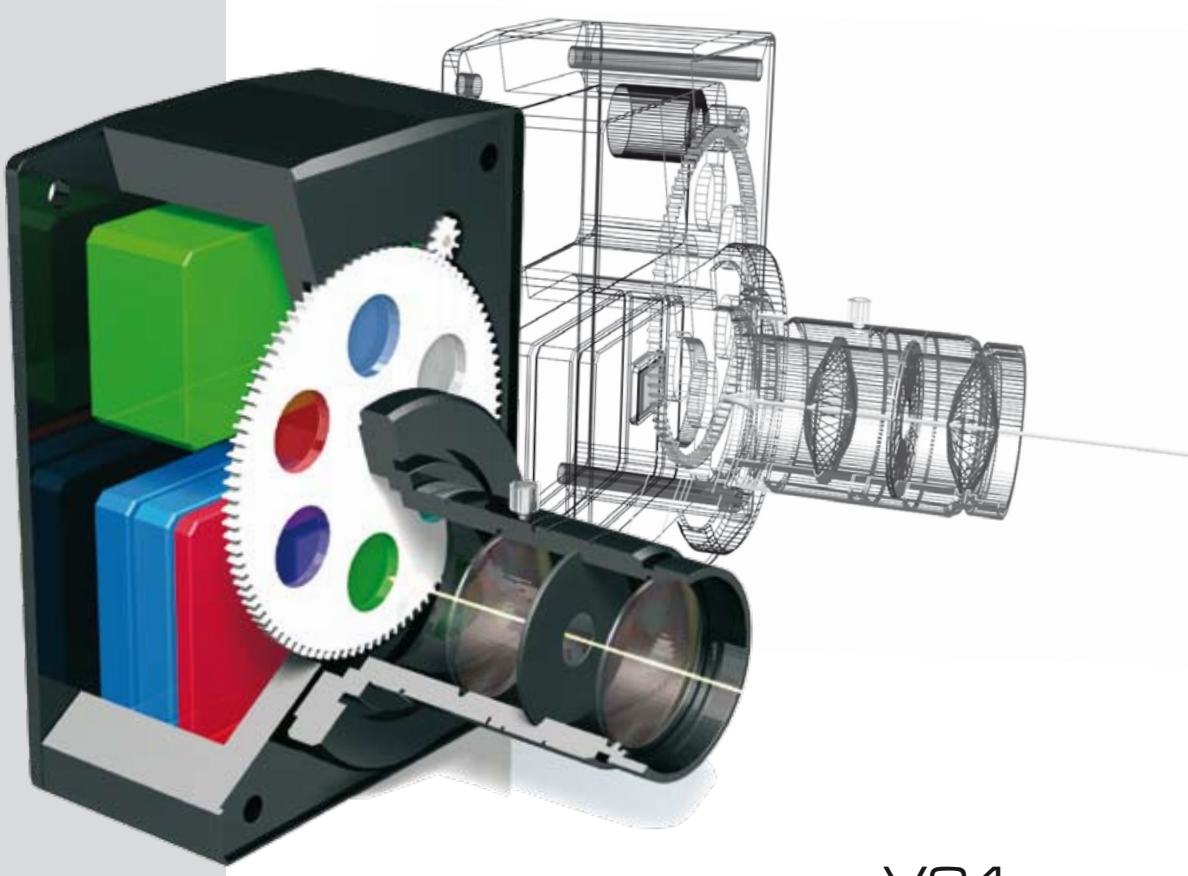
TechnoTeam
Bildverarbeitung GmbH



V2.1

VIDEO PHOTOMETER

IMAGING LIGHT AND
COLOUR MEASURING TECHNIQUE

LMK

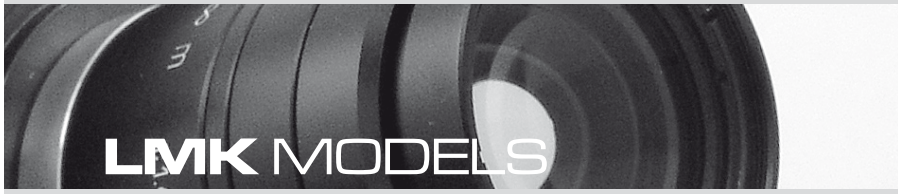
LMK models

The centrepiece of the **LMK** family is the luminance measuring camera type **LMK** 5, using selected and matched CCD matrix sensors made by Sony®.

The current available model types are **LMK** 5 and the **LMK** 5 color.

The measurement system is compact and the operation of the **LMK** 5 via Windows OS operated PC is very simple and flexible. The used PC interface works over GigaBit – Ethernet connector.

For even more flexible and less stationary applications, the **LMK** mobile air is available. It is based on high-quality digital single-lens reflex cameras of the Canon EOS series. Thus, the users have at their disposal a luminance measuring system which is easy to operate and for solving mobile measuring tasks.



LMK 5 color and **LMK** 5

LMK mobile air

Introduction

The spatially resolved analysis of light sources and illuminated scenes is getting more and more important. The complex evaluation of those scenes requires the knowledge of the luminance distribution within the whole field of view or at least in many selected parts of it. Solving the necessary measuring tasks by point by point measuring either takes an enormous amount of time or is only possible within a coarse raster grid or is not possible at all. Thus, the development of spatially resolved radiation receivers, in particular CCD matrix cameras, has enabled the user to solve measuring problems such as measurements for glare evaluation according to the UGR method, the analysis of visibility conditions in the road traffic at night, immission analyis of glare sources, the determination of contrasts in illuminated scenarios like workspaces or directly on light sources (e.g. lamps/ luminaires, displays, night design, indicators).

- measuring of luminous and illuminated surfaces
- determination of luminous and background-lit symbols
- data for simulations in the development of lamps, luminaires and headlamps
- capturing of complex illumination and light distribution situations
- cataloguing and presentation

VIDEO PHOTOMETER

IMAGING LIGHT AND COLOUR MEASURING TECHNIQUE

Advantages

- complex evaluation of luminous and illuminated scenes by means of the photograph of a spatially-resolved luminance distribution
- simultaneous recording of a large number of connected measuring data
- easy data analysis at a glance

Result data

- luminance distributions in measuring images L(x,y)
- derived lighting-engineering parameters such as illuminance distribution E(x,y) and luminous intensity distribution I(x,y)
- luminance data in various formats
- statistical data for being used in calculation programs (e.g. EXCEL®, MatLAB®, LabVIEW®)

Technical data

Sensor:

CCD - imaging matrix system
1380 x 1030 pixel *or* 2448 x 2050 pixel

Resolution (dynamic):

Single picture measurement: 1:1100 (~ 61 dB)
Multi picture measurement: 1:3600 (~ 71 dB)
High Dynamic measurement: 1:10000000 (~140 dB)
A/D conversion: 14 bit

Measurement time:

Starting with 1 sec. up to 15 sec. for different luminances, depending on adjusted exposure time

Measurement accuracy:

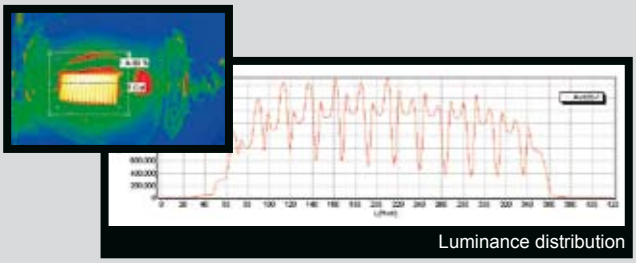
$\Delta L < 3$ % (for standard illuminant A)
$\Delta x,y < 0.0020$ (for standard illuminant A)

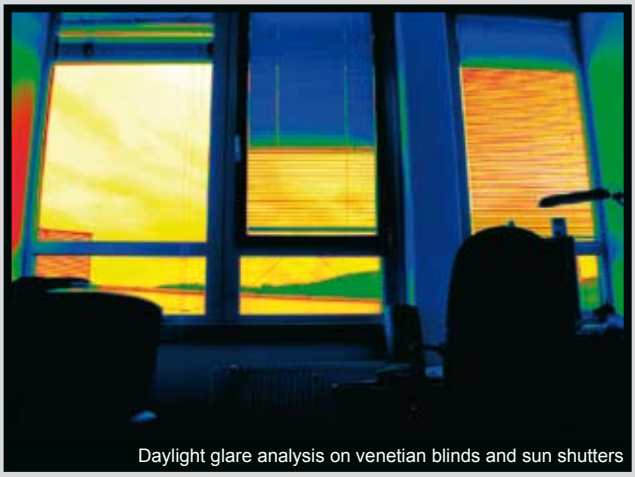
Spectral matching:

