Preprocessing Tutorial

This tutorial demonstrates how to preprocess raw BIDS-formatted MEG data using *Brainstorm* to extract necessary time series on which single and multi-channel burst detection can be applied.

The sample data used in this work can be downloaded from OpenNeuro. This BIDS-formatted dataset consists of resting state MEG recordings from 5 healthy participants who are part of the OMEGA database. In this work, we show results for the first of these subjects (sub-0002) but you may wish to apply the tutorials to all subjects (or your own data) to gain a sense of the inter-subject variability.

For convenience we recommend that the tutorial scripts, sample data, and data derivatives are all saved in the same local working directory.

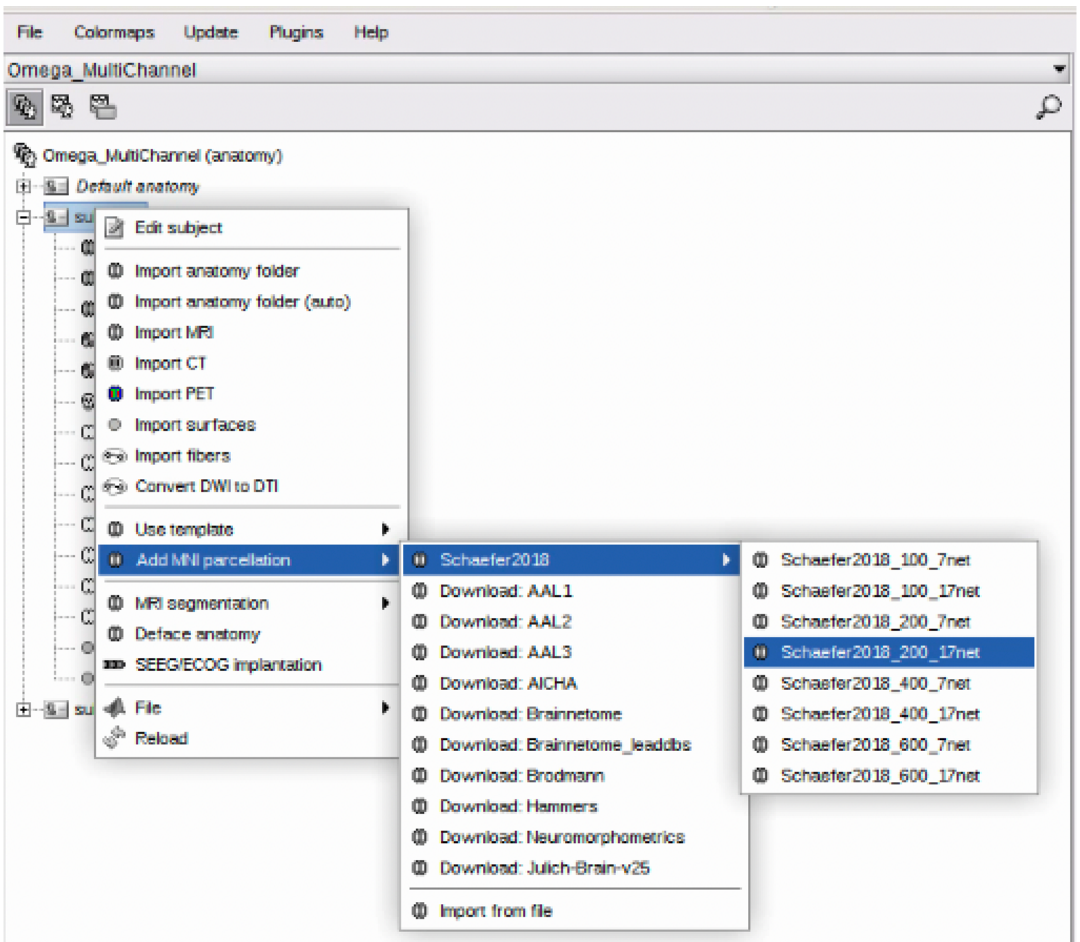
1. Download and Preprocess MEG Data

To begin, follow the steps in the Brainstorm OMEGA Tutorial up to and including step 9 (Source Estimation). For this work, it is only necessary to complete the steps for sub-0002. The completion of these steps will result in filtered, source-projected MEG data.

