MEG/EEG
Signal processing GUI

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1. Introduction

This document was written about signal processing GUI - “vb_signal_processor”.
vb_signal_processor.m is a VBMEG function to launch the GUI.
It provides basic filtering functions for MEG/EEG file. Basic filters are “Bias correction”, “Highpass”, “Lowpass”, “BandPass”, “StopBand”, “Downsampling”, and “Common reference(for EEG)”. For more information, see the Preferences of “Filters” section.

1.1. MEG/EEG file

MEG/EEG file is created using VBMEG data import function, and you can make it by yourself by reference to a format of Standard MEG/EEG file. The format document file is placed in the VBMEG document directory.
$VBMEG/functions/doc/Standard-format-MEG_EEG_1_0_1_en.pdf
These files have an extension “.meg.mat” or “.eeg.mat”.

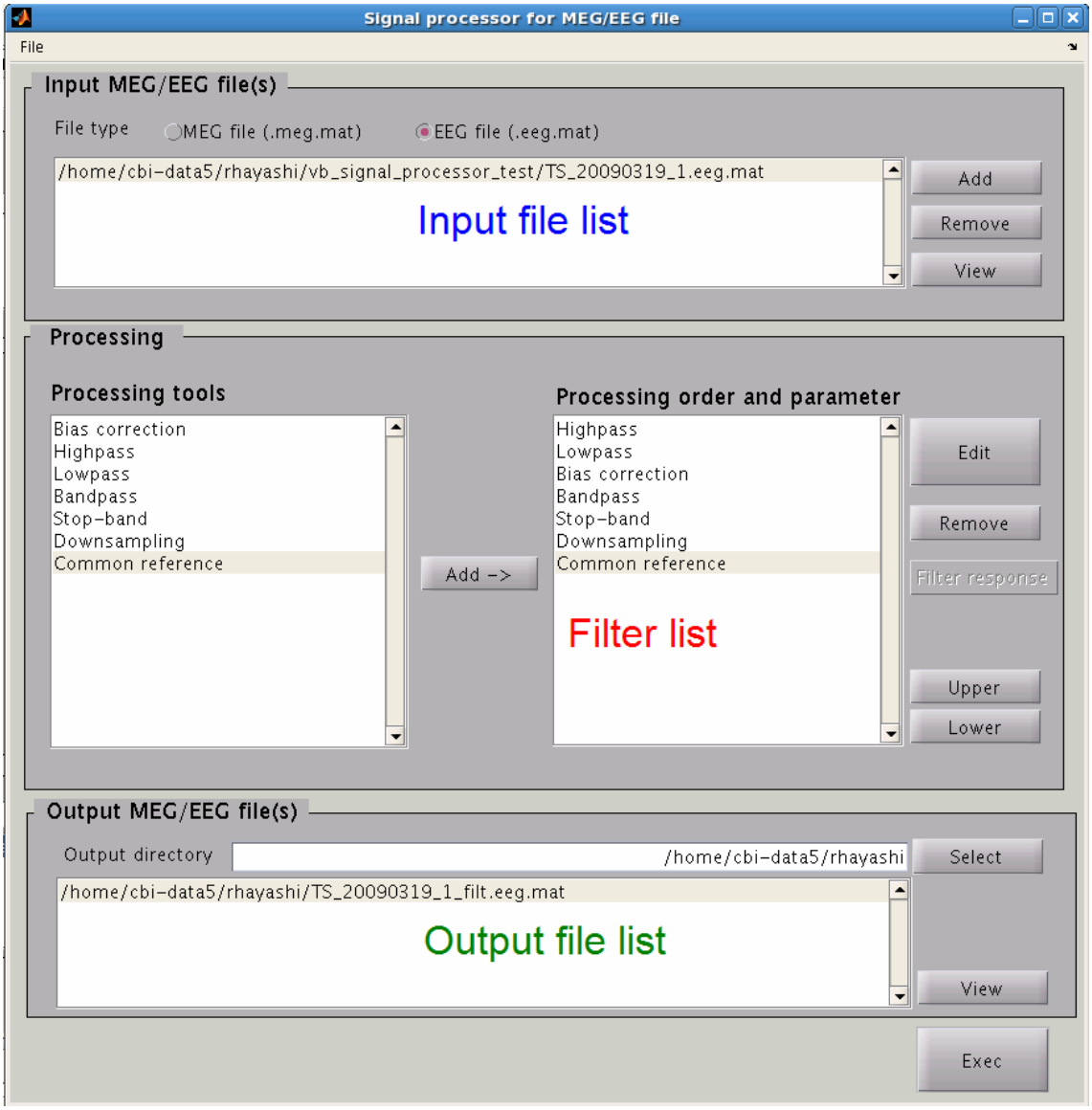
2. WorkFlow

The workflow is very simple.
(1) Specify MEG/EEG file(s) that you want to process.
(2) Choose filters and modify these settings.
(3) Push “Exec” button.

