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# D0026 - Gen1B Stroke Detection Device Service Personnel Manual

Stroke Detection Project

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## 1. Introduction

### 1.1. Purpose

The purpose of this service personnel manual is to serve as a guideline for qualified professionals trained by Openwater to safely service and troubleshoot the Openwater Stroke Detection Device as and when necessary.

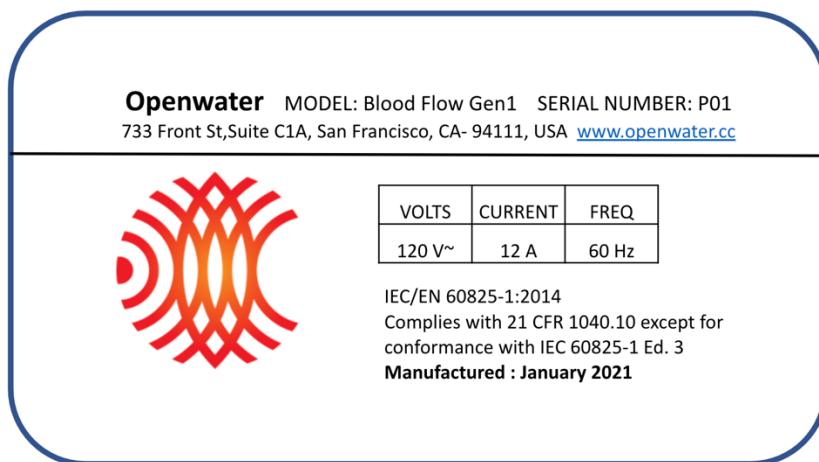


Fig 1: Title label of the product

### 1.2. Scope

This document covers aspects of servicing and troubleshooting of the Openwater Stroke Detection Device by qualified and trained Openwater personnel only, and is intended to be used along with the Operator Manual, and in strict adherence to all the safety

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measures and precautions mentioned in either of these documents. The document does not cover replacement of critical components like lasers.

Please use the Openwater Stroke Detection Device for gaining familiarity with the terminology used before attempting any repairs or services with this document.

### 1.3. Definitions, Acronyms and Abbreviations

This section is to be used to capture and define acronyms and abbreviations.

G1B: shorthand for Gen 1B, or Generation 1B of device.

TEC: Thermo Electric Cooler

TA: Tapered Amplifier

GUI: Graphical User Interface

LSB: Laser Safety Board

SM: Source Module

DM: Detector Module

## 2. Safety

**CAUTION – USE OF CONTROLS OR ADJUSTMENTS, OR DEVIATION FROM INSTRUCTIONS AND CAUTIONS SPECIFIED HEREIN MAY RESULT IN HAZARDOUS RADIATION EXPOSURE, THAT MAY CAUSE EYE DAMAGE OR BURNS.**

**Direct exposure to the beam can cause eye damage, skin and/or corneal burn. Please avoid any exposure to the beam.**

**The device emits Class 3R invisible laser radiation. Avoid eye or skin exposure to direct or scattered radiation. There is exposure from the source fiber in the wand, but there is also a possibility of exposure from the source module or damaged fibers in the source module and detector module once the Tower door is opened.**

**Please read all instructions, and the Operator Manual carefully before attempting to operate the device.**

**In case of any emergency, please press the red emergency stop button on the side of the tower (opposite to the handle), which turns off the laser.**

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**Servicing should only be performed by trained and qualified Openwater personnel, without other people around.**

**Please follow all safety and caution labels posted on the device.**

## 2.1. Laser Parameters



Fig 2: Laser warning label on the product

### 2.1.1. Embedded Laser Source Specifications (Class 3B)

The Openwater Gen 1B Stroke Detection Device is a class 3R laser product that outputs 5 mW average power under normal circumstances and utilizes a **Class 3B laser**, which is capable of producing Class 4 radiation if used in the wrong configurations by bypassing safety protocols and normal factory settings.

**Under no circumstances are the laser driver settings to be changed**, even for troubleshooting or servicing. While these settings are reset to factory settings every time a scan is run, it is possible for a service personnel to allow light emission after bypassing the safety protocols, resulting in harm. All troubleshooting and servicing should be done with the existing laser driver settings.

