THORLABS

FFS2000 Series

Fiber Splicer

User Guide

vytran®

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Chapter 1 Warning Symbol Definitions

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

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

Chapter 2 Safety

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

SHOCK WARNING

Unplug the power cord before servicing the unit. Do not operate the unit without all covers and items properly installed.

CAUTION

Before connecting the AC power cord, make sure the source voltage is between 85 and 265 VAC, 47-63 Hz. Input voltages outside these ranges may result in damage to the unit.

Ensure that the Personal Computer voltage switch is set appropriately for the local supply.

CAUTION

The colorless solution used to clean the fibers may either be acetone (> 99%) or isopropanol (> 99.5%). Both are volatile and flammable. Ensure that the work area is well ventilated to avoid excessive inhalation of the solution being used. Do not ingest and avoid contact with the skin and eyes. Prolonged skin contact may result in severe irritation.

CAUTION

The recoat material is a flammable, toxic, acrylate compound. Avoid contact with the skin and eyes.

WARNING

Argon is a chemically inert gas. It is colorless, odorless, tasteless, non-flammable, non-corrosive and non-toxic. However, the work area should be well ventilated so as to ensure that the correct oxygen level is maintained.

WARNING

Ensure that the operator is properly trained for the handling of compressed gases and regulators.

Small transparent fiber shards may be present in and around the work area, and as such, the necessary measures should be taken to ensure the safety of the employee(s).

WARNING

This unit must not be operated in explosive environments. The equipment should be used in a standard laboratory environment with temperature and humidity control.

WARNING

Acrylate can be wiped using Kimwipes and Acetone. All chemicals should be disposed of with chemical waste.

Materials containing chemicals should be disposed of in chemical solid waste.

The fuse can be replaced by using a flat head screwdriver to turn the fuse housing and remove the housing/fuse from the back of the unit. The fuse can be removed from the housing and replaced. Then the fuse housing can be secured in place using the flat head screwdriver.

Chapter 3 Description

3.1. Introduction

The Vytran® FFS2000 Series is a fusion splicing workstation designed to meet the demands of both volume manufacturing and R&D splicing. All splicing processes - strip, cleave, clean, splice, recoat, and proof test - are logically integrated into a single, automated system that produces consistent splices quickly and efficiently.

The FFS2000 Series offers convenient user control of all splicing parameters from the included Windows® 7 PC with GUI. Additionally, a fully automated 4-axis positioning system is available (Item #s FFS2000PM and FFS2000WS) for precise rotary alignment of polarization-maintaining fibers. This complete and convenient automation control, combined with the advantages of our Filament Fusion technology, makes the FFS2000 Series ideal for high-strength, specialty fiber splicing, and manufacturing.

All of the FFS2000 Series components and procedures have been designed to yield consistent, reliable high-strength, low-loss splices. These include:

- Fiber holding blocks (FHBs, sold separately) and transfer jig minimize fiber handling by precisely positioning the fiber for each process.
- Soaking and stripping procedures safely remove the fiber's acrylate coating while maintaining fiber strength.
- A built-in cleaver provides a low-end-angle cleave, important for achieving low-loss splices.
- Ultrasonic cleaning prior to splicing removes any coating particles or residue left on the glass surface which would otherwise reduce splice strength.
- A Charge Coupled Device (CCD)-based imaging system used in conjunction with sub-micron-level stepper-motor positioners automatically aligns the fibers prior to splicing.
- An incorporated video imaging system displays the fibers alternately in two perpendicular axes.
- Precise control of fusion temperature necessary for splicing is achieved by using an inert purging gas and an electric filament.
- A post-fusion fire polish process cleans any deposits or impurities on the regions adjacent to the splice thereby enhancing splice strength.
- The recoat process maintains splice strength by restoring a protective polymer coating over the fusion splice.
- The proof tester ensures that a splice meets a minimum strength requirement (Item #s FFS2000PT and FFS2000WS)

In order to achieve optimum quality splices, it is important to read the instruction manual carefully and completely before attempting to operate the machine. Additionally, the required maintenance and service work should be performed on a regular basis to ensure that the splice quality is not compromised. This manual provides instructions for performing such services. When in doubt, please contact tech support (techsupport@thorlabs.com) as they are best qualified for diagnosing problems. Improper and/or incomplete maintenance may result in impairment of the operating characteristics of your splicer.

3.2. System Overview

3.2.1. Gas Supply

Use only zero- or research-grade argon gas supply. Any other gas may damage the unit. Zero-grade argon is specified as 99.999% pure with O_2 < 0.5 ppm, H_2O < 3.5 ppm, and THC (Total Hydrocarbons) < 3.5 ppm. Research-grade argon 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 10 to 11 psi. Do not exceed 25 psi under any circumstances. If no gas pressure is present at the input port the splice process will abort.

Use only a Thorlabs-supplied gas line to interconnect the regulator to the splicing system. If an extended length gas line is required between regulator and splicer, please contact Thorlabs for purity requirements and line specifications.

NOTE: Thorlabs does not supply the gas cylinder.

3.2.2. Computer

The Windows® 7 PC, monitor, keyboard, and mouse are included. FFS3 software is preinstalled on the PC.

3.3. Standard Features

- Fiber Coating Soaking Station
- Thermal Coating Removal Station
- Ultrasonic Fiber Cleaning Station
- Fiber Cleaving Station
- True Core Imaging™ for Automatic Fiber Alignment and Accurate Splice Loss Determination
- Automatic 3-axis Fiber Positioning System (Item #s FFS2000 and FFS2000PT)
- Automatic 4-axis positioning system for PM rotation (Item #s FFS2000PM and FFS2000WS)
- Filament Fusion Splicing Station with Automatic Post-Fusion Fire Polishing for Strength Enhancement
- Recoat Station for Acrylate Buffer Restoration
- Built-in Proof Tester / Tension Tester (Item #s FFS2000PT and FFS2000WS)
- Personal Computer with Windows GUI and Networkable Database
- Analog BNC Inputs for Test and Measurement Equipment

3.4. Standard Accessories

When unpacking the FFS2000 Series splicing system for the first time, check to make sure that you have the following accessories:

- External Power Supply Unit
- DC Power Supply Cord
- AC Power Cord
- Firewire Camera Cable
- RS-232 Cable
- PC, Monitor, Keyboard, Mouse, and Software
- External Vacuum Pump
- Clear Polycarbonate Tension Test Shield (Item #s FFS2000PT and FFS2000WS Only)
- Recoat Mold Injector System
- Color Coating Agent (Item #s FFS2000PM and FFS2000WS only)
- Large Tank Regulator with Gas Line
- Tool Kit Containing:
    - Lens Tissue
    - Flat Head Screwdriver
    - Filament Extraction Tool
    - Eye Dropper
    - Two (2) 3/32” Hex Keys
    - Two (2) 5/64” Hex Keys
    - 0.028" Hex Key
    - 0.035" Hex Key
    - 0.050" Hex Key
    - Soft Cleaning “Toothbrush”
    - 0-300 Gram Tension Gauge

3.5. System Overview

The splicer workstation (splicer) is the main component of the FFS2000 Series splicing system. It performs all the splicing process steps: soaking, stripping, cleaving, cleaning, splicing, recoating, and proof testing. The PC and gas supply, as well as peripheral components such as an optical power meter, are connected to the splicer back panel.

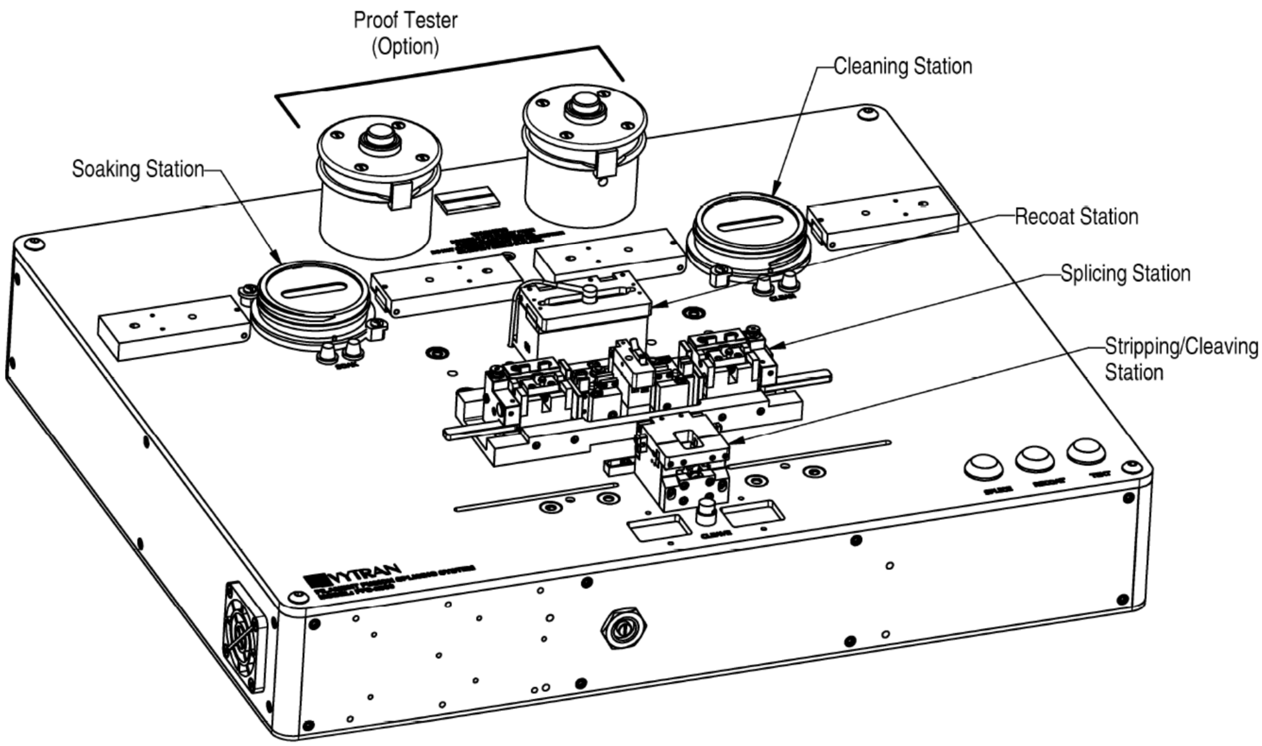


Figure 1 System Overview

The following subsections describe the components of the splicer workstation in the order of use during a splice process.

3.5.1. Fiber Holding Block and Transfer Jig

Left- and right-hand fiber holding blocks (FHBs) are used to provide an efficient, convenient, step-by-step method for preparing the fibers prior to splicing. The FHBs are also used in conjunction with a transfer jig to position the fiber for splicing and to transfer the completed splice to the recoat station.

In addition to simplifying the handling of the fiber throughout the splicing process, the FHBs and transfer jig also improve the consistency and strength of the splice by precisely positioning the fiber for each step. Fiber holding blocks are sold separately from the FSX2000PM base unit, but are installed and factory-aligned with the purchase of the system.

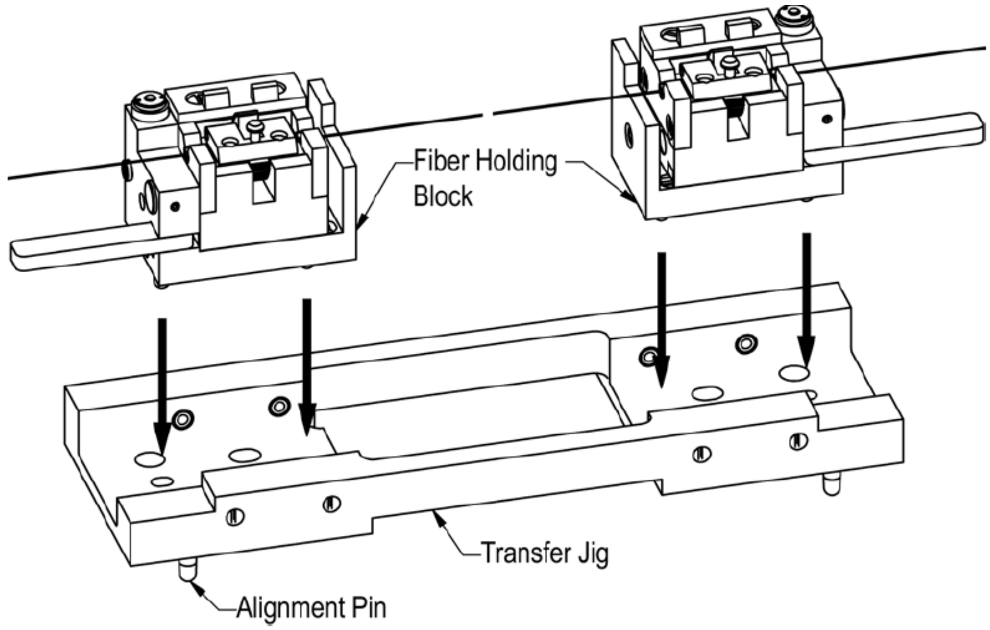


Figure 2 Transfer Jig with Fiber Holding Blocks

3.5.2. Standard Fiber Holding Block (Item #s FFS2000 and FFS2000PT)

The fiber holding block (Item # FHB1) consist of a U-shaped frame and a center, spring-loaded block that contains a replaceable vacuum V-groove bottom insert as well as a top insert. A magnetic top is used to clamp the fiber in the V-groove as the FHB is moved from station to station.

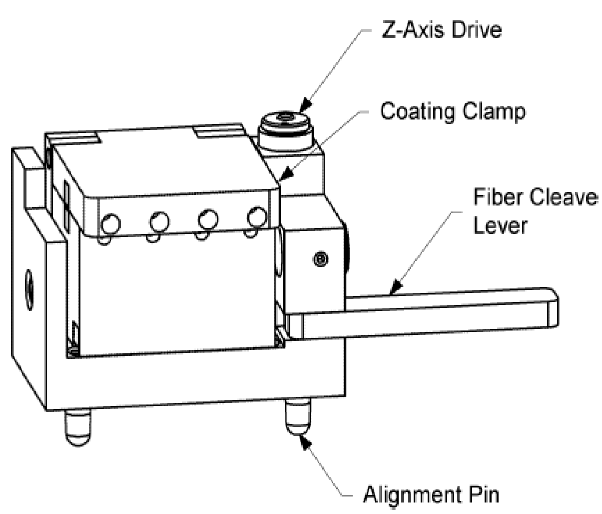


Figure 3 Standard Non-Rotating Fiber Holding Block

- **FHB Bottom V-Groove Insert and Top Insert:** The V-groove insert captures the fiber securely and allows the fiber to be transported within the fiber holding block between the stations. The bottom V-Groove inserts and top inserts are purchased separately; if purchased with an FFS2000PM base unit they will have been installed and factory aligned. Various sizes are available to support a range of coating diameters; for details please see Chapter 12. Replacements can be purchased from **www.thorlabs.com** and can be installed by the end user.

- **Fiber Cleave Lever:** The lever is used at the cleave station on the FPC200 Preparation Station (sold separately) to apply tension to the fiber.
- **Alignment Pins:** The alignment pins position the fiber holding block during the fiber handling at each station.
- **Z-Axis Drive:** The Z-axis drive positions the fiber in axial direction.

3.5.3. Rotary Fiber Holding Block for PM Alignment (Item #s FFS2000PM and FFS2000WS)

The fiber holding block (Item # FHBR1) consist of a U-shaped frame and a center, spring-loaded block that contains a replaceable vacuum V-groove insert within a rotary mechanism. A magnetic top is used to clamp the fiber in the V-groove as the FHB is moved from station to station.

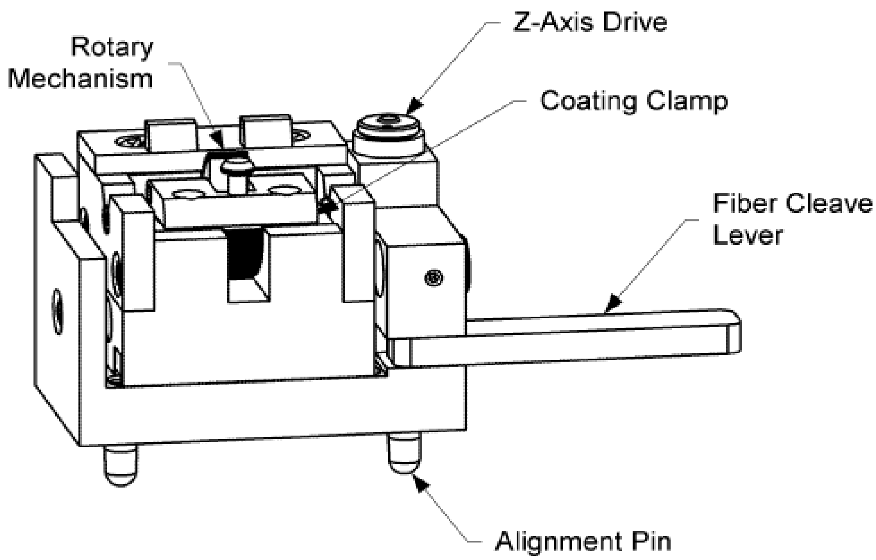


Figure 4 Rotary Fiber Holding Block

- **FHB V-Groove Insert:** The V-Groove Insert captures the fiber securely and allows the fiber to be transported within the fiber holding block between the stations. The bottom V-Groove inserts are purchased separately; if purchased with an FFS2000PM base unit they will have been installed and factory aligned. Various sizes are available to support a range of coating diameters; for details please see Chapter 12 Specifications. Replacements can be purchased from **www.thorlabs.com** and can be installed by the end user.
- **Fiber Cleave Lever:** The lever is used at the FPC200 Fiber Preparation Station (Sold Separately) to apply tension to the fiber.
- **Alignment Pins:** The alignment pins position the fiber holding block during the fiber handling at each station.
- **Z-Axis Drive:** The Z-axis drive positions the fiber in axial direction.
- **Rotary Mechanism:** The rotary mechanism is used to rotationally align the fiber with a resolution of 0.01°.

3.5.4. Soak Station

The soaking station is used to soften the acrylate polymer coating on the fiber so that it can be stripped off without scratching or abrading the underlying glass surface. The coating is softened by immersing the fiber in a solvent appropriate for the stripping method used. Presoaking will not be necessary for most fibers stripped using the thermo mechanical method. The soaking station consists of left- and right-hand dunking jigs, solvent container, and indicator lamps.

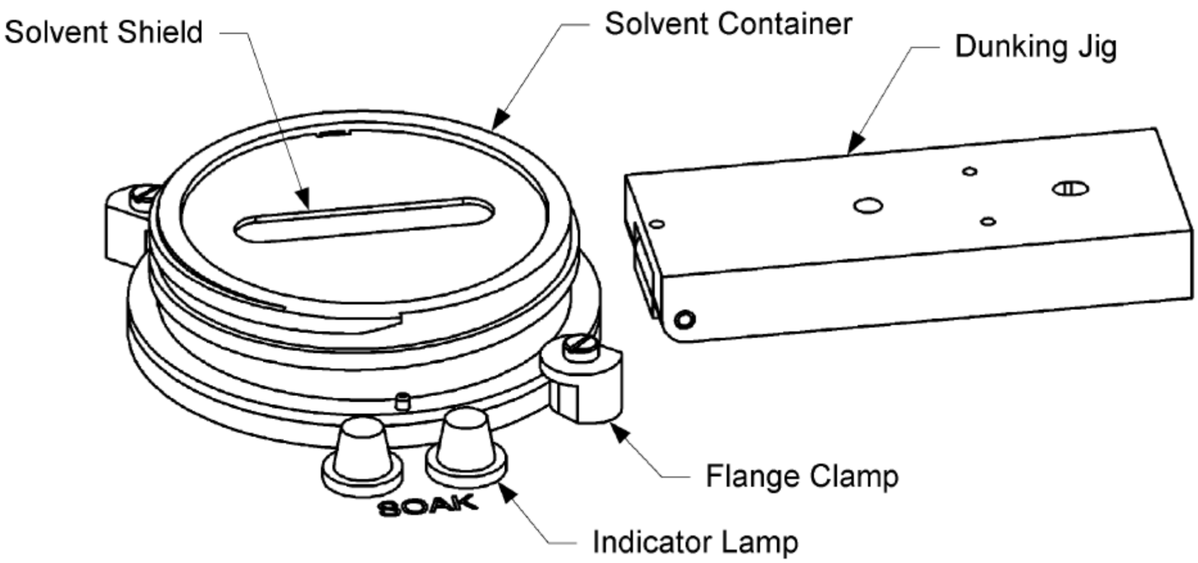


Figure 5 Soak Station

- **Dunking Jig:** The dunking jig is used to mount the fiber holding blocks at the soaking station. Vacuum is turned on when a FHB is inserted into the dunking jig in horizontal position. Vacuum turns off when dunking jig is raised to immerse the fiber in the solvent (max. 90°).
- **Solvent Container:** The solvent container holds the solvent which softens the acrylate coating on the fiber. Solvent should be filled up to 1/8" of the top of the can.

WARNING
Read the MSDS Sheet for any chemical used in the soak station.

- **Solvent Shield:** The solvent shield reduces splashing of the solvent during ultrasonic operation.
- **Indicator Lamp:** The indicator lamps light up when the soaking time expires and stay lit until the dunking jig is lowered.
- **Flange Clamp:** The flange clamps hold the solvent container in place. Unscrew 1/2 turn to release the container.

3.5.5. Strip and Cleave Station

This station serves the dual functions of stripping and cleaving. Two positions are provided for the FHBs: a slot allowing it to slide during the stripping procedure and precision aligned bushings to hold it securely for the cleaving procedure.

Strip Station

With the FHB in the stripping position, the acrylate fiber coating is captured by a matched set of stripper blades and can be removed with a light sliding force.

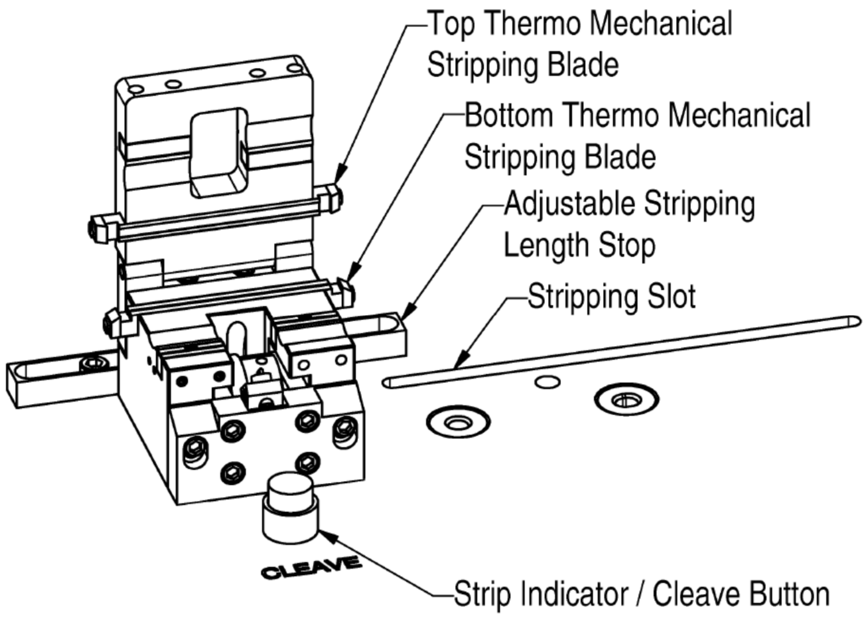


Figure 6 Strip Station

- **Stripping Slot:** The stripping slot is used to position the FHB at the stripping station. Positioning a FHB in the slot automatically activates the internal vacuum, pulling the fiber into the FHB and TMS V-groove. Simultaneously the TMS blades warm up to their preset stripping temperature. When stripping, the FHB is slid away from the stripping station assembly using a smooth, steady motion.
- **Stripping Stop:** The strip length of the fiber can be adjusted by changing the position of the stripping stop. This can be accomplished by loosening the stripping stop and manually adjusting it.
- **Stripper Inserts:** The top and bottom inserts contain a matched set of stripping blades at each end, which capture and remove the acrylate coating. In the thermo mechanical stripping set, the bottom insert also contains a heating element, used to soften the acrylate coating.
- **Strip Indicator:** The strip indicator displays the status of the thermo mechanical stripping station, as follows:
  - **Flashing:** TMS blades are heating up
  - **Lit:** TMS blades reached preset stripping temperature
  - **Off:** TMS blades not in use

Cleave Station

When the FHB is located in the cleaving position, a tension-and-scribe method of cleaving provides low-end-angle fiber end faces.

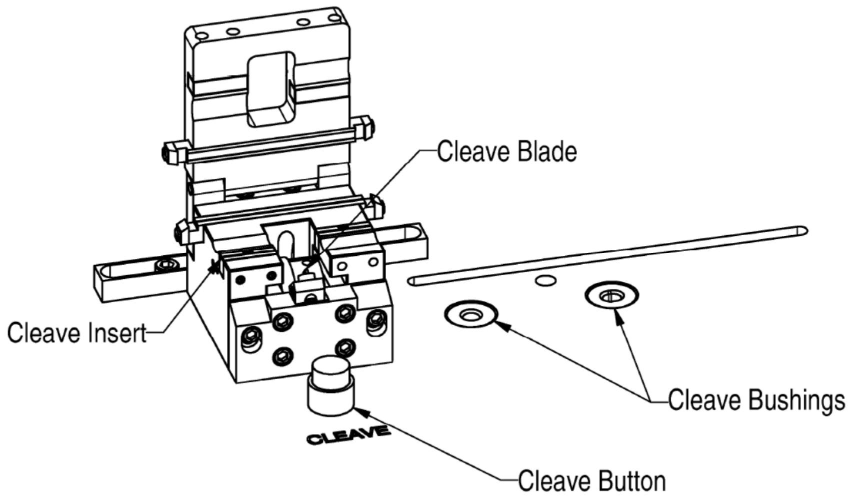


Figure 7 Cleave Station

- **Cleave Bushing:** The cleave bushings are used to position the FHB at the cleaving station.
- **Cleave Blade:** The polycrystalline diamond cleave blade is used to score the fiber during the tension-and-scribe cleaving process.
- **Cleave Button:** The cleave button is used to initiate the cleaving process.
- **Cleave Insert:** The cleave insert is used to hold the fiber in place at the cleaving station until the lid is closed.

3.5.6. Clean Station

The cleaning station is used to remove any coating particles or residue left on the glass surface which may reduce splice strength. The prepared fiber is immersed in the cleaning solution by raising the dunking jig, which automatically activates the ultrasonic cleaner to run for a chosen period. The cleaning station consists of left- and right-hand dunking jigs and an ultrasonic cleaning solution container.

