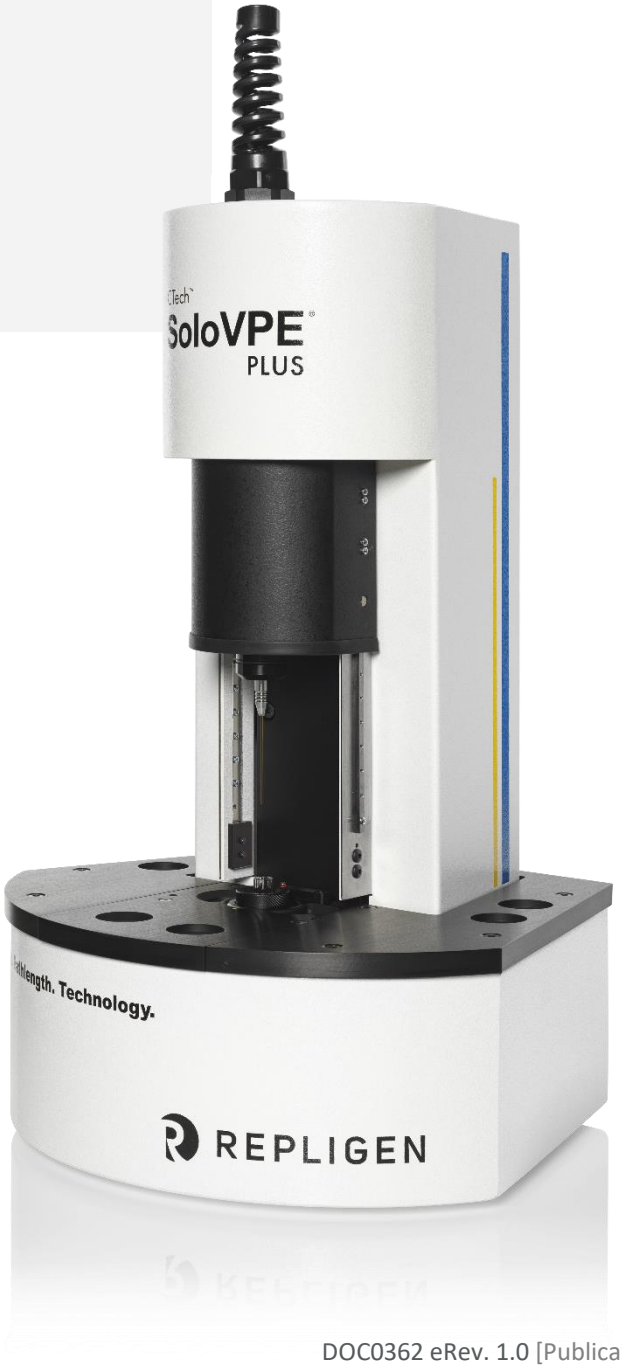
CTech™ SoloVPE® PLUS System

User Guide



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Abbreviations

ADL	Application Development Language
FAS	Field Application Scientist
PM	Preventative Maintenance
SoloVPE	Solo Variable Pathlength Extension
SVCA	Solo Validation Cuvette Adapter
VPT	Variable Pathlength Technology

1. Introduction

The CTech™ SoloVPE® PLUS System is an advanced analytical instrument for measuring product concentration. The SoloVPE PLUS System uses variable pathlength technology to measure concentration with excellent accuracy, precision, and dynamic range. Designed for use with the CTech™ ViPER® ANLYTX Software platform integrating data integrity and audit logging, the SoloVPE PLUS is an extremely capable and formidable tool for at-line process analytics.

For a full listing of performance specifications of the SoloVPE PLUS System, please see the *CTech SoloVPE PLUS System Specification Sheet* DOC0361.

2. About this document

This manual uses several different phrases. Each phrase should draw the following level of attention:

Table 1. Explanation of user attention phrases

Phrase	Description
Note	Points out useful information.
IMPORTANT	Indicates information necessary for proper instrument operation.

3. Safety Notices

Table 2. Safety precautions for the SoloVPE PLUS System

Symbol	Description
CAUTION 	CAUTION indicates a hazard that may result in personal injury if proper operating procedures are not followed. Documentation must be consulted in all cases where this symbol is marked. Do not proceed beyond a CAUTION notice until procedures and conditions of operation are met as specified.
WARNING 	WARNING: Possibility of electric shock.
PINCH HAZARD 	WARNING: Pinch hazard indicates a moderately hazardous situation that may result in personal injury if proper operating procedures are not followed.

Note: *The SoloVPE PLUS instrument is not specifically designed for use with biohazardous materials. There are no biohazards associated with the SoloVPE PLUS instrument or related hardware.*

The system is intended for indoor use only.

If used in a manner not specified by the manufacturer, protection impairment can occur.

4. Regulatory

Table 3. Regulatory information

Symbol	Description
CE Compliance	The CE marking (*conformité européenne*, or "European conformity") certifies that a product has met EU health, safety, and environmental requirements, which ensure consumer safety.
UKCA Compliance	The United Kingdom Conformity Assessment (UKCA) marking is used for products being placed on the market in Great Britain and applies to most products for which the CE marking could be used.
WEEE Compliance	The EU has developed rules on waste from electrical and electronic equipment (WEEE) to steer manufacturing towards sustainable production and consumption. The rules address environmental and other issues caused by discarded electronics.
KC Certification	Korea Certification (KC) is a product certification which ensures the conformity of products to Korean safety standards. The KC mark is similar to the CE mark in the EU but involves different requirements and testing.
NRTL	OSHA's Nationally Recognized Testing Laboratory (NRTL) Program recognizes private sector organizations to perform certification for products to ensure that they meet the requirements of both the construction and general industry OSHA electrical standards.

The above symbols are represented on the back panel of the SoloVPE PLUS instrument as shown below:

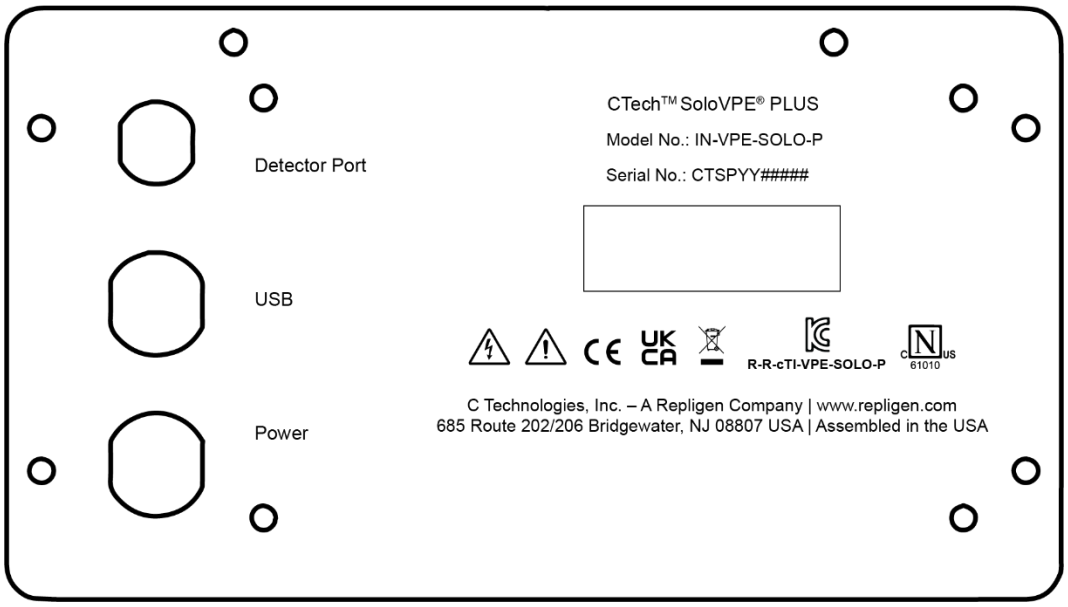


Figure 1. Regulatory information on SoloVPE PLUS instrument back panel.

WARNING (California Proposition 65): *This product can expose you to chemicals including lead and lead compounds, which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information, go to www.P65Warnings.ca.gov.*

4.1 CE Compliance

CE Compliance for the SoloVPE PLUS instrument is indicated by the following:

- The CE marking on the rear of the SoloVPE PLUS
- Repligen's Analytics business document: *CTech SoloVPE PLUS Declaration of Conformity* CTIDC-0006 (CF0598)

CE compliance covers the SoloVPE PLUS, Repligen's Analytics business-provided power supply, and three-meter cabling. SoloVPE PLUS installations utilizing cabling longer than three meters and/or customer-provided 24 VDC power through the I/O cable have not been tested for CE compliance.

The CTech SoloVPE PLUS has been designed and tested for compliance by independent testing laboratories in accordance with the standards listed on the Declaration of Conformity documents listed above.

The SoloVPE PLUS System falls into pollution degree 2 as defined in IEC 61010-1.

4.2 Mains Supply

A power supply and location-specific power cord has been provided with the system. CE compliance and expected instrument performance have only been tested with the following components.

Table 4. Mains supply information

Component	Power Voltage and Ratings
SoloVPE PLUS Instrument Mains Supply Voltage	24 VDC
SoloVPE PLUS AC Power Supply Input Ratings	100–240 VAC and 47–63 Hz
SoloVPE PLUS Instrument Max Rated Current Draw	0.5 A
Max Instrument Input Power	10 W
Cary 60 Power Requirements	100–240 VAC and 47–63 Hz

WARNING: *Shock Hazard: Danger of electrocution. Good electrical grounding is essential to avoid potentially serious shock hazards. A three-wire outlet with ground connection must be provided for the power supplies included with the Cary 60 light source and computer. Make certain that power outlets are earth grounded at the grounding pin.*

CAUTION: *It is the user's responsibility to ensure any alternate power supply conforms with the required voltage and current ratings.*

4.3 Korean Class A statement

A급 기기 (업무용 방송통신기자재)
이 기기는 업무용(A급)으로 전자파적합기기로서
판매자 또는 사용자는 이 점을 주의하시기 바라며,
가정 외의 지역에서 사용하는 것을 목적으로 합니다.

Translation: Class A (Broadcasting and Communication equipment for Business)
Sellers and users should note that this equipment is an electromagnetic device for business (class A), and is intended for use outside the home.

4.4 WEEE Compliance

Repligen Corporation has met its obligations to the EU WEEE Directive by registering in those countries to which Repligen Corporation is an importer. Repligen Corporation has also elected to join WEEE Compliance Schemes in some countries to help manage customer returns at end-of-life.