Please exercise extreme caution with the handling of the fiber, follow safety instructions and do not gaze into the apertures or point the wand towards eyes. Do not open the tower doors and/or go inside the tower unless you are a qualified Openwater service personnel. **When the tower doors are open, there is CLASS 3B invisible radiation. AVOID EXPOSURE TO THE BEAM.**

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Fig 4: Class 3B Laser warning on the source module

### 2.1.2. System Laser Output Specifications (Class 3R)

Wavelength	785 nm
Pulse duration	100 µs
Pulse Repetition Rate	14 Hz
Average Power	4.9 mW
Peak Energy per pulse (at the delivery fiber tip)	350 uJ

Observe the safety instructions AT ALL TIMES.

- Please ensure that the AC mains supply is rated for the unit (110 V, 20 A, 60 Hz outlet) before connecting. The supply must include a good ground connection.
- **All the people in the room need to wear the appropriate safety glasses (OD 3+ at the wavelength of operation), before powering on the laser.**
- Avoid having bystanders or unnecessary personnel in the room during troubleshooting.
- Please follow the instructions provided in the service personnel manual, as well as the Operator Manual, and read them thoroughly before operating the device.
- Position the tower close to the wall with an electrical outlet or cover the electric cable with the cable mat to minimize trip hazards.
- Do not under any circumstances open the source module or unplug the optical fibers without qualified personnel from Openwater present.

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- Do not point the wand directly at anyone's eyes when the system is operational/powered ON.
- Do not look directly into the beam.
- **Always use the diffusing spacer tips provided for any and all operations with the device, including servicing.**
- **Please be careful of reflections of the beam from any surfaces.**
- This system is only intended to be operated by trained personnel.

## **2.2. Exiting service mode**

**Once the servicing is done, it is very important to return the system to its original, functional state capable of making measurements with all the safety mechanisms in place. More details on this in section 13.**

## **3. System health check**

The system should routinely be checked for any physical or mechanical damage, and **before and after any maintenance or service action** requiring opening the tower.

As far as possible, any troubleshooting, maintenance or repair should be performed without opening up the SM or bypassing any safety mechanisms, before resorting to those steps.

Steps to undertake for a general health check:

- a. Run a calibration in accordance with Section 5 (Calibration Procedure) of the Stroke Detection Device Operator Manual.
- b. Compare the calibration values with the historic values. If the values are as expected, please avoid opening up the source module.
- c. Measure the energy output from the wand, following instructions from section xxx.
- d. With the **DEVICE POWERED OFF ENTIRELY**, check the fiber connections to and from the wand, detector and the source modules to ensure there is no damaged fiber or loose connections visible.
- e. Ensure there is no loose cabling or wires.
- f. Check the images saved from the calibrations to ensure that the intensity on the camera seems relatively uniform, with no dark spots or ring-like illumination (which would indicate a misalignment of the detection fiber).

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## 4. Bypassing safety mechanisms

Please be advised that the safety mechanisms in the device are designed to avoid harmful laser radiation from causing damage to the operators and users. While some services might require bypassing these mechanisms, please be aware of the risks and dangers involved in doing so. Ensure that all the steps mentioned in the previous section **Please ensure that everyone has the proper eye protection before operating, or servicing the system.**

Please keep the wand either in its holder on the side of the tower, or the service module or hold it on the calibration phantom while using any of these procedures.

### 4.1. Laser safety board (LSB)

The LSB is designed to turn the laser off by turning off the TA whenever the laser pulses exceed normal operating energy levels.

This prevents higher energy pulses from exiting the wand.

### 4.2. Align mode

The Align mode can be used to bypass the safety mechanisms put in place to only emit pulses when the user is in scan mode. By using the Align mode, laser pulses can be emitted continuously without the need to press the trigger button on the wand.

Since this mode allows such free pulsing, it should be used with extreme caution, and instructions should be followed to open **as well as to close the Align mode.** More details are provided in the subsequent section.

## 5. Align mode

- The ‘Align mode’ displays all the cameras in the detector modules in real time on the GUI with **laser pulses (CLASS 3R, invisible)** being emitted from the source fiber in the wand.
- The Align mode is a special mode of operation, to be used only in presence of/by trained Openwater personnel for troubleshooting, maintenance or alignment purposes.

