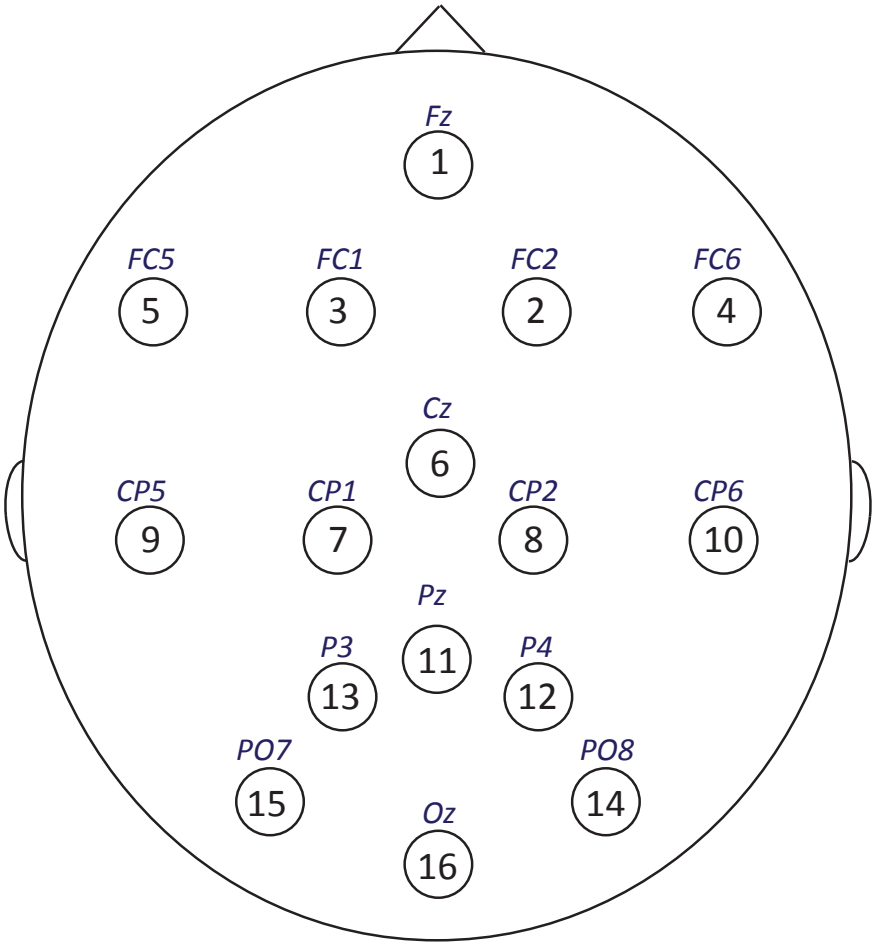
COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

Lab Instruction 2
Biological Artifacts in EEG

Brain Computer Interface Lab
ECBM 4090



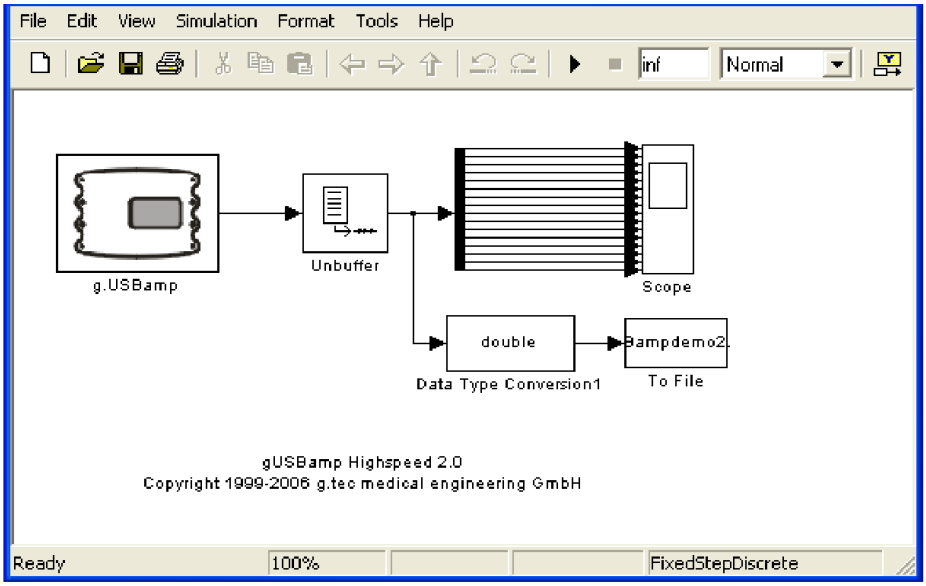
Some materials adapted from g.tec medical engineering (www.gtec.at).

