

Experiment HE-12: Targeted Exercise with Wireless Electrocardiogram (ECG)

“Get Your Cardio On”

Preparations for this experiment need to be reviewed with the students in advance. There will be exercise routines involved and participants should dress accordingly and be prepared for a workout.

Background

When you work out, are you doing too much, too little, or is your exercise routine perfect? The easiest way to know is by calculating your target heart rate. This will help you hit the perfect target each time. It is important not to over-exercise, but the other extreme is not getting enough exercise, so making sure you are doing your routine correctly and keeping your heart rate in the zone is very important.

Before you calculate and learn to monitor your target training heart rate, you have to know your resting heart rate. Resting heart rate is the number of times your heart beats per minute while it's at rest. You can check it in the morning, preferably before you get out of bed. According to the National Institute of Health, the average resting heart rate for children 10 years and older, and adults (including seniors) is 60-100 beats per minute. In well-trained athletes the heart rate can be as low as 40-60 beats per minute.

Once you know your resting heart rate, it is easy to calculate your target training/exercise heart rate.

As you exercise, you will be periodically:

- Taking your pulse on the inside of your wrist (on the thumb side) or from your neck.
 - Wrist: using the tips of your first two fingers, press lightly over the blood vessels on your wrist.
 - Neck: using the tips of your first two fingers, press lightly over the blood vessels on the outside of your neck.
- Then, count your pulse for 20 seconds and multiply by 3 to find your beats per minute. You want to stay between 50-85% of your maximum heart rate. This range is your **target heart rate**.

Using the table below find the estimated target heart rates for different ages. Generally, maximum heart rate is calculated at 220 minus your age. ([Table HE-12-B1](#)) There are other methods for calculating maximum heart rate, but this is the quickest and easiest way when you are in the middle of an exercise routine.

In your age category, read across to find your target heart rate. Heart rate during moderate activity is usually between 50-69% of your maximum heart rate. Heart rate during hard physical activity is between 70-90% of the maximum heart rate. Heart rate above the 90% range can be dangerous over a prolonged period of time.

NOTE: If your heart rate is too high, you are pushing yourself too hard. It is best to slow down. But, if your heart rate is too low, and the level intensity feels “easy,” you may want to push yourself to exercise a little harder and get your heart rate into the 50-85% zone.

Table HE-12-B1: Targeted Heart Rate Calculations

Age	Target HR Zone 50-85%	Average Maximum Heart Rate, 100%
20 years	100-170 beats per minute	200 beats per minute
30 years	95-162 beats per minute	190 beats per minute
35 years	93-157 beats per minute	185 beats per minute
40 years	90-153 beats per minute	180 beats per minute
45 years	88-149 beats per minute	175 beats per minute
50 years	85-145 beats per minute	170 beats per minute
55 years	83-140 beats per minute	165 beats per minute
60 years	80-136 beats per minute	160 beats per minute
65 years	78-132 beats per minute	155 beats per minute
70 years	75-128 beats per minute	150 beats per minute

BE SMART: During the first few weeks of starting a new exercise routine, it is a good idea to aim for the lower range of your target zone (50%) and gradually build up to the higher range (85%).

After a few weeks or months, depending on your fitness level at the start, you may be able to exercise comfortably at up to 85 percent of your maximum heart rate.

The other rule of thumb for good exercise is “if you’re not able to carry on a conversation while exercising, then that may be too much.” Slow down, catch your breath and then work back up again.

If you have a heart condition, it is always best to talk to your healthcare provider about what exercises you can engage in safely, what your target heart rate should be and whether you need to be monitored during moderate to intense physical activity. This can help you to choose the types of physical activity that are appropriate for your current fitness level and health goals.

This lab allows students to calculate their target heart rate, and perform a variety of different exercise routines to see what type of exercises maintains target heart rate the best. Have students choose: running, cycling, playing a game of basketball, doing yoga, weight lifting, anything that would allow them to exercise and move. Because the unit is wireless, you can send the students out and about and report back in an hour for data analysis of the different forms of exercise chosen.

