



CAL3-XL

User Manual

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1 INTRODUCTION

Important information: Read the manual carefully before using the device.

Inappropriate utilization may cause damage to the device, to the DUT (device under test), and/or other components of your setup.

Keep these instructions in a safe place and pass them on to any future user.

1.1 Conformity

We, Image Engineering GmbH & Co. KG, hereby declare that the CAL3-XL corresponds to the essential requirements of the following EC directive in its current version:

- Electromagnetic Compatibility - 2014/30/EU
- RoHS 2 - 2011/65/EU
- Low Voltage - 2014/35/EU

1.2 Intended use

The CAL3-XL is designed as a calibration light source based on iQ-LED technology for cameras with a wide field of view. It includes a micro spectrometer and is controlled with the iQ-LED control software or via dip switches on the device when not connected to a PC.

- Only suitable for indoor use.
- Place your system in a dry, constant tempered environment without interfering light.
- The optimal ambient temperature range is 22 to 26 degrees Celsius. The maximum ambient temperature range is 18 to 28 degrees Celsius. Please check your ambient temperature if the system temperature exceeds 38 degrees Celsius.
- The optimal system temperature range, displayed in the software user interface, is between 32 and 38 degrees Celsius. The system has internal temperature management. If there is any error regarding the internal temperature, you will get a warning message, and the system will automatically shut down to avoid any damage.

1.2.1 Departing from described setup

The following steps must be performed in the correct chronology to allow frictionless commissioning. Departing from the chronology may lead to the device working incorrectly.

1. Install the iQ-LED software
2. Connect CAL3-XL to the power and then via USB to the PC
3. Switch CAL3-XL on; the system drivers will now be installed
4. Start the software after drivers are installed completely

1.2.2 USB connection

Only an appropriate USB connection allows error-free operation of CAL3-XL. Use the delivered USB cables. If you need to extend the USB connection to longer distances, please check if powered hubs/repeaters are necessary.

1.3 General safety information



WARNING!

Some LEDs emit invisible light in the IR and UV near area.



- **Do not** look directly into the emitted light or look through the optical LED system.
- **Do not** look directly in the open sphere or light source when using high intensities or sequences with low response time.



- **Do not** open the device without instructions from the Image Engineering support team or when connected to the power supply.

2 GETTING STARTED

2.1 Scope of delivery

- CAL3-XL
- Spectrometer (built-in)
- 4-prong removable alignment aid
- Power cord
- USB cable
- Control software
- Calibration protocol

Optional equipment:

- iQ-Align-XL for CAL3-XL for a quick and easy camera alignment.
- EX2 spectrometer for external measurements.
- iQ-Analyzer software (shading module)

This module includes a special chart layout file that allows the analysis of images with and without a keyhole effect.

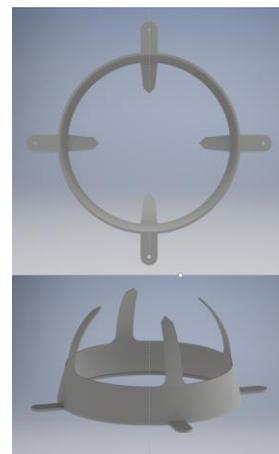


Figure 1: 4-prong alignment aid for CAL3-XL



3 OPERATING INSTRUCTIONS HARDWARE

3.1 Overview display

- 1 x USB port for software control
- 1 x port for power adapter

Use the control panel to set different light settings for the iQ-LEDs:



Figure 2: Control panel of CAL3-XL

- Use the “+” and “-” buttons to switch between up to 44 saved illuminants
- The numerical display shows the number of stored illuminants
- Use the play and stop button to start and stop a saved light sequence with different illuminants (it is possible to save one sequence on the device)
- With the power button (0 / 1), you can turn on and off the light (default illuminant)
- There are three pre-stored illuminants on your device (the intensity of each illuminant is shown in the acceptance protocol of your device):
 - 1: illuminant A (default illuminant)
 - 2: illuminant D50
 - 3: illuminant D75

Note: To store your own generated illuminants or sequences on your device, please follow the instructions in the iQ-LED software user manual.



3.2 Connecting the hardware

1. Connect the power cord to the power supply on the back of CAL-3XL.
2. Connect the USB cable to the CAL3-XL and your PC.
3. Turn on the CAL3-XL; the power switch is next to the power supply.
4. Connect the spectrometer to the PC using the USB cable. The system will install the spectrometer and the iQ-LED drivers on your PC; this will take a few seconds.
5. You can check the installation in your hardware manager.



