IEC TR 62977-1-31

Edition 1.0 2022-03

TECHNICAL REPORT

AMENDMENT 1

Electronic displays –
Part 1-31: Generic – Practical information on the use of light measuring devices

colour inside

IEC TR 62977-1-31:2021-04/AMD1:2022-03(en)

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ELECTRONIC DISPLAYS –

Part 1-31: Generic – Practical information on the use of light measuring devices

AMENDMENT 1

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Amendment 1 to IEC 62977-1-31:2021 has been prepared IEC technical committee 110: Electronic displays.

The text of this Amendment is based on the following documents:

Draft	Report on voting
110/1380/DTR	110/1404A/DVDTR

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Amendment is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications/.

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INTRODUCTION to Amendment 1

This document provides additional information to IEC TR 62977-1-31:2021 regarding the influence of spectral stray light and spectral bandwidth of a spectroradiometer on chromaticity measurements. It is described in Annex E.

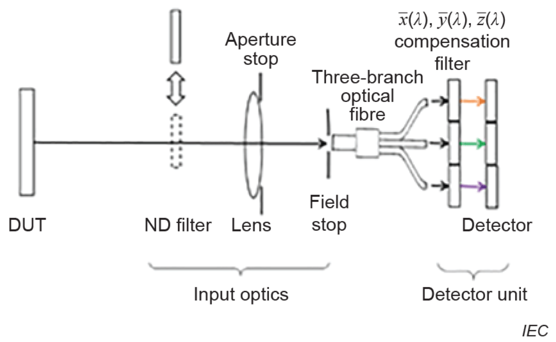
This document also provides the corrections of editorial errors of IEC TR 62977-1-31:2021. The corrections are:

– Typos are fixed:
  - “fiber” and “$x(\lambda)$, $y(\lambda)$, $z(\lambda)$” is replaced with “fibre” and “$\overline{x}(\lambda), \overline{y}(\lambda), \overline{z}(\lambda)$”, respectively in Figure 2,
  - “(%)” in the label of vertical axis is removed in Figure 9, Figure 10, and Figure 12,
  - “0” label of the tick mark of vertical axis is replaced with “1” in Figure C.4.

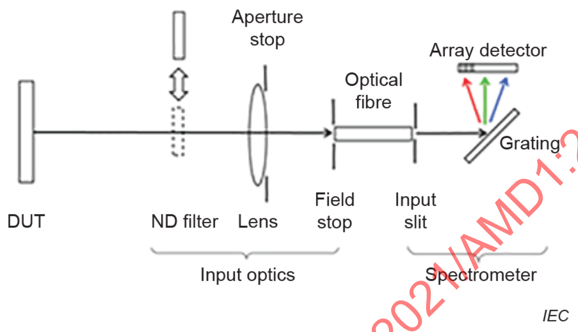
– The lists for Formula (A.1) and Formula (B.1) are aligned.

Figure 2 – Example of configurations for the input optics and detector

Replace, in Figure 2, Figure 2b) and Figure 2c) with the following new Figure 2b) and Figure 2c):



b) Colorimeter



c) Spectroradiometer with spectrometer using grating and array detector

5.5.2.1 General

Replace, in NOTE 2, the fourth sentence with the following new sentence:

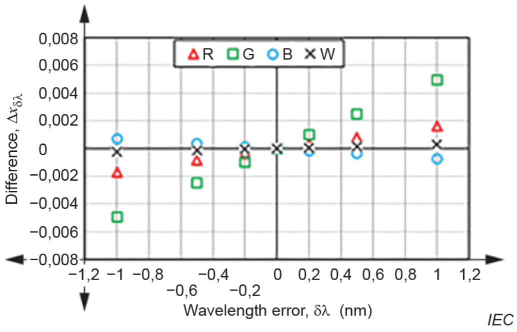
Experimental data demonstrating the influence of spectral stray light in a specific application are shown in Annex E [12].

Add, after NOTE 2, the following new NOTE 3:

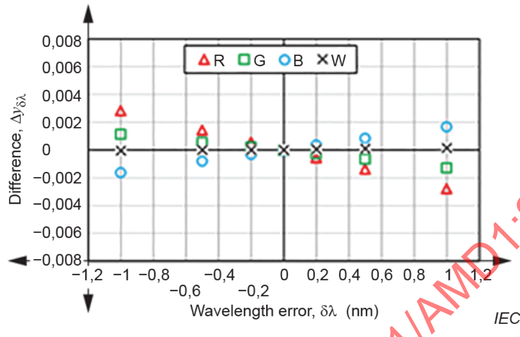
NOTE 3 The influence of spectral bandwidth on chromaticity measurements of narrow spectral linewidth light is shown in Annex E.

