

Laser Coupling Unit LCU



User's Manual and Technical Data

Version 1.8

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1. General safety information








CAUTION!

Before using this device, make sure that you have read and understood the content of this user manual. Store this documentation in a safe and easily accessible place for future reference.

Incorrect handling of this product may result in personal injury or physical damage. The manufacturer assumes no responsibility and cannot be held liable for any injury / damages resulting from operating the device outside of the normal usage defined in this manual.

1.1 Warning Symbols and Conventions

The following symbols and conventions will be used throughout this manual. Please take time to familiarize yourself with their meaning before proceeding.

	The general safety alert symbol is used to alert you to hazards that may lead to personal injury or physical damage. Follow all associated safety instructions to avoid possible injury or death.
	A high voltage warning symbol is used to indicate the presence of un-insulated, dangerous voltage inside the enclosure. Note that this voltage may be sufficient to constitute a risk of shock.
	The laser radiation warning symbol alerts you that the device can generate laser radiation. Follow all applicable laser safety instructions to avoid injury or damages.
	The device's susceptibility to electrostatic discharge (ESD) is indicated by the ESD warning symbol . Ensure that you follow proper ESD protection rules to avoid damaging the device.
CAUTION!	Make sure to follow any instructions prefaced with " CAUTION! " to avoid personal injury or damaging the device.
WARNING!	The " WARNING! " label prefaced any instructions that have to be followed to avoid severe injury or death.
NOTICE	Important tips and information for device operation that do not include a risk of injury or damage are prefaced with the " NOTICE " label.
	This symbol indicates that an earth terminal needs to be connected to the ground (to avoid risks of electrical shock).

1.2 Laser Safety Instructions



WARNING! Visible and invisible laser radiation

The LCU comes with one or more laser diode heads that can emit visible, infrared, or UV light. Infrared light is not visible to the eye! **These diode lasers can emit laser light of up to class 3b / IIIb.** Please refer to the labels affixed to the laser head for information on classification. In general the LCU is not suitable for laser light of class 4 / IV.

Laser class 3B / IIIb require that special laser safety glasses are worn. The installation room of the LCU must be labeled as laser area.

Lasers can be hazardous and have unique safety requirements. Permanent eye injury and blindness is possible if lasers are used incorrectly. Pay close attention to each safety related CAUTION and WARNING statement in the user manual. Read all instructions carefully BEFORE operating this device.

The laser diode heads of the LDH Series are manufactured according to the International Laser Safety Standard IEC 60825-1:2007 and comply with the US law 21 CFR §1040.10 and §1040.11.

Required Laser Safety Measures

Please observe the laser safety measures for class 3b / IIIb lasers in accordance with applicable national and federal regulations. The owner / operator is responsible for observing the laser safety regulations.

What does the owner / operator have to observe?

- The owner / operator of this product is responsible for proper and safe operation and for following all applicable safety regulations.
- The owner / operator is fully liable for all consequences resulting from the use of the laser for any purposes other than those listed in the operating manual. The laser may be operated only by persons who have been instructed in the use of this laser and the potential hazards of laser radiation.
- The owner / operator is responsible for performing and monitoring suitable safety measures (according to IEC/EN 60825-1 and the corresponding national regulations).
- The owner / operator is also responsible for naming a laser safety officer or a laser protection adviser (according to the standard IEC/EN 60825-1: "Safety of laser products, Part 1: Classification of systems, requirements and user guidelines" and the respective national regulations).
- When using lasers of **class 3b / IIIb**, it is required to wear special eye protection (laser safety goggles).
- The room in which the LCU is installed must be labeled as a laser area.

The following security instructions must be followed at all times.

General Safety Instructions for Operation

- Never look directly into a laser beam or a reflection of the laser beam. Avoid all contact with the laser beam.
- Do not introduce any reflective objects into the laser beam path.
- Every person involved with the installation and operation of this device has to:
 - Be qualified
 - Follow the instructions of this manual
- As it is impossible to anticipate every potential hazard, please be careful and apply common sense when operating the laser diode heads and associated driver unit. Observe all safety precautions relevant to Class 3b / IIIb lasers
- Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.
- The laser power levels accessible if the unit is opened can cause instant blindness, skin burns and fires. Class 3B / IIIb lasers can present a major hazard through exposure to the direct (intra-beam) or reflected (specular or diffuse) laser beams when the laser is inadvertently “on” and there is a direct line-of-sight path to the laser beam or its reflection. If your instrument uses another excitation system, follow the safety instructions of the relevant manual.
- Never remove the optical fiber from the system when the lasers are powered.
- Do not disable the interlocks on the LCU
- The delivered instruments are pre-set by PicoQuant to operate on the power outlet line voltage for the country of delivery. Nevertheless, please check that the actual line voltage corresponds to the value set on these instruments!
- If pulsed lasers from PicoQuant are present at the system, please check that the actual line voltage corresponds to the value set on the PDL-800-D laser driver!
- Never connect or disconnect any cable while the data acquisition and control electronics are ON. Charged signal cables can destroy the devices!
- Protect the photon detectors (SPAD, PMA, PMA Hybrid) as much as possible, particularly from excessive light intensities, e.g. room light, a microscope illumination lamp, unattenuated backscattered excitation light, etc. The SPAD detector(s) must be switched off using the remote control unit BEFORE switching off the system by the main power button.

1.3 Safety Labels on the Laser Device

The safety labels are affixed to the laser head housings, with an arrow pointing towards the laser emission aperture (see Fig. 1.1 for some examples). The label states the laser product classification, certification, power, and wavelength range relevant for the classification.

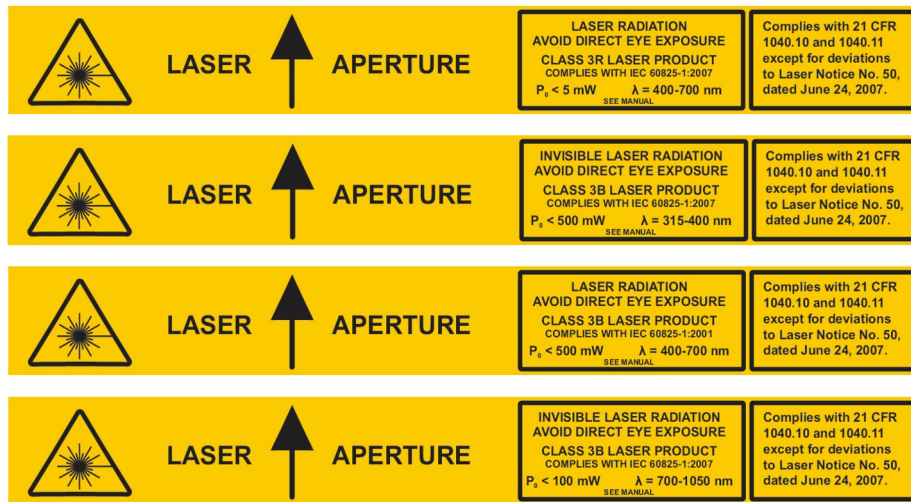


Fig. 1.1: Example of laser warning, certification, and classification label on laser heads of the LDH Series. Top: labels for cylindrical laser heads; bottom: location of such a label on a laser head from PicoQuant’s LDH Series.

Please refer to the *laser delivery report* in the Appendix for information on the central emission wavelength, maximum achievable optical output power, and pulse shape of the delivered LDH laser heads.

1.4 Laser Safety Labels on the LCU

The Laser Coupling Unit (LCU) is equipped with laser devices complying with safety standards, including International Electrotechnical Commission (IEC) 60825 and its relevant national implementations. With specific regard to the laser, the equipment complies with laser product performance standards set by government agencies for a **class IIIB laser product**.

PicoQuant equipment is clearly labeled with warnings about the equipment radiation level. All warning labels must be read and understood by personnel before working with the equipment. Be sure to observe the following warnings when operating a product equipped with a laser device. Failure to observe these warnings could result in fire, bodily injury and damage to the equipment.



Fig. 1.2 Laser Combining Unit with Laser Warning Labels

The Laser Warning Labels are located on the cover of the LCU next to the attenuation knob (A) and on the side panel of the LCU (B). In Case of an AMOT-LCU the CE- and product Label is also located on the side panel of the LCU (C).



