PICARRO

Picarro G4301
User's Instruction Manual

FOR CO_2, CH_4, AND H_2O MEASUREMENTS

Notices

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This equipment has been tested and found to comply with the limits of a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

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This is a Class A product. In a domestic environment, this product may cause radio interference, in which case the user may be required to take adequate measures.

Canada ICES Warning
This product complies with **CAN ICES-3 (A)/NMB-3(A)**

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CHAPTER 1 Overview

The Picarro G4301 provides extremely precise and simultaneous measurements of CO_2, CH_4, and water vapor at ambient levels. This instrument uses time-based, optical absorption spectroscopy of the target gases to determine concentration. It is based on wavelength-scanned cavity ring-down spectroscopy (WS-CRDS), a technology in which light re-circulates many times through the sample, creating a very long effective path length for the light to interact with the sample, thus, enabling excellent detection sensitivity in a compact and rugged instrument.

The unique backpack design lets you easily transport the analyzer when moving to a new location, allowing you to operate the analyzer in remote areas, especially those that can only be reached by foot, and on the move. The battery-powered analyzer is self-sufficient and has an autonomy of 8 hrs.

This document describes how to set up and use Picarro G4301.

Conventions

Within this manual, you may see graphic icons representing important information in the text. The purpose of these icons is to provide a visual convention to alert you of an important note or safety hazard alert.

Reminders are helpful hints for procedures listed in a document.

Notes include an important procedure that you should be aware of before proceeding. Notes also provide tips or additional insight into a feature, option, task, etc.

CAUTION ALERTS THE USER OF A POTENTIAL DANGER TO EQUIPMENT, DATA, OR TO THE USER.

A WARNING IS USED TO WARN AGAINST IMMINENT DANGER TO THE USER.

CHAPTER 2 Picarro G4301 Components and Setup

This section describes how to unpack and set up the Picarro G4301. It also includes some important notes to follow when using your Picarro G4301. Please ensure that you review this information carefully. Finally, this section also describes how to properly pack up and store the Picarro G4301.

Safety Notes

Please read and understand the following notes thoroughly before you begin using the Picarro G4301.

The Picarro Analyzer complies with the following safety standards:

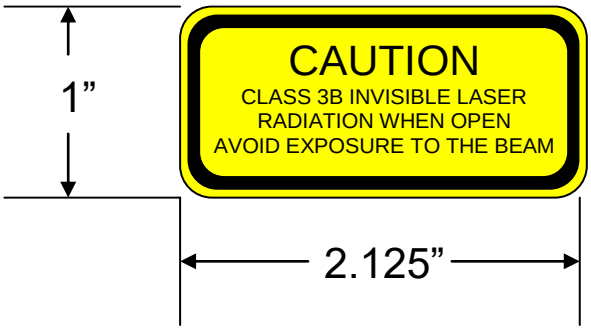
CE:	IEC EN61010-1:2010 (safety) and EN61326-1:2013 (EMC) requirements for electrical equipment for measurement, control and laboratory use.
FDA/CDRH 21	CFR Parts 1040.10-11

LASER SAFETY: THE PICARRO ANALYZER IS CLASSIFIED AS A CLASS 1 EMBEDDED LASER PRODUCT

CLASS 3B INVISIBLE LASER RADIATION WHEN OPEN, AVOID EXPOSURE TO THE BEAM

There are lasers used inside the analyzer, emitting a maximum of 50 mW of CW light in the near-infrared. There are no user serviceable components within the analyzer enclosures and so you should not open any of these enclosures within the analyzer. FAILURE TO FOLLOW THIS INSTRUCTION COULD RESULT IN EXPOSURE TO CLASS IIIB LASER RADIATION, which can permanently damage eyes and skin.

Safety Labels: The following label is affixed to the main lid of the cavity enclosure.



Please contact Picarro if you have any questions regarding the safe operation of this equipment. Refer to the appropriate section within this document relating to pump and filter replacement procedures.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE.

DO NOT USE THIS DEVICE IN THE RAIN OR ALLOW THE PICARRO G4301 TO GET WET.

DO NOT DROP THE PICARRO G4301.

DO NOT USE PICARRO G4301 IF THE WEATHER IS COLDER THAN 0°C OR WARMER THAN 45°C. IT IS IMPERATIVE THAT THE ANALYZER HAVE ADEQUATE VENTILATION AND/OR COOLING TO MAINTAIN THE AMBIENT TEMPERATURE BELOW 45 °C WHEN OPERATING. FAILURE TO PROVIDE ADEQUATE AIRFLOW TO THE PICARRO G4301 WILL RESULT IN OVERHEATING OF THE ANALYZER, CAUSING A SHUTDOWN AND POTENTIAL DAMAGE.

IF THE ANALYZER HAS BEEN STORED AT LESS THAN 0°C, ALLOW THE COMPONENTS TO EQUALIZE TO ROOM TEMPERATURE BEFORE USING THE DEVICE.

THE CAVITY BOX CONTAINS NO USER SERVICEABLE COMPONENTS. DO NOT ATTEMPT REPAIRS; INSTEAD REPORT ALL PROBLEMS TO PICARRO.

Included Items

The following items are included with your Picarro G4301 shipment. Inspect each item to assure it is not damaged. If any of these items are missing or damaged, contact Picarro for a replacement.

We recommend that you keep the shipping package. This shipping package is a very good way to ship the system to other labs or field stations. If a chance exists that the Picarro G4301 may get wet during transport, then do not ship the device. Instead, please contact Picarro for options on transporting this system.

Table 1. Included items

Item	Description
One Picarro G4301 analyzer	Includes all of the data acquisition, control, and communications hardware and firmware to perform all gas handling, spectral collection, and analysis.
One A/C Battery Charger	Charger works on 110VAC or 230VAC outlet and plugs into the charger port on the Gascouter.
One Attached Battery	One battery is already attached to your Picarro G4301. Note that additional batteries are available for purchase.
Tubing	▪ Inlet tubing with male connector ▪ Outlet tubing with female connector
External Inlet Filter	Filter attached to the inlet line to provide additional protection by trapping dust and water particles.

Items Not Included

The following additional items are not included but can be used with your Picarro G4301.

Table 2. Items not included

Item	Description
Mobile device - phone or tablet	A mobile device (phone or tablet) is used to log on to the analyzer Web-based GUI and view real-time data.
Laptop or tablet	A laptop or tablet with a wireless connection can be attached to your analyzer. When using either of these devices, you can remote desktop to the analyzer and view the analyzer GUI.
Docking station	Picarro G4301 provides two USB3 ports. With a docking station, you can attach a monitor, mouse, and keyboard giving you direct access to the analyzer. A direct connection eliminates the need to connect to the analyzer via Remote Desktop.
Backup Battery	A second battery is useful if you cannot regularly recharge the primary battery.

Picarro G4301 Components

Picarro G4301 includes the following components:

- Battery
- Lasers
- CPU
- Cavity Box
- Vacuum Pump
- Connection Ports

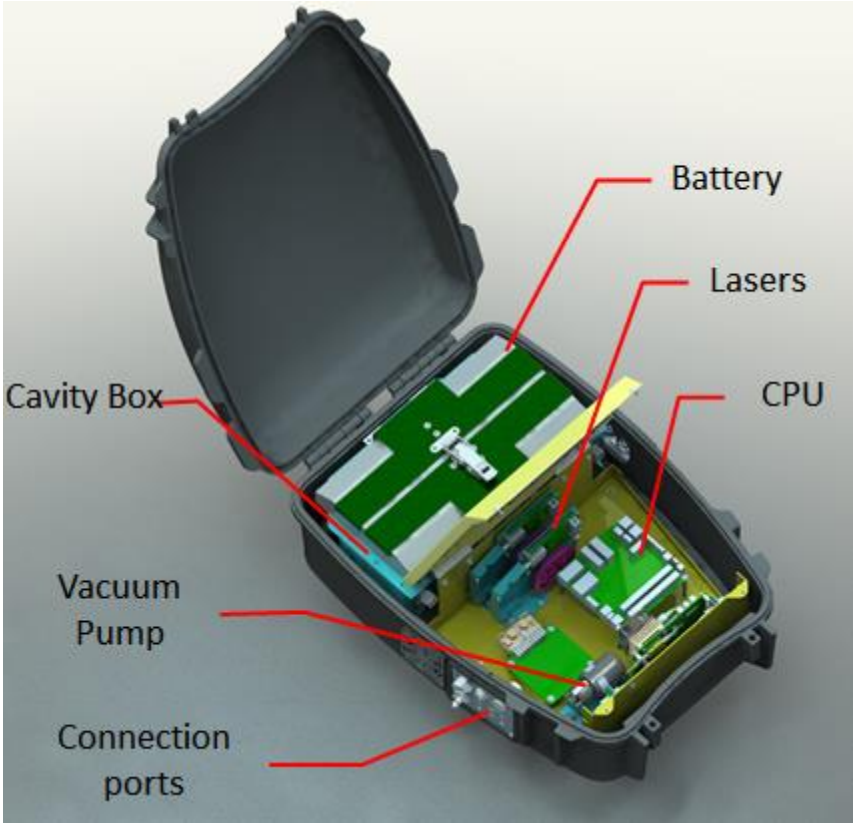


Figure 1. Components

Picarro G4301 Connections

The Picarro G4301 backplate includes the following items:

- Power On button
- Two USB3 ports, allowing you to hook up a monitor, keyboard, or even a docking station
- Gas Inlets/Outlet
- DC Power connector

The following image shows the backplate of the Picarro G4301.

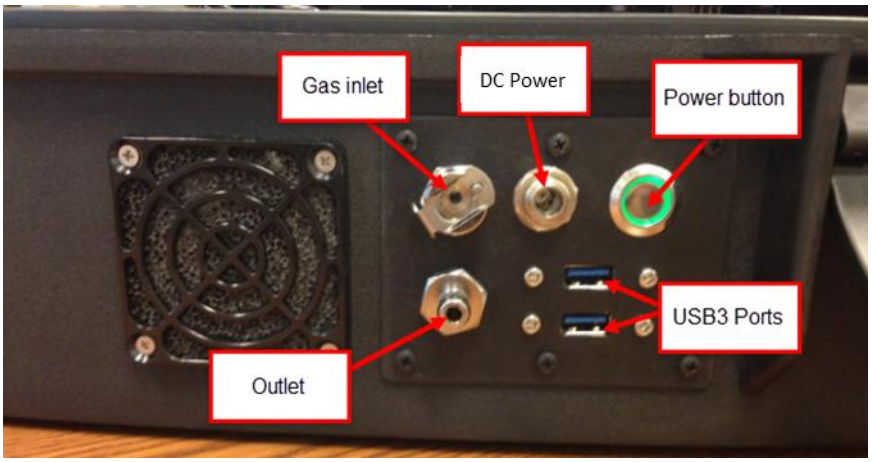


Figure 2. Picarro G4301 backplate

Battery Installation and Charging

The Picarro G4301 comes with one installed battery. A second/backup battery is available for purchase. This section describes how to swap out and charge a dead battery.

Replacing the Battery without interrupting the measurements

1. Ensure that the battery is set to 19 V
2. To replace the battery without turning off the analyzer, connect the spare lead to the charged battery and unplug the battery lead from the top of the dead battery.

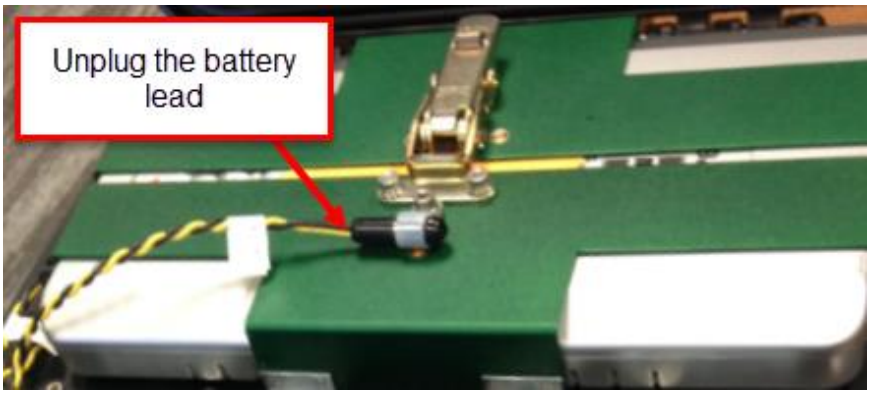


Figure 3. Unplugging the battery cable

3. Unhinge the battery buckle.

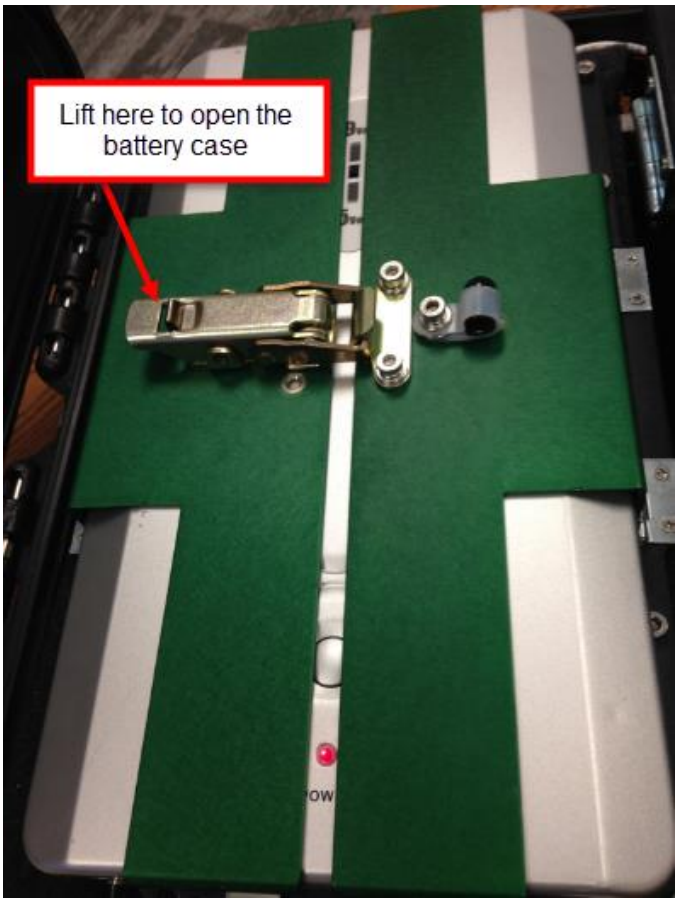


Figure 4. Opening the battery casing

4. Carefully remove the battery from the felt casing.
5. Insert powered battery into the felt casing.
6. Re-hinge the battery buckle, and re-attach the battery lead.

Charging the Battery

To recharge the battery, leave the battery plugged to the GasScouter and connect the battery charger to the DC power input of the GasScouter on one end and to a power outlet (110 VAC or 230 VAC depending on your region) on the other end of the charger.

Any time the analyzer is plugged in to a power source, the battery will charge.

Ensure the battery is set to 19 V and not 15 V.

The battery charging input voltage is between 12 to 19V. The battery consumes 3A at 16V when charging.

Inlet Filter Installation

The Picarro G4301 comes with an external inlet filter to protect the instrument from dust and water particles. Connect the filter to the inlet port before operating the analyzer.

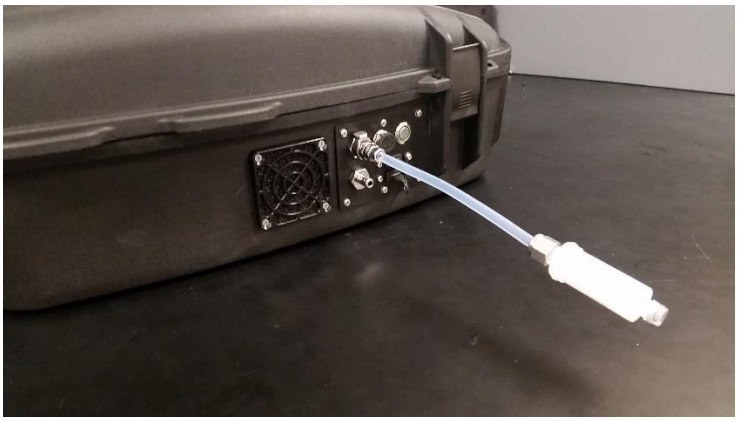


Figure 5. Inlet Filter Connection

Transportation and Storage

The following procedure can be used to repack the instrument into the original carton and prepare it for either transportation or storage.

