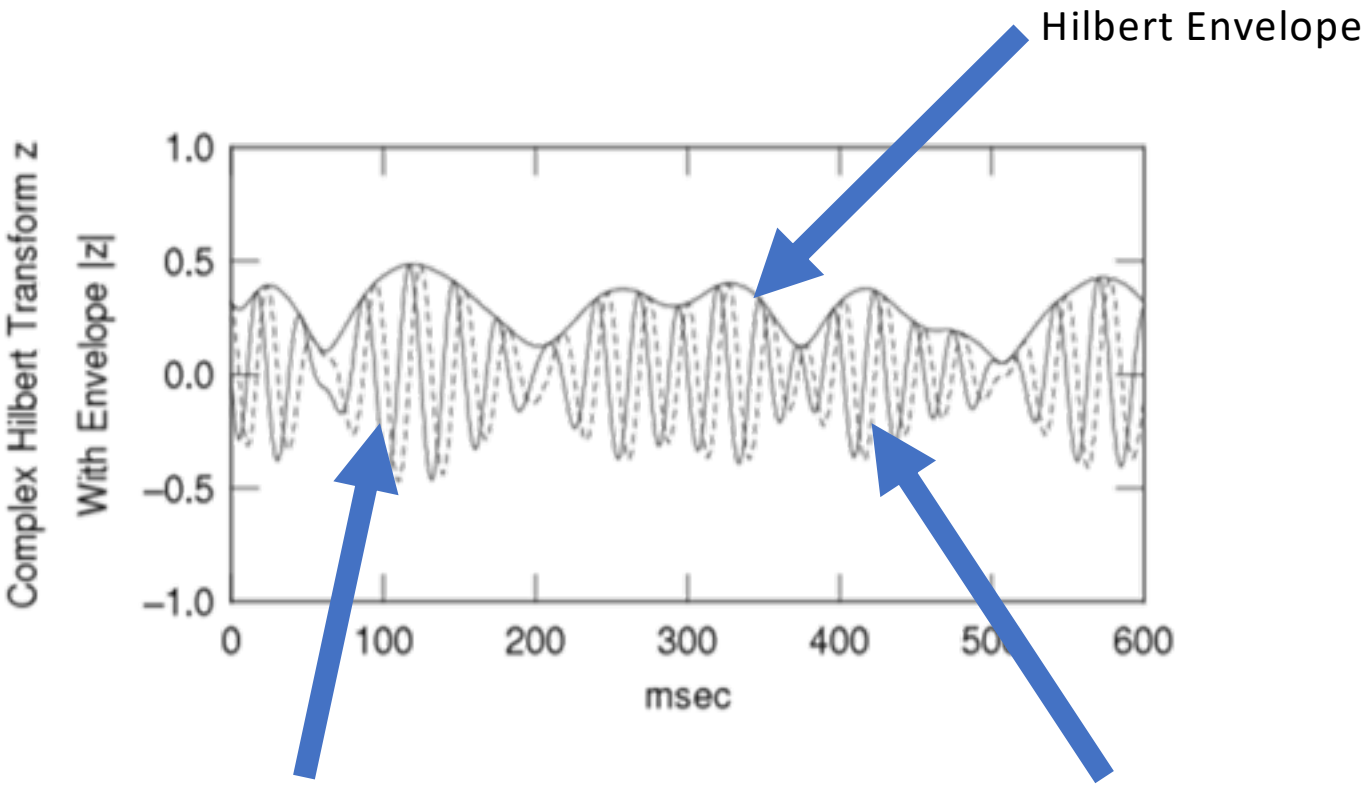
# Connectivity and other Dangerous Topics

Use at your own risk

# Resting State Connectivity

- There is no established way to do this
- All methods have issues
- Some words of caution
  - Never do connectivity in sensor space
  - Know that signal leakage exists
  - Make sure you know your data very well

# Hilbert Envelope



# Parameter File

| | |
|---|---|
| CovBand | 14 30 |
| ImageBand | 14 30 |
| SmoothBand | 0 2 |
| CovType | Global |
| DataSegment | 0 480 |
| Xbounds | -10 10 |
| Ybounds | -8 8 |
| Zbounds | -2 14 |
| ImageStep | 0.5 |
| ImageMetric | Power |
| Model | MultiSphere |
| ImageDirectory | OUTPUT |
| MRIDirectory | ../MRI |
| TimeStep | 1.0 |
| TimeInt | 1.0 |
| PropMu | 4 |