Fig. 1.3 Laser Hazard Warning (A, B)

Laser warning label used in combination with other laser safety labels on the LCU



Fig. 1.4 Class IIIB Laser Product Warning Label on the lid of the LCU (A)

This label in particular identifies parts of the system which give access to the laser beam by opening a cover. (label on the lid of the LCU)



Fig. 1.5 Class IIIB Laser Power and Wavelength Specifications Label on the side of the LCU (B)

The LCU equipment contains Class IIIB laser products. The maximum output power is 500 mW with access in the 350-1060 nm wavelength range. Laser radiation presents a visible and invisible hazard, so personnel should avoid exposure to the laser beam.

The LCU can only be operated in a room which is equipped with signs explaining the existence of a potential laser hazard. These **laser area warning signs** should be posted prominently at the entrance to the service area and in the vicinity of the installation area where laser and laser-furnished fiber optic equipment is installed, in accordance with IEC 60825. Since the service area is a temporary laser-controlled area, these signs should signal that access is limited to authorized personnel. The symbol for a laser hazard is to be prominently displayed at the top of this sign.

Personnel must be qualified in laser safety procedures and must use proper eye protection before working on this equipment. Please inform your local **laser safety officer** to arrange according laser safety precautions.



WARNING!

Do not operate controls, make adjustments, or perform procedures to a laser device other than those specified in the operation manual or in the laser device installation guide. Allow only PicoQuant authorized service technicians to repair the laser equipment.

2. Introduction and Principle of Operation

The **Laser Coupling Unit (LCU)** couples one or more laser beams into a polarization maintaining single mode (PM-SM) fiber. Up to four laser heads from PicoQuant can be mounted inside the LCU. Additional lasers can also be included using the free laser entrance port **Ext** (see Fig. 2.1).

2.1 Standard Configuration

Fig.1 shows the configuration of the LCU with three diode laser heads (LDH) and a Fiber Coupled Laser **FCL**. Via two beam aligning elements per laser, the beam displacer **BD** and the beam splitter **BS**, the beams are super-imposed and guided to the **Fiber Coupler Out**. The beam splitters **BS** allow the combination of lasers with different wavelengths. The **Attenuation Unit** allows to attenuate the beam via optical density filters in three orders of magnitude together with a fine tuning using a micrometer driven scaffold. External lasers can be coupled into the LCU via the Fiber Coupled Laser unit **FCL** or with a free laser beam using the External port **Ext**.

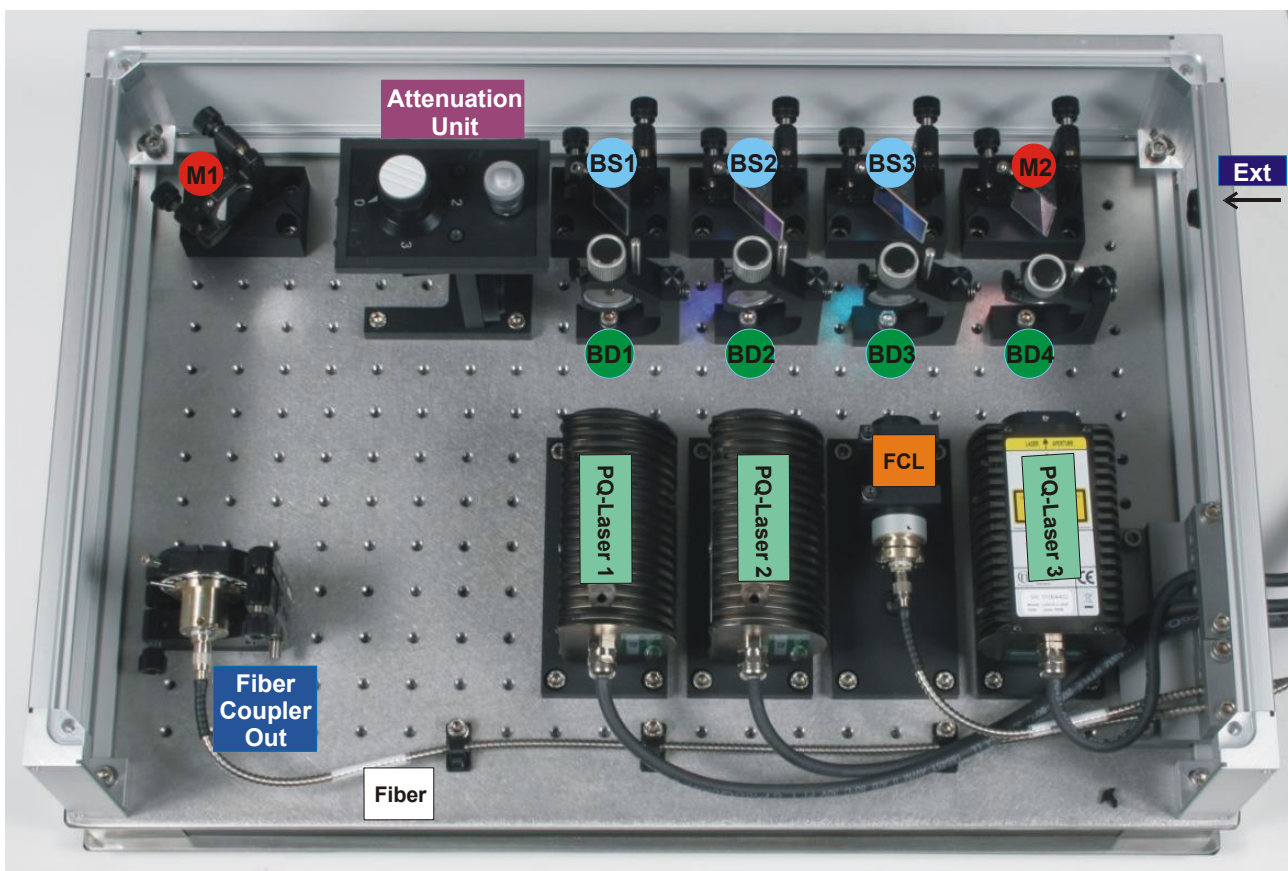


Fig. 2.1: Standard configuration of the LCU with three internal Diode-Laser-Heads (LDH) from PicoQuant and a fiber coupled laser (FCL).

- M** – Mirror
- BS** – Beam splitter
- BD** – Beam displacer
- FCL** – Fiber coupled laser
- Ext** – Entrance port for external lasers

2.2 Attenuation Unit

The LCU provides a graded and a continuous intensity attenuation by two different elements (**Attenuation Unit** see Fig. 2.1 and 2.2). With the filter wheel the attenuation is adjustable in three steps by changing the filter in the beam path.

0	= 100 % Transmission
1	= 10 % Transmission
2	= 1 % Transmission
3	= 0.1 % Transmission

The additional scaffold allows a continuous attenuation (100 % - 0 %) by clipping of the laser beams. The scaffold is controlled with a micrometer head and allows a precise intensity control.

Note that the Attenuation Unit is placed in a position where all laser beams come through. That ensures that the attenuation of the ND-filters (neutral density filters) is for all beams equal. However, the attenuation achieved with the scaffold can be different for the specific laser beams due to differences in the shape and orientation of the beam profile.

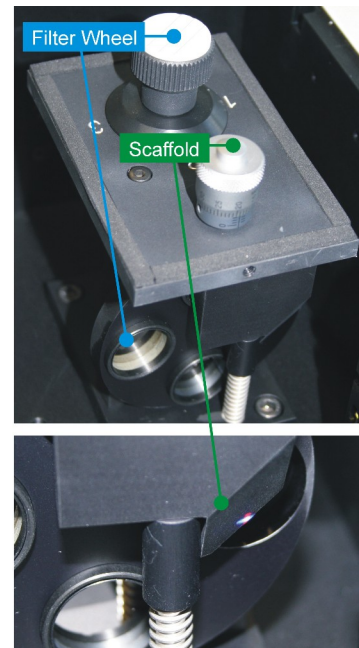


Fig. 2.2: Attenuation Unit with filter wheel and scaffold.

