GPX3800 and GPX3850
Glass Processors

User Guide

Table of Contents

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

WARNING

The filament in the glass processor furnace generates intense light when it is in operation. It is strongly advised that the user does NOT look directly at it during splicing or tapering operations.

CAUTION: HOT SURFACE

The furnace gets extremely hot when the filament is turned on. Do not touch the furnace during or immediately after the filament has been on for a few seconds, such as after a splice or tapering operation.

WARNING

The fiber handlers and the splice head can exert a fair amount of force as they move from side to side. Do not put your fingers between them, or between the fiber handlers and the slot end walls, while the machine is in operation.

DANGER

The camera tower on the glass processors can generate a fair amount of force as it moves forward and backward, and up and down. Do not put fingers between it and the furnace or mirror tower while the machine is in operation.

CAUTION

Be sure your electrical power and gas supplies meet the criteria detailed in the Chapter 9.

Chapter 3 Description

3.1. Introduction

Thank you for purchasing a Vytran® Glass Processor. This manual is intended to convey the basic instructions necessary for operating the glass processor.

The Vytran Glass Processors are a versatile glass processing platform for the fabrication of splices, tapers, terminations, couplers and combiners. All systems incorporate a filament furnace assembly that provides a stable high temperature heat source for precise control of glass processing conditions. An embedded real time control system and powerful machine level macro programming language allow the user to develop unique event-driven routines for fast and flexible process development. All high level system communication is through a user-friendly, PC based graphical interface that provides for easy operation and convenient data storage. This level of control combined with the consistency of filament fusion technology makes the glass processors a multipurpose platform for the production of fiber laser and other specialty fiber applications.

The Vytran Glass Processors consist of four different models designed to perform high-quality fusion splicing and tapering of specialty fibers. The system consists of a filament-based heater, precision stages with multi-axis control, microscopic high resolution CCD imaging system and a personal computer. The filament assembly can heat optical fiber to temperatures up to 3000 °C, which makes it possible to fuse and process various fiber types and sizes. The multi-axis stages precisely control and aid the alignment and positioning of the fibers for high quality splicing and tapering. The imaging system displays magnified fiber image with sub-micron resolution. The fiber can be viewed both from fiber side and fiber end. All glass processors have the ability to rotate fibers; making it possible to align PM fibers, eccentric core fibers or non-circular fibers.

3.2. Features

3.2.1. GPX3800

Standard Features

- Fiber Splicing and Tapering up to Ø1.25 mm Cladding
- Automated Splice Head
- XY Alignment Blocks with Rotary Capability
- Camera Tower with Ring Illuminator
- Tension Monitoring and Control System

Optional Features

- Liquid Cooling System (Item # GPXWCS)
- Fused Taper Software Enhancement (Item # GPXFBT-SFT)
- Fixture with Adjustable Gripper (Item # GPXFBT-FXTA)
- Fixture with Removable Taper Holder (Item # GPXFBT-FXTB)
- Software and Fixture Kit with Adjustable Gripper (Item # GPXFBT-KITA)
- Software and Fixture Kit with Removable Taper Holder (Item # GPXFBT-KITB)

3.2.2. GPX3850

Standard Features

- Fiber Splicing and Tapering up to Ø1.7 mm Cladding
- Automated Splice Head
- XY Alignment Blocks with Rotary Capability
- Camera Tower with Ring Illuminator
- Liquid Cooling System (Item # GPXWCS)
- Tension Monitoring and Control System

Optional Features

- Fused Taper Software Enhancement (Item # GPXFBT-SFT)
- Fixture with Adjustable Gripper (Item # GPXFBT-FXTA)
- Fixture with Removable Taper Holder (Item # GPXFBT-FXTB)
- Software and Fixture Kit with Adjustable Gripper (Item # GPXFBT-KITA)
- Software and Fixture Kit with Removable Taper Holder (Item # GPXFBT-KIT)

3.3. Accessories GPX3800 and GPX3850

Component	Description
Workstation	GPX3800 or GPX3850 Glass Processor Workstation
PC	Computer, including Monitor, Keyboard and Mouse
Vacuum Pump	Vacuum Pump for Vacuum V-Grooves (Alternative Model Supplied for 230 V Markets)
Power Supply	Dual Voltage Power Supply and Cable
Gas Tank Regulator	Regulator for Argon Tank (European DIN 477 Number 6 Also Included) An Adaptor May be Required in other Areas or Countries
Gas Line	1/8" Teflon Line for Argon Gas
RS-232 Communication Cable	9-pin D-sub Cable for RS-232 Communication
Camera Cable	6 pin IEEE-1394 Fire Wire Cable
Tool Kit	Hex Wrenches for Filament and Inserts Replacement
Fiber Holding Block Inserts	Top and Bottom Inserts for Fiber Holding Blocks
Filament Assemblies	Set of Filament Assemblies

3.4. System Overview

The Vytran Glass Processor has three basic components: a splicing and glass processing workstation, a personal computer (PC), and a gas supply. The splicer workstation is illustrated in Figure 1.

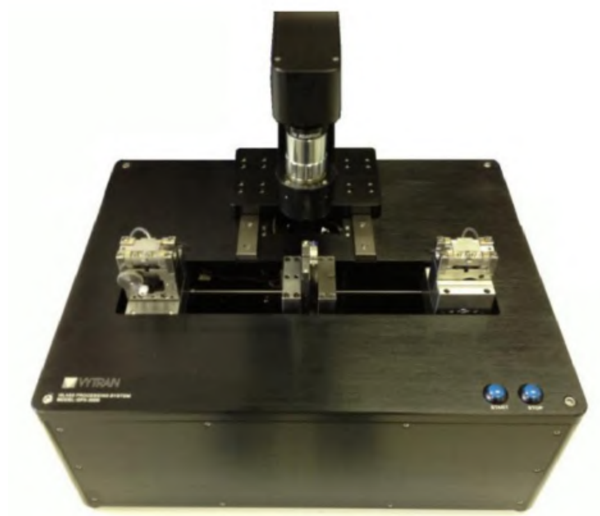


Figure 1   GPX3800 Workstation

3.4.1. External Workstation Connections

The splicer workstation is the main component of the glass processor. The PC and gas supply, as well as peripheral components, are connected to its back panel as illustrated in Figure 2.

Figure 2 GPX3800 Back Panel Connections

Power

- The glass processor workstations are powered from an external dual voltage supply. The GPX3800 uses a 5-pin round connector. The GPX3850 utilizes a 2-pin 24 V and 3-pin 12 V power cord.

Communication

- **PC** – GPX Control communication: RS-232, 9-pin D-Sub connector. Connect to Com 1 on the PC
- **Camera – PC**: IEEE-1394 6 pole connection. Connect to IEEE-1394 on PC
- **Analog Output:** 2 BNC connectors - Analog 1 & Analog 2

Gas

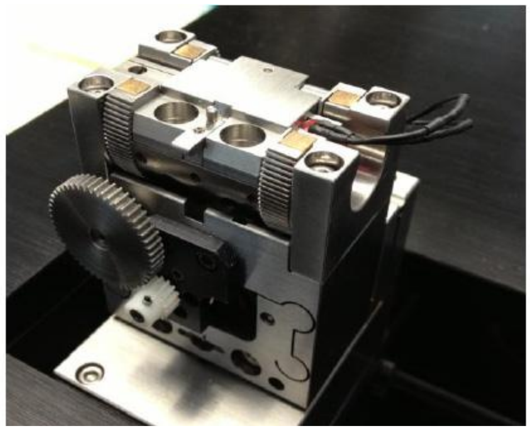
- **Argon:** 1/8" Push fit connector
- **Vacuum:** 5/32" Push fit connector

3.4.2. Fiber Holding Blocks

The fiber handlers are used for holding, positioning and moving the fibers during the various processes implemented on the a glass processor workstation. The GPX3800 and GPX3850 fiber handlers that can align fibers prior to splicing. Fiber XY alignment can be performed using either the edges of the fibers, or their cores. The GPX3800 and GPX360 fiber handlers can also perform a rotary alignment. Rotary alignment is useful for aligning the stress members of PM fibers, for aligning the cores of eccentric core fiber, and for aligning surface features of non-circular fiber.

GPX3800 and GPX3850 Fiber Holding Blocks

The GPX3800 and GPX3850 fiber holding blocks can rotate each fiber up to 200°. This is primarily used for aligning stress members of PM fibers, but can also be used to align the cores of eccentric core fibers. It can also be used to align surface features on fibers that are not round**.**



Rotary Fiber Holding Block

Fiber Holder Inserts

Different sized bottom V-grooves and top inserts are available for various coating fiber diameters. For available insert sizes, please see the selection chart in Chapter 8. In addition to the standard sizes, custom inserts may be specially designed for various applications. Contact Thorlabs for more information.

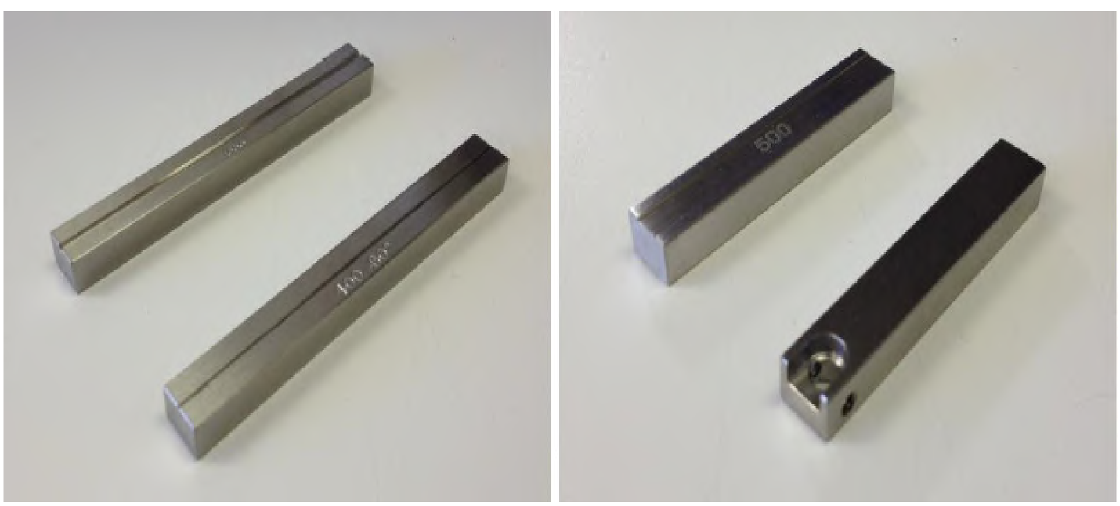


Figure 3 Bottom (Left) and Top (right) Fiber Holding Block Inserts

Fiber Handler Transfer Inserts

The fiber handler transfer insert used on the glass processors make splicing faster and easier because it facilitates repeatable fiber positioning when used in conjunction with a LDC400 Large-Diameter Fiber Cleaver. For example, if the operator uses transfer inserts to hold fibers during cleaving, the operator can then transfer each of those cleaved fibers a glass processor in the same insert that held them during cleaving and ensure that the ends of the fibers will fall exactly in the same place every time. This is due to the fact that the transfer inserts are designed to precisely sit at the same location on both the cleaver and the glass processor, and a magnetic lid on each transfer insert prevents axial movement of the fiber during transport from one piece of equipment to the other.

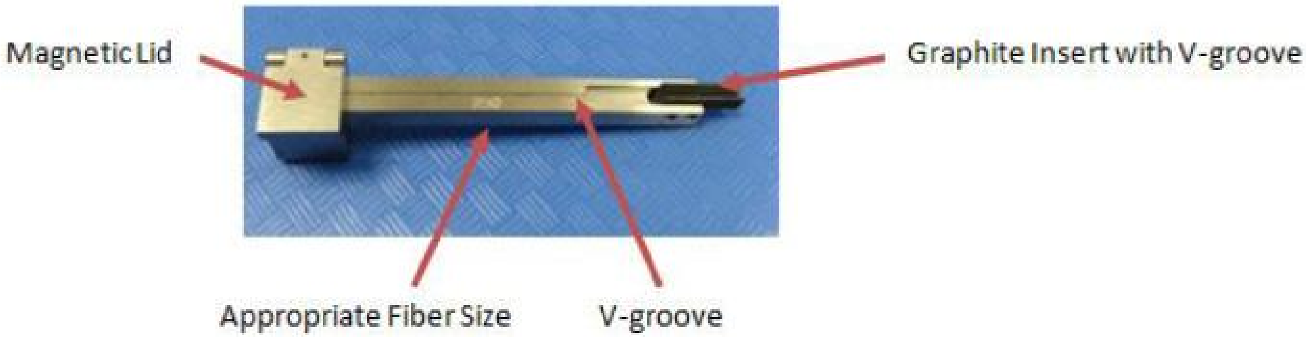


Figure 4 Transfer Insert for Fiber Handle

3.4.3. Splice Head

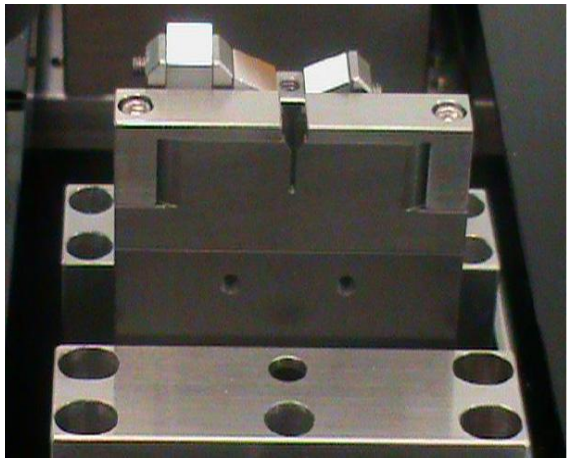
The Splice Head consists of two parts: the Filament Tower and the Mirror Tower. The splice head moves along the Z-axis to allow for viewing and splicing stationary fibers.

Figure 5 Filament Splice Head

Filament Tower

After the splice head moves to the correct position, the Filament Tower raises in the Y-axis to a predefined height to surround the fibers. A filament assembly, available in many different sizes for various applications, sits atop the filament tower. This assembly is screwed to the filament tower and also held down by two filament clamps. In addition to holding down the filament assembly, the filament clamps also serve to limit the influx of room air into the splicing area, as they have protrusions that cover most of the filament housing cavity.

To change a filament assembly, please see Section 7.4.1 Changing the Filament



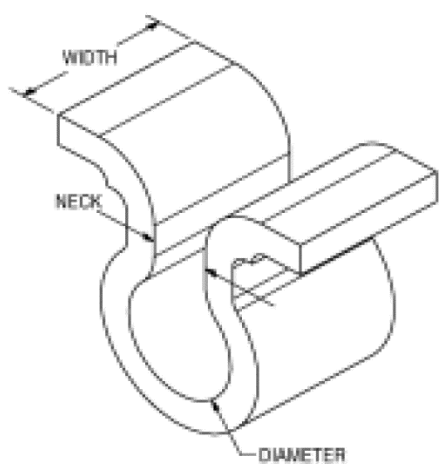
Filament Tower

Filaments

The filaments are omega-shaped resistive heaters. Thorlabs offers these filaments preassembled in a variety of sizes as well as different materials that could be more appropriate to a particular splicing application.

Graphite filaments are capable of achieving the high temperature required for splicing large-diameter silica fibers. It uses less argon and outgases very little compared to the other filaments. Iridium filaments are also available for with soft glass fibers.

Proper filament selection and splice parameters are essential for optimum splice performance. For filament selection guidelines, see Figure 7. In addition to the standard sizes, custom filaments may be specially designed for various applications. Contact Thorlabs for more information.



Filament Heater Element

Filament Assembly

Thorlabs supplies filaments pre-assembled in a filament body as shown in the Figure 6. This is called a filament assembly. Different filament bodies are used with different filaments, and are distinguished by a version number engraved on the front of the housing.

Figure 6 V and T Filament Body Version

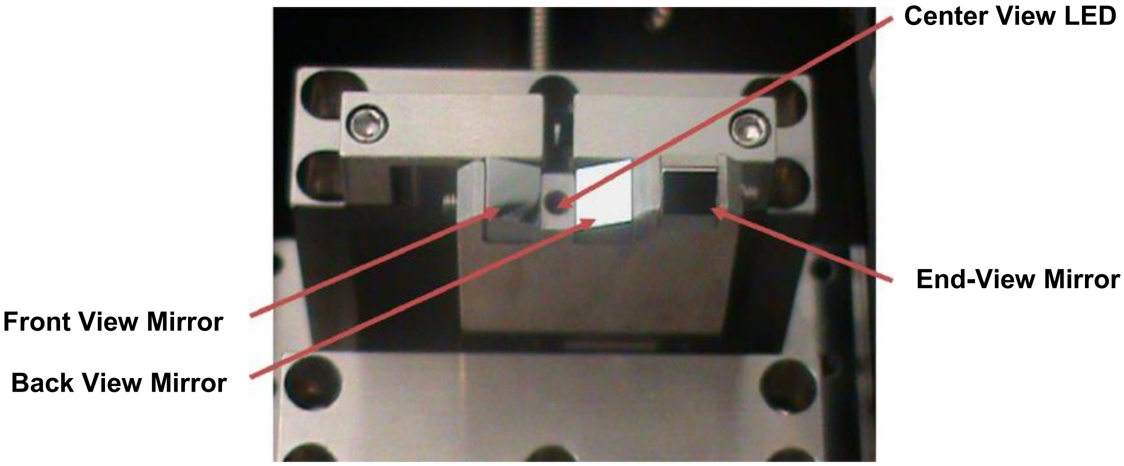
Figure 7 lists the standard graphite filament types as a function of the fiber size and application.

Item #	Filament Material	Application	Cladding Diameter (Min/Max)
FTAV2	Graphite	Splice	80 µm / 250 µm
FTAV4			125 µm / 600 µm
FTAV5			250 µm / 1000 µm
FTAV6			400 µm / 1300 µm
FTAT3		Tapering	250 µm / 1500 µm
FTAT4			400 µm / 1800 µm
FRAV1	Iridium	Splice	≤200 µm
FRAV3			≤400 µm
FRAV5			250 µm / 1050 µm

Figure 7 Filament Size Table

3.4.4. Mirror Tower

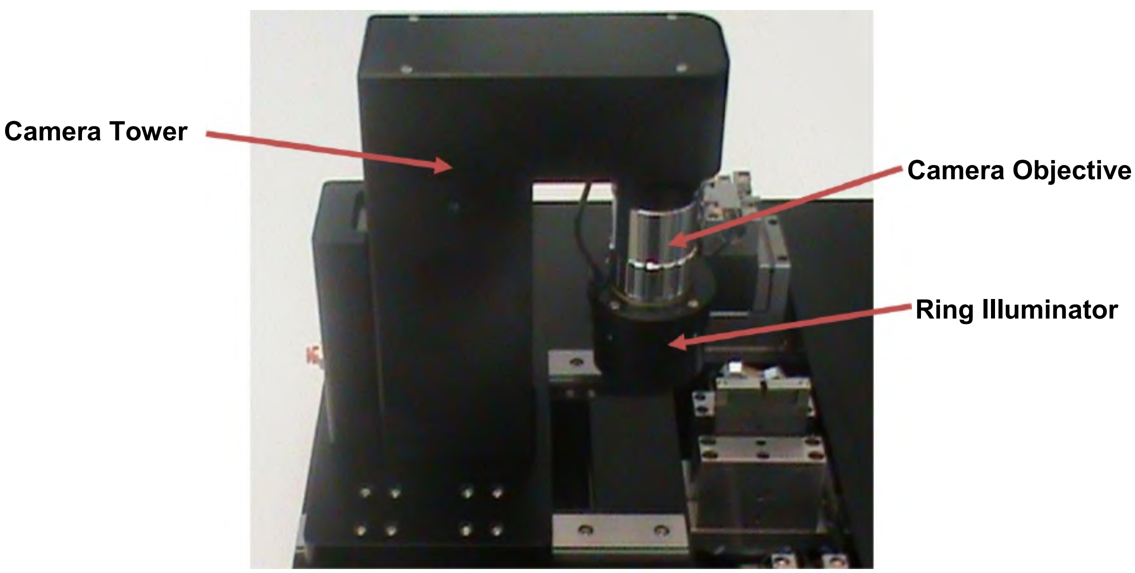
The mirror tower has two sets of mirrors and an LED. The first set of mirrors makes it possible to view the sides of the fiber. They provide the "Front View" and "Back View". The second set of mirrors makes it possible to view the ends of the fibers. The LED provides backlighting when viewing the fiber directly in center view. The Mirror Tower moves in the X-axis to provide the ability to view both the side view and end view of the fibers.



Mirror Tower

3.4.5. Imaging System

The GPX3800 and GPX3850 workstations come with an automated camera assembly used for imaging the fibers. This tower can be moved forwards and backwards as well as up and down. It is equipped with a ring illuminator that provides backlighting for the front and back views of the fiber. The camera objective may be replaced if a larger (or smaller) field of view is desired.



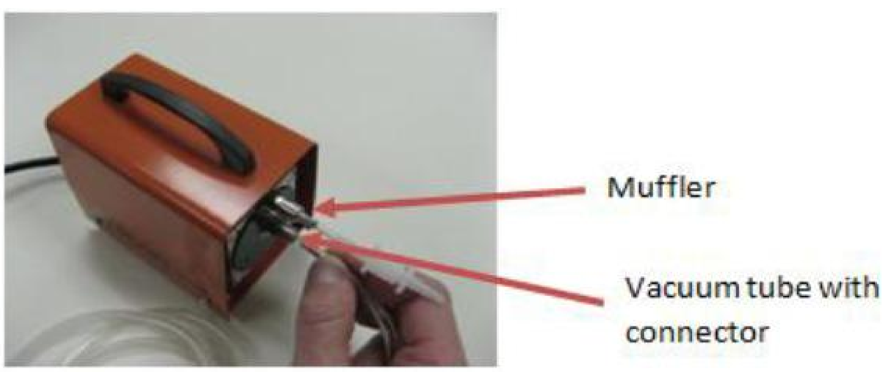
Imaging Camera Assembly

Chapter 4 Setup

1. Unpack PC, monitor and peripherals. Set-up the computer using the included instructions from the computer manufacturer.
2. Unpack the glass processor workstation and place it on a workbench. Make sure not to damage any components of the glass processor during handling of the workstation. Lift the unit using the retractable handles only. Remove the transport block marked with the red “PLEASE REMOVE BEFORE USE” label from the base of the camera tower and store in a secure location for future use.

Transport Blocks Located Near Camera Tower

3. Connect the external vacuum pump:
4. Connect the muffler to the top connector of the vacuum pump.
5. Connect the bottom connector on the vacuum pump, labeled “VAC” with the included tube to the back of the glass processor labeled “VACUUM”.

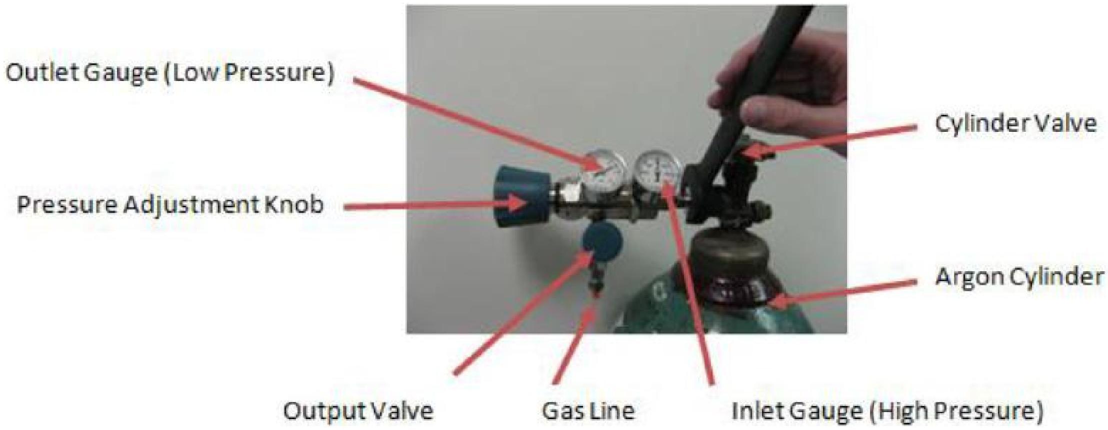


External Vacuum Pump

6. Connect the camera with the supplied IEEE-1394 Fire Wire cable to the port on the glass processor labeled “CAMERA” and to the Fire Wire port on the computer. The connector has a directional design so be sure to orientate the connector correctly. Both the computer and glass processor workstation MUST be off during this operation, otherwise damage to the CCD camera can occur.

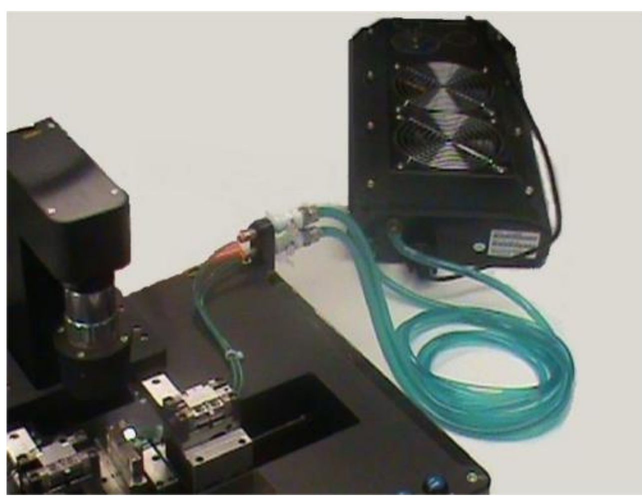
7. Connect the serial communication cable (RS-232) to the outlet in the back of the workstation labeled “SERIAL COMMS” and to the computer’s serial communication port (see instructions from the computer manufacturer). Tighten the screws on both sides of the cable to secure it in place.

8. Clean the outlet of the gas tank thoroughly to remove any debris or deposits, and then install the supplied CGA-580 or DIN 477 Number 6 gas regulator to the gas tank, using the manufacturer-supplied operating and safety instructions.



Argon Gas Regulator

9. Open the Argon Tank and allow gas to flow through the tubing to ensure a clean gas line; then connect the gas line to the back of the glass processor to the port labeled "ARGON".
10. Connect the DC power cable to the back of the glass processor to the port labeled "POWER" with the ferrite end of the cable. Plug the other end of the cable into the external DC-power supply. **Note:** make sure to align the red dot on the plug with the red dot on the receptacle.
11. Connect the AC power cord to the DC power supply and a power source of 110/230 VAC, 47-63Hz.
12. If the liquid cooling system is to be fitted to the splice head, follow the instructions provided with the cooling system.



Liquid Cooling System Connected to Glass Processor.

Chapter 5 Operation

5.1. Software Interface

The software interface involves a graphical user interface, or GUI, and an SQL database. Here is a detailed explanation for the control of the machine.

5.2. Graphical User Interface

The GUI is the main window when working on the glass processor workstation. It has different menus and toolbars that are explained later in this document. The buttons are described in this chapter from top to bottom, as indicated in Figure 8.

