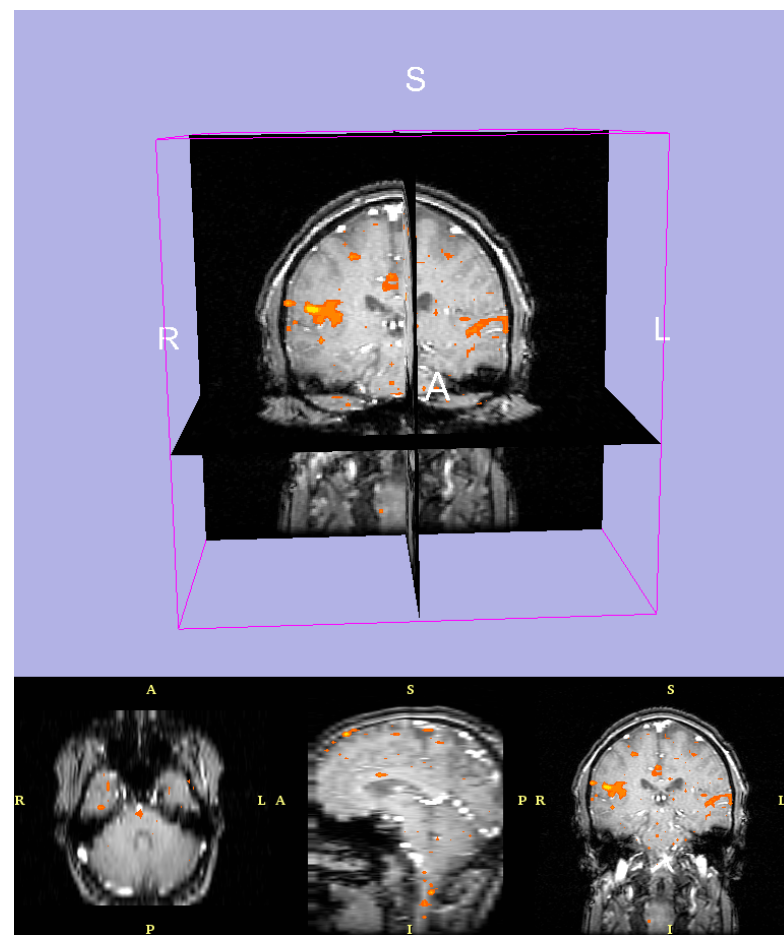


Interval browser and fMRIEngine

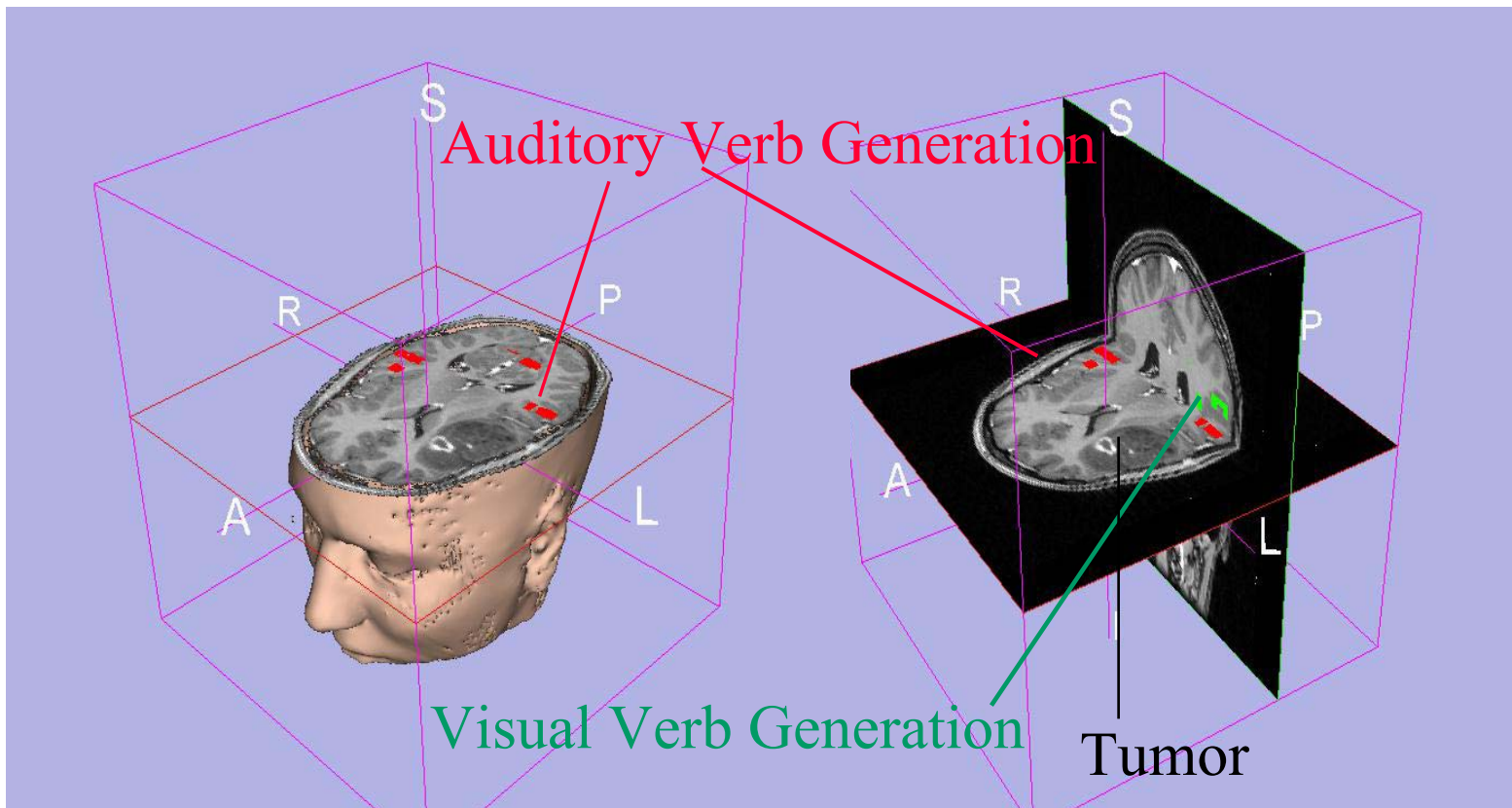
- Slicer tools for fMRI analysis and other multi-volume applications
- Separate general handling & processing of multi-volume data and more specialized application-specific processing
- Tools: [Ibrowser](#), [fMRIEngine](#) (Slicer 2.4, early prototypes)
- Interoperate with Slicer's other multimodality 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