2.3 Alignment



WARNING! Visible and invisible laser radiation

For the following steps, use only low laser power and follow the laser safety rules!

Starting point:


The laser heads are connected with their corresponding driver. Start with one laser head and ensure that it's emitting. If two or more laser heads are built into the LCU the procedure must be repeated for all lasers.

Scope:

Optimising the fiber coupling efficiency by adjusting the **Fiber Coupler Out** and the beam alignment. The coupling efficiency is monitored by measuring the laser light after the fiber output. Depending on customers equipment there are two possibilities to monitor the laser power.

- **Monitoring the laser intensity with a single photon counting detector**
- **Monitoring the laser intensity with a power meter at the microscope objective position**

Laser light is guided from the LCU to the microscope and exits the microscope objective. The first option requires that a small portion of the laser light is backscattered using the surface of a glass cover slip or a mirror placed as sample and guided to one of the single photon counting detectors (SPAD or PMT). The count rate can be observed using the oscilloscope menu of the SymPhoTime software.

1. Turn on the laser for which you want to optimize the fiber coupling.
2. Choose the adequate main dichroic for the excitation wavelength.
3. Lift the **lever** at the **LCU** to direct the internal pulsed laser light to the microscope if you have the bypass option.
4. Set the microscope in the point acquisition mode that laser light exits the objective.
5. If you want to monitor the laser intensity with a power meter, place the power meter head at the location of the objective and follow step 9.
6. Place an **OD3 attenuating filter** in the filter holder in front of the detector. Look up your detector manual for locating the filter holder position.
7. Activate the **oscilloscope window** in the SymPhoTime software () and select the **Time Trace - tab** (Fig. 2.3). Important is the setting of a **linear Count Axis**. Start the oscilloscope measurement by clicking the Start - icon. The amplitude axis can be adapted by scrolling with the mouse wheel button in case the cursor is placed on the oscilloscope window. **Be careful to avoid damaging of the detector with too high light intensity!**
8. Reduce the laser power in order not to oversaturate the detectors. Start with attenuation OD3. It is important that the **scaffold is completely open**, use only the filter wheel for attenuation of OD1 up to OD3 and the laser intensity adjustment at the laser driver. Place a **scattering sample** (e.g. the surface of a cover slide or better a mirror) in the laser focus on the microscope stage and focus for highest count rate. Adjust the count rate adapting the laser intensity to around 50 kilo counts / second as shown in Fig. 2.3.
9. Open the LCU. **Follow the laser safety rules!**
10. Control that the counts observed with the oscilloscope window are originating from the laser for which you want to optimize the fiber coupling by placing shortly some paper in the beampath between laser and fiber coupler. The signal viewed in the oscilloscope window should drop accordingly.
11. **This alignment is only performed for the first laser you want to align.** Adjust the vertical **V** and horizontal **H** alignment of the **Fiber Coupler Out** for maximal intensity viewed with the Time Trace (Fig. 2.4). Turn the screws slowly and do not lose the signal on the oscilloscope time trace window.
12. Adjust the Beam Displacer **BD** of the respective laser by turning and tilting for optimal count rate (Fig. 2.5). **Be careful not to incline the beam displacer too strong since a reflection of the laser could reach your eye.**
13. Adjust the Beam Splitter **BS** of the respective laser with the vertical **V** and horizontal **H** alignment for optimal count rate. The dials are reacting very sensitive. Be careful not to lose the signal.
14. Repeat step 12 and 13 once more. The alignment for the first laser is now finished. Repeat the steps without aligning the **Fiber Coupler Out** (step 11) for the other lasers.
15. Do **not** touch the alignment of Mirror 1 **M1** of Fig. 2.1.

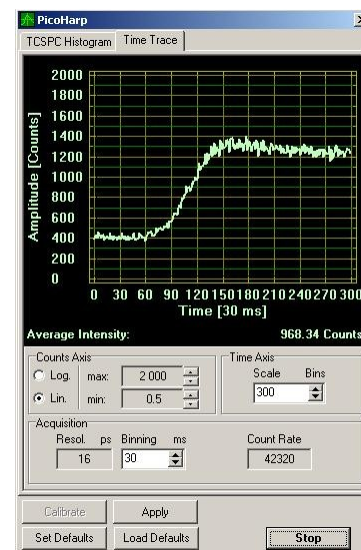


Fig. 2.3: Time Trace oscilloscope window. The easiest adjustment is reached with a binning time of 30 ms.

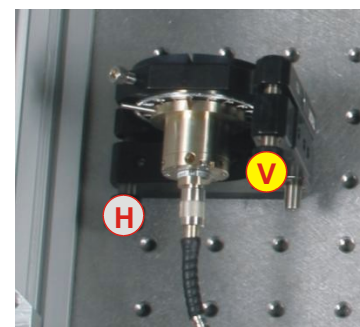


Fig. 2.4: Adjustment of the fiber out coupler using horizontal and vertical dials.

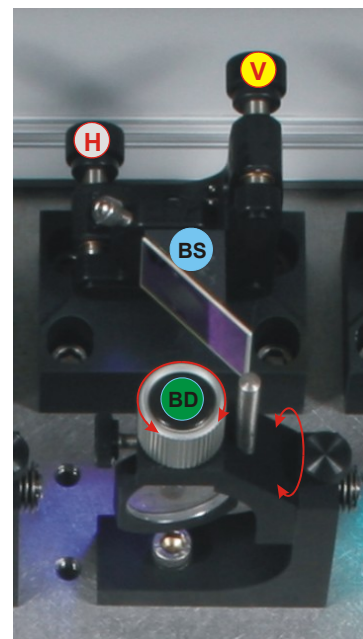


Fig. 2.5: Beam adjustment of one laser. The Beam displacer shifts the beam while the Beam Splitter adjusts its angle.

2.4 Bypass Option

The bypass configuration of the LCU is shown in Fig. 2.6. It enables the user to switch between external lasers, for example continuous wave lasers, and the internal PicoQuant laser heads without any fiber exchange or realignment. The external lasers are guided via an optical single mode fiber through the **Fiber Coupler In** into the LCU. The sliding mirror **SM** switches between the internal and the external lasers.