Clean, dry gas should be attached to the instrument prior to shutting down. This prevents condensation inside the system during storage or shipment.

1. Shut down Picarro G4301 by shutting down the analyzer (if it is running), then pressing the Power button on the backplate. (Refer to *Shutting Down Picarro G4301* for more information.)
2. Detach any attached items, such as a docking station, laptop, tablet, etc.
3. Pack the Picarro G4301 and all accessories in the original shipping container, ensuring that all of the foam pieces are in place to protect the device during shipping.

CAUTION: WHEN SHIPPING OR RELOCATING THE PICARRO G4301, IT IS IMPORTANT TO PROTECT IT FROM MECHANICAL SHOCKS. FAILURE TO DO SO CAN COMPROMISE ITS MECHANICAL INTEGRITY.

CHAPTER 3 Operation

This section describes the following basic operations of your Picarro G4301:

- Starting Picarro G4301
- Connecting to the Analyzer GUI
- Stopping the Logs
- Shutting Down Picarro G4301

Starting Picarro G4301

Press the **Power** button on the backplate of the analyzer to start Picarro G4301.

Figure 6. Power button

The LED light on the Power button will glow green when the device is powered on.

The software to operate Picarro G4301 will start automatically after the operating system has loaded. If a monitor is connected the analyzer, then the user interface will appear a few seconds after the instrument software starts along with the following status messages.

Contact Picarro Support if you encounter any error messages during startup.

Entering Measurement

Spectral scanning has started. Concentration measurements will be available in approximately 30 seconds. The instrument will continue to scan and report concentration measurements until the instrument is shutdown using the procedure below.

Measuring

This is the normal mode of operation after startup has completed.

Reading/Monitoring Data

Real-time data can be monitored and viewed on the Web-based GUI using a mobile device. Users can also remotely access the analyzer GUI using a tablet or laptop. If a docking station with a monitor and keyboard is attached to the analyzer, then users can directly connect to the analyzer GUI.

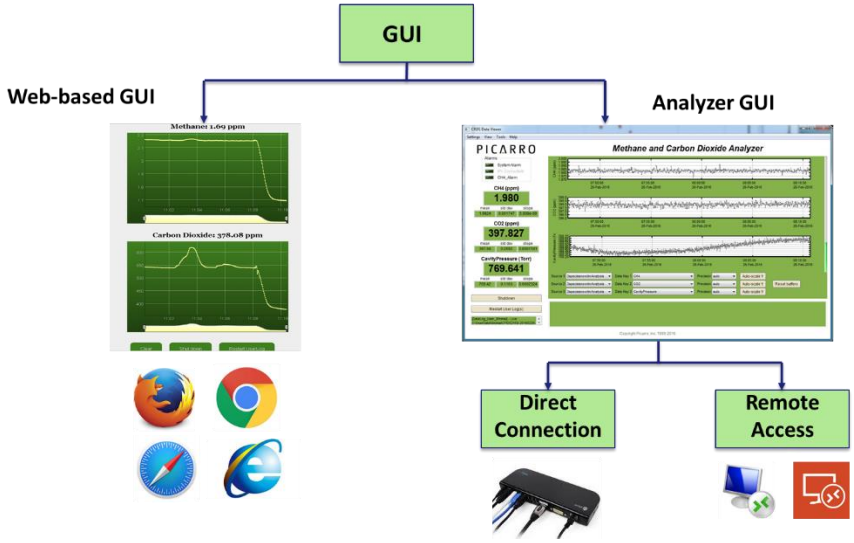


Figure 7. G4301 connection options

Logging On to the Web-Based GUI

The Web-based GUI streams real-time data for dry mol CO_2 and CH_4 readings directly to your mobile device while walking with your Picarro G4301.

Perform the following steps to log on to the Web-based GUI.

1. Ensure that Picarro G4301 is powered on and that your mobile device is within a few feet of the analyzer.
2. On your mobile device, search for and select the "**Nomadxxx**" wireless network.
3. Enter "**picarropicarro**" for this password, or enter the password provided by Picarro, Inc.
4. When the device is attached to the "Nomadxxxx" network, open a Chrome™ or Safari® browser, and navigate to 192.168.173.1:3000.

Upon successful completion, you will see a display similar to the following on your mobile device.

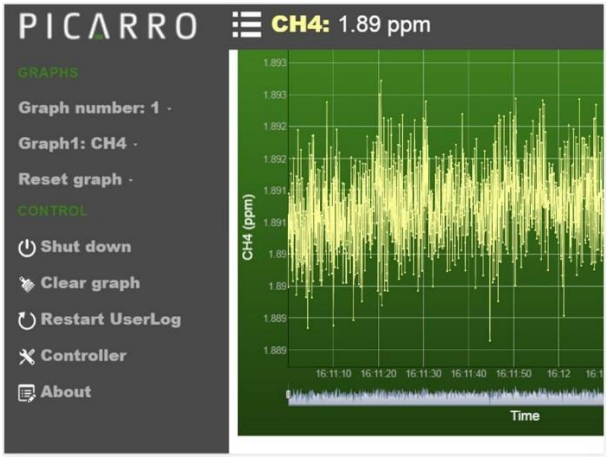


Figure 8. Mobile view GUI

At this point, you can begin scouting and viewing real-time data on your mobile device. Refer to *Using the Web-Based GUI* for more information.

Connecting to the Analyzer GUI

Based on the device(s) that you attach to Picarro G4301, select one of the following methods to connect to the analyzer GUI and review the collected data.

Table 3. Connection options

Device(s)	Connection Steps
Docking station with a monitor, keyboard, and mouse	Refer to Direct Connection to Analyzer GUI
Laptop or Tablet	Refer to Remote Desktop Connection on a Laptop or Tablet

Once connected, you will see a screen similar to the following. Refer to *Using the Analyzer GUI* for information on how to use the GUI.

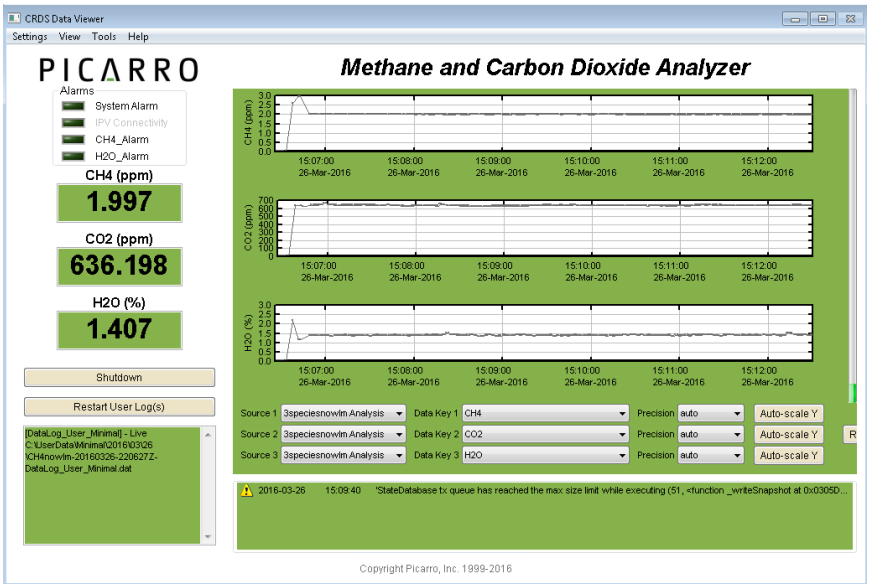


Figure 9. The Analyzer GUI

Direct Connection to Analyzer GUI

1. Ensure that Picarro G4301 is powered on.
2. Attach docking station to one of the USB3 ports. From here, you can connect a monitor, keyboard, and mouse and be directly connected to the analyzer.

Remote Desktop Connection on a Laptop or Tablet

1. Ensure that Picarro G4301 is powered on.
2. Power-on the laptop and ensure that you have a strong Wi-Fi connection to the Nomadxxxx network.
3. Launch the Remote Desktop Connection application for remote access. (For PC, this is Windows Remote Desktop; for MAC, iOS, or Android, this is Microsoft Remote Desktop.)
4. In the Computer box, enter 192.168.173.1.
5. When prompted, enter the following information for the and password:

   Username**: Corp\pica**rro

   Password: **Extreme_Science!**

Stopping the Logs

The Picarro G4301 analyzer continuously collects data while the device is powered on. In some cases, you may want to stop the current analyzer data collection but still leave the device powered on. To do this, press the **Stop User Log(s)** button on the Analyzer GUI.

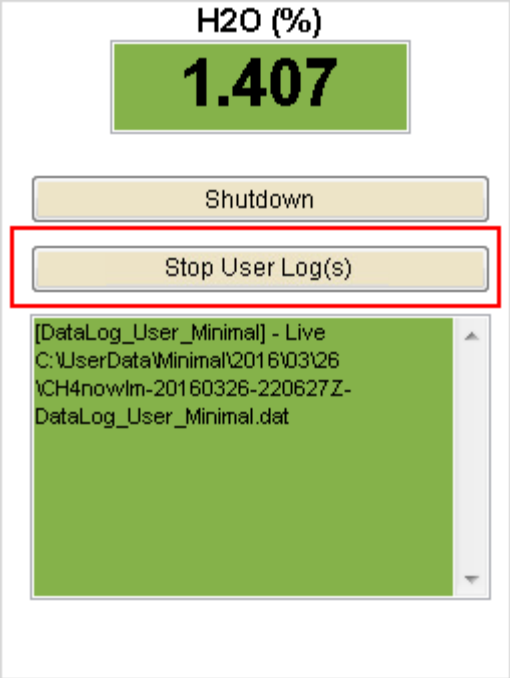


Figure 10. Stop User Log(s)

Shutting Down Picarro G4301

Preparing for Shutdown

Be sure to dry the air in the cavity prior to shutting down the analyzer. Moisture trapped in the cavity when it is out of service can result in condensation damage.

We recommend lowering the water concentration down to 1,000 ppm or 0.1%. This can be done by connecting an air dryer canister to the analyzer. Note that it will take approximately 2-3 min to bring the water concentration to an acceptable level.

Soft Shutdown

A soft shutdown will turn off the analyzer computer, but it will not turn off the power supply to the pump.

- Web-based GUI

  Click on the **Shutdown** button on the Web-based GUI. A message will display the current water concentration of the gas in the analyzer. Once the water concentration is below the recommended limit, confirm the shutdown by clicking on **Shutdown Analyzer**.

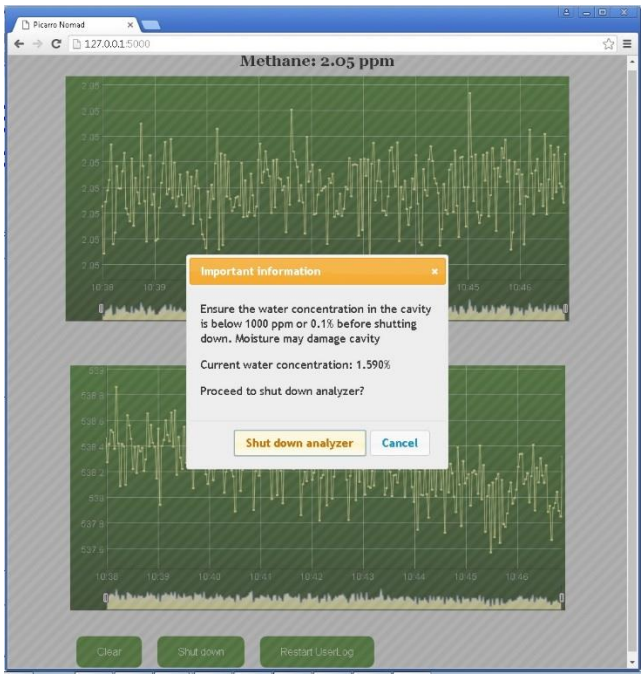


Figure 11. Shutdown Window

Make sure the water concentration is below 1,000 ppm or 0.1%. To dry the air in the cavity, follow the procedure described in *Preparing for Shutdown*.

Hard Shutdown

A hard shutdown will suppress the power from the battery to the analyzer. Press the Power button to perform a hard shutdown. The LED power light will stop glowing green when the device is fully powered down.

Figure 12. Power button

We recommend that you perform a hard shutdown only after a soft shutdown. It is possible for the data file to become corrupted if a hard shutdown is conducted without first performing a soft shutdown.

In Case of a Drained Battery

If the main battery dies and power to the analyzer is cut-off, the analyzer will cease operation. However, when the power is reapplied, the analyzer will restart automatically, and the Picarro software tools will properly close out previous files and open new files for data collection so that previously collected data, instrument diagnostics, and other parameters recorded up to the time of power outage are retained.

If the risk of power outages may be part of a routine-operating environment, Picarro recommends either purchasing a second battery and/or providing an uninterrupted power supply that will work to prevent the potential operating system and software corruption problems that can occur with repeated crashes.

CHAPTER 4 Alarms

On Analyzer GUI

An alarm panel is used to monitor the status of the internal instrument alarms. These indicators provide information about the system status, IP connectivity, gas concentration alarms such as “CH4 Too High/Low.”, and the Battery Alarm.

The Battery Alarm indicator will light up when the battery voltage falls below a threshold. This will indicate that less than 10 minutes of battery life remains and the user shall proceed with the one of the following options:

1) Charge the battery by connecting the analyzer’s DC power input to the battery charger’s DC output and by connecting the battery charger to a power outlet (110 VAC or 220 VAC depending on your region).
2) Exchange the battery with a backup battery.
3) Shutdown the analyzer to ensure that the data files are saved properly.

The gas concentration alarms are off (grayed) when the respective concentrations are below a certain value, and they are illuminated when the respective concentrations are above/below a certain value.

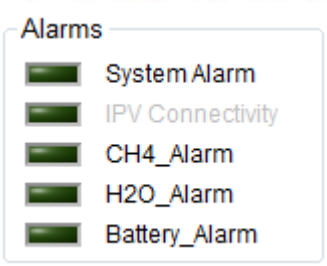


Figure 13. Alarm Panel

To view an alarm's settings, click on the alarm in the Analyzer GUI. A dialog box will appear, indicating the alarm setting and (if available) allowing the user to enable it or change the settings:

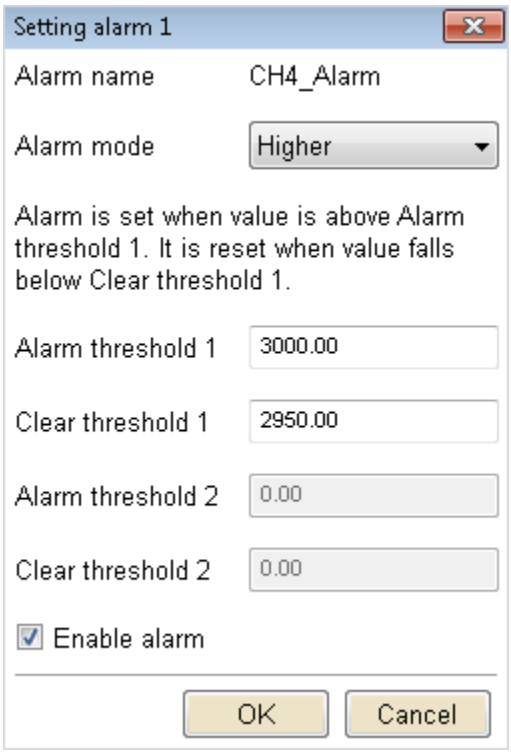


Figure 14. Setting a CH_4 alarm

The System and IPV Connectivity alarms are informational only. These alarms are always enabled. They do not require or allow any user configurations.

Type the value you want to set the alarm to, then select the **Enable alarm** check box. Press **OK** to complete your changes, or press **Cancel** to reject the alarm value. If you do nothing, the dialog box will disappear, and the alarm value will remain unchanged. The units are those that appear in the GUI graph.

On Web-Based GUI

A low-battery notification will pop up when the battery voltage falls below a threshold. It will indicate that only 10 minutes of battery life remains. The user can close the window by clicking on **OK**. It will re-appear after a couple of minutes.

At this time, it is recommended to proceed with the one of the following options:

1) Charge the battery by connecting the analyzer's DC power input to the battery charger's DC output and by connecting the battery charger to a power outlet (110 VAC or 220 VAC depending on your region).
2) Exchange the battery with a backup battery.
3) Shutdown the analyzer to ensure that the data files are saved properly.

