
THORLABS

LCM10 Laser Fiber Cutter

User Guide



 vytran®

















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Chapter 1 Warning Symbol Definitions

Below is a list of warning symbols you may encounter in this manual or on your device.

Symbol	Description
	Direct Current
	Alternating Current
	Both Direct and Alternating Current
	Earth Ground Terminal
	Protective Conductor Terminal
	Frame or Chassis Terminal
	Equipotentiality
	On (Supply)
	Off (Supply)
	In Position of a Bi-Stable Push Control
	Out Position of a Bi-Stable Push Control
	Caution: Risk of Electric Shock
	Caution: Hot Surface
	Caution: Risk of Danger
	Warning: Laser Radiation
	Caution: Spinning Blades May Cause Harm

Chapter 2 Safety

All statements regarding safety of operation and technical data in this instruction manual will only apply when the unit is operated correctly.



WARNING



Do not put your fingers under the loading dock, as they may be pinched when the platform moves down.



WARNING



Never activate the cutting function without a connector mount in place on the loading dock.



CAUTION



Do not remove the front or back panel. Invisible laser radiation when open and interlocks defeated. Avoid eye or skin exposure to direct or scattered radiation.



WARNING



If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.



CAUTION



This laser system contains a Class 4 CO₂ laser in a Class 1 enclosure.
EN 60825-1:2014



CAUTION



Shut off power and remove the line cord before servicing the fuses.



2.1. Standards Applied

- CISPR 11
- IEC 61000
- IEC 60825-1 Ed. 3 and IEC 60601-2-22 Ed. 3.1 (Laser Notice No. 56)
- EN 60825-1:2014
- EN 61010-1:2010
- EN 61326-1:2013
- ICES-003

Chapter 3 Description

3.1. Introduction

The LCM10 Fiber Cutter is designed for cutting fibers in ferrules with a high degree of accuracy, ease of use, and versatility in manufacturing or research environments. It can cut through fibers emerging from ferrules as well as epoxy beads at the ends of ferrules. The LCM10 is designed to replace the *manual cleave / hand polish / epoxy removal* steps normally employed by patch cord manufacturers with one single fast process. The largest fiber that can be cut by the LCM10 is 1.5 mm diameter. There is no lower size limit.

The LCM10 employs a 40W CO₂ laser to perform the cut and has a fan at the back of the unit that sucks the fumes generated by the process away from the user. The exhaust gas is passed through a carbon filter, which filters out the harmful waste products of the cutting process.

Off-cuts drop into a collection bin, which is easily accessed via a door in the front of the unit.

The LCM10 accepts a variety of different interchangeable connector mounts and can therefore trim the fiber emerging from SMA connectors, LC connectors and MT connectors, as well as FC/PC and SC connectors. Adding cannula stops to the bottoms of connector mounts makes it possible to hold cannulae as well. The base unit comes with all the aforementioned connector mounts. The one for FC/PC and SC connectors comes installed on the machine. The other connectors are supplied in a toolkit that ships with the machine.

3.2. Parts Checklist

Check to make sure that you have the following items:

- The LCM10
- Region-specific power cord
- Set of two keys (to activate laser)
- Fiber coil hanger
- Ferrule holder
- Off-cut bin
- Calibration pin
- FC/PC connector mount (doubles as an SC connector mount)
- MT connector mount
- SMA connector mount
- LC connector mount
- Ø1.25 mm ferrule cannula stop for LC connector mount
- Ø2.5 mm ferrule cannula stop for FC/PC connector mount
- Foot switch, if ordered (purchased separately)

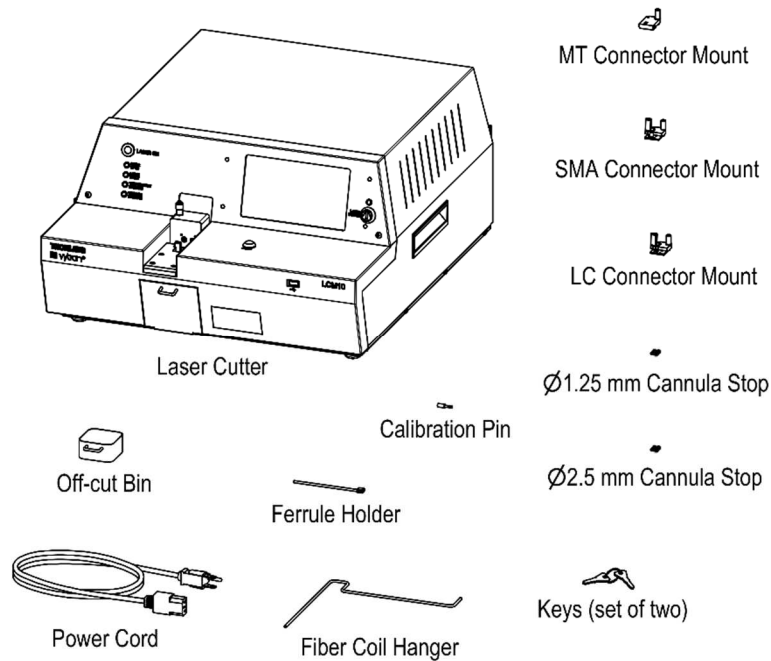


Figure 1 LCM10 Accessories

If you are missing any of the accessories or need replacements, please contact the distributor from whom you bought the fiber cutter. Visit <https://www.thorlabs.com/locations.com> for contact information.

NOTE: Please save the packaging material for returning the unit back to Thorlabs for service. This packaging will reduce the risk of damage during shipment.



Figure 2 Packing Material

3.3. Accessories

3.3.1. Connector mounts

The LCM10 comes with four connector mounts: one for FC/PC and SC connectors, one for MT connectors, one for SMA connectors, and one for LC connectors. The connector mount for FC/PC and SC connectors comes installed in the machine and the rest ship in the tool box. Connector mounts are easy to change, as they are held in place with a single thumb screw. See Chapter 15 for more details.

3.3.2. Cannula stops

There are two cannula stops available, which facilitate the holding of ferrules without stop features. The cannula stops get mounted on the bottoms of connector mounts. See Chapter 15 for more details.

3.3.3. Keys

The LCM10 comes with two keys. One key is required to power up the laser. The other key is a spare, which should be stored carefully in case someone loses the first key.

3.3.4. Fiber coil hanger

The LCM10 comes with a fiber coil hanger. To use it, insert the bottom end into the socket found on the left side of the unit. This will allow you to hang coils of fiber on the top bar of the hanger.

3.3.5. Ferrule mast

The LCM10 comes with a ferrule holder on a short mast. To use it, insert the bottom end into the socket found on the left side of the unit. There is only one socket, so the ferrule mast and the fiber coil hanger cannot be used at the same time. However, it is possible to remove the ferrule holder from the end of the ferrule mast and clip it onto the body of the fiber coil hanger, if desired.

3.3.6. Calibration pin

The LCM10 comes with a stepped pin which is used for camera image scale calibration.

3.3.7. Foot switch

The cutting process can be initiated using an optional foot switch (sold separately). Since the cutting process can be initiated using the blue button on the front of the unit, or the “Start” button on the touch screen, this foot switch is not necessary for operation of the LCM10, but some users may find it convenient.



Figure 3 **Foot Switch**

3.4. Control Overview

3.4.1. Rocker switch

The LCM10 has a rocker switch in the back which powers up the unit.

3.4.2. Laser keyswitch

The LCM10 has a keyswitch on the right side of the front panel which enables the laser. Maintenance and file management tasks can be done with the keyswitch in the “off” position, but the keyswitch must be turned clockwise to the “on” position for the LCM10 to cut anything. The laser must be warmed up for approximately 30 seconds before the cutting process can be initiated. Before the laser is warmed up, a red indicator light labeled “LASER FAULT” will glow. Once the laser is warmed up, this indicator light will go out. There is a white LED labeled “LASER POWER” that indicates when the laser is powered.

3.4.3. Start button

The LCM10 has a blue “start” button on the right side of the front work surface. This button can be used to initiate the cutting process. Alternatively, the foot switch can be used to start the process, if it is plugged into the back of the unit. It is also possible to initiate the cutting process using the touch screen.

3.4.4. Status lights

In addition to the “laser power” LED, The LCM10 has five status lights on the front surface that indicate the state of the unit. They include:

- A “LASER ON” light that indicates when the laser is actually lasing.
- A “VOLTAGE WARNING” light that indicates if the laser is not receiving enough voltage
- A “TEMPERATURE WARNING” light that indicates if the laser is running too hot
- A “LASER FAULT” light that indicates if the laser is not yet ready for use (see previous section)
- A “DOOR OPEN” light that indicates if the door to the off-cut chamber has been left open (the laser will not fire with the door open)

3.4.5. USB port

The LCM10 has a USB port in the front for transferring process files or connecting peripheral devices.

3.4.6. Loading dock

The LCM10 has a loading station that accepts different connector mounts for different ferrules. The connector mounts are attached with a single thumb screw. Normally, the loading dock goes up after a cut to make it easier to remove the ferrule and put a new ferrule in the connector mount, and then lowers for the next cut. If the user wishes, this movement can be turned off to shorten the cycle time. The loading dock can also be raised to make it easier to change connector mounts. This is discussed in Section 6.2.

3.4.7. Touchscreen

A Touchscreen Display provides full control of the LCM10. A simple user interface is displayed on the touchscreen as well as a live camera image that allows the user to see the ferrule and the fiber emerging from it. The user interacts with the user interface by touching the various buttons or icons displayed on the touchscreen. You can also slide your finger along the touchscreen to perform actions such as scrolling through lists of files or system parameters.



Figure 4 Overview of button, switch, status lights, USB port, loading dock, and touchscreen

3.4.8. Discard chamber and off-cut bin

The LCM10 has a discard chamber and an off-cut bin that goes into it. The ends of fibers that are cut by the laser drop into this off-cut bin. When it is time to empty the bin, it can be accessed by opening the door at the front of the unit. The laser will not fire while the door is open.

i **Always keep the discard bin in the discard chamber** when doing cuts to avoid damaging the discard chamber gasket. Hot off-cuts will melt holes in the gasket!



Figure 5 Off-cut bin in chamber (door open)

3.4.9. Communications ports in the back

The LCM10 has four ports in the back that enable communication with the unit. These are:





- a USB port, for file transfers
- an Ethernet port, for remote diagnostics
- a display port for connecting an external monitor, if desired
- the socket where the optional foot switch can be connected



Figure 6 Four ports in the back

Chapter 4 Setup

4.1. Initial Setup

<p>1. Plug in the AC power cord. The power supply accepts an AC input of 100-240 VAC; 47-63 Hz. Do not use a mains supply cord that is rated for less than 1.5A.</p>	
<p>2. Connect the AC power cord to the back of the unit.</p>	
<p>3. Take the discard bin from the toolbox and place it in the discard chamber. If you don't do this, hot off-cuts (pieces of fiber cut off by the laser) will melt holes in the discard chamber gasket.</p>	
<p>4. If using the optional foot switch, connect the plug to the socket in the back of the unit by inserting it and then twisting clockwise. This step is not necessary if you are not interested in using the foot switch to start the cutting process.</p>	

- 5. If desired, slide the fiber coil hanger or the ferrule holder into the socket on the left side of the unit.



- 6. Make sure the correct connector mount for your application is installed in the loading dock.



- 7. Take one of the keys from the toolbox and insert it in its slot in the laser cutter.



4.2. Power-up

To power up the unit, push the rocker switch in the back of the unit to the “on” position. The software will open on startup showing the GUI as shown below. When you are ready to use the laser, turn the key clockwise. The white LED should light up. Wait for the laser to warm up (approximately 30 seconds). Once the “LASER FAULT” light turns off, the unit is ready to use.

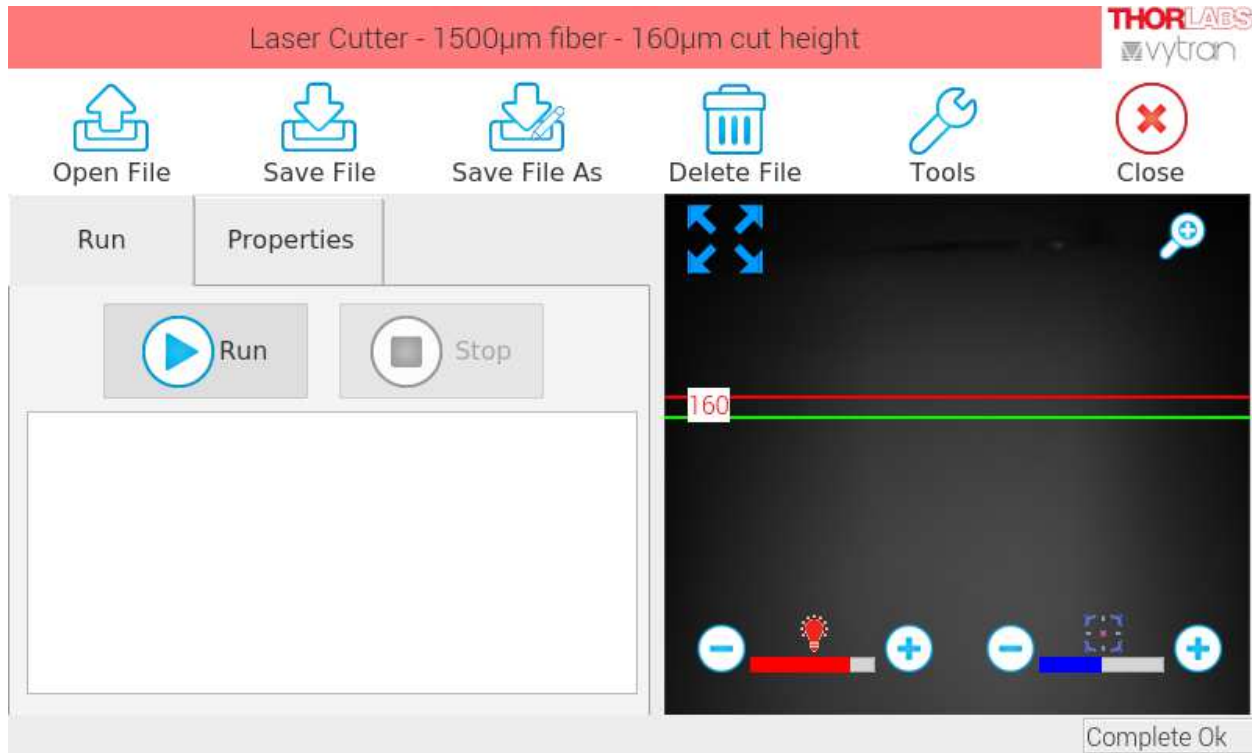


Figure 7 Main User Interface

4.3. Power-down

To turn the unit off, turn the laser key counterclockwise back into the vertical position, press the *Close* icon on the Touchscreen and wait until the display goes white. Then push the rocker switch at the back of the unit into the “off” position.

