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# Manufacturing Tests of Light Delivery Fiber Assembly

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## 1. Purpose

This document describes testing of optical fibers and diffusers as they are integrated into a headset cable assembly. These are manufacturing tests intended to ensure that assemblies will meet performance requirements at the system level.

## 2. Major possible issues

### Individual fiber

- Fiber pop
- NA not 0.22
- Light loss due to leakage into cladding
- Fiber termination/polishing issues
  - Not 0 deg polish (angled)
  - chips/dust/scratch

### Fiber diffuser assembly

- Diffuser missing
- Diffuser cracked/damaged/scratched
- Glue on the diffuser (on the rough side)
- Glue in optical path
- Diffuser not in right orientation (the rough side should face fiber, shiny side should face beam exit)
- Sapphire optic not clean/scratched
- Gap/air/dust between the fiber and the diffuser
- Other optical obstructions
- Connector issues
- Fiber termination/polishing issues
  - Not flat polish (angled)
  - chips/dust/scratch

## 3. Test setup description

Optical fibers and fiber assemblies under test are illuminated with a 635 nm CW laser diode. Three different stations are used to position the device under test (either bare ferrule, or diffuser assembly) appropriately with respect to a photodiode detector. These stations correspond to each test performed:

- Transmission of individual fiber
- Diffuser test, Near
- Diffuser test, Far (100 mm distance, 7 mm aperture)

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A different photodiode sensor is used at each station, to minimize reconfiguration required during testing. A standard FC/PC to SMA patch cable is used as reference during fiber transmission test.

Figures 1 and 2 show a block diagram and photograph of the setup, respectively.

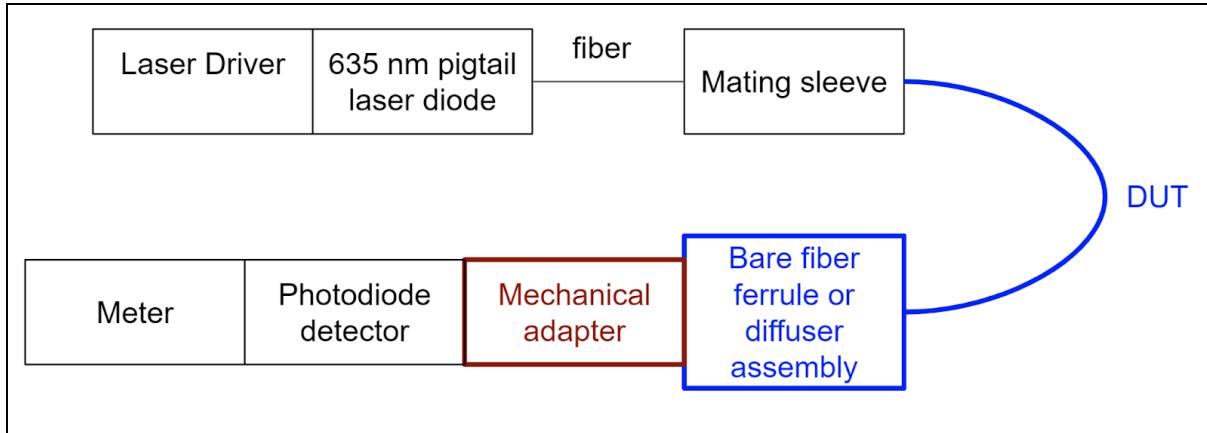


Figure 1 - Setup block diagram. Common to all three test stations.

