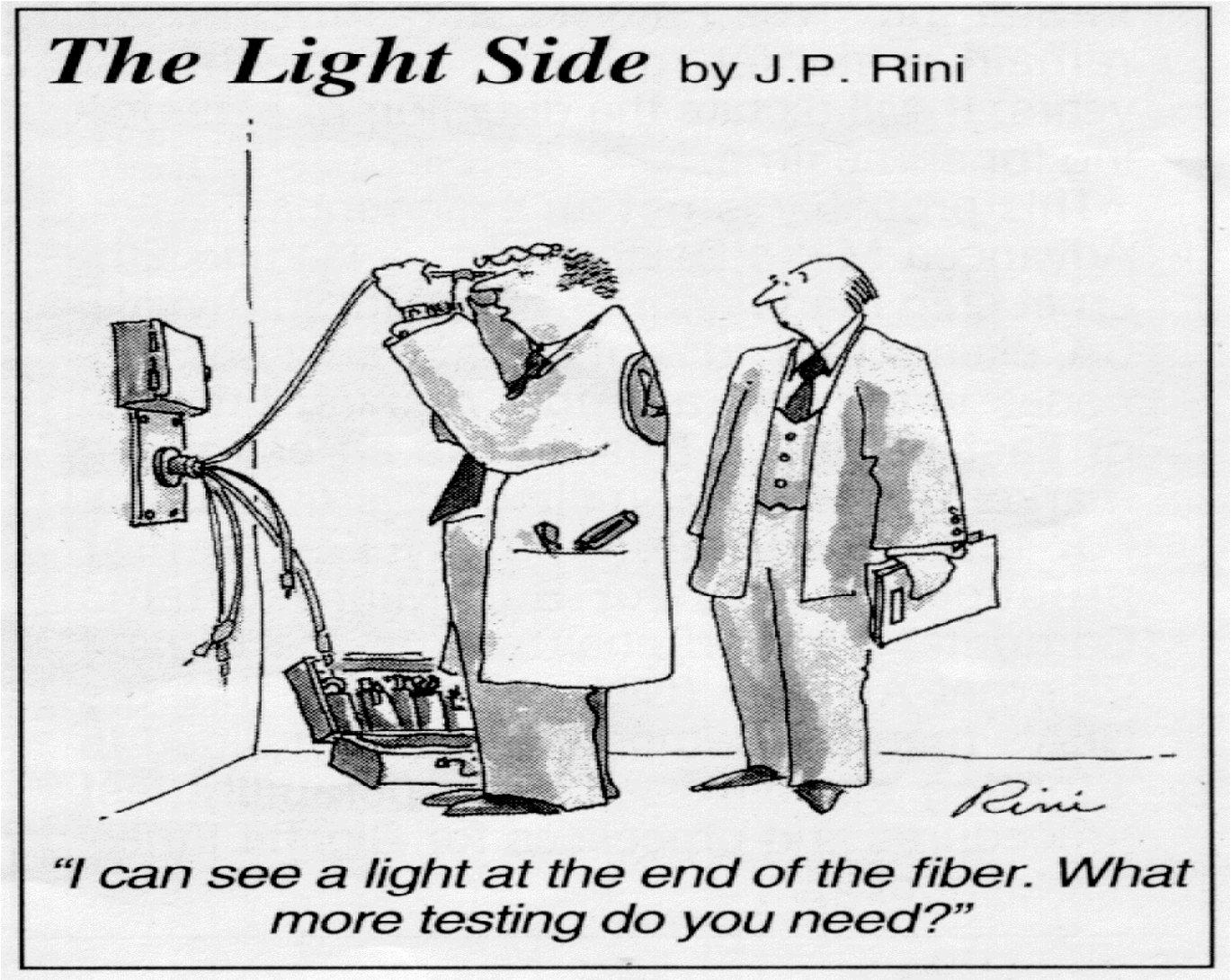
3M Mini OTDR 2000

3M Mini-OTDR 2000User training - Agenda

8:00 Welcome and Agenda Review
8:45 Introduction to Fiber Optics and OTDR Theory
9:45 Introduction to OTDR Measurements
11:00 Introduction to the 3M 2000 Mini-OTDR
11:30 Hands on Measurements with the 3M Mini-OTDR 2000
12:30 Lunch
13:30 Question and Answers
14:00 END


The Light Side by J.P. Rini
Rini
"I can see a light at the end of the fiber. What more testing do you need?"

OTDR Measurements Agenda

- Introduction to 3M Lightwave
- Fibers and Connectors
- Optical Time Domain Reflectometer Theory
- OTDR Measurements
- Introducing the 3M Mini-OTDR 2000
- Software Utilities the 3M Mini OTDR 2000
- Using the 3M Mini OTDR 2000

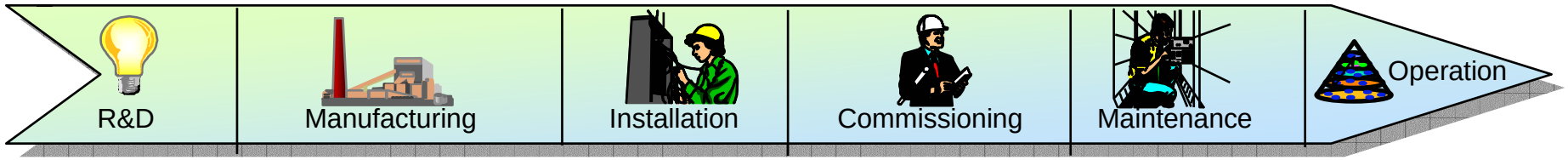
3M Lightwave Test Equipment

- Optical Switches
- Optical Routers
- Optical Mediaconverters
- Power Meters
- Loss Test Sets
- Tunable Laser SourcesAmplifier Test Systems

- Fiber Management Systems
- Mini-OTDR's
- Handheld Test Sets

3M Optical Communication Measurement -Purpose

To help our customers accelerate the development, deployment and operation of the All-Optical Network.

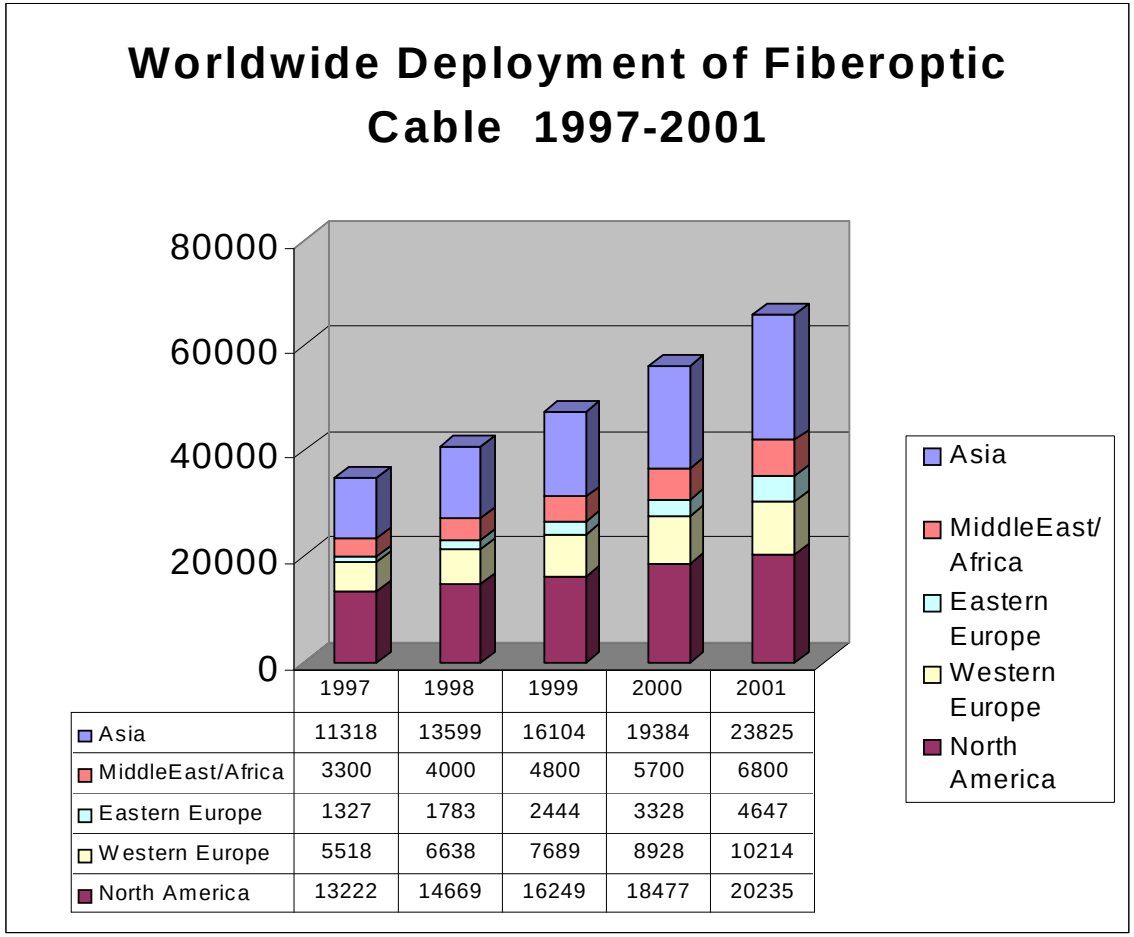


- Tun. + Fixed Sources
- Powermeters, Components
- Manuf. Test Systems e.g. EDFA

- OTDR
- Mini-OTDR
- RackOTDR
- Handhelds

- Network Management. Systems Agilent AccessFiber

Trends -Fiber usage is increasing



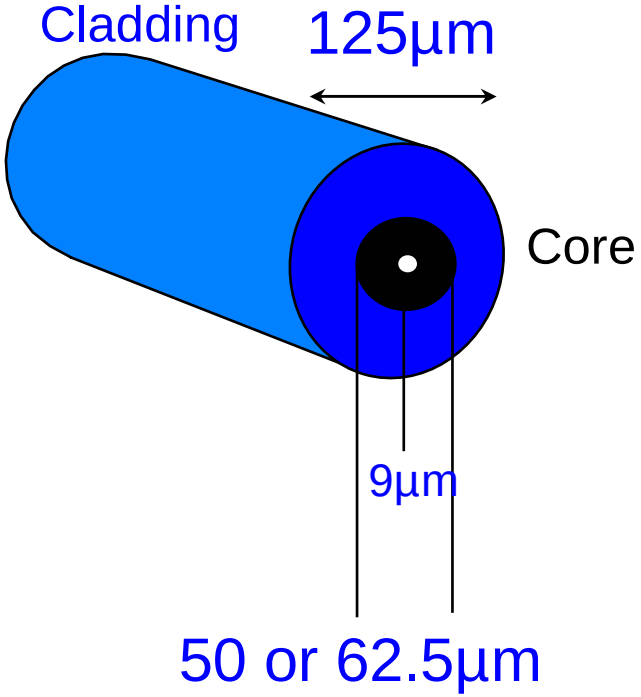
	1997	1998	1999	2000	2001
Asia	11318	13599	16104	19384	23825
MiddleEast/Africa	3300	4000	4800	5700	6800
Eastern Europe	1327	1783	2444	3328	4647
Western Europe	5518	6638	7689	8928	10214
North America	13222	14669	16249	18477	20235

Table reflects kilo-fiber-km Source PMR

6 miles of fiber has been used in the time it takes to read this sentence.

Fiber Manufactures could sell you a cable pair to connect up the Moon every week!

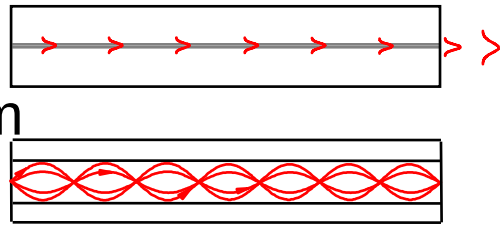
Fiber Fundamentals



Fiber types

-9/125µm Single mode

-50/125µm and 62.5/125µm multimode



Trends

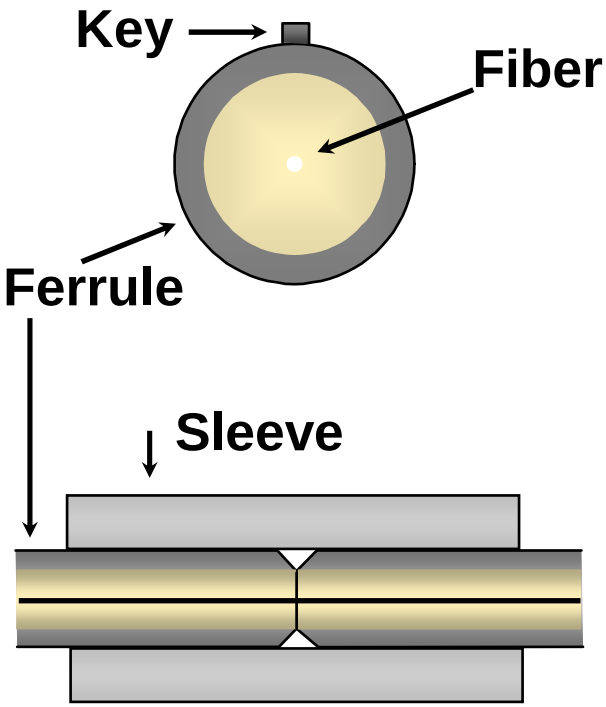
-Lower attenuation and dispersion

-Lower cost per ft.

-More fibers per cable: From 8 to 288

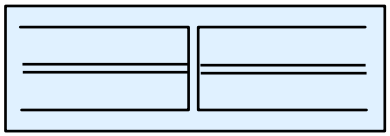
Connector Technology

- Ultra-high precision
  - *Optical axis aligned to better than ±1 µm (single-mode)*
  - *Physical contact of the glass end surfaces necessary to avoid strong reflections.*
- Connector cleanliness is paramount
  - *dirt can add insertion loss, and damage connections.*



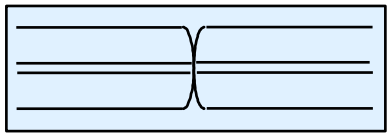
Common Connector Types Used with OTDRs

Air Gap (straight)



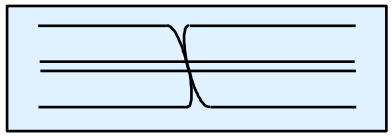
- **Worst return loss: <14 dB (Fresnel)**
- **Formerly common multimode fiber connector**

Physical Contact (straight)



- **Good return loss: >30-55dB dB**
- **Common single-mode fiber connector**

Physical Contact (Slanted)



- **Best return loss: >60 dB**
- **Used in highspeed telecom and CATV links**

A physical contact, angled-type connector on the OTDR could reduce deadzones.

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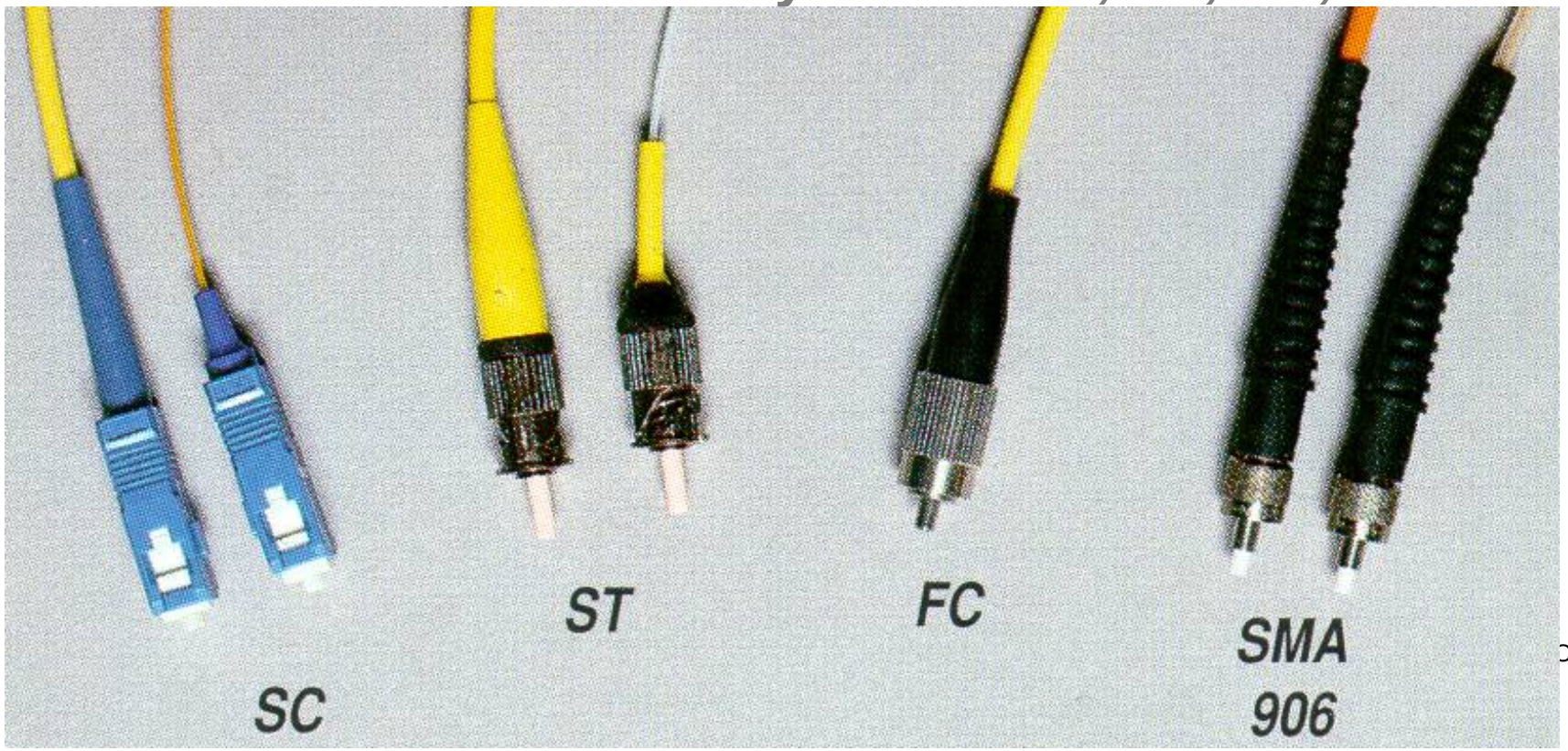
Connector Types

- **Fiber end polishing: *straight or angled***
- **Common mechanical styles: *FC/PC, ST, SC, DIN***



Gould Optics

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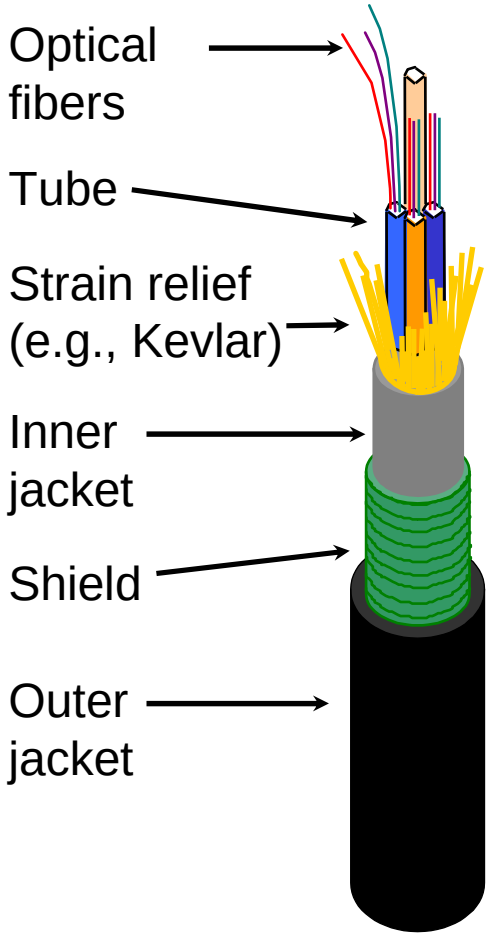
Cables

- Mechanical design: *Indoor, outdoor, or submarine installation*

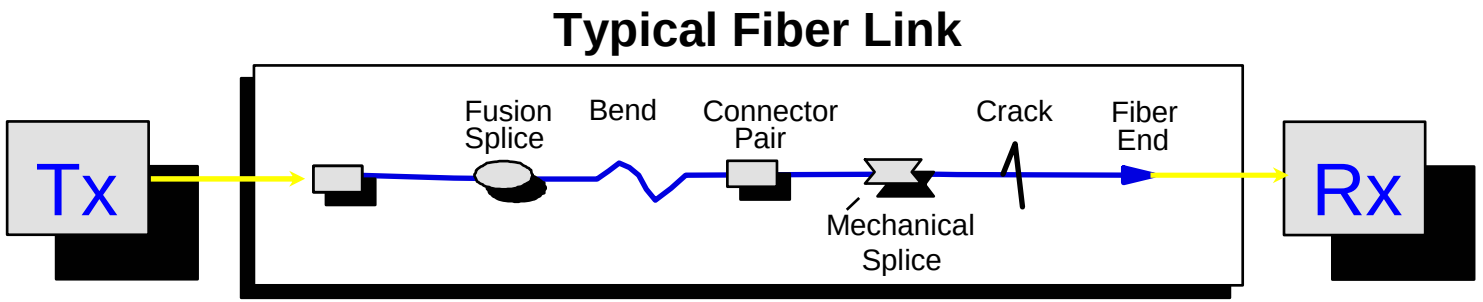
- Typical attenuation:
  - 0.2 - 0.25 dB/km @ 1550 nm, SM
  - 0.3 - 0.4 dB/km @ 1310 nm, SM
  - 0.5 - 0.7 dB/km @ 1300 nm, MM
  - 2.2 - 3.0 dB/km @ 850 nm, MM



What is a fiber optic link

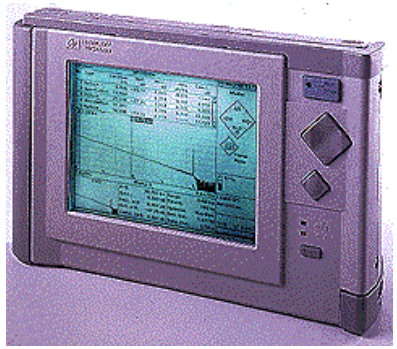
- Used to connect a transmitter to a receiver from distances between 2ft to 200 miles

- Main specifications are
  - Total Link loss and loss over distance
  - Individual reflection and total link return loss
  - Link length

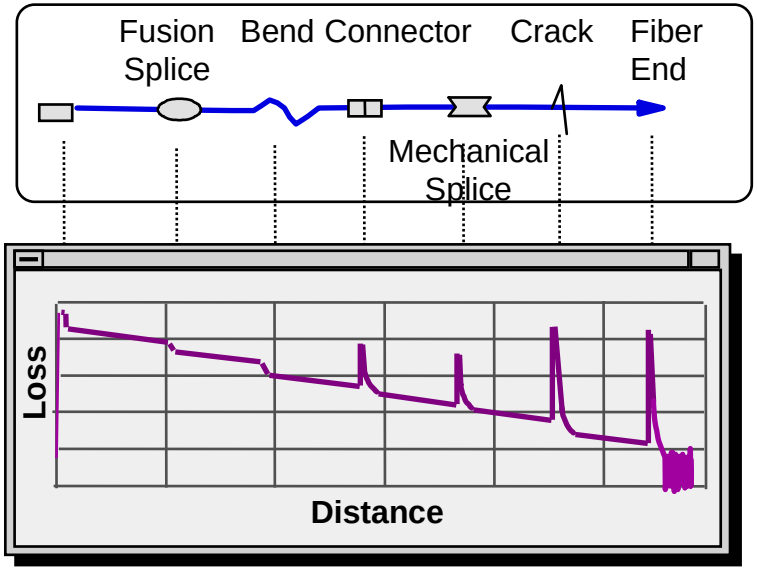


What can an OTDR do?

It is optical radar and can measure:



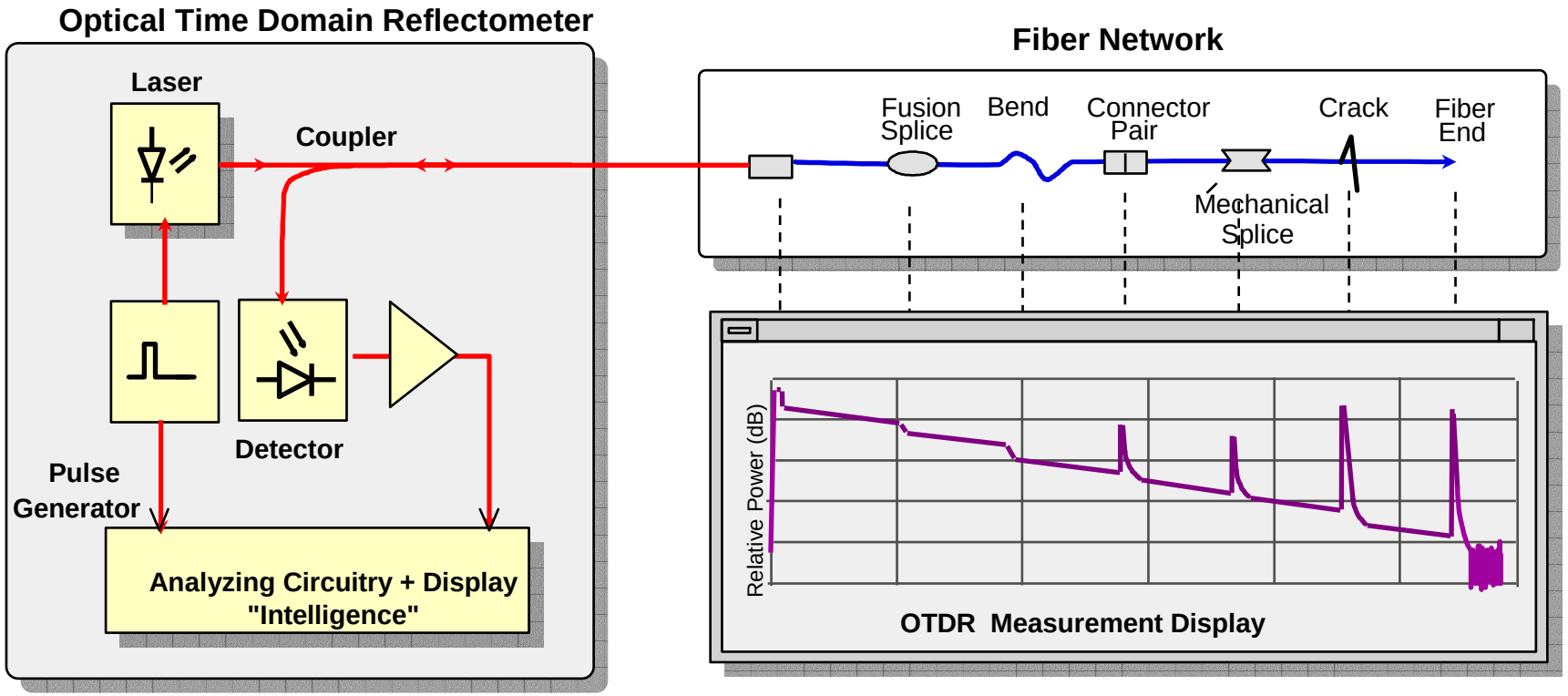
- a break point
- splice and connector losses
- point-to-point distances
- total cable length
- connector quality (return loss)
- attenuation of the fiber



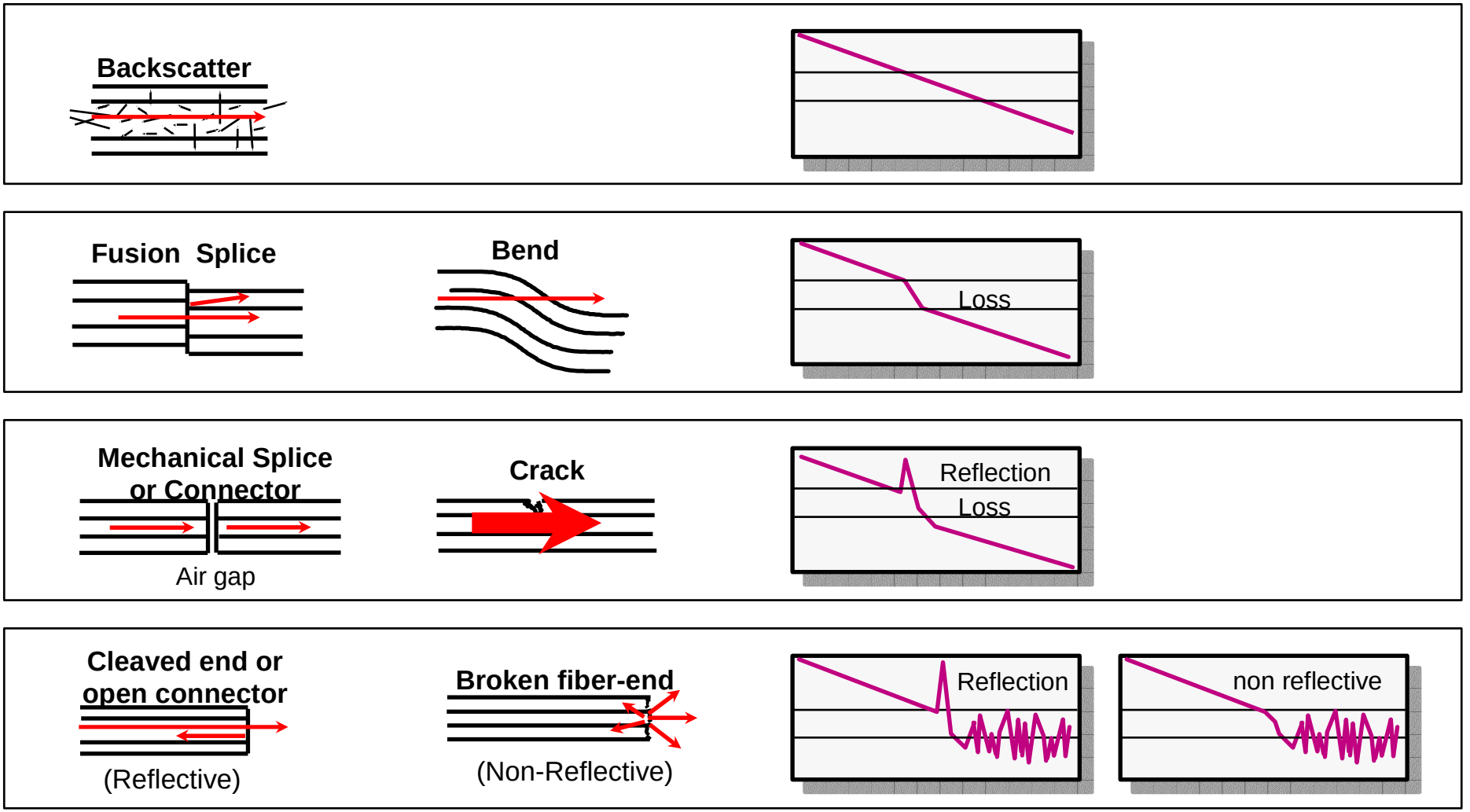
An OTDR is used for fiber:

- Installation and Commissioning
- Maintenance.
- Emergency Restoration
- Fiber identification.

What is an OTDR?



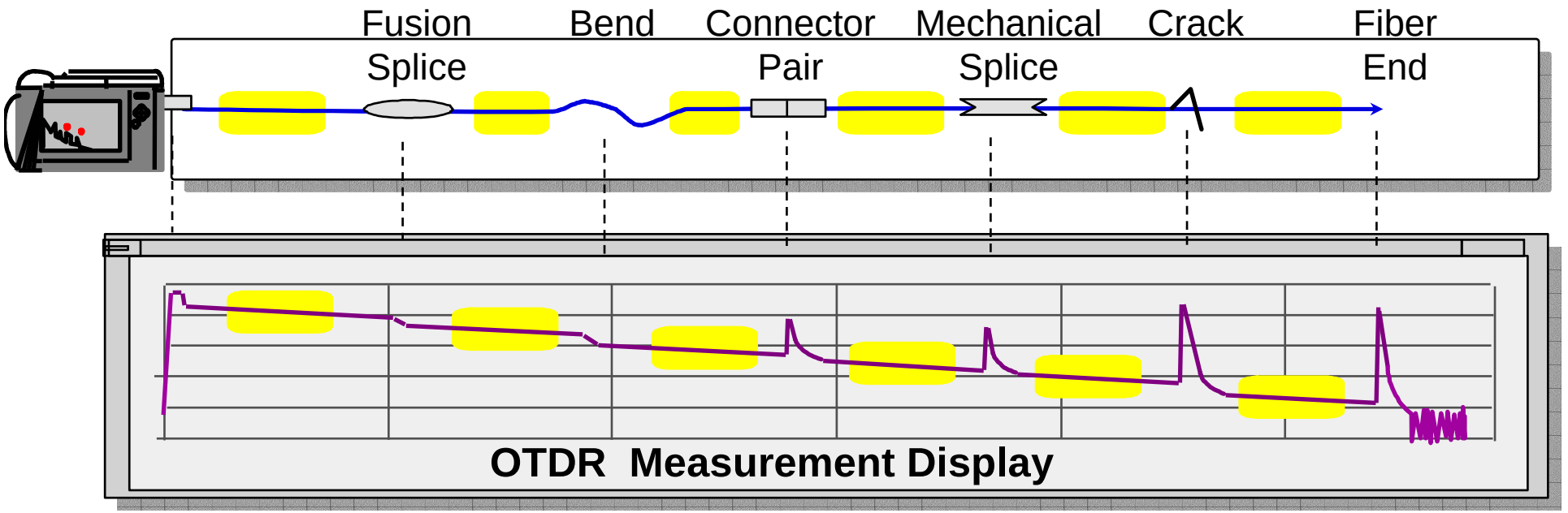
Fiber events and their trace representation

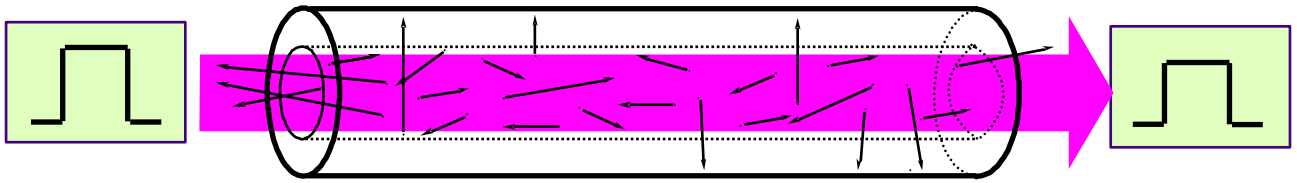


Basic Terms

- Backscatter
- IOR - Index of Refraction
- Non-Reflective Events
- Reflective Events
- Fiber End

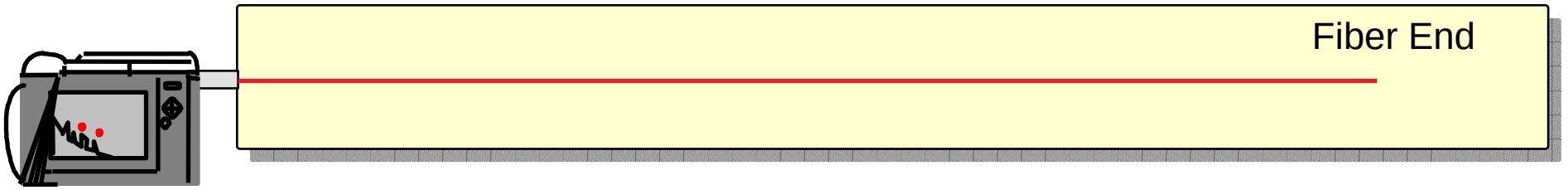
Backscatter





Backscatter is the small part of the Raleigh scattering which returns to the OTDR.

Index Of Refraction - IOR



The IOR for the fiber-under-measurement must be accurately known and entered into the OTDR.

