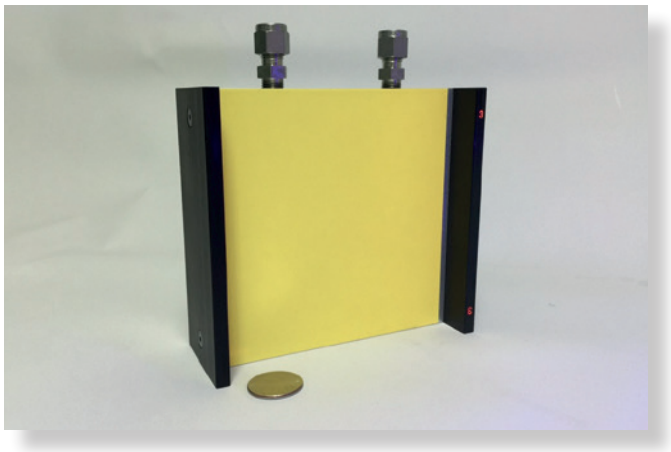
Water cooled thermal image plates for CO_2 and other molecular lasers



The water cooled thermal image plates are versatile instruments that produce real time, high resolution images of IR laser beams. They provide continuous viewing of laser beams up to 500 watts. Macken Instruments' original thermal image plates have become an industry standard for viewing the output from CO_2 and other IR lasers. However, these uncooled plates can only be used intermittently for laser power In excess of 50 watts. Now our Water Cooled Image Plates provide important additional features:

- Extended viewing time possible due to
- continuous cooling of the plate surface from water flow through the heat sink.
- Indefinite power dissipation of 500 watts or less with continuous water flow.
- Fast response time permits viewing of rapidly changing laser mode patterns when adjusting resonator mirrors.
- Offered in 4 sensitivity ranges contained on two plates. Each surface is 12.5 cm x 12.5 cm
- Cooling water circulation can be provided by a circulation pump and a container of water.

Theory of operation

The water cooled thermal image plate displays ir laser beams through the use of thermal-sensitive phosphors. These phosphors fluoresce when illuminated by a long wavelength ultraviolet light (360 nm), but the intensity of the fluorescence decreases with increasing temperature. When an IR laser beam strikes the thermal-sensitive surface, the absorbed energy raises the surface temperature and produces a corresponding thermal image. This pattern appears as a dark image on a bright fluorescent background when the surface is illuminated by an ultraviolet light.

Different sensitivity ranges are obtained by varying the amount of thermal insulation between the phosphors and the anodized aluminum heat sink. Please consult the standard data sheet on thermal image plates (Model 22-A & 22-B) for more information.

Any long wavelength ultraviolet light can be used to illuminate the surface, but Macken Instruments' lamp Model 22-UV ultraviolet lamp is the most satisfactory. Its small size and high-illumination level permits it to be conveniently positioned out of direct work area.

A water cooled thermal image plate is capable of displaying beams up to 500 watts continuously. However, the laser beam must not exceed the damage threshold power density given below for the particular surface being used. Each plate measures 13 x 13 x 1.91 cm. Each side of the plate has a 13 x 13 cm phosphor coating. Hose fittings measure 1/4". The ultraviolet lamp (22- UV) measures 15 x 5 x 5 cm.

The following table gives specifications of the four surfaces measured at 8 to 12 microns. For use at 4 to 8 microns, multiply columns a, b and c by 2.5.

Model number	Surface number	Normal sensitivity range (a) [W/cm²]	Minimum power density (b) [W/cm²]	Damage threshold (c) [W/cm²]	Response time (d) [s]	Resolution (e) [lines/inch]
20-C	1	60-200	16	800	<0.03	>300
	2	30-100	8	600	<0.03	>300
20-D	3	15-50	4	350	0.03	300
	4	7.5-25	2	200	0.03	200

a) The normal sensitivity range is the spread of power densities which can be easily viewed with no reduction in background illumination. The upper power density occurs when the surface becomes saturated, turning the area completely black and making it incapable of displaying any further detail within the beam.

b) The minimum-detectable power densities are the lowest power densities observable under the most favorable illumination levels. For this sensitivity the room lights must be dimmed and the level of ultraviolet illumination decreated to produce a dim fluorescence.

c) Damage threshold is the power density which produces a permanent change in the thermal-sensitive surface. This occurs at power factors at least four times greater than saturation. Therefore, when saturation occurs, a lower sensitivity surface should be used to display the beam.

d) The response time is the length of time it takes a change in the beam to be displayed as a change in the thermal image.

e) The resolution of a surface is the maximum number of dark and light line pairs which can be displayed with good contrast. For comparison, the resolution of a newspaper photograph is approximately 70 lines/inch. Two CO_2 laser beams intersecting at an angle of two degrees produce an 80 line/inch interference pattern.