The presence of the crossed-out wheeled bin label on this product implies that the product contains electrical or electronic materials that may be hazardous and present a risk to human health and the environment when waste electrical and electronic equipment (WEEE) is not handled correctly. Electrical and electronic equipment must be disposed of in an appropriate manner, separate from standard unsorted waste streams. Users need to follow local recycling regulations to reduce adverse environmental impact in connection with disposal of WEEE and to increase opportunities for reuse, recycling, and recovery of WEEE. As legislation and disposal facilities may vary throughout the European Union member states, please contact Repligen Corporation (customerserviceus@repligen.com) for further information regarding the proper disposal of products marked with the crossed-out wheeled bin label.

For disposal in countries outside of the European Union: This symbol is only valid for use within the European Union (EU). If you wish to discard this product, please contact your local authorities for the correct method of disposal.

4.5 Environmental Conditions

Acceptable conditions for safe operation: 5°C–38°C, 15%–80% RH (non-condensing). The area should be free of dust and have low humidity, with air conditioning recommended.

CAUTION: *Condensation buildup on the system's components may impact readings. Ensure no condensation appears on critical optical surfaces.*

5. System Overview

The CTech™ SoloVPE® PLUS System hardware is composed of several integrated components.

5.1 SoloVPE PLUS Instrument

The SoloVPE PLUS instrument measures sample concentration using absorbance spectroscopy and a derivation of the Beer-Lambert law. Light enters the instrument through the Delivery Fiber (shown in Figure 2) and passes through the Fibrette® Optical Component (shown in Figure 3) into the sample. The transmitted light is collected by the detector, which is below the sample port. The position of the Fibrette determines the optical pathlength, which is used to calculate concentration using the Slope Spectroscopy® method.

Please see Appendix 2 | The Derivation of the Slope Spectroscopy Equation for more details on Slope Spectroscopy. See Appendix 3 | SoloVPE PLUS Pathlength Defined for further explanation of the optical pathlength.

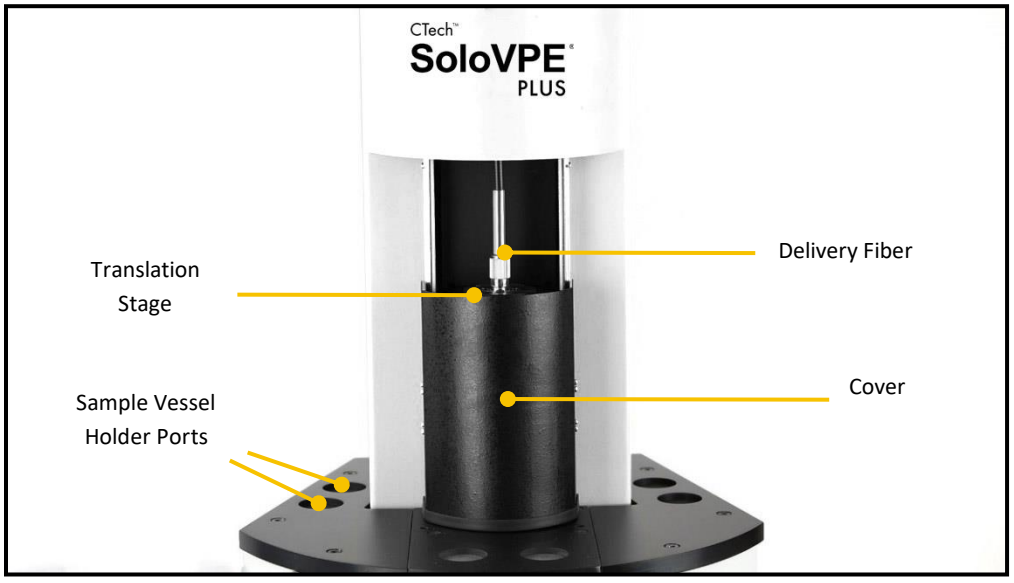


Figure 2. SoloVPE PLUS parts and components (cover down).

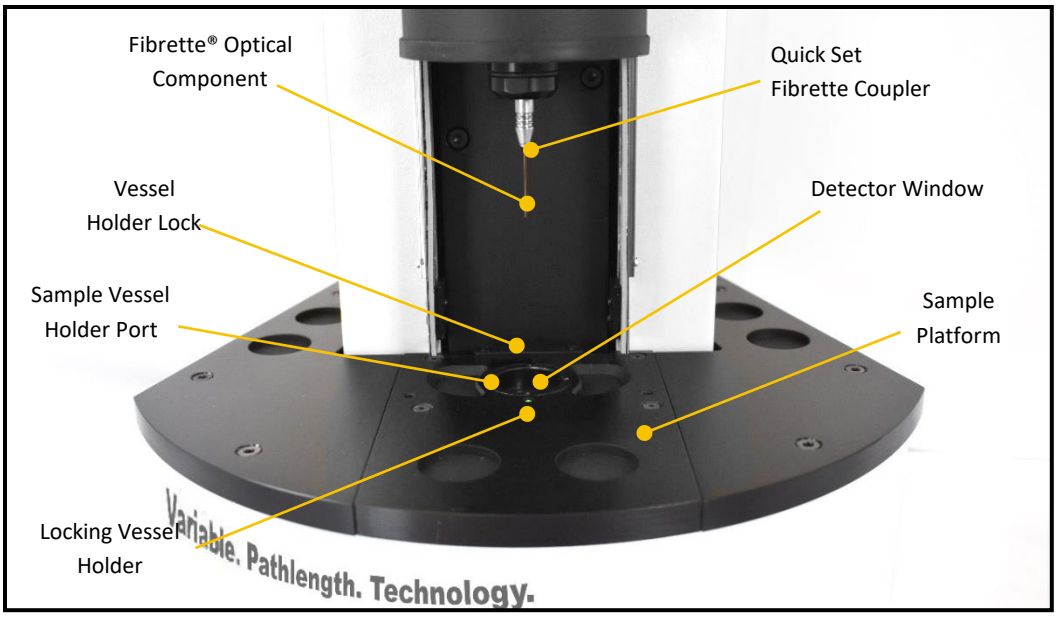


Figure 3. SoloVPE PLUS parts and components (cover up).

5.2 Cary 60 Spectrophotometer

The Cary 60 UV-Vis spectrophotometer serves as the light source and electrical power supply for the SoloVPE PLUS instrument. The Cary 60 uses a Dual Use Fiber Optic Coupler, provided by Repligen, to transmit light through the Delivery Fiber to the SoloVPE PLUS instrument.

Note: *Please reference documentation included with the Cary 60 spectrophotometer and computer for component-specific requirements, instructions, and safety considerations.*

5.3 Dual Use Fiber Optic Coupler

The Dual Use Fiber Optic Coupler couples light from the Cary 60 into the Delivery Fiber. Refer to the *Dual Use Fiber Optic Coupler User Manual* DOC0047 for more information.

5.4 ViPER ANLYTX Software

The ViPER ANLYTX software controls all aspects of configuration, data acquisition, analysis, and reporting. The overall platform is designed with an app-based architecture where each app is designed for a specific purpose.

For more detailed information about the software, please see the *CTech ViPER ANLYTX User Guide* DOC0343.

5.4.1 Computer Requirements

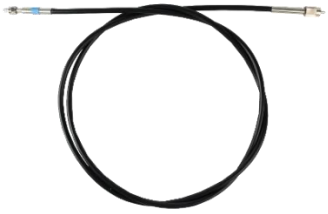
- Microsoft Windows® 10 (64 bit)
- Intel® i5 Processor (i7 Preferred)
- 8 GB RAM (16 GB Preferred)
- 250 GB Storage (solid state recommended)
- ViPER ANLYTX v1.3 or newer
- Agilent WinUV Software Suite v5.2 or newer

5.5 SoloVPE PLUS Consumables

Fibrette® Optical Components

Sample Vessels
(from left to right: plastic, Fused Silica Micro, Fused Silica Small, Fused Silica Large)

Sample Vessel Holders
(from left to right: Micro/Small, Large)



Delivery Fiber

Quick Set Fibrette Coupler Inserts

Transmission Tool

Figure 4. SoloVPE PLUS consumables. Photos are not to scale.

5.6 Solo Validation Cuvette Adapter (SoloVCA)*

The SoloVCA is an optional accessory that allows the use of cuvette filters and standards to validate the VPT instrument. The SVCA works exclusively with the SoloVPE and SoloVPE PLUS variable pathlength spectrophotometer systems.

**Note:* *The SoloVCA is not a general-use cuvette adapter for standard cuvette measurements through the SoloVPE PLUS System. Use only for instrument qualification and validation purposes.*

6. System Hardware Installation

Note: *System installation should be performed only by a trained Repligen Field Service Engineer or authorized service provider.*

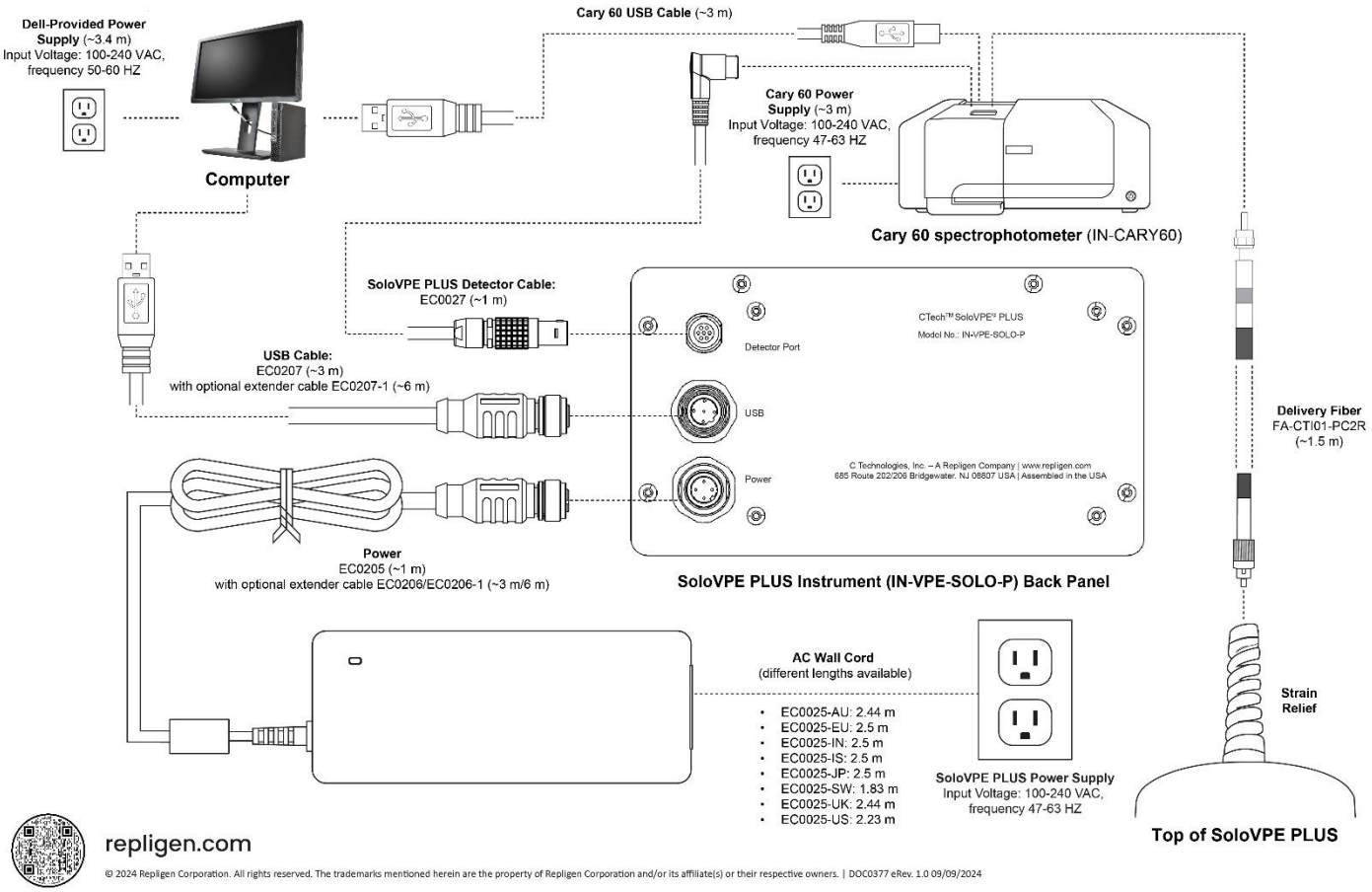
Please read and understand the following instructions prior to making any connections. These step-by-step directions guide the user through the process of making the four primary connections required between the computer, the Agilent Cary 60, and the SoloVPE PLUS instrument.