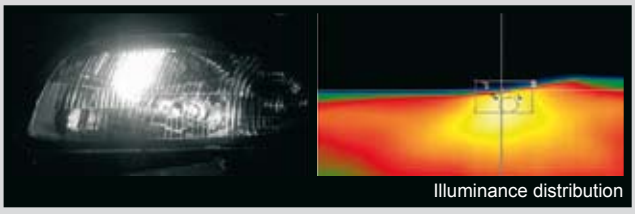
with full size filter matched to V(λ)-function for measuring luminances

arranged with X(λ)-, V(λ)- and Z(λ)-filter for measuring colour values; additionally C(λ)-, V'(λ)-, BLH (blue light hazard) and IR-filter are available

LMK


Luminance distribution


Daylight glare analysis on venetian blinds and sun shutters


Illuminance distribution


Measurement of coloured LED

Imaging measuring of luminances

The measurement of luminance distributions L(x,y) allows the complex evaluation of numerous lighting-engineering devices (lamps, luminaires, projectors and light control systems), as well as the evaluation of illumination scenes. The imaging luminance measuring technology allows the acquisition of both photometric parameters and geometrical data, enabling the user to determine further lighting-engineering quantities (luminous intensity, illuminance).
For describing lighting-engineering objects, not only simulation data but also various measuring data are necessary:

- description of luminous and illuminated surfaces of lamps and lighting fixtures by their luminance distributions L(x,y)
- determination of contrasts and spatial contrast rendering function (CRF)
- deriving additional photometrical or recognition data throughout geometrical analysis like illuminance, luminous intensity or glare data
- deducing the illuminance or luminous intensity distribution (LID) on illuminated surfaces (by use of diffuse Lambertian reflectance and fixed geometrical setup) by means of the luminance distribution

Colorimetric measuring data

The imaging measurement and determination of colour and chromaticity values, for example of lamps and lighting fixtures, is gaining more and more importance. Using the **LMK color** camera adapted to the colour matching functions of the 2° CIE standard observer (CIE 1931) by a filter wheel, not only luminances but also tristimulus values can be determined. This permits the imaging measurement of chromaticity coordinates, which can be given in different colour spaces. Therefore it is possible to solve tasks a lot faster compared to classical colour measuring techniques.

- describing the colour distribution on luminous and illuminated surfaces or symbols by means of the chromaticity coordinates x,y
- determining the dominant wavelength λ_{dom} and the correlated colour temperature (CCT in Kelvin) of LEDs and lamps

Night vision design

The dashboard, cockpit and ambient night vision design of the automotive and avionic industry offers manifold applications for the imaging luminance and colour measuring technology.

- brightness and uniformity of backlit symbol illumination
- colour, colour rendering and colour shift of functional backlit or ambient illumination
- brightness, uniformity and contrasts on screens and displays

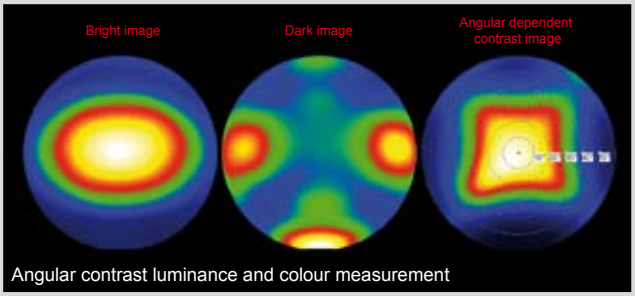
For this purpose, **TechnoTeam** has designed application adapted software tools for recording and determining low luminances of smallest symbols.
Therefore the Symbol object measures the mean luminance of backlit surfaces – using adaptive algorithms to set a classifying luminance threshold, thus offering more adaptive solutions.

Display analysis

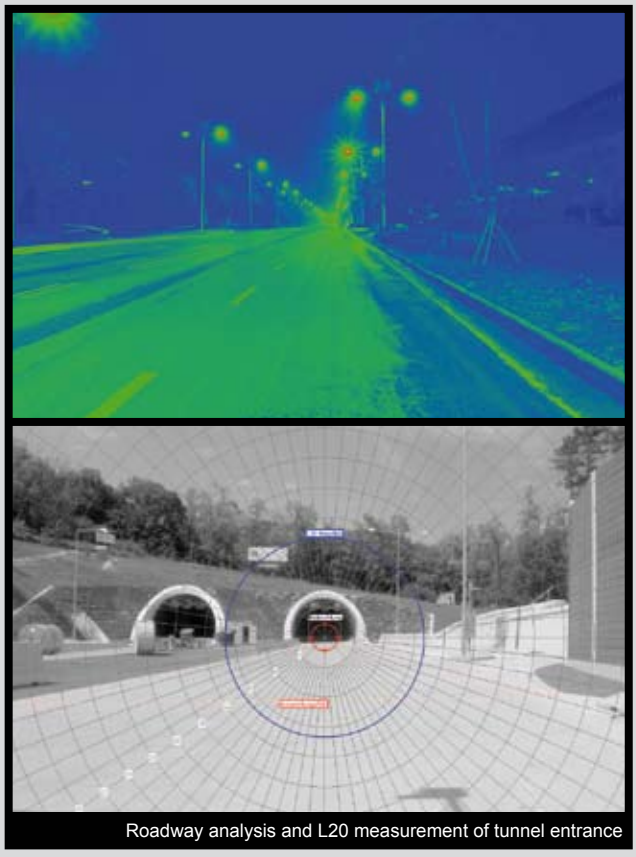
The imaging light and colour measuring technology is exceptionally well suited for analysing or checking the rendering characteristics and quality features of flat panel displays (FPD).

- checking the uniformity of backlit background luminance according to existing standards
- evaluating the angle-dependent contrast distribution on FPD (by means of a Conoscopic lens and Application close software tool)
- determining defect pixels of FPD
- BlackMURA analysis according to German Automotive OEM Work Group Displays
- Sticking image analysis of FPD

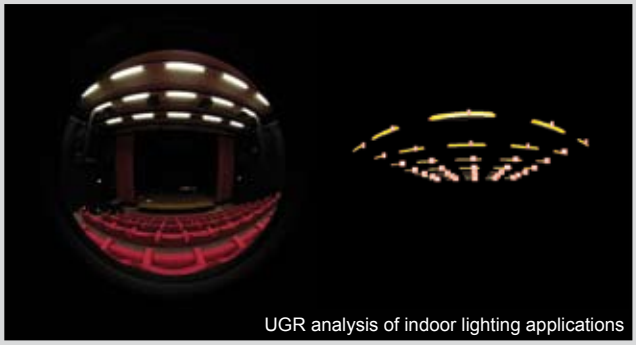
Brightness and uniformity of backlit symbol illumination – symbol



Angular contrast luminance and colour measurement



Roadway analysis and L20 measurement of tunnel entrance



UGR analysis of indoor lighting applications

Outdoor lighting

The **LMK** measuring system is very well suited to make measurements in an urban environment, on public places and spaces, on roadways or any other artificially illuminated infrastructure in order to produce data for checking and maintaining lighting design.

- checking the luminance, colour rendering and colour shift of large luminous boards and information carriers with regard to their visibility and perceptibility
- glare evaluation and determination of the visibility distance of lighting installations
- determination of the luminance distribution according to DIN EN 13201 for roadways
- performing the L20 luminance measurement of tunnel portals (CIE Publ. 88)
- checking the recognizability of roadway markings under varying weather conditions

Used in a moving car the **LMK** camera also allows for dynamic roadway luminance analysis.

Indoor lighting

The **LMK** measuring system allows spatially resolved measurements to verify existing standards and design projects to be made in a simple and fast way with regard to full illumination, ergonomics and well-being.