2. Single-Channel Methods: Extract Single Schaefer Time Series

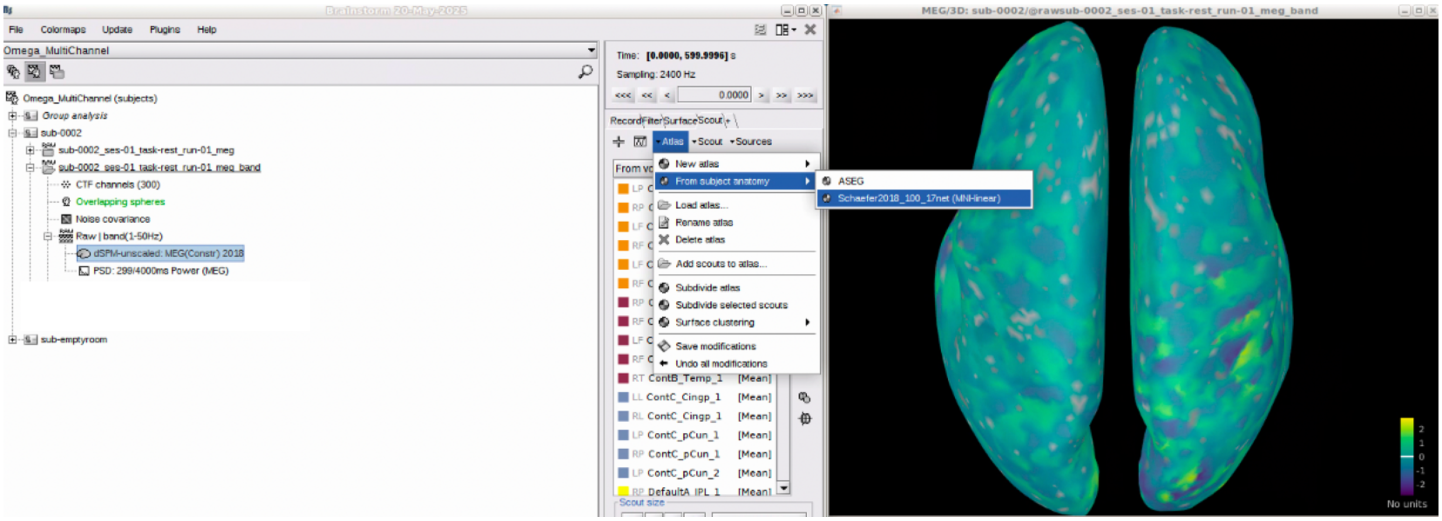
The single-channel burst detection methods are performed on a single time series representing activity in the right motor cortical region. In order to extract such a time series, we must parcellate the data using an anatomical atlas and export the time series at the region of interest as follows:

In Anatomy tab:
Right click sub-0002 > Add MNI parcellation > Schaefer2018 > Schaefer2018_200_17net



In the Functional data tab:
Double click on the source file to open a source plot

In the right panel, select the Scout tab then select Atlas > From subject anatomy > Schaefer2018_200_17net (MNI-linear)

