WP214

IMAGING SPECTRAL COLORIMETER

WESTBORO PHOTONICS

WP214

MEASUREMENT CAPABILITIES

Imaging Colorimeter
- Luminance
- Chromaticity

Spot Spectroradiometer
- Spectral Radiance

APPLICATIONS

Flat Panel Displays
- Uniformity
- Contrast
- Viewing Angle
- Gamma
- Microscopic Evaluation

Projection Displays

Backlight Units

Beam Pattern of Lamps and Luminaires

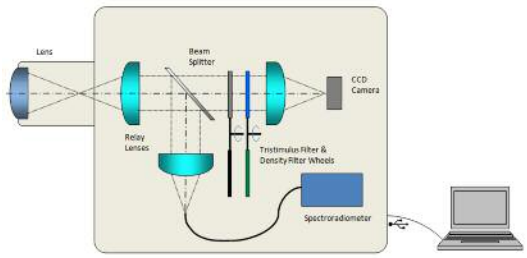
LED Displays and LED Arrays

The Highest Accuracy Imaging Colorimeter

COMBINING SPEED AND ACCURACY

The WP214 merges a high accuracy spot spectroradiometer with the advanced analysis capabilities and large field of view associated with imaging tristimulus colorimeter systems.

The system features a high dynamic range, cooled CCD imager with 0.5MP resolution and an integrated spectroradiometer which serves as the reference to correct the imager results. An automated filter wheel contains four tristimulus filters and five optional positions.



The combination of these two technologies ensures high accuracy and increased productivity. In many cases the WP214 can replace two separate instruments.

The instrument is even more practical for the lab when one considers the multitude of interchangeable lens options. When coupled with the CONOMETER® lens for example, the WP214 can measure viewing angle as a function of luminance and chromaticity with angular data out to +/- 80°.

The accompanying Photometrica® software provides a turnkey solution for analysis of FPD's, LED or OLED lighting applications. The powerful software suite offers a highly configurable user interface with extensive analysis and automation capabilities. Scripting tools are embedded directly in the software, eliminating the need for external software development for many automated production applications.

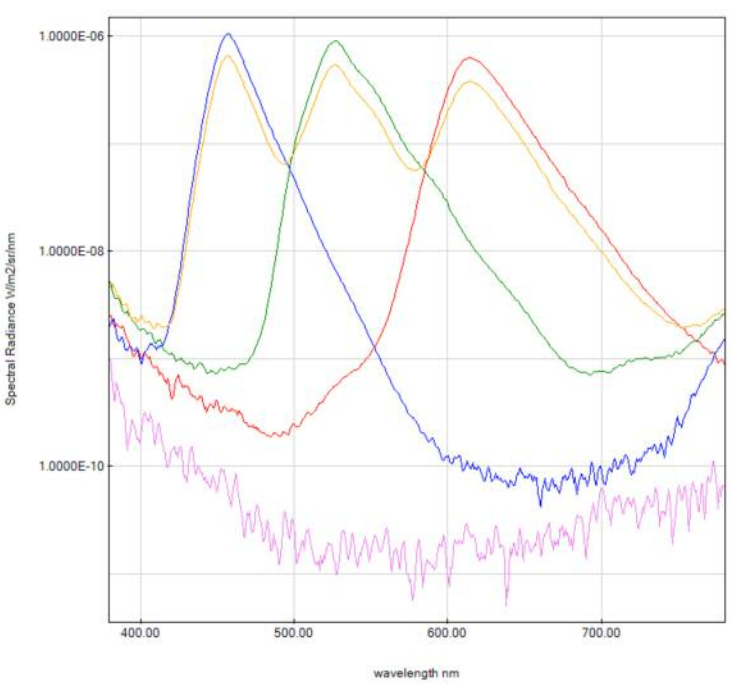
WP214

AN INSTRUMENT WHOSE TIME HAS COME

Compared to colorimeters, spectroradiometers can have much lower uncertainty than measuring instruments because their sources of error can be broken down into small verifiable evaluations including: wavelength error, bandwidth, stray light, linearity and dynamic range. Simply put, if all those specifications are optimal, then spectral distribution measurements of LEDs, OLEDs or even lasers will also be very good. The spectroradiometer in the WP214 has superb specifications:

Bandwidth	2.4nm
Wavelength Error	<0.5nm
Stray Light	<5E-4
Linearity	1%
Dynamic Range	>100,000:1

SPECTRAL RADIANCE



Red, green, blue, white and black OLED spectra measured by the WP214. For the blue OLED, the luminance is only 15 cd/m² and the peak is up to 5 decades above the instrument noise floor.

