**The Neuromechanics Laboratory**

THE UNIVERSITY OF COLORADO BOULDER

# BRAINBLOX

## Software ReadMe Documentation

### Abstract

This software, developed initially in the Department of Integrative Physiology at University of Colorado Boulder, provides an interface to capture, record, and visualize data provide by the Wii Balance Board. The current interface only works on Windows XP and newer. Funding for this project is provided by the National Science Foundation.

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This software, developed in the Neuromechanics Laboratory in the Department of Integrative Physiology at the University of Colorado at Boulder, provides an interface to capture, record, and visualize data provide by the Wii Balance Board. This software is intended for education and research use and is not intended for resale or profitable distribution of any kind.

The current interface only works on PC's with Windows XP and newer and requires a bluetooth transceiver and software to connect the software to the Wii Balance Board. Any bluetooth transceiver with Blue Solie software is suitable, this includes the Windows built-in bluetooth software-hardware combination.

For more information, please use the following resources

CU Neuromechanics Laboratory:
http://www.colorado.edu/neuromechanics/

Open-Source access to the BrainBLOX software and documentation:
https://www.dropbox.com/sh/afp441flpnhyr65/AABFL8L6rcJmO9imUVPq-q8pa?dl=0

Open-Source access to the C++ code for the BrainBLOX software:
https://bitbucket.org/cuneuromechanics/balance-board-neuro

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# Installation of Software

Follow the instructions on the CU Boulder Neuromechanics Laboratory website to download the 'BrainBLOX Download' folder. This download folder contains a folder with the applications and files (including the executable BrainBLoX.exe), the software readme file (this file), and a sample activity to get started with BrainBLoX (Your First BrainBLoX Activity.pdf).

The download folder can be moved to any location on the computer. However, it must be noted that while the documentation files including the modules and readme files can be moved out of the folder, the BrainBLOX executable file must remain in the 'Application and Files' folder along with all of the other files contained within it. If the executable file is removed from that folder it will not run.

To open the software executable, titled 'BrainBlox.exe' simply double click on the file. To open any other file in the folder double click on the file.

# Connecting the Nintendo Wii Balance Board or Wiimotes:

1. Make sure your computer has a working bluetooth transceiver or dongle, bluetooth software, and that the Wii equipment has batteries.
2. Press **and hold** the 'connect' button on the Wii equipment (located beneath the battery panel), the light will flash blue.
3. Open 'My Bluetooth Places' and select 'Add a device'.
4. Follow the prompts to add the Wii device, the balance board appears as 'Nintendo-RLV-WBC-0
5. Once the bluetooth software indicates that the device is connected, continue to hold the 'connect' button for an additional 30 seconds, this will ensure your operating software has enough time to update any drivers for the Wii equipment.
6. Release the 'connect' button. The Wii device should be connected and you can now open the BrainBLOX.exe executable.
7. Upon opening the BrainBLOX executable, click the 'Connect' button in the control panel on the right hand corner to link the software to the Wii equipment. If successful, there will be a green cursor in the middle of the plot region, and the control panel on the right side will populate with controls.

