Webinar: Hollow-Core Fiber Testing

Thank you for joining us. We will begin shortly

NOTE: This presentation includes Q&A. We will be taking questions during the presentation with answers at the end using the questions section of your control panel.

VIAVI Solutions

TRS RenTelco℠
Equipment Now. Service Beyond.

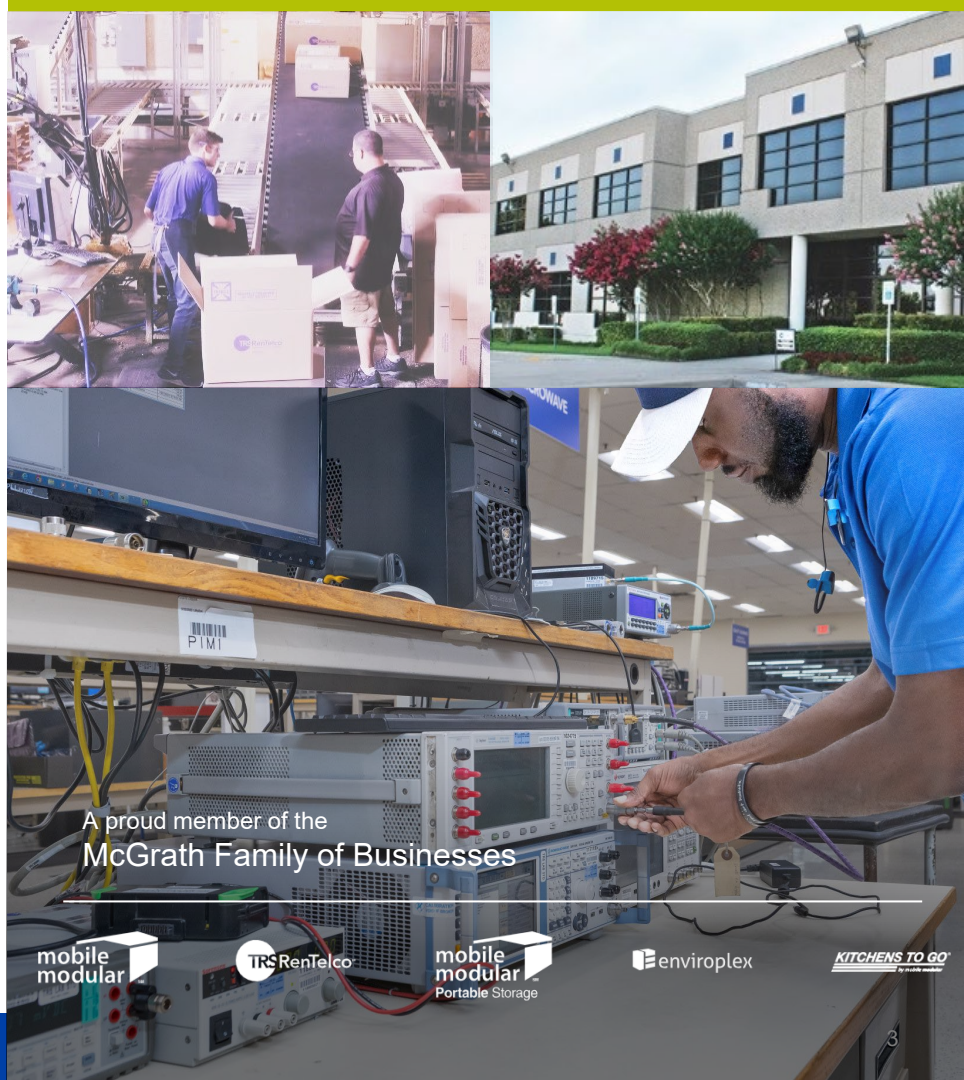
Agenda

- Welcome and Introductions
  - Lindsay Welch, TRS-RenTelco Marketing Manger
- TRS-RenTelco: Test & Measurement Solutions
  - Micah Hurd, Product Manager
- VIAVI: Hollow-Core Fiber Testing
  - Mario Simard, Product Line Manager
- TRS-RenTelco: Equipment & Special Promotions
  - Micah Hurd, Product Manager
- Q&A – Joint TRS and VIAVI

We provide comprehensive Test & Measurement solutions delivering equipment-as-a-service.

Plan, acquire, and efficiently utilize instruments to maximize return on investment.

- End-to-end fulfillment from our Dallas, TX headquarters
- 5,000+ configurable models available, valued at over $500MM
- In-House Financing and flexible procurement programs to Rent, Lease, or Buy
- State-of-the-Art 20,000 sq ft Calibration Lab on site
- Same-Day-Shipping with Next Day Delivery



VIAVI TRSRenTelco

Why Do Customers Choose TRS-RenTelco?

Customer Service Excellence

Talk with a **Live Person** when you call

Extended Technical Sales Hours from 7am – 7pm CT

Late-Order processing

Comprehensive Solutions

Customized **In-house Financing**

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80% of Calibrations Performed In-house

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Top-tier rental partner to all major manufacturers

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VIAVI Solutions

Hollow-Core Fiber Testing

Mario Simard
PLM
2025-10-09

Agenda

Understanding Hollow Core Fiber

Deployment & Certification Challenges

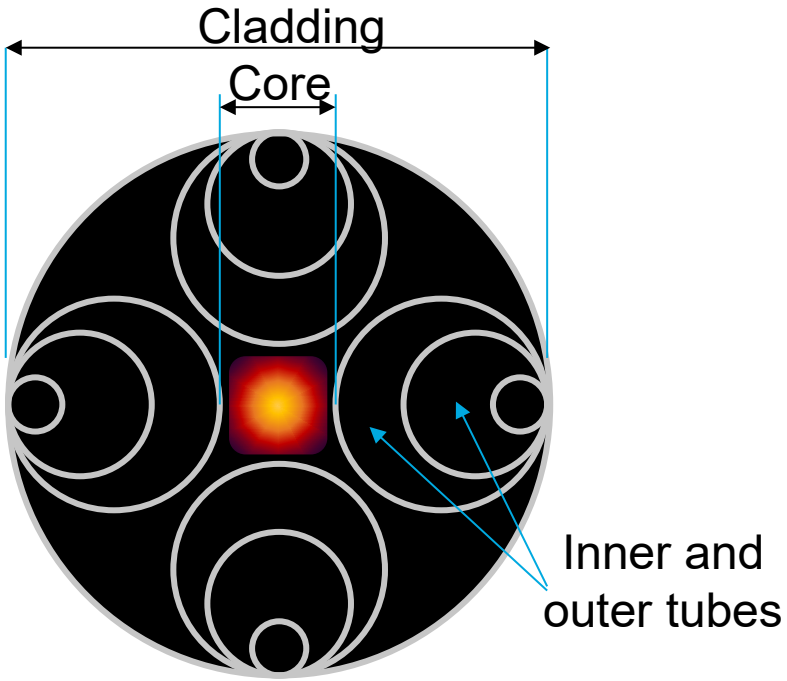
Hollow Core Fiber OTDR Measurements

Hollow Core Fiber Dispersion Measurements

Hollow Core Fiber Testing Solutions

Understanding Hollow-Core Fiber (HCF)