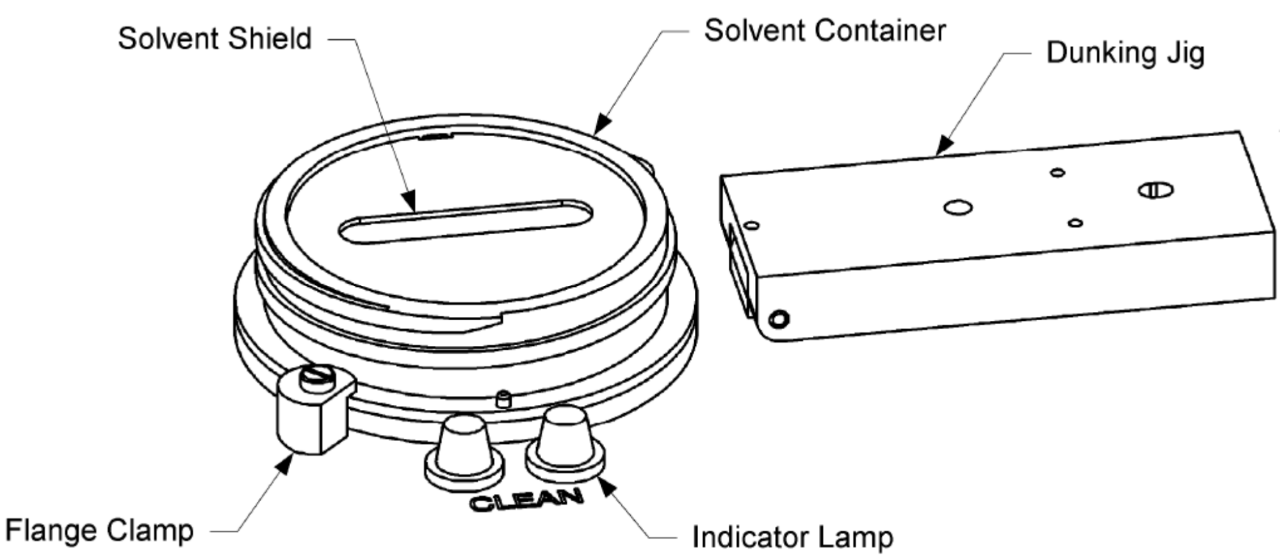


Figure 8 Clean Station

- **Dunking Jigs:** The dunking jig are used to mount the fiber holding blocks at the cleaning station. Vacuum is turned on when a FHB is inserted into the dunking jig in horizontal position. Vacuum turns off when dunking jig is raised to immerse the fiber in the solvent (max. 90°). Raising the dunking jig activates the ultrasonic cleaning mechanism.
- **Solvent Container:** The solvent container holds the cleaning solvent which removes fiber coating residue. Solvent should be filled up to 1/8" of the top of the can.

WARNING

Read the MSDS Sheet for any chemical used in the ultrasonic cleaner.

- **Solvent Shield:** The solvent shield reduces splashing of the solvent during ultrasonic operation.
- **Indicator Lamps:** The indicator lamps light up when the cleaning time expires and stay lit until the dunking jig is lowered.
- **Flange Clamps:** The flange clamps hold the solvent container in place. Unscrew 1/2 turn to release the container.

3.5.7. Splice Station

The splicing station is used to precisely position and fuse the fiber ends together. A tungsten or iridium filament (sold separately) provides the heat necessary for the fiber fusion.

Standard Splice Station (Item #s FFS2000 and FFS2000PT)

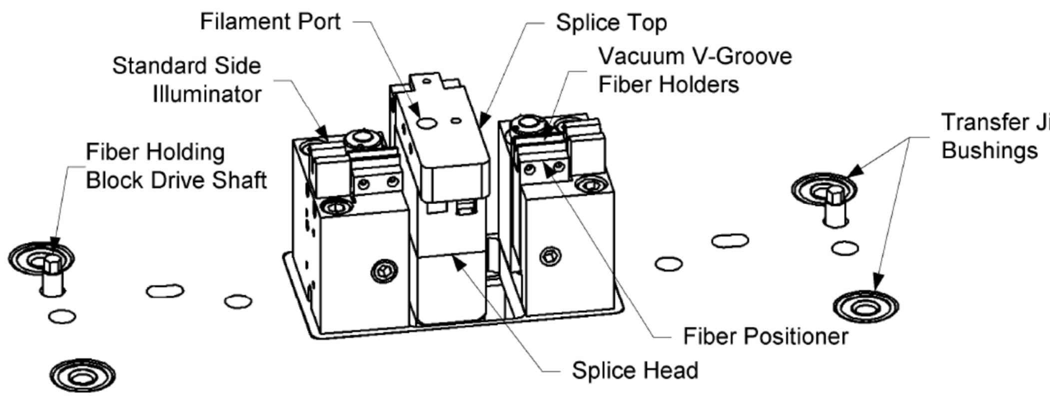


Figure 9 Standard Splice Station

- **Splice Head:** The splice head contains the tungsten or iridium filament, viewing optics, and XY illuminators. It moves axially during the high-strength fire polishing process.
- **Filament Port:** The filament port allows argon to escape during the splice process.
- **Fiber Positioner:** The stepper-motor pivot positioner is used for aligning fibers in the XY-direction with a resolution of 0.01 µm.
- **Vacuum V-Groove Fiber Holders:** The vacuum v-grooves are used to position the stripped fiber. The non-abrasive material maintains the fiber strength.
- **Side Illuminators:** The side illuminators are used to illuminate the cladding structure for end view during rotary alignment.
- **Fiber Holding Block Drive Shaft:** The drive shafts position the fiber holding blocks in Z-direction and rotate the fiber for PM alignment**.**
- **Transfer Jig Bushings:** The bushings are used to position transfer jig at the splice station.

Splice Station with PM Alignment (Item #s FFS2000PM and FFS200WS)

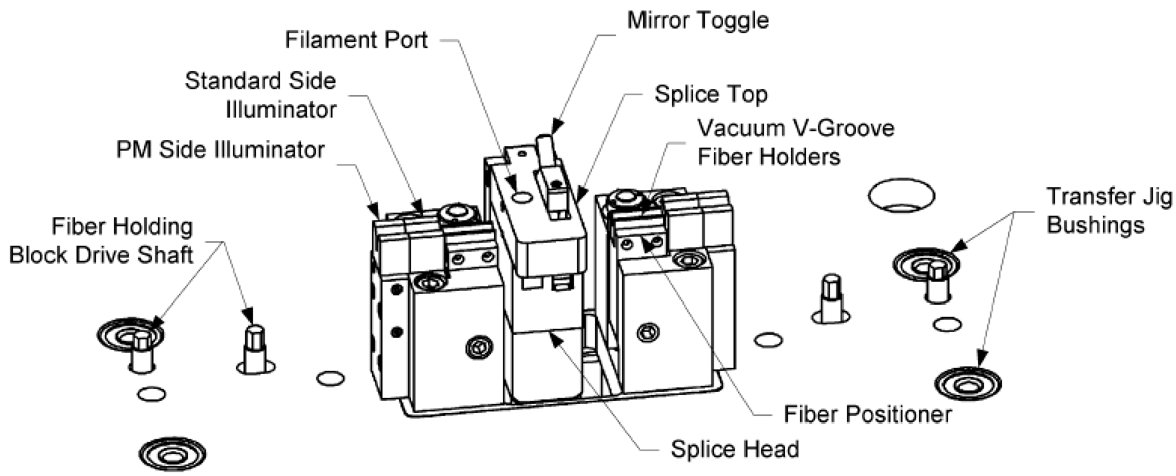


Figure 10 Rotary Splice Station

- **Splice Head:** The splice head contains the tungsten or iridium filament, viewing optics, and XY illuminators. It moves axially during the high-strength fire polishing process.
- **Filament Port:** The filament port allows argon to escape during the splice process.
- **Mirror Toggle:** The mirror toggle is used to switch between the side view (for XY alignment) and the end view (for PM alignment).
- **Fiber Positioner:** The stepper-motor pivot positioner is used for aligning fibers in the XY-direction with a resolution of 0.01 µm.
- **Vacuum V-Groove Fiber Holders:** The vacuum v-grooves are used to position the stripped fiber. The non-abrasive material maintains the fiber strength.
- **Side Illuminators:** The side illuminators are used to illuminate the cladding structure for end view during rotary alignment.
- **Fiber Holding Block Drive Shaft:** The drive shafts position the fiber holding blocks in Z-direction and rotate the fiber for PM alignment**.**
- **Transfer Jig Bushings:** The bushings are used to position transfer jig at the splice station.

3.5.8. Recoat Station

The recoat station is used to reinstate the polymer coating on the fiber, maintaining its strength and flexibility by protecting the glass surface from damage. Liquid UV acrylate material is injected into the recoat cavity and cured around the fiber using tungsten-halogen lamps to provide the necessary UV radiation.

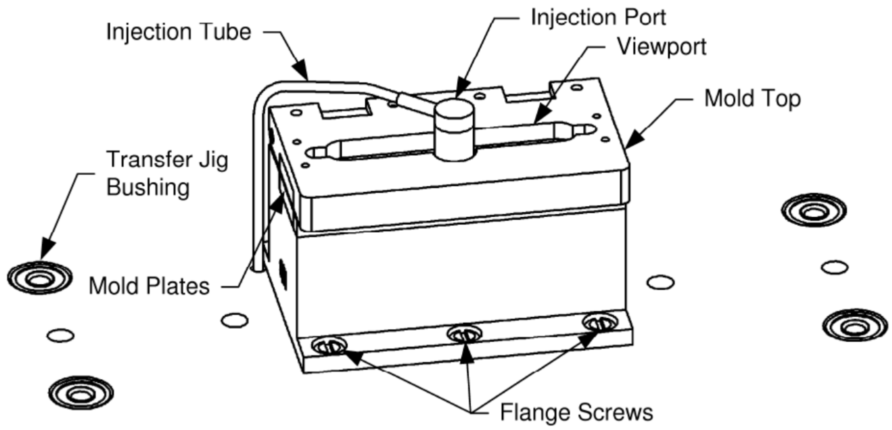


Figure 11 Recoat Station

- **Injection Port:** The injection port is used to inject the UV acrylate into the mold cavity.
- **Viewport:** The viewport allows the user to watch the UV acrylate as it flows into the mold cavity.
- **Fused Quartz Mold Plates:** The mold plates form a mold cavity for the UV acrylate material.
- **Flange Screws:** Flange screws are used to secure the position of the recoat station assembly.
- **Transfer Jig Bushings:** The bushings are used to position the transfer jig at the splice station.

3.5.9. Proof Test Station (Item #s FFS2000PT and FFS2000WS)

The proof tester can be used either to determine the breaking strength of a fiber or to ensure that a fiber or fusion splice meets a minimum strength requirement. Fiber is tested by placing it between the two mandrels. The ends of the fiber are wrapped once around each mandrel and held in place by an integral clamping mechanism. A load is automatically applied to the fiber by the rotation of one of the mandrels. The proof test or breaking load level is measured via a load cell and is recorded by the software interface.

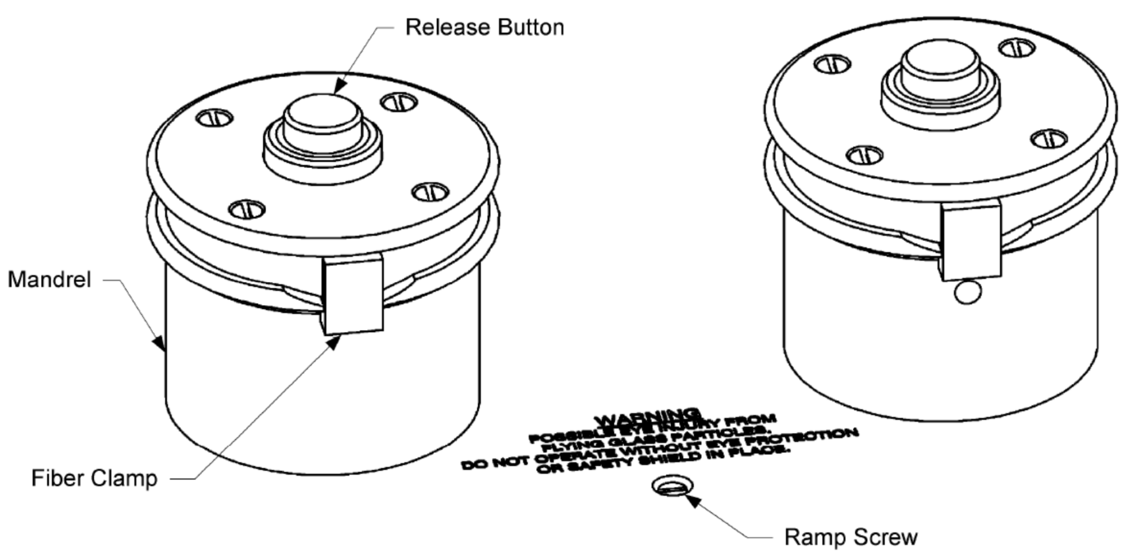


Figure 12 Proof Test Station

- **Mandrel:** During the proof test, the fiber is wrapped around the mandrels. The right mandrel will rotate, applying tension to the fiber.
- **Clamp:** The clamps hold the fiber taut between the mandrels and keep it from slipping during the proof test.
- **Release Button:** The buttons are used to release the tension on the clamps, allowing the fiber to be inserted or removed from the mandrel.
- **Ramp Screw:** The screw is used to adjust the ramp rate (the rate at which fiber tension increases during the proof test). To decrease the ramp rate turn clockwise; to increase the ramp rate turn counterclockwise.

Chapter 4 Setup

4.1. Initialize

The FFS2000 Series workstations accept an AC input range of 85 to 265 VAC, 47-63 Hz. Internally, the power supply senses the AC voltage being supplied and adjusts automatically.

Connect the power cord (wall cord), four-pin external DC power cable between the power supply and the workstation, the Argon gas line, external vacuum line, and both the serial and camera PC interface cables to the back panel.

Turn on the computer.

Start the FFS2000 Series software by selecting the FFS3 icon on the desktop.

Open argon valves at the regulator and set at 10 psi before starting the unit.

Turn on the external power supply.

Turn on the workstation power using the ON/OFF switch located on the back panel.

The cooling fans should activate. If not, check to make sure:

- the power cord is connected securely,
- the power applied meets the voltage/frequency requirement listed above,
- the power supply fuses are not blown.

Initialize the communication (comms) by selecting the initialize button  on the user interface.

The gas system will be purged. Check that the background argon flow is displayed in the ARGON window.

If the user interface buttons do not become active following initialization, then either the splicer has not been connected to a serial port on the PC, or it has been connected to the wrong port. Ensure the serial cable in the splicer is connected to either COM1 or COM2 on the PC. If the cable is correctly connected, then, select COM2 from the configuration menu if COM1 is currently selected, or vice-versa. The user interface should activate.

The system always starts with the last used splice file in memory. The interface can be set to display this file name and path by selecting this feature in the FILE menu.

Chapter 5 Software

5.1. Software Interface

The GUI is the main window when working on the FFS2000 Series. It has different menus and toolbars that are explained further later in this document. The buttons are described from top to bottom. The FFS3 graphical user interface is illustrated below.

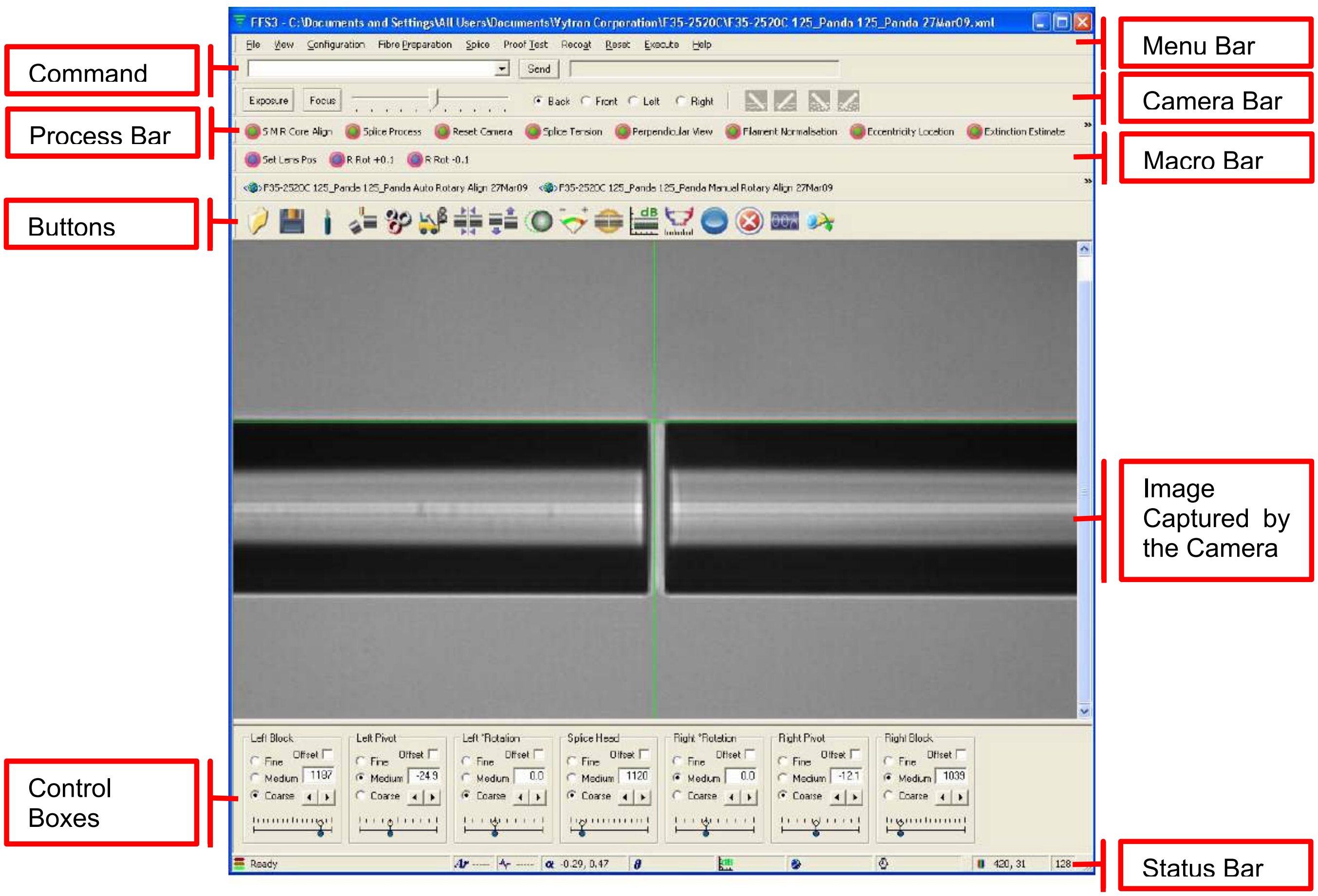


Figure 13 FFS3 Graphical User Interface

The top of the GUI contains a menu bar, a command bar, a camera bar, a processes bar, a macro bar, and a toolbar containing control buttons. The center region of the GUI contains a live image captured by the CCD. The bottom of the GUI contains control boxes for manipulating the fiber handlers and the splice head, as well as a status bar.

The following sections detail the functions of the GUI.

5.2. Menu bar

Figure 14 Menu Bar

5.2.1. File

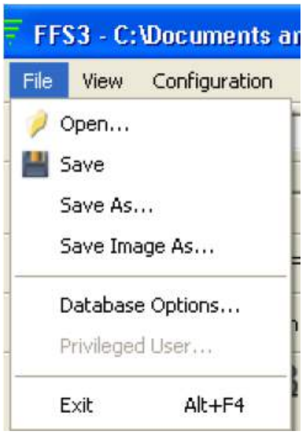


Figure 15 File Menu

Open: Open a new splice data file.

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

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

Database Options: Enables, Disables, or Resets the Database. The database has preconfigured settings that should not be altered.

Privileged User: Inactive at this time.

Exit: Close the GUI.

5.2.2. View

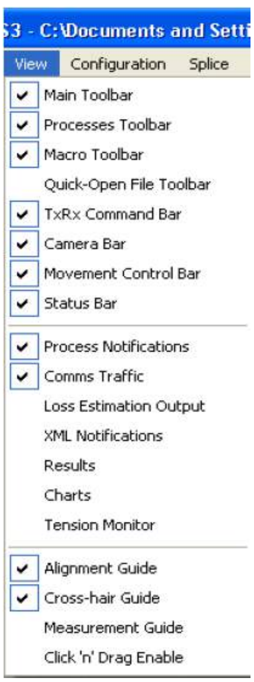


Figure 16 View Menu

Allows display control of 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; this is setup under the Configuration menu.

5.2.3. Configuration

The Configuration Menu permits the user to edit the toolbars and machine parameters.

5.2.4. Fiber Preparation

Figure 17 Fiber Preparation Menu

Allows access to the Soak, Clean, and Strip parameters.

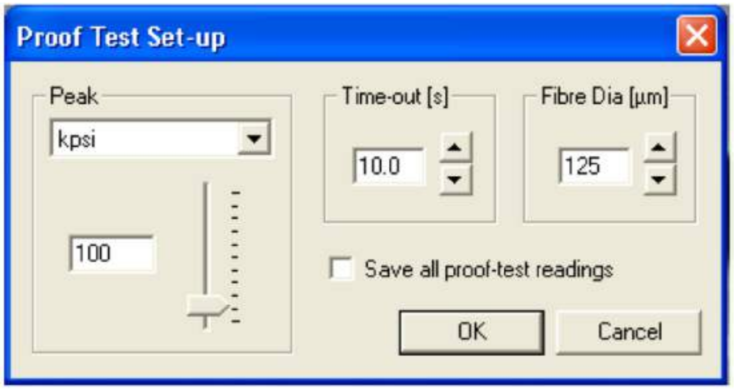
5.2.5. Splice

Figure 18 Splice Menu

The Splice Menu gives the user access to all of the parameters used in splicing.

Additionally, the Splice Menu provides access to the User Macro paths.

5.2.6. Proof Test



Allows adjustment of the proof test parameters.

Figure 19 Proof Test Menu

5.2.7. Recoat

Allows the user to adjust the recoater cure duration.

Figure 20 Recoat Menu

5.2.8. Reset

The Reset menu allows the user to initialize, stop, and reset the unit.

5.2.9. Execute

The Execute Menu can be used to perform splicing and tapering functions. For descriptions of these functions, see section 5.8: Main Toolbar.

5.2.10. Help

The Help Menu allows the user to save the event log.

5.3. TxRx Command Toolbar

Figure 21 TxRx Command Toolbar

Commands may be entered into the text box. The window to the right of the “Send” button shows the machine code response.

5.4. Camera Toolbar

Figure 22 Camera Toolbar

The “Exposure” button automatically adjusts the image so that the background is the desired brightness.

The “Focus” button automatically focuses the camera on the fiber.

Next to the “Focus” button is a slider that indicates the current focus position and allows manual adjustment of the focus.

“Back” and “Front” are 2 different side views used to align fibers.

“Left” and “Right’ views show the fibers’ end faces. External illumination may be necessary for certain fiber types; see “End View Alignment:” on page 47.

In this document and within the FFS3 software, 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.

5.5. Processes Toolbar

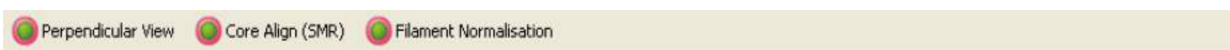


Figure 23 Process Toolbar

The Processes Toolbar allows the user to execute splice processes such as “Perpendicular View,” “Core Alignment,” and “Filament Normalization.” This toolbar can be customized by right clicking and selecting “Toolbar Properties”.

For example, “Perpendicular View” rotates both Fiber Holding Blocks 45°. This is commonly used in PM splicing. After the PM stress members are aligned horizontally, “Perpendicular View” rotates the fiber such that Front View and Back View allow the user to see the cores in two orthogonal views.

5.6. Macro Toolbar

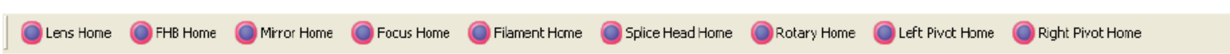


Figure 24 Macro Toolbar

The Macro Toolbar contains buttons that execute various macros. Note that it is possible to make buttons for single line commands in the macro bar as well as buttons for entire macros. Please contact Thorlabs for assistance.

5.7. Quick Open File Toolbar

This toolbar allows the creation of buttons for easy access to commonly used splice files.

5.8. Main Toolbar

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

Open: Opens a data file containing parameters for splicing or tapering. 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 a data file that can be accessed later. In the case you are using an XML file provided by Thorlabs, 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.

Cleave: Sends the cleave blade forward to scribe the fiber. Please note that this make take a few seconds the first time you run the process after opening FFS3.

Motor Engage: Pulls both FHBs out in the z-direction to ensure that the hex drive FHB pin and splicer socket mate well.

Load fibers: This moves the splice head to the splice position so that the Transfer Jig may be lowered without damaging the fibers with the filament.

Gap: Sets the fibers so that the end faces are at the pre-gap distance specified under “Splice Parameters.”

Alignment: Finds the edges of the fibers and aligns them. This will only align the fibers in the current view (front or back), so it is necessary to repeat this process in an orthogonal (left or right) view. The Alignment Process will not work if both edges of each fiber are not on the screen. In the end view mode, this process will rotate the fiber and align it based on the current PM Alignment Settings.

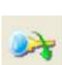
Core Alignment: Aligns the cores of the fibers, rather than aligning the fibers using their edges.

Active Alignment: Aligns the fibers actively using an external light source and power meter. The power meter must be connected to the “Analog Input 1” port on the back panel. The analog input reading can be configured under Configuration→Analog Input Configuration. The power meter should output a signal range of 0 V to 10 V.

Splice Only: Executes the basic splice process: the splice head moves 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: Estimates the loss in a splice, based on the appearance of the cores in the splice region. For a more accurate estimation, you need to have the correct calibration file; please contact Thorlabs for more assistance.

Proof Test: Performs the proof test process (Item #s FFS2000PT and FFS2000WS).



Initialize: Begins communication between the FFS3 software and the FSX2000 hardware, which is necessary whenever FFS3 is first opened.

Reset: Resets machine communication and homes the position of the fiber holding blocks. This process takes approximately 45 sec to complete. Initialize machine before operation.

5.9. Camera Image

The camera image shown below is a side view ("Front" or "Back") of a pair of fibers.

