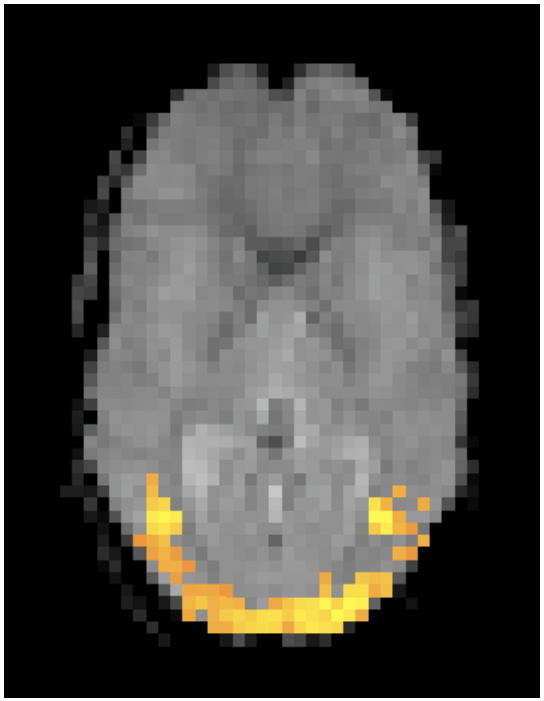
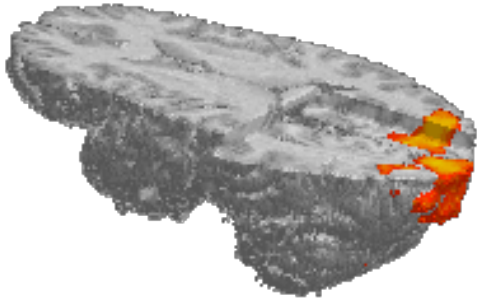
FMRI Pre-Statistics

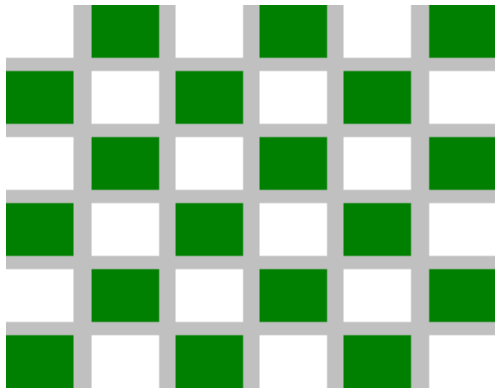
Brief introduction to Task FMRI experiments and analysis