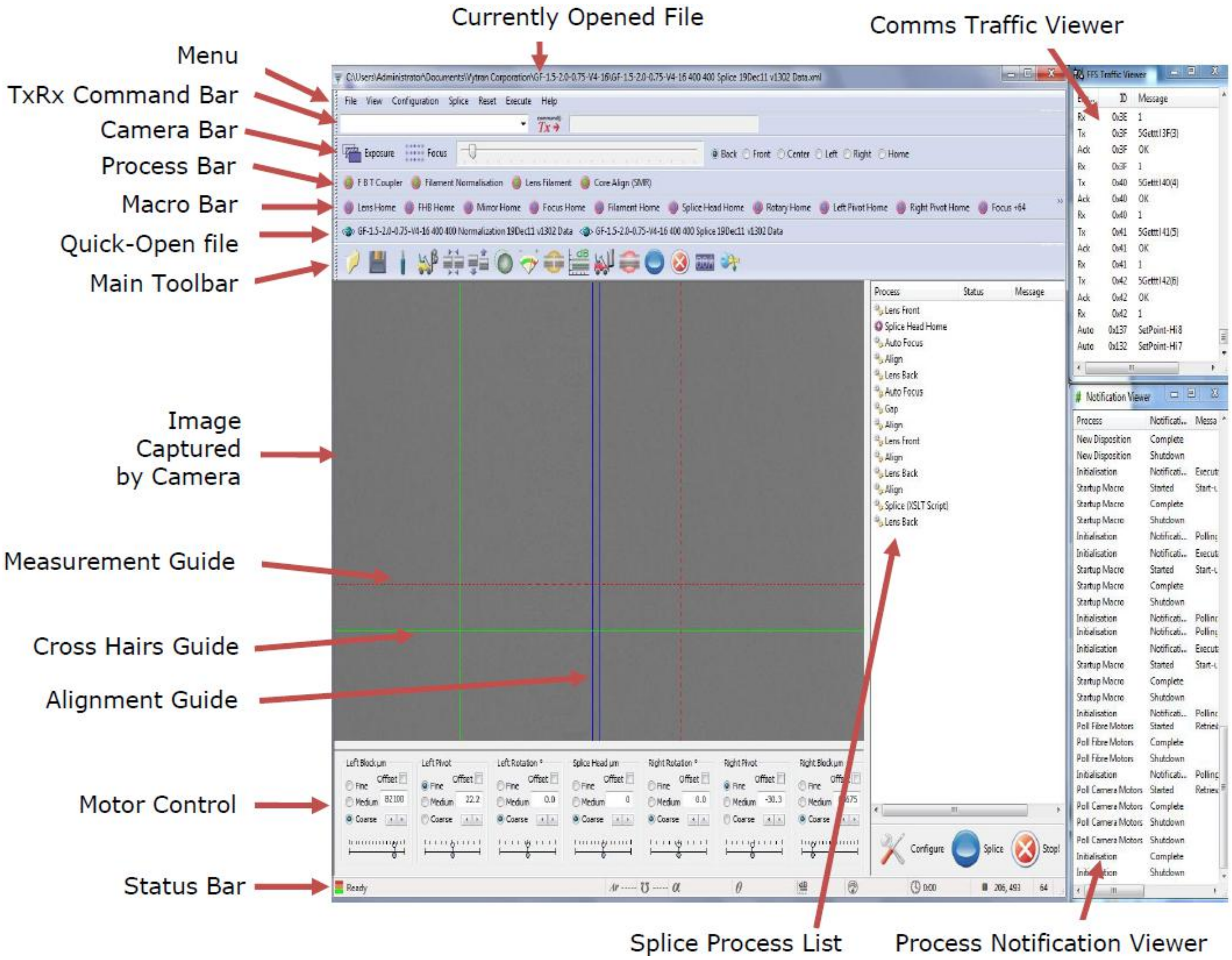
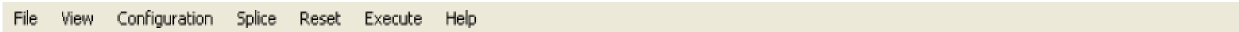


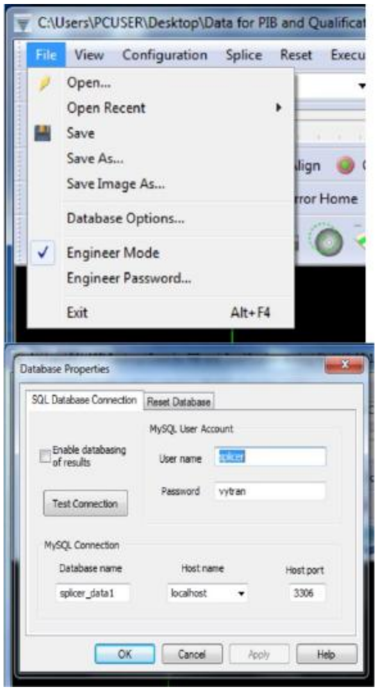
Figure 8 Software GUI Main Screen

The following sections will explain each of these components in detail.

5.2.1. Menu Bar



a. File



The File menu is structured in the same way as shown.

Open: Open a new splice data file.

Open Recent: Shows the files opened recently.

Save: Save the current settings to the current splice data file.

Save As: Save the current settings to a new splice data file.

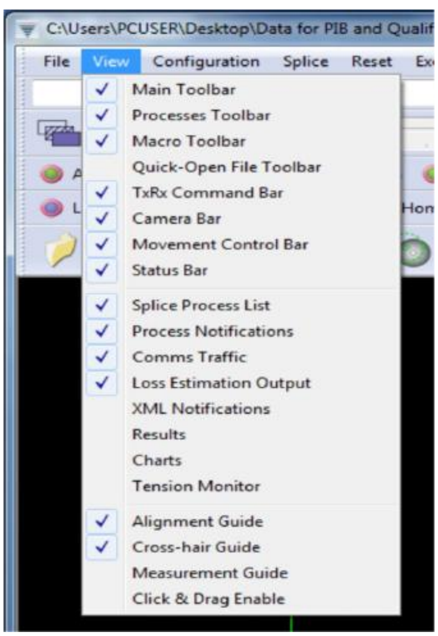
Data Base Options: Enables / Disables the Database. Reset the Database. The database has preconfigured settings that should not be altered.

Engineer Mode: Engineer mode allows full access of SW and control of the limited GUI for the Non-Engineer.

Engineer Password: Engineer mode is password protected.

Exit: Close the GUI.

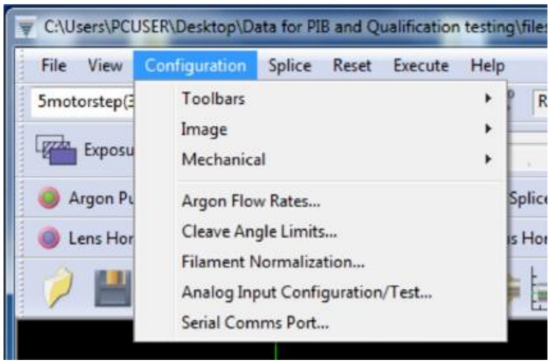
b. View



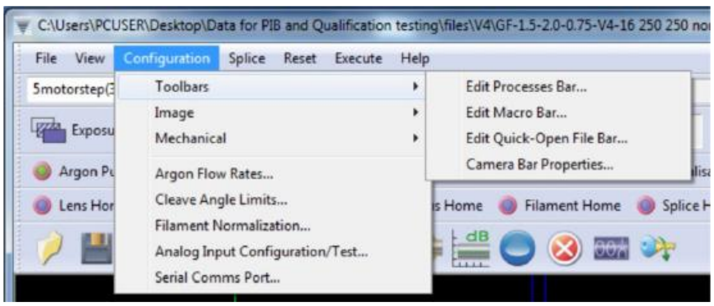
View enables the user to display or hide the various toolbars, data windows, and guides associated with the GUI (like crosshair and alignment guides). The "Processes Toolbar", "Macro Toolbar" and "Quick-Open File Toolbar" can only be activated if functions are assigned to them. You can achieve this under the Configuration menu.

Another feature under the View menu is the Tension Monitor. See Section 5.7.3 for more details.

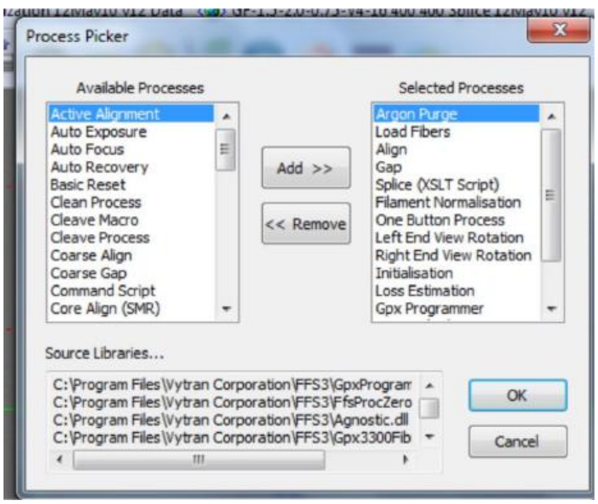
c. Configuration



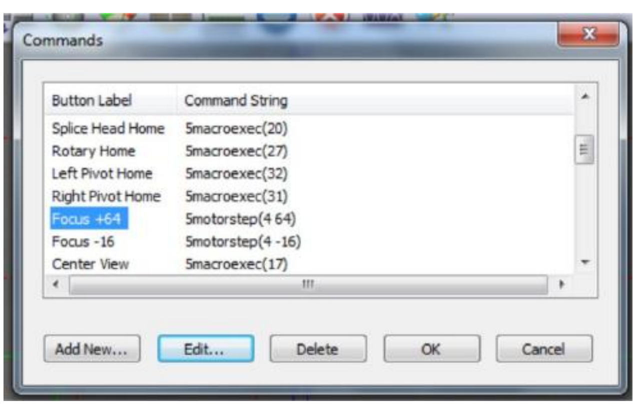
The Configuration Menu allows the user to edit the property of the user interface and also set up the machine parameters.



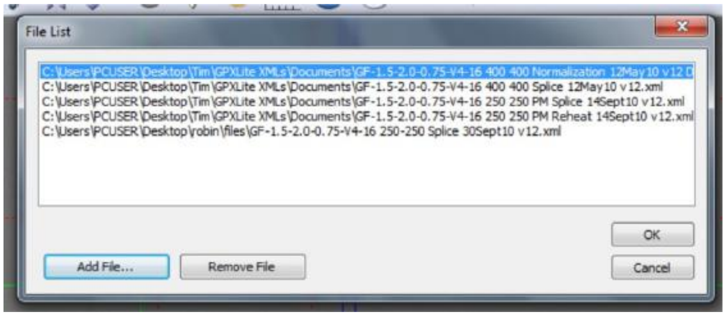
Four tool bars on the interface can be modified through Toolbars window.



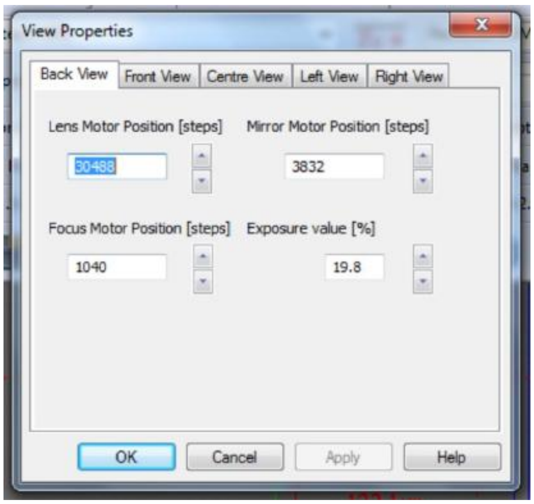
Through the Edit Processes Bar, the user can define which process will be shown in the user interface for quick usage. “Selected Processes” window includes all the processes which will be shown on the screen.



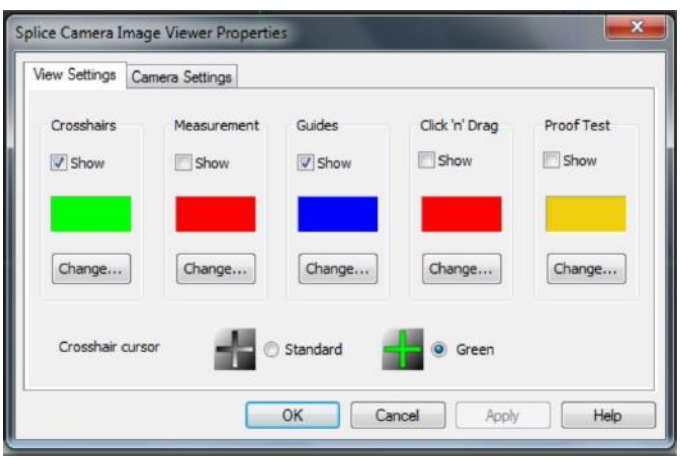
Through the Edit Macro Bar, the user can define which macro or commands will be shown on the screen.



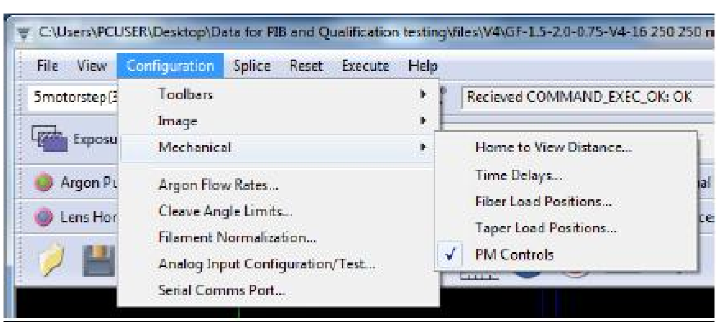
All the files added in this window will be shown on the quick-open file bar. Users can add or remove files from this window.



The camera has five image positions for viewing the fiber. Each camera position contains the settings for the camera and optics in that position.

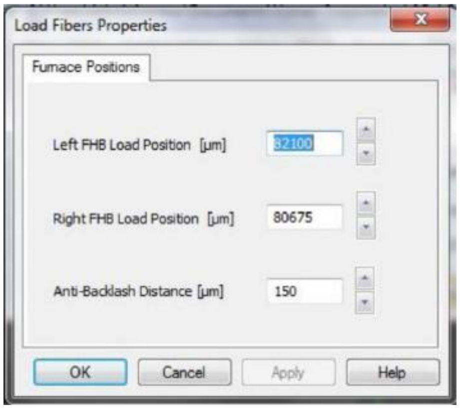


In the CCD Camera property window, the view settings allow the user to turn on and off all the cursors on the screen. Camera settings are preset, the user should not change these values.

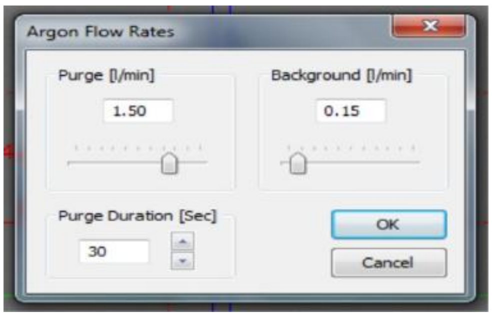


Home to View Distance sets the distance between the splice home and the actual viewing position of the splice head.

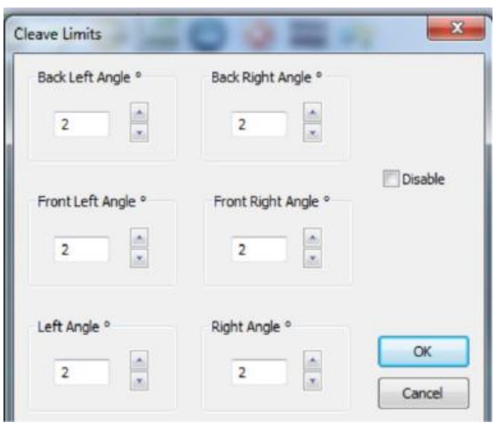
Time Delays are preset by Thorlabs.



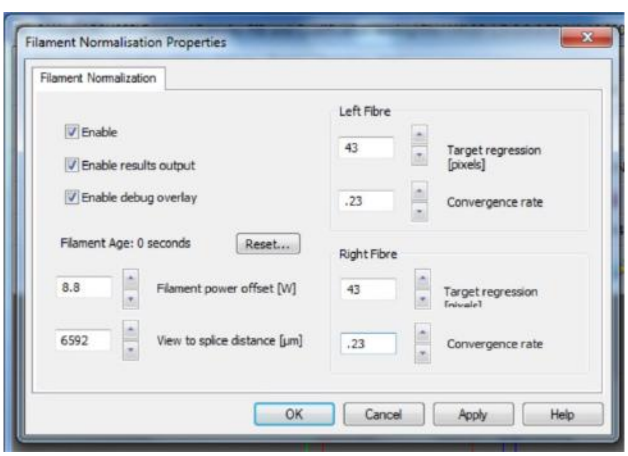
Load Fibers - This window sets the fiber holding block's position when it is ready for loading the fiber to perform the splice.



Argon flow has three rates. The purge and background settings are controlled in this window, and argon flow rate for the splice is set in the splice property window.

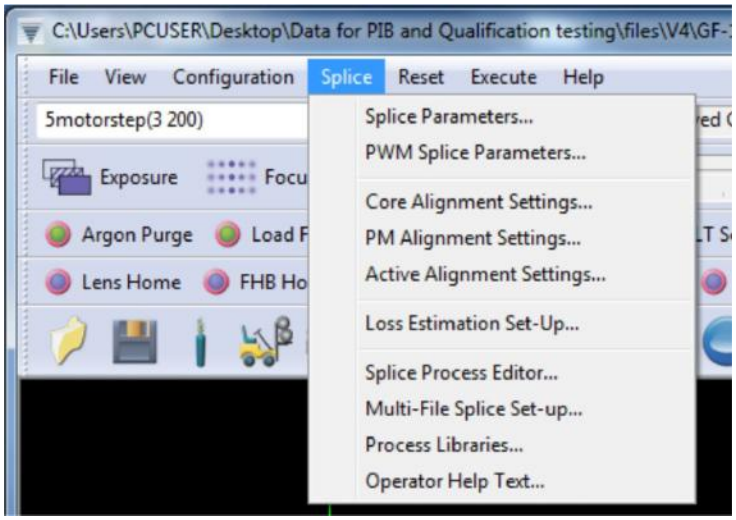


The system can measure the cleave angle of the fibers before splicing them together. The user can set the cleave angle limits to reject the poorly cleaved fiber.



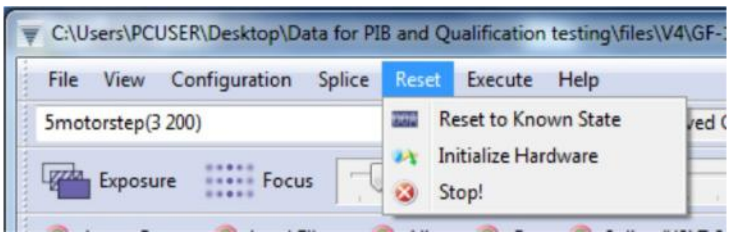
The Filament Normalization values in this window are set by the manufacturer. The process will be explained in Section 5.5.2.

d. Splice



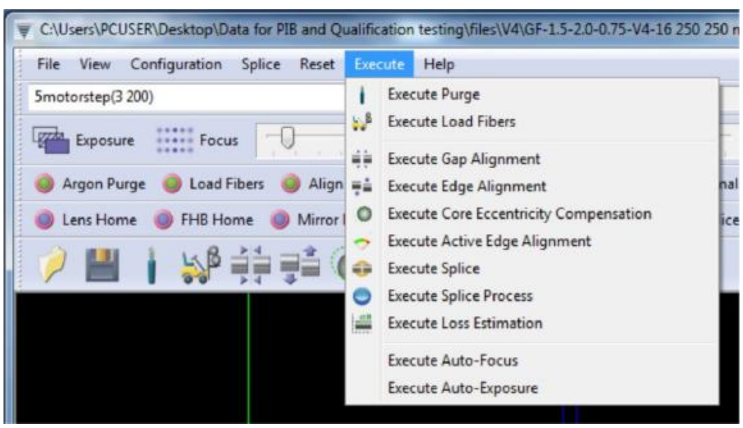
The different splice processes and parameters can be set through this window. The detail information will be discussed in Section 5.5.1

e. Reset



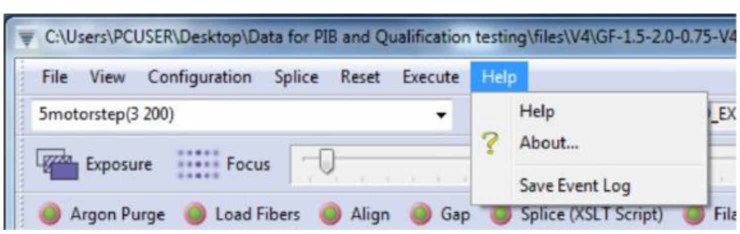
The Reset Menu allows the user to initialize, stop, and reset the GPX window.

f. Execute



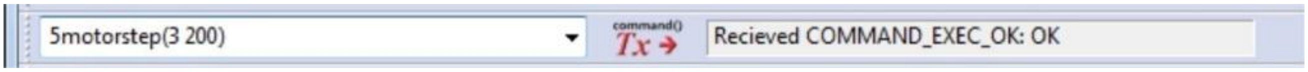
The Execute menu can be used to perform key splicing functions. For descriptions of these functions, see "Illustrated Toolbar" below.

g. Help



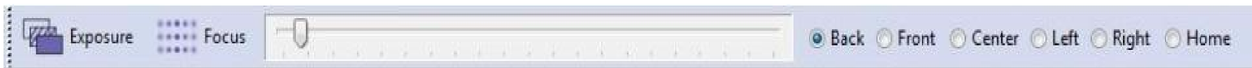
The Help menu provides information about using the GPX and the software and allows the user to save the event log.

5.2.2. Command Bar

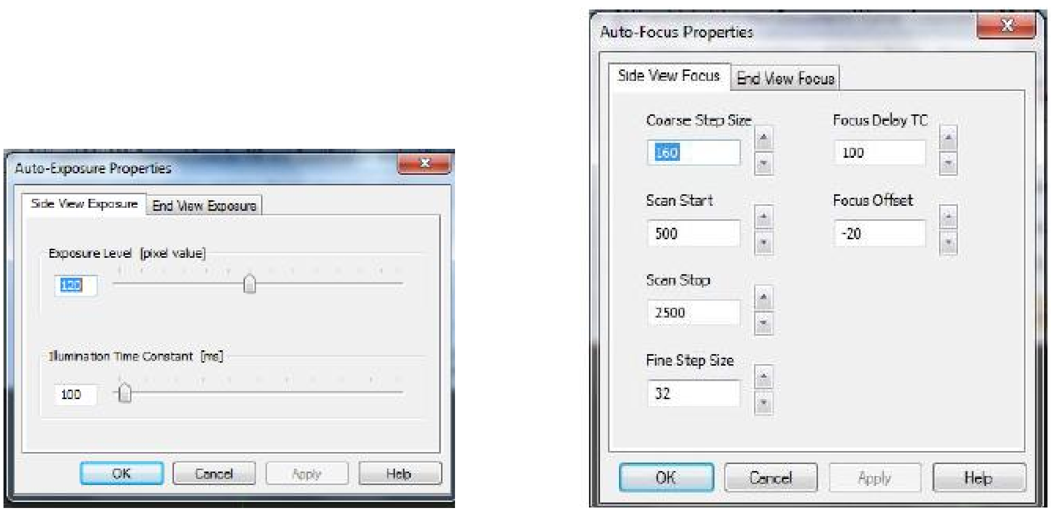


The transmission and receive command bar allows the user to directly enter a command to perform motion control of the motors. In the example above, the motor 3 (lens position) is moved forward by 200 steps. Commands are entered into the white window. The window to the right of the "Tx" button shows the machine code response.

5.2.3. Camera Bar



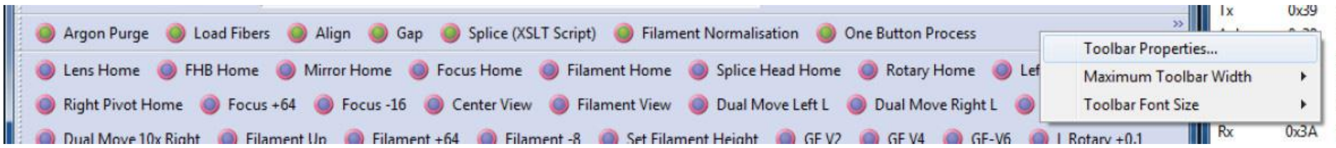
- The "Exposure" button automatically adjusts the image so that the background is the desired brightness. To change the brightness setting, right click the button and click "View Properties." Then change the exposure values and illumination time constants as you see fit.
- The "Focus" button automatically focuses the camera on the fiber. To change the properties of the auto-focus process, right-click the button and click "View properties." Then change the focus parameters as you see fit.
- Next to the "Focus" button is a slider for manually adjusting the focus.
- Next to the slider bar is a row of radio buttons for choosing the view position.
- "Home" is the position for storage and when manipulating fibers.
- "Back" and "Front" are two different side views used to align fibers. The Back view is usually used as the referenced view.
- "Left" and "Right' views show the fiber end face. External illumination may be necessary for certain fiber types.
- In this document, and in the GUI, the word "process" is used to denote a machine action that has been programmed using low-level programming language, and therefore cannot be changed by the user. This is in contrast to a "macro," (which can be changed or created) by the user.



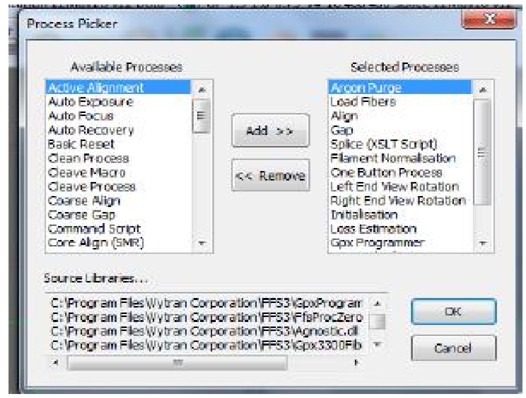
Auto-Exposure (Left) and Auto-Focus (Right) Properties Windows

5.2.4. Process Bar

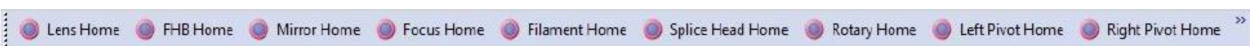
The processes bar allows the user to execute built-in processes such as “Align,” “Gap,” and “Filament Normalization.” Additional processes can be added; right click on this bar, pick “Toolbar Properties” to access the “Process Picker” window.



The processes bar can also be edited by clicking on the “Configuration” menu, then clicking on “Toolbars,” then clicking “Edit Processes Bar.” “Process Picker” window is used to add or remove processes from the Processes bar.

