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F I M

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Functional Connectivity and The Hemodynamic Response
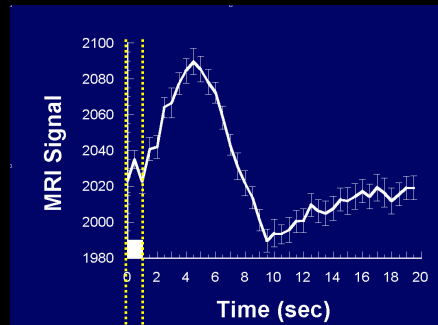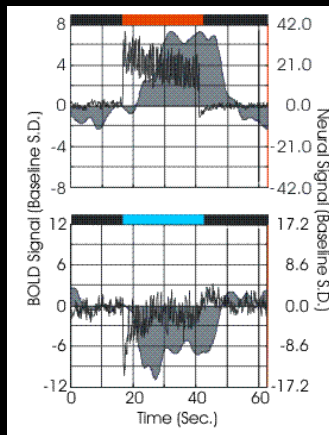## P. A. Bandettini, R. M. Birn, J. Diamond, A. Boemio
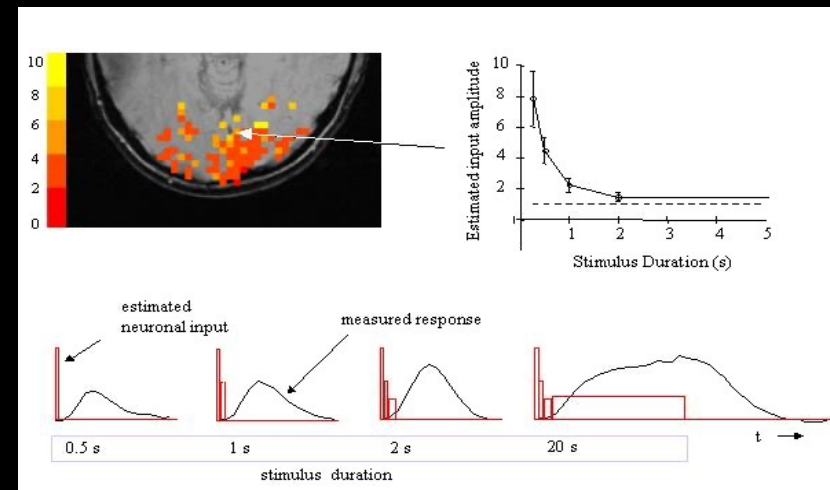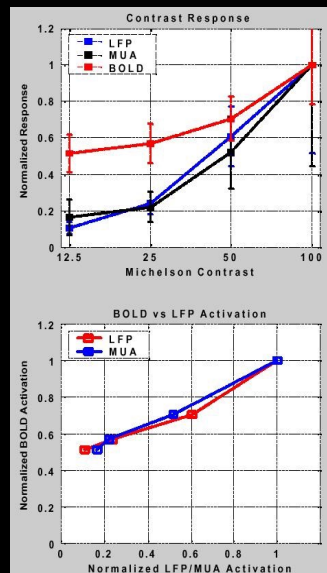
1. The Hemodynamic Response
2. Temporal Resolution
3. Spatial Resolution
4. State-dependent networks
5. Caveats, Approaches

task

Mathiesen, et al (1998), J Physiol 512.2:555-566

Schmuel et al. (2003) OHBM, 308

8% ON
25% ON
50% ON
75% ON

Logothetis et al. (2001) Nature, 412, 150-157

Bandettini et al, (2001) Nat Neurosci, 4: 864-866.

measured
linear

R.M. Birn, P. A. Bandettini, *NeuroImage*, (in press).