Refer to the documents packaged with the computer and Cary 60 for further instruction on basic installation.

Below is the list of connections in the SoloVPE PLUS System, as well as a reference diagram for each cable and connection connecting the SoloVPE PLUS instrument to the Cary 60 and computer.

Connections	Description
USB	Connects the SoloVPE PLUS instrument with the computer
Power	Provides power to SoloVPE PLUS instrument
Detector Port	Provides power to the detector on the SoloVPE PLUS
Delivery Fiber	Transmits light for spectroscopic measurements from Cary 60 to SoloVPE PLUS instrument

Figure 5. Diagram of SoloVPE PLUS cables and connections, including input voltages and part numbers.



Only a certified Repligen analytical representative should perform the system installation. Prior to starting, please clear and designate the laboratory bench space for the intended setup of the SoloVPE PLUS System. The SoloVPE PLUS instrument and Cary 60 may be set up in either of the configurations shown in Figure 7.

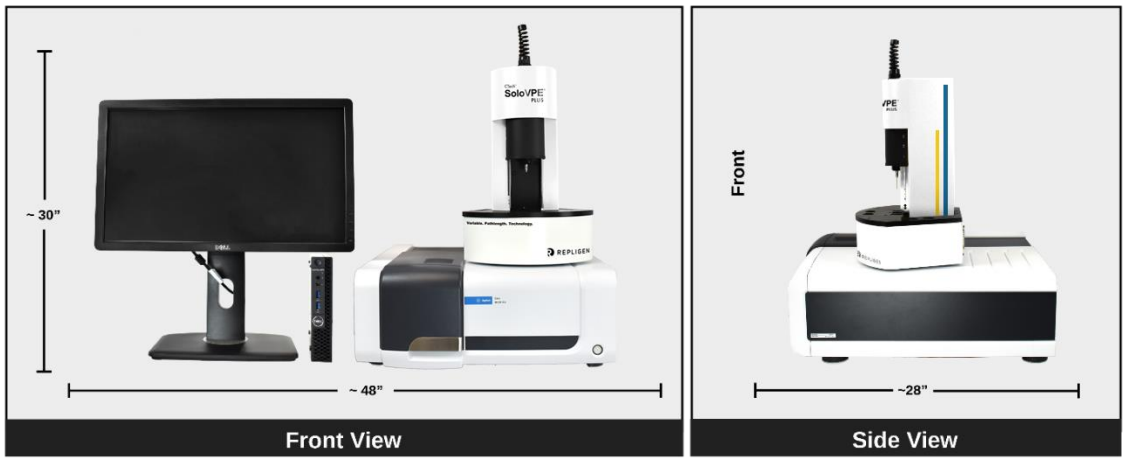


Figure 6. Dimensions of SoloVPE PLUS instrument, Cary 60 spectrophotometer, and computer.

Configuration 1: On top of the Cary 60

Configuration 2: Adjacent to the Cary 60

Figure 7. Optional configurations of SoloVPE PLUS instrument and Cary 60.

6.1 System Hardware Installation: Step-by-Step

Note: *System installation should be performed only by a trained Repligen Field Service Engineer or authorized service provider.*

Step 1: Unpack and Verify

Carefully unpack the equipment and all accessories. Confirm receipt of all items on the packing list included with the shipment.

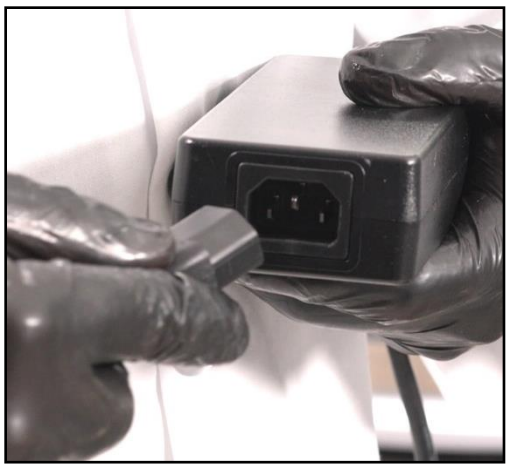
Step 2: System Computer Setup

Use the instructions provided with the computer system for proper setup.

Note: *It is best to complete this procedure with the computer turned off.*

Step 3: Connect Power Cable to SoloVPE PLUS Instrument

Connect the Power Cable (EC0205) to the back of the SoloVPE PLUS instrument. Align the notch on the connector to the black dot on the back panel, push it forward, and then tighten the metal cuff by rotating it clockwise.

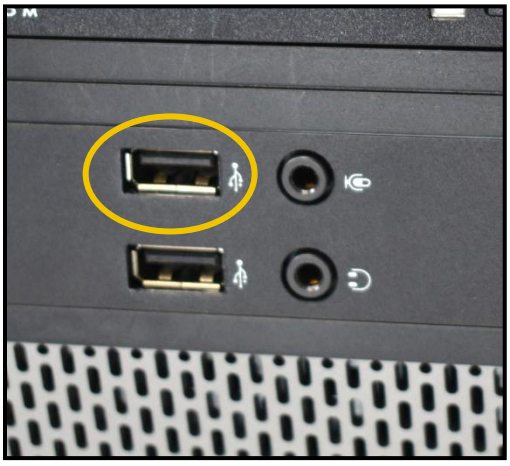


Step 4: Connect the Power Cable to the Power Brick

Connect the power cable to the power adapter brick (EC0025). Then plug the opposite end into a power outlet with the approved input voltage (see Table 4. Mains supply information or Figure 5).

Step 5: Connect USB Cable to SoloVPE PLUS Instrument

Connect the USB Cable (EC0207) to the back of the SoloVPE PLUS instrument. Align the notch on the connector to the black dot on the back panel, push it forward, and then tighten the metal cuff by rotating it clockwise.



Step 6: Connect USB Cable to Computer

Connect the other end of the USB Cable (EC0207) to one of the USB ports on the computer.

Step 7: Connect Detector Cable to SoloVPE PLUS instrument

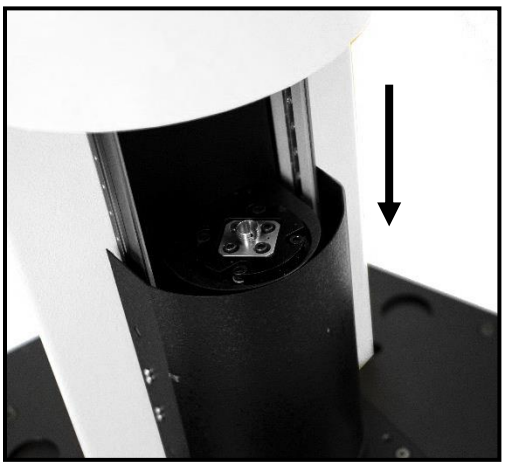
The Detector Cable (EC0027) has two different connectors. The black plastic connector is for the connection to the Cary 60. The silver connector is for the connection to the SoloVPE PLUS instrument's back panel. The silver connector is keyed.

To properly position the connector for insertion, align the red dot on the connector to the top of the detector port on the back panel of the SoloVPE PLUS device. Push firmly to make the connection to the back panel.

Set aside the black end of the USB cable to feed into the Cary 60 later.

Step 8: Attaching SoloVPE PLUS Strain Relief

The Strain Relief is shipped with the SoloVPE PLUS instrument but packed separately. Attach the Strain Relief by screwing it onto the mating thread at the top of the SoloVPE PLUS instrument.



Step 9: Slide Cover into Down Position

Before making the Delivery Fiber FC connection to the SoloVPE PLUS instrument, slide the Tower Cover into the down position.

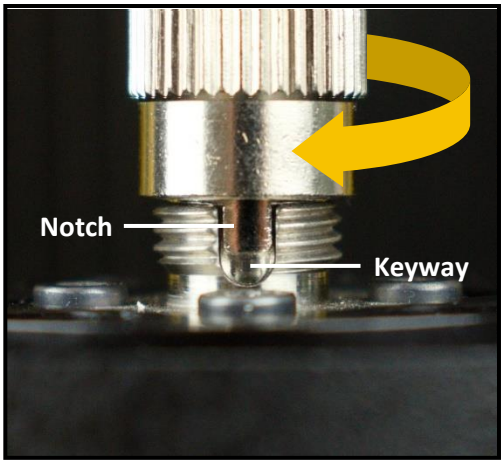
Step 10: Insert Delivery Fiber through Strain Relief

Note: *Keep the protective plastic cap on the FC end of the Delivery Fiber during this step.*

The Delivery Fiber has two different connectors: an SMA connector with a hex-shaped nut and an FC connector with a keyed connector with a round knurled nut. The FC connector should be inserted into the SoloVPE PLUS instrument and the SMA end is for the Cary 60/Coupler side.

Insert the FC connector of the Delivery Fiber through the Strain Relief to properly connect it to the SoloVPE Translation Stage.