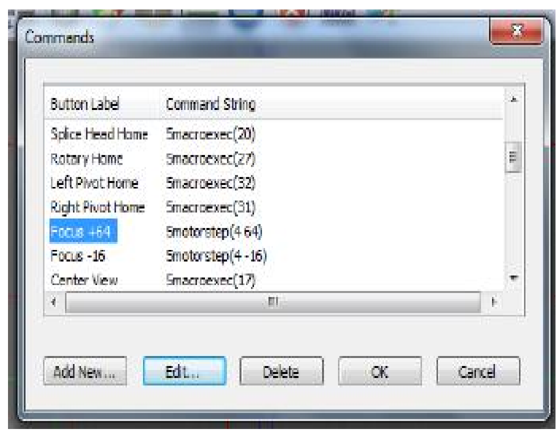


5.2.5. Macro Bar

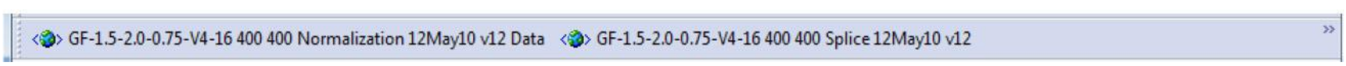


The macro bar contains buttons that execute various macros. Again, in this document and in the GUI, the word “macro” is used to denote machine actions that the user can edit, or even create from scratch.

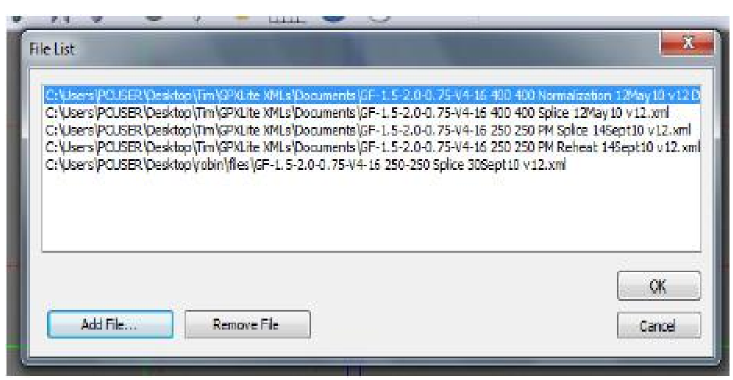
The macro bar can be edited using a right click on the empty space on the bar or clicking on the “Configuration” menu, then clicking on “Toolbars,” then clicking “Edit Macro Bar.” The “Command” window will allow the user to add, edit, or delete the macro shown in the Macro Bar. Note that it is possible to make buttons for one-or-two line commands in the macro bar as well as buttons for entire macros. Please contact Thorlabs for more assistance.



5.2.6. Quick Open File Bar



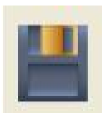
This toolbar allows the user to easily access the most common used files. Right click on the open space on the toolbar, the “File List” window will shown to allow user to add or delete the files on the toolbar. This function also can be accessed through menu bar “Configuration”, “Toolbars”, and “Edit Quick-Open File Bar”.



5.2.7. Main Toolbar

The illustrated buttons on the toolbar right above the image window execute processes critical to splicing and data management.

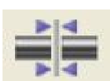
Open: opens a splice data file. This means it loads an XML file containing predefined parameters in preparation for a splice or a taper. Splicing systems are come preinstalled with basic files (such as a SMF-28 to SMF-28 splice). Those are available under specific filament folders. Be sure to have the corresponding filament installed before using a file.



Save: saves the parameters currently in use to an XML file that can be accessed later. In the case you are using an XML file given by Vytran, it is recommend that you perform a "Save As" so that the standard file can be referenced in the future.

Purge: increases the argon flow throughout the unit, removing air and impurities that may contaminate the splice process. You should perform this at least once every time you turn on the argon supply.

Load fibers: This moves the fibers to the splice position, using predetermined fiber loading positions for the fiber holding blocks. You can change these positions by right-clicking on the "load fibers" button.

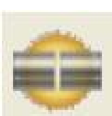


Gap: This button gaps the fibers, moving the fibers so that the end faces are at the Pre-Gap distance specified under Splice Parameters.

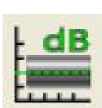
Alignment: This function will find the edges of the fibers and aligned them. This will only align the fibers in the current view (front or back). So it is necessary to repeat this process in a perpendicular view. The Alignment Process will not work if both edges of each fiber are not on the screen. In the end view, this process will rotate the fiber and align it based on the current PM Alignment Settings.

Core alignment: This button aligns the cores of the fibers, bringing the cores into alignment, rather than aligning the fibers using their edges.

Active alignment: This button aligns the fibers actively using an (external) light source and power meter. The power meter must be connected to one of the "Analog" ports on the back panel. The analog input reading can be configured under Configuration → Analog Input Configuration with the Channel set to the appropriate port.

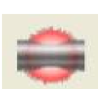


Splice only: This button executes the basic splice process, meaning it sends the lens home (if it has not been done), brings the splice head into position, and executes a splice according the splice parameters. This process will not attempt to align the fibers; it is useful in the case where the fibers have been manually aligned.



Loss estimation: This button estimates the loss in a splice, based on the appearance of the cores in the splice region. For more accurate estimation, you need to have the correct calibration file. Please contact Vytran for more assistance.

Load Taper: This button moves the fiber holding blocks into the predetermined locations for a particular Taper Process and automatically performs an antibacklash process.



Taper: This will execute the taper process. See section 5.7 for further information regarding tapering.

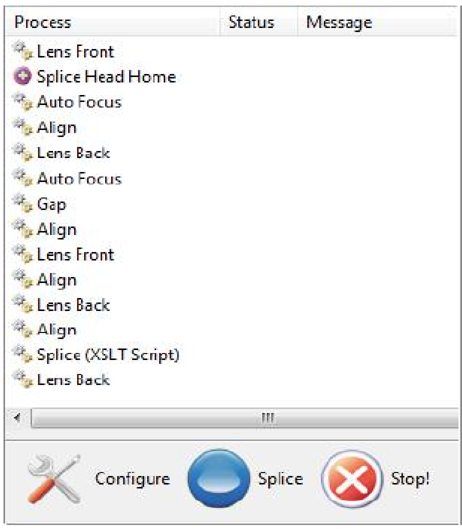
One Button Process: This executes the Splice Routine found under Splice → Splice Process Editor, which generally includes alignment and gapping. The blue button labeled "START" on the front right corner of the GPX has the same function.

Stop: This button stops whatever process is being executed. The blue button labeled “STOP” on the right front corner of the GPX has the same function.

Reset: This button resets the parameters of the GPX to the default values.

Initialize: This button initializes the unit. The system should automatic initialize after the power is on. If the machine is stopped due to any reason, it should be reinitialized by clicking on this button.

5.2.8. Splice Process List



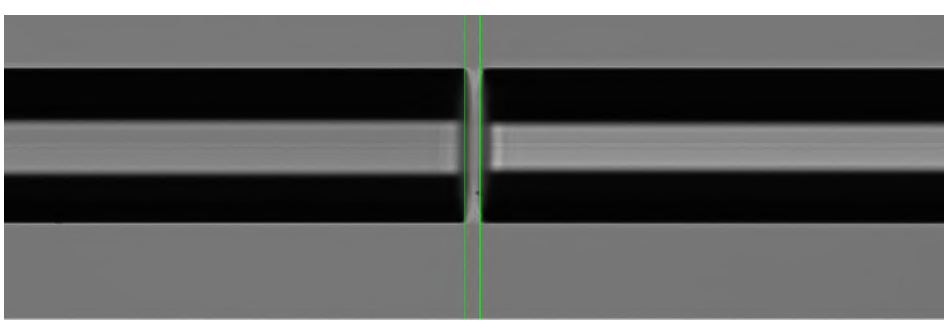
The Splice Process List is the routine run by the “One Button Process”. See section 5.6 for more information.

5.2.9. Camera Image

The camera image shown below is a side view (“Front” or “Back”) of a pair of fibers. Front and back views are captured with the help of mirrors on the mirror tower, and feature back-lighting via LED’s in the ring illuminator. Another way to get an edge view is to view the fiber pair straight on. This is accomplished by clicking on “Center View” in the Camera Toolbar. In this case the fiber will be backlit by an LED in the mirror tower. Finally, the unit is also capable of viewing fibers end-on in “Left” or “Right” view. This, too, is accomplished with mirrors on the mirror tower, but in this case the illumination comes from light injected into the fibers in the fiber holding block lids.

The camera image is fitted to the image window, which means that it may be squished or stretched, both horizontally and vertically. This becomes apparent when the end of a fiber is imaged and appears oval rather than circular. To remedy this; right-click in the image window and activate “Horizontal Scrollbar” and “Vertical Scrollbar.” Doing so will force every pixel from the camera to be treated as one pixel on the screen.

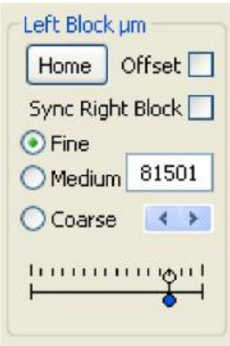
Right-clicking in the image window also enables one to turn the cross-hairs and alignment guides on or off, or to save an image as a bitmap or a TIF.



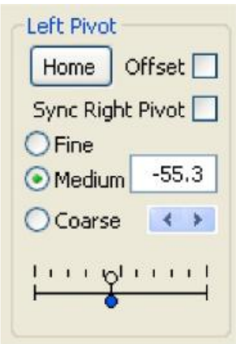
Side View of Fiber Before Splicing

5.2.10. Movement Control Bar

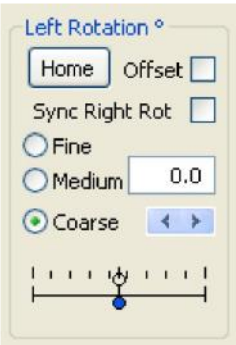
The seven boxes in the Movement Control Bar permit the user to move the fiber handlers and splice head at will, by clicking on the forward and back arrows. The radio buttons labeled “Fine”, “Medium” and “Coarse” allow the user to decide how much motion should occur with every click of an arrow. The units indicating the positions are given in motor steps. The “Home” buttons will move the motors to their home positions. If the “Sync …” check box is checked when moving a motor, than the corresponding motor on the other block will move an equal distance to maintain the relative distance and orientation between the two holding blocks.



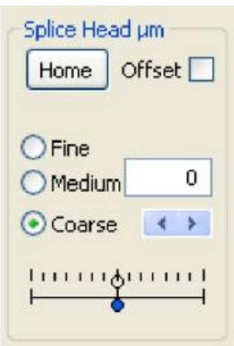
The “Left Block” box enables the user to move the left fiber handler in and out. The number shown is the position of the left block in microns, and the positive direction is defined as “in” or towards the splice head. Thus, for the left block, positive motion is to the right, with “0” being the outmost position.



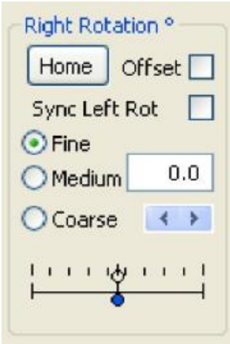
The “Left Pivot” box enables the user to pivot the left fiber holding block for alignment in the back view.



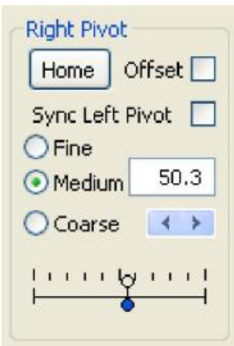
The “Left Rotation” box enables the user to rotate the left barrel for the sake of aligning stress members in PM fiber, aligning cores in eccentric-core fiber, or aligning surface features in non-circular fiber.



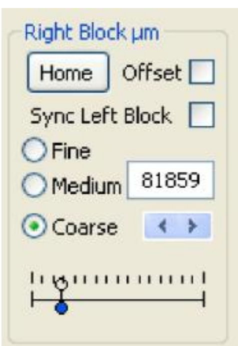
The “Splice Head” box enables the user to move the splice head left or right. Positive motion is to the right.



The “Right Rotation” box enables the user to rotate the right barrel, for the same reasons one would employ left rotation.

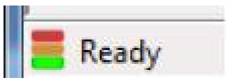


The “Right Pivot” box enables the user to pivot the right fiber handler for alignment in the front view.



The “Right Block” box enables the user to move the right fiber handler in and out. The number shown is the position of the right block in microns, and the positive direction is defined as “in” or towards the splice head. Thus, for the right block, positive motion is to the left, with “0” being the outmost position.

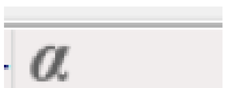
5.2.11. Status Bar



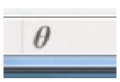
This window indicates the status of the unit. When the bottom bar is green and the window reads “Ready,” the unit is ready to execute new commands. When the top bar is red, the unit is not responding, and is either busy or needs to be initialized. It will also display the process that is running during operation.

This is the argon window. In the default state it is dormant, but if the user double-clicks it, the argon flow rate is reported, in liters per minute.

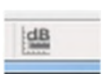
This window indicates power consumption. This function too is normally dormant, but if the user double-clicks it, the unit will periodically report voltage across and current through the splice head filament through the traffic viewer. Note that voltage and current are both reported in ADC levels. The maximum for each is 65535, which corresponds to 5V and 80A respectively.



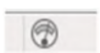
This window indicates cleave angles. The cleave angle measured on the left fiber is displayed on the left, and the cleave angle measured on the right fiber is displayed on the right. To be able to get a reading of the angles, the user has to do an automatic alignment.



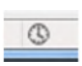
This window indicates how much the fiber is rotated from horizontal (horizontal being 0°).



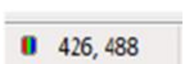
This window indicates the splice loss.



This function not yet enabled.



This window is a cumulative “on” timer for the filament.



This window indicates the position of the cursor within the image window.

This window indicates the relative brightness of the pixel under the cursor when it is within the image window. Double-click on this to adjust the brightness of the illumination in the current view.

5.3. Initialization and Shutdown

To turn on the glass processor workstation, first open the GUI and then turn on the workstation by turning on the power supply, then the workstation unit. The system will initialize automatically, or the user can launch the initialization process to establish communication between the GUI and the unit. This is done by clicking on the Initialize icon on the main toolbar. We recommend running a “Home Process” for all motors; these are found on the “Macro Buttons” toolbar.

The shutdown of the system does not require any specific sequence. However, to prevent any debris or particles falling in either the vacuum holes of the fiber holding blocks or the filament assembly opening, protect the unit with the dust protecting cover. During shutdown, turn off the unit, power supply, vacuum pump, and the gas regulator.

5.4. Storage and Transportation

When packing the glass processor workstation for storage or transportation, the following precautions are necessary:

1. Ensure that the camera assembly is at the home position.
2. Attach the transport blocks to secure the camera assembly in its home position. This is important to ensure that the camera assembly does not move during transport.
3. Send the fiber holding blocks to the “Load Position”.
4. Disconnect all gas and electrical connections.
5. Make sure that the packing foam is positioned properly in the original packing box.
6. Lower the glass processor system gently in the box.
7. Position the foam insert over the top of the glass processor then carefully close the box.
8. Do not pack any other items with the glass processor as severe damage will be caused to the system if these items move in transit.

5.5. Fusion Splicing

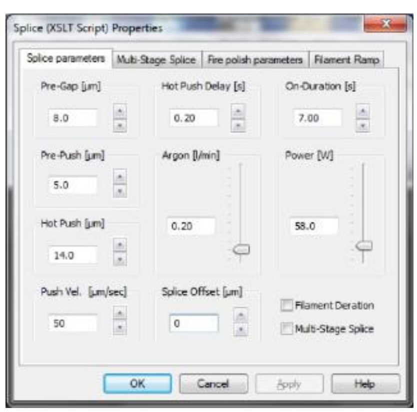
Fusion splicing is a process of joining two optical fibers end-to-end using heat. The goal is to fuse the two fibers together in such a way that light passing through the fibers is not scattered or reflected back by the splice, and so that the splice and the region surrounding it are almost as strong as the virgin fiber itself. This chapter will deal exclusively with the manner in which the glass processor can be used to perform high-quality fusion splices.

5.5.1. Filament Fusion

The glass processor uses a graphite or iridium filament to provide the heat necessary to fuse fibers together. The filament is a resistive heater typically shaped like an upside-down omega so that it is open at the top. In the beginning of the process, the fibers are roughly positioned in the center of the camera viewing area. Depending on the alignment method selected, the glass processor software will use inputs from the CCD camera, optical power meter, and/or polarimeter to precisely align the fibers. Computer-controlled stepper motors are used to position the fibers during alignment and to push the fibers together during the filament fusion.

After the software aligns the fibers, the splice head is repositioned, centering the filament under the fiber ends. Power is applied to the filament to raise its temperature to a level hot enough to melt the glass and fuse the fibers together by pushing them towards each other. An inert gas (Argon) is used to purge the splice chamber in order to prevent the filament from oxidation. In order to keep the fibers clean, the purging gas is set to flow over the fibers at a fairly high rate during the fusion process. The fiber ends are allowed to heat up and soften passed their melting point. This pre-heat process smoothes and softens the fiber ends. The hot fibers are pushed together, producing a splice with low loss and high strength.

To modify the splice properties, to go Menu Bar> Splice> Splice Parameter.



Splice Parameters Window

Splice Power This is the amount of power the filament will deliver during the splice. Check the filament power displayed in the Splice Menu. To change the splice power value, select the power window and enter the desired splice power in watts. Refer to Figure 9 for typical values.

On-Duration This is the length of time the filament will receive power during the splicing process. Check splice time displayed in Splice Menu. To change the splice time, select the splice time window and enter the desired splice time in seconds. For silica-based fibers, splice times should be between 2 - 15 s. A splice time of 5 - 7 s is typical for Ø125 µm cladding fiber.

Pre-Gap The distance between the fiber end faces established by 'Gap' process.

Pre-Push This is the distance the fibers are pushed together prior to the fusion process. Check the pre-push distance displayed in the Splice Menu. To change the pre-push distance to another value, select the pre-push window and enter the desired pre-push distance in microns.

Hot-Push This is the distance the fibers are pushed together after being pre-heated by the filament. Check the hot-push distance displayed in the Splice Menu. To change the hot-push distance, select the hot-push window and enter the desired hot-push in microns.

Push Velocity The is the velocity at which the hot push takes place in um/sec.

Hot-Push Delay This is the length of time the filament will heat up before the hot-push is performed. Check the hot-push delay displayed in the Splice Menu. To change the hot-push delay, select the hot-push delay and enter the desired hot-push delay in seconds. A value of 200 milliseconds is a good starting hot-push delay for Ø125 µm fibers.

Argon This is the flow rate of argon for when the filament turns on. There is always a background flow rate (typically 0.15 L/min). The argon gas flow rate increases when the filament is on. FTAV2 filaments typically use an argon flow rate of 0.20 L/min, while FTAV4 filaments typically use an argon flow rate of 0.35 L/min.

Splice Offset A splice offset adjusts the offset distance between the cores of dissimilar fibers. When the normalization process (Section 5.5.2) is run, the View to Splice distance is set such that the filament is centered along the z-axis between the fibers. A splice offset can help align the larger core diameter fiber with the smaller diameter core fiber.

Item #	FTAV2	FTAV4	FTAV4	FTAV6
Fiber Cladding Diameter (µm)	125	250	400	1000
Pre-Gap (µm)	8	10	15	25
Pre-Push (µm)	5	5	0	5
Hot Push (µm)	14	18	30	40
Hot Push Delay (s)	0.2	0.6	1	1.8
Hot Push Velocity (µm/s)	50	75	100	50
Argon Flow Rate (L/min)	0.20	0.35	0.35	0.50
Splice Power (W)	58	98	120	190
Splice Time (s)	7	7.5	8.5	12

Figure 9 Table of Typical Splice Settings

5.5.2. Filament Normalization

Before using a new filament, when starting the equipment, or after a long period of inactivity, it is necessary to perform the filament normalization process. Doing so will adjust some parameters to ensure a high quality splice. Two key control parameters are the “view to splice distance” (centers the filament between the fibers) and the “power offset” (ensures the furnace operates at same temperature). Before starting the Normalization process, be sure the filament is properly centered. (See Section 7.4.2 Filament Centering Procedure)

In the filament normalization process, the fibers are heated without any push. The result is that both fiber ends are burned back (as seen in Figure 10). The software then measures the level of regression of both fibers and compares it with a predefined value. A change of both the “view to splice distance” and the filament “power offset” values will be suggested; the user can choose to accept or deny these changes. If the normalization process is not successful (defined as regression values not within 90% - 110% of the target value; the process will display a window message that the normalization has not converged and another attempt is needed. In the event of a successful normalization (regression values within 90% - 110% of the target value), the system will display the message window saying normalization is successful and unit is ready for use.

To run a normalization process, the user needs to prepare two cleaved fibers for splicing. For FTAV2 filament normalization, SMF-28 fiber (Item # SMF-28-J9) should be used with the V2 normalization file provided with the glass processor. For FTAV4 filament normalization, Nufern Ø20 µm core / Ø400 µm cladding passive fiber should be used with the V4 normalization file provided with the glass processor.

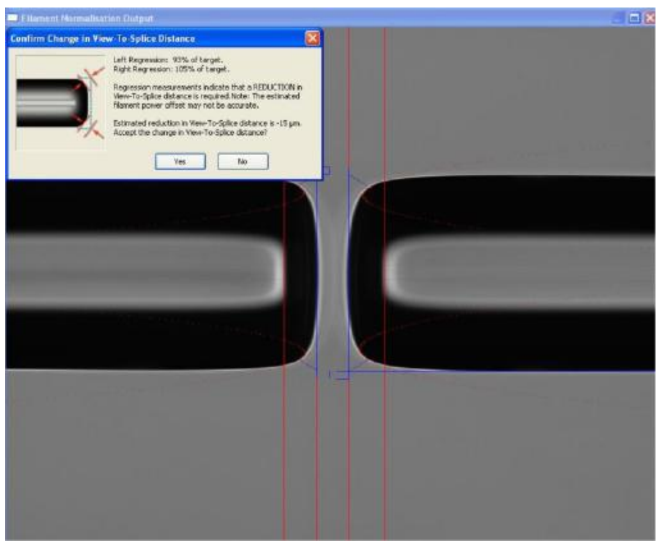


Figure 10 Filament Normalization

5.5.3. Edge Alignment

The edge alignment method aligns the edges of the fibers in the XY direction when the fibers are in the front view and back view positions. The fibers should be set to the pre-gap distance. This gap allows for individual fiber movement and ensures proper identification of the fiber edges. The software uses the image data acquired by the CCD camera to precisely determine the location of the fibers. This positional information is then used to align the fibers by moving the stepper motor positioners. Successive images are analyzed and the fibers repositioned until they are aligned.

5.5.4. Active XY Alignment

The active alignment method should be used for fibers which have a high core eccentricity. In such a case, and the edge alignment method cannot ensure proper alignment of fiber cores. Active alignment is a core-to-core alignment which uses output from an optical power meter to maximize the power transmission.

Use active alignment after a basic align process has been completed. In active alignment, the fiber is first moved away from the aligned position and then back towards the stationary fiber to eliminate motor backlash. At this point, a reference power meter reading is taken. The fiber is then moved and another power meter reading is taken and compared to the reference. This process continues until the power meter measurement reaches a maximum. The fiber is then driven back to the maximum power meter reading position.

5.5.5. Core Alignment

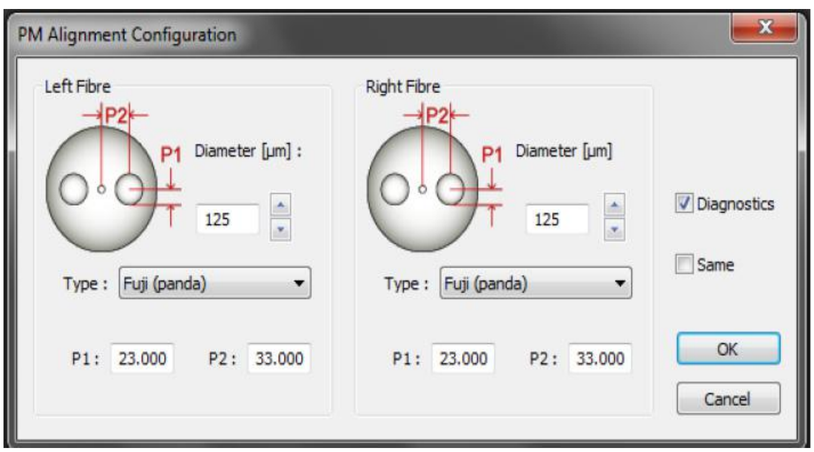
The core alignment method is similar to the edge alignment method, except the system attempts to align the fiber cores, rather than aligning the fiber edge. This process may only be used where there is a clearly visible image of the core. It is also essential that the core image is not distorted by the cladding.

5.5.6. End View Alignment (or PM alignment)

The end view alignment method is used when splicing polarization-maintaining fibers such as elliptical-core fiber (PM or PZ), panda-style PM fiber, bow-tie style PM fiber or a hybrid splice between any of these.

These types of fiber require the cores to be rotationally aligned in addition to the standard XY alignment.

The end view alignment process is initiated by using the “Lens Left or Lens Right” process in the software GUI. This process instructs the fibers to be pulled back so that the mirror tower can be inserted between two fiber end faces. The image of the fiber end is then displayed for automatic alignment.



PM alignment settings

To begin the process, select the Alignment menu then select “Enable PM Alignment”. Select “PM,” and the PM alignment window will be displayed. This window consists of 4 parameters for both the left and the right fiber. Enter the fiber cladding diameter, fiber type and the two PM geometry parameters as indicated in Figure 11. These values must be entered for both fibers; if the values are the same for both fibers, then check the “same” window. If the operator does not know the exact characteristics, it is possible to directly measure them on screen. Please note that the P1 and P2 values are measured in pixels.

Normally after the “Lens Left” process, a sequence such as, “Auto Exposure”, “End View Focus”, “Auto Exposure”, “End View Process”, would be inserted to align the fiber. If the operator is unhappy with the alignment, the process can be stopped and the fibers can be manually aligned.

Fiber Type	Parameter 1 (P1)	Parameter 2 (P2)
Generic	OD Ratio	N/A
Panda	Core Center to Stress Rod Center, (Pixels).	Stress Rod Diameter (Pixels)
Elliptical Core	Core Center to edge of ellipse, Minor diameter (Pixels).	Core Center to edge of ellipse, Major diameter (Pixels).
Bow Tie	Core Center to Stress Rod Center, (Pixels).	N/A

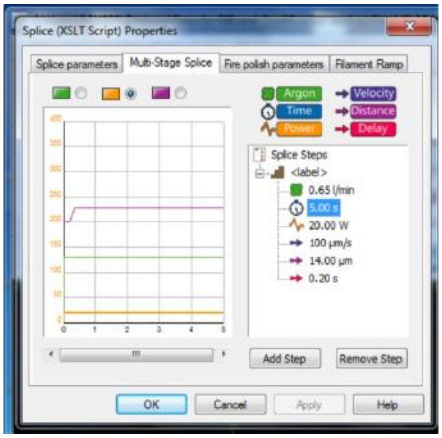
Figure 11 PM Fiber Parameters

Note that "OD Ratio" represents the fraction of the fiber diameter which will be used to calculate the fiber end angle. It is the fraction of the fiber diameter that contains the PM Structure.