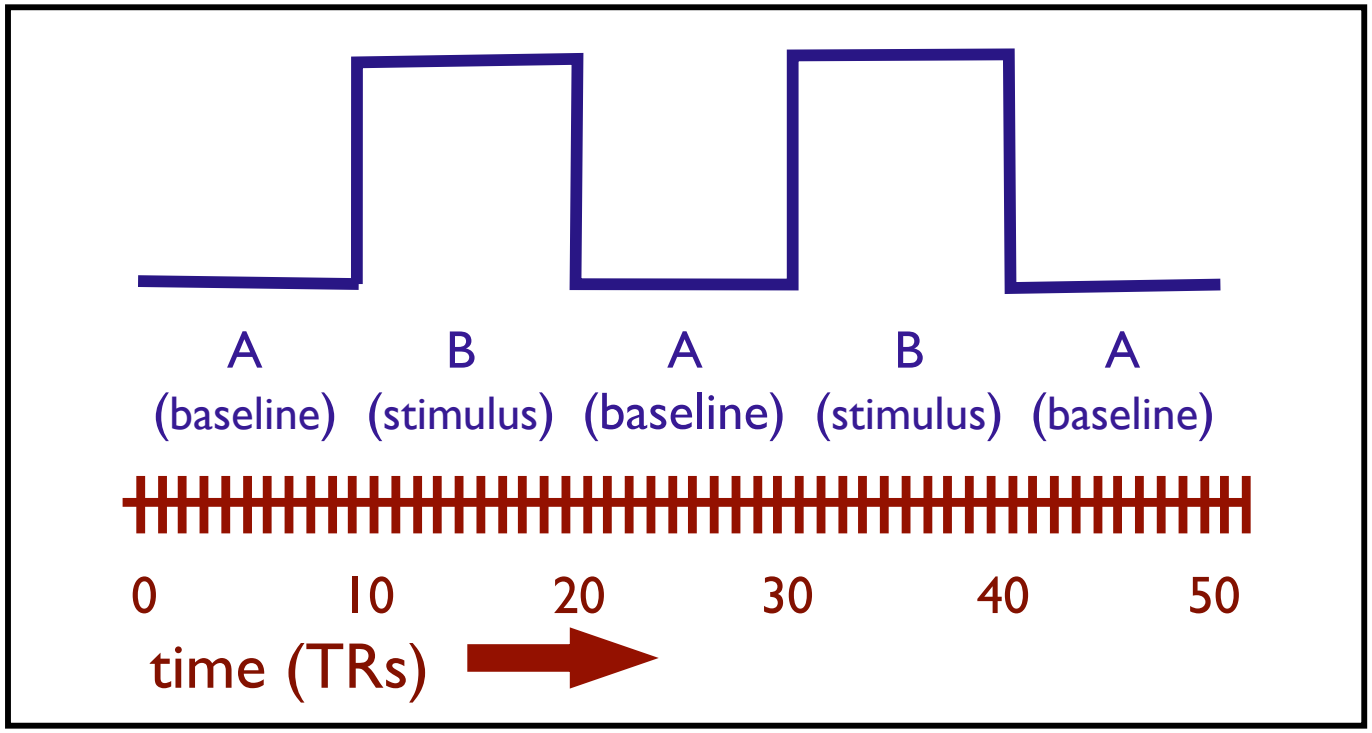


FMRI Experiments

Stimulus



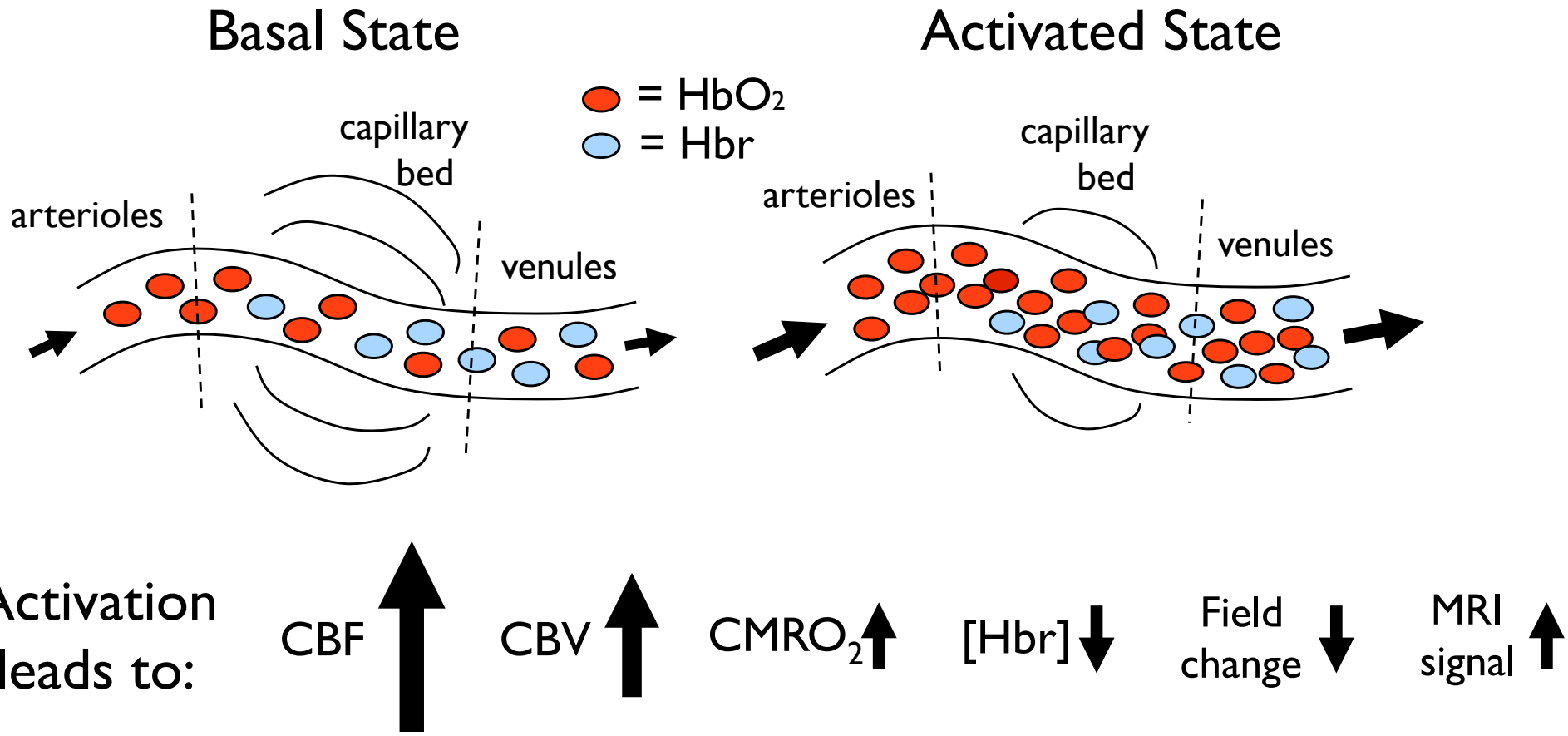
e.g. flashing chequerboard



- Simple paradigm design:
  - stimulus vs baseline
  - constant stimulus "intensity"
  - constant block lengths
  - many repetitions: ABABA

