illumia®Pro3

LED Characterization System

Hardware Manual

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CE

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Hardware Manual
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1. TABLE OF CONTENTS

2. DOCUMENT CONVENTIONS

This Operators Manual includes the following conventions:

The note icon is used to highlight important configuration information.

The caution icon is used to illustrate environments where an electrical shock hazard exists.

The heat icon indicates situations where hazardous temperatures exist.

The attention icon is used to highlight important configuration information where damage or system conflicts may occur.

The eyewear icon indicates important safety features related to the system light levels.

3. IMPORTANT SAFETY INFORMATION

Use this product only after reading the manual and the important safety information. This manual contains information and warnings that must be followed by the user for safe operation and to maintain the product in safe working condition.

3.1. General Safety Statement

Use this product only as specified. Review all safety information and precautions to avoid injury and prevent damage to the product. Carefully read all instructions and retain these instructions for future reference.

To operate this product correctly and safely, it is imperative that the operator comply with local and national safety codes. The operator should also follow generally accepted safety procedures in addition to safety precautions specified in this manual.

This product is to be used by trained personnel only. Only operators who are aware of the hazards involved should operate this equipment. There are no serviceable parts inside the housings. Users should not open the housing to attempt any repairs.

Before use, always check that the product is installed correctly and that all electrical connections are in good working order. When incorporating this product into a larger system the safety of the system is the responsibility of the assembler of the system.

3.2. To Avoid Fire or Personal Injury

Use proper power cord: Use only the power cord that is specified and certified for the country of use.
Ground the Product: This product is grounded through the grounding line in the power cord. To avoid electrical shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, make sure that the product is properly grounded.
Power Disconnect. The power cord disconnects the product from the power source. Position the equipment so that the power cord is accessible to the user to allow for quick disconnect if possible.
Terminal Ratings: Observe all terminal ratings and markings on product. Using incorrect power/current supply may result in fire or shock hazard.
Exposing Internal Electronics: Do not remove the product cover or housing. Exposure to internal electronics may result in shock hazard. No user-serviceable parts are contained in the unit.
Proper Use and Operation Failure: Do not operate unit if it is suspected that there are electrical failures. Disable the product if it is damaged and return to Labsphere at the address provided in the user manual. The product should be clearly marked as defective after power is turned off and unit is disconnected from power source.
Electrical Fuses: The fuse rating is supplied on the rear of the electronics rack that uses two 250VAC 10-amp slow blow fuses.
Maintenance: There is no user maintenance necessary.

3.3. Operating Conditions:

- Do not operate in wet or damp conditions. This includes condensation that may occur from moving the unit from a cold to warm environment.
- Keep the product clean and dry.
- Provide proper ventilation around the unit. Be aware of the ventilation openings on the unit housing. Never cover or obstruct the ventilation openings. Do not plug or push objects into the ventilation openings.
- This product is intended to be used in a clean, indoor environment.
- The maximum ambient temperature must not exceed 40°C (104°F).

3.4. Clearance Requirements

The installation site must possess sufficient clearance around the system for access and to ensure proper ventilation of the components contained within the system. Ensure proper ventilation around the system when preparing the site for installation. Any equipment installed above, below or to the side of the Labsphere system should not exhaust hot air on it.

Provide adequate clearance in front of the system and around the rear of the system to ensure proper air flow and access to all components. Your site characteristics will dictate the spacing between equipment.

3.5. Lighting Hazard

The illumia®Pro3 may emit a considerable amount of radiant energy across the 350-2500nm spectrum. **Do not look into an illuminated sphere without proper eye protection for extended periods, especially at higher output.**

3.6. System Ratings — Primary System Components

Rating Parameter	**Range**
Component Weights	
Sphere Assembly	15 kg (33 lbs.)
Labsphere ICM-500	1.5 kg (3.3 lbs.)
Arroyo 5305 TECSource	2.8 kg (6.2 lbs.)
Keithley 2461 SourceMeter	4.75 kg (10.5 lbs.)
Accessories and Cables	13.6 kg (30 lbs.)
Component Dimensions	
Labsphere ICM-500	H 13 x W 46.7 x D 44.2 cm (H 5.1 x W 18.4 x D 17.4 in.)
Keithley 2461 SourceMeter	H 10.6 x W 25.5 x D 42.5 cm (H 4.2 x W 10 x D 16.8 in.)
Arroyo 5305 TECSource	H 9 x W 21.5 x D 28 cm (H 3.5 x W 8.5 x D 11 in.)
Sphere Assembly	Refer to section 6.1 “Sphere Assembly Dimensions” on page 12.
Electrical Requirement (max)	
Electronics Power Strip	100-240VAC, 50/60Hz, 10A
Operating Temperature	+10°C to +40°C (+50°F to 104°F)
Storage Temperature	-20°C to +60°C (-68°F to +140°F)
Operating Humidity	30–90% RH (no condensation)
Storage Humidity	10–95% RH (no condensation)

3.7. Minimum System Requirements

The standard Illumia®Pro3 hardware is controlled by the provided Labsphere Integral application software running on the user's Windows computer. The Integral application can require significant CPU utilization at times. Therefore, the minimum recommended PC specifications for the user's computer are:

- Windows 10 or 11, 64-bit
- Two or more processor cores
- Two or more GHz/core
    - Four or more processor threads/core
- 8GB RAM

4. ABOUT THIS MANUAL

This manual describes the hardware, system installation and maintenance of the illumia®Pro3 system. A separate Labsphere Integral® software manual is provided that describes the use of the control software and the system operation. Separate manuals for the Arroyo 5305 TECSource Controller and the Keithley 2461 SourceMeter that provide operational details are also provided.

4.1. Use of Hyperlinks in Adobe® Acrobat®

There are numerous hyperlinked shortcuts in place throughout this manual that can be taken advantage of when viewing the manual as a PDF file in Adobe Acrobat. The Table of Contents and every text reference to a figure title, chapter name, heading, sub-heading, page number, etc. has been authored using cross-referenced hypertext that contains a link to the section of the manual being referenced. Clicking on this hypertext will instantly switch the manual's page to the referred section.

1. Locate the cross-referenced hypertext by noting any sentence or call-out that contains a reference to a chapter name, section heading, figure title, etc. (i.e. "Refer to…").
2. Roll the mouse over the text and observe if the cursor changes to a finger-pointing hand as shown on the left. If it does, then the text contains a hyperlink.
3. Click on the hypertext with the finger-pointing hand cursor. The manual will instantly advance to the section that is referenced.
4. Press and hold the "Alt" key and then press the "left arrow" key to return to the original source location.

5. SYSTEM OVERVIEW

The illumia®Pro3 is Labsphere's third generation of light characterization systems; an integrating sphere spectroradiometer designed specifically for the testing and characterization of high-power LEDs. The system runs on Labsphere's powerful Integral® software control that includes embedded routines that guide the user through industry test methods and standards. It is also completely flexible for research, development, and quality inspection.

The 0.5 m integrating sphere spectrometer, coated with Labsphere Spectraflect® diffuse white coating, comes standard with a 2π measurement geometry and is fitted with a thermal tech controller, industry-leading source meter, and Labsphere's stray light corrected spectrometer, for LIVT, pulsed modes, and DC testing of high-power LEDs.

The illumia®Pro3 system is capable of these kinds of measurements:

- Total Spectral Flux
- Luminous Flux
- Radiant Flux
- Color Performance
- Wavelength Characteristics
- LIVT
- LM-85 Test Methods:
    - LM-85 Single pulse mode
    - LM-85 Continuous pulse mode
    - LM-85 DC mode

5.1. illumia®Pro3 800-050 System Components

- Spectraflect® coated 0.5-meter sphere with 2π measurement capability
    - 4π light measurement option available
- Labsphere stray light corrected CDS-800 spectrometer with trigger module
- Temperature controlled 2π sample mount and port accessories
- Calibrated spectral flux standard lamp
- Auxiliary lamp assembly
- Labsphere ICM-500 Integral Control Module
- Keithley 2461 SourceMeter
- Arroyo 5305 TECSource
- Labsphere Integral® system operation software (on Labsphere flash drive)

5.2. Component Overview

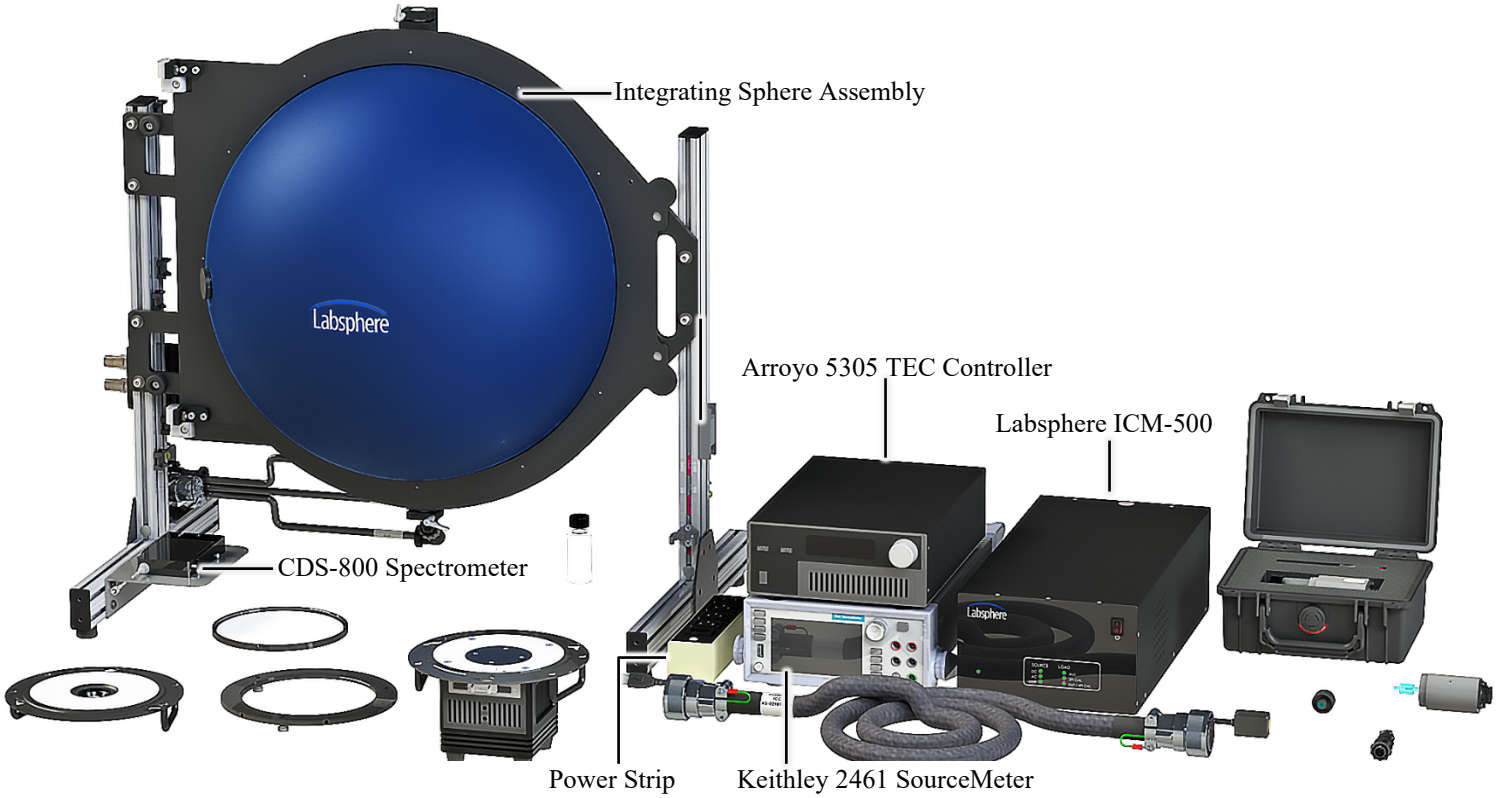


Figure 1: illumia®Pro3 Component Overview

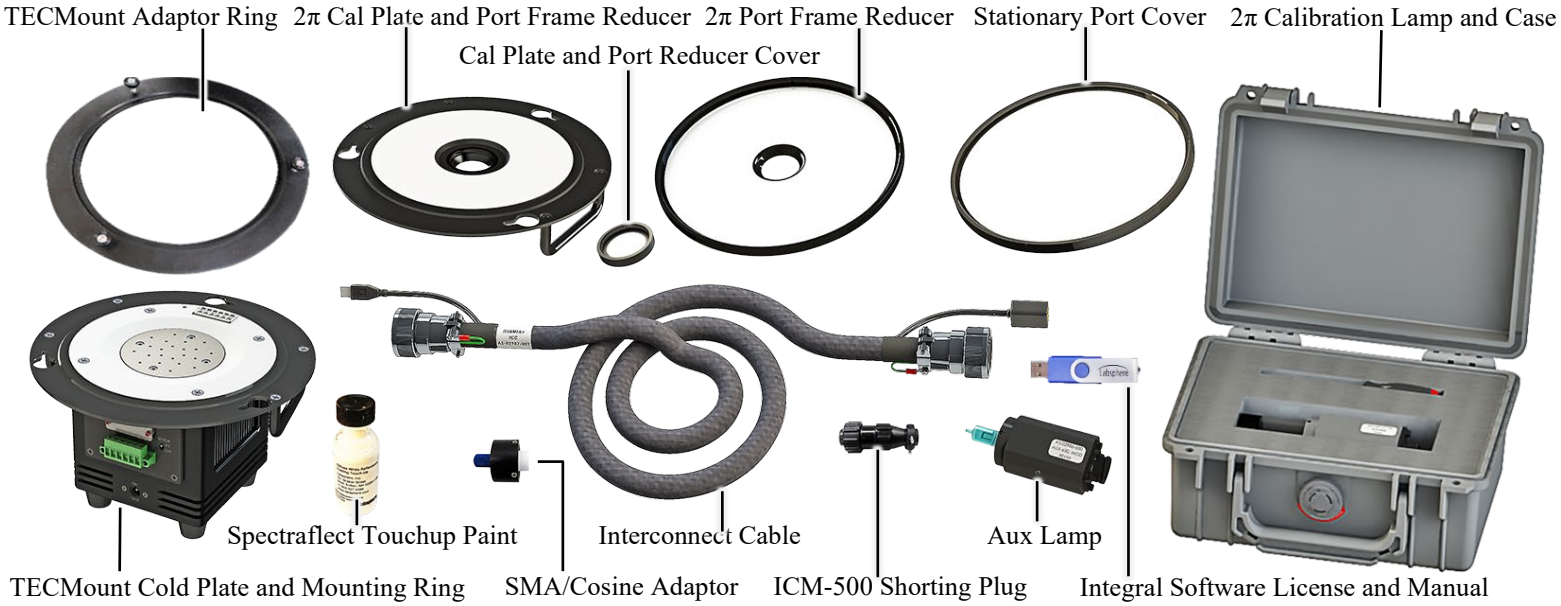


Figure 2: illumia®Pro3 Accessory Components

5.3. System Cables

6. INTEGRATING SPHERE

The illumia®Pro3 integrating sphere is made of spun aluminum and the inner surfaces are treated with Labsphere's Spectraflect® — a proprietary, high-reflectance specially formulated barium sulfate coating that produces a nearly perfect diffuse reflectance surface. The sphere assembly comes with a bottle of Spectraflect® touchup paint.

The sphere assembly is comprised of two mating hemispheres that open and close using a clam-shell design. The sphere contains a total of six ports which includes a detector port and a temperature probe port. The sphere also comes with an SMA adaptor and a cosine adaptor to connect fiber cables to the ports.

6.1. Sphere Assembly Dimensions

All dimensions are in inches.

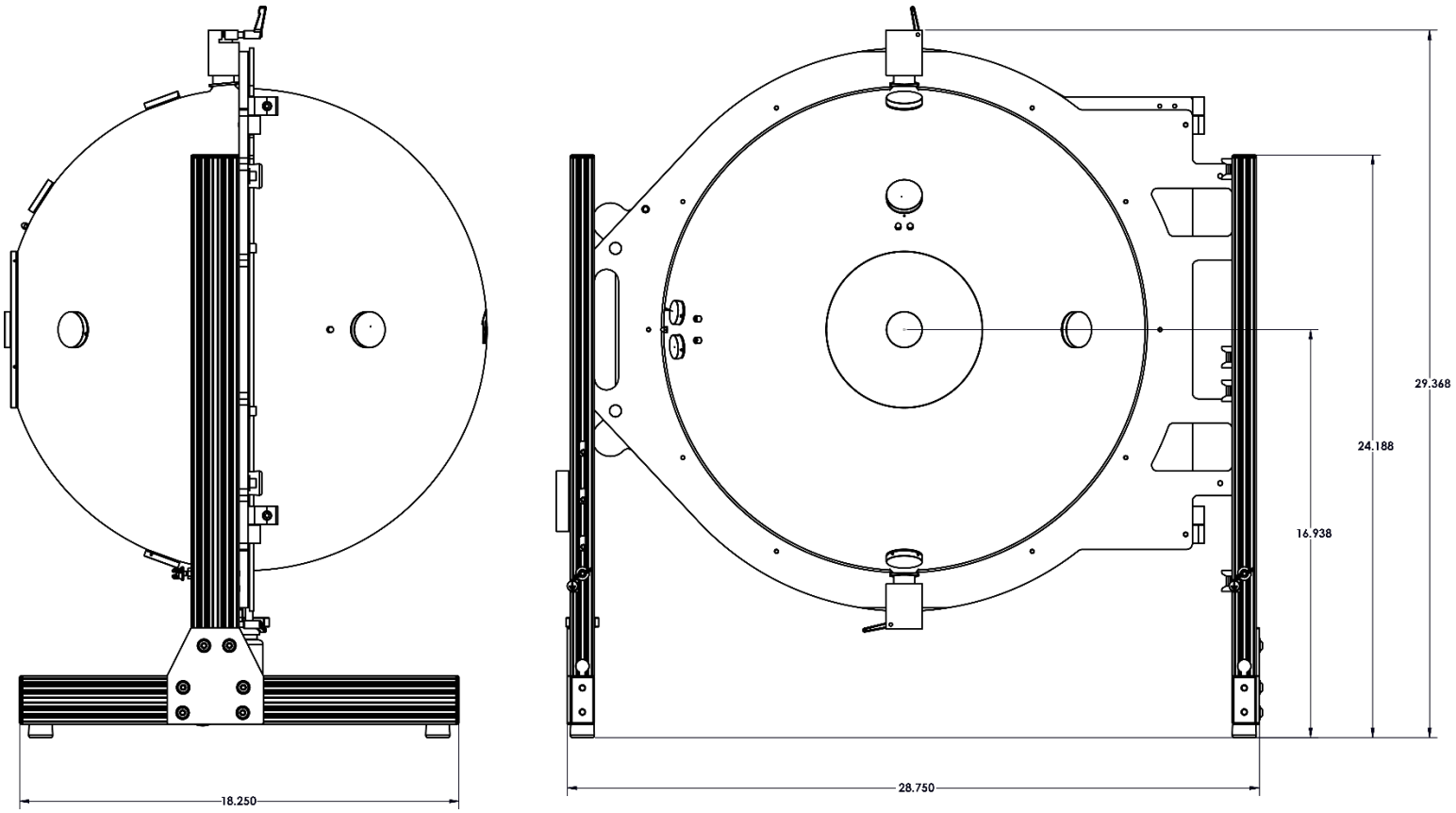


Figure 3: LMS-050 50cm Sphere Assembly Dimensions (inches)

7. SPHERE COMPONENTS

7.1. Integrating Sphere Assembly

The sphere assemblies are comprised of two mating hemispheres that open and close using a hinged, clam-shell design. The front hemisphere functions as the door and is secured in place to the rear hemisphere when closed by two neodymium magnets. The hemispheres are made of spun aluminum and the inner surfaces are treated with Labsphere's Spectraflect® — a proprietary, high-reflectance specially formulated barium sulfate coating that produces a nearly perfect diffuse reflectance surface. The sphere assembly comes with a bottle of Spectraflect® touchup paint.

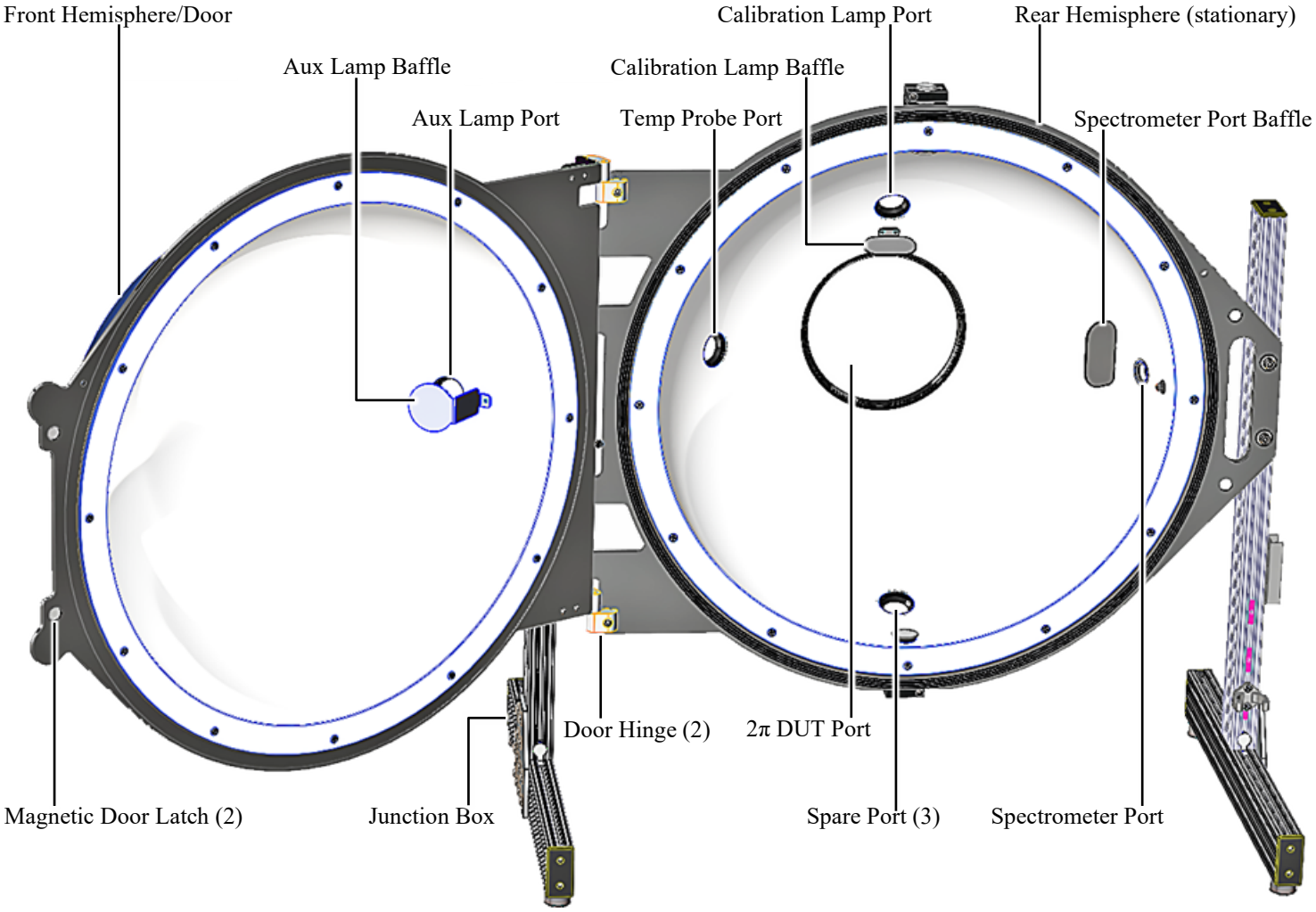


Figure 4: Sphere Assembly — open position — 50cm version shown

7.1.1. Spectraflect Coating

The interior of the hemispheres and the inside surface of the 2π port plates and covers and the outside surface of the 2π and 4π baffles are coated with Labsphere's Spectraflect® material. Spectraflect is a specially formulated barium sulfate coating that is near-Lambertian in character and produces a nearly perfect diffuse reflectance surface. Its useful wavelength range is 350 to 2400 nm and is generally used as a reflectance coating in the UV-VIS-NIR region.

The Spectraflect coating is delicate and can be easily damaged if not handled properly. Do not touch Spectraflect surfaces with bare hands or place any of the 2π port plates or covers face down on a hard surface. Always keep the hemispheres closed and the 2π port covered when the system is not in use to prevent the accumulation of any dust or debris on the Spectraflect surfaces inside the sphere.

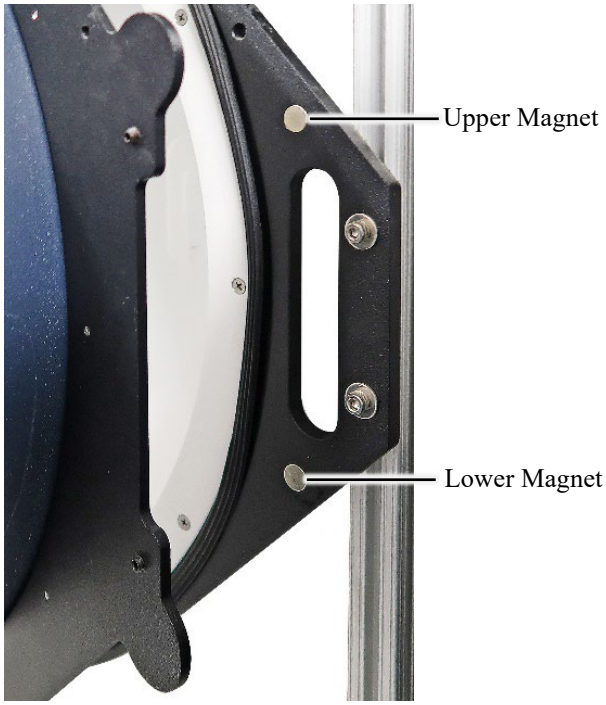
Refer to section 14.1 "Spectraflect® Care and Cleaning" on page 76 to maintain the condition of the Spectraflect surfaces.

Figure 5: Spectraflect Coated Surfaces

7.1.2. Sphere Door Latches

The sphere uses a dual magnetic latch design to secure the hemispheres closed during operations.

Magnetic Latch in Open Position



Magnetic Latch in Closed Position

Figure 6: Sphere Door Latches

7.1. TECMount Cold Plate Assembly

The TECMount cold plate assembly is an Arroyo 284 TECMount chiller attached to a custom adaptor plate. The adaptor plate has three slotted holes that interface with a mounting ring that is attached to the 2π DUT port on the rear hemisphere. There are two large handles on either side of the adaptor plate that are used to easily mount and dismount the assembly from the mounting ring. The adaptor plate also has a terminal block on the inside that connects to LED boards under test, and a terminal block on the outside that interfaces with the LED terminal junction box on the sphere frame. Refer to section 7.6 “Interconnect and Cable Junction Components” on page 23.

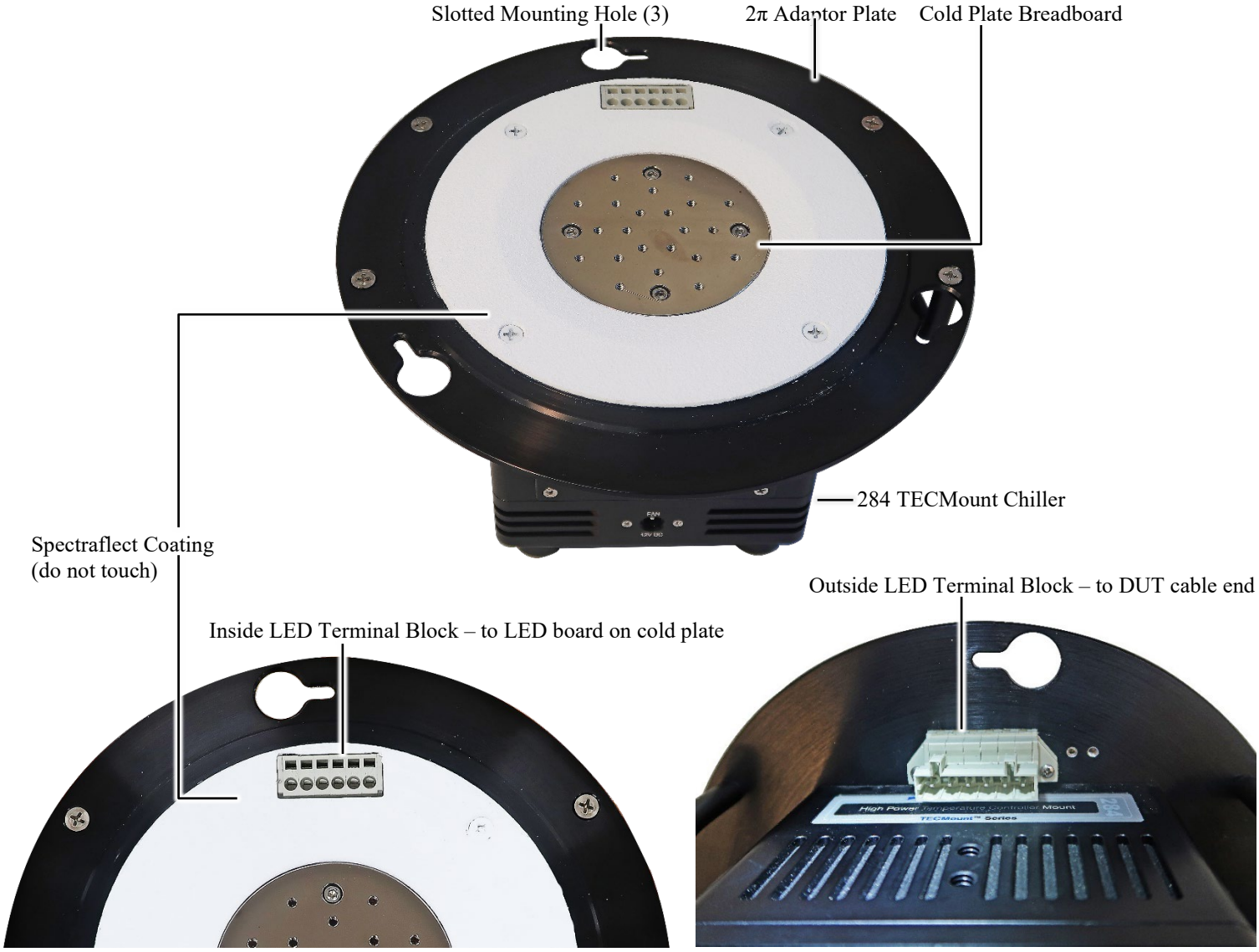


Figure 7: TECMount Cold Plate Assembly

7.2. 284 TECMount Chiller

The 284 TECMount thermal electric chiller integrates high power Peltier coolers for precise control and substantial heating and cooling capacity. It comes with an integrated fan for additional cooling capacity (not activated in this application). The 284-01 TECMount provides a flexible heating and cooling platform with a large working area and the ability to manage up to 30 watts of heat (at 25°C).

