Goniophotometer RiGO 801

General specification

Model series 1400, 1500, 1800, 2000

2018-03-13

Table of contents

Goniophotometer

The goniophotometer type RIGO801 utilizes a new image-resolving CCD measuring technique for determining ray data and luminous intensity distributions.

The correct determination of the luminous intensity distributions (LID) of lamps and luminaires is performed far within their photometric limiting distance on the basis of image-resolved measurements of luminous intensity distributions. A CCD-camera is moved by a goniometer around the measuring object at rest on a spherical surface, with the radius of this sphere being fixed only by the field angle of the camera. Thus, the goniometer can also be installed in small laboratories.

The RiGO801 model series is classified into four base models, a small system for measuring ray data and LID of LED's, two middle size systems for measuring ray data and LID of lamps and small luminaires and the large systems for measuring the LID of luminaires. The RiGO801 systems for measuring luminaires are available in four base sizes (max. size of luminous area): 1400mm, 1500mm, 1800mm and 2000 mm.

Figure 1: RiGO 801 - Luminaires

Base specifications for RiGO801 – 1400 / 1500 / 1800 / 2000

Goniometer mechanic	
Movement:	Type C (LM79): The measuring camera and the illuminance meter are moved on a sphere around the lamp (two independent axes arranged vertically to each other (δ, φ)); mounted to a fixed upper point.
Measuring position of the luminaire:	Normal position, no movement of the measuring object
Positioning accuracy:	$\varphi < 0.02°$, $\delta < 0.05°$
Repetitive accuracy:	$\varphi < 0.01°$, $\delta < 0.02°$
Material	Aluminium, coated with special black paint
Drives and control	Jetter Servo drives
Gears	High precision HarmonicDrive and Summitomo Cyclo gears

Fixing at the top

The goniophotometer models 1400 / 1500 / 1800 / 2000 need a fixed upper attachment. TechnoTeam support a fixing plate that can easily be attached to a suitable support construction to the ceiling or the side walls that is in the responsibility of the customer. The goniophotometer is attached to the fixing plate by using levelling bolts.

The upper support construction has to be stable enough to absorb any vibrations caused by the drives as best as possible to avoid vibrations of the test object support that is also fixed to this point. Although the goniometer is mounted to the fixing plate by using damping elements the topic vibration is important and has to be discussed individually. The upper support construction should be confirmed by TechnoTeam. Please refer to the laboratory specification document for more details!
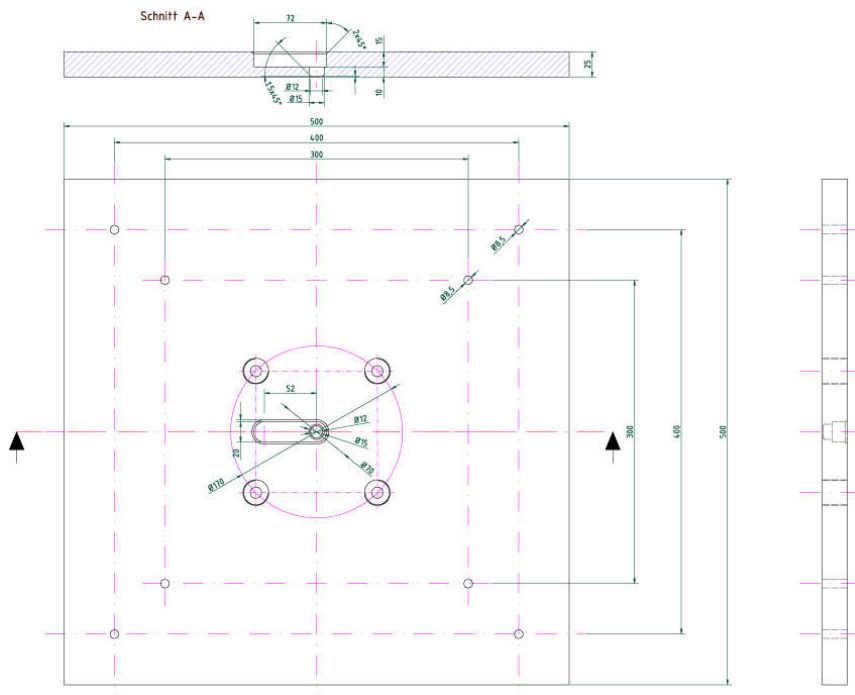
Figure 2: Fixing plate

For the required height of the fixing plate see the following section.

Goniometer RiGO801 - 1400

Specifications

Size of measuring object:	≤ 1400 / 1200 mm (luminous area)[1]
Space required:	LxWxH = ≤ 2900 x 2900 x 2800 mm³
Travel path:	φ = 0° ... 360°
	δ = 10.5° ... 349.5° (hanging test object support)
	δ = -169.5° ... 169.5° (upstanding test object support)
Installation	The goniometer mechanic needs a stable upper fixing point. For this purpose a fixing plate is supplied with the goniometer that has to be mounted to an upper construction connected to the ceiling or/and side walls. This construction is part of the customer.
	The foot of the goniometer needs to be bolted to the floor.

Figure 3: Drawing showing the height range of the fixing plate

---

[1] Smaller field of view in case of option „Filter wheel color camera"

Goniometer RiGO801 - 1500

Specifications

Size of measuring object:	≤ 1500 mm (luminous area)
Space required:	LxWxH = ≤ 2900 x 2900 x 3300 mm³
Travel path:	φ = 0° ... 360°
	δ = 8.5° ... 351.5° (hanging test object support)
	δ = -171.5° ... 171.5° (upstanding test object support)
Installation	The goniometer mechanic needs a stable upper fixing point. For this purpose a fixing plate is supplied with the goniometer that has to be mounted to an upper construction connected to the ceiling or/and side walls. This construction is part of the customer.
	The foot of the goniometer needs to be bolted to the floor.