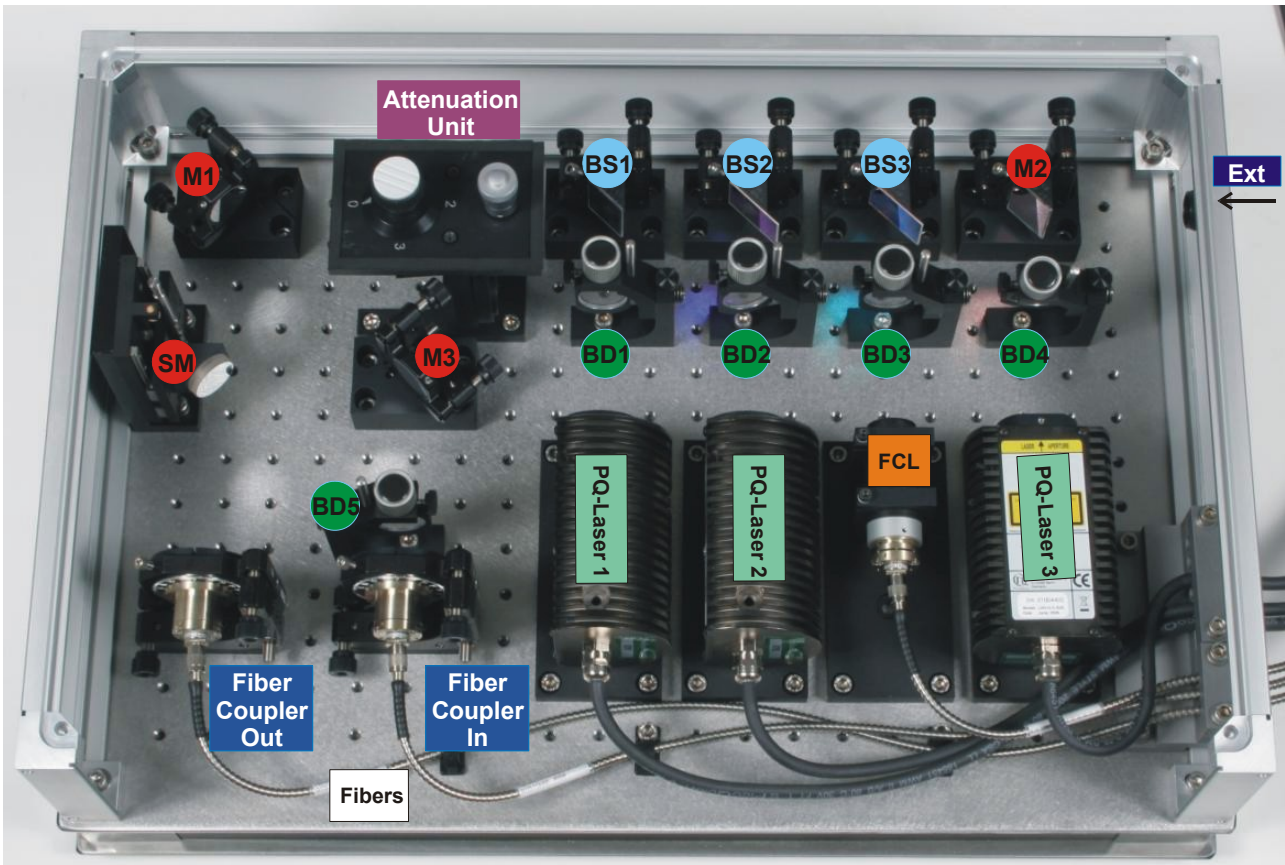


Fig. 2.6: Bypass configuration of the LCU: The Sliding Mirror **SM** allows to switch between internal lasers and external fiber coupled lasers.

- M** – Mirror
- SM** – Switchable mirror
- BS** – Beam splitter
- BD** – Beam displacer
- FCL** – Fiber coupled laser
- Ext** – Entrance port for external lasers

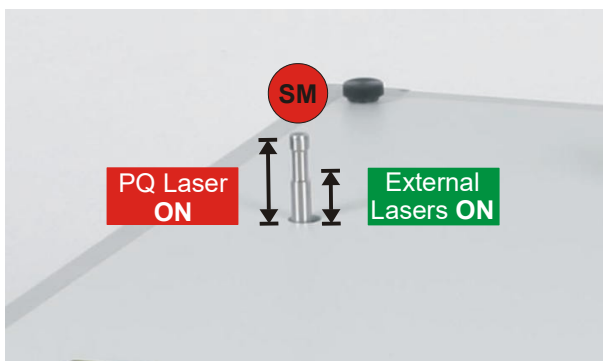


Fig. 2.7: Two positions of the Sliding Mirror **SM**: In the upper position the laser beams of the internal lasers are guided to the **Fiber Coupler In**. In the lower position the internal lasers are blocked and the external lasers are coupled into the output fiber.

2.5 Alignment Bypass Option



WARNING! Visible and invisible laser radiation

For the following steps, use only low laser power and follow the laser safety rules!

Starting point:

You have just done the alignment described in chapter 2.3. All settings of the microscope and the SymPhoTime software are still set.

Scope:

Optimising the fiber coupling efficiency for the bypass lasers by adjusting the **Fiber Coupler In** and its beam alignment. Use the read out of the time trace of the oscilloscope window as described in chapter 2.3 for the optimization of the alignment.

1. Turn on one of the external lasers which is guided through the LCU using the bypass option.
2. Lower the **lever** at the **LCU** to direct the external laser light to the microscope.
3. Choose an adequate main dichroic for the excitation wavelength and guide the light to the objective. The reflected light should be sent toward the single photon counting detector.
4. If you want to monitor the laser intensity with a power meter, place the power meter head at the location of the objective. and follow step 6.
5. Adjust the count rate of the oscilloscope window adapting the laser intensity of the external laser to around 50 kilo counts / second as shown in Fig. 2.8.
- 6. Open the LCU. Follow the laser safety rules!**
7. Control that the counts observed with the oscilloscope window are originating from the external laser by placing shortly some paper in the beampath between **Fiber Coupler In** and **Fiber Coupler Out**. The signal viewed in the oscilloscope window should drop accordingly.
8. Adjust the Beam Displacer **BD** as shown in Fig. 2.9 by turning and tilting for optimal count rate. **Be careful not to incline the beam displacer too strong since a reflection of the laser could reach your eye.**
9. Adjust the vertical **V** and horizontal **H** alignment of the **Fiber Coupler In** for maximal intensity viewed with the Time Trace (Fig. 2.9). Turn the screws slowly and do not loose the signal on the oscilloscope time trace window. Do **not** change the **Fiber Coupler Out**.
10. Repeat step 8 and 9 once more. The alignment is now finished.
11. Do **not** touch the alignment of the **Fiber Coupler Out**, Mirror **M1** and **M3** of Fig. 2.6.

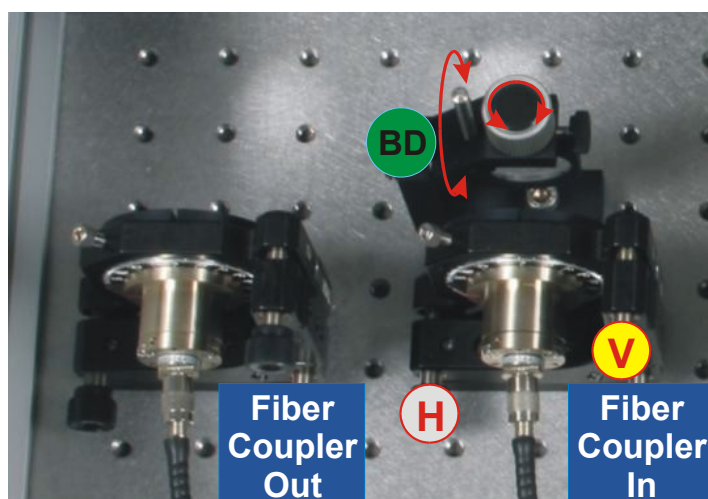


Fig. 2.8: Beam adjustment for the external bypassed lasers. The Beam Displacer **BD** shifts the beam while the Beam Splitter **BS** adjusts its angle.

2.6 Configuration for Point Source Fibers with Bypass (Nikon C2)

In order to adapt the beam diameters of the PQ LDH pulsed lasers for Point Source fiber couplers, the LCU can be configured with a set of telescopes. Using the Telescope Lens 1 **TL1** and the Telescope Lens 2 **TL2** the beam of the PQ laser heads is reduced by a factor of 3. For the bypass option the Telescope Lens 3 **TL3** and the Telescope Lens 2 **TL2** reduce the beam size of the fiber coupled external lasers by a factor of 2.

