Lumencor

Lumencor Operation Manual

CELESTA Light Engine®

Regulatory Models
Lumencor utilizes regulatory model names for all certified and CE marked products. The regulatory model names are traceable to all regulatory documentation, third party reports and certifications.

"**Regulatory Model: Celesta**" is used as a representative model for all certified and CE marked CELESTA products.

Emissions
This equipment has been tested and found to comply with the limits of EMC directive 2014/30/EU and FCC part 15 (CISPR 11:+A1:2016). These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.

Safety Certifications
TUV SUD America, CB Certification (IEC 61010-1:2010)
TUV SUD America, NRTLus Certification (UL 61010-1:2012-05)
TUV SUD America, cNRTL Certification (CAN/CSA-C22.2 No. 61010-1:2012)
TUV SUD America, EN Certification (EN 61010-1:2010)
Underwriters Laboratories (UL), CB Certification (IEC/EN 60825-1:2014 Safety of laser products)

CE Marking
Low Voltage Directive (2014/35/EU)
EMC Directive (2014/30/EU)
RoHS Directive (2011/65/EU+2015/863/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 RMA request with "Recycle product under WEEE" in the Description of Issues field.

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 dealer and ask for the correct method of disposal.

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.

Lumencor, Inc. | 14940 NW Greenbrier Parkway | Beaverton, OR 97006 USA | 503.213.4269 | www.lumencor.com

Revision G
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1. Introduction

The CELESTA Light Engine consists of 4 to 7 individually addressable solid-state laser light sources with integrated electronic control systems. The outputs of the laser light sources are merged into a common optical train, passed through a despeckler and directed to the light output port on the front panel. The light output port has a built-in adapter for connection to an SMA-terminated optical fiber or an FC/PC-terminated optical fiber. The individual laser sources within the CELESTA Light Engine are controlled by an onboard microprocessor operating Lumencor firmware. Overall control of the CELESTA Light Engine is implemented via third party microscopy data acquisition software or a GUI resident on the onboard microprocessor. These control interfaces allow users to independently enable or disable each laser source, as well as adjust the output intensity of each source. Alternatively, the light sources may be turned on and off by TTL inputs from a trigger device such as a camera or a 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 rear.

Table 1. CELESTA Light Engines

Model	Description
CELESTA (SMA Optical Fiber Output)	4–7 independently controlled laser light sources [1] with output despeckler. Output adapter for SMA-terminated optical fiber. Ethernet, serial (USB B and RS232) and TTL (DB15) control ports. Includes 1.5 mm diameter SMA-to-SMA optical fiber, USB and ethernet control cables, DC power supply and cord.
CELESTA (FC/PC Optical Fiber Output)	4–7 independently controlled laser light sources [1] with output despeckler. Output adapter for FC/PC-terminated optical fiber. Ethernet, serial (USB B and RS232) and TTL (DB15) control ports. Includes 400 µm x 400 µm square core FC/PC-to-FC/PC optical fiber, USB and ethernet control cables, DC power supply and cord.
[1] See Table 5 (Section 5) for listing of available laser light sources.	

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 CELESTA 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. Please save all safety instructions.

Instructions de sécurité:
*Veiller à lire et à respecter toutes les instructions de sécurité fournies **AVANT** d'utiliser le CELESTA 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.*

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 CELESTA 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 externe est recommandé pour une utilisation avec le moteur de lumière CELESTA . 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).*

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 bioanalytical instrument.

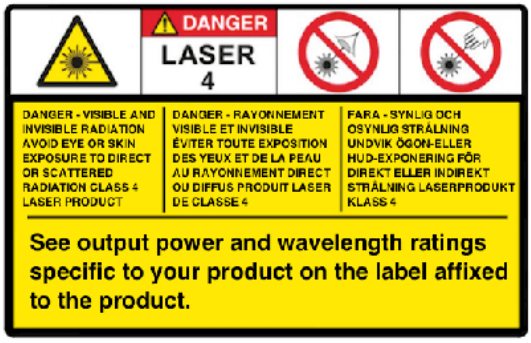
Avertissement: NE PAS regarde directement la sortie de la source lumineuse. *L'intensité lumineuse de cette source est supérieure à celle de la majorité des appareils d'éclairage disponibles dans le commerce et est conçue pour un raccordement direct à un microscope ou autre appareil de bioanalyse.*

Warning: DO NOT apply/remove power or turn on the light without the output end of the optical fiber 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 appliquer/coupter l'alimentation ou 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.*

Caution: Use of controls or adjustments or performance of procedures other than this specified herein may result in hazardous radiation exposure.