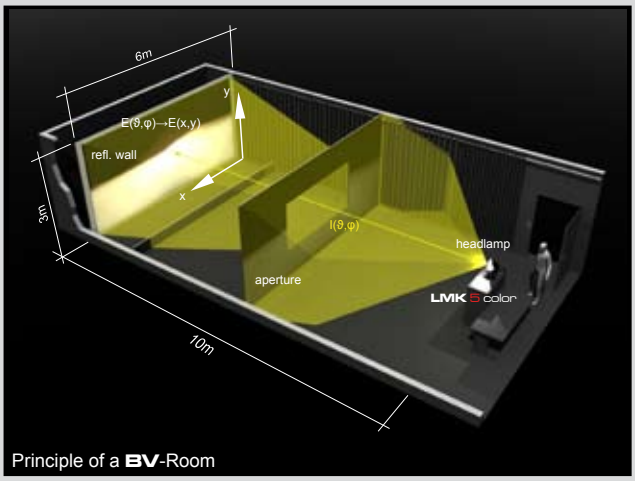
- evaluation of brightness and colour distribution and perception in rooms, offices or other indoor spaces
- glare evaluation on window surfaces, daylight systems and artificial light sources (GR, UGR, DGP)
- determination of brightness dynamics and contrast ratios (CRF)
- determination of the horizontal illuminance distribution related to ergonomic and economic aspects of workplaces and spaces
- evaluation of circadian activation potentials of artificial lighting with regard to the health and well-being of humans
- checking and maintaining emergency and safety lighting according to existing standards

Measuring headlamps

Being the supplier of measuring equipment for a large number of manufacturers of lighting and illumination devices and maintaining close contacts to its scientific environment, the **Techno**Team company has gained experience in handling both lowest and highest luminances, thus is in a position to offer solutions adapted to very special applications.

- determination of the illuminance distribution on plane surfaces
- calculation of the luminous intensity distribution of headlamps
- measurement of the colour scale and colour deviations, e.g. on bright and dark edges in the projected image of a headlamp
- verification and observance of guidelines for car headlamps by means of prescribed measuring points (e.g. HV; AK31; B50L and many more)
- automatic alignment on measurement grids and positioning of measurement spots (automatic elbow-point detection)
- calibrated for and supported by our products **KMP** and **BV**-Room

By means of the **LMK** camera, it is possible to take street lighting measurements also out of a car in motion.

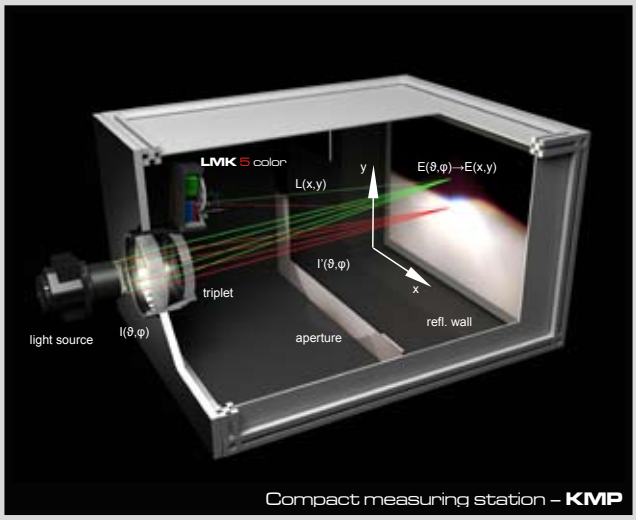


Principle of a **BV**-Room

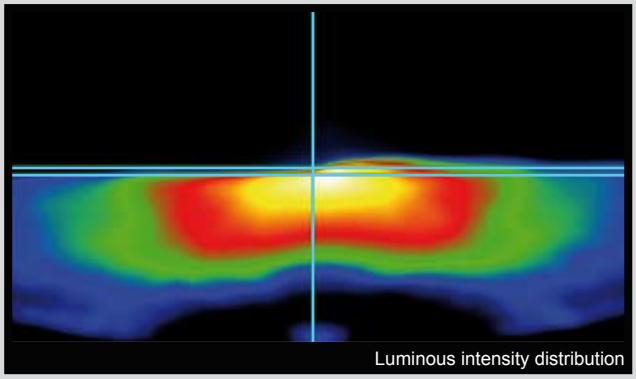

Measuring object – automotive headlamp

Compact measuring station **KMP**

The **KMP** is a realisation of the principle of the indirect luminous intensity measurement without the need of a specially adapted laboratory room. A measuring object positioned in front of the optical system of the **KMP** illuminates a reflective wall with Lambertian characteristics, which is placed in the focal plane of the optical system. Thus the reflected luminance distribution or colour distribution can be measured by using the **LMK** or **LMK** color, inside the **KMP**. The optical system of the **KMP** reduces the measuring distance to less than 1 m while maintaining the observance of the photometrical limiting distance. The geometrical and photometric relations between the light source (in spherical coordinates) and the reflective wall (in camera coordinates) are known, therefore the luminous intensity distribution I(ϑ, ϕ) can be calculated automatically from the image of the luminance L(x, y).



Compact measuring station – **KMP**


Luminous intensity distribution

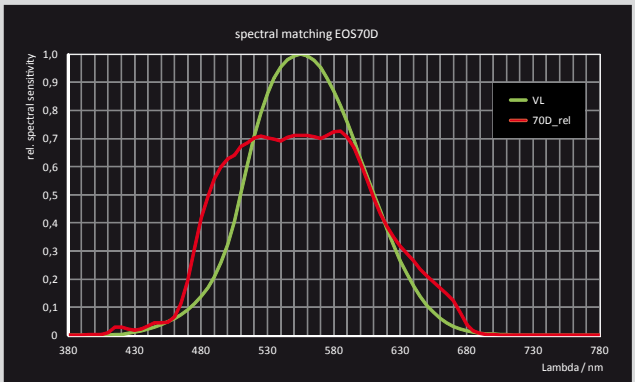
LMK MODELS

The application of high-quality digital cameras in the **LMK** system allows for easy and fast capturing of luminance images. For evaluating the images, the complete functionality of the **LMK** LabSoft software can also be utilized.

LMK mobile air Set

Ti\Av	4	5,6	8	11
1 ms	6,6	7,0	7,2	7,8
2,5 ms	5,0	5,3	5,5	6,2
25 ms	4,8	5,2	5,4	6,0
0,25 s	4,8	5,2	5,4	6,0
2,5 s	4,8	5,2	5,4	6,0

Table of measurement uncertainty for **LMK** mobile air



Halogen metal discharge lamps	2-9%
High pressure sodium discharge lamp	7-13%
Fluorescent lamp	8-10%
LED white	5-12%

Quality of spectral matching of the **LMK** mobile air

1 Calibration according to DIN 5032 Part 6 using a luminance standard led back from the Physical-Technical Federal Institute

LMK mobile air

Sensor

CMOS Canon APS-C
[5566 (H) x 3706 (V)]
effective Pixel [2748 (H) x 1834 (V)]
(resolution of the luminance image)
[14 Bit RAW
data with Bayer structure, uncompressed]

Dynamic range

Single picture measurement [SinglePic]
[1:4000 (~60 dB)]
High Dynamic measurement [HighDyn]
[1:32000 (1/1250 sec. ≤ ti ≤ 8 sec)]

Data transmission

SDHC memory card and/or USB 3.0

Metrological specifications

Spectral matching
[numerical weighting of the RGB tristimulus values (multiplying matrices)]

Focal length / Visual field angle

FishEye:
Focal length [4.5mm: ca. 180°(circular)]

Standard:
Focal length [17mm: ca. 74.6°(H) x 49,7°(H)]
Focal length [50mm: ca. 27.8°(H) x 18.6°(H)]

Tele:
Focal length [70mm: ca. 14.6°(H) x 10°(H)]
Focal length [200mm: ca. 5,9°(H) x 3,9°(H)]

Selection of measuring range

Selecting aperture,
exposure time and ISO speed.

Calibration uncertainty[1]

ΔL [< 2.5%]

Uniformity

ΔL [< 2%]

Fields of application

research and development (R&D) applications
solid state lighting (SSL) - outdoor/indoor
glare assessment

Fields of application

Can not be used for measuring coloured light sources (e.g. LED)

Limited use for measuring modulated light sources with strong modulation

LMK mobile air
APP (iOS)
Just install!

LMK 5

Sensor

[14 Bit digital, progressive scan]

LMK 5-1

CCD Sony [ICX 285 AL (2/3")]
effective Pixel [1380 (H) x 1030 (V)]

LMK 5-5

CCD Sony [ICX 655 AL (2/3")]
effective Pixel [2448 (H) x 2050 (V)]

Dynamic range

Single picture measurement (SinglePic)
[1:1100 (~61 dB)]
Multi picture measurement (MultiPic;10 pics)
[1:3600 (~71 dB)]
High Dynamic measurement
[1:10000000 (~140 dB)]

Data transmission

Gigabit Ethernet Interface(GigE®)

Metrological specifications

V(λ) [$f_1' < 3.5\%$[1]]

Measuring quantities

Luminance [L (cd/m²)]
Further measuring quantities can optionally be defined via scaling factors.