- Need baseline (rest) condition to measure *change*

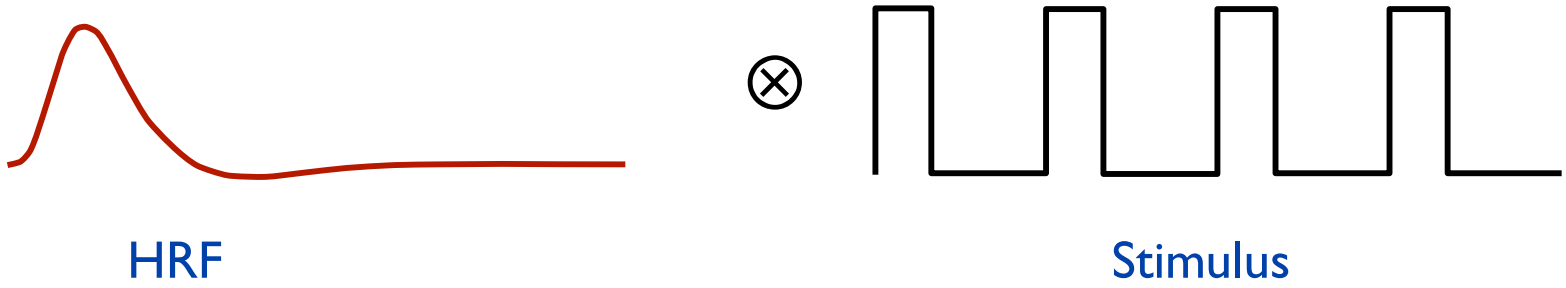
The Haemodynamic Response



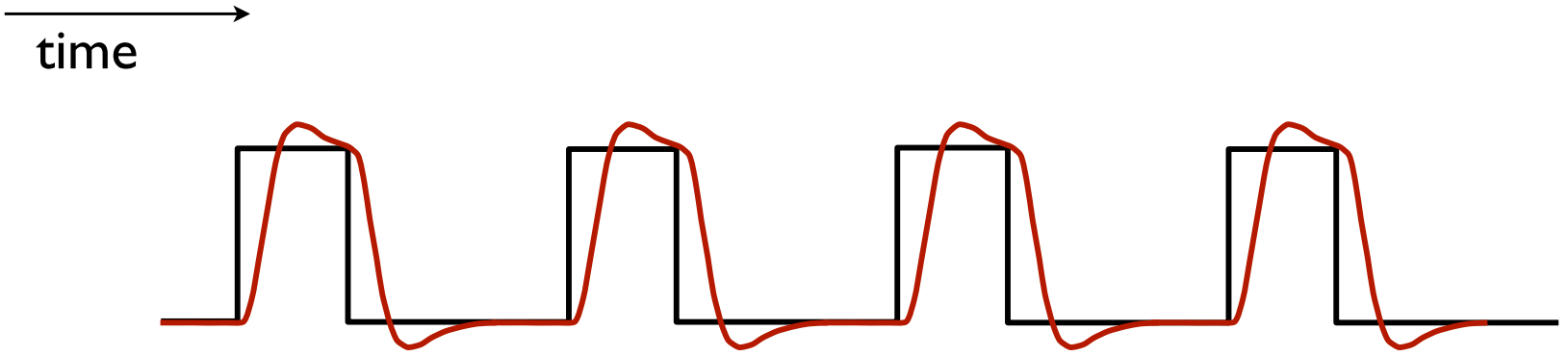
- Field changes (perturbations) --> dephasing --> T_2* effect
- BOLD-tuned MRI (T_2*-weighted) is sensitive to this effect