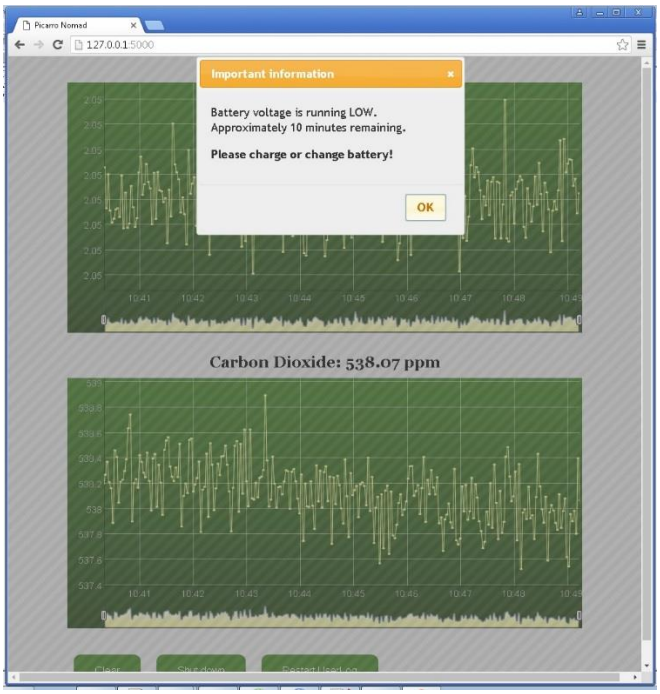


Figure 15. Low-Battery alarm

CHAPTER 5 The Picarro G4301 Web-Based GUI

The Web-based GUI connects to the analyzer using a Wi-Fi connection. This GUI outputs two graphs (CO_2 and CH_4) and includes a limited set of controls. This section describes the features and functions available in the Picarro G4301 Web-based GUI.

Using the Web-Based GUI

On your mobile device open a supported browser and navigate to 192.168.173.1:5000. (Refer to *Logging On to the Web-Based GUI* for more information.) Upon successful connection, an image similar to the following will display.

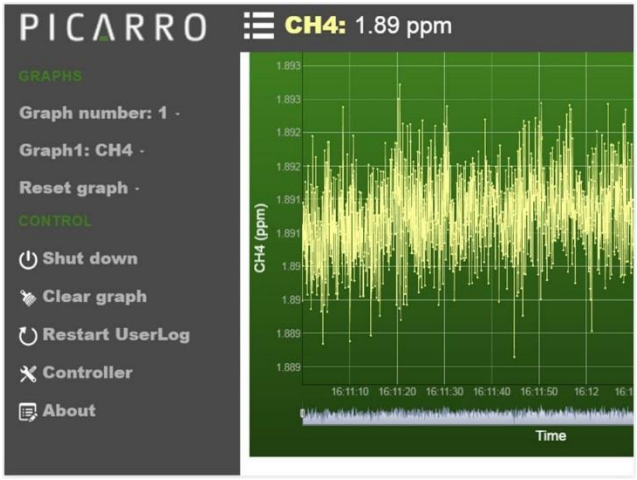


Figure 16. Web-based GUI

As you walk around with Picarro G4301, the Web-based GUI streams real-time data for CH_4 and CO_2.

The X-axis provides the current time. Using your fingers, you can squeeze the range bars below the X-axis to view a smaller time-period.

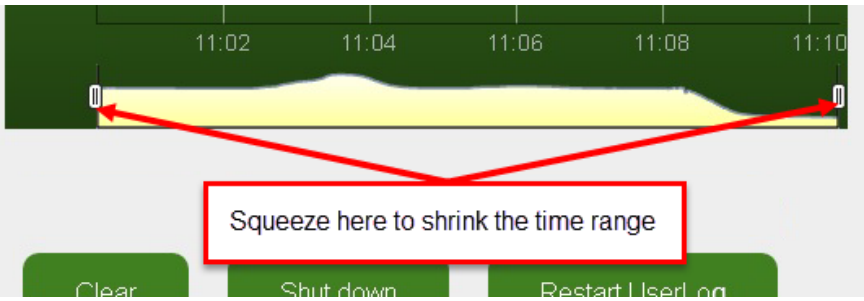


Figure 17. Narrowing the time range

The Y-axis shows the range of the current ppm values.

Use the **Clear** button to wipe the current data from the graphs. The analyzer will continue to run and update the screen with new data, which will be included in the current data file.

Use the **Restart UserLog** button to clear the current data from the graph and to begin collecting information for a new data file.

Use the **Shutdown** button to end your connection to the analyzer and to power down Picarro G4301. When you select this button, a message will display reminding you to connect dry gas to the system before shutting down. Refer to *Shutting Down Picarro G4301* (page 13) for more information.

DRY GAS PROTECTS THE CAVITY FROM MOISTURE DAMAGE. THIS STEP SHOULD NOT BE SKIPPED UNLESS YOU ARE IN A VERY DRY ENVIRONMENT.

CHAPTER 6 The Picarro G4301 Analyzer GUI

This section describes the features and functions available in the Picarro G4301 Analyzer GUI.

Using the Analyzer GUI

Connect to analyzer GUI, either through a direct or remote connection. Refer to *Connecting to the Analyzer GUI* for more information.

The remainder of this chapter describes how to use the analyzer GUI application.

Analyzer GUI Overview

The Picarro Analyzer GUI includes the following components and navigation elements.

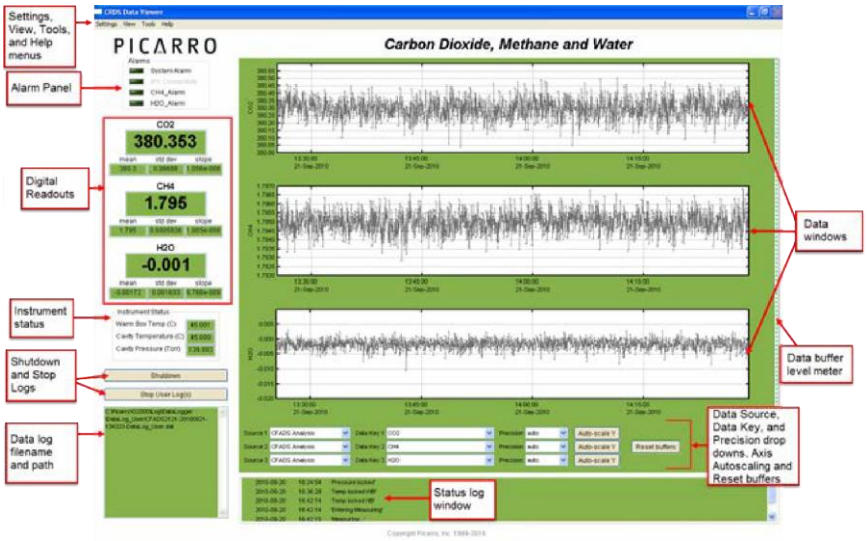


Figure 18. Graphical elements of the analyzer GUI

The following table provides a brief description of these elements. These are described in greater detail in the sections that follow.

Table 4. GUI Navigation Elements

Navigation Element	Description
Settings, View, Tools, and Help menus	These menus provide options to specify when using the analyzer GUI
Alarm Panel	Monitors the status of the internal instrument alarms
Digital Readouts	Shows the latest values recorded for a specified data key for each data window
Instrument Status	Only displays if **View > Show Instrument Status** is enabled. Shows the current temperature and pressure of the analyzer.
Shutdown and Stop Logs	Enables you to shutdown the analyzer or to keep the analyzer powered on but discontinue collecting logs
Data log filename and path	Shows the filename and path of the active data log
Status log window	Streams instrument status messages
Data Source, Data Key, and Precision drop downs. Axis Autoscaling and Reset Buffers.	Drop downs determine the data stream that displays in the data windows. Precision specifies the precision on the y-axis, between 0 and 4 digits or to auto-scale. Reset buffers clears data from the data windows.
Data buffer level meter	Shows the amount of internal memory used
Data windows	Displays a graph of any stream of data vs. system time, with a format of hh:mm:ss.

Settings, View, Tools, and Help Menus

This section describes the menu items that are available in the analyzer GUI.

Settings Menu

The Settings menu has a single option: **Change GUI Mode from Standard to Service**. Service Mode is a password protected mode with additional operational and measurement parameters. Selecting this entry opens the Cavity Ring-Down Spectrometer Controller.

Service Mode is reserved for Picarro service operators only.

View Menu

The View menu includes the following options:

- Lock/Unlock time axis when zoomed: When locked, forces the two graphs to display the same time scale during zoom.
- Show/Hide statistics: Toggles the measurement statistics display. See *Digital Readouts*.
- Show/Hide instrument status: Toggles the instruments status display. See *Instrument Status*.

Tools Menu

The Tools menu includes the following options:

- **User Calibration**: Opens the User Calibration window. The calibration slope and intercept can be entered, and their effects immediately seen in the data. Refer to *Calibration Procedure* (page 43) for more information.

User Calibration is a password-protected form, and the default password is “picarro”. This password can be reset in the QuickGui.ini file in the instrument directory:
“C:\Picarro\G2000\AppConfig\Config\QuickGUI\” under the section:
[Authorization] UserCalPassword = Picarro Show/Hide Value

- **Sequencer GUI**: Toggles the display of the External Valve Sequencer window.

Help Menu

Provides "About" information, including the version number of the instrument.

Alarm Panel

The Alarm panel shows the alarms that are available on the analyzer. You can click on the IPV Connectivity and System alarms to view information about these alarms. Click on the CH4 Alarm or the H2O Alarm to configure settings to trigger these alarms. For example:

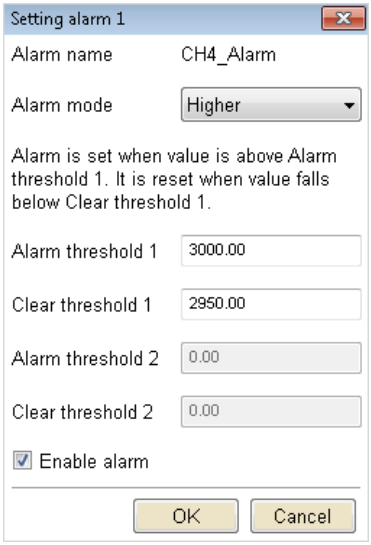


Figure 19. CH_4 Alarm

Digital Readouts

The Digital Readouts section displays the latest value recorded for the selected Data Key for each Data Window. Changing the Data Key changes the Digital Readout and changes the Data Window view. If **View > Show Statistics** is enabled, then the mean, standard deviation, and slope of the data in the graph is dynamically calculated and indicated below the digital concentration readout. These numbers change to reflect statistics of whatever data is in thedata window.

Instrument Status

If these parameters are enabled in **View > Show Instrument Status**, then digital readouts for Warm Box temperature, Cavity Temperature, and Cavity Pressure will display to the left of the main trend graphs.

Shutdown and Start/Stop User Log(s)

Start/Stop User Log(s) button

> When powered on, the analyzer automatically records all data collected on the instrument and saves it for later analysis. In addition, the user can record a separate data log file. Press **Start User Log(s)** if you want the instrument to start recording a separate data file. A dialog box will appear prompting you for a filename and location. This logging information displays in the Data Log Filename and Path section. Press **Stop User Log(s)** to stop recording the data file.

Data Log Filename and Path

This pane displays the filename and path of the active data log. The indicator is grayed-out if there is no active data log (i.e., if a new data log has not been started using the **Start User Log(s)** button). A new file will be generated at midnight, which will be saved to the same location as the original log file.

Status Log Window

This window displays instrument status messages in the following form:

“MM/DD/YYYY hh:mm:ss generic message text.” These messages include all messages sent to the DAS.

Data Source and Data Key Drop-Down Menus

These two menus determine the data stream information that is viewed in the Data Windows. Data streams available on the GUI are gas concentrations. If ‘Instrument Analysis’ is selected for a source (where instrument represents the system installed), or if “sensors” is selected for a source, then the following can be viewed:

- The analyzer’s optical cavity pressure or temperature
- The analyzer's nominal ambient temperature (“DAS temp”)
- The temperature of the analyzer’s electronics chamber, indicated as “warm chamber temp.”

Precision Drop-Down Menu

This menu allows you to select the precision that is displayed on the Y-axis. You can choose values between 0 and 4 digits of precision, or you can specify “auto”. The currently selected precision is displayed during operation.

The precision specified here does not affect the precision of the saved data in the data log files or results files.

Auto-Scale Y

The Auto-Scale Y button auto-scales the Y-axis of the data window graphs.

Reset Buffers

The Reset buffers button clears the internal data buffer of the GUI (i.e., clears the current data traces from the graphs). This has the effect of clearing all data in the data window.

Pressing this button has no effect on any of the data log files stored by the instrument. It only clears the data windows.

Data Buffer Level Meter

The meter to the right of the data windows indicates how much of the GUI internal memory is used to retain historical data collected with the Picarro G4301. There is an internal limit with a finite number of points. Once that number of data points is collected, the buffer is full, and old data is removed from the buffer as new data is collected.

This buffer affects only the data displayed in the data window, not the data stored in any files. This buffer is empty upon instrument startup and can be emptied by pressing the **Reset Data Buffer** button.

Data Windows

The data windows show graphs of any stream of data vs. system time, with a format of hh:mm:ss. Users can select which data stream are displayed using combinations from the Data Source and Data Key drop-down menus. The precision displayed can be adjusted using the Precision drop-down menu and the **Auto-scale Y** button.

These graphs are interactive. To zoom the graph, drag the magnifying glass over the section to be zoomed, and then click and hold the left mouse button. While holding down the left button, move the mouse to create a box that covers the region of interest. When the box is properly drawn, release the left button, and the boxed area will automatically scale to fill the data window. To zoom back out, double click on the left button. To auto-scale the Y-axis of either graph, use the **Auto-scale Y** button below the graph. To lock or unlock the time axes of each graph during zooming, select that menu item in the ‘View’ menu.

File Management

During operation, the analyzer generates various ASCII-format text output files that are updated after each batch of concentration measurements is complete. For example, one of the user output files is named: CFADS##-yyyymmdd-hhmm-DataLog_User_Sync.dat, where "CFADS##" (or similar) is the instrument serial number.

The file name is generated from the instrument serial number, the date, and the time when the instrument was started. For example:

CFADS01-20160127-1029-DataLog_User_Raw.dat

CFADS01 is the instrument serial number

20160127 is the date, 1/27/2016, formatted as yyyymmdd. This format ensures chronological sorting of data files.

1029 is the time when the file was started, 10:29 am, formatted as hhmm, using a 24-hour clock.

The raw user data is contained in folders in the following directory:

C:\UserData\Minimal\[year]\[month]\[day]\hour

This is data that has not been re-sampled to exact 0.1s time intervals. There is a similar directory, C:\UserData\DataLog_Sync\..., that includes data that is evenly spaced in time at the data rate of the analyzer.

Data files are created every 15 minutes and stored for 90 days before they are automatically deleted. The file deletion frequency and details can be modified in the file:

C:\Picarro\G2000\AppConfig\Config\Archiver\Archiver.ini

Analyzer Data Files

During data acquisition, the analyzer creates directories to store the data based on the date when the data were acquired. After each data file has been closed (every 15 minutes), the file is moved to an archive directory, and a new file is started in the original location. The archive directory is:

C:\Picarro\G2000\Log\Archive\

This archive directory has subdirectories: DataLog_Mailbox, DataLog_Private and DataLog_EventLogs. The files within these subdirectories are arranged by year\month\day\hour.

There are more complete data files that include additional information beyond the concentration data, including parameters such as instrument temperatures and pressure, setpoints, and spectroscopic information. This information is generally not useful to the user, but it can be useful for diagnostic purposes. This information is stores in the directory:

C:\Picarro\G2000\Log\Archive\DataLog_Private \[year]\[month]\[day]\[hour]

For more information about how to include various columns of data from the DataLog_Private file in the C:\UserData folder, please contact Picarro.

Current Data Files

The current data file can be found in: C:\Picarro\G2000\Log\DataLogger\

This directory includes subdirectories: DataLog_Private, DataLog_User_Raw and DataLog_User_Sync. Similarly, the archive directory has subdirectories arranged by file type. The subdirectories are further organized by \[year]\ [month]\[day]\[hour].