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

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

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

- Demo

Interval browser: Basic Features

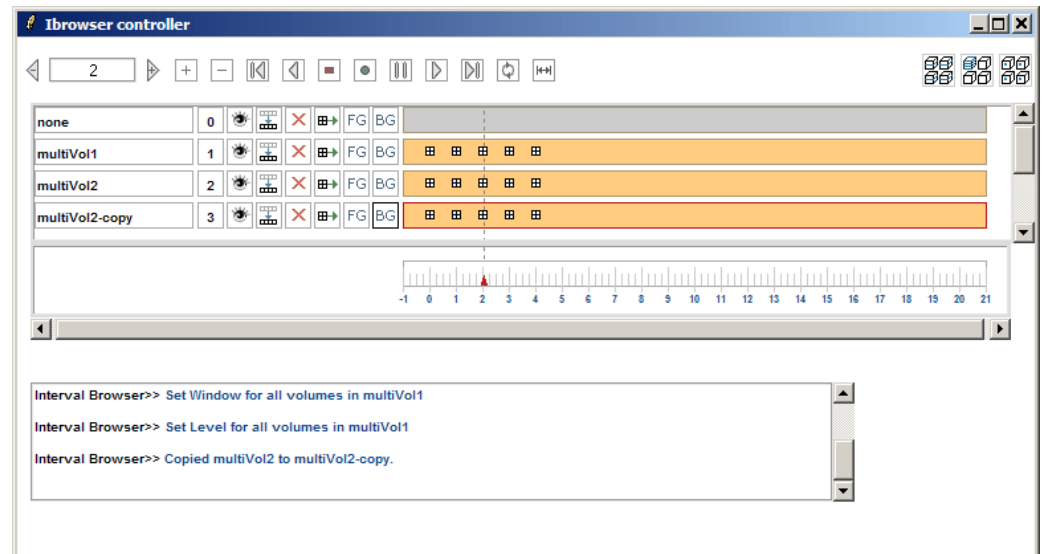
Loading: Analyze (3D and 4D), DICOM, BXH (BIAC XML Header) format data, (XCEDE soon);

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.

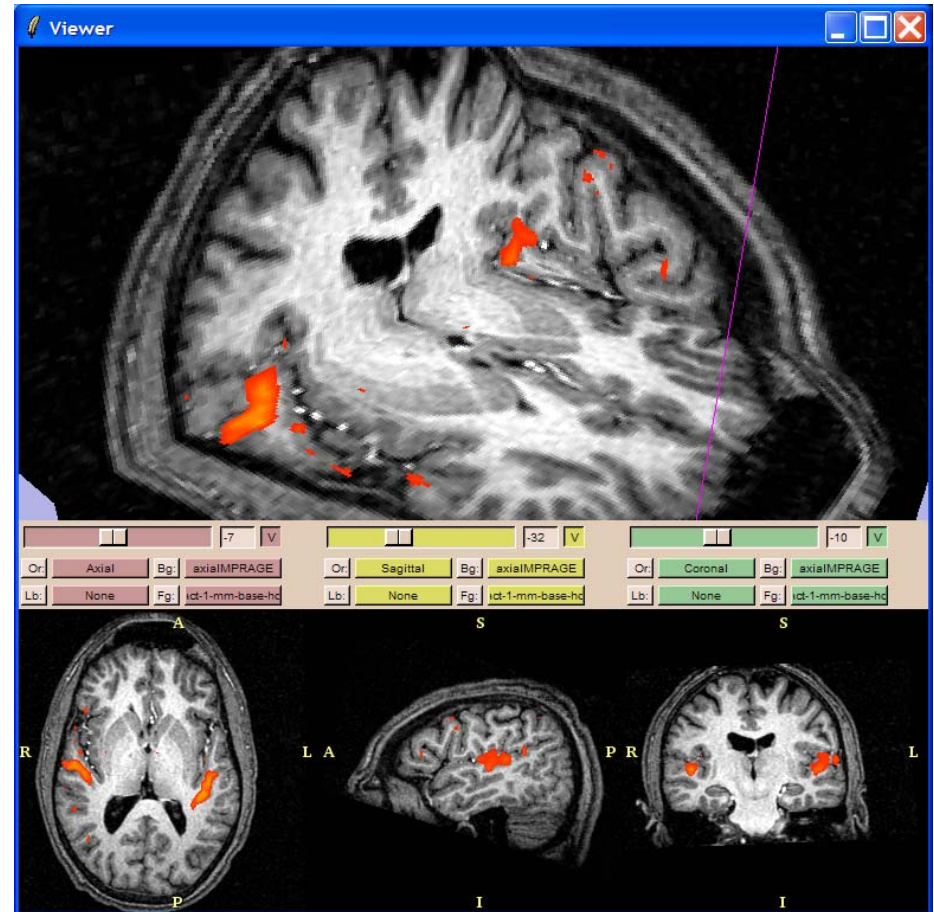
Shortcuts for manipulation and viewing: manual or automated animation over the interval.