Measuring range

Setting the luminance measuring ranges by choosing the integration time from 100 µs...15 s
Accuracy rating depending on lens (aperture number = k), e.g.:
1ms ...appr. 1800 cd/m² & 3s ...appr. 0.6 cd/m² (k = min.)
1ms ... 60000 cd/m² & 3s ... appr. 20 cd/m² (k = max.)
Higher luminances can be achieved using optional neutral density filters.

Calibration uncertainty[2]

fix focused lenses ΔL [< 2%]
focusable lenses ΔL [< 2.5%]

Repeatability[3]

ΔL [< 0.1%]

Measuring accuracy

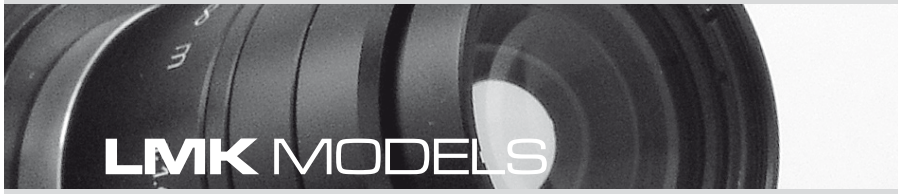
ΔL [< 3% (for standard illuminant A)]

Uniformity

ΔL [< 2%]

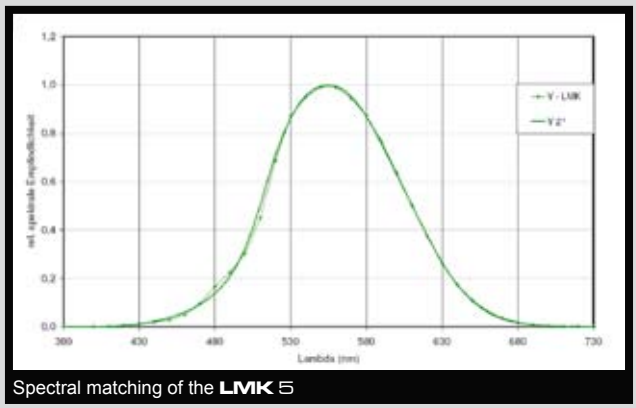
Fields of application

laboratory measurements, field measurements, industry automation



The **LMK 5** is a digital CCD matrix camera system equipped with a precise analogue electronic system for signal generation.
Each camera is equipped with carefully manufactured full filter in order to achieve a high-quality V(λ)-matching for determining luminances.

LMK 5



Spectral matching of the **LMK 5**

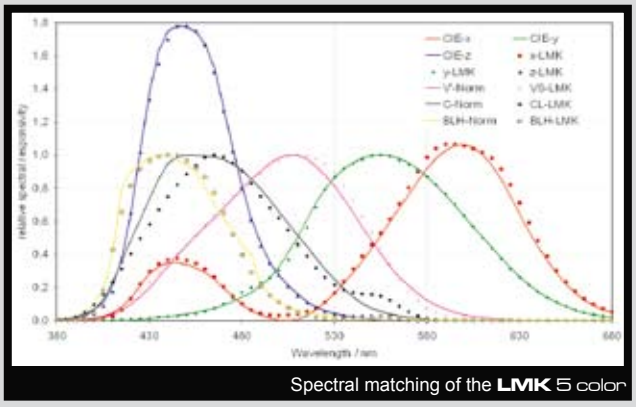
1 Measurements according to DIN 5032 Part 6/CIE Pub. 69 | 2 Calibration according to DIN 5032 Part 6 using a luminance standard led back from the Physical-Technical Federal Institute | 3 Measurement performed on a stabilized white LED light source L=100cd/m². Mean value over 100 Pixel; repeatability as variability of the mean value.

LMK MODELS

The **LMK** 5 color is equipped with a filter wheel for colour measurements, adapted to the colour matching functions of the 2° CIE standard observer (CIE 1931).
Thus, luminances and additional colour or chromaticity data can be measured. The filter wheel allows a total of 6 full glass filters to be incorporated, with 4 filters being necessary for the colour measurement.

In addition, the measuring system can also be equipped with filters for the scotopic luminance V´(λ), the circadian function of action C(λ), an IR - filter (measurements in the NIR range 780-1000 nm) a BLH (blue light hazard), or a clear glass filter.

LMK 5 color



Spectral matching of the **LMK** 5 color

1 Measurements according to DIN 5032 Part 6/CIE Pub. 69 | 2 Dominant wavelength, saturation, correlated color temperature | 3 Calibration according to DIN 5032 Part 6 using a luminance standard led back from the Physical-Technical Federal Institute | 4 Measurement performed on a stabilized white LED light source L=100cd/m². Mean value over 100 Pixel; repeatability as variability of the mean value. | 5 Measured value based on 30 test colors with different spectral distributions based on ROSCO color filters

LMK 5 color

Sensor

[14 Bit digital, progressive scan]

LMK 5-1 color
CCD Sony [ICX 285 AL (2/3")]
effective Pixel [1380 (H) x 1030 (V)]

LMK 5-5 color
CCD Sony [ICX 655 AL (2/3")]
effective Pixel [2448 (H) x 2050 (V)]

Dynamic range

Color High Dynamic measurement
[1:10000000 (~140 dB)]

Data transmission

Gigabit Ethernet Interface(GigE®)

Metrological specifications

V(λ) [f_1 < 3.5%[1]]; X(λ) [f^*_1 < 4%]
Z(λ) [f^*_1 < 6%]; V´(λ) [f^*_1 < 6%]

Measuring quantities

Luminance: L (cd/m²), chromaticity coordinates: x,y, Supported colour spaces: RGB, XYZ, sRGB, EBU-RGB, User, Lxy, Luv, Lu'v', L*u*v*, C*h*s*uv, L*a*b*, C*h*ab, HIS, HSV, HSL, WST[2]
Further measuring quantities can optionally be defined via scaling factors.

Measuring range

Setting the luminance measuring ranges by choosing the integration time from 100 µs...15 s
Accuracy rating depending on lens (aperture number = k), e.g.:
1ms ...appr.7500 cd/m² & 3 s ...appr. 2.5 cd/m² (k = min.)
1ms ... 60000 cd/m² & 3 s ...appr. 20 cd/m² (k = max.)
Higher luminances can be achieved using optional neutral density filters.

Calibration uncertainty[3]

fix focused lenses ΔL [< 2%]
focusable lenses ΔL [< 2.5%]

Repeatability[4]

ΔL [< 0.1%]
Δx,y [< 0,0001]

Measuring accuracy

ΔL [< 3% (for standard illuminant A)]
Δx,y [< 0.0020 (for standard illuminant A)]
Δx,y [< 0.0100 (set of test colours)[5]]

Uniformity

ΔL [< 2%]

Fields of application

laboratory measurements, field measurements, industry automation

LMK LabSoft software

Additionally to all camera systems of the **LMK** family, the **LMK** LabSoft is supplied.
The measuring software offers a large number of possible applications when using the luminance measuring systems, as well as for data evaluation and processing.

Ease of operation is guaranteed to the user through the integration of task-specific capture functions.

SinglePic-capture - allows a luminance image to be taken very quickly.

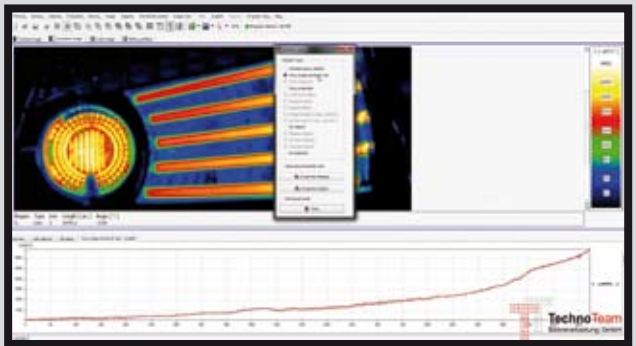
MultiPic-capture - allows the repeated capture of several single images so as to eliminate statistical measuring errors through averaging.

HighDyn-algorithm - allows the capture of a luminance image composed of single images at various integration times so as to realize a higher dynamic range.

