Master Manual of Procedures

for

Human Testing Center

Institute of Applied Life Sciences

Life Science Laboratories S360

240 Thatcher Road,

Amherst, MA 01003

at the

University of Massachusetts, Amherst

Updated:

MANUAL OF PROCEDURES

Human Testing Center

Institute of Applied Life Sciences

Life Science Laboratories S360

240 Thatcher Road,

Amherst, MA 01003

at the

University of Massachusetts, Amherst

UNIVERSITY OF MASSACHUSETTS AMHERST

INSTITUTE FOR APPLIED LIFE SCIENCES

Human Testing Center

Core Access, Training, Scheduling, Pricing, and Billing

Most relevant information for gaining access to the Cores within the Human Testing Center can be found on the Core websites. Access will only be given to users once all steps have been completed.

a) Core Access:

Internal User.

If you are a UMass Amherst, UMass system, or Five College based researcher who is doing research that would receive 'internal' pricing. The following steps outline how you will gain access to the Core Facilities.

i) Contact Michael Busa the Core Facility Director and discuss your projects needs and timelines (mbusa@umass.edu, 413-755-0574).
ii) If you are new to IALS a MOU and payment authorization form must be completed for each core facility you would like to use. The PI's Start Up paperwork can be found in the Forms tab of the webpage.

External User

If you are an external user from an academic or industry partner, please contact Michael Busa, the Core Director, to discuss your needs (mbusa@umass.edu, 413-577-0574).

b) Training: Individuals who would like to use any piece of equipment in the Human Testing Center must complete a training session with Core staff (Core Rates Apply). These trainings serve as both a technical tutorial for equipment use and an orientation for users to the Human Testing Center. For users who already have expertise in the use of a particular piece of equipment, they can request that they just demonstrate proficiency in use and skip the tutorial. Please note that even though a user may be proficient in the technical aspects of a certain piece of equipment that the integration of the billing and data storage systems in the IALS cores differs from standalone pieces of equipment. Being trained on these aspects will ensure that data is properly stored and billing records are accurate.

As part of the training, the prospective user must also provide the Core Staff with proof of the require EHS trainings. All require trainings are located at the beginning of each instruments Standard Operating Procedure.

c) Scheduling: All scheduling of equipment time is to be done through the Facilities Online Management system (FOM).
i) Supervisors (i.e. PIs) must have supervisor accounts created prior to having their RA's create profiles, the Core Director will do this for them following an initial email or phone call indicating their intention to use a core.
ii) All users must create their own FOM account and link it to their supervisor.

(1) They must then click on the individual capacity that they want to gain access to, and request a training time with the Core Staff.
(2) During registration, they must use the speedtype that matches the Payment Authorization Form that is submitted as part of the PI's Start Up paperwork. Additional speedtypes can be added by users in the case when they work on multiple projects.

d) Pricing/Usage: Pricing for facility use are posted on the Core websites.
   i) Rates are set on an annual basis and are subject to change.
   ii) Prices are set in FOM. Charges for use are based on FOM active time rounded up to the next complete scheduling period.

e) Billing: Billing is carried out by the IALS accounting staff.
   i) Statements are sent out to supervisors and their designated representative.
   ii) Disputes or changes in speedtype to the invoice must be made within 10 business days, otherwise the selected speedtype will be automatically changed.

Manual of Procedures

Exercise Intervention & Outcomes Core

Institute of Applied Life Sciences

Life Science Laboratories S360

240 Thatcher Road,

Amherst, MA 01003

at the

University of Massachusetts, Amherst

Chapter 1: ParvoMedics TrueOne 2400

1.1 *Introduction:* The TrueOne ®2400 Metabolic Measurement System (ParvoMedics, INC., Sandy, UT, USA) s an integrated metabolic measurement system for **maximal O2 consumption testing and indirect calorimetry assessment**. The TrueOne® 2400's Analyzer Module, with paramagnetic oxygen and infra-red carbon dioxide analyzers, is designed to be accurate, reliable, and easy to use. The unique flowmeter calibration algorithm, utilizing an image reconstruction technique, corrects the non-linearity of the pneumotach and provides highly accurate flow measurement.

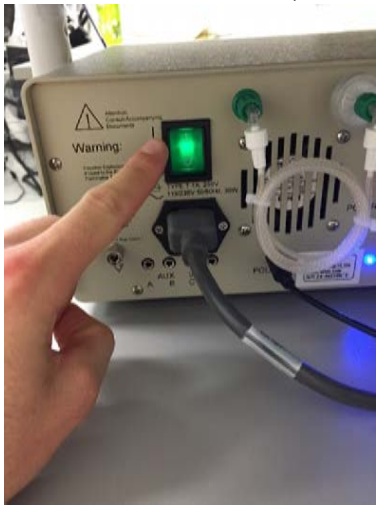
Features:

- High Precision Flowmeter Calibration
- Compact Analyzer Module
- Highly Reliable Mixing Chamber Principle Recommended Applications
- Athletic Testing
- Exercise Physiology Teaching and Research
- Sports Medicine Research
- Energy Expenditure Assessment
- Differential Diagnosis in Cardiopulmonary Diseases

1.2 *How to Calibrate*: Below is a step-by-step outline for calibrating the unit.

Preliminary Calibration Steps

1. Locate the power switch on the rear of the Analyzer Module and turn it on.
    a. Allow it 30 minutes to warm up



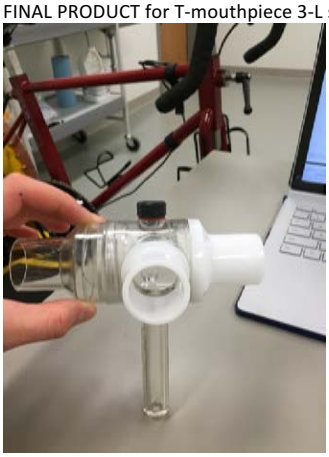
2. Turn on the computer and monitor and launch TrueOne software
    a. They do not require a warm up time of more than 2-minutes
3. Assemble the water-trap connection
    a. Connect the filter to the T-connector using the grey connection piece. Gently push the two together in a circular motion.

4. Attach this assembly to the pneumotach. Attach by pushing the water trap to the pneumotach with slight pressure. Ensure that the mixing chamber (tinted rectangular box) does not fall off the cart.

5. On the other end (labeled tube) attached one end of the hose.

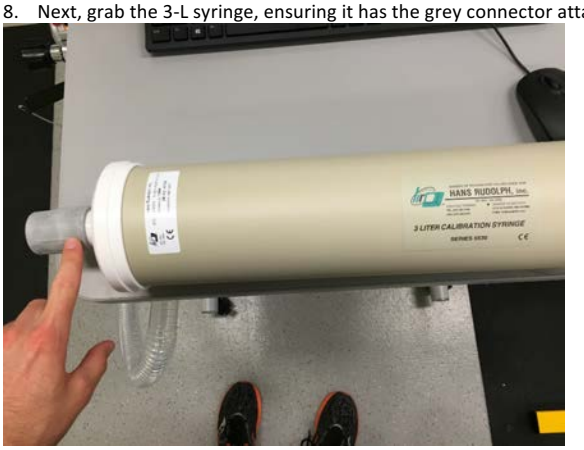
6. Next, assemble the T-mouthpiece 3-L syringe calibration assembly. Make sure the small white membranes are facing the same direction. Looking at image #3 below, when holding the unit with upright, the side of the body with the air-flow arrow facing up (small arrow on the center body piece) the membrane on this side should have surface parallel with the long water chamber. The membrane on the opposite side should be facing the same way. If you are having trouble use this resource: https://www.youtube.com/watch?v=YSg65afxMCM


FINAL PRODUCT for T-mouthpiece 3-L syringe calibration assembly

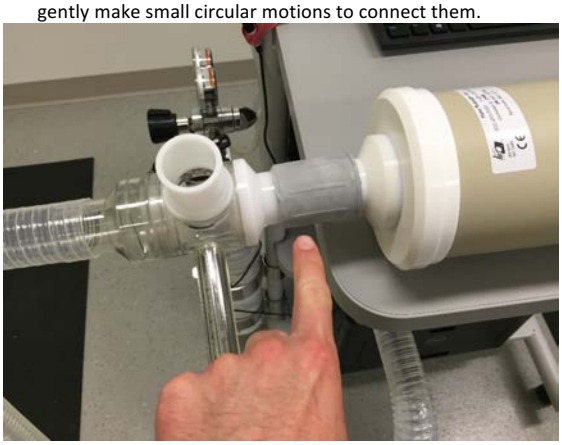


7. Take the other end of the hose (end not attached to the water trap) and connect it to the T-mouthpiece 3-L syringe calibration assembly. Make sure the hose is attached to the output valve (end with 3 metal rings).

8. Next, grab the 3-L syringe, ensuring it has the grey connector attached

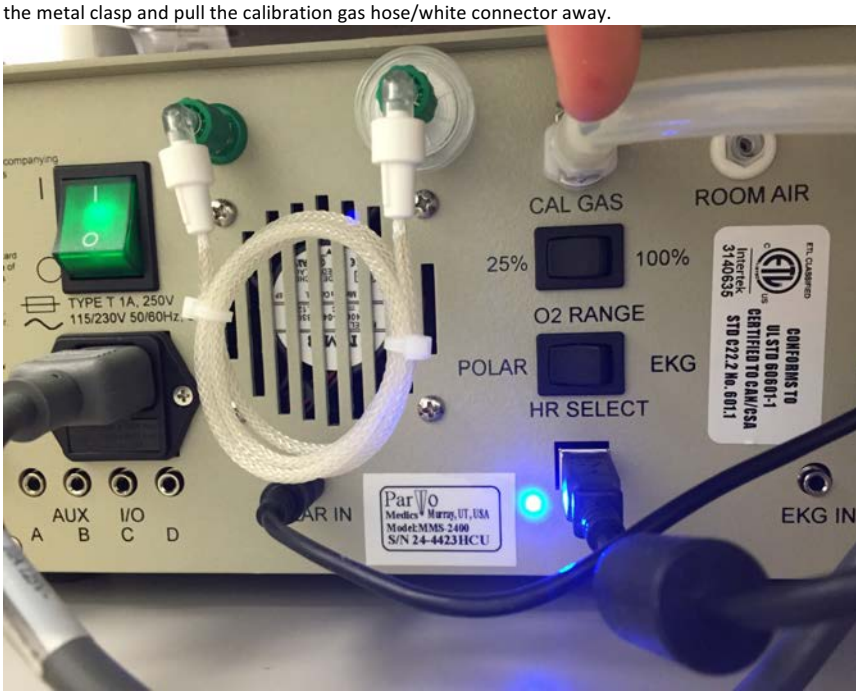


9. Interface the T-mouthpiece 3-L syringe calibration assembly with the grey end of the 3-L syringe. Make sure that the connection is tight, however do not forcefully push them together. Rather, gently make small circular motions to connect them.



10. Next, prepare for gas calibration by opening the gas cylinder. Turn the metal knob on the top of the cylinder counterclockwise 1 and ½ turns. The Cal Gas calibration is key to accurate testing results. You can run the gas calibration as many times as needed during calibration. It is recommended to run the cal gas calibration one last time just before (gets on the treadmill or ergometer) testing the subject. We need to ensure the CO2 levels the Parvo cart is reading for room air have not floated above 3-4%. If this happens, the RER value in the test window with be inflated when the test starts.

11. Now you can attach the calibration gas hose/white connector from the cylinder to the Cal Gas Port on the metabolic cart. This is located on the back of the unit. It is to the left of the Room Air port and just above the O2 Range switch. You must hold the front of the unit, so it does not fall to the floor, while bringing the calibration gas hose/white connector to the Cal Gas port. Stay parallel to the floor and push the connector straight in the port connector. To remove, push down lightly on the metal clasp and pull the calibration gas hose/white connector away.

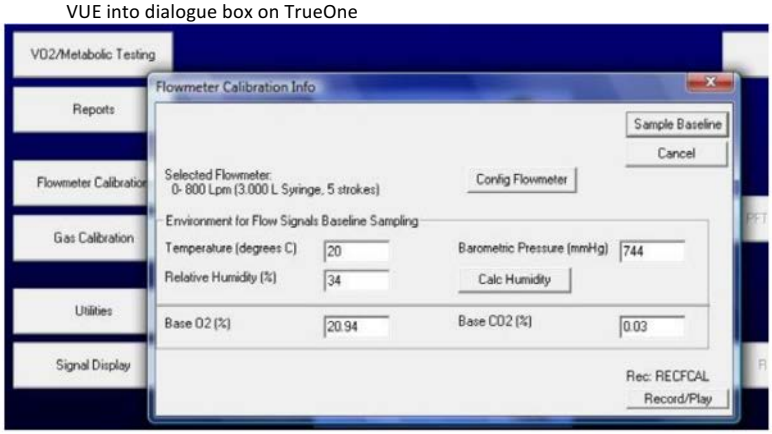


12. Now, touch pneumotach, it should be warm, indicating it is should be warmed up. Ensure that 30-minutes has passed, and contine with calibration

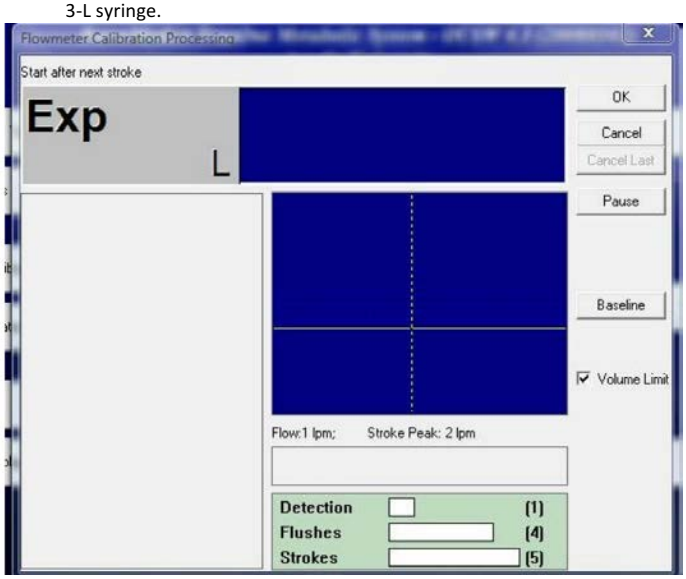
13. The system is now ready for the three step calibration. Once the system has been setup, the calibration process is very quick and easy. The system should be calibrated again in between multiple subjects or if it has been sitting turned on but not used for a long period of time. The only calibration step theoretically needed after initial calibration is to apply the calibration gas again. However, the enemy of the pneumotach is moisture. Excess moisture will electrically distort what the pneumotach is sensing; this will be reflected in erroneous reading of the 3 liter syringe as 9, 12, 15 liters etc... The screen inside the round oven needs to be as dry as possible, so you may have to use the syringe to input room air across the sensor and into the mixing chamber if you are testing multiple subjects. The pneumotach is very sensitive to subtle changes in CO2. This is the reason why we need to let the pneumotach heat up to operating temperature. Doing a test with a cold pneumotach will have distorted CO2 results – the RER and VO2 kg readings will be way off.

1.3 **FLOWMETER CALIBRATION**

1. Open TrueOne software and click “Flowmeter Calibration”
2. Enter room temperature, relative humidity, and barometric pressure readings from the Vantage VUE into dialogue box on TrueOne



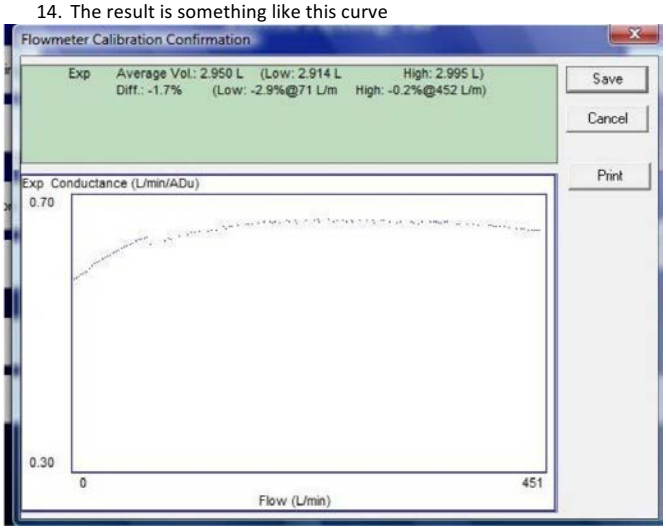
3. Click and open Sample Baseline in the upper right corner of the dialogue box
4. The Flowmeter Calibration Processing window will open. All input strokes will be done with the 3-L syringe.



5. **Detection stroke** - one input stroke indicates air is flowing into the system (mouthpiece and all assemblies are properly configured). *Notice the Flow indicator will show the real time input

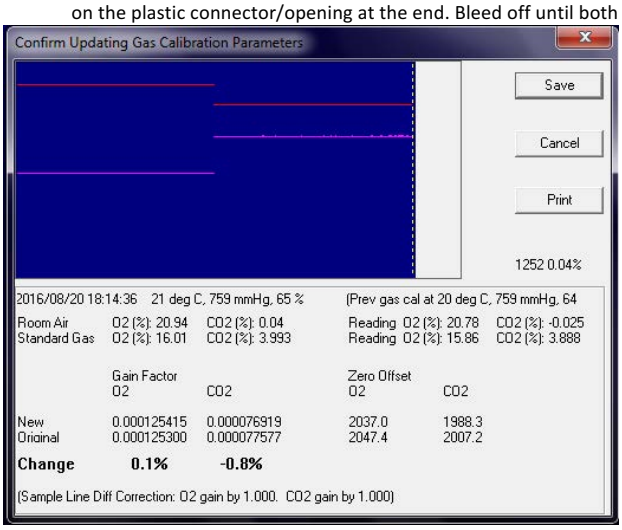
velocity, Stroke Peak with show the peak in real time and in the blank blue field beside the Cancel button, the volume of the syringe will be displayed at the end of any stroke. This value should be around 3 liters. If it reads high – 9, 12, 15 liters etc.. the pneumotach has a moisture issue (if testing multiple subjects over a short period of time) and must be allowed to dry. You can use the syringe setup to do the Flowmeter calibration, but don't open the software. You are just physically driving air across the pneumotach, through the mixing chamber and into the system

6. **Flush Stroke** – four input strokes to push fresh air into the system
7. The pneumotach can sense 800 lpm. Of the five calibration strokes input next, two must be less than 80 lpm. The number will fluctuate beside the Flow numerical indicator (to the left of Stroke Peak. **For Exercise Stroke** velocity is very very slow, very slow, slow, fast, faster.
8. Stroke 1 → approximately 50 -80 lpm (very, very slow)
9. Stroke 2 → approximately 100+ lpm (very slow)
10. Stroke 3 → approximately 200+ lpm (slow)
11. Stroke 4 → approximately 300+ lpm (fast)
12. Stroke 5 → approximately 400+ lpm (faster)
13. For Resting Stroke velocity can stay at 50 -80 lpm
14. The result is something like this curve



1.4 **GAS CALIBRATION**

1. On the home screen, click “Gas Calibration”
2. The Gas Calibration window will open, like with Flowmeter calibration, correctly input temperature, humidity, and pressure into the dialogue box. Click OK.
3. The unit will perform gas calibration and after about 20 seconds.
4. A pop-up will appear prompting you to turn off the calibration gas.
5. A summary window (similar to the one pictured below) will arise. It is recommended to do the Cal Gas calibration until you get the exact numbers on the cylinder. Also, you may do this step just before your subject is ready for testing
6. Click “Save”.
7. When done, turn off the calibration gas cylinder by turning clockwise hand tight. Then bleed of the excess left in the regulator and the calibration gas hose/white connector by gently pushing on the plastic connector/opening at the end. Bleed off until both indicators read zero



1.5 **TESTING with the Parvo2400:**

1. Fit participant with the heart rate monitor, the heart rate transmitter is located on the reticulated arm. Be sure to wet the strap or apply electrode gel before the monitor is used.
2. If you are using are using the head support system, attached sweat guard to the front of the system.

3. While the participant is seated, fit the head support so the front portion is just above the eyebrows. Ensure a snug fit. Tighten the entire band around the head using the knob on the back. You will be using a mouthpiece and nose clip with this setup. Attach a rubber mouth adapter to the small white cylinder of the mouthpiece you made earlier. You want to avoid the subject breathing out of the corner of their mouth (when at maximal exertion). We want a tight seal regardless of what device is used - head support or full mask.

4. Give the subject a nose clip to put on

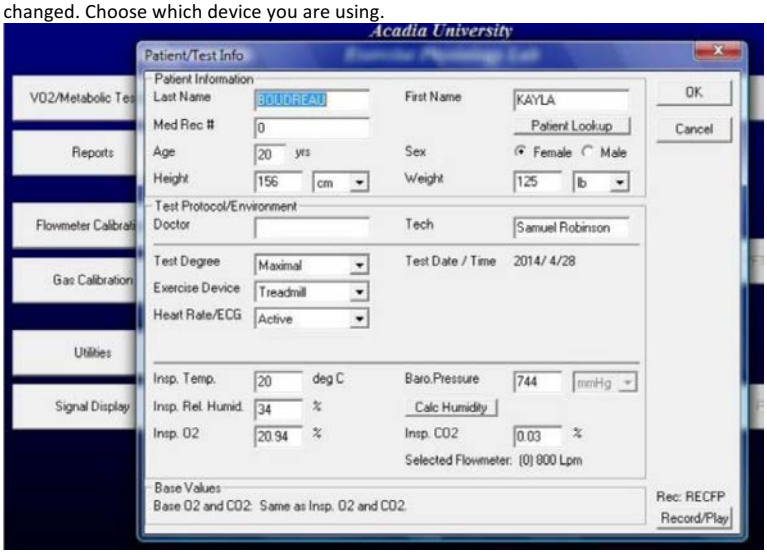
5. They are ready for the treadmill or ergometer. Attach the hose to the output end of the mouthpiece. Do not let the subject insert the adaptor yet. When it is time to start the test, the subject can just spin the adaptor toward their face, place the adaptor in their mouth and begin

mouth breathing into the valves. We must wait until the appropriate test window opens for the subject to do this. They are not to breathe into the hose at this time.

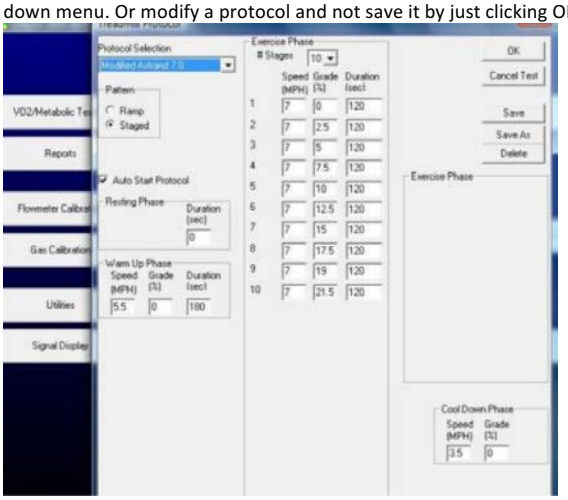
6. The full face mask does not require a nose clip to be used. To use this piece, switch out the small white cylinder for the smaller clear adapter (pictured below). Thread the end of the small clear adapter into the front hole of the blue face mask. Facial hair may interfere with a tight seal. Do not hook up the hose to the full face mask until the test starts. The straps wrap around the head and then the black connectors lock into the clear brackets of the mask. The straps are adjustable by sliding the strap through the black connector the using Velcro to keep in place. The mask covers the mouth and nose – so the straps need to be tight to ensure a good seal

1.6 **METABOLIC TESTING**

1. On the home screen, click on VO2/Metabolic Testing.
2. Input participant information. Update temperature, humidity and barometric pressure if it has changed. Choose which device you are using.

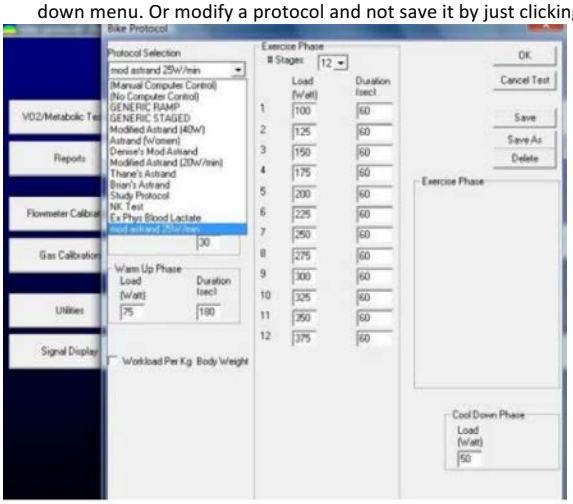


3. If you use the treadmill you need to choose a protocol. You can create a new one and name it whatever you want. Or, modify an existing one and save it. Use what is there already from the pull down menu. Or modify a protocol and not save it by just clicking OK.



4. Treadmill protocols can have a resting, warm up, exercise and cool down phase. If you do not want resting or warm up phases, make the duration = 0 .

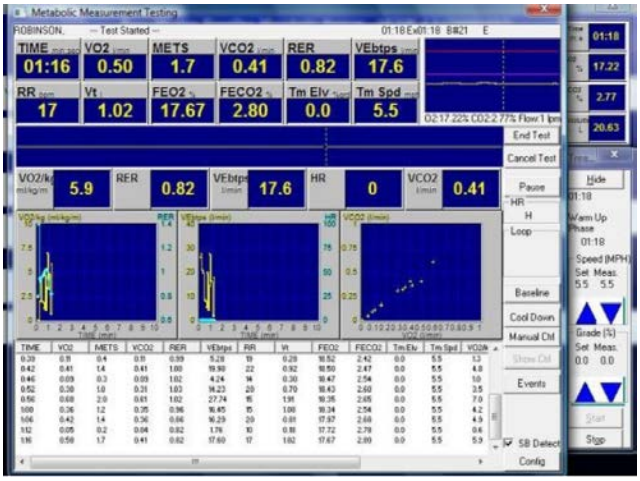
5. Click OK
6. If you use the ergometer you also need to choose a protocol. You can create a new one and name it whatever you want. Modify an existing one and save it. Use what is there already from the pull down menu. Or modify a protocol and not save it by just clicking OK.



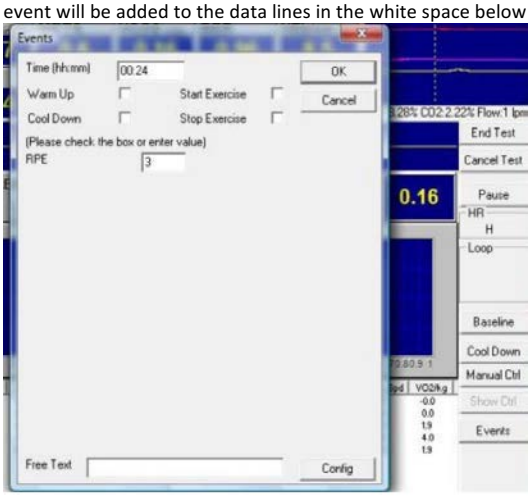
7. You have similar options when using a bike choose a protocol and press OK.
8. Now the testing windows will appear. If using the head support, you can attach the hose from the reticulated arm/T - connector to the output connector on the mouthpiece. The nose clip can be worn. Do not let the subject breath into the mouthpiece yet. If using the full face mask, do not attach the hose from the reticulated arm/T - connector to the mask yet.
9. A series of software windows will open and close.
10. Then this window will open. You will see the blank test results window open as well. The fields will be blank because the subject is not breathing into the system yet. Wait until the CO2 levels exceeds 0.03%, then click OK.

11. If using the headgear, the subject can spin the mouthpiece toward their face. The adaptor can be placed in the mouth while the nose clip is on. If using the full face mask, the hose from the reticulated arm/T can now be attached to the input connector on the full face mask.

12. There will be a delay of approximately 15 – 20 seconds before the Metabolic Measurement Testing window updates with data. The white space below will be filled with data every 5 seconds (this resolution level can be changed)



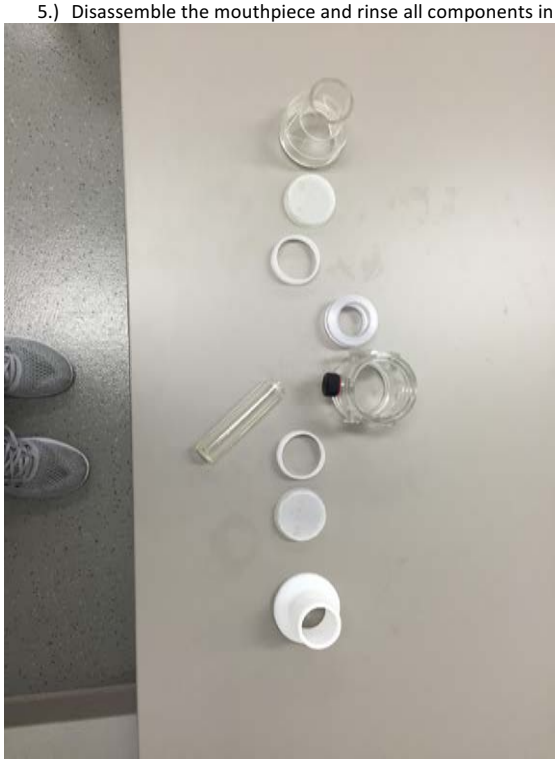
13. The Events button to the right can be used to enter RPE values, increased wattage, etc...a pop-up window will appear. Simply enter the RPE value to the empty data field in the pop-up. This new event will be added to the data lines in the white space below



14. Well documented reports are available after testing. To the right of the Cancel button is a set of timers. This will show overall test time, rest phase time left, warm-up phase time, and exercise phase time left as you go through the stages of the protocol you are using. After the test you can view data under the “Reports” tab on the home screen.

1.7 **CLEANING EQUIPTMENT**

1.) While wearing gloves, remove headgear or the full face mask from the subject. Remember to keep the subject attached to the cart for about 20 seconds after the test has finished. This allows software delay to fill in the remaining data
2.) Take all components off and bring to grey cart/sink area
3.) Detach mouthpiece from headgear
4.) Rinse the sweat guard under water. The heart rate strap and transmitter can be rinsed as well. Let these parts air dry on the pegged rack
5.) Disassemble the mouthpiece and rinse all components in sink with Johnson baby soap



6.) Rinse in _____ solution

1.8 **Contacts**

1. Parvo Medics
   8152 South 1715 East
   Sandy, UT 84093, USA
   1800-942-7255
2. Michael Busa – Core Director
   413-577-0574
   mbusa@umass.edu

Chapter 3: Monark 828 E, weight ergometer

3.1 **Introduction**

Monark Ergometer model 828 E is the world's most commonly used exercise ergometer. The adjustable brake system and the force can be set and read Kiloponds (kp) and Newton (N). The result of the resistance and cadence is displayed in power (Watts) on the electronic meter. The cycle is equipped with an electronic meter showing pedal revolutions per minute (RPM), heart rate in bpm (HR), exercise time in minutes and seconds (TIME), speed in km per hour or miles per hour (SPEED), covered distance in km or mile (DISTANCE), burned Calories (CAL) and the power on the cycle (WATT). The watt level depends on pedalling speed, it can be fine tuned by increasing or decreasing the speed or pedal rpm. Each 828 E is calibrated at the factory. This means that you can begin to use the Ergometer directly after assembly. However, if the user wishes to verify the scale, please read the instruction for "Calibration" in this manual.

Quick facts about the 874 E:

- Large, well-balanced flywheel 20 kg (44 lbs)
- Pendulum scale, easy to calibrate
- Adjustable seat height
- Adjustable handlebar with quick release lever
- Stable frame, solid steel tube
- Electronic display with heart rate

Core competencies:

1) Understanding the brake device and basics of the tension center
2) Be familiar with the Fitness computer and what metrics it generates
3) Review service actions and understand what actions you might need to take before/after using this equipment.

3.2 **User Instructions**

Cycle adjustments

Seat height should be adjusted to a comfortable position. The appropriate height is to have the knee slightly bent when the sole of the foot is centered over the pedal axle with the pedal in the bottom position. To adjust the seat height, loosen the lever (1) on the seat tube. *See Fig: Adjustments.* Also note that the handlebar stem should be inserted into the frame tube at least 3 inches. This measure is marked with "MAX" on the stem (3).

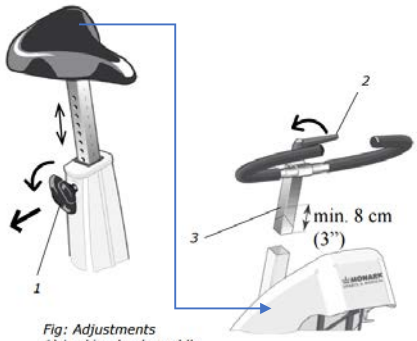


Fig: Adjustments
1) Locking knob, saddle
2) Locking handle, handlebar
3) Inserted min. 3"

Fitness computer

The Monark 874E is equipped with a Fitness computer that displays the following metrics:

1. Revolutions per minute (RPM)
2. Heart rate in bpm (HR)
    a. At the display for heart rate (HR) a heart symbol is lit which means that the meter is trying to find a pulse signal from an external source, chestbelt with electrodes, If the meter cannot find such a signal the HR function is automatically turned off after 30 seconds. When the function is turned off the heart symbol is not lit any more. The heart rate function can be turned on again by pressing a key.
3. Exercise bout time in minutes and seconds (TIME)
    a. The timer starts automatically when pedals are moved. Meter values for **Time**, **Distance** and **Calories** can be set to zero by pressing the **RESET button** (see image below for REST button location) for more than two seconds.
4. Cycling speed in km per hour or miles per hour (SPEED)
5. Covered distance in km or miles (DISTANCE)
6. Calories burned **(CAL)** and power **(WATT)** are also displayed on the computer. To get correct readings for calories and watts, the kp-value on the electronic meter (Fitness computer) has to be set to the same value as the pendulum, or the kpwindow shown to the left of the electronic meter.
    a. For example, the pendulum and the kp-window is showing 2 kp. Press the kp-key to the left on the meter. The lower display window is now showing figures in kp. Increase or decrease in steps of 0.1 kp by pressing the kp-key - (arrow up) or the RESET-key - (arrow down) until the reading corresponds with the actual or desired kp-values on the pendulum scale or in the kp-window. After that press the CAL/WATTbutton to either show the CAL- or WATT-figures. The watt reading in the display is depending on the pedalling speed. The watt reading can then be fine tuned through increase or decrease of the pedalling speed. Calories are calculated all the time.

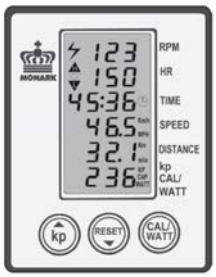
Comment [MB1]: Make a video?

Comment [GP2R1]: Made. Waiting on YouTube account.

To activate any of the functions described above, press any key or move pedals.

To reset, hold the RESET key for two seconds.

Below are sample and images of the Fitness computer and a table outlining metrics the computer displays with corresponding units and ranges.



Display		
Pedal revolution (RPM)	0-250	rev./min.
HR	50-240	bpm
TIME	0:00-99:59	min:sec
SPEED	0-99	km/h
DISTANCE	0.0-99.9	km
FORCE	0.0-7.0	kp
Calories (CAL)	0-999	kcal
WATT	0 - 7 x rpm	watt

Scale-zero adjustment

Loosen tension device so that the brake belt feels loose. Check that the pendulum will hang in vertical position.

Scale board: Check that the index on the pendulum(2) weigh is aligned with the index at the 0-position on the scale board. If adjustment is necessary, first loosen the locknut(1) and then change the position of the board. Tighten the lock-nut after the adjustment. *See fig: Scale adjustments*.

Kp-scale: At the same time, check that the kilopond-scale(5) to the left of the Fitness computer, shows 0 in line with the index. To adjust the kp-scale loosen the lockscrew for scale indicator(9). Tighten the screw firmly after the adjustment. *See fig: Calibration, Adjustment kp-scale window*.

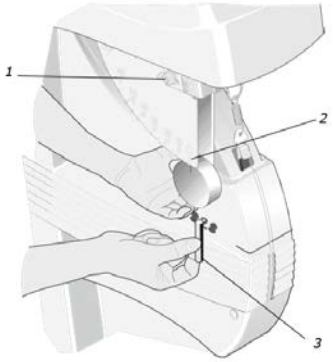


Fig: Scale adjustment
1) Locking nut
2) 0-index
3) Adjustment weight, pendulum

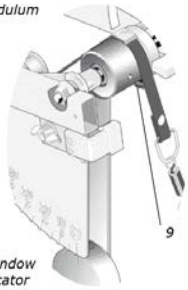


Fig: Adjustment kp-scale window
9) Lock screw for scale indicator

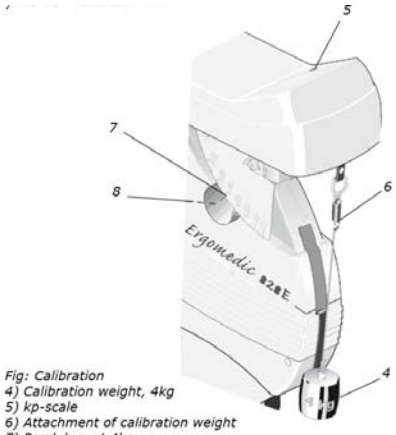


Fig: Calibration
4) Calibration weight, 4kg
5) kp-scale
6) Attachment of calibration weight
7) Pendulum at 4kp
8) Screw to adjustment weight

Calibration

Although all Ergometers are calibrated at the factory, the user may wish to verify this by performing a mechanical scale calibration. To calibrate follow the steps below:

1. Remove the blue brake belt from the spring
2. Lean the bike forward so that the calibration weight, 4kg(4) is hanging independently from the frame cover
3. Be sure that the scale board is set to zero before the weight is put on, see section ”Scale - zero adjustment”
4. Put the 4kg weight on the spring(6). When correctly set, it should be possible to read this weight from the corresponding place on the scale board(7). *See fig: Calibration*

Should there be a deviation from the calibration weight, adjust the pendulum to the correct weight on the scale by means of the adjusting weight inside the pendulum(3). *See fig: Scale adjustment*. To change the position of the adjusting weight, loosen the lock screw(8) on the back of the pendulum weight. Should the index of the pendulum weight be too low, move the adjusting weight upwards in the weight. If the index should be too high, the adjusting weight is moved somewhat downwards and locked in the new position. Repeat until the correct reading (4kg) is achieved.

Check the calibration of the pendulum weight once a year or when needed

Sample Data Sheet for Graded Exercise Test

TIME	DISTANCE	SPEED	HR	RPM	kP/meter/min→**Watts** (1kP/m/min=0.1634 watts)
1:00					
2:00					
3:00					
4:00					
5:00					
6:00					
7:00					

3.3 General troubleshooting guide

Symptoms	Probably cause/measure
There is a click noise with every pedalling (increases with the weight).	The pedals are not tightly drawn, tighten them or change pedals. There is a loose in the crank cheek, tighten. There is a loose in the base bearing, contact your dealer for service
Scratching sound is heard when pedalling.	Check that the carriage block is taken off and that none of the covers is scratching.
There is a click noise and a squeak noise when pedalling.	Untighten the chain a bit.

Maintenance Schedule:

Service action:

- Manufacturer suggest using isopropyl alcohol. Use a damp but, not wet cloth to clean the surface you wish to disinfect.
- Periodically wipe the surface with a rust preventative, especially when it has been cleaned and the surface is dry. This is done to protect the chromeand zinc parts as well as the painted parts (4 times per year).
- Check now and then that both pedals are firmly tightened. If not, the threading in the pedal arms will be damaged. Also, check that pedal arms are firmly tightened on the crank axle, tighten if necessary. When the Ergometer is new it is important to tighten the pedals after 5 hours of pedalling (4 times per year).
- Check that the pedal crank is secure to the crank axle (4 times per year).
- Be sure that the pedals are moving smoothly, and that pedal axle is clear of dirt and fibres (4 times per year).
- When cleaning and lubricating be sure to check that all screws and nuts are properly tightened (2 times per year).
- Check that the chain is snug and there is no play in the pedal crank (2 times per year).
- Check that pedals, chain and freewheel sprocket are lubricated (2 times per year).
- Be sure that the brake belt does not show significant signs of wear (2 times per year).
- Check that the handlebars and seat adjustment screws are lubricated (2 times per year).
- Be sure that all moving parts as crank and flywheel are working normal and that no abnormal play or sound exists. (I.e. play in bearings causes fast wearing and with that follows a highly reduced lifetime.)
- Check that the flywheel is placed in the center and with plane rotation.
- The crank and flywheel bearings are long term greased and do not require supplementary lubrication. If problem arises with crank or flywheel bearings, contact Monark dealer.
- Replace batteries if the computer is not on/seems to be producing incorrect measurements

3.4 **Contacts**

1.) Monark Exercise AB (Vabsbro, Sweeden)
+46(0)281 59 49 40

2.) Michael Busa – Core Director
413-577-0574
mbusa@umass.edu

Chapter 4: Monark 874 E, weight ergometer

4.1 *Introduction:* Monark Ergometer model 874 E is a safe, easy-to use bike for fitness testing and work tests. It has a brake system where the workload is determined by weights added in the weight basket. The patented weight basket system does not require calibration, the precision of the weights ensures that the workload is correct.

