- Before the subject arrives
  - Prepare the EEG Headset:
    1. Confirm that all EEG electrodes are plugged into the board correctly.
       a) Each EEG electrode is labeled with the name of the OpenBCI board pin that it should be plugged into
          (1) **It is the responsibility of the Experimenter to check that the electrodes are properly connected!** There is no way to confirm that the electrodes were properly connected after data is collected.
    2. Confirm that the ear electrodes are plugged into the board correctly.
       a) Ear electrodes are comprised of two parts:
          (1) The electrode itself:
          (2) The no touch EEG converter to make it compatible with the OpenBCI Board.
       b) Connect the ear electrode to the no touch EEG converter if not already done so.
       c) The left ear electrode will be plugged into the SRB pin on the OpenBCI board.
       d) The right ear electrode will be plugged into the BIAS pin on the OpenBCI board.
    3. Prep each electrode with the conductive Ten20 paste.
       a) A small amount of the paste should be placed in the EEG electrode and then mounted on the EEG headset.
       b) The ear electrodes can be pushed apart so the paste can be easily placed
  - Prepare the Computer
    1. Plug the OpenBCI dongle into the end of the extended USB cable
    2. Turn on the OpenBCI board and confirm that it is connecting to the dongle.
       a) Turn on the OpenBCI Board
          (1) Move the white switch on the right side of the OpenBCI board UP, to the 'PC' setting
       b) Open the OpenBCI software
          (1) Select 'Live (from Cyton)' from the 'System Control Panel'
          (2) Click 'Refresh List' and select the appropriate COM port
              (a) If unclear which COM port is associated with OpenBCI, unplug the dongle, click 'Refresh List', plug the dongle back in, again click 'Refresh' and note the new COM port that is listed
       c) Click 'Start System'. To confirm that the OpenBCI board is connecting to the dongle, monitor two things
          (1) The dongle itself with flash green and red if it is connecting
              (a) If only red flashes, the board is not connected
          (2) The white bar at the bottom of the OpenBCI will flash, 'Attempting to establish a connection with OpenBCI' and then open the EEG data collection screen
              (a) If the EEG data collection screen does not open and instead the white bar states, 'Init timeout. Verify your Serial/COM Port. Power DOWN/UP your OpenBCI & USB Dongle. Then retry initialization' the board is not connected
  - Prepare remaining supplies
    1. The following supplies should be ready to use at the desk you will be collecting EEG data:

a) The EEG headset with paste in electrodes
b) Ear electrodes with paste
c) OpenBCI dongle (plugged into USB extender)
d) A black and white EEG cap
e) 8 EEG electrode cap lids
f) A tape measure
g) Ten20 conductive paste
h) NuPrep skin prep gel
i) Alcohol dispenser
j) Cotton tipped applicators
k) Alcohol wipes
l) stopwatch

- Subject Prep Procedure
  - Go over procedure with Subject before starting
    1. Measure head
    2. EEG cap goes on
    3. EEG headset goes on top
    4. Scalp areas will be cleaned with Alcohol/nuprep
    5. Electrodes go in cap locations
    6. Test electrode impedances and improve them as needed
    7. Collect EEG data
    8. Remove electrodes from cap and clean scalp area with alcohol
    9. Remove EEG cap
  - Possible speech before starting capping procedure: *"Part of this experiment is an EEG recording. I will ask you to place this cap on your head and then I will attach the EEG device to it. We will use this device to measure the electrical activity coming from your brain. Sensors on the device will be placed in the holes in the cap. I will be doing things like parting your hair under each sensor location, applying alcohol and a gel to clean each area and gently pressing on each sensor to get a closer connection between the sensors and your head. You may feel some slight pressure on your head from each sensor, but beyond this let me know if you feel any discomfort and I will try to make some adjustments. Once I have the device properly set-up I will turn off the lights and have you close your eyes and clear your mind for 5 minutes while we record the electrical activity from your brain. Do you have any questions?"*
  - Head measurement
    1. Securely wrap the tape around the widest possible circumference of the head:
       a) Broadest part of the forehead above eyebrow
       b) Above the ears
       c) Most prominent part of the back of the head
    2. Give the subject the most appropriate EEG cap for their head size
       a) White Cap: 52-56cm
       b) Black Cap: 56-60cm
  - Place Cap on subjects head and make adjustments
    1. Ask subjects pull their ears through the holes in the cap so you have access to the ear lobes

2. Confirm that the Inion (the small bump on the back of the head) is BELOW the O1/O2 positions
3. Confirm that CZ is aligned with the Vertex by following a path from the ear to the top of the skull
4. If any of these positions are out of alignment, shift the cap until they are aligned
- Prep and Placement of Ear Electrodes
  1. Identify where the ear electrodes will be placed
     a) If you cannot place electrodes on the ear lobes due to earrings, use the top of the ear instead.
  2. Give subjects alcohol swab to clean the area of the ear you will be using for the ground/reference electrodes.
  3. Use two hands to expand the ear electrode and mount it on the ears. Give the electrodes a slight squeeze to ensure that they are seated appropriately.
- Prep Scalp areas and place electrodes
  1. Using an alcohol soaked cotton applicator, expose the subject's scalp in every electrode location on the EEG cap by moving their hair out of the way.
  2. Then, using the NuPrep gel, GENTLY exfoliate the exposed scalp areas.
  3. Afterward, place the appropriate EEG electrode in position and put the cap in place

