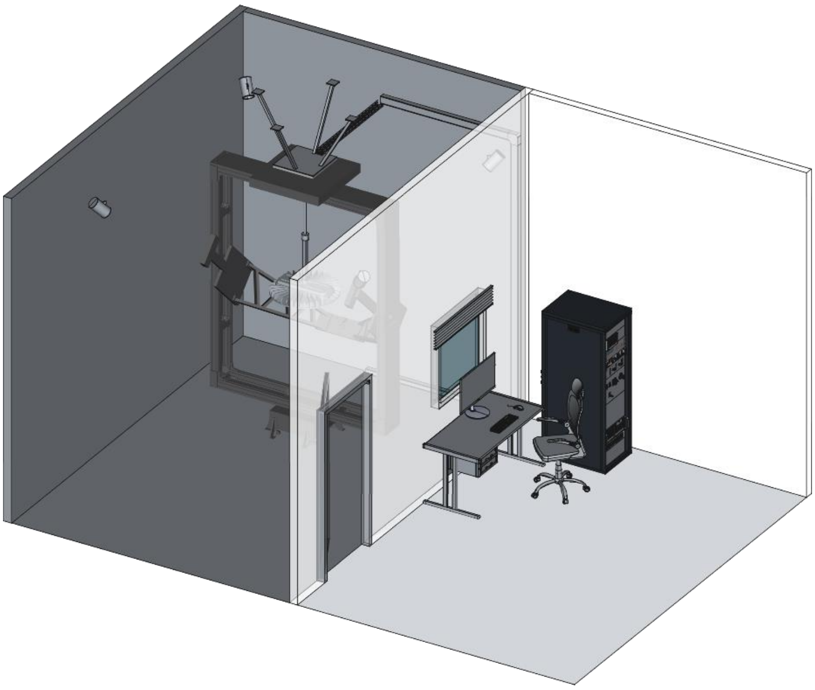
Specification

Laboratory requirements RiGO801-L



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1 Introduction

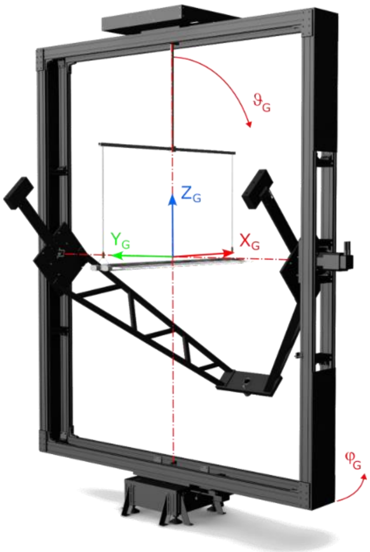
This document provides recommendations for the design of a photometric measurement laboratory equipped with a *RiGO801-L goniophotometer*. It considers both general requirements for lighting laboratories and specific aspects related to the installation of the RiGO801-L.

Relevant standards and documents for laboratory planning:

- CIE S 025 bzw. EN 13032-4
- IES LM-79-24
- RiGO801-L - Operating Manual[1]

2 System Description RiGO801-L

2.1 Fundamentals



The RiGO801-L goniophotometers of the 801-1400 to 801-2000 series enable measurements of lamps and luminaires in compliance with CIE S 025 and IES LM-79-24 standards. The following measurements are conducted:

- Luminous intensity distribution
- Luminous flux
- Spectral measurements

The RiGO801-L operates based on the near-field measurement principle. Unlike conventional far-field photometry, where luminous intensity is derived from illuminance, this system directly captures the luminance distribution of the light source at a short measurement distance. As a result, there is no need to measure beyond the photometric limiting distance.

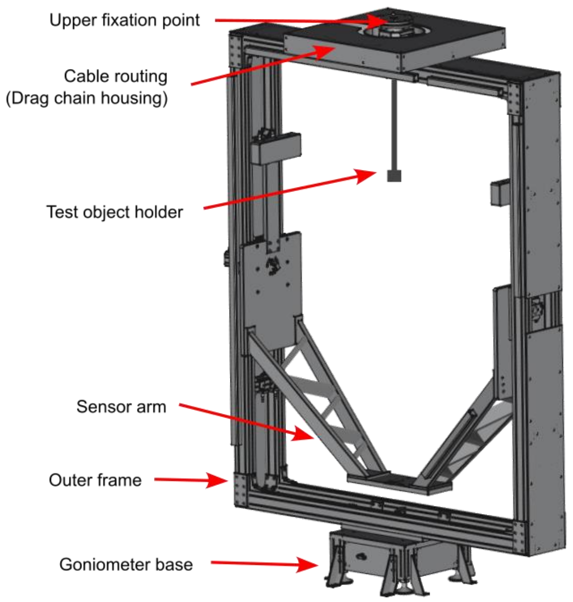
Key Features of the RiGO801-L

1. **Measurement Principle with a Stationary Object**
   - The test objects (luminaires, lamps) remain stationary, while the goniometer moves around them.
   - This simplifies the measurement setup and environmental control, as only the test object's zone needs to be stabilized.
2. **Goniometer Motion**
   - The goniometer unit consists of an outer frame, which rotates around a vertical axis (C or Phi angle).
   - A pivot arm within the frame moves around a horizontal axis (Gamma or Theta angle). The sensors are positioned at the end of the pivot arm.

[1] https://www.technoteam.de/products/goniophotometer_rigo801/rigo801__l/index_eng.html

3. **Space and Measurement Conditions**
   - The required space is solely determined by the movement radius of the goniometer.
   - No external detector (e.g., photometer, spectroradiometer) at a large distance is required, eliminating the need for an extended measurement channel.
   - Baffles for stray light suppression are unnecessary.
4. **Installation Requirements**
   - The outer goniometer frame must be fixed at the upper rotation point (see Section 4.5).
5. **Low Sensitivity to Stray Light**
   - Due to the short measurement distance, the influence of stray light is negligible, providing a significant advantage over far-field goniophotometers.

2.2 Goniometer Unit



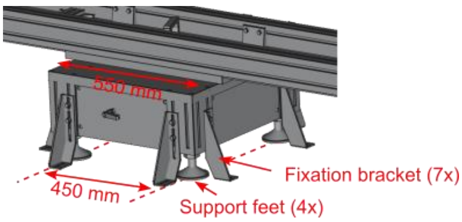
2.2.1 *Frame and Base*

The goniometer unit consists of an outer rotatable frame and an inner movable sensor arm. The frame is mounted on an integrated drive gearbox located within the base.

The entire weight of the goniometer unit is supported by the base and its four leveling feet, which are arranged 450 mm apart from each other.

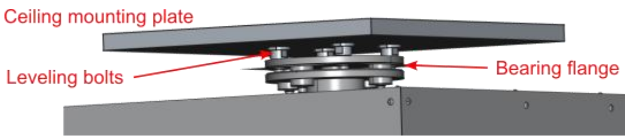
To ensure secure fixation, the base is firmly bolted to the floor using seven mounting brackets, preventing any unintended displacement.

Additionally, the base houses the mounting fixture for the lower support post. This post is guided through the hollow shaft of the drive gearbox.



2.2.2 *Ceiling Fixation*

The upper pivot point of the frame must be stabilized, which requires a bearing with a flange designed for mounting onto a suitable ceiling structure. Additionally, this flange supports the post that holds the upper support post for the test object.