FC Connector side of the Delivery Fiber



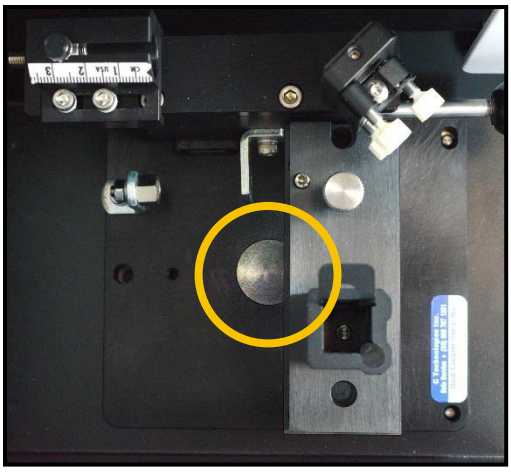
Step 11: Connect Delivery Fiber to Translation Stage

The FC Connector is a keyed connection that can only be securely attached when aligned properly. Rotate the Delivery Fiber to line up the notch on the FC connector and the keyway on the Translation Stage. Fully insert the FC connector and tighten the knurled nut securely.

Note: *When rotating the FC connector to align the notch, the entire Delivery Fiber will need to rotate. It is recommended that the FC connector be held with one hand as the Delivery Fiber is rotated with a free hand above the Strain Relief.*

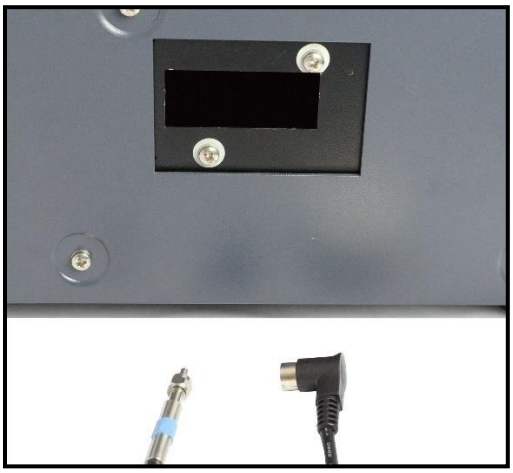
Step 12: Install Fiber Optic Coupler (FOC) in Cary 60

Position the FOC above the two raised pins in the base of the sample compartment and lower into place, making sure it connects securely.



Step 13: Secure Fiber Optic Coupler Within Cary 60

Using the large thumbscrew in its baseplate, secure the FOC to the base of the sample compartment. Tighten securely to prevent shifting.



Step 14: Pass the Cables into the Cary 60

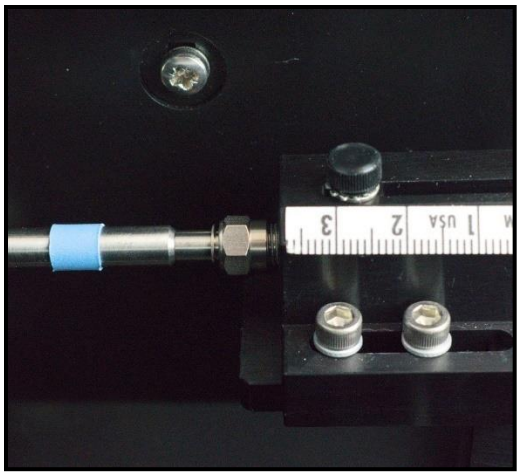
Pass the Detector Cable (black, right-angle plug end) and the Delivery Fiber (SMA/hex-nut end) into the sample compartment through the now open sample compartment access port at the rear of the Cary 60.

Step 15: Connect Detector Cable to Cary 60

Remove the Cary 60 sample compartment covers.

On the wall of the Cary 60 sample compartment, there are two connection ports: if using the Cary 60 built-in detector (cuvette option), keep the black plug that resides in the sample compartment connected.

To use the SoloVPE instrument, unplug the built-in detector cable and connect the SoloVPE detector cable (EC0027).



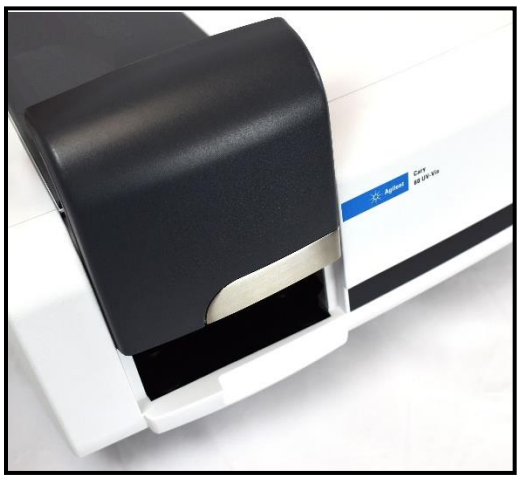
Step 16: Connect Delivery Fiber to Fiber Optic Coupler

With the FOC installed, uncap the Delivery Fiber that was fed into the sample compartment. Connect the SMA end of the Delivery Fiber to the threaded splice bushing at the back of the FOC. Use the hex nut to securely tighten the connection.

Note: *The alignment procedure must be followed in the Dual Use Fiber Optic Coupler User Manual DOC0047 to maximize transmission through the Fiber Optic Coupler.*

Step 17: Reinstall Cary 60 Sample Compartment Top Cover

Carefully slide the Cary 60 sample compartment top cover back into place. Slide the cover back far enough to allow installation of the sample compartment front cover.



Step 18: Reinstall Cary 60 Sample Compartment Front Cover

Position and slide the sample compartment cover down into place. Once fully inserted, reposition the top cover to close the compartment.

Step 19: Connect Power Cable to Cary 60

Connect the power cord (supplied with the Cary 60) to the back of the Cary 60. The transformer has a separate cord that runs to the wall outlet to allow for various power connectors.

Step 20: Connect USB Cable to Cary 60

Connect the USB Cable that came with the Cary 60 to the back panel of the Cary 60.

Note: *Do not connect the opposite end to the computer until directed to do so.*

Step 21: Power on Computer

Press the Power button on the computer to turn it on.

Step 22: Follow Manual Directions to Install All Software

Installation of the CTech ViPER ANLYTX Software should only be done by a trained Support Specialist or under the guidance of one.

While logged into the computer with administrator privileges, install the ViPER ANLYTX Software.

Step 23: Power on Cary 60

With the USB cable disconnected from the computer, press the Power button on the front of the Cary 60. Power up the Cary 60 and allow it to fully initialize.

Step 24: Allow Cary 60 to Complete Start-up Initialization

When the Cary 60 is powered on, the hardware will initialize and calibrate, and the Power button will light up and flash an orange color. After pressing the Power button to turn on the Cary 60, wait for it to turn green. A steady green light means the Cary 60 has been initiated successfully.

Note: *If the System fails to initialize and calibrate successfully, the Power button will turn red. If it fails to start-up successfully, turn it off and turn it on again.*

Step 25: Connect USB Cable to Computer

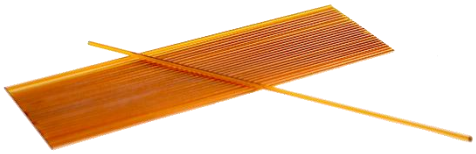
With the computer and Cary 60 powered on, connect the USB cable to the computer. The computer will audibly acknowledge that a USB device was connected and automatically detect and install the drivers for the Cary 60.

Congratulations!
The SoloVPE PLUS System is ready for use!

7. Using the System

This section provides detailed step-by-step instructions for the most commonly used features and functions of the SoloVPE PLUS System. The procedures include guidance on the proper use of the hardware and the software, as well as expectations and limitations of the system.

For more instruction on proper care, refer to *CTech SoloVPE and SoloVPE PLUS Best Practices* DOC0153 and *VPT Support: System Service Options* DOC0333 provided with the system.



7.1 Fibrette® Optical Components

The variable pathlength capability relies on the use of a light-transmitting component that moves in the sample solution, thus adjusting the pathlength. To reduce the risk of carryover and the time between measurements, the SoloVPE PLUS System has been designed to use disposable fiber optics called Fibrette Optical Components.

7.1.1 How to Clean Optical Surfaces of Fibrette Optical Component

**__Warning:__ Repligen strongly recommends that Fibrette Optical Components only be used once to avoid the risk of measurement errors associated with improper cleaning and storage, damage, or carryover. This procedure is provided strictly for support of noncritical, academic, and non-GxP implementations for which measurement accuracy tolerances have been deemed less critical.*

1. After each use of a Fibrette Optical Component, store them in distilled water in a neoprene tube or a soft container to keep them wet.
    - Fibrette Optical Component must soak for a minimum of 30 minutes, but no longer than 24 hours.
    - Soaking longer than 24 hours can damage the polyamide coating.
    - Do not soak too many Fibrette Optical Components in a container; otherwise, they will clump together.
2. At the end of the day, properly dispose of the water and fill the tube with cleaning reagent (e.g., IPA, methanol, or ethanol) and let it soak for 2 to 5 minutes.
3. Pour out the solution and lay Fibrette Optical Component out on a paper towel to dry.
4. Wipe entire length of Fibrette Optical Component with a lint-free wipe. Then spin both ends on a folded lint-free wipe.
5. Place the Fibrette Optical Component back in the clean tube for future use.

7.2 Proper Cover Use

When taking measurements, the Tower Cover must always be in the closed position to avoid issues with ambient light. While the instrument is largely immune to the effects of room light, the presence of the Tower Cover improves stability, while at the same time protects users from the motion of the SoloVPE PLUS hardware as it changes pathlengths. When the cover is raised, the Fibrette Optical Component can be loaded and unloaded into the Fibrette Coupler.

7.3 SoloVPE Quick Set Fibrette Coupler

The Quick Set Fibrette Coupler holds the Fibrette Optical Component. The coupler mechanism consistently positions the Fibrette for repeatable measurements. This component requires minimal maintenance and is replaced during annual PM service by a VPT Support Specialist.

Quick Set Fibrette Couplers are not single-use items. It is not necessary to change this coupler frequently.

Figure 8. Quick Set Coupler with Fibrette Optical Component inserted.

7.3.1 How to Remove Quick Set Fibrette Coupler Insert

Before initial installation or removal of a Quick Set Fibrette Coupler Insert, it is best to get assistance from a Repligen analytical support specialist.

1. Raise the Tower Cover of the SoloVPE instrument to view the Quick Set Fibrette Coupler Insert. You will see its rounded octagonal shape.
2. With your thumb and index finger, grip the black Quick Set Fibrette Coupler Insert Holder.
3. Rotate the Holder clockwise until it becomes free from the Translation Stage, as shown in Figure 9.