Data File Generation

To keep the data files easy to manage and to limit the size of individual files and directories, the software automatically generates new files each time the instrument is powered up and also at midnight each night. When a new file is created at midnight, its file name will contain the new date and a time of 00:00. For example if the system was started at 10:29 am on 2/5/2016 it would create a file named:

20160205\CFADS01-20160205-1029-UserLog.dat

Then at midnight a new file will be created: CFADS01-20160206-0000-UserLog.dat

File Archival

The analyzer can automatically compress (zip) and archive old files as mentioned previously. This operation is controlled by the following ini file:

C:\Picarro\G2000\AppConfig\Config\Archiver\Archiver.ini

For each file type, there are various items along with some recommended default settings, which may vary by file type:

Directory = C:/UserData/DataLog_Sync

Optionally specifies which directory to find files to archive.

MaxCount = -1

Specifies how many files to keep. A setting of -1 indicates that there is no maximum number of files. Generally -1 is used in conjunction with a maximum size limit, below.

MaxSize_MB = 1500

Specifies that a maximum of 1.5 GB of data is to be kept before the system begins todelete old data.

Compress = True/False

Specifies if archived files are to be zipped – recommended setting is true to save hard drive space. True means files are zipped, false means files are not zipped.

AggregationCount = 0

If compression is set to TRUE, specifies how many files to be included in each zip archive.

StorageMode = FIFO

First in first out. Specifies that old data is deleted first.

Quantum = 4

Generally should not be changed. Specifies the files be sorted by year\month\day\hour in the archived directory structure.

Automatic Deletion of Old Files

In addition to automatic file and directory management, the analyzer also automatically deletes various files specified in

C:\Picarro\G2000\AppConfig\Config\FileEraser\FileEser.ini

This file includes the following configurable settings:

runtime_interval_hrs = 0.5

Specifies how often in hours to run the file eraser.

path = ../../../Log/Archive/DataLog_Private

Specifies the directory to be searched for the files to delete.

extension = dat

Specifies the file extension to search for when deleting. If configured, then only files with this extension will be deleted. If empty, then all files will be deleted.

delete_time_hrs = 48

Specifies how long to keep files prior to deletion.

CHAPTER 7 Data File Viewer

Picarro Data File Viewer 3.0 is a standalone program that allows you to display and analyze Picarro data files and to concatenate and convert the data file formats. Data File Viewer also supports Python scripting for data manipulation and plotting.

With Data File Viewer you can:

- Filter data based on a combination of criteria, e.g., time, valve state, concentration range, species ID, etc.
- Change the time zone and convert time unit (e.g. date/time vs elapsed time)
- Gather files from specific date ranges
- Capture current settings and save in configuration files
- Export data and images

File Concatenation and Format Conversion

- **Concatenate data files in a specific time range**

  In the Data File Viewer UI, go to **File > Concatenate H5 Files**. After selecting the target folder, a Select Variables dialog will display. Click **Define date range** to specify time range for file concatenation. Please keep the following mind with regards to the time range:

  - A Picarro data file is named with the creation time. Data File Viewer uses the file name to determine whether the data file is within the specified time range. If the file name has ever been changed, then do not use the **Define date range** option. Instead, try concatenating all files first, and then use the next method (immediately below) to save data in the specific time range.
  - Data File Viewer does NOT concatenate data files exactly within the specified time range. Usually, the resulting dataset has a wider time range than the user specification. Perform the following steps to accurately define the date and time range. Refer to *Define Date Range* (page 31) for more information.

    (a) Load the concatenated dataset in Data File Viewer and make a time series plot for any variable.

    (b) Right-click on the time-series plot canvas, and select **Edit Plot Properties**.

    (c) Define the time range for the X-axis in the Image Editor form, then close the form. This returns you to the canvas.

- **Concatenate a large volume of data files**

  In some cases, you may want to concatenate data files of several hundreds of MB or even larger. To do this, select the **Large dataset** checkbox in the Select Variables form. For normal file concatenation, Data File Viewer loads data into memory and then sorts datasets based on the time before writing into a file. This can easily cause a memory error if a large volume of data files are concatenated. With the **Large dataset** option, Data File Viewer writes data directly into the hard disk to save memory space. This way, Data File Viewer can handle a very large dataset without causing a memory error.

  Keep in mind that, because the data is written directly into the hard disk without sorting, the resulting datasets may not be in chronological order. To ensure the correct chronological order of the datasets, data files need to be saved in directory trees named by date and time, and data files need to be named with the creation time (just like data files in the DataLog_Private folder). This way, Data File Viewer can write files to the hard disk in the correct chronological order.

The Data File Viewer UI

The Picarro Data File Viewer UI includes two main menus: File and New.

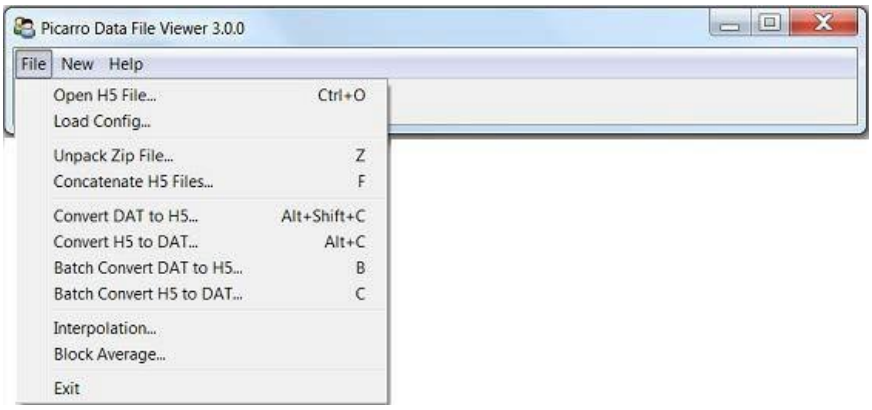


Figure 20. File menu

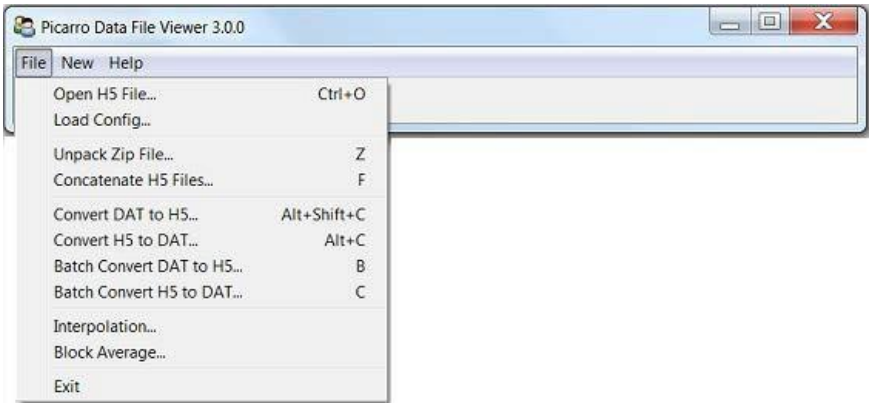


Figure 21. New menu

The File Menu

This section describes the functions available from the Data File Viewer File menu.

Open H5

File > Open H5 opens a Picarro data file (HDF5 format) for data analysis and visualization. After opening the data file, you can create a new time series plot. Refer to *New Time Series Plot* for more information.

Load Config

File > Load Config loads a configuration file (ini format) to restore parameters of a workplace. Refer to *Save Configuration* for more information.

Unpack Zip File

Use **File > Unpack Zip File** to concatenate all H5 files inside the zip file into a single H5 file. Refer to *Concatenate H5 Files* for details.

Concatenate H5 Files

Use **File > Concatenate H5 files** to concatenate multiple files and zip archives of H5 files into a single H5 file. Navigate to the desired folder, or use the **Define date range** button to specify a date range of files to concatenate. (See next section.)

After selecting the path of the data files, Data File Viewer will automatically search an H5 file in the specified zip/folder and look for all available variables in the H5 file. The variables are then listed in the left panel, and users can use "**>>**" button to move variables to the right panel for concatenation.

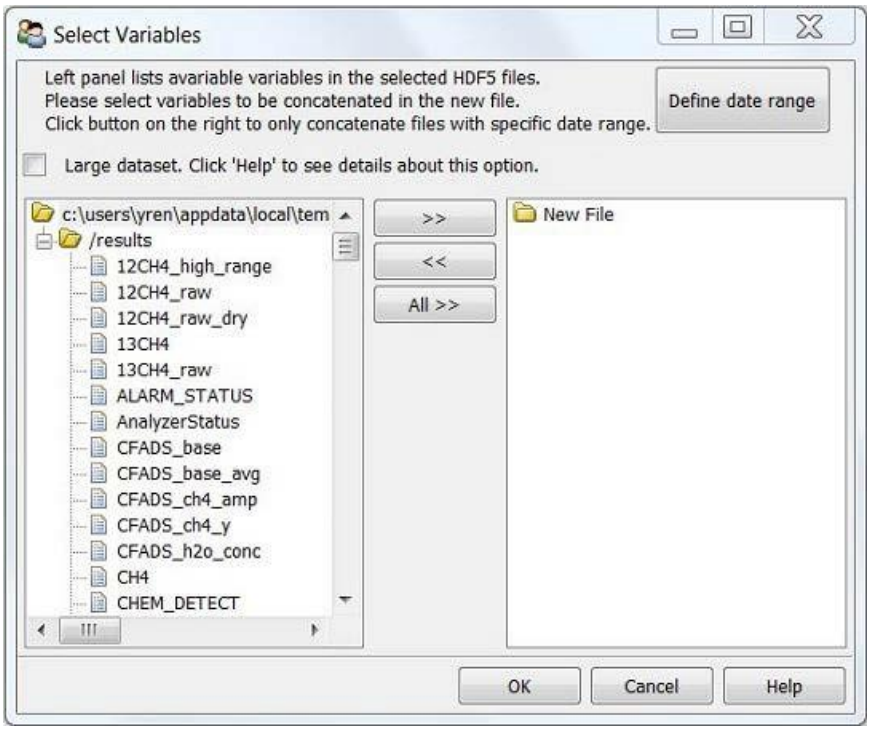


Figure 22. Select Variables form

DEFINE DATE RANGE

Data File Viewer can search data files within the desirable date range and then concatenate such files into a H5 file.

By default, TimeZone is set to your local timezone. However, if data were taken elsewhere, select the timezone where data were taken.

Select File > Concatenate H5 files, then click Define date range to specify the desired date range.

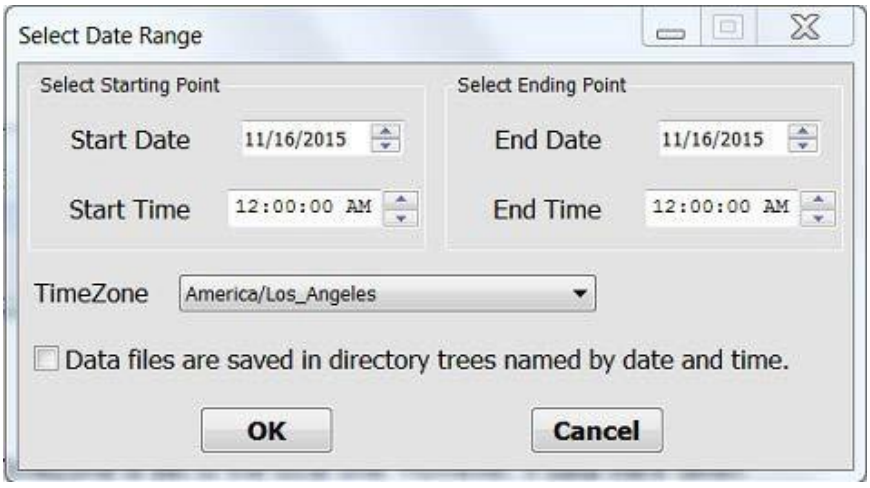


Figure 23. Defining a date range

Data files are saved in directory trees named by date and time option.

Picarro software saves data in a directory tree that is named by the creation year, month, and day. (See example directory tree in the following image.) Select this option if the target folder has this file structure. This way, Data File Viewer will only search folders within the desirable date range, which can substantially reduce processing time.

Figure 24. Data File Viewer file structure using creation year, month, and day

To save processing time, Data File Viewer does not open data files, but only determines data acquisition time based on the file name.

DO NOT DEFINE A TIME RANGE FOR DATA FILES WHOSE NAMES HAVE BEEN CHANGED.

Data File Viewer does not concatenate data files exactly within the defined time range. This is because the time extracted from file name is different from the data acquisition time. In order to not miss data points, Data File Viewer expands the specified time range, so the resulting dataset normally has a wider time range than the user specification.

Convert DAT to H5

Select **File > Convert DAT to H5** to convert a file in DAT format to HDF5 format. These formats are described below:

- DAT format: DAT files accepted by DatViewer store tabular data (numbers and text) in plain text.
  - Each line of the file is a data record. Each record consists of one or more fields separated by whitespaces.
  - The first line of data file indicates column names.
  - There must be a field “EPOCH_TIME” to store the acquisition epoch time (expressed as seconds since Jan 1, 1970) of the data. Otherwise, the first and second fields must be “DATE” and “TIME”. The “DATE” field must have the format “mm/dd/yyyy” or “yyyy-mm-dd”, and the “TIME” field must have the format “HH:MM:SS(.sss)” where (.sss) is an optional fraction of seconds.
- HDF5 format: HDF5 is a data model, library, and file format for storing and managing data. (See the HDF5 Home Page on the HDF Group Web site for more information.) When converting DAT to HDF5 format, Data File Viewer creates a table named “results” to the contain data.

Convert H5 to DAT

Select **File > Convert H5 to DAT** to convert a file in HDF5 format to DAT. These formats are described in *Convert DAT to H5*.

When converting H5 to DAT format, each column has a fixed width of 26 characters. If column headings are too long (more than 25 chars), Data File Viewer will convert or truncate them. For example, column name “fineLaser-Current_1_controlOn” will be replaced with “fineLaserCurr_1_ctrlOn”.

Interpolation

Interpolation describes the method for constructing data points with a range of a discrete set of known data points. Select **File > Interpolation** to perform interpolation on a time grid with a constant interval.

Block Average

Select **File > Block Average** to divide a dataset into small blocks based on a user-defined block size. The average is calculated for data in each block, and the results are saved in a new H5 file.

The specified block size must be greater than the average data interval.

Because the data interval is normally not a constant (unless interpolation is performed), fluctuations in the data interval will affect block averaging if the block size is comparable to the average data interval.

New Time Series Plot

You can specify to include create time-series plots with one, two, or three frames. New plots display in the Time Series Viewer.

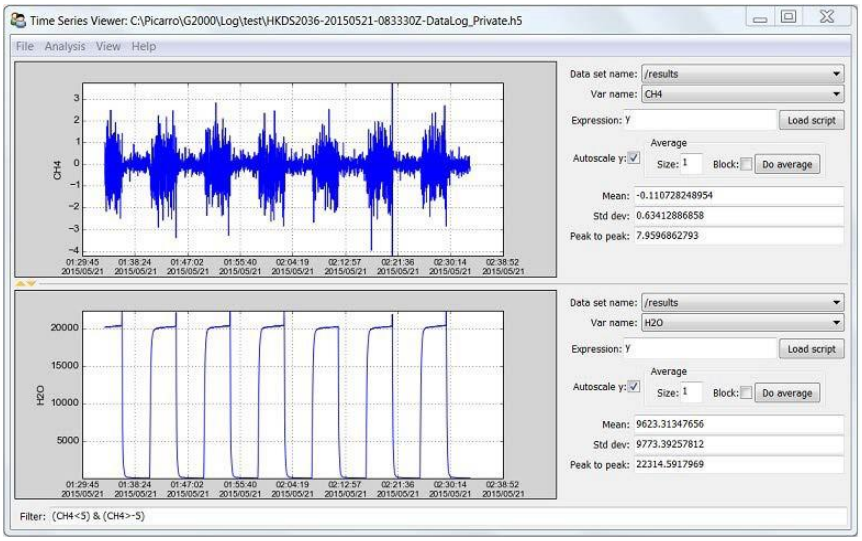


Figure 25. Time Series Viewer - two frames

The next section describes the options available on the Time Series Viewer menu bar. Refer to *The Time Series Viewer Canvas* (page 37) for information the Time Series Viewer UI features and options.