- M3 Holes
- Active TEC cooling
- 30W thermal capacity
- Large cold plate with bread-board mounting

7.2.1. 284 TECMount Specifications

Mounting Pattern	Bread-board pattern
Cold Plate	3" diameter oxygen free copper, nickel plated
Input Connectors	
TEC	DB-15,male 6-Pin Phoenix, male
Temperature Control	
Thermal Capacity	30W at 25°C
Temperature Range (°C)	+15 to +85
Sensor Type	10kΩ Thermistor
TE Module Imax (A)	7.4
TE Module Vmax (V)	16.4
TE Module Qmax (W)	78
General	
Size (H x W x D) [in(mm)]	4.75 (120.7) x 4.4 (111.8) x 4.4 (111.8)
Mounting Holes	Side holes for ¼-20 screws (post mount) 8-32 holes top and bottom

7.3. 2π Calibration Lamp Assembly

The 2π calibration lamp has been carefully screened, seasoned, and calibrated in the Labsphere manufacturing facility under the guidelines recommended by the NVLAP accredited ISO 17025 practices. It is first seasoned for 1% of its rated life and then screened for stability and repeatable performance before it is selected for calibration. It is then calibrated directly to the NIST spectral flux reference.

The 2π calibration lamp assembly includes a calibration certificate with uncertainty analysis and spectral flux data in W/nm or total luminous flux value with operating current. The spectral flux data is provided on a flash drive for uploading into the included Integral® software (refer to the provided Labsphere Integral software operation manual number AQ-81000-100).

The 2π calibration lamp assembly includes:

- ICS-650 QTH calibration lamp with protective acrylic tube
- Protective foam-lined case
- 1.5mm hex driver to install and remove the lamp from the 2π sphere port

Replacement lamps (part number AS-80003-100) can be ordered on the Labsphere webstore: https://www.labsphere.com/product/calibrated-spectral-flux-standards/

Figure 7: 2π Calibration Lamp Assembly

7.3.1. Calibration Lamp Specifications

Refer to the calibration certificate on the Labsphere flash drive for specifications.

7.4. AUX-650 Auxiliary Lamp Assembly

The AUX-650 auxiliary lamp assembly includes:

- ICS series QTH lamp assembly with protective acrylic tube
- Protective foam-lined case
- 1.5mm hex driver to install and remove the lamp from the auxiliary sphere port

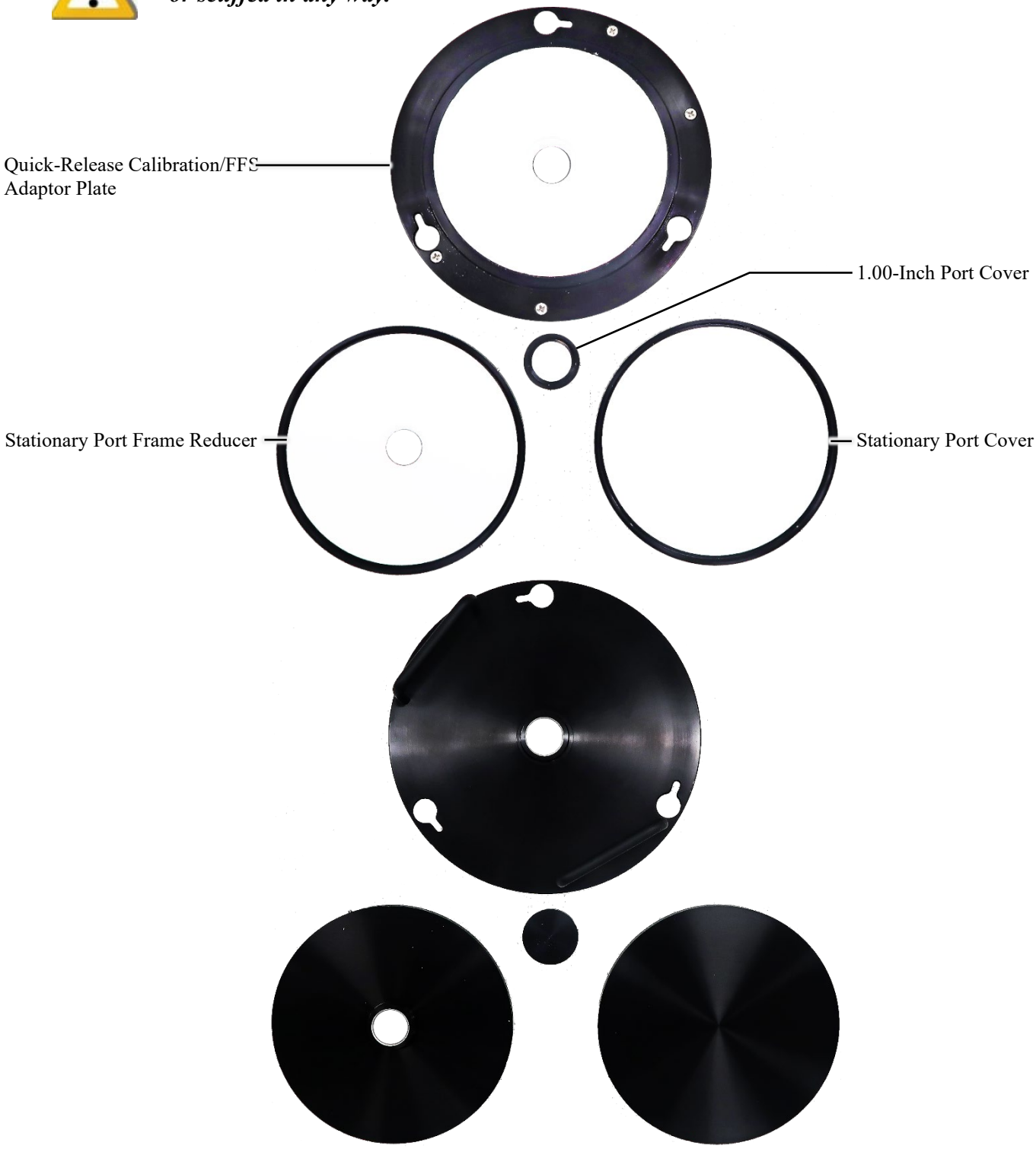
The ordering information of the auxiliary lamp assembly is stated on the label. AS-02986-650. Replacement lamps can be ordered on the Labsphere webstore:
https://www.labsphere.com/customer-support/

Figure 8: AUX-650 Auxiliary Lamp Assembly

7.5. 2π Port Hardware

In addition to the TECMount cold plate assembly, the 2π port hardware consists of these components.

The inside surfaces are coated with Spectraflect and should not be touched with bare fingers or scuffed in any way.



7.5.1. Quick-Release Mounting Plate

The quick-release mounting plate comes pre-mounted to the exit port frame and allows the TECMount assembly and calibration/FSF plate to be quickly installed and removed. It is a tool-free design that features three plastic thumbnuts on mounting posts. The slotted holes in the TECMount assembly and calibration/FSF plate fit over the thumbnuts. The user then rotates the device clockwise to engage the mounting posts into the slots, after which the thumbnuts can be tightened by hand to secure the device in place.

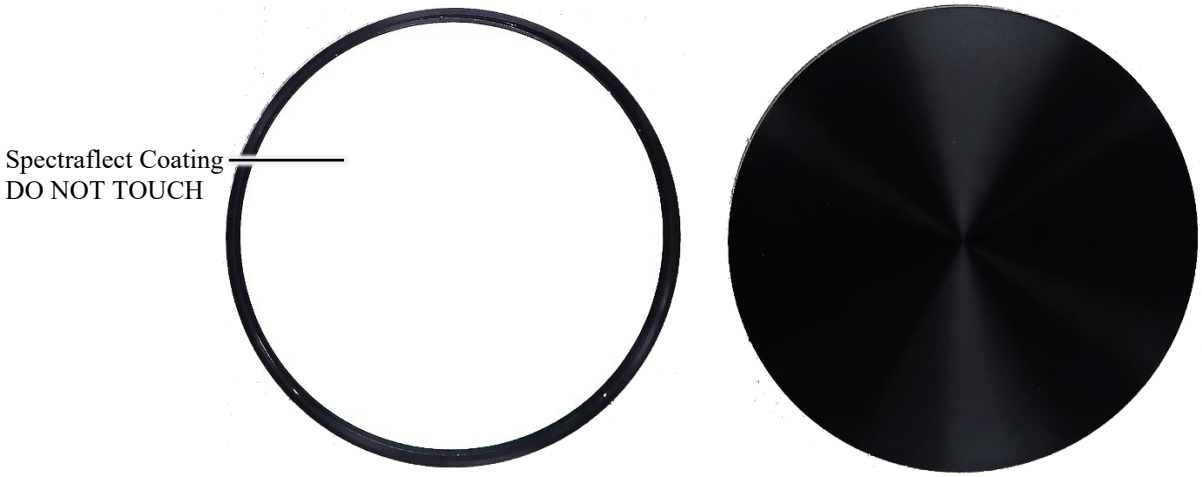
The quick-release mounting plate is mounted to the exit port frame with six setscrews and can be removed and replaced by the user with the stationary port cover or stationary port frame reducer if converting the system for 4π measurements only. The optional Labsphere 4π kit is required for this conversion. Refer to section 12 “Optional 4π Kit” on page 62.

7.5.2. Quick-Release Calibration/FSF Adaptor Plate

This Spectraflect coated plate can be quickly installed and removed whenever it is necessary to calibrate the system. The 1-inch port cover must be mounted to it for this function as shown. This component also functions as a quick-install, 6.00-to-1.00-inch port frame reducer when using the Labsphere Forward Spectral Flux Standards. The 1-inch port cover must be removed to it for this function.

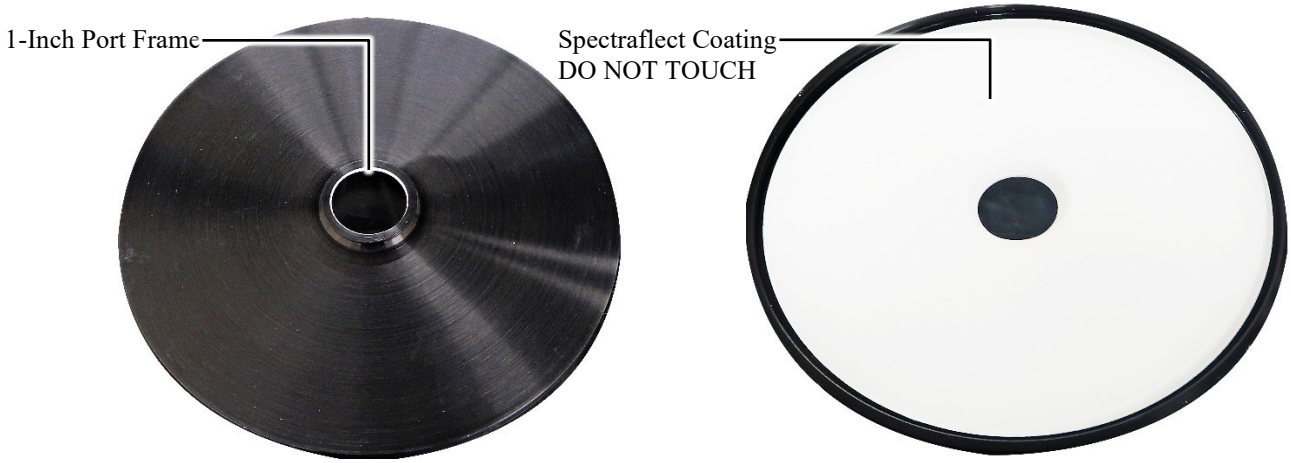
7.5.3. Stationary Exit Port Cover

The Spectraflect coated, stationary exit port cover mounts to the exit port frame with two setscrews. It is designed to be mounted to the exit port when the system is not in use for a prolonged period or when using the system indefinitely for 4π measurements. The optional Labsphere 4π kit is required for this conversion. Contact Labsphere Customer Service for details.



7.5.4. Stationary Port Frame Reducer

The stationary 6.00 to 1.00-inch port frame reducer can be installed instead of the calibration/FSF adaptor plate when using one of the Labsphere Forward Spectral Flux Standards (not included — go to the Labsphere webstore to order: https://www.labsphere.com/customer-support/). The port frame reducer converts the 6-inch DUT port frame into a 1-inch port frame upon which the Forward Spectral Flux Standard lamp assembly can be mounted to. The inside surface is coated with Spectraflect and should not be touched with bare fingers.



7.6. Interconnect and Cable Junction Components

7.6.1. Overview

The setup and operation of the illumiaPro3 system requires the user to interact with the interconnect cable bulkhead and the cable junction box. The interconnect cable bulkhead is mounted to the right-side base rail of the sphere assembly frame. The male end of the interconnect cable, combined with its bundled USB cable, connect to the socket on the bulkhead which provides DC power and Integral software control of the components on the sphere from the Labsphere ICM-500 router/controller. Refer to section 8.2 “Labsphere ICM-500 Control Module” on page 28. The cable junction box is mounted to the vertical frame rail just above the interconnect cable bulkhead and routes DC power and Integral computer control to the auxiliary and calibration lamps, and to the user’s DUT on the TECMount cold plate.

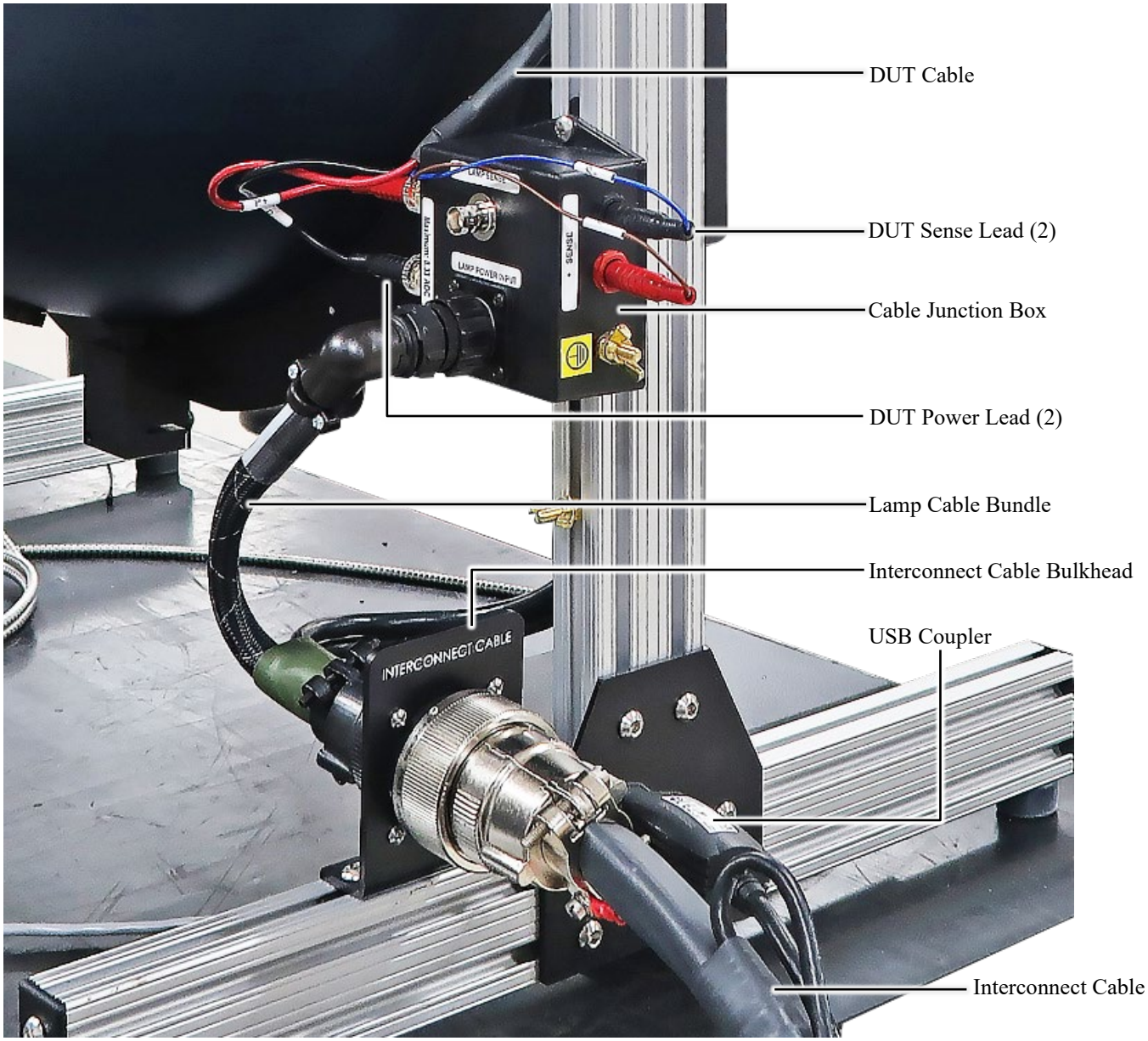


Figure 9: Interconnect and Cable Junction Overview

7.7. Lamp Cable Bundle

The lamp cable bundle is pre-connected to the other side of the interconnect cable socket, shown in the previous section. It consists of two 32-inch DC power lamp cables and one 6-inch junction box cable, each with a 7-pin twist-lock connector on one end. The twist-lock connectors are used to securely connect the cables to their respective power destinations:

- Calibration lamp; 3-pin socket
- Auxiliary lamp; 3-pin socket
- DUT (device under test); 5-pin socket in the junction box

The end of each cable is clearly labeled with the destination name. The lamp cable bundle should stay connected to the interconnect cable bracket and the DUT cable end should stay connected to the junction box..

The calibration and auxiliary power cables use three of the seven pins: plus, minus, and ground. The DUT cable is an assembly. It consists of the three-pin DUT power cable combined with the plus and minus sense cables. The three cables are wrapped together in a braided nylon sleeve.

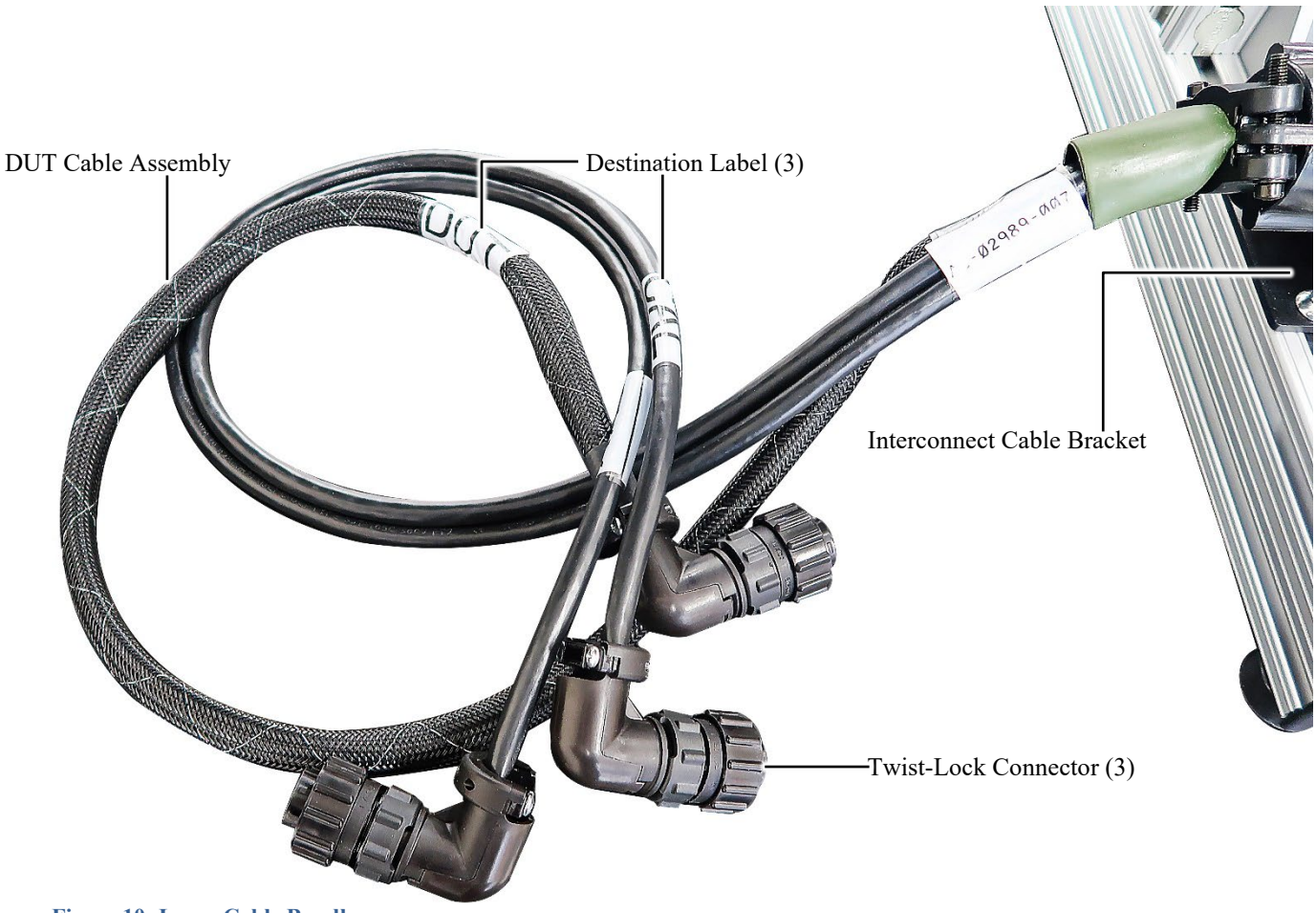


Figure 10: Lamp Cable Bundle

7.1. CDS-800 Spectrometer with Trigger Module

The trigger module version of the Labsphere CDS-800 spectrometer is used in Labsphere Illumia®Plus and illlumia®Pro systems. It contains a trigger module that has a 3.5mm jack for an external trigger cable that connects to the Illumia interconnect socket. Otherwise, the trigger module version is identical to the standard CDS-800.

The CDS-800 is a mini CCD array spectrometer with a multi-channel spectral analyzer designed for real-time spectral analysis. The instantaneous spectral acquisition provides the radiometric, photometric, and color characteristics of the device under test (DUT). It offers low noise and a broad spectral response with calibrated ranges from 200 to 1100 nm. When coupled with a Labsphere integrating sphere, the spectrometer avoids the inherent photometric errors associated with filter-based photometers; data is accurate even for narrow-band light sources such as LEDs, fluorescent lamps, and discharge lamps.

The CDS-800 typically connects to the SMA optical head or cosine adaptor on the integrating sphere via fiber optic cable, enabling the remote positioning of the spectrometer. It communicates and is powered by the host computer over a standard USB cable.

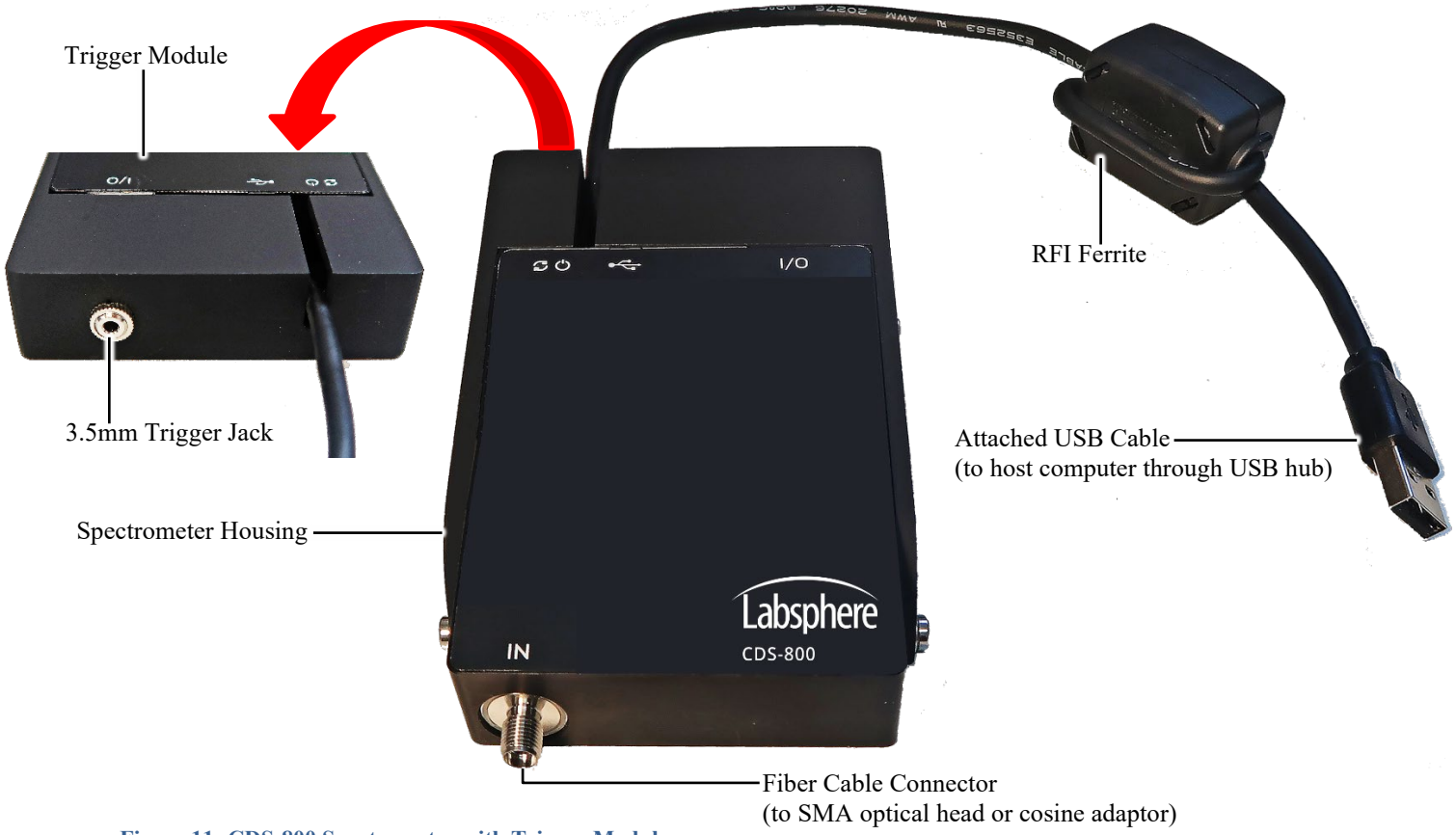


Figure 11: CDS-800 Spectrometer with Trigger Module

7.1.1. CDS-800 Specifications

Optical Bench	Symmetrical Czerny-Turner, 75 mm focal length, MK II
Wavelength Range	200 - 1100 nm
Stray Light	0.2 - 1%
Sensitivity	337.500
Detector	HAM S11639 , CMOS linear array, 2048 pixels (14x200 µm)
Signal/Noise	330:1
Dynamic Range	3300
Dark Noise	16 counts
AD Converter	16-bit, 6 MHz
Integration Time	30 µs - 40 s
Interface	USB 2.0 (480 Mbps) / pigtailed (40 cm) USB-A
Sample Speed with On-board Averaging	3.0 ms/scan
Data Transfer Speed	4.6 ms/scan
I/O	5 bidirectional programmable I/O; 1 analog out; 1 analog in, 1x5V
Dimensions, Weight	95 x 68 x 20 mm, 175 grams
Power Supply	Default USB power, 500 mA
Temperature Range	0-55^{0}C

8. ELECTRONIC COMPONENTS

8.1. Overview

The illumiaPro3 system includes the following electronic components. Labsphere recommends the stacked configuration as shown.

Figure 12: illumiaPro3 Electronic Components

8.2. Labsphere ICM-500 Control Module

The ICM-500 (illumia control module) is the central connection and switching device at the heart of the illumia®Pro3 systems. This allows the Integral software to control the routing of power from the various power supplies to the appropriate light source on the sphere. The ICM-500 provides these connections:

1. USB Hub with Six Ports
    - Six type "A" ports for the Keithley 2461 power supply, the Arroyo TEC controller, and the Labsphere CDS-800 spectrometer via the USB cable on the interconnect cable.
2. USB type "B" port for the system computer
3. Junction Socket
    - Connects to the sphere frame with the interconnect cable
4. AC Input Socket
    - Not used in this system
5. DC Input Socket
    - Connects to the Keithley 2461 power supply
6. Power Meter Socket
    - Connects to the provided shorting plug
7. User Input Terminal Strip
    - Provides bare wire terminals for additional power supplies (not used in this system)

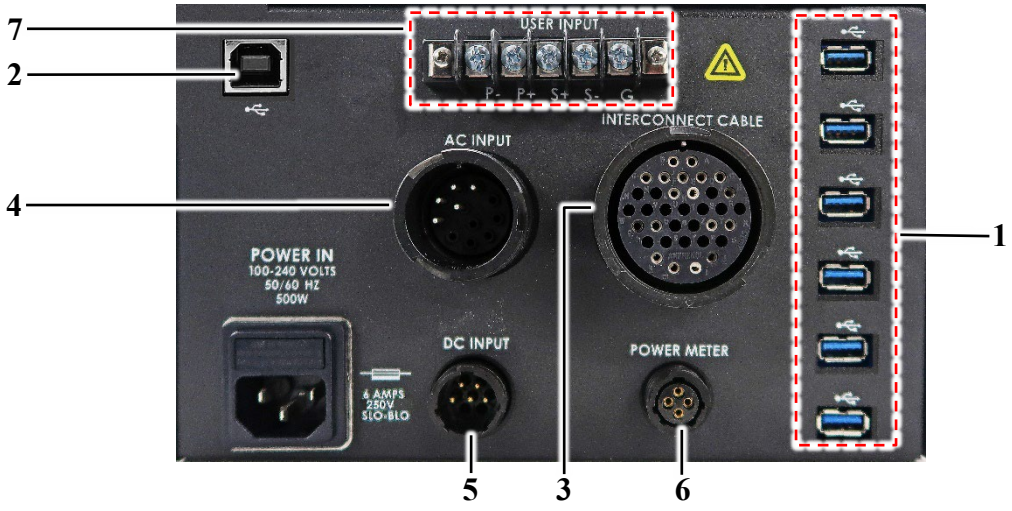


Figure 13: Labsphere ICM-500 Rear Connection Panel

8.3. Interconnect Cable

The 14 ½-foot interconnect cable connects the ICM-500 to the sphere assembly. It uses a 35-pin circular twist-lock connector at either end. 14 of the 35 pins are used. The male end connects to the 35-pin socket on the rear panel of the ICM-500 and the female end connects to the 35-pin socket on the interconnect bulkhead on the sphere frame. The cable transmits source power to the lamps on the sphere and AC power to the outlets on the junction box.