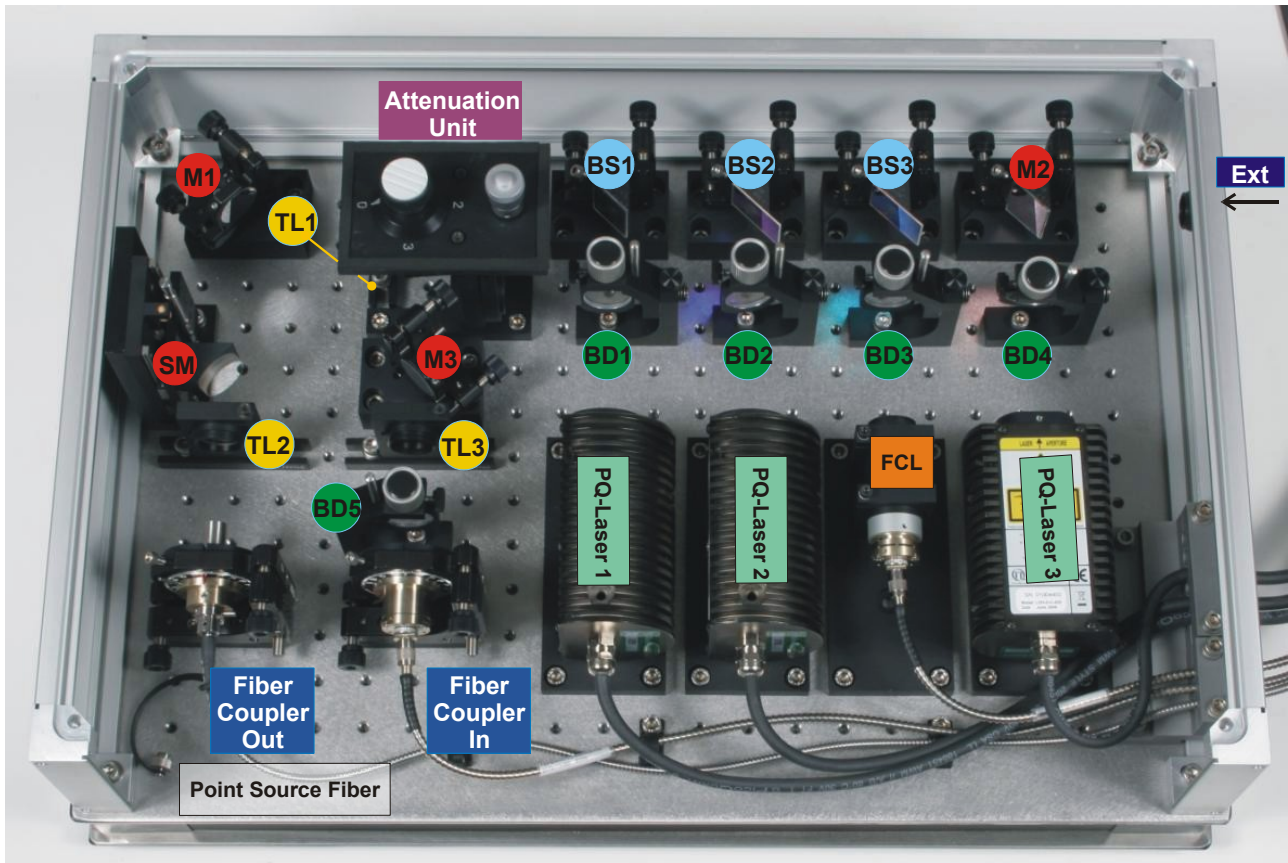


Fig. 2.9: A set of Telescope Lenses **TL** adapt the beam sizes of the internal lasers and the fiber coupled external lasers to the fiber coupler from Point Source located at the **Fiber Coupler Out**.

- M** – Mirror
- SM** – Switchable mirror
- TL** – Telescope lens
- BS** – Beam splitter
- BD** – Beam displacer
- FCL** – Fiber coupled laser
- Ext** – Entrance port for external lasers

For alignments follow the description given in chapter 2.5.

2.7 Separate Fiber Output for UV and VIS Lasers (Leica SP8)

Some microscopes like the confocal laser scanning microscope SP8 from Leica are using different fibers for wavelengths in the UV range (e.g. 405 nm) and for wavelengths in the visible (VIS) spectrum (e.g. 440 nm up to 640 nm). This modification of the LCU allows to guide internal lasers according to their wavelength to two separate fibers.

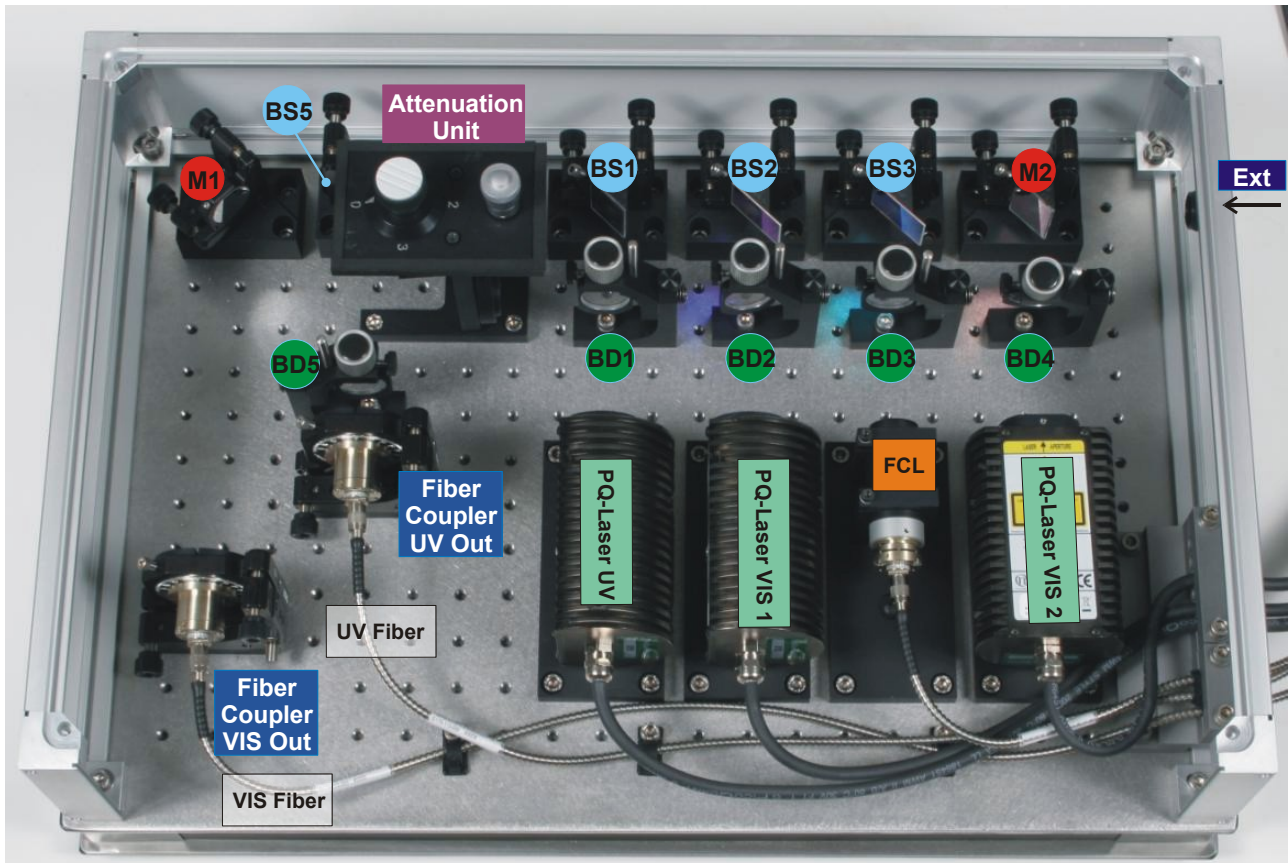


Fig. 2.10: The confocal microscope Leica SP8 needs different fibers for the UV wavelength 405 nm and VIS wavelengths (440 nm – 640 nm). In this configuration of the LCU the beams of the 405 nm laser (PQ-Laser UV) is guided via **BD1**, **BS1**, **BS5**, **BD5** to the **Fiber Coupler UV Out**. All other lasers are coupled into the VIS fiber using the **Fiber Coupler VIS Out**.

- M** – Mirror
- BS** – Beam splitter
- BD** – Beam displacer
- FCL** – Fiber coupled laser
- Ext** – Entrance port for external lasers

For alignments follow the description given in chapter 2.3. First adjust the VIS lasers (440 nm – 640 nm) together with the **Fiber Coupler VIS Out**. Then repeat the whole procedure with the UV laser (405 nm) using for the alignment the **Fiber Coupler UV Out**. The Beam Displacer **BD5** is optional and must not be built in. Do not touch **BD5** and **BS5**.

2.8 Shutter Integration for Zeiss

Some microscopes like for example the confocal laser scanning microscope 880 from Zeiss are using a special shutter control, which is delivered by Zeiss and integrated in the LCU. Therefore the LCU is equipped with two additional Lemo Connectors, called "safety" and "power" for connection of the Zeiss shutter control.