Experiment HE-12: Targeted Exercise with Wireless Electrocardiogram (ECG)

“Get Your Cardio On”

Equipment Required

PC or Mac Computer

Wireless Actiwave Cardio unit (ECG + Accelerometer)

Actiwave USB three channel Cardio dock

Two ECG snap electrodes, not pediatric size

Text Import Module User Name and Serial Number to activate the EDF file import

Optional Equipment Needed for Additional Experimentation

If testing Aerobic Fitness, VO2Max, RER, or other labs such as EMG activity while exercising, you will also need these equipment plus the equipment shown in each of those labs. You will need to open the other lab exercises.

IXTA Data acquisition unit

USB cable

IXTA power supply

For the IXTA Setup

1. Place the IXTA on the bench, close to the computer.
2. Check Figure T-1-1 in Chapter 1 for the location of the USB port and the power socket on the IXTA.
3. Check Figure T-1-2 in Chapter 1 for a picture of the IXTA power supply.
4. Use the USB cable to connect the computer to the USB port on the rear panel of the IXTA.
5. Plug the power supply for the IXTA into the electrical outlet. Insert the plug on the end of the power supply cable into the labeled socket on the rear of the IXTA. Use the power switch to turn on the unit. Confirm that the power light is on.

Start the Software

1. Click on the LabScribe shortcut on the computer’s desktop to open the program. If a shortcut is not available, click on the Windows Start menu, move the cursor to All Programs and then to the listing for iWorx. Select LabScribe from the iWorx submenu. The LabScribe Main window will appear as the program opens.
2. On the Main window, pull down the Settings menu and select Load Group.
3. Locate the folder that contains the settings group, IPLMv6Complete.iwxgrp. Select this group and click Open.
4. Pull down the Settings menu, again. Select the TargetedExercise settings file from Human Exercise.

5. After a short time, LabScribe will appear on the computer screen as configured by the TargetedExercise settings. This will allow you to import the Actiwave Cardio EDF file for data analysis.
6. Once the settings file has been loaded, click the **Experiment** button on the toolbar to open any of the following documents:
 - Appendix
 - Background
 - Labs
 - Setup (opens automatically)

Setup the Actiwave Cardio

The Actiwave Cardio snaps onto a standard ECG electrode with a short lead to another electrode that picks up the ECG signal. It is normally worn on the upper or lower chest. It is comfortable to wear continuously for long periods of time and is lightweight, waterproof and self contained. It will also record 3 axis acceleration which will allow the amount of activity to be calculated based on body movement.

The Actiwave Cardio contains a lithium polymer rechargeable battery. The life of the battery is dependent on the recording mode but is always in excess of 2 days. It must be recharged using the USB port with the Actiwave Cardio dock. It clips on to the two studs on the Actiwave dock for charging.

The same interface will be used for downloading data to a PC where the data is stored in the standard EDF (European data format) file format. The EDF file will then be imported into LabScribe for data analysis.

Install the software (the installation only needs to be performed once):

- Put the CD in the drive on your computer. It should automatically run and begin installation. The installation checks for, and will install if necessary, a Microsoft visual studio runtime library.
- Follow the installation wizard's onscreen prompts until the installation is complete. It is recommended that you install the software in the default location. The operation of this software on a remote server is not guaranteed as network settings vary considerably.
-

Set Up the Actiwave Cardio for Recording:

1. Before setting up, the Actiwave dock must be plugged in and an Actiwave Cardio unit placed in the selected position on the dock.
2. Click on the Actiwave desktop icon to open the software.
3. Double click the 'Setup' button, and the Actiwave setup software will start and the setup window will be displayed ([Figure HE-12-S1](#)).

W Set up Actiwave Cardio 000057

User/Patient ID:

Full Name:

Sex:

Date of Birth:

Weight: kg Height: cm

Recording ID:

Start On: at

Sample at: Resolution:

Channel 1

Enable ECG ?