# Introduction to the Software Interface:

The BrainBLOX software interface consists of a graphical plot region and a control panel. The graphical plot region is located on the left, and the control panel is on the right, please see Figure 1 below.
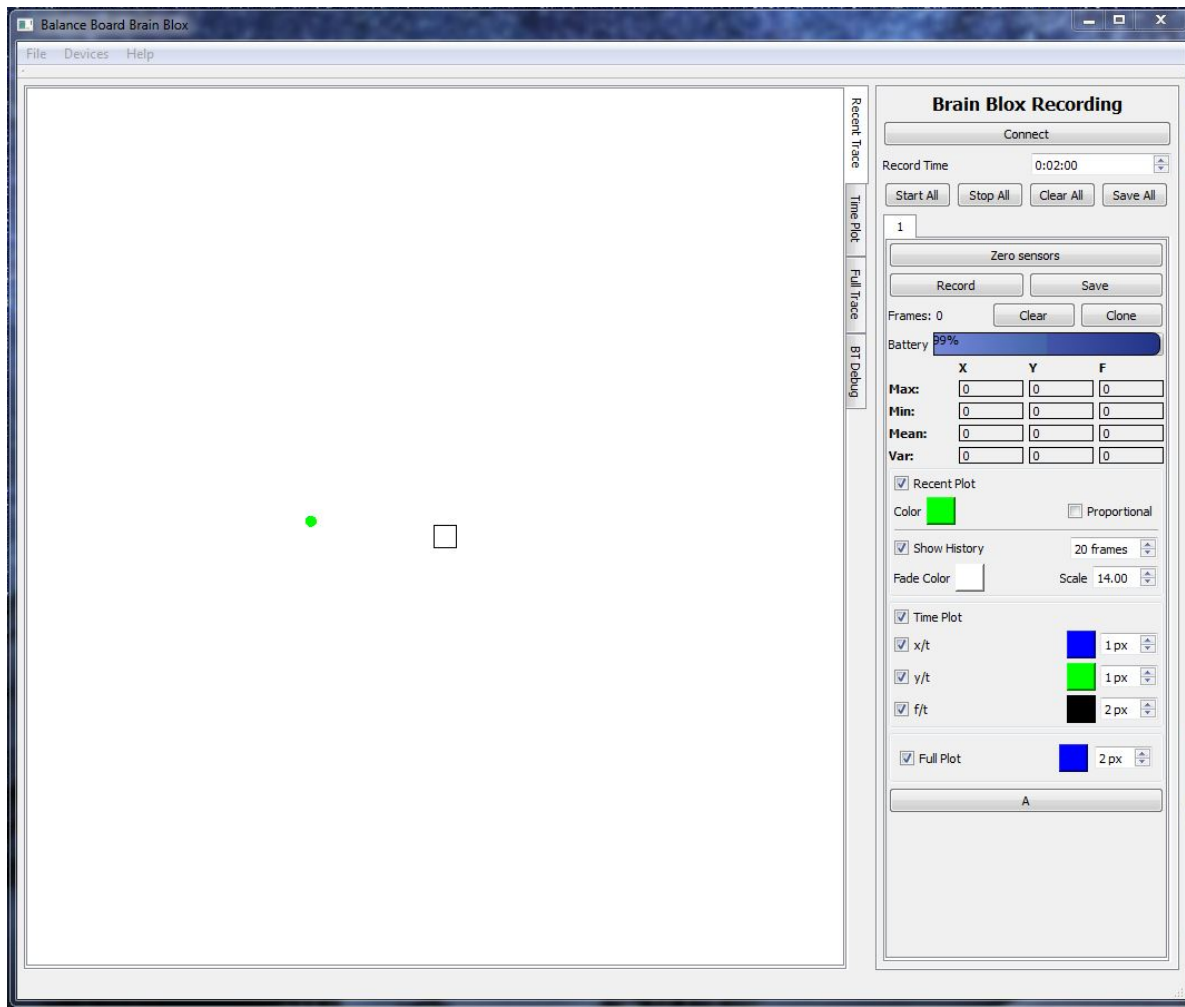


*Figue 1: A screenshot of the BrainBLOX software interface*

In order to understand the discussion of the functionality of the software there are a few key programming terms that must be understood. A channel refers to a single stream of data. If one Wii board is connected to the program, its data occupies one channel. If a Wii Balance Board and a Wiimote were connected you would have two channels of data – one for the Balance Board and one for the Wiimote. Cloning refers to copying a channel and all of its data and settings.

