Lumencor Operation Manual

SPECTRA X Light Engine®

CE Marking
Low Voltage Directive (2014/35/EU)
EMC Directive (2014/30/EU)
RoHS Directive (2011/65/EU)
REACH Regulation (EC) No. (1907/2006/EC)

EU Declarations of Conformity can be found at https://lumencor.com/company/compliance

For EU customers discarding end-of-life Lumencor electrical and electronic equipment: Please submit an online RMA request as described in the "Customer Support" section of this manual with "Recycle product under WEEE" in the *Description of Issues* field of the request form. For disposal in countries outside of the European Union: This symbol is only valid in the European Union (EU). If you wish to discard this product, please contact your local authorities or the vendor from which the product was purchased and ask for the correct method of disposal.

Research Use Only Lumencor Light Engines as supplied, and as represented in this manual, meet safety and regulatory requirements for research use only. If the light engine is incorporated into an instrument or system for a specific end-use application, it is the responsibility of the system integrator to verify that the light engine, and the system into which it is incorporated, meet all safety and regulatory requirements of that end-use application.

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1. Introduction

The SPECTRA X light engine® consists of 6 individually addressable solid-state light sources with integrated electronic control systems. The constituent light sources are LEDs or luminescent light pipes, generating output from 360–780 nm. The outputs of the constituent light sources are refined by internal bandpass filters and merged into a common optical train directed to the light output port on the front panel. Before exiting, light output is sampled by a calibrated photodiode array providing a real-time display of the power output in the onboard control GUI. The light output port has a safety-interlocked adapter for connection to microscopes and other bioanalytical instruments through a 3 mm diameter liquid light guide (LLG). The internal bandpass filters are user-exchangeable via a hinged access cover on the right-hand side of the light engine, allowing the spectral output of the light engine to be adjusted to meet changing experimental requirements. Eight bandpass filters mounted in slide-in holders are supplied with the SPECTRA X light engine, together with an additional spare empty holder.

The light sources within the SPECTRA X light engine are controlled by an on-board microprocessor operating Lumencor firmware accessed via one of two serial interfaces, USB/RS-232 or TCP. Users can independently and instantaneously enable or disable each light source by serial commands as well as change the intensity of each source. The SPECTRA X light engine can either be controlled by third-party image acquisition software or by a GUI hosted on the onboard microprocessor. Alternatively, the light sources may be turned on and off by TTL inputs from a trigger device such as a camera or real-time controller. Optimal internal operating temperature is maintained by negative pressure air cooling with the air intake at the front of the light engine and the exhaust fan at the the rear.

This manual covers **only** SPECTRA X light engines manufactured and distributed from December 2023 onwards. For SPECTRA X light engines manufactured and distributed from 2011 to 2022, the relevant operation manual is Lumencor document number 57-10006.

2. Precautions and Warnings *{Précautions et avertissements}*

A few simple practices will ensure trouble-free operation for the life of the light engine.

Les quelques règles simples suivantes permettront d'assurer un fonctionnement fiable pendant toute la durée de service de la source lumineuse.

Safety Instructions:
Please read and follow all safety instructions provided BEFORE using the SPECTRA X light engine®. Failure to comply with the safety instructions may result in fire, electrical shock, or personal injury and may damage or impair protection provided by equipment. Retain all safety instructions for future reference.

Instructions de sécurité:
Veiller à lire et à respecter toutes les instructions de sécurité fournies AVANT d'utiliser le SPECTRA X light engine® afin d'écarter les risques d'incendie, de décharge électrique, de blessure corporelle et de possibles dommages ou défaillance de la protection offerte par l'appareil. Conserver toutes les instructions de sécurité pour référence future.

Safety Definitions *{Définitions relatives à la sécurité}*:

Warning: Statements identify conditions or practices that could result in personal injury.

Avertissement: déclarations qui identifient des situations ou des pratiques susceptibles d'entraîner des blessures corporelles.

Caution: Statements identify conditions or practices that could result in damage to your equipment.

Attention: déclarations qui identifient des situations ou des pratiques susceptibles d'endommager le matériel.

Safety Items *{Mesures de sécurité}*:

Warning: ONLY use the power supply provided by Lumencor. The Lumencor-supplied 24 VDC, 9.2 A external power supply is required for use with the SPECTRA X Light Engine. The light engine is required to be supplied by an approved/certified DC power source meeting the minimum electrical ratings of the product. The DC power supply must have the AC power cord connected to a receptacle with a protective safety (earth) ground terminal.

Avertissement: utiliser uniquement l'alimentation fournie par Lumencor. Le Lumencor fourni 24 VCC/9.2 A alimentation CC externe est recommandé pour une utilisation avec le moteur de lumière SPECTRA X Light Engine. Le moteur léger doit être alimenté par une source d'alimentation CC approuvée/certifiée répondant aux caractéristiques électriques minimales du produit. L'alimentation CC doit avoir le cordon d'alimentation CA connecté à une prise avec une borne de terre de sécurité (terre).

Lumencor

Warning: DO NOT look into the output of the light engine. The brightness of this light source is higher than most commercial lighting fixtures and is intended to couple directly into a microscope or other bioanalytjcal instrument.

Avertissement: NE PAS regarde directement la sortie de la source lumineuse. L'intensité lumineuse de cette source est supérieure à celle de la majorité des appareils d'éclairage disponibles dans le commerce et est conçue pour un raccordement direct à un microscope ou autre appareil de bioanalyse.

Warning: DO NOT turn on the light without the output end of the light guide safely directed into an enclosed optical path. DO NOT point the light output directly onto any flammable or burn-susceptible material. This includes all animal or vegetable tissues, plastics, fabrics, paper and liquids.

Avertissement: NE PAS allumer la lumière sans l'extrémité de sortie du guide de lumière dirigée en toute sécurité dans un chemin optique fermé. NE PAS pointer la sortie de lumière directement sur un matériau susceptible d'être inflammable ou susceptible de brûler. Cela comprend tous les tissus, les plastiques, les tissus, le papier et les liquides animaux ou végétaux.

