

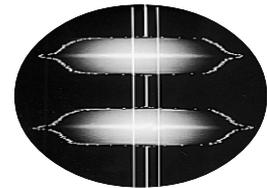
# ADVANCED OPERATION - Program structure overview

The following elements form the backbone to all FSU 995 FA splicing programs. Each will be described in greater detail on the indicated pages.

**A Program name** ..... 26  
*Certain limitations hold in splicing program names.*



**B Fiber type** ..... 26  
*Various fiber types behave differently when spliced, so the fiber type must be correctly specified in a splicing program.*



**C Splicing process** ..... 28  
*There are six different splicing processes available with the FSU 995 FA.*



**D Program parameters** ..... 36  
*The parameters contain the quantitative information needed to execute the various splicing programs. They are permanently set in the case of the pre-defined programs, however, can be edited in the case of Programs 11-50.*



# Splicing program structure

## A Program name

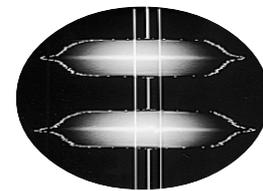
The names of FSU 995 FA splicing programs can have no more than 16 characters, and should be designed for quick and easy recognition. When a splicing program is displayed, it will always be with its number, like the pre-defined programs are:

**// NORMAL SM + SM P01 //**



## B Fiber type

Because of structural differences, different types of fiber behave in dissimilar ways when spliced. For example, dopants can change the melting temperatures and light emissions of heated glass, and fibers are often made with several differently doped layers. This variation must be taken into account during the splicing sequence, as well as in splice loss estimation, so it is important to specify fiber type when designing your own program. As an aid, the following descriptions of the major fiber types are given with a listing of the programming name for that fiber type, as well as, the number(s) of the pre-defined splicing program(s) that can be used as a base for designing your own splicing programs.

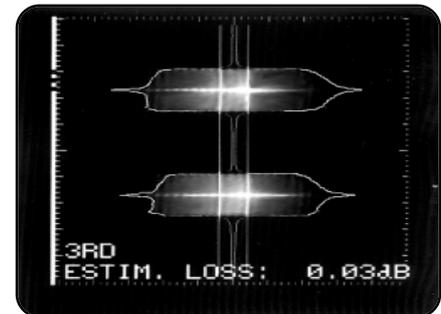


### Erbium doped fiber

### ERBIUM DOPED FIBER

Pre-defined programs: 06 & 07

Erbium doped fiber is used in amplifiers to increase the intensity of a light signal within an optical network. It achieves this through a combination of erbium dopants and a smaller than average core (usually 4  $\mu\text{m}$ , as opposed to 6-8  $\mu\text{m}$ ). However, since erbium fiber is usually being spliced to other types of fiber with larger cores, special techniques must be applied to make the best match of the dissimilar cores.



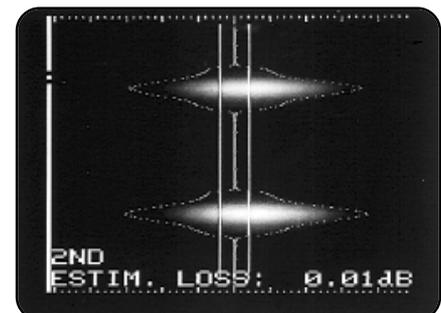
Hot image of erbium + single mode fibers

### Multimode fiber

### MULTI-MODE FIBER

Pre-defined program: 04

Multimode fiber has a larger core that permits the transmission of several light modes simultaneously, and since it does not have any mechanisms for dampening dispersion, it is usually only used in smaller, local networks. On the other hand, its advantage is that it is relatively easy to splice. If you are ever not sure whether you have multimode fiber, it is quite easy to identify it by looking at its distinctive hot image profile.



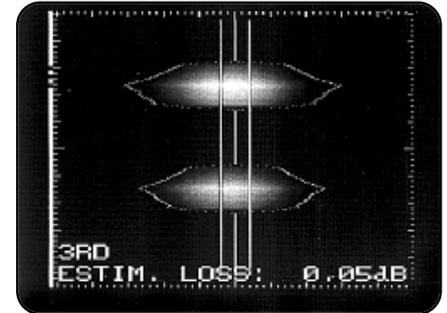
Hot image of multimode fibers

## Depressed cladding fiber

### DEPRESS. CLAD. FIBER

Pre-defined program: 02

Depressed cladding fibers are doped with both germanium in the core and fluorine in the inner part of the cladding. The purpose of this double-doping is to reduce dispersion at a chosen wavelength. As with titanium doped fibers, the increased radiation from the dopants makes it difficult to distinguish the core in hot images, so a special filtering technique must be applied. The other difficulty you might encounter is that the dopants have a tendency to diffuse during splicing, resulting in higher splice loss.



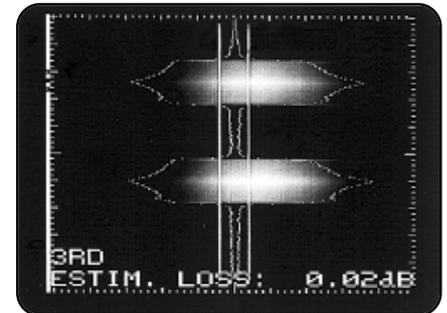
Hot image of depressed cladding fibers

## Dispersion shifted fiber

### DEPRESS. CLAD. FIBER or INVISIBLE CORE FIB.

Pre-defined program: 02

Like depressed cladding fiber, dispersion shifted fiber is designed to achieve a low level of dispersion at a chosen wavelength. And again like depressed cladding fiber, the dopants used to create the necessary gradation of refractive indexes, make the core very difficult to see in hot images. Because of their similarities, you can specify "DEPRESS, CLAD. FIBER" with dispersion shifted fiber; however, if the splice loss is too high using this fiber type specification, you should select "INVISIBLE CORE" instead.



Hot image of dispersion shifted fibers

## Silica core fiber

### INVISIBLE CORE FIB.

Pre-defined program: 02

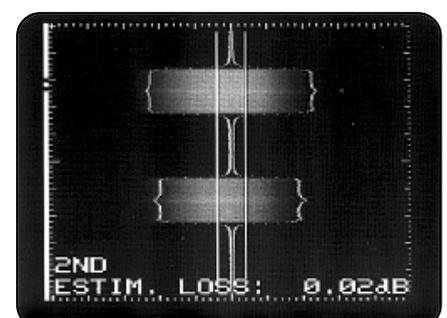
Silica core has the same difficulty as dispersion shifted fiber: namely that the high level of dopants (in this case fluorine in the cladding) can make it nearly impossible to see the core.

## Titanium fiber

### TITANIUM FIBER

Pre-defined program: 03

Titanium fibers have an outer layer doped with titanium dioxide, which has the result of increasing the fiber's resistance to fatigue. A splicing difficulty is that this titanium doped layer, when heated, emits more radiation than the cladding, making it hard to see the core in hot images. Another peculiarity is that splicing titanium fibers contaminates the electrodes more quickly than other splicing combinations. To minimize this contamination, as well as the risk of "matchsticking"--a phenomenon where the fibers do not fuse, but rather melt at their tips forming round balls at their ends--a program with a lower current should be used.

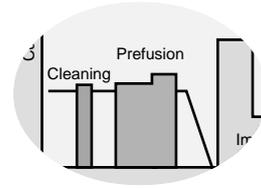


Hot image of titanium fibers

# C Splicing process

Splicing processes represent a way of dividing splicing programs into groups according to the way the splicer carries out the splicing sequence. The FSU 995 FA is organized around six splicing processes:

- 1 Normal splicing..... 28
- 1 Hot core alignment..... 29
- 1 Small core alignment ..... 30
- 1 Mode field matching ..... 31
- 1 Attenuator making ..... 34
- 1 Pulling or tapering..... 35



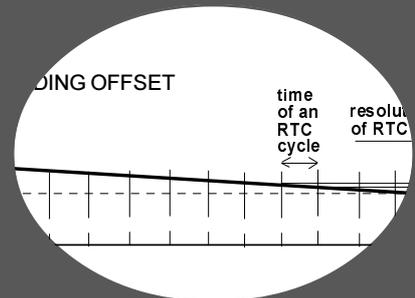
The diagrams included with the splicing processes are actually two superposed graphs. The bar graph represents the electrode currents with respect to time. The line graph represents the fiber distance with respect to time.

The following descriptions will outline the special operations and considerations involved with each splicing process, as well as, the necessary control parameters to run these operations (to read more about control parameters, see the section on program parameters, p.36). Like the explanation of fiber types, each description will be headed with a list of the pre-defined programs that use the splicing process, and thus can serve as a base for your own program.

## Real Time Control (RTC)

RTC is a sub process used in some of the FSU 995 FA splicing processes. It controls that the conditions set by program parameters are fulfilled and then stops the appropriate splicing sequence. This is usually done by taking and analyzing a number of hot images during the splicing sequence.

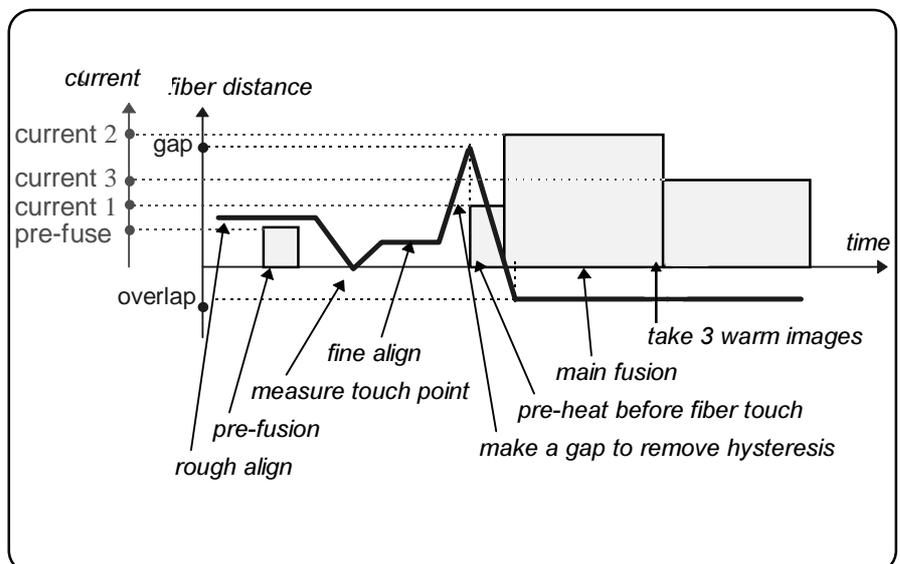
The time it takes the FSU 995 to take a hot image and analyze it is 0.2 seconds and is called an *RTC cycle*.



## Normal splicing

Pre-defined programs: 01-04, 10

The normal splicing process is suitable for standard single and multimode fibers with a core to cladding eccentricity (ie. how much the core is not centered in the fiber) of less than 0.6 μm. There are no special control parameters associated with normal splicing.