- Electrode Impedance Testing
  - Open the OpenBCI GUI and connect system
    1. If the system has trouble connecting, ask the subject to move closer to the dongle, or move it closer to the OpenBCI board.
  - Click the 'Start Data Stream' button.
    1. You should be able to immediately identify EEG channels with poor impedances by looking at the time Time Series window. Below are two examples of noisy channels:
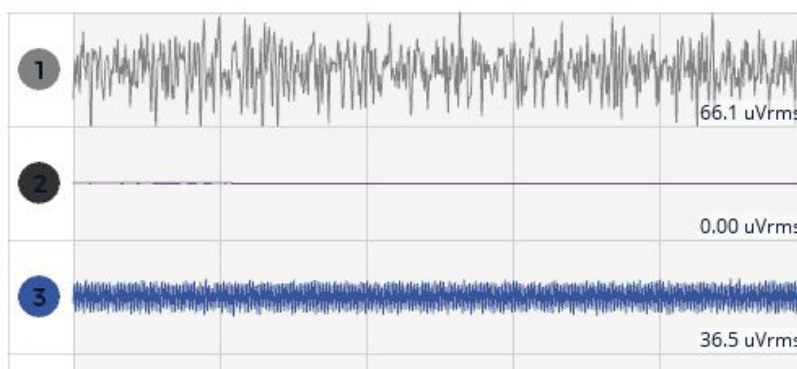

Note the noisy waveforms in channels 1 & 3 and the high values of uVrms

  - Test the impedances by clicking the Ω symbol next to each electrode channel.
    1. You can only evaluate one channel at a time
  - Adjust each electrode until the impedance measure registers at below 20kOhm (under 10kOhm is preferred).
    1. Adjust placement of the electrode
    2. Re-clean/exfoliate the scalp
    3. Add more conductive gel if necessary
    4. Adjust ear electrodes
  - When all 8 electrodes have impedances below 20kOhm, click the 'Stop Data Stream' button and prepare to collect the resting state EEG data and then click the 'Stop System' button in the System Control Panel
- Collection of Resting State EEG Data

