Operator's Manual
New Wave Research
QuikLaze, QuikLaze II & QuikLaze FE (fiber enhanced)
Nd:YAG Laser Machining System

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Preface

This manual contains information for the proper installation and operation of the QuikLaze Laser Cutter System. The term QuikLaze refers to the QuikLaze, QuikLaze II and QuikLaze FE laser systems unless otherwise noted. This system is designed for semiconductor design and failure analysis, micro-electronics machining and research applications. The QuikLaze complies with the Center for Devices and Radiological Health (CDRH) Standard 21 CFR 1040.

The QuikLaze may be mounted on the following microscopes:

Mitutoyo	Ready Products
FS50 (Green only)	A-Zoom (IR, Green, UV3, UV4)
FS60 (Green, UV3)	S-Scope (IR, Green, UV3, UV4)
FS60Y (IR, Green, UV3)	
FS70Z (Green, UV3)	
FS70L (IR, Green, UV3)	

The QuikLaze emits laser radiation that can be harmful to human eyes and skin. To avoid blindness or skin damage you must completely read and understand the SAFETY section of this manual before installing the system. Before attempting to operate the QuikLaze, it is essential that you completely read and understand the OPERATION section of this manual.

Do not attempt to repair the QuikLaze while it is under warranty. Report all problems to your supplier or New Wave Research, Inc. 47613 Warm Springs Blvd., Fremont CA 94539. Telephone 510-249-1550; Fax 510-249-1551; e-mail lasers@new-wave.com

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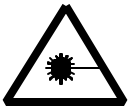
Chapter One, Laser Safety

Optical Safety

The QuikLaze Nd:YAG laser generates high energy infrared radiation that can pose serious risks to eye safety. Infrared radiation is invisible to the eye, so the hazard is not immediately obvious, but the radiation can be focussed onto the retina. For this reason it is very important to always wear protective eye wear as appropriate and to be aware of any possible reflections. Refer to ANSI 136.2 "Standards for the Safe Use of Lasers," available from the Laser Institute of America, tel. 407-380-1553.

WARNING: The New Wave Research QuikLaze is a Class IIIb laser system. AVOID DIRECT EXPOSURE TO THE BEAM.



BECAUSE THE 1064, 355, 266 AND 213 NM OUTPUT BEAMS OF A Nd:YAG LASER ARE INVISIBLE THEY ARE EXTREMELY DANGEROUS. Infrared radiation passes easily through the cornea, which focuses it on the retina of the eye, where it can cause instantaneous permanent damage including blindness. AVOID EYE AND SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION.

CAUTION: USE OF CONTROLS, ADJUSTMENTS OR PERFORMANCE OF PROCEDURES OTHER THAN THOSE SPECIFICIED HEREIN MAY RESULT IN HAZARDOUS RADIATION EXPOSURE.

Follow the instructions contained in this manual for proper installation and safe operation of your laser. Wear protective eye wear; selection depends on the energy and wavelength of the laser beam as well as operating conditions. Consult ANSI, ACHIG or OSHA standards for guidance.

At all times during installation, operation, maintenance or service of your laser, avoid exposure to laser or collateral radiation exceeding the accessible emission limits listed in "Performance Standards for Laser Products," 21 CFR 1040 10(d).

CAUTION:
THE POWER SUPPLY CORD IS USED AS THE MAIN POWER DISCONNECT DEVICE. ENSURE THAT THE

SOCKET OUTLET IS LOCATED/INSTALLED NEAR THE EQUIPMENT AND IS EASILY ACCESSIBLE.

ATTENTION:
LE CORDON D'ALIMENTATION EST UTILISÉ COMME INTERRUPTION GÉNÉRAL. LA PRISE DE COURANT DOIT ÊTRE SITUÉE OU INSTALLÉE A PROXIMITÉ DU MATÉRIAL ET ÊTRE FACILE D'ACCÉSS.

VORSICHT:
ZUR SICHEREN TRENNUNG DES GERÄTES VON NETZ IST DER NETZSTECHER ZU ZIECHEN. VERGIWISSERN SIE SICH, DASS DIE STECKDOSE LEICHT ZUGÄNGLICH IST.

Electrical Safety

The laser head and power supply contain electrical circuits operating at lethal voltage and current levels. Do not attempt to operate the laser with the power supply cover or laser head cover removed. For service, please contact New Wave Research at 47613 Warm Springs Blvd., Fremont CA 94539. The phone number for New Wave Research is 510-249-1550, fax 510-249-1551; e-mail: lasers@new-wave.com.

Certain procedures such as changing the flash lamp, water filter, or cleaning optical components require removal of the protective systems. It is important that all safety precautions outlined in this manual are observed by anyone using the laser. The most important rule when working with this laser is to switch it off completely.

There are no user serviceable parts on the electrical side of the power supply. Service procedures on system electronics must be carried out by New Wave Research. Always switch off the laser when working on any part of it.

Safety Features

The following features are built into the QuikLaze Nd:YAG lasers to conform to government regulations and provide safe laser operation.

Laser Covers

The QuikLaze laser head is enclosed in a protective housing

that prevents access to radiation in excess of Class I limits, except for the output beam, which is Class IV The cover also protects against stray radiation from the QuikLaze. Do not remove the cover, except to perform service procedures by a trained person.

Interlocks

The QuikLaze Nd:YAG laser system has a series of interlocks to prevent accidental exposure to dangerous levels of electricity or radiation. In addition, there are interlocks designed to interrupt laser operation if the laser may be damaged. The interrupts are:

Laser head cover opened

Laser head/microscope interlock

Remote interlock interrupted (if installed)

Laser head temperature too high

Power supply temperature too high

Cooling water flow too low

Exit Shutter

The QuikLaze has an exit beam shutter located on the laser head housing. The laser beam may be blocked by closing the shutter, however the laser continues to operate.

Government Regulations

New Wave Research suggests that laser users purchase a copy of the American National Standard for the Safe Use of Lasers (ANSI Z136.1-1993). This publication provides recommendations for the safe use of lasers and laser systems that operate at wavelengths between 180 nm and 1 mm. The publication is available from

Laser Institute of America
12424 Research Parkway, Suite 125
Orlando, FL 32826
(407) 380-1553

Laser Classification

The governmental standards and requirements specify that the laser must be classified according to the output power or energy and the laser wavelength. The QuikLaze is classified as Class IIIb based on 21 CFR, subchapter J, part II, section 1040-10 (d). According to the European Community

standards, the QuikLaze is classified as Class 3B based on EN 60825. This manual and other documentation for the QuikLaze will refer to the classification as Class 3B.

Location of Safety Labels

Refer to Figures 1-1 through 1-4 for the location and identification of all labels for the QuikLaze laser system. The labels are for safety, certification and identification, and a copy of each label is shown in the following figures.

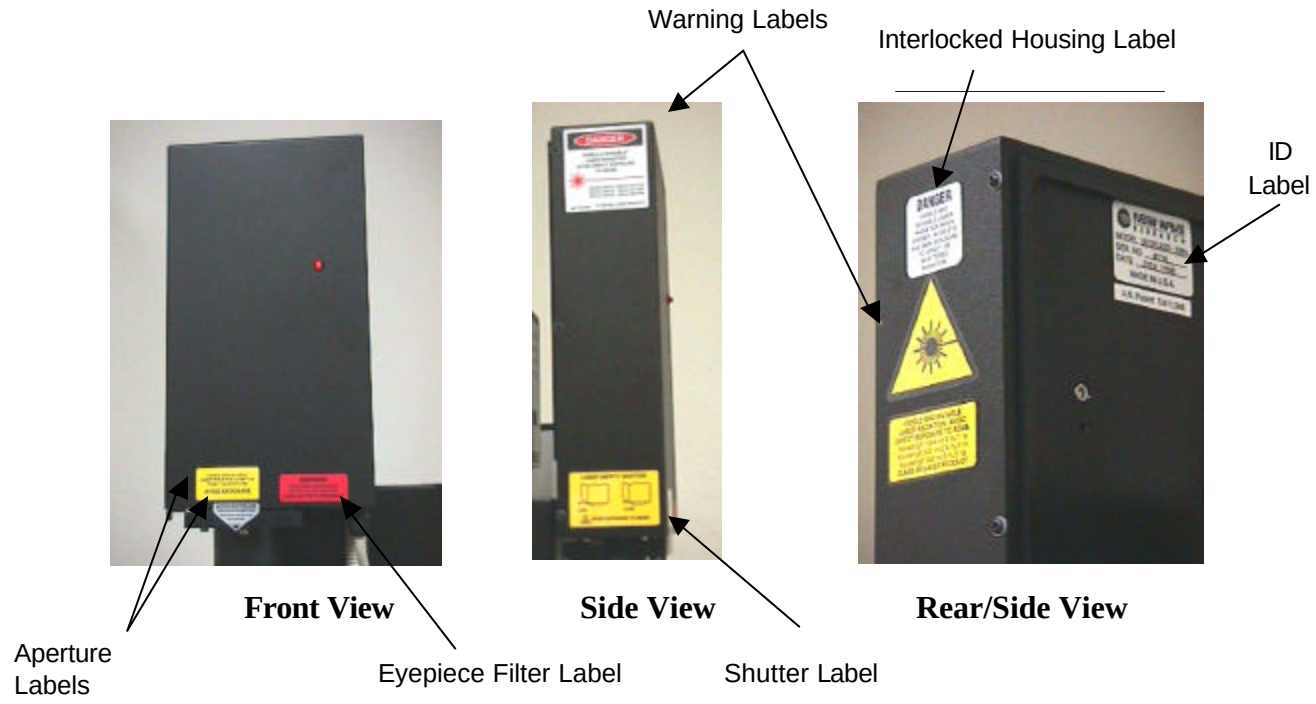


Figure 1-1. Location of Labels on Laser Head

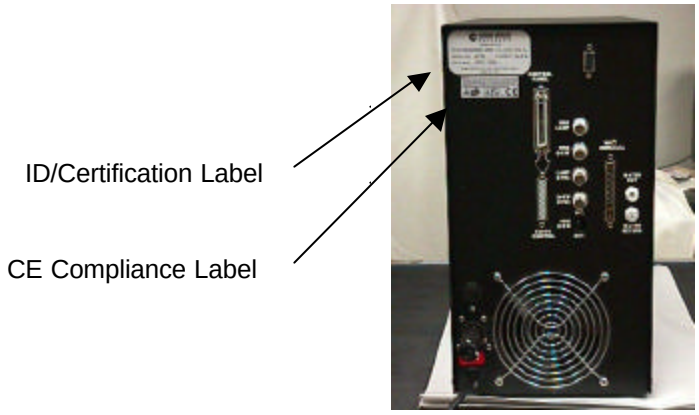
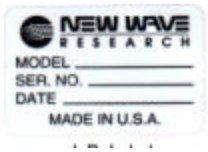


Figure 1-2 Location of Labels on Laser Power Supply

Figure 1-3 Label Location on Fiber Optic Head



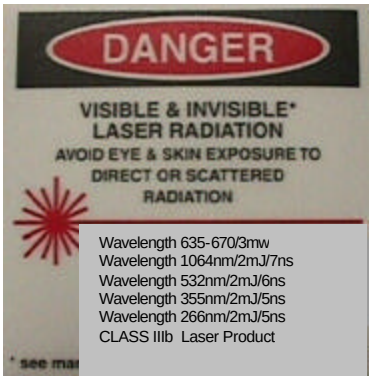
ID Label

ID/Certification Label

Aperture Label

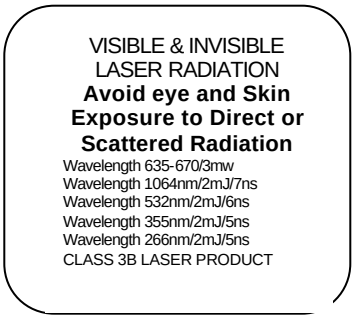
Aperture Label

Interlocked
Housing Label



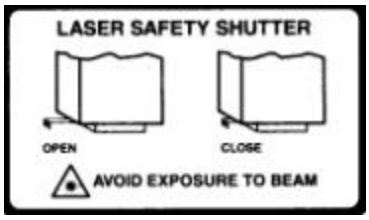
Warning Label

Warning Label



Warning Label

Eyepiece Filter Label



Laser Safety Shutter Label

CE Certification Label

Figure 1-4 Label Samples

Chapter Two, Description and Specifications

Introduction

This chapter will give you an introduction to the QuikLaze Nd:YAG laser. The optical layout of the head is explained in the following section, including the different QuikLaze configurations. A summary of system specifications is given on the last page of this chapter.