RISK GROUP 3

RISK GROUP 3	RISK GROUP 3	RISK GROUP 3
WARNING Possibly hazardous optical radiation emitted from this product. Do not look at operating lamp. Eye injury may result.	WARNING IR emitted from this product. Do not look at operating lamp. Avoid eye exposure. Use appropriate shielding or eye protection.	WARNING UV emitted from this product. Avoid eye and skin exposure to unshielded product.
Groupe de risque 3	**Groupe de risque 3**	**Groupe de risque 3**
AVERTISSEMENT Ce produit émet un rayonnement optique potentiellement dangereux. Ne regardez pas la lampe lorsqu'elle est allumée. Des lésions oculaires peuvent en résulter.	AVERTISSEMENT Ce produit émet un rayonnement infrarouge. Ne regardez pas la lampe lorsqu'elle est allumée. Évitez toute exposition aux yeux. Utilisez un écran ou dispositif de protection oculaire approprié.	AVERTISSEMENT Ce produit émet un rayonnement ultraviolet. Évitez d'exposer les yeux et la peau à un produit sans protection.
Label PN: 06-10227	Label PN: 06-10228	Label PN: 06-10229

Warning: Possibly hazardous optical radiation emitted from this product. Do not look at operating lamp. Eye injury may result**.**

Warning: Infrared (IR) radiation emitted from this product. Do not look at operating lamp. Avoid eye exposure. Use appropriate shielding or eye protection.

Warning: Ultraviolet (UV) radiation emitted from this product. Avoid eye and skin exposure to unshielded product.

GROUPE DE RISQUE 3

Avertissement: Rayonnement optique peut-être dangereux émis par ce produit. Ne regardez pas la lampe d'exploitation. Une blessure oculaire peut entraîner.

Avertissement: Rayonnement infrarouge (IR) émis par ce produit. Ne regardez pas la lampe opératoire. Évitez l'exposition des yeux. Utilisez un écran de protection ou une protection oculaire appropriée.

Avertissement: *Rayonnement ultraviolet (UV) émis par ce produit. Évitez l'exposition des yeux et de la peau au produit non protégé.*

Caution: DO NOT open the unit except to exchange filters as directed in Section 5.2. There are no field-serviceable parts inside the case enclosing the light engine's optical and electronic sub-systems. Removing the outer case and accessing the optical and electronic sub-systems will void the manufacturer's warranty.

Attention: *NE PAS ouvrir l'appareil, sauf pour remplacer les filtres comme indiqué dans la section 5.2. Il n'y a aucune pièce réparable sur site à l'intérieur du boîtier renfermant les sous-systèmes optiques et électroniques du moteur lumineux. Le retrait du boîtier extérieur et l'accès aux sous-systèmes optiques et électroniques annuleront la garantie du fabricant.*

Caution: DO NOT set liquids on the light engine. Spilled liquids may damage your light engine.

Attention: *NE PAS placer de liquide sur la source lumineuse. Les liquides renversés peuvent endommager la source lumineuse.*

Caution: DO NOT drop the light engine. It contains glass optical components that could be damaged or misaligned by the shock produced by a drop onto a hard surface.

Attention: *NE PAS laisser tomber la source lumineuse. Elle contient des composants optiques en verre susceptibles d'être endommagés ou désalignés par le choc résultant d'une chute sur une surface dure.*

DISCLAIMER: Lumencor shall not be liable for injury to the user or damage to the product resulting from the SPECTRA X light engine® being used in a way for which it was not intended and in disregard or contravention of all posted safety precautions and warnings.

AVIS DE NON-RESPONSABILITÉ: *Lumencor ne sera pas responsable des blessures à l'utilisateur ou des dommages au produit résultant de l'utilisation du SPECTRA X light engine® d'une manière pour laquelle il n'est pas destiné et au mépris ou en violation de toutes les précautions de sécurité et avertissements affichés.*

3. Installation

3.1 Contents
The SPECTRA X light engine ships with the following list of standard components:

1. The SPECTRA X Light Engine, configured with 6 solid-state light sources and an output adapter for connection to a 3 mm diameter liquid light guide (LLG). The liquid light guide is not part of the standard SPECTRA X product bundle and is only included with the shipment if it has been specifically ordered as a separate accessory (see Table 7, below).
2. A 24 V/9.2 A DC power supply (Lumencor part number 27-10019).
3. A region-specific AC power cord for the power supply (Table 1).
4. Eight 25 mm diameter bandpass filters in user-exchangeable filter holders as defined in Section 5.2. Also included is a spare empty filter holder (Lumencor part number 01-12785). The filters and empty holder are installed inside the light engine for shipment as shown in Table 4 below.
5. RJ45 ethernet cable
6. USB A (M)-to-USB B (M) cable
7. Control key, external gate jumper and remote interlock jumper (Figure 1)
8. Quickstart Guide document (57-10040)

Table 1. AC Power Cords

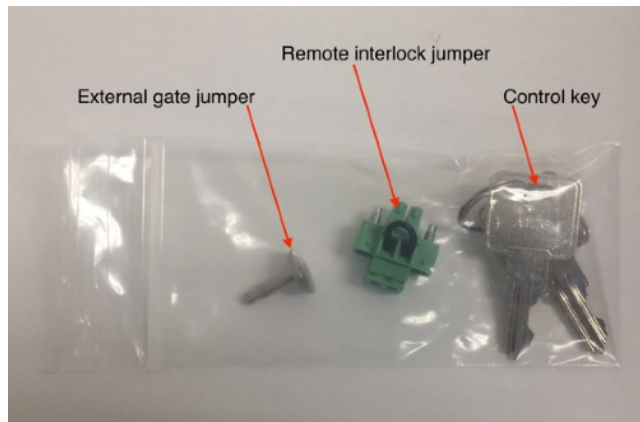| Region	Part Number
North America	29-10002
Europe	29-10005
United Kingdom	29-10004
Israel	29-10008
Australia/New Zealand	29-10024

Figure 1. Control key, remote interlock jumper and external gate jumper. These items are packed in a plastic bag inside the shipping box. Their functions are described in Section 4.1

The model name, unique 5-digit serial number and certification markings of the light engine are carried on a label affixed to the rear panel . Performance specifications for individual light engines are listed on the certificate of conformance included with the shipping documents e-mailed to the customer on the date of shipment from Lumencor (Figure 2). It is important to retain the certificate of conformance for reference, as it provides the performance benchmarks for the light engine. **If the light engine is resold, the Certificate of Conformance should be transferred to the new owner.**

Lumencor   Certificate of Conformance

Performance Measurements For Lumencor Light Engine S/N 29738

SPECIMEN

Color Channel	Bandpass	Power (mW)
Red	635/22	205
Cyan	475/28	359
Yellow	555/28	618
NIR	740/20	202
Blue	438/29	704
UV	377/54	717
n/a	n/a	n/a
n/a	n/a	n/a
Total Power:		2805

COC Output Adapter: 3 mm LLG - A
Beam Divergence (NA):   0.30

Measurement Method
This product was measured using the custom output adapter installed on the light engine. The output power was directed at a Coherent thermopile sensor head, model number PM10, S/N 0175H15R attached to a Coherent LabMax-Pro Power Meter, S/N 0236D20R. The measurement system was calibrated on 3/28/2023. The meter scale was set to average mode and the meter zeroed for each measurement. Measurements were taken at room temperature and at initial turn-on.