5.5.7. Multiple-Stage and Multiple File Splicing

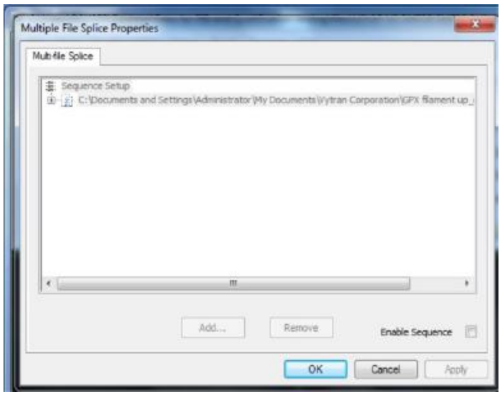
For certain special applications, the system can run several splice steps in a sequence. The setup window can be accessed from Menu Bar>Splice> Splice Parameters>Multiple-Stage Splice.

Users can set up all the parameters for each splice step, and add or remove splice steps in the *Splice Properties* Window.



Splice Properties Window

Users can add or remove multiple pre-saved splice files in the *Multiple File Splice Properties* Window. The system will perform the splicing function according to the sequence of the files in this window.



Multiple File Splice Properties Window

5.6. Steps of a Basic Splice with One Button Process

The section will discuss the use of the One Button Splice process. The idea of the One Button Splice is to run all the steps necessary to complete a splice once the fibers are loaded and the filament has been centered (Section 7.4.2) and normalized (Section 5.5.2).

5.6.1. Basic One Button Splice

Select the appropriate splice file from the file directory for the splice you are looking to complete. Files are typically named with the filament size, followed by the type of fiber, the operation (splice, taper, etc.), the date file was created, and the software version. For example, a file named *GF-1.0-1.0-0.46-V2-16 SMF SMF Splice 19Dec11 v1302* is a splice using a FTA V2 filament for SMF to SMF created on December 19th, 2011 with V1302 software.

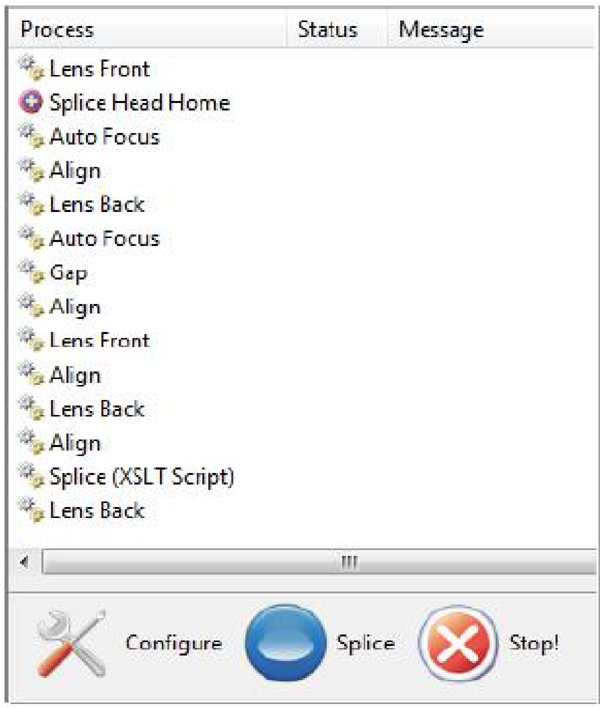


Figure 12 Splice Process List

The next step is to load a set of fibers into the glass processor. Place the fibers into the fiber holding blocks utilizing the transfer inserts described in Section 3.4.2: Fiber Holding Blocks. Then press the *Load Fibers* button to bring the fibers into the correct viewing position. While the transfer clamp insert hold a very accurate position, using different cleave lengths will require different load positions. To modify the load positions, simply right-click on the *Load Fibers* icon (or Configuration > Mechanical> Load Fiber Positions) and input a new set of positions.

Once the fibers are in position, the user can simply press the *One Button Process* button to execute the splice. The steps associated to the One Button Process will vary with each splice file. The steps for a basic splice are shown in the Splice Process List. (View> Splice Process List)

The fibers are focused, aligned, gapped, and spliced through an automated succession of steps. The final step brings the camera back into view so the user can view the splice. During the splice, both fibers are moved from loading position and brought closer during the Gap and Splice processes. Simply unload the splice and press the *Load Fibers* button before inputing a new set of files to prevent new fibers from crashing into one another.

5.6.2. Modifiying the Splice Routine

The user has the abilitly to modify the splice routine of the "One Buttton" process by right clicking on the *One Button Process* button. The Process List in Figure 13 shows the current splice routine as well as the available processes and commands that can be added to the routine.

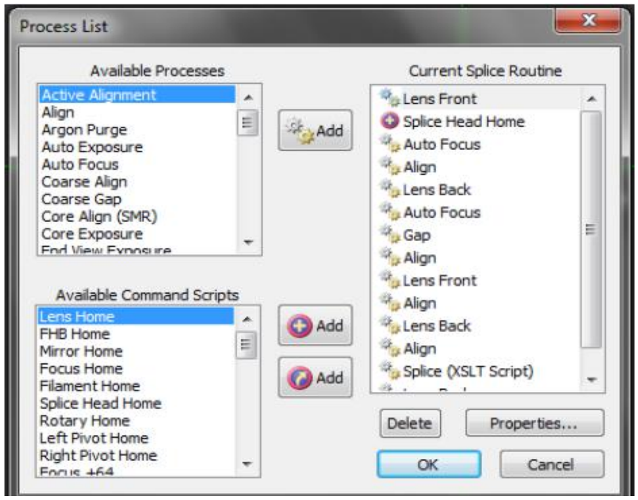


Figure 13 Splice Process List

The Available Processes are controlled by the software and input to the routine using the *Process Add* button. The Available Command Scripts listed are any of the buttons in the Macro toolbar (See Section 5.2: Graphical User Interface). The *Command Script Copy* button will copy the command script in its current form and saved in the file, even if the macro button is removed. The *Command Script Link* button will link the command script, so it will update in the routine if the command is modified. It is preferred to use this method of inclusion as it is easier to track.

5.7. Application Notes

This chapter details specialized fusion splicing applications that can be performed on the glass processor.

5.7.1. Active Rotation Alignment

The active rotation alignment method is also used for elliptical-core fiber (PM or PZ), panda-style PM fiber, bow-tie style PM fiber, or a hybrid splice between any of these. These polarization-maintaining fibers are aligned rotationally and in the XY-axes, just as in the blind rotation algorithm.

The active rotation alignment method uses a polarization analyzer to precisely align the fibers rotationally. A light source is connected to the end of one of the fibers and the polarization analyzer is connected to the other. The analyzer contains a polarizer which is set to absorb any light in a perpendicular orientation relative to the main axis of the fibers' elliptical cores. The analyzer will measure the optical power produced by the system consisting of the fibers and the polarizer. The alignment routine will align the fibers until this power reading is minimized.

The active rotation alignment method begins with a normal edge alignment, but does not execute the "Auto Gap" process. Before beginning an active rotation alignment, make sure the light source and polarization analyzer are attached correctly to the 'Analog 2' output. After completing the edge alignment at the pre-gap distance, one would normally insert the "Active Rotation" process prior to "Auto gap", "Edge Align", "Splice Process". The "Edge Align" process consists of three separate stages; an alignment from the back view, followed by an aligment from the front view, and then a repeat alignment from the back view.

5.7.2. Manual Alignment

The GPX3800 and GPX3850 workstations offer the operator the ability to perform manual splices where the alignment is carried out by the operator viewing the fibers on the screen and making the appropriate motor movements, or via a semi-automatic process where operator selects individual processes from the tool bar. Manual alignment is particularly useful when developing new process routines.

5.7.3. Drawing Tapers

A fiber may be tapered by heating it to its softening point and applying a tensile force. As the fiber elongates, its cross sectional area will be reduced accordingly. A taper is created by passing the fiber through the filament while pulling on it with the fiber holding blocks at different velocities. This process is illustrated below in Figure 14.

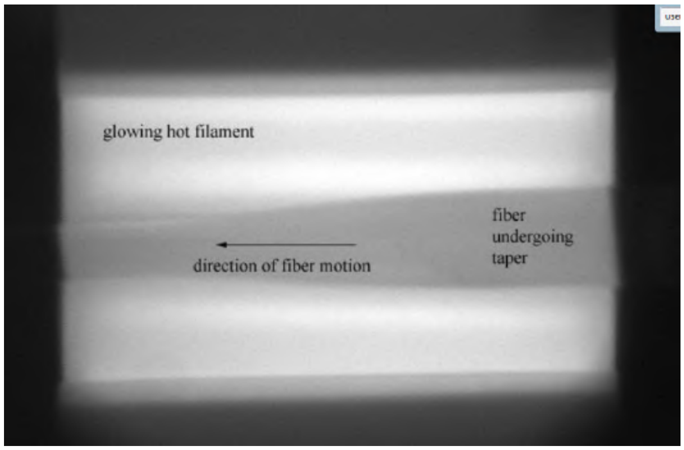


Figure 14 Image of Taper in Progress

5.7.4. Taper Properties

The user can precisely define the taper created using the Taper Properties window, which is shown below. It is accessed by opening the "Splice" menu and then clicking on "Taper Parameters."

The first tab in this window (shown in Figure 15) lets the user determine the geometry of the taper. The following are some brief notes regarding taper terminology.

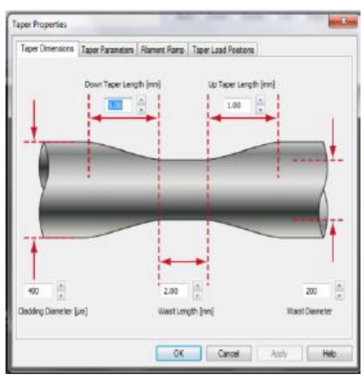


Figure 15 Taper Dimensions Interface

When the glass processor first starts stretching the fiber and tapering it down, it creates what is referred to in this document as the "down taper." When the fiber has been tapered down to a certain diameter, the workstation then maintains an unchanging rate of stretching so that a length of the fiber will have a region with the reduced, but constant, diameter. This region is referred to as the "waist" of the fiber. After the waist has been created, the glass processor diminishes the pulling force on the fiber until finally it is no longer stretching it at all. This creates what is called the "up taper."

This tapering process is in fact similar to a fiber drawing process, where the pre-form enters the furnace at a slow velocity and is pulled at a higher rate, inducing the smaller diameter fiber. The control of the diameters is achieved by a precise control of both feed and pull velocities along the process. The next tab in the Taper Properties window lets the user control the gas flow, the character of the pulling, and the filament power. It is shown in Figure 16.

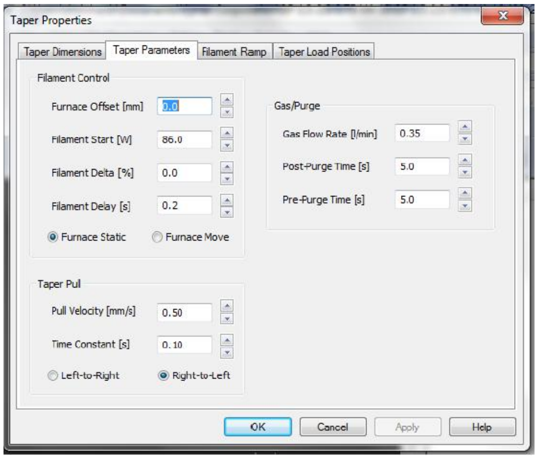


Figure 16 Editing Taper Parameters

Here are some notes regarding the values in the "Taper Parameters" window.

Furnace Offset: This will offset the filament to a desired location for the start of the taper.

Filament Start: This is the power that the filament will initially be set to when the taper is to begin.

Filament Delta: This is the percentage of reduction (negative value) or increase (positive value) in the filament power along the taper process. The power varies from P at the beginning of the "down taper" to P ± Δ at the beginning of the waist and then varies back from P ± Δ at the end of the waist to P at the end of the "up taper"

Filament Delay: This is the amount of time the filament is on before beginning the tapering process.

Gas Flow Rate: This is the flow rate of the argon during the actual tapering process**.**

Post-Purge Time: This is the amount of time spent flowing the argon at the higher rate after a taper has been pulled.

Pre-Purge Time: This is the amount of time spent flowing the argon at the higher rate before a taper is pulled.

Pull Velocity: This is the constant speed at which the fiber is feed through the filament at the beginning of the tapering process.

Time Constant: The time constant is the time interval at which the software calculates the velocities to apply to the system in order to achieve the correct taper. The default value is 0.1 s.

Furnace Move: This allows the filament to move during the taper process.

The final tab within the Taper Properties window, shown in Figure 17 is entitled “Taper Load Positions.” This tab allows the user to specify the starting positions of the fiber holding blocks and the furnace before the tapering process begins. Note that during tapering, the furnace is usually stationary, and the fiber holding blocks move to the left. Thus, the left fiber holding block can start very close to the furnace, but the right fiber holding block must be far enough away from the furnace so as to guarantee that it will not crash into it during tapering. So to avoid a crash, you simply take the overall length of your taper and multiply by 1000 to determine the distance in micrometers that the right fiber holding block needs to move. This is a very safe value because the right fiber holding block moves less than the total taper length. The anti-backlash mechanism compensates for any fiber holding block movement so the last move before the taper is in the direction of the taper.

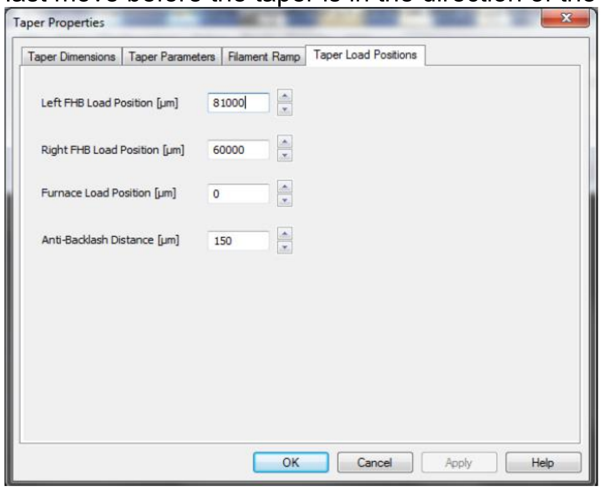


Figure 17 Taper Load Positions

CAUTION: HOT SURFACE

The filament and furnace assembly can become extremely hot upon execution of a taper so it must be handled with caution. The GPXWCS Liquid Cooling System is highly recommended for tapering applications. Allowthe furnace a few minutes to cool between each taper fabrication.

5.7.5. Tension Monitor

The Tension Monitoring System is series included with all Vytran glass processors to provide feedback on the taper process.

At system turn on, the tension monitor (shown in Figure 18) needs to be zeroed to ensure proper reading of tension being applied to the fiber. This is done by opening the Tension Monitor (View>Tension Monitor), ensuring no tension is applied to the desired fiber holding block(Right or Left) and clicking on “Zero” in the Tension Monitor window. Utilizing the Tension Monitor, the user can pre-load a tension to the fiber before the taper process, and then use the feedback to modify the taper properties if needed.

As an example, a standard 400 to 200 um taper should be pre-tensioned to approximately 20 g. This is typically done by moving the left fiber holding block to the left using the motor control bar using fine steps. Once the taper process is run, if the tension drops down to 0 or negative values; the start power should be decreased because the glass has been over softened or melted. If the tension goes very high, increase the start power because the glass is not softened enough.

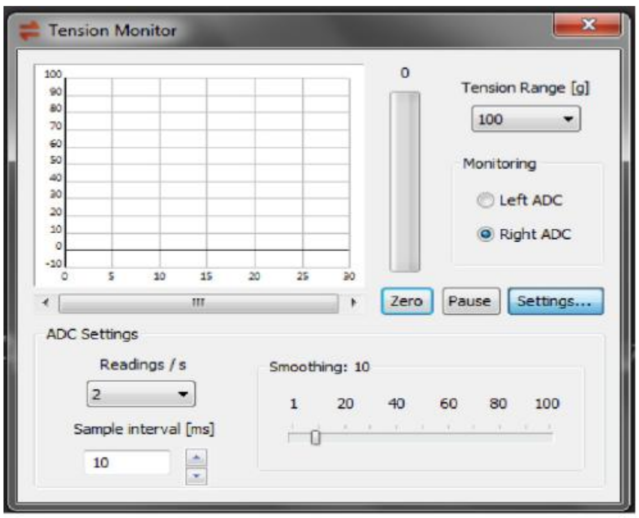
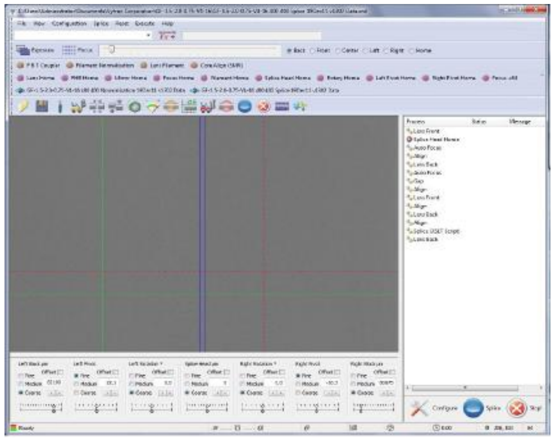


Figure 18 Tension Monitor

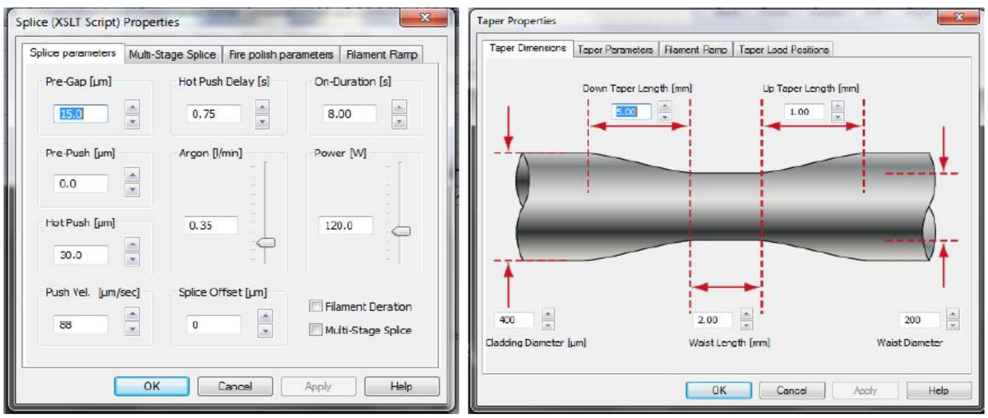
5.7.6. Filament Ramp and System Configuration

- All configurations take place on the *Filament Ramp* tab of the splice properties and taper properties pages.
- Access this page by clicking on the *Splice* menu.



Splice Menu

- Select *Splice Properties* or *Taper Properties* from the pull down menu.



Splice and Taper Properties

- Then *Filament Ramp* Tab.

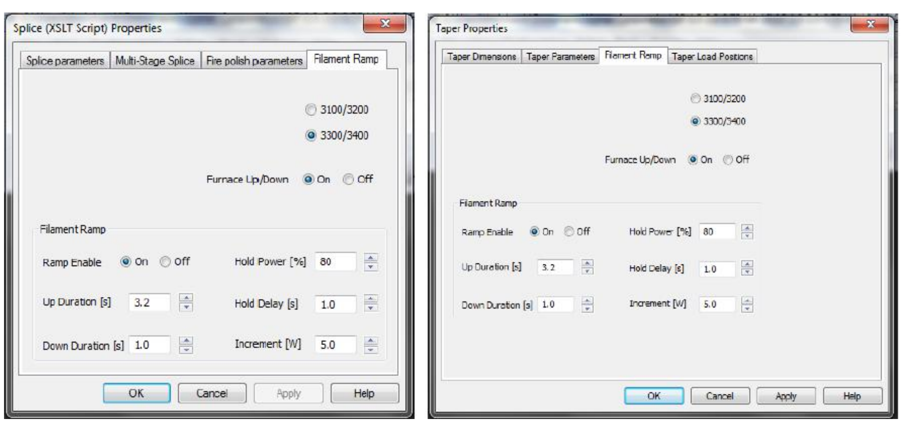


Figure 19 Filament Ramp Settings

- The default setup is shown in Figure 19.

- If using the GPX3800 glass processor then you must select the 3300/3400 radio button. Doing so tells GUI software that it must issue lens home commands prior to the start of a taper or splice. This is essential for a GPX3800 system to avoid heat damage to the lens.
- If using the GPX3800 glass processor, decide if the filament should lift and lower during a splice or taper.
    - If the GPX3800 is fitted with a “T” (Tube) type filament then the furnace Up/Down should be set to the off position.
    - If the GPX3800 is fitted with a “V” (open) type filament then there should be space for the fiber to pass through the filament opening and as such Furnace Up/Down should be set to the on position for easier fiber loading.
    - If furnace Up/Down is set in the off position, then the user must ensure that filament is in processing position before the splice or taper is started. With furnace Up/Down in the off position, the filament will neither move to nor away from the processing position.
- If the glass processor is fitted with an Iridium filament then “Ramp Enable” should be set in the off position.
- If the glass processor system is fitted with a Graphite filament then “Ramp Enable” must be set in the on position to prevent damage to the graphite filament loop.
    - When Ramp Enable is set in the on position, both the splice and the taper process step the filament power up from 0 to a hold power.
    - Ramp parameters are fully active in splice process, but, typically not modified.
    - The hold power is a set percentage of the splice power. Typically 80%.
    - The filament is held at hold power for a set time (Hold Delay) then stepped to the full process. Typically 1 second.
    - Specify the Ramp UP duration, time for the filament power to increase from 0 to the hold power. Typically 3.2 seconds.
    - Specify the Ramp Down duration, time for the filament power to decrease from splice power to 0. Typically 1.0 seconds.
    - Specify the Increment in which filament is increased from the hold power to full power. Typically 5.0 W.

5.7.7. Thermal Core Expansion

Thermal core expansion can be accomplished on the glass processors by executing a standard splice with modified fire polish parameters. To prepare for thermal core expansion, open the *Splice* menu and click on the *Fire Polish Parameters* tab. Typical fire polish parameters for thermal core expansion of Ø125 µm cladding fiber is shown in Figure 20. For splice loss optimization via this method, the fire-polish process can be executed multiple times.

For thermal core expansion, delta, number of passes, and scan velocity need to be optimized to reach the best result. Power should be the same or slightly higher than the splice power. Please note: these values are filament and fiber specific. For further assistance,please contact Thorlabs.

Once these changes have been made, load the fiber with the stripped region centered at the splice head. Click the "Splice" button, and the glass processor will perform the thermal core expansion.

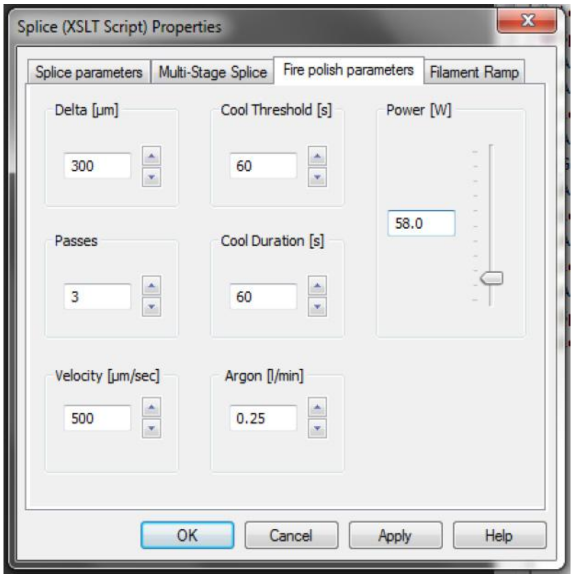


Figure 20 Editing Fire Polish Parameters in Preperation for Thermal Core Expansion

5.7.8. Fiber Lensing

There are many different types of fiber lensing applications. Some involve splicing a component onto the end of a fiber, some involve altering the end of a fiber, and some involve splicing a component onto the end of a fiber and then altering it using the furnace. Users are advised to contact Thorlabs for assistance in these matters.

5.7.9. Mode Adaptors

Fiber laser systems typically employ large-mode-area, double-clad gain fibers that must be coupled to a wide variety of dissimilar fibers. In order to optimize the signal and/or pump coupling between dissimilar fibers, a mode adaptor is often used to manage the transition This technique is rather specialized, and glass processor users wanting to fabricate mode adaptors are advised to contact Thorlabs for assistance with their projects.

5.7.10. Pump Combiners and Couplers

The glass processor workstation can be used to fuse fibers side-by-side or into bundle configurations, which is the fundamental process for the fabrication of fused tapered couplers and pump or output combiners. However, this is a highly specialized application and users are advised to contact Thorlabs for assistance.

5.7.11. GPXFBT-SFT Fused Biconic Taper (FBT) Processing Add-On Software

The Fused Biconic Taper (FBT) Processing Add-On Software allows the user to perform biconic tapers, meaning stretching the fiber by pulling outward on both fiber holding blocks while the furnace is applying heat to the fiber. This software add-on allows the user to have control on the power distribution along the process as well as shutoff process control. This process will allow the user to fabricate smaller diameter symmetric tapers, as well as 2x2 fused fiber couplers, with high level of control of the process leading to very high repeatability of the process.

The GUI is separated into three tabs:

Global Properties

In this window, the user sets the global parameters as shown in the Figure 21. The parameters control the device type (taper or coupler) and the type of graphical output (power unit/scale). It also allows the user to auto-close the GUI upon process completion and auto save the process log. This window also controls the overall parameters of filament power, furnace scan rate, and process time limit.

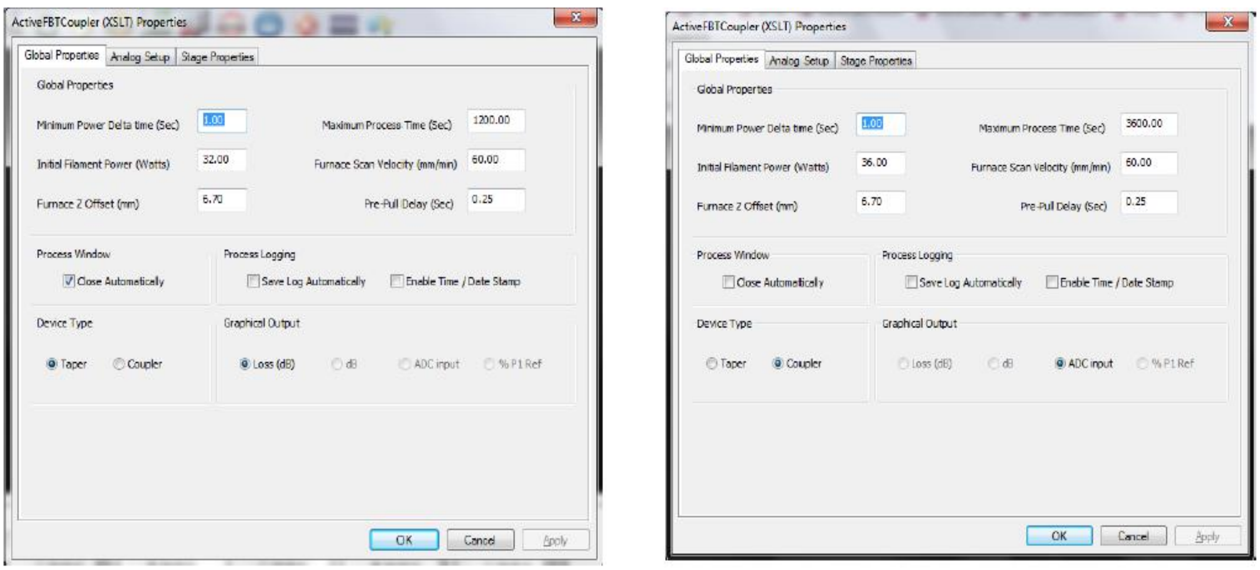


Figure 21 GUI of FBT Process in Taper Mode (Left) and FBT Process in Coupler Mode (Right)

Analog Setup

Defines the tension monitor channel (left or right), the analog power detectors used, and the ratio of filtering (smoothing data collection) as well as the power units to be used for the process.