## Plot Region

The plot region is subdivided into the graphic plot region where the data is displayed and four tabs on the right side – recent trace, time plot, full trace, and debug BT see Figure 2.
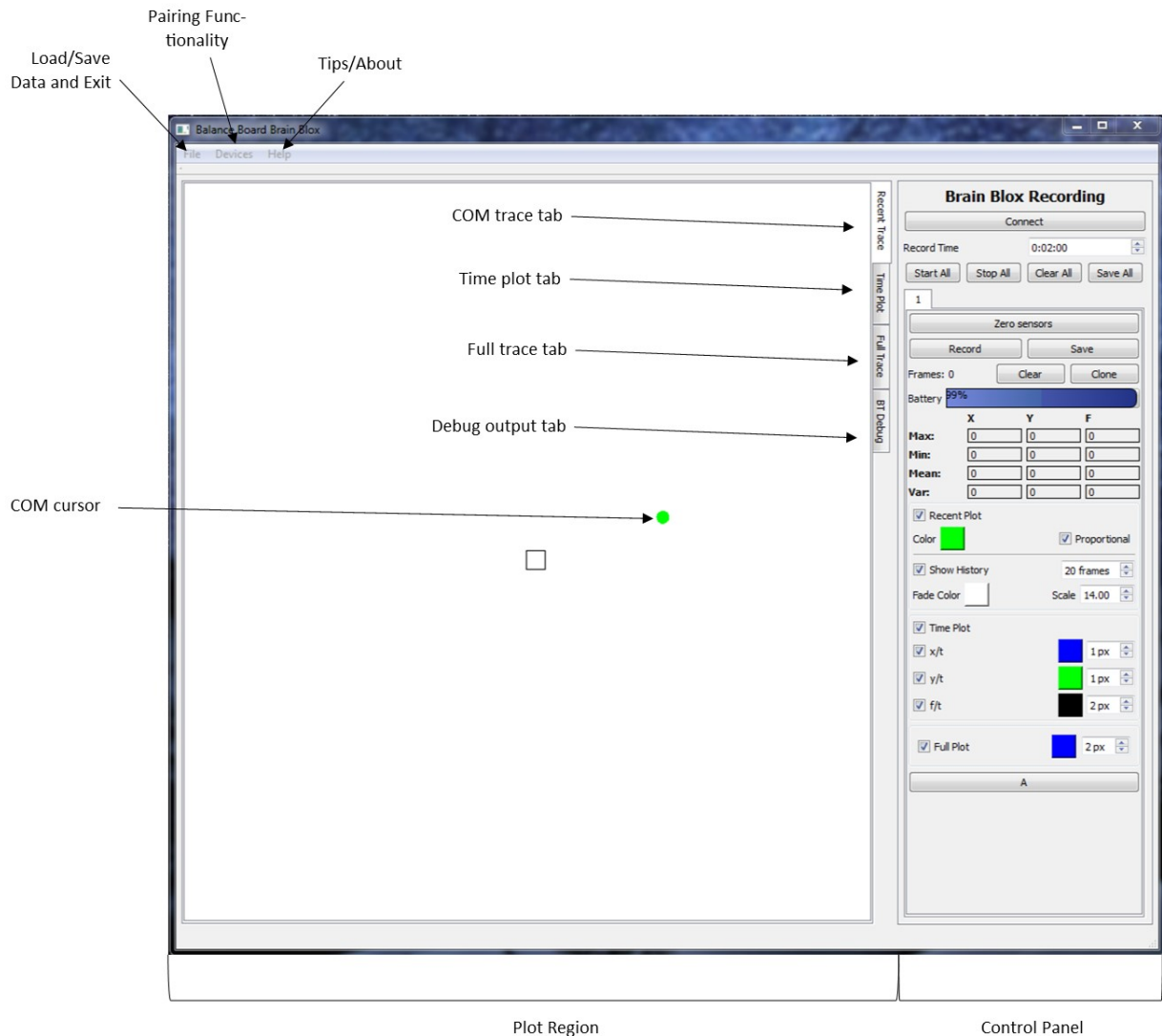


*Figure 2: A screenshot of the BrainBLOX plot region*

The recent trace plot area will display the data currently being collected from the sensors on the Wii Balance board and the real-time recording of data if you are in recording mode. At the center of the screen is the cursor which displays the location of the center of mass. By toggling settings on the control panel it can also show proportional changes in the quantity of the center of mass.