fMRIEngine: Basic Features

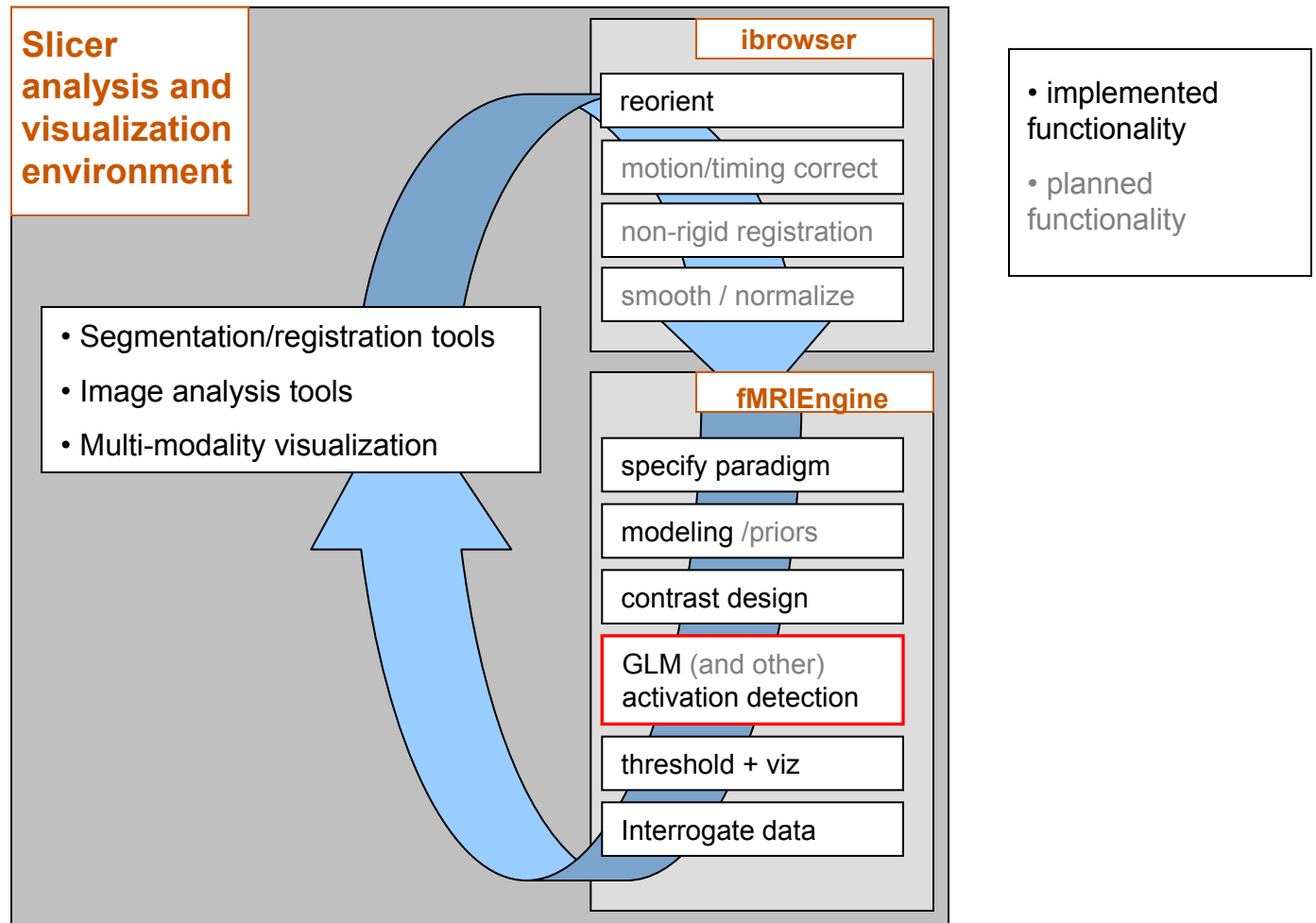
- **Data loading:** Loads Analyze (3D and 4D), DICOM, BXH (BIAC XML Header) format data, (XCEDE soon); or imports from Interval Browser;
- **Protocol specification:** input blocked design, event-related or mixed design via GUI or load/save in text file;
- **Activation computing:** specify contrasts, 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)

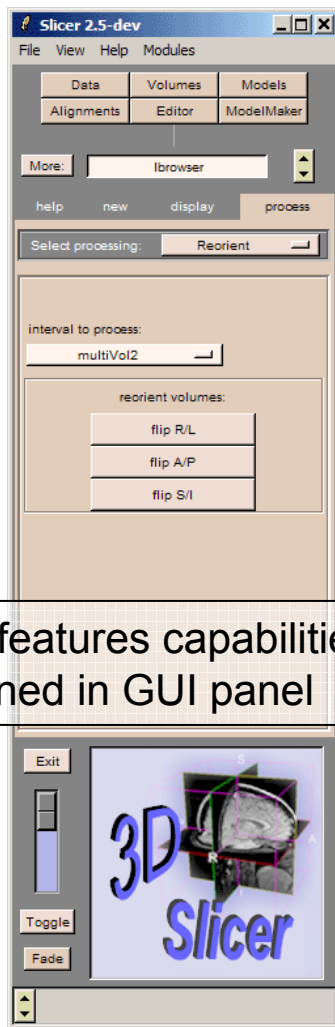


Interval browser and fMRIEngine: combined workflow

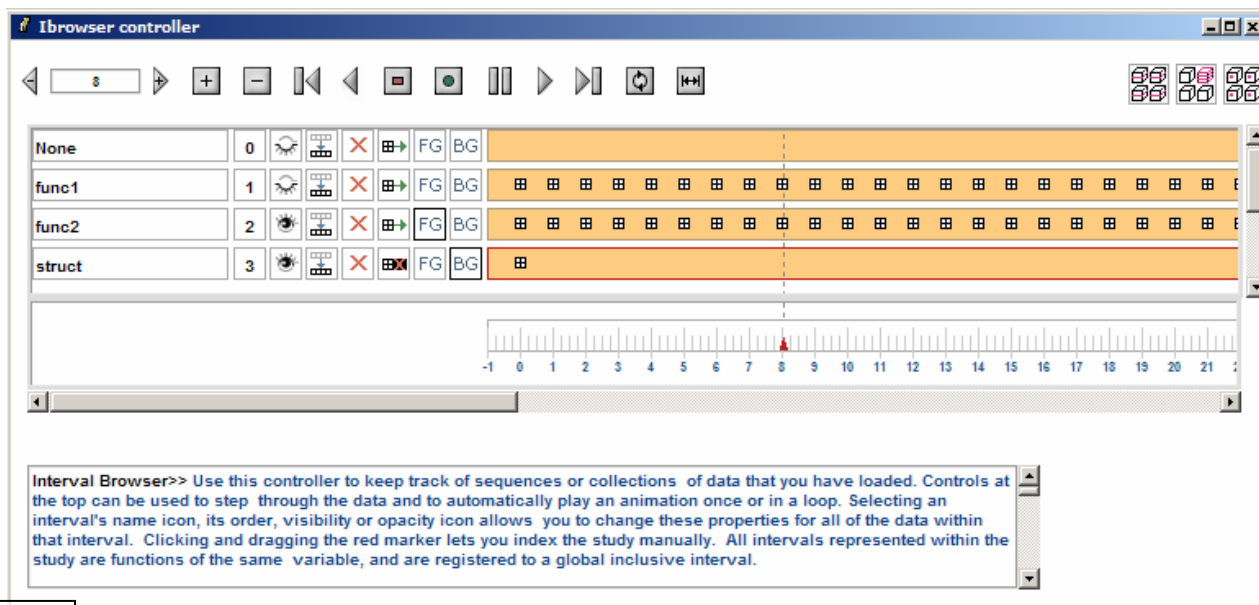
Goal: fMRI and multi-volume tools interoperate with Slicer's other modules