Figure 9 – Calculated chromaticity differences as a function of wavelength error

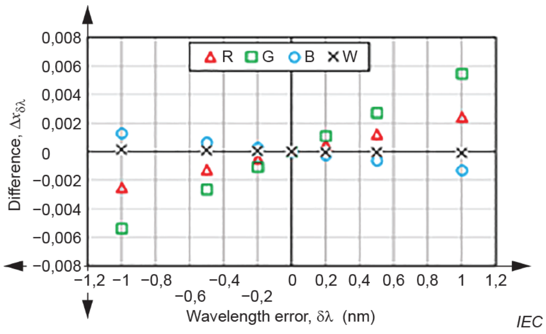
Replace Figure 9 with the following new figure:



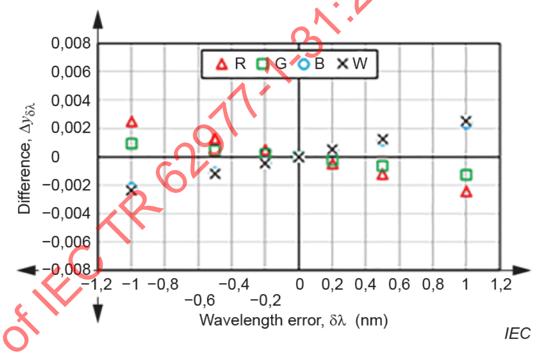
a) **DUT-1 (chromaticity coordinate, x)**



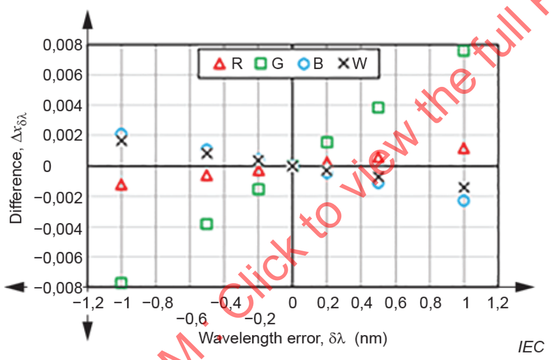
b) **DUT-1 (chromaticity coordinate, y)**



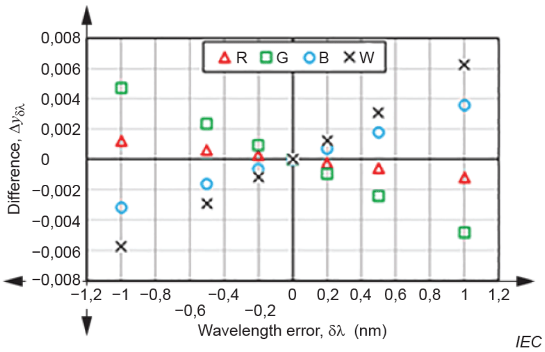
c) **DUT-2 (chromaticity coordinate, x)**



d) **DUT-2 (chromaticity coordinate, y)**



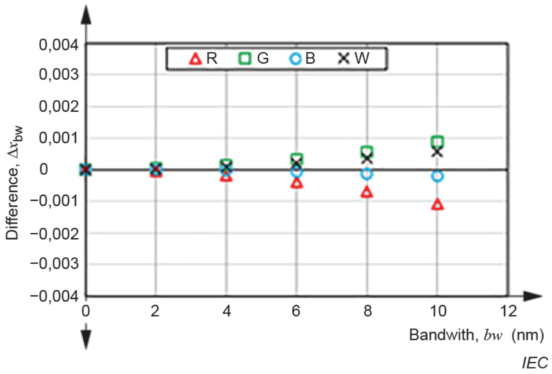
e) **DUT-3 (chromaticity coordinate, x)**



