GREEN YAG - 532nm
Nd:YAG SECOND HARMONIC GENERATOR ASSEMBLY

WARNING!!!

THE SECOND HARMONIC GENERATING CRYSTAL CAN BE EASILY DAMAGED IF THESE SPECIFIC PROCEDURES ARE NOT FOLLOWED.
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1.0 PRECAUTIONS:
THE 532nm SECOND HARMONIC GENERATOR SHOULD ONLY BE OPERATED IN THE Q-SWITCHED MODE AND AT LIMITED POWER LEVELS. ATTEMPTS TO OPERATE IT IN THE CONTINUOUS WAVE MODE, OR AT HIGHER POWER LEVELS, COULD CAUSE DAMAGE TO THE FREQUENCY DOUBLING CRYSTAL.

As with any intracavity optical device, the Frequency Doubling Crystal is subject to high circulating powers which could cause damage if improperly used or aligned. When the Frequency Doubler is being aligned, high circulating 1064nm power may be present even though the 532nm output power is low. Always perform alignments at low power levels to avoid circulating power damage. Due to the high peak powers involved, the green laser should not be operated at power levels in excess of:

1. 1 Watt at 1 KHz and 1 mj/pulse below 2 KHz,
2. 2 Watts at 2 KHz,
3. 4 Watts at 3-4 KHz.
4. 5 Watts above 4 KHz.

NOTE that not all lasers are intended to produce these average powers. Refer to the laser specification pages for expected average power from the laser in use.

Alignment and service procedures should only be performed by trained and qualified personnel familiar with laser radiation hazards and safety requirements.

2.0 GENERAL:
The 532nm Second Harmonic Generator (SHG) is a carriage mounted assembly and is generally located within the laser cavity between the front mirror and laser head. The 532nm SHG assembly includes the Frequency Doubling Crystal assembly, and a five axes mount. The mount has 2 axes of kinematic tilt for parallelism alignment, 2 axes of horizontal and vertical translation to select the area of the crystal used, and 1 rotational axis for optimum orientation. In addition to the frequency doubling crystal assembly, the system requires the use of a special dichroic front laser mirror.

2.1 THREE MIRROR APPLICATIONS:
Standard SHG lasers use the hardware as stated above. Three mirror SHG lasers include a kinematically mounted third cavity mirror located between the SHG crystal and the laser rod. This special mirror reflects
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532nm radiation while passing 1064nm radiation. Therefore, most of the green light that is generated by the SHG crystal in the direction toward the laser rod is reflected back toward the laser output.

When aligning the laser, remove the third mirror by removing the entire carriage assembly from the rail. After the standard cavity configuration is complete, replace the third mirror assembly and proceed as described in Section 6.1.

3.0 INSTALLATION:
The laser must be properly aligned for operation at 1064nm, Q-Switched TEM<sub>00</sub> mode before the Second Harmonic Generator assembly can be installed. Refer to the manual section on Optical Alignment for 1064nm alignment instructions.

Once the laser system is aligned for 1064nm Q-Switched TEM<sub>00</sub> Mode operation, follow the instructions in Section 6.0.

4.0 DAMAGE LEVEL:
When properly aligned, the Second Harmonic Generator can provide in excess of 4 Watts of 532nm green light at 5 KHz Q-Switch frequency when operated in a U.S. Laser Model 403TQG laser. In Model 403CQG lasers, 2 Watts at 5 KHz is typical maximum output. Damage to the crystal can occur when the peak pulse energy becomes too high, or when the alignment is poor and the circulating 1064nm energy becomes too great. To reach 4 Watts at 5 KHz, increase the laser lamp current in small increments and retune the frequency doubler alignment slightly each time. It should not be necessary to exceed 36 amperes lamp current for Model 403TQG lasers and 20 Amps for Model 403CQG lasers. At lower Q-Switch frequencies, the laser lamp current must be reduced, and the average output power must be reduced, to maintain the limit on pulse energy levels. This is not a linear relationship since, as the Q-Switch frequency decreases, the pulse duration decreases and the pulse peak energy increases. At 1 KHz the maximum average output power should not exceed 1 Watt. These limits will vary slightly for each particular crystal, but these values are typically safe numbers.

5.0 CRYSTAL ORIENTATION:
Reference U.S.L. Dwg. #517001 (or U.S.L. Dwg. #515010 for water cooled assemblies)
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To properly phase match the KTP SHG assembly to the input laser beam, the crystal must be correctly oriented. Proper orientation is achieved when the crystal X axis is aligned at 45° to vertical (either right or left is OK). This will provide optimum efficiency, and should not require further alignment.

