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Using and Characterizing Bend-Insensitive Multimode Fiber in Data Centers

Tony Irujo, Sales Engineer

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Agenda

- Quick Review of Bend-Insensitive Multimode Fiber (BIMMF)
  - Definition
  - Benefits
  - How it works

- Considerations for Testing BIMMF Links

BIMMF – Quick Review

Standard vs. Bend-Insensitive Multimode Fiber – Macrobend Specifications

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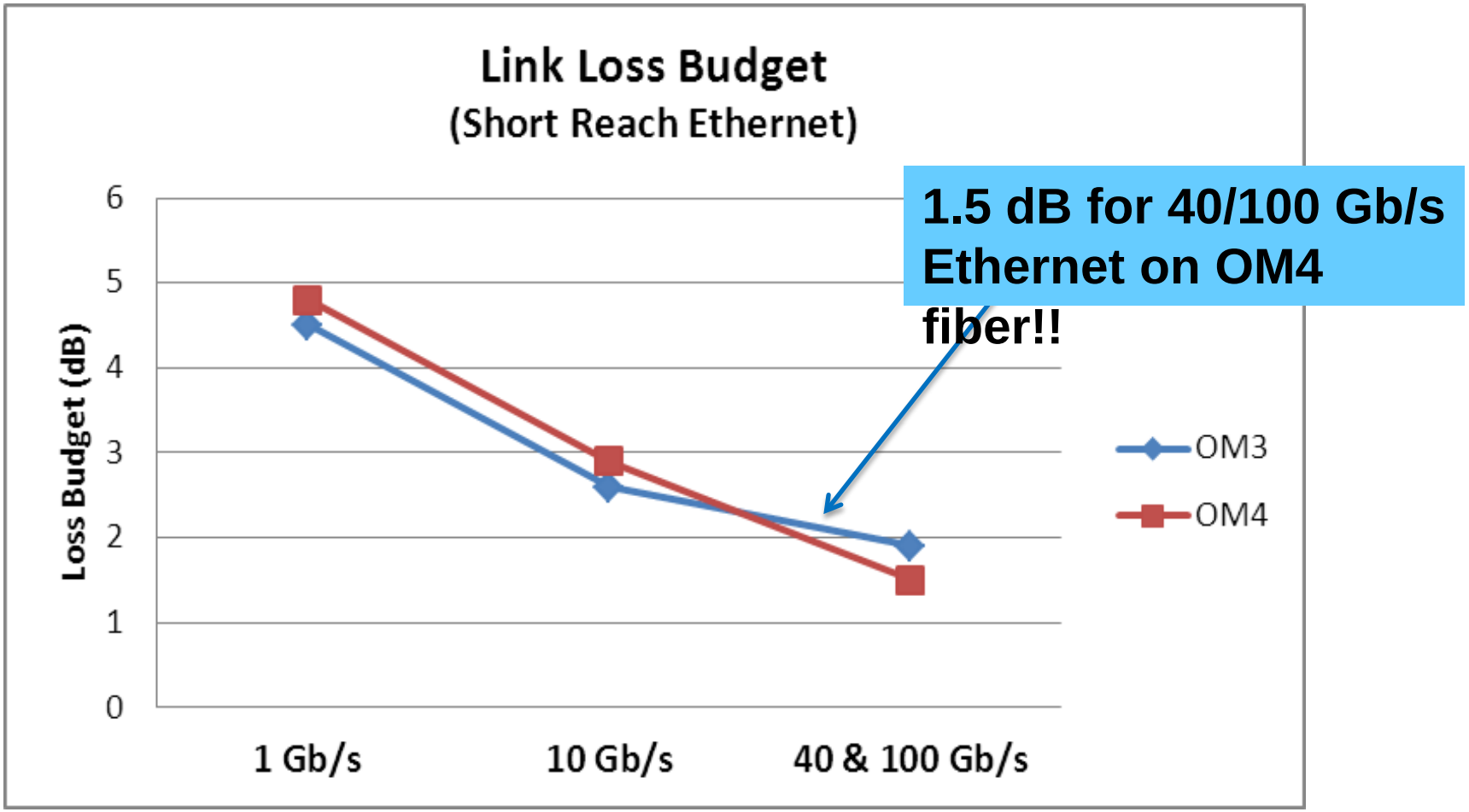
Macrobend Test	Diameter	Standard 50/125 fiber	Bend Insensitive Multimode Fiber
100 turns 37.5 mm radius	 36.8 mm radius Baseball	850 nm d 0.5dB 1300 nm d 0.5dB	850 nm d 0.5dB 1300 nm d 0.5dB
2 turns 15 mm radius	 22.4 mm radius Golf Ball	850 nm d 1.0dB 1300 nm d 1.0dB	850 nm d 0.1dB 1300 nm d 0.3dB
2 turns 7.5 mm radius	 9.0 mm radius Dime	NOT DEFINED	850 nm d 0.2dB 1300 nm d 0.5dB