Quick facts about the 874 E:

• Large, well-balanced flywheel 20 kg (44 lbs)

• Adjustable saddle and handlebar

• Stable frame, solid steel tube

• Wheels for easy transport

• Electronic meter with heart rate

Core competencies:

1) Understanding the brake device and basics of the tension center
2) Be familiar with the Fitness computer and what metrics it generates
3) Review service actions and understand what actions you might need to take before/after using this equipment

Cycle adjustments

Seat height should be adjusted to a comfortable position. The appropriate height is to have the knee slightly bent when the sole of the foot is centered over the pedal axle with the pedal in the bottom position. To adjust the seat height, loosen the lever (1) on the seat tube. *See Fig: Adjustments.* Also note that the handlebar stem should be inserted into the frame tube at least 3 inches. This measure is marked with "MAX" on the stem (3).

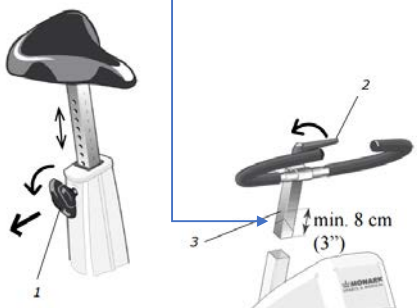


Fig: Adjustments
1) Locking knob, saddle
2) Locking handle, handlebar
3) Inserted min. 3"

Fitness computer

The Monark 874E is equipped with a Fitness computer that displays the following metrics:

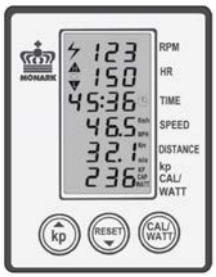
1. Revolutions per minute (RPM)
2. Heart rate in bpm (HR)
    a. At the display for heart rate (HR) a heart symbol is lit which means that the meter is trying to find a pulse signal from an external source, chestbelt with electrodes, If the meter cannot find such a signal the HR function is automatically turned off after 30 seconds. When the function is turned off the heart symbol is not lit any more. The heart rate function can be turned on again by pressing a key.
3. Exercise bout time in minutes and seconds (TIME)
    a. The timer starts automatically when pedals are moved. Meter values for **Time**, **Distance** and **Calories** can be set to zero by pressing the **RESET button** (see image below for REST button location) for more than two seconds.
4. Cycling speed in km per hour or miles per hour (SPEED)
5. Covered distance in km or miles (DISTANCE)
6. Workload (kp = weight basket + weight in kg) can be set which gives a reading of calories burned (CAL) and power (WATT). Energy is expressed in kJ (kilojoule) or cal (kilocalories, kcal). *Conversion: 1*

kCal = 4,2 kJ. Power is dependent on cadence, or pedaling speed, which makes it possible to adjust the workload/power by increasing or decreasing cadence.

a. To get correct readings for calories and watts the kp value on the electronic meter has to be set to the same value as the workload that is the weight of the basket including the weights in it. The rubber plates are included in the calibrated weight of the 1 kg weight basket.
    i. For example, the workload is 3 kg (weight basket 0,1 kg + 2 x 1kg weight). Press the kp key to the left on the meter. The lower display window is now flashing and showing figures in kp. Increase or decrease in steps of 0.1 kp by pressing the *kp button (arrow up*) or the *RESET button (arrow down*) until the reading is corresponding with the actual or desired kp values (workload) from the weight basket. After that, press the CAL/WATT button to either show the CAL or WATT figures. Next, press the CAL/WATT button to either show the CAL or WATT figures. Refer to sample images below.
    ii. The watt readings in the display are dependent on cadence. The watts can accordingly be adjusted by increasing or decreasing cadence. Calories are calculated in real-time.

To activate any of the functions described above, press any key or move pedals.

Below are sample and images of the Fitness computer and a table outlining metrics the computer displays with corresponding units and ranges.



Display		
Pedal revolution (RPM)	0-250	rev./min.
HR	50-240	bpm
TIME	0:00-99:59	min:sec
SPEED	0-99	km/h
DISTANCE	0.0-99.9	km
FORCE	0.0-7.0	kp
Calories (CAL)	0-999	kcal
WATT	0 - 7 x rpm	watt

Heart rate

Using the Monark chest-strap heart rate belt researchers can monitor participant heart rate. This technology senses electrical output of the heart to compute heart rate. Properly fitting the chest-strap is integral to providing accurate readings.

Before harnessing the chest-strap, clean skin where the belt is to be placed. Additionally, electrodes on the backside of the strap shoulide be moistened with water or specialized gel. The chest-strap should be secured at a comfortable tension around the participant's sternum, see *Fig: Placement of chest belt* for visitation. The belt should be placed such that the word "Monark" is outward facing, upright, and centered on the participant's chest. In order to properly connect with the HR receiver on the bike, the strap should not exceed 100cm in distance from the receiver. It is especially important when first pairing the chest belt with the receiver, the two units are within 60cm of each other.

Figure: Placement of chest belt

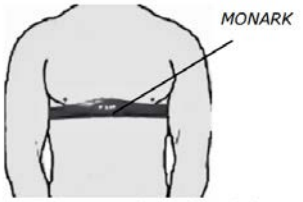


Fig: Placement of the chest belt

Wingate testing

When using this piece for wingate testing, resistance in the weight basket should be set at 0.075 kg per kilogram of the participant's body weight. When testing highly-trained athletes consider using a higher resistance, for example 1.0-1.3 kg per kilogram of participant body weight.

After the participant has completed a 3-5 minute warm up, the test should begin. After three seconds of all out pedaling, the brake cord is to be released, do so by letting go of cord. This will apply resistance to the system. The 30-seconds test allows for calculating the following variables:

1.) Peak power (PP), in watts
2.) Relative peak power (RPP), in W/kg
3.) Anaerobic fatigue (AF)
4.) Anaerobic capacity, in kilogram-Joules

Adjusting the brake cord/belt tension

Important note: To receive correct workload metrics, it is important to place the weight basket according to the description that follows. If the basket hangs too low, it may touch the flywheel. If the basket is too high, wrong workload information will be displayed.

First, check that the brake belt is lying correctly on the flywheel brake surface, see image 1 below for proper alignment. Next, put 4 kg in the weight basket (4), *see Fig: Brake device,* below. When rotating the flywheel by hand, or when pulling/releasing the brake cord, the basket should lift/drop between 40 mm and 60 mm. If this is not the case, the brake belt has to be loosened or tightened a little at the tension center.

Loosen the cord bracket (#2 in Figure Brake device) so that the cord length can be adjusted. If the basket is too low, shorten by tensioning the cord. Alternatively, if the basket is too high, lengthen the cord by easing tension.

To shorten or lengthen tension, turn the tension center (3) approximately 45 degrees, and make appropriate modifications to cord length. After that tighten the bracket again, and check that the distance between the weight basket and flywheel is between 40 and 60 mm when you pull on brake cord.

Image 1: Brake belt positioning on the flywheel

Fig: Brake cord

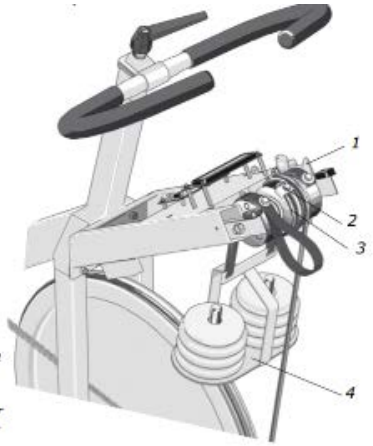


Fig: Brake device
1) Stop
2) Cord bracket
3) Tension center
4) Weight basket

Replacing the brake belt

If the brake belt needs to be replaced, loosen the brake cord and set the basket to its upper position. Loosen the lock washer that is holding the cord (#2) and remove it from the tension center. Loosen or cut off the knot on the other end of the cord and then remove the whole cord from the bike. When assembling a new brake cord, first enter one end into the hole in the tension center, and tie a knot and let the knot fall into the bigger part of the hole. Lock the end of the cord with the lock washer.

Sample Data sheet for Wingate Test

Time	RPM
0:05	
0:10	
0:15	
0:20	
0:25	
0:30	

4.3 General troubleshooting guide

Symptoms	Probable Cause / Corrective Action
The display is not working	• Check that the batteries are OK.
No heart rate	• Wet the thumbs and place them on the electrodes. A low clicking sound will appear near battery lid while you click on the electrodes with one thumb. • Check that the chest belt is positioned correctly on test person and tight enough. Check that the electrodes are wet, in difficult cases it is necessary to use a contact gel or a mixture of water with a few drops of washing-up liquid. The level for HR signal can vary from person to person. Put chest belt on another known person who has a good pulse rendering.
Uneven heart rate	• Use an external unit, for example a HR watch, to check if it also indicates an irregular pulse. If this is the case, there is probably disturbance in the room. Magnetic fields from high voltage cables, elevators, fluorescent tube etc. can cause the disturbance. Other electronic equipment could be placed too close. Move the bike to a different location in the room or change rooms. If an irregular HR remains it should be checked manually. If the HR remains irregular at work the person's health should be examined.
There is a click noise when pedalling (increases with the weight)	• The pedals are not tight. Tighten them or change pedals. • The crank is loose. Check, tighten. • The base bearing is loose. Contact your dealer for service.
Scratching sound is heard when pedalling	• Check that the carriage block is taken off and that none of the covers is scratching.
There is a click noise and a squeak noise when pedalling	• Loosen the chain.
Any problems with the computer software	• Send an email to the software developer HUR labs support: software@hur.fi

4.4 Maintenance Schedule:

Service action:

- Manufacturer suggest using isopropyl alcohol. Use a damp but, not wet cloth to clean the surface you wish to disinfect.
- Periodically wipe the surface with a rust preventative, especially when it has been cleaned and the surface is dry. This is done to protect the chrome and zinc parts as well as the painted parts (4 times per year).
- Check now and then that both pedals are firmly tightened. If not, the threading in the pedal arms will be damaged. Also, check that pedal arms are firmly tightened on the crank axle, tighten if necessary. When the Ergometer is new it is important to tighten the pedals after 5 hours of pedaling (4 times per year).
- Check that the pedal crank is secure to the crank axle (4 times per year).
- Be sure that the pedals are moving smoothly, and that pedal axle is clear of dirt and fibers (4 times per year).
- When cleaning and lubricating be sure to check that all screws and nuts are properly tightened (2 times per year).
- Check that the chain is snug and there is no play in the pedal crank (2 times per year).
- Check that pedals, chain and freewheel sprocket are lubricated (2 times per year).
- Be sure that the brake belt does not show significant signs of wear (2 times per year).
- Check that the handlebars and seat adjustment screws are lubricated (2 times per year).
- Be sure that all moving parts as crank and flywheel are working normal and that no abnormal play or sound exists. (I.e. play in bearings causes fast wearing and with that follows a highly reduced lifetime.)
- Check that the flywheel is placed in the center and with plane rotation.
- The crank and flywheel bearings are long term greased and do not require supplementary lubrication. If problem arises with crank or flywheel bearings, contact Monark dealer.
- Replace batteries if the computer is not on/seems to be producing incorrect measurements

4.5 Contacts

1.) Monark Exercise AB (Vabsbro, Sweeden)
+46(0)281 59 49 40

2.) Michael Busa – Core Director
413-577-0574
mbusa@umass.edu

Chapter 5: Velton Cycle Ergometer by Racermate

5.1 *Introduction*- The Velotron is a laboratory-grade cycle ergometer that delivers high accuracy and repeatability. Built with RacerMate's signature durability, enjoy the most realistic, science grade training experience on the world's most advanced cycle ergometer. Velotron is used worldwide by the finest universities, sports science labs, and coaching centers, often in conjunction with powerful Wingate software. The only bicycle ergometer ever approved for use in the USA Cycling National Talent Search, Velotron is also the ultimate cycling trainer.

The Velotron is equipped with a precision load generator, providing smooth virtual shifting- pedal through the gear shift, with no wait or friction. Secondly, the radical flywheel design allows for endless coasting for a true road feel, with a current drive powerful enough to deliver the widest spectrum of load resistance.

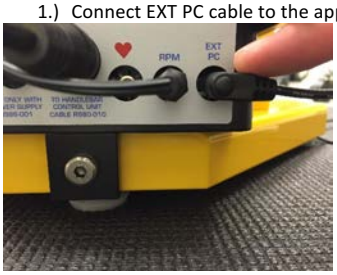
POWER GENERATOR 

FLYWHEEL 

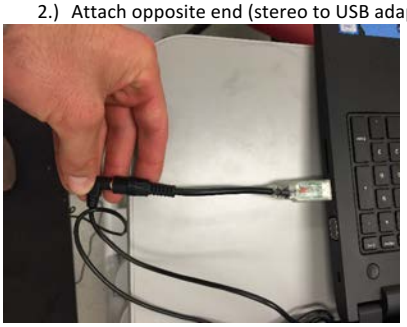
5.2 Core Competencies

Getting started with Velotron ***Coaching Software***

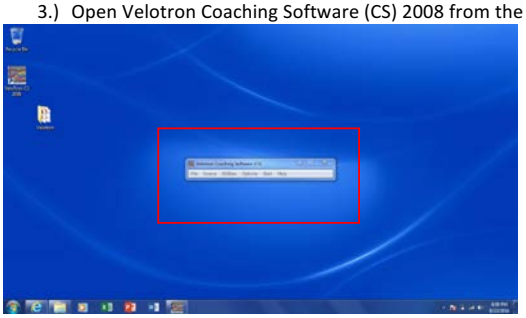
1.) Connect EXT PC cable to the appropriate spot on the back of the power generator



2.) Attach opposite end (stereo to USB adaptor) to USB on Exercise testing laptop



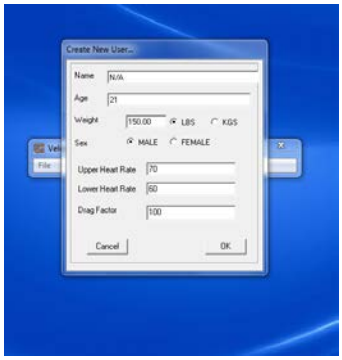
3.) Open Velotron Coaching Software (CS) 2008 from the start menu



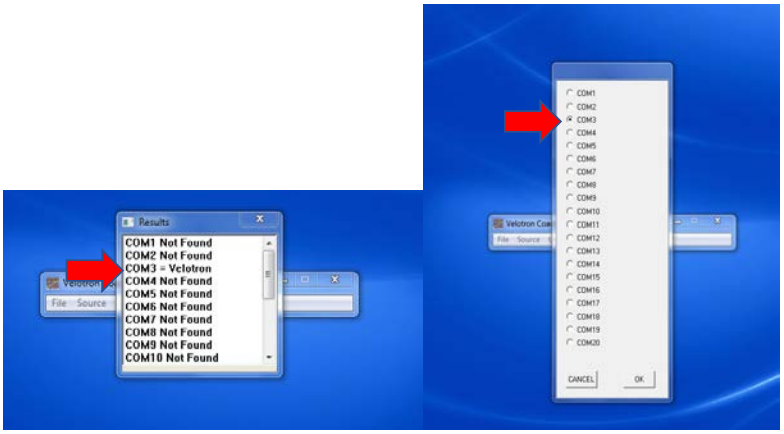
4.) Go to **Source** menu and select **Real-time**

5.) If this is your first use, select "**New**" on sub-directory of **Real-time** in **Source** menu

   a. Create a user data file, enter user information and save→**OK**. On subsequent uses select **Open** to choose this user file. If there is more than one user, create a User Data File for each person who will use the Velotron.



6.) Go to **Utilities** menu, select **"Comm Ports"** to determine what serial port Velotron is connected to. With this information, select **Source** - **Real-time** - **Comm Port** and verify the correct port found in the test has been set.



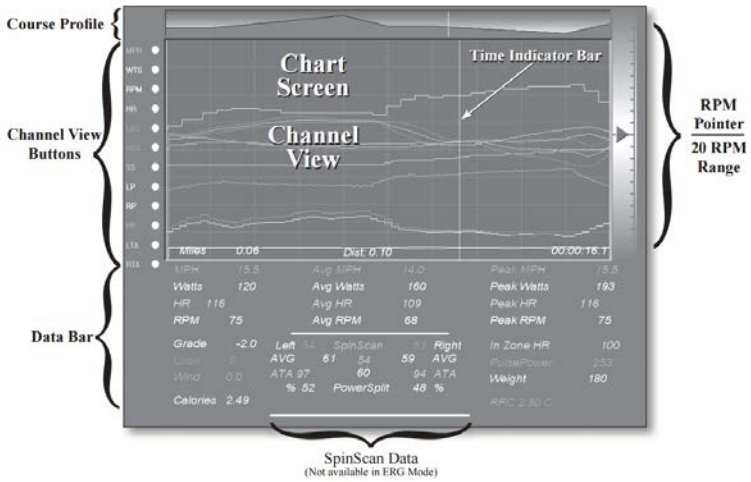
7.) Select the **Options** menu to setup your Manual Ergo settings, Screen Capture Options, Drag Factor™ settings, Reports, and decide whether you want to run the test in Miles Per Hour or Kilometers Per Hour.

8.) Select **Start,** then **Charts, Manual Ergo, Mode, or SpinScan.** By opening **Charts** a selection window for the courses or tests you want to use for your test will appear. Select a course from the "**Courses**" folder from the Velotron CS 2008 directory. Then click on **Open**, the Chart screen will appear with this selection.

9.) By selecting a course this will open the desired course in the **Charts Screen,** click the red or green buttons on the left-hand side of the chart window to enable or disable the various channels of data.

10.) Hit F1 on the Velotron Handlebar Controller to start the timer. The course or test will start.

11.) Below is a general overview of the chart features:



a. Full array of data taken directly from a Velotron saved performance file.
b. Current, Peak and Average display of data. HR zone % and PulsePower™, Gear and Gearing.
c. User selectable color graphs that correspond to the data section.
d. Time Indicator Bar to pinpoint exact time coordinates.
e. Course/program profile for Real Time use to indicate current position, or workload.
f. Multiple Zoom Levels in File Mode operation.
g. RPM zone pointer to help maintain a fixed RPM during any test. It is ideal for fixed wattage tests.

Concluding a test

1.) When you have completed your test, you can either reset the timer and run a new test, or save the performance data as a permanent record.
   a. At the conclusion of a known length test a dialog will appear asking you to **"Reset or Save."**
   b. If the test is open-ended you would press the **F5** (reset) button to prompt a **"Save, Reset, or Cancel"** (Cancel added in case you pressed **F5** by mistake). These questions can be answered using the Handlebar Controller keys shown in the dialog to eliminate having to dismount the bike

Saving/Viewing/Exporting a test

Performance files in CS are saved as .vel files. Vel file extensions are created whether the test was an ERG file, CRS file, or saved SpinScan session. The performance files will be saved with a User Name/ Course or test type/Date/Time.vel format.

1.) Press **RESET** after the completion of a test to display the "Do you want to save" dialog. Answer **Yes**.
2.) Using the Handlebar Keys, press **F1** to Save or **F2** not to save.

3.) Exporting the data. Saved Race Files from any Velotron PC program (available on your hard drive) can be exported as ASCII text files. This can be done automatically or manually. If you

always want an export performance files after a test (for use in 3rd party applications) check the AutoExport option in the **Export Options menu**. For manual export choose **File**, then select either the **Export** function or change the **Export Options** as needed (check-mark both ”short format” & “comma delimited” in the options if you plan to use these export files in a spreadsheet). You will be asked to select the original saved performance file. You can then browse to any folder where the file may reside. Once exported, these files have the same name as the original file, but with a new .txt file extension.

4.) To open a performance report, select **File, Open Report,** and navigate to the desired file and select.

Racer Mate®
Bicycle Training Technology for World Class Perfromance

PERFORMANCE REPORT
gpetrucci_test_report

Date/Time: 2016-8-23 21:25:06

Rider Data

Athlete: gpetrucci

Age: 22	Weight: 150	Gender: M
HR Limits	Lower: 60	Upper: 200

Course Data

Name: 1km.3dc	Distance: 0.54 Miles	Legs: 0
Units: English	Laps: 1	Lap Length: NA
Min Grade: 0.0%	Avg Grade: 0.9%	Max Grade: 15.0%
Min Wind 0.0 mph	Avg Wind: 0.0 mph	Max Wind: 0.0 mph
	Total Climbing Feet: 24.3	

Performance Statistics

Total Miles Ridden: 0.54	Drag Factor Setting: 100 %	Lap Avg: NA
	Finish Time: 00:04:23.88	Calories: 12.9

Item	Min	Avg	Max
Watts	0.0	56.8	163.2
Watts Per KiloGram	0.0	0.8	2.3
Heart Rate	0	0.0	0
MPH	0.0	7.4	14.9
RPM	0.0	72.9	141.1
Overall SpinScan	50.0	68.9	90.3
Left SpinScan	50.0	69.9	90.9
Right SpinScan	50.0	67.8	91.5
Power Split Left	-1.7	32.2	87.4

File Mode, viewing saved race files

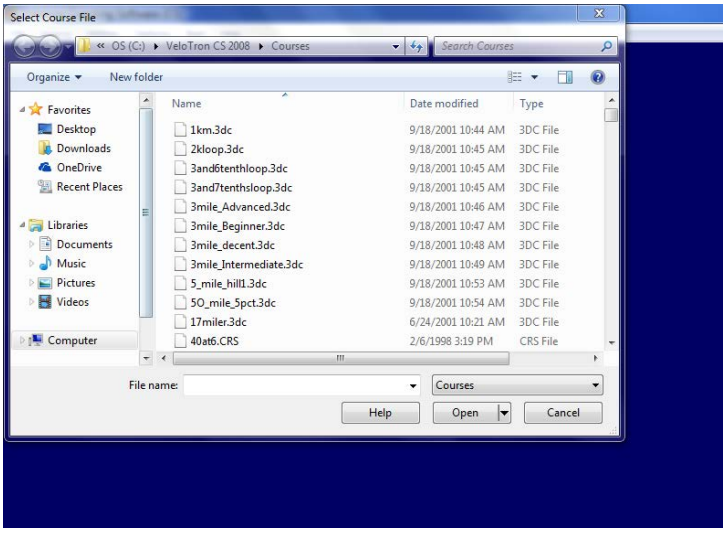
1.) Select “**Saved File**” from the **Source** menu.
2.) Select **Options** and check or uncheck **Metric** as desired.
3.) Select **Start**, then **Charts**, and you will be presented with a window where you can browse to any folder from the “Look In” drop down window to select a saved performance file. This will open in the background, therefore minimize CS 2008 and open this dialogue box. Once the file is found, highlight it and select **Open**. The chart screen will appear with the race data showing in it’s entirety. To open another file, press Ctrl - O.
4.) Click the red or green buttons on the left-hand side of the chart window to enable or disable the various channels of data.

5.) You can now move the mouse left and right over the data and zoom in and out with the left and right mouse buttons. Right-click your mouse for Full Zoom In, and scroll forward and back through the data by moving the Time Indicator Bar from the left-hand or right-hand side of the Chart Window, or establish a Zoom Window using the left/ right and up/down arrow keys of your PC keyboard and hit Enter to activate this level of zoom

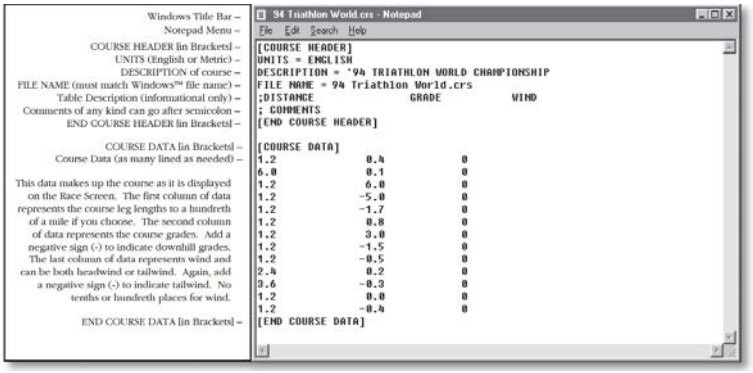
Creating a new course/program

Because course files must retain the format as shown in the image on the previous page, it is recommended to edit one of the preexisting courses when making a new course. This will almost guarantee a usable course every time.

1.) To create a new course from an existing course while in **Notepad**, first open a preexisting course.
   a. To open a preexisting course, open **Notepad** from the **Start** menu
   b. In **Notepad,** click **File,** then **Open**
   c. Navigate to **Velotron CS 2008** folder on the **C drive,** then open the **Courses** subdirectory
   d. By default Notepad looks only for "text files", but if you left-click on the down arrow in the "Files of type:" section and choose **"All Files (*.*)",** then all the files in this folder will appear. Select the course the you desire to amend and click **Open**



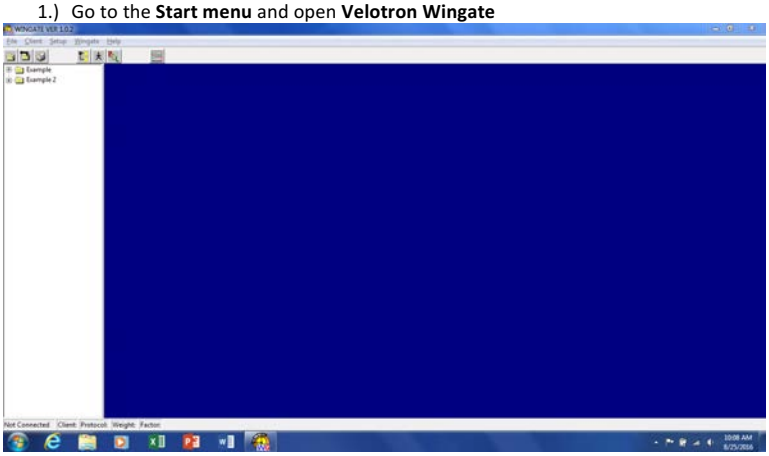
e. When the course you want to edit is open in Notepad, rename it by clicking **File**, **Save As**. Type a new name for this course and choose **All Files** (*.*) extension when saving new course.
f. Left click **Save** to make a "carbon copy" of, and close, the first opened course.
g. Now you can proceed with changes to make to your new course:
    i. Generally, to amend a course change parameters from the original course. Follow the formatting instructions outlined below:



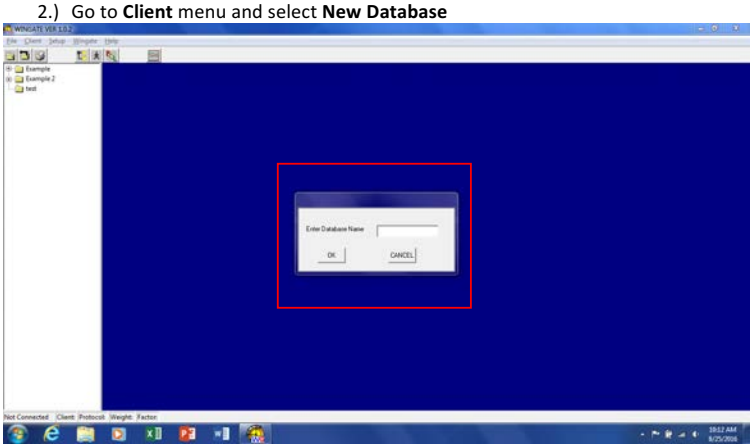
h. When finished editing, click **File/Save**.

5.3 *Getting started with Velotron* ***Wingate Software***

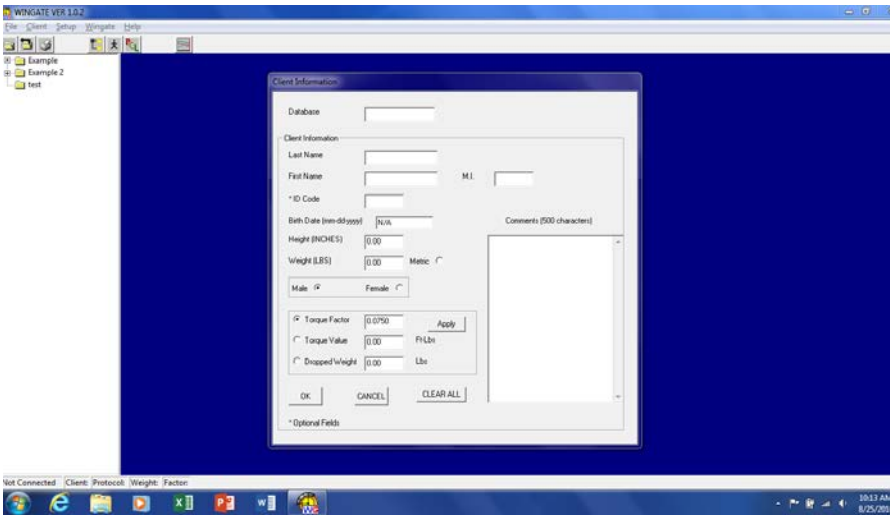
1.) Go to the **Start menu** and open **Velotron Wingate**



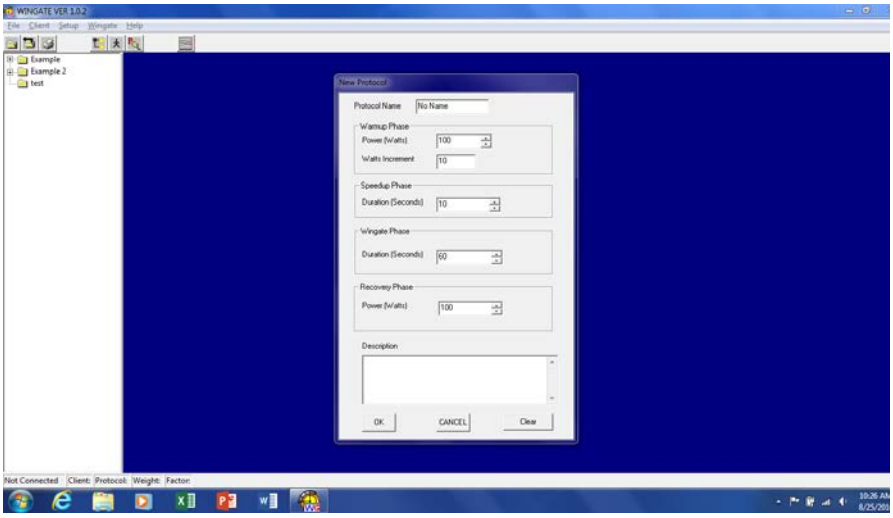
2.) Go to **Client** menu and select **New Database**



3.) Next, go to **Client** menu and select **New Client**
   a. Enter the database that you want data to be saved to, enter subject antropometric measures and apply one of the following: 1.) torque factor, 2.) Torque value, 3.) Dropped weight
   b. **OK** to save



4.) Now, go to **Wingate** menu, and select **Create new protocol**
   a. Create a name for protocol and edit testing parameters
   b. **Ok** to save to desired pathway. Suggested to save in client data folder

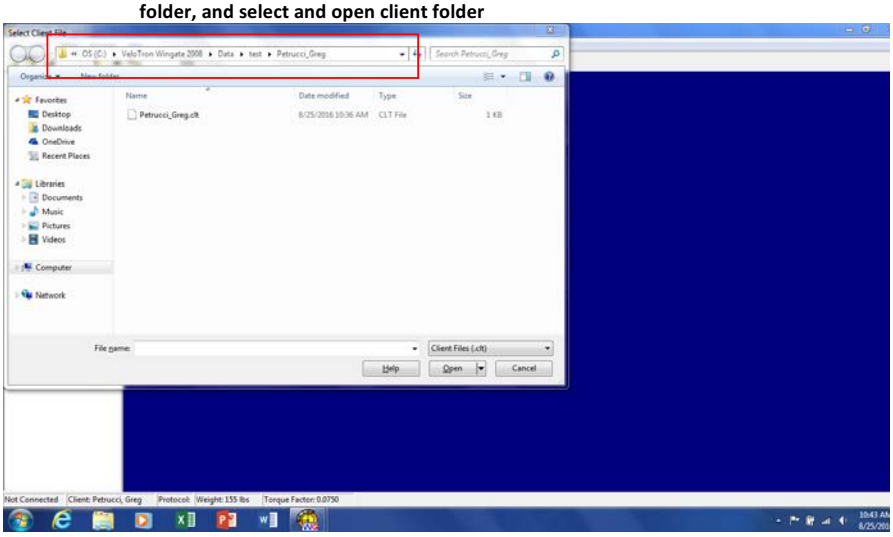


5.) Select **Wingate** menu and click **Graph Scaling.** Edit Watts and HR/ Cadence Scaling

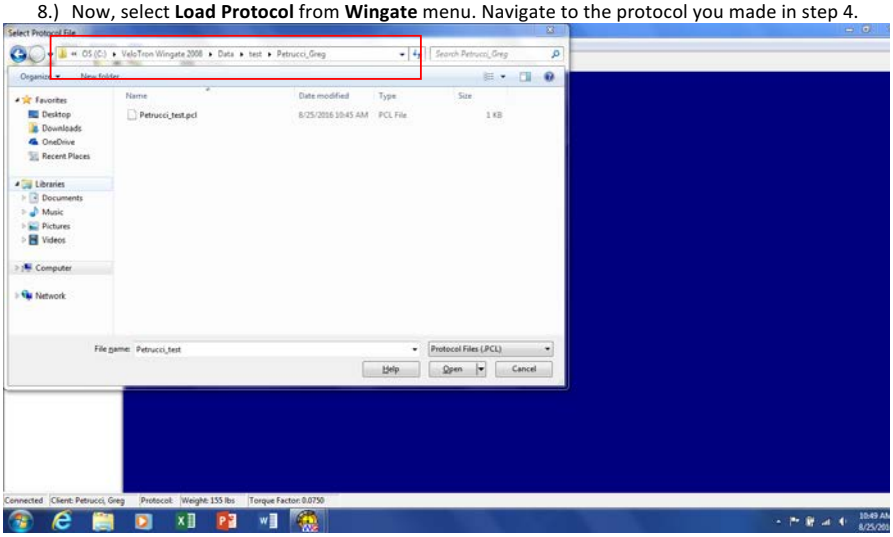
6.) Check that Velotron is plugged in to computer (see above). Select **Setup** menu and click run **Test Comm Ports.** Note which Comm in connected to Velotron. Click **OK**. Next, click **Setup** menu, and select **Comm Port**, verify that this setting matches **Test Comm Ports results**. See above section for images.

7.) Go to **Client** menu, select **Load Client** and navigate to client data.

   a. **Go to C-drive, VeloTron Wingate 2008 folder, data folder, select your desired database folder, and select and open client folder**

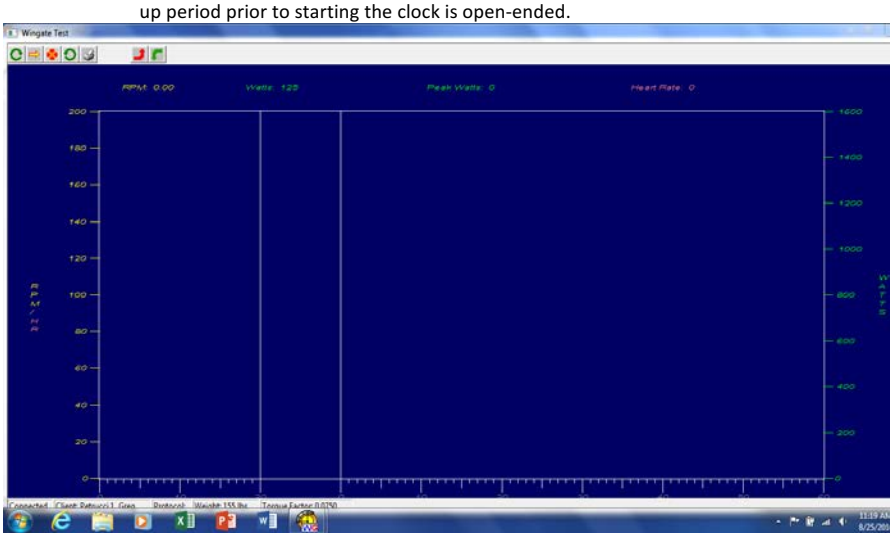


8.) Now, select **Load Protocol** from **Wingate** menu. Navigate to the protocol you made in step 4.



9.) Next, go to **Wingate** menu and click **Run Wingate**

a. The Velotron is now is "Warm-up mode." The client can warm-up using the preselected load -or- by using the Up/Down buttons on the Wingate Screen or those on the Velotron Handlebar Controller adjust the workload to suit the warm-up requirements. Due to x-axis scaling limitations there is only about 20 seconds of warm-up shown, but the warm-up period prior to starting the clock is open-ended.



10.) When you are ready to begin the test, select the **Start Wingate** button, the first icon on the toolbar

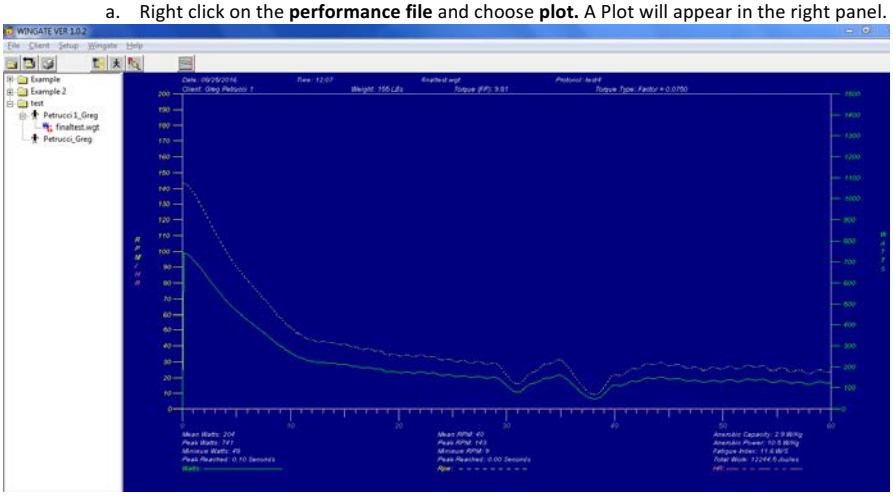
START

a. The warm-up phase that you selected will begin, then a red countdown timer will appear in the upper right hand corner, indicating when the load will be applied
b. At the end of the test a plot of the client's performance will appear. Click the **Reset** button, fourth button from the left on the toolbar. Select the pathway where you like to save the performance. Suggested saving location is the original client data folder

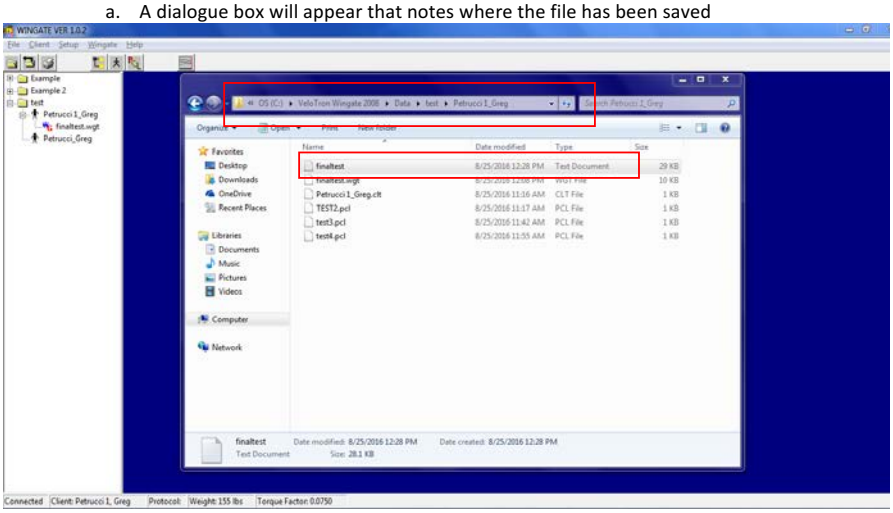
RESET

File mode, viewing and exporting saved data

1.) Return to the Wingate software homepage
2.) To view data in file mode, in the Tree-view diagram on the right side of the page select your **database**, then **client**, and finally the **client performance file**
    a. Right click on the **performance file** and choose **plot.** A Plot will appear in the right panel.



3.) To export data, return to the tree-view diagram and right click, but select **export**.
   a. A dialogue box will appear that notes where the file has been saved



   b. The program will export the performance file in comma separated text format into the same database folder the original performance file was found. The file will have the same file name, but with a TXT file extension. These files can be used Microsoft excel.

5.4 Contacts

1.) Velotron forums: https://www.racermateinc.com/help-center-faq/
2.) Michael Busa – Core Director
    413-577-0574
    mbusa@umass.edu

Chapter 6: Quinton-55 EKG Stress System

6.1. *Introduction*- Importance of Electrocardiograms

As the heart is a muscular pump comprised of four chambers, it requires electrical stimulation to control the muscular contractions and flow of blood throughout the body. An electrocardiogram is a method typically used to assess electrical conduction in the heart. This simple non-invasive test allows to check for normal rhythms, rates and proper conduction of electrical impulse throughout the cardiac tissue. This manual will allow a researcher to understand and utilize the EKG system in order to obtain EKG's for medical interpretation. For all subjects >70 years of age or if a subject has ≥2 cardiovascular risk factors, an EKG must be completed prior to beginning exercise protocols.

