

VIEWING & FOCUSING
ASSEMBLY

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W A R N I N G ! ! !

Hazardous radiation will be present during alignment of the viewing optics and the laser system. This radiation will be visible when the laser is operated in the second harmonic at .532 microns, and invisible in the fundamental wavelength at 1.06 microns and the fourth harmonic at .266 microns. Avoid exposure to direct and scattered radiation. Appropriate eye protection is mandatory for all exposed personnel.

Insure that all personnel directly involved with the laser and optics are experienced and have been thoroughly briefed with operating procedures and safety precautions.

Further information regarding compliance with Federal Safety Regulations may be obtained from:

The Center for Devices and Radiological Health
8757 Georgia Avenue
Silver Spring, Maryland 20910

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1.0 GENERAL:

This assembly is equipped with the necessary interlocks and emission imminent indicator light as required by C.D.R.H. regulations for Class I or Class IV laser systems, depending upon the application.

The two sets of two series connected interlock switches are connected into the laser interlock loop to provide the necessary operator protection. The emission indicator light is equipped with a 24 volt bulb and is connected to the interlock control panel to provide the required precautionary indication.

The T. V. Camera is located within the viewing structure and views through a kinematically mounted mirror which allows for easy field alignment. An optional electronic crosshair or the standard fixed crosshair is superimposed over the monitor image to allow accurate targeting and alignment of the focused beam.

2.0 PRECAUTIONS:

If the CCTV Camera, is of the charged coupled device (CCD) type, it is a low voltage unit. The CCTV Monitor and optional electronic crosshair generator, however, contain voltages which are potentially hazardous. Therefore, any service to the T.V. system should be performed only by a qualified service technician.

During optical alignment procedures, be cautious not to introduce hands or objects into the laser beam path; and always wear eye protection for the applicable wavelength.

3.0 SELECTION OF OPTICS:

Some Viewing and Focusing Assemblies are supplied to accommodate multiple wavelengths. In these applications, the proper optical elements must be installed when changing from one wavelength to another.

The material of each element and the dielectric coatings are specific for each wavelength or group of wavelengths. Use of the wrong optical elements may damage the optics and will reduce throughput energy.

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3.1 UPCOLLIMATOR:

The upcollimator is available in various ratios and affects the focused laser beam spot size. Be sure that the upcollimator lenses are proper for the wavelength being used and proper for the desired focused spot size and working distance. If in doubt, consult with U. S. Laser's technical staff.

3.2 DICHROIC MIRROR:

The dichroic mirror bends the beam 90° while passing visible light vertically to the T.V. camera optics. Be sure that the proper dichroic mirror is installed for the wavelength being used.

3.3 OBJECTIVE LENS:

The objective lens focuses the laser beam to the target. Numerous objective lenses are available, from single element best form lenses to multiple element apochromatic achromats, in focal lengths from 30mm to 250mm.

For further information refer to the Technical Note on focused spot size or contact U. S. Laser's technical staff.

4.0 VIEWING AND FOCUSING ALIGNMENT:

Alignment of the viewing and focusing assembly is performed at the factory during system check out. If realignment becomes necessary, proceed as follows:

- 4.0.1 Assure that the laser beam delivery optics are properly aligned up to the entry to the Viewing and Focusing Assembly.

Reference the manual section on Optical Alignment, if adjustment is necessary.

- 4.0.2 Remove the cover from the Viewing and Focusing Assembly and defeat the related interlocks.
- 4.0.3 Remove the Upcollimator Assembly.

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4.0.4 Install the supplied targeting aperture into the Entry to the Focusing Barrel.

4.1 DICHROIC BEAMSPLITTER:

Put on safety goggles and start the laser. If operating at 1.06μ , use an I.R. viewer and insure that the laser beam strikes the kinematic mounted dichroic mirror approximately in the center. If operating at $.532\mu$, the beam will be visible; and if operating in the U.V. use a white paper (business card) to probe for the beam position. At low U.V. power, the card will fluoresce in the blue visible spectrum.

The laser beam should be reflected off the dichroic mirror at 90° and should strike the targeting aperture in the entry of the focusing barrel directly in the center.