Figure 3: Hardware Manager: active iQ-LED and spectrometer

3.3 Camera positioning

Requirements for your camera (device under test, DUT):

- Maximum device diameter inside diffuser: between 100 and 150 mm
- Lens depth **inside diffuser** (see Figure 4: positioning of DUT in front of the CAL3-XL):

recommended:	75 mm ¹
minimum:	65 mm
maximum:	85 mm

Ensure that:

- The lens is exactly in the center of the diffuser, and it is not tilted
- The front end of the lens is ideally positioned at a depth of 65-85 mm inside the diffuser
- The angle of view of the lens does not exceed 180°
- Suppose you are doing multiple measurements and need comparable results. In that case, the camera must be positioned at the exact location and in the same orientation throughout the measurements to avoid deviating results.

Not fulfilling these requirements will lead to a non-homogeneously illuminated field of view and less than 90% uniformity. The easiest way to align the camera correctly is to use the included 4-prong alignment aid (see 3.4) and the optional iQ-Align-XL.

¹A depth of 75 mm has been determined to ensure the highest uniformity for fisheye cameras with an angle of view of 180°. The included 4-prong alignment aid will indicate this depth. For wide-angle cameras with an angle of view smaller than 180°, please see chapter 3.4, "Using the included 4-prong alignment aid."

