



Q-teach Animal CO₂ Package Operation Manual



Manufactured and Distributed by Qubit Systems Inc.

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Table of Content

Overview of Q-teach Animal CO ₂ Package	3
Components of Q-teach Animal CO ₂ Package	4
Q-teach 101 CO ₂ Analyzer 2000ppm	5
Soda Lime and Drying Columns	8
G212 Water trap for condensing bath	8
Q-teach 201 Pump/Flow Monitor 1LPM	9
S132 temperature Probe	11
G122 Gas Bags	11
Animal Chambers	12
LabQuest Mini data Interface	14
Q-teach Kit of Accessories	15
Logger Pro Installation	17
C404 Custom setup Files Installation	18
Quick Startup	19
Calculations of Metabolic Rate	23
Qubit Systems Warranty Information	26
Return Procedure	27

Overview of Q-teach Animal CO₂ Package

The Q-teach Animal CO₂ package has been designed for teaching principles of animal respiration. The package contains all the components required, including this operational manual. A Laboratory Manual is also included with the description and instructions of laboratory experiments for this package. The Laboratory Manual is in the editable form (Word) so instructor has the ability to make changes and additions as required by the curriculum. Before using this package, ensure that all the components are included and familiarize yourself with their function as described in this manual. If any part of the package is missing, contact QUBIT SYSTEMS INC. immediately by email at info@qubitsystems.com or phone (613-384-1977). Purchase of the **Q-teach Animal CO₂ Package** entitles you to copy the software provided, or any part of the manuals, for use in your educational institution only. You may not give, sell, or loan any part of the written or software components of the package to any other institution or person.

The Laboratory Experiments manual provides detailed notes to the instructor with step-by-step instructions for performing 3 experiments. Examples of results are also provided. At the end of each experiment, the students are assigned questions to direct them in the interpretation of their data, and the instructor's notes provide the answers to these questions. Instructors may wish to modify, add to, or delete these questions, as the laboratory manual is provided on a disk in a Word format for convenient editing.

Students can use the **Q-teach Animal CO₂ Package** to compare the metabolic rates of different organisms, investigate the effects of temperature and other environmental factors on metabolism and determine an organism's metabolic rate during sleep and various levels of activity. The Respiration Package also allows students to observe the metabolic effects of special diets, pharmaceuticals and exposure to various concentrations of O₂ and CO₂ in the animal's air supply. Many different organisms may be used in these studies, lizards, amphibians, fish, insects, small mammals and yeast suspensions. Three experimental investigations are fully described in the Laboratory Experiments manual. These can be used as the basis for many other studies that students can pursue under supervision or as independent research projects.

The Q-teach Animal CO₂ Package includes a **Q-teach 101** CO₂ analyzer (0-2000ppm), **Q-teach 201** Gas Pump/Flow Monitor (1LPM), **S132** Temperature Probe, **G113-t** Insect Chamber, **G115-t** Animal Chamber, **G230** Aquatic head space chamber, **G122** gas bags (2 x 30L), **Q-teach kit** (accessory kit with tubing, connectors, filters, valves, wrench, screwdriver, Qubitac sealant), **G212** Water Trap for ice condensing bath, **C610** Lab Quest Mini data interface (3 analog channels), **C901** Logger Pro software, **C404** USB disk with experimental files and manuals for this package. For experiments with more active animals, like small mammals **Q-teach Animal CO₂/O₂ Package** may be considered. Contact Qubit systems for details.

This manual contains detailed information about the components of this package and instructions on how to setup the system for teaching experiments. **Please note that this package is designed for teaching purposes only. It is not a research quality package.** Each of the sensors has been calibrated in factory and no further calibration is required.

Components of Q-teach Animal CO₂ Package:

Q-teach 101 CO₂ Analyzer 0-2000ppm (drying and soda lime columns included)

Q-teach 201 Gas Pump/Flow Monitor 1LPM

S132 Temperature probe

G113-t Insect Chamber (1.6cm ID, 10cm long)

G115-t Animal Chamber (3.7cm ID, 15cm long)

G230 Aquatic Head Space Chamber (8.5cm ID, 5cm active height)

G212 Water trap for ice condensing bath

Q-teach kit (tubing, connectors, blue particulate filters (3), screwdriver, wrench, PTFE filters (2), Qubitac sealant)

G122 Gas Bags (2 x 30L)

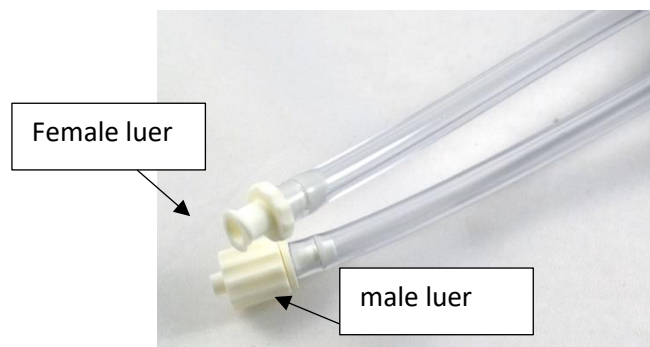
C610 LabQuest Mini (3 analog channels)

C901 Logger Pro Software

C404 USB Disk with manuals and experimental files

Q-teach 101 CO₂ Analyzer 2000ppm

The **Q-teach 101** CO₂ Analyzer is a non-dispersive infrared gas analyzer (NDIR IRGA). It has a “Gas In” and a “Gas Out” port on the front of the analyzer. Please note that “Gas In” port should be connected with a female luer connector tubing and “Gas Out” port may be left with no tubing (as gas vents to atmosphere) or with male luer connector tubing. The gas supplied to the IRGA passes through a sealed waveguide and vents from the “Gas Out” port. The analyzer has two holders on either side for a drying column and a CO₂ scrubbing column. These should be placed in upright position when in use and may be placed inside these holders.



On the back of the **Q-teach 101** CO₂ analyzer the user will find the BTA data cable for connection to the LabQuest Mini data interface (channel 1) and a power supply connection. A standard 12V power Supply with a 120/220 AC power adaptor is included with the analyzer.

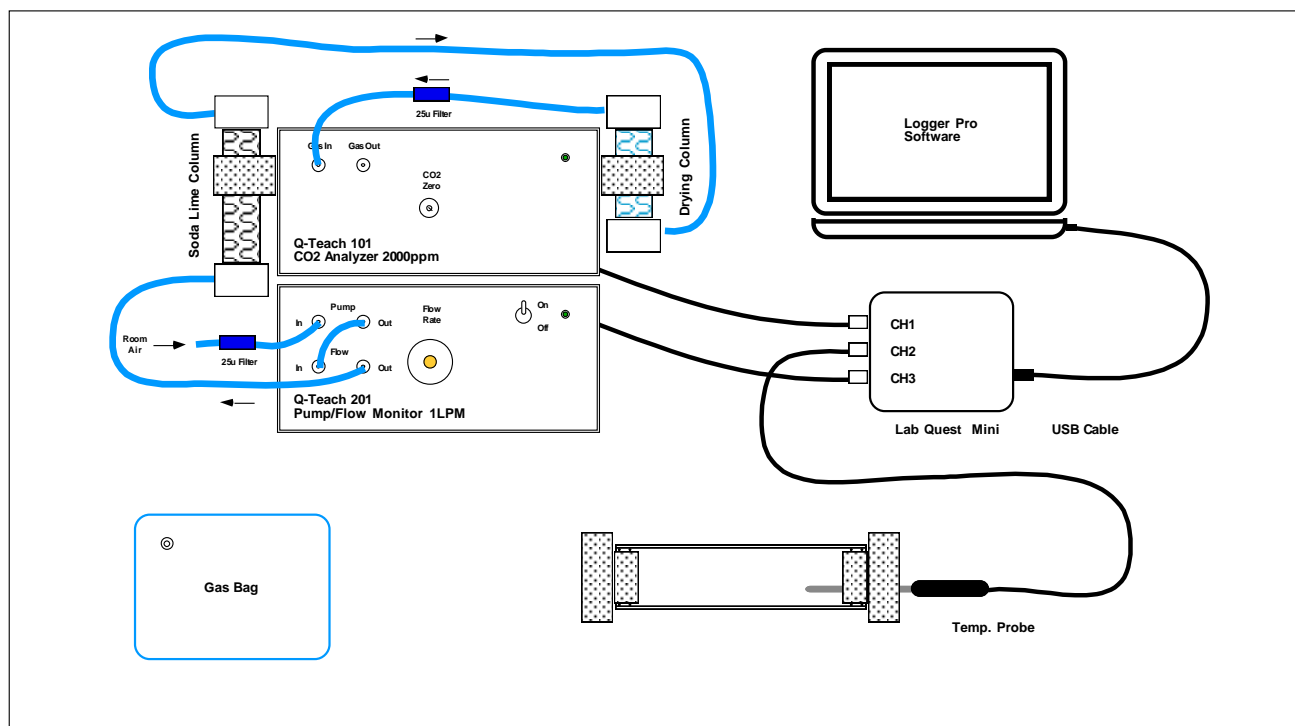
The gas entering the CO₂ analyzer “Gas In” port is delivered by the **Q-teach 201** Pump/Flow Monitor 1LPM. The maximum flow rated of gas into the CO₂ analyzer should not exceed 650 mL/min. Flow rates of about

50-150ml/min for measurements of insects and 100-250ml/min for measurements with lizards and amphibians are recommended. For measurements with the aquatic head space chamber, flows between 50-150ml/min is recommended for fish measurements and 200-400ml/min for yeast measurements.

