QUSCITE

Ultrawide Field of View TIRF Microscopy

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Product	QUSCITE
Firmware	v1.4.0

INTERHERENCE

HIGH SENSITIVITY MICROSCOPY

Manual

A. Important first words

Welcome to the QUSCITE Microscope Illumination System manual. We are delighted that you have chosen our device. The QUSCITE plug-and-play system offers an exceptionally wide field of view with Total Internal Reflection (TIR) waveguide-based illumination, providing researchers and institutes with a powerful tool for their scientific investigations. This manual serves as your comprehensive guide to understanding and utilizing the QUSCITE system effectively. Whether you are a beginner or an experienced user, we have carefully crafted this manual to assist you in effortlessly installing, operating, and maintaining the QUSCITE system.

Before operating the QUSCITE system, we urge you to thoroughly read this manual to ensure safe and optimal usage. The safety of users and the protection of the device are of utmost importance to us. By carefully following the instructions and guidelines provided herein, you can confidently explore the extensive capabilities of the QUSCITE system.

If you have any questions regarding the installation or operation of the device or if something feels amiss during the process, we encourage you to promptly contact our dedicated representatives. Our team of experts is readily available to provide assistance and ensure that your experience with the QUSCITE system is smooth and successful. Your feedback and inquiries are valuable to us as we strive to deliver outstanding customer support:

INTERHERENCE GmbH

Henkestr. 91

D-91052 Erlangen Germany

E-Mail supportinfo@interherence.com

Phone +49 9131 9232 750

B. Warning Symbols

For your safety when using the QUSCITE, it is important to familiarize yourself with the warning signs and symbols included in this manual.

	Notice! Please read this carefully. Special instructions and or circumstances are indicated.
	Warning! This situation and/or condition might damage property or equipment and lead to poor technical performance.
	Caution! Special attention is required. The situation could result in minor to medium injury. Refer to the manual.
	Electrical danger! The situation and/or condition might cause minor to medium injuries.
	Attention! Observe precautions for handling electrostatic-sensitive parts.
	Caution! Laser radiation hazard is present. Avoid direct exposure to laser beams.
	Warning! Handle fragile components with care to avoid breakage or damage.
	Danger! Special attention is required. The situation could result in severe personal injury or death if security advice is not followed.

While reading this manual, carefully observe these signs and symbols, as they are designed to guide you in operating the system safely.

C. Receiving and Unpacking

When you receive the QUSCITE System, it is crucial to follow these steps to ensure a successful setup and avoid any potential issues:

1- Inspect the packaging for damage and verify all components are included.

2- Find a clean area and carefully unpack the system, noting any "Fragile" labels.

3- Check each component against the packing list for completeness and inspect for any damage or missing parts.

4- Review the user manual and accompanying documentation for safety instructions and operational procedures.

By following these steps, you ensure a smooth unpacking process and are ready to proceed with the installation and setup of the QUSCITE. Contact our customer support if you encounter any issues or have questions.

Your system includes:

Item	Quantity
QUSCITE Control Unit (CU)	1
Light Coupling Unit (LCU)	1
Microscope adapter (MA) *microscope specific	1
Chip Carrier Base (CCB)	1
Chip Carrier (CC)	2
Substrate care kit	1
Flow cell starter kit	1
Reservoir starter kit	1
USB Type C cable (2 m)	1
SMA trigger cable (2 m)	2
Power supply unit (AC 90 -264 V, DC 12V, 9.2 A)	1
Power cable *country-specific	1

Proper handling and care during the unpacking process are crucial to prevent any damage to the components. Avoid dropping or mishandling the system components to ensure optimal performance.

D. Important Product Safety Information

To ensure safe and proper use of this product, please read and follow all safety instructions carefully. Failure to adhere to these guidelines may result in injury, product damage, or voiding of the warranty.

D.1. General Safety

Ensuring safety is crucial when using the QUSCITE System. The QUSCITE is designed in compliance with international regulatory design and safety standards, as outlined on the device and in this manual. These standards are upheld only when the system is operated in accordance with the guidelines provided here.

- Grounding:

  Ensure proper grounding is established before connecting the QUSCITE system to a power source. Adequate grounding safeguards against electrical hazards and ensures the device operates safely and effectively.

- Restricted Access:

  Do not attempt to open or modify the internal components of the QUSCITE system. Opening the device can result in electric shock, damage, or void of the warranty. For maintenance or service, contact authorized personnel.

- Power Supply:

  Connect the QUSCITE system to a power source that meets the specified voltage and current requirements. Using an incorrect power supply can cause device malfunction or pose a safety risk. Refer to the manual for accurate power specifications.

- Environmental Considerations:

  Operate the QUSCITE system in a clean and controlled environment. Exposure to excessive dust, moisture, or extreme temperatures may adversely affect device performance. Maintain an appropriate environment.

- User Training:

  Ensure all users receive comprehensive training on operating the QUSCITE system. Adequate training enhances user understanding of features, functions, and safety precautions, promoting safe and effective operation.

- Equipment Compatibility:

Use only accessories and components recommended by our company. Incompatible accessories may compromise device functionality or safety. Utilize approved accessories outlined in the manual.

D.2. Laser Safety

The QUSCITE System incorporates laser diodes, offering single-mode, fiber-coupled lasers at various wavelengths, which utilize Laser Class 2.

WARNING	
	**LASER CLASS 2**
	Do not stare into the beam

These lasers emit visible light and pose a moderate eye and skin injury risk. Avoid direct exposure to the laser beams and follow laser safety precautions.

Always prioritize laser safety precautions when working with the QUSCITE system's laser diodes. Laser beams can potentially harm the eyes and skin. To ensure safe operation, please adhere to the following laser safety guidelines:

Ensure the laser beams stay within the designated optical path and avoid unintended exposure outside the system.

Power off the laser diodes when not in use or during maintenance procedures. Follow the recommended shutdown procedures outlined in the manufacturer's documentation.

Pay attention to any warning labels or signage affixed to the QUSCITE system regarding laser safety. Follow the instructions and take necessary precautions accordingly.

D.3. Safety Features

The QUSCITE system features an enclosed design to prevent accidental exposure to internal components. It is crucial never to open the system enclosure. Opening the system without proper authorization and expertise may damage the equipment, void the warranty, and compromise safety.

Opening the system enclosure by unauthorized personnel may lead to exposure to hazardous laser radiation, electrical shock, and other safety risks. Contact our authorized service representatives for any necessary maintenance or repairs.

QUSCITE system is equipped with safety interlocks that ensure laser emission only occurs when all necessary components are properly installed and secured. These interlocks help to prevent accidental laser exposure and ensure safe operation.

Do not attempt to bypass or tamper with the safety interlocks. Doing so may result in hazardous laser emissions and compromise the safety of the user and the surrounding environment.

The QUSCITE system is labelled with prominent safety signs and warning labels to provide important safety information and instructions. These labels are strategically placed to alert users to potential hazards and precautions.

Pay close attention to the safety labels and signs on the QUSCITE system. They provide essential information on safe operation, laser hazards, and potential risks. Always follow the instructions and take necessary precautions as indicated

D.4. Safety Labels and measures

The location of the safety labels on the device is shown in Figure 1. Safety labels are located on the rare panel of CU and at the back lid of the CU.

Figure 1: The laser safety labels can be found on the front panel of QuScite CU (left image) and on the back lid of CU (right image)

D.5. Safety Label translations

Label	English	German	Japanese	Chinese
Laser radiation (1)	Do not stare into the beam Class 2 laser product	Nicht in den Strahl schauen Laser-Produkt der Klasse 2	ビームを凝視しないでください クラス2レーザー製品	请勿凝视光束 2 级激光产品

D.6. Maintaining IEC/CE/CDRH Safety Compliance

We tested QUSCITE and its components for our customers according to IEC directives 61010:2010, 61010-1:2010/AMD1:2016, 61010-2-010:2014, and IEC 61010-2-201:2017. Additionally, your device was tested according to FCC 47 CFR Part 15 and

ICES-003. Accordance with the above-mentioned directives was assured by SGS Belgium NV under CB certificate no. BE-37507/A1.

Figure 2: CE marking.

E. Legal regulations

This section outlines the legal regulations and compliance requirements applicable to the product. Please ensure that all usage complies with local laws and standards to avoid any legal or operational issues.

E.1. WEEE Compliance

INTERHERENCE GmbH is a registered supplier according to the Waste Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU. The crossed-out waste bin symbol on the control unit indicates that this electrical or electronic device must be collected separately and should not be mixed with regular waste or on a public waste disposal site. The specifics for the collection of electrical and electronic waste vary in each EU country. Reuse, recycling, and other forms of recovery are encouraged to reduce the negative impact on the environment. INTERHERENCE will help you find the correct way to dispose of our products upon request. Potential negative effects on human health and the environment could arise from inappropriate waste handling. Please be advised that it is the responsibility of the customer to delete any personal data that may be stored on the device.

