



**International
Standard**

ISO 11145

**Optics and photonics — Lasers
and laser-related equipment —
Vocabulary and symbols**

*Optique et photonique — Lasers et équipements associés aux
lasers — Vocabulaire et symboles*

**Sixth edition
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 9, *Laser and electro-optical systems*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 123, *Lasers and photonics*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement)

This sixth edition cancels and replaces the fifth edition (ISO 11145:2018), which has been technically revised.

The main changes are as follows:

- the term “power density” was replaced by “irradiance” and “energy density” was replaced by “fluence”.
- the word “radiant” was added to clarify terms for power and energy.
- “encircled-power” was added to terms [3.3.1](#), [3.4.1](#), [3.5.1](#), [3.6.1](#), [3.7.4](#), [3.7.6](#), [3.7.8](#) and [3.8.1](#).
- term and definition [3.5.3](#) “principal axis” was newly added.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Optics and photonics — Lasers and laser-related equipment — Vocabulary and symbols

1 Scope

This document defines basic terms, symbols and units of measurement for the field of laser technology in order to unify the terminology, and to arrive at clear definitions and reproducible tests of beam parameters and laser-oriented product properties.

NOTE The laser hierarchical vocabulary laid down in this document differs from that given in IEC 60825-1. ISO and IEC have discussed this difference and agree that it reflects the different purposes for which the two standards serve. For more details, see informative [Annex A](#).

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

NOTE 1 The spatial distribution of the irradiance (fluence) in a cross section of a laser beam does not always have circular symmetry. In this document, all terms related to these spatial distributions are split into those for beam cross sections with circular distributions and those for beam cross sections with non-circular distributions. A circular beam is characterized by its radius, w , or diameter, d . For a non-circular beam, the beam widths, d_x and d_y , for two orthogonal directions are given.

NOTE 2 The spatial distributions of laser beams do not have sharp edges. Therefore, the radiant power (energy) values to which the spatial terms refer are defined. Depending on the application, different cut-off values can be chosen (for example $1/e$, $1/e^2$, $1/10$ of the peak value).

NOTE 3 This document uses the subscript u to denote a percentage. For example, the percentage of the total beam power (energy) included in the value of a given parameter. When stating quantities marked by an index “ u ”, “ u ” is replaced by the specific number, e.g. A_{00} for $u = 90\%$.

NOTE 4 The beam width d_{ux} (see [3.5.1](#)) and the beam diameter d_u (see [3.3.1](#)) can differ for the same value of u ($d_{ux} \neq d_u$).

NOTE 5 In contrast to quantities defined by setting a cut-off value [“encircled radiant power (energy)”], the beam widths and derived beam properties can also be defined based on the second-order moments of the irradiance (fluence) distribution function (see [3.5.2](#)). Only beam propagation ratios (see [3.10.2](#)) that are calculated from beam widths and divergence angles derived from the second-order moments of the irradiance (fluence) distribution function allow calculation of beam propagation. In this document, quantities based on the second-order moment are marked by a subscript “ σ ”.

NOTE 6 A list of symbols is given in [Clause 4](#).

3.1 Beam position

3.1.1

beam centroid

$$\bar{x}(z), \bar{y}(z)$$

coordinates of the first-order moments of a radiant power (energy) distribution of a beam at location z

$$\bar{x}(z) = \frac{\iint x \cdot E(x, y, z) \cdot dx dy}{\iint E(x, y, z) \cdot dx dy}$$

$$\bar{y}(z) = \frac{\iint y \cdot E(x, y, z) \cdot dx dy}{\iint E(x, y, z) \cdot dx dy}$$

where the integration shall be performed over an area such that at least 99 % of the beam power (energy) is captured

Note 1 to entry: The irradiance, E , is replaced by the fluence, H , for pulsed lasers.

Note 2 to entry: "Centre of gravity", "beam position" and the term "beam centroid" are equivalent, formerly the term was called "beam position".

Note 3 to entry: These quantities are defined in the beam axis system x, y, z , in which z is the direction of propagation of the beam.

3.1.2

beam positional stability

$$\Delta x(z'), \Delta y(z')$$

four times the standard deviation of the measured beam positional movement at plane z'

$$\Delta x(z') = 4 \sqrt{\frac{\sum_{i=1}^N [\bar{x}(z')_i - \overline{\bar{x}(z')}]^2}{N-1}}$$

$$\Delta y(z') = 4 \sqrt{\frac{\sum_{i=1}^N [\bar{y}(z')_i - \overline{\bar{y}(z')}]^2}{N-1}}$$

where $\bar{x}(z')$ and $\bar{y}(z')$ are the beam centroids in the z' plane, $\overline{\bar{x}(z')}$ and $\overline{\bar{y}(z')}$ are the arithmetic means of the beam centroids in the z' plane, and N is the number of measurements

Note 1 to entry: The term "beam positional stability" is sometimes referred to as "spatial fluctuation widths", as in ISO 11670.

3.2 Beam axis

3.2.1

beam axis

straight line connecting the centroids defined by the first-order spatial moments of the cross-sectional irradiance (fluence) distribution function at successive locations in the direction of propagation (z) of the beam in a homogeneous medium

3.2.2

misalignment angle

$$\Delta \vartheta$$

deviation angle of the beam axis from the mechanical axis defined by the manufacturer

3.3 Beam diameter

3.3.1

encircled-power beam diameter

$d_u(z)$

<encircled radiant power (energy)> diameter of a circular aperture in a plane perpendicular to the beam axis that contains u % of the total beam power (energy)

Note 1 to entry: For clarity, the term “beam diameter” is always used in combination with the symbol and its appropriate subscript: d_u or d_σ .

Note 2 to entry: To measure encircled radiant power, using the “variable aperture method”, see ISO 11146-series.

3.3.2

beam diameter

$d_\sigma(z)$

<second-order moment of irradiance (fluence) distribution function> diameter defined by using the second-order moment of the irradiance (fluence) distribution function

$$d_\sigma(z) = 2\sqrt{2}\sigma(z)$$

where the second-order moment of the irradiance distribution function $E(x, y, z)$ of the beam at location z is given by:

$$\sigma^2(z) = \frac{\iint \left([x - \bar{x}(z)]^2 + [y - \bar{y}(z)]^2 \right) \cdot E(x, y, z) \cdot dx dy}{\iint E(x, y, z) \cdot dx dy}$$

where the first-order moments give the coordinates of the beam centroid $[\bar{x}(z), \bar{y}(z)]$

Note 1 to entry: For clarity, the term “beam diameter” is always used in combination with the symbol and its appropriate subscript: d_u or d_σ .

3.4 Beam radius

3.4.1

encircled-power beam radius

$w_u(z)$

<encircled radiant power (energy)> radius of a circular aperture in a plane perpendicular to the beam axis which contains u % of the total beam power (energy)

Note 1 to entry: For clarity, the term “beam radius” is always used in combination with the symbol and its appropriate subscript: w_u or w_σ .

Note 2 to entry: The beam radius is half the beam diameter $d_u(z)$.

3.4.2

beam radius

$w_\sigma(z)$

<second-order moment of irradiance (fluence) distribution function> radius defined by using the second-order moment of the irradiance (fluence) distribution function

$$w_\sigma(z) = \sqrt{2}\sigma(z)$$

Note 1 to entry: For clarity, the term “beam radius” is always used in combination with the symbol and its appropriate subscript: w_u or w_σ .

Note 2 to entry: The beam radius is half the beam diameter $d_\sigma(z)$.