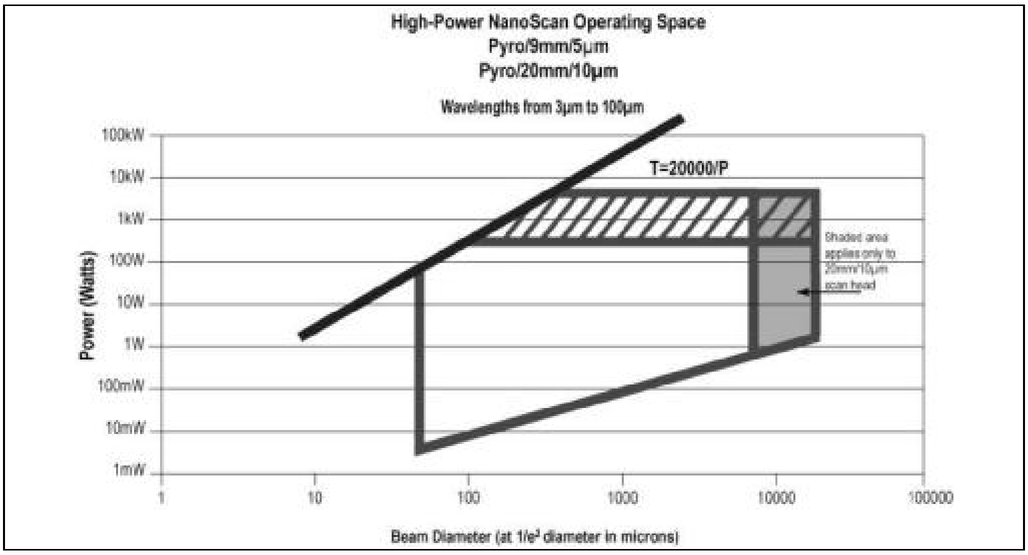
A.4. Operating Space Charts for High Power Measurements

A.4.1. 3µm to 100µm Wavelength Regime



This chart shows minimum and maximum measurable laser powers for various spot sizes for lasers with wavelengths in the 300µm to over 100µm, which includes the common lines for CO_2 lasers. The spot size ($1/e^2$) is in µm. 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 to 1.5. 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 the scan slits 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.

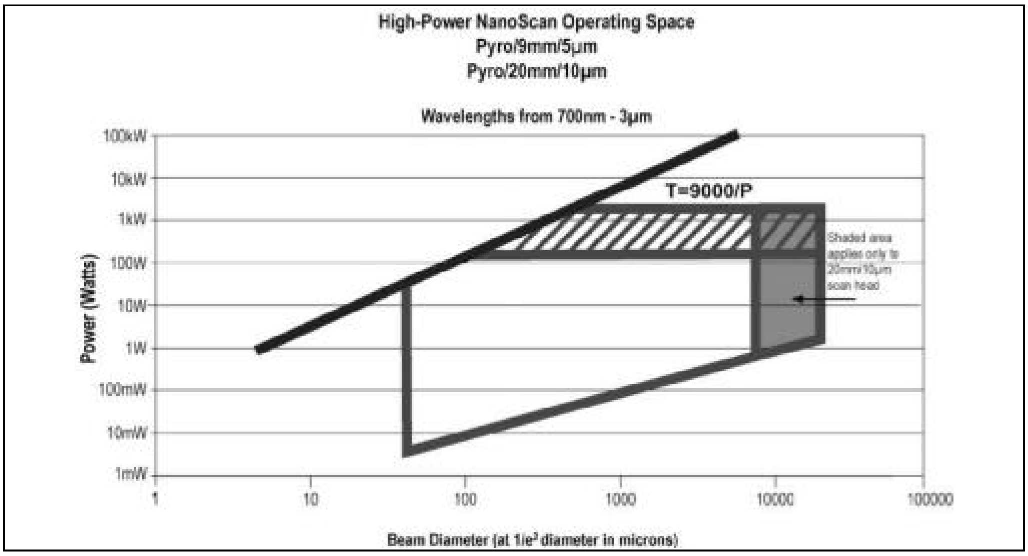
The crosshatched area indicates power levels that require limited exposure times. For example, at **5000 Watts** we suggest a four-second exposure.

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 scanhead unduly, provided that the fan is functioning and airflow is unimpeded.

A.4.2. 700nm to 3µm Wavelength Regime



This chart shows minimum and maximum measurable laser powers for various spot sizes. The spot size ($1/e^2$) is in µm. 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 to 1.5. 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 the slit material 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 slits will be increased if you expose the high power for the shortest time needed to get your measurement.