Figure 3: WEEE symbol according to directive 2012/19/EU.

INTERHERENCE and its distribution partners offer compliance with the Waste Electrical and Electronic Equipment (WEEE) Directive for all end users in the European Union the option to return defect or ‘end of life’ VAHEAT systems for disposal exempt from charges. This service holds true for parts that fulfil the following:

- marked with the crossed-out waste bin according to Figure 3
- sold to a company or institute within the EC
- currently owned by a company or institute within the EC
- still complete, not disassembled, and not contaminated.

As the WEEE directive applies to self-contained operational electrical and electronic products, this "end of life" take-back service does not refer to other INTERHERENCE products, such as

- components
- mechanics
- leftover parts of units disassembled by the user
- disposables (e.g. QuChips, reservoirs)

INTERHERENCE GmbH is a registered supplier according to §9 VerpackG under the number DE2436146393164.

For disposal in countries outside of the European Union

The symbol in Figure 3 is only valid in the European Union (EU). If you wish to discard this product, please contact your local authorities or dealer and ask for the correct method of disposal.

E.2. ROHS Compliance

The RoHS directive 2011/65/EU affects manufacturers, sellers, distributors, and recyclers of electrical and electronic equipment containing materials such as lead, mercury, cadmium, chromium (IV), polybrominated biphenyl (PBB), and polybrominated diphenyl ether (PBDE), bis(2-ethylhexyl) phthalate (DEHP), benzyl butyl phthalate (BBP), dibutyl phthalate (DBP), diisobutylphthalate (DIBP). Since July 1, 2006, these materials have been severely restricted in most electrical and electronic products sold in Europe.

Figure 4: RoHS compliance according to EU directive 2011/65/EU.

All INTERHERENCE GmbH products are fully RoHS compliant, and a declaration of RoHS compliance is available upon request. If you have questions regarding the RoHS compliance of our products, please contact us, or your distributor.

F. Standard Units and Abbreviations

API	Application Programming Interface
CC	Chip Carrier
CCB	Chip Carrier Base
CU	Control Unit

LCU	Light Coupling Unit
MA	Microscope Adapter
RoHS	Restriction of Hazardous Substances
SMA	SubMiniature version A
TIRF	Total Internal Reflection Fluorescence
WEEE	Waste Electrical and Electronic Equipment

G. Copyright Information

INTERHERENCE GmbH

Henkestr. 91

D-91052 Erlangen

Germany

support@interherence.com

1. Introduction

Thank you for purchasing the QUSCITE system!

QUSCITE has been designed, focusing on functionality, precision, and reliability for TIRF microscopy. Its exceptional wide field of view, great SNR and ability to image with air objectives empowers you to achieve unprecedented control in your measurements. We are confident that the QUSCITE system will meet and exceed your expectations.

1.1. Functional principle – waveguide TIR-based excitation

Total Internal Reflection Fluorescence (TIRF) Microscopy is a powerful optical imaging technique used primarily in biological sciences to observe events at or near the cell membrane with high spatial resolution and minimal background fluorescence. The key principle behind TIRF is total internal reflection, which occurs when light traveling through a medium with a higher refractive index (like a coverslip glass) hits the interface with a medium of lower refractive index (like water or cell cytoplasm) at an angle greater than the critical angle. This results in an evanescent wave that extends only about hundreds of nanometres into the lower refractive index medium, selectively exciting fluorophores in this thin region.

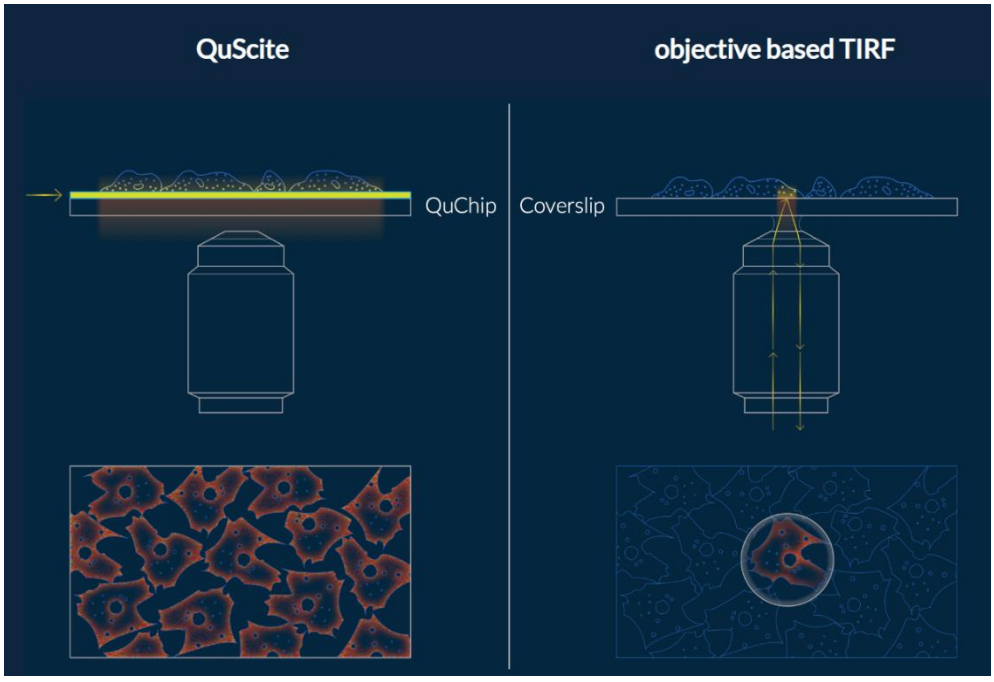


Figure 5: Sample illumination by QUSCITE (left) is different from the objective-based TIRF (right).

Your QUSCITE system employs waveguide-based TIRF, differing from conventional prism or objective-based TIRF setups by how the light is delivered to generate the evanescent wave in the sample. A comparison between the illumination concept of the QuScite and the objective based TIRF is shown in Figure 5. The waveguides are built into the QuChip, which replaces the traditional coverslip glass. This design, in combination with the QUSCITE system, separates the excitation and detection paths,

leading to a higher signal-to-noise ratio, shorter integration times, lower bleaching rates, and reduced phototoxicity.

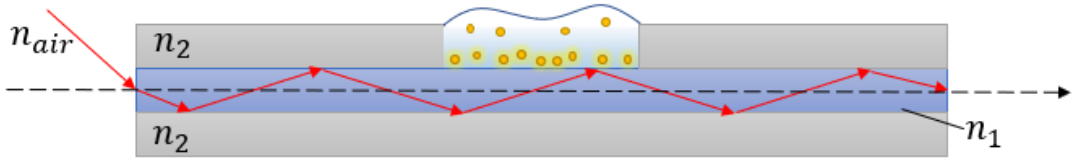


Figure 6: Image of waveguide TIRF excitation scheme of coupling with a laser through a grating.

Figure 6 shows a simplified scheme of the confined laser light propagating in the QuChip waveguide layer and generating the evanescent light at the sample area. The excitation light remains confined within the waveguide, limiting sample penetration to around 90 nm, while still offering an ultra-wide field of view, illuminating areas of several square millimeters. Since the illumination is integrated into the QuChip, your system provides intrinsically calibrated TIRF and is compatible with both commercial microscopes and custom setups.

2. System description

This section describes the QUSCITE as a main operational unit and its main components.

2.1. Parts identification

2.1.1. The control unit (CU)

QUSCITE Control Unit (CU) is the main operational system. This unit allows to operate the illumination and set parameters for your experiment. Control unit panel includes a front touch screen display and touch screen sensitive wheel. On the rear panel of the CU all necessary connections are located, including power button, power port, LCU cable, VAHEAT in, trigger in/out, USB C port and FC/APC port, see Figure 7.

Figure 7: CU front panel (left image), CU rear connector panel (right image).

2.1.2. Light coupling unit (LCU)

The Light Coupling Unit (LCU) is a component that provides the laser lights to the QuChips. It is connected to the CU via a flexible cable. An image of the LCU and its cable is shown in Figure 8. The LCU has a window through which laser emission occur across all available wavelengths. LCU contains a beam steering unit to ensure even illumination across the entire width of the waveguide. LCU attaches to the Chip Carrier Base (CCB) using magnets to hold it firmly in position.