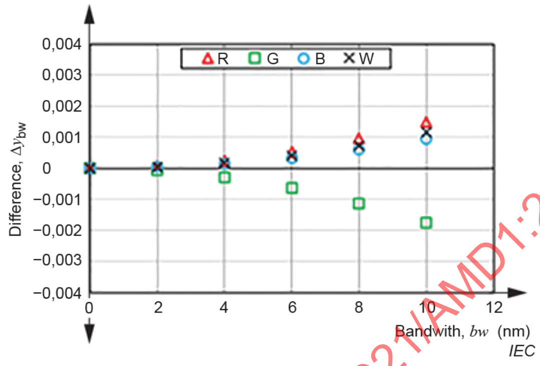
f) **DUT-3 (chromaticity coordinate, y)**

Figure 10 – Calculated chromaticity differences as a function of spectral bandwidth

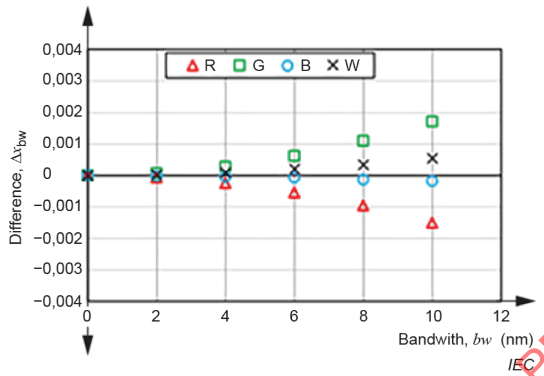
Replace Figure 10 with the following new figure:



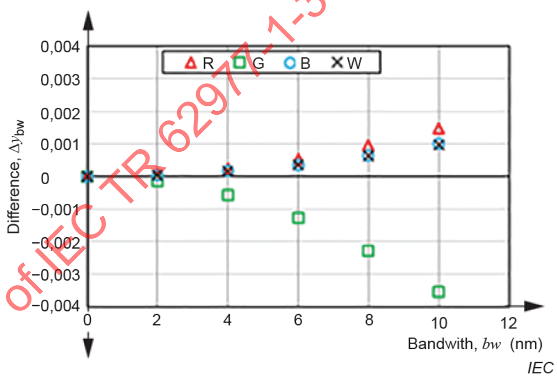
a) DUT-1 (chromaticity coordinate, *x*)



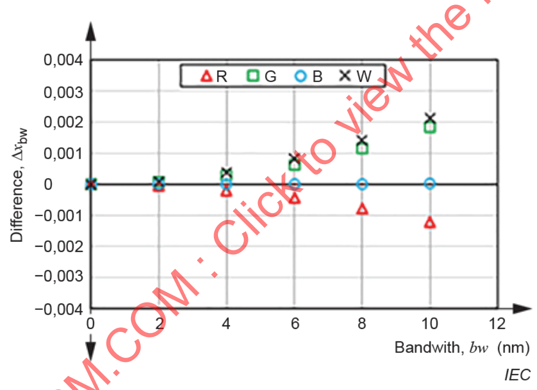
b) DUT-1 (chromaticity coordinate, *y*)



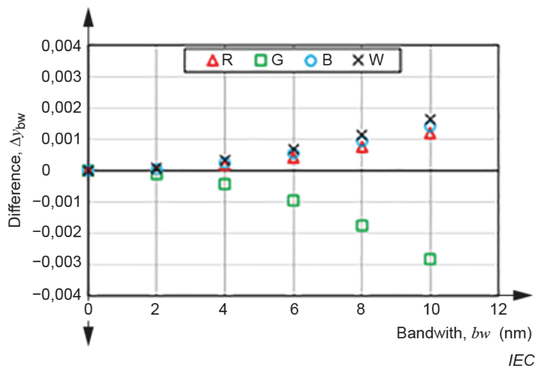
c) DUT-2 (chromaticity coordinate, *x*)



d) DUT-2 (chromaticity coordinate, *y*)



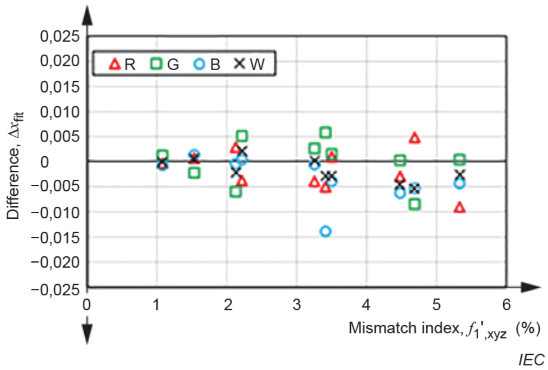
e) DUT-3 (chromaticity coordinate, *x*)