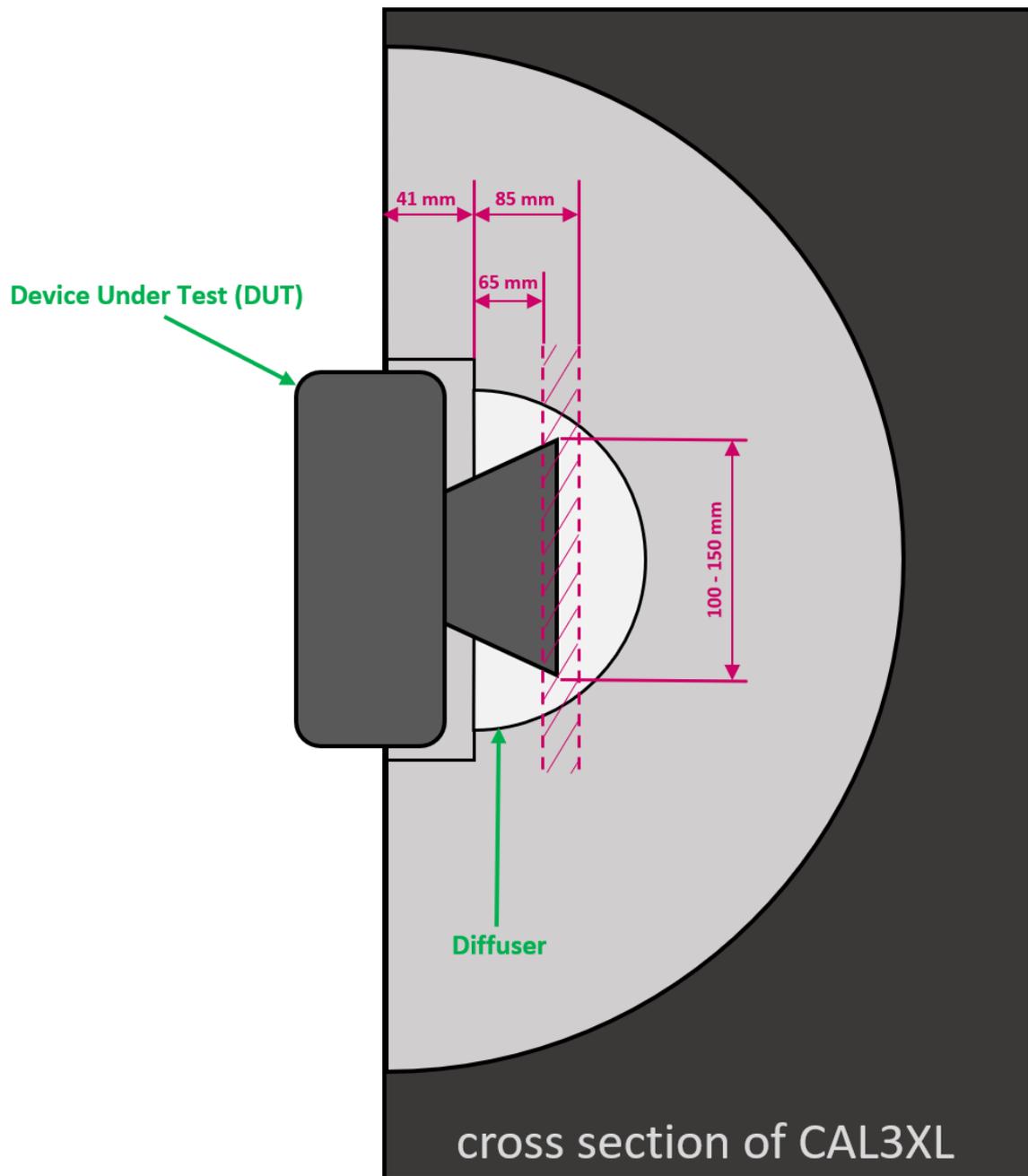


Figure 4: positioning of DUT in front of the CAL3-XL



3.4 Using the included 4-prong alignment aid

The 4-prong alignment aid can set up the DUT (Device Under Test) at the optimal depth inside the diffuser to ensure uniformity above 90% for your measurements. Steps 1 - 5 (Figure 5) illustrate the process and how to position the DUT. The camera in this example uses a circular fisheye lens with an angle of view of 180°. The lens, not the CAL3-XL, creates the visible keyhole effect.

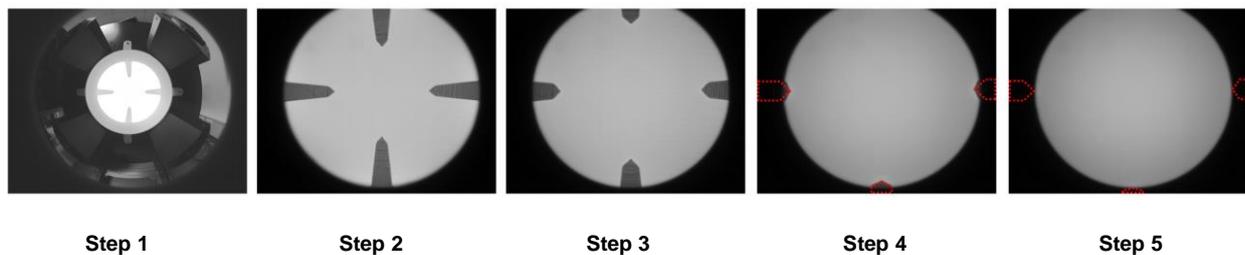


Figure 5: Using the 4-prong alignment aid

Image 1 shows the removable alignment aid mounted on the CAL3-XL from the DUT's point of view. Images 2 through 5 show the DUT moving closer to the optimal depth inside the diffuser.

The illustrated red dotted lines in image 5 show that the correct depth is reached as soon as the four prongs have completely left the frame captured by the DUT. This process works for circular and non-circular fisheye lenses and does not depend on the angle of view of the DUT. What does depend on the angle of view is the necessary depth inside the diffuser to fulfill these criteria. Devices with an angle of view less than 180° do not need a position as deep inside the diffuser as devices with a 180° angle of view.

Suppose your DUT uses a non-circular fisheye lens that diagonally reaches its maximum angle of view. In that case, it becomes necessary to rotate the device around its optical axis so the four prongs are as close to the frame edges as possible.

3.5 Measurement precautions

Ensure the device under test is completely encased in a black housing with only the lens uncovered. If it is not, we advise covering it with a black, non-reflective fabric such as Molton. Covering the DUT will ensure that light from the CAL3-XL will not reflect off the DUT (especially colored devices) and back onto the diffuser, distorting the test results.



4 OPERATING INSTRUCTIONS SOFTWARE

4.1 Requirements

- PC with Windows 7 (or higher) operating system
- One free USB port

4.2 Software installation

Install the iQ-LED control software before connecting the hardware. Follow the setup instructions from the iQ-LED control software manual.

4.3 Starting the system

Start the iQ-LED software by clicking the 'iQ-LED.exe' or the iQ-LED icon on your desktop. Follow the iQ-LED software manual to control the CAL3-XL.

NOTE

The iQ-LED devices can operate with high precision only when setup and calibration are performed correctly.