Figure 8: Light Coupling Unit (LCU)

2.1.3. Chip Carrier Base (CCB)

The chip carrier base (CCB) is the base plate where the LCU is mounted with magnets. It also holds the chip carrier (CC), housing a QUCHIP shown in Figure 9. Together with LCU, CCB forms the smallest possible footprint, which is needed to accommodate QUSCITE on your microscope.

Figure 9: Chip Carrier Base (CCB) with the Chip Carrier (CC) and QuChip mounted on top

2.1.4. Microscope Adapter (MA)

This essential component facilitates the seamless attachment of your QUSCITE to the microscope stages of various commercially available microscopes, including 2D stages, piezo stages, stage top incubators, and more. CCB is mounted on MA. Microscope adapter allows tilt adjustment and incorporates tilt adjustment screws. Please contact us so that we can provide you with the correct version of the microscope insert, suitable for the stages of the microscope at your facility.

Figure 10: Microscope Adapter (MA)

2.1.5. Chip Carrier (CC)

The CC chip carrier is a metal frame designed to hold the QUCHIP in place and safeguard it throughout your workflows. It also allows for easy handling and fast swapping of samples by either locking or unlocking the sliding key as shown in Figure 11. By firmly securing the QUCHIP, the chip carrier ensures optimal conditions for high-quality imaging and reproducible results.

Figure 11: Chip carrier opened (left), chip carrier closed (right).

2.1.6. Parts Assembly Illustration

In Figure 12 an image LCU, CCB, CC, and MA is shown where they are all come together to complete the QUSCITE system.

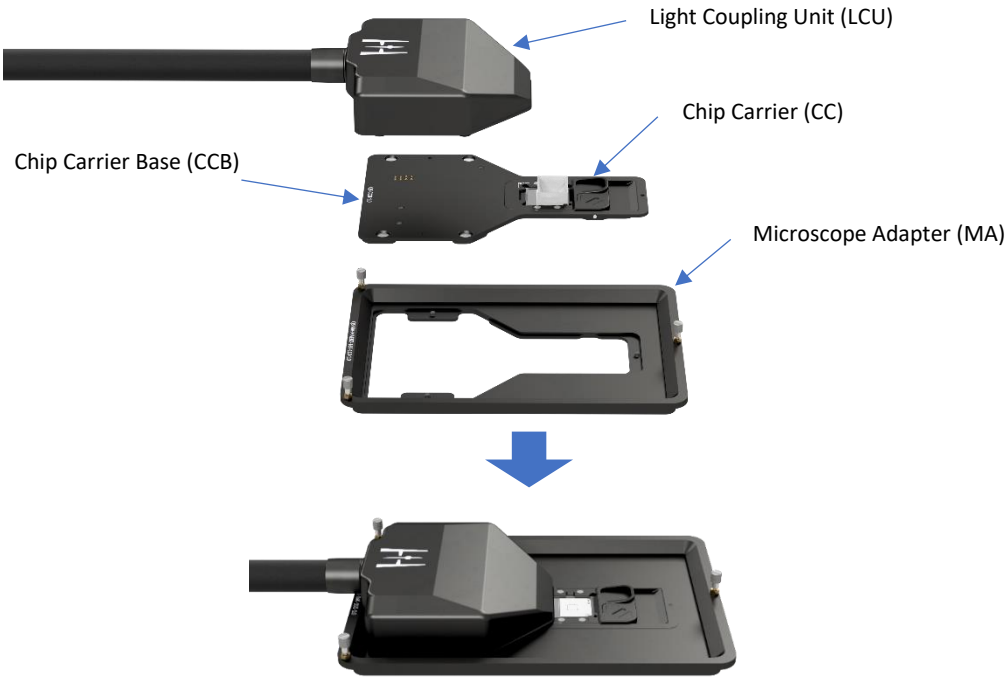


Figure 12: image of LCU, CCB, MA, and CC assembled together.

2.2. QUSCITE configurations

Standard QUSCITE includes 640 nm, 561 nm, and 488 nm illumination opportunities. Upon request, an additional functionality upgrade is available, which incorporate 405 nm laser modules. In addition, there a possibility to purchase a “Booster Box” which

provides higher power lasers if more photon energy density is needed for your imaging experiments.

2.3. Consumables

2.3.1. QUCHIP

These chips replace the coverslip in a microscope setup and contain multiple thin film optical waveguides that support a guided mode with a strong evanescent field tail entering the sample volume at well-defined depths. The scheme of the QuChip is shown in Figure 13 and indicates all the important regions of the chip.

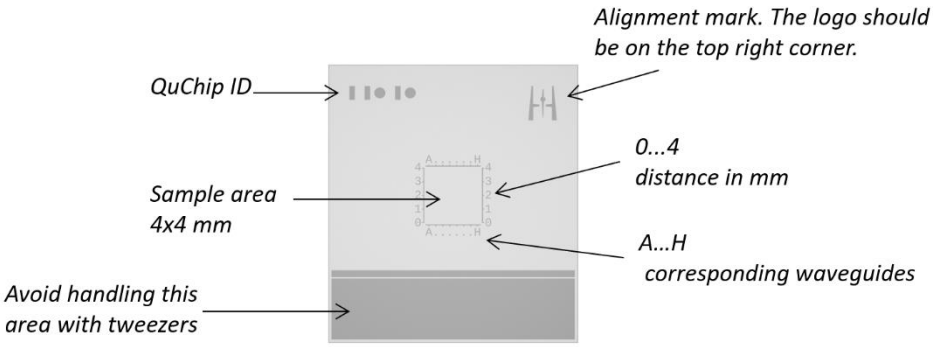


Figure 13: QuChip Top view

QuChips are multi-use substrates for your experiments. They can be cleaned and used again (up to 5-7 times). QuChips come in different types, depending on the application and QUSCITE version in use.

QuChips are ordered separately.

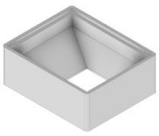
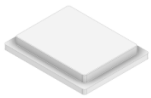
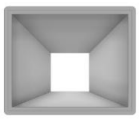
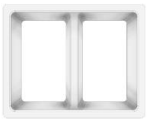
Specifications of the QuChip are listed in the table below.

Top material	SiO_2
Base material	Borosilicate glass (SCHOTT D 263®)
Size	18x20 mm^2
Thickness	170 µm
Number of waveguides	8
Compatible wavelength* *standard QuChip	488 nm 561 nm 640 nm
Sample area	4 x 4 mm
Surface roughness	< 2 nm
Maximum temperature	80°C
Usage	Multi-use

Storage	Store in the box in the cool, dry, and dust-free place

2.3.2. Reservoirs

We also offer different silicon reservoirs. Below are the types of reservoirs available.

	Small volume	Dual chamber	Large volume	Lid for reservoirs
Side view				
Top view				

The reservoirs can be mounted on top of the QuChips as shown in Figure 14.

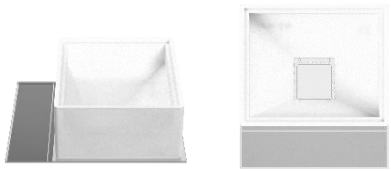


Figure 14: QuChip with reservoir mounted on top.

Reservoirs are ordered separately.

2.4. Technical specifications

General and environmental specifications

Qualifications	CE, FCC, RoHS compliant
DC input	24 V DC, <0.5 A
Overvoltage category	CAT I
Power consumption	<12 W
Remote control	Yes
WIFI	Yes
Operating temperature range	15 - 40 °C
Storage temperature range	-10 - 60 °C
Operating relative humidity	non-condensing, <80%
Water/Dust resistance	IP31/Type 2 Enclosure
Maximal altitude	2000 m
Pollution degree	2
Dimensions CU, mm^3 (WxLxH)	185 mm x 155 mm x 110 mm
Weight CU, g	without LCU: 2960 with LCU: 3440

3. System Installation

This chapter will guide you through proper installation of the QUSCITE system. Follow the step-by-step instructions below for a successful system installation.

When planning the installation of your system please consider that QUSCITE is a sensitive laboratory device. Avoid environments with strong mechanical vibrations, excessive dust, high moisture content, and extreme temperatures. Place the control unit on a flat and dry surface before operating.

No flammable materials should be in close contact with any part of the device.

Connect all necessary components to the control unit before turning QUSCITE on.

Do not operate QUSCITE unattended.