Figure 4: Drawing showing the height range of the fixing plate

Goniometer RiGO801 - 1800

Specifications

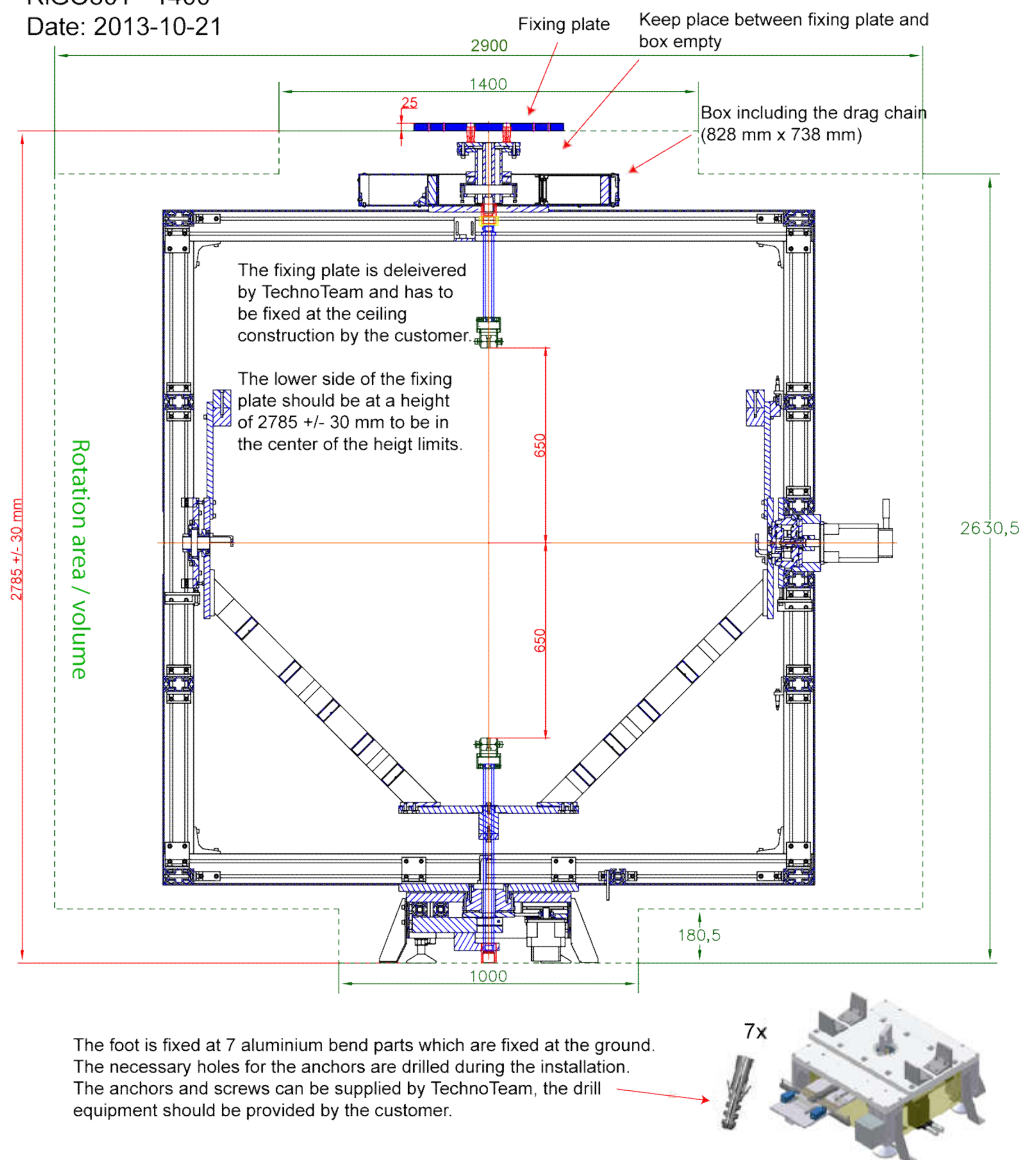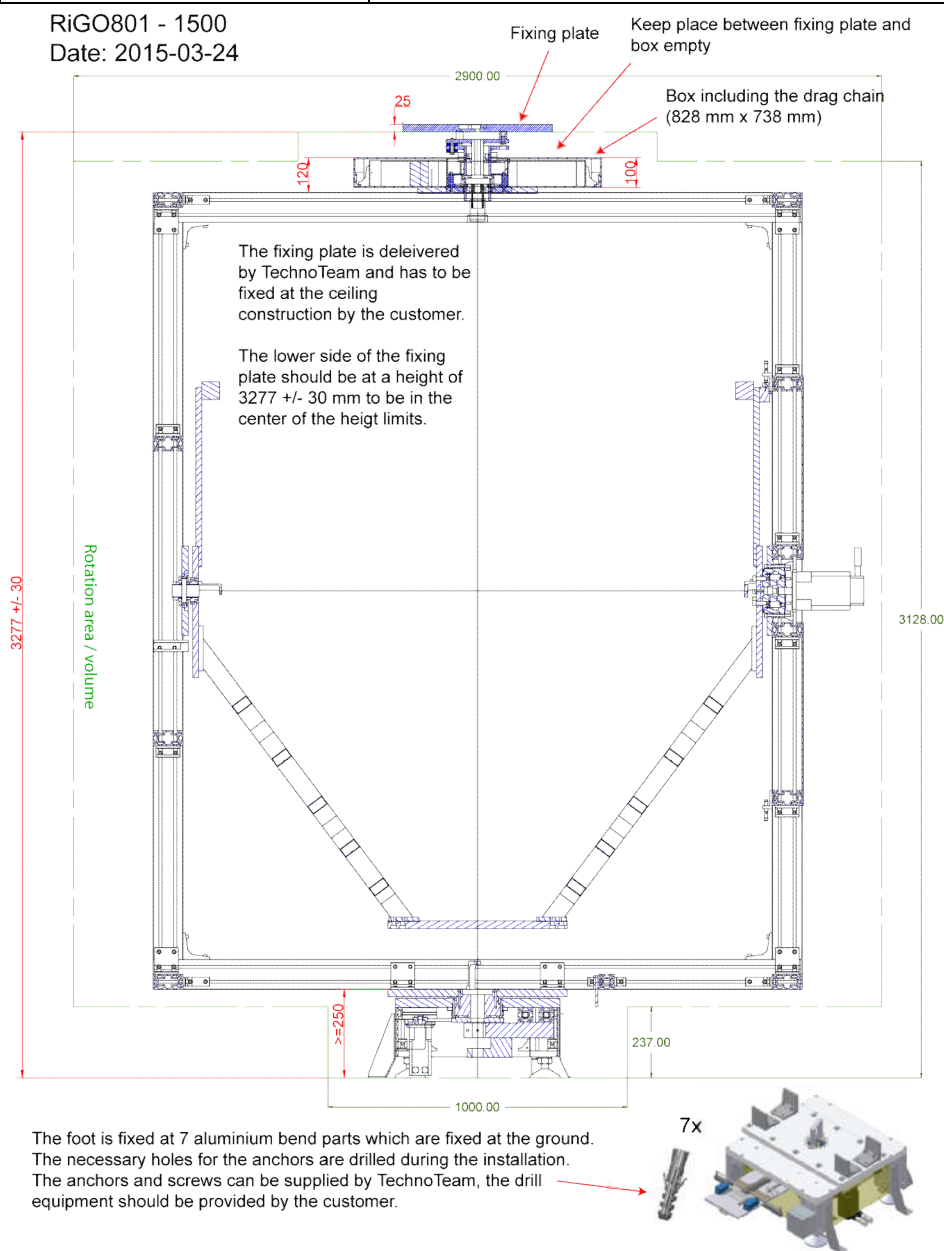| Size of measuring object:	≤ 1800 mm (luminous area)
Space required:	LxWxH = ≤ 3400 x 3400 x 3870 mm³
Travel path:	φ = 0° ... 360°
	δ = 6.5° ... 353.5° (hanging test object support)
	δ = -173.5° ... 173.5° (upstanding test object support)
Installation	The goniometer mechanic needs a stable upper fixing point. For this purpose a fixing plate is supplied with the goniometer that has to be mounted to an upper construction connected to the ceiling or/and side walls. This construction is part of the customer.
	The foot of the goniometer needs to be bolted to the floor.