The time plot is a real-time plot of sensor values versus time where the sensor values are given as their relative distance of the COP from center, and quantity of mass on the board. The blue line corresponds to the COP distance from center in the x-direction, the green line corresponds to the COP distance from center in the y-direction (in centimeters), and the black line corresponds to the quantity of mass measured by the board (in kilograms).

The full trace displays the entire trace path AFTER a trace has been actively recording, but if not in recording mode it will remain blank.

The debug BT screen displays information regarding connectivity and error signals. This information is diagnostically relevant for programming and de-bugging purposes but is not necessary for software use.

## Control Panel

The control panel is located on the right side of the screen; this is where the user can manipulate parameters and controls within the program, see Figure 3. The following descriptions for the controls on the panel are ordered from top to bottom.

**Connect Button –** this button is to be pressed at the start of the session and during the session if the connection is lost. Specifically this button initiates a protocol that searches for the bluetooth device connected to the computer.

**Record Time –** For pre-set length recorded timing, of the format hh:mm:ss. If you wanted to record 10 second trials, you would set the timer to 00:00:10. To initiate timed recordings you press the 'Start All' button, NOT the 'Record' button.

**Start All Button –** Begins recordings on all channels. Will record until stopped unless the timer (Record time) is set to a non-zero value.

**Stop All Button –** Stops all recordings on all channels when recording is untimed.

**Clear All Button –** Clears the previously recorded data from all trials. **DO NOT PRESS** this button if you want to save your recorded data until all data has been saved using the 'Save All' or 'Save' functions.

**Save all Button –** Saves the recorded data on all channels as a file with no extension. See the "Saving and Reading Data" section for instructions for how to read and save data.

**Data Channel Tabs –** The data channels and their clones (copies) are designated with a numbered tab on the control panel. The default first channel is called '1'. Channels in which data can be recorded are labeled with positive numbers, i.e. '1' or '5', clones of these channels which house recorded data but cannot be used to record new data are labeled with negative numbers, i.e. '-1' or '-3'. To work within a designated channel simply click on the corresponding tab.