3.1. Integration into your microscope

Follow the below steps to integrate QUSCITE into your microscope.

a. Position the Control Unit (CU) near the microscope setup in a convenient location. Ensure it is easily accessible for monitoring and controlling the system during operation.

b. Place microscope adapter (MA), which is designed to provide compatibility between your microscope and the QUSCITE system. The microscope adapter serves as the foundation for mounting the light coupling unit (LCU), Chip Carrier Base (CCB), and Chip Carrier (CC). By using the adjustment screws of the microscope adapter, any possible tilt of the plate can be corrected.

c. Position the LCU on top of the microscope adapter, aligning it with the designated mounting area. The LCU is held to the adapter via small magnets. Ensure that the magnets align properly to create a stable connection.

Do not open the control unit. The opening will void the warranty and might put you or your surrounding in electrical danger.

3.2. QUICK START GUIDE

To quickly begin using your product, follow these simple setup instructions.

1. Connect the power supply unit to the control unit.

Use only the supplied power supply unit. Doing otherwise voids the warranty and might result in danger to you or your surroundings.

2. Turn QUSCITE on by pressing the power button on the rear panel. The device will automatically recognize if all the elements such as LCU and CC are positioned correctly.

3. Take the QuChip, insert it in the CC and place CC in the CCB.

4. Press DETECT CHIP button in the main menu. Press CONFIRM to initiate the procedure. The system starts to scan the QuChip, it might take a while.

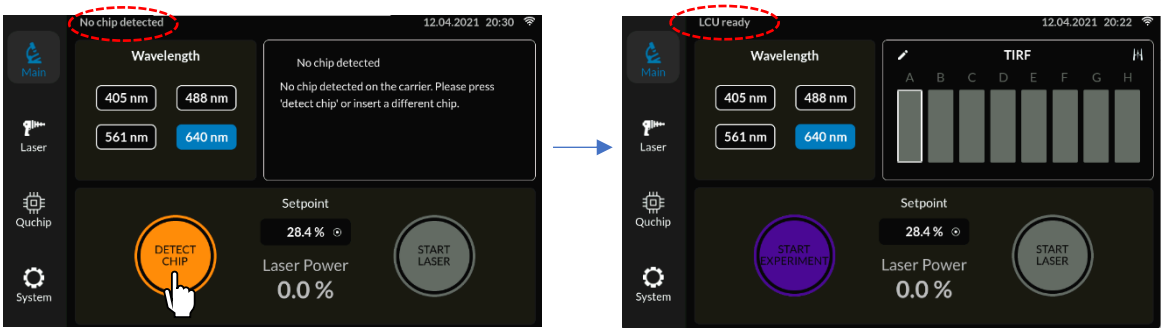


Figure 15: Once the LCU, CCB, and CC are connected correctly the system is ready to detect the chip. Press "DETECT CHIP" to initiate the detection. When the chip is successfully detected, the LCU is ready for your experiment.

5. Once aligned, the system is ready to use. On the main panel you can choose the waveguide from A to H, the laser wavelength and power in %. START LASER button will allow the laser emission and START SEQUENCE button will implement the sequencing, if it was uploaded (described in section 4.3.1).

6. Align your microscope setup: with the help of the XYZ stages of your microscope, you now may find your region of interest (illuminated waveguide) and start imaging!

Inspect your QuChip before usage and ensure that the chip surface is clean and does not contain any dust or particles.

Do not touch the QuChip with bare hands! Wear gloves and handle them with tweezers accurately.

4. Operating The Quscite

4.1. Chip loading and swapping

To insert the chip in the chip carrier, open the lock of the chip carrier, place the chip inside using tweezers, and lock back the chip carrier. Chip has to sit in the holder and be blocked by all four sides:

1. Unlock the chip carrier key, granting access to the chip loading area.

2. Take QuChip and carefully place it in the chip carrier (CC). The correct orientation of the QUCHIP relative to the chip carrier is shown in Figure 16. Lock the chip into place by securing it from the bottom as shown in the 1st step of Figure 17. Once the chip is appropriately situated, carefully re-engage the chip carrier lock, effectively securing the chip within the carrier.

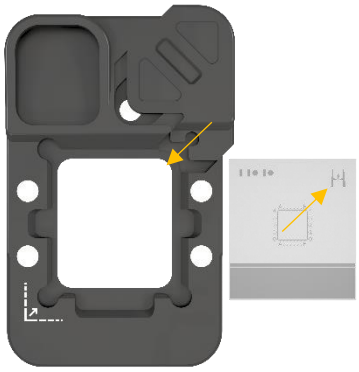


Figure 16: The correct orientation of the QUCHIP on the CC is such that the Interherence logo is on the top right side where the sliding key is located.

3. Install the chip carrier with the chip onto the designated area of the LCU as shown in the 2nd step of the Figure 17. The chip carrier will be secured under the LCU via magnets. If the chip carrier is installed correctly the plane of the chip carrier is parallel to the plane of the microscope adapter.

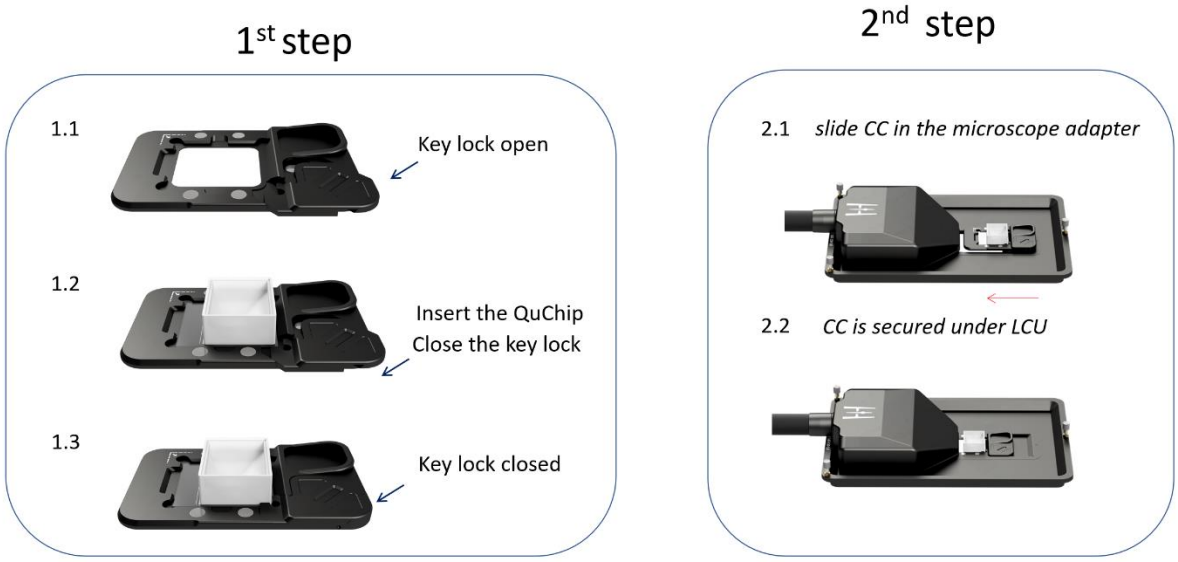


Figure 17: The 1st steps demonstrates the change/swap of QUCHIPs on the chip carrier. The 2nd step shows how to mount the chip carrier on the microscope adapter.

Note: It is important to make sure the chip fits in the holder and supported well on all four sides of the chip carrier. The QuChip shall not be pressed inside or inserted with any other additional force. This way, it stays stable and aligned perfectly during experiments. You can easily switch between different QuChips while keeping your experiments consistent and accurate.

4.2. Illumination and waveguide selection

The QUSCITE system incorporates a scientifically advanced waveguide selection and illumination mechanism to facilitate precise control and optimization of experimental setups.

4.2.1. Illumination selection

To choose the desired illumination, please select in the main menu laser wavelength in the Wavelength window as show in the Figure 18. This windows shows all the wavelengths that are installed on the QUSCITE system. Confirm the selection in the popped-up confirmation window.

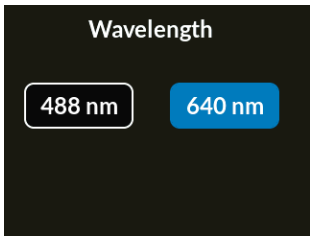


Figure 18: You can change the illumination wavelength from the main menu. Depending on the QUSCITE system, you will see the available wavelengths.

4.2.2. Waveguide selection

To initiate the waveguide selection process, navigate to the main interface where the QuChip has been successfully detected and assigned. Within this interface, you can conveniently select the desired waveguide by pressing on QUCHIP TIRF window which is located on the right side of the screen of the main menu as shown in Figure 19.

