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Field Testing and Troubleshooting of PON LAN Networks per IEC 61280-4

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Fluke Networks

BICSI

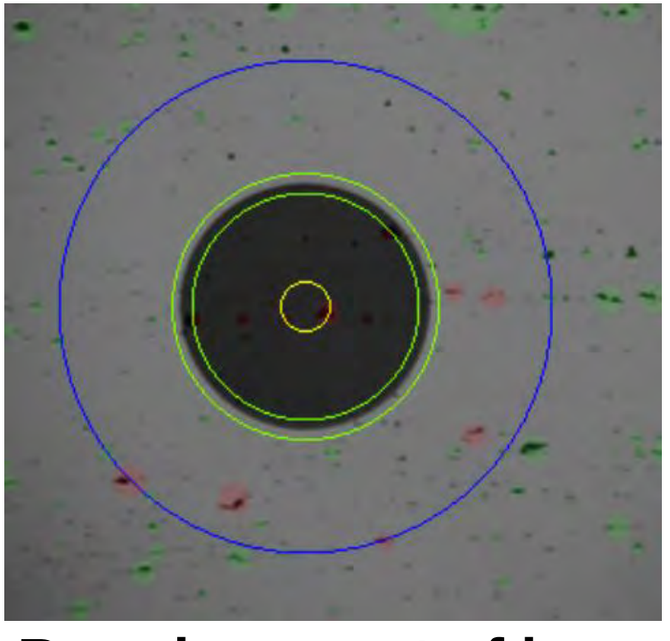
Agenda

- Inspection and Cleaning
  - APC vs UPC
- PON basics
  - Wavelengths
  - Architecture
    - Splitters
- Loss Budget – how many Connectors/Splitters
  - Setting a reference
- Troubleshooting
  - OTDR
  - Power Meter
- Document Results

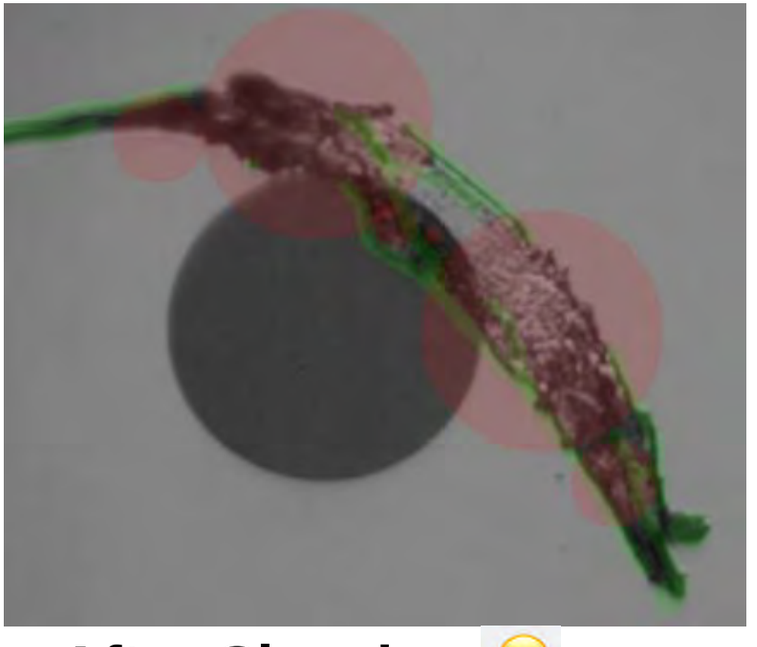
INSPECTION, AND, IF NECESSARY, CLEANING (REPEAT AS NEEDED)

Please be sure to Inspect ALL Connectors before installing, clean them if necessary, inspect again!!

Video Microscope



Brand new out of bag

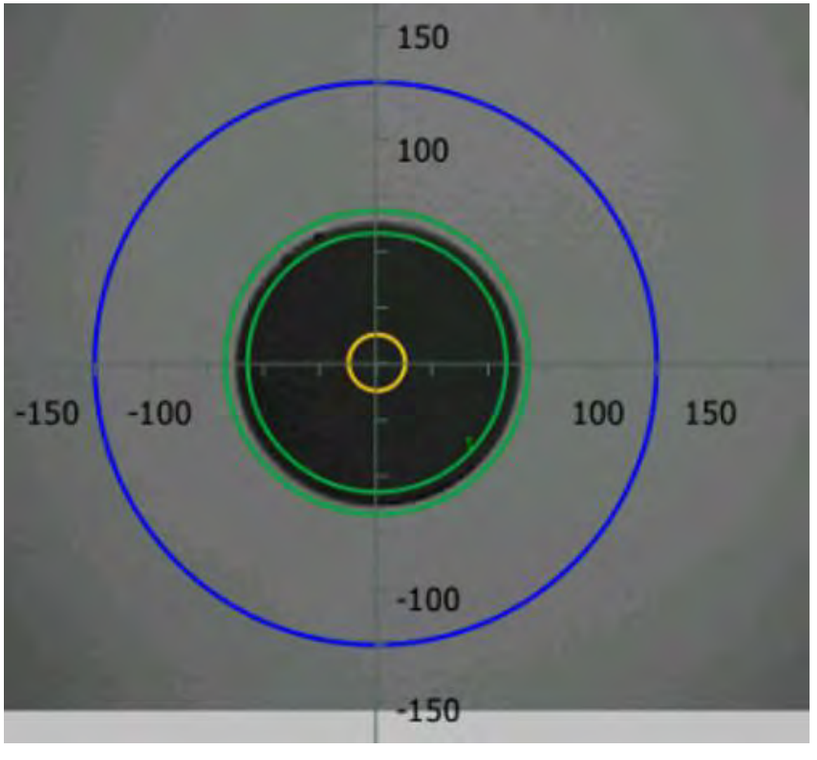


After Cleaning 🙄

Automated Analysis – Single Mode APC Limits

IEC 61300-3-35 ED.2 SM APC

Zone Name	Scratches	Defects
A: Core (0-25µm)	4 ≤ 3 µm None > 3 µm	None
B: Cladding (25-115µm)	No Limit	No Limit < 2 µm 5 from 2 - 5 µm None > 5 µm
C: Adhesive	No Limit	No Limit
D: Contact (135-250 µm)	No Limit	No Limit < 10 µm None > 10 µm

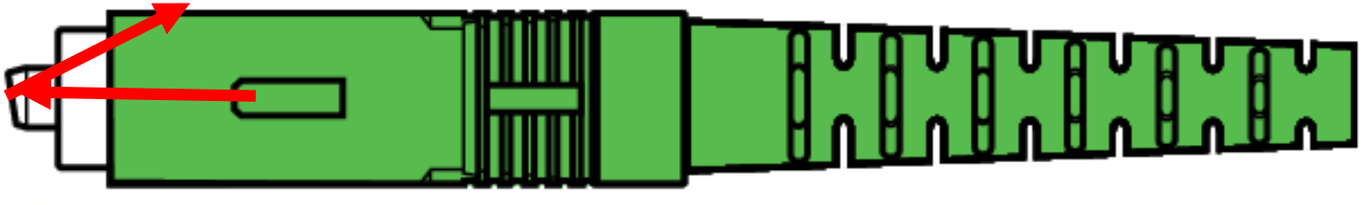


That little angle on the APC minimizes back reflection

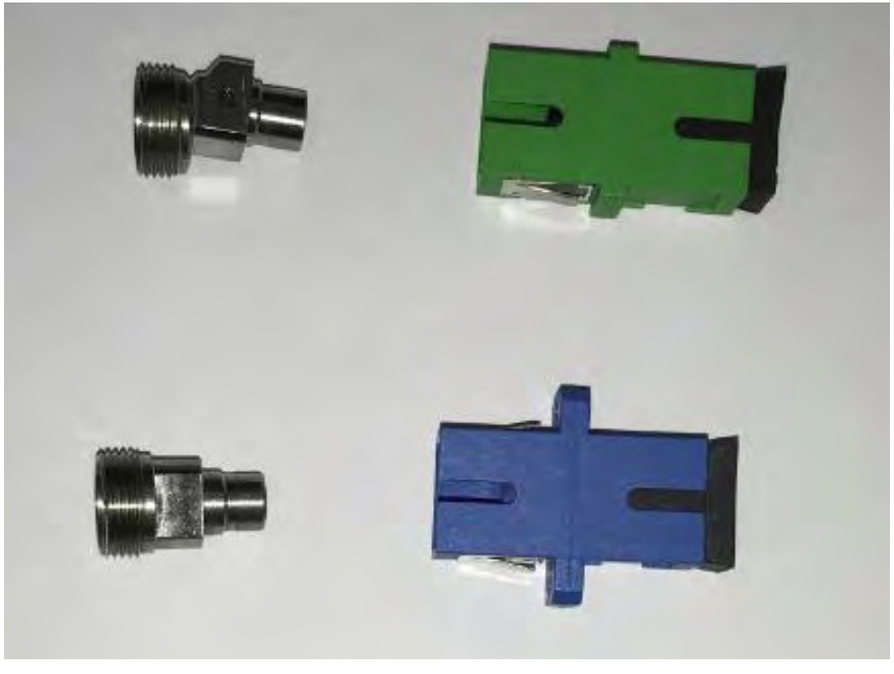
Especially important with high-power transmissions to avoid damage to equipment