Attention: *L'utilisation de commandes ou de réglages ou l'exécution de procédures autres que celles spécifiées dans le présent document peuvent entraîner une exposition à des radiations dangereuses.*



Class 4 Laser Warning

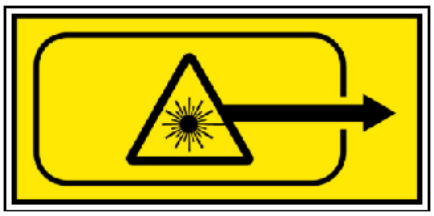
Warning: This product contains Class 4 laser sources. Avoid eye and skin exposure to direct or scattered visible and invisible laser radiation.

Avertissement: *Ce produit contient des sources laser de classe 4. Évitez l'exposition des yeux et de la peau au rayonnement laser visible ou dispersé visible et invisible.*

Laser Sources			
Color	**Center Wavelength (nm)**	**Power**	**Beam Divergence**
See label located on product.	300-1150 nm. See label located on Product.	See label located on product.	Beam divergence shall be calculated at the end-system. Refer to Certificate of Conformance for the light engine beam divergence (NA) at the output aperture.

Laser Aperture Warning

OR



Warning: Avoid exposure - laser radiation is emitted from this aperture. Do not apply/remove power or turn on light engine without first connecting an optical fiber to the output aperture. The distal end of the optical fiber must be coupled into an enclosed optical path prior to operation. Each operational control and laser aperture that can be separated by 2 m or more from a radiation warning device shall itself be provided with a radiation warning device. Do not exceed 2 m without providing a radiation warning device in accordance with EN 60825-1:2014.

Avertissement: *Évitez l'exposition - le rayonnement laser est émis à partir de cette ouverture. N'appliquez/coupez pas alimentation et n'allumez pas light engine sans d'abord connector une fibre optique à l'ouverture de sortie. La sortie est interverrouillée et une fibre optique doit être connecté et couplé dans un chemin optique inclus avant l'opération. Chaque commande opérationnelle et l'ouverture laser qui peuvent être séparées de 2 m ou plus à partir d'un dispositif d'avertissement de rayonnement doivent être munies d'un dispositif d'avertissement de rayonnement. Ne dépassez pas 2 m sans fournir un dispositif d'avertissement de rayonnement conformément à la norme EN 60825-1:2014.*

Warning: DO NOT open the unit. There are no serviceable parts inside and opening the light engine enclosure will void the manufacturer's warranty.

Avertissement: NE PAS ouvrir l'appareil. *Il ne contient aucune pièce réparable et l'ouverture de son boîtier a pour effet d'annuler la garantie.*

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 CELESTA Light Engine being used in a way for which it was not intended and in disregard or contravention of any 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 CELESTA 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

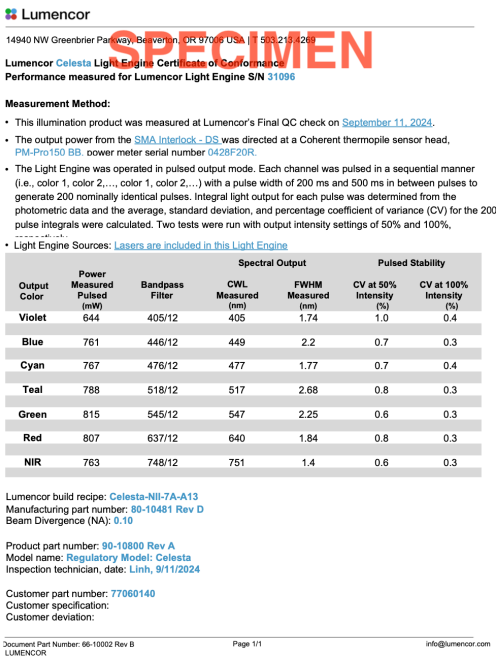
3.1 Contents

The CELESTA Light Engine ships with the following list of standard components:

1. The CELESTA Light Engine, configured with 4 to 7 output channels and an output adapter for connection to an SMA-terminated **or** FC/PC-terminated optical fiber as documented on the certificate of conformance (Figure 1).
2. A 1.5 mm diameter SMA-terminated (10-10533) **or** 400 µm square FC/PC-terminated optical fiber (10-10939).
3. A 220 W (24 V/9.2 A DC) power supply (27-10019).
4. A region-specific AC power cord for the power supply (Table 2).
5. RJ45 ethernet cable.
6. Control key, external gate jumper, and remote interlock jumper (Figure 2).
7. Quickstart Guide instruction document (57-10040).