6.2 EKG Settings

Unless specifically requested otherwise, EKGs should be run with the following standard settings:

Paper Speed: 25 mm/sec
Calibration Standard: 1mV = 10mm
Rhythm Lead: Default Lead II

6.2.1 Skin Prep

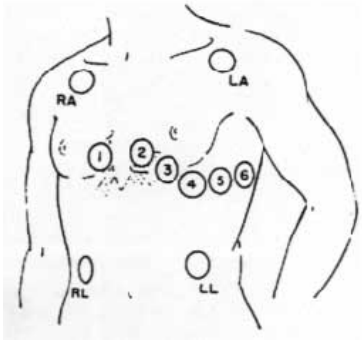
Patients with excessive chest hair should be shaved at the electrode site. Abrade these areas with fine sandpaper or an abrasive pad, and then clean with alcohol-saturated gauze. Allow the skin to air dry before placing electrodes. Be sure the subject does not have any jewelry that could interfere with the tracings (necklaces, piercings etc.).

6.3 Limb Lead Placement

RA (White) – Right Arm electrode is placed on a distal portion of the right lateral side of the upper arm below the shoulder.
LA (Black) – Left Arm electrode is placed on a distal portion of the left lateral side of the upper arm below the shoulder.
RL (Green) – Right Leg electrode is placed on the inside calf, midway between knee and ankle.
LL (Red) – Left Leg electrode is placed on the inside calf, midway between knee and ankle.

6.4 Precordial Lead Placement

V1 (COLOR) – 4th intercostal place at the right margin of the sternum.
V2 (COLOR) – 4th intercostal place at the left margin of the sternum.
V3 (COLOR) – Midway between V2 and V4 (on top of the 5th rib).
V4 (COLOR) – 5th intercostal place at the left mid-clavicular line.
V5 (COLOR) – At the horizontal level of V4, at the left anterior line.
V6 (COLOR) – At the horizontal level of V4, at the mid-axillary line.



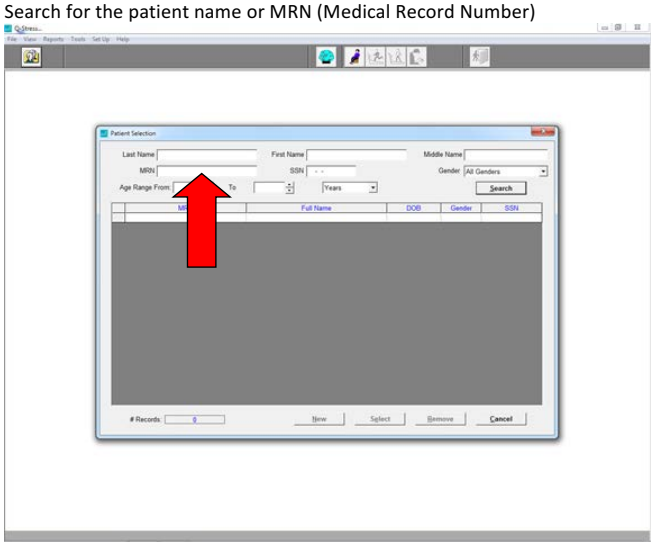
NOTE: Lead placement does affect the EKG waveform. When the limb leads are placed on the torso, waveform changes might be seen in the QRS amplitude, axis shift occurs, Q waves can be seen, and T waves might appear flipped or flattened. These changes are clinically significant in that they are associated with cardiac ischemia. If a non-standard lead placement is used, note the variation in the EKG comment field.

6.5 Inputting a New Patient

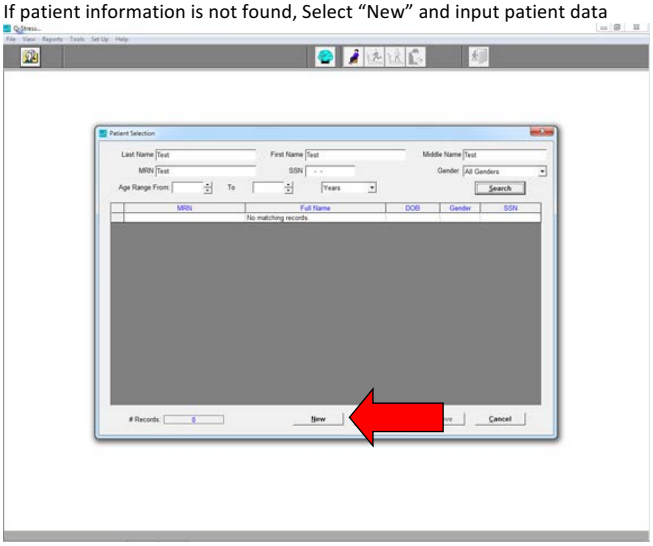
a. To initialize the Q-stress program, click on the icon on the desktop

b. To first search for previous patients, click the patient icon

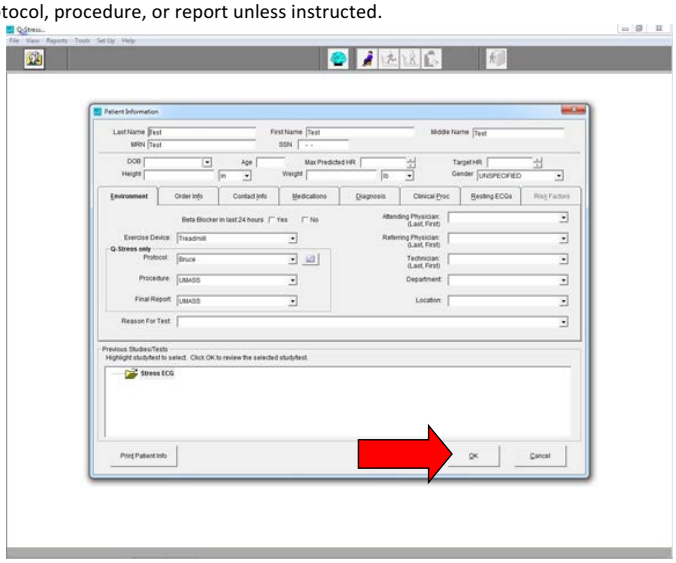
c. Search for the patient name or MRN (Medical Record Number)



d. If patient information is not found, Select “New” and input patient data

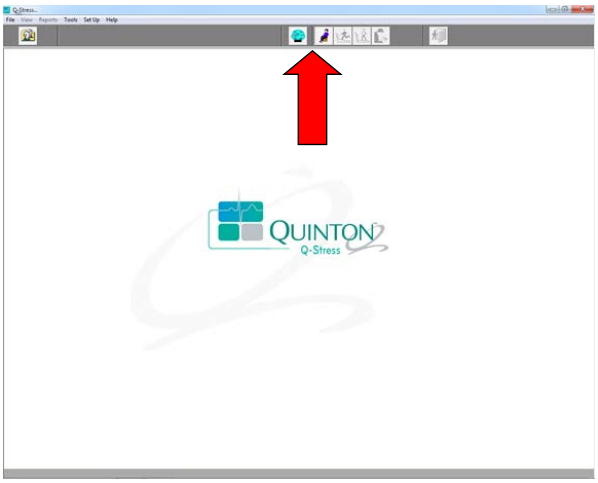


e. The following screen will allow you to enter all possible demographic information. Click OK when completed to complete the data entry. Also note there should be no changes made to protocol, procedure, or report unless instructed.

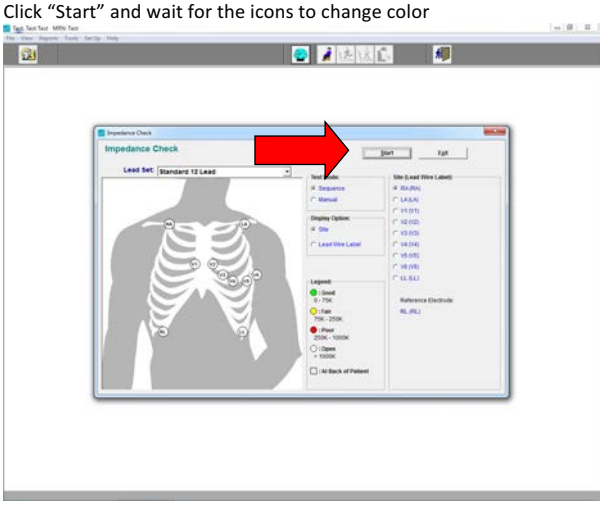


6.6 Check Lead Placement and Artifact

a. After patient data is complete, click on the light blue icon to check lead placement and connections.



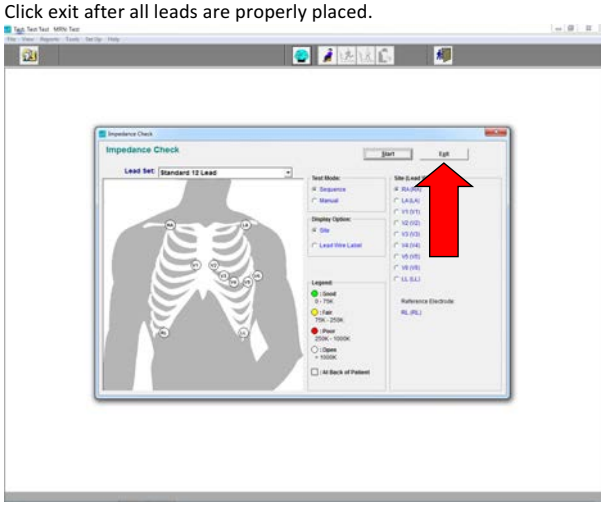
b. Click “Start” and wait for the icons to change color



NOTE: Leads should be in the “good” range

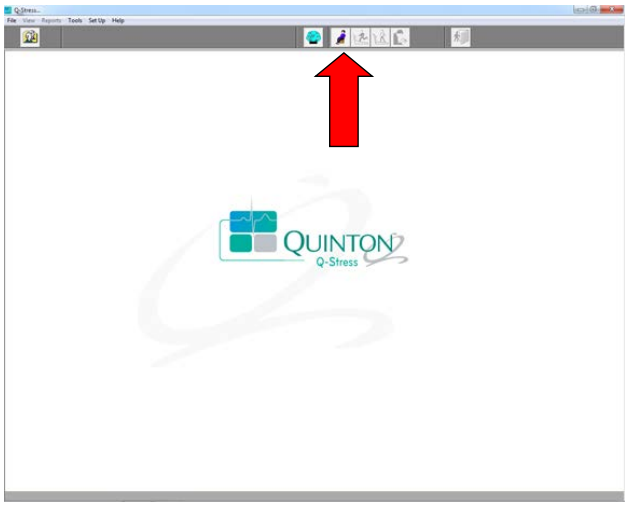
c. If Leads are not within acceptable “good” range, remove leads and prep the electrode sites again

d. Click exit after all leads are properly placed.

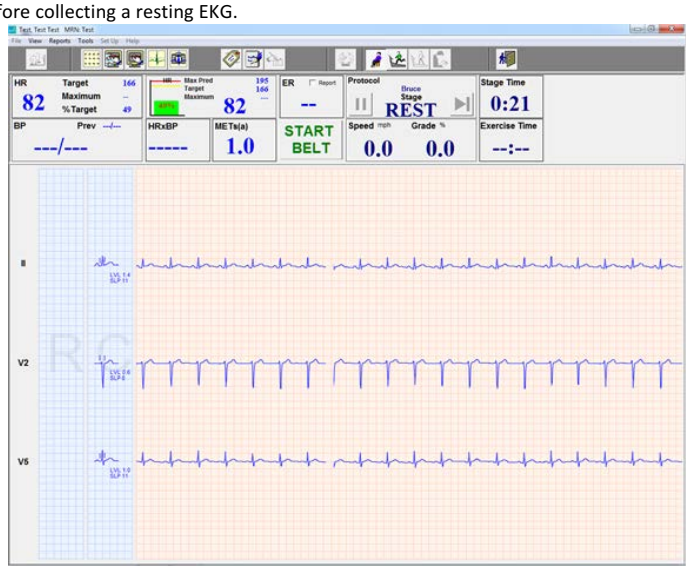


6.7 Baseline Waveform

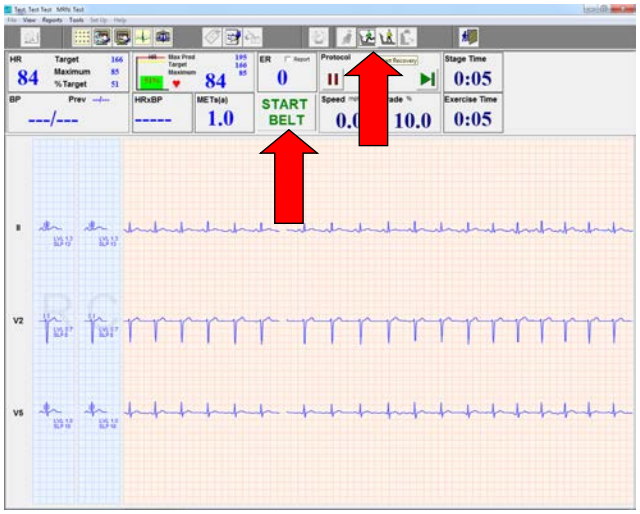
a. After the leads are placed and the patient data is input, click on the rest icon to begin resting waveforms.



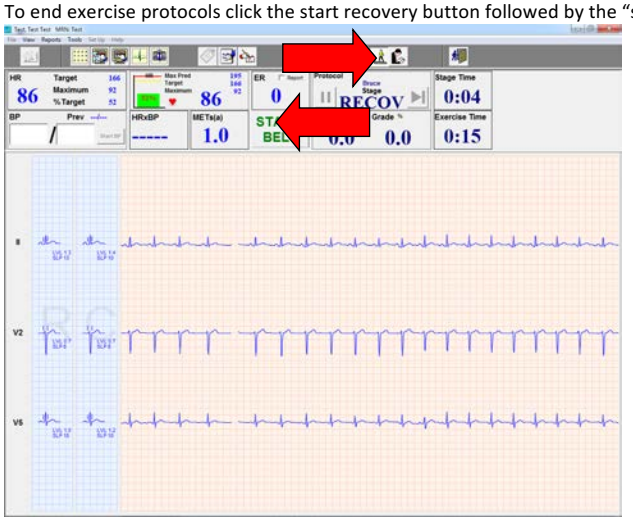
b. The screen will begin to display heart rate and EKG waveforms. Allows about 10 seconds to pass before collecting a resting EKG.



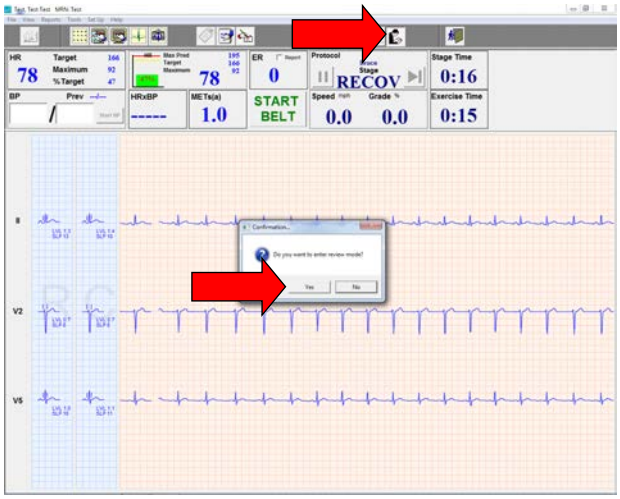
c. Press F5 to print out a full 12-lead resting EKG
d. Press F6 to print the current 3-lead screen
e. To begin exercise protocols click on the “start belt” icon followed by the start exercise button



f. To end exercise protocols click the start recovery button followed by the “stop belt” button

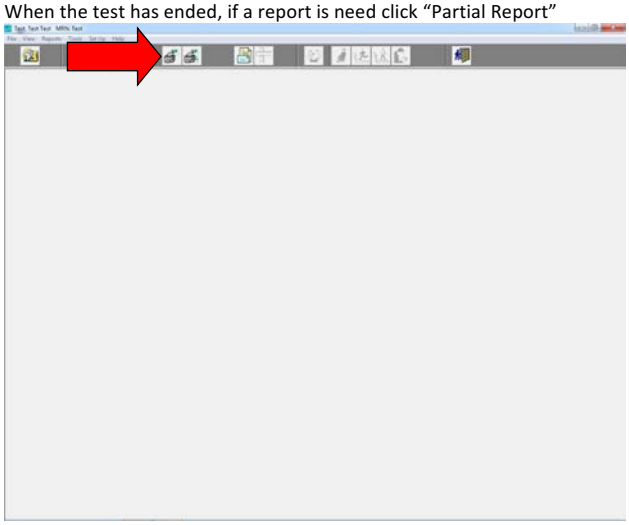


g. To review the collect EKGs click the review tab and click “Yes”



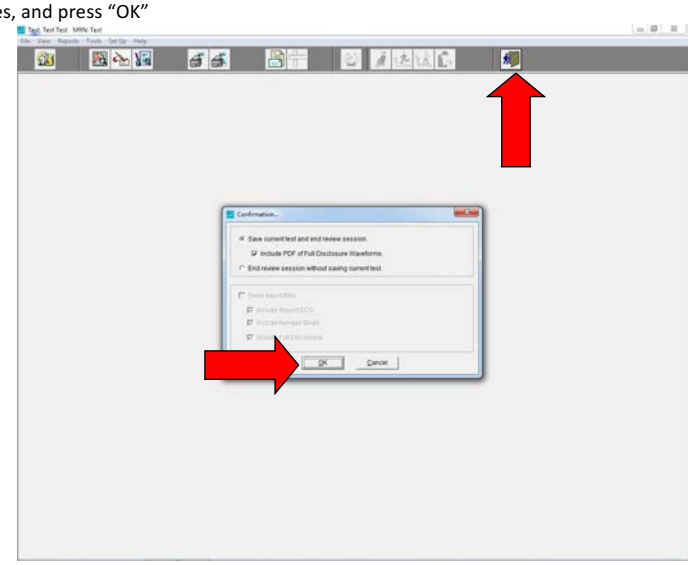
h. Click yes when entering review mode. This will end the test.

i. When the test has ended, if a report is need click “Partial Report”

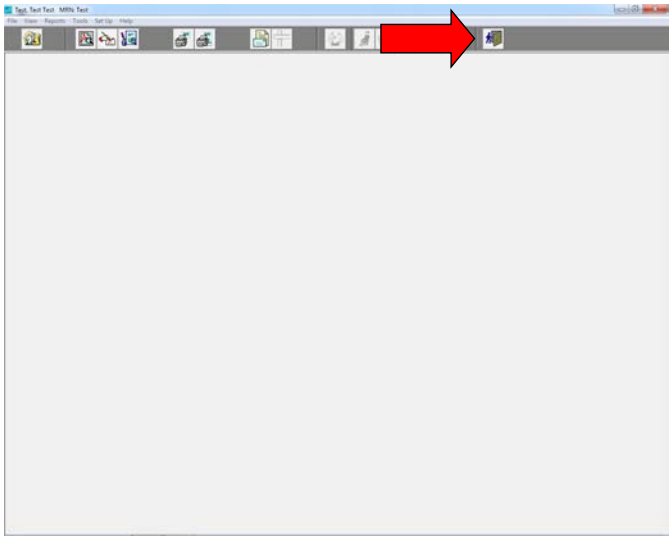


This will print a summary report of the procedure

j. When finished reviewing, click “Exit” to save the test. When prompted, be sure PDF is clicked yes, and press “OK”



k. To exit current patient, press “Exit” again



After obtaining a baseline waveform, the EKG should be interpreted by a medical professional. The interpretation will be completed by either a certified clinical exercise physiologist (CCEP) or medical doctor (MD) within the department.

An exercise physiologist may interpret the baseline waveforms with some restriction. If the EKG is determined to be satisfactory and without contraindications to exercise, the exercise portion will resume without referral from the medical doctor. However, if the exercise physiologist determines that the baseline waveform is questionable in any way (based on current ACSM recommendations to exercise), the medical doctor should be consulted to verify the EKG. The doctor will then determine whether or not to proceed with testing. Questionable baseline EKG's can include but are not limited to: frequent ectopy, abnormal heart rates (<40bpm or >100bpm at rest), ST segment abnormalities <2mm depression or conduction delays.

Subjects with significant abnormalities will be excluded from the study. Significant EKG abnormalities may include but are not limited to: dysrhythmias, electronically paced rhythms, conduction blocks, >1mm ST segment elevations or >2mm ST segment depressions.

6.8 Exercise Protocols

As there is no continuous EKG monitoring during CADENCE-Adults, protocol is not significant when collecting EKG's. EKG will be an "as needed" procedure to ensure safety.

6.9 Follow-Up

If at any time during testing protocols, a subject becomes dizzy, lightheaded or complains of chest pain, a follow-up EKG should be performed along with blood pressures. Interpretation of the EKG should be immediately referred to the Exercise Physiologist or MD on site.

6.10 Cleaning

All wires and connections should be wipes with disinfecting wipes. Used electrodes should be thrown away. The treadmill and any other equipment associated with the test should be thoroughly cleaned between participants with alcohol wipes.

Chapter X:

Biodex System 4 Pro Dynamometer

Turning things on:

1. Make sure the Biodex is plugged in.

2. Turn on the main power switch (located on the bottom left of the back of the Biodex cart) by flipping it from O to I.

3. Turn on the power for the computer and dynamometer (green switches on the bottom right of the back of the Biodex cart) by flipping them from O to I.

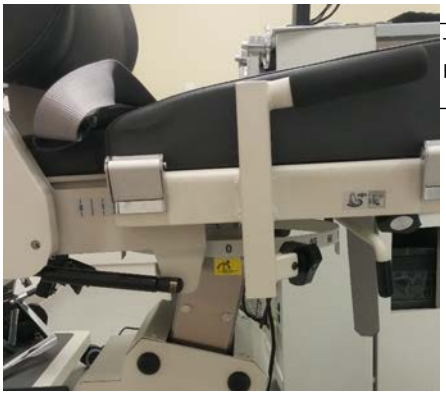
4. Turn on the computer tower.

Basics of setting up the Biodex

The dynamometer and the Biodex chair can be translated in space side to side and vertically and rotated. The following images point out how to move the chair and dynamometer.

Comfort stop button. Pushing this button will immediately stop a test and exit out of testing mode. Use as a kill switch only.

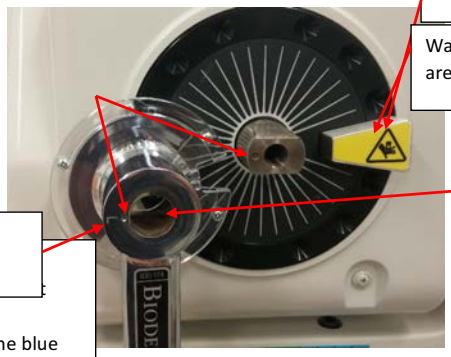
Tilt the dynamometer head by loosening this knob.



This knob is used to tilt the seat back

This lever is used to rotate the seat

Watch out, fingers/hands are crushable!



Attachments without a nut on them will use the attachment handle stored on the dynamometer head (see above)

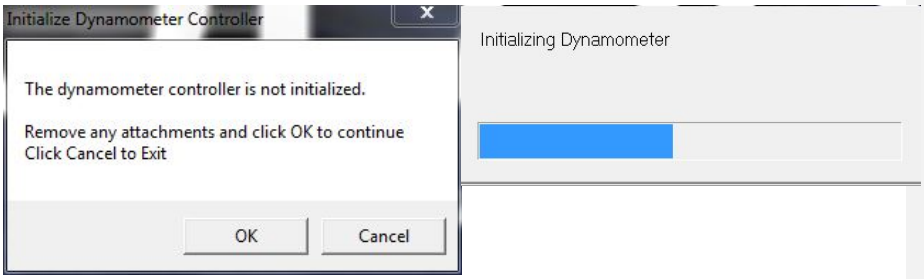
Letter corresponds to side (left/right) you're testing

align. You can rotate the dynamometer dot using the blue buttons on the dynamometer head

Running a Test in Biodex Advantage:

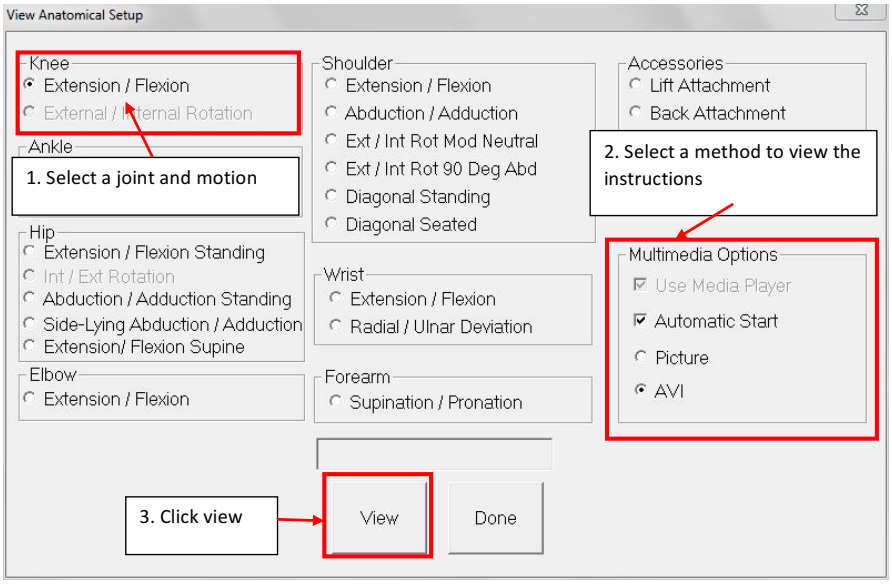
These instructions will take you through running a test on the Biodex. If you wish to use the Exercise or Biofeedback modes, please see the instructions in the Biodex user manual or help documentation.

1. When the computer boots up, it will ask you to initialize the dynamometer. Remove any attachments (the attachment post will rotate) and click OK. The dynamometer will then initialize.

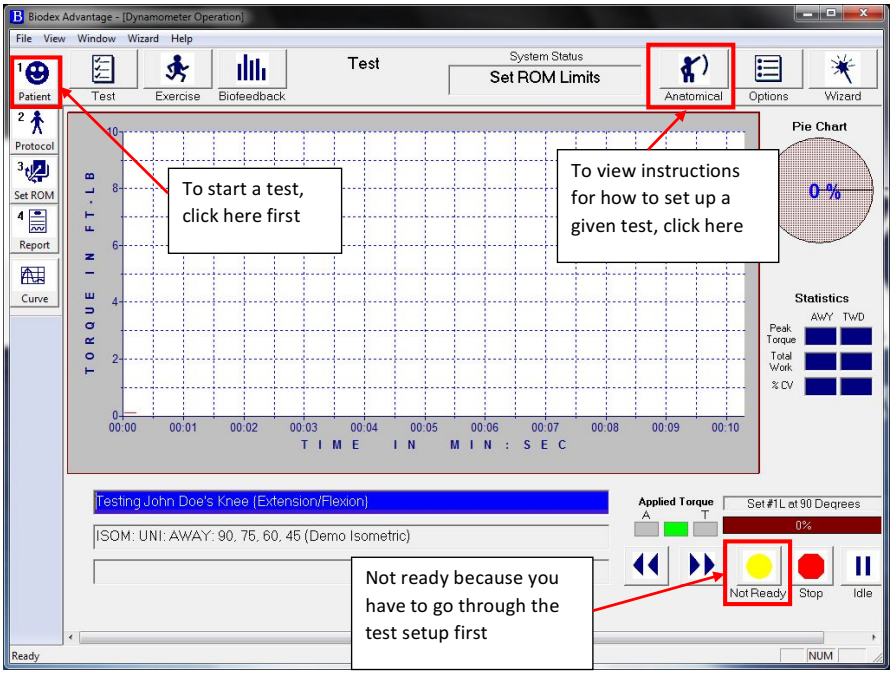


2. Biodex Advantage usually boots up to the last test that was run.

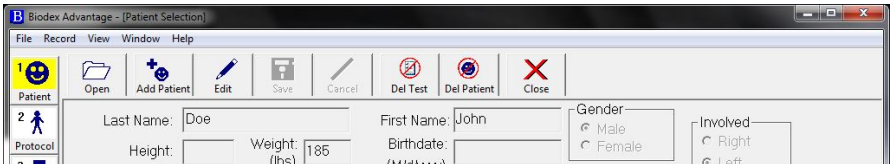
    A. If you need to see how to set up the biodex attachments for a given test, click the "Anatomical" button. In the window that pops up, you can select the joint and joint motion you're testing to see a video of how to set up the machine.

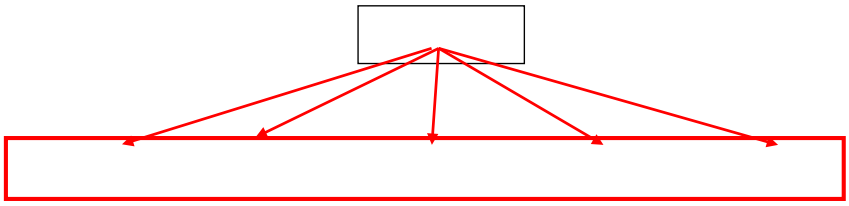


B. Before starting a new test you need to load a "patient" and select a protocol. Follow the buttons on the left from 1-4. As you go through the steps, the active window will be yellow.

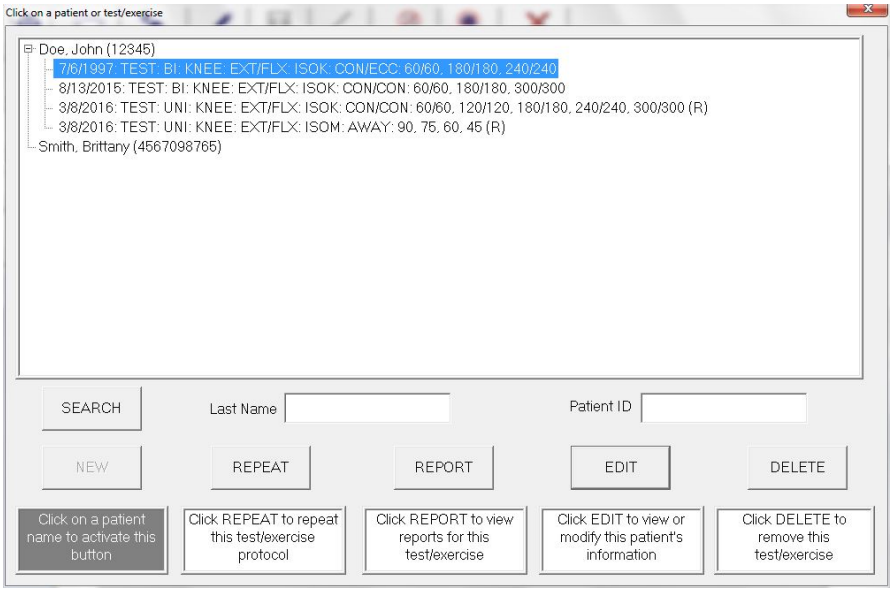


3. The Patient window gives you options to open an existing patient, add a patient, or edit an open patient.

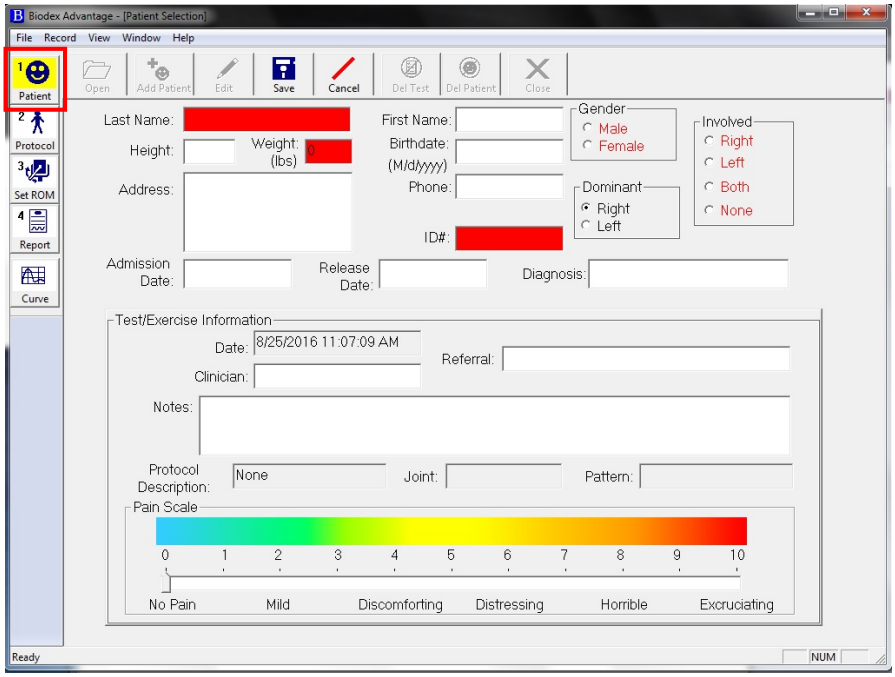




A. If you click “Open,” you can see a list of existing entries and select one to create a new testing session for. If you select a patient from this list, you can begin a new test by clicking the “NEW” button or EDIT the patient’s information. If a patient has existing tests, you can REPEAT one of these, print a report for an existing test, or DELETE an existing test.

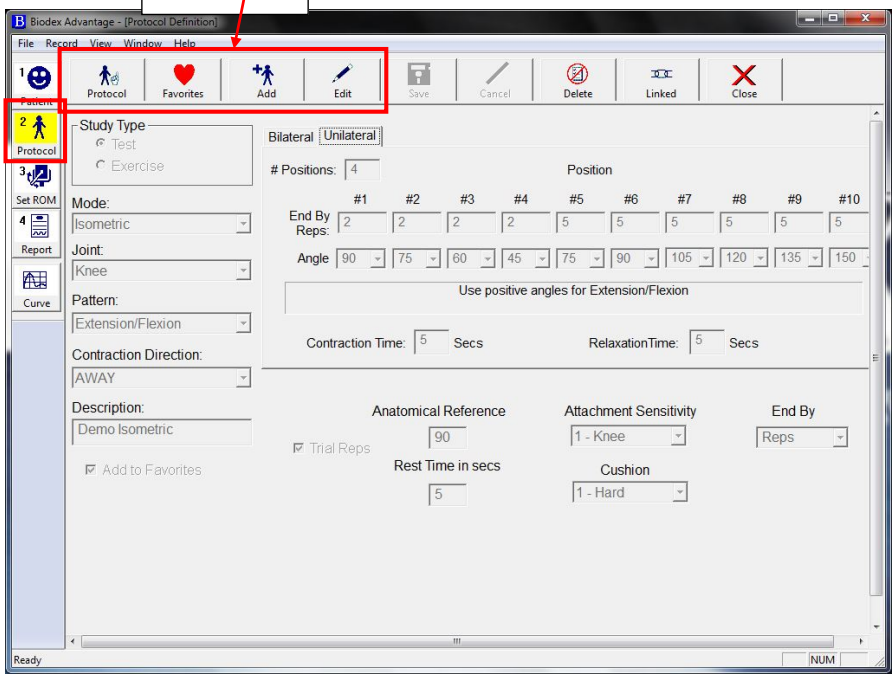


B. If you click “Add Patient,” the window will change to the view below. At minimum, you must fill out any information boxes that are in red. **NOTE:** Personal identifying information should *never* be entered into the Biodex software. Only enter study participant IDs into name fields. *Never* enter names, birthdates, age, address, phone number, or other information that could identify an individual. Weight and gender are required by Biodex and can be entered.



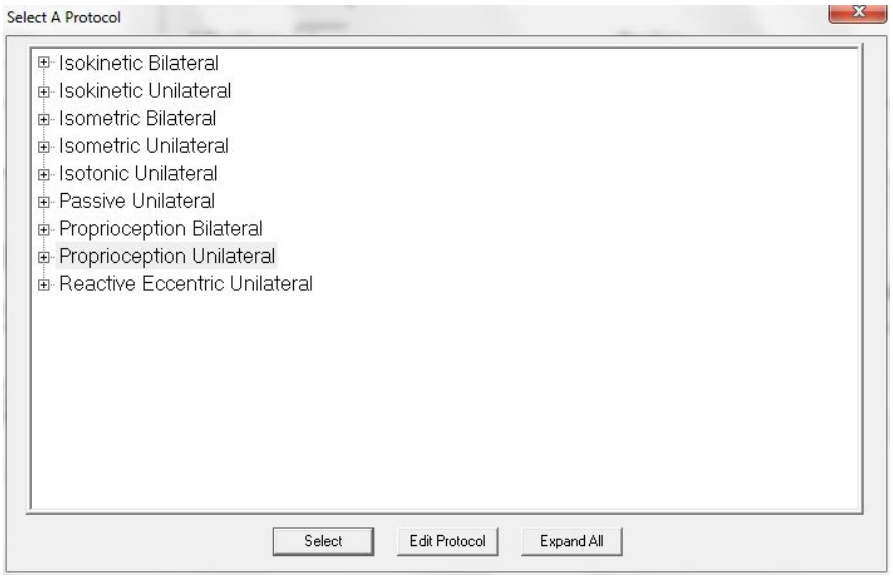
C. After entering all necessary patient information, click “Save,” and then click on “Protocol.”

4. Here you can Option buttons a protocol, or edit a selected protocol.



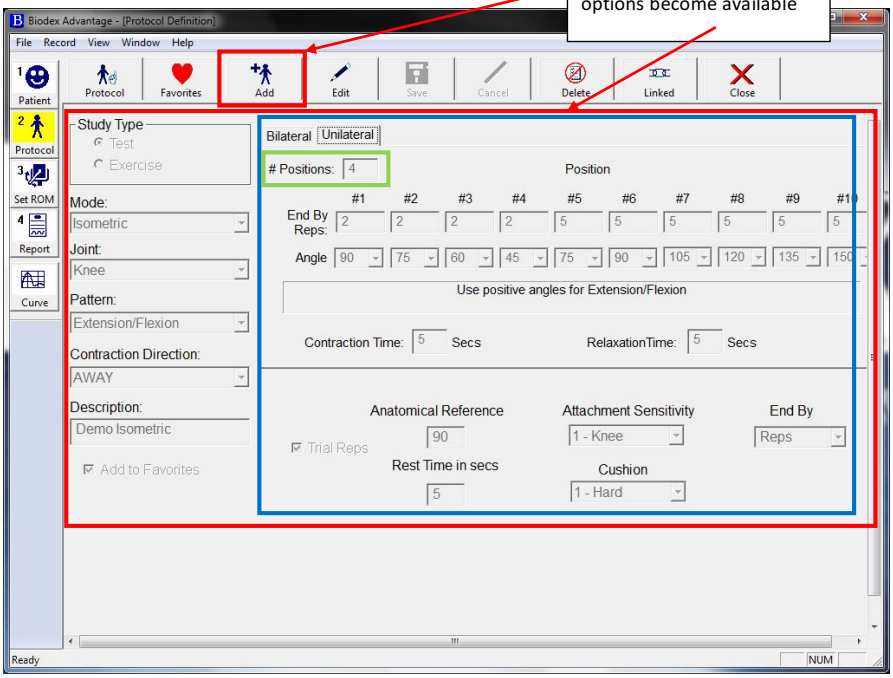
A. If you click the 

button, the following window will pop up. Here you can view built-in or previously designed testing protocols.



B. If you want to create a new protocol, click the 

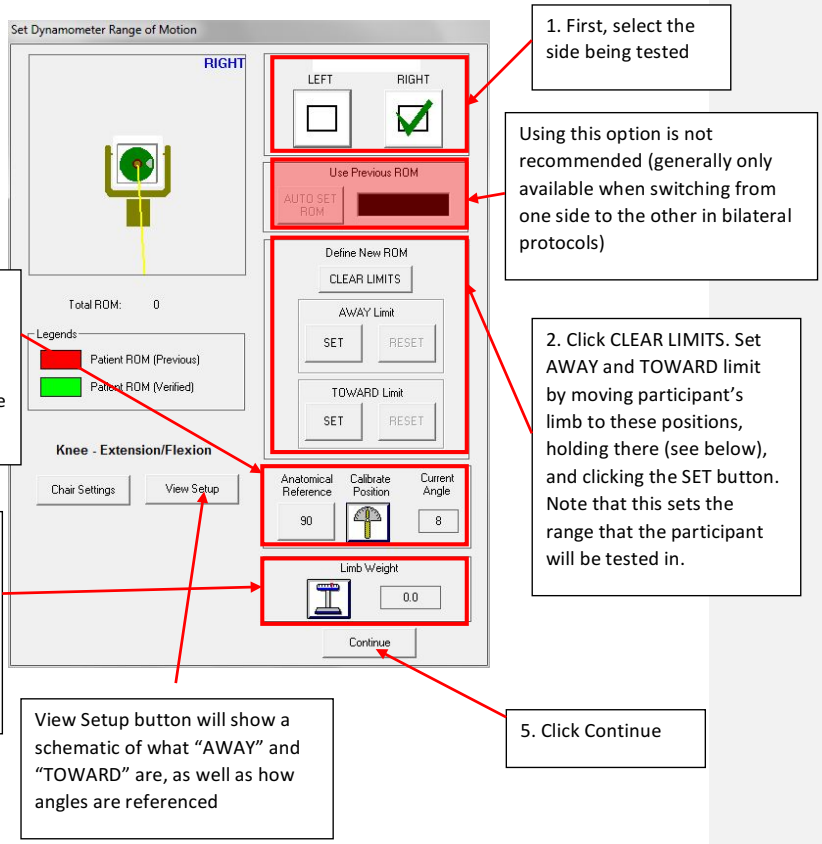
button. This will activate the editable portions of the protocol pane.



i. Depending on the "Study Type" and "Mode" options you choose, the other options in the blue box above will change. For example, if you change from Isometric mode to Isokinetic mode, instead of "# Positions," the green box will be labeled "# Sets."