**Zero Sensors Button –** This function will tare all sensors connected to the software.

**Record Button –** This initiates untimed recording of data. Collection of data can be terminated by clicking this button a second time.
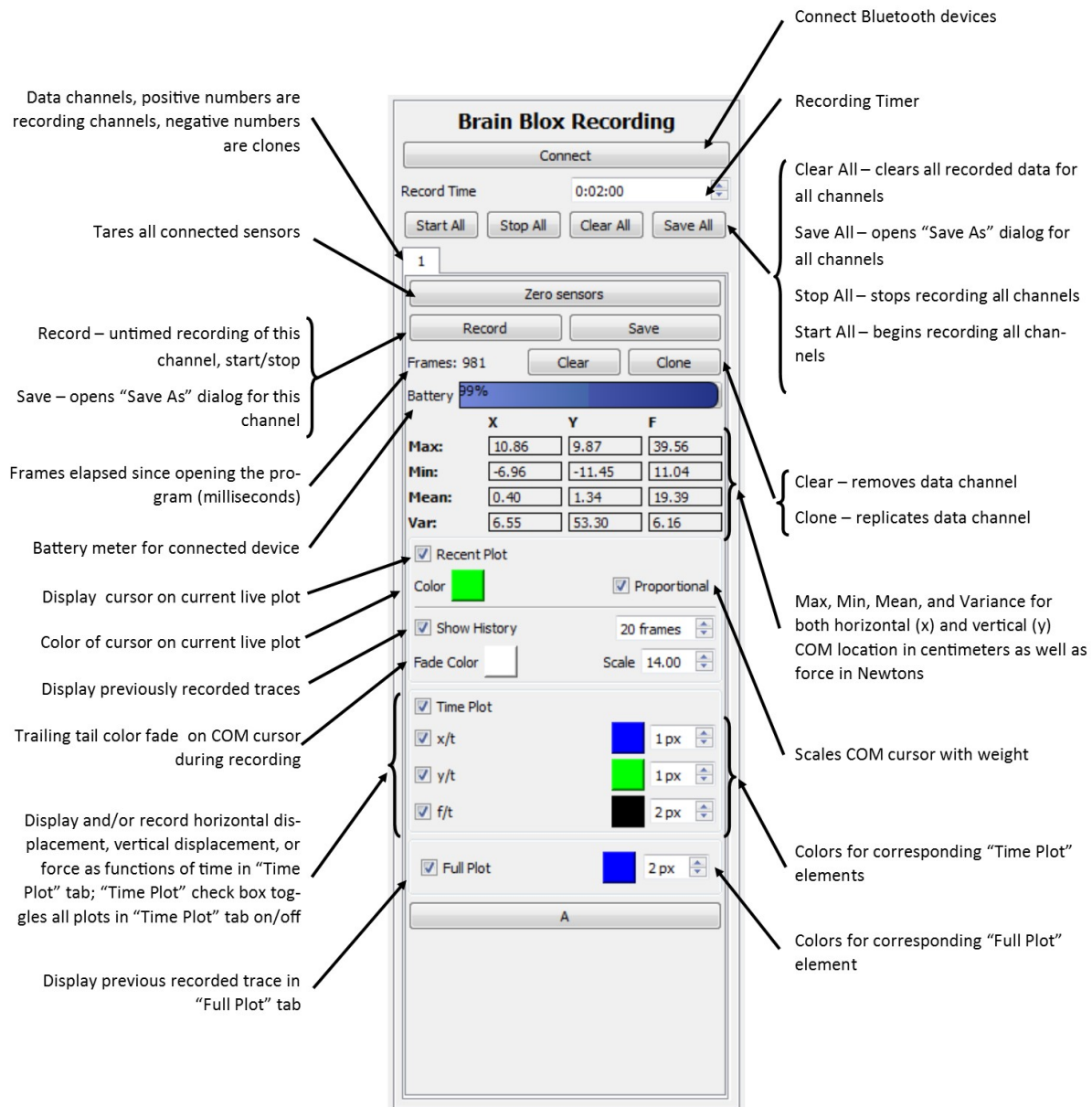
*Figure 3: A screenshot of the BrainBLOX control panel*

**Save Button–** Will open a "Save As" dialog to save the data recorded in this channel only as an extension-less file. For more information on saving and reading data, see "Saving and Reading Data". This will save data in the active channel only, to save data from all channels use the 'Save All' function.

**Frames Count–** The number of milliseconds that have elapsed since the program began in milliseconds.

**Clear Button –** This removes all of the data within the active channel.

**Clone Button –** This wil copy all of the data and preferences within the current channel into a clone, or copy, channel, indicated with a negative number such as '-1'. A cloned channel cannot record new data.

**Battery Meter –** The battery meter gives the user a read-out of the battery levels for the device connected into that channel.

**Data Matrix –** This matrix consists of all of some data outputs including the maximum, minimum, mean, and variance values for COP movement in the x- and y-direction as well as for the forces applied to the board.

**Recent Plot Checkbox –** Toggles the display of the cursor in the 'Recent Plot" graphics view. The color box beneath it allows the used to alter the color of the recent plot cursor.

**Proportional Checkbox –** Causes the cursor on the recent plot to change radius proportionally with the amount of force applied to the board.

**Show History Checkbox –** Toggles on/off the display of previous cursor location once previous data has already been recorded in that channel.

**Fade Color Checkbox –** When in recording mode, the cursor will have a trail which fades from the color of the cursor (default green) to the fade color. The default color for fade is set as white.