Optical Layout

This section gives an introduction to the optical layout in the QuikLaze Nd:YAG laser micromachining system. See Figure 2-1. QuikLaze is designed to operate with the Mitutoyo FS60, FS70, as well as the A-Zoom and S-Scope from Ready Products. The A-Zoom and S-Scope require a laser adapter kit from Ready Products. The QuikLaze FE has a second optical head that mounts directly on the microscope. This second optical head contains the XY shutter and camera adapter. In this case the laser beam is carried from the main QuikLaze head to the fiber optic head through a fiber optic cable. The main QuikLaze FE head is placed on a flat surface near the microscope.

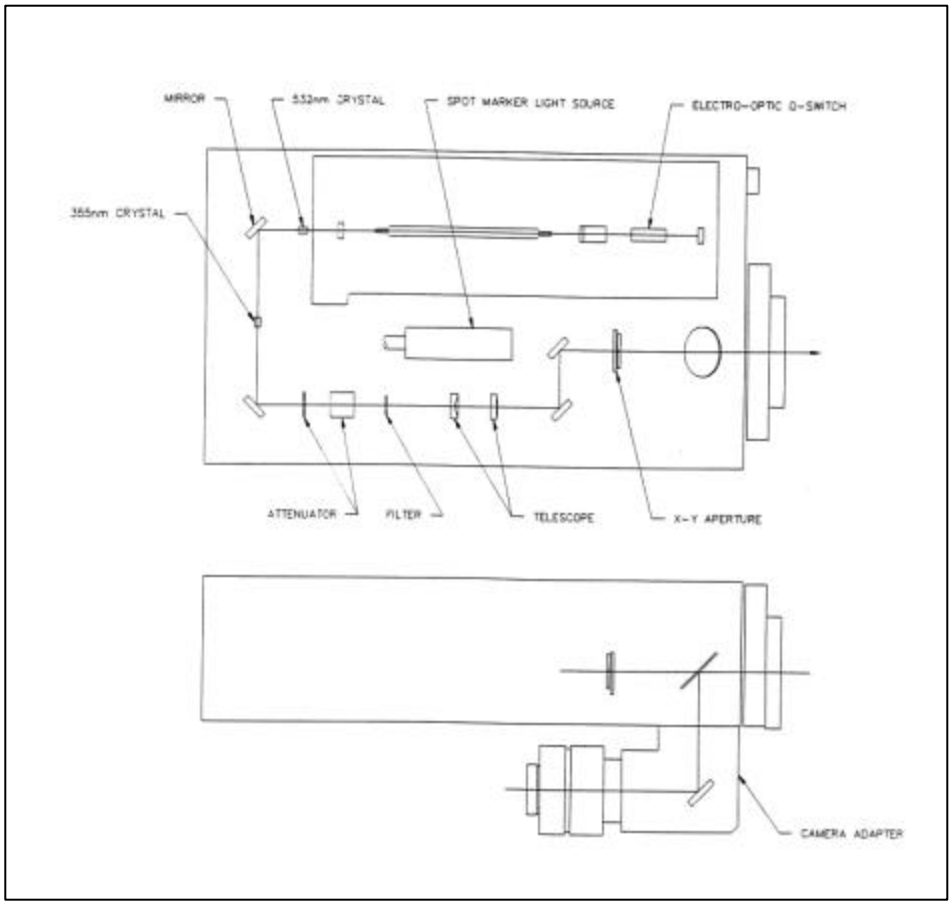


Figure 2-1 QuikLaze Optical Layout

Second Harmonic Generation

The 1064 nm laser pulse exits the IR head and then different harmonic wavelengths may be generated if these options have been installed. Passing the IR beam through an angle tuned KTP crystal generates the second harmonic at 532 nm. The

Third Harmonic Generation

Combining the fundamental and second harmonic generates third harmonic at 355 nm if the option has been installed.

Fourth Harmonic Generation

Doubling the second harmonic at 532 nm can generate the fourth harmonic at 266 nm if this option has been installed.

Optical Attenuator

The optical attenuator serves to control the laser energy without affecting the beam quality. The patented optical attenuator (US Patent 5703713) is designed to work with the fundamental and harmonic beams, and is placed directly after the harmonic generation crystals.

The optical attenuator consists of a multiple wavelength wave plate, followed by a polarizer. The wave plate is secured to a motorized rotating mount. The angle is controlled by input from the remote control panel or external computer control and the angle is set using a servomotor. The wave plate serves as a half wave plate for all the wavelengths in the QuikLaze. The energy is adjusted by rotating the angle of the wave plate. The polarizer is aligned to transmit vertically polarized light. This maintains the polarization of the light as it propagates through the optical train to the Second Harmonic Generator.

Wavelength Selector

After the optical attenuator, the Wavelength Selector allows selection of specific wavelengths by absorption of unwanted wavelengths by absorbing glass filters. A different filter(s) is required for each high and low setting of each wavelength. There are a maximum of six filter sets depending upon the wavelength model of the QuikLaze, except the IR only model which does not have a Lo Energy setting and therefore has no wavelength selector.

XY Aperture

The XY aperture shapes the beam to the rectangular size selected with the XY controls on the remote control panel. The maximum opening of the XY aperture is 3 x 3 mm which becomes a maximum cut size of 50 x 50 um with a 50x objective lens on a Mitutoyo FS60 microscope.

Local Control or Remote Computer Control

The QuikLaze Nd:YAG laser system can be controlled either from the remote control panel or externally through RS232 and a computer using the PCLaze software provided by New Wave Research or other user developed software. PCLaze provides control over most functions of the laser through a graphical user interface.

Safety Interlocks

Three internal interlocks in the laser head (laser head cover off, laser removed from microscope, and laser head over temperature); two interlocks in the power supply (power supply over temperature and low cooling water flow); one external interlock, and one mechanical shutter provide safeguards for the equipment and user(s). The external interlock connector is located at the rear of the power supply, which can be shorted with the supplied connector. The user can install a safety interlock to a door or some other device to provide increased safety when using the laser. See chapter 3 for additional information on interlocks.

Power Supply

The power supply provides the QuikLaze Nd:YAG laser system with power, control electronics and cooling.

Electronics

The upper portion of the power supply contains the control electronics and power to run the laser.

Water Cooling System

The water cooling system is required to keep the system running within an acceptable temperature range. The cooling system consists of a water pump, flow switch, reservoir, DI cartridge, heat exchanger and fan.

QuikLaze Specifications

Following are specifications for the QuikLaze and QuikLaze II laser systems.

	Typical Pulse Energy at (mJ/pulse); HI/LO Setting			
MODEL	1064 nm	532 nm	355 nm	266 nm
IR	4 / 1.6			
Green		4 / 1		
IR/Green	3 / 1.2	3 / 0.8		
Green/UV3		3 / 0.8	0.8 / 0.3	
TriLite	1 / 0.4	1 / 0.25	0.6 / 0.25	
Green/UV4		0.6 / 0.2		0.3 / .1
Maximum allowed Energy	5	2	2	2

Table 2-1. QuikLaze Typical Pulse Energy Specifications Before Microscope

Parameter	**Specifications**
Aperture Range	50x50 um w/50x objective
	30 x 30 um w/50xUV obj. @ 266 nm
	1x1 um w/100x objective
	2x2 um w/100x obj. @ 1064 nm
Attenuation Range	> 100:1 for 532 nm using HI/LO
	> 40:1 1064 355/266 nm, 355 & 266 nm using HI/LO ranges
Pulse Rate	Single shot or 1-40 Hz QuikLaze II Single shot or 1-20 Hz QuikLaze

Table 2-2: QuikLaze System Specifications

Wavelength (nm)	Pulse Width (ns)
1064	7
532	6
355	5
266	5

Table 2-3: Typical QuikLaze Pulse Widths

Chapter Three, Installation

Introduction

The QuikLaze requires some preparation before it can be used. This chapter provides the information needed to install the complete system for safe operation. The chapter starts with the modifications to the microscope, then continues to laser preparation. You will need a set of metric hex wrenches, 3, 2.5, 2, 1.5 mm and a flat blade screw driver.

Microscope Conversion

The QuikLaze is designed to operate on specially modified Mitutoyo FS60Y and FS50 and Ready products A-Zoom and S-Scope microscopes. Become familiar with your microscope before attempting to install the QuikLaze.

WARNING: Operation of the QuikLaze laser without the eye protection filter installed may result in SEVERE EYE DAMAGE OR BLINDNESS.

Eye Protection Filter

All microscopes must be fitted with an eye protection filter or a beam blocking mechanism before the laser head unit is installed on the scope. Following is the procedure for installing the eye protection filter in the Mitutoyo microscope. Ready Products install the eye protection filter for the A-Zoom and S-Scope. **INSURE THE EYE PROTECTION FILTER IS INSTALLED BEFORE OPERATING THE LASER.**

Remove the eyepiece assembly and the three screws that secure the eyepiece to the body of the microscope. See Figure 3-1.

Place the filter assembly over the eyepiece hole, with the flat side facing out. Align the mounting holes with those in the microscope body.

Secure the eye protection filter assembly between the body and the eyepiece using the cap screws (2 or 2.5 mm hex) provided.

Laser Adapter Ring

To install the laser on the microscope while maintaining strict safety, the adapter ring must be installed on the microscope video port.

The laser adapter ring supplied includes a pin that activates an interlock switch. If the pin is not present, the laser will not fire.

Note: Install the eye protection filter before installing the laser adapter ring.

Remove the three cap screws (2.5 mm hex) that secure the old adapter ring it to the microscope, Figure 3-1.

Install the new laser adapter ring with the interlocking pin positioned slightly to the right of front/center of the microscope.

Use the three original cap screws to secure it to the microscope.

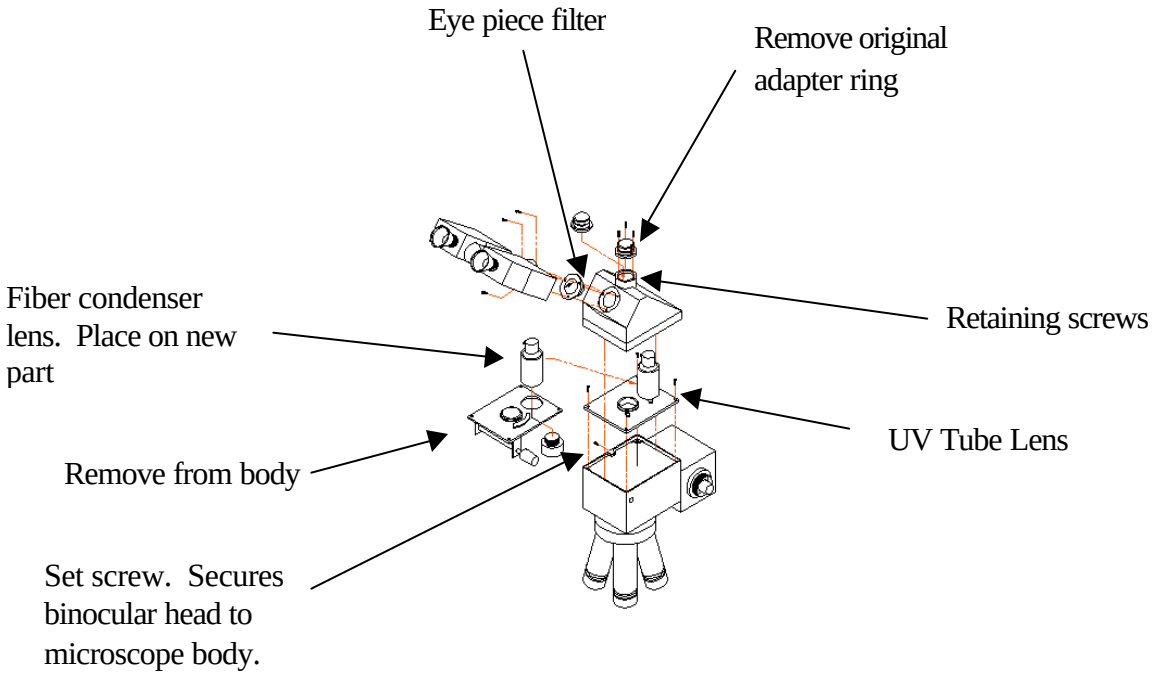


Figure 3-1. Microscope modifications

Microscope UV Conversion Kit

A UV tube lens kit allows UV3 (355 nm) energy to be transmitted through the Mitutoyo FS70Z, FS60 and FS60Y. IR (1064 nm) energy cannot be transmitted through the FS60 or FS70Z. The FS70L and FS60Y transmit IR energy, so no conversion is required if only the IR or green wavelengths will be used.