5. After you select a protocol, click on the “Set ROM” button. At this point, the chair and dynamometer should be in position, the correct attachment should be on the dynamometer, and the participant should be seated and strapped in.

A. Below is the “Set ROM” window. Follow the blinking red text through each step.



1. First, select the side being tested

Using this option is not recommended (generally only available when switching from one side to the other in bilateral protocols)

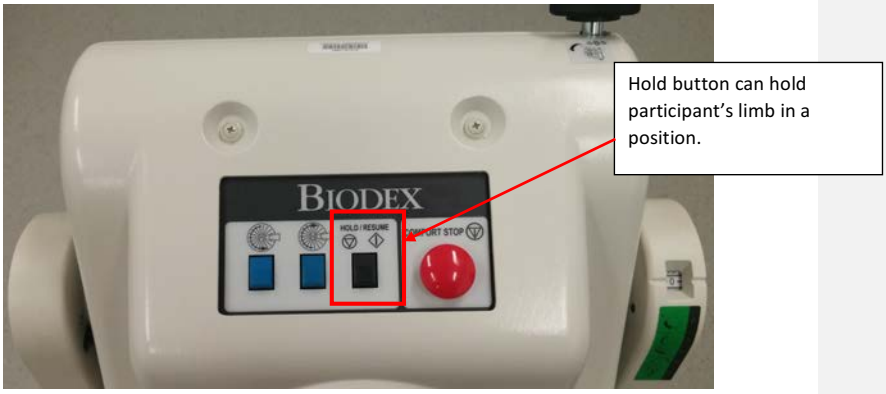
2. Click CLEAR LIMITS. Set AWAY and TOWARD limit by moving participant’s limb to these positions, holding there (see below), and clicking the SET button. Note that this sets the range that the participant will be tested in.

3. Move limb to Anatomical Reference position, hold there, and click the Calibrate Position button. Anatomical Reference can be changed by clicking on the button that reads “90” here.

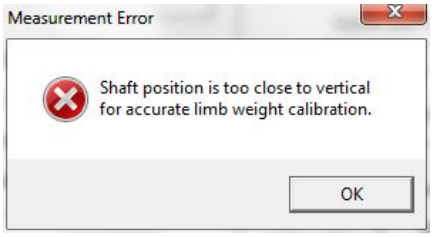
4. Move limb to AWAY limit, hold there (using hold button), have participant completely relax limb, and click the Limb Weight button. If you get an error on this, see text below in i.

View Setup button will show a schematic of what “AWAY” and “TOWARD” are, as well as how angles are referenced

5. Click Continue



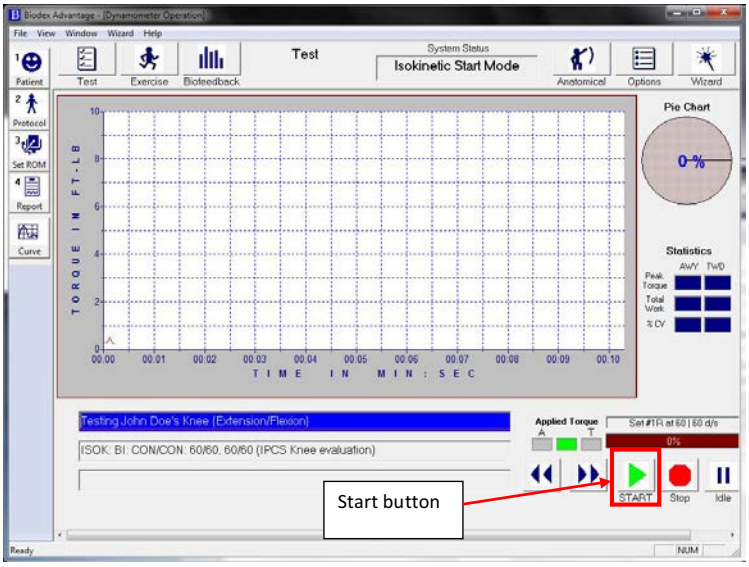
i. Clicking "Limb Weight" may give the following error:



ii. If this occurs and the limb was weighed at the AWAY limit, you will need to increase the AWAY limit, move the limb to this position, and weigh again. If the AWAY limit is already at the participant's limit for the given test.

6. After hitting "Continue" in the Set ROM window, the program will move on to testing. The program will switch to the following window and wait there until you hit START. If Start is not an option, it means you missed something between step 3 and this step. When you are ready to begin your test, click START.

A. If you want to change the visualization for a test (e.g., bar graph instead of line), click on the options  button.

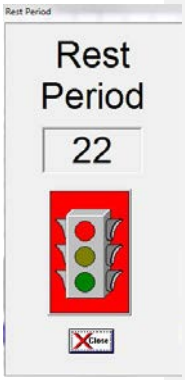


B. First, a trial reps window will appear. Here, the participant can practice the motion and speed of the test before the program starts collecting data. When you're ready to start the real reps/sets, have the participant hold their limb in the start position (usually TOWARD limit).

C. Once the participant holds at the start position for a sufficient time, the test will begin. You will see this window:

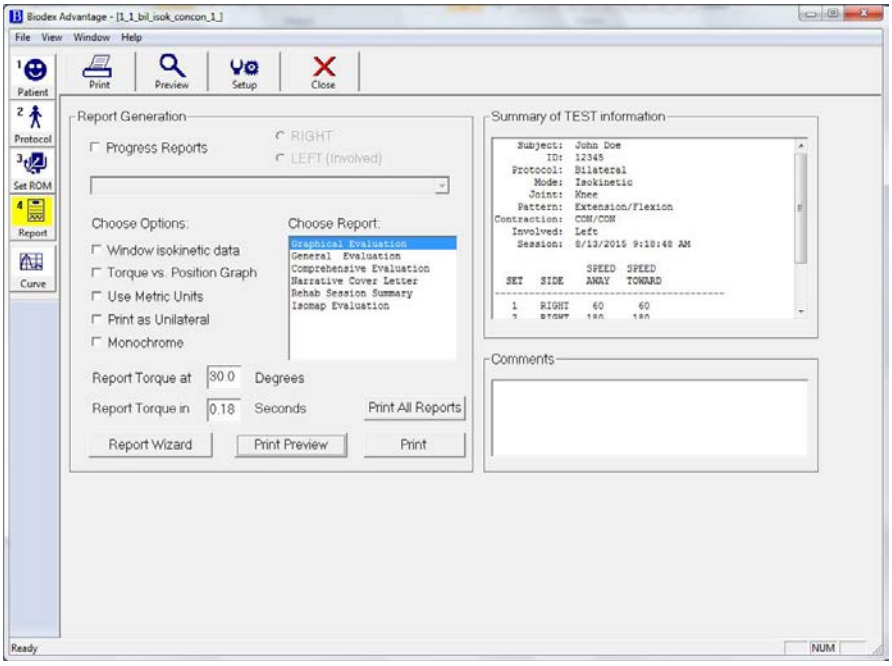
D. Once the test begins, you will see real-time data of the torque the participant is generating, as well as progress through the current set via the Pie Chart.

E. During rest periods between sets or sections of a protocol, the window to the right will count down to the next set.



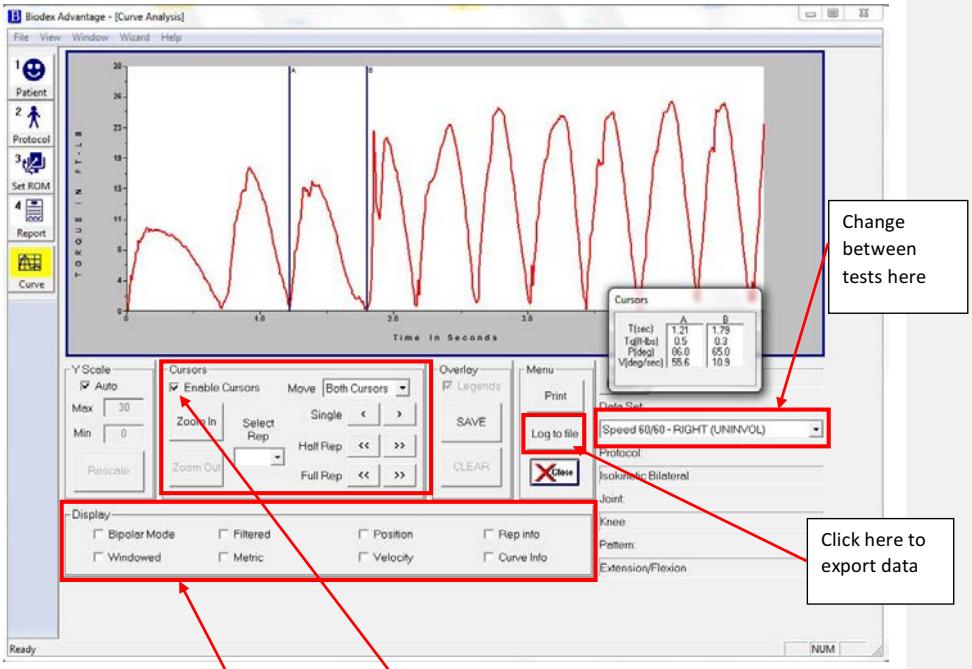
7. When a test is done, you can click on the Report button or the Curve button to view results.

A. The report window gives options for generating standard reports. This is an easy way to give participants feedback on their performance. Here you can preview a report or print a report. If you will not be printing a report and all tests are complete, the testing session is over.



B. To analyze results in Biodex Advantage or export data to an ASCII format, click on the Curve button.

i. There are many options for real-time analysis in the curve window. These are pointed out below.



Change between tests here

Click here to export data

Options for adjusting graph display and performing some real-time analysis. We do not recommend using the "Filtered" option except for demonstration purposes

Enable cursors (blue lines in graph above) and use buttons here to select ranges of data

ii. Data exported from the Curve window can be taken off the computer on a USB drive and analyzed using other software (e.g., MatLab, Excel).

MANUAL OF PROCEDURES

Human Motion Core

Institute of Applied Life Sciences

Life Science Laboratories S360

240 Thatcher Road,

Amherst, MA 01003

at the

University of Massachusetts, Amherst

Chapter 1

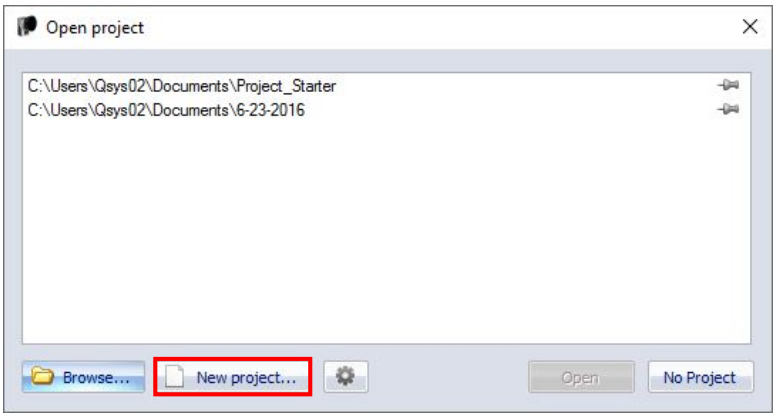
Qualisys Oqus 700+/500+ w/ AMTI Force Platform integration

Chapter 1.1 - Creating a New Project in QTM

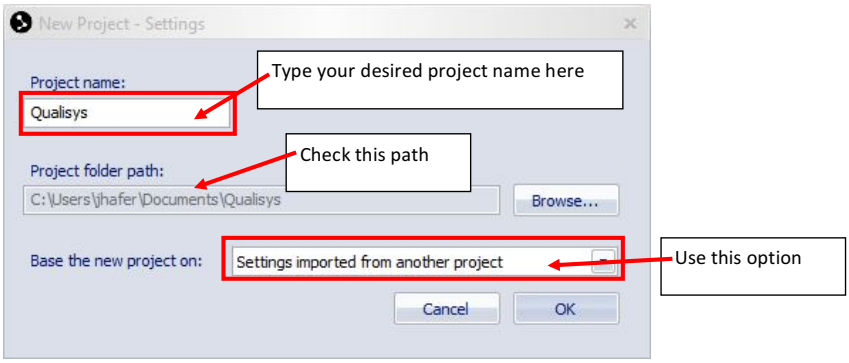
When beginning a new study you will need to create a new project in QTM. This process ensures that you don't inadvertently alter another study's project settings and also creates a designated directory for your study's data.

1. First, open QTM

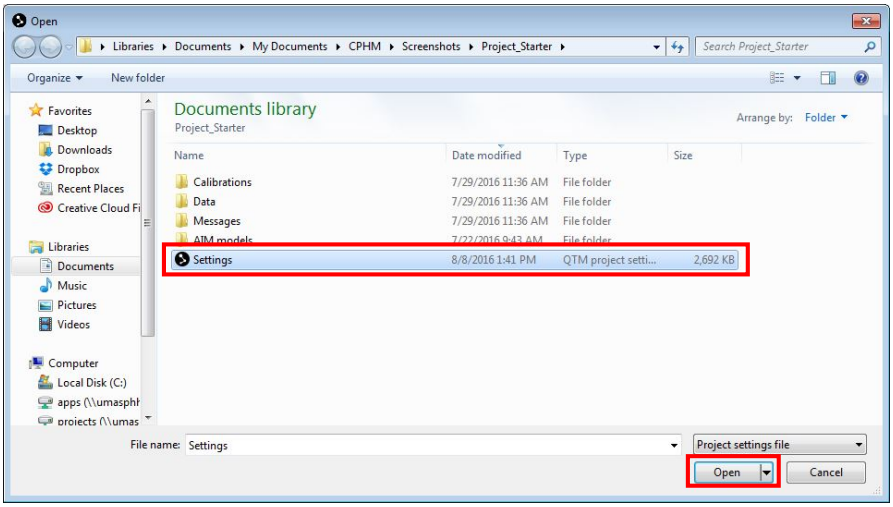
2. A window displaying current projects will pop up when you open QTM. When creating a new project, click "New project…"



3. The following window will pop up. In "Project name:" type the name of your study or the name you would like to be applied to your directory. Note that when you change this name, the end of the "Project folder path:" will change. If you would like the project folder to be located somewhere other than where is indicated by the "Project folder path:" you can browse to that location using the "Browse…" button. When your name and path are set, select "Settings imported from another project" and hit "OK."

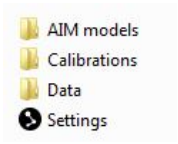


4. Another dialog window will open asking you to select a "Settings" file to base your new project on. Navigate to C:\Users\Qsys02\Documents\Project_Starter and select the "Settings" file found there. These project settings have been created specifically to act as a starting point for new projects.



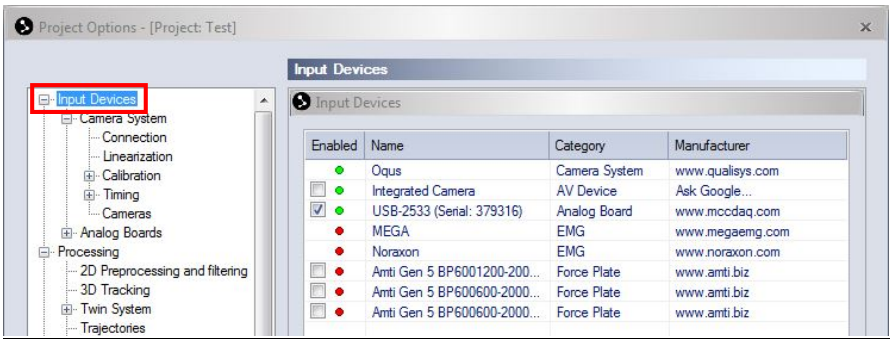
5. After clicking “Open,” QTM should start up. Ensure that you are in your new project by checking the top bar on the QTM window. It should now read [Project: *Your project name*]

Additionally, there should now be a folder at the path you previously designated that has the following folders/files in it:

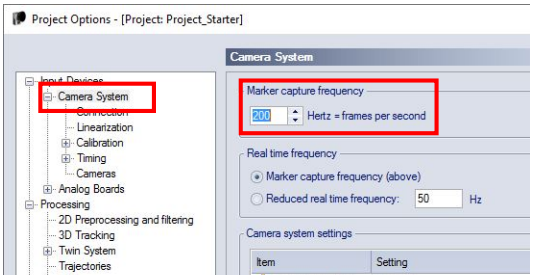


6. After verifying that your new project has been created correctly, you can begin changing settings. To do this, first click on the project options button. There are several project settings that you may wish to change (NOTE: after any change is made, you must hit “Apply”). This section in this manual is not all-encompassing; for further details see the online Qualisys user manual section “Project options” by clicking Help > Help topics.

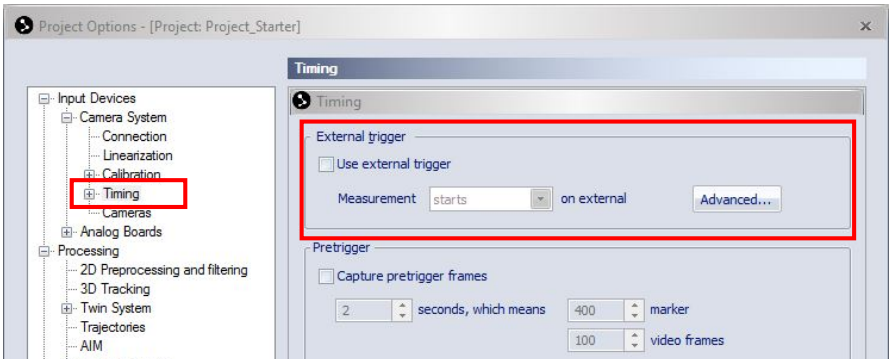
Input Devices. Here you can change which devices you will be collecting with. Oqus cameras cannot be disabled, but in this setting window you can select or disable forceplate collection (USB-2533) and EMG inputs (MEGA, Noraxon).



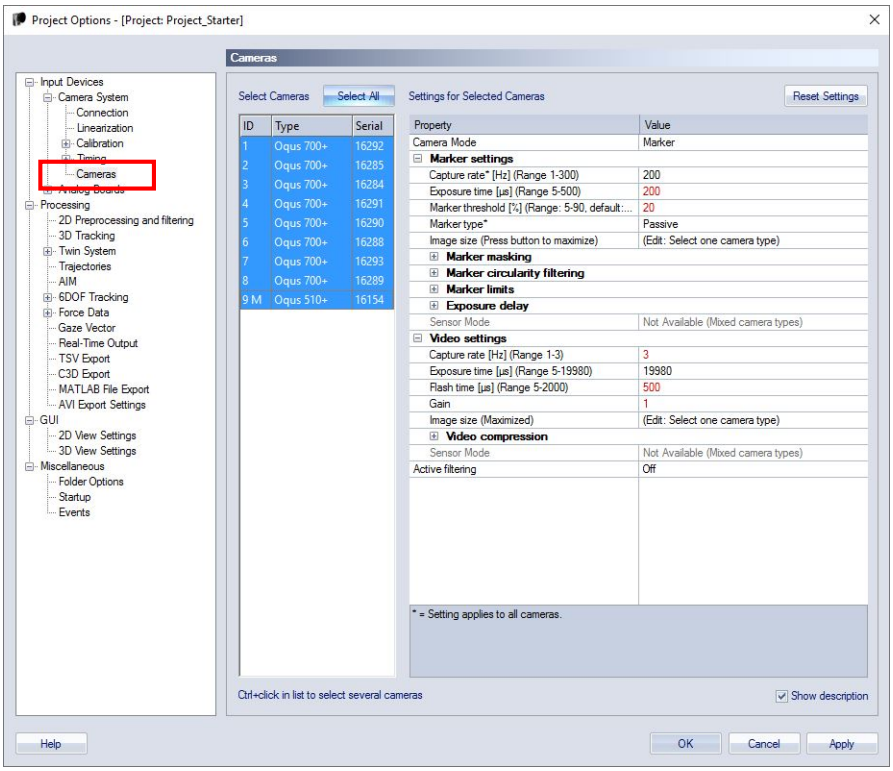
Marker capture frequency. Change this number to adjust how many frames of marker data are collected per second. Capture frequency needed depends on speed of movement being captured.



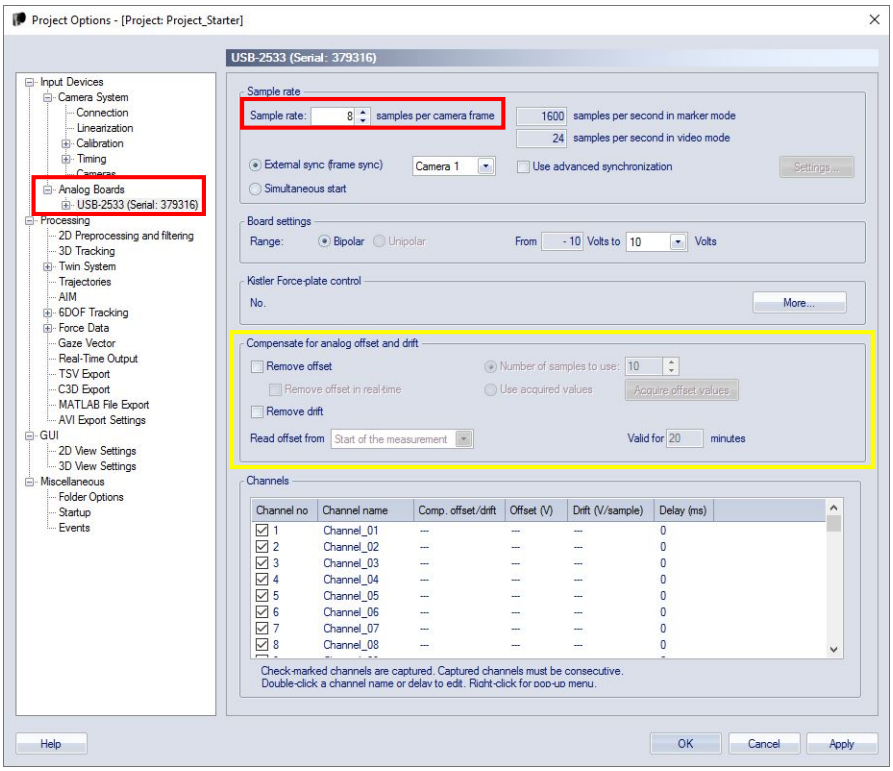
Timing options. Use these settings to activate an external trigger. This may be desired if you are synchronizing multiple data acquisition softwares (e.g., QTM and EMG software) or if you wish to trigger a data capture from in the collection space instead of from the computer.



Camera settings. In this tab you can adjust capture settings for individual cameras. Note that you can adjust settings for multiple cameras at a time by holding Ctrl while clicking on camera numbers or you can adjust each camera individually. In general, camera settings should not need to be changed. Instances when they may need to be adjusted include the use of a device in the capture space that is very shiny or very small or very large markers. If you wish to change camera settings it is recommended that you read the Qualisys help topics.



Analog settings. Here you can change the capture rate for any analog devices you include in your project. Sample rates must be a multiple of the camera frame rate and can be changed in the box outlined below. There are also settings here for removing offset from analog data (yellow box). Use caution if activating these options as the software offset removal assumes that there is nothing on the forceplates when it removes any baseline offset, a feature that may be problematic if someone happens to cross over a forceplate during the offset removal.



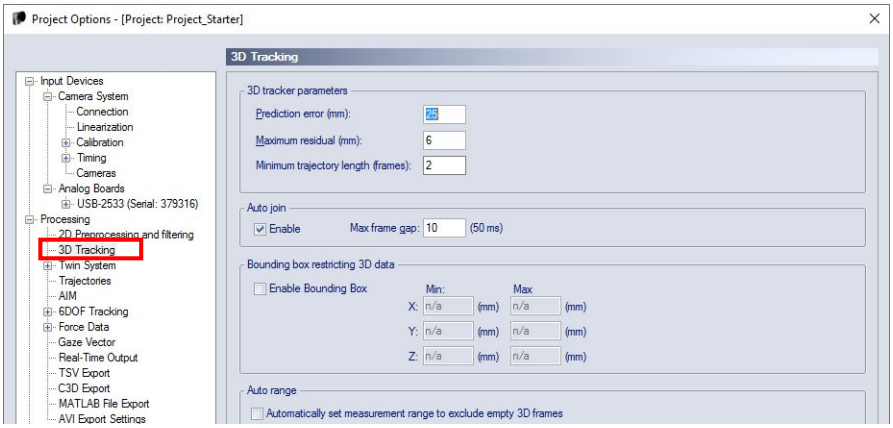
3D tracking. Here you can adjust settings for error tolerance in 3D marker tracking.

"Prediction error" is the maximum distance between a marker's predicted location and the captured location of the marker. If the captured location is outside of this predicted location, the software will not reconstruct it. Increase this value to increase the tolerance in reconstruction.

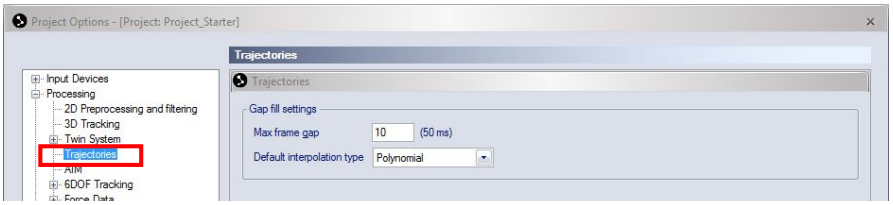
"Maximum residual" is the maximum deviation in camera 2D views of a marker that can be converged into a single marker trajectory. Qualisys recommends that this value be 2-5 times the average residual values from the calibration results.

"Minimum trajectory length" is the minimum number of frames of data to create a trajectory. Data seen for fewer frames will not be assigned to a trajectory. The minimum value for this option is 2.

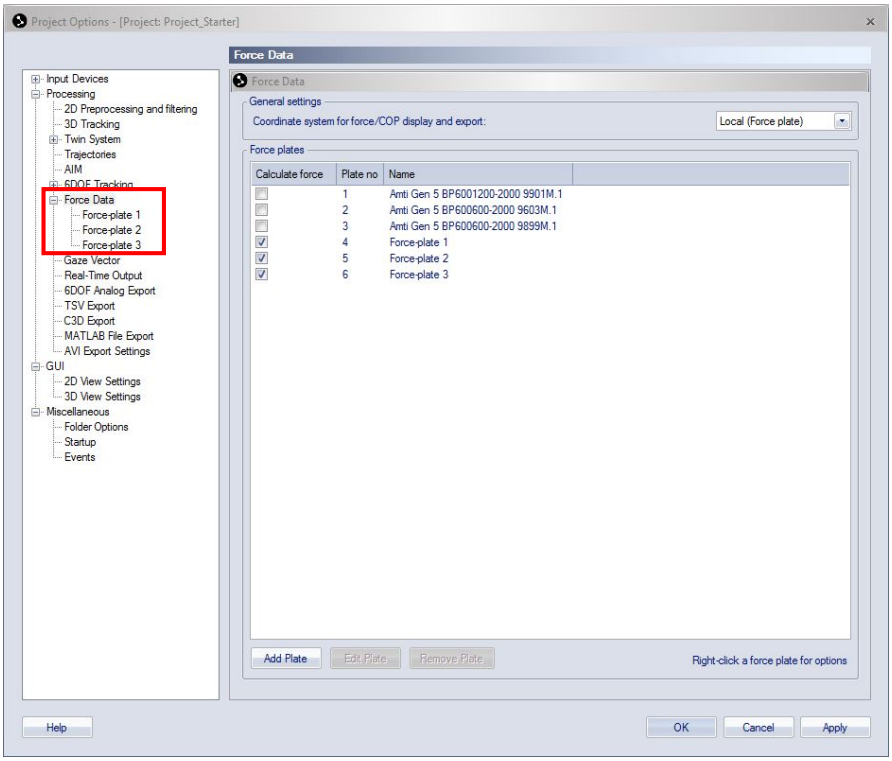
"Auto join" automatically joins trajectories that appear to belong to the same marker in 3D space. This may reduce the number of parts in a trajectory and may make tracking easier. *This does not automatically fill gaps*.



Trajectories. Here you can adjust settings for automatically filling gaps.



Force Data. In these settings you can select which force plates you'd like to collect with and check advanced forceplate options.



GUI. In GUI, 2D View Settings, and 3D View Settings you can adjust settings such as the real-time screen refresh, and the appearance of the screen in 2D and 3D modes.

Miscellaneous. Here you can adjust folder settings and QTM startup settings. Please do not adjust the "Global directories" options (in Folder Options) or the "Automatically load a project at startup" options (in Startup) as these change defaults for all users.

Project options are automatically saved to your project Settings file when you click "Apply" and then "OK." It is recommended that you always pilot data collection, processing, and analysis using your new project settings. This will ensure that your settings are sufficient to capture the information you need.

Chapter 1.2

QTM Data Collection

If collecting data on a participant, turning the system on and calibration steps should be performed before the participant arrives. Cameras and forceplates should be allowed to warm up for at least 20 minutes before calibrating.

Turning things on:

1. Turn on data collection computer.

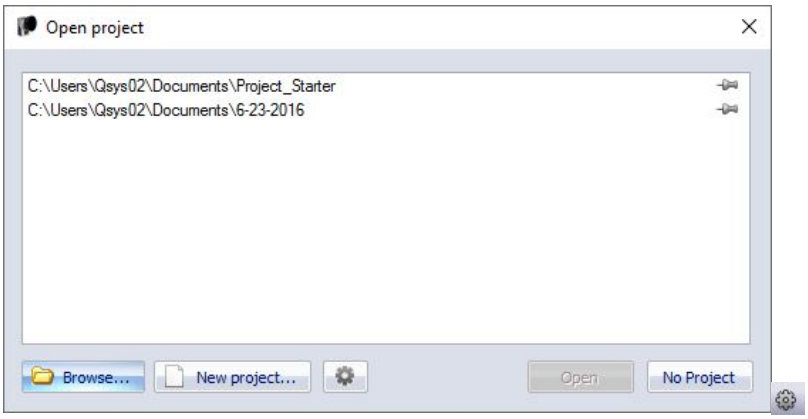
2. Turn on power strip for cameras (located on tower to left of data collection computer)

3. Make sure forceplates are on (3 boxes directly to the left of the computer monitors).

4. Find/add new participant folder to project folder (C:\Users\Qsys02\ Documents*your project folder*\Data).

5. Open QTM

6. Load your project



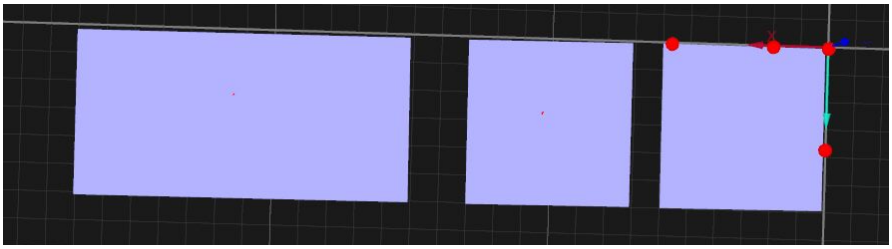
7. If you need to create a new project, follow instructions in Chapter X.X

Calibration:

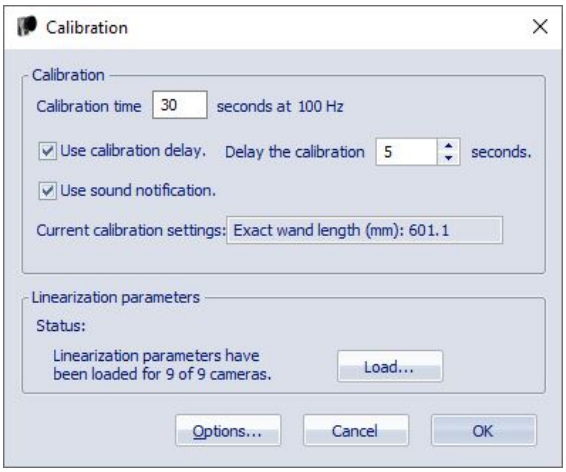
1. Hit the “new” button  (top left of toolbar)

2. Click on 2D view, check camera views to make sure each camera is seeing 0 markers.

3. Place L frame on forceplate 1 (end small FP) with the long arm pointing towards the big forceplate. Make sure it fits tightly to the forceplate corner (use drop-down legs), aligns with the forceplate edges, and is level. If the levels are off the tilt of the L can be adjusted using the round screws on the arms. Adjust them until the L is level in both planes.



4. Put the calibration wand together. Click the calibration button  .

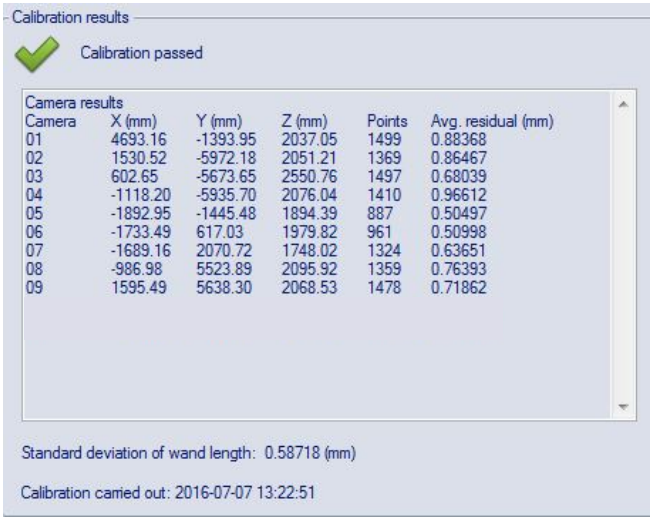


5. Adjust calibration settings as preferred. For calibrating a volume for gait (all 3 forceplates + space) 60 seconds may be necessary. Using a calibration delay will give you time to hit “OK” and get set in the volume before the start of calibration capture. When you are ready to calibrate, hit “OK.”

6. Calibrate the volume. It’s generally recommended to do this in a systematic method, covering the entirety of the desired capture volume with the calibration wand in a way that all cameras view the wand over the full volume (i.e., don’t have your back to one wall of cameras throughout the entire calibration).

7. Calibration will end when the set time has elapsed. This window will pop up:

Standard deviation of wand length should be less than 1 mm. If this criteria is met, hit “OK” and put away calibration equipment.



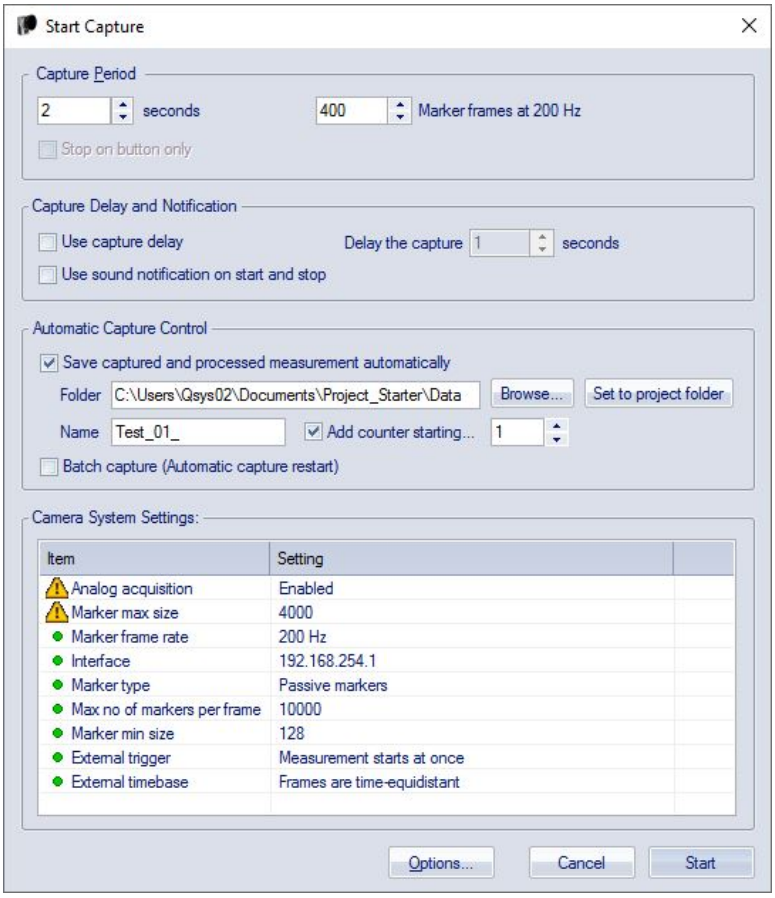
8. Calibration will occasionally fail. If calibration fails, check camera 2D views to make sure no markers other than the L and the calibration wand are visible. If no other markers or reflections are visible, start calibration over again.

Note: cameras will pick up anything reflective, including running shoes and reflective tags on clothing. Make sure you do not have anything reflective on when calibrating.

Data Collection:

1. With nothing on the forceplates, zero forceplates (orange buttons on forceplate boxes). When plates are zeroed, the orange lights should be off.

2. Click the “capture” button.  This window will pop up:



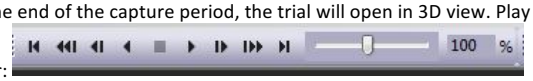
3. Adjust the Capture Period to the desired length of time. Changing the time box will automatically change the number of marker frames box.

4. Check the “Save captured and processed measurement automatically” box. Make sure folder that is directed to is where you would like your data to be stored.

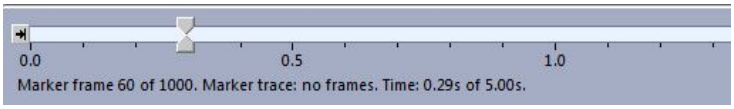
5. Change the “Name” box to whatever you would like the prefix of your files to be. If you would like files to be automatically numbered as you collect them, check “Add counter starting…”

6. Click “Options…” to check Camera System Settings to make sure frame rate and trigger settings are correct.

7. When you are ready to collect a trial, hit “Start.”

8. At the end of the capture period, the trial will open in 3D view. Play through the trial using the buttons in the toolbar: 

or by dragging the top arrow along the bottom timebar:



9. Labeling data (to create an AIM model, use a motion trial, not a static trial):

Scan through the trial to make sure all necessary marker and force data were captured. Move data to a timepoint where all markers are visible in the 3D view.

To label data, first open trajectory windows by clicking View > Trajectory Info > All.

Right-click in the “Labeled trajectories” window and select “Load label list…”

Select your marker list.

If you have not previously created a label list, right-click on the word “Trajectory” and select “Add new label.” This will create a “New ####” label.

Add as many labels as markers in your markerset and name them appropriately.

When all labels are created, right-click in the “Labeled trajectories” window and select “Save label list…”

II. To begin labeling markers, select the first marker in the label list and click the 

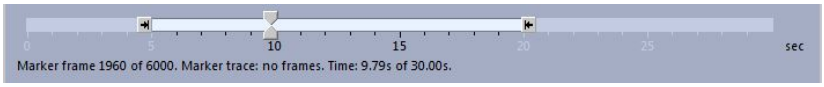
button (left vertical toolbar).

III. In the 3D view, click on the marker corresponding to the first label. In ID mode, the program will progress to the next label in the label list when a marker is clicked on.

IV. Continue clicking on the markers in the 3D view that correspond to the label highlighted in the label list until you reach the end of the label list.

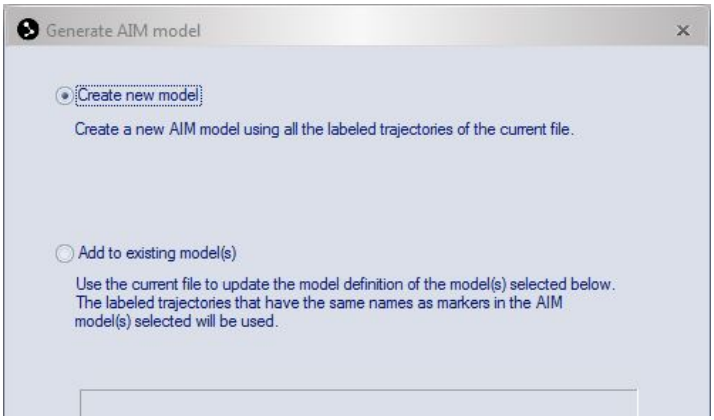
V. Click the  button to turn off ID mode.

C. Trim trial so that only labeled data are included using the side arrows of the timebar. Only labeled data are included when all marker fill levels are at 100% (in labeled trajectory window).



D. Click “Generate AIM model” button 

E. Select “Create new model” in the window that pops up and then click “Next.”



F. In the next window, verify that the model looks correct, and then click “Next.”

G. Enter a filename for your AIM model and click “OK.” In the final window, click “Finish.”

10. To have AIM applied as you collect data, in Project Options , go to AIM and add the model you just created to the “Applied models:” window. Hit “Apply,” then “OK.”

11. Continue collecting trials until finished.

12. If you wish to overwrite a trial, set the Name and counter to match the trial you wish to overwrite. When you hit “Start,” a window will pop up asking if you wish to overwrite the trial. Data will begin collecting when you hit “Yes.”

13. When data collection is completed, turn off cameras and copy data to appropriate location (e.g., external hard drive, network folder, etc.).