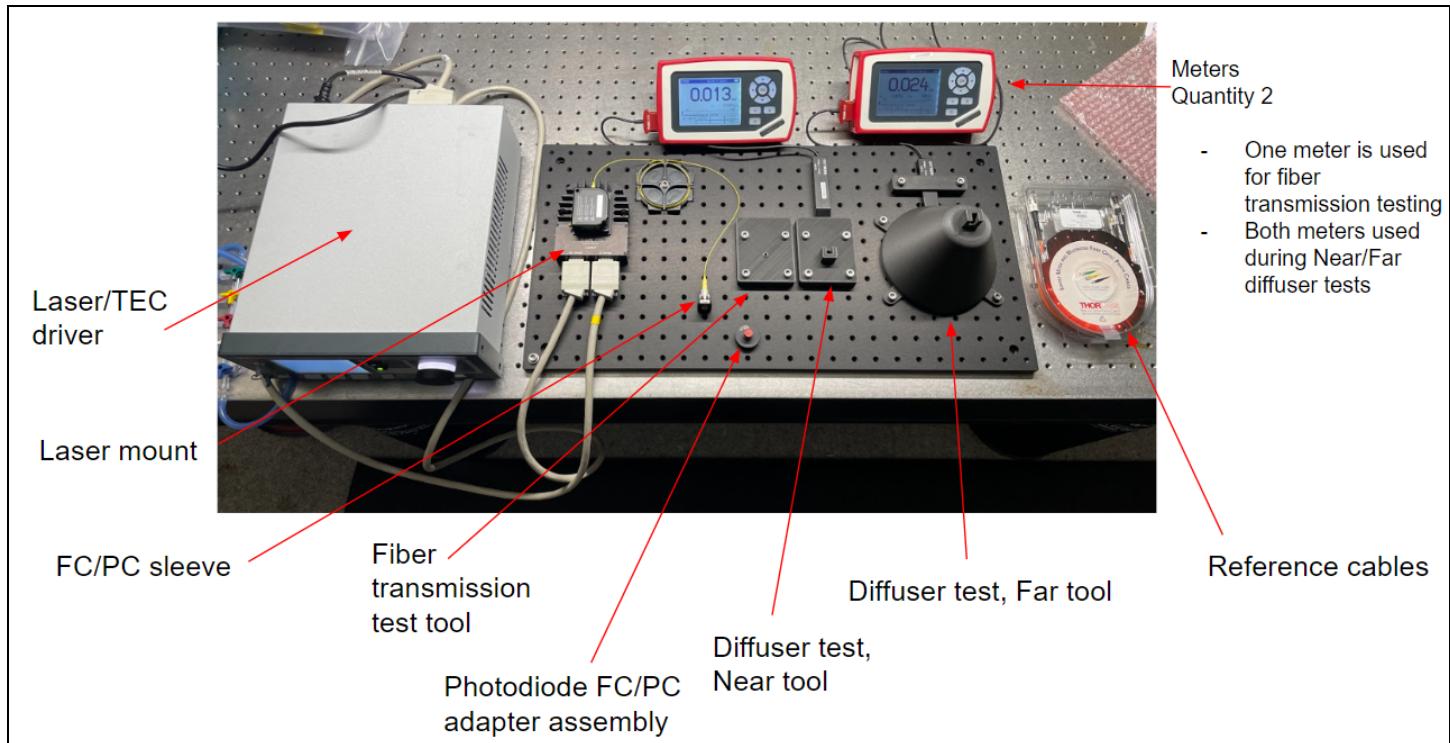


Figure 2 - Photograph of setup

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Summary of key components:

Component	Manufacturer	MFG PN
Laser/TEC controller	Thorlabs	ITC4001
Laser mount	Thorlabs	LDM9LP
Laser diode	Thorlabs	LPS-635-FC
Patch cable reference	Thorlabs	M36L01
Photodiode detectors	Thorlabs	S130C
Meters	Thorlabs	PM100D

See Openwater assembly 7000-0239 for detail.