The A-Zoom and S-Scope microscope require the laser adapter kit, available from Ready Products. A special laser adapter kit is also available for the 266 nm wavelength for the S-Scope and A-Zoom.

FS60 UV Tube Lens Kit Installation

The Mitutoyo FS70Z and FS60 microscopes require installation of a UV tube lens for operation of the QuikLaze with the UV3 (355 nm) wavelength. Installation of the UV tube lens is described below. See Figure 3-1.

FS60. Remove the binocular head by loosening the set screw on the left side of the microscope (2.5 mm hex). The screw is located in the seam separating the binocular head from the main body of the microscope. After the screw has been loosened, the binocular head can be lifted from the microscope body.

Remove the plastic zoom control knob and c-clip from the zoom shaft. Newer Mitutoyo microscopes require that the plastic cap be removed from the zoom knob and a set screw inside the knob loosened to release the knob.

Remove the four screws (3 mm hex) that secure the zoom mechanism plate or tube lens to the FS60 microscope body.

Remove the zoom mechanism by lifting the back of the zoom mechanism plate while tilting it to the right.

Unscrew the ring nut that secures the fiber optic condenser lens assembly to the zoom mechanism plate. The lens assembly is often glued and sufficient force must be applied to break the glue.

Reinstall the fiber optic condenser lens assembly onto the UV tube lens kit mounting plate. Ensure that the aperture lever is facing the outside edge of the mounting plate so it is accessible once the microscope has been reassembled.

Install the replacement UV tube lens kit plate.

Reinstall the binocular head on the microscope body.

FS60Y UV Tube Lens Kit Installation

The Mitutoyo FS60Y microscope requires installation of the UV tube lens to transmit the UV3 (355 nm) wavelength. Installation of the UV tube lens is describe below. See Figure 3-1.

Remove the binocular head by loosening the set screw on the left side of the microscope (2.5 mm hex). The screw is located in the seam separating the binocular head from the main body of the microscope. After the screw has been loosened, the binocular head can be lifted from the microscope body.

Remove the tube lens plate and the four screws that secure it to the microscope body (3mm hex).

Unscrew the ring nut that secures the fiber optic condenser lens assembly to the zoom mechanism plate. The lens assembly is often glued and sufficient force must be applied to break the glue.

Reinstall the fiber optic condenser lens assembly onto the UV tube lens kit mounting plate. Ensure that the aperture lever is facing the outside edge of the mounting plate so it is accessible once the microscope has been reassembled.

Install the UV tube lens kit plate.

Reinstall the binocular head on the microscope body.

FS70Z UV Tube Lens Kit Installation

FS70Z. Remove the binocular head by loosening the two set screws on the right and left sides of the microscope (1.5 mm hex). The screws are located just above the seam separating the binocular head from the main body of the microscope. After the screws have been loosened, the binocular head can be lifted from the microscope body.

Unscrew and remove the zoom shaft. Remove the four screws (3.5 mm hex) that secure the zoom mechanism plate to the FS70Z microscope body.

Remove the two screws securing the small zoom control gear. Remove the three set screws (1.5 mm hex) holding the large plastic gear to the zoom mechanism.

Unscrew the three screws securing the zoom mechanism to the zoom mounting plate.

Install the replacement UV tube lens kit into the large threaded hole in the middle of the zoom mechanism plate.

Reinstall the zoom plate on to the microscope body. Reinstall the binocular head on the microscope body.

Laser Preparation

This section provides power requirements information for the laser. Turn the key switch to the Off position before installing the laser.

Voltage Requirements

The power supply has been preset at the factory for 95 – 125 VAC or 200 – 250 VAC single phase operation, depending upon the voltage supply available at your location. The power supply required about 300 watts. The external spot marker illuminator requires about 300 watts.

Power Line Fuse

Two power line fuses are installed on the back panel near the power cord. For 100 – 125 VAC operation two 6.3 amp/250V, SPT, 5 x 20 mm, T.L., HBC fuses are installed. For 200 – 250 VAC operation two 4 amp/250V SPT 5 x 20 mm T.L. HBC fuses are installed. Acceptable fuses are:

Manufacturer	95–125 VAC	200–250 VAC
Schurter	MST034.6623	MS034.6621
Wickman	19181/6.3A	19181/4A

The high voltage switching power supply and the low voltage power supply have two each PC board mounted fuses. They are T125mA/250V, Schurter MST034.6606 or equivalent.

Laser Installation

The laser can be installed now. The power supply should be placed on the floor, near the microscope.

Laser Head Mounting

<u>QuikLaze</u>
The laser head may now be mounted on the microscope. Tighten the set screws that secure the base of the laser head to the laser adapter ring. See Figure 3-2. Use a 2 mm hex wrench to tighten the two set screws. The red emission LED should face the operator when standing in front of the microscope.

<u>QuikLaze FE</u>
Place the main QuikLaze head within five feet (1.5 meters) of the microscope. Mount the Fiber Optic Head to the microscope video port as describe above.

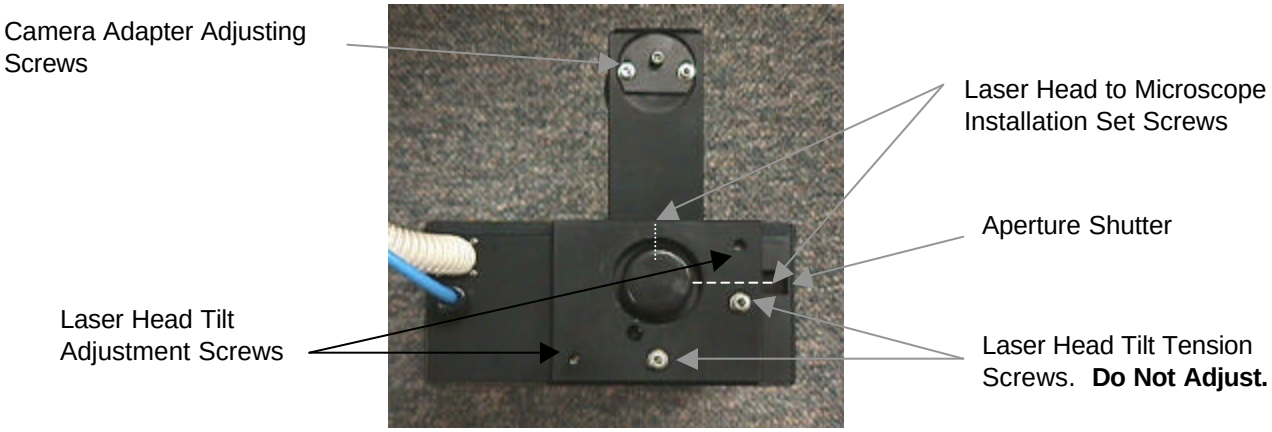


Figure 3-2 Laser Head Mounting/Adjusting screws. Bottom view

Electrical Connections

Turn the power supply key to the "OFF" position before making any electrical connections. See Figure 3-1.

Laser Umbilical

Connect the laser umbilical to the power supply back panel connector. Be sure to tighten the connector screws to the chassis. Connect the cooling system hoses to the cooling system fittings on the back panel of the power supply, Figure 3-3.

NOTE: It is very important that the screws that secure the umbilical connectors to the power supply are tightened. If they are not tightened damage will occur to the high voltage contacts in the connector causing the system to fail.

Control Panel

Connect the control panel cable to the remote control panel and the connector to the back of the power supply, Figure 3-2. Secure the cable at both connectors with the wire securing tabs. Attach the foot switch connectors to the two-pin connector on the back of the control panel. See Figure 3-3.

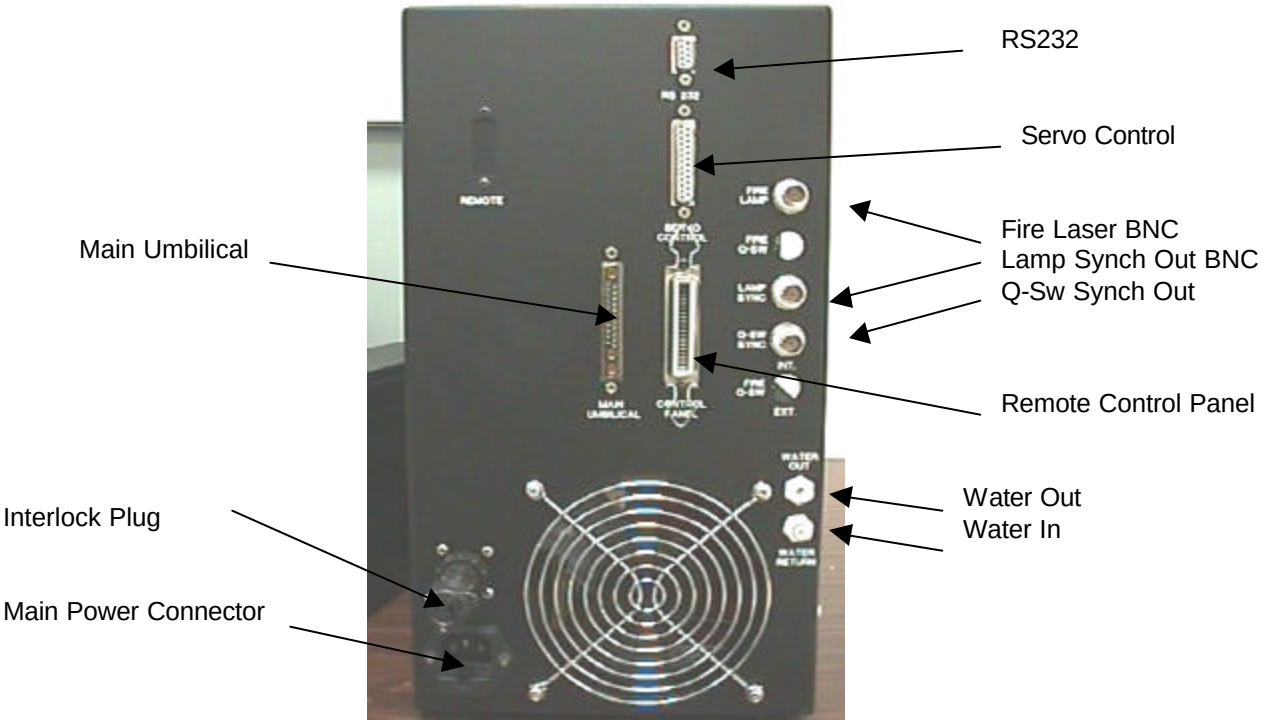


Figure 3-3. Power supply back panel

Interlock Connector

An interlock connector is supplied with the system and must be installed before the system may be operated. The purpose of the interlock connector is to provide a method of interlocking the operation of the laser with a safety switch that may be installed on a laboratory door or other location. See Figure 3-3 for the location of the interlock connector.