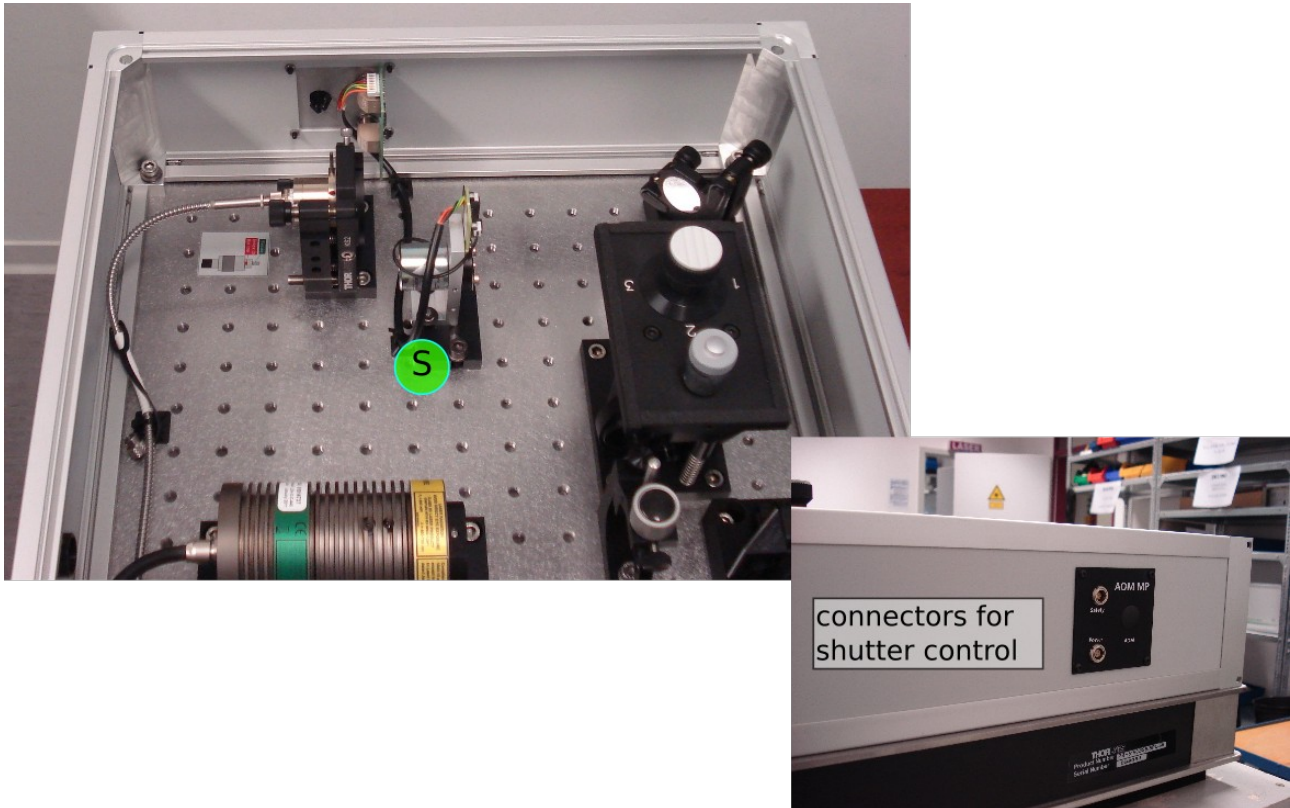


Fig. 2.11: LCU equipped with shutter control from Zeiss

- S** – Motorized laser attenuators
- – Connectors for shutter control "safety" and "power"

2.9 Motorized LCU Option (AMOT-LCU for LSM)

As an additional option some LCUs for LSM can be equipped with motorized laser attenuators (AMOT-LCU). This modification of the LCU allows to control the laserpower in the software. The motorized laser attenuators don't need to be adjusted by the customer. At the moment this option is only possible for a few LSM upgrade systems. For more information please contact our support (see Chapter 5. .)

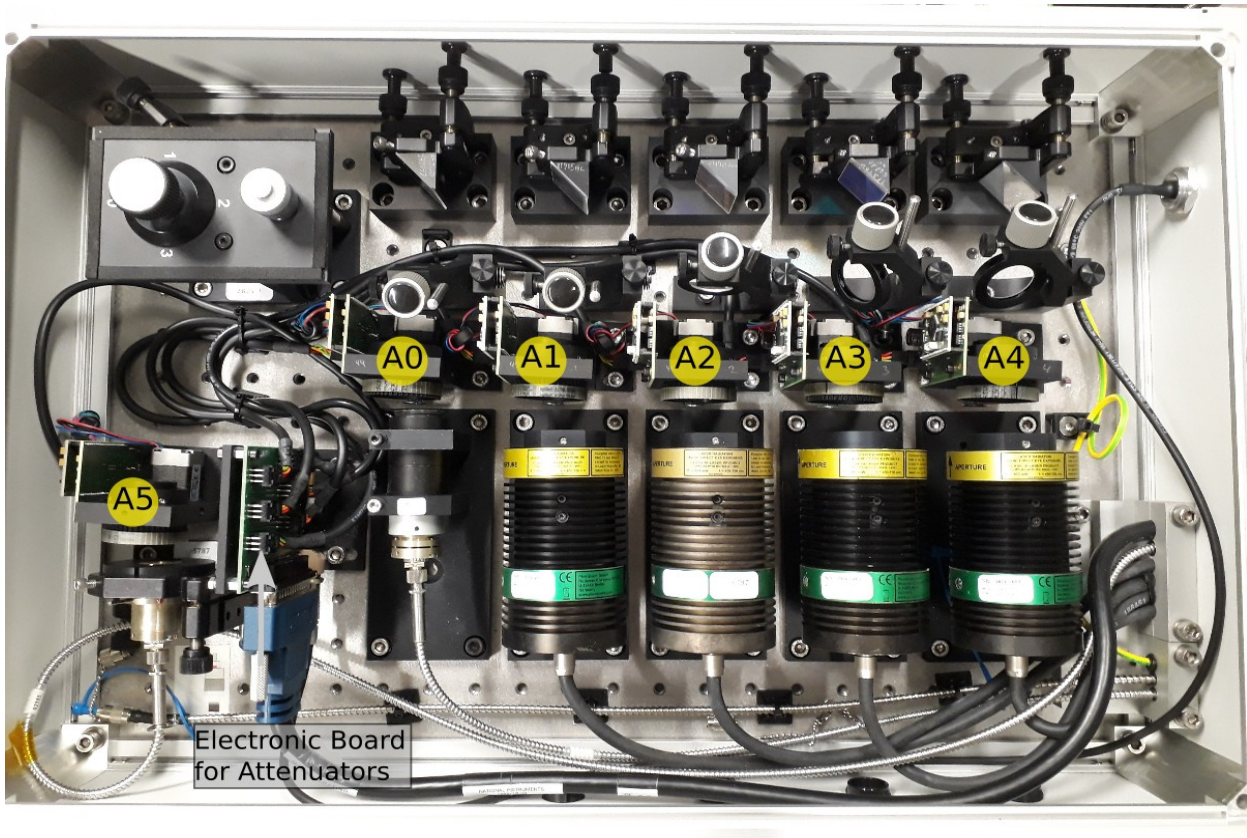


Fig. 2.12 LCU equipped with motorized laser attenuators

- A** – Motorized laser attenuators
- A5** – Electronic Board for motorized laser attenuators

Optical Fibers

WARNING! Visible and invisible laser radiation



Never remove or mount the optical fibre while the laser is powered on

For the following steps, use only low laser power and follow the laser safety rules!

The **LCU** is assembled and aligned according to the customer needs. During shipment some of the beam guiding elements are covered with protective caps, which have to be removed before the first operation. Additionally, in some cases the single mode fiber has to be mounted to the (appropriate) fiber coupler and the laser heads have to be connected with their corresponding driver (PDL 800-B/D, PDL 808/828 Sepia-I/II).

2.10 Mounting of the Optical Fiber

The PM-SM-fibers are equipped with FC-APC connectors with both end cut at 8°. The angled polish of the fiber ferule (see Fig. 2.13) prevents back reflection from the fiber end into the fiber and into the beam path respectively. Every FC-APC connector has a so called **index**. The index (see Fig. 2.13) is a protection against rotation inside the fiber coupler. Furthermore, the polarization axis and the 8° angled polish are orientated in different configurations. The following chapter describes the mounting of the SM-PM-fibers for the different configurations of the LCU.