A USB extension cable is attached within the outside wrapping of the interconnect cable. Its male end is at the male end of the interconnect cable and its female end is at the female end of the interconnect cable. This USB cable is used to connect a the CDS-800 spectrometer installed at the sphere end, with the other end plugged into the USB hub on the ICM-500 rear panel.

Figure 14: Interconnect Cable

Figure 15: 35-Pin Male Socket

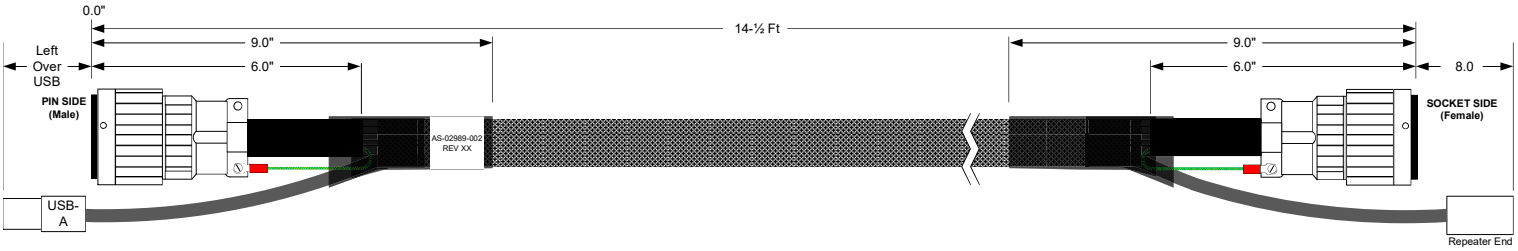


Figure 16: Interconnect Cable Dimensions

8.4. Arroyo 5305 TECSource Controller

The Arroyo 5305 TECSource controller controls the thermal conditions on the TECMount that contains the user's LED DUTs. It uses a large VFD display to simultaneously display set point temperature, actual temperature, current, and voltage. The 5305 supports all common sensor inputs (thermistor, RTD, AD590, and LM335), and has a four-wire RTD mode to eliminate connector resistances. Refer to the provided Arroyo 5305 TECSource controller manual for complete operational details.

The 5305 USB output connects to the USB hub on the ICM-500 rear panel. It also has an RS232 computer interface. The 5305 also features an AutoTune process that automatically calculates PID parameters. Primary 5035 features include:

- AutoTune automatic PID
- 60W of TEC power
- 0.004°C stability
- Bi-polar output: heat & cool
- Thermistor, RTD, LM335, & AD590 sensors
- Four-wire RTD mode

Refer to the provided Arroyo 5305 manual in the OEM packaging for complete technical specifications.

Refer to page 11 and 12 of the Arroyo 5305 manual on how to set the voltage for your installation before powering on the unit. It can be set for 100VAC, 120VAC, or 230VAC. Not setting this properly will lead to damage.

8.4.1. Ventilation

The 5305 has vent holes on the rear and left side of the unit. The heat from the vent holes is vented out of the electronics rack through the vent panel in the rear. Do not block these vent holes or the vent panel to avoid overheating damage to the unit.

8.4.2. Warm-up and Environmental Considerations

The 5305 should be powered on for at least one hour in the LED Test Station prior to taking measurements to achieve the highest level of accuracy. Also ensure that the unit is not operating outside its ambient temperature range or humidity conditions.

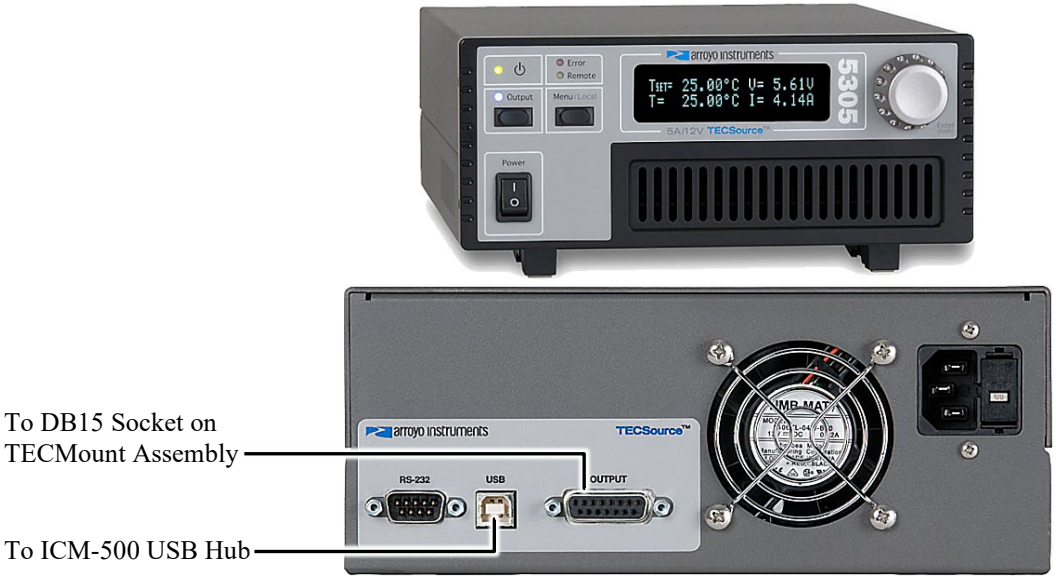


Figure 17: Arroyo 5305 TEC Controller

8.5. Keithley 2461 SourceMeter

The electrical activity of the LEDs being tested (DUTs) is powered and monitored by the touchscreen Keithley 2461 SourceMeter that combines a precise, low-noise, highly stable DC power supply with a low-noise, highly repeatable, high-impedance multimeter. It also supplies DC power to the calibration and auxiliary lamps. The 2461 has 0.012% basic accuracy with 6½-digit resolution. At 6½ digits, the SourceMeter delivers 520 readings/second over the IEEE-488 bus. At 4½ digits, it can read up to 2000 readings/second into its internal buffer.

Refer to the provided Keithley 2461 SourceMeter manual for complete operational details.

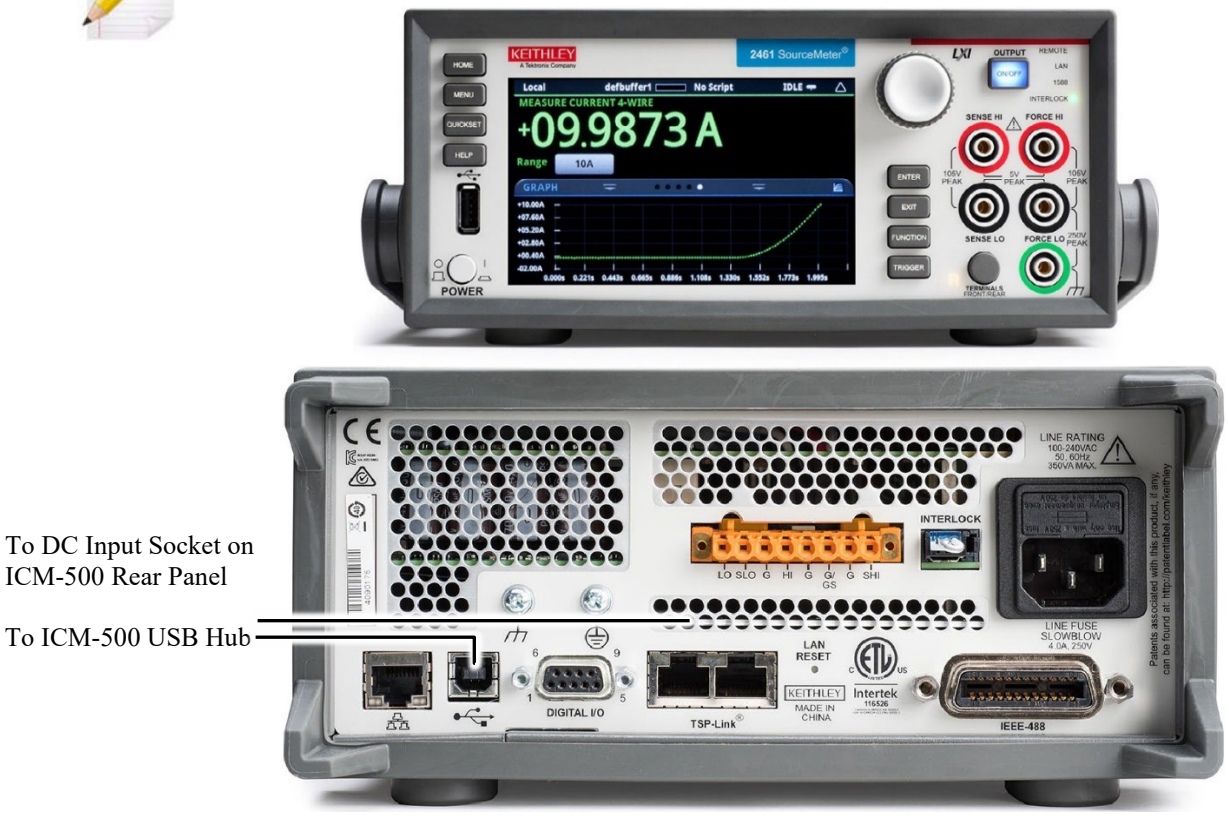


Figure 18: Keithley 2461 SourceMeter

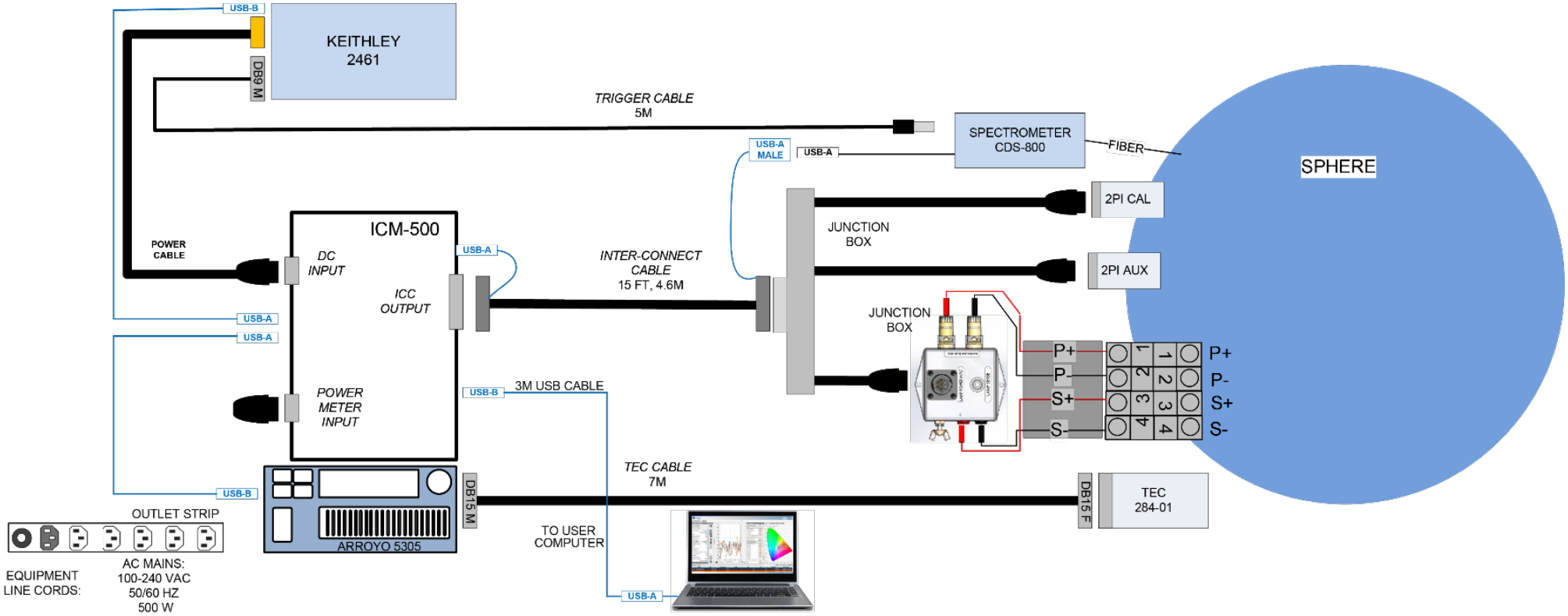
8.5.1. Keithley 2461 Basic Specifications

Refer to the Keithley 2461 SMU manual in the OEM packaging for complete technical specifications.

Max Output Voltage	100 V
Max DC Current	7 A
Max Pulse Current	10 A
DC/Pulse Power	100 W/1000 W
Digitizers	Dual 18-bit 1 MS/s
Wideband Noise	<4.5 mVrms typ.
Sweep Types	Linear, Log, Dual Linear, Dual Log, Custom
Reading Buffer Size	>2 Million Point Reading Buffer
Programming Command Type	SCPI Programming + TSP Scripting
PC interface	GPIB, USB, Ethernet (LXI)
Signal Input Connections	Front: Banana Jacks Rear: Mass Screw Terminal Connection

9. INSTALLATION

9.1. Connection Diagram



9.2. Setup Overview

The installation process of the illumia®Pro3 800-050 system consists of three primary procedures:

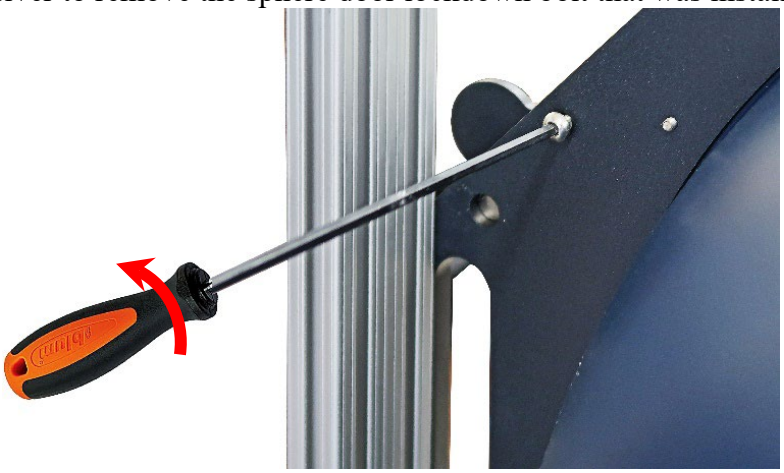
1. Installation and connection to the sphere and its components
2. Installation and connection to the electronic components and host computer
3. Installation of the Integral software

The setup components in the illumia®Pro3 800-050 system includes:

- Sphere assembly interconnect bulkhead
- 2π LED TECMount assembly
    - 2π 1-inch port frame reducer when using the FSF
- Aux lamp assembly
- Calibration lamp assembly
- Lamp and junction box cables
- ICM-500 interconnection module
- Arroyo 5305 TECSource controller
- Keithley 2461 SourceMeter
- CDS-800 spectrometer
- Labsphere Integral operating system software.

9.3. Installation of the Sphere Assembly and its Components

1. Uncrate the sphere assembly and its associated components and transport them to the installation site.
2. Unbundle all cables.
3. Take note of the orientation of the sphere to ensure clearance when the hemisphere is opened.
4. Use a 5/32 hex driver to remove the sphere door lockdown bolt that was installed for shipping.



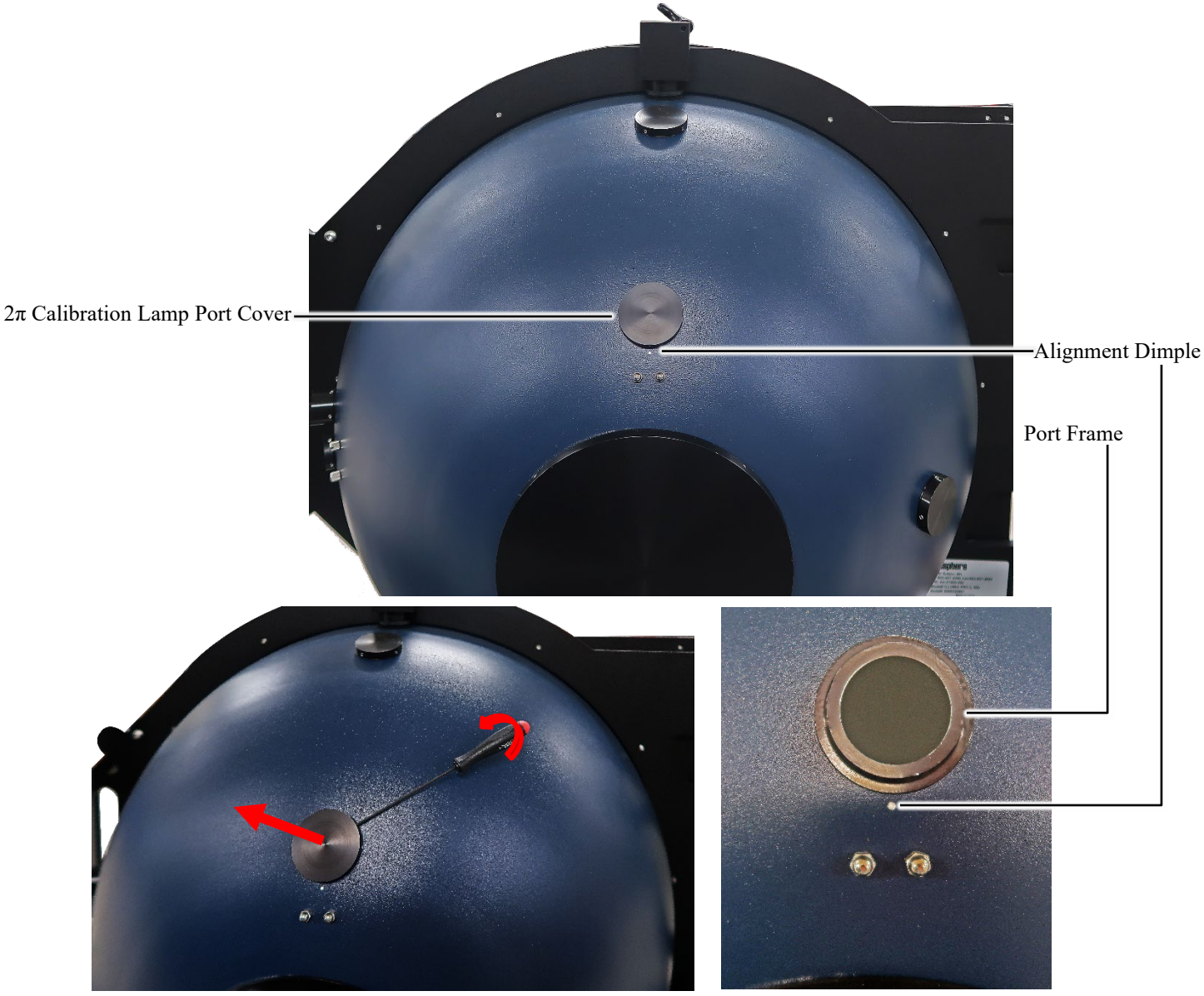
Once the sphere is positioned, ensure that adequate spacing is available around the sphere by releasing the latch and opening the sphere. Refer to section 3.4 “Clearance Requirements” on page 7. Note the position of the junction panel or socket on the sphere frame and its proximity to the electronics rack. Ensure that the attached interconnect cable can reach the sphere’s junction socket labeled “INTERCONNECT CABLE” with no strain on the cable. The interconnect cable is about 14 ½-feet (4.4-meters) and should completely lay on the floor.

9.4. Installation of the 2π Calibration Lamp

The 2π calibration lamp ships inside its own protective case and is identified on the case as "2PI-1-INT-650". Refer to section 7.3 "2π Calibration Lamp Assembly" on page 18 and to the included calibration certificate.

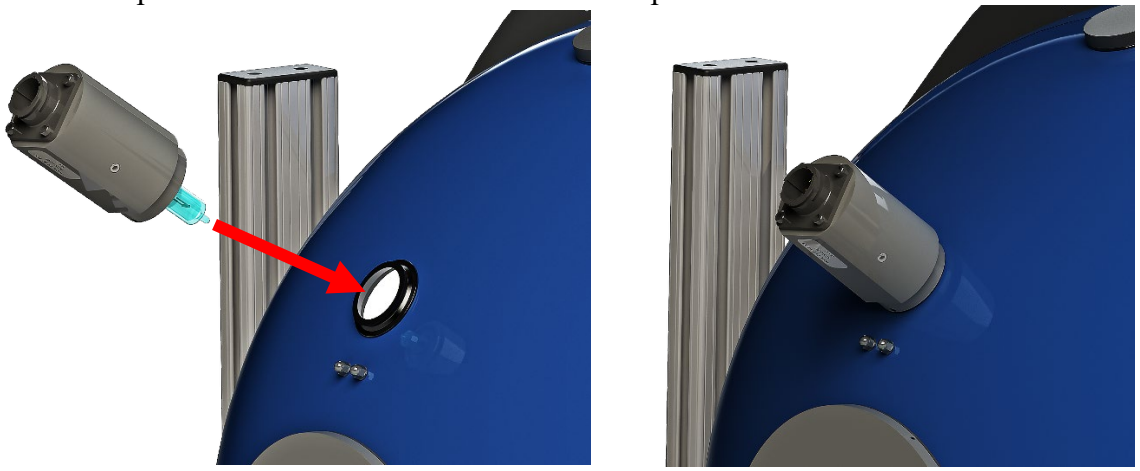
Aligning the lamp in the calibration port is critical to this installation. This is done by lining up the alignment dimple in the sphere under the port frame with the mounting setscrew on the flat surface of the lamp housing.

1. Open the 2π calibration lamp case and obtain the 1.5mm hex driver.
2. Locate the 2π calibration lamp port cover on the upper-back section of the rear (fixed) hemisphere. Remove the port cover by loosening its two set screws with the hex driver.



3. Remove the 2π calibration lamp from its case and remove its protective acrylic tube using the 1.5mm hex driver. ***Take care not to touch the bulb with bare fingers. Wearing nitrile or latex gloves is recommended.***

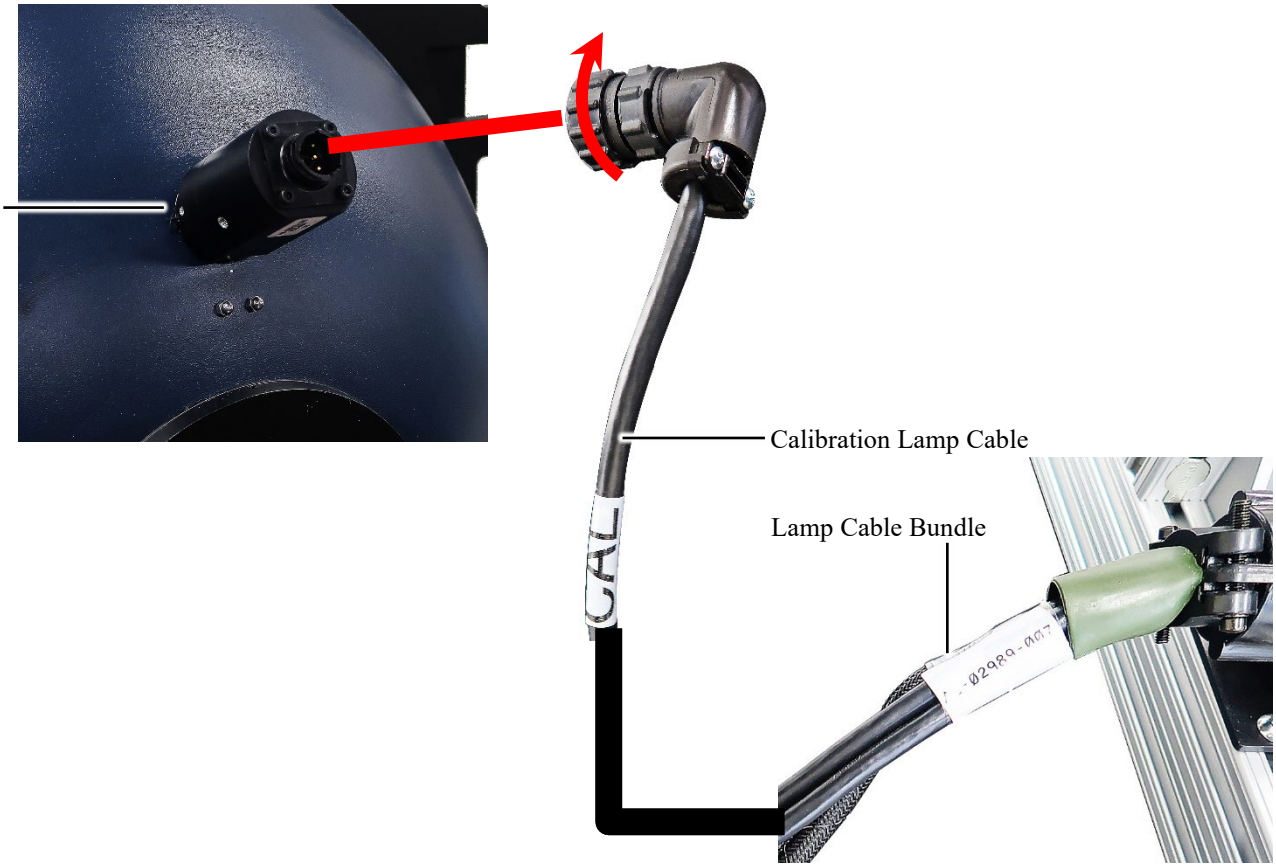
4. Carefully insert the bulb end of the lamp assembly into the open port until the outside collar of the lamp enclosure is flush with the base of the port frame.



5. Rotate the lamp housing to where the setscrew on the flat surface of the housing is lined up with the alignment dimple on the sphere under the port frame.

6. Securely tighten the two set screws with the 1.5mm hex driver.

5. Locate the lamp cable labeled “CAL” in the lamp cable bundle and connect its twist-lock connector to the calibration lamp socket. Refer to section 7.7 “Lamp Cable Bundle” on page 24.



9.5. Installation of the Auxiliary Lamp

Installation of the auxiliary lamp does not require an alignment process like the calibration lamp.

1. Locate the auxiliary lamp port cover on the left side of the front (door) hemisphere, next to the sphere frame.

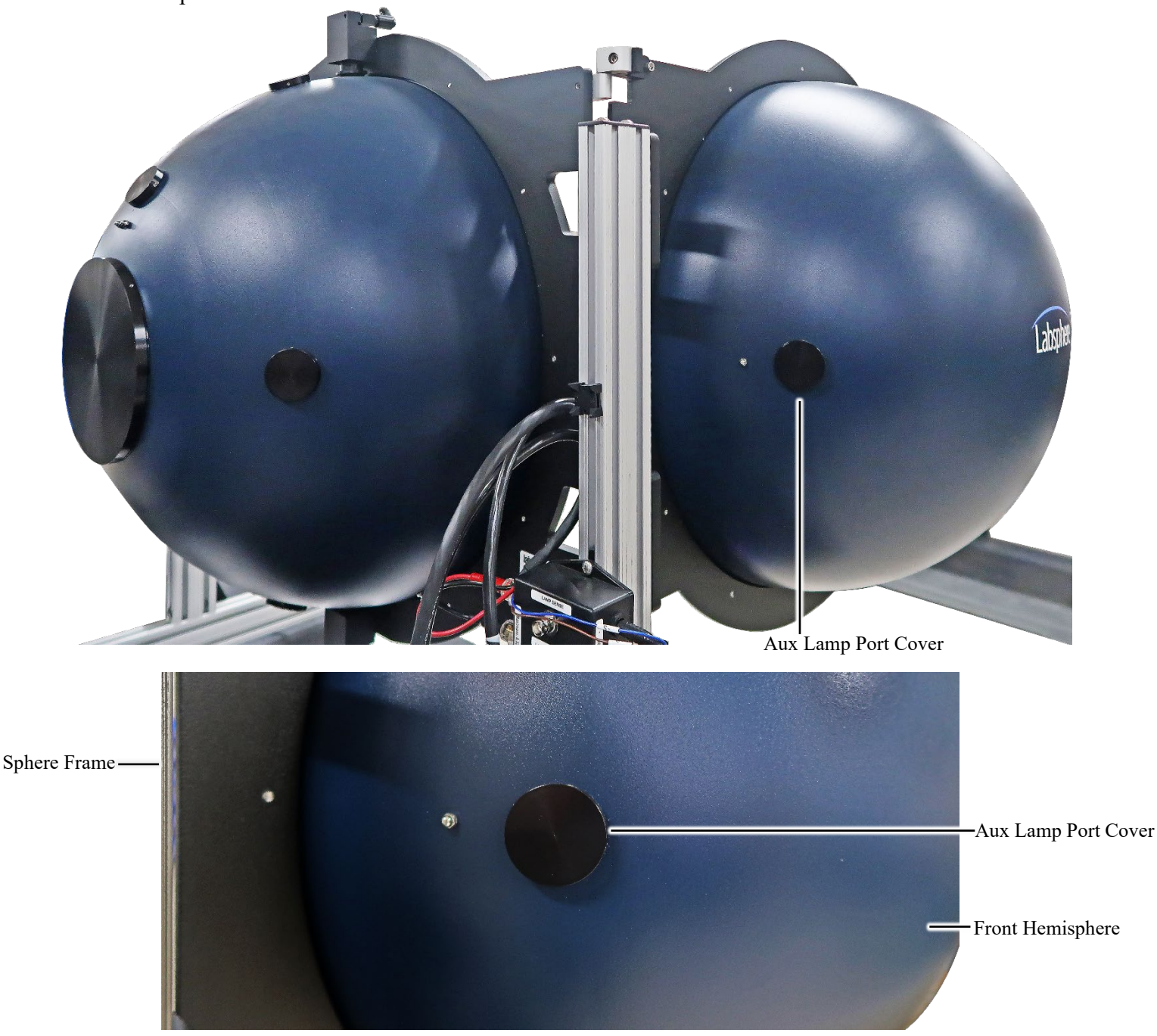
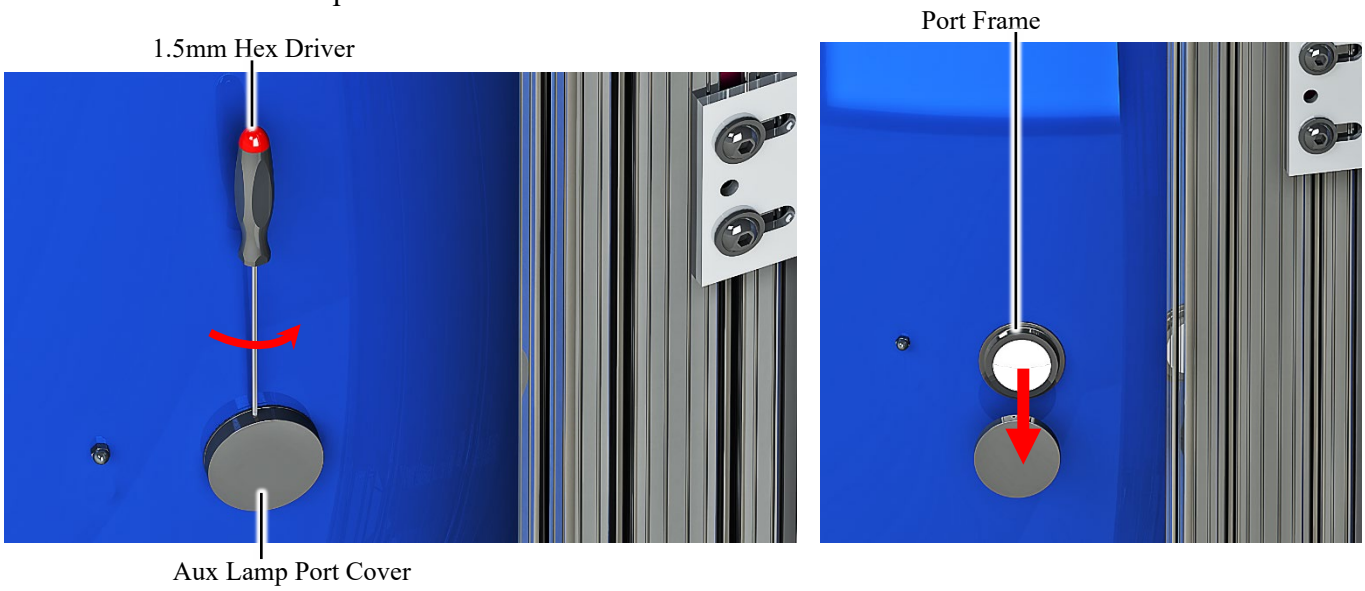
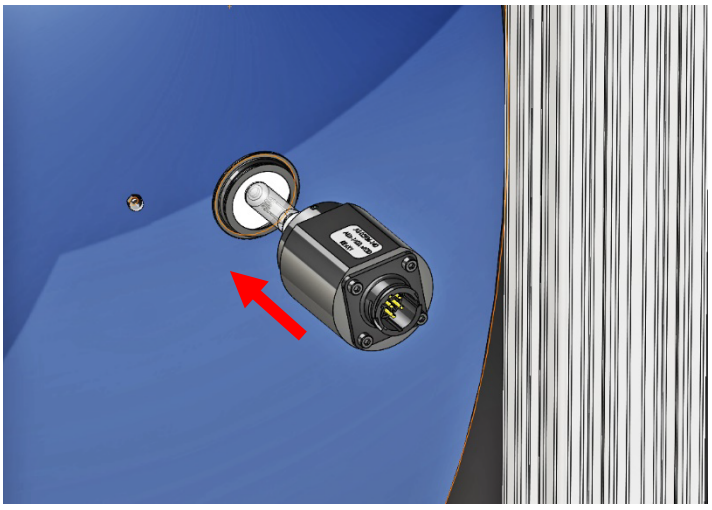


Figure 19: Aux Lamp Port Cover Location

2. Loosen the two setscrews on the outside edge with a 1.5mm hex driver, remove the port cover and locate the port frame underneath.