3. GUI

The GUI consists from three parts.

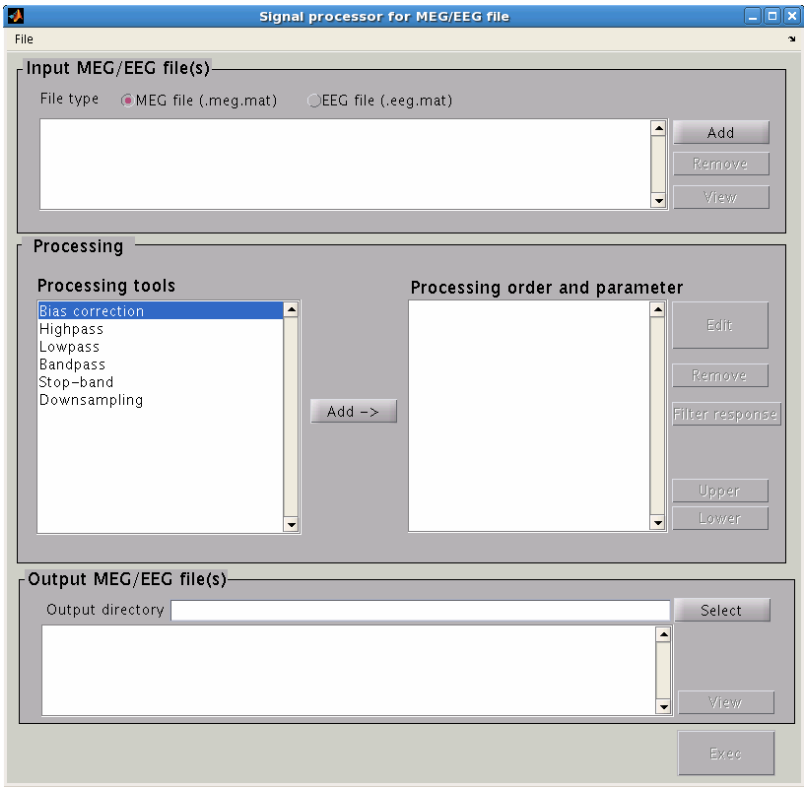
Data flow is top to bottom. [Input files] → [Filtering] →[Output files].



4. Practical operation

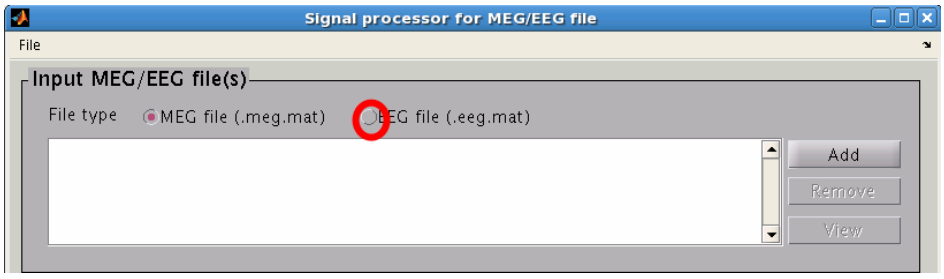
So, let's try to process an actual EEG data.