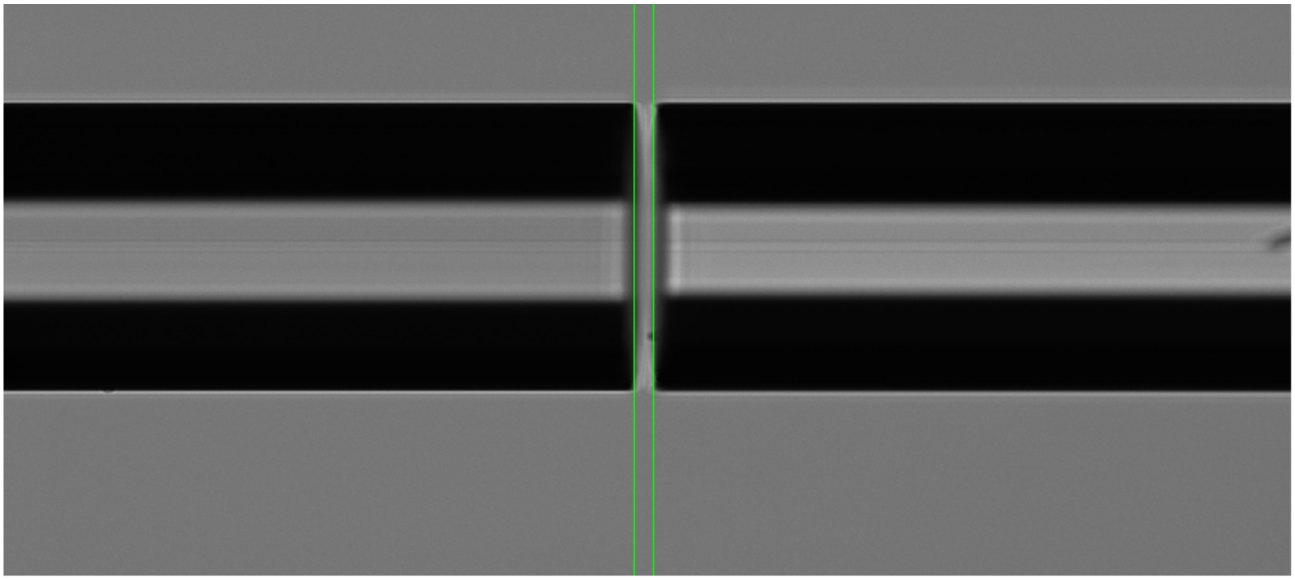
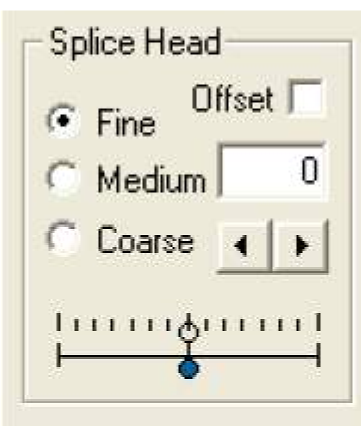


Figure 25 Example of a Side View

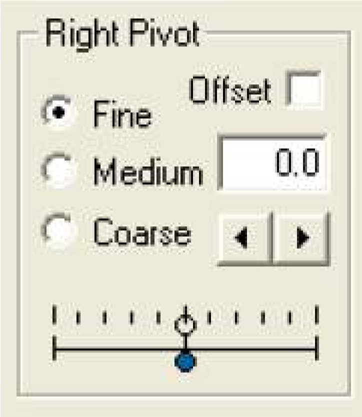
The pixels are compressed so that the entire image fits in the window. This becomes apparent when the end of a fiber is imaged and appears elliptical rather than circular. To achieve square pixels and a 1:1 aspect ratio, right click on the image area to activate the "Vertical Scrollbar" and the "Horizontal Scrollbar".

5.10. Movement Control Bar

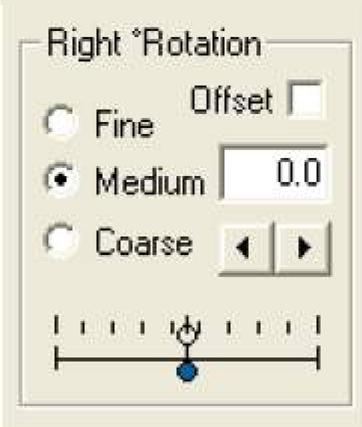
The seven boxes in the Movement Control Bar permit the user to move the fiber holding blocks and splice head at will, by clicking on the forward and back arrows. The radio buttons labeled "Fine," "Medium" and "Coarse" adjust the magnitude of each step.



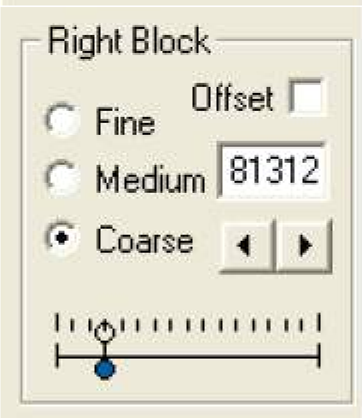
The "Splice Head" box enables the user to move the splice head left or right. Positive motion is to the right and the position is displayed in microns.



The “Right Pivot” box enables the user to move the right fiber for alignment in the front view. There is an identical box for “Left Pivot” to move the left fiber for alignment in the front view.



The “Right Rotation” box enables the user to rotate the right fiber. There is an identical box for “Left Rotation” to rotate the left fiber.



The “Right Block” box enables the user to move the right fiber handler in and out in the z-direction. 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. There is an identical box for “Left Block” that moves the left fiber holding block in the z-direction.

By checking the Offset box, you can temporarily set the current location to zero.

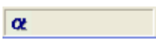
5.11. Status Bar

Figure 26 Status Bar

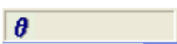
This window indicates the status of the unit. When the bottom bar is green and the window reads “Ready,” the unit is ready to execute new commands. When the top bar is red, the unit is not responding, and is either busy or needs to be initialized.

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.

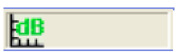
This window indicates the power applied to the filament.



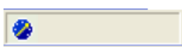
This window indicates cleave angles, it is updated whenever an Align Process is performed.



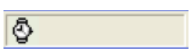
This window indicates the amount that the fibers have been rotated.



This window indicates the estimated splice loss.

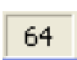


This window reports the tension last measured by the proof tester.



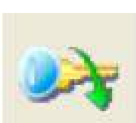
This window is a cumulative “on” timer for the filament.

This window indicates the position of the cursor (in pixels) 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.

5.12. Initialization and Shutdown



When the FFS2000 Series is turned on, it is necessary to hit the initialization button in order to establish communication with it. Before initialization takes place, most of the buttons on the GUI will appear grey, and the status bar light will be dull red instead of green.

5.13. Failure

If a process fails for any reason, a popup window will appear and give four options:

- If you press Abort, the current One Button Process will end.
- If you press Retry, the failed process will run a second time and if it fails again, the one button splice will end.
- If you press Continue then the failed process will be skipped and the next process in the process list will be executed.

Figure 27 Failure Process Window

- If you press reset then the reset macro will run. On completion you can choose to “abort or retry or continue”.

5.14. Splice Properties

To customize the splice parameters, go to Splice → Splice Parameters.

- **Pre-Gap:** Defines the target distance between the end faces of the fibers prior to running the Splice Process.
- **Hot Push Delay:** The time between when the filament has reached full power and when the fibers are pushed together.
- **On-Duration:** Defines how long the filament is at full power in addition to the hot push delay.
- **Pre-Push:** Pushes the right fiber inwards prior to turning on the filament.
- **Argon:** Defines the amount of argon flow during the splice.
- **Power:** Defines the amount of power applied to the filament.
- **Hot Push:** Defines the distance that the right fiber is pushed inwards after the Hot Push Delay.
- **Push Velocity:** Defines how fast the right fiber is pushed in.
- **Splice Offset:** Adds an offset value to the View to Splice distance, such that the filament is not centered around the gap.

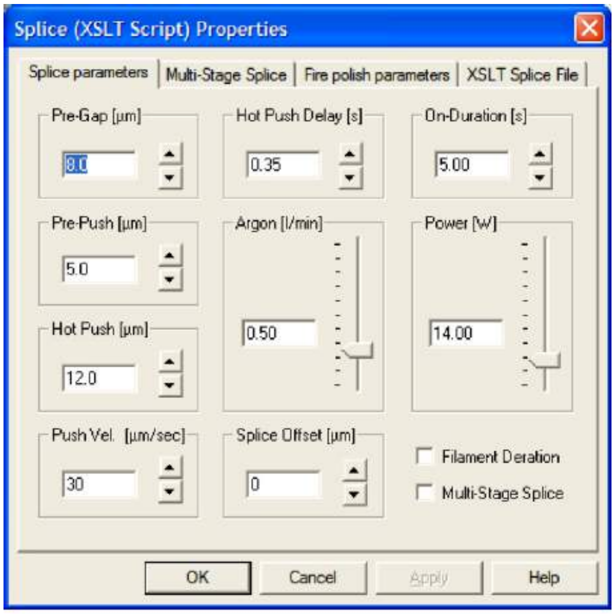


Figure 28 Splice Properties

5.14.1. Multi Stage Splice Properties

Enabling the Multi Stage Splice Process

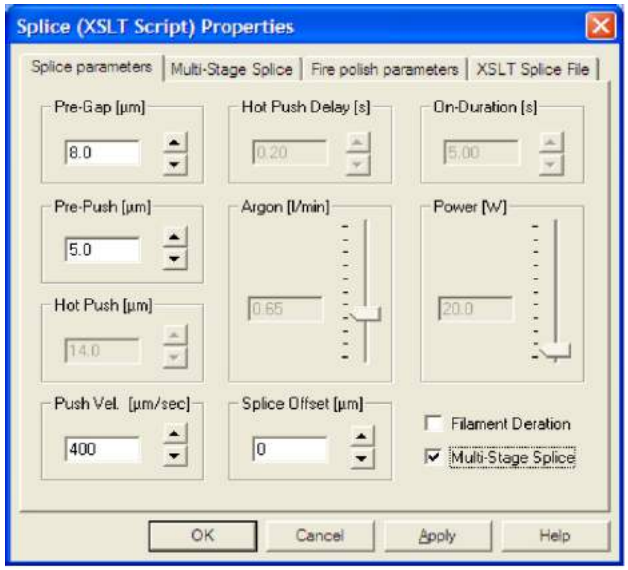


Figure 29 Activating Multi-Stage Splice

- Go to Splice → Splice Parameters.
- The normal default is for Multi Stage Splice to be disabled. Check the Multi Stage Splice check box as shown in Figure 29.
- Most of the splice parameters will become grayed out, the parameters that remain active are: Pre Gap, Pre Push, Push Velocity and Splice Offset.
- After setting the "Pre Splice" parameters then open the Multi Stage properties page by clicking on the Multi Stage Splice tab. The Multi-Stage Splice tab is pictured in Figure 30.

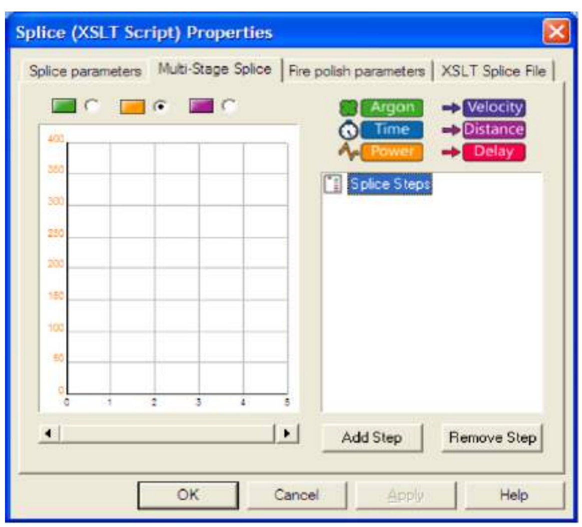


Figure 30 Multi-Stage Splice Tab

- At this time there are no splice stages set.
- Click on Add Step. A default set of splice parameters are added. A graphical representation of the splice parameters is shown on the left side.

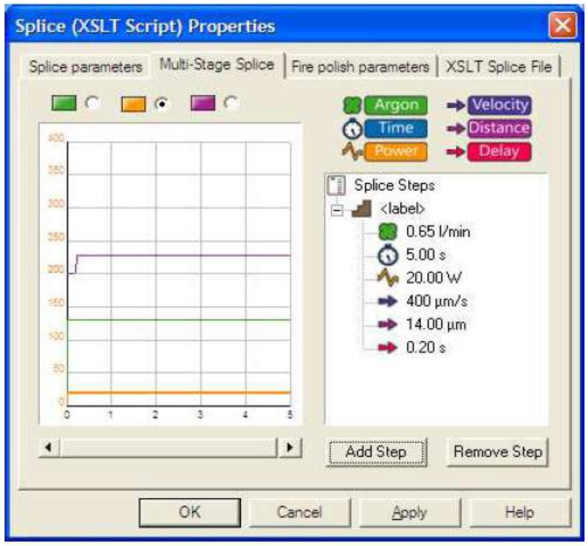


Figure 31 Adding Stages

- The parameters that may be set are:

Parameter Icon	Parameter Description
<label>	Splice stage name: <Label>
Argon	The argon flow rate for the splice process.
Time	The splice time in seconds.
Power	The splice power in watts.
Velocity	The velocity at which the fibers are pushed together during fusion.
Distance	This is the distance that the fibers are pushed together after Hot Push Delay
Delay	The length of time after beginning of the specific stage, before pushing fibers

- All parameters are edited in the same manner: click once, wait a second, click again to highlight for editing as shown in Figure 30 and Figure 31.
- Set the parameters to perform the process that is required. For example, a preheat step might be setup as shown in Figure 32.

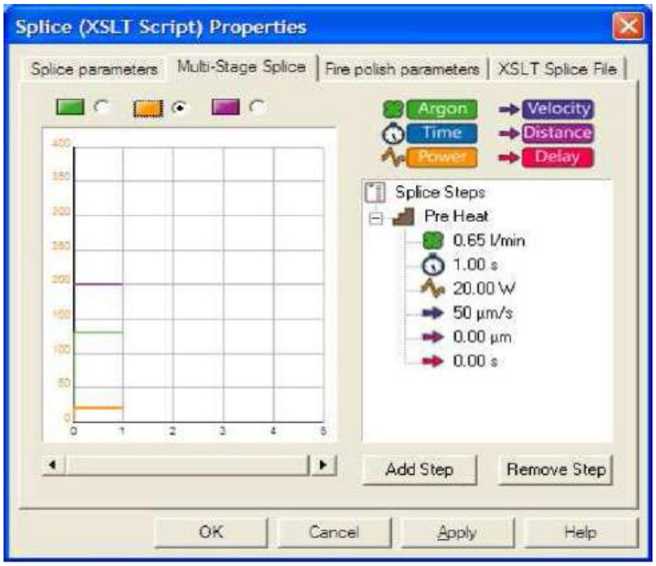


Figure 32 Sample Stage

- Any number of splice stages may be added. Click Add Step to add a second stage as shown in Figure 33. Add as many heating, cooling, and pushing stages as are required.

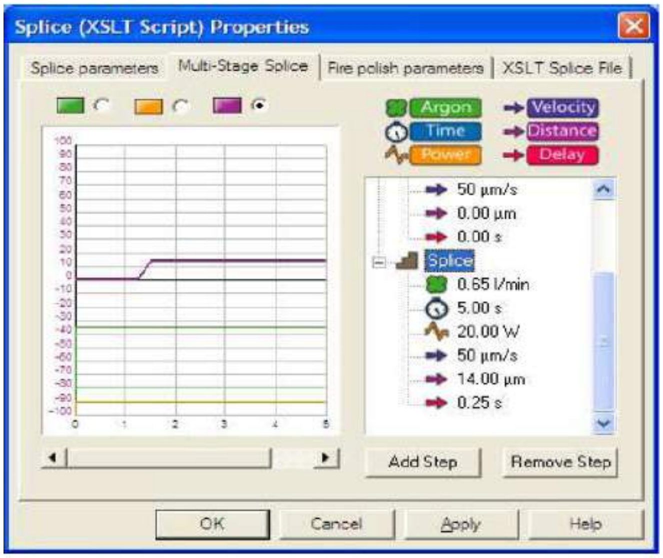


Figure 33 Sample Stage 2

- On completion of all of the splice stages the splice process will proceed with the Fire Polish Step.
- A Multi Stage Splice requires a special splice XSLT file to be selected. In Figure 34, the file FFS3 Combo Splice.xslt is selected.

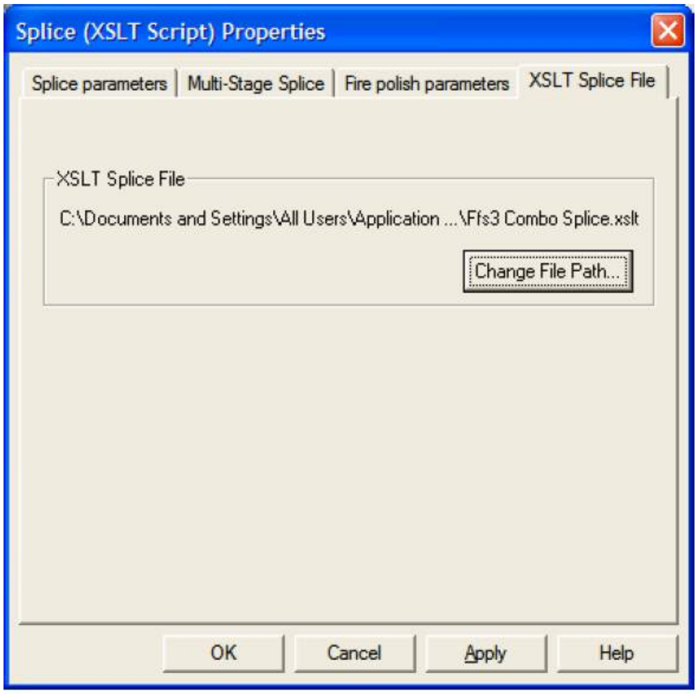


Figure 34 Setting the .xslt File path

- To select the correct XSLT file, open the XSLT splice file tab. This file path will be saved into the splice data file so that once selected, a splice file is always linked to the correct XSLT file unless the operator changes the splice file. Please also note that the Multi Stage splice flag is saved in the splice file. Once saved, a splice file is set as being a multi stage splice.
- If the splice file is to be reverted to the standard routine then follow the procedure below to disable Multi Stage Splice.

Disabling Multi Stage Splice

- Open the splice parameters menu and uncheck Multi Stage Splice. This reinstates the standard splice parameter window and disables the Multi-Stage Splice tab (although any parameters set in the multi stage splice window are still visible).
- Now open the XSLT splice page and select the standard splice xslt file (FFS3 Splice.xslt).
- Be sure to save any changes at File → Save.

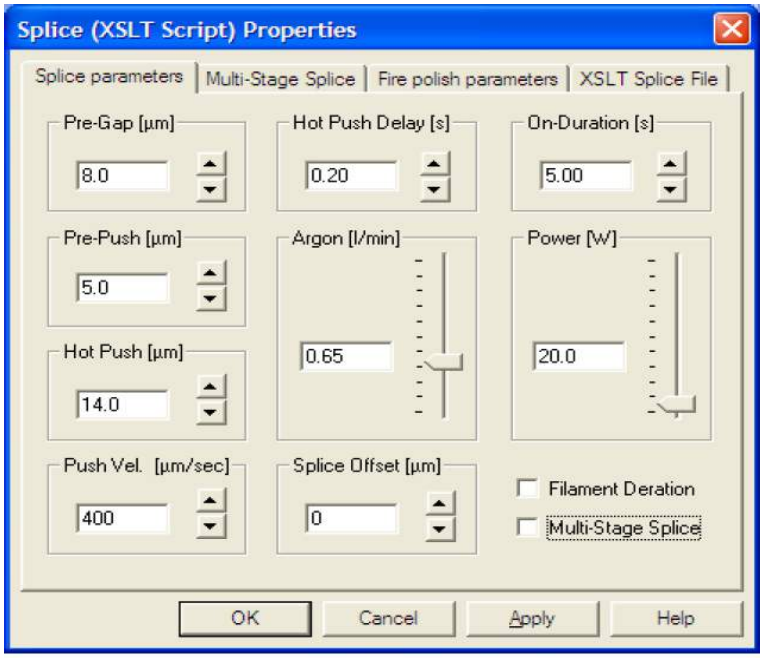


Figure 35 Disabling Multi-Stage Splice

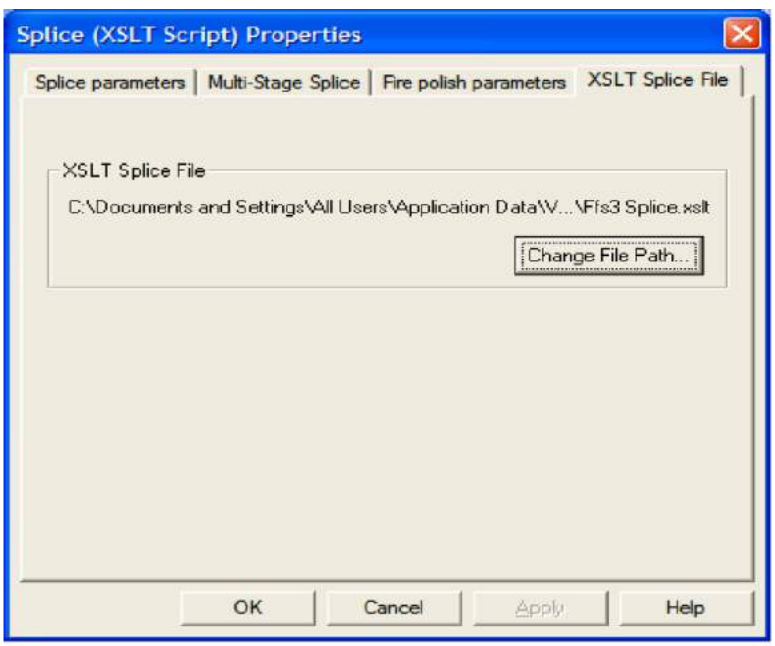


Figure 36 Setting .xslt to Default Path

Chapter 6 Fiber Preparation

Before preparing the fiber make sure that the splicer workstation meets the following criteria:

- Individual stations of the splicer are prepared, and all surfaces are clean.
- The inserts in the FHBs, the Graphite V-Grooves, and Cleave Inserts are of the appropriate size for the fiber to be spliced.
- Top and bottom TMS blades are of the appropriate size for the fiber to be spliced.
- Filament is of appropriate size for the fiber to be spliced and has been calibrated.
- Recoat mold size is of appropriate size for the fiber to be spliced.
- The appropriate Splice File is loaded in the GUI (full filename and path displayed across the top of the GUI window).

6.1. Loading the Fiber

Place both Fiber Holding Blocks into the Dunking Jigs on either side of the Cleaning Can with the Fiber Clamps open and the Cleave Lever in the forward position, pointing towards the user. This will activate the internal vacuum pump. Take the first fiber and have approximately 100 mm projecting from your right hand towards the left hand side of the machine. Load the Fiber into the right FHB by lowering it into the Fiber Clamp, still with 60-80mm of fiber overhanging the left end of the right FHB. The Vacuum will keep the Fiber in place, but if necessary a finger can be placed on top of the fiber as it is slid through. Draw the fiber to the right, observing the 'curl' of the fiber, and rotating it between thumb and forefinger so that the fiber coming out of the left side of the FHB is *facing downwards.* It is important that the curl does not rise up from the FHB, or that the fiber does not point towards the back of the machine or towards the user. Keep drawing the fiber back until the end of the fiber is level with the outside edge of the Clean Lamp indicator. Lower the Fiber Clamp in place and repeat the process for the left FHB.

Checking the Fiber Length at the Stripping and Cleaving Stations

In order to set the length accurately, it is important that the user checks that the fiber does not overlap the Stripper Blades on the far side of the Stripper, and also that the fiber does not fall short of the Cleave Insert (there should be minimum of 3-4mm of fiber sitting in the Cleave Insert). The process is illustrated in Figure 37.

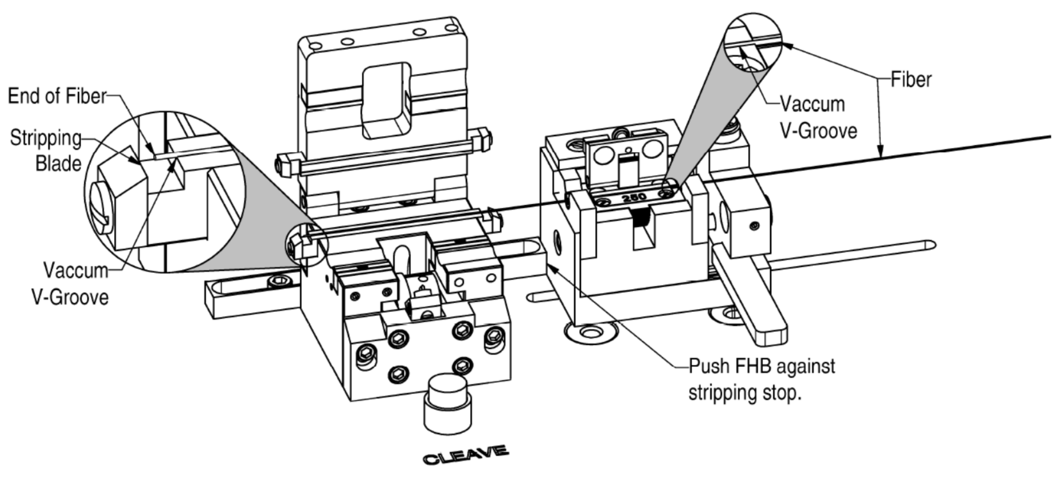


Figure 37 Checking the Fiber Length

Open the Cleave Lid of the Cleave Block. Place the right FHB with its locating posts in the right Stripping slot. Raise the 'inside end' (the face of the FHB towards the Cleave Block) of the FHB slightly and push the FHB towards the Stripping Stop. Drop the FHB to the surface of the machine; at this point the vacuum to the V-grooves of the FHB and the bottom TMS blade will turn on. Ensure that the Cleave Lever still points towards the user; if it doesn't, bring it forward now. Then smooth the fiber in place with a finger. At this point verify that the fiber is not too long, or too short as shown in the inset of Figure 37. *It is fine to remove the FHB at this point and place it at the Cleave position and check the fiber length there if necessary (if you suspect it is too short). With practice it becomes second nature to judge the correct fiber length quite accurately*.

During this process, the bottom TMS blade warms up to the preset stripping temperature, which is indicated by the blinking strip indicator/cleave button. If it is necessary to adjust the fiber length at this point open the FHB coating clamp and insert the fiber with the left end slightly protruding the stripper V-groove, but not extending past the stripping blade. Figure 37 shows the Fiber length being adjusted in this way and the maximum length the fiber should extend. The fiber will be pulled into the TMS and FHB V-groove with the activated vacuum. Gently close the FHB coating clamp to capture the fiber.

Note: Pushing the FHB towards the stripping stop will turn vacuum and TMS heating on. Pushing the FHB away from the stripping stop will turn the vacuum and TMS heating off.

6.2. Coating Removal

The coating removal procedure removes the acrylate coating on the fiber without scratching or abrading the underlying glass surface. During the removal process the coating is softened, captured by a matched set of stripping blades, and then pulled free. The fiber strength does not degrade during the stripping process since the coating is soft when it is stripped and the stripping blades never touch the glass surface. Clean the stripping station with the soft toothbrush (provided) or the optional vacuum cleaning system. Remove any stripped coating or other particles from the V-grooves and around the stripper blades.