Chapter 1.3 - QTM Data Processing

Data Processing in **QTM**

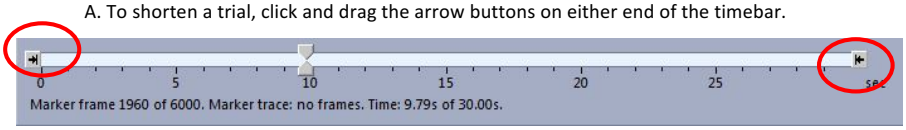
After data are collected, they must be tracked and exported from QTM for further analysis.

Tracking marker data

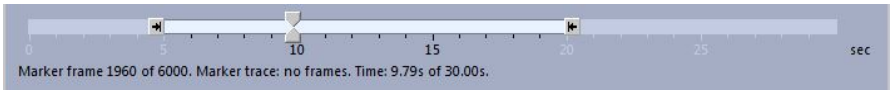
1. Navigate to location of motion capture data on the computer. QTM files end in *.qtm and can be opened on a computer with QTM software either by double-clicking on the file from Windows Explorer or using the "Open file"  button in QTM.

2. Before tracking your data, you may wish to trim the trial to only the range of frames of interest. For example, you may wish to do this if you want a single stride of data from a trial which includes data of your participant walking all the way across the data capture space.

A. To shorten a trial, click and drag the arrow buttons on either end of the timebar.



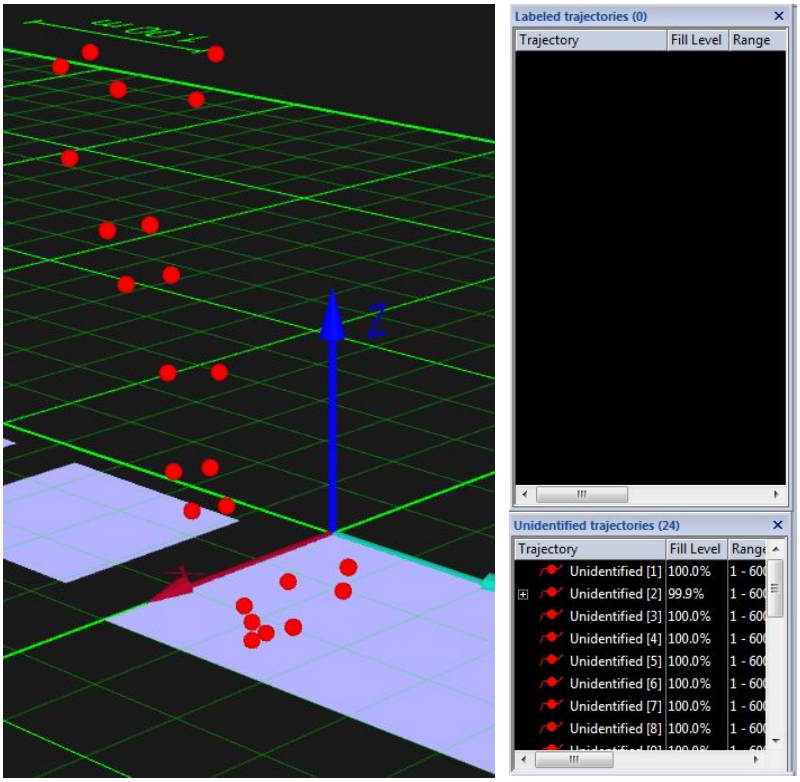
B. For example, here I have trimmed off the beginning and end of a trial of data.



C. Once you trim a trial, marker information will only be displayed for the frames inside the timebar arrows. Note that this range can always be changed later on if you decide you want to track more of your trial.

3. If markers are already labeled, skip to step 5.

4. If markers are not yet labeled, a label list will need to be created. Un-labeled markers appear red and all trajectories will be listed in the “unidentified trajectories” box. If you don’t see the trajectory boxes, click View > Trajectory Info > All to open these boxes.



A. Right-click in the “Labeled trajectories” window and select “Load label list…” Select your marker list.

I. If you have not previously created a label list, right-click and select “Add new label.” This will create a “New ####” label.

II. Add as many labels as markers in your markerset and name them appropriately.

III. When all labels are created, right-click in the “Labeled trajectories” window and select “Save label list…”

B. To begin labeling markers, select the first marker in the label list and click the 

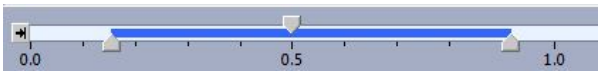
button.

C. In the 3D view, click on the marker corresponding to the first label. In ID mode, the program will progress to the next label in the label list when a marker is clicked on.

D. Continue clicking on the markers in the 3D view that correspond to the label highlighted in the label list until you reach the end of the label list.

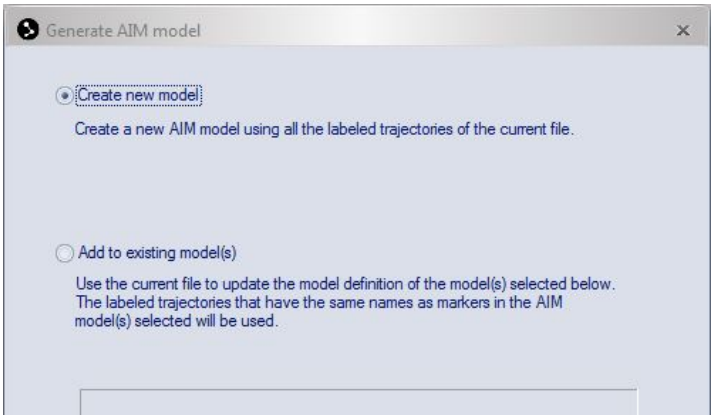
E. Click the  button to turn off ID mode.

F. Trim trial so that only labeled data are included using the bottom arrow of the timebar:



G. Click “Generate AIM model” button 

E. Select “Create new model” in the window that pops up and then click “Next.”

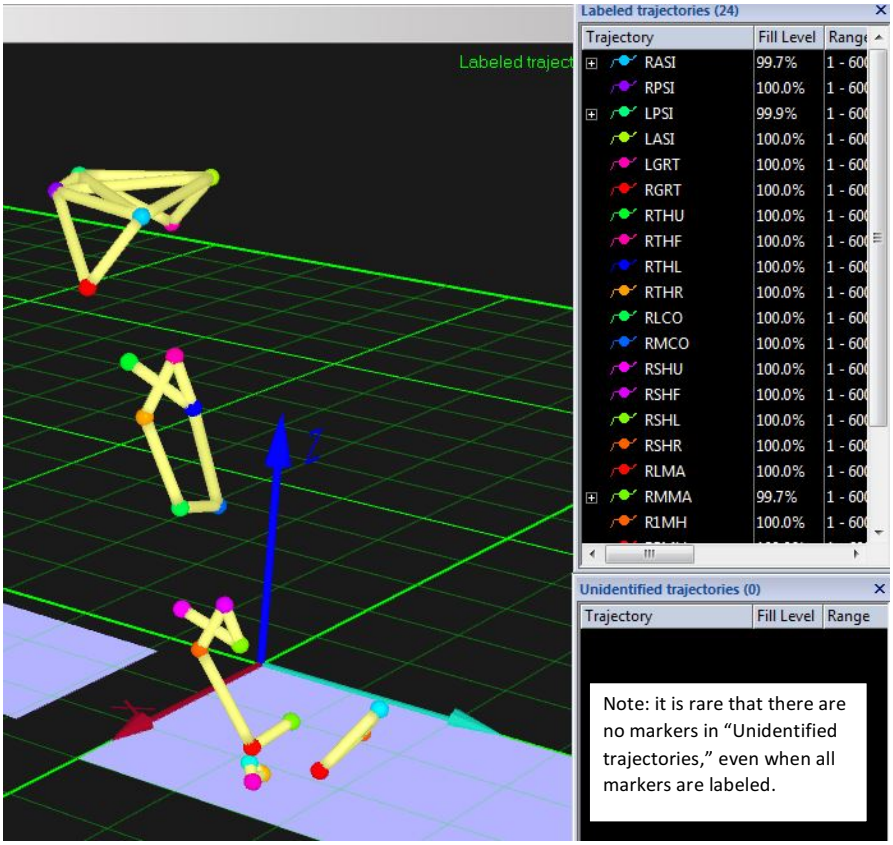


F. In the next window, verify that the model looks correct, and then click “Next.”

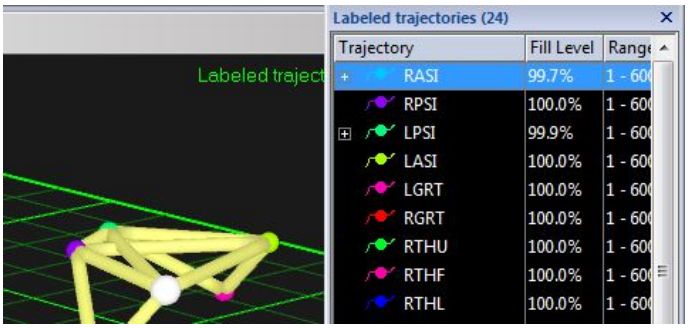
G. Enter a filename for your AIM model and click “OK.” In the final window, click “Finish.”

H. After creating an AIM model, the model can be applied to new, unlabeled files of the same participant/data collection session using the  button.

5. If markers are already labeled, the next step is to clean-up the data. Generally, the goal of cleaning-up the data is to make sure there are no gaps in marker data.

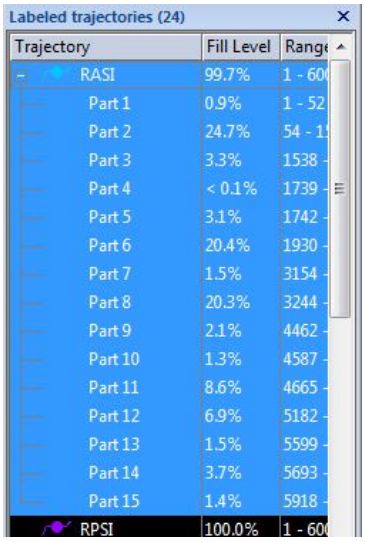


6. First, check that all markers are correctly labeled (e.g., the Right ASIS is actually labeled as RASI rather than as RSHF or something else). To check this, you can click on a marker in the "Labeled trajectories" box and it will be highlighted in the 3D view (and vice versa). Also note that label colors in the "Labeled trajectories" box match the color of the markers in the 3D view.



A. The "Fill Level" column for each marker tells you what percent of the trial contains data and a label for this marker. The "Range" column tells you during which frames the labeled marker appears. At the end of data tracking marker data you want all markers of interest to be at 100% for the range of frames of interest.

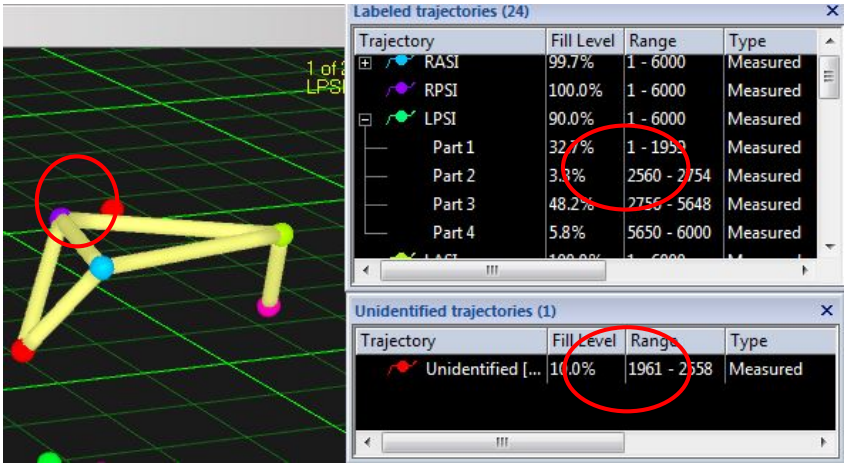
B. The + sign next to a marker indicates that this marker trajectory is made up of multiple parts. If you expand by clicking on the + sign, you can see how many parts are in a given trajectory and what frames they appear during.



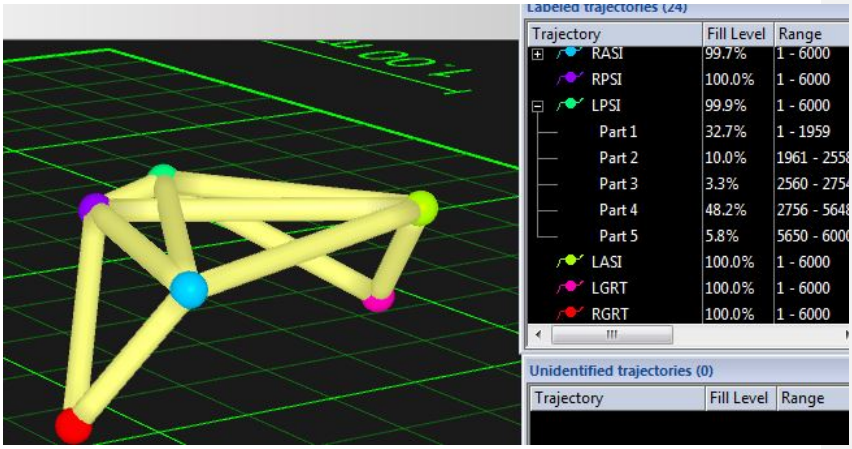
7. When you have confirmed that all markers are labeled correctly, you can begin fixing gaps in data. There are 2 general methods for fixing gaps in data which are detailed below.

A. **Option 1**: filling a gap in a marker trajectory when there is an unlabeled trajectory available (best option if available)

I. Sometimes QTM does not do a perfect job of identifying which marker is which, even after you label data. This will result in sections of data where there is a marker in the 3D view but it is unlabeled (or in some cases, is labeled incorrectly). Below, we see that the Left PSIS (LPSI) is labeled for 90% of the trial, except for the frame range 1960-2559. There is an unidentified trajectory that coincides with most of this frame range.

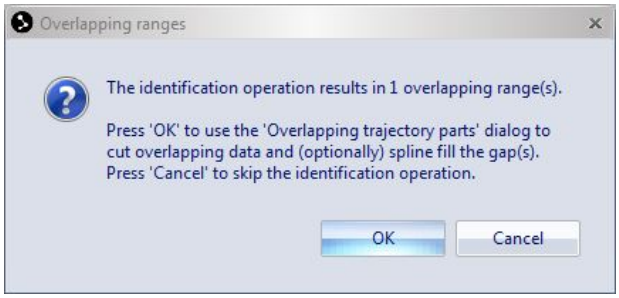


II. To add this unidentified trajectory to the LPSI, click and hold on either the unidentified marker in the 3D view or the Unidentified trajectory in the "Unidentified trajectories" box, and drag it to LPSI in the "Labeled trajectories" box.



III. Now the unidentified trajectory has been added to LPSI.

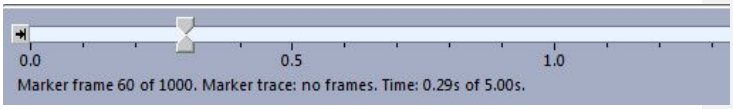
IV. Sometimes the unidentified trajectory you are trying to add to fill a gap in a labeled marker overlaps with existing data and you will get the following message:



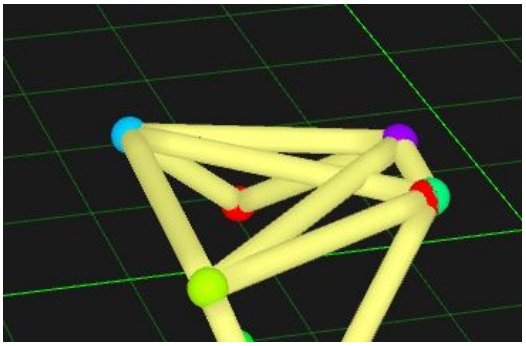
a. If you hit “OK,” a box showing 3D trajectories will pop up in which you can select the range of the unidentified marker you’d like to keep. This tool can be unwieldy and difficult to use at times.

b. If you hit “Cancel,” you can instead manually identify the overlapping data.

c. In the example below, you can see that the unidentified trajectory contains 2 parts of data which cover the range 1961-2558. LPSI already has data for frames 2553-2559. To determine which data to keep (the data already in LPSI for these frames or the data from the unidentified trajectory for these frames), navigate to this frame range in the 3D view using the timebar at the bottom of the screen.



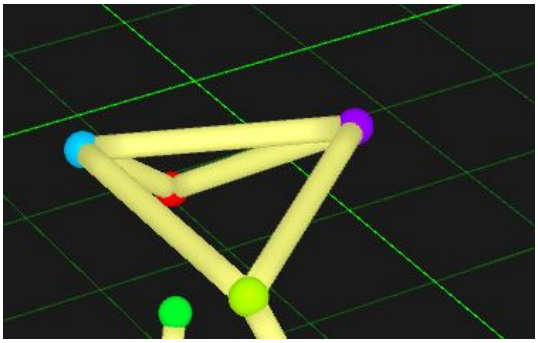
d. During the overlapping frames, you should be able to see two markers. These may overlap very closely in space (as shown below) or they may not.



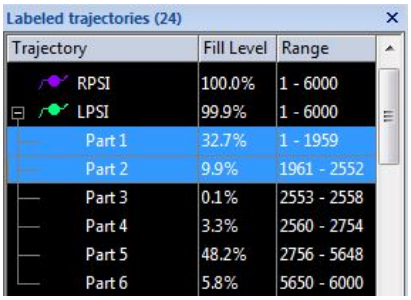
e. At this point you need to choose which data you want to keep. If you wish to keep sections of one marker which go before and after another (in this case, say we want to take the unidentified marker for the range before and after the overlapping LPSI data), you may need to split one trajectory. To do this, navigate to the last time point you'd like to keep of the trajectory of interest, right-click on the trajectory in the "Labeled trajectories" or "Unidentified trajectories" box, and click "Split part after current frame." This will cut the selected trajectory into 2 parts. You may need to do this again at the end of the range of interest. Then the split part or parts can be dragged and added to the labeled trajectory.

B. **Option 2**: gap-filling a gap in a marker when there is no unidentified trajectory to swap in

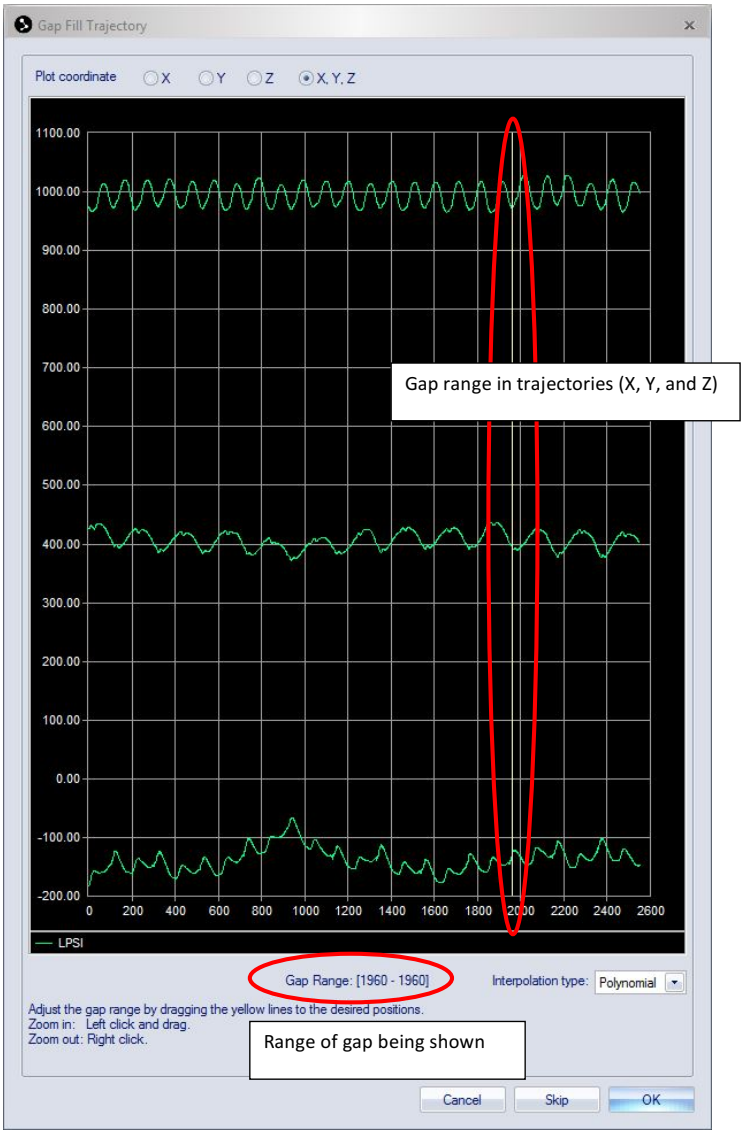
I. Below, we see an example of a frame of data where there is no LPSI, and no unlabeled trajectory to swap into its place. In cases like this, you have to perform a gap fill.



II. To gap fill data, select the Parts on either side of the gap (below, there are data from 1-1959 and 1961-2552, but no data for frame 1960), right-click, and select "Gap fill trajectory with preview"



III. A window displaying the 3D trajectory of the selected marker will pop up and show how the gap is to be filled. Following the instructions in the bottom of this window, you can zoom in on the gap and adjust the range of frames you want the gap fill to span. Note that gap fills must begin and end at labeled marker data as the fill is constructed using a polynomial fit based on existing data.



IV. General guidelines for gap filling data:

a. Use caution when filling larger gaps (range depends on frequency of data capture, speed of movement, etc.). Gap filled data is not *real* data and large gap fills may be a distorted representation of the true motion of a marker.

b. Adjust gap fill frames so that there are not abrupt shifts/discontinuities in the 3D trajectories. Often times before a marker drops out and creates a gap, the cameras are having difficulty calculating its position and so the last/first frame or two of existing data will be shifted.

c. For any gap fill larger than a few frames, always view the 3D representation of the gap fill by playing through the corresponding frames while watching the 3D view of your data to check for visible errors in the gap filled data.

8. When all markers are labeled at 100%, data tracking is complete.

9. After data tracking, data must be exported from QTM for further processing. Files can be exported in the following formats:

-C3D: Visual 3D file format

-TSV: tab-delimited data that can be viewed in excel and read into a variety of programs

-MAT: MatLab file format

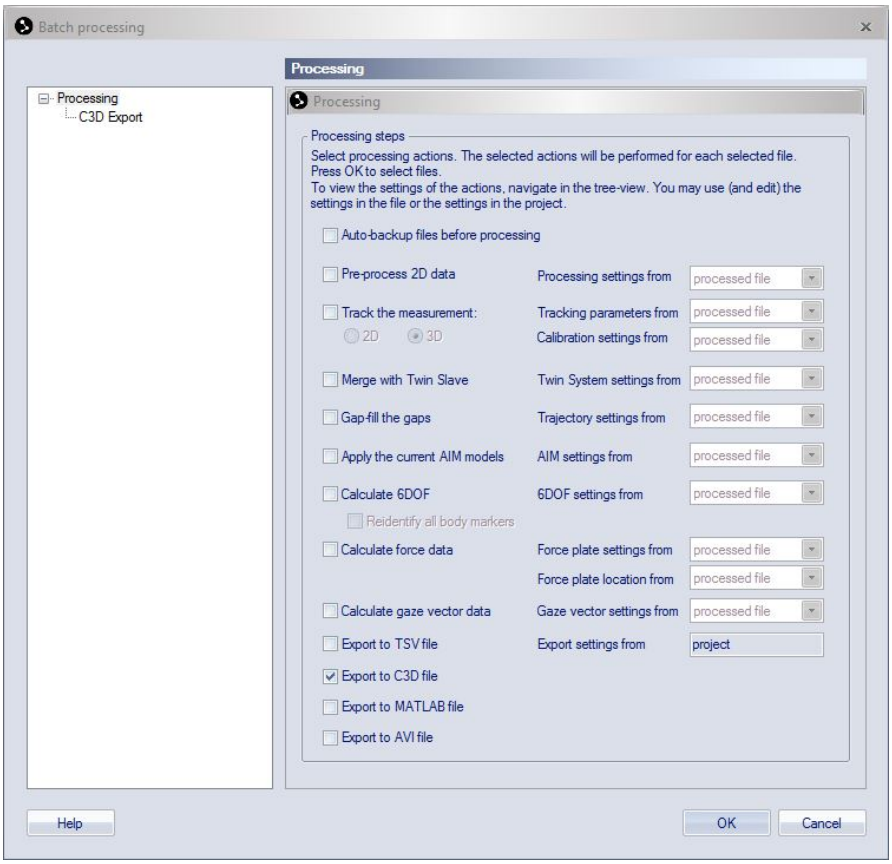
-AVI: video file of marker data

A. Files can be exported one-at-a-time or in bulk.

I. To export files in bulk, click File > Batch Process

a. When using Batch Process, the first window to pop up asks you to select the desired files. After selecting the desired files and clicking "Open," a window similar to the one below will pop up.

b. In the “Processing” tab (shown below), you can select which file format you want to export to and also set additional processing options. If you want to export the data in the form that you currently have (e.g., markers tracked, trials trimmed, etc.), DO NOT select any options except for your exporting file format. Other options may undo work that you have already done (e.g., selecting “Track the measurement” will re-track all files in raw, unlabeled format).



c. In the secondary Batch Processing tab (above, this would be the “C3D Export” tab on the top left), you can select options specific to that file format.

II. To export files one-at-a-time, click File > Export > [desired file type]. Using this dialog, only the secondary window options described above in C will pop up.

10. After exporting data, processing in QTM is complete

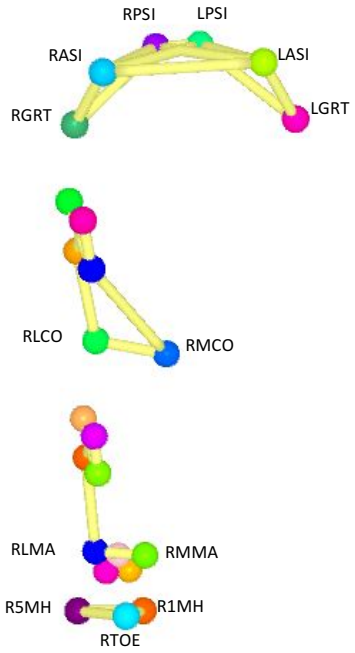
Chapter 1.4 - Example Marker Sets

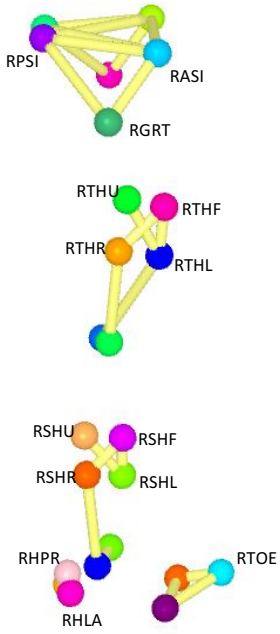
The Human Motion Core has some standard markersets that may be used for motion capture of certain tasks. These markersets include full-body, right lower extremity, left lower extremity, and head with Frankfort plane. Users can feel free to copy these markersets and modify as needed. In general, the full body and lower extremity marker sets are optimized for calculation of lower extremity joint mechanics. A more detailed markerset than the full body markerset would be needed to calculate upper extremity mechanics, but the current markerset can be used to account for segment sizes/masses for center-of-mass calculations.

Below are images of the standard markersets with markers labeled. At the end of this document is a definition of the marker labels. Note that in the standard markersets, marker labels are consistent from markerset to markerset.

Unilateral Lower Extremity

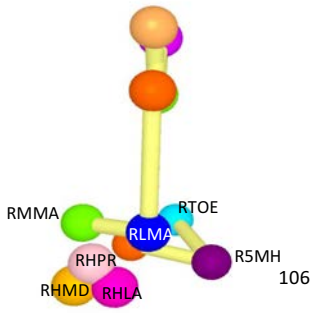
This markerset exists in a right side and left side version. The right side is shown below. There are some differences in the markers on the lower extremity between this model and the full-body model. This model has a foot markerset that can be used to calculate whole foot and rearfoot angles. Additionally, this model has different pelvic markers compared to the whole body model which will lead to difference pelvic segment definitions but no substantial differences in segment motion calculations.





Frontal view of unilateral markerset

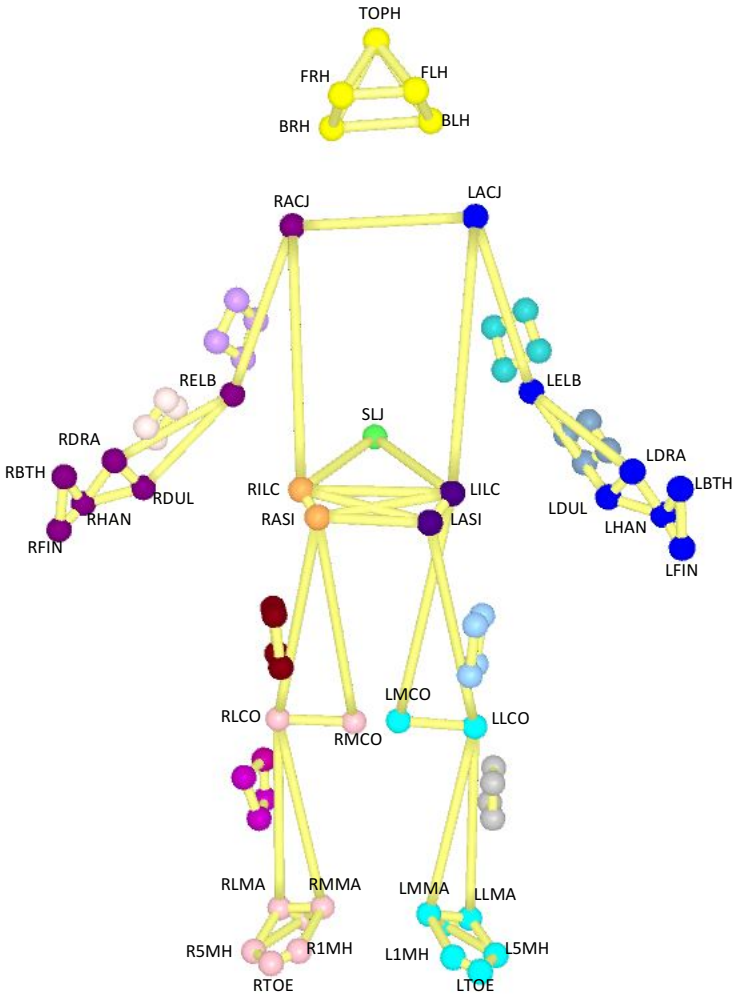
Posterior view of unilateral markerset



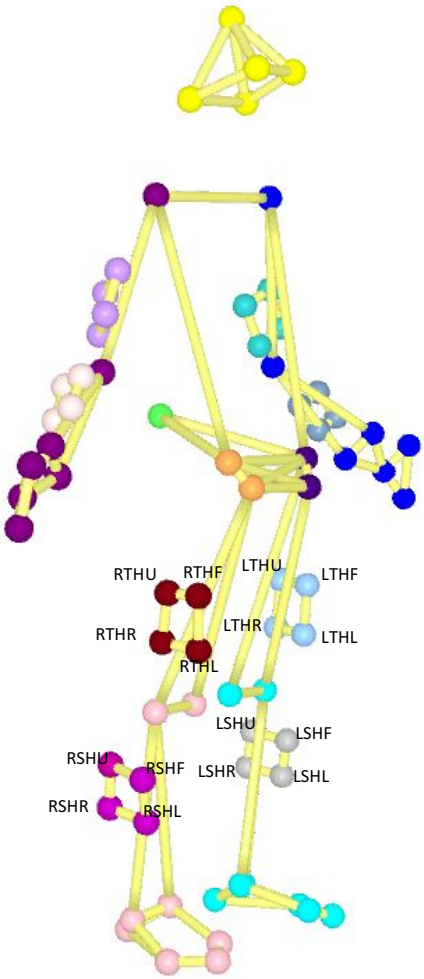
Close up of rearfoot of unilateral markerset

Full Body

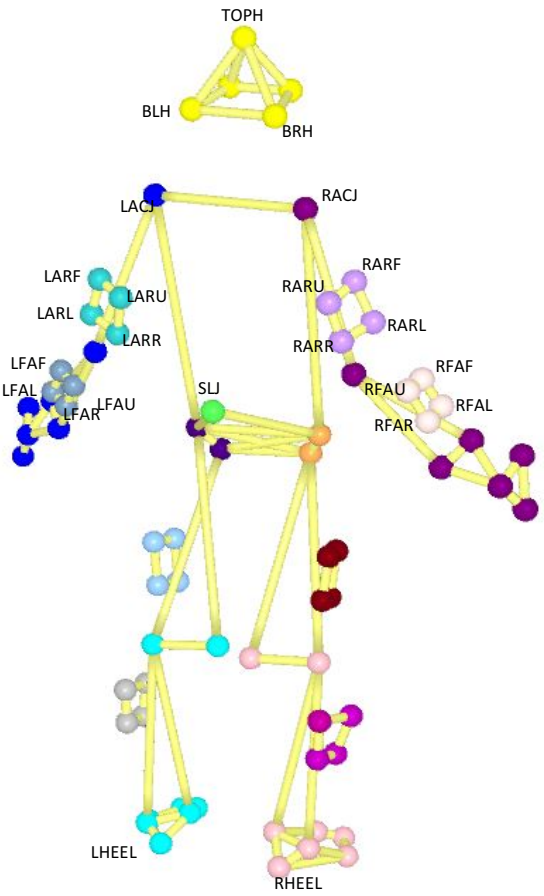
This markerset includes the same general lower extremity model as the lower extremity markersets, but adds a trunk, arms, and a head. Note that this markerset does not include the 3-marker rearfoot. This can be easily added as shown in the lower-extremity image.



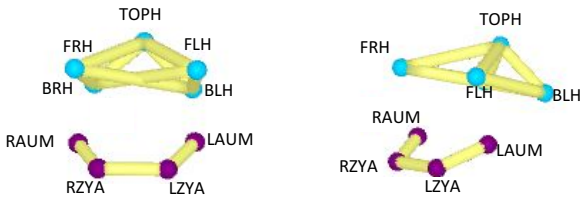
Frontal view of full body markerset



View of right/front side of full-body markerset



Posterior View of full-body markerset



Head Markerset for Gaze Tracking

Marker name definitions

Marker labels are listed by segment

Head:
Crown/helmet
TOPH – top of head
FRH – front right of head
BRH – back right of head
FLH – front left of head
BLH – back left of head

Frankfort plane
R/L AUM – right/left auditory meatus
R/L ZYA – right/left zygomatic arch

Trunk:
R/L ACJ – right/left acromioclavicular joint
Upper Back Trunk Cluster
Lower Back Cluster (if you want both lumbar & thoracic spine)

Arm:
Upper arm rigid cluster
R/L ARU – right/left arm upper
R/L ARF – right/left arm front
R/L ARL – right/left arm lower
F/L ARR – right/left arm rear

Forearm rigid cluster
R/L FAU – right/left forearm upper
R/L FAF – right/left forearm front
R/L FAL – right/left forearm lower
F/L FAR – right/left forearm rear

R/L DRA – right/left distal radius (radial styloid)
R/L DUL – right/left distal ulna (ulnar styloid)
R/L HAN – right/left hand
R/L BTH – right/left base of thumb
R/L FIN – right/left second finger

Pelvis:
R/L ASI – right/left anterior superior iliac spine (ASIS)
R/L ILC – right/left iliac crest
R/L PSI – right/left posterior superior iliac spine (PSIS)
SLJ – sacrolumbar joint
R/L GRT – right/left greater trochanter

Lower extremity:
Thigh rigid cluster

R/L THU – right/left thigh upper
R/L THF – right/left thigh front
R/L THL – right/left thigh lower
R/L THR – right/left thigh rear

Shank rigid cluster
R/L SHU – right/left shank upper
R/L SHF – right/left shank front
R/L SHL – right/left shank lower
R/L SHR – right/left shank rear

R/L LCO – right/left lateral femoral epicondyle
R/L MCO – right/left medial femoral epicondyle
R/L LMA – right/left lateral malleolus
R/L MMA – right/left medial malleolus

R/L 1MH – right/left first metatarsal phalangeal joint
R/L 5MH – right/left fifth metatarsal phalangeal joint
R/L TOE – right/left toe
R/L HEEL – right/left heel
R/L HPR – right/left heel proximal
R/L HMD – right/left heel medial
R/L HLA – right/left heel lateral

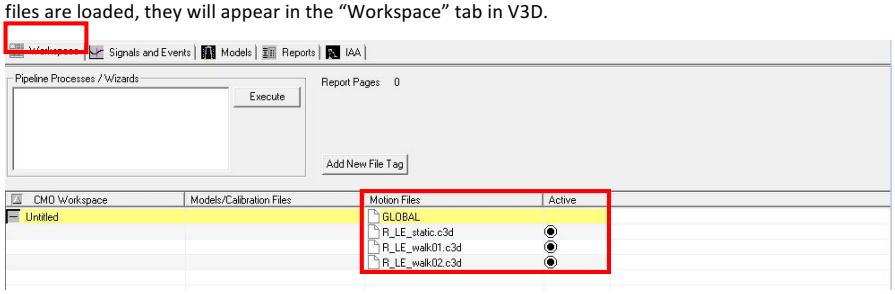
Calibration Markers
Both Calibration & Tracking Markers
Tracking Markers

Visual3D (V3D) is a motion capture analysis software package that can make data analysis relatively straightforward and streamlined. C-Motion, the developers of V3D, have created a high-quality set of documentation for this software (https://www.c-motion.com/v3dwiki/index.php/Visual3D_Overview). If you are a first-time user of V3D it is highly recommended that you go through the V3D tutorials (https://www.c-motion.com/v3dwiki/index.php/Visual3D_Tutorials) to fully appreciate the tools included in this program, as well as the implications of incorrectly modeling/computing your results.

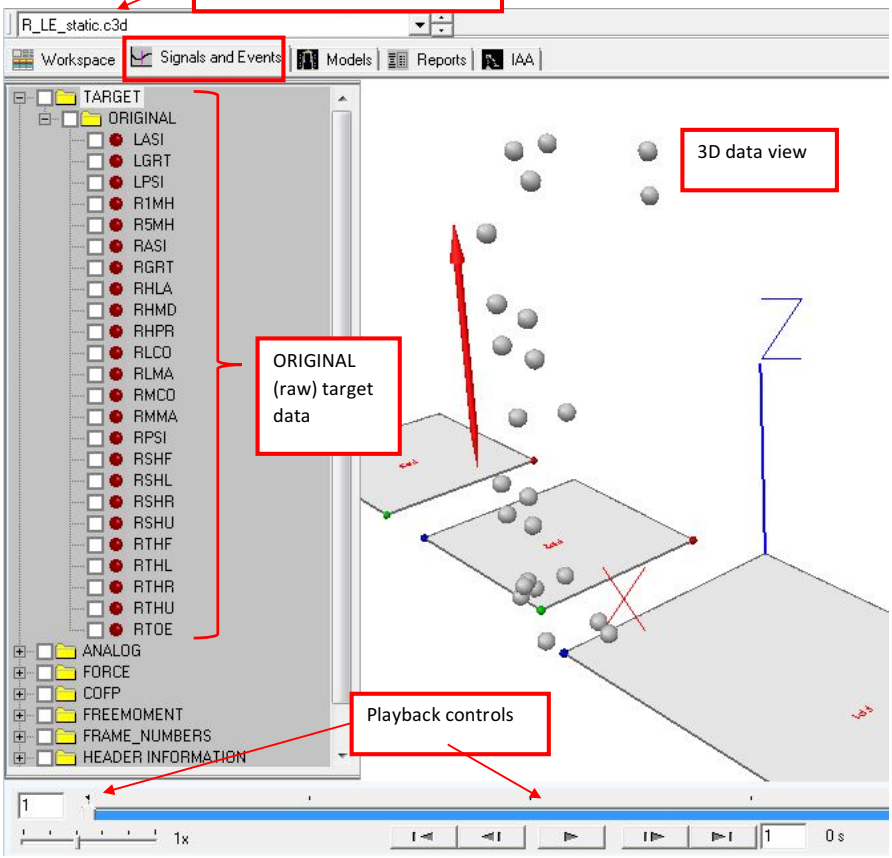
I. V3D Basics

1. V3D works with motion files that are in .c3d format. Motion capture data can be exported from QTM in this format which will include any marker, analog, and force data captured in a trial. NOTE: V3D cannot work with files/commands/tags that have spaces in the name. Never use spaces in file names, marker names, etc.

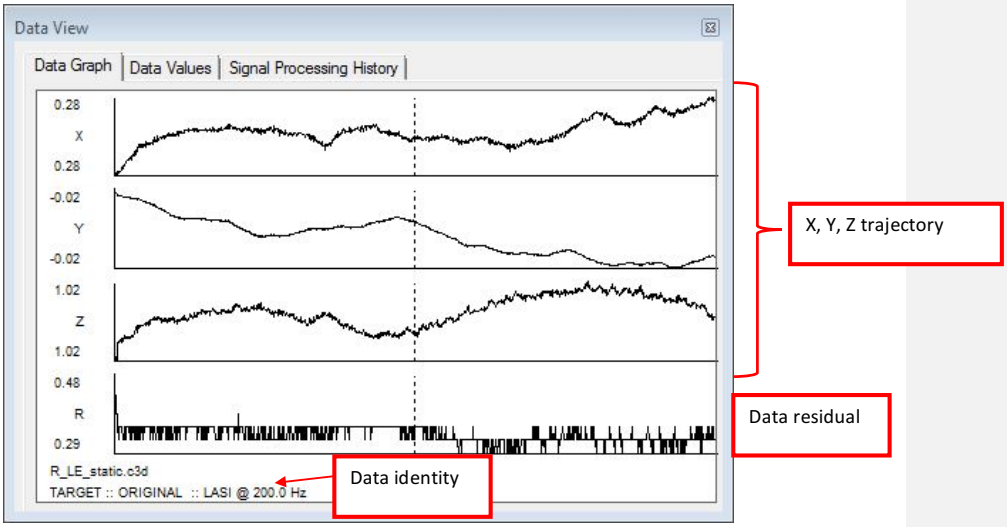
2. To load raw data files in V3D, click the open button  and select the c3d files you wish to view. When files are loaded, they will appear in the "Workspace" tab in V3D.