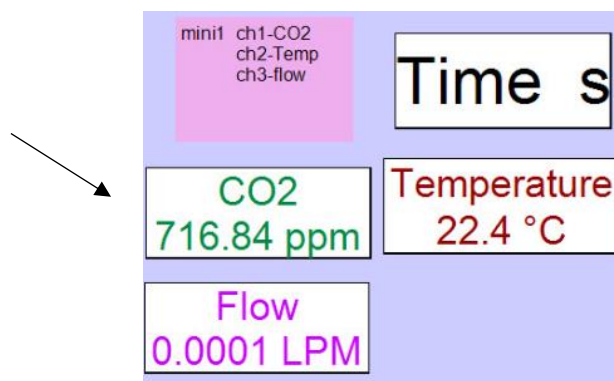
Gases entering the **Q-teach 101** CO₂ analyzer must be clean and dry, since particulate matter may absorb infrared light and cause erroneous readings. Water vapour will not interfere with the IR absorption measurement of CO₂, but water vapour will dilute the CO₂ concentration. The CO₂ analyzer is supplied with a short drying column containing blue DRIERITE. This drying agent removes moisture from the analysis gas before it enters the CO₂ analyzer. Wool plugs at the base and top of the column prevent particulate matter from leaving the column. The drying column should be attached to the CO₂ analyzer "Gas In" port via a small blue tubular particulate filter (25µm). This filter will prevent any particulate matter from getting inside the analyzer. Three of these filters are included with the **Q-teach Accessory Kit**. Over time these filters may get plugged up with particulates, but they can be cleaned by washing them in water and blow drying them with compressed air.

The **Q-teach 101** CO₂ analyzer requires a 15 to 30-minute warm-up period with air running through the analyzer. When used over a period of few days or weeks it is recommended to keep the analyzer powered continuously (with the gas pump turned off) for better stability of the signal. If running a teaching laboratory, it is recommended that the teaching assistant set up the analyzers before the laboratory session begins so that the analyzer is warmed up. Once the analyzer has warmed up it may be connected to the LabQuest Mini data interface (channel 1) for data collection.

The **Q-teach 101** CO₂ analyzer has a linear response to changes in CO₂ levels. The linear response is delivered with the analyzer's factory calibration. No further calibration by the user is required. Calibration constants have been entered in the experimental setup file (**Q-teach Animal CO₂ Setup**) and the voltage reading is converted into ppm of CO₂ in the software. However, before the start of an experiment, it is recommended to check the zero CO₂ reading and adjust it if required. This is done by connecting the CO₂ scrubbing column (long white column filled with soda lime) to the "Gas In" port on the analyzer (maintaining the drying column and the blue filter connection as described above. The soda lime will be attached before the drying column in line to the analyzer as per diagram below:



Soda lime will scrub CO_2 from the room air delivered to the analyser and a reading of zero CO_2 should be observed in the CO_2 meter of the experimental file (bottom left-hand side).



To open the Logger Pro software and visualize the CO_2 readings it is necessary to follow the instructions below on how to load the software, connect the sensors and use the experimental setup file (pg. 17-19).

When the CO_2 reading in the software (CO_2 meter on page 1 of the experimental file) stabilizes but is not zero, the user can adjust the “ CO_2 Zero” on the front panel of the analyzer using the small flat screwdriver provided with the Q-teach Accessory Kit. Turning the screw clockwise will increase the reading and anticlockwise it will reduce the reading. Once the zero CO_2 has been set, one can start the experiments. It is recommended to check the zero CO_2 at the beginning of each experiment and at least at the beginning of the day and at the end of the day to ensure no changes. The Q-teach 101 CO_2 analyzer is sensitive to big temperature and pressure changes therefore we recommend using it in temperature-controlled laboratory.

Remove the soda lime scrubbing column before starting the experiments unless background air needs to be CO₂ free.

Soda Lime and Drying Columns

The **Q-teach 101** CO₂ analyzer is designed to analyze dry gas samples and has been calibrated in factory with dry gases. A short drying column is provided which is filled with DRIERITE to dry the gas before analysis. The column has a wool plug at both ends to prevent particulates from being carried through the system. It is supplied ready for use. The column should be mounted **vertically** on the side of the CO₂ analyzer with the gas in port (female luer) at the bottom and gas out port (male luer) at the top.

DRIERITE contains an indicator that is blue when the column is functional and pink when the DRIERITE is saturated with absorbed water vapour. When spent (pink), the DRIERITE should be replaced or reconditioned. To **recondition**, remove the **DRIERITE** from the column and place it in a drying oven at **210 °C for 1 hour**, or until the blue coloration reappears. Note that it will be paler blue color after regeneration. The replacement DRIERITE is #8 mesh, order #23005 from DRIERITE.com.

To extend the life of the drierite during experiments it is recommended to use the condensing ice bath before gas exiting the animal chambers enters the drying column as mentioned below.

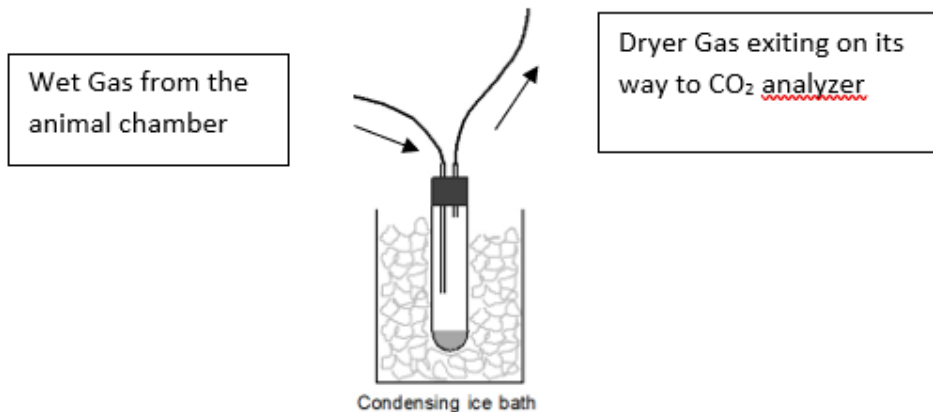
Soda lime column is used to scrub CO₂ from air. It is the long column filled with white soda lime. A small amount of wool is placed at the ends of the column to prevent particulates from getting into the gas stream. The soda lime column should be used in a **vertical** position to ensure the gas has maximal contact with the crystals when flowing through the column. This is achieved by placing the column in one of the holders on the side of the **Q-teach 101** CO₂ analyzer. Again, the gas in port (female luer) should be at the bottom and gas out port (male luer) should be at the top.

The soda lime provided with the CO₂ analyzer has a coloured indicator to show when it is saturated with absorbed CO₂. The soda lime should be replaced when most of it has changed from its original white colour to a pale purple. This colour change is subtle, and the purple coloration often does not persist, but appears as a band in the column at the junction between active and inactive soda lime. Replacement supplies may be obtained from Fisher Scientific (product #S200I-3) or other chemical supply company.

Warning: Soda lime can cause burns and should be handled with gloves. Users should read and comply with the Material Safety Data Sheet supplied with the soda lime.