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

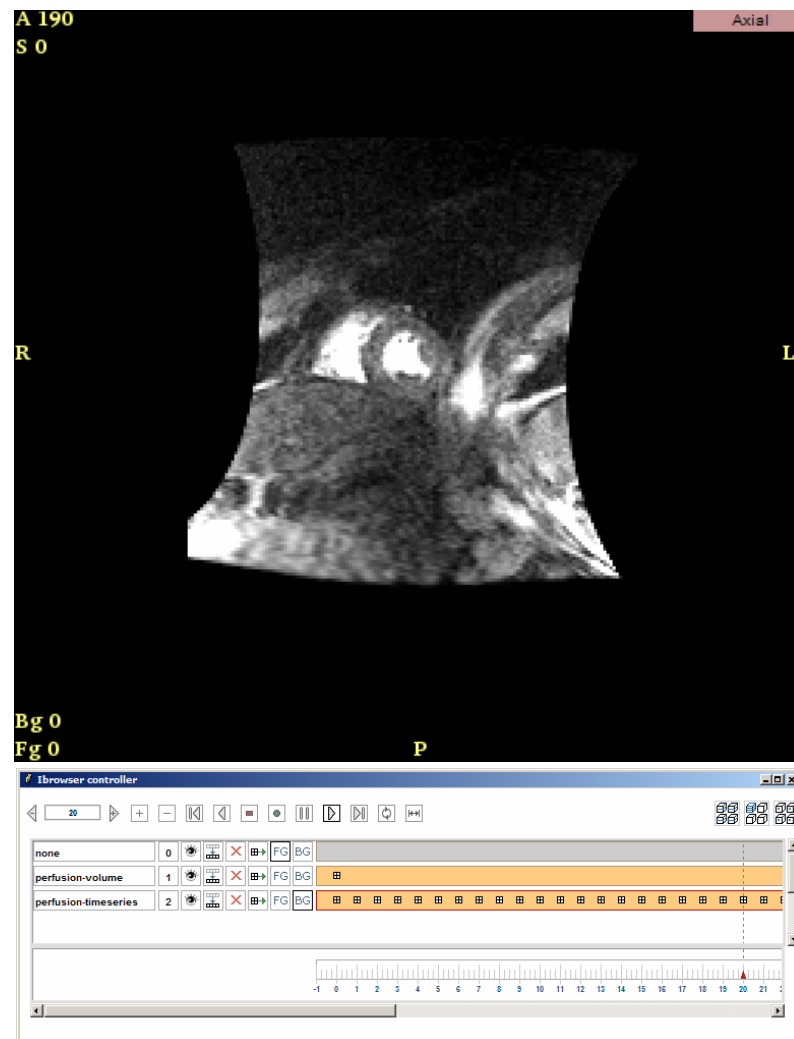
The image displays two software interfaces. On the left is the Slicer 2.5-dev GUI, showing a menu bar (File, View, Help, Modules), a toolbar with buttons for Data, Volumes, Models, Alignments, Editor, and ModelMaker, and a central panel for processing intervals. The 'interval to process' is set to 'multiVol2', and 'reorient volumes' options (flip R/L, flip A/P, flip S/I) are visible. On the right is the 'Ibrowser controller' window, which features a toolbar with navigation and animation controls, a table of intervals, and a timeline. The table lists intervals: 'None', 'func1', 'func2', and 'struct', each with a sequence number, visibility icons, and viewer options (FG, BG). A red box highlights the 'animation & viewing' toolbar, and another red box highlights the 'manual indexing' feature on the timeline. A third red box highlights a list of actions: name, order, visibility, copy, delete, hold, viewer FG, and viewer BG, with arrows pointing to the corresponding icons in the table. A text box at the bottom right explains the controller's purpose: 'Interval browser controller to keep track of sequences or collections of data that you have loaded. Controls at the top can be used to play through the data and to automatically play an animation once or in a loop. Selecting an interval's name, visibility or opacity icon allows you to change these properties for all of the data within that interval. Dragging the red marker lets you index the study manually. All intervals represented within the study are functions of the same variable, and are registered to a global inclusive interval.'

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



visualizing animated cardiac perfusion study courtesy Raymond Kwong (BWH)

Interval browser: Features under development

Loading: XCEDE, MINC...

Representation:

MRMLIntervalData,

MRMLVolumeGroups, [MRML3](#)