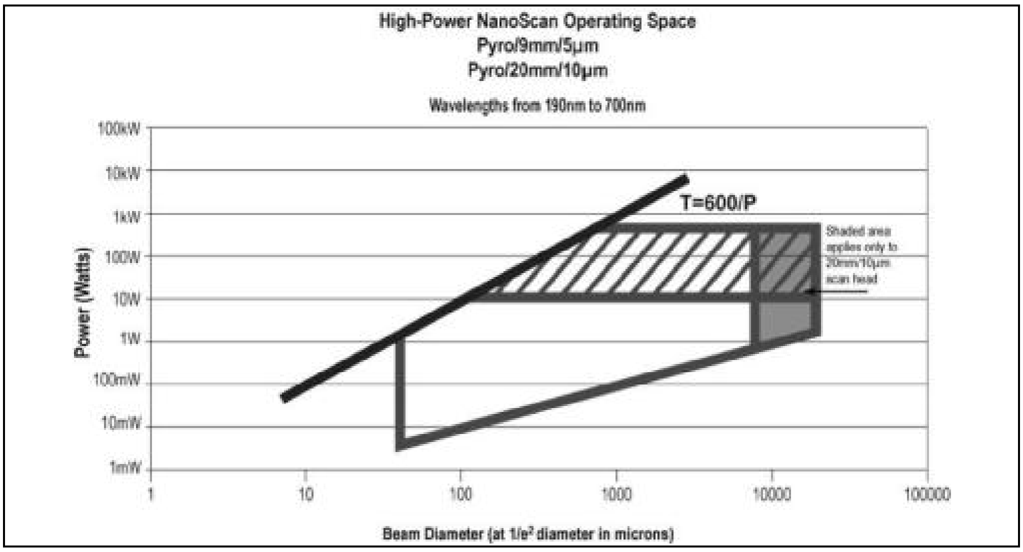
The crosshatched area indicates power levels that require limited exposure times. For example, at **2272 Watts** a four second exposure is suggested.

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 over heating the scanhead, provided that the fan is functioning and airflow is unimpeded.

A.4.3. 190nm to 700nm Wavelength Regime



The above chart shows minimum and maximum measurable laser powers for various spot sizes. The spot size (1/e^2 diameter) is in µm. The upper boundary is limited by the detector saturation and or the maximum input power density, which is **0.16x10^6 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 to 1.5. 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 the slit material 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.

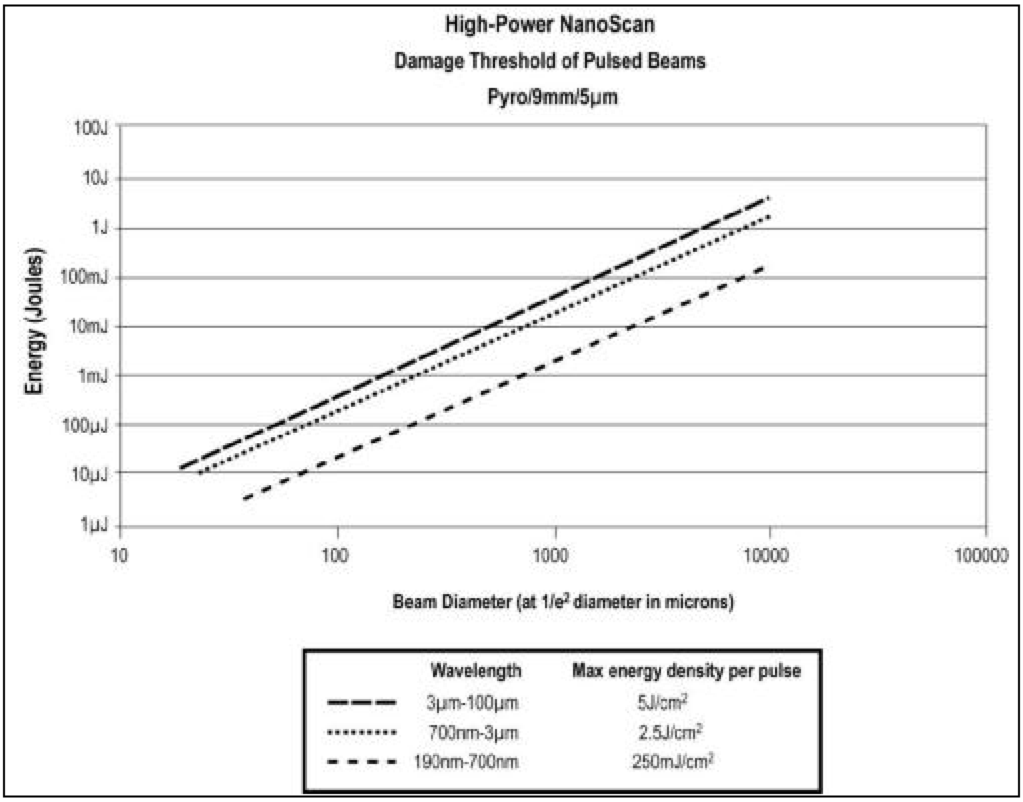
The suggested maximum exposure time for powers within the crosshatched area can be estimated from the equation below.

T(sec) = 600/ laser power in watts

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

A.5. Power Considerations for Q-Switched Pulsed Beams

The actual energy per pulse is an important additional consideration for pulsed beams. Energy is measured in joules, and as discussed above, individual pulses may damage the scanhead, 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.



This chart 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 3 to 100 micron wavelengths, 2.5J/cm^2 for the 700nm to 3 micron 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 scanhead slits.

A.6. Setup Considerations for Measuring High Power Lasers

A.6.1. Limiting High Power Exposure Time

High power lasers are designed to work materials—they cut, weld, drill, and more. Since NanoScan is based on reflective, heat-resistant metals that can be damaged by sufficiently high power density and/or long exposure times, it is advised that you keep exposures to the minimum required and within the limits discussed earlier with the Operating Space Charts. This will maximize the life of your NanoScan profiler. Heat takes time to dissipate. Measuring your high power beams too frequently, without allowing sufficient cool-down