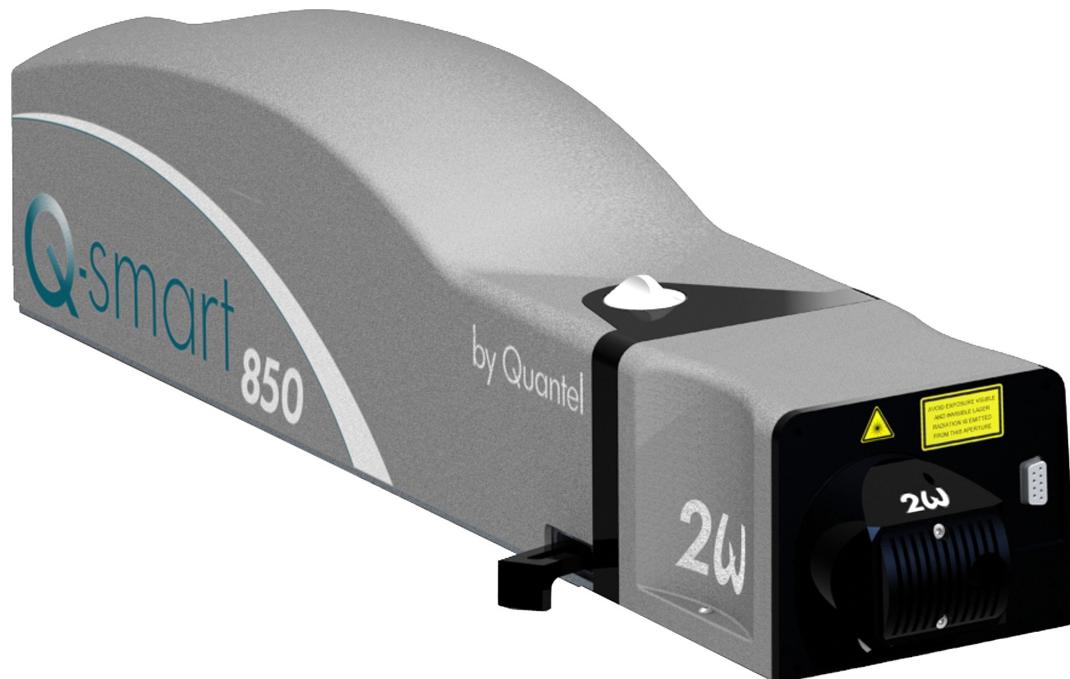


Quantel | User Manual Q-smart



CE

Q-smart 450/850 User Manual



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Q-smart User Manual

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USER MANUAL

Authorization Memorandum

I have carefully assessed the User Manual for the Q-smart.
This document has been completed in accordance with the
requirements of Quantel.

MANAGEMENT CERTIFICATION

To be signed by Patrick Quero

Quality Director & Regulatory Affairs - Quantel Group

Q-smart User Manual

This manual is provided in digital form to conserve paper.
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LASER SAFETY

1.0 Hazard Information

Hazard information includes terms, symbols and instructions used in this manual or on the equipment to alert operating and service personnel to the recommended precautions in the care, use and handling of Class IV laser equipment.

2.0 Terms & Warning Symbols

	DANGER Imminent hazards which, if not avoided, will result in serious injury or death.
	WARNING Potential hazards which, if not avoided, could result in serious injury or death.
	CAUTION Potential hazards which, if not avoided, could result in minor or moderate injury.
	CAUTION Potential hazards which, if not avoided, could result in product damage.
	NOTE Points of particular interest for more efficient or convenient equipment operation; additional information or explanation concerning the subject under discussion.
	WARNING: LASER RADIATION Avoid exposure of eyes or skin to direct or diffused laser radiation. Permanent eye damage or blindness may occur.
	WARNING: HIGH VOLTAGE Electric shocks and burns from capacitor discharge or power circuits could lead to serious injury or even death.

3.0 Acronyms and Abbreviations

AEL: Accessible Emission Limits

BNC: Bayonet Neill-Concelman RF connector often used with coaxial cable

ICE: Integrated Cooling and Electronics (Laser Power Supply)

I/O: Input/Output

LASER: Light Amplification by Stimulated Emission of Radiation

PRF: Pulse Repetition Frequency

Dimensions listed in this manual are:
SI Metric mm [U.S. Standard Units inches].

4.0 General Hazards

The following descriptions are of general hazards and unsafe practices that may result in product damage, severe injury or death. Other more specific warnings and cautions are presented as appropriate throughout this manual.

	DANGER Serious Personal Injury	This Class IV laser configures to emit 1064 nm, 532 nm, 355 nm, 266 nm and 213 nm laser radiation. Do not allow laser radiation to enter the eye by viewing direct or reflected laser energy. Laser radiation may be reflected from various surfaces; care should be taken to avoid inadvertent reflection of laser energy while working with the laser. Wear appropriate protective eye-wear when working in an area with an exposed laser beam. Avoid looking directly into the laser output aperture or at reflections of the beam from other surfaces.
	DANGER Serious Personal Injury	This product is not intended for use in explosive, or potentially explosive, atmospheres.
	WARNING Serious Personal Injury	U.S. customers should refer to and follow the laser safety precautions described in the American National Standards Institute (ANSI) Z136.1-2007 document, Safe Use of Lasers. Procedures listed in this Standard include the appointment of a Laser Safety Officer (LSO), operation of the product in an area of limited access by trained personnel, servicing of equipment only by trained and authorized personnel, and posting of signs warning of the potential hazards. European customers should appoint a Laser Safety Officer (LSO) who should refer to and follow the laser safety precautions described in EN 60825-1,2007 – Safety of Laser Products
	WARNING Serious Personal Injury	Materials processing with a laser can generate air contaminants such as vapors, fumes, and/or particles that may be noxious, toxic, or even fatal. Material Safety Data Sheets (MSDS) for materials being processed should be thoroughly evaluated and the adequacy of provisions for fume extraction, filtering, and venting should be carefully considered. Review the following references for further information on exposure criteria: ANSI Z136.1-2007, Safe Use of Lasers, section 7.3. U.S. Government's Code of Federal Regulations: 29 CFR1910, Subpart Z. Threshold Limit Values (TLVs) published by the American Conference of Governmental Industrial Hygienists (ACGIH). It may be necessary to consult with local governmental agencies regarding restrictions on the venting of processing vapors.

5.0 Other Hazards

The following hazards may be considered typical for this product:

- Risk of exposure to hazardous laser energy and injury through failure to follow appropriate laser safety procedures.
- Risk of exposure to hazardous laser energy through unauthorized removal of protective covers.
- Risk of exposure to hazardous or lethal voltages through unauthorized removal of protective covers.
- Risk of injury when lifting or moving the unit.

6.0 Disposal

This product contains material that is considered hazardous industrial waste. If for any reason a laser is rendered unusable and is not repairable, Quantel recommends that disposal of the system follow all appropriate guidelines for such hazardous waste to prevent environmental degradation.

7.0 Safe Operation of the Laser

1. Never look at the direct beam from the laser or one of its reflections. No visual alignment should be made when the electric power supply of the laser is ON. Permanent eye damage or blindness may result.
2. Avoid exposing any part of the body to the beam. Avoid blocking the laser beam with any part of the body.
3. Limit work area access to the required personnel only. Only use the laser in supervised areas, which are clearly marked and have supervised access.
4. Remove all objects with a reflecting or shiny surface from the work area, as well as all inflammable materials.
5. Do not wear reflective jewelry while using the laser, as it may cause hazardous reflections.
6. Maintain a high level of ambient lighting in the laser operation area so the eye pupil remains constricted, reducing the possibility of hazardous exposure.

7. Place warning signs at all work area accesses. The signs must be appropriate and clearly visible. It is recommended that work area accesses be interconnected to the Laser Remote Interlock.
8. During normal operation, the laser area (work area) must be marked off by screens, walls or other means that ensure that laser beams outside the area are less than the AEL (class 1 type laser). These screens must **not** be covered by materials that may reflect the laser wavelength. They must not be inflammable, nor may they, when exposed to the direct laser beam (even only for several seconds), allow laser radiation greater than the AEL limit to pass.
A warning area limited by barriers is necessary to warn all people of the potential risk that lies within the laser area.
9. Only qualified people may operate the lasers. When not in use, the lasers must be completely inoperable. This may be done by removing the laser key, for example. It must be impossible for unauthorized people to operate the laser.
10. Aiming laser radiation at individuals, vehicles, aircraft or any other flying object is prohibited by federal regulations.
11. Due to the risk of electric shock, the power supply must be switched off and disconnected from the Laser Head prior to any maintenance operation. Electric shocks or burns resulting from the power supply may cause serious injury or death.
12. Operate the laser at the lowest possible beam intensity, given the requirements of the intended application.
13. Increase the beam diameter wherever possible to reduce beam intensity and thus reduce the hazard.
14. Use an IR detector or energy detector to verify that the laser beam is off before working in front of the laser.
15. Provide enclosures for the beam path whenever possible.
16. Set up an energy absorber to capture the laser beam, preventing unnecessary reflections or scattering.

8.0 Additional Safety Information

There are several public resources for good laser safety information.

United States

- The American National Standards Institute (ANSI) Z136.1-2007 document Safe Use of Lasers prescribes procedures intended to promote safety in using lasers. The document describes practices such as the appointment of a Laser Safety Officer (LSO), operation of the equipment only by trained personnel and in an area of limited access, equipment servicing only by trained and authorized personnel, and appropriate use of warning signs to increase awareness of potential hazards.
- The Occupational Safety and Health Administration (OSHA) provides an online Technical Manual (located at www.osha.gov/dts/osta/otm/otm_iii/otm_iii_6.html). Specifically, Section III, Chapter 6 and Appendix III contain specific laser safety information.
- The Laser Institute of America (LIA) has a comprehensive web site (located at www.laserinstitute.org).

Europe

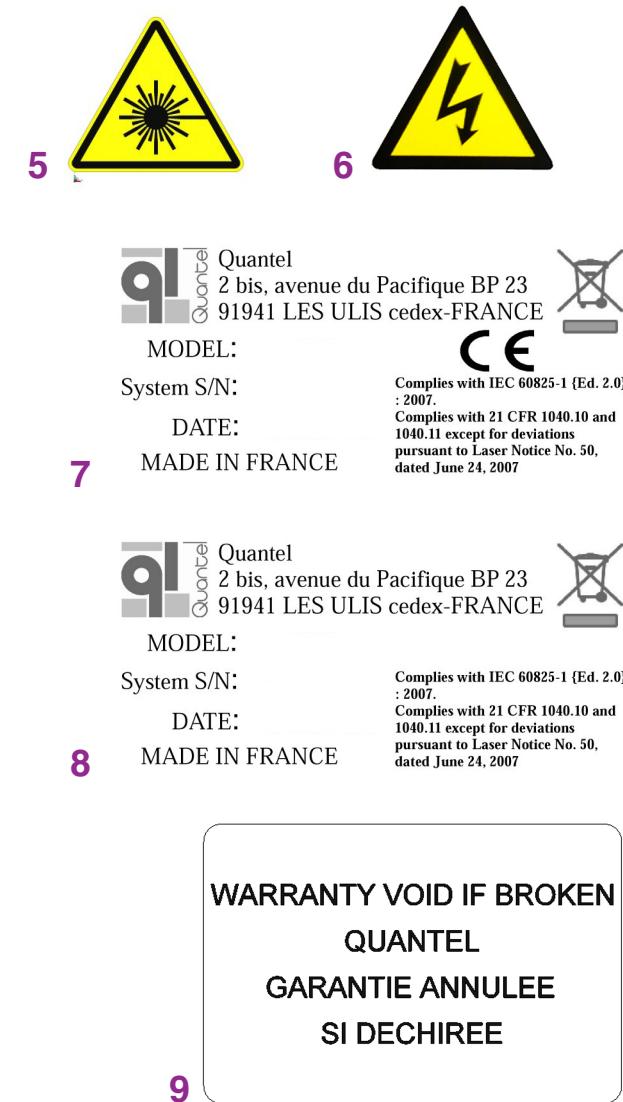
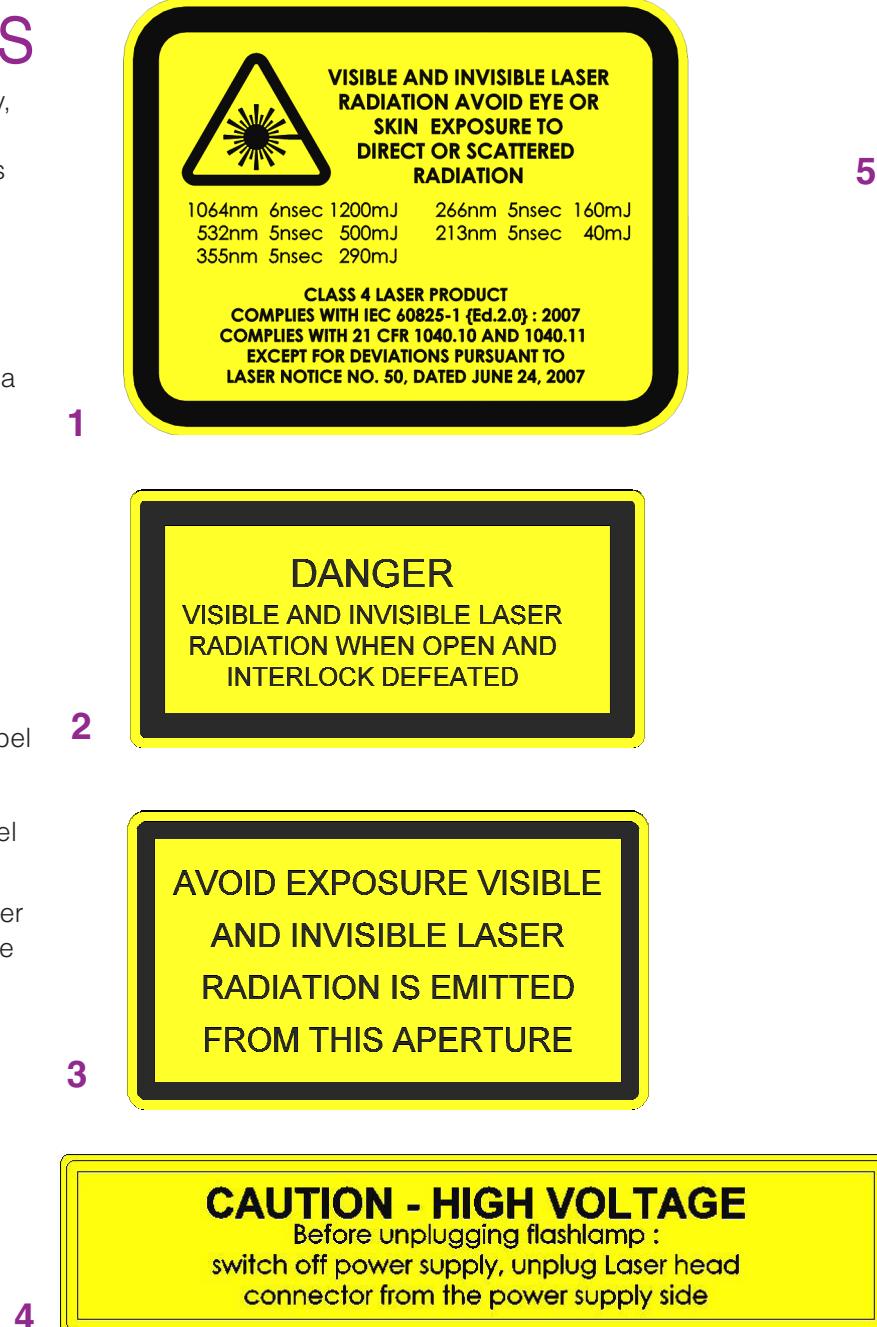
- Norm EN 60825-1 - Safety of laser products, Part 1: Equipment classification, requirements and user guide
- Norm EN 207 - Personal eye protection - Filters and eye protectors against laser radiation
- Norm EN 208 - Personal eye protection - Eye protector for adjustment work on lasers and lasers systems.

SAFETY LABELS

The following figures show the safety, model number, serial number and origination labels, and their locations on the Q-smart laser system. These labels are installed at the factory and should not be removed by the user. If for some reason a label is removed, obscured or damaged in any way, please contact Quantel for a replacement.

The Q-smart Laser System has the following labels with product serial numbers and information:

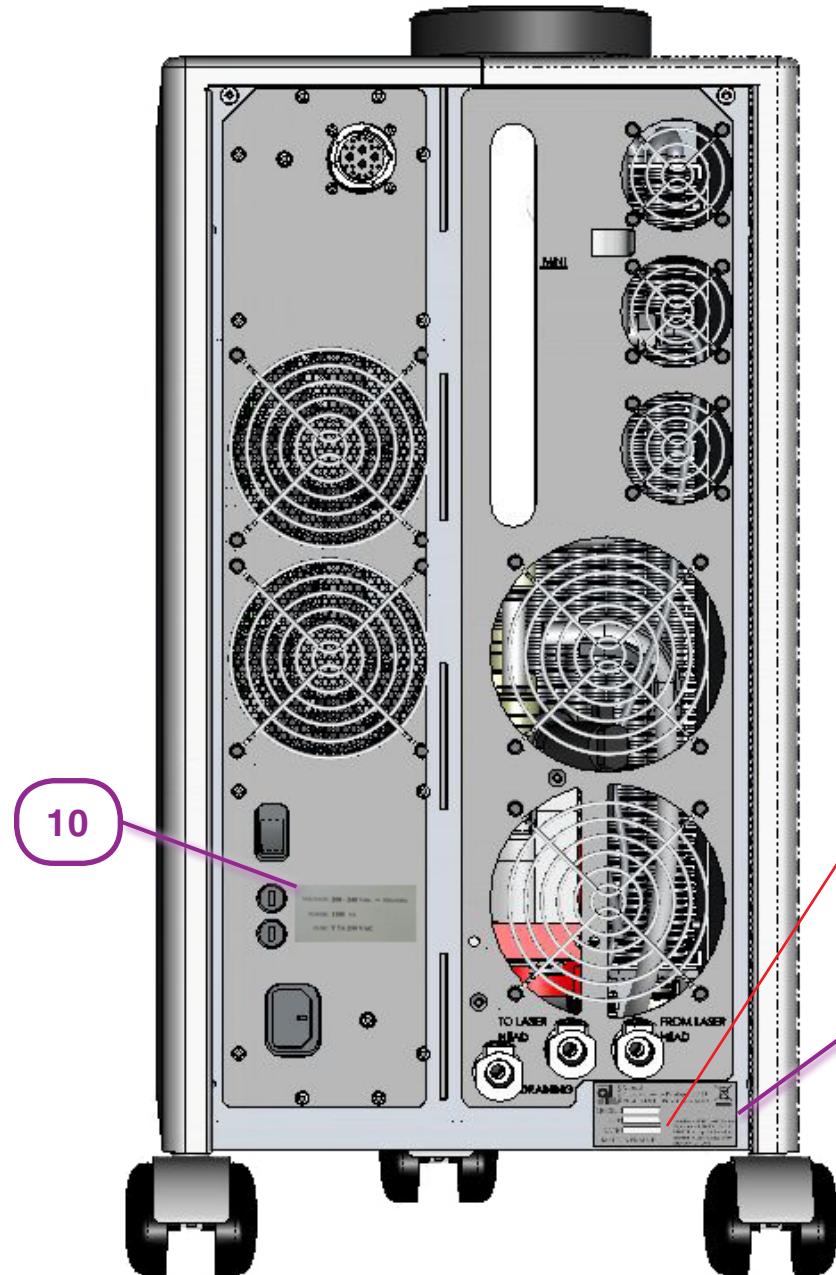
- System Origination Label (located on the ICE)
- Power Supply Serial Number Label (located on the ICE)
- Power Board Serial Number Label
- Cooling Serial Label
- Laser Head Serial Number Label (located on the Laser Head)
- Harmonic generator Part Number Label located on the HG module (one per module purchased)
- Q-touch Serial Number



VOLTAGE: **200 - 240** Volts , ~ 50Hz/60Hz

POWER: **1100** VA

FUSE: **T 7A 250 VAC**



ICE BACK PANEL

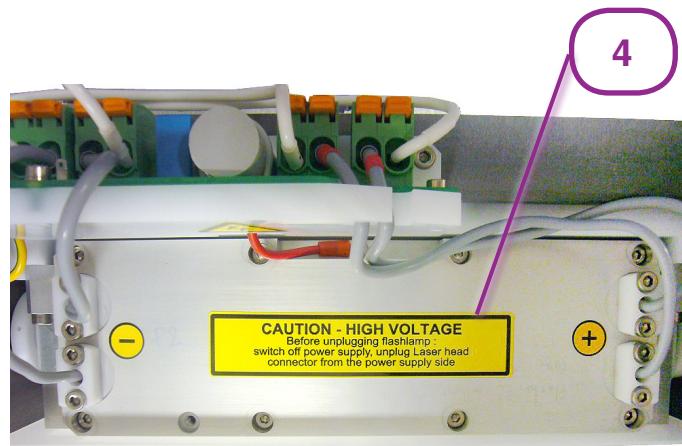
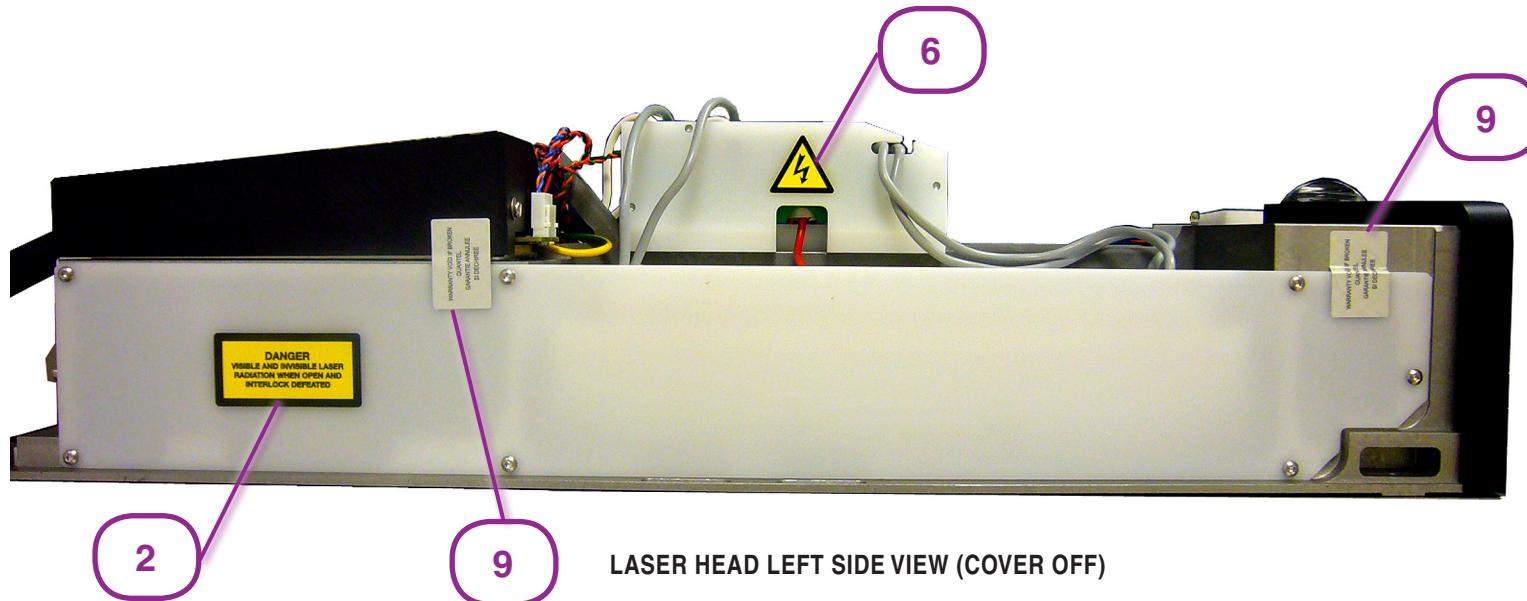
8

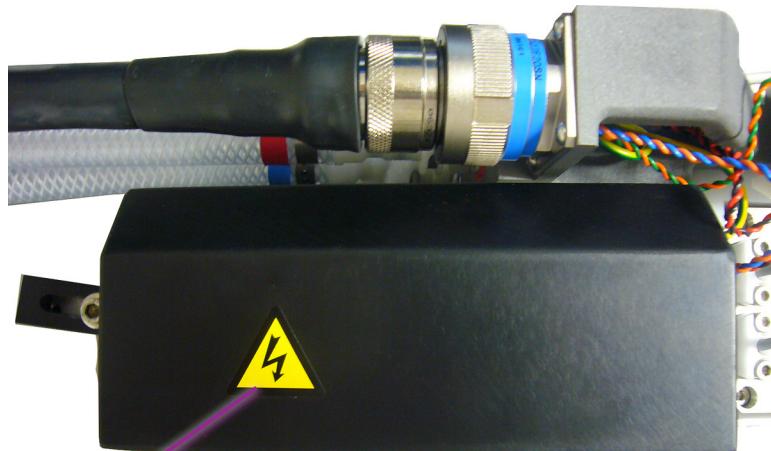
Have this serial number ready when you call customer service.

