

MEG preprocessing, channel & source analysis of tMEG and rMEG

Introductory Note

Magnetoencephalography is a non-invasive electrophysiological technique that measures the magnetic fields caused by neuronal and volume currents. The signal that is picked up mainly reflects synchronized postsynaptic potentials in the apical dendrites of pyramidal cells in the neocortex. As opposed to the BOLD-signal MEG more directly relates to the electric activity of the brain, and its temporal resolution is not constrained by the sluggish haemodynamic response. In the HCP, MEG has been acquired at 2 kHz and the processed data has been downsampled to 0.5 kHz. This high sampling frequency does not only allow for investigation of the activity of the brain at a millisecond timescale, it also allows for a characterization of the activity in terms of oscillatory components. Rhythmic activity has been shown to be a prominent feature of both spontaneous and task-related activity. Moreover, brain rhythms have been hypothesized to play a mechanistic role in local and long-range neuronal communication. One important limitation of MEG is due to the fact that the magnetic fields are measured outside the brain. We need mathematical inverse modelling techniques to reconstruct the underlying source activity from the sensor measurements. The spatial resolution of these source reconstructions techniques is inherently limited, which always needs to be kept in mind when interpreting the data.

In this practical session we are going to explore the high-temporal resolution MEG data. We will start by looking at the raw signals at the sensor-level, and explore the brain activity time-locked to movement onset. Next, we will investigate what this activity looks like at the reconstructed source level. We will also look into the rhythmic activity in relation to the movement, both at the sensor and the source level.

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All executable and spec files mentioned below are located in:

/home/hcpcourse/day5-friday/practical1-morning/

Unless stated otherwise.

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Exercise 1: Visualize the sensors where data is acquired and the Source Space where it is projected.

Learning objective of this exercise:

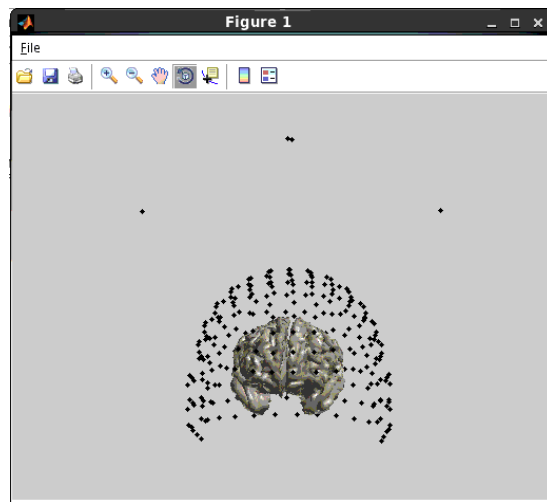
- Appreciate the spatial configuration of the MEG-sensor array relative to the position of the brain.

Instructions:

- Click on the shortcut to **day5-friday** on the Desktop, and click on the **practical1-morning** folder.
- Change the file browser display settings to List View (in the upper right corner).
- Run the **P1E1_PlotSensAndBrain.sh** script: Left Double Click on P1E1_PlotSensAndBrain.sh and in the pop-out window click "Run in Terminal"
- Wait until the figure showing the sensor array and the cortical sheet is presented.
- Use the *Rotate 3D tool* to examine the sensor coverage and the distance of sensors from the brain.

The recorded MEG data is the magnetic flux density captured by the magnetometer coils. The strength of the magnetic field that results from intra- and extracellular currents in the head rapidly decays as a function of distance to the measurement coils.

Therefore, the sensors far away from the brain solely pick up magnetic fields due to ambient noise, and are used for noise suppression. Note that the measurement coils are still quite far away from the active cortical tissue (~5 cm). In order to get an idea of the sources of the neuronal activity, MEG-data needs to be subjected to inverse modelling techniques.



- Press **Ctrl+C** to close the figure and exit.

End of Exercise 1

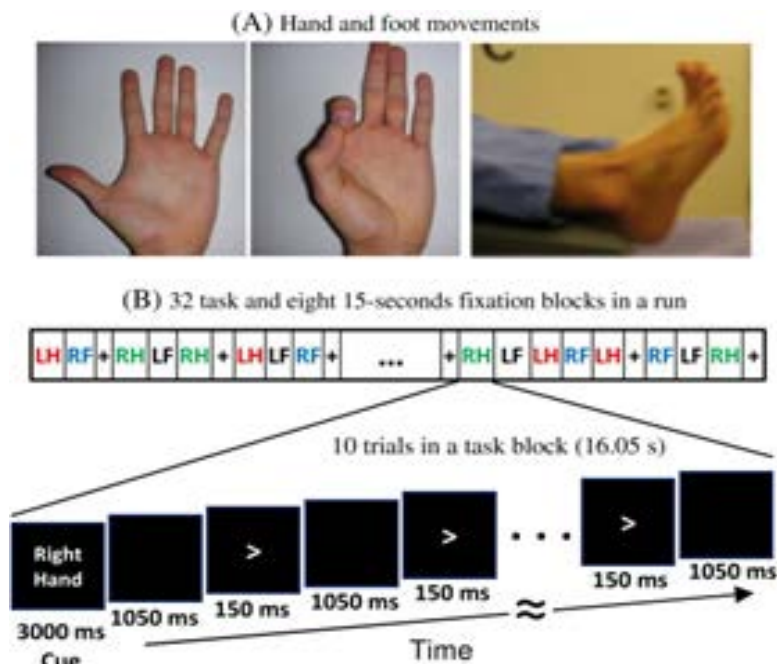
Introducing the advantage of MEG in Time and Frequency using the Motor Task

Sensory-motor processing has been assessed using a task in which participants were presented with visual cues instructing the movement of either the right hand, left hand, right foot, or left foot. Movements were paced with a visual cue, which is presented in a blocked design. This task was adapted from the one developed by Buckner and colleagues (Buckner *et al.* 2011; Yeo *et al.* 2011).

Participants are presented with visual cues that ask them to either tap their left or right index and thumb fingers or squeeze their left or right toes. Each block of a movement type lasted 12 seconds (10 movements), and was preceded by a 3 second cue. In each of the two runs, there were 32 blocks, with 16 of hand movements (8 right and 8 left), and 16 of foot movements (8 right and 8 left). In addition, there were nine 15-second fixation blocks per run (see image below).

Electromyographic (EMG) signals were acquired and used for the detection of the onset of hand and foot movement. EMG electrodes were applied to the skin to the lateral superior surface of the foot on the extensor digitorum longus muscle and near the medial malleolus, also the first dorsal interosseus muscle between thumb and index finger, and the styloid process of the ulna at the wrist.

Data has been cut in trials relative to a) EMG onset and b) Onset of Pacing flashing cross. A period of -1.2 sec to +1.2sec relative to the reference has been included in each trial. See the [500 Subjects + MEG2 Release Reference Manual](#) for more details.



Exercise 2: Visualise cleaned data recorded at the sensor array.