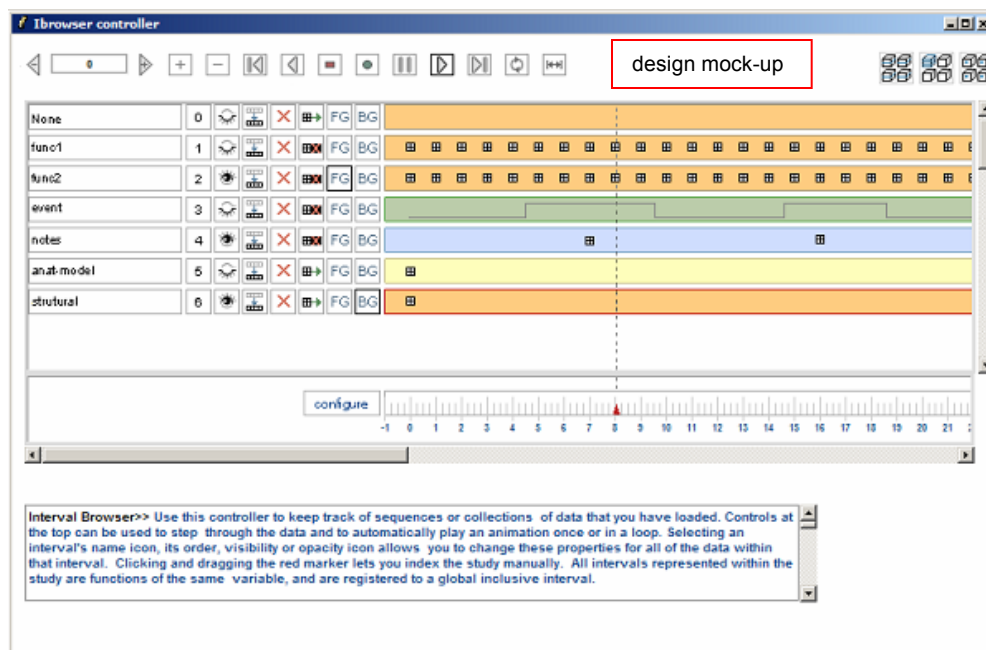
General processing: workflow for fMRI preprocessing; non-rigid registration tools; normalized morphological space...

Viewing: lightbox views.

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

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

...

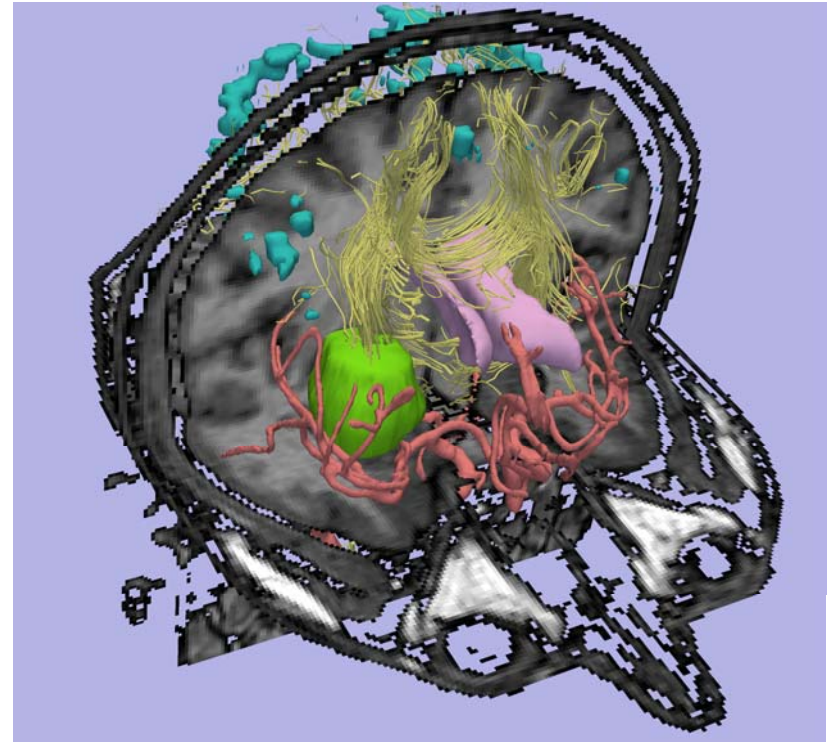


fMRIEngine: motivation

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

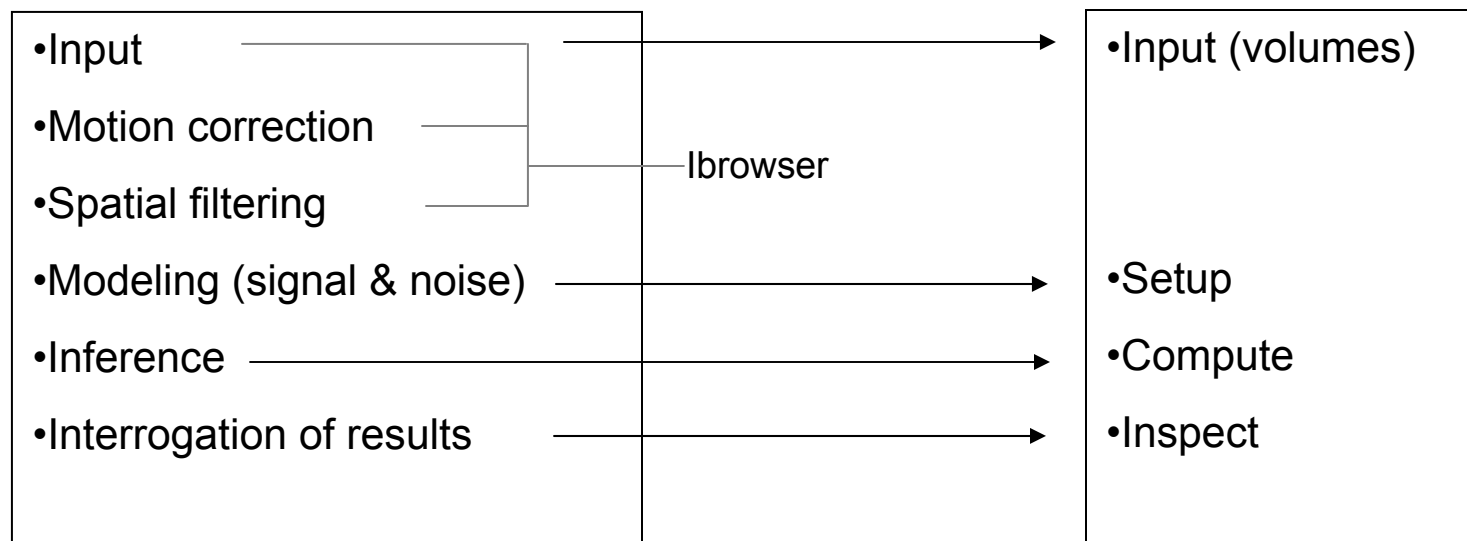
Interfaces for fMRI analysis packages tend to be complicated.

