Diffuse Reflector Pump Chamber for Lithotripsy Applications

Thank you for your interest in MegaWatt Lasers' products. 4X125 pump chamber are often used for Cr,Tm, Ho:YAG (CTH:YAG) lasers. In addition to providing pump chambers, we can offer recommendations for the system design and component sources.

Attached are outline drawings of our 4X125 and 4X125C2 pump chambers and R4X125C2 resonator assembly.

For lithotripsy applications, typical operational parameters are up to 30 Watts of average power at 10 Hz with an electrical pulse duration of 350 microseconds. Using an M100 flashlamp, the capacitor bank voltage is approximately 830 volts. Usually a relatively large capacitor bank (~ 3000uF) is used and the flashlamp current is switched with an IGBT. The resulting current pulse is roughly "square" in shape.

Careful selection of wetted cooling system components is very important for long pump chamber life. The pump chamber requires clean deionized water as a coolant. The resistivity should be about 1 MΩ·cm (conductivity ~ 1 S/cm) and should be free of organic contamination. High quality stainless steel, such as 316-L is acceptable, but parts should be passivated. Aluminum must be anodized with a high quality process, such as MIL-A-8625F, Type II, Class 1. Titanium is also acceptable and Grade 2 (unalloyed, standard oxygen) has been used successfully. Copper and cooper alloys, such as brass, should be avoided. Many plastics, including polypropylene, polyethylene, Teflon, Delrin, Noryl, etc. have been used successfully, but it is important that these materials do not leach plasticizers into the coolant. Wetted materials that are rated for milk transport are often good candidates for cooling system components. When considering cooling components, it is important to ensure the components do not introduce contamination into the coolant. This is different from the components being "compatible with distilled or deionized water." Ordinary Steam Distilled Water, available from grocery stores usually has a resistivity of 0. 6- 1.2 MΩ·cm and this is acceptable coolant if laboratory distilled or deionized water is not available. If all wetted components are inert, it is generally not necessary to use a deionization filter in the cooling system. If a deionization filter is used, ensure it does not introduce organic contamination into the coolant. The UV from the flashlamp will sterilize biological organisms in the coolant. If the system will not be operated for more than a month, the cooling system should be drained and dried using filtered compressed air or UHP nitrogen. For a system that is used weekly, the coolant should be changed every six months. Wetted components in the pump chamber include anodized 6061-T6 aluminum, passivated SS 316-L, silicate glass or fused silica, and silicon O-rings.

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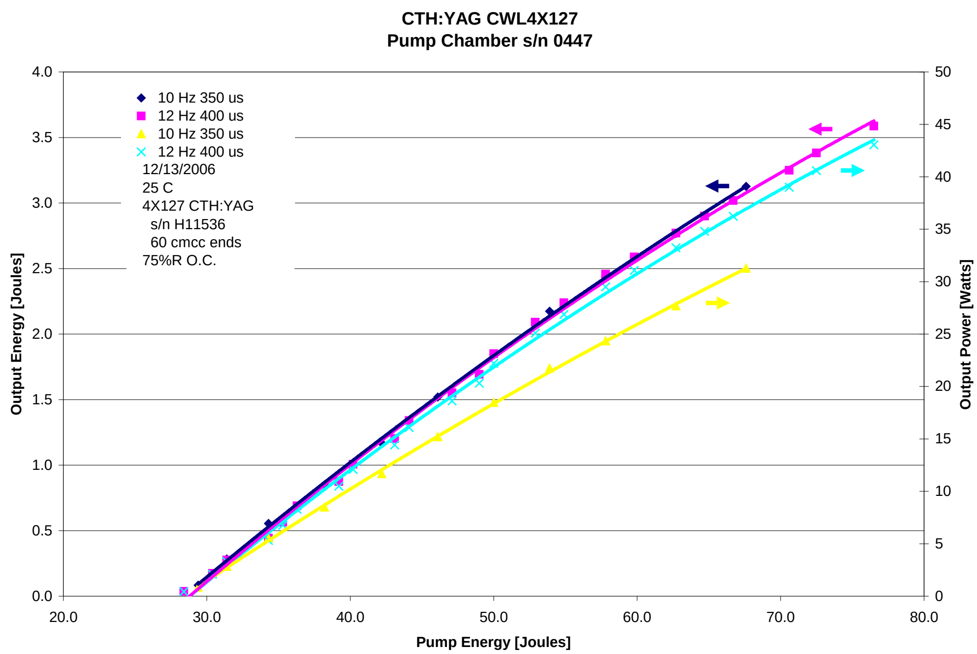
Coolant flow for the 4X125 and 4X125C2 pump chambers should be 10 – 12 liters per minute. Note the majority of pump chamber failures are caused by inadequate coolant flow.