3. ***Put on nitrile, latex or lint-free cloth gloves at this point.*** Take the auxiliary lamp from its case and remove the protective sheath by loosening the two setscrews that hold it in place with a 1.5mm hex wrench. ***Do not touch the auxiliary lamp bulb with bare fingers.***
4. Carefully guide the auxiliary lamp into the AUX port while positioning the mounting collar over the port frame until it is flush against the port frame base. Tighten the two setscrews in the auxiliary lamp's mounting collar with a 1.5mm hex driver.



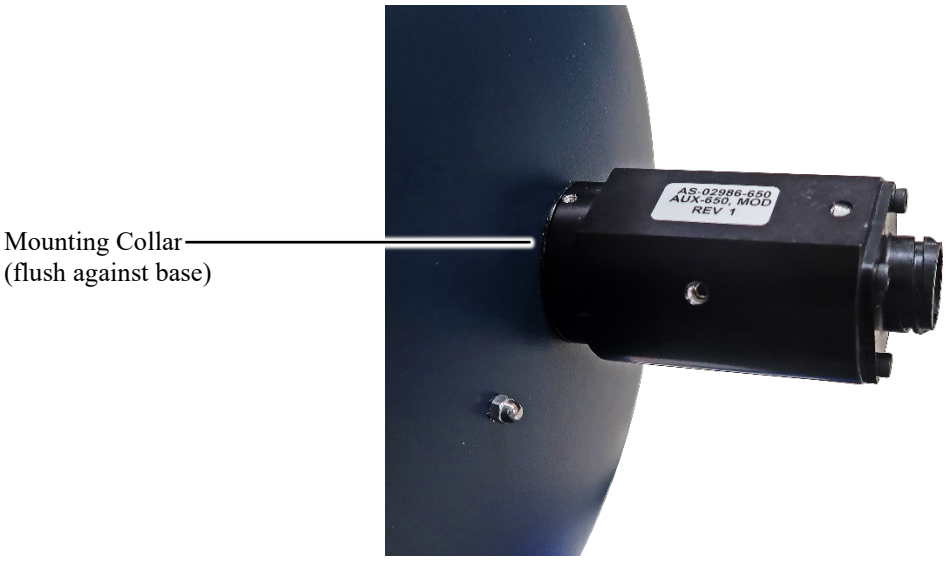


Figure 20: Auxiliary Lamp Installed in Rear Hemisphere

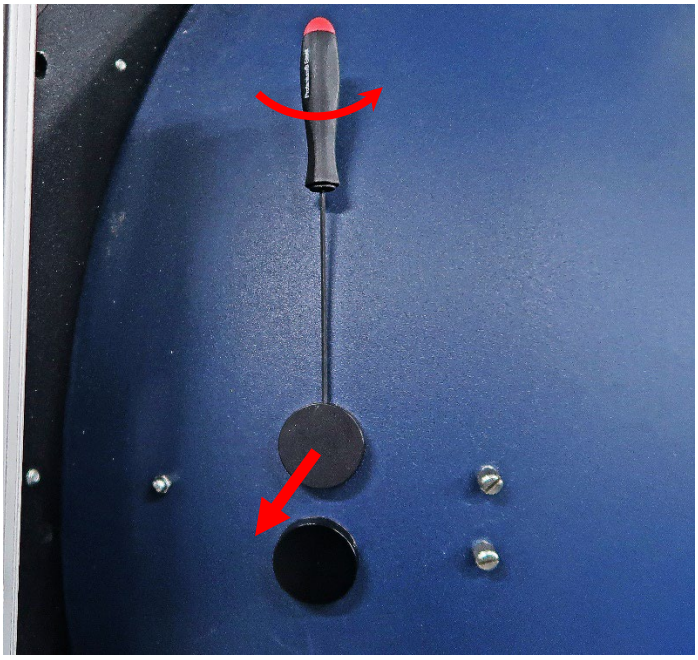
5. Locate the lamp cable labeled “AUX” in the lamp cable bundle and connect its twist-lock connector to the aux lamp socket. Refer to section 7.7 “Lamp Cable Bundle” on page 24.

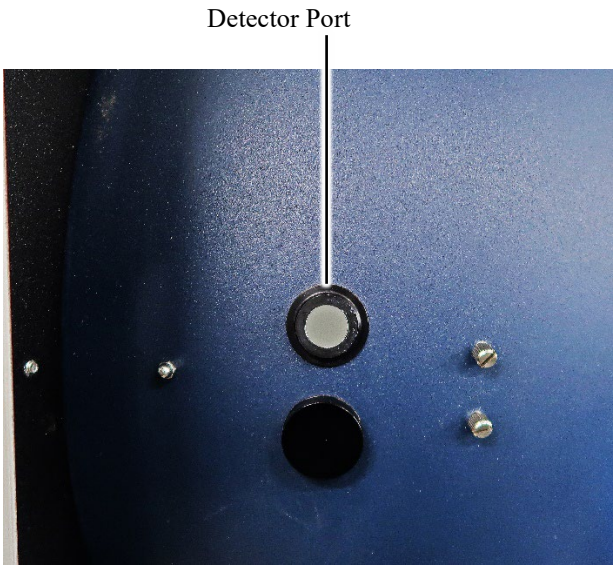
Figure 21: Aux Lamp Cable Connection

9.6. SMA Port Installation and Spectrometer Fiber Cable Connection

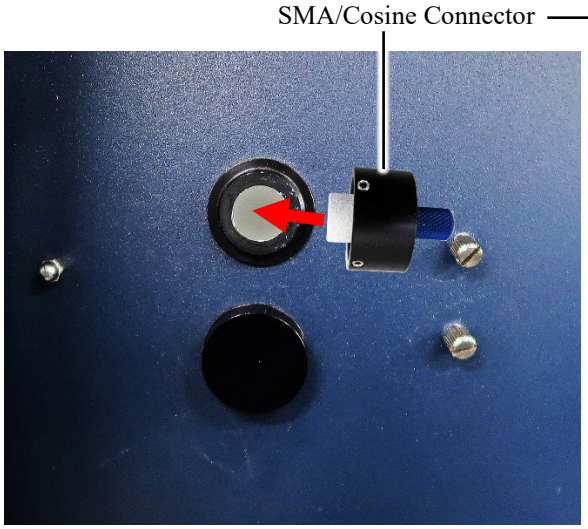
If not pre-installed, the SMA/Cosine connector must be installed into either one of the two detector ports to provide the fiber cable connection to the CDS-800 spectrometer in the system.

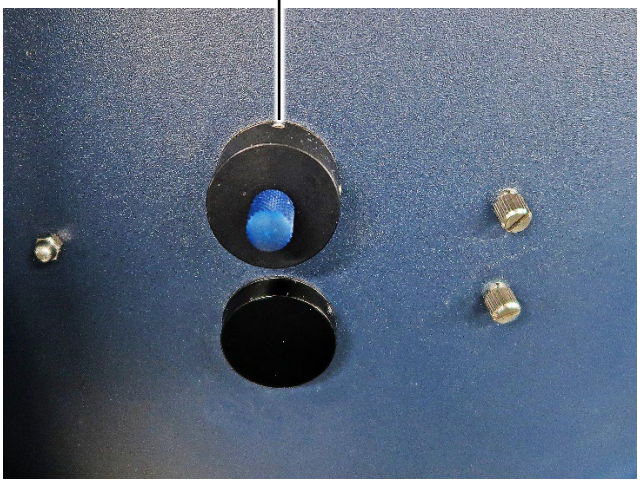
1. Remove one of the two detector port covers by loosening the two setscrews with the 1.5mm hex driver.



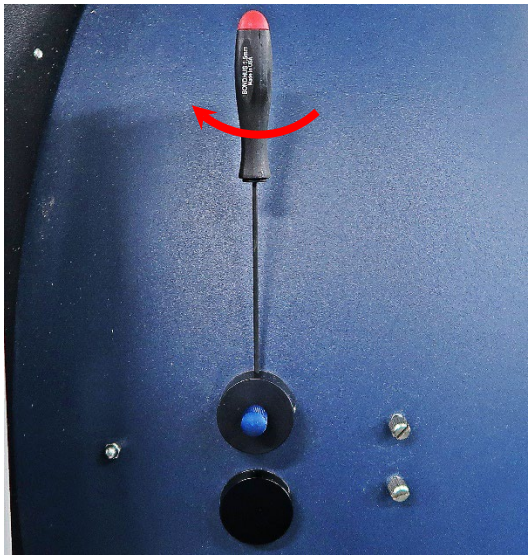


2. Take the SMA/Cosine connector from the accessory box and insert it into the open detector port. Its collar fits over the base of the port frame.

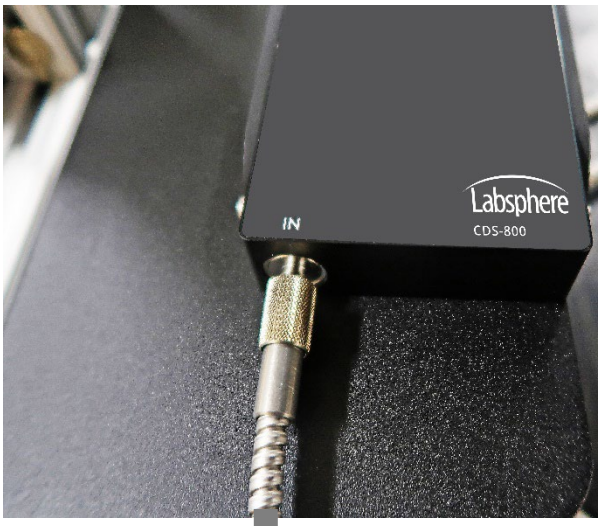




3. Hold the collar flush against the sphere wall and tighten the two screws with a 1.5mm hex driver.



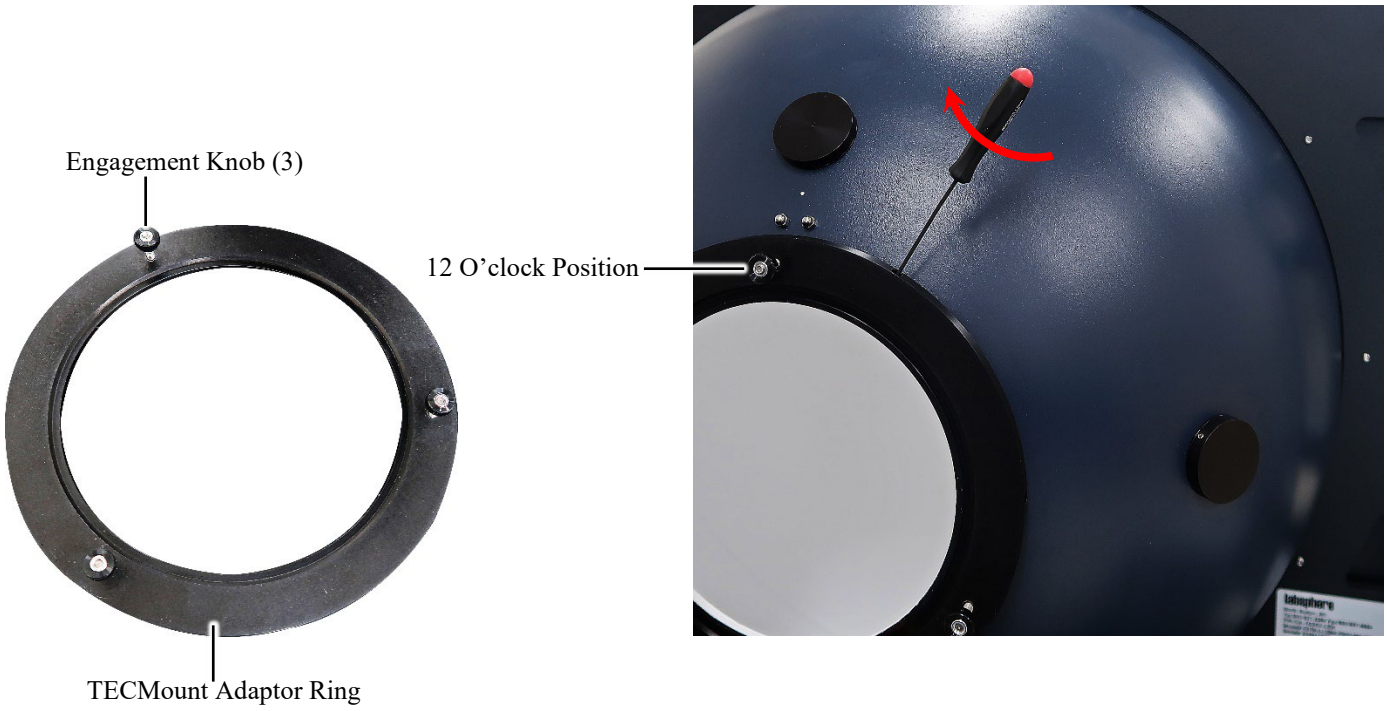
4. Unscrew the protective blue cap from the SMA/Cosine connector and thread on the unconnected end of the fiber cable to the CDS-800 spectrometer.



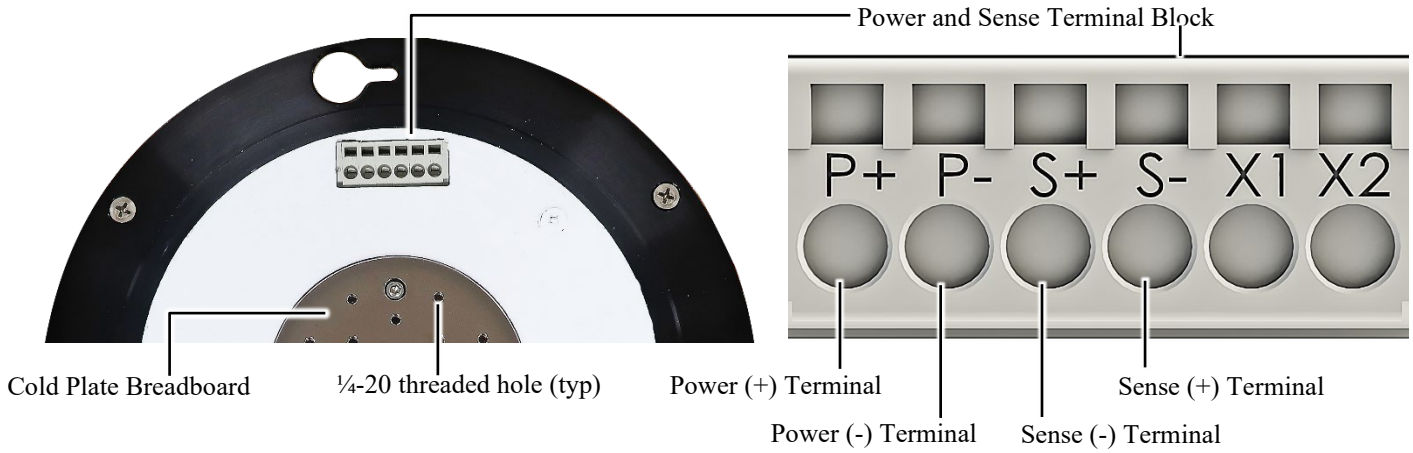
9.7. Installation of the TECMount Cold Plate Assembly

1. If the DUT port cover is on the sphere, remove it by loosening the two set screws in its port-frame collar with the 1.5mm hex driver.

2. Replace the DUT port cover with the TECMount adaptor ring and orient the three engagement knobs with one positioned at 12 o'clock as shown below. Fasten the ring in place by tightening the two set screws in its port-frame collar with the 1.5mm hex driver.



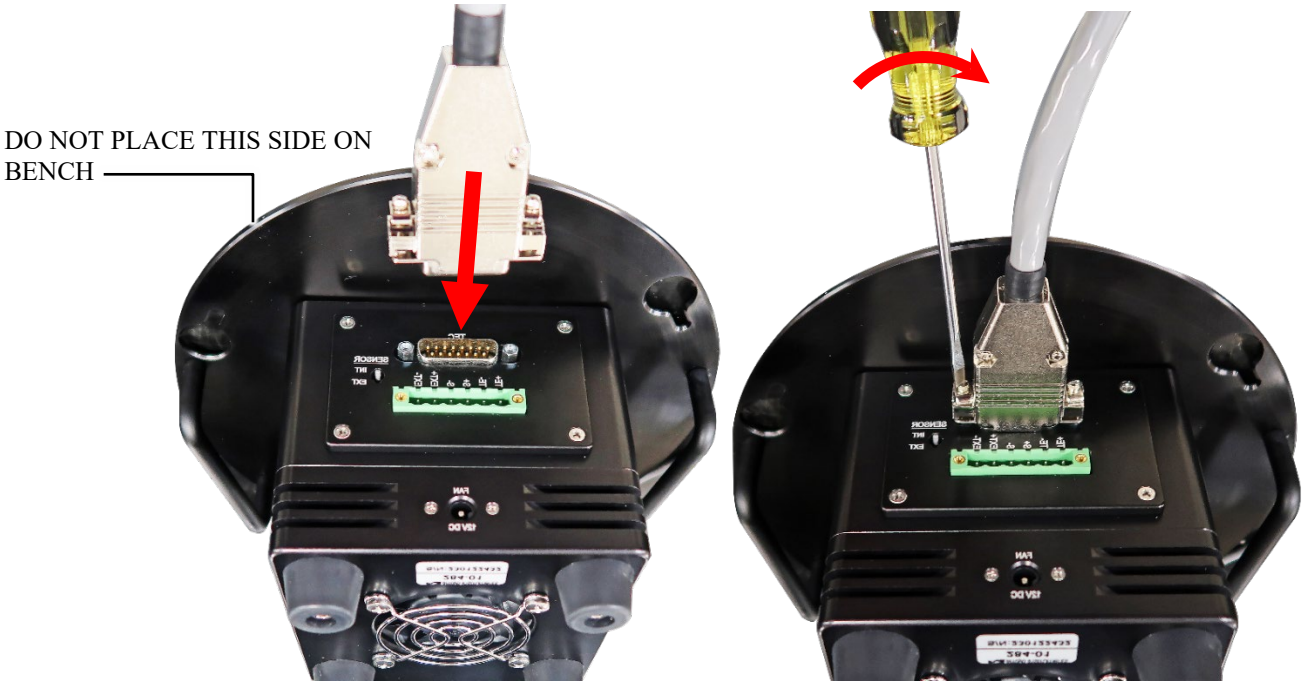
3. Mount the LED assembly to be tested to the cold plate bread board using ¼-20 screws. Wire the LED assembly to the power and sense terminal block above the cold plate.



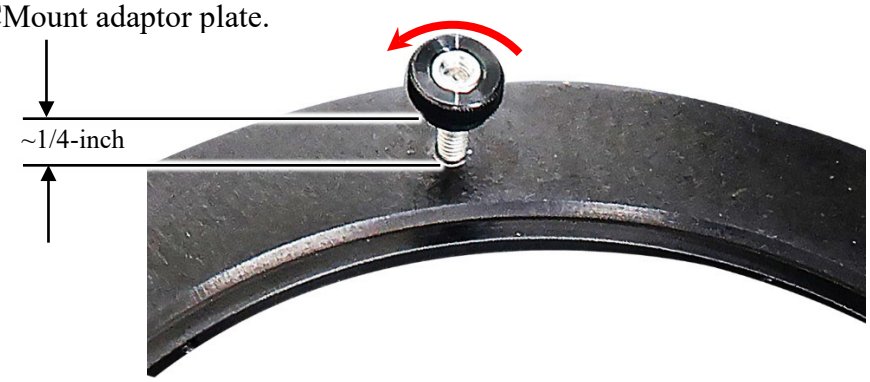
4. Place the TECMount assembly facing up on its rubber feet.

DO NOT PLACE THE COATED SURFACE SIDE ON THE BENCH.

5. Locate the 7-meter DB9 TEC control cable and plug the female connector into the male socket on the base of the TECMount assembly. Secure it in place by tightening the terminal screws with a small flat-head screwdriver.



4. Turn the engagement knobs counter-clockwise to provide approximately ¼-inch clearance for the TECMount adaptor plate.



5. Hold the TECMount chiller plate assembly by its two handles and carefully position it over the adaptor plate and line up the three slotted holes in the adaptor plate with the three engagement knobs. Push the TECMount assembly forward over the engagement knobs.

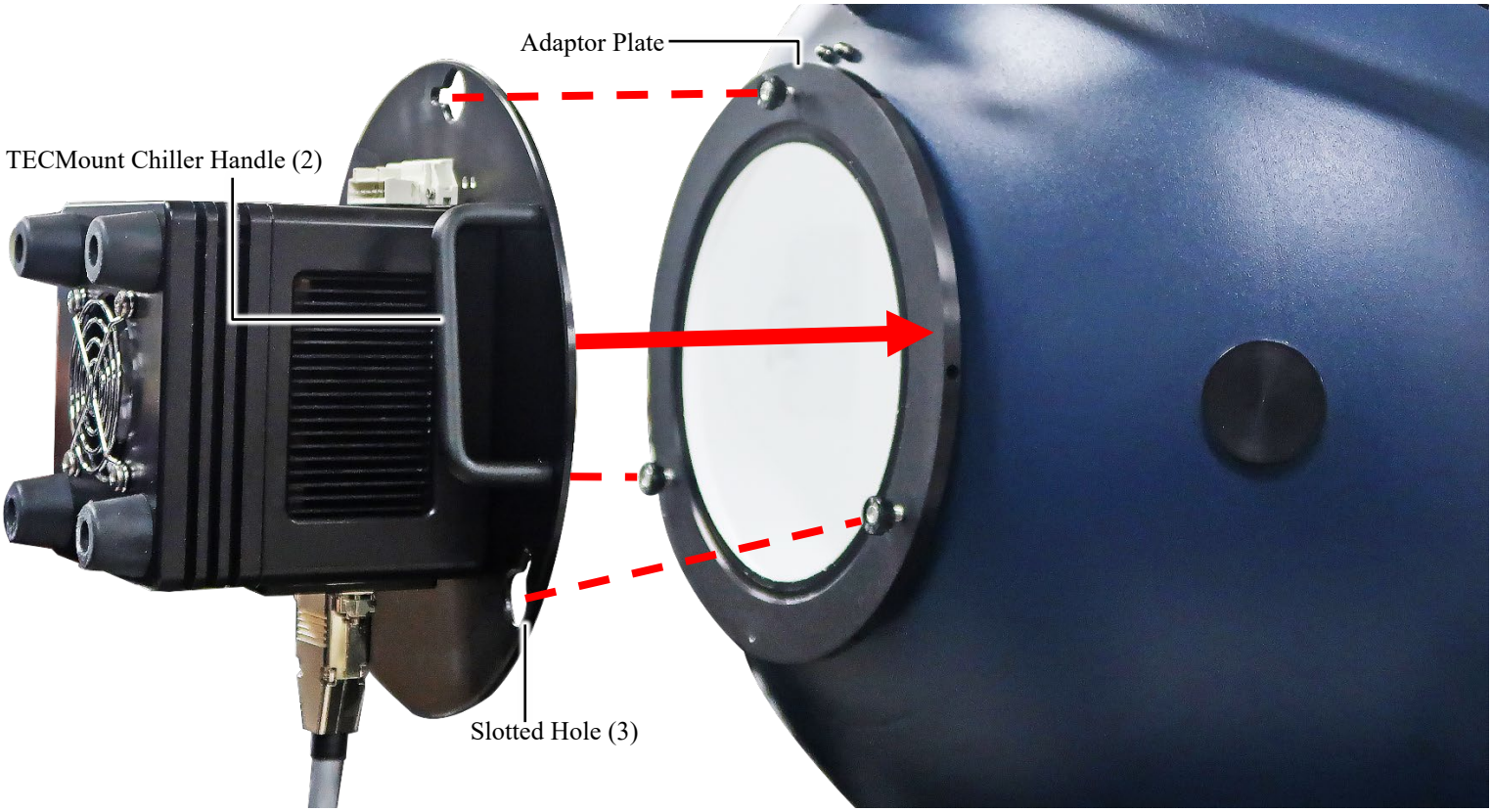


Figure 22: Align Slotted Holes over Engagement Knobs

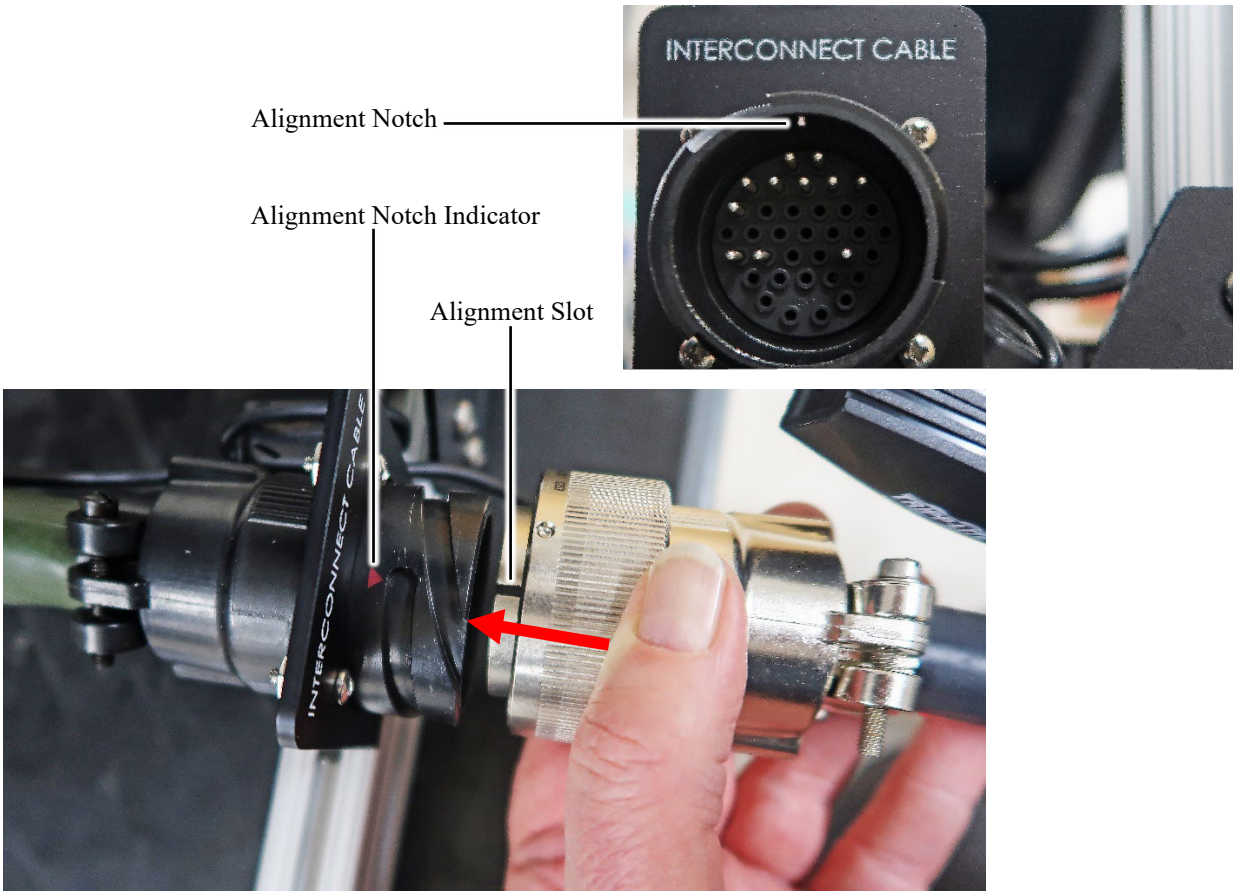
6. Once the slotted holes have cleared the engagement knobs, rotate the TECMount assembly clockwise to interface the slots with the engagement knob shafts.