Quantum Design

Quantum Design
1 avenue de l'Atlantique
Bâtiment Fuji-Yama
91940 Les Ulis - France

Tél. : +33 1 69 19 49 49
france@qd-europe.com
www.qd-europe.com

MACKEN INSTRUMENTS INC.

Water cooled thermal image plates for CO_2 and other molecular lasers

Models 20-C & 20-D

- Each plate has two brass fixtures on the top, one is for intake of water and the other is for the output. Insert the tubing (We recommend polyethylene) into the 1/4" fittings and tighten. Hook up to laboratory water supply and submerge water pump in a water bucket. Keep the cool water supply flowing through the plate. Plastic and brass ferrules are provided with each plate depending on your choice of tubing to be used.

- Illuminate the surface of the water cooled image plate with Macken Instruments' Model 22-UV Ultraviolet Light or equivalent to produce a uniform fluorescence. Stand the UV lamp on end and place it 6" to 9" from the surface.

- Permit the laser beam to strike, the fluorescing surface. When working with a beam of an unknown power density, start with the least sensitive surface until the darkened image of the beam is obtained.

- Avoid power densities in excess of those which cause a portion of the image to saturate (complete loss of fluorescence). When a significant part of the beam appears black on the fluorescent plate, one is approaching (within a factor of four) the power density which can damage the surface. At this point, a less sensitive surface should be used. If the laser power density is too high, for even the No. 1 surface, then the laser beam should have the power density reduced by one of the following methods:

- A. Attenuate the laser beam.

- B. Expand the laser beam with a lens or mirror.

- C. Turn down the total laser power.

- Do not pass the plate through the focus of a laser beam unless the total power of the beam is less than 0.04 watts.

- To increase the sensitivity of any surface, decrease the level of UV illumination to produce a dim fluorescence and, if necessary, dim the room lights. The contrast and brilliance can be improved if the plate is positioned in a shadow of facing a darker portion of the room.

- Keep the water cooled thermal image plate away from direct sunlight for prolonged periods of time. Remove UV illumination when it's not necessary. Don't expose the plate to acid fumes since this exposure can destroy a protective component in the coating which makes the phosphor become photo-sensitive to ultraviolet light.
  This sensitivity can ultimately cause the surface to darken. Do not clean the surface with water because water can partially damage the protective coating. If the surface must be cleaned, use an acetone dampened cloth very sparingly.

- **CAUTION**: Do not allow the beam to strike the metal surfaces of this product as this may result in stray beam reflections. These metal surfaces are anodized to reduce the reflection of CO_2 laser light; however, protective goggles should be worn when using this product.

Power dissipation external water source

The Water Cooled Thermal Image Plate is capable of continuous display of laser beams up to 500 watts. The 500 watt power can be dissipated indefinitely, as long as cool water is running through your plate at a rate of 2 liters per minute (half gallon per, minute).

Submersible water source

A submersible water pump makes it possible to run the water cooled image plate for extended periods of time without connection to an external water source. A bucket of water can act as a portable heat sink for the water cooled thermal image plate by using the submersible pump to recirculate the water through the plate. For example, 4 liters (1 gallon) of water can absorb the heat of a 500 watt laser beam for ten minutes with an acceptable temperature rise.

Safety

Precautions have been taken to eliminate specular reflections from the water cooled plate. Both the thermal sensitive surfaces and the anodized aluminum have matte finishes and show little surface reflection at 10.6 microns. However, standard safety precautions, such as wearing protective glasses should always be observed when working with IR lasers.

For use with lasers emitting at other wavelengths, tests should be made by the user to determine the appropriate safety precautions. The laser beam should never be allowed to strike the ultraviolet lamp or its cord.
The ultraviolet radiation from Model 22-UV lamp is not harmful. If other UV lamps are used, they should only emit "long wave" ultraviolet.