

Introduction to EEG system in ABL




1 Introduction







These instructions are to provide information to work with the EEG systems in ABL. ABL has two EEG measurement BrainAmp amplifiers and three electrode sets (actiCAP) made by BrainProducts GmbH. More detailed information about the BrainProduct systems can be found from their own manuals (actiCAP, Record-software, Analysis software). Manuals can be found from the BrainProducts website, or from the DVDs (AC cabinet).

1.1) Equipment

EEG systems are installed in the shielded room (DC-room) of ABL. When measuring, system's amplifiers and electrode sets (actiCAP) should locate inside the room, where as monitoring devices (PC, monitor) are in the control room.

Table 1: The EEG system components

Product	Image	Location
EEG PC		Control Room

actiCAP electrode set (x3)	 aEB09011749 (1) aEB16065002 (2) aEB16105372 (3)	Control Room, DC shelves				
EEG cap (x6) Sizes: <table border="1"> <tr> <td>54, 56, 56, 58, 58, 60</td> <td>32ch</td> </tr> <tr> <td>58</td> <td>64ch</td> </tr> </table>	54, 56, 56, 58, 58, 60	32ch	58	64ch		Control Room, DC shelves Control Room, AC cabinet
54, 56, 56, 58, 58, 60	32ch					
58	64ch					
Control Box (x2)	 aCAP08091276 (1) aCAP10101472 (2)	Control Room, DC shelves				
BrainAmp + PowerPack (x2)	 Amp0202049 (1) Amp0202044 (2) PP1003642 (1) PP1003641 (2)	DC, Feedthrough cabin				
USB2Adapter	 BUA128-1002152	Control Room, DC monitor table				
Parallel Box and EEG Input Box		Control Room, DC Shelves				

1.2) Consumer products and cleaning items

Consumer products like gels, syringes and nets, which you need in preparation of the subject, can be found from the AC cabinet. Cleaning equipment can be found from the Sink cabinet.

Product	Description / Location
Syringes (5ml, 10ml)	AC cabinet
Needles	AC cabinet
Gel	AC cabinet
Net	AC cabinet
Toothbrush	Sink cabinet
Detergent	Sink cabinet
Towels	Sink cabinet

There are also some miscellaneous stuff in AC cabinet, such as tapes, extra electrodes, etc..

If some of these consumer products are running low, please contact personnel.

1.3) Wiring

The wiring of the installed EEG systems is described in the figure below.

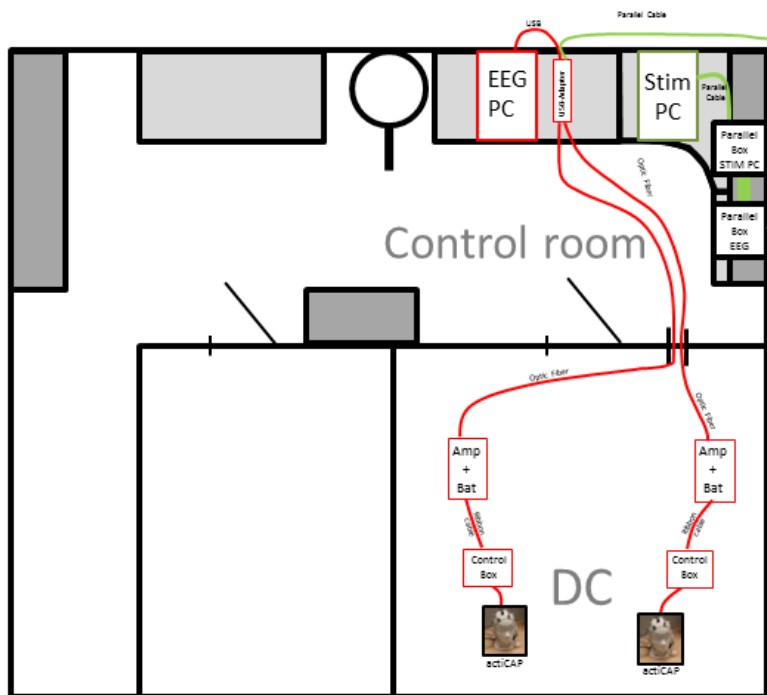


Image 1: Wiring of the EEG systems in ABL

The setup in the control room is a permanent installation and shouldn't be altered. Still, always check before measurements that everything is correct. The following should be connected.