Hollow-Core Fiber Structure



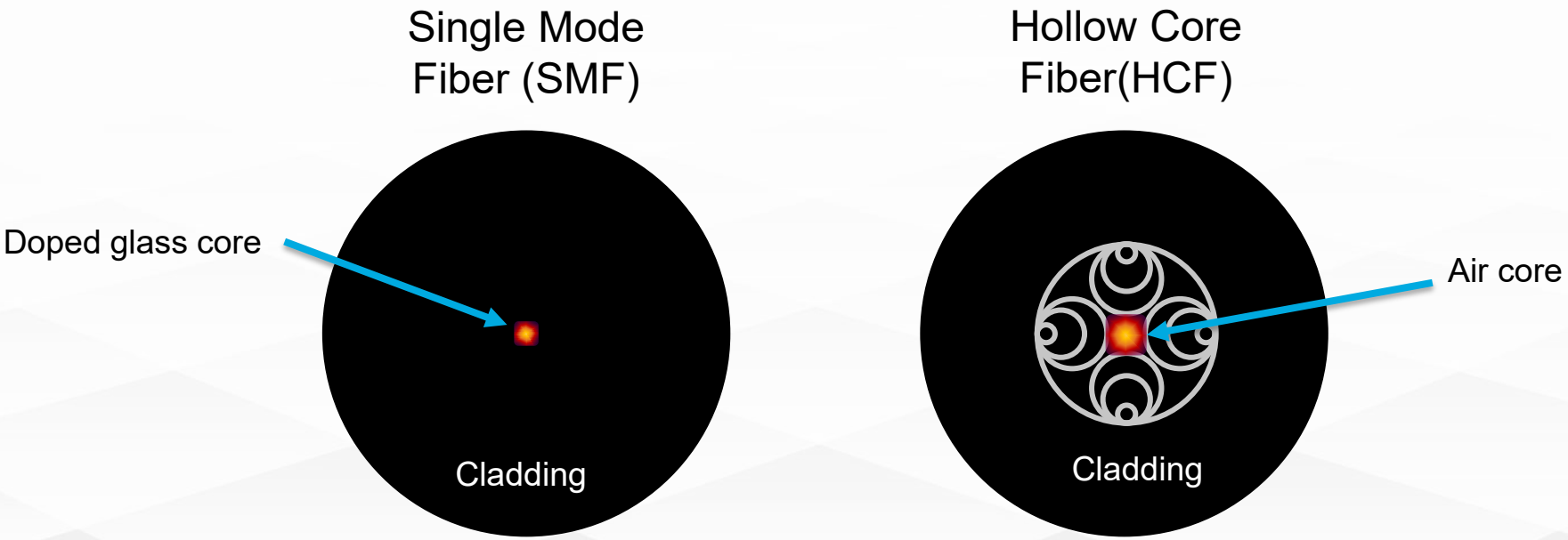
Ex: 4T-DNANF
Fourfold truncated double-nested anti-resonant

- **Core**: central air-filled region where light is guided (ex: 14/15 µm)
- **Cladding**: solid glass that encloses the entire structure including the nested tubes
- **Inner and outer antiresonant tubes**: thin-walled glass tubes that confine light in the air-core

Note: This is an example only. There is no standard design, although the three main components mentioned above are generally consistent: size, dimensions, and the number of tubes may vary.

Hollow-Core Fiber

HCF vs SMF



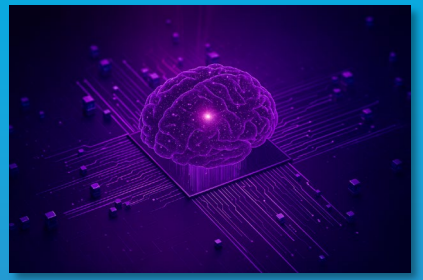
Hollow Core Fiber Benefits

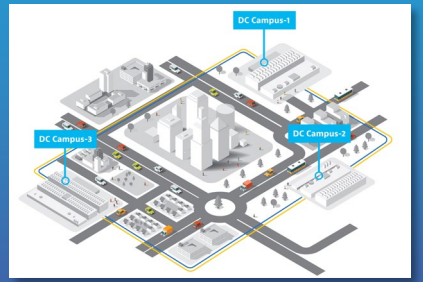
- **Lower Latency, 30% less**
  - Light travels faster in air: **~3.33 µs/km** vs. **4.9 µs/km** in single-mode fiber (SMF).
- **Reduced Chromatic Dispersion (CD), 70% less**
  - ~5 ps/nm/km vs. ~17 ps/nm/km in SMF.
- **Similar Polarization Mode Dispersion (PMD)**
  - <0.1 ps/√km vs. 0.1 ps/√km in SMF.
- **Minimal Nonlinear Effects**
  - Air core minimizes light-material interaction.
- **Lower Attenuation at Specific Wavelengths**
  - Down to 0.076 dB/km (83 km), better than SMF (~0.2 dB/km).
- **High Optical Power Handling**
  - Air core allows higher damage threshold.

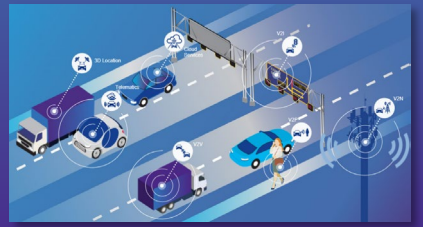
Lower latency and higher bandwidth

Hollow Core Fiber Applications

- **AI & High-Performance Computing**
  - AI model training, synchronization, and real-time inference.
- **Quantum Communication**
  - Maintains light coherence for quantum key distribution and ultra-secure networks.
- **Remote Data Centers**
  - Allows DCs to be located 60–90 km away from urban centers, reducing costs, energy use, and environmental impact.
- **Defense & Secure Communications**
  - Air-guided structure makes HCF resistant to tapping
- **Smart Cities, Edge Computing and 5G/6G Infrastructure**
  - Enables fast, highly reliable and responsive network for IoT, autonomous systems, and real-time data processing close to the edge.
- **Financial Services**
  - Ideal for high-frequency trading and low-latency transaction networks.