Stage Properties

Defines the parameters for each process stage (up to a maximum of 5 stages). During each stage, the user can control the power variation based on tension, displacement, time or unchanged. The “Stage Advance Control” area will determine how each stage is to be completed. This can be based on displacement (typical for taper applications), or based on power (i.e. measure power from detectors) as in the case of couplers. Furthermore, each stage can have its own set of process parameters such as fiber holding block pull velocity, furnace can distance and argon flow rate.

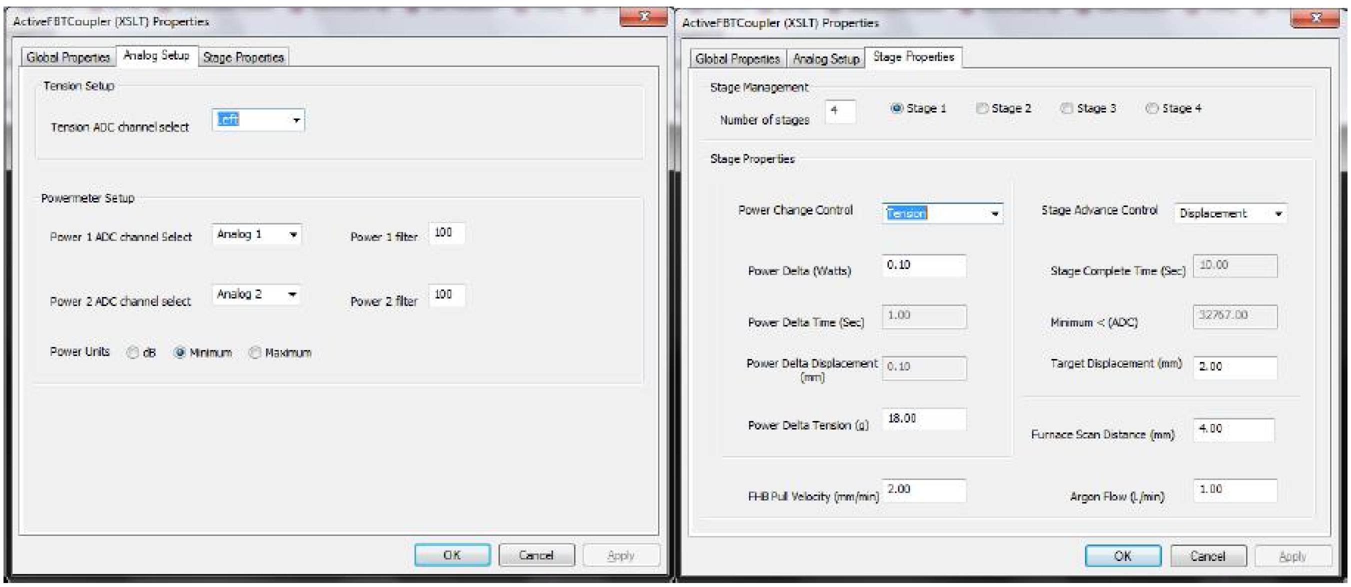


Figure 22 Analog Setup (Left) and Stages Properties (Right) Tab

The process to generate a biconic taper consists on heating a section of fiber and pulling outward on the fiber using the fiber holding blocks in order to stretch it and therefore reducing its diameter. In order to controllably heat the fiber, the filament is scanned back and forth around its central position. Reducing the furnace scan width will increase the rate of diameter change in the taper; it will reach a smaller diameter with less elongation and less pulling distance. Increasing the scan width will lower rate at which the diameter changes while creating a longer tapered region in the fiber. In general, the pull and scan velocities only affect the power required to fabricate the taper.

The same interface is used to manufacture 2x2 couplers. The coupling can be monitored between the two legs of the coupler during the process by using the analog channels available on the glass processor when connected to power detectors. Typically, a multi-stage process is required to fully manufacture a 2x2 coupler, where the power delivered to the fibers during each stage is precisely controlled. Our recommended approach is to control the power delivered by the furnace based on the tension applied to the fibers for the early stages, going from a target of 20 g tension towards a target of 5 g tension just before the last stage. The last stage however should keep the power unchanged and monitor the amount of coupling to each leg via the analog channels. One can set-up the coupler fabrication by targeting a specific coupling value in dB (i.e. 3dB equivalent to 50% coupling), targeting a minimum value of light remaining in Leg1, or a maximum value of light coupled to Leg2 for example.

5.7.12. Taper Tension Process

Using the software add-on, a user can automatically apply a predefined tension on a fiber (or pair of fibers) loaded on a glass processor. This process (shown in Figure 23) requires the user to input the target tension in grams as well as the tension tolerance (typically a value from 1 g to 2 g). The user can also specify which fiber holding block is used to apply the tension.The parameters entered in the window are saved as a splice file and can be included in the splice list editor to be run with standard processes. A taper tension process can be prepared before any tapering process to ensure that the fiber is under some tension prior to tapering. Please note that the tension monitor has to be zeroed with no load applied and the *Reset Tension* button should be pressed immediately after initializing the glass processor.

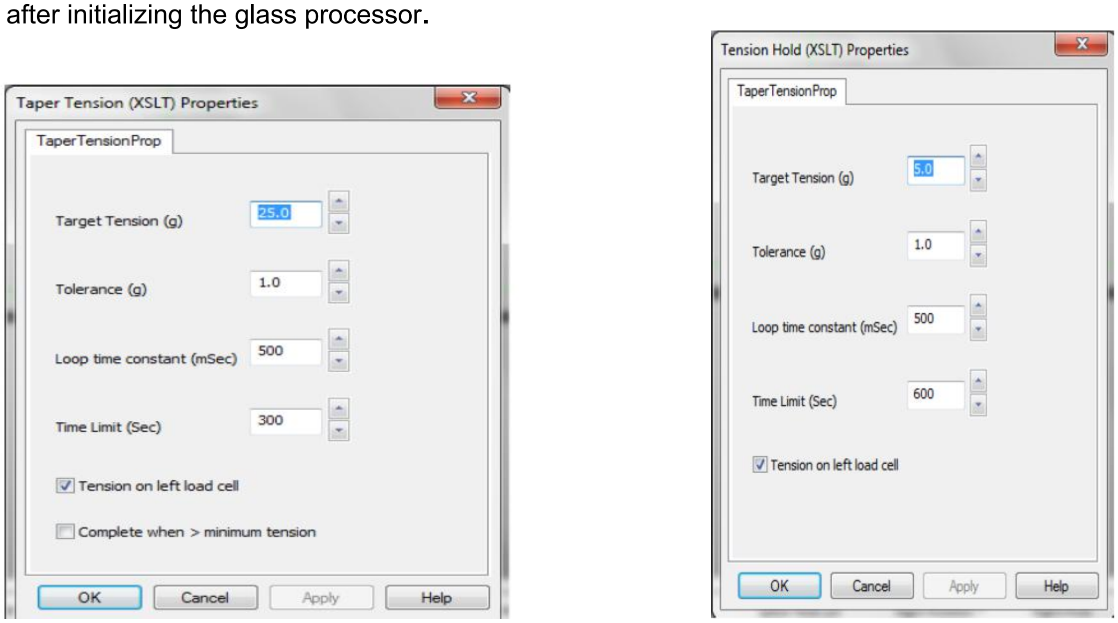


Figure 23 Taper Tension (Left) and Tension Hold (Right) Interface Windows

Tension Hold Process

The tension hold process allows the user to apply and maintain a predefined tension value on the fiber (or pair of fibers) after a taper process has completed. The process requires the user to input the target tension and tolerance in grams as well as the duration of the tension hold process. The user needs to also specify which fiber holding block to use for tension correction.

How To Set Parameters

This section outlines one method for determining the optimum taper parameters for fabricating a microtaper. The “Minimum Power Delta Time” and “Furnace Scan Velocity” parameters are typically kept to their default values. The “Maximum Process Time” value should be larger than the actual process time by a factor of x1.5. The “Furnace Z Offset” parameter should be set to the same value as the “View to Splice Offset” parameter in order to have the process begin with the centered portion of the fiber. We recommend using “Pre-Pull Delay” parameter values of 0 s to 0.2 s for small initial diameter fibers (cladding diamters ≤500 µm) and 0.5 s to 2 s for large-diameter fibers (cladding diameters ≥500 µm).

The software allows the user to define up to five stages to run the full taper process. At each stage the user can control the filament power, the duration or elongation of the stage, scan width, pulling velocity, and argon gas flow rate.

Filament Power Control

The power delivered to the filament can be controlled in four ways:

1. **Tension.** The software will reduce the filament power by the amount specified per second when the tension applied to the fiber is below the target value. When the applied tension is above the target value, the system does not modify the filament power.
2. **Displacement.** The software will reduce the filament power by the specified value per displacement (e.g., 0.2 W per 0.2 mm elongation).
3. **Time.** The software will drop the filament power by the specified value per time increment (e.g., 0.2 W per 2.0 s).
4. **Disabled.** The filament power remains unchanged during the stage.

Stage Advance Control

The full taper process can be divided in up to five different stages. The stage advance control parameters define when to stop the current stage and move to the next one. In the case of the last stage, it will indicate when to end the full taper process. This control can be achieved in four separate ways:

1. **Power.** The software will compare the reading from the connected power detector with the type and value of the power target (i.e. Min target, Max target or dB or % target).
2. **Displacement.** The software will stop the current stage when the “Target Displacement” value has been reached.
3. **Time.** The software will stop the current stage after the specified period of time has elapsed.
4. **Disabled.** The software will not automatically end the current stage and the process will have to be stopped manually.

Furnace Scan Distance

The furnace scan distance is the distance in mm that the furnace (i.e. filament assembly) will move around its zero position as defined by the “Furnace Z Offset” value. The filament will scan from –d to +d, where d is the specified furnace scan distance. A larger scan width will create a gentle taper (small diameter change over a long taper distance) that reduces losses in the resultant taper. Alternatively, a smaller scan width will generate a higher slope taper that results in a higher loss device. One method for achieving low loss devices while minimizing overall device length is to use a multi-stage process with a large scan width during early stages and a reduced scan width during later stages.

Fiber Holding Block Pull Velocity

The fiber holding block pull velocity is the speed at which the fiber is pulled apart during the taper process. When using a reduced pulling velocity, the amount of heat delivered to the fiber is larger and therefore the power of the filament needs to be adjusted accordingly. The pull velocity will control the overall process time, where a larger pull speed will result in a faster taper process, all other parameters being equal. Use a constant pull velocity throughout the process stages to avoid any jerking motions that could affect the taper quality. If varying the pull velocity is necessary, do not increase the velocity such that the required filament power is too large for the filament in use. The pull velocity also needs to be slow enough to allow the system enough time to respond to the tension feedback measurements.

Argon Flow

The argon flow rate will depend on the filament used and the power delivered to the filament. Use a constant argon flow rate during all stages.

Defining Overall Elongation - Stages

To determine the amount of elongation required to achieve a desired fiber diameter for the taper, use the “Biconic Taper Diameter Estimator” to determine the final fiber diameter for a given set of starting parameters. First, determine the total elongation required to achieve a target diameter and subdivide that value for an equal number of stages. For example if the total elongation required is estimated to be 12.0 mm, 4 stages with an elongation of 3.0 mm each is one possible process. Elongation is measured by the distance moved by one fiber holding block, and therefore the actual total elongation is twice that value (i.e. $Elong_{Act} = Elong_{Left} + Elong_{Right}$).

In general, the first stage uses a constant filament power and maintains a constant tension on the fiber. This will ensure that the process is more repeatable with aging filaments and changing ambient conditions. In this case, the tension applied to the fiber is a more accurate gauge of the heat delivered to the fiber.

The final stage will define when the process is completed. For manufacturing a standard taper, typically the final stage is determined by the displacement of the fiber. For coupler manufacturing, the final stage is determined by the ouput power measured in the coupler.

Chapter 6 Added Capabilities of GPX3800 / GPX3850

The GPX Cleave Module controls the integrated cleaver on the GPX3800 and GPX3850 Glass Processors. Additional processes are provided to enable the imaging system and cleaver to be automated using the *One Button Process* function. Hot view imaging provides the ability to observe the splice or taper during the heating process. The End View Quality Tool (software) provides a magnified view of a fiber end face together with a small collection of measurement tools to assist in verifying fiber quality and measuring fiber artifacts.

6.1. Cleave Module Library

The Cleave Module Library contains the following macro processes:

- GpxCleaveProcess – Controls FHB & Furnace Offset, Tension and Cleave Lever
- GpxCleaverView – Moves Cleave Blade to a Viewable Position
- GpxCleaveExposure – Cleave View Exposure
- GpxCleaveFocus – Cleave View Autofocus
- GpxCleaveHome – Homes the Cleave Lever
- GpxCleaveBladeService – Advances the Cleave Lever for Servicing
- GpxCleaveTensionBase – Takes a Baseline Analog-to-Digital Converger (ADC) Reading for Tensioning
- GpxCleaveBackstopAdjust – Provides a Visual Assist to Backstop Adjustment
- GpxPreTension – Provides Pre-Tensioning to Pull Fiber to Stable Position for Viewing

6.1.1. Glass Processor Cleave Process

The *GPXCleaveProcess* macro is based on similar software used in the LDC400 Series Fiber Cleaver, although modifications have been incorporated to suit the different hardware and environment of the glass processor. The glass processor cleave macro provides the additional ability to offset the fiber holding blocks and furnace for viewing of the cleave blade and backstop in the camera view window. Cleave tension can be applied to either the left or right fiber holding block. The cleave process properties window is shown in Figure 24.

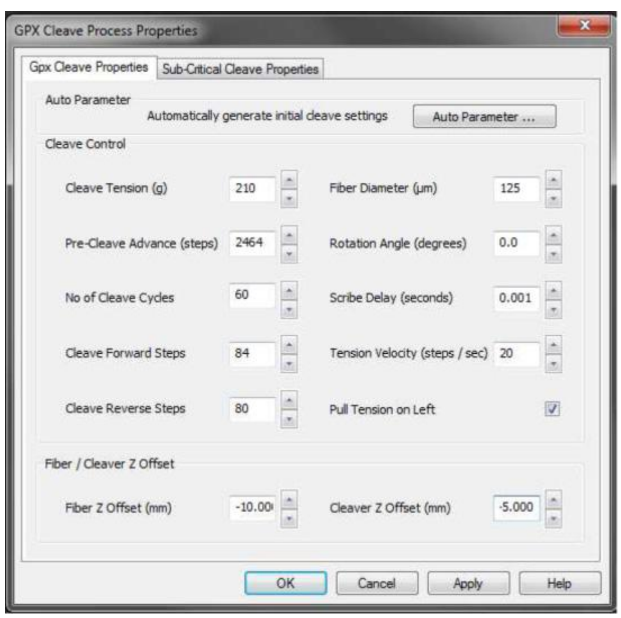


Figure 24 Cleave Properties Page

Cleave Tension (g): This parameter is the load, in grams, applied axially to the fiber prior to initiating the scribe process. The configuration menu provides both manual and auto-set options for setting the cleave tension. The optimal cleave tension depends on the cross-sectional area of the fiber and its material properties. The auto-set option will provide the appropriate cleave tension for silica fibers based on the fiber diameter specified by the current fiber file.

Pre-Cleave Advance (steps): This parameter is the distance, in steps, that the cleave blade moves forward prior to initiating the scribe oscillation cycle. The configuration menu provides both manual and auto-set options for setting the pre-cleave advance. The ideal precleave advance is dependent upon the fiber diameter, and must be reduced as the fiber diameter increases**.**

No of Cleave Cycles: This parameter is the maximum number of oscillations that the cleave blade will attempt during the scribe process. Because the cleave blade advances towards the fiber on each oscillation, this value will determine the maximum total distance that the blade can advance during the scribe. The default is 60.

Cleave Forward Steps: The number of forward steps that make up the forwards component of blade oscillation. This parameter is the distance, in steps, that the cleave blade moves toward the fiber during each blade oscillation. Typically, this parameter is set to 84 steps. Increasing this parameter (and correspondingly the *cleave reverse steps* parameter) may be beneficial for the micrometer stop specialty process. The *cleave forward steps* parameter must always be greater than the *cleave reverse steps* parameter for the blade to oscillate toward the fiber.

Cleave Reverse Steps: The number of reverse steps that make up the reverse component of blade oscillation. This parameter is the distance, in steps, that the cleave blade moves away from the fiber during each blade oscillation. Typically, this parameter is set to 80 steps. Increasing this parameter (and correspondingly the *cleave forward steps* parameter) may be beneficial for the micrometer stop specialty process. The *cleave reverse steps* parameter must always be less than the *cleave forward steps* parameter for the blade to oscillate toward the fiber.

Fiber Diameter: The fiber diameter in micrometers.

Rotation Angle: The rotation applied to the fiber (in degrees) for making angled cleaves. (Auto Parameter can provide an estimate of this value).

Rotation Angle (degrees): This parameter is the rotation angle, in degrees; the fiber is twisted prior to initiating the tension process. The optimal rotation angle for a specific angle cleave is dependent upon the cross sectional area of the fiber, the material properties of the glass, and the tension applied. Experimentation will be required to identify the rotation angle required for the desired cleave angle. (Auto Parameter can provide an estimate of this value). Set the rotation angle to 0° for a perpendicular cleave.

Scribe Delay: This parameter is the delay, in seconds, between each of the cleave blade oscillations. Typically, the scribe delay is set to 0.001 seconds (1 ms). Increasing the scribe delay may be beneficial for the subcritical and the micrometer stop specialty processes.

Tension Velocity (steps/sec): This parameter is the velocity (in steps per second) of the motor tensioning the fiber prior to the scribe process. Typically, this value is set to 20 steps per second. Lower tension velocities may be beneficial when the subcritical specialty process is enabled.

Pull Tension On Left: When checked, the left fiber holding block is driven outwards to apply tension and the right load cell is used for tension monitoring. When unchecked, the right fiber holding block is driven outwards to apply tension and the left load cell is used for tension monitoring.

Fiber Z offset: The optional Z-axis offset (in mm) that will be applied to both fiber holding blocks. A negative value will move the fiber holding blocks to the left; a positive value will move the fiber holding blocks to the right.

Cleaver Z offset: An optional Cleaver Z-axis offset that will be applied to the furnace and cleave blade. A negative value will move the cleaver to the left; a positive value will move it to the right.

The cleave properties page allows user access to cleave setup parameters. In addition, fiber holding block and cleaver (furnace) z-axis offset values can be entered. A negative value produces an offset to the left and a positive value an offset to the right. When *Pull Tension on Left* remains unchecked, the tension is applied on the right fiber holding block. Tension readings are always taken from the Analog-to-Digital Converger (ADC) opposite to the fiber holding block applying tension.

Auto Parameter is a helper utility that automatically populates some of the cleave parameters based on just a few requirements as shown in Figure 25.

Figure 25 Auto Parameter Utility

The auto parameter utility calculates a set of initial starting values for tension, scribe delay and (if making an angled cleave) rotation angle.

- Fiber Diameter: The fiber diameter in micrometers.
- Target Cleave Angle: Desired cleave angle in degrees.
- Distance Between Fiber Holding Blocks: Distance in mm between fiber holding blocks.
- Fiber Modulus: Modulus of Rigidity in GPa. (Typically 28 for Silica fibers).

The user can get a good initial starting set of properties for cleaving using only fiber diameter for a flat cleave. For angled cleaves, the target cleave angle, fiber holding block distance and fiber modulus are also required.

The GPX3800 and GPX3850 also supports sub-critical cleaving (the scribe is made while the fiber is at a lower tension than would normally be used, then increased until the scribe fracture propagates and the fiber is cleaved). Figure 26 shows the sub-critical cleave parameters window.

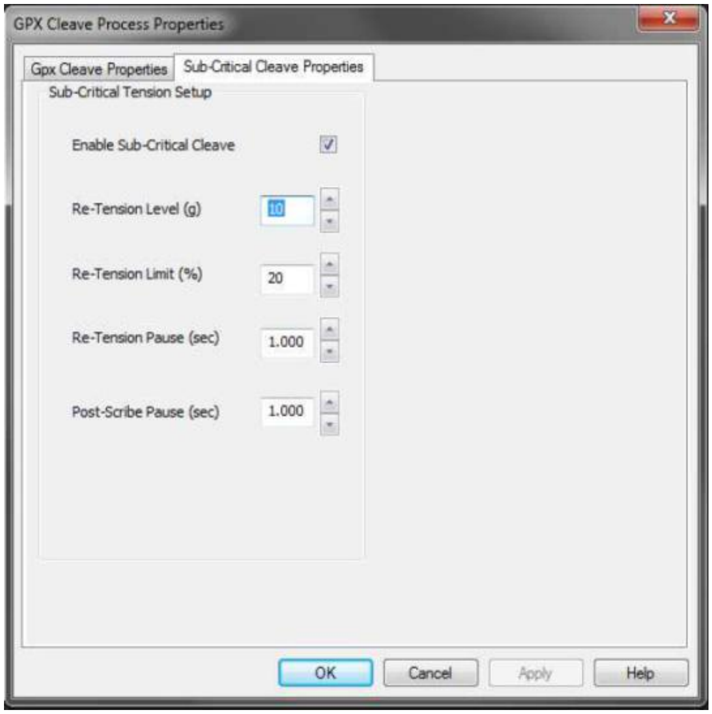


Figure 26 Sub-Critical Cleave Parameters

Re-Tension Level (g): This parameter is the load, in grams, applied axially to the fiber after the post-scribe pause. The optimal re-tension level is dependent upon the effective cross sectional area, material properties and type of fiber as well as scribe size. Experimentation will be required to optimize the re-tension level but it will typically be less than 50 grams.

Re-Tension Limit (%): This parameter limits the additional tension, expressed as a percentage of cleave tension, applied axially to the fiber after the post-scribe pause. The retension limit is typically set at 20%.

Post-Scribe Pause (seconds): This parameter is the pause, in seconds, between the last blade oscillation and the first re-tension. Typically, the post-scribe pause is set to 1 – 3 seconds. This is enough time for the scribe to propagate and cleave the fiber if the scribe was too large.

Re-Tension Pause (seconds): This parameter is the pause in seconds, between each retension. The optimal re-tension pause is dependent upon the effective cross sectional area, material properties and type of fiber as well as scribe size. Experimentation will be required to optimize the re-tension pause parameter.

6.1.2. GPX Cleaver View

The *GpxCleaverView* macro works very much like any other side-view process (i.e., the lens position must be unique). When in the cleave view, the illumination LED and focus position is set by running additional processes.

Lens Motor Position (steps): The position of the lens motor when in *Cleave View*.

Mirror Motor Position (steps): The position of the mirror motor when in *Cleave View*.

Focus Motor Position (steps): The position of the focus motor when in *Cleave View*. This value is updated with the position of optimum focus whenever Cleave Focus is executed.

Furnace Motor Position (steps): The position of the furnace motor (and hence, the Cleave Blade) when in *Cleave View*.

FHB Offset (mm): The position offset applied to both fiber holding blocks when in *Cleave View*. A negative offset will move both fiber holding blocks to the left, a positive offset will move both fiber holding blocks to the right. Together with the furnace motor position, this makes it possible to view the cleave operation through the imaging system.

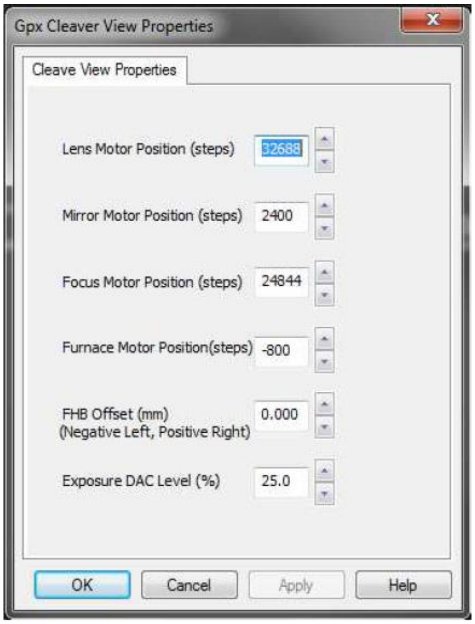


Figure 27 GPX Cleaver View Properties

6.1.3. GPX Cleave Exposure

GpxCleaveExposure works in the same way as regular side view exposure. This process provides the correct amount of illumination to be able to view the cleave process. The GPX Cleave Exposure Properties window is identical to that of any regular side view exposure properties.

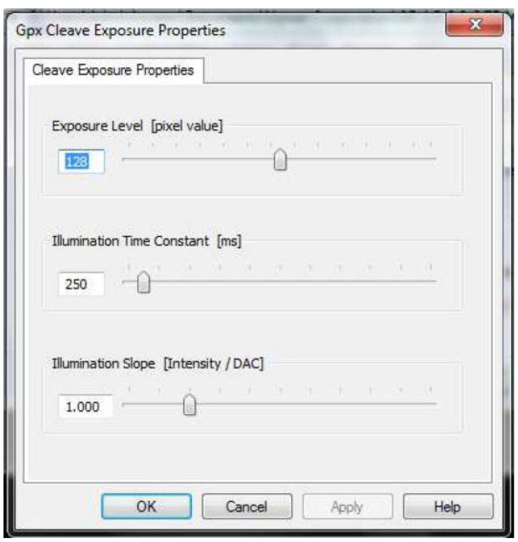


Figure 28 GPX Cleaver Exposure Properties

6.1.4. GPX Cleaver Focus

GPXCleaveFocus uses a focus measurement call that will determine which edge of the fiber is visible and the user then determines the optimal focus.

6.1.5. GPX Cleave Home

GpxCleaveHome is an XSLT-based process that compiles and executes the homing process via an opto-sensor to establish the starting point of the cleave blade.

6.1.6. GPX Cleave Blade Service

The *GpxCleaveBladeService* macro provides a safe method of advancing the cleave blade to a position where it can be serviced or replaced. The distance for the cleave blade to travel in order to reach the fiber can also be set in this window.