Once a switch has tripped the interlock circuit, operation of the laser is stopped, and the laser must be restarted. The trigger switch must be set to the START position and the ON button pressed.

Plug the line cord into a utility outlet.

Video Spot Marker

If a video system is used and the video spot marker option is installed, the electrical connections to activate the video spot marker are as follows. See Figure 3-3.

Using a BNC cable, connect the output from the video camera to the VIDEO IN connector on the remote control panel.

Connect a BNC cable from the VIDEO OUT connector on the remote control panel to the video monitor input connector.

Figure 3-4 Remote Control Panel Connections.

Cooling System

Carefully read and understand the SAFETY section of this manual. Take utmost caution to avoid spilling water inside the power supply. Prior to operating the laser, the cooling system must be filled with deionized/distilled water.

Remove the quick connect water fitting on the front of the power supply.

Use the plastic squeeze bottle to fill the reservoir to about 80% full with deionized or distilled water.

NOTE: Only fill the system with deionized or distilled water. Use of any other water will damage the system and void the warranty.

Turn the key switch on the power supply to the ON position.

Set the X and Y shutter controls to 0 (aperture closed) and set the energy switch to the LO position and adjust the Energy level potentiometer until the LED display reads 000. Turn the Trigger knob to the START position. See Figure 4-1 for the location of controls.

Close the manual shutter on the laser head.

Press and hold down the ON button on the control panel to activate the pump. The ON button must be held down until water has filled the system and the flow switch is activated.

Press the OFF button

Add additional deionized (distilled) water until the reservoir is at least 80% full. The water level may be seen through the water level window on the front of the power supply.

Press and hold down the ON button and observe the water level to ensure sufficient water is in the cooling system. Add deionized (distilled) water as necessary.

Press the OFF button. Replace the quick connect fitting.

Note: The pump may require priming to initiate water flow. This may be done by disconnecting the water hose at the WATER OUT connector and forcing water into the system from this connector on the back of the power supply.

Laser Head Alignment

The laser is internally aligned at New Wave Research. The output beam is aligned to exit the center of the aperture and run along the axial path. No internal adjustment of the optics inside the laser head is necessary.

The purpose of the alignment procedure is to center the laser beam along the optical path of the microscope. Adjustment screws tilt the laser head, thus affecting alignment. See Figure 3-2 for location of laser head tilt adjusting screws.

Adjust the Energy setting to 200 and set the Energy switch to LO.

Set the X and Y aperture settings to 9 and select the green (532 nm) wavelength.

Fully open the manual shutter on the laser head. See Figure 3-2 for location of shutter.

Place a white card on the working surface beneath the objective lens, Figure 3-5.

Select a 50x, 80x or 100x objective.

Turn the microscope source light to minimum intensity.

Raise the microscope with the focus adjustment knob, or lower the stage if possible, to increase the size of the light spot to about one inch (25 mm), Figure 3-5.

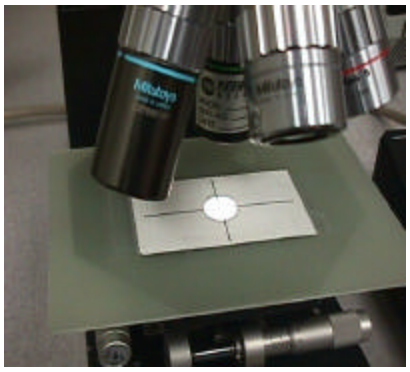


Figure 3-5. Place illumination in center circle on target

Turn the power supply key to the ON position, set the trigger switch to START and press the ON button. Set the trigger switch to CONT and select a repetition rate with the Hz knob. The laser will begin firing.

Adjust the position of the green laser beam on the white card by slightly tilting the laser head, Figure 3-6. This is done by adjusting the laser head tilt adjustment screws (2.5 mm hex) in the back left corner (Y adjustment) and front right corner (X adjustment) of the base plate, which mates the laser head to the microscope, See Figure 3-2. Adjust the laser head tilt screws until the square green laser beam is in the center of the round white microscope spot.

Figure 3-6. Aligning the green laser spot on the white card

If the green laser spot is not visible, change to a lower magnification objective lens and center the laser beam. Then

switch back to a 50x, 80x or 100x objective for the final alignment.

Spot Marker Adjustments

The spot marker provides a preview of the cutting region. The location on the video monitor and parfocality with the eyepiece may be adjusted when viewed via the video camera.

Camera Focus

The camera focal plane can be matched to the eyepiece focal plane (parfocality) by adjusting the camera focus ring. See Figure 3-7.

Bring a sample material into focus through the eyepiece. Loosen the focus ring set screw (1.5 mm hex) on the camera adapter. Turn the focus ring to lower or raise the camera until the image is in focus on the video monitor. Retighten the focus ring set screw.

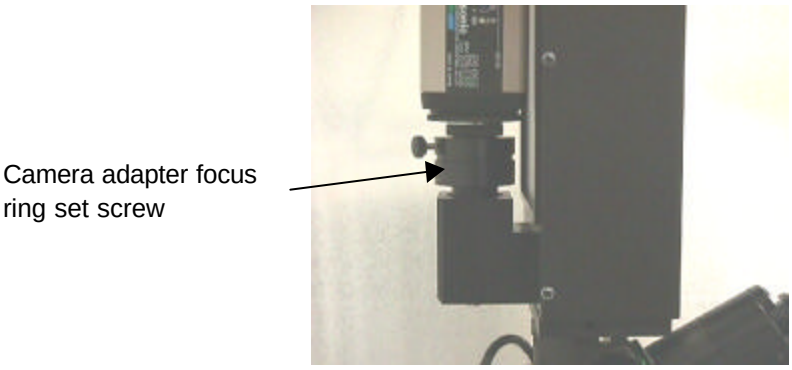


Figure 3-7. Camera Adapter Focus Ring

Centering the Spot Marker

Center the spot marker on the video monitor by adjusting the video camera adjusting screws. The video camera adjusting screws are located on the lower side of the camera adapter. See Figure 3-2.

Adjust the spot's image location by releasing the two socket head screws and moving the mounting plate. When the image is properly positioned, re-tighten the screws.

Spot Marker Illumination

The spot marker illumination is provided by an external 150 watt white light that is fiber coupled to the laser head. It can installed using the following instructions.

Connect the fiber optic cable that exits from the laser head into the external illuminator.

Plug the external illuminator power cord into a utility strip. The illuminator is turned on and off and the light intensity is increased and decreased by the front panel switch on the illuminator.

Video Marker Adjustment

The X and Y location of the video spot marker may be adjusted using the black "Position Vert. or Position Horiz." knobs on the rear panel of the Remote Control Panel. The color of the video marker may be changed between black and white using the "Black/White" knob. See Figure 3-4.

The video marker is adjusted at the factory to closely match the size of the laser cut. However, if the video marker does not closely match the size of the laser cut (PAL vs NTSC) the video marker may be adjusted using the adjusting potentiometers on the video marker PCB located behind the access panel in the remote control panel. See Figure 3-8.

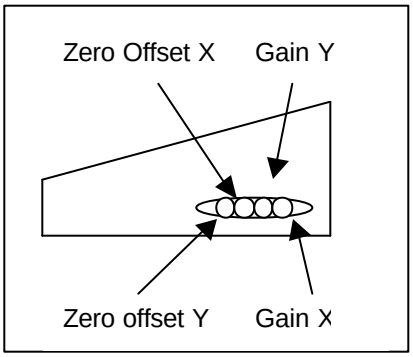


Figure 3-8 Video Marker Adjustment Potentiometers

Open the XY shutter to the maximum size in both the X and Y directions. Make a test cut at low energy on a device, in a large open area, preferably on a soft piece of material such as photo mask or chrome. Adjust the X and Y Gain potentiometers until the video marker correctly outlines the cut area. Now reduce the X dimension until there is a 5 – 10 um opening. Make another test cut. Adjust the location of the video marker and then adjust the X Zero Offset potentiometer until the Video marker matches the cut size. Open the X aperture fully and reduce the Y aperture to a 5 – 10 um size. Make another test cut. Center the Video marker and then adjust the Y Zero Offset potentiometer until the Video marker matches the cut. This is an iterative process and may have to be repeated a second or third time.

Computer Interface

The QuikLaze can be controlled via the RS-232 interface by a user developed program or the PCLaze program supplied by New Wave Research.

Attach an RS232 serial cable to the 9 pin connector on the back of the power supply.

Plug the 9 pin connector in to the serial port of a PC or work station.

The trigger switch on the remote box must be set to "REMOTE" for the QuikLaze system to be controlled through the RS-232 interface.

Chapter Four, Operation

Starting the Laser

After the installation procedure is completed and the laser safety section is thoroughly understood, the laser may be started. All covers must be installed and the reservoir filled with deionized (distilled) water. See Figure 4-1 for location of controls. The key switch on the power supply must be turned to the ON position prior to operation of the laser.

Ensure that the QuikLaze has been properly installed and that you have read and understand the SAFETY section of this manual.

1) Close the shutter on the bottom of the laser head. Turn the power supply key switch to the ON position.

2) Set the energy switch on the remote control box to the LO position.

3) Turn the triggering switch to the START position.

4) Press and hold down the START/STDBY button until the red INTERLOCK LED is off and the EMISSION LED is on. Note that after the red EMISSION LED is on there is a ten second delay before laser firing can occur.

5) Use the trigger selector switch to select the desired operation mode. The operating modes are described below.

6) Open the manual shutter when ready to operate safely (see safety section).

7) Open the X-Y aperture to the desired dimension when you are ready to fire the laser.

Turning the Laser Off

The laser can be turned off at any time and will shut off automatically if an interlock is interrupted. There is also a standard way to turn the laser off and this is performed using the following method.

1) Press the OFF button on the remote control box.

2) Close the laser shutter.

3) Turn the power supply key switch to the OFF position.

Interlocks

The QuikLaze Nd:YAG laser system is equipped with both internal and external interlock switches. The internal interlocks ensure that the laser itself is within operating parameters and will not be damaged. The external interlock can be used to interlock laboratory doors or microscope lifts that can shot off the laser if the interlock switch is tripped.

Internal Interlocks

The QuikLaze Nd:YAG laser system has the following internal interlocks:

- Laser head cover
- Laser head high temperature
- Microscope/laser head interlock
- Cooling system low flow
- Power supply over temperature

External Interlock

The laser may be interlocked so that laboratory or room doors cannot be entered while the laser is running continuously. The connector on the back of the power supply may be wired so as to interrupt power to the supply, thus disabling the laser if an external interrupt switch has been tripped. If the external interlock circuit is opened the red INTERLOCK LED will be illuminated. To restart the laser, turn the key switch to the OFF position and reset the external interlock switch. The laser may then be started using the procedure given above in the section "Starting the Laser."

Triggering and Timing

The QuikLaze has a flexible system to allow triggering the laser internally or externally. If the QuikLaze is triggered internally there are several outputs to simplify synchronizing an experiment with the laser.

There are three external BNC connections located on the back of the power supply. One of the connections is an input for triggering the laser. The other two are outputs used for synchronizing the laser to other equipment. The location of the BNC I/O connections is shown in Figure 3-2. The input BNC's are activated only when the trigger switch on the control panel is set to REMOTE.

"Fire Laser Input" – A positive 5 volt, 1 ms, 5 mA nominal, pulse. This input will fire the flash lamp and the Q-switch at a preset time following the external fire laser signal.

"Lamp Sync Out" – A 5 volt, 3.5 ms nominal, pulse. A positive transition from 0 volts to +5 volts occurs when the flash lamp is fired. The laser pulse exits the laser head approximately 200 µs after the lamp synch out signal.

"Q-Switch Sync Out" – A 5 volt, 6 microsecond nominal pulse. A positive transition from 0 volt to +5 volts occurs when the Q-switch is energized. The laser pulse will exit the laser head approximately 80 ns after this signal.