Benefits of Bend-Insensitive Multimode Fiber

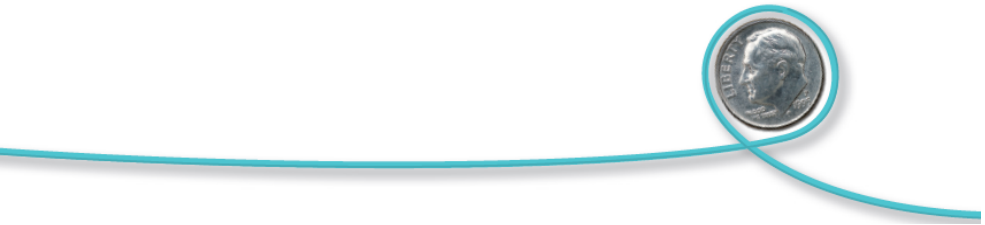
- BIMMF provides an opportunity to re-design cable management for improved space efficiency
- Denser, more compact trays and shelves improve airflow and cooling in data center racks and cabinets
- Smaller bend radii allow shorter distances between an adapter faceplate and door front.
- BIMMF provides relief from strict cable management policies for standard multimode fiber, *but bend radius control and good installation and routing practices* must not *be abandoned!*

Multimode Channel Insertion Loss Budgets Declining

- Increasingly tight system attenuation requirements!

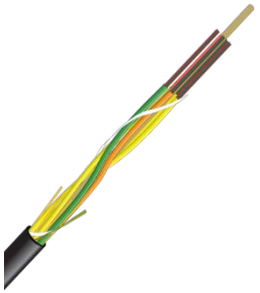


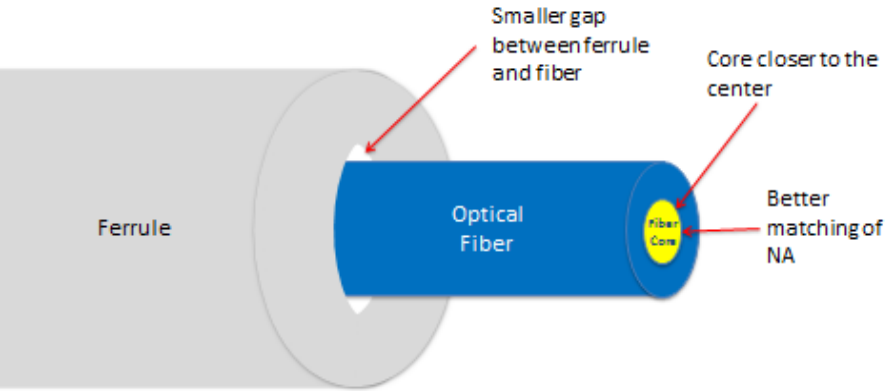
Improving Channel Insertion Loss



Improved Macrobend Performance
(Lower Bend Loss)