Typical imaging colorimeters use four filters to approximate the response of the CIE tristimulus functions: two filters are needed to approximate the X response, one for Y and one for Z. The filters always have localized responsivity errors as compared to the CIE model. The only way to correct a colorimeter for errors for unknown sources is to also measure the radiometric spectrum of those sources and to know the response of the colorimeter. Getting a "typical spectrum" for a source is problematic, as many sources, including LED and tungsten lamps, change their spectral power distribution with temperature or current level.

The WP214 overcomes these obstacles by correcting every measurement through a comparison of the exact location on the sample with tristimulus data from the imaging colorimeter and the spectroradiometer.

UNIFORM RESPONSIVITY

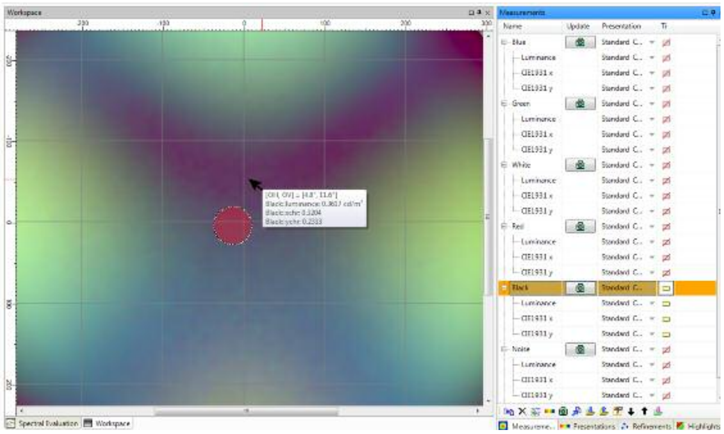
Unlike most other tristimulus colorimeters, the filters in the WP214 are in the relay section of the optical assembly. In this region, the light is more collimated and optical absorption, which is determined by the optical path length through each filter, is the same for all parts of the image. Traditional imaging colorimeters do not have this advantage and as a result can suffer from significant spectral responsivity differences from the center to the corners of the image – especially for the very large sensors.

MEASUREMENT LAYERS AND THE WORKSPACE

Upon acquiring a tristimulus (XYZ) measurement, the measurement Workspace shows an RGB rendering of what the object looks like. Luminance and a selection of other measurement layers may also be automatically generated, including:

- CIE 1931 (x, y)
- CIE 1976 (u', v')
- CCT
- Dominant Wavelength
- Purity

Those measurements may be shown in the measurement Workspace and pseudo-color mapped as required. Any measurement can quickly be evaluated with appropriate pseudo-color mapping.



Photometrica® screenshot showing several measurement layers with luminance and x and y component layers. The Black layer is selected and RGB rendered in the Workspace. The cursor tooltip provides more detail.

COMPUTATIONS

Photometrica® includes a Computations window to create new measurement layers. In this window, an algebraic editor uses inputs including AOI statistics, measurement layers, scalars and standard syntax such as ( ) + - * / and ^ to generate new measurement layers. In this way, users can create new types of measurement layers such as contrast, illuminance or luminous intensity. Computations can even be applied to the results of other computations. These actions can be set to run manually or automatically after a measurement.

SPATIAL FILTERS

A set of standard spatial filters are available such as 3 x 3 average or median filter. There is also a spatial filter creator where users can create their own spatial filters.