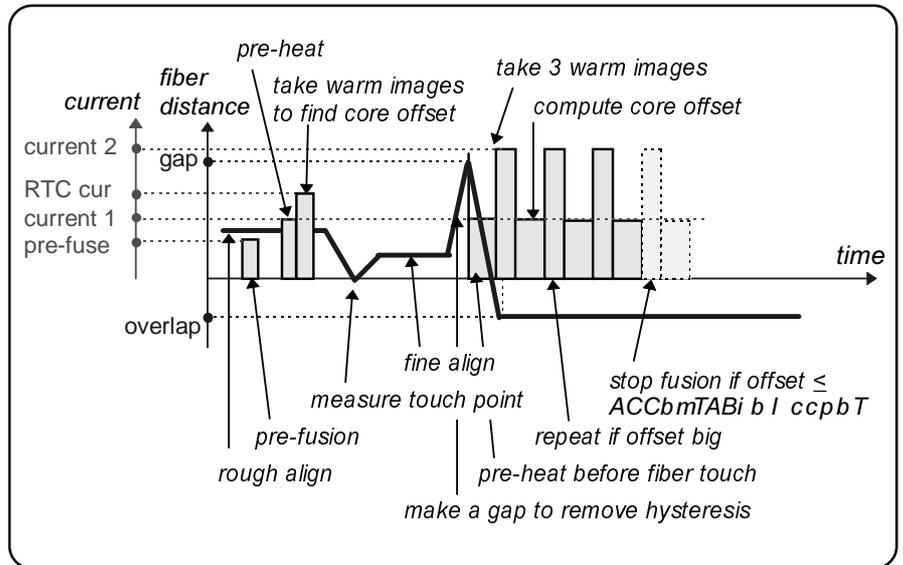


A typical splicing sequence for the normal splicing process

## Hot core alignment

Pre-defined program: 05

Hot core alignment is designed for single mode fibers with a core to cladding eccentricity greater than  $0.6 \mu\text{m}$ . To be able to line up and splice fibers who are not susceptible to the normal splicing method of lining up the claddings with the assumption that the cores will thereby also be aligned, the FSU 995 FA makes use of hot images and real time control (RTC).



A typical splicing sequence for the hot core alignment process

The FSU 995 FA employs hot image analysis and RTC in the hot core alignment process to overcome the two main difficulties associated with highly eccentric cores. The first difficulty is that the splicer must locate the cores and align them properly. The second difficulty is that alignment of the eccentric cores inevitably means that the claddings will not line up. This would not be such a problem in and of itself if it were not for the fact that the misalignment of the claddings leads to surface tension during fusion that bends the fibers, and pulls the cores back out of alignment.

## Hot core alignment control parameters

### MAX. ECCENTRICITY

is used to decide whether the fibers should be spliced at all. To determine whether the maximum allowable eccentricity has been exceeded, the splicer takes hot images before splicing. If this reading is above the value of the parameter, you will receive a warning in the monitor, and the splicing sequence will stop.

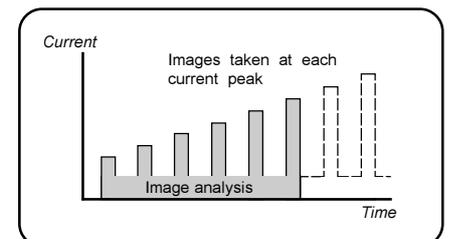
### ACCEPTABLE OFFSET

regulates whether a RTC sequence with its compensatory elements or a normal splicing sequence will be used to splice the fibers. It can be that the offset measured in the first part of the process is so small (ie. is acceptable) that it is just as well to line up the claddings and splice normally.

### RTC CURRENT

is the current applied to take the hot images needed for measurement of the eccentricity of the fibers. You can set it manually, or use the current test (see p. 57), which sets it automatically.

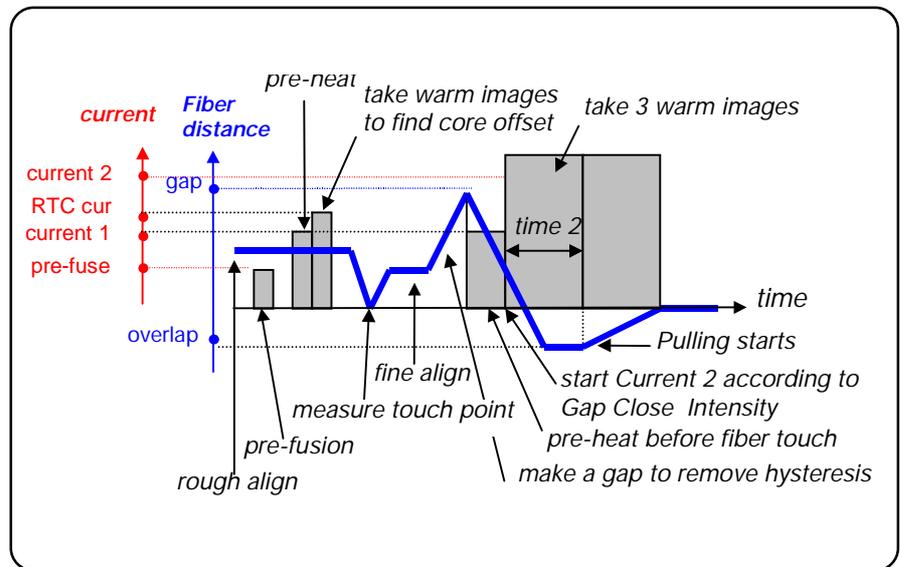
- **FUSION CURRENT 2** is not specifically a hot core alignment parameter, but you should take note that if you choose a value of 0.0 mA, the current test sets this parameter automatically the same time it determines the RTC CURRENT. Otherwise you will have to set it manually.



Model of current test

## Small core alignment

The small core alignment process is a special hot core alignment process, recommended for use when splicing small core fibers that has highly eccentric cores. Compared with single mode fiber, small core fibers with high eccentric cores requires a higher degree of accuracy during alignment in order to avoid high splice losses. This is achieved by combining the hot core alignment process with functions that helps to overcome the problems of misalignment and surface tension.



A typical splicing sequence for the small core alignment process

## Small core alignment control parameters

The control parameters used for the small core alignment process are the same as for the hot hot core alignment process. However, the parameters MAX. ECCENTRICITY and ACCEPTABLE OFFSET incorporates, besides their initial function, other parameters which functions are described below (see also p. 38).

### GAP CLOSE INTENSITY

is used for initiating FUSION CURRENT 2 before the fiber ends touch to soften the fibers ends even more than during the FUSION CURRENT 1 phase.

The value of the parameter specifies the measured light intensity from the FSU 995 FA lamp when the fiber ends are aligning. If you set a high parameter value, the gap between the fiber ends will be wide when FUSION CURRENT 2 is initiated, and vice versa.

### ECF FACTOR

stands for Eccentricity Compensation Function factor and allows you to offset the the core alignment to compensate for surface tension.

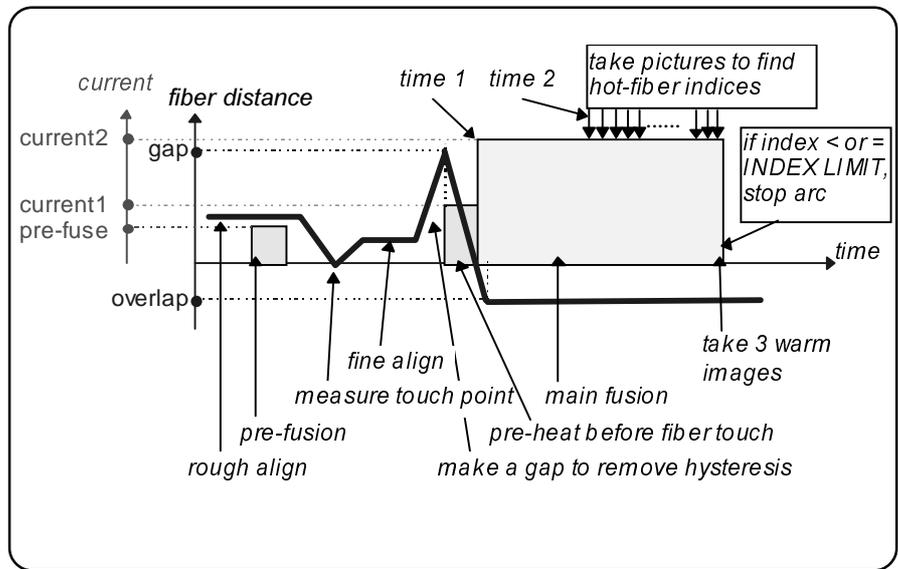
### PULLING DISTANCE

is the distance in micrometers ( $\mu\text{m}$ ) that the two fibers is to be pulled.

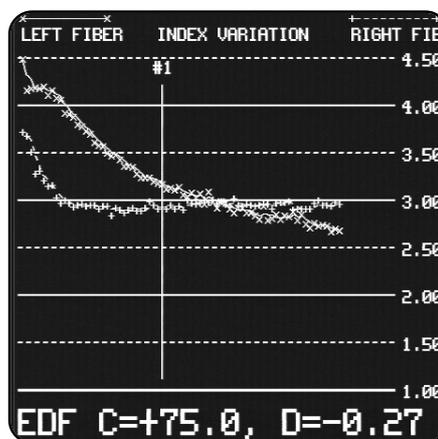
## Mode field matching

Pre-defined programs: 06 & 07

The mode field matching process is intended for splicing fibers with very dissimilar mode field diameters. That is to say: Different types of fiber require different diameter cores to carry their fundamental mode. Erbium fiber, for example, has a smaller than average core, and when you want to splice an erbium fiber with another type of fiber, you must find some way to make the transition from one core to the other as smooth as possible in order to avoid power loss around the unmatched core edges. This is achieved by means of a hot fiber index profile. During splicing, a fiber's dopants will diffuse into its core, decreasing its index profile. With two fibers this can result in a convergence of their profiles. With RTC this process can be observed and the arc stopped when the best match of profiles has been achieved.



A typical splicing sequence for the mode field matching process



A graph from a Threshold type test (see p.32) plotting of the index profiles for two fibers. Note how the profiles converge.

## Mode field matching control parameters

### INDEX LIMIT

represents the value the hot fiber index will be allowed to reach before the arc will shut off, thus ending the splicing sequence. We recommend that the first time you splice a new fiber combination that you run the Threshold type test (see next page). See also *Using the index limit parameter* on p. 33.

### THRESHOLD TYPE

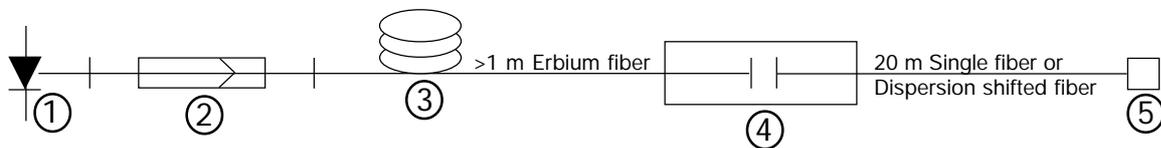
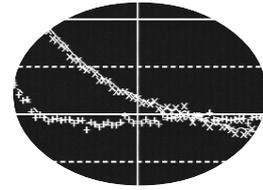
represents the type of comparison that should be made between the hot fiber index profiles for the two fibers. The easiest way to set the Threshold type is by running the Threshold type test (see next page).