## 4. Initial setup

### Purpose

- Measure output of pigtail diode

### Pass criteria

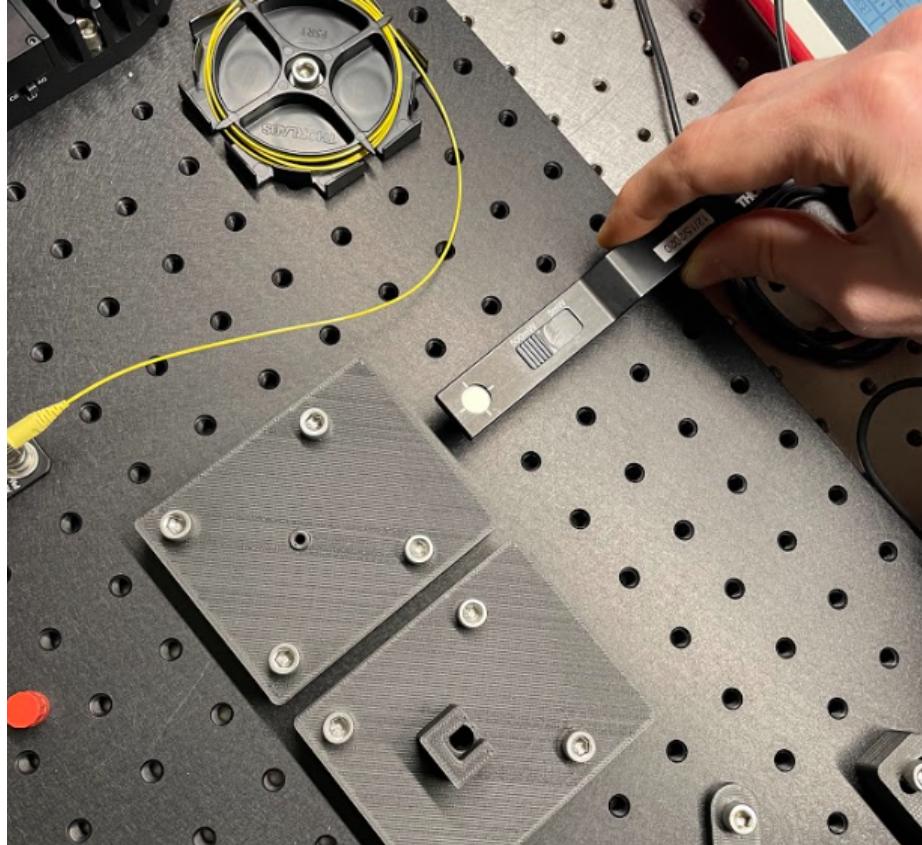
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### Procedure

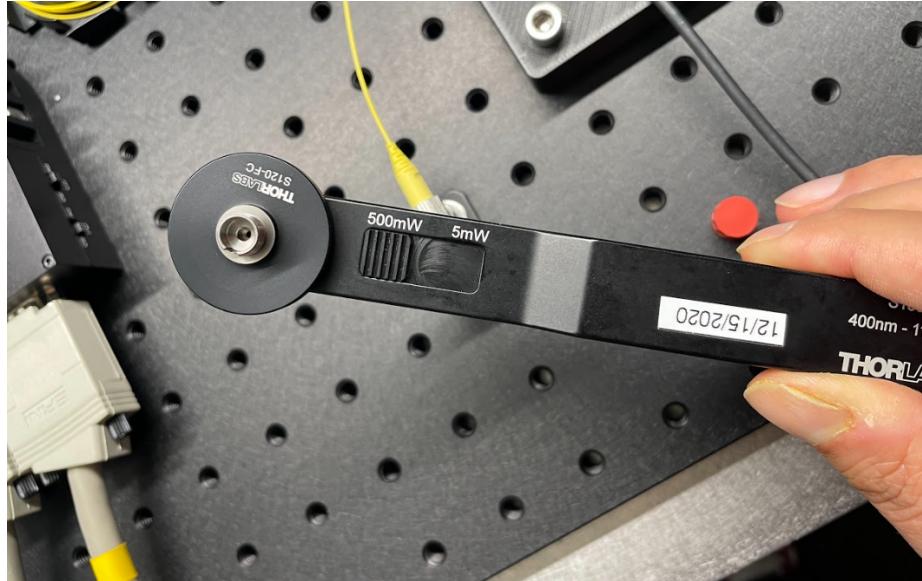
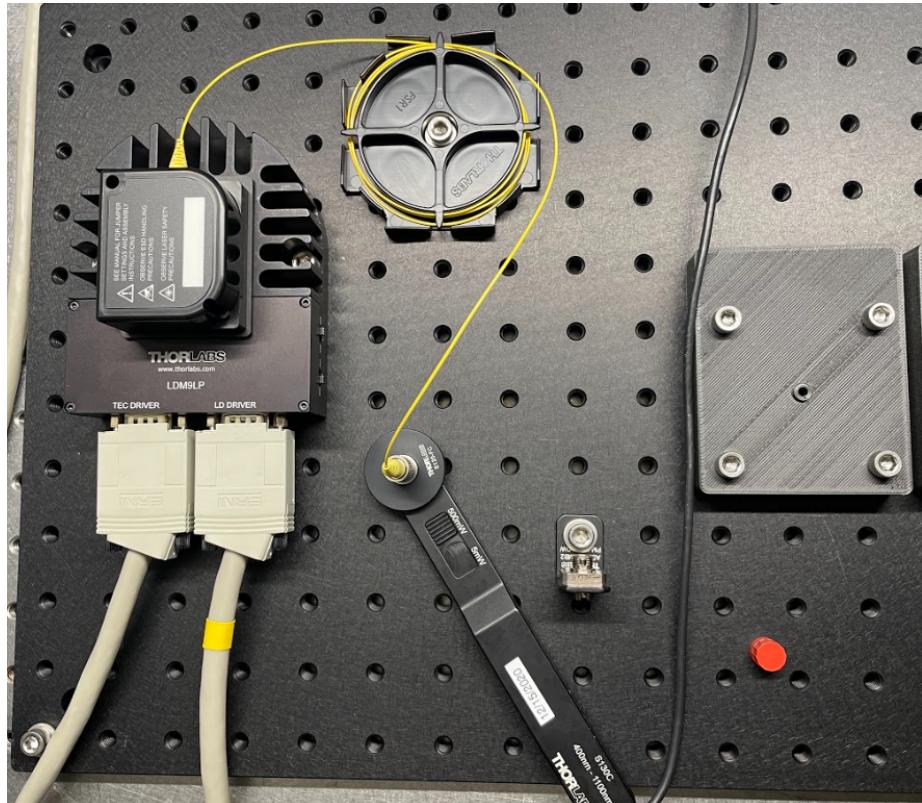
Power meter settings:

Parameter	Setting
Wavelength	635 nm
Range (Sensor)	1.20 mW
Range (Meter)	500 mW*
BW	LO
AUTO	OFF

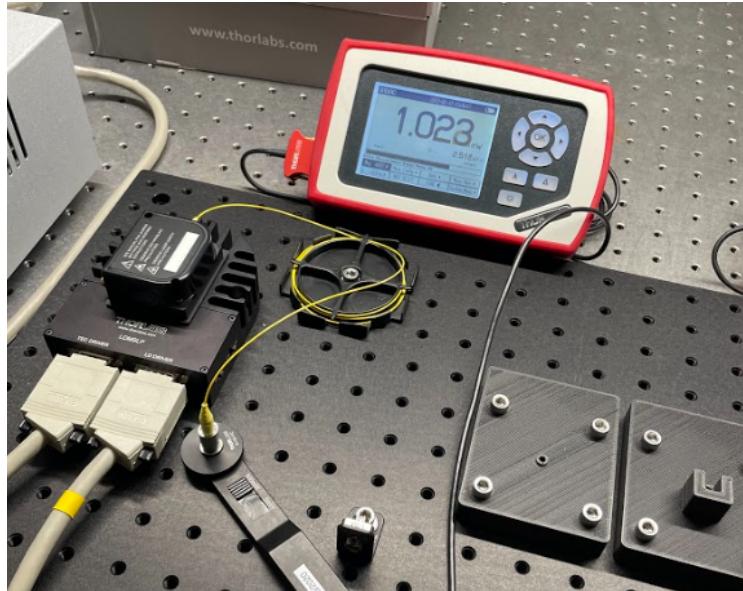
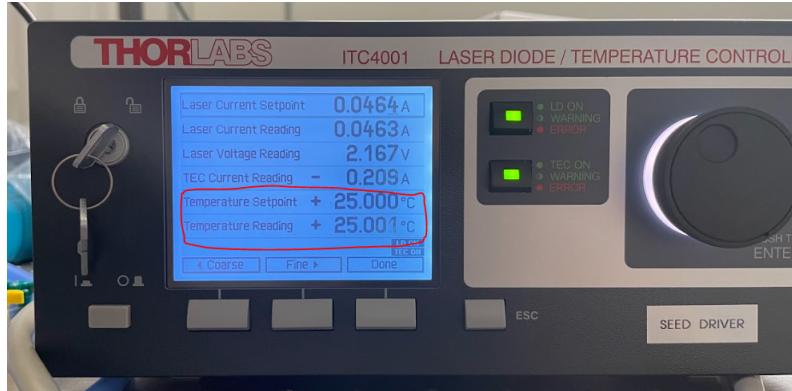
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Step	Description	Detail/Photo
10	Remove the photodiode sensor from the transmission measurement station by pulling it out of the tool. Verify that setting is 500 mW.	