Learning objective of this exercise:

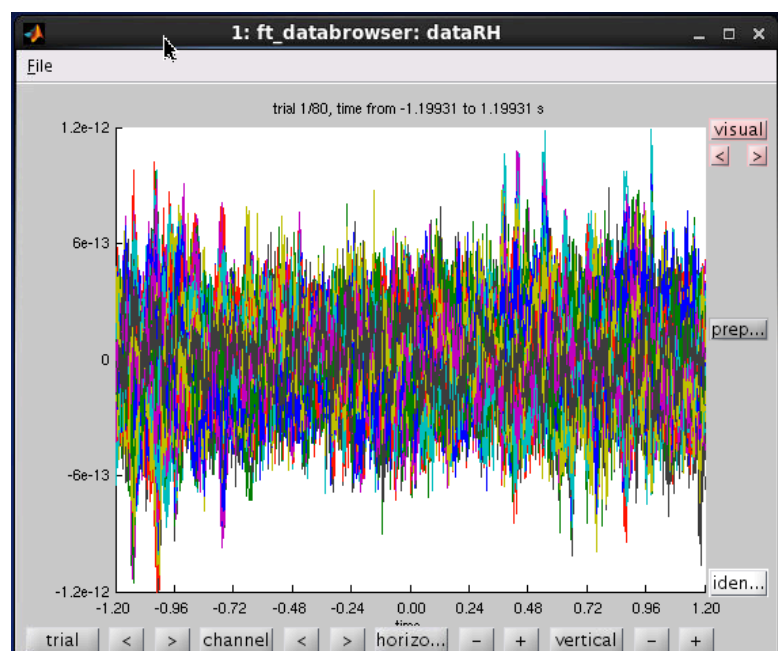
- Get a feel of what artifact-free MEG sensor data looks like.

Instructions:

- Back in the file browser, run the **P1E2_SensorDataBrowse.sh** script: *Left Double Click* on P1E2_SensorDataBrowse.sh and in the pop-out window click "Run in Terminal"

The pop-out figure shows the data from Left Hand movements from the Motor Task for all sensors and for EACH trial.

Notice the Time Resolution. There are 500 data points within each



second. Here the time spans from -1.2 to 1.2 sec relative to movement onset as measured by the onset of EMG signal on the Right Hand.

- Use the arrows to the right of the “trial” button at the bottom left to scroll through different trials.
- By pressing the “channel” button, you can make a selection of channels to be displayed, so that the figure looks less cluttered.
- By pressing the “+” and “-” buttons next to the “horizontal” and “vertical” buttons you can play around with the horizontal and vertical scaling, respectively.

Explore the data by pressing the various buttons on the bottom row of the figure panel.

- Press *Ctrl+C* to close the figure and exit.

End of Exercise 2

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Exercise 3: Visualize that EVENT RELATED FIELD at the sensor level.

As we have seen in the previous exercise, MEG sensor data is inherently noisy. In order to extract some meaningful signals from the data it is common to average across extracted epochs of data that are aligned to an external event. This is called the event-related field.

Learning objectives of this exercise:

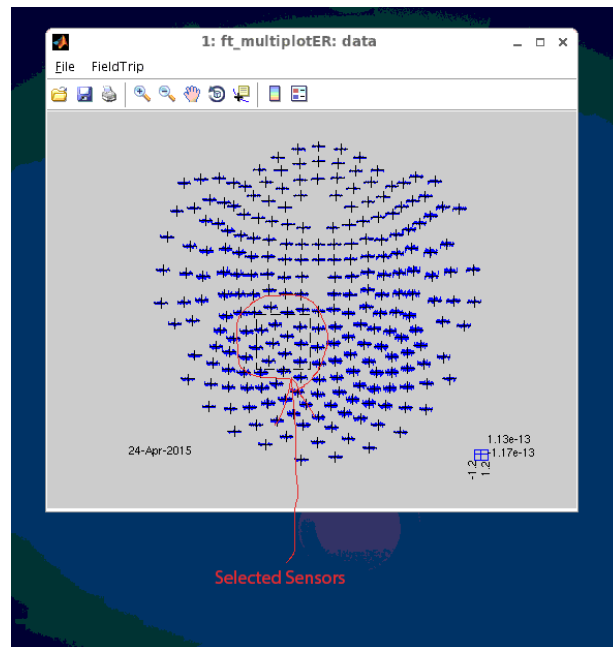
- Get a feel of what processed (event-related field) MEG sensor data looks like.
- Get an idea of the spatial spread of local cortical activation on the MEG sensor-array.

Instructions:

- Back in the file browser, double click the **P1E3_ERFavg.sh** script and in the pop-out window click “Run in Terminal”.

The figure shows the average Magnetic Field for each sensor. This plot is interactive.

In order to identify neural activity LOCKED to a



specific event we average the data across trials at each time point. This eliminates any non-event locked components.

- Select a group of sensors (+) in a box, by *holding the left mouse button and dragging it over the plot*.
- After selecting the sensors, *release the left mouse button and click again* just once inside the selected box.

A new window appears with the average time-series of the selected sensors. This plot is interactive too, allowing you to select a time interval.

Notice the peak around 0.1 sec. This peak has a duration of about 100 mseconds. With MEG we can capture events in this time scale due to the high sampling rate.

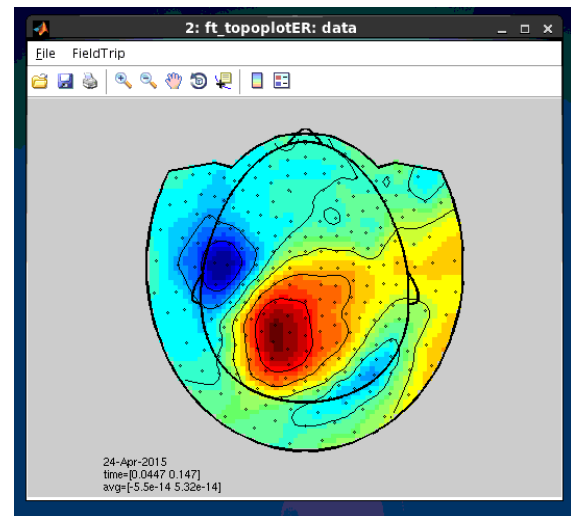
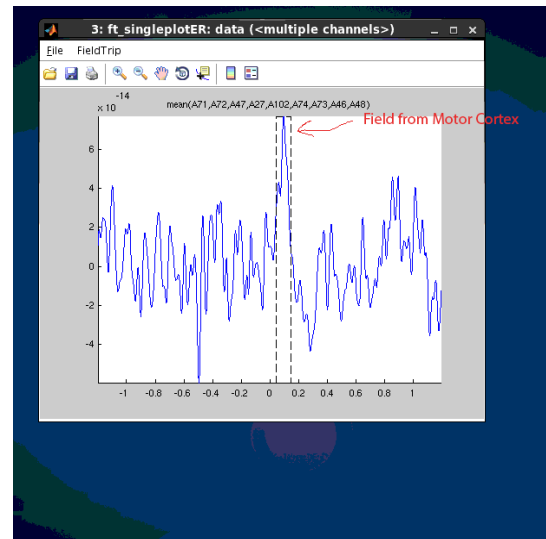
- Select the time interval at that peak, by *holding the left mouse button and dragging it over the plot*.
- After selecting the interval, *release the left mouse button and click again* just once inside the selected box.