Lumencor Build Recipe: SpectraX III-LCR-6A-A1   Model Name: SpectraX III 6-LCR-AA

Manufacturing Part Number: 80-10511 Rev. A   Customer Deviation: n/a

Product Part Number: 90-10945 Rev. A

Customer Part Number:

Customer Specification:

Inspected By: Tammy

Inspected Date: Dec 22, 2023

Document Part Number: 50-10027 rev E

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Figure 2. Specimen certificate of conformance (C of C) for SPECTRA X Light Engine. The C of C identifies the color channels installed in the light engine and the bandpass filters associated with each channel. Full (100%) power outputs measured at the distal end of the liquid light guide (LLG) are recorded in the third column.

3.2 Installation

NOTE: Any end-product/system incorporating or coupled to a Lumencor Light Engine shall be fully evaluated to verify all applicable safety and regulatory compliance requirements prior to use.

When setting up the SPECTRA X light engine, place the unit on a hard surface within 6 feet (2 meters) of an AC electrical outlet and 6 feet (2 meters) of the microscope (assuming use of a standard 2 meter liquid light guide). Avoid blocking or restricting airflow at the air inlet (front panel; Figure 3) or exhaust port (rear panel). Restricting the airflow will cause the unit to operate at elevated temperatures and will result in decreased product lifetime and/or premature failure. Provide at least 6 inches (15 centimeters) of clear space on the right-hand side of the light engine to allow for opening of, and access to, the filter compartment (see Figure 9, below). Complete the external connections with reference to Figure 3 as follows:

3.2.1 Connect the DC power supply to the input port on the front of the light engine (Figure 3, #4). Do not connect the DC power supply to the AC utility supply until you are ready to turn the light engine on.

3.2.2 Insert the control key and external gate jumper (Figure 2) in the locations shown in Figure 3. Insert the remote interlock jumper in the receptacle on the the rear panel of the light engine as shown in Figure 4.

3.2.3 **Fully** insert a 3 mm liquid light guide in the light output port as shown in Figure 3. The output port incorporates a safety interlock that will disable light output until the light guide is fully inserted. Secure the light guide with the set screw on the right-hand side of the port. In the event that the M3 thread set screw is mislaid, one of the twelve case screws may be used as a temporary replacement.

3.2.4 Connect cables to the control ports (Figure 3, #7). The number and types of cables to be installed will depend on operational requirements, as further described in Section 4. USB and ethernet (LAN) cables are included with the light engine. RS232 and TTL breakout cables are optional accessories (Table 7).
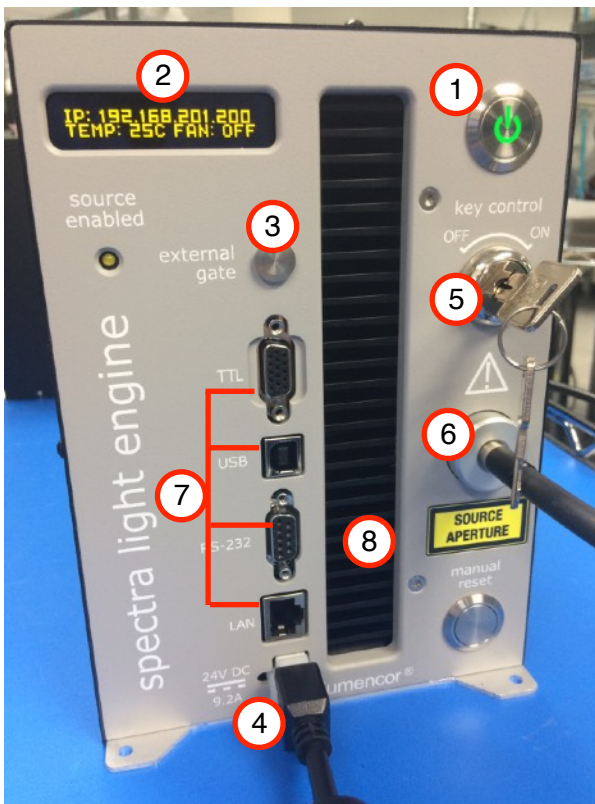

Figure 3. SPECTRA X Light Engine front panel.
1. Master power button. **2.** Status indicator display.
3. External gate port with jumper inserted. **4.** DC power input. **5.** Key Control. **6.** Light output port with liquid light guide inserted. **7.** Control ports. Top-to-bottom: TTL, USB B, RS232, LAN (ethernet). **8.** Air intake.

Figure 4. Remote interlock jumper inserted in the labeled receptacle on the lower left side of the rear panel of the light engine.

4. Operation

4.1 Description of Controls and Interlocks

The **master power button** on the front panel (Figure 3, #1) turns the electrical power to the unit on or off. A green inlay in the button is lit when the power supply is connected to the light engine and the power button is in the on position. Initialization of the onboard microprocessor takes about

30 seconds after the master power switch is turned on. When initialization is complete, the status indicator display (Figure 3, #2) will automatically activate.

The **Key Control** (Figure 3, #5) must be in the on position before light output can be turned on. The key must be removed and stored in a secure location when the product is not in use. **ONLY** trained individuals should use and have access to the key.

The **Source Enabled Indicator** (below the status indicator display; Figure 3) provides a warning indication that one or more light sources are active and emitting invisible and/or visible radiation.

The **External Gate** port allows light output to be selectively disabled by control signals from an external device such as a microscope. When no external gate control is in use, light output will be disabled **unless** the external gate jumper (Figure 1) is inserted in the port (Figure 3, #3).

The **Remote Interlock Connector** (rear panel) allows light output to be disabled upon opening of an enclosure in which the light engine is housed. When no external enclosure is in use, the interlock is closed by the remote interlock jumper (Figure 4).