1. Run the following script. The GUI appears.

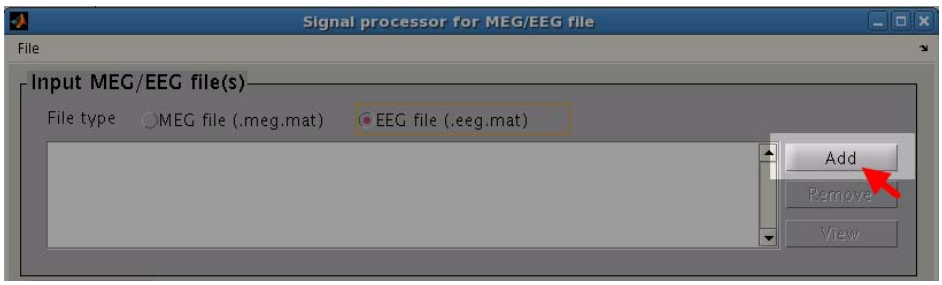


$>vb_signal_processor

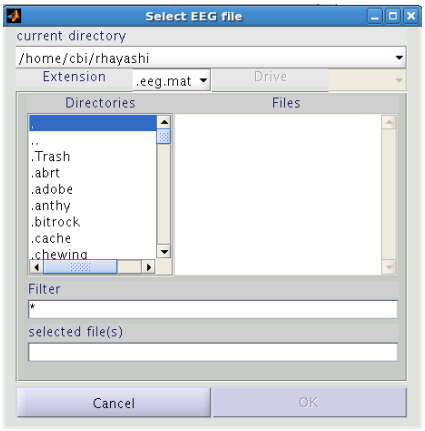
2. Set File type to EEG file(.eeg.mat)



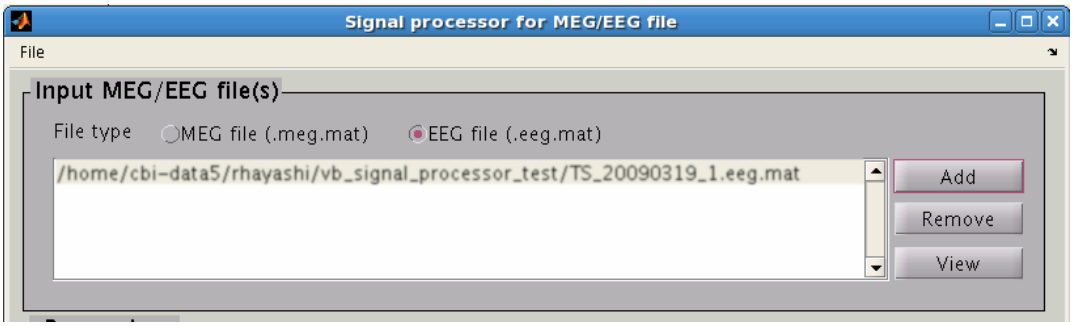
3. Click the "Add" button to specify EEG file.



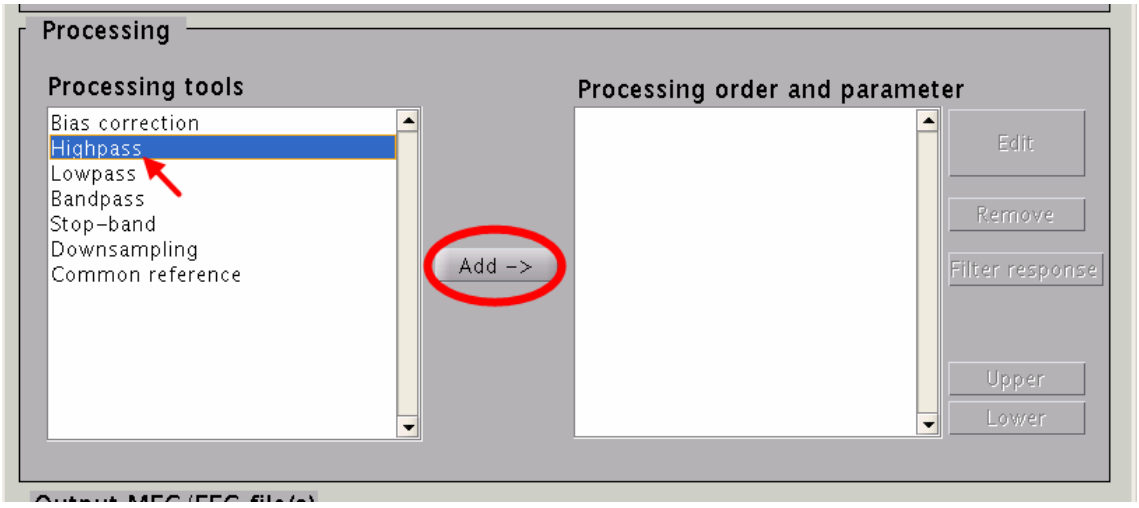
4. Select EEG file in the appearing dialog.



The selected file was added.