This will produce a new figure where the topology of the average magnetic field at the sensor level is plotted.

Notice the dipolar field pattern located over the left Motor Cortex that corresponds to neural activation that is time-locked to the movement of the right hand.

When interpreting these topographies, one should keep the 'right hand rule' in mind: a current results in a magnetic field that goes around the current. In the figure, one can think of a current source (operationalized as an equivalent current dipole) in between the red and blue 'blobs' with an orientation pointing to the right upper corner of the figure.

When building an inverse model of the sensor data, we estimate the spatial configuration and activity profile of neuronal sources that best explain our sensor data based on a set of assumptions. For this we use information from our forward model, which is a collection of 'spatial fingerprints' (magnetic field patterns observed at the sensors) for a predefined set of dipole locations.



This plot is also interactive (you can select sensors again and get a plot of the average time-series of the selected sensors). This process can go on for ever, or until the computer crashes....

- *Press Ctrl+C* to close the figure and exit.

End of Exercise 3 -----

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Exercise 4: Visualize the event related POWER time-series on the cortical sheet

In this exercise we will explore the spatiotemporal characteristics of the data used in the previous exercise, but now after the application of a source reconstruction technique. As a result of the source reconstruction the data are now represented as time series defined on 8004 vertices describing the cortical sheet. In this example, we have used a linearly-constrained minimum variance (LCMV) beamformer. At each of the vertex locations, neural activity is modelled as an equivalent current dipole.

Learning objectives of this exercise:

- Get a feel of what processed (event-related field) MEG source level data looks like.
- Explore MEG source-reconstructed event-related fields in `wb_view`.

Instructions:

- *Right click* on **P1E4_SrcAvgERpow.spec** in the File browser. *Select* **Open With>wb_view**.
- In the Open Spec File window *click* **Load**.
- For this exercise you only need 2 tabs. (1) Montage and (3) Chart.
- *Click* the **(1) Montage** tab (at the top Left).
- In the **Overlay Toolbox**, **Layers** tab, *tick* the box at very left of the first row.

The functional map should appear on the cortical sheet with a “hot” colormap. On the right of the ticked box, in the “File” section you can see the file from which the functional data is loaded:

177746_MEG_Motort_srcavglcmv_[LM-TEMG-RH]_[IT-avg].power.dtseries.nii

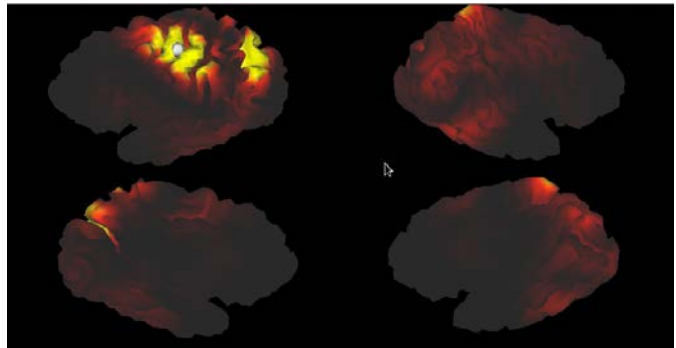
In the Map field you can see a drop-down list with the value -0.79872 seconds.

- *Click* on the dropdown arrow to reveal a long list containing all the time points for which the power has been calculated.

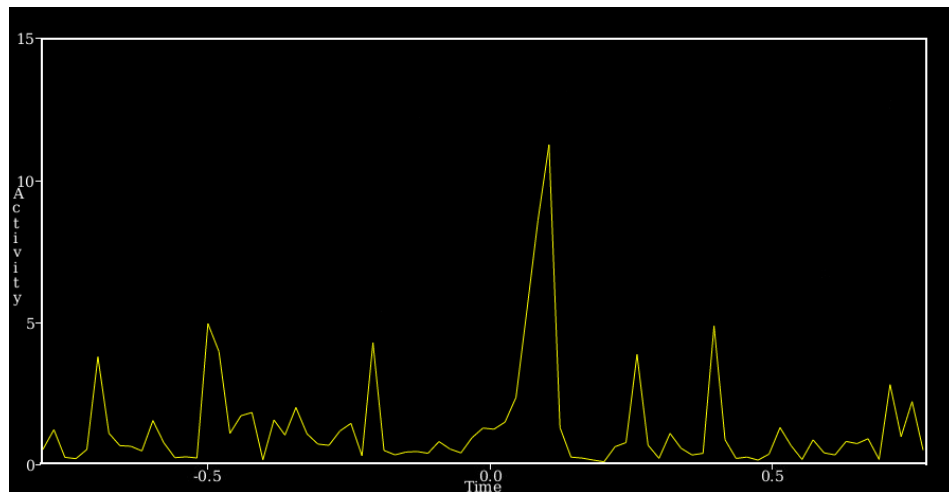
This time is relative to the reference which, in this case, is the onset of movement as measured by the EMG signal of the right hand.

- *Select* the time 0.105686.

You should now see the Left Motor Cortex light up. This corresponds to the peak that you saw in Exercise 3 at the sensor level.



- Click on the third Tab, **(3) Chart**.
- In the **Overlay Toolbox, Charting, Loading** tab, *tick* the box next to the “Charting File” containing the functional data.
- Go back to Tab (1) Montage and with the left mouse button select the point of maximum activity (most yellow) on the motor cortex.
- Now go back to Tab (3) Chart . You should be able to see the power time-series of the selected node. The peak motor cortex activity peaks around 0.1 sec after movement onset.



- Close the **Information Box** and *minimize* Workbench for now, we will use it again in Exercise 6.