- 1) USB adapter attached to EEG PC via USB cable
- 2) Parallel EEG box attached to USB-adapter
- 3) Optic fiber attached to USB-adapter
- 4) Green license dongle (Recorder software) attached to EEG PC

When measuring, do also the following:

- 1) Attach Optic fiber attached to the Amplifier
- 2) Attach BrainAmp to Control Box via ribbon cable
- 3) Attach PowerPack to Amplifier via power cable
- 4) Turn on Amplifier

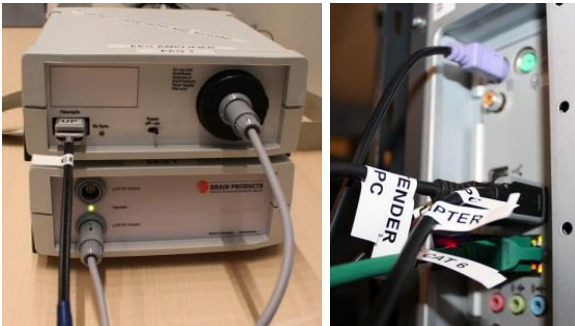
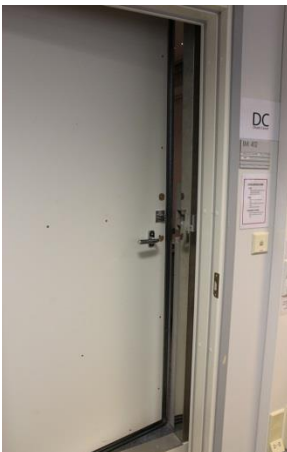


Image 2: Left image: Amplifier and PowerPack connected. Right image: Back side of the EEG PC

If you are using two (2) EEG caps simultaneously: repeat the last 1-3 phases.

1.4) Electrically shielded room

DC-room is an electrically shielded room; it serves as a Faraday cage, reducing external electric and radio frequency interference in EEG measurements. The cage is made out of galvanized steel.



Keep the door closed when conducting EEG measurements. Read the instruction next to the door on the wall (inside and outside) about how to open can close the door. In emergency, when the door is stuck, use the emergency opener (instructions on the wall).

2 EEG PC

2.1) Recorder Software

Start the recorder software by clicking the “BrainVision Recorder”. The software dongle (green) needs to be connected to the PC before running the Recorder software.

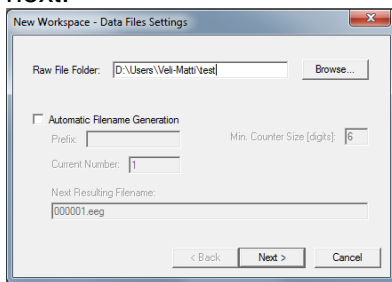
You can also use Recorder software with actiCAP Control software, where you can modify the settings of the actiCAP easily. Notice that when using an actiCAP Control software, the control box needs to be connected via USB-cable to EEG PC (remove the batteries first).

This software is meant for recording only, and doesn't include any analysis features.

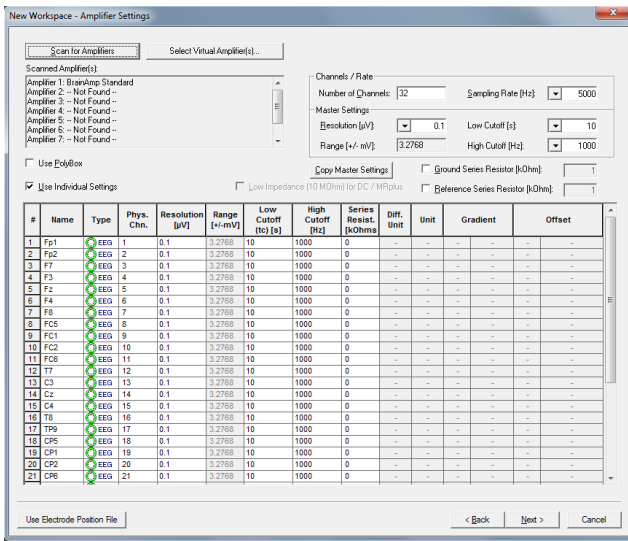
2.1.1 Creating workspace

Create new workspace by choosing File->New Workspace.

Set folder name for “Raw File Folder”; use your *user* folder, for example: “D:\Users\xxx\”. Click next.