# Command Line

```
$ sam_cov -m beta_multisphere.param
        -r EYZQADGL_rest_20180608-f.ds  -v

$ sam_wts -m beta_multisphere.param
        -r EYZQADGL_rest_20180608-f.ds  -v

$ sam_power -m beta_multisphere.param
        -r EYZQADGL_rest_20180608-f.ds  -v
```

# Output

EYZQADGL,beta_multisphere,14-30Hz,PWR.nii

Normalize to Talairach space:

```
$ 3dresample -dxyz 5 5 5 -prefix TT_N27resampled
        -inset TT_N27+tlrc
$ 3dWarp -matvec_out2in mri/EYZQADGL/brain.Xat.1D -NN
        -gridset TT_N27resampled
        -prefix EYZQADGL,beta_multisphere,8-14Hz,PWR_tlrc.nii
        EYZQADGL,beta_multisphere,14-30Hz,PWR.nii
```

# Concatenate all subjects

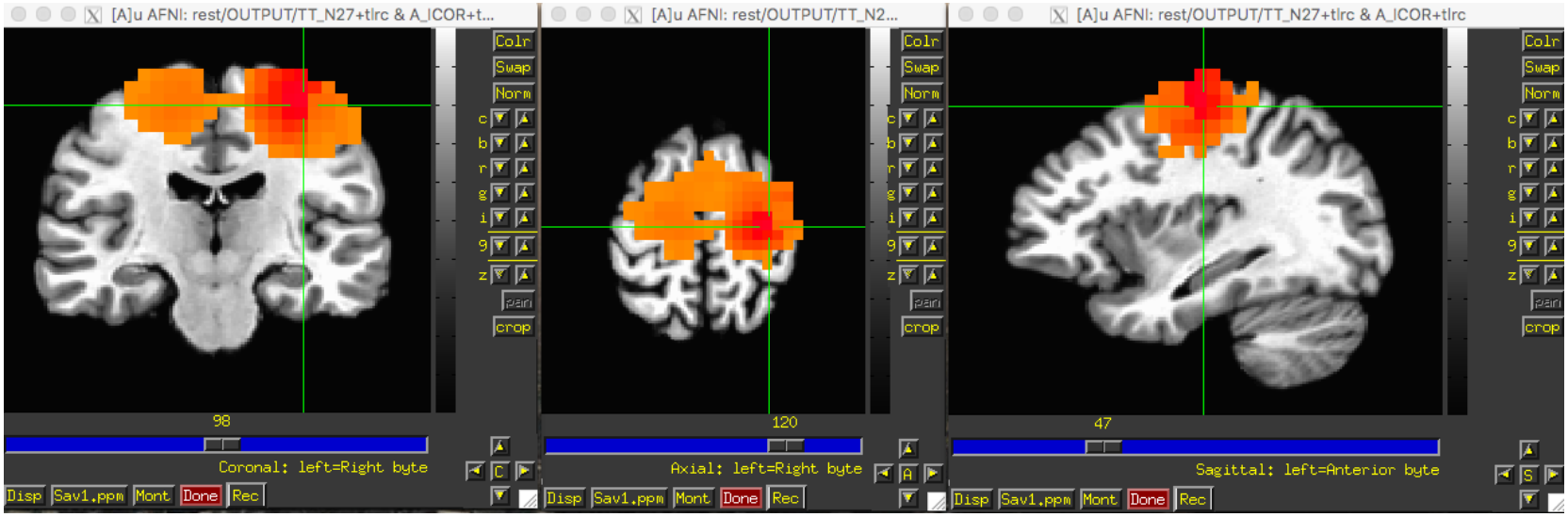
$ 3dTcat -prefix ALL_subs_beta *beta*tlrc*.nii.gz