### LOSS FACTOR

is a compensatory variable used in splice loss estimation to account for the difference between INDEX LIMIT (the value entered in the parameter) and the measured index after splicing.

## Threshold type test

When you are presented with a new fiber combination it is highly advisable to run the Threshold type test. You do so by setting the parameter THRESHOLD TYPE to Threshold type test (see page 43, for instructions as to how you edit parameters), as well as setting up the test configuration shown below. During the Threshold type test, you will get an index profile of the two fibers based on how they behave during heating (see picture on previous page). The result of the test will be a value for the Index limit, as well as, the information necessary to choose a Threshold type. While the test is running, it is recommended to do a splice loss measurement, as well, which you do by pressing the #-button when the loss is at a minimum. You can save up to three data points (eg. press the #-button three times) for the splice loss measurement, and the final value will be their average.



1. Light source
2. Lightwave isolator
3. 3 spools with a diameter of approximately 5-8 cm for mode filtering
4. Splicer: FSU 995 FA
5. Detector

*Set-up for the threshold type test*

## Threshold types

### DIFFERENCE

When the difference between the two index profiles decreases during splicing, it is possible to determine the optimal match by just measuring the difference between the two index profiles, stopping the splicing sequence when the difference is at a minimum. See also on next page.

### LEFT INDEX *and* RIGHT INDEX

When the difference between the two index profiles does not become smaller during splicing, it is necessary to measure the absolute indexes of the fibers, rather than their difference. You should measure the fiber who has the least variation in its index profile.

If the left fiber's index varies least, choose LEFT INDEX  
If the right fiber's index varies least, choose RIGHT INDEX.

### HIGHER INDEX

When one fiber always has a higher index profile than the other or when the profiles cross frequently during heating, it is best to measure the higher absolute index.

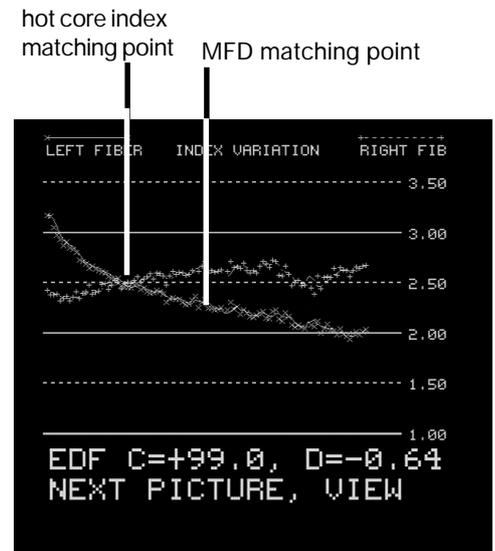
### HIGHER START

It is also possible to choose to measure the absolute index of the fiber that has the higher index in the first cycle of measurement.

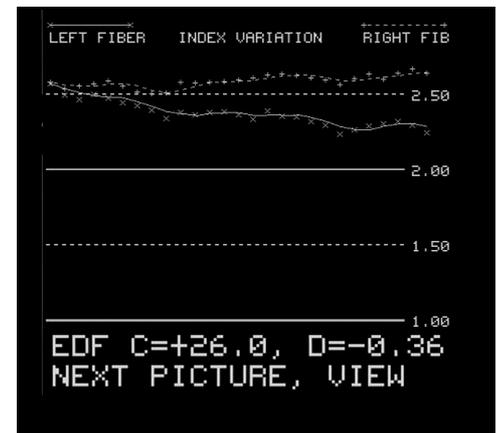
## Using the index limit parameter

The parameter INDEX LIMIT can be either a positive or a negative value. For most cases you will most probably use a positive value. The arc will then shut off when the monitored index profile of one or both fibers, depending on the Threshold type used, has *decreased* to the set value.

The only case you will need to use a negative index limit is when you find that the best match of the index profiles, the so called MFD matching point, is found after the two index profiles have diverged (see top figure). A negative value means that the mode field matching process will terminate when the difference between the two index profiles has *increased* to the set index limit value. For the process not to terminate before the divergence, the RTC procedure must be initiated when the profiles have converged (see bottom figure). This you achieve by adjusting the splicing parameter FUSION TIME 2 (p. 39). Estimate, using the Threshold type test graph, the time it takes from that the RTC procedure starts to that the index profiles converge and then add that time to the FUSION TIME 2 parameter. Note that the RTC procedure used in the Threshold type test takes approximately 20 seconds (100 RTC cycles x 0.2 seconds).



A graph from a Threshold type test where the MFD matching point is found after the hot core index match point

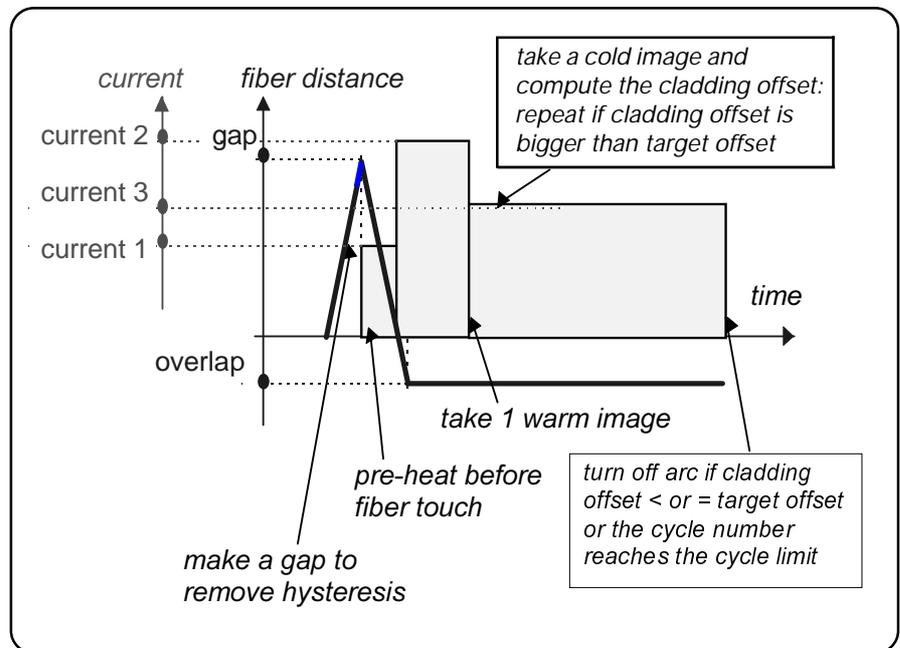


An example of a graph when the RTC procedure is initiated just after the index profiles have diverged.

## Attenuator making

Pre-defined program: 08

Attenuator making is the process you use when you want to reduce the strength of a signal – because of a short distance between a transmitter and receiver, for example. This signal strength reduction is, for most cases, achieved by using RTC to measure and set a cladding offset (see diagram) to the desired attenuation value. When the targeted attenuation value is reached, the fibers are spliced.



### Note:

For fibers with highly eccentric cores it is essential that the fibers are spliced with respect to the position of the cores to get a good result. To achieve this, you need to increase the parameter FUSION CURRENT 3 to 12 mA from its initial setting of 9mA. This will trigger the attenuator making process to take hot instead of cold images during the RTC procedure, thereby making it possible to locate the cores.

## Attenuator making control parameters

### DESIRED ATTENUAT.

is measured in dB, and quantifies the desired attenuation--the degree to which you want to reduce signal strength. If you select a value greater than 0 dB, as well as, give the mode field diameters for each of the fibers in the parameters LEFT MFD and RIGHT MFD, the splicer will automatically set a target offset for the desired attenuation.

### OFFSET ADJUSTMENT

is the means by which you can adjust the target offset (the intended offset after the splicing sequence). The value you enter here will be added to the target offset calculated by the splicer. To make the value negative, you should use the  $\ominus$  button.

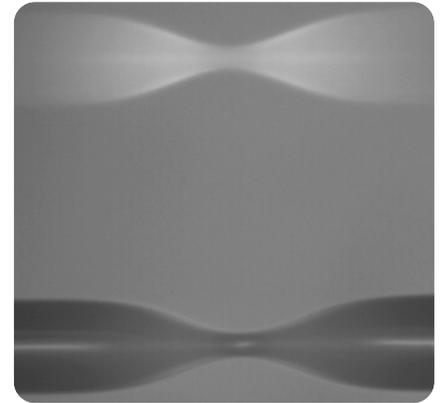
### ECF FACTOR

when set at a value between 1 and 10, compensates for the surface tension mentioned in relation to hot core alignment that bends the cores out of alignment. If, on the other hand, it is set to 0, RTC is disabled, and if set above 10 it determines the limit to the number of RTC cycles the splicer will carry out before ending the splicing sequence automatically (see above diagram).

## Pulling or tapering

Pre-defined program: 09

Pulling or tapering is used primarily to create micro-lenses and microscope fiber probes out of fiber end-faces. During the process, the splicer simultaneously pulls and heats the fibers into an hour glass shape that eventually divides at the tip. This tapering process increases the mode field diameter to give the fiber a higher numerical aperture. To then capitalize on this phenomenon to make a micro-lens, the ends are made to take on a semi-spherical form which can focus light from an external source into the core.

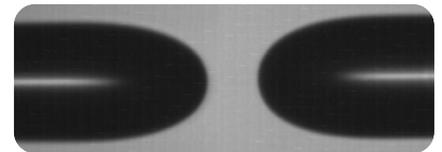


*Hour-glass form at the end of the first pulling step using Program 09*

## Pulling or tapering control parameters

### PULL 1, PULL 2, PULL 3

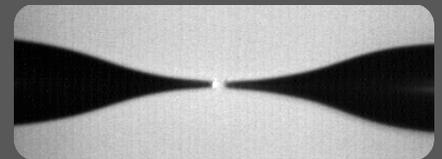
are the three parameters controlling the pulling or tapering process. They represent three rounds of pulling, and each is associated with the FUSION CURRENT and FUSION TIME carrying the same number (eg. FUSION CURRENT 2 is the current used during PULL 2). The PULL parameters are binary and can only be turned off or on.



*Example of micro-lenses formed using Program 09*

### Sample program for creating fiber probes

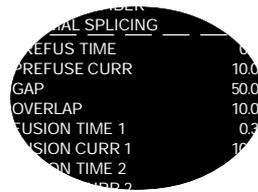
FUSION CURRENT 1	12 mA
FUSION TIME 1	15 sec.
PULL 1	Yes
FUSION CURRENT 2	10 mA
FUSION TIME 2	5 sec.
PULL 2	Yes
FUSION CURRENT 3	7 mA
FUSION TIME 3	10 sec.
PULL 3	Yes



*Example of fiber probes for a microscope*

## D Program parameters

The program parameters are the variables used by each splicing program to guide the splicing sequence. The FSU 995 FA distinguishes three sets of program parameters: the general parameters, the control parameters and the splicing parameters. The following tables will list all of these parameters, along with their ranges of possible values and default values.



### General parameters

The general parameters hold information that concerns the overall structure of the splicing program.