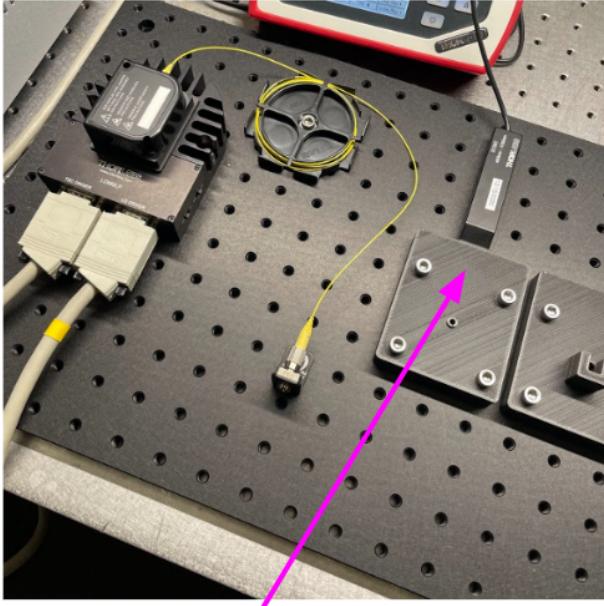
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20	Install the FC/PC mounting adapters to the sensor end: Thorlabs PN1 and Thorlabs PN2. Make sure that parts are fully seated and set screws are tightened.	
30	Unscrew the diode pigtail FC/PC connector the sleeve, and install onto the detector.	

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40	<p>Power on the laser driver, and adjust current until approximately 1 mW power is reached. Let sit until temperature is stabilized at setpoint. Record settings.</p>	  <p>Laser drive current: _____</p>

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50	<p>Power off the driver. Reinstall diode pigtail to FC/PC sleeve. Remove optomechanical components from sensor and return to measurement station. Ensure that it seats fully in the tool.</p>	 <p>A photograph showing a photodiode sensor assembly mounted on a grey pegboard-style measurement station. A yellow fiber cable is connected to the sensor. A pink arrow points from the text below to the sensor assembly. In the background, there are other electronic components and a digital multimeter.</p> <p>Install photodiode sensor to this station Selector switch on the sensor should remain set at 500 mW</p>
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## 5. Inspection and test of individual laser fibers

### 5.1. Visual inspection

Visually inspect the laser fiber and ensure that

- Fiber cable is free of damage and kinks
- Ferrule and ferrule-cable joint are undamaged
- Fiber does not protrude from the end of the ferrule or moves axially when pushing/pulling on the cable ('fiber pop')
- Fiber connector is intact and free of damage

### 5.2. Transmission efficiency test

#### Purpose

- Ensure the transmission efficiency of each assembly is within a certain range.
- Missing/damaged diffuser will result in different transmission.

#### Pass criteria

- Transmission of each finished fiber is  $80\% < \text{Eff} < 95\%$

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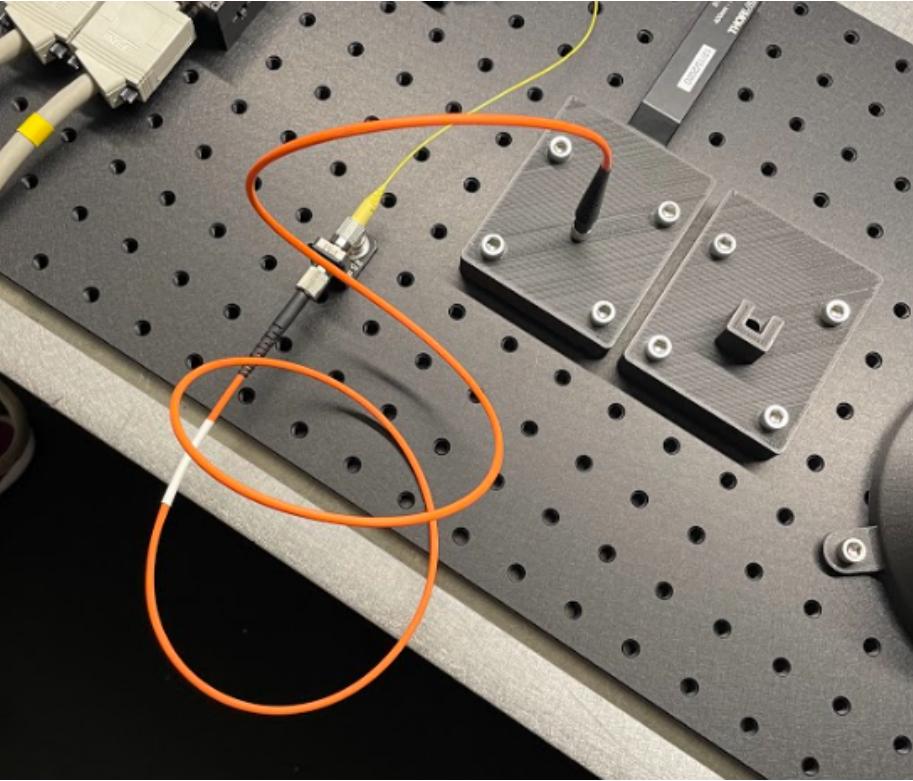
- If testing with only the FC connector (no diffuser), the transmission should be very close to the reference fiber.