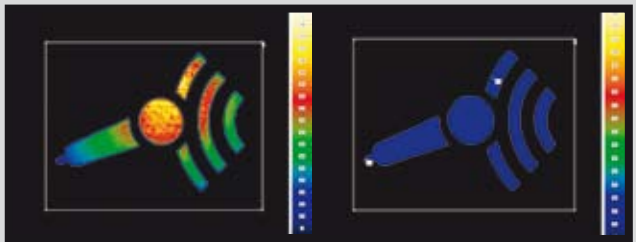
For the visualization of the measuring results, the user can choose, among other things, from a freely scalable pseudocolouring as well as several logarithmic representations. Pre-made and freely scalable point, line, circular and rectangular cursors allow the measuring data to be accessed in a quick and flexible way. The definition of measuring regions by means of geometrical basic shapes facilitates the evaluation process. In addition, they provide many auxiliary means for the statistical evaluation of the data (tables, sectional diagrams, histograms, and photometric evaluation algorithms).
Furthermore, the software offers a function for an automatical detection of regions by means of luminances. This is both useful and advantageous for detecting complex geometrical structures.

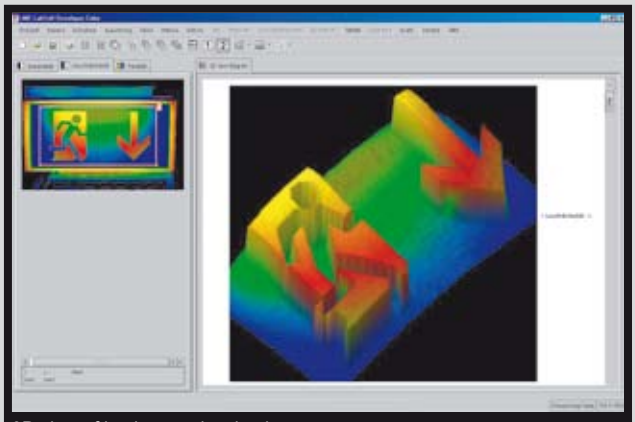
An integrated report function allows for the export of measurement and evaluation data to MS Word® and MS Excel®. Thus it offers a simple and comfortable way for communicating and sharing measurement results. Furthermore a standard or individual printing template can be created for report printing.

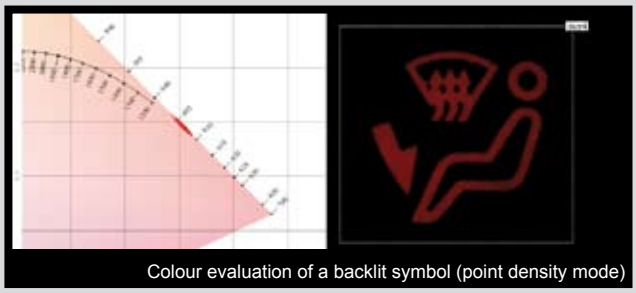
The **LMK** LabSoft software provides a big variety of data formats for the export and import of image and measuring data, for example for MATLAB®, LabVIEW® and SPEOS®. The data exchange with Microsoft Office® products and other software programs is ensured by functions of the Windows® clipboard.



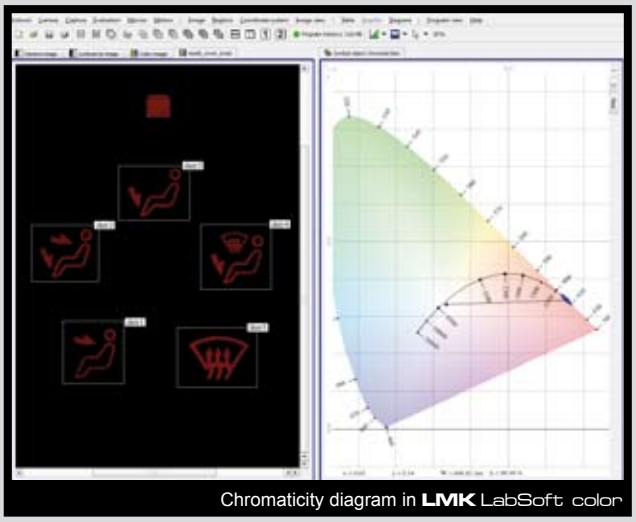
Sectional view statistic tool in **LMK** LabSoft


Luminance image (left) and statistical symbol detection (right)

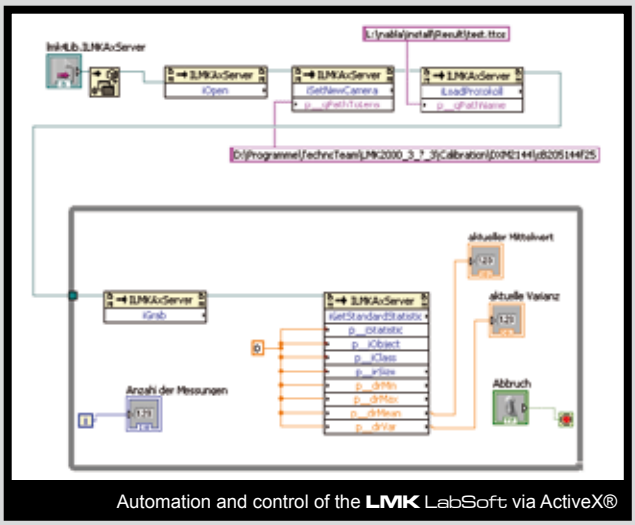

3D view of luminance drawing in **LMK** LabSoft



Colour evaluation of a backlit symbol (point density mode)



Chromaticity diagram in **LMK** LabSoft color



Automation and control of the **LMK** LabSoft via ActiveX®

LMK LabSoft color software package

With the **LMK** LabSoft color the complete functionality of the luminance measuring software **LMK** LabSoft is available for the assessment of chromaticity values out of three channel colour images. The measured X,Y,Z colour values can be converted into different colour spaces (e.g. RGB, XYZ, sRGB, EBU-RGB, Lxy, Luv, L*a*b*, HIS, HSV). In case of measuring LEDs or lamps a colour space showing the dominant wavelength, the colour saturation and the correlated colour temperature is available. It is possible to calculate colour distances and colour differences in several colour spaces.
With the colour symbol object-chromaticity coordinates can be matched to their luminance levels. So it is easier to detect regions for a colourimetric evaluation (e.g. backlit symbols) with respect to a luminance threshold.

The user can exert an influence on the calibration data and change the algebra of matrices. Therefore it is possible to adjust the **LMK** system for an own colour space or for balancing the **LMK** system with own reference quantities. In this way the spectral matching can be adapted to specific measurement tasks (e.g. LED measurements).

Throughout the measurement in several channels X, Y, Z and V´(λ) and optional C(λ) or BLH (Blue Light Hazard) and the subsequent image processing different radiation measurements for different perception models can be made (e.g. mesopic brightness perception).

LMK LabSoft extended software package

With this version of the **LMK** LabSoft software the possibilities for an interaction and automation of the image processing procedures are rapidly increased. By using an ActiveX® Interface the **LMK** LabSoft and its essential functionalities can be controlled by several other software applications. The assessement of the image and measurement data can be done directly via the host application. Therefore, the software can easily be integrated into existing workflows.

Version packages of LMK LabSoft

LMK LabSoft

With the measurement and analysis software **LMK** LabSoft **Techno**Team provides a consistently ongoing analysis software development. This can be seen as the result of an intensive exchange of experience with our customers and so we can enhance our evaluation functionalities continously. Thus the functionalities for the documentation and the reporting of the measurement results are now totally compatible with MS Office®.
Our customers can directly profit from this development during the whole life-time of their **LMK** systems with free of charge software updates.

LMK LabSoft simple

The **LMK** LabSoft simple package offers a measurement system which includes the known camera hardware in combination with only essential software components at a lower price.
Therefore, all video photometer systems can be equipped with the **LMK** LabSoft simple software. This software is reduced to several selected basic functionalities.