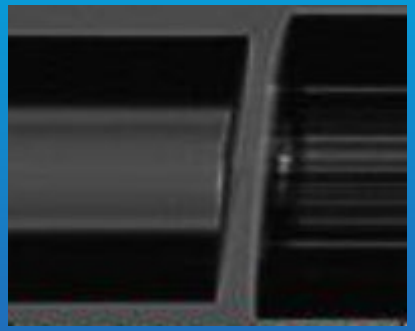


Hollow Core Fiber Manufacturers

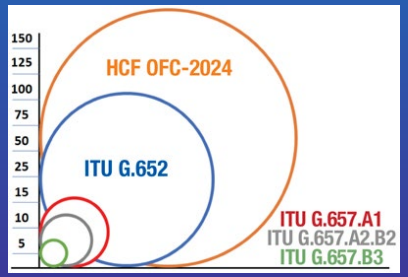
- Lightera
- Linefiber Technology
- Microsoft (Lumenisity)
- Relativity Networks
- YOFC
- And others

Hollow Core Fiber Challenges

SMF to HCF



Bending radius HCF



Hollow-Core Fiber

Performance and installation challenges

- **Current infrastructure compatibility**
  - Current systems are not designed to directly support HCF
  - SMF at both ends of the HCF link
  - SMF-to-HCF adapters/transitions introduce loss and reflection
- **Physical constraints**
  - HCF is 10× more sensitive to bending than SMF
  - More delicate handling, especially during splicing
- **Operational limitations**
  - No standardized Method of Procedure (MoP)
  - Few trained professionals and limited tech. expertise
  - Post-processing « currently » required

Hollow-Core Fiber

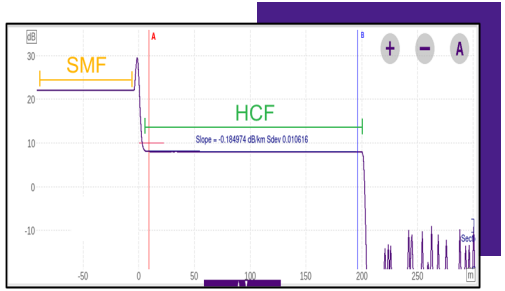
Fiber certification challenges

- Rayleigh backscattering (RBS) signal is ~ 30 dB lower → Impact on OTDR dynamic range at short pulse width
- Variable backscattering coefficient along the fiber → non-standard OTDR trace profile
- HCF-to-HCF splices are harder to evaluate → Require bi-directional measurement and a specialized analysis SW

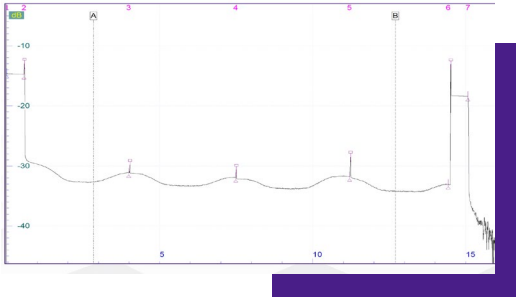
Example for 90 km HFC

	OTDR	CD/PMD/AP
Total fiber loss (90kmx0.1dB/km)	9	9
Total splice loss (15x0.2dB)	3	3
Total loss SMF to HCF adapter (2x0.3dB)	0.6	0.6
Signal to noise ratio (dB)	6	N/A
SMF-HCF RBS diff. (dB)	15	N/A
Total required dynamic range (dB)	33.6*	12.6