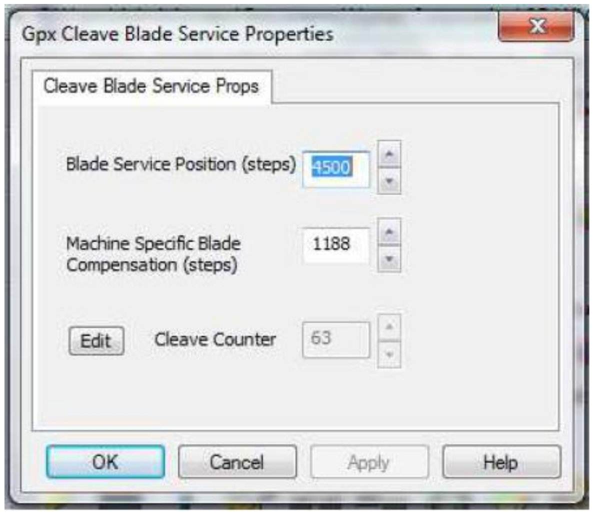


Figure 29 GPX Cleaver Blade Service Properties

Blade Service Position (steps): The position that the cleave blade advances to when the Cleave Blade Service process executes. Advancing the cleave blade out of its shroud provides better access for adjusting or replacing the blade.

Machine Specific Blade Compensation (steps): A cleave blade position offset value that allows the user to compensate for small variations in the cleave blade fixing. Ideally, the data file from one GPX should be able to function correctly on another GPX. This is achieved by maintaining the Cleave Blade Offset to a particular machine.

Cleave Counter: Automatically increments after each cleave. The user can reset the counter when the blade is replaced or repositioned.

6.1.7. GPX Cleave Tension Base

GpxCleaveTensionBase provides a self contained process for capturing the appropriate ADC base reading to establish a 'zero' tension value. The user is instructed which FHB lid should be raised for releasing tension to ensure there is no tension on the FHB when the base reading is taken. GPXCleaveTensionBase should be run when the unit is turned on. GPXCleaveTensionBase can be added to a Start Up file that also homes all the motors before using the GPX.

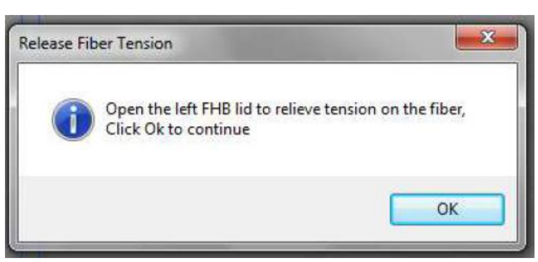


Figure 30 GPXCleaveTensionBase Prompt

6.1.8. GPX Cleave Backstop Adjust

GpxCleaveBackstopAdjust provides a visual assist to backstop adjustment. At the start of the process, both left and right fiber positions in the Y axis are captured. As the backstop is adjusted, the process window displays the measured deflection of each fiber. The left and right vertical bars will show green if the fiber deflects towards the backstop and red when the backstop causes fiber deflection.

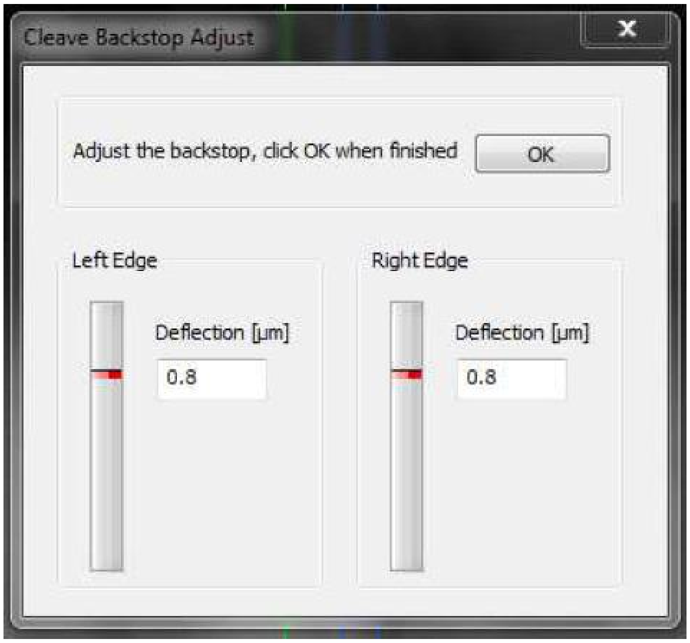


Figure 31 Cleave Backstop Adjust

6.1.9. GPX PreTension

GpxPreTension is a newly developed process that allows the fiber to be placed under tension while the splice point is determined. It is used in the fabrication of segmented components.

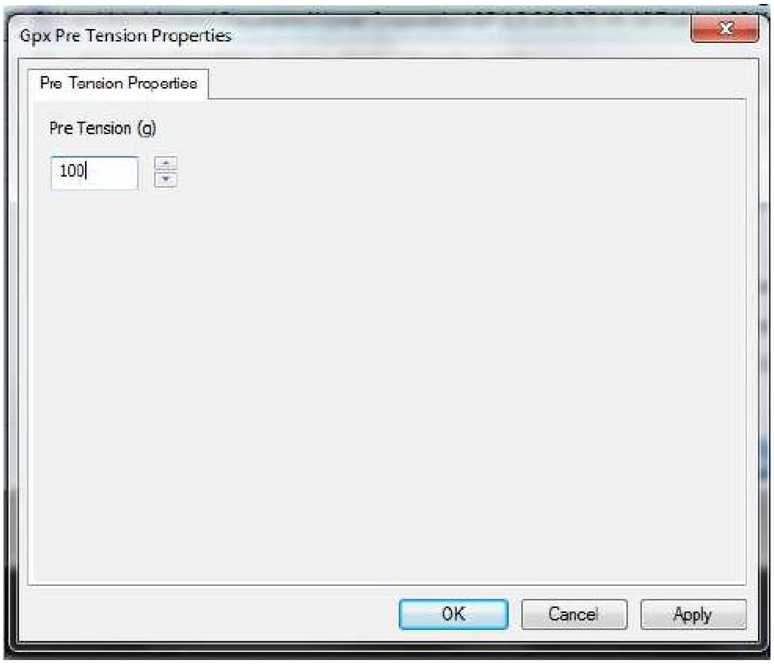


Figure 32 GPX PreTension Properties

6.1.10. Typical Process List for GPX Cleave

Figure 33 shows a sample process list for a splice then cleave using the GPX Cleave. It includes the views, focus, and adjustment need to complete the process with the "one button" process.

6.2. Hot View Imaging

The Hot View Imaging provides the ability to watch the splice or taper in real time through a special filter attached to the Ring Illuminator of the GPX Lens. The Hot View Imaging is turned On via the Filament Ramp tab in the Splice properties menu (Splice> Splice Properties> Filament Ramp)

The optical density filters are pivoted into place on the lens. There are 2 filters of varying densities which can be used separately or together, depending on the amount of illumination coming from the filament.

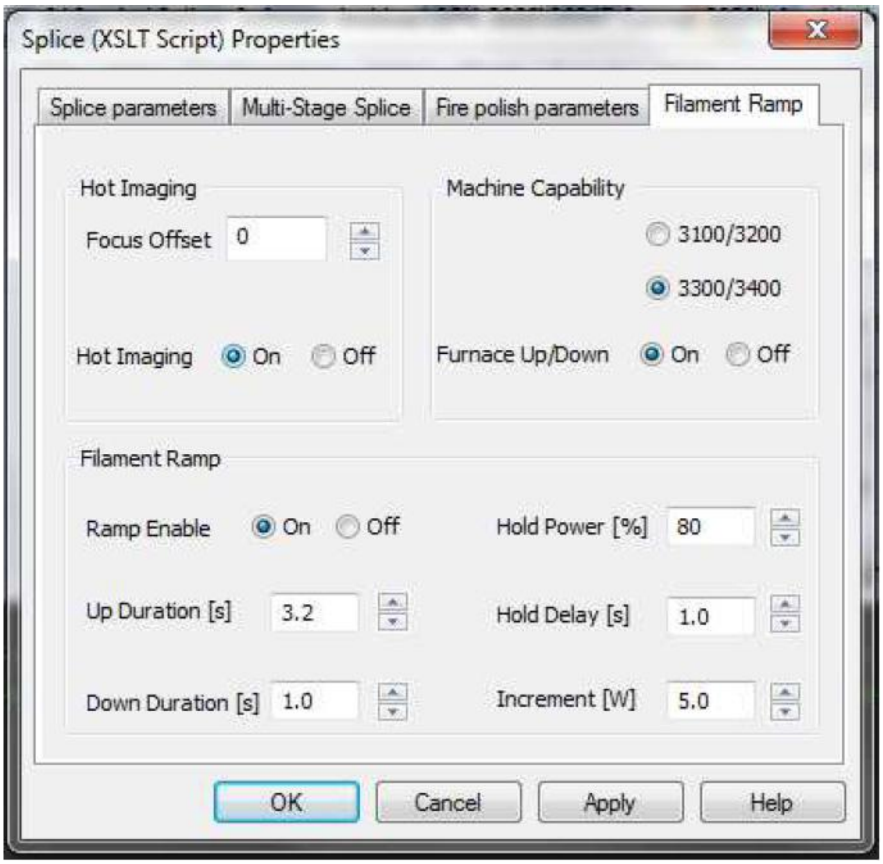


Figure 34 Splice Properties – Filament Ramp Tab

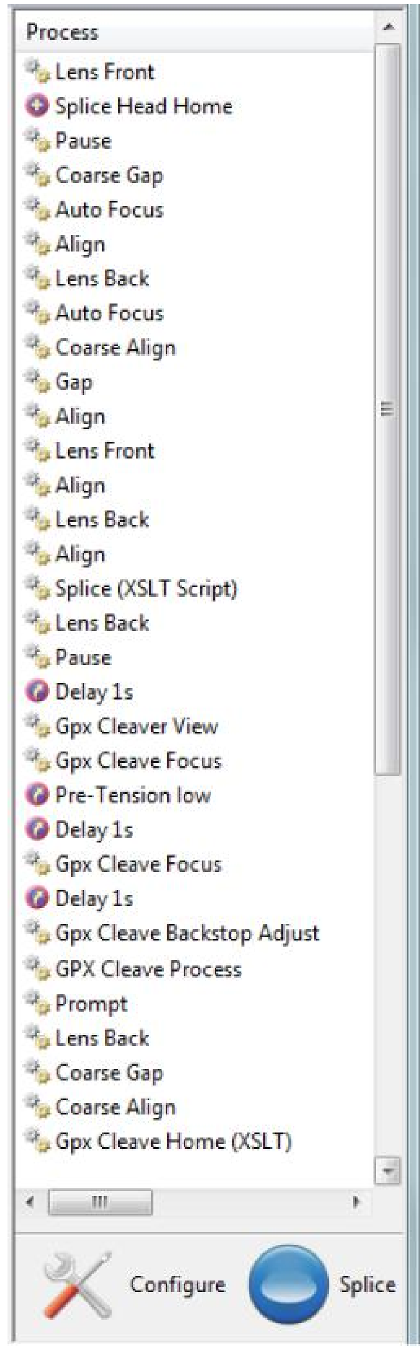


Figure 33 Typical Process List for Splice then Cleave

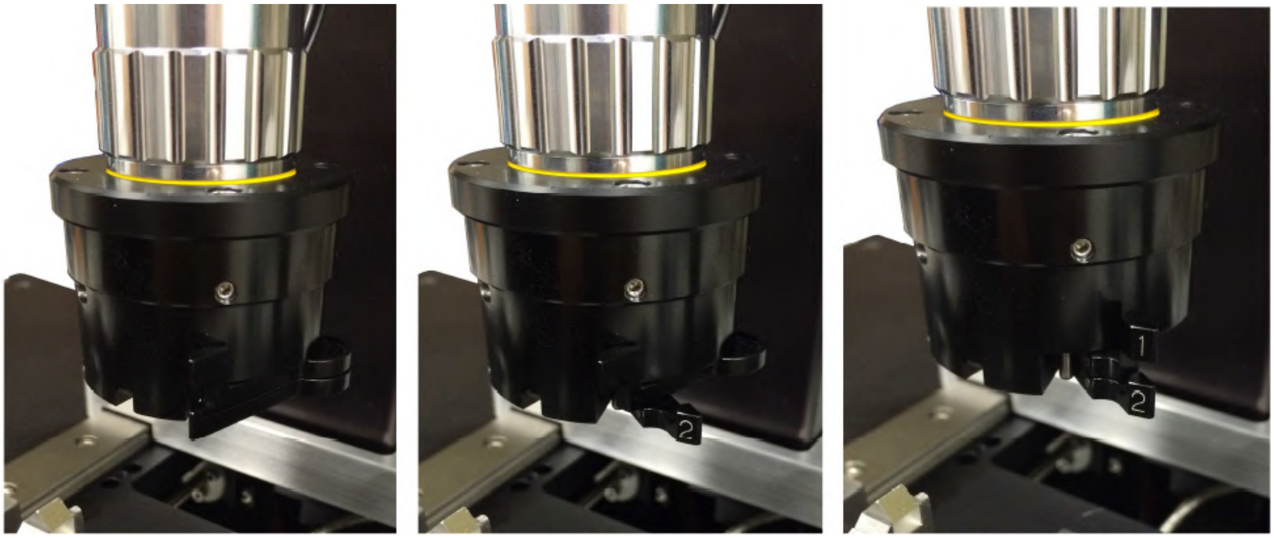


Figure 35 Hot View Filters

When Hot View is On, the lens tower will not automatically go to the Home position before the splice. The ideal position is for the lens to be in Center View, thus looking directly down at the fibers during Hot View. A prompt message is inserted into the Process List to instruct the user to put the filter in place and to remove the filter after the splice.

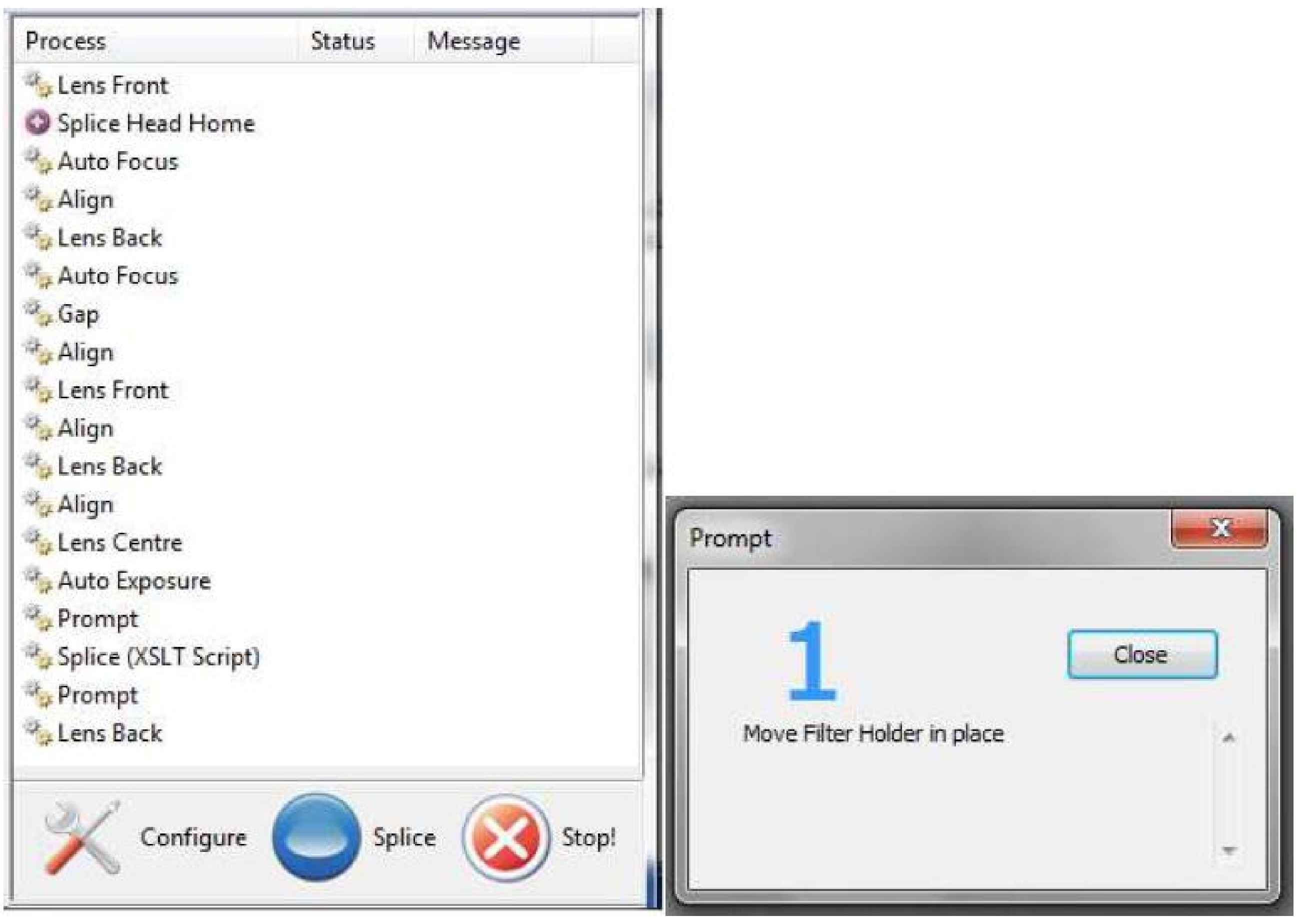


Figure 36 Hot View Process List and Prompt

6.3. End View Quality Tool

The End View Quality Tool provides a (software) magnified view of a fiber end face together with a small collection of measurement tools to assist in verifying fiber quality and measuring fiber artifacts.

6.3.1. End View Quality Tool User Interface

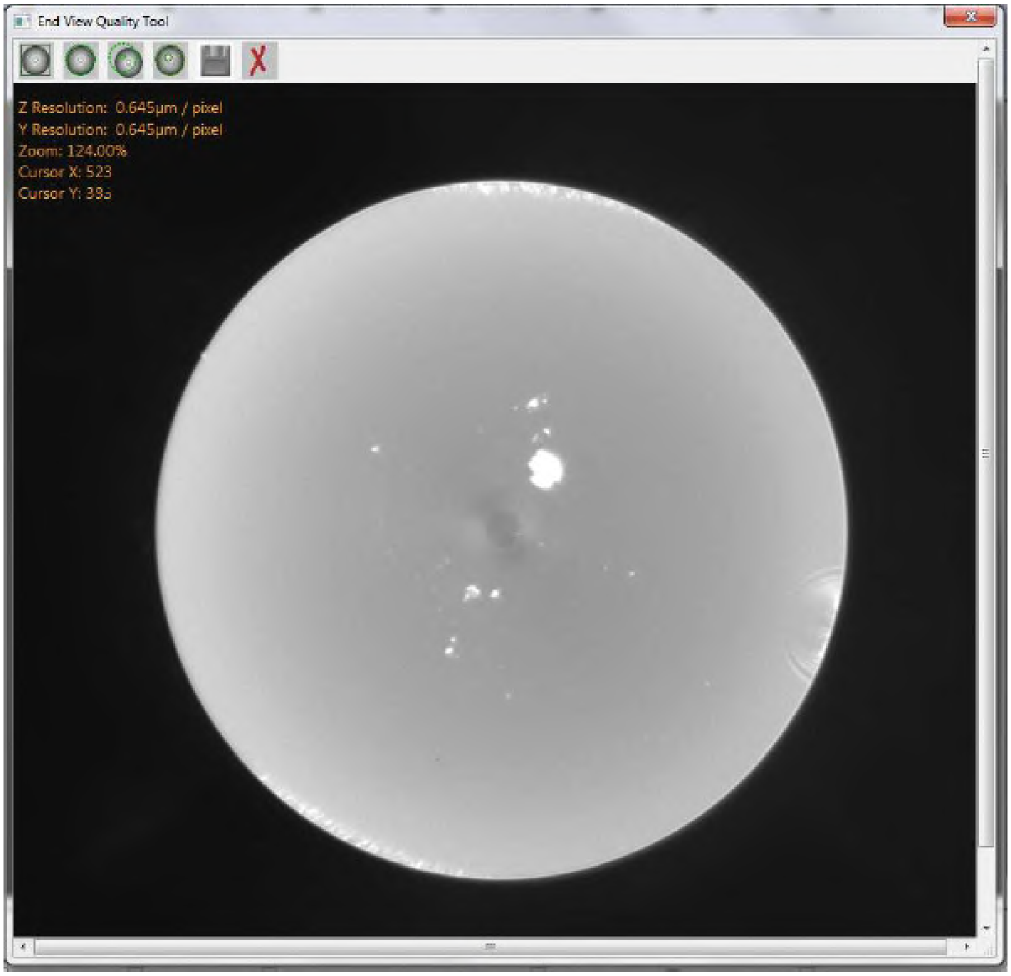


Figure 37 End View Quality Tool Window

The main window consists of a toolbar containing each of the measurement tools, a scrollable viewing window and overlay information. The measurement output is always rendered on the overlay.

Image magnification is increased or decreased by either resizing the window or by scrolling the scroll wheel of the mouse while the cursor is over the image.

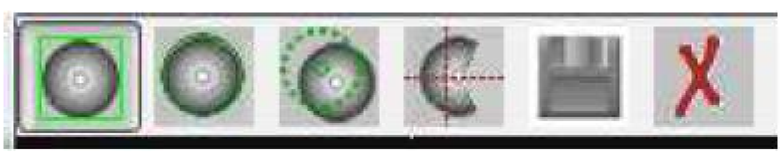


Figure 38 Toolbar

The toolbar contains buttons to invoke Rectangle Tool, Circle / EllipseTool, AutoLocate Tool, Centroid Tool, File Save and Exit. The Toolbar shows a pop-up ToolTip when the cursor is placed over one of its buttons.

6.3.2. Rectangle Tool

The Rectangle Tool allows the user to construct a bounding rectangle over the image. The width, height and diagonal measurements are displayed in microns in the overlay.

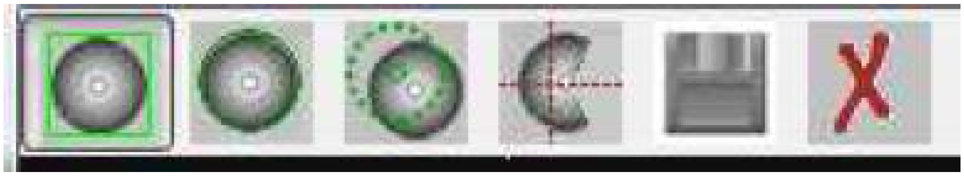


Figure 39 Rectangle Tool Button

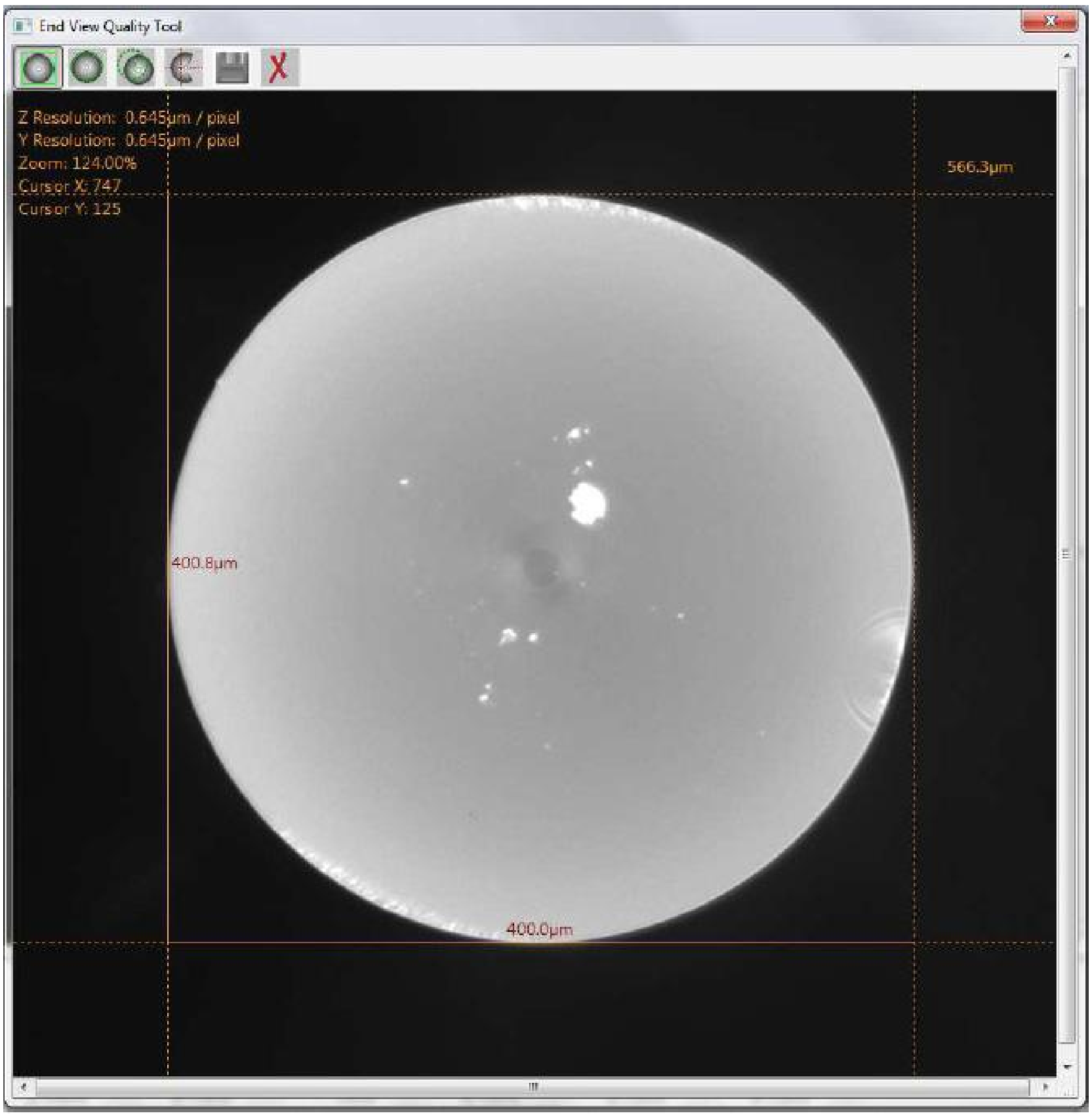


Figure 40 Rectangle Tool

6.3.3. Circle / Ellipse Tool

The Circle/Ellipse Tool allows the user to construct a bounding circle or ellipse over the image. The width and height measurements are displayed in microns in the overlay.