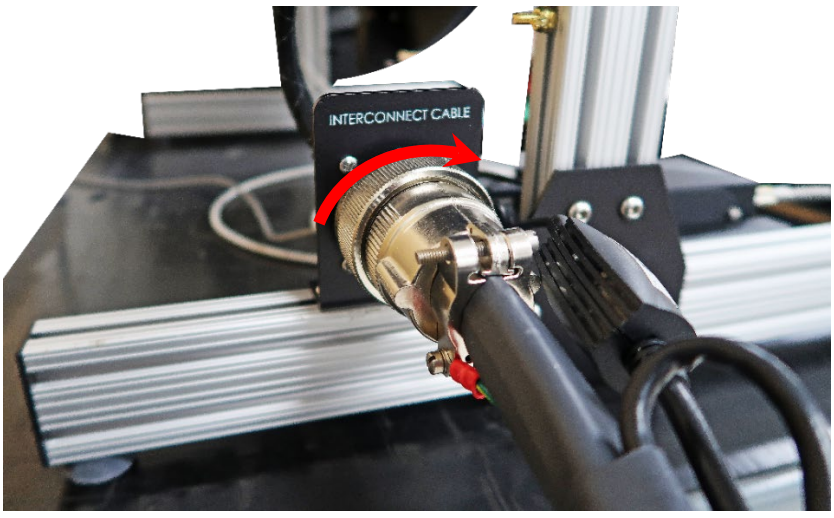
7. Tighten the three engagement knobs by hand to secure the TECMount chiller plate assembly in place.

8. Plush the plug of the DUT power cable from the junction box into the mating TECMount socket until it snaps into place.

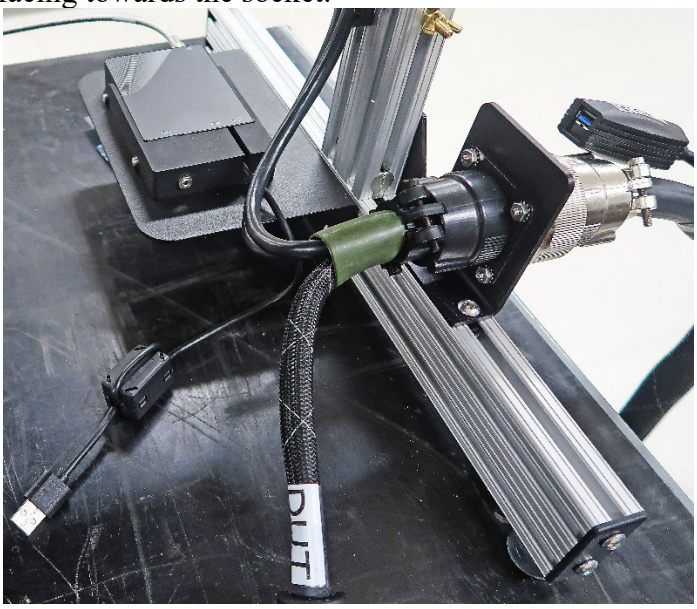
9.8. Interconnect Cable and Spectrometer Connections

1. Locate the 14.5-foot interconnect cable and prepare to plug the female 35-pin twist-lock end into the male socket labeled “INTERCONNECT CABLE” on the base of the sphere frame. Locate the alignment slot in the outer collar of the cable end and line it up with the alignment notch inside the male socket. The alignment notch is also indicated on the top of the socket enclosure with a red arrow. Align the two components and carefully push the female connector into the socket and turn its circular collar ¼-turn clockwise to lock it in place. A click will be felt when it is locked in position.

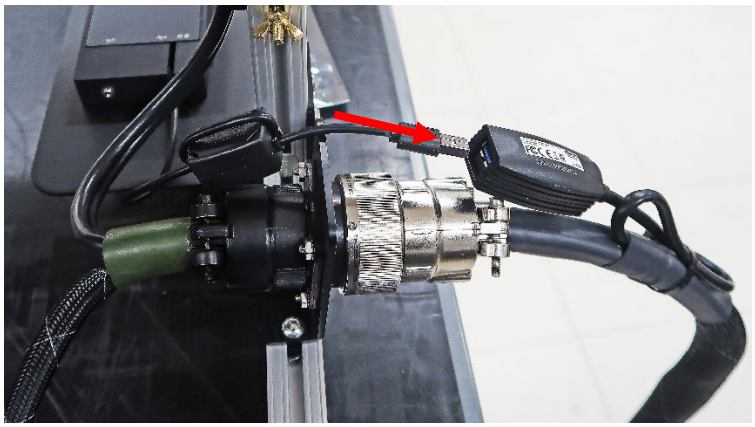


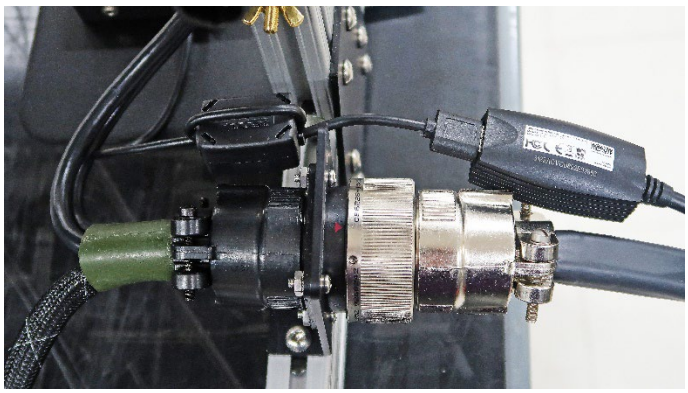


2. Place the CDS-800 spectrometer on the small metal shelf next to the interconnect socket with its attached USB cable facing towards the socket.

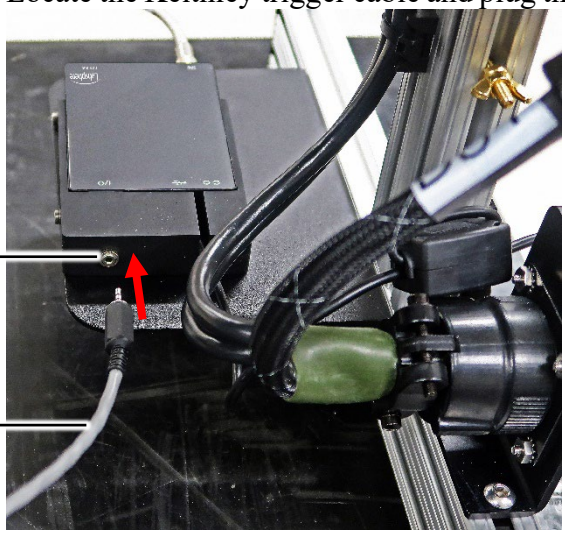


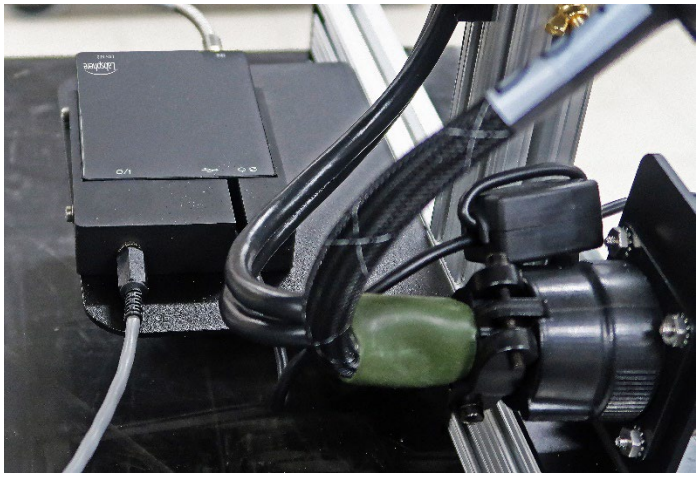
3. Plug the spectrometer USB cable into the female USB connector that is attached to the end of the interconnect cable.





4. Locate the Keithley trigger cable and plug the 2.5mm connector into the spectrometer trigger-in jack.



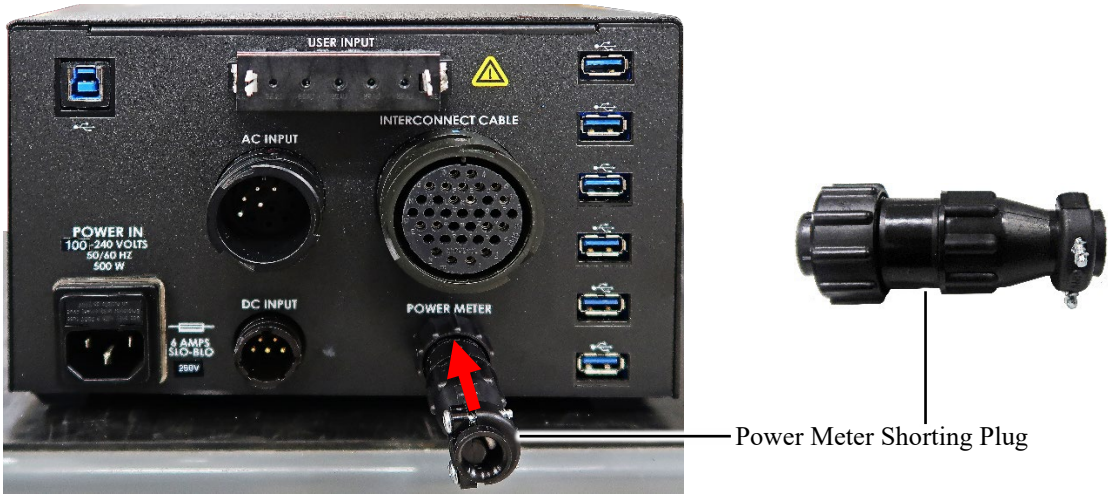


9.9. Installation of the Primary Electronic Components

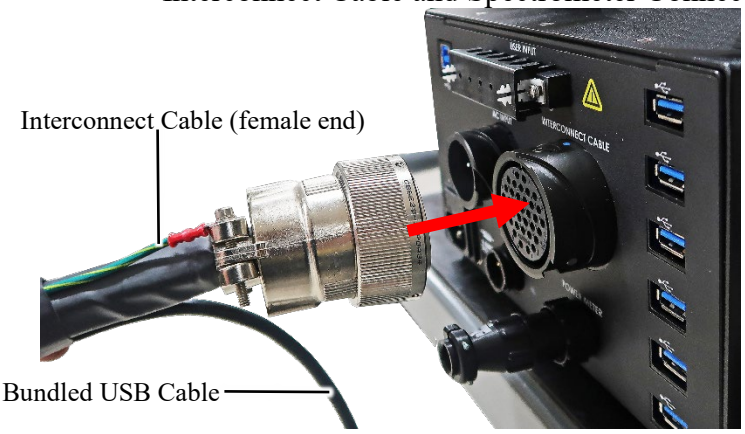
This is the configuration recommended by Labsphere to accommodate the lengths of the cables that are provided to connect the electronic components together. This configuration can vary to accommodate the needs of the installation site, however, different length cables from those provided may be required.

2. Position the electronic components on a bench to within 3-feet of the sphere assembly. Place the Labsphere ICM-500 on the bench first with the rear panel facing the same direction as the rear of the sphere assembly.

2. Locate the power meter shorting plug in the ICM-500 box and plug it into the socket labeled "POWER METER".

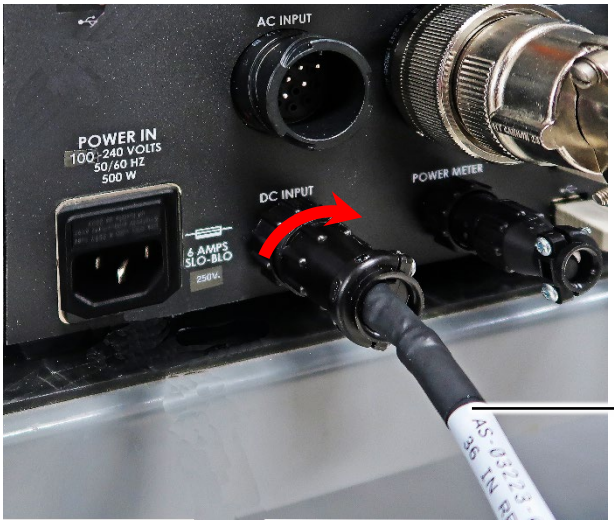


3. Connect the male end of the interconnect cable to the socket labeled “INTERCONNECT CABLE”. Use the same notch alignment and connection procedure as connecting the female end of the cable to the interconnect socket on the sphere assembly frame. Refer to section 9.8 “Interconnect Cable and Spectrometer Connections” on page 46.



4. Plug the USB A cable that is bundled with the interconnect cable into any one of the USB A sockets on the ICM-500.

5. Locate the Keithley 2461 DC output cable and plug the circular end into the socket labeled “DC Input”. Refer to section 5.3 “System Cables” on page 11. Turn the twist lock collar cklockwise to secure it in place.



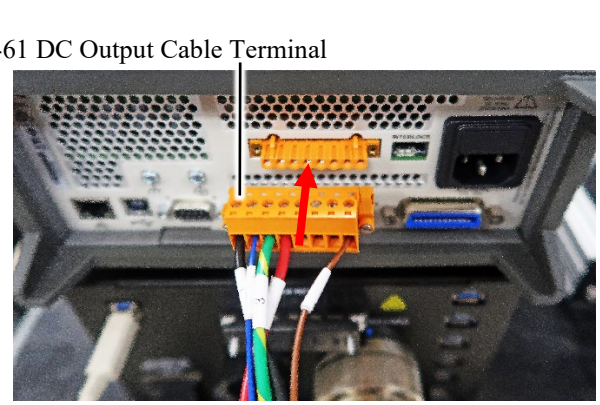
6. Locate the long USB A-to-B cable and plug the B connector into the USB B socket on the ICM-500 rear panel.

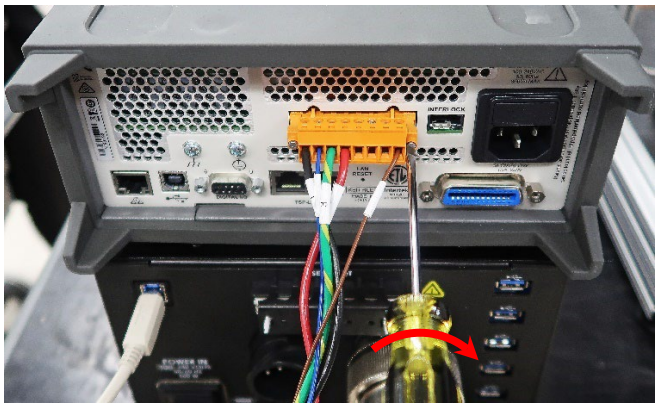
7. Plug the female end of one of the detachacle AC power cables into the AC power input socket. Do not plug the male end into the power source yet.

8. Place the Keithley 2461 on top of the ICM-500.

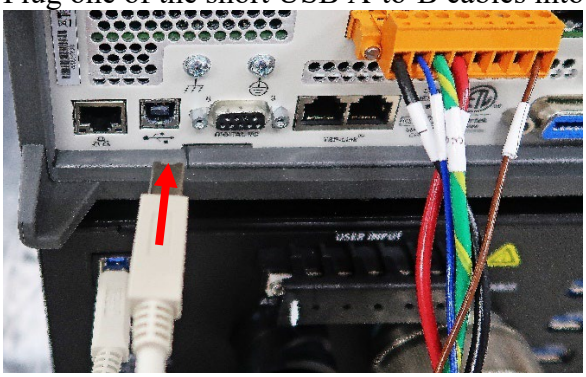
9. Plug the orange terminal connector end of the Keithley 2461 DC output cable into its mating socket on the Keithley 2461 rear panel. Secure it in place by tightening the two terminal screws with a small flat balade screwdriver.

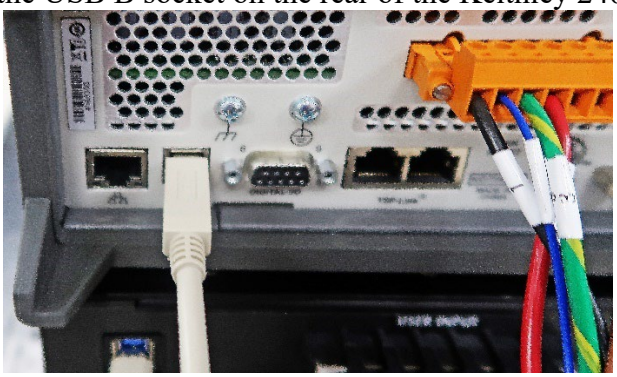
Keithley 2461 DC Output Cable Terminal



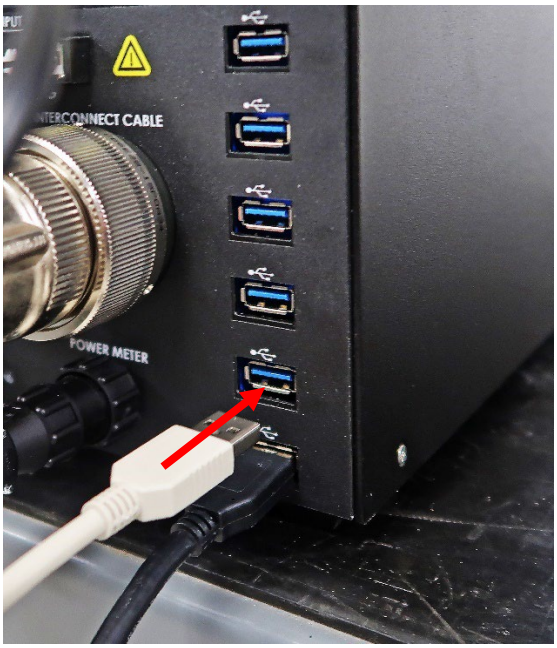


10. Plug one of the short USB A-to-B cables into the USB B socket on the rear of the Keithley 2461.

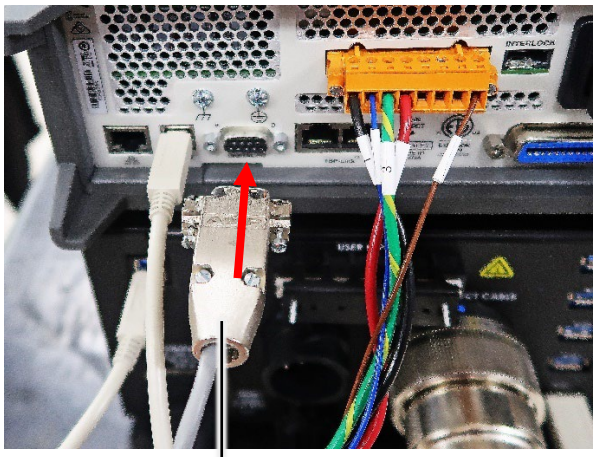




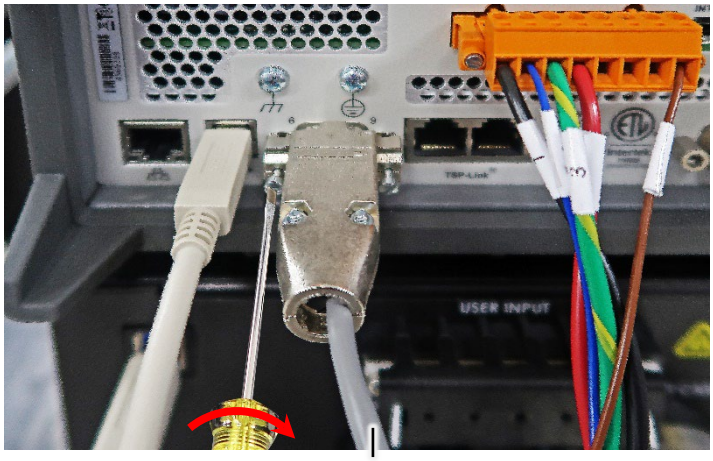
11. Plug the other end of the USB cable into one of the USB A sockets on the rear of the ICM-500.



12. Locate the Keithley 2461 spectrometer trigger cable and plug the DB9 connector end into the DB9 socket on the rear of the Keithley 2461. Refer to section 5.3 “System Cables” on page 11. Secure it in place by tightening the two terminal screws with a small flat blade screwdriver.

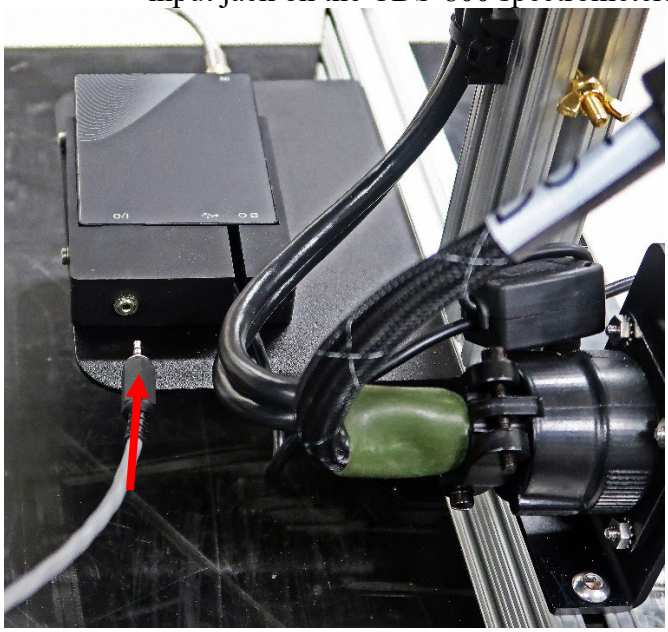


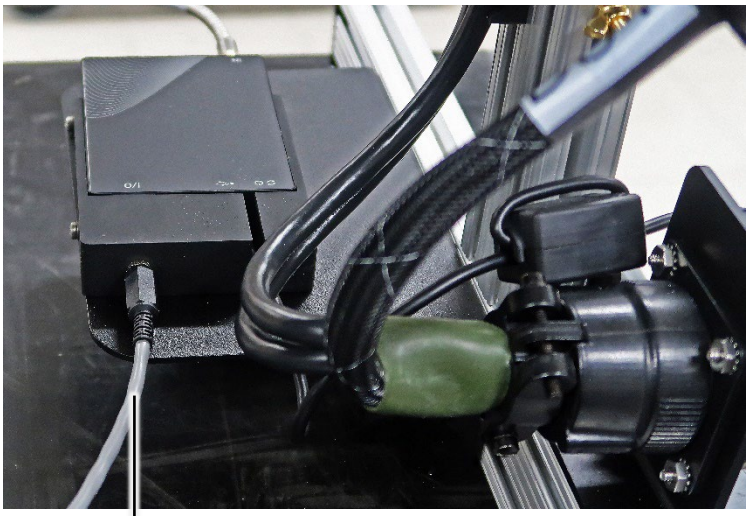
DB9 Connector



Keithley 2461 Trigger Cable

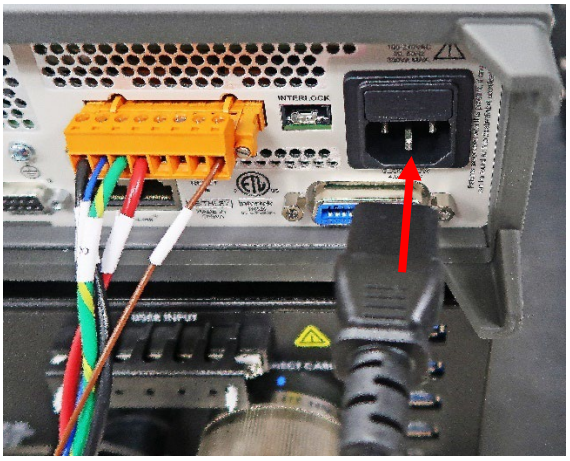
13. Plug the 2.5mm diameter end of the Keithley 2461 spectrometer trigger cable into the trigger input jack on the CDS-800 spectrometer.

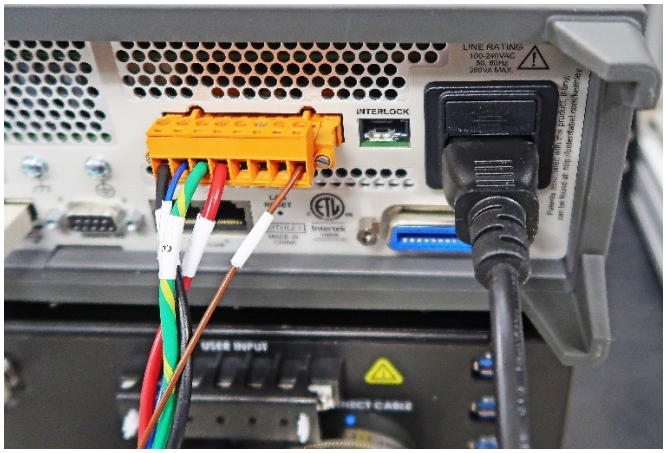




Keithley 2461 Trigger Cable

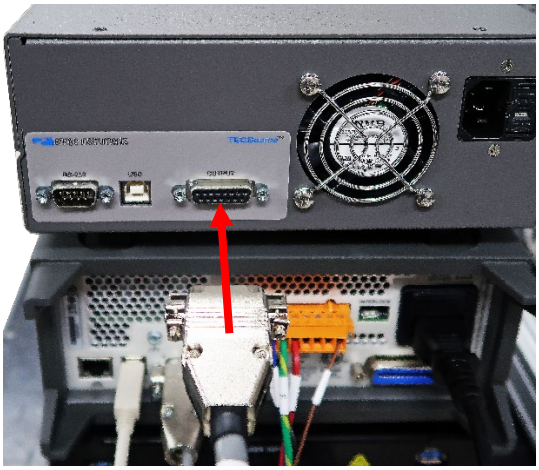
14. Plug the female end of one of the detachacle AC power cables into the AC power input socket. Do not plug the male end into the power source yet.

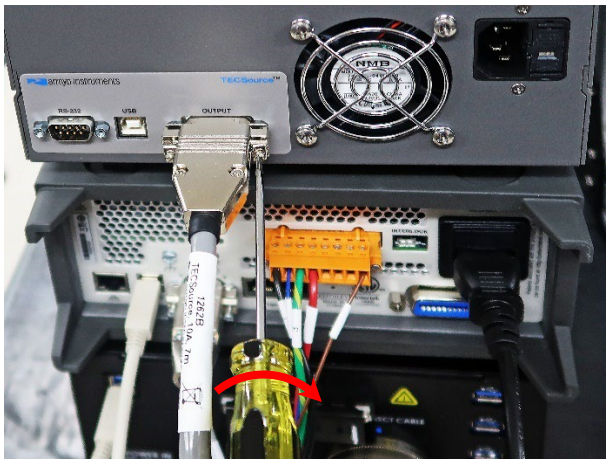




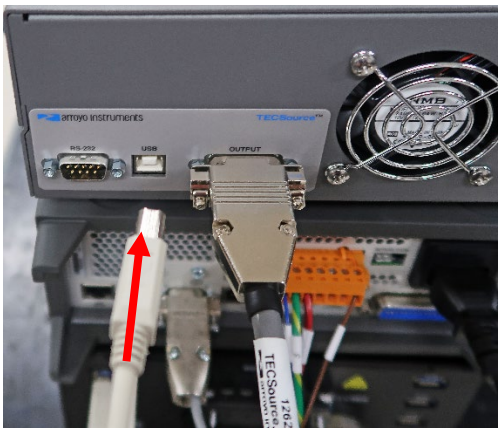
15. Place the Arroyo 5305 TEC Controller on top of the Keithley 2461.

16. Locate the 7-meter Arroyo 5305 TEC controller DB15 cable. Refer to section 5.3 “System Cables” on page 11. Plug the male end of the cable into the female DB15 ssocket labeled “OUTPUT”. Secure it in place by tightening the two terminal screws with a small flat blade screwdriver.

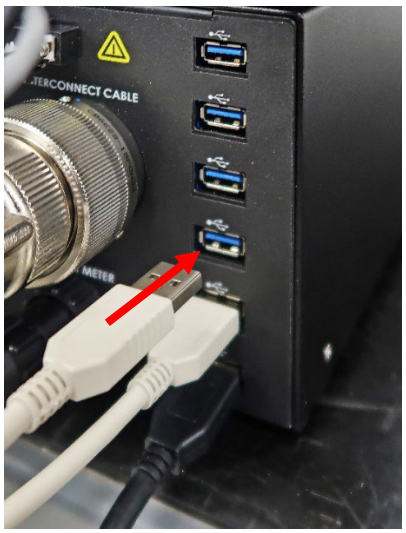




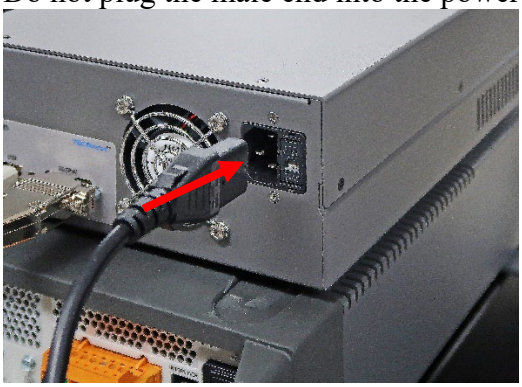
16. Plug one of the short USB A-to-B cables into the USB B socket on the rear of the Arroyo 5305.



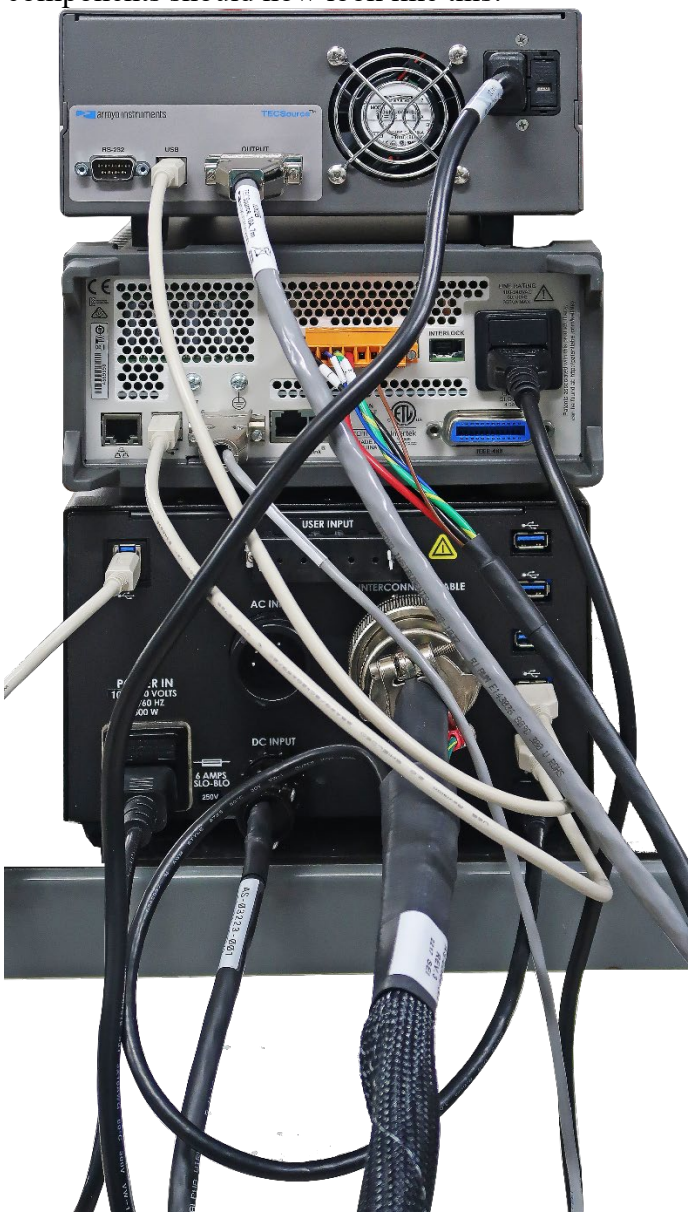
17. Plug the other end of the USB cable into one of the USB A sockets on the rear of the ICM-500.