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- This mode bypasses the requirement of using the contact microswitch and the wand trigger button, and emits the laser pulses directly, which is why it needs to be **used with extreme caution**.
- **Please ensure that only trained personnel are in the room while using the Align mode, and they have appropriate eye protection (OD 5+ glasses at 785 nm).**
- Use the Align mode with the wand on the Calibration phantom.

Using the 'Align' mode:

- a. If the scan GUI is open, please close the GUI window. If Scanner was not running previously, please open the Scanner app by double clicking the Scanner Icon on the desktop and then close the GUI (launching the Scanner app opens the GUI and the Powershell window).
- b. Go to the Powershell window that is open (it looks like the Terminal window on Mac or 'cmd prompt' on Windows systems).
- c. Type '**python .\scanUI.py --align**' in the command line (or press the up arrow till you get this command), and press return.
- d. This launches the scan GUI window, with the Align button now on the bottom left.
- e. Place the wand on the Calibration phantom.
- f. Click the 'Align' button on the GUI.
- g. This launches the window displaying all 4 cameras in real time.
- h. Please keep in mind that this mode DOES NOT REQUIRE THE TRIGGER and **starts laser emission from the wand as soon as 'Align' mode is launched**.
- i. When done with the align mode, **press STOP button** on the align/camera image display window, and **close the GUI** and relaunch it per usual by double clicking the Scanner icon from the desktop.

## 6. Service module

The Service Module is provided to enable repeatable and hands free energy measurements and calibration, and can be used any time a service is being performed.

The service module consists of a holder for the wand, and holders for the energy meter and for the calibration phantom.

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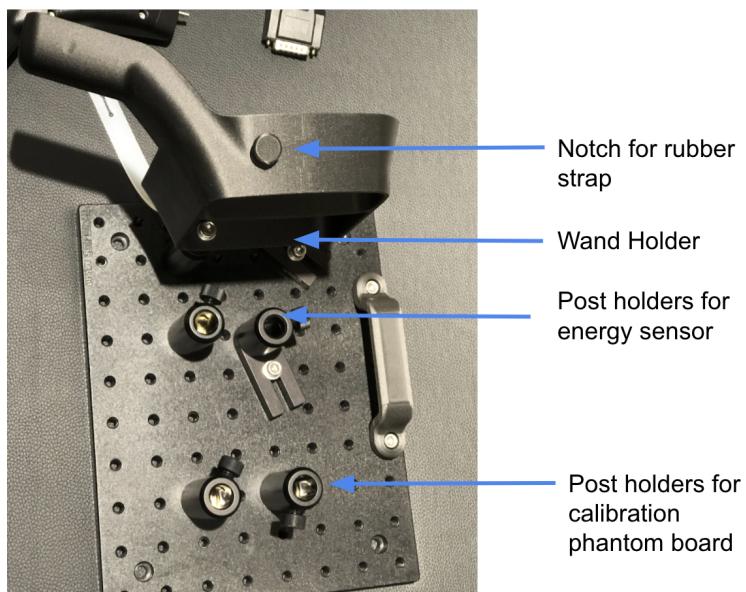


Fig: Parts of the service module

### 6.1. Using the service module for energy measurements:

To use the service module for energy measurements:

1. Ensure that the laser is not firing (app is closed).
2. Place the service module on a flat surface (like the tower top).
3. Place the energy sensor (it should already have the post mounted at the appropriate height) and then place the wand in the wand holder, and tighten the rubber strap to secure it in its place. Changing the order (first wand and then energy meter) might make it difficult to place the sensor at the right place.
4. Make sure that the energy meter is aligned with the source fiber.
5. Open the app and use the align mode to measure the energy.