Parameter	Function	Range	Default
PROGRAM NAME	Max 16 character name	All characters except "@"	empty
KEY NUMBER	Max 3-digit security code	000 to 999	000
SECURITY TYPE	0 = Open (available to all) 1 = Read only 2 = Confidential	0 to 2	Open (=0)
FIBER TYPE	Specifies fiber type: 0 = Standard fiber 1 = Titanium fiber 2 = Depress. clad. fiber 3 = Erbium doped fiber 4 = Invisible core fiber 5 = Multimode fiber	0 to 5	Standard fiber (=0)
PROCESS TYPE*	Specifies splicing process: 0 = Normal splicing 1 = Hot core alignment * 2 = Mode field matching 3 = Attenuator making 4 = Pulling or tapering	0 to 4	Normal splicing (=0)

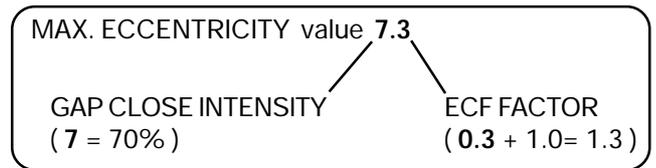
\* Choose the Hot core alignment process if you are to use the Small core alignment process.

## Control parameters

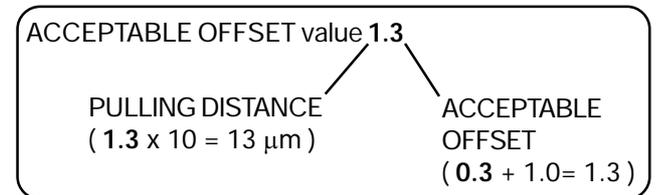
The control parameters are the parameters that control the specific operations of each of the splicing processes, and the following tables organizes them accordingly.

Observe that two of the control parameters for Small core alignment, MAX. ECCENTRICITY and ACCEPTABLE OFFSET (see next page), have multiple functions. The figures on the right shows you how to set these parameters.

For more details on the control , you can also refer to the preceding section on splicing processes (p. 28-35).



*Setting the **MAX. ECCENTRICITY** parameter when running the Small core alignment process*



*Setting the **ACCEPTABLE OFFSET** parameter when running the Small core alignment process*

Note that you will revoke the small core alignment process and invoke the hot core alignment process if you set MAX. ECCENTRICITY to a value that is greater than 2.9 μm. Also, if you set ACCEPTABLE OFFSET to a value that is greater than 0.9 μm, you will set the PULLING DISTANCE parameter and thereby revoke the pulling procedure.

	Parameter	Function	Range	Default
Hot core alignment	MAX.ECCENTRICITY	Max core to cladding eccentricity	0.00 to 2.99 μm	1.0 μm
	ACCEPTABLE OFFSET	Max acceptable core offset	0.0 to 0.9 μm	0.3 μm
	RTC CURRENT	Heating current for initial RTC images	6.0 to 29.9 mA	11 mA
Mode field matching	INDEX LIMIT	Min acceptable hot fiber index	0.0 to 9.99	0.4
	THRESHOLD TYPE	Comparison method for hot fiber indexes (see also p. 32) 0 = Threshold type test 1 = Difference 2 = Left index 3 = Right index 4 = Higher index 5 = Higher start	0 to 5	0
	LOSS FACTOR	Adjusts splice loss estimation	0.00 to 9.99	0.35

*Continued on the following page →*

	Parameter	Function	Range	Default
Attenuator making	DESIRED ATTENUAT.	Desired level of attenuation	0.0 to 29.9 dB	0
	OFFSET ADJUSTMENT	User adjustment added to target offset (Offset as seen in upper view)	-29.9 to +29.9 $\mu\text{m}$ (use +/- buttons to change sign)	0
	ECF FACTOR	Surface tension compensation factor/ RTC control parameter*	00.0 to 99.0	1.5
Pulling or tapering	PULL 1	Controls first round of pulling	YES/NO	YES (=1)
	PULL 2	Controls second round of pulling	YES/NO	YES (=1)
	PULL 3	Controls third round of pulling	YES/NO	YES (=1)
Small core alignment	MAX. ECCENTRICITY (recommended value = 7.3)		5.0 to 9.9 $\mu\text{m}$	
		GAP CLOSE INTENSITY Gap between fibers that initiates FUSION CURRENT 2	50 to 90 %	
		ECF FACTOR Surface tension compensation factor*	1.0 to 1.9	
		MAX. ECCENTRICITY Max core to cladding eccentricity	1.0 $\mu\text{m}$ (unchangeable)	
		ACCEPTABLE OFFSET (recommended value = 1.3)	1.1 to 1.9 $\mu\text{m}$ ( lower limit ) 2.1 to 2.9 $\mu\text{m}$ ( upper limit )	
		PULLING DISTANCE The distance the fibers are to be pulled	11 to 19 $\mu\text{m}$ ( lower limit ) 21 to 29 $\mu\text{m}$ ( upper limit )	
		ACCEPTABLE OFFSET Max acceptable core offset	0.1 to 0.9 $\mu\text{m}$	
	RTC CURRENT (recommended value = 11.8)	Heating current for initial RTC images	10.0 to 12.0 mA	

\*ECF = 0: RTC disabled

0<ECF<1.0: Align offset = Computed offset *and* Target offset = ECF x computed offset

1.0<ECF<10.0: Align offset = ECF x target offset *where* Target offset = Computed offset

ECF > 10: Fixed number of RTC cycles where number of cycles = ECF - 10

Align offset = The offset the splicer sets at the beginning of the splicing sequence.

Computed offset = The offset calculated by the splicer based on DESIRED ATTENUAT. and RIGHT MFD and LEFT MFD.

Target offset = The intended offset at the end of the splicing sequence.

## Splicing parameters

The splicing parameters are the parameters that control the general operations of the splicing sequence. Regardless of splicing process, the following parameters are applied to guide the splicer through alignment, prefusion and fusion.

*Nevertheless, some of these parameters are used slightly differently during particular processes. If this is the case, the parameter's special use will be indicated in italics.*

Parameter	Function	Range	Default
PREFUSE TIME	Time prefusion current runs	0.0 to 9.9 sec	0.2 sec
PREFUSE CURRENT	Current during prefusion	0.0 to 29.9 mA	10.0 mA
GAP	Gap set right before splicing	0.0 to 99.9 $\mu\text{m}$	50.0 $\mu\text{m}$
OVERLAP	Overlap during splicing	0.0 to 49.9 $\mu\text{m}$	8.0 $\mu\text{m}$
FUSION TIME 1*	Fusion time before the fiber ends touch	0.0 to 99.9 sec	0.3 sec
FUSION CURRENT 1	Fusion current before the fiber ends touch <i>During Hot core alignment it is the initial RTC current</i>	0.0 to 29.9 mA	10.5 mA
FUSION TIME 2	Fusion time after the fiber ends touch <i>During Mode field matching and Attenuator making it also represents the waiting time before the RTC procedure begins.</i>	0.0 to 99.9 sec	2.0 sec
FUSION CURRENT 2	Fusion current used from the point the ends touch <i>During Hot core alignment, if it is set to 0, the auto-current will be used.</i>	0.0 to 29.9 mA	15.0 mA
FUSION TIME 3	Relaxation time <i>During Hot core alignment it is used only if the core eccentricity is small.</i>	0.0 to 99.9 sec	2.0 sec
FUSION CURRENT 3	Relaxation current <i>During Hot core alignment it is used only if the core eccentricity is small.</i>	0.0 to 29.9 mA	12.5 mA

*Continued on the following page* →

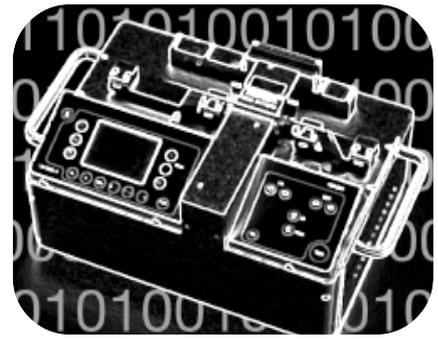
\* As the fiber moving speed = GAP/FUSION CURRENT 1, do not set FUSION CURRENT 1 to 0.0.

Parameter	Function	Range	Default
LEFT MFD	Mode field diameter for left fiber	2.0 to 19.9 $\mu\text{m}$	9.8 $\mu\text{m}$
RIGHT MFD	Mode field diameter for right fiber	2.0 to 19.9 $\mu\text{m}$	9.8 $\mu\text{m}$
SET CENTER	Sets normal splicing or off-center splicing	150 to 360 pixels	255 pixels
AOA CURRENT	Arc-on-alignment current Disable by setting to 0.	6.0 to 29.9 mA	0
EARLY PREFUSION	Do prefusion before any alignment	YES/NO	NO
ALIGN ACCURACY	Accuracy for axis alignment	0.01 to 9.99 $\mu\text{m}$	0.15 $\mu\text{m}$
LOSS SHIFT	Adjusts the difference between estimated and measured loss	-1.00 to +1.00	0 db
AUTO ARC CENTER	Activate the <i>Automatic Arc Re-centering</i> function	YES/NO	NO

The splicing parameters listed on this page will be discussed in greater detail in the section on “Advanced splicing parameters,” p. 55.

## Pre-defined programs: Programs 01 - 10

As explained in the section on Basic Operation, the FSU 995 FA comes with ten pre-defined programs. These programs represent all five splicing processes, and are intended to cover a wide array of splicing needs. It is also recommended that you use them as a base when designing your own programs. With this in mind, the following cards list these programs' parameters. You can also see a program's parameters by following the instructions on page 13 for bringing up the screen-viewer. Keep in mind, though, that these programs are NOT editable. So if you want to make modifications you will have to copy the program to one of the editable slots by following the instructions in the following section.