Accelerometer

X Axis Sample at:

Y Axis

Z Axis

Recording time will be 9 hrs, 11 mins.

Figure HE-12-S1: The Cardio setup window.

4. Enter the correct information for your subject:
 - **Required** – enter user or patient ID.
 - **Required** – Start date and time must be entered. Date format is:
 - Day (xx)/Month (xx)/Year xxxx).
 - **Required** – Sample at 512Hz with a Resolution of 10 bits.
 - Note: if you are going to record on single subject for longer than 3 hours, lower the sampling rate to 128Hz.
 - **Required** – Channel 1: check Enable and ECG. ECG0 will show in the window.
 - **Required** – Make sure the check boxes for the Accelerometer are checked – sample at 32Hz.
 - **Optional** – Enter the subject's weight (kg) and height (cm).

- **Optional** – Enter the subject's DOB.
 - **Optional** – Select the subject's gender.
5. Click OK to send the setup information to the Actiwave Cardio unit.

NOTE: *The unit's previous information WILL be erased (which can take a few minutes) and it can then be removed and placed on the wearer. It will not start recording until the start time is reached. If a long start delay has been set the Actiwave will enter a low power sleep mode until it needs to start logging.*

Place the Wireless Cardio Unit on the subject:

1. Procedure for Skin Preparation:

- Clean the skin to ensure that it is clean, oil free and preferable hairless. This can easily be achieved by using warm water and soap. Alcohol should **not** be used as this can potentially cause skin irritation. Shaving is also not ideal, but if it must be done, do this several days in advance.
- Rub the skin where the electrodes will be placed with a towel or other cloth vigorously enough to remove the top layer of skin. Some redness will be seen; this is normal and should not be cause for concern.
- Apply the two snap electrode pads to the chest.
 - Place one electrode pad in the center of the chest and snap the round Cardio unit on it ([Figure HE-12-S2](#)).

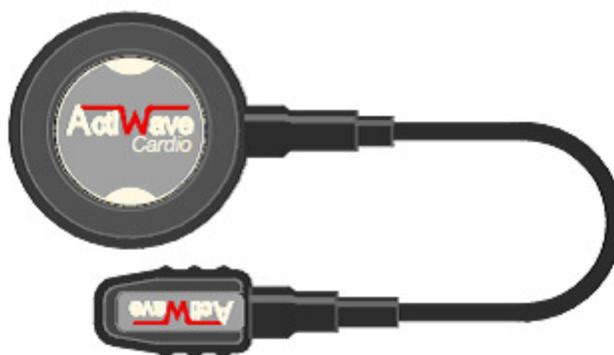


Figure HE-12-S2: The Actiwave Cardio unit showing the main circular recorder and the oval attachment for 2nd electrode.

- Attach the second electrode pad to the oval clip on the Cardio unit and use the wire to position the second electrode.

- **Electrode Positioning:** The best ECG signals can usually be picked up by placing the round end of the Cardio unit in a position midway between and below V1 and V2. The other electrode can be placed at V4 or V5. A position on the upper chest shown in the diagram below can also be used ([Figure HE-12-S3](#)).

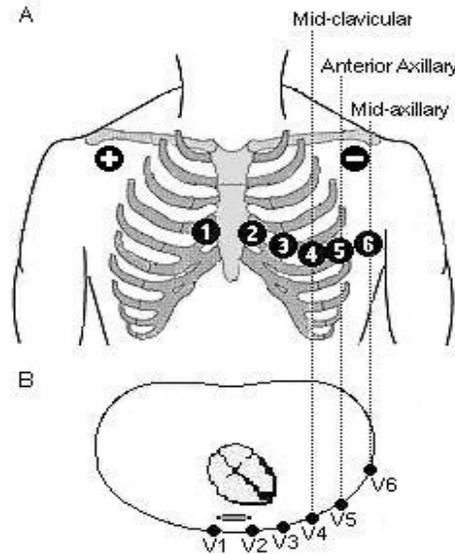


Figure HE-12-S3: Top view of chest showing possible placement of electrodes.