18. Plug the female end of one of the detachacle AC power cables into the AC power input socket. Do not plug the male end into the power source yet.



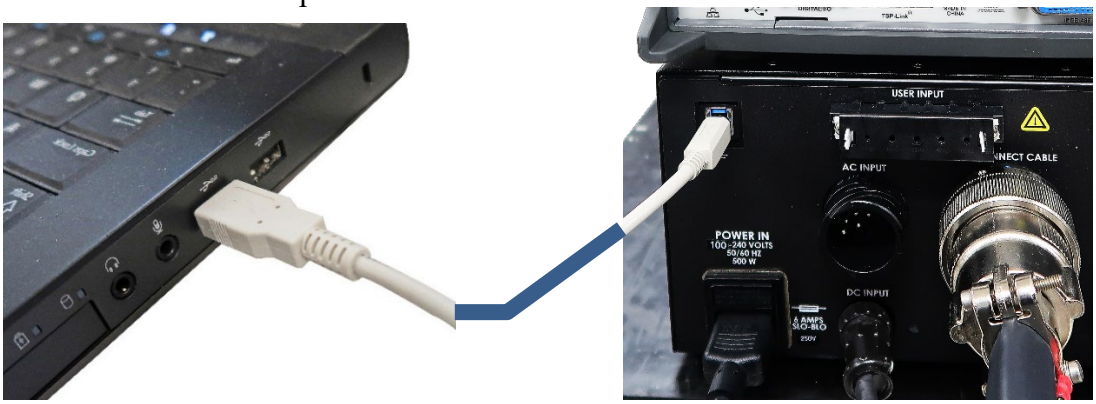
The wired electronic components should now look like this:



9.10. Computer and Power Connections and System Start Up

The latest version of the Integral software is required to run the illumia®Pro3 system. The host computer will require the full Integral installation using the provided Labsphere flash drive.

1. Locate the USB A-to-B cable that was previously plugged into the ICM-500 and plug it into a USB socket on the host computer.



2. Plug the three AC power cables from the electronic components into the system power strip.

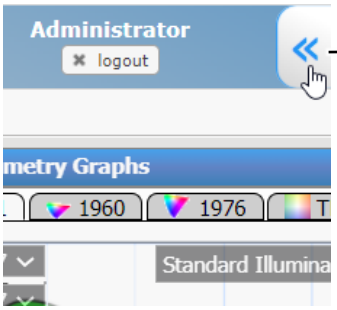
3. Plug one end of the AC mains cable into the power strip and the other into the 100-240VAC, 50/60Hz power source.

10. INTEGRAL INSTALLATION

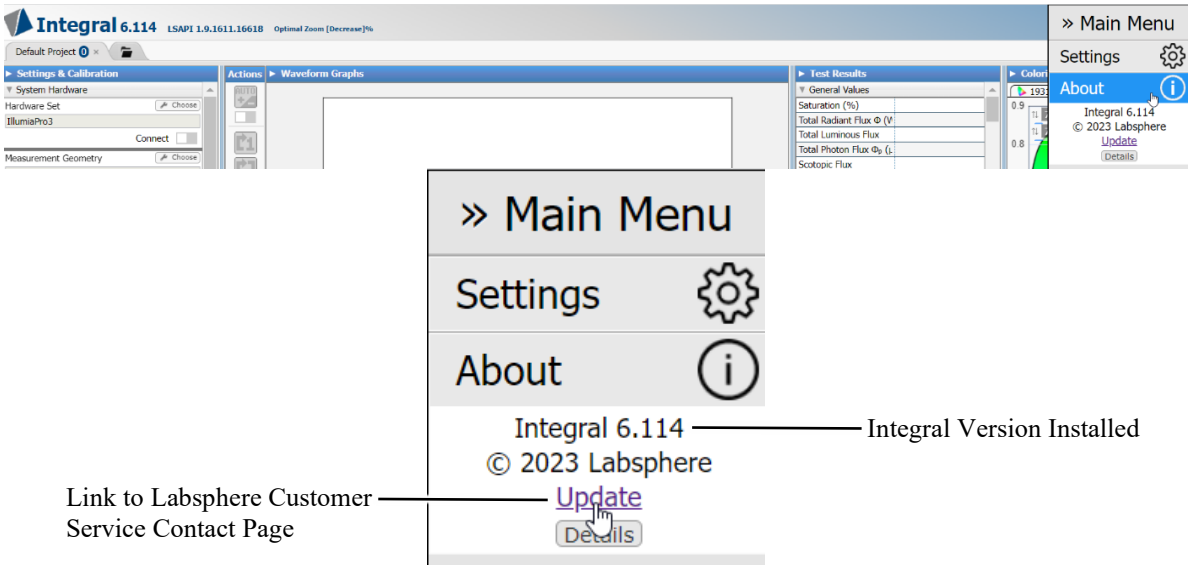
Refer to the provided Integral software manual AQ-81000-100 for more information.

1. Turn on the host computer and wait for Windows to load, then turn on the power switch on the front panel of each electronic component.
2. Insert the supplied Labsphere USB flash drive into a USB socket in the host computer and run the Integral Installer.

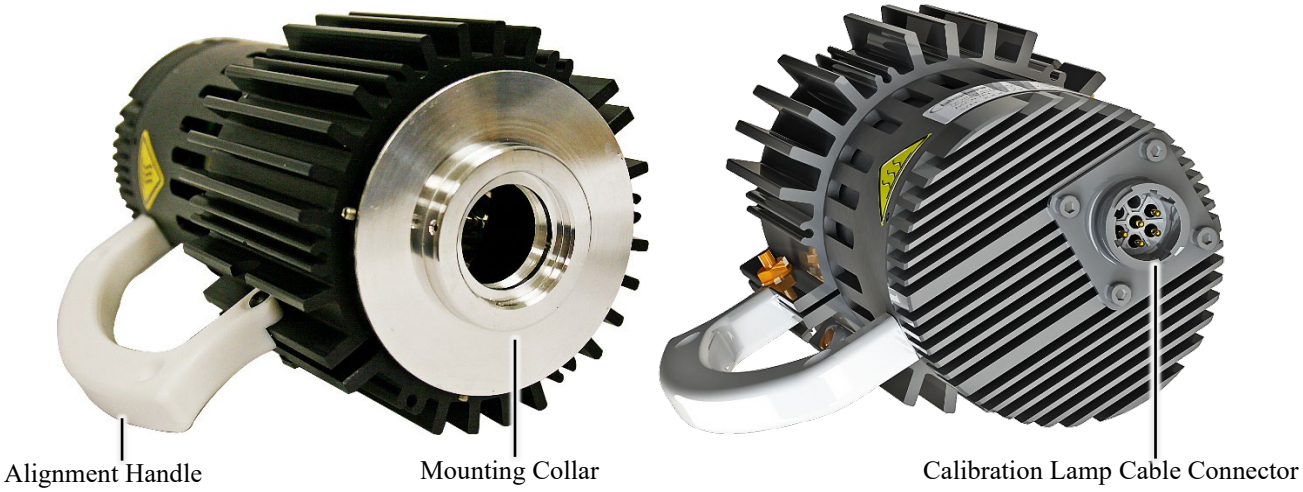
3. Launch the Integral program and click the double left arrows in the upper right corner to open the Main Menu dropdown.



4. Click "About" to see what version of Integral has been installed. Integral version 6.114 is shown in the About screen below. Click the "Update" link to navigate to the customer service contact page on the Labsphere website to inquire about Integral software updates.



11. OPTIONAL FORWARD SPECTRAL FLUX STANDARD



Labsphere's Lamp Standards of Forward Spectral Flux provide an exceptional artifact for calibrating integrating sphere spectrometers for total spectral radiant flux responsivity from 350 to 1050nm. All of Labsphere's standard lamps are first seasoned for 1% of their rated life and then screened for stability and repeatable performance before they are selected for calibration. The selected lamps are then calibrated directly to the NIST spectral flux reference. All calibration certificates include a complete uncertainty analysis.

All lamp standards include a calibration certificate and spectral flux data in W/nm and total luminous flux. The spectral flux data is provided for uploading into Labsphere's spectral light measurement software included with our world leading light measurement systems. Click this link for pricing and ordering information: https://www.labsphere.com/product/calibrated-forward-spectral-flux-standards/

Refer to the calibration certificate on the Labsphere flash drive for specifications.

11.1. Ordering Information

Model Number	Order Number
FFS-100-400	AS-02768-100
FFS-100-1000	AS-02768-200

11.2. Quick-Release Mounting Plate Removal

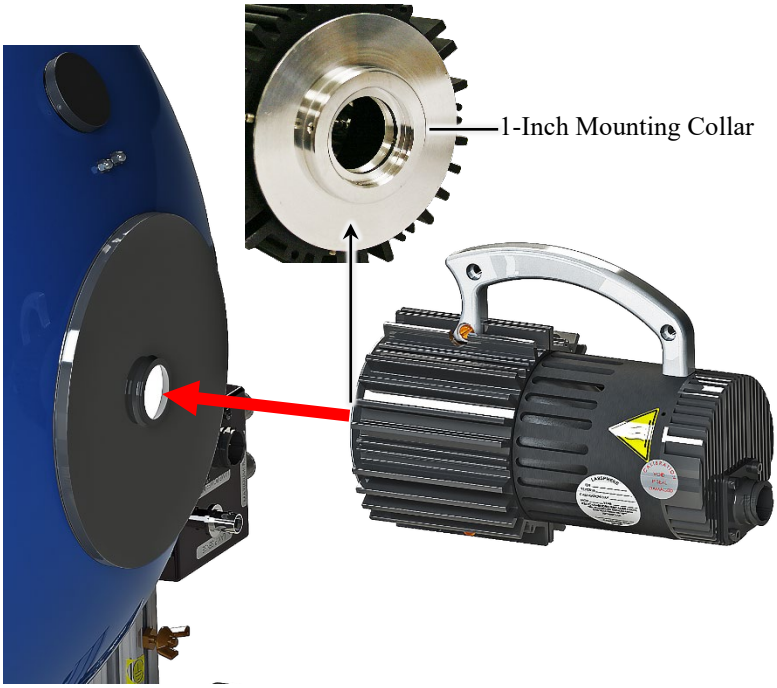
This procedure can be done when using the Forward Spectral Flux Standard (shown in this section) or closing the 2π port indefinitely for long term 4π measurements.

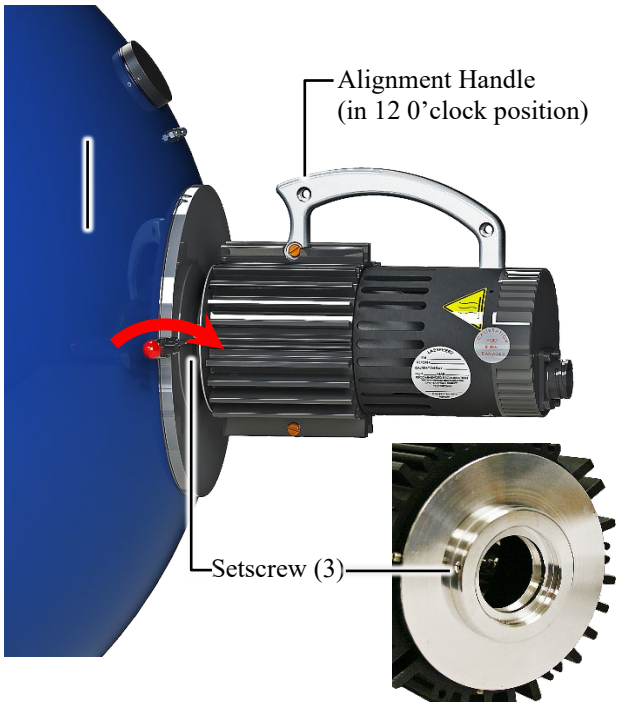
1. Remove the TECMount or quick-release calibration/FSF adaptor plate if already mounted on the quick-release mounting plate.
2. Loosen the six setscrews in the mounting plate collar with the provided 1.5mm hex driver.
3. Pull the mounting plate collar straight off of the exit port frame.

4. Place the stationary port reducer on the exit port frame and tighten the two setscrews in the collar with the 1.5mm hex driver.

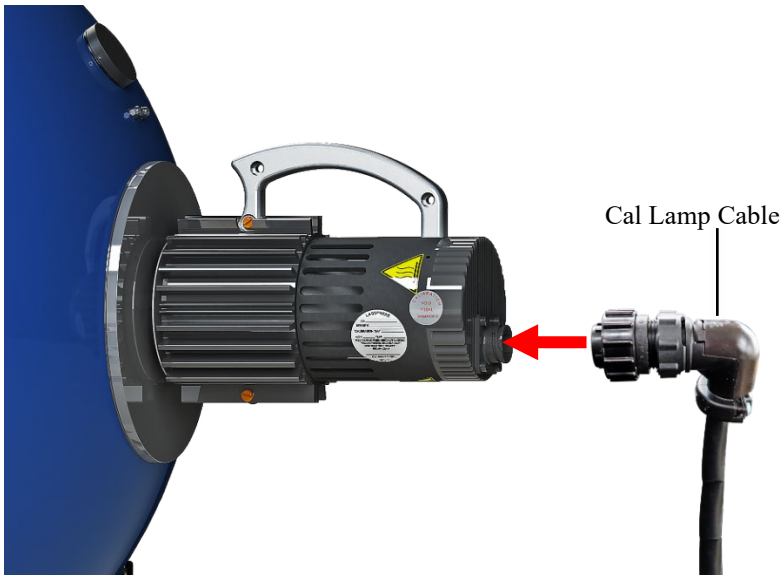
5. Remove the calibration lamp (if installed) and replace it with a 1-inch port cover. Refer to section 9.4 “Installation of the 2π Calibration Lamp” on page 34 and reverse the steps.

6. Locate the 1-inch mounting collar on the optional Forward Spectral Flux Standard lamp assembly and place it over the 1-inch port frame. Rotate the lamp assembly to where the alignment handle is in the 12 o’clock position. Then tighten the three setscrews with the 1.5mm hex driver.



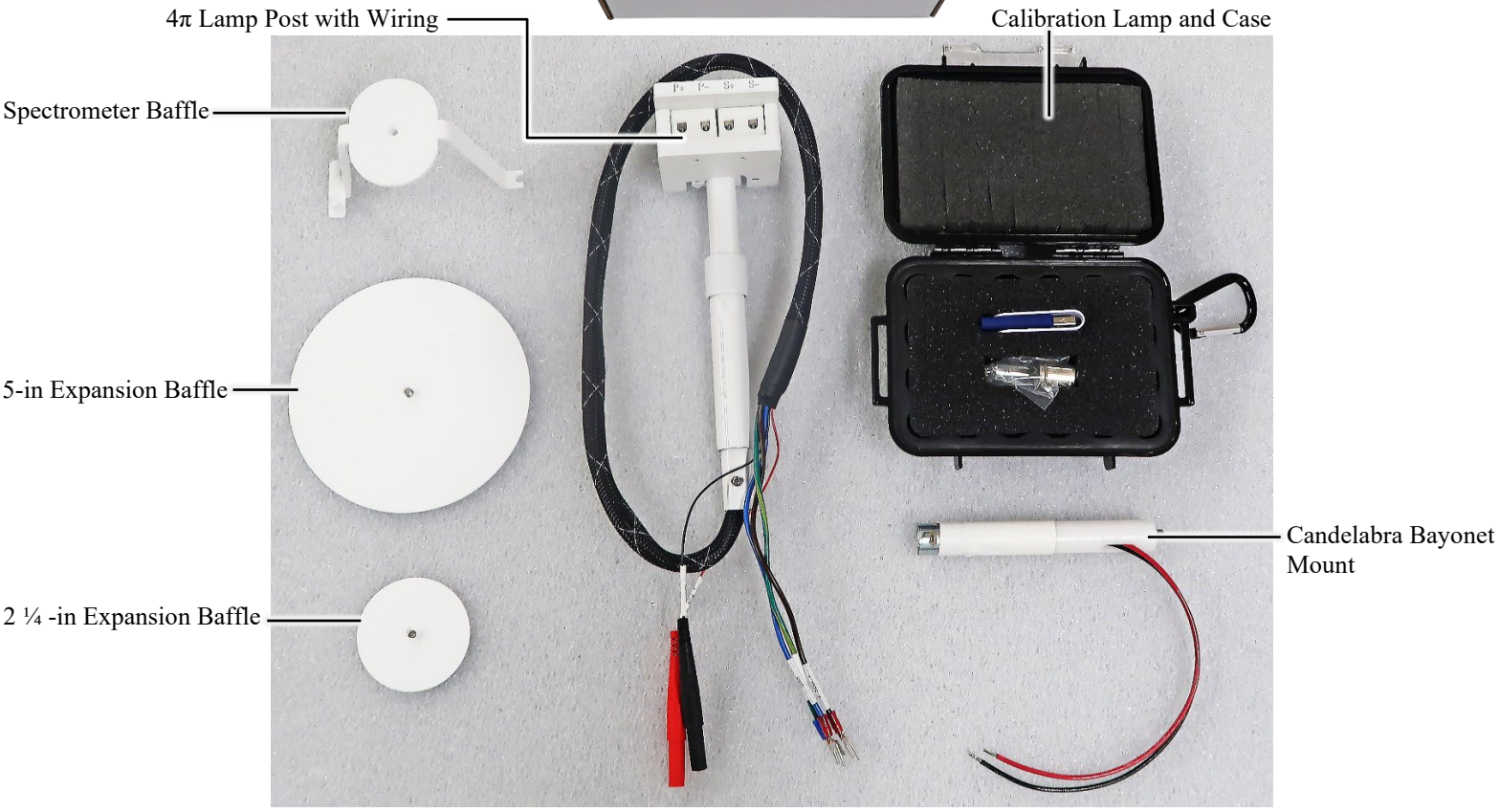


7. Attach the CAL lamp twist-lock power cable to the power connector on the other end of the optional Forward Spectral Flux Standard lamp assembly.



12. OPTIONAL 4π KIT

The optional 4π kit is used to perform 4π measurement geometry with 2π systems. The kit includes the 4π lamp post with wiring, the candelabra bayonet mount, the spectrometer baffle, two spectrometer expansion baffles, and the calibration lamp. The Labsphere 4π kit order number is **AA-41001-050** and can be ordered on the Labsphere webstore:
https://www.labsphere.com/customer-support/



12.1. 4π Kit Installation

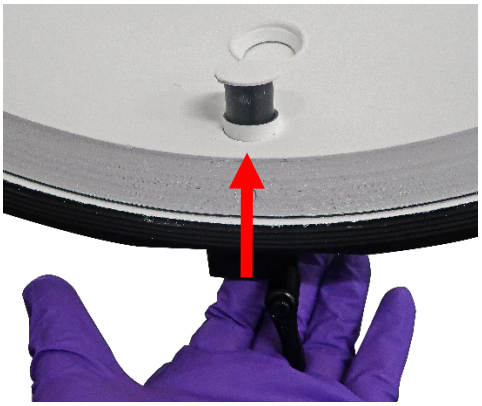
12.1.1. Preparation Steps

1. Power down the system.
2. Remove the TECMount from the 2π port if mounted.
3. Cover the 2π port using any of the three devices shown in section 7.5 “2π Port Hardware” on page 20.

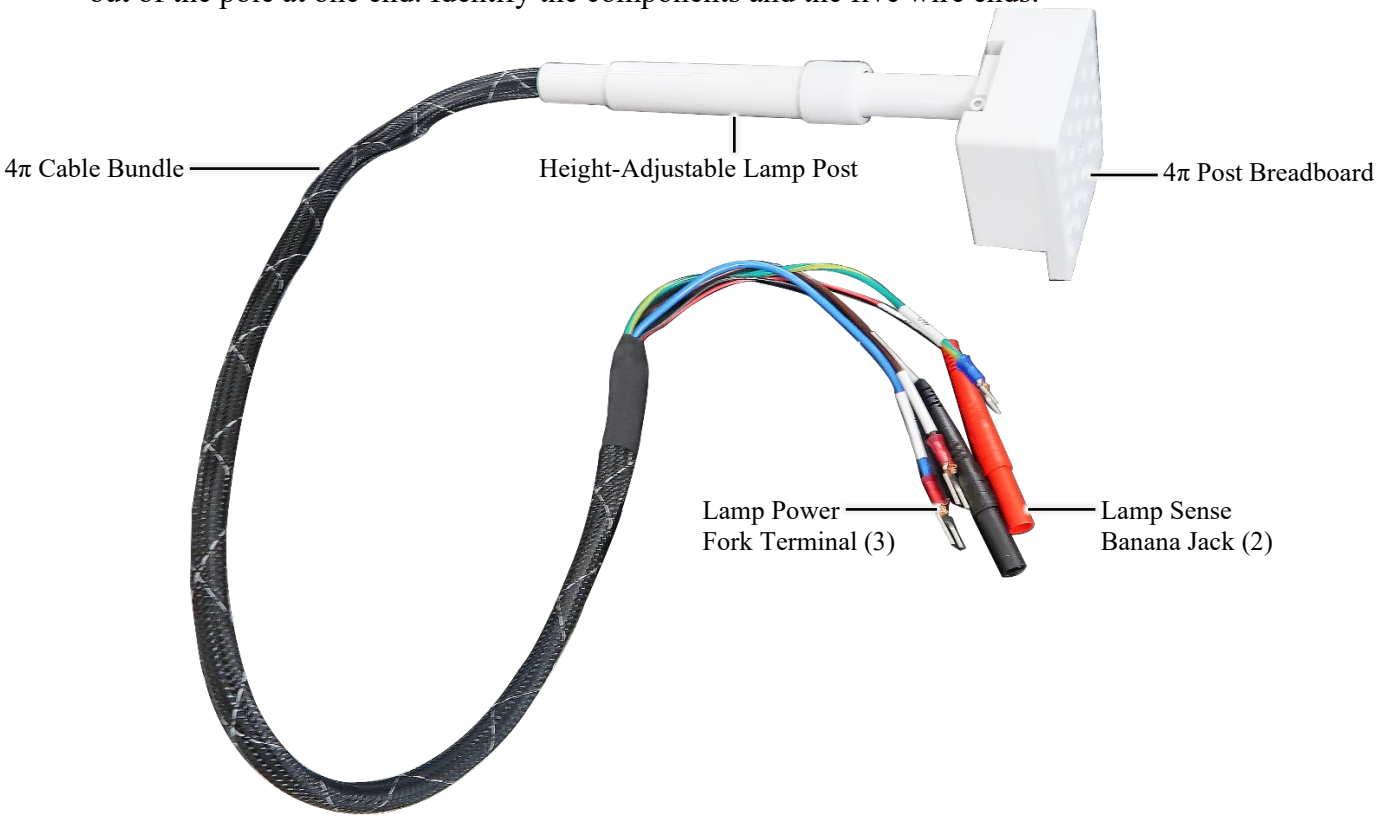
12.1.2. DUT Mounting Pole Assembly

1. ***Put on latex or nitrile gloves and do not touch any of the Spectraflect surfaces with bare hands.***
2. Open the front hemisphere and locate the 4π lamp post plug and its retaining clamp and lever at the bottom of the rear hemisphere.

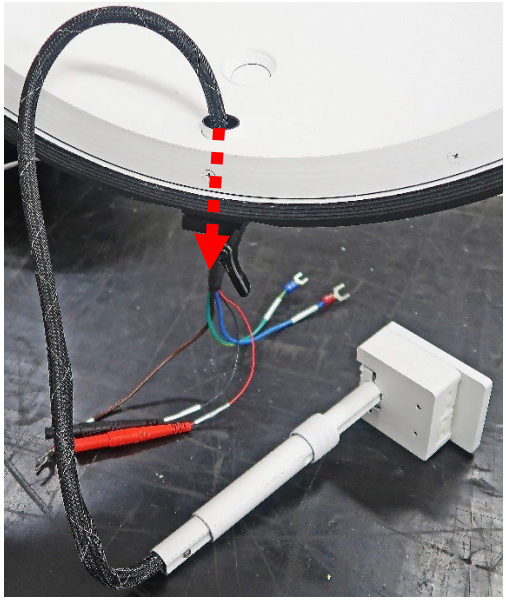
3. Remove the lamp post plug by turning the clamp lever counterclockwise with one hand while pushing up in the bottom of the plug hole with an index or middle finger on the other hand to remove the plug.



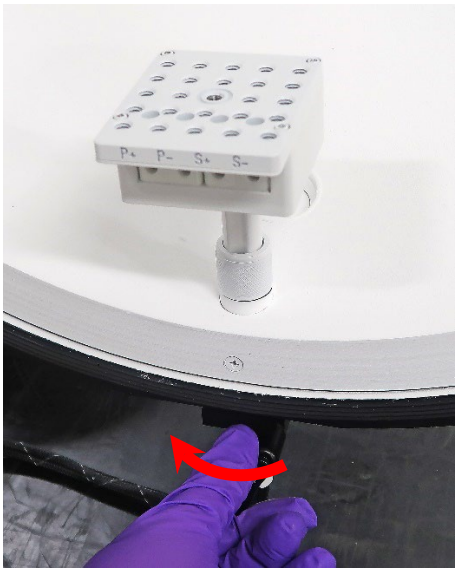
4. Remove the 4π lamp post assembly from the accessories box and locate the cable bundle coming out of the pole at one end. Identify the components and the five wire ends.



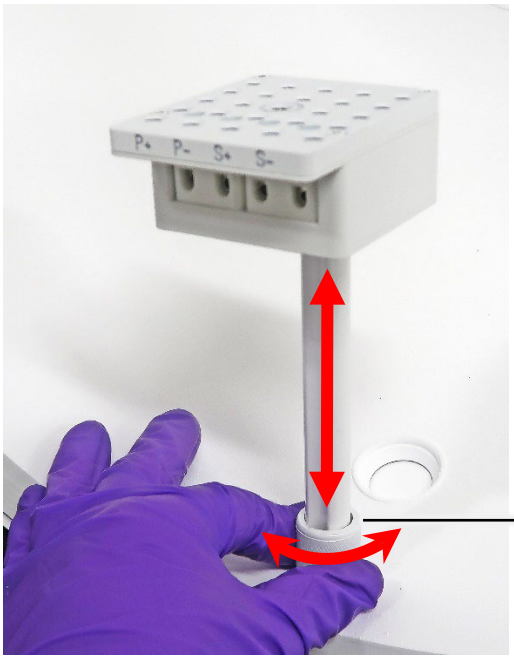
5. Route the two lamp sense banana jacks through the open lamp post hole on the other side, followed by the three lamp power fork terminals, and then the rest of the cable bundle.



6. Insert the 4π lamp post into the lamp post hole and turn the clamp lever tightly clockwise to lock the post in place.

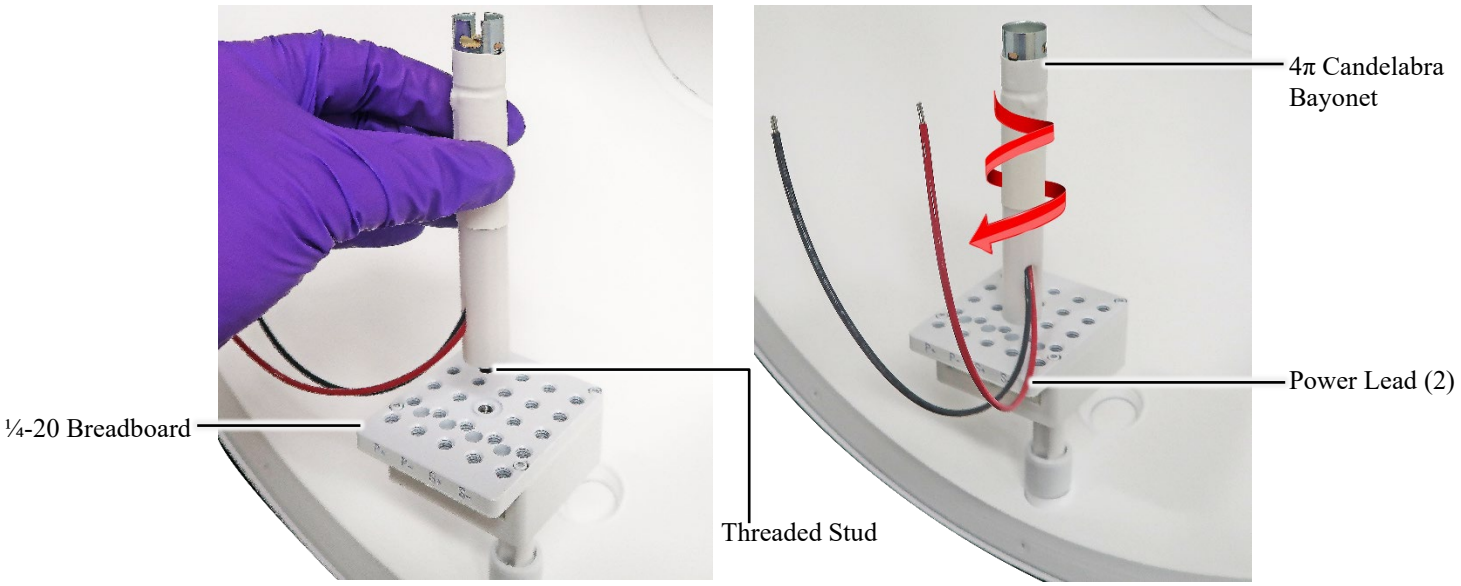


7. The 4π lamp post is telescopic. Loosen the compression collar and slide the upper end of the post up or down to the desired height. Tighten the collar once the adjustment is set.