4.4. Connecting the LCM10 to a monitor or the internet

It is possible to connect a monitor to the LCM10 using the display port in the back of the unit. The connection to the monitor should be made with a commercial grade high-speed HDMI¹ cable with ferrite cores (such as part 41-150-015, available from Show Me Cables at showmecables.com).

It is also possible to get software updates using the Ethernet port in the back of the unit. The Ethernet cable should be fitted with a ferrite bead (such as part 0461167281, available from Fair-rite Products Corp. at <https://www.fair-rite.com/>).

¹ HDMI is a trademark or registered trademark of HDMI Licensing Administrator, Inc. The use of such trademark by Thorlabs does not constitute or imply any affiliation with or sponsorship, approval, certification or endorsement by HDMI Licensing Administrator, Inc. of Thorlabs or any Thorlabs products. All references by Thorlabs to such trademark are for identification purposes only.

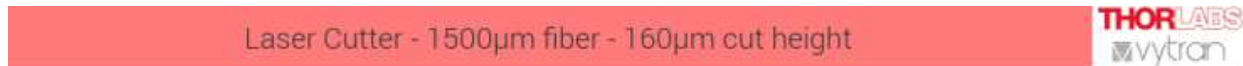
Chapter 5 Quick Start Guide

The touchscreen interface provides a simple, easy-to-use interface for configuring, controlling and monitoring the LCM10. The following sections contain a quick-start guide followed by a more detailed explanation of some of the more advanced features.

5.1. Main Window

On startup, the LCM10 Main Window is displayed. This window is made up of the following elements.

5.1.1. Title Bar



The Title Bar contains the name of the file that is currently in use. In the example above, the file name is “1500µm fiber - 160µm cut height.” The file contains the parameters that control the cutting process. If changes have been made to any of the parameters since the last time the current file was saved, the file name will be followed by an asterisk (*). Once the file is saved again, the asterisk will be removed.

5.1.2. Tool Bar



The Tool Bar provides quick access to common functions. Pressing on an icon will perform the function described below.

- Open File – Allows selection of a previously saved file. Once a new file is opened, the Title Bar will change to reflect the name of the file opened.
- Save File – Saves any parameter changes made to the currently selected file. If no file is currently opened, you will be prompted to enter a file name.
- Save File As – Allows you to create a new file with the current LCM10 parameters. An alpha-numeric keypad will open up allowing you to enter the desired name.
- Delete File – Provides a list of saved files and allows selection of files to remove from the system
- Tools – Displays a menu of various tools available for configuring and maintaining the LCM10. These tools will be described in more detail in later sections
- Close – This will close the LCM10 application and shut down the computer. Power will still be supplied to the system and you will still need to toggle the Power Rocker switch on the back of the unit to remove power entirely. It is recommended that you use the *Close* option when shutting down the system to ensure that system parameters are properly saved before power is turned off. Press the “Close” icon and wait a few seconds for the screen to go dark before toggling the Rocker Switch in the back to turn off the power.

5.1.3. Control Window

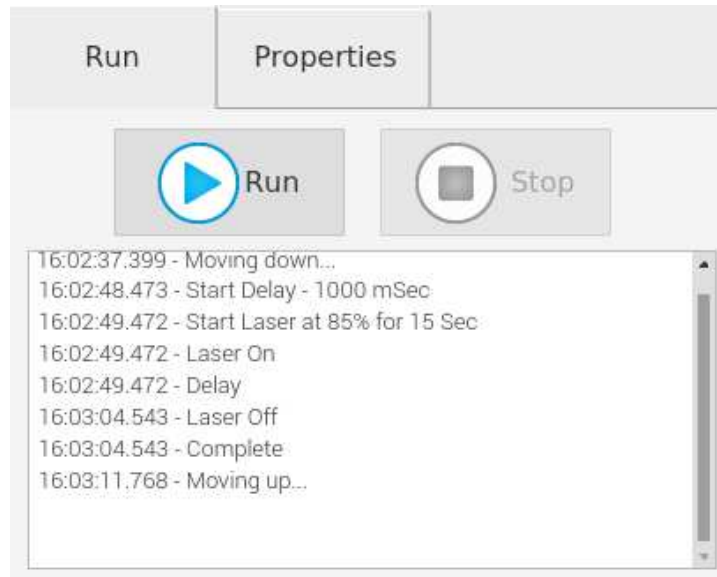


Figure 8 Control Window Run Tab

The Control Window is where you configure the system to perform the required cut and initiate the cutting process. The window has two tabs, the “Run” tab and the “Properties” tab. The *Run* tab contains a “Run” button to start the cut process, a “Stop” button to cancel a cut in progress, and a status area that will display information about the cut process in progress.

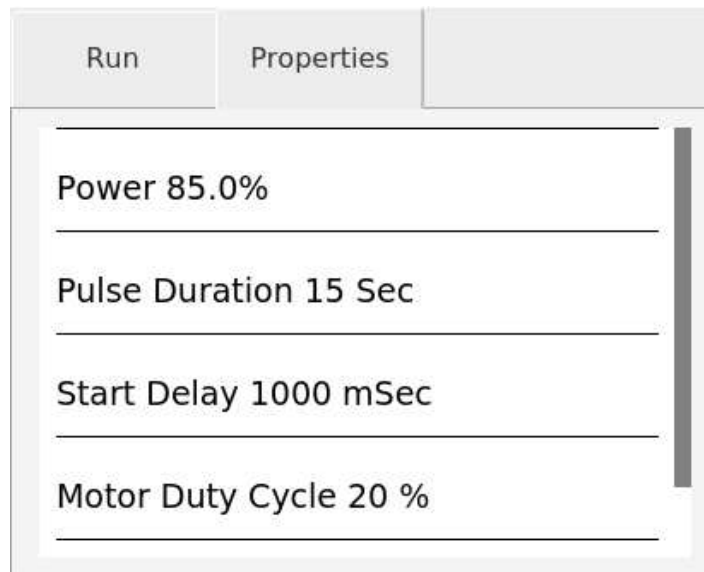


Figure 9 Control Window Properties Tab

Touching the Properties tab will switch the view to show the parameters available that control the actual cutting process.

The parameters are provided in a list that can be scrolled using the touch screen. Slide the list up or down to access the desired parameter. Pressing on the desired item will open up a numeric keypad that will allow you to enter the desired value.

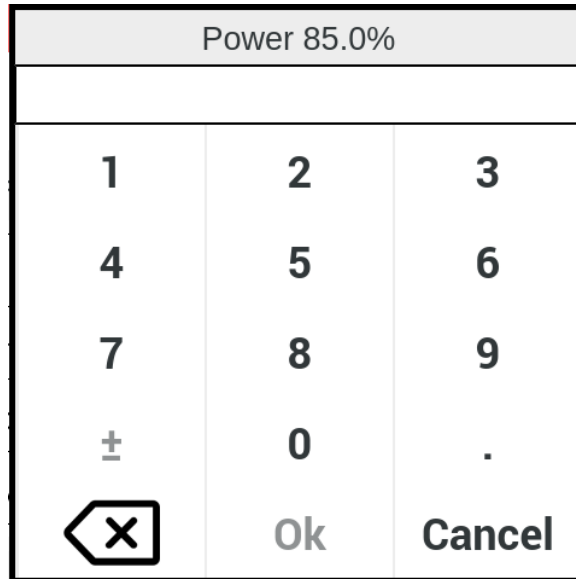


Figure 10 **Numeric Keypad**

The available parameters are described below:

- **Power** – this property controls the power of the laser when a cutting process is performed. The parameter is entered as a percentage of full power. 100% will give you 40W of power.
- **Pulse Duration (Seconds)** – this property will control how long the laser will stay energized to perform the cut. The value is entered in seconds.
- **Start Delay** – the Start Delay will cause the system to pause after turning on the exhaust fan and the jitter motor in order to give them time to reach the desired operating condition before the laser is energized. The delay time is entered in milliseconds.
- **Motor Duty Cycle** – this parameter controls the speed of the jitter motor that sweeps the laser beam. The parameter is entered as a percentage of full motor speed.
- **Fan Duty Cycle** – similar to the Motor Duty Cycle, this parameter controls the speed of the exhaust fan. This parameter is entered as a percentage of the full speed of the exhaust fan.

5.1.4. Camera Window

A live camera image is displayed in the Camera Window. Guide lines that can be turned on or off are overlaid on top of the live image. The green line indicates the location of the laser cut. The red line is a guide for positioning the ferrule to achieve the desired cut length. Dashed red lines are error bars that can be used to visually verify that an acceptable cut was obtained. Configuring these guides will be explained in more detail in Chapter 7.

The Camera Window also has some icons that can be used to adjust the view.

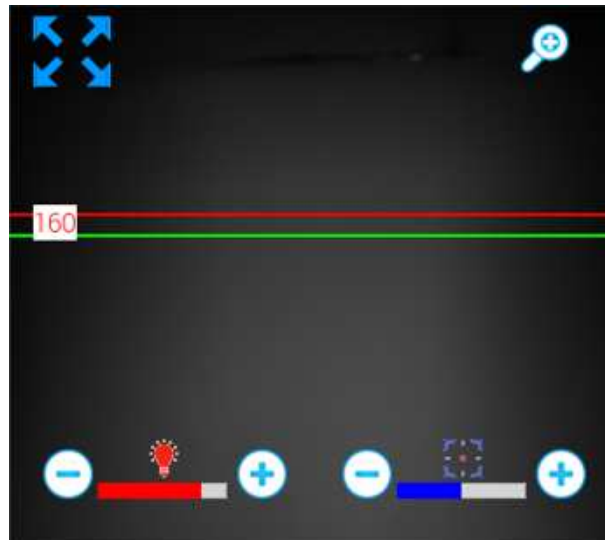


Figure 11 Camera Window



Pressing on the + or – icons will increase or decrease the illumination for the camera image.



Pressing on the + or – icons will bring the camera image in and out of focus



Selecting this icon will expand the camera image to fill the display.



The expanded camera window can be restored to the original size by pressing this icon.



The magnifying glass icon will zoom in and out of the image to allow you to see more detail. When zoomed in, you can reposition the viewing region by dragging the image on the touch screen.

Chapter 6 Maintenance

6.1. Enabling Maintenance Window

The Maintenance menu is hidden by default. To activate it, go to the Tools menu and press “User.”

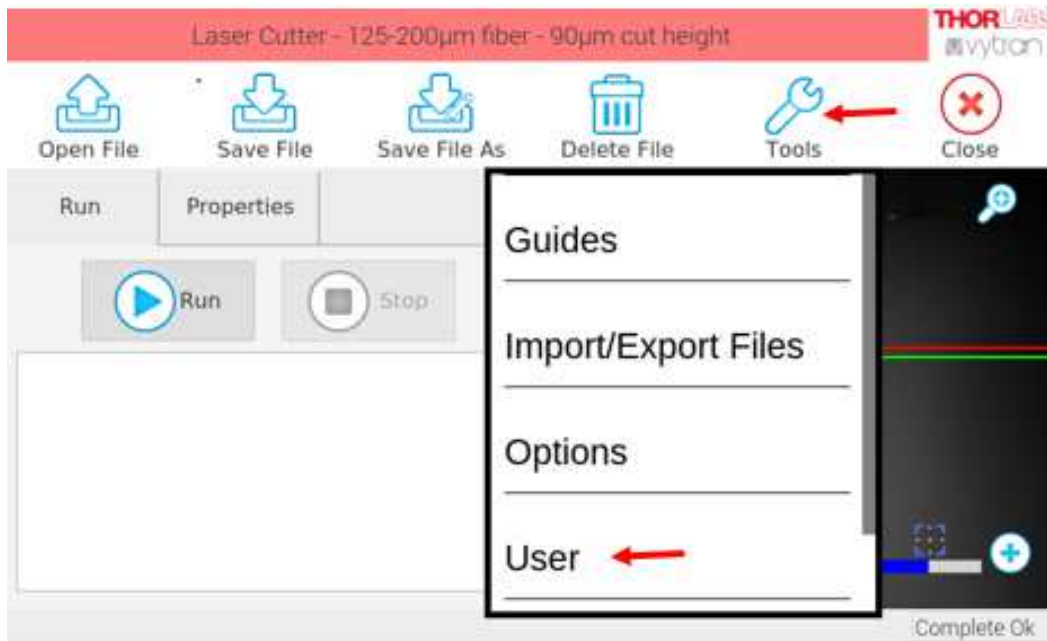


Figure 12 Opening the “User” Window

Next, click on the *Login* icon, and enter the user password **077510**. Press *OK*, and then *Close* to exit to the main user interface.

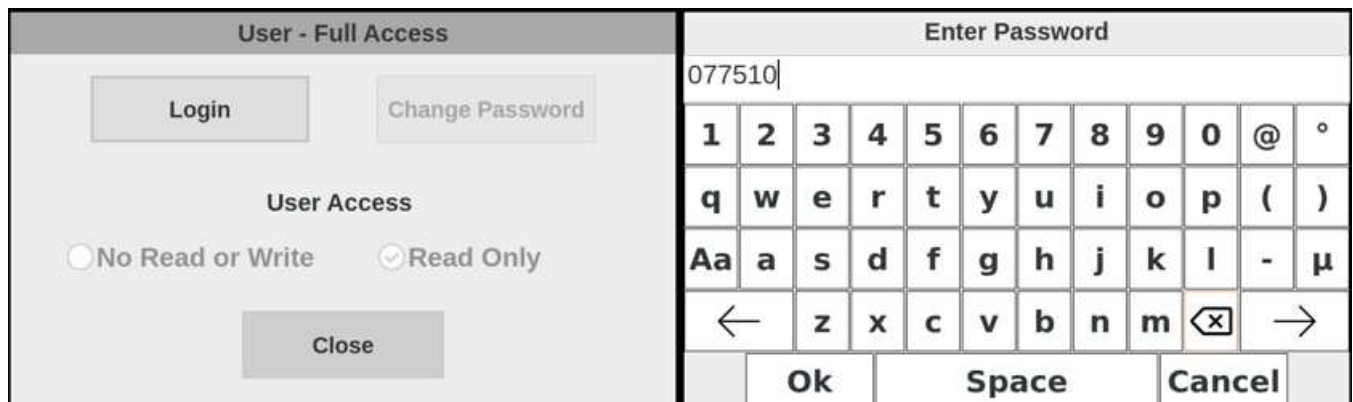


Figure 13 Typing in the User Password

Upon completion of the login, the *Maintenance* menu should appear under Tools as shown on the left side of Figure 14. Clicking on *Maintenance* will open up the *Maintenance* window, as shown on the right side of Figure 14.

