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High Power NanoScan

High Dynamic Range Beam Profilers

NanoScan for High-Power Beam Applications

Photon's High-Power NanoScan can measure focused CO_2 laser beams up to 5 kilowatts. The High-Power NanoScan is equipped with a pyroelectric detector with copper slits and drum. A cooling fan mounted on the scan head body provides additional heat management. With the new "peak connect" algorithm and the software controlled variable scan speed, the High-Power NanoScan is ideal for measuring lasers operating with pulse width modulation (PWM) power control. Measurement of Q-switched lasers and other higher frequency pulsed lasers is also possible using this feature.

What Can be Measured?

Measuring high-power beams can be tricky. The lasers have the potential to damage the scan head, and any reflected light can be dangerous to both the operator and the surroundings. The High-Power NanoScan can measure these beams because it uses a combination of highly reflective components with high thermal dissipation capability. It is important to manage the reflected beam so that it neither reenters the laser cavity nor sends stray beams into the surrounding area. The scan head is designed to make short duration measurements to avoid excessive heating of components. The head should be only in the incident beam for 10 to 60 seconds depending on the power levels to prevent excessive heating of the components. The High-Power NanoScan scan head has been shown to be able

to handle power densities of $3.2 MWcm^{-2}$ at 10.6µm, the power density of a 200µm beam at 1kW. At the shorter wavelengths of the other common industrial lasers, Nd:YAG and DPSS, the upper limits are a little less, due to the slightly lower reflectivity of the components at wavelengths around 1000nm. Visible and UV lasers can also be measured, but these will have lower limits yet.

Measuring Pulsed Lasers

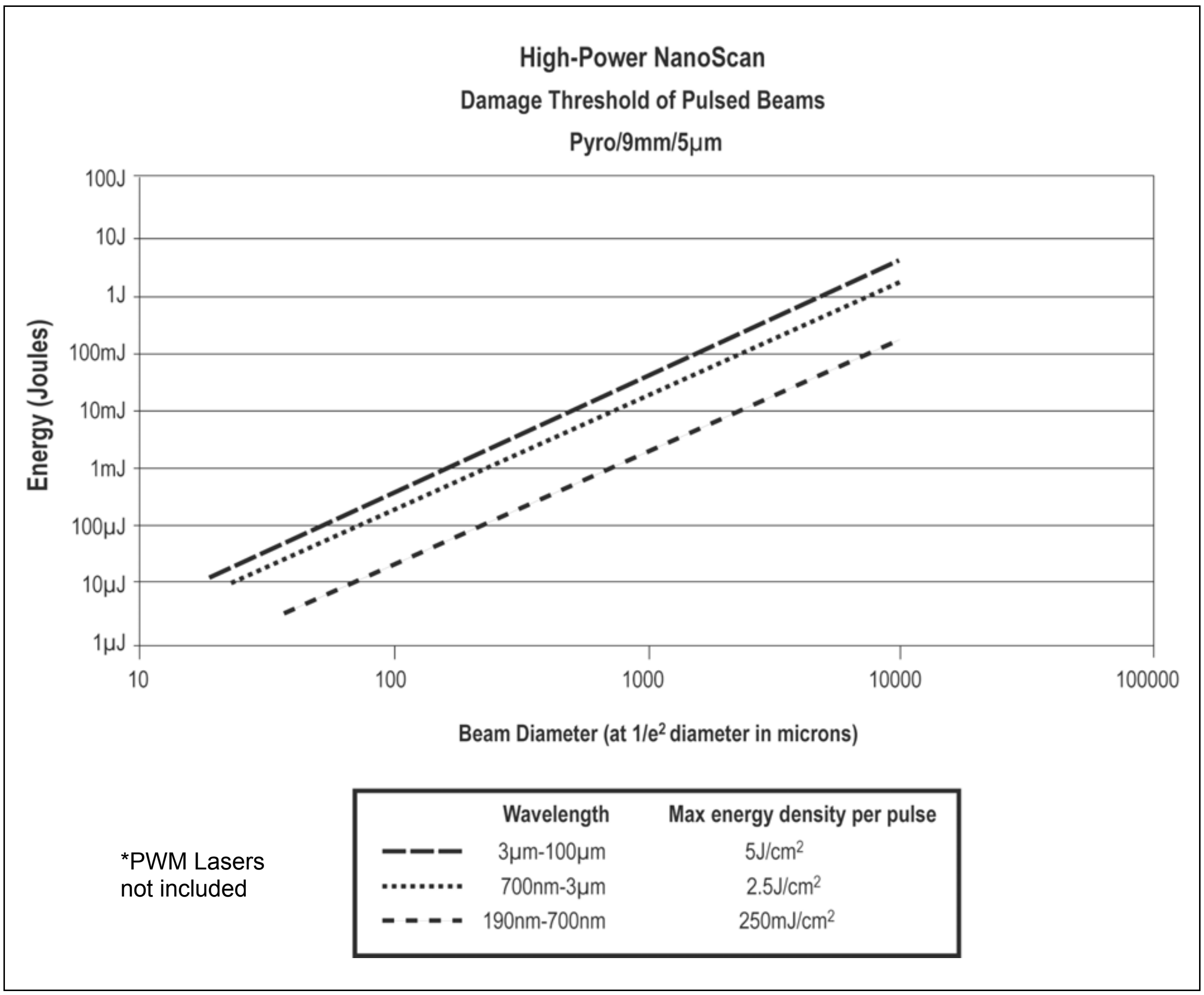
The actual energy per pulse is an important consideration for pulsed beams. Individual pulses may damage the scan head, even when the average power falls within the safe region of the operating space chart. For this reason it is necessary to understand the limits in Joules for lasers that use pulsing to increase the delivered energy, most commonly the Q-Switched laser. PWM lasers can be treated as CW for power/energy considerations.

