CONTINUOUS WATER SAMPLER
A0217

Installation & User's Manual

The manual includes information on how to set up and operate a Continuous Water Sampler with a L2130-*i* or L2140-i.

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Thank you for purchasing a Picarro product. Your Picarro Continuous Water Sampler is a quality product that has been designed and manufactured to provide reliable performance.

This manual is an important part of your purchase as it will help familiarize you with the module and explain its features. Please read this manual thoroughly before using your Picarro Continuous Water Sampler.

Please contact Picarro or your authorized Picarro distributor should you have questions regarding specific applications or if you require additional information.

Contact Technical Support:

Email: support@picarro.com

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(See “Need help from Picarro?” chapter for more information.)

Contact Customer Service:

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Picarro, Inc. has prepared this manual for use by its customers as a guide for the proper installation, operation and/or maintenance of the Picarro product.

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INTRODUCTION

The Picarro Continuous Water Sampler (CWS) is designed for real-time, continuous analysis of $\delta^{18}O$ and $\delta^{2}H$ in liquid water. At the heart of the Picarro CWS is a porous membrane that enables diffusive sampling of water isotopes. By tightly controlling the physical factors that affect fractionation of liquid to vapor across a membrane, the CWS, when coupled to a Picarro isotopic water analyzer achieves stable and repeatable results from an automated analysis system. Automated switching from samples to standards enable quick and easy calibration in the field.

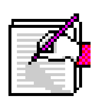
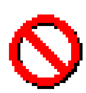
The CWS can be paired with a Picarro L2130-*i* or the Picarro L2140-*i*, in $\delta^{18}O$ / $\delta^{2}H$ mode ('normal' mode). This manual should be used in conjunction with the Operation, Data Analysis, Maintenance and Troubleshooting User's Manual which accompanies your isotopic water analyzer (L2130-*i* or L2140-*i*), and it assumes Basic Analyzer Installation is complete.

Important Acronyms

CWS	Continuous Water Sampler

Important Conventions

Throughout the manual, you will see graphic icons representing important information in the text.

NOTE	CAUTION	WARNING	REMINDER
			

NOTE is an important procedure that you should be aware of before proceeding.

CAUTION alerts you to a potential danger to the equipment or the user.

WARNING indicates an imminent danger to the user.

REMINDER is a helpful hint to procedures listed in the text.

GETTING STARTED

INSPECTING THE BOXES

All Picarro products are inspected and tested prior to shipment from the factory. The shipping container system has been tested and proven to be safe for most dropping, crushing or spiking events.

Upon delivery of instrumentation, the package should be checked thoroughly for damage or signs of shock.

ACCEPTABLE Outer Box Condition

DAMAGED Outer Box Condition

In the event of severe damage to the outer box, photograph the damage and contact Picarro (please email picture) for consultation on best course of action.

UNPACKING THE BOXES

CAREFULLY unpack the contents from the boxes. The shipment will come with a packing list. Please consult this list to confirm all contents are present. If any of these items are missing, contact Picarro for a replacement. Inspect each item to assure it is not damaged.

Picarro recommends boxes and packaging are stored for future use.

INSTALLATION

This section describes how to install the Continuous Water Sampler with a Picarro L2130-*i* or L2140-*i*.

Installation Requirements

The CWS has the following power requirements:

- Input voltage: 100 to 240 VAC
- Total power consumption during warm-up: < 50 W
- Total power consumption at steady state: ~ 30 W

The CWS sits directly on top of your Picarro L2130-*i* or L2140-*i*, adding 7" in height. In total the analyzer with CWS and all connections will require approximately 2' x 2' in surface space and approximately 18" in vertical space. Additional space may be required for the analyzer's monitor, keyboard, mouse along with any sampling lines and standard sources for your CWS.

The following tools and parts are required to complete installation:

- 9/16" wrench
- 7/16" wrench
- USB communication cable (provided by Picarro)
- Power cable (provided by Picarro)
- Heated transfer line (provided by Picarro)
- Sample tubing (provided by Picarro)

Step-by-step installation instructions

1. Place the CWS on top of your water isotope analyzer. Remember the basic installation of the Picarro L2130-*i* or L2140-*i* should already have been completed.
2. Connect the transfer line between the CWS and analyzer by connecting the 7/16" fitting on the transfer line to the port labeled "H_2O Vapor Out" on the rear of the CWS. Connect the other end (9/16" fitting) to the analyzer inlet.

	You may need to remove the 7/16" cap that was placed on the "H_2O Vapor Out" port for shipping.
	Swagelok fittings should be finger-tightened and then tightened using a ¼" turn using the appropriately sized wrench. Do not over-tighten the thread or tighten the fitting when it cannot initially be finger-tightened. To avoid damage to the threading, when it is not possible to finger-tighten the fitting, check that the threading is correctly aligned before using a wrench.

Figure 1: Rear of the CWS with H_2O Vapor Out port highlighted in yellow.

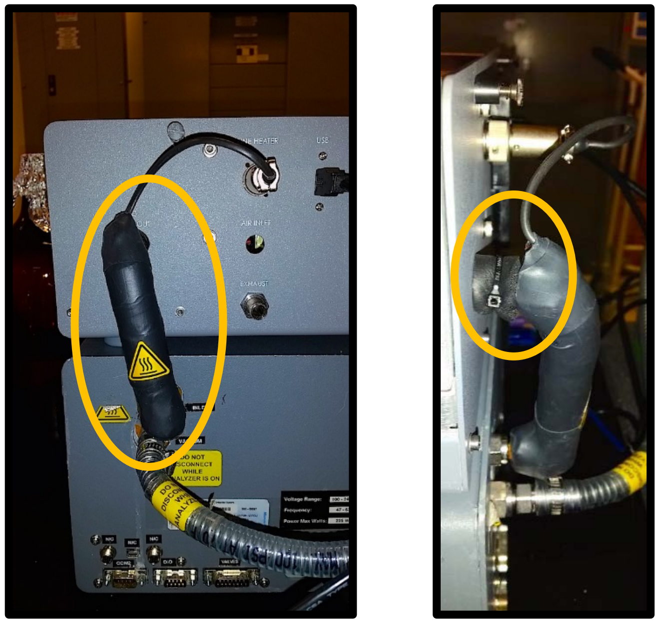


Figure 2: Rear of the CWS with the transfer line connected between the CWS and the analyzer (left). In addition, a small piece of foam is zip-tied around the upper Swagelok connector (right) to reduce the possibility of a cold spot in the transfer of H_2O from the CWS to the analyzer.

3. Once the transfer line is physically connected between the CWS and analyzer, connect the line heater using the quick connect on the rear of CWS.

Figure 3: Rear of the CWS with Line Heater quick connect highlighted in yellow.

4. Connect the USB cable between the CWS and analyzer. It does not matter which USB port is used on the analyzer.

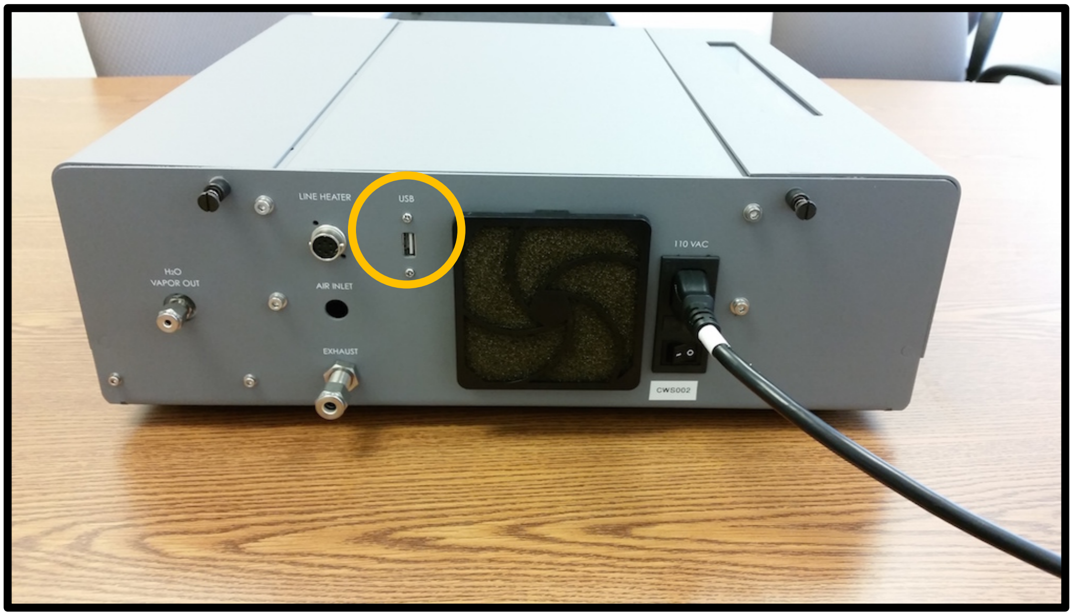


Figure 4: Rear of the CWS with the USB port highlighted in yellow.

5. After ensuring that the power switch is in the O (off) position, plug in the power cable on the rear of the CWS and also to a power outlet.

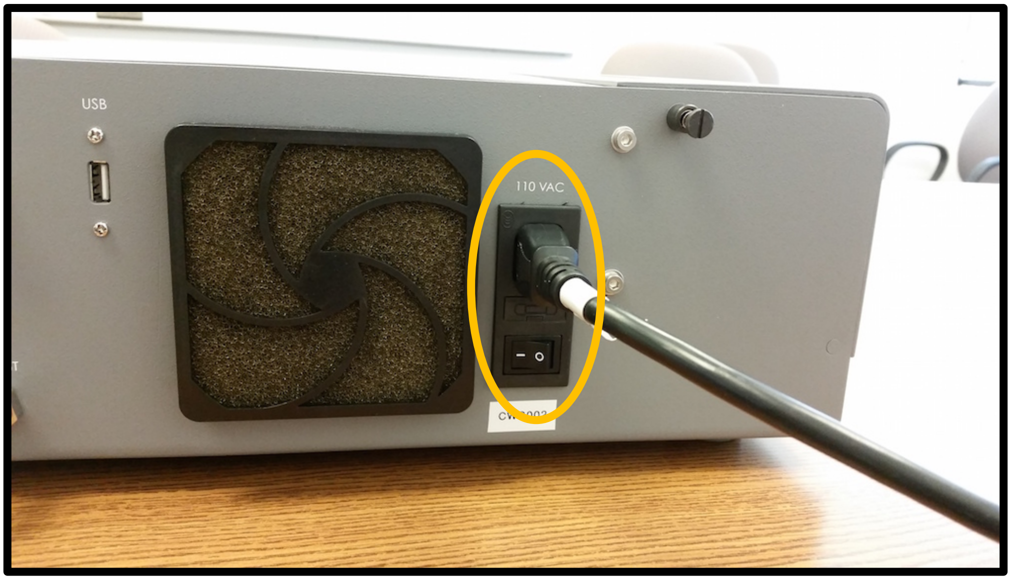


Figure 5: Rear of the CWS with power switch and cable. The power switch is "On" in this image ("I" is depressed).

6. Once the CWS is connected to the analyzer, connect the CWS to your water sources using the ports on the front of the CWS. There are four inlet ports and one outlet port. The inlet and outlet ports are designed to fit 1/8" tubing using a 1/8" Swagelok nut and ferrule. Picarro recommends using 1/8" PFA tubing, a small amount of which is supplied with the CWS.

Figure 6: Front of the CWS with the four inlet ports and one outlet port highlighted in yellow.