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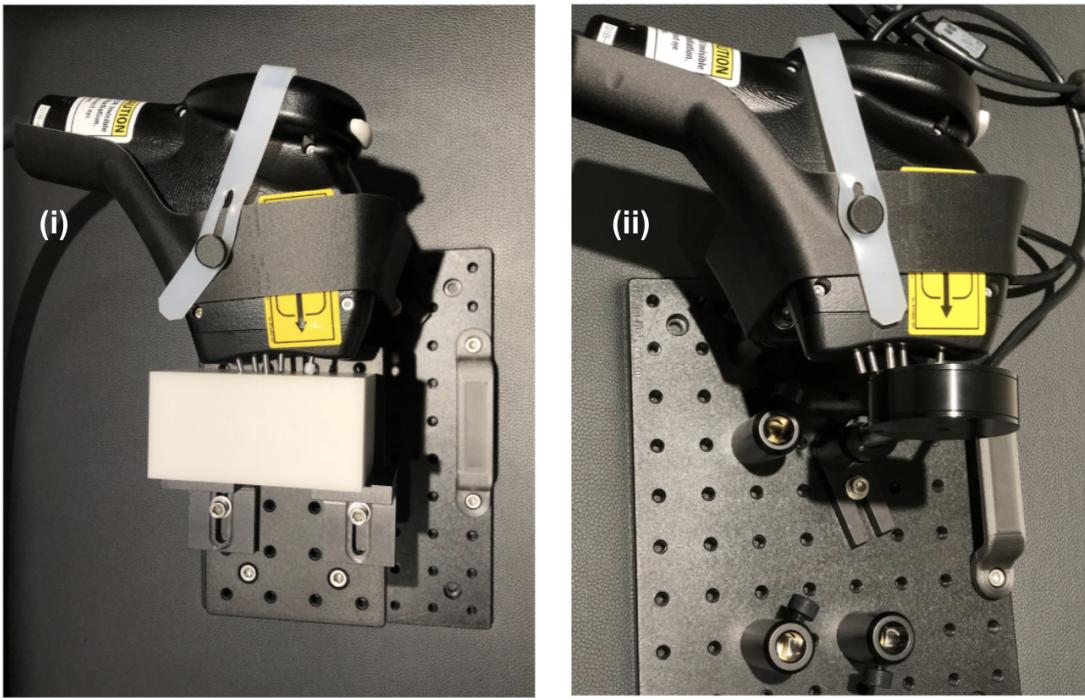


Fig: (i) Shows the service module used for calibration. (ii) shows the service module being used for energy measurement.

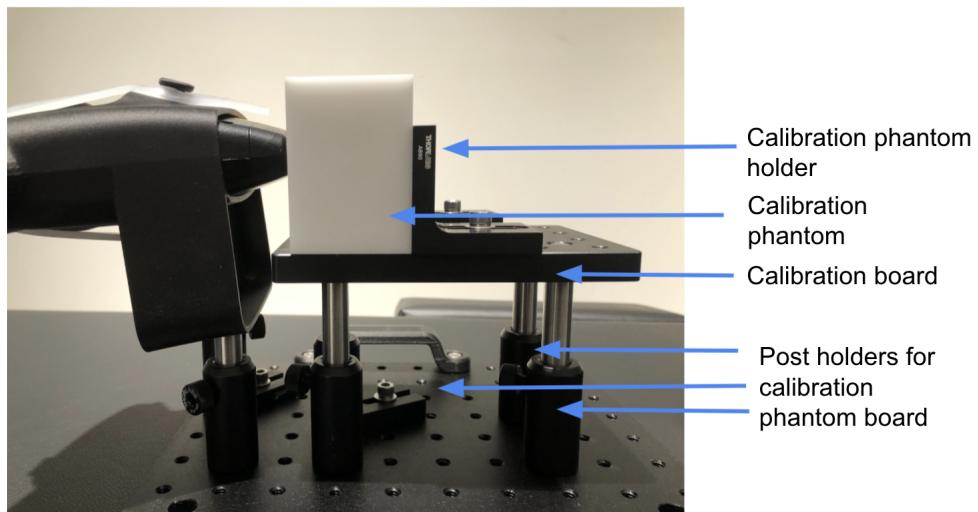


Fig: Shows the service module used for calibration

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## 6.2. Using the service module for calibration:

To use the service module for calibration:

1. Ensure that the laser is not firing (app is closed).
2. Place the service module on a flat surface (like the tower top).
3. Place the calibration board, and then place the wand in the wand holder, and tighten the rubber strap to secure it in its place.
4. Then place the calibration phantom on the board, loosening the screws on the calibration phantom holder to allow the placement, and then tighten them to hold the phantom in place.
5. Take the necessary measurements.

## 7. Opening the tower doors

The doors are locked at all times.

After the service, the doors should be locked again and the key should be returned to its original location.

Please be aware that the tower houses a CLASS 3B laser. **When the tower doors are open, there is CLASS 3B invisible radiation. AVOID EXPOSURE TO THE BEAM.**



### 7.1. Opening the front door

If a service personnel needs to access the tower, the front door can be opened with the key provided.