In the new window “New Workspace – Amplifier Settings”, click “Scan for Amplifiers”. If the amplifier(s) is connected and turned on, the list of electrodes should appear. In this window you can define the setting of each electrode, and set the “Sampling rate” and “Number of channels”. By default the “Sampling Rate” is 5000Hz. NOTICE: High Cutoff is set to 1000Hz, which you cannot alter.



In the upcoming windows you can define filters and averaging parameters. When collecting raw data, you don't necessarily need to define anything. After these, prompts "save as" window, were you can set the name and folder for your workspace file. Use "D:\Data\Vision\Workfiles\" folder.

You can edit settings later from File->Edit Workspace.

2.1.2 Recording

After correct workspace is opened:

- Press "eye" -icon to monitor the view
- Press "play" to start recording
 - After press, "saving file" menu will prompt. After pressing "save" button, the recording will start immediately.
- Press "pause" for pausing
- Press "stop" for stop recording
- Press "S icon inside red ball", to stop the monitor view.

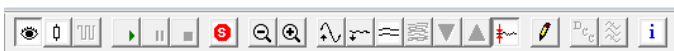


Image 3: Setup window

Notice that recording must be ON before you can receive any triggers. You can also annotate the data by clicking "pen" (annotation) during the recording.

3 Stimulus PC

You can synchronize EEG data with the stimulus presentation by sending TTL pulses from the Stimulus PC.

There are few software (Presentation, ExperimentBuilder, PsychoPy, Matlab) which are already installed in the ABL and can send TTL-triggers. Contact personnel if you want to use some other software.

3.1) Wiring

Parallel port of the Stimulus PC is connected to “Parallel interface box” via ribbon cable and “EEG input” box is connected to EEG PC via Parallel cable. These wiring enables connection between two computers with the BNC cables between the boxes.

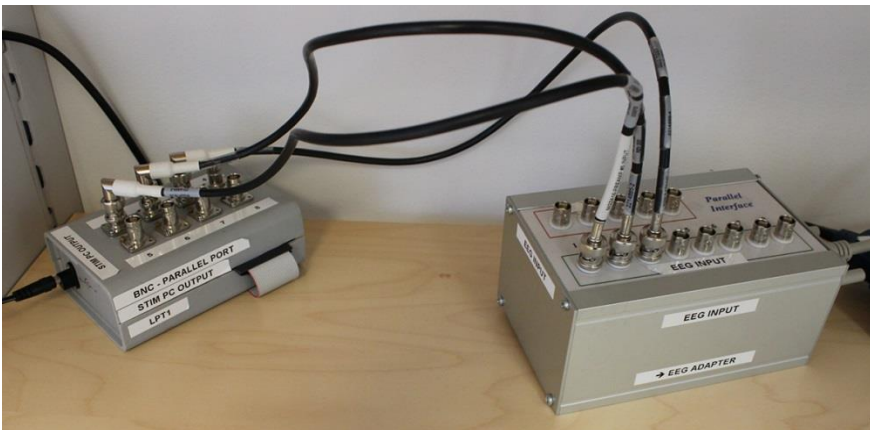


Image 4: “BNC – Parallel port” and “EEG Input” boxes are connected with BNC-cables. This will make the connection from Stimulus PC to EEG PC.

Connect the cables to “input” channels of EEG parallel interface box.

3.1.1 Presentation software

The parallel port output box enables of sending TTL pulses. TTL-pulses from the parallel port are automatically seen in the EEG monitor view window, and are stored into *.VMRK –file by default.

TTL triggers are sent from Stimulus PC to the Host PC via parallel ports. These triggers/markers are shown directly in the data file.

3.1.1.1 Presentation Settings

In the Presentation, an output port needs to be defined in the port setting menu (Settings/Port).

Add new output port (Output Ports->Add). Set the output port as LPT1-port. You can also define the length of the pulse (Default Pulse Width).