**Time Plot Checkbox –** Will toggle the display on/off for the time plot which can be viewed by clicking the 'Time Plot' tab to the right of the plot. The three checkboxes below will toggle the individual data streams on the Time Plot on/off, they are the COP x-displacement through time (x/t), the COP y-displacement through time (y/t) and the force through time (f/t). The color boxes across from these checkboxes change the color traces for these streams and the scroll boxes beside them change the line weight.

**Full Plot Checkbox –** This toggles the Full Plot trace on/off. The Full Plot can be viewed only after recording data in the channel, and is displayed under the 'Full Plot' tab to the right of the plot region.

# Cloning Channels for Data Comparison:

Cloning the channel is another way of saying "copying' the channel. The following steps allow the user to make a copy the channel in order to compare a second set of data that will be record to the first set of data that has already been recorded.

1. The numbered tabs on the control panel are called channels. The default channel is labeled '1'. Data can only be recorded in channel '1', but a copy can be made of the data that has already been recorded so that more data can be collected without losing any previously recorded data.

2. Click the 'Clone' button to make a copy of the channel. A second tab labeled '-1' to the right of the channel '1' tab will appear, this is the copy, or clone, channel.

3. In order to record new data without viewing the data that has already been collected, un-check the checkboxes labeled 'Show History' and 'Recent Plot' in the **copy channel** which again is labeled '-1'. Ensure the active tab is the original data stream, channel '1', and not the copy; in the copy channel the 'Zero Sensors' and 'Record' buttons are toggled off so they cannot be clicked on.

4. Click the channel '1' tab to take data for a second trial.

5. Click the 'Clear' button, this clears the channel, new data can now be collected.

# Acclimation to Data Collection:

In order to better analyze how various manipulations can affect the COP traces, it is often helpful to record the data for comparison either within the BrainBLOX software.

1. Use Figure 4 on the following page to help you navigate Part 1 of this activity.

   On the computer in the BrainBLOX software, you should see a small green cursor in the middle of the white screen. Step on each the four corners of the board and watch the cursor on the screen move to each respective corner. The cursor represents the location of the center of mass (COM).

   The white screen that composes the left two thirds of the software interface is called the plot region. The plot region has four tabs, each with a different presentation of the data. The two tabs that you will be using are the 'Recent Trace' tab which displays the real-time COM location, and the 'Full Plot' tab which displays the entire history of COM shift after a recording.

   The right-most third of the interface is called the 'Control Panel', this houses all of the toggles and controls that you will use to interact and manipulate data presentation. The collective stream of data coming from the Wii Balance Board is referred to as a channel of data; because we have one Balance Board we have one channel to record data.

2. Check the box labeled "Proportional" in the Recording Panel on the right of the screen. The cursor should increase in size as you push harder or bounce up and down on the Balance Board, The changing radius indicates relative change in magnitude of weight pushing down on the balance board.

3. Test the Wii Balance Board functionality. Have one person stand on the board.

   a. Move around and observe how cursor moves with weight shifts.

   b. Change the 'Fade Color' by clicking on the color block to the right of the 'Fade Color' text (default color is white). A color selection window will appear; select a color and click 'OK', this will close out the window and set the 'Fade Color' to the color of your choosing.

   c. Press the 'Record' button and have a person shift their weight around on the board. During recording you will notice the cursor now has a tail which will fade from the default green set for the 'Recent Plot' color to the 'Fade Color' you selected in the previous step. The presence of this tail will help you remember if you are or are not presently recording. When you are finished hit 'Record' again to stop.

   d. Click the 'Full Trace' tab on the right of the plot region to view the full trace of the COM movement during the recording.

   e. Hit the 'Clear All' button near the top of the control panel to remove all recordings.