TOOLS TO CREATE OBJECTS

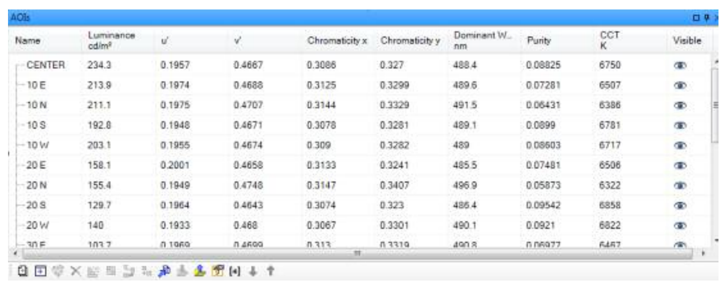
Photometrica® has many standard tools to locate objects of interest: circle, ellipse, square, rectangle, polygon, magic wand, and lasso. Once an object is created that object is loaded into the AOI table.

AREAS OF INTEREST

A key feature of Photometrica® is the AOIs window. Here a user can easily accumulate a table of statistics for various test locations – which we call Areas of Interest, or AOIs. There is one row per AOI. The columns can be selected from the active or any available measurement layer. Alternatively, the columns may be derived by user calculation or could answer a logical question such as "is an AOI in a specific color region?"

Users can rank the rows by clicking on a column header. When clicking on a row in the AOI table, that AOI becomes active and highlighted in the Workspace.

When dealing with very large AOI arrays, their statistics can further be summarized and evaluated in the Evaluations window.



AOIs

Name	Luminance cd/m²	u'	v'	Chromaticity x	Chromaticity y	Dominant W... nm	Purity	CCT K	Visible
CENTER	234.3	0.1957	0.4667	0.3086	0.327	488.4	0.08825	6750	
10 E	213.9	0.1974	0.4688	0.3125	0.3299	489.6	0.07281	6507	
10 N	211.1	0.1975	0.4707	0.3144	0.3329	491.5	0.06431	6386	
10 S	192.8	0.1948	0.4671	0.3078	0.3281	489.1	0.0899	6781	
10 W	203.1	0.1955	0.4674	0.309	0.3282	489	0.08603	6717	
20 E	158.1	0.2001	0.4658	0.3133	0.3241	485.5	0.07481	6506	
20 N	155.4	0.1949	0.4748	0.3147	0.3407	496.9	0.05873	6322	
20 S	129.7	0.1964	0.4643	0.3074	0.323	486.4	0.09542	6858	
20 W	140	0.1933	0.468	0.3067	0.3301	490.1	0.0921	6822	
30 E	103.7	0.1969	0.4699	0.313	0.3319	490.8	0.06977	6467	

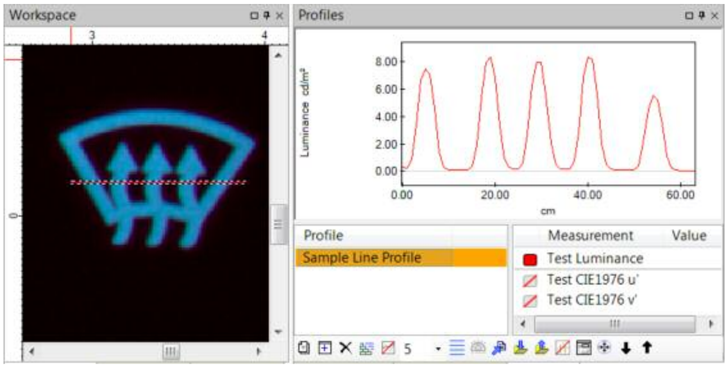
The AOI window tabulates AOI statistics with user defined columns.

EVALUATIONS

The Evaluations window provides a single place to summarize the measurement. Users can ask for aggregate statistics, or create evaluations based upon metrics from the AOI table or any measurement layer(s). The output of evaluations may be used as inputs to display a final result (i.e. the pass-fail decision).

PROFILES

Profiles drawn in the workspace can be plotted in the Profile window. The profile thickness is user-selectable. Profiles may be drawn at any angle.