	Picarro recommends placing a 2 μm filter upstream of the water inlet to remove particulates from your water source. This is not necessary for clean water (e.g., isotope standards, rainwater) but is strongly encouraged for waters with a high particulate load (e.g., estuary water, river water, brines). Although the cassette holding the diffusion membrane is user-replaceable, the inlet sample selector should be protected from clogging by placing a filter upstream. Below are two examples of filters that have been tested with the CWS: 1. FL Smidth, KREBS gMax Cyclone Filter, Model No. GMAX1U-3125. This cyclonic filter design is ideal for long-term field studies. 2. GE Osmonics, Inc., Memtrex, Model No. MNY921EGS (25 cm length, 0.2 μm pore size).
	To prevent siphoning, the waste water port should be placed at a height equal to or greater than the CWS. If siphoning occurs, there is the possibility for increased noise in water concentration and delta values.

The CWS is now ready for operation.

OPERATION

This section describes how to operate the Continuous Water Sampler with a Picarro L2130-*i* or L2140-*i*.

Starting up the CWS

Upon completion of installation, follow these steps to start up the CWS.

1. Turn on the mains power switch on the rear of the CWS by depressing the power switch. The mains power is on when the “I” is depressed.

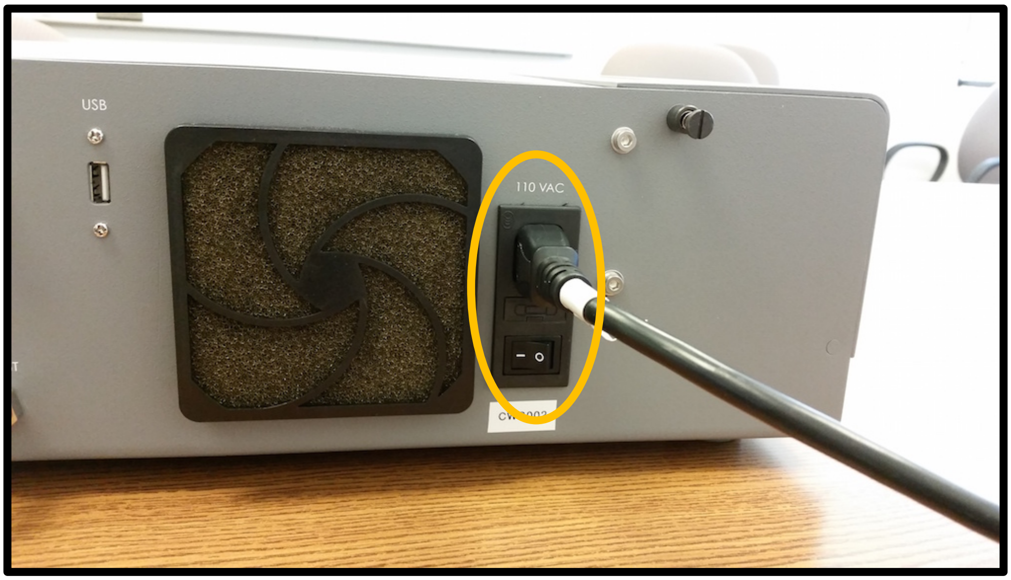


Figure 7: Turn on the mains power by depressing the power switch.

2. Press and hold the power button on the front of the CWS for approximately 2 seconds to provide the system power.

Figure 8: Power button on front of CWS is off (no light).

Figure 9: Power button on front of CWS is on (green light).

If the power does not stay on after your remove your finger, the possible causes are:

a. You did not depress the button for long enough. Try again making sure to depress the button for at least 2 seconds.

b. Make sure that the mains power switch in the rear of the CWS in ON.

c. The CWS was not shut down properly using the power switch. If the CWS was powered off with one of the following methods:

- By directly switching off the mains power switch in the rear of the CWS unit.
- By cutting the power supply to the CWS while it is on, from a power outage or unplugging the power cable

then the power switch needs to be reset by depressing the button for at least 2 seconds. The second time you depress the power button, the CWS will turn on.

d. The leak detector in the system has detected a water leak. In this case, you will hear the vacuum pump turn on when the button is depressed, but as soon as you remove your finger from the button the pump will turn off and the button will not remain green. If the leak sensor has trip, pop off the right top-to-side panel of the CWS.

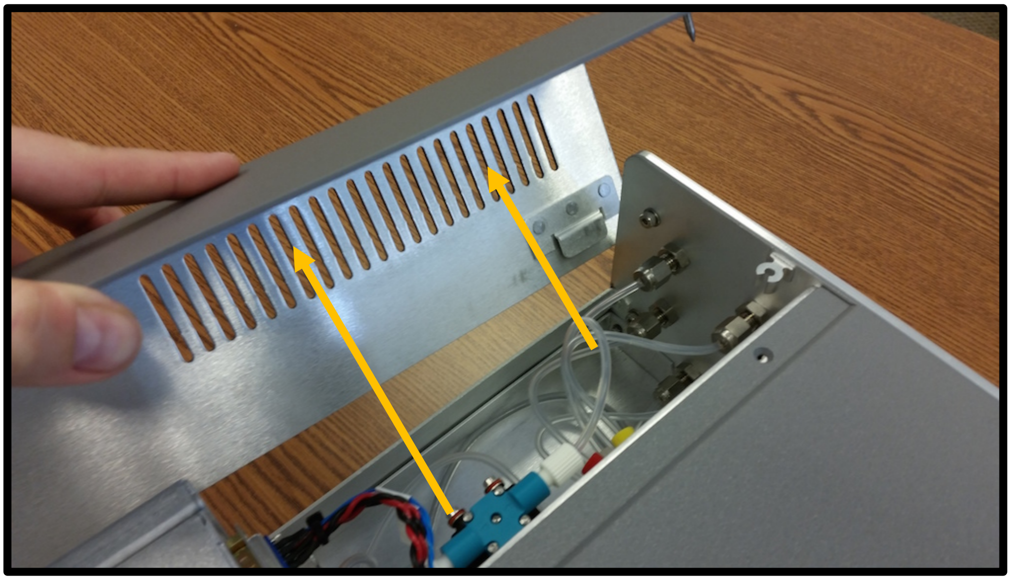


Figure 10: Remove the right top-to-side panel (when looking at front of CWS)

e. Once the panel is removed, you will see the water sampling lines, sample selector and membrane cassette housing. This section of the CWS contains all of the liquid water lines. It is separated from the electronics (beneath the middle panel of the CWS) for your safety. On the bottom of the tray, there is a small leak sensor that is used as a safety mechanism for the system. The leak sensor will be green when no water is detected. If water is detected, the light will turn red and then the power will shut off. Once you have the right top-to-side panel removed, press and hold the power button. If a leak is present, the light will remain red while the power button is depressed. At this point, remove your finger from the power button and clean up the leak.

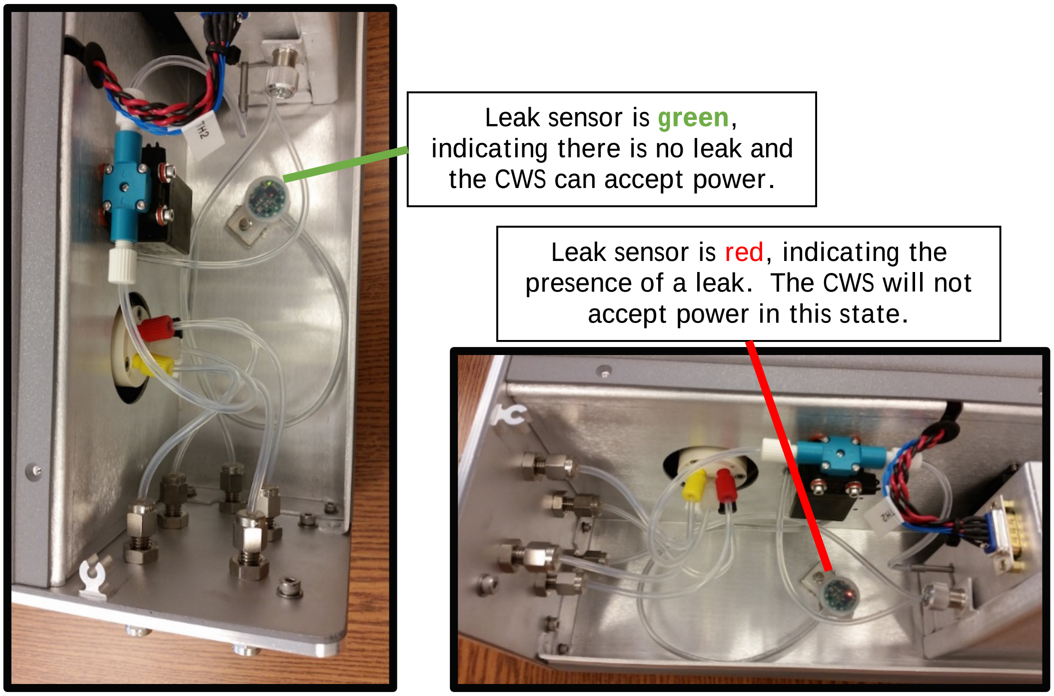


Figure 11: Leak sensor for protecting the CWS electronics from water and for customer safety.

3. Once the green power light is on and remains solid after you remove your finger from the button, the CWS is on. At this point, power is supplied to the fans, pump which backs the Nafion dryer and the computer chip. The air pump and water pump will not start until the Coordinator is launched.

	When you are not using the CWS, we recommend turning the power off to the CWS (the analyzer can remain on) following the Shut Down procedure. Once the power to the CWS is off, it is possible to leave the CWS off but attached to the analyzer. This is because the transfer line from the CWS to the analyzer is an open split. When the CWS is off, but attached to the analyzer, the analyzer will sample room air which is the preferred analyzer idle state.
	Upon starting up the CWS, it is possible to see a spritz of water come out of the pump exhaust (labeled “Exhaust” on the rear of the CWS). This is normal and should not cause alarm. It can also occasionally occur during operation of the CWS. The water spritz is caused by minor condensation on the back side of the air pump. The pump is used in conjunction with a Nafion tube to create a partial pressure gradient in water concentration that dries your ambient air gas stream.
	Remember to reset the Power switch if the CWS was not turned off properly. See Section Operation>Starting up the CWS>2.C.

Priming the CWS

Now that your CWS is installed and powered, you are ready to prime the CWS prior to running it. This section describes how to manually operate the water pump and the port selector to prime the inlet lines of the CWS.

1. Double-click on the “CWS Priming” icon on the analyzer desktop. The window below will pop up.

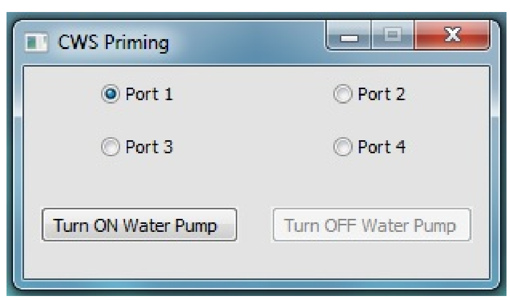


Figure 12: Picarro CWS Priming window.

2. Ensure that inlet and outlet tubing are properly connected to the water source.
3. Select the port of interest on the “CWS Priming” window.
4. Click on “Turn ON Water Pump”. The water will start pumping from the selected water source.
5. Allow about 4 minutes to ensure that the line is filled with water and large air bubbles are removed from the line. You should see water coming out the outlet line.

6. Once a port is primed, you can switch to another port without having to turn off the water pump and by selecting the next port of interest.
7. Repeat step 5 and 6 until all the ports are primed.
8. Click on “Turn OFF Water Pump” to stop the pump.
9. Priming is completed, you can close the “CWS Priming” window.

Running the CWS

Now that your CWS is primed, you are ready to start running the CWS. This section describes how to use the coordinator to control the CWS.

	Before you start, make sure you are operating in the Air measurement mode, and if you are running a Picarro L2140-*i*, make sure you are operating in the “normal” $\delta^{18}O$ and $\delta^{2}H$ mode. The CWS is not designed to operate in the ^{17}O-excess mode of the L2140-*i* and it should not be run when operating in the ^{17}O-excess mode. To change the analyzer measurement mode, double click the “Picarro Mode Switcher” icon on your desktop. Using the drop down menu, select “iH2O Air” and then click “Launch”. If the system is already running you will get a warning about re-starting your CRDS analyzer. Select “Yes” to restart the analyzer in the selected measurement mode.