8



ICE BOTTOM VIEW





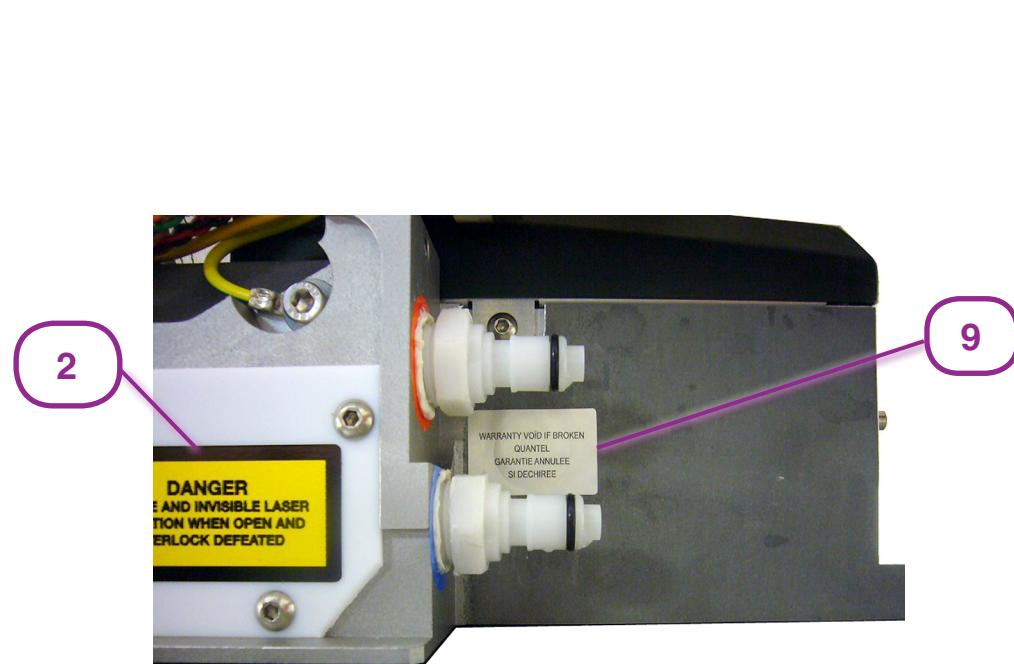
LASER HEAD PARTIAL VIEW (COVER OFF)



LASER HEAD BOTTOM VIEW



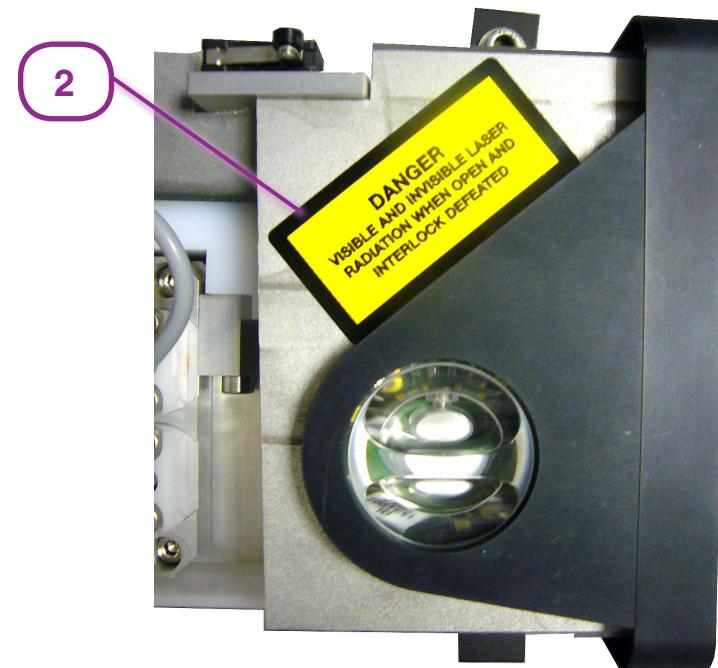
LASER HEAD END VIEW



LASER HEAD RIGHT SIDE VIEW (COVER OFF)



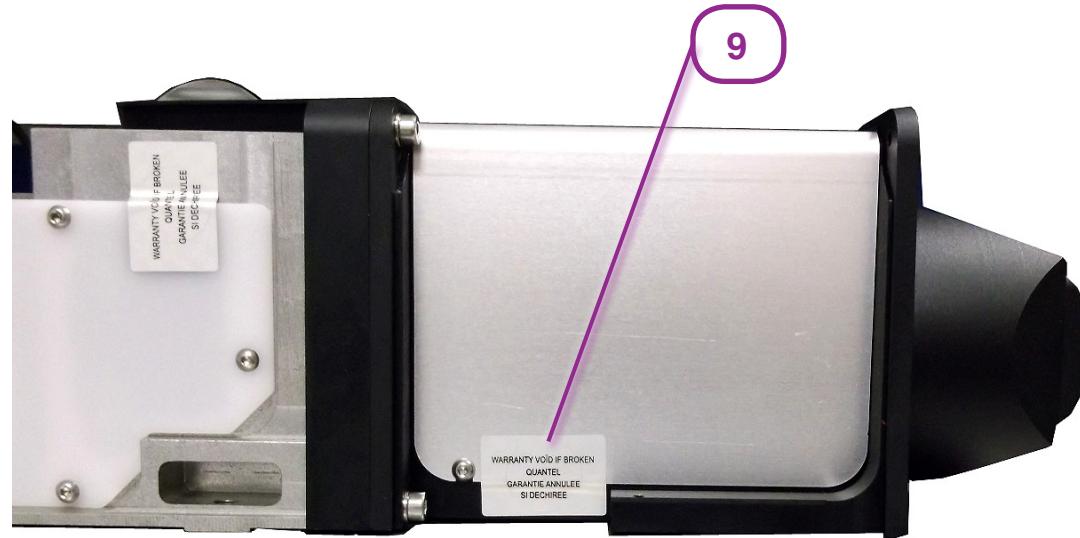
LASER HEAD FRONT



LASER HEAD SHUTTER TOP



HG MODULE FRONT



HG MODULE SIDE



HG MODULE BOTTOM

FEATURES

1.0 ICE Front Panel

Key Switch

ON: To turn the ICE ON, rotate the key to the ON ("I") position. With the Key Switch in the ON position, the laser system is ready for use. The key is not removable when in the ON position.

OFF: To turn the ICE OFF, rotate the key to the OFF ("O") position. Remove the key to keep unauthorized personnel from operating the laser.

Indicator Lights

AC Mains Power ON Indicator: This indicator illuminates when the AC power switch located on the ICE rear panel is turned on and the unit is connected to 100–240 VAC, 50/60 Hz AC Mains power.

Laser ON indicator: This indicator illuminates when the flashlamps are on to warn you that laser output is possible. When the Key Switch is turned ON the "LASER ON" message illuminates for the first 3 seconds. You must be observing all laser safety precautions when this indicator is ON.

Ethernet Connector

Use this input to connect a computer to remotely control the system. See **Software on page 51** for details.

Note: To disable remote computer control, press any button on the Q-touch.

Q-touch Connector

Use this input to connect the Q-touch for access to settings and operating parameters.

Note: The Emergency Stop is on the Q-touch, when it is connected.



Figure 1: ICE Front Panel

BNC Connectors

Lamp Sync In: A signal applied to this BNC connector causes the flashlamp to fire when external flashlamp triggering is selected from the Q-touch or software interface. Your signal source must supply a pulse with the characteristics listed for [External Trigger Signal Requirements on page 58](#).

Lamp Sync Out: Use this BNC connector to synchronize your experiment with the laser flashlamp trigger signal output. The flashlamp firing corresponds with the rising edge of this positive TTL signal, which is 5 V, 20 mA max, and greater than 50 μ s pulse width.

Q-Switch Sync In: A signal applied to this BNC connector causes the Q-Switch to trigger when external flashlamp triggering is selected from the Q-touch or software interface. The time delay between the input signal and the pockels triggering may range between 600 to 700 ns from one laser to another, but is fixed for any particular laser. The input resistance of this circuit is about 10 K Ω . Triggering corresponds to the rising edge of the signal. See [External Trigger Signal Requirements on page 58](#) for details.

Q-Switch Sync Out: Use this BNC connector to synchronize your experiment with the laser Q-Switch trigger signal output. The Q-Switch trigger corresponds to the rising edge of this positive signal (5 V, 20 mA max, and greater than 10 μ s pulse width).

SLM Sync Out: This BNC connector allows synchronization for use with the SLM option.

Warning: Use this BNC output to connect an external laser-warning indicator. This switch is short-circuited when the flashlamps are operating (either flashing or with simmer current). The maximum allowed voltage when the circuit is open is 50 V. The maximum current for the shorted circuit is 500 mA.



CAUTION: This output is not short-circuit protected.

Interlock (Remote Safety Feature): Use this BNC to connect an external safety shutdown switch. For the laser to operate, this connector must be shorted. When this circuit is open, the ICE high voltage is disabled and capacitor banks discharge in less than 5 seconds. Leave the attached BNC shorting cap installed on this connector if this function is unnecessary.

Note: Multiple safety switches must be in a series connection.

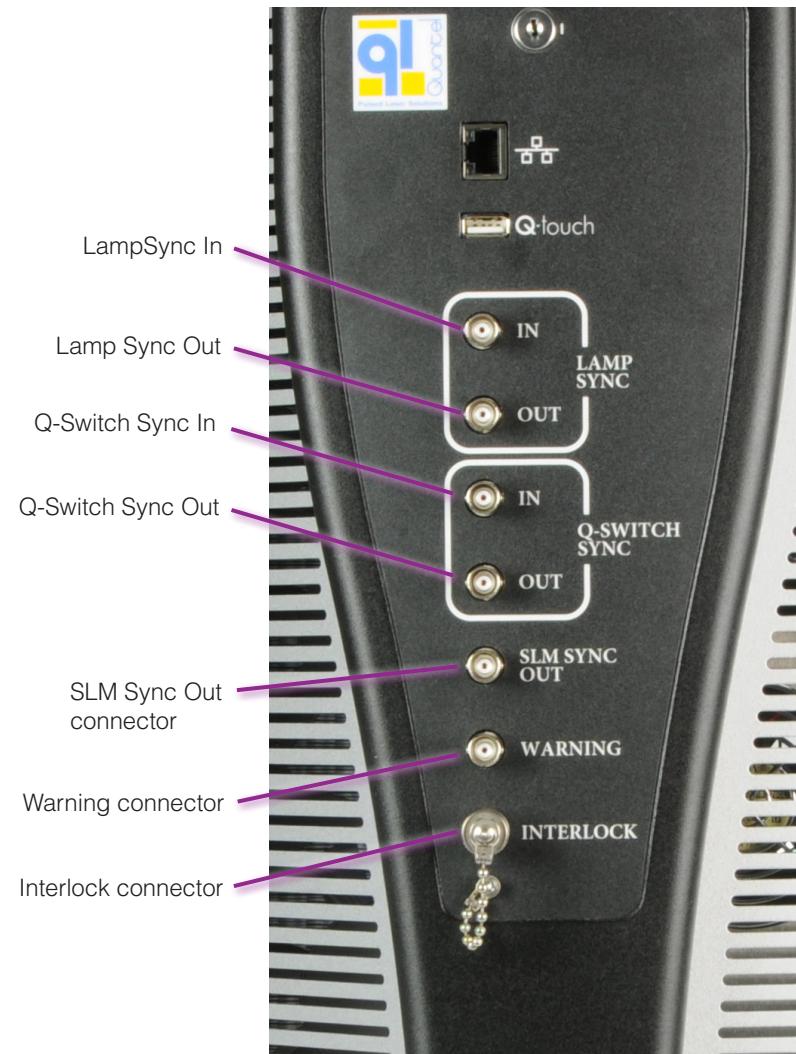


Figure 2: BNC Connector Locations

2.0 ICE Rear Panel

Laser Input/Output (I/O)

The Laser I/O cable is the electrical Interface between the Laser Head and the ICE.

 **CAUTION:** Ensure that AC power is turned OFF before connecting or disconnecting the Laser I/O cable or system damage may result.

AC Mains Power

AC Mains Power Connector: Standard power connector for AC Mains power at 100-240 VAC, 50/60 Hz, single-phase.

AC Mains Power Switch: This switch turns ON ("1") or OFF ("0") the supply of AC Mains power to the system.

Fuses: These fuses disconnect the ICE from AC Mains power in the event of an electrical fault. The label next to the fuse holder specifies the fuse type and rating.

 **CAUTION:** Replace the fuses with the specified fuse only. See **Replacing the ICE Fuses on page 67**. Failure to do so may result in equipment damage or personal injury. For your safety, disconnect the power cord before servicing fuses.

Coolant Ports

Coolant OUT Port: Connect the blue coolant tube to provide coolant to the Laser Head.

Coolant IN Port: Connect the red coolant tube to allow the return of "warmed" coolant from the Laser Head.

Coolant Drain Port: Use this port to connect the drain tube when it is necessary to drain the coolant system. **Draining the ICE on page 63** for details. The system must always be drained prior to shipping or maintenance.

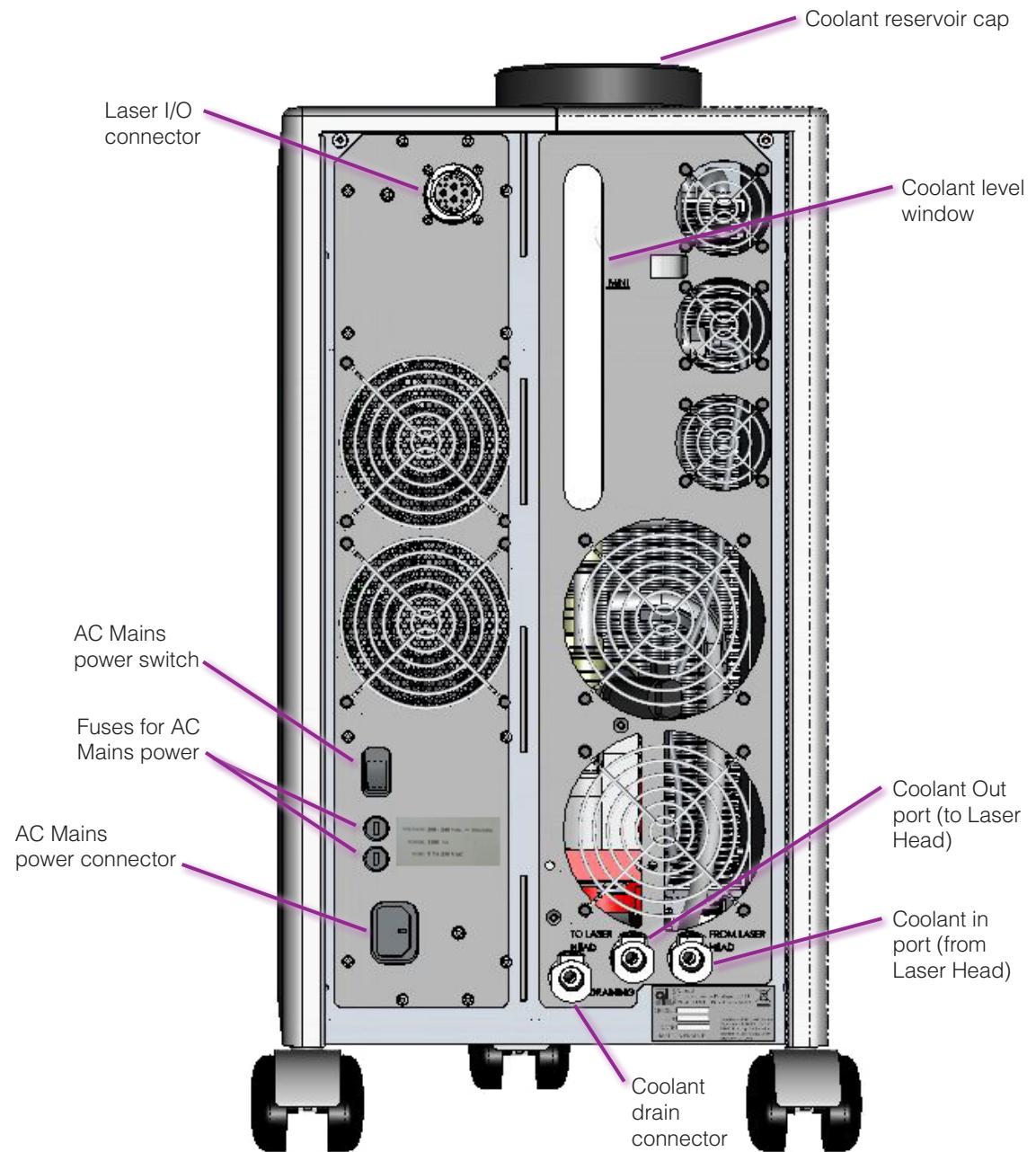


Figure 3: ICE Rear Panel

3.0 Laser Head

Electronics Connectors

9-pin connector: The 9-pin connector is used to connect the Harmonic Generation (HG) module electronics to the Laser Head.

Laser I/O: The Laser I/O cable is the electrical Interface between the Laser Head and the ICE.

CAUTION: Always turn OFF AC power before connecting or disconnecting the Laser I/O cable or system damage may result.

Coolant ports

Blue: Connect the tube to the blue port to bring coolant from the ICE to the Laser Head.

Red: Connect the tube to the red port to return “warmed” coolant from the Laser Head back to the ICE.

Emission Warning

The manual shutter is transparent. It contains an Emission Warning light to warn you of the potential for dangerous laser emission.

CAUTION: You must be observing all safety precautions. Laser emission may occur at any time when the Emission Warning is lit.

Unlit: The Emission Warning is not lit when the system is in Run Mode.

Solid illumination: The Emission Warning is illuminated continuously to indicate the high voltage is enabled and the flashlamps are active.

Flashing: The Emission Warning flashes at a 1 Hz rate to indicate that a Q-Switch is enabled.

Manual Shutter

Open: To open the shutter and allow laser output, rotate the knob to align with the aperture.

Closed: To close the shutter and block laser output, rotate the handle so that it is perpendicular to the aperture. Quantel highly recommends stopping the Q-Switch before you close the shutter.

CAUTION: Whenever the shutter is open, you must be observing all safety precautions as though laser emission will occur at any time.



Figure 4: Laser Head

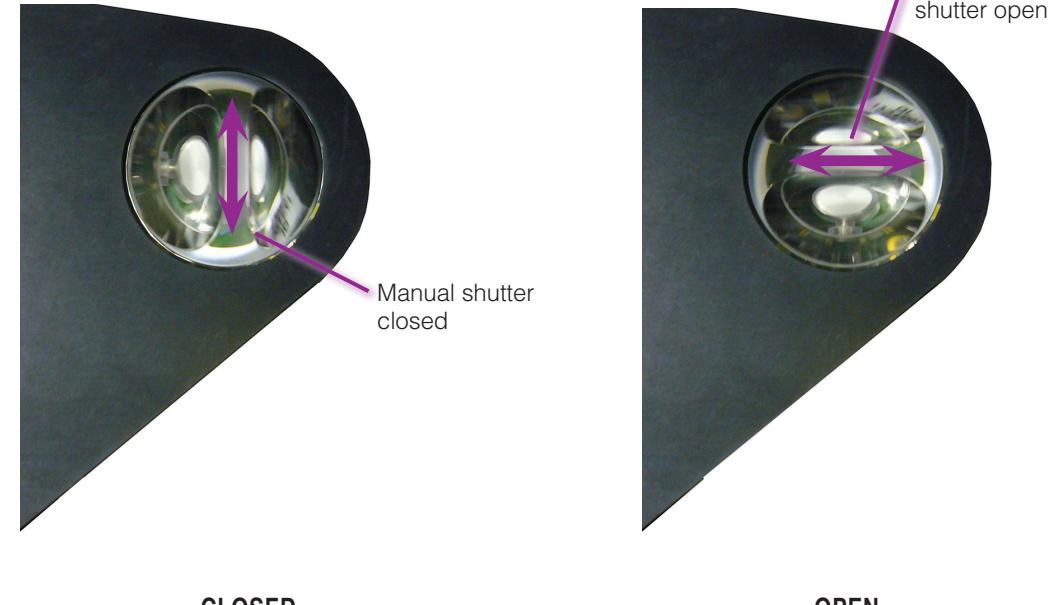


Figure 5: Manual Shutter Positions

4.0 Harmonic Generation Modules

Harmonic generation modules attach to the Laser Head to provide additional wavelength options.

The Second Harmonic Generation (2 ω HG) module electronics connect to Laser Head via the 9-pin connector. Successive HG modules connect to the previous HG module via a similar 9-pin connector.

Modules are available to provide the following wavelengths:

Wavelength (nm)	Modules
1064	base frequency exiting Q-smart Laser Head
1064 and 532	with 2 ω HG
1064, 532, and 355	with 2 ω HG + 3 ω HG
1064, 532, and 266	with 2 ω HG + 4 ω HG
1064, 532, 266 and 213	with 2 ω HG + 4 ω HG + 5 ω HG

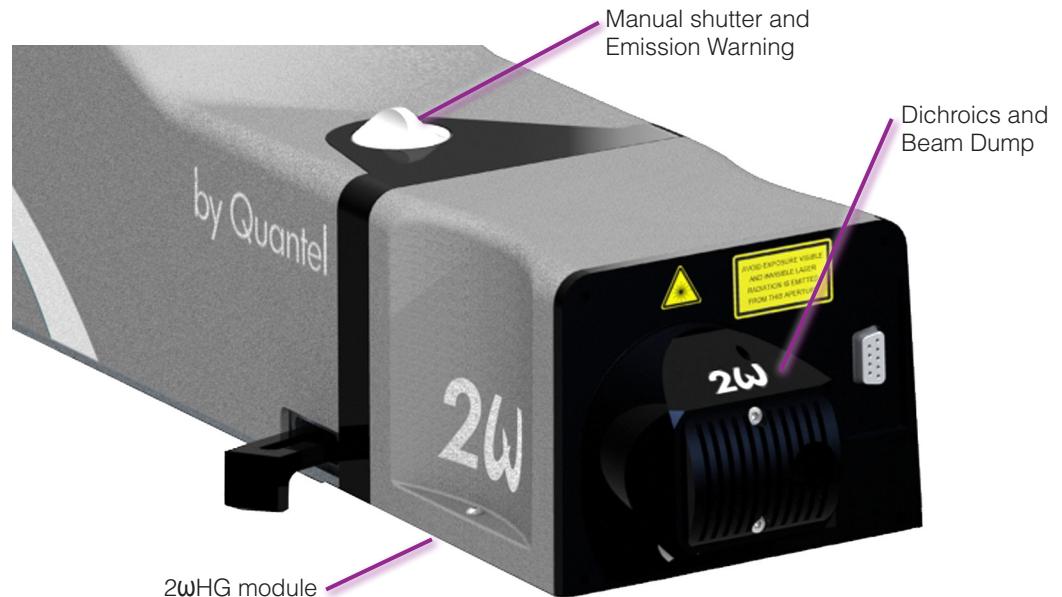


Figure 6: Second Harmonic Generation Module Installed



Figure 7: Second and Fourth Harmonic Generation Modules Installed

5.0 Dichroics Module

Multiple wavelengths exit the aperture of the HG module. When mixed wavelength output is not desired, attach the dichroics module that matches the HG module you are using. **Dichroics** separate the frequencies produced by the HG module to provide separate wavelength outputs as illustrated in Figure 8. See Figure 10 for additional details.

A modular dichroics unit, matched to the HG module, makes it easy to install the equipment needed for your desired wavelength configuration.

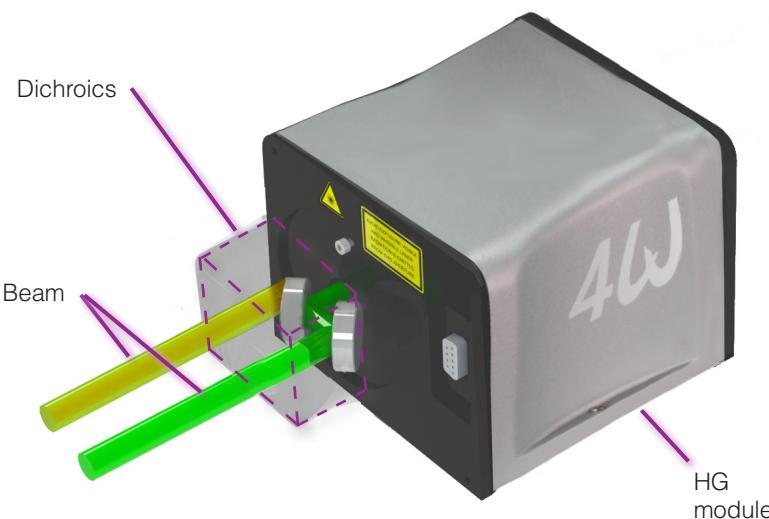


Figure 8: Dichroics

6.0 Beam Dump Module

The **Beam Dump** is used to block residual wavelengths from exiting the dichroics module to result in the single desired wavelength as illustrated in Figure 9. When the Beam Dump is not attached wavelengths are output from the dichroics via two separate apertures.

The combination of HG, dichroics, and beam dump modules make it easy for you to customize your Q-smart laser to achieve the desired wavelength (see Figure 10). See the pages that follow for installation details.

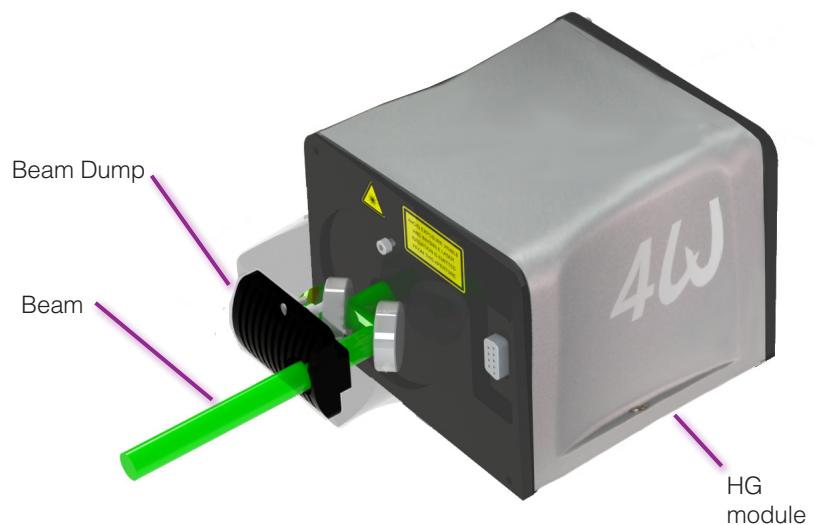


Figure 9: Beam Dump

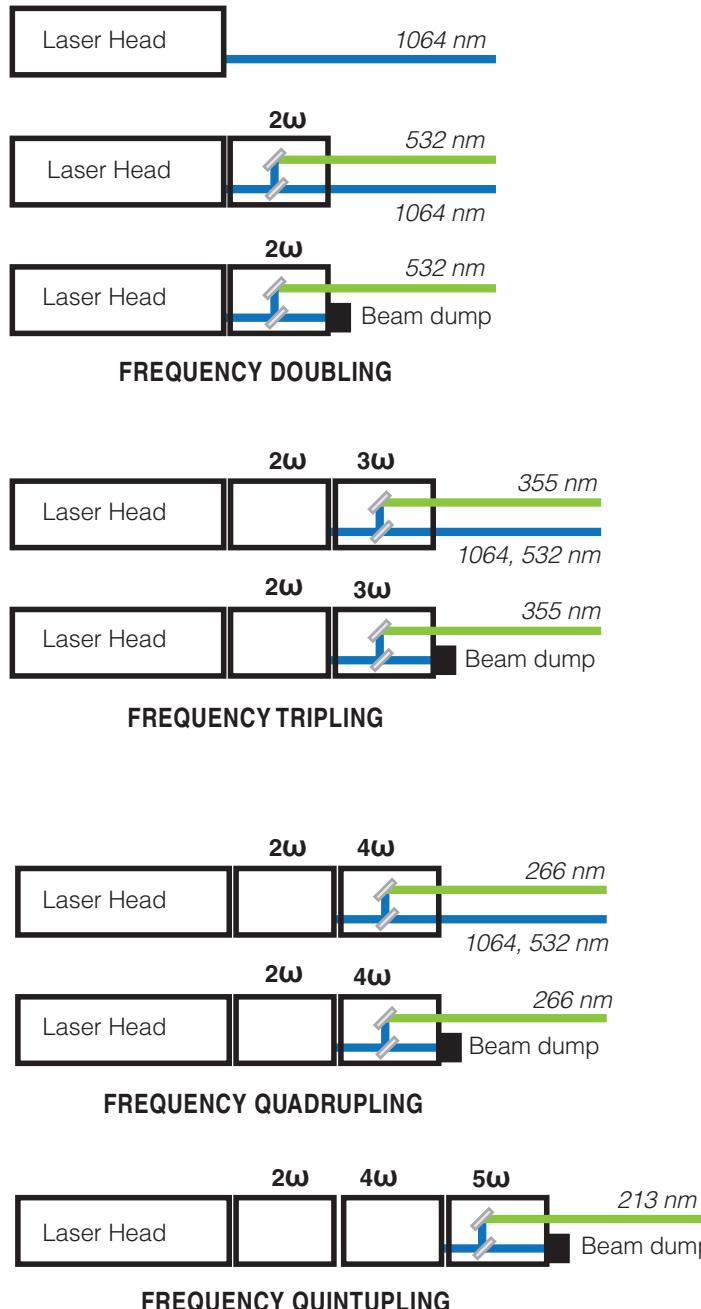


Figure 10: Wavelength Configurations

7.0 Installing the 2ωHG Module

Use the following steps to attach the 2ωHG module to the Laser Head:

1. Verify that the AC Mains power is turned OFF.
2. Remove 2 screws fastening the 2ωHG outer cover and set it aside.
3. Position 4 screws in the HGM mounting plate.
4. Raise the HGM and align its pin, connector, and circular guide to the matching features on the Laser Head.
5. Tighten the 4 pre-positioned screws to fasten the HGM to the Laser Head.
6. Replace the HGM cover.
7. See **Installing a Dichroics Module on page 18** and also **Installing Additional HGM Modules on page 19**. For additional details on required adjustments, see **Automatic Phase Matching (APM) on page 41**.