$ afni

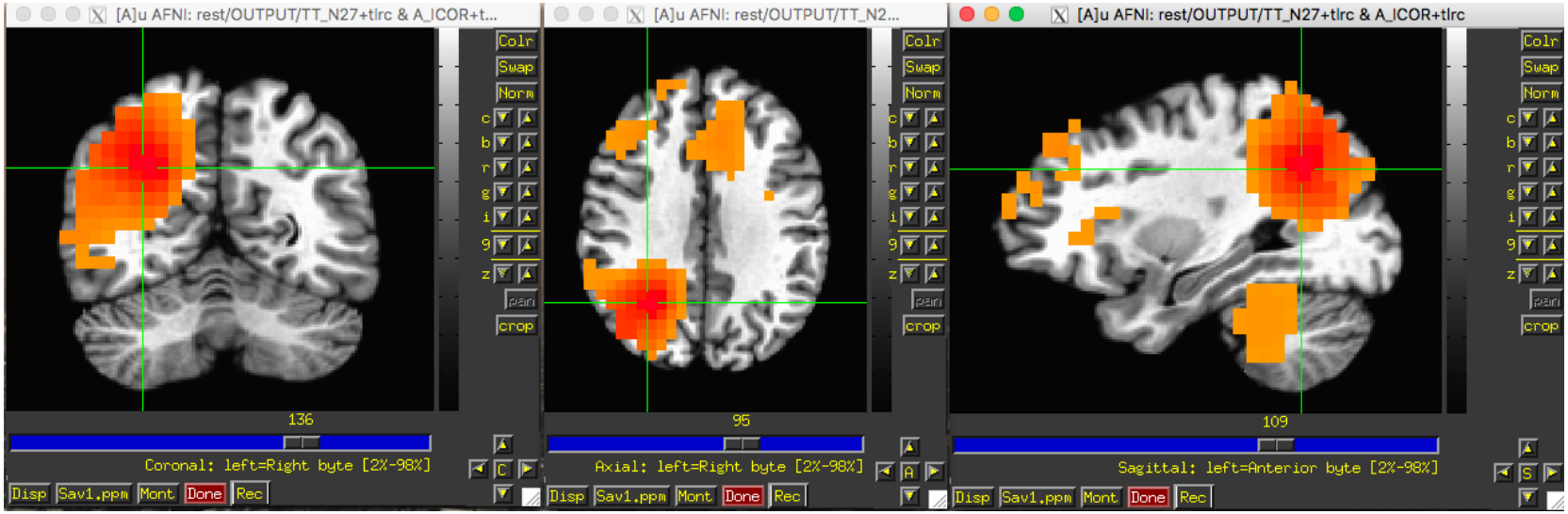
# InstaCorr

- Simple correlations with a seed voxel
- Note that this is not how you would actually analyze your data, as this incorporates no leakage correction
- Nevertheless, it is a good sanity check

# Motor network

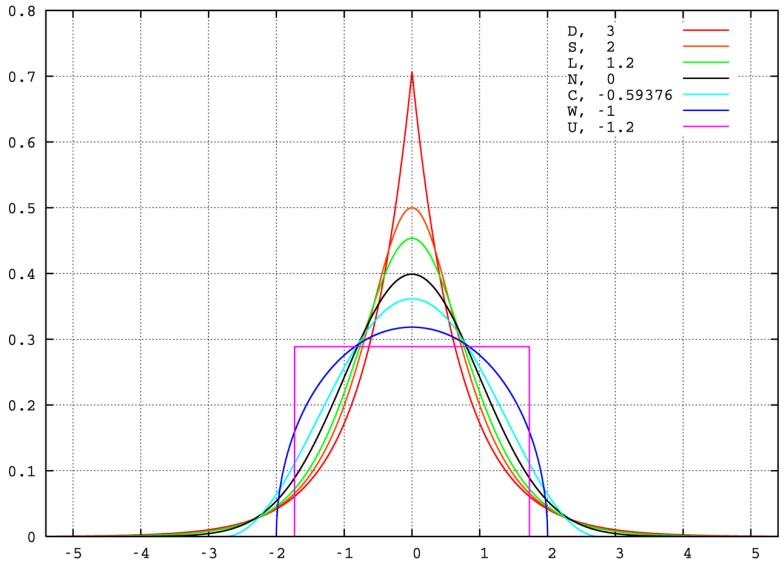


# Frontal parietal network



# Other Tools

- Epilepsy Spike detection:
  - SAMepi – operates on the filtered time series data to flag voxels displaying excess kurtosis
  - SAMhfo – operates in frequency space to flag voxels with spikes in the high frequency portion of the spectrum