4.2 FOCUSING BARREL:

Remove the Objective Lens Assembly from the bottom of the Focusing Barrel and install the supplied alignment aperture into the EXIT of the Focusing Barrel. The laser beam reflected off the dichroic mirror should be centered through BOTH the Entry and Exit of the Focusing Barrel. Corrections can be made by using the kinematic adjustment knobs on the dichroic assembly. If coarse alignment is necessary, the four mounting screws must be loosened and the entire dichroic assembly can be translated as required.

4.3 UPCOLLIMATOR:

The U. S. Laser Model 1004 upcollimators are essentially reverse Galilean Telescopes and are used to expand laser beams, thus decreasing beam divergence and focused spot size. High quality fused silica, A.R. coated lenses are used in 1.06 and .532 micron applications to provide minimal insertion loss, with maximum damage resistance. Special U.V. grade lenses are used for third and fourth harmonic systems. The lenses used are specially selected and matched to minimize optical aberrations. The upcollimators are supplied mounted in an adjustable 3 axis mount to allow precise alignment to the laser system. The magnification of the upcollimator will increase the laser beam diameter by a factor X, while simultaneously reducing the angular divergence of the beam by a factor $1/X$. This technique results in a lower F# optical system by increasing the beam size in order to more completely fill the objective

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lens. The design also minimizes the power density at the lens surface, thus reducing the probability of optical damage to the lens.

4.3.1 UPCOLLIMATOR ALIGNMENT:

Reference U.S.L. Drawing #518016

Re-install the Upcollimator. Install the supplied alignment aperture into the Entry of the Upcollimator. The laser beam should pass through the Upcollimator Entry aperture, and the expanded beam should exit the Upcollimator centered through the output lens. Corrections can be made by loosening the four locking screws on the front of the Upcollimator and translating the entire Upcollimator assembly as required. Confirm that the expanded beam impinges fully on the Dichroic mirror, and that the reflected beam is centered into the entry of the Focusing Barrel.

Minor corrections can be made using the tilt adjustment knobs located on the rear of the upcollimator, if necessary.

4.4 FOCUS:

Remove all alignment apertures from the Upcollimator and Viewing and Focusing Assembly, and install the Objective lens into the exit of the Focusing Barrel.

While disregarding the CCTV viewing image, set the Focusing Barrel for optimum focusing of the laser beam. Optimum focus can be performed by doing trial and error processing tests or use the technique of section 6.0. See also paragraph 8.0. Viewing alignment will be set in the following steps.

This completes the laser beam delivery alignment.

5.0 CCTV CAMERA ALIGNMENT:

Connect the T.V. camera and monitor assembly, apply power to both units and allow a few minutes warm-up time.

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5.1 Using a suitable target, turn the laser on briefly to provide a laser burn spot. Using the two adjustment knobs on the front of the viewing optics assembly, align the crosshairs on the T.V. monitor such that they are superimposed over the center of the laser burn spot.

5.2 If the system is equipped with a binocular viewing element, the crosshairs are aligned to the laser spot as follows:

After performing the operations of paragraphs 5.0 and 5.1, loosen the allen set screws at the binocular crosshairs adjusting wedges and rotate the wedges until the crosshairs align to the burn spot. Then tighten the set screws. Note that the binocular is interlocked with a safety shutter so that viewing can not occur during lasing.

6.0 FOCUS COINCIDENCE:

Although preset at the factory, it is recommended that the focus coincidence be rechecked after installation. This alignment verifies that the CCTV (visual) focus and the laser focus are coincident (coplanar).

Using a suitable method, dynamically verify that the laser is in optimum focus. (Disregard or turn off the CCTV Monitor.)

6.1 FOCUS DETERMINATION:

A highly recommended method of determining optimum focus is to mount a piece of exposed (black) Polaroid film or other suitable laser burn paper on an angled plate ($\approx 30^\circ$) (The U. S. Laser Focus Kit Part No. 3962, includes both burn paper and an angle mounting plate.) beneath the laser beam with the approximate focus set at the center of the burn paper. With the laser set at a low operating level, scan the entire assembly across the beam path (See Fig. 1). The resultant image on the surface of the film is a good representation of the laser's relative focus.

