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**Optics and photonics — Test methods  
for telescopic systems —**

**Part 10:  
Test methods for axial colour  
performance**

*Optique et photonique — Méthodes d'essai pour systèmes  
télescopiques —*

*Partie 10: Méthodes d'essai pour la performance de couleur axiale*



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# Contents

	Page
<b>Foreword</b> .....	<b>iv</b>
<b>Introduction</b> .....	<b>v</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms and definitions</b> .....	<b>1</b>
<b>4 Requirements</b> .....	<b>1</b>
4.1 General.....	1
4.2 Test arrangement.....	1
4.3 Preparation and carrying out of measurements.....	2
4.4 Determination of results.....	2
4.5 Uncertainty and fundamental limit of the measurement.....	3
4.6 Test report.....	3
<b>Annex A (informative) Measurement method for axial colour performance of the dioptric tester</b> ...	<b>4</b>
<b>Bibliography</b> .....	<b>6</b>

## 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](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, 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 [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 4, *Telescopic systems*.

A list of all parts in the ISO 14490 series can be found on the ISO website.

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](http://www.iso.org/members.html).

## Introduction

ISO 14490-7 mentions several characteristics to determine image quality of telescopic systems besides the limit of resolution evaluation. One unmentioned characteristic in ISO 14490-7 is the “axial colour performance” which may be noted by the user as a coloured halo around objects or even a hue of objects in the centre of the field of view. Typically, the axial colour performance also affects the colour performance in the entire field of view.

The axial colour performance of a telescopic system is mainly determined by two major intrinsic contributions. These are spherical aberration and axial chromatic aberration. According to ISO 10934 axial chromatic aberration is defined as the aberration of a lens, by which light of different wavelengths is focused at different points along the optical axis. The axial chromatic aberration originates from the intrinsic difference of the refractive index of glass as a function of the incident wavelength of light, i.e. the dispersion. For a singlet (positive) lens the axial chromatic aberration yields different focal lengths for different wavelengths, which may also be called chromatic focal shift. Multi-lens groups or assemblies are designed to reduce and compensate this focal shift to go below the intrinsic dispersion of singlet systems. The footprint of the axial chromatic correction of lenses is partially classified by terms like “achromatic” or “apochromatic” lenses.

Axial chromatic aberration originates from the dispersion of the lens material. In contrast, spherical aberration is related to the geometry of a lens and is classified as a monochromatic aberration. Spherical aberration causes rays in the image space to intersect the optical axis before or after the image point formed by the paraxial rays (see also ISO 10934). As a consequence the “best focus” is not well defined even for a monochromatic evaluation of a system. From that it is obvious that the measurement of a pure axial chromatic aberration may be influenced by spherical aberration.

This document thus describes the measurement of the joint effect of these two major contributions since in practical use an observer will not be able to separate these two effects. However, for deeper analysis in the laboratory the two effects may be analysed separately.

In the case of afocal systems, such as telescopes, the axial chromatic aberration as well as the spherical aberration of the objective lens is imaged to infinity by the eyepiece (looked at by the user) and can be measured in dioptres. The measurement of the axial colour performance as described in this document may be combined with a monochromatic evaluation of the modulation transfer function (MTF, see ISO 9336-3) to obtain an overall figure for the imaging performance of a telescopic system.



# Optics and photonics — Test methods for telescopic systems —

## Part 10: Test methods for axial colour performance

### 1 Scope

This document specifies the test method for the measurement of the axial colour performance which includes axial chromatic aberration and spherical aberration of telescopic systems and observational telescopic instruments.

### 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 14132-1, *Optics and photonics — Vocabulary for telescopic systems — Part 1: General terms and alphabetical indexes of terms in ISO 14132*

ISO 14490-1:2005, *Optics and optical instruments — Test methods for telescopic systems — Part 1: Test methods for basic characteristics*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14132-1 apply.

ISO and IEC maintain terminological 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/>

### 4 Requirements

#### 4.1 General

All measurements shall be performed on optical axis, i.e. the target shall be situated at the centre of the field of the specimen. The measurement principle relies on the evaluation of the best focus position for different wavelengths. Therefore the target size and structure have to be suitable to evaluate the best focus but do not necessarily need to contain a structure at the theoretical resolution limit of the specimen.

#### 4.2 Test arrangement

The measurement of the axial colour performance shall be carried out with the test arrangement shown in [Figure 1](#). It ideally consists of a negative back lit test target screen at the focal plane of a collimator. The light source has to be bright enough to guarantee sufficient luminance after spectral filtering. In addition a dioptric tester is used for analysis.