## Procedure

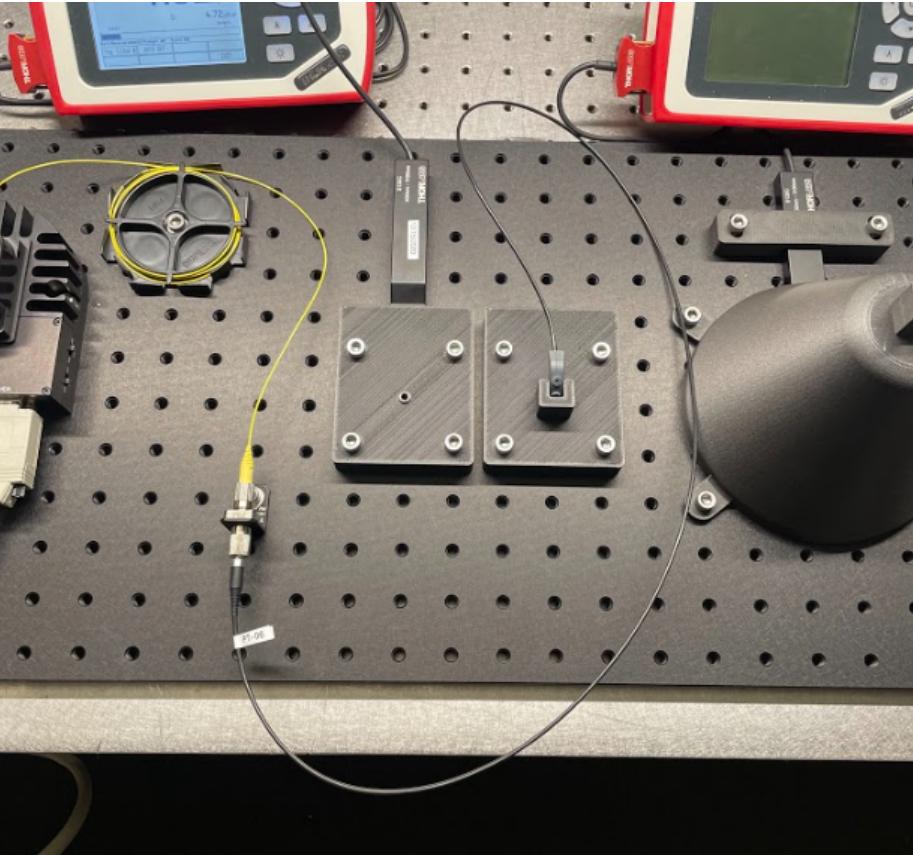
Parameter	Setting
Wavelength	635 nm
Range (Sensor)	1.20 mW
Range (Meter)	500 mW*
BW	LO
AUTO	OFF

Step	Description	Detail/Photo
10	Ensure that photodiode meter is plugged in and set properly per table above.	
20	Clean patch cable FC/PC end. Connect a golden patch cable to the FC/PC sleeve. Insert the SMA end into the test station. Record the cable SN in documentation.	