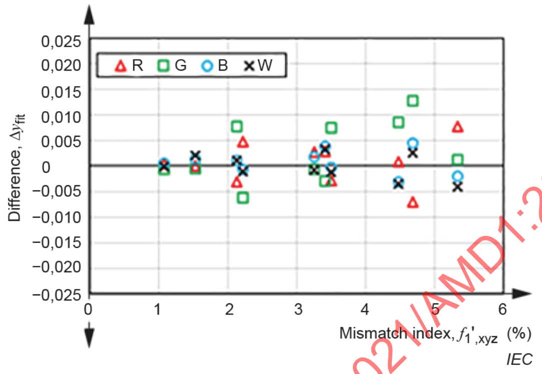
f) DUT-3 (chromaticity coordinate, *y*)

Figure 12 – Calculated chromaticity differences as a function of f_1', xyz

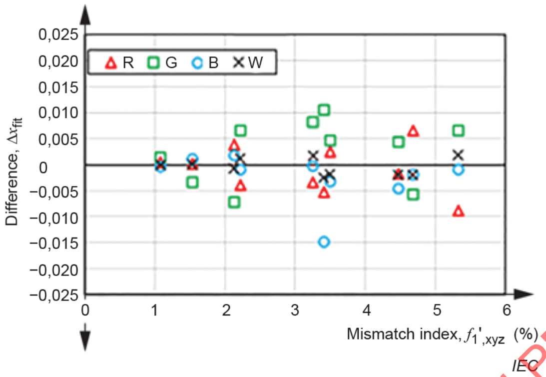
Replace Figure 12 with the following new figure:



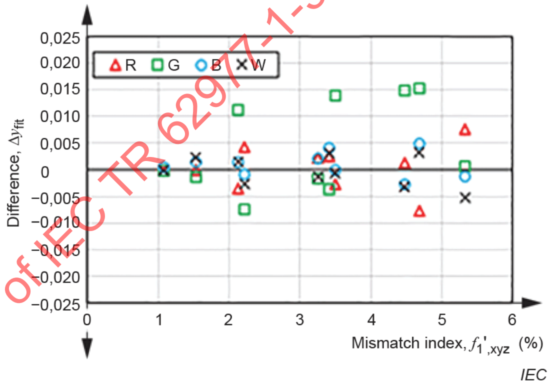
a) **DUT-1 (chromaticity coordinate, x)**



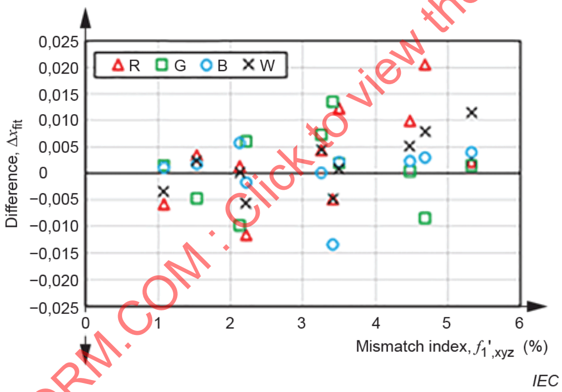
b) **DUT-1 (chromaticity coordinate, y)**



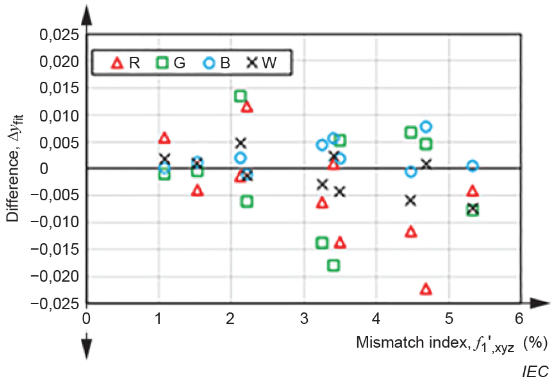
c) **DUT-2 (chromaticity coordinate, x)**



d) **DUT-2 (chromaticity coordinate, y)**



e) **DUT-3 (chromaticity coordinate, x)**



f) **DUT-3 (chromaticity coordinate, y)**

Annex A – Photometry and colorimetry

A.2 Photometry

Replace the list for Formula (A.1) with the following new list and text:

L_v is the luminance ($cd \cdot m^{-2}$),

$L_e(\lambda)$ is the spectral radiance at wavelength λ ($W \cdot sr^{-1} \cdot m^{-2} \cdot nm^{-1}$),

K_m is the maximum luminous efficacy ≈ 683 ($lm \cdot W^{-1}$).