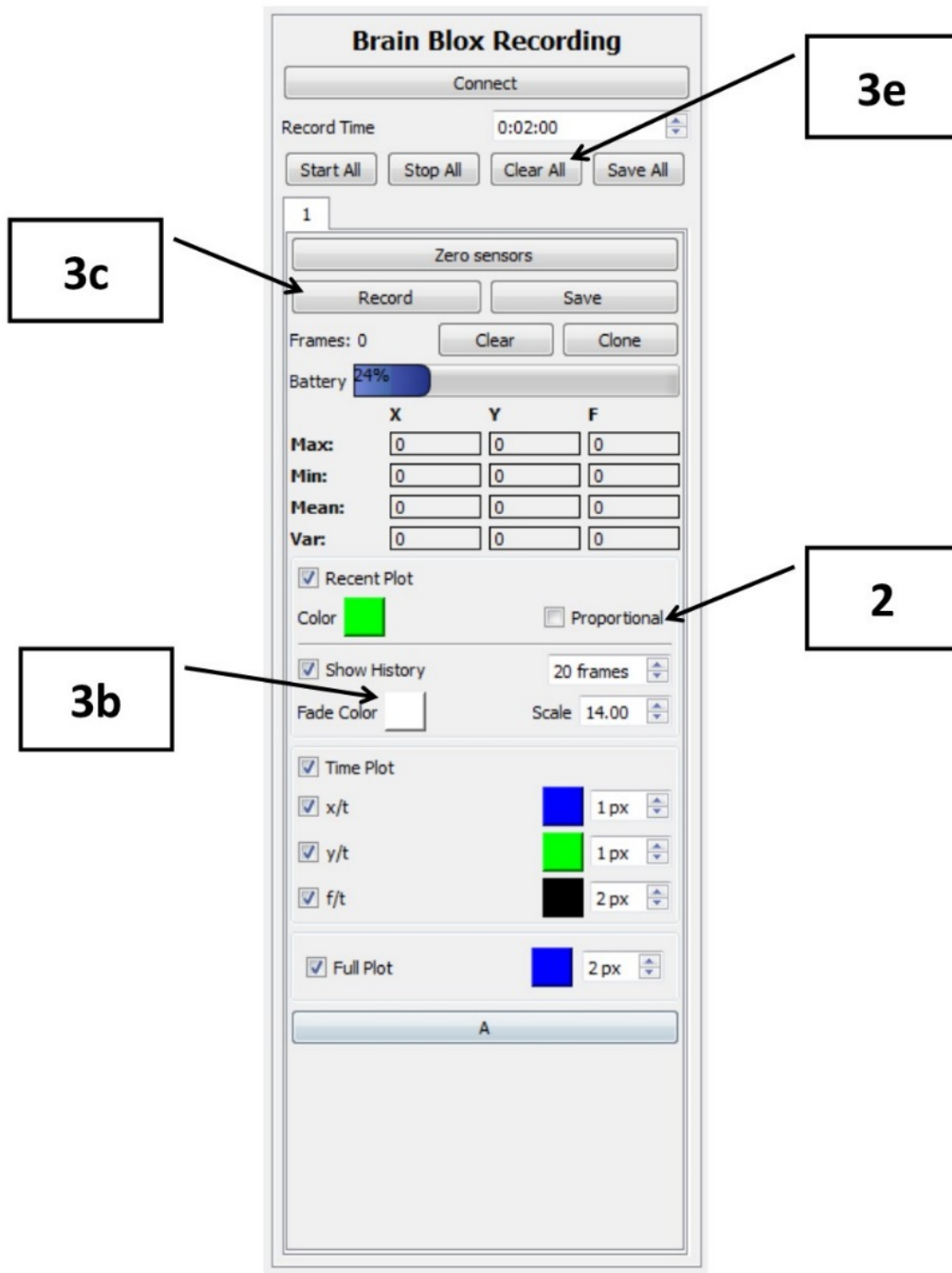   f. Click the 'Recent Trace' tab on the right of the plot region to return to real-time data observation.

*Figure 4: A screenshot of the BrainBLOX control panel with labeled steps for the acclimation activity*

# Saving and Reading Data:

Although there are means to graphically compare the data within the BrainBLOX software as discussed in the "Cloning Channels for Data Comparison" section, it is often necessary or more useful to the user to analyze or view the data in other programs, or, to save data recorded in the program in order to be loaded back into the software at a future point in time.