Opening the front door gives access to laser drivers (seed and TA drivers), the computer, the detector module and part of the source module.

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## 7.2. Opening the back door

The backdoor can be opened by lifting the latch on the backdoor, on the right side.

The back door gives access to the detector module, source module (including source fiber coupler), the octopus, the computer and the back panel of the laser drivers, as well as the tower fan, and the wand access into the tower.

For any servicing, it is more convenient to remove the back door by unhinging it from the top by pulling down the latch, and lifting the door up, making sure not to disconnect the fan power cable.

To replace the door, hold it firmly from both sides, lift it up and place the bottom rod into the notch in the frame (left corner), pull down the latch on top left corner and slide the door into its place, and release the latch.



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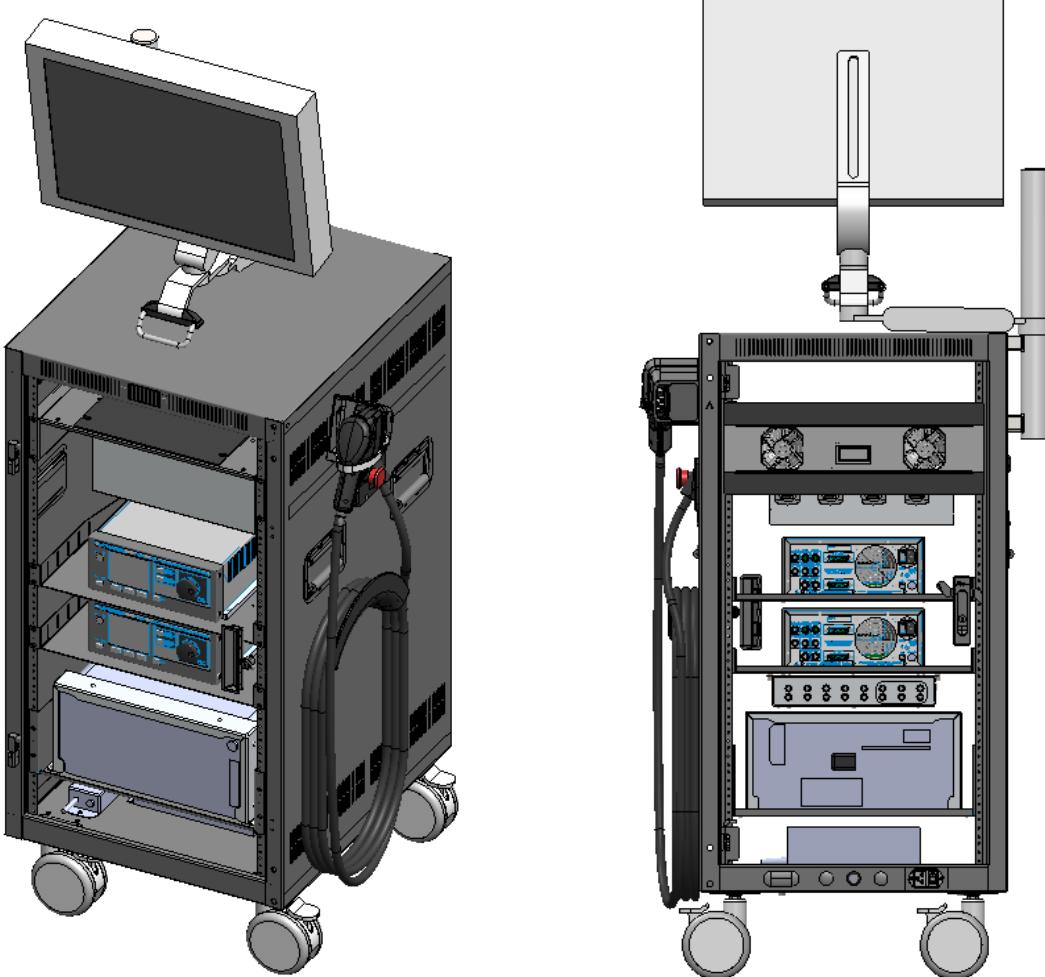


Fig: Front and back of the gen1B tower

## 8. Laser driver service

**The seed laser and TA driver settings should not be changed.**

In case of persistent laser errors displayed on the GUI, please check the laser driver screens to get the exact error message responsible for the software failure.