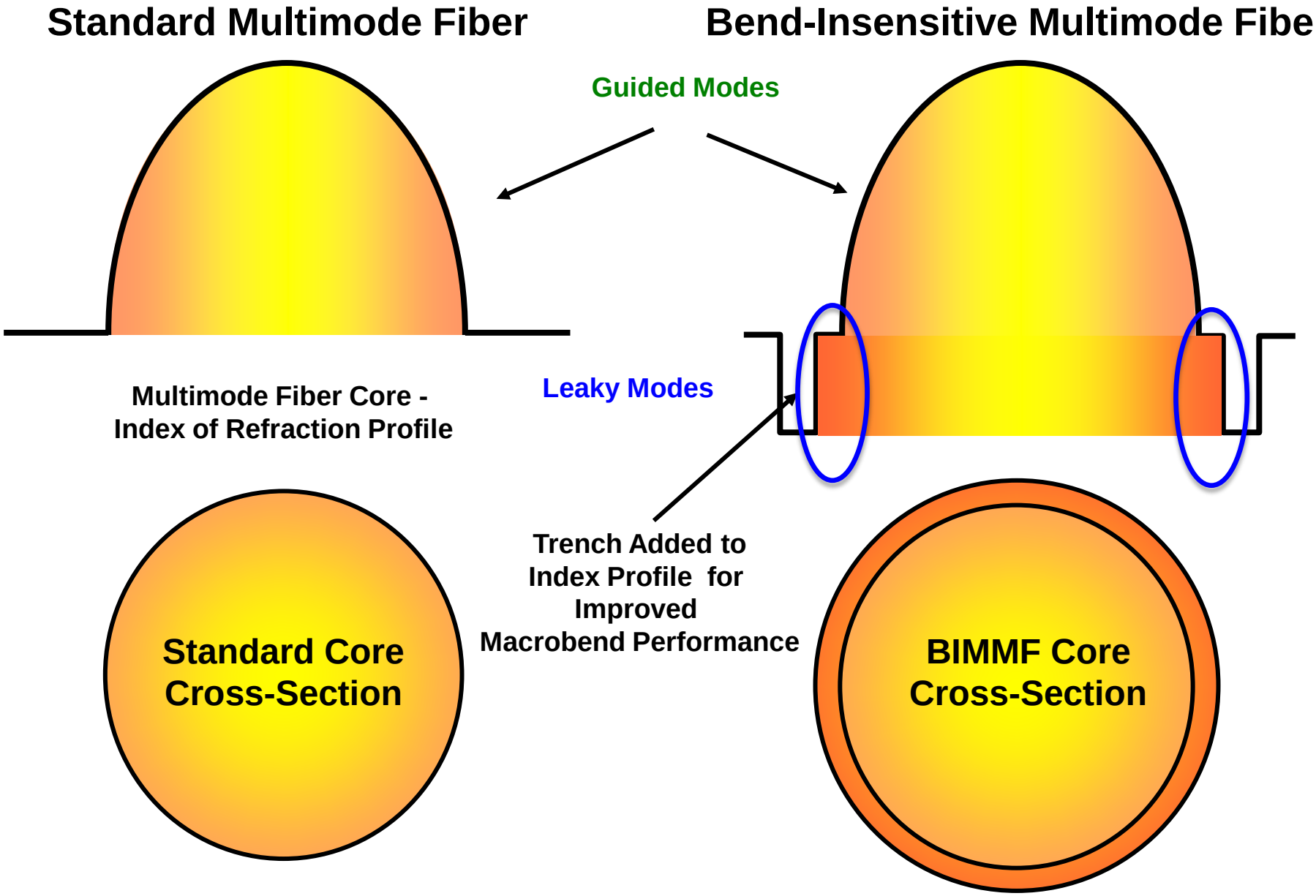
Lower fiber attenuation for lower cable attenuation





