

High Density Fiber Connection with Very Small Form Factor Connector for Over 51.2Tbps Co-Packaged Optics

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Optical Component Division
Fujikura Ltd.**

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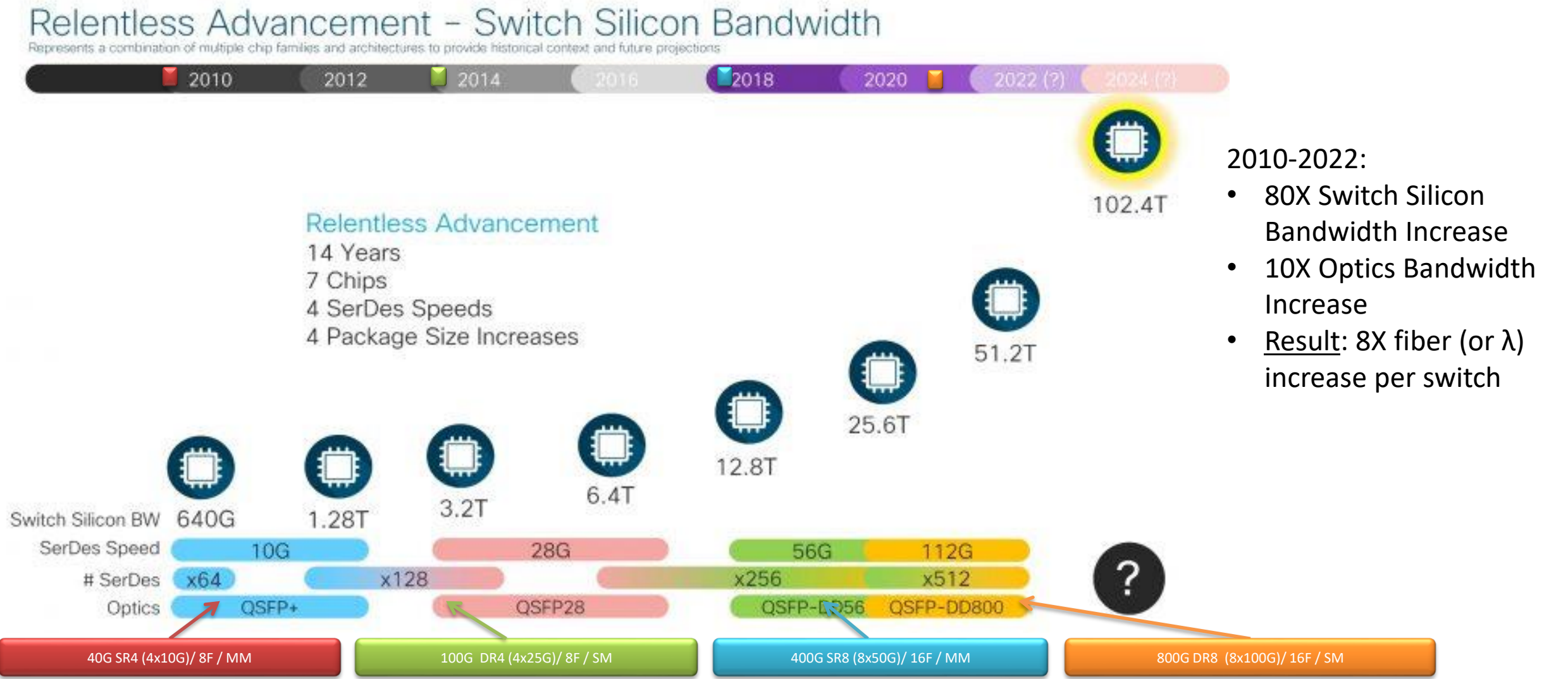
- 1. Demand of High Density Fiber Connection for CPO**
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- 3. Characteristics of MMC**
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Demand of High Density Fiber Connection for CPO

Decade of Switch Silicon, SerDes, + Parallel Optics



Source: Cisco / SP360: Service Provider /Co-Packaged Optics and an Open Ecosystem; R. Chopra
US Conec Ltd., /Optical Connectivity Considerations for Co-Packaged Optics; Tom Mitcheltree

Demand of High Density Fiber Connection for CPO

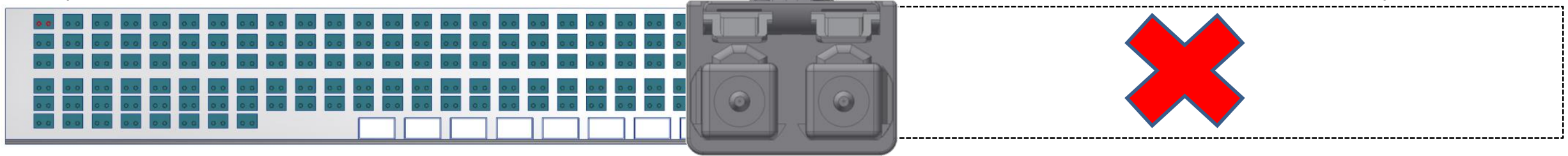
Front Panel Density Considerations: 1st Gen - 51.2TB CPO