PC/UPC

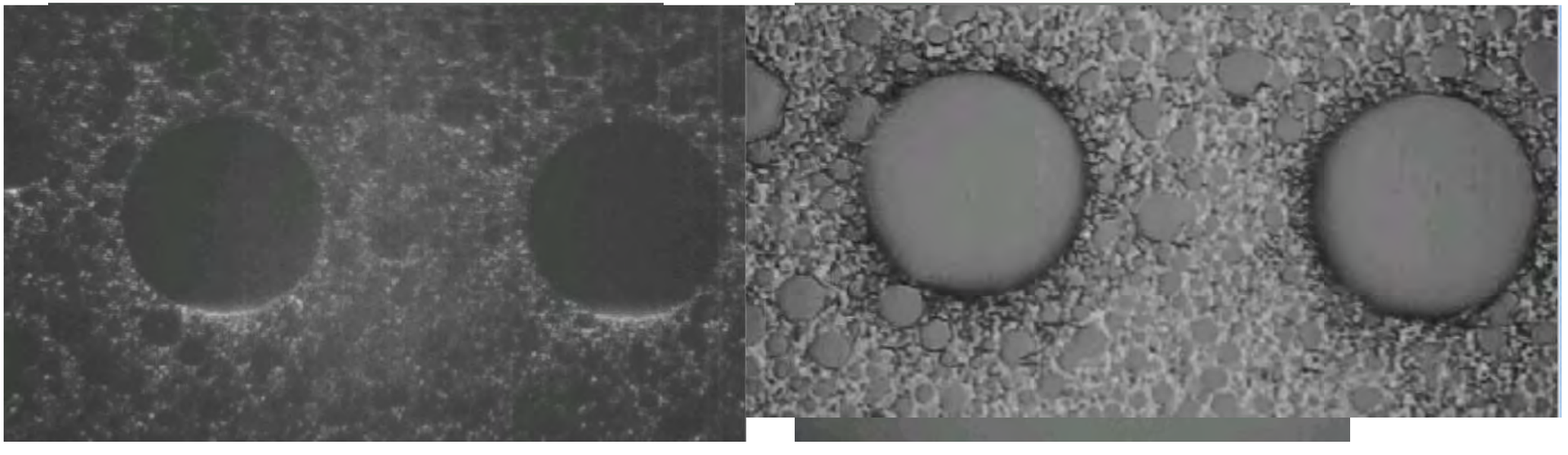
APC



APC Tips have a slight bend – these are SC

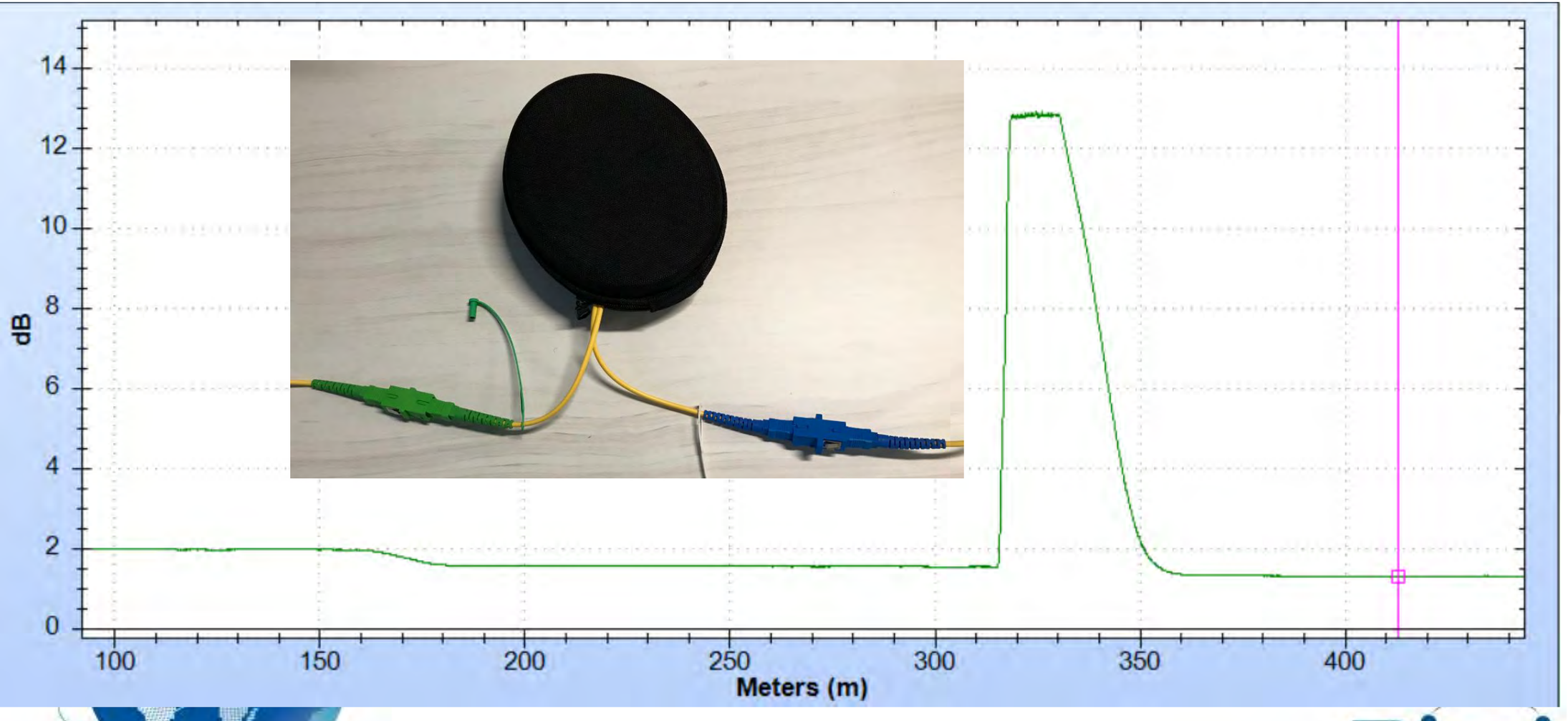


APC connectors may need a “Twist” to show up

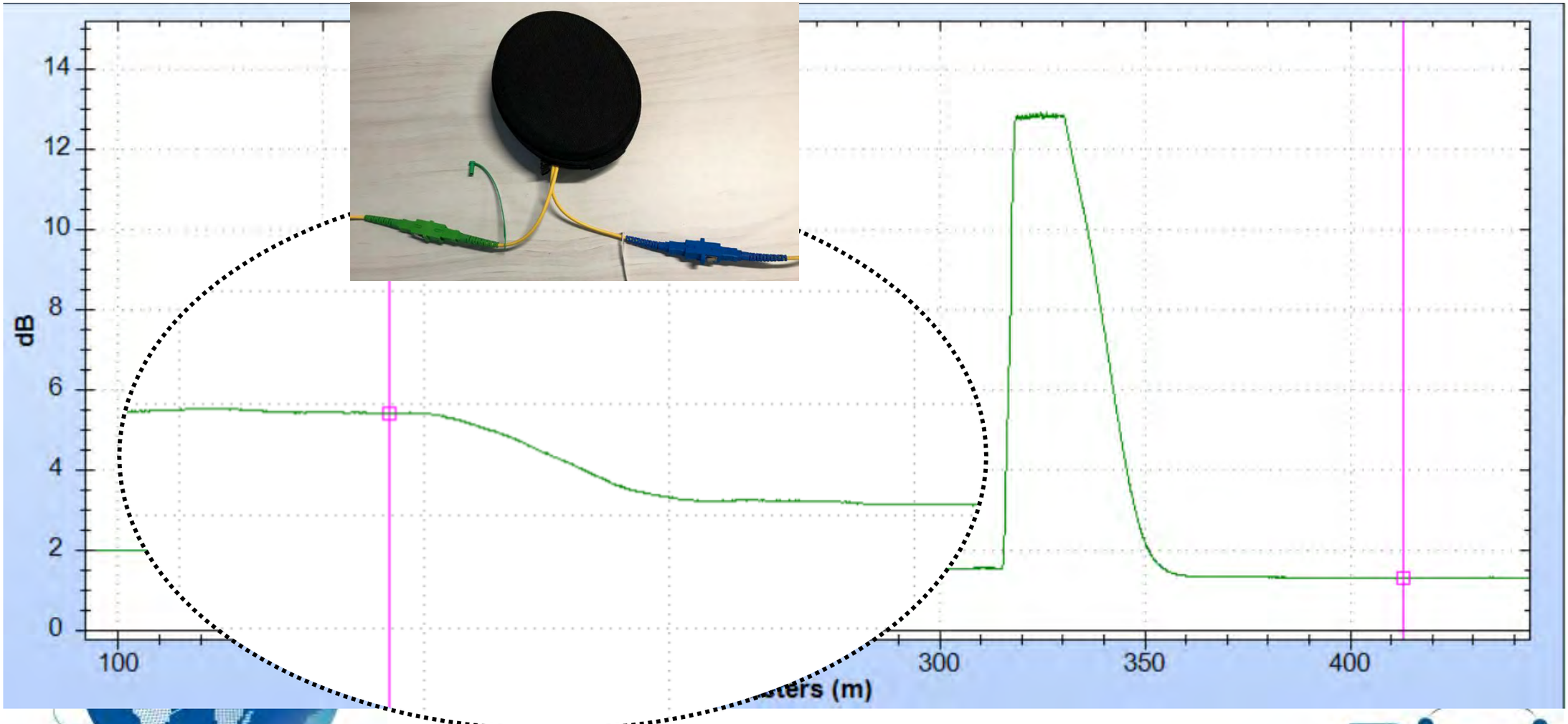


Single Mode MPO connectors will also require a special adapter

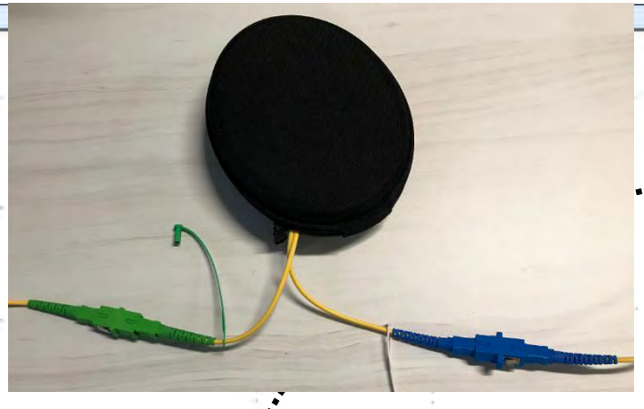
APC Connector vs. UPC Connector



APC Connector vs. UPC Connector



APC Connector vs. UPC Connector



BACK TO PASSIVE OPTICAL NETWORKS

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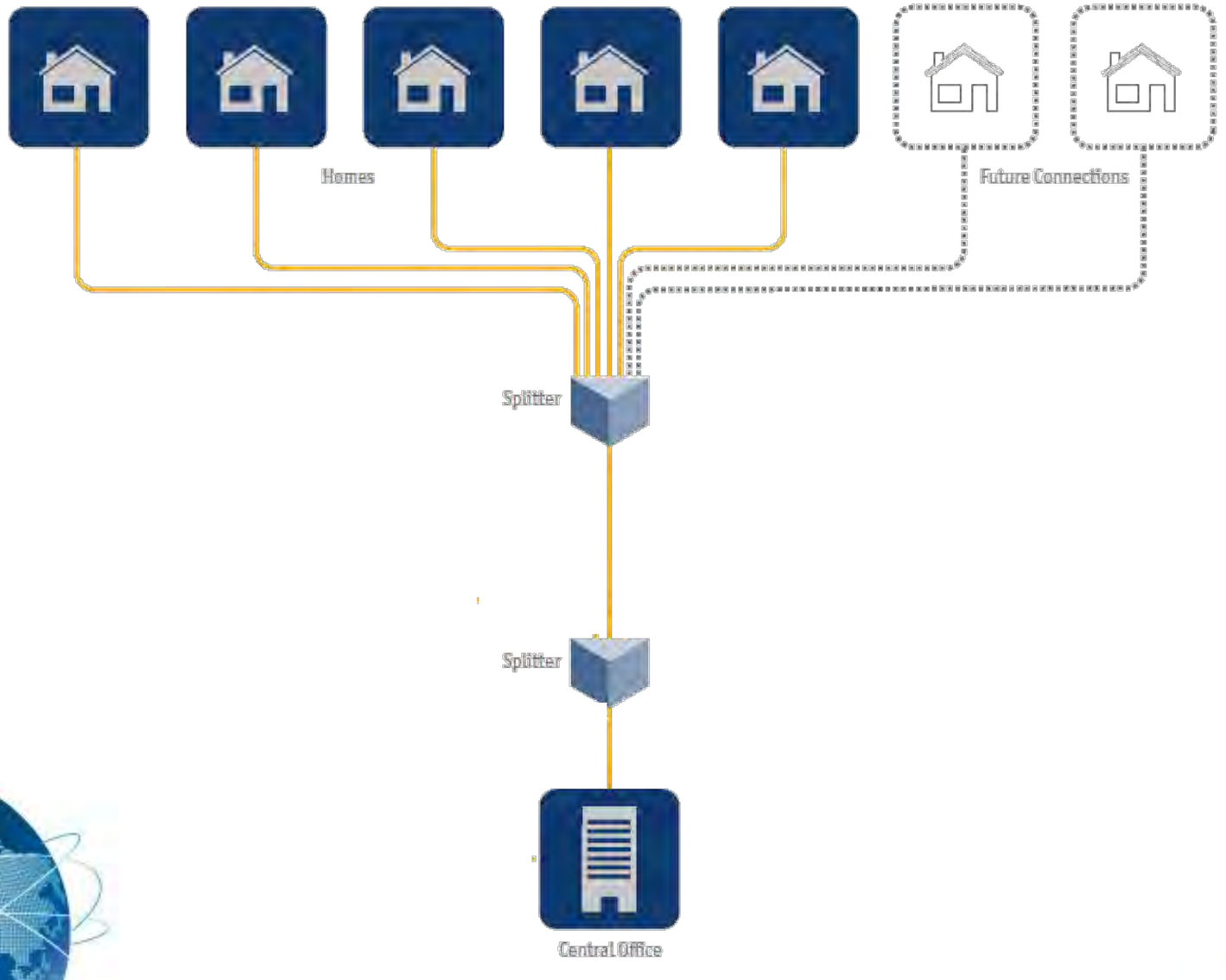
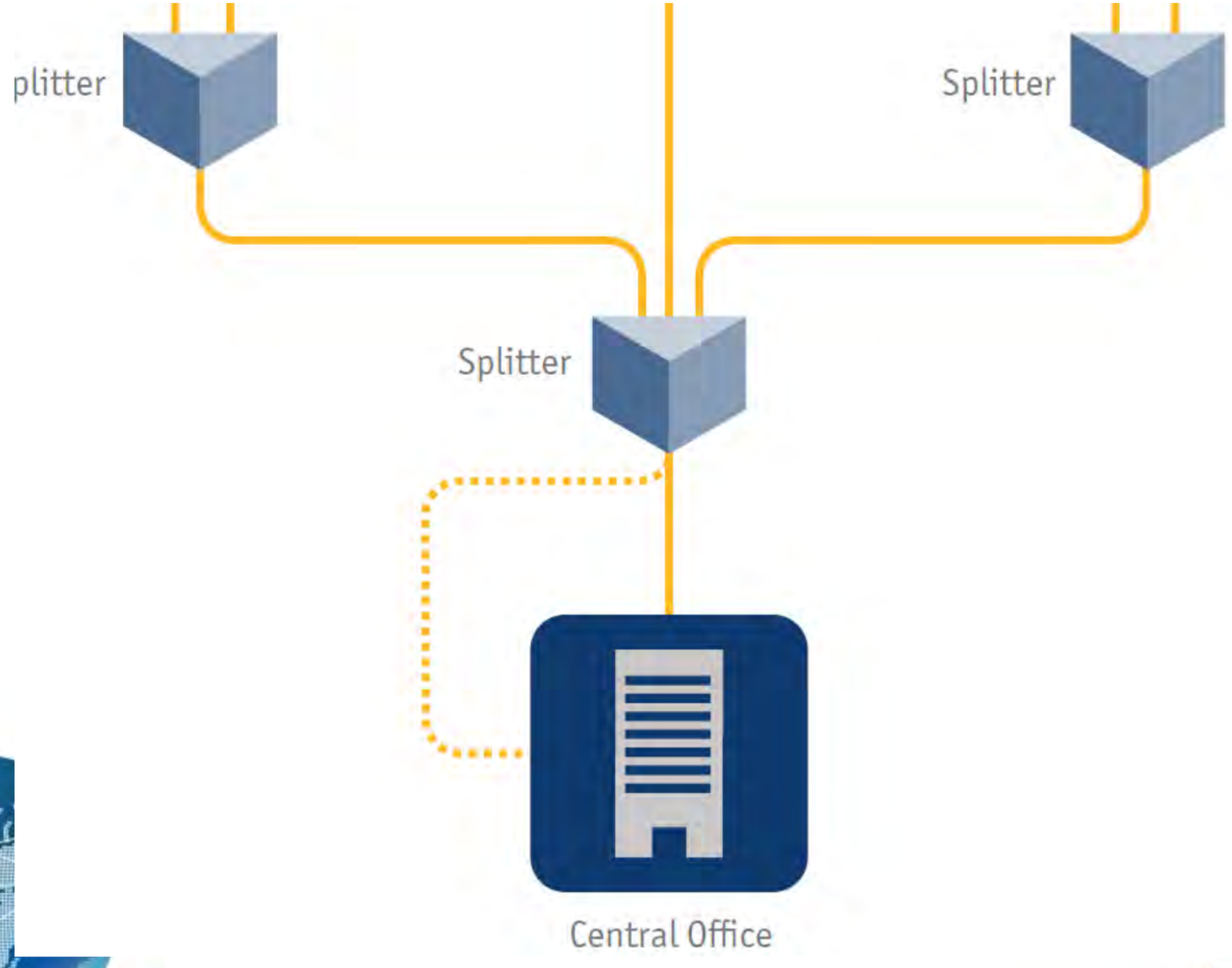
“Flavors” of Passive Optical Networks