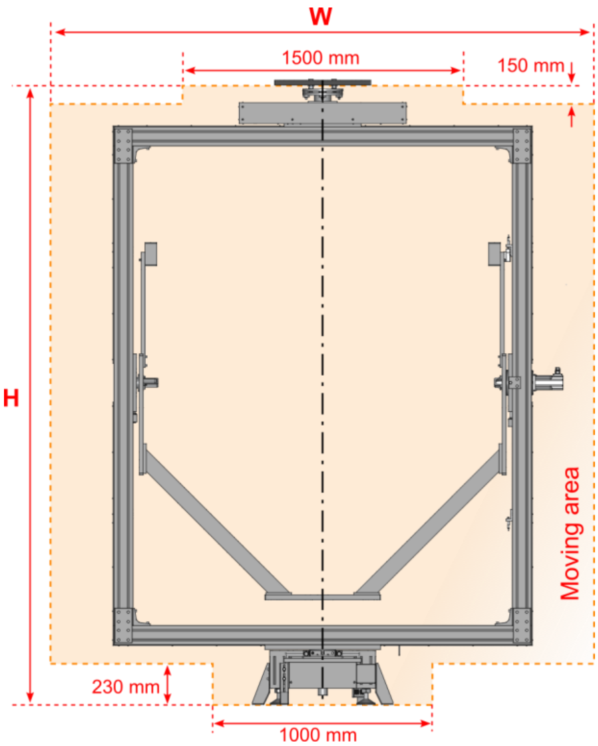


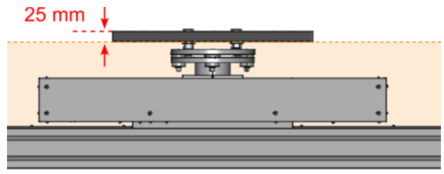
To ensure proper fixation and leveling of the upper bearing flange, a mounting plate is supplied. This plate must be securely bolted to the ceiling structure. The specific requirements for the ceiling construction are detailed later in this document.

2.2.3 *Sizes, Dimensions, and Weight*

The goniophotometers are available in various sizes. For laboratory planning, it is particularly important to consider the required room height and the movement radius. If the room height is insufficient or structural elements are present within the movement area, a detailed analysis of the dimensions of moving components may be necessary. In some cases, the goniometer base can be recessed into the floor, or the ceiling height can be selectively adjusted in specific areas, such as at the frame fixation point or cable routing enclosure.

In the following dimensional specifications, **H** represents the distance from the floor to the *underside* of the ceiling mounting plate, which has a thickness of 25 mm. Since both the base and the upper bearing flange have variable heights, the height values include a tolerance range of ±30 mm. The parameter **W** indicates the diameter of the movement area.





Model	H / mm	W / mm
801-1400	2785 +/- 30	2900[2]
801-1500	3277 +/- 30	2900
801-1800	3870 +/- 30	3400
801-2000	4100 +/- 30	3600

The weight of the goniometer unit varies depending on the model size, ranging between 400 kg and 500 kg. The surface load is determined by the footprint of the four leveling feet on the base (see Section 2.2.1).

2.2.4 *Special Designs / Custom Adaptations*

If the selected goniometer model does not fit within the designated space, a customized version can be implemented in certain cases. One example is the 801-1400 model, which was specifically designed for rooms with a low ceiling height of 2800 mm.

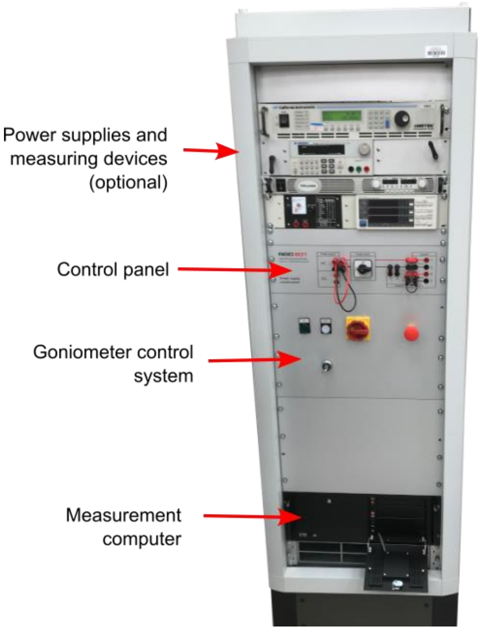
To achieve this adaptation, the frame was slightly shortened, and the opening angle of the sensor arm was expanded. Additionally, the height of the goniometer base was reduced by approximately 50 mm, allowing for a maximum test object diameter of 1400 mm[3].

These custom adaptations can be evaluated and implemented based on the specific spatial conditions.

[2] The frames of models 801-1400 and 801-1500 have the same width

[3] 1400 mm when using the monochrome luminance measurement camera, 1200 mm when using the filter wheel camera

2.3 Control Cabinet



The control cabinet includes the drive control system for the goniometer unit, the measurement computer, and a control panel for operating the test object. Optionally, power supplies and measurement devices (e.g., power analyzer) can be integrated.

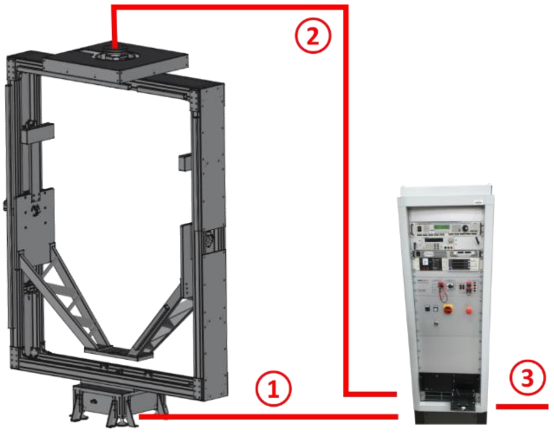
Control Cabinet Dimensions: 600 × 800 × 1900 mm

Weight: Approx. 100 kg (plus optional equipment)

2.4 Cable Routing

Two cable bundles run from the goniometer unit to the control cabinet. The first bundle, originating from the base, carries cables for the frame drive system and the power supply to the lower support post. The second bundle, from the upper rotation point of the frame, contains cables for the inner drive system, the optical sensors (photometer, camera, spectroradiometer) and the upper support post.

When planning the cable routing, the available cable lengths must be carefully considered. Additionally, the size of the cable bundles and the connectors must be taken into account to ensure proper installation, particularly when routing cables through wall openings.



2.4.1 *Cables from the Base (1)*

Bundle Diameter: approx. 25 mm

Connector Size: max. 40 mm

Cable Length: **10 m**

2.4.2 *Cables from the Upper Rotation Point of the Frame (2)*

Bundle Diameter: ca. 40 mm

Connector Size: max. 60 mm

Cable Length: **15 m**

2.4.3 *Mains Supply (3)*

In the standard configuration, two mains connections are required—one for the goniometer control system and one for the measurement computer. Any optional additional devices integrated into the control cabinet are powered via the goniometer control system's mains supply.

For this purpose, an internal multiple socket outlet is provided, which is equipped with its own residual current circuit breaker (3.5 mA) and is deactivated via the emergency stop switch.

Alternatively, additional devices can be powered independently through a separate electrical circuit.

Mains Supply Specification

Parameter	Specification	Remarks
Supply Voltage	220 / 230 V (50/60 Hz) 1 phase	Custom mains voltage available on request
Fuse Protection	16 A	
Mains Type	TN or TT System (IEC60364-1)	Operation on an IT power system is not possible.
RCD	Type F / 0.03 A (An RCD may be omitted for fixed installation).	Type F = Designed for frequency inverter applications to prevent nuisance tripping.
External wiring	A permanently installed connection cable or an industrial connector (e.g., IEC 60309, L+N+PE, 6H) may be used.	
Internal wiring	Spring clamp terminals 2.5 mm²	
Cable length	3 m + length to socket or terminal connection.	The cable entry is located at the control cabinet base.

Measurement Computer

Provision of a standard socket (optionally for IT equipment) near the control cabinet (< 2 m distance).

