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Yavuz Lab

Fiber Tapering Manual

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# Lab Safety

## Laser Safety

The lab space has a variety of both free space and fiber lasers operating at 780 nm and 1080 nm. When entering the lab rooms googles should be worn if any laser is operating above 5 mW. The lab has several pairs of googles for these two different lasers and it is important that before using a pair that you check that it effectively blocks light at the wavelengths being used. This information can be found printed on the lens themselves or on the sides of the goggles. When checking ensure an optical depth (OD) of at least 5 for the required wavelength. Some of the pairs will block both but most will only block 780nm or 1064nm, so it is important to always check before entering a space with high strength laser light.

In our group we have multiple safety indicators that turn on when laser light exceeds safe levels. The first system you should check is the boxes outside the lab, these display the status and location of our most powerful lasers, if the indicator light is on you should knock and wait until someone brings you safety goggles. Often when these lasers are turned on a pair will be placed on the door handle leading into the lab. If you begin using a laser while others are in the lab space, you should let everyone know or provide goggles at the appropriate wavelength and OD rating.

The next system is a pair of indicator lights above either side of the doors connecting the two lab rooms. These will turn on when a laser in either room is operating above safe power levels but does not tell you which laser is on. If you see these on, then you should put on goggles before entering the other room.

Not all of our lasers are connected to the automatic system, such as the 1064nm laser you will use in the tapering process, which is not integrated but runs at 25 mW and should be operated with goggles on. Additionally, if you ever see goggles placed on a door handle you should always put them on before entering, even if all safety lights are off, only taking them off once you’ve confirmed with the occupants that all lasers are off or in safe operating ranges.

## Chemicals

The tapering process uses isopropyl and acetone, which are both very flammable, and since you will be working with an open flame it is important to keep them isolated from the torch to prevent accidents. If you manage to get either chemical in your eyes there is an eye washing station in room 5315. And for larger spills there is a shower station in both rooms. The safety sheets for these chemicals can be found at Sigma-Aldrich or by following the following links: [acetone](https://www.sigmaaldrich.com/US/en/sds/sigald/179124?srsltid=AfmBOopg0q9DoIviFOzZs3VhRdeZjxvi9nVzKRVltzLo3JOVG2IjVLlu) and [isopropyl](https://www.sigmaaldrich.com/US/en/sds/SIAL/W292912?userType=undefined)

## Gas Canisters

# Fiber Tapering

## Equipment

* Bare 1064nm single mode fiber spool
* 1064 nm laser
* Fiber tapering jig
* Hydrogen gas tank
* Hydrogen torch system
* Wire cutter
* Fiber cleaver
* Bare fiber connectors
* Kim wipe
* Isopropyl
* Acetone
* Paper tape
* Acrylic Box
* UV resin
* UV lamp
* Fiber fork
* 3-axis translation stage
* Leitz Orthoplan (1975) microscope
* APT modules
* Motorized translation stages
* Power meter
* Felt bottomed magnets
* Gloves

## Software

* Thorlabs optical power meter program
* APTUser
* Gimp

# Procedure

## Initial Setup

First turn on the power meter, computer, and motor controllers. Once on open both the power meter and motor controller software. Once the motor controller software is open begin by switching to the move sequencer window and loading the appropriate sequence. Next hit home on both windows to return the stages to the center of the jig.

Next turn on the hydrogen gas, this can be done by opening the valve on top of the gas canister all the way. Once this is open move to the blue pressure value and turn clockwise until the gauge reads 10 PSI. Once at pressure, open the valve on the torch head and ignite the flame allowing to burn for 3-5 seconds before closing the valve to clear the tube of any contaminants.

## A wire cutter with yellow handlesFiber prepping

To prep the fiber first strip the outer plastic coating using the widest wire stripper on the wire cutters, if struggling to get a good enough grip on the fiber using nitrile gloves can help give extra grip on the bare fiber. Next clean off the fiber using a Kim wipe with isopropyl. Once clean place the fiber inside the fiber cleaver positioning it such that there will be at least 1 in of bare fiber after cleaving, and that the fiber at least reaches the far edge of the device else cleaving maybe not work. If not enough fiber can be left while also reaching the far side, strip more of the coating off. Once correctly positioned secure fiber in place with magnetic flap and then close the lid and push the cutter all the way to cleave it. It is important to not make the stripped portion too long else it will be prone to breaking inside the fiber connector, however if it is too short it will not fit. 1-1.5 inches is ideal for the length of the striped portion post cleave.