- ○ The procedure for starting the system for the Resting State data collection are the same as for testing the electrode impedance, with one important difference. You must **set the file name**.
- ○ Before starting the system, click the 'Autogenerate File name' button and then use the left arrow key to move to the left most section of the name.
- ○ Use the following naming convention:
    1. [Expt Name]_[Subject #]_[Type of EEG data collected]_[Autogenerated date]
    2. For example: RAIN_31012_Rest_2017-03-31_09-49-48
- ○ Before clicking the 'Start System' button, remind subjects of the instructions for the resting state data collection:
    1. Be in a comfortable and relaxed position
    2. Hold your head (most importantly) and body as still as possible
    3. Clear your mind and try to think about nothing
    4. Keep your eyes closed and as still as possible
- ○ Possible speech to subject before starting data collection: *"We are now going to start the recording session. I am going to be turning off the lights for 5 minutes. During this time please remain still, close your eyes, and relax – but remain awake. You will not be able to talk during this recording session, so do you have any questions now? Just a reminder to remain as still as possible. Any movement, including things like moving your eyes under your eye lids, moving your head, or clenching your jaw, can cause an artifact in the recording. Are you ready?"*
- ○ Click the 'Start System' and the stopwatch simultaneously and record data for 5:30 minutes.
- ● Observations During Resting State Data Collection
- ○ During the resting state data collection, you should be observing the Time Series and FFT to ensure the quality of the data
- ○ During eyes closed resting state data collection, electrodes positioned closest to the occipital lobe should elicit an 'alpha peak' response.
    1. Typically an alpha peak occurs between 8-13hz as seen in channel 2 below:
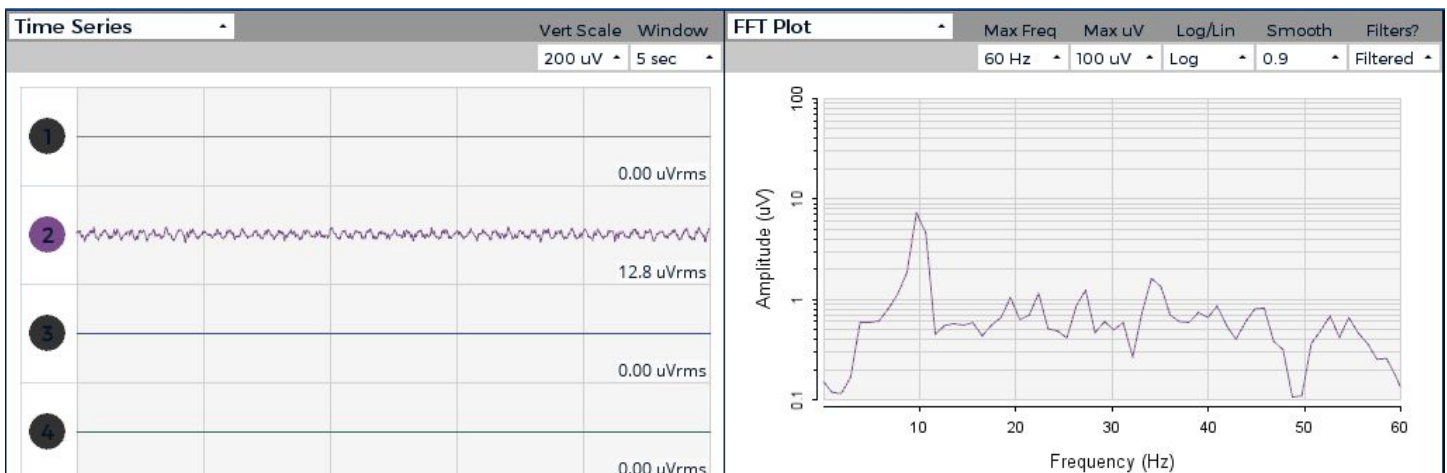
- ○ Some individuals may not show an alpha peak in any channel and is not an indicator of poor data collection
- ○ Using the Time Series and EMG windows, you should be able to detect when EMG artifacts occur in the data. Here is an example of a high EMG signal:
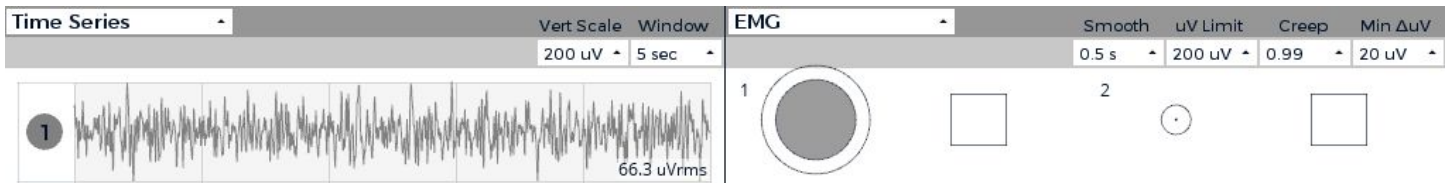
- Here the EMG artifact is clearly identified by the noisy waveform in the Time Series and the high EMG measure indicated in the EMG toolbar
- If you notice EMG artifacts during the beginning of the data collection, the subject is likely clenching their jaw or furrowing their brow. Remind them to relax during the EEG data collection and re-start the data collection
- If you observe consistent spikes in the Time Series approximately every second, you may be observing an EKG artifact:
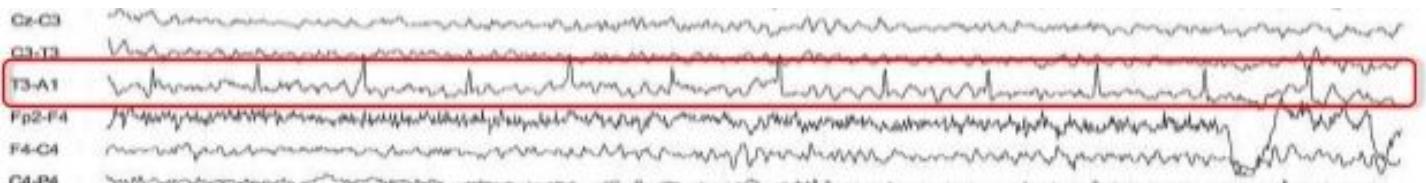
- In this situation, the pulse of the Subject is impacting the ground or reference channels.
  1. In this situation, stop the data collection, adjust the ear electrodes (consider using top of ears) to reduce this EKG artifact and recollection the data.

- Subject Cleanup Procedure
  - After the resting state data has been collected, click the 'Stop Data Stream' and 'Stop System' buttons.
  - Remove the EEG electrode caps and pull the electrodes away from the subject's scalp.
    1. Try to remove as much conductive paste as possible when removing the electrodes.
    2. Before asking the subject to remove the EEG cap, use the alcohol wipes to clean the areas where the electrodes were placed on the scalp.
  - Also remove the ear electrodes at this time
    1. Give the subject an alcohol wipe to clean the paste off their ears
- EEG Headset Cleanup Procedure
  - Separate OpenBCI Board structure from EEG electrode housing.
  - Take EEG electrode housing and ear electrodes to sink and clean off any paste on the electrodes.
  - When cleaned place electrode housing and ear electrodes on wall to dry
  - Put all remaining equipment away