RiGO801 - 1800
Date: 2013-03-24

Fixing plate

Keep place between fixing plate and box empty

Box including the drag chain (828 mm x 738 mm)

The fixing plate is deleivered by TechnoTeam and has to be fixed at the ceiling construction by the customer.

The lower side of the fixing plate should be at a height of 3870+/-30 mm to be in the center of the heigt limits.

Rotation area / volume

The foot is fixed at 7 aluminium bend parts which are fixed at the ground. The necessary holes for the anchors are drilled during the installation. The anchors and screws can be supplied by TechnoTeam, the drill equipment should be provided by the customer.

7x

Figure 5: Drawing showing the height range of the fixing plate

Goniometer RiGO801 - 2000

Specifications

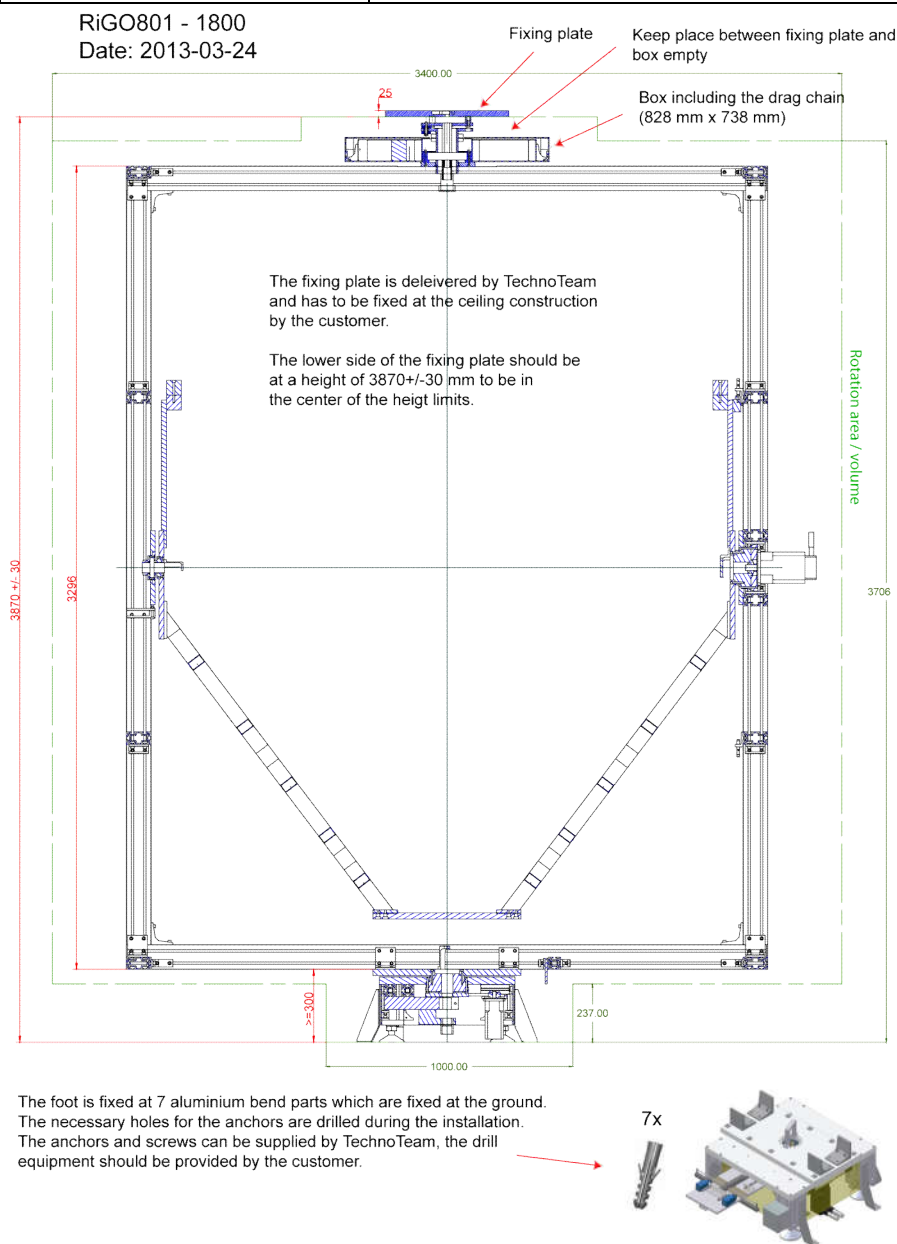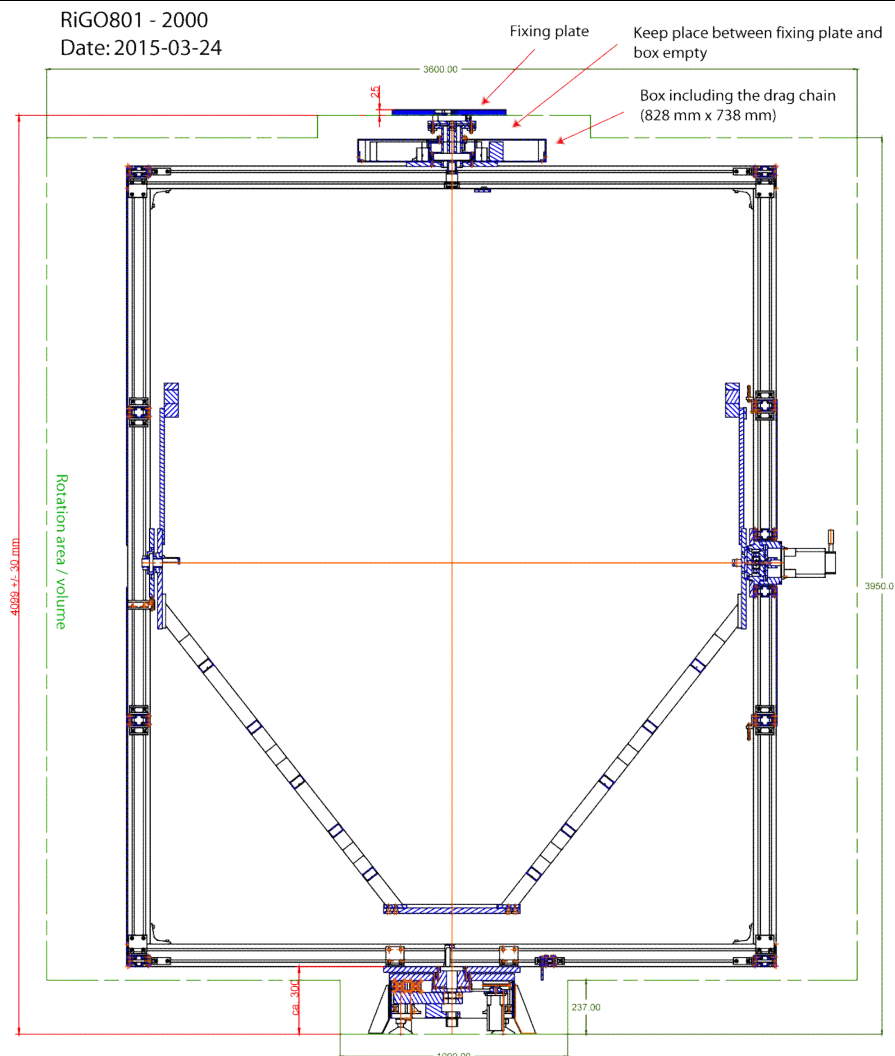| Size of measuring object:	≤ 2000 mm (luminous area)
Space required:	LxWxH = ≤ 3600 x 3600 x 4100 mm³
Travel path:	φ = 0° ... 360°
	δ = 6° ... 354° (hanging test object support)
	δ = -174° ... 174° (upstanding test object support)
Installation	The goniometer mechanic needs a stable upper fixing point. For this purpose a fixing plate is supplied with the goniometer that has to be mounted to an upper construction connected to the ceiling or/and side walls. This construction is part of the customer.