WARNING: The **Remote Interlock** relies on a passive continuity circuit for proper operation. It does not provide a voltage source for external circuitry, nor can external voltage sources be applied to it. UNDER NO CIRCUMSTANCES should a voltage or voltage source be applied to the **Remote Interlock** circuit. APPLYING A VOLTAGE OF EITHER POLARITY MAY RESULT IN ANOMALOUS OPERATION AND/OR DAMAGE THE PRODUCT, AND COULD IMPACT SAFETY. **DO NOT** interconnect remote interlocks between multiple light engines.

AVERTISSEMENT: *Le verrouillage à distance repose sur un circuit de continuité passif pour un fonctionnement correct. Il ne fournit pas de source de tension pour les circuits externes, et aucune source de tension externe ne peut lui être appliquée. EN AUCUN CAS, une tension ou une source de tension ne doit être appliquée au circuit de verrouillage à distance. L'APPLICATION D'UNE TENSION DE POLARITÉ OU DE POLARITÉ PEUT ENTRAÎNER UN FONCTIONNEMENT ANOMAL ET/OU ENDOMMAGER LE PRODUIT, ET POURRAIT AVOIR UN IMPACT SUR LA SÉCURITÉ.*

Table 2. Summary of Safety Interlocks

Description	Function	Closed (light output permitted)	Open (light output disabled) [1,2]
Key Control	Limits light engine operation to authorized key holders only	Key Control ON	Key Control OFF
Remote Interlock	Allows light output to be disabled upon opening of an enclosure in which the light engine is housed	Enclosure closed or jumper inserted	Enclosure open or jumper removed
Light Output Port Interlock	Prevents light output unless a 3 mm liquid light guide is correctly installed in the output port	Liquid light guide correctly inserted in output port	Liquid light guide not correctly inserted in output port
Filter Compartment Interlock	Prevents light output when the filter compartment access cover is open	Filter compartment access cover closed	Filter compartment access cover open
Footnotes: [1] If any interlock is opened **after** light output has been enabled, the **Manual Reset** button (front panel, lower left; Figure 3) will need to be pushed to resume light output. Interlocks that are opened when there is no active light output will close automatically as soon as the cause of the open condition is rectified. [2] Open interlock conditions are indicated by a red ILK indicator (•) in the control GUI (Figure 5, #9).			

The **Light Output Port Interlock** disables light output **unless** a 3 mm liquid light guide is fully inserted in the output port as shown in Figure 3 (#6).

The **Filter Compartment Interlock** prevents light output when the filter compartment access cover is open (Figure 9).

Note: In the event of **ANY** normal or abnormal interlock fault condition (including high ESD/EMP/EFT conditions ~2kV) you MUST clear the latched fault condition by depressing the manual reset button.

4.2. Start Up and Shut Down
4.2.1 Insert the control key, turn it to the on position.
4.2.2 Connect the isolated DC power supply to the light engine.
4.2.3 Connect the AC power cord to the DC power supply.
4.2.4 As soon the DC power supply is energized, the master power button inlay (Figure 3, #1) will automatically light up. The light engine automatically starts when the power is connected; there is no need to push the master power button [1].
4.2.5 Wait 30–45 seconds for the initiation sequence (onboard microprocessor boot-up) to complete. Do not press any buttons or insert any plugs during this time.
4.2.6 When the initiation sequence completes, "LUMENCOR" will flash on front display panel and then be replaced by a display showing the current light engine IP address, the internal temperature and the fan status. At the same time, the fan will come on at HI for about 2 seconds and then shut off automatically.
4.2.7 The light engine is now ready for use.
4.2.8 When the light engine is no longer required for immediate use, make sure that the **Source Enabled Indicator** (Figure 3) is off. Then press the master power button to shut down the light engine. Shut down can also be accomplished using the "Shut Down" button in the control GUI (Figure 5).

Footnote
[1] If the DC power supply remained energized after the the previous shut down, press the master power button to start.

4.3. Ethernet Connection and Control GUI
WARNING: Prior to turning the light output on, be sure the output end of the liquid light guide is safely directed into an enclosed optical path (e.g. microscope epilluminator or a beam dump).

The onboard control GUI provides a quick and easy way to control the Light Engine using a static LAN connection and a web browser. The GUI consists of the **Control** page and the **Settings** page (Figure 5). The control page primarily contains light on/off and intensity controls. Responses to these controls are essentially instantaneous (<1 second). The control page also displays real-time output power readings for each light source (Figure 5, #4). The settings page contains various configuration settings and cumulative operating time data for each light source.

To access the control GUI, follow the protocol below [1]:
4.3.1 Connect the LAN port of the light engine to a computer ethernet port using the RJ45 ethernet cable supplied with the SPECTRA X light engine [2,3,4].

4.3.2 On Windows systems, go to the the Start menu > Control Panel > Network & Internet and/or Network & Sharing Center.

4.3.3 Click Change Adapter Settings

4.3.4 Right-click on Local Area Connection

4.3.5 Click on Properties (in pop-up)

4.3.6 Select Internet Protocol Version 4 (TCP/IPv4)

4.3.7 Click Properties button

4.3.8 Use the following IP addresses:
     Manual/Static IP Address: 192.168.201.201 [5]
     Subnet Mask: 255.255.255.0
     Default gate way and DNS Server are OK to leave blank

4.3.9 Type the Light Engine IP address (Figure 3, #2) into any web browser address bar to access the resident Web GUI. The factory default IP address is 192.168.201.200.

Footnotes

[1] These instructions are also included in the *Quickstart Guide* document enclosed in the light engine shipping box.

[2] Any type of computer may be used, including Windows, MacOS and Android systems.

[3] If the computer does not have an available ethernet port, a USB-to-ethernet adapter may be used instead.

[4] The control GUI and image acquisition software connected via the USB or RS232 ports can be run simultaneously.

[5] Do not use DHCP.

4.4 Control via Serial Ports

WARNING: Prior to turning the light output on, be sure the output end of the liquid light guide is safely directed into an enclosed optical path (e.g. microscope epilluminator or a beam dump).

The SPECTRA X may be controlled by third-party image acquisition software via either the USB or RS232 ports (Figure 3, #7). Connection to the computer requires a USB-A-to-USB B cable (29-10058, included with the light engine) or USB-to-RS-232 cable (29-10011, optional accessory, Table 8). A compatible device driver must first be selected; this selection is typically found under the "Devices" tab of the third-party software. The COM port address assigned by the computer to the light engine USB or RS232 serial port must be correctly registered in the third-party software at the same location. Third-party device drivers may use either STANDARD or LEGACY mode commands (as defined below). If you have questions about the appropriate command mode selection for a particular device driver, e-mail Lumencor Technical Support at techsupport@lumencor.com.