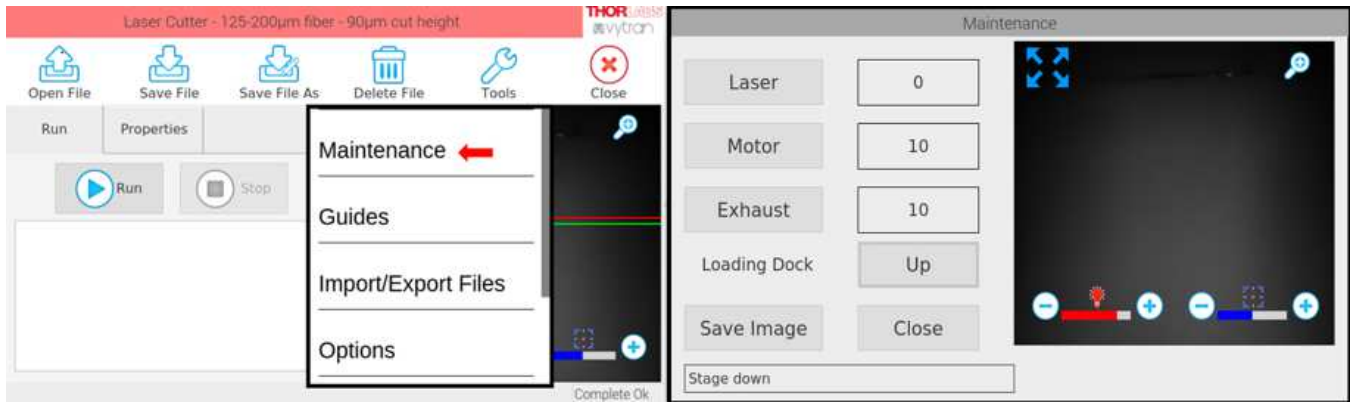


Figure 14 "Maintenance" Window Outlook

6.2. Changing Connector Mounts

The default position of the loading dock is the *down* position. Clicking the *Up* button will automatically bring the loading dock to the *up* position to ease the process of changing the connector mount.

To remove a connector mount, turn the thumb screw counterclockwise, and pull up. To install a new connector mount, make sure the locating pin on the loading dock goes into the hole in the new connector mount, then tighten the thumb screw.

When you are done installing the connector mount, click the *Down* button to move the loading dock back down.

If you need to hold a cannula (a ferrule with no stop feature), attach a cannula stop to the bottom of a connector mount. The cannula stop will set the height of the cannula since it includes a stop feature. The stop feature will not interfere with the fiber emerging from the cannula.

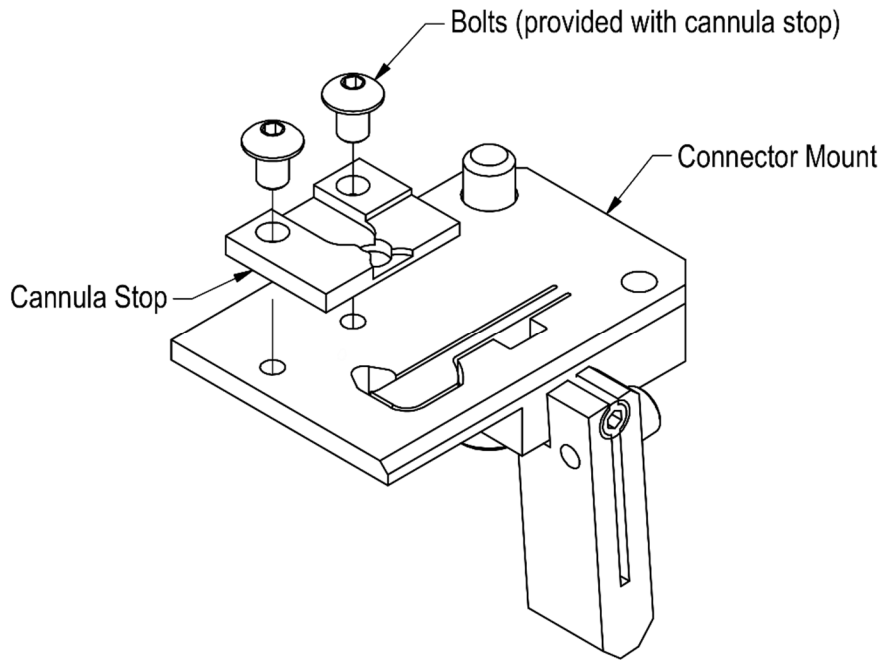


Figure 15 Attaching a cannula stop to the bottom of a connector mount

6.3. Recipe development

The *Maintenance* window is a useful tool for cutting recipe development time since each parameter of the system can be individually controlled and optimized.

Laser	0
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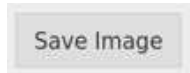
Laser output power can vary from 0% to 100% with a resolution of 0.1%.

Motor	50
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Motor Speed can vary from 50% to 100% with a resolution of 1%.



Exhaust fan speed can vary from 60% to 99%.



Images of the connector before and after process can be saved.

The LCM10 laser cutter has pre-defined cutting recipes saved for fibers with common core sizes such as 125 μm , 200 μm , 400 μm , 600 μm , 800 μm , 1000 μm , and 1500 μm . If you have a fiber with a core size different from the values listed previously, you should choose the pre-defined cutting recipe whose diameter most closely matches your fiber diameter and fine-tune each process parameter in the Maintenance window to optimize the cutting efficiency and quality.

Some general rules of thumb:

- 1) Increase the laser power if the protruded fiber and epoxy bead cannot be sufficiently removed by the laser.
- 2) For fibers with large cores, cutting efficiency can be improved by both increasing the laser power as well as reducing the motor speed. Reducing the motor speed in this case will allow longer laser-material interaction time. As a result, more thermal conduction will take place and the cutting efficiency will go up.
- 3) Increasing the exhaust fan speed can enhance the efficiency of the fume extraction; however, it does have a cooling effect, which can potentially lower the cutting efficiency.
- 4) An optimized cutting recipe is generally a balance of all three aforementioned parameters.

Chapter 7 Guides

Before performing any cuts, it is recommended that the user do an *image scale calibration*. The calibration button is accessed through the Guides menu, and a user password is required to access this function. (please refer to section 6.1 on how to log in with the password). Once the password is entered, the calibration button will automatically appear in the bottom left corner of the Guides menu as shown in Figure 17.

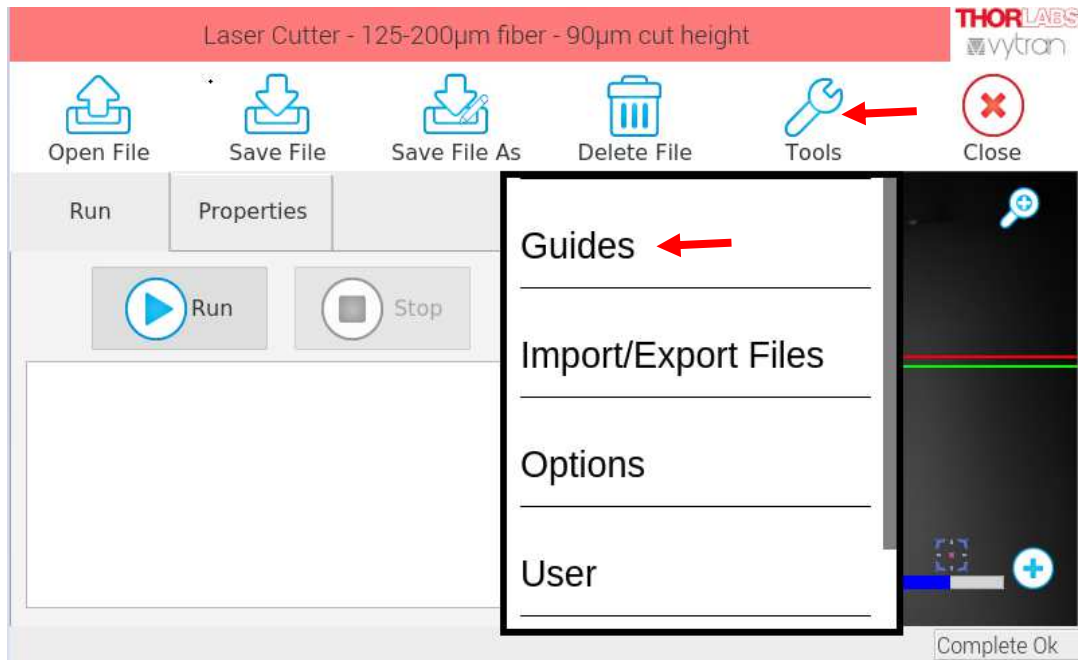


Figure 16 Opening the "Guides" Window

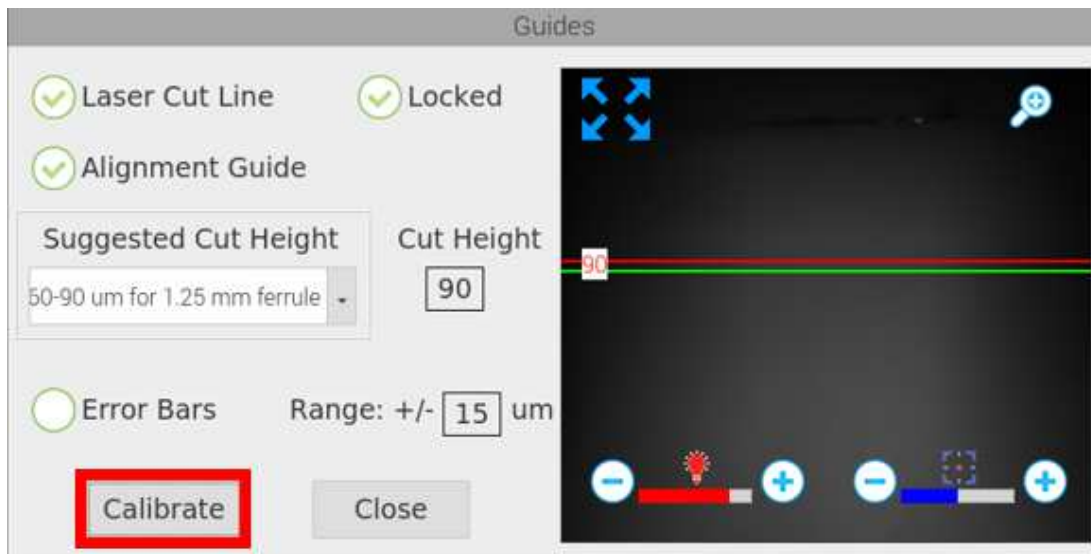


Figure 17 "Guides" Window

To perform the *image scale calibration*, you will need the calibration pin. If you have changed connector mounts, you will have to re-install the default FC/PC connector mount that came with the unit (see Section 6.2). With the correct connector mount in place, the calibration pin can be inserted and locked in place with the lever. (See Figure 18)



Figure 18 Inserting the Calibration Pin

Click the *Calibrate* button to open up the Calibrate window.

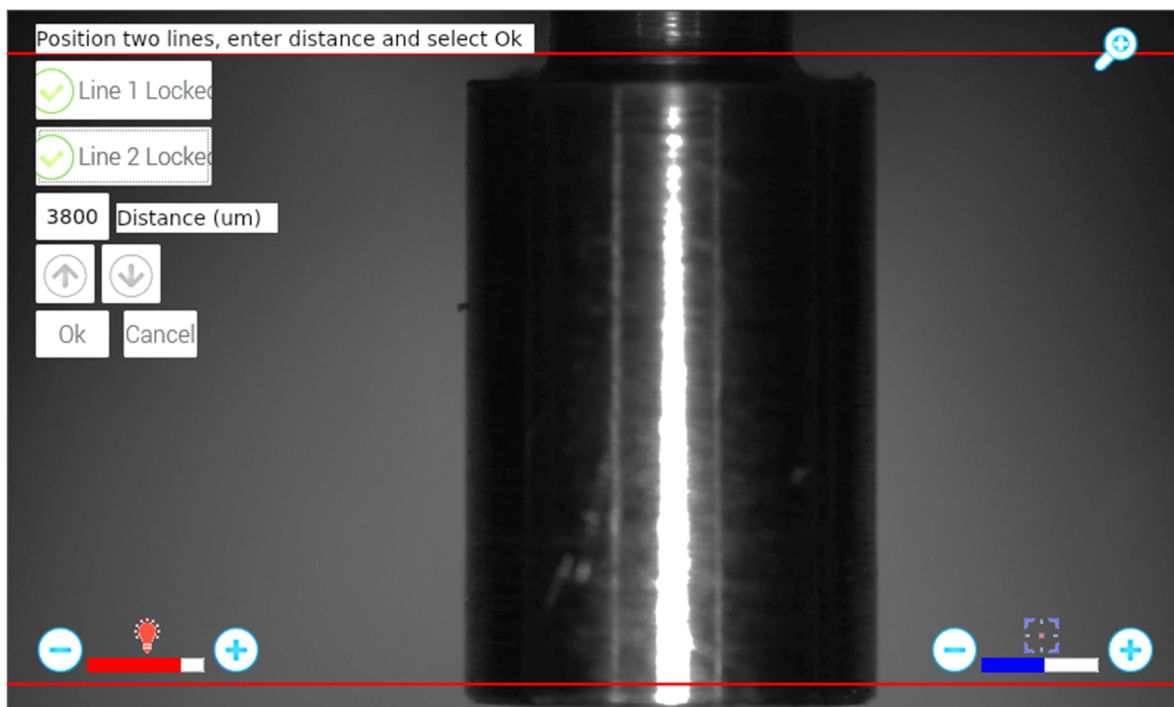


Figure 19 The "Calibrate" Window

The image in the calibration window may be dark or out of focus. Adjust the LED illumination intensity and the camera focus (using the +/- scroll bars located at the bottom of the screen). The bottom portion of the calibration pin has a height of 4000 microns. If this portion is not fully captured by the camera field of view, adjust the manual micrometer (See in Fig. 21) on the loading dock until the 4 mm portion is roughly at the center of the screen.