2.4.4 *Cable Entry into the Control Cabinet*

All cables entering the control cabinet are routed through a panel on the rear side of the cabinet base.

3 Laboratory Layout – Overview

When planning the laboratory layout for a RiGO801-L goniophotometer, various aspects must be considered. This section provides a general overview, while a detailed specification can be found in Section 4.

There are two primary areas within the laboratory:

- The goniometer unit environment
- The operator's workspace

Since the requirements for these areas differ significantly, a physical separation is ideal. If this is not possible, additional measures must be taken, such as restricted access to the hazardous area and light-tight partitioning to prevent measurement disturbances.

3.1 Room Size and Ceiling Fixation

The required room size depends on the selected RiGO801-L model. Since the goniometer requires an upper fixation point, the implementation of the corresponding mounting structure must be considered when determining the room height.

The complexity of the upper fixation structure depends on the ceiling structure:

- If the ceiling is suitable as a fixation point, a simple mounting structure is sufficient.
- If the ceiling is not load-bearing or unsuitable, an alternative solution must be chosen, such as wall-mounted supports or a self-supporting portal structure.

3.2 Requirements for the Measurement Laboratory

The goniometer environment must meet the requirements of a black measurement laboratory according to relevant standards (see Section 4.1.1). This includes:

- **Darkening**, to prevent unwanted light interference.
- **Climate control**, to ensure standard-compliant conditions.

Another key aspect is securing the hazardous area when the goniometer is in motion:

- If the goniometer unit is in a separate room, access control via door sensors is sufficient.
- If no physical separation is possible, an access protection system must be implemented within the room, such as light curtains, pressure-sensitive mats, or safety fences, depending on the available space.

3.3 Operator Workspace and Control

The goniophotometer workspace should provide a well-lit, standard laboratory environment and include:

- The control cabinet
- The operator’s desk

The maximum distance between the workspace and the goniometer unit is determined by cable length and routing. If physical separation is not possible, a light-tight curtain should be installed between the measurement area and the workspace. This allows for separate lighting in the operator area without interfering with the measurement.

A direct line of sight to the goniometer unit is beneficial during the setup phase. If the areas are separated, a window with blackout covering can provide visibility.

3.4 Preparation of Luminaires

For efficient preparation of luminaires for testing, a dedicated workspace should include:

- A workbench
- Tools
- Storage space for accessories

A step ladder or work platform is required for mounting the test object in the goniometer. Ideally, this should be stored close to the goniometer, such as behind a small curtain. If very heavy luminaires need to be handled, a suitable lifting or transport device should be considered.

3.5 Pre-Stabilization of Luminaires

To reduce stabilization time, a dedicated pre-stabilization area could be established. This allows the luminaire to be installed in a pre-warmed state, ensuring that the stability conditions required by the standards are met more quickly.

4 Room for the Goniophotometer – Requirements and Recommendations

4.1 Climate Control

4.1.1 *Requirements*

According to LM-79-24 and CIE S 025 / EN 13032-4, the temperature in the vicinity of the Device Under Test (DUT) must be maintained at **25 °C ± 1.2 °C** at a distance of **1.5 m**.

Air turbulence near temperature-sensitive luminaires must not exceed 0.25 m/s (CIE S 025 / EN 13032-4). Additionally, LM-79-24 specifies that airflow around the SSL product being tested must not interfere with its natural convective airflow. For moving test objects, a maximum tangential air velocity of 0.2 m/s is defined. However, this specification applies specifically to moving test objects, not to general air movement in the laboratory. As a precaution, a maximum air velocity of **0.2 m/s** should be assumed.

The **relative humidity** should be maintained between **10% and 50%.**

4.1.2 *Implementation Options*

Maintaining temperature and airflow conditions according to standards presents significant challenges for climate control systems. One major advantage of the RiGO801-L design is that the goniometer moves around the stationary test object, meaning that climate conditions **only need to be maintained in the central measurement area**.

To ensure compliance with the maximum permissible airflow velocity, air circulation should be distributed over a large area. This can be achieved using dedicated air ducts or special textile air outlets (climate tubes). Companies specializing in such solutions include:

- https://www.prihoda.com/
- https://www.airquell.com/
- https://www.fabricair.com/
- https://www.kieferklima.de
- https://www.ke-fibertec.com/
- https://kienzler-klima.de/
- https://thermotex.de/

It is important to note that airflows can affect curtains, especially when separating areas with supply and exhaust air systems.

4.1.3 *Temperature and Humidity Monitoring*

Compliance with standard environmental conditions should be continuously monitored and recorded using appropriate temperature and humidity sensors.

The RiGO801-L system offers an optional data logger integration with a high-precision temperature and humidity sensor. This sensor is mounted on the goniometer frame at the height of the test object, allowing for precise monitoring of environmental conditions during measurements.

Alternatively, the standard synchronization options with a central laboratory environmental monitoring system can be used.

4.2 Darkening

All room elements must be black and as matte as possible to minimize reflections. A matte black carpet is well suited for the floor covering, while room partitions can be effectively implemented using matte black curtains (Molton fabric).

4.3 Vibrations

The goniophotometer room should be free from noticeable vibrations, as disturbances can negatively impact measurement accuracy.

Since the goniometer unit is mounted to both the floor and either the ceiling or walls, building vibrations—caused by forklifts, manufacturing machines, or other industrial equipment—can be transmitted to the system.

Vibrations at the upper goniometer bearing are particularly problematic, as they are directly transferred to the upper support post of the test object, potentially leading to unacceptable measurement conditions. Additionally, floor vibrations can affect the entire goniometer unit, introducing measurement inaccuracies.

4.4 Room Size and Goniophotometer Placement

The minimum required room dimensions are determined by the movement range of the goniometer unit, which forms a cylindrical volume. The specific diameters and heights for each model are provided in Section 2.2.3.

To minimize stray light reflections from the walls and to facilitate installation and general operation, it is recommended to choose slightly larger room dimensions. An additional clearance of 2 to 3 meters is beneficial for this purpose.

The location of the goniometer unit should be selected to ensure unobstructed access for the installation and mounting of test objects.

4.5 Upper Goniometer Fixation

As explained in Section 2.2.2, the goniometer frame must be secured at the upper pivot point. The goniophotometer delivery package includes a special mounting plate, to which the upper bearing flange is bolted using leveling elements. This plate must be mounted by the customer while ensuring compliance with the following requirements.

4.5.1 *Static Loads and Dynamic Properties*

Die Befestigung der oberen Goniometerlagerung muss sowohl statischen als auch dynamischen Belastungen standhalten.

<u>Vertical Loads</u>

The upper goniometer bearing fixation must withstand both static and dynamic loads.

- The mounting components weigh approximately 50 kg.
- The maximum allowable weight of the luminaire is 50 kg.
- This results in a **total load** of at least **100 kg**.

Under this load, the vertical displacement of the upper fixation point must **not exceed 0.5 mm**.

Torque Load

If the test object is placed off-center, an additional torque acts on the fixation.

- Assuming a mass of 25 kg positioned 600 mm off-center, a torque of **150 Nm** is generated.
- This torque must not significantly affect the goniometer axis (i.e., the axis of the upper bearing flange).
- The **maximum allowable rotation** of the upper fixation plane under this load is **0.02°**.

Dynamic Properties and Vibration Damping

The goniometer drives generate minor vibrations, typically in the range of several tens of Hz, depending on the axis speed. These vibrations are transmitted via the flange assembly to the upper fixation, potentially causing resonance effects that lead to oscillations of the support post.

To reduce vibration transmission, damping elements (rubber buffers) are already integrated into the flange fastening system. However, the upper fixation structure should be as rigid as possible, which can be achieved by oversizing the structure and adding additional reinforcements.