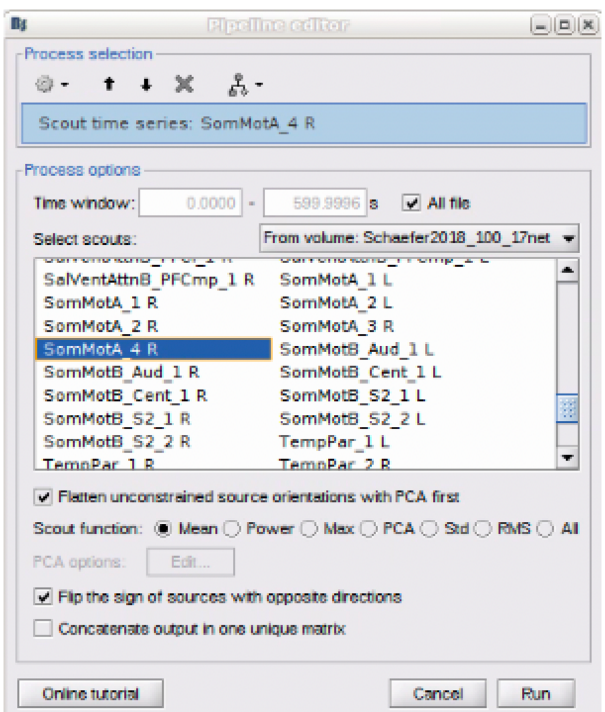


This will load the subject-specific Schaefer parcellation

Close all figures

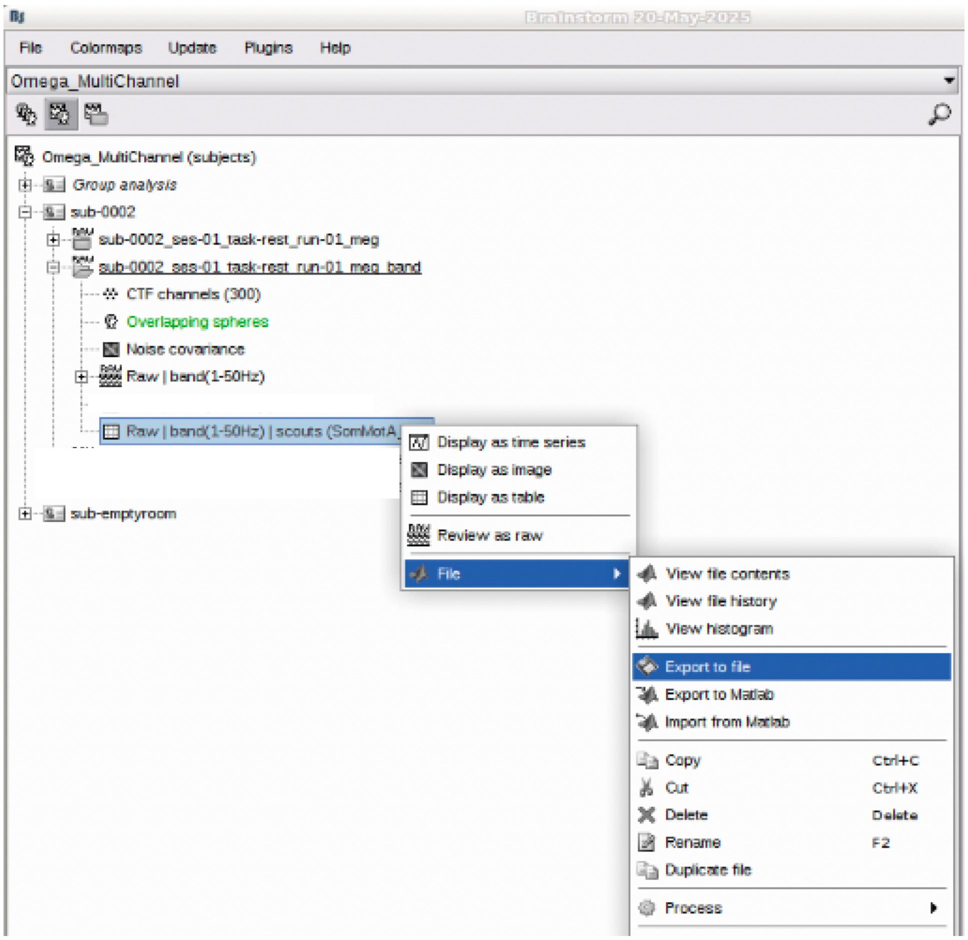
Drag sub-0002 to Process 1 box and select Process sources > Run

Process > Extract > Scout time series: all file, Select scouts from volume: Schaefer2018_200_17net, highlight region 'SomMotA_4 R', Scout function: mean



Click Run

There should now be a new matrix object containing the time series data for the Schaefer parcel of interest. To export this time series for use in the burst detection tutorials:
Right click on the matrix > File > Export to file > save as .mat file



For a simple transition to the Jupyter tutorials, save the matrix under the name 'sub-002_SomMotA_4_R.mat'

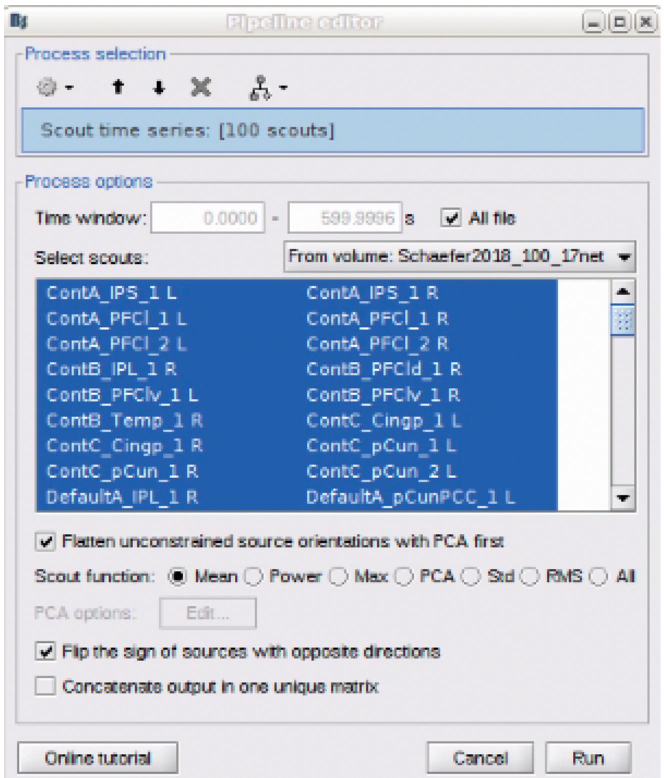
You should now be able to run any of the single channel burst detection tutorials including: Amplitude_thresholding.ipynb, Cyclebycycle.ipynb, Microstates.ipynb, PAPTO.ipynb, or eBOSC.ipynb.