- E-PON and G-PON – most common today
- 10G or XG-PON, NG-PON, NG-PON2
- TBD-PON
- FTTx
- PON-LAN
- We don’t care what you put on the road – we want to make sure the road is in good shape to support today’s applications
  - Loss Budgets, Distances, Reflectance limits may be
  - tighter with future versions

‘basic’ PON architecture



‘basic’ PON architecture - redundancy



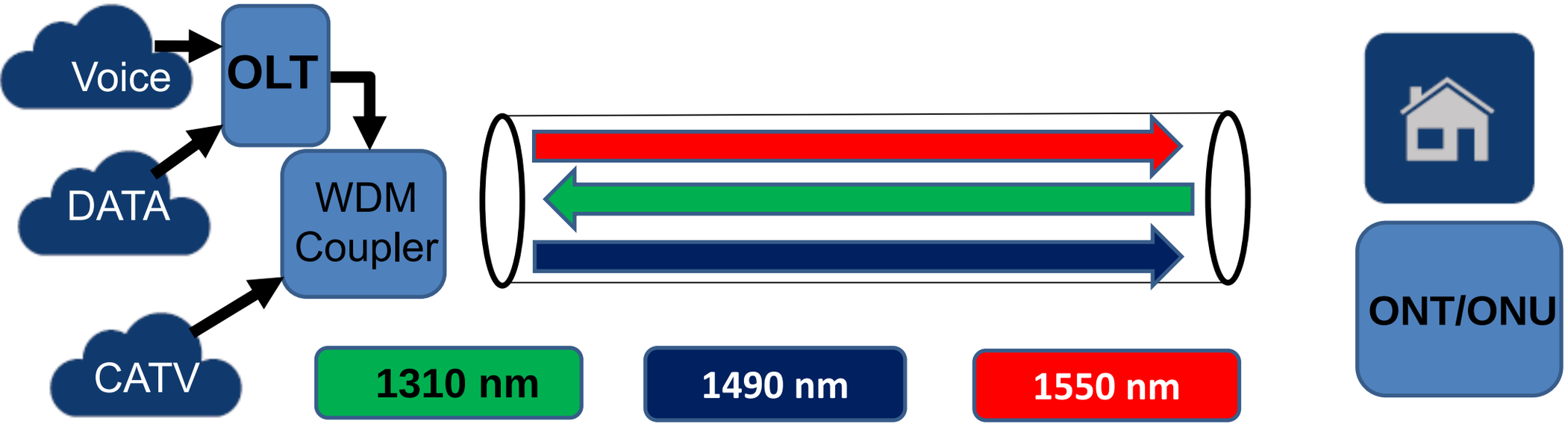
Basic PON LAN Layout

Fiber Concentration Point (FC/FCP)

Fiber Distribution Terminal (FDT)

Fiber Distribution Hub (FDH)
DataCenter/MDF Single Administration Point

Multiple Wavelengths λ One Fiber



OLT – Optical Line Terminal
ONU – Optical Network Unit (ONT – Optical Network Terminal)

SPLITTERS – PUTTING THE *P*ASSIVE IN *P*ON

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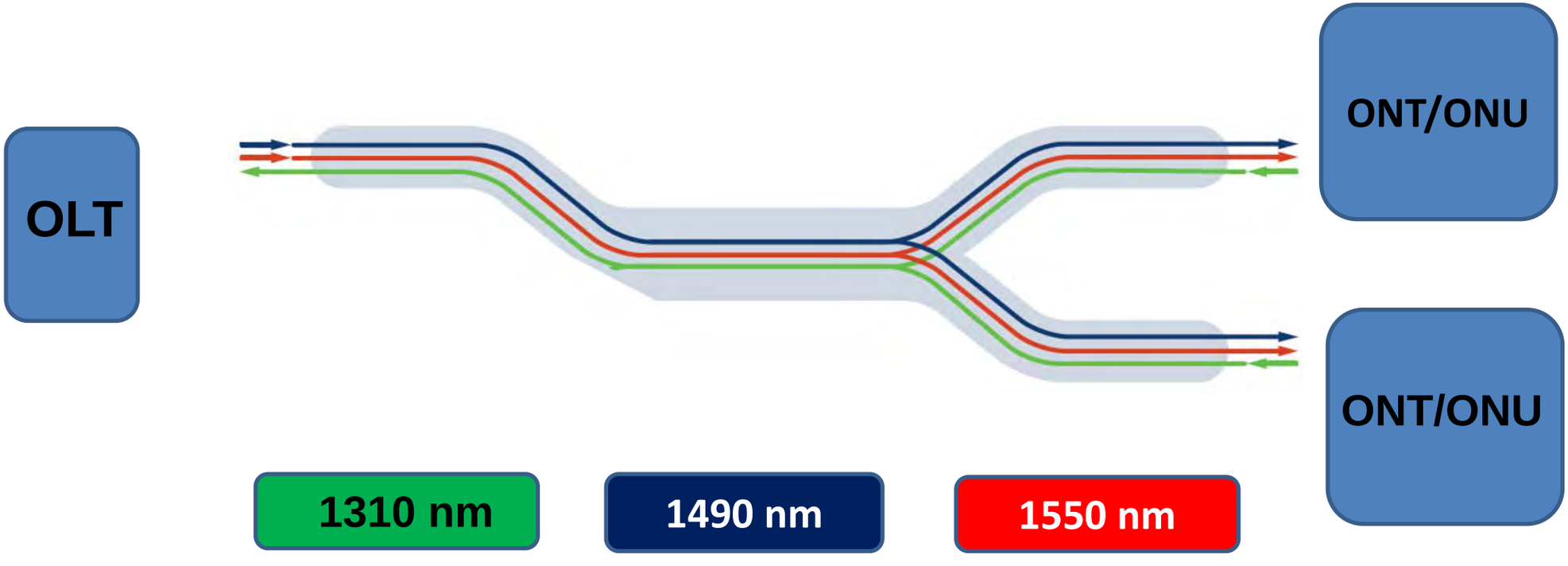
Multiple Wavelengths λ One Fiber - Split



OLT – Optical Line Terminal
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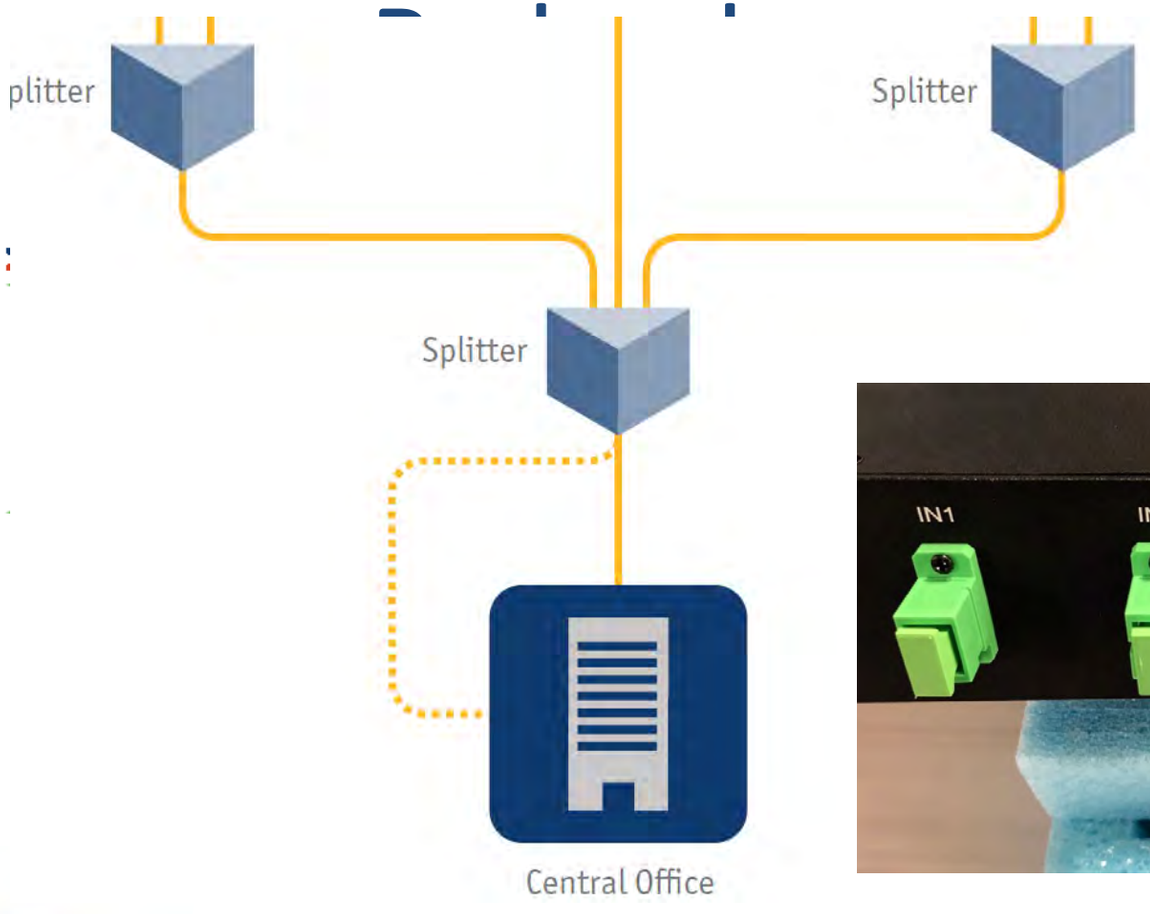
Multiple Wavelengths λ One Fiber –



OLT

ONT/ONU

OLT – Optical Line Terminal
ONU – Optical Network Unit (ONT – Optical Network Terminal)

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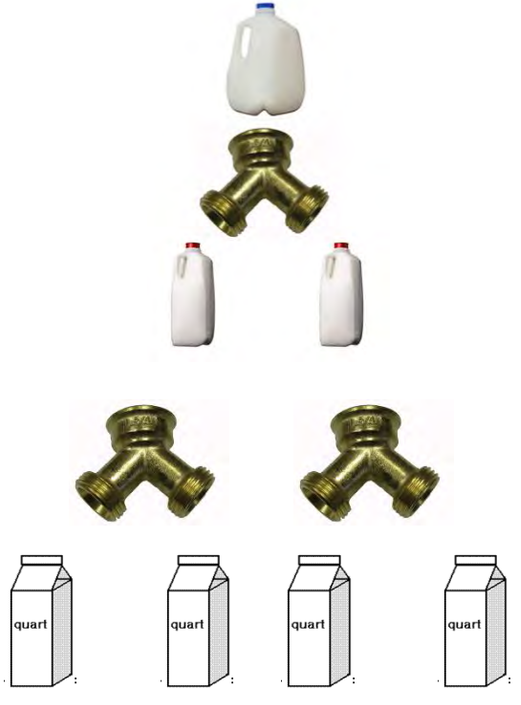
Splitters, as the name suggests, divide the light

- Think of a splitter like a “Y” on a garden hose
  - If you put a gallon of water into the hose, you will get ½ gallon on each port
  - In optical power, that “loss” would be expressed as 3 dB
    - And a little bit for the connectors more for SC or LC connectors than a fusion splice
    - A 1 x 2 splitter should have about 3.5 dB of loss

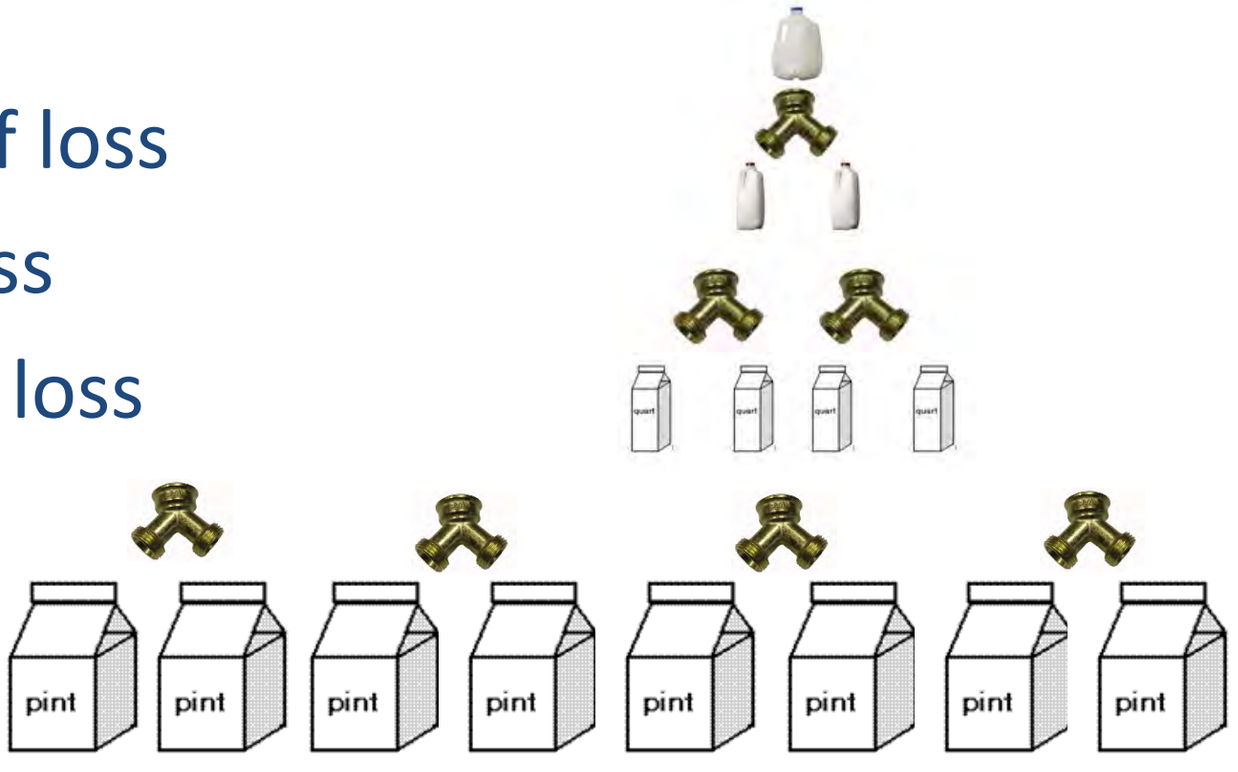
As you increase the split, you attenuate the light that is coming out of a splitter