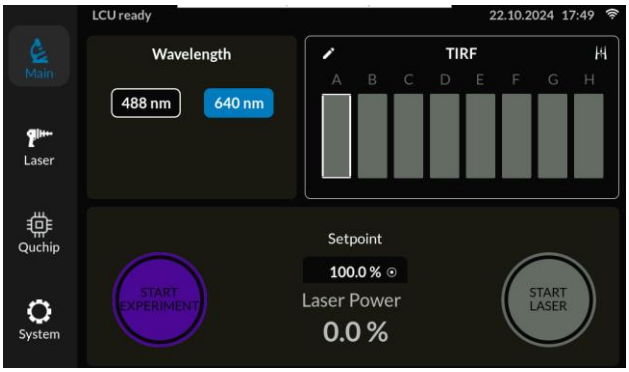


Figure 19: On the main menu you can select the waveguide on the top right side of the screen

The window of waveguide selector will pop up, using the touch sensitive wheel, select the waveguide and press CONFIRM, see Figure 20.

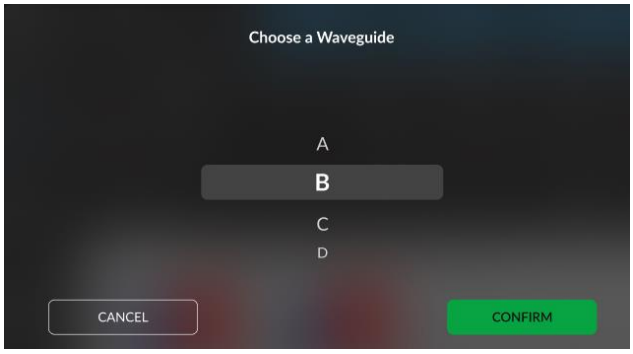


Figure 20: Waveguide selection panel. Use the touch sensitive wheel to select a waveguide and press CONFIRM.

Upon selecting a waveguide, the QUSCITE system automatically adjusts its positioning to ensure accurate alignment. To provide visual feedback, the chosen waveguide is visually highlighted with a distinct white line.

Once the waveguide is successfully chosen and positioned, you can proceed to activate the laser illumination with round START LASER button. You can also start a specific experiment or sequence by choosing START EXPERIMENT shown in Figure 21. For this, the experiment or sequence must have already defined and loaded, see 4.3.1 and 4.3.2.

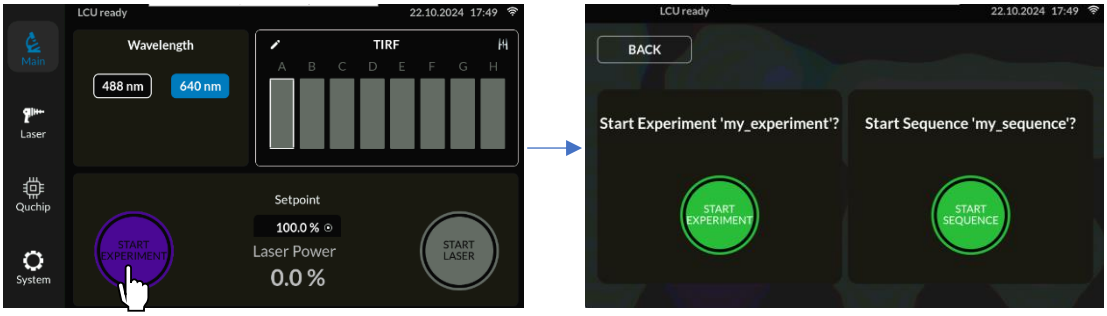


Figure 21: By choosing "START EXPERIMENT" you can start an already defined experiment or sequence.

Note: For an optimized illumination, please adjust the “Camera exposure time” in the laser setting based on your camera exposure time, see laser setting in section 4.3.

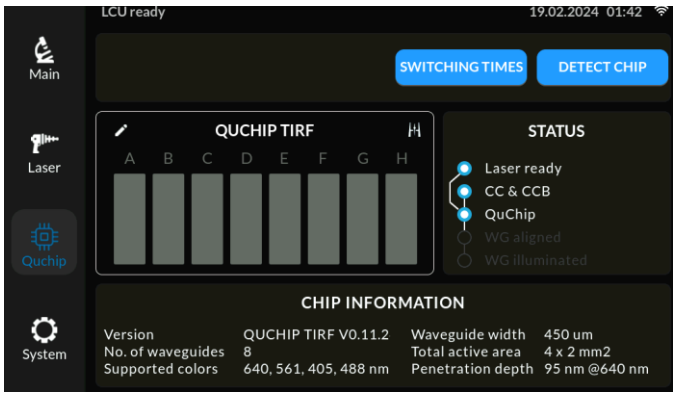


Figure 22: QuChip properties and device status bar on the QUCHIP page.

Safety precautions: Always prioritize safety when operating lasers. Avoid direct eye exposure to the laser beams and wear appropriate eye protection if necessary. Adhere to the safety guidelines provided to ensure the safe operation of the system.

Alternative option for waveguide selection is provided in the QuChip page in the main panel. Status bar shows the status of the alignment and illumination of the waveguides shown in Figure 22, QUCHIP TIRF bar shows the available waveguides for selection.

4.3. Laser settings

The laser page in the main menu selection allows to modify the illumination, offers trigger options and colour sequencing.

To choose and `change the laser setting, press on the corresponding button as shown in Figure 23.

The following options can be configured in the laser settings.

- **Feedback: ON/OFF** –enables or disables the feedback.
- **TRIGGER:** This function allows to control the laser with trigger in 3 different modes**:** DISABLED, MASTER, SLAVE.
- **LASER INTENSITY/Sequence** plots the laser intensity vs time / shows the current loaded colour sequence
- **SEQUENCE EDITOR** Menu for editing/ creating colour sequences described in details in section 4.3.1
- **Camera exposure time:** to synchronise the laser illumination with your microscope, please enter the camera exposure time of your imaging system.

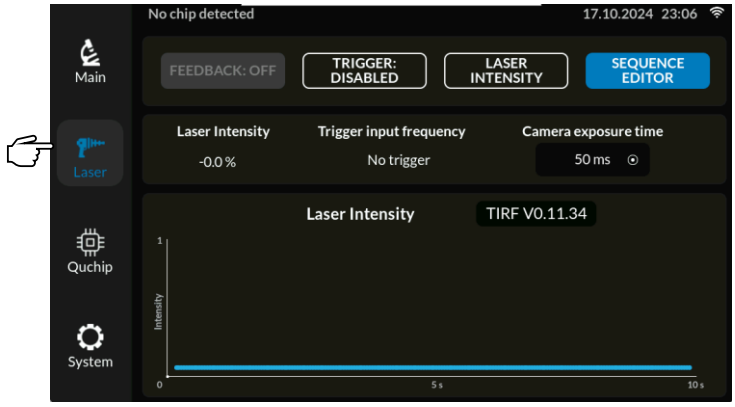


Figure 23: Laser settings.

In the QUSCITE system, the scanning illumination technique is employed to illuminate the waveguide. To ensure accurate data acquisition, it is important to synchronize the laser scanning with the frame acquisition of your camera.

You can conveniently configure the settings on the laser page interface to achieve this synchronization. Specifically, you can enter the desired camera exposure parameters in this section.

By synchronizing the laser scanning with the camera's exposure period, you can minimize artefacts, motion blur, or misalignment in the captured images or video sequences. This synchronization ensures that the laser illumination and the camera's frame acquisition are precisely aligned, resulting in high-quality and accurate imaging data.

4.3.1. Sequence editor

Sequence editor or colour sequencing allows you to define and customize sequences of laser colours for your experiments. With this you will be able to define a sequence to choose which waveguide (sample area) is illuminated, the colour (laser wavelength), the laser intensity and the illumination duration. Simply select the desired colours and set the desired timing for each colour in the sequence. Once configured, the QUSCITE device will automatically cycle through the defined colours in the specified order and timing. This feature enables you to easily switch between different laser colours and create dynamic illumination patterns tailored to your experimental needs.

By following the steps below you can set your sequence:

1. Go to “Laser” settings
2. Choose “SEQUENCE EDITOR”
3. Here you can choose if you want to edit an experiment “EXP EDITOR” or edit a sequence “SQ EDITOR”
4. Once the “SQ EDITOR” is selected, you can select on the sequence name “UNTITLED.SQ”
5. Now you can either select an already existing sequence to be edited/loaded or create a new sequence by choosing “CREATE NEW”
6. Now you can add or remove steps from your sequence using “+” and “-” icons. On each step you can define the following parameters. Choose each parameter and change the parameter value using the control unit touch sensitive wheel.
    - Waveguide, which defines the waveguide that is illuminated
    - Colour, defines the illumination wavelength
    - Intensity, defines the illumination intensity as percentage of the maximum possible illumination
    - Duration, which defines the time duration that the illumination lasts
    - Pause, which is the pause before executing the next step
7. If the values for the “Pause” is highlighted with orange colour, that means the assigned pause time is shorter than what QUSCITE needs before executing the next step. The pause time needs to be increased until it is accepted by QUSCITE and the pause time value turns to a white colour.
8. Once your sequence is defined, you can “Save” it.
9. Give your sequence a name and save.

