

Laboratory 1 | Electrocardiography

SYSC 4203: Bioinstrumentation and Signals | Lab Manual

Guidelines

Instructions



Indicates the step requires a screenshot. Save your screenshots as '*sectionX_stepX*', replacing *X* with the appropriate section and step number. This takes little time and will make your lab much easier to write up.

Make sure you rename the images after you save them. They are saved under the “reports” folder in BioRadio Lab Data. Follows the path:

C:\Documents and Settings\LoginName\My Documents\BioRadio Lab Data\LoginName\ECGI



Indicates the step requires saving data.

Save your data files with the name indicated. This will make your postlab quicker to complete.

Lab Write-up

The lab submission worksheet should be printed, completed and submitted to the dropbox near the SCE office (ME4460). All printed material should be labelled.

To load a collected data file in matlab, you can use

```
a = load('recorded-data.data');
```

to load the file as a double array.

Laboratory 1A | Electrocardiography

Learning objectives x Introduction to the Great Lakes Neuroethologies wireless BioRadio system (how to use it, collect/store data, retrieve and analyze data outside of the laboratory)

- Observe the ECG waveform (PQRST), including intra-subject variability
- Observe motion artefact and ways of eliminating
- Observe 60 Hz power line interference and ways of eliminating

Materials

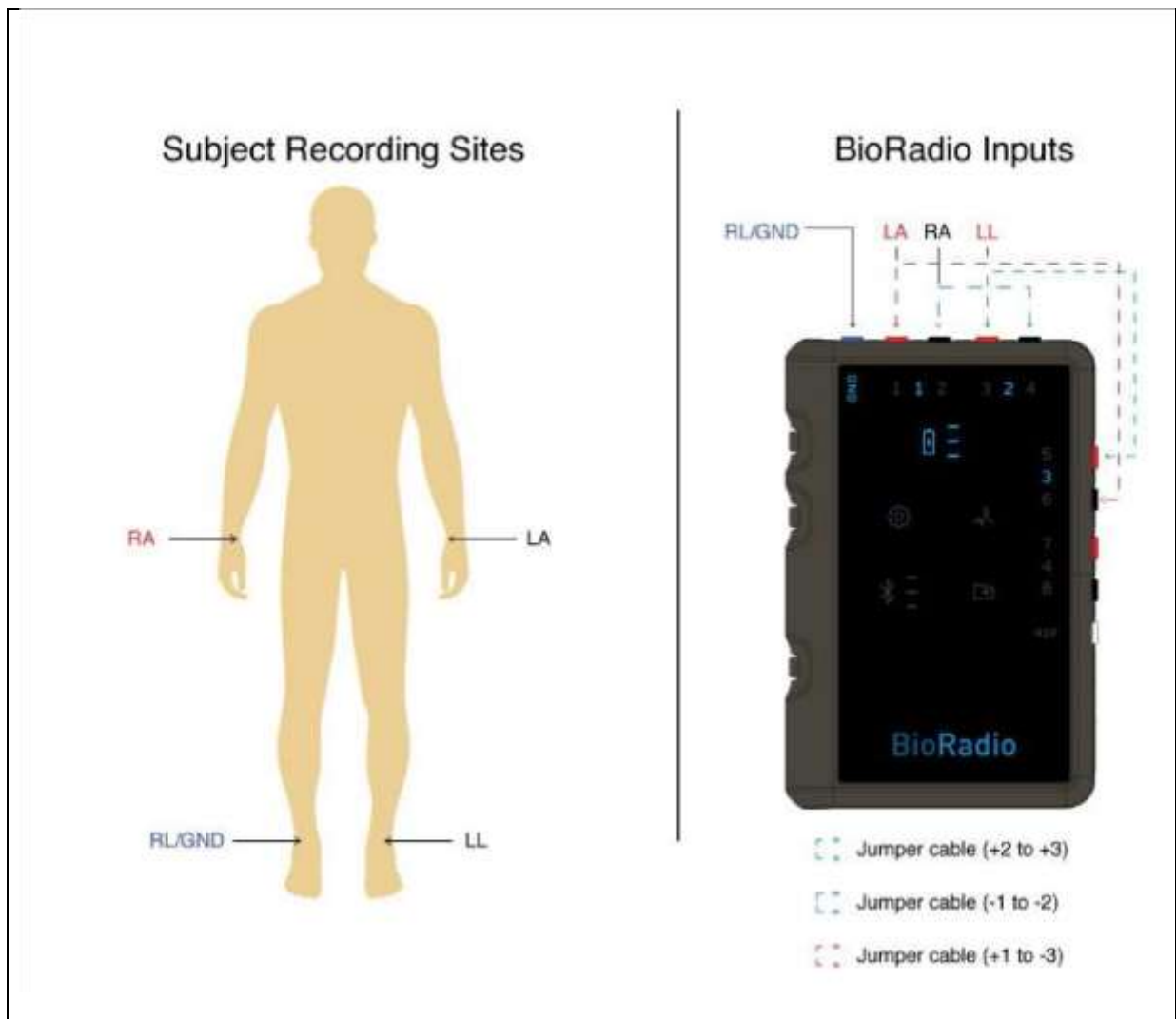
- Wireless BioRadio System
- 3 Jumpers
- 8 snap electrodes
- Gel may be required if electrodes start to dry out
- Alcohol wipes
- 4 Leads

