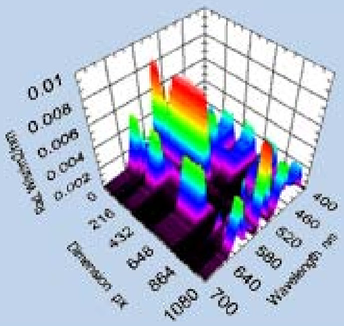
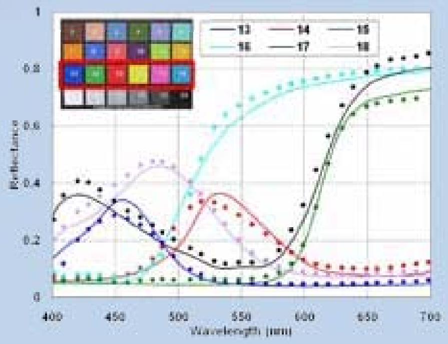
MULTISPECTRAL IMAGING DEVICE

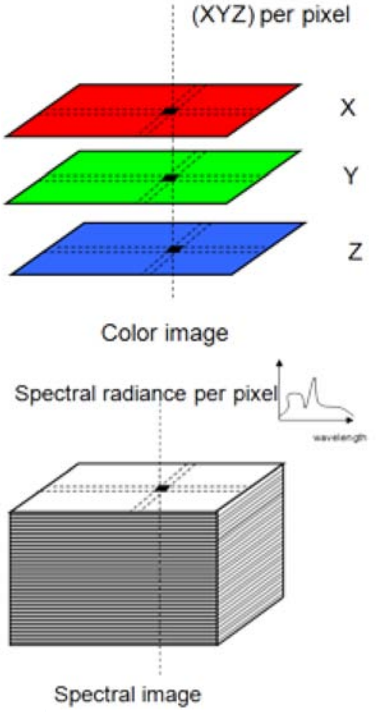




MOST ACCURATE HOMOGENEITY MEASUREMENT OF SPECTRAL RADIANCE

UMasterMS1 & UMasterMS2

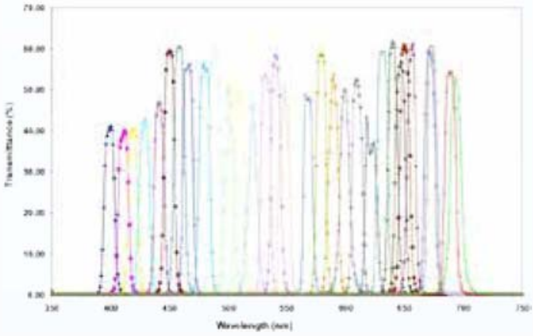
ADVANCED LIGHT ANALYSIS by ELDIM



Colorimetry & Multispectral

Photograph of Umaster MS

Band pass filter wheel of UMaster MS



Transmittance of 31 band pass filters

UMaster MS Description

Multispectral imaging systems generate different images of the same object at different wavelengths. Compare to color imaging this technique is much more powerful avoiding metamerism problems and analyzing in depth the light emission properties of any object. Until now, this technology has been limited to select military, medical and scientific applications. Indeed, absolute measurements are quite difficult to obtain using most of these techniques. We present here a system that allows absolute multispectral measurements in the visible range with excellent accuracy.

UMaster MS includes a true 16-bit Peltier cooled CCD camera , different filter wheels with band pass filters and imaging objective telecentric on sensor side.

High accuracy

ELDIM is manufacturing on its own all the key components of its systems. The quality of the optics is optimum thanks to advanced technologies such as magneto-rheological polishing or stitching interferometry. Antireflective coatings and optical alignments are performed in house to reduce straight light. The imaging objective is telecentric on the sensor side which ensures same light collection efficiency at each distance and the same transmittance in all the imaging field for the band pass filters.

High sensitivity

Peltier cooled CCD sensor with true 16-bit analog digital converter allows optimum sensitivity for **UMaster MS**. Large size CCD versions can be used to detect very low light levels while maintaining a good resolution.