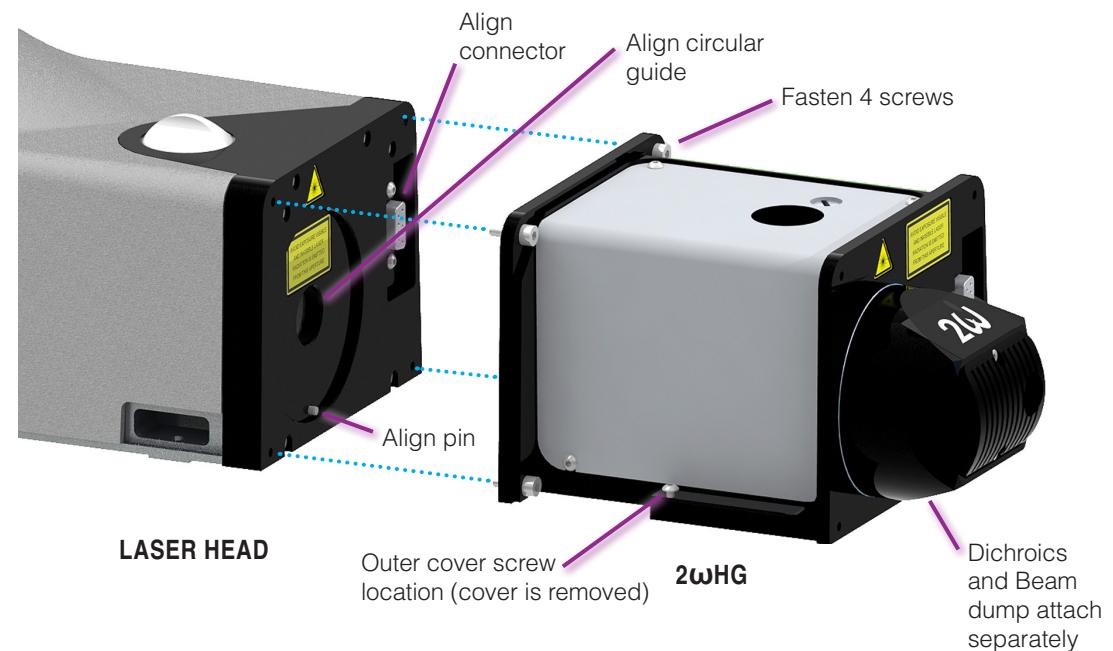


Figure 11: Installing the 2ωHG Module

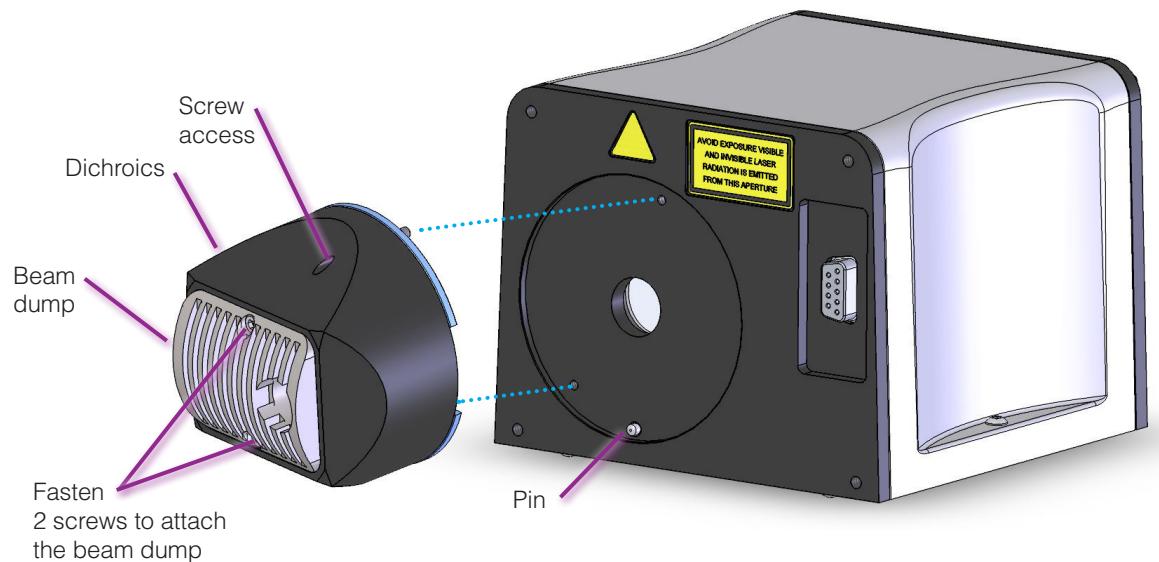
8.0 Installing a Dichroics Module

Use the following steps to attach the matching dichroics module to last HG module installed: For example: When the 2WHG is the only module installed, use the 2W dichroics.



CAUTION: The dichroics module must match to the last HG module in the chair or the system will not function properly.

1. Select the dichroics module that matches the last HG module in use.
For example: Use the dichroics marked 2W with the 2WHG module.
2. Align the pin from the HG module to the matching hole in the dichroics.
3. Tighten the 2 screws located at the top and bottom of the dichroics to fasten it to the HG module.
4. See **Automatic Phase Matching (APM) on page 41** for required adjustments.



9.0 Installing the Beam Dump

To attach the beam dump to the dichroics, fasten two screws as shown in Figure 12.

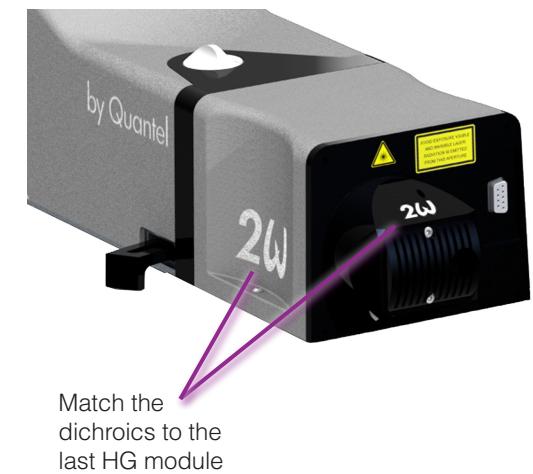


Figure 12: Installing the Dichroics and Beam Dump

10.0 Installing Additional HGM Modules

Use the following steps to change or add additional HG modules to achieve the desired wavelength configuration (see Figure 10).

1. Verify that the AC Mains power is turned OFF.
2. Remove 2 screws from the dichroic module to detach the dichroics with the beam block from the HG module in use. Place this dichroics module in the storage container.
3. Remove the cover from the HG module to be added.
4. Align the additional HG module to the pin, connector, and circular feature on the existing HG module.
5. Tighten four screws to fasten the added module. Replace its cover.
6. Attach the appropriate dichroics module. For example, when the 5ω HG module is the last module installed, use the 5ω dichroics; when the 3ω HG module is the last module installed, use the 3ω dichroics.



Figure 13: Installing Multiple HG Modules

UNPACKING

1.0 Inspecting the Shipment

Check both boxes you receive for damage before you unpack the laser system. Note any damage visible on the exterior of the boxes.

Notify both the carrier and Quantel or its representative of any damage within 3 days of receiving the system.

2.0 Unpacking the System

Unpack the reusable boxes and unwrap the system. Retain the boxes for use in storage or shipping the system if any repairs are necessary during the warranty period.

3.0 System Contents

Verify that you have received the following items:

- Laser Head
- ICE (Laser Power Supply and Integrated Cooling System)
- Q-touch control panel
- HG modules
- miscellaneous parts including —
 - key and USB drive with manual and data sheet
 - test report
 - mounting feet
 - stoppers
 - drain tubes (laser head is not self-sealing)

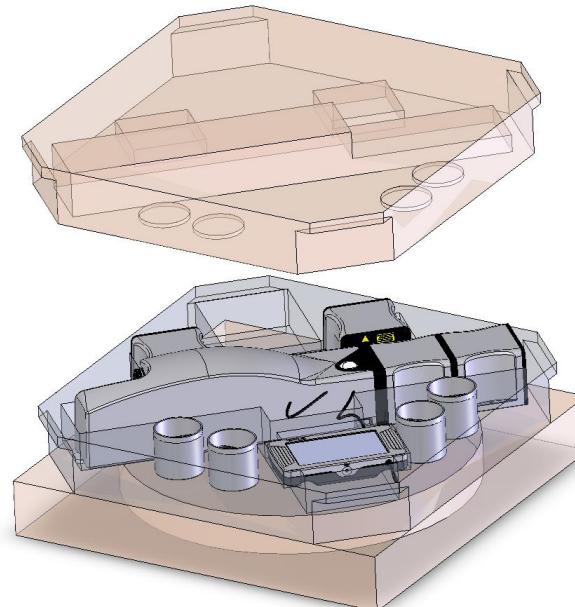
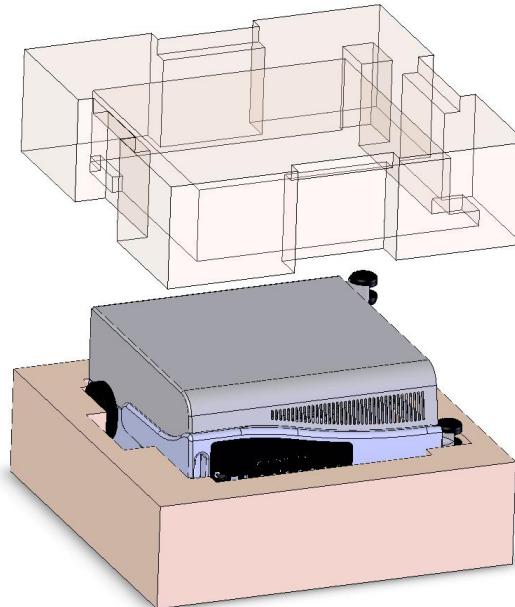


Figure 1: Crated System

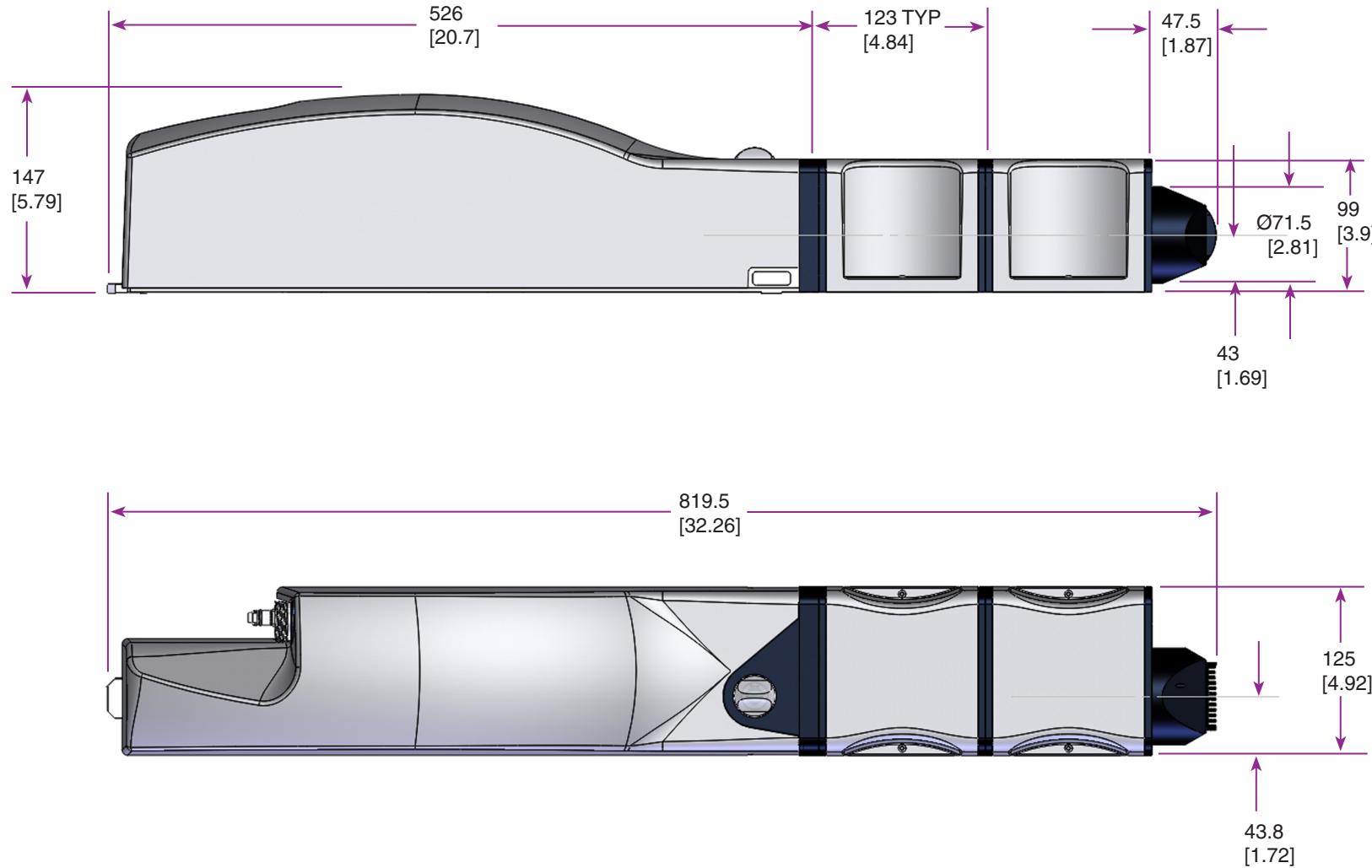


Figure 2: Laser Head Exterior Dimensions



Figure 3: ICE Exterior Dimensions



Figure 4: Q-touch Control Panel

SETUP

1.0 Mounting the Laser Head

Use the three mounting feet to secure the Laser Head to a flat mounting surface. It is important that the mounting surface be flat, to prevent distortion.

Two optional tapped M6 mounting holes are provided on the bottom of the Laser Head.

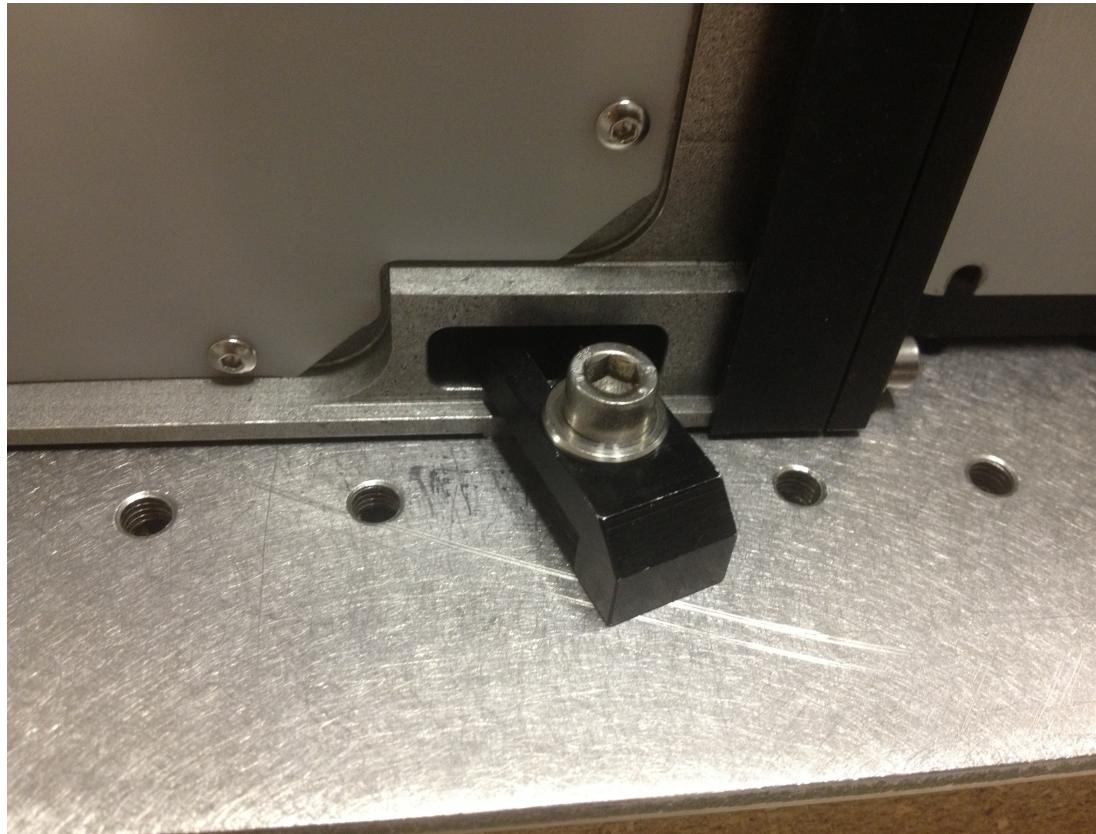


Figure 5: Attaching the Mounting Feet

2.0 Connecting



CAUTION: Do not power up the laser system before thoroughly reading the installation and operation instructions.

1. Verify that the ICE Key Switch is turned OFF.
2. Verify that the AC Mains power switch, located on the ICE rear panel, is turned OFF.
3. Connect the Q-touch to the dedicated port located on the ICE front panel.



Q-TOUCH



ICE FRONT PANEL



ICE REAR PANEL

Figure 6: Connecting the Q-touch Control Panel

4. Remove the caps from the Laser Head coolant fittings.
5. Connect the coolant tubing between the Laser Head and the ICE rear panel. Make sure to match connector colors: blue to blue and red to red. Coolant flows from the ICE into the Laser Head via the blue hose and returns to the ICE via the red hose.

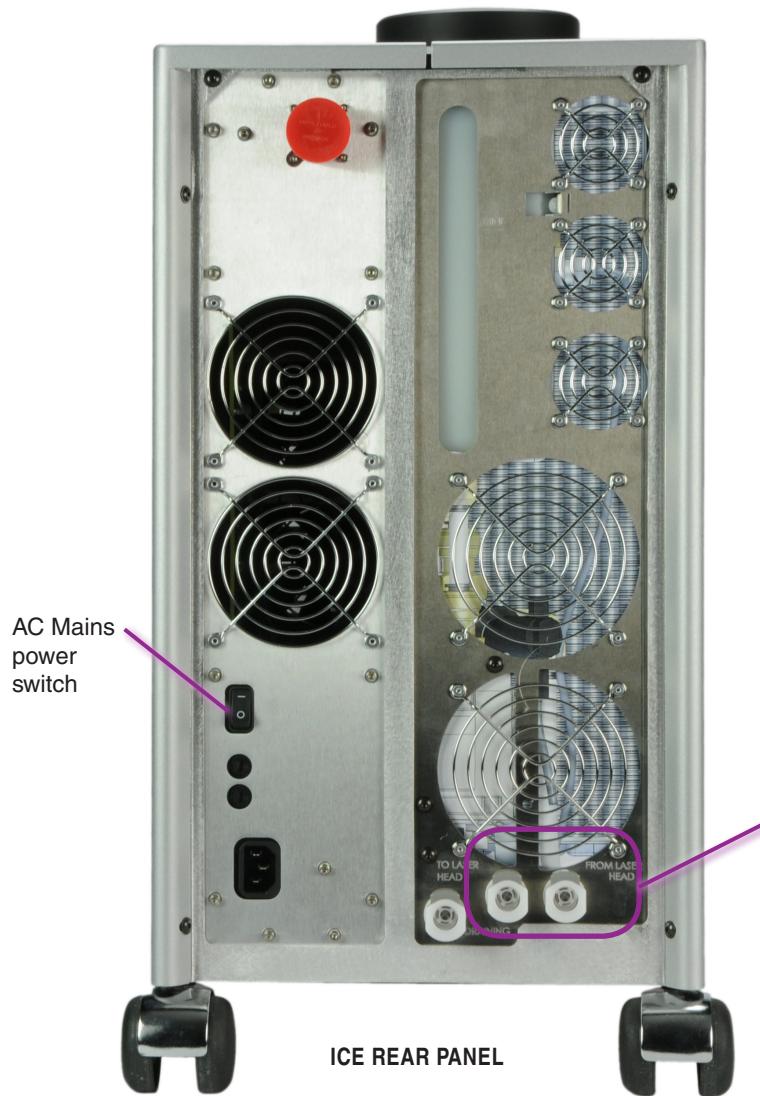


Figure 7: Connect the Coolant Tubing

6. Remove the cover from the Laser I/O connector port located on the ICE rear panel.
7. Connect the Laser I/O cable (umbilical) between the ICE rear panel and the Laser Head. Rotate each connector until tight to seat it fully.
8. Connect the AC Mains power cable from the ICE rear panel to 100-240 VAC, 50/60 Hz power.

CAUTION: Ensure the system is connected to the proper voltage. The voltage rating is marked on the ICE back panel. Operating the system at the incorrect voltage may damage the system.

CAUTION: Ensure that the power outlet used is properly grounded.

CAUTION: Do not operate the system until it has been filled. Running the pump without coolant may damage the pump.



ICE REAR PANEL

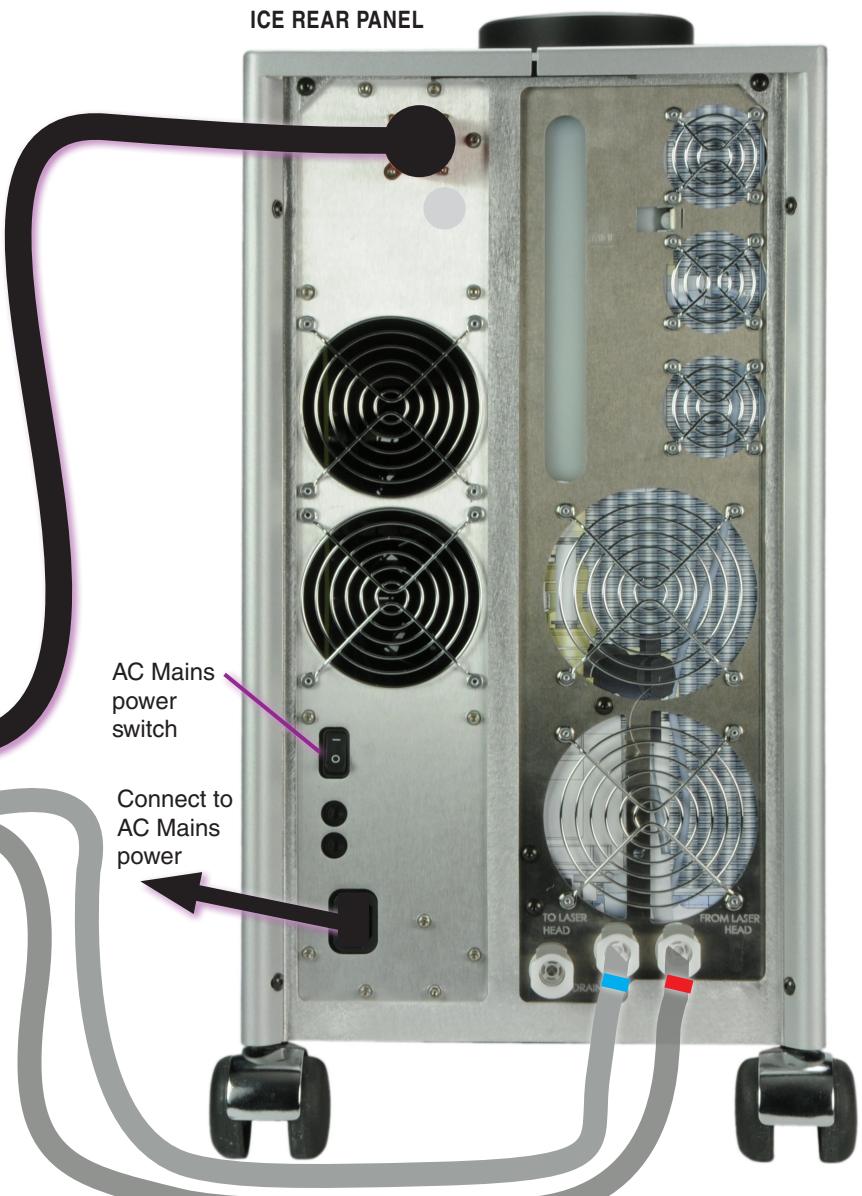


Figure 8: Connect the Electrical Cables
Version B - April 2014

3.0 Filling the ICE



CAUTION: Complete all preliminary steps prior to laser operation, including visual inspection for damage, filling coolant, properly connecting all cables, and performing all laser safety precautions. Running the system without coolant may damage the system.

Always drain the system before shipping or storage. See [Draining the ICE on page 63](#).

Use only distilled/demineralized water with 1 MΩ-cm to 5 MΩ-cm resistivity.

1. Remove the reservoir cap.
2. Fill the reservoir with distilled/demineralized water to the "MAX" level marked on the reservoir window.
3. Turn ON the ICE AC Mains power switch. "I" is ON, "0" is OFF.
4. Turn ON the Key Switch located on the ICE front panel.

The pump inside the ICE turns on and coolant begins flowing. The fluid level in the reservoir begins to lower as the coolant tubes fill.

Note: ignore the fault message on the Q-touch during this step.

Note: The pump shuts off automatically when the coolant falls below the reservoir "MIN" mark.

5. Use the Key Switch to turn the ICE OFF.
6. Add additional coolant to refill the reservoir to the "MAX" level.
7. Turn the Key Switch ON. Coolant resumes flowing.
8. Turn the Key Switch OFF and wait a few minutes, then turn it back ON. Do this several times to remove air bubbles from the Laser Head and coolant tubes.
9. Verify that there are no air bubbles in the coolant tubes.
10. Turn OFF the ICE. Add coolant to fill the reservoir to the "MAX" level
11. Replace the reservoir cap. The system is now ready.