3. Source-Level HMM: Extract Schaefer Time Series

For the HMM we will use the lower resolution Schaefer100 atlas. As with the Schaefer200, the atlas will need to be imported and fit to the current subject. Repeat the steps above to generate a subject-specific Schaefer-100 parcellation (Schaefer2018_100_17net).

Drag sub-0002 to Process 1 box and select Process sources > Run

Process > Extract > Scout time series: all file, Select scouts from volume: Schaefer2018_200_17net, highlight all regions, Scout function: mean



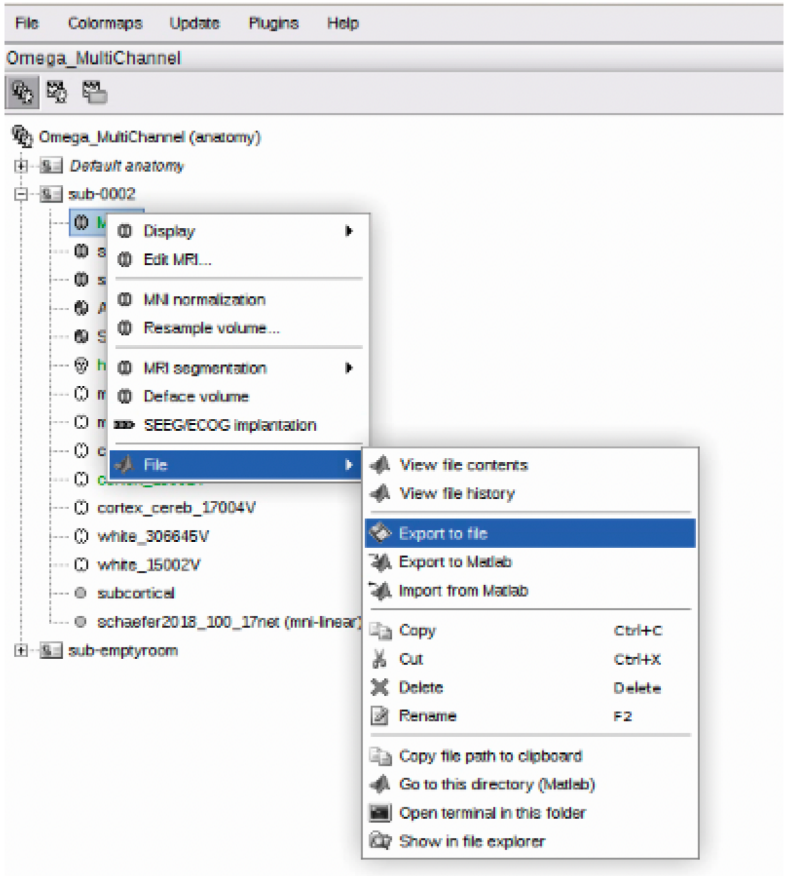
Click Run

Export the resulting matrix: Right click on the matrix > File > Export to file > save as .mat file

Save the matrix to your working directory as 'matrix_scout_schaefer100.mat'

Finally, to generate HMM power maps on the subject's anatomy, the T1 anatomy file and Schaefer100 volume atlas will also need to be exported.

To do this, navigate to the anatomy tab and right click on MRI T1 > File > Export to file > save as .nii file in your working directory.



Repeat this procedure to export Schaefer2018_100_17net (MNI-linear)

You should now have everything you need to run HMM.ipynb

4. A Note on Sensor-Level Multichannel Methods (CDL/Microstates)

For the sensor-level multichannel methods (i.e., CDL and microstates segmentation), extensive preprocessing in Brainstorm is not performed. For these methods, source localization and time series extraction is not required. Therefore, for simplicity, the BIDS-formatted data is loaded directly into the Jupyter notebook and basic preprocessing (e.g., filtering, SSP) is performed using MNE python prior to applying the method of interest. The preprocessing steps are matched to those used in the Brainstorm-processed data.

As such, Microstates.ipynb and CDL.ipynb can be run immediately following the download of the OMEGA sample data.