End of Exercise 4

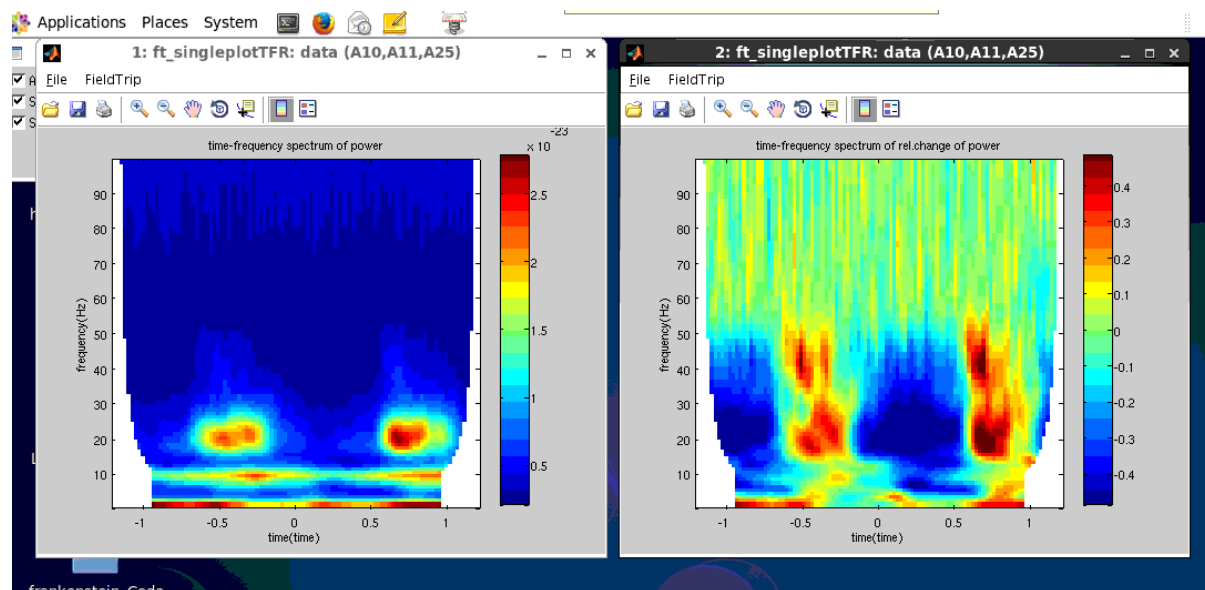
Exercise 5: Time-Frequency representation of data. (a first glimpse at the sensor level)

It is well known since the time of Hans Berger that brain activity is characterized by oscillatory patterns in a wide range of frequencies. The main range of such oscillations is between 1 and 100 Hz or in terms of period (time) 0.1 to 1 sec. The high temporal resolution of MEG makes possible the fine-grained decomposition of the measured signal not only in the time domain but also in the frequency domain.

To demonstrate this decomposition, we use again the Motor task and specifically the trials of Right Hand movement. One reason we selected this task is that during hand movements it is well known that oscillations in the frequency range around 20 Hz are suppressed and at the termination of the movement they rebound (this suppression and rebound is depicted in the oscillatory power). This is known as ERD (Event related desynchronization).

Instructions:

- Back in the file browser, double click the **P1E5_TFRavg.sh** script and in the pop-out window *click* “Run in Terminal”. Two figures should pop out.



In the left figure, you can see the time-frequency spectrum of power in a set of sensors over the left motor cortex. At time 0 is the onset of the movement. It is obvious that around 20 Hz the power is suppressed during movement and rebounds after its completion (after 0.5 sec). We also see a somewhat similar pattern in the lower frequencies around 10 Hz.

Instead of just plotting the raw power, it is common to plot the power relative to that of a baseline period. This can be seen on the right figure where the baseline has been set to the interval [-0.5 to 0 sec]. As you can see in this representation, a similar suppressed and rebound pattern is observed for higher frequencies around 45 Hz in addition to the 20 and 10 Hz cases. And this is only for the given set of sensors.

Oscillations are believed to play an important role in communication between brain areas. That is why it is important to study them.

- Press **Ctrl+C** to close the figures and exit.

End of Exercise 5

Exercise 6: Time-Frequency representation of data on the cortex

For the source-reconstruction of the time-frequency data, we used a so-called “Dynamic Imaging of Coherent Sources” (DICS) beamformer. In order to stay consistent with the resting-state MEG pipelines, we have reconstructed the data in a limited set of frequency bands, rather than across a fine-grained set of frequencies. According to more or less typical definition of frequency bands of brain oscillation, we defined 8 bands:

Delta (0-4 Hz), Theta (4-7 Hz), Alpha (7-14 Hz), low Beta, (14-21 Hz), high Beta (21-31 Hz), low Gamma (31-51 Hz), mid Gamma (51-76 Hz), and high Gamma (76-101 Hz).

For each of the frequency bands, we estimated the time-varying power at each vertex on the cortical sheet. Such results are saved in “dtseries” cifti files that can be viewed in `wb_view`.

In order to demonstrate this, we used data from the Right hand movement trials of the Motor task resolved in time and frequency.

- Maximize **wb_view** from the tab at the bottom of your screen.
- Click on File>Open File.
- Navigate to **/home/hcpcourse/day5-friday/practical1-morning**
- *Select* **P1E6_SrcAvgTFRpow.spec** and *click* **Open**.
- For this exercise you only need 2 tabs. (1) Montage and (3) Chart.
- In the Montage tab, in **Overlay Toolbox>Layers**, *tick* the box on very left of the first row.
- Click the drop-down list under **File**; you should be able to see 8 loaded files of functional data, one for each frequency.
- At the top of the list, *select* the file: **177746_MEG_Motort_srcavgdics_[LM-TEMG-RH]_[FB-betalow].power.dtseries.nii**

The functional map should appear on the cortical sheet with a “hot” colormap and corresponds to the Beta Low frequency band for which in the previous exercise we observed the suppression and rebound of power during and after movement, respectively.

In the Map field you can see a drop-down list with the value -0.8 seconds for this displayed file.

- *Click* on the dropdown arrow to reveal a long list containing all the time points for which the power has been calculated.

This time is relative to the reference which, in this case, is the onset of movement as measured by the EMG signal of the right hand.

- *Select* the time 0.7 seconds.

You should now see the Left Motor Cortex light up and, to a lesser degree, the Right Motor Cortex. This corresponds to the rebound peaks that we saw for frequency ~20 Hz on the Left figure of the previous exercise 5.

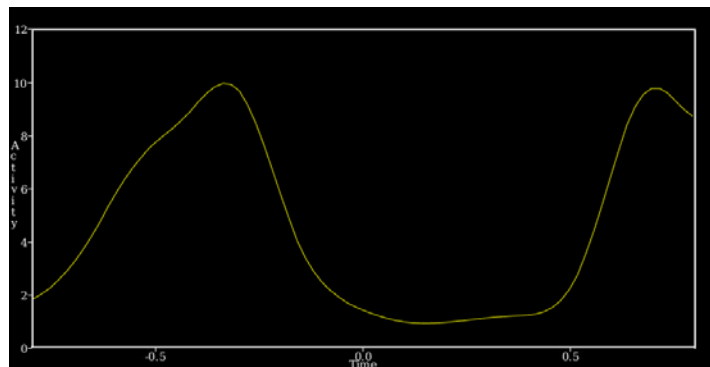
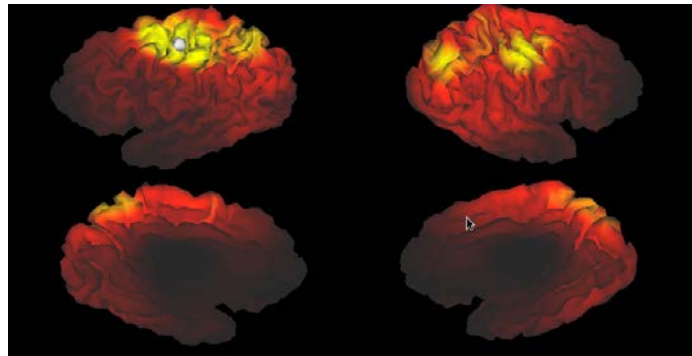
- Click on the third Tab, **(3) Chart**.