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30	<p>Power on the laser driver at the setting determined during setup. Record power. This is P_ref.</p>	

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40	Turn off the driver. Remove the patch cable from the setup. Clean DUT fiber FC/PC and install to sleeve and tool.	
50	Turn on the driver, and record the measured power. This is P_out.	
60	Unscrew the FC/PC connector and retighten it, observing the measured power. Repeat the process 5 times.	
70	If the power measured at the final position is significantly (>10 uW) different between the attempts, flag that fiber (FAIL) as defective and inspect the FC/PC connector on it.	
80	Calculate transmission	$P_{out}/P_{ref} = \text{Eff (transmission efficiency)}$

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	efficiency and record Pass/Fail.	Pass: 80 % < Eff < 95%
90	Repeat for additional fibers under test. Ensure that SNs are also recorded.	

#### Example data collection sheet

Fiber Number	Power in mW	Transmission ( $P_{out}/P_{ref}$ )
<b>Patch cable SN:</b>	( $P_{ref}$ )	
001		
002		
003		
.....		

## 6. Inspection and test of laser fiber diffuser assemblies

### 6.1. Visual inspection

Visually inspect the laser fiber diffuser assembly and ensure that

- Fiber cable is free of damage and kinks
- Fiber connector is intact and free of damage
- There is no debris on the output facet of the assembly.
- There is no glue ON the diffuser (it will look rough/transparent).
- The diffuser is aligned the right way (rough side facing towards the fiber tip, shiny side facing the glue/sapphire window).
- There are no scratches on the diffuser/sapphire window or air gaps between the two.

### 6.2. Quantitative diffusion test

#### Purpose

- Measure the diffusion in a quantitative manner

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- Missing/damaged diffuser will result in different diffusion.

#### Pass criteria

- Power ratio of (power in through 7 mm aperture 100 mm away/ total power at 0 mm) < 0.25%
- Only valid for fibers with diffusers.

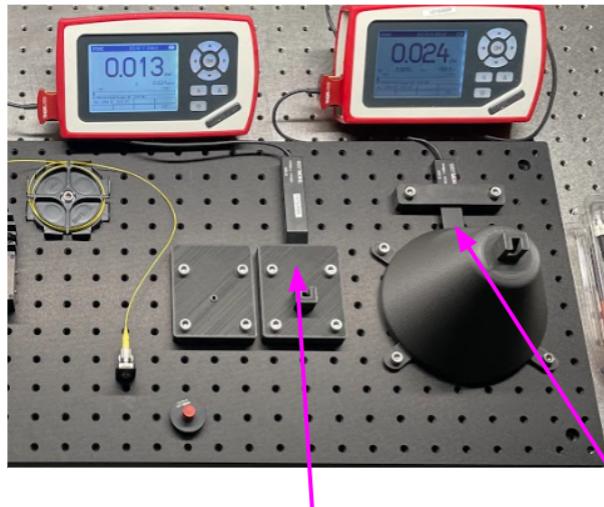
#### Procedure

Power meter settings:

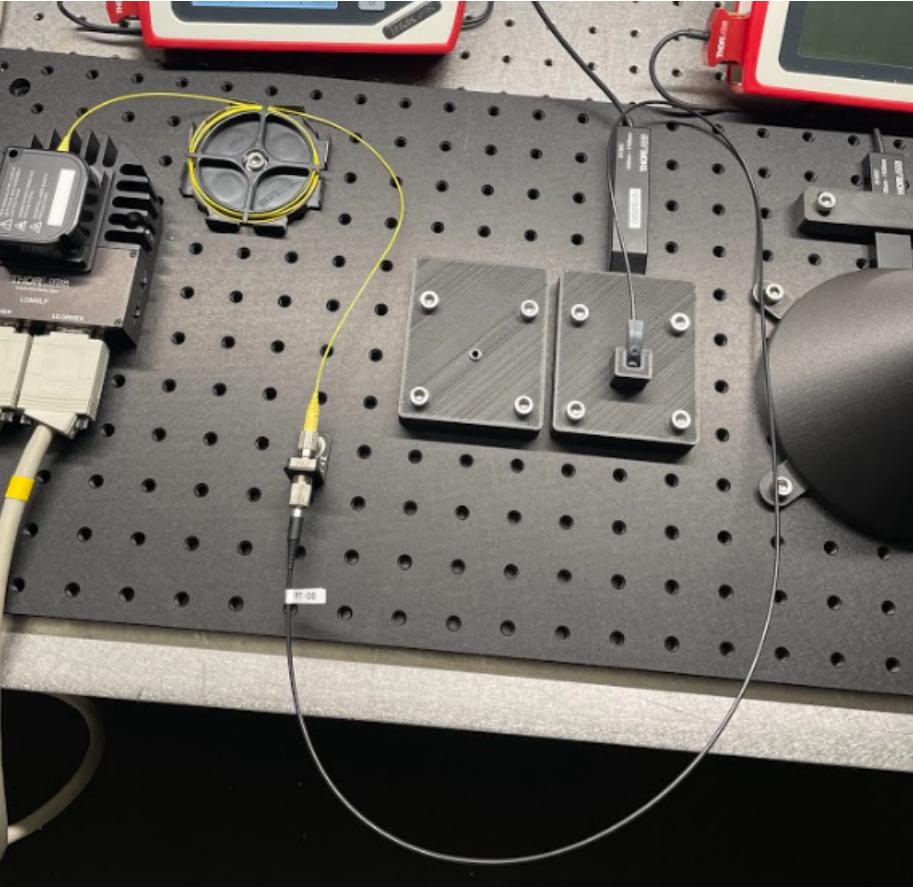
Setting	Near Measurement	Far Measurement
Wavelength	635 nm	
Range (Sensor)	1.20 mW	14.0 µW
Range (Meter)	500 mW	5 mW
BW	LO	
AUTO	OFF	

