International Standard

ISO 13694

Optics and photonics — Lasers and laser-related equipment — Test methods for laser beam irradiance (fluence) distribution

Optique et photonique — Lasers et équipements associés aux lasers — Méthodes d'essai de distribution de l'éclairement énergétique (exposition énergétique) du faisceau laser

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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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 fourth edition cancels and replaces the third edition (ISO 13694:2018), which has been technically revised.

The main changes are as follows:

— Terminologies “power”, “energy”, “power density”, and “energy density” were replaced by “radiant power”, “radiant energy”, “irradiance”, and “fluence”, respectively, in order to be consistent with ISO 80000-7 and IEC Electropedia (https://www.electropedia.org/).

— The terminologies “beam width” and “beam diameter” were restricted to be used only for those given by the second order moment which is defined in ISO 11146-1, and new terminologies “encircled-power beam width”, “encircled-power beam diameter”, “clip-level beam width”, and “clip-level beam diameter” were introduced, in order to avoid confusion of plural definitions.

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.

Introduction

Many applications of lasers involve using the near-field as well as the far-field irradiance (fluence) distribution of the beam. The irradiance (fluence) distribution of a laser beam is characterized by the spatial distribution of radiant power density (radiant energy fluence) with lateral displacement in a particular plane perpendicular to the direction of propagation. In general, the irradiance (fluence) distribution of the beam changes along the direction of propagation. Depending on the radiant power (energy), size, wavelength, polarization, and coherence of the beam, different methods of measurement are applicable in different situations. Five methods are commonly used: camera arrays (1D and 2D), apertures, pinholes, slits, and knife edges.

According to ISO 11145, it is possible to use two different definitions for describing and measuring the laser beam diameter. One definition is based on the measurement of the encircled radiant power (energy); the other is based on determining the spatial moments of the irradiance (fluence) distribution of the laser beam.

The use of spatial moments is necessary for calculating the beam propagation factor, K, and the beam propagation ratio, M^2, from measurements of the beam widths at different distances along the propagation axis. ISO 11146-1 and ISO 11146-2 describe this measurement procedure. For other applications, other definitions for the beam diameter can be used. For some quantities used in this document the beam width based on the encircled radiant power (energy) is more appropriate and easier to use.

Optics and photonics — Lasers and laser-related equipment — Test methods for laser beam irradiance (fluence) distribution

1 Scope

This document specifies methods by which the measurement of irradiance (fluence) distribution is made and specifies parameters for the characterization of the spatial properties of laser irradiance (fluence) distribution functions at a given plane.

The methods given in this document are intended to be used for the testing and characterization of both continuous wave (cw) and pulsed laser beams used in optics and optical instruments.

This document provides definitions of terms and symbols to be used in referring to irradiance distribution, as well as requirements for its measurement. For pulsed lasers, the distribution of time-integrated irradiance (i.e. radiant exposure) is the quantity most often measured.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 11145, *Optics and photonics — Laser and laser-related equipment — Vocabulary and symbols*

ISO 11146-1, *Lasers and laser-related equipment — Test methods for laser beam widths, divergence angles and beam propagation ratios — Part 1: Stigmatic and simple astigmatic beams*

ISO/TR 11146-3, *Lasers and laser-related equipment — Test methods for laser beam widths, divergence angles and beam propagation ratios — Part 3: Intrinsic and geometrical laser beam classification, propagation and details of test methods*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11145 and the following 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/

3.1 Measured quantities

3.1.1
irradiance distribution
$E(x, y, z)$
set of all radiant power densities at location z of a certain cw beam with non-negative values for all transverse coordinates (x, y)

Note 1 to entry: $E(x, y, z)$ is represented as a density of incident radiant power $P(z)$ with respect to area A at a location (x, y).