- For females – the unit may be placed below the breasts. Underwire bras may impact the signal. It is best to wear a wireless exercise bra.
2. Positioning of the Actiwave Cardio for the Accelerometer
- For good, accurate measurement of activity the cable needs to be placed as horizontal as possible. If necessary, use a small piece of tape (Micropore or similar) to hold the cable in a horizontal position.
 - The accelerometer output of the Cardio unit is labeled in X, Y and Z axes ([Figure HE-12-S4](#)).

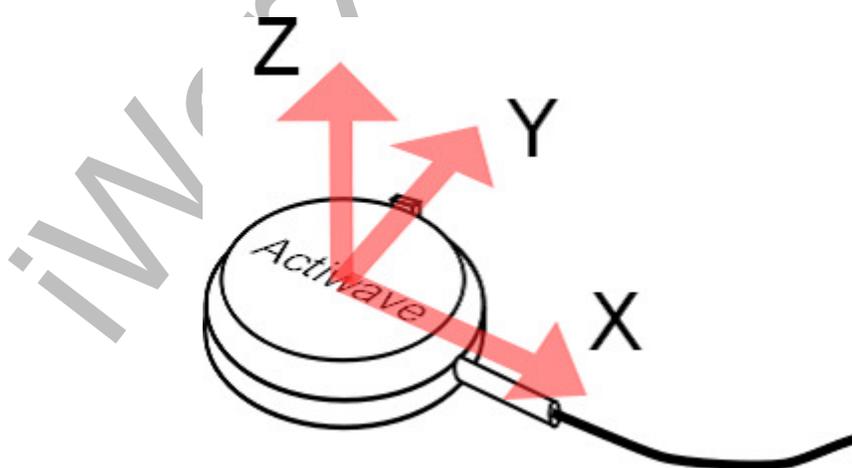


Figure HE-12-S4: The Actiwave Cardio accelerometer positions.

- The direction of positive X acceleration is outward from the body of the unit along the wire.
- The direction of positive Y acceleration is outward from the unit in the direction of the plastic button for releasing the clip.
- The direction of positive Z acceleration is outward from the unit in the direction of the lid. For example this would be directly upwards if the device is resting normally on a table with the label upwards.

The Actiwave Cardio is now ready to use. Open any other iWorx Lab and follow the directions for using the Cardio unit in conjunction with all of our other lab experiments.

Experiment HE-12: Targeted Exercise with Remote Electrocardiogram (ECG)

“Get Your Cardio On”

Exercise 1: Remote ECG and Heart Rate

Aim: To measure the heart rate of a resting subject.

Procedure

1. Make sure the Actiwave Cardio unit is attached to the subject's chest correctly as shown in the Set Up documentation.
2. Have the subject take their pulse and record their resting heart rate. Also have the subject figure out their Target Heart rate and choose an exercise routine they would like to participate in.
3. Noting the start time that was programmed into the Cardio set up, make sure to start the actual experiment at that start time.
4. Immediately after the start time, have the subject sit still for 10 minutes and record a good, resting ECG.
5. After the 10 minutes of recording a resting ECG and heart rate, have the subject begin the chosen exercise protocol/routine to be recorded by the Actiwave Cardio. This is the time to “Get Your Cardio On” and get active.
 - If you are using the Cardio unit in conjunction with another iWorx lab – open that lab at this time and follow the directions for doing the recordings necessary. **The Actiwave Cardio unit will continuously record remote ECG and heart rate during any experiment.**
5. As the subject exercises, have them periodically take their pulse and record heart rate. A partner should write down the time, physical activity being performed, and the subject's heart rate at that point. Heart rate should be taken at least three (3) times during the recording of data.

Data Import and Analysis

Once the data are collected using the Actiwave Cardio, the file must be exported from the unit and saved as an EDF file. Once this file is saved, it can then be imported, opened and analyzed using LabScribe3.