1.0 – Equipment Preparation

- 1.1 Carefully read the instructions given in the *BioRadioUserGuide082714* to set up the wireless system. The TA shall demonstrate initial system set up, follow the instructions properly.
- 1.2 The standard configuration for a 3 lead ECG is shown in the table below. **The right leg (RL) will be used as ground. (LA = left arm, RA = right arm, LL = left leg).**

Lead/Channel	+Ch	-Ch
I	LA	RA
II	LL	RA
III	LL	LA

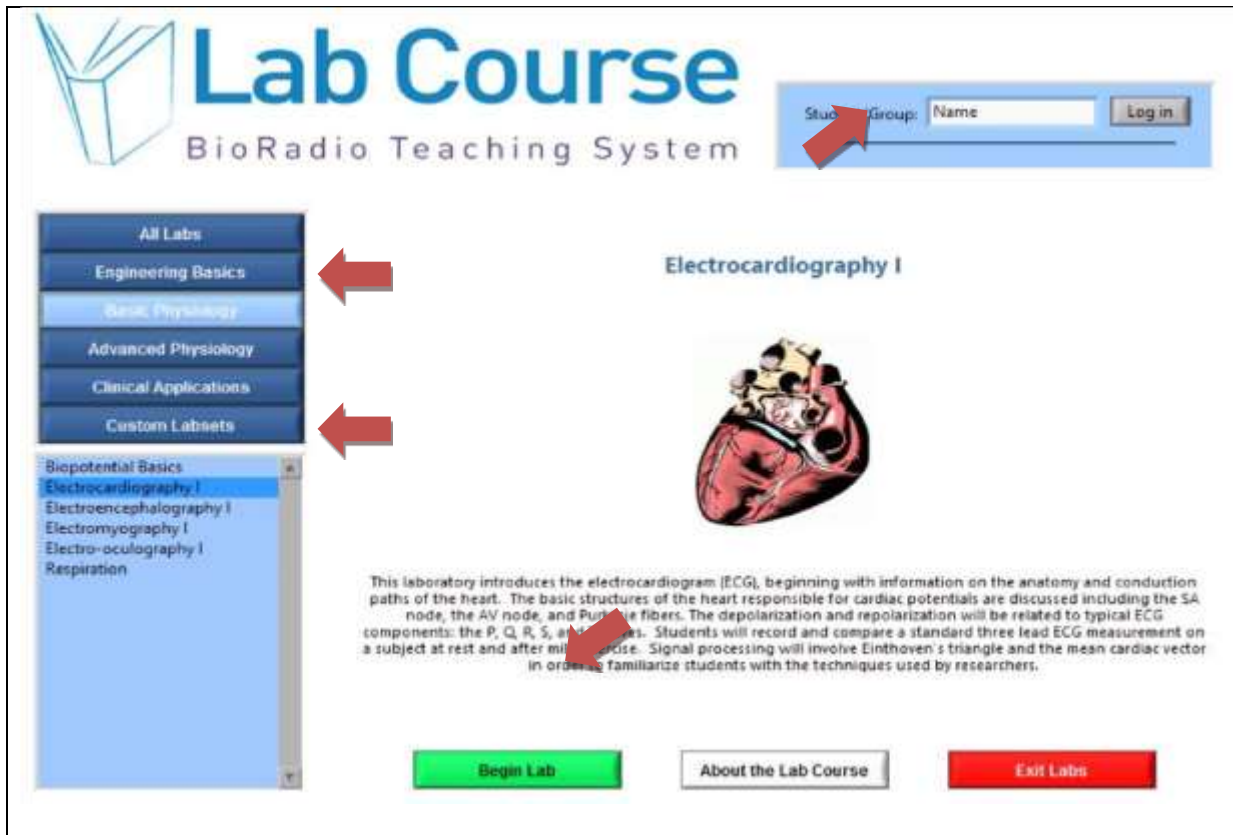
- Prepare the skin at the wrist and ankles with an alcohol wipe, then place the **4** snap electrodes on the subject.
- Connect 1 snap wire to each of the snap electrodes.
- FIRST** Connect the jumpers, **THEN** connect the electrode wires to the BioRadio inputs as shown in the following figure. (Jumpers are short black wires with connectors on both ends, they go in first into the BioRadio.) There are Two numbering sets on the BioRadio, ask for assistance if needed.