** At the shortest possible pulse width*



SMF to HCF – OTDR View



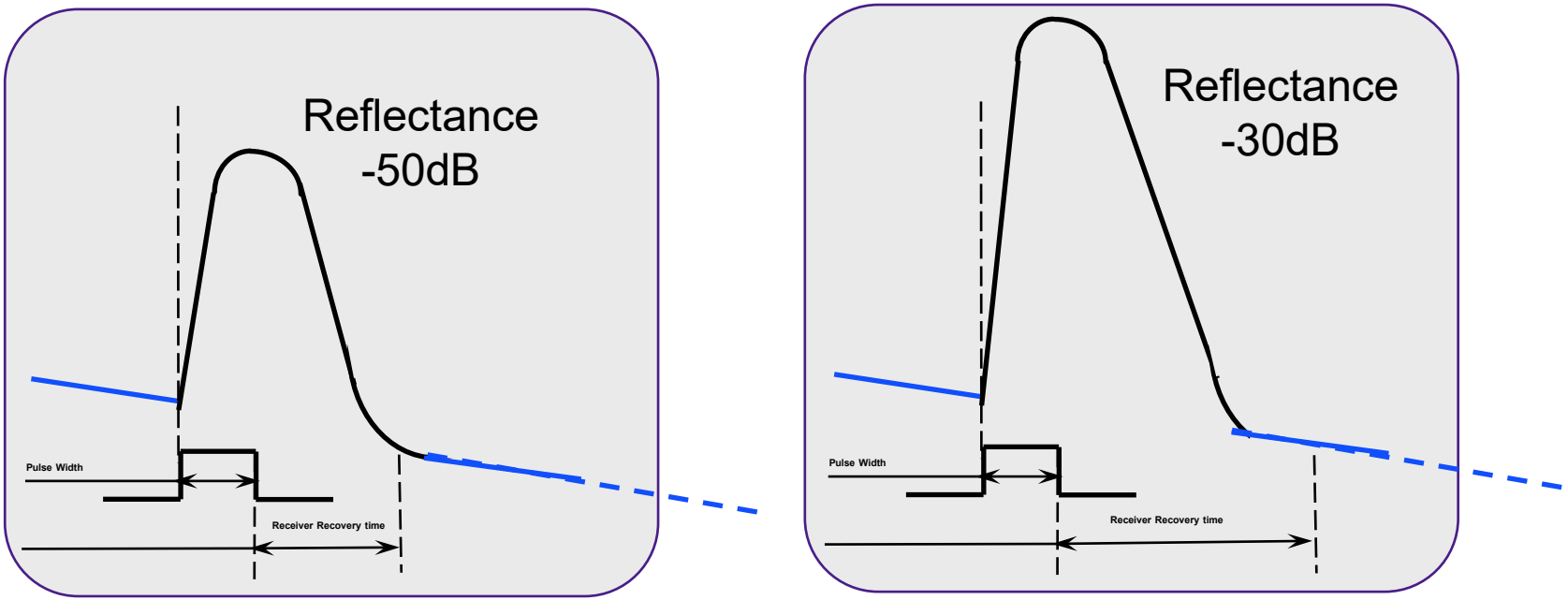
Spliced HCF link- OTDR View

Hollow Core Fiber OTDR Measurements

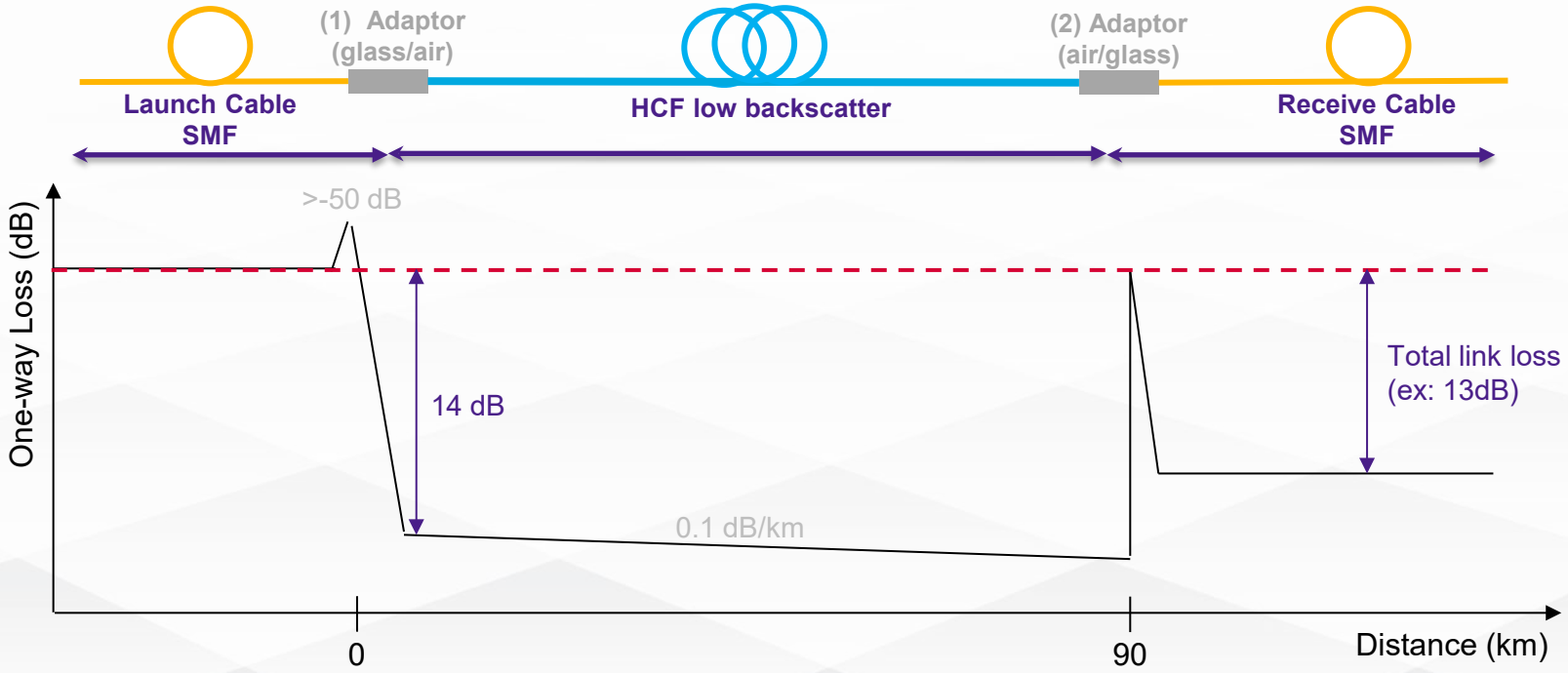
Inline glass/air transition

Impact on OTDR measurement

Pulse width/dynamic range/event detection



Typical OTDR Testing Scenario



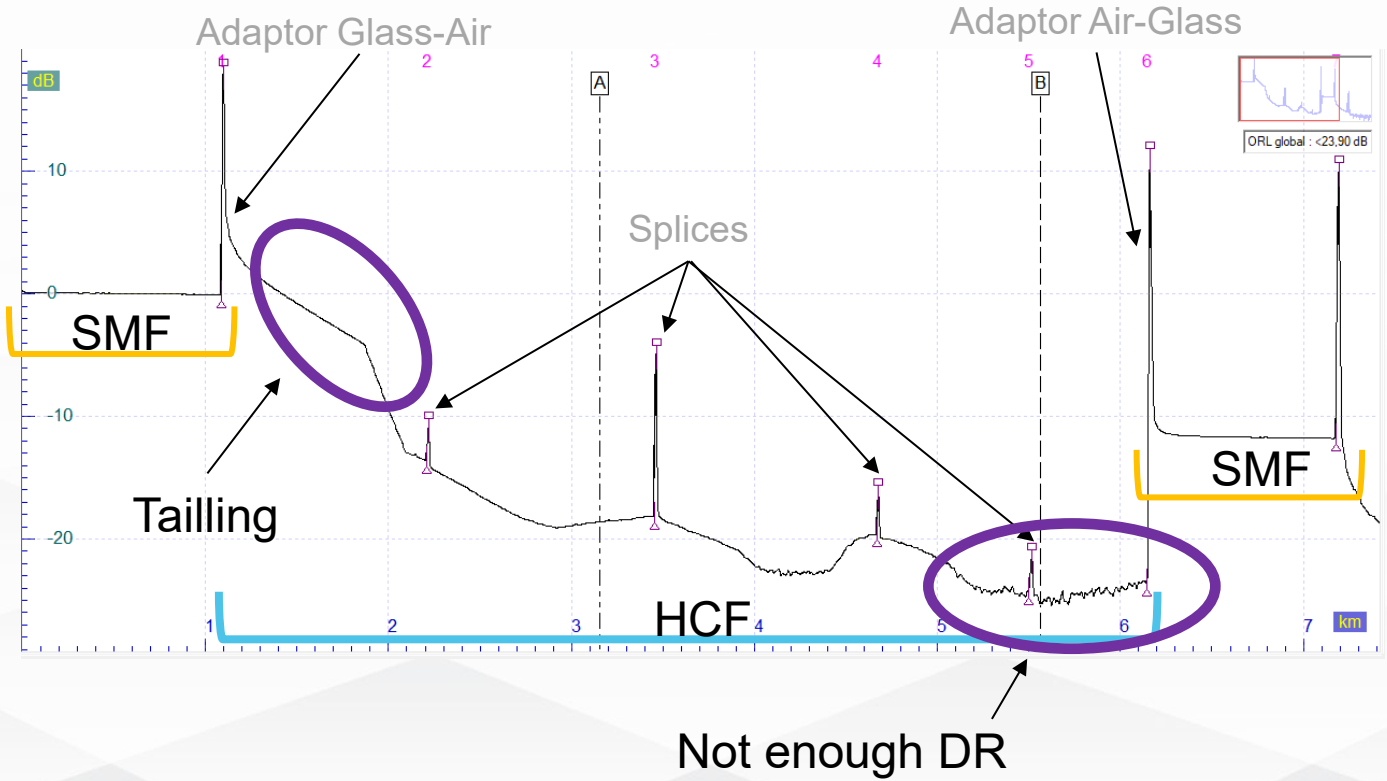
Selecting the right OTDR