1. Start the CWS coordinator by double-clicking the “Coordinator Launcher” icon on the analyzer desktop. From the drop down menu, select “Continuous Water Sampler” and click “Launch”

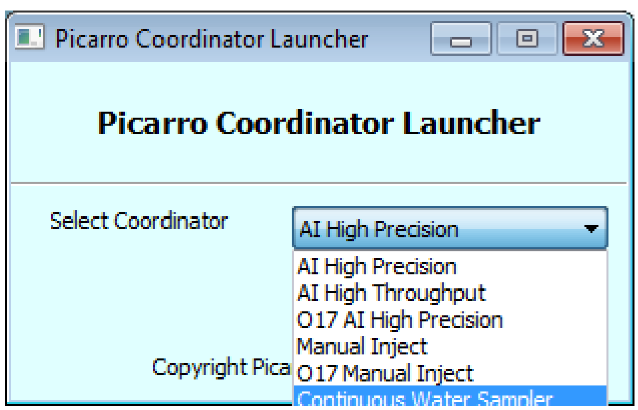


Figure 13: Picarro Coordinator Launcher window. Use drop down menu to select Continuous Water Sampler, then click "Launch".

2. Upon opening the coordinator, a window will pop up. This window enables the user to select the configuration relevant to their setup.

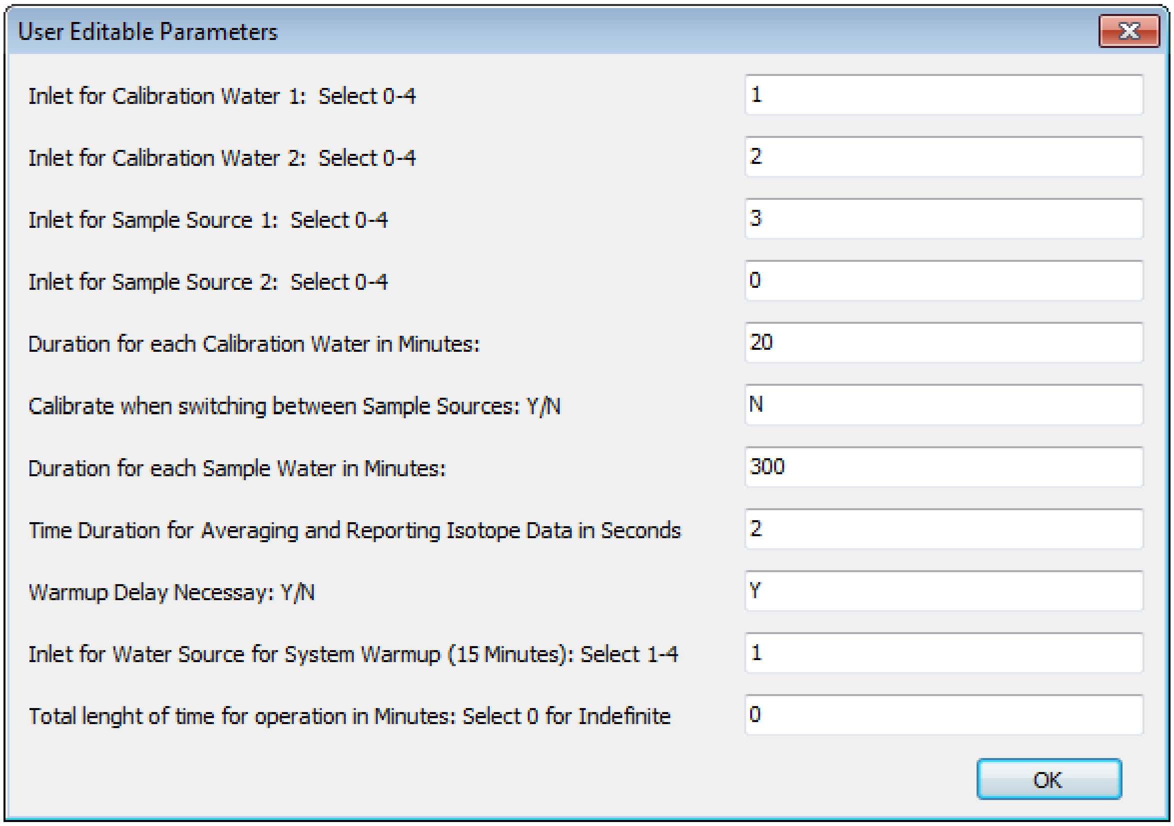


Figure 14: Pop up window for selecting User Editable Parameters for running the CWS. See table below for explanations on the parameters.

User Editable Parameters	Options	Explanation
Inlet for Calibration Water 1	Select 0-4	Use this parameter to select the inlet port for your first calibration water. If no calibration water is attached, select 0.
Inlet for Calibration Water 2	Select 0-4	Use this parameter to select the inlet port for your second calibration water. If no calibration water is attached, select 0.
Inlet for Sample Source 1	Select 0-4	Use this parameter to select the inlet port for your first sample water. If no sample water is attached, select 0.
Inlet for Sample Source 2	Select 0-4	Use this parameter to select the inlet port for your second sample water. If no sample water is attached, select 0.
Duration for each Calibration Water in Minutes	0 to > 1,000	Picarro recommends measuring your calibration waters for 20 minutes. A 20 minute measurement ensures sample-to-sample isotopic memory is minimized, while also enabling at least 5 minutes of averaging. The user should select the duration relevant for their set up based on the maximum isotopic difference between inlet waters, and the precision required for your application.
Calibration when switching between Sample Sources	Y / N	Select if you want to have a calibration performed when you switch between sample sources.
Duration for each Sample Water in Minutes	0 to > 1,000	Use this parameter to select the duration of measurement time for you sample waters. The default set by Picarro is 300 minutes (5 hours). The length of time selected by the user will depend on their application (measuring multiple sources or one source with temporal changes) and the frequency of calibration. Picarro recommends calibrating the CWS system two to three times per 24 hours with two calibration standards. Ideally, a third calibration standard will be used as a check upon initial installation.

Time Duration for Averaging and Reporting Isotope Data in Seconds	0 to > 1,000	Use this parameter to determine the averaging window and reporting frequency for your CWS data. Keep in mind, all raw data (recorded at a frequency of ~ 1 Hz) will be stored in the User Data Log if you wish to post-process your data using a different averaging interval.
Warmup Delay Necessary	Y / N	The warmup delay is used to warmup the system up to optimal temperature. It should be used every time the coordinator is started, unless the coordinator was halted temporarily (< 5 minutes). The default set by Picarro is Y.
Inlet for Water Source for System Warmup (15 minutes)	Select 1-4	This sets the water source used for the warmup. Picarro recommends using a water source with unlimited supply. The warmup period takes 15 minutes, consuming between 2-3 mL of water per minute (30 to 45 mL total).
Total length of time for operation in Minutes:	Select 0 for Indefinite	Unless you select a period of time, the CWS loop will continue indefinitely. Select the time period after which you want to cease CWS operation. For example, if you are planning a 2 week experiment in the field and have sufficient standards, you could select 20160 minutes (= 60 minutes x 24 hours x 14 days).

3. After selecting your configuration options, click “OK”. At which point the coordinator window will open and the analyzer will attempt to communicate with the CWS. Assuming communication is successful, the CWS will start to run working through the sequence of events you selected on the previous screen, typically starting with a 15 minute warm up period.
    a. If the COM port fails to connect with the CWS, you will get the following error:

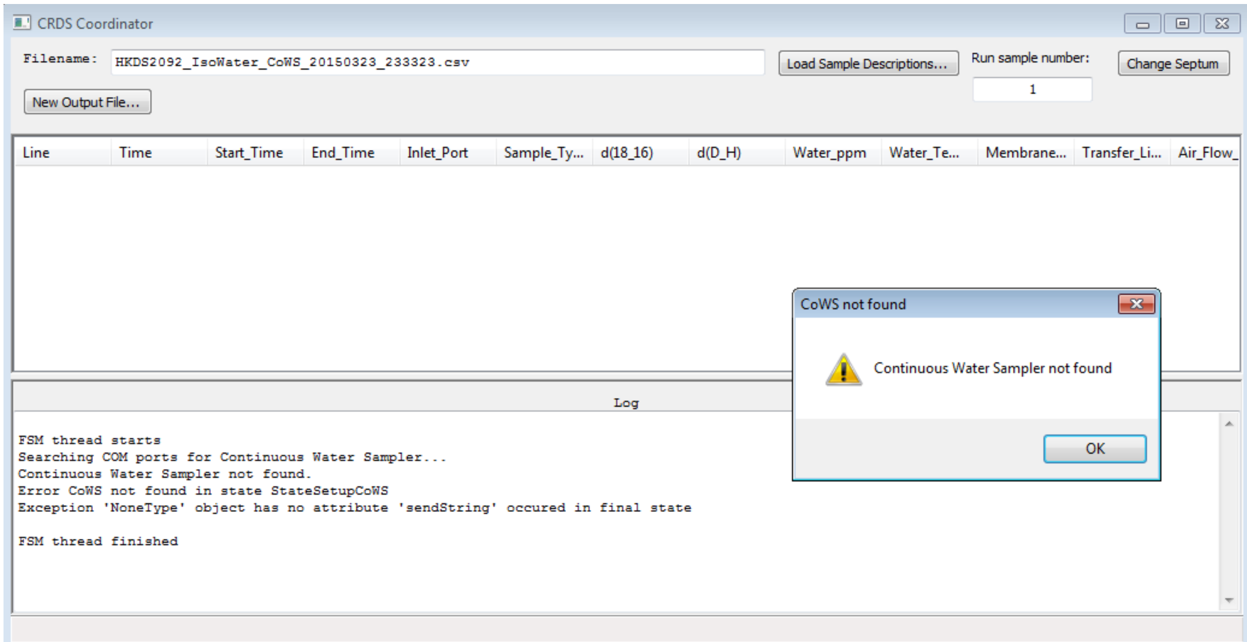
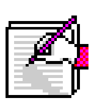


Figure 15: Example of communication error when CWS isn't found.

Upon receiving this error check (i) the USB connection between the CWS and the analyzer, and (ii) that the CWS has power. The CWS must be physically connected and have power for the COM port to find the CWS. If the analyzer has trouble connecting to the CWS, disconnect the analyzer end of the USB cable and then re-connect it. Try to launch the Coordinator again.

5. The CWS Coordinator will now proceed to collect and record data. The sample selector will switch between inlets 1-4 based on the configuration set up during the launch of the CWS Coordinator. You can review the location of the CWS Coordinator data, raw data and descriptions of the Column Headers the section labeled “Data Files and Definitions”.



If you abort the Coordinator before it reaches the end of its operation (see “Total length of time for operation in Minutes” in User Editable Parameters of CWS Coordinator), the Coordinator software may become unresponsive. You can force quit out of the CWS program, however be aware that the pumps and CWS temperature control will continue. Therefore:

- **If you have finished your analysis**, turn off power to the CWS by using the mains switch on the back of the CWS.
- **If you are still analyzing data**, restart the CWS Coordinator and continue your data collection after re-initializing the analysis.

Shutting Down the CWS

When you have finished using the CWS, it can be easily shut down. We recommend turning off the power to the CWS when the system will not be used for a period of 2 hours or more. By turning off the CWS power, you preserve both the pump lifetime and Drierite lifetime.

1. First depress the power switch in the front the CWS. The light will turn off.
2. Turn off the mains power switch on the rear of the CWS by depressing the power switch. The mains power is off when the “O” is depressed.