Table 2. 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



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14940 NW Greenbrier Parkway, Beaverton, OR 97006 USA | T 503.213.0229

SPECIMEN

Lumencor Celesta Light Engine Certificate of Conformance
Performance measured for Lumencor Light Engine S/N 31096

Measurement Method:

- This illumination product was measured at Lumencor's Final QC check on September 11, 2024.
- The output power from the SMA Interlock - DS was directed at a Coherent thermopile sensor head, PM-Pro150 BB, power meter serial number 0428F20R.
- The Light Engine was operated in pulsed output mode. Each channel was pulsed in a sequential manner (i.e., color 1, color 2,..., color 1, color 2,...) with a pulse width of 200 ms and 500 ms in between pulses to generate 200 nominally identical pulses. Integral light output for each pulse was determined from the photometric data and the average, standard deviation, and percentage coefficient of variance (CV) for the 200 pulse integrals were calculated. Two tests were run with output intensity settings of 50% and 100%,
- Light Engine Sources: Lasers are included in this Light Engine

			Spectral Output		Pulsed Stability	
Output Color	Power Measured Pulsed (mW)	Bandpass Filter	CWL Measured (nm)	FWHM Measured (nm)	CV at 50% Intensity (%)	CV at 100% Intensity (%)
Violet	644	405/12	405	1.74	1.0	0.4
Blue	761	446/12	449	2.2	0.7	0.3
Cyan	767	476/12	477	1.77	0.7	0.4
Teal	788	518/12	517	2.68	0.8	0.3
Green	815	545/12	547	2.25	0.6	0.3
Red	807	637/12	640	1.84	0.8	0.3
NIR	763	748/12	751	1.4	0.6	0.3

Lumencor build recipe: Celesta-NII-7A-A13
Manufacturing part number: 80-10481 Rev D
Beam Divergence (NA): 0.10

Product part number: 90-10800 Rev A
Model name: Regulatory Model: Celesta
Inspection technician, date: Linh, 9/11/2024

Customer part number: 77060140
Customer specification:
Customer deviation:

Document Part Number: 66-10002 Rev B
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Figure 1. CELESTA Light Engine Certificate of Conformance (C of C). Column 1: Laser light source output color. Column 2: 100% output power of laser light source measured at output of SMA-terminated **or** FC/PC-terminated fiber. Column 3: Bandpass filters. Columns 4 and 5: Center wavelength (CWL) and full-width at half maximum (FWHM) bandpass of laser light sources. Columns 6 and 7: Pulsed output stability at 50% and 100% intensity respectively (see Section 5.2 for summary of test methodology).

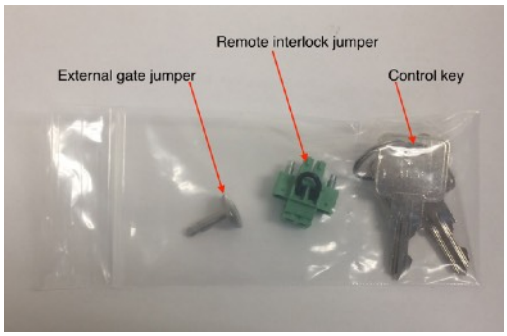

Figure 2. Control key, remote interlock jumper and external gate jumper. These items are packed in a plastic bag inside the shipping box. Their functions are described in Section 4.1.

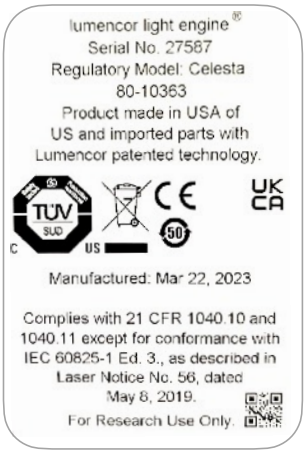

Figure 3. Model and serial number identification label on the CELESTA Light Engine rear panel.

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 (Figure 3). Performance specifications for individual light engines are listed on the certificate of conformance included with the shipping documents e-mailed to the customer (Figure 1). 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**.

3.2 Installation

Note: Any instrument 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 CELESTA Light Engines up for use, place the unit on a hard surface and avoid blocking or restricting airflow at the air inlets (front panel; Figure 3) or exhaust ports (rear panel) on the enclosure. Restricting the airflow will cause the unit to operate at elevated temperatures and will result in decreased product life and/or premature failure.

The operating environment should conform to the specifications in Table 6 (Section 6). In particular, ambient temperature should be maintained at <30° C with a humidity level sufficient to maintain a dew point of <15° C. Thermal overload protection is provided by the onboard computer in conjunction with an onboard temperature sensor. If the internal temperature registered by the sensor exceeds 50° C **OR** the fan rotor is stopped, all light output channels automatically turn OFF and are 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 4, #2) and in the control GUI (Figure 6, #8).

The CELESTA Light Engine may be configured for light delivery via a FC/PC-terminated optical fiber or a SMA-terminated optical fiber. For CELESTA Light Engines with an output adapter for connection to a FC/PC terminated optical fiber, connect the FC/PC-terminated optical fiber to the

output coupler ensuring that the ridge on the barrel of the FC/PC connector ("key") engages with the notch in the receptacle on the light engine ("lock"). Failure to correctly engage the lock and key will result in an open safety interlock condition (Table 3).

Install all required control cables (Figure 4, #7), control key, (Figure 4, #5) external gate jumper (Figure 4, #3), and remote interlock jumper (Figure 5).