6.0 532nm OPTICAL RAIL ALIGNMENT:
The following procedure is intended to align the laser rail components for 532nm wavelength, Q-Switched, TEM₀₀, laser output.

CAUTION!!!
ASSURE THAT PROPER SAFETY EYE PROTECTION (1064nm & 532nm) ARE WORN BY ALL ATTENDANT PERSONNEL, AND OBSERVE ALL SAFETY PRECAUTIONS AS DESCRIBED ELSEWHERE IN THE LASER AND SYSTEM MANUALS.

A) Refer to the U. S. LASER Component Location Layout drawing. Insure that all laser components are installed in their correct locations on the optical rail, and that all carriage knobs are securely tightened.

B) Set the Laser Power Supply and Q-Switch Controller power to OFF.

C) For systems incorporating 1064nm and 532nm Quick-Change carriages remove the 1064nm carriage assembly and install the 532nm carriage assembly. The location of the carriages on the laser rail is determined by the rail alignment pin position.

D) For systems not equipped with Quick-Change carriages, remove the 1064nm output coupler mirror and install the 532nm output coupler mirror in the front mirror mount. The arrows, or the dielectric coated surface, if the arrows are not visible, should face the laser head assembly.

E) Open the Safety Shutter and autocollimate the front 532nm mirror to the laser rod. For Quick Change carriage systems, autocollimate the front 532nm mirror AND the Frequency Doubler crystal to the laser rod. The front spatial filter aperture may need to be removed.
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F) For systems not equipped with Quick-Change carriages, install the Frequency Doubler Assembly between laser head and front spatial filter, and autocollimate to the front mirror. (Which has been autocollimated to the laser rod in Step E)

G) Close the Safety Shutter, start the cooling pump, and set the Q-Switch Controller power ON, frequency set to 5 KHz, and function switch set to Internally Gated Q.

H) Insert a piece of white paper (a business card or index card is suitable) in front of the frequency doubler, between the doubler and the front mirror.

I) Start the laser. Set lamp current to about 25 amps for Model 403TQG lasers and 15 amps for 403CQG lasers.

J) Open the safety shutter. A bright light spot should be visible on the white card. Adjust the X-Y translation of the doubler to provide a perfectly round circle spot on the white card.

K) Close the safety shutter. Turn off the laser. Remove the white card from between the doubler and the front mirror.

L) Re-Autocollimate the KTP crystal by using the kinematic tilt adjustment knobs on the doubler mount.

M) Install the front Spatial Filter Aperture.

N) Start the laser. Set lamp current to about 25 amps for Model 403TQG lasers and 15 amps for 403CQG lasers. Open the safety shutter. Using the kinematic tilt adjustment knobs on the frequency doubler mount, adjust the doubler until 532nm lasing begins. Continue adjustments until maximum 532nm lasing power is achieved. Allow the laser to run for several minutes to reach thermal equilibrium. Adjust the front mirror and spatial filter as required to maximize the average power.

O) Observe the 532nm laser beam as it exits the Frequency Doubler. If the beam is not roughly centered through the exit aperture of the doubler, adjust the X-Y translation of the doubler mount to roughly center the beam through the exit aperture. Confirm peak alignment.
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P) Adjust the rear mirror, followed by both apertures, for maximum output power. (Do NOT adjust either the front mirror or Q-Switch). Since the adjustments all have some interaction with each other, it may be necessary to repeat adjustments several times to achieve maximum efficiency.

The laser rail components are now aligned for 532nm, TEM_{oo}, Q-Switched operation in standard configuration.

6.1 THREE MIRROR CONFIGURATION:
After completing the above alignment, install the third mirror carriage assembly in the laser rail between the SHG assembly and the front spatial filter. (Refer to the Component Location Layout Drawing.) Operate the laser at a low current setting with the output impinging on a flame proof target several feet away. Tune the third mirror kinematic mount adjustments to bring the two green output beams into coincidence.

Then direct the laser output into a power meter and increase the power supply current setting to a nominal level (Refer to the original check out data section.) Repeat the adjustment of Section 6.0 P). Reconfirm the coincidence of both beams, and the alignment is complete.

The third mirror configuration will add 25 to 50% more green power over the standard configuration when the laser is operated at its higher power output level.

7.0 SYSTEMS WITH CCTV VIEWING:
Systems built with T.V. viewing include a diopter lens on the front of the T.V. camera lens. This diopter provides wavelength corrections for the laser operation at 1064nm. When operating in the visible green region at 532nm, it is necessary to remove this diopter lens in order to obtain focus coincidence between the laser spot and T.V. image. Refer to the C.C.T.V. Viewing and Focusing Manual Section.