### Program 01

"NORMAL SM + SM"  
Standard single fiber  
Normal splicing

PREFUSE TIME	0.2 s
PREFUSE CURRENT	10.0 mA
GAP	50.0 μm
OVERLAP	10.0 μm
FUSION TIME 1	0.3 s
FUSION CURRENT 1	10.5 mA
FUSION TIME 2	2.0 s
FUSION CURRENT 2	16.3 mA
FUSION TIME 3	2.0 s
FUSION CURRENT 3	12.5 mA
LEFT MFD	9.8 μm
RIGHT MFD	9.8 μm
SET CENTER	255
AOA CURRENT	0.0 mA
EARLY PREFUSION	NO
ALIGN ACCURACY	0.15 μm
LOSS SHIFT	0 dB
AUTO ARC CENTER	NO

P01

### Program 02

"DSF SM + SM"  
Depressed cladding fiber  
Normal splicing

PREFUSE TIME	0.2 s
PREFUSE CURRENT	10.0 mA
GAP	50.0 μm
OVERLAP	8.0 μm
FUSION TIME 1	0.3 s
FUSION CURRENT 1	10.5 mA
FUSION TIME 2	2.0 s
FUSION CURRENT 2	15.0 mA
FUSION TIME 3	2.0 s
FUSION CURRENT 3	12.5 mA
LEFT MFD	9.8 μm
RIGHT MFD	9.8 μm
SET CENTER	255
AOA CURRENT	0.0 mA
EARLY PREFUSION	NO
ALIGN ACCURACY	0.15 μm
LOSS SHIFT	0 dB
AUTO ARC CENTER	NO

P02

### Program 03

"TITAN SM + SM"  
Titanium fiber  
Normal splicing

PREFUSE TIME	0.2 s
PREFUSE CURRENT	10.0 mA
GAP	50.0 μm
OVERLAP	8.0 μm
FUSION TIME 1	0.3 s
FUSION CURRENT 1	10.5 mA
FUSION TIME 2	2.0 s
FUSION CURRENT 2	14.0 mA
FUSION TIME 3	2.0 s
FUSION CURRENT 3	13.0 mA
LEFT MFD	9.0 μm
RIGHT MFD	9.0 μm
SET CENTER	255
AOA CURRENT	6.5 mA
EARLY PREFUSION	YES
ALIGN ACCURACY	NO
LOSS SHIFT	0 dB
AUTO ARC CENTER	NO

P03

### Program 04

"NORMAL MM + MM"  
Multimode fiber  
Normal splicing

PREFUSE TIME	0.3 s
PREFUSE CURRENT	11.5 mA
GAP	50.0 μm
OVERLAP	12.0 μm
FUSION TIME 1	0.3 s
FUSION CURRENT 1	12.0 mA
FUSION TIME 2	2.0 s
FUSION CURRENT 2	15.5 mA
FUSION TIME 3	1.0 s
FUSION CURRENT 3	12.5 mA
LEFT MFD	9.8 μm
RIGHT MFD	9.8 μm
SET CENTER	255
AOA CURRENT	0.0 mA
EARLY PREFUSION	NO
ALIGN ACCURACY	0.25 μm
LOSS SHIFT	0 dB
AUTO ARC CENTER	NO

P04

**Program 05****"ECCENTRIC SM + SM"**Single fiber with eccentric core  
Hot core alignment

MAX ECCENTRICITY	1.0 μm
RTC CURRENT	12.5 mA
ACCEPTABLE OFFSET	0.3 μm
PREFUSE TIME	0.3 s
PREFUSE CURRENT	10.0 mA
GAP	50.0 μm
OVERLAP	8.0 μm
FUSION TIME 1	0.2 s
FUSION CURRENT 1	10.5 mA
FUSION TIME 2	0.3 s
FUSION CURRENT 2	0.0 mA
FUSION TIME 3	3.0 s
FUSION CURRENT 3	16.0 mA
LEFT MFD	9.8 μm
RIGHT MFD	9.8 μm
SET CENTER	255
AOA CURRENT	0.0 mA
EARLY PREFUSION	NO
ALIGN ACCURACY	0.10 μm
LOSS SHIFT	0 dB
AUTO ARC CENTER	NO

P05

**Program 06****"ERBIUM + SM MCVD"**Erbium fiber with single fiber  
Mode field matching

INDEX LIMIT	0.4
THRESHOLD TYPE	Difference
LOSS FACTOR	0.35
PREFUSE TIME	0.3 s
PREFUSE CURRENT	10.0 mA
GAP	50.0 μm
OVERLAP	8.0 μm
FUSION TIME 1	0.3 s
FUSION CURRENT 1	10.5 mA
FUSION TIME 2	2.0 s
FUSION CURRENT 2	15.5 mA
FUSION TIME 3	0.5 s
FUSION CURRENT 3	12.0 mA
LEFT MFD	7.5 μm
RIGHT MFD	8.5 μm
SET CENTER POSITION	255
AOA CURRENT	6.5 mA
EARLY PREFUSION	NO
ALIGN ACCURACY	0.10 μm
LOSS SHIFT	0 dB
AUTO ARC CENTER	NO

P06

**Program 07****"ERBIUM + DSF OVD"**Erbium with dispersion shifted  
Mode field matching

INDEX LIMIT	2.6
THRESHOLD TYPE	Higher start
LOSS FACTOR	0.35
PREFUSE TIME	0.3 s
PREFUSE CURRENT	10.0 mA
GAP	50.0 μm
OVERLAP	4.0 μm
FUSION TIME 1	0.3 s
FUSION CURRENT 1	10.5 mA
FUSION TIME 2	1.5 s
FUSION CURRENT 2	15.0 mA
FUSION TIME 3	0.5 s
FUSION CURRENT 3	12.0 mA
LEFT MFD	7.5 μm
RIGHT MFD	9.0 μm
SET CENTER POSITION	255
AOA CURRENT	6.5 mA
EARLY PREFUSION	YES
ALIGN ACCURACY	0.10 μm
LOSS SHIFT	0 dB
AUTO ARC CENTER	NO

P07

**Program 08****"SM ATTENUATOR"**Standard single fiber  
Attenuator making

DESIRED ATTENUAT.	15 dB
OFFSET ADJUSTMENT	0.0 μm
ECF FACTOR	1.3
PREFUSE TIME	0.3 s
PREFUSE CURRENT	10.0 mA
GAP	50.0 μm
OVERLAP	4.0 μm
FUSION TIME 1	0.3 s
FUSION CURRENT 1	10.0 mA
FUSION TIME 2	0.6 s
FUSION CURRENT 2	12.0 mA
FUSION TIME 3	0.3 s
FUSION CURRENT 3	9.0 mA
LEFT MFD	9.8 μm
RIGHT MFD	9.8 μm
SET CENTER POSITION	255
AOA CURRENT	6.5 mA
EARLY PREFUSION	NO
ALIGN ACCURACY	0.10 μm
LOSS SHIFT	0 dB
AUTO ARC CENTER	NO

P08

**Program 09****"SM FIBER LENS"**Standard single fiber  
Pulling or tapering

PULL 1	YES
PULL 2	YES
PULL 3	YES
PREFUSE TIME	0.3 s
PREFUSE CURRENT	10.0 mA
GAP	0.0 μm
OVERLAP	0.0 μm
FUSION TIME 1	9.0 s
FUSION CURRENT 1	15.0 mA
FUSION TIME 2	7.0 s
FUSION CURRENT 2	12.0 mA
FUSION TIME 3	2.0 s
FUSION CURRENT 3	7.0 mA
LEFT MFD	9.8 μm
RIGHT MFD	9.8 μm
SET CENTER POSITION	255
AOA CURRENT	0.0 mA
EARLY PREFUSION	NO
ALIGN ACCURACY	0.15 μm
LOSS SHIFT	0 dB
AUTO ARC CENTER	NO

P09

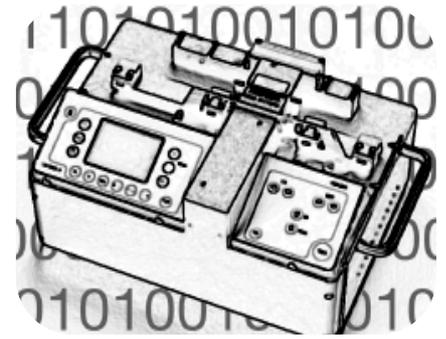
**Program 10****"SM 80 UM MICRON"**Standard single fiber  
Normal splicing

PREFUSE TIME	0.2 s
PREFUSE CURRENT	8.0 mA
GAP	40.0 μm
OVERLAP	4.0 μm
FUSION TIME 1	0.3 s
FUSION CURRENT 1	8.5 mA
FUSION TIME 2	2.0 s
FUSION CURRENT 2	12.0 mA
FUSION TIME 3	0.0 s
FUSION CURRENT 3	0.0 mA
LEFT MFD	8.5 μm
RIGHT MFD	8.5 μm
SET CENTER POSITION	255
AOA CURRENT	0.0 mA
EARLY PREFUSION	NO
ALIGN ACCURACY	0.10 μm
LOSS SHIFT	0 dB
AUTO ARC CENTER	NO

P10

# Program editing: Programs 11 - 50

One of the most important features of Advanced Operation is that you yourself can design your own splicing programs. The FSU 995 FA comes with 40 slots for user-defined splicing programs, and the following ten steps outline how you can fill them. Note that program editing with the FSU 995 FA is organized serially, meaning that to reach a later step you must pass through the ones preceding it. (eg. You cannot directly jump to Step 5, but rather must first go through Steps 1-4.)

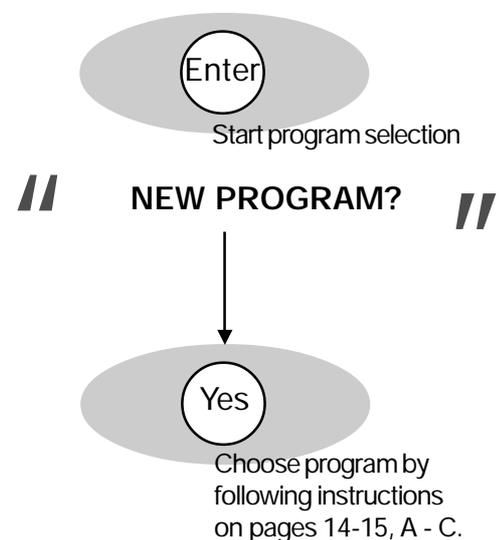


1	Choose a program to edit .....	40
2	Enter editing mode .....	41
3	Pass through security .....	41
4	Use another program as a base .....	42
5	Set or change security .....	43
6	Name or re-name the program .....	44
7	Change the fiber type and splicing process .....	45
8	Edit control parameters .....	46
9	Edit splicing parameters .....	48
10	Re-edit program .....	49

## 1 Choose a program to edit

To choose a program to edit you follow the program selection process. You start by pressing ENTER, which brings up the question "New Program?" You then answer **Yes** and follow the instructions listed on pages 14-15, steps A - C.

If you have already selected the program you want to edit, you can jump to step 2.



You should note that nearly all of the splicer messages listed during program editing appear in the *message field*. From the point you press ENTER in the first step, the *mode field* is devoted to showing the program you are editing. The adjacent figure shows an example where the program we are editing is Program number 26, MODIFICATION 1.

**MODIFICATION 1 P26  
NEW PROGRAM?**

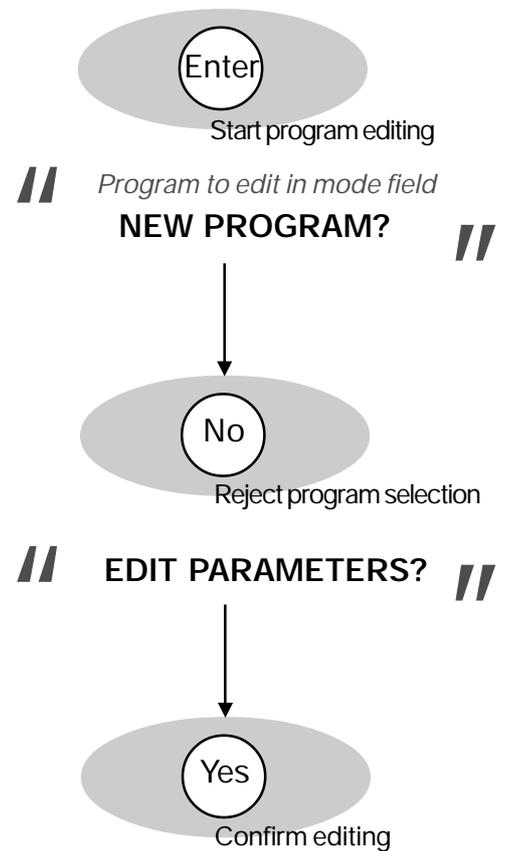
## 2 Enter editing mode

Regardless of whether you have just gone through the program selection procedure, or are starting program editing here, you press ENTER to enter editing mode. (It is equivalent to step D in the program selection procedure.) The splicer will then ask you (possibly for the second time) if you want to change program.