High dynamic

Additional neutral densities are available to allow measurements of very bright sources.

high wavelength resolution & Nir

UMaster MS uses high quality band pass filters. Two wavelength resolutions are available (10nm for MS1 and 20nm for MS2). All the visible wavelength range is covered (400-700nm). Near infrared filters up to 950nm can be available on request.

A range of imaging objectives

UMaster MS is available with an objective of 8° aperture. Additional optics for high spatial resolution are also available.

Data analysis and software

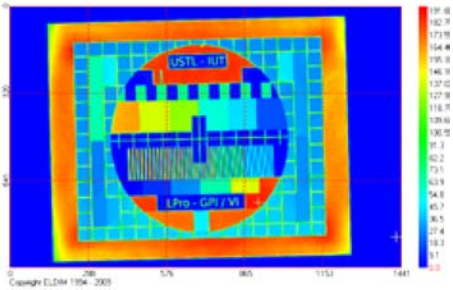
Each **UMaster** system comes with a powerful, Windows-based software suite created by ***ELDIM***. This software provides extensive instrument control, data acquisition and image analysis capabilities. The software provides also a simple, user-friendly interface to fully automated, pre-programmed capabilities. This enables each customer to perform sophisticated measurements and tests in a completely automated way with limited efforts.

UMaster provides a number of tools to analyze completely the multispectral measurements. Luminance and color maps can be computed easily. Spectral information at any position on the image can be extracted and average on small zones is possible. Dedicated algorithms for display analysis are available such as contour extraction, Moiré removal and LED detection and integration. The captured images can be immediately analyzed with comprehensive, integrated graphs, charts and spreadsheets for:

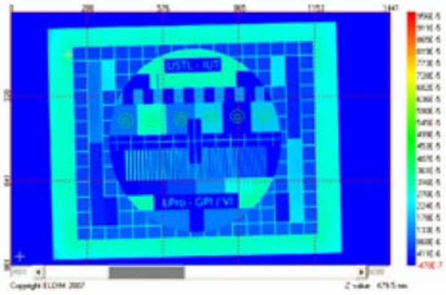
- Radiance
- Luminance
- Color
- Illuminance
- Luminous Intensity
- Total Luminous Flux
- Irradiance
- Radiant Intensity
- Total Radiant Flux
- CIE Chromaticity Coordinates (x,y , u',v' and a,b)
- Correlated Color Temperature (CCT)
- Contrast ratio

Data and graphs can be easily exported to other Windows applications.