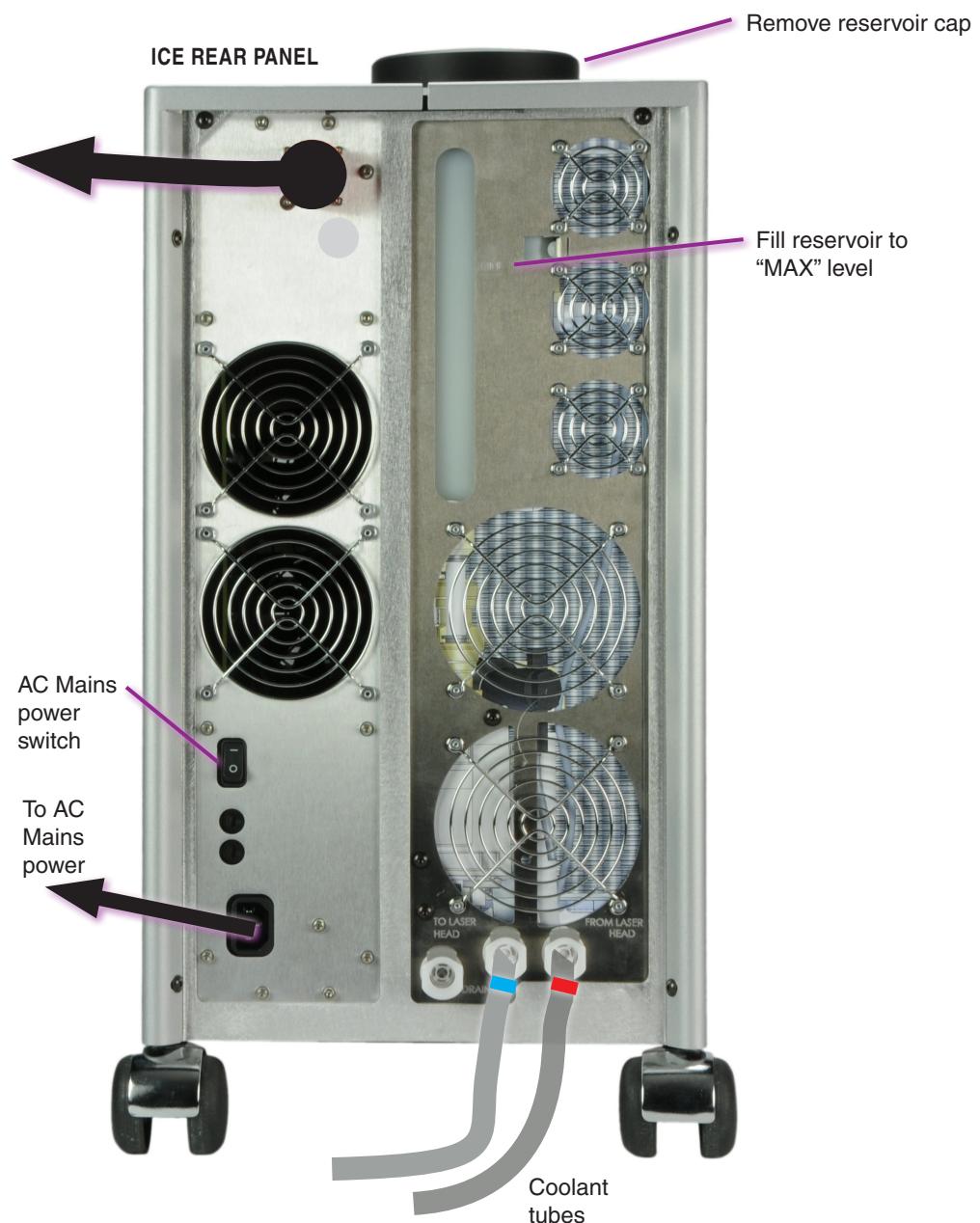


Figure 9: Fill ICE Coolant

OPERATION

1.0 Safety

 **CAUTION:** Obey all safety procedures. See **Laser Safety starting on page 1.**

 **CAUTION:** Wear eye protection. Obey safety precautions as though the system is capable of lasing at any time.

2.0 Precautions

Follow these guidelines to avoid laser damage.

- Store the laser in a dust-free environment. Keep the Laser Head covered when not in use. This protects the output window from dust and particulate.
- Avoid back reflections. Back reflections of even a small percentage of the output energy can damage optical components in the Laser Head.

Example: An uncoated convex lens or a glass disk calorimeter reflects about 4% of the incident energy. While the reflection may seem harmless, it can perturb the resonator operation and degrade the near-field beam intensity profile and damage laser optics. It may also affect the resonator holdoff, causing prelasing and catastrophic optical damage. In some cases, even anti-reflection coated glass optics reflect enough energy to damage laser optics. It is best to use only quality optics coated for the operating wavelength.

 **CAUTION:** To avoid damaging the laser, minimize back reflections of the output beam. When reflections are unavoidable, direct them away from the optical axis of the system by canting the optics off-axis. Failure to do so can damage the laser and void the warranty.

3.0 Remote Interlock

The Interlock BNC connector provides an interface for an external safety shutdown switch. The Interlock can be connected to a lab door or other system outputs for safety purposes. When using the Interlock, only an isolated switch, such as a relay, should be used in order to avoid ground loops. If external safety switches are used, it is important that they are connected in series.

The Interlock connection must be completed in order to operate the laser. If an open circuit occurs, the ICE high voltage is disabled and the Q-touch screen shows a fault indication.

The system is shipped with the BNC shorting cap attached on this connector. Leave this connector in place if this function is not needed. See **Interlock on page 12.**

4.0 Emission Warning

The Emission Warning indicator illuminates when the shutter is open. See **Emission Warning on page 14.**

5.0 Manual Shutter

 **CAUTION:** If the shutter is open, take precautions as though the laser is capable of lasing, regardless of any other status. See **Manual Shutter on page 14.**



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

6.0 Operating Modes

The follow methods may be used to operate the laser:

1. Directly via the Q-touch interface.
2. Remotely via ethernet software similar to that of the touchscreen.
See [Ethernet Interface on page 51](#).

The same software interface is used to control the system from the touchscreen or from software running remotely. The only difference is that commands are selected by touching icons on the screen or by using a mouse to click the icon.

7.0 The Control Software



WARNING: Follow all safety precautions, See [Laser Safety](#)

starting on page 1. During laser operation, everyone present in the laser room must wear eye protection appropriate for the specific output wavelengths.



Figure 10 Q-touch

Main Functional Areas

The control software has the following main functional areas:

- **Status area** showing System, Control and Shutter states
- **Emission Warning icon** appears when the system is lasing
- **Laser control area** with Flashlamp and Q-Switch Stop buttons
- **Menu icons** to access settings and information.
- **Settings area** to view and set laser system parameters. The options shown in this area depend on which menu icon is selected.

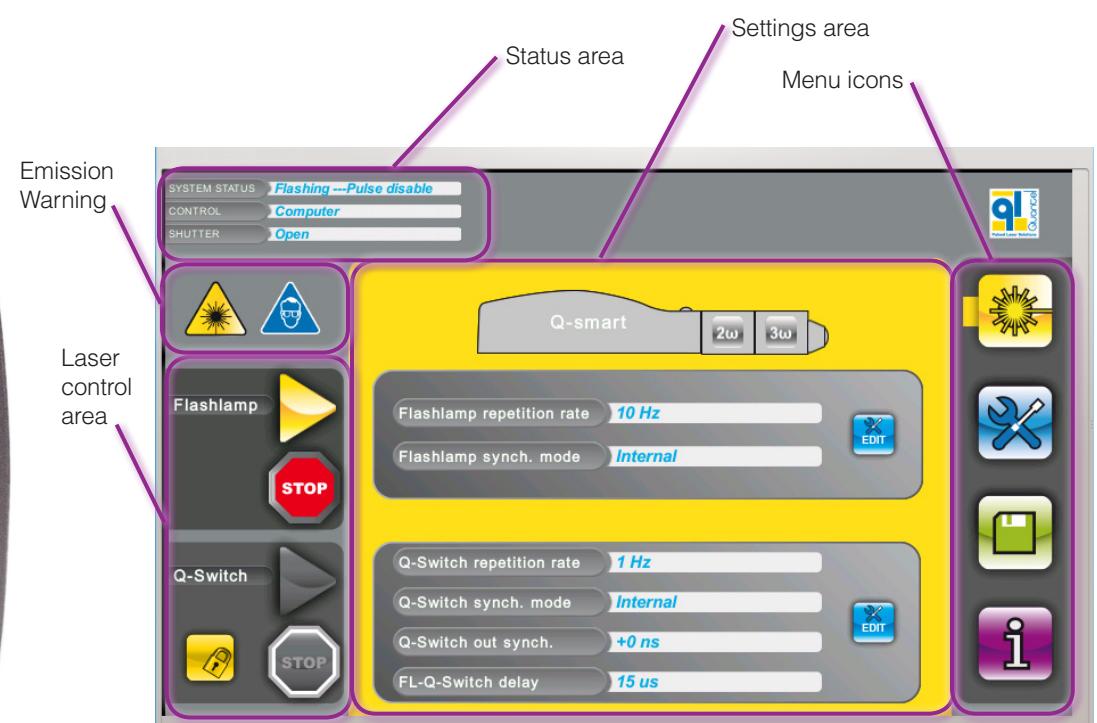


Figure 11 Software Screen

8.0 Emission Warning Area

The following buttons warn you of laser emission.



Emission Warning: Whenever the laser emission is ON, this warning icon flashes. Everyone in the area must be wearing proper eye protection and following all safety precautions.



Safety Eyewear: Whenever this icon is ON, everyone in the area must be wearing proper eye protection and following all safety precautions.



CAUTION: Follow safety precautions as though the system is capable of lasing at any time, whenever the laser is in the ready state.

9.0 Status Area

The status area shows the system state, control method and the shutter state.



System Status: Displays the laser status. The following messages appear in this area

Laser interlock: The remote interlock circuit is open.

System warm up: The laser is warming up during start up and is not ready for operation (about 15 minutes).

Laser ready: The warm up is complete and the laser is ready for Run mode. The flashlamp start icon changes to solid yellow.

Flashing---Pulse disable: The system is in Run mode, and the Flashlamp start icon is selected (high voltage enabled), the lamps begin flashing (if a trigger is present). The Q-Switch is not yet enabled, either due to an interlock issue or the required 8 second delay between flashlamp start and Q-Switching.

Flashing---Pulse enable: Eight seconds after the laser is stabilized in RUN mode, Q-Switching is enabled.

Laser ON---auto (or Burst/scan): Depending on the settings you have selected and if no HG modules are connected you may see this laser state.

Laser ON---NLO warm up: Either the HG crystals have not reached their set point temperatures or the number of shots for stable energy has not been reached. APM is not available, until the system reaches the set point temperature.

Laser ON---NLO ready: HG module crystals are warmed up and the required number of shots for stable energy has been reached.

Laser ON---APM #1 running: Automatic Phase Matching for 2 ω is running.

Laser ON---APM #2 running: Automatic Phase Matching for 3 ω or 4 ω is running.

Laser ON---APM #3 running: Automatic Phase Matching for 5 ω is running.

Control: Computer, Q-touch, or TDL is indicated, depending on which method is being used to control the system.

Shutter: The state of the shutter (Open or Closed) is shown.

10.0 Laser Control Area

The laser control area provides controls to start and stop the flashlamp and Q-Switching. The icons appear as follows:

Flashlamp

Icon	Meaning
	Grey icon indicates that the flashlamp is not able to be activated because the system is still warming up.
	Solid yellow icon indicates that the flashlamp is ready to be started. Select this button to start the lamp flashing.
	Blinking yellow icon indicates that the lamp is flashing. The laser Emission Warning is flashing. Everyone in the area must be wearing proper eye protection and following all safety precautions.
	Stops the flashlamp and ceases laser emission. Note: To stop the laser at any time, do any of the following: <ul style="list-style-type: none"> • Press the STOP icon • Turn OFF the Key Switch on the ICE front panel.
	The flashlamp is not started and so cannot be stopped and therefore this selection is “grayed out”.

Q-Switch

Icon	Meaning
	Grey icon indicates that the system is not ready and the Q-Switch cannot be started. Until the system status shows as Flashing---Pulse disable , the Q-Switch is not able to be started.
	Solid yellow icon indicates the system is ready and the Q-Switch may be started. The laser Emission Warning is flashing. Everyone in the area must be wearing proper eye protection and following all safety precautions. Single shot mode: Press this button once for a single shot Continuous mode: Press this button continuously until it blinks. Then launch continuous mode and the laser is running at the selected rep rate
	Blinking yellow icon indicates that the Q-Switching is running. The laser Emission Warning is flashing. Everyone in the area must be wearing proper eye protection and following all safety precautions.
	Stops the Q-Switch and ceases laser emission. Note: To stop the laser at any time, do any of the following: <ul style="list-style-type: none"> • Press the STOP icon • Turn OFF the Key Switch on the ICE front panel.
	The Q-Switch is not started and so cannot be stopped and therefore this selection is “grayed out”.
	The Q-Switch is “locked” and cannot be started manually.
	The Q-Switch is “locked”. Touch the lock icon to change it to unlocked.
	The Q-Switch is “unlocked” and can be used for single pulse or continuous operation. See Single Shot Mode on page 40 .

11.0 Menu Icons

Use the menu icons to access the following screens:

Menu Icon	Function
Laser Operation 	Enters the screen to view laser parameters such as internal temperature, output power, diode current, diode temperature or crystal temperature. To change the values, use the Settings screen.
Settings 	Enters the screen to set laser parameter values.
Configuration 	Enters the screen to view or set network configurations for remote control of the system.
Information 	Enters the screen to view system information such as laser information, synch information, and fault status.

Indicates item is selected



12.0 The Laser Operation Screen

Item	Function
Flashlamp repetition rate	Displays the flashlamp operating frequency in Hz. When in the Flashlamp synch. mode is set to Internal, the ICE fires the flashlamp at this frequency; when set to External, the ICE compares the frequency of the external trigger with this setting. If the External trigger frequency is too low or too high for the factory settings, the flashlamp will be disabled.
Flashlamp synch. mode	Displays the flashlamp trigger mode in use. Internal: The flashlamp pulses at the frequency set for Flashlamp repetition rate. Example: Starting the flashlamp cause the flashlamp to fire at 10 Hz. External: The flashlamp fires when a valid signal is applied to the "Lamp Synch In" connector on the ICE front panel.
Q-Switch repetition rate	Displays the Q-Switch operating frequency in Hz.
Q-Switch synch. mode	Displays the Q-Switch trigger mode in use. Internal: The Q-Switch fires at the rate set based on the Q-Switch Settings repetition rate. See Q-Switch Settings on page 38 for details. External: The Q-Switch fires when a valid signal is applied to the "Q-Switch Synch In" connector on the ICE front panel.

Item	Function
Q-Switch out synch.	Displays the delay (in ns) between the Q-Switch pulse and the signal output to the Q-Switch Synch. Out BNC connector
FL-Q-Switch delay	Displays the delay (in ns) between the flashlamp pulse and the Q-Switch pulse

Select to switch to the Settings screen to edit values

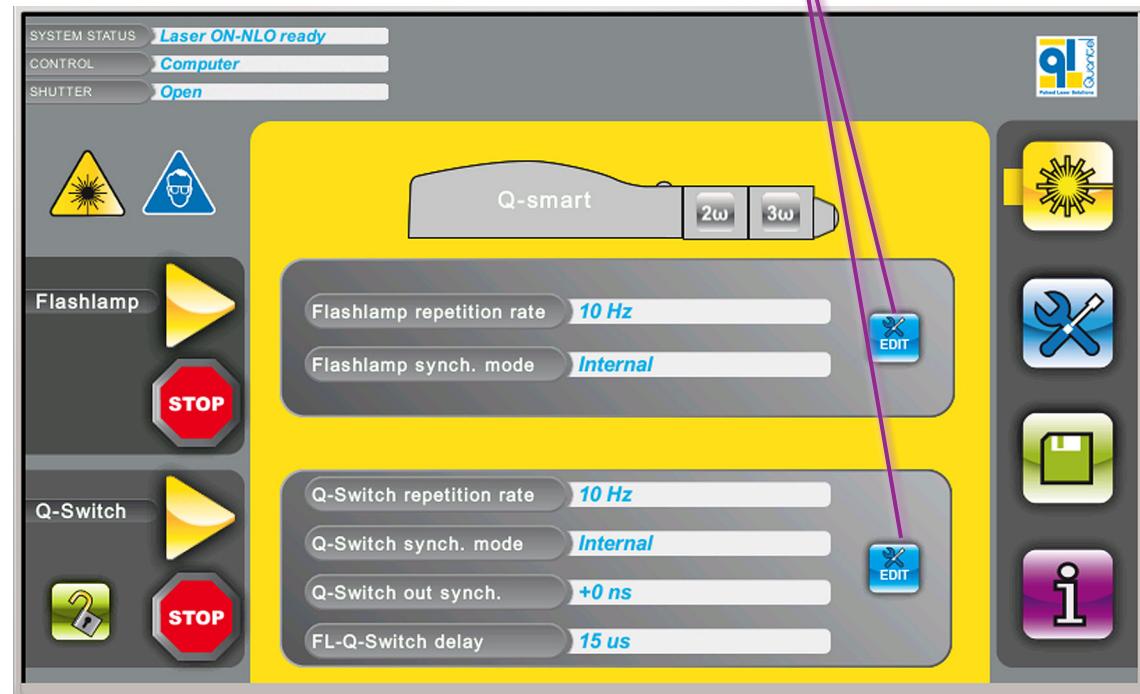


Figure 12 Example Laser Settings Screen

13.0 Laser Operation Modes



CAUTION: Everyone in the area must be wearing proper eye protection and following all safety precautions.

Internal Flashlamp/Internal Q-Switching

In this mode, the ICE automatically generates the flashlamp pulses at the rate set for **Flashlamp repetition rate**. The Q-Switch pulses occur after the flashlamp pulse at a time specified by the value set for **FL-Q-Switch delay**. Adjusting this delay is one method of adjusting the optical energy of a laser pulse. No external signal generator is needed. Any signals to the external trigger Inputs are ignored. See Figure 13 for a timing diagram showing Internal/Internal mode.

To obtain continuous emission of laser pulses:

1. Set **Flashlamp synch. mode** to **Internal**. See **Flashlamp Settings on page 37** for details.
2. Set **Q-Switch synch. mode** to **Internal**.
3. Open the manual shutter on the Laser Head.
4. Touch the Flashlamp start icon. The icon begins blinking to show the flashlamp is running.
5. Touch the Q-Switch start icon. The icon begins blinking to show the Q-Switch is started. Laser emission begins and the Emission Warning icon appears on the screen. The Emission Warning LED on the Laser Head blinks. See additional details for **Q-Switch Settings on page 38**.



To cease laser emission:



1. Press the Q-Switch Stop icon or press the Flashlamp Stop icon. The Emission Warning icon on the Q-touch and the Emission Warning indicator on the Laser Head will stop flashing.
2. Close the shutter on the Laser Head.

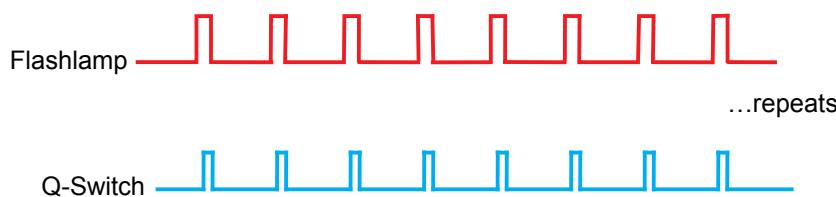


Figure 13 Internal/Internal Timing Diagram

External Flashlamp/Internal Q-Switching

In this mode the flashlamp trigger is received from your external source. The flashlamp trigger frequency is limited by the ICE. If an external trigger event occurs before the minimum allowed period (1/PRFMAX), the trigger is ignored. Refer to the **External Trigger Signal Requirements on page 58** for details. The Q-Switch trigger and timing is internal and is controlled by the ICE. If an external Q-Switch trigger is present, it is ignored.

To use External Flashlamp/Internal Q-Switch mode:

1. Connect your flashlamp external trigger source to the Lamp Sync In BNC connector on the ICE front panel. See **BNC Connectors on page 12**.
2. From the Q-touch set **Flashlamp synch. mode** to **External**.
3. Set **Q-Switch synch. mode** to **Internal**.
4. Open the manual shutter on the Laser Head.
5. Touch the Flashlamp start icon. The icon begins blinking to show the flashlamp is running.
6. Touch the Q-Switch start icon. The icon begins blinking to show the Q-Switch is started. Laser emission begins and the Emission Warning icon appears on the screen. The Emission Warning LED on the Laser Head blinks.

To cease laser emission:



1. Press the Q-Switch Stop icon or press the Flashlamp Stop icon. The Emission Warning icon on the Q-touch and the Emission Warning indicator on the Laser Head will stop flashing.
2. Close the shutter on the Laser Head.

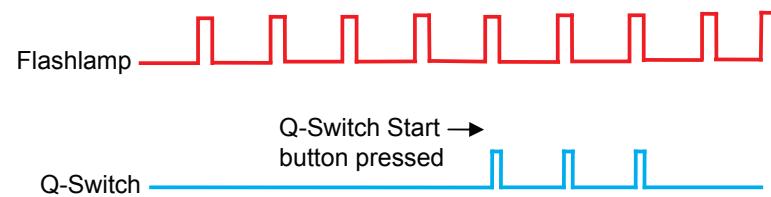


Figure 14 External Flashlamp/Internal Q-Switch Timing

External Flashlamp/External Q-Switching

Both the flashlamp and Q-Switch triggers are received from an external signals provided by the user. The input signals control all frequency, timing, and delays. The flashlamp trigger frequency is limited by the ICE. If an external trigger event occurs before the minimum allowed period (1/PRFMAX), the trigger is ignored.

See the **Laser Data Sheet** provided with your laser to determine the necessary Q-Switch delays. Refer to the **External Trigger Signal Requirements on page 58** for signal requirement details.

To use External Flashlamp/External Q-Switch mode:

1. Connect your flashlamp external trigger source to the Lamp Sync In BNC connector on the ICE front panel. Connect your Q-Switch external trigger source to the Q-Switch Sync In BNC connector on the ICE front panel. See **BNC Connectors on page 12**.
2. From the Q-touch, set **Flashlamp synch. mode** to **External**.
3. Set **Q-Switch synch. mode** to **External**.
4. Open the manual shutter on the Laser Head.
5. Touch the Flashlamp start icon. The icon begins blinking to show the flashlamp is running.
6. Touch the Q-Switch start icon. The icon begins blinking to show the Q-Switch is started. Laser emission begins and the Emission Warning icon appears on the screen. The Emission Warning LED on the Laser Head blinks.



To cease laser emission:



1. Press the Q-Switch Stop icon or press the Flashlamp Stop icon. The Emission Warning icon on the Q-touch and the Emission Warning indicator on the Laser Head will stop flashing.
2. Close the shutter on the Laser Head.

14.0 The Settings Screen

The Settings screen provides access to settings via selectable tabs for Flashlamp, Q-Switch, Harmonics, and Maintenance.

Flashlamp Settings

View or set the following items:

Area	Item: Function
Flashlamp Parameters	<p>Repetition Rate: Shows the flashlamp operating frequency in Hz. When set to Internal, the flashlamp fires at this frequency; when set to External, the ICE compares the frequency of the external trigger with this setting. If the External trigger frequency is too low or too high for the factory settings, the flashlamp will be disabled.</p> <p>Voltage: Adjusts the flashlamp voltage.</p> <p>CAUTION: Quantel advises against decreasing the energy of the flashlamp(s) to reduce the output energy.</p> <p>Pulse width: Adjusts the flashlamp pulse width.</p>
Flashlamp counter	<p>Internal counter: Shows the number of flashlamp fires since set at factory.</p> <p>User counter: Shows the flashlamp fires since last reset by the user.</p> <p>Reset button: Click to reset the user counter.</p>
Synchronization mode	<p>Use the slider to select between Internal and External flashlamp trigger modes.</p> <p>Internal: The flashlamp pulses at the frequency set for Flashlamp repetition rate. Example: Starting the flashlamp cause the flashlamp to fire at 10 Hz.</p> <p>External: The flashlamp fires when a valid signal is applied to the "Lamp Synch In" connector on the ICE front panel.</p>

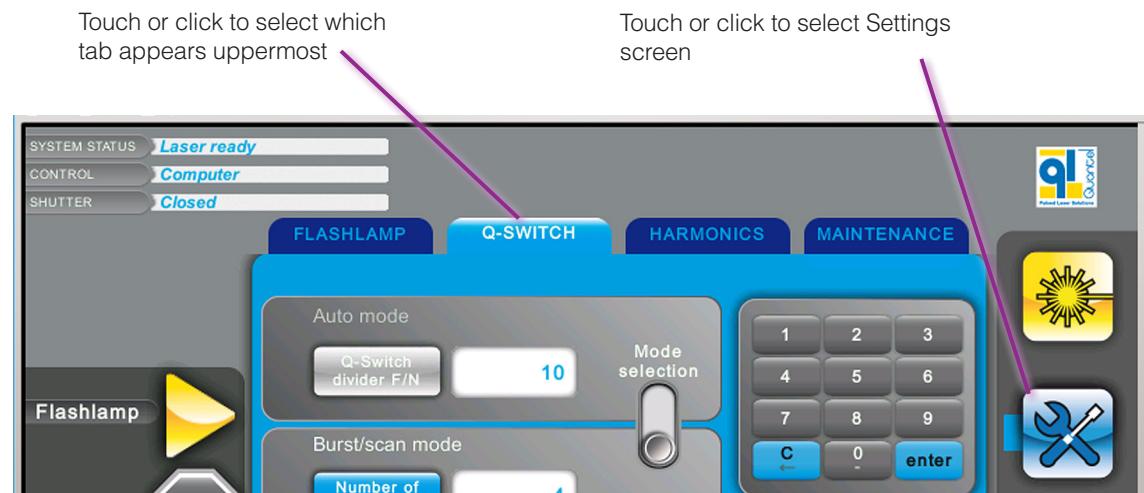


Figure 16 Example Operational Settings Screen

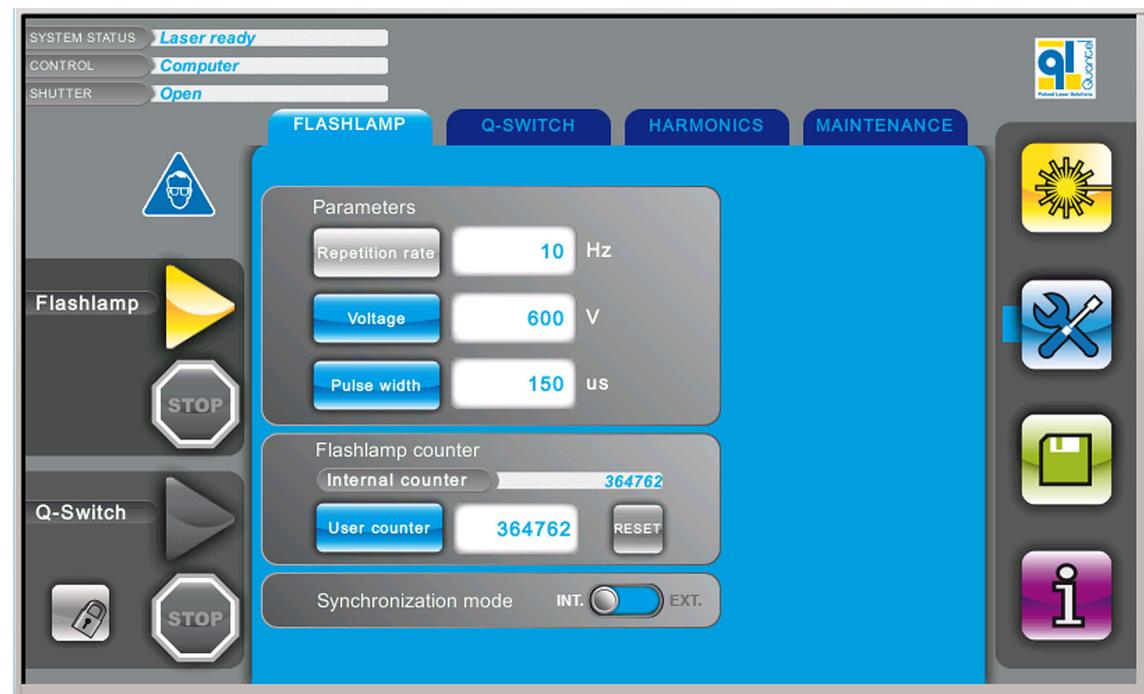


Figure 17 The Flashlamp Tab of the Operational Settings Screen

Q-Switch Settings

The following items can be viewed or set via the Q-Switch tab of the Operational Settings screen:

Item	Function
Automode	
Q-Switch divider F/N	Allows you to change the ratio of flashlamp pulses to Q-Switch pulses. See details on page 39.
Burst/scan mode	
Allows you to specify a group or “burst” of Q-Switch pulses that fire sequentially with every flashlamp pulse. These can range from one single shot to 999 pulses each time you press Q-Switch Start. Burst mode requires that the Q-Switch be set to internal sync. See additional details on page 39.	
Number of scans	Enter a value for the number of times to repeat a group of active and passive Q-Switch pulses. After the total number of scans is complete, the Q-Switch is disabled. A value of 0 results in continuous repetition of the active and passive pulses.
Number of active shots	Enter the number of active Q-Switch pulses for each Scan group. This is the number of flashlamp pulses that have an associated Q-Switch pulse and therefore cause laser light to be emitted
Number of passive shots	Sets number of flashlamp pulses that have no Q-Switch pulse and therefore produce no laser emission
Synchronization mode	Int./Ext. This toggle makes it easy to change between Internal and External Q-Switching.