Time Series Viewer Menus

The Time Series Viewer form includes the following menus:

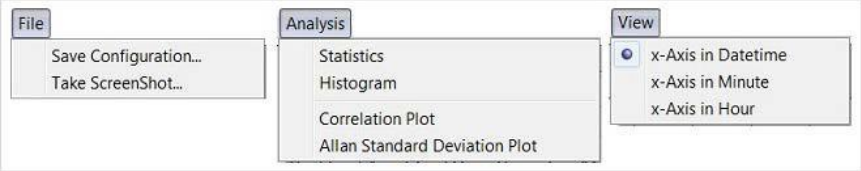


Figure 26. Time Series Viewer menus

These menus are described in the sections that follow.

TIME SERIES VIEWER FILE MENU

Use the File menu to save a configuration or take a screenshot.

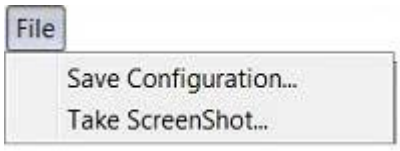


Figure 27. File menu

Save Configuration

Click **File > Save Configuration** to open the Feature Capture form. With this form, you can save figures properties, expressions, filters, and other settings to a configuration file so that it can be easily loaded in the future.

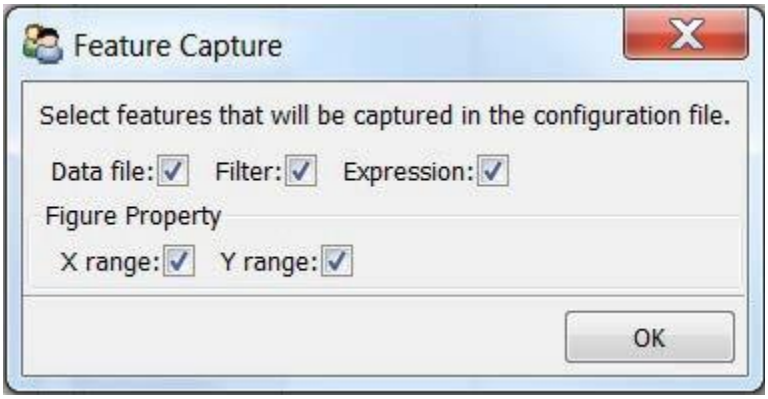


Figure 28. Feature Capture form

If a feature is not captured, it will be omitted when the configuration file is loaded.

Depending on the features captured, loading a configuration file can have different effects. For example:

- If all features are captured, a saved workplace is reproduced.
- If Data file is not captured, saved parameters will be applied to the data file in memory.
- If Expression is not captured, plots will not be transformed.
- If X (Y) range is not captured, figures will be auto scaled on the x (y) axis.

Take ScreenShot

Use **File > Take ScreenShot** to take a screenshot of the Time Series Viewer and save it as a .png to a specified file.

TIME SERIES VIEWER ANALYSIS MENU

Use the Analysis menu to calculate statistics, generate a histogram, and to plot correlations and Allan Standard deviations.

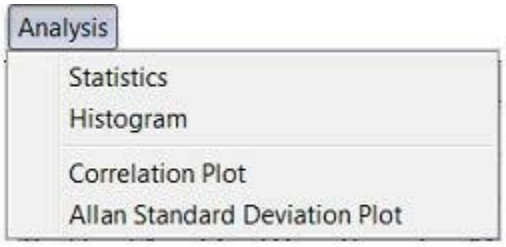


Figure 29. Analysis menu

Statistics

Use **Analysis > Statistics** to calculate mean, standard deviation and peak to peak for all plots in the current window.

Histogram

Use **Analysis > Histogram** to generate a histogram of data as shown below.

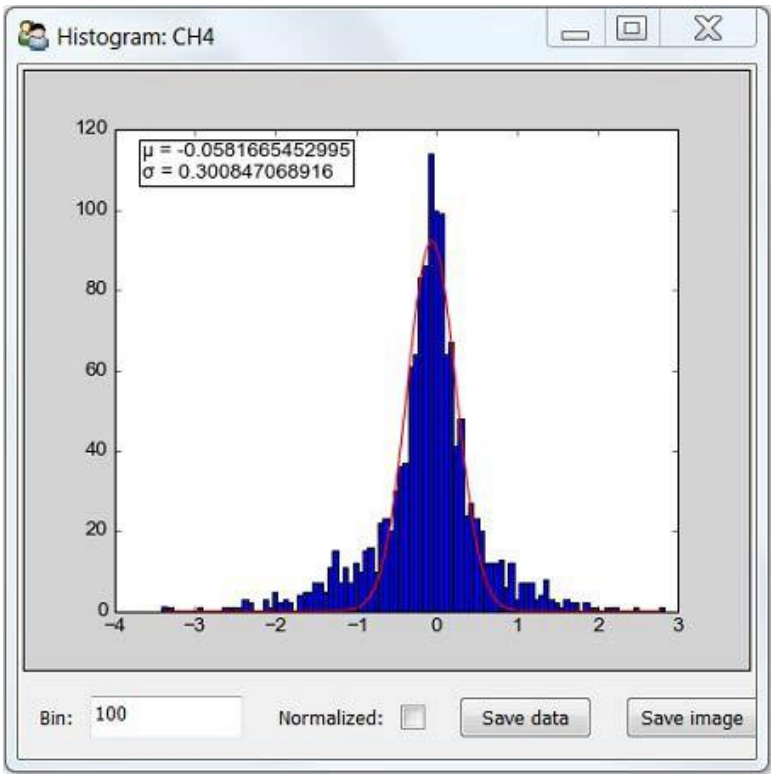


Figure 30. Analysis > Histogram window

Red Line: A Gaussian function fitted to the histogram. Fitting results of μ and σ are shown in the top-left corner of the plot.

- **Bin**: Specifies the number of intervals that the range of values is divided into.
- **Normalized**: When selected, the sum of the histograms is normalized to 1.
- **Save data**: Saves histogram data to a CSV file.
- **Save image**: Saves the histogram image as a JPEG/PNG/PDF file.

Correlation Plot

Use Analysis > Correlation Plot to plot Y-axis data in one frame versus that in the other. This can be used when two or more frames exist in the current Time Series Plot window. See Correlation/XY Plot for details.

Allan Standard Deviation Plot

Use **Analysis > Allan Standard Deviation Plot** to create an Allan Standard Deviation plot (versus a standard deviation plot) for data in the current window. See Allan Variance for more information.

TIME SERIES VIEWER VIEW MENU

Use the View menu to view X-axis information in datetime, minute, or hour format.

Figure 31. View menu

When switching from Datetime to Minute or Hour, the X-axis data is subtracted by the earliest point shown in the panel and then converted to the desired unit.

The Time Series Viewer Canvas

The Time Series Viewer canvas is comprised of interactive graphs and a variety of configuration options.

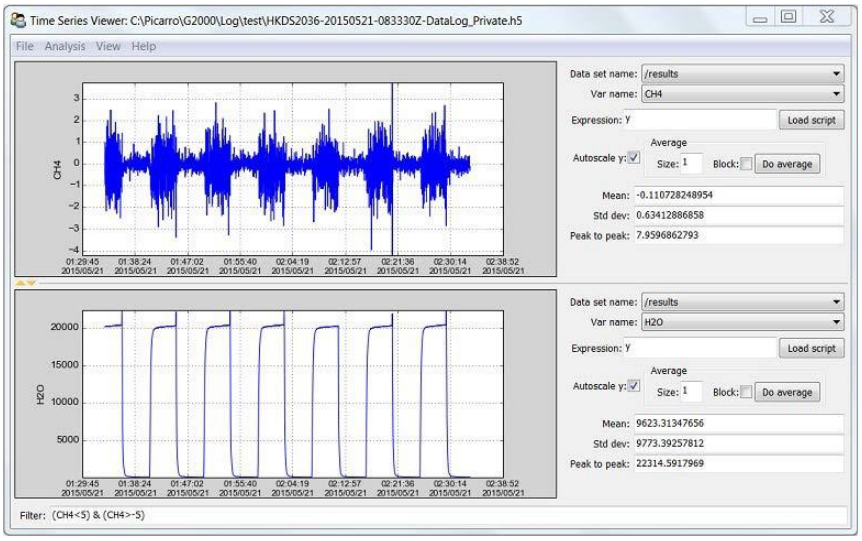


Figure 32. Time Series Viewer canvas

Refer to the following for more information:

- Mouse Options and Graph Transform
- Right-Click Menu
- Data Set Name and Var Name
- Expression
- Autoscale Y
- Average
- Mean, Std Dev, and Peak to Peak
- Filter

MOUSE OPTIONS AND GRAPH TRANSFORM

The following mouse actions can be used in the canvas graphs:

- Left click and drag: Zooms in to the selected area of the plot.
- Left click and drag with SHIFT key down: Pans the plot.
- Left click and drag with CTRL key down: Zooms out from the plot.
- Left click and drag with ALT key down: Stretches the plot.
- Right click: Opens an additional menu. Refer to the next section.

RIGHT-CLICK MENU

Right-clicking on the canvas provides opens a pop-up menu.

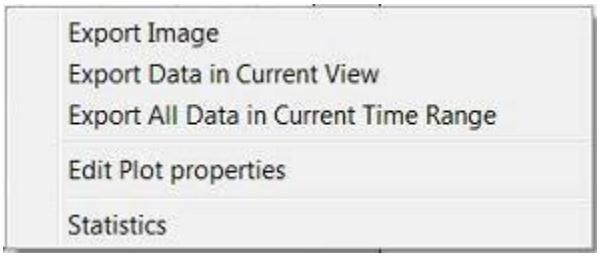


Figure 33. Canvas right-click menu

Export Image: Exports the current plot as a jpeg, png, or pdf file.

Export Data in Current View: Exports only date/time and the selected variable in the current view to an HDF5 or CSV file.

Export All Data in Current Time Range: Exports all variable columns of the selected dataset in the current time range to an HDF5 file. Refer to *Concatenate H5 Files* (page 31) for more information.

Edit Plot properties: Opens the Image Editor form, where the following options can be specified:

- **Title**: Edits the title of the plot.
- **Line**: Specifies the line pattern of the plot. If **None** is selected, then data points will plotted without connecting lines.
- **Marker**: Specifies the marker type to indicate data points. If **None** is selected, data points will not be shown.
- **Min and Max**: Specifies the minimum and maximum of data range for the X-axis and the Y-axis.
- **x[0]**: Sets the earliest time of the dataset as the minimum of the X-axis.
- **Time zone**: Sets the time zone for date/time variables. This defaults to the local time zone.
- **Label**: Specify a label for the X-axis and the Y-axis.

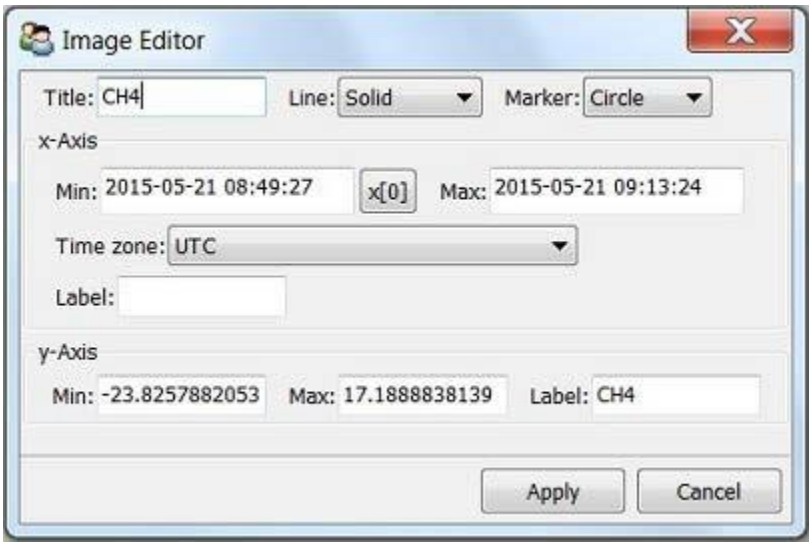


Figure 34. Image Editor form

Statistics: Calculates the mean, standard deviation, and peak to peak for data in the current view.

DATA SET NAME AND VAR NAME

An HDF5 file can store one or more tables. Each of these tables is called a Data set. A table can contain one or more columns. Each column is called a variable (Var).

Use the **Data set name** drop down to select the dataset that will be used for this time series graph. Use the **Var name** drop down to select the column in the dataset to use in the graph.

EXPRESSION

An expression is a mathematical function that applies on the selected data and transforms the plot. For example:

```
y + CO2
```

In this expression, `y` is the data of selected variable (y-axis data of the plot), and `CO2` is the data of CO2 column in selected table. As a result, this expression transforms the plot to be summation of selected the variable and CO2 data.

All variables in the selected dataset can be used in the Expression field by calling the variable name. However, if a variable name starts with a number, it must be appended with a prefix of “dat”. For example, “12CO2” must be called “dat12CO2” in the Expression field. In addition, `x` and `y` are defined as short-cuts for x-axis and y-axis data of the plot, correspondingly.

The Expression field is applied after Filter but before Average.

AUTOSCALE Y

When the Autoscale Y option is selected, the Time Series Viewer will autoscale on the Y-axis to make sure that all data within the range of the X-axis is displayed.

AVERAGE

If **Block** is selected, a block average is calculated when you click the Do average button is clicked. Otherwise a moving average is calculated.

For a block average, **Size** specifies block size in unit of minute. For a moving average, **Size** specifies subset size in unit of data points.

Averaging is performed after the Filter and Expression are performed.

MEAN, STD DEV, AND PEAK TO PEAK

The **Mean**, **Std dev** (Standard deviation) and **Peak to peak** fields provide all of the statistical information of data in the current view.

FILTER

Filter is a mathematical expression that specifies data to include or exclude from plot(s). For example:

```
(CH4 < 5) & (CO2 < 10)
```

In this example, CH4 and CO2 are both variable names in the selected data set. As a result, this filter removes all rows that have CH4 >= 5 or CO2 >= 10 from dataset.

Available logical operators for the Filter field are:

& (AND)

| (OR),

~ (NOT)

^ (XOR)

All variables in the selected dataset can be used in the Filter field by calling the variable name. However, if variable name starts with a number, it must be prepended with a prefix of “dat”. For example, “12CO2” must be named “dat12CO2” in the Filter field.

A Filter is applied before an Expression.

Correlation/XY Plot

The Correlation/XY Plot includes two menu items: File and Analysis.

- For details about the File menu, see *Save Configuration*.
- For details about the Analysis menu, see *Analysis Menu*.

The canvas in this plot is interactive. For details about the plot canvas, see *The Time Series Viewer Canvas*.

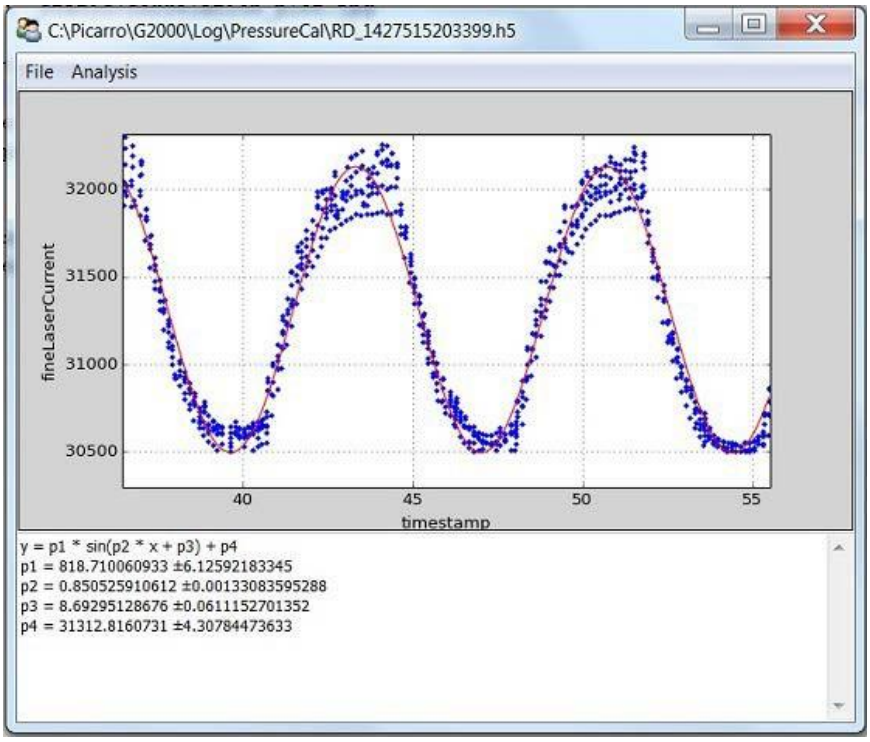


Figure 35. Correlation/XY plot

Analysis Menu

The Analysis Menu includes three options. These options are described in the sections that follow.

