SLOVENSKI STANDARD
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Optika in fotonska tehnologija - Laserji in z laserji povezana oprema - Slovar in simboli (ISO/DIS 11145:2017)

Optics and photonics - Lasers and laser-related equipment - Vocabulary and symbols (ISO/DIS 11145:2017)

Optik und Photonik - Laser und Laseranlagen - Begriffe und Formelzeichen (ISO/DIS 11145:2017)

Optique et photonique - Lasers et équipements associés aux lasers - Vocabulaire et symboles (ISO/DIS 11145:2017)

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31.260	Optoelektronika, laserska oprema	Optoelectronics. Laser equipment

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

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

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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 documents 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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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 172, *Optics and photonics*, Subcommittee SC 9, *Electro-optical systems*.

This fifth edition cancels and replaces the fourth edition ISO 11145:2016, which has been technically revised and includes the following changes:

a) The term beam ellipticity was clarified;

b) The term optical resonator was included;

c) The formula in the term beam diameter was adjusted.

d) The order of the terms has been adjusted.

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 terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

NOTE 1 The spatial distribution of the power (energy) density in a laser beam does not always have circular symmetry. In this document, all terms related to these distributions are split into those for beams with circular cross-sections and those with non-circular cross-sections. 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 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 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_{90} for u = 90 %.

NOTE 4 The beam width $d_{x,u}$ (see 3.5.1) and the beam diameter d_u (see 3.3.1) may differ for the same value of u ($d_{x,u} \neq d_u$).

NOTE 5 In contrast to quantities defined by setting a cut-off value ["encircled power (energy)"], the beam widths and derived beam properties can also be defined based on the second moment of the power (energy) density distribution function (see 3.5.2). Only beam propagation ratios (see 3.7) that are calculated from beam widths and divergence angles derived from the second moments of the power (energy) density distribution function allow calculation of beam propagation. In this document, quantities based on the second moment are marked by a subscript "σ".

3.1 Beam axis

3.1.1
beam axis

straight line connecting the centroids defined by the first spatial moment of the cross-sectional power (energy) density distribution function at successive positions in the direction of propagation (z) of the beam in a homogeneous medium

3.1.2
misalignment angle

$\Delta\vartheta$

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

3.2 Beam cross-sectional area

3.2.1
beam cross-sectional area

$A_u(z)$

⟨encircled power (energy)⟩ smallest completely filled area containing *u* % of the total beam power (energy)

Note 1 to entry: For clarity, the term “beam cross-sectional area” is always used in combination with the symbol and its appropriate subscript: A_u or $A_{\boldsymbol{\sigma}}$.

3.2.2
beam cross-sectional area

$A_\sigma(z)$

⟨second moment of power (energy) density distribution function⟩ area of a beam with circular cross-section

$$\left(\frac{\pi}{4}\right) \cdot d_\sigma(z)^2$$

or elliptical cross-section

$$\left(\frac{\pi}{4}\right) \cdot d_{\sigma x}(z) \cdot d_{\sigma y}(z)$$

Note 1 to entry: For clarity, the term “beam cross-sectional area” is always used in combination with the symbol and its appropriate subscript: A_u or $A_{\boldsymbol{\sigma}}$.

3.3 Beam diameter

3.3.1
beam diameter

$d_u(z)$

⟨encircled 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 $d_{\boldsymbol{\sigma}}$.

3.3.2

beam diameter

$d_\sigma(z)$

⟨second moment of power (energy) density distribution function⟩ diameter defined by using the second moment of the power (energy) density distribution function

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

where the second moment of the power density distribution function *E(x,y,z)* of the beam *z* is given by

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

where the first moments give the coordinates of the centroid $(\bar{x}(z), \bar{y}(z))$, i.e.

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

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

and 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 power density E is replaced by the energy density H for pulsed lasers.

Note 2 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

beam radius

$w_u(z)$

⟨encircled 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.

3.4.2

beam radius

$w_\sigma(z)$

⟨second moment of power (energy) density distribution function⟩ radius defined by the using the second moment of the power (energy) density distribution function

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

Note 1 to entry: For a definition of the second moment $\sigma^2(z)$, see 3.3.2.

Note 2 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.