In the **Overlay Toolbox, Charting, Loading** tab, you should be able to see the 8 files from which the functional data for each frequency band has been loaded from.

- Tick the box next to **177746_MEG_Motort_srcavgdics_[LM-TEMG-RH]_[FB-beta_low].power.dtseries.nii** at the top of the list.
- Go back to Tab (1) Montage and with the left mouse button select the point of maximum activity (most yellow) on the motor cortex.
- Now go back to Tab (3) Chart .

You should be able to see the power time-series of the selected node. The peak motor cortex activity peaks around -0.5 and 0.7 sec, relative to movement onset.

- Now plot and explore the power time-series for other frequency bands and other seed locations.
- Close the **Information Box** and minimize Workbench for now, we will use it again in Exercise 8.



End of Exercise 6

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Exercise 7: Time and Frequency resolved Connectivity - Brain to Muscle. (A first glimpse at the sensor level)

It is a well-known phenomenon that sensorimotor cortical and spinal neuronal populations synchronize their activity during muscle activation. Muscle contractions can be readily measured with surface EMG, where the motor unit action potentials (i.e. the spikes in the EMG signal) reflect spiking activity in the alpha motoneuron pool. This synchronization is rhythmic in nature, and is most commonly observed in the beta frequency range, around 20 Hz.

Rhythmic synchronization can be studied with the coherence coefficient (which can be thought of as a frequency-resolved correlation coefficient, with the one difference in that it is bounded by 0 and 1, rather than by -1 and 1). Here we examine this corticospinal coherence for fine-grained frequency and time resolution at the sensor level, similar to the examination of the Event related Fields in exercise 3.

Instructions:

- Back in the file browser, double click on the **P1E7_SensEMGcoh.sh** script and select “run in terminal”.

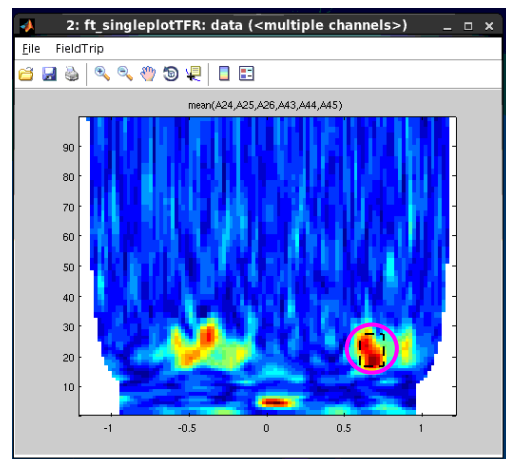
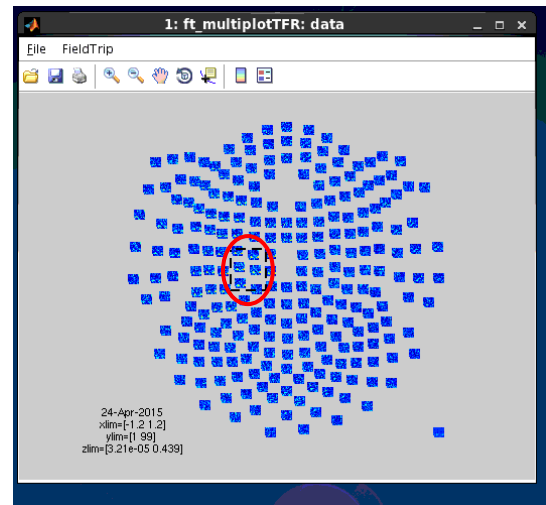
The pop-out figure shows the corticospinal coherence spectrum for each sensor. This plot is interactive.

- Select a group of sensors (+) in a box (indicated by the red circle in the image) by *holding the left mouse button and dragging it over the plot*.
- After selecting the sensors, *release the left mouse button and click again just once inside the selected box*.

A new window appears with the average time-frequency spectrum of coherence for the selected sensors.

This plot is interactive too. You can select a time interval-frequency interval. Notice the peak around 0.7 sec and ~20 Hz. This peak has a duration of about 100 mseconds.

- Select that peak, by *holding the left mouse button and dragging it over the plot*.
- *Release the left mouse button and click again just once inside the selected box*.

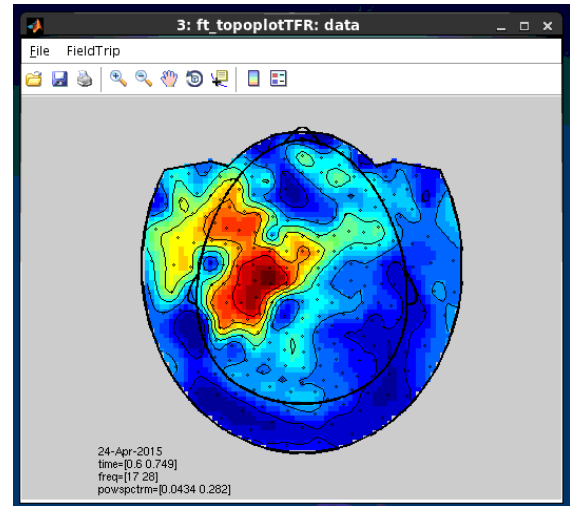


This will produce a new figure where the topology of the average time-frequency coherence spectrum is plotted.

Notice the Coherence peak over the left Motor Cortex that corresponds to corticospinal coherence during movement of the right hand at ~ 20 Hz. This represents functional connectivity between the cortex and muscle.

This plot is also interactive (you can select sensors again and get a plot of the average time-frequency spectrum of coherence for the selected sensors). This process can go on for ever, or until the computer crashes....

- *Press Ctrl+C to close the figure and exit.*



End of Exercise 7

Exercise 8: Time and Frequency resolved Connectivity - Brain to Muscle.

Learning objectives:

- Explore the time and frequency resolved corticomuscular coherence reconstructed on the cortical sheet.

Instructions:

- Maximize **wb_view** from the tab at the bottom of your screen.
- Click on File>Open File.
- Select **P1E8_SrcEMGcoh.spec** and click **Open**.
- For this exercise you only need 2 tabs. (1) Montage and (3) Chart.
- In the Montage tab, in **Overlay Toolbox>Layers**, tick the box on very left of the first row.
- Click the drop-down list under **File**; you should be able to see 8 loaded files of functional data, one for each frequency.
- Near the top of the list, select the file: **177746_MEG_Motort_srcavgdics_[LM-TEMG-RH][CM-emgcoh]_[FB-betalow].emgcoh.dtseries.nii**.

This will open the corticomuscular coherence (emgcoh) map that corresponds to the right hand movement condition (RH), for the Low Beta frequency band. The functional map appears on the cortical sheet with a “hot” colormap.