- Fitting
- Integration
- Statistics

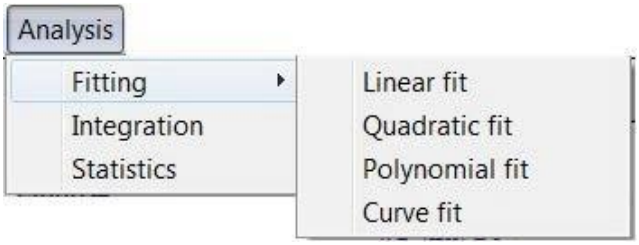


Figure 36. Analysis menu

FITTING

The fitting menu allows you to specify the fitting method to include in the Correlation/XY plot.

- Linear fit: Specifies to fit to linear function $y = c_1x + c_0$
- Quadratic fit: Specifies to fit to quadratic function $y = c_2x^2 + c_1x + c_0$
- Polynomial fit: Specifies to fit to polynomial function of degree n: $y = \Sigma c_n x^n$
- Curve fit: Specifies to use non-linear least squares to fit an arbitrary function to data. This option opens the following menu:

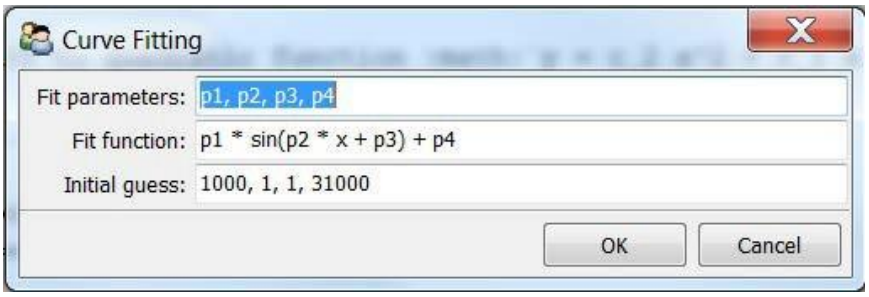


Figure 37. Curve fitting

The **Initial guess** values are important for curve fitting. Try to make a best guess for the specified parameters.

If the **Fit function** is a polynomial function, then it is better to use the Polynomial Fit method instead of Curve Fitting.

INTEGRATION

Integration specifies to calculate the area under the curve using the composite trapezoidal rule.

STATISTICS

Statistics specifies to calculate the mean, standard deviation and peak to peak for data in the current view.

CHAPTER 8 Calibration Procedure

Calibrating your Picarro analyzer involves three steps:

1. Measuring the concentrations of known standards with the analyzer.
2. Determining the relationship between the measured value and the known value.
3. Adjusting the settings on the analyzer to correct for any difference between the measured and known values so that the on-screen readings are accurate.

Standard Gas

Because the Picarro Analyzer is extremely linear, it is only necessary to use three calibration standards to calibrate each gas species. (Two points define the calibration line, and a third intermediate point is used for verification.) The concentration value of each calibration standard is not of particular importance as long as they span a representative range of values over which the analyzer will typically be operated. It is reasonable to use a concentration of zero for the low calibration value, for example. Although it is not necessary to use more than three standards, additional standards can be used to further constrain the linear calibration coefficients.

Calibration Methodology

To perform a calibration or verification of calibration, the user simply introduces the calibration standard into the analyzer for a period long enough for the analyzer to yield a stable measurement of that sample.

Setup

This section describes the connections from the analyzer to the gas tank.

- The pressure regulator at the outlet of the gas tank protects the analyzer from over-pressurizing. The pressure should be set to about 1 psi.
- The toggle valve allows rapid shutoff of the gas delivery.
- Tubing is connected to the male quick-disconnect connector provided with the analyzer.
- The male connector is inserted to the inlet port of the analyzer.

To replace the gas tank:

1. Turn off the main valve on the gas tank.
2. Disconnect the pressure regulator assembly from the tank.
3. Connect the pressure regulator assembly to the next gas tank.

Figure 38. Connecting a gas tank to the analyzer

Measurement Time for Each Standard

The measurement period for a calibration standard is dependent upon the recorded precision of the standard gas and performance characteristic of the analyzer. (See the Allan variance plot that follows.) For instance, if the reported absolute accuracy of the CO_2 standard is 0.1 ppm, the averaging time to achieve that precision for a single measurement is 20 sec. Furthermore, if measurements are taken for 5 min (300 sec), using the Allan standard deviation plot tells us that we can reach precisions of 0.1ppb for CH_4 and 30 ppb for CO_2. This level of certainty converts to an absolute accuracy in your standard once calibrated

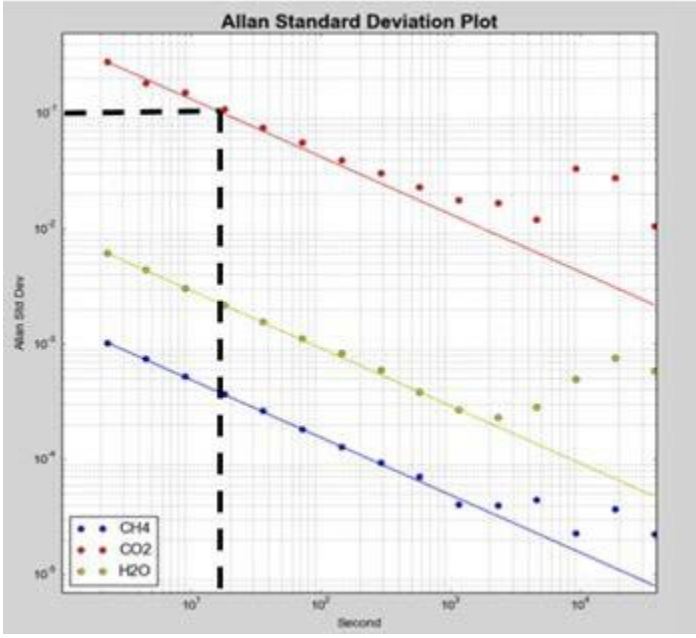


Figure 39. Allan variance plot

Measuring Multiple Gas Standards

When measuring multiple gas standards, the order of the gas standard is not important. However, make sure that you measure the gas standard slightly longer than the time you determined in the previous section because the usable/effective data set will be trimmed down.

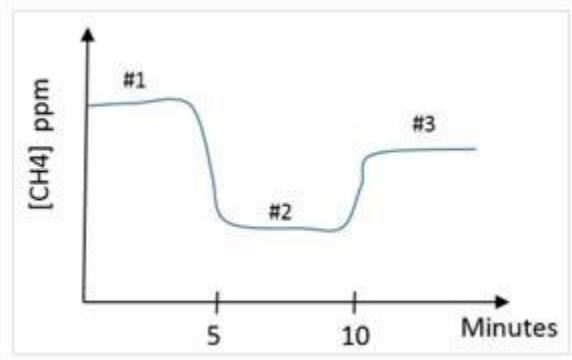


Figure 40. Measuring multiple gas standards

Calibration Data Processing

1. Process the calibration results from the .dat file (see *File Management* (page 25)), and calculate the average recorded value for each standard.
2. Plot these values versus the certified values from the gas supplier, and determine the linear relationship between the known calibration values and the analyzer's reported values. A linear best-fit equation can be calculated from the data.

It is important to plot the analyzer's reported concentration on the horizontal axis and the gas standards' stated concentrations on the vertical axis.

The slope and intercept of the best-fit line through these points are the two values that are used to calibrate the analyzer. By determining the linear relationship between the known calibration values and the analyzer's reported concentration values in this way, a calibration offset (slope and intercept) can be calculated so as to add a correction term to the analyzer's factory or previous calibration.

Inputting the Calibration Setting

Changing the analyzer's calibration is intended to be done infrequently. Instead of recalibrating frequently to increase the accuracy of the data, users often just verify the calibration by measuring three or more gas standards and use the same regression procedure described here to calculate an offset by which to correct their data offline. Using the following equation in the graph below, this calculation would be accomplished point-by-point by calculating the corrected data "y" using the analyzer's data "x" so that:

Datacorrected = 0.9866•Dataraw+5.268

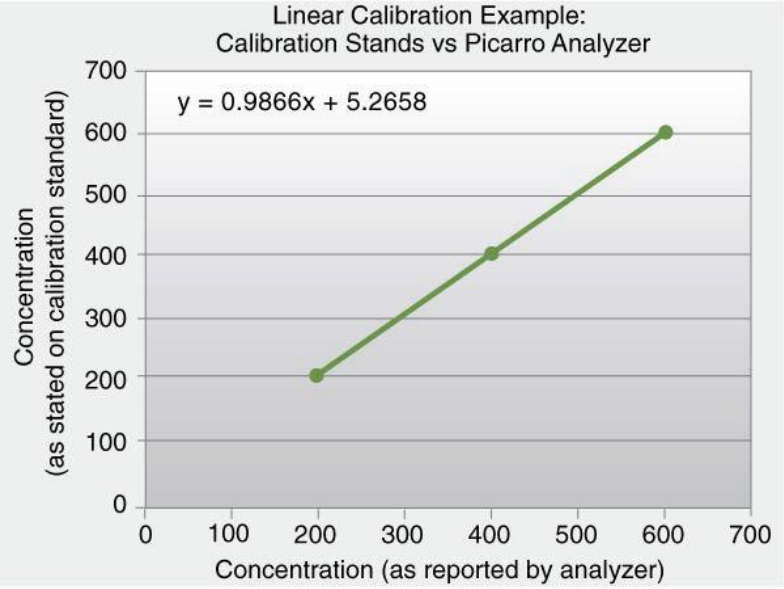


Figure 41. Linear calibration example

Calibration values are input into the analyzer by selecting **Tools > User Calibration**, and then entering the slope and intercept for each species.

User Calibration is a password-protected form, and the default password is "picarro". This password can be reset in the QuickGui.ini file as previously described. (Refer to *Tools Menu*.)

The calibration will take effect immediately after clicking **OK**. To return to the factory calibration, simply set the slope to 1 and the intercept to 0 for each species.

CHAPTER 9 Service and Maintenance

The advanced, rugged design of the Picarro analyzers provides stable, long-term operation with minimal service or maintenance. The following items are serviceable:

- Replacing the battery, PN# S2040
- Replacing the inlet filter, PN# S1021
- Replacing the fan, PN# S1071
- Replacing the pump, PN# S2010
- Replacing the fuse

With the exception of these items above, the analyzer is not user serviceable. Should it appear to malfunction, please refer to *Troubleshooting* or contact Picarro.

Opening the Case

Open the case to access the internal components. See Figure 42. To open the case:

1. Release the latches on either side of the case.
2. Lift the case cover.
3. Remove the screws from the inner cover (Figure 42).
4. Open the inner cover

Figure 42. Open the Case

Replacing Inlet Filter

When the inlet filter is clogged or heavily fouled, replace the filter with a new one (PN# S1021) by unscrewing the ¼" Swagelok nut. Make sure the filter is installed in the proper direction.

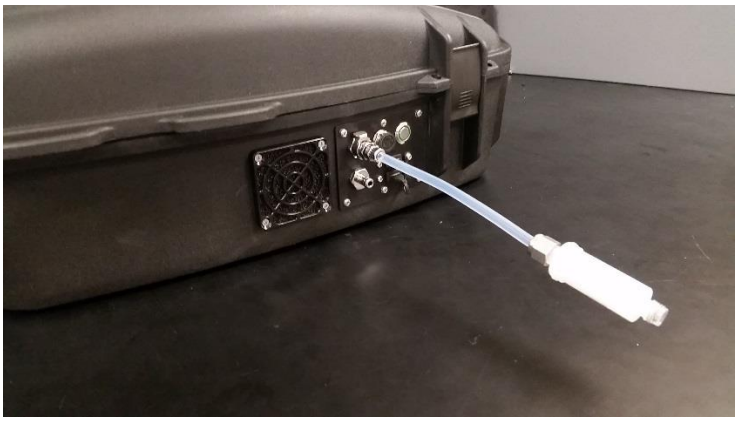


Figure 43. Inlet Filter

Replacing Fuses

Two 3A - 32V Mini Blade fuses are located in the analyzer behind the backplate. They can be replaced by simply opening the fuse case cover and pulling out the Mini Blade fuse.

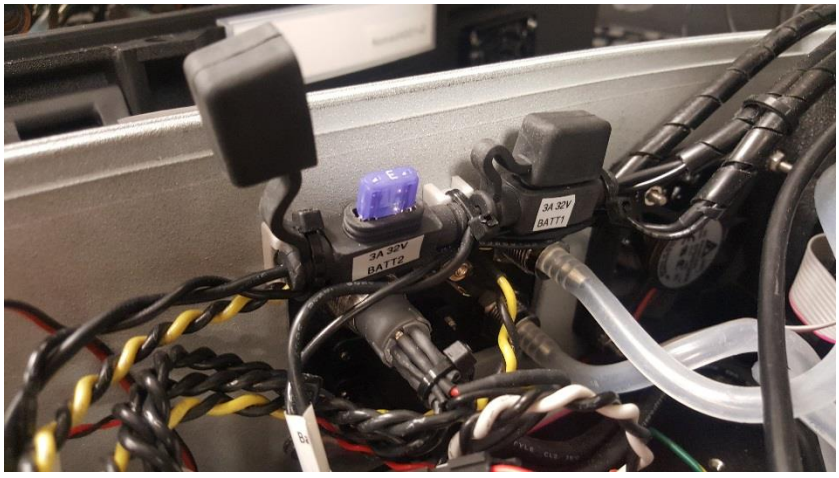


Figure 44. Fuses

ENSURE THE BATTERY AND POWER OUTLET CABLE ARE DISCONNECTED WHEN REPLACING THE FUSES.

Replacing Fan

1. Remove the fan's power connector from the *Analyzer Power Distribution Board*. Figure 45.

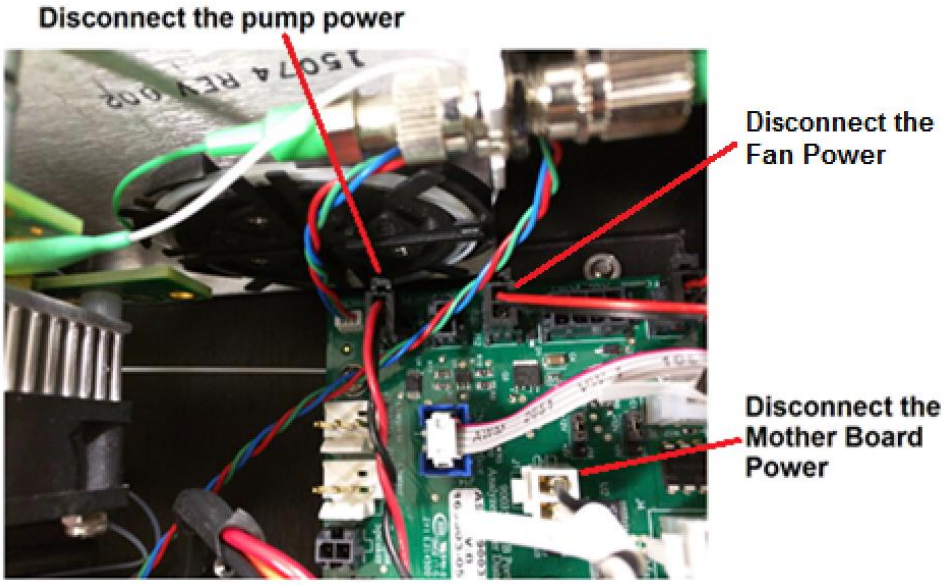


Figure 45. Analyzer Power Distribution Board

2. Remove the four nuts securing the fan to the inner enclosure. Figure 46.
3. Pull the fan out and over the ends of the four screws.
4. Remove the fan.