The workstation provides a chemo-mechanical in addition to thermo-mechanical method of removing the acrylate coating. These methods differ in the process used to soften the acrylate coating. In the chemo-mechanical method, the fiber is soaked in a solvent to swell and soften the acrylate coating, whereas the thermo-mechanical method uses heat to soften the acrylate coating before it is stripped. The coating removal is completed by pulling the fiber through a matched set of stripper blades that separate the coating from the glass.

Note: Some fibers may require a combination of chemo- and thermo-mechanical softening prior to stripping as shown in Table 5.1.

The following procedures are described for the right-hand FHB. It is recommended that one begin with the right-hand FHB to prevent the left- and right-hand fibers from crossing over at the stations. Once the right-hand fiber has been prepared for splicing (after it has been cleaned and cleaved), follow the same procedures for the left-hand fiber using the left-hand FHB. With practice an operator should be able to handle left and right side operations simultaneously, greatly reducing the overall splice procedure time.

6.2.1. Setting Up

The appropriate parameters are stored as part of the Splice File. If necessary these may be adjusted from within the Fiber Preparation menu:

Fiber Preparation Parameters

- **Soak Time (Chemo-Mechanical Only):** Check the parameters of the 'Soak Time' and adjust as needed. The soak time will need to be set to prevent the chemical agent from 'wicking' too far up inside the Jacket of the Fiber, and the appropriate settings can only be determined through experimentation depending upon the type of chemical agent employed and the particular fiber. Contact Thorlabs for assistance if required.
- **Strip Set-Up:** Check the parameters of the 'Strip Set-Up' in the 'Fiber Preparation' menu of the software interface and adjust as needed.

NOTE
Parameter changes in the software interface are not saved to the configuration file (*.xml) until a file save is executed.

The thermo-mechanical stripping method uses heat to soften the acrylate coating. A heating element is incorporated in the bottom V-groove insert at the stripping station. The heating element is kept at a low background temperature at all times, which for some fibers (such as SMF-28) is sufficient to strip the coating almost immediately. Other fibers require a high temperature “boost”, which rapidly increases the coating temperature such that it can be stripped with minimal pull force. The boost time is typically less than 5 seconds. Some fibers may also require a presoaking in acetone to soften the coating prior to thermo-mechanical stripping. The recommended procedures for thermo-mechanically stripping various fiber types are shown in the table below.

Coating Type	Fiber Type	Heating Time	Background Current	Boost Current	Pre-Soak	Soak Time & Solvent
Typical Dual Coat Acrylate, 250 µm	Corning SMF-28	5 s	1500 mA	3500 mA	No	N/A
Typical Dual Coat Acrylate, 250 µm	Corning CS-980 Flexcore 1060	5 s	1500 mA	3500 mA	No	N/A
250 µm and 165 µm Acrylate	Fibercore Series HB, HB-G, and HB-T	10 s	1500 mA	3500 mA	No	N/A
250 µm Acrylate	AT&T Erbium	0 - 5 s	1500 mA	3900 mA	Yes	60 s in acetone
250 µm Acrylate	Most Other AT&T Fiber	5 s	1500 mA	3900 mA	No	N/A

Soaking Station Preparation (Chemo-Mechanical Only)

Make sure the solvent is “topped up.” It should be approximately 1/8" to 1/4" below the lip of the solvent container.

Stripping Station Preparation

Clean the stripping station with the soft toothbrush (provided) or the optional vacuum cleaning system, keeping your free hand as a ‘shield’ around the rear of the open Cleave Lid, to prevent debris being thrown up onto other parts of the machine. Remove any stripped coating or other particles from the Cleave Inserts and around the Stripper Blades. It is important that these surfaces are kept clean, or subsequent Strip or Cleave operations may be less effective until these surfaces are cleaned.

WARNING

Do NOT clean the V-groove insert with solvent when the vacuum is turned on. The solvent will be drawn into the vacuum system and will cause internal damage. If the V-Groove appears to be damaged, replace the inserts.

6.2.2. Soaking Procedure (Chemo-Mechanical Only)

Place the right FHB with the preloaded fiber on the right side dunking jig at the soaking station. Inserting the FHB pins into the dunking jig will activate the internal vacuum to the FHB V-groove. With the fiber secured in the FHB, tilt the end of the dunking jig to immerse the fiber into the soaking station. Make sure that the FHB Cleave Lever is in the forward (down) position to immerse the fiber deeper into the solvent, as shown in Figure 38.

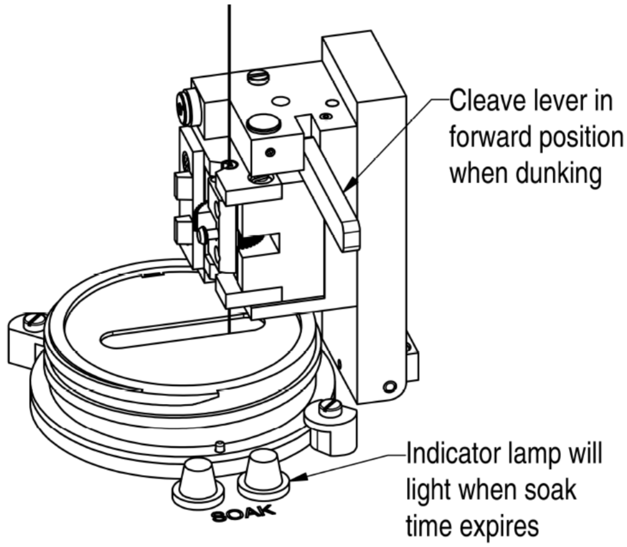
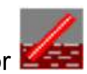


Figure 38 Soaking Procedure

Once the dunking jig has been raised the vacuum will shut off and the Soak Right Indicator  of the GUI will highlight red. The indicators will remain in this state for the preset soak time.

After the soak time has elapsed, the right soak indicator lamp on the splicer workstation will light red, and the Soak Right Indicator of the GUI  will highlight green.

When the dunking jig is lowered, the Soak Right Indicator of the GUI  will cease to be highlighted and the red indicator lamp of the splicer workstation will turn off.

Note: The quickest, most convenient way to remove the FHB from the dunking jig, when in the dunked position, is to grab the FHB and allow the dunking jig to "fall" back into place. If the FHB and dunking jig are first lowered back together, the vacuum will activate and make removal of the FHB more difficult.

6.2.3. Stripping Procedure

The Thermo-Mechanical Stripper (TMS) is incorporated into the Cleave Block assembly. The TMS consists of a heated guide piece and a cover piece. Both parts have blades at either end that pinch the fiber coating. Sufficient force is applied to the coating such that it may be removed cleanly from the fiber. The blades are manufactured to close tolerances; if they are in any way damaged then it is likely that the cladding surface will be damaged as the coating is removed. Damage to the stripper blades normally occurs when the fiber is not correctly positioned in the V-groove guide or if a larger fiber cladding size is used than specified for the stripper blades in use.

The TMS is designed for use only on Acrylate coated fibers and options are available for purchase separately as listed in the table below.

Item #	Accepted Cladding Diameter[1]		Maximum Buffer Diameter
	End 1	End 2	
CST080180	80 µm	80 µm	180 µm
CSTM080125	80 µm	125 µm	250 µm
CST125250	125 µm	125 µm	250 µm
CST125400	125 µm	125 µm	400 µm

For some coatings, the stripping force is unacceptably high even if the operating temperature of the TMS insert is increased or reduced. For these coatings, either revert to traditional chemical stripping techniques, or alternatively, employ the Soak method described above with an appropriate solvent prior to thermal stripping. This will often soften the coating enough to strip effectively with TMS.

With the fiber loaded in the FHBs open the Cleave Lid of the Cleave Block and position the fiber in the groove to the right of the stripper/cleaver block against the stripping stop. The internal vacuum will activate and draw the fiber into the stripper V-groove. Make sure:

- The cleave lever is in the forward position, pointing towards the user.
- The fiber is properly seated in the V-groove of the bottom TMS.
- The fiber does not protrude past the stripper blade.

Gently lower the Cleave Lid top to capture the coating. There are magnets built into the Cleave Block, and the Lid ‘gets heavier’ as it closer to the Closed position. Some users find it easier to place their thumb at the front of the Cleave Block, to hold the lid very slightly open, so they can better control the closing force of the Lid. Repeatedly closing the Cleave Lid heavily can cause damage to the Cleave Inserts.

It takes approximately five (5) seconds for the TMS blades to reach the appropriate temperature. During the heat up period, the strip indicator/cleave button light will flash. The thermo-mechanical stripper is ready to be used when the indicator stops flashing. The heating element will be maintained at the stripping temperature for a period of time as defined in the TMS setup (usually 10 - 30 seconds). At this point, the indicator light will extinguish, and the heating element will return to the background temperature. To reactivate the heating element, remove the FHB from the stripping station (make sure the stripper/cleaver top is open first) and then reinsert. This will reinitiate the thermo-mechanical stripping process.

When the heating element reaches the pre-set temperature (strip indicator/cleave button on, not flashing), the fiber can be stripped. Slide the FHB away from the stripper/cleaver block. Use a smooth, even sliding action to strip the coating to the proper length.

[1] *For different cladding diameters than those listed here, please contact Thorlabs Technical Support. TMS blade inserts are available for cladding diameters up to Ø200 µm upon request.*

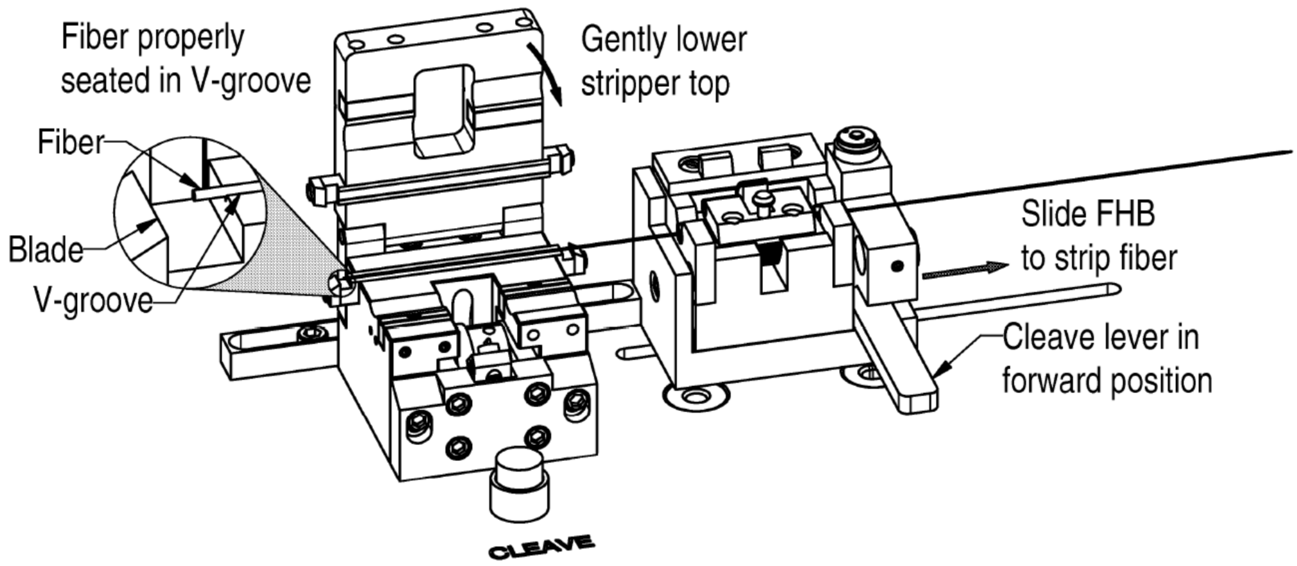


Figure 39 Stripping Procedure

The coating should strip off with a light sliding force. In some cases there may be some debris still attached to the Fiber, but so long as these come free during the clean operation this is not cause for concern. It is only important that the fiber is completely clean when loaded to the Splice Position. If the remaining cladding adheres tightly to the fiber, and this occurs repeatedly, then there may be a problem either with the blades themselves, or their setup.

Some fibers have an inner as well as outer buffer coating. Some manufacturers make these two coatings of different materials. For example, certain fibers have an inner coating comprised of a soft silicone material. These fibers tend to strip evenly, although the resulting stripped coating pieces will not be in a tube form. If such a silicone buffered fiber is stripped, the residue should be dissolved using an appropriate silicone solvent and properly rinsed before cleaving the fiber. Thorlabs can suggest manufacturers of suitable silicone solvents that may be appropriate.

Raise the top of the Cleave Block and remove the stripped coating and all particles from the V-groove and around the Stripper Blades. Use the optional vacuum cleaning system or a soft toothbrush (provided), and place a free hand around the rear of the Cleave Block when cleaning.

WARNING

Do NOT clean the V-groove insert with solvent when the vacuum is turned on. The solvent will be drawn into the vacuum system and will cause internal damage. If the V-Groove appears to be damaged, replace the inserts.

6.2.4. Diagnostics

Problem	Possible Cause	Solution
Vacuum won't hold fiber in FHB V-grooves.	FHB V-Grooves are dirty.	Clean the FHB V-grooves with the soft brush (provided).
	Obstruction present under dunking jig.	Make sure that the area underneath the dunking jig is free of dirt particles. If necessary clean the surface with a mild soap.
	Bad or missing O-ring on the underside of the dunking jig.	Contact Thorlabs for a replacement part.

Problem	Possible Cause	Solution
	Excessive fiber curl due to residual deformation of the buffer material.	Physically straighten the fiber/buffer and apply heat to relax the residual buffer deformation.
Coating is difficult to strip.	Soaking solution not full.	The soaking container must be filled to within 1/4" to 1/8" below the lip.
	Too long between soaking and stripping procedures	The stripping procedure should be performed within 10 s after the soaking procedure is completed. Additional time allows the jacket to shrink back down around the fiber.
	Soaking time too short.	Leave the fiber in the coating removal soak longer to allow the jacket more time to soften.
	The stripper V-grooves and blades are dirty.	Clean the stripper V-grooves and blades with the soft brush or a cotton swab dipped in isopropanol.
	Soaking time loo long.	Reduce the time the fiber soaks in the solvent.
Coating peels back prior to stripping.	Solvent not appropriate for the fiber jacket.	Try an alternate solvent.
Coating peels back prior to stripping.	Some fibers tend to peel back after soaking.	We recommend an alternate stripping method for fibers that peel back after soaking: • Clip off the end of the fiber using small diagonal cutting pliers. • Soak the fiber for the desired soak time. The coating will peel back from the end to the soak point. • Using tweezers, carefully grasp the coating and snap it off at the soak point without damaging the fiber.
	Fiber needs to be soaked in acetone prior to stripping.	Some fibers strip better if they are presoaked in acetone prior to thermo-mechanical stripping.
Coating is difficult to strip or some coating remains on the fiber.	Cleaning solution not full.	The clean container must be filled to within 1/4" to 1/8" below the lip.
	Fiber not properly seated in the stripper V-groove.	Dirt particles may keep the fiber from properly seating in the V-groove. Clean the V-groove and make sure the fiber is fully seated before stripping.
	Fiber getting too much or too little heat.	Vary TMS parameters. If increasing Boost Current, reduce Boost Time to a minimum to reduce the risk of premature wear to the TMS heater element. Normally background current should be left as standard to prevent the Cleave Block from cooling too much and acting like a heat sink.
	Soak Required	Some fiber coatings strip properly only if they are presoaked in acetone prior to thermomechanical stripping.
	Soaking solvent needs to be changed.	The soaking solvent is good for approximately 200 strips. Properly dispose of the old solution. Clean the soaking container and refill with fresh solvent.
	Soaking time too short.	Allow the coating to soak for a longer period to further soften the jacket. Soak time may be varied through the GUI.

Problem	Possible Cause	Solution
	Heating time too long.	If the fiber is pre-soaked, a long heating time may dry out the soft buffer making it difficult to remove. To avoid this the fiber should be stripped as soon as possible after the heating element reaches the proper temperature (indicator on steadily) or the Boost Current should be reduced.

6.3. Cleaning the Fiber

The fiber is cleaned at the ultrasonic cleaning station. This removes any coating particles or residue left on the glass surface that may reduce splice strength.

6.3.1. Setting Up

The appropriate parameters are stored in the Splice File and may be accessed in the fiber Preparation Menu in the GUI.

Fiber Preparation Parameters

Check the parameters of the "Clean Time" and adjust as needed. Typical values range from 20 to 180 seconds, depending upon solvent and inner coating composition. 30 seconds is a good starting clean time.

Note that parameter changes in the GUI are not saved into the Splice File (*.xml) until a file save is executed.

Cleaning Station Preparation

Make sure the cleaning solvent is "topped up." It should be approximately 1/8" to 1/4" below the lip of the solvent container.

6.3.2. Cleaning Procedure

Place the right FHB with the preloaded fiber on the right side dunking jig at the cleaning station. Inserting the FHB locating posts into the dunking jig will activate the internal vacuum to the FHB V-groove. With the fiber secured in the FHB, tilt the end of the dunking jig to immerse the fiber into the cleaning station.

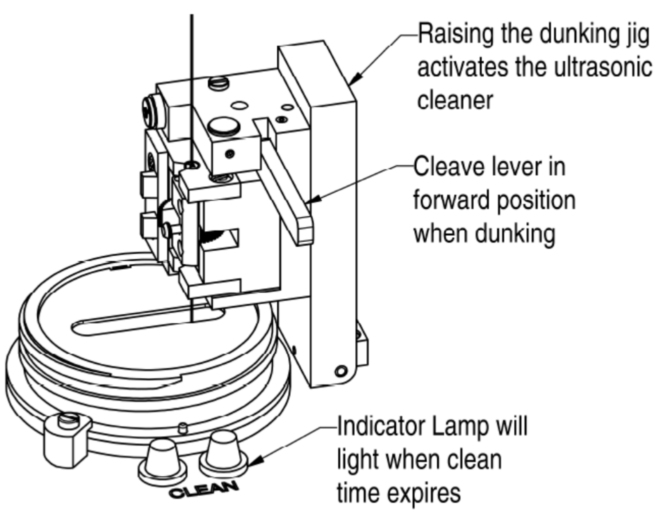


Figure 40 Cleaning Procedure

Once the dunking jig has been raised, the vacuum will shut off, the ultrasonic cleaner will automatically turn on and the Clean Right Indicator  of the GUI will highlight red. The indicators will remain in this state for the preset clean time.

After the clean time has elapsed the ultrasonic cleaner will shut off, the right clean indicator lamp (see Figure 40) on the splicer workstation will light red, and the Clean Right Indicator  of the GUI will highlight green.

When the dunking jig is lowered, the Clean Right Indicator  of the GUI will cease to be highlighted and the red indicator lamp of the splicer workstation will turn off.

Note: The quickest, most convenient way to remove the FHB from the dunking jig, when in the dunked position, is to grab the FHB and allow the dunking jig to “fall” back into place. If the FHB and dunking jig are first lowered back together, the vacuum will activate and make removal of the FHB more difficult.

6.3.3. Diagnostics

Problem	Possible Cause	Solution
Vacuum won’t hold fiber in FHB V-grooves	FHB V-grooves are dirty.	Clean the FHB V-grooves with the soft brush.
	Obstruction present under dunking jig	Make sure the area underneath the dunking jig is free of dirt particles. If necessary clean the surface with a mild soap.
	Bad or missing O-ring on undersurface of dunking jig	Contact Thorlabs for a replacement part.

6.4. Cleaving the Fiber

A Tension and Scribe method of cleaving is used to provide consistent, low end-angle cleaves.

6.4.1. Setting up

The appropriate parameters should be pre-loaded and may be accessed in the Fiber Preparation Menu in the GUI.

Fiber Preparation Parameters

Check the parameters of the ‘Cleave Angle Limits’ and adjust as needed.

The Cleave Parameters determine the distance that the Cleave Blade moves towards the Fiber, before the Cleave operation commences. This should already be setup for your workstation. Refer to the maintenance section or contact Thorlabs if you require further advice on this.

Note: Parameter changes in the software interface are not saved into the configuration file (*.xml) until a file save is executed.

6.4.2. Cleaving Procedure

Once the coating has been stripped, position the FHB at the right cleave station, just forward of the stripper slot. When the FHB is properly seated, the vacuum will automatically activate. Make sure:

- The cleave lever is in the forward position prior to seating.
- The fiber lies properly in the cleave insert V-groove.

Move the cleave lever to the back position to apply tension to the fiber. The center, moving part of the FHB will move away from the Cleave Block 1 to 2 mm, but should then stop. DO NOT continue with the Cleave operation if the moving part of the FHB continues to move. If this occurs, clean the mating surfaces of the Cleave Block and the FHB, and prepare new fibers. If this happens repeatedly refer to the maintenance section for further advice or contact Thorlabs.

Press the Cleave Button to initiate the Cleave process, which will bring the Cleave Blade up towards the Fiber, before starting a series of forward and backward arcs in a 'pecking' motion, slowly approaching the fiber to be cleaved. As soon as the fiber is cleaved, the center block of the FHB will snap back to the right. Raise the Cleave top (it is not necessary to wait for the Blade to return to Home), remove the FHB, and finally remove the cleaved off piece of fiber from the V-groove to be disposed of safely.

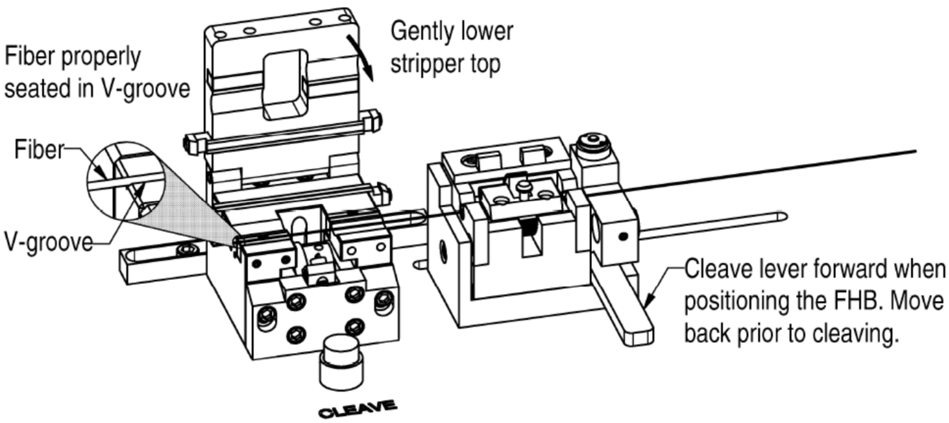


Figure 41 Cleaving Procedure

Note: When the cleave lever is released, the center sliding portion of the FHB should remain in the forward position and not slip backwards. Tension is reduced if the center sliding portion slips backwards prior to the fiber being cleaved which might degrade the quality of the Cleave, and in some circumstances damage to the Cleave Blade may occur.

6.4.3. Diagnostics

Problem	Possible Cause	Solution
Fiber does not cleave.	Contamination under the FHB, under the fiber in the FHB insert, or in cleave insert resulting in a raised fiber line.	Scrub the bottom of the FHB, Cleave insert, or FHB insert with the toothbrush supplied and retry. This is the most common cause of cleave failure.
	Cleave blade positioned too far back from the fiber.	It is possible that repositioning the cleave blade may result in a situation where one or both fibers may not cleave. Please contact Thorlabs for assistance.
Blade rubs along the fiber without cleaving.	FHB is slipping due to dirty FHB V-grooves or top caps.	Clean the FHB V-grooves and top cap with isopropanol or acetone and a cotton swab. **WARNING** **Do not clean the V-groove insert with solvent when the vacuum is turned on. The solvent will be drawn into the vacuum system and will cause internal damage.**

Problem	Possible Cause	Solution
	Cleave blade is dirty.	Clean the cleave blade with a cotton swab dipped in isopropanol.
	Cleave tension is insufficient (check for FHB slippage; see above).	Increase the cleave tension.
	Cleave blade height adjustment may be required	Please contact Thorlabs for instructions.
The FHB cocks forward when the cleave lever is released.	The bottom of the FHB or the plate where the FHB sits is dirty.	Scrub with toothbrush provided.
	Cleave tension is too high.	Reduce cleave tension.
Fiber slips through or breaks in the V-groove.	Stripper/cleaver top or V-grooves are dirty, or FHB V-grooves are dirty.	Clean the top and V-grooves using the soft brush or a cotton swab dipped in isopropanol. **Note:** If the fiber breaks in the stripper/cleaver block and enough fiber remains in the V-groove, remove the broken piece and re-cleave.
Blade doesn't touch one or both fibers.	Fiber not in V-groove.	Ensure fiber is correctly located in the V-groove.
	Cleave blade height adjustment may be required.	Please contact Thorlabs for instructions.
Bad cleave.	FHB not sliding Freely.	The FHBs must move smoothly and freely for the correct tension to be applied to the fiber. If the FHBs have become contaminated it may be necessary to strip down and rebuild them. Please contact Thorlabs for assistance.
	Cleave tension needs adjustment.	Adjust the cleave tension.
	Cleave blade may be damaged.	Inspect blade for chips/cracks. See the Maintenance Section for instructions to rotate the blade 180° to expose a new blade edge.

Chapter 7 Splicing the Fiber

7.1. Introduction

7.1.1. Filament Fusion

The FFS2000 Series uses a tungsten or iridium filament (sold separately) to provide the heat necessary to fuse the fibers together. The filament is a thin tungsten or iridium ribbon shaped to form a loop that is open at the top (see Figure 42). The FHBs are placed in the Transfer Jig at the splicing station with the fibers roughly positioned in the center of the camera viewing area. Depending on the alignment method selected, the FFS3 software will use inputs from the CCD camera and/or the external optical power meter 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.

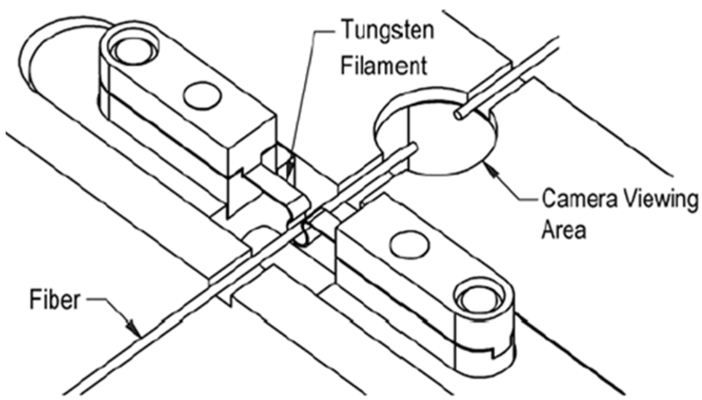


Figure 42 Splice Filament

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 fuse the fibers together, typically about 2600°C. Because the tungsten filament would oxidize (burn up) if brought up to such a high temperature in air, an inert gas (argon) is used to purge the splice chamber of oxygen. In order to keep the fibers clean and improve splice strength, the purging gas is set to flow over the fibers at a high rate during the fusion process. The fiber ends are allowed to heat up before they are pushed together. This smoothes over any discontinuities in the fiber ends and increases the plasticity of the glass. The hot fibers are pushed together, producing a smooth splice while maintaining the precision alignment.