The IOR lies typically between 1.4 and 1.5.
The exact value is supplied by the cable manufacturer.

The Index of Refraction is a number used to express the ratio of the speed of light in vacuum to the speed of light in the fiber.

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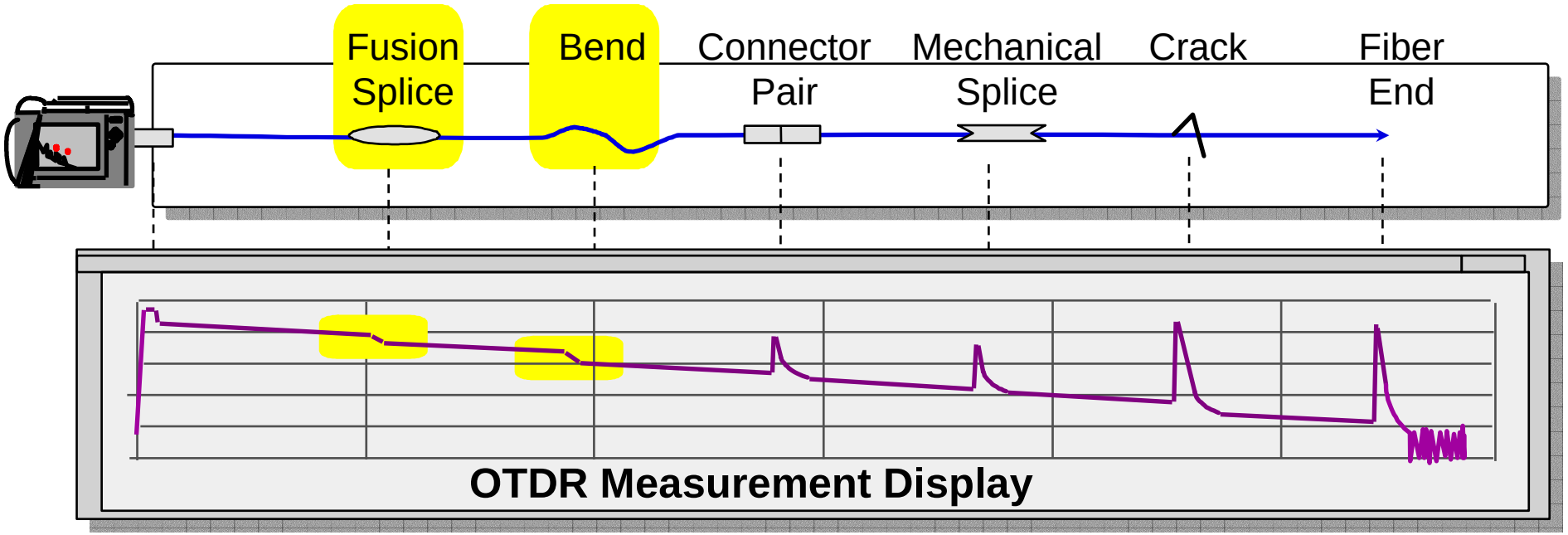
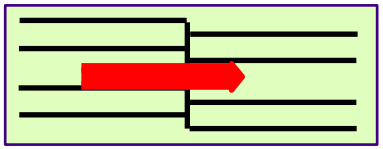
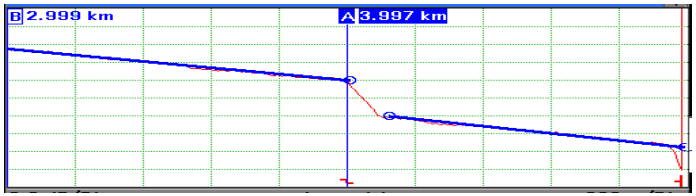
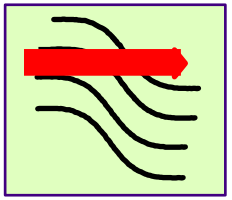
Non-Reflective Events



Fusion Splice



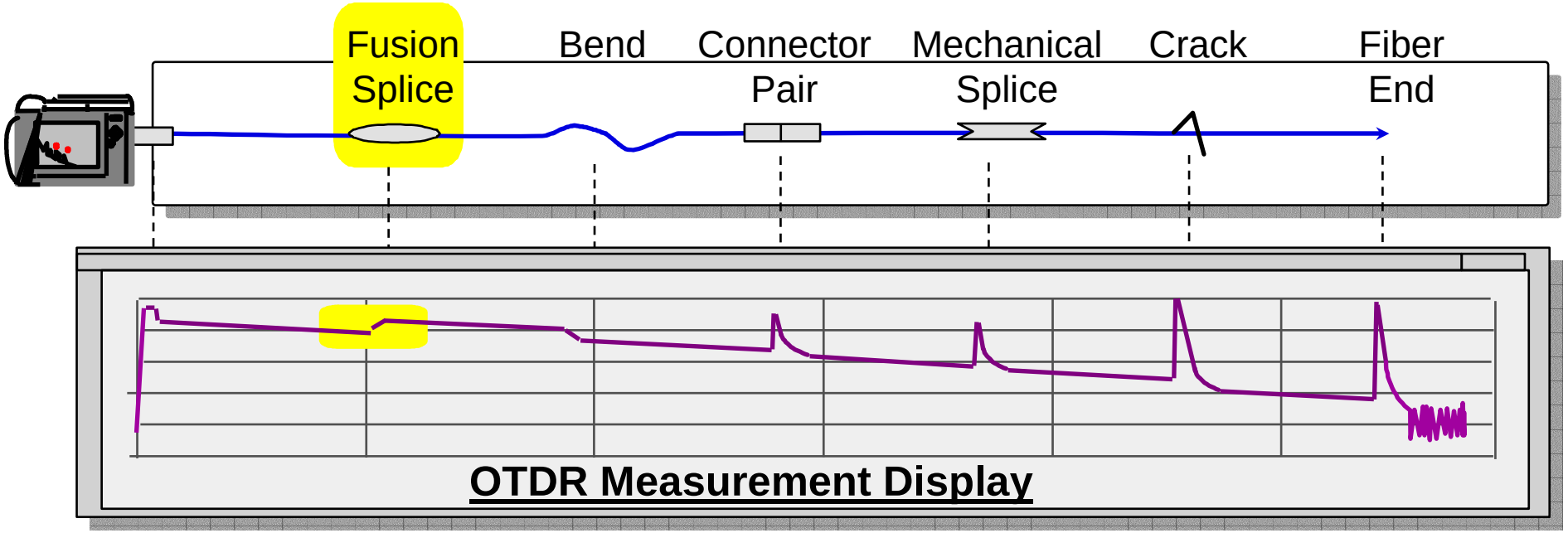




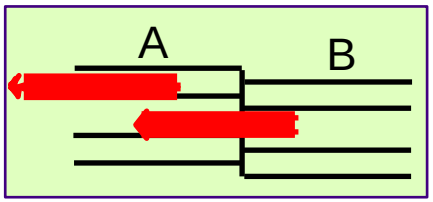
Bend

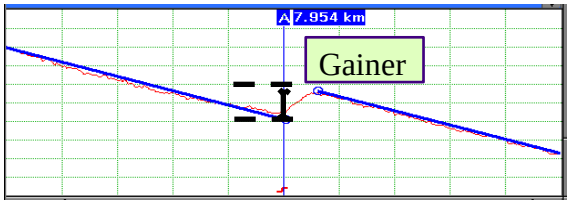
Fusion splices and bends cause loss, but no reflection.
Their signatures are similar on an OTDR display.

Gainer Phenomena



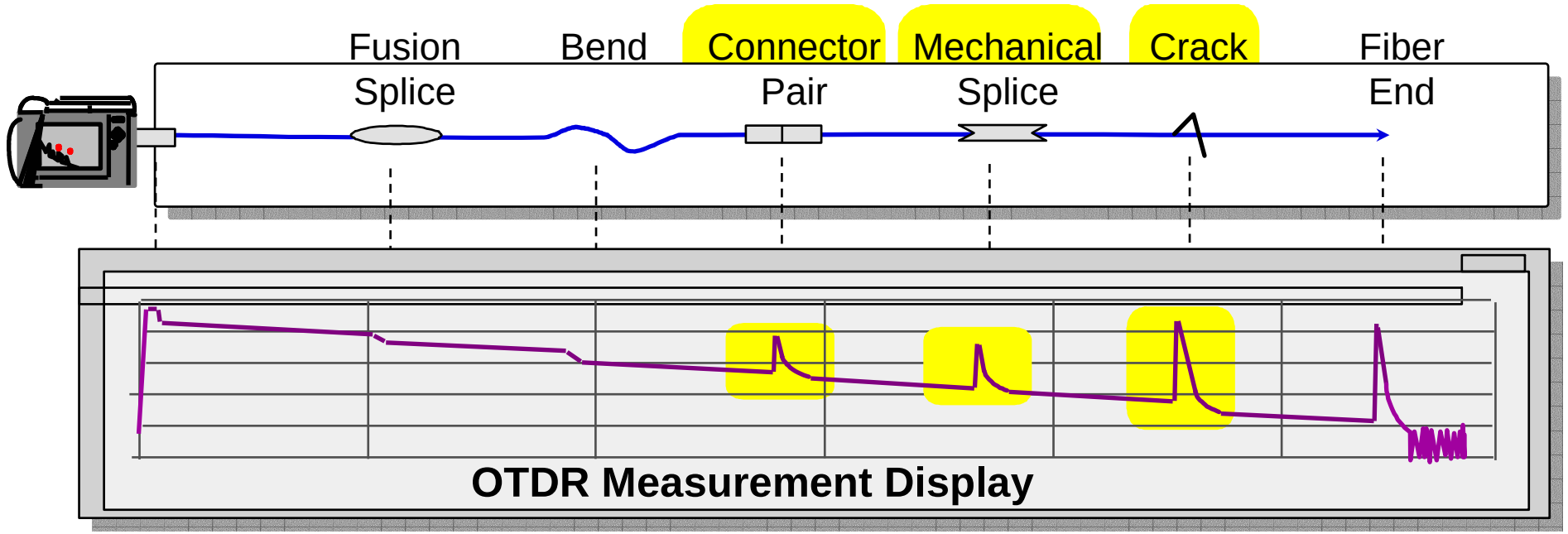
Backscatter coefficient
Fiber B > Fiber A



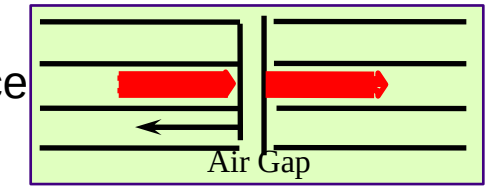


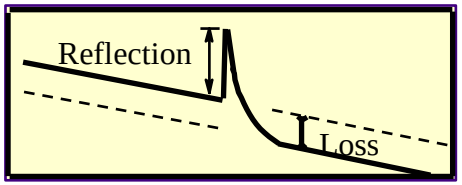
To find the "real" splice loss, measure the splice from both sides and take the average.

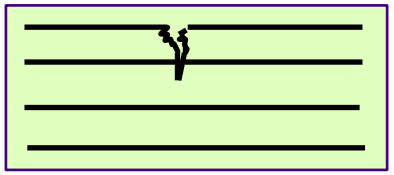
Reflective Events



Mechanical Splice or Connector







Crack

Mechanical splices, connectors and cracks cause both reflections and loss. Their signatures are similar on an OTDR display.

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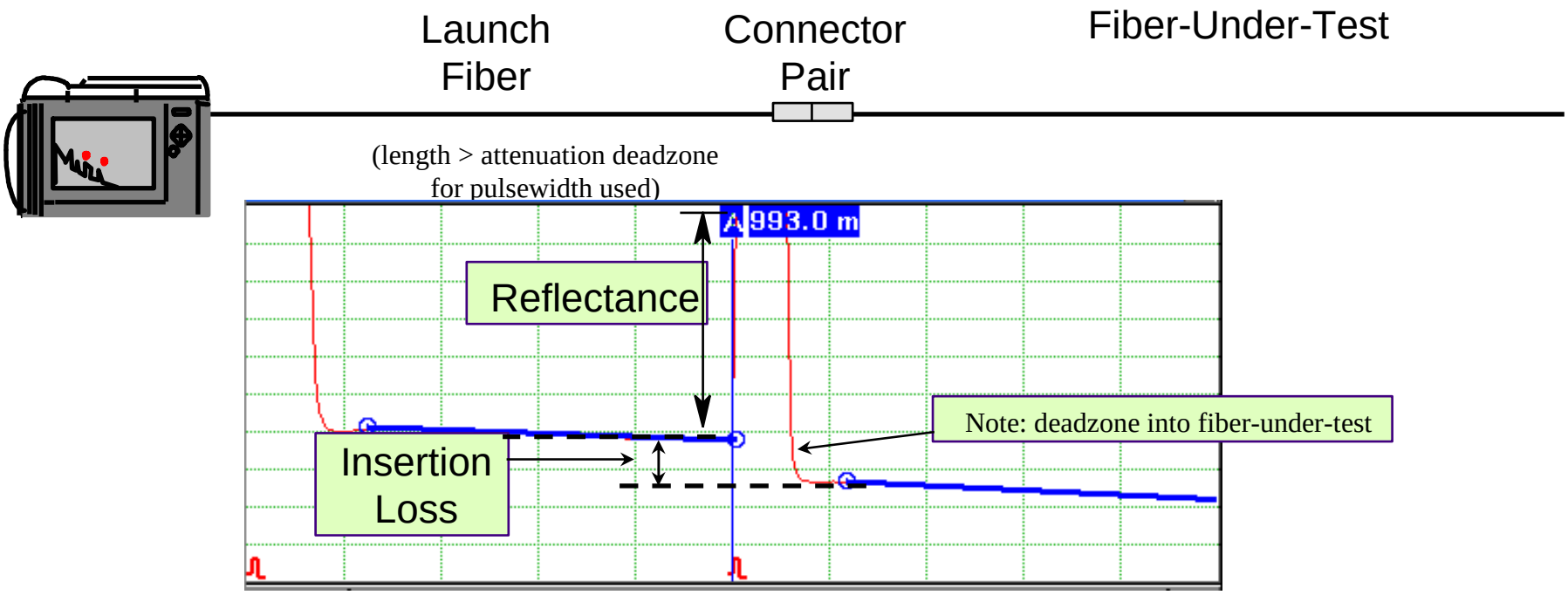
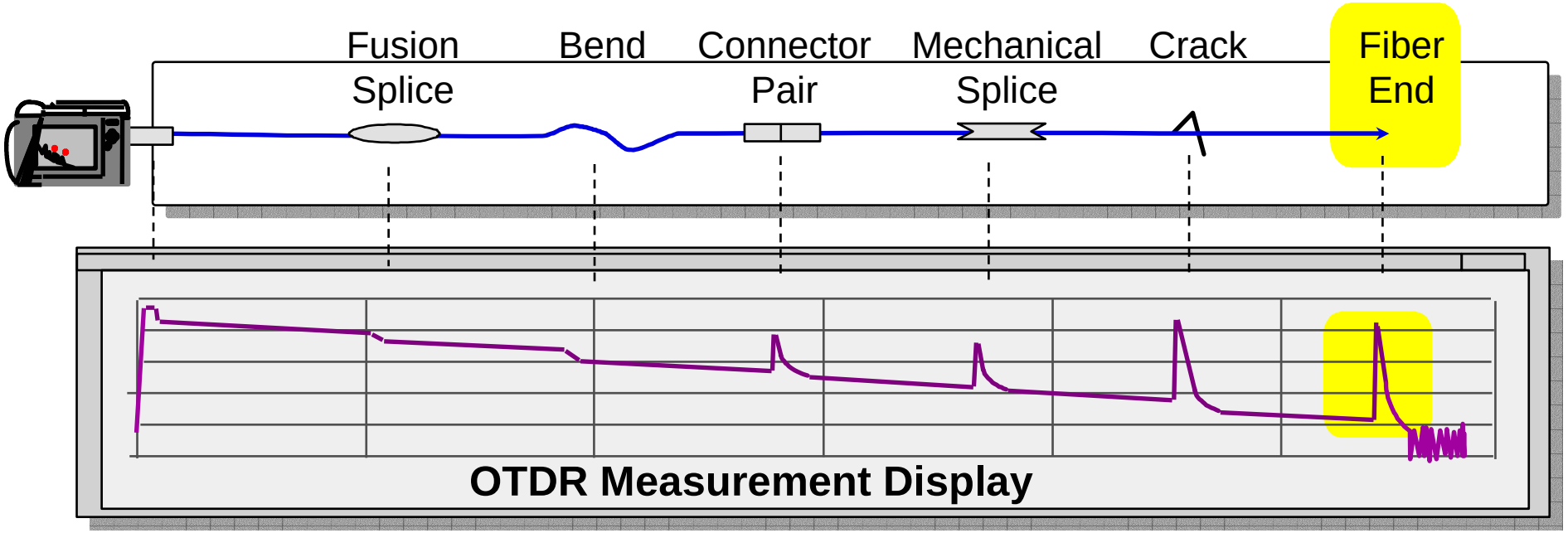
Measuring Insertion Loss and Reflectance of the First Connector

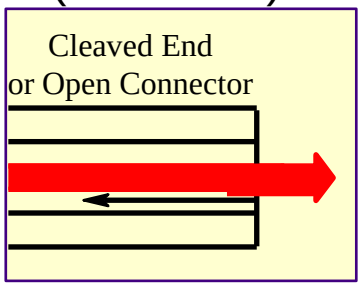


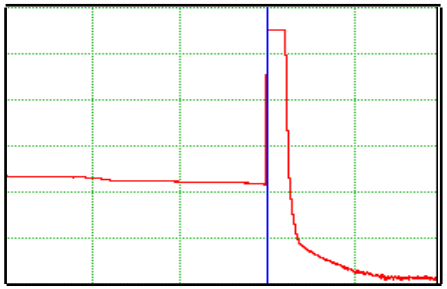
An external or connectorized launch fiber can be used so that the first connector's insertion loss and reflectance can be measured.

Fiber-End

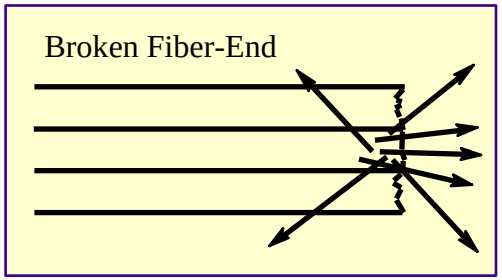


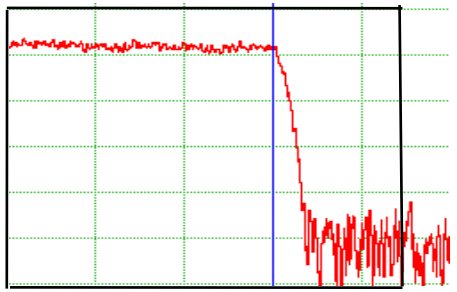
(Reflective)



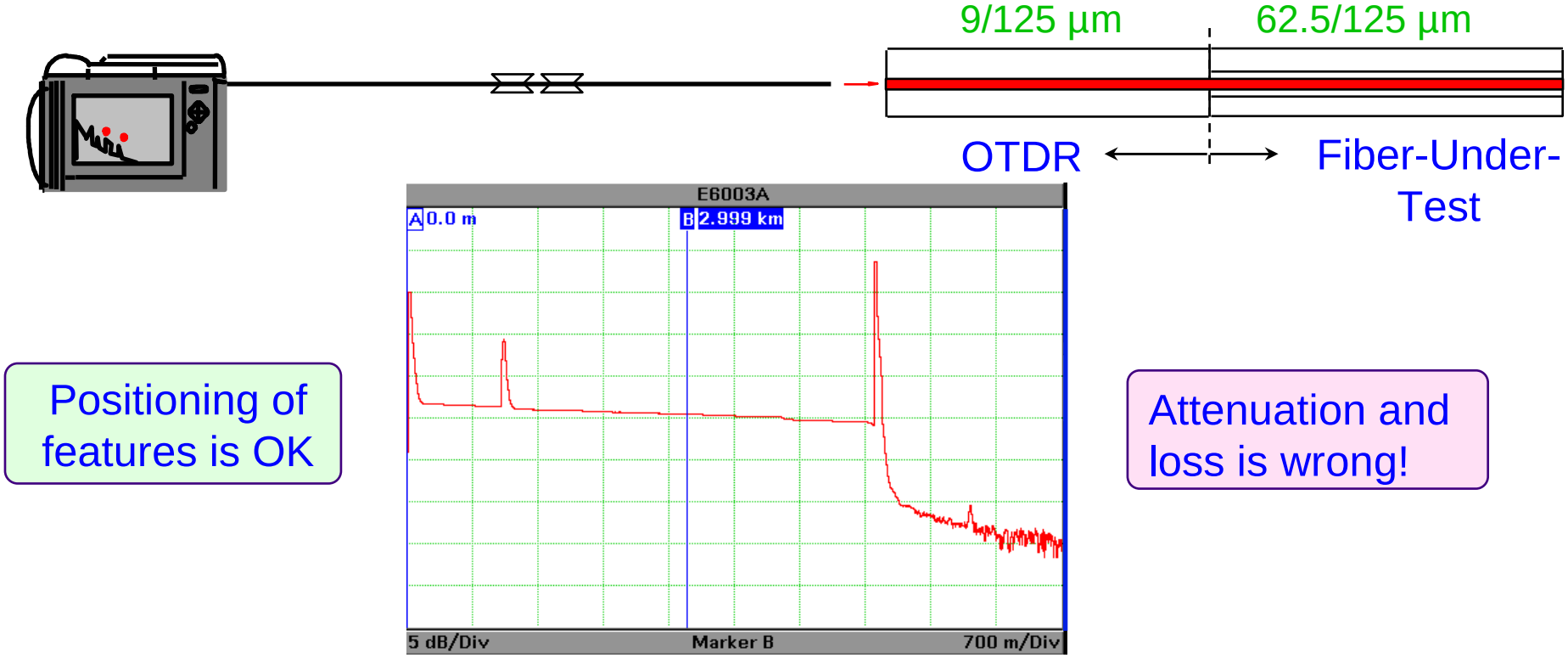


(Non-Reflective)





What Happens if a Single Mode OTDR is Used to Measure a Multimode Fiber ?

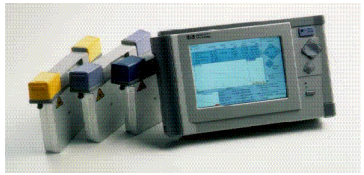


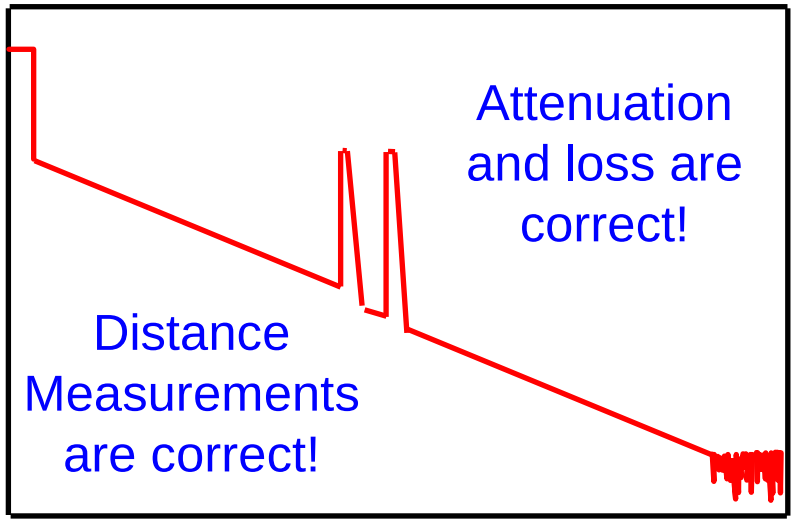
Positioning of features is OK

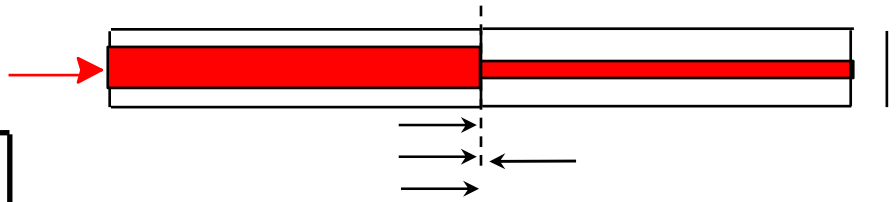
Attenuation and loss is wrong!

You can use the OTDR to locate features or breaks for a larger fiber core diameter, but not to measure loss accurately.

Can I use an Agilent Multimode OTDR to Measure a Singlemode Fiber? YES!







Agilent OTDR with Advanced Multimode Module

Singlemode Fiber Under Test

You lose about 7dB at the front connection. All measurements are accurate. You can easily measure 10 km of singlemode fiber

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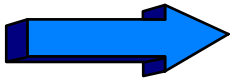
OTDR Measurements Agenda

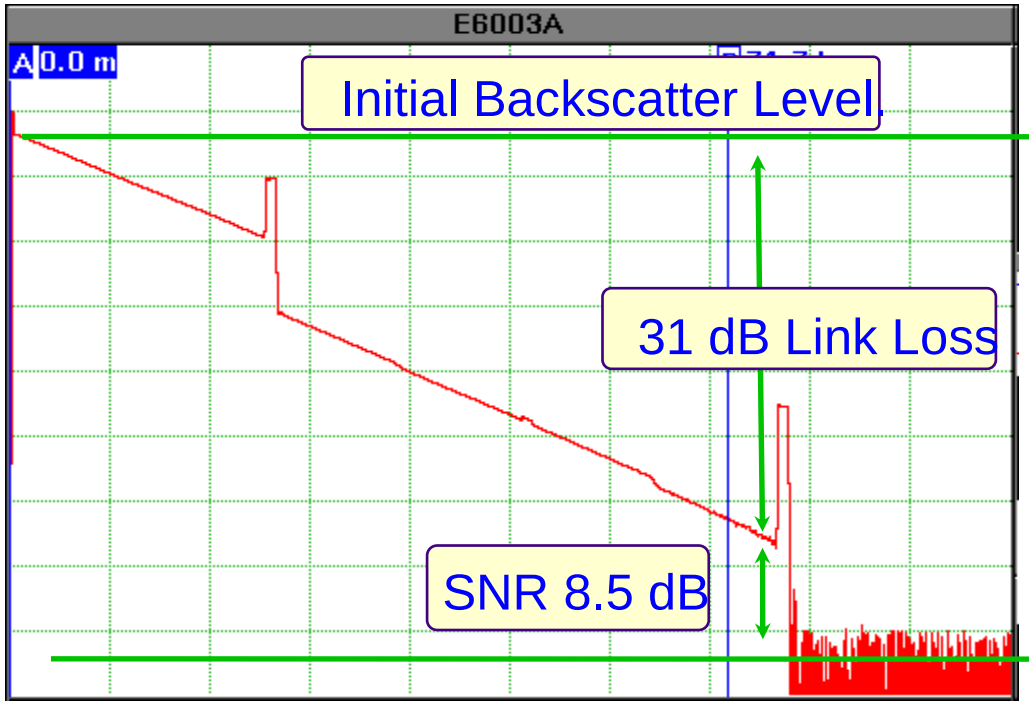


- Basic Terms
- Fibers and Connectors
- OTDR Measurements
- Introducing the 3M Mini-OTDR 2000
- Software Utilities

Performance Parameters

- Dynamic Range
- Deadzone
- Distance Accuracy
- OTDR Design

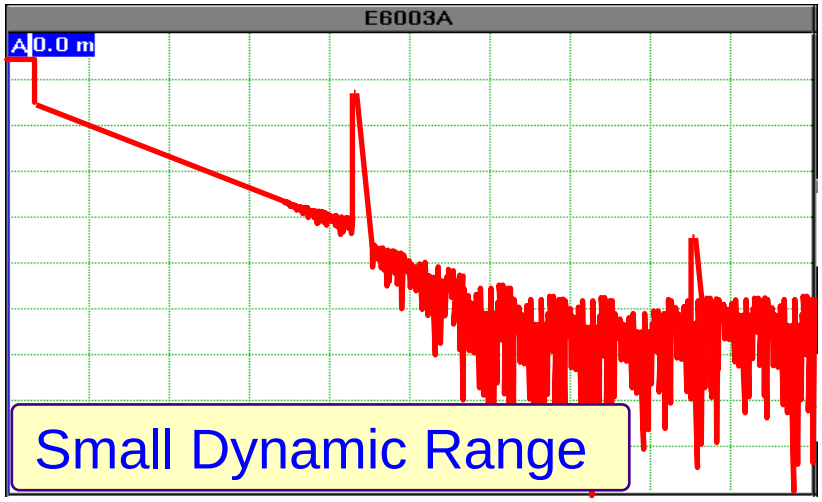
The Need for Large Dynamic Range

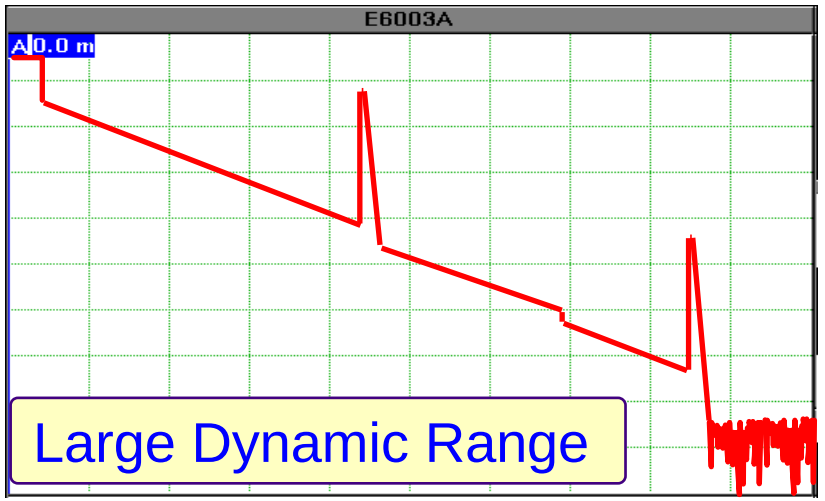


Splice Loss	Required Signal /Noise Ratio
0.1 dB	8.5 dB
0.05 dB	10.0 dB
0.02 dB	12.0 dB

Add the required Signal/Noise Ratio to the total link loss to determine the dynamic range (SNR=1) required.

What Distance Can I Measure ?

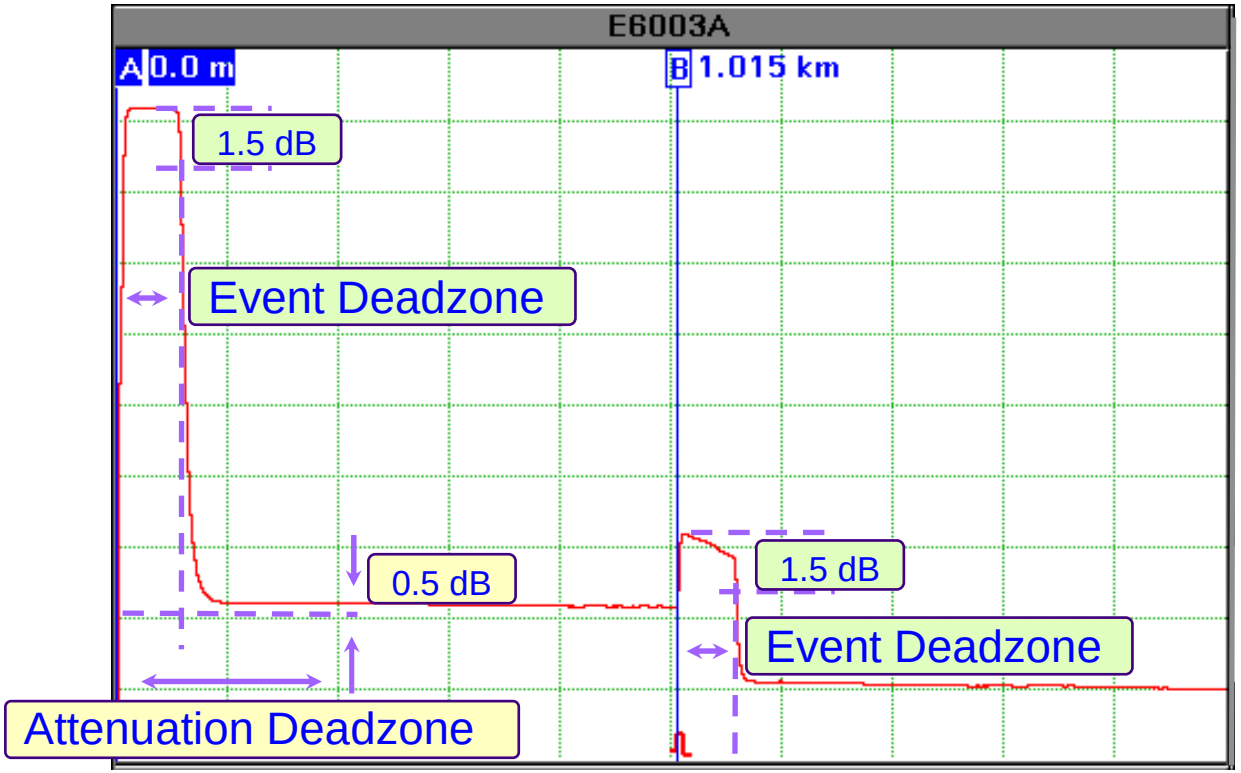




The maximum distance you can measure depends on the attenuation of the fiber and the dynamic range of your OTDR.

To measure long fibers, or fast measurements on short fibers, you want a high dynamic range.

Deadzone or 2-Point Resolution

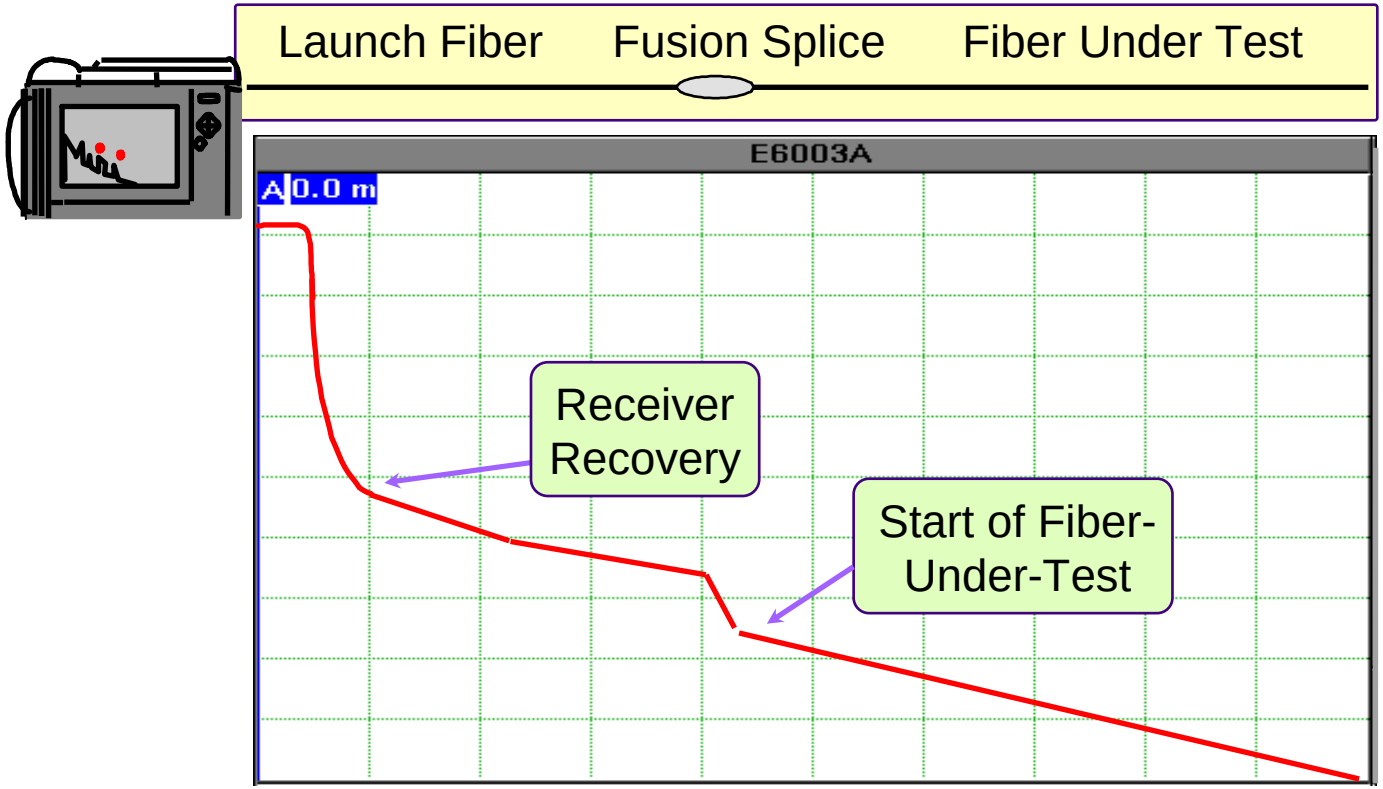


Event Deadzone minimum 3 m.