Consult the iQ-LED software manual for a comprehensive description, and read it carefully.

4.3.1 Spectrometer settings

The iQ-LED software (see iQ-LED software manual) automatically generates the best spectrometer settings for your lighting conditions after pressing the "auto-detect" button. For special applications, it is also possible to set the spectrometer settings manually. If you have further questions, please contact the Image Engineering support team.

4.3.2 iQ-LED calibration

The individual LED lights of the iQ-LED inside the CAL3-XL depend on many different types and wavelengths. Some LEDs will change their intensity level and peak wavelength slightly in the first 500-600 working hours because of a burn-in effect.

The LEDs will also degrade in intensity during their lifetime. To ensure that all measurements including the auto-generated and standard illuminants are correct, you must perform a spectral calibration regularly.

You must also consider the degradation of the LEDs when saving self-defined presets. Suppose you save a preset with LED channels that uses its maximum intensity. In that case, the possibility exists



that this intensity cannot be reached after the burn-in time or the long-time degradation of the LEDs. In this case, you will get a warning message from the iQ-LED control software.

During the first 500-600 working hours, we recommend performing a spectral calibration every 50 operating hours.

After the first 500-600 operating hours, a calibration of every 150 working hours suffices.

Factors that indicate the need for a spectral calibration include unsatisfactory illuminant generation, the aberration of the intensity values, or a spectral curve that does not fit with the predefined standard illuminants of the corresponding preset.

If you run into problems when generating illuminants, please check if:

- The spectrometer works correctly
- The spectrometer settings are correct
- All LED channels work correctly
- The dark measurement is correct
- Your measurement environment is correct
- Your ambient temperature is correct

How to perform the spectral calibration is described in the iQ-LED control software manual.

4.4 Low intensity use

When using your system with very low intensity, the spectral measurement values will start to fluctuate. The lower the intensity, the higher the fluctuation. The generated light is still stable up to a certain point. The fluctuation of the values is caused by the noise of the spectral measurement of the internal spectrometer. The light intensity will continue to get lower when the influence of the noise continues to get higher. When using standard illuminants with an intensity lower than 25 lux, it will no longer be possible to get a correct value.

5 ADDITIONAL INFORMATION

5.1 Maintenance

Your spectrometer comes fully NIST traceable calibrated. The spectrometer requires a recalibration once a year, regardless of the operating hours. Please contact our office for a calibration quotation if a spectrometer calibration is necessary. Use appropriate packaging to prevent the spectrometer from being damaged during shipping.

A temporary replacement spectrometer can be provided to bridge the time gap while your spectrometer is recalibrated. Please contact us for conditions and procedures.

For instructions on removing the spectrometer from your CAL3-XL, see chapter 5.1.1. below.



5.1.1 Spectrometer removal for yearly calibration

To gain access to the spectrometer, remove the four screws securing the maintenance cover to the rear of the CAL3-XL (see Figure 6). Secure the cover with one hand before removing the last screw to avoid it falling off.