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### 8.1. Laser connection/other issues:

Most common possible issues with the laser with regards to the system are that the scan can not start because either connection to the laser failed, or the laser setting did not match the expected settings. The exact error should be checked in the Powershell Window

In either case, the service personnel will need to open the tower front door and work with the laser drivers.

Please be mindful of the laser inside the source module, and follow instructions as mentioned before to open the tower door.



1. If there is a connection issue, please check the following things:
  - a. The TA and Seed drivers should be powered on (Power Button should be depressed).
  - b. Key switch should be in an unlocked position for both devices.
2. If the INTLK (interlock) indicator is ON, it indicates that the Laser Safety Board is being tripped, in which case, please call Openwater HQ for support.

Manual for seed driver: [ITC4001-EnglishManual](#)

Manual for TA driver: [ITC4020-EnglishManual](#)

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## 8.2. Replacing the mains fuses in the TA and Seed drivers

In the event that the fuses need to be replaced in either of the ITC40XX units, open the back door of the tower according to previous instructions.

The two power input fuses in each ITC40XX unit are externally accessible. If they have opened due to line disturbance or other influences from the outside, they can be replaced at the rear without opening the unit.

### Warning

To avoid fire hazard, replace the two mains fuses with fuses of the specified type and rating only. Fuse Type: IEC60127-2/1 (High breaking capacity!), F10 H 250V, fast acting (F) 10 Amperes, size 5 x 20 mm.

1. Power off the ITC4000 and disconnect the mains cable.
2. The fuse holder (R14, see Figure 62) is located below the 3-terminal power connector of the mains jack (R10). Release the fuse holder by bending its two plastic retainers with the aid of two small screwdrivers. The retainers must be pressed towards the center of the fuse holder.
3. Replace the defective fuses (R15). We recommend changing both fuses, even if only one fuse has opened. Press in the fuse holder into the mains jack until locked on both sides.
4. Switch on the unit. If it cannot be switched on, please contact your supplier or Thorlabs.



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## 9. Detector module services/repairs

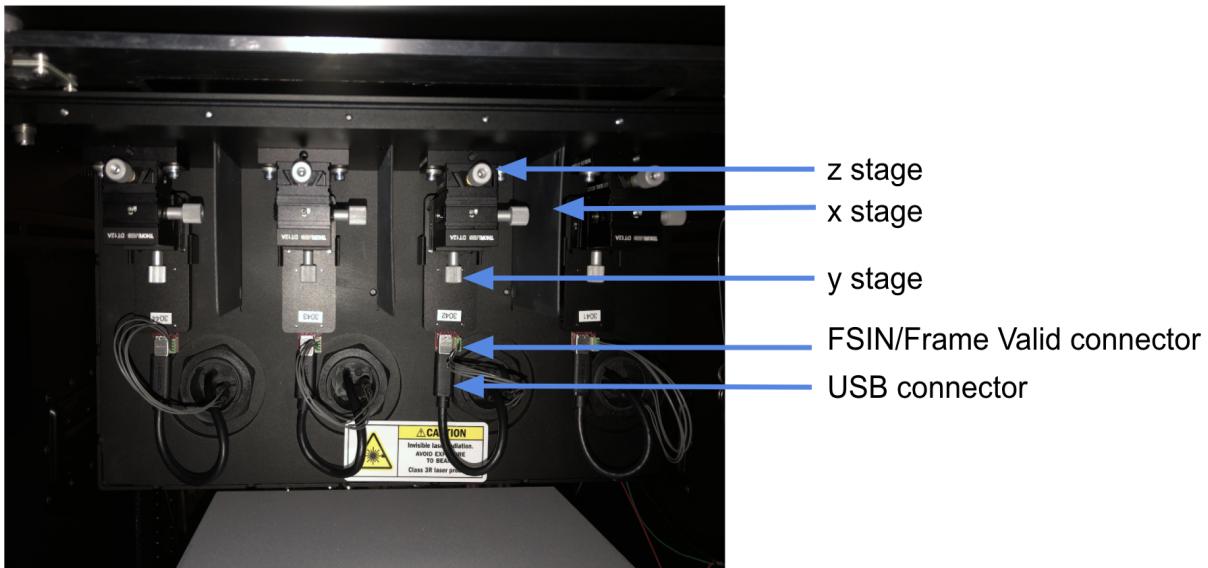


Fig: Interior of the detector module.