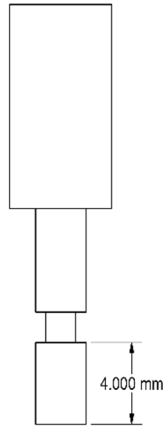


Figure 20 Bottom of the Calibration Pin

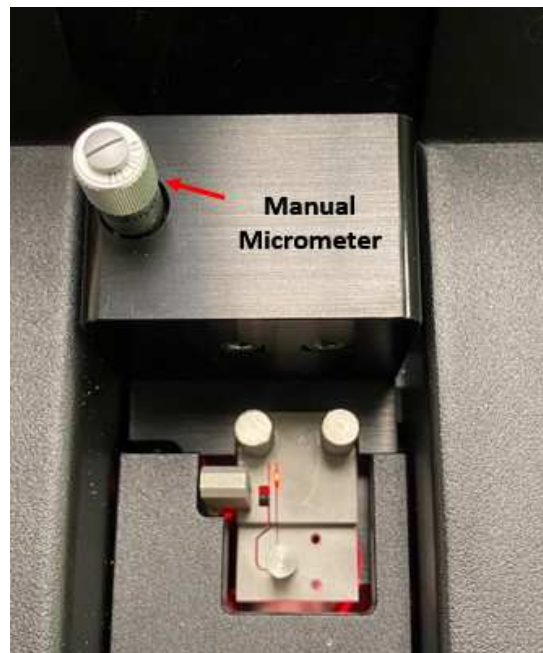


Figure 21 Manual Micrometer

At the top left corner of the calibration window, there are two check boxes. In Figure 22, *Line 1* and *Line 2* are shown as locked and are colored red. To move the lines, uncheck the boxes, and the activated lines will turn green. For coarse adjustment, tap the line on the touch screen, move and drag it up and down. For fine adjustment, use the UP and DOWN arrow buttons for movement in the size of the camera resolution. After a line has been placed, lock the line by checking its box in the top left. As described before, the bottom portion of the calibration pin has a height of 4 mm (4000 μm), so move line 1 to the upper edge and move line 2 to the bottom edge of the pin. If using any other calibration pin for reference, you can change the distance from its default value of 4000. Once the calibration lines and distance have been set, click "OK" to accept the values or "Cancel" to leave the Camera Calibration

window without implementing any changes. Return the calibration pin to its storage bag or a safe storage location. The *image scale calibration* is now complete.

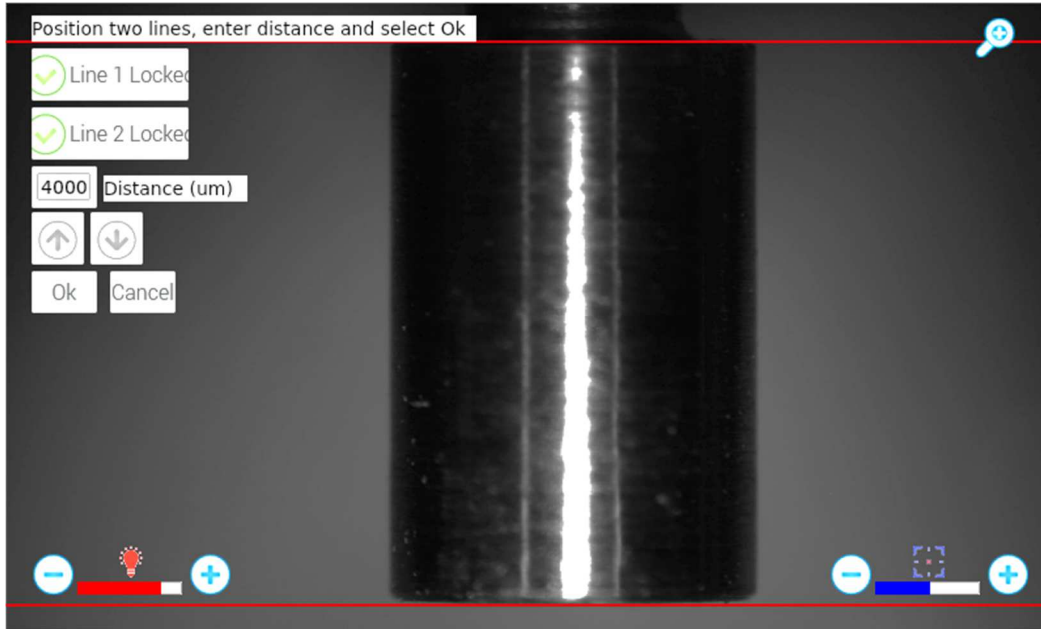


Figure 22 Two Guide Lines Locked

7.1. Defining the Laser Cut Line

Upon completion of the image scale calibration, the GUI should return to the *Guides* window. Uncheck the boxes in front of **Laser Cut Line**, **Locked**, **Alignment Guide**, and **Error Bars** (see image below), and click *Close* to exit to the Main menu. To determine the location of the *Laser Cut Line*, use a piece of scrap terminated connector with either 125 or 200 μm fiber as a test sample. All connector mounts use the bottom mating surface as the reference, so any compatible connector may be used. Insert the sample into the connector mount. Adjust the manual micrometer on the loading dock until the tip of the ferrule is high enough to be out of the camera field of view. This is to ensure that the laser will cut the bare fiber instead of hitting the ferrule. See Figure 24.

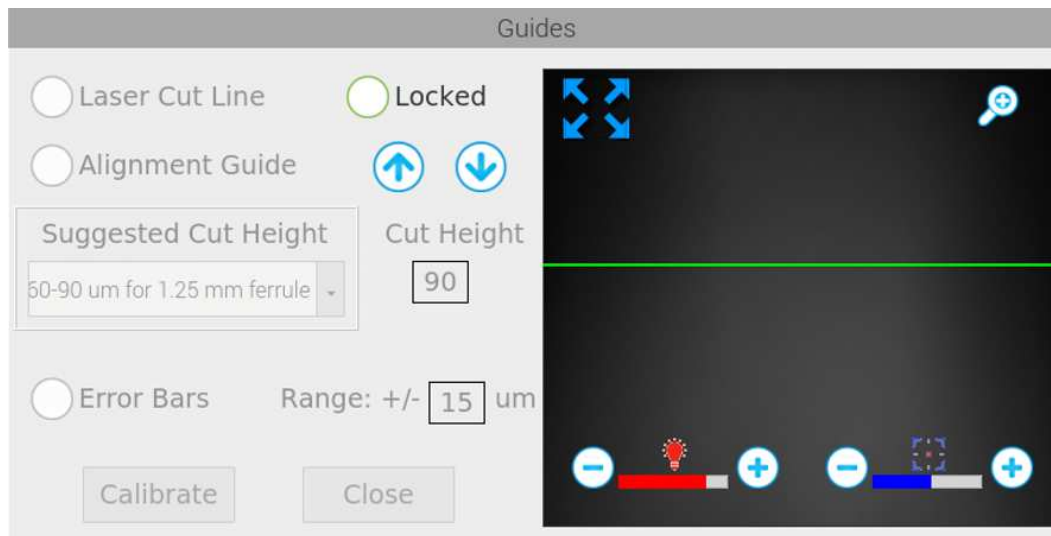


Figure 23 Uncheck the boxes in the “Guides” Window

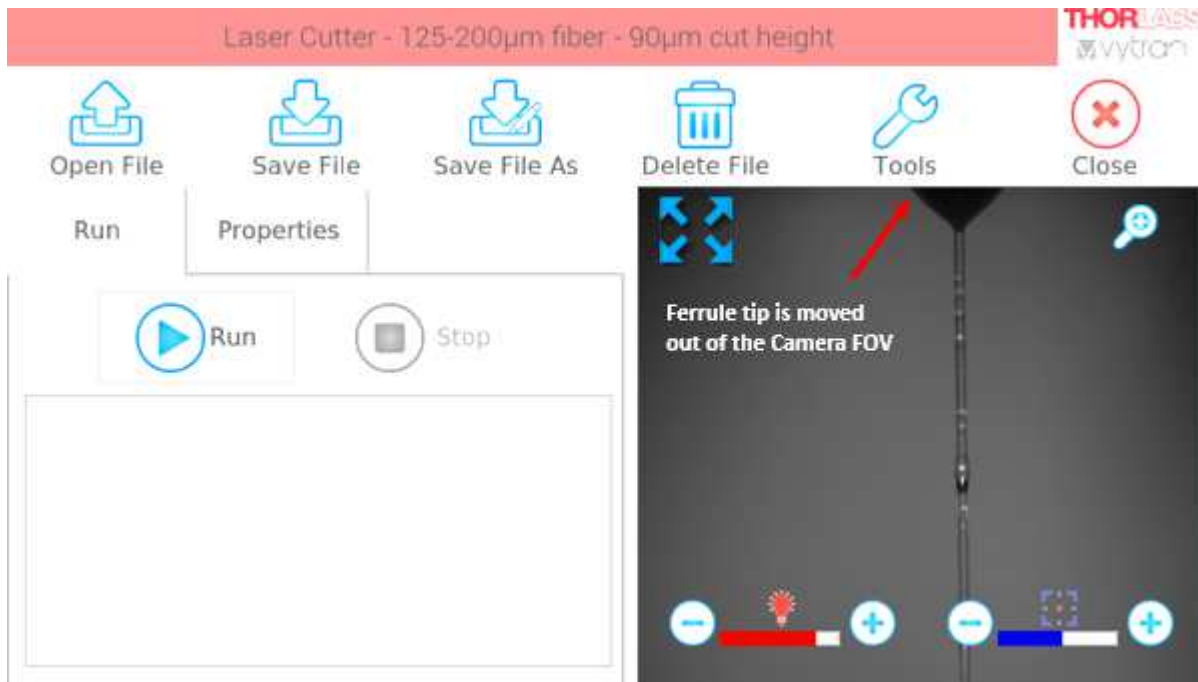


Figure 24 125 µm Test Sample

Go to **Open File**. The software should have a pre-defined cutting recipe for 125/200 µm connector samples. Tap on it and the software will automatically load the correct file for performing the test cut.

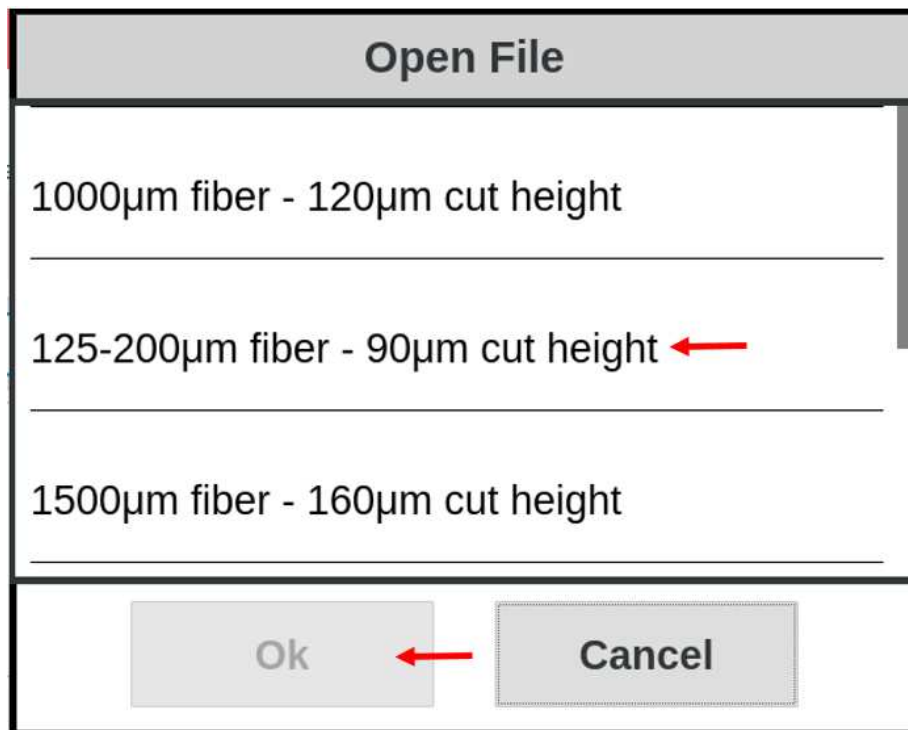


Figure 25 Choosing the Appropriate Cutting Recipe for the Test Sample

Click on **Run**, press the blue start button, or depress the foot switch pedal. The unit will start executing the cutting recipe file. Figure 26 shows an example of the fiber connector sample after a test cut.

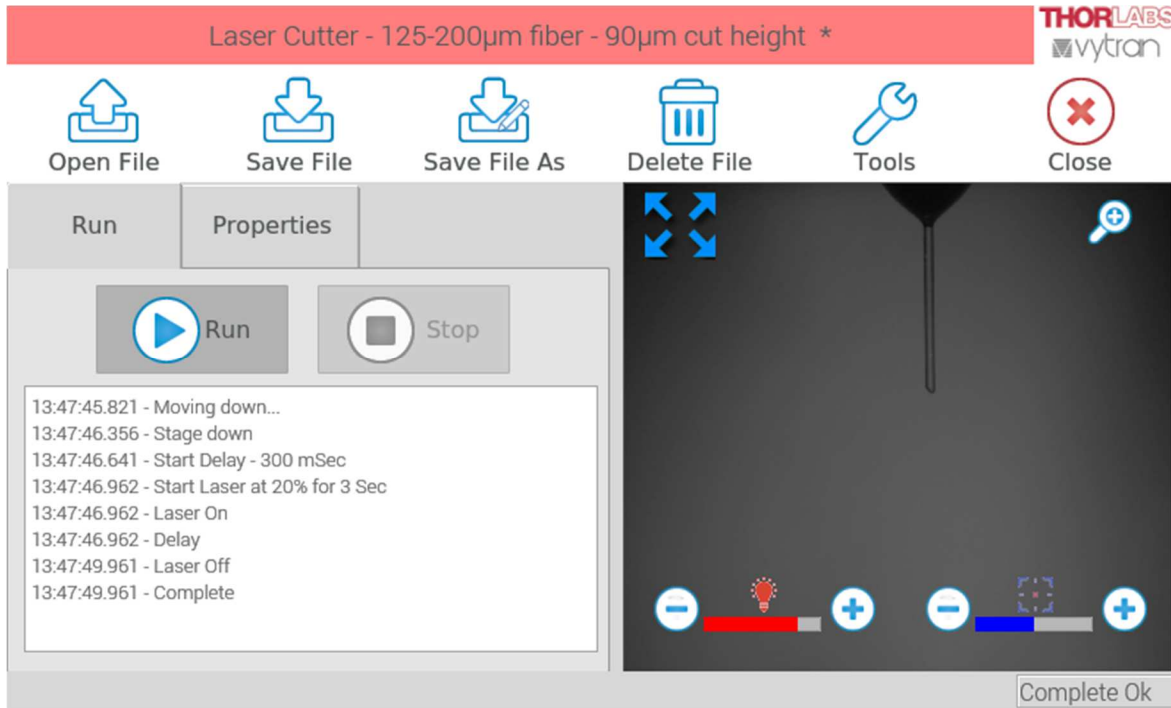


Figure 26 Fiber Connector Sample After Test Cut

The cut profile of the fiber tip will look similar to what is shown in Figure 27. The differences in the cut profiles from the left and right sides of the fiber are due to the fact that scanning beams at left and right have slightly different focused spot sizes.