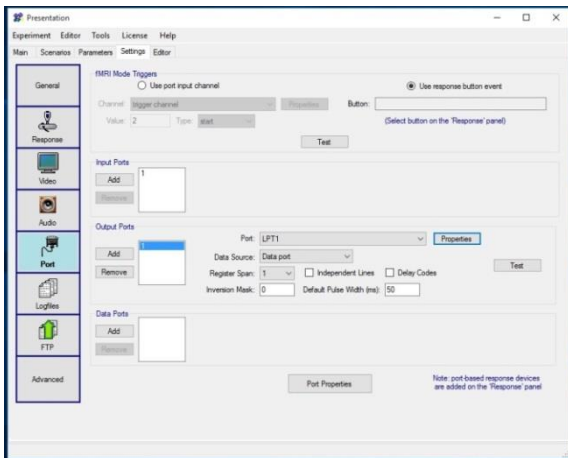


Image 5: Setting the output port, LPT1

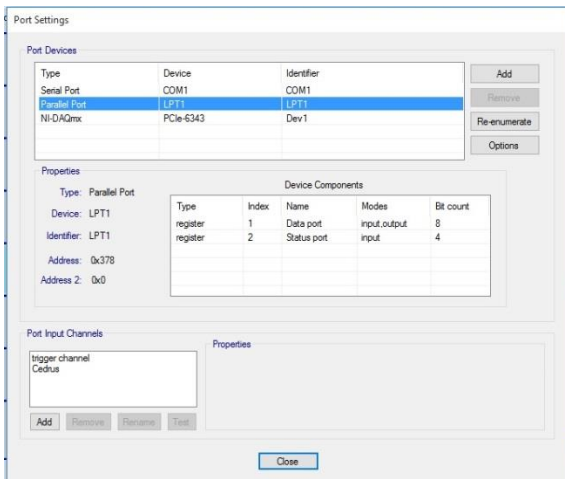


Image 6: Setting the LPT1 port

3.1.1.2 Scenario files

In the scenario file, “port_code” should be included inside the trial. The codes are sent at the time the trial is presented (started). You can send numbers between 0-255.

```
trial {
  picture { box { height = 10; width = 10; color = 0,0,0; }; # shows a black box
  x = 0; y = 0;
  } pic1;
  port_code = 2; # this code is sent at the time “trial1” is presented
}trial1;
```

For example if you send port_code = 2, you will see S2 in your data:

Mk5=Stimulus, S 2,5023,1,0 ; Mk=<Type>,<Description>,<Position>, <Size>, <Channel number>

The marker that you see in the EEG-data file is an onset trigger. The number “5023” is number order of data points. So with the sampling rate 1000Hz, this trigger would appear at 5023ms from the start.

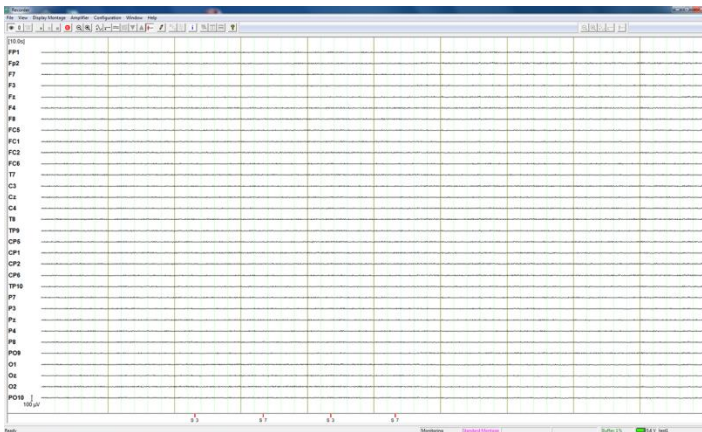


Image 7: Marker triggers at the bottom: "S3, S7, S3 S7".

3.2) Experiment Builder

The Experiment Builder is a visual experiment creation tool for use with the EyeLink eye tracker made by SR Research. While a primary goal of the Experiment Builder has been to create EyeLink experiments; the Experiment Builder can also be used to create non EyeLink experiments that do not need eye tracking functionality.

You can also send TTL-pulses using LPT1 port.

3.3) PsychoPy

<http://www.psychopy.org/>

3.4) Matlab Psychtoolbox

<http://psychtoolbox.org/>

4 EEG Preparation

4.1) Subject Preparation

- Ask subject to wash their hair at the morning before the EEG.
- Avoid drinking coffee or anything else with caffeine, which can affect the results, before measurement.

- Ask subject to remove all electronic devices before entering the shielded room.

4.2) Setting up the system

Get needles, syringes, gel and paper towels ready for measurement and place them on the preparation table of the DC-room. Use “Electrode support cups” to carry the stuff.