7.1.2. Fire Polish

When a fusion splice is made, silica will evaporate off of the hot center joint region of the splice and condense on either side of the joint where the fiber is cooler. These condensed silica deposits, composed primarily of β-SiO_2 or crystobalite, act as stress raisers (flaws) and if the splice is put under tension, the fiber will break at one of these points. The purpose of the fire polishing process is to remove or minimize these deposits, and thereby improve splice strength.

Fire polishing is performed immediately after the splice is complete, before the filament is turned off. The splice head is quickly traversed back and forth along the length of the fiber, such that the hot filament passes over the regions where the deposits have formed. This quick surface hot treatment reflows the existing deposits without generating new concentrations.

7.2. Setting Up

During purchasing Thorlabs personnel will have advised on your application and configured Splice Files to suit. Be sure to have the appropriate Splice File loaded for the fiber combination to be processed.

7.2.1. Splice Settings

- Splice Parameters: Check the parameters of the 'Splice Parameters' in the 'Splice' menu of the GUI under Splice Parameters. Refer to the table below for **typical** values.

Parameter	Fiber Diameter	
	80 µm	125 µm
Pre-Gap	8 µm	8 µm
Pre-Push	5 µm	5 µm
Hot Push	10 – 14 µm	10 – 14 µm
Push Vel	88 µm/s	88 µm/s
Hot Push Delay	0.35 s	0.35 s
Argon	0.5 L/min	0.65 L/min
Splice Offset	0 µm	0 µm
On-Duration	1 – 5 s	1 – 5 s
Power	15.0 – 17.5 W	18.0 – 23.0 W

- Fire Polish Parameters can be found in the 'Splice' menu of the GUI, under Splice Parameters > Fire Polish. If the power is set to ZERO then the Fire Polish is OFF. Refer to the table below for **typical** values.

Parameter	Fiber Diameter	
	80µm	125µm
Delta[2]	300 µm	300 µm
Passes[2]	1 - 3	1 - 3
Velocity	2000 µm/s	2000 µm/s
Cool Threshold	60 s	60 s
Cool Duration	90 s	90 s
Argon	0.5 L/min	0.65 – 2.0 L/min
Power (same as splice power)	15.0 – 17.5 W	20.0 – 23.0 W

- Tack Parameters: The Tack option should be selected only for splicing specialty fiber. To access the tack parameters, select the 'Tack Parameters' in the 'Splice' menu of the software interface. The settings in the tack dialog are the same as those in the splice dialog. If the tack power is set above zero then a tack will be performed before the splice process.

Note
In most instances the tack power is set approximately 1 watt lower than the splice power.

- PM Alignment Settings: Check the parameters of the 'PM Alignment' in the 'Splice' menu of the software interface. Load the correct splice file corresponding to the fiber to be spliced.

7.3. Splicing and Fire Polishing Procedure

7.3.1. Preparing the Splice Station

Place the Transfer Jig over the Splice Station into the grooves of the bushings as shown in Figure 43. Do not place the pins into the holes of the bushings. The Transfer Jig is thereby slightly elevated over the top plate of the splicing workstation.

[2] *Delta x Passes ≤ 1000*

When both, the right- and left-hand fibers have been prepared for splicing (see Chapter 6), open the Splice Cap and locate the FHBs in their respective positions on the Transfer Jig. The Cleave Lever should be in the released, or back, position.

Note

If splicing fibers with excessive curl or to obtain a high-strength splice, execute the "Load Fiber" command from the software interface prior to loading the fibers at the splice station as described in Section 7.3.2

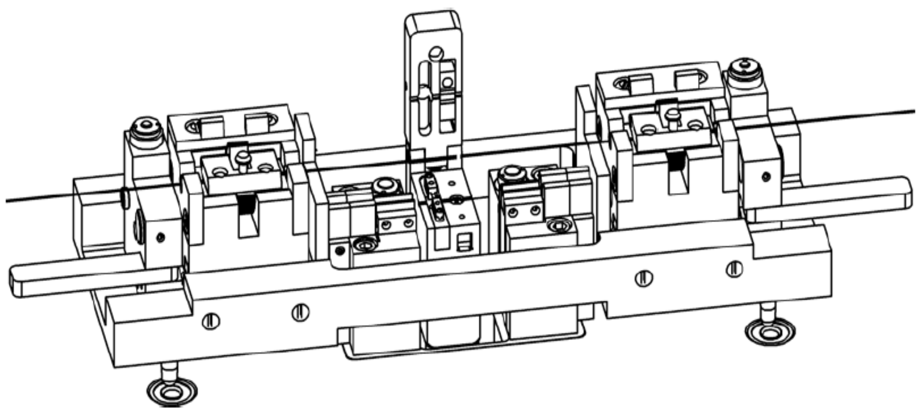


Figure 43 Load FHBs into Transfer Jig

7.3.2. Loading the Fibers

Before loading the fibers the Splice Head has to be moved into the Load Fibers (Splice) position.

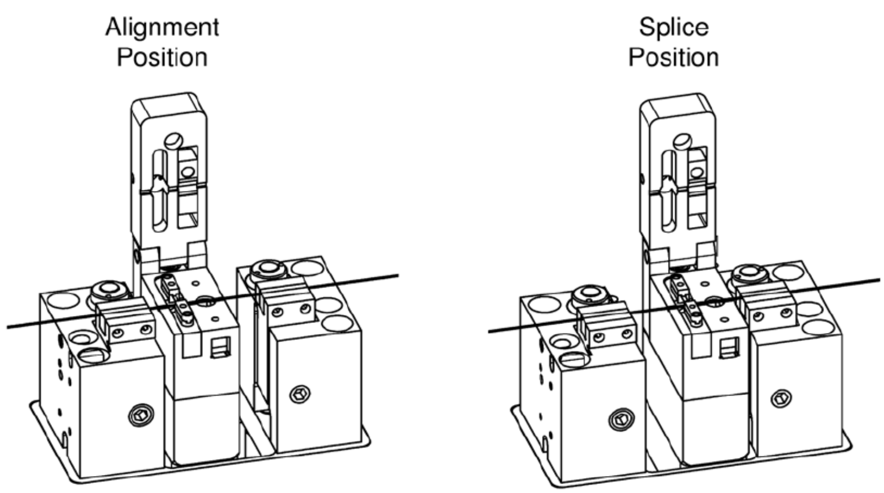


Figure 44 Splice Head Positions

The Load Fibers Process is always invoked at the start of a One-Button Automatic Splice Process. Move the Splice Head to the Load Fibers position by pressing the Splice Button on the splicer or using Execute the Entire Splice command from the software interface. The "load fiber dialog" will appear on the screen.

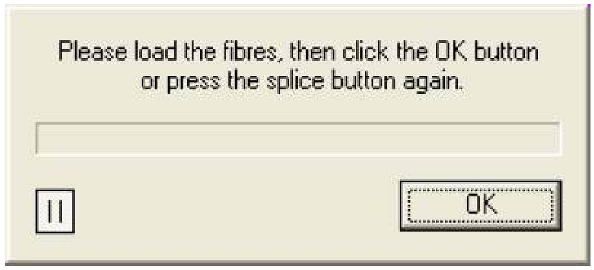


Figure 45 Load Fiber Dialog

Note:

Do NOT use the Splice  **command, as it will execute a splice immediately without allowing the operator to load the fiber.**

Load the fibers by carefully placing the transfer jig with its pins into the bushings. Make sure to guide the transfer jig during the placement so that the fibers don't touch any components of the splicing station besides the Graphite V-groove inserts. The Transfer Jig can be dropped the last few mm. Once the Transfer Jig is positioned, the vacuum activates, which draws the fibers into the Graphite V-groove inserts of the fiber positioners.

Check to ensure that:

- The Fibers are lying in the bottom of the Graphite V-Grooves and no debris is visible.
- The Fibers are lying in the center of the Channel (fiber groove) running across the Splice Head surface.
- The Fibers are sitting within the Omega-shaped Filament.

DO NOT touch the bare glass of the fiber. Finish the loading procedure by gently lowering the splice top.

- Make sure the mirror toggle is positioned with the 135° side view mirror down as shown in Figure 46 prior to closing the splice top. Scratching of the 90° mirror can result if it is lowered onto the bar fiber in the camera viewing area.

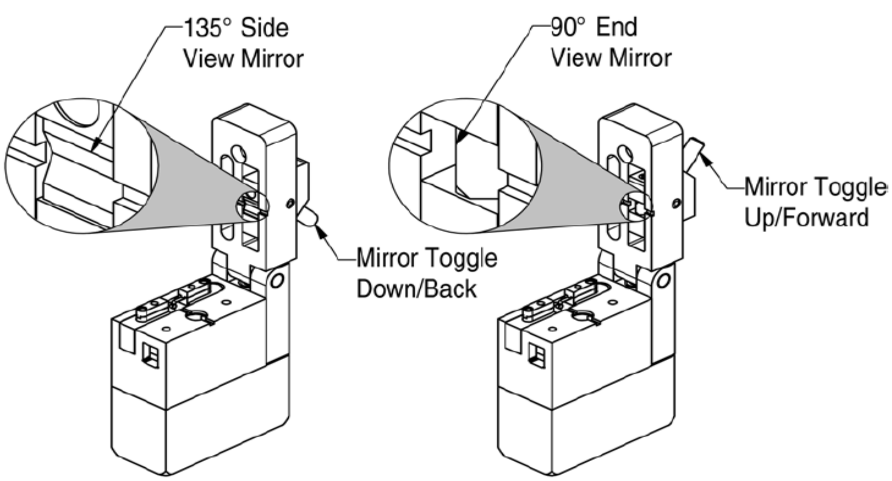


Figure 46 Mirror Toggle of Splice Top

After closing the Splice Cap, a live view of the fibers is displayed in the software interface. The fibers should be roughly centered on the screen in the front and back view with a slight gap between the fiber ends, and they should be roughly focused. If the fibers are overlapped, skewed, or completely missing from the screen, refer to the diagnostics section at the end of this chapter for the appropriate action.

To continue the One Button Splice Process, click OK in the “load fiber dialog” or press the Splice Button on the workstation again. The activated splice routine consists of multiple sub-processes that are defined within the Splice Process Editor. These sub-processes can be grouped into fiber alignment, fiber splice, fire polish, and loss estimation, which are further defined in the following sections.

7.4. Splice Routine

7.4.1. Fiber Alignment Methods

After the user starts the splice routine, the fibers will be aligned according to the subroutines assembled in the active splice routine. The alignment routines are:

- Edge Alignment
- Active XY Alignment
- End View Alignment (for PM fibers)
- Active Rotation Alignment (for PM fibers)

Edge Alignment:

The Edge Alignment method uses image data from the CCD camera to align the fibers in the XY direction with the Z-direction being the fiber line. This method is capable of aligning fibers of two different cladding diameters.

Active XY Alignment:

The Active XY Alignment method is used for fibers that have a core eccentricity. In such a case, the Edge Alignment method cannot ensure a low-loss splice. Active XY Alignment uses input from an optical power meter to maximize power transmitted between the fiber ends to determine the optimal XY alignment. **Note:** Connect the optical power meter to the Analog 1 BNC input on the back panel of the FFS2000 Series.

End View Alignment:

The End View Alignment method is used for elliptical-clad fiber (PM or PZ), Panda fiber, or Bow Tie style fiber, or a hybrid splice between any of these. These polarization-maintaining fibers are aligned rotationally as well as in the XY-direction. Before loading the fibers into the FHBs, the fiber cladding can be coated with the pink dye material. This enhances the contrast of the fiber structure. The PM alignment parameters (P1 and P2) must be set correctly for each fiber type as described in the PM Alignment section.

Active Rotation Alignment:

The Active Rotation Alignment method is used for 3M elliptical-clad fiber (PM or PZ), Panda fiber, or Bow Tie style fiber, or a hybrid splice between any of these. These polarization-maintaining fibers are aligned rotationally and in the XY-direction, just as in the End View Alignment method above.

In addition to the End View Alignment method, 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 analyzer is connected to the other fiber and the output of the analyzer is connected to Analog Port 1 or 2. The analyzer contains a polarizer which is set to absorb any light in a perpendicular orientation relative to the main axis of the fiber’s PM core. 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 the power reading of the analyzer is minimized.

7.4.2. Splice Method

Standard Splice

After the proper alignment is achieved, the fusion process begins. Before the filament turns on, the right-hand fiber is moved towards the left-hand fiber a distance defined by the Pre-Push distance. The Argon flow will increase to splice levels for about 3 seconds to clean the system of any impurities and purge the Splice Head of remaining oxygen. The Splice Head will then move the View To Splice Distance so that the filament is centered on the fibers (assuming no Splice Offset is set). The filament is turned on and allowed to heat up for the user-specified amount of time (Hot Push Delay) before the right-side fiber is pushed the distance defined as Hot Push, bringing the fibers together. This allows any discontinuities in the edges of the fibers to "round-over", and also increases the plasticity of the glass. The hot-push method of splicing results in a smoother splice and ensures precise alignment.

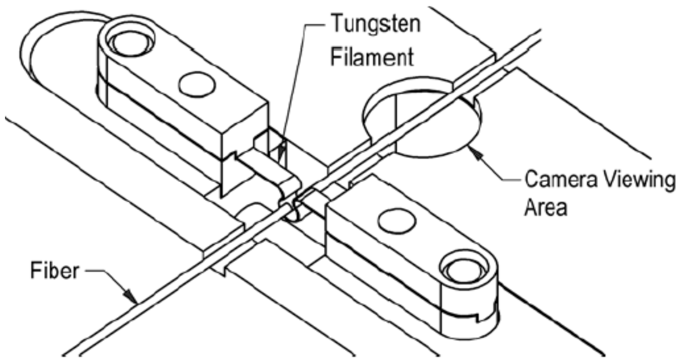


Figure 47 Filament in Splice Position

Fire Polish

If Fire Polish is not activated (Fire Polish Power is set to zero), the Filament will turn off after the preset splice time (On Duration) has elapsed. If Fire Polish was selected, the Filament remains on and the Splice Head will traverse back and forth cleaning the Splice Region.

Splice Complete

After the Splicing and Fire Polishing processes are complete, the Filament shuts off, the Argon returns to background levels, and the Splice Head returns to the view position (with the splice centered in the CCD camera viewing area).

The spliced fibers are displayed in the Side View image (Back or Front View). When an Automatic One Button Splice is completed, a small amount of tension is put on the fiber, which helps when removing the Transfer Jig to avoid touching the Filament with the completed Splice. The amount of tension placed on the fiber can be specified by selecting *Splice→Set-Up→Post Splice Tension…* from the menu bar.

7.5. Guidelines for Achieving a High Strength Splice

The following guidelines are helpful in achieving a high-strength splice:

- Splice strength will be seriously decreased by any abrasion to the glass surface. Care should be taken not to touch the stripped portion of the fiber with fingers or try to wipe the bare fiber with a cloth or brush.
- If small pieces of coating remain on the glass surface after stripping, do not try to restrip the coating. If the coating pieces cannot be removed by ultrasonic cleaning or by a quick “dunk” in a soaking solvent, break off the section of bare fiber and then prepare the fiber again
- When positioning the fiber at the splice station, it is important not to knock or rub the fiber against any surfaces except the vacuum graphite V-grooves.
- Always perform a Load Fibers operation when loading the fibers into the splice station and, if it is necessary, to remove unspliced fibers from the Splice Position.
- Do not lift the FHB lid (which acts as the coating clamp) before removal of the Transfer Jig from the splicing station. After the fiber is spliced, a slight tension is placed on the fiber to minimize the chance of abrading the fiber during removal. If the FHB coating clamps are opened, the tension will be released.

- Lift the left side of the Transfer Jig first, then the right side. This allows the square end on the right side to keep the Transfer Jig straight (so it does not rock towards the user or towards the back of the machine), once the fiber is clear, then lift the RHS of the Transfer jig.
- Proper Splice Optimization will avoid overheating the fiber during splicing. Overheating can be brought about by use of an excessive splice power and/or splice time. This causes an increase in silica deposits on the fiber, which can't be completely removed during the fire polish step. The result will be decreased splice strengths. Thorlabs personnel can advise on the correct methods of performing splices to avoid this issue.
- Use only Thorlabs supplied or recommended gas lines and regulators, and use the specified grade of Argon purity. Other gas lines or regulators may contain contaminants, which could reduce splice strength.
- The gas line should always be purged when the gas supply is turned on and/or whenever the gas line is connected. Note: A low flow purge is always maintained even when the purge light is out or when the system is shut off.
- Exchange the Cleaning Solvent regularly, and wipe the Cleaning Can with clean tissue. In particular IPA is hygroscopic and *should be renewed every shift in production environments*. Also take care to replace the Vapor Shield over the Cleaning Can when not in use.

7.6. Diagnostics

Problem	Possible Cause	Solution
Fibers poorly positioned on screen	Vacuum not present at v-grooves.	Ensure vacuum is turned on and connected properly.
	Contamination present on fibers or in graphite v-grooves.	In order to preserve splice strength use the Load Fibers routine before removing the FHBs from the splice station. Insert the contaminated fiber into the cleaning station to remove excess coating and debris. Use only the flat toothbrush provided to clean the graphite v-grooves.
	Contamination on Splice Head surface or under Splice Cap.	Clean surfaces with a cotton swab moistened with IPA. Take care not to brush dirt onto the Lens Port or the mirrors. Check that the filament is properly seated.
	Fiber strip distance is too short (Strip shoulder is unintentionally within graphite).	Ensure that the FHB is pushed up to the Strip Length Stops before closing the Cleave Lid. The FHB lever should be in the forward position when stripping, so on machines which are set up for the very minimum strip length, neglecting to position the lever correctly will result in the coating hitting the edge of, or sitting within, the Graphite v-grooves. Re-prepare the fiber in this case.
	Strip length stops are in a bad position.	Move stops inward to increase Strip Length.
Pre-loss is high.	Coating particles adhering to fiber prevent proper seating in the positioner V-grooves.	In order to preserve splice strength use the Load Fibers routine before removing the FHBs from the splice station. Insert the contaminated fiber into the cleaning station to remove excess coating and debris. Use only the flat toothbrush provided to clean the graphite v-grooves.
	Background argon flow too high.	Excessive argon flow above the standard 0.15 liters per minute may cause the left-hand fiber to vibrate in the gas flow.
	Very poor cleave with damage in core region.	See the diagnostics section for the cleaving process.

Problem	Possible Cause	Solution
Splice loss drops instantly, then slowly increases.	Filament power is too high.	Run filament normalization. System will automatically optimize power level and view-to-splice distance.
	Filament has aged.	Run filament normalization. System will automatically optimize power level and view-to-splice distance.
Splice is not fully fused, or loss does not "bottom out".	Filament power is too low.	Run filament normalization. System will automatically optimize power level and view-to-splice distance.
	Splice time is too short.	Increase the splice time in 0.5 s increments.
	New filament installed without carrying out filament normalization.	Run filament normalization. System will automatically optimize power level and view-to-splice distance.
Bubble occurs at splice.	Fiber ends did not meet properly due to cleave defect. Fiber ends did not meet properly due to contamination on the fiber ends.	Check the cleaver and adjust if necessary (refer to Maintenance section for procedures). Inspect fiber end for dirt/debris. Remove dirt/debris by using the cleaning station or re-cleave fiber. (Note: Clean cleaver blade with Q-Tip and acetone prior to re-cleaving. See Maintenance section.)
Neckdown occurs at splice. (Fibers are fused but the point of the splice is narrower than the normal fiber diameter.)	Fiber ends were not touching during the hot-push.	The right hand fiber did not push sufficiently because the strip length was incorrect and the shoulder of the primary coating butted the end of the Graphite, or the fiber gap was incorrect due to a poor cleave, or the FHB hit a software or hardware limit.
Bulge occurs at splice.	Hot Push distance too high.	Decrease the Hot Push distance.
Fiber ends bubble apart in "q-tip" splice.	Fiber ends too far apart prior to the Hot Push.	Increase the Pre-Push distance by 2 µm increments, but do not exceed 16 µm total pre-push.
	Filament power is too high.	Run filament normalization. System will automatically optimize power level and view-to-splice distance.

Chapter 8 Recoat

8.1. Manual Injection System

The purpose of the recoat is to maintain the strength and flexibility of the fiber or fusion splice by protecting the glass surface from damage. It should be noted that recoating a splice does not make the splice stronger.

To recoat a fusion splice, the section of exposed fiber in its FHB is placed in the quartz recoat mold assembly. To allow for tolerance variations from the fiber manufacturer, the diameter of the recoat mold cavity is generally specified to be slightly larger than the nominal outside coating diameter (e.g. 280 µm for a nominal 250 µm coating). A liquid acrylate material is injected into the mold cavity and is cured by exposure to ultraviolet light from a built-in UV source. The recoat process maintains a near original fiber diameter and delivers a flexible fusion splice that can be handled or tightly coiled as if no splice were present.

8.2. Setting Up

It is important to check the following items before beginning the recoat process.

Recoat Time

This is the time the four halogen bulbs located below the recoat mold will be on during UV curing. Check the value displayed in the Configuration→ Recoater menu. If a recoat time other than that displayed is needed, enter the new value. Only integer values will be accepted. The default recoat time is 15 seconds.

Clean the Recoat Mold

The recoat mold assembly contains two very flat quartz plates, each with a semi-circular channel running longitudinally down the center of their mating surfaces. One plate is mounted in the hinged top which, when closed, forms a circular mold cavity with the bottom plate. In order for the top and bottom plates to mate flush together, they must be cleaned of all dirt and/or coating particles.

The quartz mold plates can be cleaned with a soft lint-free lens tissue wetted with isopropyl alcohol. Wipe off any dirt particles from both the top and bottom plates. The soft brush provided can be used to clean the mold channels of any cured coating particles. Coating particles that adhere to the mold plates can be softened with acetone if necessary. Do not rub any hard objects across the surface of the plates as this could scratch the optical coating.

The mold should be replaced if there are chips along the recoat length, which can be observed using an eye loupe. The recoated fiber can also be observed; excessive flashing will be evident if the mold is not aligned or has excessive chipping.

UV Acrylate Level in the Injection Port

For users who only occasionally recoat fiber, we recommend using the injection plunger with a syringe to inject the acrylate into the mold. The top quartz plate contains an injection port which must be filled with UV acrylate material (supplied) prior to placing the fiber in the recoat mold. The injection port can be filled by using a syringe (supplied) to dispense the UV material. Care must be taken to prevent the formation of bubbles in the UV material when loading both the syringe and the injection port.

WARNING

Prior to handling the UV acrylate material, be sure to read the Material Safety Sheet for your material. MSDS for UV acrylate material purchased from Thorlabs can be found by visiting www.thorlabs.com **and searching for the Thorlabs' Item #.**

8.3. Priming the Remote Manual Injection System

The following procedure is required to prime the remote manual injection system:

1. Make sure to have lens tissue and cleaning solution (acetone or alcohol) available prior to proceeding.
2. Raise the recoater top.
3. Position the selection lever of the remote injector to the inject position (lever horizontal) and screw in (turn clockwise) the knurled syringe screw until a slight resistance is felt at the end of travel. Do not use excessive force when turning in the screw once the end of travel is reached. The end of travel point is reached when the leading edge of the syringe screw is approximately level with the step in the syringe body.

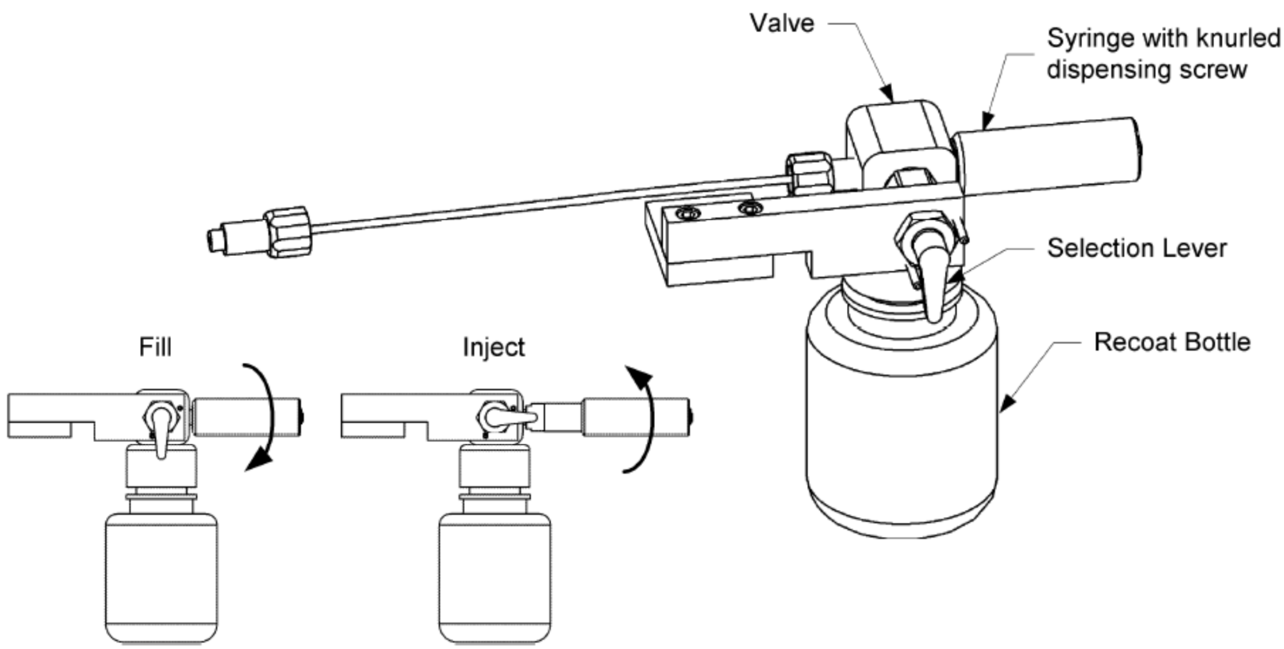


Figure 48 Schematic of Remote Manual Recoat Injection System

4. Fit a recoat bottle with fresh recoat material to the system. The red inject tube should be long enough to just reach the bottom of the recoat bottle. If using a shorter bottle than the supplied (30 ml) recoat bottle the red tube may need to be trimmed to length.
5. Turn the selection lever to the fill position (lever down). Unscrew (turn counter-clockwise) the knurled syringe screw to draw recoat material from the bottle into the syringe. Continue unscrewing the syringe screw approximately 3/4" or until it is felt to spin freely.

WARNING

Do not pull on the syringe screw once the end of travel is reached; this will pull the plunger out from the syringe body.

6. Turn the selection lever to the inject position (lever horizontal) and screw in (turn clockwise) the syringe screw until the inject end of travel point is reached.

WARNING

If the syringe screw was fully unscrewed until it spun freely, a slight forward pressure may initially be required to re-engage the threads.