R. M. Birn, (2001) NeuroImage, 14: 817-826.

1. The Hemodynamic Response
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3. Spatial Resolution
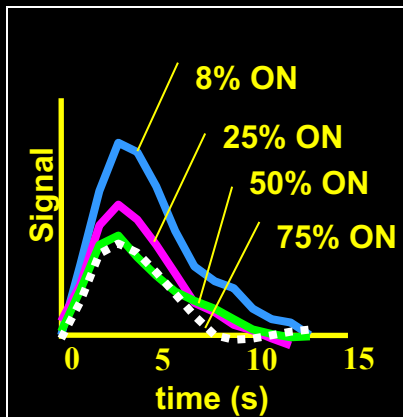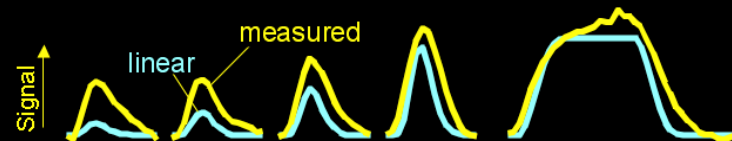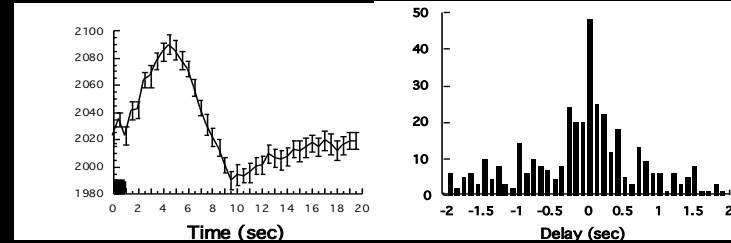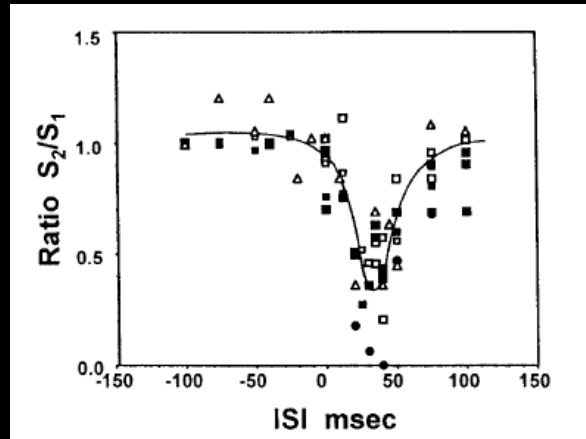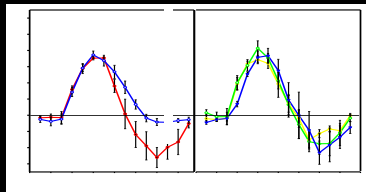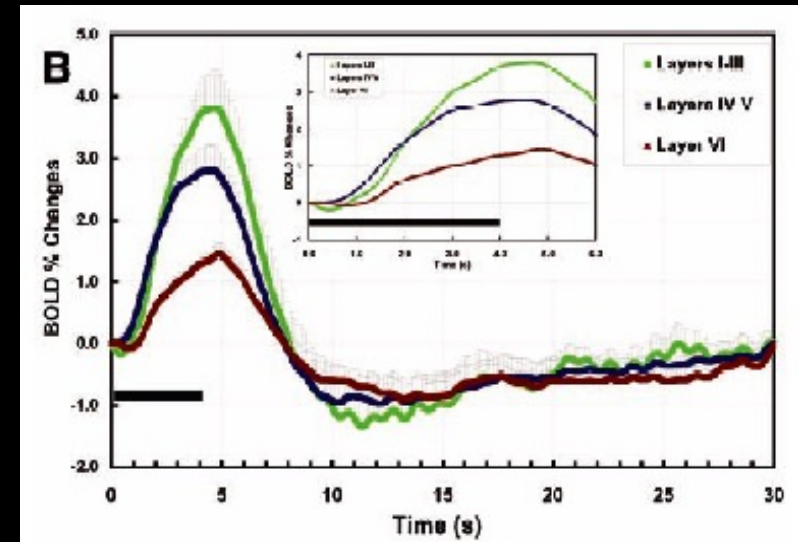4. State-dependent networks
5. Caveats, Approaches