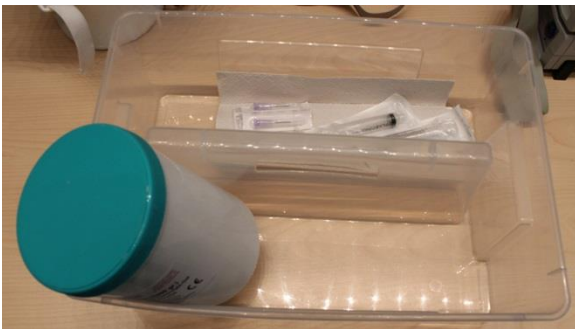


Image 8: Electrode support cups including Gel, Syringes, Needles and paper towels



Image 9: Preparation table ready for preparation. ActiCap on the top left, control box in the top middle and amplifier and power pack on the top right. Consumer products for two are in the bottom, including needles, syringes and pack of Gel. Also some paper towels to wipe things. Red measurement tape is on the right.

Connect actiCAP system and amplifier to the control box. Check that both cables refer to same channel numbers (for example ch1-32).

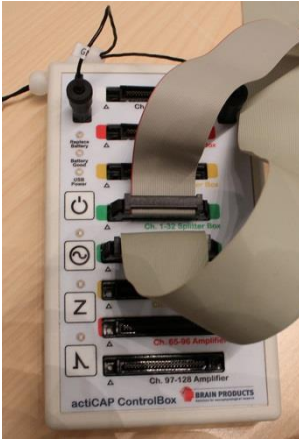


Image 10: Connect actiCAP to “splitter box” and amplifier to “amplifier” connector on control box. When connecting, “the arrows” in the connector should meet together. Also connect REF and GND electrodes to the control box.

4.3) Preparation of the actiCAP

4.3.1 Placing the cap

Choose a cap. Measure the circumference of head in centimeters. Normally in the ABL, there are three 32 channel electrode sets already attached to the caps (sizes 56, 58, 60). There is also a cap sized 54 and two extra caps (size 56 and 58).

There is also one 64ch cap (size 58). You can use this cap with two electrode sets simultaneously. When using, connect both electrode sets (+ REF and GND) into on control box; and connect to two different amplifiers.

Measure subject’s head size frominion to nation. The actiCAP uses 10-20 standard, where the distance from inion/nasion to the first electrodes (Oz, fp1/fp2) is 10% from the total distance (inion to nasion). Choose a cap which can meet the criterion.

Nasion is “pit” between the eyes, just above the bridge of the nose. Inion “is the lowest point of the skull from the back of the head and is normally indicated by a prominent bump.”

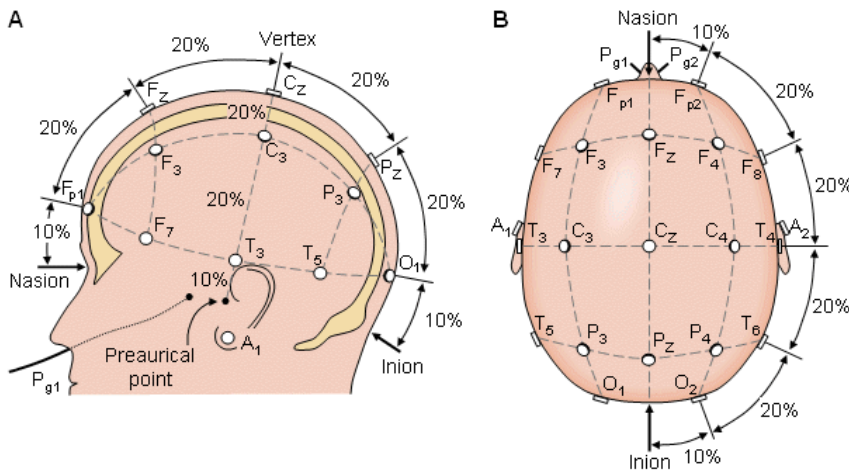


Image 11: Placing the cap according to the 10-20 standard. /Image from “Bioelectromagnetism Principles and Applications of Bioelectric and Biomagnetic Fields, Chapter 13 Electroencephalography”/.

Open subject hair (pony tail, plait, etc..) before placing a cap.

Place the cap to subject’s head and tighten the strap under the chin. Place all electrodes to the cap (if not already connected). Also remember REF and GND electrodes.