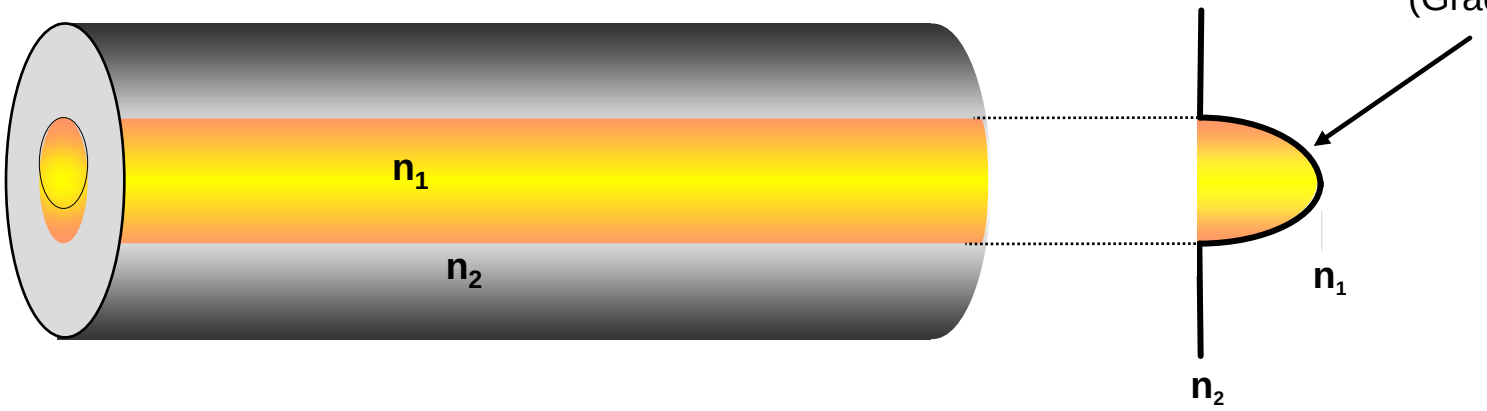
Tighter geometries to lower connection loss

What Makes BIMMF Bend-Insensitive?



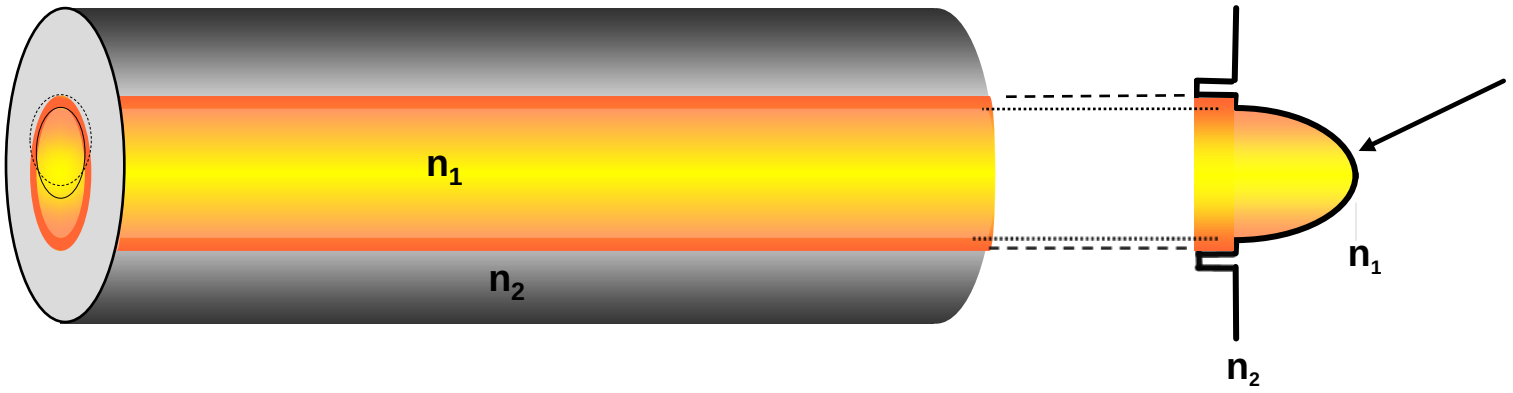
What Makes BIMMF Bend-Insensitive?

Standard Multimode Fiber



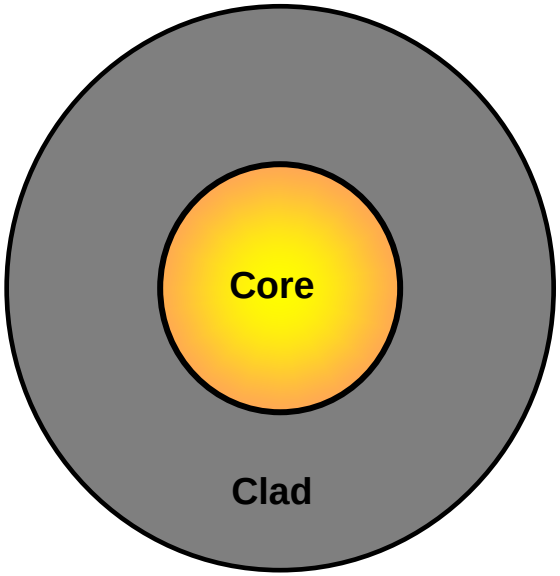
Index Profile
(Graded Index)