2.0 – ECG Signal (Time and Frequency Analysis)

Procedure and Data Collection

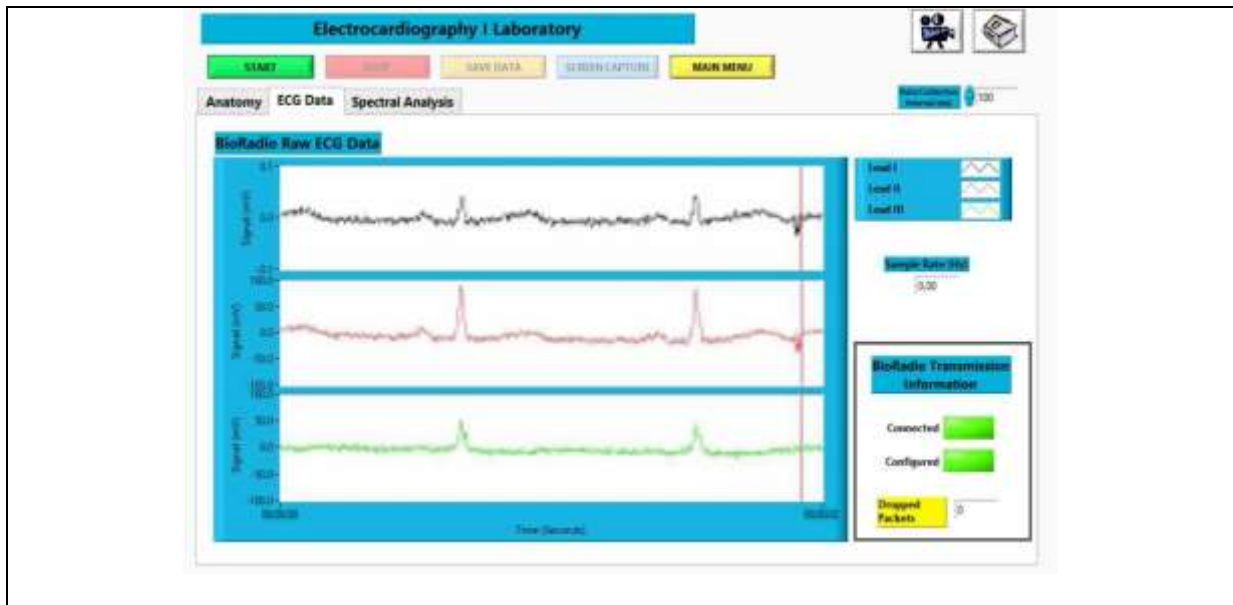
2.1 Open *BioRadio_Lab_Course* (Start -> Programs -> BioRadio_Lab_Course). Login (use any name, this is just to name a folder where your recorded data will be saved), and select *Electrocardiography I* from the *Basic Physiology* laboratory section on the left. Select *Begin Lab*.



2.2 The program will then begin a search for your device. Turn on the BioRadio by pressing the power button for 5 seconds. The battery indicator will turn on and pulse twice. (If the charge level is less than 6%, the battery symbol will turn red.) Search again, Select your Device and Select Done.



2.3 Click on the ECG Data tab, then on the green START button. The subject with the electrodes should be still. You should see something like:



2.4 Adjust the plot scales to see the ECG signal clearly (data collection interval, ...).



2.5 With your test subject standing still and not moving, click SAVE DATA and record data for 30s. Save the file as **Subject1_Still_ECG**. Click the same yellow button to stop the recording. Click on SCREEN CAPTURE to save a screenshot and name accordingly. This will document your signal and any parameter values you may want to remember.



i. It is important to name all your files carefully so that they are easily identifiable and that you do not overwrite your files. Check to make sure your data are saved on your computer, perhaps in the *C:\Documents\BioRadio Lab Data\LoginName\ECGI* folder.

E.



2.6 Click on Spectral Analysis (frequency tab), save a screenshot of the unfiltered data. Adjust filter parameters to remove the 60Hz noise. You may need to adjust the Data Collection Interval (ms) value. Use a low pass filter and vary the cut off value (40, 30, 20, 10, 5 and 1Hz). Save a screenshot of the filtered data in the time and frequency domain for each cut off value.

Report

Include a screen shot of your work from section 2.4 and 2.5 in your report.

- a. What do you notice in the time domain signal as the cut off value is lowered? How about in the frequency domain?
- b. Using the “standing still” files, plot a few heart beats and label the P, Q, R, S and T segments of one beat. Select the best lead to show your signal. What is the amplitude of your QRS complexes? How do the shapes of the individual heart beat signals compare within a single same subject?
- c. What is the source of the 60Hz noise? Identify the 60Hz noise in the frequency plot.
- d. Look at the signals for low pass filters with a range of cut off values. What happens to the time signal with the cut off value decreases? What happens to the frequency signal? Is there an optimal cut off value? What happens when the cut off value is too high? Can it be too low?