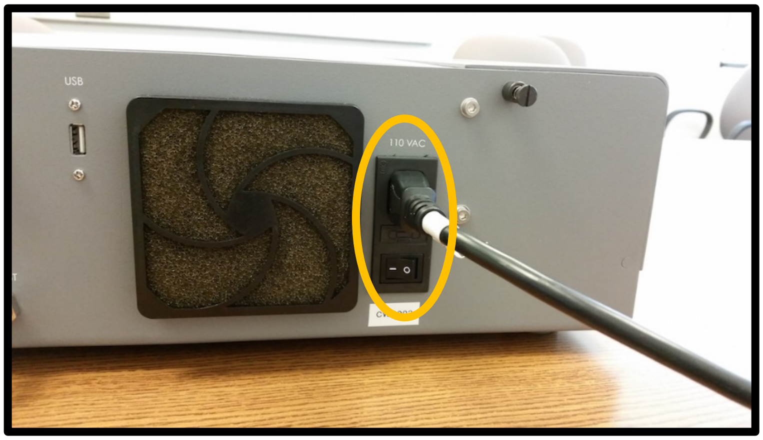


Figure 16: Turn off the power switches.

	Once the power to the CWS is off, it is possible to leave the CWS off but attached to the analyzer. This is because the transfer line from the CWS to the analyzer is an open split. When the CWS is off, but attached to the analyzer, the analyzer will sample room air which is the preferred analyzer idle state.
	If you have been running salt water through the CWS, we recommend flushing the CWS with fresh water prior to shutting it down for a long period of time, e.g., a week or more. To do this, move one of your inlet lines to a freshwater source. Then open the coordinator and set that inlet port to measure for 30 minutes. Below is an example of the Coordinator settings required if fresh water was sourced from inlet 3: Inlet for Calibration Water 1 = 0 Inlet for Calibration Water 2 = 0 Inlet for Sample Source 1 = 3 Inlet for Sample Source 2 = 0 Duration for each Calibration Water in Minutes = 0 Calibration when switching between Sample Sources = N Duration for each Sample Water in Minutes = 30 Time Duration for Averaging and Reporting Isotope Data in Seconds = 0 Warmup Delay Necessary = N Inlet for Water Source for System Warmup (15 minutes) = 3 Total length of time for operation in Minutes = 30

CALIBRATION, PERFORMANCE VERIFICATION & BEST PRACTICES

This section includes recommendations on how to use and operate the CWS. It does not represent the only way to operate the CWS, nor does it suggest an exhaustive analysis of best practices by Picarro.

Calibration

The CWS should be calibrated prior to use and we recommend measuring two standards alongside your samples during data collection. Ideally, the CWS should also be calibrated using three standards in the lab prior to deployment in the field. The addition of a third standard will enable a 3-point linear regression, or a two point with a check standard. Once linearity is confirmed, it is only necessary to measure two standards in the field.

The CWS consumes approximately 1 mL of water per minute, therefore primary isotope standards of limited supply should not be used to calibrate the CWS. We recommend developing large volumes of a tertiary standard (over 10 L per standard) to measure on the CWS. These tertiary standards can be referenced to other in-house, or primary, water standards using a Picarro water isotope system with vaporizer for liquid water injections.

Due to sample-to-sample isotope memory, we recommend calibrating the system by measuring each isotope standard for approximately 20 minutes. Using this approach, the last 5 minutes of data collection can be averaged to determine the measured isotope value for that standard. This will ensure sample-to-sample memory is overcome prior to determining the measured isotope value.

	Picarro guarantees that after 7 minutes, your CWS system will report better than 99% and 98%, for $\delta^{18}O$ and $\delta^{2}H$ respectively, of the true difference between two isotope standards.
	Picarro guarantees a precision of better than 0.1 ‰ and 0.2 ‰, for $\delta^{18}O$ and $\delta^{2}H$ respectively, based on the 1σ of a 5-minute average measurement.
	In combination, the sample-to-sample isotope memory and precision can be used to guide the length of time a user elects to measure each standard. Picarro recommends 20 minutes, although this time period could be reduced based on the difference in isotope space between two adjacent samples, and the precision and accuracy requirements of the application.

Picarro recommends calibrating your CWS two to three times per day, this equates to 80 to 120 minutes, out of 1440 minutes per 24 hours, or a duty cycle of 5 to 8%. At 1 mL per minute, this equates to a maximum of 120 mL per day, or approximately 4 L of tertiary standard water consumption per month assuming the CWS is used every day of that month.

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Performance Verification

If you are concerned about the performance of your CWS, it is possible to perform some simple in-lab tests.

> **Test 1:** Measure a single source of water for 12 hours. Calculate the standard deviation of 5-minute averaged data bins over 12 hours. This test is used at Picarro to determine the performance prior to shipping. At the time of manufacture, the CWS system must yield values for this test of better than 0.1 ‰ and 0.2 ‰, for $\delta^{18}O$ and $\delta^{2}H$ respectively. *This assumes both a new CWS and a new analyzer.*
>
> **Test 2:** Set up a 6-hour test where you switch between two waters at intervals of 20 minutes. Calculate the last 2-minute average for each time a water is measured. Calculate the standard deviation of these averages. Then calculate the average of these standard deviations for both waters. At the time of manufacture, the CWS system must yield values for this test of better than 0.4 ‰ and 1.0 ‰, for $\delta^{18}O$ and $\delta^{2}H$ respectively. *This assumes both a new CWS and a new analyzer.*

If your results differ significantly from the values listed for Test 1 and Test 2, read the "Troubleshooting" section of this manual, or contact Picarro's Technical Support team (see section "Need Help from Picarro?").

Best Practices

Filtration: Picarro recommends placing a 2 μm filter upstream of the water inlet to remove particulates from your water source. This is not necessary for clean water (e.g., isotope standards, rainwater) but is strongly encouraged for waters with a high particulate load (e.g., estuary water, river water, brines). Although the cassette holding the diffusion membrane is user-replaceable, the inlet sample selector should be protected from clogging by placing a filter upstream.

Calibration: Picarro recommends two standards are measured alongside your samples while the CWS is deployed in the field. See "Calibration" section.

Spectral Interference: The diffusive membrane used in the CWS is permeable not only to water vapor, but also other gas phase molecules. In particular, CH_4 and H_2S may diffuse through the membrane and enter the gas stream sampled by your Picarro analyzer. While operating in the Air mode, the L2130-*i* and L2140-*i* measures and corrects for CH_4. Spectral interference from H_2S is unlikely, although possible at very high concentrations. Spectral interference should be considered for other non-typical gas mixtures. Contact Picarro if you suspect other dissolved gases are present in your water source. Please send your CWS coordinator output file, and if possible, a Private Data Log from the time period when you were measuring that water source.

Drierite consumption: The CWS combines a Drierite desiccant column with Nafion tubing to dry ambient air prior to contact with liquid water in the membrane cassette. You can track the effectiveness of the indicating Drierite using the window on the left top and side of your CWS. Indicating Drierite changes from blue to purple when it is no longer effective at removing water vapor. See section "Replacing the Drierite Column" in "Service & Maintenance" for instructions on how to replace the Drierite.

Water vapor concentration stability: Water vapor concentration can affect the isotopic measurements on the analyzer. Although, active feedback control of the factors that affect water concentration and kinetic fractionation across membrane (e.g., temperature and flow rate) are in place, hydrostatic pressure created by the sampling set up can also contribute to the variation in the water concentration.
For optimum and consistent performance of the CWS, we recommend:

- Setting the sample sources feeding all the CWS inlet ports at the same elevation.
- Inlet and outlet tubing length should all be the same (approx. 3ft / 1m).
- Discharge from the outlet tubing should not be submerged in water and should not be elevated high above the CWS.

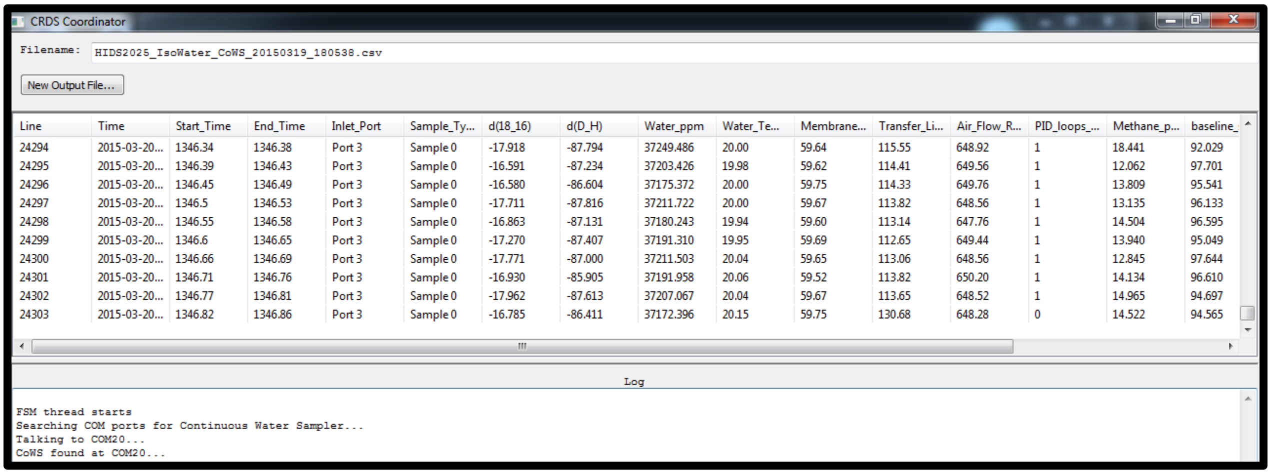
Below are the variations that have been observed:

Variations	d18O	dD
+/- 2ft (60 cm) in inlet tubing length	+/- 0.1 ‰	+/- 0.4‰
+/-1.5 ft (50 cm) in sampling elevation	+/- 0.1‰	+/- 0.5‰

DATA FILES & DEFINITIONS

Data collected by the Picarro CWS Coordinator is exported as a .csv file. All coordinator data are found in the following folder: **C:\IsotopeData**. You can open .csv files on your Picarro using Notepad++, or transfer the data to another computer for import into other programs, such as Microsoft Excel, Matlab or the computing language of your choice.

While the CWS is measuring, the following Coordinator window will be visible from the desktop of your Picarro. It is possible to scroll across to see all of the data columns, and to scroll up to view past data. There is also a Log window that will track activity.



The CWS Coordinator stores the following data columns.

Line	Line counter. Each line represents a data point, and the frequency of the data points reported in the Coordinator are set based on the selection made for "Time Duration for Averaging and Reporting Isotope Data in Seconds" when opening the Coordinator.
Time	Time the line was recorded in "Year-Month-Day Hours:Minutes:Seconds".
Start_Time	The start time of that measurement interval (Line), relative to the opening of the Coordinator. Line 1 will always have a start_time of zero.
End_Time	The end time of that measurement interval (Line), relative to the opening of the Coordinator.
Inlet_Port	Reports which inlet is being measured at that line (Port 1.0 to 4.0).
Sample_Type	Reports the type of sample (Warm Up, Sample 1, Sample 2, Calibration 1, Calibration 2). Values are defined based on selection made when opening the Coordinator.
d(18_16)	The average $\delta^{18}O$ value, in per mil (‰), measured at that interval (Line). The typical raw data acquisition rate on a L2130-*i* and L2140-*i* is ~ 1 Hz. For example, if "Time Duration for Averaging and Reporting Isotope Data in Seconds" was set to 5 when opening the Coordinator, d(18_16) will be the average of approximately 5 raw data points. The reported delta values are not calibrated. Post-processing is required for calibration.
d(D_H)	The average $\delta^{2}H$ value, in per mil (‰), measured at that interval (Line). The typical raw data acquisition rate on a L2130-*i* and L2140-*i* is ~ 1 Hz. For example, if "Time Duration for Averaging and Reporting Isotope Data in Seconds" was set to 5 when opening the Coordinator, d(D_H) will be the average of approximately 5 raw data points. The reported delta values are not calibrated. Post-processing is required for calibration.
Water_ppm	The average water concentration, in ppm, measured at that interval (Line). The typical raw data acquisition rate on a L2130-*i* and L2140-*i* is ~ 1 Hz. For example, if "Time Duration for Averaging and Reporting Isotope Data in Seconds" was set to 5 when opening the Coordinator, Water_ppm will be the average of approximately 5 raw data points.
Water_Temp_C	The average water temperature in °C. The water temperature is controlled by the CWS firmware, and is set to ~ 15°C. During warm up the temperature will not be stable at 15°C. During analysis, the temperature should average to be 15°C, with a standard deviation of < 0.05°C. This data column can be used to track system performance.