In a scientific experiment, an artifact is any error in the signal produced by the equipment or technique. In EEG, it is important to be able to identify artifacts so you can learn to collect clean data in future experiments. In this lab, you will practice recording EEG data under conditions with different kinds of artifacts.

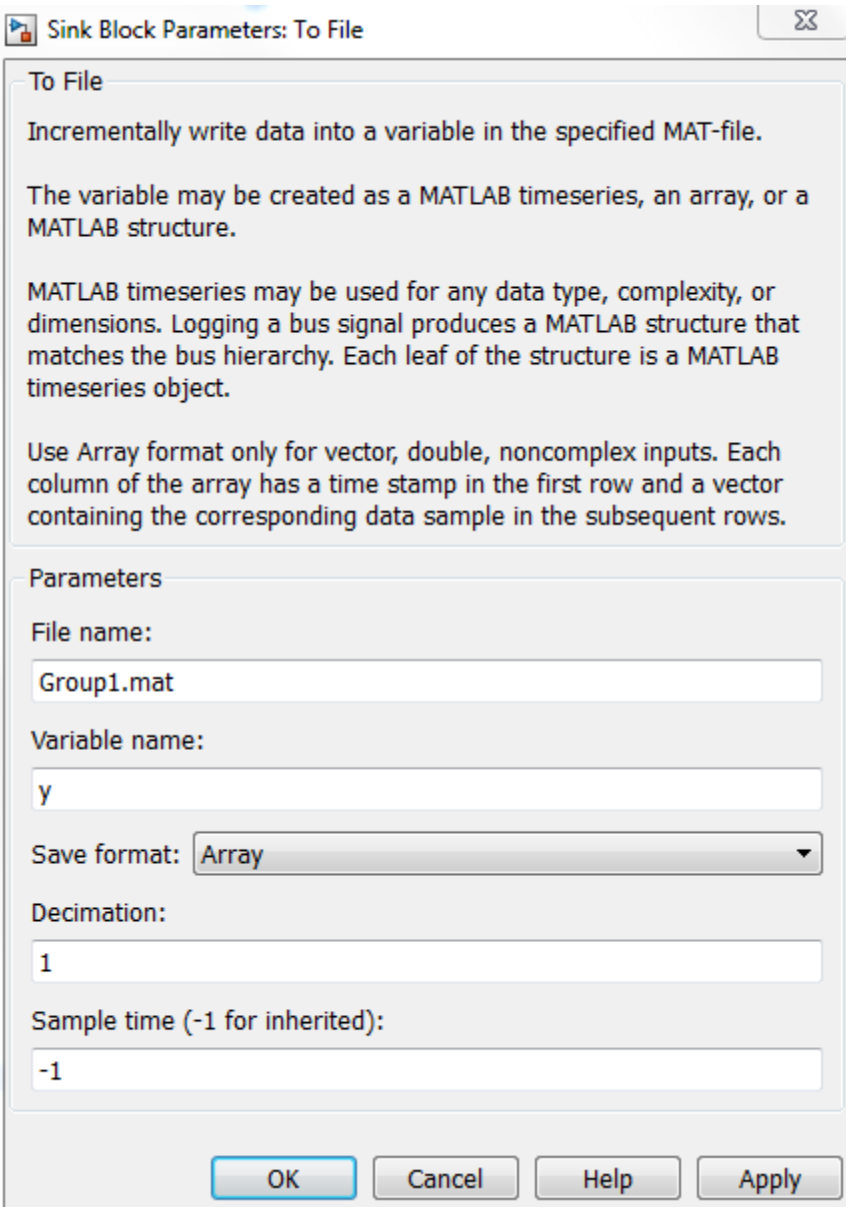
Experiment 1: EEG signal visualization and data storage

In this experiment, you will measure the EEG activity of **Fz, FC1, FC2, and Pz** during a variety of conditions: while the subject is sitting silently, blinking, rolling eyes, chewing, tensing the neck, and touching the electrodes.