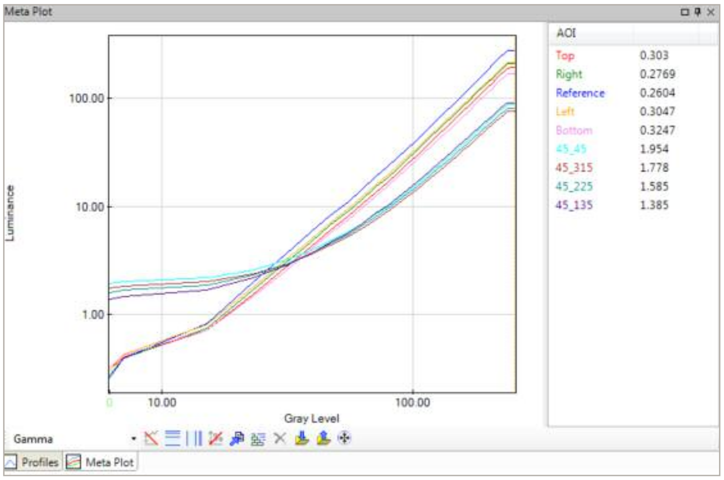


Photometrica® window shows an illuminated wall feature profiled at an angle.

METADATA

How does the display contrast change as a function of illumination level, or versus backlight level?

In Photometrica® any measurement layer can have user-defined metadata, such as time, illumination level, backlight level, current, grey level, etc. Once a layer has been tagged with metadata, the Meta Plot window can discriminate the measurements for plotting AOI versus that measurement data.



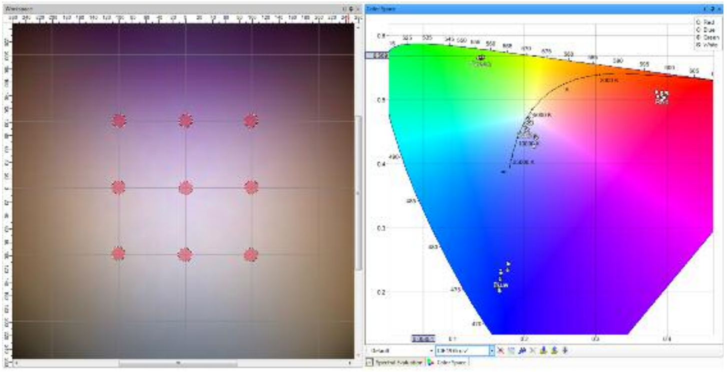
A Meta Plot showing gamma: luminance of various measurement AOIs as a function of the metadata value: Grey Level

EXPORTING AND REPORTING

Tabular data in any window can be exported as text to the clipboard or to a file; graphical information in any window can be exported as an image to the clipboard or a file.

CIE COLOR SPACE

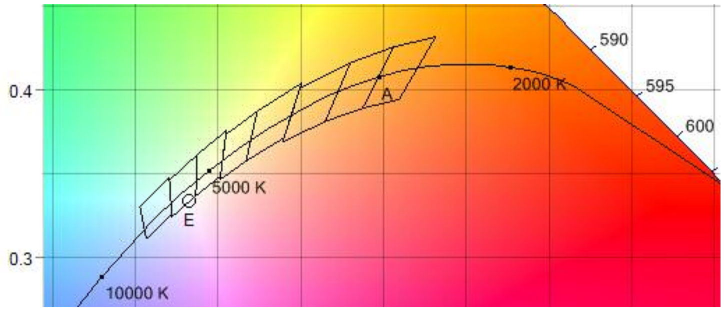
All AOIs for the selected measurement layers are plotted in the active CIE color space. The Color Space window graphically shows the distribution of chromaticities in CIE color space 1931 or 1976.The chromaticity of the spectral measurement is also available to be plotted.