Attenuation Deadzone minimum 10 m.

A deadzone always occurs at the front panel connector reflection and at any other reflective event on the link.

Using Launch Fibers to Eliminate the Deadzone



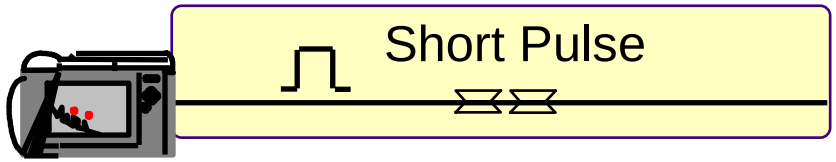
The launch fiber should be longer than the attenuation deadzone caused by the used pulsewidth.

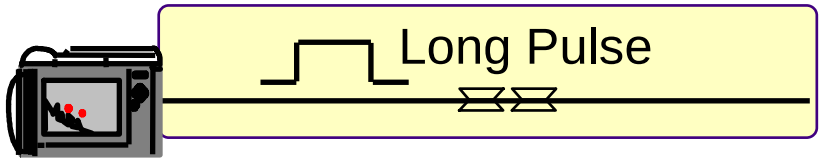
Only a launch fiber spliced to the fiber under test can help eliminate front connector deadzone.

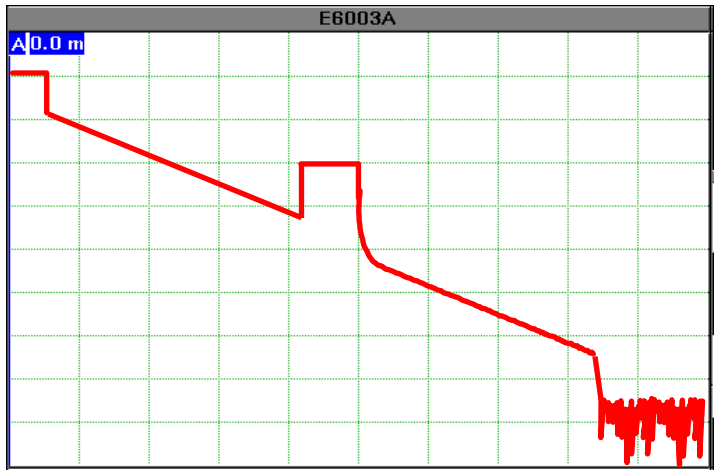
What Affects the Dynamic Range & Deadzone?

Dynamic range is a function of:	Deadzone is a function of:
– pulsewidth – averaging time – OTDR design	– pulsewidth – size of the reflection – OTDR design

How Pulsewidth Affects Dynamic Range & Deadzone

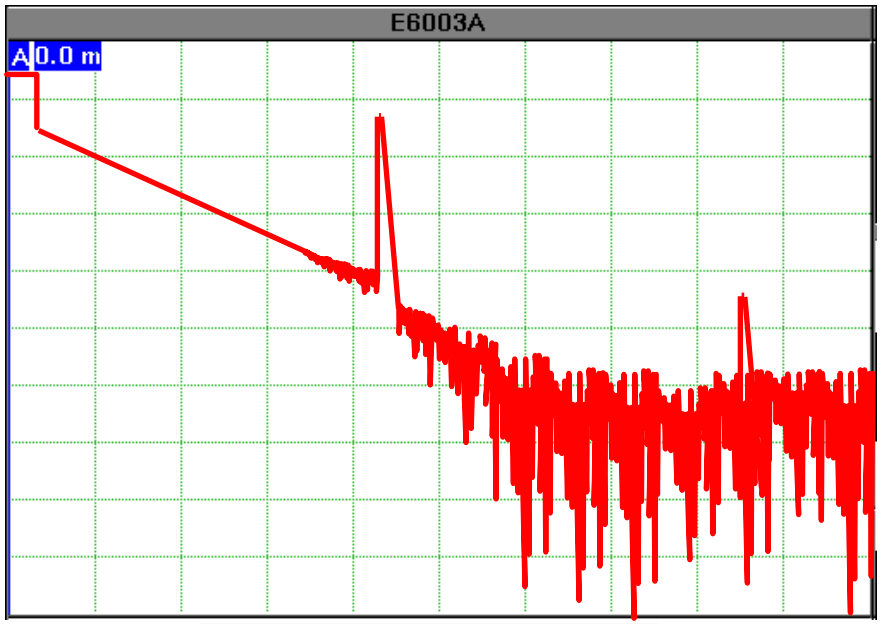




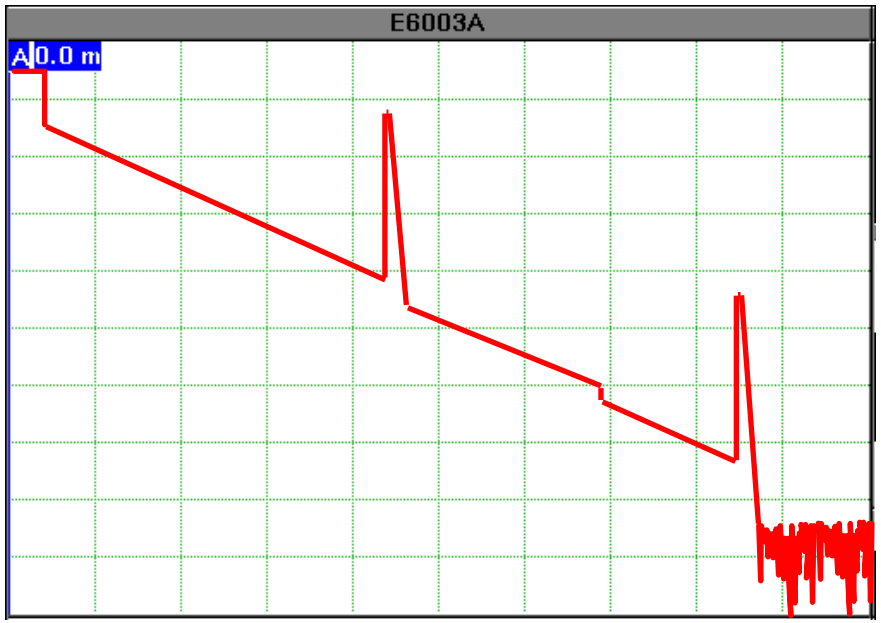


Short pulses provide better deadzones but a smaller dynamic range; long pulses provide a better dynamic range but longer deadzones.

How Averaging Time Affects the Dynamic Range



After 10 seconds

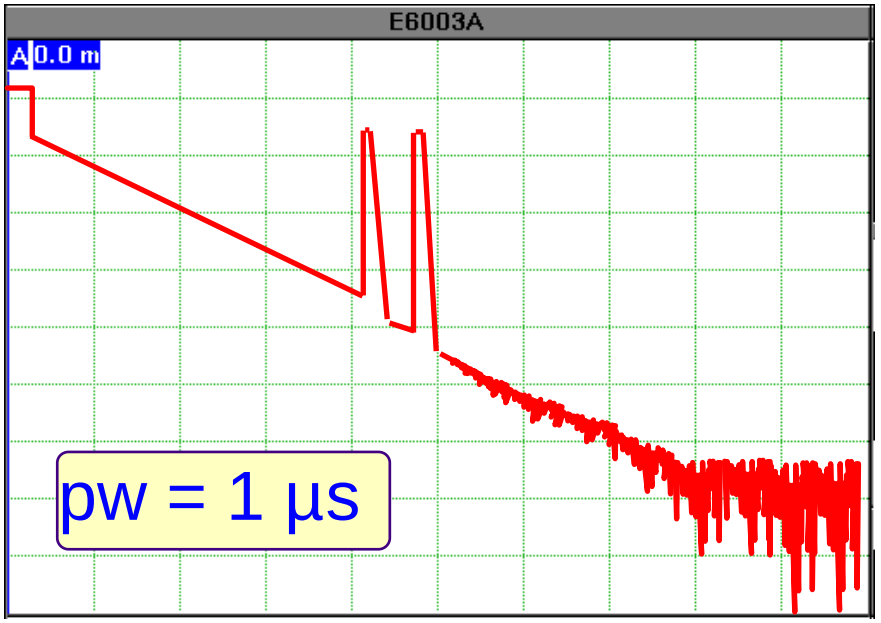


After 3 minutes

A longer averaging time increases the dynamic range by decreasing the noise floor of the OTDR.

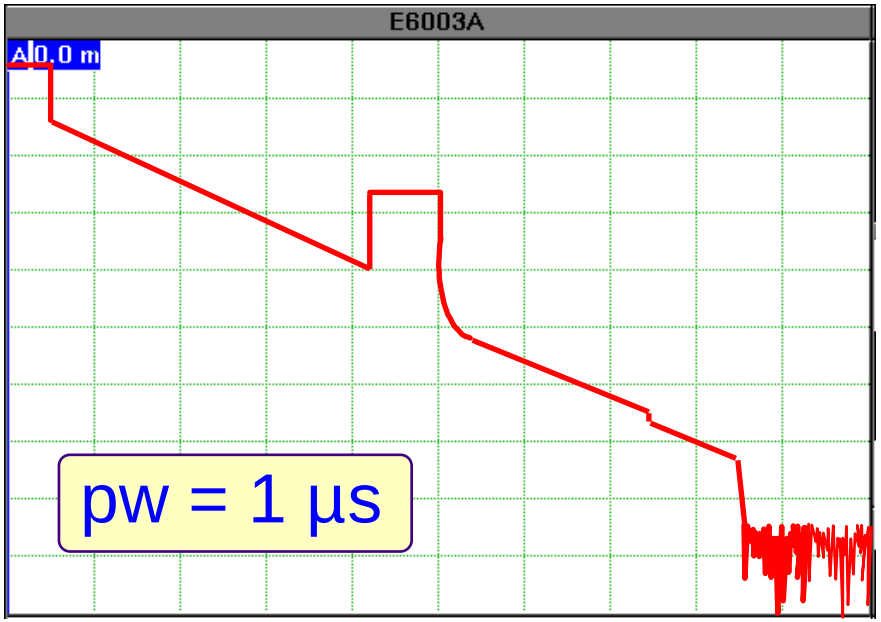
OTDR Design

Optmize for Resolution



Use a wide receiver bandwidth:

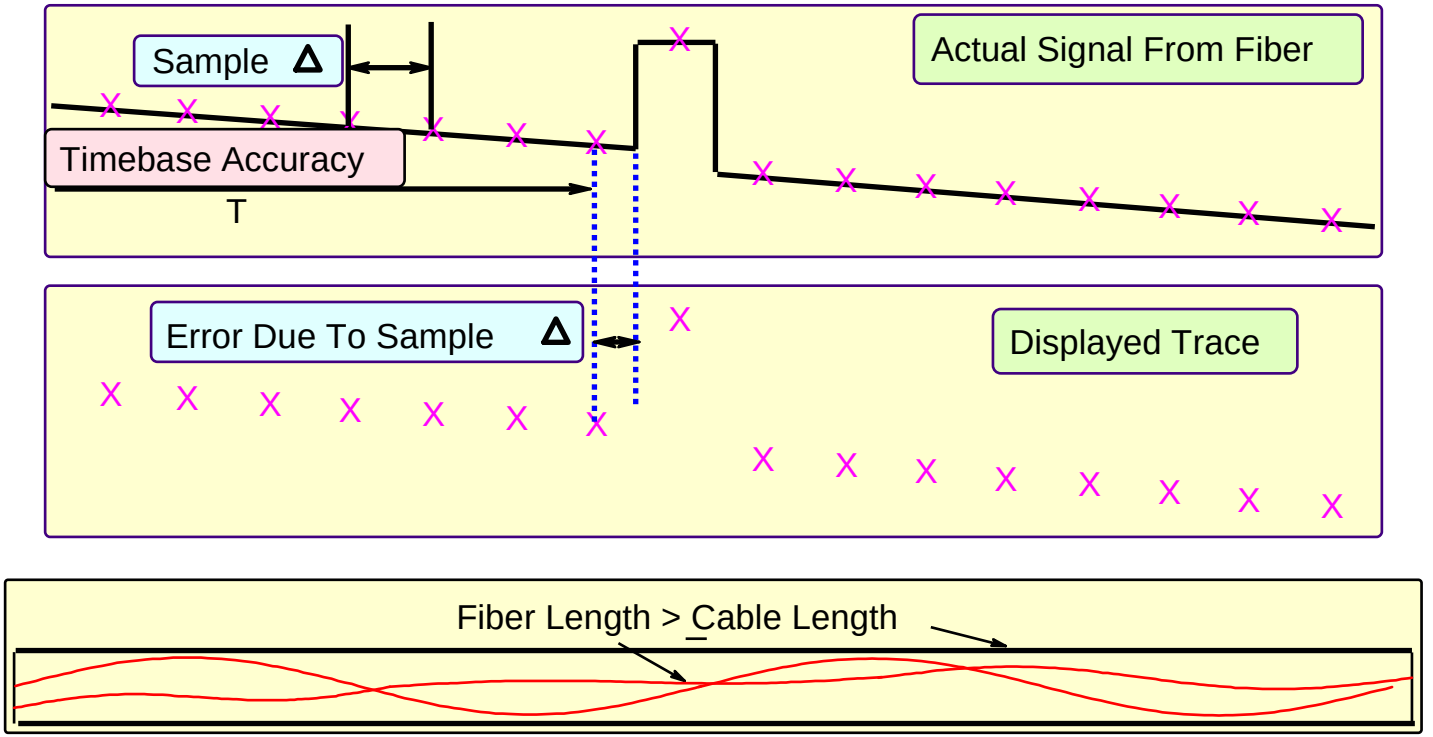
Optimize for Dynamic



Use a narrow receiver bandwidth

Optimizing for resolution offer short deadzones, but a smaller dynamic range;
Optimizing for dynamic offer a large dynamic range but long deadzones.

Distance Accuracy & 1-Point Resolution



Distance accuracy is a function of timebase accuracy, sample distance Δ , index of refraction setting and cabling factor.

Performance Parameters - Summary

- Dynamic Range: determines how far into the fiber you can measure as well as the time required to see an event.
- Deadzone: affects how close together you can resolve two events and can be reduced by decreasing pulsewidth.
- Distance Accuracy: of the event location. It is determined by sample distance spacing and error, IOR and cabling factors.
- Optimize for Dynamic Range: provides a larger dynamic range, but longer deadzones.
- Optimize for Resolution: provides a smaller dynamic range, but shorter deadzones, and better event resolution.

3M

OTDR Measurements Agenda

- Basic Terms
- Fibers and Connectors
- OTDR Measurements
- Introducing the 3M 2000 Mini-OTDR
- Software Utilities

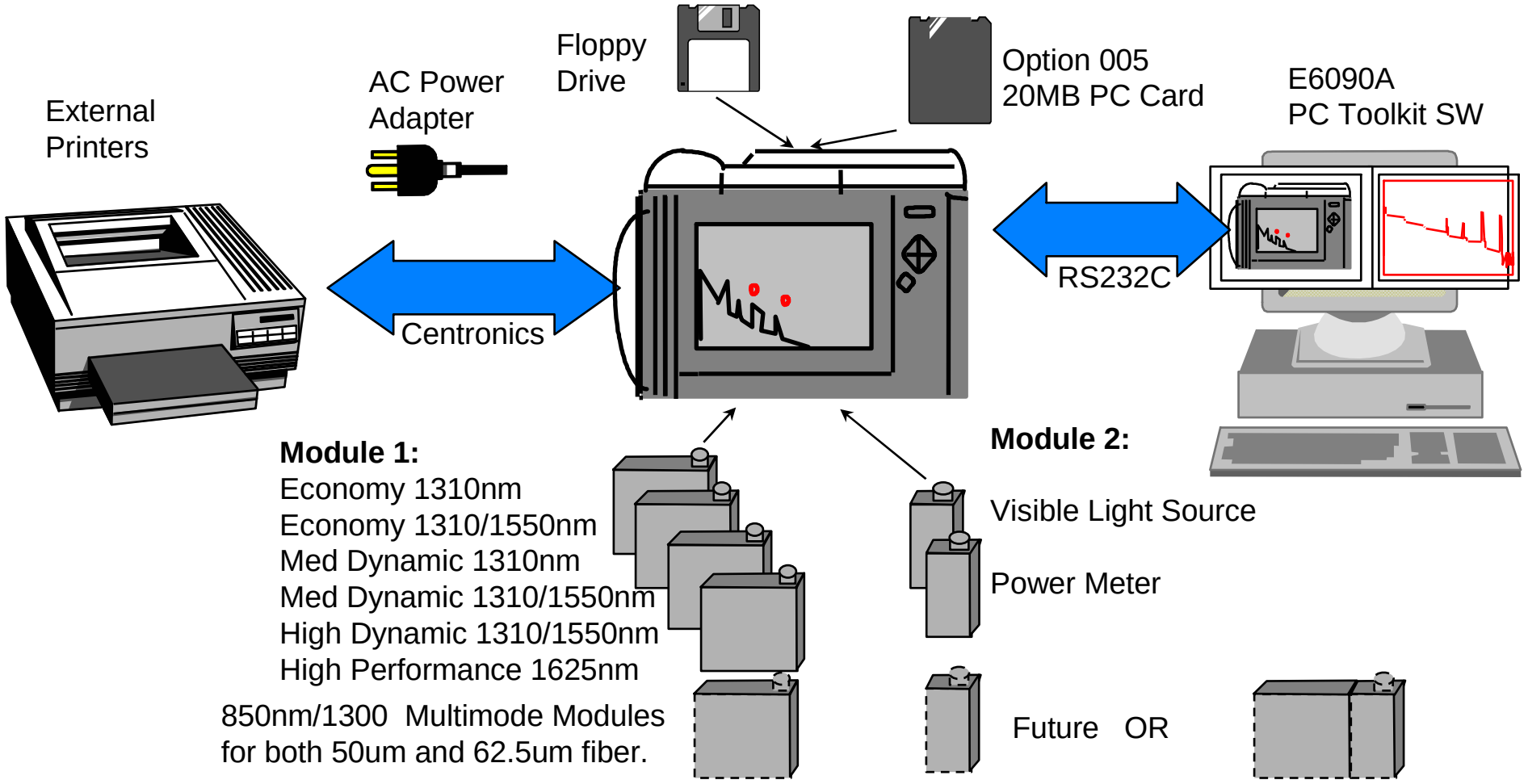
3M 2000B Mini-OTDR

Target application:
Fault location and maintenance of single and multi-mode fiber cables

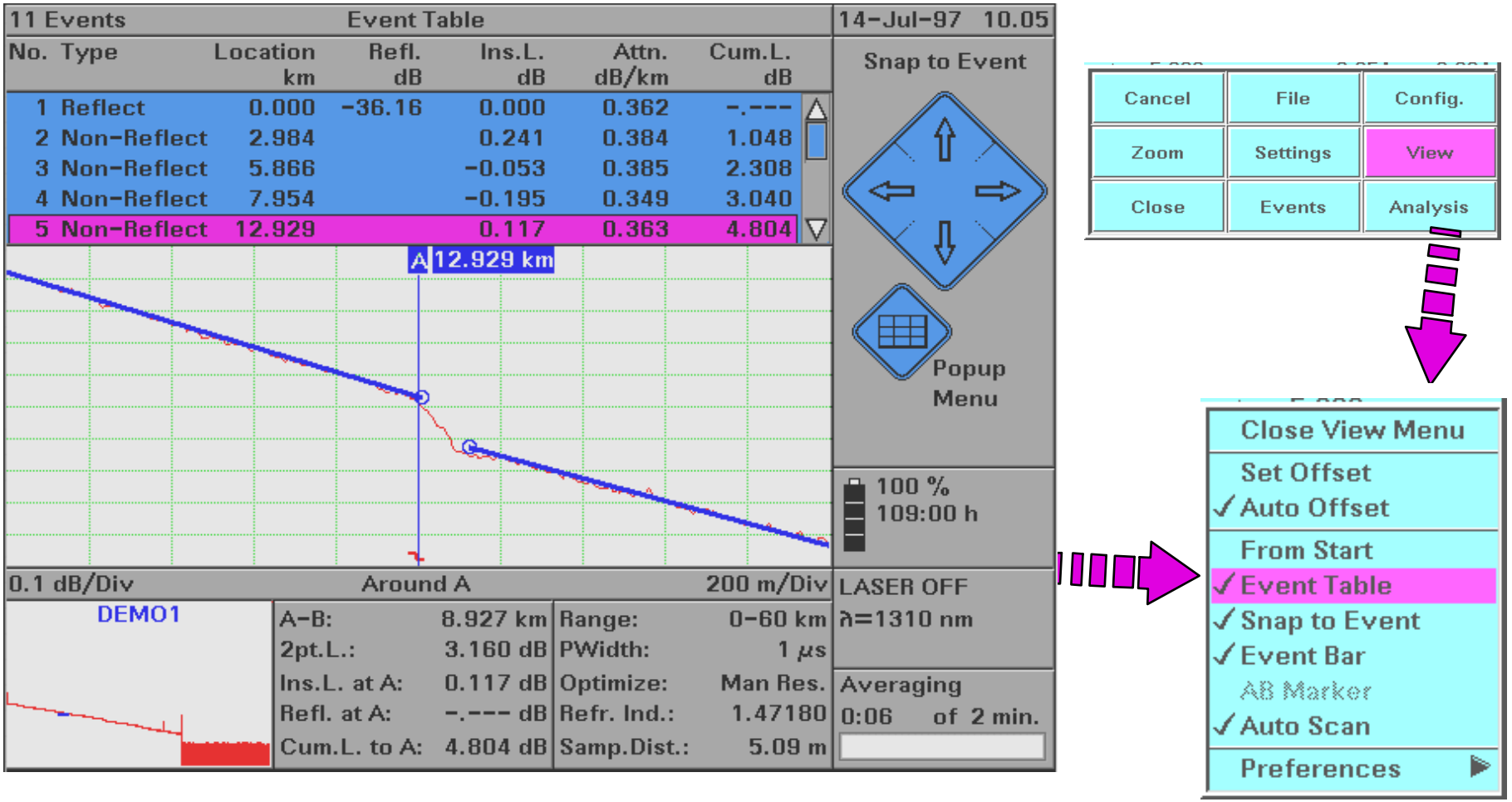
Key contributions:
Performance/speed
Ease of use
Low-Cost
Size (Lightweight)
Flexibility

3M 2000 Mini OTDR Accessories supplied

The 3M 2000 Mini OTDR Solution

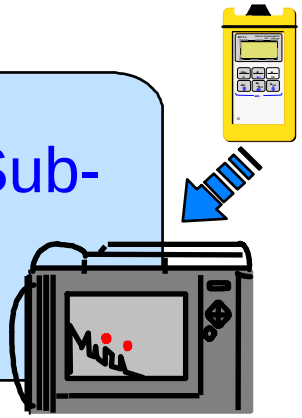


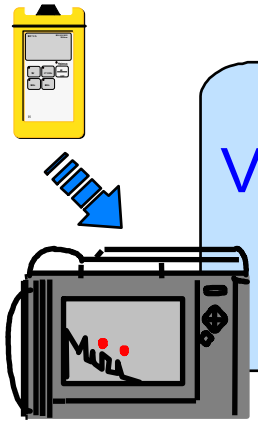
A Full Featured OTDR



The 3M 2000 Mini-OTDR Tool Bag

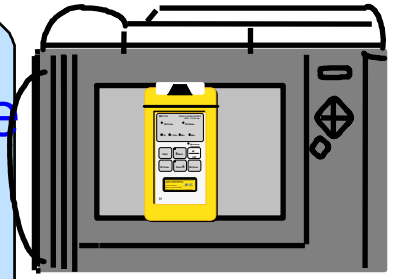
Power Meter Sub-Module



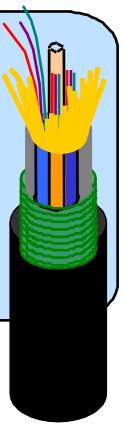


Visual Fault Finder

Built-In Source Mode



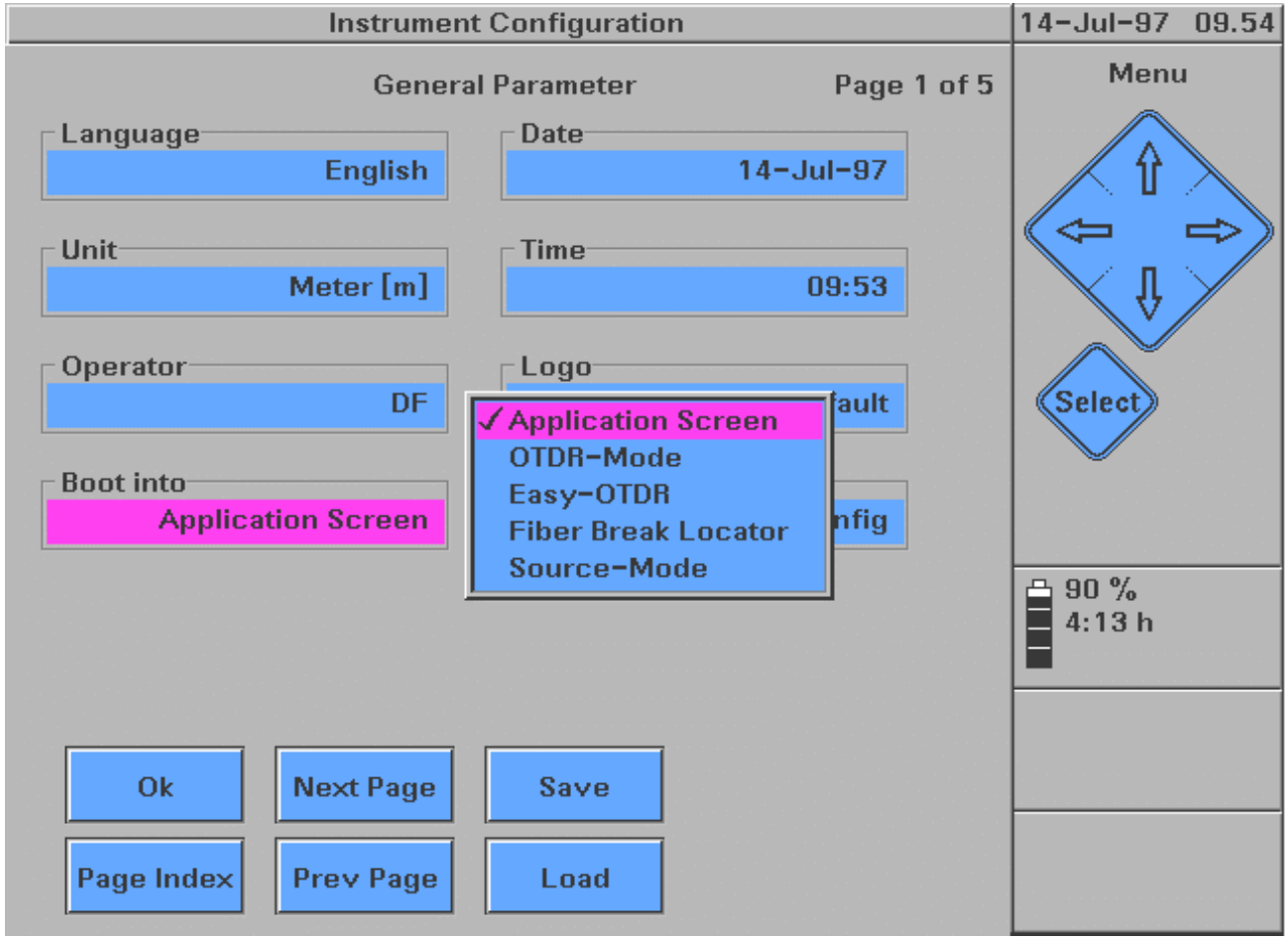
Multifiber Test Mode



3M

When You Turn the Mini-OTDR On

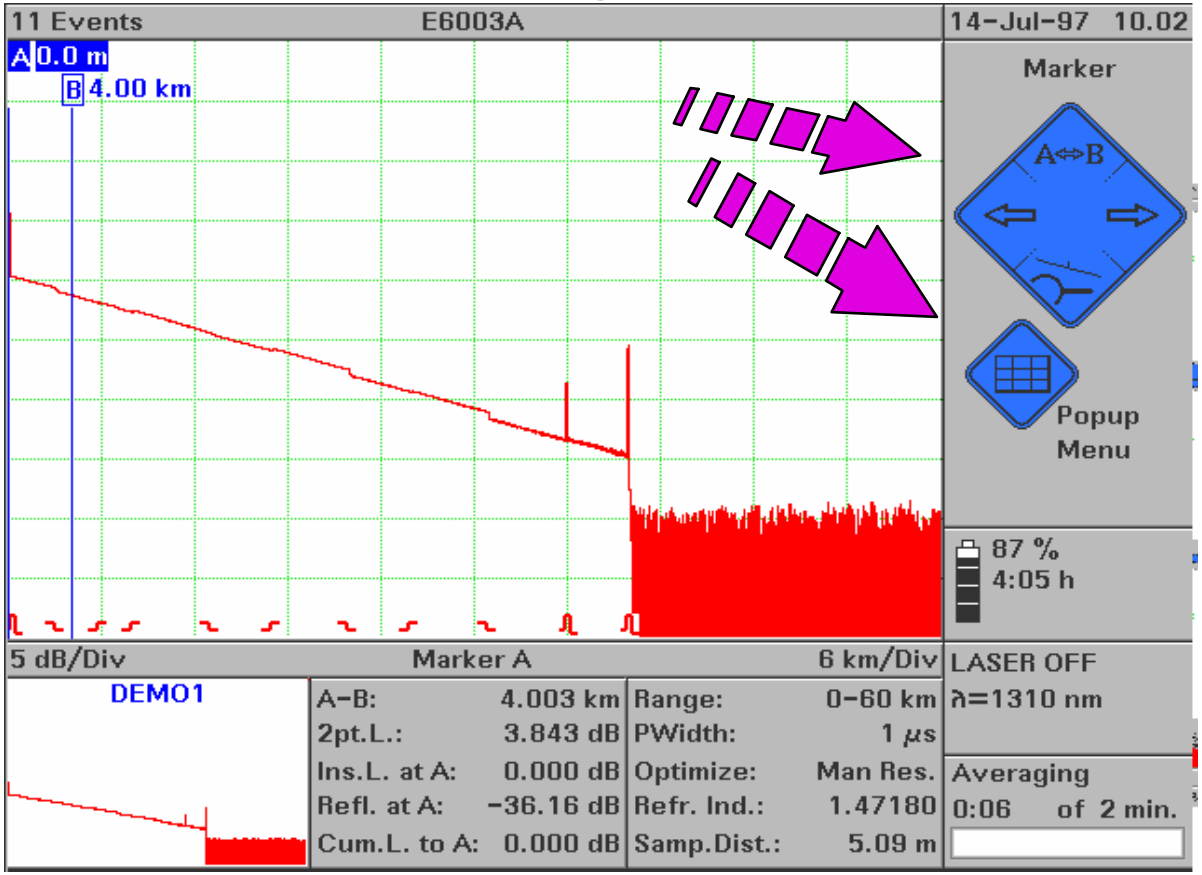
You Can Select

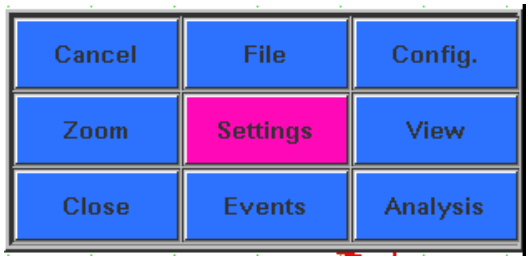


You can select which instrument you want the next time you turn the Mini on.