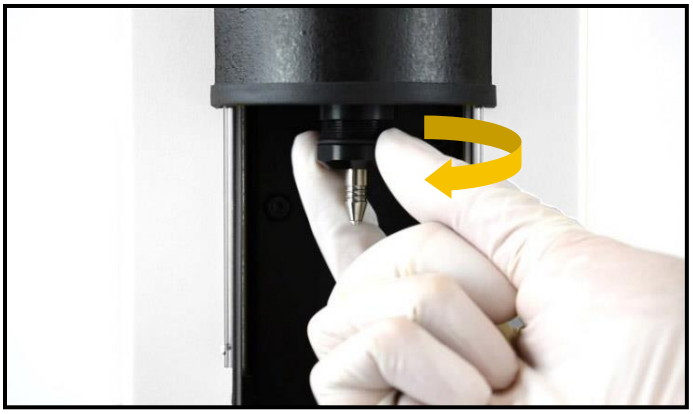


Figure 9. Removing Quick Set Fibrette Coupler.

4. Push the insert up through the Holder for removal, keeping the white O-ring in place. Their connection is magnetized, so there will be some resistance (see Figure 10 and Figure 11).

Figure 10. Push Quick Set Fibrette Coupler Insert.

Figure 11. White O-ring.

7.3.2 How to Install Quick Set Fibrette Coupler Insert

1. To install a new Quick Set Fibrette Coupler Insert, place the insert directly into the holder, passing the tip of the insert through the larger opening. You should feel the magnetization pull the insert into the holder.
2. Place the holder back onto the Translation Stage of the SoloVPE PLUS instrument and rotate counterclockwise until fully secure.
3. To ensure the Quick Set Fibrette Coupler Insert was installed properly, actuate the coupler a few times (as if loading a Fibrette Optical Component).
4. You should feel the magnetization smoothly pull the insert back down, as you push up and let go.

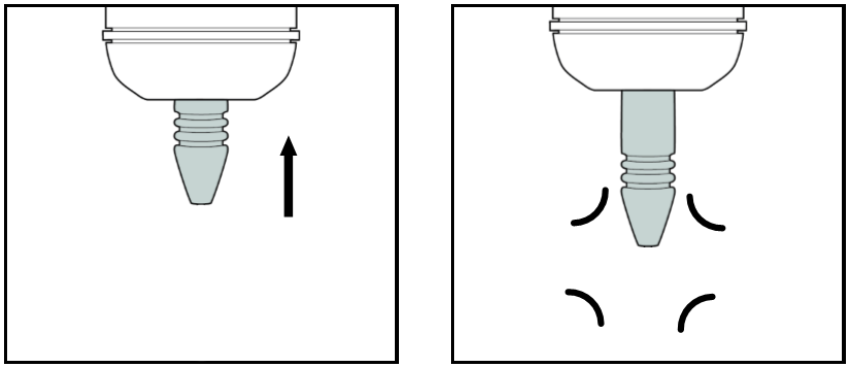
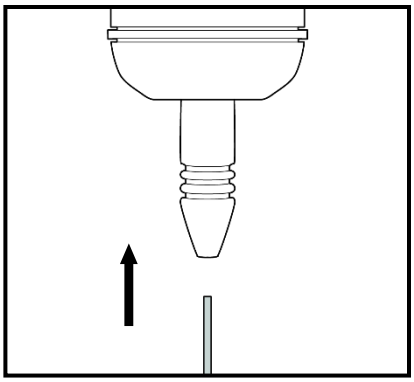


Figure 12. Actuate Quick Set Fibrette Coupler.

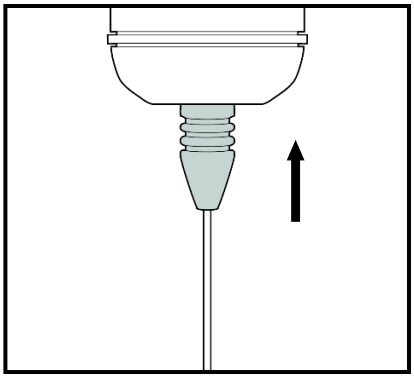
7.3.3 How to Load the Quick Set Fibrette Coupler

The unique design of the Quick Set Fibrette Coupler eliminates the need for setting or pulling the Fibrette Optical Component down. The Quick Set Fibrette Coupler will automatically set the distance of the Fibrette Optical Component for the user.



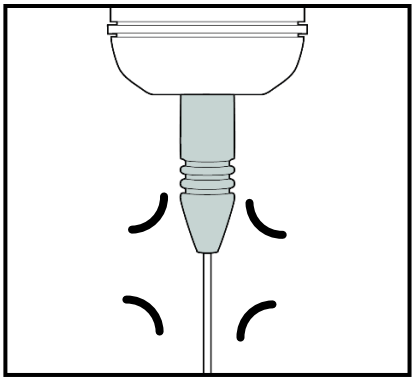
Step 1: Load the Fibrette Optical Component

To load the Fibrette Optical Component into the Quick Set Coupler, gently push the Fibrette Optical Component fully upward until it stops against the surface of the Delivery Fiber.



Step 2: Push Up Against Quick Set Coupler

Push up against the Quick Set Coupler insert until it stops. An audible click may be heard.



Step 3: Engaging the Quick Set Coupler

Release the Quick Set Coupler Insert to set the Fibrette Optical Component gap in preparation for sample acquisition.

7.4 How to Clean Delivery Fiber Surfaces

1. Delivery Fiber must be disconnected from the SoloVPE PLUS System.
2. To disconnect the Delivery Fiber, unscrew the connector and pull straight up through the Strain Relief to remove the fiber end from the transport mechanism.
3. Fold a lint-free wipe and firmly wipe the fiber connector surface in one direction. Repeat a few times.
4. Spray compressed air over connector surface.
5. If residue persists, add cleaning reagent to a lint-free wipe. Wipe the fiber optic surface in one direction until the residue is removed. See weekly actions in *CTech SoloVPE and SoloVPE PLUS Best Practices* DOC0153.
6. Repeat if necessary.
7. Reconnect Delivery Fiber, making sure the connector key is properly positioned in the Delivery Fiber. Mount and tighten by turning the nut clockwise (see Figure 13).

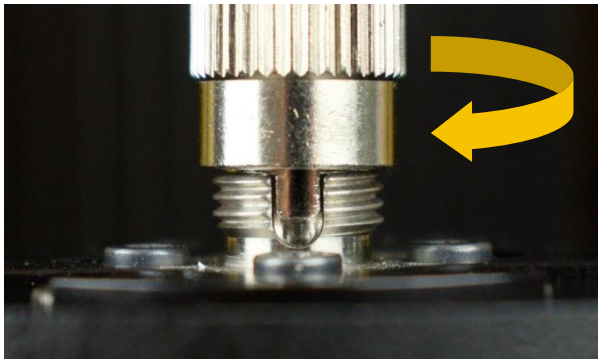


Figure 13. Reconnect Delivery Fiber to Translation Stage.

7.5 Sample Vessels and Sample Vessel Holders

The following section will explain the proper use of both plastic and fused silica sample vessels, sample vessel holders, and their specifications and best practices. Reference this section when identifying which vessel to use for samples of certain concentrations and types and their recommended volumes.

7.5.1 Fused Silica Sample Vessels

The system ships with three styles of fused silica sample vessels and the sample vessel holders required to use them. The three sample vessels provided are the large, small, and micro sizes. Each sample vessel has an associated maximum vessel pathlength and volume requirements based upon its geometry. Figure 8 provides information to help users choose the appropriate vessel for their application. Repligen does not recommend reuse of sample vessels. If you do wish to reuse a sample vessel, please follow the steps for proper cleaning listed in *CTech SoloVPE and SoloVPE PLUS Best Practices* DOC0153.

7.5.2 Standard Vessel Data

Table 5. Table of recommended volumes of standard vessels

Vessel Size	Maximum Pathlength	Volume Needed for Max Pathlength
Micro	5 mm	60 µl
Small	5 mm	120 µl
Large	15 mm*	2.5 ml*

**The volumes listed cover the maximum pathlength of the vessel. Large vessels are typically used to measure dilute samples of 0.1 mg/ml or less.*

Each sample vessel must be used with the correct sample vessel holder. The holder securely positions the sample vessel properly in the SoloVPE PLUS System for measurement. The large and small/micro Vessel Holders are included with every new SoloVPE PLUS System sold.

7.5.3 Plastic Sample Vessels

In addition to the fused silica vessels, Repligen's Analytics business unit provides OC0009-1 small disposable UV-grade plastic vessels.

Plastic vessels can be used across a broad wavelength range (220 nm to 800 nm) while providing excellent resistance to a wide variety of chemical species. The UV plastic vessel fits into the existing micro/small Vessel Holder and the volume requirements are the same as the small fused silica vessel. Samples can also be retrieved prior to disposing of vessel, if desired.

Table 6. Plastic vessel physical properties

Required Volume at Max Pathlength (5 mm)	Pathlength Range	Shelf Life	Wavelength Range
120 µl	0.002 mm–5.000 mm	18 months	220 to 800 nm

7.6 How to Handle Hardware and Maintenance

The following section contains excerpts from *CTech SoloVPE and SoloVPE PLUS Best Practices* DOC0153 for basic system-scheduled maintenance.

Note: *The SoloVPE PLUS instrument does not require decontamination. All optical surfaces on the SoloVPE PLUS instrument must be kept dust free. To clean the optical surfaces, use dry, lint-free wipes and/or compressed air. For hard to remove stains, it is recommended to use IPA wipes with 70% IPA.*

System Maintenance Checklist				
	Daily	Weekly	Monthly	Annually
Quick Check Test	✓	✓	✓	✓
Clean Fibrette® Optical Components & Fused Silica Vessels	✓	✓	✓	✓
Clean Delivery Fiber		✓	✓	✓
Restart Cary Spectrophotometer		✓	✓	✓
Run Standard Test			✓	✓
Coupler Check			✓	✓
Annual System PM *The equipment is to be serviced by the manufacturer only.				✓

System Maintenance Guidelines

Quick Check Test

Perform with a new Fibrette Optical Component.
ViPER Passing Criteria: %T at 70.00% or greater.

Fibrette Optical Components (only if cleaning)

After each use of a Fibrette Optical Component, store in distilled water in a small beaker or neoprene tube to keep them wet (minimum 30 minutes). Fibrette Optical Components are not to be stored in water for longer than one day.