## Saving Data

To save any recorded data follow the proceeding steps.

1. To save the data in only the active channel click the 'Save" button (below the 'Zero Sensors' panel). Top save the data from all channels click the "Save All" button (near the top of the control panel).
2. Both of these functions will bring up a 'Save filename' window. Navigate within the window to your desired saving location. Type the filename in the white box near the bottom of the window, no file extension is needed. Click 'Save' in the lower right-hand corner to save the data and close the window.

*Hint: Assign a name to the data file that indicates which device was used to record the data, i.e. 'BalanceBoard1_trial01'. This is especially helpful if you are connecting multiple devices because the data is loaded back into the software differently for Balance Board data and Wiimote data.*

## Loading Data into BrainBLOX

Data can be loaded back into the BrainBLOX software. In order to do this NO FILE EXTENSION can be attached to this file. Assuming the file was saved without an extension it can be loaded back in with the following steps. If a file extension has been added, rename the file without an extension first before reloading the data.

1. In the upper right-hand corner of the BrainBLOX software interface, click on the 'File' drop-down menu.
2. Select either 'Load Board Data' for loading data collected with the Wii Balance Board, or 'Load Accel Data' for loading data collected with the Wiimotes.
3. Additional channels of data can be loaded, meaning that more than one data set or one type of data set can be loaded at a time, each data set will appear as its own channel. Remember, like cloned channels, these cannot be used to record new data.

## Reading the Data

The data is automatically saved as a file with no extension, and in order to read the data with another program it must have an extension. You can read the data into Excel manually.

To read the data into Excel manually, the file must be opened as a .csv or comma separated value file. Microsoft Excel can read this type of file. Use the following steps to open the data files as a .csv in Microsoft Excel.

1. Open Microsoft Excel
2. Navigate to the 'Open' function, this can be found either under the 'File' drop down menu in older versions or the 'File' ribbon in the newer versions. Follow the dialog prompts to navigate to the file's location, select the file, and click 'Open'. If the file is not visible in the location it was saved in, ensure that in the lower right hand corner the window is displaying 'All Files' and not 'All Excel Files'.
3. A dialog prompt will appear, it reads "The file format and extension of 'filename' don't match. The file could be corrupted or unsafe. Unless you trust its source, don't open it. Do you want to open it anyway?" Click 'Yes', this will open the 'Text Import Wizard'.
4. Two options for reading the data will appear, select 'Delimited' which reads the spaces inserted between the values as column breaks. Click the 'Next' button.
5. To read the data into the columns, select the check box for 'Space' as a delimiter, and click 'Next;.
6. The following screen allows changes to the data type in each column. All of the data recorded from BrainBLOX is numeric, so the default general settings are appropriate. Do not alter these settings, click 'Finish'.
7. The data should be read into Excel with eight columns. The key below indicates which data is saved in which column.
   Column A: Time in milliseconds elapsed since program was opened
   Column B: Force from sensor 1 (top left) in kilograms
   Column C: Force from sensor 2 (top right) in kilograms
   Column D: Force from sensor 3 (bottom left) in kilograms
   Column E: Force from sensor 4 (bottom left) in kilograms
   Column F: COP distance from center in the x-direction in centimeters
   Column G: COP distance from center in the y-direction in centimeters
   Column H: Total force (sum of columns 2-5) in kilograms

## Troubleshooting and FAQ's:

Q: After connecting my Nintendo Wii device, upon opening the program I receive an error message that states "No bluetooth dongle connected" despite the device appearing connected in 'My Bluetooth Devices'.

A: After the bluetooth software connects the device, the operating system searches, updates, and installs drivers for the device. If the connect button is released before this event occurs the device driver can install incorrectly or not at all, giving this error message. Close the BrainBLOX program, disconnect and then reconnect the bluetooth device. This time be sure to hold down the connect button for 30 seconds after the initial bluetooth connection is established.