G212 Water Trap for Condensing Ice Bath

Because gas leaving the animal chamber (especially the head space aquatic chamber) is high in water vapour it is recommended to also use an ice condensing bath before gas enters the drying column. A water trap vessel (G212) is included in the package for this application. It should be connected to the tubing with gas that is exiting the chamber after the PTFE filter. The output of the vessel should be connected to the tubing of the drying column before the CO₂ analyzer. The vessel should be placed in a beaker with ice. This will allow the water vapour to condense out of the gas that enters the vessel and prolong the lifespan of the drying column.



Q-teach 201 Pump/Flow Monitor 1LPM

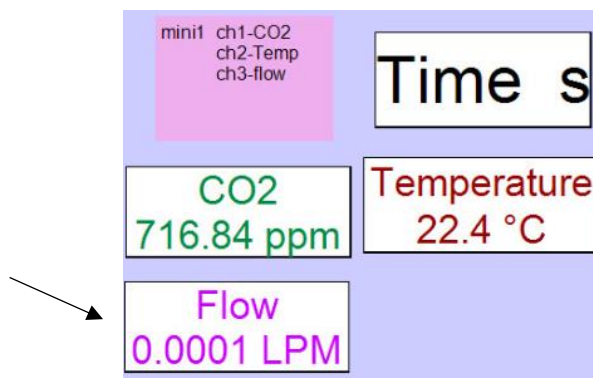
The Q-teach Animal CO₂ Package comes with the **Q-teach 201**, which is a gas pump and flow monitor combination. The gas pump can generate flow rates of up to 1LPM and the mass flow monitor can measure these as voltage changes. The voltage output from the flow monitor is delivered via the data cable with a BTA connector (on the back of the unit) to the Lab Quest Mini data interface (channel 3) and is read in the software. The voltage output is linear, and the flow monitor has been calibrated in factory. No further calibration is required. Calibration coefficients used to convert voltage into flow rate (LPM) are incorporated in the experimental Setup file (**Q-teach Animal CO₂ Setup**) provided. To use the **Q-teach 201** ensure that the power supply provided with the device is plugged in and the power switch on the front of the unit is in the “on” position.

The **Q-teach 201** Pump/Flow Monitor has one set of “In” and “Out” ports associated with the gas pump (top) and a second set associated with the flow monitor (bottom). Four pieces of tubing with luer connectors are delivered with the unit. It is important to connect the tubing with female luer connector to the “Gas In” ports and the male luer connector tubing to the “Gas Out” ports. The gas from the source (gas bag) should be connected to the pump “In” port via a blue tubular particulate filter (to keep the gas entering the system free of debris). The pump “Out” port is connected with the flow monitor “In” port. The flow monitor “Out” port delivers the gas either directly to **Q-teach 101** CO₂ analyzer (during reference gas measurement) or to the animal chamber first and the output from the chamber is carried to the CO₂ analyzer. The flow rate of the **Q-teach 201** Pump/Flow Monitor is controlled by the needle valve on the front of the instrument.



The flow rate of the **Q-teach 201** Pump/Flow Monitor has been set at factory around 150ml/min. This may need to be adjusted depending on which animal chamber is used for measurements and the activity of the animal. Flow rates of about 50-150ml/min for measurements with insects and 100-250ml/min for measurements with lizards and amphibians are recommended. For measurements with the aquatic head space chamber, flows between 50-150ml/min is recommended for fish measurements and 200-400ml/min for yeast measurements.

Increasing the flow rate will reduce the CO₂ signal and decreasing the flow will increase the signal (and sensitivity). Before changing the flow rate ensure that the Q-teach 201 is connected to the LabQuest Mini data interface and the Logger Pro software, and the experimental file (**Q-teach Animal CO₂ Setup**) is open (see pg. 17-18 for instructions on setting up logger pro and C404 disk files). This file is found on the C404 disk supplied with the package. The flow rates may be observed in the meter labelled "Flow" on page 1 of the experimental Setup file as shown below:



To increase the gas flow, turn the needle valve anticlockwise and to decrease the flow turn it clockwise.

S132 Temperature Probe

The temperature sensor **S132** included with this package is a semi-conductor device mounted on the end of a stainless-steel probe. It is inherently linear with an operational range from -40°C to $+125^{\circ}\text{C}$. The temperature sensor does not require calibration. It is also automatically recognized by the software when plugged into the LabQuest Mini data interface and calibration is loaded when the experimental file (**Q-teach Animal CO₂ Setup**) is opened. The sensor is mounted on a stainless-steel support, which fits through the temperature sensor ports in animal chambers supplied with this package. Two small o-rings are placed on the probe and should be pushed tightly into the chamber probe port by the white sleeve around the probe. This will ensure a good seal around the temperature probe and no leaks from the chamber. The temperature sensor port in the chambers must be plugged with a solid stainless-steel stopper when the sensor is not in use to prevent gas leaking out of the chamber.



The S132 temperature sensor may be used to measure temperature inside the animal chamber or the temperature of the environment where experiments are being conducted.

G122 Gas Bags

This package is delivered with 2 x 30 L heat-sealed gas bags. These are made from a gas-impermeable nylon-polyethylene laminate. Tygon tubing with a locking valve is attached to each bag by a luer-lock fitting. The fitting on the other end of the tubing attaches directly to the fittings on the **Q-teach 201 Pump** “In” port. The gas bags can be filled with air from a compressor (or another gas mixture from a commercial tank) to provide a **constant source of CO₂**. When measuring CO₂ respiration activity of any organism, it is crucial that the background levels of CO₂ (reference or incurrent CO₂ level) is constant. This is achieved by using gas bags to deliver background gas to the animal. Outside air has a constant level of CO₂ (close to 400 ppm) and may be used directly with a long piece of tubing connected to the Pump “In” port and the other end hanging out the window. If this is not possible then gas bags should be filled with outside air and used as the background gas in experiments. **Inside air in the lab can vary several hundred ppm in CO₂ due to human activity and should not be used in experiments directly unless higher CO₂ levels are required for the experiments.**

To fill the gas bag with air connect the gas “out” port from the **Q-teach 201 Pump** to the bag inlet and increase the gas flow rate to maximum (opening the needle valve to maximum gas flow). Bags may also

be filled with compressed air from the compressor or a gas tank. Bags should not be overinflated, as this can cause weakening of the seams and eventual leakage. After use, the bags should be fully deflated, preferably by attachment to a vacuum-line or to pump “In” port.



Animal Chambers

The Q-teach Animal CO₂ Package includes 3 animal chambers. The **G113-t** is the insect chamber. It is ideal for small animals such as insects. The inside diameter of the chamber is 1.6cm and the length is 10 cm. This chamber has two removable end caps that fit on the outside of the polycarbonate clear tubing and the seal is made with O-rings that fit on the inside of the end caps. Each end cap has one gas port with a removable piece of tygon tubing with a luer connector at either end. The male connector is used on the gas “Out” port (connected to the CO₂ analyzer) and the female connector is used on the gas “In” port (connected to the **Q-teach 201** Flow Monitor “out” port). One end cap also has the temperature probe port that should be plugged with the stainless-steel rod plug when temperature probe is not used.

G113-t



For larger animals, like lizards and amphibians **G114-t** animal chamber is included in the package. This chamber has a 3.7cm ID and active length of 15cm. The two end caps fit on the inside of the polycarbonate tube and the length of the tube that is available for the animal is 15cm. Similarly, to the insect chamber there is one gas port at each end cap supplied with removable piece of tygon tubing and luer connectors. Again, one end cap also has the temperature probe port that should be plugged with the stainless-steel rod plug when the temperature probe is not connected. The seal between the end caps and the tubing is made with double O-rings at each end. A small amount of vacuum grease is included with each chamber. This may be used to coat the O-rings and aid in the sliding of the endcaps into the tubing. Apply only very thin layer of the vacuum grease on the O-rings if needed to avoid a messy setup.

G115-t



The final chamber of this package is the aquatic headspace chamber **G230**. This chamber has been designed for measurements of head space CO₂ levels above the liquid with an aquatic animal like a fish or suspension

of cells like yeast. This chamber is constructed with 8.5cm ID polycarbonate tubing on a flat base and comes with only one end cap that hosts two gas ports and a temperature port. Gas “In” port is connected to a piece of tubing with a diffuser for delivery of gas to the liquid. Both, gas “in” and “Out” ports have a small piece of tubing with luer connectors for gas delivery to the chamber and out of the chamber. Again, when the temperature probe is not used with the chamber the temperature probe port should be plugged with the stainless-steel plug provided.