	The foot of the goniometer needs to be bolted to the floor.

Figure 6: Drawing showing the height range of the fixing plate

Goniometer components

DUT support posts

There are two support posts for attaching the devices under test to. One can be mounted at the top of the goniometer frame and is hanging. The other can be mounted at the goniometer socket and is upstanding. Both posts are not moved while the two goniometer axes are moving. Only one post at time can be used for operating the Goniophotometer.

The electrical connection to the DUT power supply panel is included in the posts in form of a multi-pole plug at the goniometer attachment side and 5 safety banana plug sockets at the DUT attachment side.

Upper hanging post

The upper hanging post is mounted to an adapter part at the upper center of the goniometer frame (cf. Figure 7). This adapter is fixed to a flange that goes through the ball bearing flange the outer goniometer frame and is directly mounted to the ceiling attachment. Thus it is not moving with the rotation of the outer frame.
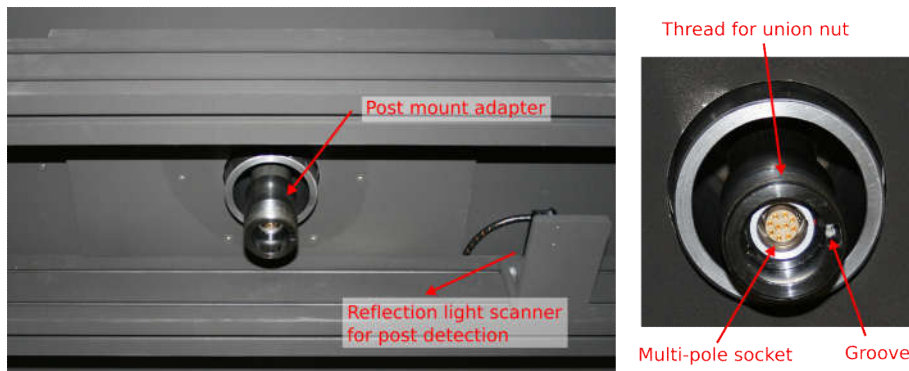
Figure 7: Upper post mount adapter

Figure 8: Upper post

Figure 9: Mounted upper post

Lower upstanding post

The lower upstanding post is mounted to an adapter part located below the hollow shaft of the gear in the goniometer base (cf. Figure 10).