Membrane_Temp_C	The average temperature of the membrane in °C. The membrane temperature is controlled by the CWS firmware, and is set to ~ 45°C. During warm up the temperature will not be stable at 45°C. During analysis, the temperature should average to be 45°C, with a standard deviation of < 0.1°C. This data column can be used to track system performance.
Transfer_Line_Temp	The average temperature of the transfer line in °C. The transfer line temperature is controlled by the CWS firmware, and is set to ~ 115°C. During warm up the temperature will not be stable at 115°C. During analysis, the temperature should average to be 115°C, with a standard deviation of < 2°C. This data column can be used to track system performance.
Air_Flow_Rate_sccm	The average air flow rate in standard cubic centimeters per minute (sccm). The air flow rate is controlled by the CWS firmware, and is set to 500 sccm. During analysis, the air flow rate should average to be 500 sccm, with a standard deviation of < 1 sccm. This data column can be used to track system performance.
PID_loops_locked	If the temperature and air flow control loops are locked and stable, this column will report the value 1. If the control loops are not locked, this column will report the value 0. If the control loops report 0 during measurement, read the "Troubleshooting" section of this manual, or contact Picarro's Technical Support team (see section "Need Help from Picarro?"). It is normal for the control loops to be unlocked (reading 0) during warm up.
Methane_ppm	The average methane concentration, in ppm, measured at that interval (Line). This column can be used to track potential spectral interference and data integrity. Methane concentration is not calibrated, and should not be used directly to determine the methane concentration in the water source.
baseline_shift	The average value for baseline shift, in ppb/cm, measured at that interval (Line). Baseline_shift is a spectral term that is measured on the L2130-*i* and L2140-*i*. It is the change in the constant term of the fitted baseline, relative to an empty cavity baseline which is measured at the Picarro factory. This column can be used to track potential spectral interference and data integrity.
baseline_curvature	The average value for baseline curvature, in ppb/cm, measured at that interval (Line). Baseline_curvature is a spectral term that is measured on the L2130-*i* and L2140-*i*. It is the change in the quadratic term of the fitted baseline, relative to an empty cavity baseline which is measured at the Picarro factory. This column can be used to track potential spectral interference and data integrity.

slope_shift	The average value for slope shift, in ppb/cm, measured at that interval (Line). Baseline_shift is a spectral term that is measured on the L2130-*i* and L2140-*i*. It is the change in the linear term of the fitted baseline, relative to an empty cavity baseline which is measured at the Picarro factory. This column can be used to track potential spectral interference and data integrity.
residuals	The average value for residuals, in ppb/cm, measured at that interval (Line). This term represents the RMS residual of the least-squares fit of the measured spectra versus the expected spectra. This column can be used to track potential spectral interference and data integrity.

SERVICE & MAINTENANCE

The following section describes standard service and maintenance procedures that can be carried out by the user in their lab, and sometimes in the field.

Replacing the Drierite Column

The CWS combines a Drierite desiccant column with Nafion tubing to dry ambient air prior to contact with liquid water in the membrane cassette. You can track the effectiveness of the indicating Drierite using the window on the left top and side of your CWS. Indicating Drierite changes from blue to purple when it is no longer effective at removing water vapor. To replace your Drierite column, or refresh the Drierite held within the column, follow the instructions below.

1. Turn off the mains power switch on the rear of the CWS by depressing the power switch. The mains power is off when the “O” is depressed.

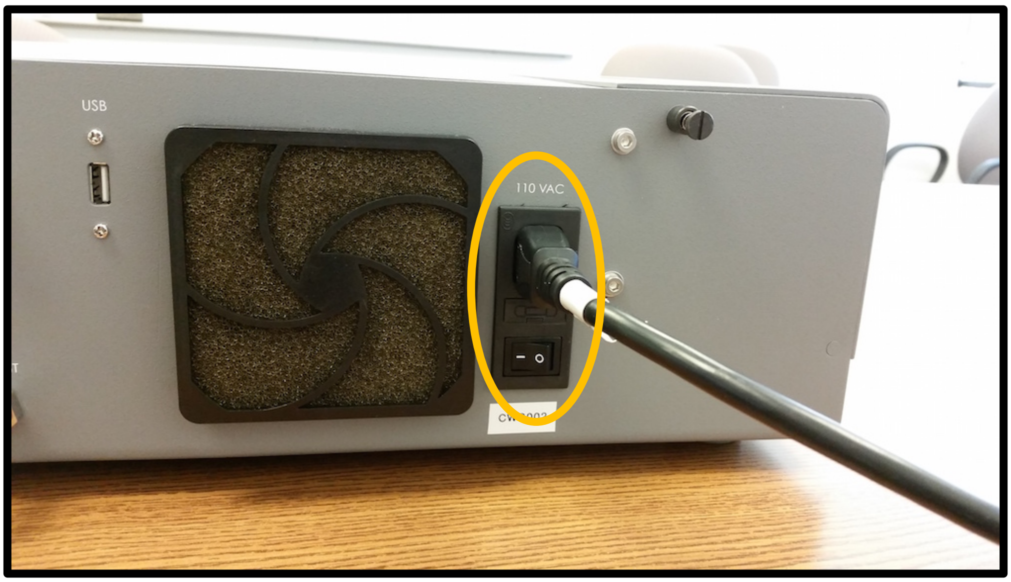


Figure 17: Turn off the mains power by depressing the power switch.

2. Remove the left top-to-side panel of the CWS to reveal the Drierite column.

Figure 18: Drierite column with the CWS left top-to-side panel removed.

3. Lift the Drierite column out of the two gray brackets that hold it in place.

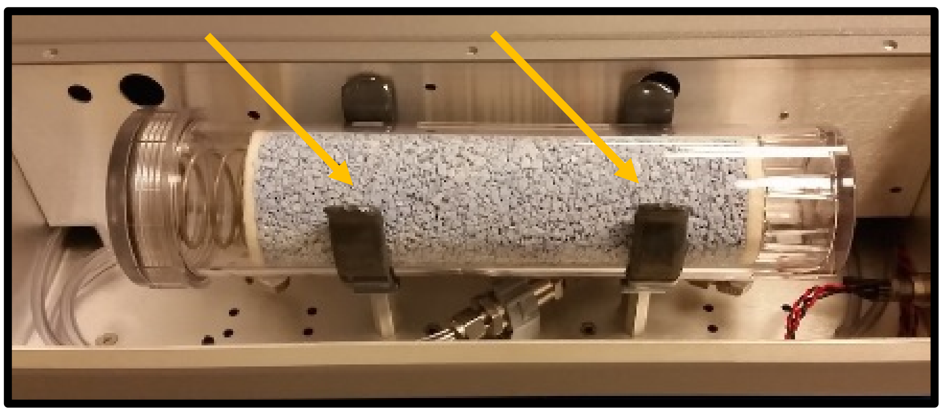


Figure 19: Drierite column with two gray brackets holding it in place.

4. Loosen the Swagelok connections using a 9/16" wrench and remove the Drierite column. Use the two black Drierite wrenches supplied with the CWS to open the Drierite column and refill the column with fresh Drierite. Replace the column and tighten the Swagelok connections.

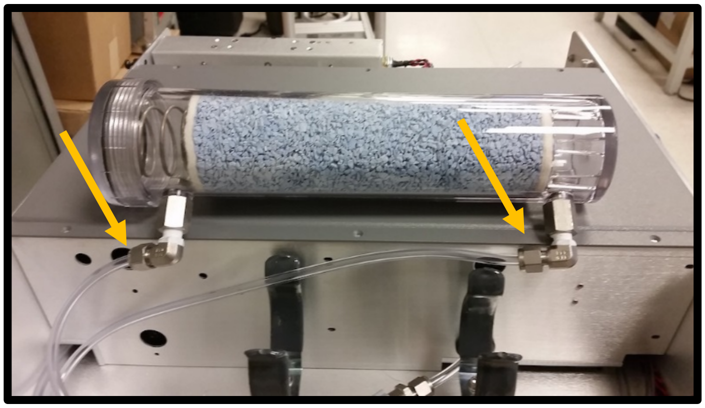


Figure 20: The two highlighted Swagelok connections should be loosened to remove and replace the Drierite.

5. After replacing the Drierite and reconnecting and tightening the Swagelok connections, push the Drierite column back into place and replace the CWS lid.

Replacing the Membrane Cassette

The diffusion membrane cassette on the CWS is user-replaceable. The following tools are required for replacing the membrane cassette:

- Metric 2.5 Allen wrench for M3 screws

🚫	**Warning!** The membrane cassette is hot during operation of the CWS (45°C). Ensure the cassette has cooled down prior to replace the membrane cassette.

1. Turn off the mains power switch on the rear of the CWS by depressing the power switch. The mains power is off when the "O" is depressed.

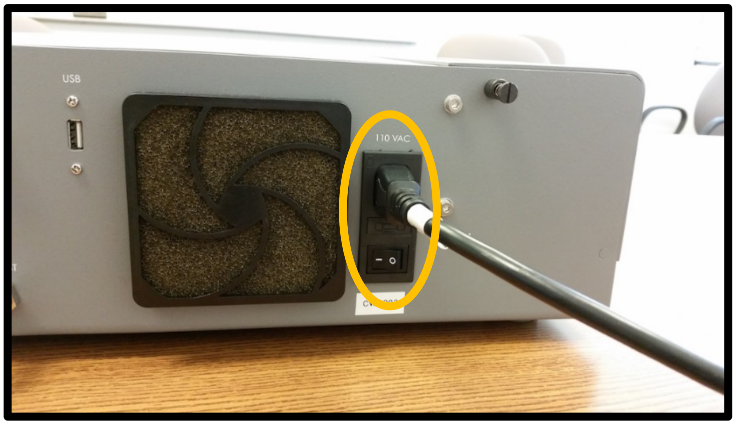


Figure 21: Turn off the mains power by depressing the power switch.

2. Remove the right top-to-side panel of the CWS.

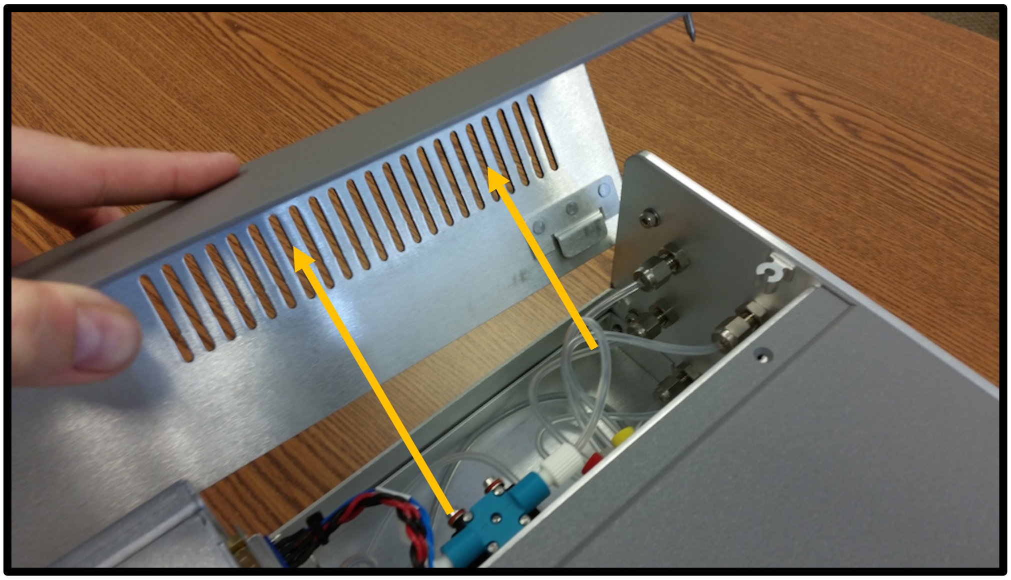


Figure 22: Remove the right top-to-side panel (when looking at front of CWS)

3. Unscrew the cover of the temperature-insulated housing which holds the membrane, and slide the cover off by moving it the left.