Bend-Insensitive Multimode Fiber



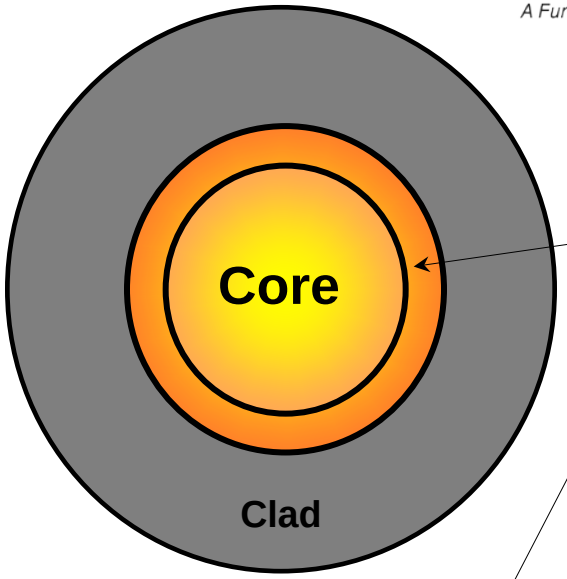
Index Profile
(Graded Index, with trench)

Standard Multimode Fiber and BIMMF Fiber Appearance

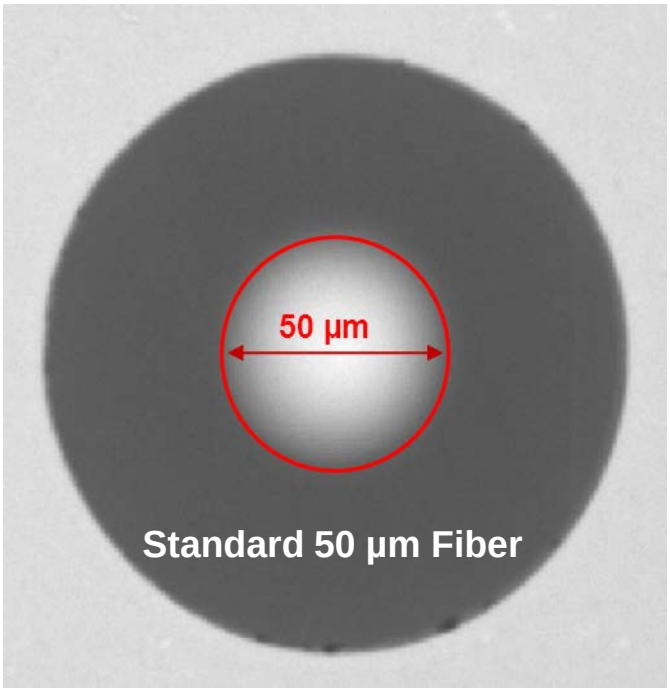


“Halo” provides a visual indicator of BIMMF

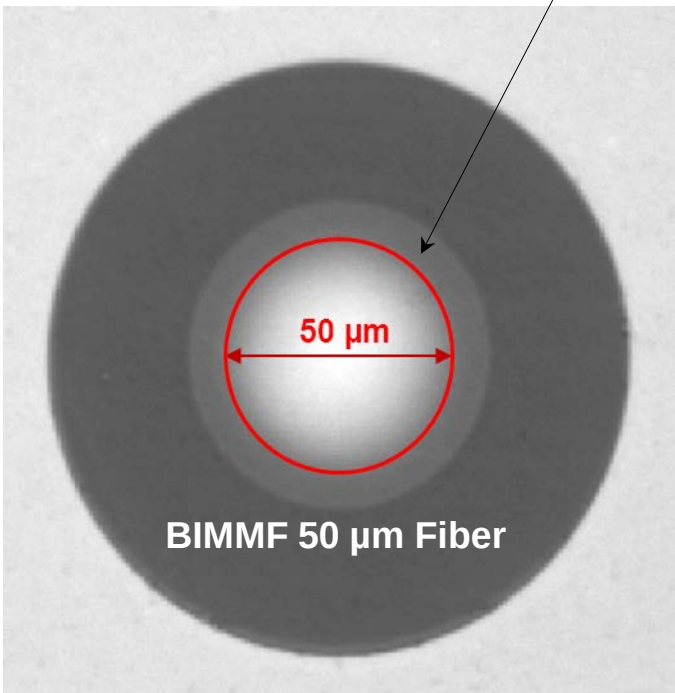
A properly designed BIMMF trench has no effect on system performance!