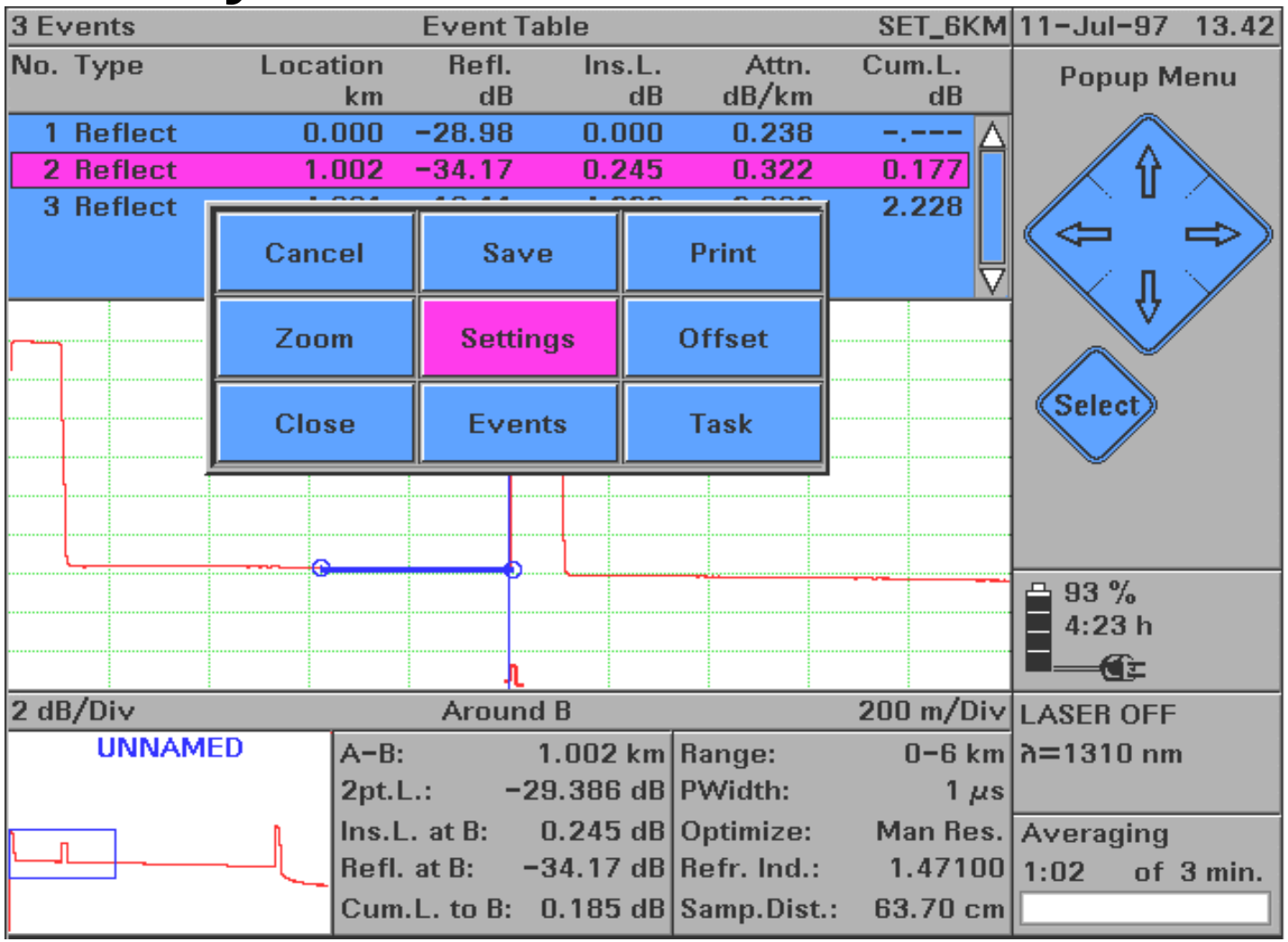
A Full Featured OTDR

Control's under your thumb

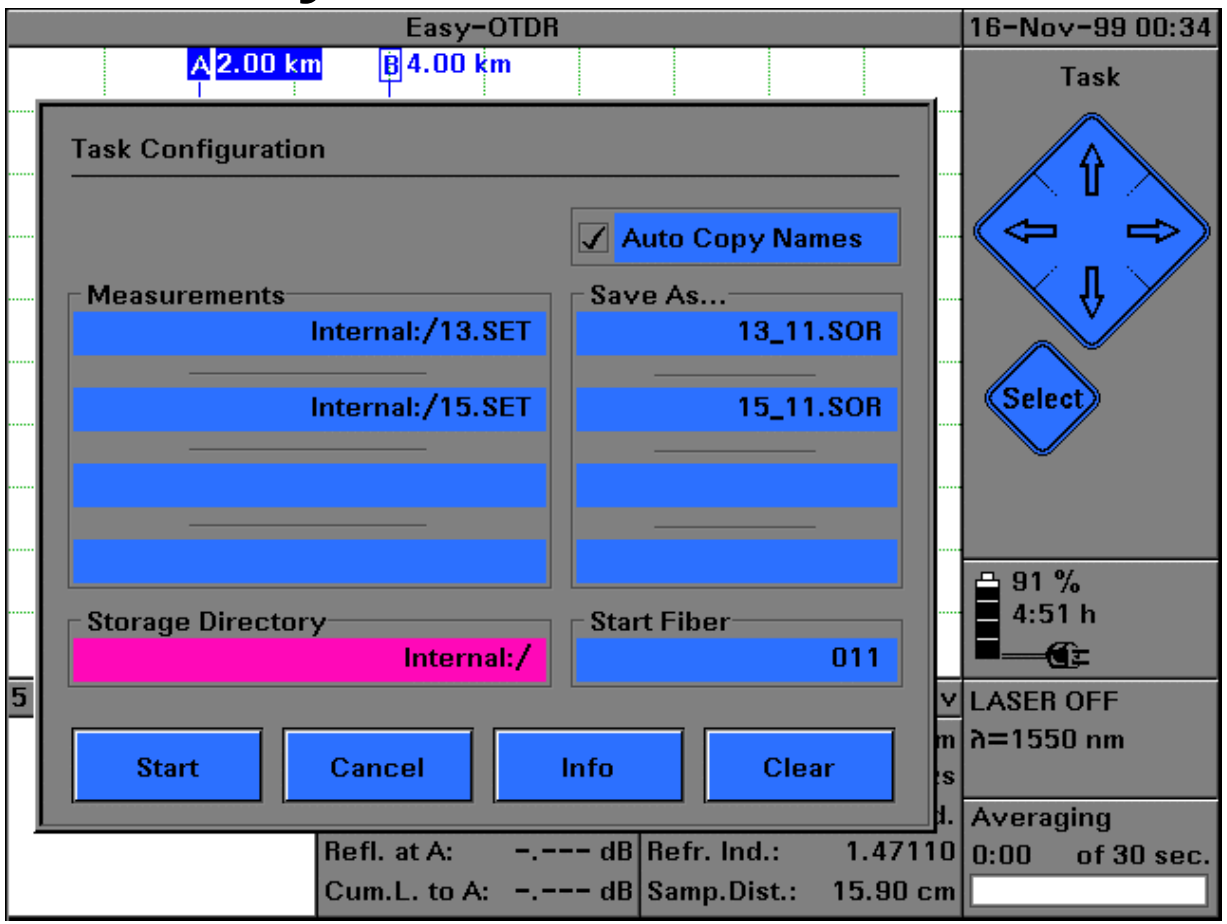




Easy OTDR

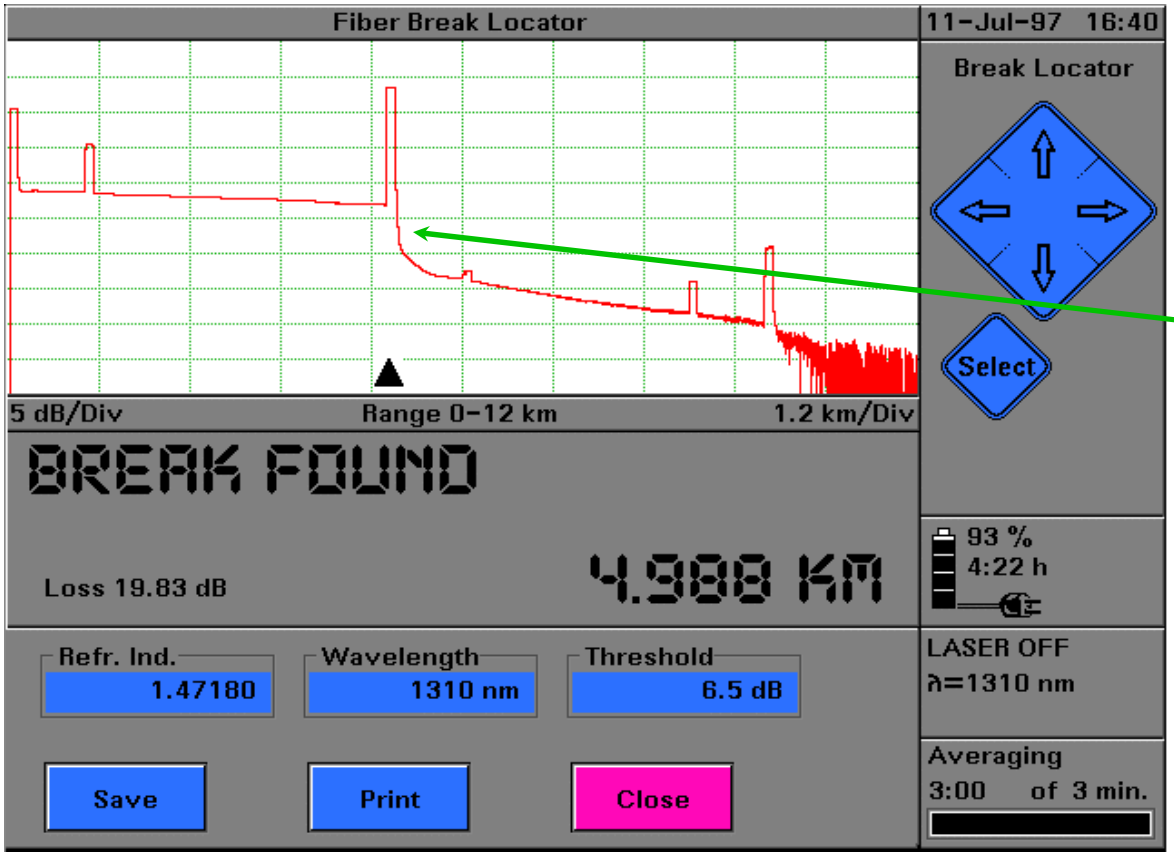

3 Events
Event Table
SET_6KM
11-Jul-97 13.42
No. Type
Location km
Refl. dB
Ins.L. dB
Attn. dB/km
Cum.L. dB
1 Reflect 0.000 -28.98 0.000 0.238 -.---
2 Reflect 1.002 -34.17 0.245 0.322 0.177
3 Reflect 2.228
Cancel
Save
Print
Zoom
Settings
Offset
Close
Events
Task
Popup Menu
Select
93 %
4:23 h
2 dB/Div
Around B
200 m/Div
LASER OFF
λ=1310 nm
UNNAMED
A-B: 1.002 km
2pt.L.: -29.386 dB
Ins.L. at B: 0.245 dB
Refl. at B: -34.17 dB
Cum.L. to B: 0.185 dB
Range: 0-6 km
PWidth: 1 µs
Optimize: Man Res.
Refr. Ind.: 1.47100
Samp.Dist.: 63.70 cm
Averaging
1:02 of 3 min.

Multifiber Test Mode- The Task Key



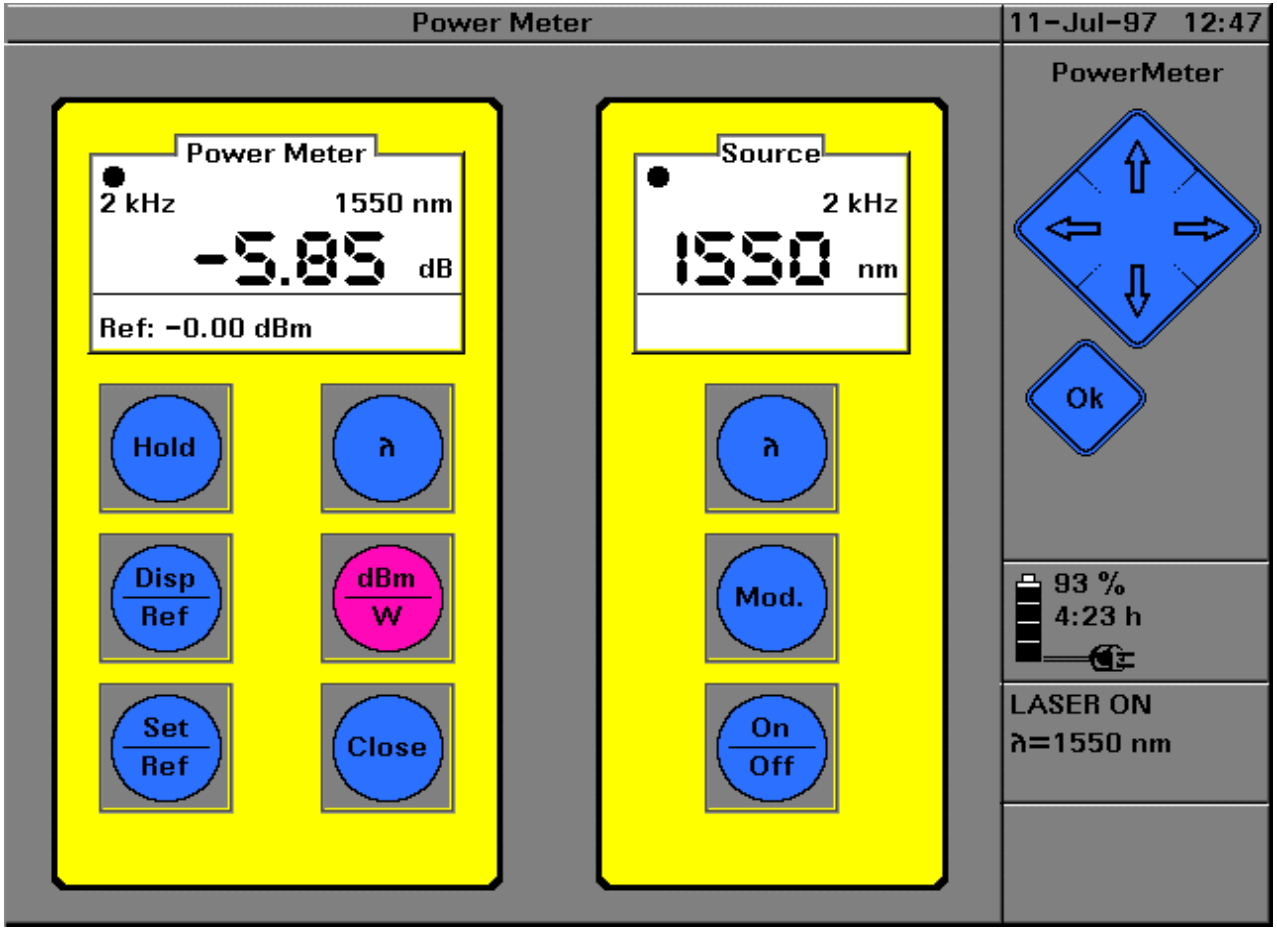
The Task key can run up to four tests on one or more fibers and can store all the traces.

The Fiber Break Locator

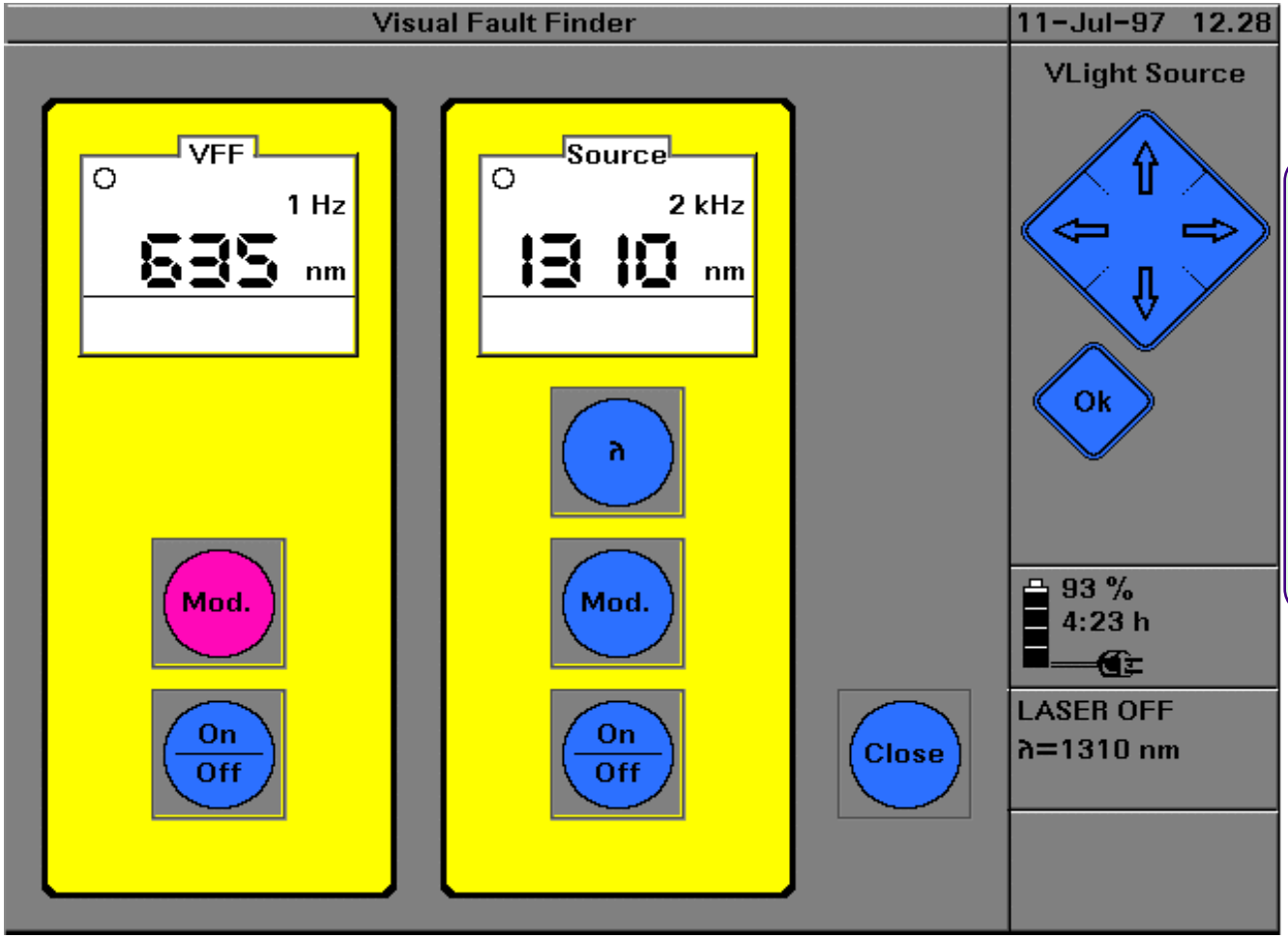


The first drop of the signal below the threshold will be marked.

The Optical Power Meter Sub-Module



The Visual Fault Finder



The Visual Fault Finder has two applications:

- fault location
- fiber identification

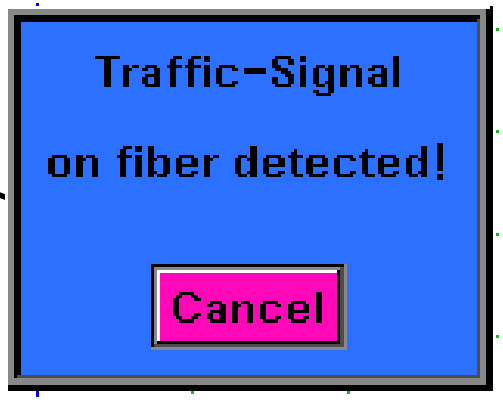
3M 2000 Mini OTDR`s Traffic Detection Protects The Transmitter

Fiber under traffic

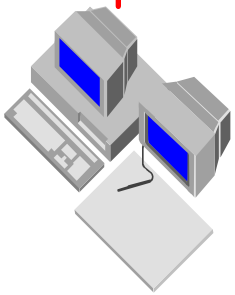
or

The OTDR checks whether there is optical power on the fiber BEFORE it begins to send high power pulses.
This prevents possible damage to expensive transmitters and receivers attached to the fiber.

Traffic Detection



Transmission System



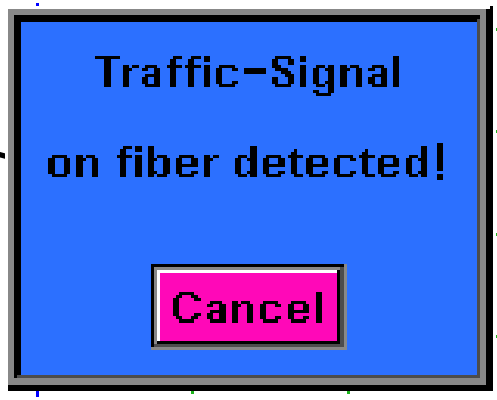
PC w/ optical LAN card

3M 2000 Mini OTDR's Traffic Detection Protects Other OTDRs

Fiber under test

The Agilent OTDR checks whether there is optical power on the fiber BEFORE it begins to send high power pulses. If power is detected it does not send pulses that could damage other OTDR's and it disables it's owns sensitive receiver to prevent damage from other sources

Traffic Detection



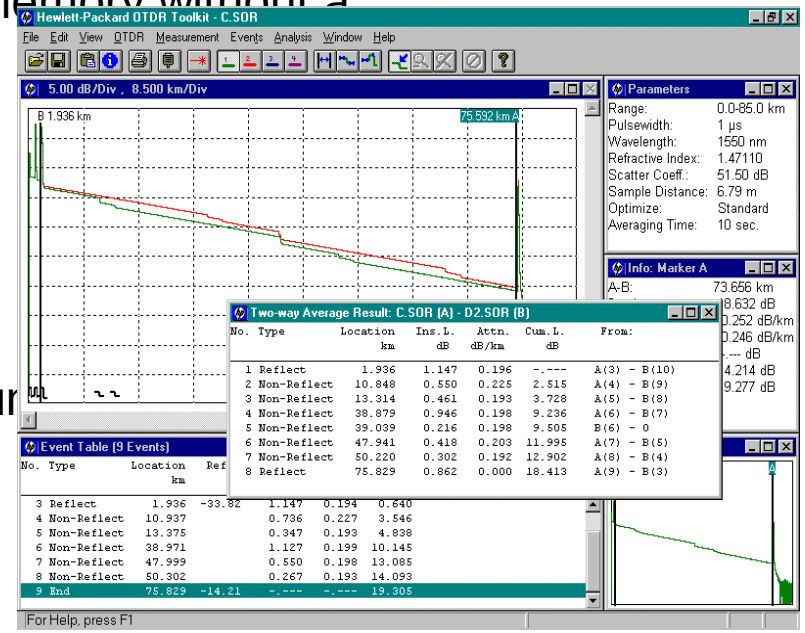
Remember:
A high power signal input can not damage the Agilent OTDR

OTDR Enabling technologies

Intelligent High Capacity NiMH batteries
for long predictable performance

New Flash PC Card for the 3M Mini-OTDR
2000stores
up to 3000 traces in flash memory without a battery!

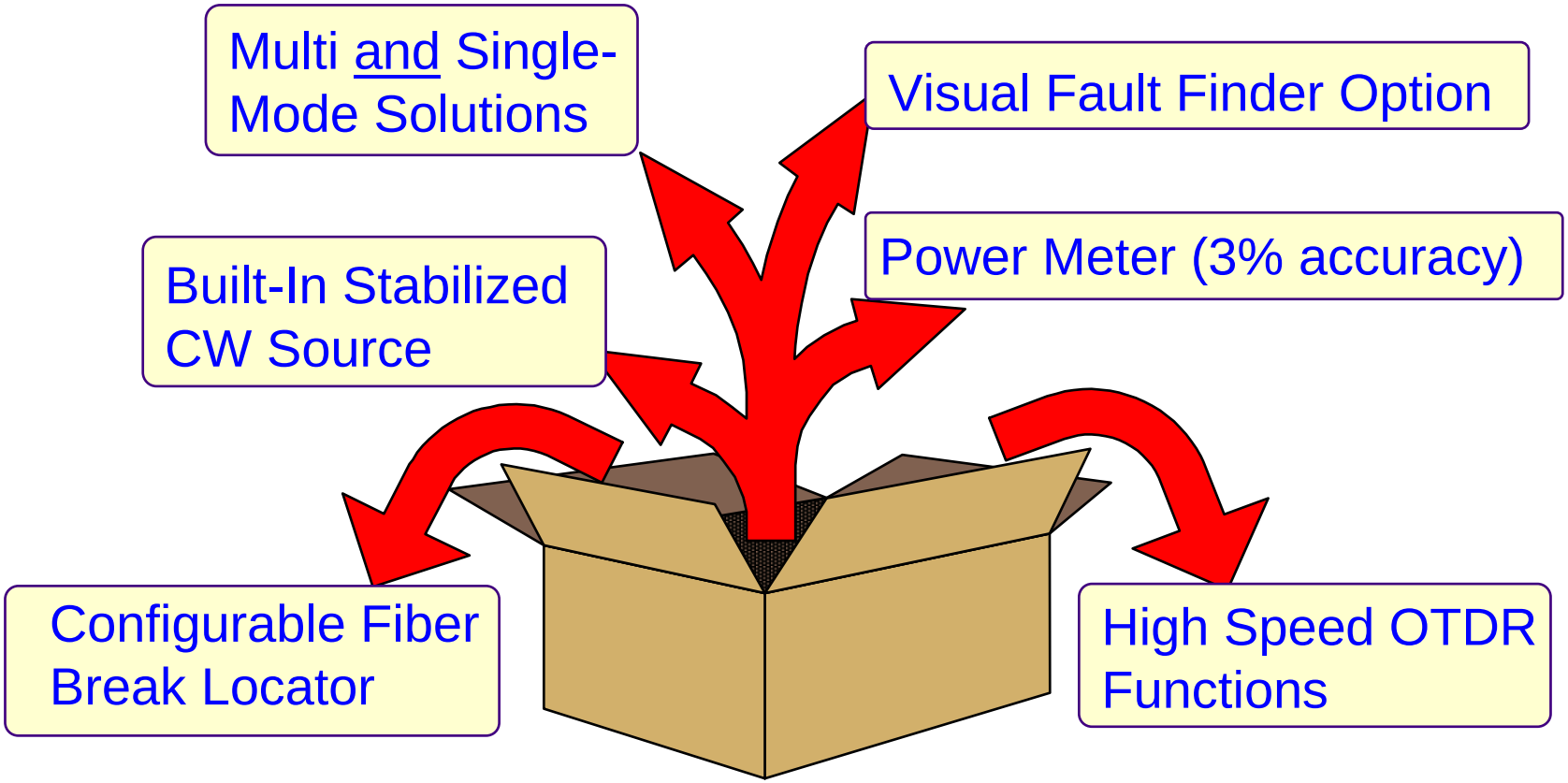
3M's OTDR Support CD provides software tools,and files.



Free Trace Viewer and transfer PC Software run under all Windows versions.

In summary .....

- Great features in a small package . . .

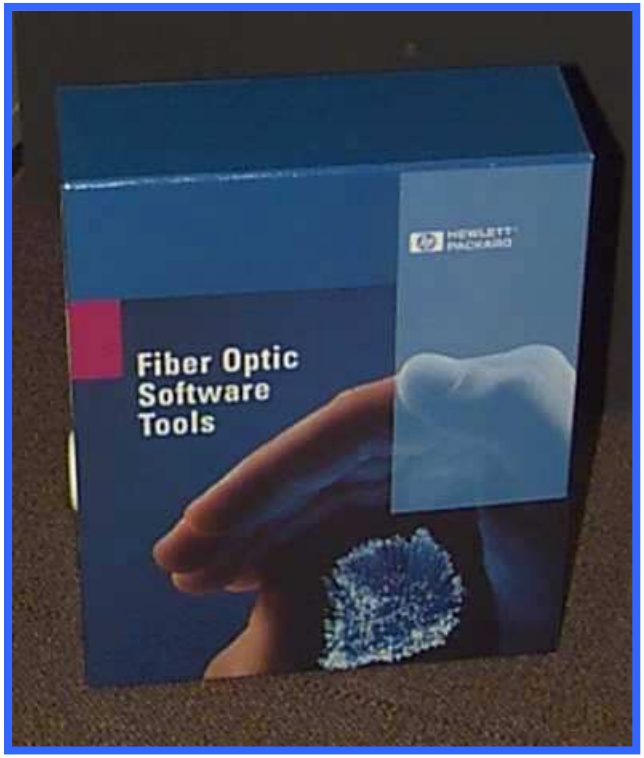


OTDR Measurements Agenda

- Basic Terms
- Fibers and Connectors
- OTDR Measurements
- Introducing the 3M Mini-OTDR 2000
- Software Utilities

3M 2000 MINI OTDR: The 3M OTDR Toolkit

Desktop viewing and post-processing of OTDR trace data in a Windows™ environment



- Analysis of splices, connectors and attenuations.
- Comparison of up to four traces simultaneously.
- Remote control of Agilent's OTDR
- Trace Navigator
- Trace Browser
- Print multiple traces
- Process multiple traces
- Two-way averaging
- Subtract traces
- Comprehensive context sensitive online help.
- ASCII export
- Copy to clipboard

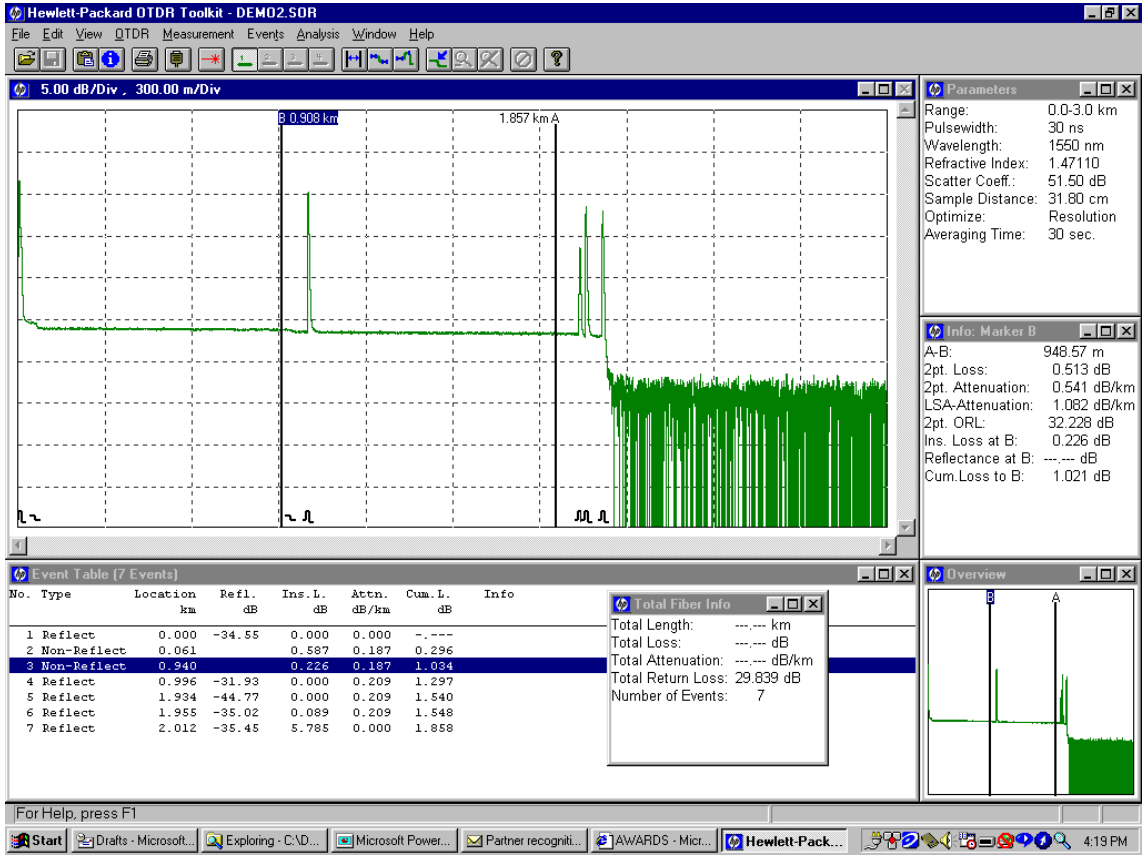
Try our free OTDR TraceViewer Software. Go to http://www.tmo.hp.com/tmo/ and select Product Information In Search Key type “E6090A”, select Agilent E6090A OTDR Toolkit and follow the instructions

3M

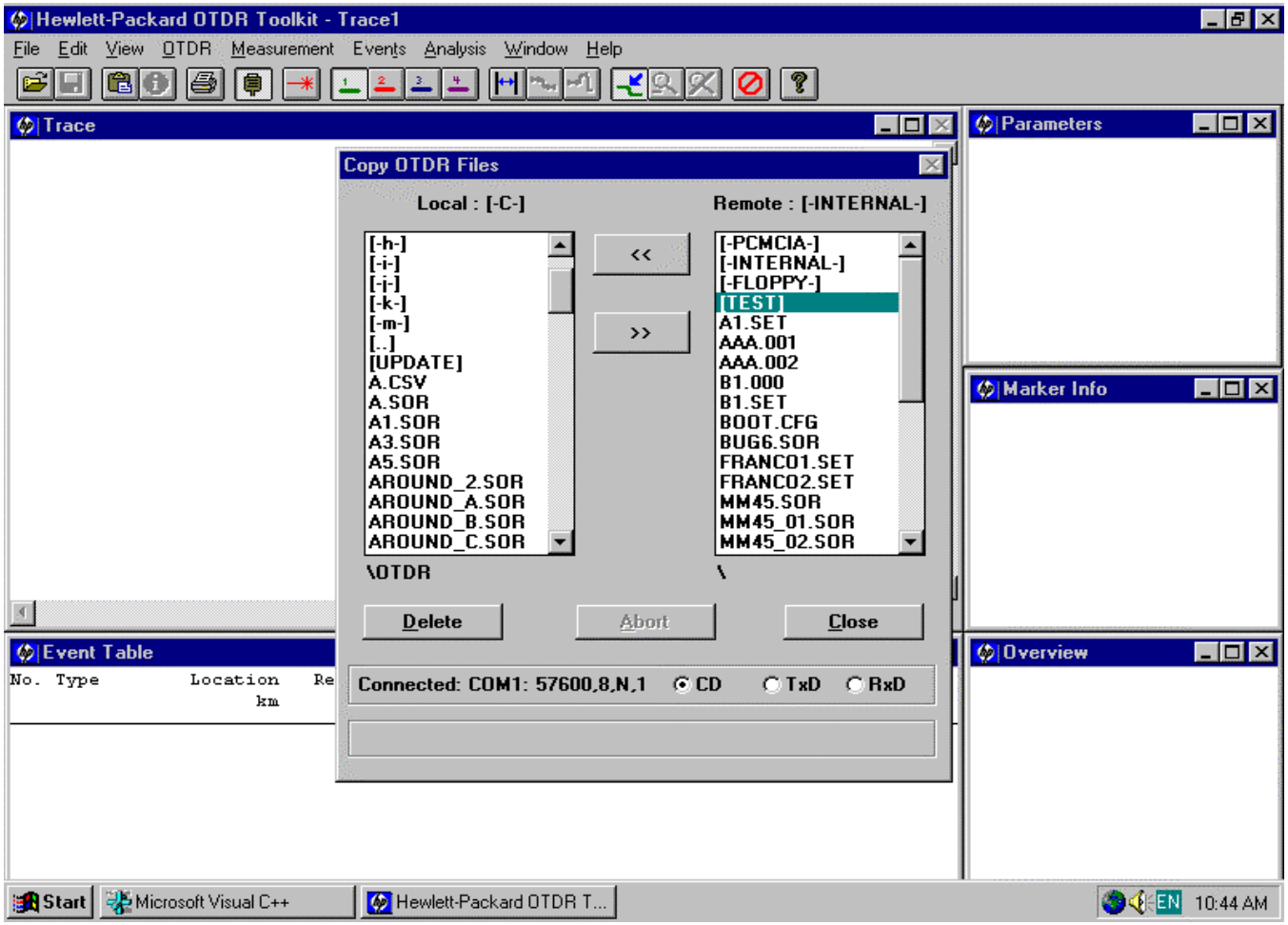
Free Trace Viewer

Download from the Web or from Agilent's OTDR Support CD

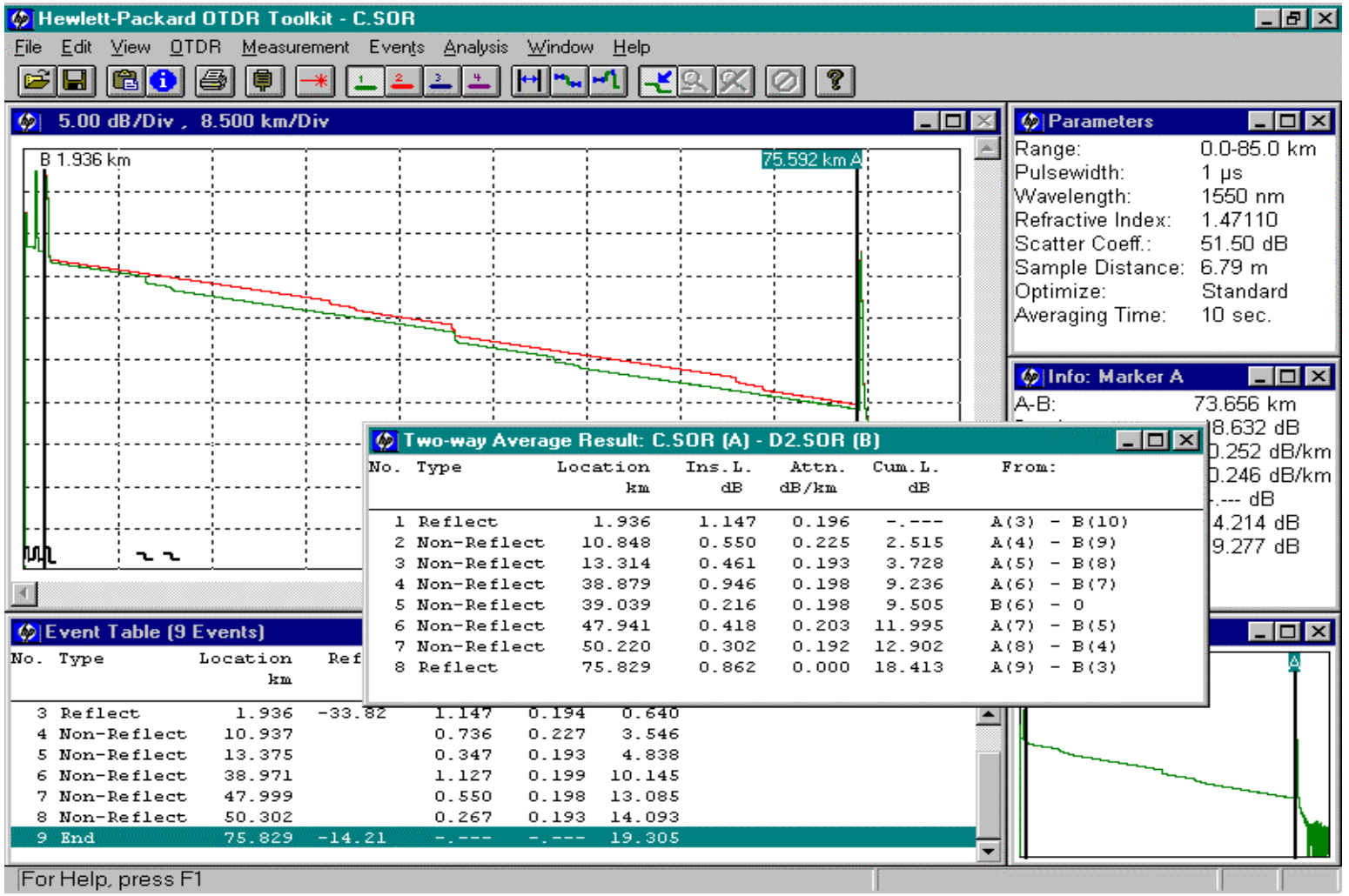
Free Trace Viewer and transfer PC Software runs under all Windows versions.