7. Watch the injection port for signs of recoat material. Make sure to collect the recoat material as it comes out of the mold injection port. Do not allow recoat material to run down the face of the mold and under the mold plate.
8. The above steps of filling and injecting the syringe must be repeated several times to fully displace air from the system. Recoat material should run freely from the mold without bubbles. If bubbles are still present, run additional fill-inject sequences. It may help to turn the recoat plunger back and forth several times during the inject sequence in order to remove air trapped at the O-ring seal. It is also sometimes helpful to fill the syringe and then lift the left side of the unit such as to angle the syringe approximately 30 degrees. Leave the unit angled in this position for approximately 15 minutes. This will allow any air trapped in the syringe to rise up towards the distribution valve such that it can then be injected out.

WARNING

Make sure that soak/clean station is tightly capped before angling the unit.

9. Once the system runs free of air bubbles, clean the mold plates of any excess recoat material.

8.4. Fiber Recoating Procedures

8.4.1. Positioning the Fiber

Make sure both quartz plates are clean and that the injection port has enough UV material for the recoat. Raise the splice head top and the top of the recoat block.

It is important that the fiber be kept taut between the FHBs in the transfer jig to prevent the fiber from bowing at the recoat. For this reason, the system puts a slight tension on the fiber when exiting out of the splice program back to the Menu Screen.

It is also important to avoid touching the exposed glass surface, as this could significantly lower the strength of the fiber. Care should be taken to avoid rubbing the exposed section of fiber against the mold assembly. If proper caution is taken when positioning the fiber, the recoat process will not degrade the strength of the fiber.

Hold the four corners of the transfer jig and lift straight up, clearing the filament in the splice head. Move the transfer jig to the recoat station and slowly set the pins under the jig into the bushings on the plate. Be careful not to rub the fiber on the recoat top. Make sure the fiber is in line with the mold cavity. Lower the recoat top to capture the fiber in the recoat channel.

8.4.2. Injecting the Acrylate

Once the fiber has been captured in the recoat mold assembly, the injection plunger should be turned clockwise to inject the UV acrylate material into the mold cavity. The material will flow from the injection port, down a shallow channel, into the recoat cavity. The plunger should be turned slowly to give the material time to flow smoothly along the injection path.

Use the viewport in the recoat top to watch the material flow into the mold. Continue turning the plunger until the acrylate material reaches both coating interfaces of the exposed section of fiber. A slight migration of the acrylate material outside of the injection path between the two mold plates can be expected. The bottom mold plate has a dielectric coating that prevents this material from curing and forming a characteristic mold flashing. Excessive flashing flow indicates that the plates did not mate flush together. This is generally caused by dirt particles on the mold plates and/or by trying to recoat a fiber that has a larger coating diameter than the recoat mold.

8.4.3. Curing the Coating

The liquid UV acrylate material cures to a solid state when exposed to ultra-violet light. The necessary UV radiation is provided by four tungsten-halogen lamps located below the bottom mold plate. The optical coating on the bottom plate ensures that any material which flows between the two plates will not cure and form a flashing on the recoated section of the fiber.

Cure times are dependent on the mold size and recoat material, but they range from approximately 12 - 15 seconds for the Thorlabs Item # RM280 mold assembly with high-index Thorlabs Item # AB950200 recoat material to 30 - 60 seconds with the low-index Thorlabs Item # PC373 recoat material. If you would like to use the low-index material with your FFS2000 series system, we recommend contacting Thorlabs for assistance.

WARNING

Do not look directly at the recoat assembly while the recoat lamps are on. The recoat lamps emit ultra-violet radiation which can cause damage to the eyes. The mold top must be closed during recoat lamp operation.

To cure the fiber coating, use the following procedures:

1. Press the **Recoat** button to turn on the UV lamps. The recoat lamps will shut off automatically after the set cure time.
2. To remove the recoated splice, first raise both FHB tops. Next, raise the recoat mold assembly top.
3. Remove the recoated fiber from the mold assembly. The fiber may remain tacked to either the top or bottom mold plate. In this case, it may be necessary to gently pull on the fiber to release it.

8.5. Diagnostics

Problem	Possible Cause	Solution
Fiber snaps when mold top lowered.	Recoat mold not properly aligned to fiber.	Check that the fiber is seated in the FHB V-grooves correctly. Check that the Tension Fiber Process is in the splice sequence and that it has been allowed to execute.
	Grooves on recoat mold plate and cap do not line up.	Ensure that the FHBs and Transfer Jigs used are not those from another machine. Align mold to single piece of stripped fiber stretched between FHBs in transfer jig. Contact Thorlabs for splicer servicing.
Material flows excessively outside of mold cavity or does not flow down mold cavity (“puddling”).	Recoat mold plates are dirty.	By far the most common cause of recoat problems. Dirt between quartz mold plates will not allow them to lay flush, causing the acrylate to flow excessively outside the mold cavity. The recoat mold plates should be cleaned as described in Section 8.2.
	Fiber is not taught in FHBs.	Set up Post Splice Tension or ensure that the Post Splice Tension process executes before removing the Transfer Jig from the Splice Station.
	Grooves on recoat mold plate and cap do not line up.	Contact Thorlabs for servicing.
Flashing forms along the length of the recoat.	Cure time too long.	This will increase the modulus of the coating and make it stiffer. In the future, decrease the cure time. This flashing can generally be removed by wiping the recoated section with a dry lens tissue. For very tough flashing, it may be necessary to use the gray abrasive square to gently rub off the flashing material.
Recoat feels tacky or can be easily rubbed off by pulling the fiber between fingers.	Cure time too short.	Increase the cure time.
	One of the Recoat bulbs is burned out.	Replace the recoat bulb. Dispose of the old bulb with general waste or with glass waste.
Bubble in recoat.	System refilled but unpurged.	Purge injection system and any tubing.
	Supply of recoat material expiring.	Refill injection system. Purge system until the recoat flows bubble free.

Problem	Possible Cause	Solution
	Remote injector system leaking	A leak in the remote injector system will allow air to enter causing bubbles. Refill the tubing and check that it will withstand a moderate pull.
Recoat top does not lift easily or recoated section adheres tightly to mold plate.	Recoated fiber is adhering to recoat plate and/or top.	It may be necessary to coat the mold plates with a release agent prior to recoating. Contact Thorlabs for release agent recommendations and instructions for use.
Fiber sticks to recoat mold consistently.	Recoat mold plates are dirty.	The recoat mold plates should be cleaned as described in Section 8.2.
Fiber snaps when lifting the recoat mold top.	Failed to first release the FHB tops before lifting the recoat mold top.	If the recoat mold top is lifted with the FHB tops closed, the fiber may stick to the recoat mold top and snap or degrade the strength of the fiber. Always open the FHBs before lifting the recoat mold top.

Chapter 9 Proof Test (Item #s FFS2000PT and FFS2000WS)

The proof testing station of the FFS2000PT or FFS2000WS can be used to determine the breaking strength of a fiber or to ensure that a fusion spliced fiber meets a minimum strength requirement. The section of fiber to be tested is located between two mandrels. The ends of the fibers are wrapped once around each mandrel and held in place by an integral clamping mechanism. A load is automatically applied to the fiber by the rotation of one of the mandrels. The load can be taken up to a predetermined level and released (proof test) or it can be taken up to the breaking strength of the fiber (tension test). The tension level is displayed on the monitor as a bar graph which can be configured to display the tension in units of pounds, kilograms, kpsi, newtons or GPa.

9.1. Setting Up

It is important to check the following items before beginning the proof test.

Fiber Diameter

In order for the proof test station to calculate the tensile stress applied to the fiber under test, the diameter of the fiber must be entered. To access the Proof Test Configuration popup window, select Configuration → Proof Tester from the Menu Bar. If a fiber diameter other than the one displayed is desired, enter the new value in microns.

Units

Check the units selection displayed in the Proof Test Configuration popup window, Select the desired units: kpsi, lb, kg, N, or GPa.

Timeout

Limits the length of the proof test. This is necessary in case the fiber breaks before reaching the peak tension level. The proof test mechanism will reset after the chosen timeout period. If the fiber strength exceeds the proof test peak, the proof test mechanism will automatically reset before the chosen timeout period has expired. Check the timeout value displayed in the Proof Test Configuration popup window. If a timeout value other than that displayed is desired, enter the new timeout in seconds. Allowable values are 0 - 20 seconds. A default setting of 10 seconds will be used if either an out-of-range value or no value is entered.

Peak

This is the level to which the proof test will be performed. Check the selected value displayed in the Proof Test Configuration popup window. If a peak level other than that displayed is desired, enter a peak level in the current units.

9.2. Proof Testing

9.2.1. Loading the Fiber

Position the fiber so that the splice region or portion of fiber to be tested is centered between the mandrels. Press and hold the button on top of one mandrel to release its clamp. Wrap the fiber around the mandrel twice, centering it on the rubber grips. Make sure the wrapped fiber is not overlapped. Release the button on top of the mandrel, securing the fiber end under the clamp. Repeat with the other mandrel. The fiber should be taut (no slack) between the mandrels**.**

CAUTION

Always use the safety shield or wear safety glasses when proof or tension testing fiber. The fiber under test can shatter and send glass particles flying.

After failed proof tests, clean up glass debris, as this can cut the skin. Any glass debris should be disposed of in a glass waste container, such as Thorlabs' Item # FTDU.

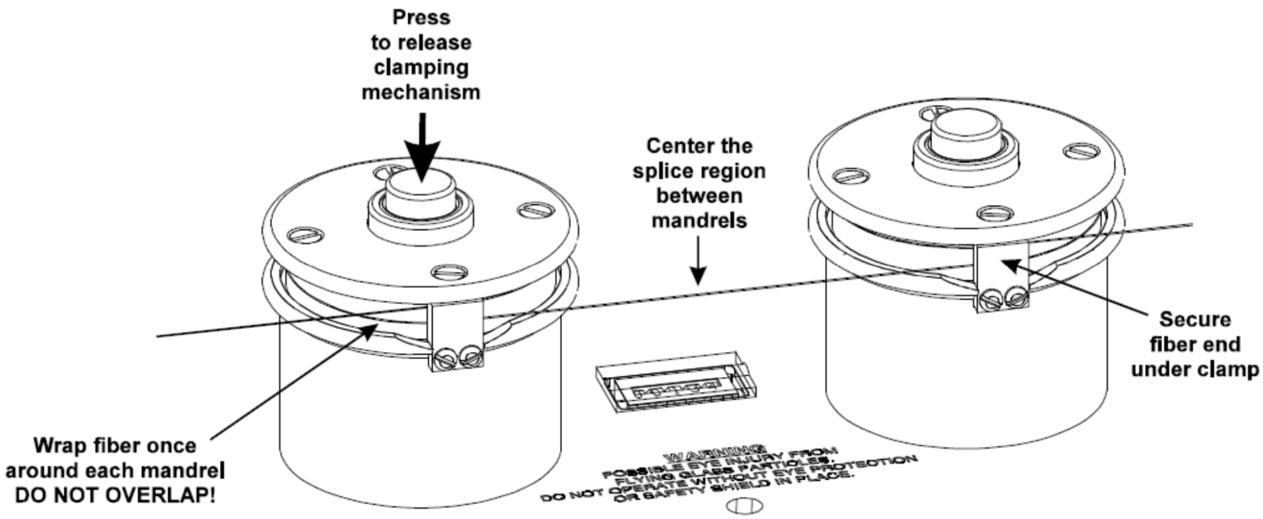


Figure 49 Proof Test Mandrels and Fiber Splice in Test Position

9.2.2. Adjusting the Proof Test Cycle

The ramp rate, cycle time, and/or peak tension setting may need to be adjusted to obtain the desired proof test cycle. It is recommended that a test piece of fiber be used when first adjusting the proof test cycle. The procedures for adjusting the proof test cycle are as follows:

1. Ensure the proof test presets are set as desired.
2. Load a piece of test fiber onto the proof test mandrels. (Refer to Section 9.2.1 for instructions).
3. Make sure the safety shield is in place and you are wearing safety glasses. (Note: Anyone observing the test should also take precautions against flying glass particles.)
4. Initiate the proof test by selecting the **Test** button on the splicer.
5. The peak level should be reached slowly (≈5 seconds) and held briefly (≈1/2 second). If the peak tension is not reached, increase the ramp rate by turning the Ramp screw on the splicer counterclockwise. If the peak tension is reached too quickly, decrease the ramp rate by turning the Ramp screw clockwise. Some iteration between the ramp rate and peak tension setting may be required in order to achieve the desired proof test cycle.

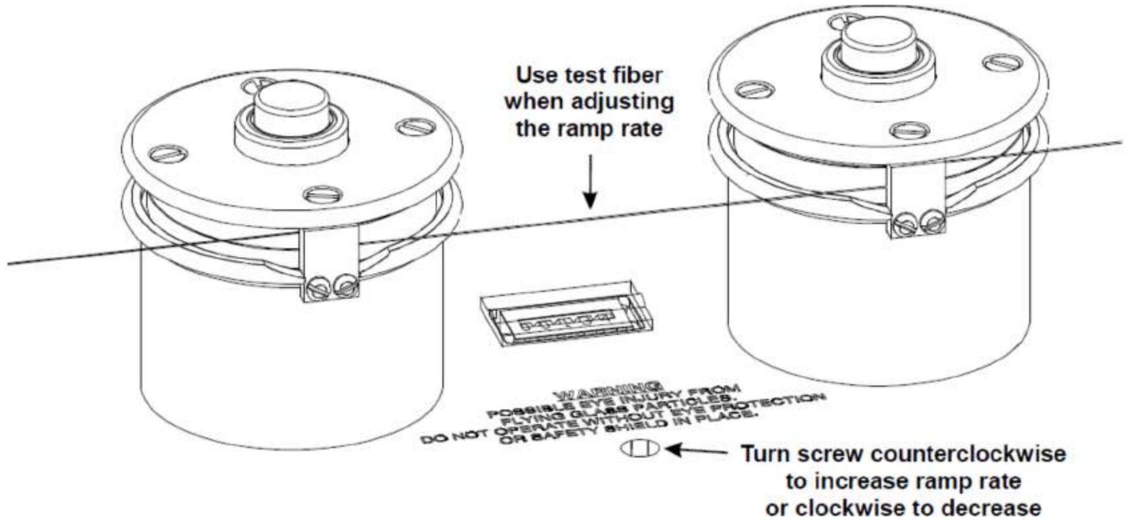


Figure 50 Schematic of Proof Test Load Ramp-Rate Adjustment

9.2.3. Proof Testing

CAUTION

Always use the safety shield or wear safety glasses when proof or tension testing fiber. The fiber under test can shatter and send glass particles flying.

The proof test is used to determine whether a fiber or fusion splice meets a minimum strength requirement. During the proof test, the peak load is applied to the fiber and held for the desired cycle time.

The procedures for proof testing are as follows:

1. Ensure the proof test presets are as desired.
2. Adjust the proof test cycle if necessary. (Refer to Section 9.2.2 for instructions).
3. Load the fiber to be tested. (Refer to Section 9.2.1 for instructions).
4. Make sure the safety shield is in place or that you are wearing safety glasses. (Note: Anyone observing the test should also take precautions against flying glass particles.)
5. Initiate the proof test by selecting **Test** button on the splicer.
6. The proof test process can be monitored by watching the bar graph that is displayed in front of the main display area. The maximum tension applied to the fiber will be displayed on the bar graph. If the fiber breaks prior to reaching the proof test level, the breaking strength will be displayed.

9.3. Diagnostics

Problem	Possible Cause	Solution
Fiber Slips at very high tension levels.	Proof test grips are dirty.	Clean proof test grips with a cotton swab dipped in alcohol.
	Proof test grips are work out.	Contact Thorlabs to order replacements.
	An additional fiber wrap around the mandrel may be required.	When proof testing at high tension levels, the fiber should be wrapped twice around the proof test grips to prevent slippage.
	Proof test clamps are rubbing against the rubber grips, preventing the clamps from gripping the fiber.	Reposition the rubber grips to clear the clamps.
Tension levels seem extraordinarily high or low for the particular fiber being tested.	Wrong fiber diameter entered.	The fiber diameter is used in the tension level calculation. Check the current fiber diameter. If it is incorrect, re-enter the fiber diameter
	Wrong peak tension level set.	Correct the peak tension level.
Splice breaks consistently 3/16" to the left of the splice point.	Left fiber scraped against the filament when placing or removing the FHB at the splicing station.	Carefully place and remove the FHBs from the splicing station. Scraping the bare fiber against the tungsten filament seriously degrades the strength of the fiber. Using the load fibers routine when placing the fibers into the splice head will ensure careful placement.
Fiber breaks at the strip point.	Stripper blades are out of alignment.	Realign the stripper blades (refer to the Maintenance section for procedures).
Fiber breaks at the fusion point with dark deposits on either side of the splice	The fire polish process was not selected.	Ensure that the fire polish is set to on.
	The fire polish power was set too low.	Increase the fire polish power to the same level as the splice power.
	The gas flow rate was too low during the fire polish.	Check that the argon gas flow is set to the same value as for the splice (0.5 – 0.65 l/min).
	The argon gas supply is not of sufficient purity	Refer to Section 3.2.1 for gas supply specifications.

Chapter 10 Shutting Down and Storage

10.1. Shutting Down

The following procedures should be followed when shutting down the FFS2000 Series system:

- Turn off the power to the splicer (i.e., ON/OFF switch on the back panel) and the external power supply, and shut down the FFS3 software.
- Turn off the argon gas supply at the regulator.
- Replace the tops on the soak and clean containers.
- Ensure that the recoat molds are properly cleaned before placing tissues between the plates.
- Close the tops on the FHBs and splice station, and recoat block.

10.2. Storage and Transportation

Please retain the original packaging for the FFS2000 Series splicer and use for all transportation of the unit.

When packaging the splicer for storage or transportation, the following precautions are necessary.

- Do not store or transport the splicer with the soaking or cleaning containers filled.

WARNING
Leakage of solvent or cleaner could seriously damage the unit.

- Make sure the acrylate injector port is empty, particularly if it is stored near a fluorescent light source. If it is stored when not empty, the material may cure (harden) in the port. To empty the injector, open the recoat mold top. Turn the injection plunger clockwise to force the UV acrylate material out of the injection port and onto the recoat mold plate. Wipe up the acrylate as it is ejected with a soft lint-free cloth.
- FHBs must be positioned on the transfer jig at the splice station.
- Disconnect the recoat mold injector.
- Disconnect all gas and electrical connections.
- Make sure that the foam is positioned properly and carefully close the carton.

Chapter 11 Maintenance

11.1. Planned Maintenance

The FFS2000 Series is designed for a production environment to give trouble free operation provided normal planned maintenance is adhered to. Maintenance and repair procedures should only be performed by trained personnel. Improper service and/or repair could result in the safety features being disabled and can also lead to damage that will not be covered under warranty.

Planned Maintenance Schedule

	Every Cycle	Every Shift	Daily	Monthly	3 Months	6 Months	1 Year
Inspect/Clean Vacuum V-grooves[3]		✓	✓	✓	✓	✓	✓
Inspect/Clean Cleave Inserts[3]		✓	✓	✓	✓	✓	✓
Inspect/Clean Cleave Blade				✓	✓	✓	✓
Inspect/Clean TMS Inserts[3]	✓	✓	✓	✓	✓	✓	✓
Check Mold[3]	✓	✓	✓	✓	✓	✓	✓
Replace UV Lamps[4]				✓	✓	✓	✓
Flush Recoat System						✓	✓
Replace Recoat Material						✓	✓
Replace Solvents				✓	✓	✓	✓
Check Proof Test Calibration / Recalibrate							✓

11.2. Fiber Holding Block

11.2.1. Inspect/Clean FHB Vacuum V-Grooves

The FHB vacuum V-grooves should be inspected regularly for dirt and debris. The V-groove can be cleaned, using the soft brush provided in the tool kit. The bristles of the brush can be wetted with acetone if more thorough cleaning is required (such as removing dried PM coloring agent).

Note: Never immerse the entire FHB in cleaning solution! Do not clean the FHB V-groove inserts while the vacuum is on. Wear safety glasses and be very careful when "brushing" with acetone, as acetone may "spray" from the brush.

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[3] Maintenance operations can be performed by the user.
[4]Lamp replacement schedule based on 2000 recoats/month at 15 seconds per recoat.

If the vacuum ports at the bottom of the V-groove appear plugged it may be necessary to remove the inserts so they can be “blown clean” from behind. If necessary, a 0.002” plastic shim (red) from the shim kit can be used to clear the V-groove ports.

Note: Never use any sharp metal objects to “clean” the V-grooves or vacuum ports as this can damage the surfaces.

11.2.2. Change / Remove FHB Inserts

The FHBs contain replaceable V-groove inserts which are designed to hold a specific coating size. Follow the appropriate instructions below based on the style of FHBs supplied with the system.

Standard FHB (Included with Item #s FFS2000 and FFS2000PT)

To change the V-groove inserts, back off the four 2-56 set screws in the base of each FHB using a 0.035″ hex key (one full turn counter-clockwise should be sufficient). The insert should slide freely side-to side and can easily be removed by “overhanging” one end of the insert and then lifting it up and out with the hex key.

Install the new insert such that the V-groove side is up and the size label (if so imprinted) is right side up. Make sure the new V-groove is fully seated and that the ends are flush side-to-side with the FHB sliding block. Gently tighten the four set screws to secure in place.

The top FHB inserts can be similarly changed by loosening the four set screws accessible from the front edge of the FHB top. For standard Ø250 µm coated fibers or smaller, the top insert is simply a flat. However, one side is beveled more at the ends to minimize potential damage to the coating when it exits the FHB. Make sure to install the insert with the beveled surface out.

For holding Ø900 µm fiber coatings, the top insert has a recessed center section to allow the top to close more parallel to the base. When installing these inserts, make sure the recessed surface is facing out.

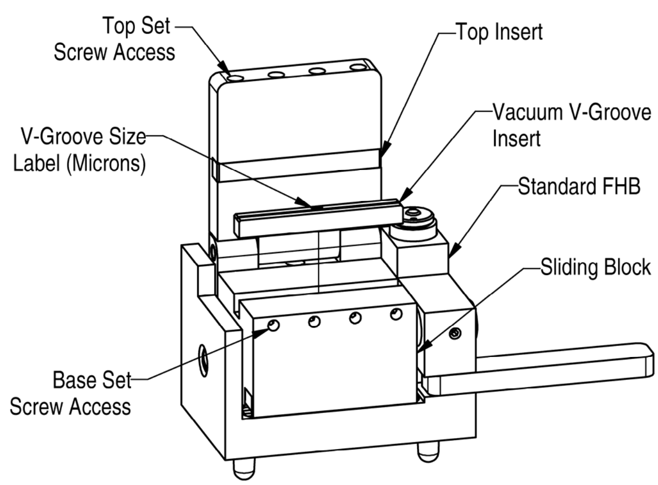


Figure 51 Change Standard FHB Insert

Rotary FHB (Included with Item #s FFS2000PM and FFS2000WS)

To change the inserts, fully loosen the two 00-96 pan head screws with a flat bladed jeweler’s screwdriver. The screws (and insert) can be removed by lowering and raising the FHB top such that the magnets grab the screw and/or insert. After the old insert is removed, make sure the insert pocket is clean. Then install the new insert (V-groove side up). Replace the screws and tighten gently.

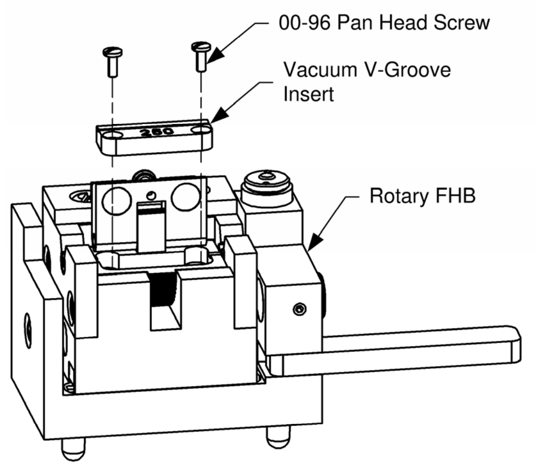


Figure 52 Change Rotary FHB Insert

11.2.3. Adjust Cleave Tension

1. Insert the FHB to be adjusted at the appropriate cleave position on the splicer. **Note:** Make sure to leave the cleave lever in its released position.
2. Manually push the center sliding block up against the inside wall against the FHB (towards the cleave block).
3. Engage the dial tension gage with its tangent point on the sliding block of the FHB as shown in Figure 53. “Pre-load” the tension gauge until it reads slightly below the desired cleave tension.
4. Release the center sliding block. The block should move backwards very slightly and be “supported” by the tension gauge. If the block does not move at all or moves back to far, try again with different “pre-load” tension. Repeat until the “pre-load” tension is such that it just “catches” the sliding block when it is released. This tension is the cleave tension. With practice, this process can be quickly accomplished by “tapping” the sliding block up against the inside wall of the FHB while applying tension with the tension gauge. **Note:** It is important to read the cleave tension just as the sliding block moves off the inside wall of the FHB, as this corresponds to the cleave location.
5. If the cleave tension needs adjustment, access the tension screw with a 0.050” hex key through the access hole in the FHB (Figure 53). Increase the tension by turning the screw clockwise; decrease the tension by turning the screw counter clockwise. One full turn of the screw adjusts the tension approximately by 20 grams.

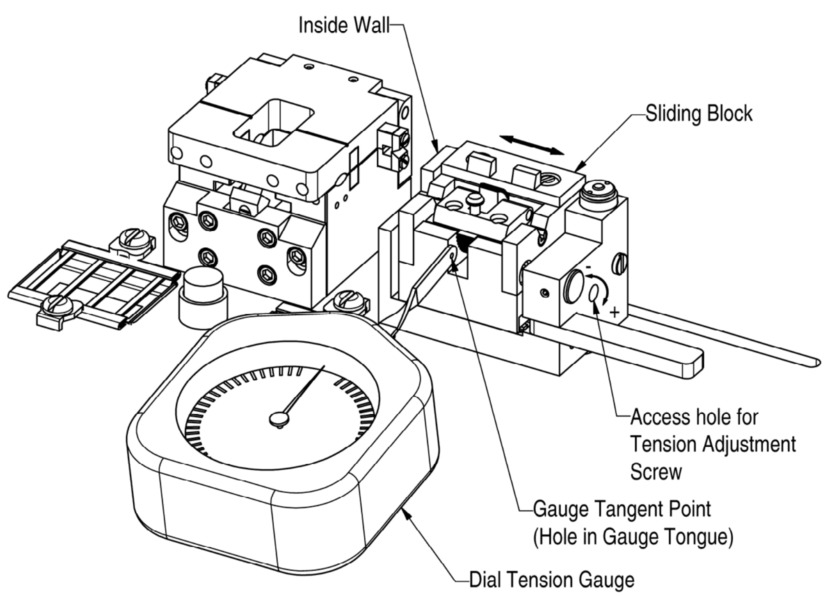


Figure 53 Adjust Cleave Tension

11.3. Strip/Cleave Station

11.3.1. Inspect/Clean Cleave Inserts

The cleave vacuum V-grooves, as well as the cleave top insert clamping surfaces, should be inspected regularly for dirt, debris and/or damage. Damage or dirt on these surfaces could cause the fiber to break at the insert when cleave tension is applied. The V-grooves and top insert can be cleaned with the soft brush provided in the tool kit. Wet the bristles of the brush with acetone for more thorough cleaning.