BIMMF “Halo”



Connector End Face Photographs Of Standard Fiber and BIMMF



Identification of BIMMF

Method 2: Read the Jacket Printing

Identification of BIMMF

Method 3: Test the Jumper

- Two turns around a 10 mm radius mandrill
- Attenuation less than 0.2 dB → Bend insensitive Multimode Fiber
- Attenuation greater than 0.2 dB → Standard Multimode Fiber

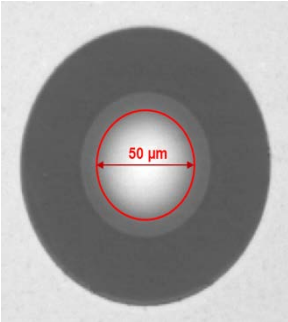
This method is the best way to validate if a jumper is bend insensitive.

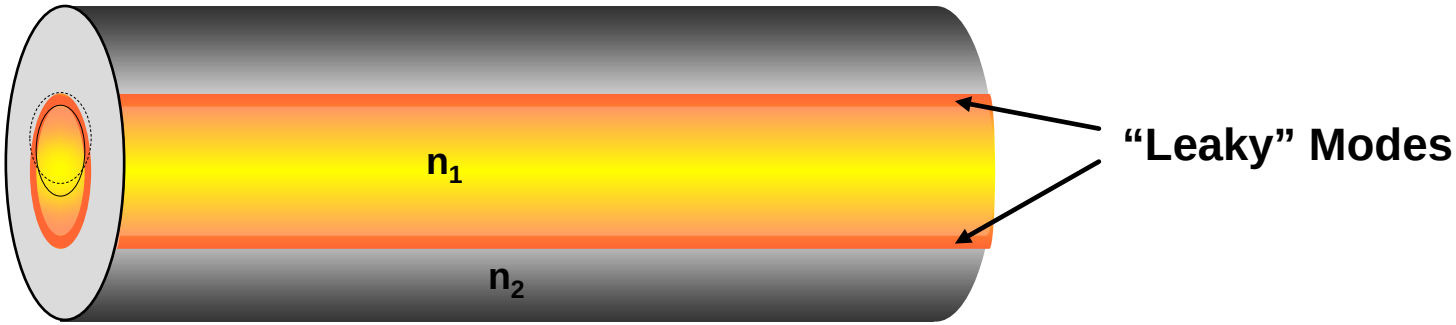
Testing BIMMF Links

Use Encircled Flux Compliant Launch (EFL)

- Recommend using Encircled Flux compliant launch.

- With BIMMF, light in the “halo” region can travel 10’s of meters (leaky modes), resulting in poor characterization of performance.





- Using an EF Launch helps mitigate this effect.