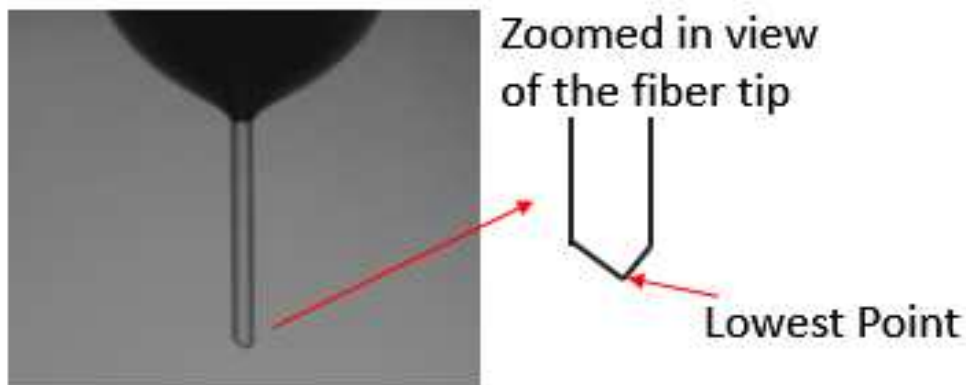


Figure 27 Cut Profile of the Fiber Tip

Go to Tools, select the Guides menu again, and check the box in front of Laser Cut Line. A green line will appear on the display. Use the full screen zoom icon to get a zoomed-in view of the fiber tip. For coarse adjustment, tap the line on the touch screen, move and drag it up and down. For fine adjustment, use the UP and DOWN arrows button below the word "Locked." Look for the lowest point of the cut profile on the bare fiber and move the green line onto that point. Then, check the box in front of "Locked" to secure the position of the line. Now the Laser Cut Line is defined.

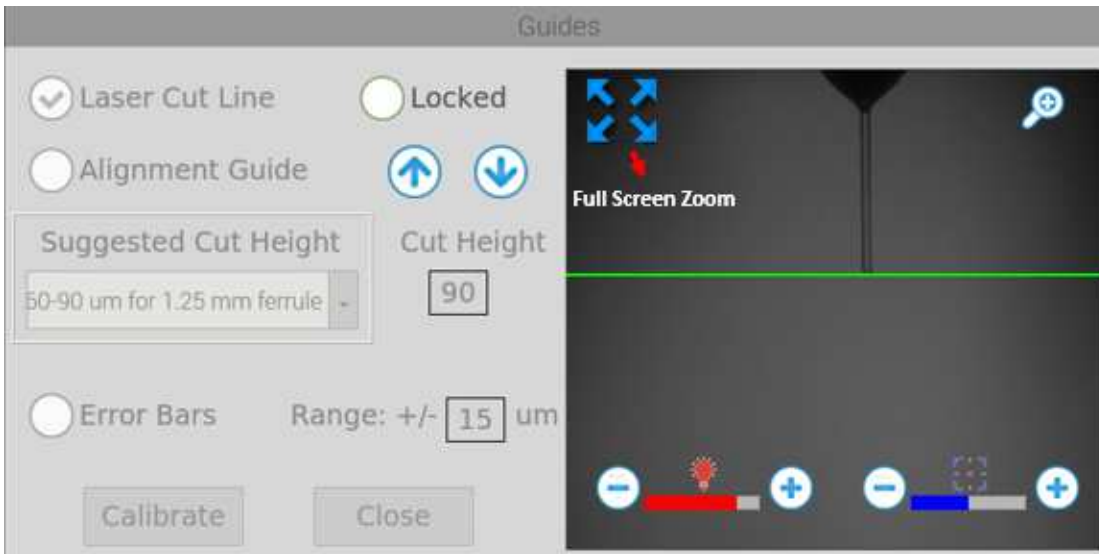


Figure 28 Locate and Lock the Laser Cut Line

To verify the Laser Cut Line is properly placed, a second test cut is needed. Uncheck the box in front of "Laser Cut Line." Check the box in front of "Error Bars" and type the value 15 in the square box. (see Figure 29) This step enables a $\pm 15 \mu\text{m}$ error bar around the previously defined Laser Cut Line. A zoomed-in view can be seen in Figure 30. In that figure it is possible to see the two distinct bars. When you are zoomed out, or when the range is less than 10 microns, the two error bars lie so close together that there is no discernable gap between them.

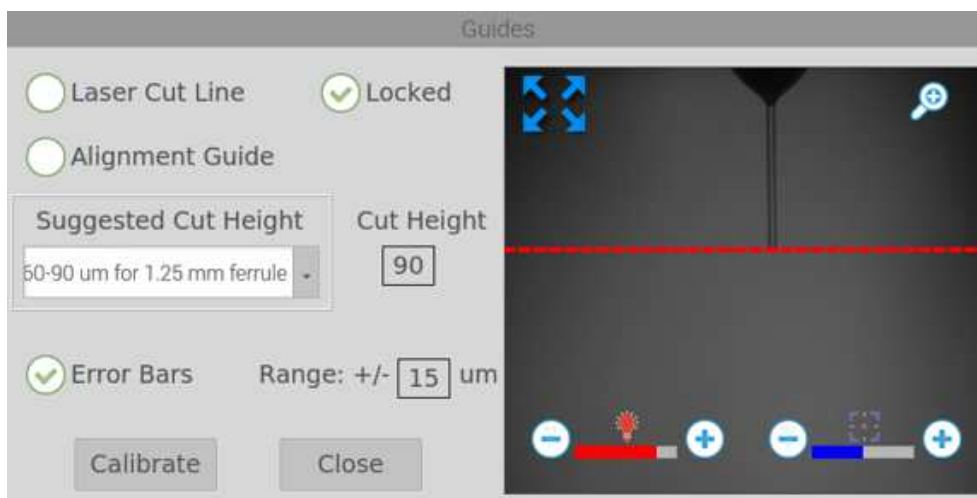


Figure 29 Enabling the Error Bars

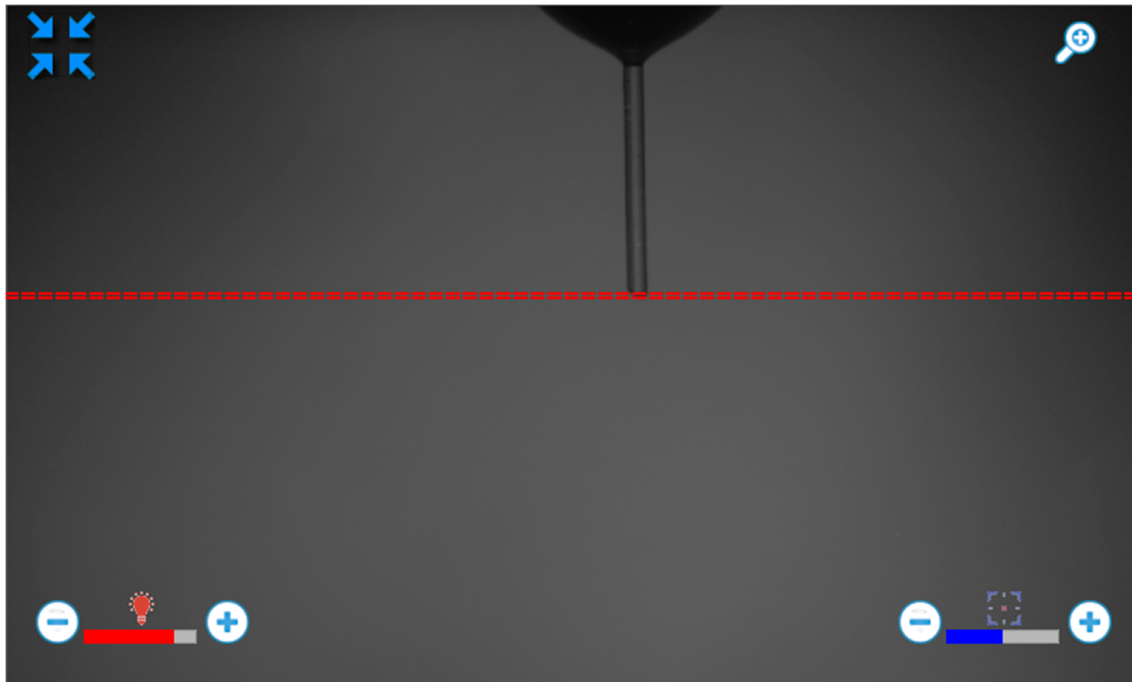


Figure 30 **Zoomed-in View of Error Bars**

Next, adjust the manual micrometer on the loading dock, move the sample downwards to get ready for a second test cut. (see Figure 31)

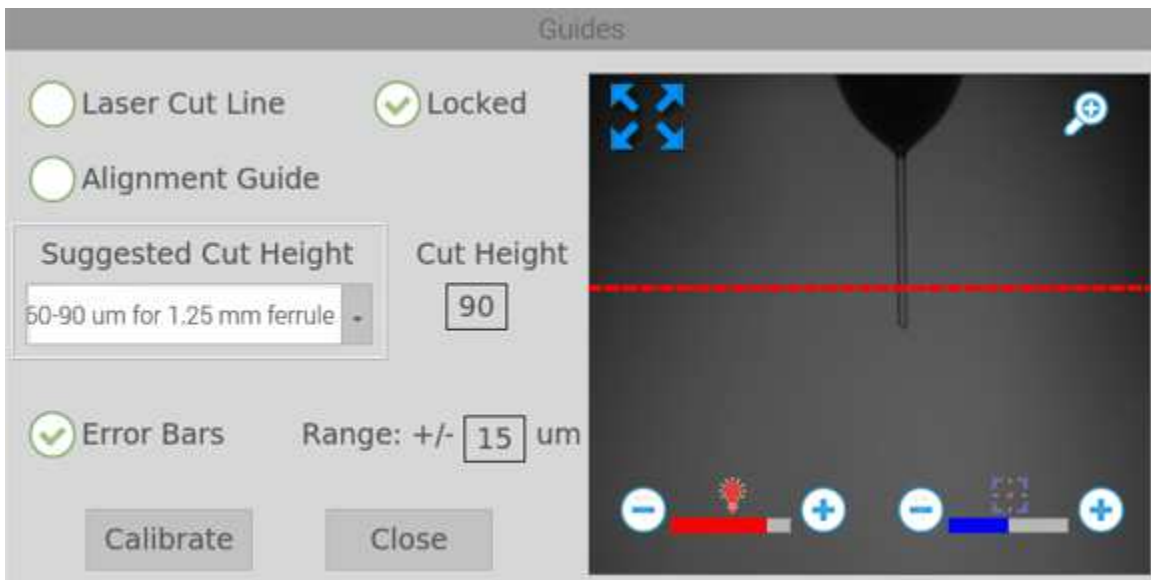


Figure 31 **Moving Sample Down For a Second Test Cut**

Go back to Main User Interface, click on *Run* to perform the second test cut. If the fiber tip from the second cut is within the area defined by the two error bars, the placement of the Laser Cut Line is acceptable. If the fiber tip lands in an area outside, repeat the previous steps to optimize the placement of the Laser Cut Line.

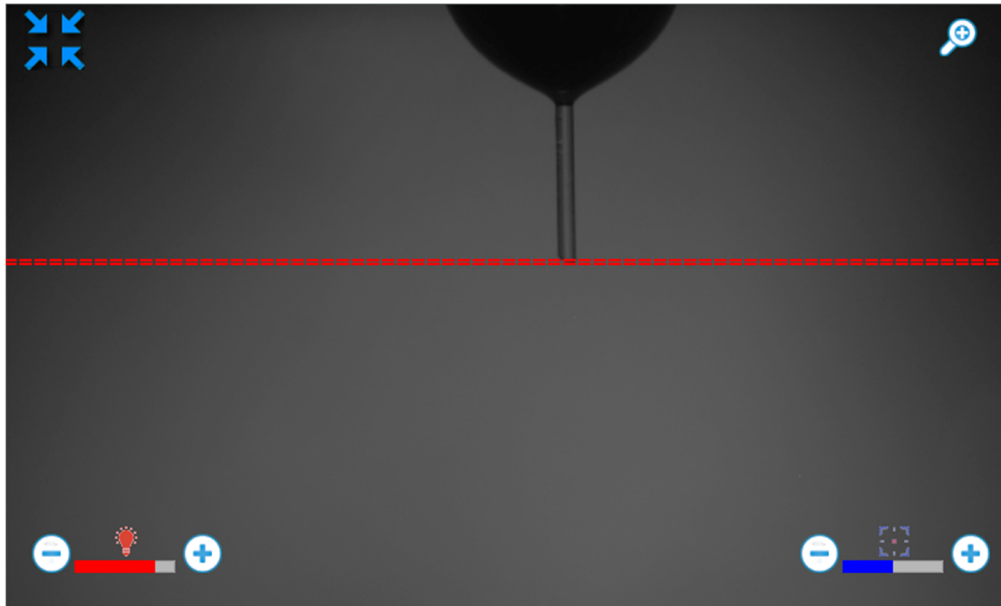


Figure 32 Fiber Tip From Second Test Cut Falls Within The Area Defined By The Error Bars

7.2. Define & Set Proper Cut Height

Go to the *Guides* window and uncheck the box in front of “Error bars.” Then, check the boxes in front of “Laser Cut Line” and “Alignment.” This will activate a red line above the green laser cut line. Under **Suggested Cut Height**, there is a drop-down list with three recommended options: 60-90 μm for $\text{Ø}1.25$ mm ferrule; 80-120 μm for $\text{Ø}2.5$ mm ferrule; 120-160 μm for $\text{Ø}3.2$ mm ferrule. Choose the appropriate option based on the ferrule size of the sample, then enter a specific number in the **Cut Height** box. The red line should be displaced at the requested distance away from the laser cut line (in Figure 33).