3. To view these data files, switch to the “Signals and Events” tab. Here you can select which file to view using the drop-down menu, [illegible] the tools at the bottom, or view raw TARGET (marker), ANALOG, or



4. If you left-click on any data item, a Data View window will pop up to show you trajectories and values for that data item. You can also right-click on a data item to plot it.



5. Viewing raw data has limited utility. Generally you will want to build a model and apply this model your data trials.

II. Models in V3D

Models in V3D are the base files from which skeleton/segment characteristics are applied to motion files. In order to create a model to apply to your motion files, you must have a static calibration trial. For human motion, especially gait, the static trial is generally captured while an individual stands still in anatomic position. These instructions will take you through some general steps for creating a model from a static trial. This is not the only way to create a model; further instructions can be found on the V3D wiki.

There are demo V3D files that you can use to explore the following instructions. A completed analysis can be viewed by opening R_LE_walk.cmo. The files used to build this analysis include one static trial (R_LE_static.c3d), two treadmill walking trials (R_LE_walk01.c3d and R_LE_walk02.c3d) a model file (R_LE_model.mdh), and a pipeline (R_LE_walk_pipeline.v3s). These files are for demonstration only and can be used to explore some capabilities of V3D but are not inclusive of all tasks that V3D is capable of.

There are some pre-created models available for general use. These include unilateral lower extremity models for both the right and left limbs and a full-body model. These models are based on the markersets that are also available for general use and can be used and modified as needed. These models are not meant to be all-inclusive but rather provide examples and starting points for development of project-specific models. Note especially that the upper extremities in the full body model do not follow ISB

recommendations for the shoulder, elbow, or forearm. Users should always review the V3D wiki recommendations for modeling of segments and joints above the pelvis.

General facts about models

Models in V3D consist of definitions of segments and landmarks used to create these segments. These definitions are needed so that the 3D orientation of segments can be tracked during a movement. In general, segments are defined using real or virtually-defined markers at the proximal and distal ends, as well as radii of the proximal and distal ends. At least three markers are needed to define the orientation of a segment. When a segment is created, it is assigned a coordinate system (see red, green, and blue orthogonal axes in image below) which is rigidly associated with the segment's proximal joint (e.g., the thigh coordinate system will be anchored at the hip joint). Models must also include assignment of tracking markers, or markers that are registered to the segment definition in a calibration trial and are then used to track the movement of the segment during movement trials. The segment coordinate system is modeled as rigidly related to the orientation of the tracking markers and for this reason tracking markers are often placed on plastic shells (e.g., thigh and shank clusters) or on anatomical locations with little skin motion artifact (e.g., acromio-clavicular joints during lower extremity tasks). In addition to segment-specific definitions, models require an individual's height and body mass for calculation of segment inertial properties and joint kinetics.

The orientation of adjacent segment coordinate systems with respect to each other provides the joint angle or joint translational position. For this reason, it is important to pay attention to the orientation of segment coordinate systems as they are created. In the image below, you can see that all visible segments have the red (X) axis oriented to the model's left. This matching orientation provides ease of understanding for joint definitions. For example, rotations about X between the shank and thigh are sagittal plane joint angles, those about Y are frontal plane joint angles, and those about Z are transverse plane joint angles. In order to obtain accurate and meaningful data, it is critical that you correctly define and construct your model. Recommendations for modeling segments and joints of interest can be found on the V3D wiki, as well as in published recommendations from the International Society of Biomechanics.

Applying an existing model to movement trials

In a new V3D workspace or window, on the menu, click "Model," then "Create (Add Static Calibration Trial)," and "Hybrid Model from C3DFile."

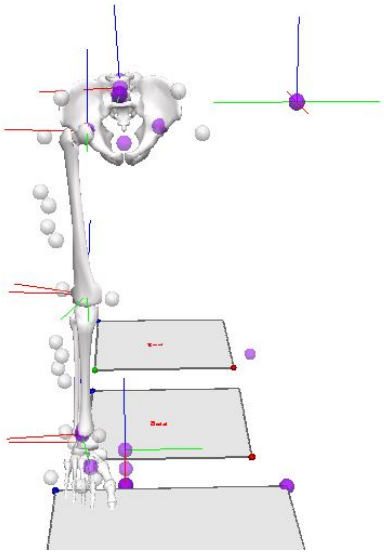
A. In the window that pops up, select your static calibration trial.

B. V3D will automatically switch to the "Models" tab.

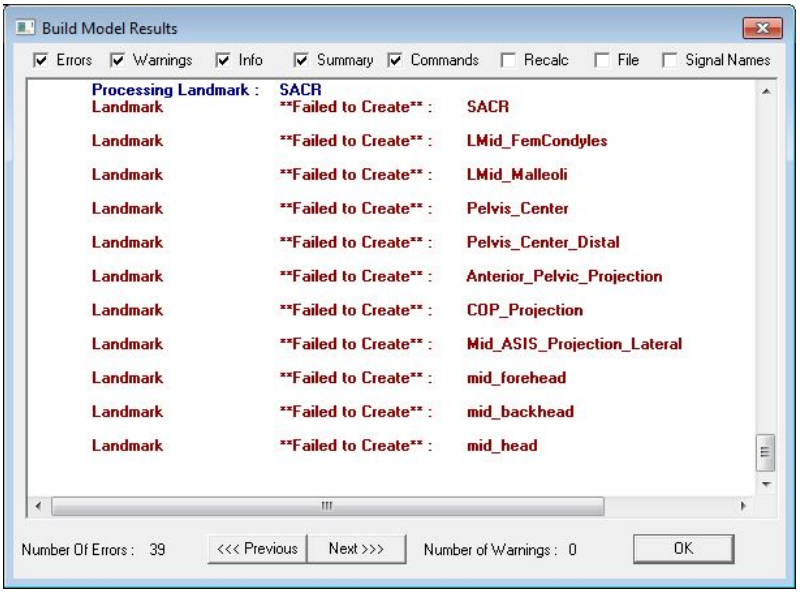
C. Click the Load Model Template button 

i. Select the model file (*.mdh) you would like to use.

ii. The model should now be applied to your static trial.

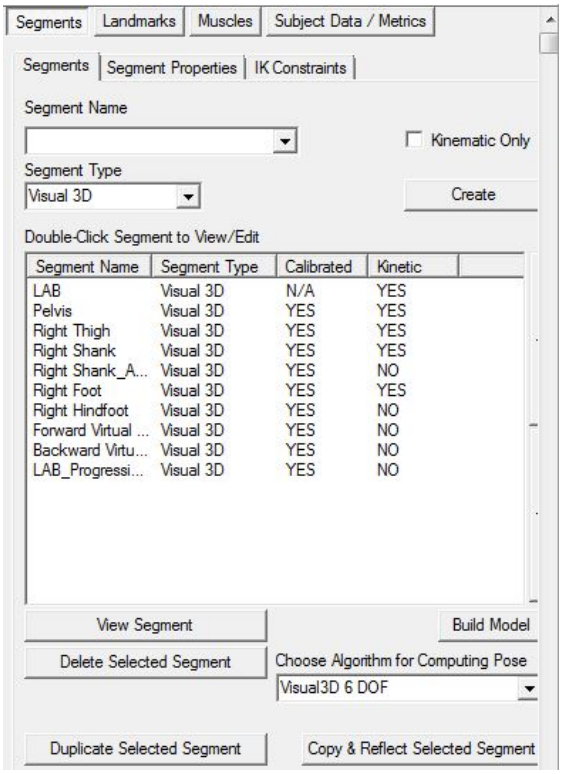


iii. In some cases, there will be errors in building the model. These will be detailed in a “Build Model Results” window.

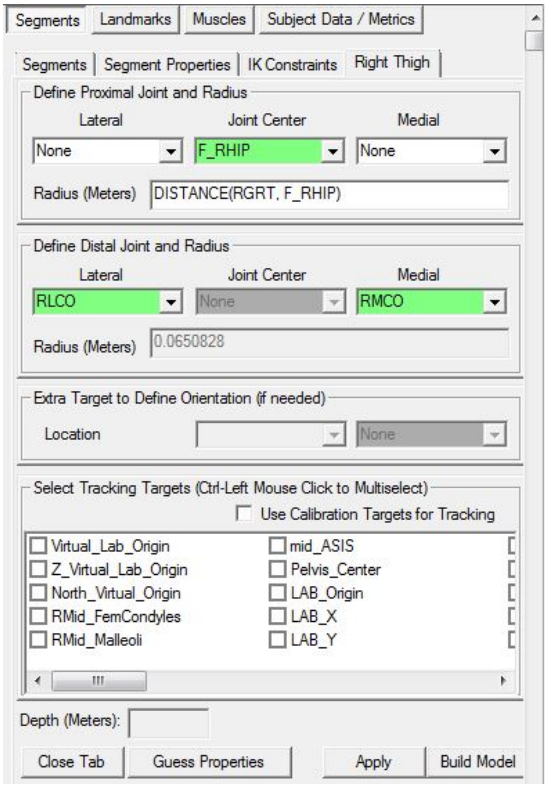


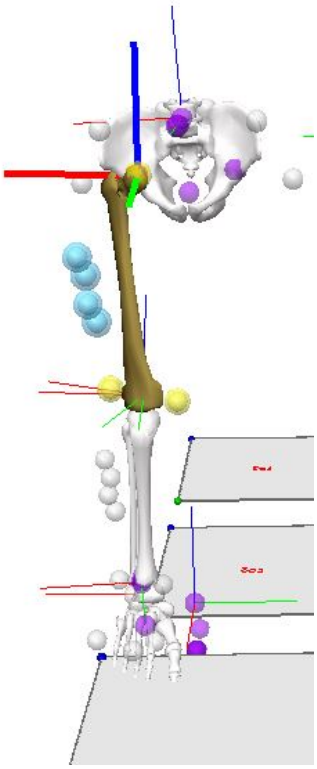
iv. If this occurs, you can scroll through the errors and/or warnings to determine what issues are present. Fixing these issues may involve finding a correct, complete static trial, correcting the names of markers, or modifying the model to correspond to different segment/landmark definitions.

D. Definitions of how model segments and landmarks are created can be found by double-clicking on a segment or landmark in the left-hand window in the Models tab.



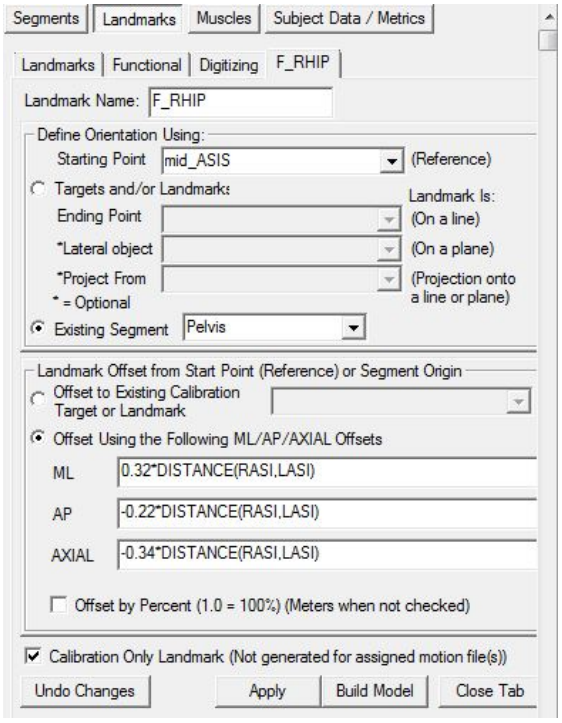
i. For example, if you look at the right thigh in this model, you will see the following definitions.



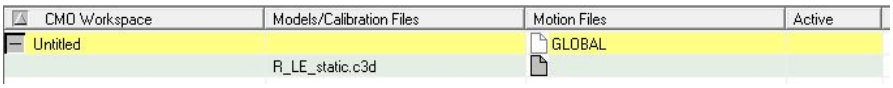


ii. Note that some of the markers used for defining the proximal and distal joints are real markers that were placed on an individual (e.g., RLCO, RMCO) while other markers are "landmarks," or virtual markers created in V3D based on the position of other markers. Here, the F_RHIP is a landmark.

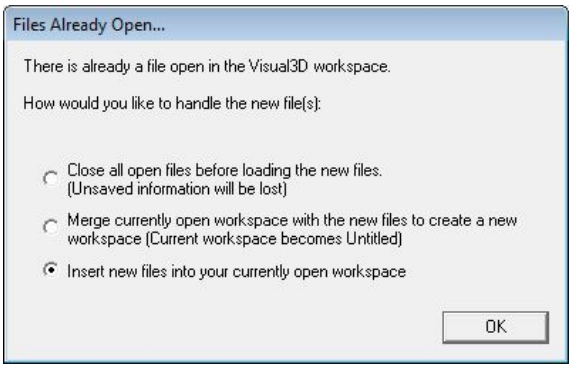
iii. If we look at F_RHIP in the "Landmarks" tab, we can see how this landmark was created. This landmark is a hip joint center definition based on literature regression equations.



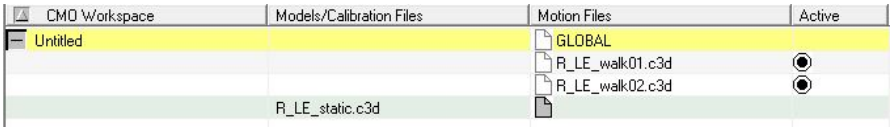
E. After applying your model, the workspace should look something like this:



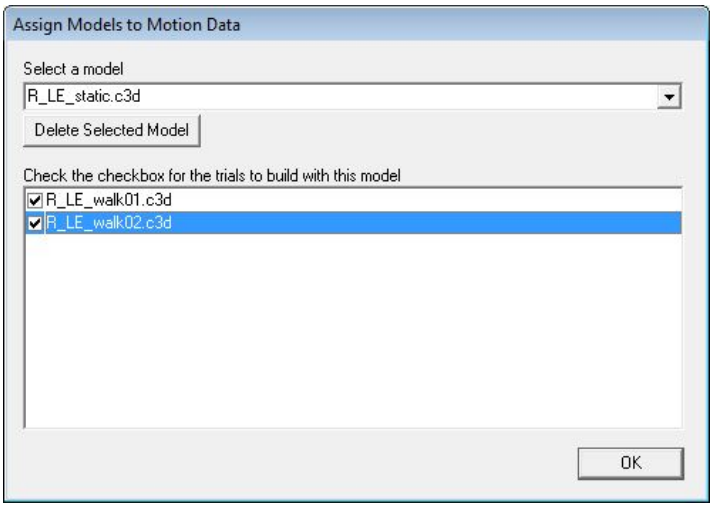
F. Now you must add motion files. To do this, click the open button  and select your motion trials. A warning window will pop up, select “Insert new files into your currently open workspace.”



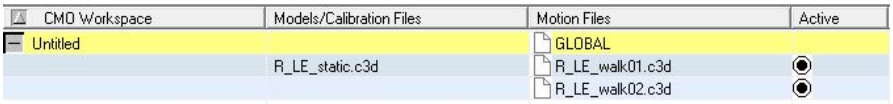
i. After selecting your motion trials, your workspace will look something like this:



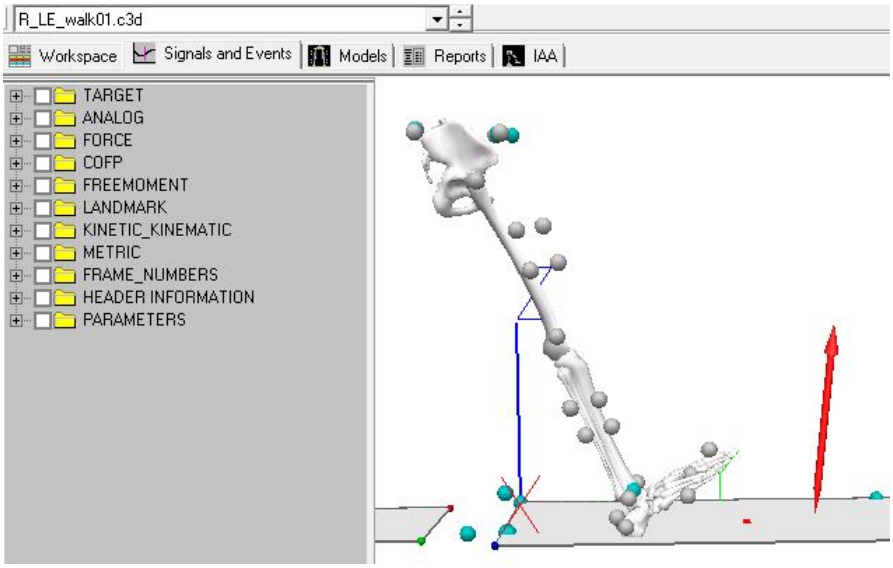
G. You can now apply your model to your motion files. To do this, click Model > Assign Model to Motion Files. Select the trials which you would like to apply the model to



i. Now your workspace should show your motion files within their assigned model.



ii. If you view your motion trials in the "Signals and Events" tab, you will see the model applied to the trials (assuming your data were tracked correctly with marker names the model expected.) Note that the model is not necessarily to scale or completely correct anatomically (e.g., model femoral heads are often not in the acetabulum), the model is meant as a visual aid.

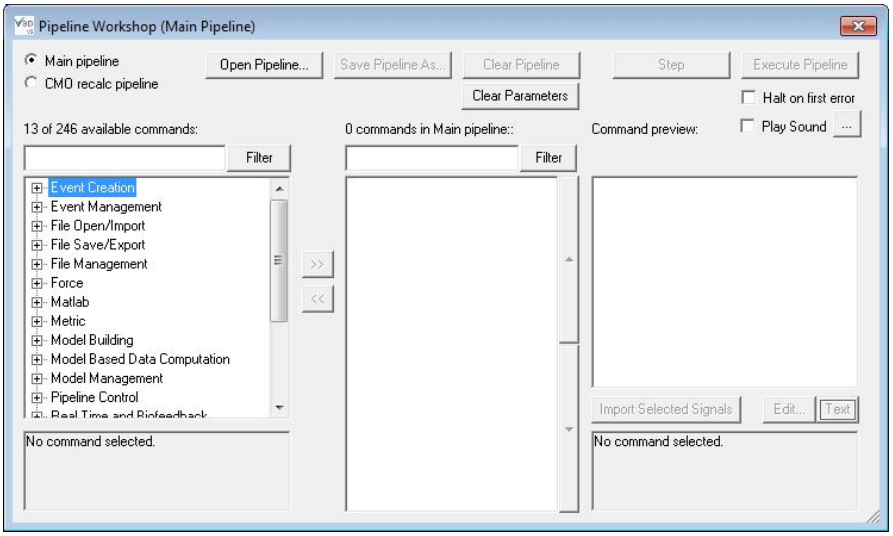


iii. If a segment is missing or incorrectly oriented in a motion trial it is due to incorrectly labeled data. Check that all tracking markers are present in the motion trial and that the marker names assigned to the motion trial match those in the model.

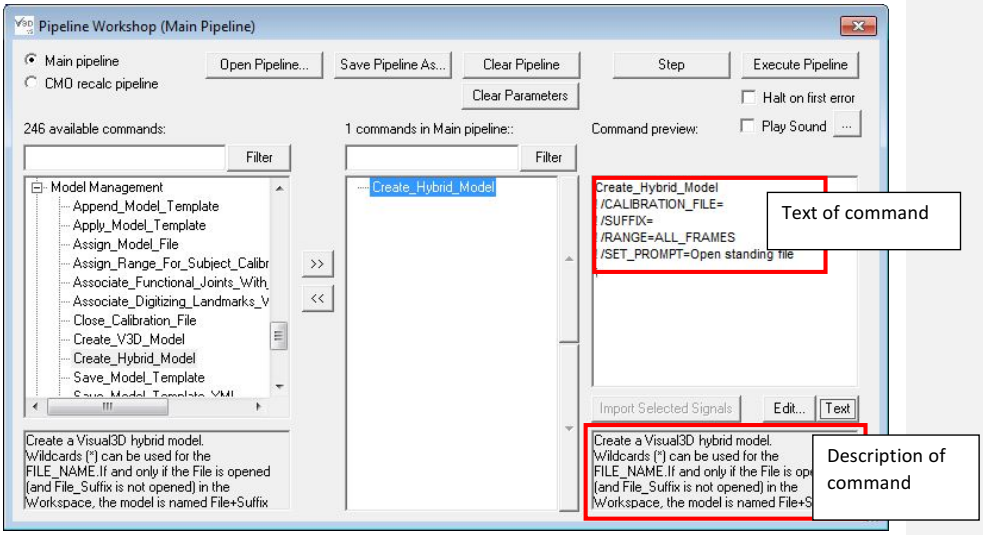
III. Data Analysis and Pipelines

Once you have data loaded into V3D and a model assigned to your motion files, you can process your signals, create motion events, and compute outcomes (e.g., joint kinematics and kinetics). This can be done using some point-and-click steps but is more efficiently implemented using pipelines. Pipelines consist of a series of commands which can be saved and used for multiple participants/conditions/iterations in a study and thus assist with batch processing and calculation consistency. The following instructions will go through some basic pipeline commands that may be used during any analysis. As you work through pipeline commands it will become clear that there are many tools available in pipelines. Further information about each command can be found in the V3D wiki documentation. For an example pipeline, in the CPHM demonstration data provided, the analysis of the R_LE_walk.cmo file was performed using the R_LE_walk_pipeline.v3s file.

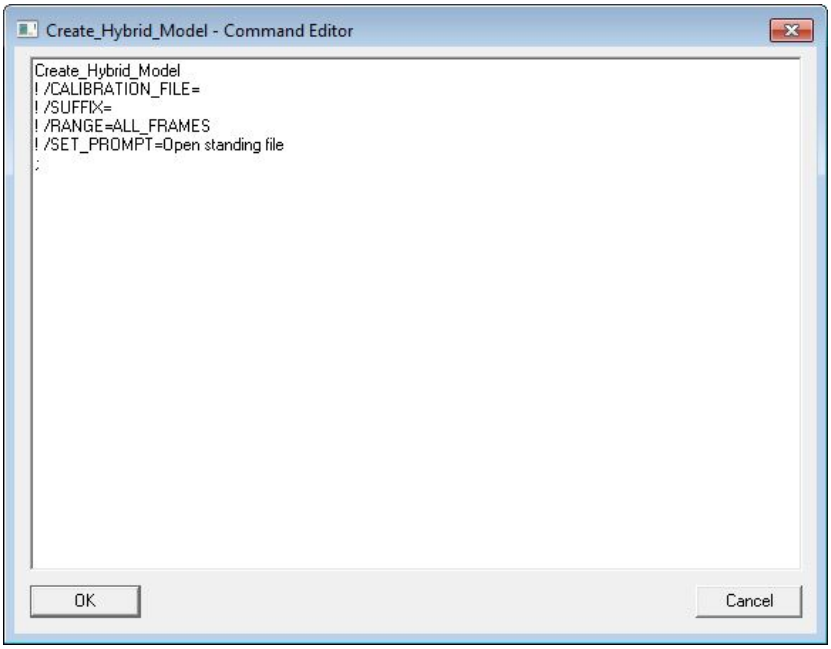
1. To use the pipeline tool, click on the pipeline button.  The following window will pop up.



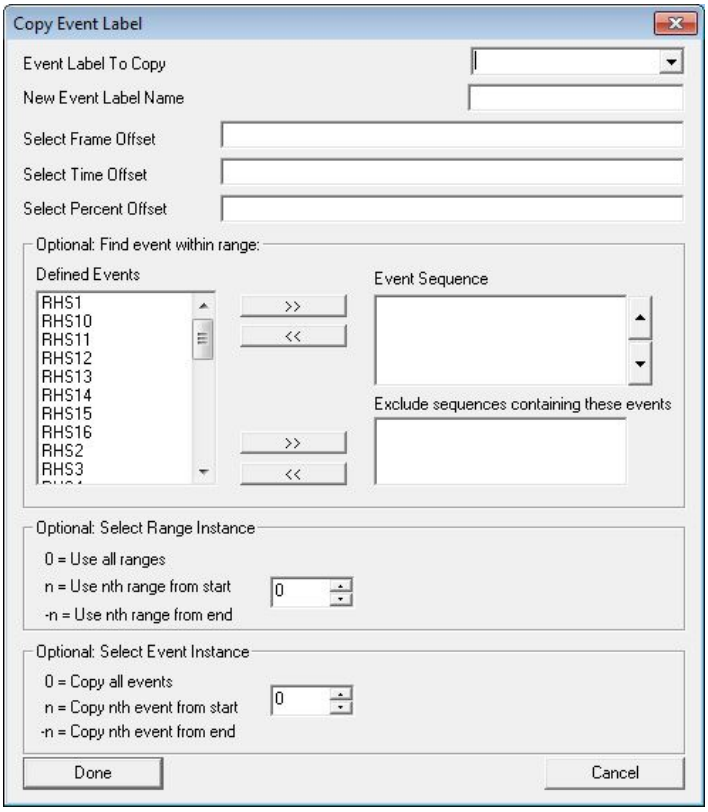
2. In the left hand pane of this window are all available commands, organized into subgroups. The center pane shows commands in the current pipeline, and the right hand pane shows a preview of a command in the current pipeline when it is selected. For example, if you were to start creating a pipeline with a command to create a model from a static trial, the window would look like this:



3. When you have a command in a current pipeline highlighted, the initial text of that command as well as a description of the command will appear in the right hand pane. To edit the command, double-click on the command in the middle pane. For the “Create_Hybrid_Model” command, double-clicking on the command will bring up a window of text that can be edited. In these types of windows, “!” indicates that the pipeline should skip this line of code or use the default value. In the window below, this means that there is no specific file that the pipeline is pulling, it will instead open a dialog window asking the user to “Open standing file.” If there is a specific file you’d like to load using this command, the path to this file can be entered in the “/CALIBRATION_FILE=” line and the “!” can be removed from this line.



4. In some cases, there are two different formats in which to edit a command. For example when you double-click on the “Event_Copy” command, it opens a GUI-type window. If you prefer to edit the command in text format, you can click on the command in the middle pane of the pipeline window and click the Text button.



5. When a pipeline is created and saved, the .v3s file can be opened as a text document for ease of batch editing (e.g., changing export file names on a subject-by-subject basis).

6. Pipeline window buttons:

A. “Open Pipeline…” allows you to open a previously-created pipeline. If you click this button when commands are already in the middle pane of the pipeline window, you will be given the option to replace the current commands or append the pipeline you are opening to the end of the current commands.

B. “Save Pipeline As…” allows you to save your pipeline. Pipelines do not automatically save. If you clear the pipeline or replace the pipeline by opening another pipeline, the pipeline will not be saved and you will not be prompted to save it.

C. “Clear Pipeline” clears all commands from the middle pane of the pipeline window.

D. “Clear Parameters” will clear any parameters entered in pipeline commands.

E. “Step” will execute the command currently highlighted in the middle pane.

F. “Execute Pipeline” will execute the entirety of the commands in the middle pane of the pipeline window from the first command to the last.

G. Note that there is no “undo” button anywhere in V3D.

7. Key pipeline commands. Users can follow along in the “R_LE_walk_pipeline” for examples of the implementation of each of these commands.

A. Create_Hybrid_Model + Apply_Model_Template: while models can be created and applied using the point and click steps detailed above, it is often useful to automate these steps once a model has been created and piloted. The “Create_Hybrid_Model” command will prompt a user to open a standing calibration trial and load this trial into the V3D workspace. The “Apply_Model_Template” command will prompt the user to select a model (.mdh) file and then apply this model to the standing calibration trial.

B. File_Open: this command prompts the user to open files which will be loaded into the V3D workspace. In the “R_LE_walk_pipeline,” this command is used to load movement trials after the creation of the model.

C. Assign_Model_File: this command will prompt the user to assign the model file to movement trials.

D. Lowpass_Filter: target (marker) and analog data often need to be filtered to remove noise. There are many filter options in V3D pipelines (see the “Signal Filter” section in the left hand pane of the pipeline window). In general, raw data should be filtered before performing calculations. Which filters should be used and at what step of the analysis they should be implemented depends on the task being performed and the analysis required. In the “R_LE_walk_pipeline” example, a lowpass Butterworth filter is applied to the marker data to remove signal above 8 Hz. The “NUM_REFLECTED” line in the command provides 100 reflected points on either side of the data to minimize time shifts in the data due to the filter. Note that when the target data are filtered, the filtered data are placed in a new folder: TARGET > PROCESSED, while the original, unfiltered data remain in the TARGET > ORIGINAL folder.

E. Interpolate: this command will fill data gaps of a specified size. This should not be used in lieu of tracking data in QTM but rather as a final sweep to correct any small gaps that were missed in tracking.

F. Select_Active_File: this command can be used to select all files or groups of files for further pipeline commands. When paired with an earlier “Assign_Tags_To_Files,” the Select_Active_File command can be used to perform pipeline commands on only a subset of files.

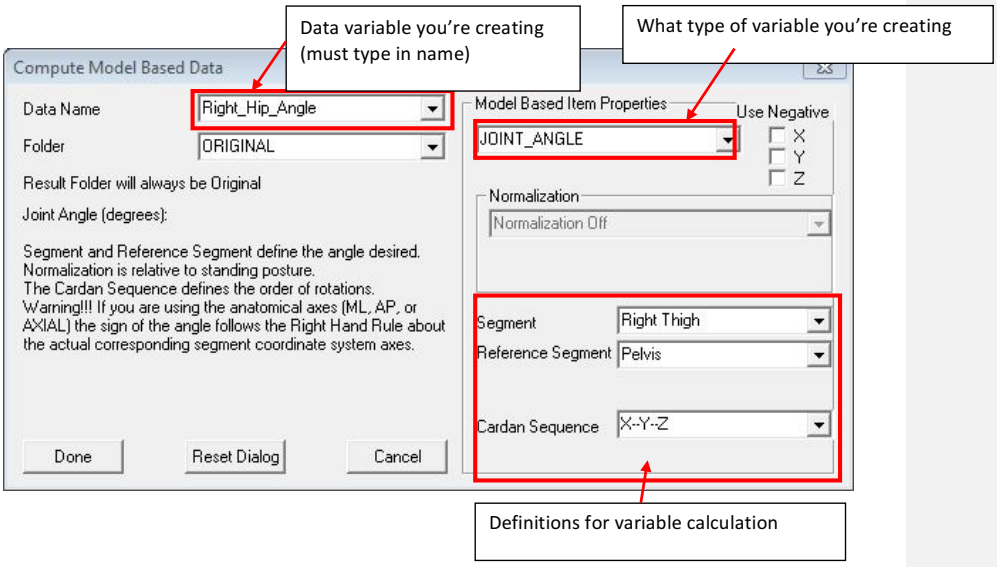
G. Event commands (e.g., Event_Minimum, Event_Maximum, Event_Threshold): can be used to automatically create events such as heel-strikes, toe-offs, maximum flexion, etc. These commands can be found in the “Event Creation” and “Event Management” sections of the left hand pane of the pipeline window. Note that it is often most useful to edit these commands using the “Text” option rather than the default GUI window.

H. For loops: the “For_Each” and “End_For_Each” commands can be used to begin and end for loops. In the “R_LE_walk_pipeline” example, these are used to recursively rename gait cycle events.

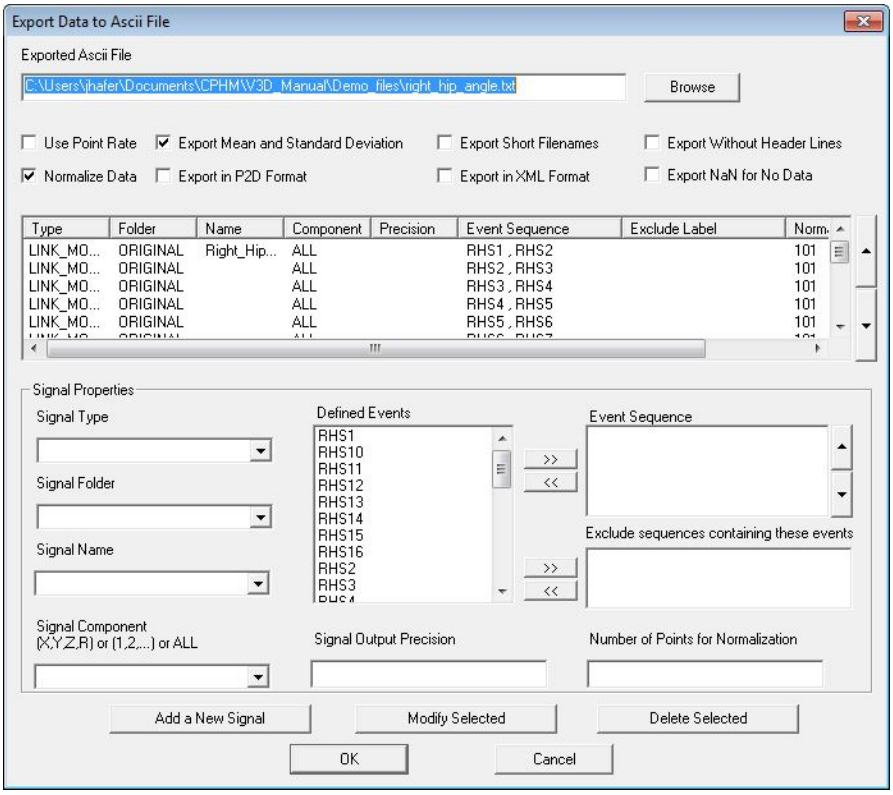
I. Signal math commands: these commands can be used to perform simple arithmetic on signals. For example, in the “R_LE_walk_pipeline,” the number of frames between consecutive heel strikes and between heel strikes and toe-offs are used to determine gait cycle times (using Subtract_Signals) and, subsequently, the percent of the gait cycle spent in the stance phase (using Divid_Signals).

J. Metric commands: these commands create new signals in the “METRIC” folder.

K. Compute_Model_Based_Data: this command is perhaps the most important command in V3D pipelines. With it, a user can compute a huge range of variables. When editing this command the following window appears. In it, you name the data variable you are creating, identify what type of variable you are calculating, and define the data being used to calculate this new variable. There are many different types of variables that can be created and the specifics of the algorithms used or computational order can be found in the V3D online documentation. The “Use Negative” options allow you to multiply a signal by -1 as you calculate it, which is commonly used to align data directions with common reporting practices (e.g., the right-hand rule will generally result in knee extension being a positive value, while reporting practices generally follow that knee flexion should be positive). Cardan Sequence should generally follow from axis of largest expected excursion to axis of smallest expected excursion for the movement of interest. In the below example window, for the right hip during walking we would expect the largest excursion to be in the sagittal, or X, axis, followed by frontal (Y axis) and transverse (Z) motion.



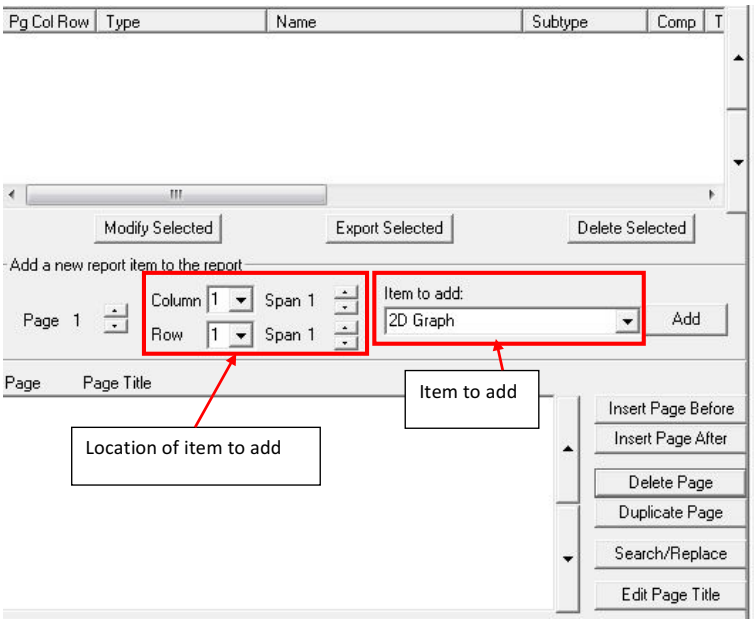
L. Export_Data_To_Ascii_File: this command is used to export data to a tab-delimited text file which can be read in excel or imported into a further data analysis program, such as MatLab. In the GUI window which pops up when you edit this command, you can designate the path for your exported Ascii file, select options such as exporting the mean and standard deviation of your data (if you have multiple trials), normalize your data (to make all trials the same relative length), among other options. When you select the signal type, folder, name, and component you'd like to export, you must click "Add a New Signal" to save these selections into the command. Likewise, if you wish to edit an existing command, you must click the "Modify Selected" button after making your edits to save them. In the example from "R_LE_walk_pipeline," note that each stride of data must have a separately designated event sequence and thus a separate line in the GUI. If you run this command (with an appropriately renamed file name path), you can open the exported file in excel to view the format of V3D Ascii files. If "Export Mean and Standard Deviation" is selected, the mean and standard deviation of all lines in the GUI will be computed, and these will appear as columns 2-7 in the Ascii export. Note that if you re-run the "Export_Data_To_Ascii_File" command without changing the "Exported Ascii File" name, you will overwrite any existing file at that file address. V3D will not give a "are you sure you wish to overwrite…" warning dialog before overwriting existing data.



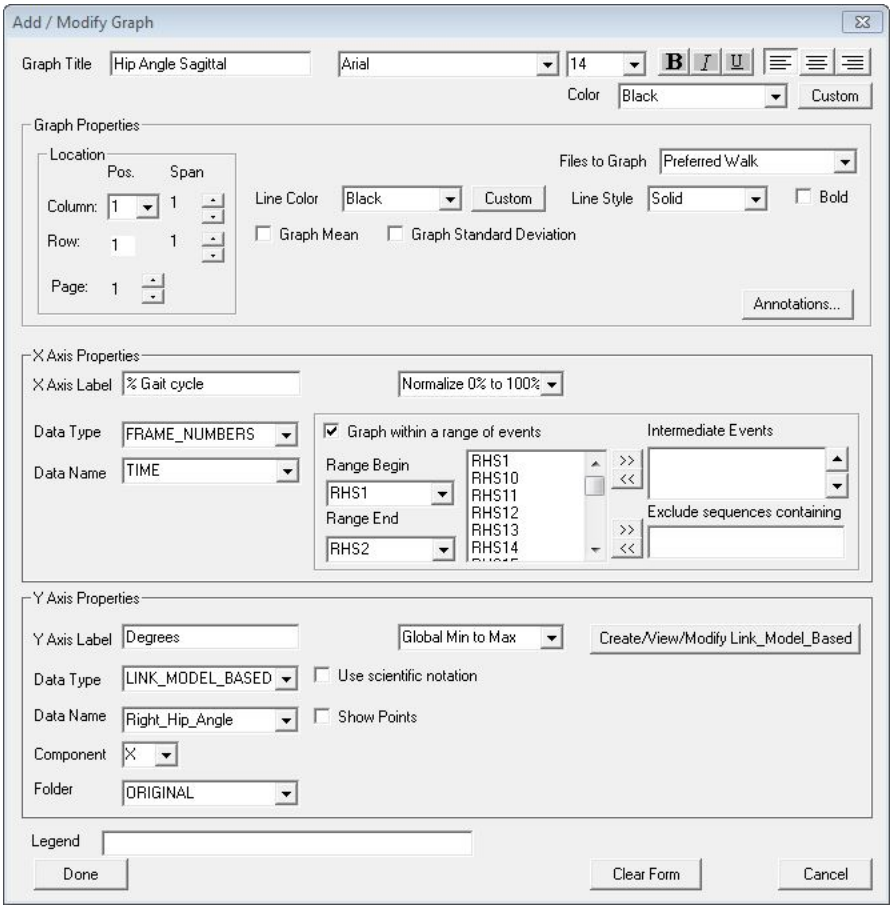
IV. Reports

V3D can create reports to assist with data visualization. These reports can plot variables that have been calculated and can generally be useful for checking calculations. A report is included in the "Reports" tab of the "R_LE_walk.cmo" file and the corresponding report template file is included in demonstration files as "R_LE_report_template.rgt." This report consists entirely of 2D graphs of joint kinematics. Reports are also able to generate tables, bar graphs, and other graphics. Below are some guidelines for creating a report.

1. When creating a new report from scratch, first designate the location of the item (graph/graphic) you wish to add, select the type of item you wish to add, and click the "Add" button.