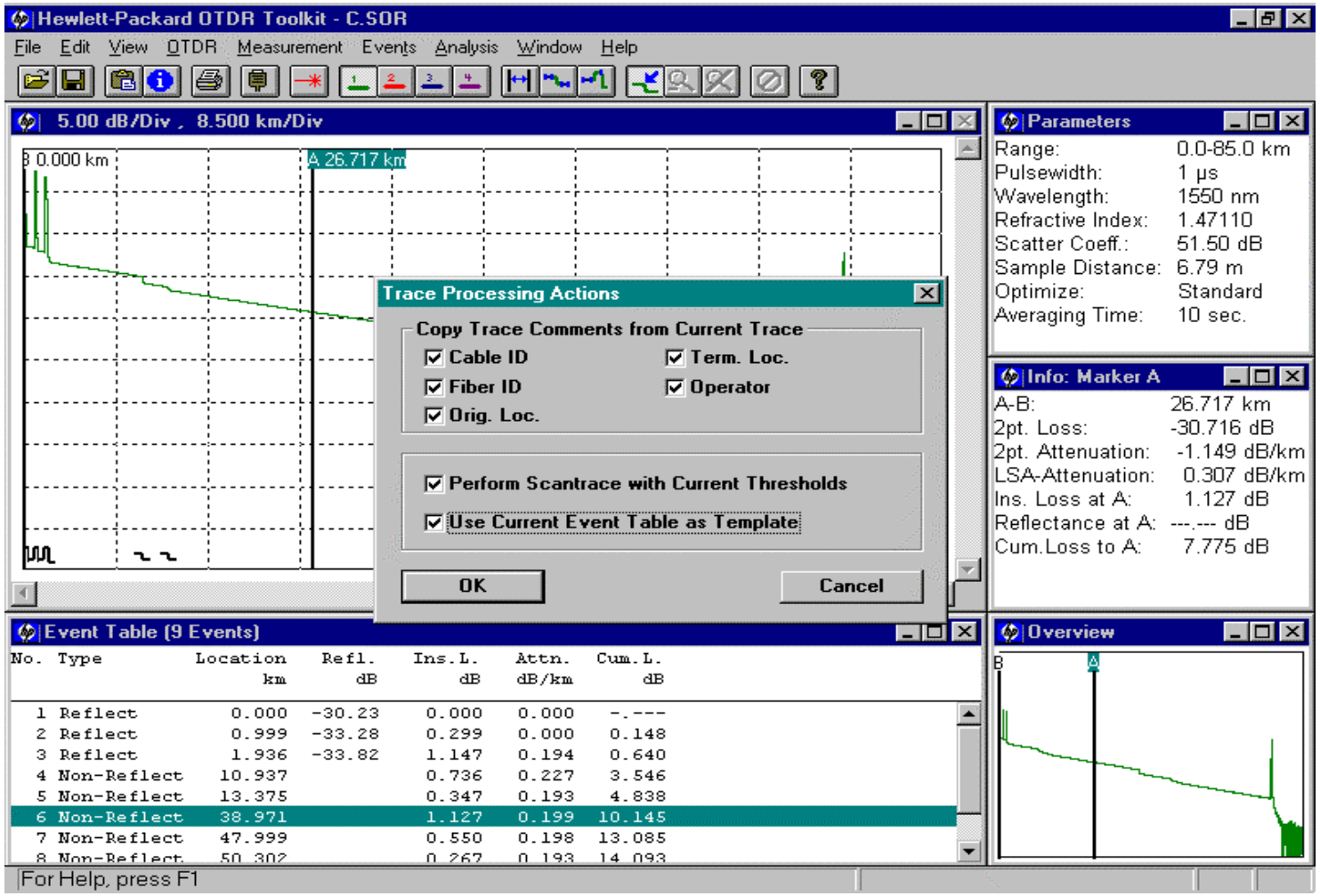
Trace Manager



Two-Way Averaging



Processing Multiple Traces

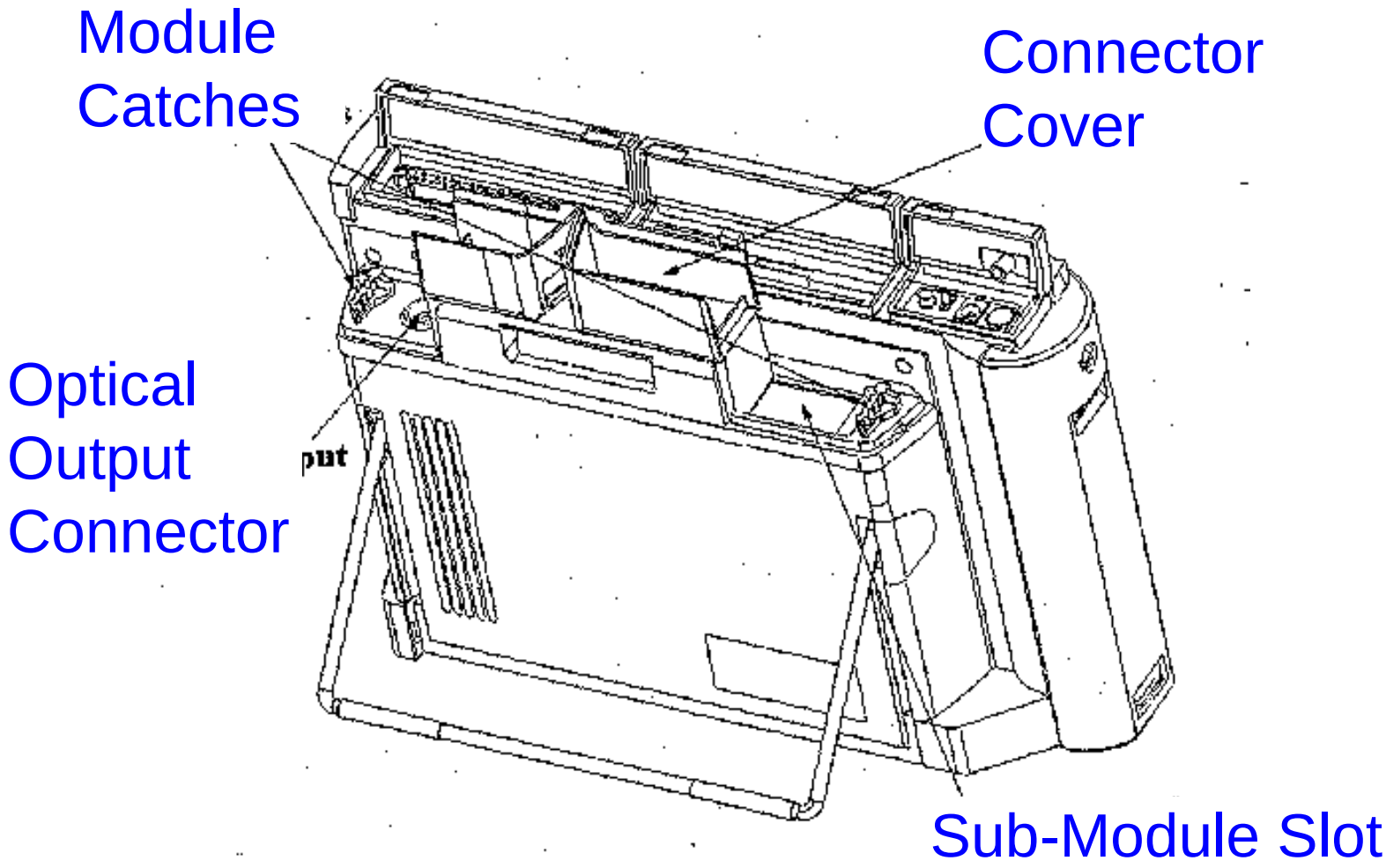


Hands on with the 3M 2000 Mini-OTDR

Using the 3M 2000 Mini-OTDR

- The Hardkeys- Softkeys and Menus
- Getting started- Storing your Setups
- Measurement Parameters
- Analyzing Traces
- Using Easy Mode
- Printing and Saving Traces

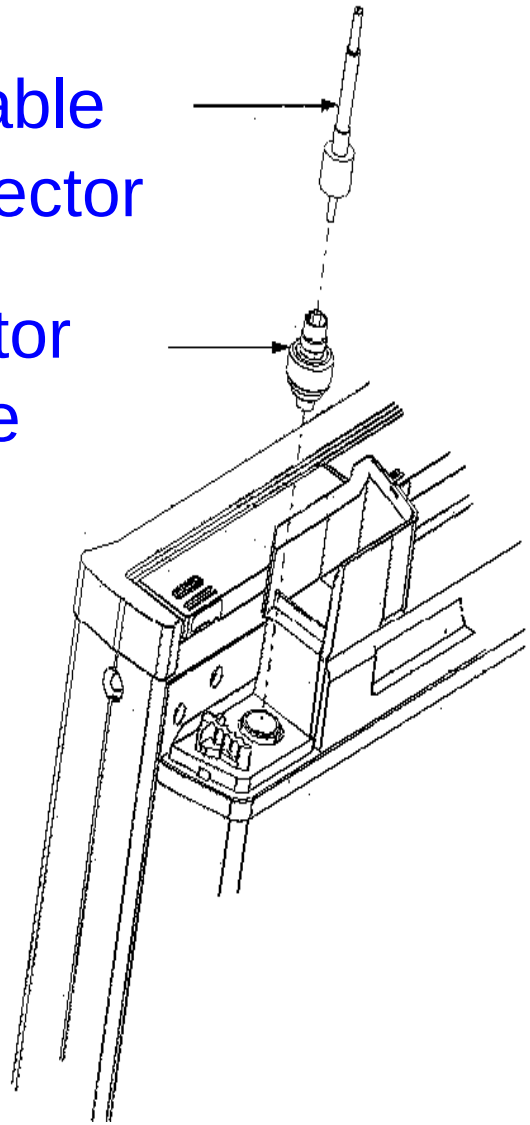
Preparing your Mini



Preparing your Mini

Optical Cable
and Connector

Connector
Interface



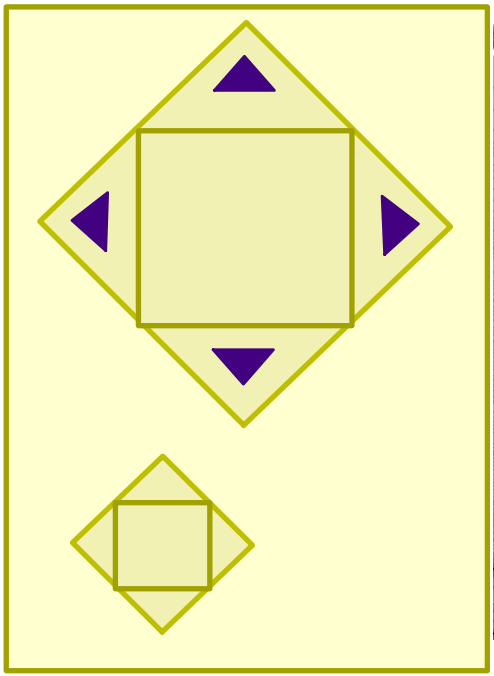
The Connector Interface is exchangeable:

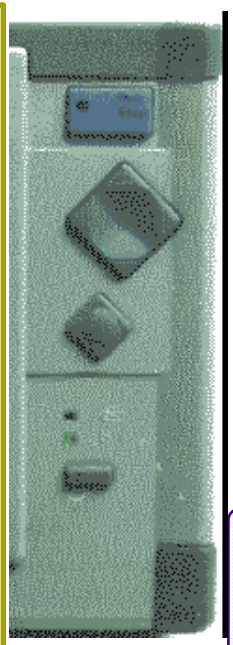
ST - Connector DE-0100-0830-3
SC - Connector DE-0100-0832-9
FC/PC - Connector DE-0100-0831-1
DIN - Connector DE-0100-0833-7
E-2000 - Connector DE-0100-0824-6
Angled Connectors are avaliable on request

The Hardkeys on the Mini

These are the main Hardkeys.

The upper "mouse-key" is used for moving the cursor; the lower key is the Select key.





The Run/Stop key is used to start and stop the measurements.

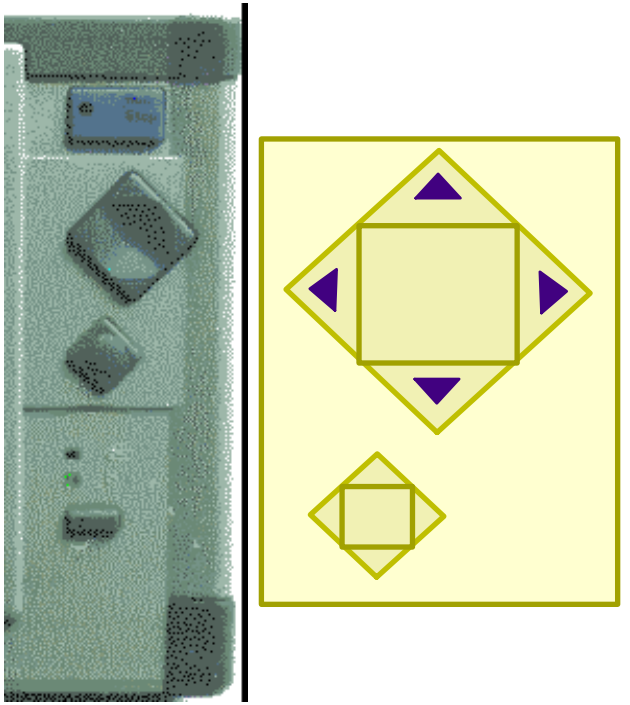
Run/
Stop

Push the Helpkey anytime to get on-line help.

?

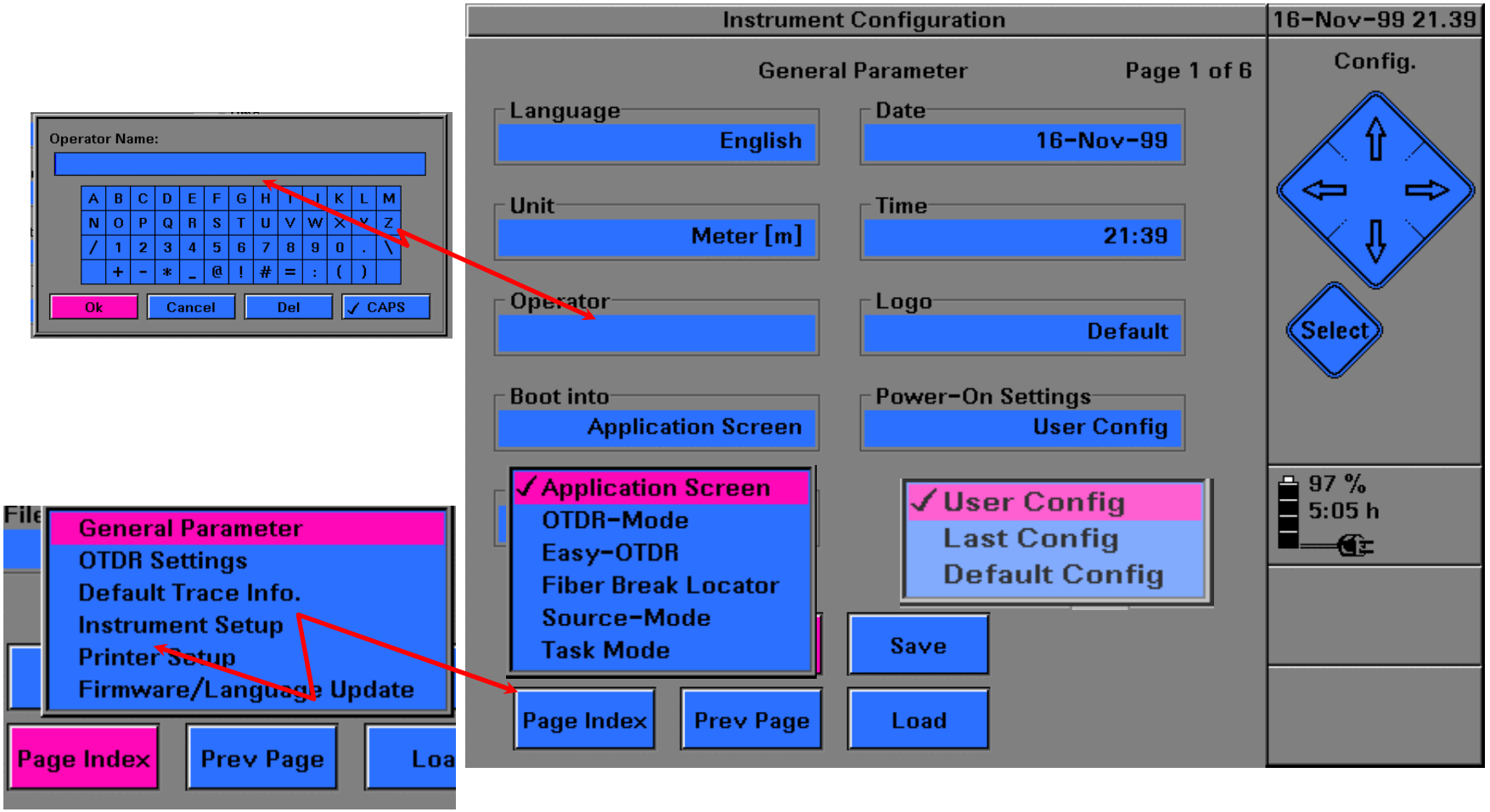
The Function Hardkeys are used to activate a variety of simple tasks.

Selecting Instrument

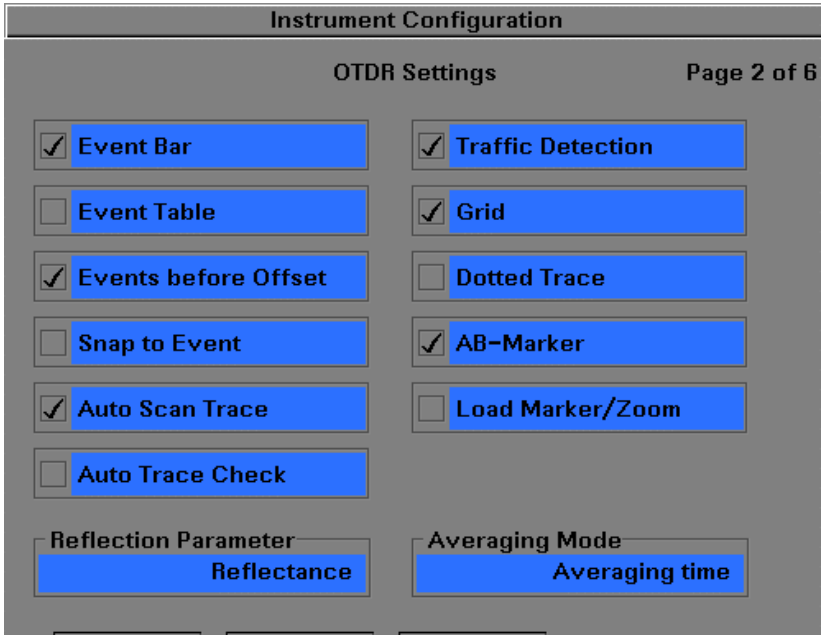


Use the cursor keys to highlight your selection - then push the Select key.

Instrument Configuration 1

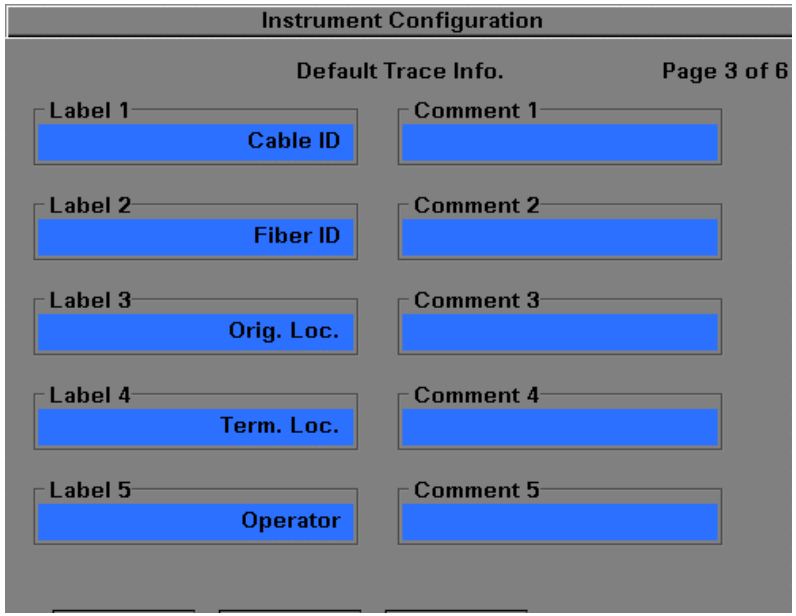


Instrument Configuration 2

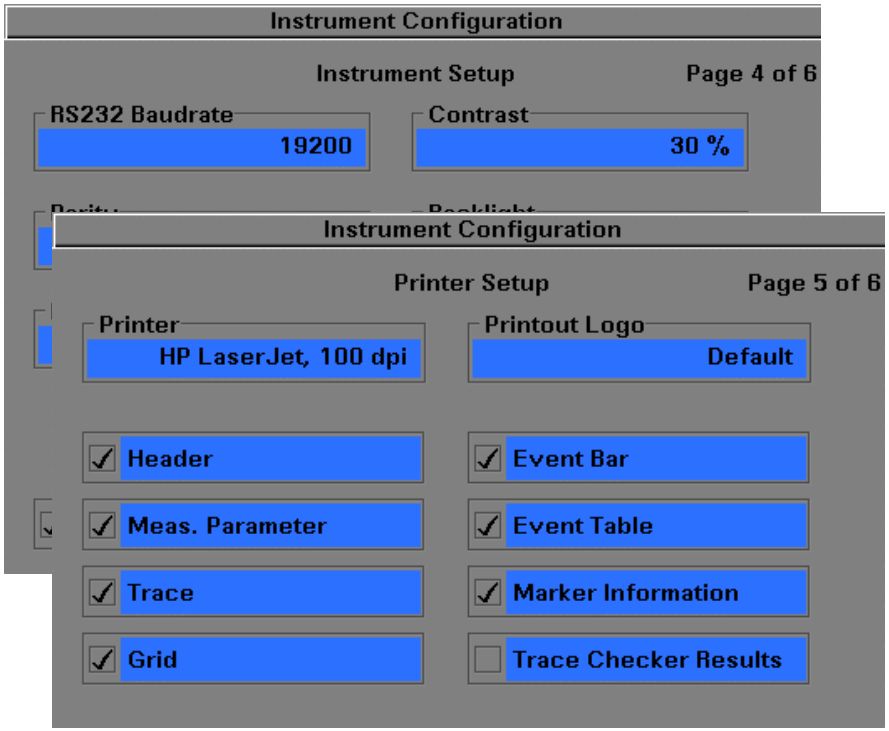


Check the settings you want to be activated.

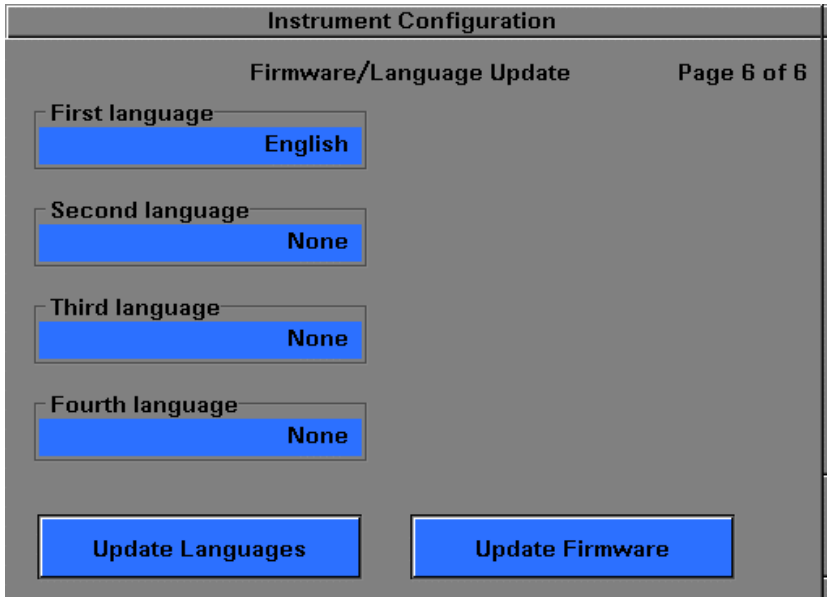
Pre-define the Trace Info. Labels and the comments.



Instrument Configuration 3

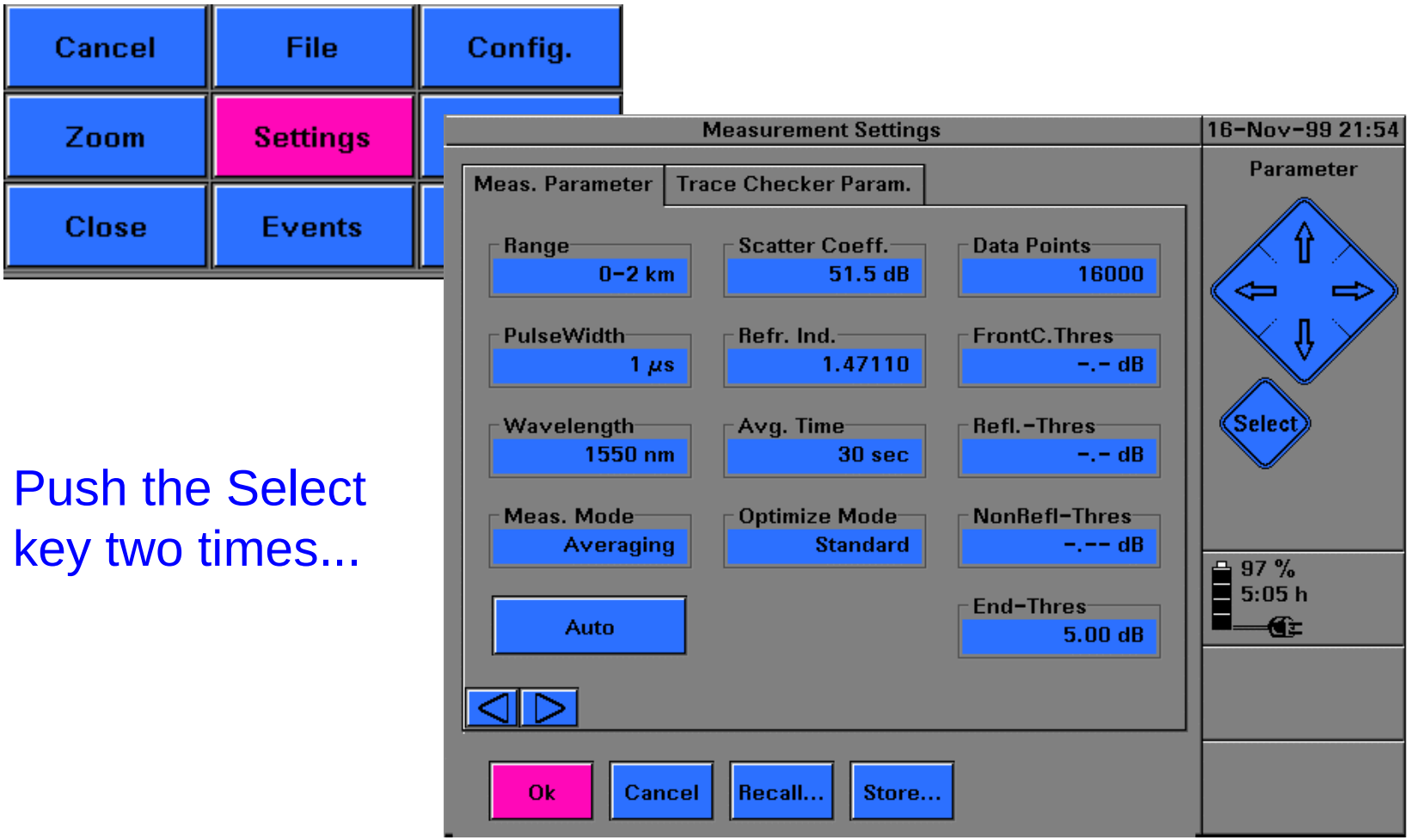


Update language selections and firmware.



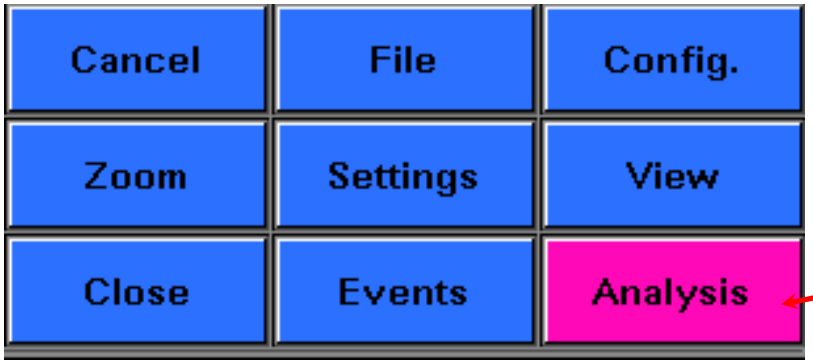
Check the information you want to have printed.

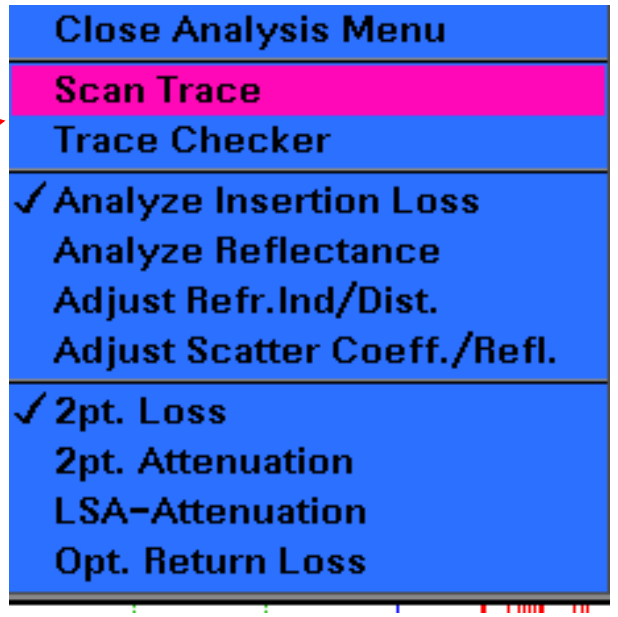
The OTDR's Menus: Settings



Push the Select key two times...

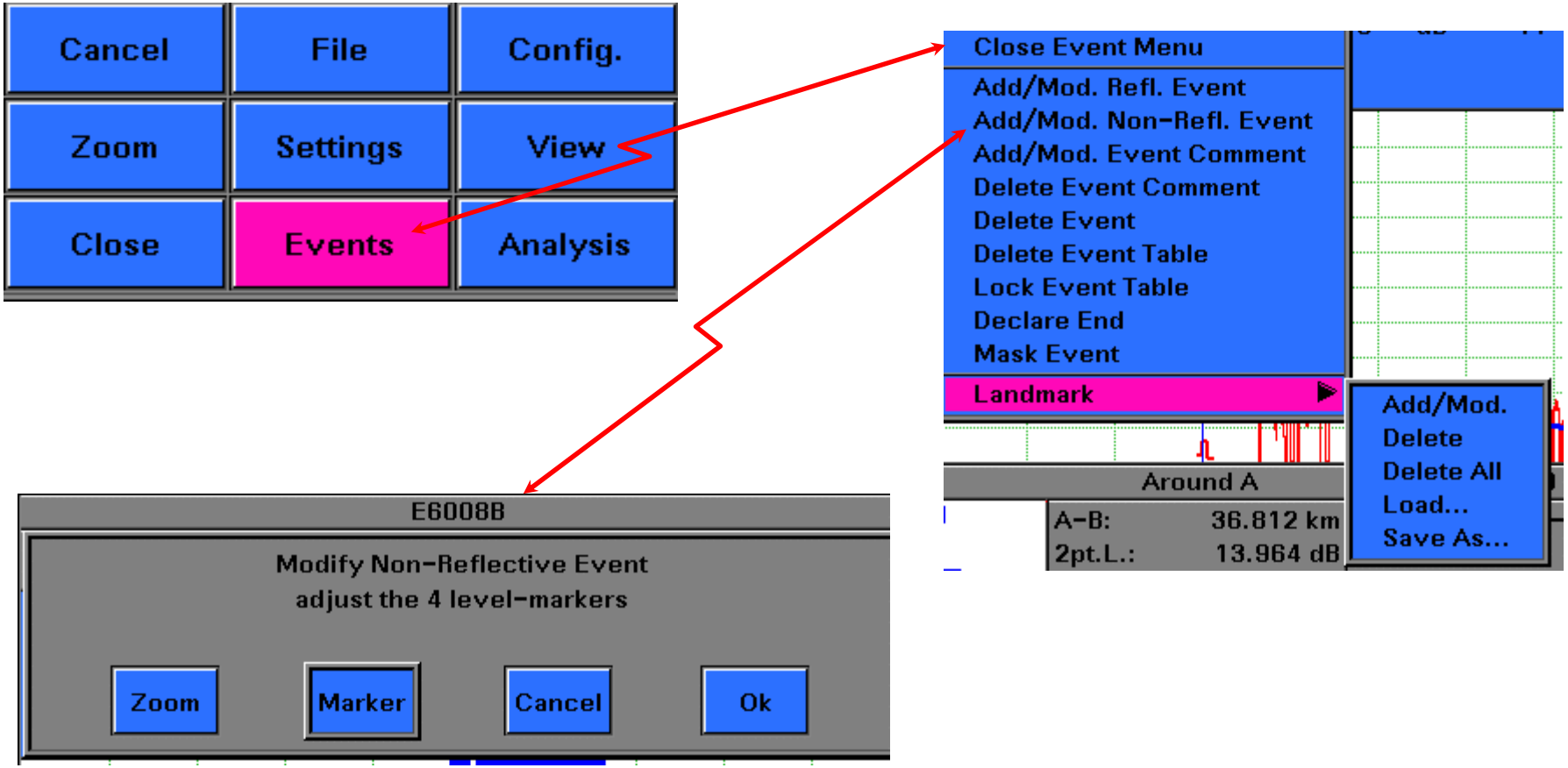
The OTDR's Menus: Analysis



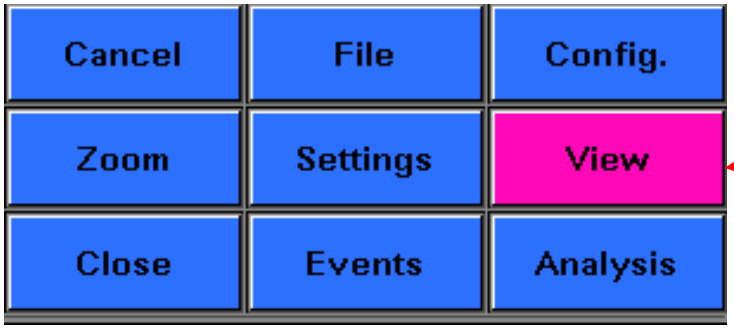


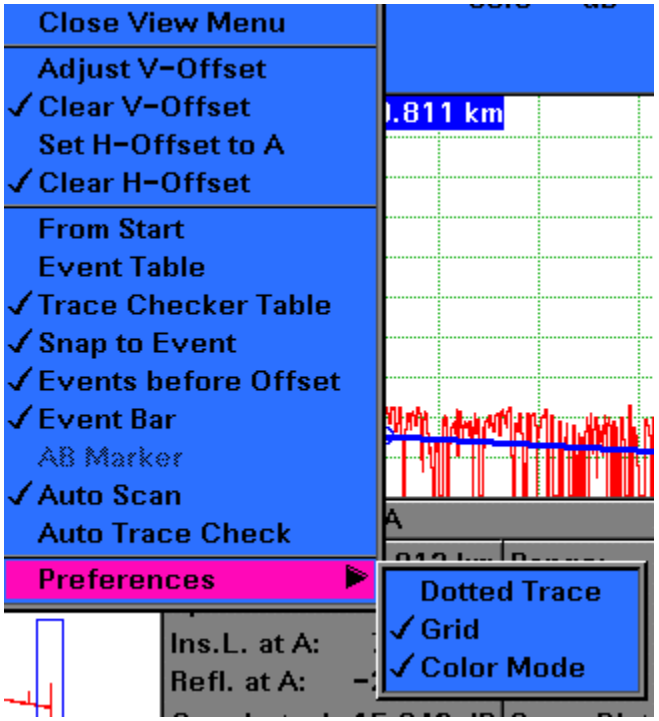
Manually analyzing the trace.