Note: *Do not soak too many Fibrette Optical Components in a container, or they will clump together.*

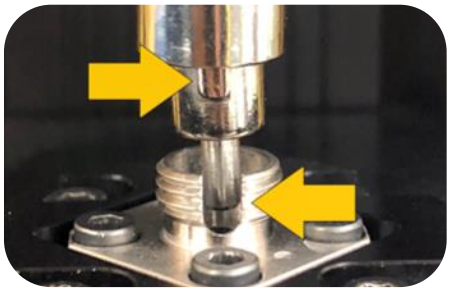
- At the end of the day, pour out water and fill tube with IPA, Methanol, or Ethanol, and let it soak for 2–5 minutes.
- Pour out solution and lay Fibrette Optical Components out on paper towel to dry.
- Wipe entire length of Fibrette Optical Component with a lint-free wipe, then spin **both** ends on a folded lint-free wipe.
- Place the Fibrette Optical Component back in the clean tube for future use.

Fused Silica Sample Vessels

Clean after each use. Follow current procedures for fused silica vessel cleaning. Water rinse followed by cleaning agent (IPA, methanol, or ethanol). Rinse, then airdry or spray with compressed air.

Cleaning Delivery Fiber

- Disconnect Delivery Fiber from SoloVPE PLUS instrument by turning the nut counterclockwise.
- Fold a lint-free wipe and firmly wipe the fiber connector surface in one direction 3–5 times.
- Use compressed air over connector surface (optional).
- Reconnect Delivery Fiber, making sure the notch is properly positioned in the fiber platform, and tighten the nut by turning clockwise.



- With no vessel and no vessel holder installed, blow compressed air across the Detector Window in the sample platform. Clean with a lint-free wipe if necessary.

Cary Spectrophotometer

Restart the Cary once a week or before every run (if run > 7 days). This is recommended by Repligen for consistent performance.

Run Standard Test

Run provided CHEM013 standard, ConfiRM® slope reference material, or the current UV standard (e.g., BSA).

Coupler Check

Run a Coupler Check after cleaning Delivery Fiber.

Annual System PM & Service Contract

Both services provided by Repligen.

Cleaning General Instrument Surfaces

The following are recommended cleaning solutions for wiping down SoloVPE PLUS surfaces:
70% EtOH (ethanol)
70% IPA (isopropyl)
Low pH sterilant/disinfectant

8. Performing Transmission Tests

8.1 Coupler Check

The Coupler Check test conducts a transmission check using the Transmission Tool. The Coupler Check test establishes a baseline transmission reading for the SoloVPE PLUS System. This will also measure the maximum transmission of the system. Quick Check then takes a transmission reading and compares it with the Coupler Check results. The output displayed in the Quick Check window is the percentage transmission achieved using Coupler Check as the baseline. Users can confidently determine that their system is receiving acceptable overall transmission.

1. Press the Coupler Check button on the Instrument Control panel in the Validate VPT application, as seen in Figure 14.

Figure 14. Validate VPT App: Instrument Control panel.

2. A prompt will appear with instructions (see Figure 15). Follow the instructions to remove the Delivery Fiber from the Translation Stage by turning the FC connector end of the Delivery Fiber counterclockwise (see Figure 16). Attach the FC end of the Delivery Fiber to the Transmission Tool; be sure to align the notch on the Delivery Fiber to the keyway on the Transmission Tool (Figure 17).

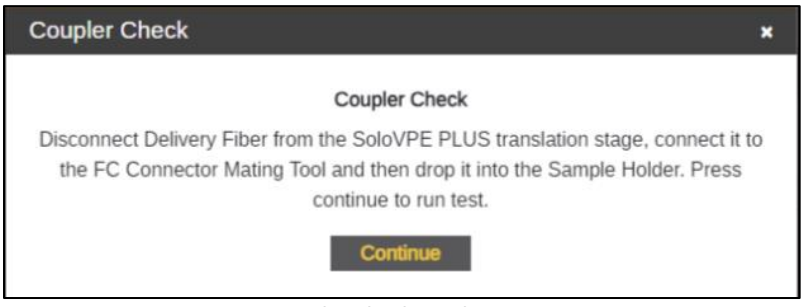


Figure 15. Coupler Check window prompt.

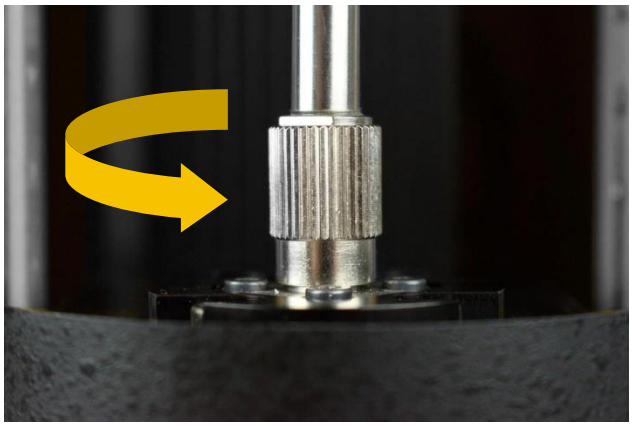


Figure 16. Disconnect Delivery Fiber from Translation Stage.

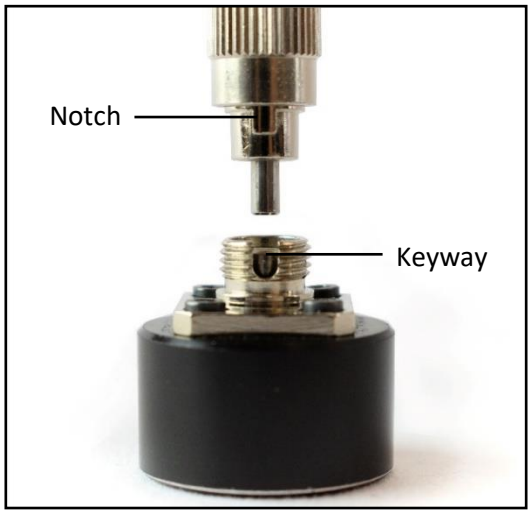


Figure 17. Connect Delivery Fiber to Transmission Tool.

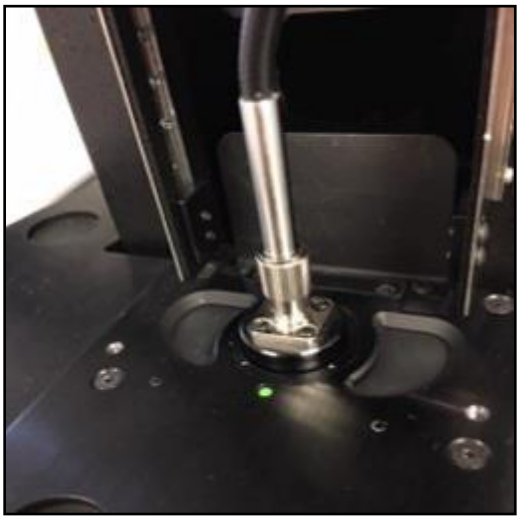


Figure 18. Connect Transmission Tool to Translation Stage.

3. Place the Transmission tool on top of the SoloVPE PLUS Detector Window (Figure 18).
4. Press Continue on the prompt window when ready. The Coupler Check will then be performed.
5. Once completed, the results are displayed in the prompt window. The user may add comments that will be recorded in the Validate VPT Log.
6. During the Coupler Check, the system will assess the change in transmission compared to the previous Coupler Check.
    - If the Coupler Check result surpasses the change threshold, a prompt recommending a system cleaning will appear. Perform the daily and weekly maintenance best practices, then retry the Coupler Check.
    - The threshold setting is configured within the App Configuration tab of Admin Settings. The default is 5.00%.

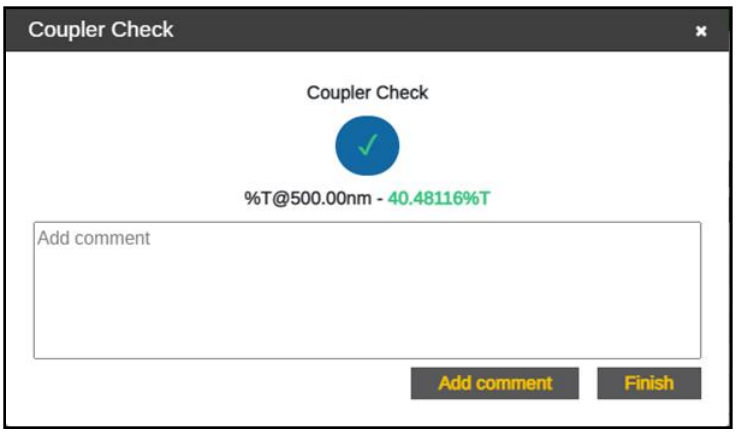


Figure 19. Coupler Check window with Coupler Check results.

7. Remove the Delivery Fiber from the SoloVPE PLUS device and detach the Fiber from the Transmission Tool.
8. Reinsert the Delivery Fiber through the top of the SoloVPE PLUS device via the Strain Relief and reattach it to the SoloVPE PLUS Translation Stage connection by aligning the notch into the keyway and rotating the FC connector end clockwise (see the image below).

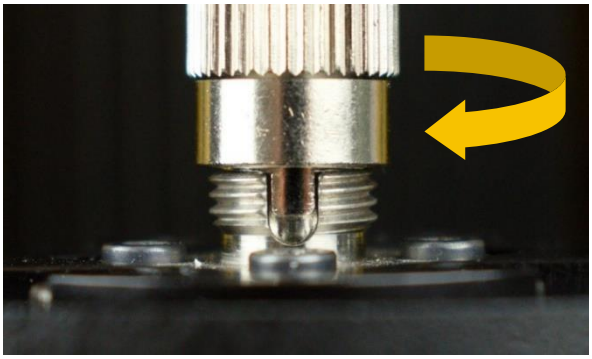


Figure 20. Reconnect Delivery Fiber to Translation Stage.

8.2 Quick Check

The Quick Check test measures transmission through the instrument when there is no sample present. The output displayed in the Quick Check window is the percent transmission relative to the result from the Coupler Check.

1. Click the Quick Check button on the Instrument Control panel in the Validate VPT app.
2. The software will prompt the user to prepare the Fibrette Optical Component and SoloVPE PLUS System for the test (Figure 21). It is critical that the test is run under the following conditions:
    - A clean, new Fibrette Optical Component should be pushed fully upward until it stops. Do not pull down.
    - The SoloVPE PLUS Detector Window should not have a sample vessel or sample vessel holder in place.
    - The SoloVPE PLUS cover should be in the down position.

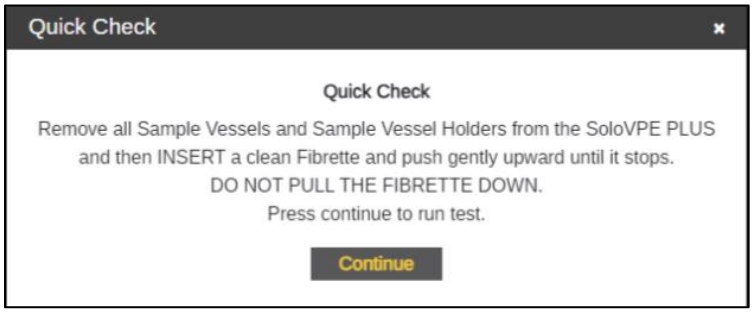


Figure 21. Prepare for Quick Check window prompt and requirements.