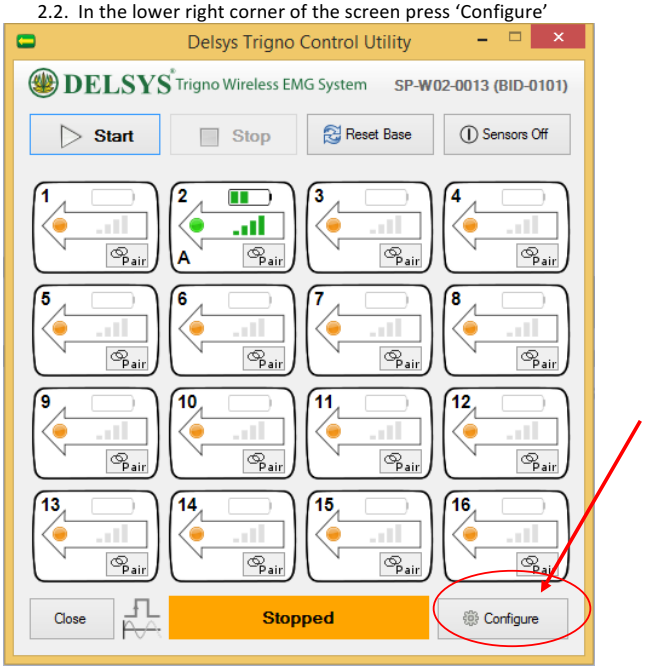
2. An “Add/Modify Graph” window will pop up. Here you can designate what data to graph in which position. Below is an example of this window populated for plotting one stride of sagittal hip angle data.



3. In a report with multiple movement cycles and multiples variables of interest, there will be many lines in the report generation dialog. Along with multiple columns and rows of plots on a single page, reports can contain multiple pages, allowing for easy visualization of lots of data. If you are interested in generating reports, it is recommended that you explore the documentation on reports in the V3D wiki (https://www.c-motion.com/v3dwiki/index.php/Tutorial:_Creating_a_Report) for further information and examples.

1. General Information about Trigno Sensors
   1.1. Sensors 1-8 have EMG + Triaxial Accelerometer sensors.
      1.1.1. When used in conjunction with QTM the sensors have collection frequencies of EMG 1925.25Hz (upsampled to 2000 Hz) and 148.48 Hz (upsampled to ??).
   1.2. Sensors 9-16 have EMG + Triaxial Accelerometer, Gyroscopes and Magnetometers.
      1.2.1. When used in conjunction with QTM the sensors have collection frequencies of EMG 1925.25Hz (upsampled to 2000 Hz) and 148.48 Hz (up sampled to ??).

2. Configuring the Trigno Sensors
   2.1. Open the 'Delsys Trigno Contorl Utility'
   2.2. In the lower right corner of the screen press 'Configure'



Add the rest of the configuration screens – what they are how they work.

3. Pairing Sensors.

3.1. Pair the sensors you would like to use

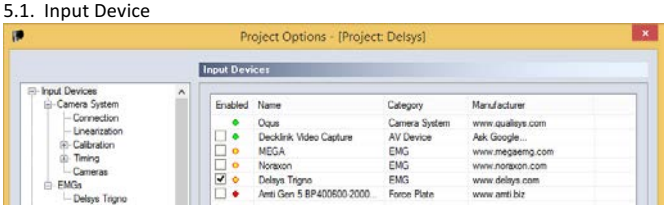
3.1.1.Push the pair button in “Delsys Trigno Control Utility’ software.

3.1.2. Push the button on the sensor until you see a flashing green light. You should also receive a confirmation on the computer screen that the sensor has successfully paired

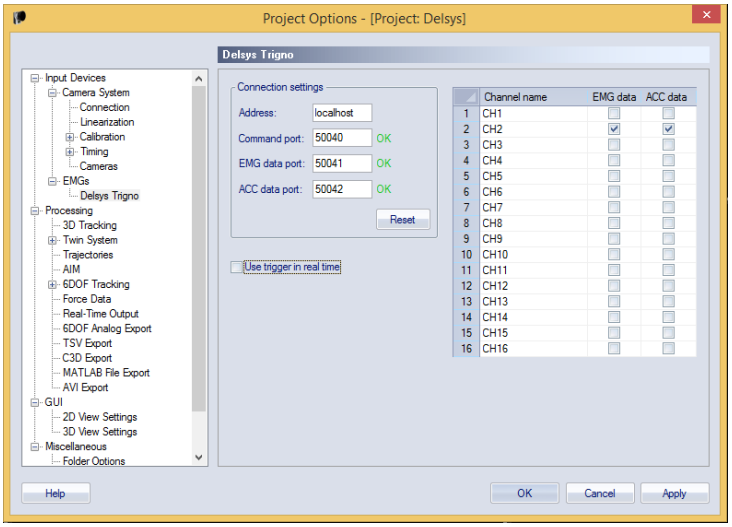
4. Placement and orientation of sensors

5. Enabling Sensors in QTM

5.1. Input Device

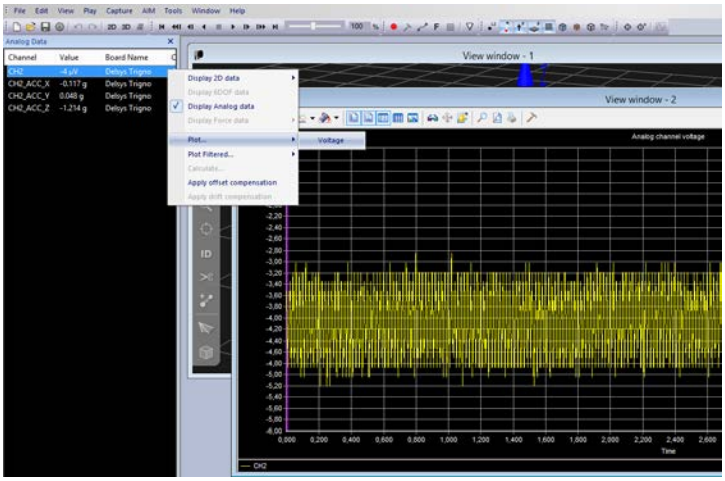


6. Labeling Sensors in QTM



7. Accessing Sensor data in QTM

7.1. Sensor data can be viewed in real time



MANUAL OF PROCEDURES

Living Science Core

Institute of Applied Life Sciences

Life Science Laboratories S360

240 Thatcher Road,

Amherst, MA 01003

at the

University of Massachusetts, Amherst

UNIVERSITY OF MASSACHUSETTS AMHERST

INSTITUTE FOR APPLIED LIFE SCIENCE

Human Testing Center

Living Science Core

Chapter 1: Oxycon Mobile

1.1 *Introduction*: The Oxycon mobile is a portable indirect calorimetry unit that measures metabolic responses to exercise, work or other activities that stationary metabolic units cannot measure. The wireless capabilities of this unit operate via telemetry, up to 1,000m in line of sight range. The Oxycon Mobile affords users the opportunity for on-the-spot recording of cardiopulmonary and deduced parameters such as: VO_2, VCO_2, RER, VEO_2, $VECO_2$, $PETO_2$. VE, VT, BF, BR, and SpO_2, etc. Researchers can choose to monitor parameters in either, breath-by-breath or intrabreath epochs. Additionally, researchers can monitor these data in real-time (via telemetry), or post hoc, as data are stored to an internal SD memory card.

Core Competencies:

1. Be able to follow calibration instructions
2. Understand how to outfit participant with equipotent
3. Review steps for setting up, collecting, and reviewing session data through a screen report
4. Familiarize yourself with how to generate a .CSV report

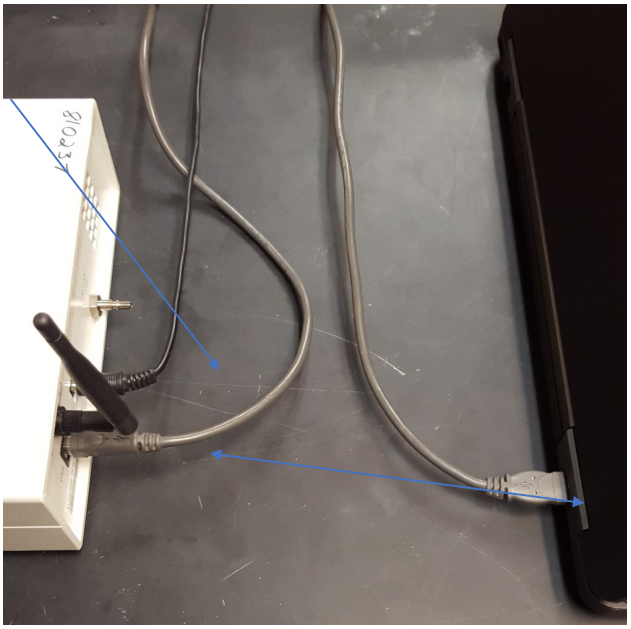
1.2 *How to Calibrate*: Below is a step-by-step outline for calibrating the unit.

Preliminary Calibration Steps

1.) Retrieve Computer from Oxycon case
   a. Username: labsup Password: lab
2.) Collect receiver unit (pictured below)

3.) Plug in power and connect computer to receiver unit using grey USB cable

Power cord



4.) Grab the two packs (SBX, DEX) and a memory card
   a. SBX: Sensor box (O2 & CO2 sensor)
   b. DEX: Data exchange unit

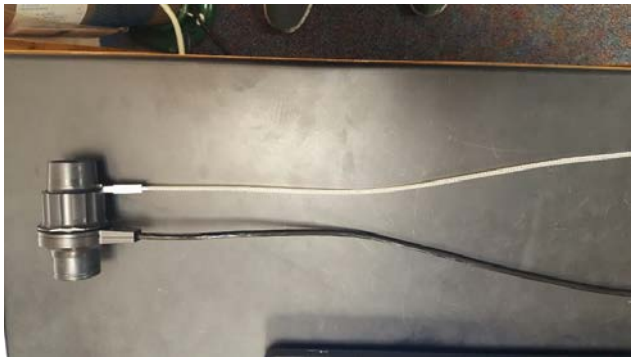
5.) Warm up SBX by connecting it to the receiver with yellow Ethernet cable

6.) Open lab manager
    a. Allow warm-up for 15 minutes

7.) Assemble necessary components of mask
   a. Attach turbine to turbine holder (metal (silver) side in first)

   b. Make sure turbine is not wet
   c. Connect infrared sensor to turbine

   d. Be sure sampling tube is attached to the turbine holder (opposite end of infrared)



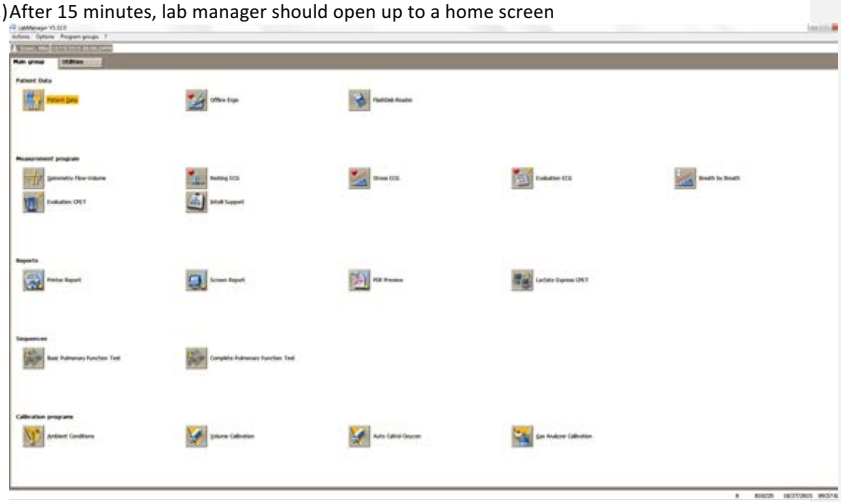
8.) Attach mask components and tighten sampling tube and infrared sensor to SBX


Oxycon
Mobile
SBx

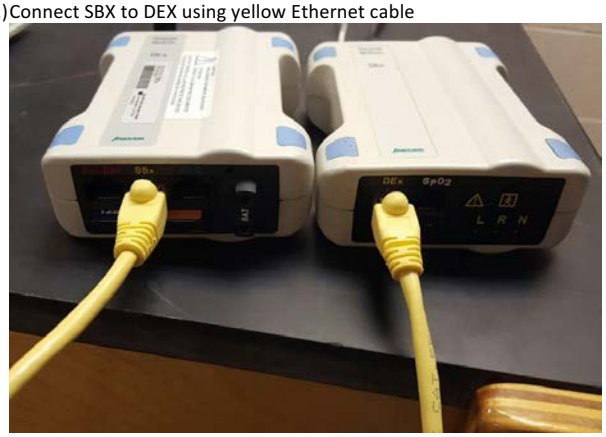
9.) Place appropriate study memory card in DEX unit and add battery (make sure it is charged)

a. If DEX doesn't turn off right away, press off button

10.) After 15 minutes, lab manager should open up to a home screen



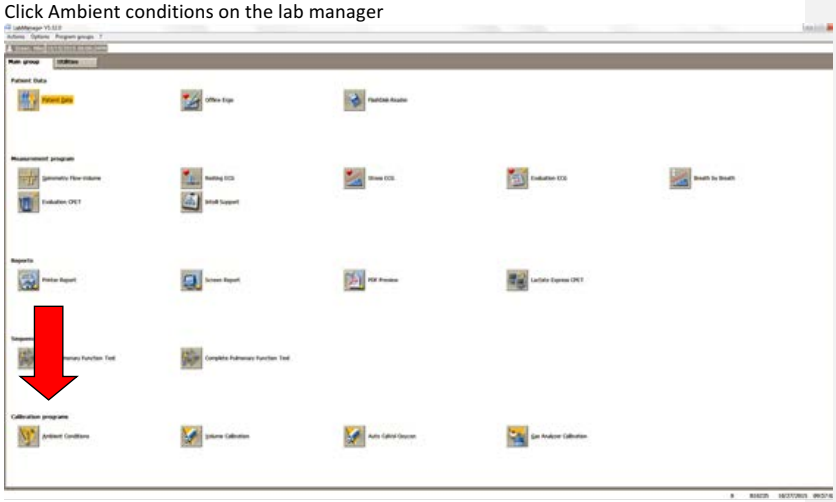
11.)Connect SBX to DEX using yellow Ethernet cable



a. After a few seconds of SBX **vibrating**, a light should flash on SBX
b. If the battery is low, SBX will beep and a note will pop up on the screen
c. Be sure green LED's on both units are lit prior to calibration

1.3 **Oxycon Mobile Calibration**

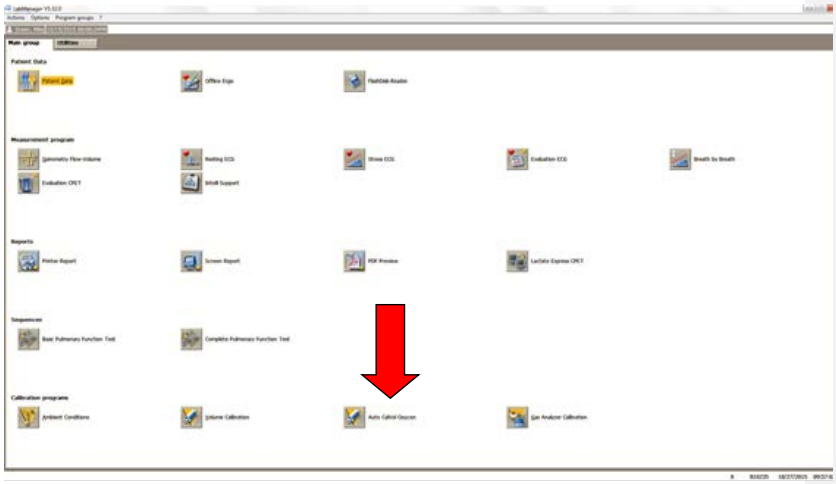
1. Click Ambient conditions on the lab manager



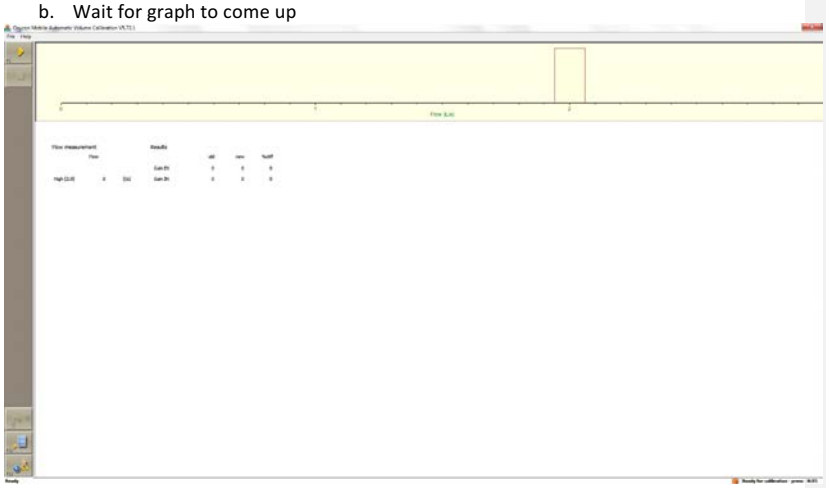
a. DEX senses
    i. Usually accurate temperature and barometric pressure
    ii. Manually enter humidity
b. Check grey box in the laboratory on the Parvo metabolic cart for environmental conditions
    i. Press F1 to change temperature, barometric pressure and humidity
    ii. Leave barometric pressure as is
c. Press F12 to save

2. Connect SBX back to receiver using yellow Ethernet cable
    a. Wait for SBX to get power (will vibrate and LED lights up green when ready to continue)

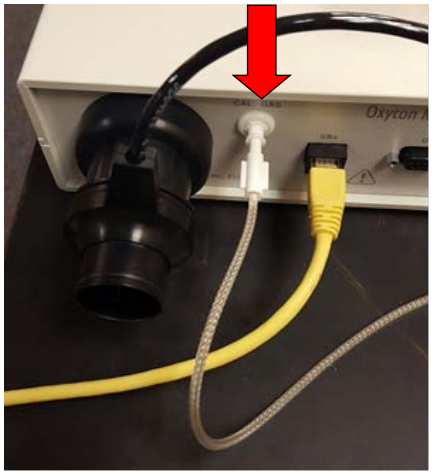
3. Set up for AutoVolume Calibration
    a. Click Auto volume calibrations from calibrations group



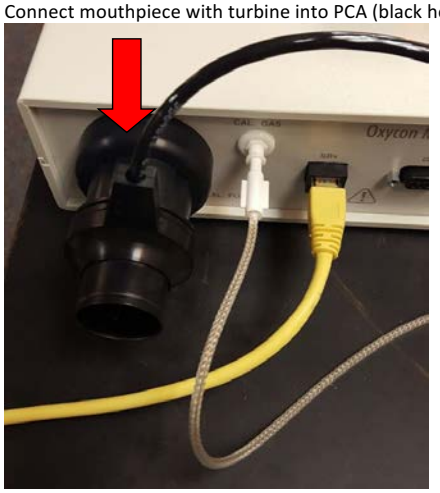
b. Wait for graph to come up



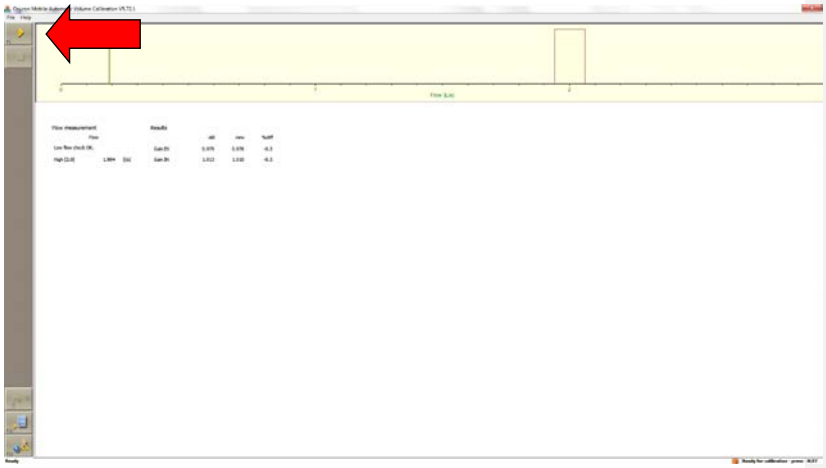
4. Connect white sampling tube, into receiver and SBX



5. Connect mouthpiece with turbine into PCA (black hole) with sample tube hole covered

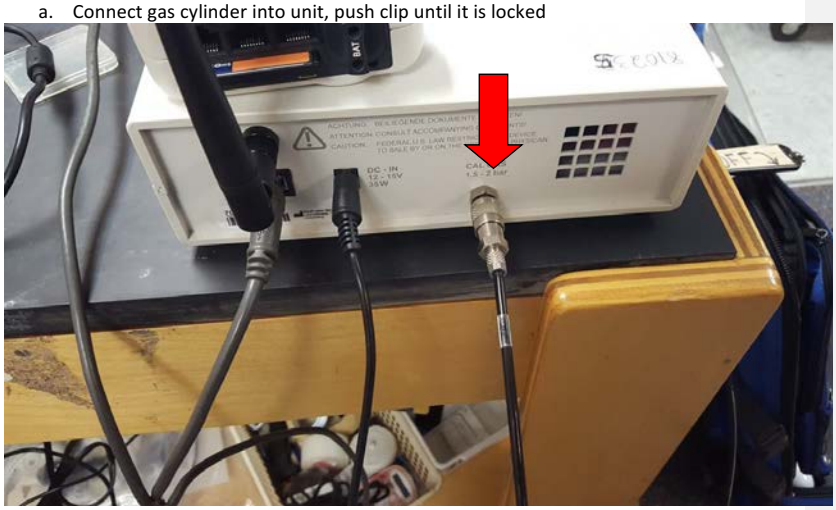


6. Press F1 to begin AutoVolume Calibration



a. If %difference is less than 3% press F12 to save
b. If %difference is greater than 3%, check lines and connections and retry

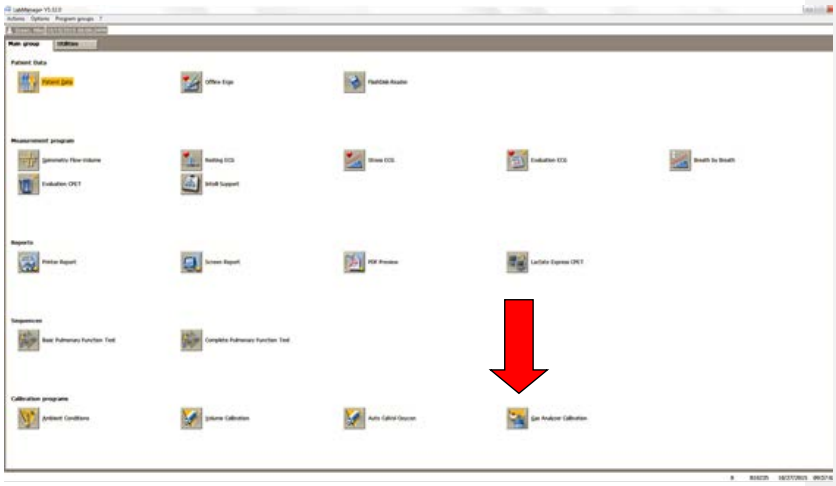
7. Gas Analyzer Calibration
   a. Connect gas cylinder into unit, push clip until it is locked



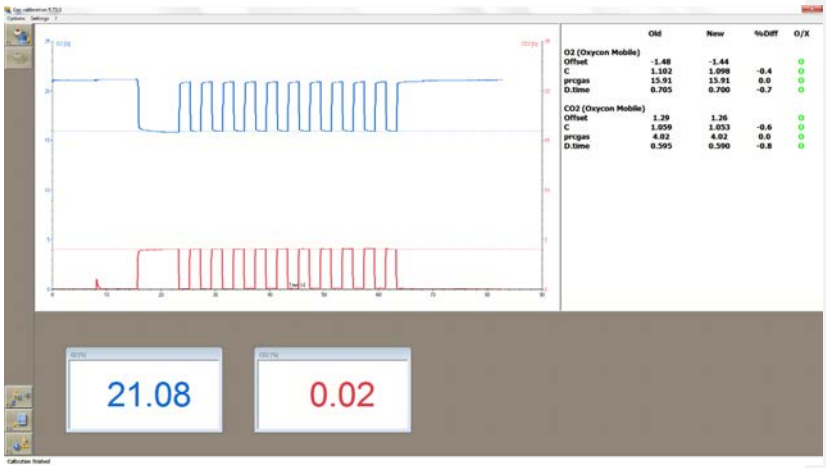
b. Open gas cylinder by twisting the valve from the calibration gas two complete turns

i. Cylinder contains 15.98% O2 and 3.9% CO2 concentrations

c. Click on Gas Analyzer Calibration in the lab manager

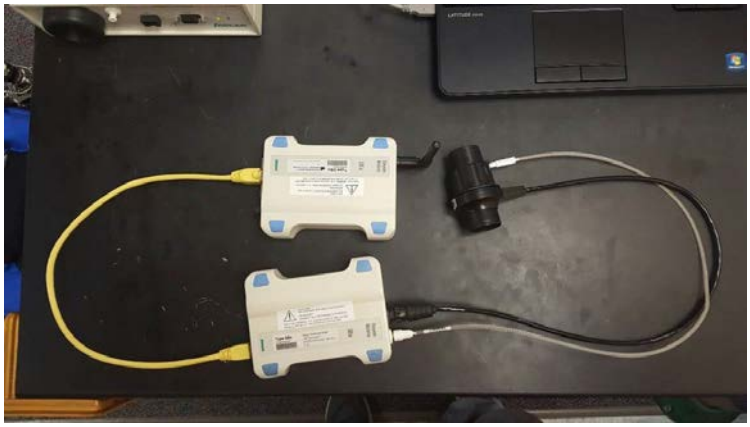


d. Click on the settings tab at the top and enter in analysis results from the "Certificate of Analysis" provided by Airgas, this sheet should be with the gas tanks
e. Then, press F1 to begin, Graph will appear and calibration will begin
f. Calibration will sample room air along with cylinder air



g. O2 peaks at 21 and valley; blue line
h. CO2 will valley at 0 and then peak; red line
i. If percent difference less than 3% press F12 and save
j. Turn of air cylinder
k. If percent error greater than 3%, repeat process

8. Reassemble SBX and DEX with yellow Ethernet



9. Reassemble mouthpiece with sampling tube
    a. Place new battery in DEX

1.4 **Testing with the Oxycon Mobile**

1. Input patient data
    a. Press F2 to create new subject
    b. Be sure to fill out Last Name, First Name, Identification, DOB, Gender, Height and Weight (press enter to navigate through patient inputs)

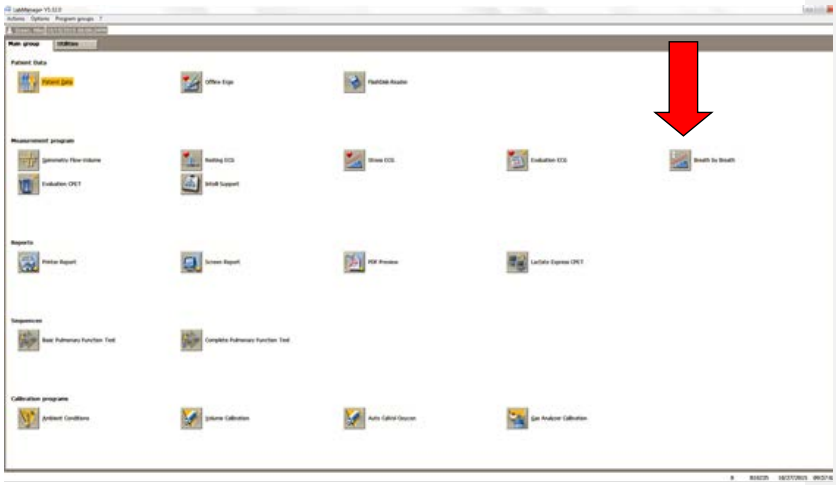
    c. Press F12 to save current subject information

2. Size subject for heart rate belt
    a. Wet sensors
    b. Attach sensors to belt
    c. Subject puts on heart rate monitor ensuring the sensor is at the sternum

3. Size subject for mask
    a. Have subject put mask on and cover breathing hole
    b. Have the subject blow to make sure there are no leaks
    c. Attach the four clips to the mask
    d. Have the subject hold the mask in place while the researcher clips the black head gear net to the mask (tag goes in front)

4. Size subject for backpack
    a. Attach the SBX and DEX to the backpack (wires facing up)
    b. Subject puts on backpack
    c. Attach mask with white sampling tube (white sampling tube should be closest to the subjects face)

5. To begin data collection, click breath by breath

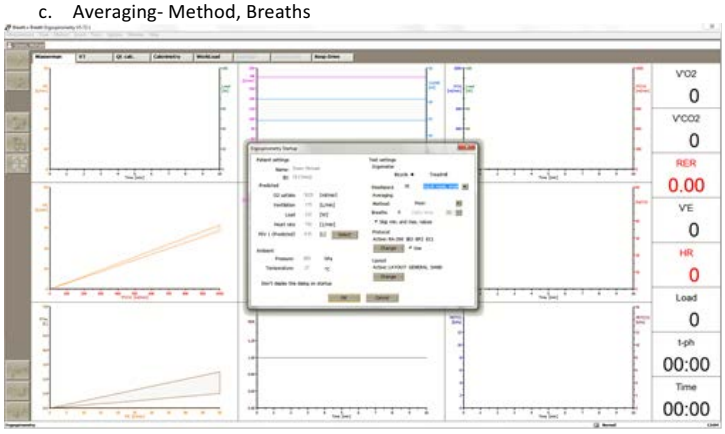


   a. Make sure DEX and SBX have green lights
      i. If yellow, flip SBX and DEX, check HR belt position, check battery

6. Ensure all Patient Data is correct

7. Check Test settings

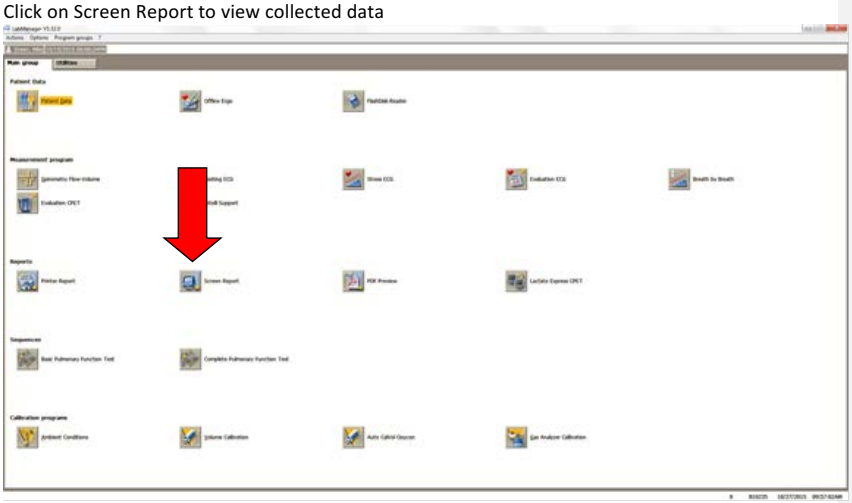
a. Ergometer- Modality must be bicycle
b. Dead Space- click appropriate size corresponding to subject's mask size
c. Averaging- Method, Breaths



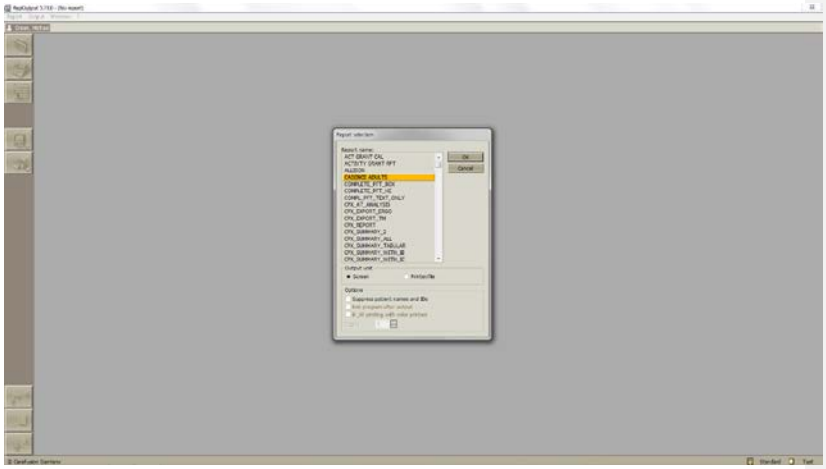
8. Press F1 or play to analyze baseline information (background zeroing, noted in bottom right corner)
9. Press F1 or play again to start recording data
10. After data collection is complete be sure the upper left button (play) is now a "stop" button to end recording
11. Press 12 to exit and save

1.5 **Reviewing the Data**

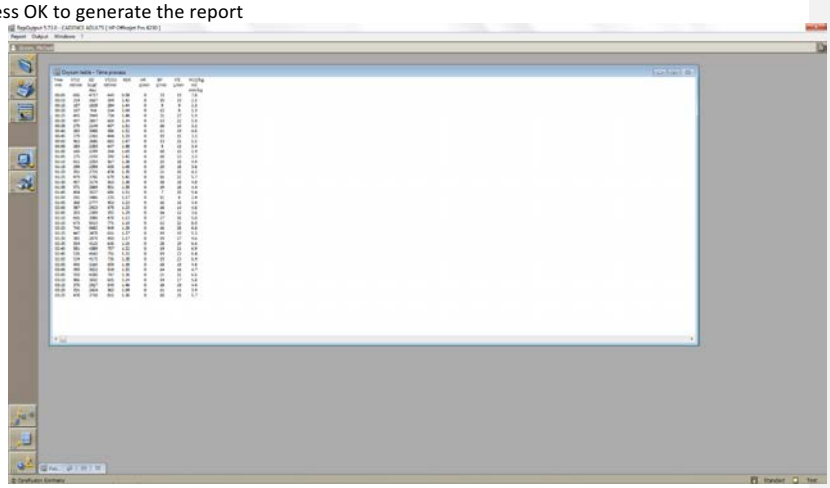
1. Click on Screen Report to view collected data



2. From the report list, choose the report view you would like (study specific, for more information on creating new data visualization templates see below)

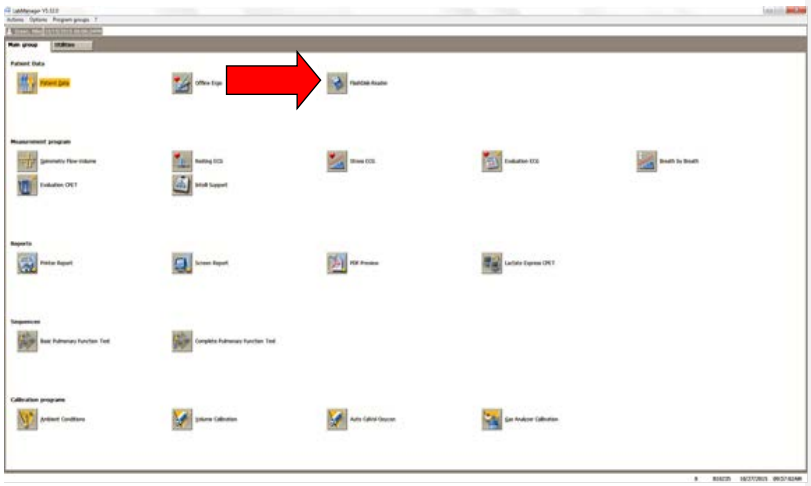


3. Press OK to generate the report

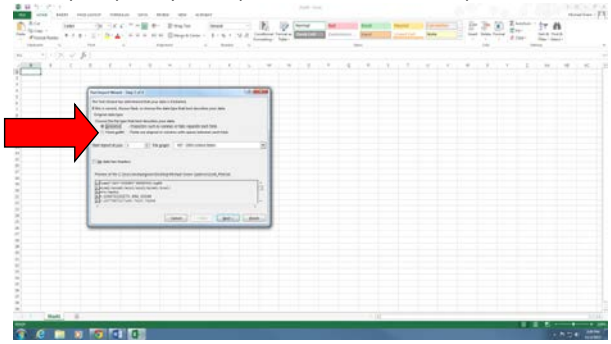


4. To export usable data press F9 and save on a local drive

5. To import from storage device select Flashdisk reader

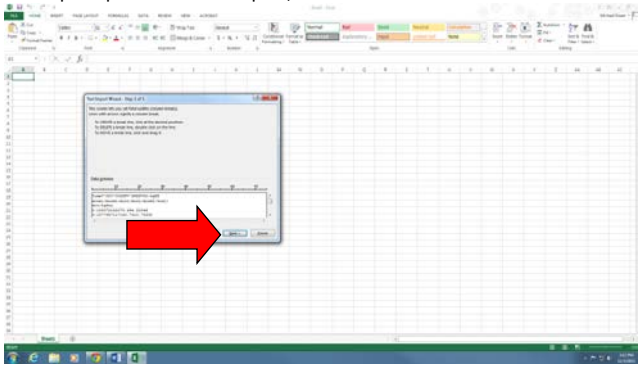


6. Import the file you would like to review
7. Make sure the Current patient matches the file you are trying to import
8. Press F1 to read file
9. After file is loaded press F12 to save
10. Repeat Steps 1-4
11. To view saved file in Excel, open Excel and go to File-Open
12. Find the saved file
13. When prompted by the Import Wizard, Make sure Import Row is at 1 and Fixed Width is selected

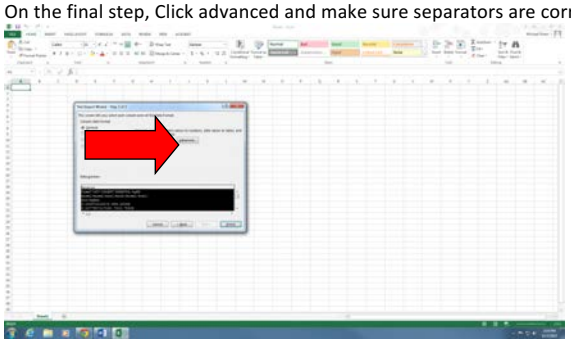


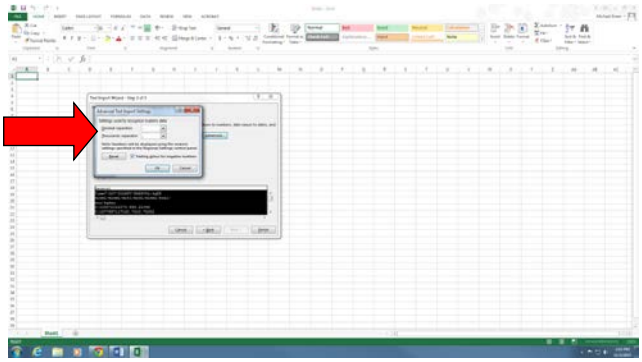
14. Click Next

15. When prompted with text import, also click next

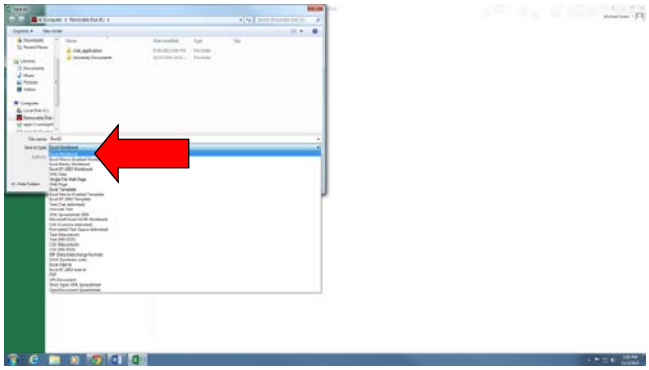


16. On the final step, Click advanced and make sure separators are correct





17. After import is complete, select Save as and be sure to check the correct file extension



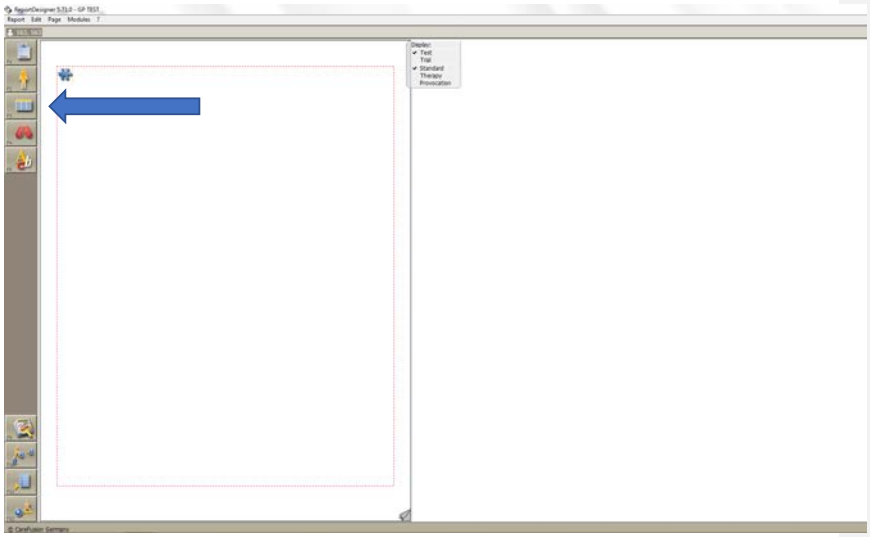
1.6 **Cleaning Equipment**

1. Disassemble all pieces to be cleaned
2. Wipe turbine holder and infrared sensor with alcohol wipes.
3. Headgear straps and heart rate monitors should be rinsed and hung up to dry
4. Masks should be soaked in a 25:1 cleaning solution for 30 seconds and rinsed thoroughly
5. The turbine must be soaked in a special solution
    a. In the marked container, fill the to the brim with Sterilizing and Disinfecting solution
    b. In the clear plastic cup located nearby, fill the cup to the first indent (black line) with the Activator solution
    c. Pour the Activator solution in the sterilizing solution and mix thoroughly
    d. Place the plastic grate into the solution with the turbine inside
    e. Allow the turbine to sit for 15 minutes
    f. Remove from solution and rinse with water
    g. Let air dry

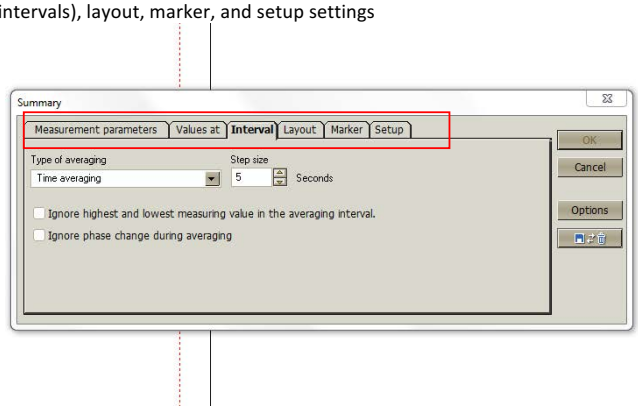
1.7 Creating a New Data Visualization Template

1. Click on the utilities tab
2. Enter password: abcd
3. Click on report designer
4. Name new report, output unit: default printer (JLAB pdf printer)
5. Click ok
6. Click on the table at the right (has F3 on button)

Comment [MB3]: Is this actually the password?