3.0 – Signal Artefact

Procedure and Data Collection



3.1 Repeat steps 2.4 and 2.5 with the same subject, but have the test subject gently wave their hand rather than stand still. Save the file as **Subject1_Waving_ECG**.

Report

- a. Look at each lead. Does the ECG Data look different? Why? Does the Spectral Analysis look different? Why?
- b. Did you notice motion artefact on all leads? Why did each lead have motion artefact (or not)?

4.0 – Recovery after Exercise

Procedure and Data Collection



4.1 Have the test subject run on the spot for 1 minute. When finished stop and immediately save a 1 minute ECG data sample. Save your data file as **Subject1_Afterexercise_ECG** and take screenshots (time & freq. domain) of your optimum filter parameters.

Report

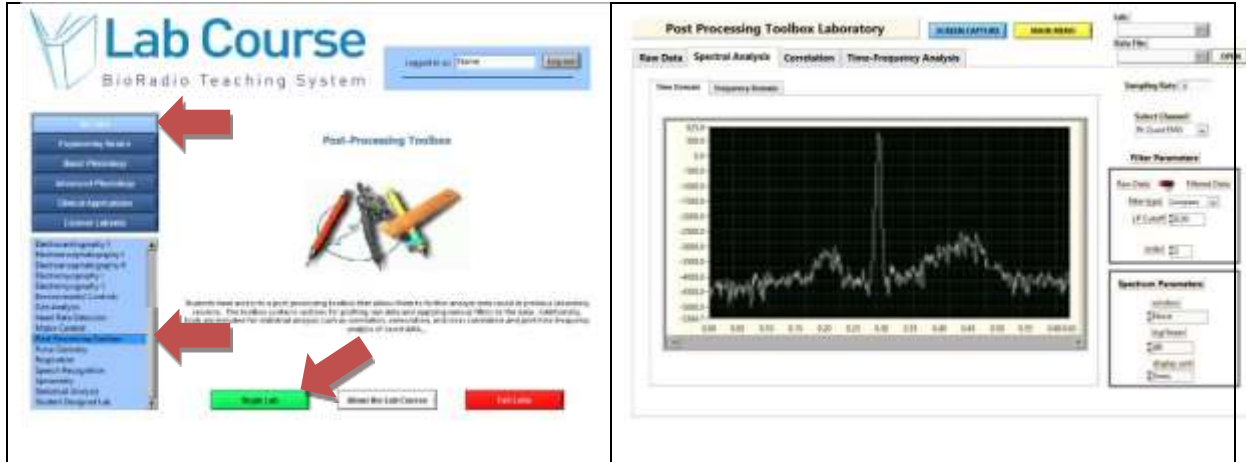
- a. Does the R-R interval change with time? Why? Does the Spectral Analysis look different? Why?
- b. What do you notice in the time domain signal as the cut off value is lowered? How about in the frequency domain?
- c. Plot the first 5 heart beats and the last 5 heart beats of lead I in separate figures, with Matlab. Measure the average R-R distance and calculate the heart rate for both figures. Is there a difference between your two heart rate values? Why?
- d. Compare the PQRST shape in the first and last 5 seconds. Are the shapes compressed? Is the firing rate increased? Explain why.

5.0 – Post Processing

Procedure and Data Collection



- 5.1 Go to MAIN MENU, Click on ALL LABS and open the Post Processing toolbox, then click Begin Lab.



- a) Open **Subject1_Still_ECG.data** file. Examine each of the three lead signals. Click on the Spectral Analysis tab, then on the Time domain tab and play with the filter parameters to see how they affect the signals by selecting a high pass filter with cut off values of 40, 30, 20, 10, 5 and 1 Hz. Take one screenshot of lead 1 raw. Take screenshots of the filtered signal in time & freq. domain for each filter settings.
 - b) Open the **Subject1_Waving_ECG.data** file, and change parameters by selecting a high pass filter with cut off values of 40, 30, 20, 10, 5 and 1 Hz, to see how they affect your signal. Take one screenshot of lead 1 raw. Take screenshots of the filtered signal in time & freq. domain for each filter settings.
- 5.2 Make sure you have all the data files and screenshots you need to answer the questions. Save the data folder(s) and the reports folder(s) onto a USB stick. Turn your BioRadio off and neatly put away all other accessories.
- 5.3 Do not forget to remove your USB drive!

Report

- a. What are the sources of noise in this lab? Are they low or high frequency? How can you remove/reduce them? You may support your answer by showing some of the graphs recorded during the lab.
- b. Does your signal ECG have a DC component? What is the source of the DC component? How can you remove it?