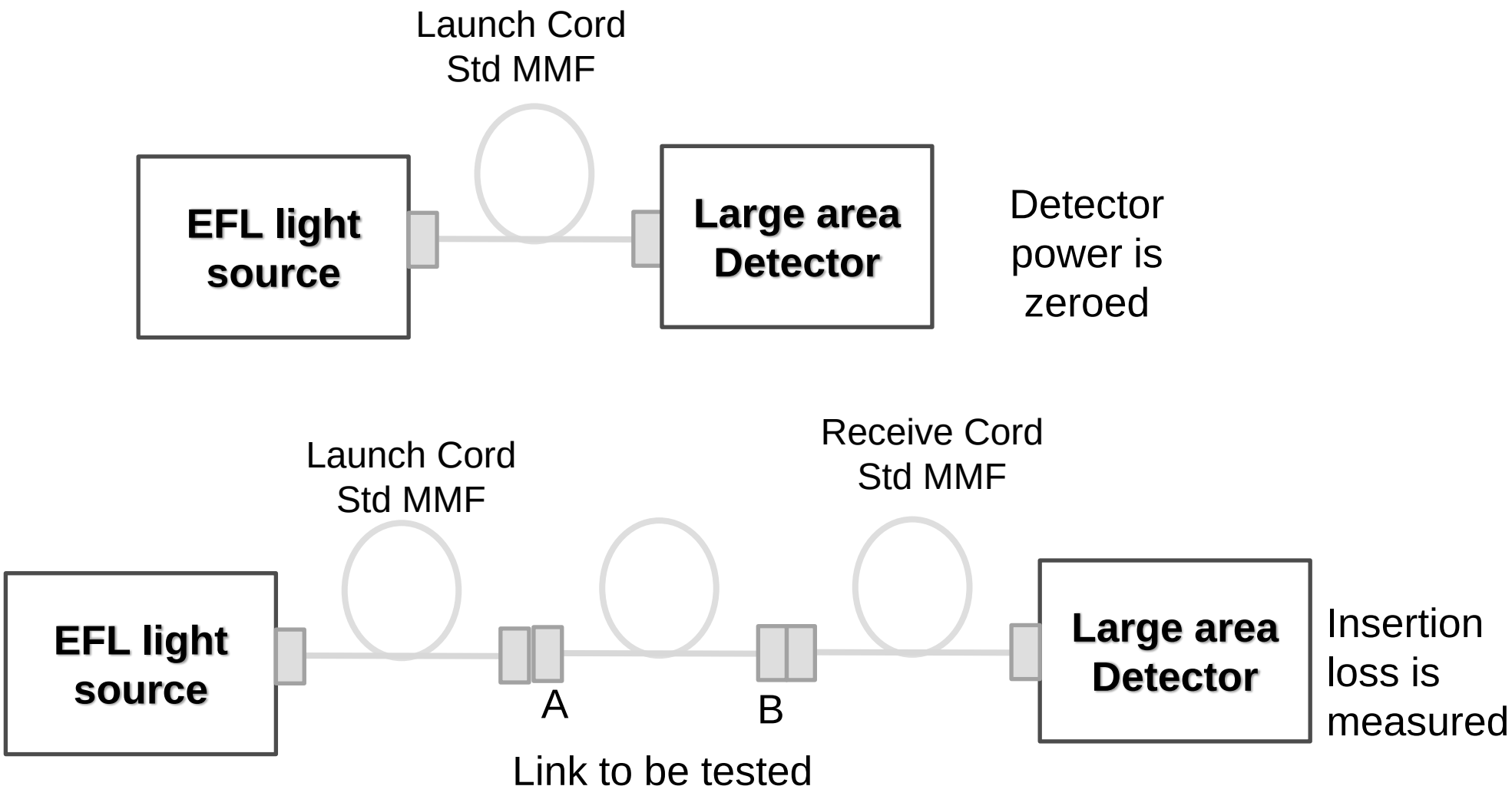
- CPR / HOM launches are better than Overfilled Launch (OFL) but not as good as EFL.