Summary of Requirements

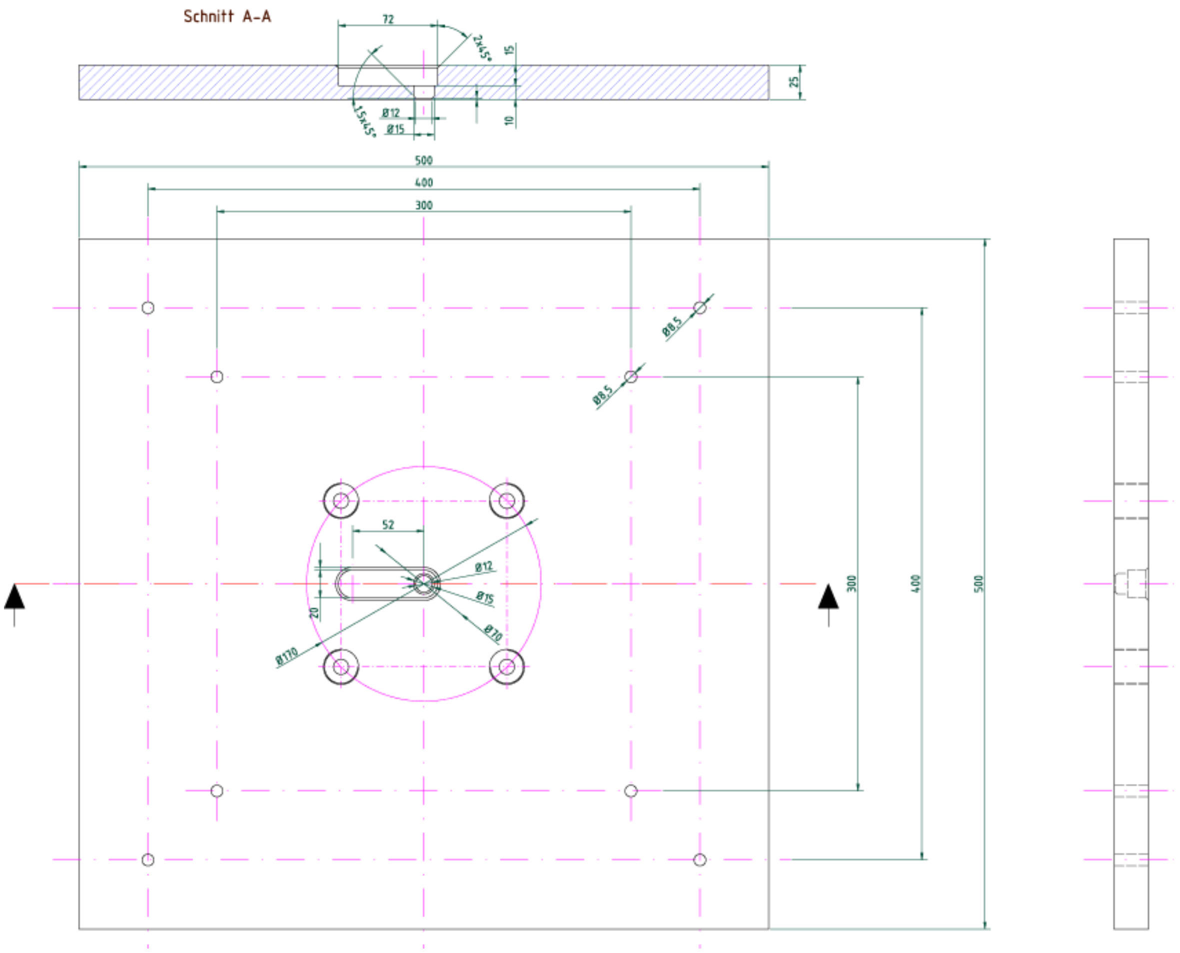
- Vertical load: 100 kg → Maximum displacement of the fixation point: 0.5 mm
- Torque load: 150 Nm → Maximum rotational displacement: 0.02°

4.5.2 *Mounting Plate*

The mounting plate is made of aluminum, and its exact dimensions are provided in the technical drawing. The goniometer is attached to the plate using leveling bolts, which allow for precise leveling of the flange, meaning the plate itself does not need to be perfectly horizontal.

For ceiling fixation, eight outer mounting holes are provided. If necessary, additional holes or threaded inserts can be added outside the inner circle of the leveling bolts.

A proven method is to use a counterplate with identical dimensions and hole patterns, which is attached to the ceiling structure. The goniometer can then be securely clamped between the mounting plate and the counterplate, ensuring stable fixation.



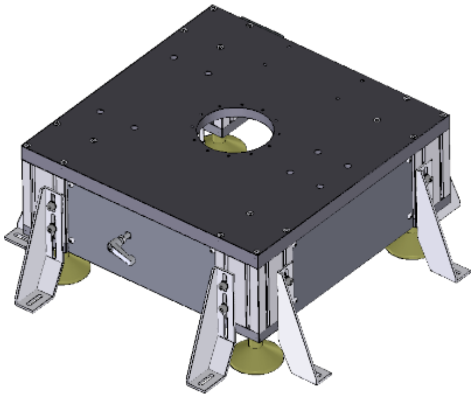
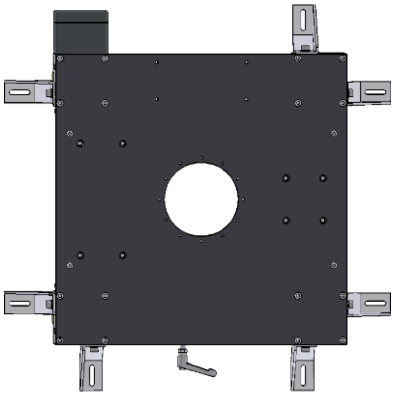
4.5.3 *Height*

The underside of the mounting plate (thickness: 25 mm) must be installed at a specific height depending on the goniometer model. The corresponding values and tolerances are provided in Section 3.2.3.

4.6 Floor Anchoring of the Base

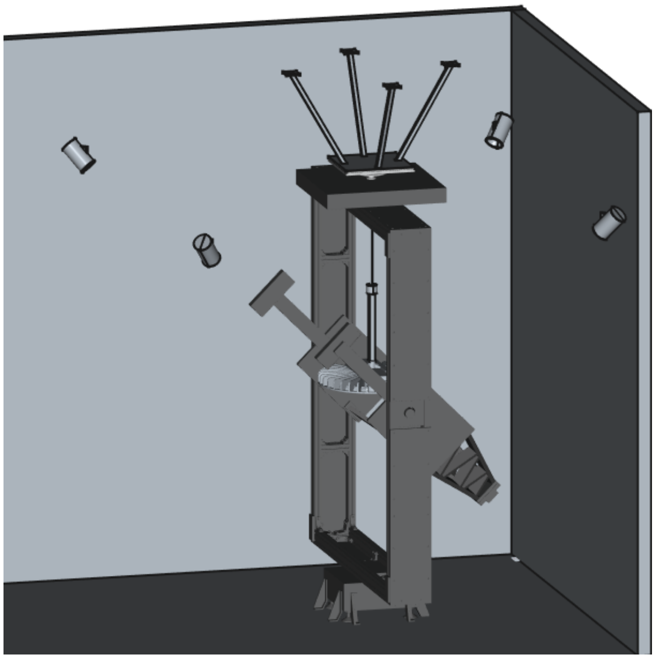
The goniometer base is securely bolted to the floor using seven mounting brackets. The fastening typically involves 10 × 50 mm nylon expansion anchors in combination with M8 × 60 hex head wood screws (ISO 571).

The necessary drill holes are only made during installation to ensure precise positioning.


Caution: If drilling into the floor is not permitted (e.g., due to underfloor heating), an alternative fixation method must be determined.