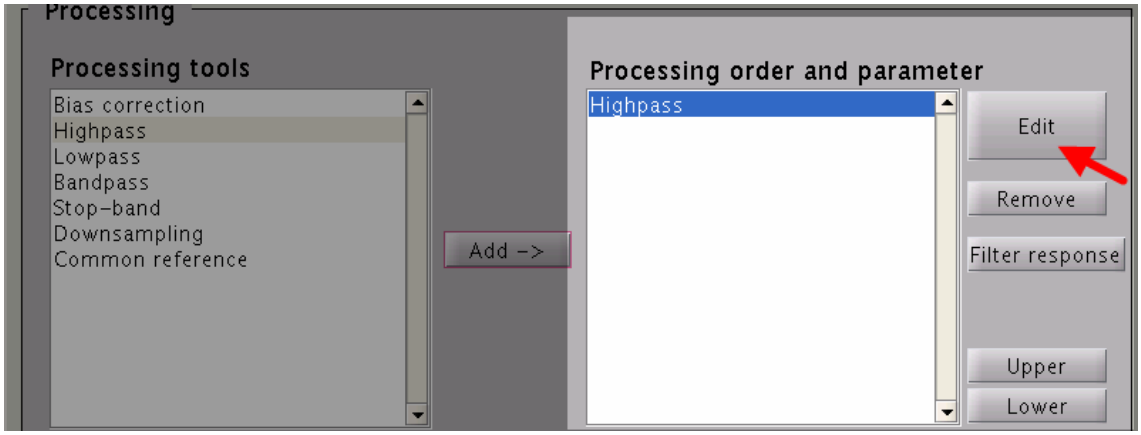


5. Click the “Highpass” from the list of processing tools and press the “Add->” Button.

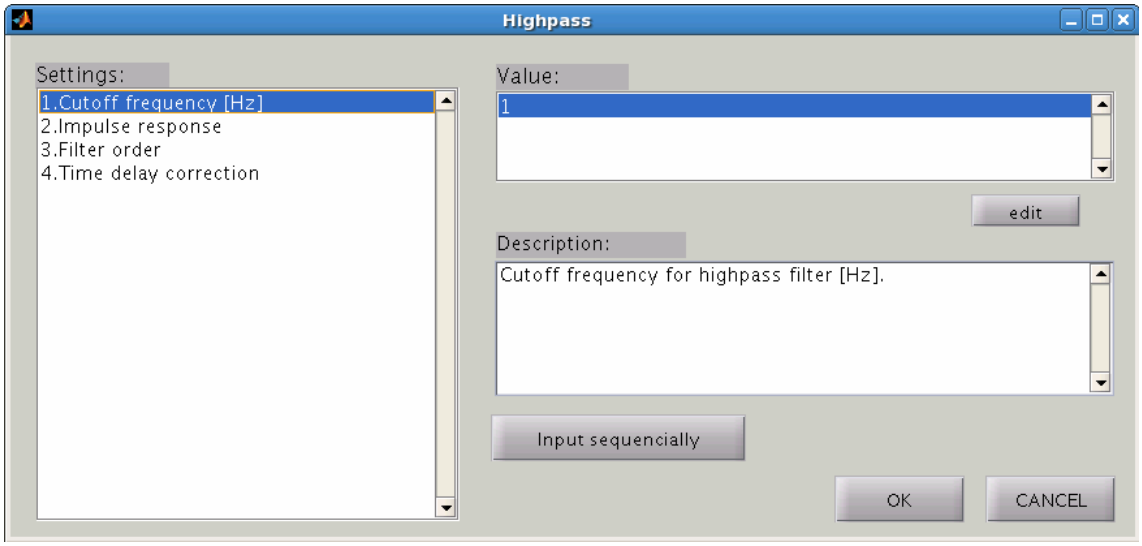


Highpass filter was added to the list of “Processing order and parameter”.

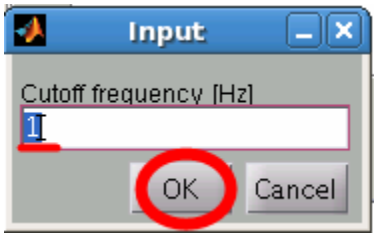
6. Press the “Edit” button to modify the setting of selected Highpass filter.