Chart 1 below shows the damage thresholds for pulsed beam energies for the three wavelength regimes. The lines represent the maximum energies per pulse for various spot sizes that correspond to 5J/cm^2 for the 3µm to 100µm wavelengths, 2.5J/cm^2 for the 700nm to 3µm range, and 250mJ/cm^2 for the UV-Visible range from 190nm to 700nm. When operating with pulsed lasers, calculate the energy per pulse to ensure that the values fall below these lines for the wavelength of the laser. Operation above these values will likely cause damage to the scan head apertures.

The three Operating Space Charts that follow present minimum and maximum measurable laser powers for various spot sizes for lasers with wavelengths from 3µm to over 100µm (Chart 2), which includes the common lines for CO_2 lasers; wavelengths from 700nm to 3µm (Chart 3); and wavelengths from 190nm to 700nm (Chart 4).

For more information on measuring pulsed lasers, refer to Photon's Application Note, *Measuring Pulsed Beams with a Slit-Based Profiler.* Available on the Photon website.

Chart 1 – Damage Threshold of Pulsed Beams*

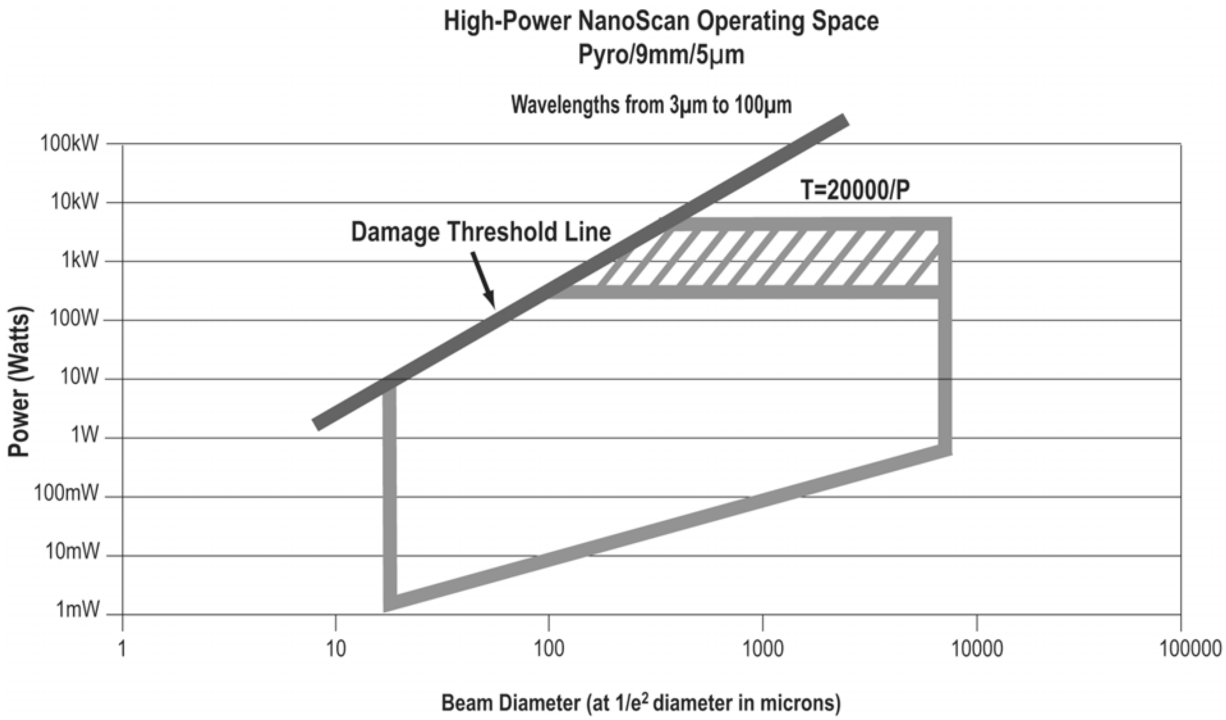


Operating Space Charts

Operating Range is at Peak Sensitivity of Detector.
Operating Space is NOT absolute.
THESE CHARTS TO BE USED AS A GUIDE ONLY.

Chart 2

3µm to 100µm Wavelength Regime



This chart shows minimum and maximum measurable laser powers for various spot sizes for lasers with wavelengths in the 3µm to over 100µm, which includes the common lines for CO_2 lasers. The spot size ($1/e^2$) is in microns. The upper boundary is limited by the detector saturation and/or the maximum input power density, which is **$5x10^6$ Watts/cm^2**. The left boundary is limited by the smallest accurately measurable spot size, which is dependent on the slit width, and the right side represents the useful instrument detector diameter. Generally the largest beam size will be approximately this value divided by 1.3 to1.5. The lower boundary represents the lowest useful input power, below which the signal-to-noise ratio will be less than 10:1.

The front cap entrance aperture diameter is larger than the instrument detector diameter to prevent light reflected from the scan drum being captured on the inside of the front cap and heating it. The beam should be centered in the aperture to ensure that it will be correctly measured.

Boundary line widths are extremely wide. This is because these boundaries are imprecise due to actual detector response and slit width variations. Damage to apertures is a function of many things including surface finish, tarnish, dirt and more. Thus the boundaries are only a guide. The life of the scan head will be increased if you expose the high power for the shortest time needed to get your measurement.

The crosshatched area indicates power levels that require limited exposure times. For example, at **5000 Watts** we suggest a four-second exposure.