Use *non-BIMMF*, Reference Grade Test Cords

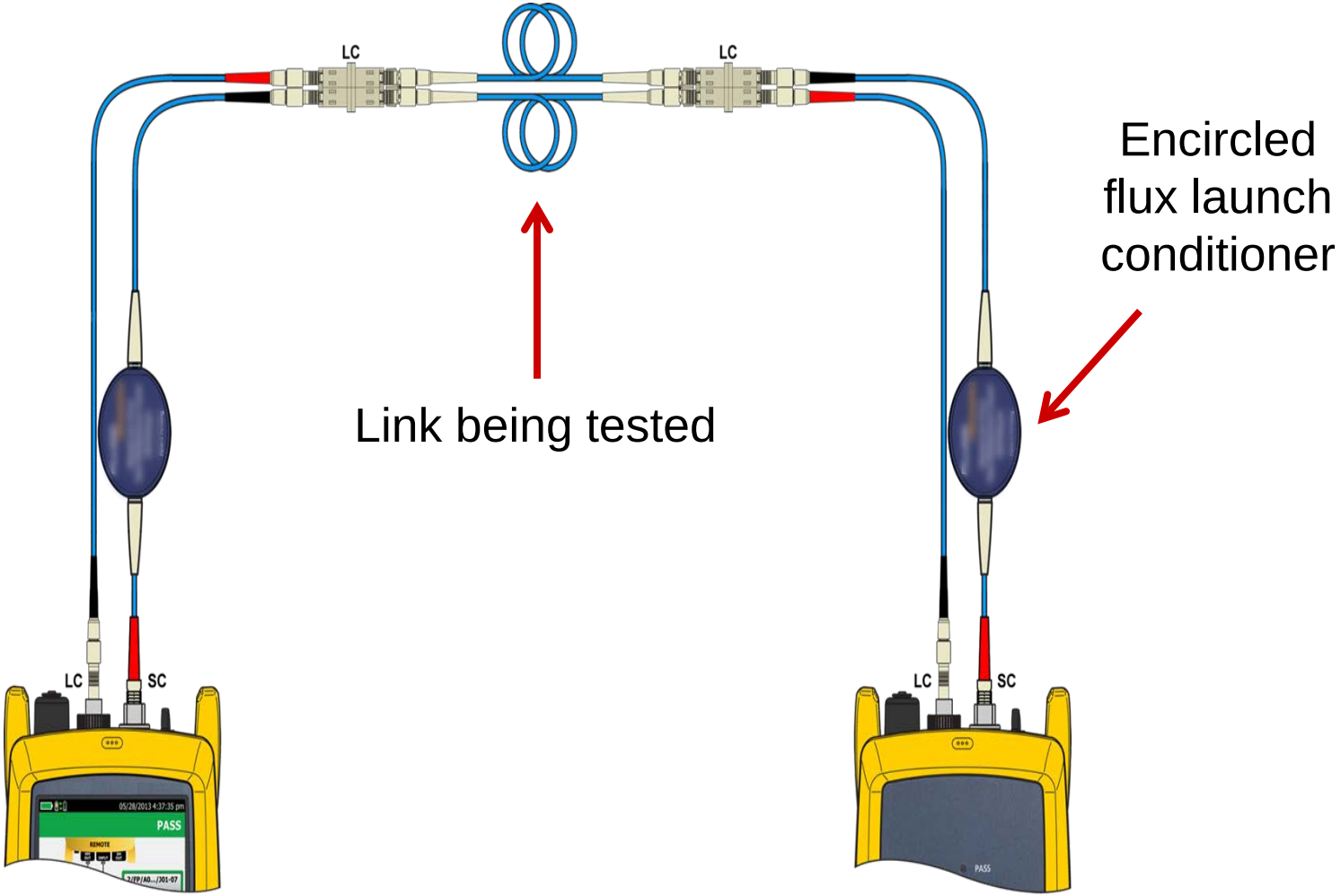
- Launch Cord
  - Using a BIMMF test lead can result in as much as 0.5 dB error in the loss measurements.
  - Reference grade cords help preserve encircled flux condition.

- Receive Cord
  - Using a BIMMF receive cord can result in ~0.1 dB error, usually overly optimistic.
  - Helps filter any leaky modes that may result in measurement errors.
  - Ensures that core size and NA of jumper being tested are near nominal target.

Testing BIMMF Links



Example of a Duplex Link Test



Conclusion

- BIMMF is being widely deployed.

- BIMMF provides benefit:
  - Reduced fiber management footprint.
    - (Must still adhere to bend radius control.)
  - Reduced Channel Insertion Loss.

- BIMMF interoperates seamlessly with standard MMF.

- Due to leaky modes in BIMMF, there are considerations for link testing:
  - Use Encircled Flux Launch condition.
  - Use non-BIMMF, reference-grade test leads at launch and receive.

- BIMMF standardization is nearing completion in IEC. Will then be adopted in TIA.

Thank You

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