1. Insert the Actiwave Cardio into the Cardio dock ([Figure HE-12-L1](#)).
2. Open the Actiwave software by clicking the desktop icon.
3. Click on the read button. The data will be downloaded as an EDF file and added to the list of other Actiwave files that have been previously exported from the unit.

NOTE: The recorded data in the Actiwave Cardio device is **not erased** after the download. It is only erased if the unit is set up again.

4. Once the EDF file is saved, Open LabScribe by clicking on the desktop icon.

NOTE: It will help to save the EDF files to a folder on your Desktop for ease of finding the files.

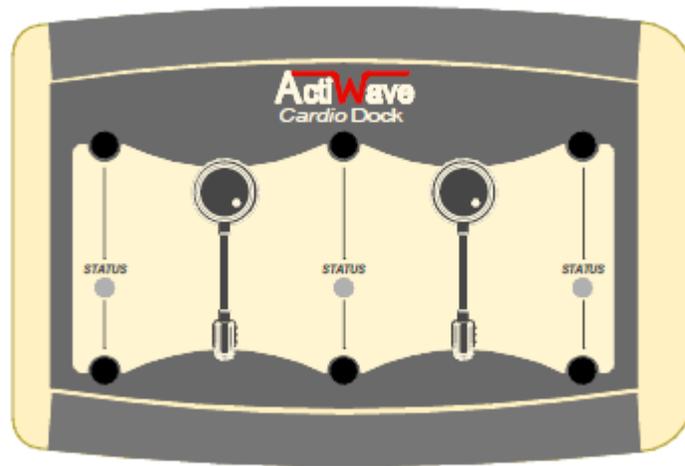


Figure HE-12-L1: Actiwave Cardio dock.

5. Choose either IX-TA or the IWX-214 from the list of units that pops up (if the unit is already plugged in and turned on, this menu will not appear). Click OK.
6. If using the IX-TA, click OK to the second pop-up window; iWire Devices to emulate: iWire B3G ([Figure HE-12-L2](#)). If using the IWX-214, there will not be a second menu item.