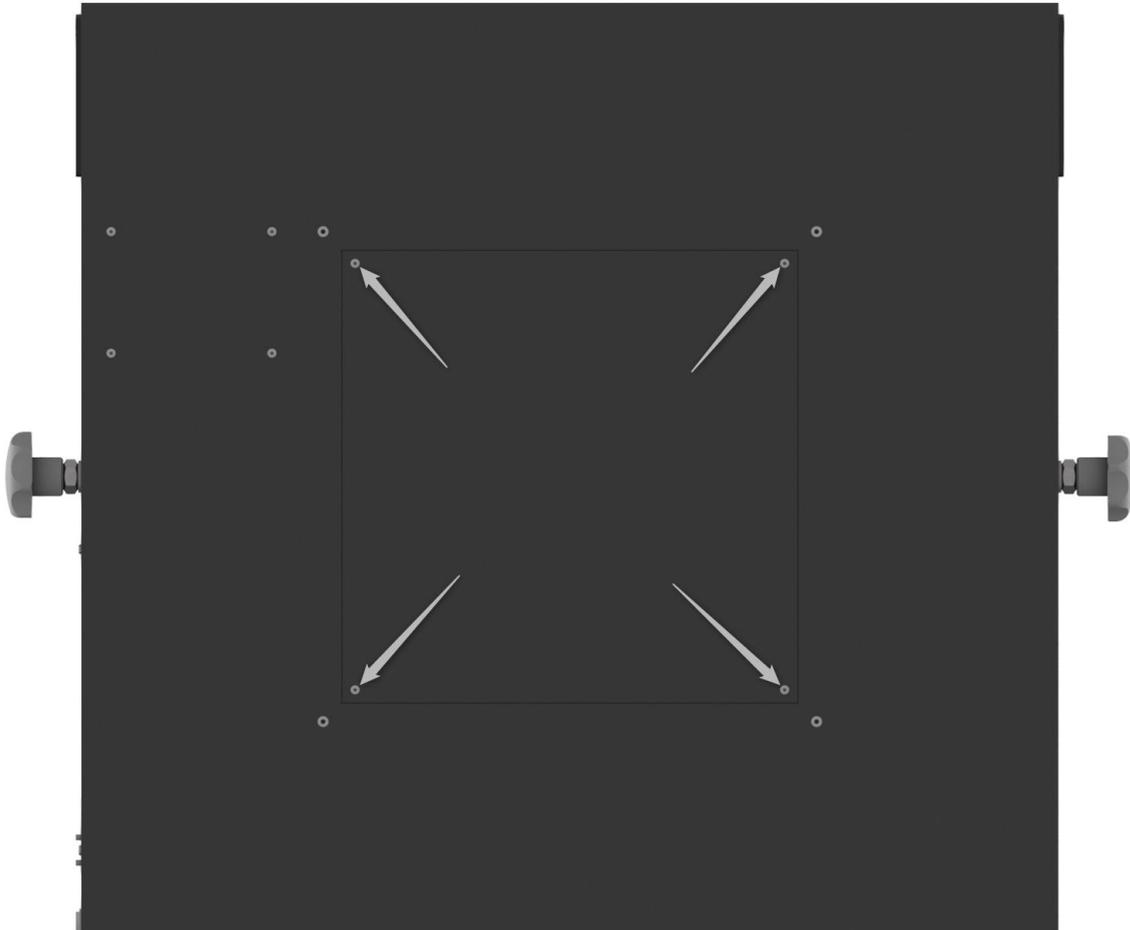


Figure 6: Screws holding maintenance cover in place

When you have removed the cover, you can see that the fiber of the spectrometer is screwed on at the apex of the hemisphere with a knurled nut (see Figure 7). You can unscrew this nut by hand and remove the fiber. If available, protect the end of the fiber with a suitable protective cap. Also indicated in Figure 7 are the mounting points of the spectrometer itself.

You can reach the spectrometer by hand through the maintenance cover. Hold it while you remove the four screws on the top left of the maintenance cover. Now you can remove the spectrometer from the CAL3-XL housing.

Figure 8 shows where the spectrometer is mounted from the inside. Carry out these steps in reverse order to put everything back together after you receive your recalibrated spectrometer.