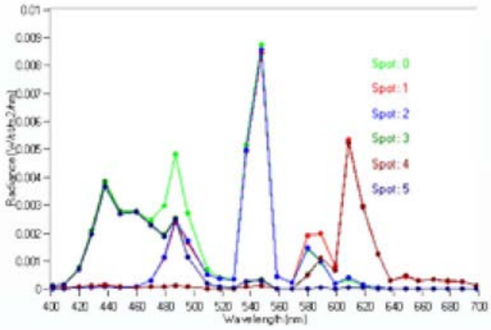
Test Card color image on LCD



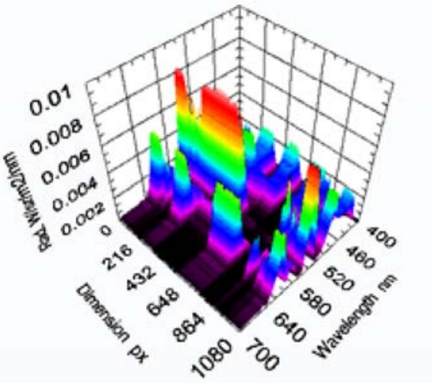
Test Card luminance image on LCD



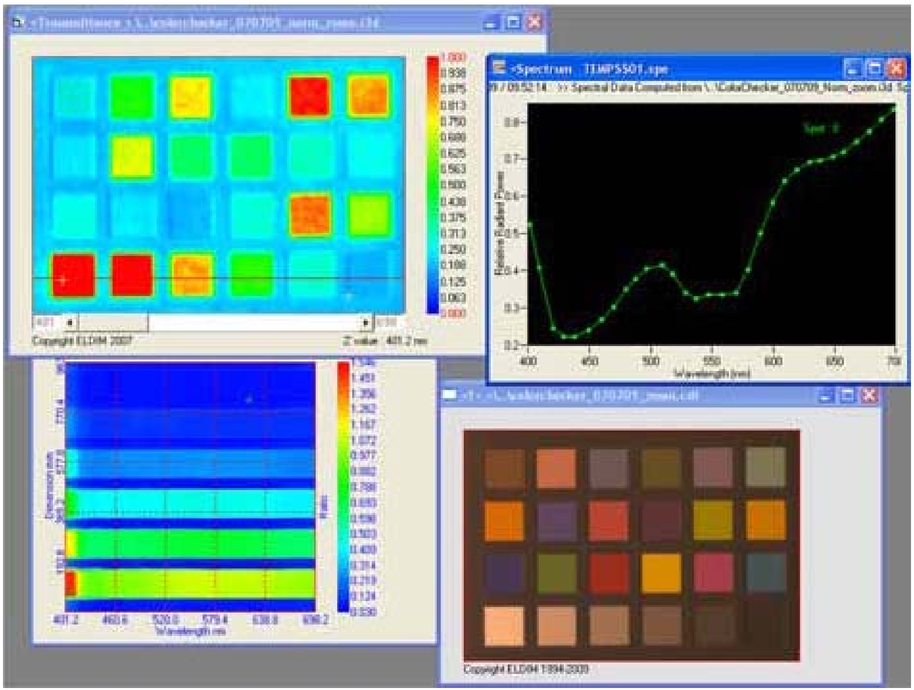
Test Card radiance image on LCD



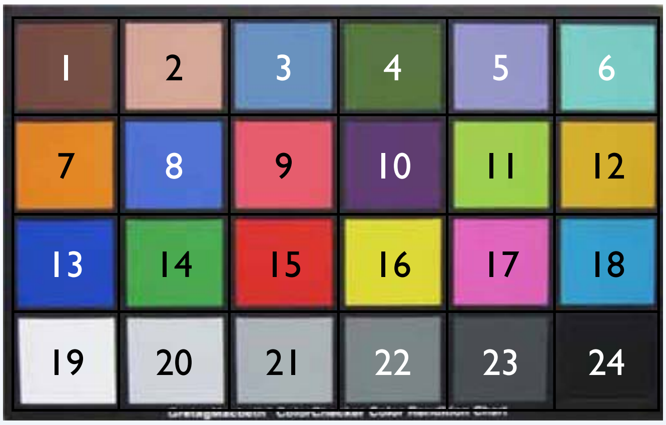
Spectral data on 5 spots



Spectral data along horizontal Analysis with spot s



Spectral analysis of color checker



color checker

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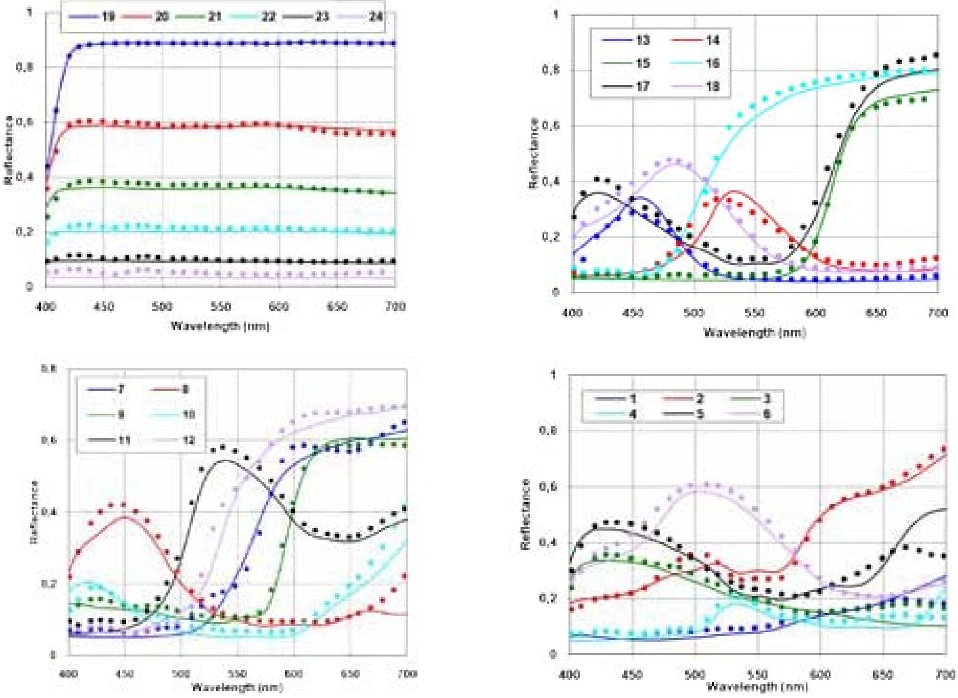
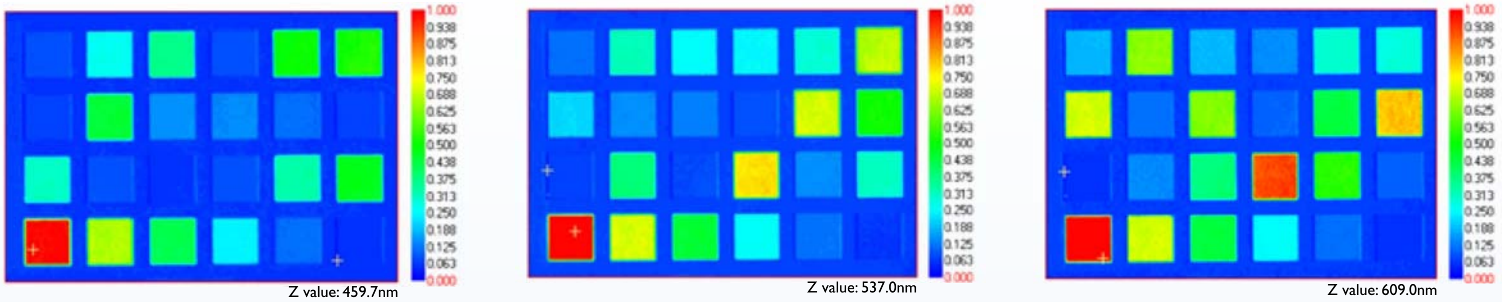
color checker illuminated with white LED

Spectral reflectance

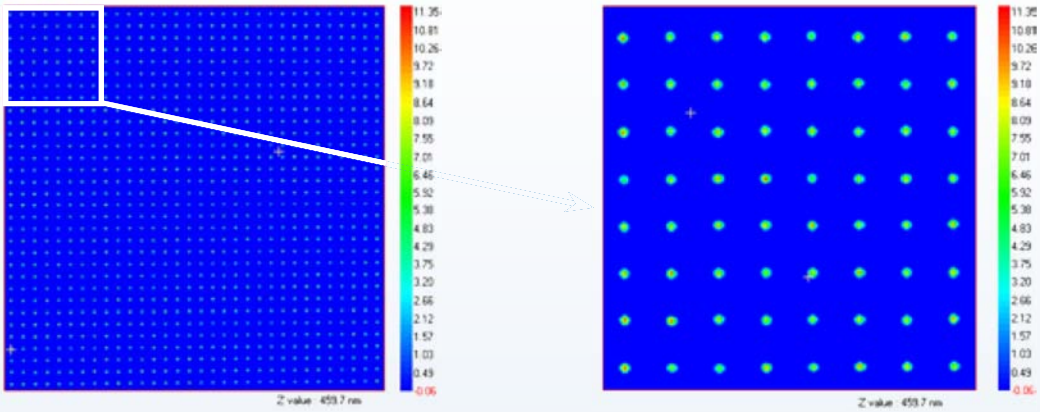
Absolute spectral reflectance is require in many situations. Combined with a stabilized white source **UMaster MS** can provide easily absolute spectral reflectance in the visible range of any object. Accuracy of the system has been checked using a color checker with 24 different zones of well controlled color and spectral reflectance . The measurement is made using a stabilized white LED illumination. The non-homogeneity of the illumination is corrected making the same measurement on a white reference. The spectral reflection of each zones is then computed taking white zone (19) as reference. Some results are reported hereafter compared to the theoretical spectral reflectance provided by the color checker constructor. Agreement is excellent is quasi all the cases.