The only on field permitted services on the detector module are switching out/reconnecting the electrical cables and optical fiber.

The optical fiber and BNC cables can be accessed from the back door of the tower, and the USB cable can be accessed at multiple points between the computer USB hub and the camera, and should be accessed away from the detector module if possible.

## 10. Source module services/repairs

The source module only allows the change/alignment of the source fiber as a repair or service. For any other service, call Openwater HQ.

Since the Source Fiber cannot be changed as a stand alone, the whole wand needs to be replaced. For instructions on replacing the wand and realigning the fiber, please refer to the next section.



## 11. Changing the wand

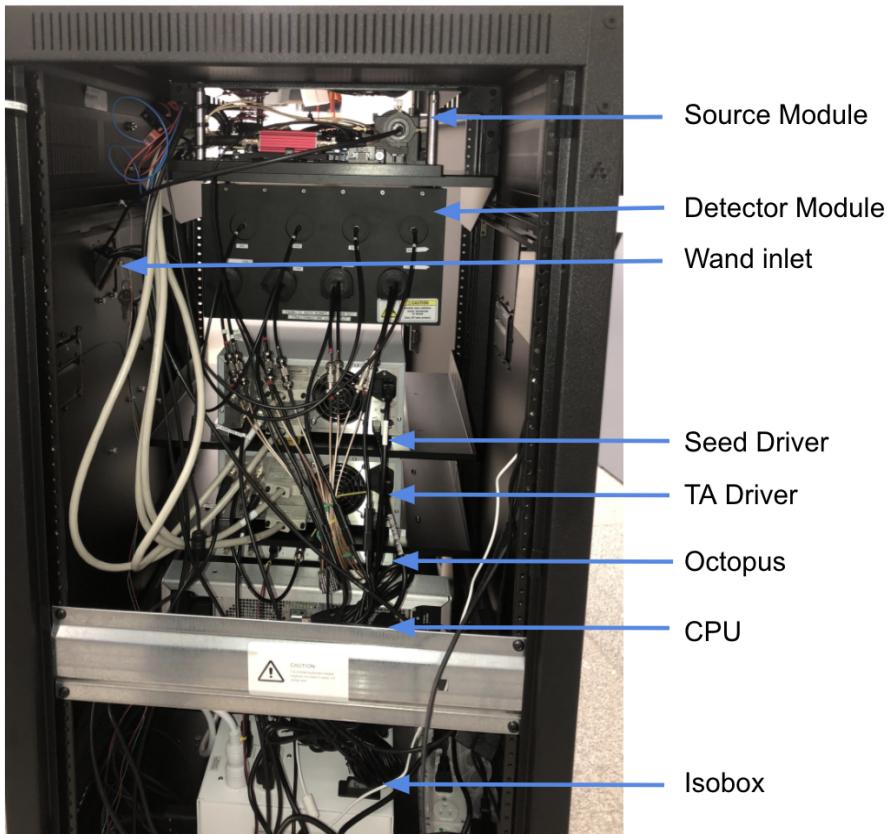


Fig: cable connections inside the tower

Once you have a replacement wand ready to go, to change the wand, follow the following steps:

### 11.1. Removing the wand:

1. Ensure the tower is in a place where you can work freely, and the wheels are locked.
2. Place the service module on a flat surface, and refer to section 7.2 and follow the instructions to measure energy.
3. Put the energy sensor in the correct position, and place the energy meter such that the readings are visible from behind the tower.
4. Put the wand in the wand holder in the service module and secure it with the rubber strap.

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5. With the system on, and in align mode, measure the energy coming out of the wand and note it down.
6. Turn the app and the computer off, and power off the device(power switch is on the back at the bottom corner).
7. Once the device is switched off, take off the back door of the tower.
8. Referring to the figure above, disconnect the fibers from each of the cameras from the back of the detector module carefully, putting fiber caps on each one as you remove them to protect the fiber surface.
9. Carefully reach into the source fiber coupler and remove the source fiber, trying not to change the x,y,z axis settings. Put a fiber cap on the fiber.
10. Disconnect the two BNCs from Octopus (Digital In 1 bottom and Digital Out 6 bottom).
11. Remove the emergency stop button by using the hex tool to remove the two bottom screws. Place it safely on a surface.
12. Extricate the wand cable with all the fibers and electrical cables slowly and carefully through this hole created by removing the emergency button.
13. Remove the rubber strap and then remove the wand from its holder, and place it in a bag.