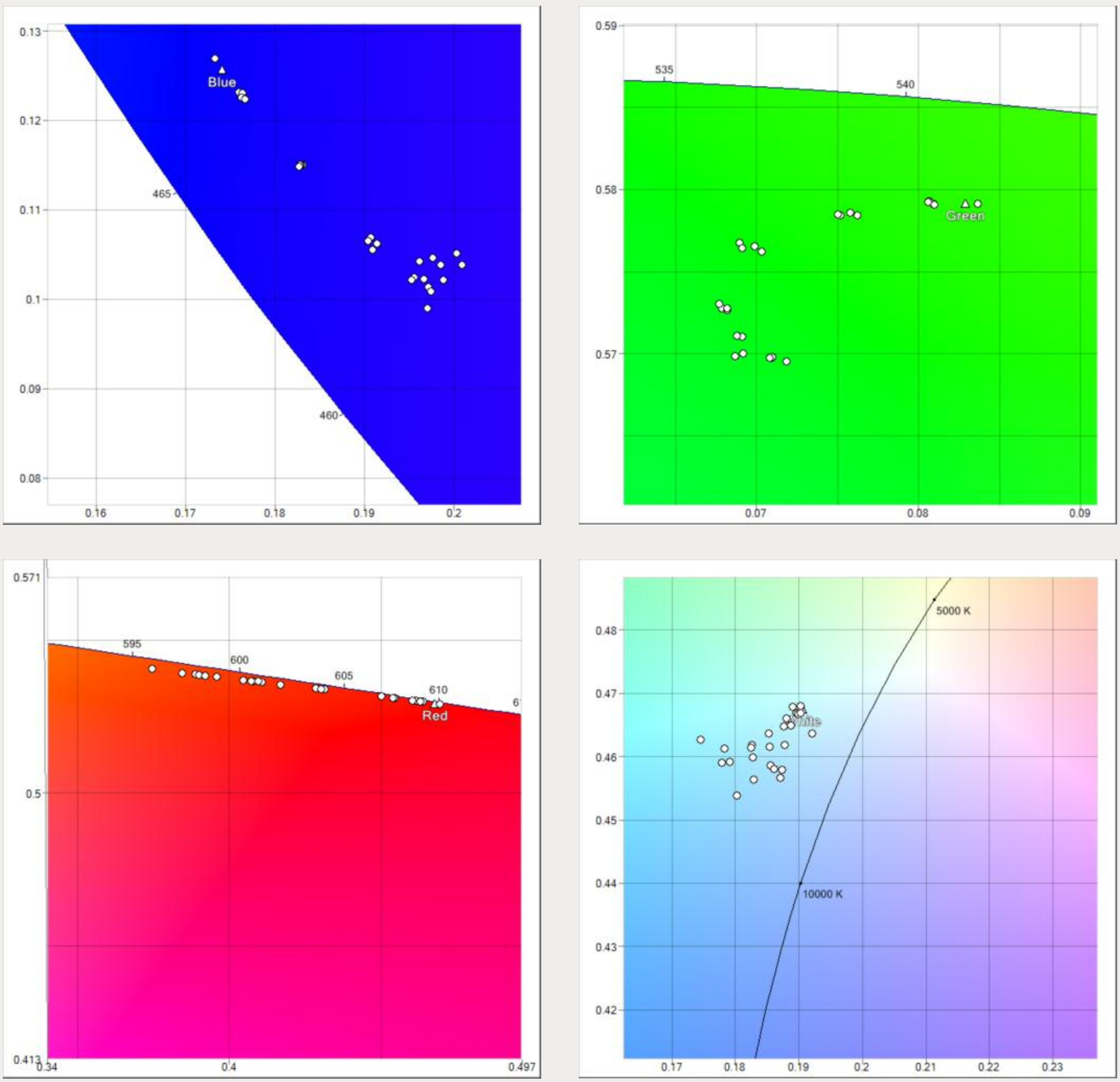
Nine AOIs on a display are plotted in CIE 1976 color space when the display is set to white, red, green and blue.

COLOR REGIONS

Photometrica® includes a library of standard color regions which can be used to perform automated pass/fail analysis based on the measured chromaticity. Multiple regions can be used simultaneously and referenced to specific AOIs within the same measurement. Users may add their own region definitions within the software.



CIE plot with built-in ANSI SSL color regions.



Examples of how the chromaticity varies at test points out to 50 degrees from the center for an OLED display set to blue, green, red and white.