Connect the DC output to the 6-pin receptacle on the front of the light engine (Figure 4, #4). Connect the DC power supply to a grounded AC wall outlet using the power cord supplied with the light engine. The light engine will now automatically power up, indicated by illumination of the master power button (Figure 4, #1).

The light engine is now ready for use.

4. Operation

4.1 Controls and Interlocks

The **Master Power Switch** button on the front panel (Figure 4, #1) turns the electrical power to the unit on or off. A green power indicator embedded 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 computer takes about 30 seconds after the master power switch is turned on. When initialization is complete, the status indicator display (Figure 4, #2) will activate.

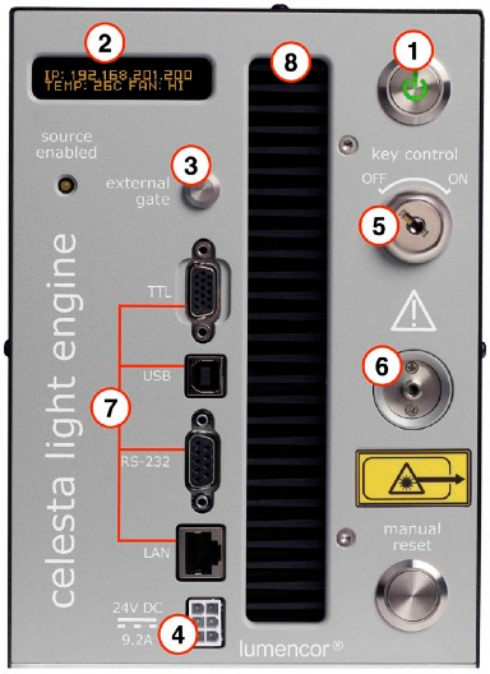

Figure 4. CELESTA Light Engine front panel. **1.** Master power button. **2.** Status indicator display. **3.** External gate port with jumper inserted. **4.** DC power input. **5.** Key Control. **6.** Light output port. **7.** Control ports. Top-to-bottom: TTL, USB B, RS-232, LAN (ethernet). **8.** Air intake.

The **Key Control** (Figure 4, #5) must be in the on position before the laser light sources 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 **Master Power Switch** button, **Key Control** and **Remote Interlock** can be used to shut off laser output.

The **Source Enabled** indicator LED (below the status indicator display; Figure 4) provides a warning indication that one or more laser sources are active and emitting invisible and/or visible radiation.

The **External Gate** port (Figure 4, #3) allows light output to be selectively disabled by control signals from an external device such as a microscope. When external gate control is not in use, light output will be disabled **unless** the external gate jumper (Figure 2) is inserted in the port.

Figure 5. Remote interlock jumper inserted in the labeled receptacle on the lower left side of the rear panel of the light engine.

The **Remote Interlock Connector** (Figure 5) 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 2).

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.**

Customers planning to connect multiple Light Engine remote interlocks together will need to contact Lumencor prior to integration. **INTERCONNECTING LIGHT ENGINES OR USING THE REMOTE INTERLOCK INCORRECTLY CAN RESULT IN ANOMALOUS BEHAVIOR AND/OR DAMAGE TO THE PRODUCTS.**

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.***

Les clients prévoyant de connecter plusieurs verrouillages à distance Light Engine ensemble devront contacter Lumencor avant l'intégration. ***L'INTERCONNEXION DE MOTEURS LÉGERS OU L'UTILISATION INCORRECTE DU VERROUILLAGE À DISTANCE PEUT ENTRAÎNER UN COMPORTEMENT ANOMAL ET/OU ENDOMMAGER LES PRODUITS.***

WARNING: Prior to turning the light output on, be sure the output end of the optical fiber connected to the light engine is safely directed into an enclosed optical path (e.g. a beam dump).

Table 3. 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 an SMA-terminated or FC/PC-terminated optical fiber is correctly installed in the output port	SMA-terminated or FC/PC-terminated optical fiber correctly inserted	SMA-terminated or FC/PC-terminated optical fiber not correctly inserted

[1] If any interlock is opened **after** light output has been enabled, the **Manual Reset** button (Figure 4, lower right) 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 an ILK=RED indicator (●) in the control GUI (Figure 6, #9).

AVERTISSEMENT : Avant d'appliquer/de couper l'alimentation ou d'activer la sortie de lumière, assurez-vous que l'extrémité de sortie de la fibre optique est dirigée en toute sécurité dans un chemin optique fermé (par exemple, une décharge de faisceau).