Integration is carried out over a wavelength range from 360 nm to 830 nm [4].

Annex B – Method for reducing the measurement difference of colorimeters

B.2.1 Matrix calibration process 1: RGB calibration

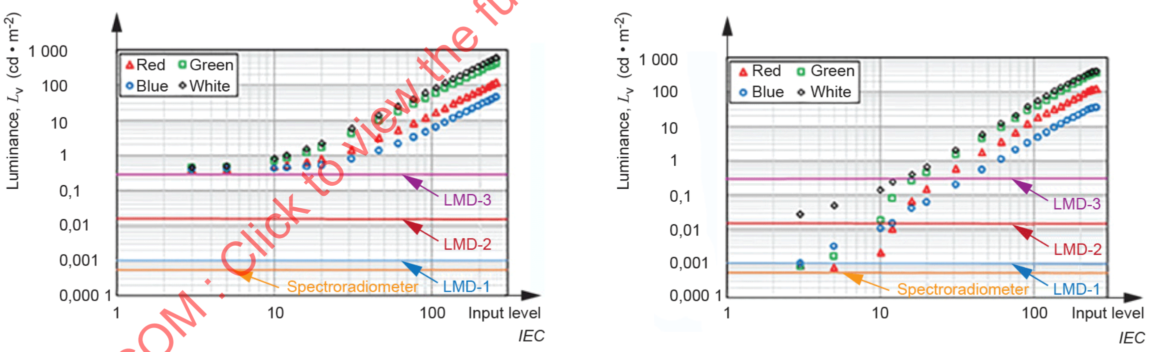
Replace the list for Formula (B.1) with the following new list:

$L_{e,\,Q}(\lambda)$, $L_{e,\,R}(\lambda)$, $L_{e,\,G}(\lambda)$, and $L_{e,\,B}(\lambda)$ are the spectral radiances of colours Q, R, G, and B, respectively,

k_R, k_G, and k_B are the independent coefficients of colours R, G, and B, respectively.

Annex C – Input data in Clause 5 and Clause 6, and calculation methods in 5.8 and 6.5

Replace Figure C.4 with the following new figure:



a) DUT-1 b) DUT-2

Add, after Annex D, the following new Annex E:

Annex E
(informative)

Influence of spectral stray light and spectral bandwidth on chromaticity measurements of narrow spectral linewidth light

E.1 General

Annex E provides the example data of spectral stray light such as measured spectral power distributions and calculated CIE 1931 chromaticities without and with spectral stray light correction. It also provides information on the influence of spectral bandwidth on the measured chromaticity.

E.2 Example experimental data on spectral stray light

E.2.1 Measurement method and conditions

The spectral irradiance of a retinal scanning projection display is measured by an integrating sphere and spectroradiometer LMD. The details of measurements are described in [12].

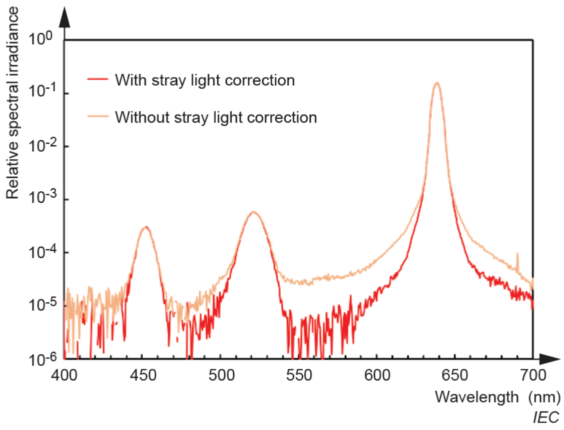
NOTE The data are from an irradiance measurement. However, the correction method is also valid for radiance measurements. The data demonstrate the influence of stray light of a spectrometer, which is installed in an LMD such as a spectroradiometer (see 4.3.1 3)), on the measured spectral power distribution.