Spectral reflectance of the different zones (points) compared to theoretical spectra (lines): zone 19 (white) is taken as reference.



Spectral reflectance at three different wavelengths



Radiance of blue LEDs at 459nm

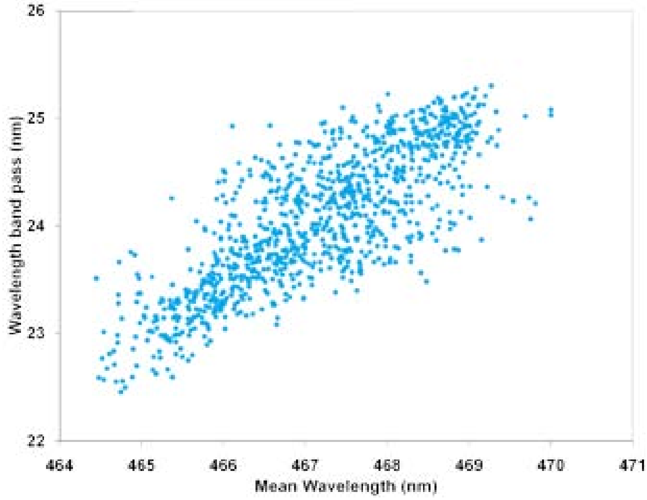
LEDWall analysis

Due to statistic LED emission dispersion, all LEDWall tiles generally require a colorimetric calibration. This can done using color measurements of each type of LED (generally blue, green and red). Automated procedure have been developed for ***ELDIM* UMaster** videocolorimeter. **UMaster MS** allows more in depth analysis of LEDWall emission.

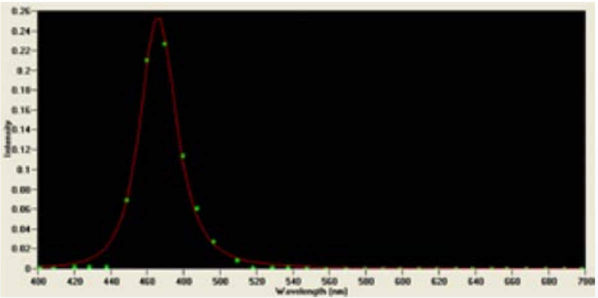
Emission spectra of each LED can be measured directly and mean wavelength emission λ_m and wavelength band pass $\Delta\lambda_m$ can be deduced. For the multispectral imaging measurement, each emission spectrum is extracted and adjusted using a Pearson VII law:

$$f(\lambda)=\frac{1}{\left[1+\left(\frac{2(\lambda-\lambda_m)\sqrt{2^{1/M}-1}}{\Delta\lambda_m}\right)^2\right]^M}$$

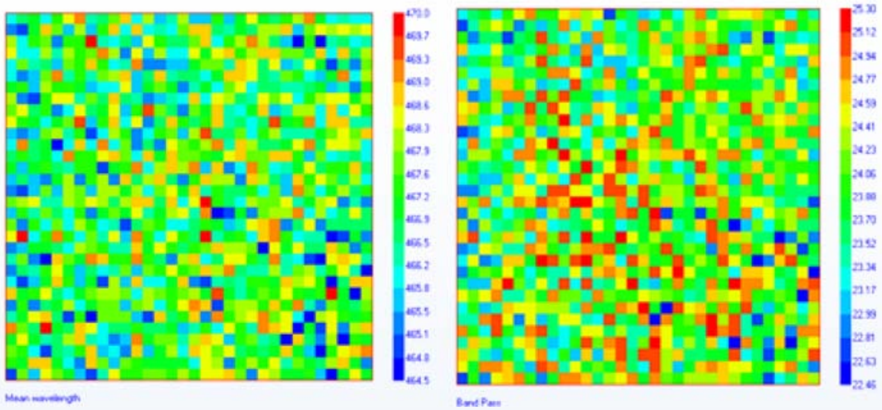
M is a shape parameter that is fixed to 1.6 for LED emission spectra. Detailed emission properties of one LEDWall tile can be deduced. In addition to allow luminance and color correction spectral information are useful to understand and reduce the emission imperfections.