Latency

Magnitude

Venogram

+ 2 sec
- 2 sec

Smallest latency
Variation Detectable
(ms) (p < 0.001)

16 sec on/off

8 sec on/off

11   Number of runs
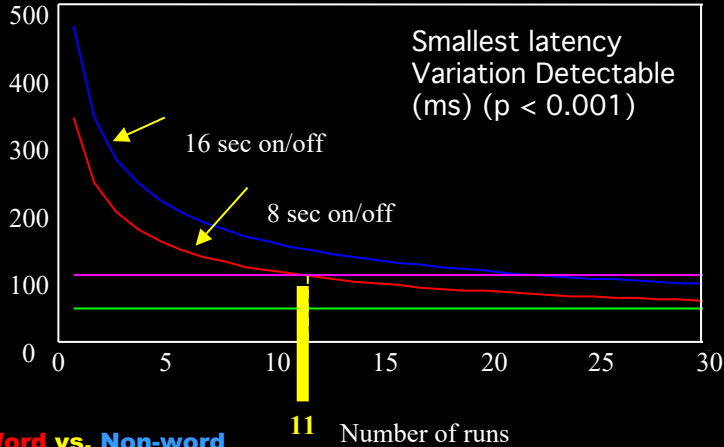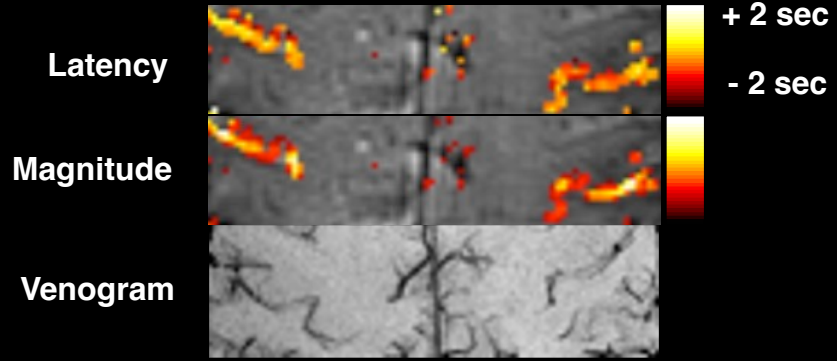
P. A. Bandettini, (1999) "Functional MRI" 205-220.

Word vs. Non-word

0°, 60°, 120° Rotation

Ratio S₂/S₁ — Ratio S_2/S_1

ISI msec

BOLD % Changes

Time (s)

Layers I-III
Layers IV V
Layer VI

Ogawa, et al (2000), PNAS 97 (20)11026–11031

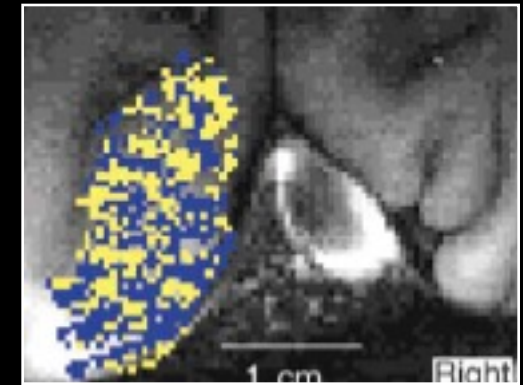**Silva, et al (2002), PNAS 99, 15182-15187**

Bellgowan, et al (2003), PNAS 100, 15820–15283

1. The Hemodynamic Response
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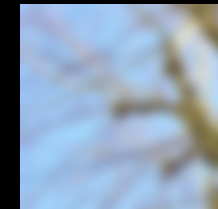4. State-dependent networks
5. Caveats, Approaches