Mark Sweep; wikipedia

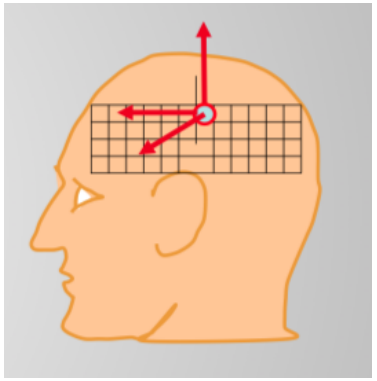
# Experimental tools (coming soon!)

- SAMcoreg

  Data driven method for determining the optimal coregistration between the MRI and the MEG based upon the normal vectors of the cortical surface

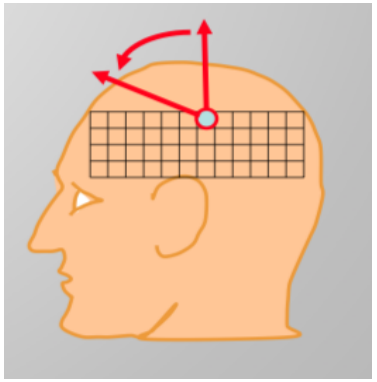
# Types of Beamformers

- Vector Beamformer



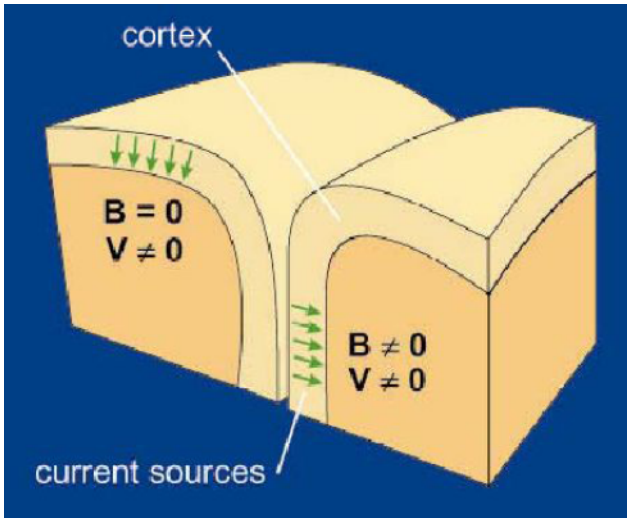
At each voxel, solve for orthogonally oriented current sources

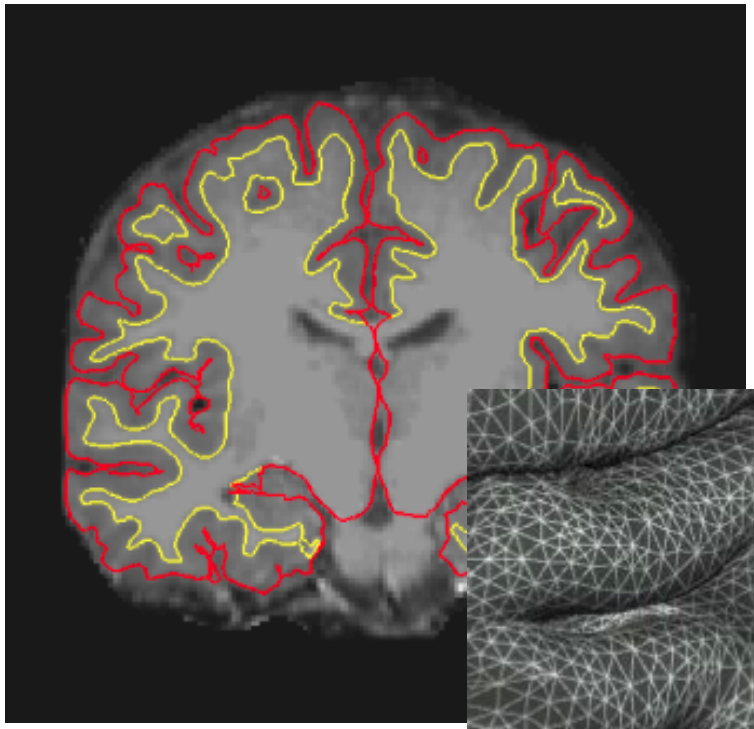
- Scalar Beamformer



At each voxel, solve for the optimal orientation of a single current source

# In the cortex, we already know the optimal orientation…



# SAMcoreg

- Requires an MRI adequate for accurate Freesurfer parcellation
- Extremely computationally intensive
- Completely eliminates the need for potentially inaccurate fiducial placement and localization