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)



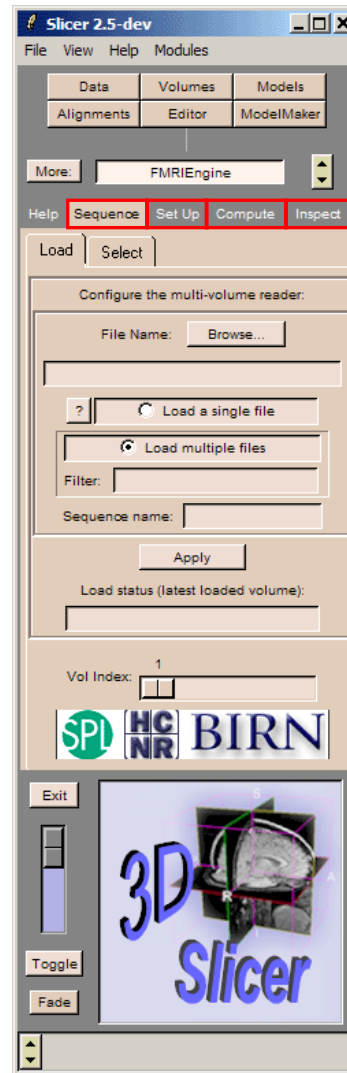
Lai, Gollub, Hoge, Greve, Vangel,
Poldrack, Greenberg, Teaching
Statistical Analysis of fMRI Data
Proc ASEE, 2003

fMRIEngine

(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

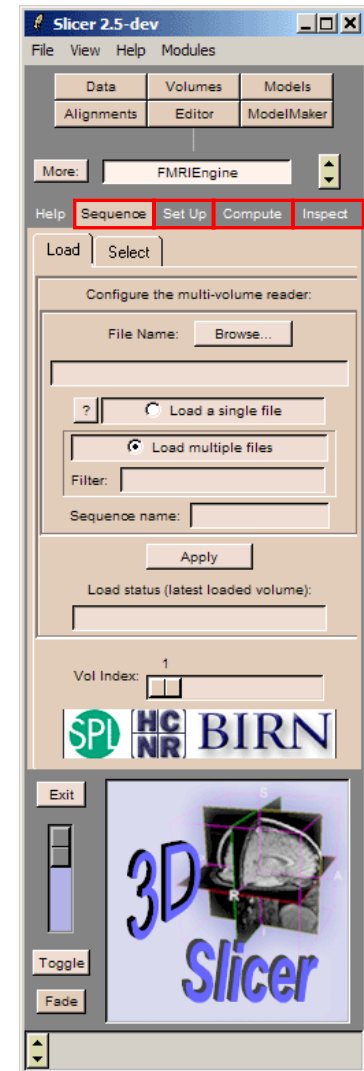
•Inspect

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

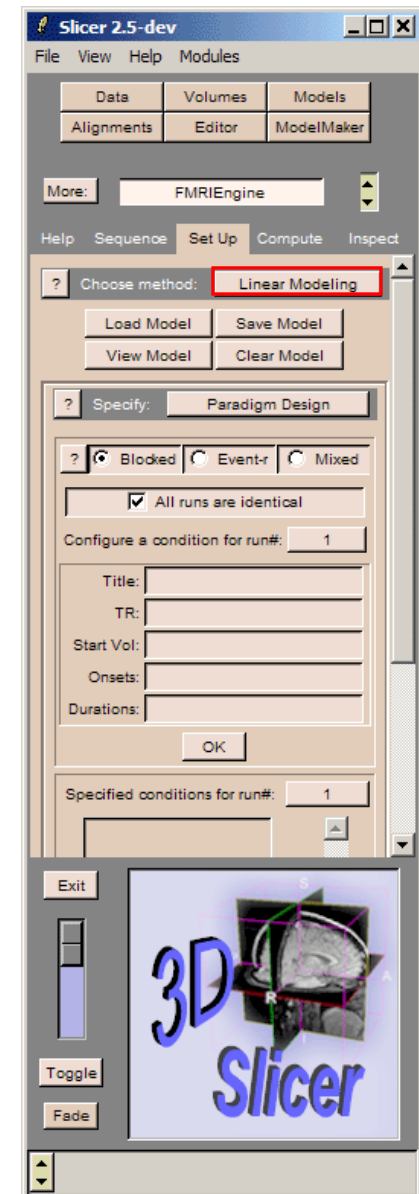


fMRIEngine: Basic and developing features

Gui consistency to simplify user's experience:

Set up frame: choose a detector

Only Set up frame changes depending on detection method selected



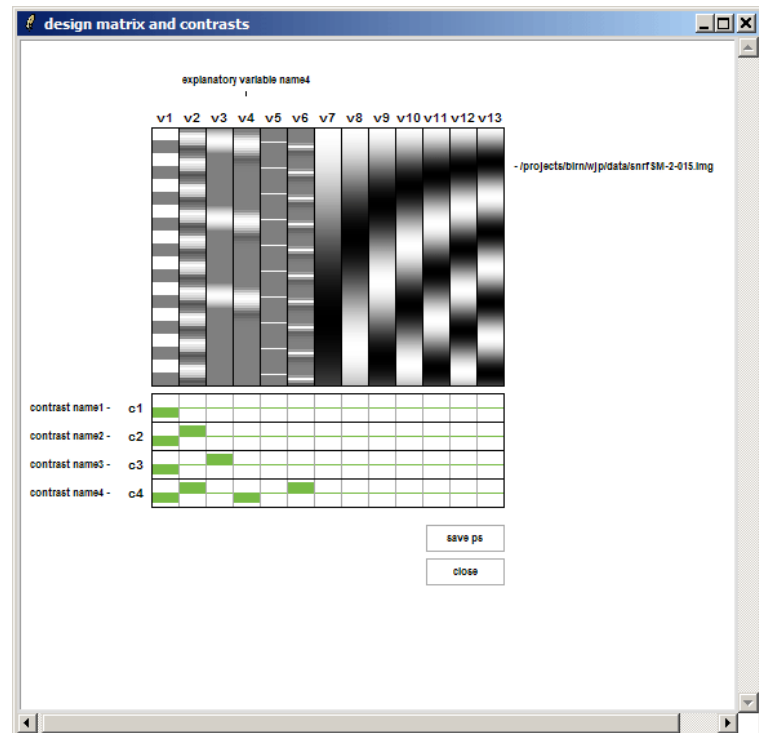
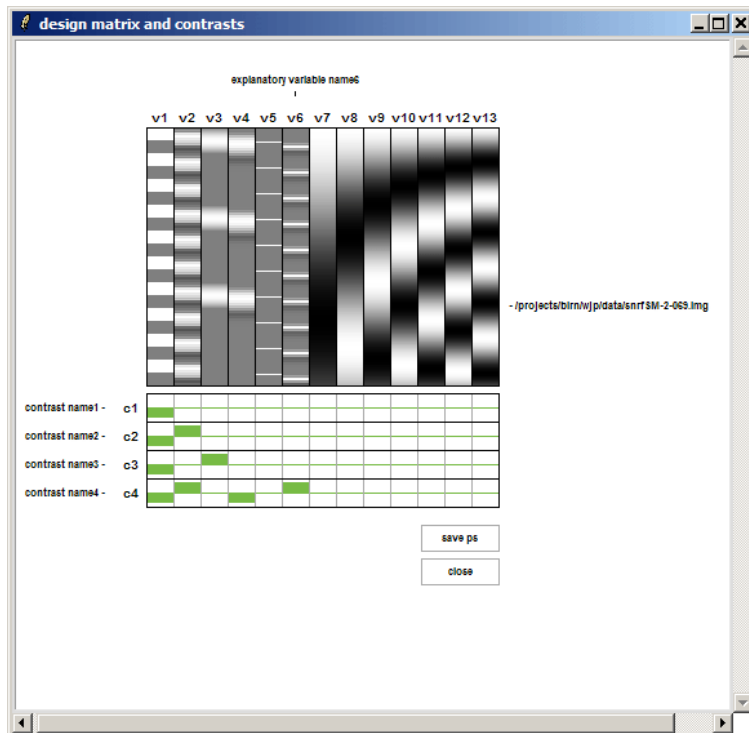
fMRIEngine: Basic and developing features

Visualizing design:

Popup window shows defined explanatory variables and contrasts

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

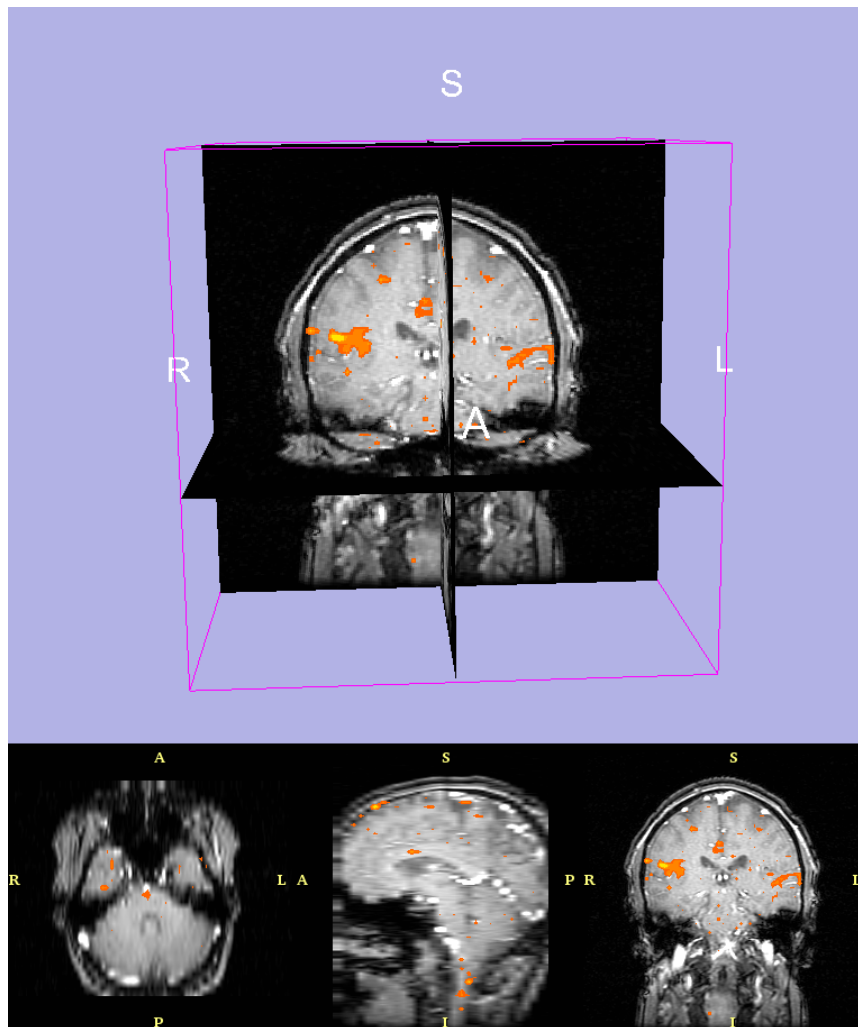
Save to file



(fake paradigm and additional regressors!)

fMRIEngine: Basic and developing features

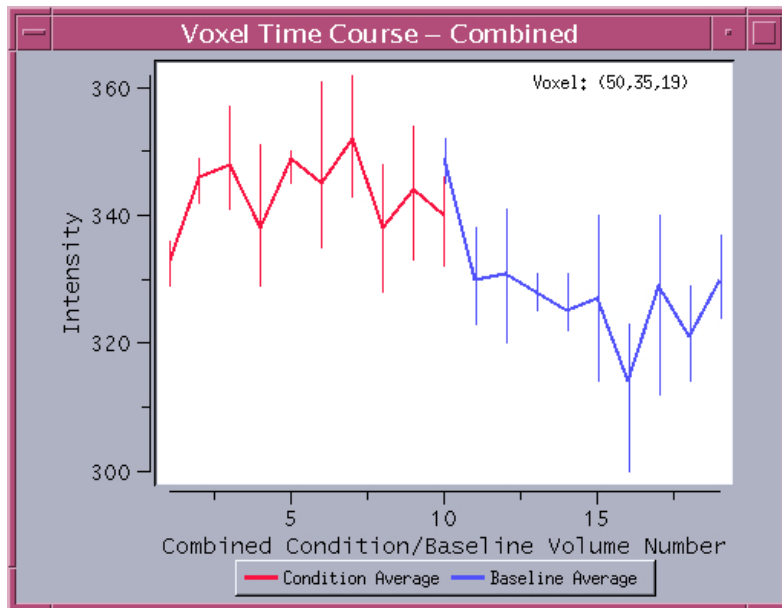
fMRIEngine: interactive inspection of voxel timecourse



Click on a voxel in the slice windows...