Figure 10: Lower post mount adapter

Figure 11: Lower post

Figure 12: Mounted lower post

DUT mounting

The DUT is installed to the mount of the post (cf. Figure 13). A cylindrical mount adapter fits into the mount and is secured from falling down by a locking lever. Finally it can be fixed by a clamp. The mount adapter has a centred hole for M8 screws where the individual DUT support construction can be fixed. On top of the DUT mount there are 5 protected banana sockets for the electrical supply of the DUT.

Figure 13: DUT mount

Technical Specification

Maximum load:	50 kg
Maximum Voltage:	230 V AC
Maximum Current:	20 A

Measuring device components

LMK98 – 4 Image-resolving luminance measuring camera

The LMK 98-4 is a high-tech digital CCD camera system equipped with a precise analogue electronic system for signal generation. Each camera is provided with a especially calculated and manufactured full filter in order to achieve a high-quality V(λ)-adaptation for determining the luminance.

For RiGO801 measurements the camera is used in a special digital 2x2 binning mode and the measured luminance images are used internally in the software for ray data calculation. The full resolution and the evaluation of luminance images is available in combination with the software package LMK LabSoft.

Figure 14: LMK98 - 4

Specifications:

Type	Kappa DX 4
Sensor	CCD Sony ICX 285 AL (2/3")
Full Resolution (effective pixel)	1390 (H) x 1040 (V)
Binning resolution in RiGO801 mode (effective pixel)	695 (H) x 519 (V)
Video signal	12 bit digital, progressive scan, data transfer with CameraLink interface (max. 20m PC-cable)
Video signal in RiGO801 mode (digital binning)	13 bit digital, progressive scan, data transfer with CameraLink interface (max. 20m PC-cable)
Dynamic (luminance-measurement)	Single picture measurement: 1:1100 (~ 61 dB)
	Multi picture measurement:1:3600 (~71 dB)
	High Dynamic measurement: 1:10000000 (~ 140 dB)
Measurement values	Luminance: L (cd/m²)
	Further measuring quantities can optionally be defined via scaling factors
V(λ) adaption	V(λ) – full filter-adapted, f1' typical < 3.5 %
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 ~ 1800 cd/m² & 3s ~ 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%]
Repeatability[3]	ΔL [< 0.1%]
Measuring accuracy	ΔL [< 3% (for standard illuminant A)]
Uniformity	ΔL [< 2%]

More information available on http://www.technoteam.de

LMK98 – 4 Filter wheel extension

The LMK 98-4 with filter wheel extension is equipped with a filter wheel with 6 positions. Beside our pre defined color set in case of our LMK98-4 color measuring camera the filter types can be defined individually (e.g. special spectral filters, ND filter).

For RiGO801 measurements the camera is used in a special digital 2x2 binning mode. The filter wheel position can be selected by software for each measurement (ray data or luminous intensity distribution). Measured images are used internally in the software for ray data calculation. The evaluation of images in full resolution is available in combination with the software package LMK LabSoft.
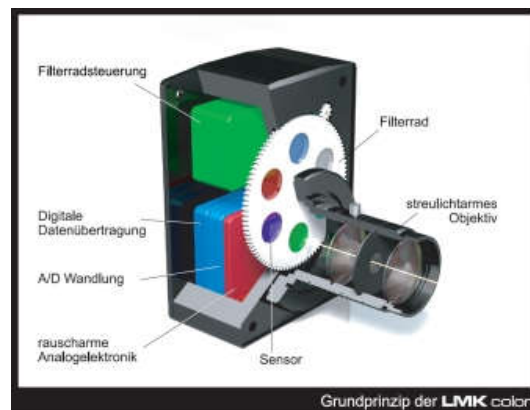
Figure 15: LMK98 with filter wheel

Specifications:

Please refer also to the specifications of the base camera LMK98-4.

Filter wheel:	6 positions
Control	By software

More information available on http://www.technoteam.de

LMK98 – 4 color

The LMK 98-4 color is equipped with a filter wheel for colour measurement, adapted to the CIE colour matching functions of the 2° standard observer (CIE 1931). Thus, luminances and

---

[2] Calibration according to DIN 5032 Part 6 using a luminance standard traced 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

colour coordinates can be measured in a spatially resolved way. The filter wheel permits a total of 6 filters to be incorporated, with 4 filters being necessary for 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 .

For RiGO801 measurements the camera is used in a special digital 2x2 binning mode. The filter wheel position can be selected by software for each measurement (ray data or luminous intensity distribution). Measured images are used internally in the software for ray data calculation. The full resolution and the evaluation of luminance and color images is available in combination with the software package LMK LabSoft.
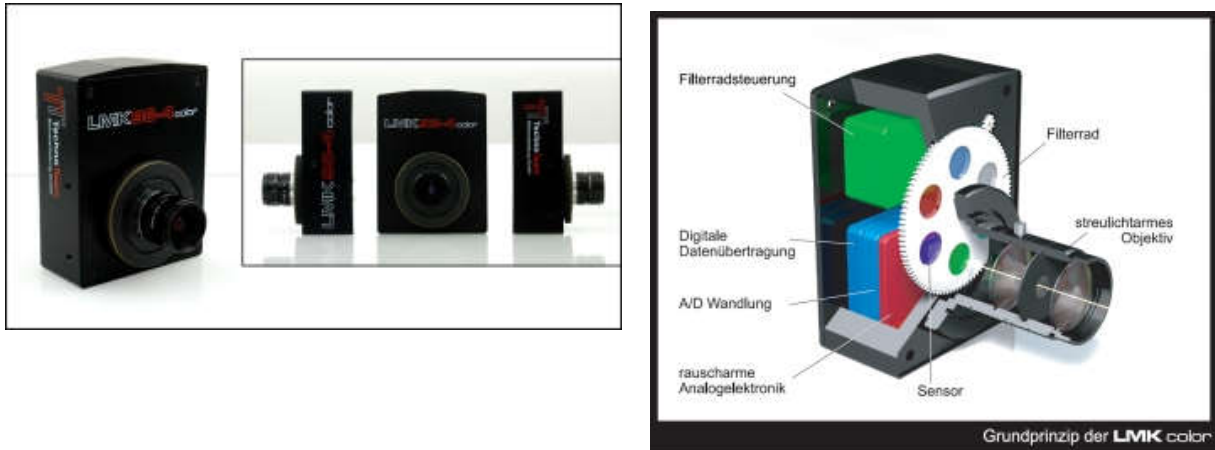
Figure 16: LMK98 – 4 color camera