G230



When using the G230 chamber and measuring head space CO₂ levels above liquid it is important that a head space of at least 1.5 cm depth is maintained. **It is also crucial that the gas “Out” port tubing is connected to the CO₂ analyzer via the circular PTFE filter which will trap any water that may enter the lines and prevent it from getting inside the CO₂ analyzer and damaging it.**

Qubit System is not responsible for any damage to the CO₂ analyzer when the system is used without the PTFE filter.

PTFE filter will stop water and will also stop the gas flow. If this occurs remove the PTFE filter from the line and blow out the water with some dry compressed air. The filter may be used again once the water has been removed.

When animal chambers are not in use please remove the end caps from the polycarbonate tubing and store them disassembled. This will prolong the life span of the O-rings on the end caps.

LabQuest Mini Data Interface

The Q-teach Animal CO₂ Package comes with one LabQuest Mini data interface. This interface has 3 analog and 2 digital channels. The interface is connected to the computer (PC or Macintosh) by a USB cable. The USB cable is used to transfer data to the software and to power the LabQuest Mini. The interface converts the analog voltages (12-bit A to D) from the sensor to digital signals which are transmitted to the computer via

USB and processed by the Logger Pro software. The digital channels can be used and programmed in LoggerPro with a Digital Control Unit (not included), for instrument control based on input data crossing a threshold. This package only uses the analog channels. The complete guide to the use of LabQuest Mini is included with the package on the C404 disk. This manual only provides a general outline of the use and capabilities of LabQuest Mini data interface within the scope of this package.



The 3 analog channels are used to connect the sensor of this package in the following order:

Channel 1 – **Q-teach 101** CO₂ Analyzer

Channel 2 – **S132** temperature probe

Channel 3 – **Q-teach 201** Flow Monitor

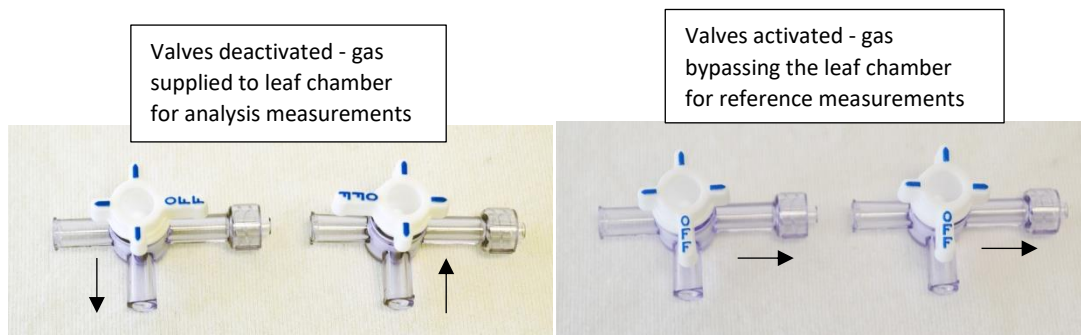
Only the temperature probe is automatically recognized when the experimental Setup file is open. The CO₂ analyzer and Flow monitor need to be manually selected as described below on pg. 20.

Q-teach Kit of Accessories

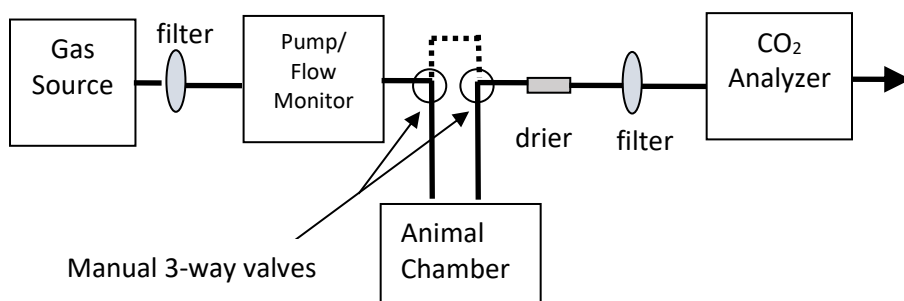
The Q-teach Animal CO₂ Package comes with the Q-teach kit of accessories. These include extra tubing, luer-lock connectors, extra Drierite, PTFE filters, blue Qubitac sealant, flat screwdriver, blue tubular 25um particulate filters, two 3-way valves and in some cases a small wrench.



The blue Qubitac sealant is useful if leaks develop anywhere in the system. This sealant may be easily applied and removed after the experiment. It is of playdough consistency and may be used over and over many times. The blue particulate filters should be attached to the gas in port of the CO₂ analyzer and the gas pump to prevent any particulate matter from entering the system. These can get plugged up over time but may be washed out and blew out with compressed air to be used again. In the early versions of the Q-teach package the Q-teach 201 pump/flow included a lockable valve for changing the flow rate through the system. To adjust the valve a locking ring had to be loosened first. A small wrench is provided in the Q-teach kits for use with the lockable valve. Two 3-way valves are also included. These may be used to redirect the flow of gas to bypass the animal chamber for reference CO₂ (iCO₂) measurements. If used with the system, the flow of gas through the animal chamber is stopped temporarily and this period should be kept as short as possible, so CO₂ does not build up in the animal chamber to high levels.



The diagram below and photos above show how the flow may be redirected using the 3-way valves.



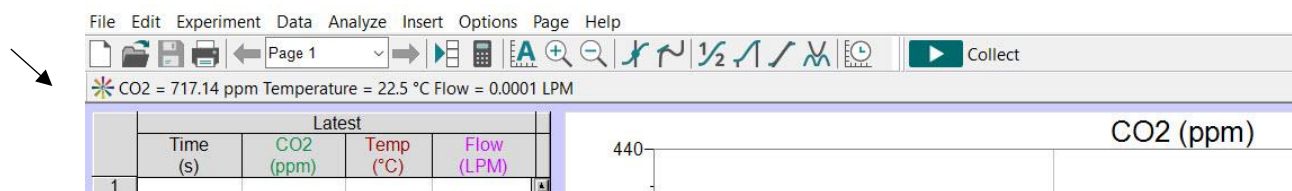
Logger Pro 3 Installation

Logger Pro software is delivered with the package on a CD and requires a CD drive to load onto a computer. If the CD drive is not available, please contact Qubit Systems for alternative solution. This software can run on both PC and Mac computers and the licence allows use on as many computers per institution as required. Therefore, all students that are using this package may obtain copies of the software on their personal computers. Free updates of this software are regularly released and may be accessed directly from the manufacturer website at the following link:

<https://www.vernier.com/downloads/logger-pro-updates/>

PC Users:

- (1) To use this package, a complete copy of Logger Pro 3 must be installed on the computer. Before starting the installation, make sure all USB cables are disconnected from the computer. Failure to do so may cause an error in the installation of the USB drivers.
- (2) Run the installation and do not change the default destination directory. Logger Pro 3 will be installed in C:/Program Files/Vernier Software/Logger Pro 3.
- (3) The setup process will automatically load the USB drivers for connecting the LabQuest Mini to the computer.
- (4) If QuickTime 6 (or greater) is not installed on the computer, install it when prompted. QuickTime will allow use of the picture and movie features of Logger Pro 3.
- (5) You will be prompted to connect the LabQuest Mini or other interfaces to the computer via the USB connection.
- (6) Click 'Finish' to complete the installation process.
- (7) Proceed to C404 disk installation (below) before opening the Logger Pro.
- (8) Double click the "**Q-teach Animal CO₂ Setup**" file (create a shortcut on the desktop once moved from the C404 disk for easy access) to start Logger Pro and data collection. When Logger Pro detects the LabQuest Mini interface, the Logger Pro screen will appear with a star icon in the top left corner.



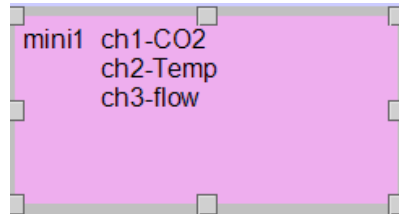
- (9) If Logger Pro cannot detect the LabQuest Mini Interface, a message will appear “no device connected”. Check that the LabQuest Mini is attached to the computer directly via USB cable. The LED power lights on the Mini should be green. No LED light indicates that power is not supplied to the Mini - check the USB cable connection as the power is supplied via this cable directly from the computer. A red LED indicates that power is on but there is no communication between the interface and the software. In this case, exit the experimental file and disconnect the USB cables from the computer. Reconnect the USB cable and reopen the “**Q-teach Animal CO₂ Setup**” file. You may try different USB port in case the problem is with the computer.