Dynamic range and pulse width constraints

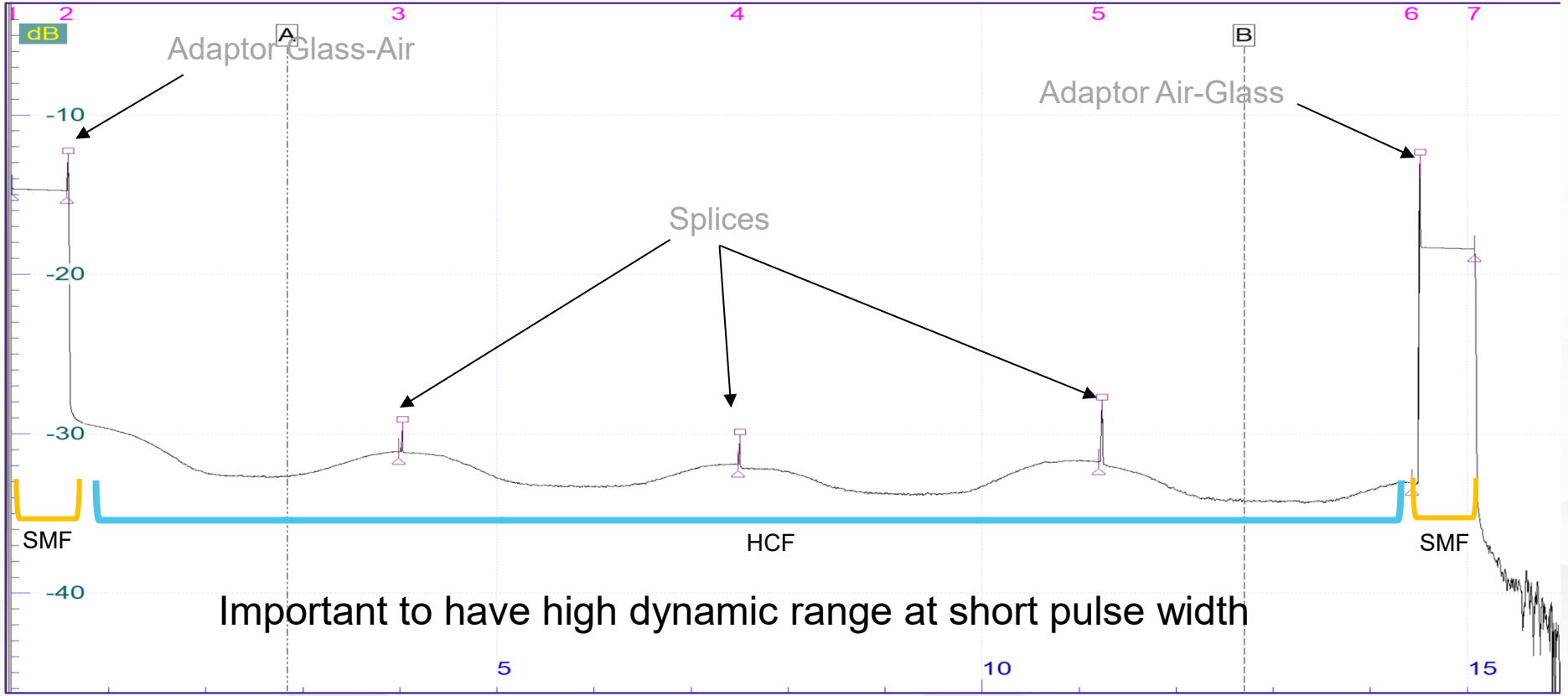
Below example for 90 km HFC

	Loss (dB)
Total fiber loss (90kmx0.1dB/km)	+9
Total splice loss (15x0.2dB) 15 sections of 4km each	+3
Total loss SMF to HCF adapter (2x0.3dB) 1 adapter at each end	+0.6
Signal to noise ratio (dB) Vs. OTDR RMS dynamic range specifications	+6
SMF-HCF RBS diff. (dB)	+15
Dynamic range required (dB) At the shortest possible pulsewidth	=33.6