- A 1 x 2 = 3.5 dB of loss
- 1 x 4 = 7 dB of loss



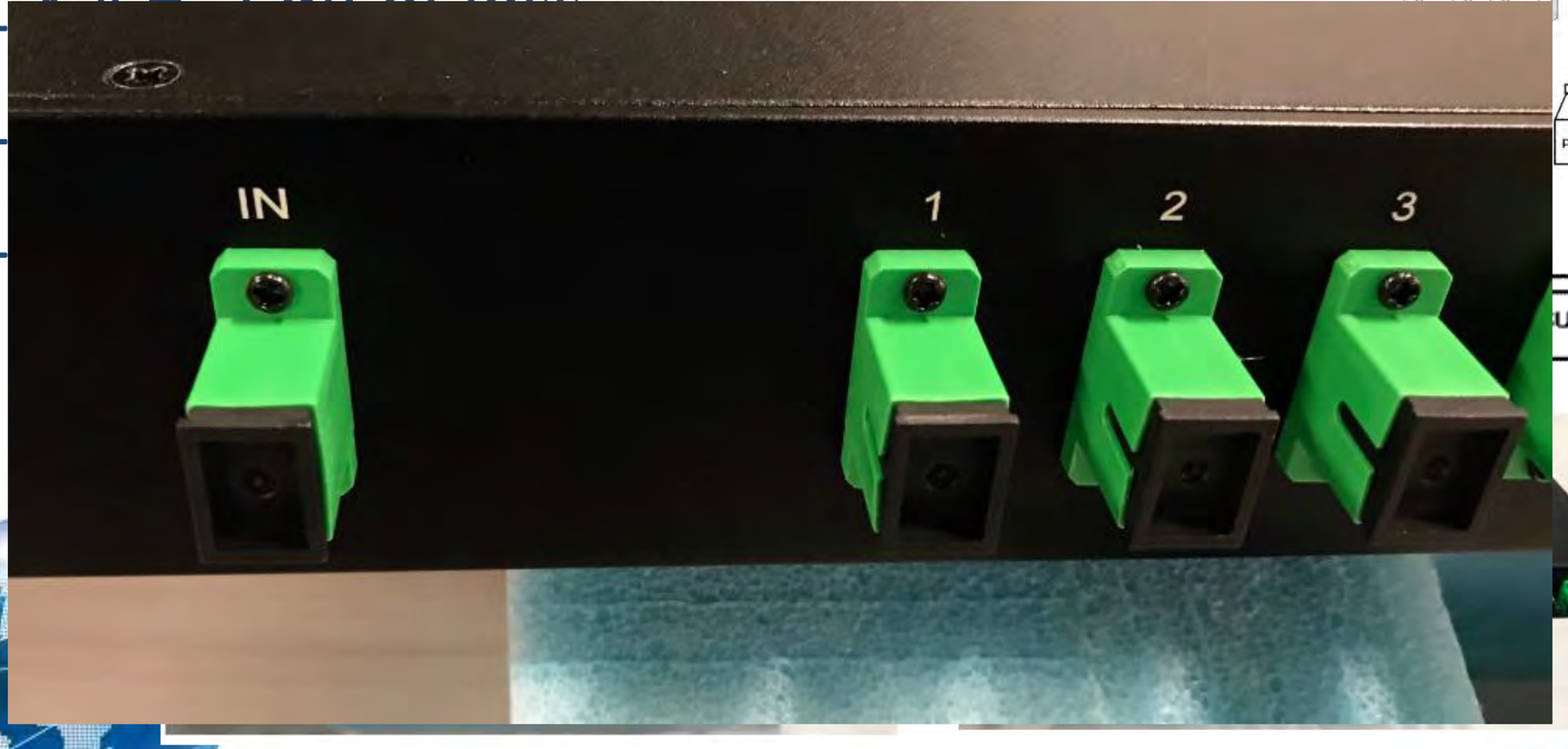
As you increase the split, you attenuate the light that is coming out of a splitter

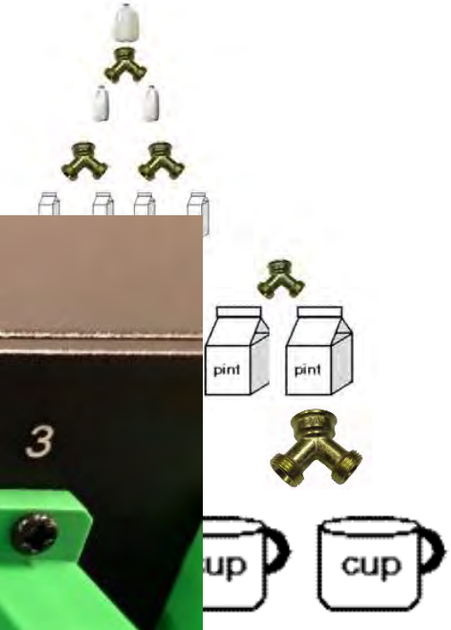
- A 1 X 2 = 3.5 dB of loss
- 1 X 4 = 7 dB of loss
- 1 X 8 = 10.5 dB of loss



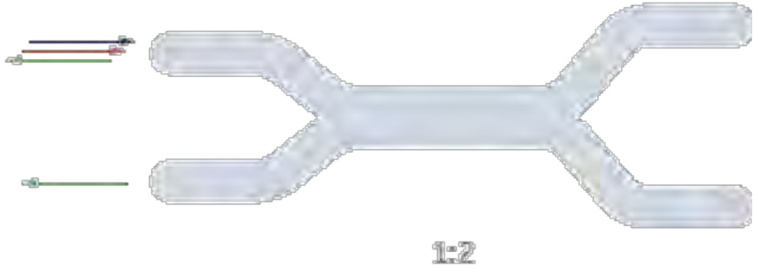
As you increase the split, you attenuate the light that is coming out of a splitter

- A 1 X 2 = 3.5 dB of loss
- 1 X 4 = 7 dB of loss
- 1
- 1





Loss Budget per Split per TIA-568 Annex D



Maximum permitted loss 3.9 dB

TEST OF PON NETWORKS

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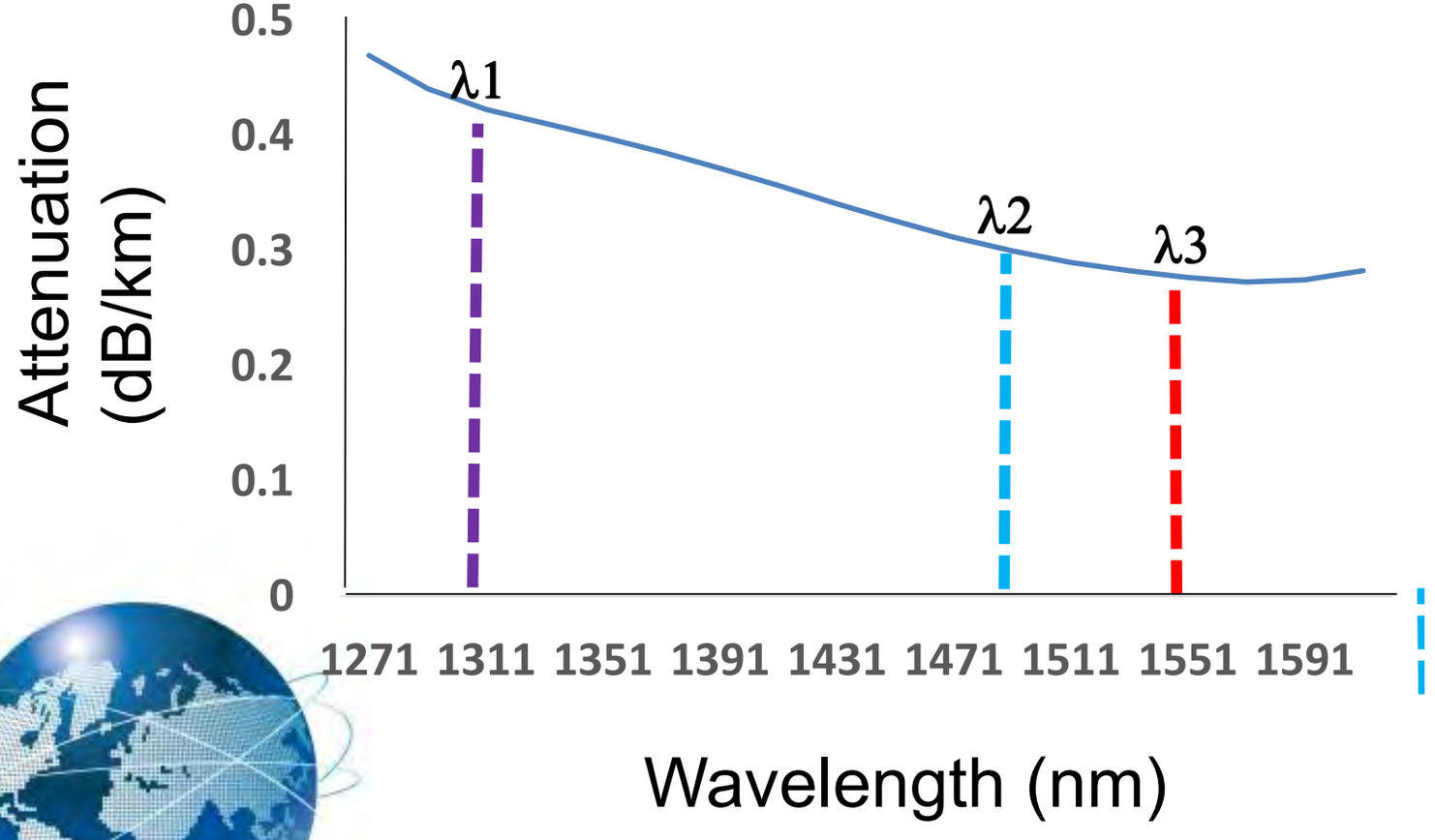
What To Test – Per IEC 61280-4-3

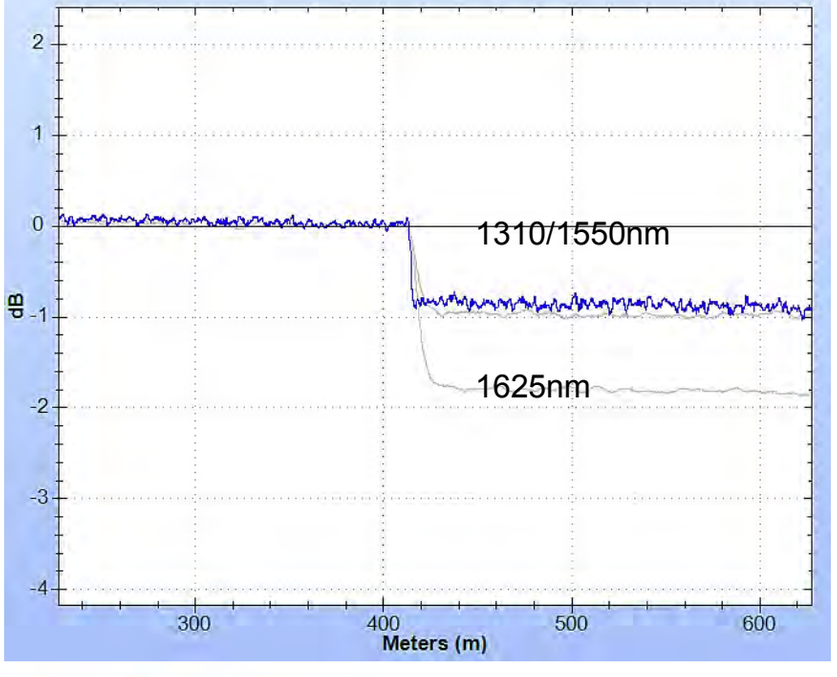
- Single Stage Optical Distribution Network (ODN)
- Multiple Stage ODN
- Attenuation
  - Light Source and Power Meter
  - 1310 and 1550 nm
  - OTDR (only in the upstream direction)
- ORL and Reflectance
  - OTDR

We don’t need to test every wavelength to identify problems – they are “bound”
If one of two wavelengths is off – there is a problem