Anatomy

BOLD

Perfusion

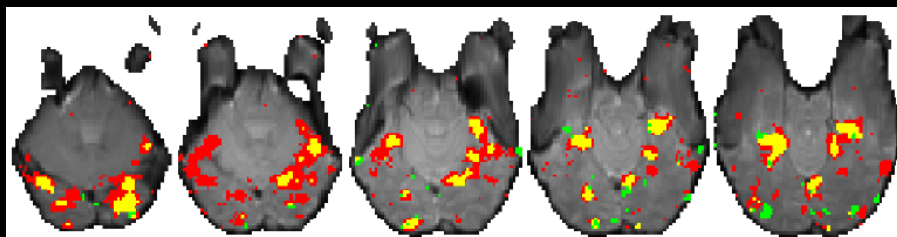0.47 x 0.47 in plane resolution

1 cm   Right

Cheng, et al. (2001) Neuron,32:359-374

Activation-based **mapping: data smoothing**
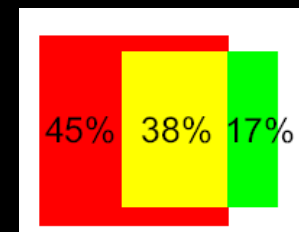   (classical approach)

Information-based **mapping: local multivariate analysis**

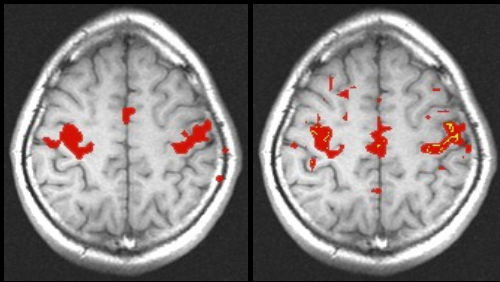**volume scanned with MANCOVA searchlight→**

45%   38% 17%

🟩 activation-based   🟥 information-based
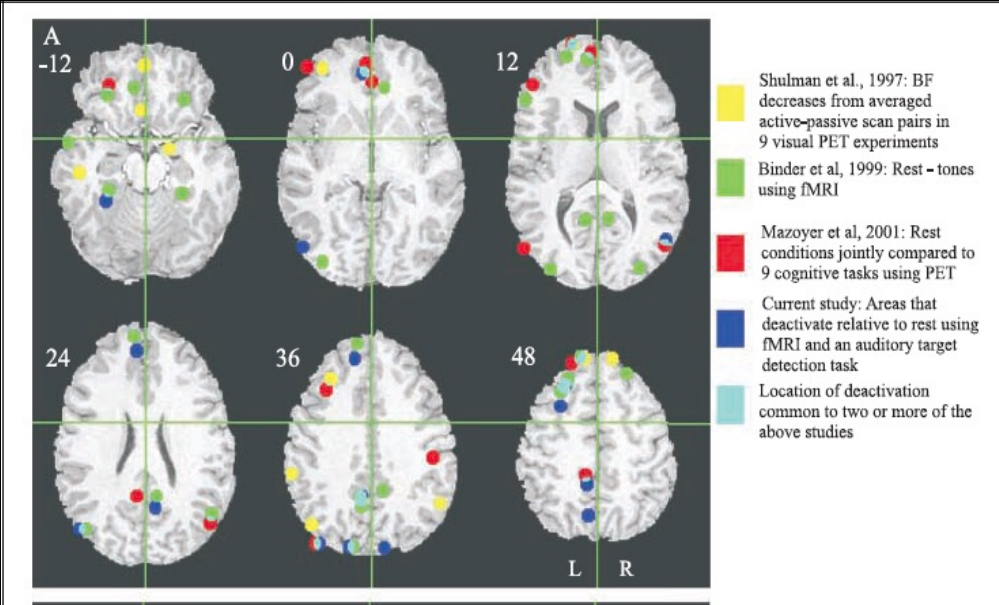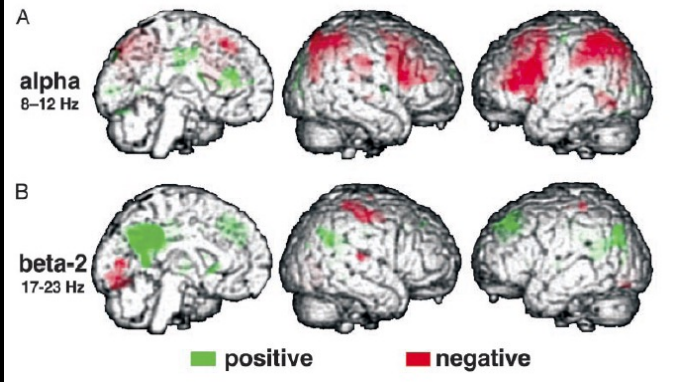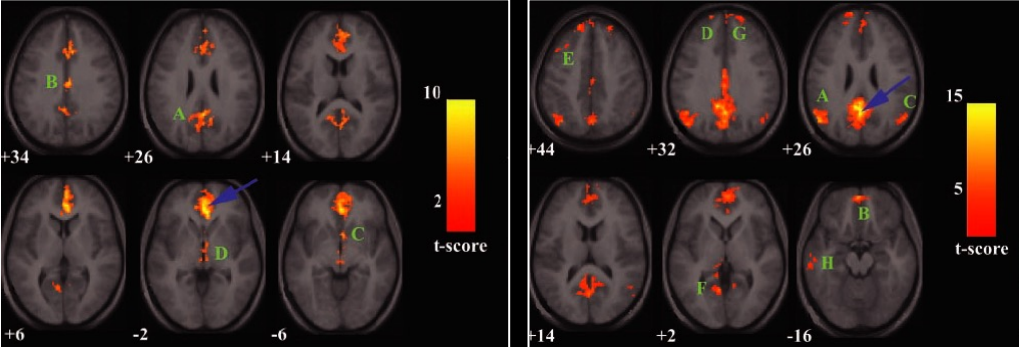🟨 intersection