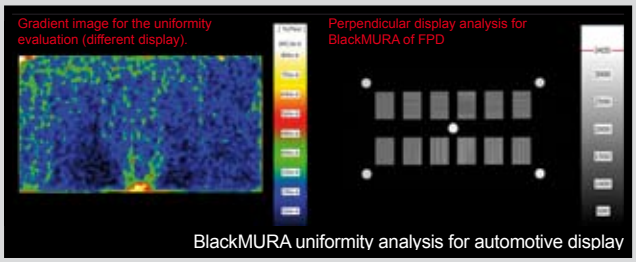
Software functionality	LMK LabSoft simple	LMK LabSoft
Image capture		
Live image (grey scale value)	x	x
Exposure adjustment	x	x
Image capture (SinglePic, MultiPic, HighDyn, Color HighDyn)	x	x
Capturing modulated light	x	x
Live luminance image SinglePic, HighDyn, Color HighDyn		x
Capturing measurement series *(manual, time controlled, mechanical controlled)*		x
Representation of images *(Pseudo-colours, ISO colours, scaling)*	x	x
Working with images *(load, save, delete, copy, print)*	x	x
Displaying measuring values by means of cursors (standard, rectangle, circle, line, circular ring, cross, zoom)	x	x
Measurement regions *(load, save, copy, paste, group, print)*	x	x
Measuring value indication using inspectors		
Standard statistics *(standard evaluation, histogram, sectional view, time statistics, luminance object, integral object, symbol object, arc object, filament object)*	x	x
Report function *(create, load, save, print)*	x	x
Evaluation images and image processing		
Additional evaluation images	1	N
Physical parameters and units	x	x
Assigning list of regions		x
Assigning image tab windows		x
Image arithmetics		x
Coordinate transformation		x
Projective rectification - orthophotographs	x	x
ISO lines in luminance images	x	x
Colour images and colour metrics		
Colour space and measuring values	x	x
Calculation of colour differences	x	x
Decomposition of colour images into colour extract images		x
Composition of colour extract images into colour images		x
Test colour images		x
Measurement protocols *(create, load, save, comments)*	x	x
Automation via ActiveX®		
ActiveX® programming interface	●	●
Running IPED – autom. image processing macros		●
Additional software addon		
Motor control		●
BlackMURA - display measurement		●
Sticking image – display analysis		●
LID – luminous intensity distribution measurement		●
CCM – conoscopic contrast measurement		●
EN13201 – street analysis		●

x available ● optional available

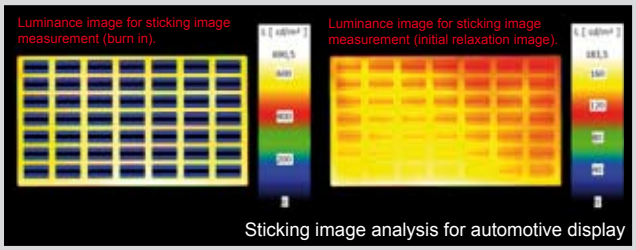
LMK LabSoft AddOn user application software

For more frequent applications with complex analysis steps **Techno**Team developed a number of additional and optional software tools for **LMK** LabSoft. Thus the user has a fast and easy access on specific measurement results and data. **LMK** LabSoft AddOn are not available for the **LMK** LabSoft simple version. Some of them are free of charge.

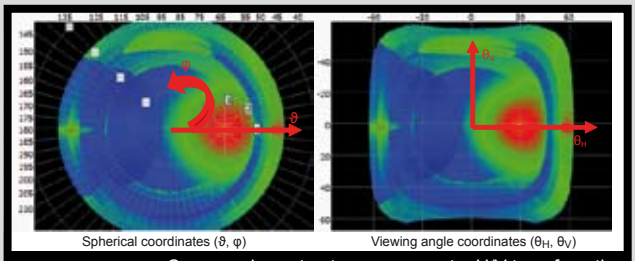
- **LMK** BlackMURA supplies the analysis of display screen quality according to the black-level uniformity.
  Thus the package is providing an extension to the functions of the **LMK** LabSoft for realising a gradient filter detection of particular non-uniformity on the display screen.
- **LMK** Sticking image supplies the analysis of display screen quality according to the three-level burn-in method developed by Dr. Lauer.
- **LMK** Conoscopic contrast measurement – CCM
  The software package allows the user to perform the application of angular contrast determination of display in an easy way. It provides the capability of H/V angular coordinates conversion as well as the definition of measurement regions and points in the ϑ,ϕ and ϑ_H, ϑ_V angular coordinate system.
- **LMK** motor controls allows the control and automation of external motion units. Several control standards via RS232 interface are implemented.



BlackMURA uniformity analysis for automotive display



Sticking image analysis for automotive display



Conoscopic controst measurement – H/V transfomation

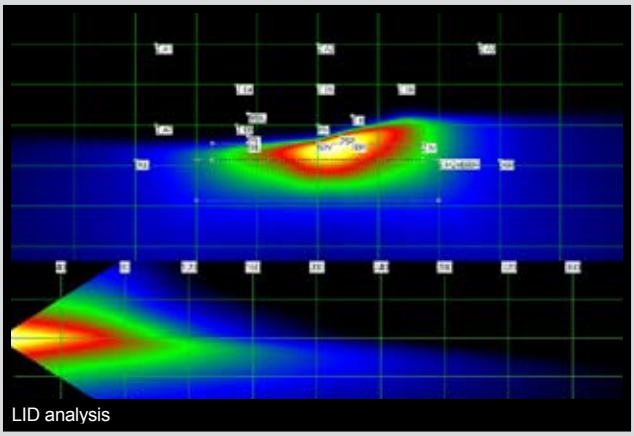
LMK LabSoft-AddOn user application software

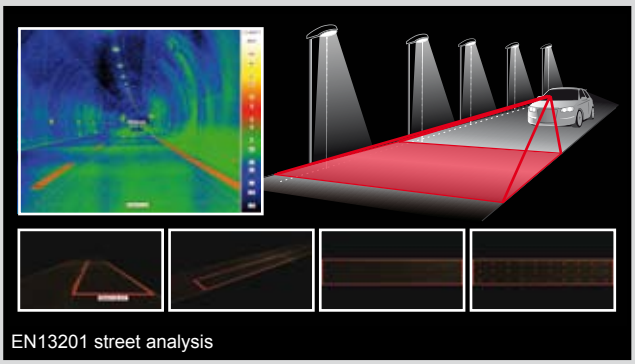
For more frequent applications with complex analysis steps **Techno**Team developed a number of additional and optional software tools for **LMK** LabSoft. Thus the user has a fast and easy access on specific measurement results and data. **LMK** LabSoft AddOn's are not available for the **LMK** LabSoft simple version. Some of them are free of charge.

LMK LID analysis is an additional functionality for analysing luminous intensity distributions especially of headlamps. It enables the user to transform the measured luminance image into the corresponding luminous intensity or illuminance distribution. Here the illuminance can be determined either on a plane (e.g. on a projection wall located at a distance of 10 m) or on a hemisphere (e.g. 25 m radius for ECE).

LMK EN13201 street analysis is an additional package for measuring road lighting in a fast and easy way. The user is able to acquire all parameters necessary for the DIN EN 13201 standard by one single capture. The measured luminance values will then be processed by the software for further use. Also the user is able to determine important quantities such as the vertical illuminance, the solid angle of the glare source, and the veiling luminance according to common standards. Therefore the disability glare for road lighting conditions can be calculated - Threshold increment (TI).

LMK UGR contains a data package which allows the fast and easy assessment of UGR parameters. Using the software, the user is able to determine glare entrance quantities such as the glare and the adaptation luminance level, the vertical illuminance, the solid angle and the position index of the glare sources.
Based on these quantities the unified glare rating (UGR) and almost all other glare sensations can be calculated.


LID analysis


EN13201 street analysis


UGR analysis

ACCESSOIRES

aperture (f=mm)	min. measuring distance (mm)	least field of view (circa)	least field of view (mm x mm)	field of view with a distance of 500 mm	field of view with a distance of 1000 mm
8	500	60°(H) x 56°(V)	520 x 390	520 x 390	1125 x 845
16	185	30°(H) x 22°(V)	85 x 64	270 x 203	540 x 407
25	220	20°(H) x 15°(V)	58 x 44	160 x 120	360 x 275
50	280	10°(H) x 7°(V)	32 x 23	75 x 56	160 x 120

Further lens solutions with other viewing types can be realized on request.

Available lenses for **LMK** 5

Hemispheric fisheye lens (left) and hemispheric image made with **LMK** 5

Special imaging systems - Conoscopic lens and Macro lens (left) and **LMK**

1 measuring distance = lens - leasing edge of camera

Lenses

Various focusable lenses with a fixed aperture for different focal lengths f´= 8 mm, 16mm, 25 mm, 50 mm are on offer. These lenses have a low stray light level. They are individually set and optimized by **Techno**Team for the application of the customer. For an integration time of 3 sec., the sensitivity of these lenses is up to 1cd/m² measurement range end value. Furthermore all those lenses can be ordered with a fix focus for fixed measurement distances.