Predicted Response

- The process can be modelled by convolving the activity curve with a "haemodynamic response function" or HRF



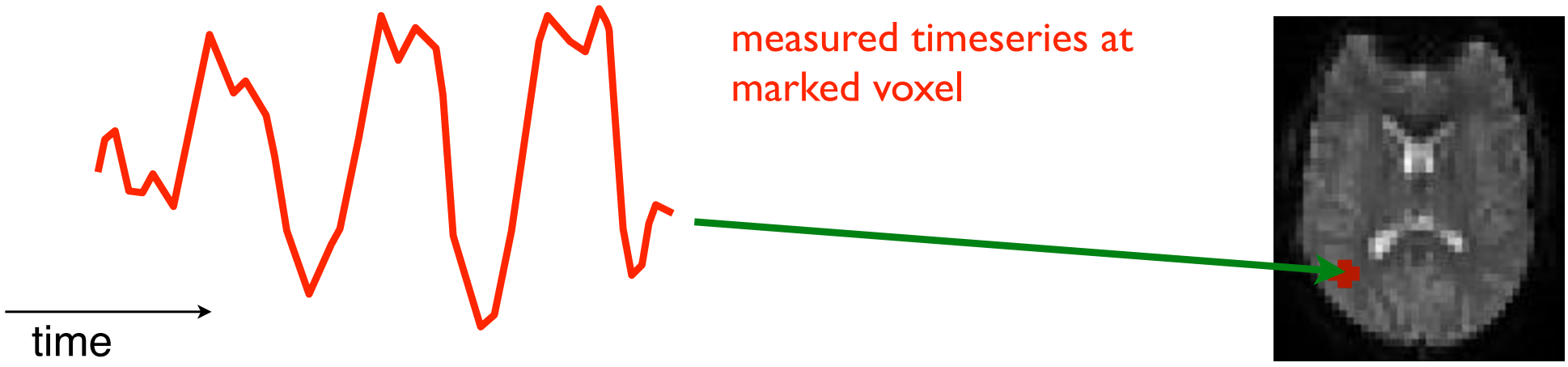
HRF ⊗ Stimulus



Predicted response

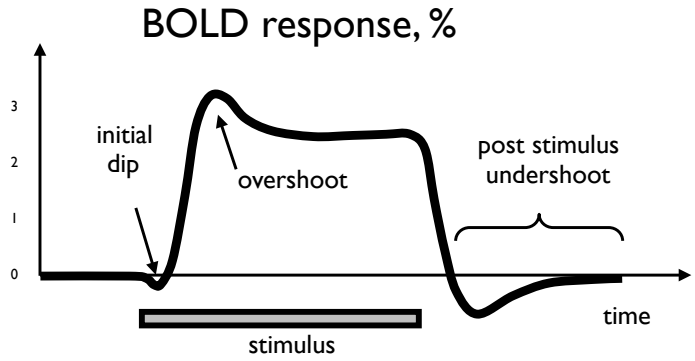
FMRI Experiments: Analysis

- Each voxel contains a time-varying signal (BOLD signal)