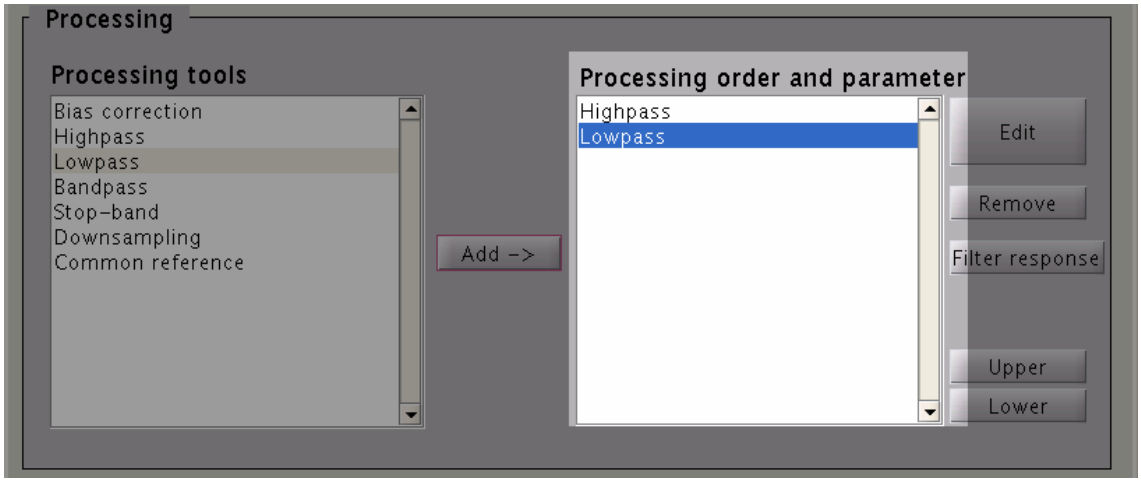
7. Setting dialog appears. Double-click the left item that you want to modify. (Or choose the item and press the “edit” button.) The description of the item can be seen on the lower right pane.



8. Value input dialog appears. Enter a value and press the “OK” button.

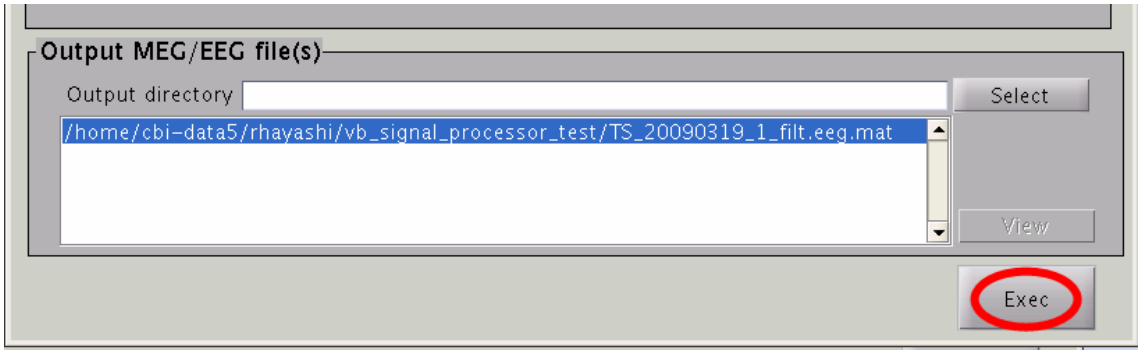


9. In the same way, add “Lowpass” to the right list.

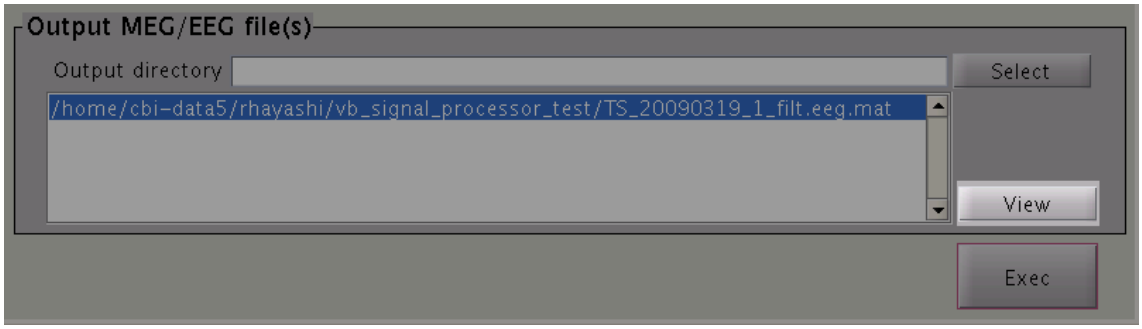


The filters will be applied from the top of the list. If you change the order, press the “Upper” and “Lower” button.