Item	Function
Delays	
Q-Switch out synchronization	Adjusts the delay (in μ s) between the Q-Switch pulse and the signal output to the Q-Switch Synch. Out BNC connector
FL-Q-Switch delay	Adjusts the delay (in μ s) between the flashlamp pulse and the Q-Switch pulse
Number pad	Provides touch screen number entry into the active item

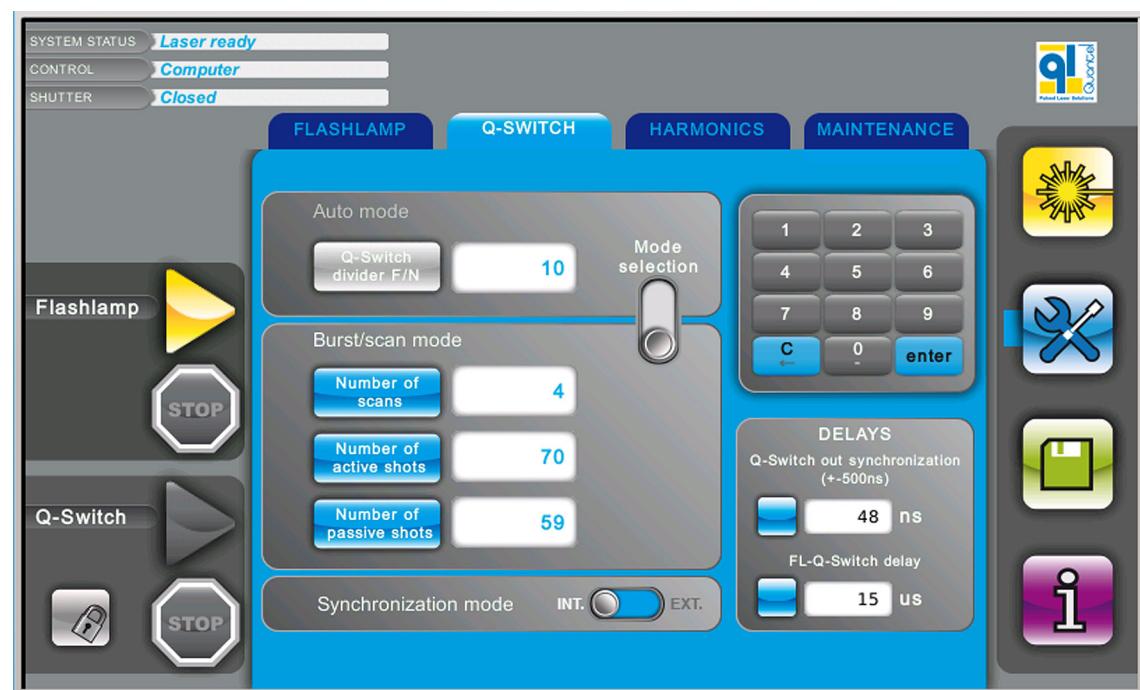


Figure 18 The Q-Switch Tab of the Operational Settings Screen

15.0 Burst/Scan Mode Operation

In this mode the flashlamp trigger is received internally or externally. The Q-Switch trigger and timing is internal and is controlled by the ICE. Parameters (number of scans, number of active shots, number of passive shots) are set to control the number of active Q-Switch pulses for each flashlamp pulse.

To use Burst/scan mode:

1. Set Q-Switch synchronization mode to **Internal**.
2. Set the number of scans, number of active shots, number of passive shots from the Q-Switch tab of the Operational Settings screen. System status will indicate Laser ON---Burst/scan mode.
-  3. Open the manual shutter on the Laser Head.
-  4. Touch the Flashlamp start icon. The icon begins blinking to show the flashlamp is started.
-  5. Touch the Q-Switch start icon. The icon begins blinking to show the Q-Switch is started. Laser emission begins and the Emission Warning icon appears on the screen. The Emission Warning LED on the Laser Head blinks.
-  6. Unlock the Q-Switch area on the Q-touch by pressing the lock button. The icon appears unlocked.

To cease laser emission:

1. Press the Q-Switch Stop icon. The Q-Switch returns to the locked state. The Emission Warning icon on the Q-touch and the Emission Warning indicator on the Laser Head will stop flashing.
2. Close the shutter on the Laser Head.

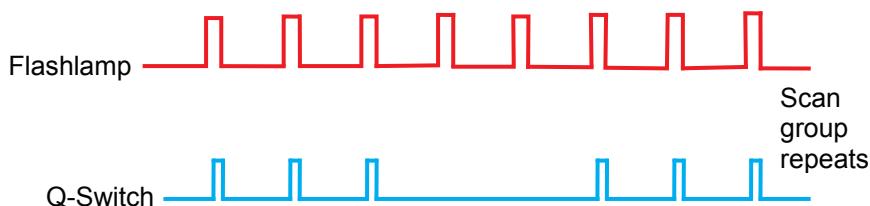


Figure 19 Example Timing Diagram for Burst/scan Mode (QS Pulses = 3)

16.0 Q-Switch Divider (Auto-Ratio)

This mode causes the Q-Switch to fire once for every specified number of flashlamp pulses. The Q-Switch Divider value is the number of flashlamp pulses to the number of active Q-Switch pulses. An example is shown in the timing diagram below, where the Auto-ratio value is set to three:

To use Q-Switch Divider:

1. From the Q-Switch tab, enter a value greater than 1 for Q-Switch Divider in the Automode area. A value of 1 would cause the Q-Switch to fire every time the flashlamp fires.

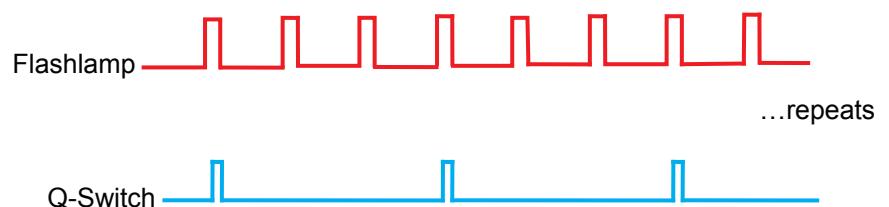


Figure 20 Q-Switch Divider Mode Timing (value set to 3)

17.0 Single Shot Mode

Single-shot mode fires the Q-Switch one time, producing a single pulse of light from the laser. This mode is useful while aligning the experimental setup. See Figure 21 for an example timing diagram. For a single shot, the Q-Switch mode must be set to Internal.

To obtain a single-pulse emission from the laser:



1. Verify that the flashlamp is running.
2. Open the manual shutter on the Laser Head
3. Press the Q-Switch start button once. One laser pulse will be generated.
4. You may need to consider the Time out for the Lock button.

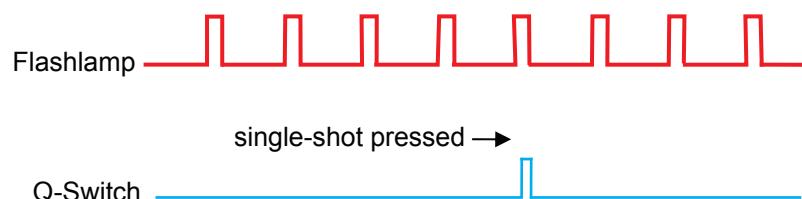


Figure 21 Timing Diagram: Single-Shot Mode

18.0 Continuous Pulse Mode

To use continuous pulse mode:

- 
1. Verify that the flashlamp is running.
 2. Open the manual shutter on the Laser Head.
 3. Press the Q-switch start button until the icon begins blinking
 4. Latch it to start pulsing.

19.0 Automatic Phase Matching (APM)

Harmonic generation within the system is very stable, in general. However, each crystal used in harmonic generation behaves slightly differently. When you add a harmonic generation module to change the system wavelength, you will need to fine tune the system using the APM function.

- APM is only available when internal trigger modes and nominal repetition rates are used.
- Before APM can be run, the crystals must be at thermal stability and a required number of shots must be reached.
- The APM process tracks optimum energy levels. When an optimal value is found, the phase-matching process stops automatically.

Though the phase-matching is automatic, it is not constantly monitoring the system. You need to launch it whenever:

- you install or remove an HG module.
- you move the system to a new location.
- you notice a decrease in system energy levels.

Use these steps to launch APM:

1. From the Operational Settings screen, select the **Harmonics tab**.
2. Select the icon of the HG module to adjust, for example: 2w or 3w.
3. Select **Start**. If APM is not available, Start will be "grayed-out". The APM process starts. The APM process may take up to 15 minutes, depending on how far the system is from optimum energy level.
4. Once APM is complete, a message appears where you can accept or cancel the new operation set point. If you select **OK**, APM is complete. If you select **Cancel**, the system returns to the previous setting and may take few minutes to restabilize.
5. You can also select **Escape** at any time to exit the APM process.
6. To reset the crystals to their factory settings, select **Default T° set point**.

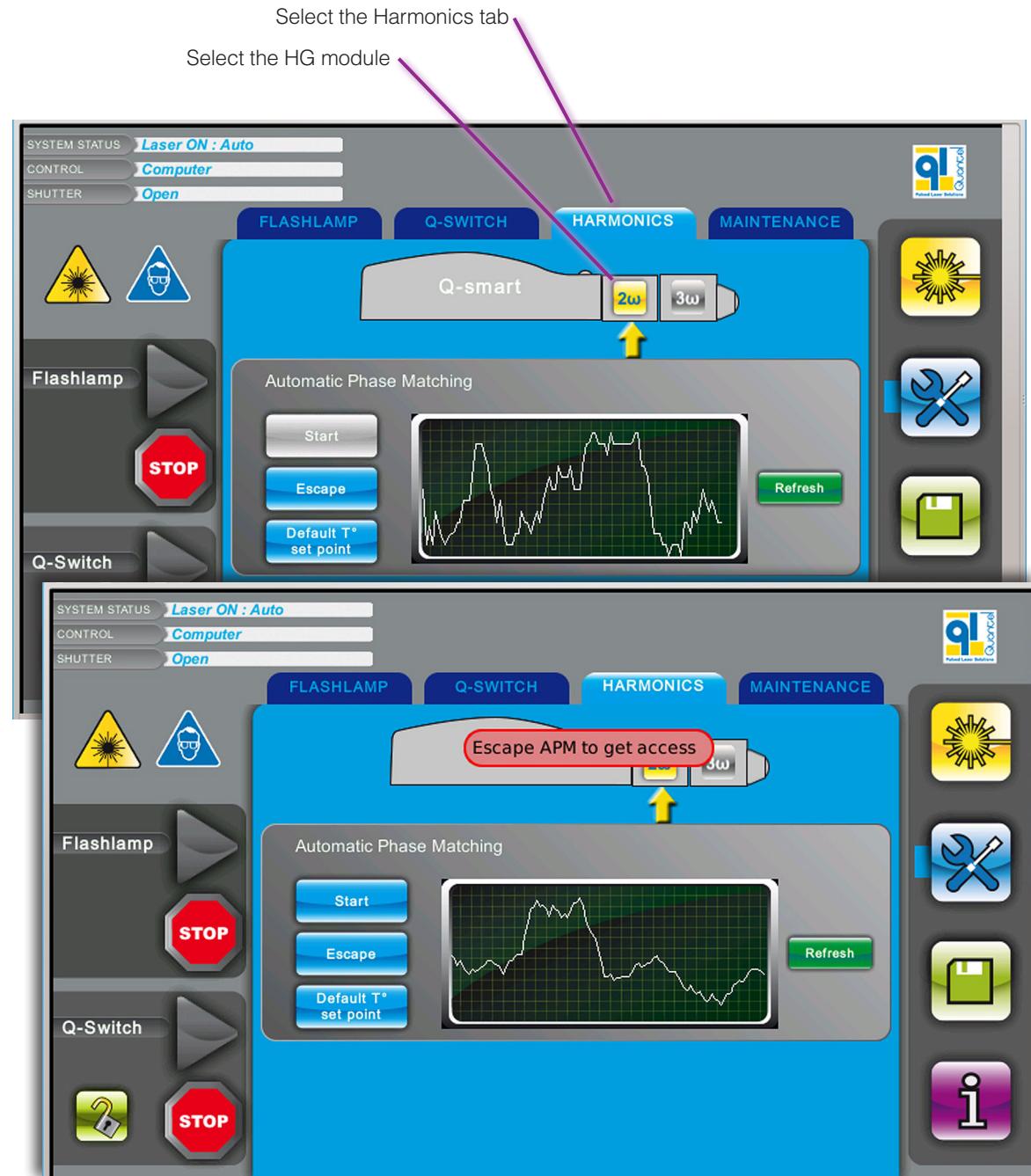


Figure 22 Automatic Phase Matching

APM for 2ω HG (SHG) Configurations

Use the following steps when adjusting for 2ω HG:

1. From the Operational Settings screen, select the **Harmonics tab**.
2. Select the **2ω** HG icon.
3. Select **Start**. If APM is not available, Start will be “grayed-out”. The APM process starts.
4. The graph displays the photodiode signal during the APM process. Select **Refresh** to clear the data on the graph.
During APM, the signal may reach transient values higher than the final optimal result. The APM process may take up to 15 minutes, depending on how far the system is from optimum energy level.
5. Once APM is complete, a message appears where you can accept or cancel the new operation set point. If you select **OK**, APM is complete. If you select **Cancel**, the system returns to the previous setting and may take few minutes to restabilize.
6. You can also select **Escape** at any time to exit the APM process.
7. To reset the crystals to their factory settings, select **Default T° set point**.

APM for 3ω HG (THG) Configurations

When running the APM for 3ω , the system will automatically optimize the required 2ω HG module first.

Use the following steps when adjusting for 3ω HG:

1. From the Operational Settings screen, select the **Harmonics tab**.
2. Select the **3ω** HG icon.
3. Select **Start**. If APM is not available, Start will be “grayed-out”. The APM process starts.
4. The system status indicates which crystal the APM is analyzing. One of the following will display in the system status area:
 - APM#1 when applied on **2ω** HG
 - APM#2 when applied on the **3ω** HG
5. The graph displays the photodiode signal during the APM process. Select **Refresh** to clear the data on the graph.
During APM, the signal may reach transient values higher than the final optimal result. The APM process may take up to 15 minutes, depending on how far the system is from optimum energy level.
6. Once APM is complete, a message appears where you can accept or cancel the new operation set point. If you select **OK**, APM is complete. If you select **Cancel**, the system returns to the previous setting and may take few minutes to restabilize.
7. You can also select **Escape** at any time to exit the APM process.
8. To reset the crystals to their factory settings, select **Default T° set point**.

APM for 4 ω HG (FoHG) Configurations

When running the APM for 4 ω , the system will automatically optimize the required 2 ω HG module first.

Use the following steps when adjusting for 4 ω HG:

1. From the Operational Settings screen, select the **Harmonics tab**.
2. Select the **4 ω** HG icon.
3. Select **Start**. If APM is not available, Start will be “grayed-out”. The APM process starts.
4. The system status indicates which crystal the APM is analyzing. One of the following will display in the system status area:
 - APM#1 when applied on 2 ω HG
 - APM#2 when applied on the 4 ω HG
5. The graph displays the photodiode signal during the APM process. Select **Refresh** to clear the data on the graph.
Note: During APM, the energy level will quickly drop to a few mJ, then it will reach an optimum level and then drop again. The system will finally stabilize to the optimum.
The APM process may take up to 15 minutes, depending on how far the system is from optimum energy level.
6. Once APM is complete, a message appears where you can accept or cancel the new operation set point. If you select **OK**, APM is complete. If you select **Cancel**, the system returns to the previous setting and may take few minutes to restabilize.
7. You can also select **Escape** at any time to exit the APM process.
8. To reset the crystals to their factory settings, select **Default T° set point**.

APM for 5 HG (FiHG) Configurations

(2 ω + 4 ω + 5 ω HG)

Before installing the 5 ω HG, the 4 ω HG must be optimized. Use the following steps to optimize the 5 ω HG.

1. Follow the procedure “APM for 4 ω HG (FoHG) Configurations” on page 43.
2. Once the APM for 4 ω HG is complete, place a power meter at the output of the 5 ω HG.
3. Remove the cover from the 5 ω HG.
4. Unlock the locking screw located near the top of the 5 ω HG module.
-  5. Ensure that everyone in the laser area is following all safety precautions and wearing appropriate eye protection.
6. Start the Q-Switch.
7. Tune the crystal in order to get the maximum energy level. Use a screwdriver to carefully adjust the tuning mechanism, which is a cam. The cam returns to its starting position at each turn.
8. Wait 30 seconds for the laser energy to stabilize. During this waiting period, the energy level will either increase or decrease.
9. Use a screwdriver to finely adjust the crystal tuning cam once again.
10. If you do not reach the expected energy, follow the procedure again “APM for 4 ω HG (FoHG) Configurations” on page 43.
11. Relock the locking screw located near the top of the 5 ω HG module.
12. Replace the module cover.

20.0 The Maintenance Tab

The Maintenance tab provides access to the following items
(See [Maintenance on page 63](#) for more details):

Item	Function
DI Cartridge	Replacement date, next replacement date due, and DI cartridge part number.
Service center France and International	Service center email address
Service center USA and Canada	Service center email address for USA and Canada
Flashlamp counter	User set flashlamp counter and reset.
Screen Brightness	Adjusts the screen brightness as a percentage of the maximum brightness.

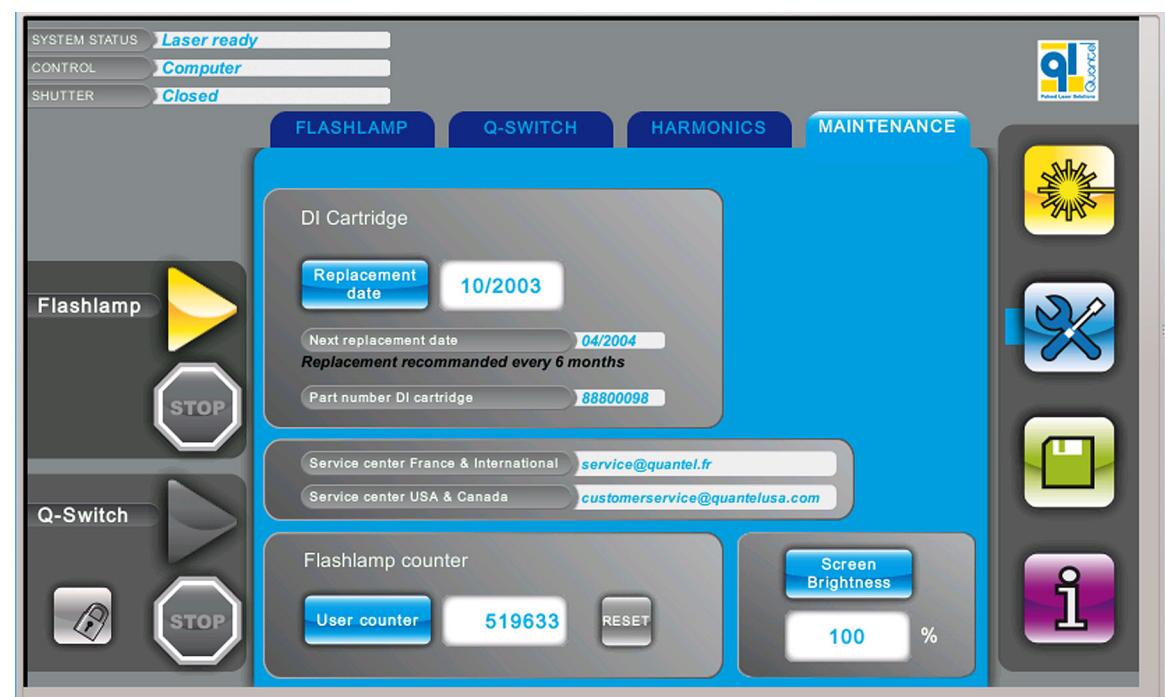


Figure 23 The Maintenance Tab

21.0 The Configuration Screen

The Configuration screen provides access to store and load stored settings, as well as select factory defaults. Laser parameters currently in use appear in the Operational settings area at the right of the screen.

You can store up to 4 configurations containing the following items:

- QS Divider
- FL Voltage (V)
- Number of active shots
- Number of scans
- Number of passive shots
- Q-Switch out sync (ns)
- FL-Q-Switch delay (μs)

To store a configuration:

1. Use the Q-touch Settings screen to establish the laser parameters. You cannot enter parameter values using the Configuration screen.
2. Select the button for the configuration number where you will store your current operation settings, for example: **Config.1**.
3. Select the **Save as** button. You will see the parameters listed for that button update to your parameters in use.

To load a configuration:

1. Select the button for the configuration number of the parameters to use, for example: **Config.1**
2. Select the **Load** button.
3. The Operational parameters area updates to show the parameters loaded from your configuration.

To load the factory default settings:

Select the **Factory settings** button.

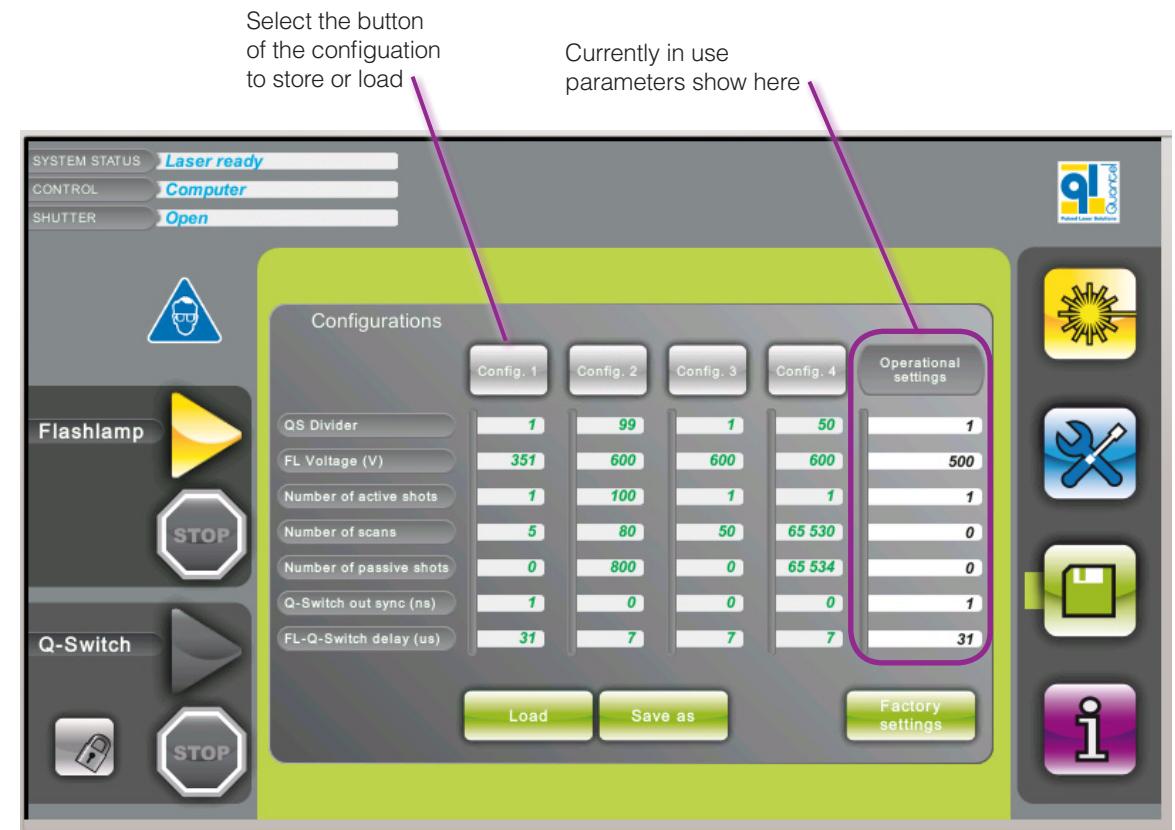


Figure 24 The Configuration Screen

22.0 The Information Screen

The Information screen provides access to laser information, synch information, and fault status.

The Laser Information Tab

The Laser Information tab shows serial numbers and other helpful information about the laser system, as follows:

Item	Function
Laser Information	
Laser head serial #	Laser head serial number
Power supply serial #	Power supply serial number
I/O cable length	Cable length in meters
Firmware version	Firmware version number
Flashlamp	
FL shot counter	System flashlamp shot counter
FL part #:	Flashlamp part number
DI Cartridge	
Last replacement date	User entered date
Recommended replacement date	Calculated replacement date based on Quantel recommendations

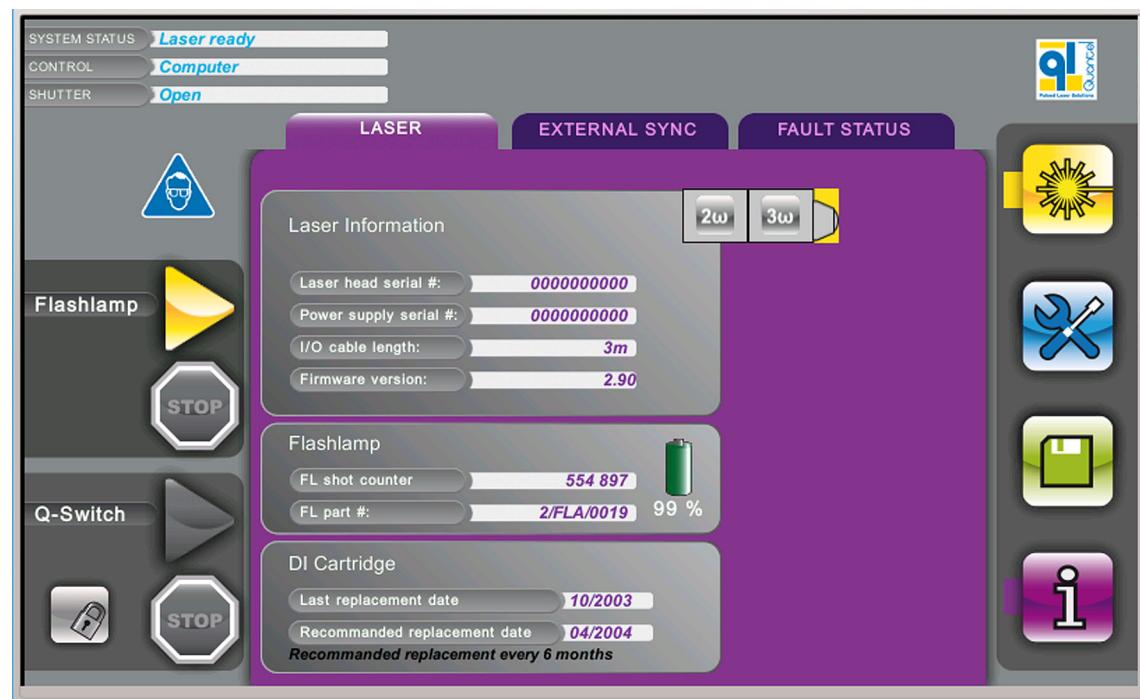


Figure 25 Example Information Screen, Laser Tab

The External Synch Tab

The External Synch tab shows the timing diagram. See **Timing**

Diagrams on page 59 for a view of the same diagram.