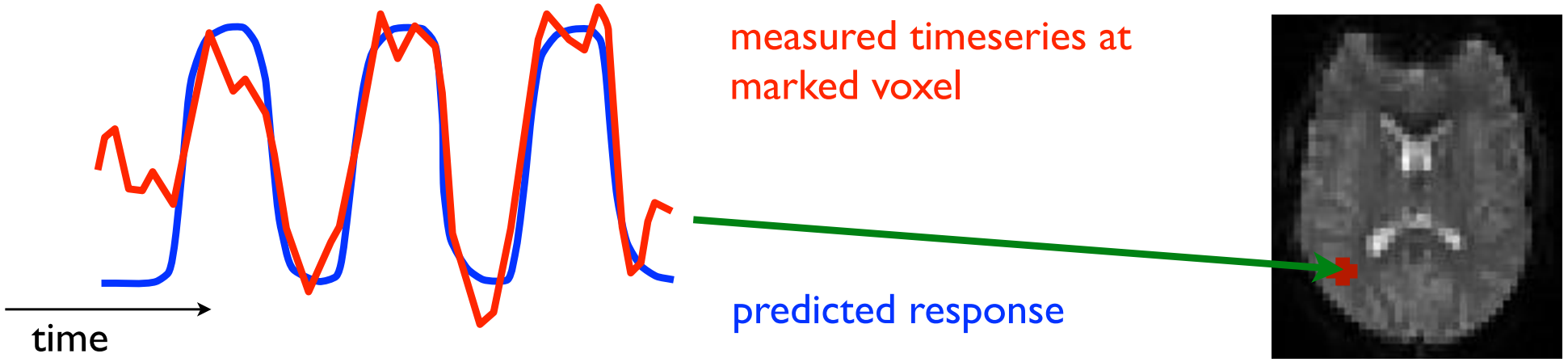


FMRI Experiments: Analysis

- Each voxel contains a time-varying signal (BOLD signal)
- Model the stimulus-induced change in BOLD signal (predicted response)