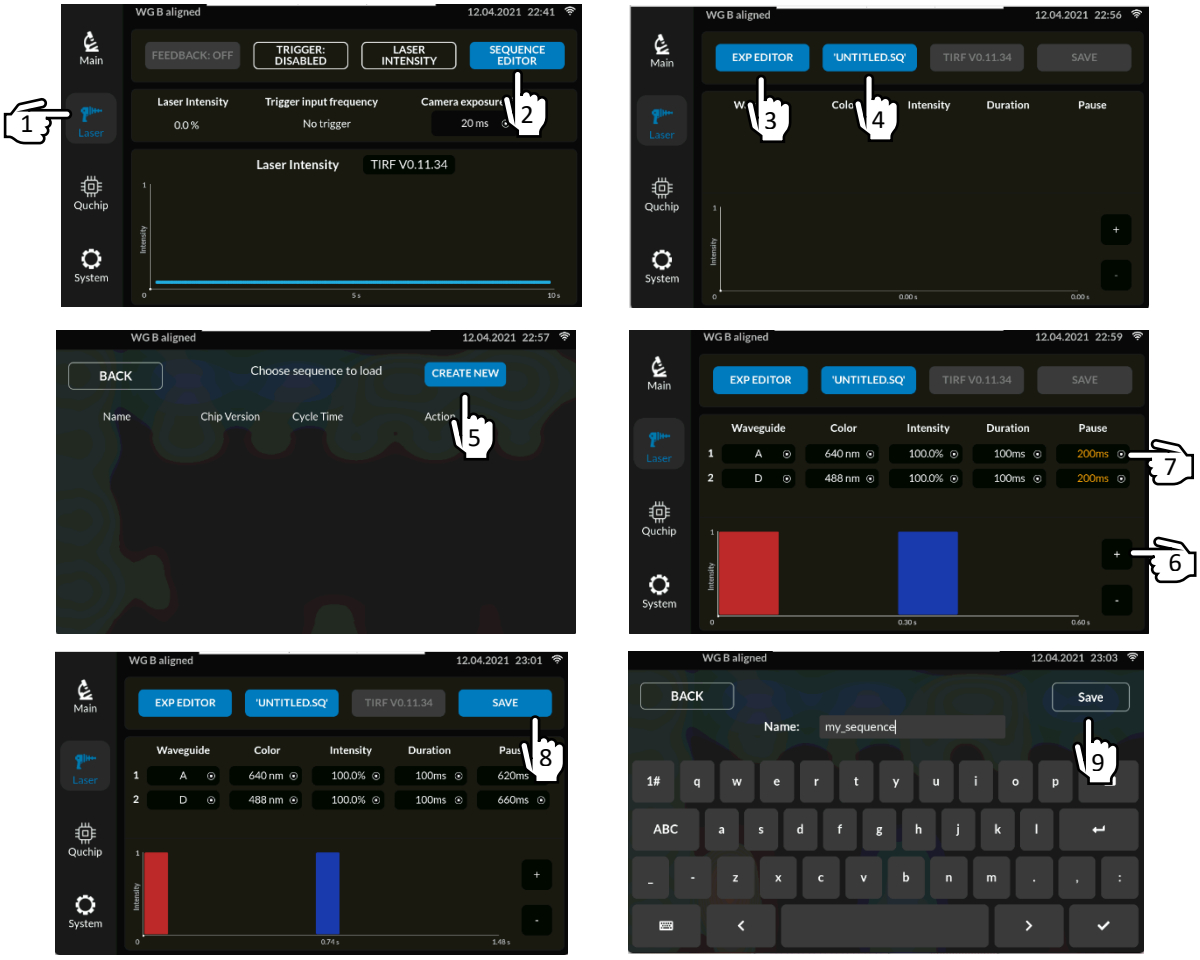


Figure 24: The steps required to define a sequence using the sequence editor of the QUSCITE.

After defining and saving your sequence, your sequence can be executed or it can also be used to edit an experiment which is explained in the next section.

4.3.2. Experiment editor

The experiment editor allows you to combine several sequences and define the repetition times for each sequence and pauses between the sequences. Configuring an experiment is very similar to the sequence editor. You can configure your experiment by following the steps outlined below. Please note that configuring an experiment requires already defined and saved sequences.

1. Go to “Laser” settings
2. Choose “SEQUENCE EDITOR”
3. Here you can choose if you want to edit an experiment “EXP EDITOR” or edit a sequence “SQ EDITOR”
4. Once the “EXP EDITOR” is selected, you can select on the experiment name “UNTITLED.EX”
5. Now you can either select an already existing experiment to be edited/loaded or create a new experiment by choosing “CREATE NEW”

6. Now you can add or remove steps from your experiment using “+” and “-” icons. On each step you can select an already saved sequence. The “Cycle Time” shows the time your selected sequence needs for one cycle. For each sequence step you can define:
    - Repetitions, which defines the number of cycles that a sequence is repeated.
    - Pause, that is the the pause time before executing the next sequence.
7. If the values for the “Pause” is highlighted with orange colour, that means the assigned pause time is shorter than what QUSCITE needs before executing the next step. The pause time needs to be increased until it is accepted by QUSCITE and the pause time value turns to a white colour.
8. Once your experiment is defined, you can “Save” it.
9. Give your experiment a name and save.