Specifications

Type	Kappa DX4
Sensor:	CCD Sony ICX 285 AL (2/3")
Full Resolution (effective pixel)	1390 (H) x 1040 (V)
Binning resolution in RiGO801 mode (effective pixel)	695 (H) x 519 (V)
Video signal	12 bit digital, progressive scan, data transfer with CameraLink interface (max. 20m PC-cable)
Video signal in RiGO801 mode (digital binning)	13 bit digital, progressive scan, data transfer with CameraLink interface (max. 20m PC-cable)
Dynamic (luminance-measurement)	Single picture measurement: 1:1100 (~ 61 dB)
	Multi picture measurement:1:3600 (~71 dB)
	High Dynamic measurement: 1:10000000 (~ 140 dB)
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[4]
	Further measuring quantities can optionally be defined via scaling factors.

---

[4] Dominant wavelength, saturation, correlated color temperature

Filter wheel	6 positions (x1, x2, y, z, glass, user defined)
V(λ) adaption	V(λ) – full filter-adapted, f1' typical < 3.5 %
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 ~ 1800 cd/m² & 3s ~ 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[5]	fix focused lenses ΔL [< 2%]
Repeatability[6]	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)][7]
Uniformity	ΔL [< 2%]

More information available on http://www.technoteam.de

Optical Lens TT 4.2

- Focal length: 4.2 mm
- Aperture angle: ~ 90 deg
- Photometrically corrected (shading / flat-field)
- Distortion-corrected

Optical Lens TT 8

- Focal length: 8 mm
- Aperture angle: ~44 deg
- Photometrically corrected (shading / flat-field)
- Distortion-corrected

Optical Lens TT 25

- Focal length: 25 mm
- Aperture angle: ~14 deg
- Photometrically corrected (shading / flat-field)
- Distortion-corrected
- This optical lens is used for the adaption to smaller test objects

---

[5] Calibration according to DIN 5032 Part 6 using a luminance standard traced back from the Physical-Technical Federal Institute

[6] Measurement performed on a stabilized white LED light source L=100cd/m². Mean value over 100 Pixel; repeatability as variability of the mean value

[7] Measured value based on 30 test colors with different spectral distributions based on ROSCO color filters

ND Filter set

- 6 ND Filters with transmissions from ~25 % … ~0.02 %

- Filter thread 30.5 x 0.5 mm (RiGO – LED), 35.5 x 0.5 mm (RiGO – Lamps)

- For RiGO – Luminaires: Special mount, Filter thread 49 x 0.75 mm

Ø30.5 mm   Ø35.5 mm   Ø 49 mm

Figure 17: Three ND filter diameters

Photo current amplifier (CZIBULA & GRUNDMANN GMBH)

- Current range: 0.1 pA to 1 mA

- Illuminance range (RiGO801 configuration): 0.7 … 690000 lx

- Integration time: 10ms to 400ms

- Number of ranges: 13

- Linearity: < 0.1 %

Photometer head (CZIBULA & GRUNDMANN GMBH)

- V(λ)-calibrated f1' < 1,5 %

- Cosine - adaptation f2 < 1,5 %

- thermostatic stabilized photometer head

Spectrometer JETI Specbos 1211-LAN

Figure 18: Spectrometer Specbos 1211-LAN

Short specifications

Optical Parameters	
Spectral range:	350 nm - 1000 nm
Optical bandwidth:	4.5 nm
Wavelength resolution:	1 nm
Digital electronic resolution:	16 Bit ADC (15 Bit used)
Measuring values:	• Spectral radiance • Total luminance/ total radiance • Total illuminance/ total irradiance • Chromaticity coordinates x , y ; u', v' • Correlated Color Temperature, color purity • Color Rendering Index, RGB • Circadian metrics, Photosynthetically Active Radiation
Measuring ranges and accuracy	
Measuring range luminance:	0.1 - 2500 cd/m² (higher values with optional filter)
Measuring range illuminance	2 - 10 000 lx
Luminance accuracy	± 2 % @ 1000 cd/m² and 2856 K
Luminance reproducibility	± 1 %
Chromaticity accuracy	± 0.002 x , y @ 2856 K
Color reproducibility	± 0.0005 x , y
CCT reproducibility	± 20 K @ 2856 K
Wavelength accuracy	± 0.5 nm
Other technical data	
Interface:	Ethernet
Dimensions	180 mm * 82 mm * 53 mm
Dispersive element	Imaging grating (flat field)

For the detailed technical specification please refer to the web site:
http://www.jeti.com/cms/index.php/instruments/radiometer/specbos-1211

Integration of Spectrometer into RiGO801 goniophotometer

The Spectrometer is mechanical attached at the back side of the moved sensor platform next to the camera and photo current amplifier. For the optical coupling an irradiance probe is positioned next to the optical lens of the luminance measuring camera and connected via optical fibre to the spectrometer unit. The fibre curvature is fixed and is not changed during the measurements.

Additional components

E27 Test socket

This test socket is suitable for mounting inside all goniometer types except RiGO801 – LED.