Typical OTDR trace

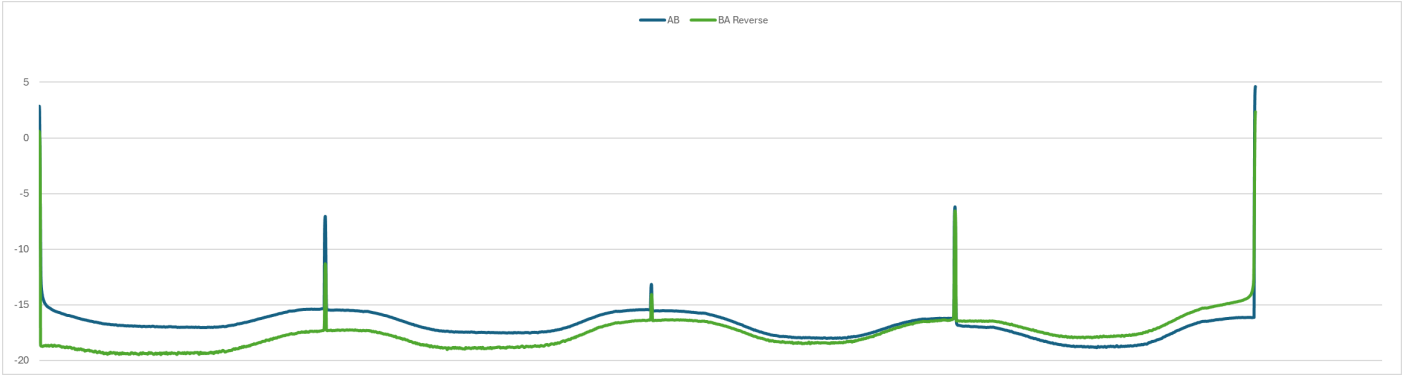


Typical OTDR trace



Hollow-Core Fiber analysis with ReportPRO

- Due to the unique trace characteristics (RBS varying along the fiber), standard OTDR post-processing analysis algorithms do not apply.



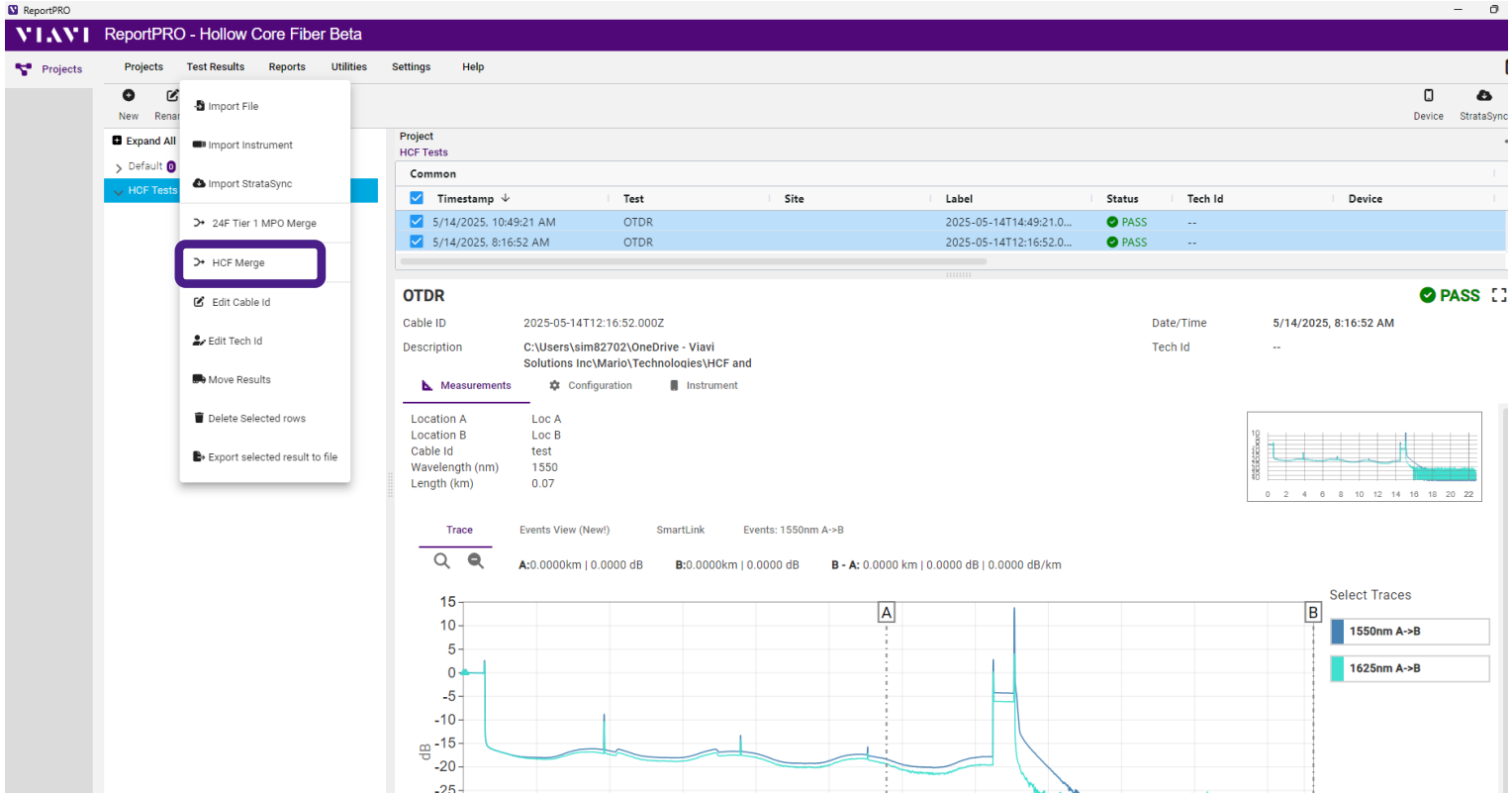
OTDR traces acquire from testing HCF in both directions

Hollow-Core Fiber analysis with ReportPRO

- It is necessary to match each point/event from each direction, align the two traces and make a bidirectional analysis, (AB-BA)/2, to obtain the actual loss profile.