3. Once the Fibrette Optical Component and SoloVPE PLUS System are prepared as described, click the Continue button to run the test.
    - Quick Check will automatically move the Fibrette Optical Component to make transmission measurements.
4. Once completed, the results will display the disposition of the SoloVPE PLUS System, which can be Fail or Pass (Figure 22 and Figure 23). The user may add comments that will be recorded in the Validate VPT Log.
    - A passing result means the system observed a transmission of 70.00% or greater at 500.00 nm. This number is derived from the baseline transmission using the Coupler Check.
    - A failed result means transmission is too low for most measurements, either due to particulates, debris, or blockage in the optical path. Perform the daily and weekly maintenance best practices and retry the Quick Check once completed.
    - The Pass/Fail criteria can be revised in the App Configuration tab in Admin Settings. Repligen recommends keeping this value at 70.00% for 500.00 nm.

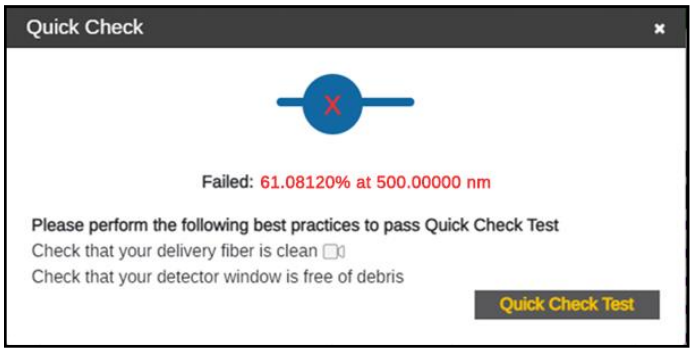


Figure 22. Failed Quick Check.

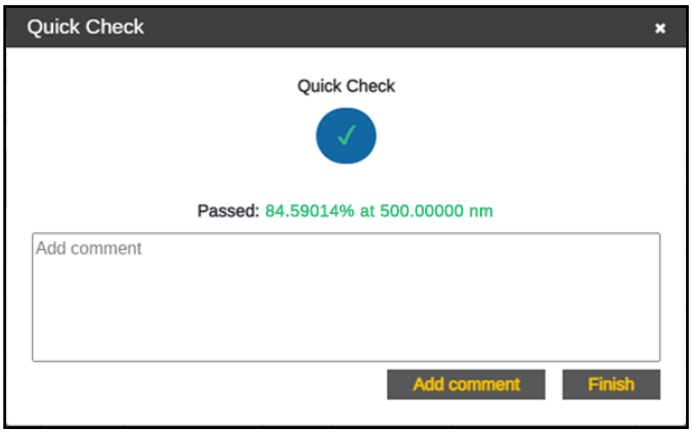


Figure 23. Passed Quick Check.

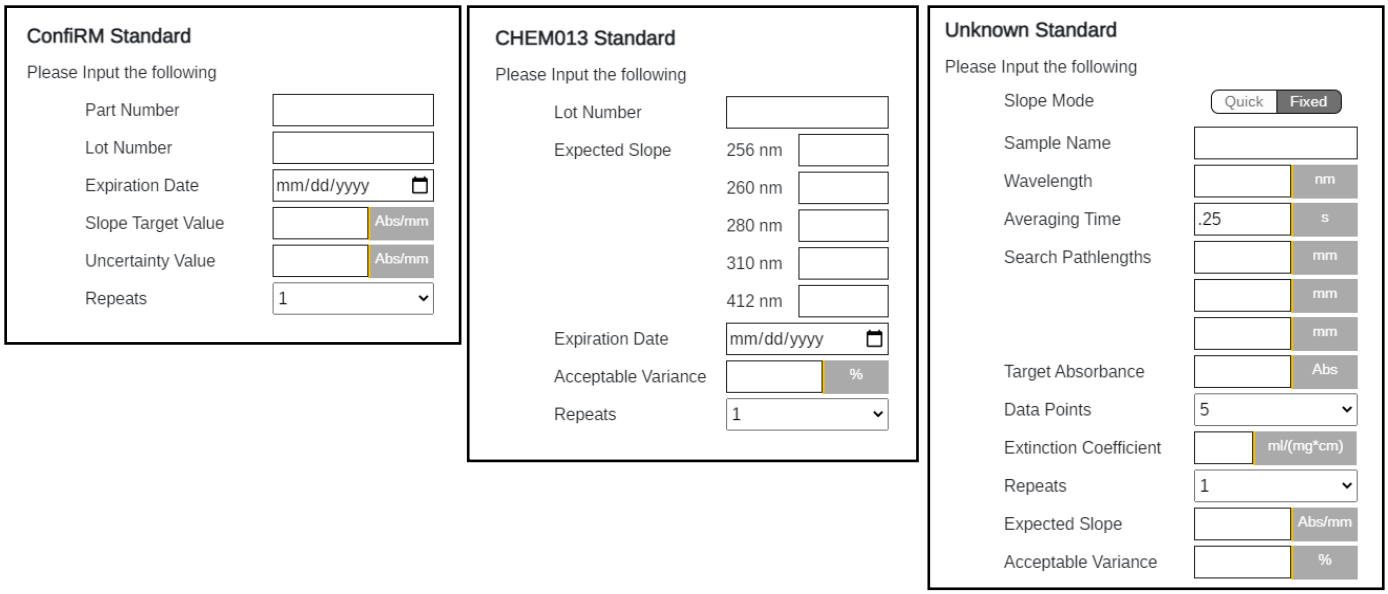
5. View your results in the Validate VPT Log to see more details about the Quick Check results.
    - Filter Type allows the user to sort the results between All Types, Coupler Check, and Quick Check.
    - Users can define specific dates and times to find results. Press Apply after selecting the range of dates and times to see the search result.
6. Press Done to close the Quick Check window.

8.3 System Suitability Test

The System Suitability Test verifies that the photometric capabilities and variable pathlength functionality of the system are working properly. The result of the System Suitability Test depends on the reference standard used, which may be ConfiRM slope reference materials, CHEM013 standard, or another standard of the user's choice.

1. Open the Validate VPT app and click the System Suitability button in the Instrument Controls panel. Alternatively, a System Suitability Test can be initiated from the Quick Slope, AAV, or ADC applications by clicking the System Suitability button in the navigation bar.
2. Insert the reference standard into a sample vessel. Fill the vessel at least two-thirds full.
3. Select the appropriate reference standard from the list and enter the required information (Figure 24).
    - If the reference standard is unknown, choose Unknown Standard.

Figure 24. Reference Standard Information Fields



4. Load the filled sample vessel into the sample vessel holder and insert a clean, new Fibrette Optical Component into the Quick Set Coupler. Slide the SoloVPE cover down to block stray light from reaching the detector.
5. Click OK. Wait for the System Suitability Test to finish.
6. Test results will be added to the System Suitability Log. If the test was initiated through the Quick Slope or AAV app, the test result will be displayed in the report.

9. General Troubleshooting

This chapter lists possible unexpected performance of the system, likely causes of these conditions, and recommended actions to resolve the issue.

Table 7. General troubleshooting issues and suggested actions

Issue	Cause	Action
Cary 60 Indicator Lamp Not Lit	• The Cary 60 instrument is powered off. • Power is not reaching the Cary 60. • The Cary 60 is not plugged into a power outlet.	• Confirm if instrument power is turned on. If not, press the power button located in the front of the unit to turn it on. • Check to make sure the power cable is securely connected to the Cary 60 and power outlet.
Low Transmission (Failing Quick Check Test)	• Possible contamination in the optical path reduces the amount of light available to make measurements.	• Check transmission using the Quick Check Test to verify the functionality of the system. • Systematically cleaning the Delivery Fiber and SoloVPE PLUS Detector Window surfaces will help clear the optical path.
SoloVPE PLUS Not Moving	• Check the connection on the back of the SoloVPE PLUS. • Check the connection of the cable with the power brick. • Check the connection to the outlet. • Two-or-more OPC Core windows are open. Only one can be connected to the instrument at one time.	• Check transmission using the Quick Check Test to verify the functionality of the system. • Systematically cleaning the Delivery Fiber and SoloVPE PLUS Detector Window surfaces will help clear the optical path.
Cary Displaying Red LED Upon Start-Up	• Cary 60 is not properly calibrated. • Light is not being read by the sample and/or reference detector.	• Power down the Cary 60 and restart the instrument. • Make sure Cary 60 is not plugged into an intermittent power supply.
Hockey Stick Shape in Data Plot 	• The Fibrette Optical Component is bending in the sample. • Zero position has been changed or modified. • Broken pieces of Fibrette Optical Component are trapped in the Quick Set Coupler.	• Check Zero Position with a large, empty vessel. Check Fibrette Optical Component for tightness by rotating the vessel in the holder. • Inspect Fibrette Coupler for broken pieces of Fibrette Optical Component, and clean or replace Fibrette Coupler if needed. Retest with a new aliquot to see if the hockey stick is present.
Inconsistent Measurement Reading	• Cary 60 is not properly calibrated. • Dirty vessel and/or Fibrette Optical Component. • The optical pathway is obstructed.	• Restart the Cary 60 for self-calibration by turning the instrument off and then on. • Clean the Delivery Fiber. • Clean Fibrette Optical Component and sample vessel, or use a new Fibrette Optical Component and vessel. • Make sure the optical path is clean and that dust particles or debris are not present in sample compartment.
Plateau in Section Curve Upper End (Similar Abs Values at Long Pathlengths) 	• Insufficient sample volume to cover pathlength range specified. • Fibrette Optical Component came out of the sample and resulted in a plateau in the pathlength cross-sectional curve.	• Add more sample volume to the sample vessel and repeat the test. Refer to Appendix 1: Sample Volume Help Sheet for additional guidance.