- 4-pole E27 socket with hard gold plated contacts
- separate contacts for power supply and sensing

Calibrated luminous flux standard lamp, E27 socket

- Incandescent lamp Riva B6000 E27 24V 100W „F",impact resistant, TechnoTeam version
- Socket basis black (15 mm above socket)
- Traced back to national luminous flux standard by accredited laboratory

Software

RiGO801 base software

The measuring program RiGO801 offers the operator a comfortable setup and execution of the measurement.

Feature list

- Easy alignment of the objects to be measured by means of the measuring camera. Image grid which can be activated, and metric coordinate system

- Fast on-the-fly measurement

- Measurement of luminous intensity distributions with the camera in the case of large measurement objects in relation to the sensor distance (near-field mode) or with the photometer in the case of small objects to be measured (far-field mode)

- Saving in the TechnoTeam – format (.TTL), conversion into various standard formats (LDT, IES). The measurements will be evaluated using LumCAT.

- Angular step sizes 0.1° ... 2.5° (camera), 0.1° ... 90° (photometer)

- Capturing ray data, saving in the TechnoTeam – format (.TTR). Conversion into various standard formats using the Converter801 program.

- Spectrometer measurement (option)

- Protocolling the pole illuminances for stability monitoring (pole monitoring)

- Protocolling the burn-in process and automatic start of the measurement

- Controlling the filter wheel of a color measuring camera (option)

- Data acquisition of external devices (e.g. power analyzer or data logger)

- Synchronisation of external data acquisition software to the measurement by triggering

- Batch processing of several measurements

- Available languages: German, English

Converter801 ray data generation software

The program Converter801 is used to process the TechnoTeam ray data files (.TTR). The conversion into various file formats with ray tracing on different target geometries is possible. Embedded additional information as the luminous intensity distribution, luminance images, DUT alignment, the burn-in protocol and acquired measuring values of external measuring devices (e.g. Power Analyzer) can be visualized and exported. An additional integration of spectral information is possible (spectrum ➔ wavelength per ray).

Feature list

- Visualization of all data (ray data, luminous intensity distribution, luminance images, alignment of the object to be measured, burn-in protocol as well as the logged measure-

ment data of external devices such as power analyzer) contained in TechnoTeam ray files (.TTR).

- Generation of various ray data formats (ASAP, Optis, LightTools, LucidShape, Zemax, TracePro, SimuLux, Photopia)

- Raytracing to basic geometries (sphere, cylinder, cuboid)

- Rotation and displacement of the ray data

- Integration of spectral information possible (spectrum ➔ wavelength per ray)

- Recalculation of the luminous intensity distribution in other angular resolutions

- Output of the luminous intensity distribution in various formats (EULUMDAT, IES)

- Provision of customized formats possible

- Batch processing of conversion processes

- API for accessing the TechnoTeam ray data format

- Available languages: German, English

This software is free of license fees and can be used without any restrictions and transferred to any ray data users.

LumCAT

LUMCat is a database, which allows the management of photometric data together with all product properties like texts, images etc due to a relational database-table system. Also it includes editors for the intensity distribution which allows modification in many different ways.

The LumCAT license allows the installation on more than one evaluation computer of the same customer.

Feature list

- Support for TechnoTeam measurement data files (*.TTL), EULUM-DAT, TM14, IES, Calculux

- System for managing and processing luminaire data

- Integrated relational database, realized as standard ACCES-DB version

- Modification of all product information

- Tabular processing of the luminous intensity distribution

- Function for turning, inclining and swivelling the luminous intensity distributions

- Modification of the operating efficiency ratio (scaling)

- Multiple processing function for loading information, dimensions, manufacturer and article names

- Photometric product valuation in the form of a print-out or as WMF-file

- Output of the luminous intensity distribution (polar, cartesian, cone diagram)

- Output of the illumination efficiency ratios

- Glare evaluation according to Söllner and UGR

- Isolux diagrams

- Illumination efficiency ratios according to LiTG Publ. 3.5

Available languages: German, English

LMK LabSoft luminance measuring software (full version)

The LMK LabSoft is a laboratory software package that offers a variety of functions for capturing and evaluating luminance and for instance color images. LabSoft is bundled with the measuring camera LMK98-4 and the calibration data set.

Specification

Image capture
- Live image   - Exposure adjustment   'SinglePic'-image   'MultiPic'-image   'HighDyn'-image   - Capturing modulated light   - Live Luminance and Live HighDyn   - Capturing measurement series (manual, time controlled, mechanical controlled)   - Representation of images (Pseudo-colours, ISO colours, scaling)   - Working with images (load, save, delete, copy, print)   - Displaying measuring values by means of cursors (standard, rectangle, circle, line, circular ring, cross, zoom)   - Measurement regions (load, save, copy, paste, group, print)
Measuring value indication using inspectors
- Standard statistics (standard evaluation, histogram, sectional view, time statistics, luminance object, integral object, symbol object, arc object, filament object)   - Report function (create, load, save, print)
Evaluation images and image processing
- Unlimited evaluation images   - Physical parameters and units   - Assigning list of regions   - Assigning image tab windows   - Image arithmetics   - Coordinate transformation   - Projective rectification - orthophotographs   - ISO lines in luminance images
Automation via TCL-Macro
- Recording of TCL - Macros   - Running of TCL - Macros

Further information is also available on http://www.technoteam.de.

LMK LabSoft color extension

Specification

The color specific functions are only available in combination with a LMK98 – 4 color camera.

Image capture
• Color 'HighDyn'-image
Colour images and colour metrics
• Colour space and measuring values
• Calculation of colour differences
• Decomposition of colour images into colour extract images
• Composition of colour extract images into colour images
• Test colour images
• Measurement protocols (create, load, save, comments)

Further information is also available on http://www.technoteam.de.

LMK LabSoft ActiveX extension

Using the LMK LabSoft as ActiveX control allows the development of own software to command each function from a suitable programming software (e.g. LabView).

Specification

Active X
• Active X programming interface

Further information is also available on http://www.technoteam.de.

Switching cabinet components

Switching cabinet

The switching cabinet basically includes the measuring computer and the motor controller. It provides space for additional devices like power analyzer and power supplies. If those optional components are included in the order, they are mounted and wired to the switching cabinet by TechnoTeam.