Laser Controls

The QuikLaze Nd:YAG laser may be controlled by using the remote control panel. See Figure 1-1. The remote control panel connects to the laser power supply via a 10 ft (3 m) cable that allows the remote to be placed in a convenient location. All controls and indicators are located on the remote control panel, except for the key switch and power ON LED indicator, which are located on the power supply.

Figure 4-1 Remote Control Panel

Key Switch

The KEY switch is located on the power supply. The key switch turns AC power on and off to the laser system. When the key switch is in the ON position the amber (yellow) POWER ON LED above the key switch is illuminated.

The interlock LED is located on the front panel of the remote control panel. The INTERLOCK LED will be illuminated when an internal or an external interlock has been activated. The internal interlocks are located in the power supply and in the laser head. The laser head cannot be removed without activating an interlock. The external interlock connector is located on the back of the power supply. The wire loop from the connector may be put in series with a laboratory door switch for safety purposes.

ON/OFF Switches

The ON switch starts the pump and high voltage supply when the Trigger switch is set to the START position. The laser may fire 10 seconds after the ON button has been pressed, the interlock light has turned Off and the Emission Indicator has turned On. The OFF switch shuts off the pump and high voltage power supply.

Emission LED
Interlock LED

The emission LED is illuminated after the ON button is pressed and 10 seconds before laser emission can occur. The Interlock LED is illuminated if any of the internal or external interlock switches are open. The Interlock LED is always ON just before the ON button is pressed because the flow interlock switch is open until the pump establishes adequate flow.

Trigger Switch

There are several controls and indicators on the remote control panel to make the laser easier to operate. The trigger switch is rotated to select the desired operating mode for the laser. The operating modes are:

REMOTE: This mode activates the RS-232 port on the back of the power supply. The laser can be controlled using New Wave Research PCLaze, or the user's own program. This mode also activates the "Fire Laser" BNC on the rear panel of the power supply.

1 SHOT: Allows a single shot to be fired by pushing the fire button on the remote control box or by depressing the foot switch.

BURST: A burst of pulses is fired while the remote control fire button is depressed or the foot pedal is depressed. The HZ knob sets the repetition rate.

CONT: Continuous firing at the rate set by the HZ knob.

HZ Control Knob

The Hz control knob allows control of laser repetition rate when the trigger switch is in the BURST or CONT. position.

Energy

The output energy can be adjusted using the potentiometer knob located below the LED display on the remote control panel. The LED display shows “000” to “1000” to indicate the minimum to maximum energy range. The Energy control works for all of the available wavelengths. The transmission function of the Energy control is shown in Figure 4-2.

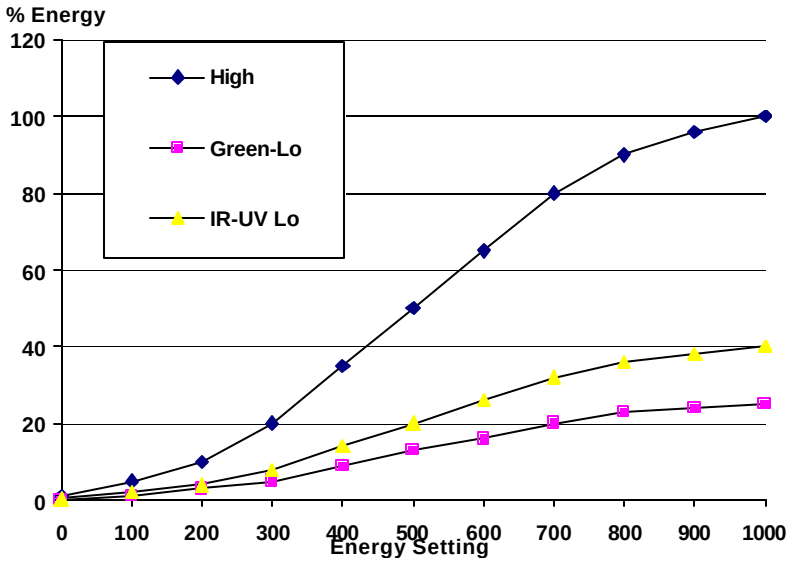


Figure 4-2 Energy level vs. Energy control setting

Energy HI/LO Switch

The energy HI/LO switch is an attenuating feature that changes the maximum transmitted energy available. This switch operates independently from the variable attenuator. The switch has the following two settings.
HI – full energy is available from the laser. Variable attenuation is about 30:1 for green and about 20:1 for IR and UV. LED indicates 000 – 1000 across the full range.

LO – Approximately 30% of maximum energy for green and 40% of maximum energy for IR and UV is available. Variable attenuation is about 100:1 for IR and green and 40:1 for UV. The LED indicates 000 – 1000 across the reduced energy range. The Low Range is not available for IR only lasers.

Note: The LED display shows 000 – 1000 relative to the available energy. That is, an indication of 800 with the energy switch in the LO position corresponds to approximately 300 with the energy switch in the HI position for the Green

wavelength and approximately 400 for the IR & UV3 wavelengths.

The LO setting is safer for testing and is also used for low energy applications such as polyimide removal with UV. Ask your New Wave Research sales engineer or representative for guidelines and useful techniques.

Wavelength Selector

The output wavelength emitted by the laser is selected using the wavelength selector switch located on the remote control panel. Select the output wavelength by turning the wavelength selector knob to the corresponding LED indicator.

LED Indicator	Wavelength
Red	1064 nm (IR)
Green	532 nm (green)
Blue	355 nm (UV3) or 266 nm (UV4)

NUV (near ultraviolet) or UV objective lenses must be used to transmit UV energy. NIR (near infrared) objective lenses must be used to transmit IR energy. Green light can pass through standard, NIR, NUV or UV lenses.

Do not use standard objective lenses with IR or UV wavelengths. These wavelengths may damage the standard lenses.

Spot Marker

The spot marker highlights the area that will be irradiated by the laser pulse. The spot marker and laser both travel through the same X-Y aperture, thus adjusting the aperture determines the shape and size of the area to be irradiated. To achieve the best-cut definition, focus the microscope so that the aperture edges are in sharp focus when viewed through the eyepieces.

The 150 W white light external spot marker brightness is controlled by the front panel potentiometer located on the illuminator.

Note: The image of the spot marker is more visible when the microscope's background lamp is reduced in intensity. Also, the microscope fiber optic illuminator has a sliding aperture control at the input location of the fiber into the microscope. Reducing the aperture tends to increase the viewing depth of focus image and enhance the visibility of the spot marker.

Video Spot Marker

The video spot marker (if installed) generates a video rectangle that closely approximates the XY aperture settings. The "Position Horiz./Vert." knob on the rear of the remote control panel allows adjustment of the rectangle location relative to the actual cut size. Color may be changed between black and white with the "Black/White" knob.

Chapter Five, RS 232 Control

RS232 Control

The New Wave Research microprocessor controlled computer interface controller (CIC) for QuikLaze allows the laser system to be controlled through a PC or workstation RS 232 serial port with either a communications program or a user designed program. Once the trigger switch is set to the "Remote" position, the external PC or workstation may control most QuikLaze functions.

Hardware Interface

The rear panel connector on the QuikLaze power supply for RS 232 control is a serial, DB 9 connector. The maximum rate is 9600 baud, 8 bits, no parity, 1 stop bit (9600, 8, N, 1). Flow Control both hardware and software (XON, XOFF) must be turned off.

Software Interface

A Software interface to the RS232 port must be through an ASCII communications type program. PCLaze may act as the user interface when communicating to the laser. The Laser Computer Interface Controller (CIC) may be accessed in two modes: 1) Program Mode and 2) Menu Mode. In Program Mode, a customer supplied user interface program or PCLaze must be used to interact with the computer interface controller (CIC). In Menu Mode, the user with a terminal communication program such as Microsoft Hyper Terminal or other communications program, may interact with the CIC directly through a menu provided by the CIC. The default setting upon power up is Program Mode. The user may toggle between Menu Mode and Program Mode by pressing ";". In both modes the CIC accepts only one character at a time. Alternatively, pressing "P" will always enable Program Mode. THE PC OR **WORKSTATION MUST LISTEN AFTER EACH COMMAND IS SENT TO THE CIC FOR AN ACKNOWLEDGMENT BEFORE THE NEXT COMMAND IS SENT.**

Data Cable

Attach a male DB 9 serial cable to the 9 pin connector on the back of the power supply. Connect the other end of the cable to the serial port of the PC or workstation. A DB 9 to DB 9/25extension (straight through) cable must be used between the serial port of the PC or workstation and the Laser DB 9 connector. The pin assignments for the DB 9 connector for the Laser are:

2	Receive Data
3	Transmit Data
5	Ground

RS232 (Remote) and Local Control

The trigger switch on the remote control panel controls CIC mode. In the REMOTE position, computer control through the attached PC or workstation is enabled (remote mode), and the control panel controls are disabled except the key switch and off button.

Operating Modes

The laser functions which may be controlled by the CIC are described in the following section. The first section describes computer control through Menu Mode and the second describes control through Program Mode. Flow control, either hardware or software (XON, XOFF), must be turned off.

Menu Mode

Menu Mode allows the use to control the laser through a pre-set menu of laser functions. These functions allow the user to control the aperture, attenuator, firing rate, spot marker ON/OFF, pulse the laser, specify the number of shots to be made in a burst and select wavelength in multiple wavelength systems.

Using Menu Modes

To activate Menu Mode upon establishing a communications connection with the CIC type in the ";" character. A pre-set menu of laser functions will appear. See Menu below.

To select a function the operator first inputs a Function Number. With Function Numbers 0-6, 8, 9 and A, a sub-menu will be displayed asking for a value. After entering a value followed by Enter, the main menu will be updated. If an invalid character is input for the Function Number, the character will not be accepted. If an invalid number is input in response to a sub-menu, an error message, "Number out of bounds = (invalid number) Press ENTER" will be displayed. Invalid characters are not accepted. If a Function Number is entered and Laser AC Power is OFF, the following error message will be displayed: "Laser must be ON before setting function "X" where "X" is the Function Number just entered.

ESC may be used at anytime to exit a sub-menu. ESC may also be used to stop the laser from firing in the middle of a burst of shots. No data will be accepted if ESC is pressed.

The ";" character may be input to toggle between Menu Mode and Program Mode. The character "P" may also be sent to initiate Program Mode. Following is the menu for Menu mode.

New Wave Research - Laser Control Menu

Function Number	Laser Function	Function Value
	Laser ON	
1 -	Attenuator Setting	122
2 -	X Marker Setting	6
3 -	Y Marker Setting	7
4 -	Energy Switch Setting	Hi
5 -	Single Pulse or Continuous	Pul
6 -	Spot Marker Setting	On
7 -	Pulse Laser	
8 -	Wavelength Select	GRN
9 -	Number of Shots in Burst	1
A -	Pulse Rate	5
B -	Filter Number Select	3
Q -	Q-Switch On/Off	On
W -	Warm Up Pulse Number	0
@ -	Laser on/Off	1

The functions in menu mode are detailed below.

