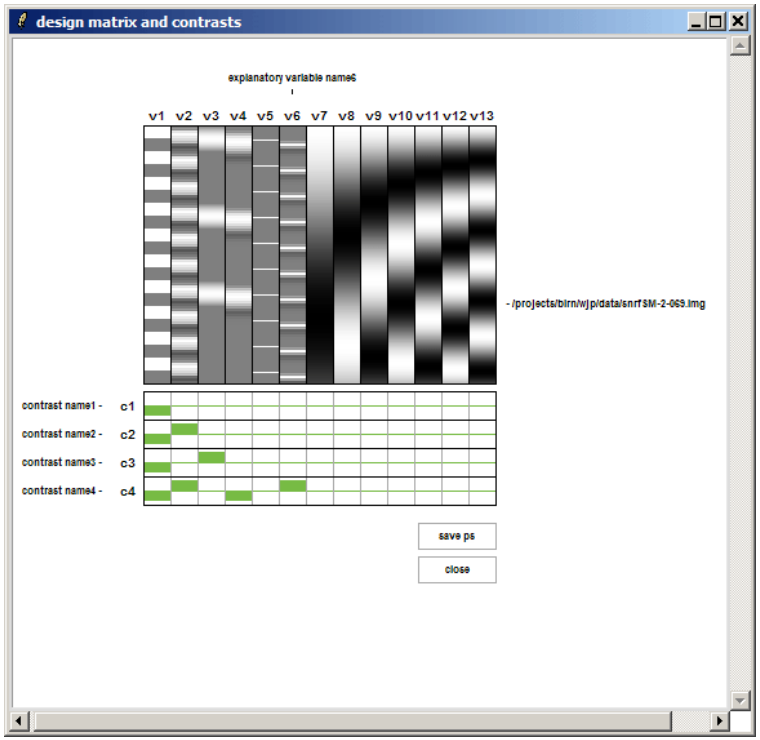
fMRIEngine: Basic and developing features

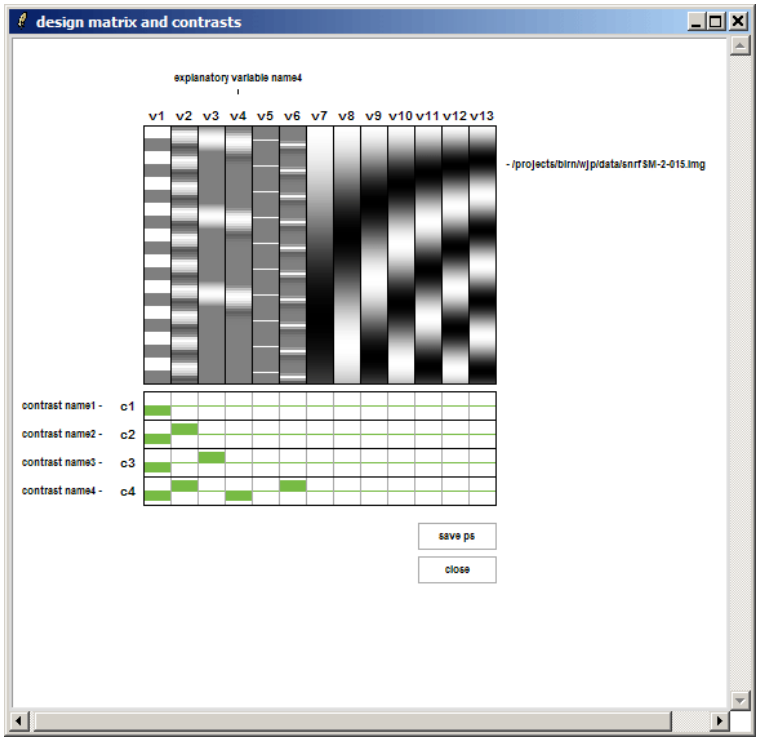
Visualizing design:

Popup window shows defined explanatory variables and contrasts

Surfable: displays user-defined explanatory variable names and associated filename on mouseover.