4.7 Lighting



The lighting in the goniophotometer area must meet several requirements. In addition to general room illumination, a focused lighting setup is necessary for the central area of the goniometer unit.

For optimal alignment of test objects, targeted lighting can be used, particularly in combination with the measurement camera. Ideally, the lighting should come from four directions, positioned diagonally from above, for example, from the room corners.

During measurements, no light reflections from the luminaires must occur, as these could distort the measurement results. If necessary, light-blocking panels (e.g., motorized) or curtains should be installed to eliminate unwanted light sources.

4.8 Hazard Area Protection

The goniometer unit is classified as a machine, meaning that it must comply with safety and health protection requirements. The operating manual contains detailed information on risk assessment and the connection options for protective devices.

It must be ensured that no personnel enter the hazardous area while the goniometer axes are in motion. To achieve this, a non-separating safety device must be connected to the safety relay (Pilz PNOZ S5) of the goniometer control system.

If the safety device is triggered, an immediate emergency stop is initiated, followed by power shutdown of the drives. To restart the system, a reset button on the control cabinet must be pressed.

4.8.1 *Physical Separation of the Hazardous Area*

If the hazardous area is physically separated, the access door can be equipped with a safety switch. This is the simplest and most cost-effective solution.

4.8.2 *No Physical Separation of the Hazardous Area*

If the goniometer is freely accessible, a minimum safety distance must be maintained between the non-separating safety device and the moving components.

According to EN ISO 13855, with a system stop time of 1000 ms, the minimum required distance is 1.6 m.

Possible safety devices include:

- Light curtains / light grids
- Laser scanners
- Safety mats

Depending on the type of safety device, an additional distance may be required, which must be determined in advance.

Alternatively, a safety fence with a door and safety switch can be installed, allowing for a reduced safety distance.

4.9 Equipment for Mounting Test Objects

The installation of luminaires in the goniophotometer typically requires a work platform or ladder. When selecting equipment, occupational safety regulations must be followed, particularly considering the maximum weight of test objects and the corresponding requirements for the load capacity, stability, and ergonomics of the ladders, work platforms, or lifting devices used.

If heavy luminaires or bulky test objects need to be installed, the use of appropriate lifting aids or mechanical support systems may be necessary to ensure safe and efficient handling.

The movement and storage of this equipment within the goniometer area must be considered during the planning phase of the facility to ensure sufficient space and accessibility.

4.10 Aids for Aligning Test Objects

The measurement camera can be used to align test objects within the goniometer. The camera is positioned at three orthogonal positions, allowing the test object to be aligned using an on-screen coordinate system. Proper illumination is essential for this process (see Section 4.6).

For convenient camera-based alignment, it is recommended to place a monitor within the operator's line of sight to the goniometer. The monitor can be wall-mounted or positioned for easy visibility. During the measurement process, darkening can be achieved using a curtain to prevent unwanted light interference.

As an alternative to camera-based alignment, a laser alignment system can be used. Suitable laser modules can be installed in the room to indicate the center of the measurement area or, additionally, the central plane of the test object (e.g., cross-line laser).

5 Operator Workspace – Requirements and Recommendations

5.1 Location

The operator workspace for the goniophotometer consists of the control cabinet and a desk. Since the PC is integrated into the control cabinet, the desk should be placed nearby, considering the 5-meter limit of the monitor and USB cables.

The distance between the workspace and the goniometer unit is constrained by the maximum cable length and cable routing. The location should allow the operator to access the goniometer unit easily, as frequent interaction is required during the measurement setup. The operator should not sit with their back to the device, and a direct line of sight is recommended. If a partition wall separates the workspace from the goniometer area, a viewing window with a blackout covering option is advisable.

The control cabinet houses at least the PC and the control panel for the test object power supply. Typically, power supplies and a wattmeter are also integrated. Since these components require regular operation and monitoring, the front of the control cabinet should be easily accessible from the operator's desk.

Additionally, the rear door of the control cabinet must be conveniently accessible at all times. To facilitate this, a minimum clearance of 0.6 meters behind the cabinet should be maintained.

5.2 Environment and Lighting

Ideally, the operator workspace should resemble a standard, well-lit laboratory environment. The lighting should be sufficient for a PC workstation, ensuring comfortable operation. However, it must not interfere with the darkened goniometer area during measurements.

To prevent any unwanted light exposure affecting the goniometer environment, it is recommended to separate the lighting zones between the operator workspace and the measurement area.

5.3 Control Cabinet Mains Connection

The mains connection requirements for the control cabinet are specified in Section 2.4.3. A dedicated industrial socket or a direct cable connection must be provided for this purpose. The mains supply up to the terminals inside the control cabinet must be provided by the customer.

For the PC integrated into the control cabinet, a separate power socket must be made available, following the country-specific standard.

5.4 Miscellaneous

5.4.1 *General Power Outlets*

Standard power outlets for a PC workstation should be available near the operator workspace.

5.4.2 *Lighting Switches*

The switches for the goniometer area lighting should be located near the operator's workspace for easy access.

5.4.3 *Measurement Process Signaling*

It is advisable to indicate an active measurement process using a signal light. The signal activation can be controlled manually via a switch or automatically through a switching output (24V / 1A) on the goniometer control system.

6 Cable Routing

Two cable bundles run from the base and the upper fixation point of the goniometer unit to the control cabinet (see specifications in Section 2.4). The cables must be routed using appropriate cable management components to ensure a safe and organized installation.

It is important to ensure that all visible elements within the goniophotometer area are black to minimize reflections and interference with measurements.

There are various methods for cable routing, which should be selected based on spatial conditions and specific requirements. The following section outlines key considerations and some proven cable routing solutions.

6.1 Cable Routing from the Goniometer Base

When routing cables from the goniometer base, it is essential to ensure that no tripping hazards are created and that the placement of ladders or work platforms for mounting test objects is not obstructed.

A proven solution is the use of a floor cable channel for the initial cable section. The cable channel should be routed from the access direction toward the back to keep the working area clear.

Alternatively, a floor cable trench can be implemented. Such a trench should either be accessible from above or spacious enough to allow for easy routing of cables with connectors, as well as future adjustments if needed.

The cable routing should ultimately lead toward the control cabinet, typically along a wall. If a partition wall separates the goniometer from the control cabinet location, a sufficiently large wall opening must be planned to accommodate the cable passage.

6.2 Cable Routing from the Upper Fixation Point

When routing cables from the upper fixation point to the control cabinet, the maximum available cable length must be considered. Typically, the cables run horizontally towards a wall, then vertically down to the floor, before being merged with the cable bundle from the goniometer base. The starting point of the routing is laterally positioned at the upper goniometer mounting plate.

The exact routing depends on the structural conditions and room configuration. The following key aspects should be considered:

First Section: From the Upper Fixation Point to the Wall

- If the ceiling is not far away, a cable duct can be installed directly along the ceiling.
- If the ceiling is too far away (considering cable length limitations), the cable bundle should be guided via a cable tray towards the nearest wall. Alternatively, the routing can be diagonal towards a room corner, from where it is further directed downward.

Routing to the Floor

- A sufficiently large cable duct (e.g., 90 × 60 mm) is required.
- The weight of the cables must be considered—mounting components and cable supports must be adequately dimensioned for stability.
- If a 90° bend is required, a suitable bending radius must be maintained (use appropriate angled elements).
- If the goniometer area and the control room are separate, the cable duct can either run along the wall in the goniometer area or on the rear side within the control room.
- For wall penetrations, an adequately sized opening must be planned to accommodate cables and connectors without obstruction.

6.3 Merging of Both Cable Bundles

The cable routing from the goniometer base and the upper fixation point can either be kept separate up to the control cabinet or merged at an earlier stage.