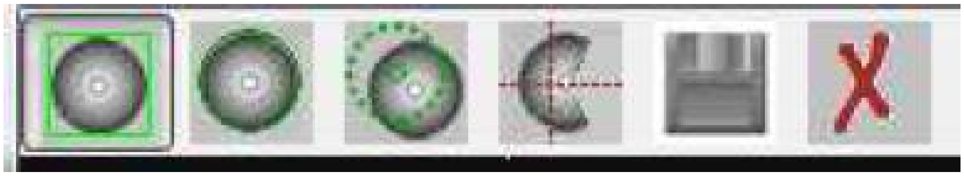


Figure 41 Circle / Ellipse Tool Button

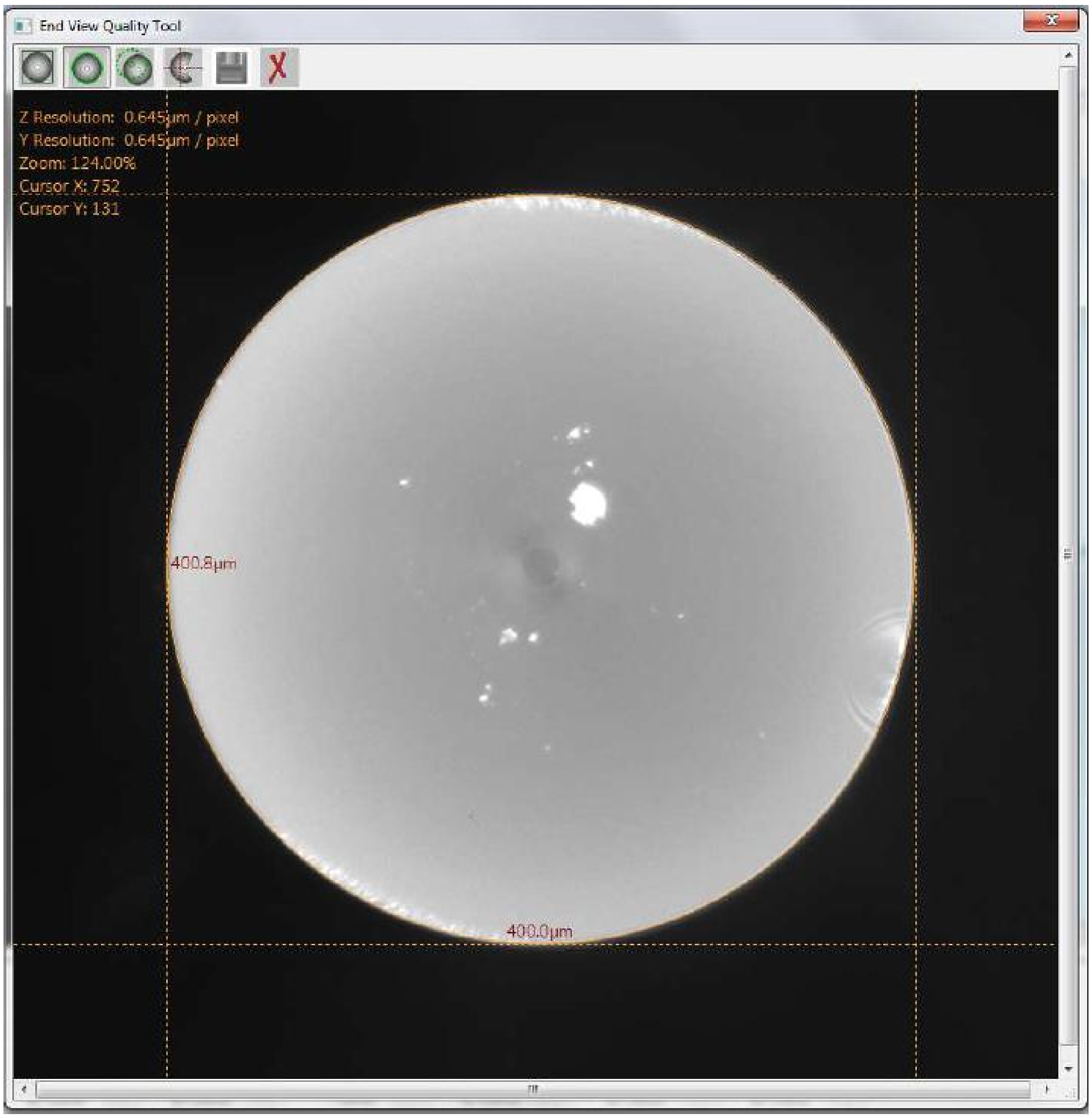


Figure 42 Circle / Ellipse Tool

The Circle / Ellipse Tool will also render the shape into the overlay giving an indication of the actual geometric shape.

6.3.4. AutoLocate Tool

The AutoLocate Tool automatically determines the diameter and position of a circular fiber.

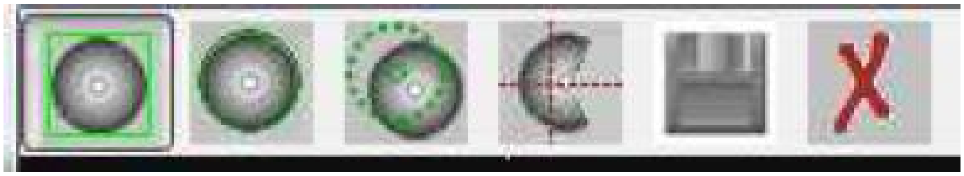


Figure 43 AutoLocate Tool Button

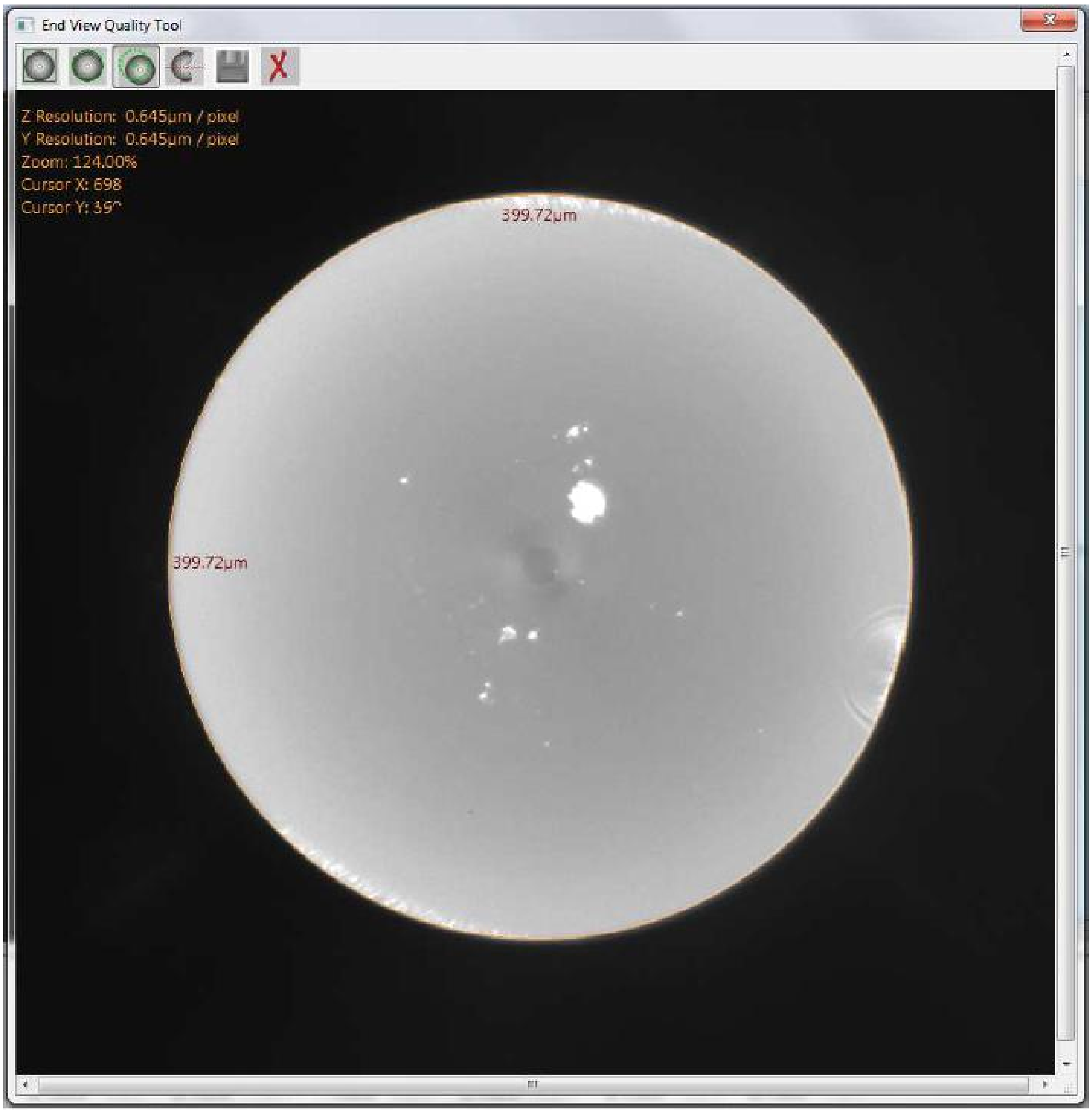


Figure 44 AutoLocate Tool

6.3.5. Centroid Tool

The centroid tool automatically determines the centroid of a fiber using the Center Of Area method. This will work with any fiber geometry.

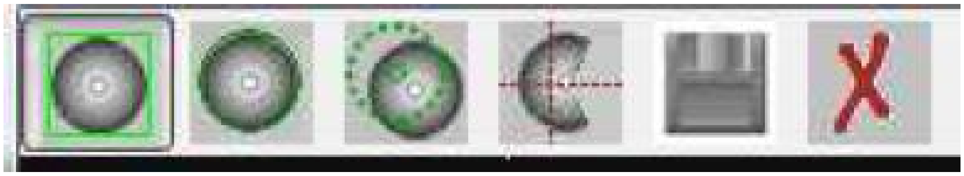


Figure 45 AutoLocate Tool Button

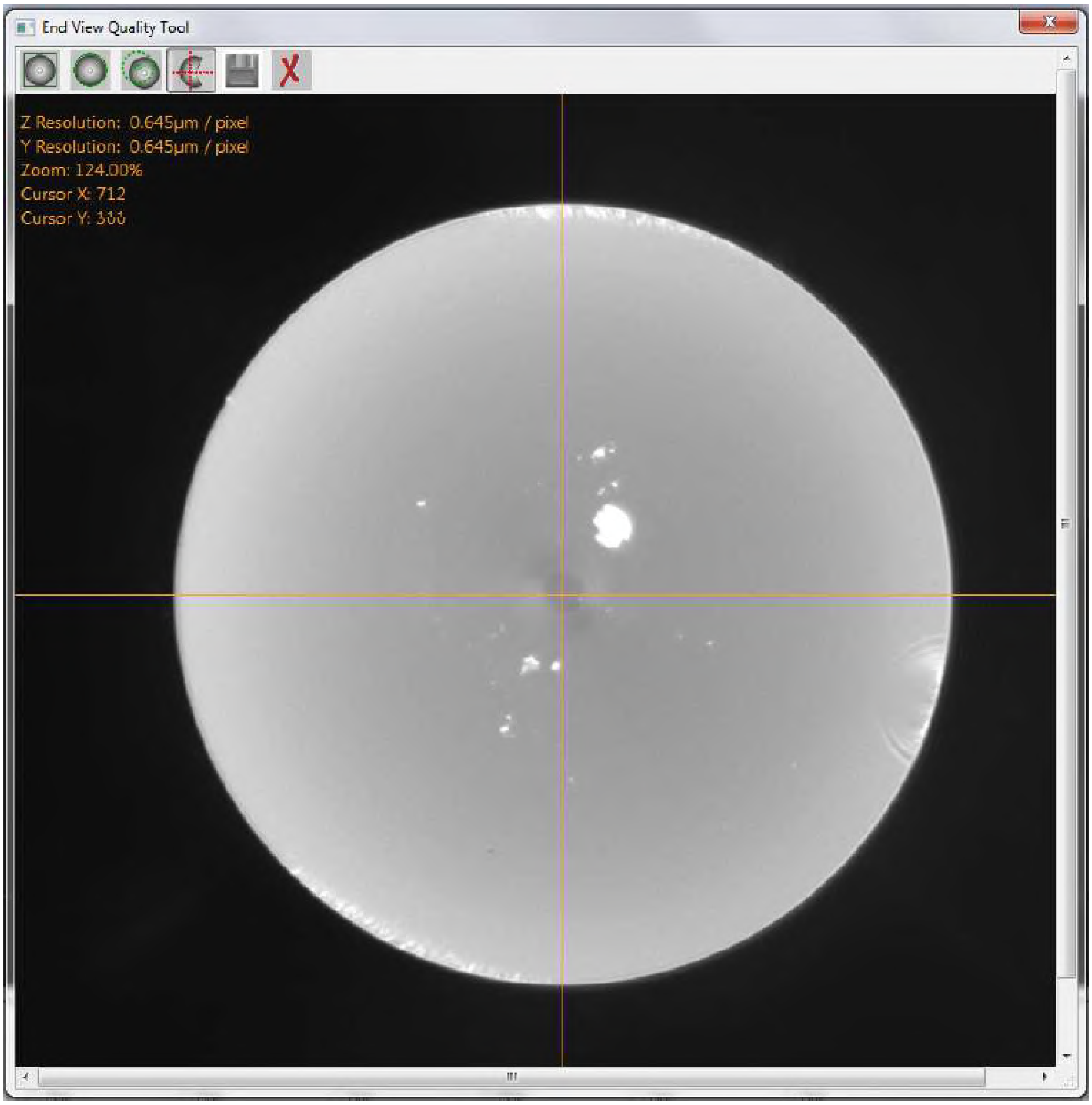


Figure 46 Centroid Tool

Chapter 7 Maintenence

7.1. General Care

The simple procedures and safeguards outlined in this section will help maintain the glass processor workstation in working condition.

7.2. Keep the System Clean

The system should be kept clean at all times; dirt particles trapped in the furnace and fiber holder blocks can cause problems during operation. Use a soft brush or canned air (Item # CA3) to blow dirt and dust off the equipment. Small, battery-powered vacuums sold for cleaning PC keyboards are can be used to remove loose dirt from the splicer. A soft brush attachment should be used with these vacuums. A lint-free cloth with denatured alcohol may be used to clean the surfaces of the splicer.

CAUTION

Do not use acetone or other harsh solvents near the lettering on the main panel. Acetone will soften and remove the white lettering.

Ensure that all the fiber ends and coating particles are cleaned off the workstation. This type of debris can cause improper operation of the equipment.

7.3. Fiber Handler Maintenance

Fiber handlers must be cleaned periodically to ensure accurate fiber positioning. It is also sometimes necessary to change inserts to accommodate different fiber sizes. The following sections will discuss how these two tasks are accomplished.

7.3.1. Changing Transfer Inserts:

The GPX3800 and GPX3850 are designed to use fiber holder transfer inserts that can be used to move fiber between multiple compatible Vytran systems.

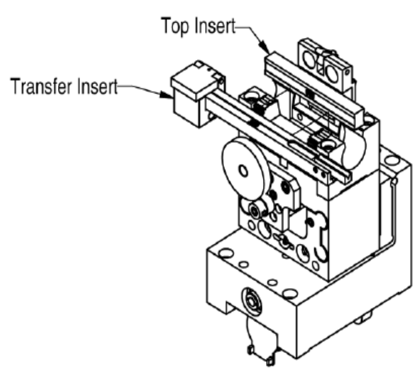


Figure 47 Fiber holding block

Transfer inserts are normally held in place with magnets -- not setscrews. There are three setscrews that can be used to clamp the transfer insert in place, but they are not necessary. Magnetic locking of the transfer inserts ensures that they can be quickly dropped in place after cleaving, and can be quickly removed to process another fiber.

The top insert, however, is held in place with setscrews. These two set screws are located in the back of the lid and must be loosened before the top insert can be replaced.

7.3.2. Cleaning the Fiber Holding Block Insert

Debris in the fiber holding block v-grooves may interfere with fiber positioning. The v-grooves should therefore be cleaned carefully, using a soft brush moistened with acetone**.**

7.3.3. Adjusting the Transfer Insert Block

The block at the end of the transfer insert can be adjusted to accommodate fibers of slightly different diameter (see Figure 48 for details). To do this, one must first loosen the two set screws in the back of the block. One then adjusts the set screw in the bottom of the block. If going to a smaller diameter fiber, one turns the screw clockwise. If going to a larger fiber, one turns the screw counterclockwise. The side of the block should remain flush with the end of the insert. Once the correct block height has been reached, the two setscrews in the back of the block should be re-tightened.

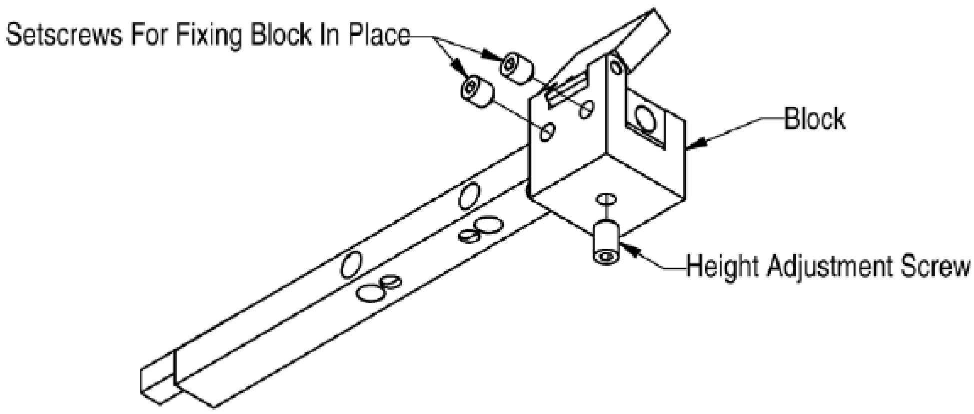


Figure 48 Adjusting the block on the transfer insert

7.4. Filament Replacement Procedure

7.4.1. Changing the Filament

1. Switch the glass processor on and initialize.
2. Home the lens by clicking on the “Lens Home” macro button.
3. Home the fiber holding blocks by clicking on “FHB Home” macro button.
4. Switch the glass processor OFF.
5. Remove the 2 screws that secure the stainless steel cover plates (as seen in Figure 49) onto the furnace using a 5/64" hex key or balldriver.

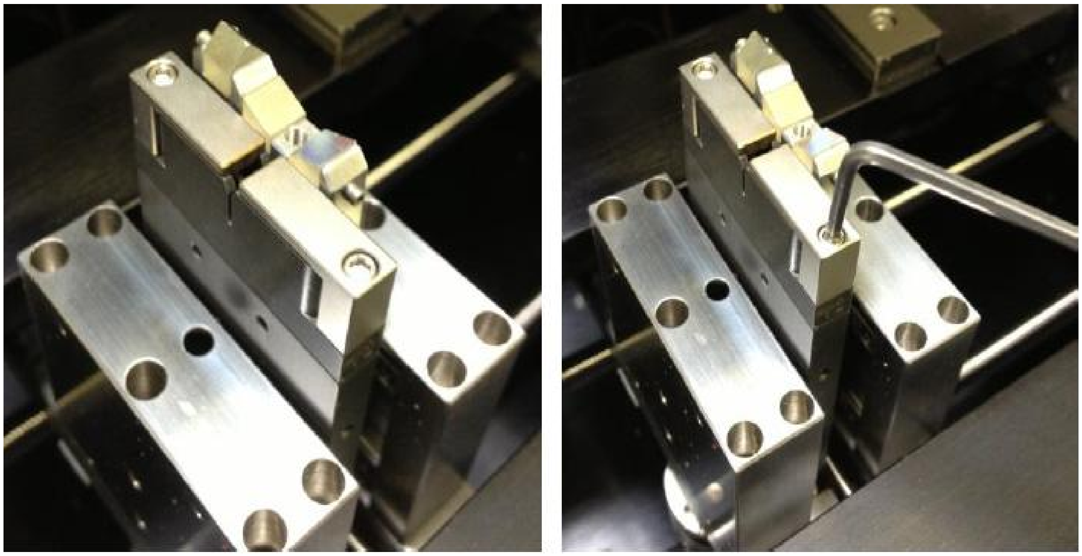


Figure 49 Remove the screws on the stainless steel cover plates

6. Remove the Stainless Steel cover plates.

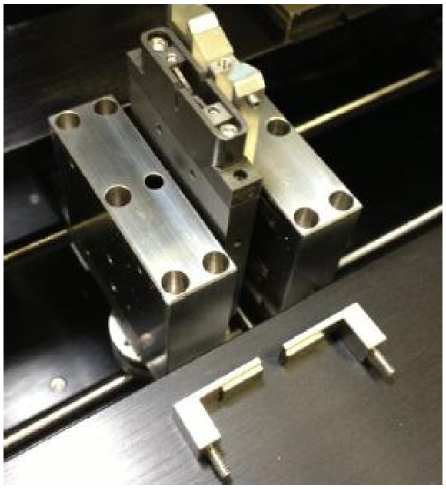


Figure 50 Remove the stainless steel cover plates

7. Remove the 2 screws that secure the filament to the furnace body using a 5/64" hex key or balldriver (See Figure 51).

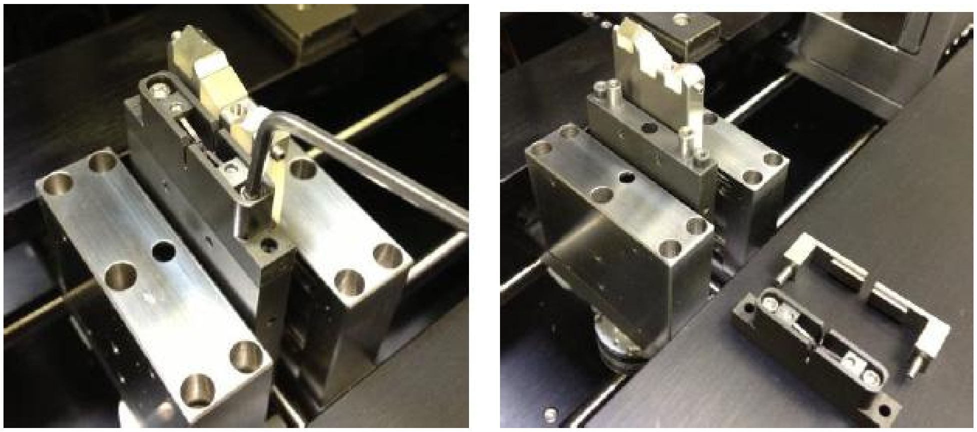


Figure 51 Remove filament body screws using a 5/64" hex key or balldriver.

8. Remove the filament body and replace with a new one. Be sure to have the filament "V" number inscription facing toward the front (user side) of the unit.

9. Fit and secure the 2 screws that fasten the filament body to the furnace. Do not over tighten (use a Set the torque of 6 lb-in).

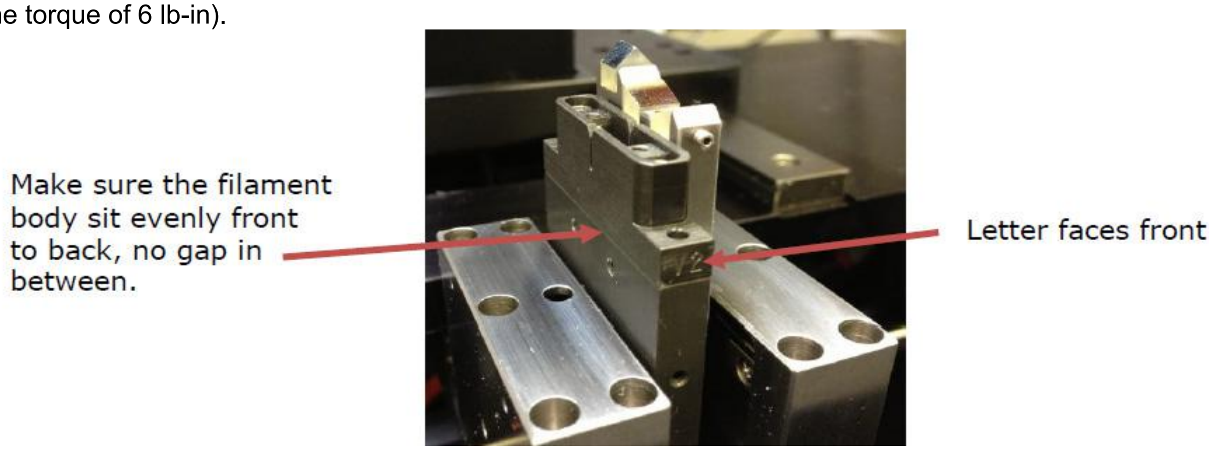


Figure 52 Fit and resecure the filament body to the furnace.

10. Refit the stainless steel cover plates and secure the two screws at a torque of 6 lb-in.

Figure 53 Secure the stainless steel cover plates on the filament assembly

7.4.2. Filament Centering Procedure

1. Switch the on and home all motors.
2. Press *Load Fibers* button to bring the fiber holding blocks to the load position.
3. Load a fiber into to the left and right fiber holding blocks.
4. Move the lens to *Back View*
5. Gap and align the fibers in both *Back View* and *Front View*.
6. Press the *Lens Filament* process button. The glass processor will move the lens and the mirror to left end view position.
7. Shine an external light source into the fiber so that the end face is illuminated. It may take some adjustment to get the light and the fiber positioned correctly.
8. First adjust the focus on the filament edge, and then move the fiber in or out to be in the same focus plane as the filament. Adjusting the focus is accomplished by moving the slider in the camera bar. Moving the fiber is accomplished by clicking the arrows in the Left Block box.
9. Check that the filament is positioned in the center of the filament height-wise (ydirection).
10. If the Filament is too large to see the full filament housing on the screen, use the command *5motorstep(3 XX)* to move the camera until you can see the filament housing edge.
11. Use the *Filament +XX* and *Filament –XX* to adjust the filament height. Alternatively, the motor step command on motor 14 can be used. (e.g. send *5motorstep (14 8)* to raise the splice head 8 steps). When the fiber is perfectly centered in the filament, press the *Set Filament Height* button.
12. To home the filament vertically, press the *Filament Home* macro button. Then press the *Filament Up* command. View the image on the screen to make sure the fiber is still centered in the filament.

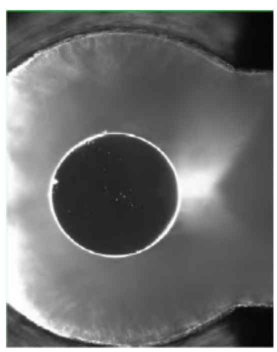


Figure 54 Ensure that the fiber is centered on the filament.

13. The user should also check that the filament does not contact the fiber when it is raised and lowered.
14. If the filament does contact the fiber, check that the fiber is properly loaded in the fiber holding block. Also check that the correct fiber holder insert being used.
15. If the filament position is OK, then send the lens home.
16. Home the filament.
17. Home the fiber holding blocks.

The filament is ready for normalization.

7.5. Cleaning the Mirror

The fiber image is distorted by debris that accumulates on the mirror surfaces. This debris may be dust from the atmosphere, small pieces of fiber coating, finger prints, etc. Care must be taken when cleaning the mirror surfaces, as they are all silver-coated on the front surface. If it is possible to visibly discern debris on the fiber image or if the system is unable to focus the image, then the mirrors should be cleaned.

7.5.1. Procedure

1. Move the lens assembly to the home position.
2. Move the fiber holding blocks to the home position.
3. View each mirror surface using a 10x eye loupe (Item # EYL10X).
4. Remove debris using a clean cotton swab and a commercial lens cleaner. Please note that the mirrors are silver-coated on the front surface. Never use a cotton swab that has been laying on the work surface; dust particles on a used cotton swab will scratch the mirror.
5. Wipe the mirror surface in a single direction, rotating the swab to lift debris away from the mirror surface. Do not reuse the cotton swab.
6. View the mirror through the eye loupe. Re-clean the mirror if necessary.
7. Repeat for all mirror surfaces as required.