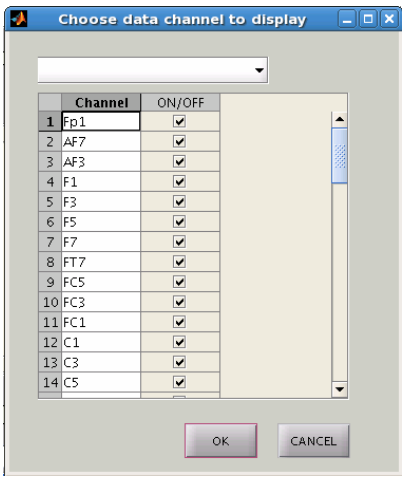
10. Finally press the “Exec” button. Output file will be created.
Output filename: fixed. (original filename+”_filt”)
If you want to change output directory, Press the “Select button” and choose an output directory. (Or enter it to the edit box directly.)



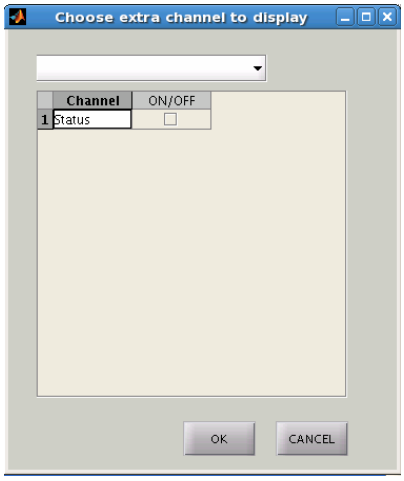
[TIPS] If you want to specify the output filename, save parameters as M-script from the menu:[File]->save as batch file(M-script), then modify and execute it.
“Now processing” dialog appears. When the processing finished, “View” button is activated.



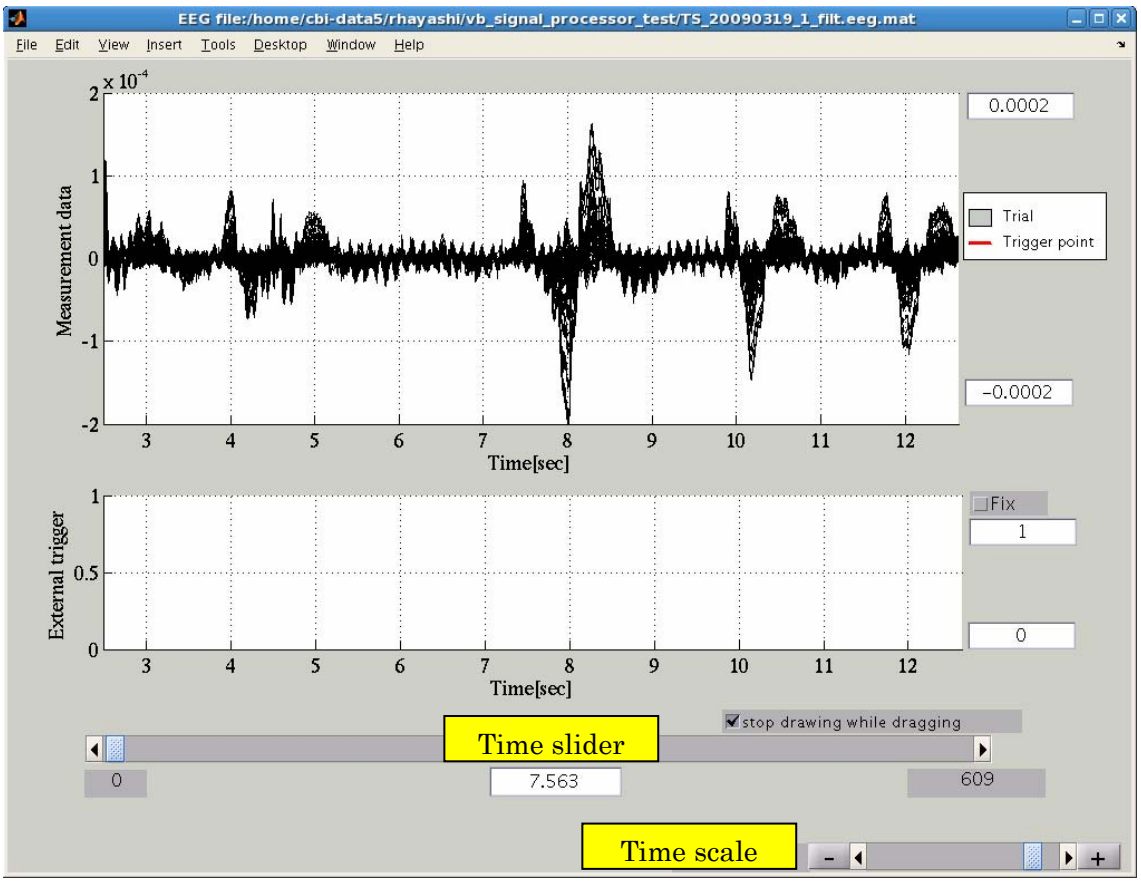
11. Press the “View” button to check the filtered EEG file.
    The dialog appears as below. Specify channels to show by checkbox.
    Then press the “OK” button.