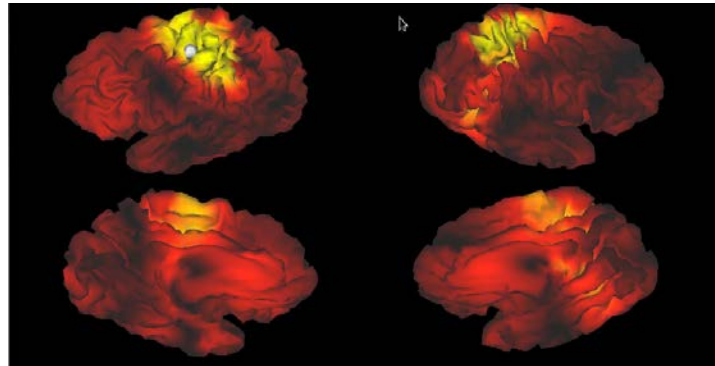
In the Map field you can see a drop-down list with the value -0.8 seconds for this displayed file.

- Click on the dropdown arrow to reveal a long list containing all the time points for which the cortico-muscular coherence has been calculated.

This time is relative to the reference which, in this case, is the onset of movement as measured by the EMG signal of the right hand.

- Select the time 0.76 seconds.

You should now see the Left Motor Cortex light up. This corresponds to the rebound peaks that we saw for frequency ~20 Hz on the Left figure of the previous exercise 5.

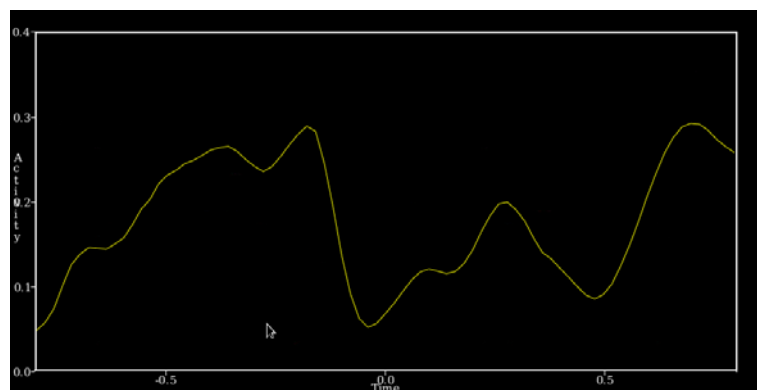


- Click on the third Tab, **(3) Chart**.

In the **Overlay Toolbox, Charting, Loading** tab, you should be able to see the 8 files from which the functional data for each frequency band has been loaded from.

- Tick the box next to **177746_MEG_Motort_srcavgdics_[LM-TEMG-RH]_[CM-emgcoh]_[FB-betalow].emgcoh.dtseries.nii** in the second row.
- Go back to Tab (1) Montage and rotate the left lateral image forward as in the image above.
- Left click to select the point of maximum activity (most yellow) on the motor cortex.
- Now go back to Tab (3) Chart.

You should be able to see the corticomuscular coherence time-series of the selected node. The peak coherence occurs around -0.4 and 0.7 sec, relative to movement onset.



- Close the **Information Box** and *minimize* Workbench for now, we will use it again in Exercise 10.

End of Exercise 8-----

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Exercise 9: Introduction to resting state data

The HCP protocol includes three resting state sessions. Since the resting state consists of spontaneous activity, without any trial definition, the pipelines used are slightly different from task ones as well as the metrics used in connectivity analysis. One of the most important steps in the preprocessing is the decomposition of the sensor level signal in brain and artifact components. This is accomplished by an ICA approach. The relevance of this approach is twofold:

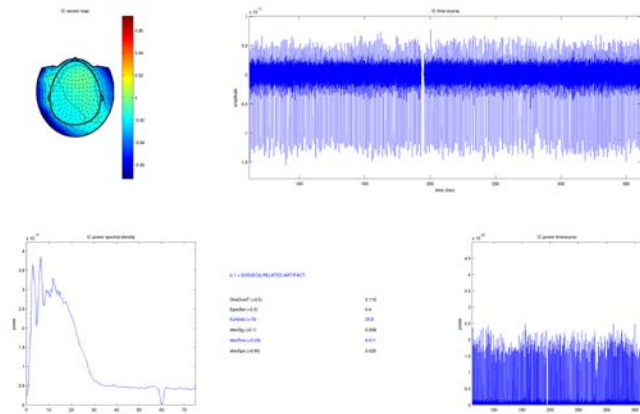
- improvement of the signal to noise ratio by removing the contribution of artifacts to the signal
- improvement in the source reconstruction by performing a Minimum Norm Least Square Estimate separately for each component.

The ICA decomposition algorithm allows for an automatic classification of the components. In this exercise, you will be able to browse through obtained components in two ways:

1. Open bitmap files produced by the `hcp_icaclass` pipeline. Here are a few examples of both artifact ICs and brain ICs. The figures show the topology of the components as well as their time and frequency characteristics:

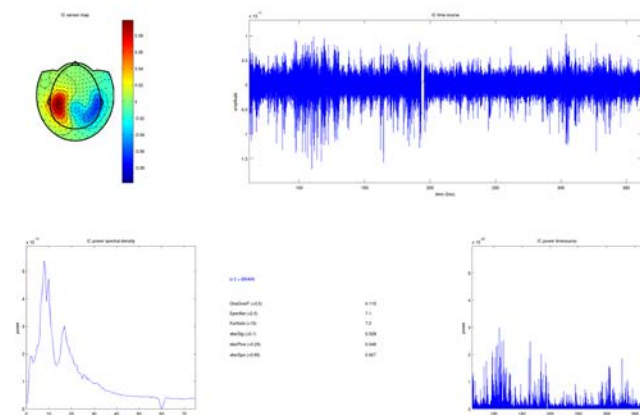
- Go to
`/home/hcpcourse/data/177746/MEG/Restin/icaclass/figures/`
- Open (double click on)
`177746_MEG_3-Restin_icaclass_1.png`

This is an example of an artifact due to heart activity.



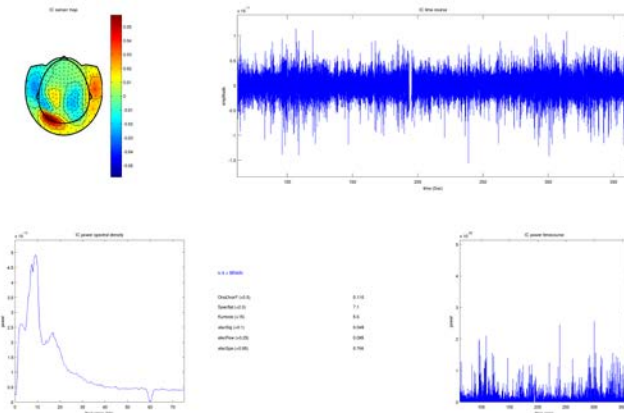
- Open **`177746_MEG_3-Restin_icaclass_2.png`**

This is an example of dipolar-like brain related activity.



