TECHNICAL NOTE

MEASURING LASER POWER WITH THE IS SERIES: A VERSATILE SOLUTION WITH FAST RESPONSE

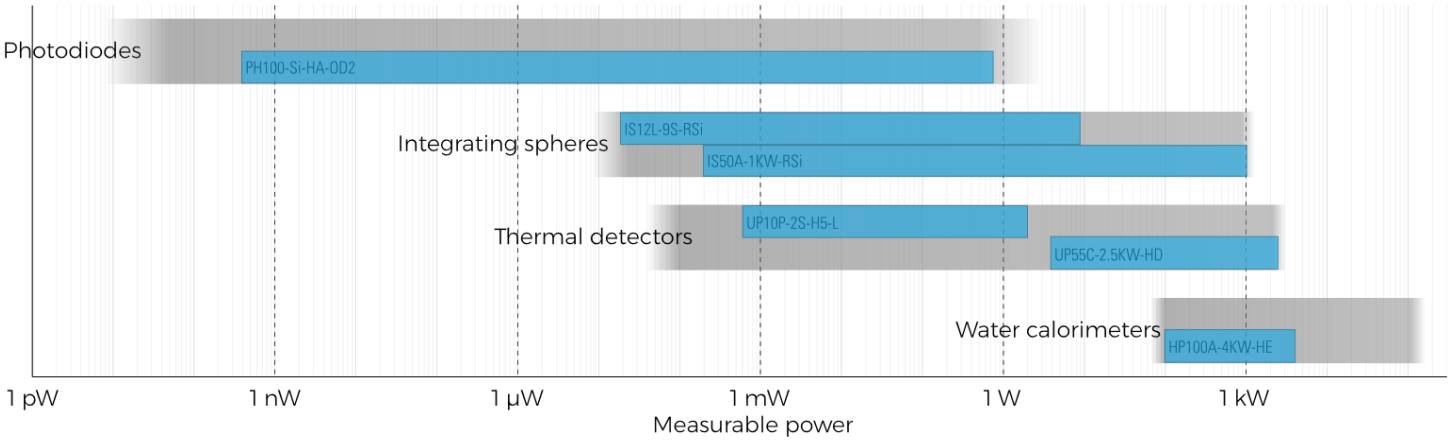
Gentec-EO's new IS power detectors combine the speed of photodetectors with the attenuation of integrating spheres. Combining these two technologies with Gentec-EO's own recipe for a high damage-threshold absorber offers many advantages, such as:

- outstanding dynamic range
- fast response
- reduced angular back-reflections

This technical note explores both the pros and cons of this technology.

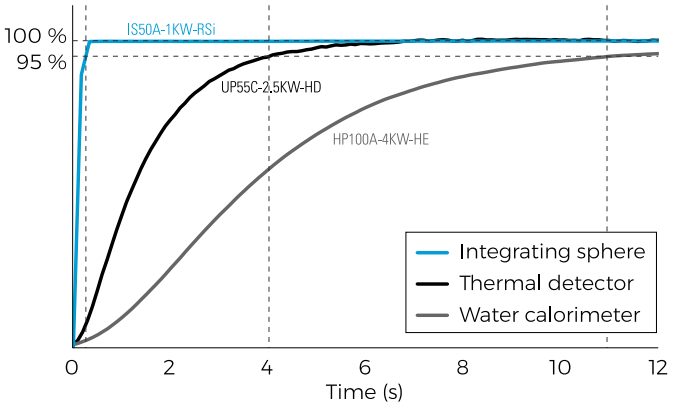
FROM LOW POWERS TO THE MULTI-KILOWATT LEVEL

The broad dynamic range and very low noise equivalent power (NEP) of the IS integrating spheres provide users the ability to measure several lasers with different average powers with only one single device, possibly lowering initial and maintenance/recalibration costs. Outstanding signal-to-noise ratios (SNR) are also more than welcome. Photodiodes have a comparable dynamic range and lower noise but cannot measure average powers above ~1 W. Thermal detectors and water calorimeters have much shorter dynamic ranges and much higher noises, but can measure average powers well above 1 kW depending on the model.



TECHNICAL NOTE

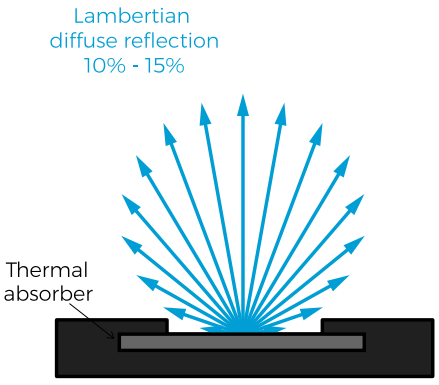
MONITOR HIGH POWER LASERS AT HIGH SPEED



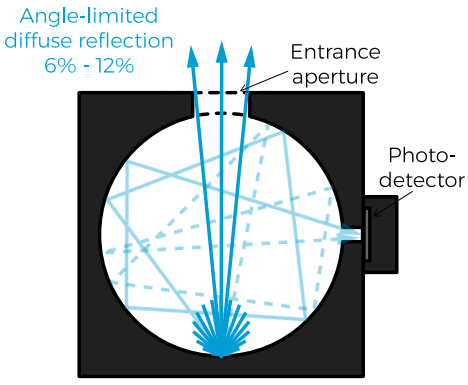
Inherently faster than thermal detectors and water calorimeters thanks to their photodiode-based sensor, integrating spheres of the IS series allow average powers of up to 1 kW to be measured in under 200 ms, tens of times faster than with both other technologies. This gives users the opportunity to follow the ramp-up of high-power sources and to discern relatively quick changes in laser power.