The command mode setting (Figure 5, #13) of the SPECTRA X Light Engine must be set to correspond to the command set implemented in the the third-party software device driver. The command mode setting is user accessible via the control GUI (Figure 5, #13). Setting changes are instantaneously applied and are retained between power cycles. LEGACY commands are limited to controlling light output on/off switching and intensity adjustment of selected individual color channels. Only one of the two serial ports can be set to LEGACY mode at one time. The STANDARD mode command set gives access to an extensive panel of operating status reports and configuration settings in addition to the the basic control functions of the LEGACY command set. A complete listing of STANDARD mode commands is provided in Lumencor's *Light Engine Command*

Reference (Document number 57-10018). Note that LEGACY and STANDARD mode communications use different serial protocols (9600,8,N,1 and 115200,8,N,1 respectively).
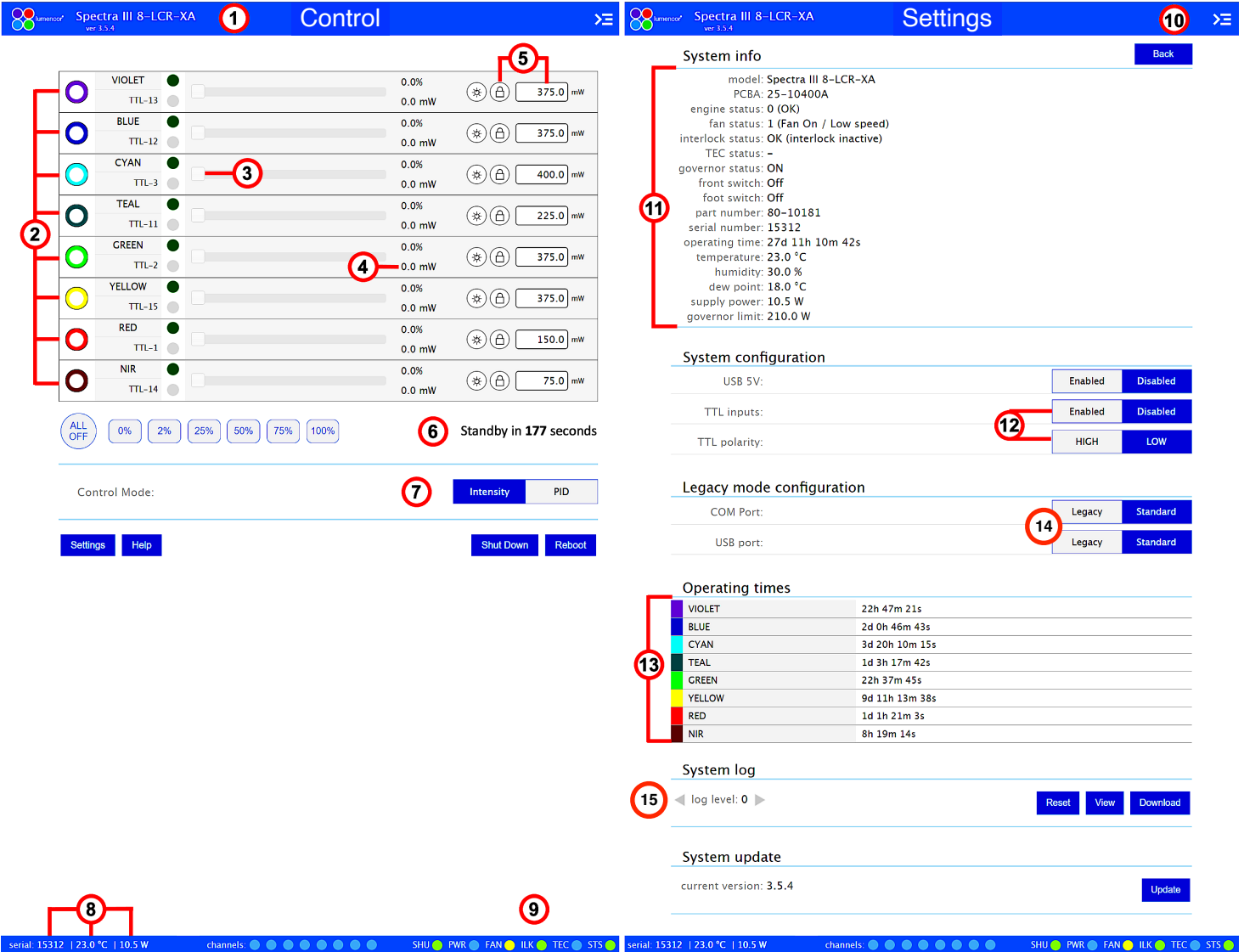

Figure 5. SPECTRA X GUI, **Control Page** (Left) and **Settings Page** (Right). 1) Lumencor light engine model number and software version, 2) ON/OFF toggle control of source channel (filled circle = ON, ring = OFF), 3) Intensity slider, 4) Live power read out in mW, 5) power regulation controls: locked in when padlock and input box are grey, 6) Standby mode countdown timer, 7) Intensity control mode setting. **Intensity** is the default setting and is recommended for most applications, 8) serial number of light engine, live temperature read out, and live power draw read out, 9) System status indicators, 10) Command line access, 11) System information, 12) TTL port configuration controls, 13) Cumulative light source operating time read out. 14) Command set selection for USB and RS232 (COM) ports. 15) Microprocessor log file portal. Log level should be set to 0 (zero) for normal operations.

4.5 Control From Light Engine Control Pod

WARNING: Prior to turning the light output on, be sure the output end of the liquid light guide is safely directed into an enclosed optical path (e.g. microscope epilluminator or a beam dump).

4.5.1 Before starting up the light engine, connect the SPECTRA X to control pod (p/n 83-10007) using USB A-to-USB B cable (p/n 29-10058).