- **Open 177746_MEG_3-Restin_icaclass_6.png**

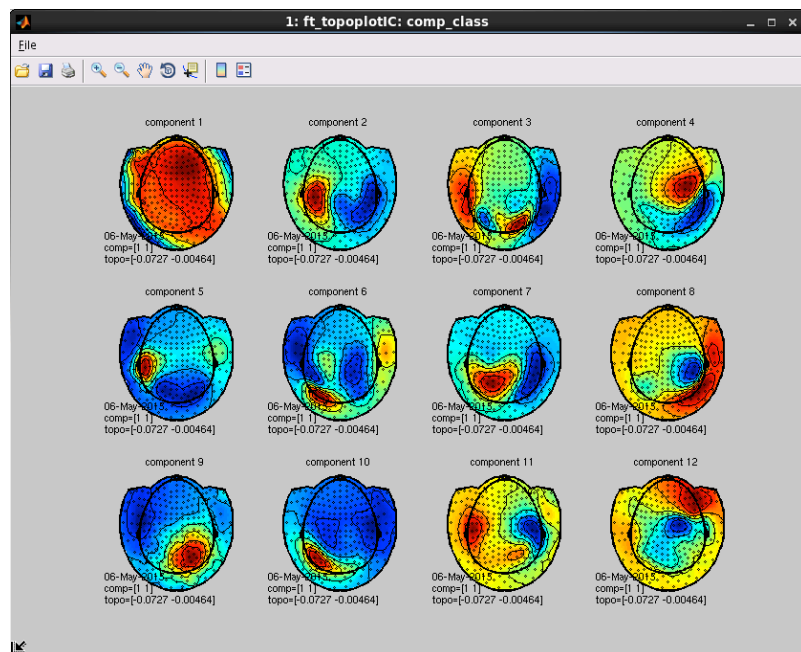
This is an example of more complex brain related activity.



2. FieldTrip visualization. Here, we visualize the first 12 obtained components using FieldTrip. This will be useful in combination with next exercise.

- Back in the file browser in **/home/hcpcourse/day5-friday/practical1-morning/**, double click on the **P1E9_SensICApLot.sh** script and select “run in terminal”.

The pop-out figure shows the topologies of the first 12 IC components. Leave the window open for next exercise.



End of Exercise 9-----

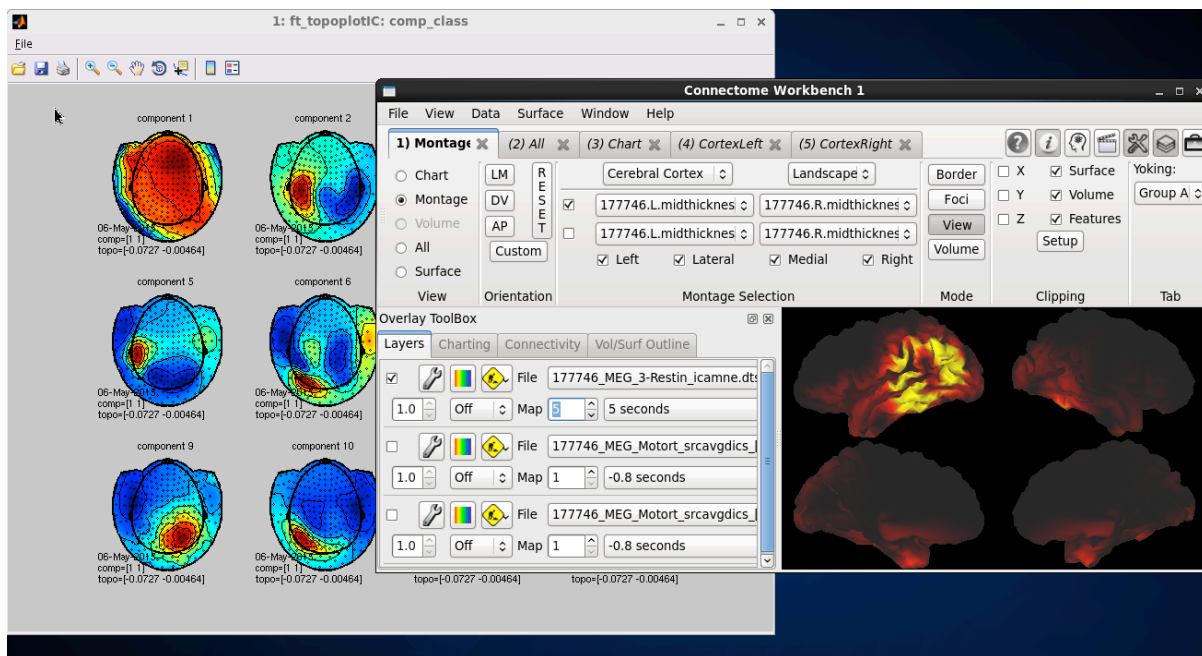
Exercise 10: Visualization of the obtained IC maps in the source space

Obtained Independent Components are projected to source space independently by using a MNE approach. Note that since the released source structures are in .mat format you should transform them

into .nii files using the **P1E10_SrcICAConvert2Nifti.sh** script. You can do this on the course computers, but we have created the .nii files for you to speed things up.

To browse through the source level maps:

- Maximize **wb_view** from the tab at the bottom of your screen.
- Click on File>Open File.
- Select **P1E10_SrcICA.spec** and click **Open**.
- In the Montage tab, in **Overlay Toolbox>Layers**, tick the box on very left of the first row.
- Click the drop-down list under **Map**; you will see a list of timepoints. These are not timepoint maps actually, they are instead maps of different IC components, in the same order as we saw in the FieldTrip image above (i.e. Component 1=1 second, etc.).
- Change the Map number or “time value” to show different source level IC maps and compare them with the corresponding sensor level figure from FieldTrip.
- Close the FieldTrip window.
- Leave Workbench open, we will use it again in Exercise 11.



End of Exercise 10-----

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Exercise 11: Band Limited Power dtseries (slow signal fluctuations)

The main goal of this part is to get you familiar with slow fluctuations in the MEG signal using BLP dtseries data. BLP data is provided in 9 bands (delta, theta, alpha, betalow, betahigh, gammalow, gammamid, gammahigh, whole band). These are obtained by linearly combining IC source level maps (only brain related) with the corresponding IC time courses. Then, the Band Limited Power (BLP) is evaluated.

Below, you will compare the BLP from different seeds, or the BLP of the same seed, across different bands. Comparison across seeds from within the same-network and seeds from different networks will show the non-stationarity of BLP-based connectivity. By selecting multiple seeds from the same network, (vs. randomly chosen seeds) will allow you to make a qualitative inspection of the degree of correlation (evolving in time) of BLP time courses.

A dlabel file containing a selection of seed (*meg_seeds.dlabel.nii* in the */home/hcpcourse/day5-friday/practical1-morning/restin/analysis/* folder) will be used. This file contains as set of pre-defined seed indices, based on a set of fMRI (resting state) based locations. These seeds were originally described in volumetric space. Seed vertices were defined as those nearest to the seed voxel locations. A list of the seeds, along with their corresponding network and hemisphere location is at the end of MEG Practical 2.