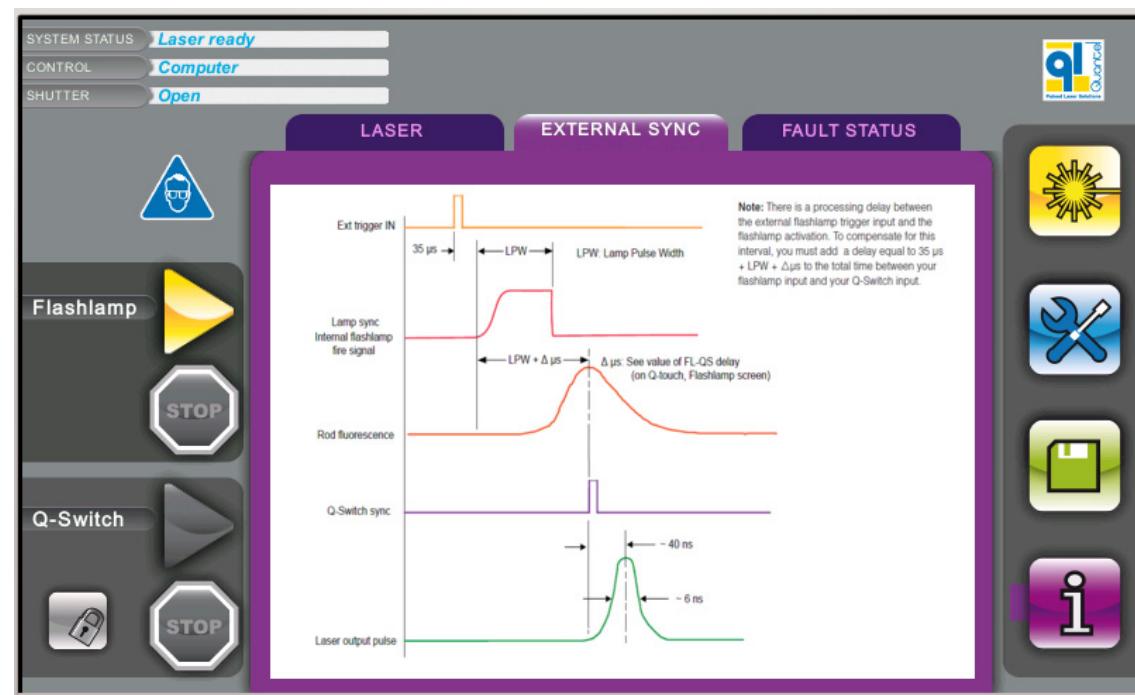


Figure 26 The External Synch Tab

The Fault Status Tab

The system constantly monitors for potentially hazardous conditions. If any of these conditions exist, laser output ceases and the screen shows a message indicating the fault condition.

When no alarm conditions are present, the fault indicators show green. When alarm conditions are present the fault indicators show red.

Clearing a Fault Condition

 A red indicator identifies the fault condition that caused system operation to cease. To clear a fault condition, first remedy the issue, then choose **Reset alarms**, located near the center of the Alarms screen. See **Resolving Interlock Fault Conditions on page 75** for details.



Figure 27 The Fault Status Tab

23.0 Example Start-Up Procedure



WARNING: The following steps result in laser light emission from the output aperture of the Laser Head. During laser operation, everyone present in the laser room must be wearing eye protection appropriate for the specific output wavelengths.



Note: Verify that you removed the protective cover from the aperture.

To start the laser system, follow this procedure:

1. Turn the AC power switch located on the ICE rear panel to ON ("I").
2. Turn the Key Switch located on the ICE front panel to ON ("I").
3. As the Key Switch is turned to ON, verify that the "Main Switch On" and the "Power ON" indicators on the ICE front panel. If not, check the Q-touch for fault messages. If necessary, see **Troubleshooting on page 74** to remedy the issue.
4. Use the Q-touch menus to select the desired operating mode. If using an External mode, connect the external signal generator to the appropriate "Lamp Synch In" and/or the "Q-Switch Synch In" BNC connector(s) on the ICE.
5. Open the manual shutter on the Laser Head.
6. Touch the Flashlamp start icon. The icon begins blinking to show the flashlamp is started.
 - In Internal mode, the flashlamp begins flashing at the frequency set for the Flashlamp Repetition Rate.
 - In External mode, the flashlamp will flash at the frequency determined by the external signal generator.
7. Touch the Q-Switch start icon. The icon begins blinking to show the Q-Switch is started. Laser emission begins and the Emission Warning icon appears on the screen. The Emission Warning LED on the Laser Head blinks. See additional instructions earlier in this section.



To cease laser emission:



1. Press the Q-Switch Stop icon or press the Flashlamp Stop icon. The Emission Warning icon on the Q-touch and the Emission Warning indicator on the Laser Head will stop flashing.
2. Close the shutter on the Laser Head.

24.0 Example Shutdown Procedure

To shut down the laser system, follow this procedure:

1. Press the Q-Switch Stop icon or press the Flashlamp Stop icon. The Emission Warning icon on the Q-touch and the Emission Warning indicator on the Laser Head will stop flashing.
2. Close the shutter on the Laser Head.
3. Verify the ICE front panel "Laser ON" indicator is off.
4. Turn the Key Switch located on the ICE front panel to OFF ("0").
5. Turn the AC power switch located on the ICE rear panel to OFF ("0").
6. Disconnect the power cord from the ICE AC Mains power if you will not be using the system for an extended period.

25.0 Decreasing Output Energy

Specifications are guaranteed at the maximum energy. Nevertheless the energy can be adjusted.

Operation at a decreased energy level is useful when starting an experimental setup or testing equipment. A simple way to decrease the laser output energy is to increase the delay between the flashlamp and Q-Switch to a value that is higher than optimal. You can do this using the Q-touch.



CAUTION: Quantel advises against decreasing the energy of the flashlamp(s) to reduce the output energy. Decreasing the energy of the flashlamp(s) will cause a change in beam characteristics. Divergence and position of the focal points may cause damage to the laser's internal optics.

To adjust the output energy using the Q-touch:

1. From the Operation Settings screen, select the **Q-Switch tab** or select the **Flashlamp tab**.
8. Enter a new value for the **FL-Q-Switch Delay**.

26.0 Increasing Output Energy



WARNING: Do not attempt to modify the pumping power by using the Q-touch to increase the flashlamp energy. This energy has been factory set for optimal laser performance.

Increase the flashlamp energy with the Q-touch only if the flashlamp efficiency decreases. Please contact **Quantel Customer Service** to determine the cause of the efficiency decrease.

27.0 Remote Operation

The Q-smart may be controlled by a remote computer using the Ethernet port located on the ICE front panel. The Ethernet connection allows you to manage the laser operation directly from your computer thru a standard RJ45 10Base-T and 100Base-TX Link (autonegotiation supported). The protocol used is the telnet com port control option defined by the RFC 2217. **Ethernet Interface on page 51** for details.

SOFTWARE

1.0 Ethernet Interface

The Ethernet connection allows you to operate the laser from a computer. The connection thru a standard RJ45 10 Base-T and 100 Base-TX (auto-negotiation supported), uses Telnet Com port control (RFC 2217) command line protocol.

To use the software interface via the Ethernet port, you will need to install the Com port redirector software provided on the USB memory device that shipped with your system. This software redirects Ethernet communication to act as standard Windows® COM port.

- RS 232 communication parameters are:
- 115200 baud
- 8 bit
- 1 stop bit
- no parity
- half duplex
- does not use Xon/ Xoff
- does not use RTS/CTS.

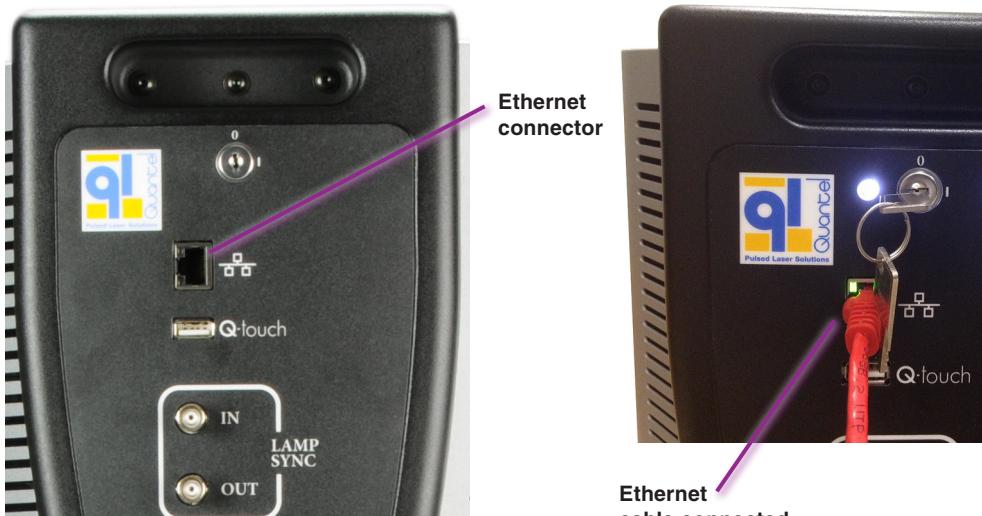


Figure 28: ICE Ethernet Connector

Command Syntax

- Commands are in ASCII, UPPER CASE only, and must be terminated by the “CR” or “LF” or “CRLF” (Carriage Return Line Feed) character.
- Responses are messages followed by a LF.
- Commands can be sent at a maximum rate of 10 Hz. Sending a new command only after receiving the response from the previous one is the best way to ensure you meet this requirement.
- Answer message ‘ERROR: UNKNOWN’ is returned when the computer doesn’t recognize the characters sent,
- Answer message ‘ERROR : OUT OF RANGE’ is returned when, while programming a data, the number of figure exceeds the authorized one,
- Answer message ‘ERROR : BAD PARAM’ is returned when the entered character is not an expected numeric character.

Installing the Com Port Redirector Software

1. Run the installer file appropriate for your operating system (Windows XP, 7 or 8).
2. Answer the prompts as needed.

2.0 Command Reference

System Commands

Commands	Command with Parameter	Description	Example Response
PSVER		Power supply firmware version	PSVERS = 1.00
LVERS		Laser brain firmware version	LVERS = 1.00
UIVERS		GUI version	UIVERS = 1.00
CGTEMP		Reads the cooling group temperature (°C)	CGTEMP = 38.2
CHKSERIAL		Reads the status of the flux	CHKSERIAL = 0
	CHKSERIAL 0	0 no control flux	OK
	CHKSERIAL 1	1 uses control flux (default)	OK
	ECHO 0	0 no	OK
	ECHO 1	1 echoes the command sent	OK

State Command

Commands	Description	Example Response	Response Meaning
Commands	Descriptions	Example Response	Response Meaning
STATE	Reads the laser state	STATE #	
		STATE 0	Boot Fault
		STATE 1	Warm up
		STATE 2	Laser ready for a RUN command
		STATE 3	Flashing – lamp disabled
		STATE 4	Flashing awaiting shutter to be opened
		STATE 5	Flashing – Pulse enabled
		STATE 6	Pulsed Laser ON /NLO Warm up
		STATE 7	Harmonic generator thermally stabilized
		STATE 8	NLO optimization
		STATE 9	APM ok : NLO ready

Commands must be entered by sending a carriage return character, CR ('\r', 0x0D) and line feed character, LF ('\n', 0x0A), in that order.
 #' represents a number value (0 through 9)

Flashlamp Commands



CAUTION: Use procedures described in **Operation starting on page 29** when varying voltage and pulse width parameters to avoid optical damage.

Commands	Command with Parameter	Description	Example Response
CAPVSET		Reads the flashlamp voltage (V)	CAPVSET = 600
	CAPVSET ###	Programs the flashlamp voltage (V). The limits are defined by the command LVMIN and LVMAX	CAPVSET = ###
LPW		Reads the flashlamp pulse width (μ s)	LPW = 170
	LPW ###	Programs the flashlamp pulse width (μ s)	LPW = ###
SSHOT		Reads the flashlamp shot counter (9 digits)	SSHOT = 538941
USHOT		Reads the user's shot counter (9 digits)	USHOT = 84261
	USHOT 0	Resets the flashlamp user's shot counter	USHOT = 0
TRIG xy	Example: TRIG IE	Sets internal or external flashlamp and Q-Switch synchronization mode	OK or ERROR:BAD PARAM
		x=I: internal Flashlamp x=E : external Flashlamp y=I : internal Q-Switch y=E : external Q-Switch	
RUN		Activates the Flash lamps at the nominal repetition rate in internal mode	OK or ERROR
STOP		Stops the flash lamps	OK or ERROR

Commands must be entered by sending a carriage return character, CR ('\r', 0x0D) and line feed character, LF ('\n', 0x0A), in that order.

'#' represents a number value (0 through 9)

Q-Switch Commands

Commands	Command with Parameter	Description	Example Response
QSPAR1		Reads the number of cycles for Burst/Scan mode	QSPAR1 = 10
	QSPAR1 #	Defines the number of cycles for Burst/Scan mode. For Automode (infinite pulse), set QSPAR1 to 0 and QSPAR2 equal to QSPAR3. Range: 0 to 65535.	OK or ERROR:BAD PARAM
QSPAR2		Reads the number of passive pulses per cycle (cycle length) for Burst/Scan mode	QSPAR2 = 2
	QSPAR2 #	Defines the number of passive pulses per cycle for Burst/Scan mode. Range: 0 to 65535.	OK or ERROR:BAD PARAM
QSPAR3		Reads the number of active Q-Switch pulses per cycle for Burst/Scan mode	QSPAR2 = 1
	QSPAR3 #	Defines the number of active Q-Switch pulses per cycle for Burst/Scan mode. Range: 0 to 65535.	OK or ERROR:BAD PARAM
Examples:	QSPAR1 1	Sets the Q-Switch to fire once for every 400 pulses in burst mode.	OK
	QSPAR2 400		
	QSPAR3 400		
	QSPAR1 0	One active Q-Switch pulse for every flashlamp pulse. (F/1) (setting QSPAR1 to 0 uses continuous mode).	OK
	QSPAR2 1		
	QSPAR3 1		
	QSPAR1 0	Sets the Q-Switch to fire once for every two pulses (F/2) in continuous mode.	OK
	QSPAR2 2		
	QSPAR3 1		

Scan mode: QSPAR1=0 (infinite pulse) and QSPAR2>QSPAR3

Burst mode: QSPAR1=n, (where n is a finite # of pulses) and QSPAR2 > QSPAR3

F/N mode: QSPAR1=0 and QSPAR2=N and QSPAR3=1

Commands must be entered by sending a carriage return character, CR ('\r', 0x0D) and line feed character, LF ('\n', 0x0A), in that order.

represents a number value (0 through 9)

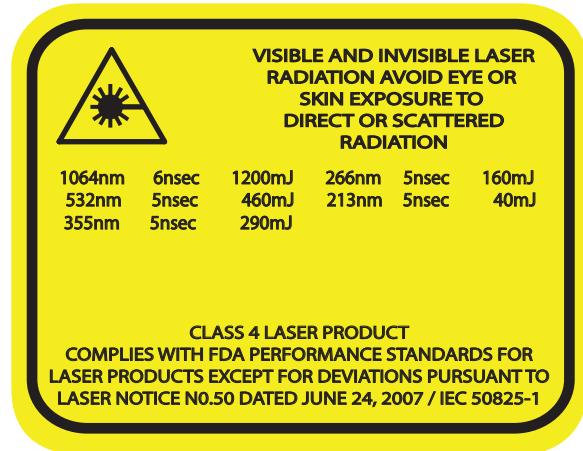
Q-Switch Commands, Continued

Commands	Command with Parameter	Description	Example Response
QDLY		Reads the delay between the end of the flashlamp pulse and the beginning of the Q-S pulse (in ns)	QDLY = 30
	QDLY #	Sets the FL-Q-Switch delay (in ns). Range: 0 to 255.	OK or ERROR: BAD PARAM
	Example: QDLY 20	Sets the FL-Q-Switch delay to 20 ns.	OK
QDLYO		Reads the delay between the Q-Switch pulse and the Q-Switch Synch. Out	QDLYO = -500
	QDLYO #	Sets the Q-Switch synchronization out delay (in ns). Range: from -500 ns to +500 ns	OK or ERROR: BAD PARAM
	Example: QDLYO 0	Sets the Q-Switch Synch Out delay to 0 ns.	OK
QSW	QSW 1	Starts the Q-Switch laser emission	OK or
	QSW 0	Stops the Q-Switch laser emission	ERROR : BAD PARAM

Commands must be entered by sending a carriage return character, CR ('\r', 0x0D) and line feed character, LF ('\n', 0x0A), in that order.

represents a number value (0 through 9)

TECHNICAL SPECIFICATIONS



1.0 General Specifications

Power input:

- 100-240 VAC, 50/60 Hz, 850 VA; Power Factor Corrected (PFC)

Cooling System:

- Coolant: distilled water with resistivity 1.0 MΩ/m
- De-Ionizing (DI) cartridge inline with the ICE coolant lines maintains coolant conductivity at 1.0 µS m⁻¹ (resistivity 1.0 MΩ/m).
- DI cartridge contains a particle filter.
- Coolant connectors are shut-off quick-disconnect style.

Environmental Conditions:

- Ambient temperature range: 18 to 28°C for specified system performance specifications.
- Storage Temperature Range: 5°C to 50°C.
- The system must be installed in a Pollution degree 2 or better environment (normally only non-conductive pollution occurs; occasionally, a temporary conductivity caused by condensation is to be expected)

Quantel reserves the right to modify the specifications without notice.

Regulatory Compliance:

- Complies with the Restriction of Hazardous Substances Directive (RoHS) 2002/95/EC.
- Electromagnetic Compatibility (EMC).
- Conforms to EMC Directive 89/336/EEC and Low Voltage Directive 73/23/EEC.
- Refer to the **Declaration of Conformity on page 80** for applicable standards tested relating to electromagnetic emissions and immunity.

Safety:

- Conforms to EN 61010-1 and IEC 61010-1 general safety requirements for electrical equipment for measurement, control, and laboratory use.
- Installation/over voltage category II
- Enclosure degree of protection rated IEC 60529 IPX0.
- Conforms to Laser Emission Equipment standard EN 60825-1 and Federal Laser Product Performance Standard, 21 CFR Part 1040.10 (FDA-CDRH) except for deviations pursuant to CDRH Laser Notice 50.

Installation:

- Dimensions (H x W x D): 507 mm x 283 mm x 503 mm [20.18" x 11.14" x 19.95"]
- Weight:
Laser Head: 7 kg [15.4 lbs] without coolant
Harmonic Generation Modules: 2.1 kg [4.6 lbs]
ICE: 27 kg [59.5 lbs] without coolant

2.0 Laser Data Sheet

Your system was shipped with a Data Summary Sheet that lists important information about your system. Refer to your Data Summary Sheet for the specific values for minimum and maximum limits, Q-Switch delay, and other information that may be unique to your configuration.



Q-smart

FINAL TESTS

Repetition rate :10 Hz

Serial number : _____

Energy :

Wavelength	Energy	Specs
1064 nm		
532 nm		
355 nm		
266 nm		
213 nm		

Flashlamp discharge voltage : _____ V

Pulse duration (FWHM) @ 1064nm : _____ ns

Far field pattern @ 1064nm shown on attached page

**Burn pattern
(30 cm)**

=

GENERAL OPERATION CONTROL

RS232 : O

External flashlamp trigger : O

External Q-Switch : O

Security interlocks : O

Date : _____

Tested by : _____

7/20/2013

3.0 External Trigger Signal Requirements

External triggering will not function properly unless the external signal applied to the ICE input connector meets the specified requirements:

- The signal generator must be set up to drive the ICE 50 Ω input. Figure 29 shows a signal generator driving the external trigger input of the ICE.
- The external flashlamp input to the ICE has an impedance of 50 Ω. In order for V_i to be 5 V, the signal generator must drive 50 mA into the trigger input.
- If it is not clear that the signal generator is driving the signal properly, measure the trigger signal using the method shown in Figure 30. Connect to the trigger signal circuit using a BNC “tee”. Verify that the oscilloscope input is in high-impedance mode (greater than 1 MΩ).
- The duration of the signal must be at least 100 μs. If the signal from the external generator does not meet the required parameters, adjust or replace the generator until it does.
- Figure 31 shows the required characteristics of the flashlamp trigger signal.

Note: There is a processing delay of 175 to 330 μs between the external flashlamp trigger input and the flashlamp activation. To compensate for this interval, you must add 175 to 330 μs to the total time between your flashlamp input and your Q-Switch input. See Figure 33 which shows an example of this delay, and the compensated Q-Switch signal.



CAUTION: To maintain a fast rise time and therefore minimal jitter, the Q-Switch input is not optically isolated and does not have over-voltage protection circuitry. Do not apply voltages greater than 5 V to prevent damage to sensitive components.

Symbol	Parameter	Min.	Max.	Unit
V _{IL}	Input low voltage	0.0	0.8	V
V _{IH}	Input high voltage	3.0	5.0	V
T _R	Rise time		1	μs
T _W	Pulse width	100		μs
V _{PK}	Peak voltage		5.5	V

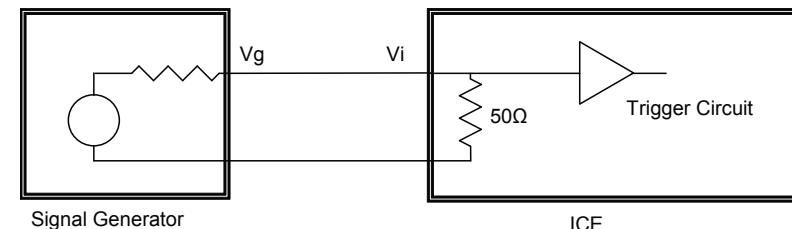


Figure 29 Signal Generator to Trigger Circuit

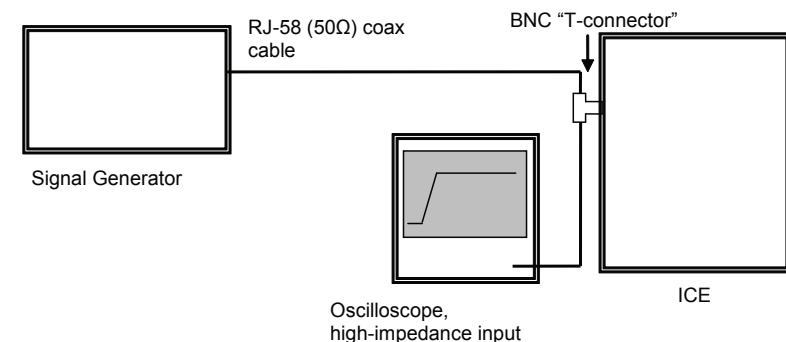


Figure 30 Preferred Method of Measuring Trigger Signal

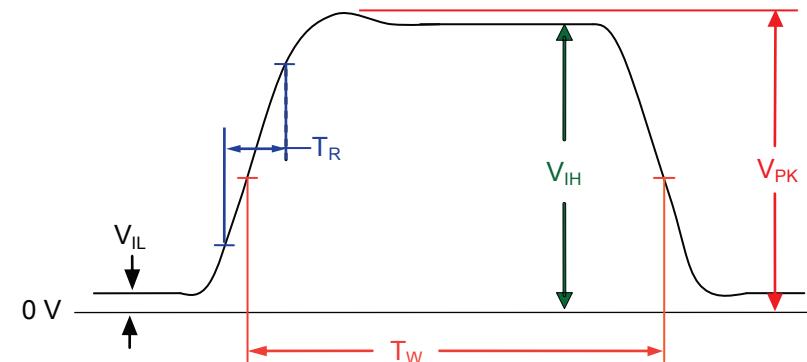


Figure 31 Required Characteristics of Flashlamp and Q-Switch Trigger Input Signals