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

4.2 Start Up and Shut Down

4.2.1 Check that the optical fiber is correctly installed as described above in section 3.2.
4.2.2 Check that the external gate jumper (Figure 2) is installed in the labeled socket on the front panel (Figure 4, #3). Check that the remote interlock jumper is correctly installed in the labeled socket on the lower left corner of the rear panel (Figure 5) [1].
4.2.3 Turn the control key to the **ON** position (Figure 4, #5) [1].
4.2.4 Connect the isolated DC power supply to the light engine (Figure 4, #4).
4.2.5 Connect the AC power cord to the DC power supply.
4.2.6 As soon the DC power supply is energized, the master power button (Figure 4, #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.
4.2.7 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.
4.2.8 When the initiation sequence completes, "LUMENCOR" will flash on the status indicator display (Figure 4, #2) 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 [2]. The light engine is now ready for use. Prior to turning the light output on, verify that the output end of the optical fiber is safely directed into an enclosed optical path.
4.2.9 When the light engine is no longer required for immediate use, make sure that the **Source Enabled** indicator LED (below the status indicator display; Figure 4) is off. Then press the master power button (Figure 4, #1) to shut down the light engine. Shut down can also be accomplished using the Shut Down button in the control GUI (Figure 6) [3].

Notes

[1] To enable light output of the light engine, the external gate jumper, control key, remote interlock jumper, and optical fiber must be correctly installed. The control key must be switched to the ON position.
[2] If any interlocks are open, the fan will come on at HI but will not shut off automatically.
[3] For subsequent start ups, use the master power button to start or shut down the light engine.

4.3 Ethernet Connection and Control GUI

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 6). The GUI **Control** page primarily contains light on/off and intensity controls and also displays real-time output power readings for each light source (Figure 6, #4). The GUI **Settings** page

contains various configuration settings and cumulative operating time data for each laser light source.

To access the control GUI, follow the protocol [1] below:

4.3.1 Connect one end of the RJ45 ethernet cable that was supplied with the light engine to the LAN port on the light engine (Figure 4, #7). Connect the other end to the computer [2, 3].
4.3.2 On Windows systems, go to the Start menu > Control Panel > Network & Internet and/or Network & Sharing Center [3].
4.3.3 Click on 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 the Properties button.
4.3.8 Use the following IP addresses:
Manual/Static IP Address: 192.168.201.201 [4]
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 4, #2) into any web browser address bar [5] to access the control GUI [6]. The factory default light engine IP address is 192.168.201.200.

Notes

[1] These instructions are also included in the *Quickstart Guide* document (57-10040) enclosed in the light engine shipping box.
[2] If the computer does not have an available ethernet port, a USB-to-ethernet adapter may be used instead.
[3] Any type of computer may be used, including Windows, MacOS and Android systems.
[4] This IP address **must be different** from that of the light engine.
[5] Do not use a https:// prefix
[6] The control GUI and image acquisition software connected via the USB or RS-232 ports can be run simultaneously.

Control of CELESTA Light Engines is implemented through a built in library of software commands. A complete listing of the commands is provided in the *Lumencor Light Engine Command Reference* (57-10018). These commands can be delivered using using Transmission Control Protocol (TCP) to the LAN input. The IP address of the light engine required for LAN communication is shown on the front panel status display (Figure 4, #2) or can be obtained using the GET IP command addressed to the RS-232 or USB serial ports. The light engine software commands can also be delivered via the USB or RS-232 serial ports (Figure 4, #7) from various third-party data acquisition software packages.

CELESTA Light Engines that are operating on software version 2.1.19 and above (Figure 6, #1) have a **standby mode** (Figure 6, #6) to conserve power during periods when no active light output generation is required. The light engine automatically switches into standby mode after a latency period (i.e. after the last light output = OFF command was issued). The default latency period is 300 seconds (5 minutes), this can be temporarily reset by the user by using the “WAKEUP” command in