Correlation between mean wavelength and wavelength band pass for the 1024 blue LEDs of a tile.



Emission peak adjustment of blue LED using Pearson VII model



Mean wavelength and wavelength band pass for all the blue LEDs of a tile

Reflective display & aspect

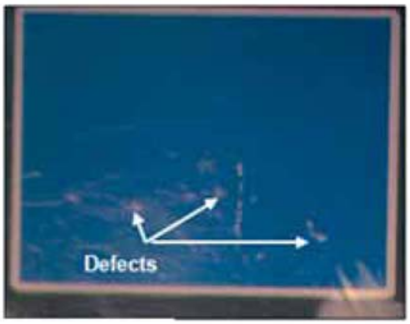
UMaster MS can provide full spectral characterization of reflective displays. Global spectral reflectance homogeneity can be checked. The display image aspect can be also predicted under any illumination conditions.

Spectral reflectance homogeneity

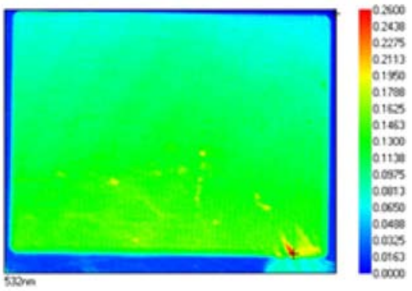
UMaster MS is capable to provide high spatial resolution spectral information and not only luminance and color measurements. On reflective displays and after normalization with a measurement on a white reference under the same illumination conditions, the spectral reflectance homogeneity can be checked. Diffusion defects can be also easily detected.

Image aspect under various illuminants

Absolute spectral reflectance for a given image using the reflective display can be measured. Then the display aspect with this image and any type of illumination can be calculated and predicted.



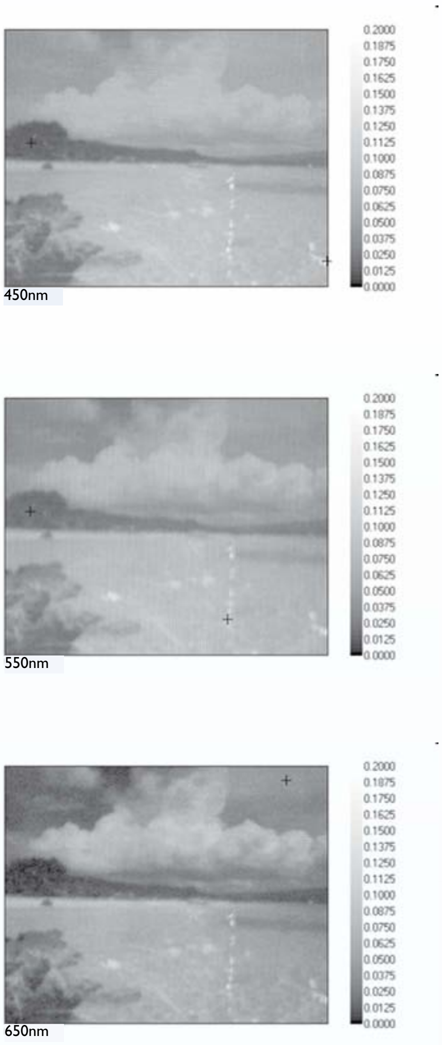
Color Measurement of blue state on Ipod display



