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 all tutorial scripts, sample data, and data derivatives be saved in the same local working directory.

1. Download and Prepare MEG Data

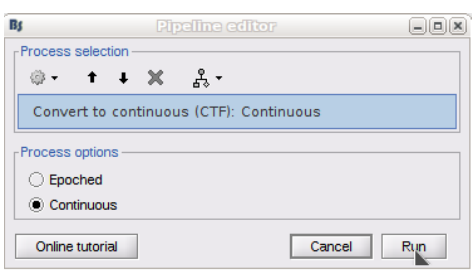
To begin, follow the steps in the [Brainstorm OMEGA Tutorial]() up to and including step 6 (Refine the MEG-MRI Registration). For this work, it is only necessary to complete the steps for sub-0002.

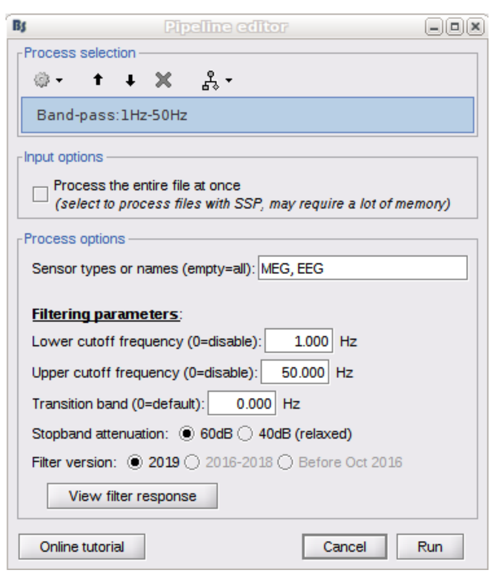
At the end of these steps, all data should be loaded into Brainstorm, co-registered, and ready for preprocessing.

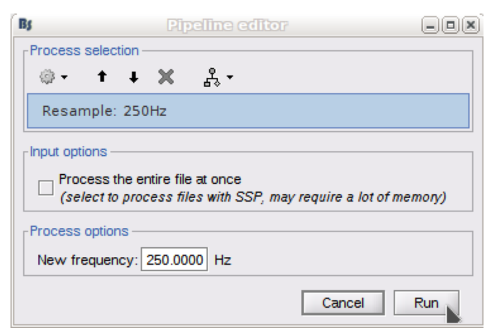
2. Preprocess MEG Data

Apply bandpass filter (1-50 Hz) and resampling (250 Hz):

- Drag and drop all the subjects (including sub-emptyroom) into the Process1 box and click on [Run]
- Select process: **Import > Import recordings > Convert to continuous (CTF)**: Continuous
- Add process: **Pre-process > Band-pass filter**: High-pass filter at 1Hz, low-pass filter at 50 Hz, 60dB, Process entire file.
- Add process: **Pre-process > resample**: 250 Hz

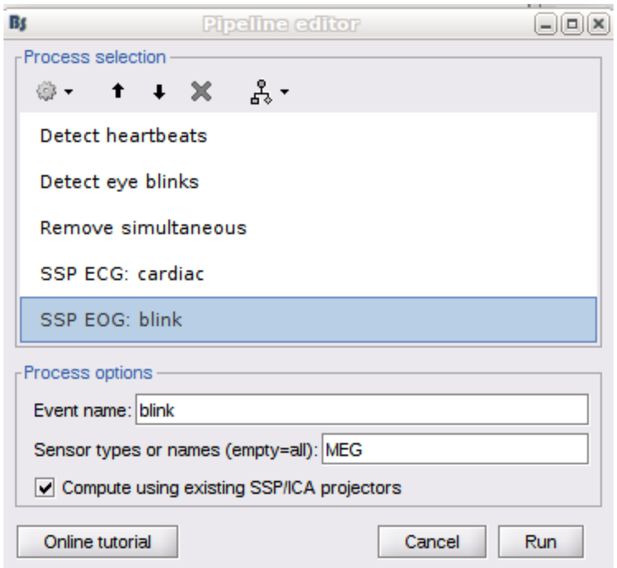






Artifact cleaning – remove heartbeats and eyeblinks using automate SSP procedure

- In Process1, select all the subject rest recordings (all the subjects, excluding sub-emptyroom)
- Select process: **Events > Detect heartbeats**: channel name ECG, all file, cardiac
- Add process: **Events > Detect eye blinks**: channel name VEOG, all file, blink
- Add process: **Events > Remove simultaneous**: remove cardiac close to blink, delay:250 ms
- Add process: **Artifacts > SSP > Heartbeats**: cardiac, MEG, use existing SSP
- Add process: **Artifacts > SSP > Eye blinks**: blink, MEG, use existing SSP



3. Source Estimation

Complete section 9 (Source Estimation) in the [Brainstorm OMEGA Tutorial.]