C404 Custom Setup Files Installation:

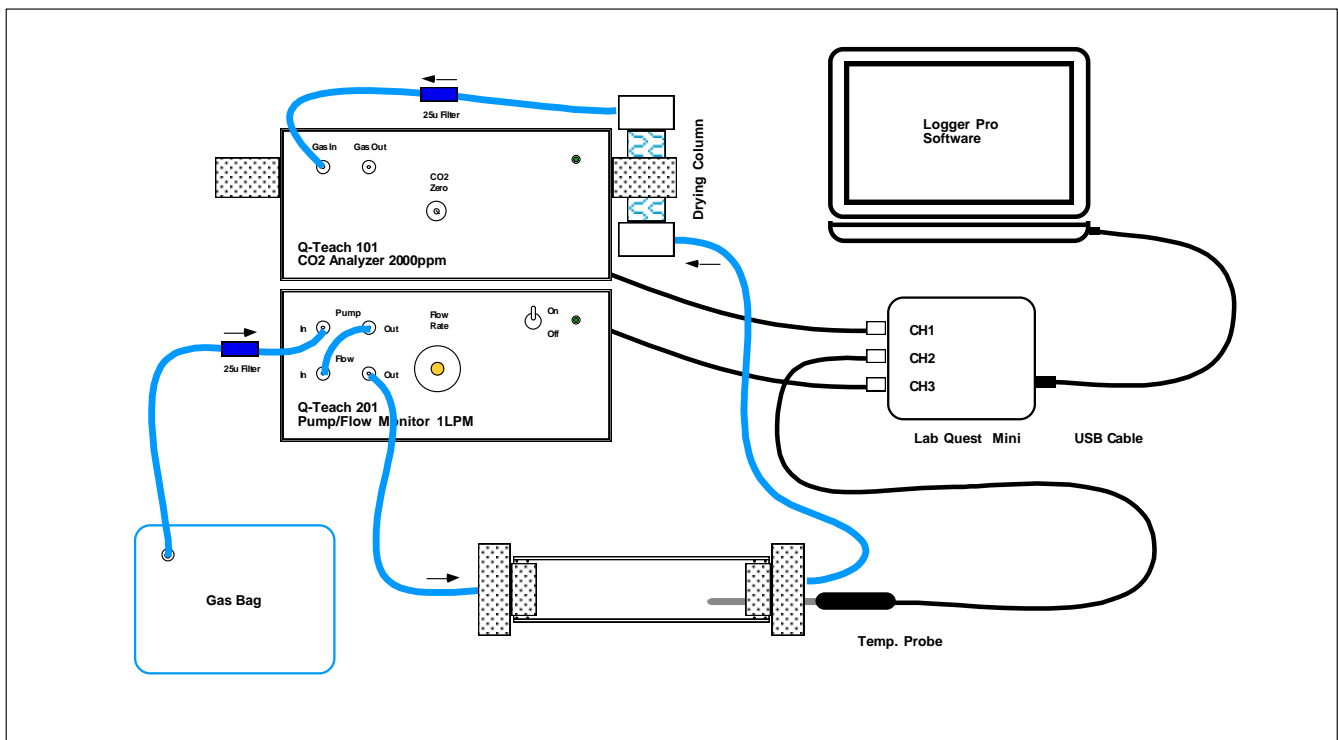
Qubit Systems’ C404 USB disk contains experiment setup file (designed by Qubit Systems) for this package (**Q-teach Animal CO₂ Setup**). This file is composed of 4 pages. Page 1 shows the raw data collected from the sensors and pages 2, 3 and 4 contain calculations for experiments 1, 2 and 3. Students collect all the data first and then do analysis and calculations on pages 2, 3 and 4 after completion of the experiment. The C404 disk also contains the pdf file of this operational manual and a word (editable) file of Laboratory experiments manual for this package. Also included is the manual for the LabQuest Mini data interface. These files can be copied to user specified location on the computer and the experimental setup file should be placed in an accessible location or have a shortcut created on the desktop to the file. We highly recommend for the user to make a copy of the original files and keep them in a safe place on the computer in case the originals are accidentally altered.

Quick Start-up:

1. Read this operational manual (pdf file on the C404 USB disk) to become familiar with all the components before setting up and using the package.
2. Load Logger Pro software on the computer (follow instructions pg. 17)
3. Copy experimental setup file “**Q-teach Animal CO₂ Setup**” and the manuals from C404 disk to the computer.
4. Set up all the components of the package as shown in the diagram below and connect the sensors to the correct analog channels on the LabQuest Mini as indicated by the window below:



Please note that the gas bag and the animal chamber do not need to be connected to the system while the system is warming up.



5. Power up and turn on the **Q-teach 101** CO₂ analyzer and the **Q-teach 201** Pump/Flow Monitor and allow the CO₂ analyzer to warm up for at least 15-20 min while running room air across the sensor.
6. Open the “**Q-teach Animal CO₂ Setup**” file. The following screen will appear:

Sensor Confirmation

The file you have opened was saved with sensors connected. At least one of these sensors was not automatically detected. To continue using this file you must do one of:

- 1) Connect autoID sensors
- 2) Connect a non-autoID sensor, confirm interface, channel, and sensor type, and click "Connect"
- 3) Click "Continue Without Data Collection"

When sensors are connected, automatically or manually, they will be removed from the list. When all sensors have been connected, this dialog will close automatically.

Undetected Sensors:

Q-S151 CO2 Analyzer (2000ppm)
Raw Voltage (0-5V)

Active Sensors:

Stainless Steel Temperature

Connect Non-AutoID Sensors:

Interface and Channel: CH1 on LabQuest Mini: 1

Sensor: Q-S151 CO2 Analyzer (2000ppm)

Connect

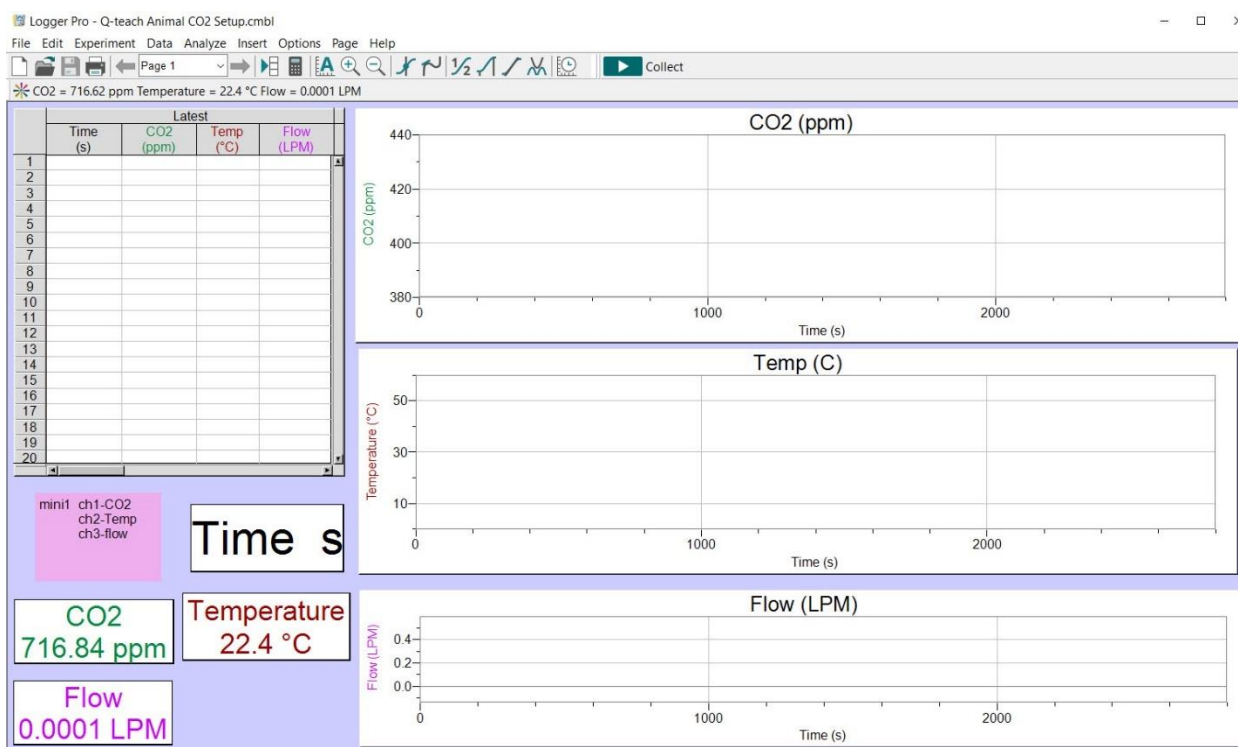
If you wish to use a Wireless Dynamics Sensor System or Go Wireless Sensor for any of the Undetected Sensors, click the appropriate button below to initiate connection to the wireless device.