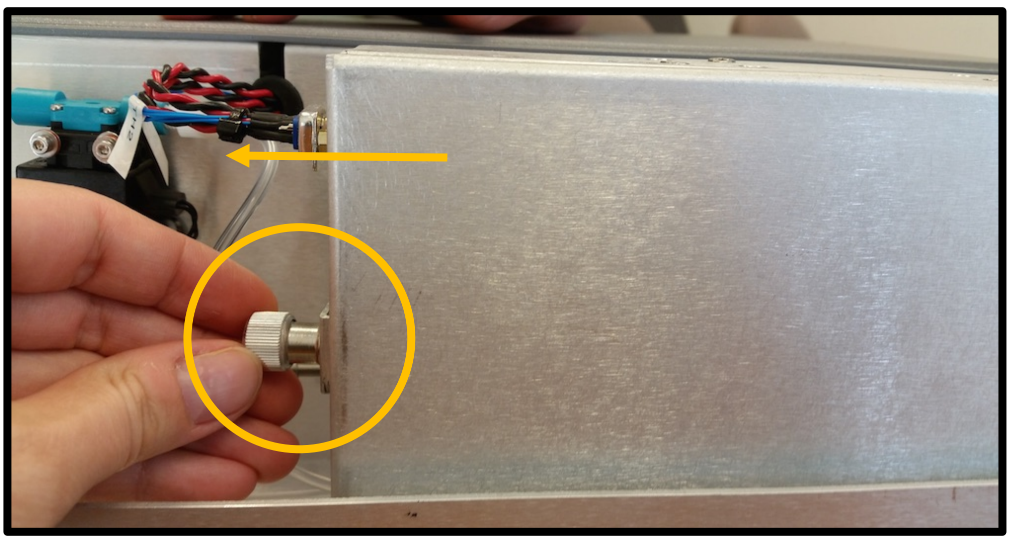


Figure 23: Unscrew the cover of the temperature-insulated membrane housing, and slide the cover to the left to remove it.

4. Once the membrane housing is removed, locate the membrane and unscrew the four screws (using a metric 2.5 Allen wrench) holding the membrane cover in place.

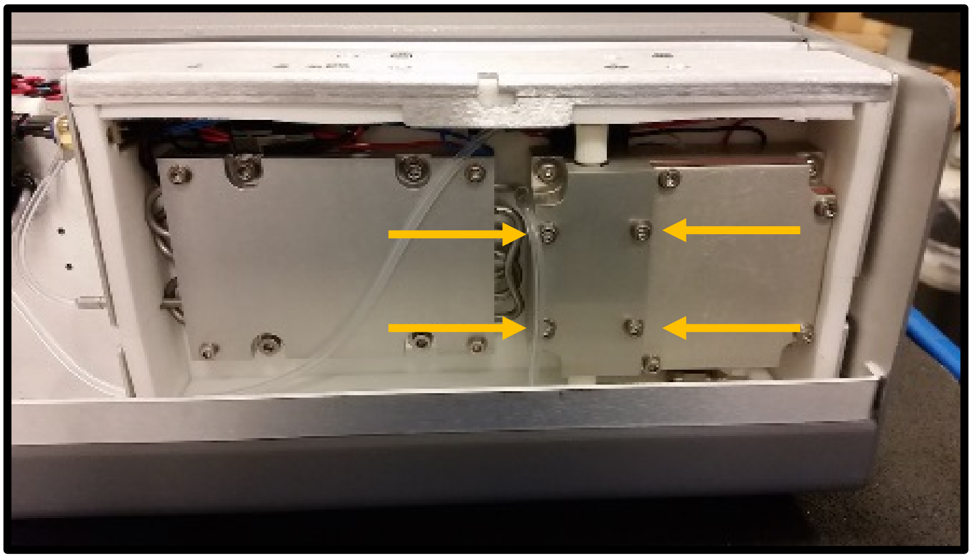


Figure 24: Location of the four screws that hold the membrane cover in place.

5. Gently pull out the membrane from its mounting location, and loosen the upper and lower screws that attach the water tubing to the membrane. Keep track of which tubing attaches to the top of the membrane cassette, and which attaches to the bottom.

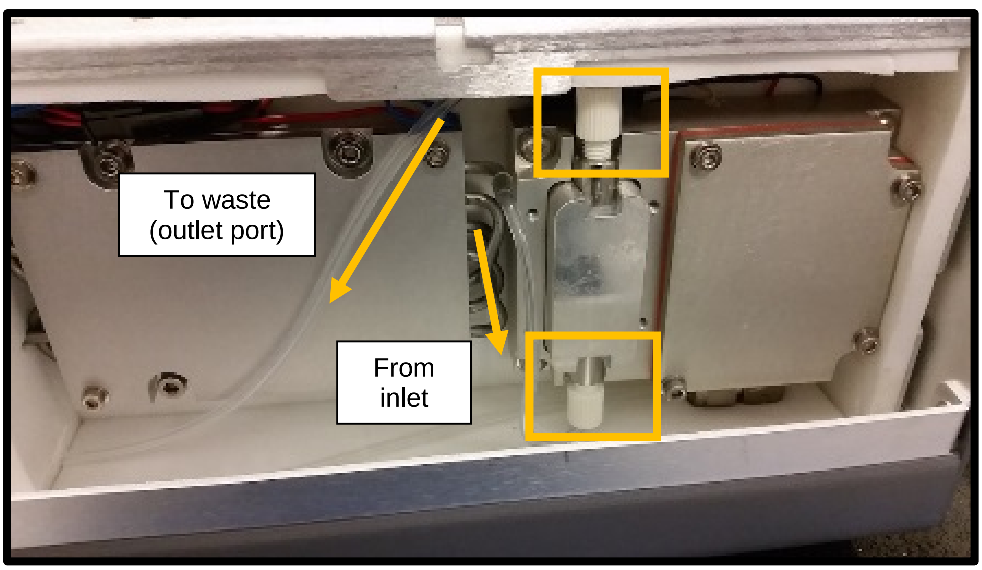


Figure 25: The membrane can be gently removed from its position. Then you can unscrew the connections to the membrane cassette (yellow boxes). The top screw and ferrule goes to the waste port, while the bottom screw and ferrule is source from the inlet via a water heat exchanger.

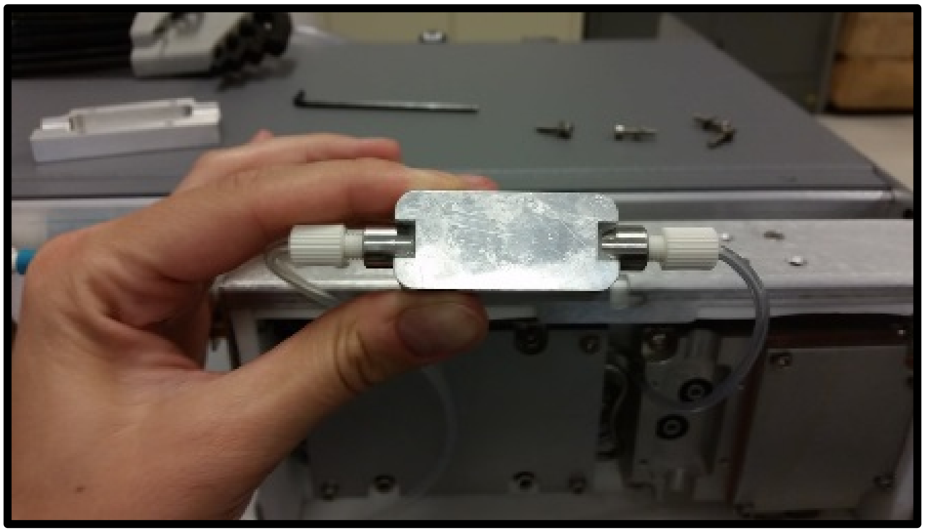


Figure 26: Photo of the membrane removed from the housing. Once it is out of the housing, it is easy to unscrew the tubing connections and replace the cartridge.

6. Once the screws are entirely loose, remove the membrane cassette and replace it with the spare cassettes supplied with your CWS. It is also possible to order replacements cassettes from Picarro.

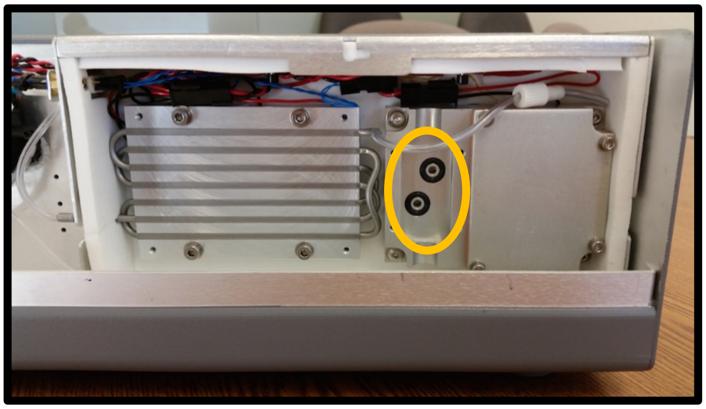


Figure 27: Spare cartridge with holes on rear side (left). These holes should be align with the holes with black o-rings (right) when replacing the cartridge.

7. Connect the tubing and screw in the connections. If you suspect a tube has collapsed consider replacing the ferrules that are used to screw the tubing into place.

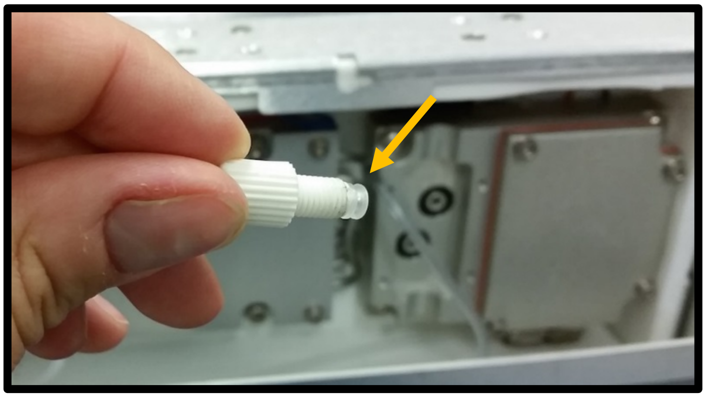


Figure 28: Membrane ferrule.

8. Align the cassette with the bracket that holds it in place and make sure the plastic tubes are free from being compressed when you close the membrane cassette housing. The outlet tube should be routed via the small indent on the left side of the membrane housing.