2.10.1 Standard Configuration

(MicroTime 200, Olympus FV1000/3000, Nikon C2, Leica SP8 for VIS lasers (440nm – 640nm))

The connector specification of the standard polarization maintaining single mode fiber (PM-SM-fiber) for the MicroTime 200 is given in Fig. 2.13. The 8° angled polish of both ends is rotated by 90° to the connector index. The polarization axis (slow axis – see chapter 3) goes through the index (see Fig. 2.13 – left). The diode laser heads inside the LCU and the fiber output coupler are aligned in that way that the polarization plane of the laser beams is vertical to the ground plate of the LCU and parallel orientated to the polarization axis of the fiber.



Fig. 2.13: Standard FC-APC connector with 8° angled polish which is rotated by 90° to the connector index. With the standard PM-SM-fiber of the LCU the used polarization axis of the fiber is orientated as demonstrated on the left hand side. The polarization plane of the laser beams are parallel aligned to this axis.

The **Fiber Coupler** is capable for every kind of FC-APC connectors. To compensate the tilted escaping beam the retainer for the fiber connector is also tilted. Therefore it is very important that the connector is mounted in the right position.

The **Fiber Coupler** has two sockets for the connector index, the Standard and the Point Source socket. For the standard configuration of the LCU only the **Std. Socket** is used. Fig. 2.14 shows the two sockets and their position. The **Std. Socket** is perpendicular to the plane area at the cylindric fiber coupler where the small fixing screw for the fiber ferule is located.

Carefully plug the ferule into the coupler and avoid damaging of the face at the fiber end. Rotate the connector until the connector **index** fits into the **Std. Socket** (see Fig. 2.15). Then screw the lock ring by hand and fix the ferule with the small screw **only finger tip tight** (see Fig. 2.15 - use a appropriate screw driver from the supplied toolbox). **Keep in mind that for the disassembling of the fiber the ferule has to be unlocked.**

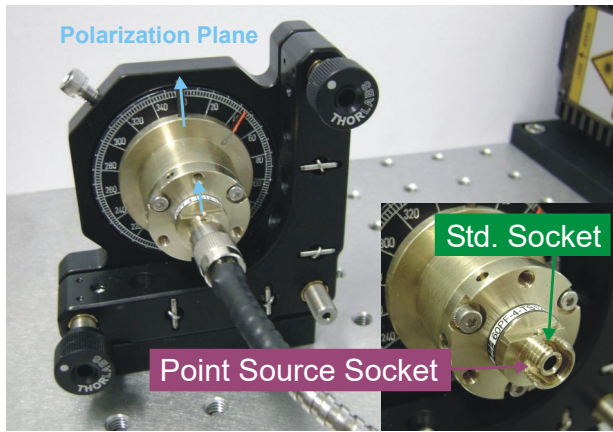


Fig. 2.14: The **Fiber Coupler** of the LCU has two sockets for the connector index: For standard fibers the **Std. Socket** and for Point Source fibers the **Point Source Socket**. The blue arrows show the standard orientation of the polarization from the PicoQuant lasers inside the LCU.

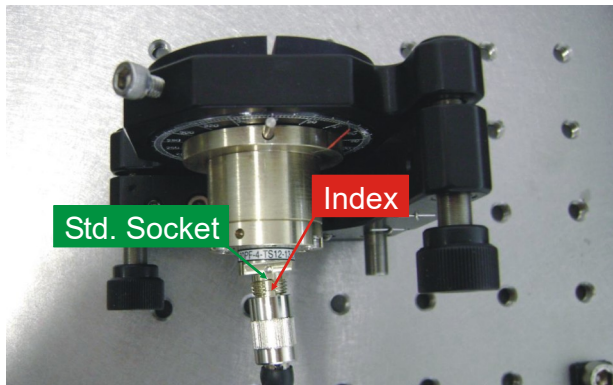


Fig. 2.15: For the standard configuration of the LCU (MicroTime 200) the connector **Index** has to be fit in to the **Std. Socket** of the fiber coupler.

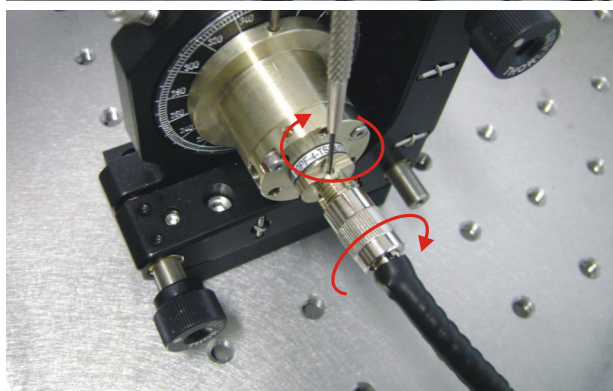


Fig. 2.16: Only a correct mounting of the fiber enables a stable coupling efficiency. Therefore screwing the lock ring by hand and fix the ferule **slightly** with an appropriate screw driver. **Force will destroy the fiber!**

2.10.2 Fiber Coupling for Laser Scanning Microscope (LSM) Upgrade Kits

Some manufacturers of Laser Scanning Microscopes are using a different norm for the FC-APC connectors, which was invented by the manufacturer Point Source. The difference can be seen in Fig. 2.17, left. In contrast to the standard FC-APC norm (Fig. 2.17, right) the angled polish is falling off to the connector **Index**. The used polarization axis (slow axis – see chapter 3) has the same orientation like the angled polish and the **Index** (Fig. 2.17, left).

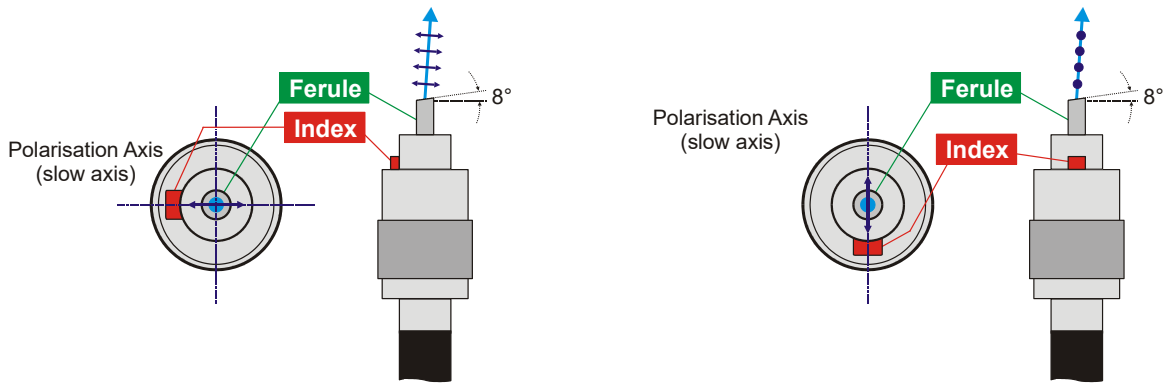


Fig. 2.17: Left: Connector specification of the Point Source PM-SM-fiber. The used polarization axis has the same orientation like the 8° angled polish and the **Index**.
Right: Standard FC-APC connector where the index is rotated by 90° to the angled polish (see also Fig. 2.13).

The following connector norms are used for the different LSM manufacturers:

- Zeiss LSM510: Point Source norm (Fig. 2.19).
- Olympus FV1000/3000: New in coupling with polarizing beamsplitter: Connector at both sides: Standard norm (Fig. 2.15).
- Leica SP8: Connector at the side of the Leica SP8: Point Source norm (UV) or special fiber outcoupler (VIS). Connector at the side of the LCU: Standard norm, but polarization perpendicular to the index (Fig. 2.18).
- Nikon C1si: standard norm on both sides: Nikon C1si and LCU (Fig. 2.14).