Special imaging systems

For small object fields or tasks with high magnifying a various set of of macro lenses is available. With a modular construction system **Techno**Team is able to realise many different small object fields at various distances.

The hemispherical lens allows the capture of an object field at a field angle of ±92°. This FishEye lens can be used for capturing complex illumination situations, for example in the case of the evaluation of interiors.

For determining the radiation characteristic in a smaller field of view, for example for determining the angle-dependent contrast of displays, the hypercentric conoscopic lens is offered. It can be used to record the luminance within an angular range of ± 60° of the object.

Neutral density filters

ND-filters with different transmissions ranging from 0.5 … 0.00001 enhance the measurement range of the CCD camera to be increased for the measurement of very high luminances.

Spectral matching filters

TechnoTeam does already offer the following spectral matching filters functions: C(λ); V'(λ); BLH; IR 780 and IR 715 for built inside the **LMK** 5 color.

L³-standard

With the L³-standard **Techno**Team offers coloured standards for Luminance, Luminous flux and Luminous intensity based on LED.
The stability of the photometric quantities is achieved through a temperature control containing a Peltier device and an intensity control containing a spectrally matched photodiode. In the closed housing, which has an exchangeable end cover, a pre-aged and selected high-power LED is used for each L³-standard operated at about 2/3 of the rated current.

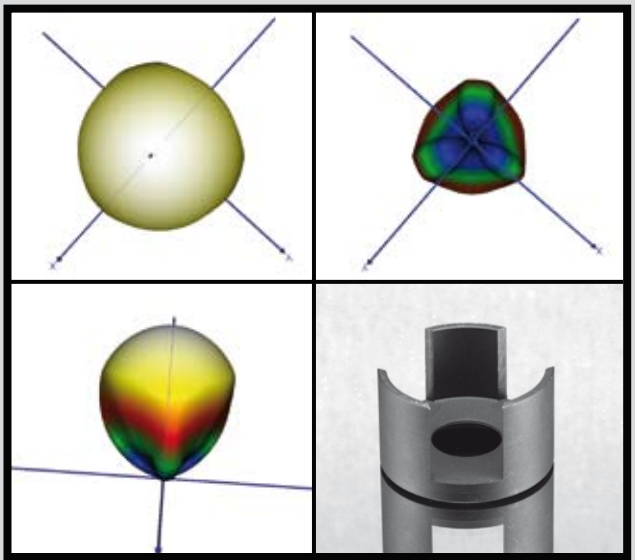
- high stability of the luminance (**<1%/100h**)
- high stability of the dominant wavelength/ colour (**<1nm/100h**)
- stable function independent of the room temperature (**15°C up to 30°C**)
- homogeneous luminance across the outlet opening (**<2% inhomogenity**)
- standard equipment in red, green, blue, yellow, orange, white
- USB interface for reading the current operation status (serial number, working hours, temperature, …)

In addition to the standard colours, also other colours can be supplied on customer's request. For this, the customer shall select, in cooperation with the **Techno**Team, the type of LED.
For each L³-standard **Techno**Team provides a certification for the factory calibration. For the traceability of the photometric data of the LED luminance standards it is possible to calibrate the devices at a national metrology institute (e.g. PTB (D) or METAS (CH)).

Battery Pack

For extending the running time and making the **LMK** 5 more flexible in use the Battery Pack is available. The stable housing can be mounted directly and carries an battery that can deliver the **LMK** 5 up to 6 hours with electrical power.


L³-standard with optional accessories


Different views of a LID measured with a crown cover

Battery Pack mounted on **LMK** 5 color

AUTOMATION

Movement unit

Using a stationary movement unit for the handling of the **LMK** 5 camera enables the user to place the **LMK** with a high accuracy and reproducibility towards the object to be measured.
TechnoTeam offers a range of linear, rotating and turning axis movement units.

The motor and motion control of the movement unit can fully be integrated to the **LMK** LabSoft software using the **LMK** Motor control software (see page 15).

LMK 5 color with 5 axis movement unit

LMK & ROBFLOW®
New Measuring Robotics System

The **LMK** 5 camera device and the **ROB**FLOW® software means a combination of an Imaging Luminance Measuring Photometer with a Measuring Robotics System for the determination and analysis of objective quality characteristics in brightness, colour and other visibility or recognition requirements. The **ROB**FLOW® software is designed for high quality industrial robots of several manufacturers, provides freely programmable movement curves with haptic control and regulation to ensure a broad range of applications and provides the user with highest possible flexibility in its functions.

Robotic measuring components for luminance and colour measurement:

- Robotic arm with control interface
- **LMK** colorimeter or photometer
- Measuring-robotic software **ROB**FLOW®

Multi-sensor fitting for efficient testing processes:

- **LMK** colorimeter or photometer for optical backlit symbol or display testing
- Force-Feedback sensor for haptic testing
- Laser line sensor for mechanical profile and slit dimension control
- Acoustic sensor for testing haptic noises

BATTENBERG
ROBOTIC MEASURING

LMK 5 color and optical test equipment

LMK 5 color mounted on LBR light-weight robotic arm

LMK

AUTOMATION

Light Checker using **LMK** in automation

The Light Checker software is a semi-automatic stand-alone system for quality management inside or at the end of a production line.

Symbol Checker

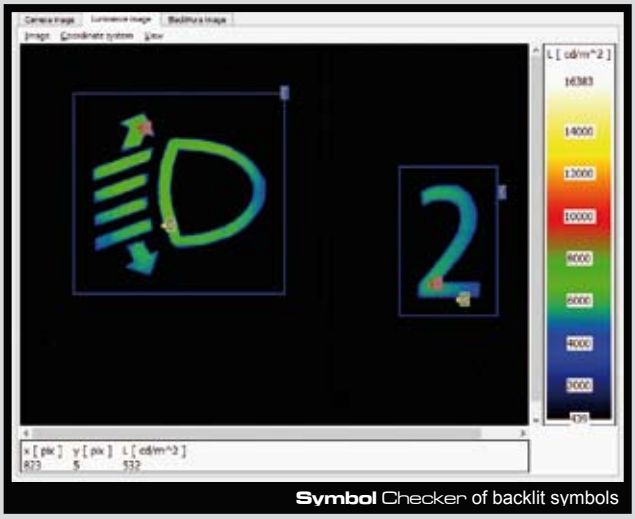
The application enables the user to automatically measure mean, maximum and the minimum luminance of an automatically detected symbol. By using the integrated symbol teaching, the user can create reference symbol data to determine symbol quality:

- **Average of luminance:** as an average value for the automatically detected complete backlit symbol
- **Uniformity:** is calculated with the minimum, average value and maximum of the luminance within the symbol, determined with a measuring spot of a variable pixel-size.
- **Position:** as the average of the segment centroids, calculated out of the contour of the segment. The determination of the contour is sub pixel exact.
- **Structure width:** geometrical measurement of symbol segments with parallel outer lines. With the calculated distances over an iterative calculated average value the structure width of the symbol is determined.
- **Symbol quality:** percentage matching of the symbol with the recognized reference pattern.

LED Checker

The application enables the user to automatically measure luminance of LEDs and also colour distance between the LEDs. For several applications, like emergency lights, the measurement results of each LED is of interest:

- **Average of luminance:** as an average value for the automatically measured light source
- **Colour and chromaticity:** colour data in manifold color spaces for classifying LED
- **Position:** as the average of the segment centroids, calculated out of the contour of the segment.



Symbol Checker of backlit symbols

LED and halogen spot lamps

Light Checker
Using **LMK** in automation

The Light Checker Software is a semiautomatic stand-alone system for quality management inside or at the end of a production line.