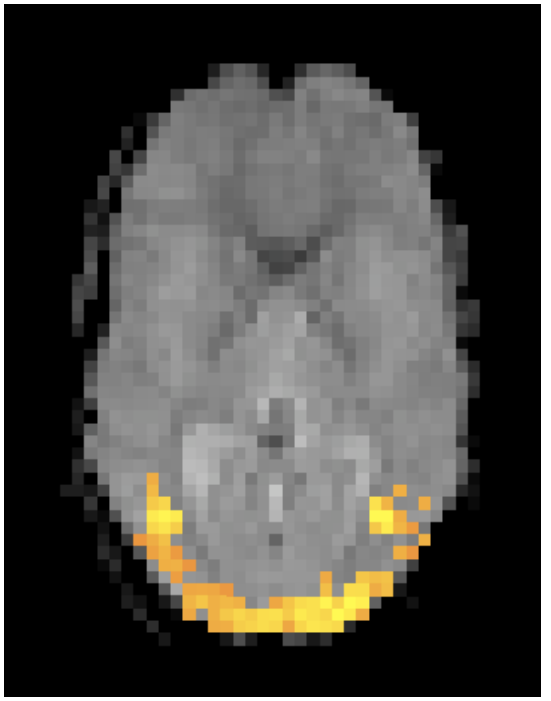


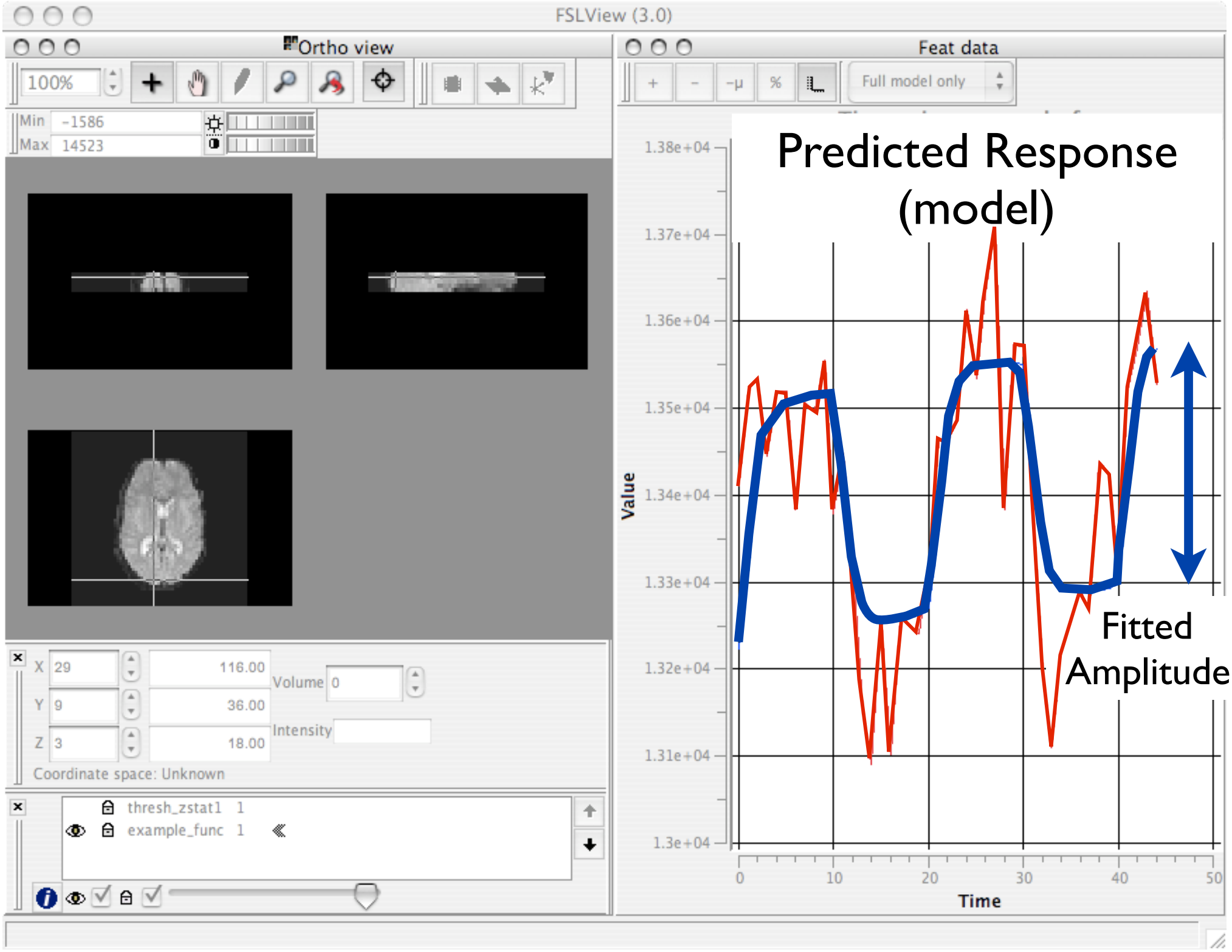
- Find which voxels have signals that match the model
- Good match implies activation related to stimulus