VIEWING ANGLE MEASUREMENTS

CONOMETER® LENS

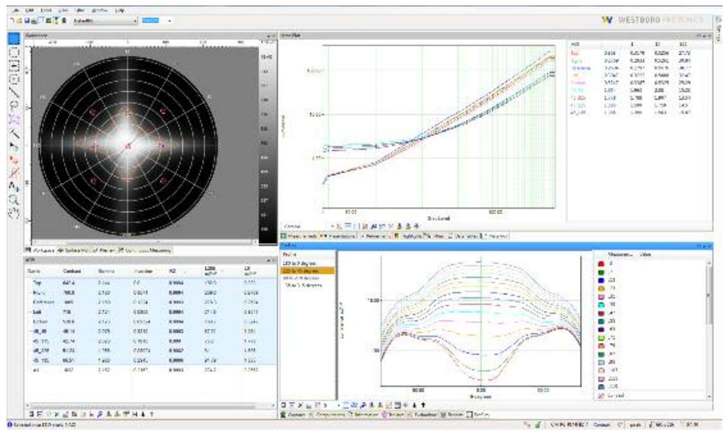
Luminance and chromaticity as a function of viewing angle can be measured when the WP214 is equipped with the CONOMETER® lens. LCD, OLED and LED displays are measured quickly and easily. The high-accuracy integrated spectroradiometer and automatic tristimulus correction of the imaging colorimeter improves the measurement accuracy of the displays' white and gamut points and everything in between.

In addition to the spectrometer correction, Photometrica® also includes a four color (RGBW) matrix correction to improve the chromaticity accuracy when light levels are sufficient for the imaging colorimeter, but too low for the spectroradiometer.

The WP214 with the CONOMETER® lens is able to measure from 0.01 to 18,000 cd/m^2. The optional internal density filters increase the maximum luminance measureable up to 18,000,000 cd/m^2. Users can feel confident to measure both black levels and backlights of displays.

LUMINANCE LEVELS AND CONTRAST

Photometrica® can display and compute luminance versus viewing angle for any grey level. Derived measurement layers include: Contrast, Gamma, Gamma Fitting, Inversion and Delta E. Users may easily create new measurement layers using the algebraic editor in Photometrica's® Computations window.



A series of measurements of the display luminance are taken from grey level "0" to "255". From the luminance measurement layers, derived layers of gamma, inversion and gamma fitting are created. The above screenshot of Photometrica® shows:

1. **Several test locations are created with AOIs in the Workspace.**
2. **AOI table summarizes all of the luminance statistics for the test locations.**
3. **Gamma plot shows all of the test locations plotted for luminance versus grey level.**
4. **A log luminance profile graph for each grey level. The selected profile is at 45 degrees from horizontal.**

WP214 SPECIFICATIONS WITH CONOMETER® LENS

Luminance Range	0.01 to 18,000 cd/m^2
	0.01 to 18,000,000 cd/m^2 with optional internal ND filters
Viewing Angle	80 degrees from Normal
Angular Data Interval	0.21 degrees per pixel
Working Distance	1mm to infinity

BEAM PATTERN MEASUREMENTS

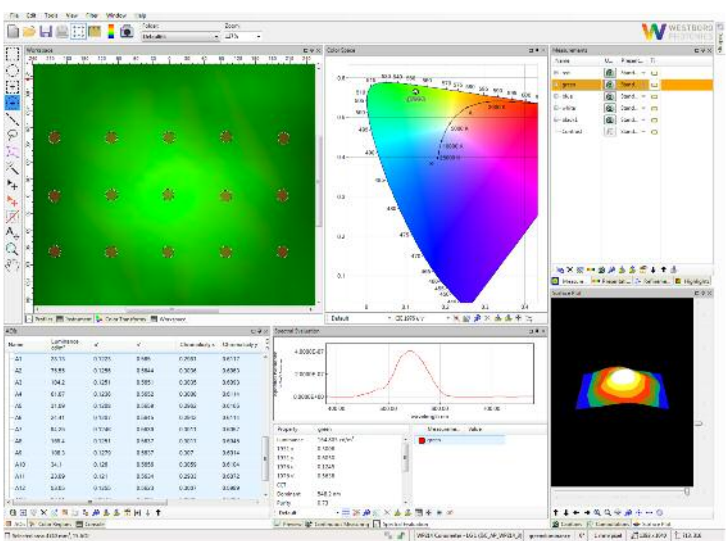
The WP214 is calibrated to measure the spatial distribution of luminance and chromaticity. The system can also be configured to measure the luminous intensity and illuminance of lamps. Photometrica® software provides users with menu-driven, geometrical and tristimulus calibration processes to create the required calibrations.