Examine burn pattern and verify that an "hourglass" shape as shown in Figure 1 is present. If not, refocus and adjust the laser power until the correct burn pattern is achieved. Carefully mark the narrowest burn width; this is the optimum focus point. Turn on the CCTV Monitor

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if it has been shut off. Being careful not to readjust focus, position the film assembly under the marked (narrowest) point on the burn paper. Adjust the CCTV camera lens until the image is in sharp focus.

6.2 DIOPTER LENSES:

In order to obtain the coincidence as discussed above, most applications involving a 1.06μ laser or a U.V. laser require diopter lenses attached to the camera focusing lenses. These lenses are factory supplied and serve to shift the visible focal length to coincide with that of the laser beam.

When operating at $.532\mu$ either the diopter lenses must be removed, or in some cases the camera focusing lens may adjust sufficiently to produce proper focus coincidence. In either case, the focus coincidence must be checked when changing laser wavelengths.

Once the focus coincidence is set, it will remain coincident provided the CCTV camera lens is not readjusted.

6.3 TARGET ALIGNMENT:

When refocusing the T.V. cameras, a slight target position walk-off may occur. Therefore, check for target crosshair alignment as in Section 5.0.

7.0 REMOVAL OF DICHROIC BEAMSPLITTER:

(For Cleaning or Inspection)

Typical Viewing and Focusing Assemblies are supplied with a single dichroic beamsplitter. This beamsplitter is specially coated to provide maximum reflectivity at 1064nm and 532nm and visible transmission for satisfactory viewing. Multi-wavelength systems may be supplied with multi-band dichroics or with more than one dichroic mirror. To remove and change the dichroic, refer to drawing #506029-A, Dichroic Mount Assembly. Carefully unscrew the knurled dichroic retainer from its holder.

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CAUTION: Do not invert the holder after removal unless the dichroic is supported, then remove the beamsplitting element from the knurled holder using care so as not to contact the surfaces. Please refer to the U. S. Laser Manual "Cleaning Laser Optics" for proper cleaning procedures.

8.0 FOCUS ADJUSTMENT, USING THE FOCUSING BARREL:

The objective lens is mounted in a precision focusing barrel. The barrel moves the objective up or down without rotating the lens, thus preventing spot wander.

The lens will move vertically .0003 inches per degree of rotation (or 7.6 microns per degree), thus assuring fine control of the focused laser spot. There is approximately one inch of fine focus, and a coarse slide which provides an additional 2" of focus adjustment.

Various focusing extenders and recess adapters are available for special applications. Consult with U. S. Laser's technical staff for these optional devices.

9.0 OPTIONAL COAXIAL ILLUMINATOR

The Viewing and Focusing Assembly may be equipped with an optional Coaxial Illuminator Assembly in order to provide viewing illumination to the work piece that is coaxial to the laser beam. For certain material surface textures, color, and reflectance, coaxial illumination will enhance the T.V. image quality.

9.1 OPERATION:

The level of coaxial illumination provided to the work piece can be adjusted from the Operator Control Panel potentiometer. The final CCTV Monitor image contrast and quality will depend upon the following adjustments: A) the illumination level setting, B) the CCTV monitor contrast and brightness settings, C) the height of the bulb assembly in the illuminator housing, D) the position of the polarizer at the base of the illuminator housing.

9.1.1 ADJUSTMENTS:

To maximize the video image picture quality, each of the four controls should be varied while viewing the T.V. monitor. Adjustment C) is essentially to prevent the bulb filament from

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being imaged into the T.V. system. To change the bulb assembly height, loosen the thumb screw and slide the assembly up and down while viewing the T.V. monitor. Adjustment D), polarization, is performed by rotating the thumb wheel at the base of the illuminator assembly.

9.2 BULB CHANGE:

Refer to the USL Viewing and Focusing Layout and Optical Schematic.

To change the illuminator bulb, loosen the thumb screw on the side of the housing and lift the bulb assembly, with the power cord, out of the housing. Remove the old bulb, install a new bulb, and reassemble the illuminator. The illuminator bulb used is a 12 Volt unit. (U.S.L. #8000-750-015)

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FOCAL POINT

SCAN DIRECTION

FIGURE 1