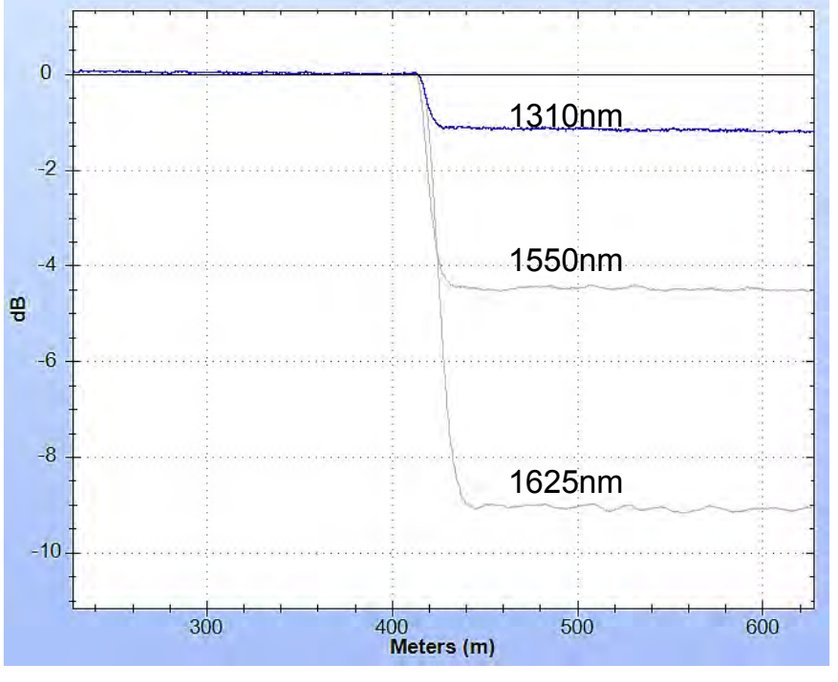


Macrobend Detection

Small Bend



Large Bend

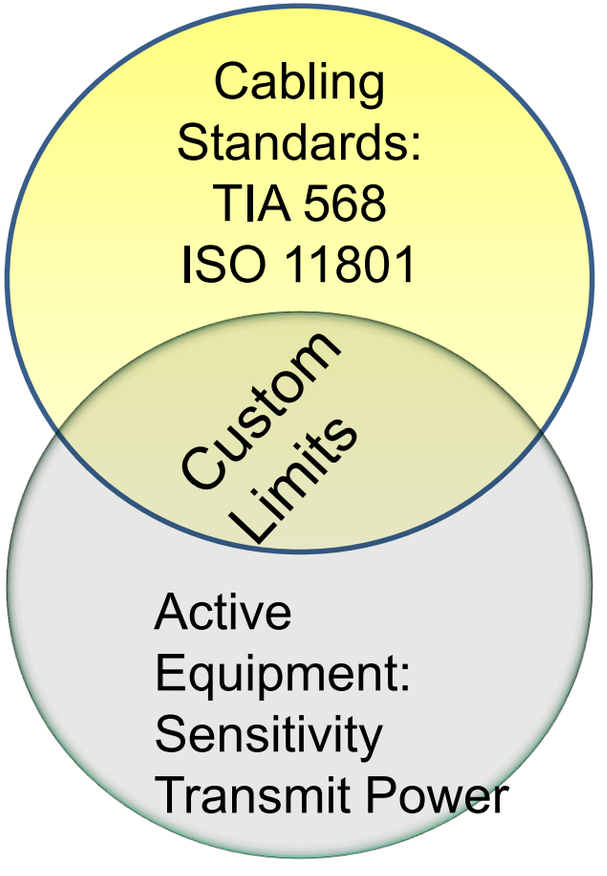


Bend detection on bend insensitive fiber.

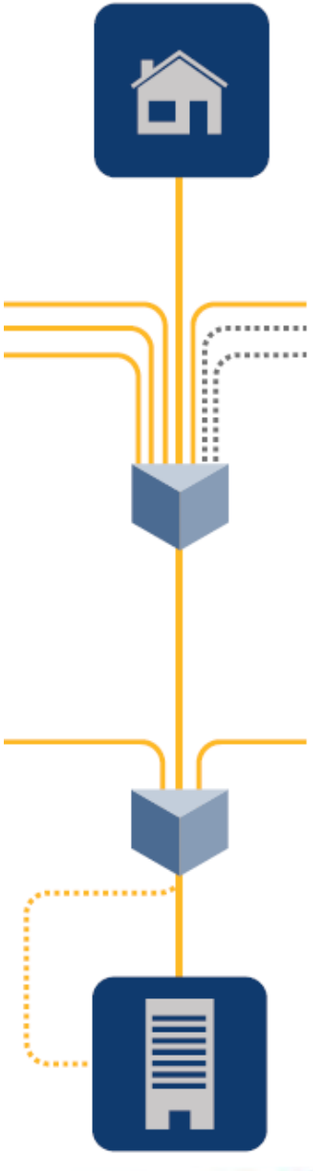
LOSS BUDGET CALCULATION

What loss budget to use when testing

- There can be different loss budgets that can be used
  - A Cabling limit, like the one called out in the IEC standard
    - Cable + Connectors + Splitters
  - An active equipment limit – depends on equipment
    - Fixed value 27 dB



Loss Budget Calculation



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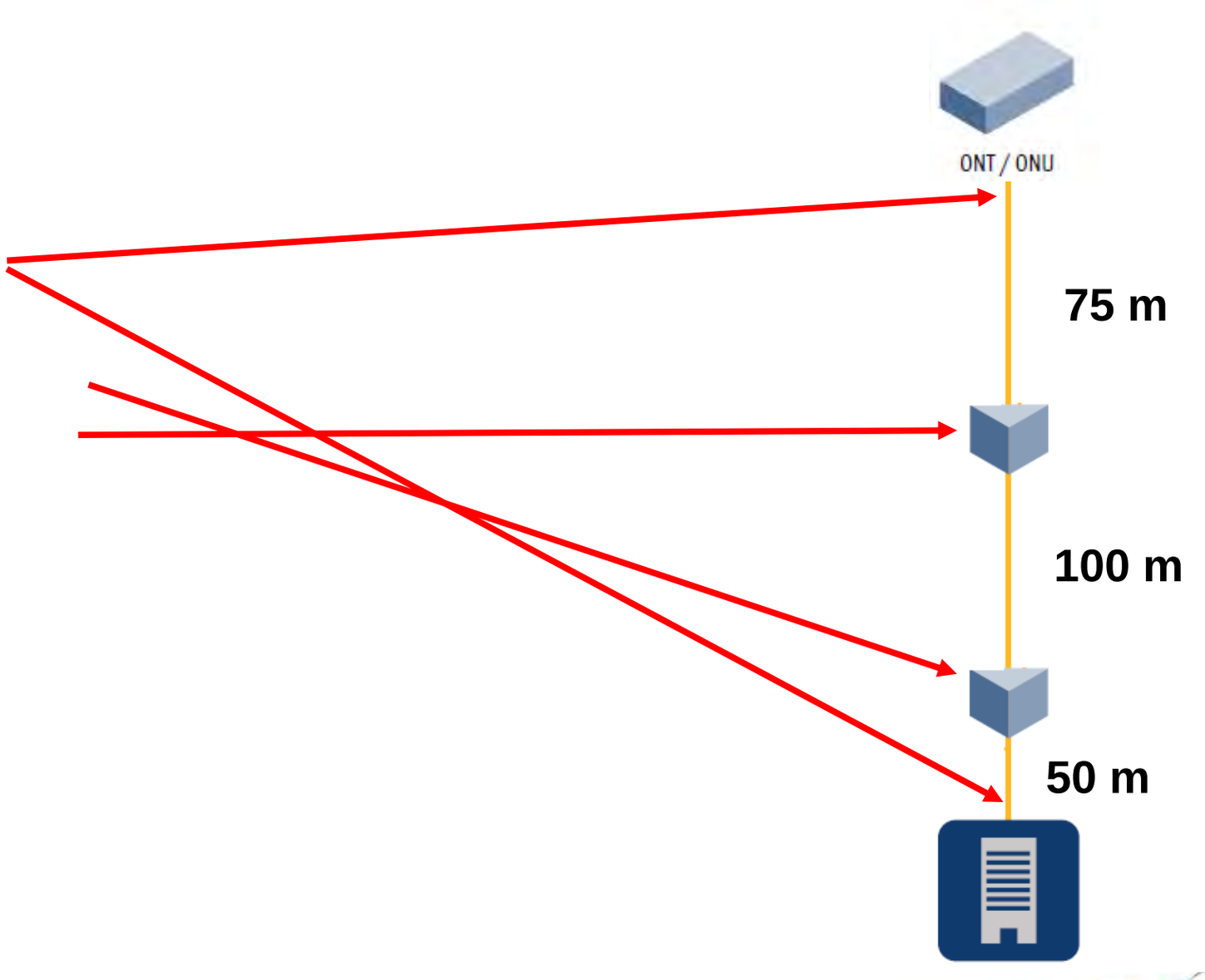
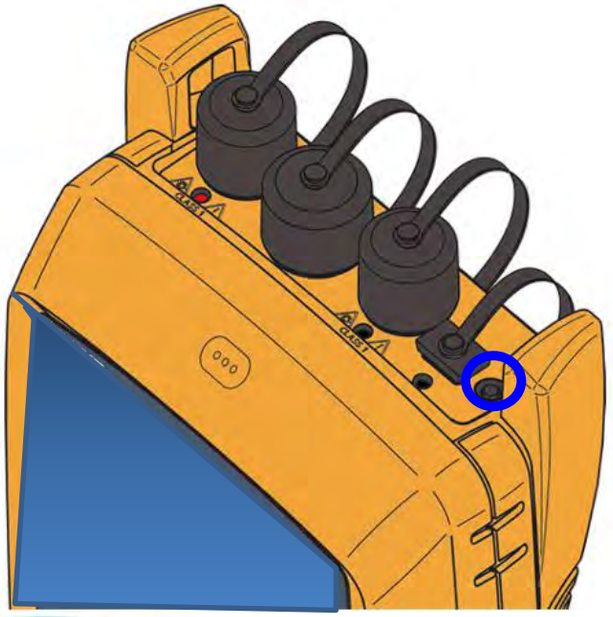
Loss Budget Calculation



LOSS TESTING WITH MINIMAL UNCERTAINTY AND MAXIMUM REPEATABILITY

Bicsi

Accurate Loss Testing will assure support for today's and future network applications

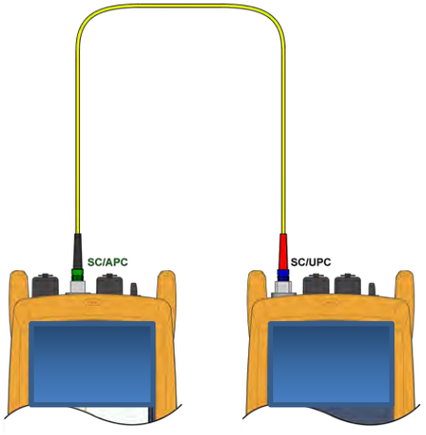


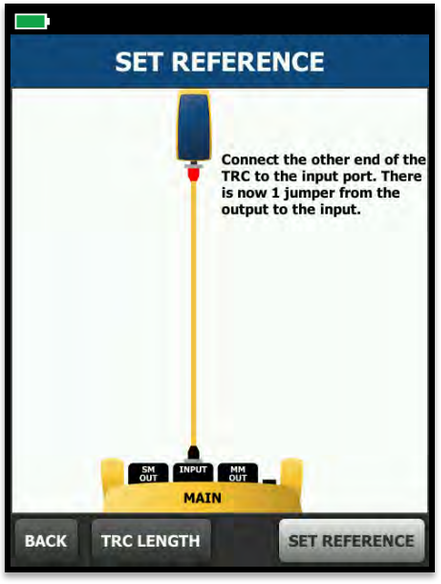
- A One Jumper reference is called out in the standard
- A Simple Light Source and Power Meter can be used, or you can use common **OLTS** units, provided they can be put into a "Far End Source Mode"

Pressing this button again sets the singlemode port to 1310/1550 nm

Single fiber testing – setting a reference

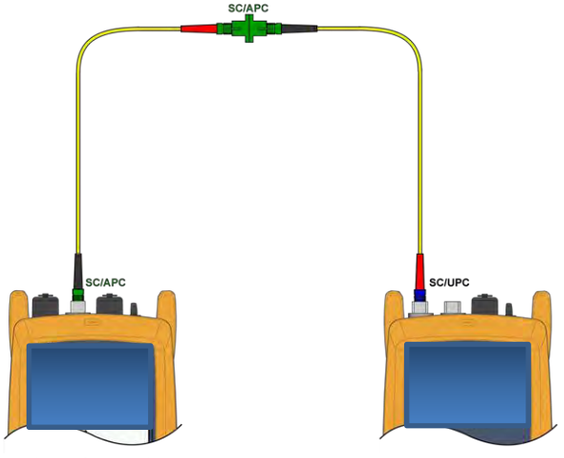
- Connect the MAIN and SOURCE units together
  - **One Jumper Reference**
  - **Must have input port that is the same as the connector to be tested**

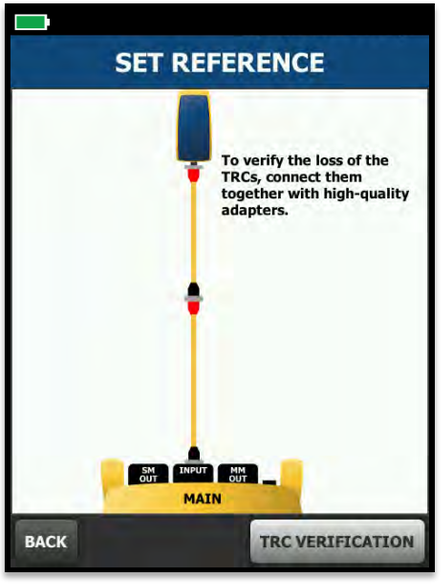




Single fiber testing – setting a reference

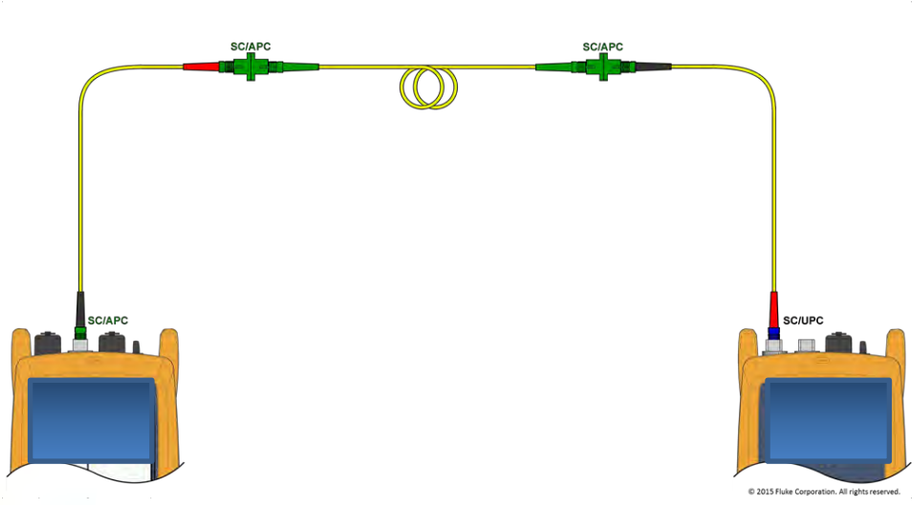
- After the reference is set, verify the condition of the other Test Reference cord
- This loss should be less than 0.25 dB
- Save this in your test results!