Scan for WDSS Scan for Go Wireless Sensor

Scan for Wireless LabQuest Stream

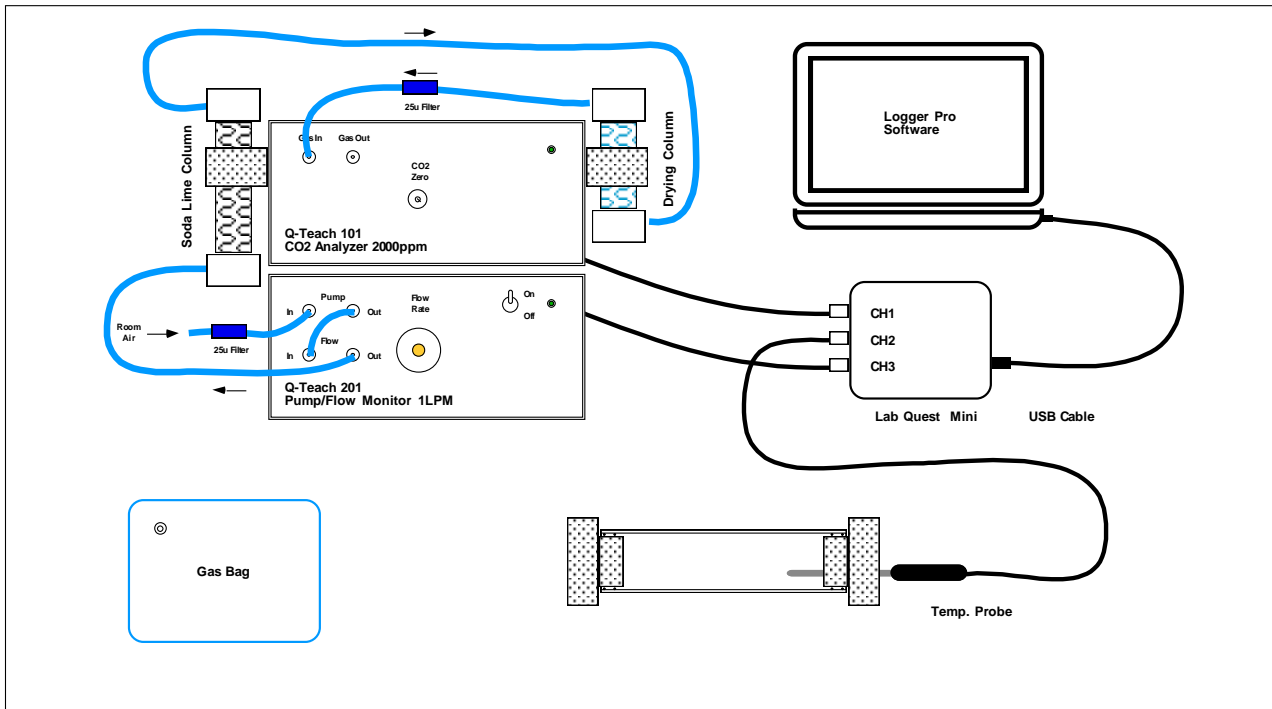
Help Continue Without Data Collection

7. Connect the CO₂ Analyzer to channel 1 and the Raw Voltage of the Flow monitor sensor to channel 3 on the LabQuest Mini in the software. The Stainless-Steel temperature probe will already be automatically connected and listed in the "active sensors" list.
8. The following screen will be shown in the software once the sensors are connected. This is page 1 of the software where all the raw data will be displayed:

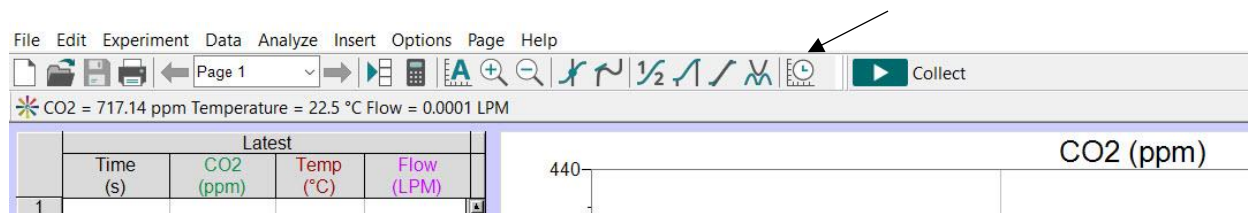


The CO₂, flow rate and temperature data will be shown in the top menu and the meters at the bottom of the page. Once the collection of data is started (green button "Collect" clicked), the table and graphs will also populate with the logged data.

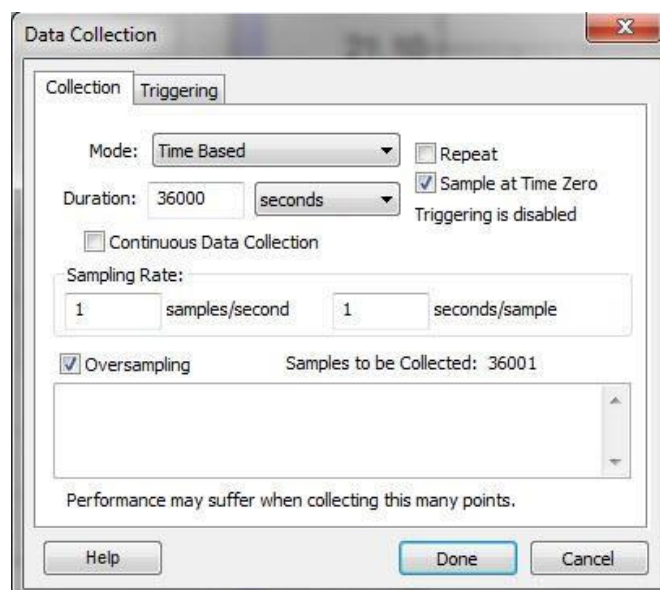
9. While the CO₂ analyzer is warming up the flow rate through the system should be set up as described above on pg. 9. Briefly, turn the valve on the **Q-teach 201** pump/Flow monitor clockwise to reduce the flow rate and anticlockwise to increase the flow rate through the system.
10. After CO₂ analyzer has warmed up and the flow rate has been set, check the zero by connecting the soda lime column (long white column) to the gas “out” port of the flow monitor of the **Q-teach 201** and attach the out port of soda lime column to the drying column and the CO₂ analyzer (as shown in the diagram below).



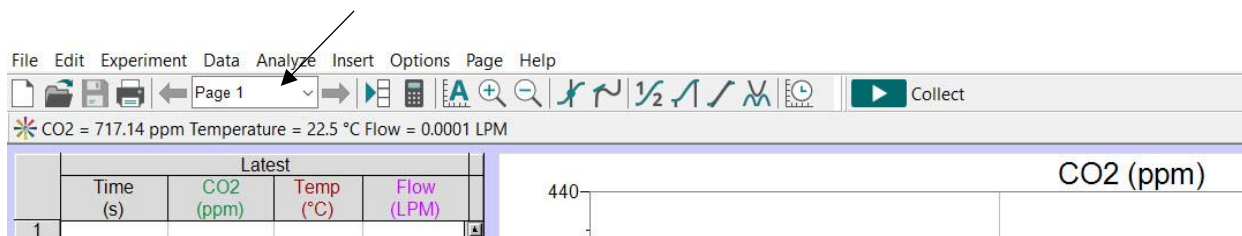
11. Allow the scrubbed room air to enter the CO₂ analyzer and observe the CO₂ signal in the software drop to zero. When the reading stabilizes but is not at zero adjust the “CO₂ zero” screw on the analyzer with the screwdriver provided in the Q-teach kit as described above in the manual on pg. 7). Briefly turn the “CO₂ zero” screw clockwise to increase the reading and anti-clockwise to reduce the CO₂ reading.
12. Once CO₂ zero has been established and adjusted, connect the gas bag filled with outside air to the pump “in” gas port on the **Q-teach 201** and observe the CO₂ signal in the software rise to approximately 400ppm. Once this signal stabilizes the system is ready to use for experiments with animals.
13. Always measure background levels of CO₂ (reference, or incurrent CO₂) for few minutes before starting measurements with animals as these will be used in calculations of metabolic rate later.
14. Before starting data collection in each experiment, select the time icon to set up experiment duration and data collection frequency



15. The following window will appear. Input experiment length and data sampling rate as required. The default is 1 sample per sec or 60 samples per min.