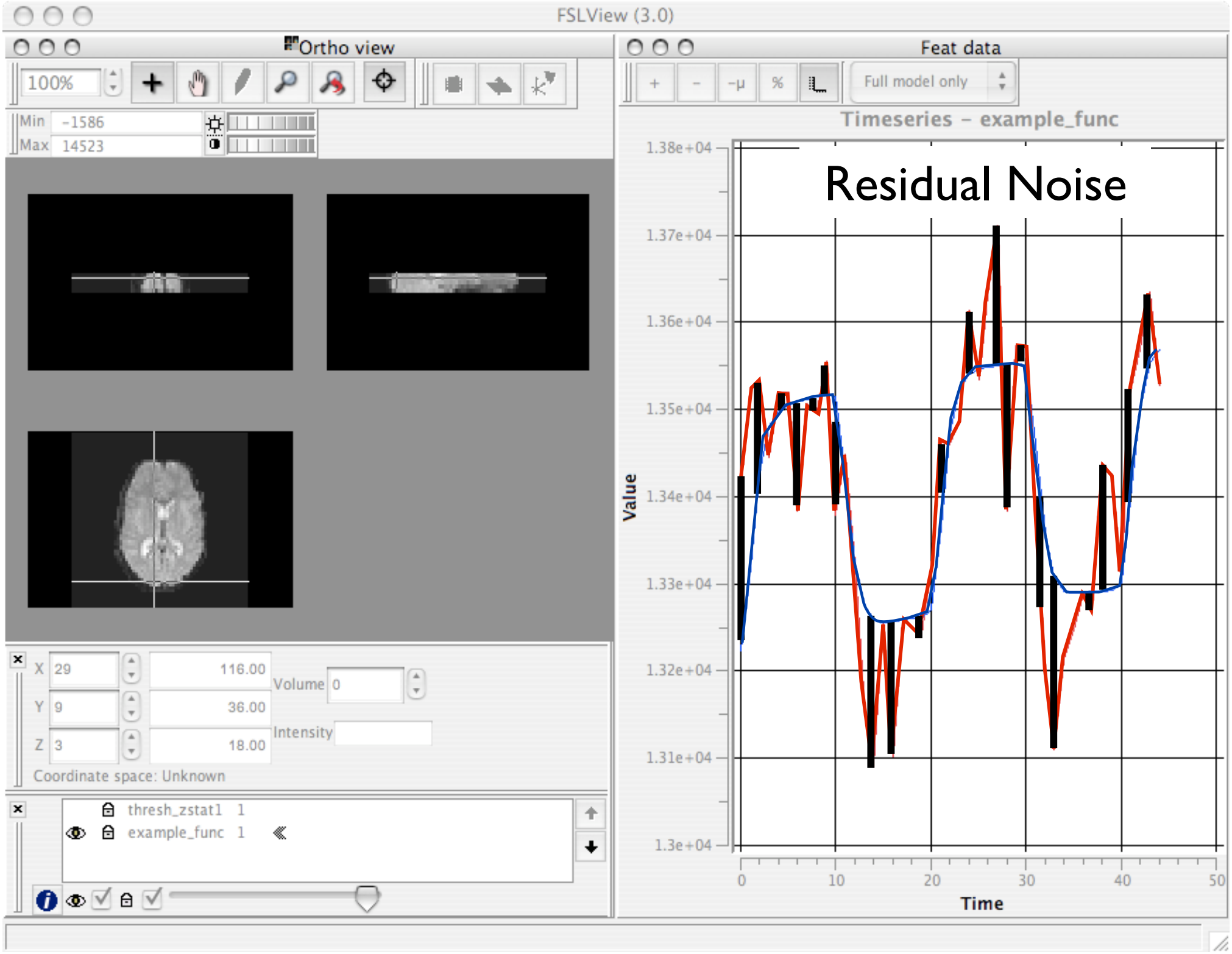


Standard GLM Analysis

- Correlate model at each voxel separately
- Measure residual noise variance
- *t*-statistic = model fit / noise amplitude




FSLView (3.0)
Ortho view
100%
Min -1586
Max 14523
X 29
Y 9
Z 3
116.00
36.00
18.00
Volume 0
Intensity
Coordinate space: Unknown
thresh_zstat1 1
example_func 1
Feat data
Full model only
Predicted Response
(model)
Fitted
Amplitude
Value
Time
1.38e+04
1.37e+04
1.36e+04
1.35e+04
1.34e+04
1.33e+04
1.32e+04
1.31e+04
1.3e+04
0
10
20
30
40
50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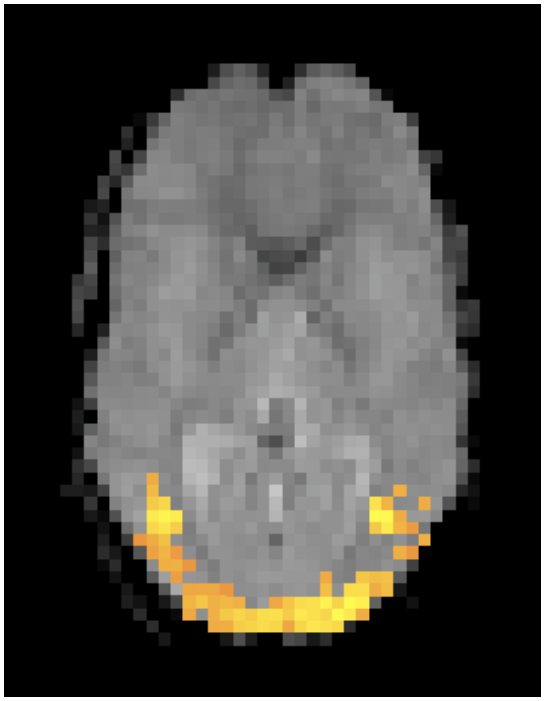
thresh_zstat1 1
example_func 1
Feat data
Full model only
Timeseries – example_func
Residual Noise
1.38e+04
1.37e+04
1.36e+04
1.35e+04
1.34e+04
1.33e+04
1.32e+04
1.31e+04
1.3e+04
Value
0
10
20
30
40
50
Time

Standard GLM Analysis

- Correlate model at each voxel separately
- Measure residual noise variance
- *t*-statistic = model fit / noise amplitude
- Threshold *t*-stats and display map



Signals of no interest (e.g. artifacts)
can affect both activation strength and
residual noise variance

Use pre-processing to reduce/eliminate
some of these effects

FMRI Pre-Statistics

Summary:

- Task experiment involves stimuli that is:
  - repeated many times
  - includes two or more conditions
- FMRI is based on BOLD effect
- HRF models the delay and spread of blood response
- GLM matches predicted response with data at each voxel to get amplitude
- Ratio with residual error gives statistic
- Thresholded values give map of significant voxels