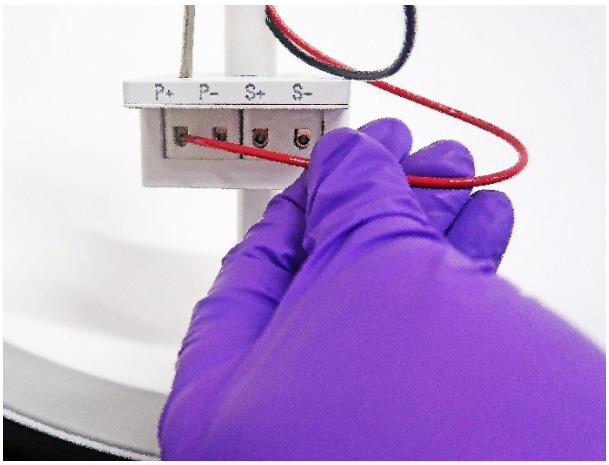


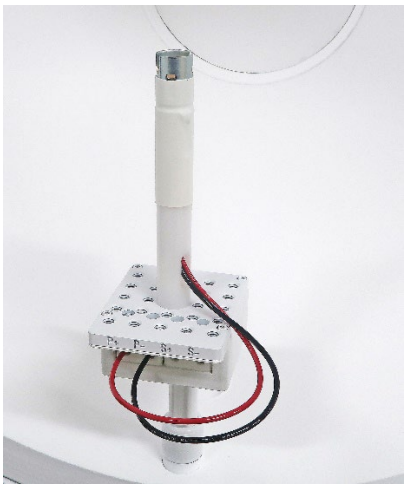
8. Install the 4π candelabra bayonet by screwing the ¼-20 threaded stud at the base into one of the threaded holes in the 4π post breadboard.

Be careful not to let the ends of the power leads scratch the Spectraflect surface when screwing in the candelabra bayonet.

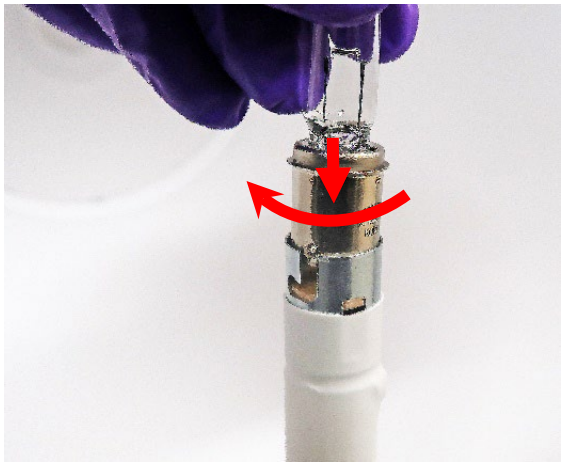


9. Insert the tinned end of the red power lead into the terminal clamp labeled "**P+**" and secure it in place by tightening the clamp screw from above with a small flat-blade screwdriver. Repeat the process with the black power lead in the terminal labeled "**P-**".



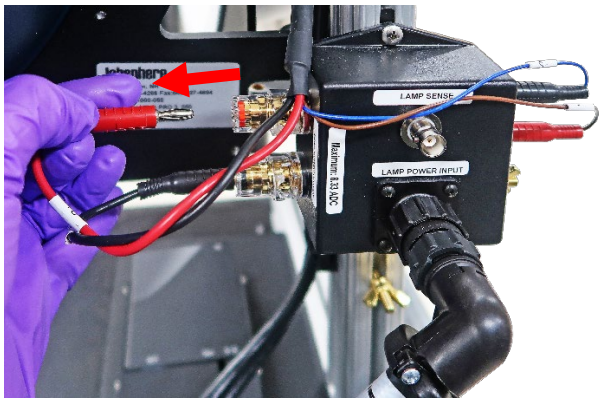


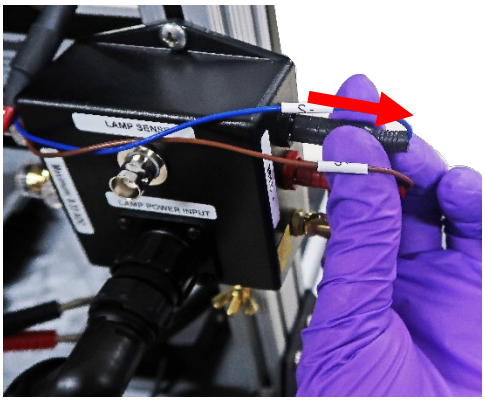
10. Locate the 4π calibration lamp case in the accessory box. Using gloves, remove the bulb and insert it into bayonet socket at the top of the candelabra. Gently push the bulb down and rotate it clockwise to lock it in place.

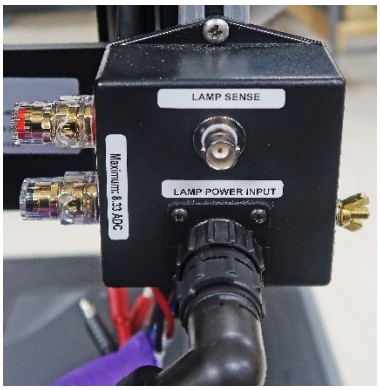


12.2. 4π Junction Box Connections

1. Remove the 2π power and sense cables from the junction box by pulling them straight out of their sockets.



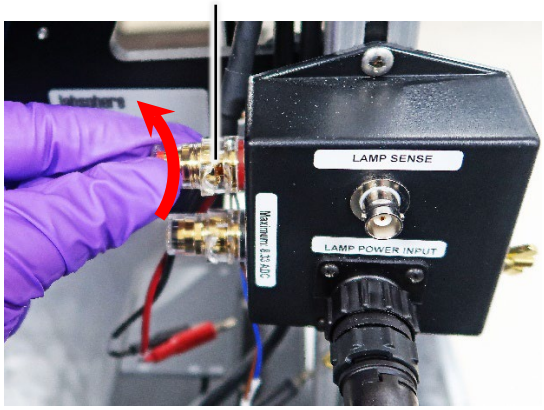


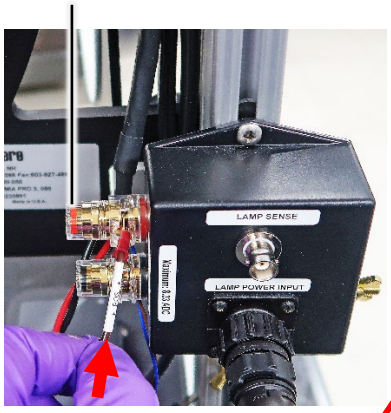


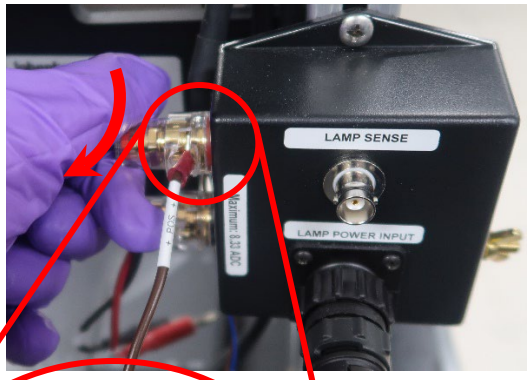
2. Loosen the red power terminal knob enough to open the fork connector slot on the side. Insert the fork connector labeled "+ **POS** +" into the connector slot as far as it will go, then tighten the red power terminal knob to secure it in place.

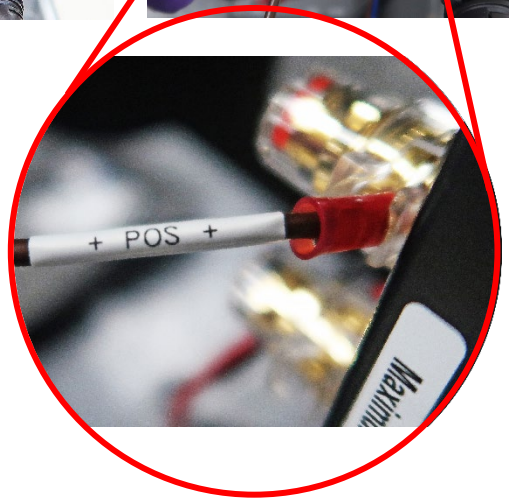
Fork Connector Slot

Red Power Terminal Knob





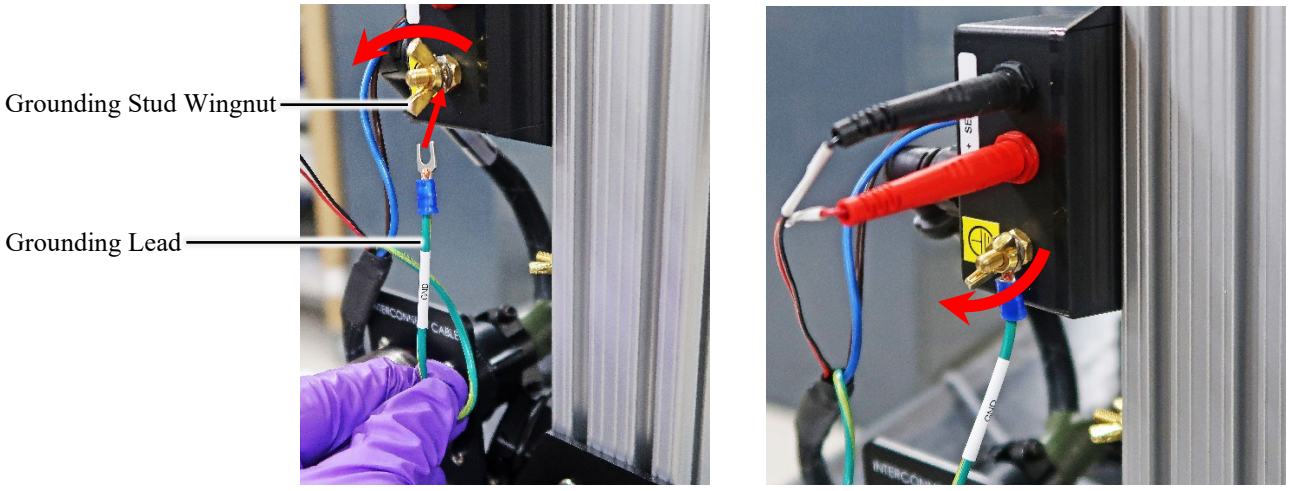




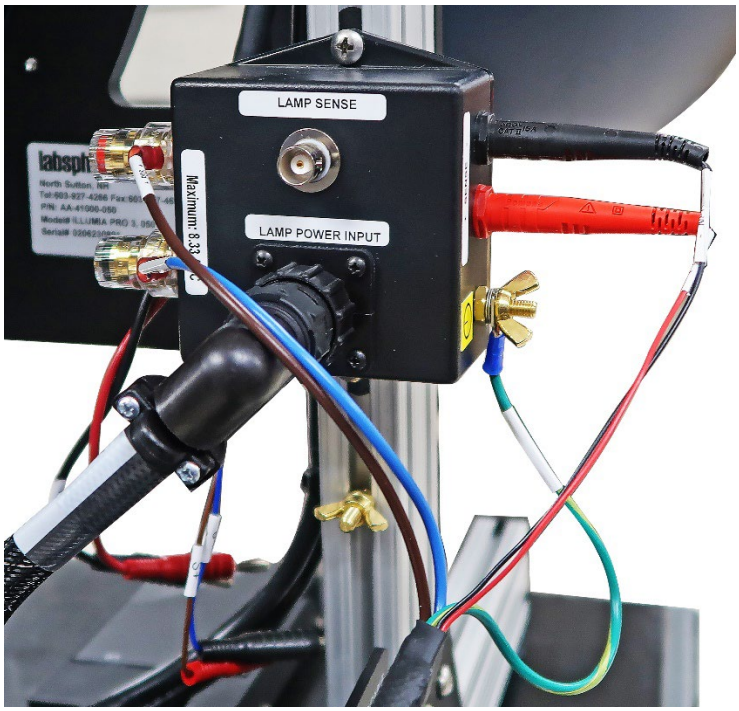
3. Repeat step 2 with the black power terminal knob and the fork connector labeled "**- NEG -**".

To Black Power Terminal Knob

4. Loosen the grounding stud wingnut and insert the fork connector labeled "**GND+**" over the stud slot as far as it will go, then tighten the wingnut to secure it in place.



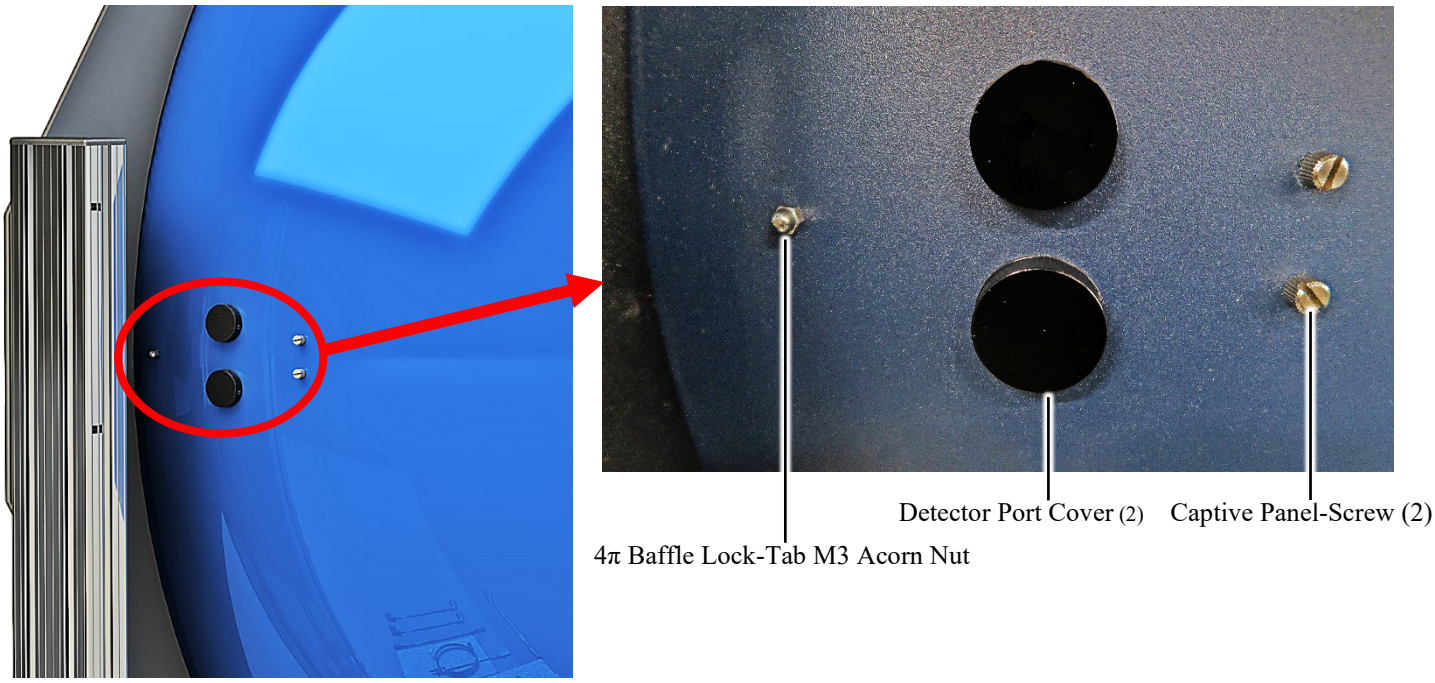
The 4π junction box will look like this when the connection have been completed:



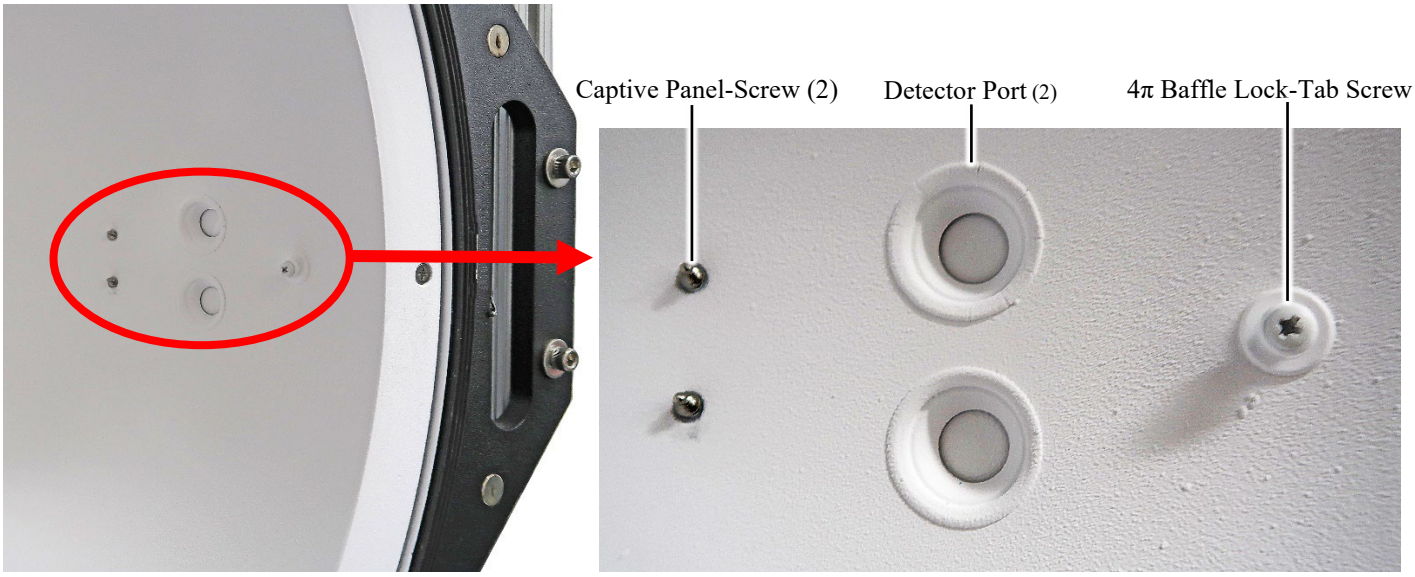
12.3. Installation of the 4π Baffles

The 4π baffle must be installed over the two detector ports when using the 4π DUT mounting post assembly. The 4π baffle and hardware are in the same carton as the 4π post assembly.

1. Locate the two knurled, captive panel-screws and the 4π lock-tab M3 acorn nut on the outside of the rear hemisphere, just to the right of the two detector port covers.



2. Open the sphere and locate where the two captive screws and the 4π baffle lock-tab screw come through sphere wall on the inside.



3. ***Put on latex or nitrile gloves and do not touch the baffle or inside surface of the sphere with bare hands.***
4. Take the 4π baffle from the accessories kit and locate the two threaded cylinders that are swaged to the inside mounting flange.

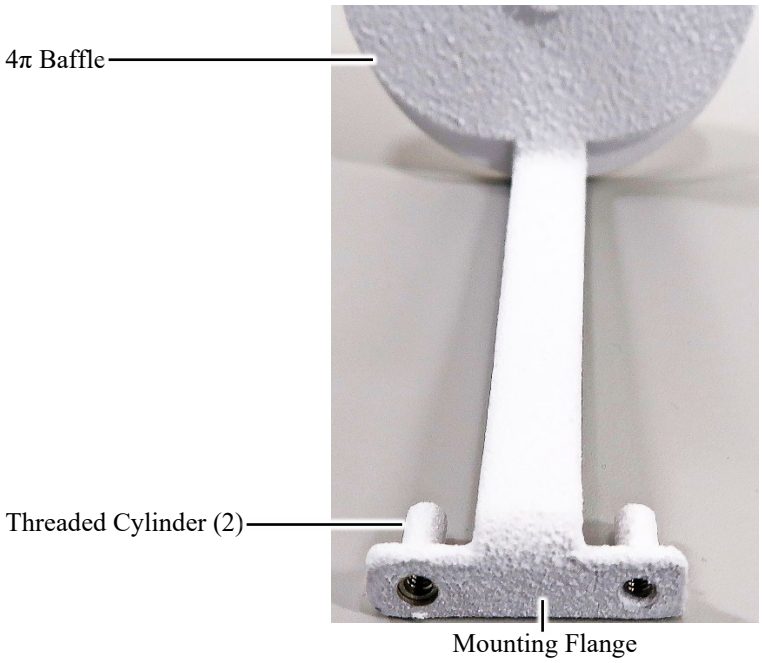
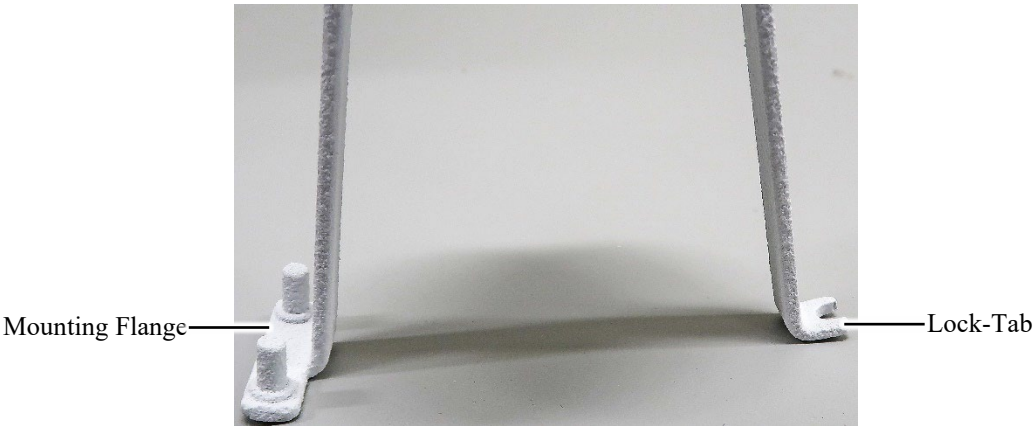
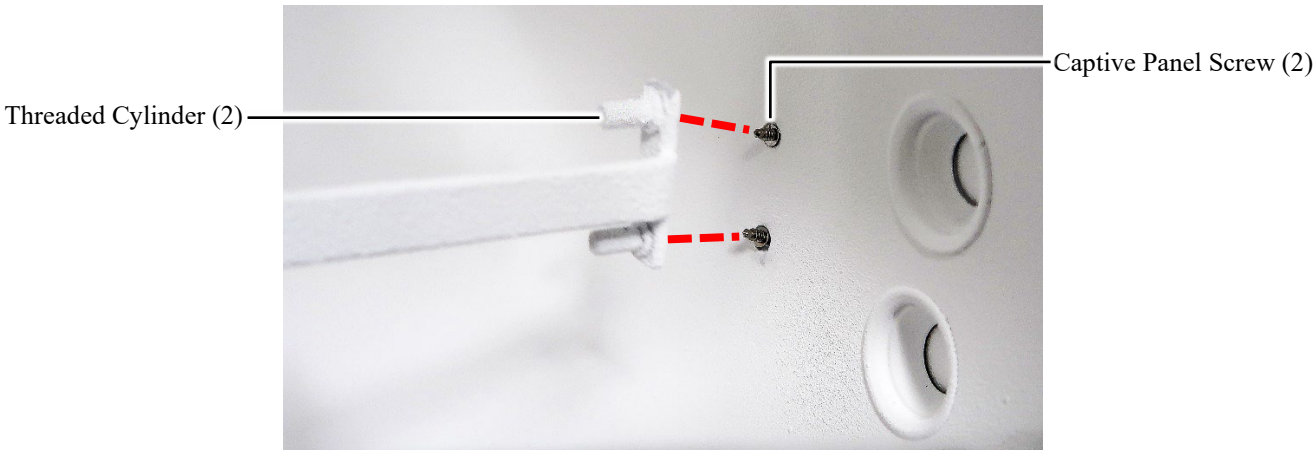


Figure 23: 4π Baffle Mounting Flange

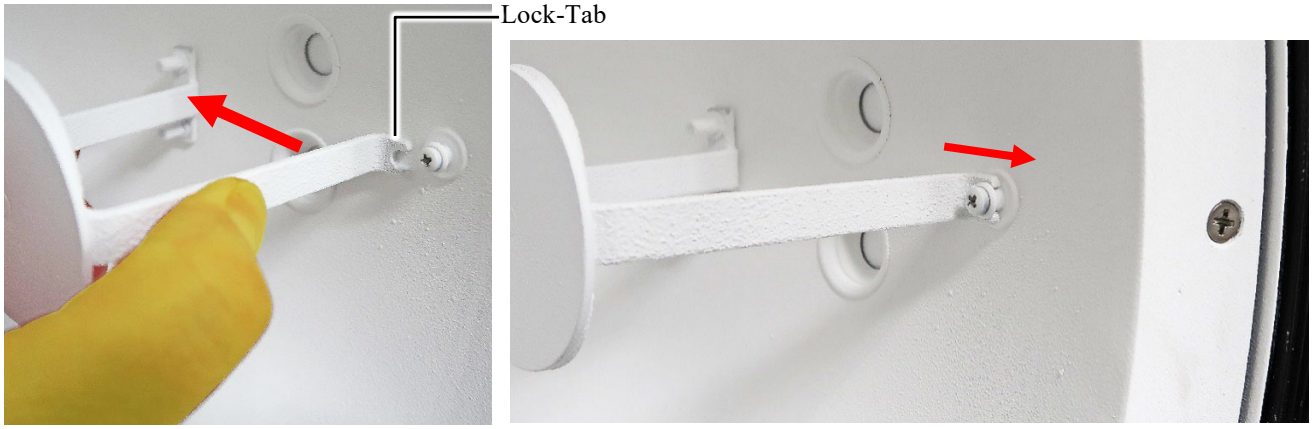
5. Locate the locking tab at the base of the other baffle leg.



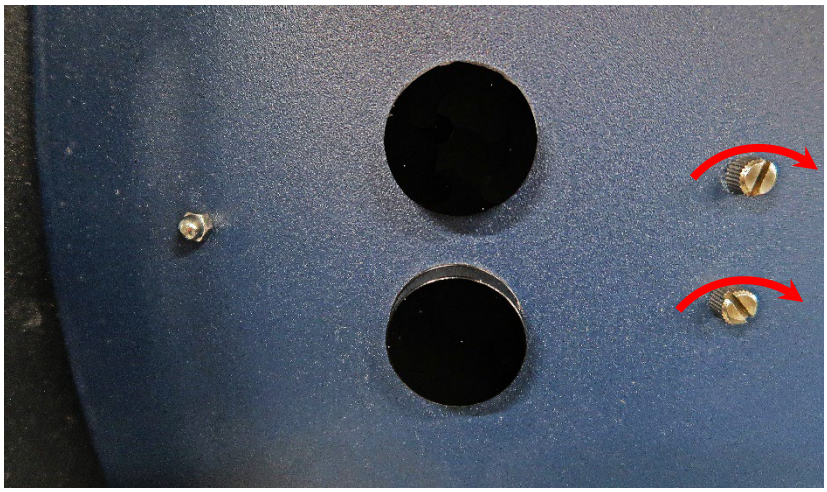
6. Place the 4π baffle's threaded cylinders on the two captive panel-screws threaded studs on the inside of the rear hemisphere. Orient the baffle so that it covers the ports and that the flange is on the left side.



7. Mount the baffle in place by hand-threading the two knurled captive panel-screws from the outside into the two threaded cylinders on the baffle flange on the inside.
8. Squeeze the two 4π baffle legs together, just enough to slip the lock-tab on the right leg into the gap under the lock-tab screw's flat washer.



7. Once the baffle is in place, tighten the two knurled captive panel-screws from the outside by hand.



13. RTD AMBIENT TEMPERATURE PROBE (OPTIONAL)

The optional RTD (resistance temperature detector) probe provides accurate and repeatable temperature measurements inside the closed integrating sphere. The RTD probe works by using a basic principle; as the temperature of a metal increases, so does the resistance to the flow of electricity. An electrical current is passed through the sensor, the resistance element is used to measure the resistance of the current being passed through it. The tip of the temperature probe includes a shield that blocks the direct radiated energy from the light source in the sphere so that an accurate measurement of the air temperature can be made.

The RTD probe must be installed into the rear port of the stationary hemisphere. The thermocouple lead on the end of the probe plugs into the provided TC08 junction box that connects to the ICM-500 module via USB.