Save to file

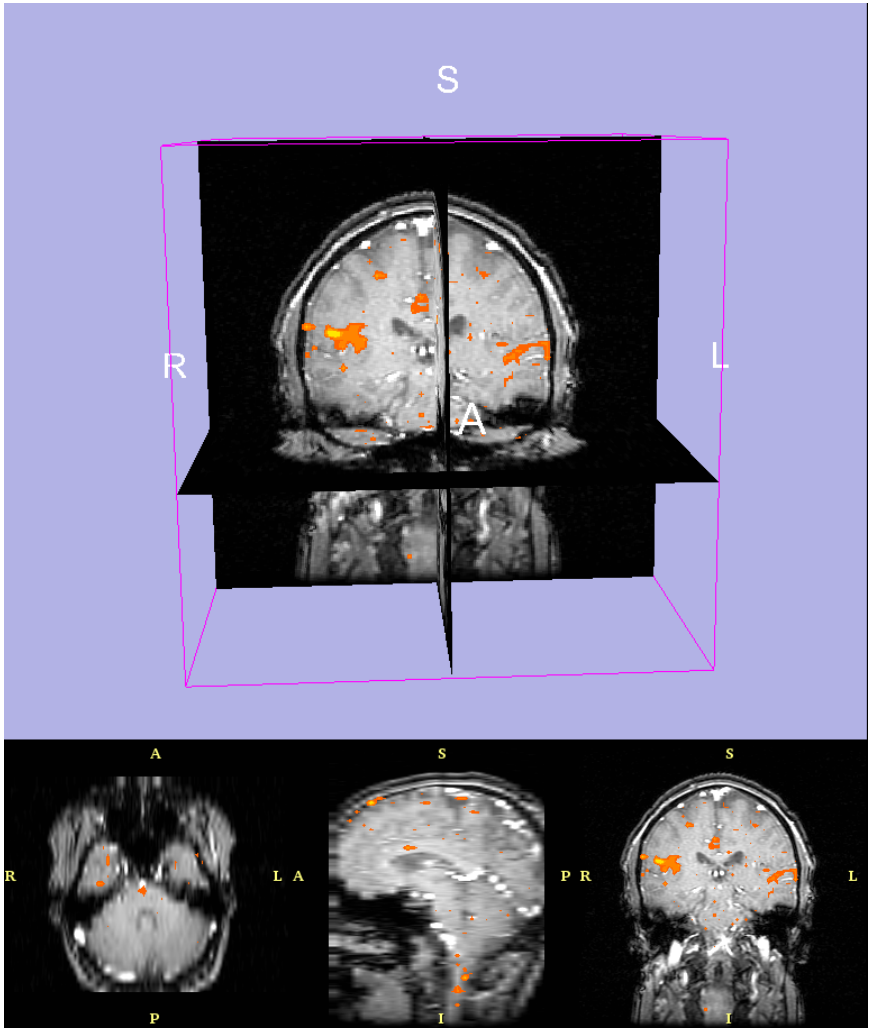




(fake paradigm and additional regressors!)

fMRIEngine: Basic and developing features

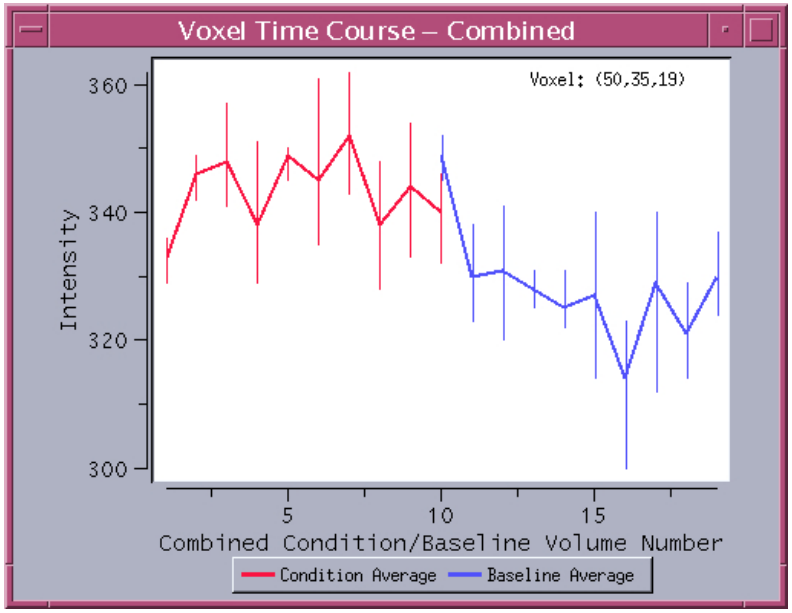
fMRIEngine: interactive inspection of voxel timecourse



Click on a voxel in the slice windows…

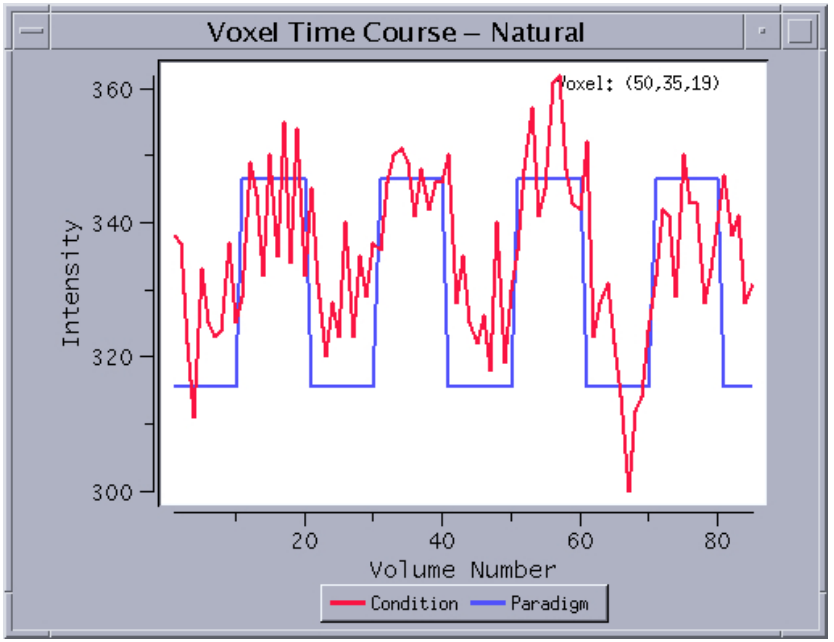
fMRIEngine: Basic and developing features

popup voxel timecourse plotting:



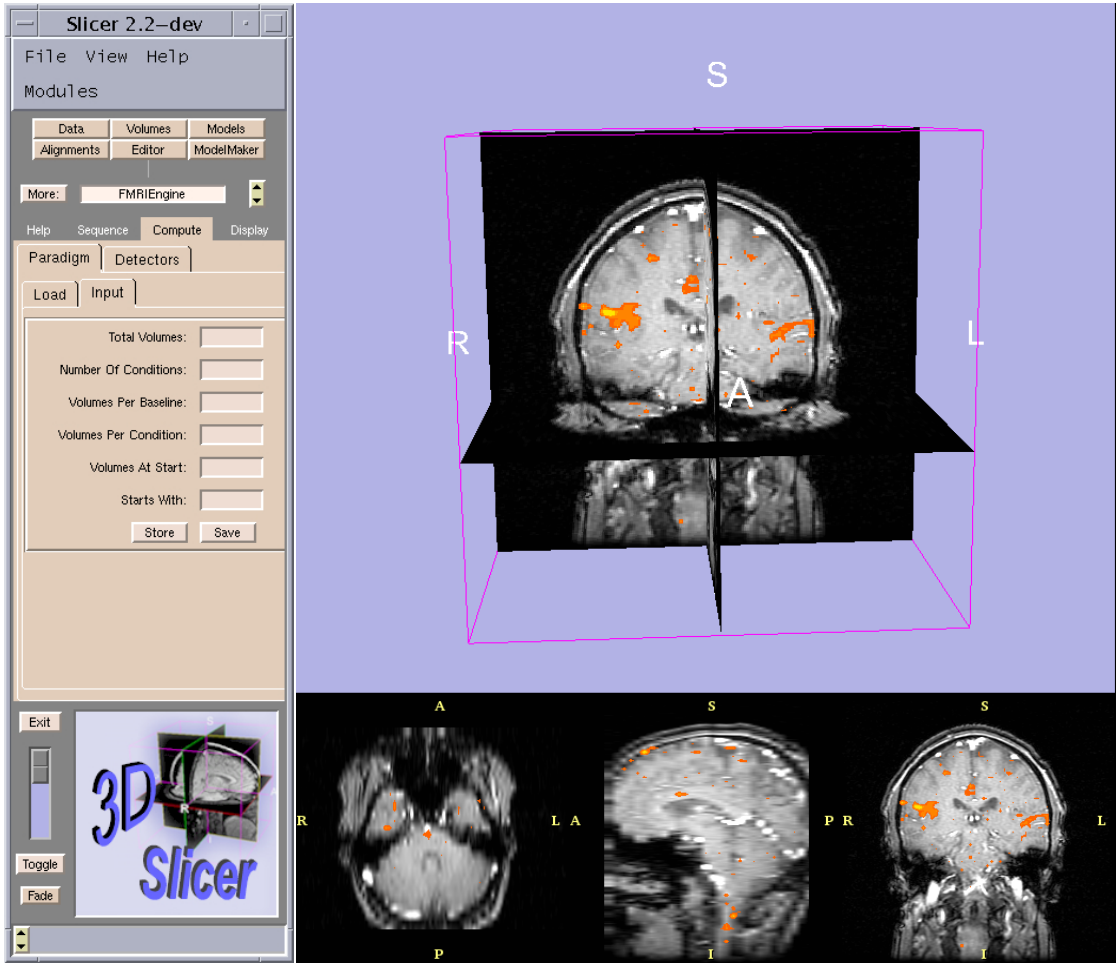
Peristimulus histogram: Average voxel timecourse for all volumes in each of two experimental conditions

observed voxel timecourse versus condition over entire protocol



fMRIEngine: Slicer 2.4 release (early version)

Simpler interface, basic data loading, paradigm specification, activation detection (linear modeling with single regressor), visualization and timecourse plotting.



fMRIEngine: Features under development

ongoing & future work:

Visualizing FSL data: currently reads FSL-generated output in Slicer, including activation detection results, pop-up voxel timecourse plots and FSL's HTML analysis report (old version of FSL); improving interoperation with FSL.

Modeling, contrast specification: error modeling, other basis functions for drift (polynomial, spline), modeling linear, quadratic effects, F-tests

Analysis and Visualization: island removal, ROI analyses,

Saving output: scenes, quantitative output from timecourse plots and report.

Extending native I/O: plans to develop native I/O routines to support other image formats, including XCEDE NIfTI and MINC.

Additional approaches to activation detection: MI-based activation detection, PCA-based approach, incorporation of spatial priors (Sandy Wells)

fMRIEngine: paradigm for demo

demo