4.5.2 Open the control GUI interface as described in Section 4.3.

4.5.3 Go to the SETTINGS page in the onboard control GUI. Make sure that the USB port

Table 3. TTL Connector Pin Definitions

OUTPUT COLOR	Pin#	OUTPUT COLOR	Pin#
RED	1	BLUE	12
GREEN	2	VIOLET	13
CYAN	3	nIR	14
Gnd	6,7,8,10	Global Shutter	9

V_{ihigh} (min) = 2.0V, V_{ihigh} (max) = 5.5V
V_{ilow} (min) = 0.0V, V_{ilow} (max) = 0.8V
- TTL pin references are also indicated next to the ON/OFF toggle buttons in the control GU (Figure 5, #2)

Figure 6. BNC breakout cable (p/n 29-10156). The same cable configuration with SMB connectors instead of BNC is also available (29-10216)

configuration is set to LEGACY mode (Figure 5, #13) and USB 5V is set to ENABLED.
4.5.4 The pod must be set in SPECTRA X control mode. The Light Engine control mode setting is shown in green letters at the bottom of the pod display screen. If the pod is not in SPECTRA X control mode, change the setting by holding down the MODE button on the pod until the Light Engine selection menu appears. Move the cursor to "SPECTRA X" by turning the pod control knob. Press the MODE button again to select SPECTRA X control mode and return to the main control screen.
4.5.5 Follow the instructions on Lumencor's *Light Engine Control Pod Operation* sheet (p/n 54-10036). In brief, press the COLOR button to select output light output channel, press the MODE button to toggle light output on and off and turn the control knob to adjust intensity for the current light output channel selection.

4.6 TTL Control
WARNING: Prior to turning the light output on, be sure the output end of the liquid light guide is safely directed into an enclosed optical path (e.g. microscope epilluminator or a beam dump)

TTL triggering provides users with faster on/off switching of color channel outputs than is obtainable using serial commands (Section 4.4). Intensity settings are independent from on/off commands and can only be applied using serial commands. TTL trigger inputs are provided for each color channel, as shown in the Table 3. As a safeguard against unintended light output when the inputs are initially connected, the TTL port is disabled by factory default. To enable the TTL trigger input, click the Enabled button next to "TTL inputs" in the GUI under the Settings tab (Figure 5, #12) or send the STANDARD mode command "SET TTLENABLE 1" to the LAN port. Input TTL signals can be conveniently addressed using an accessory breakout cable (Lumencor part no. 29-10156 or 29-10216; Figure 6) connected to the front panel TTL port. The breakout cable also provides a global shutter input (labeled "shutter"). TTL signals input to the global shutter will synchronously toggle all currently enabled source channels on and off.

5. Light Output Characteristics

5.1 Unfiltered Output

The SPECTRA X light engine generates light output from to 360–780 nm (Figure 7). Typically, filters are applied to restrict the output to 20–40 nm bandpasses required for fluorescence microscopy applications, as described in Section 5.2. However, if desired, the light engine may be operated with the filters removed to access the full spectral output range.
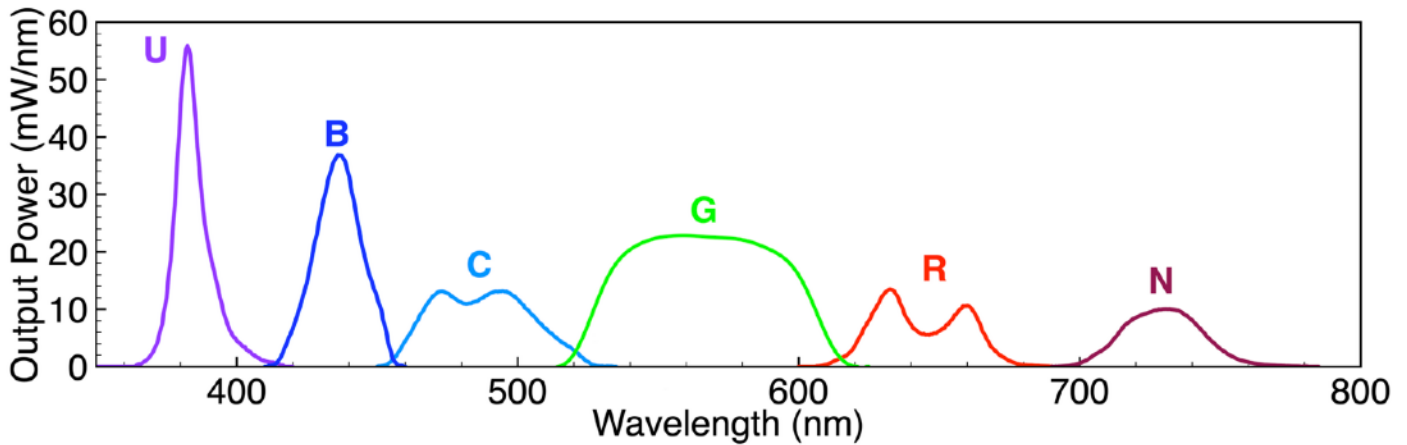

Figure 7 SPECTRA X light engine unfiltered spectral output. Labeling of the 6 sources corresponds to that of the filter slots (Table 4).

5.2 Filtered Output

Each of the 6 individually addressable solid-state light sources in the SPECTRA X light engine is associated with a user-exchangeable bandpass filter that refines its spectral output (Figure 8). Filtering of excitation light inside the light engine makes exciters in microscope filter cubes
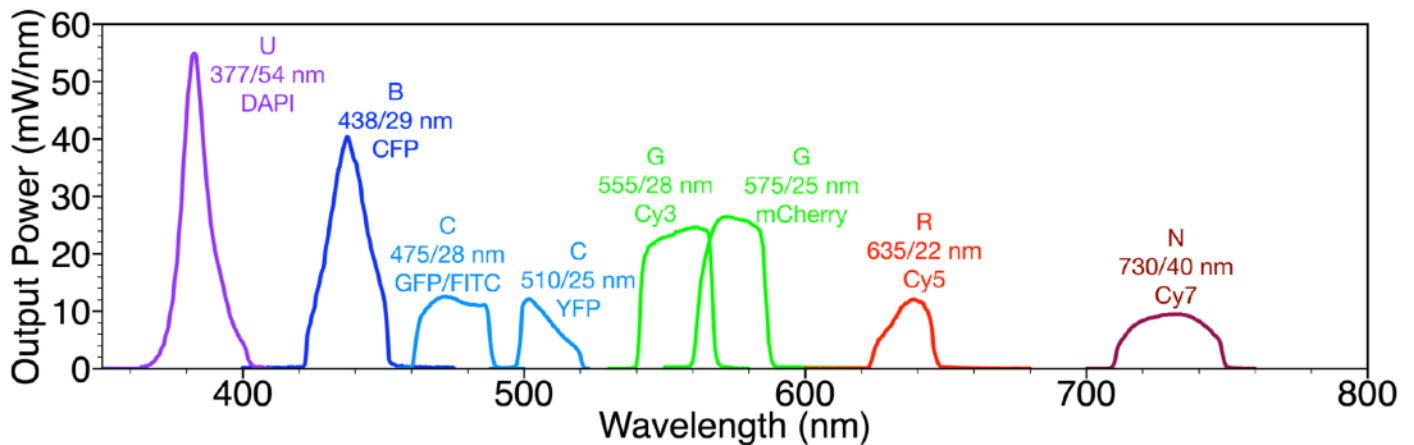