If the program listed in the *mode field* is indeed the one you want to edit, you should answer **No**, and reject program selection.

The splicer will then ask if you want to edit parameters, and you confirm this by pressing **Yes**. At this point you will enter program editing mode.

If you answer No, you will exit both program editing and program selection, and will return to splicing mode.

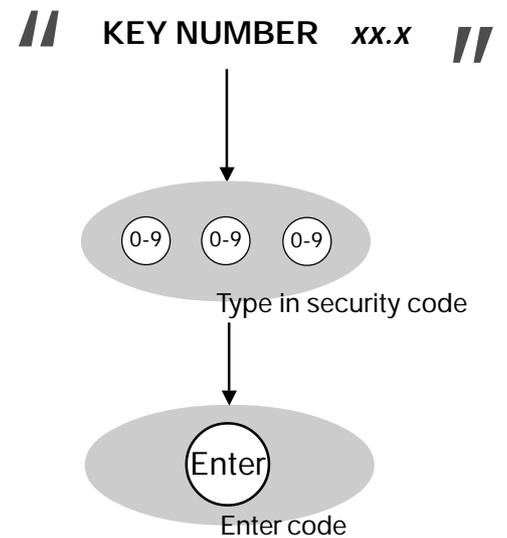


## 3 Pass through security

If the program you have selected in step 1 is classified as an "Open" program, you will not be asked to enter a key number (a security code).

If, however, the selected program is classified as either "Read only" or "Confidential," you must enter the security code at this point using the number buttons. Remember that the number buttons are organized such that the first button (from the left) corresponds to the first number of the code, the second button to the second number, and the third to the third.

You will then have to confirm the code by pressing ENTER. If you have entered the wrong code, you will be aborted from program editing.



## 4 Use another program as a base

As has been recommended earlier, it is helpful to use another program as a base when designing your own. If you want to do so, and copy the parameters of another program into the slots of your new program, you should press **Yes** at this point. If you do not want to copy parameters from another program--because you are editing again a program you designed previously, for example--you should press No and go onto step 5 on the following page.

The splicer will then ask in the *message field* which program you want to copy ("Copy Source Pyy"), and you must enter the number of the program you want to copy by using the first two number buttons (from the left). Let's say that we chose to copy the parameters from Program 08. In that case you would enter a "0" with the first number button and an "8" with the second.

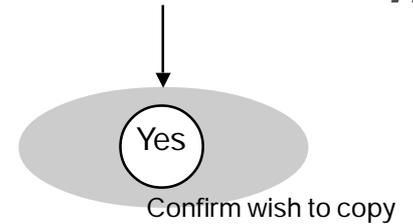
You enter the choice of source program by pressing ENTER.

The splicer will then ask you to confirm that you want to replace the parameters in the program selected in step 1 with those of the source program just selected. This confirmation is very similar to what computers do when they ask you if you are sure you want to delete a certain file, because copying the source program's parameters will erase whatever parameters were there beforehand.

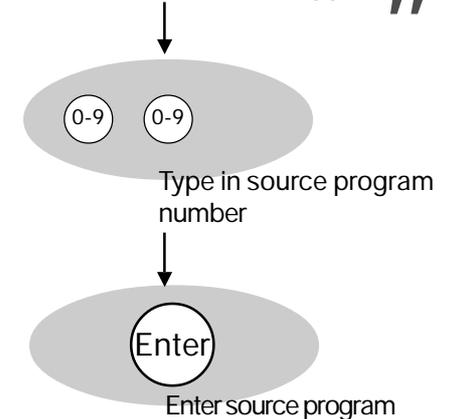
To confirm your desire to copy the source program, press **Yes**. If you press No, then the copying will be cancelled.

As a last precaution, the splicer will then ask for the security code for the source program if the source program is classified as "Confidential". This is to ensure that no one has access to programs they shouldn't just by copying them to a new slot. To give a source program's security code, you follow the same procedure as in step 3.

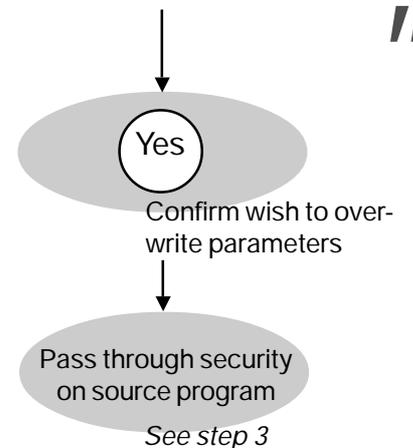
### // COPY PARAMETERS? //



### // COPY SOURCE Pyy //



### // OVERWRITE Pxx? //



## 5 Set or change security

Before you start creating or editing your program it is important to stop and determine what type of security you want on it. If, for example, you just copied the parameters out of one of the pre-defined programs, the security is classified as "Open," meaning that anyone could come along after you and change the parameters again. If you don't want this to happen, you can protect your program by making it either "Read only" or "Confidential."

**A** The first step in changing security is to change the security code. If you are intending that the program have a security type other than "Open," it is necessary to have a code known only by those who need access to the program's parameters. Remember that the security code imported from pre-defined programs is "00.0," and is printed in the manual.

To confirm that you want to change the security code, press **Yes**.

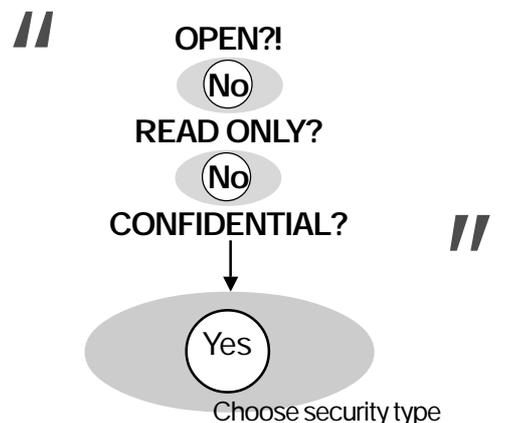
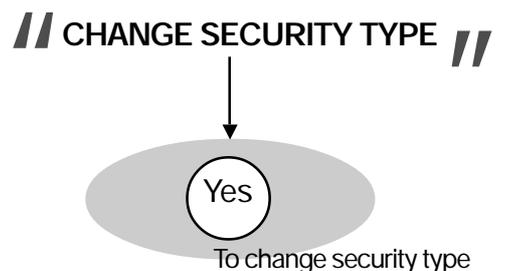
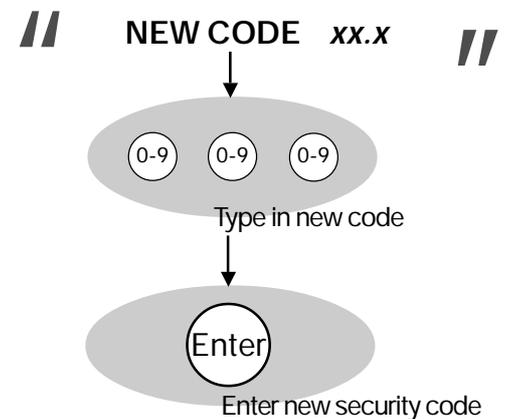
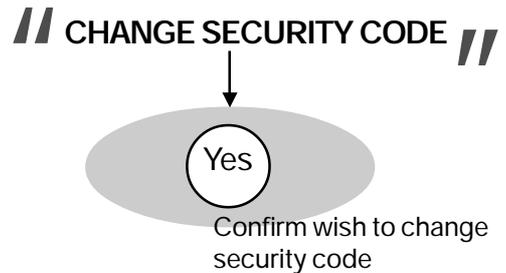
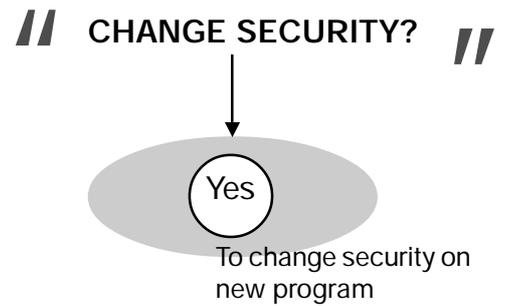
The message field will then open up for you to enter a new code by displaying "New code xx.x." You can then type in your new code using the number buttons. As always with security codes, it is best to pick something memorable but not too obvious.

You enter your new security code by pressing ENTER.

**B** It is now time to change the security type--to choose whether the program will be classified as "Open," "Read only" or "Confidential." The splicer will ask in the *message field* "Change security type"?, and to do so, press **Yes**. If you press No, you go to step 6.

The splicer will then present each possibility one by one. It will first read "Open?!" in the message field, and if you do not want the program to be classified as Open you press **No**. It will then offer "Read Only?" as an alternative, and after that "Confidential?" If you press **No** when it reads "Confidential?" "Open?!" will come up again.

In short, you scroll through this list with the **No** button until the security type you want is shown in the *message field*, and then press **Yes**.



To orient yourself within the splicing program structure, you should take note that the step we just completed was to change two of the general parameters listed on page 36: KEY NUMBER and SECURITY TYPE. The other three general parameters (PROGRAM NAME, FIBER PROCESS, and FIBER TYPE) are changed in the following steps, steps 6 and 7.

### General parameters

The general parameters h

#### Parameter

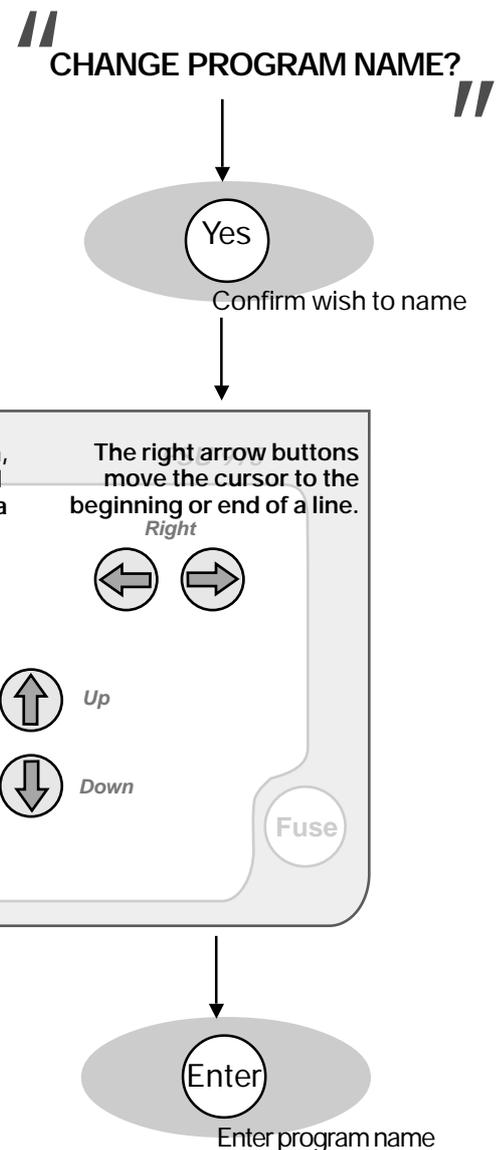
PROGRAM NAME

## 6 Name or re-name the program

The next step is to name--or re-name, in the case of simple editing--the splicing program. As explained above, the program name will be stored, with the security code and security type, amongst the general program parameters. The splicer will ask in the *message field*, "Change program name?," and to do so, you press **Yes**.