voxel sets

1. The Hemodynamic Response
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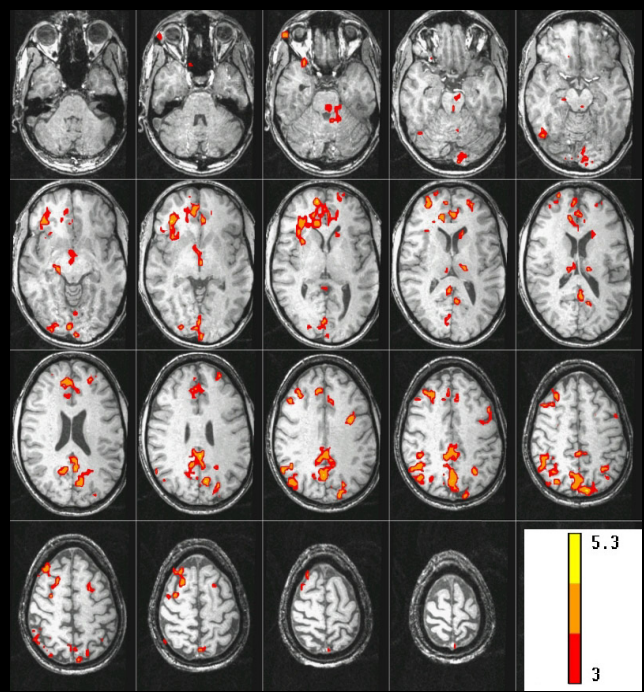5. Caveats, Approaches

Biswal, et al (1995), MRM 34, 537-541

Laufs, et al (2003), PNAS 100 (19), 11053-11058

Shulman et al., 1997: BF decreases from averaged active-passive scan pairs in 9 visual PET experiments

Binder et al, 1999: Rest – tones using fMRI

Mazoyer et al, 2001: Rest conditions jointly compared to 9 cognitive tasks using PET

Current study: Areas that deactivate relative to rest using fMRI and an auditory target detection task