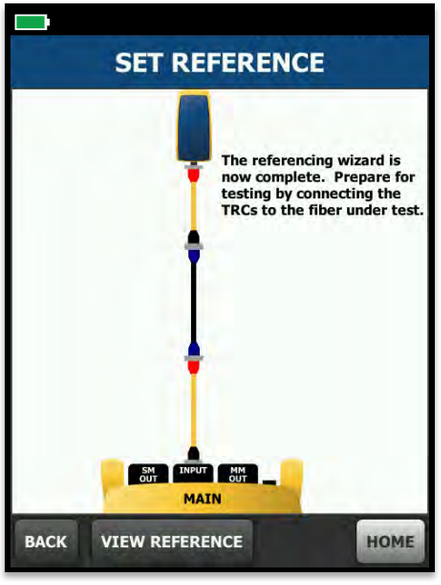




Single fiber testing – setting a reference

- Connect to the link you wish to test





Sample Test Results

Cable ID: HGI ROOM 204
Date / Time: 12/29/2017 09:28:09 AM
Cable Type: OS2 Singlemode

n = 1.4670 (1310 nm)
n = 1.4680 (1550 nm)

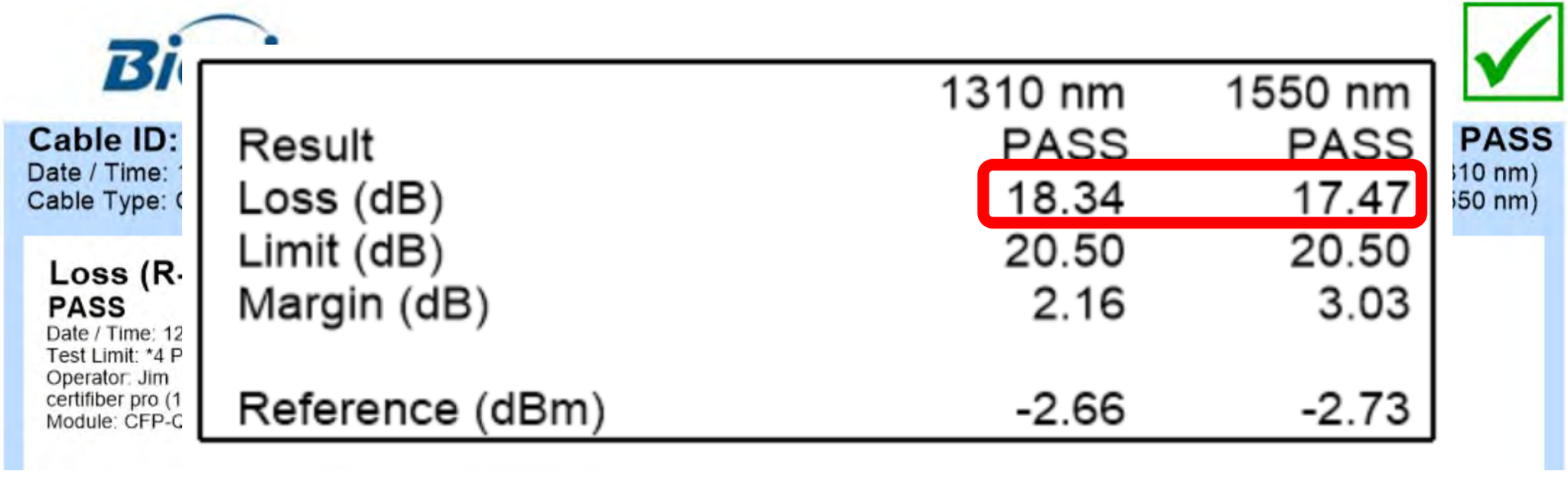
Test Summary: PASS
Backscatter Coefficient: -79.5dB (1310 nm)
Backscatter Coefficient: -82.0dB (1550 nm)

Loss (R->M)
PASS
Date / Time: 12/29/2017 09:28:09 AM
Test Limit: *4 PORT & 8 PORT*
Operator: Jim
certifiber pro (17455007 v5.3 build 20171229
Module: CFP-QUAD(2427616)

	1310 nm	1550 nm
Result	PASS	PASS
Loss (dB)	18.34	17.47
Limit (dB)	20.50	20.50
Margin (dB)	2.16	3.03
Reference (dBm)	-2.66	-2.73

Connector Type: LC
Patch Length1 (m): 2.0
Reference Date: 12/29/2017 09:08:10 AM
1 Jumper

Sample Test Results - Detail



Cable ID:
Date / Time:
Cable Type:

Loss (R-
PASS
Date / Time: 12
Test Limit: *4 P
Operator: Jim
certifiber pro (1
Module: CFP-C

	1310 nm	1550 nm
Result	PASS	PASS
Loss (dB)	18.34	17.47
Limit (dB)	20.50	20.50
Margin (dB)	2.16	3.03
Reference (dBm)	-2.66	-2.73

PASS
310 nm)
550 nm)

Alternate Loss Budget Calculation

- Single Mode
- Often, they

Interface P

GPON Port

- Class B+
- Receiver sensitivity: -27dBm
- Wavelengths: US 1310 nm, D

Cisco
Table

Table

Typ

PON

GPON

- De acordo com o padrão GPON ITU-T G.984.x;
- Transmissor de 1.244Gbps sentido upstream em mod
- Receptor de 2.488Gbps sentido downstream;
- Comprimento de onda de transmissão: 1310nm;
- Comprimento de onda de recepção: 1490nm;
- Framing totalmente compatível com ITU-T G.984;
- Múltiplos T-CONTs por dispositivo;
- Múltiplos GEM Ports por dispositivo;
- Suporta modo Single T-CONT ou modo Multiple T-C
- Mapeamento flexível entre GEM Ports e T-CONTs;
- Forward Error Correction (FEC);
- Suporte para Multicast GEM Port;
- Mapeamento de GEM Ports em um T-CONT com filas de prioridade;
- Potência Óptica de Transmissão: 0,5dBm ~ +5dBm
- Potência Óptica de Recepção: -8dBm ~ -27dBm

- BBF TR.156 - Using GPON in the context of TR.
- Advanced Encryption Standard (AES)
- Forward Error Correction (FEC)
- Class B+ optics (28dB)

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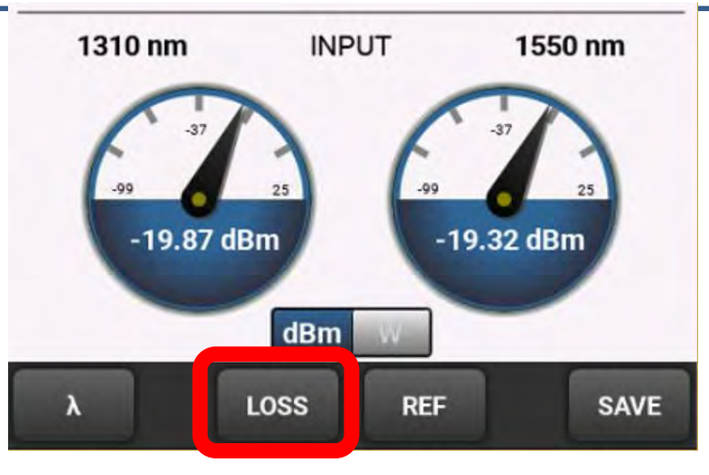
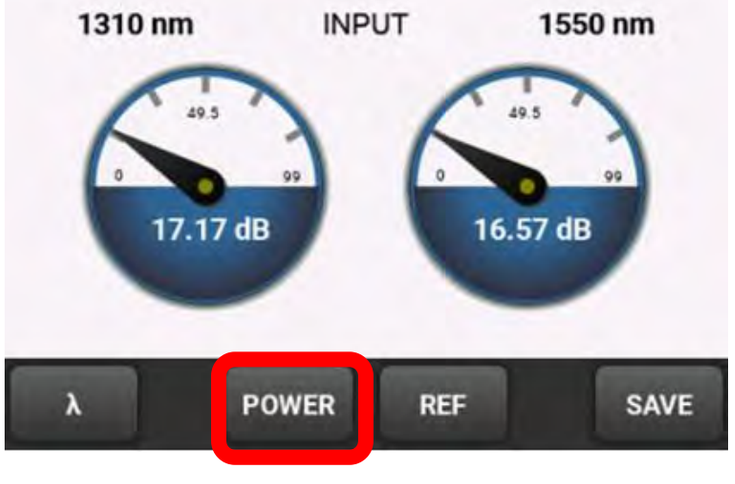
Alternate Loss Budget Calculation

- Single Mode light sources are very powerful
- Often, they can accept any amount of light down to a given level
  - Usually -27 dBm
  - Rule of thumb – give yourself some margin 3 dB?
- When troubleshooting or testing with the OLT installed check for greater than -27 dBm in the



The Button in this example changes from one to the other



Alternate Loss Budget Calculation

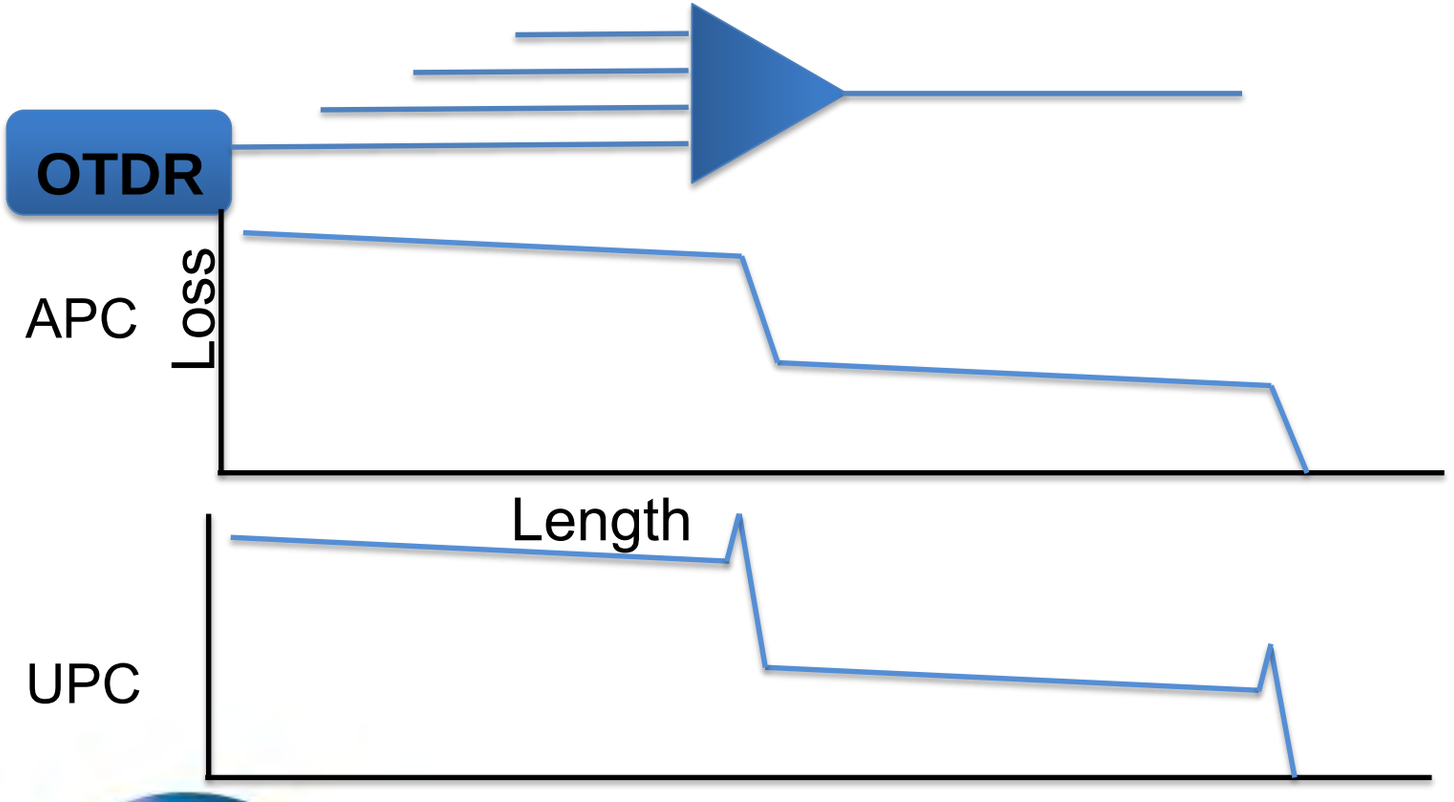
- Single Mode light sources are very powerful
- Often, they can accept any amount of light down to a given level
  - Usually -27 dBm
  - Rule of thumb – give yourself some margin 5 dB?
- When troubleshooting or testing with the OLT