7. Choose Oxycon table, then click summary
8. Here you can choose measurement program (breath-by-breath, endtidal, cardiac output, intrabreath, etc.)
9. Depending on the measurement program selected you can add parameters to your summary, do this by highlighting a parameter you are interested in and click “Insert”. This will add it to your screen report summary
10. By further navigating through the tabs at the top of the dialogue box, you can select averaging type (intervals), layout, marker, and setup settings



11. Press F12 to save the report, and name the report. Note: the name you give the report will be how it is presented in the screen report section (see **Reviewing the Data** to re-familiarize yourself with this step)

1.8 Contacts

1. Kim at Carefusion: 1 800 231 2466
   Operator will prompt you through a screener, click 1 at first question, click 2 at second question, click 3 at third question.

Note: Have receiver unit on hand when you call, it has serial number they will need when assisting you.

2. Michael Busa – Core Director
   413-577-0574
   mbusa@umass.edu

Chapter 2: Actigraph Link (GT9X)

2.1 Supplies

1) ActiGraph GTX accelerometer charging cable
2) ActiGraph dock
3) ActiLife 6 software
4) Computer to run ActiLife 6 software

2.2 Device Charging

The ActiGraph GT9X accelerometer contains a rechargeable Lithium Polymer battery which is capable of providing power for continuous data collection periods of 10 or more days without recharging. If the battery has been fully depleted at the time of charging, it will take approximately 3-4 hours for the ActiGraph GT9X accelerometer to reach full charge.

Charging Procedures

1) Connect ActiGraph dock to computer or wall outlet using mini USB cable
2) Plug the ActiGraph Link into the dock with the ActiGraph logo facing up. Once connected, the red LED light on the right side of the dock will turn yellow, the device screen will display the serial number, and the batter icon will blink to indicate charging.
3) Once the device is fully charged, the yellow light will turn green and the battery icon on the device will show as full and stay on steady

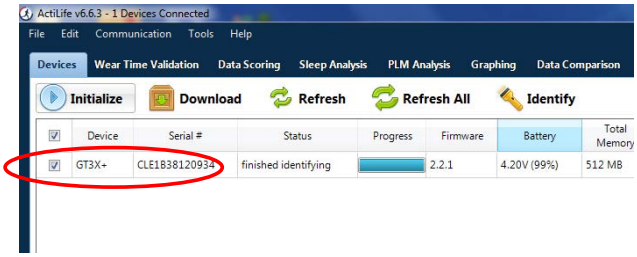
2.3 Device Initialization

The ActiGraph GT9X accelerometers are initialized with the ActiLife 6 software package. The ActiGraph GT9X accelerometer will not collect data unless it is initialized using the ActiLife software.

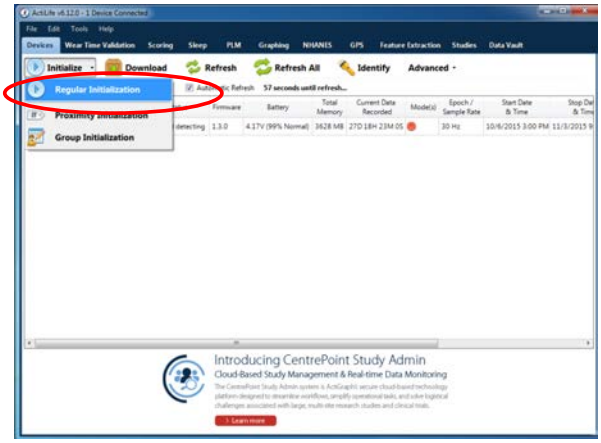
Initialization Procedures

1) Open the ActiLife 6 software by double-clicking on the desktop icon or by single-clicking on the start menu shortcut for the program.

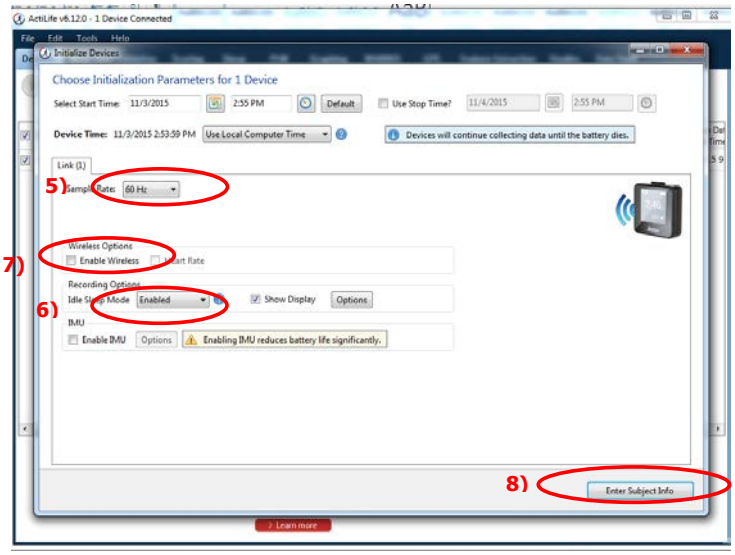
2) Plug the charging cable into a standard USB port on the computer running the ActiLife 6 software.
3) Select the accelerometer that will be initialized by checking the box beside the accelerometer device name and serial number.



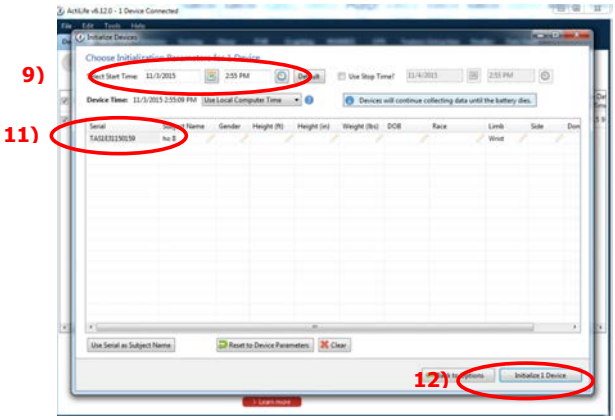
4) From the “Initialize” button choose “Regular Initialization”. This will open the primary initialization window.



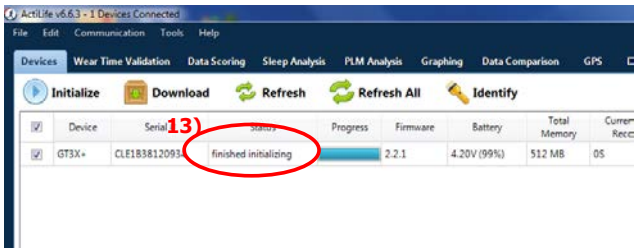
5) Select a sampling rate
6) Select idle sleep mode.
7) Note: Select Wireless Option, heart rate, sleep mode, and IMU
8) Click the “Enter Subject Info” button. This will open the secondary initialization window.



9) Select a start date and time at the time subject orientation is scheduled to begin
10) Select a stop date and time to stop data collection at a specified time (can be left blank)



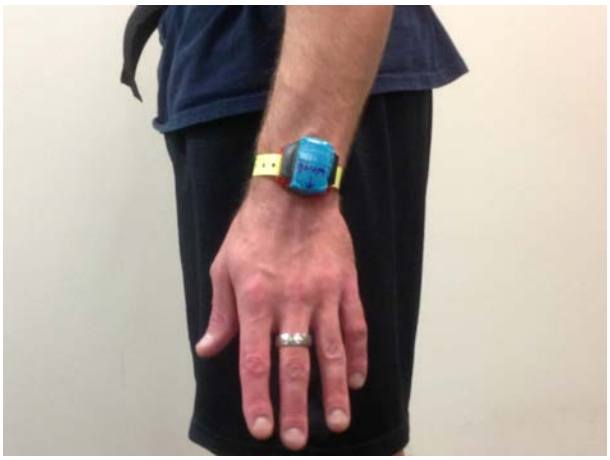
11) Input an appropriate identifier (e.g., "S#") in the "Subject Name" field.
12) Input the appropriate "Limb" and "Side" information (e.g. right hip or left wrist)
13) Click the "Initialize 1 Device" button. This will close the window and return to the main software window.
14) If properly initialized, the words "finished initializing" should appear underneath the "Status" column.



15) The ActiGraph GT9X accelerometer is now ready for data collection. Unplug accelerometer from the charging cable.

2.4 Accelerometer Placement

The ActiGraph GT9X can be worn at the hip (around the waist) and on the wrist. Elastic belts and wrist straps will be used to secure the accelerometers to the participant's body (see pictures for details).



Secured around the waist at the right hip and attached to an elastic belt. Make sure that the GT9X is positioned directly on the body's side (mid-axillary line)

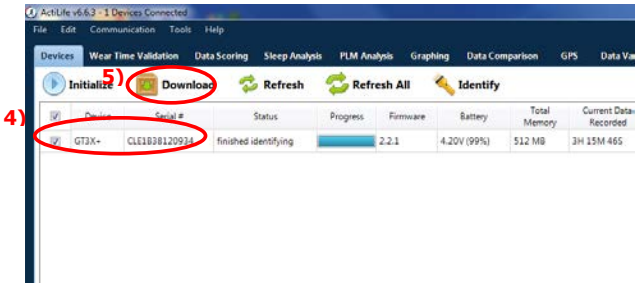
2.5 Data Retrieval and Download

The previously described ActiLife 6 software utility is required to download data from the ActiGraph GT9X accelerometer.

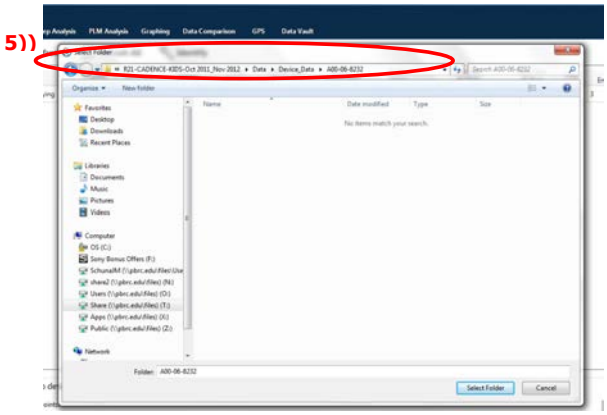
Download Procedures

1) Open the ActiLife 6 software by double-clicking on the desktop icon or by single-clicking on the start menu shortcut for the program.

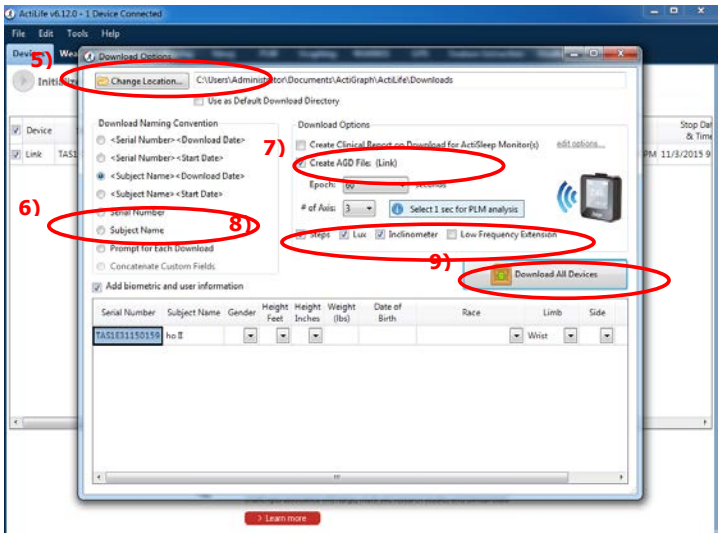
2) Plug the ActiGraph Link into the dock with the ActiGraph gold plates contacting the gold pins of the dock.
3) Plug the charging cable into a standard USB port on the computer running the ActiLife 6 software.
4) Select the accelerometer that will be initialized by checking the box beside the accelerometer device name and serial number.



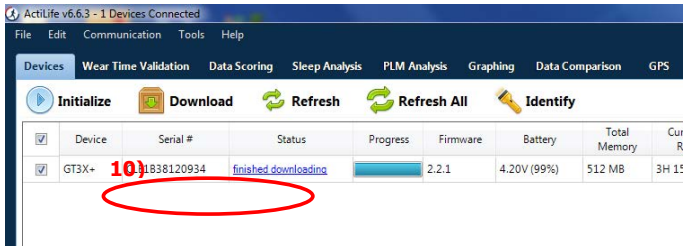
5) Click on the “Download” button. This will open the primary download window.
Click “Change Location” to select destination file
6) Within the “GT9X Download Options” box, make sure the “Create AGD File” box is checked and specify the “Epoch”.
7) Check the appropriate boxes for your protocol.



8) Click the “Download All Devices” button. The primary download window will close and return to the main software window and dialog box will appear asking you to name the file. The download process may take several minutes.



9) If properly data was properly downloaded, the words “finished downloading” should appear underneath the “Status” column.



10) Now it is necessary to process the default filter .agd file. Select “Scoring” > Check all item > click “Remove Selected” > Click “Add Dataset” > Select the previously downloaded AGD File
11) Click “Calculate”
12) Go to “Details” on the calculated file and click “Export All Epochs”
13) Go to “Open Containing Folder”, rename the file (S#_ActiGraph_Location.csv) and put it in the appropriate folder

MANUAL OF PROCEDURES

Room Calorimeter Core

Institute of Applied Life Sciences

Life Science Laboratories S360

240 Thatcher Road,

Amherst, MA 01003

at the

University of Massachusetts, Amherst

UNIVERSITY OF MASSACHUSETTS AMHERST

INSTITUTE FOR APPLIED LIFE SCIENCE

Human Testing Center

Room Calorimeter Core

Chapter 1: Quick Guide for Calibration/Validation

Supplies

Quick Guide: Calorimeter Room Operation

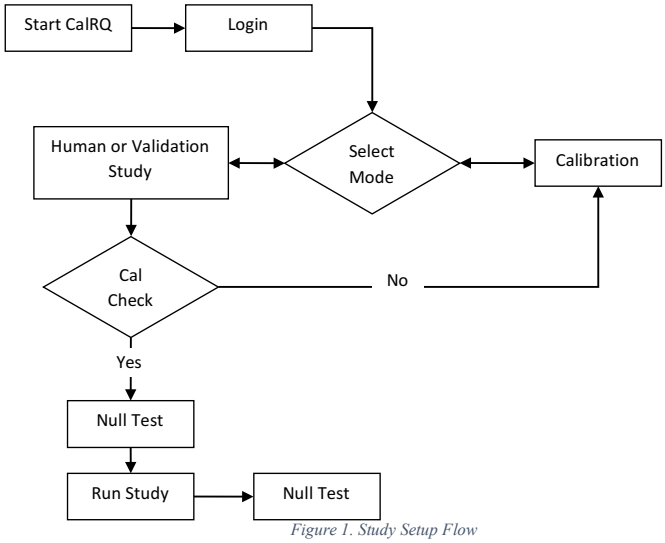


Figure 1. Study Setup Flow

Gas Tank Check List

Prior to calibration tests and validation studies, check tank pressures.

Tank	**Minimum Pressure**	**Tests**
CO_2	100 psi	Infusion, Short Circuit, Blender Calibration
O_2	800 psi for blender cal, NA for infusion	Blender calibration

N_2	1500 for blender cal, 800 psi for Infusion, 500 for Short Circuit	Infusion, Short Circuit, Blender Calibration
Zero Tank	400 psi	Tank Calibration, Cal Check
Span Tank	400 psi	Tank Calibration, Cal Check
Ref Tank	400 psi	All tests – always open

Panel instrument settings for all tests

		Std Setting
1	Chamber 1 O_2 Rotameter	1.25 L/min
2	Chamber 1 CO_2 Rotameter	1.25 L/min
3	Chamber 2 O_2 Rotameter	1.25 L/min
4	Chamber 2 CO_2 Rotameter	1.25 L/min
5	Inflow O_2 Rotameter	1.25 L/min
6	Inflow CO_2 Rotameter	1.25 L/min
7	Chamber 1 Sample Pressure Gauge	2 psi
8	Chamber 1 Sample Pressure Regulator	2 psi
9	Chamber 2 Sample Pressure Gauge	2 psi
10	Chamber 2 Sample Pressure Regulator	2 psi
11	Inflow Sample Pressure Gauge	2 psi
12	Inflow Sample Pressure Regulator	2 psi

Analyzer Calibration

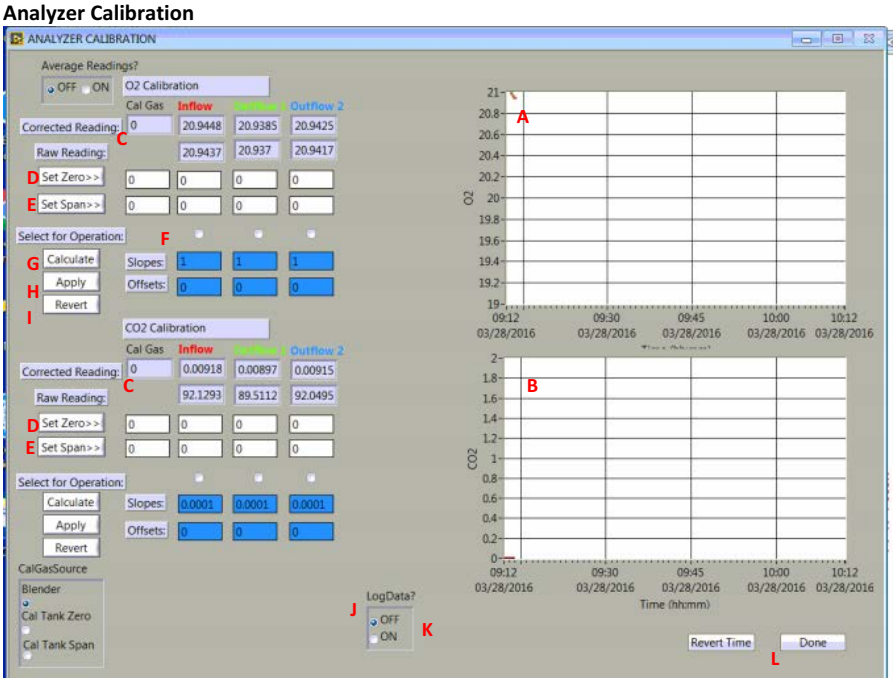


Figure 2. Calibration Screen

Cal Check: flow zero and span gases to check values

Analyzer Gain: Subtract the apparent concentration on the computer of the span value from the apparent concentration on the computer of the zero value. This delta should match the delta of the span from the blender or tanks (Span (20.95) – Zero (20.05) = 0.9 delta).

Analyzer Calibration: Flow zero and span gases, change slope and offset values in the analyzer. If analyzer values are out of range (<19.8% or >21.2% for O_2; >1.1% for CO_2) perform calibration on analyzers, when analyzers are stable, perform calibration on software, if needed.

Software Calibration: Flow zero and span gases, change slope and offset values in the software

Delta: The difference between the span value and the zero value. Subtract the apparent concentration of the span value displayed on the computer from the apparent concentration on the computer of the zero value.

$$Delta = zero - span \quad \text{eq (1)}$$

$$0.9 = 20.95 - 20.05 \quad \text{eq (2)}$$

Data file is recording when the logging button (J) displays “Logging On” and Enter Note box (K) appears. File recording will stop when logging button displays “Logging Off” or “Done” (L) is pressed. “Done” also closes the window.

Blender Calibration:

1. Open N2, CO2 and O2 tanks
2. Flip Instrumentation Panel valves to match those shown in Figure 3. Flip blender valves for calibration.
3. Check flow rates (1.25 lpm) and pressures (~2 psi) for each analyzer
4. Once the gas is flowing, watch the O_2 (A) and CO_2 (B) graphs until the values are steady. Turn Averaging on, and let blender run for at least an hour.
5. After hour is complete, press the "Set Zero" button (D).
6. After the values are stored, enter the calibration tank's gas concentrations in their respective entry boxes in the "Cal Gas" column (C) (i.e. if a calibration gas consisting of a blend of 21.02 %O2 and 0 %CO2 is flowing into the analyzers, 21.02 would be entered in the "Cal Gas" column for the O2 analyzers and 0 would be entered for the CO2 analyzers). Default tank values can be changed on the Preferences screen.
7. Repeat steps 3-6 using the Span Blend.
8. Select radio buttons (F) for each analyzer you would like to calibrate. Buttons will turn blue if calculations will be performed for that analyzer.
9. After zero and span values have been stored, press "Calculate" (G). New slopes and offsets are calculated, but not applied to analyzer gas values.
10. If slopes and offsets are acceptable, press "Apply" (H). New slopes and offsets are saved to the configuration file.
11. Record the new slope and offset values in lab notebook.
12. Flow Zero gas blend through the analyzers to confirm the calibration values. Repeat with the Span gas blend. If either blend does not match the set values, repeat the calibration.

Comment [MB4]: What are acceptable values?

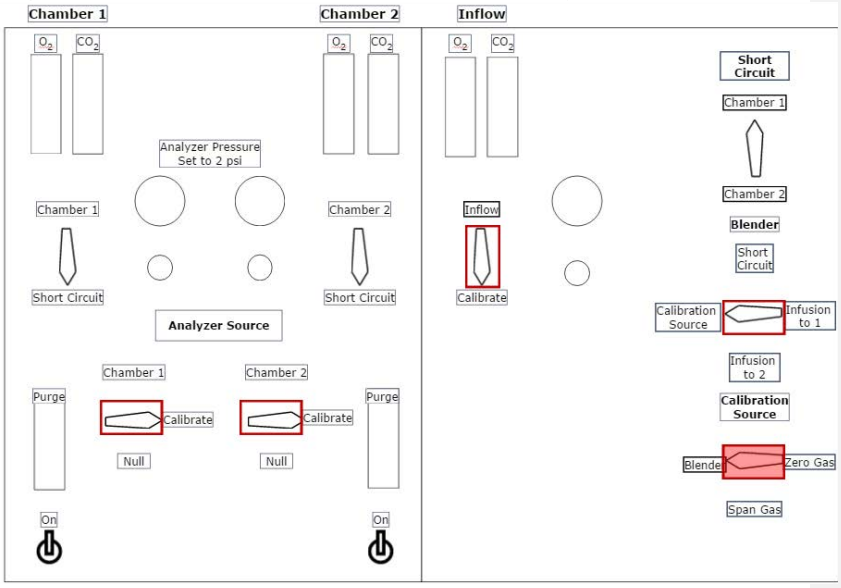


Figure 3. Panel Layout for Blender Calibration

Gas Tank Calibration

1. Open zero and span tanks
2. Flip valves as those shown in Figure 4
3. Check flow rates (1.25 lpm) and pressures (~2 psi) for each analyzer
4. Once the gas is flowing, watch the O_2 (A) and CO_2 (B) graphs until the values are steady. Once steady, press the "Set Zero" button (D).
5. After the values are stored, enter the calibration tank's gas concentrations in their respective entry boxes in the "Cal Gas" column (C) (i.e. if a calibration gas consisting of a blend of 21.02 %O2 and 0 %CO2 is flowing into the analyzers, 21.02 would be entered in the "Cal Gas" column for the O2 analyzers and 0 would be entered for the CO2 analyzers). Default tank values can be changed on the Preferences screen.
6. Repeat steps 3-6 using the Span Calibration Gas.
7. Select radio buttons (F) for each analyzer you would like to calibrate. Buttons will turn blue if calculations will be performed for that analyzer.
8. After zero and span values have been stored, press "Calculate" (G). New slopes and offsets are calculated, but not applied to analyzer gas values.
9. If slopes and offsets are acceptable, press "Apply" (H). New slopes and offsets are saved to the configuration file.
10. Record the new slope and offset values in lab notebook.
11. Flow Zero gas blend through the analyzers to confirm the calibration values. Repeat with the Span gas blend. If either blend does not match the set values, repeat the calibration.

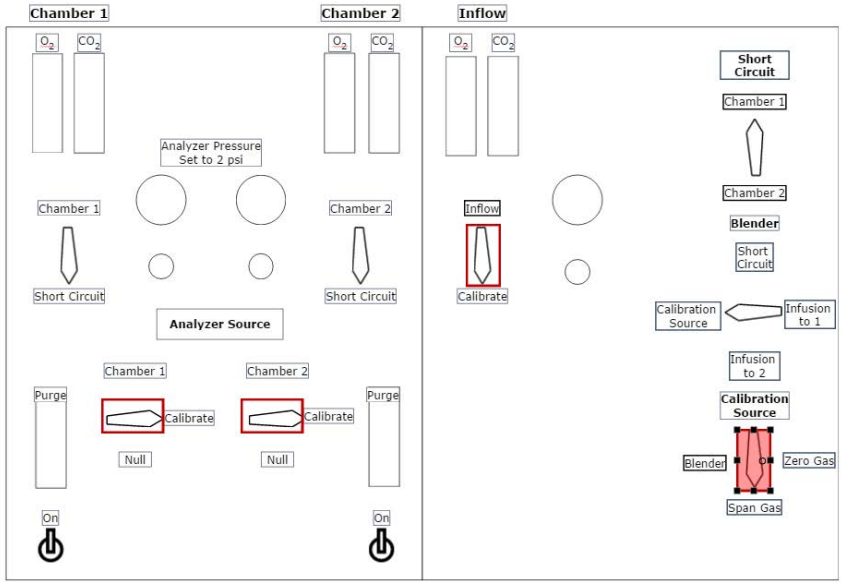


Figure 4. Panel layout for Span Gas Calibration (flip the highlighted Calibration Source valve from Span Gas to Zero Gas for span calibration)

Tank Cal Check

Purpose: Check analyzer calibration values before a study (human and validation).

1. Open Zero and Span calibration tanks
2. Set panel up as shown in Figure 4.
3. Flow zero gas to the analyzers by turning the "Calibration Source" valve to "Zero Gas".
4. Check flow rates (1.25 lpm) and pressures (~2 psi) for each analyzer
5. Once the gas is flowing, watch the O_2 (A) and CO_2 (B) graphs until the values are steady. Once steady, record the zero value.
6. Repeat steps 3-4 using the span gas.
7. Calculate the gas delta by subtracting the zero gas measured on the analyzer from the span value measured on the value.
8. $$Delta = Zero\ Tank\ Gas\ Percentage - Span\ Tank\ Gas\ Percentage$$
   ex. O_2: $0.9 = 20.95 - 20.05$
   ex. CO_2: $0.99 = 0 - 0.99$
9. Verify the delta is within +/-3% of the expected delta.
10. If delta is not within +/-3% of the expected delta, perform a Tank software calibration.

Table 1. Delta Example

Expected Delta	Allowable Difference
0.9	0.027
1	0.03

Null Test

A null test verifies the offset of the gas analyzers. The test is performed by flowing the inflow air (med air) to both the inflow and outflow analyzers. An offset correction is made on the Calibrate Analyzers screen in CalRQ™ or can be made during post processing.

1. Open a file to log data (Human Study, Validation Study, or Calibration)
2. Turn the Sample Source Valve to Null (Figure 5).
3. Let the system run until the humidity reading, plus VO_2 and VCO_2 on the software stabilize. This indicates that the dryers are conditioned.
4. Once the readings are stable, record the null data for at least 10 min.
5. If applying the null correction in real time, calculate offset correction by subtracting Inflow O_2 concentration from Outflow O_2 concentration. Repeat for CO_2. Apply offset correction to the inflow analyzer offset for both O_2 and CO_2.

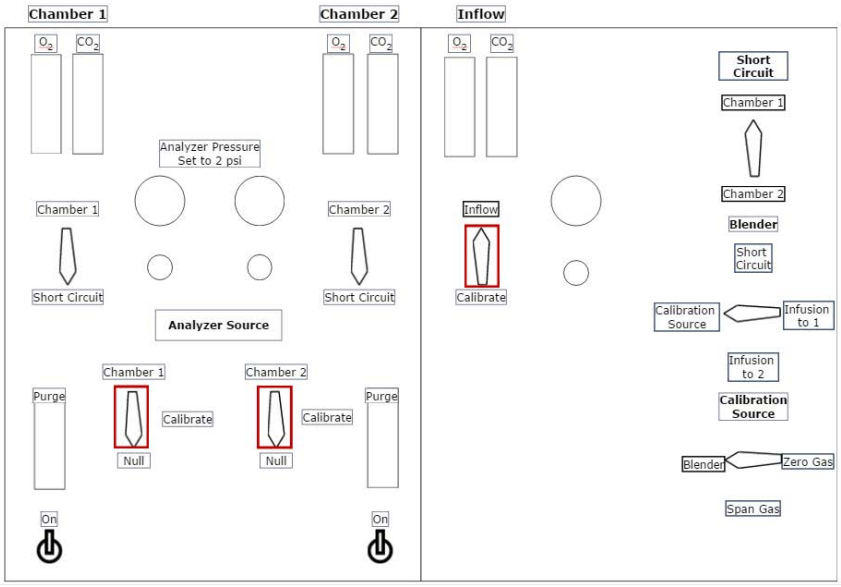


Figure 5. Panel layout for null test

Short Circuit

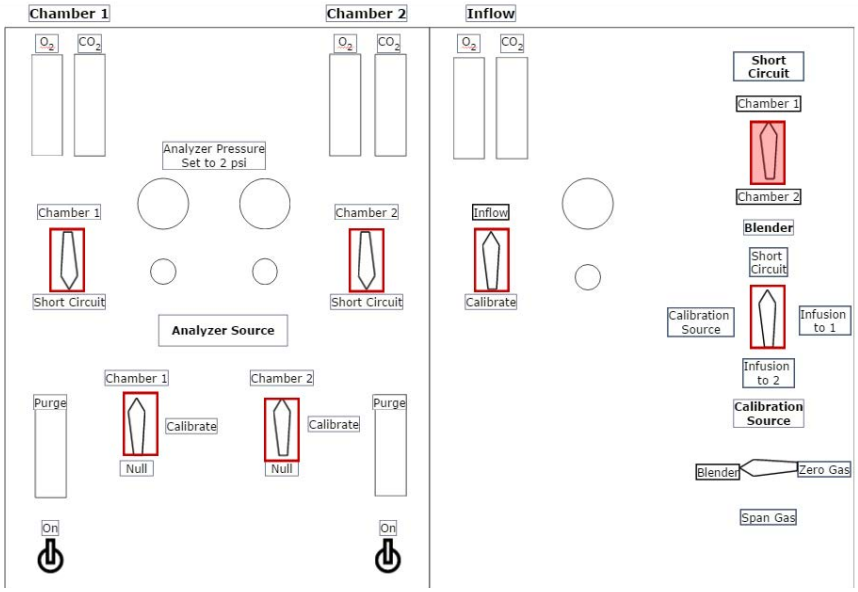


*Figure 6. Short Circuit (SC) Rack Panel Configuration. Red boxes highlight the valves that must be turned for the correct gas stream to reach the analyzers. **Shaded red box highlights the valve that determines where the SC infusion is sent. Turn the valve to select the desired chamber***

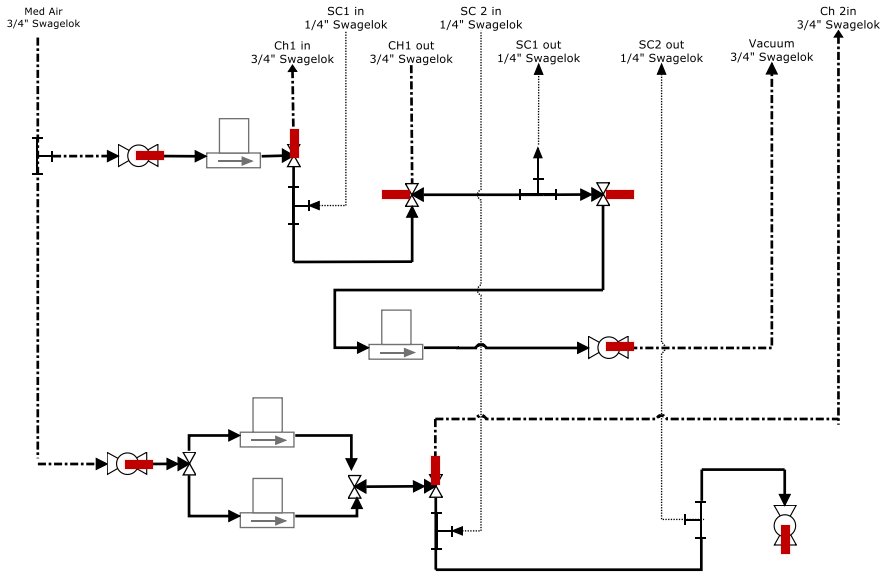


Figure 7. Short Circuit MFC Panel Configuration

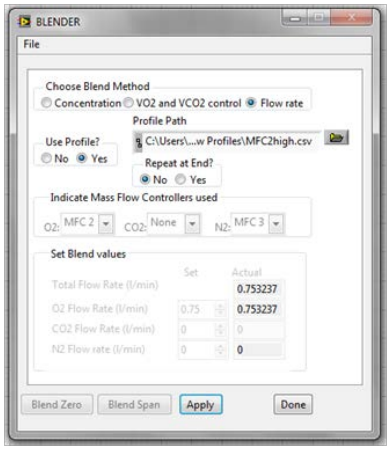
1. Set up rack panel as shown in Figure 4.

Change MFC panel as shown in Figure 7

2. Figure 9.
3. Start a Validation Study (File -> New Validation Study)
4. Choose Infusion Radio Button
5. Enter Validation ID – Filename will be Validation ID – Chamber # - Infusion-Date
6. Set desired Inflow and Outflow rates (Edit ->Manual MFC Set)
    a. Inflow Rate = 60 lpm
    b. Outflow Rate = 0 lpm
    c. Use the high flow MFC for chamber 2. Set to 60 lpm
7. Enter flow rate in Inflow Setting press “Apply Inflow”. Check Current Inflow Rate is as expected.

8. Run a null – same gas should be going to both the inflow and outflow analyzers (Valves on the panel should be pointing to null)
9. Check flow rates (1.25 lpm) and pressures (~2 psi) for each analyzer
10. Set chamber volume to 0 on the Preferences Screen.
11. Open Blender Screen (Edit -> Adjust Blender). Choose Flow Rate radio button
12. Select Appropriate MFC and set flow rate or select desired profile. Press “Apply” to start flow through blender.
13. Flow each N_2/CO_2 blend for at least 10 min after VO_2 and VCO_2 have stabilized
    a. Quick check: VCO_2 should be close to CO_2 flow rate; VO_2 should be close to

$$(N_2 \text{ flow} + CO_2 \text{ flow})*[O_2 \text{ inflow}]$$



Infusion

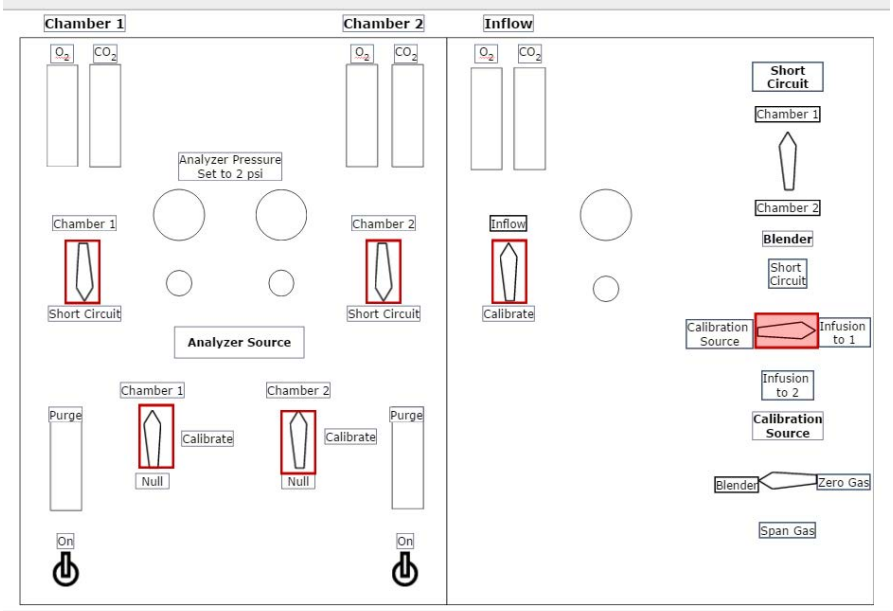


*Figure 8. Infusion Panel Configuration - Red boxes highlight the valves that must be turned for the correct gas stream to reach the analyzers. **Shaded red box highlights the valve that determines where the infusion is sent. Turn the valve to select the desired chamber***

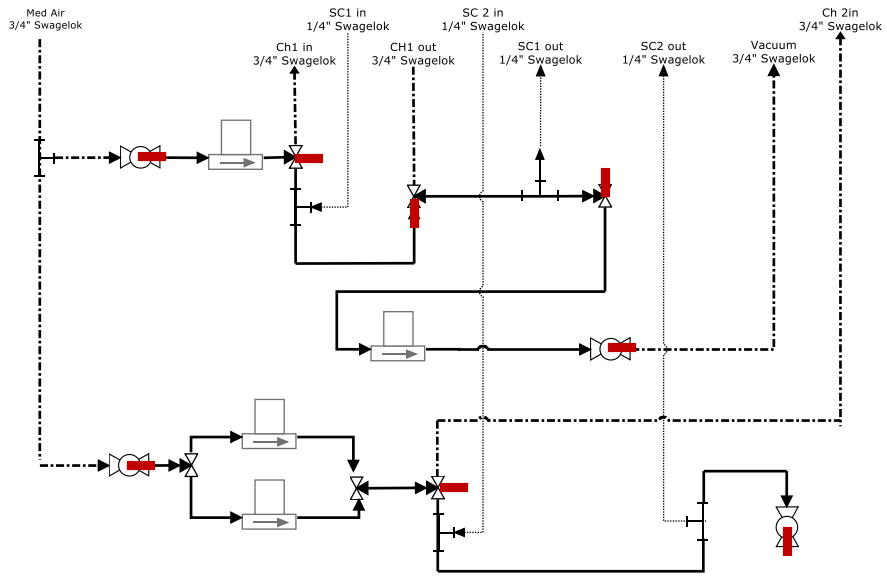


Figure 9. Chamber Study MFC Panel Setup

1. Set up Rack panel as shown in Figure 6. Select the correct chamber to send gas infusion. *Change MFC panel as shown in*
2. Figure 9
3. Start a Validation Study (File -> New Validation Study)
4. Choose Infusion Radio Button
5. Enter Validation ID – Filename will be Validation ID – Chamber # - Infusion-Date
6. Set desired Inflow and Outflow rates (Edit ->Manual MFC Set)
    a. Inflow Rate = 60 lpm
    b. Outflow Rate = 0 lpm
    c. Use the high flow MFC for chamber 2. Set to 60 lpm
7. Enter flow rate in Inflow Setting press “Apply Inflow”. Check Current Inflow Rate is as expected.

8. Run a null (~15 mins) – same gas should be going to both the inflow and outflow analyzers (Valves on the panel should be pointing to null)
9. Check flow rates (1.25 lpm) and pressures (~2 psi) for each analyzer
10. Set Chamber Volume to appropriate volume (Chambers = 32500 liters, Flex = 5000 liters)
11. Close chamber door.
12. Add a note to data file with chamber set up (what furniture is the room, platform, bike or empty in the small room)
13. Switch null valve to Study. Let run for about 15 minutes
14. Open Blender Screen (Edit -> Adjust Blender). Choose Flow Rate radio button
15. Select Appropriate MFC and set flow rate or select desired profile. Press “Apply” to start flow through blender.
16. Set flow rates and select “Apply”
17. Verify Outflow O2 and Outflow CO2 values are changing as expected.