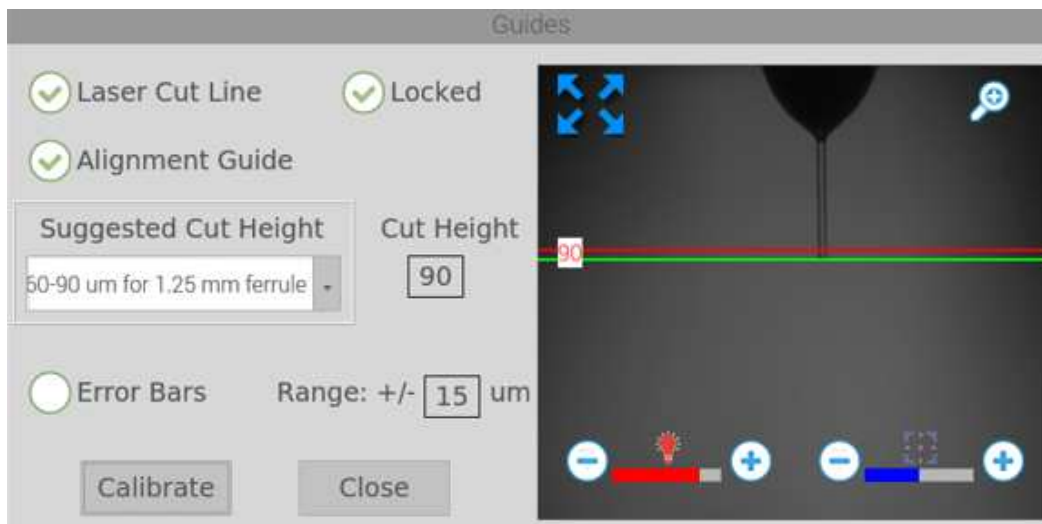


Figure 33 Enabling The Alignment Guide With The Appropriate Cut Height

The next step is to adjust the manual micrometer on the loading dock to lower the connector ferrule until the tip of the ferrule is flush with the Alignment Guide (as in Figure 34). You should adjust the camera focus to ensure that the image of the ferrule tip is sharp, as this will improve the accuracy of the alignment.

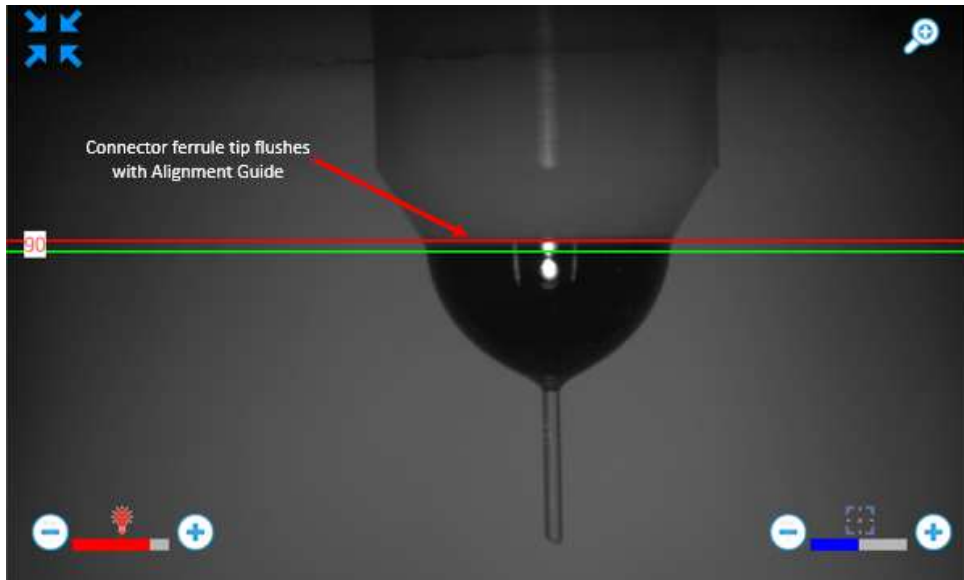


Figure 34 Positioning the Ferrule to Achieve the Desired Cut Height

7.3. Optimize Cut Height

Close the Guides window to exit out to the Main panel. Using the same cutting recipe as before, click on **Run** or press the blue start button or depress the foot switch pedal to activate the cutting process. The figures below show the appearance of the connector sample after the cut with and without the guide lines.

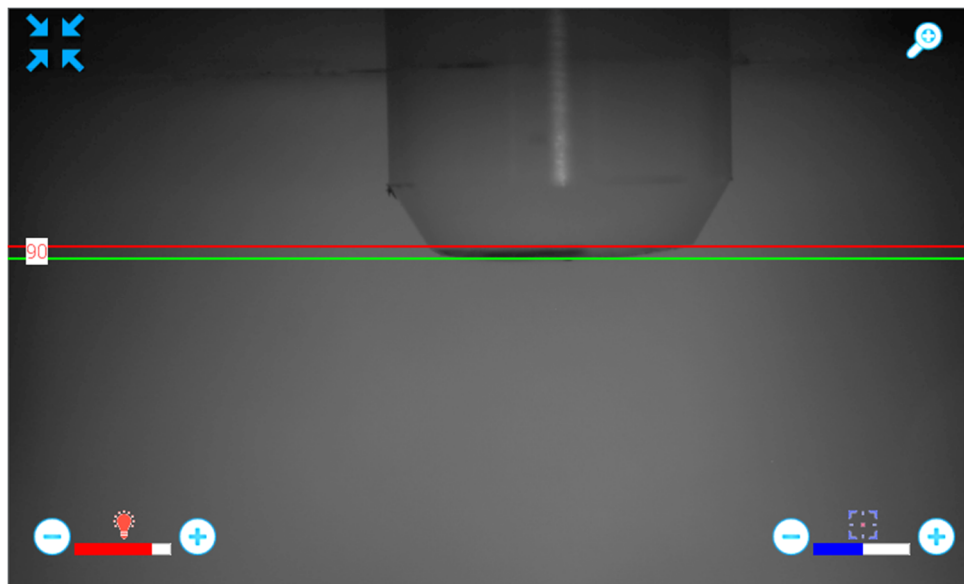


Figure 35 Connector Test Sample After Cutting with Guide Lines

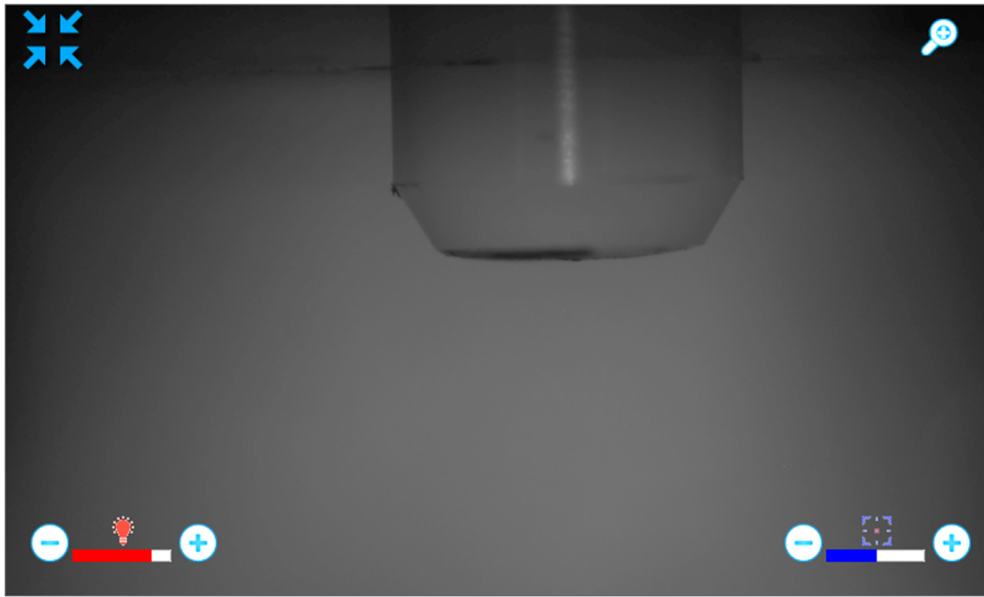


Figure 36 Connector Test Sample After Cutting without Guide Lines

Evaporation of the epoxy bead will occasionally leave stains on the side of the ferrule. They can be easily cleaned using a KimWipe wetted with acetone. To minimize the chances of such stains appearing on the side of the ferrule, you can increase the exhaust fan speed. To do this, go to the **Properties** tab at the main menu, and increase the exhaust fan speed.

If burn marks or cracks are observed on the side of the ferrule, it most likely indicates the ferrule is not sitting at the right height with respect to the laser beam. In this case, you should increase the cut height, reset the ferrule tip location using the manual micrometer on the loading dock, and repeat the aforementioned steps until a clean cut is achieved.

Chapter 8 Import/Export Files

The Import/Export Files features allows transfer of configuration files and saved images between the LCM10 and a USB Flash Drive plugged into the USB Port in the front of the LCM10. To access this function, touch the Tools Icon and then select "Import/Export Files" from the displayed list. The following window should be displayed.

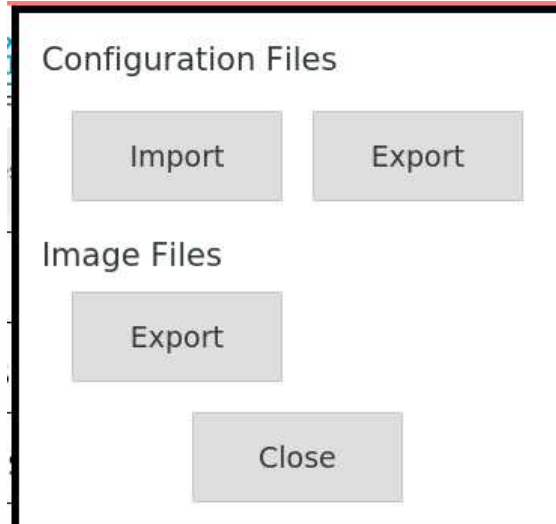


Figure 37 Import/Export Files

8.1. Import/Export Configuration Files

Configuration Files are the files saved using the *Save File* and *Save File As* buttons and contain all the parameters that control the cut process. These files can be backed up and restored using the *Import* and *Export* buttons available in this window. If you press the *Export* button, a new window will be displayed that has a list of all available configuration files on the LCM10 as well as some options to change the way the list is sorted and to control how files are selected.



Figure 38 Select File Window

Here are explanations for the different radio buttons:

Select All – when this option is selected, all available files will be selected.

Select Range – after selecting this option, touch the first file in the list that you want to export, then scroll down the list to find the last file you want to export and touch that file. All files between the two files that you selected will also then be selected

Select Multiple – when this option is selected, any file you touch will be selected. If a file is selected, if you touch that file again it will be unselected.

Once you have the files that you want to export selected, touch the *Ok* button and these files will be copied to the USB Flash Drive. Before selecting the *Ok* button to export the files, you have the option to press the *Move* button. If you do this, then after the files are copied to the USB Flash Drive they will be removed from the LCM10.

Similar to the *Export* function, if you select the *Import* Button, then the same window displayed above will be shown, however it will now be showing configuration files found on the USB Flash Drive. If the USB Flash Drive contains folders, the folder names will also be displayed in the list. You can navigate into the folders by touching the folder name in the list. To return to a higher level folder, touch the “. . .” icon. In this window you will have the same options for selecting the files as you do when Exporting files. Once you have selected the desired files and touch the *OK* button, these files will be copied from the USB Flash Drive to the LCM10.

8.2. Export Image Files

When you touch the *Export* button under the Image Files heading, the same window displayed in Figure 38 will be shown, now showing any Camera Image files that have been saved. The same options for selecting files and copying/moving these files to the USB Flash Drive described above are available here as well.

Chapter 9 Options

Touching the *Tools* icon and then selecting *Options* from the list of available tools will display this window:

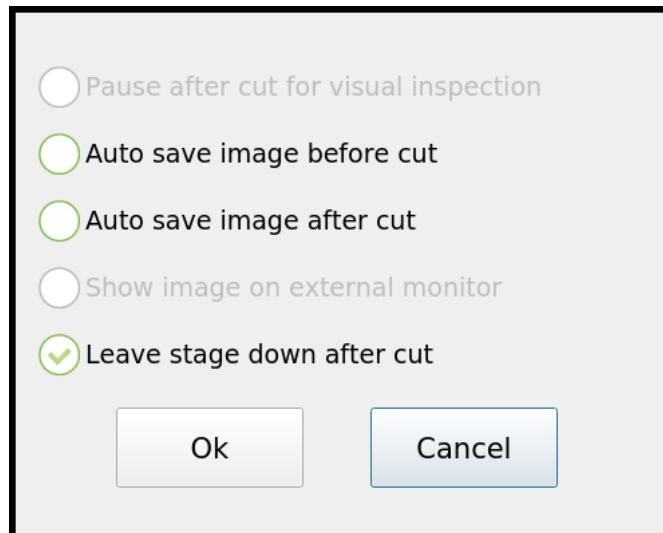


Figure 39 Options Window

If “Pause after cut for visual inspection” is selected, when a Cut Process is run, the system will stop after the cut is performed and before the loading dock is moved back to the unload position to allow you to visually inspect the fiber in the camera image. The *Start* button in the control window will change to display the word “Continue.” Touching this button will finish the cut process by moving the loading dock to the unload position to allow the ferrule and fiber to be removed. The “Pause after cut for visual inspection” option will be greyed out if the “Leave stage down after cut” option described below is selected.

If “Auto save image before cut” is selected, the camera image will be saved showing the fiber before the cut occurs. This image will automatically be named “PreProcessImage” followed by the current date and time. See Chapter 8.2 for information on exporting the saved images.

Similarly, if “Auto save image after cut” is selected, the camera image will be saved after the cut occurs and before the loading dock moves up to the unload position. This file will be named “PostProcessImage” followed by the current date and time. See Chapter 8.2 for information on exporting the saved images.

