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Technical Note

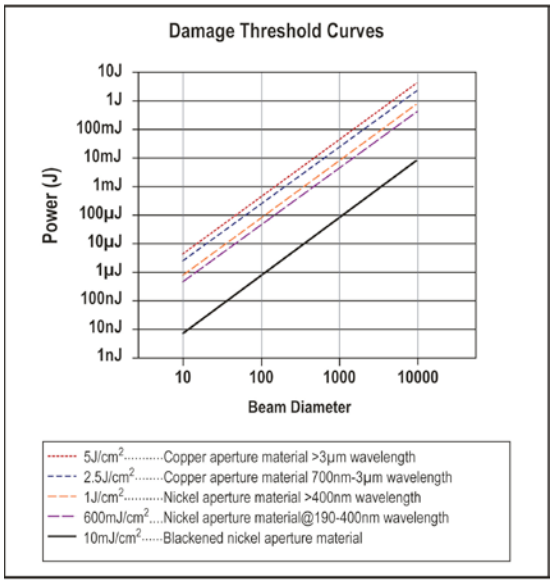
Determining Damage Thresholds for Laser Measurement with a Slit Based Profiler

Measuring lasers can be a daunting task, particularly as the power or energy levels get higher. Many applications require that precise information about laser beam sizes be known, but these lasers may be capable of damaging the profilers. The slit-based profiler, such as the Photon NanoScan is ideally suited for measuring these higher power lasers, because it can accept a relatively high powered beam directly, without attenuation. Nonetheless there are limits. Determining these limits can be complicated, especially if the laser is operated in the pulsed mode, since both power and energy can contribute to the damage threshold.

Continuous wave lasers are measured in Power, or watts per cm²; pulsed lasers are measured in Energy, or Joules per cm². The energy is a function of the average power and the pulse frequency and is inversely related to the frequency. The formula for this is simply:

$$E_{pulse} = \frac{P_{avg}}{f_{laser}}$$

Therefore the higher the frequency, the lower the energy. Some lasers have adjustable frequency, and it is very important to remember that if the frequency is lowered the energy goes up; *e.g.,* a perfectly safe level at 80 kHz may damage the scanhead at 60 kHz.



Photon has developed a tool to assist customers in determining the damage potential for their lasers. It is an Excel® spreadsheet called the “Slit Damage Calculator” which is available on the Photon website, www.photon-inc.com, or by requesting it by phone or email.

Using the Calculator

The Slit Damage Calculator is divided into five rows that represent the type of slit material (standard blackened, standard unblackened or copper) and the wavelength regime of the laser. Select the row that represents the NanoScan slit type and the appropriate wavelength regime.[1]

Enter the values for the approximate smallest beam diameter to be measured, the average power and the pulse frequency. If the laser is CW, enter CW in this space[2]. The spread sheet will then calculate the power and energy densities, and if they exceed the damage thresholds for either value, that value will be displayed in red. Note that it is entirely possible to be within the safe area for power, but exceed the energy damage threshold. This is real, and it will cut the slit material.

Values can only be entered into the diameter, average power and frequency spaces. All the other parameters are calculated. Sometimes users will only know the energy parameter of a laser. In this case, simply enter the frequency and then adjust the average power value until the calculated energy is the expected value.

Slit	WL Range	Diameter(um)	Avg Pwr(W)	Freq(kHz)	Energy(J)	Power Density(W/cm^2)	Energy density (J/cm^2)
Cu	>3um	3000	500	5	1.00E-01	7.07E+03	1.41E+00
Cu	700nm-3um	30	1	10	1.00E-04	1.41E+05	***1.41E+01***
Ni/Cu	190-400nm	1000	0.8	0.1	8.00E-03	1.02E+02	***1.02E+00***
Ni	>400nm	2500	100	100	1.00E-03	2.04E+03	2.04E-02
Ni Blk	190-700nm	100	0.001	70	1.42857E-08	1.27E+01	1.82E-04
Ni Blk	700nm>3um	1000	0.1	cw	NA	1.27E+01	NA

Although this calculator was designed for use with the NanoScan slit based profiler, it can also be useful in determining the energy or power densities for selecting attenuators for camera applications as well.

[1] The slit’s resistance to damage is based on a combination of reflectivity and heat dissipation. The reflectivity varies as a function of the wavelength.

[2] CW will cause the sheet to report NA for all the energy results