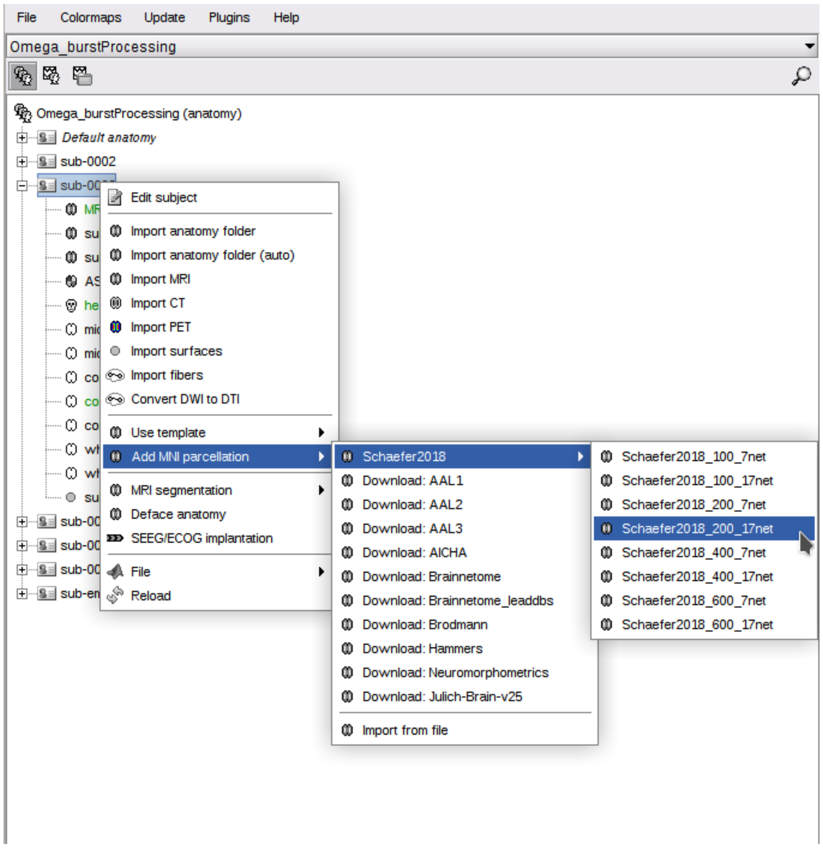
The completion of these steps will result in filtered, source-projected MEG data.

4. 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:

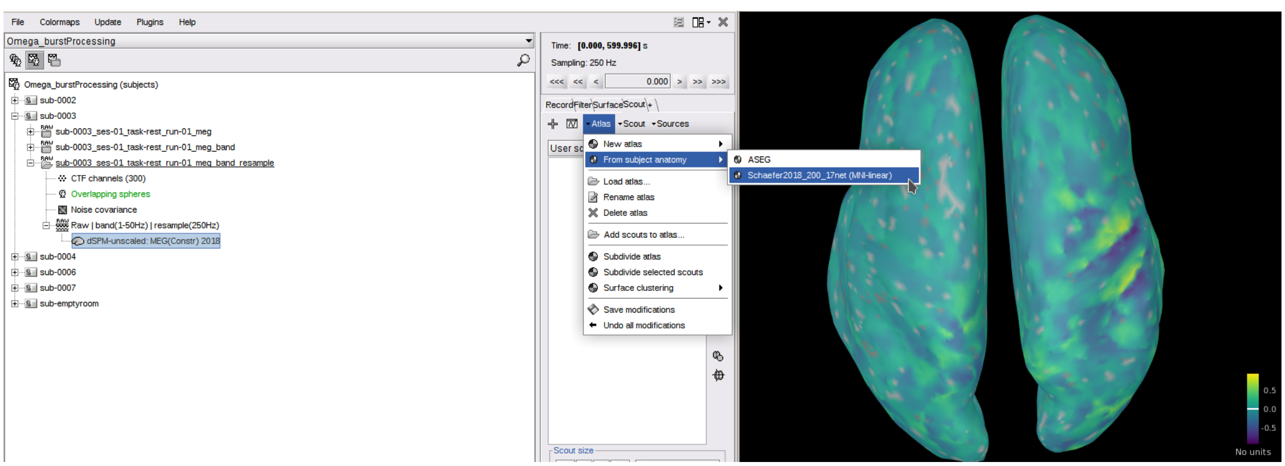
In Anatomy tab:

- Right click sub-0003 > Add MNI parcellation > Schaefer2018 > Schaefer2018_200_17net

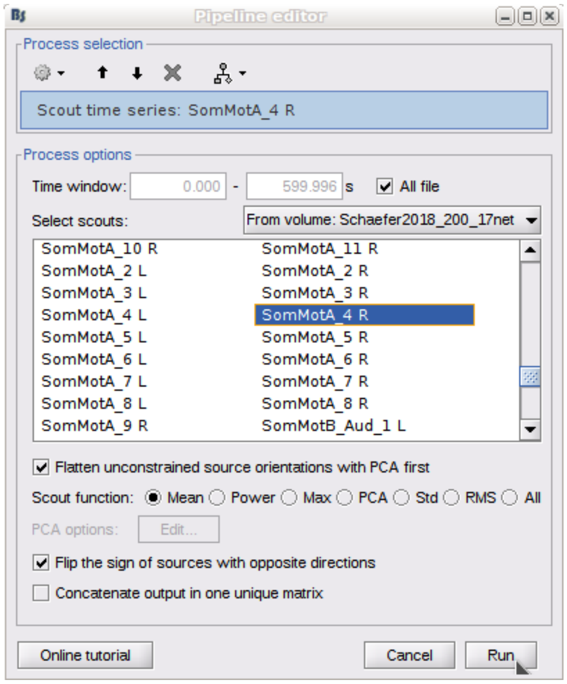


In the Functional data tab:

- 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)

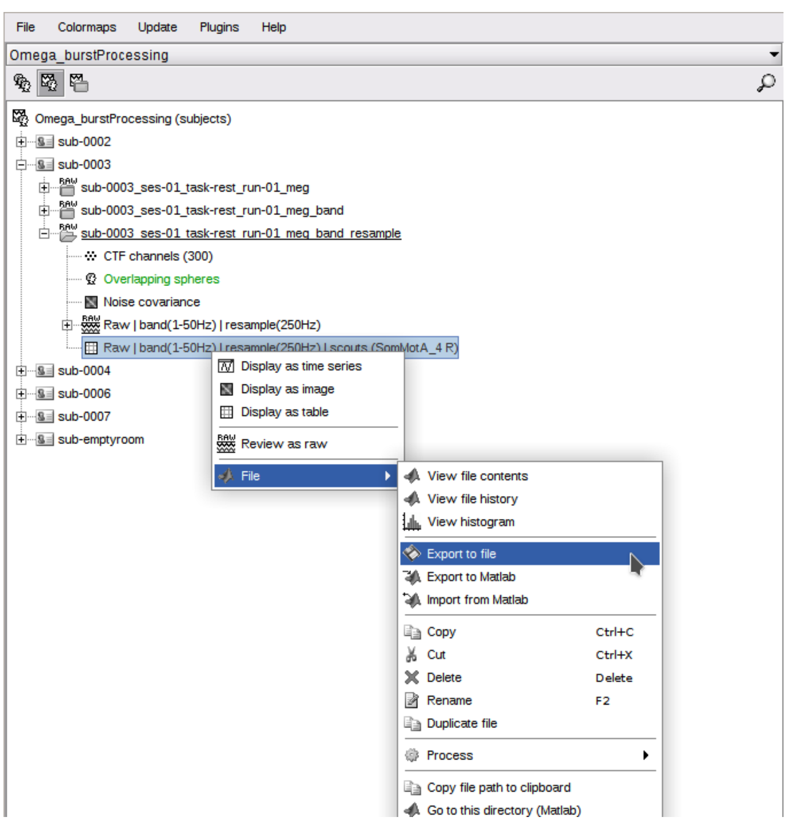


- This will load the subject-specific Schaefer parcellation
- Close all figures
- Drag sub-0002 to Process 1 box and select Process sources > [Run]
- Select process: **Extract > Scout time series**: all file, Select scouts from volume: Schaefer2018_200_17net, highlight region 'SomMotA_4 R', Scout function: mean



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-0002_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, HMM.ipynb, or eBOSC.ipynb.

5. A Note on Sensor-Level Multichannel Methods (CDL)

For the sensor-level multichannel methods (i.e., CDL), extensive preprocessing in Brainstorm is not performed. For this method, source localization and time series extraction is not required. Therefore, for simplicity, the BIDS-formatted data is loaded directly into the Jupyter notebook and the preprocessing steps indicated in step 2 (e.g., filtering, artifact removal) are 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, CDL.ipynb can be run immediately following the download of the OMEGA sample data.