*** Laser source not OLT**

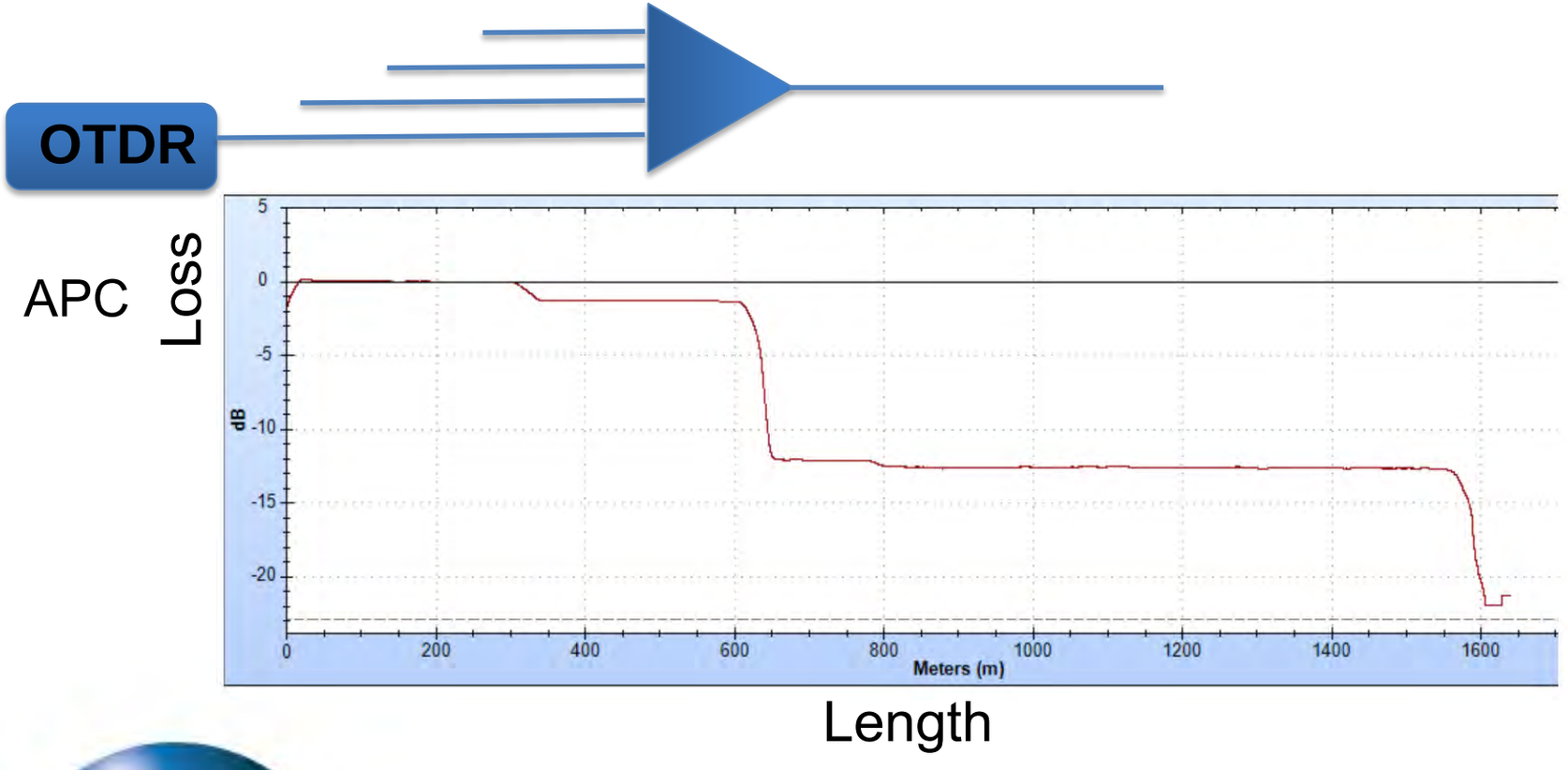
OTDR testing

- Used to measure loss and reflectance of events
- Upstream only
- Requires a launch and tail cord
  - Cords should have close backscatter coefficient to link under test
- Shall be capable of using a short pulse ≤ 20ns
- Check the launch a receive cords prior to testing (B.6.2)