LID Checker

The application is especially designed for measuring headlamps and is available with our products compact measuring station **KMP** and **BV**-Room. **Techno**Team provides an interactive user interface for applying test specifications in automated measurements. It is possible to define various measurement regions including their tolerance values. Algorithms for automated elbow point detection and ReAim are included. In addition, the resulting measurement values can be summarized in individual protocols. The **LID** Checker also supports the TCP/IP interface for the communication with a process control system for fully automatic measurements:

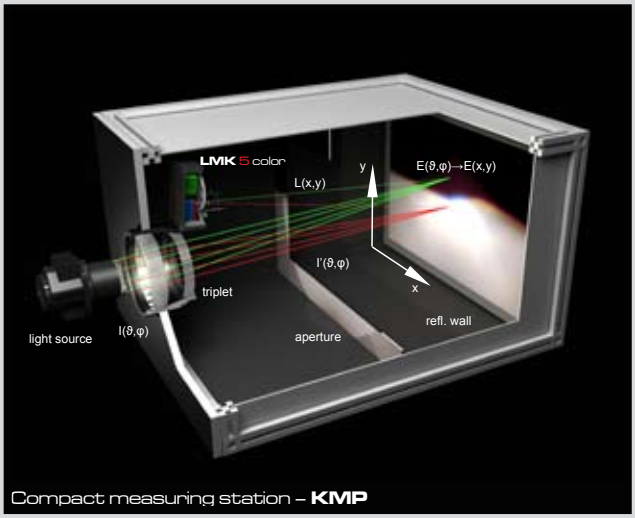
- **Luminous intensity distribution**: Available for fixed geometry and angular distribution ranges
- **Measurement Regions**: verification and observance of guidelines for car headlamps by means of prescribed measuring points e.g. HV; AK31; B50L and many more

Display Checker

The application enables the user to automatically measure display uniformity, mean, maximum and minimum luminance:

- **BlackMURA analysis AddOn**: Enables the user to additionally get the gradient image of the measured display and the BlackMura value, which equals the maximum gradient.
- **Sticking image analysis AddOn**: Features essential functions for applying measurement series and regions for analysing the sticking image phenomena.

AUTOMATION

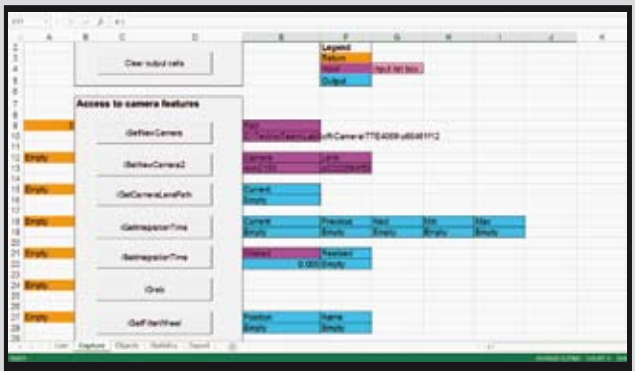


Compact measuring station – **KMP**

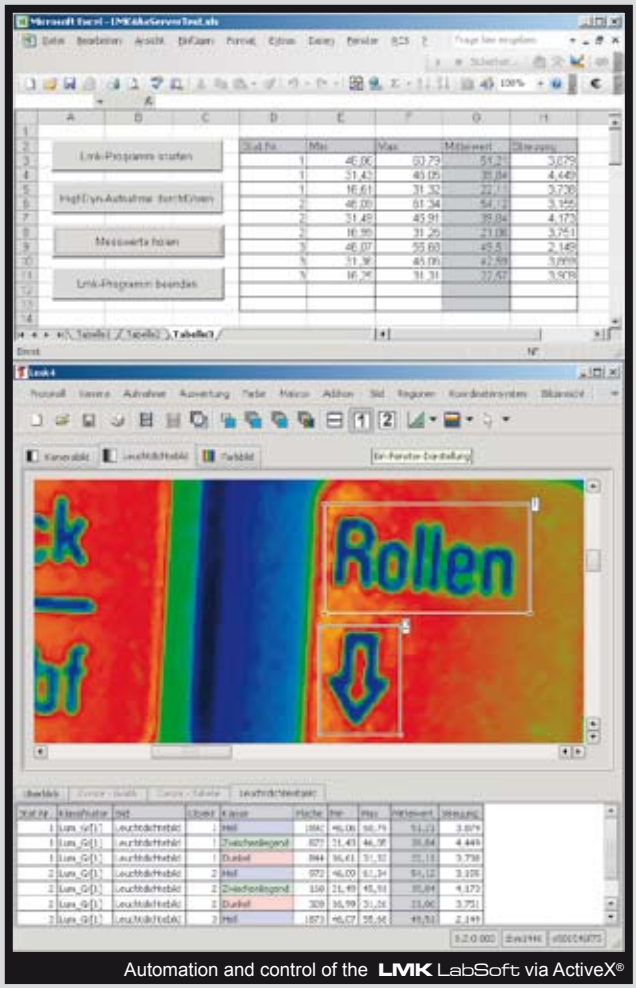

Measuring object – airfield lighting


Measuring object – automotive head lamp

SOFTWARE



Automation and control of the **LMK** LabSoft via ActiveX®



Automation and control of the **LMK** LabSoft via ActiveX®

Programming interface **LMK** LabSoft extended

The **LMK** LabSoft extended has an ActiveX® interface available and can be controlled by a host application with ActiveX® capability (e.g. MS Excel®, LabView®, MATLAB®). In this way it is possible to use the functionality of the **LMK** LabSoft as a server for other applications.

All capturing modes will be provided: capturing Live camera images; SinglePic-, Multi- Pic- and HighDyn-algorithm for the capturing and calculation of luminance images; Colour-High-Dyn-algorithm for calculation of colour values by using a **Techno**Team **LMK** 5 color filter camera.

By using the interface all statistical operators e.g. luminance, integral and symbol object are available. So directly after the image capturing the currently measured data can be imported into the host application e.g. Excel spread sheet analysis. In addition it is possible to open and save already prepared protocol files with parameterised statistic objects via ActiveX®.

On customer request it is possible to extend the interface to all functions of the functionality provided in the interactive use of the **LMK** LabSoft.

References (abstract)

Adam Opel AG I Audi AG I BMW AG I Daimler AG I Dr. -Ing. h.c. F. Porsche AG I Ford AG I SEAT, S.A. I ŠKODA AUTO a.s.I VW AG II ALPINE ELECTRONICS GmbH I Automotive Lighting GmbH I Behr-Hella Thermocontrol GmbH I Blaupunkt GmbH I Bosch-Gruppe Motometer GmbH I Continental Automotive AG I Delphi Packard Deutschland GmbH I DST Dräxlmaier Systemtechnik GmbH I Goodrich Lighting Systems GmbH I Hella KG Hueck & Co. I Leopold Kostal GmbH I Marquardt GmbH I TRW Automotive Electronics & Components & Co. KG I Valeo Auto-Electric Hungary LLC I VISTEON Deutschland GmbH I Ansorg GmbH I AE Austria Email I Lehner WerkMetall Jürgen Lehner GmbH I D. Swarovski & Co. Lichtlabor I Diemer & Fastenrath OHG I GE Hungary ZRt. I OSHINO Lamps GmbH I OSRAM GmbH I OSRAM Opto Semiconductors GmbH & Co. OHG I Philips GmbH I Philips Lighting B.V. I RZB-Leuchten I TRILUX-LENZE GmbH+Co. KG I Siteco Beleuchtungstechnik GmbH I Zumtobel GmbH I BOE-LA Siebdrucktechnik GmbH I Bosch Siemens Hausgeräte GmbH I Braun GmbH I Cherry GmbH I Comtronic GmbH I Fresnel Optics GmbH I Hella Aerospace GmbH I Optrex Europe GmbH I Siemens AG I BGIA Berufsgenossen-schaftliches Institut für Arbeitssicherheit I HVBG Hauptverband der gewerblichen Berufsgenossen-schaften e.V. I Fraunhofer Institut Solare Energie-systeme I VBG Verwaltungsberufsgenossenschaft I Autobahnamt Thüringen I BASt Bundesanstalt für Straßenwesen I LANUV Landesamt für Natur, Umwelt und Verbraucherschutz Nordrhein-Westfalen I Magistrat der Stadt Wien I METAS Bundesamt für Metrologie (CH) I BTU Cottbus I Carl-v.-Ossietzky Universität Oldenburg I EFI Trontheim I ETH Zürich Institut für Hygiene und Arbeitsphysiologie I FH Aachen Solar Institut Jülich I FH Biberach I FH Göttingen I FH Jena I Technische Universität Berlin I Technische Universität Dresden I Technische Universität, Ilmenau I Universität der Bundeswehr Hamburg I Universität Dortmund I Universität Paderborn I Universität Teheran

V2.1

LMK

VIDEO PHOTOMETER

Presented by:

TechnoTeam **Bildverarbeitung GmbH**
Werner-von-Siemens-Str. 5
98693 Ilmenau
GERMANY

Tel. +49 3677 4624 0
Fax +49 3677 4624 10

info@TechnoTeam.de

www.TechnoTeam.de