4.0 Timing Diagrams

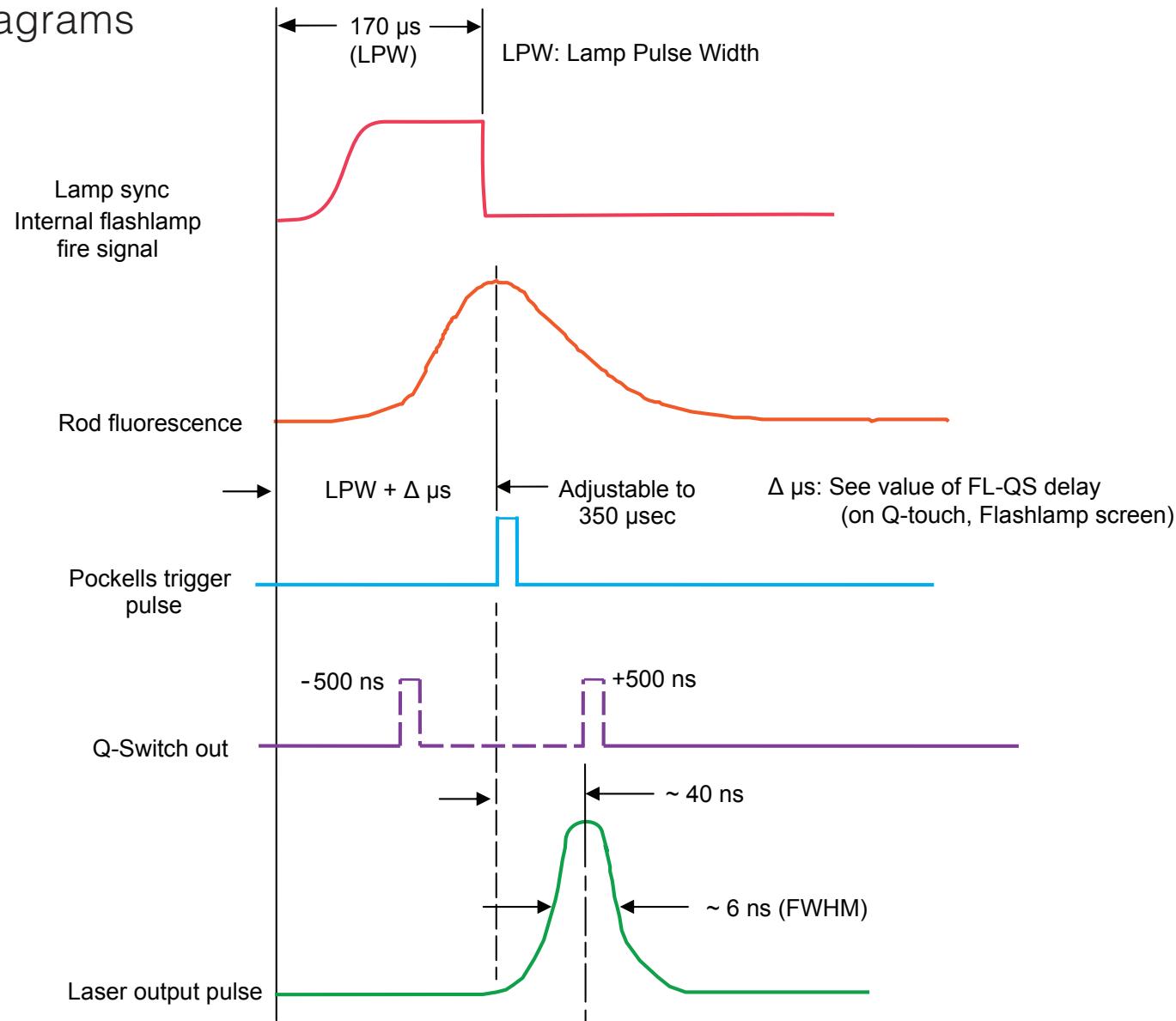
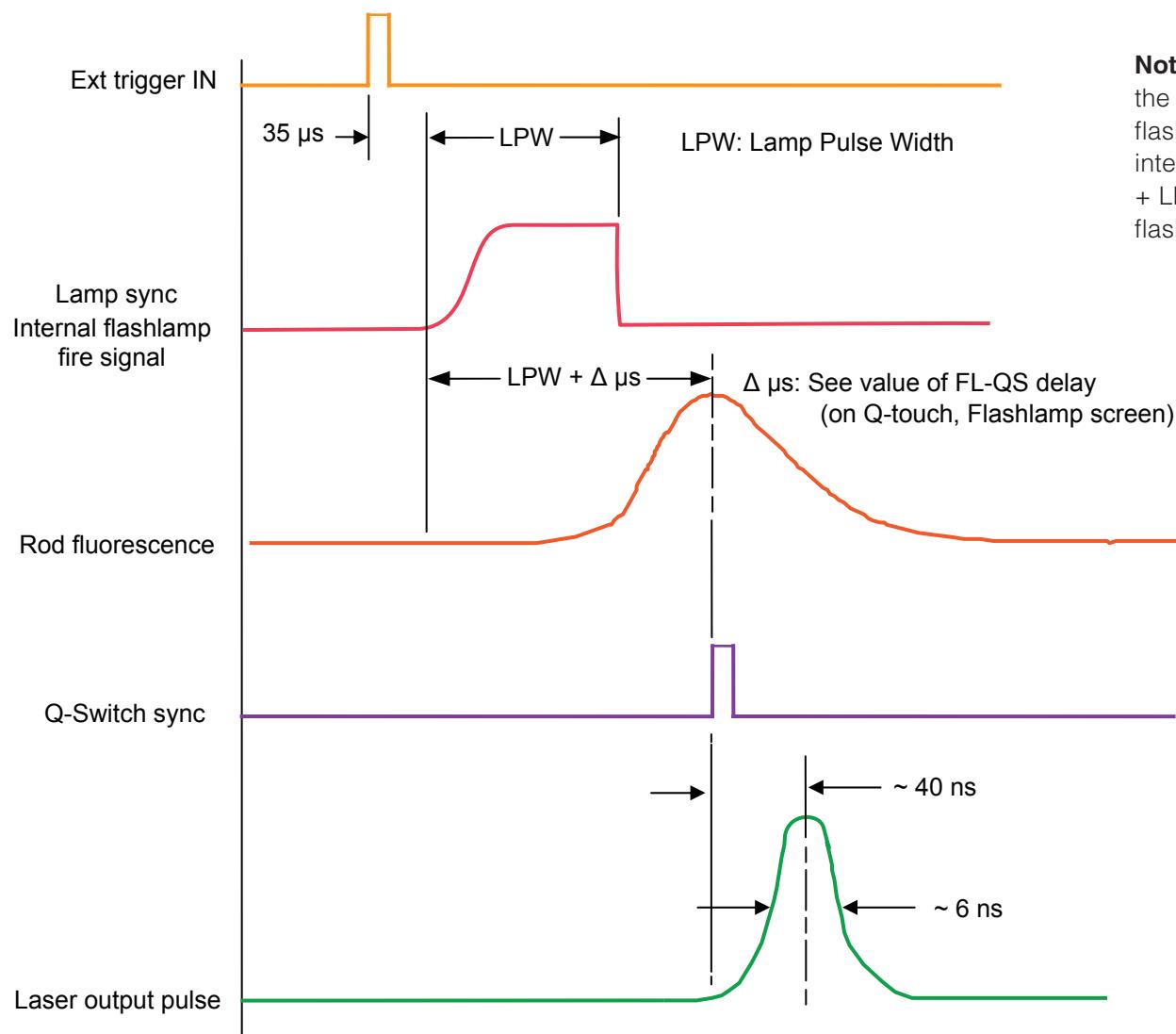


Figure 32 Timing Signals in Automatic Mode
Flashlamp Internal/Q-Switch Internal

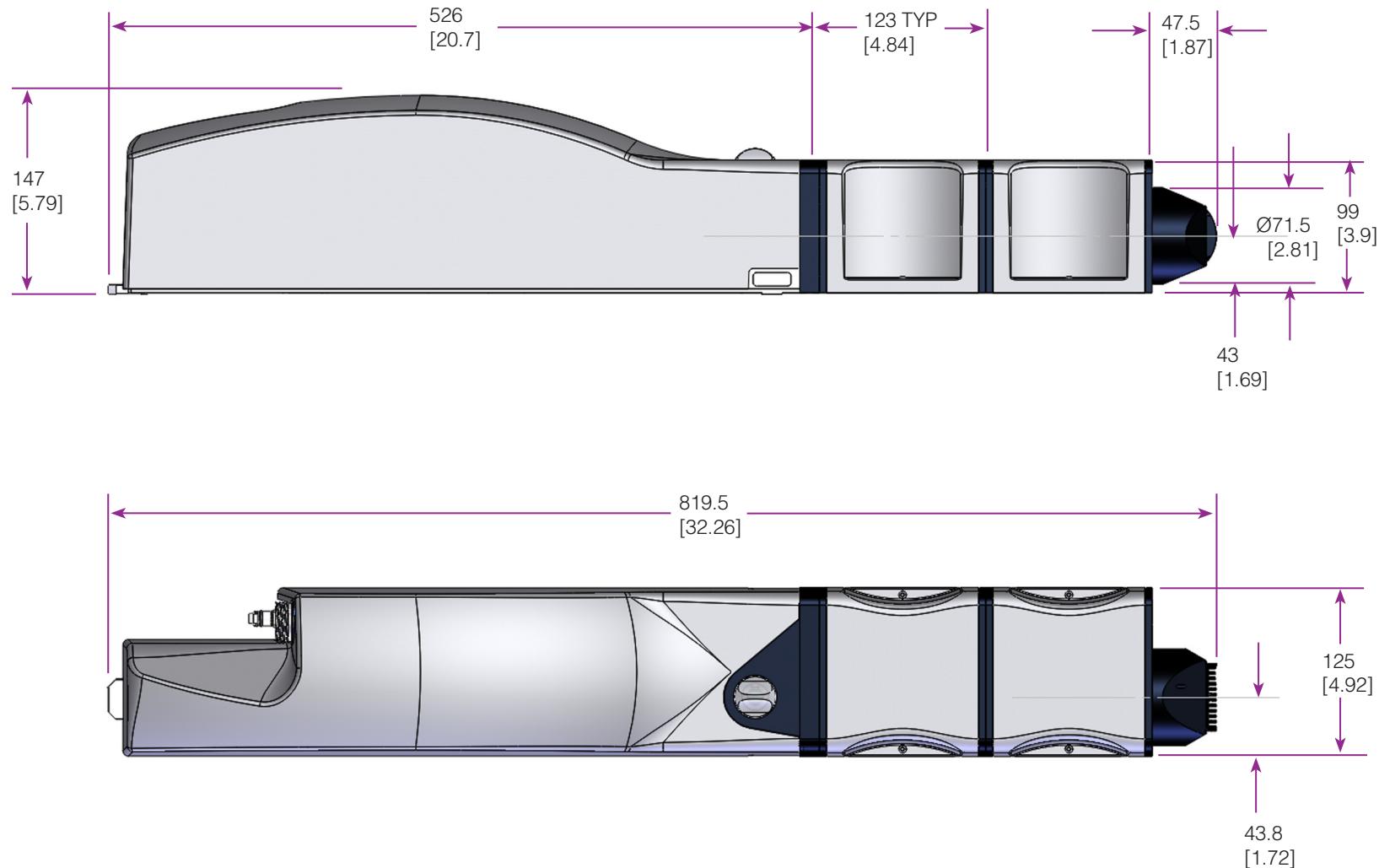


Note: There is a processing delay between the external flashlamp trigger input and the flashlamp activation. To compensate for this interval, you must add a delay equal to $35 \mu\text{s} + \text{LPW} + \Delta \mu\text{s}$ to the total time between your flashlamp input and your Q-Switch input.

**Figure 33 Typical Timing Diagram for External Mode
External Flashlamp/Internal Q-Switch or External Flashlamp/External Q-Switch**

DRAWINGS

1.0 Laser Head



2.0 ICE



MAINTENANCE



CAUTION: Inadequate cooling system maintenance may result in coolant contamination and/or system damage.

1.0 Scheduled Maintenance

Perform the following maintenance procedures on a regular schedule:

- ❑ Turn the Key Switch ON to operate the pump and circulate coolant for at least 30 minutes every month when the laser is not in use.
- ❑ Inspect the coolant level in the reservoir through the reservoir-level window on the ICE.
- ❑ Replace the Deionizing cartridge every 6 months and each time the flashlamp is replaced to maintain coolant integrity.
- ❑ Replace the flashlamp after every 100 million shots.

2.0 Draining the ICE



CAUTION: Remove ALL coolant. Trapped coolant may freeze during shipping or storage and cause irreversible damage to the internal components.

Note: You will need a suitable container to hold the drained liquid.

Use the following procedure to drain the system:

1. Ensure that the ICE Key Switch is OFF.
2. Place the ICE on a short table, so that it is above ground level but **below** the Laser Head. It must be enough higher to allow gravity to drain the system into the container sitting at ground level.
3. Remove the reservoir cap.
4. Connect the drain tube to the ICE rear panel Drain port. Place the free end of the drain tube in a suitable container to hold the drained fluid.
5. Disconnect the red coolant tube from the Laser Head.
6. Disconnect the blue coolant tube from the Laser Head.
7. Once the reservoir is empty, tilt the ICE toward the drain tube to drain any remaining coolant.
8. Disconnect the drain tube.

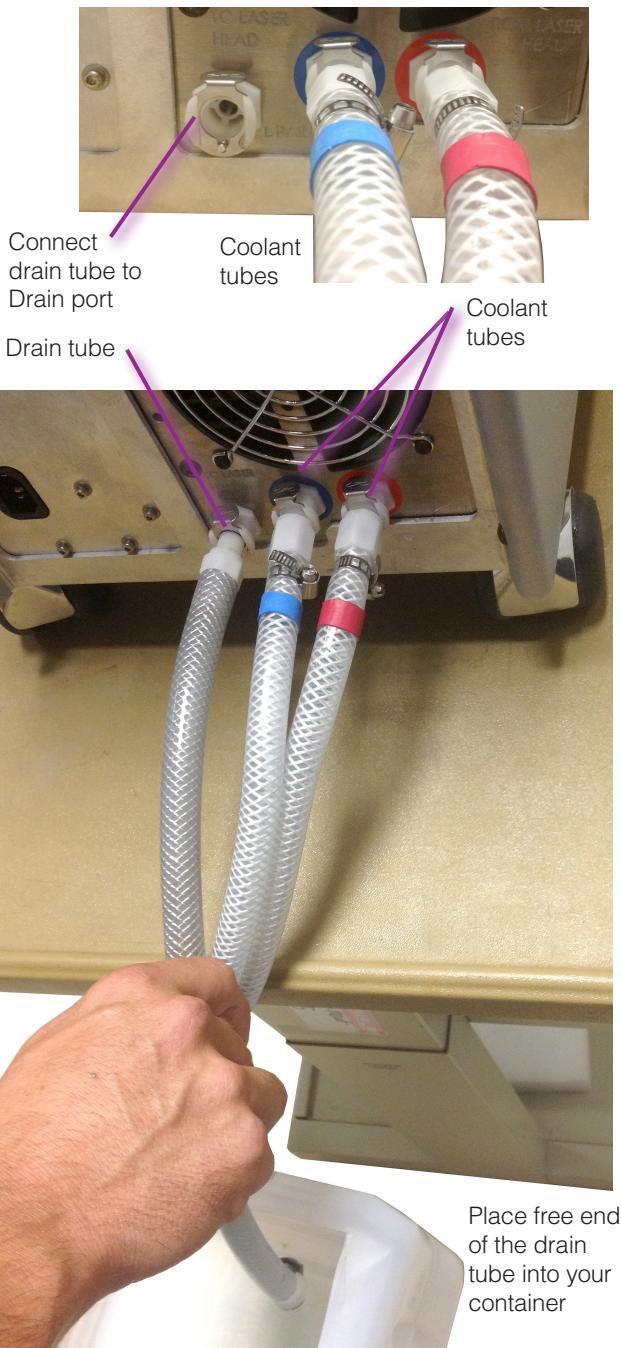


Figure 34: Draining the ICE

3.0 Draining the Laser Head

1. Gravity-drain the Laser Head by tilting it so that coolant flows out from the lower drain port and into your container.
2. Gently blow dry nitrogen through the blue coolant connector to empty any remaining coolant.

Note: The trace amount of coolant remaining in the system after following this procedure is not a concern.

4.0 Draining the Hoses

1. The coolant hoses should be detached from the back of the ICE and the Laser Head.
2. Connect the coolant change connectors to the stainless steel connectors on the ends of the coolant hoses. Place the end of the coolant hoses in your container.
3. Press in on the white plastic top of the connector to allow air into the hoses. Do not cover the entire end of this connector, or the coolant will not drain. Raise the end of the hose while pressing in on the connector top to drain the entire length of the hose.

The coolant is now drained and the ICE is ready to refill, store or transport.

5.0 Inspecting the Drained Coolant

Inspect the discarded coolant. The coolant should be very clear and free from contaminants. There should be no organic contaminants (such as algae) or large particles in the waste coolant.

- Black particulate is typically a sign of pump wear.
- Green coloration may be a sign of organic contamination.

 **CAUTION:** All contaminants need to be removed from the coolant loop prior to operating the laser. Please contact [Quantel](#) if you suspect contaminated coolant.

6.0 Preparing for Shipping or Storage

1. To prepare the system for shipment, wipe all residual coolant droplets from all coolant ports prior to placing the ICE in a plastic bag. This helps prevent moisture condensing on sensitive parts during shipment.
2. Place the plastic covers that originally shipped with the system over the coolant ports on the Laser Head.

Refilling the Reservoir (unless transporting)

1. To refill the cooling system, remove the coolant change connectors (if installed).
2. Reconnect the coolant lines between the Laser Head and ICE.
3. Refill the reservoir using the standard process. See [Filling the ICE on page 28](#).

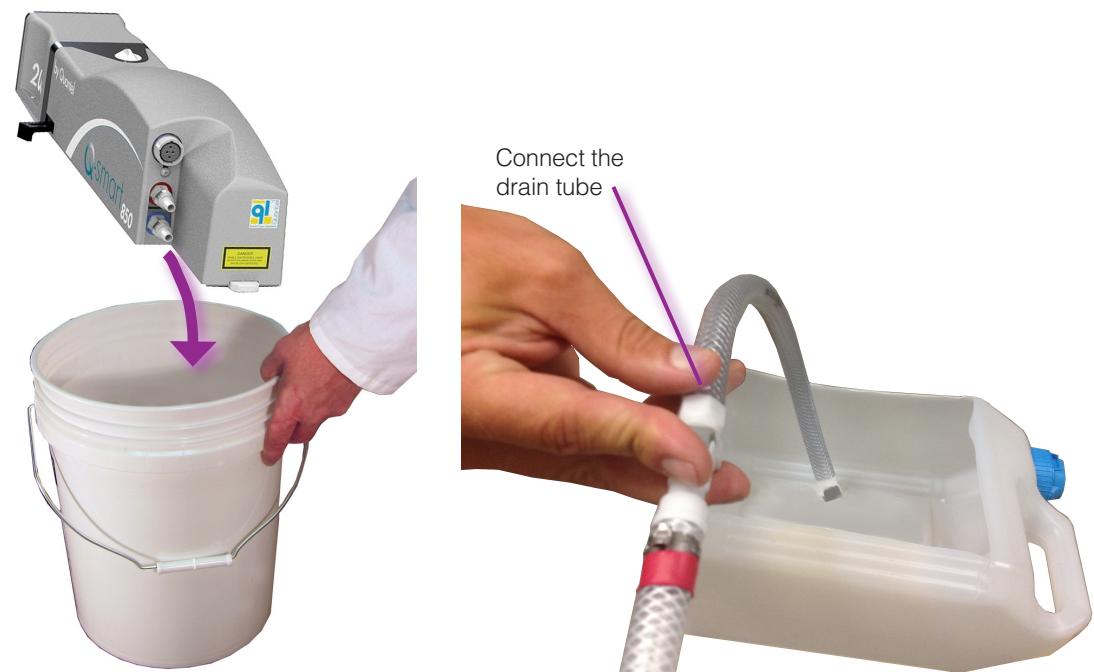


Figure 35: Draining the Laser Head and Tubing

7.0 Replacing the DI Cartridge

The DI cartridge should be replaced every six months and each time the flashlamp is replaced to maintain coolant integrity.

Deionizing the coolant helps maintain low coolant conductivity. The conductivity of the coolant should be less than $1.0 \mu\text{S} \cdot \text{cm}^{-1}$ (have a resistivity $\geq 1.0 \text{ M}\Omega \cdot \text{cm}$). This ensures the electrical field generated by the trigger transformer ionizes the gas inside the flashlamp and reliably establishes the simmer current. Coolant that is not properly deionized may prevent the lamp from simmering and may overheat and damage the trigger transformer.

 **CAUTION:** Before proceeding, verify that the ICE Key Switch is OFF. Unplug the AC Mains power cord.

1. Drain the coolant from the ICE. See **Draining the ICE on page 63**.
2. Disconnect the blue coolant line from the back of the ICE and the Laser Head. Drain the coolant from the blue line into an appropriate container.
3. Locate the DI Filter Cartridge. **Note its flow arrow direction** before removal.
4. Press the gray collet against the tan body fitting of the DI cartridge in the direction shown with orange arrows. Firmly hold the collet in this position while pulling on the coolant line in the direction shown with the green arrow to remove the filter.

 **CAUTION:** Failure to follow this process causes the collet teeth to damage the surface of the O-ring of the internal coolant line fitting.

5. Orient the new cartridge flow arrow in the correct direction (away from the ICE). Then one at a time, push the tube stems into the cartridge fittings, until the tube stem presses fully against the internal stop.
6. Test the cartridge installation by attempting to pull the coolant lines out of the cartridge. Ensure that the tube stem is fully inserted before continuing to the next step.
7. Reconnect the blue coolant line between the ICE and the Laser Head.
8. Add distilled/demineralized water to refill the reservoir.
9. Use the Q-touch to set the DI Cartridge replacement date.



Figure 36: DI Cartridge Installation

8.0 Ethylene Glycol Flush for Transport or Storage

CAUTION: Your system must be COMPLETELY drained and purged before transporting or storing the system to prevent damage to the Laser Head or ICE.

Purge the system with Ethylene-glycol using the following procedure:

1. Drain the system following the procedure **Draining the ICE on page 63**.
2. Prepare a mixture of 50% of Ethylene glycol (BDH Prolabo Analar Normapur) and 50% of deionized water.
3. Use the 50%/50% Ethylene glycol/water solution to fill the reservoir to about 3/4 of the maximum level, checking the level window on the ICE rear panel.
4. Turn the system on to run the pump and circulate the fluid mixture for 3 minutes.
5. Drain the mixture from the system using the usual procedure.
6. Repeat the process of filling the system with the 50%/50% Ethylene glycol/water solution to 3/4 of the maximum level and circulating this fluid to flush the circuit again.
7. Install the shipping covers over the coolant ports and inputs.

The system is now drained and ready to store or ship.



Figure 37: Flush with Ethylene Glycol/Water Mixture

9.0 Replacing the ICE Fuses

These fuses disconnect the ICE from AC Mains power in the event of an electrical fault. The label next to the fuse holder lists the specified fuse type and rating.

 **CAUTION:** Only replace the fuses with the specified fuse. Failure to do so may result in equipment damage or personal injury. For your safety, disconnect the power cord before servicing fuses.

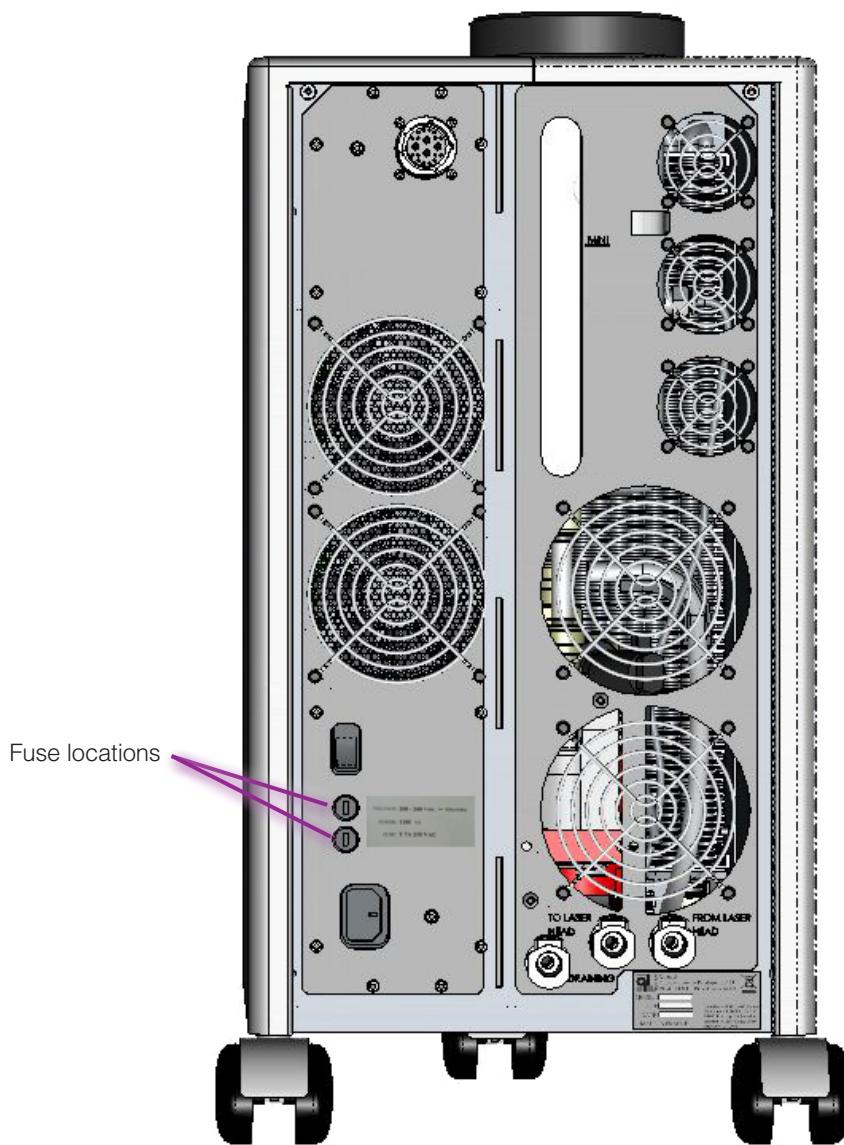


Figure 38: Replacing the ICE Fuses

10.0 Flashlamp Replacement

For optimal performance, the flashlamps should be replaced approximately every 100 million shots. See [page 37](#) for information on viewing the shot counter.

(A) The battery symbol on the Q-touch Information screen, Laser tab turns red to indicate the flashlamp needs to be replaced. You should also replace the flashlamp if output energy can no longer be adjusted to an acceptable level.

Note: Gradual lamp degradation is normal. Lamp degradation requires gradual small increases in input energy levels to maintain the original output level.

Lamp Removal

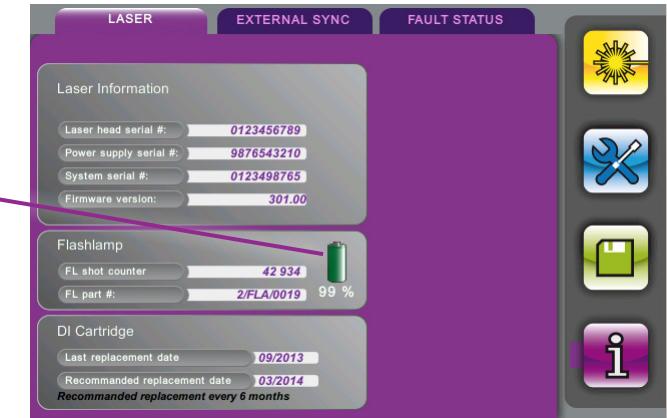
CAUTION: Failure to follow these procedures may flood the Laser Head with coolant, may result in personal injury, and will void the warranty.

CAUTION: Keep the Laser Head horizontal throughout the lamp change process! If tilted, any coolant remaining in the pump cavity will drain into the laser cavity and permanently damage laser components.

CAUTION: Handle flashlamps only with talc-free, rubber finger-cots or gloves.

Use the following steps to remove the flashlamps:

1. Ensure that the ICE Key Switch is OFF.
2. Ensure that the Mains power switch is OFF
3. Disconnect the main AC power cord.
4. Disconnect the Laser I/O cable from the Laser Head.
5. Disconnect the coolant tubing from the Laser Head.
6. Ensure that the coolant is completely removed from the Laser Head. See [Draining the Laser Head on page 64](#).
7. Place the Laser Head with its bottom surface resting horizontally on a flat surface.
8. (B) Remove the screw located on the rear of the Laser Head. Slide the cover back about 20 mm and then remove it.
9. Note the "+" and "-" signs corresponding to anode and cathode on the flashlamps, and also on the pump chamber cover, and the circuit board. The new flashlamp must match the polarity indicated. Also note that the flashlamp anode and cathode wires are different lengths.
10. (C) Disconnect the flashlamp wires from the termination blocks.



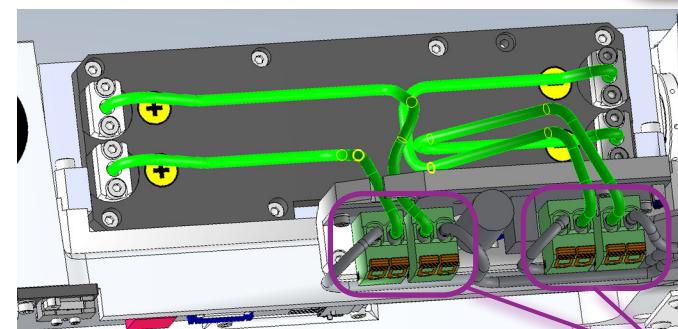
A The Information screen, Laser tab, shows flashlamp life



Remove this screw



B Remove the screw and slide the cover back and then off.