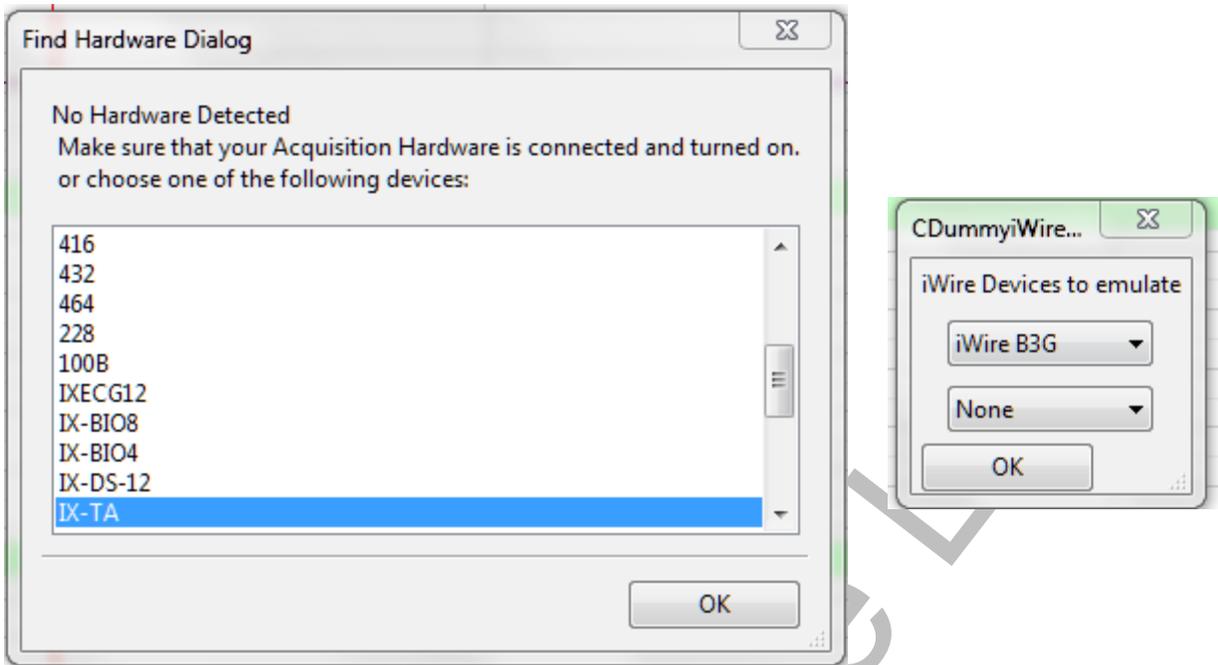


Figure HE-12-L2: Menu options for choosing the hardware type for importing the Cardio EDF file.

7. Make sure to load the Human Exercise – TargetedExercise settings if it has not already been selected.
8. Click File → Import from the menu ([Figure HE-12-S3](#)).

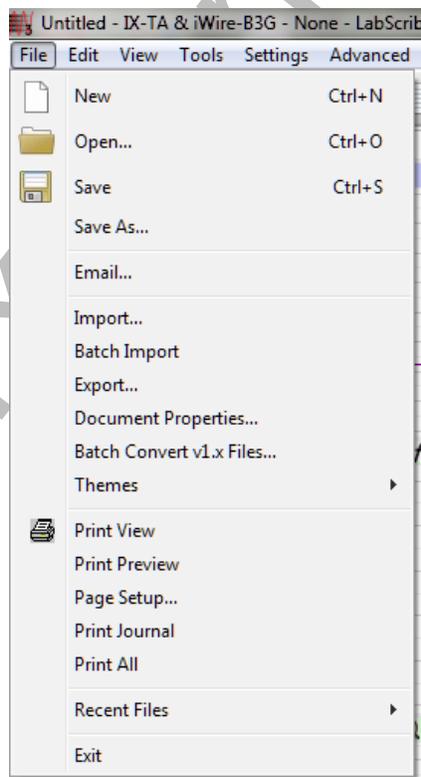


Figure HE-12-L3: File → Import screen.

8. A new window will open, navigate to where the EDF files have been saved, preferably in the folder you created on your Desktop.
9. Choose the file you wish to open and click Open. You can also double click the name of the file.
 - If this is the first time using the Import feature, you will be asked for your User Name and Serial Number.
 - Enter these into the appropriate blanks. This information only needs to be entered once.
10. Choose “Yes” when asked to Use Current Settings for Import? ([Figure HE-12-L4](#)).

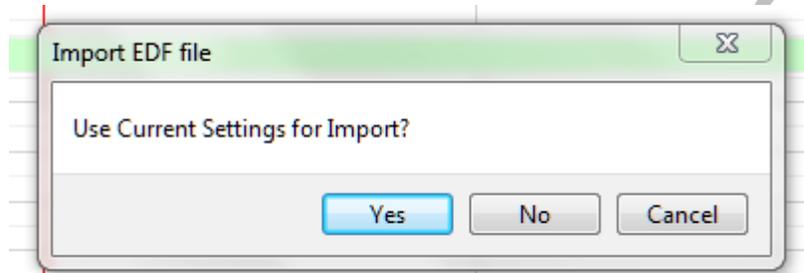


Figure HE-12-L4: EDF Import Settings selection dialog.

11. Once the file has been imported, the data should show ECG, Activity and Heart Rate Channels. See [Figure HE-12-L5](#).