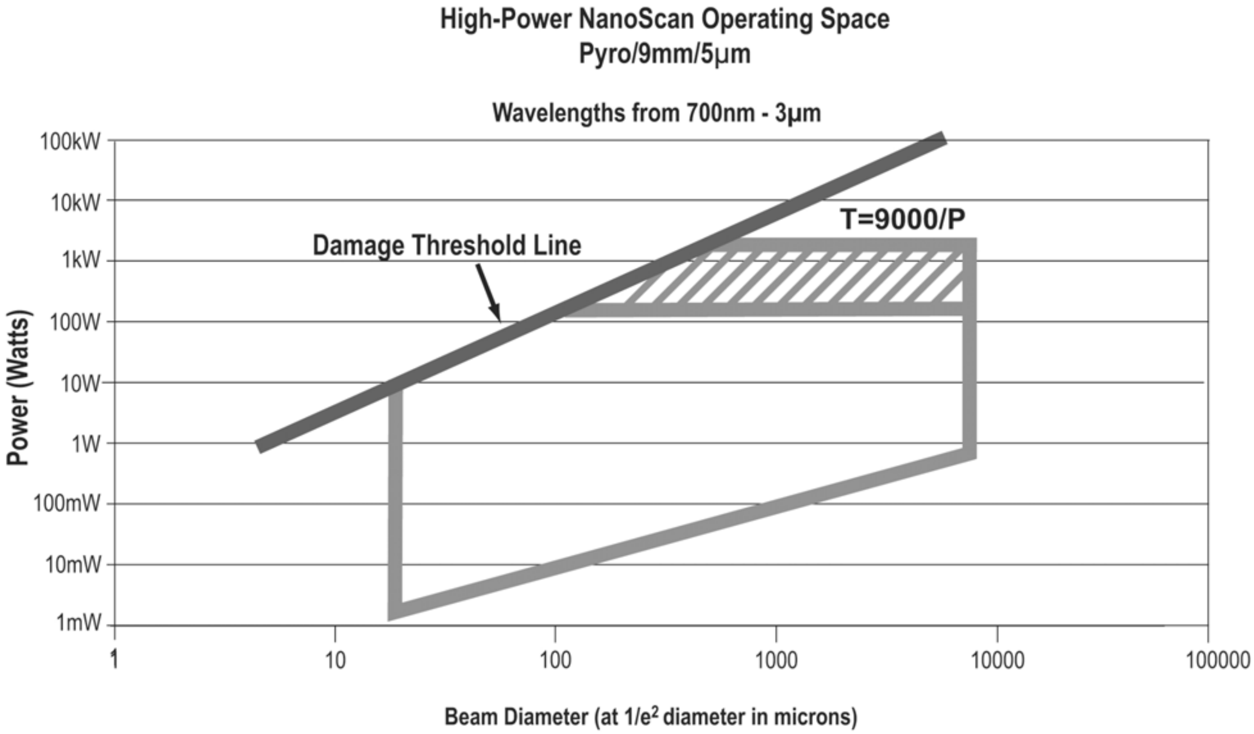
The suggested maximum exposure time for powers within the crosshatched area can be estimated from the equation below.

T(sec)= 20000/laser power in watts

Below the crosshatched area and within the operating space continuous operation should be possible without heating the scan head unduly, provided that the fan is functioning and airflow is unimpeded.

Chart 3

700nm to 3µm Wavelength Regime



This chart shows minimum and maximum measurable laser powers for various spot sizes in the 700nm to 3µm range. The spot size ($1/e^2$) is in microns. The upper boundary is limited by the detector saturation and/or the maximum input power density, which is **$2.2x10^6$ Watts/cm^2**. The left boundary is limited by the smallest accurately measurable spot size, which is dependent on the slit width, and the right side represents the useful instrument detector diameter. Generally the largest beam size will be approximately this value divided by 1.3 to1.5. The lower boundary represents the lowest useful input power, below which the signal-to-noise ratio will be less than 10:1.

The front cap entrance aperture diameter is larger than the instrument detector diameter to prevent light reflected from the scan drum being captured on the inside of the front cap and heating it. The beam should be centered in the aperture to ensure that it will be correctly measured.

Boundary line widths are extremely wide. This is because these boundaries are imprecise due to actual detector response and slit width variations. Damage to apertures is a function of many things including surface finish, tarnish, dirt and more. Thus the boundaries are only a guide. The life of the scan head will be increased if you expose the high power for the shortest time needed to get your measurement.

The crosshatched area indicates power levels that require limited exposure times. For example, at **2272 Watts** we suggest a four second exposure.