Figure 8. SPECTRA X light engine filtered output. U, B, C, G, R, N represent the operational filter slots (see also Table 4). DAPI, CFP etc indicate fluorophores typically excited with each source+filter combination.

redundant. The filters are accessed via a hinged cover on the right-hand side of the light engine (Figure 9). The cover incorporates a safety interlock to prevent light output when the cover is open. There are 9 filter slots arranged in two rows. The frontmost 6 slots labeled U, B, C, G, R, N are operational, holding the filters associated with the 6 individually addressable solid-state light sources as detailed in Table 4. The 3 unlabeled slots in the rear are non-operational and house the alternate teal (510/25 nm) and yellow (575/25 nm) filters and the spare empty filter holder. Only 6 spectral

Figure 9. SPECTRA X filter compartment with hinged access cover open and the red (635/22 nm) filter extracted. The red line marks the boundary between the six operational filter slots and the 3 rearmost slots used for non-operational storage.

Table 4. Default SPECTRA X Filters

Source	Wavelength Range#	Filter Slot	Installed Filter‡	Alternate Filter**
1	365–400 nm	U	377/54 nm	
2	425–450 nm	B	438/29 nm	
3	460–510 nm	C	475/28 nm	510/25 nm
4	520–600 nm	G	555/28 nm	575/25 nm
5	630–680 nm	R	635/22 nm	
6	710–750 nm	N	730/40 nm	

\# Without filters. ‡ Filters are specified as CWL/BW where CWL is center wavelength of the transmission window and BW is bandwidth of the transmission window in nanometers. BW is measured at 50% of maximum transmission (FWHM). **Alternate filters are housed in the unlabeled slots at the rear of the filter panel.

outputs can be operational at one time. To obtain teal (510/25 nm) output, remove the 475/28 nm filter from slot C and replace it with the 510/25 nm filter. To obtain yellow (575/25 nm) output, remove the 555/28 nm from filter slot G and replace it with the 575/25 nm filter. To replace a mounted filter, release its holder as shown in the left panel of Figure 10. Insert the replacement filter holder in the

Table 5. SPECTRA X Filters#

P/N	CWL/BW❖	P/N	CWL/BW❖
10-10766	375/30	10-10285	550/15
10-10399	377/54	10-10579	555/28
10-10374	390/22	10-10369	560/32
10-10281	395/25	10-10286	575/25
10-10745	434/21	10-10412	575/35
10-10361	438/29	10-10453	585/35
10-10282	440/20	10-10377	631/28
10-10283	470/24	10-10509	635/22
10-10508	475/28	10-10287	640/30
10-10364	485/25	10-10413	648/20
10-11172	505/25	10-11167	655/40
10-10487	511/16	10-10466	730/40
10-10284	510/25	10-10400	740/20
10-10367	542/33		

#Filters are 25 mm diameter, 5 mm thickness. Filters shown in red text are supplied with the SPECTRA X. ❖Filters are specified as CWL/BW where CWL is center wavelength of the transmission window and BW is bandwidth of the transmission window in nanometers. BW is measured at 50% of maximum transmission (FWHM).

Figure 10. SPECTRA X filter holders. **Left:**Empty holder. Squeeze at the points indicated by the red arrows while pulling outwards to release the filter holder from the light engine. **Right:** Holder showing correct insertion of a filter and the bandpass specification (475/28 nm) marked on the filter.

same orientation and push it in until the latch engages. Ensure that the bandpass specification of the replacement filter matches the spectral output of the source that it is paired with (Figure 7, Table 4). Additional filters can be purchased as accessories (Table 5) to supplement the eight filters supplied with the SPECTRA X (Table 4). The holders accommodate 25 mm diameter filters with

5 mm thickness. Spacers (p/n 01-12889; Table 7) are available to allow installation of filters with 25 mm diameter and 3.5 mm thickness. To remove a filter from the holder, simply slide it along the guide slots in the holder. Reverse the process to insert the replacement filter.

5.4 Output Intensity

Output intensity settings in the GUI (Figure 5, #3) are expressed as 0–100% and can be set in 0.1% increments. Light output power is linear as a function of intensity setting. The recommended operating intensity range is 5–100% [1]. There are two selectable intensity control modes labeled "Intensity" and "PID" in the control GUI (Figure 5, #7). "Intensity" is the factory default setting and is recommended for most applications.

Footnote
[1] An intensity setting of 0% (Figure 5, #3) is NOT functionally equivalent to OFF (Figure 5, #2).

6. Operating Specifications

SPECTRA X Light Engines must be operated and stored under the environmental conditions

Table 6. SPECTRA X Light Engine Operating Specifications

Specification	Detail
External temperature	
Operating	32 to 86° F (0 to 30° C)
Non-operating	-4 to 158° F (-20 to 70° C)
Humidity	
Operating and non-operating	0 to 80% relative humidity, non-condensing#
Dew point	
Operating	32 to 59° F (0 to 15° C)
Altitude	
Operating	0 to 10,000 feet (3,048 meters)
Non-operating	0 to 45,000 feet (13,176 meters)
Dimensions	
Size (W x L x H)	145 mm x 340 mm x 203 mm (5.7 in x 13.4 in x 8.0 in)
Weight	8.7 kg /19.1 lbs
System	
Lifetime	Time for light engine output to decrease to 70% of the values recorded on the original certificate of conformance¶
AC power requirements	100–240 V, 50–60 Hz
DC Power supply	220 W (24 VDC / 9.2A)
Temperature control	See description below
Sound Level	Sound level at 1 meter < 65dB(A)
Control Interfaces	USB, RS232, TCP, TTL
Warranty	24 months parts and labor
# The SPECTRA X Light Engine must be operated in a non-condensing environment (dew point <15ºC with controlled ambient temperature <30º C). ¶The corresponding number of days/months/years may vary considerably depending on the duty cycle implemented by the user and the prevailing environmental conditions during operation.	

specified in Table 6. Performance specifications for individual light engines are listed on the certificate of conformance included with the shipping documents e-mailed to the customer (see example shown in Figure 2). It is important to retain the certificate of conformance for reference. In

the event that the light engine is sold, the certificate of conformance should be transferred to the new owner. Certificates of conformance are also recorded in Lumencor's database and copies can be requested by e-mail to techsupport@lumencor.com. The request message must include the 5-digit serial number of the light engine marked on the rear panel ID sticker and also displayed in the control GUI (Figure 5, #11).