This data may be useful to our CTH:YAG customers. This data was acquired with a CWL4X127 pump chamber, which is internally essentially equivalent to our 4X125 pump chamber design. The first plot shows output energy and power as a function of pump energy for 10Hz/350μs and 12Hz/400μs.



The second plot shows the output energy as a function of pump energy for a 60cmcc rod. At 15Hz, the average pump power is approaching 1kW and the spot size on the mirrors is very small. For longevity, I do not recommend operating this resonator design at average pump power greater then about 900 watts.

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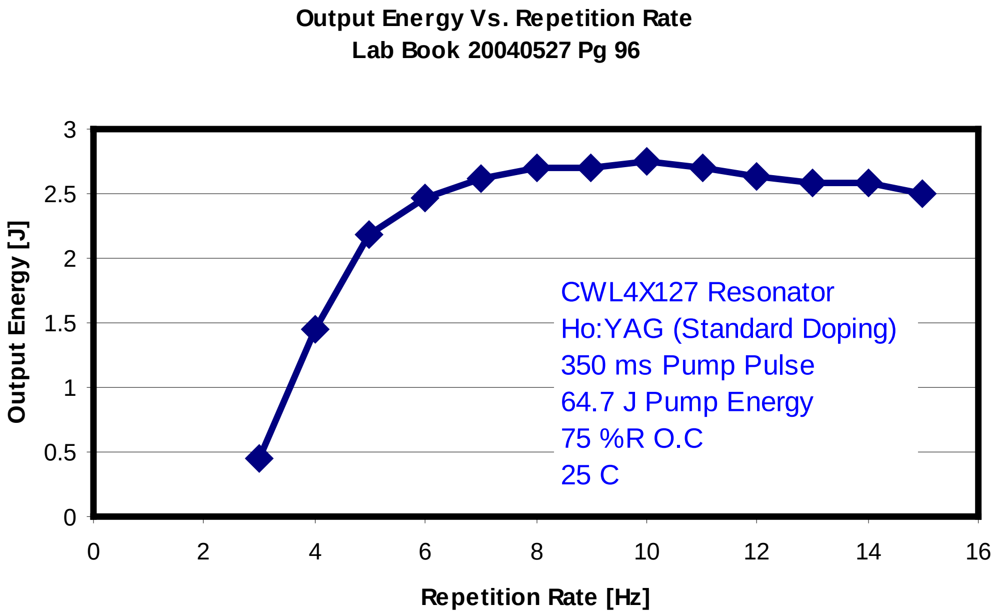
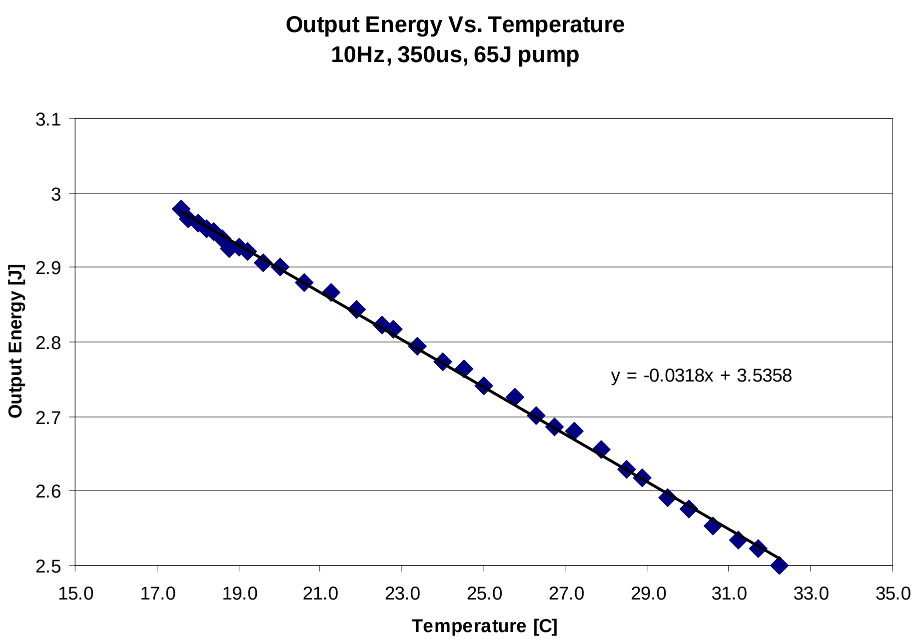


CTH:YAG is very sensitive to temperature changes. As shown in the following chart, the resonator loses about 3%/°C temperature rise.