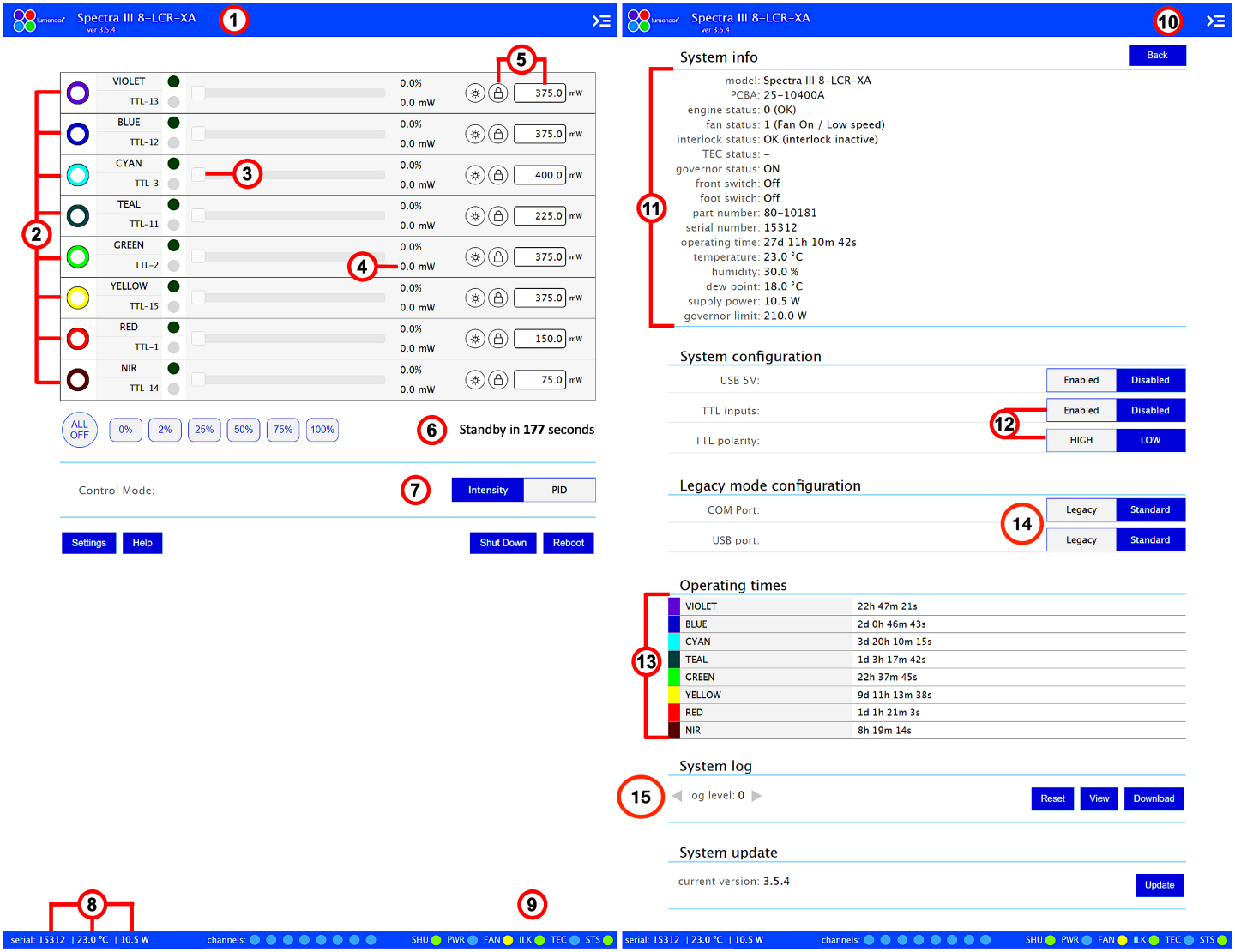

Figure 6. Control GUI for CELESTA Light Engines. **Control Page** (Left) and **Settings Page** (Right). **1.** Lumencor Light Engine model number and software version. **2.** ON/OFF toggle control of source channel (filled circle = ON, ring = OFF). **3.** Intensity control slider. **4.** Live power read out in mW. **5.** Power regulation controls: locked in when padlock and input box are gray. **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 RS-232 (COM) ports. **15.** Microprocessor log file portal. Log level should be set to 0 (zero) for normal operations. **Note** that although the figure shows a SPECTRA Light Engine control GUI, the CELESTA Light engine control GUI has the same format, features and functionality.

the **command line** (Figure 6, #10). Standby mode is also marked by an automatic shut-off of the main cooling fan. Standby mode automatically terminates when the next light output = ON command is issued.

Output power regulation allows users to minimize variations in light output due to temperature fluctuations and other environmental factors. It is primarily useful in applications where continuous light output over long periods (minutes, hours) is required. It is not recommended for use in typical

fluorescence microscopy applications where light output is synchronized with camera exposures, repetitively switching on and off in one second or less. To use power regulation through the control GUI, enter the desired reference power value in milliwatts (Figure 6, #5) and click on the padlock icon next to the reference power value to activate power regulation (Figure 6, #5). Gray shading of the padlock icon and the reference power value shows that power regulation is active for the selected output channel.

4.4 Control via Serial Ports

CELESTA Light Engines have two serial ports, labeled USB and RS-232 (Figure 4, #7), which can be set to receive either LEGACY or STANDARD mode commands. Connection to the computer requires a USB-A-to-USB B cable (29-10058) or USB-to-RS-232 cable (29-10011). LEGACY commands are limited to controlling on/off switching and intensity adjustment of selected individual laser sources. 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 Light Engine Command Reference* (57-10018). Note that LEGACY and STANDARD mode communications use different serial protocols (9600,8,N,1 and 115200,8,N,1 respectively). Changes to the command mode setting for a serial port can be made via the **Settings** page of the control GUI (Figure 6, #14). Changes are applied instantaneously and are retained between power cycles.

Select the command mode setting for the serial port that is compatible with the Light Engine device driver in the control software. This selection is typically found under the “Devices” tab. 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 COM port address assigned by the computer to the light engine USB serial port must be correctly registered in configuration settings of the external control software.

4.5 Control From Light Engine Control Pod

4.5.1 Before starting up the light engine, connect the CELESTA to the control pod (83-10007) using a USB A-to-USB B cable (29-10058).