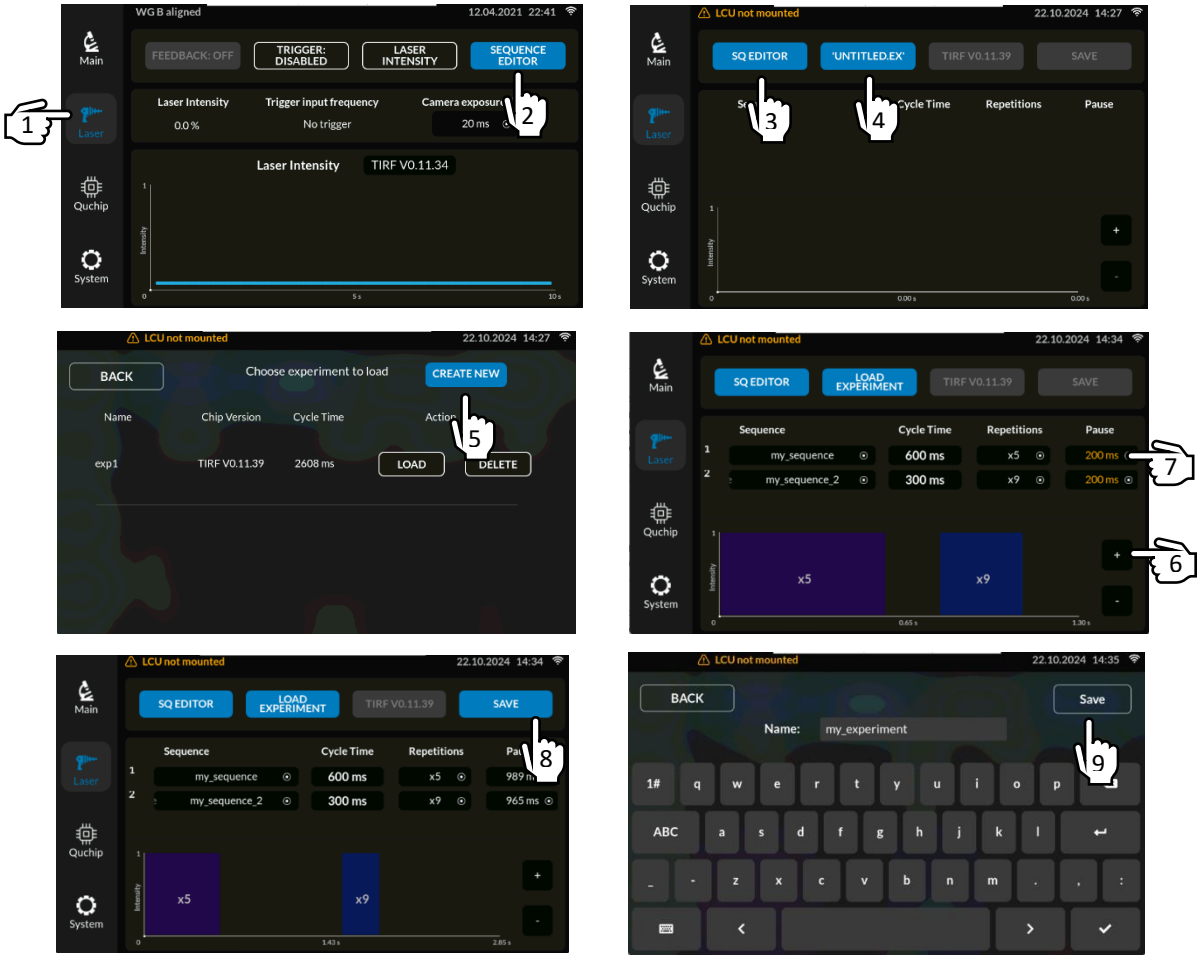


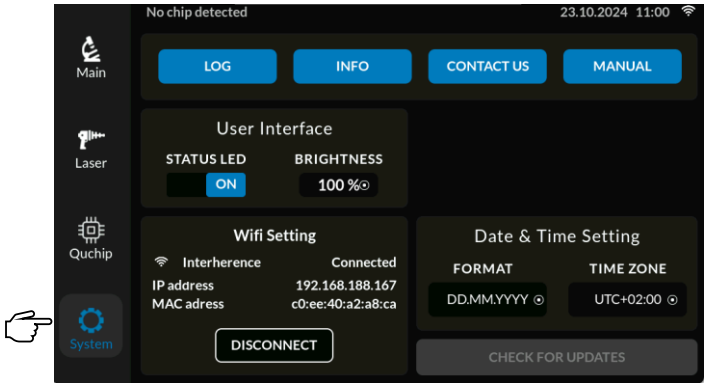
Figure 25: The steps required to define an experiment using the experiment editor of the QUSCITE.

Now that your experiment is defined, you can start your experiment from the main menu.

4.4. General Device Settings

In the panel “Setting” you can change the general settings of the device. These included:

- User Interface:
    - STATUS LED: turns on/off the illuminated Interherence logo on CU
    - BRIGHTNESS: changes the CU screen brightness
- Wifi Setting: Enables the CU to connect to WiFi. By connecting to the Internet, you can update the QUSCITE software, and if requested, remote troubleshooting for any errors you encounter can also be performed.
- CHECK FOR UPDATES: This feature verifies whether your QUSCITE software is up to date. If an update is available, you can start the software update process.
- INFO, CONTACT US, and Manual: Provides you with URL links and a QR code to access additional information, contact details, and the webpage for downloading the latest version of the QUSCITE manual.
- LOG: This feature allows you to switch the GUI between user mode and developer mode.



4.5. Synchronization with your workflow

The QUSCITE system is designed to seamlessly integrate with your existing workflow, allowing you to incorporate it into your experiments and data acquisition process without disruptions. The following table provides the information needed for the synchronization with your workflow.

Compatibility with the common software	Windows, Linux, Mac OS
Customizable settings	Laser power adjustment, laser wavelength selection, colour sequencing, SMA trigger,
Workflow automation	Waveguide auto - alignment and scan, laser operation time
User-friendly interface	The intuitive GUI interface of the QUSCITE system simplifies the operation and control. It allows you to easily navigate through different functions, adjust settings and monitor the operational status of the system

Seamless data management	The system facilitates efficient data management. It allows you to conveniently store, retrieve, and analyse your data, enhancing your overall workflow and data integrity, as well as accessing via web-interface
Multi-use QuChips	QuChips are multi-use microscope slides.

4.6. Turning the system off

To turn off the QUSCITE system:

- Turn off the laser power
- Locate the power button on the back panel of the control unit.
- Press the power button, and you will notice the screen on the front panel of the control unit turning off, indicating that the system has been powered down.

5. QUCHIP - Handling recommendations

The QuChip is a sophisticated waveguide-based chip with nanostructures, engineered for TIR illumination in microscopy applications. It offers a wide field of view and uniform illumination through its integrated multifunctional design. Due to the delicate nature of the glass substrates, careful handling is essential. Following the guidelines provided below will help optimize the performance of the QuChips and reduce the risk of damage to their functionality:

- Handle the QuChips with extreme care
- Use clean tweezers at all times
- Don't touch chips with bear hands - gloves are recommended
- When holding the QuChip with tweezers, grip only the outer regions, which are marked in green in Figure 26. To ensure the sample area and the QuChip's nanostructures remain uncontaminated and undamaged, avoid handling the red-marked areas shown in Figure 26.

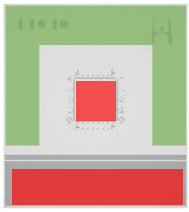


Figure 26: Avoide touching the QuChips with tweezer on the red area and only grab the QuChips from the grean area.

For disposal of QuChips check your local regulations for general glass waste. If QuChips are contaminated with flammable, explosive, or other harmful substances dispose of them according to the respective material safety datasheet.

QuChips can be purchased separately via INTERHERENCE or your local distributor. Only use original chips, doing otherwise will diminish functionality, and performance and void the warranty.

QuChips are fragile elements and can easily break. Handle them accordingly. Broken substrates might have sharp edges and can lead to injuries.

6. Remote control

6.1. Application programming interface (API)

Application Programming Interface (API) is a tool that allows different software applications to communicate with each other seamlessly. In this product, the API enables you to interact with our system by sending requests to retrieve or update data without directly accessing the system's core. To establish a connection between your device and QUSCITE, you need to use the USB-C port located on the rear panel of the Control Unit (CU) of the QUSCITE, as shown in Figure 27.

Figure 27: The USB-C port located on the rear panel of the QUSCITE control unit can be used to establish a commination link to your PC to access the API.

The API communication requires a USB-to-serial protocol, where you send structured requests in JSON format. The system will then respond with the necessary information or actions. In the table below, the API commands and their corresponding descriptions are detailed.

Command name	Parameters	Range/Unit	Description
set_laser	intensity	0 – 100 / percent	Sets the intensity of a laser with provided wavelength to the value. If wavelength is not provided sets intensity of currently active laser.
	enable	• true	Turns on or off selected laser

		• flase	
	wavelength	• 405 • 488 • 561 • 640	Which laser will be changed. Must always be provided
get_laser	up_time	none / hours	Returns time that laser was ON
	intensity	0 - 100 / percent	
	enable	• true • false	
	wavelength	• 405 • 488 • 561 • 640	Must always be provided
get_photodiode	photodiode	• pd_1 • pd_2 • pd_fiber • pd_ambient • all	If not specified defaults to “all”. Based on this readings of a given photodiode will be send back
	timestamp	• on • off	Sets whether or not send a timestamp with the photodiode readings
get_temperature	sensor	• cu • lcu • laserbank • all	Returns temperature reading of a given sensor. If not specified defaults to “all”
set_trigger	mode	• master • slave • disabled	Must always be provided. Master will output high whenever any laser is on and low when no laser is on. Slave will accept trigger from input and operate laser according to it (trigger high = laser on)
get_trigger	mode	• master • slave • disabled	
set_wifi	ssid	none/text	Connected to specific network
	password	none/text	
	disconnect	true	Disconnect WiFi
get_wifi	none	none	Returns SSID of the wifi network to which device is connected
goto_xy	x_mm, y_mm	mm	Moves the positioning system to (x,y)
get_xy	none	mm	Returns the position of the stepper motors
set_bsu_mode	mode	• ac • dc	Set bsu mode to AC or DC
arm_waveguide	waveguide_number wavelength	a-h / number 640 561 488 405	Moves to selected waveguide and potentially performs piezo alignment
illuminate_waveguide	enable	true/false	
	intensity	0-100/percent	
detect_chip	none		Initiates chip detection procedure
stop_lcu	none		Stops any running process, motors, lasers and piezo
toggle_bsu_ac_mode			switches the piezo between AC and DC

get_lcu_state			gets state of the system
get_chip_info			reads out chip specifications
get_system_info			gets info on FW version, serial number
set_brightness			sets screen brightness

6.2. Trigger Options

Trigger options of the QUSCITE allows you to send or receive a signal from the system which only controls the laser operation to be on or off. The triggers are communicated through SubMiniature version A (SMA) cables that are connected to the back panel of the QUSCITE control unit as shown in Figure 28. The input SMA cables must operate at 5 V and at maximum frequency of 5 kHz.

Figure 28: The SMA cables for the trigger IN and Out are connected to the QUSCITE control unit back panel.

The trigger status can be changed from the “Laser” windows. Initially the trigger status is disabled. You can press on the Trigger icon and change the status to the “Slave” or “Master” mode as shown in the Figure 29.