3.5 Beam width

3.5.1
beam width
$d_{x,u}(z)$, $d_{y,u}(z)$
<slit transmitted power (energy)> width of the smallest slit aligned with the x or y transverse axes of the power (energy) density distribution function, transmitting u % of the total beam power (energy) along x or y.

Note 1 to entry: For circular Gaussian beams, $d_{x,95,4}$ equals $d_{86,5}$.

Note 2 to entry: For clarity, the term "beam width" is always used in combination with the symbol and its appropriate subscripts: $d_{\sigma x}$, $d_{\sigma y}$ or $d_{x,u}$, $d_{y,u}$.

3.5.2
beam width
$d_{\sigma x}(z)$, $d_{\sigma y}(z)$
⟨second moment of power (energy) density distribution function⟩ width defined by using the second moment of the power (energy) density distribution function along x or y

$$d_{\sigma x}(z) = 4\sigma_x(z)$$

$$d_{\sigma y}(z) = 4\sigma_y(z)$$

where the second moments of the power density distribution function $E(x, y, z)$ of the beam at at z are given by

$$\sigma_x{}^2(z) = \frac{\iint (x-\bar{x})^2 \cdot E(x,y,z) \cdot \mathrm{d}x\mathrm{d}y}{\iint E(x,y,z) \cdot \mathrm{d}x\mathrm{d}y}$$

$$\sigma_y{}^2(z) = \frac{\iint (y-\bar{y})^2 \cdot E(x,y,z) \cdot \mathrm{d}x\mathrm{d}y}{\iint E(x,y,z) \cdot \mathrm{d}x\mathrm{d}y}$$

where $(x-\bar{x})$ and $(y-\bar{y})$ are the distances from the current point's coordinates to the centroid $(\bar{x}, \bar{y})$ and where the first moments give the coordinates of the centroid, i.e

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

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

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 power density E is replaced by the energy density H for pulsed lasers.

Note 2 to entry: For clarity, the term "beam width" is always used in combination with the symbol and its appropriate subscripts: $d_{\sigma x}$, $d_{\sigma y}$ or $d_{x,u}$, $d_{y,u}$.

3.5.3
beam ellipticity
$\varepsilon(z)$
parameter for quantifying the circularity or squareness of a power (energy) density distribution at z

$$\varepsilon(z) = \frac{d_{\sigma y}(z)}{d_{\sigma x}(z)}$$

where the direction of *x* is chosen to be along the major axis of the distribution, such that ~~so~~ $d_{\sigma x} \geq d_{\sigma y}$

Note 1 to entry: If ≥ 0,87 , elliptical distributions can be regarded as circular.

Note 2 to entry: In case of a rectangular beam profile, ellipticity is often referred to as "aspect ratio".

Note 3 to entry: In contrast to the definition given here, in literature the term "ellipticity" is sometimes related to $1 - \frac{d_{\sigma y}(z)}{d_{\sigma x}(z)}$. The definition given here has been chosen to be in concordance with the same definition of ellipticity in ISO 11146-1 and ISO-13694.

3.5.4
circular power density distribution
power density distribution having an ellipticity greater than or equal to 0.87

3.6
beam parameter product
product of the beam waist diameter and the divergence angle divided by 4

$$d_{\sigma 0} \cdot \Theta_{\sigma}/4$$

Note 1 to entry: Beam parameter products for elliptical beams can be given separately for the principal axes of the power (energy) density distribution.

3.7
beam propagation ratio
M^2
measure of how close the beam parameter product is to that of a perfect Gaussian beam

$$M^2 = \frac{\pi}{\lambda} \times \frac{d_{\sigma 0}\Theta_{\sigma}}{4}$$

Note 1 to entry: This quantity is equal to the ratio of the beam parameter product of the actual laser beam to the beam parameter product of the fundamental Gaussian beam (TEM_{00}), both beams with the same wavelength.

Note 2 to entry: The beam propagation ratio is unity for a theoretically perfect Gaussian beam, and has a value greater than one for any real beam.

3.8
beam propagation factor
K
Reciprocal of the beam propagation ratio

$$K = 1/M^2$$

3.9
beam position
displacement of the beam axis relative to the fixed mechanical axis of an optical system in a specified plane perpendicular to the mechanical axis of the optical system