Homogeneity of reflectance at 523nm on IPod display

Original image

Spectral image & selection zone

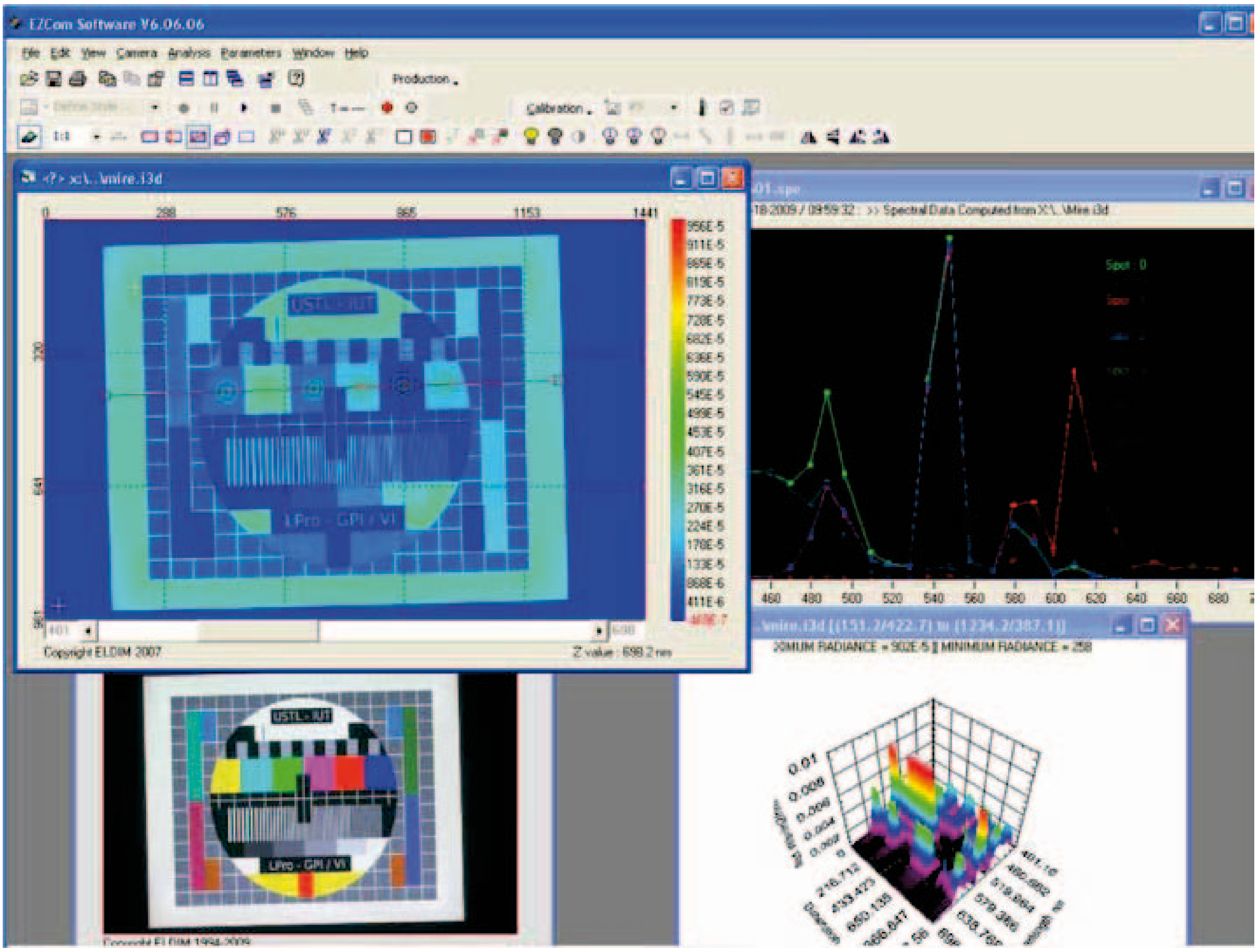


Normalized reflectance image for each wavelength

Resulting color image under D65 illumination

Resulting color image under A illumination

UMaster MS comes with a complete software solution for measurement and data analysis.



Some characteristics of the EZCom 6 software package for UMaster MS

Features	Details
Measurement Capacities	Imaging Radiance
Data analysis	Color & Luminance computation
	Color unit: xy, u'v', Lu*v* or La*b*
	Color intensity, Color Difference, Color Dispersion, Color Triangle, Color Temperature, Equivalent Wavelength
	Cross section (Horizontal, Vertical and free), Isocurves, False Color representation, 3D representation,
	Smoothing Filtering, Rotation, Clipping, R.O.I. extraction, Averaging, Contour extraction, Moiré removal
	Spectral reflectance calculation and color computation for any illuminant
	Average and extraction on rectangular or circular zones
Data export	Copy to clipboard
	Save in text and excel format
	Multi-spots statistics
Programming capacities	All features can be controlled by OCX interface
	Examples of automated measurements and analysis provided