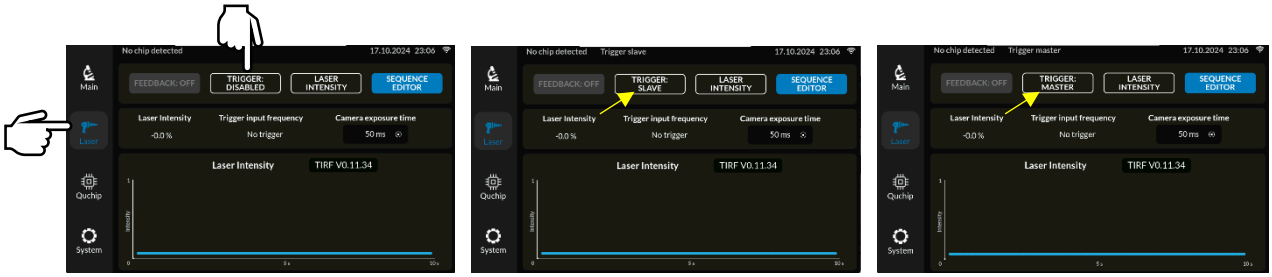


Figure 29: Trigger status can be changed from the laser settings. Three different trigger status are: disabled, slave, and master.

When the trigger status is set to "slave," the QUSCITE activates the laser whenever it gets a trigger signal. In "master" mode, the QUSCITE sends a signal reflecting whether the laser is on or off. It's important to note that the trigger function only controls the laser's on/off status and does not affect the laser color, waveguide, or intensity, which are configured in the main menu.

7. Maintenance and cleaning

7.1. Cleaning of the components

1. **Optics** (e.g. LCU window): Use a clean, lint-free microfiber cloth or lens-cleaning tissue to gently wipe the optics and lenses. Avoid applying excessive pressure or using abrasive materials that could scratch or damage the surfaces. If necessary, moisten the cloth or tissue with a small amount of optical lens cleaning solution or isopropanol alcohol and wipe in a circular motion. Ensure that the optics are completely dry before use.

2. **Microscope Adapter (MA), chip carrier (CC), chip carrier base (CCB):** Use a lint-free cloth or soft brush to clean the surfaces. If necessary, lightly moisten the cloth with a mild cleaning solution or isopropanol alcohol and wipe the surfaces.

3. **Exterior Surfaces**: Wipe the exterior surfaces of the control unit, LCU, optical fiber, and other system components with a clean, damp cloth. For stubborn stains or fingerprints, use a mild cleaning solution. Avoid using harsh chemicals or solvents that could damage the surface finish. Dry the surfaces thoroughly after cleaning.

4. **Cables and Connections**: Check the cables and connections periodically for dust or debris accumulation. Use compressed air or a soft brush to gently remove any particles. Ensure that the cables are properly connected and securely tightened.

5. **Regular Maintenance**: Follow the recommended maintenance schedule provided in the user manual. This may include more extensive cleaning procedures or professional servicing by authorized technicians. Adhering to the maintenance schedule will help keep the components clean and in optimal working condition.

7.2. Good operating practices

By following these good operating practices, you can optimize the performance, reliability, and lifespan of the QUSCITE system, enabling you to achieve accurate and consistent results in your research and experiments.

- Familiarize yourself with the user manual provided with the QUSCITE system. Reading and understanding the manual will help you operate the system effectively and avoid potential issues.

- Before using the QUSCITE system, ensure it is properly set up and calibrated according to the instructions. Check the connections, power supply, and any necessary adjustments to ensure everything is in order.

- Operate the QUSCITE system according to the prescribed procedures outlined in the user manual. This includes turning the on/off the system correctly, adjusting settings, and following recommended sample preparation and handling protocols.

- Handle the QUSCITE system and its components with care. Avoid applying excessive force, dropping or mishandling delicate parts, or exposing the system to extreme conditions that may cause damage.
- Operate the QUSCITE system in a suitable environment that meets the specified temperature, humidity, and cleanliness requirements. Protect the system from exposure to dust, liquids, strong magnetic fields, or other potentially harmful elements.
- Ensure that operators are properly trained on the operation and maintenance of the QUSCITE system. Stay updated with the latest developments, best practices, and safety guidelines related to the system.

7.3. System storage and transport

Store the QUSCITE system in a secure and controlled environment to protect it from unauthorized access and potential damage. Choose a clean and dry area away from direct sunlight, excessive heat, humidity, or extreme temperatures.

Use suitable protective covers or cases to shield the system from dust, moisture, and physical damage. Ensure that the covers provide adequate cushioning and protection. Properly organize and secure all cables, optical fibers, and connectors before storing the system. This helps prevent cable tangling, strain, and potential damage to the connectors.

Store the QUSCITE system on a stable and elevated surface, away from potential spills or accidental contact with liquids. This helps minimize the risk of liquid damage to the system.

Use suitable packaging materials to protect the system during transportation. Wrap the system with cushioning materials and secure it inside a sturdy box or case to prevent movement and potential impacts.

Handle the system with care during transport. Secure all movable parts and components, to prevent them from shifting or getting damaged during transport. Clearly label the packaging with appropriate handling instructions, such as "Fragile" to alert the transport personnel about the delicate nature of the contents.

8. Troubleshooting

8.1. Common errors

Error	Cause / Solutions

No chip carrier	The chip carrier is not correctly inserted into the chip carrier base. Ensure that the chip carrier is securely in place, firmly positioned on the base, and not tilted.
No chip detected	5.1.1. QuChip is not inserted correctly into the chip carrier. Make sure the four side of the chips are blocked by the chip carrier, see section 4.1. 5.1.2. The surface of the QuChip is contaminated with large particles. Gently clean the surface by using an air blow. 5.1.3. LCU window is dirty. Clean the LCU window by following the guidelines mentioned in section 7.1.
Chip sticks to the surfaces	If the QuChip drops onto a surface, use a small piece of paper to lift its edge, then carefully pick it up with tweezers. Clean the QuChip with IPA/Acetone and blow dry it to remove any contamination from the surfaces.
Damaged QuChip	If the QuChip is damaged during handling, such as breaking or cracking, it will need to be replaced. However, if the crack is only on the very edges, the QuChip may still be usable.
LCU is not mounted	LCU is not properly mounted on the Chip Carrier Base (CCB). Make sure that there is not obstacle between the LCU and CCB such that LCU sits flat on CCB. Demount and mount LCU on the chip carrier base such that the connectors are properly connected.

Please contact us directly in case an error arises that is not covered in this chapter. We will work hard to solve your problem.

8.2. Remote Service

Remote Service is designed to facilitate efficient support and troubleshooting. Through this feature, our highly skilled support team can remotely access your QUSCITE system with your explicit consent to diagnose and resolve any issues you may encounter. This remote access capability allows our technicians to efficiently review system settings, perform diagnostics, and guide you through troubleshooting steps, all while minimizing disruptions to your work. We understand the importance of privacy and data security and rest assured that remote access will only be conducted with your explicit permission and in compliance with strict confidentiality protocols. This Remote Service feature ensures prompt and effective support, providing you with the convenience of receiving assistance from our experts without the need for on-site visits.

9. Warranty

Thank you for choosing the QUSCITE system manufactured by INTERHERENCE GmbH. We stand behind the quality and performance of our products and offer the following warranty terms for your peace of mind. b

The QUSCITE system is covered by a limited warranty, applicable to products exclusively manufactured by our company. Please note that this warranty does not extend to third-party accessories used in conjunction with our products.

The warranty period for the QUSCITE system is one (1) year from the date of shipment or 2000 hours of operation, whichever comes first. This warranty ensures that all mechanical, electronic, and optical parts and assemblies are free from defects in workmanship and materials during the warranty period.

In the unlikely event of a defect, our company's liability is limited to repairing, replacing, or providing credit for the defective equipment, up to the original purchase price. However, prior authorization must be obtained from an authorized representative of our company before returning any items. Any repaired or replacement equipment will be covered for the remaining duration of the original warranty period.

Please note that this warranty is valid only when the QUSCITE system is assembled, installed, and operated according to the instructions provided with the product. It becomes void if the product is subjected to any form of mistreatment, such as deviating from the installation, operating, and maintenance instructions, tampering with the product, operating it in hostile environments not specified in the instructions, experiencing substantial mechanical shock, sustaining damage from static discharge (which should not occur under normal operation), or being operated in unclean environments.

It is important to understand that this warranty does not cover any incidental or consequential damages. Furthermore, our company expressly disclaims any other warranties, whether expressed or implied, including merchantability and fitness for a particular purpose, unless otherwise stated in this warranty. Any implied warranties imposed by law are limited to the terms outlined in this warranty.

Please feel free to contact us directly for any questions, concerns, or warranty-related issues.