Laser Functions - Menu Mode:

FunctionLaser Number	Function	Input Range
1	Attenuator	0 (min.) - 255 (max.) . up one unit , down one unit > up 10 units < down 10 units
2	X Marker	0 (close) -255 (full open) . up one unit , down one unit > up 10 units < down 10 units
3	Y Marker	0 (close) - 255 (full open) . up one unit , down one unit > up 10 units < down 10 units
4	Energy SW	1 (Low) (except IR only) 2 (Hi)
5	Trigger	0 pulse laser on command 1 pulse laser continuously
6	Spot Marker	0 (Off) 2 (On)

7	Pulse laser	Fires laser number of shots defined in Function Number 9.	
8	Wavelength	1 IR 2 Green 3 UV (355 nm)	
	Green/UV Model	1 Green 2 UV	
9	Number of Shots in burst	1 - 9999 (QuikLaze) 1 - 50 (EzLaze)	
A	Pulse Rate (Hz)	1 - 5 (EzLaze) 1 – 20/40 (QuikLaze/ QuikLaze II)	
B	Filter	1 - 6	
	Q	Q-Switch On/Off	0 - Off 1 - On
	W	Warm Up pulse number	1-9999 (QuikLaze) 1-10 (EzLaze)
	@	Laser On/Off	0 - Off 1 - On

PROGRAM MODE

Program Mode allows a use interface program to communicate with the CIC directly through ASCII character streams rather than using the pre-set menu in Menu Mode. The control functions are the same as those defined in Menu Mode. When the Remote Controller trigger switch is set to REMOTE CIC Communication is initiated in Program Mode. Menu Mode may be selected by typing the character ";". Program Mode is re-selected by typing ";" again. Alternatively, "P" may be pressed to initiate program mode. It is good practice to initiate communications with the CIC by sending "P" to insure the system is in Program Mode for user developed interface programs.

In Program Mode the CIC looks for a Function Number followed by a value and Enter (ASCII 13, CR, or CTRL M). Function Numbers "7" (Pulse Laser) and characters ";" (toggle between Menu Mode and Program Mode), "Escape" (ESC) and "P" (initiate Program Mode) do not require that the Function Number or Character be followed by Enter. Input values are echoed back, except Enter, which is not echoed

back. Following Enter, a validity character is displayed: Y (input was valid), N (input was not valid) plus either the new setting if the input was valid, or the previous setting if the input was invalid and a line feed (AX0A) and carriage return character (DX0D).

For example, the character stream "1234Enter" tells the CIC to set the Attenuator (Function Number 1) to the value 234. Since this is a valid command the CIC will respond back "1234Y234 plus line feed and carriage return". "1234" is the original command echoed back, "Y" indicates that the original command was valid and 234 is the new setting for the attenuator.

Laser Functions

Program Mode. Note - the last character echoed back by the CIC is followed by a line feed character “a” or X0D and carriage return character “d” or X0A.

Function Number	Laser Function	Input Range	Program Reply:
0	Laser AC power & Computer Control	.	Echoes back “0” plus “1” (ON) or “0” (OFF) and “L” (local, front panel control) or “R” (remote, computer control). For example, 01R means the power supply is on and the Trigger switch on the control panel is set to REMOTE (remote operation).
1	Attenuator Setting	0 – 255 (max) . up one unit , down one unit > up 10 units < down 10 unit	Function Number is echoed back. After the Enter key is pressed a validity character is returned, "Y" for a valid input character plus the new number, e.g. 1234Y234, or "N" for an invalid input value plus the last valid number, e.g. 1567N234.
2	X Marker Setting	0-255 (open) . up one unit , down one unit > up 10 units < down 10 units	Same as Attenuator
3	Y Marker Setting	0-255 (open) . up one unit , down one unit > up 10 units < down 10 units	Same as Attenuator

Function Number	Laser Function	Input Range	Program Reply:
4	Energy SW Setting	1 - Low (except IR only) 2 – High	Input is echoed back. After Enter is pressed Y will be displayed for a valid input plus either 1 (low) or 2 (high), e.g. 41Y1; or N plus the last valid setting for an invalid input, e.g. 45N1.
5	Trigger Setting	0 - pulse laser on command 1 – pulse laser continuously	Input is echoed back. After Enter is pressed Y will be displayed for a valid input plus 0 (pulse) or 1 (cont.), e.g. 50Y0; or N plus the last valid setting for an invalid input, e.g. 55N0.
6	Spot Marker Control (EzLaze only)	0 (off) 2 (on)	Input is echoed back. After Enter is pressed Y will be displayed For a valid input plus 0 (OFF) or 2 (ON) e.g. 62Y2; or N plus the last valid setting for an invalid input, e.g. 65N2.
7	Pulse Laser number of shots set in Burst (See Function Number 9)		Input is echoed back. Returns a Y.
8	Wavelength Select	1 IR 2 Green 3 UV	Input is echoed back. After Enter is pressed Y1 will be displayed if IR is selected or Y2 if green is selected or Y3 if UV is selected; e.g. 8Y1; or N plus the last valid setting for an invalid input is sent, e.g. 85N1 if the last valid input was 1.
9	Number of Shots in Burst	1 - 9999 (QuikLaze) 1-50 (EzLaze)	Input is echoed back. After Enter is pressed Y123 will be displayed if the number 123 was input, e.g. 9Y123 or 9Y1 if the number 1 was input. If an invalid number is input the letter N puls the last valid number will be displayed, e.g. 9ABCN1 if the last valid input was 1.

Function Number	Laser Function	Input Range	Program Reply:
A	Pulse Rate (Hz)	1 - 5 (EzLaze) 1-30 MiniLase 1-20/40 (QuikLaze/ QuikLaze II)	Input is echoed back. After Enter is pressed Y will be displayed followed by 20 if the number 20 was input, e.g. AY20. If an invalid number is input then N will be returned followed by the last valid input, e.g. A9999N20 if 20 was the last valid input.
B	Filter Number Select	1- 6 (All QuikLaze & 1 - IR Lo EzLaze TriLite) 2 - IR Hi 3 - Green Lo 4 - Green Hi 5 - UV Lo 6 - UV Hi 1- 4 (EzLaze exc. TriLite) 1 - Green Lo 2 - IR Hi, UV Hi 3 - Green Hi 4 - IR Lo, UV Lo	Input is echoed back. After Enter is pressed Y will be displayed followed by 1 if the number 1 was input, e.g. Y1. If an invalid number is input N will be returned followed by the last valid input. IR only lasers do not have a filter selector.
Q	Q-Switch Off/On	0 - Off 1 - On	Input is echoed back. After Enter is pressed Y will be displayed followed by 1 if the number 1 was input, e.g. Y1. If an invalid number is input N will be returned followed by the last valid input.
W	Warm Up number of pulses. Fires the laser flash lamp but no laser light is emitted.	0-9999 (QuikLaze) 0-10 (EzLaze)	Input is echoed back. After Enter is pressed the letter Y and the input value is echoed back.
@	Laser ON/OFF	0 - Off 1 - On	Input is echoed back. After Enter is pressed there is a 2 second delay followed by Y and then 1 or 0 depending upon the command sent.

Function Number	Laser Function	Input Range	Program Reply:
?	Laser Information		Input is echoed back followed by laser information. For example, ?0 requests Laser Type. The controller may return "0?EzLaze" if the laser is an EzLaze.
		0 - Laser type	EzLaze, QuikLaze or MiniLase
		1 - Firmware version	For example: EL1.12, QL1.12, ML1.12
		2 - Wavelength version	1 - IR 2 - Green 3 - IR/Green 6 - Green/UV3 7 - TriLite (IR/Green/UV3) 10 - Green/UV4 11 - TriLite (IR/Green/UV4)
		3 – Number of wavelengths	1, 2 or 3

4, 5 and 6 specify the Wavelength String. The laser controller looks for four jumpers that specify the wavelengths present in the system. The first jumper specifies if IR is present, the second jumper specifies if Green is present, the third jumper specifies if UV3 (355 nm) is present and the fourth jumper specifies if UV4 (266 nm) is present. The maximum number of jumpers is three.

	4 - Wavelength string #1 - looks for the 1st jumper	IR - if it is an IR, IR/Green or TriLite or GRN – if it is a Green or Green/UV laser
	5 - Wavelength string #2 - looks for the 2nd jumper	GRN - if it is an IR/Green or TriLite or UV3 – if it is a Green/UV3 UV4 – if it is a Green/UV4
	6 - Wavelength string #3 - looks for the 3rd jumper	UV3 - if the laser is a TriLite UV4 - if the laser is a Green/UV4
	7 – Number of holes in the wavelength filter selector	0 - if it is any IR only 4 – if it is the EzLaze Green IR/Green or Green/UV 6 – if it is any QuikLaze or (exc. IR) or EzLaze TriLite
	8 - Maximum repetition rate	5 for the EzLaze or 30 for MiniLase 40 for QuikLaze II.

Special Program Keys

Note - the last character echoed back by the CIC is followed by a line feed character “a” or X0D and carriage return character “d” or X0A.

Key	Function	Program Reply
ESC	Aborts Function command or stops a laser burst.	Displays the letter "E" after the Function Number e.g. 2E or 7E.
;	Toggles between Menu and Program Mode.	Displays the menu from Menu Mode.
P	Initiates Program Mode	Y

Input Format for Program Mode

"x", "xx", "xxx" or "xxxx" where "x" is a positive integer or a character followed by "Enter". The first digit specifies the Control Function. The number(s) following the first digit specifies the value for the Control Function. except Function Number ";" (change modes), "P" (initiates Program Mode) and "7" (Pulse Laser) where Enter is not required. For Function Numbers 1, 2 and 3 the characters "," "." "<" and ">" may also follow the Function Number.

Examples of valid input commands are:

Command	Computer Displays	CIC Action
0	01R+LF+CR	Displays the status of Laser AC Power ("01" - ON or "00" -OFF) and CIC status (R - Remote i.e. trigger switch is set to remote, or L - Local, i.e. trigger switch is set to local mode is OFF).
;	; +LF+CR	Toggles between Program Mode and Menu Mode.
1234[ENTER]	1234Y234+LF+CR	Set attenuator to value 234.
222[ENTER]	222Y22+LF+CR	Set X aperture control to value 22.
2<[ENTER]	2<Y12+LF+CR	Decrement last X aperture value by 10 (last value was 22).
41[ENTER]	41YL+LF+CR	Set Energy Level switch to Low.
50[ENTER]	50YP+LF+CR	Set Trigger Setting to pulse laser on command.
7	7Y+LF+CR	Pulse laser number of shots set in burst (function number 9). Trigger Setting is set to pulse laser on command e.g. 50.
920[ENTER]	920Y20+LF+CR	Set number of shots in burst to 20. When the command "7" is entered, the laser will fire 20 times. To stop the pulsing before 20 shots have been fired, enter the "ESC" command.

Laser Function Status

The status of Laser Function settings may be obtained by typing the Function Number plus Enter. The program will return N plus current status. For example 1 [ENTER] will have the program return N111 + LF + CR assuming the current status of the attenuator is 111. The status of Laser Functions 1 -6, 8, 9, A, B, Q, W and @ may be obtained in the same manner.

The status of the laser remote control panel switches (also interlock status) (OFF/ON) and the Remote Controller Trigger switch (Remote/Local) switch may be obtained by pressing the number "0". Examples of status messages are shown below.

Hardware Status Messages – Requested Status

Hardware Switch	Setting	CIC Message
Key switch, power supply	OFF	No response is given by the controller.
Key switch, power supply	ON	
Remote Control Panel (Laser On)	ON	Sending 0 will give back 1 plus Trigger switch status. R or L. Example: 01R or 01L
Remote Control Panel (Laser Off)	OFF	Sending 0 will give back 0 Plus Trigger switch status. R or L. Example: 00R or 00L
Remote Control Panel Trigger Switch Setting	Start, 1 shot.. (not Remote)	Sending 0 will give back Laser (Interlock) ON/OFF status (see above) plus L i.e. Local, Computer Control is OFF). Example: 01L.
	Remote	Sending 0 will give back Laser (interlock) ON/OFF status (see above) plus R i.e. Remote, Computer Control is ON. Example: 01R.

When the laser status is shown as 01R, the CIC will accept all commands. When the laser status is shown to be 00R the @1, P, and 0 commands will be accepted. If the laser status is 01L only the 0 command will be accepted.

Hardware Status Messages – Automatically sent.

Hardware Switch	Setting	CIC Message
Remote Control Panel ON/OFF		When On is pressed the letter O is sent. When OFF is pressed or an interlock has opened the letter F is sent. No further commands should be sent if the character F has been received except 1, P and @1.
Remote Control Trigger Switch		When the Trigger switch is changed to Remote the letter R is sent. When the Trigger switch is changed from Remote to Start, 1 shot, etc. the letter L is sent.