Location of deactivation common to two or more of the above studies

McKiernan, et al (2003), Journ. of Cog. Neurosci. 15 (3), 394-408

Patterson, et al (2002), NeuroImage 17, 1787-1806

**Greicius, et al (2003), PNAS 100 (1), 253-258**

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Other approaches:
combined use of MEG, TMS, EEG, behavior,
physiology, anatomy, DTI and novel processing

1. Principles of spatiotemporal pattern formation
    • fMRI resolution (spat and temp), baseline state
2. Measuring connectivity and dynamics
    • Deadline paradigm, learning, habituation (fMRI)
    • DTI and Fractional Anisotropy data is suggestive but may not be useful scale
3. Clinical aspects of anatomical and functional connectivity
    • Schizophrenia, Alzheimers, reading disorders

Deadline Paradigms

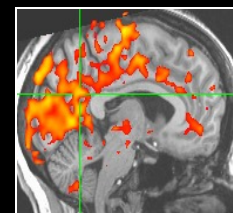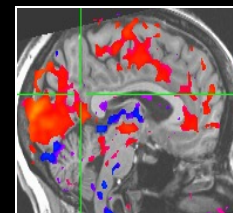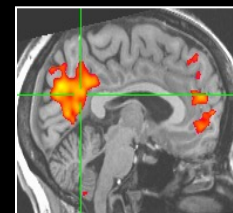16 ms   48 ms   160 ms   512 ms
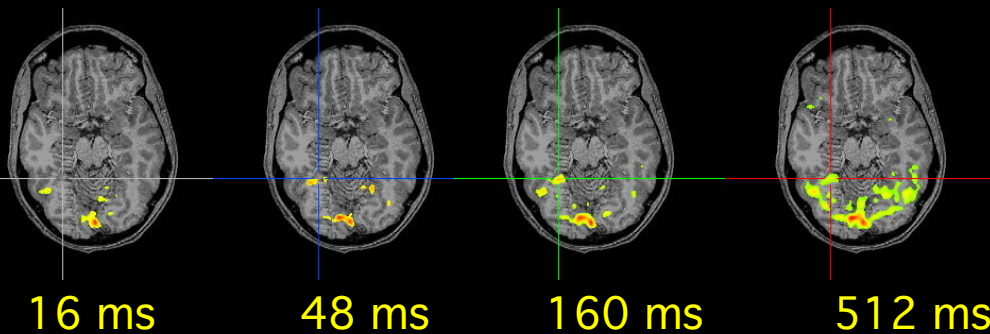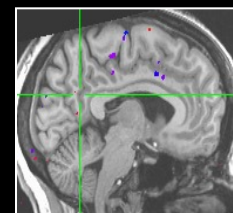
Lexical Task
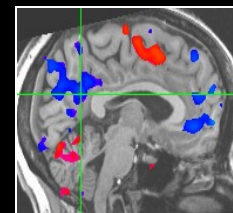
ROI