If merging the cable bundles, suitable cable feedthroughs must be used. It is particularly important to ensure that sufficient space is available from this point onward to accommodate both cable bundles.

6.4 Cable Routing at the Control Cabinet Location

The cable routing terminates at the wall near the base of the control cabinet. From there, the cables are loosely routed in a loop before being fed through the cabinet base.

To allow for some flexibility in moving the control cabinet, an additional cable length of approximately 1.5 meters should be considered.

6.5 Points to Avoid

The following conditions should be avoided to ensure proper cable routing and maintenance:

- Tight or hard-to-access cable feedthroughs
- Routing above suspended ceilings that cannot be opened or are difficult to access
- Hard-to-reach cable trenches
- Pipes that are too narrow for the required cables
- Tight 90° bends in cable ducts – It is recommended to use appropriate angled connectors with a sufficient bending radius.

7 Examples

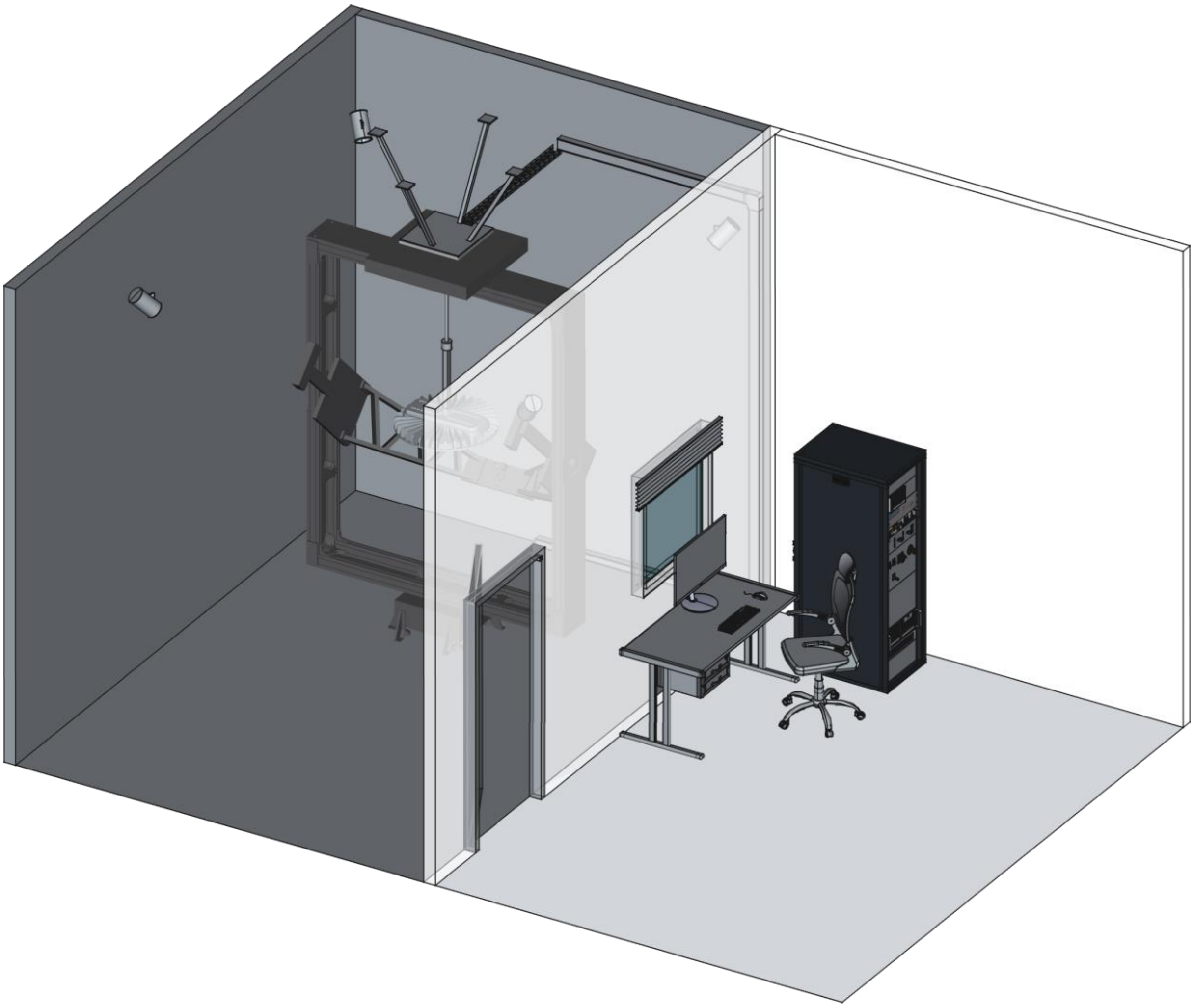
7.1 Laboratory with Room Separation

The following sections describe a proven laboratory configuration using a RiGO801-1500 goniophotometer. For larger models, the room dimensions must be scaled accordingly.

7.1.1 *Overview*

The goniometer unit is housed in a separate room or partitioned from the operator workspace by a wall.

Access to the goniometer area is provided through a door, separating the operator workspace from the measurement room.

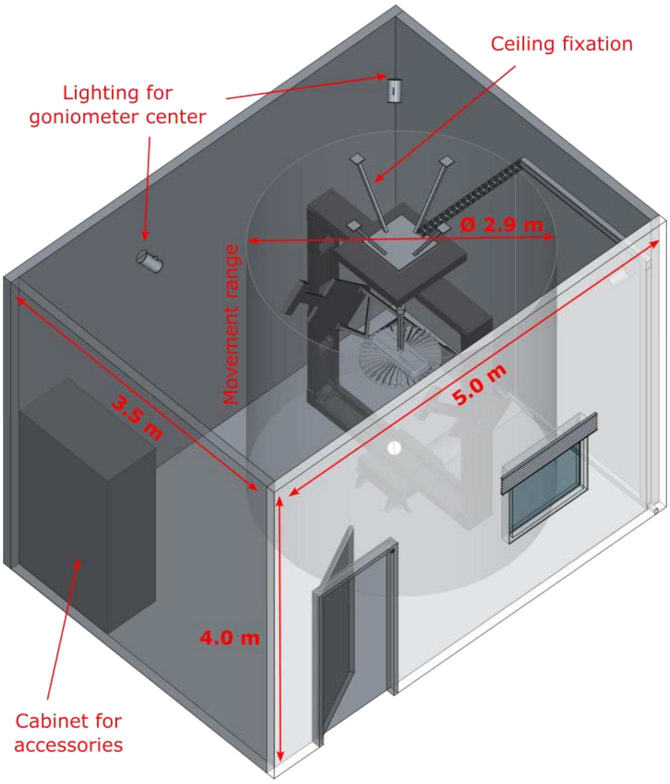


The upper fixation point of the goniometer is secured via a ceiling-mounted brace, ensuring stable fixation.

The control cabinet and the operator's workspace are located in the control room. A viewing window with a blackout covering allows for a visual connection to the goniophotometer while preventing unwanted light interference.