Note: Do not clean the cleave V-groove inserts while vacuum is on. Wear safety glasses and be very careful when “brushing” with acetone, as acetone may “spray” from the brush.

If the vacuum ports at the bottom of the V-groove appear plugged, and/or the top or bottom inserts appear damaged, it may be necessary to remove them for more thorough cleaning and/or replacement.

11.3.2. Change/Remove Cleave Inserts

The cleave assembly contains replaceable V-groove inserts which are designed to hold a specific fiber size. To change an insert, loosen the two appropriate 2-56 set screws in the base of the cleave block using a 0.035” hex key (one full turn counter-clockwise should be sufficient). Slide the insert sideways to remove. Install the new insert such that the V-groove side is up and the size label (if imprinted) is right side up. Make sure the new V-groove is fully seated and that the ends are flush side-to-side with the base block. Gently tighten the two set screws to secure in place.

The top cleave inserts can be similarly changed by loosening the two appropriate top set screws, which are accessible from the front edge of the top. Top cleave inserts can be flipped “upside down” for a “new” clamping surface.

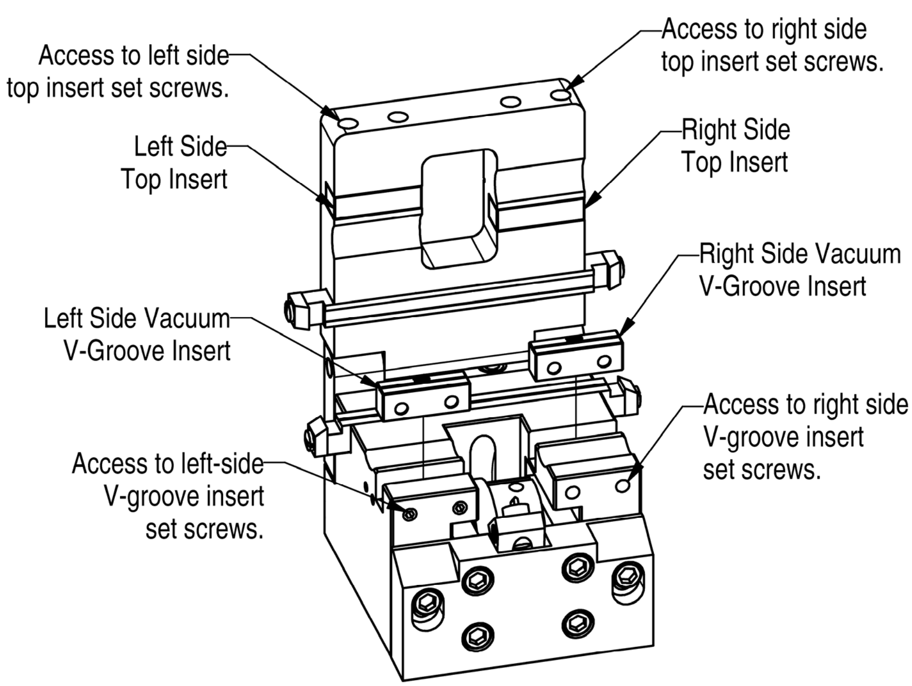


Figure 54 Change Cleave Inserts

11.3.3. Inspect/Clean TMS Inserts

Although the top and bottom TMS (Thermo-Mechanical-Stripper) inserts are cleaned after every strip, they still should be inspected periodically for build-up of dirt and debris and/or damage to the stripper blades. For a thorough cleaning, use the soft brush provided in the tool kit and wet the bristles with acetone. Make sure to clean both the top and bottom inserts, including bottom V-groove and all blades.

Note: Do not clean the TMS inserts while vacuum is on. Wear safety glasses and be very careful when “brushing” with acetone, as acetone may “spray” from the brush.

11.3.4. Change/Align TMS Inserts

The top and bottom TMS (Thermo-Mechanical Stripper) inserts contain a matched set of stripping blades at each end. Make sure to keep top and bottom sets together to ensure optimal performance.

Note: Changing strippers means changing the entire TMS insert (both top and bottom). Do not attempt to adjust the blades at the ends of the TMS insert. The stripper blades are precision-aligned at Thorlabs. Any misalignment will result in poor stripping performance and possibly fiber damage.

Remove the TMS Inserts

1. Make sure power to the main unit is turned off.
2. Close the stripper top. The top insert is held in place by three set screws accessible from the back of the stripper block. Back off one full turn on the set screws, using a 0.035" hex key. The bottom insert does have provisions for holding with set screws, but these are typically not required. Make sure the bottom set screws are backed off at least one full turn.

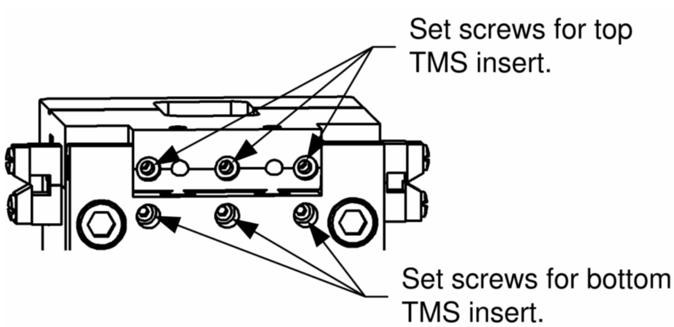


Figure 55 Set Screw Location on Back Side of Stripper Block

3. Open the stripper top. The top insert should lift or slide easily out of its channel. Remove the bottom insert by simultaneously lifting straight up on the protruding ends of the insert.
4. Clean the top and bottom channels where the insert sits by blowing with clean, dry (canned) air.

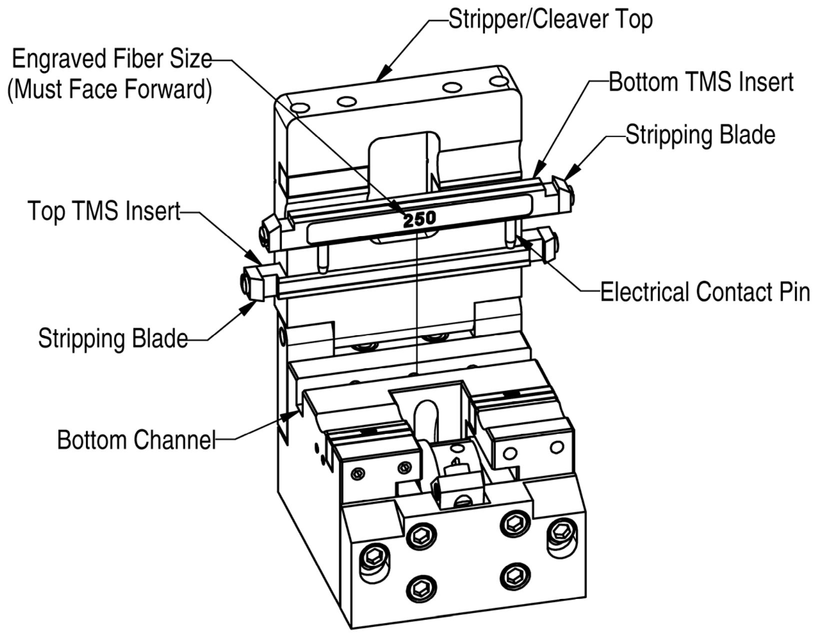


Figure 56 Removing TMS Inserts

Install New TMS Inserts

1. Position the bottom TMS insert such that the electrical contact pins line up with the two sockets in the bottom channel and the engraved fiber size faces forward. Carefully press the pins down into the sockets until the insert is flush with the stripper block surface.
2. Close the stripper/cleaver top.
3. Orient the top insert such that the engraved fiber size is facing forward, with the stripping blades pointing downwards. Slide the top blade assembly into its channel, making sure the stripping blades do not touch each other. If the top blade does not slide in easily, lift up slightly on the stripper/cleaver top.
4. Align the top TMS insert so that the offset on the right and left side between the top and bottom plates is the same. This should correspond to aligning the “notched” edges of the top and bottom insert as shown in Figure 57.

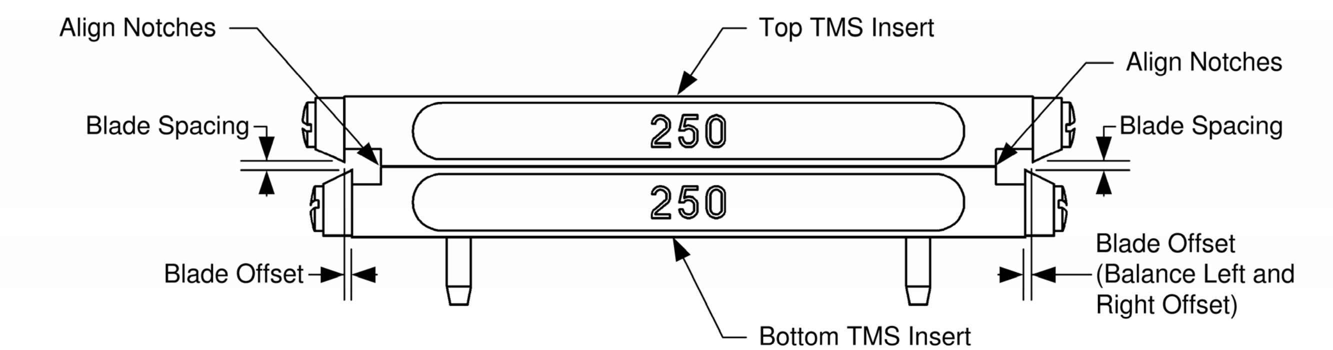


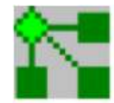
Figure 57 Aligning the Top TMS Insert

5. Tighten the three set screws that hold the top blade assembly. Re-check alignment, and readjust if necessary. **Note:** The bottom insert is held in place by the electrical contact pins and does not need to be secured with the set screws.
6. Check the stripping performance to confirm that the fiber is being stripped cleanly and that splice strengths are satisfactory. If one side is not stripping cleanly, shifting the top insert to tighten up the blade offset on that side may help.

11.3.5. Inspect/Clean Cleave Blade

The diamond edge of the cleave blade should be regularly inspected for debris and/or damage that may result in sub-optimum cleave performance. For easier inspection and cleaning, the cleave blade can be advanced forward from its parked or "home" position. This can be achieved by sending the command:

MOTORTO(11 -1000)

from the command line (note the negative sign on the motor position). This will advance the cleave blade up approximately 45°. Alternately, assign the macro "Service Cleave Blade.txt" to the user macro  by selecting Splice | User Macro Path 1… from the menu bar, and then execute by clicking on the User Macro icon.

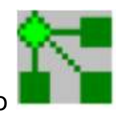
The cleave blade should be cleaned using a cotton-tipped applicator wetted with acetone or isopropyl alcohol. Wipe both sides of the blade starting away from the shank of the blade and wiping towards and over the diamond edge, using very light pressure only. Never touch the edge of the blade with any hard or metal object. For very loose debris, the cleave blade may also be cleaned by blowing clean (canned) air across the edge.

CAUTION

Do not attempt to clean the diamond blade with your fingers or you will cut yourself.

To reposition the cleave blade after inspection and cleaning, send the command:

MOTORTO (11 0)

from the command line. Alternatively, assign the macro "Home Cleave Blade.txt" to the user macro  by selecting Splice | User Macro Path 1… from the menu bar, and then execute by clicking on the User Macro icon.

The cleave blade can also be homed by running the reset macro (click the reset  icon).

11.3.6. Reposition the Cleave Blade

Only a small portion of the cleave blade diamond 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 of the fiber slipping during the cleave due to improper cleave tension and/or fiber clamping. The fiber will slide along the edge of the blade and take a small semi-circular "bit" out of the current section. For small localized damage such as this, the blade can be re-positioned up to maximum of 5 times.

To reposition the cleave blade:

1. Loosen the two 2-56 socket head screws at the outside edges of the cleave blade assembly front plate using a 5/64" hex key. **Note:** Do not loosen any of the 4 center screws.
2. Using a pair of scissors, cut a section of 0.010" plastic shim (brown) from the tool kit, such that it matches in size with the bottom edge of the cleave assembly front plate.
3. Insert the shim under the bottom edge of the cleave blade assembly front plate. **Note**: The front plate is difficult to raise due to the cleave belt tension. It may be necessary to fully remove the clamping screws and angle the front plate upwards.

Do not add more than two 0.010" shims under the front plate of the cleave blade assembly. After adding two shims, if adjustment is still required, remove all shims and rotate the cleave blade 180° so that the bottom edge of the blade is now at the top (see 11.3.8). If the blade has already been flipped, and two shims have already been added, then a new cleave blade must be installed.

- Apply downward pressure to the front plate assembly and retighten the clamping screws, securing the front plate. Check that the front plate is flush side-to-side with the main stripper/cleaver base. Adjust if necessary.
- Home the cleave blade by sending the command:

  MOTORTO (11 0)

  from the command line. Alternatively, assign the macro "Home Cleave Blade.txt" to the user macro  by selecting Splice | User Macro Path 1… from the menu bar, and then execute by clicking on the User Macro icon. The cleave blade can also be homed by running the reset macro (click the reset  icon).
- Run some test cleaves to check both the left and right side cleave quality and to ensure that the blade is striking the fiber in the middle of its oscillation cycle. Adjust if necessary (see Section 11.3.7).

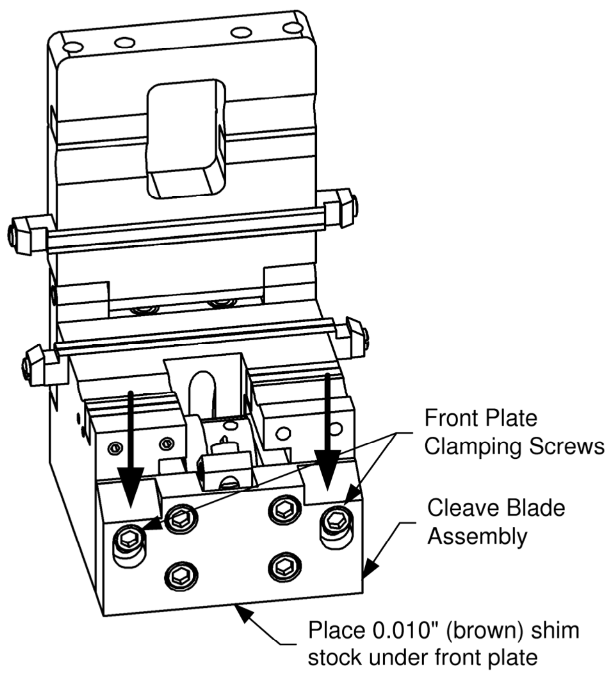


Figure 58 Adjusting the Cleave Blade

11.3.7. Check/Adjust Cleave Blade Forward Move

During a cleave, the cleave blade first advances forward to a position just short of the fiber, then begins oscillating back and forth while advancing further forward towards the fiber. The blade should touch the fiber and initiate the cleave roughly in the middle of this oscillation cycle. Run some test cleaves to check cleave quality and to ensure that the blade is striking the fiber somewhere near the middle of its oscillation cycle.

If the cleave blade is not striking the fiber near the middle of its oscillation cycle, then the initial cleave blade advance must be adjusted in the cleave macro. This is accomplished as follows:

1. Locate and open the appropriate cleave macro (blade cleaver right.txt or blade cleave left.txt) using either Windows Explorer (FFS directory) or by right clicking and opening the appropriate macro under the menu Splice | User Macro Path 1…. The third line of the macro will look like:

   MOTOREXSTEP (11 -2445)0 ;step forward for left cleave

   The first number in parentheses is the motor number; the second is the number of motor steps. Increase the number of forward steps (larger negative number) if the blade is not reaching the fiber or is striking the fiber at the end of the oscillation cycle. The total oscillation cycle is 100 steps, so typical incremental changes should be 30 to 50 steps. Decrease the forward steps (smaller negative number) if the blade hits the fiber prior to starting its oscillation cycle.
2. After adjusting the forward move, scroll to the end of the macro and similarly adjust the backward move line, which will look like:

   MOTOREXSTEP (11 2345)0 ;step back approximately 100 steps short of home switch (Forward Move – 100)

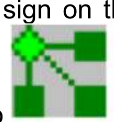
   The backward number of steps should be 100 steps less than the forward number of steps (positive number).
3. Adjust both left- and right-hand macros as required. Save the files after making the appropriate changes. In order for the changes to take effect, power to the system must be cycled off and on. This will cause the new cleave macros to be uploaded.
4. Confirm that the fibers are now cleaving mid-range of the oscillation cycle. Re-adjust if necessary.

11.3.8. Rotate/Replace the Cleave Blade

If the cleave blade has already been shimmed up twice and needs further adjustment, it can be rotated 180° to flip the bottom edge of the blade to the top. If the blade has already been flipped and shimmed twice, then a new cleave blade must be installed. Either way, follow the instructions below:

1. Advance the cleave blade forward from its parked or "home" position. This can be achieved by sending the command:

   MOTORTO (11 -1000)

   from the command line (note the negative sign on the motor position). Alternatively, assign the macro "Service Cleave Blade.txt" to the user macro  by selecting Splice | User Macro Path 1… from the menu bar, and then execute by clicking on the User Macro icon. This will advance the cleave blade up approximately 45°, such that the set screw securing the blade is accessible on the left side of the cleave blade arm as shown in Figure 59.
2. Loosen the cleave blade set screw using the 0.035" hex key. **Note:** one full turn counter-clockwise is sufficient.
3. If simply rotating the cleave blade, proceed to step 7, and follow instructions for rotating and aligning the cleave blade.
4. If replacing the blade, push on the bottom of the blade shank, which is accessible through the hole in the cleave blade arm. Push out the old blade sufficiently far such that it can be grabbed and removed with a pair of tweezers.
5. Select a new cleave blade, and, with the protective plastic tube still in place over the front of the blade to act as a handle, insert the shank of the blade as far as possible into the cleave arm.
6. Re-tighten the setscrew until it is just snug and remove the protective tube from the front of the blade, exposing the diamond tip.
7. Check if the stainless steel cleave blade base is fully seated against the cleave arm and that the diamond blade is oriented perfectly vertically. If required, loosen the setscrew and re-position the blade using a pair of flat-tipped tweezers to rotate and seat the stainless steel base. Take great care not to touch the diamond blade with the tweezers or any other hard objects or it will get damaged.

CAUTION

Do not push on the diamond tip of the cleave blade with your fingers or you will cut yourself.

8. Tighten the set screw and confirm the blade position.
9. Home the cleave blade by sending the command:

   MOTORTO (11 0)

   from the command line. Alternatively, assign the macro "Home Cleave Blade.txt" to the user macro  by selecting Splice | User Macro Path 1… from the menu bar, and then execute by clicking on the User Macro icon. The cleave blade can also be homed by running the reset macro (click the reset  icon).
10. Run some test cleaves to check both the left and right side cleave quality and ensure that the blade is striking the fiber in the middle of its oscillation cycle. Adjust if necessary (see Section 11.3.7).

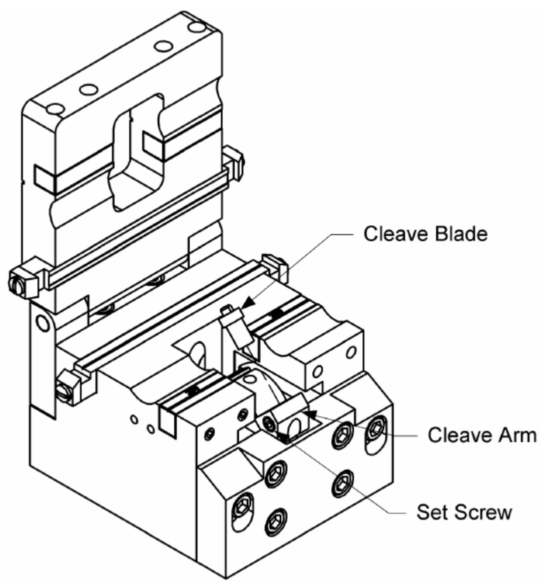


Figure 59 Rotate the Cleave Blade

11.3.9. Replace Ionize Unit

The ionizing units are good for approximately one year from the date stamped on the underside of the metal case. To replace a unit, loosen the two clamps holding the unit in place. Lift out the old unit being careful not to touch the gold plated element. Exchange with a fresh unit.

Note: Do not discard the old unit. Place it in the supplied case and return to:

NRD, Inc.
2937 Alt Boulevard
Grand Island, New York 14072 USA
Telephone: +1 (716) 773-7634

Contact Thorlabs for information regarding ionizing units.

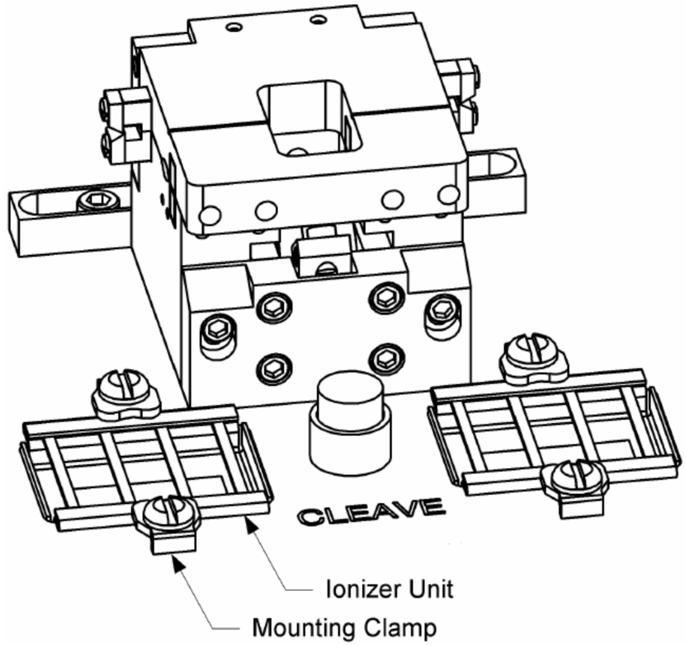


Figure 60 Replace Ionizing Units

11.4. Splice Station

11.4.1. Clean Mirror

Standard Mirror (Item #s FFS2000 and FFS2000PT)

If the fiber image is distorted or pieces of dirt are visible on the mirror surface under 10-20X magnification, the mirror surfaces should be cleaned. This can be done using a commercial lens cleaner with a no-lint cotton swab.

Since it is harder to view, the 135° mirror must be cleaned with the aid of the image. Close the splice top to display the image from the 135° on the computer screen. Raise the splice top and wipe the 135° mirror with a single stroke. Close the top and reexamine the mirror surface in the image. Continue in this manner until the mirror is sufficiently clean.

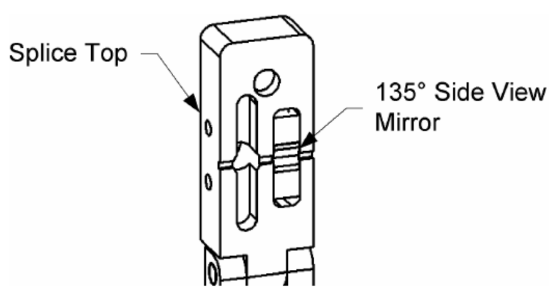


Figure 61 Cleaning the Mirror (Item #s FFS2000 and FFS2000PT)

End View Toggle Mirror (Item #s FFS2000PM and FFS2000WS)

If the fiber image is distorted or pieces of dirt are visible on the toggle mirror surface under 10-20X magnification, the mirror surfaces should be cleaned. This can be done using a commercial lens cleaner with a no-lint cotton swab.

To clean the 90° mirror, raise the splice top and flip the 90° end view mirror down. Wipe it with the cotton swab and lens cleaner using a single-direction stroke.

Since it is harder to view, the 135° mirror must be cleaned with the aid of the image. Close the splice top to display the image from the 135° on the computer screen. Raise the splice top and wipe the 135° mirror with a single stroke. Close the top and reexamine the mirror surface in the image. Continue in this manner until the mirror is sufficiently clean.

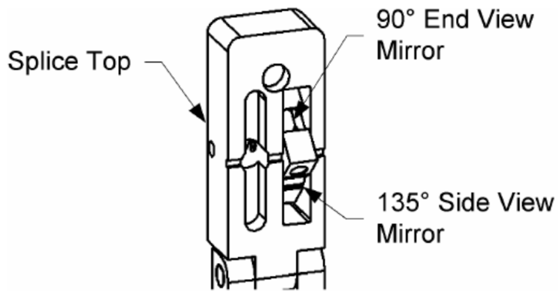


Figure 62 Cleaning the Toggle Mirror (Item #s FFS2000PM and FFS2000WS)

11.4.2. Check/Clean Graphite V-Grooves

The splice station uses graphite vacuum V-grooves to precisely hold the fiber for alignment and splicing. Any small amount of dirt or debris that collects at the bottom of the V-groove could cause alignment and/or strength issues.

A special long-hair, anti-static brush cam be used specifically for cleaning the graphite V-grooves. Gently brush out any dirt or debris that is apparent in the V-grooves. If necessary, the V-grooves can be blown clean using clean dry (canned) air.

Note: The graphite material is very soft to ensure that it will not scratch the glass fiber. It can easily be damaged or scratched. Never use any metal or hard materials to clean the graphite V-grooves. Even the “soft” blue handled brush has sufficiently hard bristles to damage the graphite. Use only canned air or a “long-hair” anti-static brush.

11.4.3. Replace Filament

1. Raise the splice top.
2. Loosen the 2-56 setscrews on the filament extraction tool using a 0.035" hex key.
3. Locate the slotted end of the extraction tool over the filament in the splice head with the setscrews facing to the right. Make sure the extraction tool is centered front-to-back and is sitting flush on the splice head.
4. Tighten both setscrews on the extraction tool to clamp the filament.
5. Gently lift the filament straight out using a slight front-to-back rocking motion.
6. Remove the filament assembly from the extraction tool by loosening the setscrews.