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

4.5.3 Go to the **Settings** page of the control GUI (Figure 6). Make sure that the USB port configuration is set to LEGACY mode (Figure 6, #14) and USB 5V under System Configuration is set to ENABLED.

4.5.4 The pod must be set in CELESTA 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 CELESTA 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 “CELESTA” by turning the pod control knob. Press the MODE button again to select CELESTA control mode and return to the main control screen.

4.5.5 Follow the instructions on Lumencor’s *Light Engine Control Pod Operation* sheet (54-10036; download at www.lumencor.com). In brief, press the COLOR button to select the desired laser source, press the MODE button to toggle light output on and off and turn the control knob to adjust intensity for the current laser source selection.

4.6 TTL Control

The TTL Interface provides users with a faster method of switching color channel outputs on and off. Individual TTL inputs are provided for each color channel as listed in Table 4. As a safeguard against unintended light output when the inputs are initially connected, the light engine TTL port is disabled by factory default. To enable the TTL input click the ENABLED button next to “TTL inputs” in the control GUI under the **Settings** page (Figure 6, #12) or send the standard mode command SET TTLENABLE 1 to the LAN port. TTL response polarity can be set to ACTIVE = HIGH or ACTIVE = LOW on the control GUI settings page (Figure 6, #12). Input TTL signals can be conveniently addressed using an accessory BNC breakout cable (29-10156 or 29-10216; Figure 7) connected to the front panel TTL port (Figure 4, #7). The breakout cable also provides a global shutter input (labeled “shutter”, pin 9). TTL signals input to the global shutter will synchronously toggle all currently enabled source channels on and off.

Table 4. TTL Connector Pin Definitions

OUTPUT COLOR	Pin#	OUTPUT COLOR	Pin#
RED	1	BLUE	12
GREEN	2	VIOLET	13
CYAN	3	nIR	14
TEAL	11	YELLOW	15
Ground	6,7,8,10	Shutter	9

V_{ihigh} (min) = 2.0 V, V_{ihigh} (max) = 5.5 V
V_{ilow} (min) = 0.0 V, V_{ilow} (max) = 0.8 V
TTL pin references are also indicated next to the ON/OFF toggle buttons in the control GUI (Figure 6, #2)

Figure 7. BNC breakout cable (29-10156). The same cable configuration with SMB connectors instead of BNC is also available (29-10216).

5. Light Output Characteristics

5.1 Output Wavelength

CELESTA Light Engines may be configured with 4 to 7 laser sources selected from a portfolio of 10 options (Table 5). The specific solid-state laser sources installed in the CELESTA Light Engine are listed on the certificate of conformance included with the shipping documents e-mailed to the customer (Figure 1). The certificate of conformance also shows full (100%) power outputs for each source measured at the output end of the optical fiber. Laser light source outputs are constrained by internal bandpass filters. These filters generally have a bandpass of 12 nm centered on the laser CWL. In fluorescence microscopy applications, having a second excitation filter located in the microscope cube is not required and may be counterproductive. Lumencor offers dichroic beamsplitters and emission filters matched to the excitation outputs from the CELESTA Light Engine for use in fluorescence microscopy applications. Specifications for these dichroic beamsplitters and emission filters can be found at https://lumencor.com/products/accessories/dichroic-mirrors-and-filters.

Table 5. CELESTA Light Engine Laser Sources [1]

Color	CWL [2]	Fluorophores
Violet	405 nm	DAPI
Blue	446 nm	CFP
Cyan	477 nm	FITC, GFP
Cyan	488 nm	FITC, GFP
Teal	518 nm	YFP
Green	545 nm	TRITC, Cy3
Yellow	577 nm	mCherry, Texas Red
Red	637 nm	Cy5
Red	680 nm	miRFP, Cy5.5
Near infra-red	748 nm	Cy7

[1] CELESTA Light Engines can accommodate up to 7 laser light sources selected from this list.
[2] CWL = center wavelength. Nominal values are listed here. Specific CWL values for individual CELESTA Light Engines are reported on the certificate of conformance (see Figure 1).

5.2 Temporal Characteristics

Light output in response to an ON command is essentially instantaneous on timescales longer than 1 ms. Rise times for all laser light sources are generally 100 µs or less. Thus TTL triggering with a 0.5 kHz/50% duty cycle square wave will produce a train of essentially square 1 ms duration light output pulses. Lumencor performs pulsed stability testing for each solid-state laser source within the CELESTA Light Engine to ensure consistent laser illumination and performance. These output stability tests are performed with the light engine in stroboscopic output mode, generating 400 nominally identical pulses with 200 ms pulse width. Integrated light output for each pulse is determined from the photometric data and the average, standard deviation and percentage coefficient of variance (CV) for the 400 pulse integrals are calculated. CV results for tests run at 50% and 100% intensity are reported on the light engine's certificate of conformance (Figure 1).

5.3 Intensity

Output intensity settings in the control GUI (Figure 6, #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 6, #7). "Intensity" is the factory default setting and is recommended for most applications.