Summary of commands for QuikLaze and EzLaze

Command	Input Range	Description
0		Laser status and computer control status
1	0-255 "." "," "<" ">"	Attenuator setting
2	0-255 "." "," "<" ">"	X marker setting
3	0-255 "." "," "<" ">"	Y marker setting
4	1,2	Energy switch setting
5	0,1	Burst mode or continuous
6	0,2	Spot marker setting
7		Fire laser
8	1 IR 2 Green 3 UV3	Wavelength select for all models except Green/UV
	1 Green 2 UV3/4	Wavelength select for Green/UV models
9	1-9999 (QuikL) 1-50 (EzLaze)	Number of shots/burst
A	1-40 (QuikL) 1-5 (EzLaze)	Pulse rate
B	1-6 (QL/EL TriL) 1-4 (EL exc. TriLite)	Filter number select
Q	0 – Off 1 – On	Q-switch ON/OFF
W	0-9999 (QL) 0-10 (EzLaze)	Number of warm- up shots
@	0,1	Remote On/Off
ESC		Cancels last input or stops laser firing
;		Toggles between Menu and Program modes
P		Initiates Program mode
?	1-8	Laser Information

Command	Input Range	Description
L		Remote control Panel set to Local Mode
R		Remote control Panel set to Remote
O		Laser On
F		Laser Off (Interlock Open)

Chapter Six, Service

Introduction

The QuikLaze Nd:YAG laser system will provide years of reliable service if it is kept clean and well maintained. This section describes several procedures that should be performed on a regular basis. The QuikLaze system is designed such that the head and power supply need to opened only for system maintenance.

QuikLaze Periodic Maintenance Summary

Following is a summary list of weekly, monthly, yearly, and as needed recommended maintenance items. These items should be performed according to the schedule below to insure proper operation the QuikLaze.

Weekly

1. Circulate the cooling system water by operate the laser at least 30 minutes per week. This is necessary to help prevent a build up of contaminants in the cooling system.

Monthly

1. Check cooling water level in the power supply. Keep the water level at 80% of full. **Add only dionized or distilled water.**
2. Check laser head alignment on the microscope.
3. Check cooling system for signs of leakage.

Yearly

1. Replace DI cartridge
2. Check the energy level of all wavelengths through the appropriate objective lens. Measure energy with an energy meter after the objective lens, with all controls set to maximum and the XY shutter fully open. Energy measurement should be greater than: 1064 nm – 200 uJ; 532 nm – 150 uJ; 355 nm – 60 uJ; and 266 nm – 90 uJ.

As needed

1. Replace spot marker illuminator lamp – Type EKE lamp, 21 volts, 150 watts.
2. Replace flash lamp. The need for replacement will depend upon usage. The flash lamp should be good for about 30,000,000 shots.

3. Replace cooling system pump.

Cooling System

The cooling system is an important part of the QuikLaze Nd:YAG laser system, allowing the laser to operate at repetition rates up to 40 Hz. The cooling system must be maintained periodically to ensure reliable performance. Running the pump allows the deionizing filter to purify the water.

Circulate the cooling water by running the laser power supply and pump at least 30 minutes each week. This is essential to prevent the build-up of contaminants in the system, which will be deposited on the flash lamp and laser rod resulting in decreased output energy. If you cannot run the laser at least 30 minutes each week, you must completely drain the cooling system and blow clean dry air through the lines.

WARNING!!! Never add tap water to the cooling system. Only deionized or distilled water may be used.

Deionization Cartridge Replacement

The deionization (DI) cartridge must be replaced approximately once every two years. The following procedure can be used to replace the deionization cartridge.

1) Set the triggering switch to the "START" position to ensure that the laser will not fire.

2) Disconnect the lower WATER RETURN hose from the back of the power supply and hold it over a drain container.

3) Depress the ON button on the remote to start the pump. The pump will force the cooling water from the hose into the drain container. Hold the ON button down until all water has been pumped out of the system. Press the OFF button on the remote to stop the pump.

4) Turn the power supply off with the key, and disconnect the AC power to the power supply.

5) Remove the power supply cover.

6) Disconnect the hose from the top of the deionization cartridge, Figure 6-1. (White Cylinder)

7) Disconnect the hose leading from the bottom of the deionization cartridge, see Figure 6-1.

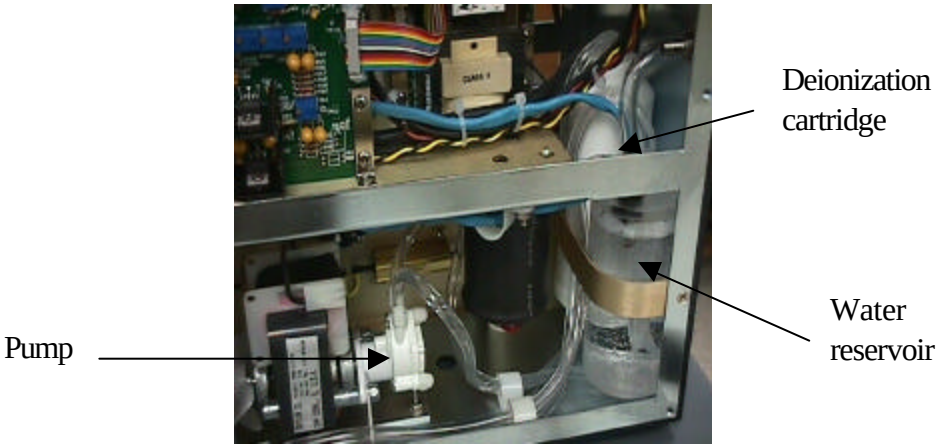


Figure 6-1. Cooling System in the Power Supply

8) Remove the old deionization cartridge by sliding it up and out of the power supply. Disconnect the hose from the old deionization cartridge.

9) Connect the hose to the bottom of the new deionization cartridge. Install the new deionization cartridge. Reconnect the water hose to the top of the cartridge and to the flow switch.

10) Refill the cooling system with deionized or distilled water and run the system briefly to check for leaks before replacing the power supply cover. Disconnect power before replacing cover.

Cooling System Flush

If a noticeable drop in laser energy has occurred, it may be necessary to flush the cooling system to remove any contaminants. Carbon dioxide from the air and metal ions will naturally collect in the cooling water over time. The cooling system can be cleaned using a 5% acetic acid solution or full strength distilled white vinegar. Follow the procedure below to flush the cooling system:

1) Set the trigger switch to the START position to ensure that the laser will not fire.

2) Disconnect the lower WATER RETURN hose from the back of the power supply and hold it over a drain container.

3) Start the power supply. The pump will force the cooling water from the hose into the drain container.

4) Use clean, dry compressed air to blow the remaining water from the laser head umbilical tubing. Also, blow clean, dry compressed air into either hose fitting on the back of the power supply. Additional water will be forced into the reservoir. Remove this water with a syringe.

5) Disconnect the power cable to the power supply and remove the power supply cover.

6) Disconnect the hoses from the top and bottom of the DI filter and by-pass the DI filter, Figure 6-1.

7) Reconnect the laser head water hoses and power cable to the power supply.

Ensure that the DI cartridge is bypassed before any acetic acid is added to the cooling system. Acetic acid will destroy the DI cartridge.

8) Refill the cooling system with a solution of 5% acetic acid in distilled water. Alternately, distilled white vinegar may be purchased at the grocery store and used. Start the power supply and add more of the solution to completely fill the system (reservoir about 80% full). See Chapter 2-2, Cooling System Installation.

9) Operate the power supply and cooling system for at least 6 hours with the acetic acid solution circulating through the laser head.

10) Completely drain the cooling system and blow the acetic acid solution from the system.

11) Completely refill the cooling system with pure deionized water.

12) Operate the system for at least 2 hours. The deionization cartridge is still bypassed. This flushes acetic acid and contaminants from the system.

13) Completely drain and refill the cooling system with new deionized or distilled water.

14) Operate the system for another two hours, then completely drain and blow the lines.

15) Completely fill the system again with pure deionized/distilled water. Re-install the DI cartridge. The laser is now flushed. Measured output should be back to normal.

Flash Lamp Replacement

The flash lamp needs to be changed when the specified energy cannot be achieved or if the laser energy fluctuates significantly from shot to shot. This can be seen over the course of several hundred pulses. The flash lamp should be useful for at least 30 million shots. Use the following procedure to install a new flash lamp.

1) Place the power supply at a lower elevation than the laser head.

2) Disconnect all power to the laser and remove the laser head cover.

3) Disconnect both water hoses from the back of the power supply and place them into a drain container. This will allow water to drain from the pump chamber and minimize leakage in the laser head. Connect the two ends of the hoses together after sufficient water has drained from the pump chamber so that you see air in the water line.

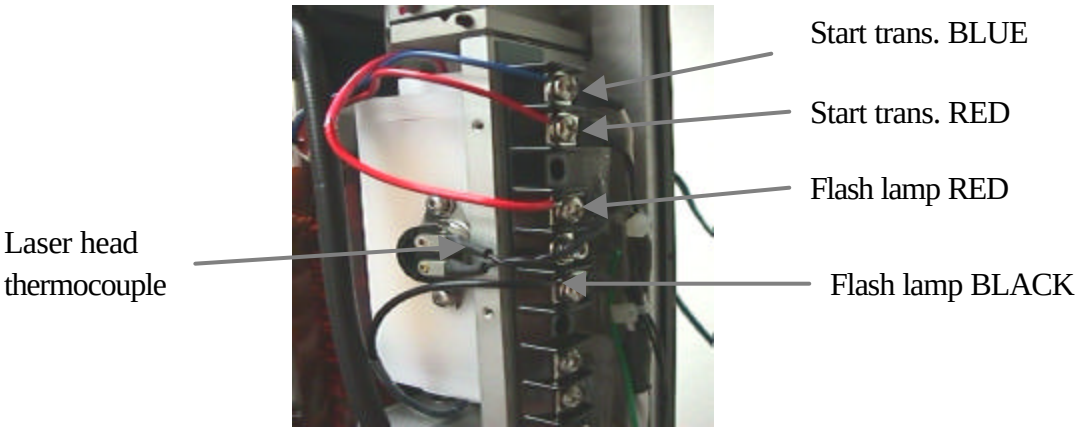


Figure 6-2. Removing Leads to Replace Flash Lamp

4) Remove the small RED and BLUE start transformer leads from the terminal strip, Figure 6-2.

5) Remove the RED and BLACK flash lamp leads from the terminal strip, Figure 6-2.

6) Remove the two screws holding the pump chamber thermocouple in place, Figure 6-2.

7) There are three recessed screws that secure the pump chamber to the terminal block and resonator. Turn the three recessed screws counter clockwise to release the pump chamber, Figure 6-2.

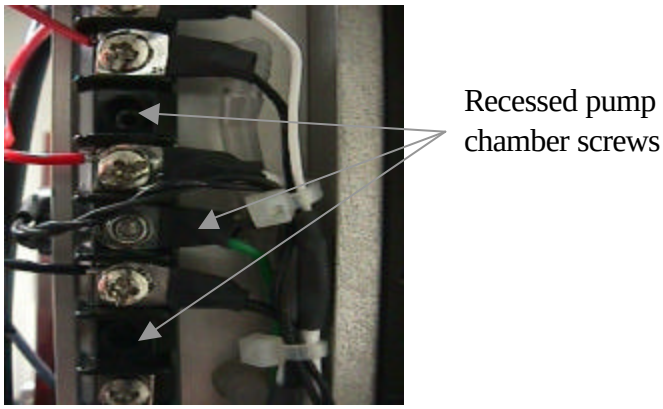


Figure 6-3. Recessed Pump Chamber Screws

8) Remove the pump chamber from the laser head and carefully place it on a clean surface.

9) Remove the pump chamber end caps that secure the flash lamp within the pump chamber, Figure 6-4.