Entering text on the FSU 995 FA is controlled by the arrow buttons, according to the adjacent description. You can also use a method of quick character selection, which is described on page 61 to facilitate the process. Regardless how you enter the name, it should be no more than 16 characters long, and sufficiently specific that you will recognize it quickly and easily.

When you have successfully typed in the new program name, you press ENTER to save it.



## 7 Change fiber type and splicing process

At this point the splicer will ask if you want to change fiber type and/or splicing process. If you have copied over a source program (step 4) for which you only want to modify a few parameters, you may be able to skip this step. However, this is also a chance to verify that the right fiber type and splicing process are specified. To see these parameters you can press VIEW and bring up the screen-viewer. The fiber type and splicing process will be highlighted.

If you wish to change fiber type and/or splicing process, press **Yes**.

If you do not, press No and go on to Step 8.

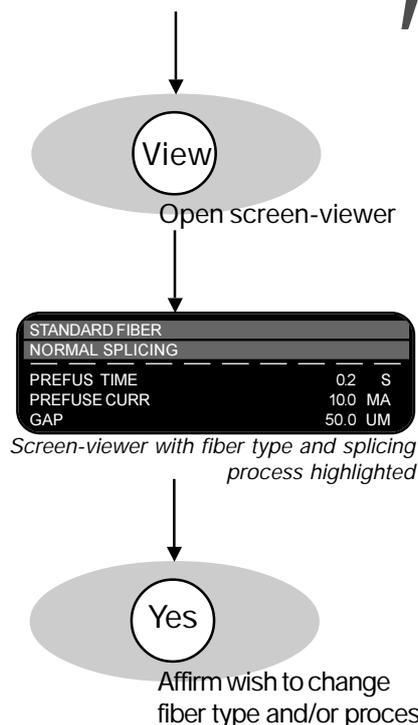
**A** The splicer will start with fiber type and ask you whether you want to change it by displaying "Change fiber type?" in the *message field*. If you are interested in changing the fiber type, press **Yes**.

If you are only interested in changing the splicing process, press No, and continue reading at "B" on the next page.

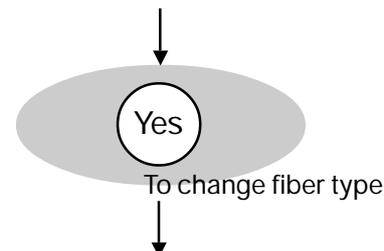
The splicer will then present you the options for fiber type in the same format as it did with security types: Each fiber type will successively be shown in the message field, while you scroll through them by pressing **No**.

When the fiber type you want is shown in the message field, you press **Yes**.

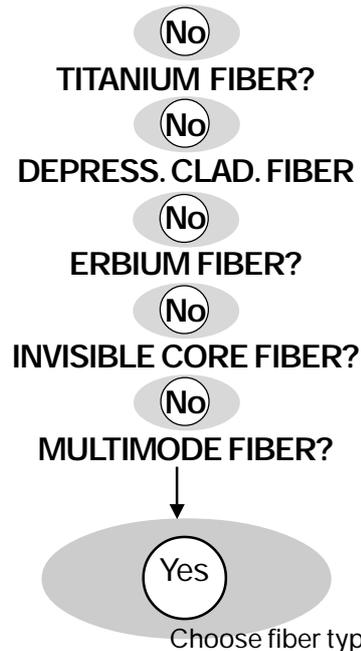
### // CHANGE FIBER/PROCESS //



### // CHANGE FIBER TYPE? //



### // STANDARD FIBER?!

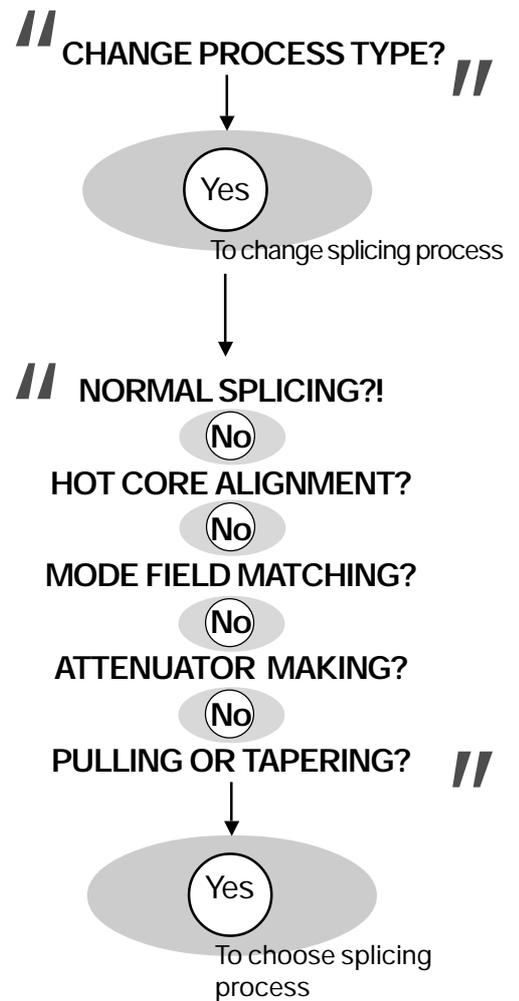


**B** The same procedure is then repeated in the case of splicing process. The splicer will ask "Change process type?", and you respond by pressing **Yes** if you do indeed want to change it.

If you only wanted to change the fiber type, and do not want to change the splicing process, you can press No and go on to step 8.

If you press Yes, the list of splicing processes will present itself one by one in the message field, while you scroll through the list by pressing **No**. If by chance you miss the splicing process you want you can get it back in the monitor by pushing **No** until the list wraps around (eg. If you press No after "Pulling or tapering?" you will next see "Normal splicing!?" again).

When the splicing process you want is in the message field you should press **Yes**.



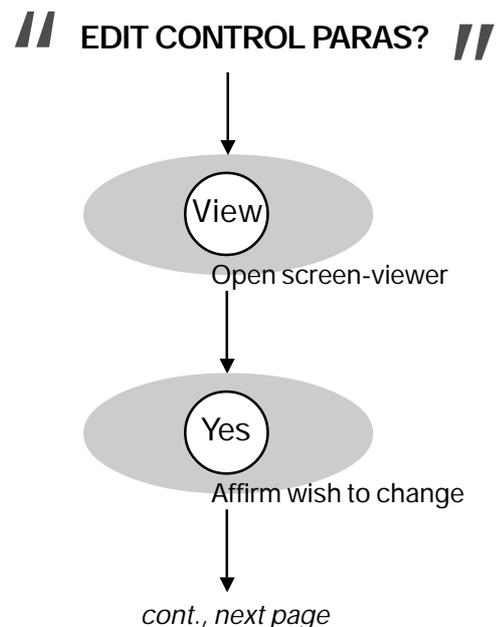
## 8 Edit control parameters

*For a full list of control parameters, see p. 37.*

This step only applies if you are editing a program that uses a splicing process with control parameters (eg. if the splicing process is NORMAL SPLICING, the splicer will not ask you whether you want to edit control parameters). In the cases that there are control parameters, the splicer will ask you "Edit control paras?." You have the option at this point of pressing the VIEW button and bringing up the screen-viewer to see what values the parameters have. The screen-viewer will come up with the fiber type and splicing process highlighted as seen in the picture on the previous page.

If you decide that do want to edit the control parameters, press **Yes**.

If you press No, you go on to step 9.



As all splicing processes have different control parameters (see pages 28-35), we will take the control parameters for mode field matching as an example. The range for possible values for mode field matching control parameters is listed on p. 37.

In the example shown to the right, the values you can change are highlighted. However, they will not be highlighted in the *message field* of the splicer.

**Step-by-step:**

In the adjacent example, you will first see "Index limit" with its present value, which you can change by pressing the first two numerical buttons (from the left) until the desired value is displayed. You then press ENTER.

The next control parameter is Threshold type, which will be presented to you in the form of a list of all the possible values. You scroll through this list by pressing No, until the desired value is displayed. You then press **Yes**.

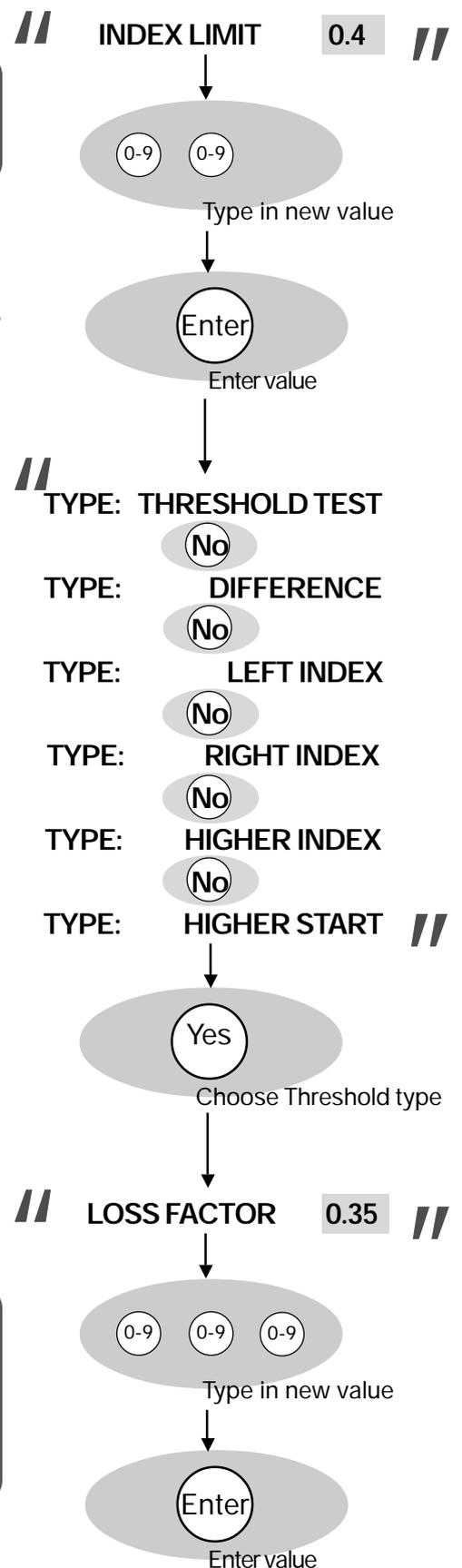
The last mode field matching parameter is LOSS FACTOR, which will appear in the *message field* along with its present value. You enter a new value, if desired, with the numerical buttons, and then press ENTER.