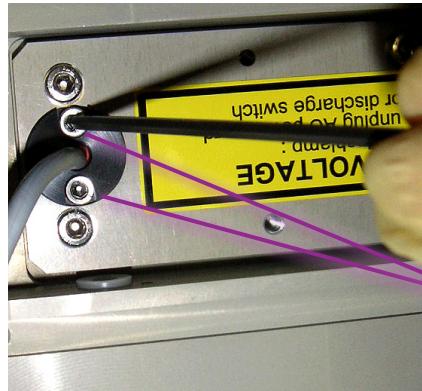


Press the orange tab and gently pull the wires to disconnect them

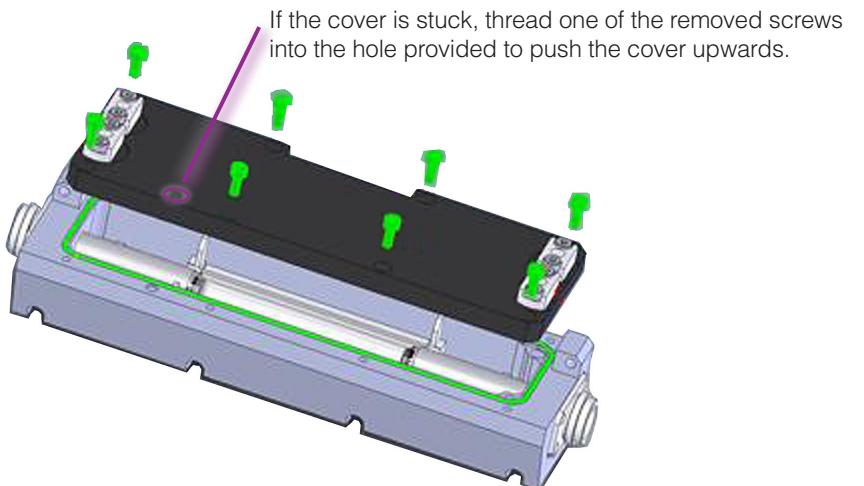
C Remove the anode and cathode wires from the flashlamp termination blocks.

Flashlamp termination blocks

11. (C) Loosen, but do not remove the 2 screws holding each of the pass-through retainers.
12. (D) Remove the 8 screws fastening the cover.
13. Lift the cover off of the assembly. If the cover is stuck, thread one of the removed screws into the threaded hole provided. This will push the cover upwards.
14. (E) Gently remove the flashlamps from the holder.



C Loosen the 2 screws holding each of the pass-through retainers.



D Remove the 8 screws fastening the cover.



E Gently remove the flashlamp.

Installing the New Flashlamps

Flashlamps from Quantel are individually certified by the Quality Control department as meeting Quantel's specifications. Samples from suppliers are regularly tested to determine lifetime (laser output energy measurement over time). This testing assures you of a quality flashlamp which is mechanically, electrically and optically suited for the Q-smart laser system.

CAUTION: Using a flashlamp from another vendor may cause optical damage and will void the warranty.

CAUTION: Keep the Laser Head horizontal throughout the lamp insertion process! If tilted, coolant left in the pump cavity will drain into the laser cavity, permanently damaging laser components.

When ordering a flashlamp, specify Quantel part number 1/FLA/0019.

To install the new flashlamps use the following steps:

1. (A) Identify the anode (+) and cathode (-) of the new flashlamp.
2. (B) Gently insert the flashlamp end wires through the cover holes, matching the polarity indicated on the pump cavity cover.
3. Verify the polarity of the flashlamp is correct by inspecting the markings on the lamp and the cover.
4. Center the new flashlamp by adjusting the wires.

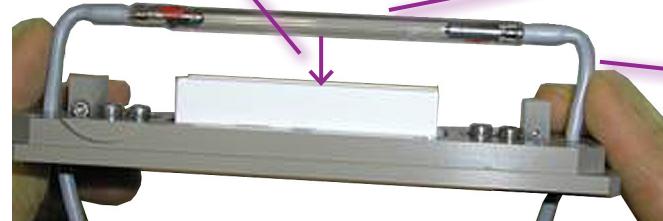
CAUTION: The wires must not be strained, to avoid breaking the flashlamps.

5. Gently seat the flashlamp against the plastic receptacle.
6. Verify that the flashlamp glass contacts the plastic receptacle.
7. Repeat this process to install the other flashlamp.
8. (C) Inspect the thin black o-ring to verify it is properly within in its groove.
9. (D) Reinstall the pump cavity cover.
10. Gradually tighten the eight screws using a crosswise pattern until the cover is in contact with pump cavity.
11. (E) Tighten the pass-through retainer screws to seal the pump cavity.



- A** Identify the anode and cathode of the new flashlamp.

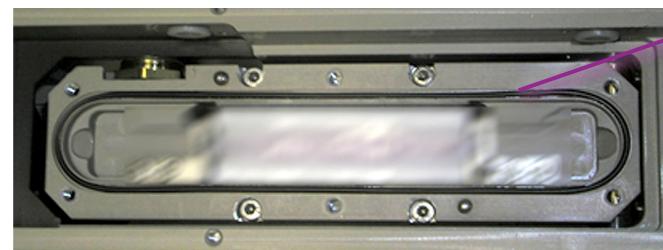
The flashlamp must touch the plastic receptacle



Center the flashlamp in the holder

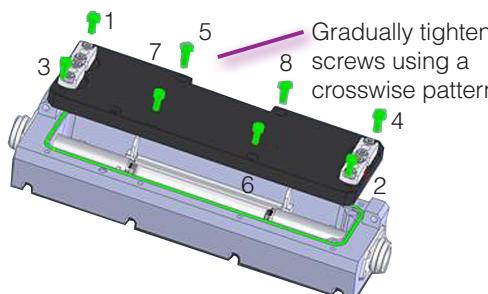
Do not strain the wires to avoid breaking the flashlamp

- B** Gently insert the flashlamp end wires through the holes in the holder, matching the polarity as noted on the cover. Center the lamp and gently seat it against the plastic receptacle.

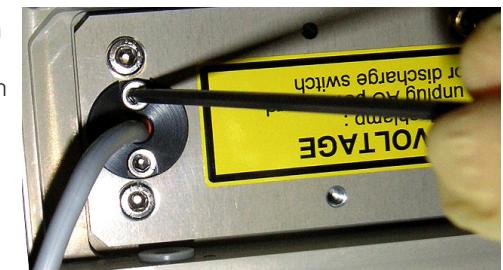


Verify the o-ring is seated in its groove

- C** Inspect the o-ring and ensure it is within its groove.



- D** Reinstall the pump cavity cover.



- E** Retighten the pass-through retainer screws.

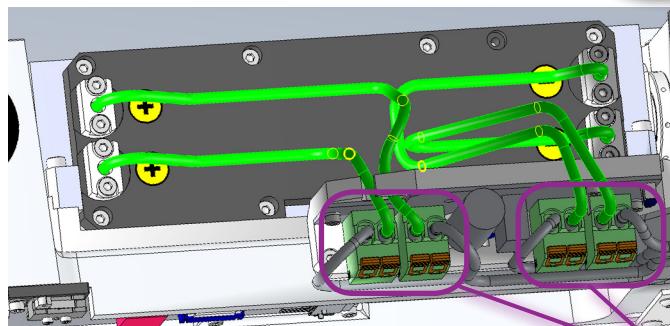
12. Verify the flashlamp are oriented with the correct polarities.
13. Connect the anode and cathode wires to the termination blocks.
14. Connect the I/O cable between the ICE and the Laser Head.
15. Turn on the AC Mains power switch located on the ICE rear panel.
16. Turn on the Key Switch located on the ICE front panel.
17. Inspect the pump cavity cover for water leaks. If any leak or moisture is found, turn off the ICE Key Switch and AC Mains power and then disconnect the Laser Head I/O cable.
18. Remove the pump cavity cover. Verify that the o-ring is undamaged and is properly in place within its groove.
19. Replace the pump cavity cover, gradually tightening the screws using a crosswise pattern and complete the process for installing and connecting a new flashlamp.
20. Wipe off all of the surfaces before turning on the system to retest it. Test for coolant leaks again. If a leak is detected, remedy the situation or call customer support. If the pump body is properly sealed, the continue on.



CAUTION: Operation of the system with a flashlamp that is not fully seated will flood the Laser Head and cause permanent damage. This will void the warranty. Permanent damage to the laser may result if the flashlamp wire is not properly reconnected. If there is any doubt about this lamp insertion process, please call Quantel Customer Service.

21. Reinstall the Laser Head cover using the original screw. The I/O cable must be disconnected for the cover to slide on.
22. Continue on to **Resetting the Shot Counter** and **Adjusting the Flashlamp Voltage** on page 72

Connect the anode and cathode wires in the proper locations



Flashlamp termination blocks

Resetting the Shot Counter

After replacing the flashlamp, follow these steps to reset the shot counter:

1. From the Q-touch, select the Settings screen.
2. Select the Flashlamp tab so it appears uppermost.
3. Click **Reset**, adjacent to **Flashlamp counter** to zero the value.
4. Note: You can also use the flashlamp commands sent from a remote computer to reset the counter.
See **Flashlamp Commands on page 53**.

Adjusting the Flashlamp Voltage

After replacing the flashlamp, the flashlamp voltage needs adjustment. During the usual process of gradual lamp degradation, small increases to the flashlamp voltage helped maintain the output level. Now that you have replaced the flashlamp, this higher energy level is no longer correct.

To adjust for the energy level needed for a new flashlamp, use the following steps:

1. From the Settings screen, Flashlamp tab, set the flashlamp voltage to its minimum allowed.
2. Optimize the output energy by gradually adjusting the flashlamp voltage.

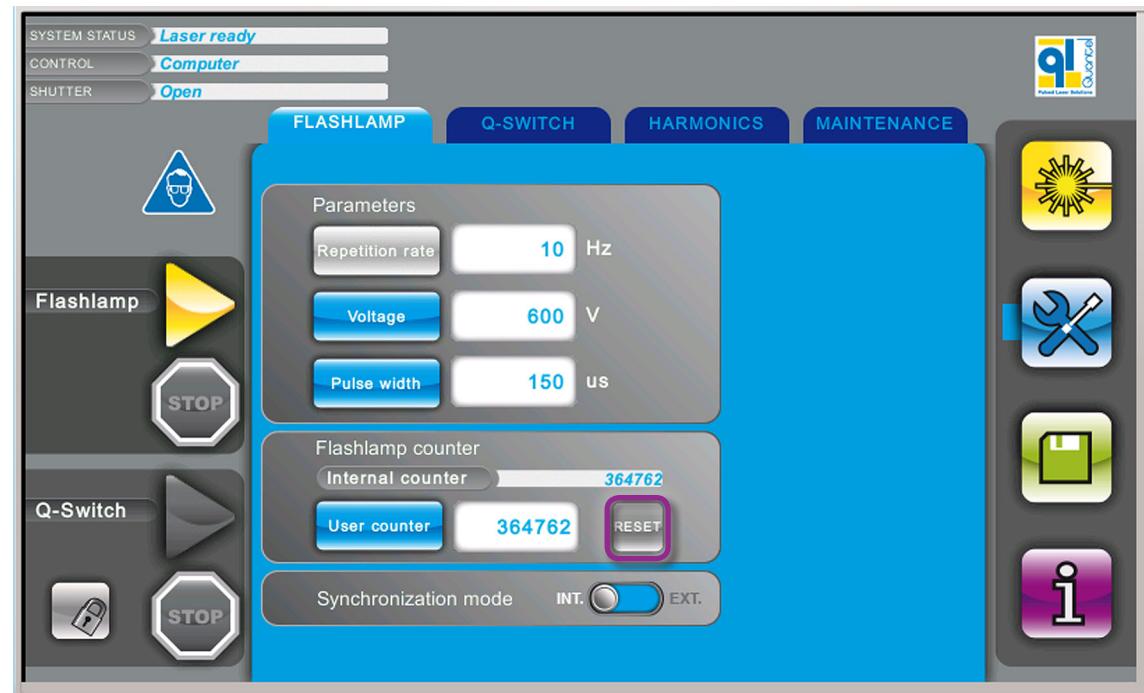


Figure 39: Flashlamp Tab for Resetting Counter and Voltage

11.0 Cleaning

Do not use any cleaning spray products or harsh mechanical means when cleaning the parts of the Q-touch laser system.

Use a soft dry optical tissue when cleaning is necessary.



Use soft dry optical tissue for cleaning



TROUBLESHOOTING

The ICE is designed to control the laser and warn the user of problems that may occur. The microprocessor-based system monitors the laser system and automatically shuts down if a fault occurs. Software limits have been factory selected to protect the laser system against damage. The following section may help you correct or identify the problem before calling Quantel Customer Service.

www.quantel-laser.com

Contact Us

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Phone: +33-1-6929-1700
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service@quantel.fr

QUANTEL USA, Inc. (North America)
601 Haggerty Lane
Bozeman, MT 59715 USA
Service toll free: +1-800-914-8216
Fax: +1-406-522-2007
CustomerService@quantelusa.com



1.0 General Information

No *internal* parts of the ICE are user serviceable. The only items on an this laser system that may be serviced by the user are:

- DI cartridge, see **Replacing the DI Cartridge on page 65**
- Flashlamp, see **Flashlamp Replacement on page 68**
- Fuses see **Replacing the ICE Fuses on page 67**

All other service or repair of the ICE, Laser Head or Laser Head optical alignment issues require a qualified Quantel technician or trained Field Service Representative.

Basic troubleshooting can help you resolve:

- security system faults, such as external safety interlocks
- connection issues

If a failure occurs at start-up or during operation, use the Key Switch to shut the laser OFF. Then use the troubleshooting methods presented next to resolve the issue.

2.0 Interlocks

The ICE constantly monitors the system for potentially hazardous conditions. If any of these conditions exist, the laser operation ceases and the Q-touch shows a message indicating the fault condition.

NOTE: Contact Quantel USA for any repair actions necessary beyond those described in this manual. Attempts to adjust, repair or replace any portion of the laser system may damage the system and void the warranty

3.0 Resolving Interlock Fault Conditions

The Fault Status Tab

The system constantly monitors for potentially hazardous conditions. If any of these conditions exist, laser output ceases and the screen shows a message indicating the fault condition.

When no alarm conditions are present, the fault indicators show green. When alarm conditions are present the fault indicators show red.

Clearing a Fault Condition



A red indicator identifies the fault condition that caused system operation to cease. To clear a fault condition, first remedy the issue, then choose **Reset alarms**, located near the center of the Alarms screen.



Figure 40 The Fault Status Tab

4.0 Communications Troubleshooting

The ICE has an important safety feature that may prevent serial communication during use of the Q-touch. Pressing any button on the Q-touch disables the serial port communications. To verify that this feature has not disabled serial communications, use the Q-touch System Info menu and ensure the Serial link item is set to ON. Once it is set to ON, do not press any Q-touch buttons as this would automatically disable serial communications again.

Problem	Possible Cause	Solution/Suggestion
Ethernet port does not operate: no communications.	Port is disabled	For safety reasons, the Ethernet connection is disabled when any button is pressed on the Q-touch.
	Baud rate incorrect	See Ethernet Interface on page 51 for correct baud rate setting.
	Com port redirector not installed	See Ethernet Interface on page 51 for details.
	Cable problem	Verify that the cable connection to the Ethernet port is secure. Verify that the cable is wired correctly.

5.0 Diagnosing Problems

Problem	Possible Cause	Solution/Suggestion
No System Power	No power connected	Check the simple things first—make sure the power cord is plugged into the outlet and making connection to the back of the ICE. Verify that the circuit breaker is allowing power to the outlet.
	Mains Power switch is OFF	Verify that AC Mains power is ON by checking the Key Switch.
	Key Switch is OFF	Turn the Key Switch on the front of the ICE to the ON “ ” position.
	System fuses	Check both fuses located on the ICE back panel. If necessary, replace the fuses. See Replacing the ICE Fuses on page 67 .
No Laser Output	System Fault condition	The Q-touch displays a red Fault button in top left corner. Select this Fault button or navigate to the Information screen, Fault tab to find the fault information. Refer to Resolving Interlock Fault Conditions on page 75 for more details.
	Cables not connected	With the Key Switch OFF and the system unplugged, check all electrical connections between the Laser Head and the ICE. Make sure all connections are secure. If any of the cables are not installed properly, the system will not function. Turn off the system power before connecting or disconnecting any cables.
	Shutter is closed	The manually controlled shutter is located on the Laser Head. Check that the manual shutter is fully open. See Manual Shutter on page 14 for details.
	Energy Level setting	Refer to the Laser Data Sheet that shipped with your system. Verify that the FL-QS delay is at its factory settings. Correct if necessary.
	Q-Switch not enabled	Verify that the Q-Switch is enabled and properly functioning. Use the Q-touch to determine the system status. Wait 8 seconds after flashlamp operation starts.
	Q-Switch setup not correct	Verify the flashlamp and Q-Switch synchronization mode are set correctly. Navigate to the Settings screen, Q-Switch tab to verify parameters.

Problem	Possible Cause	Solution/Suggestion
Energy is Low	Flashlamp degradation	These changes are normal over time and after shot accumulation (>100 million). The pump energy can be increased to compensate for lamp degradation. However, excessive input energy (voltage) to the lamp must be avoided since pre-lasing and optics damage may result. Navigate to the Information screen, Laser tab and examine the energy level. If significant lamp degradation is suspected, follow the instructions for Flashlamp Replacement on page 68 .
	Coolant degradation	Operating the laser system with contaminated coolant can adversely affect energy. Inspect the coolant. The coolant should be very clear and free from contaminants. There should be no large particulate or organic contaminants in the coolant. Black particulate is a sign of pump wear. Green or brown color is a sign of organic substances growing in the cooling system. If contaminated coolant is suspected, the cooling system must be purged and properly cleaned prior to operating the laser. Please consult Quantel for instructions on how to clean your cooling system if you suspect organically contaminated coolant. See Replacing the DI Cartridge on page 65 for information on coolant properties.
	Incorrect Q-Switch delay	The FL-Q-Switch Delay value is system dependent. Your system shipped with a Laser Data Sheet specifying the correct Q-Switch delay for your system. Verify that the FL-QS delay is at its factory setting.
	Misaligned	If beam quality has degraded, it may suggest an alignment problem. Contact Quantel for details.
Flashlamp Does Not Fire	Flashlamp mode not set correctly	Verify the flashlamp synchronization mode is correct for your use: internal or external.
	External flashlamp trigger input does not fire flashlamp	External trigger signal does not meet the specified requirements as shown in External Trigger Signal Requirements on page 58 .
	Flashlamp failure	The flashlamp has failed. Please contact Quantel Service.
	Simmer problem	The flashlamp failing to flash may indicate a lamp simmer problem. Either ionized or contaminated coolant, or a degraded flashlamp may be the cause. Coolant resistivity must be within the specified range for proper operation. See Replacing the DI Cartridge on page 65 for details. Replace the coolant. If the lamp still does not simmer, replace the flashlamp, see Flashlamp Replacement on page 68 .

WARRANTY

We at Quantel are proud of our specialty laser systems. Our manufacturing and quality control processes emphasize consistency, stability, ruggedness, reliability and performance. We strive to make reliable laser systems and to provide superior customer support.

Should there be a problem with operation or failure of any kind, please have your serial numbers ready (see **The Laser Information Tab on page 46**) then call:

Quantel Service Center France
33-1-6929-1700 (International)

Quantel toll-free customer service hotline
1-800-914-8216 (inside the U.S. & Canada)

We will do our best to get your system fully operational as quickly as possible.

Feedback

We welcome your feedback regarding your use, the performance of the laser system and these manuals. Product improvements and refinements come about from your input as we strive to continually improve our product reliability, performance and customer satisfaction.

International customers, please call our service center in France at 33-1-6929-1700. Within the United States and Canada, call our toll free number: 1-800-914-8216.

You can also visit us online at:
www.quantel-laser.com.

Warranty

(a) Quantel USA warrants the lasers it manufactures and produces to be free from defects in materials and workmanship for twelve (12) months following the date of shipment provided that all operating instructions are properly followed. 213 nm optical components are warranted for 90 days following the date of shipment. Flashlamps are warranted for 50 million shots or one year, whichever comes first. Consumables (filters, coolant) are excluded. This warranty is limited to the original purchaser of the laser and is not transferable.

During the 12 months warranty period, we will repair or replace, at our option, any defective products or parts at no additional charge, provided that the product is returned, shipping prepaid, to Quantel USA, 601 Haggerty Lane, Suite C, Bozeman, MT 59715. All replaced parts and products become the property of Quantel USA.

(b) This warranty is the only warranty made by QUANTEL USA with respect to the goods delivered hereunder and no representative or person is authorized to bind QUANTEL USA for any obligations or liabilities beyond this warranty in connection with the sale of QUANTEL USA's goods.

(c) Remedies are available only if QUANTEL USA is notified in writing by Buyer promptly upon discovery of any defects and in any event within the warranty period for the individual goods, whereby Seller's examination of such goods discloses to QUANTEL USA's satisfaction that such defects actually exist and the goods have not been (i) repaired, worked on or altered by persons not authorized by QUANTEL USA so as, in QUANTEL USA's sole judgment to effect the stability, reliability or proper operation of such goods; (ii) subject to misuse, negligence, abuse or accident; or (iii) connected, installed, used or adjusted otherwise than in accordance with the instructions furnished by QUANTEL USA or normal usage.

(d) All goods that Buyer considers defective shall be returned, freight and insurance prepaid, to QUANTEL USA's office, as designated on the face hereof. QUANTEL USA shall not be liable for additional transportation costs arising from the goods having to be shipped to a location remote from the original one. Buyer shall obtain return authorization from QUANTEL USA before returning any goods. QUANTEL USA shall not bear responsibility for damage or loss to goods not properly prepared for transportation.

(e) If it is found QUANTEL USA's goods have been returned without cause and are still serviceable, Buyer will be notified and the goods returned at Buyer's expense, freight collect. In addition, a charge for testing and examination and/or for reimbursement of shipment costs paid by QUANTEL USA under subsection (d) above, may, at QUANTEL USA's sole discretion, be made on goods so returned which such charges shall also be payable by the Buyer.

(f) The foregoing warranty is exclusive and in lieu of all other warranties whether written, oral or implied, including any warranty of merchantability or fitness for a particular purpose, and shall be the Buyer's sole remedy and QUANTEL USA's sole liability on contract or warrant or otherwise for the product.

(g) This warranty shall not apply in the event that the original device identification markings have been removed, defaced or altered, or if any parts have been substituted or modified without the express consent of QUANTEL USA.

(h) This warranty will not apply if the customer's general account at QUANTEL USA is delinquent in whole or in part.

QUANTEL USA's liability under, for breach of, or arising out of this agreement and/or sale will be limited to repair or replacement of any defective goods or a refund of the purchase price of the goods, at QUANTEL USA's sole discretion. In no event will QUANTEL USA be liable for costs of procurement of substituted goods by buyer, nor will QUANTEL USA be liable for any special, consequential, incidental or other damages (including without limitation loss of profit) whether or not QUANTEL USA has been advised of the possibility of such loss, however caused, whether for breach or repudiation of contract, breach of warranty, negligence or otherwise.

CERTIFICATES

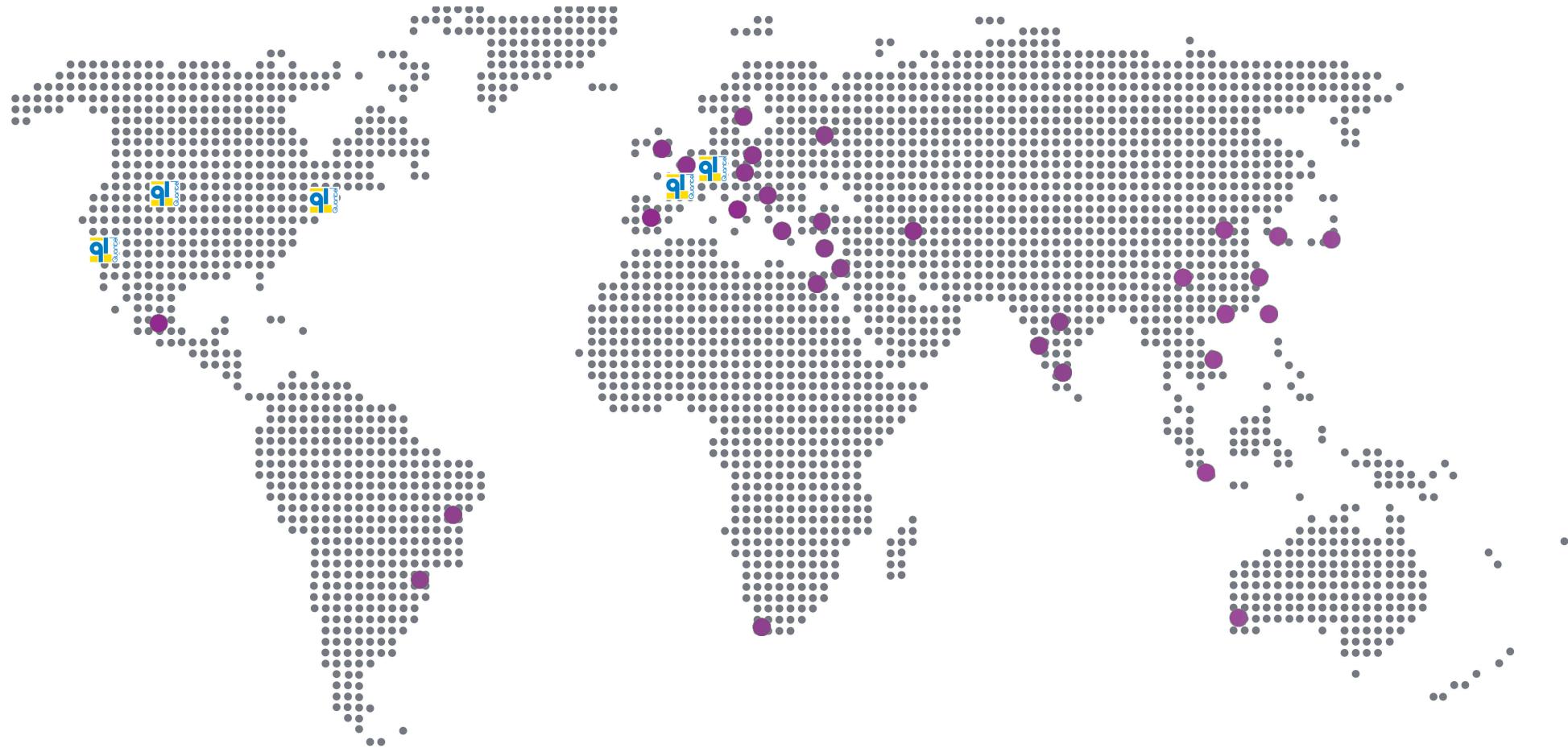
CE Certificate of Conformance

By affixing the CE marking, Quantel assures that the ICE meets all the essential requirements of all applicable European Union (EU) directives required for market placement in the European Economic Area (EEA).

Declaration of Conformity

Conforming to standards according to ISO/IEC Guide 22 and EN 45014. See the Certificate of Conformance for Electromagnetic Compatibility (EMC), electrical safety standards, and requirements applicable to the CE certification mark of the ICE.





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