Qualitative inspection of the BLP dtseries can be done in wb_view performing the following steps:

- Click on **File>Open File**.
- Select **P1E11_blpenv.spec** and click **Open**.
- In the Montage tab, in **Overlay Toolbox>Layers**, tick the box on very left of the first row.
- Click the drop-down list under **File**; Note that only 5 bands of the 9 available Band Limited Power dtseries bands are loaded.
- Select the file: **177746_MEG_3-Restin_icablpenv_alpha.power.dtseries.nii**
- Click in the *Map name field* (showing 0.20029 seconds). You will see the list of timepoints. If you click again, without selecting a particular timepoint, you'll see that the Map name field is gray, meaning that it is active for scrolling with your mouse wheel.
- Use the *map scrolling feature* to quickly visualize many BLP maps over time.
- Select a different band's **177746_MEG_3-Restin_icablpenv_<band>.power.dtseries.nii** file and similarly scroll through some of the timepoints to qualitatively inspect the BLP of that band. Toggle off the first layer and toggle on layer 2, showing the *meg_seeds.dlabel.nii* file.

This shows the seed locations described above on the cortex (below).

- Click on the third Tab, **(3) Chart**.

- In the **Overlay Toolbox**, **Charting**, **Loading** tab, tick the box next to the “Charting File” **177746_MEG_3-Restin_icablpnv_alpha.power.dtseries.nii**

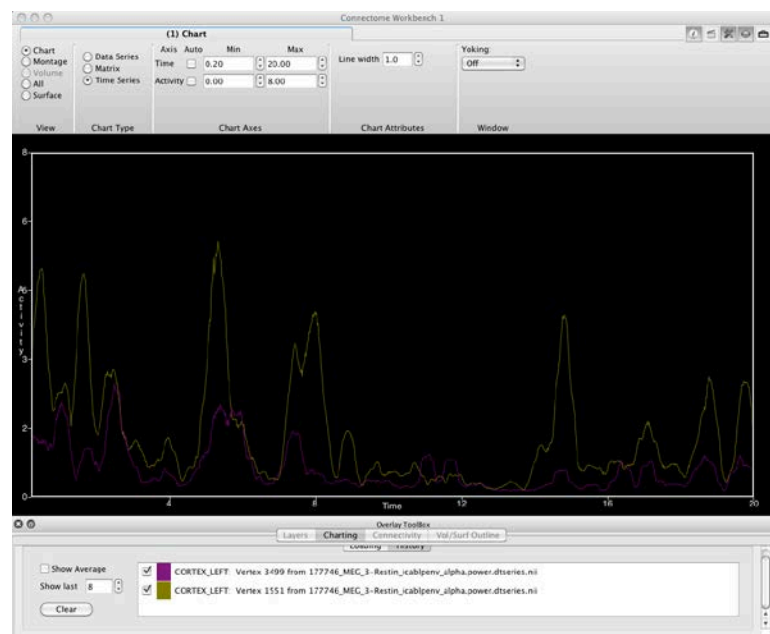
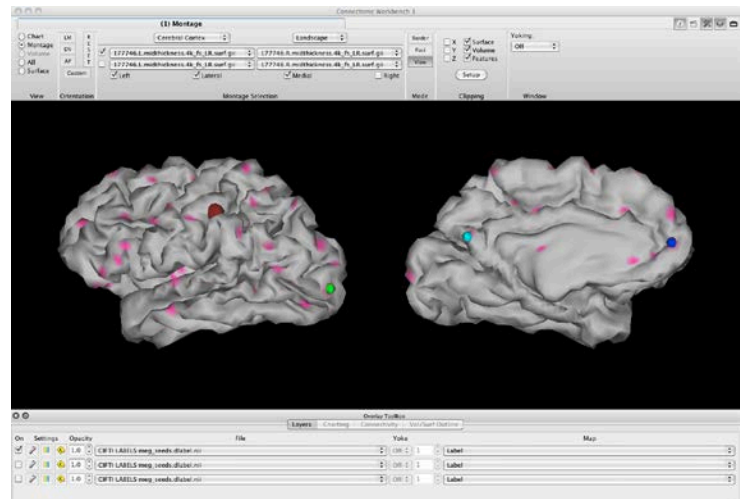
- Go back to **Tab (1) Montage** and with the left mouse button select seed locations in the left precuneus (L-PCC, the cyan dot on the right) and in the left anterior cingulate (L-AC1, the blue dot on the right) pertaining to the default mode network (DMN) —also notice the colors of the ID spheres (vertices) you selected.

- Now go back to **Tab (3) Chart**.

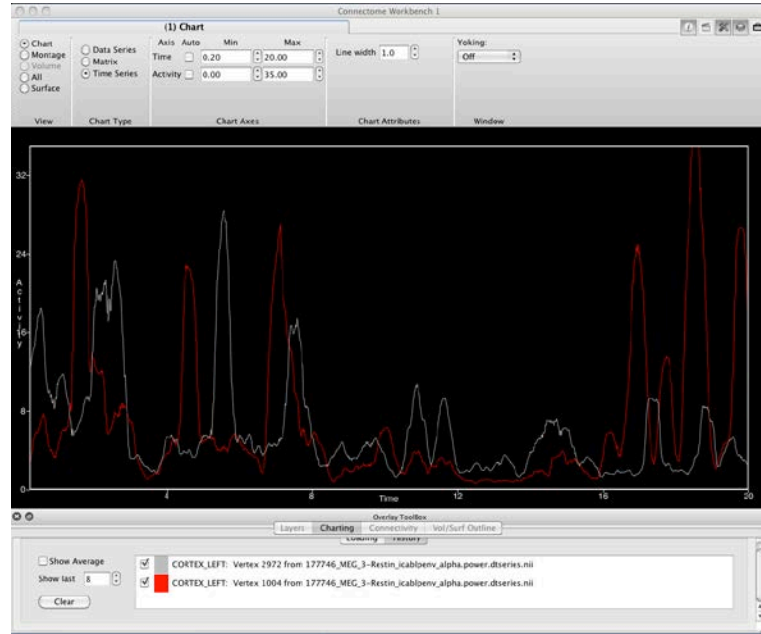
You can now compare the power time-series of the selected nodes—the colors here match those of the vertices selected on the surface. Although L-PCC and L-AC1 are seeds that are very far away from each other, they will show epochs of high correlation degree, since they belong to the same network, as well as epochs of desynchronization (see image next page).

- Click on the **Charting, History** tab.
- Click the **Clear** button to clear the charts for the previously selected vertices.
- Go back to Tab (1) Montage and with the left mouse button *select* seed locations in the lateral occipital cortex (L-Fovea-LO, the green dot above) and in the left pericentral cortex (L-dPoCe, the red dot above).
- Return to the Chart tab.

L-Fovea-LO and L-dPoCe will show very different BLP time courses (shown next page).



Now that you know the basics, you can select more seeds to compare at a single band, or compare different bands' BLP time courses for a given seed.



End of Exercise 11-----

End of MEG Practical 1-----

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