The OTDR's Menus: Events



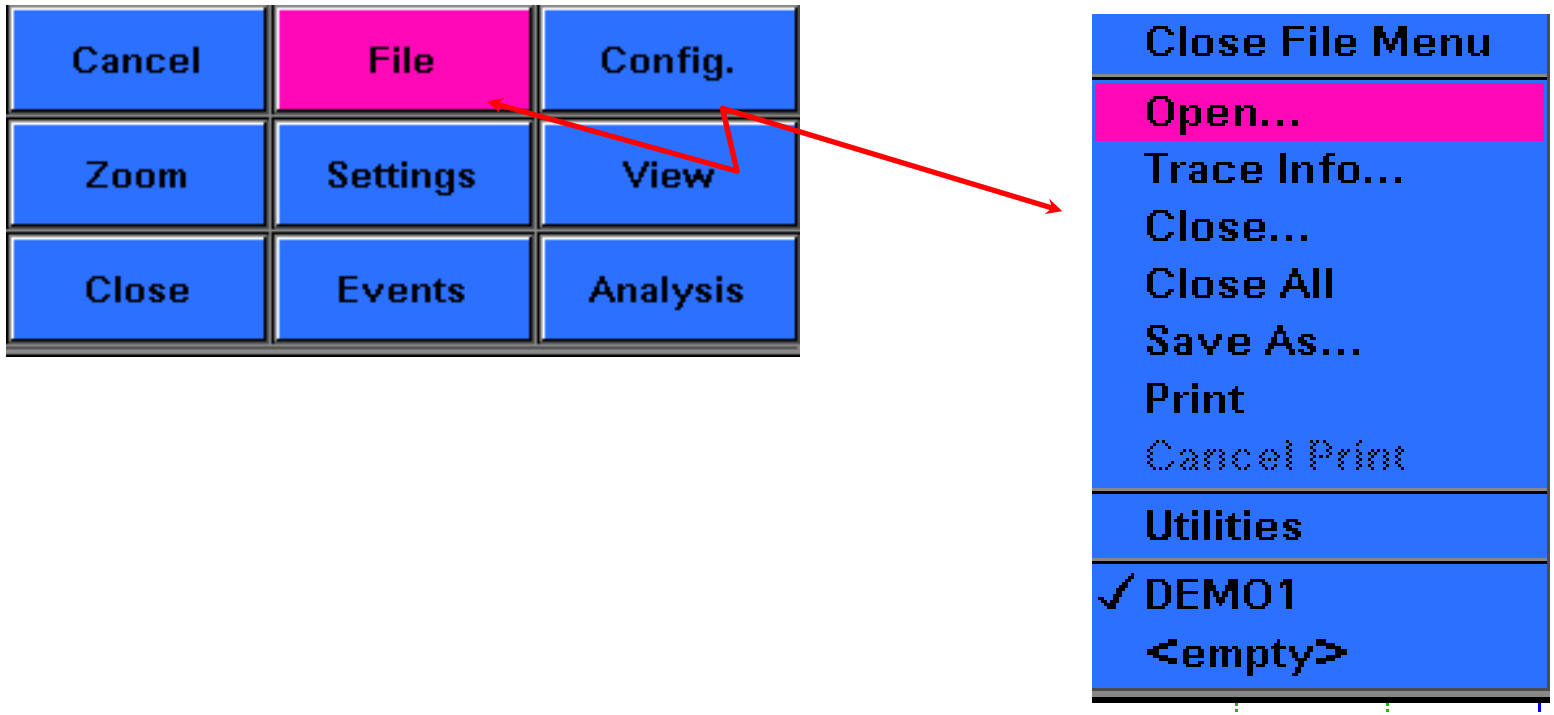
The OTDR's Menus: View



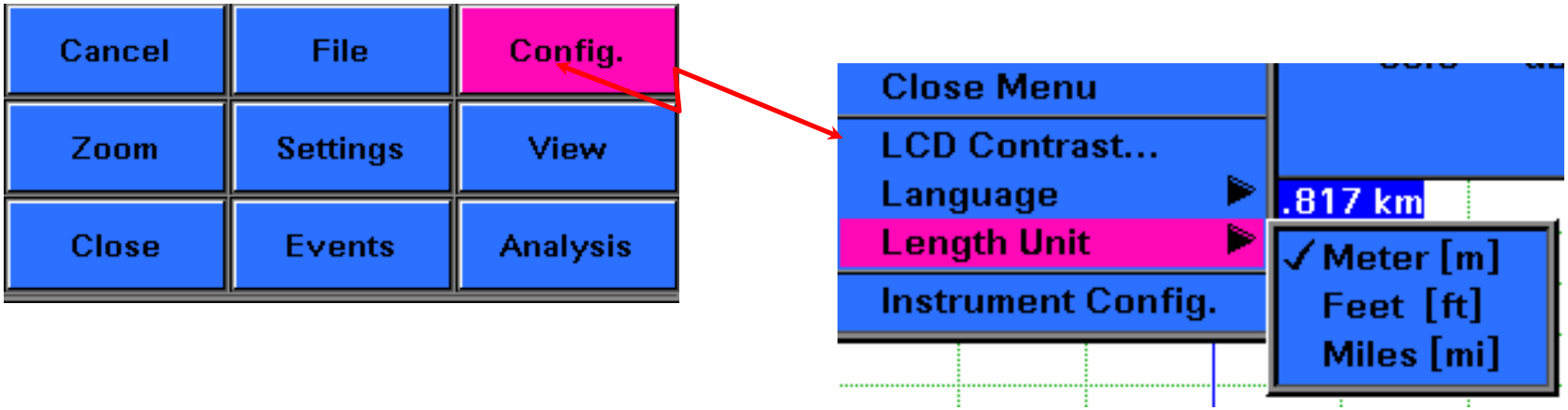


Select what you want on the display.

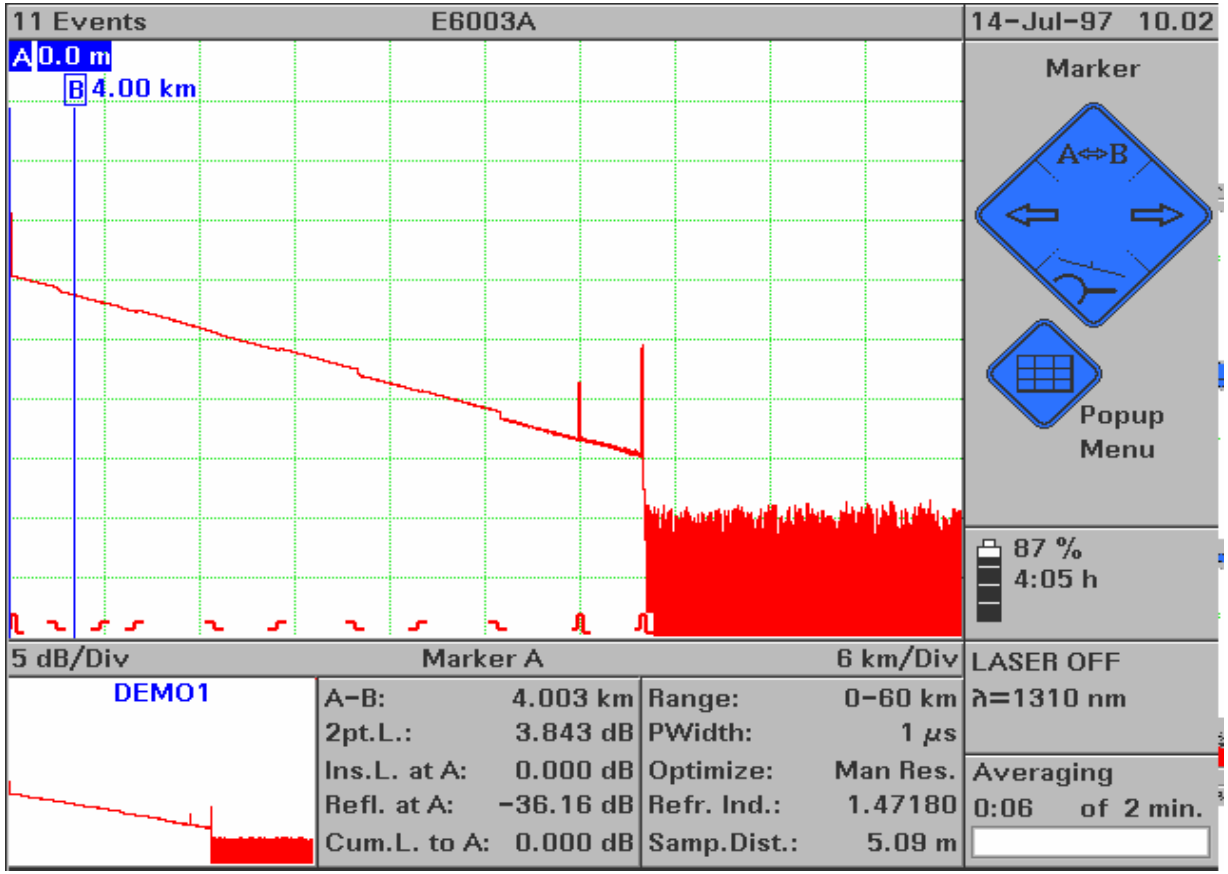
The OTDR's Menus: File



The OTDR's Menus: Config.



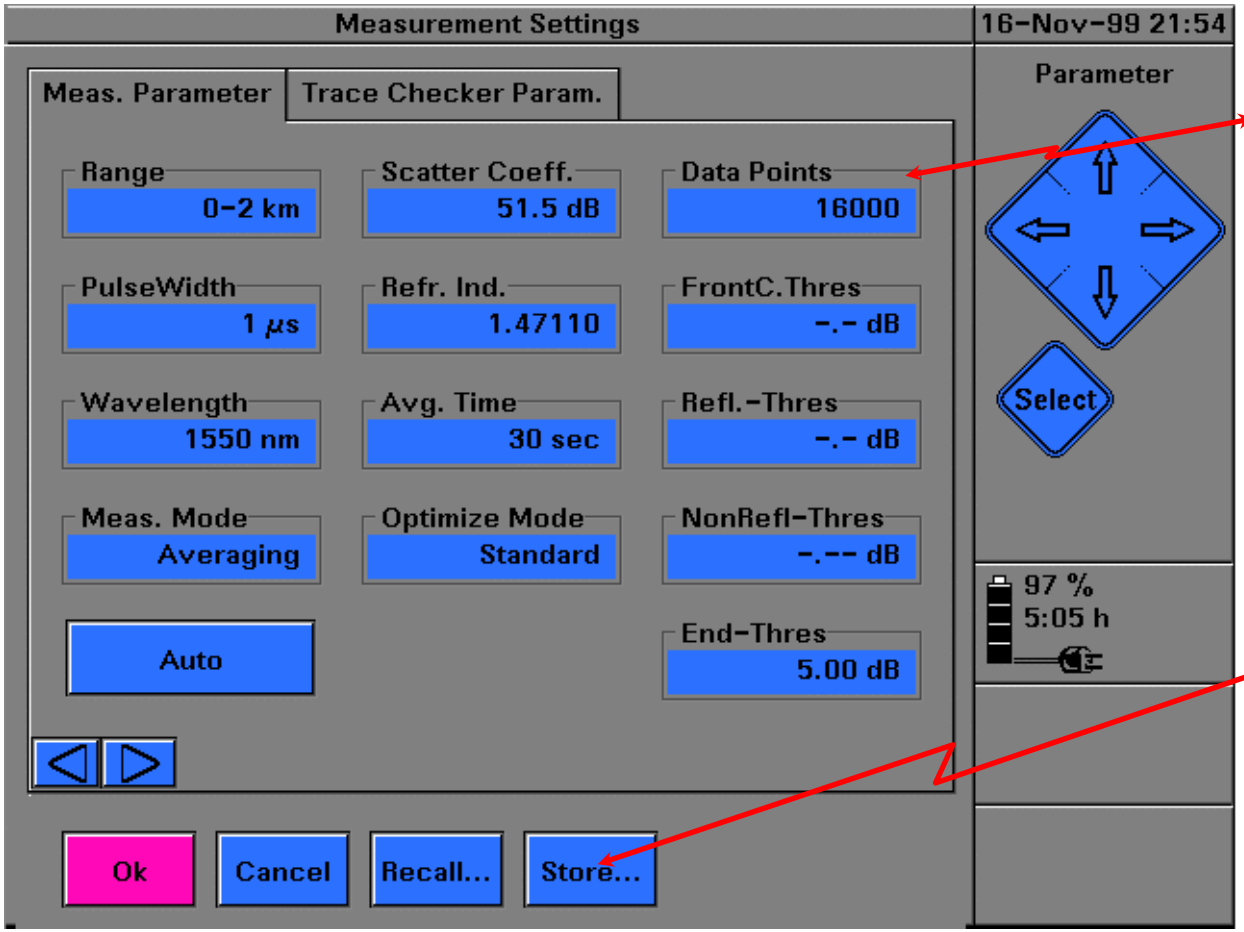
Measuring with the Mini-OTDR



1. Attach the fiber to be tested. (Clean the connectors).
2. Select wavelength if you have a dual wavelength module.
3. Check Refractive Index.
4. Check if set to "Auto".
5. Hit "Run/Stop".

THAT'S IT!!

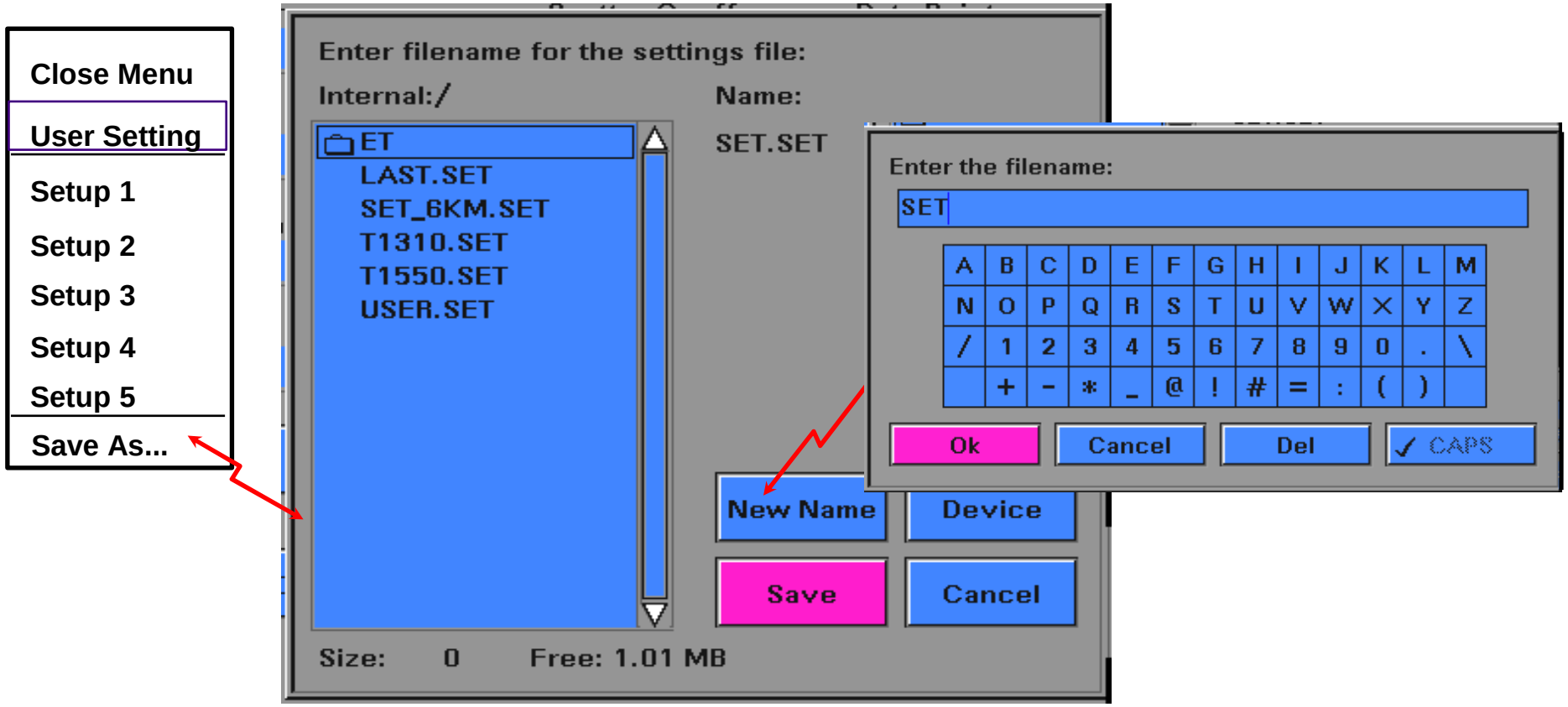
Setting and Saving your Defaults



Modify the settings you need...

... and save them.

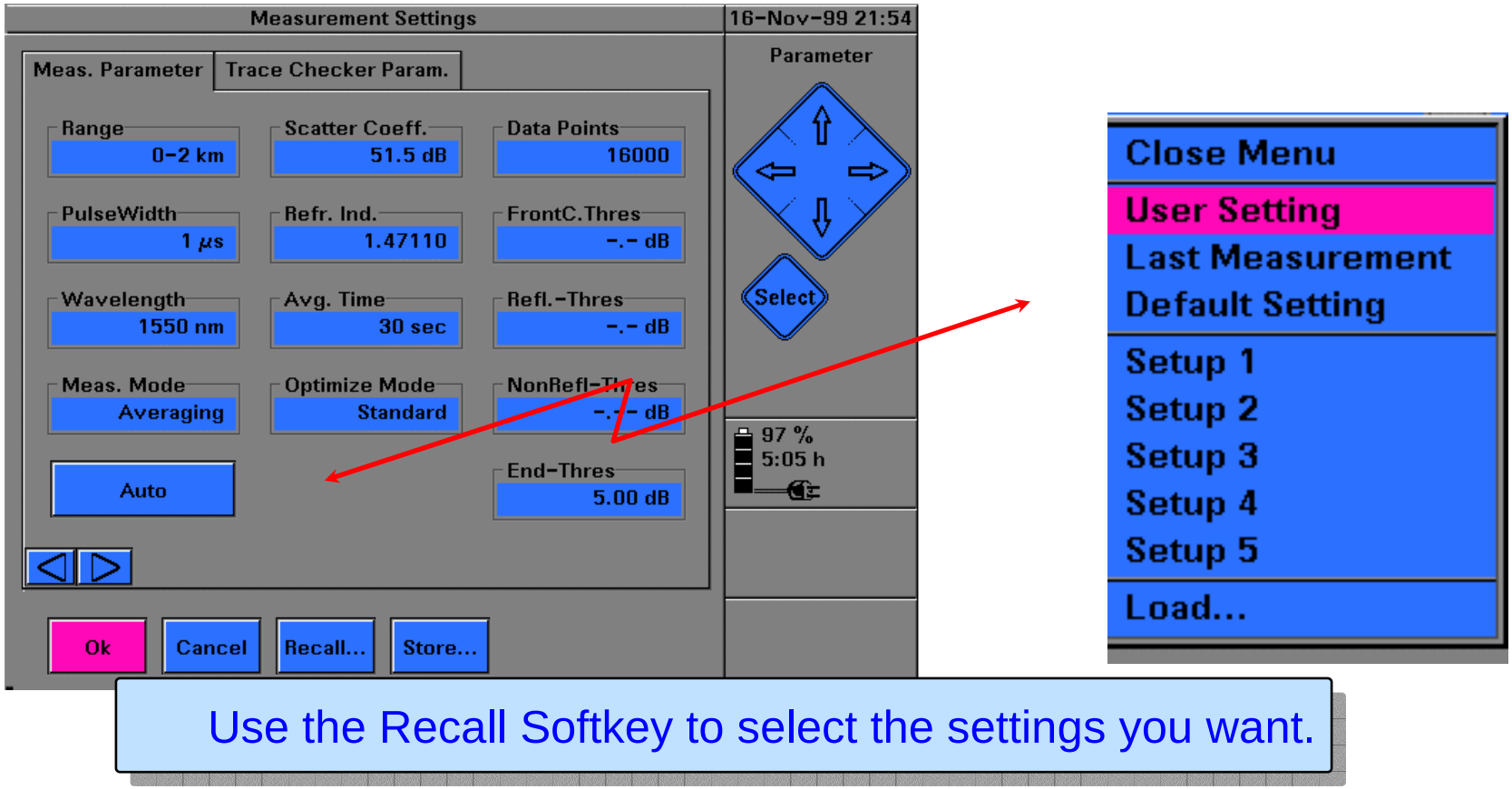
Saving Defaults . .



Select a name for your settings, and accept with Select.

Selecting the Defaults

(from the "Measurement Settings" page)



Use the Recall Softkey to select the settings you want.

Measurement Parameters

The Settings Page (1)

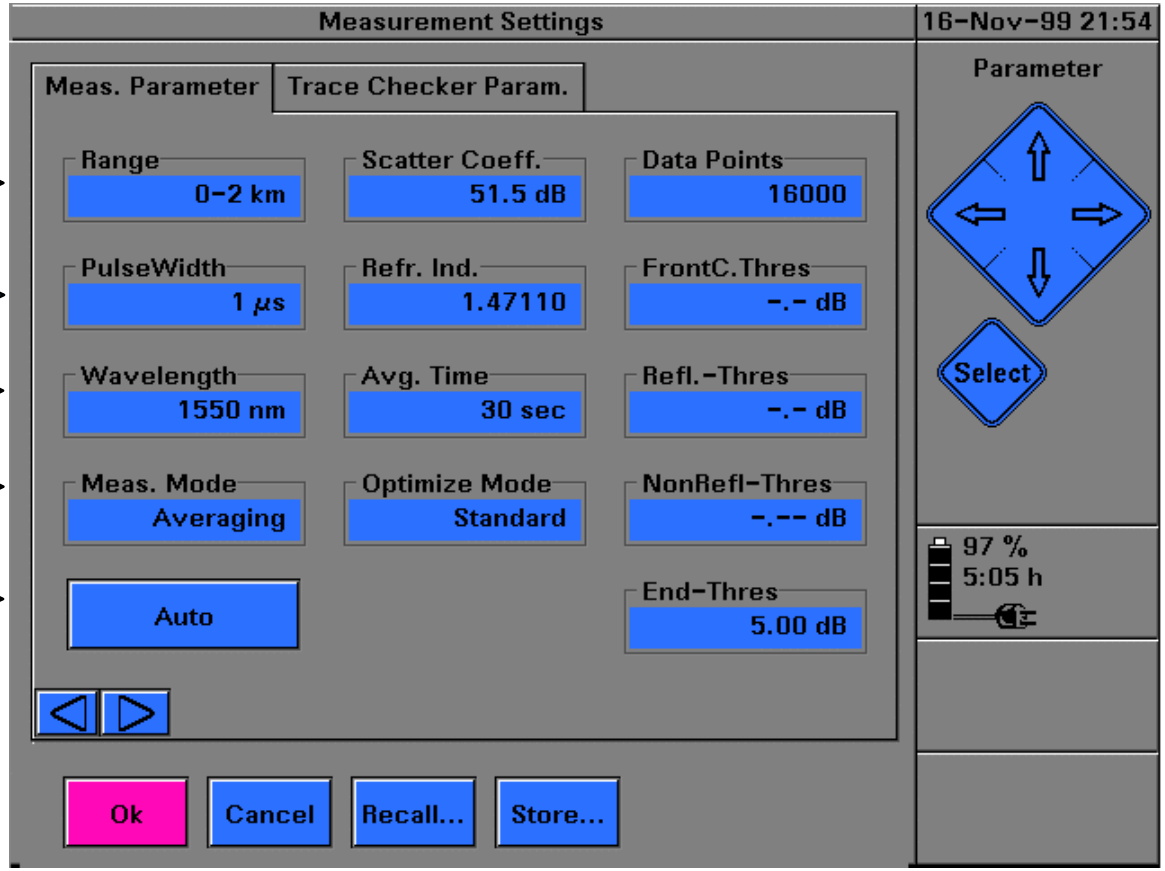
To set the start and stop position for the measurement in any position.

Sets pulsewidth for the measurement.

Sets the wavelength based on module

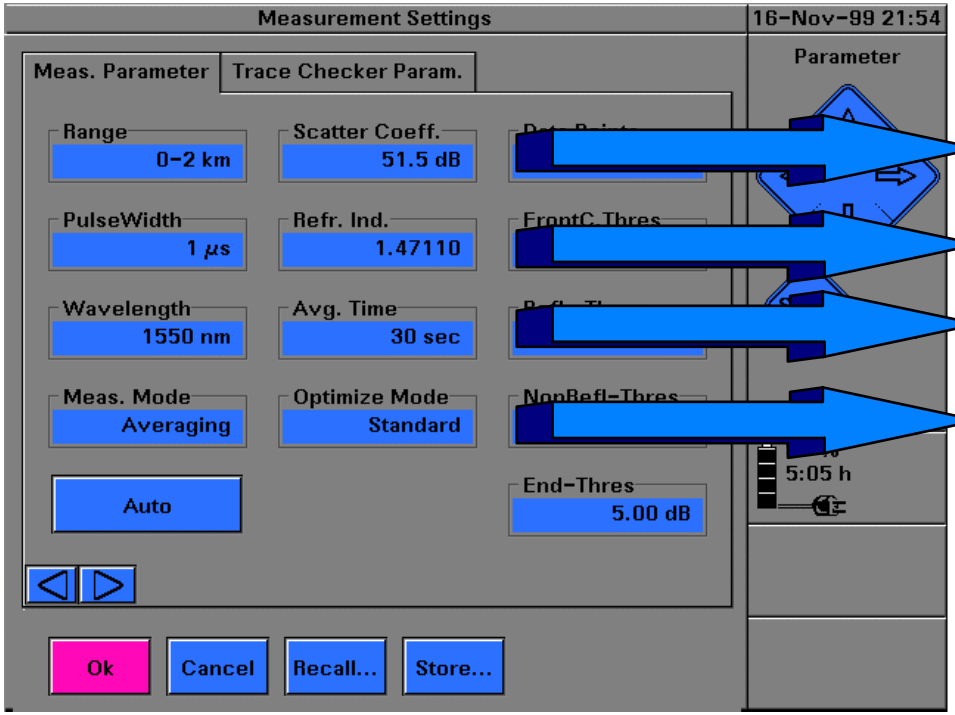
Choose between Real-time, Continue or Average Mode

Makes range and Pulsewidth automatic



Measurement Parameters

The Settings Page (2)



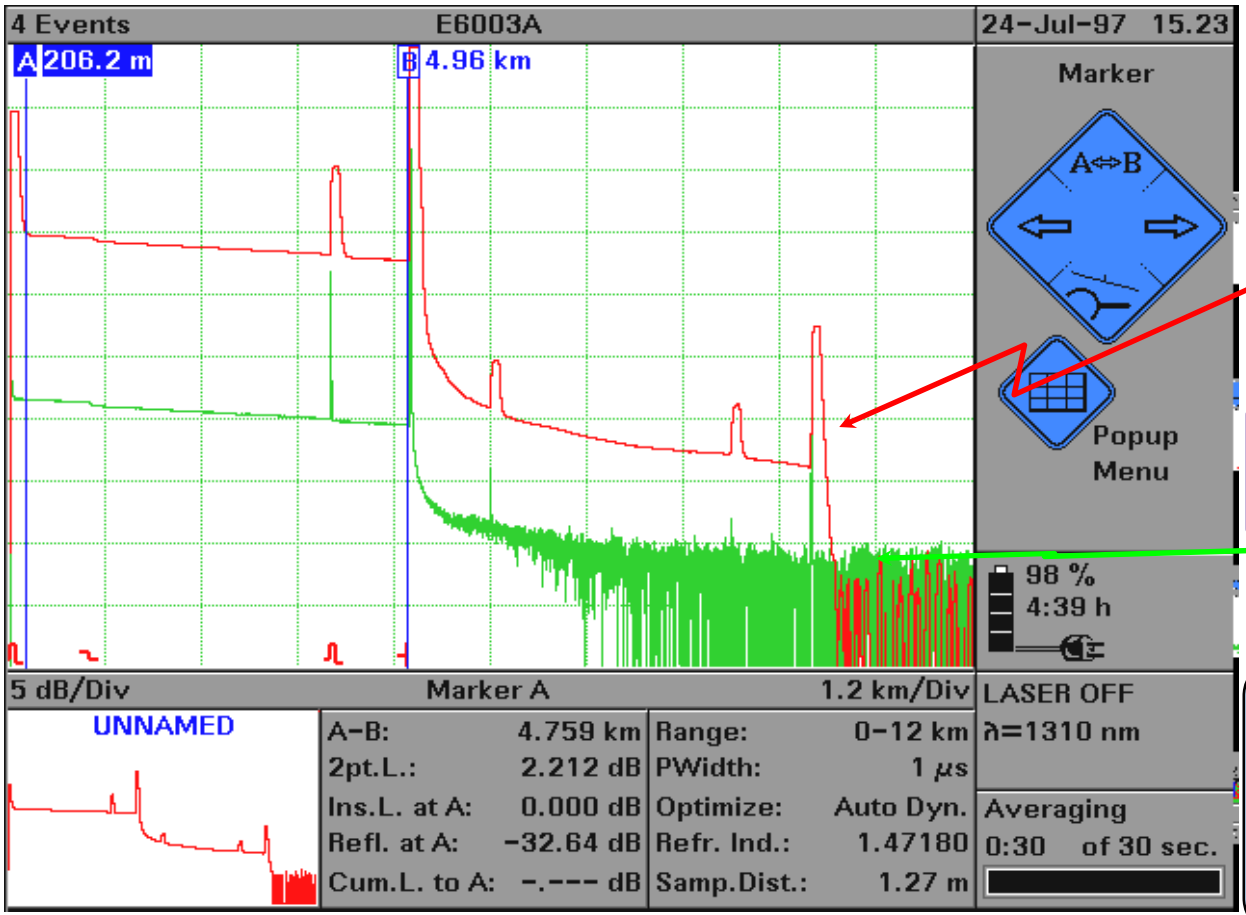
Sets the backscatter coefficient for the fiber.

Sets the Index of Refraction for the fiber.

Sets the averaging time.

Select Standard, Resolution or Dynamic Optimize Mode.

Optimize Mode - Dynamic

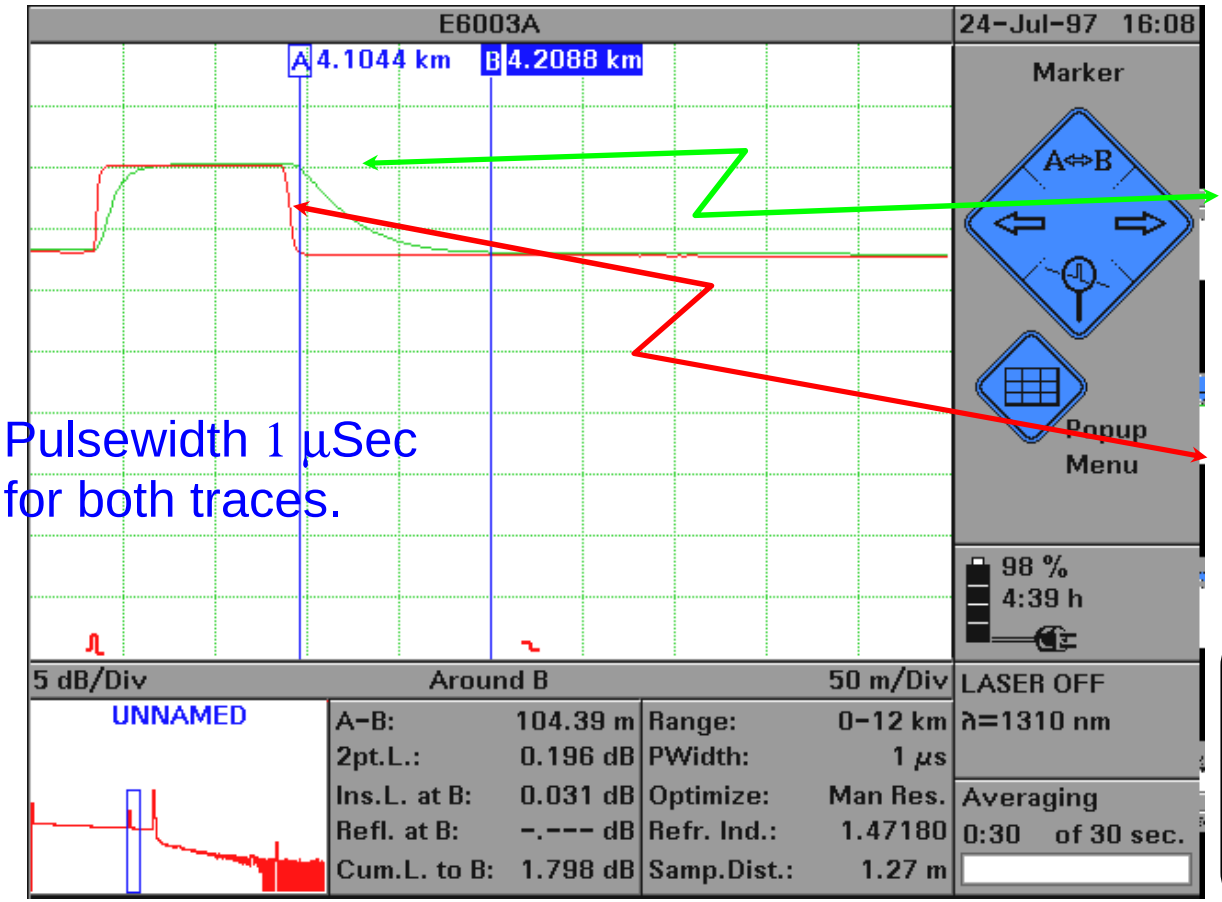


The red trace is optimized for Dynamic Range.