Plateau in Section Curve Lower End (Similar Abs Values at Small Pathlengths)	• Sample vessel or Sample Vessel Holder not properly installed/seated in the sample platform. • Incorrect sample vessel selected in the software.	• Reseat the sample vessel and Sample Vessel Holder. • Confirm the correct sample vessel was selected in the software.
No Transmission	• SoloVPE PLUS Detector Cable unplugged. • Possible broken Delivery Fiber. • Obstruction in the optical path.	• Check to make sure the SoloVPE PLUS Detector Cable is properly connected between the Detector Port on the SoloVPE PLUS and the Detector Port inside the Cary 60 sample compartment. • Disconnect both ends of the Delivery Fiber and hold it up to the light to make sure there is not a break. If broken, contact Repligen's Analytics Support. The light should be visible through the fiber. • Ensure that the Fiber Optic Coupler is set in the proper position.
Noisy Spectra	• Poor optical alignment. • Obstructed optical path. • Cover not lowered into data collection position. • FC connector of the Delivery Fiber not fully secured.	• Confirm that the cover is slid into the down position prior to measurement. • Clean the optical path. • Restart Cary 60. • Check and secure the FC connector of the Delivery Fiber on the SoloVPE PLUS Translation Stage.
Unable to Access ViPER Software (Error Alerts)	• Permissions may not be set properly in SecureVPT.	• ViPER software uses Windows active directory for permission.
No Light Coming from Cary 60	• Cary 60 or Fiber Optic Coupler could be misaligned. • Xenon flash lamp could need replacing.	• Perform a Coupler Check (see Section 5.3.14). Follow the No Transmission Actions. Then, if results are still Zero, please contact Repligen.
Random Spikes in Spectra	• Cary 60 is not calibrated properly. • SoloVPE PLUS detector is malfunctioning and could need replacing. • Xenon flash lamp could need replacing.	• Restart Cary 60. • Run CHEM013 standard to verify the accuracy of the SoloVPE PLUS Detector. • If you suspect the Xenon flash lamp needs replacing, contact Repligen.

For additional assistance, please call VPT Support at (908) 707-1201 or email analytics-support@repligen.com

Appendix 1 | Sample Volume Help Sheet

When using the variable pathlength technology of the SoloVPE PLUS System, it is always important to make sure that enough sample volume has been dispensed to cover the range of pathlengths to be measured. Use the following suggestions and the volume matrix provided in Table 8 to help guarantee adequate sample volume is available for the desired measurement pathlengths.

For estimated volumes for use in concentration determination, please reference Section 7.6 or view *CTech SoloVPE and SoloVPE PLUS Best Practices* DOC0153.

Tip: *When using the Quick Tools such as Quick Slope and Quick Survey, it is always preferable to use the maximum volume allowed by the sample vessel being used. Maximum volumes and pathlengths are bolded in Table 8.*

Table 8. Sample volume matrix.

Vessel	Vessel Name	Pathlength (mm)	Minimum Volume (ml)
	Micro Vessel	0.1	0.010
		0.2	0.010
		0.5	0.010
		1.0	0.013
		2.0	0.025
		5.0	**0.062**
	Small Vessel	0.1	0.010
		0.2	0.010
		0.5	0.012
		1.0	0.025
		2.0	0.050
		5.0	**0.125**
	Large Vessel	0.1	0.016
		0.5	0.080
		1.0	0.160
		2.0	0.320
		5.0	0.800
		10.0	1.600
		12.5	2.100
		15.0	**2.400**
	Plastic Vessel	0.1	0.010
		0.2	0.010
		0.5	0.012
		1.0	0.024
		2.0	0.048
		5.0	**0.063**

Appendix 2 | The Derivation of the Slope Spectroscopy Equation

Variable pathlength technology enables the Slope Spectroscopy method for finding the concentration of a sample. The Slope Spectroscopy equation is derived from the Beer-Lambert law.

Equation	Definitions
$A = \varepsilon l c$ **Beer-Lambert Law**	Where: A is the absorbance of the sample. ε is the absorption coefficient or the molar absorptivity of the absorber. l is the distance that the light travels through the material (the pathlength). c is the concentration of absorbing species in the material.
$y = mx + b$ **Linear Equation**	Where: y is the predicted value of the dependent variable/axis. m is the slope of the line. x is the given variable. b is the *y*-intercept of the line.

Derivation of the Slope Spectroscopy Equation:

$$A = \varepsilon l c \qquad \frac{A}{l} = \varepsilon c$$

We define $m \equiv \frac{A}{l}$, yielding:

$$m = \varepsilon c$$

Appendix 3 | SoloVPE PLUS Pathlength Defined

Figure 25 shows a SoloVPE PLUS sample vessel and Fibrette Optical Component as they are used in the SoloVPE PLUS System. The pathlength is defined by the bottom of the Fibrette Optical Component and the bottom of the sample vessel.

By dynamically changing this gap, the SoloVPE PLUS System can produce thousands of different pathlengths for measurement.

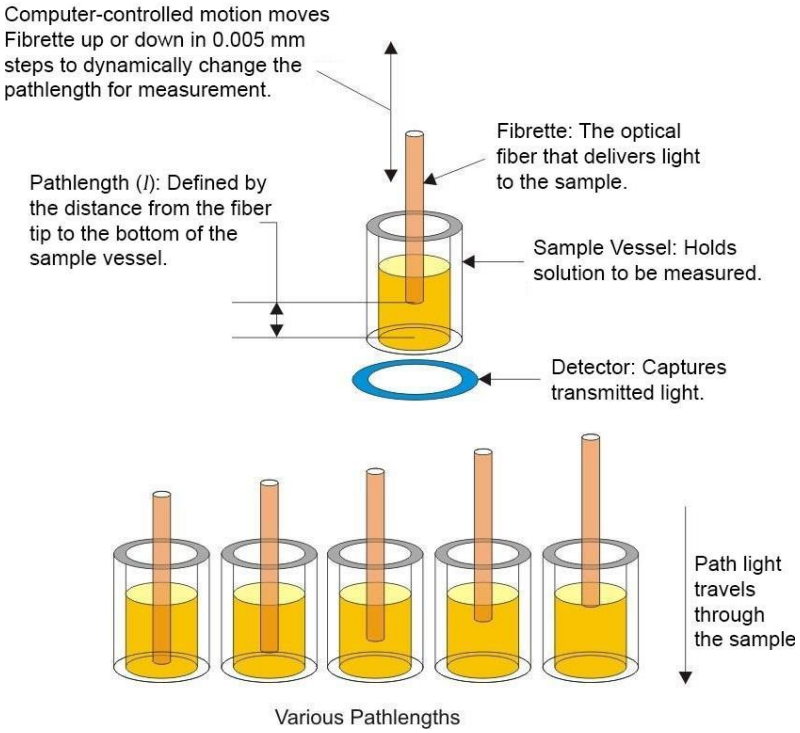


Figure 25. SoloVPE PLUS pathlength geometry.

Glossary

There are many terms, definitions, and naming conventions associated with your SoloVPE PLUS System that are helpful to know and understand. This section of the manual provides an overview of these concepts and serves as a quick reference.

This glossary contains content developed by Repligen subject-matter experts or retrieved (whole or in part) from the American Society for Quality glossary, the International Accreditation Forum website, and *Spectroscopy* magazine's "The Molecular Spectroscopy Terminology Guide" online.

Averaging Time: The Cary Spectrophotometer setting that configures how long the system will collect data at each wavelength. Able to be configured in seconds, this number corresponds to many pulses of the Xenon flash lamp. One pulse corresponds to 1/80th of a second or 0.0125 seconds; therefore, each second is 80 pulses of the lamp.

Beer-Lambert Law: The law of physics that describes the proportional relationship between absorbance, pathlength, and concentration.

Delivery Fiber: The fiber-optic cable that carries light from the Cary spectrophotometer to the variable pathlength device.

Detector: A device used to detect light being transmitted through the sample.

Detector Cable: This component sends absorbance information from the VPT instrument to the Cary 60 to be analyzed and displayed for the user.

Detector Window: The transparent, protective cover of the VPT instrument's Detector.

Extinction Coefficient (EC): An intrinsic property of a substance, described by a numerical value that quantifies the propensity of a substance to absorb electromagnetic radiation at a specific wavelength. It is one of the terms used in Beer-Lambert law (ε).

Fibrette Optical Component: The component of the SoloVPE PLUS System that delivers the light from the Delivery Fiber to the sample. It allows the measurement pathlength to be changed based upon its vertical motion within the sample.

Fixed Zero: The position the system drives down to prepare the SoloVPE PLUS and Fibrette Optical Component for data acquisition. When in this position, the Fibrette tip is in contact with the bottom of the sample vessel. All pathlength parameters and motion are referenced from this position, which corresponds to a pathlength of zero millimeters. Also referred to as Zero Position and Zero Pathlength.

Home Position: This is the fully raised position of the SoloVPE PLUS System. This allows maximum access to the sample vessel, sample vessel holder, and the Fibrette Coupler. It is the position the SoloVPE PLUS needs to be in for loading and unloading of Fibrette Optical Component and Fibrette Coupler.

Insert Holder: The component of the SoloVPE PLUS System that holds the Quick Set Fibrette Coupler Insert, connecting it to the Translation Stage.

Pathlength: The distance the measured light travels through the sample when making absorbance spectroscopy measurements based upon the Beer-Lambert law. In the variable pathlength system, this distance, generally expressed in millimeters, is defined by the physical gap between the bottom of the sample vessel containing the solution and the tip of the Fibrette Optical Component that is submerged in the sample.

Quick Set Fibrette Coupler: The current Fibrette Coupler design. Comprising the stainless-steel Insert and the black-plastic Insert Holder, it allows consistent positioning of the Fibrette Optical Component.

Quick Set Fibrette Coupler Insert: The stainless steel Fibrette holder. A replaceable, disposable part to be used with the Quick Set Fibrette Coupler.

Sample Vessel: The component of the SoloVPE PLUS System that holds the sample to be measured. There are different sizes (volumes) of sample vessels and materials (fused silica and UV plastic).

Sample Vessel Holder: The component of the SoloVPE PLUS System that properly secures the sample vessel in the instrument in preparation for measurement. Sample vessel holders come in different configurations to match the style of sample vessel being used (micro/small and large).

Slope Spectroscopy: An analytical technique based upon the Beer-Lambert law, which utilizes the slope term of a statistically analyzed absorbance vs. pathlength plot to make calculations and predictions of sample properties.

Solo Validation Cuvette Adapter: The SVCA is an optional accessory that provides an additional technique for validating the SoloVPE PLUS device and specifically allows the use of filters and standards based on a cuvette form factor.

SoloVPE PLUS (Variable Pathlength Extension): The variable pathlength instrument that enables Slope Spectroscopy measurement methods.

Threshold: A user-specified limit specified in absorbance units (AU) that the SoloVPE PLUS system will scan the pathlength range to find, if possible.

Zero Pathlength: The position the system drives down to prepare the SoloVPE PLUS and Fibrette Optical Component for data acquisition. When in this position, the Fibrette tip is in contact with the bottom of the sample vessel. All pathlength parameters and motions are referenced from this position, which corresponds to a pathlength of zero millimeters. Also referred to as Zero Position and Fixed Zero.

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