Connect the ribbon cable of the actiCAP to the control box. Connect the amplifier to the control box via ribbon cable. Make sure that actiCAP and amplifier refers to same channels (for example 1-32) on control box.

4.3.1.1 Extra electrodes

You can connect extra electrodes (i.e. EOG) via second amplifier. Connect passive electrodes to “Electrode input Box -64channels” box. Connect electrode box directly to amplifier with a ribbon cable. NOTICE: Own REF and GND electrodes are required for this second amplifier. In the recorder software; choose two amplifiers.

Attach the electrodes with two-sided tape on the skin.

4.3.2 Preparation

1. Carefully use the blunt needle of the nozzle through the electrode aperture as far as the test subject's head skin.
2. Gently roughen the test subject's head skin by means of careful circular movements of the blunt needle of the nozzle. This increases the contact area between the electrode gel and the skin of the head.
3. Use the nozzle to apply a small amount of gel (0.2 to 0.3 ml) directly to the skin of the head. Fill the remaining space in the electrode with gel.
4. In this way, you will easily achieve the transition resistance of 25 to 35 kOhm that is required in order to perform measurements with actiCAP.

Image 12: Instruction for preparing the subject is copied from the actiCAP operation manual.

Read more details from "actiCAP_Operatinginstructions.pdf"

4.4) Measuring

Before measurement, check that raw data looks ok in real time view.

You can test and also show to your subject how the ocular and muscle movement causes artifacts.

Instruct the subject to do in turns:

- close eyes
- blink the eyes
- bite the jaw
- frown

Instruct subject to avoid moving and blinking during the recording.

5 After Usage

- Stop data viewing on EEG PC
- Turn off the control box.
- Turn off the amplifier.
- Detach all cables from the control box.
- Detach optic fiber from the amplifier

EEG-caps and electrode sets should be cleaned after measurement.

- Bring the cap and electrodes to corridor sink; carry them in plastic cup holder
- Handle the electrodes with care and always set them on a soft plane, towel/plastic cup.
NOTICE: Do not let the splitter box get wet.

- Remove the electrodes from their holders and put them in a plastic cup. Clean the electrodes and cap with few drops of "Ivory" shampoo (on sink cabinet) and a toothbrush. Rinse the electrodes under lukewarm running water and wrap them in a towel for 10 minutes.
- Hang the caps and electrodes to dry.

See more detailed instructions about handling the caps from "actiCAP Operating Instructions, Chapter 8: Cleaning the electrodes and cap".

6 PowerPack

PowerPack locates in the storage room, where they are always connected to power supply.



After the use, please return the battery to its place, and connect it to a charger.

7 EEG artifacts

There are several sources that can induce noise artifacts. Most common ones are:

Physiologic Artifacts

- Muscle activity: Temporalis muscles are common causes.
- Glossokinetic artifact: Tongue functions as dipole
- Eye Movements: Generates a large-amplitude alternate current field
- ECG artifact: rhythmic/regular
- Pulse: When an EEG electrode is placed over a pulsating vessel
- Respiration artifacts: Slow and rhythmic activity
- Skin artifacts: Sweating (due to heat or stress) may produce huge slow baseline sways.

Extraphysiologic Artifacts

- Electrodes popping: Sharp waveforms
- Alternating current artefact (50Hz)
- Movements of other persons

In general, instruct your subject to avoid extra movement during the measurement. Make sure that the subject is feeling comfortably (not too hot, no stress).

8 Analysis

8.1) Data formats

Recorder software will produce three files for each recording:

- .eeg –file, eeg-data
- .vhdr –file, header file and channel information
- .vmrk –file, marker information

Files will be located on “Raw File Folder”, which you have set in the workspace.

8.2) Software

8.2.1 Analyser 2

Analyser 2 is versatile analysis software for EEG-data, made by BrainProducts. Analyser 2 is installed in ANI analysis corner. License dongle (EEG) needs to be connected when using the software.

http://www.brainproducts.com/promo_analyzer2.php

8.2.2 EEG-Lab

EEG-Lab is a Matlab Toolbox for EEG (or MEG) data. The toolbox can be downloaded for free, but you need a licensed Matlab to work with it.

<https://sccn.ucsd.edu/eeglab/>

8.3) MNE-python

MNE is Python base software

<https://martinos.org/mne/stable/index.html#>