Major specifications of UMaster MS1 & MS2

Common specifications		MS1	MS2	Options
Imaging lens	*Telecentric on sensor* *Motorized focusing*	Max 8° Software adjustment		Standard Optional
Front entrance iris	*Diameter* *Other diameters*	6mm from 2mm to 10mm		Standard Optional
Additional optics	*For high spatial resolution (only available for 1.6M pixel sensor)*	x1 x2 x4		Optional Optional Optional
Radiance	*Band pass Flters from 400 to 700nm* *Additional NIR filters*	31 2	16 6	Standard Optional
Densities	*To add on the imaging objective*	From ND1 to ND4		Optional
Sensor configuration	*Monochrome Peltier cooled CCD grade 1*	1500x1000 or 1.6M pixels 2000x2000 or 4M pixels		Standard Optional
Radiance Range	*Standard* *Optional*	0.001 to 500Cd/m^2 up to 125 000Cd/m^2 with ND filters		Standard Optional
Accuracy	*Radiance* *Luminance* *Chromaticity (x,y) RMS*	±3% (*1) ±3% for any color stimulus(*2) ±0.003 for A type illuminant (*2) ±0.005 for any color stimulus (*2)		Standard Standard Standard Standard
Repeatability	*Radiance* *Luminance* *Chromaticity*	±0.5% for full resolution(*1*3) ±0.5% for full resolution(*1*3) 0.001 for full resolution(*1*3)		Standard Standard Standard
Measurement time	*Radiance*	<3mn(*4)	<90s(*4)	Standard
Using conditions	*Temperature range* *Humidity range*	0 to 40°C 0-85% non condensing		
Interface	*Compute controlled by OCX components*	USB 2.0		
Power	*Independent Power Supply*	AC adapter (100-240V 50/60Hz)		
Current consumption		90W		
Weight		9Kg		

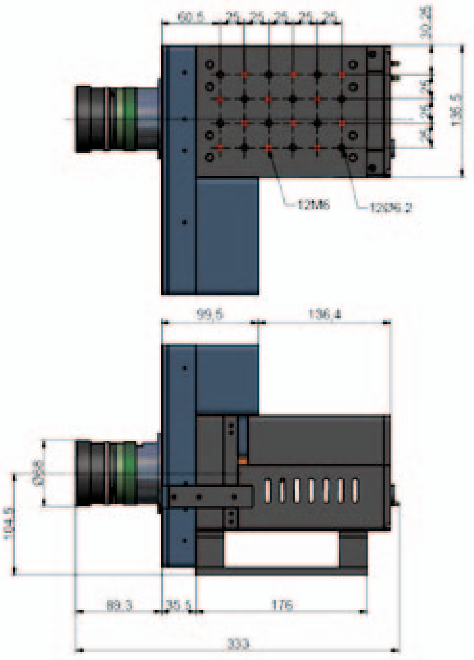
(*1) For a radiance level higher than 10mW/Sr/m^2/nm

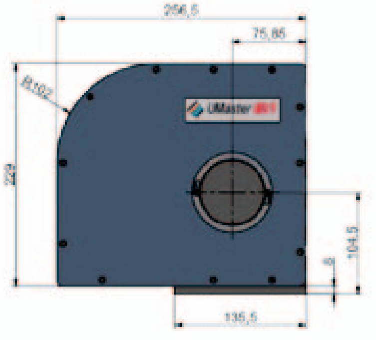
(*2) The accuracy is guarantied for any type of color stimuli in contrast to competitors that generally guaranty only reference white.

(*3) The repeatability is given for full resolution. When a binning level N is used it is divided by a factor of N^2. With standard CCD sensor and for a resolution of 375x250 the radiance repeatability is only ±0.03% !

(*4) Measurement times are highly dependent on the target and on the conditions. Given times are for a source with a radiance level higher than 10mW/Sr/m^2/nm at all the wavelengths and already determined optimized exposure times for all the filters.

Outer dimension (unit mm)





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