The green trace is optimized for resolution.

Dynamic range optimizes the OTDR for reducing the noise on the measurement.

Optimize Mode - Resolution



Pulsewidth 1 µSec for both traces.

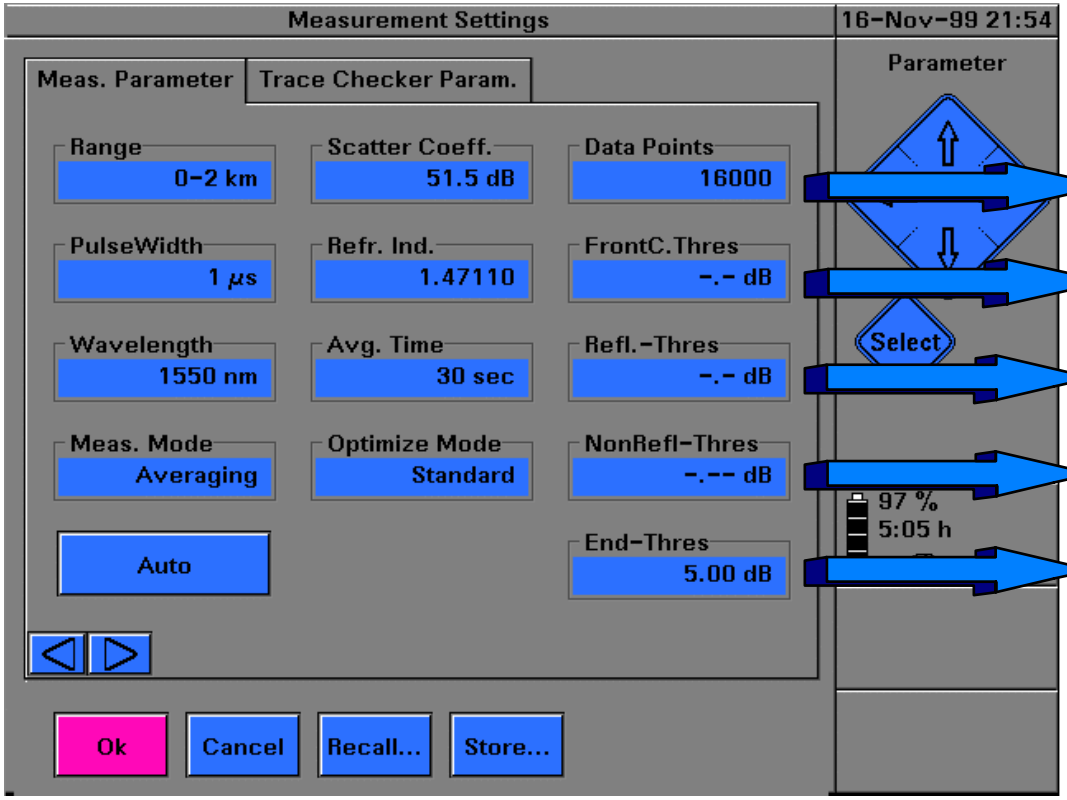
The green trace is optimized for Dynamic Range.

The red trace is optimized for Resolution.

Resolution optimizes the OTDR for reducing the "blind spots" due to reflections.

Measurement Parameters

The Settings Page (3)



Select the number of points sampled along the trace.

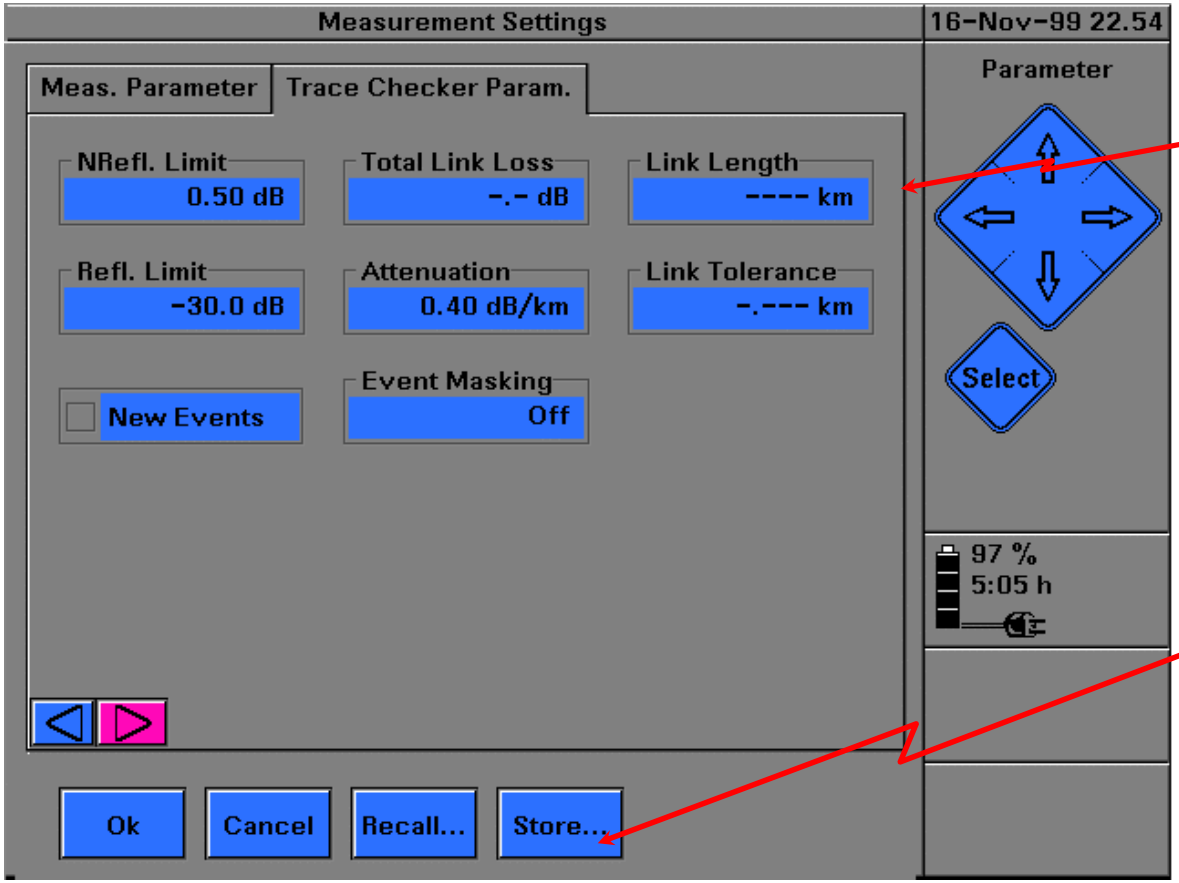
Sets the alarm threshold for front connector. 0.00 for off!

Sets the threshold for reflections to be measured.

Sets the threshold for non-reflective events to be measured.

Sets the threshold for the "End of Fiber" algorithm.

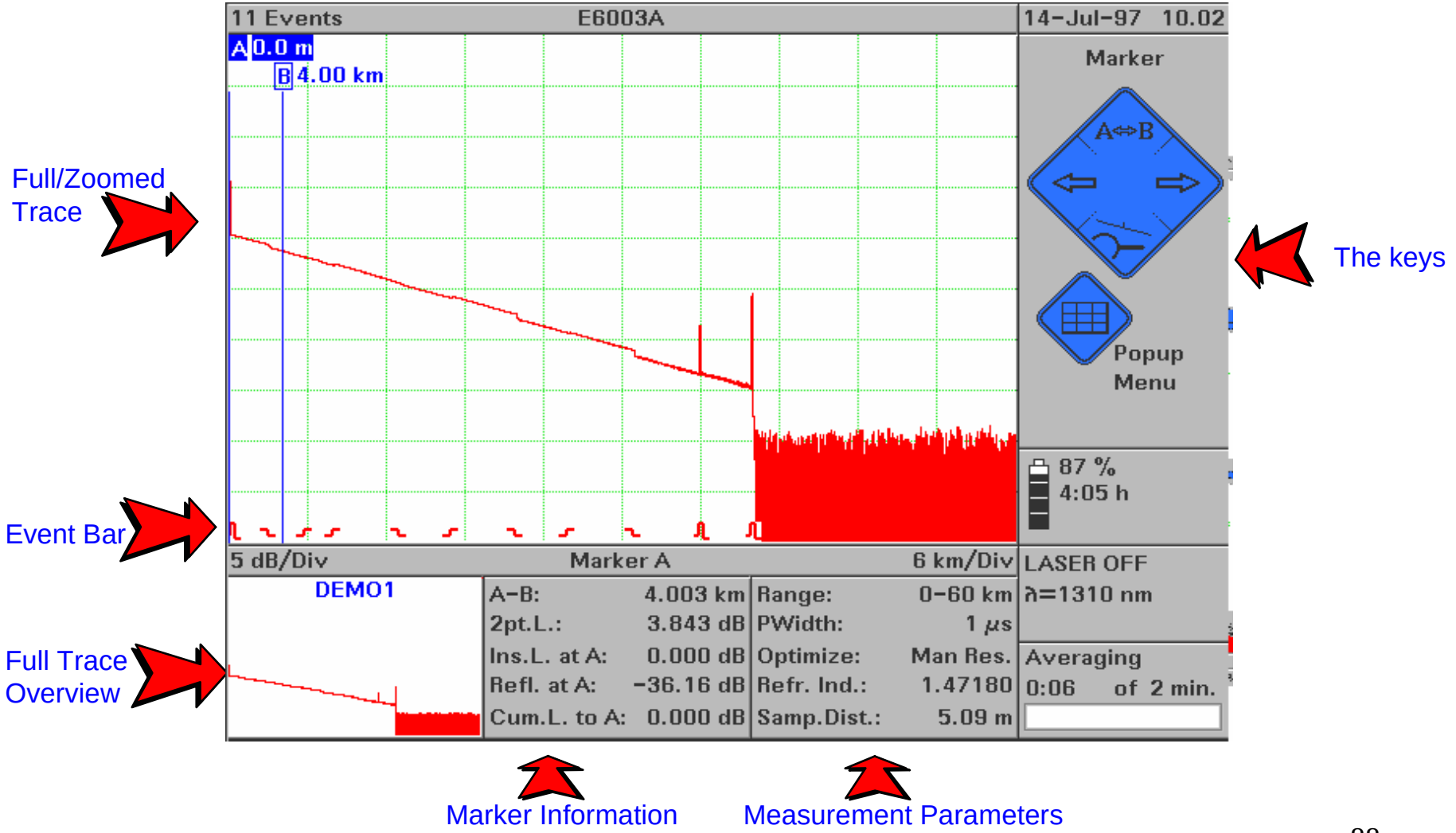
The 3M Trace Checker



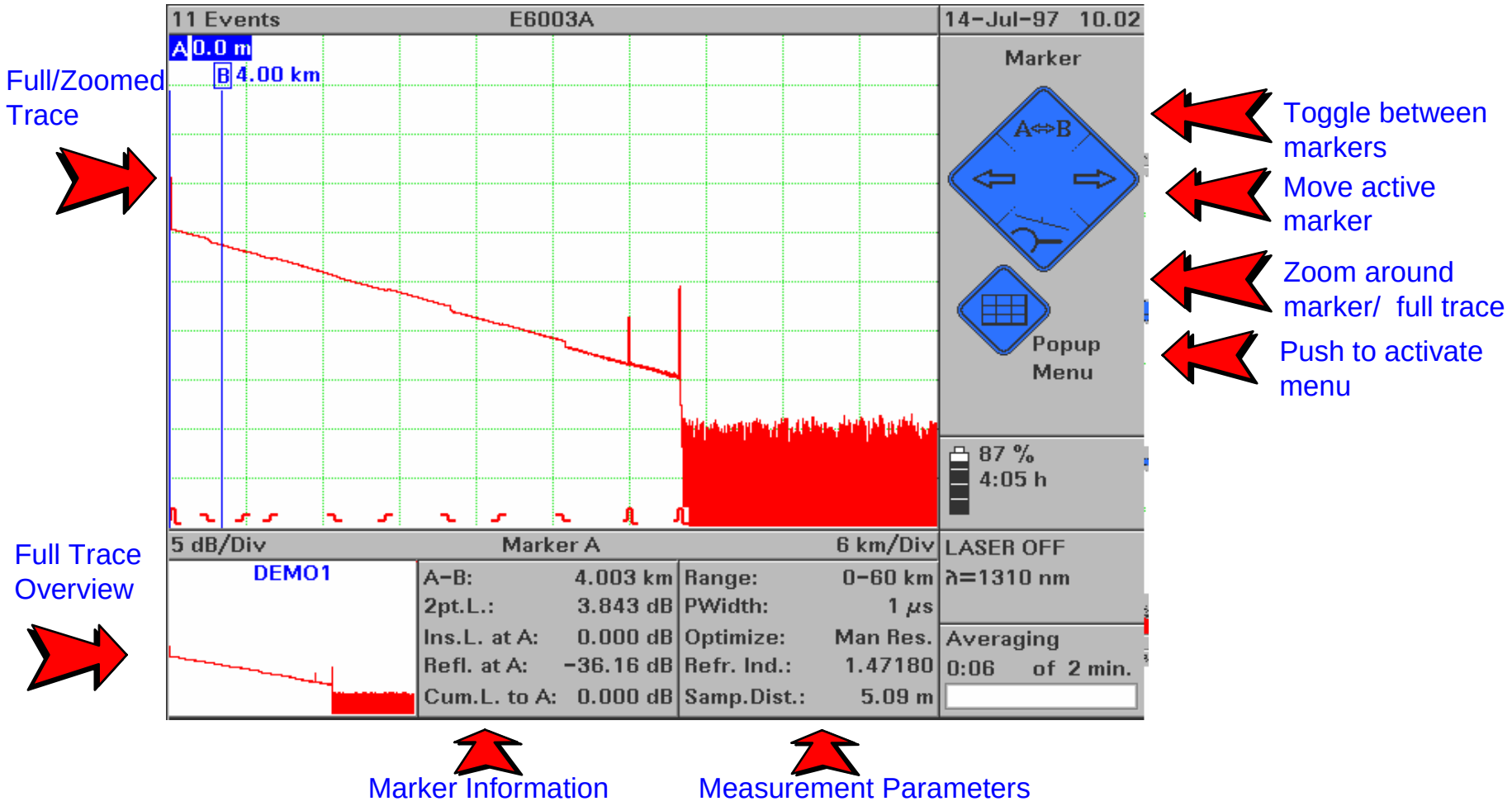
Modify the limits you need to test a link too..

Don't forget to save the parameters.

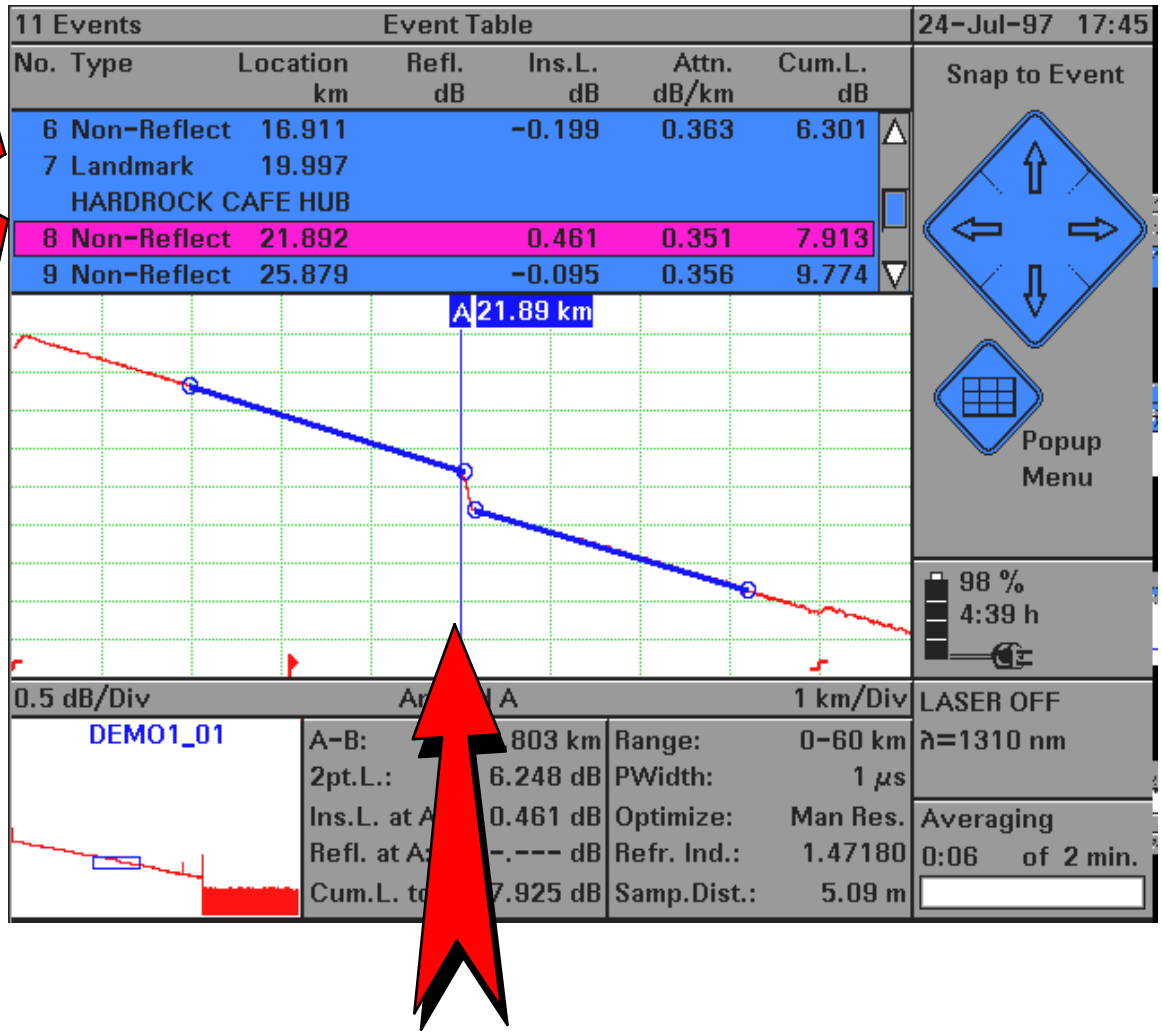
A Typical Trace Display



Analyzing the Trace



A Typical Event Table



Landmark Information

Selected Event

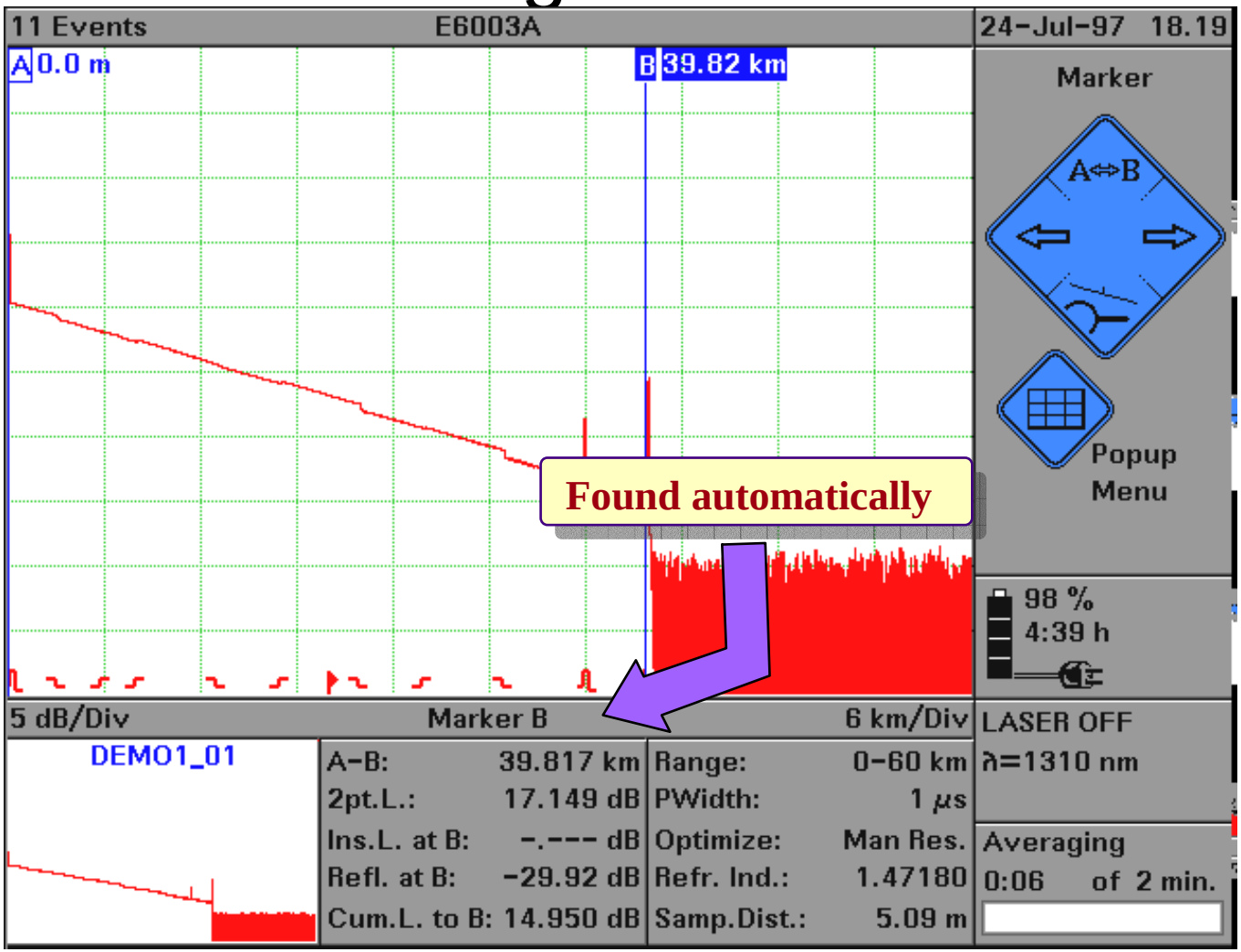
Full Trace Overview

Zoomed Event

In Snap-to-Event Mode.

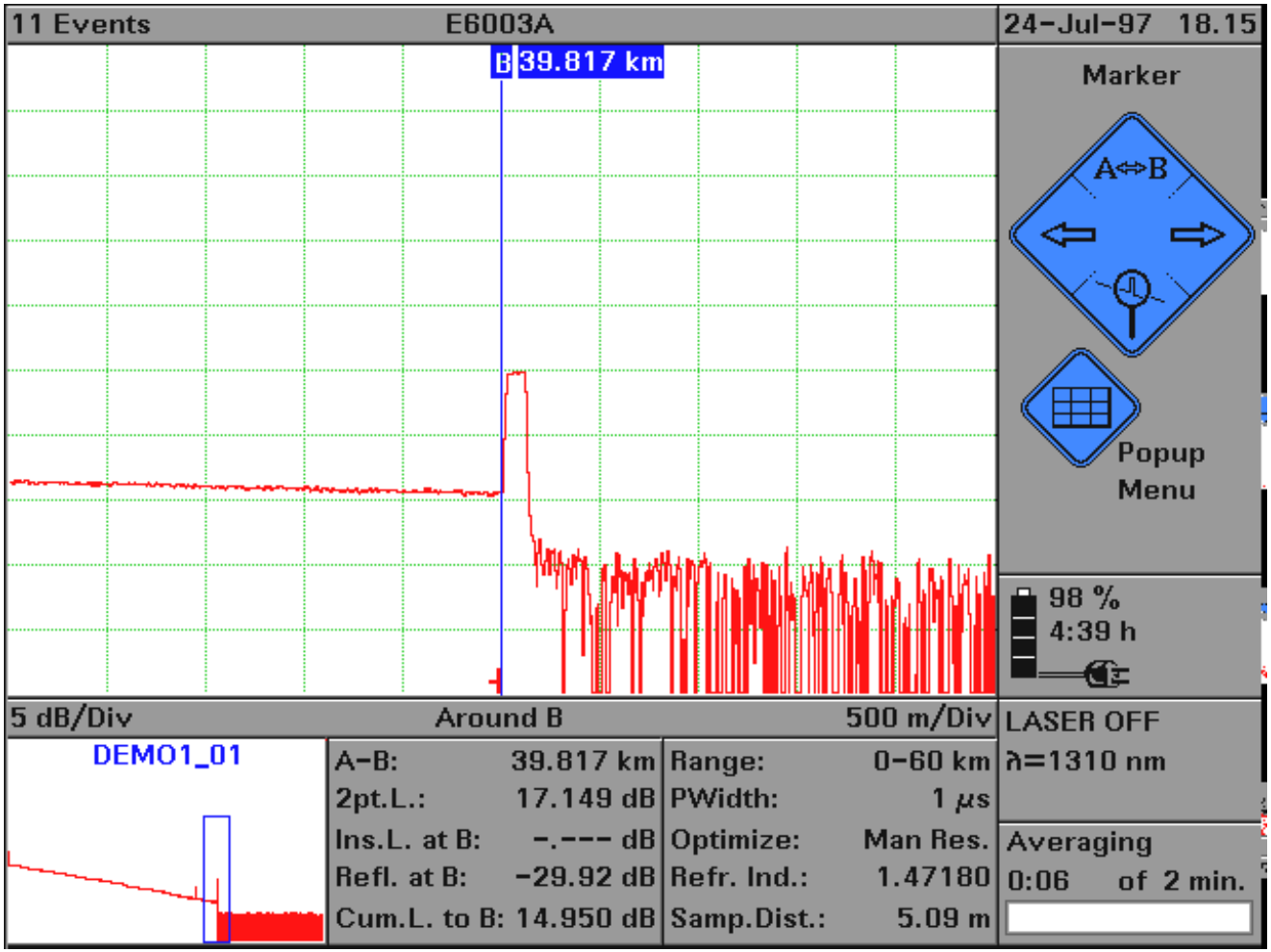
- Close View Menu
- Set Offset
- Auto Offset
- From Start
- Event Table
- Snap to Event
- Event Bar
- AB Marker
- Auto Scan
- Preferences

Locating the Fiber End



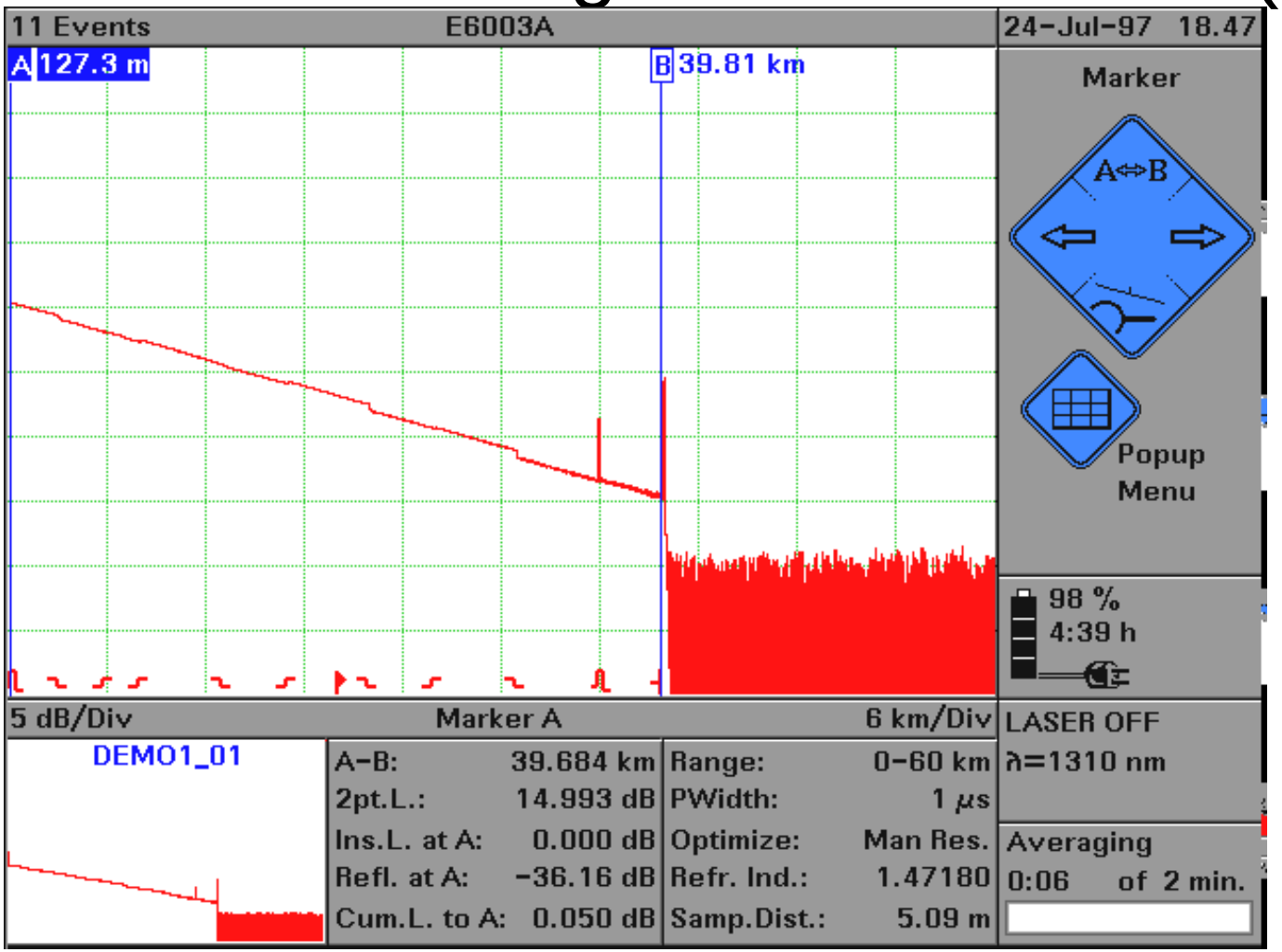
The end of the fiber is automatically found.

Manually Locating the Fiber End



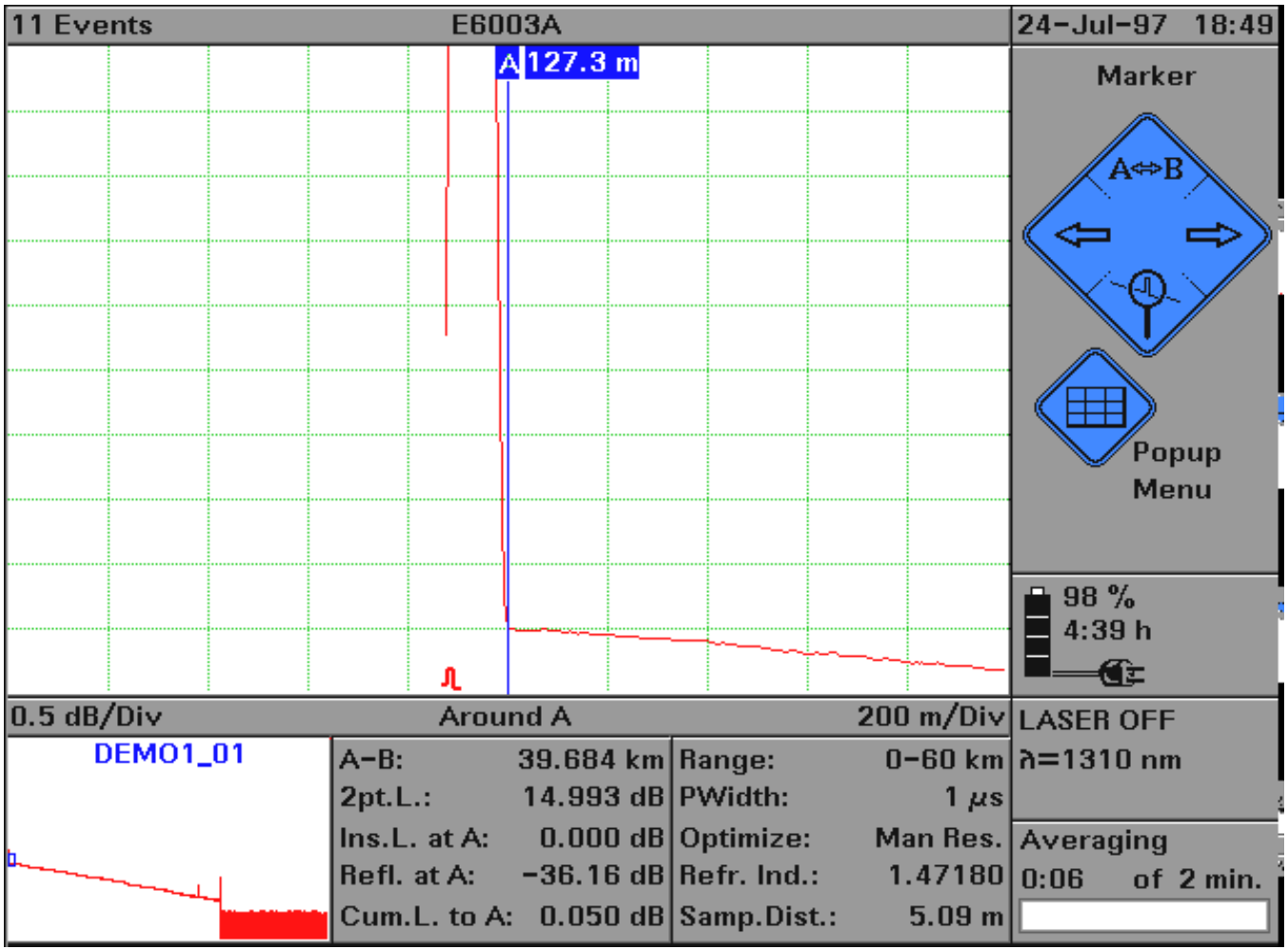
Press the "magnifying glass" to zoom in. Position the corner on Marker B.