7.1.2 *Goniometer Room*

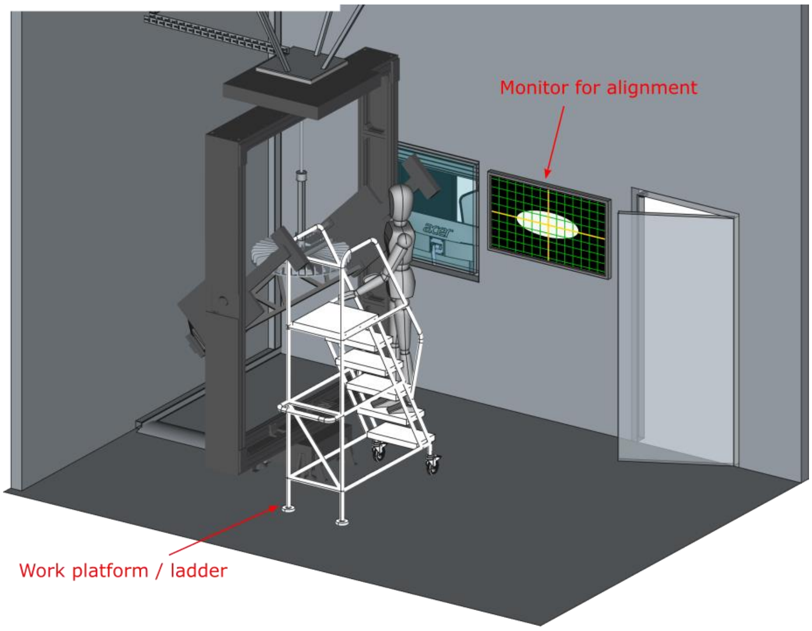
The goniometer room has a width of 3.5 m, which is only slightly larger than the minimum movement range of 2.9 m, but its length of 5 m provides additional space for storage of accessories, as well as for a ladder or work platform. The assumed room height is 4 m.



In the black-painted goniometer room, it is essential to ensure adequate lighting. Particular attention should be given to the focused illumination of the central area of the goniometer unit (see Section 4.7), which facilitates the alignment of test objects and ensures an optimal working environment during setup.

7.1.3 *Equipment for Mounting and Aligning the Test Object*

For installing the luminaire in the goniophotometer, a stable platform ladder is used in this example. To facilitate the alignment of the test object, a second monitor is positioned within the operator's line of sight (blackout covering not shown).



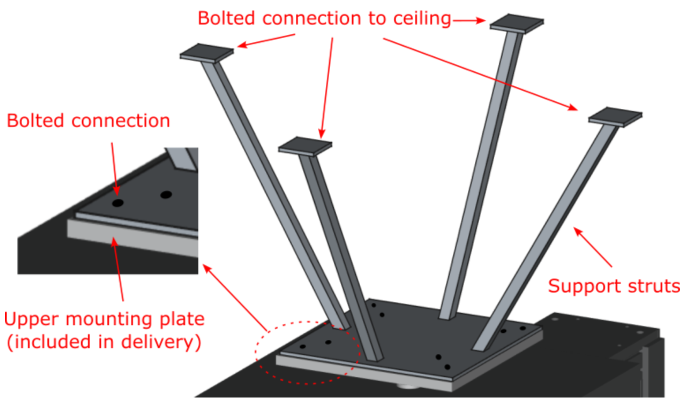
7.1.4 *Ceiling Fixation*

In this example, the room height is 4 m, allowing the ceiling to serve as the mounting point for the upper frame fixation. The required height compensation is 698 mm ±30 mm (4000 mm – 3277 mm – 25 mm, see Section 2.2.3).

<u>Proposed Construction:</u>

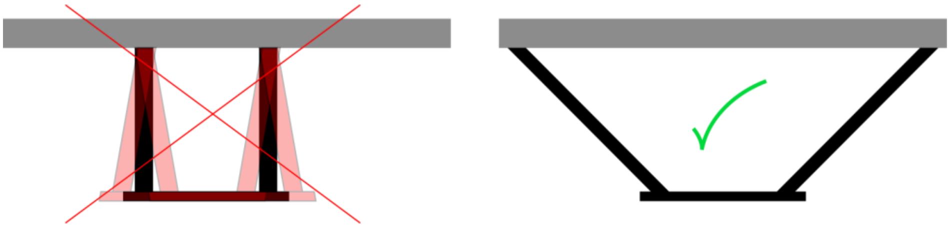
A metal plate with the same dimensions (500 × 500 mm) as the mounting plate supplied with the goniophotometer is used. This plate is connected to the ceiling via support struts and securely bolted.

Special Construction Guidelines:



- The support struts should be positioned at an angle to the ceiling (e.g. 30°) to ensure higher structural stability.
- This angled arrangement creates a truss-like structure based on triangular geometry[4], which provides significantly better resistance to vibrations and mechanical loads compared to a vertical mounting.

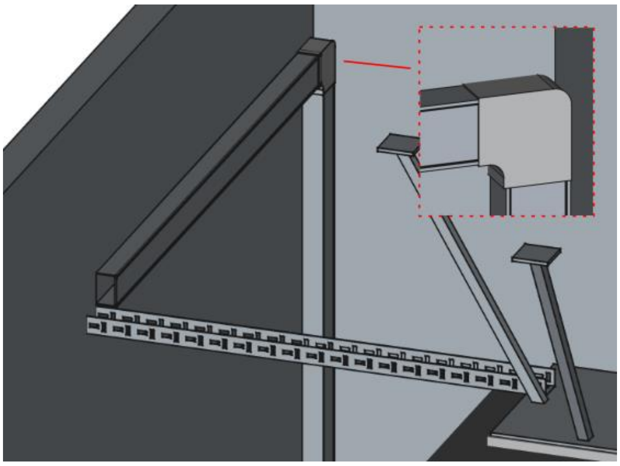
This method ensures that the upper frame fixation of the goniophotometer is stable and vibration-resistant.



The profiles used should be generously dimensioned to account for dynamic loads (see Section 2.2.2).

To further increase the rigidity of the structure, additional reinforcements should be considered if necessary. These are especially critical when there is a significant distance between the mounting plate and the ceiling.

7.1.5 *Cable Routing*

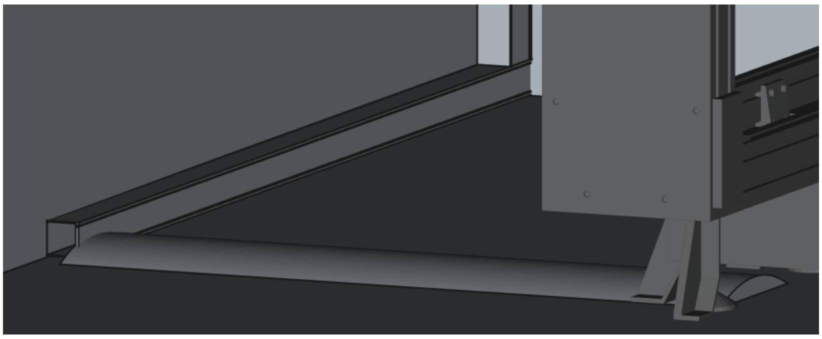
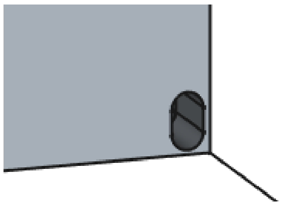


The cables from the upper fixation point are first routed via a cable tray to the rear wall. From there, they run horizontally along the wall in a 90 × 60 mm cable duct until reaching the partition wall of the control room. A curved angled element (ensure sufficient bending radius!) transitions the cables into a vertically running cable duct that extends down to the floor.

The cables from the goniometer base are initially routed through a floor cable channel (Adam Hall, Defender NANO BLK) to the rear wall. From there, a 60 × 60 mm cable duct continues the routing toward the partition wall of the control room.

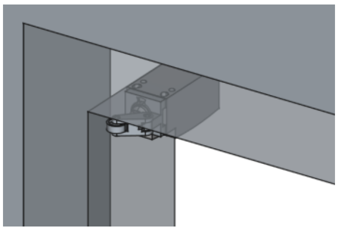
At this point, both cable bundles are merged and fed through a sufficiently large wall opening into the control room. In this example, two 40 mm drilled holes were positioned vertically aligned to accommodate the cables.

[4] https://en.wikipedia.org/wiki/Truss

All cable routing components must be black.