1. Modify the Simulink block you created during lab 1.
   a) Add the following modules:



   b) In the g.USBamp module:
      i. Select the following channels: **Fz, FC1, FC2, & Pz**
      ii. Mark the 4 electrodes in the list-box.
      iii. Select the appropriate bandpass (0.5 to 60Hz) and notch (60Hz) filters and apply to all channels.
      iv. Close the configuration window with OK.
   c) Change the number of scope channels to match the number of electrodes.
   d) In the "To File" module:
      i. Change the File name to your group number.
      ii. Change the variable name to y.
      iii. Change the Save format to Array.



2. Record EEG data under different behavioral conditions.
    a) In the “To File” block, change the File name to Experiment1.mat.
    b) Click Start to begin the EEG acquisition.
    c) Inspect the data.
        i. Use the Autoscale function to see the EEG data.
        ii. Check if the EEG data from all 4 channels is visible and if you are recording clean EEG data.
        iii. When you see clean EEG data stop the simulation and instruct the subject to sit quietly.

d) Record different behavioral conditions.

   i. Instruct the subject to sit quietly and restart the simulation.

   ii. Using the watch in Simulink, ask the subject to change their behavior every 30 seconds. Record each of the following behaviors for 30 seconds, for a total of 3 minutes of recording:

      1. Sitting silently
      2. Blinking
      3. Rolling eyes
      4. Chewing
      5. Tensing the neck
      6. Touching the electrodes

   iii. After the last task, press the Stop button.

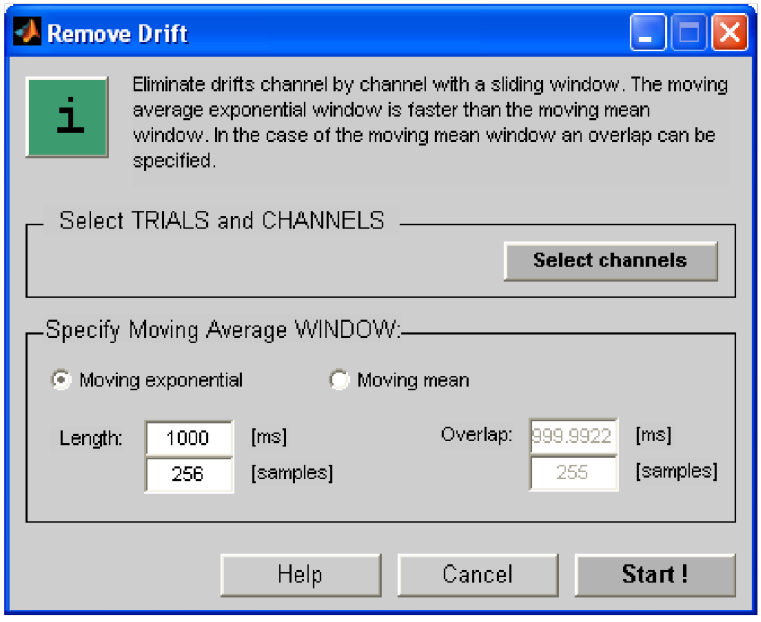
3. Analyze the EEG profiles of different artifacts.

a) Start g.BSanalyze by typing gbsanalyze into the MATLAB command window.

b) Load the data set. Select "Load" from the File menu and select the file you just recorded, which will save it in the MATLAB folder.

c) In order to visualize the data correctly, some pre-processing steps are necessary.

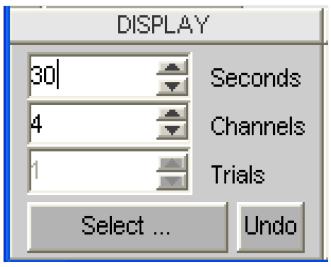
   i. Remove the offset of the electrodes by opening the Remove Drift window from the Pre-Processing menu. Select the Moving exponential window with 1000 ms Length. Press the Start button to perform the operation.



ii. Channel 1 contains the sample count and is not needed for further processing. Delete it with Cut Trials & Channels from the Transform window.