**In short:**

Each of the parameters appears successively in the *message field*, and you first change its value with either the number buttons, in the case of quantitative parameters, or Yes and No buttons, in the case of a binary (On/Off) parameters, and then press ENTER to save the new value. The only exceptions are parameters, such as Threshold type test, which have several distinct, non-numerical values. These parameters will present themselves as fiber type and splicing process do.

You should note that the procedure for editing control parameters has a logic that applies to all parameter editing, so once you are used to the logic for control parameter editing, you will know how to change any FSU 995 FA parameter (see also p. 53 for a review of this logic).

Cont. from preceding page  
 The following example is for a program using mode field matching:



# 9

## Edit splicing parameters

For a full list of splicing parameters, see p. 39.

If you have just edited control parameters, this step will be very straight-forward. First, the splicer will ask you "Edit splicing paras?," and once again you have the option of pressing the VIEW button to bring up the screen-viewer. If opened, the screen-viewer will come up with the splicing parameters highlighted.

Next, if you want to edit the splicing parameters, press **Yes**. If you press No, you go on to step 10.

In the example shown to the right, the values you can change are highlighted. However, they will not be highlighted in the *message field* of the splicer.

### Step-by-step:

After you press Yes, the first splicing parameter, PREFUSE TIME, will appear in the message field along with its current value. If you want to change it, you use the number buttons to change it. When you have the desired value for the parameter, press ENTER.

The splicer will then display the second parameter, PREFUSE CURR, and its value, which you can also change using the number buttons. Save the new value by pressing ENTER.

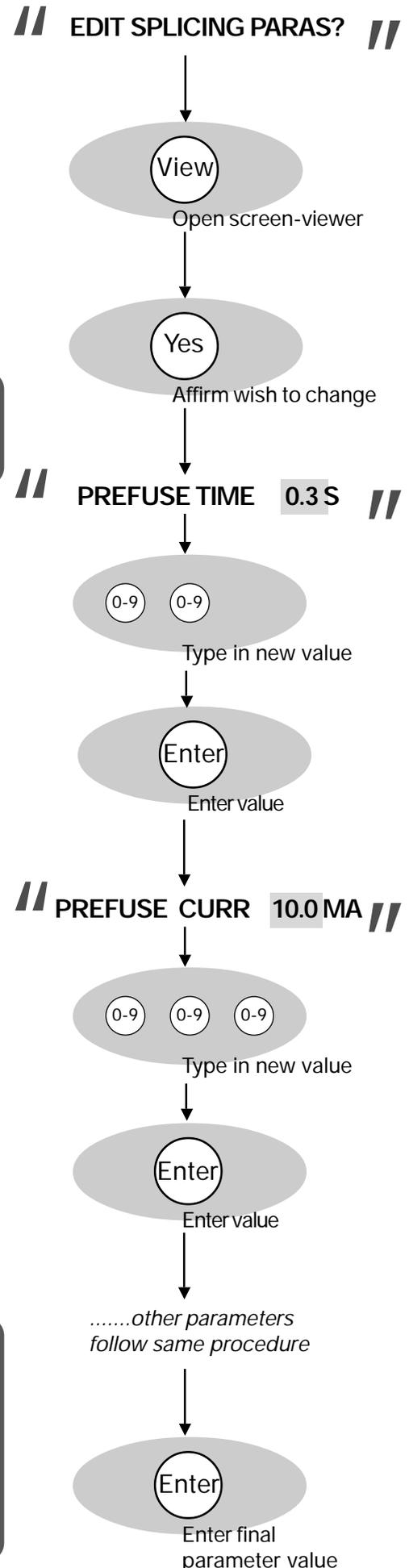
The rest of the parameters will follow this exact same procedure, with the exception of EARLY PREFUSION. For an example of how to deal with such binary parameters, see the parameter editing summary on page 53.

**Splicing parameter editing is complete when the value for the last parameter has been entered.**

### In short:

Each of the parameters appears successively in the *message field*, and you first change its value with either the number buttons, in the case of quantitative parameters, or Yes and No buttons, in the case of a binary (On/Off) parameters, and then press ENTER to save the new value.

For those of you who skipped over control parameter editing, we want to once again point out that the procedure for editing splicing parameters has a logic that applies to all parameter editing. So once you are used to the logic for splicing parameter editing, you will know how to change any FSU 995 FA parameter (see also p. 53 for a review of this logic).



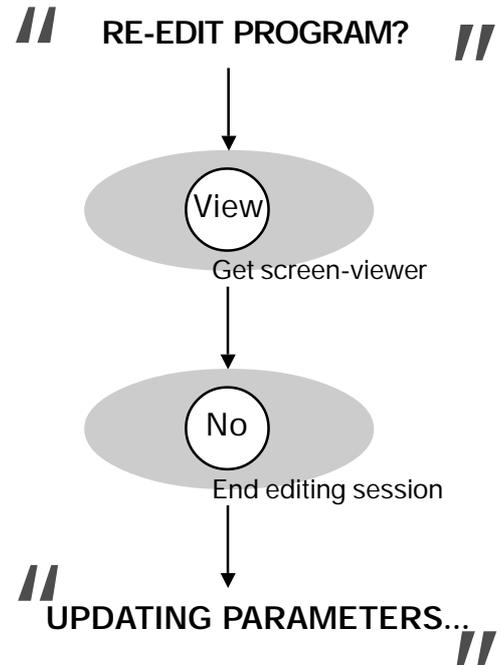
## 10 Re-edit program

At this point you have finished editing the splicing program. The splicer gives you a chance to go back, however, and make adjustments you might have missed the first time round.

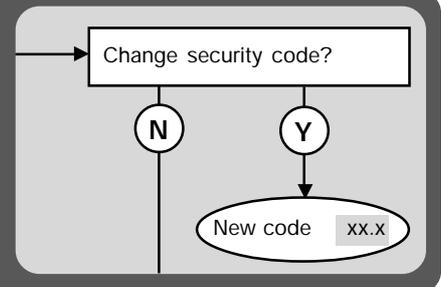
If you are not sure about whether you are satisfied with the current version of the program, you should press VIEW and bring up the screen-viewer. The screen-viewer will give you a list of all parameters (control and splicing) and their values.

If you are satisfied with the program, press **No** and end the editing session. The splicer will tell you it is "Updating parameters..." and then return to splicing mode.

If you press Yes, you will return to step 5 (p. 46).



Once you have gone through the program editing sequence once or twice, you will probably no longer need the step-by-step guide presented on these pages. Nevertheless, you may still want some reference for locating specific parameters and keeping tabs on where you are in the overall editing tree. If this is the case, you can look at the program editing flow chart in Appendix C, p. 77 .



## Parameter editing review

When considered step by step parameter editing can seem interminable; however, there is a basic logic that guides the editing procedure. Once you have become familiar with this logic, parameter editing will go easily and quickly.



### The programming buttons



The ENTER button has two functions:  
1. To initialize the editing procedure.  
2. To enter new values for the parameters.



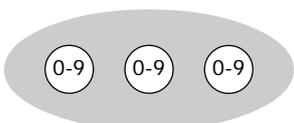
The VIEW button brings up the screen-viewer, so you can check the current values for parameters.



The YES button is used to answer two sorts of questions:  
1. In navigation through a procedure, to answer that you want to make the changes involved in the next step.  
2. With binary parameter values (see description on the following page), to turn a parameter ON.



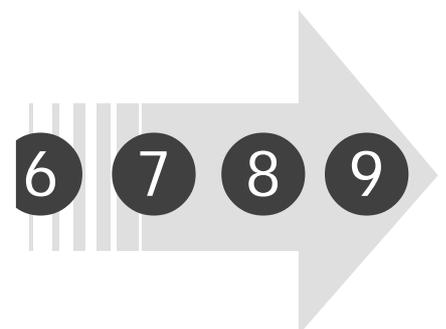
The NO button is used to answer two sorts of questions:  
1. In navigation, to answer that you do NOT want to make the changes involved in the next step. It is by pushing the NO button that you accelerate yourself from step to step during the editing procedure.  
2. With binary parameter values (see description on the following page), to turn a parameter OFF.



The number buttons are used to enter numerical values for quantitative parameters.

### Navigation through the parameter editing procedure

Navigation during parameter editing occurs by means of Yes/No questions. The editing procedure has been designed in blocks. The steps 1-10 you have just gone through correspond to these blocks. If you notice each of these blocks is prefaced by a Yes/No question. If you answer Yes, you go through the step and carry out the changes it entails. If you answer No, you jump to the next step. This makes it possible to speed up the editing procedure if you know in advance what you want to change.



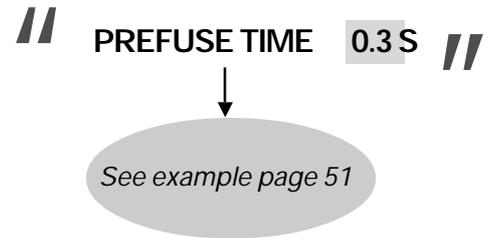
## Types of parameter values

Parameters can be divided according to the kind of values they hold. In the FSU 995 FA there are three major types of parameter values, each of which involves a slightly different editing procedure.

### 1 Quantitative parameter values

A quantitative parameter value is a number. An example is found in PREFUSE TIME, which we saw edited on page 51. The general procedure is as follows:

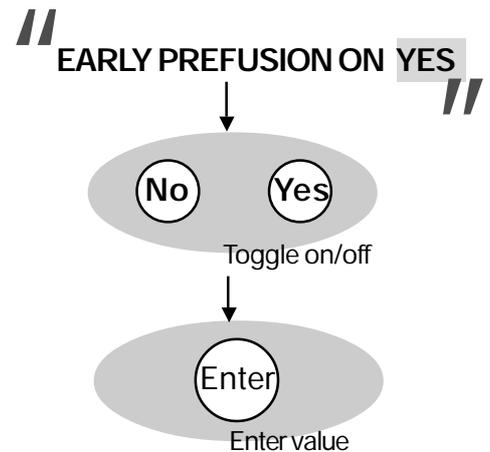
- The parameter appears with its current value.
- You can change the value using the number buttons
- You press ENTER to save the new value.



### 2 Binary parameter values

A binary parameter value has two states, usually either ON or OFF. An example of this type of value amongst the splicing parameters is EARLY PREFUSION, which we will take as an example here:

- The parameter name is presented as a question, and a variable region which toggles between Yes and No.
- Press the (No) button to turn the parameter off, and the (Yes) button to turn it back on again.
- Press ENTER to save the value of the parameter.



### 3 Parameters with multiple values

There are a few parameters which have multiple, non-numerical values. An example amongst the general parameters is SECURITY TYPE, which we saw edited on page 46. The general procedure is as follows:

- The first possible value for the parameter occurs with a question mark.
- If this is not the value you want, you press (No), at which point the second value appears, again as a question.
- You continue to press (No) and scroll through the list of possible values until the value you want is shown in the message field. At which point you press (Yes) and enter the new value for the parameter.