Users can create custom solutions using the tools in Photometrica®, or Westboro Photonics can provide pre-configured systems. There are two different methods to measure the beam pattern of lamps: the reflective screen is best suited to measure large lamps; and the transmissive screen for smaller lamps.

MODERN LAMPS NEED AN ACCURATE SOLUTION

Narrow band sources such as LEDs, are prone to inaccuracies when measured with tristimulus colorimeters. With the integrated spectroradiometer the accuracy of the WP214 is significantly improved making it a natural fit for beam pattern characterization of these challenging samples.

For multi-LED applications, manufacturers can mix LEDs from a variety of bins to reduce cost while maintaining good color performance. The integrated spectroradiometer in the WP214 reliably corrects the colorimeter for every sample, regardless of the mix of LEDs.



The results of a full analysis of a green emission source are displayed in the Photometrica® enviroment. Areas of interest, a line profile, surface plot, and 1976 u' v' color plot reveal the uniformity of the scene.

BP100

The BP100 is a compact, turnkey measurement accessory for fast and precise beam pattern measurements of small lamps. The method uses a diffusely transmitting screen up to 1 meter diagonal. Add the BP100 to the WP214, and there is everything needed to setup and measure the chromaticity and luminous intensity (or illuminance) of small lamps.

BP200

The BP200 includes a diffuse reflection screen, calibration accessories and fixtures to hold the WP214 and test lamp. The included calibration lamp provides a known luminous intensity to the entire test area. With this lamp, all imperfections in the reflecting wall and the optical system are neutralized by the calibration process.

IMAGER SPECIFICATIONS*1

Basic Measurements	Luminance and Chromaticity
Units	cd/m^2, fL, lux, fc, cd, CIE (x,y) and (u’, v’), K (CCT), dominant wavelength, purity, extended calculations such as deltaE, contrast, uniformity etc.
A/D	16-bit, single exposure; 24-bit with electronic bracketing
Measurement Speed	<1s luminance and spectrum only <10s luminance and chromaticity and spectrum
Exposure Timing	Electronic Shutter
Luminance (<10:1 S:N)	.01 to >500,000 cd/m^2 (with optional ND filters)
Luminance Accuracy, Repeatability *3	3%, 0.1%
Chromaticity Accuracy *3	0.002 (x,y)
Polarization Dependence	0.5%
Optional filters	5 positions for Scotopic, Radiometric, Circadian, custom, etc.

SPECTRORADIOMETER SPECIFICATIONS*1

A/D	16-bit, 24-bit with electronic bracketing
Spot Size	47 pixels diameter in image plane
Luminance (>100:1 S:N) *2	1 to >12,000 cd/m^2
Luminance Accuracy, Repeatability *3	3%, 0.3%
Bandwidth	2.4 nm
Wavelength Accuracy *3	0.5 nm
Stray Light	<0.05%
Chromaticity Accuracy *3	0.002, [x,y]
Polarization Dependence	<0.5%

GENERAL SPECIFICATIONS*1

Weight	7.5 kg
Power Consumption	24 V, 25 W
Dimensions (L x W x H)	247 x 140 x 258 mm
Mounting	Standard 1/4"-20 mount
Computer Interface	USB2

*1 Typical values for Illuminant A, on axis and for a spot size of 100 pixels.
*2 Optional range of 1 to 100 kcd/m^2 with additional iris calibration and or density filters.
*3 Immediately after calibration and relative to calibration standard.

* Specifications are subject to change without notice. 14-06

1505 CARLING AVE. SUITE 301 OTTAWA ON CANADA K1Z 7L9 TEL: 613 729 0614 F: 613 729 9067 WPHOTONICS.COM