If a monitor is plugged into the display port on the back of the LCM10, then the “Show image on external monitor” option will be enabled. Selecting this will display the live camera image on this monitor.

If “Leave stage down after cut” is selected, the loading dock will not automatically move up to the unload position after the cut occurs. This option allows for faster cycle time when cutting fibers that can easily be loaded and unloaded when the loading dock is in the cut position by eliminating the need for the platform to move up and down each cycle.

Chapter 10 User

The *User* function allows the LCM10 to be configured to require password entry before making changes to the LCM10 parameters.

With a password, users can protect the controller and its files from unauthorized access or modification.

The controller defaults to *No Password, Full Access* enabled.

A password is required (if one has been set) to change the “access permissions.” These permissions are the mechanism for protecting files and parameters.

To access the *User* function, select the *Tools* icon and then touch *User* in the list of available tools. The following window will be displayed.

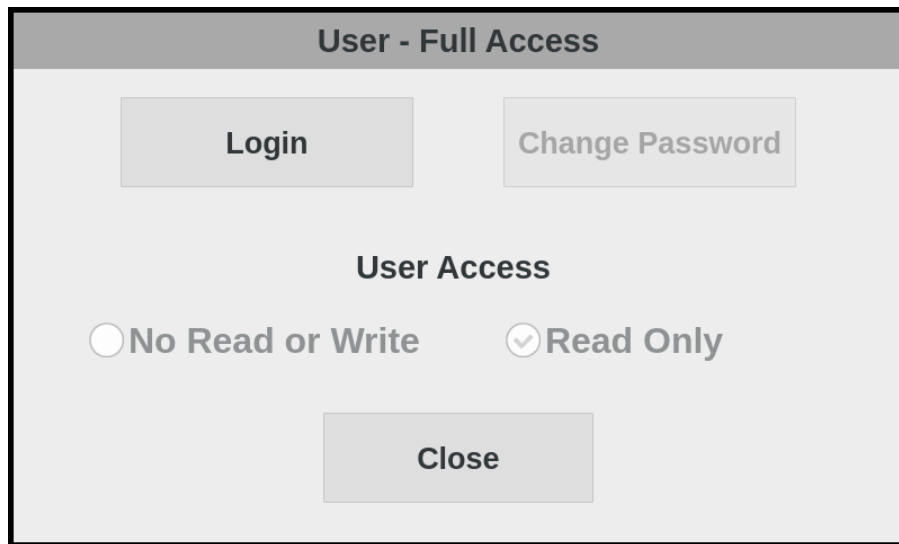


Figure 40 User Window

If no password has been set up yet, the password is effectively an empty string. Touch the *Login* button and an alphanumeric keypad will be displayed to allow you to enter a password. If a password has been set up, enter the password and then touch the *Ok* button. If a password has not yet been configured, just press the *Ok* button. If the password was entered correctly, the *User Access* options will now be enabled as well as the *Change Password* button. Also, the *Login* button will change to now read *Logout* and the window title bar will indicate that full access is enabled. Full access will remain enabled until you select the *Logout* button. This will allow a user who has successfully entered a password to make changes to the LCM10 parameters.

If a password has not yet been configured, once you have entered the empty string to login you should now select the *Change Password* button. This will display the same alpha numeric key pad previously displayed and will allow you to enter the desired password. Passwords can be any characters, can be any length and are case sensitive. Once you have entered the password you want, select the *Ok* button.

When a password has been successfully entered, you can configure the user access level that will be in effect when logged out. The choices are:

- **No Read or Write:** users are not allowed to make or save any changes to the file parameters and also are not allow to open a new file.
- **Read Only:** users are allowed to use Open File to select a new file but are not allowed to make or save any changes to the file parameters.

Once the desired User Access level is selected and the Logout button is touched, the selected level will be displayed at the top of the User Dialog. When the User window is closed, Features that users no longer have access to will not be enabled.

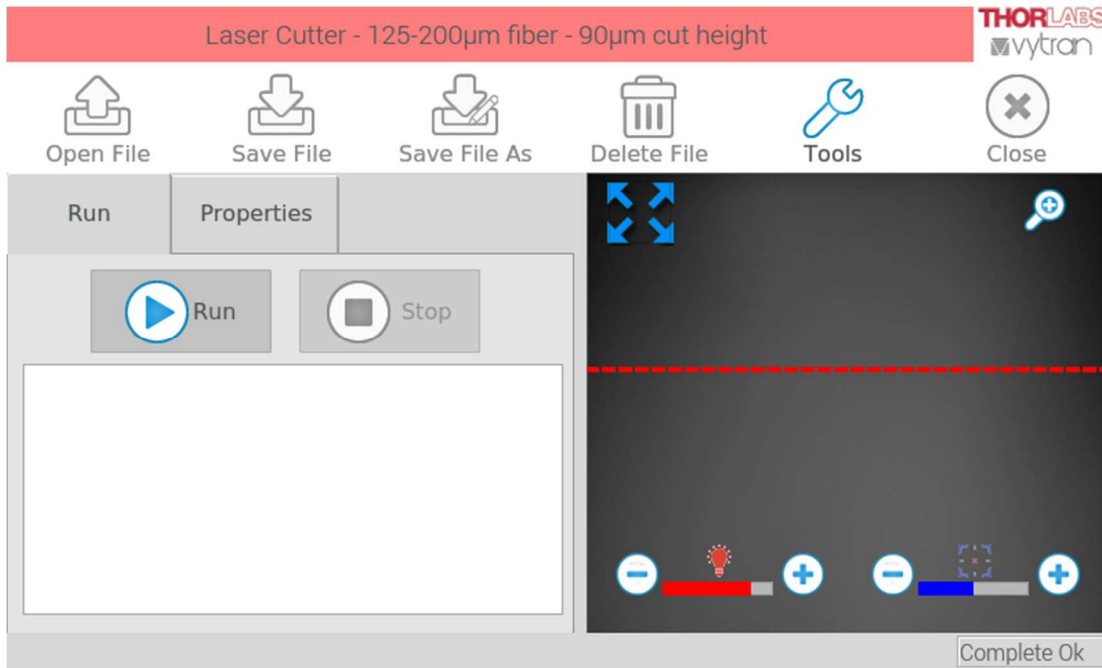


Figure 41 Main Window with No Read or Write Access permitted

To disable the User Access Level feature:

- Select User from the Tools list
- Enter the current password
- Select Change Password and then select Ok to save a blank password
- Select Logout

Chapter 11 About

Selecting *About* from the Tools list opens a window that displays some system information including the applications current version number. From this screen, the user is able to update the application via external USB flash drive. To do this, simply load an appropriate TLCMController file supplied by Thorlabs onto a USB flash drive, plug the flash drive into the USB port in the front of the LCM10 and select the Update button on this screen and then follow the prompts.

Chapter 12 Theory of Cutting

12.1. Manual Processing

Today's fiber optic connector assembly line will typically follow the following flow chart. Among all the steps, Manual Cleaving, Hand Polishing and Epoxy Removal are facing the most challenges when it comes to the consideration of cost, consistency and scalability.

Cut to length → Strip/Prep → Clean → Insert → Adhesive → Cure → Assembly → **Manual Cleave** → **Hand Polishing & Epoxy Removal** → A Series of Machine Polish Steps → Clean → Inspect → Test → Packaging

An example of an uncleaved connector tip is shown in Figure 42. Such a sample typically has a 300-1500 μm epoxy bead thickness formed at the bottom of the ferrule tip. The protrusion length of the fiber is commonly in the range of 5-50 mm.

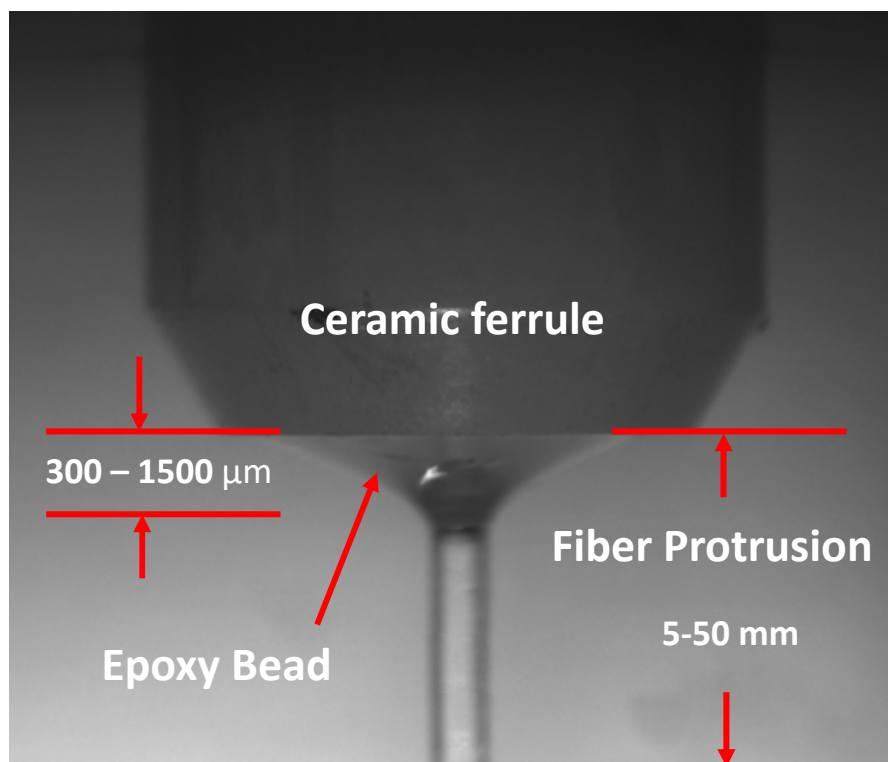


Figure 42 **Uncleaved Connector Tip**

12.2. Manual Cleaving

Scoring is a technique for manual cleaving a fiber (as shown in Figure 43). In this technique, the user utilizes a scribe tool (i.e. Thorlabs S90R) to make a small cut in the fiber that becomes a stress point for cleaving. Upon completion of scoring, the user grips the fiber tip and then pulls along the mechanical axis of the fiber directly away from the connector to cause separation of the fiber.

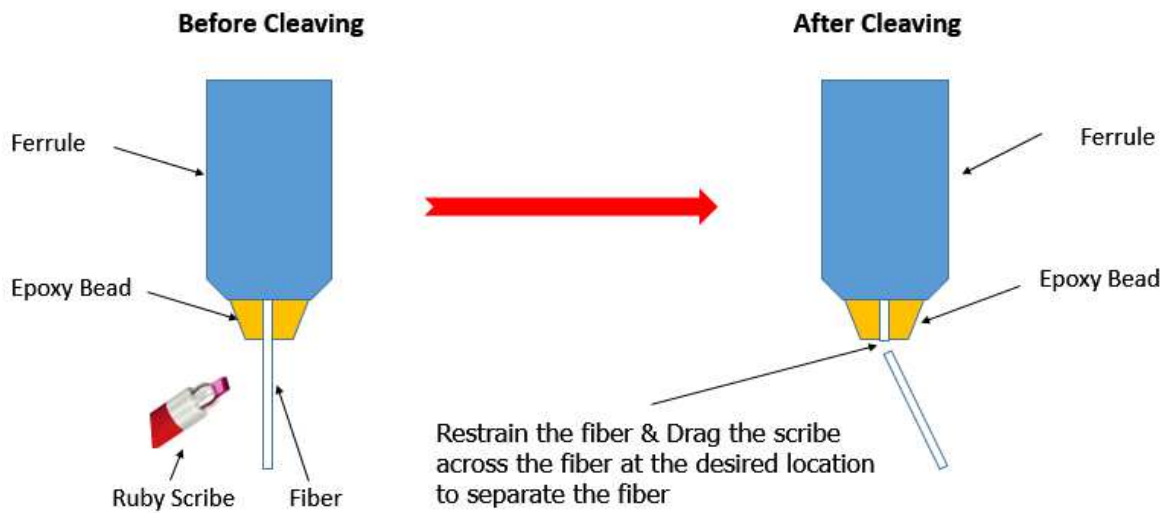


Figure 43 Manual Cleaving

12.3. Hand Polishing & Epoxy Removal

After manual cleaving, typically there is still a very small section of the fiber that is protruding from the surface of the epoxy bead. It must be gently hand polished before it can go through the normal polishing procedure, and this process is typically referred to as “hand polishing” or “manual denubbing”. A coarse polishing film (i.e. Thorlabs LF30D 30 μm polishing film) is commonly used to rub the fiber in a back-and-forth motion until it is flush with the epoxy bead. This process on average takes about 30s for smaller core-sized fibers, but may take up to 1 min for fibers with large diameters. Upon completion of the hand polishing process, a small portion of the epoxy bead is removed along with the protruded fiber, and the remaining epoxy bead thickness will typically end up in the range of 300-500 μm. The hand polishing process is shown in Figure 44 below:

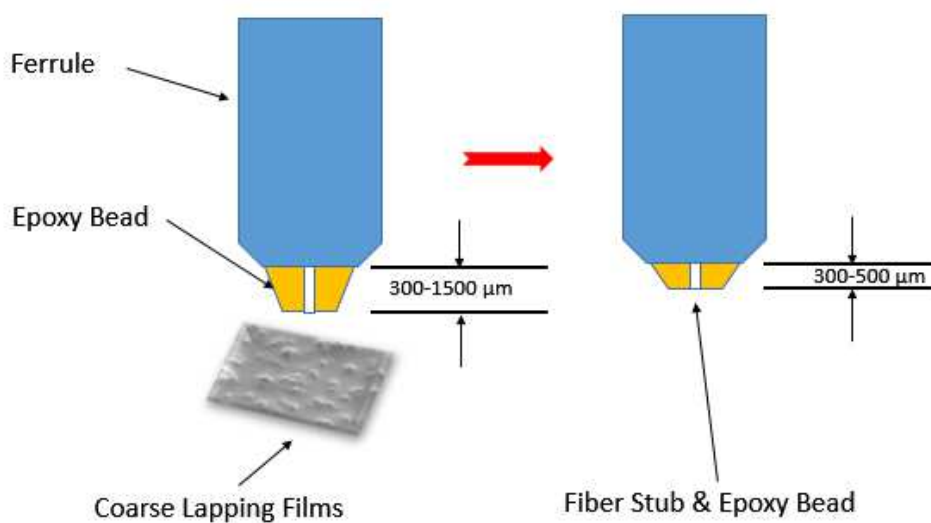


Figure 44 Hand Polishing & Epoxy Removal

12.4. Problems with Manual Processing

In this section, some common problems associated with the manual processing are described.