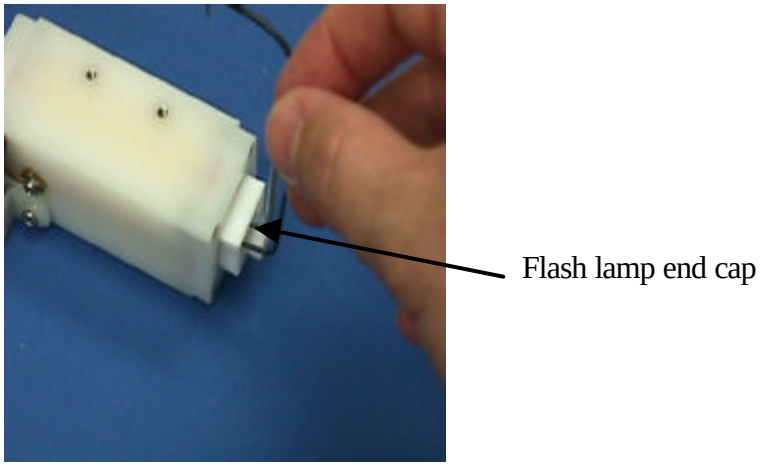


Figure 6-4. Removal of Pump Chamber End Cap

10) Carefully straighten the lamp leads and remove the flash lamp from the pump chamber. Note the position of the RED and BLACK lamp leads.

11) Install the new flash lamp with the RED and BLACK leads on the same side as the original lamp. The RED lamp lead should be at the same end of the pump chamber as the start transformer. Bend the lamp leads so that they are perpendicular to the lamp.

Do not touch the glass surface of the lamp with your bare fingers, or other skin. This may leave grease marks that will degrade lamp performance and may shorten lamp lifetime

12) Carefully place the o-rings over the flash lamp and slide them into place using tweezers, Figure 6-5. Reinstall the pump chamber end caps and carefully tighten the screws to hold the lamp in place. The flash lamp leads should come straight up from the pump chamber.

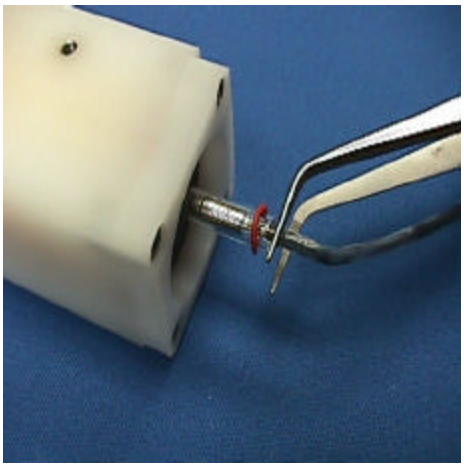


Figure 6-5. Installing O-ring on Flash Lamp

13) Carefully check the two o-rings on the resonator side plate, Figure 6-6. The o-rings seal the pump chamber against water leaks. Ensure that the o-rings are in place, before replacing the pump chamber in the resonator.

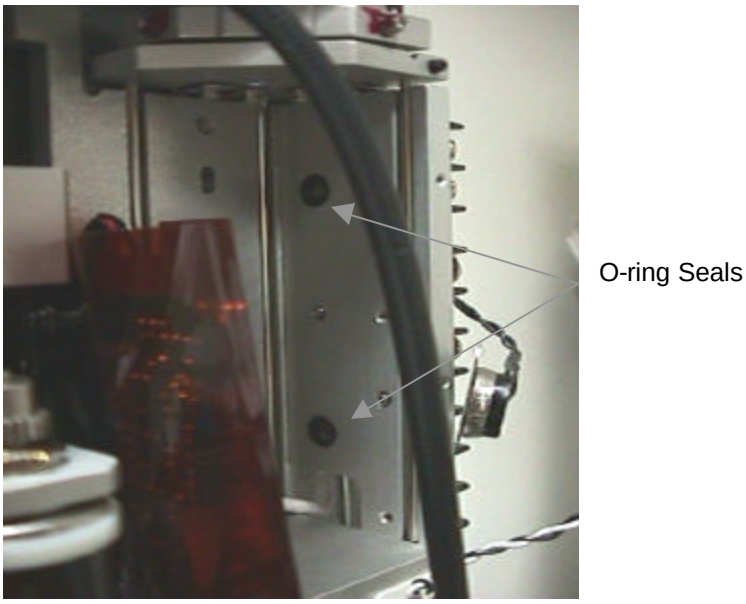


Figure 6-6. Pump Chamber Water Seal O-rings

14) Reinstall the pump chamber. Tighten the three screws to connect the pump chamber to the resonator.

15) Reconnect the thermocouple, and the RED and BLUE start transformer leads.

16) Reconnect the RED and BLACK flash lamp leads.

17) Reconnect the cooling water hoses to the power supply

18) Start the power supply and check the cooling system for leaks and adequate water level before replacing the laser head cover. Disconnect power before replacing the laser head cover.

Chapter Seven, Troubleshooting

Introduction

This chapter lists a number of conditions that may be observed during the lifetime of the QuikLaze Nd:YAG laser system. Following the list of conditions is a set of procedures that may be used for resolving specific conditions to improve laser performance.

Observed Conditions

To use this section, find the observed condition in this section that matches the condition of the laser. Follow the recommended procedure to correct the situation. If the problem cannot be resolved by following the procedure then phone New Wave Research at 510-249-1550, Fax 510-249-1551, email: lasers@new-wave.com to get technical support for the laser.

Table 1. Observed Conditions

Observed Condition	**Recommended Procedure**
Laser does not start	Procedure 1
Low output energy	Procedure 2
Unstable laser energy	Procedure 3
Clipped beam profile	Procedure 4

Recommended Procedures

The following procedures should be followed to resolve the observed conditions listed in the section above. Please contact New Wave Research at 510-249-1550, Fax 510-249-1551 for more detailed information regarding these procedures.

Procedure 1. Laser does not start

If the laser does not start, please check the following points. The laser AC power cord is plugged in and the outlet has power.

The key switch on the power supply is turned to the ON position, and the AC power light is illuminated.

The trigger switch is set to the START position.

All interlocks switches are closed check; external interlocks, laser head cover interlock, laser microscope interlock, flow switch interlock.

Procedure 2. Low output energy

Make sure that the Hi/Lo switch is in the Hi position.

Check the setting of the attenuator. Increase to at least 500.

Make sure a 50x or higher magnification objective lens is being used.

Test other locations on the sample for consistency. Flush the cooling system as described in Chapter 5.

Procedure 3. Unstable laser energy

The pulse stability for the QuikLaze Nd:YAG laser is specified as ±7% at 532 nm this is measured at maximum 532 nm energy with the xy aperture fully open and the laser removed of the microscope. If the pulse stability at 532 nm does not meet this specification then check the following.

Check the number of shots on the flash lamp. This can be estimated from the date of the last flash lamp change and the average usage per day. If the number of shots fired exceeds 30 million shots, change the flash lamp.

Experiment with samples of different materials.

Call New Wave Research if it is not possible to improve laser pulse stability by this procedure.

Procedure 4. Clipped laser beam

The output beam of the QuikLaze Nd:YAG laser should be square, symmetric with even energy distribution. Some object in the beam path may clip the laser beam, then the output will appear asymmetric, with a sharp edge. If the output beam is clipped, check the following.
Check the beam path to ensure that there are no foreign objects in the path.

Check that the manual shutter is fully open and completely removed from the beam path and is not clipping the beam.

Check the microscope alignment for each individual objective used for laser cutting.

When you have found the object that is responsible for clipping the beam, correct the situation and ensure that the beam path is fully clear.

Procedure 5. Non Uniform Energy Distribution

If the energy distribution does not appear to be uniform across the cut area check the following.

Check that the laser beam is not clipping a mount or some other object, and that there are no foreign objects in the beam path. Check microscope alignment

Check microscope alignment

Check that the microscope optics are clean, with no dust particles on any surface. Clean the optics if necessary.

If the beam still appears to be non uniform try cuts on different samples. Try increasing the energy setting. If the laser still makes uniform cuts call New Wave Research for service information.

Appendix A, Warranty

New Wave Research (Manufacturer) mechanical, electrical, and optical parts and assemblies are warranted against defects in materials and workmanship for a period of twelve (12) months from date of shipment to end user or fifteen (15) months from date of shipment to supplier whichever is less. The warranty period for flash lamps fiber optic cable and nonlinear crystals is 90 days from the date of shipment to the end user or 120 days from the date of shipment to supplier whichever is less. Degradation of optics due to long-term exposure to fourth harmonic, dust, dirt or contamination is not considered a defect. If Manufacturer receives notice of such defects during the warranty period, Manufacturer shall at its option, either repair or replace hardware products that prove to be defective. If equipment fails during the warranty period, end user shall notify Manufacturer and request return authorization. The defective product shall then be returned with a failure report attached, to the Manufacturer, freight prepaid. The warranty does not cover consumable supplies such as fuses or illumination or indicator lamps.

New Wave Research software and firmware products which are designated by Manufacturer for use with a hardware product, when properly installed on that hardware product, are warranted not to fail to execute their programming instructions due to defects in materials and workmanship for twelve (12) months from date of shipment to end user or fifteen (15) months from date of shipment to supplier. If Manufacturer receives notice of such defects during the warranty period, Manufacturer will repair or replace software media and firmware, which do not execute their programming instructions due to such defects. Manufacturer does not warrant that the operation of the software, firmware or hardware shall be uninterrupted or error free.

LIMITATION OF WARRANTY. The above warranties are contingent upon proper use in the application for which the equipment was intended and does not cover equipment which was modified or disassembled without Manufacturer's approval, was subjected to contamination, abuse or unusual physical or electrical stress, operated outside of Manufacturer environmental specifications for the product, or failed as a

result of Distributor furnished software or hardware interfacing equipment.

THE WARRANTY STATED ABOVE IS EXCLUSIVE AND NO OTHER WARRANTY, WHETHER WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED. MANUFACTURER SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THIS STATED EXPRESS WARRANTY IS IN LIEU OF ALL LIABILITIES OR OBLIGATIONS OF MANUFACTURER FOR ALL DAMAGES INCLUDING, BUT NOT LIMITED TO, CONSEQUENTIAL DAMAGES OCCURRING OUT OF OR IN CONNECTION WITH THE USE OF PERFORMANCE OF MANUFACTURER'S PRODUCT. MANUFACTURE'S LIABILITY IS LIMITED TO A REFUND TO THE END USER OF THE PURCHASE PRICE PAID TO MANUFACTURE FOR THE PRODUCT.

Appendix B, Part Numbers

Part Numbers

The following part numbers can be ordered by contacting the New Wave Research order processing department at 408/328-0220.

Table B-1. Part Numbers for Laser Head

Flash lamp	0002-0036

Table B-2. Part Numbers for Laser Power Supply

Deionizing cartridge	1300-0001
Fan	2600-0002
Flow switch for pump	5200-0001
Pump	5850-0001
Reservoir	0002-0555

Table B-3. Part Numbers for External Illuminator

Spot marker illuminator lamp	Type EKE: 21VDC, 150 watts

Table B-4 Part Numbers for Fuses

Main Fuses – 2 each	95-125 VAC 6.3A/250V SPT 5x20mm	200-250 VAC 4.4A/250V SPT 5x20mm
Schurter	MST034.6623	MST034.6621
Wickman	19181.6.3A	19181/4A
Low voltage/High Voltage PCB Fuses – 2/PCB		
Schurter	MST034.66066, T125mA/250V	

Declaration of Conformity

Application of Council Directives:

- **73/23/EEC, 89/336/EEC**

Standards to which Conformity is Declared:

- **EN 61010; EN 60825**
- **EN 55022; EN 50082**

Manufacturer's Name and Address:

New Wave Research, Inc.
47613 Warm Springs Blvd.
Fremont CA 94539

Type of Equipment: Nd:YAG Laser System

Model No's: MiniLase, QuikLaze

Date CE Mark Affixed: 1997

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directives and Standards.

Place: Sunnyvale, CA Date: 3/26/97

Edward North

President