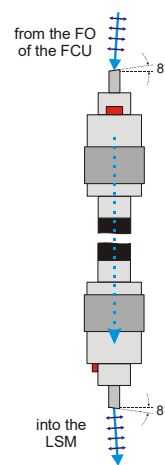
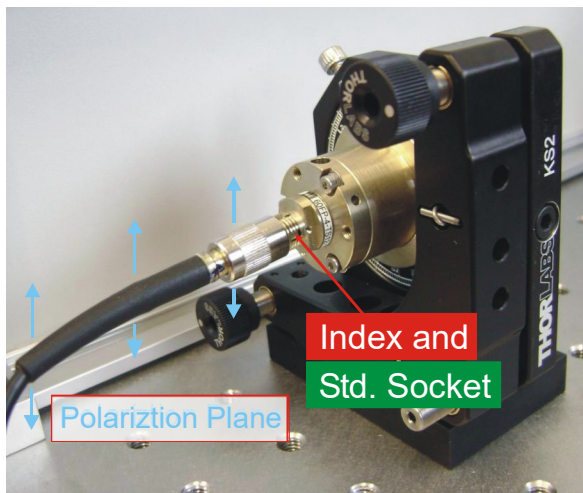


Fig. 2.18: Leica SP8, only 405 laser: Mounting of the standard fiber end to the **Fiber Coupler**. The connector index has to be fit into the **Std. Socket**. The other end is attached to the LSM. The polarization is indicated with blue arrows. The Index and the fixation screw (compare Fig. 2.16) must point to the right side!

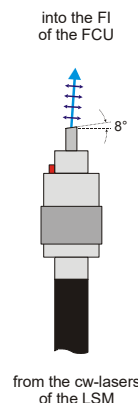
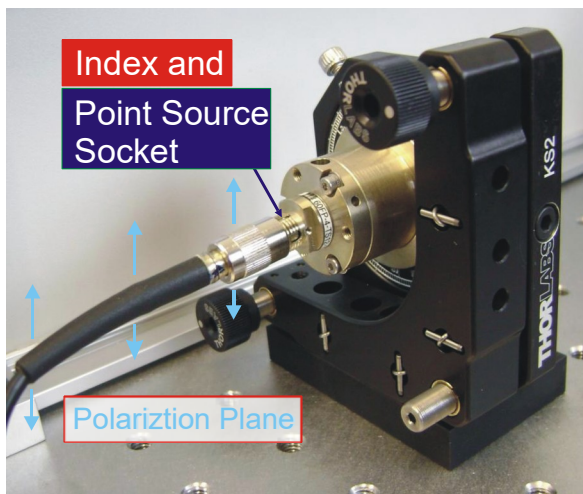


Fig. 2.19: Zeiss LSM 510: Mounting of the fiber from and to the LSM to the **Fiber Coupler Out** and the **Fiber Coupler In**. The connector index has to be fit into the **Point Source Socket**. The polarization is indicated with blue arrows. Some Point Source fibers are delivered without a FC connector and fit into a special adaptor of the **Fiber Coupler Out**.

3.

3.0.1 Laser Polarization Orientation

The coupling of several laser beams into one polarization maintaining single mode fiber (PM-SM-fiber) requires that the used polarization axis of the fiber is adapted to the polarization orientation of the lasers. All laser are mounted with an polarization plane perpendicular to the base plate inside the LCU.

3.0.2 Alignment of the PM-SM-fiber with Respect to the Polarization Plane

Polarization maintaining single mode fibers have two perpendicular preferential polarization axes, called “fast” and “slow” axis. The axis are due to the birefringence resulting from tensions inside the fiber material (cladding). Linearly polarized light launched along one of the preferential axes remain aligned with the axis as it propagates through the fiber. The slower axis is orientated parallel to the tension field and is mainly used because of better folding and crosstalk characteristics. Linear polarized laser beams which are not perfectly matched to one of the two axis will become elliptically polarized at the end of the fiber due to the different propagation speeds of the polarized components.

When using a polarization maintaining fiber, the polarization plane of all laser beams must be aligned to match one of these axis. The provided PicoQuant lasers are already optimally aligned and a realignment is only necessary if the fiber is exchanged. The polarization planes of all internal lasers are vertical and if possible, the polarization plane of external lasers should also be matched to this plane. As standard configuration the slow axis of the PM-SM-fiber is used and adjusted to the laser polarization.

The fiber axis can be turned at the **Fiber Coupler**, by loosening the Allen hex screw, as shown in Fig. 3.1. The actual position can be determined from the scale at the **Fiber Coupler**.

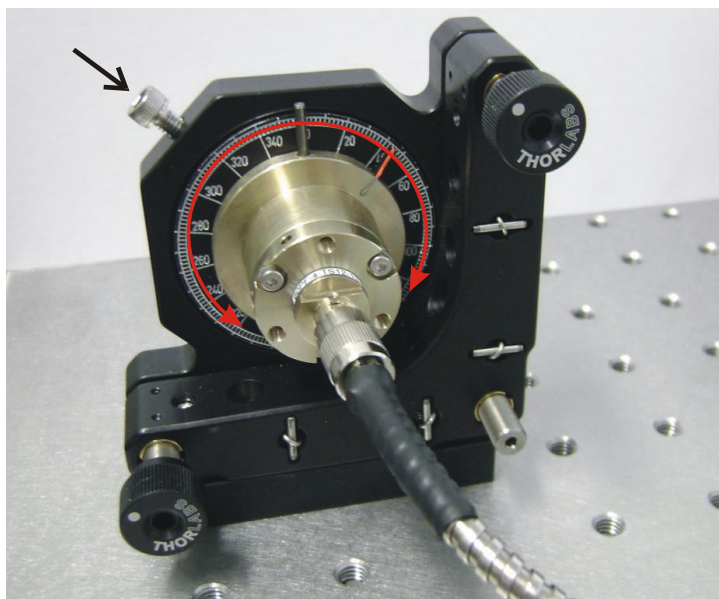


Fig. 3.1: Alignment of the slow axis of the PM-SM-fiber with respect to the polarization plane inside the LCU. Loosen the appropriate Allen hex screw (arrow) to rotate the fiber coupler.

To align the plane of beam polarization to one of the preferential axes, guide the light from the fiber output through a polarizer to a power meter. Find the minimum and maximum (i.e. 90° with respect to the minimum) intensity. The ratio of these two values should be better than 1 : 80. Evaluate this polarization ratio by turning the **Fiber Coupler** in steps of 20°; proceed with smaller steps near the found maximum (e.g. in steps of 2°). After each turn, the laser intensity at the fiber exit must be optimized using the adjustment screws (Fig. 2.4) at the **Fiber Coupler** because the rotation of the **Fiber Coupler** mount might lead to a tilting of the fiber input end.

Due to the individual construction of each laser head, the polarization planes of the lasers might be tilted by few degrees with respect to each other. When using several lasers, a compromise has to be made by using an average value (e.g. Laser 1 @ 350° and Laser 2 @ 352° => fiber polarization plane @ 351°).

4. Technical Data

4.1 Specifications

Connectors Main-LCU

Laser Cable..... Lemo.3B.812
 SM Fiber..... Endcap FC-AFC

Connectors motorized Version

NIDAQ Electronic Cable..... SUB-D 37 pol.
 Power..... Kycon 4pol. KPJX-PM-4S-S, 12V DC,
 max. 45W

Connectors Zeiss Upgrade Version

Shutter Controll..... Lemo female

Temperature Range..... 19°C - 25°C

Humidity..... < 60% rel. humidity

Location Hight..... max. 2000 m over sea level

Dimensions (Length x Width x Height, in mm)

Main-LCU..... 400 x 600 x 230

Weight

Main-LCU..... ~ 35 kg

Retraction of old Devices

Waste electrical products must not be disposed of with household waste. This equipment should be taken to your local recycling centre for safe treatment.

WEEE-Reg.-Nr. DE 96457402



5. Support

If you observe any malfunction, please try to find a reproducible error situation. E-mail a detailed description of the problem and relevant circumstances to info@picoquant.com. Your feedback will help us to improve the product and documentation.

In any case, we would like to offer you our complete support. Please do not hesitate to contact PicoQuant if you would like assistance with your system.

Of course, we also appreciate good news: If you have obtained exciting results with the system, we would also like to know!

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