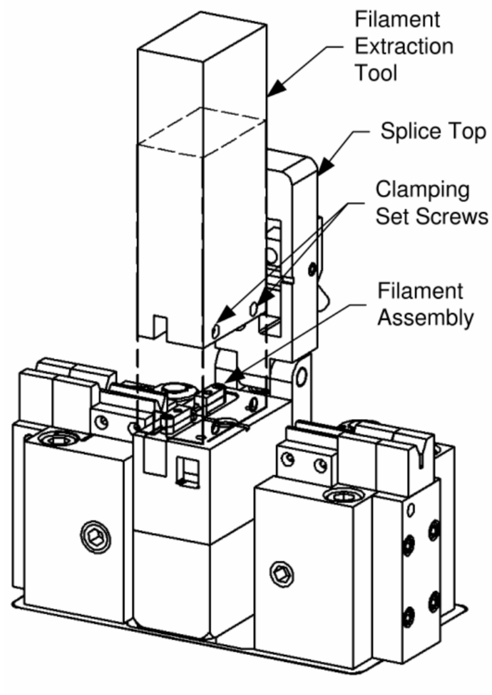


Figure 63 Removing the Filament

- Locate the pink foam diffuser in the purge port of the filament channel (Figure 64). If the foam diffuser looks to be seated approximately 1/32" below the top of the filament channel, and does not appear to be damaged or dirty, proceed to step 13.
- Remove the foam by inserting a pair of narrow tweezers into the orifice. Without exerting any downward pressure, grab the tip of the foam and gently lift out.

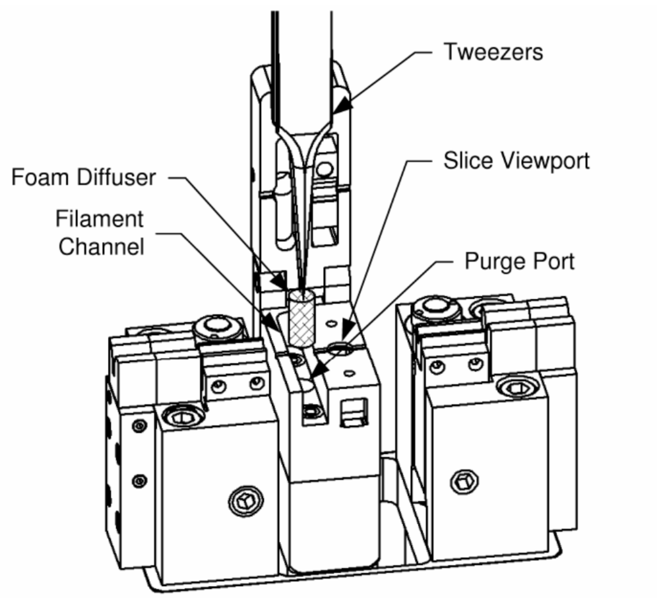


Figure 64 Removing the Foam Insert

7. If the foam is sticky, dirty, and/or has lost its resiliency, it should be replaced. If the foam is dusty, clean it off using canned air.

8. To replace the foam, it must first be compressed into a tight cylindrical shape. Pinching the foam tightly between two (clean) fingers, use the tweezers to roll it tightly into a cylinder.
9. Reinsert the foam into the gas orifice in its compacted form. Maneuver the foam so that it is 1/32" below the filament channel surface. Be sure not to insert the foam too deeply in the orifice.
10. Make sure the foam is evenly distributed in the orifice, not bunched up in any spot. An uneven distribution will affect the gas flow into the splice head, which in turn will affect splice strengths. If the foam is not inserted correctly, remove it and begin again.
11. Before inserting a new filament, make sure the new filament and the filament channel are clean, using canned air if necessary. Avoid blowing canned air down the splice viewport.
12. Insert a new filament with the rounded end facing the rear of the splice block and the straight end facing outward.
13. Gently press on the filament base until it is flush with the surface of the splice block.
14. Ensure that the splice top sits flush when closed. At each of the four corners, the top should be able to grab a piece of 0.0005" thick shim (silver color).
15. The new filament should be pre-fired several times at the standard setting and then calibrated by running the burnback process (see 11.4.4).

11.4.4. Filament Calibration

In order to ensure consistent splice process conditions, new filaments must be calibrated to adjust for absolute power (offset) and filament centering (view-to-splice distance). This is accomplished by running a burnback process, in which two fibers are “spliced” without ever pushing them together. Because the cleaved fiber ends never touch, they will melt back forming “Q-tips.” Image processing is used to analyze the size of the “Q-Tips” and adjust the calibration as desired.

To run a burnback filament calibration:

1. Open the appropriate splice file for the typical fiber diameter being used:

Filament Type	Burnback File
Normal Filament, Ø125 µm Glass Fiber	burnback.ffs
Normal Filament, Ø80 µm Glass Fiber	burnback80.ffs

Note: Do not modify a burnback file.

2. Select a sample of standard single mode fiber of the appropriate diameter. For Ø125 µm fiber, the burnback should be performed with standard SMF-28 fiber.
3. **Note:** Never use PM fibers for the burnback process as this will give erroneous results.
4. Prepare the fibers normally as for splicing (strip, clean, cleave) and position the FHBs at the splice station.
5. Initiate the burnback “splice” process by pressing the blue Splice button. After the burnback, the system will examine the Q-tips and adjust the filament calibration. If a large change is required, a dialog box will appear asking to repeat the process. If so, prepare a new set of fibers and repeat the process. Several iterations may be required.
6. **Note:** Make sure to break off the Q-tip ends of the burnback process prior to re-stripping the fiber. Pulling the large Q-tip through the stripper could potentially damage the stripper blades.
7. Once the burnback process runs successfully without the prompt to re-prepare fibers, the filament calibration is complete. Reopen the appropriate splice file.

11.5. Recoat Station

11.5.1. Check/Replace Recoat Bulb

The lamps are powered in two series pairs; if one lamp burns out only two will remain illuminated. If a lamp is burned out, remove the recoat assembly and replace the burned out lamp. Avoid handling the glass envelope. Fingerprints left on the envelope shorten the lamp life. If you do touch the lamp, be sure to clean it with a soft lens tissue wetted with alcohol or acetone. Make sure all of the bulbs are positioned in a straight line and that they illuminate when a bulb check is performed. Replace and align the recoat assembly. The bulb is RoHS compliant and can be disposed of in general waste or with other glass waste.

11.5.2. Remove/Align Recoat Assembly

1. Close the mold top and unscrew the fitting of the injection tube from the mold top.
2. Remove the six 4-40 flange screws at the base of the recoat mold assembly.
3. Lift the recoat assembly straight up until it clears the recoat lamps. Keep track of the micro switch actuator post, which may slide free from the assembly.
4. Before replacing the recoat assembly, make sure the baseplate, button of the mold assembly and the micro switch actuator post are cleaned of any dirt particles.
5. Replace the micro switch actuator post by inserting the long end into the recoat assembly. Verify that the post moves up and down freely.
6. Lower the assembly straight down over the recoat lamps.
7. Replace the six 4-40 flange screws. Lightly tighten two diagonal screws only to allow for adjustment of the recoat assembly.

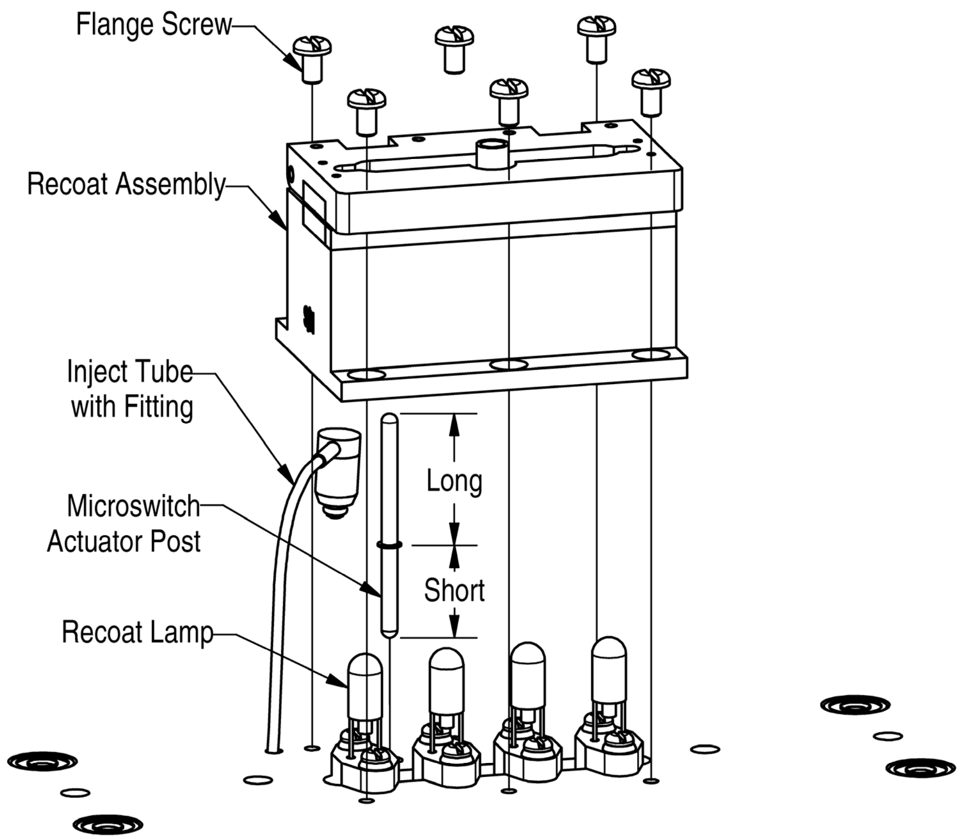


Figure 65 Removing the Recoat Assembly

8. Place the transfer jig with its pins into the bushings at the recoat station and insert the FHBs into the transfer jigs.
9. Open the recoat tops and the FHB tops.
10. Clamp a length of coated fiber between the holding blocks such that the fiber is under slight tension.
    a. **Note:** A fiber normal smaller than that of the diameter of the recoat mold should be used.
11. Using a 10X magnifying loupe, view the fiber straight down at the right edge of the recoat station, as shown in Figure 66. Adjust the recoat assembly such that the fiber is centered in the bottom recoat groove.
12. Repeat the previous step while viewing the fiber at the left edge of the recoat station.

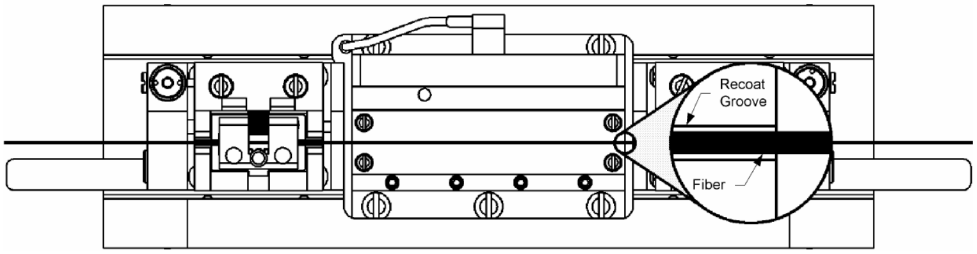


Figure 66 Align Recoat Mold

11.5.3. Flush Recoat System

The recoat pumping system should be flushed clean every 6 months as part of the recoat material replacement procedure. Before flushing the system, make sure to have lens tissue and cleaning solution (acetone or alcohol) available prior to proceeding. To flush the system follow the instructions below and see Figure 67:

1. Raise the mold top.
2. Position the selection lever to the inject position (lever horizontal).
3. Screw in (turn clockwise) the knurled syringe screw until a slight resistance is felt at the end of travel. Do not use excessive force when turning the screw once the end of travel is reached. The end of travel point is reached when the leading edge of the syringe screw is approximately level with the step in the syringe body.
   Note: Make sure to collect the recoat material as it comes out of the mold injection port. Do not allow recoat material to run down the face of the mold and under the mold plate.
4. Replace the recoat bottle with one containing clean solvent.
5. Turn the selection lever to the fill position (lever down).
6. Unscrew (turn counter-clockwise) the knurled syringe screw. Continue unscrewing the syringe screw approximately 3/4" or until it is felt to spin freely.
   a. **Note:** Do not pull on the syringe screw once the end of travel is reached; this will pull the plunger out from the syringe body.
7. Turn the selection lever to the inject position (lever horizontal) and screw in (turn clockwise) the syringe screw until the inject end of travel point is reached.
   a. **Note:** If the syringe screw was fully unscrewed until it spun freely, a slight forward pressure may initially be required to re-catch the threads.
8. Watch the injection port for signs of solvent.
   a. **Note:** Make sure to collect the solvent as it comes out of the mold injection port. Do not allow solvent to run down the face of the mold and under the mold plate.
9. The above steps of filling and injecting the syringe must be repeated several times to fully displace recoat material from the system. Repeat until clean solvent flows from the injection port.
10. Clean the mold plates of all excess solvent and recoat material.
11. Remove the bottle containing the solvent and dispose the solvent according to proper handling guidelines.
12. Repeat steps 5 – 7 with no bottle present to purge any solvent from the injection system.
13. Prime the recoat system.

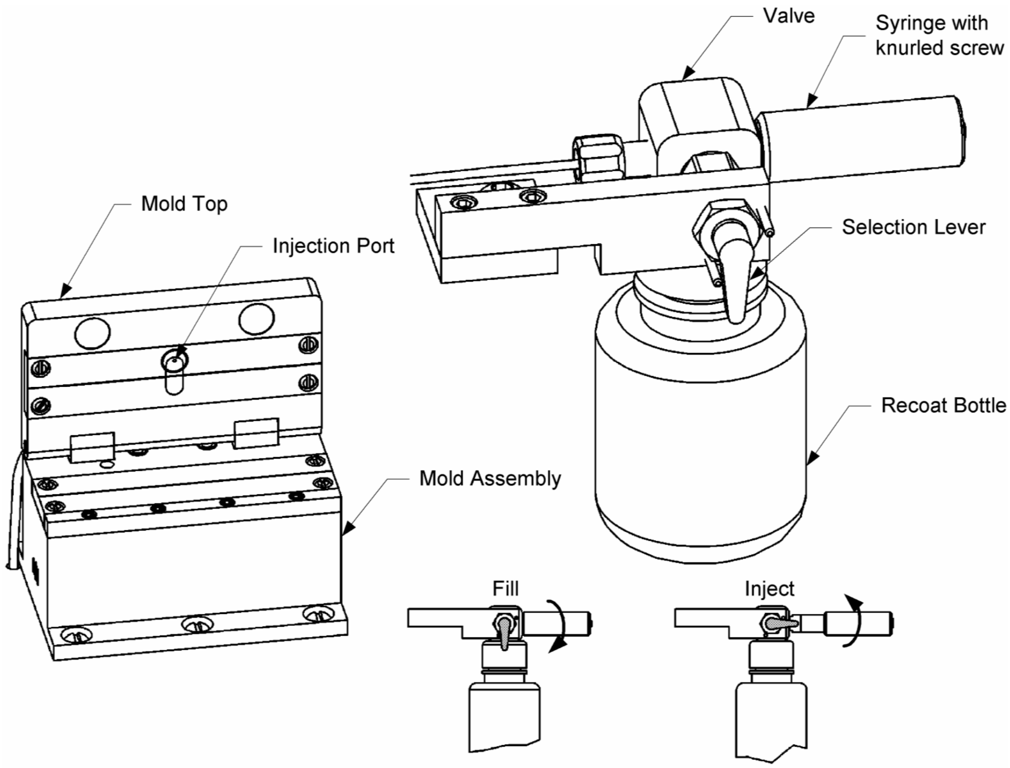


Figure 67 Flushing the Recoat System

11.6. Soak / Clean Station

11.6.1. Replace Indicator Bulb

Unscrew the red indicator cap, and remove the bulb. Replace only with a Thorlabs supplied or recommended bulb. Replace the indicator cap.

11.6.2. Replace Solvents

WARNING

Danger of shock and damage to the unit if it is left connected to the power supply! Turn off power, and disconnect the power supply.

Soaking Station

Tightly screw on the soaking container. While pushing down on the container top, unscrew the flange clamps ½ turn to release the container (Figure 68). The soaking container can now be lifted straight up and out.

Properly dispose of the old fluid and clean the container. Replace with clean fluid and screw the top on tightly. Replace the soaking container and turn the flange clamps ½ turn to secure the container.

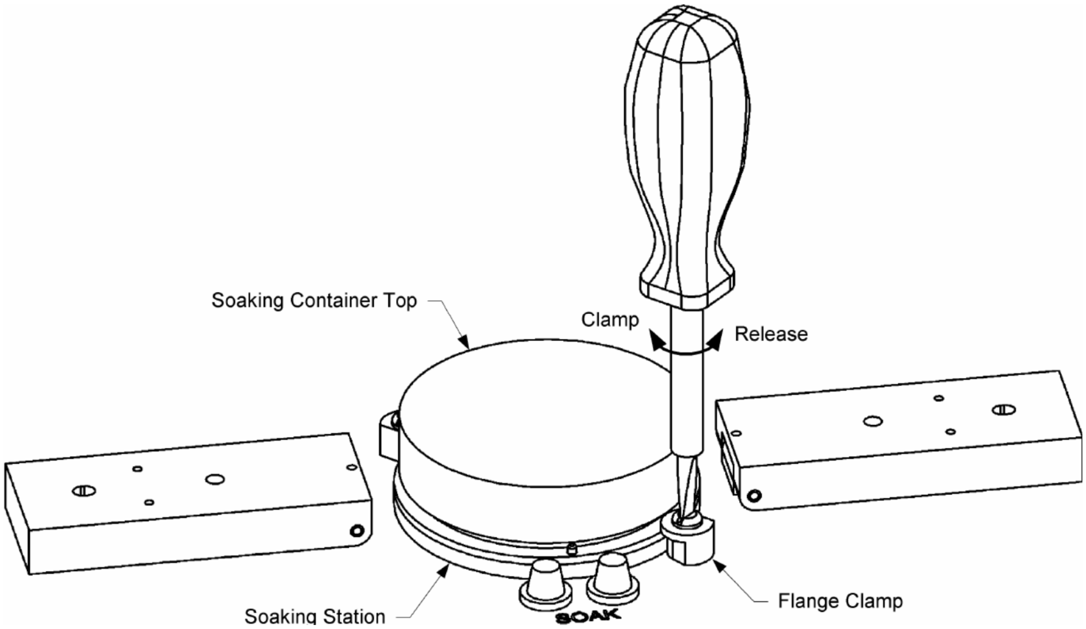


Figure 68 Replace Soaking Solvent

Cleaning Station:

The cleaning container is wired into the unit, and must be removed carefully. Tightly screw on the top of the cleaning container. While pushing down on the container top, unscrew the flange clamps ½ turn to release the container (Figure 69). Gently lift the container out and detach the two wires at the connector. The transducer attached to the bottom of the container is fragile and should be handled gently.

Properly dispose of the old fluid and clean the container. Replace with clean fluids and screw the top on tightly. Re-attach the connector on the cleaning container. Carefully place the container in position and turn the flange clamps ½ turn to secure the container.

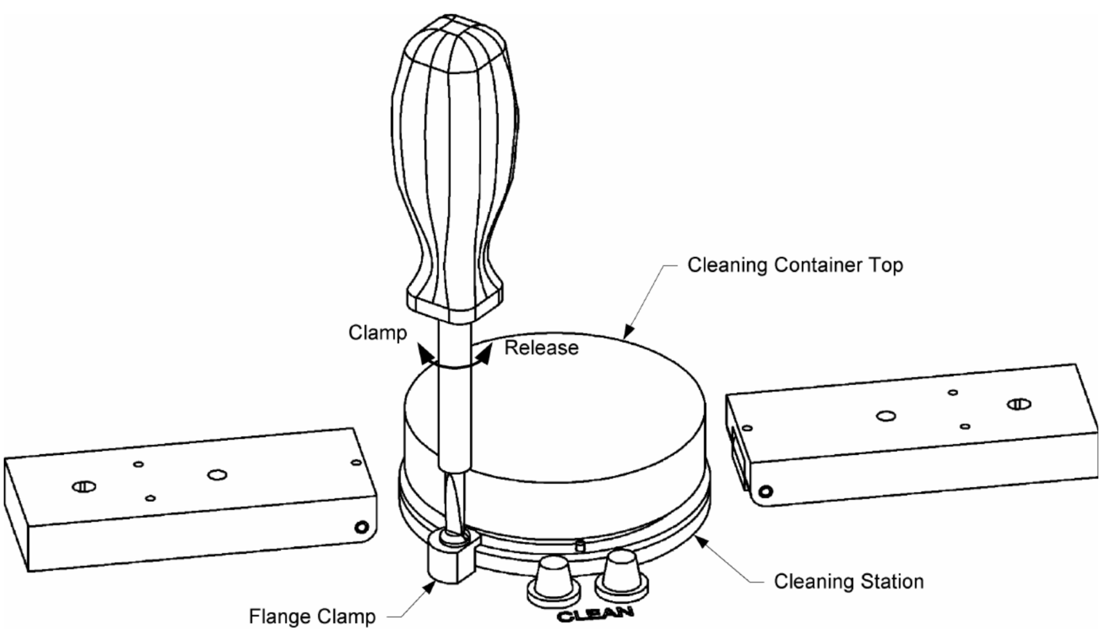


Figure 69 Replace Cleaning Solvent

11.7. Proof Test Station

11.7.1. Replace Proof Test Grip

Remove the 4 flat head screws on top of the proof test mandrel and lift off the flanged top. Depress the mandrel clamp button and remove the rubber grip. Install a new grip making sure that the grip is uniformly positioned around the mandrel and seated below the bottom flange. Replace the top flange and 4 flat head screws. Make sure that the mandrel clamp operates freely and that the rubber grip does not rub against the clamping arm. After replacing the proof test grips, a calibration check should be performed.

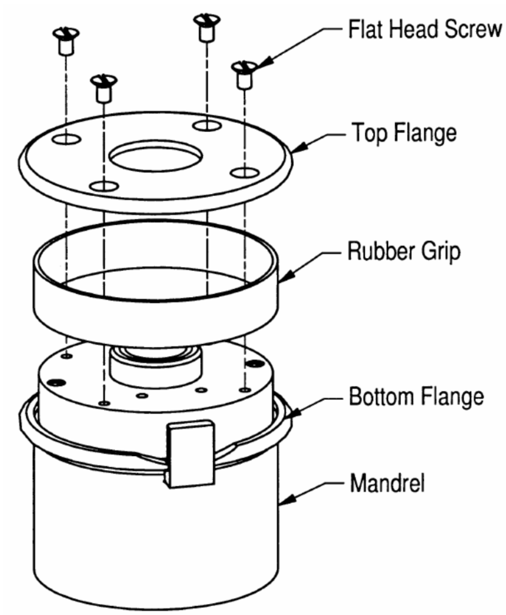


Figure 70 Replace Proof Test Grip

Chapter 12 Specifications

12.1. Common Specifications

Thermo-Mechanical Stripper	
Accepted Coating Materials	Single or Dual Acrylate
Maximum Stripping Temperature	~130 °F (54 °C)

Ultrasonic Cleaner	
Accepted Cleaning Solvents	Acetone or Isopropyl Alcohol
Cleaning Time	1 to 120 s

Cleaver	
Cleave Method	Tension and Scribe
Cleave Type	Flat (0°)
Maximum Tension[5]	2.45 N (0.55 lbs)

Splicing	
Fusion Method	Filament Fusion
Filament Power	40 W (Max)
Alignment Method	Fully Automated by True Core Imaging™ or External Feedback
XY Fiber Positioning Resolution	Stepper Motor Controlled with 0.01 µm Resolution
Z Fiber Feed Resolution	Stepper Motor Controlled with 0.125 µm Resolution
Insertion Loss (SMF to SMF)	0.02 dB (Typical)
Tensile Strength	>250 kpsi (Typical)

Recoating	
Recoat Mold	Quartz
Recoat Diameter[6]	Ø280 µm, Ø430 µm, or Ø600 µm
UV Source	Four Tungsten Halogen Lamps

General Specifications	
Size (L x W x H)	17.0" x 13.9" x 5.0" (432 mm x 353 mm x 127 mm)
Weight	26 lbs (11.8 kg)
Power	12 V DC External Power Supply with Universal AC Input
Operating System	Included Windows® 7 PC with Software GUI Installed

[5] Tension can be adjusted manually by the user for different fiber sizes. The cleaver is calibrated using standard weights that are hung off a pulley, so the tension settings are programmed in grams. This maximum tension corresponds to 250 g.
[6] Depending on your selection of Recoat Mold Assembly (sold separately on www.thorlabs.com).

12.2. FFS2000 Specifications

Fiber Specifications	
Accepted Fiber Cladding Diameters	80 to 200 µm
Fiber Type	SM or MM

12.3. FFS2000PT Specifications

Fiber Specifications	
Accepted Fiber Cladding Diameters	80 to 200 µm
Fiber Type	SM or MM

Proof Testing	
Maximum Tension[7]	89 N (20 lbs)
Mandrel Size	Ø2" (Ø50.8 mm)
Accuracy	±2%

12.4. FFS2000PM Specifications

Fiber Specifications	
Accepted Fiber Cladding Diameters	80 to 200 µm
Fiber Type	SM, MM, or PM

PM Rotation Specifications	
Rotation Alignment	Fully Automated by End-View Alignment Technology or External Feedback
Rotation Resolution	Stepper Motor Controller (0.01° Resolution)
Rotation Travel	190°
Extinction Ratio	-35 dB (Typical)

[7] The proof tester is calibrated using standard weights that are hung off a pulley, so the tension settings are programmed in grams. This maximum tension corresponds to 9.1 kg.

12.5. FS2000WS Specifications

Fiber Specifications	
Accepted Fiber Cladding Diameters	80 to 200 µm
Fiber Type	SM, MM, or PM

PM Rotation Specifications	
Rotation Alignment	Fully Automated by End-View Alignment Technology or External Feedback
Rotation Resolution	Stepper Motor Controller (0.01° Resolution)
Rotation Travel	190°
Extinction Ratio	-35 dB (Typical)

Proof Testing	
Maximum Tension[c]	89 N (20 lbs)
Mandrel Size	Ø2" (Ø50.8 mm)
Accuracy	±2%

Chapter 13 CE Certificate

THORLABS
www.thorlabs.com

EU Declaration of Conformity

in accordance with EN ISO 17050-1:2010

We: Thorlabs Inc.

Of: 56 Sparta Avenue, Newton, New Jersey, 07860, USA

in accordance with the following Directive(s):

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

hereby declare that:

Model: ***FFS2000, FFS2000PM, FFS2000PT and FFS2000WS***

Equipment: **All-in-one workstation for fusion splicing processes**

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

EN ISO 12100	Safety of Machinery. General Principles for Design. Risk Assessment and Risk Reduction	2010
EN 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements	2013
EN 62471-1	Photobiological Safety of Lamps and Lamp Systems	2009

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

does not contain substances in excess of the maximum concentration values tolerated by weight in homogenous materials as listed in Annex II of the Directive

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

Signed: *On:* 04 October 2016

Name: Ann Strachan

Position: Compliance Manager *EDC - FFS2000, FFS2000PM, FFS2000PT a...*

CE

Chapter 14 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 15 Thorlabs Worldwide Contacts

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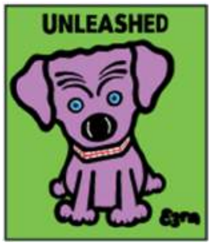

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