The next two plots illustrate the raw divergence of the resonator by measuring "energy into the bucket." This means that the energy was measured through an aperture that defines 20 mrad. The ratio of the aperture through the aperture with the total energy is

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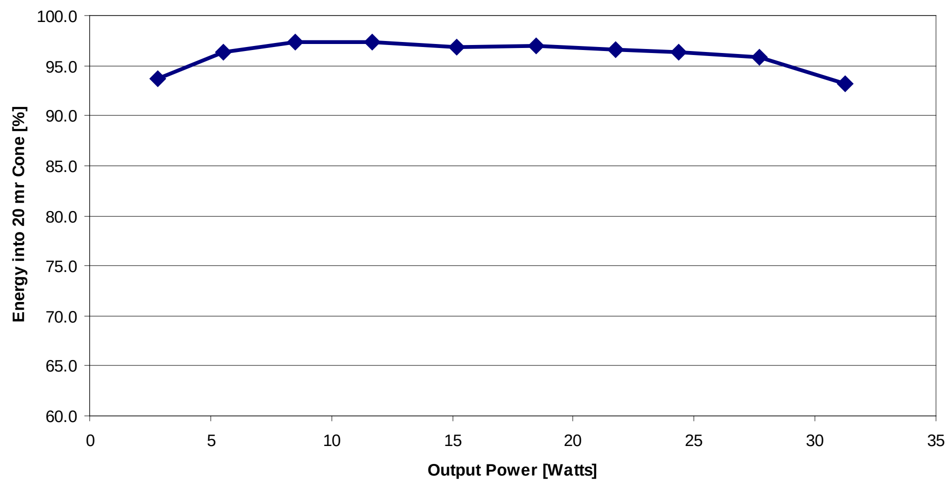
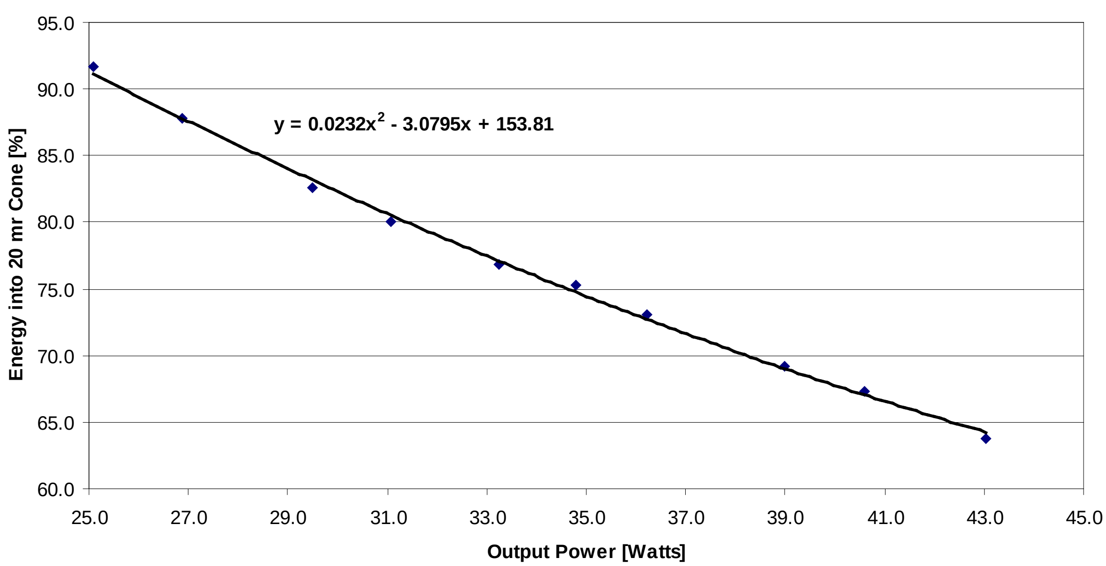
plotted against output power. The divergence angle is defined as the point where $1/e^2$ (86%) of the total energy is lost. In the 10Hz/350µs data set, the $1/e^2$ point is not reached; however, in the 12Hz/400µs data set, the $1/e^2$ point is reached at 28 Watts. Please note, this is only a measurement of raw beam divergence; it is not a measurement of beam quality and the beam quality cannot be derived from this data as the waist size and location are not know.

Divergence
CWL4X127, 10 Hz, 350 us, 25 C



Divergence
CWL4X127, 12 Hz, 400 us, 25 C



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