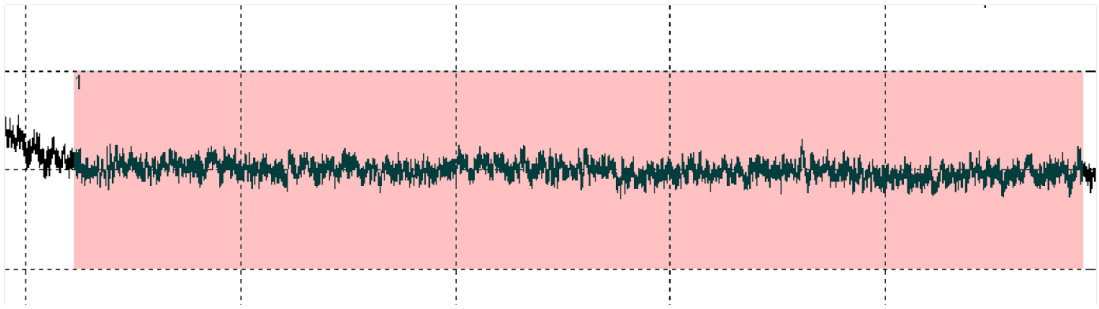
iii. Open the Scaling window from the View menu. Enter 100 µV Scale for channels 1-4.

iv. In Display, set seconds to 30 to view each condition on one page.



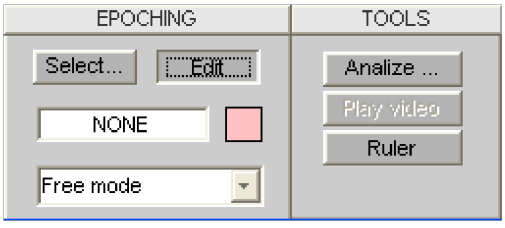
d) Analyze the data with the Analyze and Ruler Tools of g.BSanalyze.

i. First press on the Edit button and mark specific epochs in the Data Editor by dragging a window over the channel. The epochs are identified by the number in the top left corner of the rectangle. Note that multiple channels can be marked by dragging a rectangle over all channels you want to mark.



ii. Click Analyze to investigate the frequency distribution of the epoch. The Merge segments checkbox must be disabled to investigate the epochs separately.

1. Press the Ruler button to investigate the amplitudes of the EEG traces.
2. Drag the horizontal lines to each channel to measure the amplitude. The values are shown below the Ruler button.



Report:

• Create a screenshot of each of the conditions to show its characteristic wave shapes. Adjust the number of seconds on the display so you can see the type of artifacts, and include x- and y- scaling in the printout. (3 pts)

• Measure and report the amplitude of each artifact for all 4 channels. (2 pts)

• By comparing silent sitting to each of the other conditions, find the frequency range where each artifact is present and record your data in the following table: (1 pt)

Condition	Frequency Range (Hz)
Blinking	
Rolling eyes	
Chewing	
Tensing the neck	
Touching electrodes	

Experiment 2: Bipolar derivation

1. Double click on the g.USBamp block and select bipolar derivations between FC1-Fz, FC1-FC2, and FC1-Pz.

Report: Create graphs that compare the bipolar derivations with the mono-polar derivations when you produce EMG artifacts by 1) blinking and 2) chewing. Which derivation suppresses the EOG artifacts best? Why? Which derivation suppresses the EMG artifacts best? Why? (3 pts)

2. Switch off the notch and bandpass filter for all channels and perform one bipolar derivation to compare with the monopolar derivations.

Report: Create a graph that compares the derivations. Does the bipolar recording help reduce the power line interference? How large is the reduction of the 50/60 Hz power line noise in dB? (1 pt)

Homework:

- Open the EEG file in MATLAB.
- Describe the data structure used to record the EEG signals. (1 pt)
- Write scripts and include figures showing the following:

  1. Plot the raw EEG signals. (1 pt)

  2. Eliminate the DC component of every channel. (2 pt)

  3. Design filters for Alpha (8-13Hz) and Beta (14-32Hz) frequencies. Report the power in each band during conditions A-F. (6 pts)
  You can design your own filter or use eegfilt.m from EEGLAB.