E.2.2 Measurement and calculation data

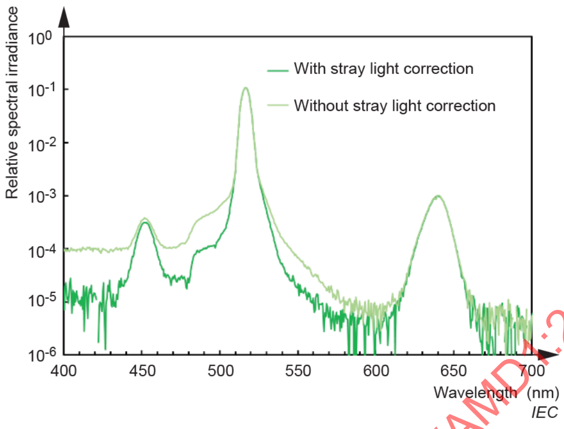
Figure E.1a), Figure E.1b), and Figure E.1c) show the relative spectral irradiances of the display outputs at full-screen single-colour input R, G, and B, respectively. The relative spectral irradiances are measured by the integrating sphere and spectroradiometer LMD without and with the spectral stray light correction. After the correction, the magnitude of the spectral stray light caused by the LMD decreases from about 1:100 – 1:1 000 to 1:1 000 – 1:10 000 of the primary colour output peak irradiances.

NOTE Small spectral irradiances of primary colour outputs, for which there is no input signal, are also observed. They are caused by the DUT, i.e., laser diodes biased around the threshold current for high-speed modulation. These observed spectral irradiances are not caused by the LMD.

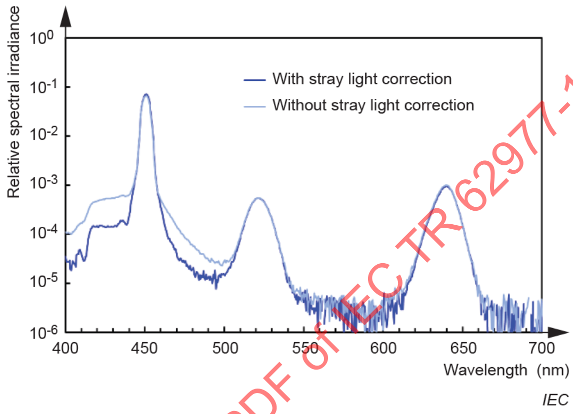
The CIE 1931 chromaticity (x, y) of spectral power distributions for R, G, and B input signals is calculated as described in Annex A. The differences between the chromaticities obtained without and with correction are shown in Table E.1. The effect of the correction of stray light is significantly dependent on the wavelength being measured, with the largest difference for green producing 0,002 5 and -0,016 2 in Δx and Δy, respectively, in this experiment. Note that the influence of the spectral stray light on the calculated chromaticities usually depends on the LMD performance and DUT characteristics.



a) **Red**



b) **Green**



c) **Blue**

Figure E.1 – Measured relative spectral irradiance for each primary input signal

Table E.1 – Calculated CIE 1931 chromaticity differences between measurements without and with spectral stray light correction

Primary colour	**Without correction minus with correction**	
	Δx	**Δy**
Red	-0,002 1	0,001 4
Green	0,002 5	-0,016 2
Blue	0,000 8	0,000 6

E.2.3 Calculation of chromaticity with increasing background level

The background level of spectral power distribution can have a significant influence on the measured chromaticity of saturated colours. The influence of the background is simulated in Figure E.2. In this simulation, the CIE 1931 chromaticity is calculated from synthetic spectra created at 1 nm increments. The spectra for each wavelength on the spectrum locus are represented by a normalized signal at that wavelength, and they assume a line-shape with a 0 nm spectral bandwidth such as a Dirac delta function. The chromaticity of each spectrum is calculated as the background level is increased, reducing the signal-to-noise between peak and background. No matter what causes the background level, for example stray light or high electronic noise, reducing the background level will allow for more accurate measurements of saturated colours. For the stray light, spectral stray light correction can help to reduce the background level. It is clear from Figure E.2 why the primary green colour has the most benefit from the low background level.