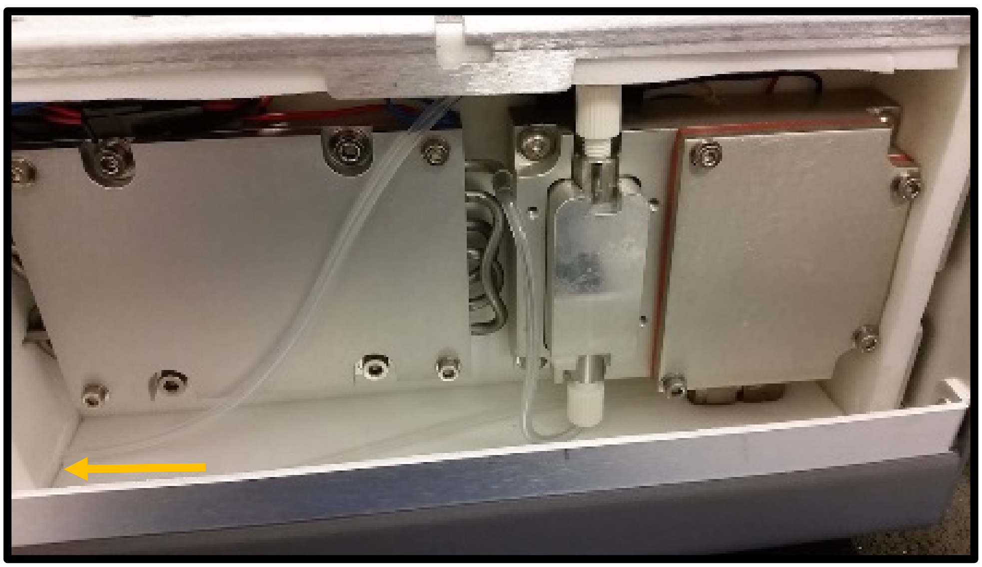


Figure 29: Route the outlet tube via the indent on the left side of the membrane housing.

9. Screw the membrane cover back on using a metric 2.5 Allen wrench.
10. Once the membrane cassette has been replaced, replace the housing cover. To do this, hover the membrane housing cover over the indents that are at the top and the bottom of the membrane box. Push the cover into place and then slide it to the right until it locks. Tighten the screw of the cover and then replace the top-to-side panel of the CWS.

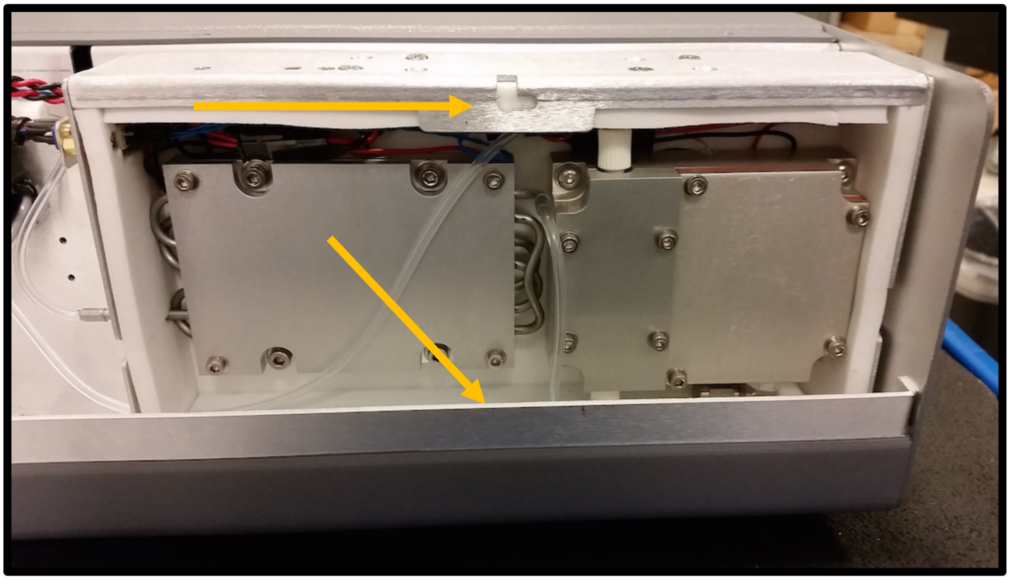


Figure 30: Photo of open membrane housing. The yellow arrows point to the indents which are used to slide the cover onto the membrane box.

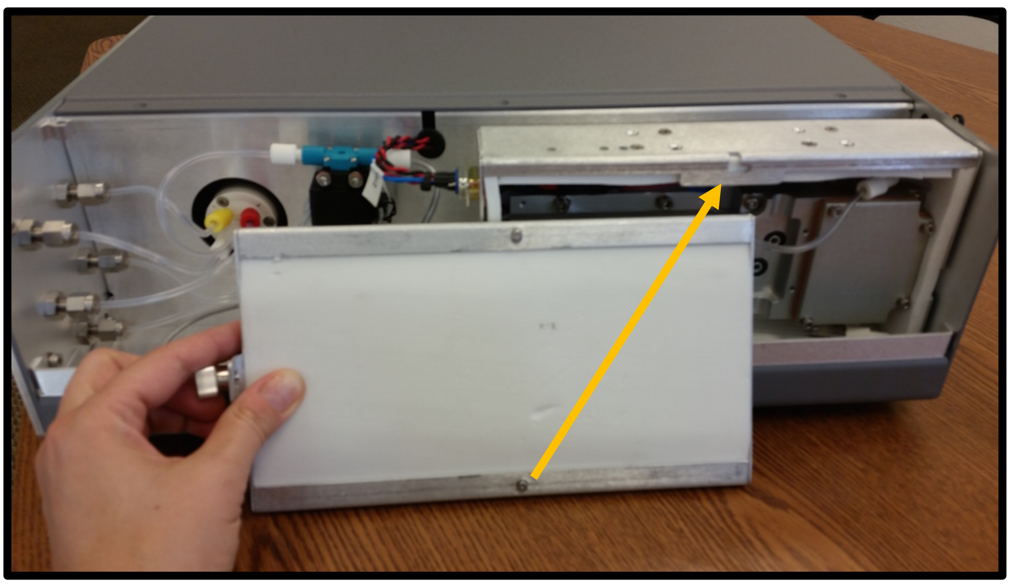


Figure 31: The membrane housing cover is shown here with alignment to the indents on the box. These are guides for sealing the temperature-insulated membrane box.

Replacing the CWS Fan Filter

If dirty, the CWS fan filter can be replaced. Simply snap off the fan cover, and replace the filter. The filter can be purchased from your local computer store. Alternatively, it is possible to clean the filter in water, dry it and replace it.

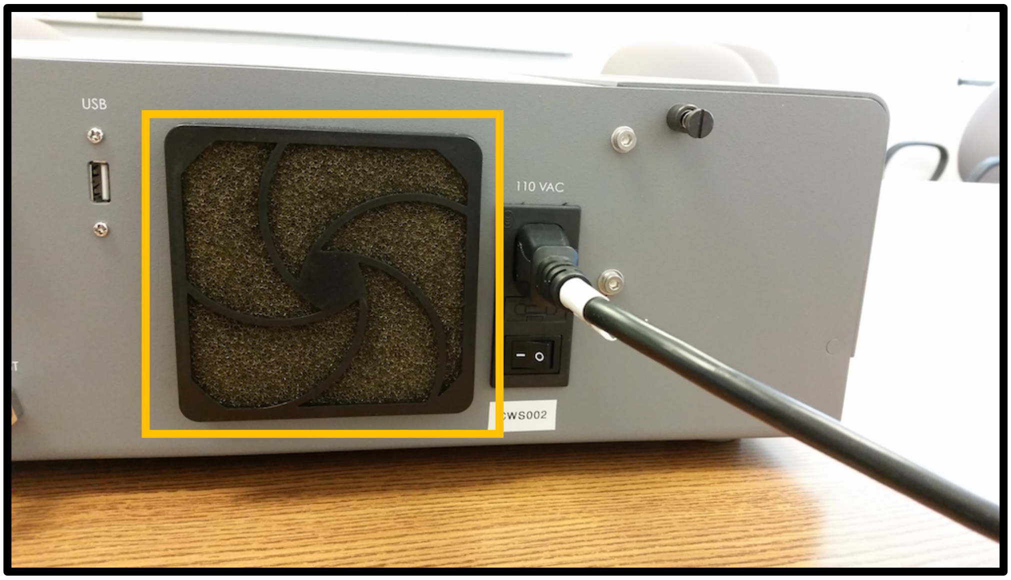


Figure 32: Rear of the CWS with the fan filter highlighted.

TROUBLESHOOTING

The following section lists solutions to a common problem that may be encountered while using the CWS. If, after attempting these procedures, the problem remains unresolved, please contact Picarro Customer Service at support@picarro.com. More troubleshooting information is also available at the www.picarro.com/community website. If you do not have access to the Community, please register on our website or contact support@picarro.com.

1. **Symptom:** Water concentration reported on the analyzer is low (<10,000 ppm).
   - **Recommendations:** Ensure the CWS is primed; that is, the inlet line is filled with water and the water is exiting the outlet line. If the CWS is not primed, no water is flowing through the membrane cassette and only dry air feeds the CWS. To prime the CWS, refer to the Priming procedure in the Operation section of this manual.
2. **Symptom:** High variability in water concentration reported on the analyzer. Typical water concentration is 18,000 to 25,000 ppm, with a variability of ± 400 ppm. The typical water concentration is system dependent, and water concentration variance is membrane dependent.
   - **Recommendations:** High water concentration variability typically represents a problem with the CWS membrane or water flow.

     Oscillatory behavior in the water concentration can indicate membrane seepage. Typically variance in water concentration due to seepage is reflected in variance in the isotope signals. Below is an example of membrane seepage. If you suspect membrane seepage, the membrane cassette should be replaced (see “Replacing the Membrane Cassette” in “Service & Maintenance”).

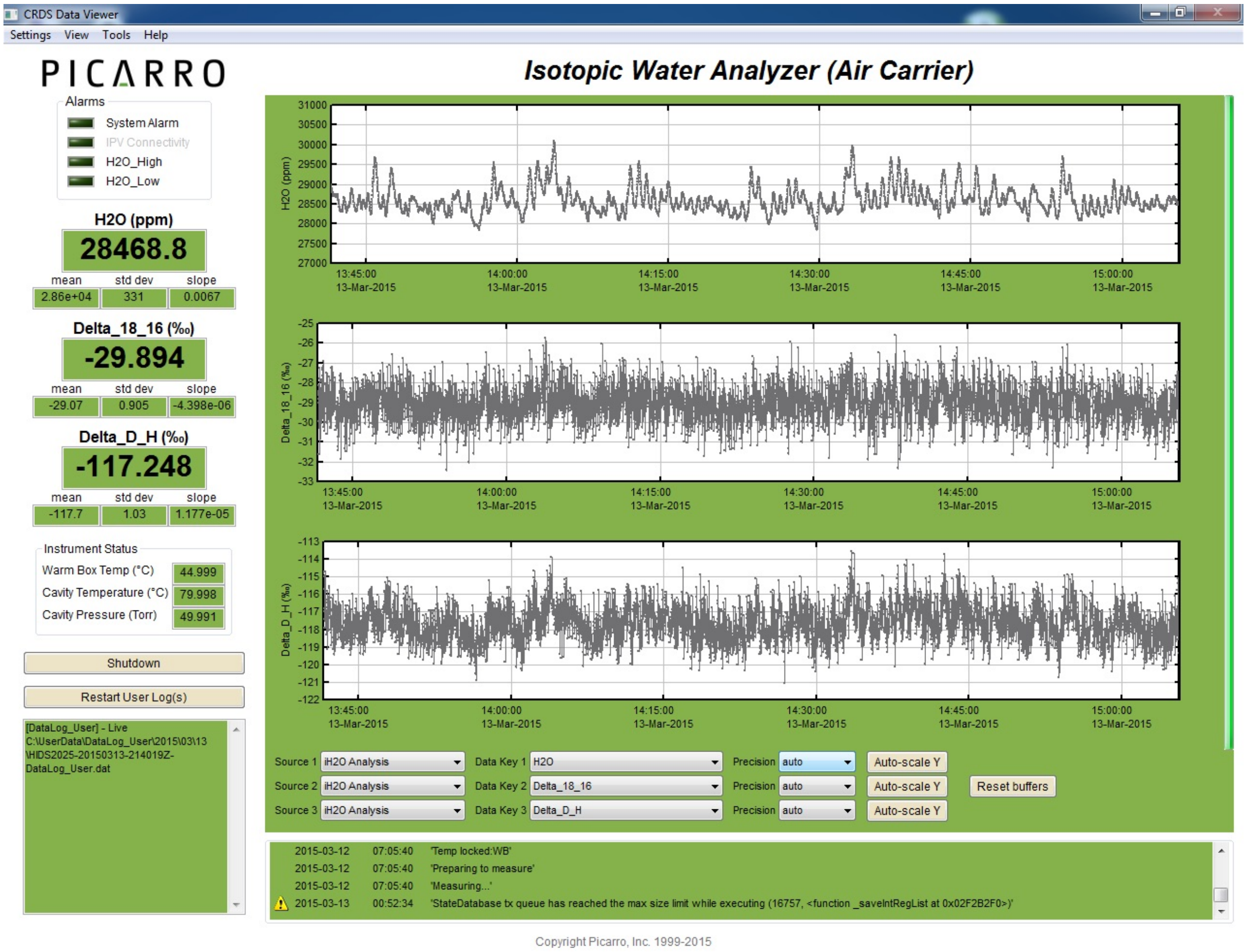


Figure 33: Example of membrane seepage.