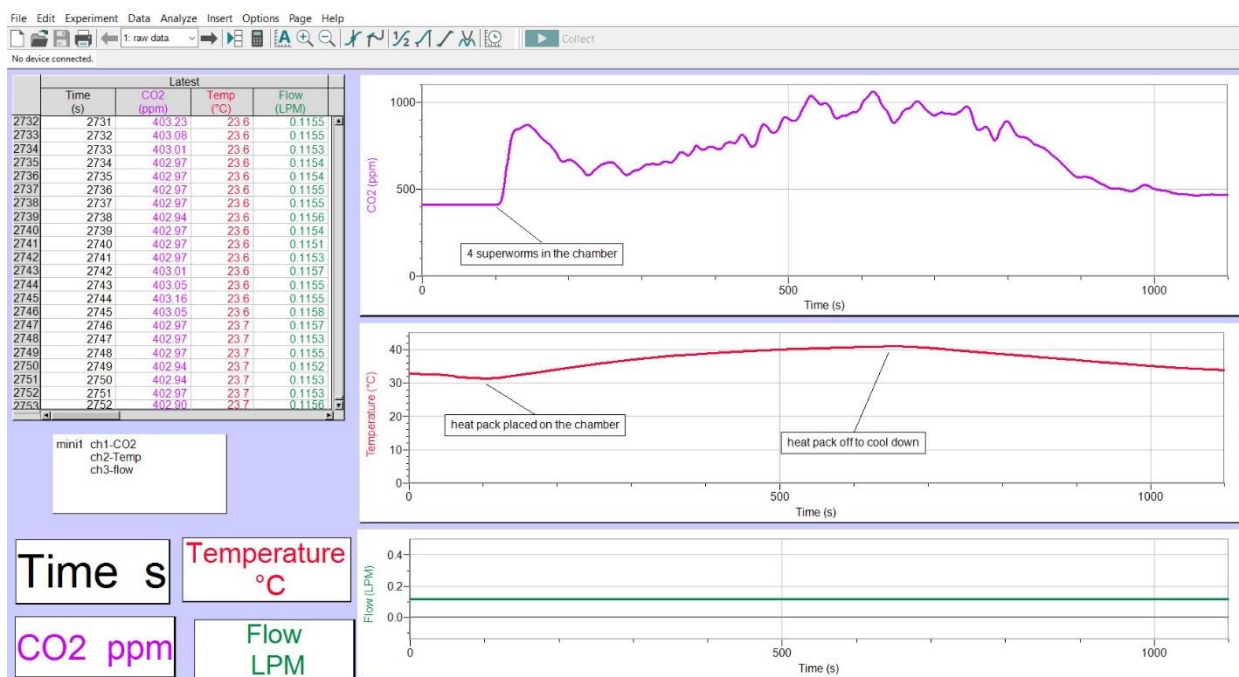
16. Save experimental file under a new name following each experiment so the original setup file is not accidentally overridden.
17. To start data collection, click the "Collect" green button in the top menu. To stop data collection, click the red "Stop" button (collect button will turn red during data collection).
18. Once the data has been collected the experimental file should be saved under a new name by selecting **File>Save As** from the top menu or clicking on the disk icon.
19. Saved data may be analyzed later with the various analysis tools available in Logger Pro. Pages 2, 3 and 4 of the experimental setup file contain calculations for the laboratory experiments listed in the laboratory manual of this package. Data may also be exported for opening in a spreadsheet program by selecting **File>Export As>CSV**
20. Calculations of the metabolic rates from the collected data are described below and may be done page 2, 3 or 4 of the setup file. Page number may be selected in the top menu.



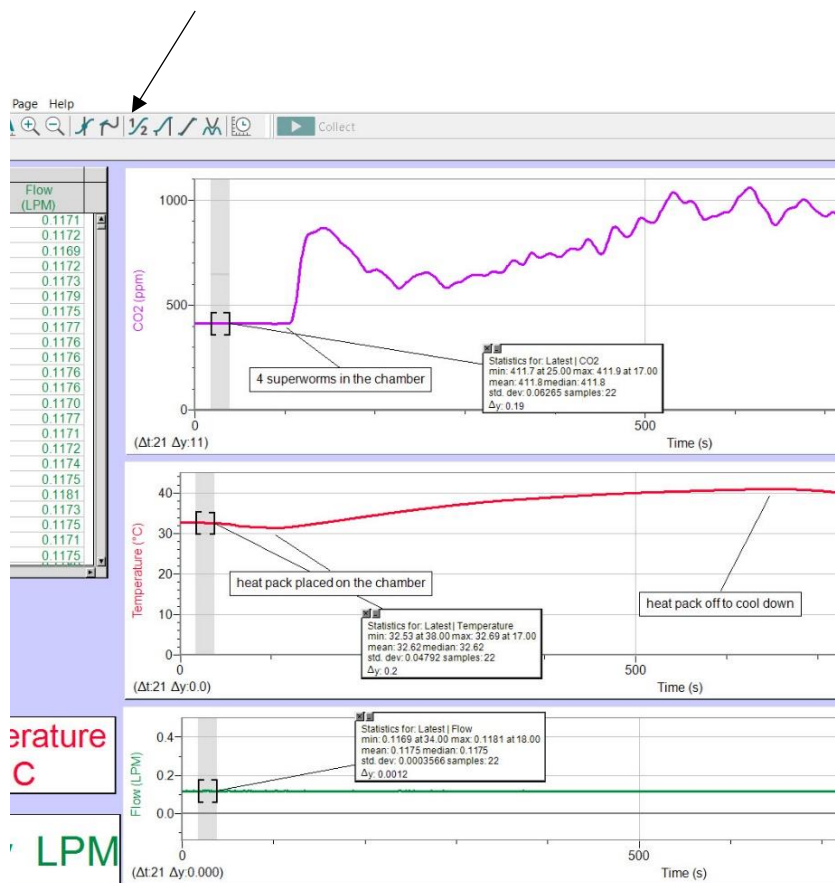
21. To proceed with specific laboratory experiments please refer to the **Laboratory Experiments for Animal CO₂ Package** Manual included on the C404 disk.

Calculations of Metabolic Rate

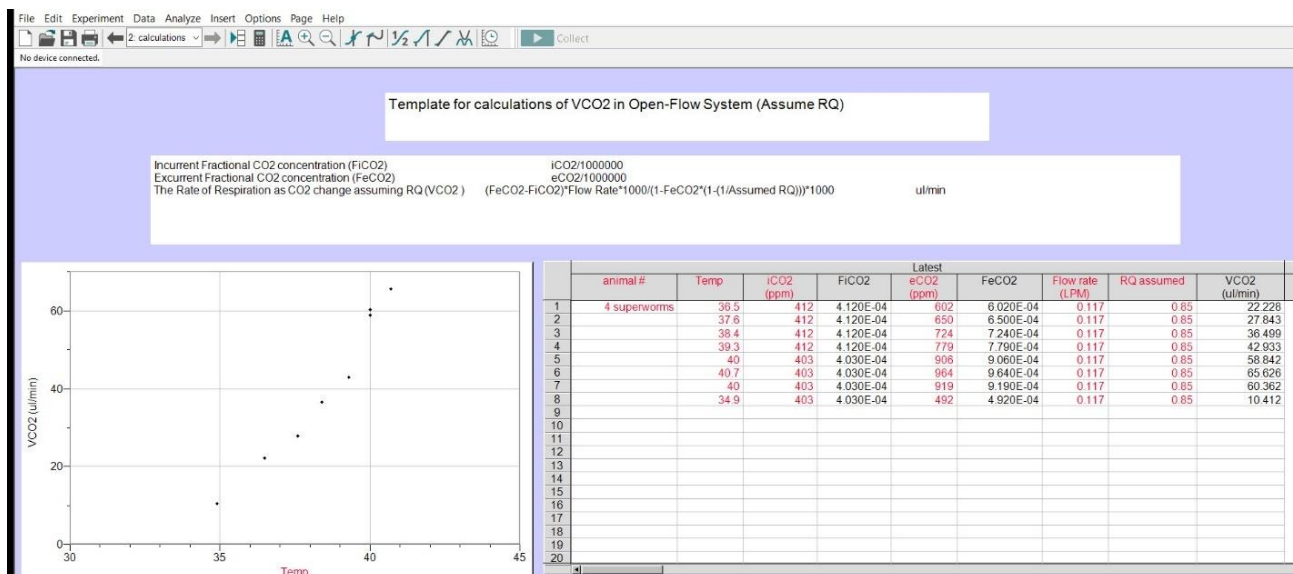
All the raw data collected in the software is shown on page 1 of the **Q-teach Animal CO₂ Setup** file. It is displayed in the table and graphs. The print screen below shows an example of experimental data with 4 superworms placed in the insect chamber and exposed to changes in temperature.