1. The quality of Manual Cleaving and Hand Polishing are highly dependent on the experience level of the operator as well as the quality of the tools (hand scribe, polishing film, etc.). A bad cleave may result in an end face with core cracks or endface chips, and will require rework.
2. Epoxy bead size can vary drastically from manufacturer to manufacturer, since each of them have their own unique adhesives and cure procedures. Even with the same recipe, the resulting epoxy bead size can vary from operator to operator based on their skill levels.
3. Hand-polishing often results in overuse of consumables. This can be costly in the long run.
4. Manual cleaving and hand-polishing can be very challenging when it comes to large diameter fibers or specific connector types such as SMA.
5. With manual processing, manufacturers are typically forced to find a compromise solution to balance yield, throughput, quality, and cost requirements.

12.5. Laser Cutting

Vytran’s LCM10 laser cutter utilizes a non-contact laser system that replaces cleaving, polishing and manual epoxy removal with a single step. The system is based on a high-power CO₂ laser with an emitting wavelength of 10.6 microns. The main specifications of the laser are listed in the table below.

LCM10 Main Specifications	
Laser Type	CO ₂ (Carbon Dioxide) Laser
Optical Output Power	40 W (Max)
Power Stability	± 5%
Duty Cycle	0 - 99%
Power Input	90 - 264 VAC, 47 - 63 Hz 8.2 A @ 115 VAC, 3.9 A @ 230 VAC

The laser beam has a theoretical diffraction-limited focus spot size that is comparable to the size of a typical 125 micron diameter fiber. The cutting action is performed in a scanning movement of the focused spot in a direction perpendicular to the axis of the fiber. A novel, proprietary scanning mechanism in conjunction with a unique optical path enables the possibility of two-directional cutting – both the front and back side of the fiber can be processed by the laser simultaneously. This two-directional cutting feature has been proven to greatly improve the cutting efficiency especially for optical connectors with large core fibers, i.e. Ø1 mm and Ø1.5 mm. Figure 45 is an example of a Ø200 µm fiber terminated in Ø2.5 mm ferrule FC/PC connector, processed by the LCM10 Laser Cutter, before and after cutting. The laser cutter successfully cut the fiber and removed the majority of the epoxy bead, making the sample ready for further polishing steps.

The primary advantages of laser cutting compared to traditional manual processing include but are not limited to the following:

- The automation process removes assembler/operator skill dependency
- It significantly reduces the need for and over-use of scribes and other consumables
- It provides consistent final cut heights with a ±10 µm cut height repeatability
- It improves connector end-face quality, reducing the chances of cracks and/or chips
- Laser cutting provides higher yields, since the risk of cracking the core is eliminated.

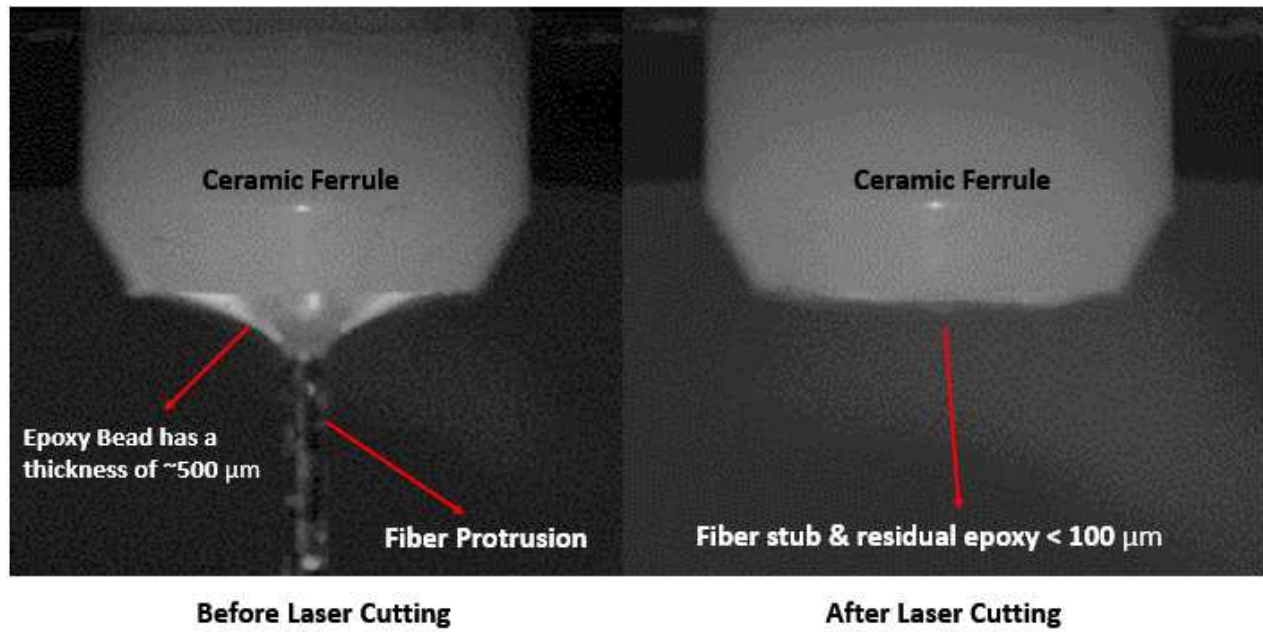


Figure 45 Ø200 μm fiber in ferrule, before and after cutting

Chapter 13 Cutting

13.1. Overview

The LCM10 cuts fiber using a CO₂ laser as follows:

1. A connector with a fiber protruding out of the end is inserted into a connector mount in the front of the LCM10.
2. The user presses the start button (or steps on the foot switch, or touches “Run” in the GUI), and the connector mount lowers the connector into the working area.
3. The laser turns on, and the beam sweeps back and forth, cutting off the end of the fiber (including end of the epoxy bead).
4. The end of the fiber drops into the off-cut bin.
5. During this process, fumes are sucked away from the work area. The exhaust from the impeller is sent through a carbon filter.
6. The connector mount raises the connector so that it is once again accessible.
7. The user removes the connector.

Chapter 14 Maintenance

These fiber cutters are designed to provide trouble-free operation in a production environment provided that planned maintenance is performed as described below.

As a rule, none of the maintenance procedures require operation of the CO₂ laser in conditions that do not meet OSHA Laser Safety recommendations, neither by the user, nor by the service specialist. The user may not perform any action related to the laser, including laser beam alignment. Only Vytran authorized personnel are allowed to perform laser replacement or laser beam alignment.

Planned Maintenance Schedule

Action	Frequency
Empty the off-cut bin	Every shift
Clean the fiber connector holding plate	Daily
Verify the location of the laser cut line	Once per week
Replace the carbon filter	Every six months

14.1. Emptying the off-cut bin

To empty the off-cut bin, open the door in the front of the unit by pulling on the handle. Pull out the off-cut bin, dump the off-cuts into the garbage, and put the off-cut bin back in the discard chamber. Then close the door again.

14.2. Clean the fiber connector mount

The fiber connector mount needs to be cleaned daily to ensure the accuracy of the cutting results. Please note that if fumes condense at the bottom of the mount and can be seen on the camera display, the user should detach the connector mount and clean it right away before further processing. To clean the ferrule hole and the plate, use alcohol with a cotton-tipped applicator, or a pipe brush.

14.3. Verify the location of the laser cut line

It is recommended that the user verify the location of the laser cut line once a week to make sure there is no significant drifting after volume sample production. If there is discernable variation, please refer to Section 7.1 to re-optimize the location of the laser cut line. Please contact the manufacturer if significant drifting is observed. In this case, an onsite re-alignment of the optical train might be required.

14.4. Replacing the carbon filter

To replace the carbon filter, use a small flat-head screw driver to pry off the off the cover in the back of the unit. Pull out the old carbon filter and replace it with a new one. Press the cover back in place, using the alignment marks to position the cover correctly.



Figure 46 Removing the carbon filter cover

Chapter 15 Connector Mounts and Cannula Stops

Here is a list of all the connector mounts and cannula stops that come with the LCM10. The LCM10A0 is installed on the unit at the factory. The other ones ship in the toolkit box. To make it easier to change a connector mount, hit the “Raise Dock” button on the touch screen.

Item #	Description	Ferrule Diameter
LCM10A0	Connector mount for FC/PC and SC connectors	2.5 mm
LCM10A1	Connector mount for MT connector	N/A (Rectangular)
LCM10A2	Connector mount for SMA connector	3.17 mm
LCM10A3	Connector mount for LC connector	1.25 mm
LCM10A4	Cannula stop for Ø1.25 mm ferrule	1.25 mm
LCM10A5	Cannula stop for Ø2.5 mm ferrule	2.5 mm

The cannula stop LCM10A4 for Ø1.25 mm ferrules is compatible with connector mount LCM10A3.

The cannula stop LCM10A5 for Ø2.5 mm ferrules is compatible with connector mount LCM10A0.

Chapter 16 Specifications

Item #	LCM10
Laser Wavelength	10.6 μm
Laser Output Power	40 W (Max)
Power Stability	$\pm 5\%$
Duty Cycle	0 - 99%
Maximum Fiber Size	$\varnothing 1.5$ mm
Supported Connector Types (One Mount for Each Included)	FC/PC (and SC) MT SMA LC
Included Cannula Stops	$\varnothing 1.25$ mm Cannula Stop (For LC Connector Mount) $\varnothing 2.5$ mm Cannula Stop (For FC/PC Connector Mount)
Power Input	90 - 264 VAC, 47 - 63 Hz 8.2 A @ 115 VAC, 3.9 A @ 230 VAC
Dimensions (L x W x H)	23.11" x 18.25" x 9.95" (586.9 mm x 463.6 mm x 252.7 mm)
Weight	46.8 lbs (21 kg)
Packaged Weight	64.8 lbs (29 kg)
Operating Temperature	15 to 40 $^{\circ}\text{C}$
Altitude Range	0 to 2000 m Above Sea Level
Operating Humidity	0 to 75% Relative Humidity (Non-Condensing)
Storage Temperature	-20 to 60 $^{\circ}\text{C}$
Storage Humidity	0 to 90% Relative Humidity (Non-Condensing)
Cut Time, Fiber Diameter ≤ 600 μm	< 4 seconds
Cut Time, Fiber Diameter > 600 μm	< 8 seconds
Fiber Protrusion Distance (Before Cutting)	1 – 50 mm
Minimum Cut Height, 1.25 mm Ferrule ²	60 – 90 μm
Minimum Cut Height, 2.5 mm Ferrule ¹	80 – 120 μm
Minimum Cut Height, 3.2 mm Ferrule ¹	120 – 160 μm
Cut Height Repeatability	± 10 μm

² There is a range of minimum cut heights since the beam is conical, and the angle of the cone and the diameter of the ferrule determine how close the fiber can be cut.

Chapter 17 Servicing and Troubleshooting

17.1. Packaging

Note: Please keep the original packaging that the unit came in. Re-use it if your system needs to be returned to Thorlabs for service or evaluation. The illustrations below show the correct way to re-pack the LCM10. Please ensure that the bottom of the box is taped securely before re-packing the unit. If returning a malfunctioning unit for repair, we ask that you return the accessories with the unit in case one of the accessories happens to be the source of the problems.



Figure 47 System sitting in inner box



Figure 48 Addition of honeycomb spacer in inner box



Figure 49 Addition of tray on top of system in inner box



Figure 50 Inner box placed inside outer box

17.2. Frequently Asked Questions

Q: How can I check the quality of my fiber ends?

You can check endface quality using an interferometric cleave checker.

For other questions, contact techsupport@thorlabs.com.

Chapter 18 Regulatory

As required by the WEEE (Waste Electrical and Electronic Equipment Directive) of the European Community and the corresponding national laws, Thorlabs offers all end users in the EC the possibility to return “end of life” units without incurring disposal charges.

- This offer is valid for Thorlabs electrical and electronic equipment:
- Sold after August 13, 2005
- Marked correspondingly with the crossed out “wheelie bin” logo (see right)
- 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 Thorlabs products, such as:

- Pure OEM products, that means assemblies to be built into a unit by the user (e. g. OEM laser driver cards)
- Components
- Mechanics and optics
- Left over parts of units disassembled by the user (PCB's, housings etc.).

If you wish to return a Thorlabs unit for waste recovery, please contact Thorlabs or your nearest dealer for further information.

Waste Treatment is Your Own Responsibility


If you do not return an “end of life” unit to Thorlabs, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

Ecological Background

It is well known that WEEE pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS directive is to reduce the content of toxic substances in electronic products in the future.

The intent of the WEEE directive is to enforce the recycling of WEEE. A controlled recycling of end of life products will thereby avoid negative impacts on the environment.

Chapter 19 CE Certificate



THORLABS
www.thorlabs.com

EU Declaration of Conformity

in accordance with EN ISO 17050-1:2010

We: Thorlabs Inc.
Of: 56 Sparta Avenue, Newton, New Jersey, 07860, USA

in accordance with the following Directive(s):

2006/42/EC	Machinery Directive (MD)
2014/30/EU	Electromagnetic Compatibility (EMC) Directive
2011/65/EU	Restriction of Use of Certain Hazardous Substances (RoHS)

hereby declare that:
Model: **LCM10**

Equipment: **Laser Cutter**


is/are in conformity with the applicable requirements of the following documents:

EN ISO 12100	Safety of Machinery. General Principles for Design. Risk Assessment and Risk Reduction	2010
Authorised to compile the technical file:	Thorlabs GmbH Münchner Weg1, 85232 Bergkirchen, Deutschland	
EN 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements	2013
EN 60825-1	Safety of Laser Products	2014-05

and which, issued under the sole responsibility of Thorlabs, is/are in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8th June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment, for the reason stated below:


contains no substances in excess of the maximum concentration values tolerated by weight in homogenous materials as listed in Annex II of the Directive

I hereby declare that the equipment named has been designed to comply with the relevant sections of the above referenced specifications, and complies with all applicable Essential Requirements of the Directives.

Signed:  On: 13 September 2021

Name: Danielle Strong
Position: Director of Quality and Compliance

EDC - LCM10 -2021-09-13



Chapter 20 Thorlabs Worldwide Contacts

For technical support or sales inquiries, please visit us at www.thorlabs.com/contact for our most up-to-date contact information.



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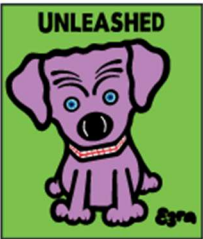
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