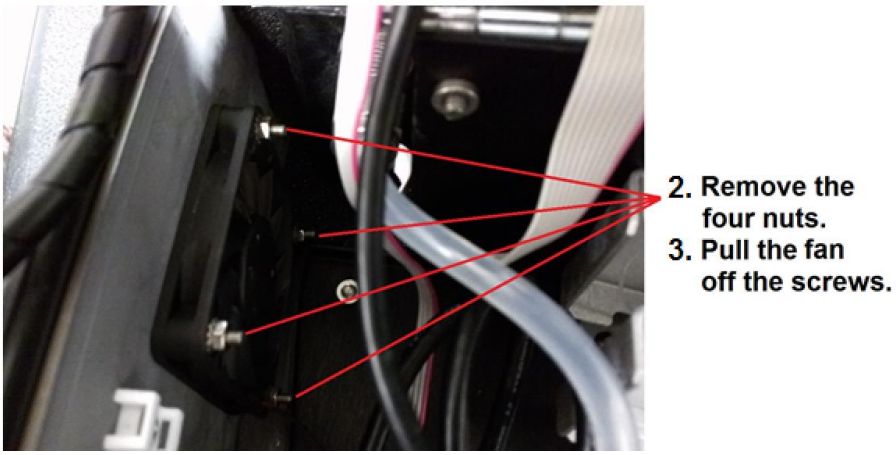


Figure 46. Remove the Fan

5. Repeat steps one through four to install a new fan.

Replacing Pump

1. Disconnect the pump power connector.
2. Disconnect the mother board power connector. Figure 48.
3. Detach the two USB connectors to access the pump. See Figure 47.

Figure 47. Disconnect the USB Connectors

4. Release the tie-wrap securing the pump.

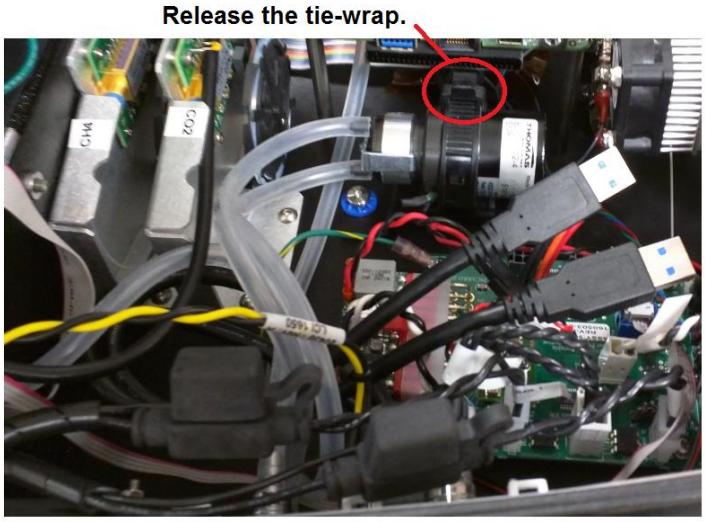


Figure 48. Release the Tie-Wrap

5. Remove the vacuum tubing from the pump

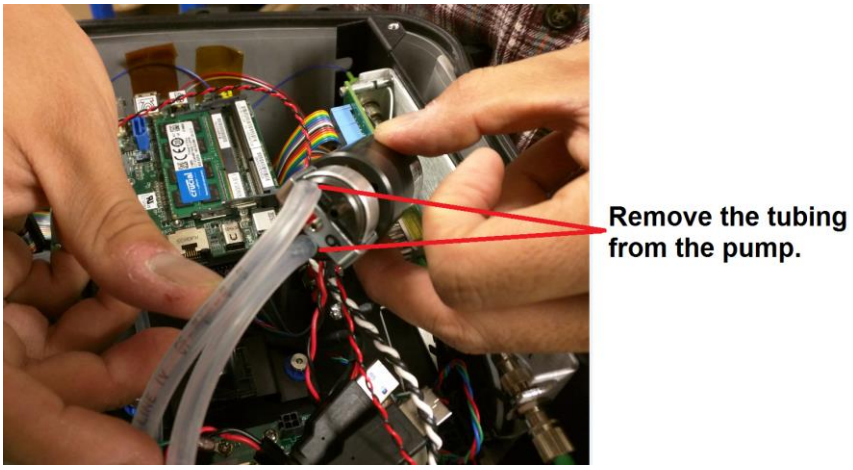


Figure 49. Remove the Vacuum Tubing

6. Attach the new pump to the tubing.
7. Reconnect the USB connectors and the mother board power connector.
8. Close the inner cover and replace the two screws.
9. Close and latch the outer cover.

CHAPTER 10 Troubleshooting

The following section lists problems that may be encountered during installation and operation of the analyzer. The corresponding step-by-step procedures provide resolution in most cases. If, after attempting these procedures, the problem remains unresolved, please contact Picarro Technical Support.

- Power LED on analyzer does not illuminate (page 49)
- User interface program does not start (page 49)
- Sample pressure cannot be controlled to the appropriate value for concentration measurements (page 49)
- User interface program "freezes" and does not update graphs as data are collected (page 50)

1. Power LED on analyzer does not illuminate

Context: Turning on the analyzer by momentarily depressing its front panel power switch should apply power. The green power LED is illuminated when it detects the correct power levels.

a) Check that the AC power cord is attached and plugged into a working outlet.
b) Check that the rear on-off switch near the AC power cord is in the on position.
c) Press and hold the front panel power switch for at least 5 seconds as the analyzer may take several seconds to respond.

2. User interface program does not start

Context: The computer may be configured to start the instrument and the associated user interface program automatically after it completes its bootup sequence, or the program may be launched using the "Start instrument" icon on the desktop.

a) Communications problems with the analyzer may occur if the analyzer fails to initialize correctly on power up. Should the analyzer initialization process not complete correctly, shut down the instrument by shutting down the Windows operating system on the control computer: use the Start menu, select the red Shut down button and select "Shut down" in the drop-down box under "What do you want the computer to do?". Wait for the shutdown to complete normally and for the computer and analyzer to turn off completely. After a few seconds, restart the computer by momentarily depressing the power button.

Do not simply restart Windows because this does not cycle the power to the analyzer.

3. Sample pressure cannot be controlled to the appropriate value for concentration measurements.

Context: Under normal operation, the cavity pressure is automatically locked to the correct value by means of electronically controlled inlet and outlet valves. The message "Pressure Locked" on the front panel display and the user interface indicates that the cavity pressure is at the appropriate value. Should either of the messages "Pressure high" or "Pressure low" be displayed, the cavity pressure is out of its correct operating range.

a) The “Pressure low” message indicates that there is insufficient gas available at the inlet of the analyzer. Check the inlet plumbing to the analyzer and ensure that the pressure at the inlet is within the specifications.
b) The “Pressure high” message indicates that gas cannot be removed from the analyzer at a sufficient rate. Check the vacuum line between the analyzer and the power vacuum unit for leaks. Failure of the vacuum pump, injecting dilution gas at excessive pressure, or excessive pressure at the inlet can also cause this problem.

4. User interface program “freezes” and does not update graphs as data are collected

Context: The computer may become unresponsive causing the programs that control the analyzer to stop functioning. The computer and analyzer should be shut down and restarted.

a) Re-setting the computer and the instrument requires that the computer be shut down and restarted. If the computer responds to the mouse, a normal Windows shutdown may be carried out: use the Start menu, select the red Shut down button and select “Shut down” in the drop-down box under “What do you want the computer to do?” Wait for the shutdown to complete normally and for the computer and analyzer to turn off completely. After a few seconds, restart the computer by momentarily pressing the power button.
b) If the computer does not respond to the mouse, hold down the power switch on the front panel for a few seconds until the computer and the instrument turn off. After another few seconds, restart the analyzer by momentarily pressing the power button.

CHAPTER 11 Return Merchandise Authorization

Picarro, Inc. reserves the right to revise the RMA process and to make changes from time to time.

DAMAGE IN SHIPMENT - Your analyzer should be inspected and tested as soon as it is received. The product is packaged for safe delivery. If the product was shipped Ex Works Santa Clara, CA (or similar designation under INCOTERMS), then you should immediately file a claim with the carrier or, if insured separately, with the insurance company. Otherwise, please contact Picarro immediately to report any damage.

ADJUSTMENT – No electrical, mechanical or optical adjustments to the product(s) are permitted.

REPORTING A DEFECT, WARRANTY REPAIR OR OTHER PROBLEM - Customers must obtain a Return Merchandise Authorization Number from Picarro, Inc. prior to returning any product, peripheral or component.

Products being returned for repair must be shipped in their original shipping cartons or similar to avoid damage.

The Purchaser's exclusive remedy with respect to any defective Product shall be to have Picarro repair or replace such defective Product or credit the Purchaser's account, whichever Picarro may elect in its sole discretion. If it is found that any Product has been returned which is not defective, the Purchaser will be notified and such Product returned at the Purchaser's expense. In addition, a charge for testing and examination may, at Picarro's sole discretion, be made on any Product so returned.

These remedies are available only if: i) Picarro is notified in writing by the Purchaser promptly upon discovery of a Product defect, and in any event within the warranty period; ii) Picarro's examination of such Product discloses to Picarro's satisfaction that such defects actually exist and the Product has not been repaired, worked on, altered by persons not authorized by Picarro, subject to misuse, negligence or accident, or connected, installed, used, or adjusted otherwise than in accordance with the instructions furnished by Picarro.

APPENDIX A DataLog_User and DataLog_Private Parameters

This section describes the parameters that are avaialble in the DataLog_User and DataLog_Private files.

DataLog_User Parameters

The following table describes the columns available in the DataLog_User file.

Table 5. DataLog_User Parameters

Column	Description	Units (if applicable)
DATE	Date of measurement(UTC)	Year-Month-Day
TIME	Time of measurement (instrument time, GMT)	Hour:Minute:Second.ms
FRAC_DAYS_SINCE_JAN1	Fraction of days since Jan 1 (max = 365)	
FRAC_HRS_SINCE_JAN1	Fraction of hours since Jan 1 (max = 8760)	
JULIAN_DAYS	Julian days in since Jan 1 00:00 GMT	
EPOCH_TIME	Number of seconds that have elapsed since Jan 1, 1970 GMT	
ALARM_STATUS	Binary system alarm (0 = no alarm; 1 = alarm)	
INST_STATUS	Hardware status code; should always equal 963 if the analyzer is operating properly	
H2O	Mole fraction of water vapor	Percent
CH4	Mole fraction of methane, not corrected for effect of water vapor	PPM

Column	Description	Units (if applicable)
CH4_dry	Dry mole fraction of methane, corrected for line shape effects and dilution by water vapor	PPM
CO2	Mole fraction of carbon dioxide, not corrected for effect of water vapor	PPM
CO2_dry	Dry mole fraction of carbon dioxide, corrected for line shape effects and dilution by water vapor	PPB
CavityPressure	Cavity Pressure	Torr
CavityTemp	Cavity Temperature	deg C
Battery_Current	Current flow to the analyzer battery	Ampere
Battery_Temperature	Temperature of the battery	deg C
Battery_Voltage	Voltage output of the battery	Volt

DataLog_Private Parameters

The following table describes the columns available in the DataLog_Private file.

Table 6. DataLog_Private Parameters

Column	Description	Units (if applicable)
ALARM_STATUS	Binary system alarm (0 = no alarm; 1 = alarm)	
AmbientPressure	Not used	
Battery_Charge	Proxy for charge held in battery	Coulombs
Battery_Current	Current output of battery	Ampere
Battery_Temperature	Temperature of battery	deg C
Battery_Voltage	Voltage output of battery	Volt
CH4	Mole fraction of methane, calibrated but not corrected for effect of water vapor	ppm

Column	Description	Units (if applicable)
CH4_dry	Dry mole fraction of methane, calibrated and corrected for dilution and line shape change by water vapor	ppm
CO2	Mole fraction of carbon dioxide, calibrated but not corrected for effect of water vapor	ppm
CO2_dry	Dry mole fraction of carbon dioxide, calibrated and corrected for dilution and line shape change by water vapor	ppm
CavityPressure	Cavity Pressure	Torr
CavityTemp	Cavity Temperature	deg C
DasTemp	Temperature measured on the data acquisition system board	deg C
Delta	Isotopic Deviation for 13CO2 to 12CO2	Percent
Etalon1	ADC output from photodiode monitoring etalon 1 transmission in wavelength monitor (WLM)	DN
Etalon2	ADC output from photodiode monitoring etalon 2 transmission in WLM	DN
EtalonTemp	Temperature measured at the WLM	dec C
FRAC_DAYS_SINCE_JAN1	Fraction of days since Jan 1 (max = 365)	
FRAC_HRS_SINCE_JAN1	Fraction of hours since Jan 1 (max = 8760)	
FanState	Binary output fan (off/on)	
Flow1	Not used	
H2O	Mole fraction of water vapor	percent
HotBoxHeader	DAC output to hot box heater controller	DN
HotBoxHeatsinkTemp	Temperature measured at the hot box heatsink	dec C
HotBoxTec	DAC output to hot box thermoelectric cooler	DN
INST_STATUS	Hardware status code; should always equal 963 if the analyzer is operating properly	

Column	Description	Units (if applicable)
InletValve	DAC output to proportional valve at cavity inlet	DN
JULIAN_DAYS	Julian days since Jan 1 00:00 GMT	
Laser1Current	Current to Laser 1	mA
Laser1Tec	DAC output to Laser 1 thermoelectric cooler	DN
Laser1Temp	Temperature of Laser 1	dec C
Laser2Current	Current to Laser 2 (not used on this analyzer)	mA
Laser2Tec	DAC output to Laser 2 thermoelectric cooler	DN
Laser2Temp	Temperature of Laser 2	dec C
Laser3Current	Current to Laser 3 (not used on this analyzer)	mA
Laser3Tec	DAC output to Laser 3 thermoelectric cooler	DN
Laser3Temp	Temperature of Laser 3	dec C
Laser4Current	Current to Laser 4 (not used on this analyzer)	mA
Laser4Tec	DAC output to Laser 4 thermoelectric cooler	DN
Laser4Temp	Temperature of Laser 4	dec C
MPVPosition	Integer code for the valve position	
cal_enabled	Binary flag set to 1 if WLM calibration is enabled	DN
ProcessedLoss1	Not used	
ProcessedLoss2	Not used	
ProcessedLoss3	Not used	
ProcessedLoss4	Not used	
Ratio1	Ratio of etalon to reference output for etalon 1	Floating point number
Ratio2	Ratio of etalon to reference output for etalon 2	Floating point number

Column	Description	Units (if applicable)
Reference1	ADC output from photodiode monitoring etalon 1 reference beam in WLM	DN
Reference2	ADC output from photodiode monitoring etalon 2 reference beam in WLM	DN
SchemeTable	Location of this data set in scheme used to control data acquisition	
SchemeVersion	Version number for scheme used to control data acquisition	
SpectrumID	Integer code identifying the spectrum used to generate this line of data (=23 for H2O and CH4, 10 for CO2	Integer
ValveMask	Integer code describing the state of the valve sequencer	
WarmBoxHeatsinkTemp	Temperature measured at the warm box heatsink	deg C
WarmBoxTec	DAC output to warm box thermoelectric cooler	DN
WarmBoxTemp	Temperature measured at the warm box	deg C
cal_enabled	Binary flag set to 1 if WLM calibration is enabled	
cavity_pressure	Cavity Pressure	Torr
cavity_temperature	Cavity Temperature	deg C
ch4_base	Background absorption at the frequency of the methane peak	ppb/cm
ch4_cal	Mole fraction of methane after applying instrument-specific calibration	ppm
ch4_conc_dry	Mole fraction of methane with water correction but before applying instrument-specific calibration	ppm
ch4_conc_raw	Mole fraction of methane from peak absorption only, without water correction or instrument-specific calibration	ppm
ch4_fineLaserCurrent	ADC output controlling fine current adjustment to the methane laser for ring-downs at absorption peak	DN
ch4_fit_time	Time spent in the fit script for the methane spectrum	seconds