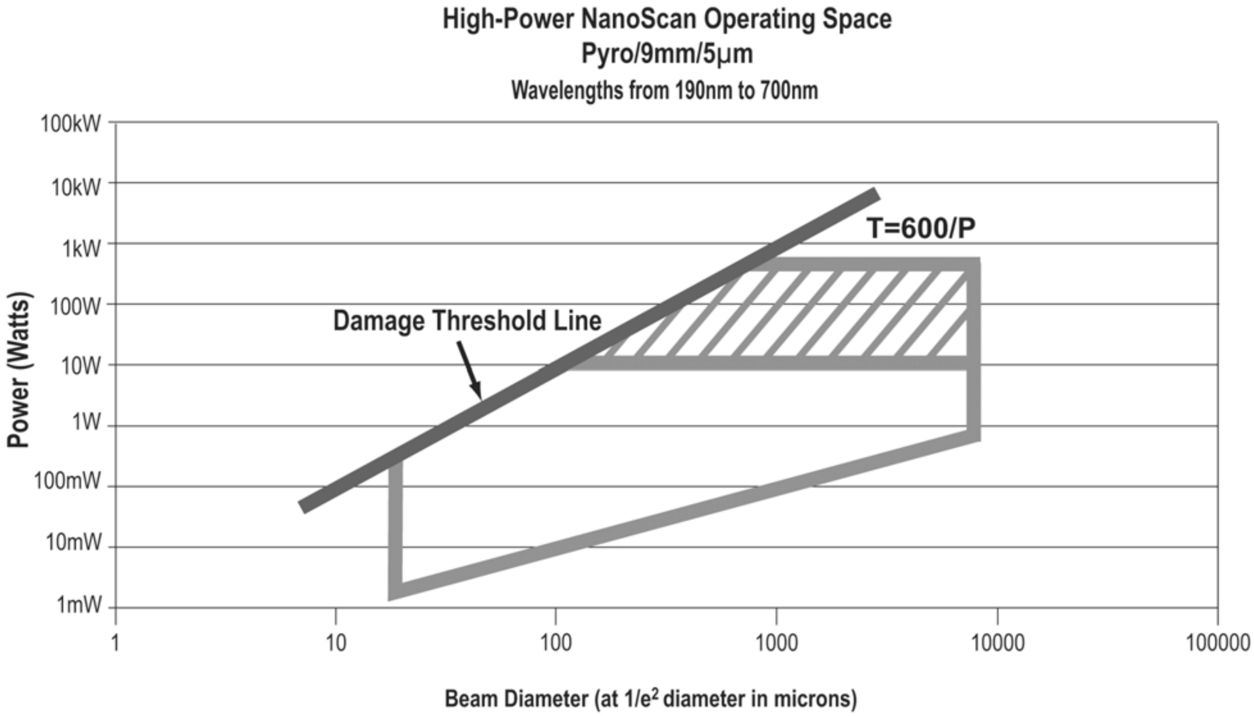
The suggested maximum exposure time for powers within the crosshatched area can be estimated from the equation below.

T(sec)= 9000/ laser power in watts

Below the crosshatched area and within the operating space continuous operation should be possible without heating the scan head unduly, provided that the fan is functioning and airflow is unimpeded.

Chart 4

190nm to 700nm Wavelength Regime



This chart shows minimum and maximum measurable laser powers for various spot sizes in the 190nm to 700nm range. The spot size ($1/e^2$) is in microns. The upper boundary is limited by the detector saturation and/or the maximum input power density, which is **0.16×10^6 Watts/cm^2**. The left boundary is limited by the smallest accurately measurable spot size, which is dependent on the slit width, and the right side represents the useful instrument detector diameter. Generally the largest beam size will be approximately this value divided by 1.3 to1.5. The lower boundary represents the lowest useful input power, below which the signal-to-noise ratio will be less than 10:1.

The front cap entrance aperture diameter is larger than the instrument detector diameter to prevent light reflected from the scan drum being captured on the inside of the front cap and heating it. The beam should be centered in the aperture to ensure that it will be correctly measured.

Boundary line widths are extremely wide. This is because these boundaries are imprecise due to actual detector response and slit width variations. Damage to apertures is a function of many things including surface finish, tarnish, dirt and more. Thus the boundaries are only a guide. The life of the scan head will be increased if you expose the high power for the shortest time needed to get your measurement.

The crosshatched area indicates power levels that require limited exposure times. For example, at **156 Watts** we suggest a four second exposure.

The suggested maximum exposure time for powers within the crosshatched area can be estimated from the equation below.

T(sec)= 600/ laser power in watts

Below the crosshatched area and within the operating space continuous operation should be possible without heating the scan head unduly, provided that the fan is functioning and airflow is unimpeded.

High-Power NanoScan Mechanical Dimensions