Loss profile obtained using ReportPro HCF bidirectional analysis

ReportPRO


ReportPRO
ReportPRO - Hollow Core Fiber Beta
Projects
Projects
Test Results
Reports
Utilities
Settings
Help
New
Import File
Import Instrument
Import StrataSync
24F Tier 1 MPO Merge
HCF Merge
Edit Cable Id
Edit Tech Id
Move Results
Delete Selected rows
Export selected result to file
Device
StrataSync
Expand All
Default
HCF Tests
Project
HCF Tests
Common
Timestamp
Test
Site
Label
Status
Tech Id
Device
5/14/2025, 10:49:21 AM
OTDR
2025-05-14T14:49:21.0...
PASS
5/14/2025, 8:16:52 AM
OTDR
2025-05-14T12:16:52.0...
PASS
OTDR
PASS
Cable ID
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Date/Time
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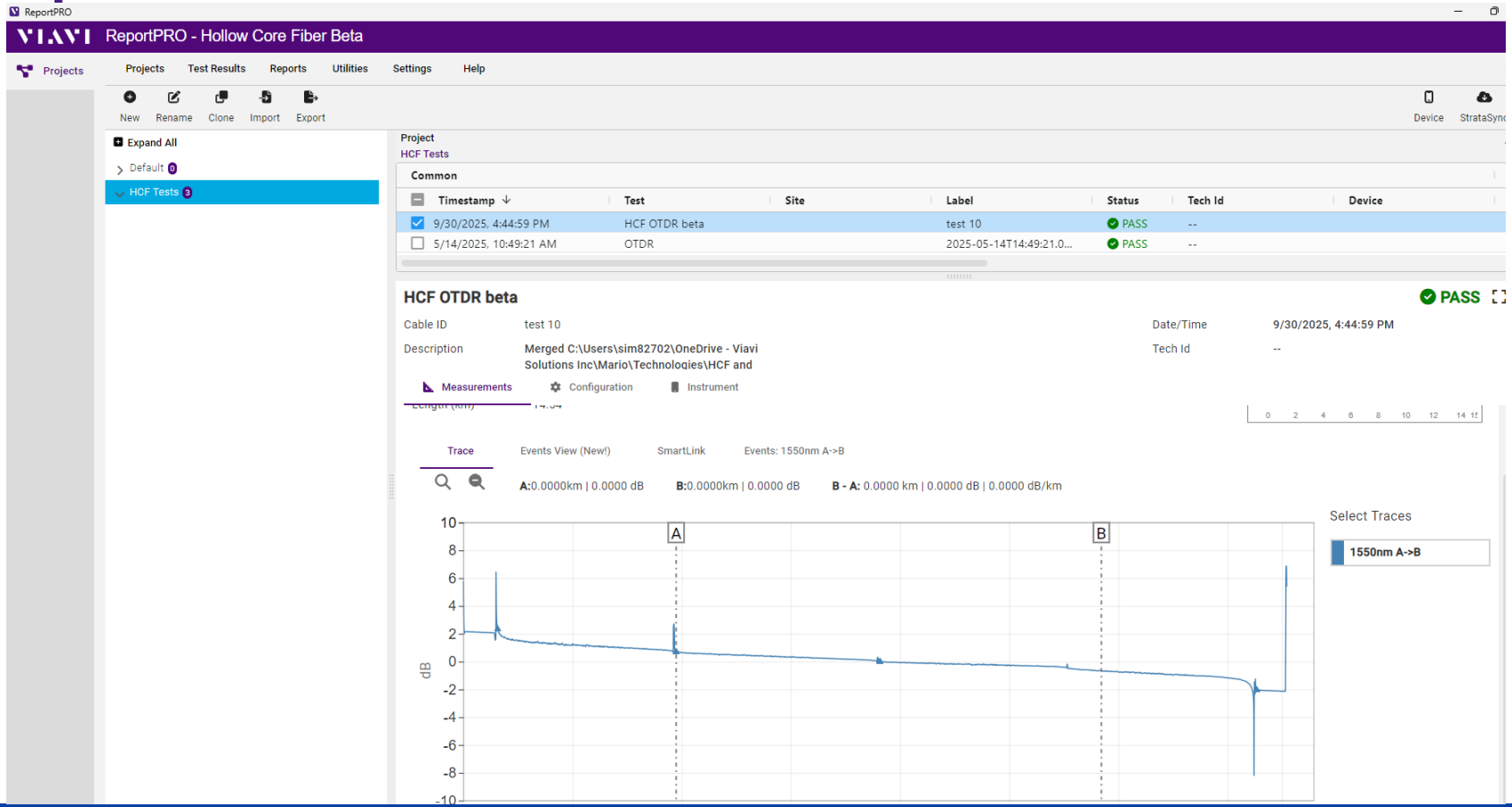
Description
C:\Users\sim82702\OneDrive - Viavi Solutions Inc\Mario\Technologies\HCF and
Tech Id
Measurements
Configuration
Instrument
Location A
Loc A
Location B
Loc B
Cable Id
test
Wavelength (nm)
1550
Length (km)
0.07
Trace
Events View (New!)
SmartLink
Events: 1550nm A->B
A:0.0000km | 0.0000 dB
B:0.0000km | 0.0000 dB
B - A: 0.0000 km | 0.0000 dB | 0.0000 dB/km
Select Traces
1550nm A->B
1625nm A->B
dB

ReportPRO


ReportPRO
ReportPRO - Hollow Core Fiber Beta
Projects
Projects
Test Results
Reports
Utilities
Settings
Help
New
Rename
Clone
Import
Export
Device
StrataSync
Expand All
Default 0
HCF Tests 3
Project
HCF Tests
Common
Timestamp
Test
Site
Label
Status
Tech Id
Device
9/30/2025, 4:44:59 PM
HCF OTDR beta
test 10
PASS
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5/14/2025, 10:49:21 AM
OTDR
2025-05-14T14:49:21.0...
PASS
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HCF OTDR beta
PASS
Cable ID
test 10
Description
Merged C:\Users\sim82702\OneDrive - Viavi Solutions Inc\Mario\Technologies\HCF and
Date/Time
9/30/2025, 4:44:59 PM
Tech Id
--
Measurements
Configuration
Instrument
Trace
Events View (New!)
SmartLink
Events: 1550nm A->B
A:0.0000km | 0.0000 dB
B:0.0000km | 0.0000 dB
B - A: 0.0000 km | 0.0000 dB | 0.0000 dB/km
Select Traces
1550nm A->B
dB
A
B

Hollow Core Fiber Dispersion Measurements

Dispersion for Hollow Core Fiber

Dispersion tests

In addition to OTDR testing, Chromatic Dispersion (CD) and Polarization Mode Dispersion (PMD) are key for full HCF link characterization.

However, OTDR-based dispersion tests are limited by the 14–20 dB drop in Rayleigh backscatter and dynamic range constraints, making them suitable only for short links.