To calculate the metabolic rates from raw data the user needs to enter the average raw data from page 1 on pages 2, 3 or 4 in the experimental Setup file. All the calculations of metabolic rates at specific times during the experiment are done on pages 2, 3 or 4 depending on the experiment. The average raw data is obtained by first clicking to highlight all the graphs (hold shift key and click on each graph) and then dragging the mouse over the selected data to select it (see print screen below). Various analysis icons may then be selected from the top menu to obtain the data required. In this case selecting the “statistics” icon will result in popup windows with all the statistics for the selected data including the mean values that need to be manually entered on pages 2, 3 and 4.



When the mean values of CO₂, Flow and Temp are entered on page 2, 3 or 4 of the Setup file the metabolic rate will automatically be calculated. The print screen of page 2 is shown below:

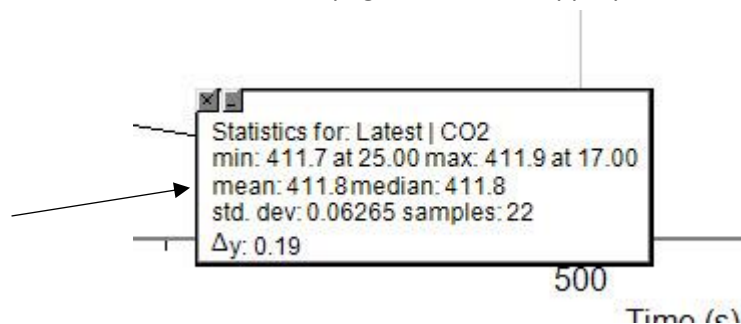


Data is entered in the red columns and black columns will populate automatically with calculated numbers.

Metabolic rate is calculated as CO₂ produced per unit time ($\dot{V}\text{CO}_2$) in the units of $\mu\text{L}/\text{min}$.

Respiratory Quotient, RQ, is the ratio of CO₂ produced to O₂ consumed (i.e. $\text{RQ} = \dot{V}\text{CO}_2 / \dot{V}\text{O}_2$). It is directly related to the animal's diet and metabolic condition. RQ is usually less than 1.0, which means that more O₂ is consumed than CO₂ is produced. When only $\dot{V}\text{CO}_2$ is measured an assumption about the RQ value must be made. The assumed RQ value is assigned by the user in the table on page 2 of the Experiment setup file. If the diet is not known, an assumption of RQ of 0.85 is most appropriate.

The incurrent and excurrent CO₂ is measured by the **Q-teach 101** CO₂ analyzer. When the animal chamber is not connected to the system and only background gas is being measured that is incurrent or reference levels of CO₂ (**iCO₂**). When the animal chamber is connected to the system and the animal is inside it, then excurrent levels of CO₂ (**eCO₂**) are being measured. These are used to calculate the fractional concentrations of CO₂ that enters and exits the flow through animal chamber. These values are obtained directly from the raw data by manually highlighting the data collected in the reference mode (no animal chamber) and later with the animal in the chamber. Description of this may be found above. Once the statistics icon in the top menu is selected the pop-up window will show all the statistics including the mean value of CO₂ for the selected raw data. The print screen of one of the pop-up windows is shown below. Enter the mean value from this window on pages 2, 3 or 4 in appropriate column (iCO₂ or eCO₂).



The same procedure is followed for obtaining other mean raw data with the animal in the chamber.

Since the **flow monitor** in this package is **upstream** of the CO₂ analyzer and O₂ is not removed from the excurrent gas stream at any point, the following equation is used to calculate $\dot{V}\text{CO}_2$:

(<http://warthog.ucr.edu/WartHogPage/LAX%20website/respirometry.html>)

$$\dot{V}\text{CO}_2 = (\text{FeCO}_2 - \text{FiCO}_2) * \text{FR} / (1 - \text{FeCO}_2 * (1 - (1/\text{Assumed RQ})))$$

Where FeCO₂ is the fractional excurrent CO₂ concentration, FiCO₂ is the fractional incurrent CO₂ concentration and FR is the gas flow in mL/min.

$$\text{FeCO}_2 = \text{eCO}_2 \text{ in ppm} / 1000000$$

$$\text{FiCO}_2 = \text{iCO}_2 \text{ in ppm} / 1000000$$

The summary data is also graphed on pages 2, 3 and 4 of the setup file once calculations have been completed. If more data needs to be added to this table for example treatment, proceed to the top menu and select Data>New Manual Column and the following window will appear:

Enter the name of the column and short name plus units and click done. The new data column will appear in the table. Data may be entered in this column and then used to graph metabolic rate in a summary graph. To create a new summary graph, click in the top menu **Insert>Graph**. A new graph will appear on that page. Right click on the graph to give it a title. Click on **Axes Options** tab to select which column (parameters) to graph. Logger Pro software provides numerous analysis and data display functions. It is very user friendly and has an extensive Help menu. Always save the new modified data file under a new name so the original is not overridden.

Qubit Systems Warranty Information

QUBIT warrants all its instruments to be free from defects in materials or workmanship for a period of **one year** from the date of invoice/shipment from QUBIT.

If at any time within this warranty period the instrument does not function as warranted, return it and QUBIT will repair or replace it at no charge. The customer is responsible for shipping and insurance charges (for the full product value) to QUBIT. QUBIT is responsible for shipping and insurance on return of the instrument to the customer.

No warranty will apply to any instrument that has been (i) modified, altered, or repaired by persons unauthorized by QUBIT; (ii) subjected to misuse, negligence, or accident; (iii) connected, installed, adjusted, or used otherwise than in accordance with the instructions supplied by QUBIT.

The warranty is return-to-base only, and does not include on-site repair charges such as labour, travel, or other expenses associated with the repair or installation of replacement parts at the customer's site.

QUBIT repairs or replaces the faulty instruments as quickly as possible; maximum time is one month.

QUBIT will keep spare parts or their adequate substitutes for a period of at least five years.

Returned instruments must be packaged sufficiently so as not to assume any transit damage. If damage is caused due to insufficient packaging, the instrument will be treated as an out-of-warranty repair and charged as such.

QUBIT also offers out-of-warranty repairs. These are usually returned to the customer on a cash-on-delivery basis.

Wear & Tear Items are excluded from this warranty. The term Wear & Tear denotes the damage that naturally and inevitably occurs as a result of normal use or aging even when an item is used competently and with care and proper maintenance.

Qubit Systems also offer a **service package** for all the Q-teach Packages components, whereby once a year all of the components may be returned to Qubit for calibrations, service and minor repairs. Contact Qubit Systems for details.

Return Procedure

Before returning any instrument to QUBIT:

Consult the operating manual or contact Qubit to ensure that the instrument(s) is in fact faulty and has not just been set up improperly.

Contact QUBIT before sending anything back. We will issue an RMA number and provide shipping instructions. QUBIT will refuse any goods that are returned without an RMA number, or which are sent in a manner outside of QUBIT'S stipulations.

If you have encountered a program failure, we need a printed copy of any faults you have seen, including how to reproduce them. Include these in the return package along with your mailing address.

Include a copy of the Invoice on which the product was shipped to you.

All returns must be shipped prepaid. Unpaid packages will not be accepted.

In case of questions contact QUBIT by

E-mail: info@qubitsystems.com, by

phone: (01)-613 384 1977, or by fax:

(01)-613 384- 9118.