DIFFUSED BACK-REFLECTIONS CONFINED IN AN ANGULAR CONE

While thermal detectors and water calorimeters will diffusely reflect approximately 10% to 15% of the incoming light in a more or less Lambertian manner, integrating spheres of the IS series will reflect a lower 6% to 12% in a more directional way through their optical aperture, potentially helping security in the measurement environment by making it easier to deal with back reflections. The total angle of the cone is 30 degrees and its apex is located at the back of the sphere.



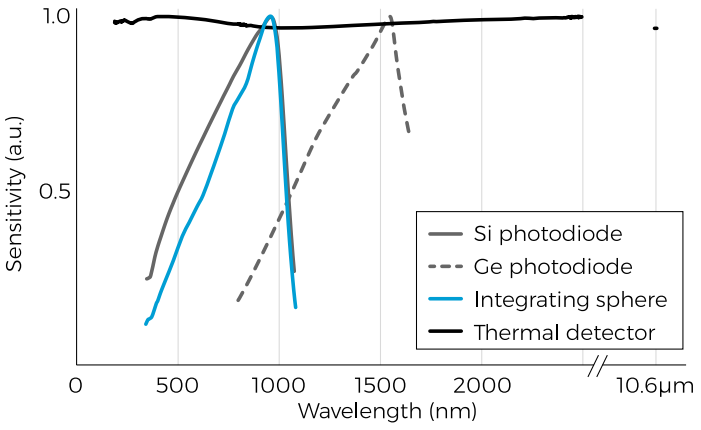
Back-reflections with a thermal detector



Back-reflections with an integrating sphere

NARROW BANDWIDTH VS BROADBAND DETECTORS

Integrating spheres of the IS series are spectrally limited as their photodiode-based sensor can only provide calibrated measurements for lasers with wavelengths contained in the 400 nm to 1070 nm range. The 340 nm to 400 nm and 1070 nm to 1100 nm ranges are for relative measurements only (uncalibrated). Thermal detectors and water calorimeters have the advantage of being broadband and having a relatively flat absorption/response from 190 nm to 20 µm. They can be calibrated from 248 nm to 2100 nm, and from 2100 nm to 2500 nm or at 10.6 µm on special request.



TECHNICAL NOTE

THE BEST DETECTOR TECHNOLOGY FOR YOUR APPLICATION

While the IS series offer many advantages, it might not be the best choice for your application. The table below summarizes the pros and cons of each laser power measurement technology currently on the market.

INTEGRATING SPHERES *IS series*	PHOTODETECTORS *PH series*	THERMAL DETECTORS *UP series*	WATER CALORIMETERS *HP series*
Fast response time (< 0.2 s) ▪ Photodiode-based sensors respond in a fraction of a second ▪ Allow users to follow the ramp-up of high-power lasers and gross temporal shape of any measurable signal	As fast (< 0.2 s)	Slower (~1 s)	Much slower (~10 s)
Broad dynamic range (~8 orders of magnitude) ▪ Can be used to measure several lasers with different levels of average power ▪ Outstanding signal-to-noise ratios for all measurements	Similar but in the lower range (~9 orders of magnitude)	Narrower, mid-range (~4 orders of magnitude)	Narrower, high-range (~3 orders of magnitude)
Low back-reflections (~6%-12%) ▪ Lower and directional back-reflections are easier to deal with when it comes to security in the measurement environment	Not much of a concern since used to measure low and very low powers only	More back-reflections (~ 10% - 15%) Diffused, Lambertian	More back-reflections (~ 10% - 15%) Diffused, Lambertian
Limited spectral range (340 nm-1100 nm) ▪ Only cover the VIS spectrum and a small portion of the NIR ▪ Not suitable for UV and IR lasers	Limited, VIS or NIR only depending on sensor type	Broadband, relatively flat spectral response from 190 nm to 20 µm	Broadband, relatively flat spectral response from 190 nm to 20 µm
Divergence-limited (20° full angle) ▪ Not suitable to measure highly-divergent sources	No limitation as long as the beam is entirely contained in the sensor	No limitation as long as the beam is entirely contained in the sensor	No limitation as long as the beam is entirely contained in the sensor
High minimum repetition rate (10 kHz) ▪ Suitable for CW or pulsed sources with high repetition rates only	Higher minimum repetition rates (~100 kHz)	Lower minimum repetition rates are required (~10 Hz)	Much lower minimum repetition rates are required (~1 Hz)

If you are in doubt as to which technology is best for you, Gentec-EO's team of laser beam measurement experts is available to help you choose.

LEADER IN LASER BEAM MEASUREMENT SINCE 1972

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