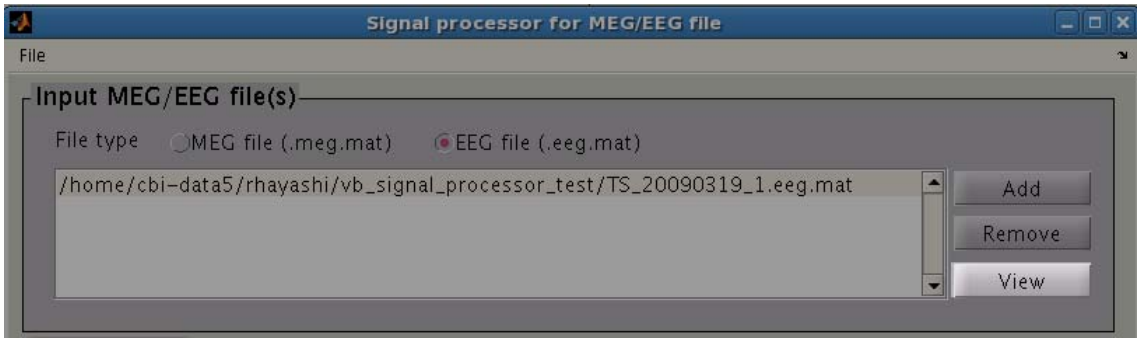
12. And also Specify external channels to show by checkbox.
    Then press the “OK” button.



13. Data Viewer appears. Set the display time and adjust the Time scale by slider.



Original EEG file can be seen from the “View” button as well.



5. Preferences

5.1. Filters

5.1.1. Bias correction

parameter	commentary
mode	0: No Bias correction. 1: Constant Bias correction by using all time samples. 2:Linear trend removal and Constant Bias correction by using all time samples. [t1 t2]: Bias correction by time window [t1 t2] (msec). time is specified by [msec] from the begining of data.

5.1.2. Lowpass

parameter	commentary
Cutoff frequency	Cutoff frequency for lowpass filter [Hz].
Impulse response	1:Finite impulse filter 2:Butterworth filter
Filter Order	Filter order for Butterworth filter. For finite impulse filter, this value is not used.
Time delay correction	0: 'filter' is applied for online filter case, 1: Time delay correction is applied by using 'filtfilt'

5.1.3. Highpass

parameter	commentary
Cutoff frequency	Cutoff frequency for highpass filter [Hz].
Impulse response	1:Finite impulse filter 2:Butterworth filter
Filter Order	Filter order for Butterworth filter. For finite impulse filter, this value is not used.
Time delay correction	0: 'filter' is applied for online filter case, 1: Time delay correction is applied by using 'filtfilt'

5.1.4. Bandpass

parameter	commentary
Lower cutoff frequency	Lower cutoff frequency for bandpass filter. [Hz]
Higher cutoff frequency	Higher cutoff frequency for bandpass filter. [Hz]
Impulse response	1:Finite impulse filter 2:Butterworth filter.
Filter Order	Filter order for Butterworth filter. For finite impulse filter, this value is not used.
Time delay correction	0: 'filter' is applied for online filter case, 1: Time delay correction is applied by using 'filtfilt'

5.1.5. Stop-band

parameter	commentary
Lower cutoff frequency	Lower cutoff frequency for stop-band filter.[Hz]
Higher cutoff frequency	Higher cutoff frequency for stop-band filter. [Hz]
Impulse response	1:Finite impulse filter 2:Butterworth filter.
Filter Order	Filter order for Butterworth filter. For finite impulse filter, this value is not used.
Time delay correction	0: 'filter' is applied for online filter case, 1: Time delay correction is applied by using 'filtfilt'

5.1.6. Downsampling

parameter	commentary
New sampling frequency	New sampling frequency[Hz]. Before downsampling, lowpass filtering with cutoff frequency less than 'New sampling frequency/2' should be applied.