Next insert the prepped fiber into the fiber connector such that it just protrudes out the other side, no more than 1 mm. Be gentle inserting the fiber and stop and remove the fiber if there is any resistance at all (if there is any resistance, refer to the steps [below](#_Blocked_Fiber_Connector) to clean the connector). The bare fiber is quite brittle and prone to breaking inside the connector and is difficult to remove. If after several attempts the fiber still will not pass through the connector try wiping it off with isopropanol again. If it still will not pass through you may have to re-cleave the fiber and try again.

Once fiber is correctly inserted, insert the fiber connector to the power meter and check to see that the power level is at an appropriate power level.

Next lay the fiber across the taper jig ensuring enough length to allow the acrylic box to fit overtop with pulling or otherwise harming the fiber. Identify which part of the fiber lays over the hydrogen torch and strip approximately 1.5-2 inches of the coating off. Try and remove as much of the coating as possible and then wipe the fiber with a Kim wipe using acetone, and then again using isopropyl to remove any residue.

Next lay the fiber down across the jig, securing it with the four felt bottomed magnets ensuring it lays inside the groves and the stripped portion is centered over the hydrogen torch. It is worth checking that the stages are homed before securing with the magnets, as homing after is likely to snap the fiber. Once secured note the power level reading.

## Tapering

To begin light the torch by pushing the head as far back as possible so the initial ignition does not damage the fiber. Once the valve is opened completely (at least 3 turns) return the torch head to its resting position. Quickly place the acrylic box overtop the jig, making sure not to place it down on the fiber or pull on it as this can break the fiber. Once the box is in place click run on both windows of the motor control software and begin monitoring the power meter graph.

The power will drop, however if there is a seemingly instantaneous drop to zero the fiber has broken and the run should be stopped, the torch turned off and the process started over again. Signs of a successful run will typically be the emergency of a beat frequency in the power meter graph. Additionally, the final power typically will not be below 2/3 the initial power. However, some successful fibers do not display these signs.

## Fiber Fork Attachment

During the tapering process the fiber tends to bow upwards, to fix this switch to the graphical view window of the motor controller and jog both the motors once and check the fiber to see that it has flattened. Typically only one jog each will be required but for very bowed fibers you may need more. You can also change the jog distance, but jogging should never exceed 0.15 units. Once the motor sequence has finished remove the acrylic box and turn off the torch by closing the valve and note the final power level.

Now that the fiber is flattened note the final displacement and then lower the 3-axis translation stage as low as it can go before attaching a fiber fork to it, just hand tightening the screws. Next raise the stage until the fiber just rests upon the fork, ensuring the taper is in the center of the fork. Next place a small drop of UV resin on each arm of the fork. This resin is particularly sticky and can be irritating, gloves are suggested whenever using it. Once the resin has been applied, hold the UV lamp over the fork and turn it on. The lamp will turn itself off at 45 seconds, and the resin needs ~2 minutes to properly cure, you will need to turn it on 3 times to ensure the best cure, else the weak cure can lead to the fiber breaking.

Once fully cured remove the fiber from the connector and cut it off from the spool and remove the magnets. Using the long ends of the fiber to create bunny ears across the fork between the taper and the screws and secure them with paper tape.

## Measuring the Fiber

Remove the fiber fork from the 3-axis stage and move it to the microscope. Turn the dial on the microscope box to turn on the microscope light, 6 Volts is all you will need to see. Start by bringing the microscope into focus over the wide end of the fiber all objectives have roughly the same focal plane so starting with the lowest magnification will make your life easier. Once in focus switch to the x50 objective and find the fiber again, if you have the fiber in the center of the view beforehand it should still be visible. Next, follow along the fiber until finding the narrowest portion, adjusting the focus as necessary along the way.

Once the narrowest portion has been found take a picture of the image through the right eye piece (the one with the graduation marks). Upload the photo to the computer and open it with Gimp. In Gimp using the measure tool, measure the pixel distance between any of the numbered ticks, this is equal to 24 microns and can be used to convert from pixels to distance. Next measure the width of the fiber using the same tools and convert this to the width in microns if your fiber is between 1.5-2.5 microns then you have made a successful fiber.

## A screenshot of a computerFiber Storing

Upon making a successful fiber fill out a fiber chart in the google doc and save it following the naming convention “S0xxx” and write this on the paper tape on the fork. Place the fork inside the fork holder in the controlled atmosphere cabinet making care the long ends of the fiber do not break any of the other fibers. Once inside the fork holder, place the lid back on top gently, don’t lock the lid in place this may cause fiber breakage, and return the box to the cabinet.

# Common Issues, Trouble Shooting, Best Practices (\*\*\*)

## Flame Volume

A close-up of a device

AI-generated content may be incorrect.If the fiber is failing to taper at all or is tapering too much or too little, it is often a problem with the flame volume. This can be adjusted by manipulating the regulator attached to the table leg below the torch head. It is best to do this with the lights off so you can easily see the flame.

## Blocked Fiber Connector