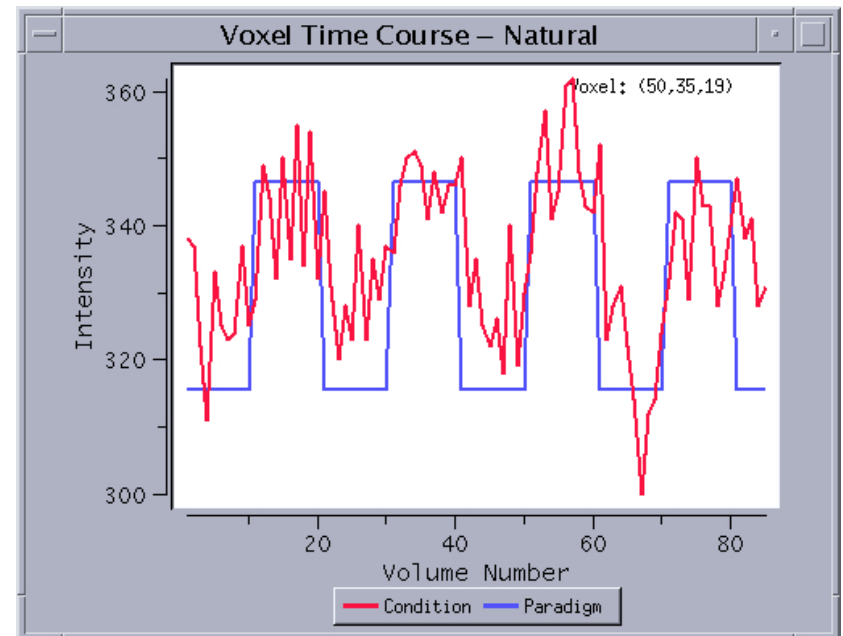
fMRIEngine: Basic and developing features

popup voxel timecourse plotting:



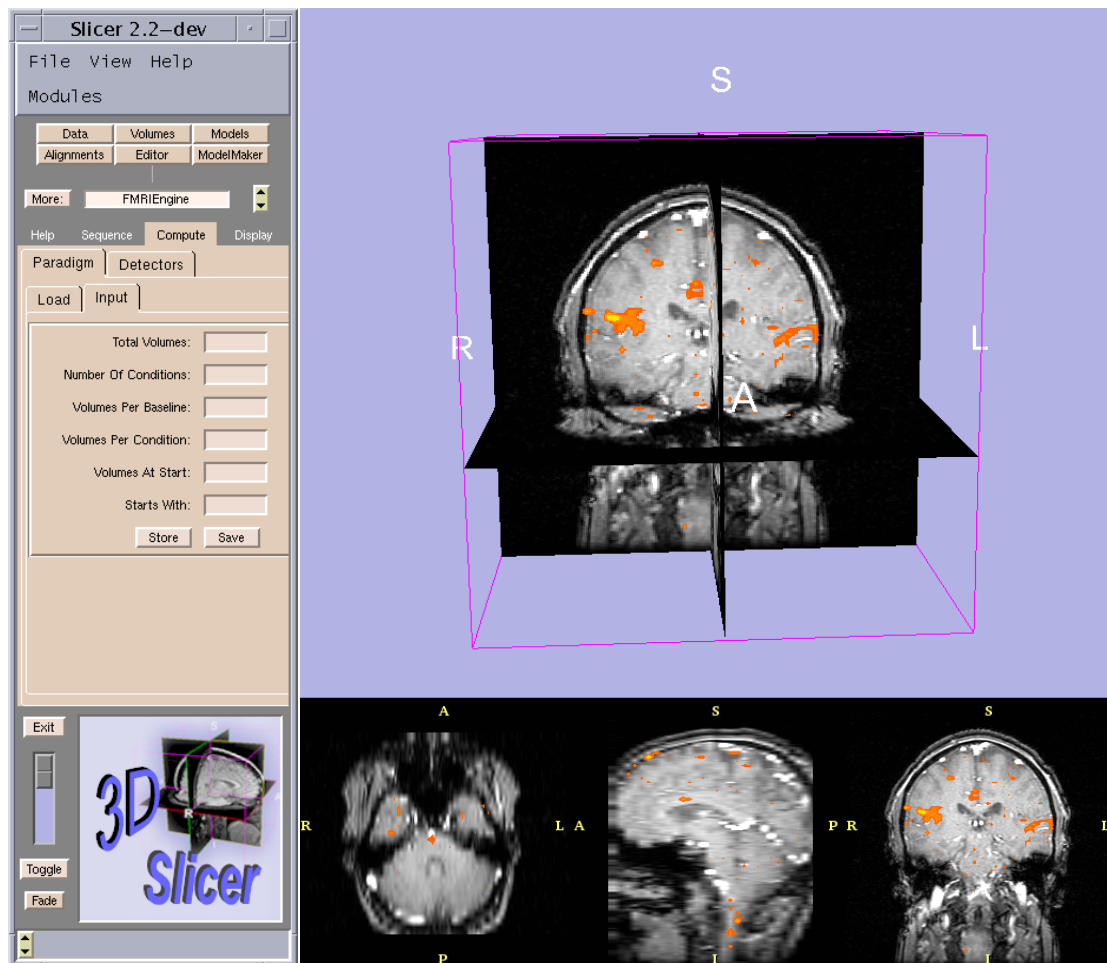
Peristimulus histogram: Average voxel timecourse for all volumes in each of two experimental conditions

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 interoperability 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

Mismatch Paradigm Diagram