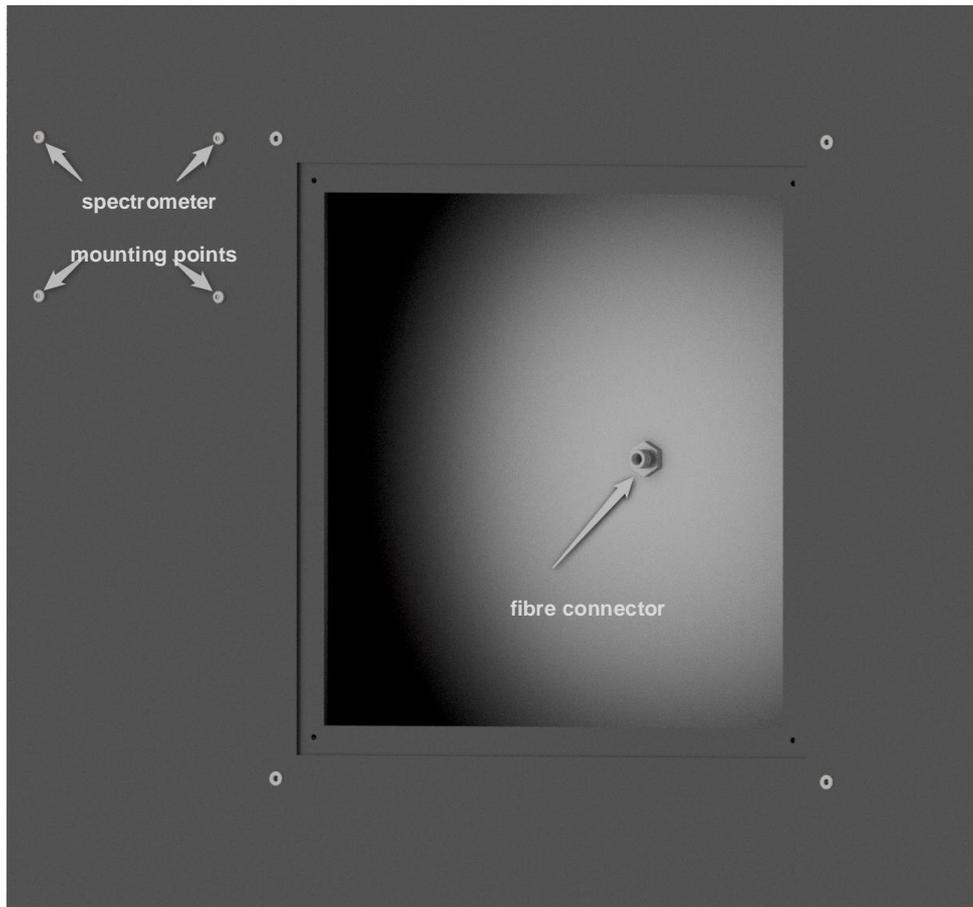


Figure 7: Fiber connector and spectrometer mounting points

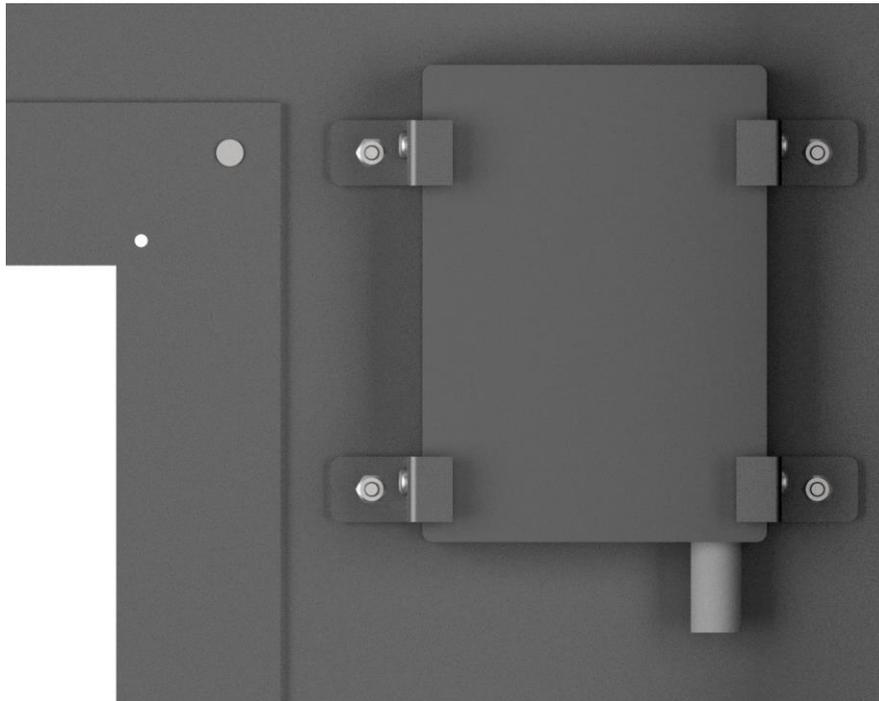


Figure 8: Inside view of the spectrometer

5.2 Care instructions

- Do not touch, scratch, or pollute the diffuser.
- If there is any dust on the diffuser, clean it with an air blower.
- Do not remove the fiber from the spectrometer. Otherwise, the calibration is invalid, and the spectrometer must be **recalibrated!**
- Only store and transport the CAL3-XL in the delivered hard case.

5.3 Disposal instructions

After the service life of CAL3-XL, it must be disposed of properly. Electrical and electromechanical components are included in CAL3-XL. Observe your national regulations and ensure that third parties cannot use CAL3-XL after disposing of it.

Contact Image Engineering if assistance for disposal is required.

6 TECHNICAL DATA SHEET

See annex for the technical data sheet. It can also be downloaded from the website of Image Engineering: <https://image-engineering.de/support/downloads>.