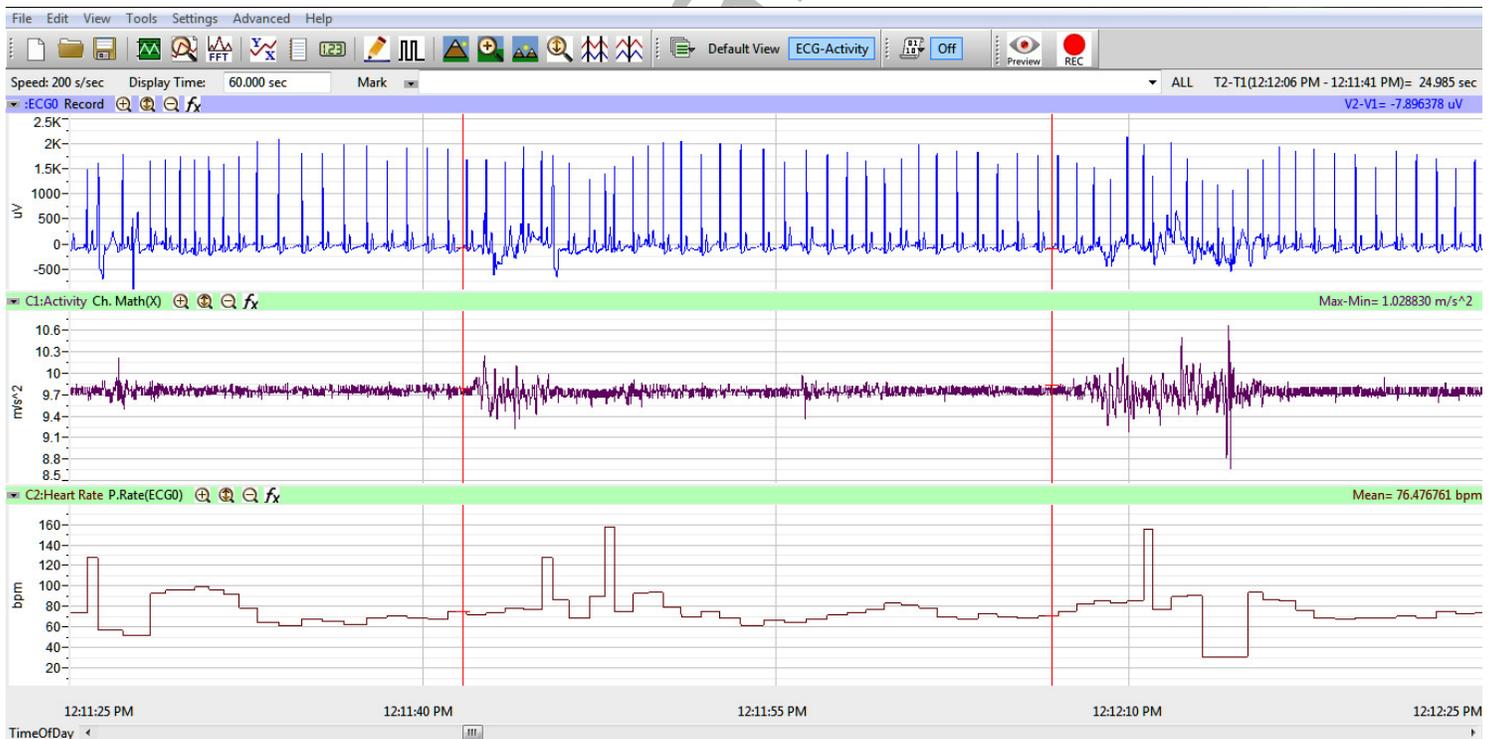


Figure HE-12-L5: Cardio data file showing ECG, Activity Level and Heart Rate.

12. Sixty (60) seconds of data will be shown on the screen. Display time can be adjusted by clicking the double or half display time icons on the LabScribe Toolbar or typing in the display time in the Display Time box. (Figure HE-12-L6).