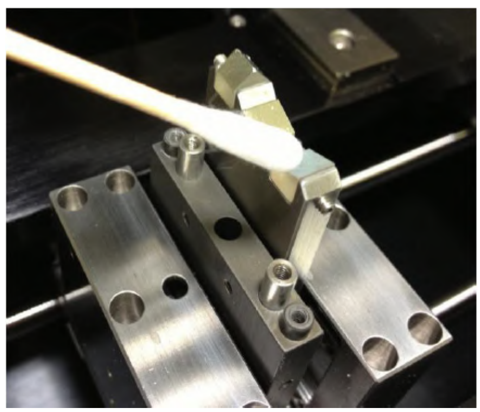
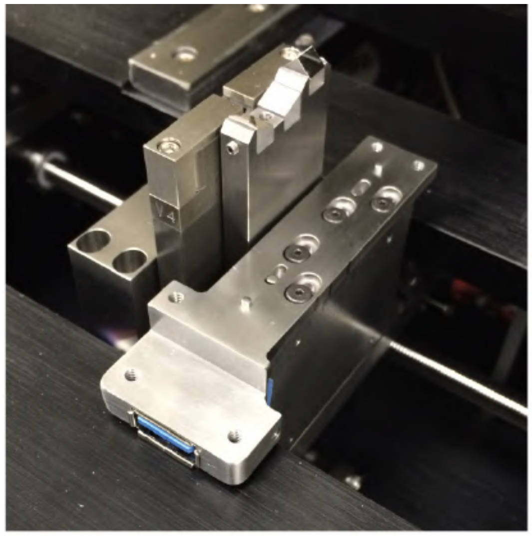


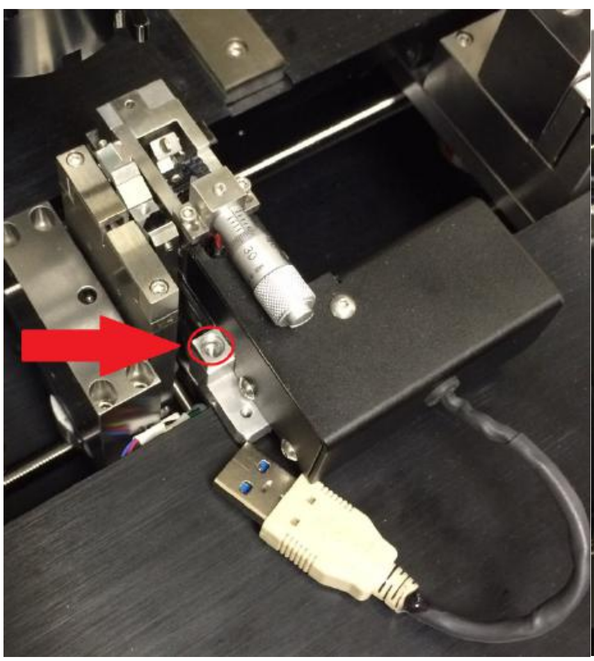
Figure 55 Use a clean cotton swab and lens cleaner to remove debris from the mirror surface

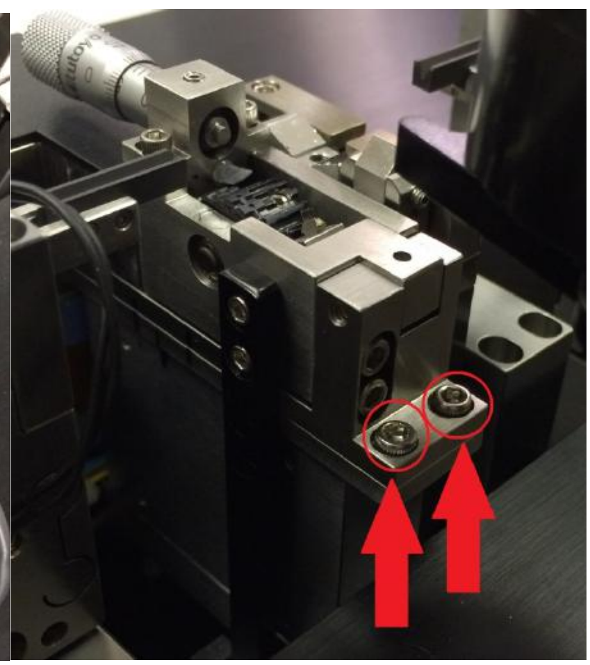
7.6. Installing the GPX Cleaver

To install the GPX Cleaver; simply place the cleave assembly onto the adapter plate in which the location is controlled by 2 locating pins.



The cleaver is secured by 3 screws. The location of the 3 screws is shown by the red arrows below.

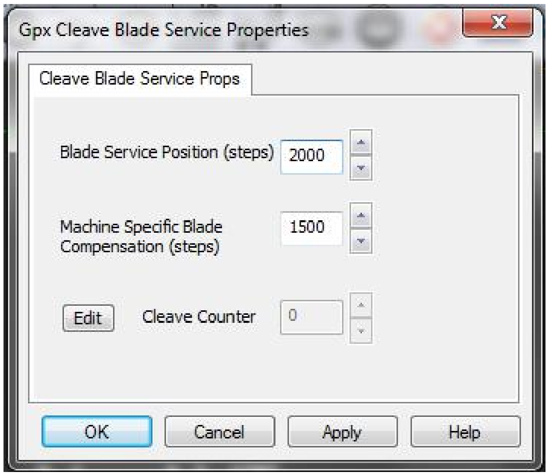




With the power of the GPX OFF, plug the USB end into the socket.

CAUTION
Do Not plug anything other than the GPX Cleaver into this USB socket.

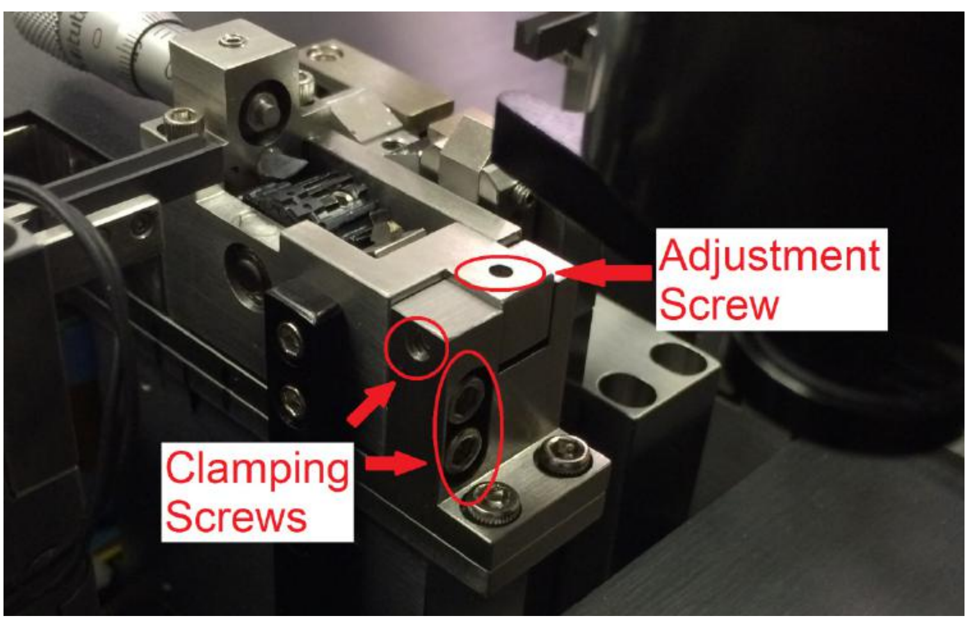
Upon re-installing the GPX Cleaver, you may need to adjust the “Machine Specific Blade Compensation” value under the GPX Cleave Blade Service process.



7.7. Adjusting the Cleave Blade Height

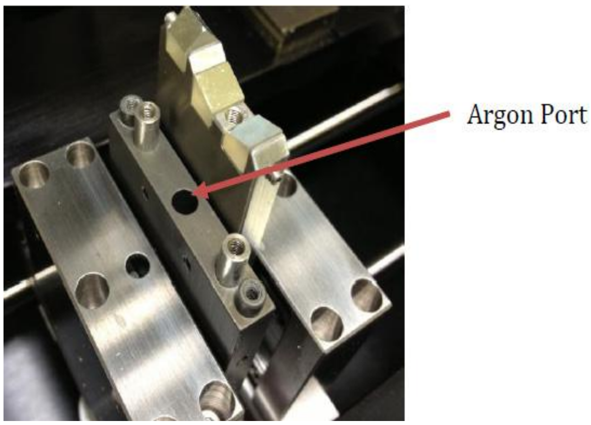
Only a small portion of the cleave blade edge is used to scribe the fiber. If this local portion of the edge gets damaged, the blade can be re-positioned to a new “un-used” section. While the lifetime of a given section of the blade can be very long (greater than 10,000 cleaves), it is also very easy to damage the blade due to excessive lateral stresses (stresses perpendicular to the edge of the blade). This can occur if the blade is in contact with the fiber and the fiber then moves sideways across the edge of the blade. The most common occurrence of this is a result the cleave tension being set so low that the fiber is unable to be cleaved. In this scenario, the fiber will slide along the edge of the blade and take a small semi-circular “bite” out of the current section. For small localized damage such as this, the blade can be re-positioned up to a maximum of 10 times.

1. To re-position the cleave blade:
2. Loosen the two (2) “Clamping Screws” located at the back of the cleave assembly using the 3/32” Allen wrench and the “Clamping Set screw” on the right side of the cleave assembly using the .050” Allen wrench; turning counter-clockwise ¼ to ½ turn is sufficient.
3. Turn the “Height-Adjustment Screw” exactly ¼ turn clockwise using the 1/16” Allen wrench. This will raise the “Cleave Blade Housing” and re-position the blade to a new section of the diamond edge.
4. Re-tighten the (3) “Clamping Screws”.



7.8. Measuring the Argon Flow Rates

1. The argon gas flow rate settings should be adjusted when switching between different fiber diameters.
2. The flow rate settings are set in the splice file.
3. To check and/or calibrate the argon flow rates:
4. Ensure the system is on and the regulator is set to9 – 12 psi.
5. Remove the filament assembly according to the directions given in Section 7.4: Filament Replacement Procedure.
6. Insert the flow meter tube into the argon port as shown in Figure 56. Place the flow meter vertically on a solid surface for the most accurate reading.
7. Select *Argon Flow Rate*s from the menu bar. In the popup window, set the desired flow rate. Initiate the purge using the Purge tool bar item. Wait 5-10 seconds for the flow meter reading to stabilize. Verify that the flow meter measures the set flow value. Reset the purge flow rate to 2 l/min on completion of the test.



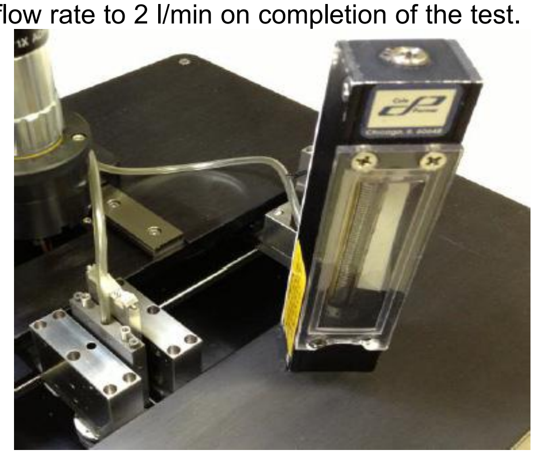


Figure 56 Image of Argon Gas Port (Left). Flow Meter in Vertical Position (Right)

7.9. RMA Process

Contact Thorlabs for information on requesting an RMA for a purchased GPX3800 or GPX3850 glass processor.

ATTENTION

When returning the product to Thorlabs, please use the original packaging and pink anti-static bag that the unit came in.

The illustrations below show the correct way to re-pack your glass processor workstation. 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.

RMA Packing Process

Chapter 8 Appendix

8.1. Top Inserts

The GPX3800 and GPX3850 Glass Processors require fiber holder inserts to be placed in the fiber holding blocks in order to clamp the fibers during the splicing process. Fiber holder top inserts sit in the lid of the fiber holding blocks and come in a variety of groove sizes. They can be used to clamp the cladding, coating, or buffer of a fiber. The top inserts and bottom inserts can be paired in a variety of combinations to accommodate all fiber sizes compatible with the glass processors, as shown in Figure 60. Multiple combinations of top and bottom inserts may be required to accommodate all sizes of fiber to be spliced.

There are two types of top inserts. The standard top inserts (Item #'s starting with VHA) come in single-sided and double-sided versions; the specified fiber diameter (in µm) is engraved on the part. These top inserts cannot be used for end-view imaging. They are, however, compatible with the FPS300 Fiber Preparation Station, LDC Series of Fiber Cleavers, and LFS4100 Fusion Splicer. For end-view imaging and alignment, an insert with an indent for LED illumination (VHB00 or VHB05) is required. This mode of operation allows for alignment of the cores of polarization-maintaining, eccentric-core, and microstructured specialty fibers. These LED illumination inserts are also compatible with the LFS4100 Fusion Splicer.

Fiber Holder Insert	Side 1 Accepted Diameter (Min / Max)	Side 2 Accepted Diameter (Min / Max)
VHB00	57 µm / 759 µm	N/A
VHB05	410 µm / 1008 µm	560 µm / 1269 µm
VHA00	57 µm / 759 µm	275 µm / 970 µm
VHA05	410 µm / 1008 µm	560 µm / 1269 µm
VHA10	812 µm / 1515 µm	1036 µm / 1770 µm
VHA15	1288 µm / 2022 µm	1534 µm / 2268 µm
VHA20	1772 µm / 2505 µm	2032 µm / 2944 µm
VHA25	2278 µm / 3029 µm	N/A
VHA30	2609 µm / 3198 µm	N/A

Figure 57 Acceped Outer Diameters for Fiber Holder Top Inserts

8.2. Bottom Inserts

Fiber holder bottom inserts sit in the bottom section of the fiber holding blocks and come in a variety of groove sizes. They can be used to clamp the cladding, coating, or buffer of the fiber. The top inserts (sold above) and bottom inserts can be paired in a variety of combinations to accommodate all fiber sizes compatible with the the glass processor, as shown in Figure 60.

There are two types of bottom inserts. The bottom inserts for fibers with cladding or buffer diameters up to 1.047 mm (indicated with Item #'s starting with VHF) are transfer inserts; they allow for a single fiber to be transferred between the Vytran FPS300 Fiber Preparation Station, LDC400 Series of Fiber Cleavers, and glass processors without loss of positional reference. All of these transfer inserts require the VHT1 transfer clamp; the transfer inserts for diameters ≤550 µm also require a graphite V-groove.

Fiber Holder Insert	Side 1 Accepted Diameter (Min / Max)
VHF160	112 µm / 208 µm
VHF250	177 µm / 320 µm
VHF400	279 µm / 519 µm
VHF500	346 µm / 795 µm
VHF750	516 µm / 1047 µm

Figure 58 Acceped Outer Diameters for Fiber Holder Transfer Inserts

Fiber Holder Bottom Inserts for larger cladding or buffer diameters (indicated with Item #'s starting with VHE) come in single-sided and double-sided versions; the specified fiber diameter (in µm) is engraved on the part. These bottom inserts can also be used in the FPS300 Fiber Preparation Station, LDC Series of Fiber Cleavers, and LFS4100 Fusion Splicer. Positional reference of the fibers will not be maintained when these inserts are transferred between systems.

Fiber Holder Insert	Side 1 Accepted Diameter (Min / Max)	Side 2 Accepted Diameter (Min / Max)
VHE10	773 µm / 1271 µm	1034 µm / 1523 µm
VHE15	1280 µm / 1769 µm	1534 µm / 2007 µm
VHE20	1787 µm / 2267 µm	2033 µm / 2513 µm
VHE25	2270 µm / 2844 µm	N/A
VHE30	2692 µm / 3198 µm	N/A

Figure 59 Acceped Outer Diameters for Fiber Holder Bottom Inserts

8.3. Fiber Holder Insert Size Selection Guide

Figure 60 indicates the minimum and maximum diameters that can be accommodated by different combinations of top and bottom inserts. It also indicates how far offset the fiber will be for recommended combinations of top and bottom inserts. Note that this outer diameter may be the fiber cladding, jacket, or buffer. If one side of the fiber is being discarded, it is preferable to clamp onto the cladding of this section except in special cases (such as non-circular fiber) where the coating or buffer may be preferable. Sections of fiber that are not being discarded should always be clamped on the coating or buffer in order to avoid damaging the glass. This may require different sets of fiber holder inserts to be used in the left and right holding blocks. In this case, it is important to minimize the difference in the offsets introduced by the left and right sets of inserts when attempting to produce high quality splices.

1. **First, select the bottom insert that matches your fiber size most closely.**
   For an Ø800 µm fiber, the VHF750 insert is the closest match, since it is only 50 µm smaller.
2. **In Figure 60, look to the right of your chosen bottom insert. Select a compatible top insert based on the fiber diameter size range shown in each cell. Green cells indicate the best fit, orange cells indicate the second best fit, and white cells indicate the third best fit.**
   For the Ø800 µm example fiber from step 1, the green cell is in the 750 µm groove column for the VHA05 and VHB05 top inserts, which have two grooves. The numbers listed in the green cell indicate that this combination of inserts is good for fibers from 728 to 963 µm in diameter. Our Ø800 µm fiber is within this range, so this is a good choice. There are several other options that will accommodate an Ø800 µm fiber as well, but the green shading in the chart indicates that the 750 µm groove in either the VHA05 of VHB05 provides the best fit. Of these two top insert options, the VHB05 is compatible with end-view imaging but the VHA05 is not.
3. **The second line of numbers in each cell shows the range of offsets that can be expected for any given combination of top and bottom inserts. When selecting inserts for the right and left fiber holding blocks, try to minimize the offsets between the pairs of inserts on each side.**
   If we choose a VHF750 bottom insert and the Ø750 µm groove in the VHA05 top insert, we can use fiber as small as 728 µm, in which case the center of the fiber would sit 23 µm below the surface of the bottom insert. We could also clamp a fiber as large as 963 µm, in which case the center of the fiber would sit 213 µm above the surface of the bottom insert. We could interpolate to find the offset expected for our hypothetical 800 µm fiber, but it turns out that in a 60°V-groove, the offset is equal to the diameter difference. So, that means that the center of our fiber is going to sit 50 µm above the bottom insert surface because it is 50 µm larger than the fiber that the bottom insert was designed for (800 - 750 = 50).
4. **Holding blocks designed for fibers less than 1000 µm in diameter have vacuum holes, designed to aid in aligning small fiber within the groove, while bottom inserts for fibers of Ø1000 µm or larger do not have these holes.** The LFS4100 has a vacuum pump that provides a small holding force via these holes, keeping small fibers in place as the clamps are lowered.

Top Insert Item #		VHA00 VHB00	VHA00	VHA05 VHB05		VHA10		VHA15		VHA20		VHA25	VHA30
Accepted Diameter (Nominal)		≤320 µm	400 µm	500 µm	750 µm	1000 µm	1250 µm	1500 µm	1750 µm	2000 µm	2250 µm	2500 µm	3000 µm
Bottom Insert Item #	Accepted Diameter (Nominal)	Min/Max Accepted Diameter (µm) Min/Max Offset (µm)											
VHF160	160 µm	112/208 -49/48	-	-	-	-	-	-	-	-	-	-	-
VHF250	250 µm	177/320 -73/69	275/323 25/74	-	-	-	-	-	-	-	-	-	-
VHF400	400 µm	279/519 -122/119	377/517 -23/117	410/519 -9/119	-	-	-	-	-	-	-	-	-
VHF500	500 µm	346/592 -153/93	447/647 -53/147	476/711 -24/211	560/795 61/296	-	-	-	-	-	-	-	-
VHF750	750 µm	516/759 -234/9	617/970 -132/221	643/878 -107/128	728/963 -23/213	812/1047 62/297	-	-	-	-	-	-	-
VHE10	1000 µm	-	-	773/1008 -172/63	858/1093 -88/147	943/1178 -3/232	1036/1271 90/325	-	-	-	-	-	-
	1250 µm	-	-	-	1034/1269 -176/59	1119/1354 -91/144	1212/1447 2/237	1288/1523 78/313	-	-	-	-	-
VHE15	1500 µm	-	-	-	-	1280/1515 -172/63	1373/1608 -79/156	1449/1684 -2/233	1534/1769 82/314	-	-	-	-
	1750 µm	-	-	-	-	-	1534/1770 -159/76	1611/1846 -83/152	1695/1930 2/237	1772/2007 78/313	-	-	-
VHE20	2000 µm	-	-	-	-	-	-	1787/2022 -171/64	1871/2106 -86/149	1947/2183 -10/225	2032/2267 74/309	-	-
	2250 µm	-	-	-	-	-	-	-	2033/2268 -167/68	2109/2344 -91/144	2193/2429 -6/229	2278/2513 78/313	-
VHE25	2500 µm	-	-	-	-	-	-	-	-	2270/2505 -172/64	2355/2590 -87/148	2439/2675 -2/233	2609/2844 167/402
VHE30	3000 µm	-	-	-	-	-	-	-	-	-	2692/2944 -256/-4	2777/3029 -171/81	2946/3918 -2/250

Figure 60 Recommended Fiber Ranges for Top and Bottom Inserts

Chapter 9 Specifications

Item #	GPX3800	GPX3850
Splicing Specifications		
Fiber Types (Non PM)	Single Mode, Multimode, Photonic Crystal, Large Mode Area, Non-Circular[1]	
Fiber Types (PM)	Panda, Elliptical, Bow-Tie[1]	
Fiber Cladding Diameter	Up to 1.25 mm (Max)	Up to 1.7 mm (Max)
Fusion Method	Filament Fusion	
Filament Temperature Range	Room Temperature to 3000 °C	
Splice Loss	0.02 dB (Typical)[2]	
Splice Loss Estimation	True Core Imaging® Technology	
Splice Strength	>250 kpsi (Typical)[3]	
Strength Enhancement	Fire Polish	
Polarization Cross Talk	Panda: >35 dB Other Fiber Types: >30 dB	
Fiber Inspection		
Fiber Side Viewing	True Core Imaging Technology	
Fiber End Viewing	Facet Inspection and PM Core Alignment (VHB00 or VHB05 Top Insert Required)	
Core / Cladding / Fiber Diameter	Automated Measurement	
End Face Inspection	Inspection via GUI Display	
Cleave Angle	Automated Measurement	
Fiber and End Face Alignment		
Fiber Z-Axis Movement	180 mm (Max)	
Z-Axis Movement Resolution	0.25 µm via Stepper Motor	
XY Axis Fiber Positioning Resolution	0.02 µm via Stepper Motor	
Rotation Alignment	Fully Automated End-View Alignment for Panda, Bow Tie, Elliptical-Core Fibers External Extinction Ratio Feedback for Automatic Alignment of PM Fiber Types	
Rotation Drive Resolution	0.02°	
Rotation Travel	200°	

[1] Other fiber types than those listed are compatible. Contact Tech Support to determine if your fiber type can be used.
[2] For Ø125 µm Cladding Single Mode Fiber
[3] Measured for single mode fiber prepared using an LDC400 Series Cleaver or other appropriate fiber preparation equipment.

Item #	GPX3800	GPX3850
Tapering		
Tapering Length	~2 mm[4] (Min) Up to 150 mm[4] (Max)	
Tapering Ratio (Max)	Adiabatic Tapers up to 1:10 (Ratios Up to 1:100 Possible)	
Tapering Speed	1 mm/s (Typical)[5]	
Adiabatic Tapering Loss	<0.01 dB (Typical)	
Computer and Software		
PC Computer	Included	
Splice Files	Built-In Library for Common Fibers and Processes	
Physical		
Size	16.0" x 12.5" x 6.3" (410 mm x 320 mm x 160 mm)	
Weight	45 lbs (20 kg)	
External Power Supply	Universal Input: 96 - 260 VAC, 47 - 63 Hz, Single Phase Glass Processor Input: 12 V and 48 V DC, 10 A PC Input: 115 or 230 VAC, 47 - 63 Hz, Single Phase	
Gas Supply	Argon, >99.999% Purity at 12 psig (Not Included)	
Environmental		
Operating Temperature	15 to 40 °C	
Altitude Range	0 to 2000 m Above Sea Level	
Operating Humidity	0 to 75% Relative Humidity (Non-Condensing)	
Storage Temperature	-20 to 60 °C	
Storage Humidity	0 to 90% Relative Humidity (Non-Condensing)	

9.1. Electrical Power

The glass processor workstation comes with an external power supply unit, which requires 90-260 VAC, 47-63 Hz, single phase. This external power supply provides the unit with a 12 V line and a 48 V line (10 A max).

The glass processor workstation is controlled via a personal computer. The computer serves as an interface between the user and the workstation. The computer requires 115 or 230 VAC, 47-63 Hz, single phase.

9.2. Gas Supply

These glass processing workstations use a high purity argon gas to purge the splice chamber of oxygen during the filament fusion process. This is necessary to keep the fibers clean and to prevent the filament from oxidizing at the high fusion temperature.

Thorlabs supplies a high purity Teflon gas line and a large gas regulator with the GPX. These are for use with a large gas tank (not available from Thorlabs) which has a CGA-580 output port; a DIN 477 Number 6 output port connector is also included. Zero grade argon gas with purity of ≥99.999% is recommended. Research grade argon gas is preferred especially for fiber laser applications. Any other gas may damage the unit.

[4] Dependent on Taper Geometry
[5] Tapering speed depends highly on the type of process used. 1 mm/s is a typical speed for a standard tapering process.

9.2.1. Gas Supply Specifications

- It is recommended that only zero or research grade argon gas be used with the glass processor. Any other gas may damage the unit or shorten the lifetime of the filament. Please note that zero grade argon gas is specified as 99.999% pure with O_2 < 0.5ppm, H_2O < 3.5ppm, and THC (Total Hydrocarbons) < 3.5 ppm. Research grade argon gas is cleaner with specifications of 99.9995% purity with CO_2 < 0.5 ppm, H_2O < 0.5 ppm, N_2 < 3.0 ppm, O_2 < 1.0 ppm, and THC < 0.5 ppm.
- When using a large tank of gas, be sure the regulator is set to approximately 12 psi. Do not exceed 25 psi under any circumstances. If no gas pressure is present at the input port, the splice station will interlock and the “Low Argon” message box will be displayed if operation of the filament is initiated.
- Use only the included gas line to interconnect the regulator to the splicing system. If an extended length gas line is required between the regulator and the splicer, please contact Thorlabs for purity requirements and line specifications.

Chapter 10 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

Wheelie Bin Logo

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 11 Thorlabs Worldwide Contacts

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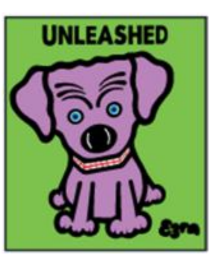
UNLEASHED