RTD temperature probes (part number AS-03003-400) can be ordered on the Labsphere webstore: https://www.labsphere.com/product/tpm-temperature-probe-monitor/

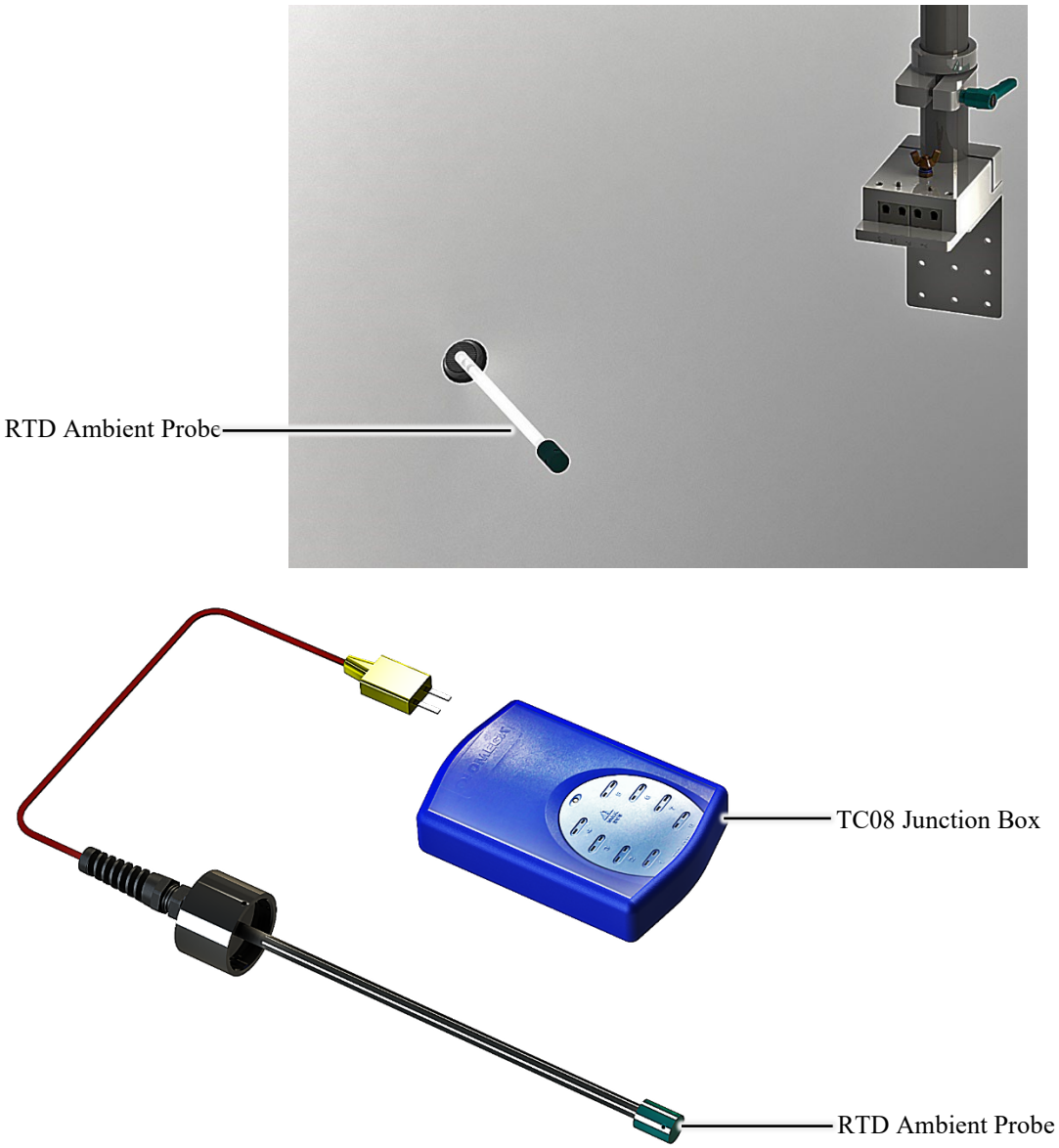
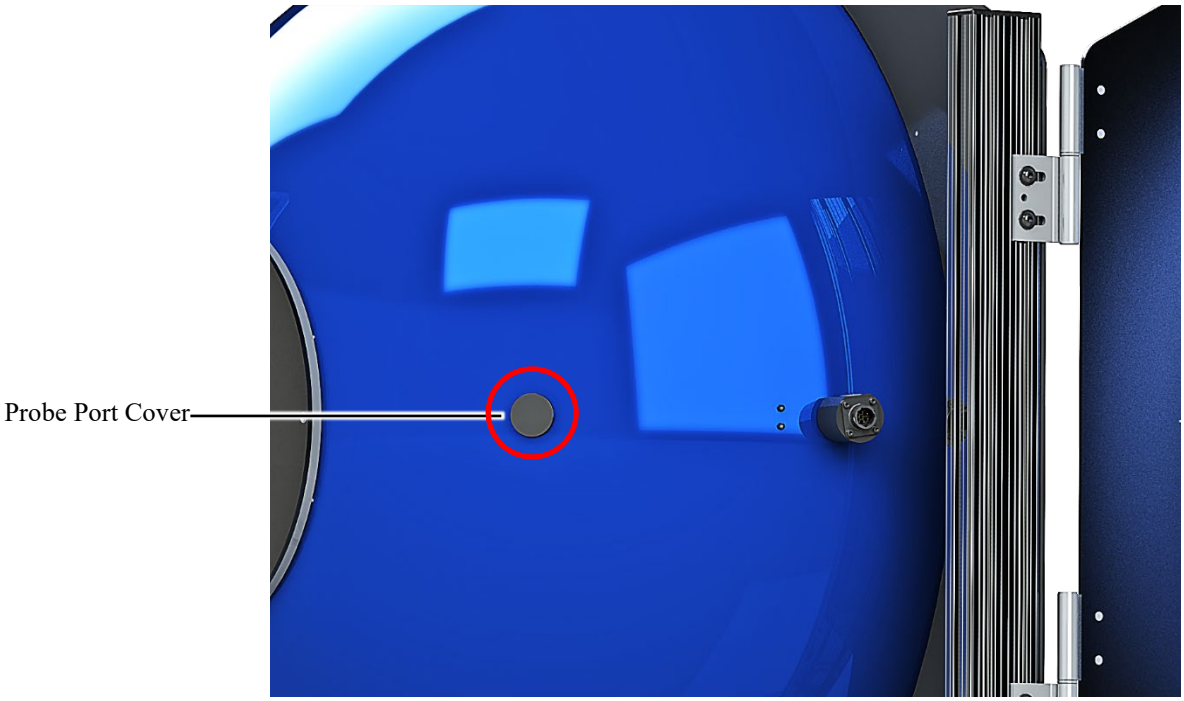


Figure 24: RTD Probe and TC08 Junction Box

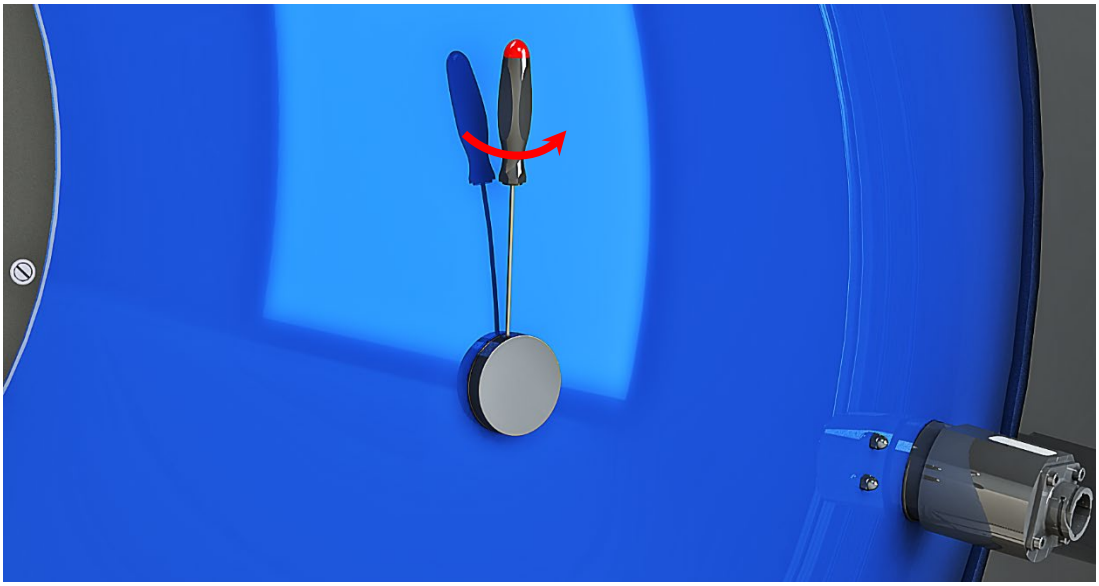
13.1. Installation of the RTD Ambient Temperature Probe

The optional RTD ambient temperature probe assembly consists of the probe itself and the TC-08 junction box that the probe leads plug into.

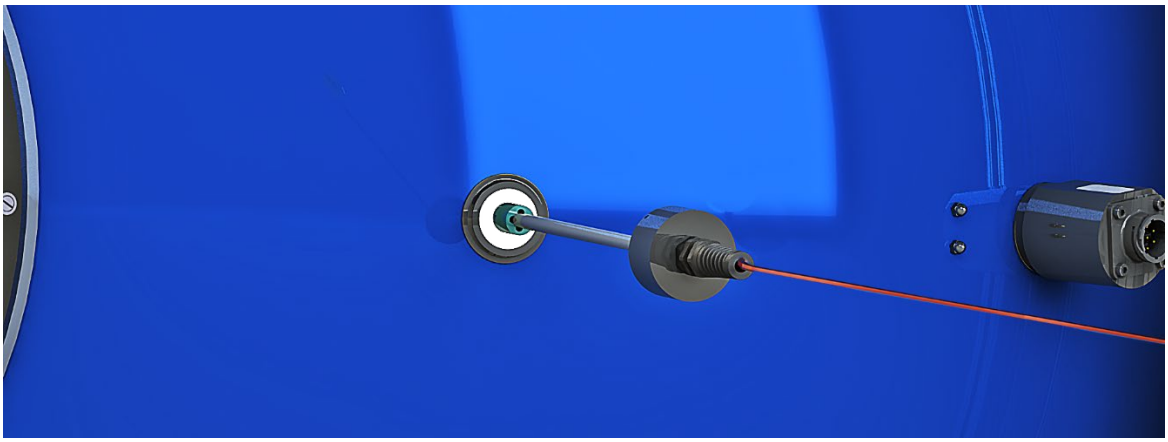
1. Locate the probe port cover on the back of the rear (fixed) hemisphere.



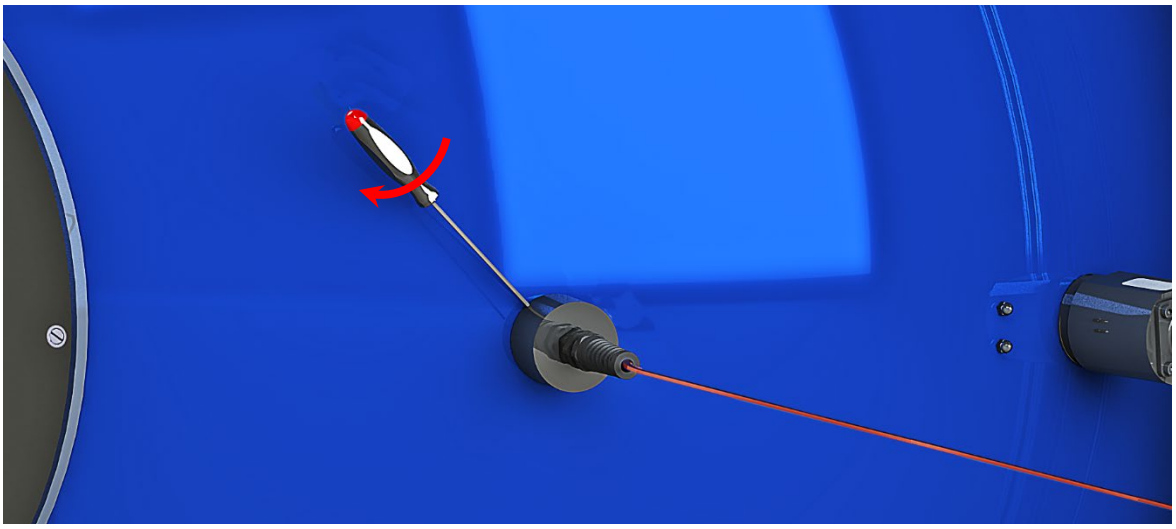
2. Remove the probe port cover by loosening the two setscrews on the collar with a 1.5mm hex driver.



3. Insert the probe into the port.



4. Position the mounting collar over the port frame until it is flush against the port frame base. Tighten the two setscrews in the mounting collar with a 1.5mm hex driver.



5. Insert the probe lead plug into one of the sockets in the TC08 junction box.
6. Connect the “B” end of a type A-to-B USB cable to the USB socket on the side of the TC08 and the “A” end of the cable to one of the “A” USB sockets on the rear panel of the ICM-500.

14. MAINTENANCE

14.1. Spectraflect® Care and Cleaning

Spectraflect is a specially formulated barium sulfate coating which produces a nearly perfect diffuse reflectance surface. To maintain the unique optical and reflectance properties of Spectraflect Diffuse Reflectance Coating, the following handling procedures must be followed:

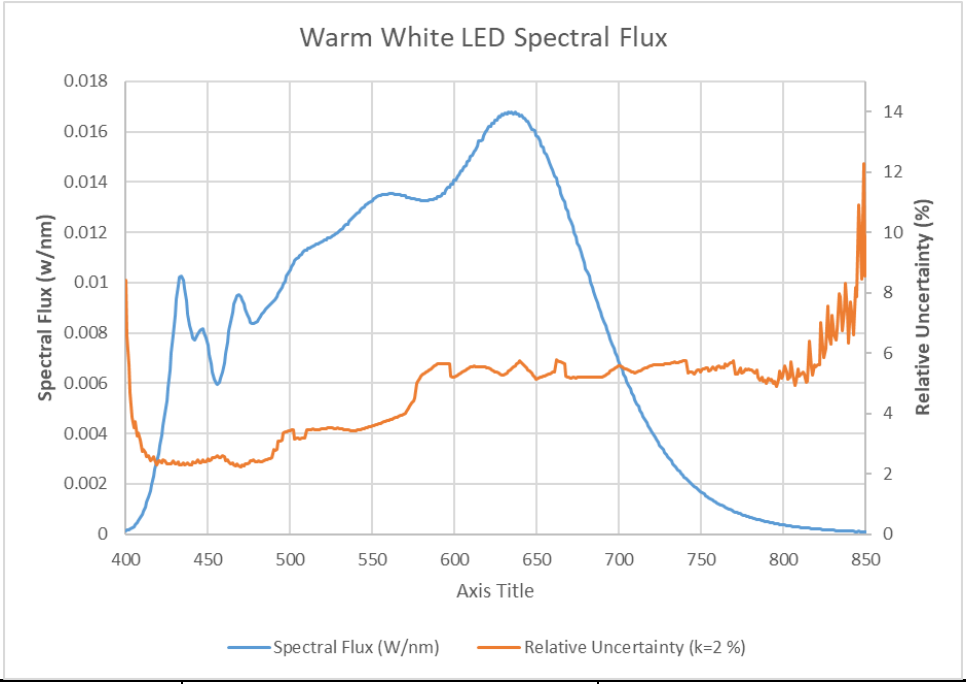
1. Wear powder free vinyl gloves whenever touching the coated surface.
2. Never attempt to clean the surface of a coated product with any form of liquid cleaner. Spectraflect is water-soluble and will run if exposed to liquids.

DO NOT wipe Spectraflect to try to clean it.

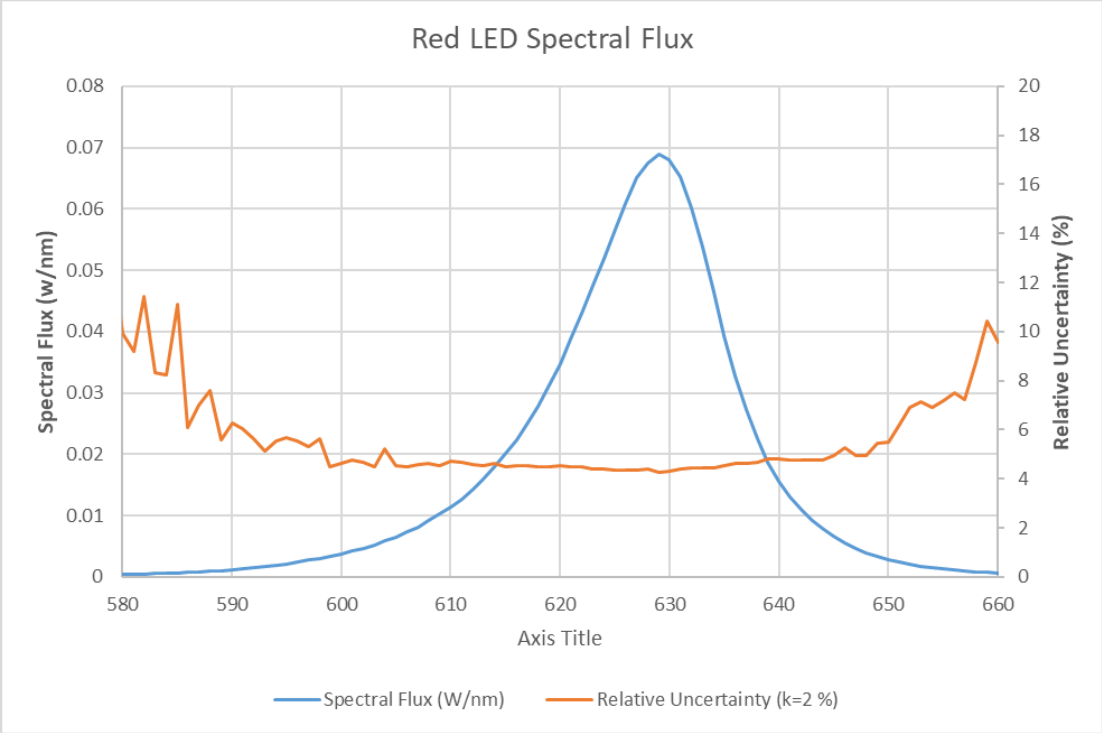
DO NOT use water, or any type of liquid to try to clean Spectraflect.

3. If particulates are found inside the integrating sphere, a low-pressure, dry, air source can be used to blow them off the sphere. Particles that contaminate the surface may be removed with a clean dry, filtered burst of compressed air (Nitrogen is recommended). The air nozzle should be held no closer than 3 inches. Air compression should be no greater than 30 PSI.
4. Never place the coated surface face down onto another surface, unless it is specifically directed by a procedure.

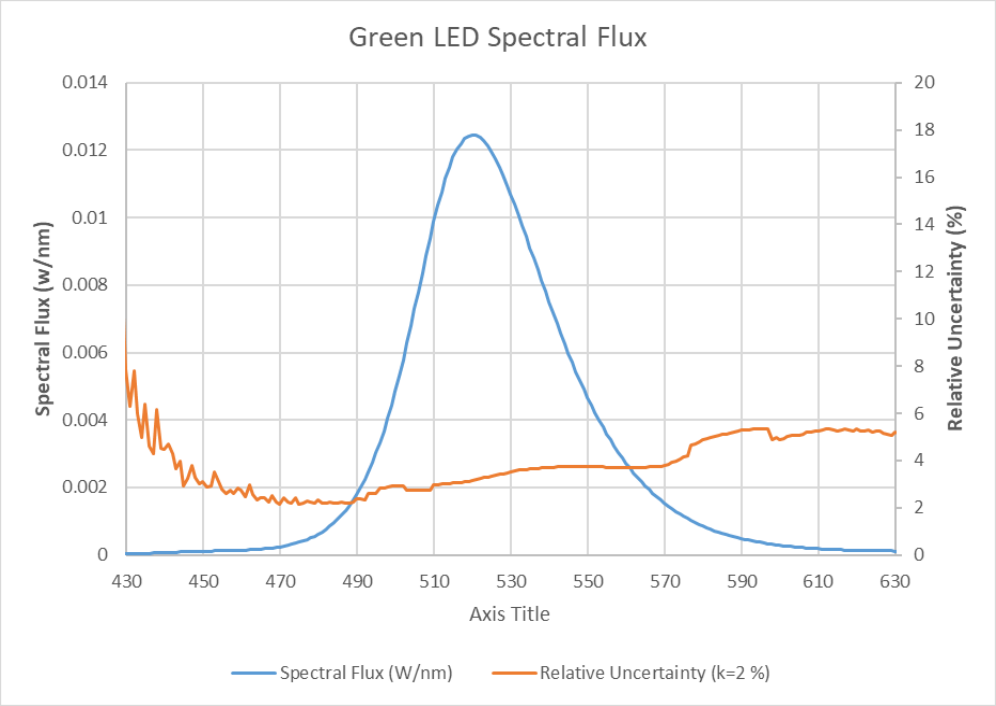
APPENDIX A: UNCERTAINTY MEASUREMENT SPECIMEN RESULT EXAMPLES



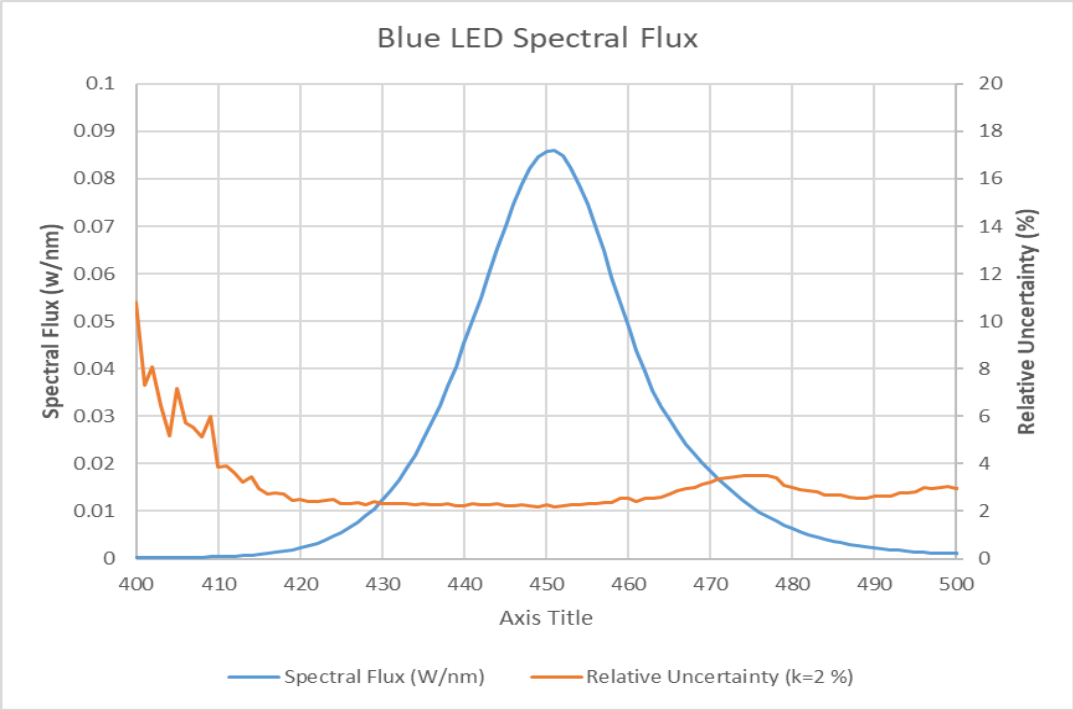
Measurement Quantity	Result	Relative Expanded Uncertainty (%) (k=2)	Expanded Uncertainty, (k=2)
Measurement Band (nm)	350-1050		
Method of measurement	DC-Mode		
Pulse condition	None		
Junction temperature	25°C		
Photometric method	Sphere spectroradiometer (2π)		
Reference standard	ICS-650-K5		
Correction factors	Self-absorption		
Photometric condition	0.5 m sphere		
Input current (A)	0.270011	0.026%	0.000069
Forward voltage (V)	33.836	0.034%	0.012
Electrical power (W)	9.1362	0.043%	0.0039
Total luminous flux (lm)	949.8	0.72%	6.8
Luminous efficacy (lm/W)	103.96	0.72%	0.75
Total radiant flux (W)	3.568	0.53%	0.019
Radiant efficiency	39.05%	0.53%	0.21%
Chromaticity coordinate u'	0.22681		0.00031
Chromaticity coordinate v'	0.3369		0.0010
Correlated color temperature (K)	3875		37
Duv	0.00119		0.00065
CRI (Ra)	98.25		0.55
Cx	0.3870		0.0014
Cy	0.3833		0.0010



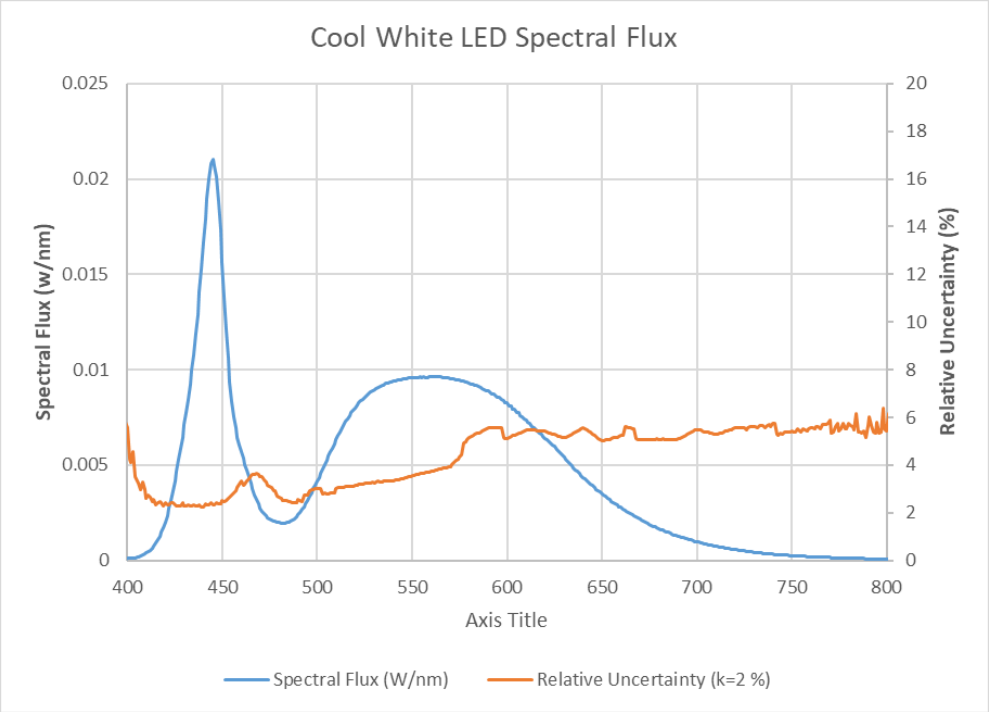
Measurement Quantity	Result	Relative Expanded Uncertainty (k=2)	Expanded Uncertainty, (k=2)
Measurement Band (nm)	547-743		
Method of measurement	DC-Mode		
Pulse condition	None		
Junction temperature	25°C		
Photometric method	Sphere spectroradiometer (2π)		
Reference standard	ICS-650-K5		
Correction factors	Self-absorption		
Photometric condition	0.5 m sphere		
Input current (A)	0.70000	0.026%	0.00018
Forward voltage (V)	7.2725	0.038%	0.0028
Electrical power (W)	5.0908	0.046%	0.0023
Total luminous flux (lm)	295.8	1.49%	4.4
Luminous efficacy (lm/W)	58.11	1.49%	0.86
Total radiant flux (W)	1.374	1.53%	0.021
Radiant efficiency	26.99%	1.53%	0.41%
Chromaticity coordinate u'	0.518780		0.000058
Chromaticity coordinate v'	0.34806		0.00058
Correlated color temperature (K)	N/A		-
Duv	N/A		-
CRI (Ra)	51.7500		0.0064
Cx	0.69100		0.00027
Cy	0.30900		0.00027



Measurement Quantity	Result	Relative Expanded Uncertainty (k=2)	Expanded Uncertainty, (k=2)
Measurement Band	350-1050		
Method of measurement	DC-Mode		
Pulse condition	None		
Junction temperature	25°C		
Photometric method	Sphere spectroradiometer (2π)		
Reference standard	ICS-650-K5		
Correction factors	Self-absorption		
Photometric condition	0.5 m sphere		
Input current (A)	0.70000	0.026%	0.00018
Forward voltage (V)	9.7787	0.029%	0.0028
Electrical power (W)	6.8451	0.039%	0.0027
Total luminous flux (lm)	290.6	0.83%	2.4
Luminous efficacy (lm/W)	42.45	0.83%	0.35
Total radiant flux (W)	0.597	1.84%	0.011
Radiant efficiency	8.72%	1.84%	0.16%
Chromaticity coordinate u'	0.071283		0.000083
Chromaticity coordinate v'	0.38072		0.00036
Correlated color temperature (K)	N/A		-
Duv	N/A		-
CRI (Ra)	-12.00		0.37
Cx	0.19498		0.00085
Cy	0.69425		0.00080



Measurement Quantity	Result	Relative Expanded Uncertainty (k=2)	Expanded Uncertainty, (k=2)
Measurement Band	350-1050		
Method of measurement	DC-Mode		
Pulse condition	None		
Junction temperature	25°C		
Photometric method	Sphere spectroradiometer (2π)		
Reference standard	ICS-650-K5		
Correction factors	Self-absorption		
Photometric condition	0.5 m sphere		
Input current (A)	0.7000	0.026%	0.00018
Forward voltage (V)	9.209	0.030%	0.0027
Electrical power (W)	6.4461	0.039%	0.0025
Total luminous flux (lm)	87.95	0.61%	0.54
Luminous efficacy (lm/W)	13.64	0.62%	0.084
Total radiant flux (W)	2.28	3.95%	0.090
Radiant efficiency	35%	3.95%	1.4%
Chromaticity coordinate u'	0.20266		0.00019
Chromaticity coordinate v'	0.05745		0.00017
Correlated color temperature (K)	N/A		-
Duv	N/A		-
CRI (Ra)	-54.9		0.21
Cx	0.154052		0.000072
Cy	0.029191		0.00011



Measurement Quantity	Result	Relative Expanded Uncertainty (k=2)	Expanded Uncertainty, (k=2)
Measurement Band	350-1050		
Method of measurement	DC-Mode		
Pulse condition	None		
Junction temperature	25°C		
Photometric method	Sphere spectroradiometer (2π)		
Reference standard	ICS-650-K5		
Correction factors	Self-absorption		
Photometric condition	0.5 m sphere		
Input current (A)	0.7000	0.026%	0.00018
Forward voltage (V)	9.397	0.030%	0.0028
Electrical power (W)	6.578	0.039%	0.0026
Total luminous flux (lm)	591	0.74%	4.4
Luminous efficacy (lm/W)	89.8	0.75%	0.67
Total radiant flux (W)	1.87	1.29%	0.024
Radiant efficiency	28.4%	1.29%	0.37%
Chromaticity coordinate u'	0.2049		0.00055
Chromaticity coordinate v'	0.3156		0.00081
Correlated color temperature (K)	5797		61
Duv	-0.0002		0.00060
CRI (Ra)	73.5		0.61
Cx	0.3261		0.0013
Cy	0.3350		0.0014

APPENDIX B: CE DECLARATION OF CONFORMITY

EUROPEAN UNION
DECLARATION OF CONFORMITY

We,

Labsphere, Inc.
231 Shaker Street
North Sutton, NH 03260 USA

declare, under our sole responsibility, that the product:

ICM-500 and illumia Pro 3 (standard models that use the ICM-500)

Conforms with the following standard(s) or other normative document(s):

Product Safety Standards

• IEC 61010-1:2010+A1:2016 and EN 61010-1:2010+A1:2016, Edition 3.0:	"Electrical Equipment For Measurement, Control and Laboratory Use; Part 1: General Requirements"
EMC, EN 61326-1:2013; Clause 7.2	
• CISPR 11 Edition 5.0: 2009, A1: 2010	Conducted Emissions, Group 2, Class A
• CISPR 11 Edition 5.0: 2009, A1: 2010	Radiated Emissions, Group 2, Class A
Immunity Requirements, EN61326-1:2013	
• IEC 61000-4-2: 2008	Electrostatic Discharge
• IEC 61000-4-3: 2006, A1: 2007, A2:2010	Radiated Immunity
• IEC 61000-4-4: 2004, A1: 2010	EFT/Burst, Power Ports and I/O Ports
• IEC 61000-4-5: 2005	Surge Immunity, Power Ports
• IEC 61000-4-6: 2008	Conducted Immunity, Power Ports and I/O Ports
• IEC 61000-4-11: 2004	Voltage Dips and Interrupts

in accordance with the provisions of the following European Council Directives:

Low Voltage (LVD) 2014/35/EC
EMC Directive 2014/30/EU

I, the undersigned, hereby declare that the equipment specified above conforms to the listed directives and standards.

Place of Issue: North Sutton, NH
Date: March 10, 2023

James Lockitt
Vice President Engineering
Tel: +1 (603) 927 1100

Labsphere
advancing the technology of light

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Labsphere offices are in the United States, France, Germany, the United Kingdom and the Asia Pacific region. Visit www.labsphere.com for location-specific contact information.

We at Labsphere are committed to achieving sustained business excellence by integrating quality principles and our core values into everything we do.