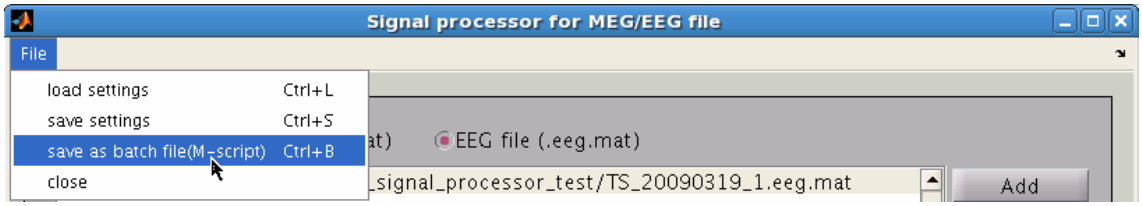
5.1.7. Common reference(for EEG)

parameter	commentary
mode	0:OFF 1:ON. Common reference is one way of EEG reference channel specification. For EEG data, reference voltage is assumed as the average of all channel data. Namely, the average of all channel data is subtracted from each channel data for each time sample.

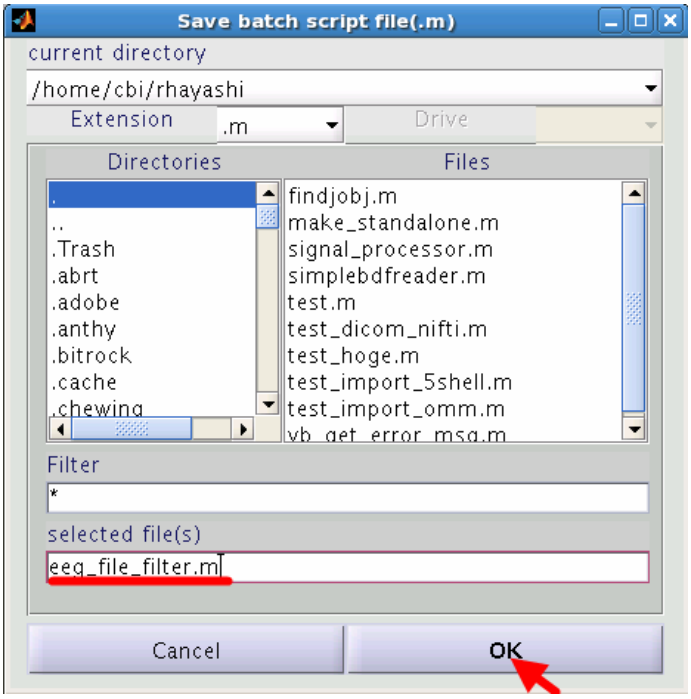
5.2. Batch processing

Once you decide filter settings, you may want to apply the same settings to the other MEG/EEG file(s). In such cases, you can use a function to save settings as MATLAB M-script file.

1.Choose [File]->save as batch file(M-script)



2.In the appearing dialog, enter the filename and press the “OK” button.



3. Open the batch M-script file.

```
% Apply signal processing to MEG/EEG-MAT file(s).
proc_parm.input_files{1,1} = '/home/ rhayashi/test /test1.eeg.mat';
proc_parm.output_files{1,1} = '/home/rhayashi/test/test1_filt.eeg.mat';
proc_parm.process_list{1,1}.type = 'highpass';
proc_parm.process_list{1,1}.cutoff_freq = 1;
proc_parm.process_list{1,1}.impulse_response = 2;
proc_parm.process_list{1,1}.order = 5;
proc_parm.process_list{1,1}.filtfilt = 1;
proc_parm.process_list{1,2}.type = 'lowpass';
proc_parm.process_list{1,2}.cutoff_freq = 20;
proc_parm.process_list{1,2}.impulse_response = 2;
proc_parm.process_list{1,2}.order = 5;
proc_parm.process_list{1,2}.filtfilt = 1;

% Run batch process
vb_signal_processor_batch_exec(proc_parm, 0)
```

proc_parm.input_files and proc_parm.output_files are one-to-one correspondence.
Please modify these files and run it as MATLAB script.
proc_parm.process_list(highpass and lowpass) will be applied to input_files.