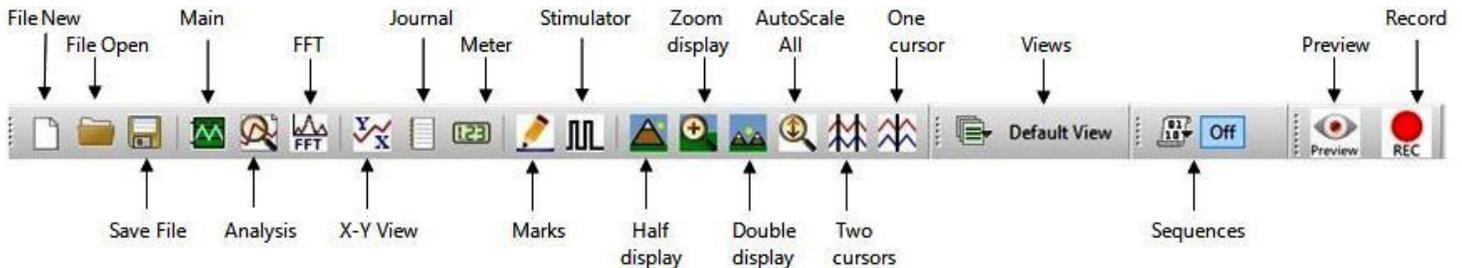


Figure HE-12-L6: The LabScribe toolbar.

13. Click on and move the two vertical cursors to areas of interest in the data recording.

- Move the cursors to the first few minutes of the recording to determine the subject's Resting Heart Rate. Place the cursors at least two minutes (120 seconds) apart by doubling the display time and moving the cursors to either side of the recording. The value, **Mean**, on the right side of the Heart Rate channel will state the subject's mean heart rate in beats per minute (bpm) as bracketed by the cursors.
- Also look at the Activity channel. The **Max-Min** value will show a measurement of the subject's activity. During resting, the activity level should be low.
- Scroll through the recording to the beginning of where the subject started actively exercising. Place the cursors at least two minutes (120 seconds) apart by doubling the display time and moving the cursors to either side of the recording. The value, **Mean**, on the right side of the Heart Rate channel will state the subject's mean heart rate in beats per minute (bpm) as bracketed by the cursors.
- Also look at the Activity channel. The **Max-Min** value will show a measurement of the subject's activity. During the start of the exercise routine, the activity level should still be low, but should show an increase.
- Continue to scroll through the recording while the subject was actively exercising. Periodically, approximately every 2-3 minutes of recording, repeat the analysis of Heart Rate and Activity. If the exercise routine was longer than 30 minutes, data can be taken every 5-10 minutes.

14. Fill in the data table below for the subject's heart rate and activity levels at each time interval.

Table HE-12-L1: Heart Rate and Activity Level while Resting and Exercising

Time Interval	Heart Rate	Activity Level
Resting		
Beginning Exercise		
Exercise 3 min		
Exercise 6 min		
Exercise 9 min		
Exercise 12 min		
Exercise 15 min		
Exercise 18 min		
Exercise 21 min		
Exercise 24 min		
Exercise 27 min		

Questions:

1. What was the subject's resting heart rate? Did the resting heart rate calculated by the Actiwave Cardio match the subject's measured resting heart rate? If not, what could be a factor contributing to this?
2. What was the subject's activity level while resting?
3. What is the subject's maximum heart rate based on age and fitness level?
4. What is the subject's target heart rate? Remember this is 50-85% of maximum heart rate. Keep in mind that if the subject is not physically fit, the level should be closer to 50%; if the subject is very fit, it should be closer to 85%.
5. What was the subject's heart rate at the beginning of the exercise routine? Activity level?
6. What was the subject's heart rate and activity level 3-5 minutes into the exercise routine? 6-10 min? 9-15min? Etc...
7. Did the subject reach his or her target heart rate? Could the subject stay within the target heart level while doing the exercise routine that was chosen?
8. How did this exercise routine compare to a different type of exercise?
9. Do these different types of exercise allow the person to maintain their target heart throughout the entire exercise routine or does the heart rate fluctuate?
10. How does keeping to a target heart rate improve exercise quality compared to a heart rate that moves in and out of range?

11. Is there one exercise routine that does this better than others?

iWorx Sample Lab