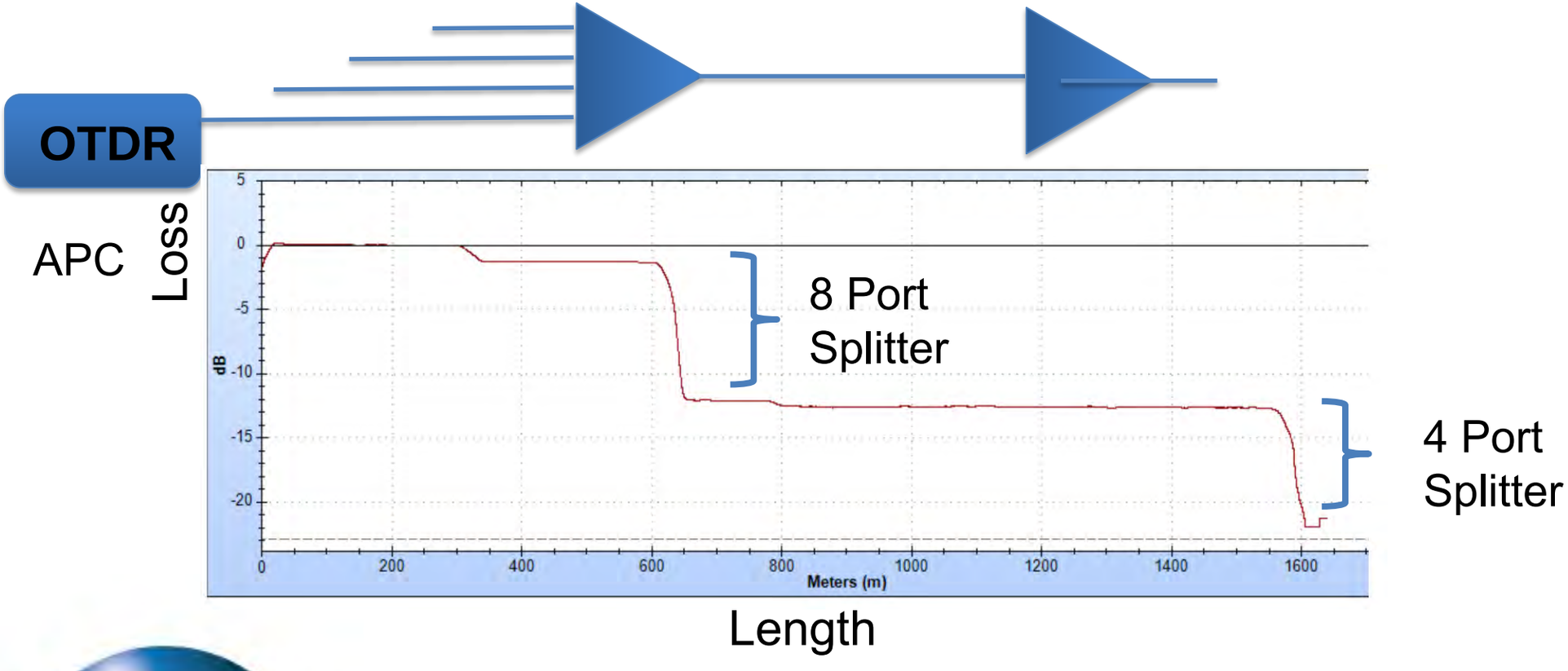
Upstream OTDR Testing



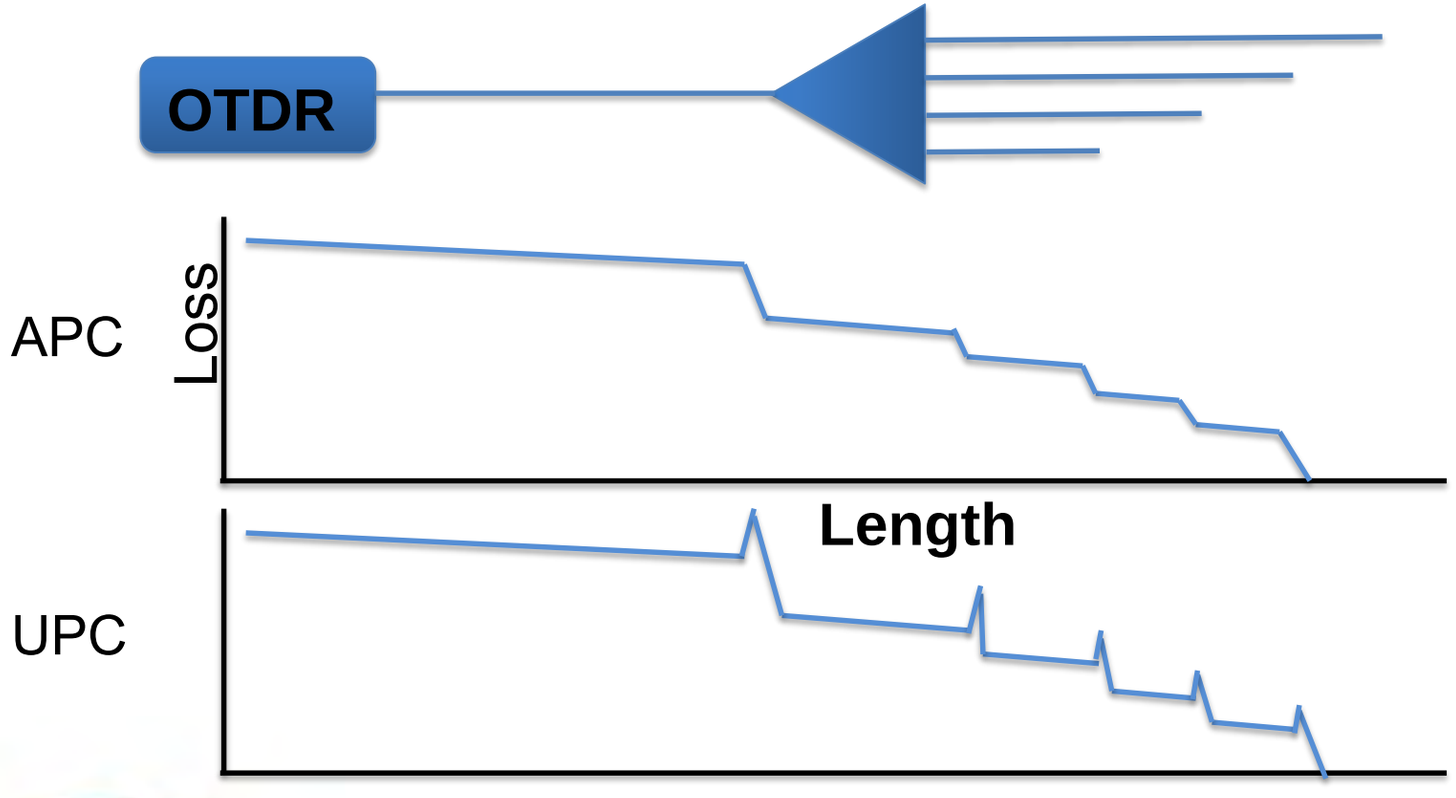
Upstream OTDR Testing



Upstream OTDR Testing

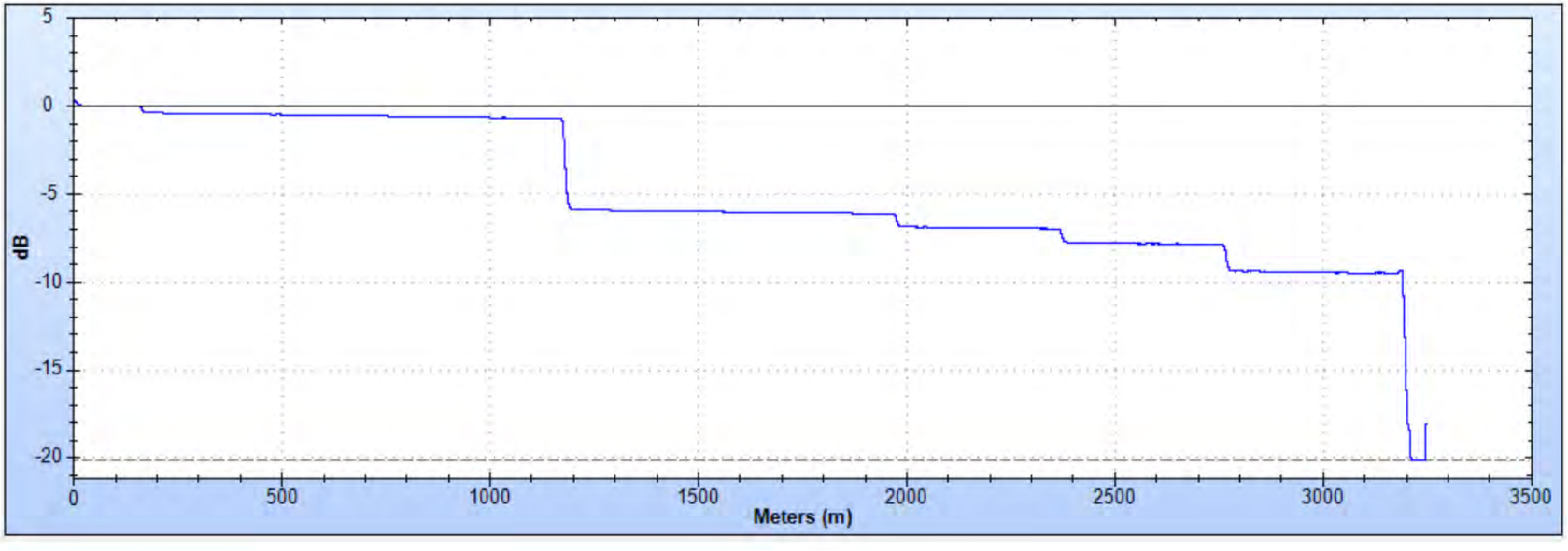


Downstream Testing



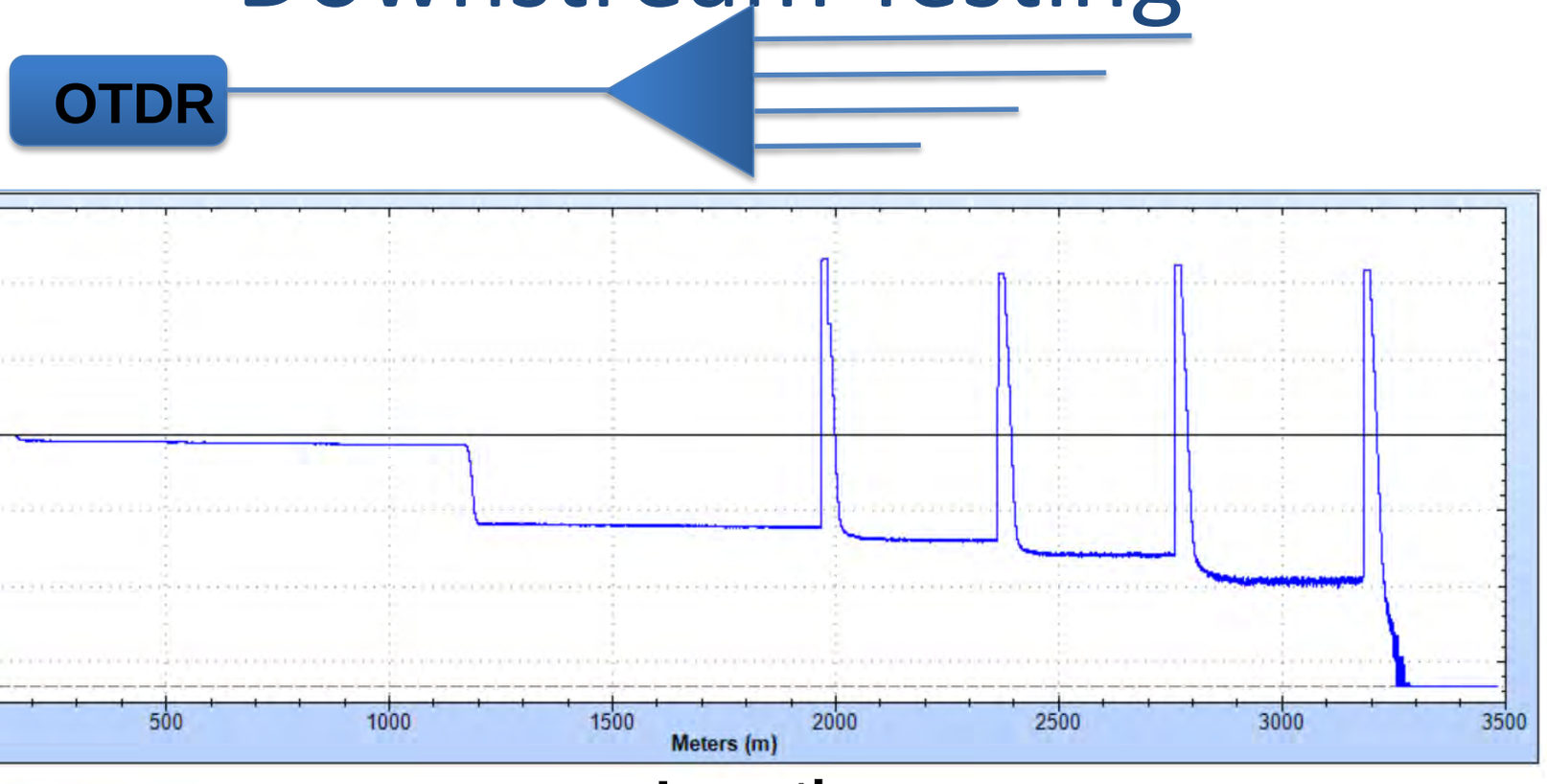
Downstream Testing

APC Loss



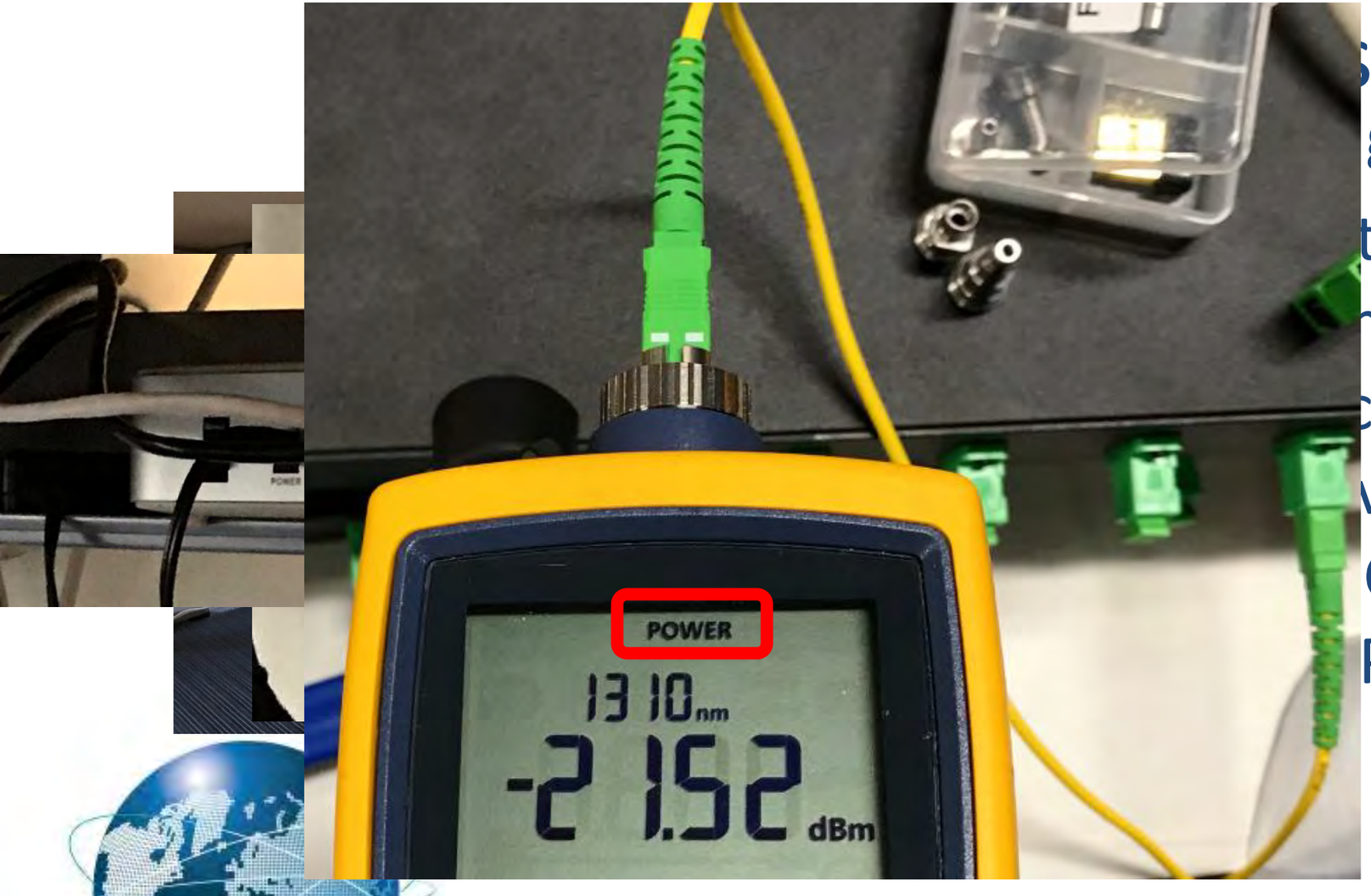
Length

Downstream Testing



TROUBLESHOOTING LINKS

Did you try rebooting?



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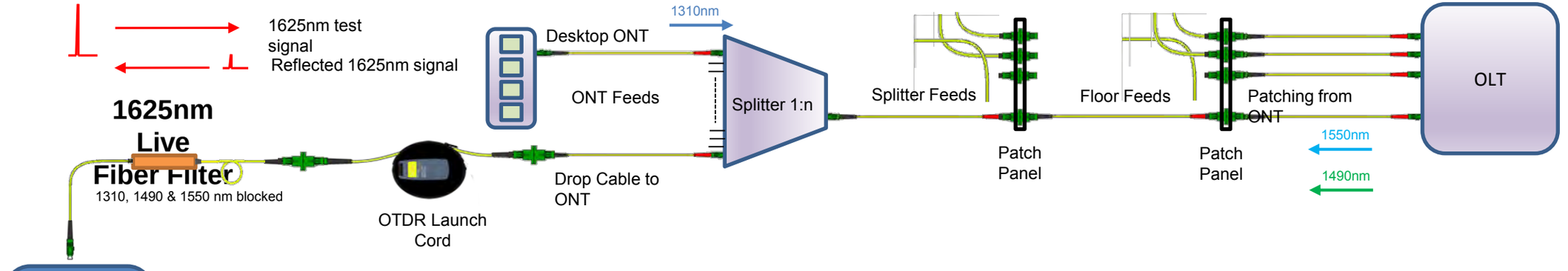
Troubleshooting a live network with an OTDR

- OTDR shoots a pulse of light
- Measures time for light to return
  - Closer events come back sooner
  - Farther events take longer to return
- What if there is an OLT transmitting on the fiber?
  - Light is always arriving
  - How to tell the difference from OTDR transmitted pulse and OLT pulse
  - Unplug from OLT (and run)
  - Unused wavelength – 1625 nm or 1650 nm

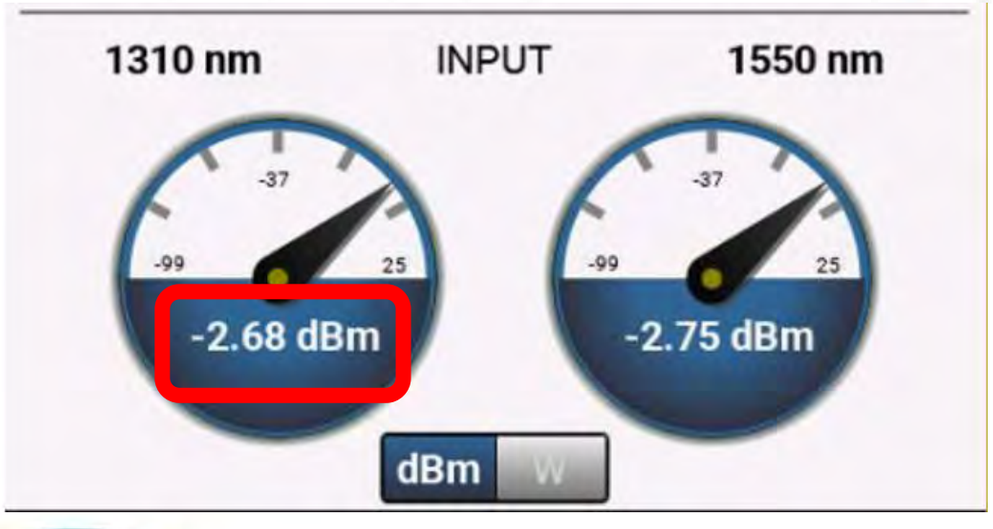
Filtered test configuration for POLAN



- When troubleshooting a connectivity issue you need to be able to connect into a live system with an OTDR to troubleshoot without disturbing the system and without the POLAN signals interfering with the OTDRs measurements.
  - A 1625nm **Live Fiber Filter** allows the OTDR to use an out of band 1625nm test wavelength to meet this purpose.
    - 1625nm will not interfere with the active POLAN signals
    - The filter blocks the 1310nm, 1490nm and 1550nm wavelengths from entering the OTDR port, preventing them from interfering with the measurement

Gotcha – don’t plug ONT to OLT with 2 meter patch cord to check if it

- Potência Óptica de Transmissão: 0,5dBm ~ +5dBm
- Potência Óptica de Recepção: -8dBm ~ -27dBm



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Documenting Results

- Request your test results in Native Format, not

Fiber Loss Measurements:						
Date and Time of test:						
Location:						
Personel:						
Fiber	Identification	Reference Value	Measured Value	Loss	Limit	P/F
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
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24						

r only delivers results in Paper format?

ing a cloud based results management

the reference value is correct and

rify the known good leg?

- Deliver the results today, not in a month
  - While your team still has access to the site

In Conclusion

- PON or POL is a valid alternative to pure copper networks
- Many niche markets are appearing
  - Hospitals
  - Hotels
  - Government
- Follow best practices for loss testing
  - One Jumper reference, accurate loss budget
- OTDRs can be used for Troubleshooting
  - Clean the fibers before you connect them!

Thank you, Gracias, Obrigado

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