Functional Connectivity: Rest
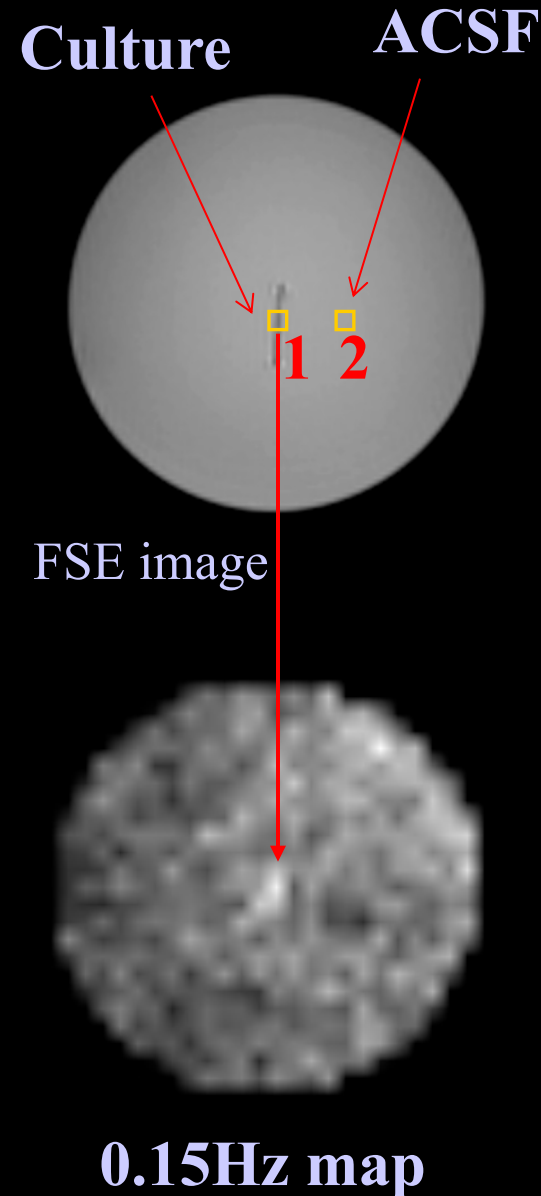
Correlation with Respiration Vol./Time

Functional Connectivity: Constant Resp.

Correlation with Respiration Vol./Time: Constant Resp.
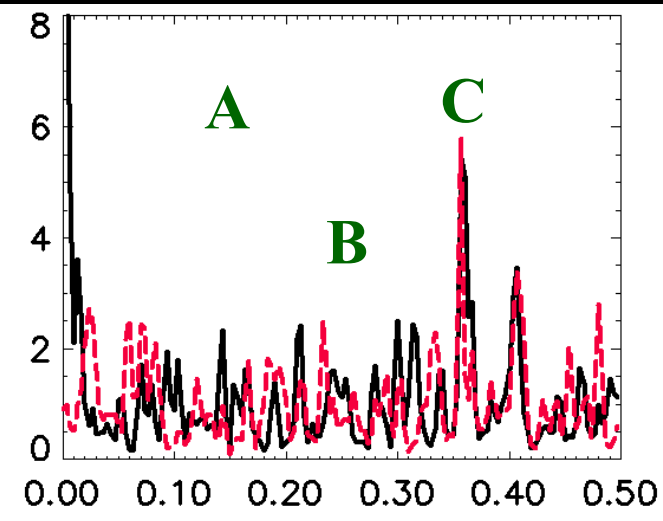
3 Tesla data

Culture   **ACSF**

FSE image

0.15Hz map

1: *culture*   **2: *ACSF***
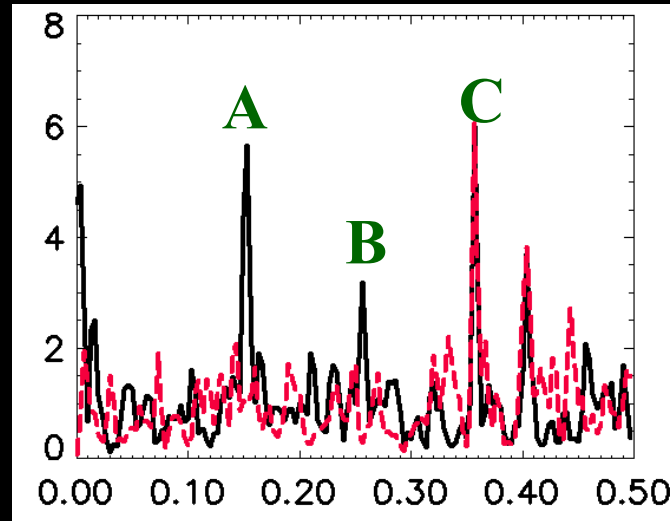
Hz   Hz

Active condition: black line
Inactive condition: red line

A: 0.15 Hz activity, on/off frequency
B: activity
C: scanner noise (cooling-pump)