Measuring Total Link Loss (1)



Position Marker A just at the right side of the front panel reflection

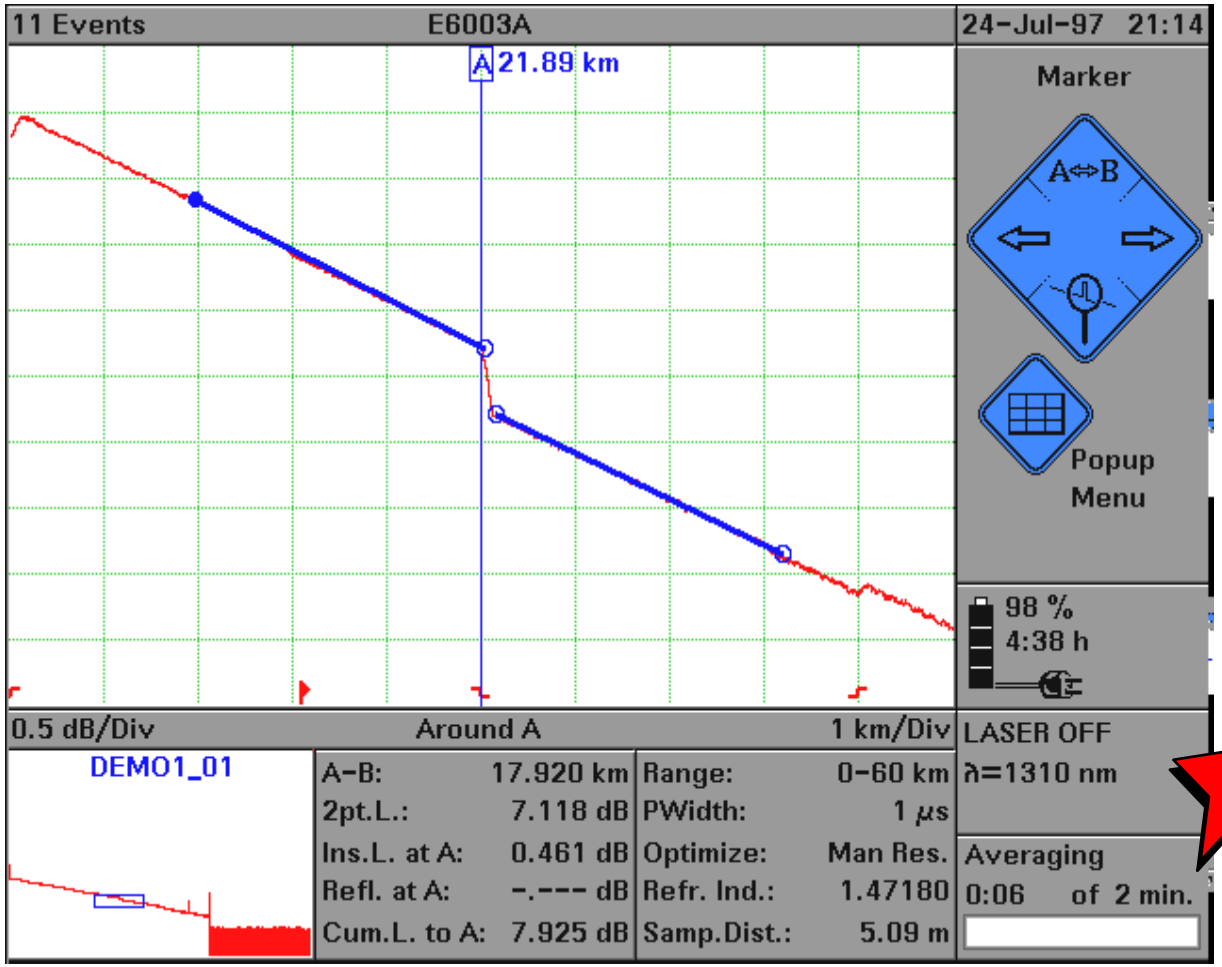
Measuring Total Link Loss (2)



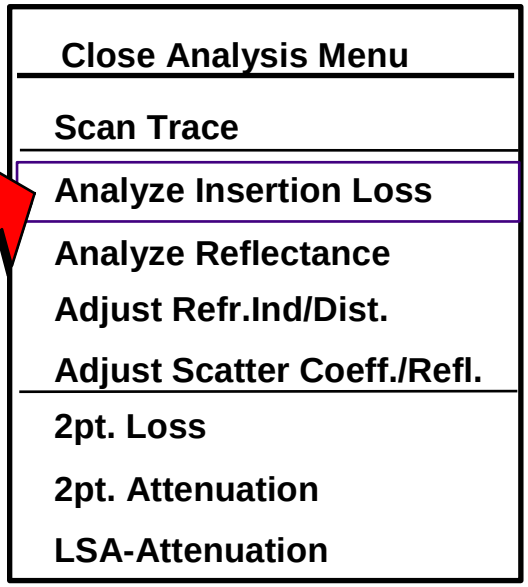
Position Marker A, so it is in the same vertical position as the backscatter, extrapolated back to 0 m.

The total link loss is shown as "2pt.Loss".

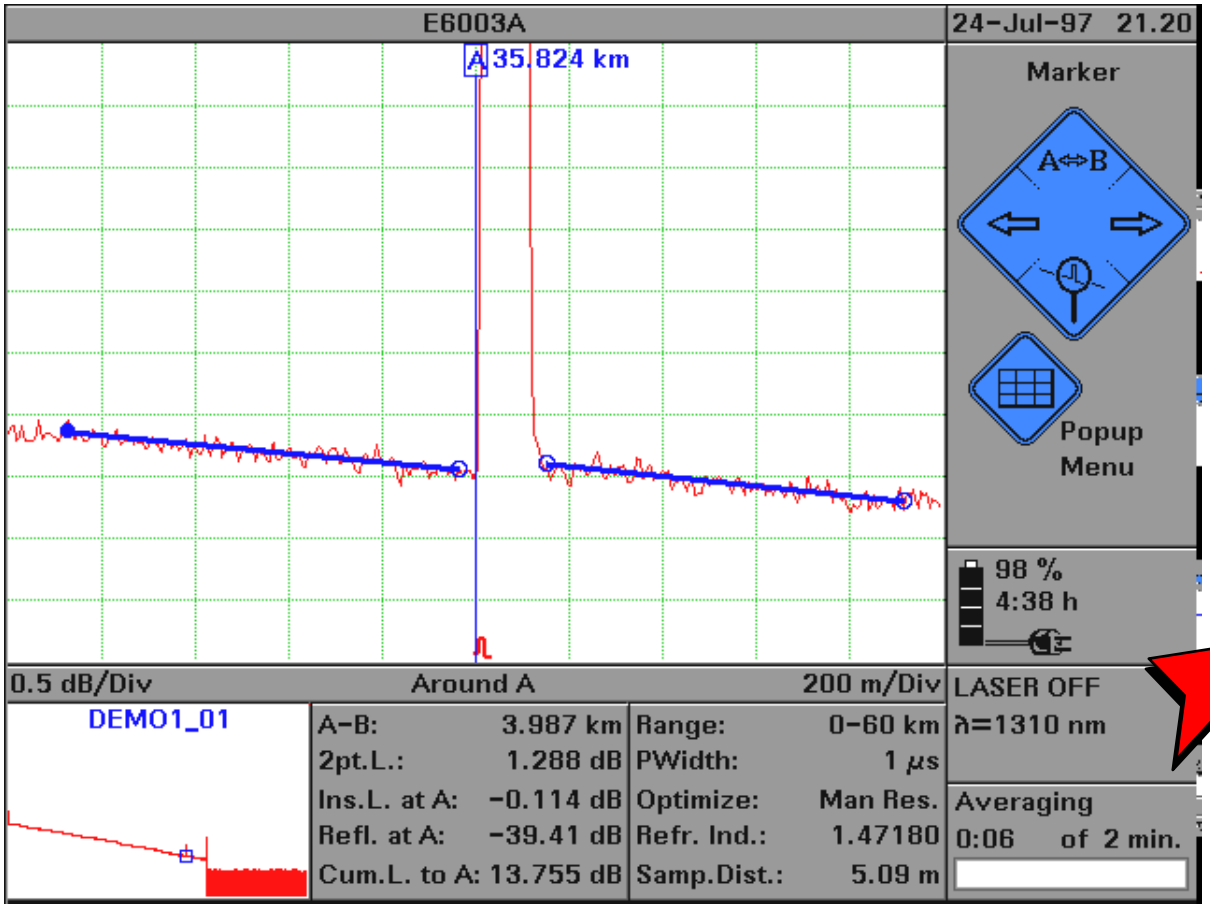
Insertion Loss of Non-Reflective Events



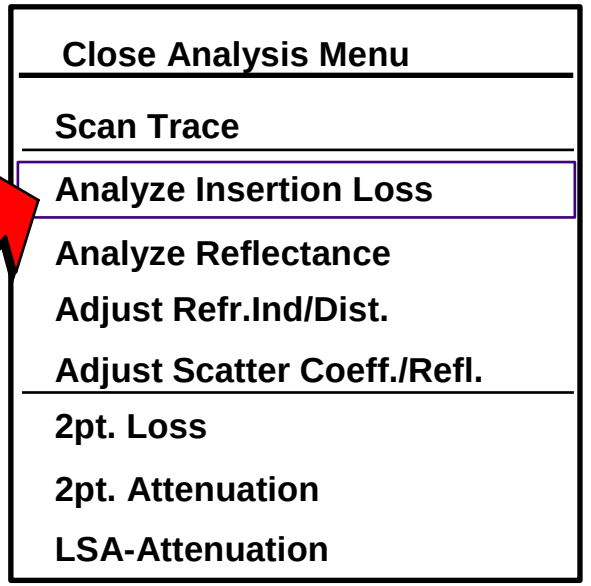
Use Current Marker and position the four splice loss markers as shown. "Ins. Loss at <marker>" shows the splice loss.



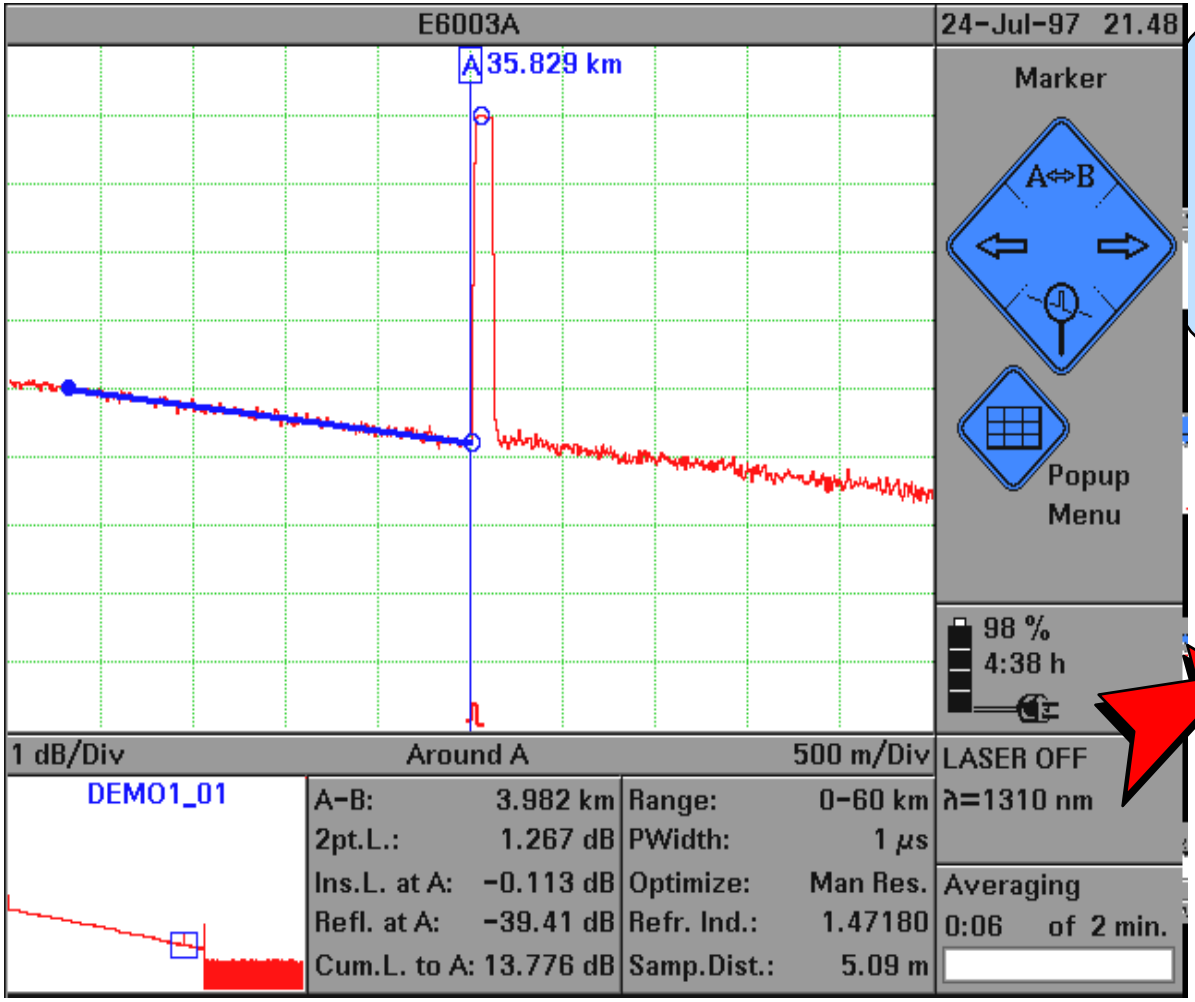
Insertion Loss of Reflective Events



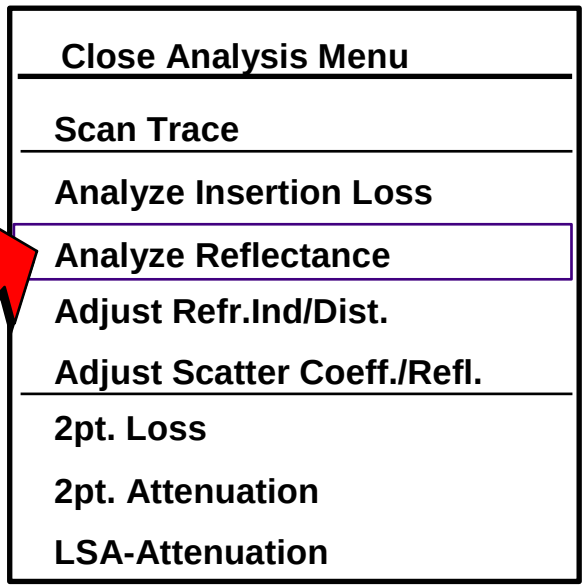
Use Current Marker and position the four loss markers as shown. "Ins. Loss at <marker>" shows the insertion loss.



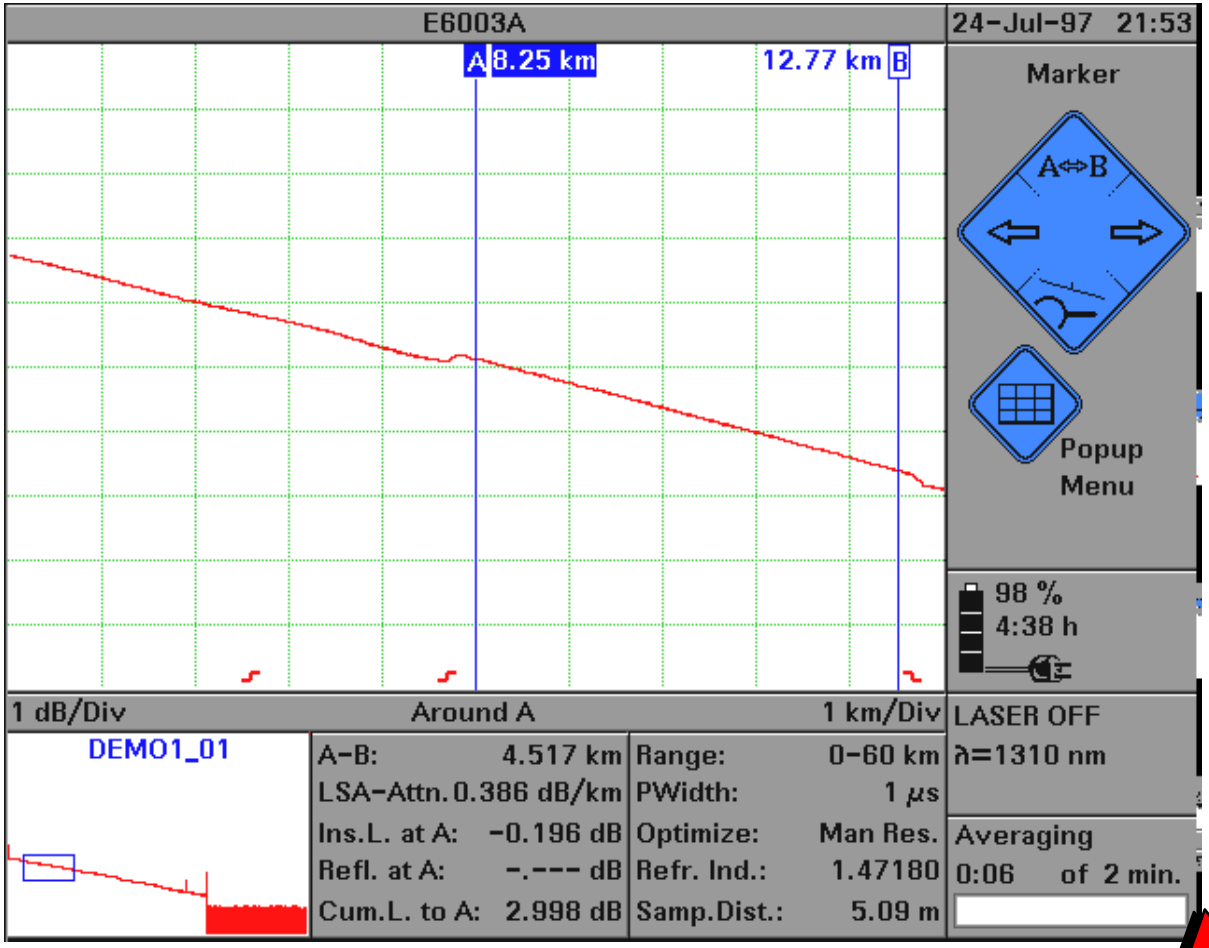
Reflectance of Reflective Events



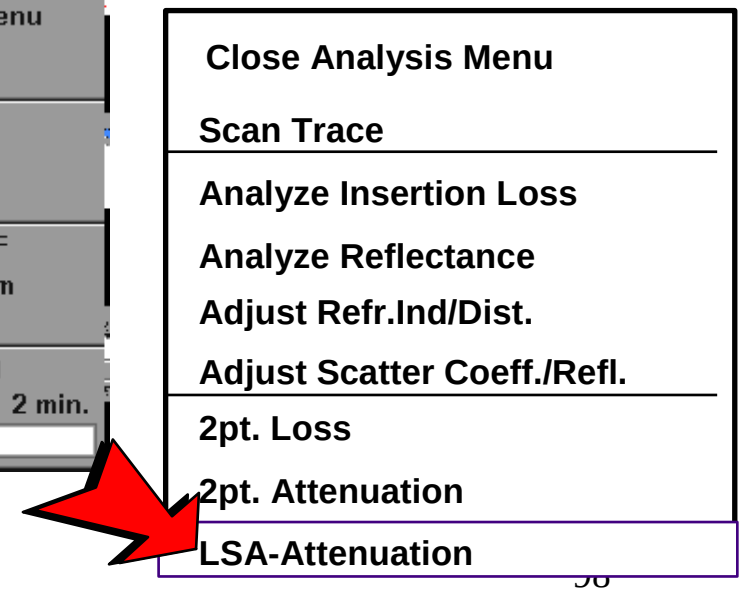
Use current marker and position the three markers as shown. "Refl. at <marker>" shows the reflectance



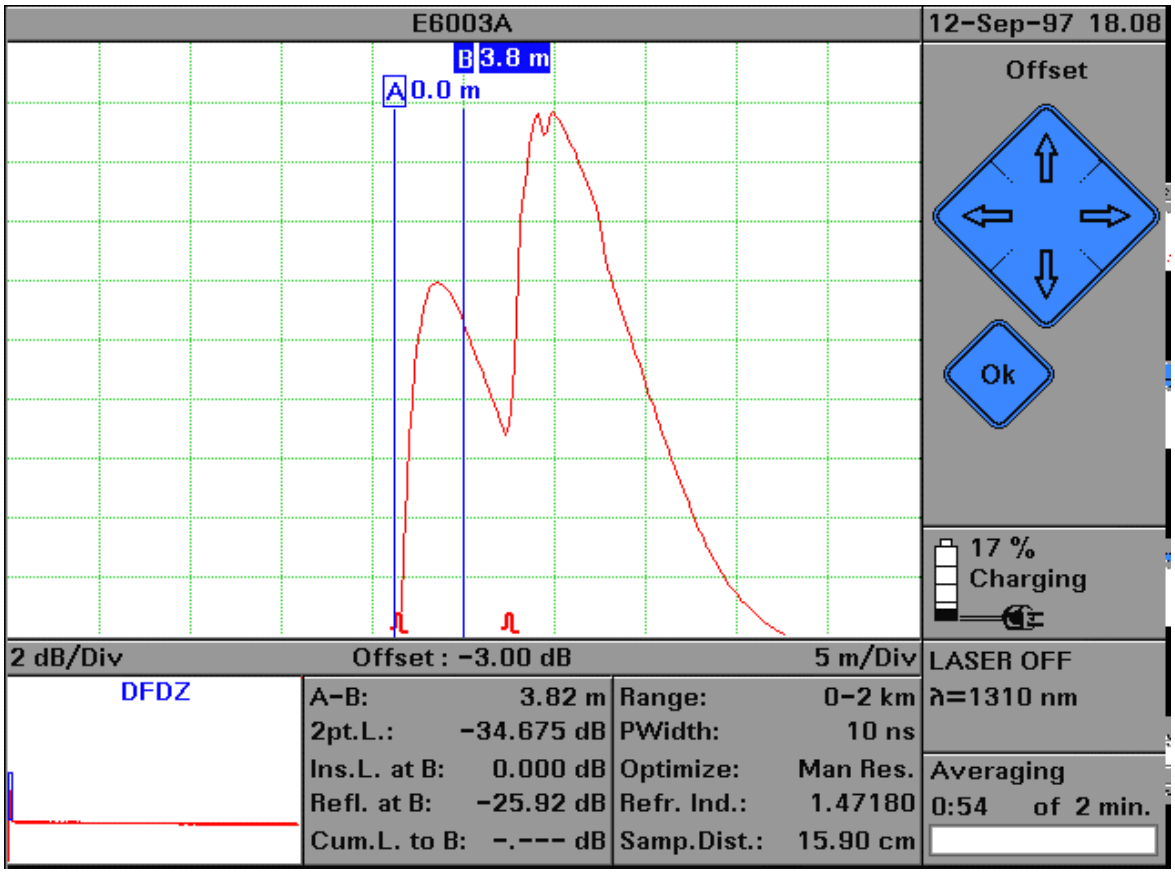
Measuring Fiber Attenuation



Position Markers A and B on the fiber between splices.
The attenuation is shown as LSA-Attn.

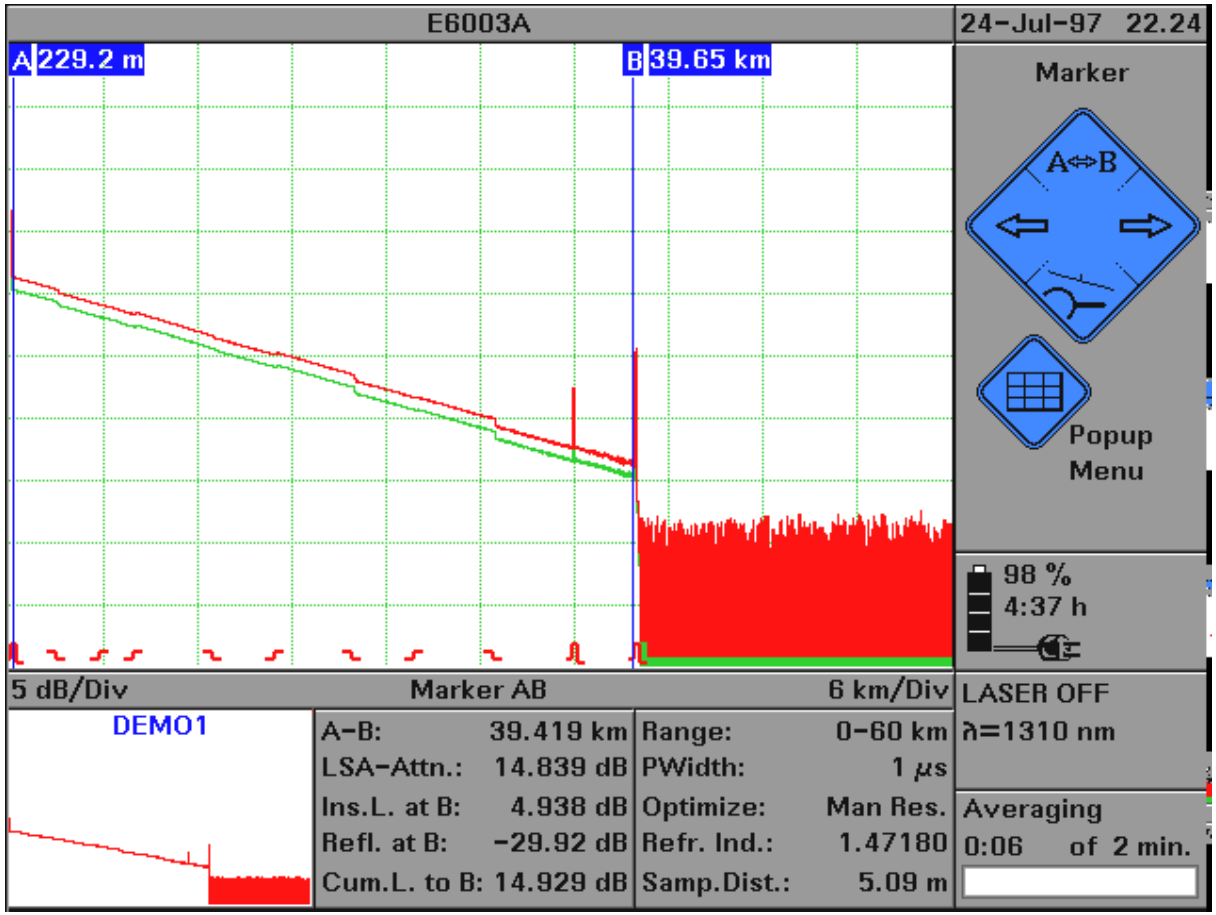


Measuring Reflections Close Together

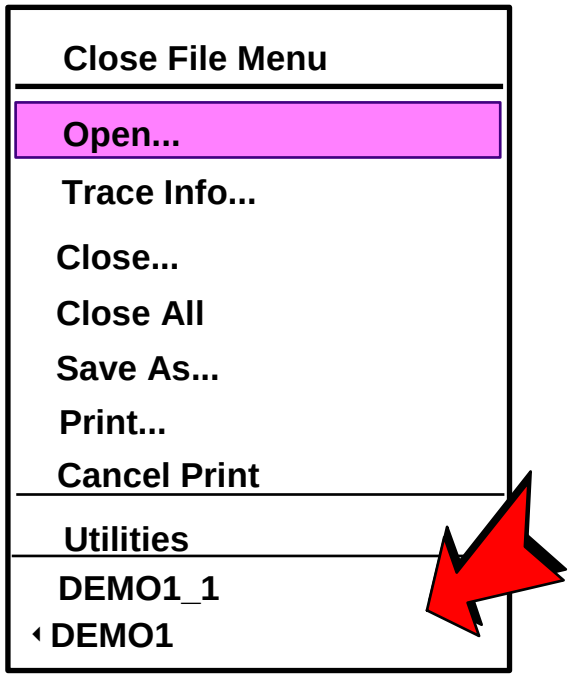


To measure reflections close together, use 10 ns pulsewidth and the Resolution Mode for the shortest event deadzone.

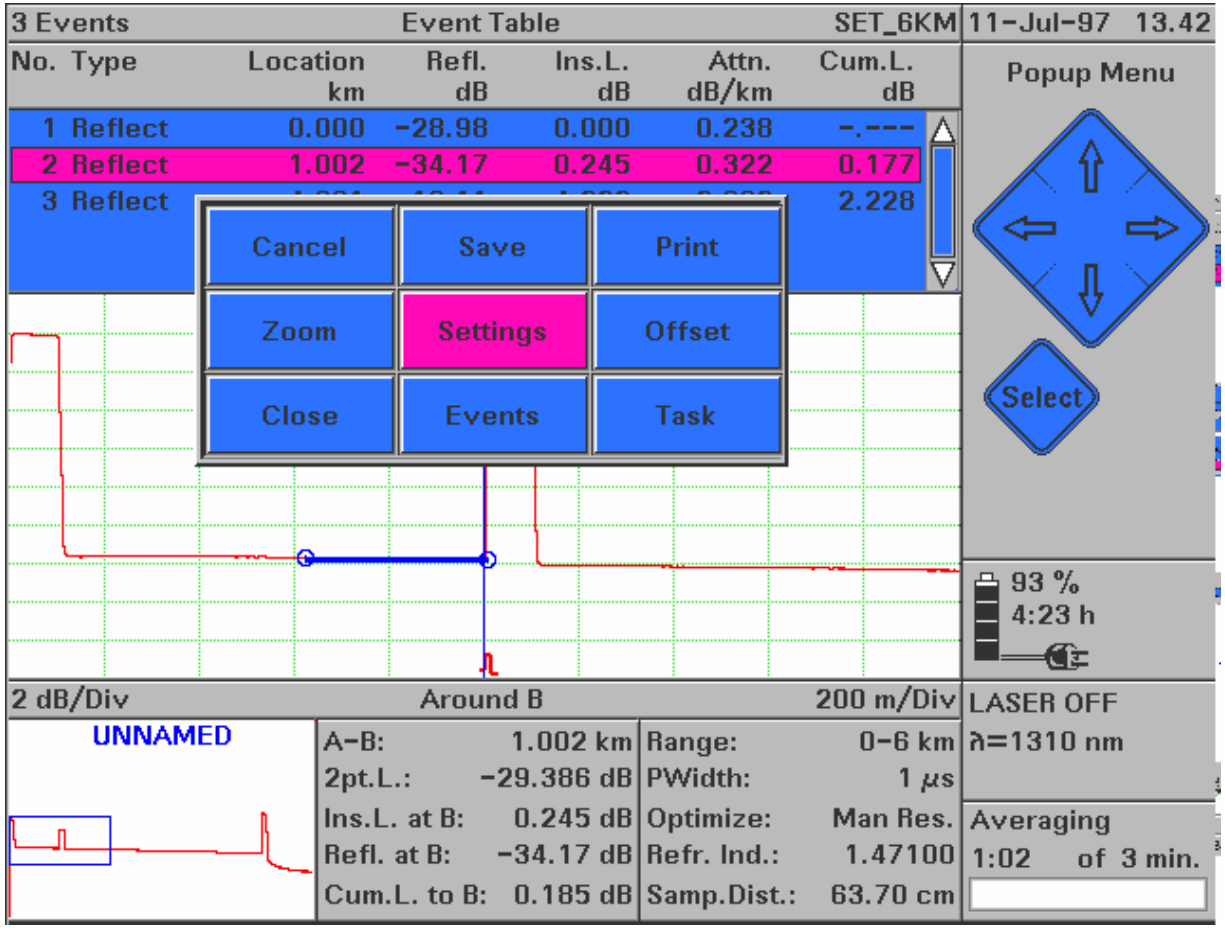
Viewing Two Traces



Use the File menu, to select the active trace.

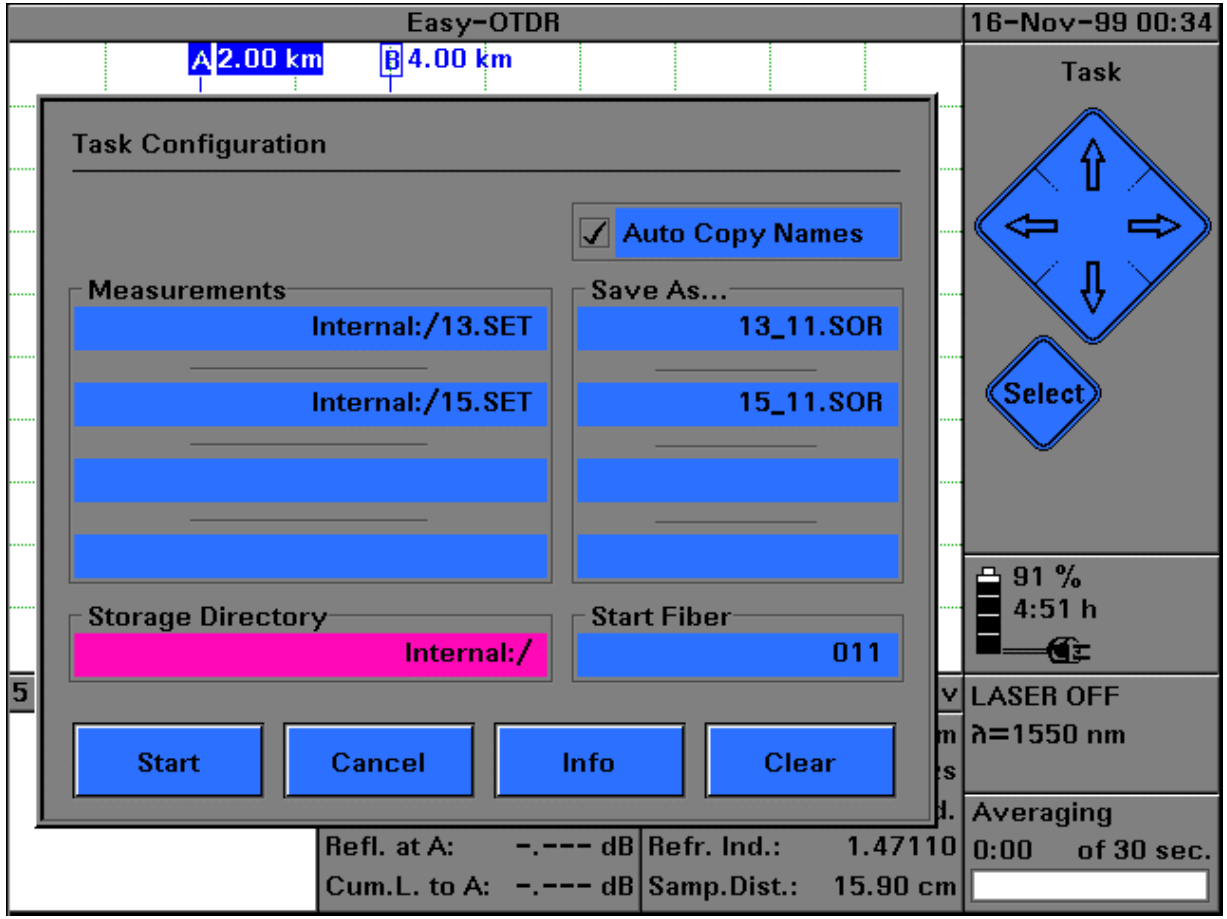


Using Easy OTDR



Select "Easy OTDR" from the Boot screen, or set "Boot into Easy-OTDR" on the Instrument Configuration Screen.

Configuring Multifiber test



Use the Multifiber test application to define a series of measurements and how they are stored

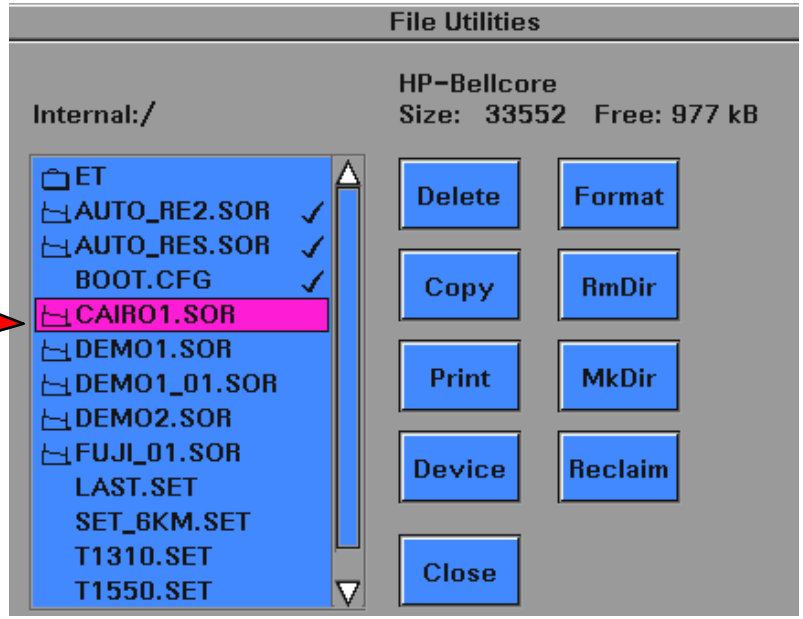
How to Print

Push the Help hardkey, and hold it a second:
this will print the current screen
Or select "Print" in the "File" menu

?

You can print more than one trace at a time using the "Utilities" selection in the "File" Menu.

Select the traces with the cursor and the Select key (labeled Ok)



In the Instrument Configuration Menu, you define your printer and what to print.

3M

Your future is in your hands!

Welcome to 3M Performance!