Step	Description	Detail/Photo

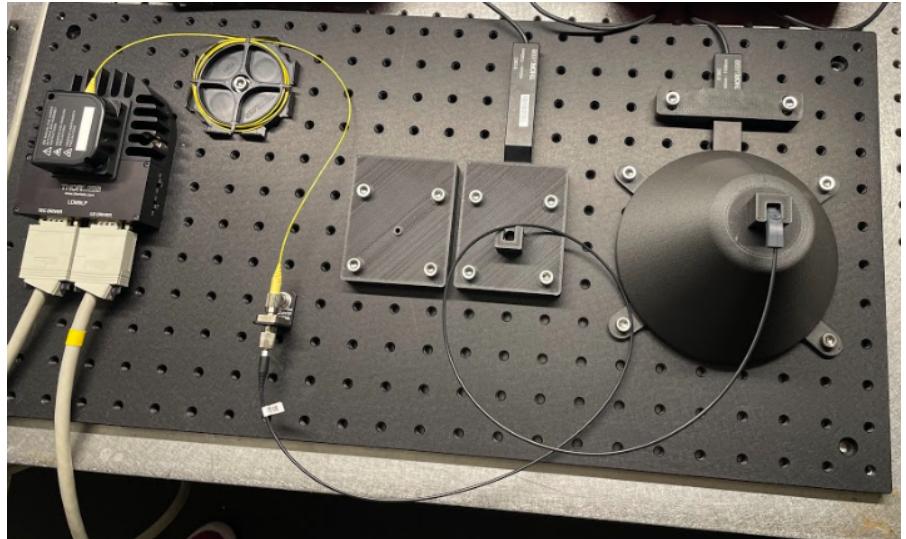
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10	<p>Move photodiode sensor from transmission test station to diffuser Near test station, if not already done.</p>	<p><b>Near meter</b></p>  <p>Photodiode installed in diffuser Near test station. Set to 500 mW</p> <p><b>Far meter</b></p> <p>Photodiode installed in diffuser Far test station. Set to 5 mW (note that this photodiode is clamped in place and not easily adjustable)</p>	
	Ensure that meters are set properly per table above.		

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20	Clean DUT FC/PC. Install the DUT fiber assembly to the FC/PC sleeve. Insert the diffuser end into the Near test station.	
30	Power on the laser driver at the setting determined during setup. Record power. This is P_0mm.	

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40	Turn off the laser driver, and move the diffuser assembly to the Far test station.	
50	Power on the laser driver at the setting determined during setup. Record power. This is $P_{100mm}$ .	
60	Calculate power ratio and record Pass/Fail.	<b><math>P_{100mm} / P_{0mm} = \text{Diffusion ratio}</math> (this should be &lt;0.0025 or 0.25 %)</b>
70	Repeat for additional fibers under test. Ensure that SNs are also recorded.	

#### Example data collection sheet

Fiber Number	$P_{0mm}$	$P_{100mm}$	Diffusion ratio	Pass/Fail
001				
002				
003				
.....				

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## Appendix I - Reference Documents

7000-0239 - FIBER TRANSMISSION AND DIFFUSER TEST ASSEMBLY