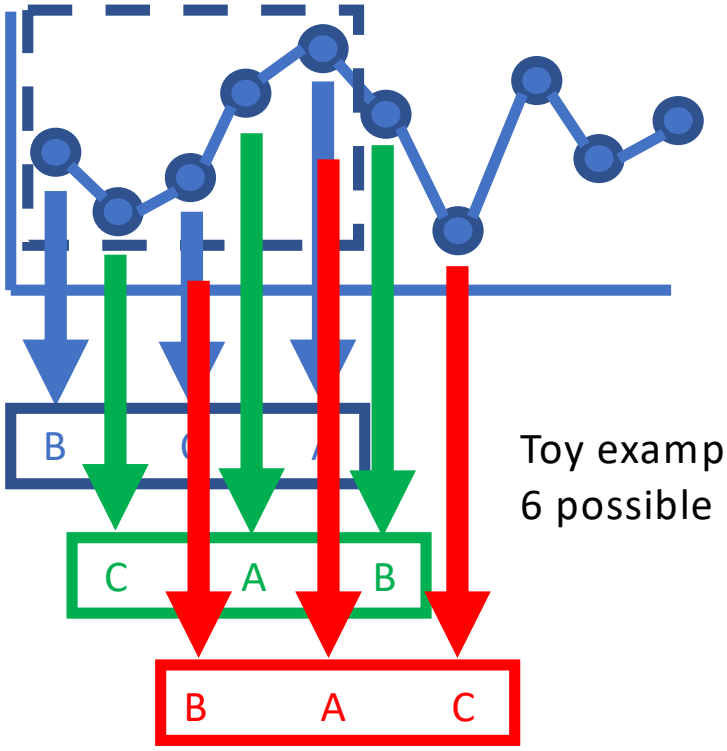
# ROIwts and PATCHwts

Rather than calculate the beamformer weights at every voxel, calculate them for every patch in a parcellated cortical surface

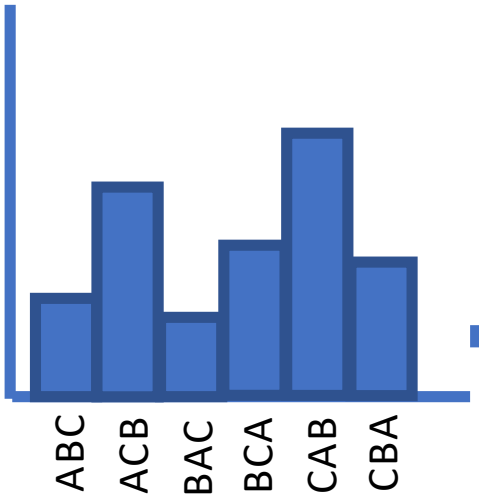
- Higher Signal to Noise
- Use Freesurfer parcellation or coordinate lists and extents
- Requires SAMcoreg

# Rank Vector Entropy – sam_entropy

Embedding dimension m = 3
Lag $\xi$ = 2




Toy example:
6 possible rank vectors




Probability of each state $p_n(k)$

$$h(k) = \frac{1}{\log_2 M!} \sum_{n=1}^{M!} -pn(k)\log_2 p_n(k)$$

Entropy of each state

↑ Entropy = ↑ complexity = ↑ information carriage

# Symbolic Transfer Entropy (coming soon)

- Measures directed transfer of information
- STEers – computes event related changes in symbolic transfer entropy in ECoG data
- STEcoherence – calculates the optimal decay rate of information transfer based upon comparisons with a surrogate dataset

# New directions?

- We welcome user engagement, problems to be solved, and requests for added capabilities