## 11.2. Connecting the new wand:

1. Place the new wand securely in the service module wand holder.
2. Carefully snake the wand cable with all the fibers through the gap created near the wand holder by removing the emergency button.
3. Pull the cable such that only the jacketed part of the wand cable is hanging outside the tower.
4. Connect the BNC cables to the Octopus (Digital In 1 bottom and Digital Out 6 bottom) as indicated by the individual labels.
5. Match the labels on the detector fibers and screw them into the respective detectors in the detector module (detector 1 to SD 1, etc).
6. Connect the source fiber to the fiber coupler on the source module, trying not to change the x,y,z settings.

### 11.2.1. For aligning the source fiber:

1. Refer to section 7.2 and setup to measure energy out of the source fiber.
2. Put the energy sensor in the correct position, and place the energy meter such that the readings are visible from behind the tower.

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3. If the energy reading is the same as or higher than with the previous wand, no need to change anything.
4. If the energy is lower, you will need to optimize the alignment of the source fiber- please stop at whichever point you reach the same energy as before the swap.
  - a. Slowly and deliberately rotate the rotational ring, stopping at the highest energy setting found in a full 360° turn.
  - b. If the energy is still not the same as before the swap, going one step at a time, slowly and deliberately move the x and y axis.
  - c. Lastly, if you have still not attained the same energy, move the z axis slightly.
  - d. ensure that the output beam does not have a donut profile.
  - e. Optimize the alignment and note down the output energy in the log.

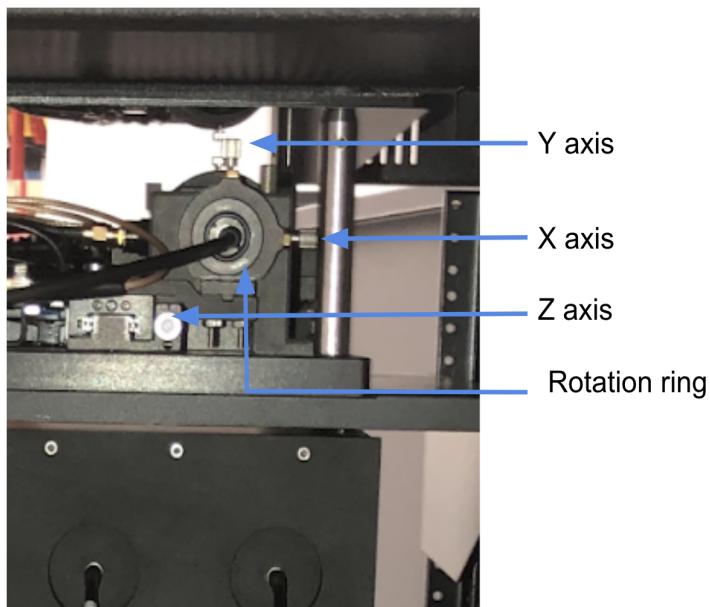


Fig: Shows the x,y,z and rotational adjustments for the source fiber

## 12. Measuring energy delivered from the source fiber

It is advisable to maintain a note of all energy measurements made.

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In the event that you need to measure the laser energy being delivered from the source fiber, follow these instructions:

- 1. Follow all safety instructions, and ensure that everyone present has their eye protection on. Even with proper eye protection, direct viewing of the beam should be avoided at all costs.**
2. Please don't use the scanner app until it is necessary to have laser pulses from the wand to reduce risks.
3. Follow instructions from section 7.2 to measure the energy using the service module.

## 13. Exiting service mode

Once the servicing is done, it is very important to return the system to its original, functional state capable of making measurements with all the safety mechanisms in place.

Please ensure all these steps have been followed:

1. Please ensure that the LSB is powered and connected, and the laser is off.
2. If the Moglabs cover was taken off, please put it back and screw it in.
3. Remove any external optics or instruments from the optical path.
4. Please replace the SM cover, and screw it shut. This also reactivates the interlock (gets rid of the override).
5. Ensure that the tower is covered and the top is screwed in, and the doors are shut.
6. Ensure that the scanner app on the computer is closed as well.
7. Run a calibration to ensure that the values (intensity, speckle contrast) have not changed significantly.