Specification:

Type	Rittal 19" switching cabinet
Height	1900 mm
Width / Depth	600 / 800 mm
Ventilation	Roof fan

Example configuration:

Power analyzer

DC power supply

AC power supply

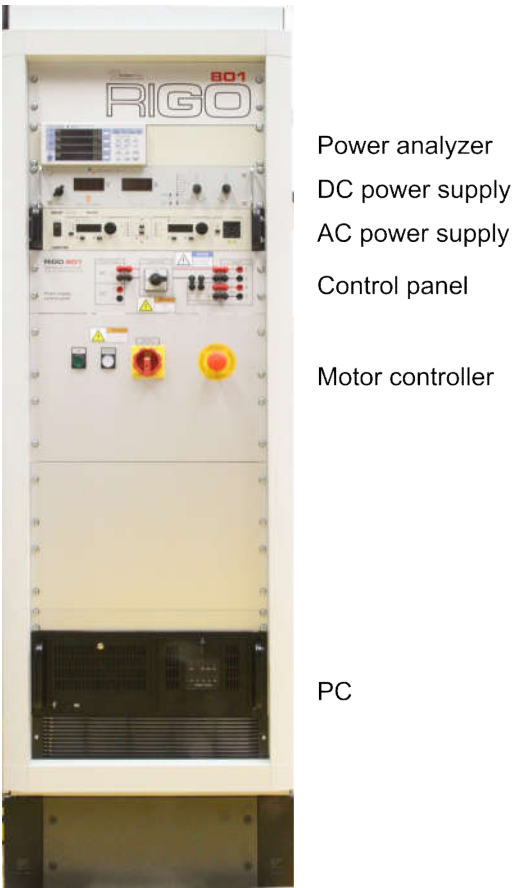Control panel

Motor controller

PC

Figure 19: Example configuration of the switching cabinet (only front view)

Control panel LSF 95

Control panel to be mounted as front panel of the switching cabinet for a comfortable setup of the connections between the power supplies, the power analyzer and the DUT. The output lines of the control panel are directly connected to the plugs of the test object support inside the go-niophotometer.
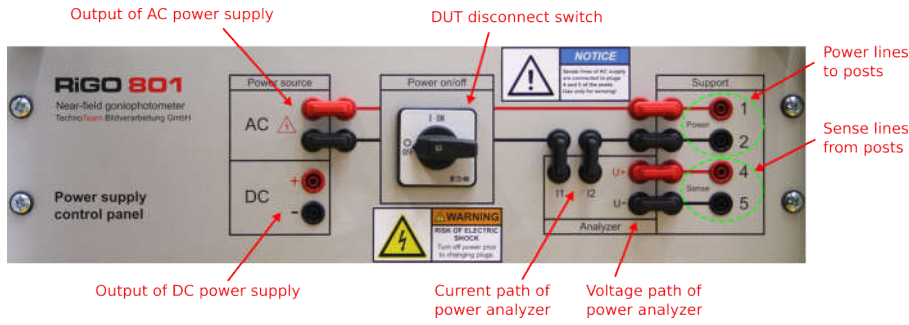
Figure 20: Control panel with standard configuration

Specification

Material:	Aluminium
Dimension:	482.6 mm x 132 mm
Maximum current:	20A
Maximum Voltage:	230 V
Sockets:	Ø 4 mm Safety sockets

AC Power Supply (Chroma 61600 Series)

Short specification

Model	61601	61602	61604
Output Rating - AC			
Power:	500 VA	1000 VA	2000 VA
Voltage range:	150V/300V		
:			
Current (rms):	4A/2A (150V/300V)	8A/4A (150V/300V)	16A/8A (150V/300V)
Frequency:	DC, 15~1kHz		
Output Rating - DC			
Power:	250 W	500 W	1000 W
Voltage range:	212V/424V		
:			
Current (rms):	2A/1A (212V/424V)	4A/2A (212V/424V)	8A/4A (212V/424V)
Input Rating			
Voltage and Frequency:	90 to 250 VAC, 47 to 63 Hz, single phase		
Current (rms):	10A Max. @ 90V	18A Max. @ 90V	28A Max. @ 90V

Detailed specification:

http://www.chromaate.com/product/61600_series_Programmable_AC_Source.htm

DC Power Supply (DELTA Electronica SM 70-22)

Short specification

Output	
Voltage:	0 to 70 V
Current:	0 to 22 A
Autoranging (2 ranges) max. output current/voltage:	60 A / 0 to 26 V 30 A / 26 to 52 V
Input	
Voltage and Frequency:	90 to 265 VAC, 48 to 62 Hz, single phase
Current:	0 to 22 A
Autoranging (2 ranges) max. output current/voltage:	60 A / 0 to 26 V 30 A / 26 to 52 V
Stability	
CC (After 1hr warm-up during 8 hrs):	9.10^{-5}
CV (After 1hr warm-up during 8 hrs):	6.10^{-5}

Power analyzer (Yokogawa Digital Power Meter WT310E)

- Maximum input with assured accuracy: 26 A

- Basic accuracy: 0.1%

- DC measurement: 0.5 Hz to 100 kHz frequency range

- 5 mA range for very low current measurements

- USB and GPIB interface

Evaluation computer

- Advantech SYS-4U400-4S03, Rackmount

- Intel® Core™ i7-4770S Processor

- 4GB DDR3-1333

- DVD-RW drive

- 500 GB SATA HDD

- Expansion Slots 3x PCI 32-bit/33 MHz, 2x PCIe x 1 (Gen2), 2x PCIe x16 (Gen3)

- 2x GbE LAN, 2x DVI, 1x VGA, 2 USB 3.0; 7 USB 2.0 (1 x USB Type-A)

- Windows 10 Professional / 32 Bit

- Two RS232 ports

Installation of the goniophotometer and user training

- Installation of the goniophotometer in the laboratory

- Testing of the complete equipment

- Test measurements

- User training (8 to 16 h)