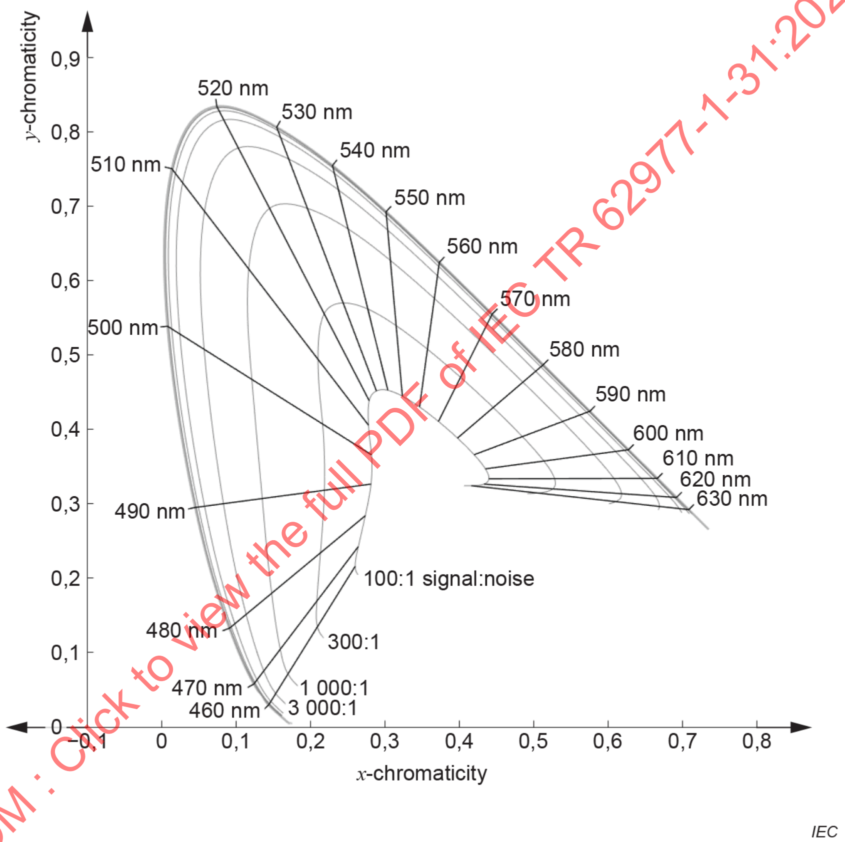


Figure E.2 – Calculated CIE 1931 chromaticities of simulated monochromatic spectra with various wavelengths with increasing background levels (signal-to-noise ratios)

E.3 Influence of spectral bandwidth

E.3.1 Calculation of chromaticity with increasing spectral bandwidth

The boundary of the spectrum locus in the chromaticity diagram is determined by the monochromatic wavelengths of light in the visible region. These are ideal narrow spectral linewidth light sources, which in practice can be realized by lasers. However, the measurement of their spectra, and subsequently their chromaticity, will depend on the spectral bandwidth of the spectroradiometer used to measure the light. Figure E.3 illustrates how the chromaticity of each monochromatic wavelength on the spectrum locus will become less saturated with increasing spectral bandwidth. The general trend for a large spectral range is shown in Figure E.3a), and a higher resolution plot for the green region is shown in Figure E.3b). The calculation was performed by using a synthetic spectrum at 1 nm increments, where each wavelength was represented by a single normalized peak with a Gaussian spectral profile. Chromaticity values were calculated from the synthetic spectra with increasing spectral bandwidth, which was defined as the full-width-at-half-maximum (FWHM) of the Gaussian profile. Note that the bandwidth of actual spectroradiometers is usually at most about 10 nm. Figure E.3 demonstrates the influence of the chromaticity calculation for the various monochromatic wavelengths, with the green colours exhibiting the greatest influence from spectral bandwidth [12].

E.3.2 Additional information on spectral properties of spectroradiometers

As shown in Formula (A.2) to Formula (A.4), in calculating tristimulus values, the spectral distribution is weighted by the colour-matching functions (CMFs) at each wavelength. This subsequently influences the chromaticity results (see Formula (A.5) and Formula (A.6)). As the LMD Gaussian profile and bandwidth broaden beyond the original DUT linewidth, there is greater overlap of the measured LMD spectra with the CMFs. This LMD measurement artefact suggests that the DUT contained a broader range of wavelengths than were actually in the true DUT spectra. Therefore, the calculated chromaticity values can include inevitable errors when using LMDs with large spectral bandwidths. Also from this point of view, the spectral bandwidth of actual spectroradiometers is usually designed to have little influence on the calculation of tristimulus and chromaticity values.

The major spectral properties which affect the chromaticity measurements by spectroradiometer are the wavelength accuracy and bandwidth as shown in 5.5. The influence of wavelength error and bandwidth on chromaticity measurements of narrow spectral linewidth light is calculated under specific conditions and the results show that the influence depends on wavelength [35].