When the light engine is operating, internal temperature control is provided by the onboard microprocessor in conjunction with an onboard temperature sensor and the cooling fan located at the rear of the light engine. After the initiation sequence is complete (Section 4.2) the fan will turn off until light output is turned on. The fan will remain on for the duration of light output and for 5 minutes after light output is turned off, after which the fan will automatically shut off. If the internal temperature exceeds 50°C OR the fan rotor is stopped, all light output is automatically turned OFF and is locked in this state until the internal temperature is below 50°C and/or the fan restarts. The current reading of the onboard temperature sensor is displayed on the front panel status display (Figure 3, #2) and in the Control GUI (Figure 5, #8).

7. Maintenance and Troubleshooting

No routine maintenance is required. There are no user-replaceable components or sub-assemblies inside the SPECTRA X Light Engine. Opening the light engine enclosure will void the manufacturer's warranty. Replaceable external parts are listed in Table 7. In the event that the light engine fails to perform in accordance with the specifications listed on the certificate of conformance, follow the

Table 7. Accessories and Replacement Parts for SPECTRA X Light Engine

Description	Part Number	Note
Bandpass filters	See Table 5	8 included, others available for purchase as accessories
Filter holder	01-12758	1 included, others available for purchase as accessories
Filter holder spacer	01-12889	For installation of 3.5 mm thick filters in filter holder p/n 01-12758
Control key, external gate jumper and remote interlock jumper (3 item set)	83-10012	1 set included with product
24 V/9.2 A DC power supply	27-10019	Included with product
3 mm liquid light guide	10-10084	Not included with product. Required for operation
USB to RS232 cable	29-10011	Not included with product.
9-channel TTL breakout cable	29-10156	BNC terminated. Not included with product.
9-channel TTL breakout cable	29-10216	SMB terminated. Not included with product.
Footnotes: To order accessories and replacement parts, e-mail your purchase order to orders@lumencor.com. For price quotations, submit our online quote request form with the "Accessories" box checked.		

troubleshooting procedures detailed in Table 8. If the problem remains unresolved, please contact Lumencor Technical Support for assistance, as directed in Section 8.

Table 8. Troubleshooting Procedures

Problem	Check the following
No response to serial (USB or RS-232) commands	Check that the LEGACY or STANDARD command mode selection (GUI Settings; Figure 5, #13) is compatible with the software driver.
No response to TTL trigger commands	Check that **TTL inputs** are ENABLED (GUI Settings; Figure 5, #12) and that the **TTL polarity** setting is consistent with the trigger inputs. Also check that all serial ON/OFF controls are in the OFF state.
No light output in response to source **ON** command (serial or TTL).	Check the following: 1. Control key must be inserted in front panel and turned to the"ON" position¶. 2. Liquid light guide must be fully inserted in light output receptacle¶. 3. Remote interlock jumper must be inserted in rear panel¶. 4. External gate jumper must be inserted in front panel (Figure 3, #3).
No light output in response to source **ON** command (serial or TTL) after passing checks 1–4 above.	A live output power reading of 0.0 mW (Figure 5, #4) when the source enabled indicator (described in Section 4.1) is lit and intensity is set to 5% or above is directly indicative of a source failure requiring factory service. In this case, submit an online RMA request as described in Section 8.
Unusually weak fluorescence signals across all detection channels	Weak fluorescence in all detection channels (DAPI, FITC, TRITC, Cy5 etc) is likely to be due to poor light transmission by the liquid light guide, the adaptor connecting the liquid light guide to the microscope epilluminator or another distal component of the microscope optical path, and not to abnormally low light output from the light engine.
Unusually weak fluorescence signals in a single detection channel (e.g. DAPI)	1. Check that the light engine power output reading in the control GUI (Figure 5, #4) is normal. 2. Check that the dichroic beamsplitter and emission bandpass filter in the microscope are compatible with the light engine excitation filter specifications shown on the certificate of conformance (Figure 2). 3. Check that the SPECTRA X filters are inserted in appropriate filter slots (Table 4, Figure 8).
High, spatially uniform "fluorescence" background	Check that the dichroic beamsplitter and emission bandpass filter in the microscope are compatible with the light engine excitation filter specifications shown on the certificate of conformance (Figure 2).

¶ Open interlocks for these conditions will be indicated by a red ILK status indicator (●) in the lower right corner of the GUI control screen (Figure 5, #9)

8. Customer Support

For technical support on the installation and operation of the SPECTRA X Light Engine, please contact Lumencor by phone at 503-213-4269 or through e-mail at techsupport@lumencor.com. Please be prepared to provide the 5-digit serial number of the light engine. Any light engine returned to Lumencor for repairs or upgrades requires a pre-issued return material authorization (RMA) number. To request an RMA number, fill out and submit the online request form. It is the customer's responsibility to properly package and safely ship products to Lumencor. Instructions for shipping will be provided in the e-mail giving notification of the RMA number.

9. Warranty

The SPECTRA X Light Engine is backed by a 24 month warranty to end users. Warranty coverage starts on the original date of shipment from Lumencor. Light Engines qualifying for warranty service must be verifiably delivering performance that is substantially at variance with the levels documented

in the certificate of conformance. The light engine must also have been used and maintained under operating conditions consistent with the specifications given in Section 6 of this manual, and observing all the Precautions and Warnings notified in Section 2. This warranty does not extend to light engines that have been subject to shipping damage, misuse, accident, tampering or improper installation. Accessories including (but not limited to) liquid light guides, collimators, cables and control consoles are not covered by the warranties attached to light engines. Please fill out and submit the online warranty registration form. This will facilitate provision of warranty service should it be required.