Note

[1] An intensity setting of 0% (Figure 6, #3) is NOT functionally equivalent to OFF (Figure 6, #2).

5.4 Spatial Characteristics

Single-molecule localization microscopy requires higher levels of irradiance than can be obtained from Köhler illumination. To facilitate these applications, Lumencor has developed critical

epilluminators for use in combination with the CELESTA Light Engine [1] that provide uniform illumination over a smaller field of view but with much higher irradiance than Köhler illumination (Figure 8). Critical epilluminators compatible with all major research microscope brands are available.

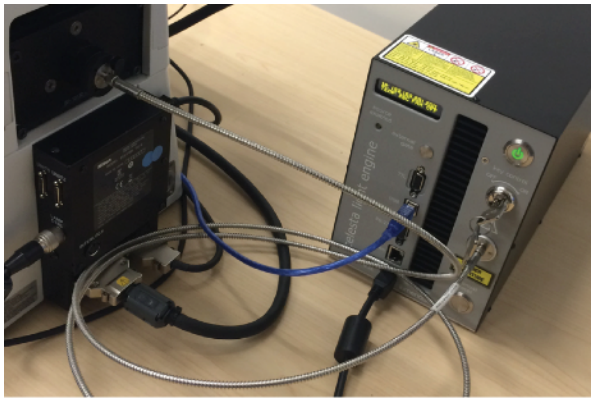

Figure 8. Critical epilluminator installed on a Nikon Ti2 microscope, with FC/PC-terminated optical fiber connection to CELESTA Light Engine.

Note

[1] Critical epilluminators have FC/PC input connectors and are designed to connect to CELESTA Light Engines via a 400 µm square FC/PC-terminated optical fiber (10-10939).

6. Operational Specifications

CELESTA Light Engines must be operated and stored within the environmental conditions 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 (Figure 1). 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.

Table 6. CELESTA Light Engine Operational Specifications

Specification	Detail
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 [1]
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 [2]
AC Power Requirements	100-240 V, 50-60 Hz
DC Power Supply	220 W (24 V / 9.2 A)
Warm-up Period	30 seconds initialization after power-up
Protection	Thermal overload (see section 3.2)
Sound Level	Sound level at 1 meter < 65dB(A)
Control Interfaces	USB, RS-232, TCP, TTL
Warranty	24 months parts and labor from date of original shipment
[1] The CELESTA Light Engine must be operated in a non-condensing environment (dew point <15° C with controlled ambient temperature <30° C). [2] 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.	

7. Routine Maintenance and Troubleshooting

No routine maintenance is required. There are no user-replaceable components or sub-assemblies in the CELESTA Light Engine. Opening the light engine enclosure will void the manufacturer's warranty. In the event that the light engine fails to perform in accordance with the specifications listed on the certificate of conformance, follow the troubleshooting procedures detailed in Table 7. If the problem remains unresolved, please contact Lumencor Technical Support for assistance, as directed in Section 8.

Table 7. 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 6, #14) is compatible with the command syntax implemented in the software driver.
No response to TTL trigger commands	Check that **TTL inputs** are ENABLED (GUI Settings; Figure 6, #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 and turned to "on" position (Figure 4, #5) [1]. 2. Optical fiber must be inserted in light output receptacle (Figure 4, #6) [1]. 3. Remote interlock jumper must be inserted in rear panel (Figure 5) [1]. 4. External gate jumper must be inserted in front panel (Figure 4, #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 6, #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.
Unstable laser output	Turn ON the laser source in question with its intensity set at 0% for about 1 minute prior to initiating data collection. Any control software including the onboard control GUI can be used for execution. This process should pre-condition the laser to minimize output fluctuations due to thermal equilibration during data collection. The 0% intensity setting will minimize light delivery to the sample plane for the duration of the pre-conditioning process.
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 a downstream component of the 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 6, #4) is normal. 2. Check that the dichroic beamsplitter and emission bandpass filter in the microscope are compatible with light engine excitation specifications shown on the certificate of conformance (Figure 1) [2].
High, spatially uniform fluorescence background	Check that the dichroic beamsplitter and emission bandpass filter in the microscope are compatible with light engine excitation filter specifications shown on the certificate of conformance (Figure 1) [2].

[1] Open interlocks for these conditions will be indicated by a red status indicator (●) in the lower right corner of the control GUI screen (Figure 6, #9). [2] Excitation filters are installed in the light engine. Excitation filters installed in the microscope cube are generally redundant and it is recommended that they are removed.

8. Customer Support

For technical support of the CELESTA 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 CELESTA 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, and observing all the Precautions and Warnings notified in Section 2. This warranty does not extend to light engines that have been subject to misuse, accident, tampering, improper installation, or shipping damage. Accessories including (but not limited to) optical fibers, 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 within 90 days of the original date of shipment from Lumencor. This will facilitate provision of warranty service should it be required.