Column	Description	Units (if applicable)
ch4_freq_locked	Binary flag set to 1 if methane laser frequency is centered at methane absorption peak	
ch4_gaps	Number of gaps in the methane spectrum, i.e. places where one or more modes are missing from the data set	Integer
ch4_i2f_cubic	Cubic term in the current-to-frequency transformation for the methane laser	DN
ch4_i2f_lin	Linear term in the current-to-frequency transformation for the methane laser	DN
ch4_i2f_offset	Constant term in the current-to-frequency transformation for the methane laser	DN
ch4_i2f_quad	Quadratic term in the current-to-frequency transformation for the methane laser	DN
ch4_interval	Time between successive methane spectra	seconds
ch4_laser_temp_offset	Offset applied to the temperature controller for the methane laser	dec C
ch4_max_gap	Maximum number of consecutive modes missing from the methane spectrum	Integer
ch4_peakPoints	Number of discrete frequencies at the peak of the methane absorption feature	Integer
ch4_pointsInRange	Number of discrete frequencies in the full methane spectrum	seconds
ch4_res	RMS residual of the fit to the methane spectrum	ppb/cm
ch4_shift	Frequency shift between the best fit to the methane spectrum and the frequency assignments in the spectral library	wavenumbers
ch4_slope	Fitted slope of the background absorption underlying the methane absorption feature	ppb/cm / wavenumber
co2_626	Mole fraction of the carbon dioxide 626 isotopologue from peak absorption, without correction or calibration	ppm
co2_base	Background absorption at the frequency of the carbon dioxide peak	ppb/cm

Column	Description	Units (if applicable)
co2_cal	Mole fraction of carbon dioxide after applying instrument-specific calibration	ppm
co2_conc_dry	Mole fraction of carbon dioxide with water correction but before applying instrument-specific calibration	ppm
co2_conc_raw	Mole fraction of carbon dioxide from peak absorption only, without water correction or instrument-specific calibration	ppm
co2_fineLaserCurrent	ADC output controlling fine current adjustment to the carbon dioxide laser for ring-downs at absorption peak	DN
co2_fit_time	ADC output controlling fine current adjustment to the carbon dioxide laser for ring-downs at absorption peak	seconds
co2_freq_locked	Binary flag set to 1 if carbon dioxide laser frequency is centered at methane absorption peak	
co2_gaps	Number of gaps in the carbon dioxide spectrum, i.e. places where one or more modes are missing from the data set	Integer
co2_i2f_cubic	Cubic term in the current-to-frequency transformation for the carbon dioxide laser	DN
co2_i2f_lin	Linear term in the current-to-frequency transformation for the carbon dioxide laser	DN
co2_i2f_offset	Constant term in the current-to-frequency transformation for the carbon dioxide laser	DN
co2_i2f_quad	Quadratic term in the current-to-frequency transformation for the carbon dioxide laser	DN
co2_laser_temp_offset	Offset applied to the temperature controller for the carbon dioxide laser	deg C
co2_max_gap	Maximum number of consecutive modes missing from the carbon dioxide spectrum	Integer
co2_peakPoints	Number of discrete frequencies at the peak of the carbon dioxide absorption feature	Integer
co2_pointsInRange	Number of discrete frequencies in the full carbon dioxide spectrum	seconds

Column	Description	Units (if applicable)
co2_res	RMS residual of the fit to the carbon dioxide spectrum	ppb/cm
co2_shift	Frequency shift between the best fit to the carbon dioxide spectrum and the frequency assignments in the spectral library	wavenumbers
co2_slope	Fitted slope of the background absorption underlying the carbon dioxide line	ppb/cm / wavenumber
dm_latency	Interval between successive calls to the data manager script	seconds
goodCH4	Binary flag set to 1 if methane spectral data set and fit pass all fitter tests	
goodCO2	Binary flag set to 1 if carbon dioxide spectral data set and fit pass all fitter tests	
groups	Total number of discrete frequencies represented in the data set	Integer
h2o_cal	Mole fraction of water vapor after applying instrument-specific calibration	percent
h2o_conc_raw	Mole fraction of water vapor from peak absorption only, without correction for line shape effects	percent
max_fitter_latency	Interval between successive calls to the fitter script	seconds
peak31	Peak absorption of the water vapor line from Levenberg-Marquardt fit	ppb/cm
peak_10	Peak absorption of the methane line from Levenberg-Marquardt fit	ppb/cm
peak_40	Peak absorption of the carbon dioxide line from Levenberg-Marquardt fit	ppb/cm
rds	Number of ring-down measurements comprising the spectrum	Integer
shift31	Frequency shift between the fitted water and methane lines and the frequency assignments in the spectral library	wavenumbers
spect_duration	Time spent acquiring the spectrum	seconds

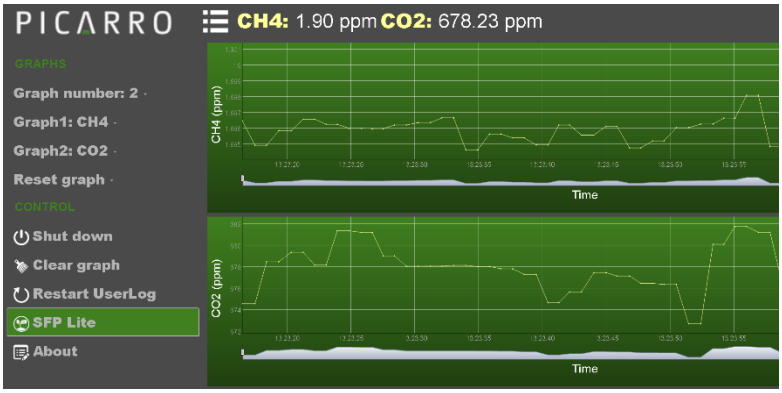
Column	Description	Units (if applicable)
spect_latency	Interval bewteen spectrum acquisitions	seconds
spectrumId	Integer code designating the spectral region being measured (=10 for CO2, 23 for CH4 and water)	
str10	Coefficient multiplying normalized Galatry function for the methane line, from Levenberg-Marquardt fit	ppb/cm
str10_norm	Methane line strength normalized by fitted collisional broadening parameter	ppb/cm
str31	Coefficient multiplying normalized Galatry function for the water line, from Levenberg-Marquardt fit	ppb/cm
str40	Coefficient multiplying normalized Galatry function for the carbon dioxide line, from Levenberg-Marquardt fit	ppb/cm
str40_norm	Carbon dioxide line strength normalized by fitted collisional broadening parameter	ppb/cm
str42	Coefficient multiplying normalized Galatry function for the carbon dioxide 636 line, from Levenberg-Marquardt fit	ppb/cm
str43	Coefficient multiplying normalized Galatry function for the carbon dioxide 628 line, from Levenberg-Marquardt fit	ppb/cm
str50	Coefficient multiplying normalized Galatry function for the strongest methane line in the carbon dioxide region	ppb/cm
temp_correction_ch4	Correction to reported methane mole fraction from thermal ground-state population	Floating point number
temp_correction_co2	Correction to reported carbon dioxide mole fraction from thermal ground-state population	Floating point number
temp_correction_h2o	Correction to reported water vapor mole fraction from thermal ground-state population	Floating point number
time	Number of milliseconds since midnight Jan. 1, 1970 (also called EPOCH_TIME)	milliseconds
timestamp	Unix time stamp for this spectrum	milliseconds
y10	Collisional broadening parameter for the methane line	dimensionless number

Column	Description	Units (if applicable)
y31	Collisional broadening parameter for the water line	dimensionless number
y40	Collisional broadening parameter for the carbon dioxide line	dimensionless number

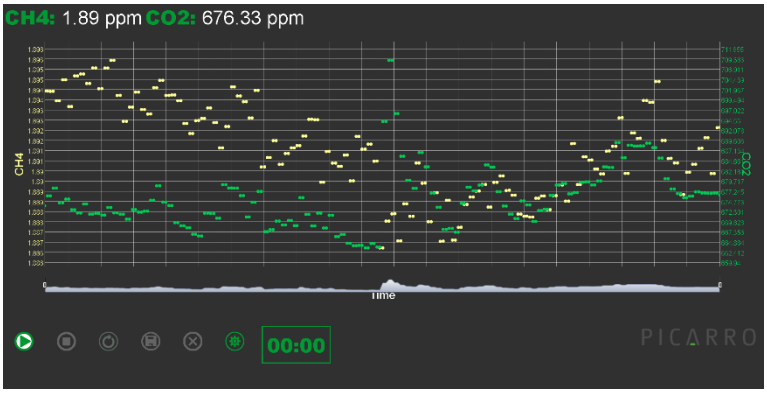
APPENDIX B SFPlite – (If Applicable)

Optional Soil Flux Processor Lite

The Soil Flux Processor Lite (SFPlite) is a program that computes the flux of a given area or ground usually covered by a soil chamber. The increase in concentration over time is measured by the GasScouter and the SFPlite then calculates the flux by fitting to a model that takes in customer inputs, including chamber volume, pressure and temperature.



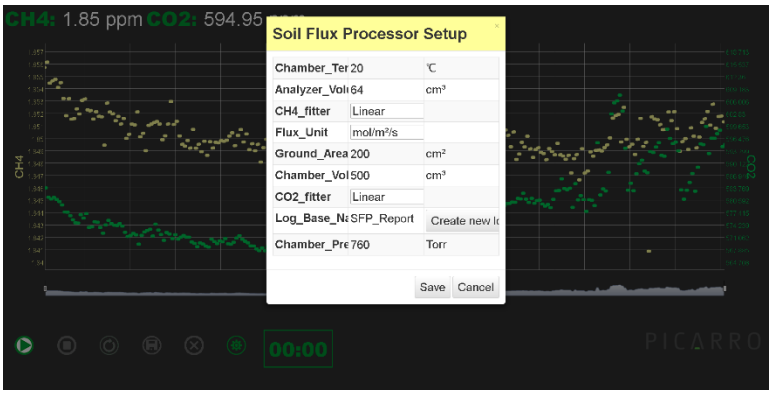
To access the SFPlite, click the designated link left menu of the WebGUI (shown above). This link will only be available if additional features are added to the purchasing of the GasScouter. The link will open a new tab in your browser, so you will be able to toggle back and forth between the whole data set view the WebGUI offers, and the SFPlite calculations.



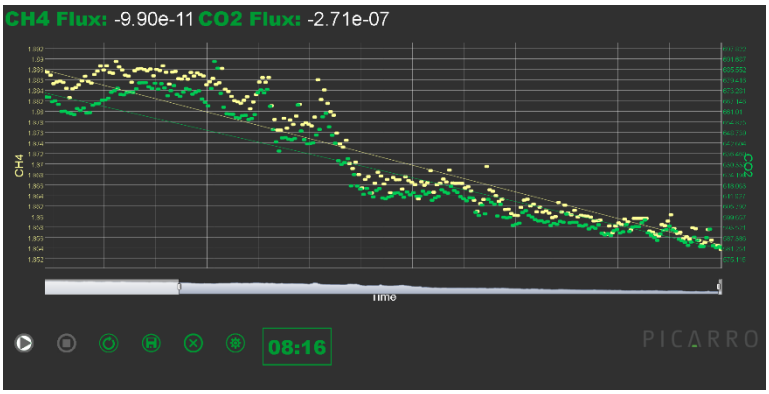
Above is a picture of the SFP Lite interface where only green icons can be clicked on.

To apply settings of your current experiment to your current measurements click the SETUP icon ⚙. Here you can input ambient temperature, chamber pressure, chamber volume, and area of ground covered by the chamber in cm^3. The chamber volume should also account for the volume within the tubing

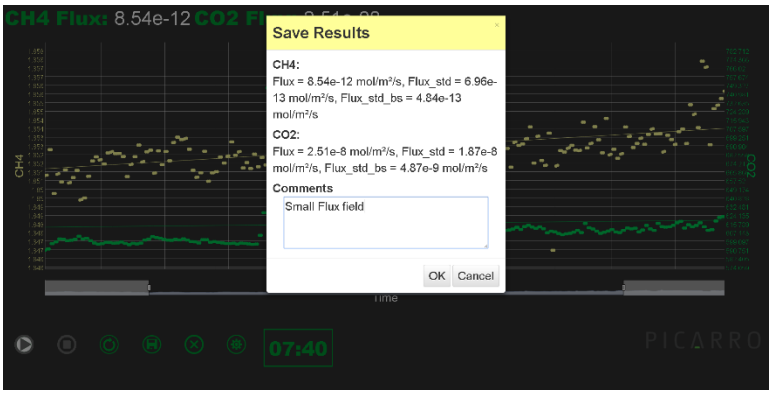
connection the chamber to the analyzer. Chamber pressure is by default set to the measured Cavity Pressure + 30 torr, but this can change depending on setup, so it is encouraged to measure this on a secondary sensor or app. As an addition feature you can change the different functional form of the fitted flux, between a linear, quadratic or Hutchinson & Mosier model. You can also change the name of a new SFP .dat file that summarizes calculated flux data. When you click "**OK**" all of these settings will be saved to the instrument and applied until they are changed by the user.



Once you are ready to take a measurement and the chamber is placed, click the PLAY button ⏵. The graph will be cleared and the ticker will increase to let you know the duration of your measurement. Once you have collected enough data for a flux determination click the STOP button ⏹. The data is automatically fit to the functional form with unites that were chosen in the SETUP menu, and shown at the top of the screen. Three green buttons have also been shown available to click, shown below. If you would like to trim the data from the beginning or end of the measurement, move the sliders on the bottom of the graph to select the desired data to be fit. Once you have selected the portion of data for fitting click the REPROCESS botton, ↻.



You now can save the flux to a .csv file located in "C:\UserData\SFPlite" press the SAVE icon, 🖫. The data file saves flux, chamber characteristics, temperatures, and GPS coordinates (if applicable). It is also possible to save comments associated with the current flux measurement in the "Comments" area on the Save Results window (shown below); and then click OK once complete. If you do not wish to save the data click the DISCARD button ⊗, this will automatically clear the screen and wait for you to press the PLAY button again. The next flux measurement that you save will be appended to the SFPReport.csv file already created.



You can now use the Soil Flux Processor Lite to quickly determine soil fluxes.

NOTE: *If you are using and iPhone or iPad as the tablet device, the screen may become zoomed when inputting text, such as comments of volumes. If this happens, click OK to save changes. If the screen remains zoomed double tap on any plain gray space that is not ion the graph. This will resize the window to fit the screen. Pinching in or out on the map will only rescale the map.*

APPENDIX C GPS – (If Applicable)

Adding GPS Capabilities to Data Stream

This section explains how to add the purchased GPS unit from Picarro to the GasScouter.

Remove GPS unit from Box. Hang hook part of the plastic body over the cam lever threaded screw on the side of the GasScouter chassis. Tighten this down by clamping down the Cam lever, just like a bicycle tire. To tighten or loosen the tension on the body of the GPS release the cam lever so that it can be easily moved and rotate it clockwise or counter-clockwise, respectively. You want the body to be held firmly by the clamp, but you should not have to force the lever down, push it down by holding between with thumb and index finger.

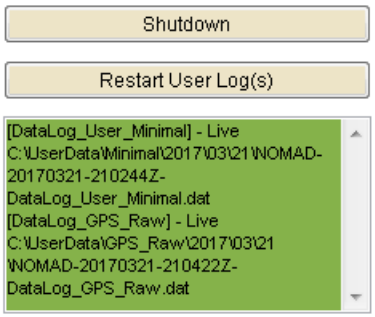
CAUTION: FORCING THE LEVER DOWN WITH TOO MUCH FORCE CAN LEAD TO BREAKING THE GPS UNIT CHASSIS OR BRACKET AND RESULT IN MALFUCTION OR IMPROPER MOUNTING.

Once mounted plug the USB into the port on the side panel of the GasScouter. Once you turn on the analyzer the GPS will be initialized and start logging data into your instrument datastream. Once the data is being logged and sent to the instrument you will see a green LED on the USB the flashes every 1 second. To be sure that your GPS is logging data, you can look at the data from the WebGUI or through

the Remote Desktop standard Picarro GUI. The following columns will be added and logging non-zero numbers.

GPS_ABS_LAT	Latitude in degrees
GPS_ABS_LONG	Longitude in degrees
GPS_FIT	Quality of GPS data 0-2
GPS_ALTITUDE	Altitude
GPS_TIME	GPS time in seconds

This fills in the columns that are already made in the User Minimal logs found *C:\UserData\Minimal.* In addition to this new files are created found here C:\UserData\GPS_Raw. These files are only created when the GPS is logging and initialized with non-zero values. You can see if a current file is being written by looking at the normal Picarro QuickGUI and looking in the lower left section and it will show you the name and location of the current file. (Shown Below) It also shows the file the current concentration data is being written to.



GPS utilizes satellites to define your current position. If the instrument is started without a **clear line of sight to the open sky** the GPS will log zeroes until it obtains signals; hence no GPS log file will be started until it gets signal. GPS fits 1 and 2 are the flags for a good GPS signal.