



Comparison of Laser and Incoherent Light Sources

Both Photometric and Radiometric responses to laser sources differ from the more common incoherent sources partly as a function of spectral content. Lasers are typically very narrowband emitters, usually on a single line. Compared with the more common wideband sources, laser spectra are often on the order of 1 nanometer. Tungsten-Halogen and Xenon luminaires emit spectral continuums, although some variation in intensity across the spectrum exists. Mercury vapor lamps emit characteristic spectral lines, but still have a broader spectra than any typical gas or solid state laser.

To compare the brilliance of a laser and non laser source, compensation must be made for the spectral distribution of energy and the efficacy upon the eye. Thus, light energy measured on a radiometric power meter will need to be corrected by the spectral content of the light over the efficacy upon the retina. This latter function is the Photopic response curve.

For example, two lasers are each emitting a one watt beam. One laser produces 500 mW of 488 nM and 500 mW of 647 nM, equaling one watt total. The other laser, emitting 1 watt of 532 nM, will appear much brighter to the eye as the photopic response at 532 nM is higher than the sum of both 488 nM and 647 nM. This effect is accentuated as the wavelength(s) approach either end of the photopic curve. Thus, even 1 watt of 694 nM or 415 nM light may not be especially bright.

Incoherent, broadband sources are often a continuum of wavelengths across the spectrum, with various power levels, and the same photopic efficacy curve. Blue light is less bright than green light. To compare with a laser, we could scan the emission spectrum in 1 nanometer steps, measure the power at each wavelength, apply photopic correction, and sum the results. As this is only about 300 steps, the task is reasonable. This would allow measurement of the light source with the same (milliwatts/cm²) units that would be used to measure a laser.

Standard silicon detectors have a spectral response curve that the meter calibration seeks to normalize. Assuming a linear detector, let us compare a 532 nM laser with a White light source that emits 500 mW at 450 nM, 200 mW at 500 nM, and 300 mW at 650 nM.

For this illustration, the following wavelengths will have the efficacy values:

| | |
|---------------|-------------|
| 450 nM | 0.03 |
| 532 nM | 0.85 |
| 500 nM | 0.29 |
| 650 nM | 0.14 |

Multiply each wavelength power by the efficacy value:

| | | | | |
|--------------|--------|---------|------|------------------------|
| Laser | 532 nM | 1000 mW | 0.85 | 850 mW @ 555 nM |
|--------------|--------|---------|------|------------------------|

| | | | | |
|--------------------|--------|--------|--------------|------------------------|
| White Light | 450 nM | 500 mW | 0.03 | 15 |
| | 500 nM | 200 mW | 0.29 | 58 |
| | 650 nM | 300 mW | 0.14 | 42 |
| | | | Total | 113 mW @ 555 nM |

The laser @ 532 nM will be 7.5 times brighter than the White light source.

By normalizing the power at each emitted wavelength via photopic correction, comparison of the perceived brightness of Broadband and Narrowband sources possible. However, knowledge or measurement of the spectral intensity data of the source will be necessary.

Second Example:

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|--------------------|--------|--------|--------------|------------------------|
| Argon Laser | | | | |
| | 488 nm | 400 mW | 0.129 | 52 |
| | 514 nm | 600 mW | 0.408 | 245 |
| | | | Total | 297 mW @ 555 nM |

| | | | | |
|------------------------|--------|--------|--------------|--------------------------|
| TH Incandescent | | | | |
| | 400 nm | 125 mW | 0.005 | 0.6 |
| | 450 nm | 125 mW | 0.03 | 3.75 |
| | 500 nm | 125 mW | 0.29 | 36.25 |
| | 550 nm | 125 mW | 0.99 | 124 |
| | 600 nm | 250 mW | 0.29 | 72.5 |
| | 650 nm | 250 mW | 0.14 | 35 |
| | | | Total | 272.1 mW @ 555 nM |

As a general rule, the greener the source, the brighter it will appear. Thus a laser emitting 532 will generally appear much brighter (750%) than an equal irradiance exposure from an incandescent lamp, whereas an Argon laser will appear only slightly brighter (~9%). The Nd:YAG laser @532 nm will appear nearly 3 times brighter than the Argon laser, because of its higher efficacy.