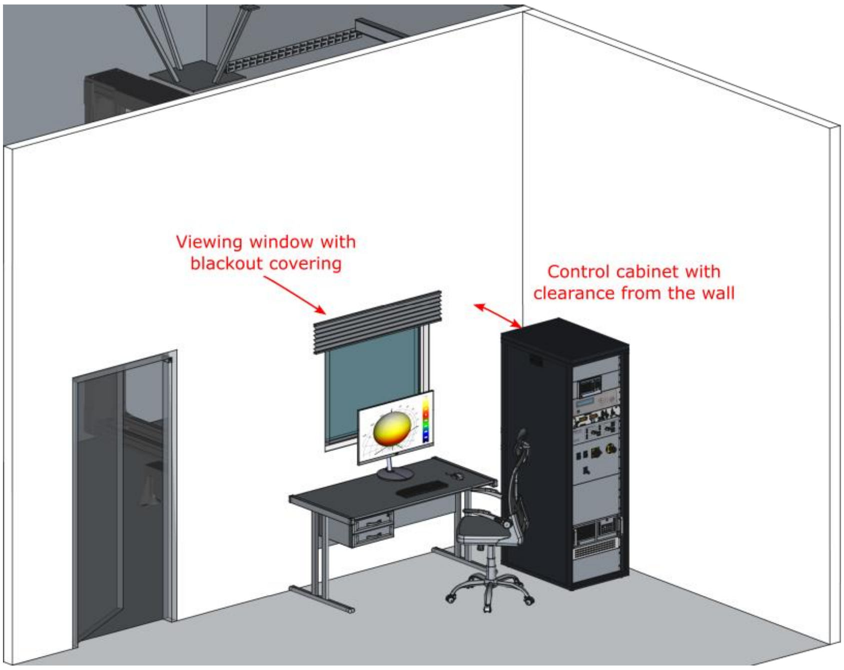
7.1.6 *Access Protection*



Access to the hazardous area is secured using a door switch (**2NO**, e.g., Eaton 266120 LS-20). When the door is opened, the motor control is deactivated, and if the goniometer axes are in motion, an emergency stop is triggered, followed by a shut-down of the drives.

For connecting the switch to the control cabinet, a **four-wire cable** is required. This cable must be routed appropriately based on the local conditions.

7.1.7 *Control Room*



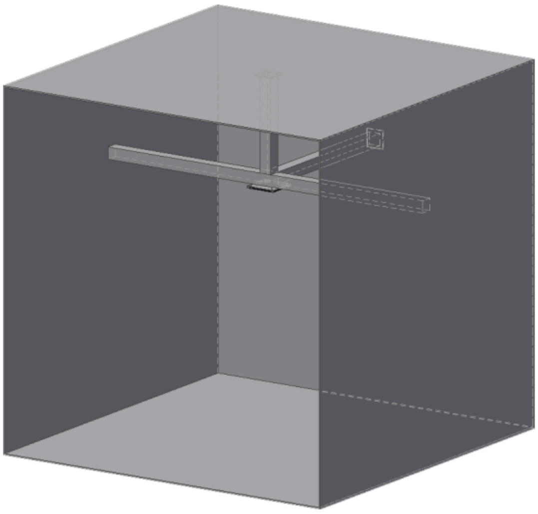
The control room is designed as a standard, well-lit workspace. A viewing window provides visual access to the goniophotometer. The blackout system, represented here as a simple blind, should be installed inside the goniometer room and should be matte black to prevent unwanted reflections.

The control cabinet is positioned to ensure an efficient and straightforward cable routing. Additionally, sufficient clearance must be planned behind the cabinet to allow unobstructed access to the rear door.

The illustration does not yet include a trunking system with power outlets and light switches.

7.2 Upper Frame Fixation Structures

7.2.1 *Steel Profiles Connected to Side Walls and Ceiling*

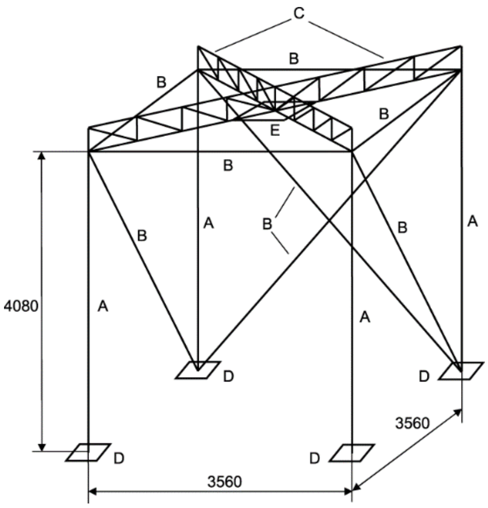


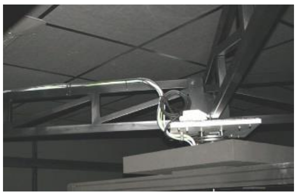
The adjacent illustration presents an example construction for the upper goniometer fixation, using steel profiles connected to both the side walls and the ceiling.

In principle, the upper fixation point should be stabilized in three directions. In the shown example configuration, the connection to the right side wall could be omitted if structural stability is still ensured.

7.2.2 *Portal Structure*

The following construction method is used in rooms where neither the ceiling nor the side walls provide sufficient stability. In such cases, a portal structure must be implemented to ensure secure fixation of the upper goniometer frame.



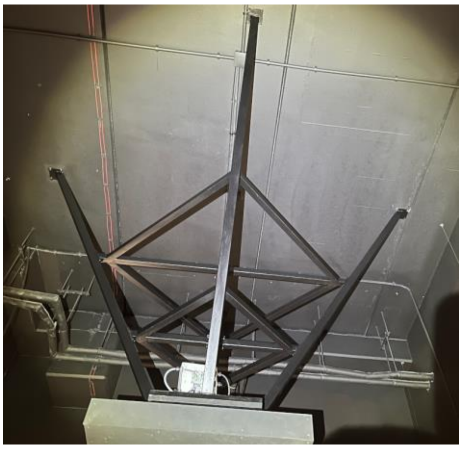


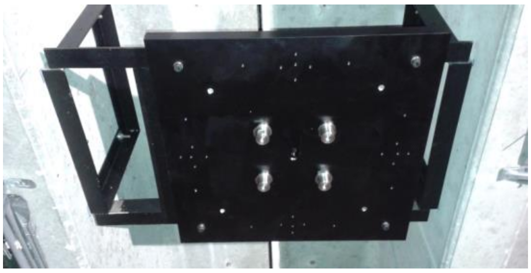
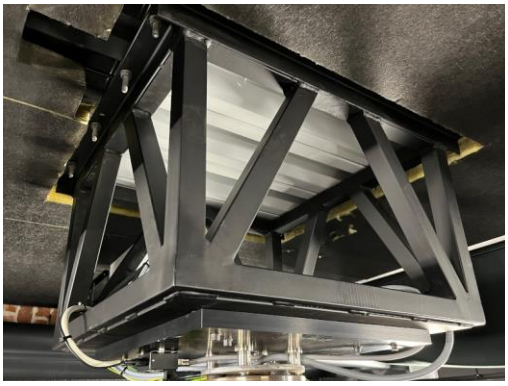
- Frame made of steel hollow profiles
- **A:** Vertical steel profile
- **B:** Crossbars and stabilizing diagonal braces (hollow profiles, rectangular profile, longer side oriented vertically)
- **C:** Load-bearing structure (square hollow profiles)
- **D:** Floor-mounted base plates
- **E:** Adapter plate for mounting the upper fixation plate. The required height can be found in the corresponding goniometer drawings.

All components must be dimensioned according to the static and dynamic load requirements outlined above. The entire frame must be matte black coated to minimize light reflections.

7.2.3 *Ceiling Fixations*

Examples of direct ceiling mounting.

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