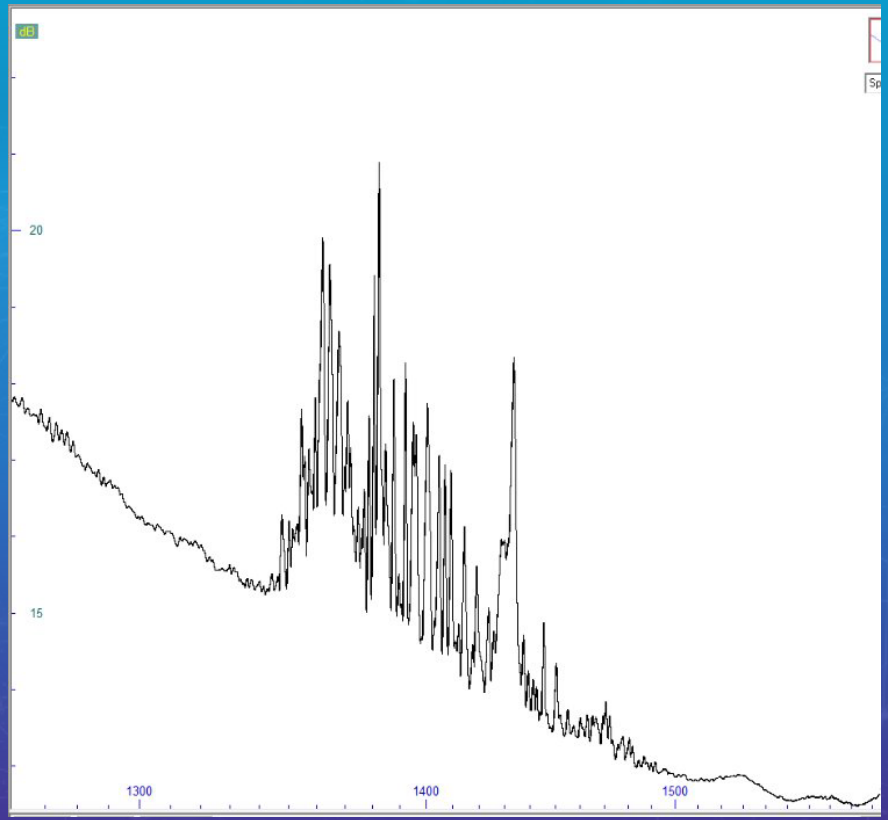
A more accurate approach uses dedicated equipment like VIAVI's

Optical Broadband Light Source and ODM module, which bypasses these limitations and enables reliable long-distance testing.

Techniques such as phase shift for CD and fixed analyzer for PMD offer precise results with greater dynamic range.

Attenuation Profile for Hollow Core Fiber

Attenuation profile (AP) testing helps identify non-ideal transmission characteristics such as absorption regions caused by for example water vapor, factors that can impact system reliability and efficiency. During manufacturing presence of gas could generate degassing process creating absorption at certain wavelengths. Field trials have shown that some customers request this data to assess link quality and verify performance claims. In this context, attenuation profiling is not just a technical formality, it is a necessary step to build confidence in HCF deployment and to support informed decision-making in real-world applications. To capture the complete AP, the measurement should cover from 1250 to 1640 nm.



Hollow Core Fiber Testing Solutions

Hollow Core Fiber « All-in-one » Field Portable Solution

1. 1310/1550/1625 nm OTDR (8136D or 4136C-FCOMP)
2. Optical Dispersion Measurements module (CD/PMD and AP) or Optical Broadband Source module (BBS2A)
3. Visual fault locator and Broadband Power Meter
4. Headset port, 2x USB Ports (for USB key, INX)
5. 8-inch Platform
6. Connector Endface Inspection Microscope

INX Series

OneAdvisor 800

- Modern 8″ High-Vis. Multi-touchscreen
- Field proven: lightweight and compact design
- Linux based
- Highly scalable: OLTS, OTDR, CD, PMD, AP, BERT/Ethernet, OSA without module swapping
- Seamless connectivity

All-in-one Instrument
=
Red zone friendly

ONA800A Kits - Main Software/UI Components

Expert OTDR offers greater depth of analysis and more control. It is designed for users who require manual OTDR trace management and access to advanced test settings.

When FiberComplete PRO is active, Expert OTDR becomes an extension and measurements are correlated.

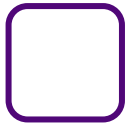
Instrument Job Manager (IJM) handles job files (VIAVI .json format), guides technicians through a simplified testing process, and consolidates test results and reports (offline).

The **Chromatic Dispersion (CD)** measurement is based on phase shift method (defined in IEC 60793-1-42 and ITU-T G650.1 standards) offering **industry-leading accuracy** and **speed** and, making it suitable for a wide range of applications (from low to high dispersion fibers).

The **Polarization Mode Dispersion (PMD)** measurement is based on fixed-analyzer method offering **industry-leading accuracy** and **speed** and, making it suitable for a wide range of applications (from low to high dispersion fibers in various environmental conditions).

ONA800A Kits - Main Software/UI Components and Post-Processing

Attenuation Profile (AP)
Hollow core fiber (HCF) performance varies by manufacturer due to different design approaches, making post-installation validation critical. Spectral attenuation analysis confirms transmission capability, detects issues like water vapor absorption, and identifies non-uniform behaviors — such as ripples near 1550 nm — that can affect transmission windows. VIAVI is the only provider offering this advanced testing in the field, ensuring the fiber meets the promised dB/km and certifying readiness for transmission equipment deployment.



ReportPRO* (license option RP-HCF) post-processing software is essential for fully characterizing hollow-core fiber. The bidirectional loss profile analysis for hollow core fiber is a must to be able to confirm the fiber has been installed in accordance with the specifications and identify elements such as splices that require rework. ReportPRO aligns the OTDR traces measured from both ends – A to B and B to A – and calculate the difference at each point using the formula [(AB-BA)/2]. This calculation removes inconsistencies caused by variations in HCF backscattering coefficient, providing the “true” loss profile.

*Beta version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The TRS & Viavi Partnership

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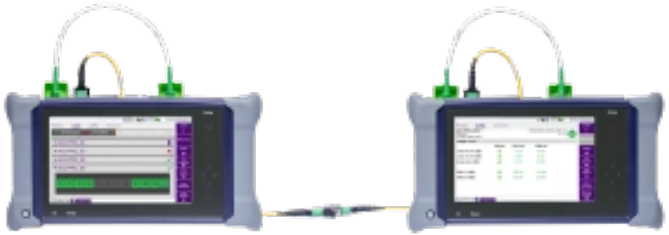
Exclusive Viavi Rental Partner with the most expansive inventory, including recommended solutions for testing Hollow-Core Fiber.



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