Another cause of water concentration variance is water flow instability. This is typically represented by longer frequency oscillations in water concentration, above the standard noise. In this case, blockage in the water flow path is likely the cause. If you suspect the blockage has occurred due to tubing collapse at the entrance to the membrane, it is possible to replace the ferrule at the connector of the water to the membrane cassette (see “Replacing the Membrane Cassette” in “Service & Maintenance”). If you suspect the blockage is at the sample selector or water pump, contact Picarro. To limit these cases, Picarro recommends using a 2 µm water filter upstream of the water inlet to the CWS.

3. **Symptom:** Water concentration is trending down over a period of days while measuring dirty waters.

    - **Recommendations:** This likely represents degradation in the membrane. If this is accompanied by degradation in system performance, the membrane cassette should be replaced (see “Replacing the Membrane Cassette” in “Service & Maintenance”).

4. **Symptom:** Water concentration is trending up over a period of days.
    - **Recommendations:** This likely represents the expansion of membrane pores. If this is accompanied by degradation in system performance, the membrane cassette should be replaced (see “Replacing the Membrane Cassette” in “Service & Maintenance”).
5. **Symptom:** The PID loops are not locked (PID_loops_locked = 0 in the Coordinator output).
    - **Recommendations:** First, check to ensure you are not still in the “Warm Up” phase of CWS operation. If you are not in the “Warm Up” phase, and the PID loops are still not locked check which control loop parameter is not locking (water temperature, membrane temperature, transfer line temperature, or air flow rate). Use section “Data Files and Definitions” as a guide. If the transfer line temperature is unlocked, ensure the quick-connect for the Line Heater is connected (step 3 of “Step-by-step installation instructions”). Contact Picarro if the other control loop parameters are not locked.
6. **Symptom:** The average air flowrate is below 500 sccm as viewed in the Coordinator output file (Air_Flow_Rate_sccm).
    - **Recommendations:** Pressure drop across the Drierite filter prevents the pump from delivering 500 sccm. To reduce the pressure drop, remove some of the filter media (~ 1 inch) from the Drierite column following the procedure in the **Service and Maintenance** section.

WARRANTY CLAIMS

In order to track incidents, and enable our customers to follow progress using the online Picarro Support Community, Picarro has adopted a case number structure for service requests. If you need help from Picarro, please contact us in accordance with these instructions.

1. Contact Technical Support to be assigned a case number.

   Please call: +1 408 962 3991

   Or email: support@picarro.com

   To help us assist you, please provide the following information:

   - Analyzer Serial Number
   - Your Institution
   - A description of the symptom, including error codes when relevant. This will, for example, help us understand whether the problem is related to hardware, software or sample handling.
   - Screen captures, data and photos can also help us
   - We have a number of tools to help customer online and an internet connection will be extremely useful.

2. In some cases, Picarro is unable to resolve the situation remotely and a return is necessary. We will do our best to make this as painless as possible. The first step in the process is to secure a Return Material Authorization number. Your Technical Support representative will email a link to complete and submit our RMA form online. Upon completion of the form, the RMA number will be sent, automatically, as well as additional information regarding the return process, such as appropriate packing, insurance. Units returned without a valid RMA number will not be worked on until the RMA process is complete.

PICARRO

NEED HELP FROM PICARRO?

We are committed to helping our customers! Following the steps below will help us get to your problem faster!

STEP 1: Visit our popular Community forum! It offers a wealth of information with answers to thousands of questions from our customers as well as useful links and updates to operate your analyzer optimally: www.picarro.com/community

If this is your first time visiting this forum, you will be asked to login using your username and password, which can be created easily with a special email invitation from Picarro. These invitations are automatically emailed to current customers upon purchase and to interested individuals. Please contact us to request an invitation to community (support@picarro.com).

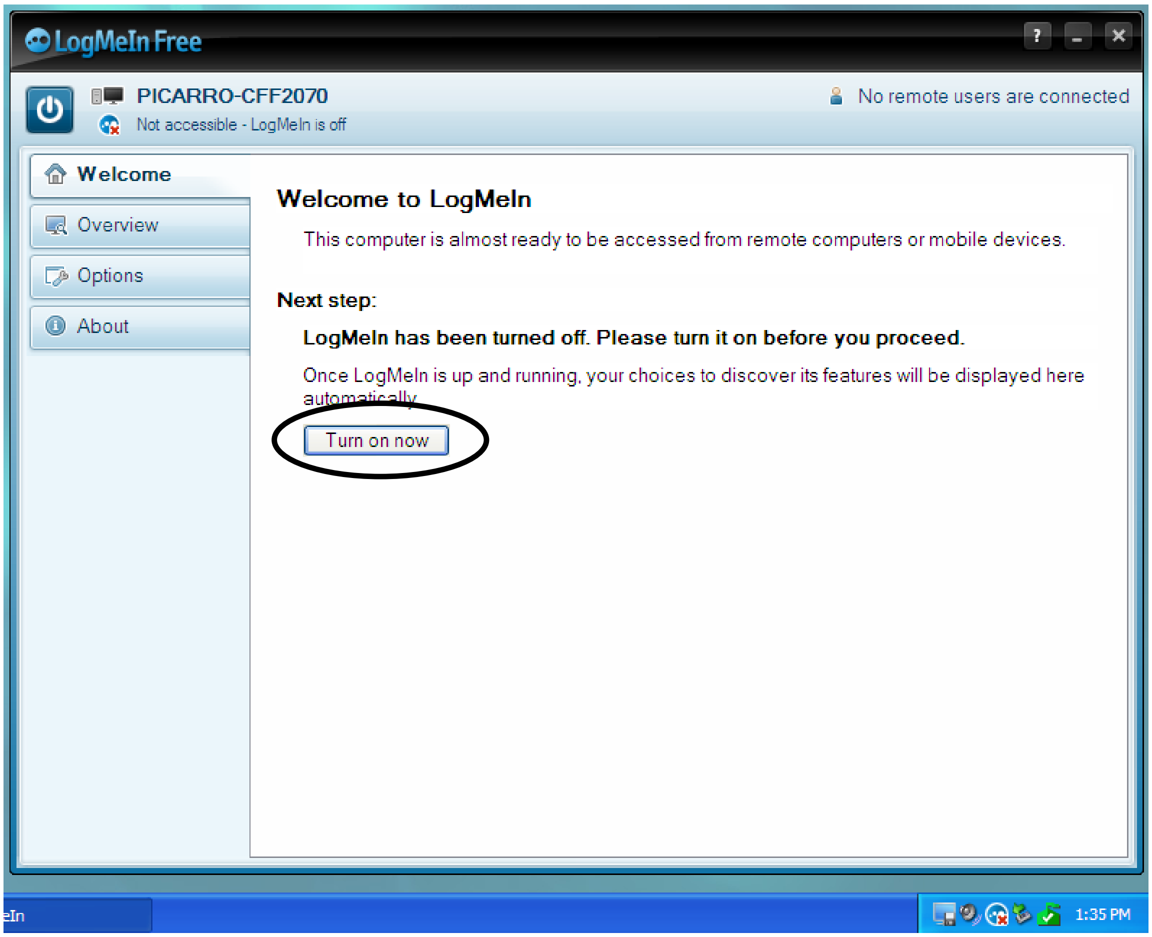
STEP 2: If you can't find the answer your question in the Community, **please activate the Logmein software before emailing us (see directions below).** This activation allows our technical engineers to get access to your analyzer's desktop remotely, allowing us to find and solve your problem quickly. This access can be turned off easily by the user.

STEP 3: Email us at support@picarro.com. Please include your analyser serial number, and feel free to attach data and/or screen shots to your email that you feel might help us diagnose your problem. They always do! We will get back to you right away! You can also call us at +1 408.962.3991.

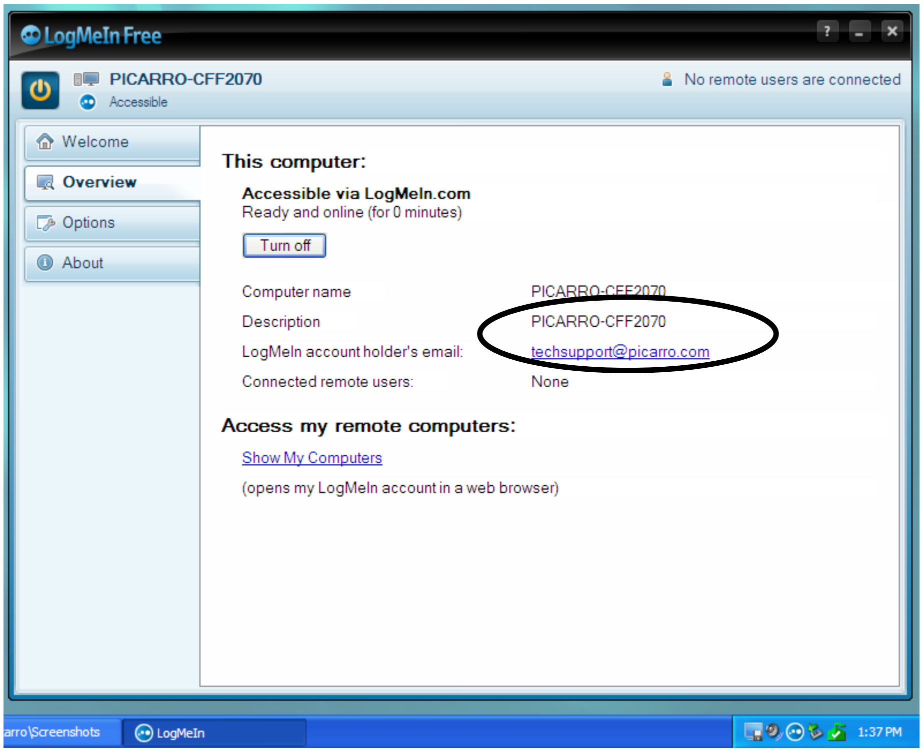
TO ACTIVATE THE LOGMEIN SOFTWARE:

1 Click on the "LogMeIn" icon in the Windows task bar at the lower right hand corner of your screen. The "LogMeIn Free" window will pop up.

2 Click the "Turn on now" button.



3 Send both the “Description” and “LogMeIn account holder’s email” entries to Picarro, including a description of your problem. The “LogMeIn account holder’s email” shows the account that the instrument is linked to. By default, this is set to techsupport@picarro.com.



4 After your problem has been solved, you can turn off Picarro’s access to your analyzer computer by clicking on the “Turn off” button (see screenshot above).