FR 256f

DR 1024f

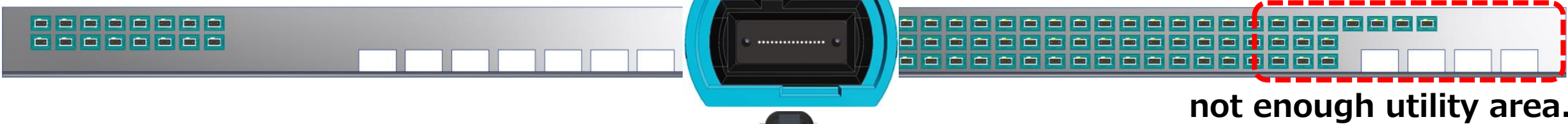
128 Duplex LC's → 2RU

512 Duplex LC's → 8RU??



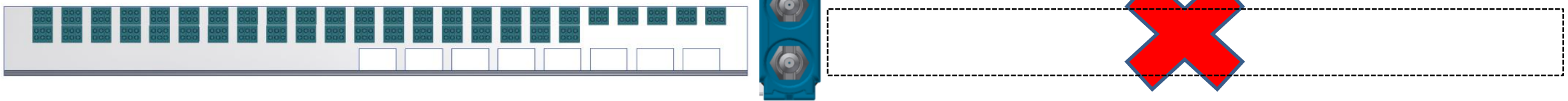
16 MPO-16's → 1RU

64 MPO-16's → 1RU



128 MDC's → 1RU

512 MDC's → 2-3RU??



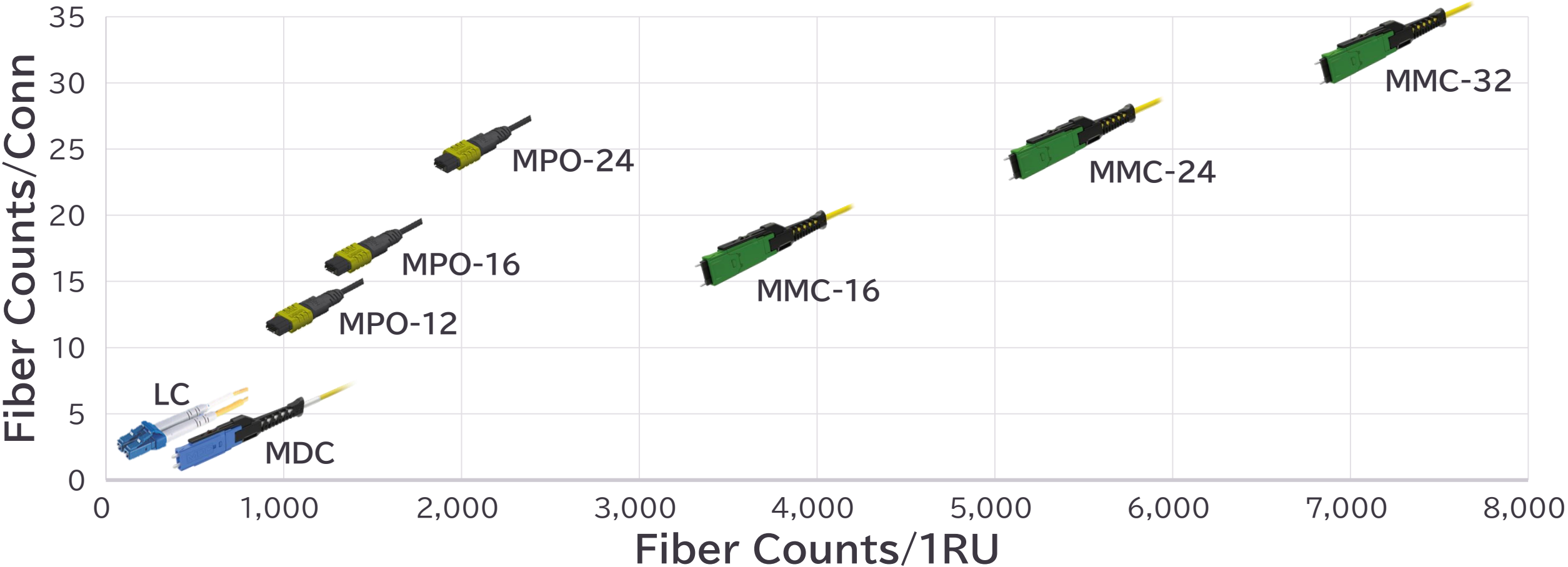
16 MMC-16's → 1RU

64 MMC-16's → 1RU



Demand of High Density Fiber Connection for CPO

Connector Type	DxLC	MDC	MPO-12	MPO-16	MPO-24	MMC-16	MMC-24	MMC-32
Fiber Counts/Conn	2	2	12	16	24	16	24	32
Fiber Counts/1RU	144	432	960	1,280	2,560	3,456	5,184	6,912

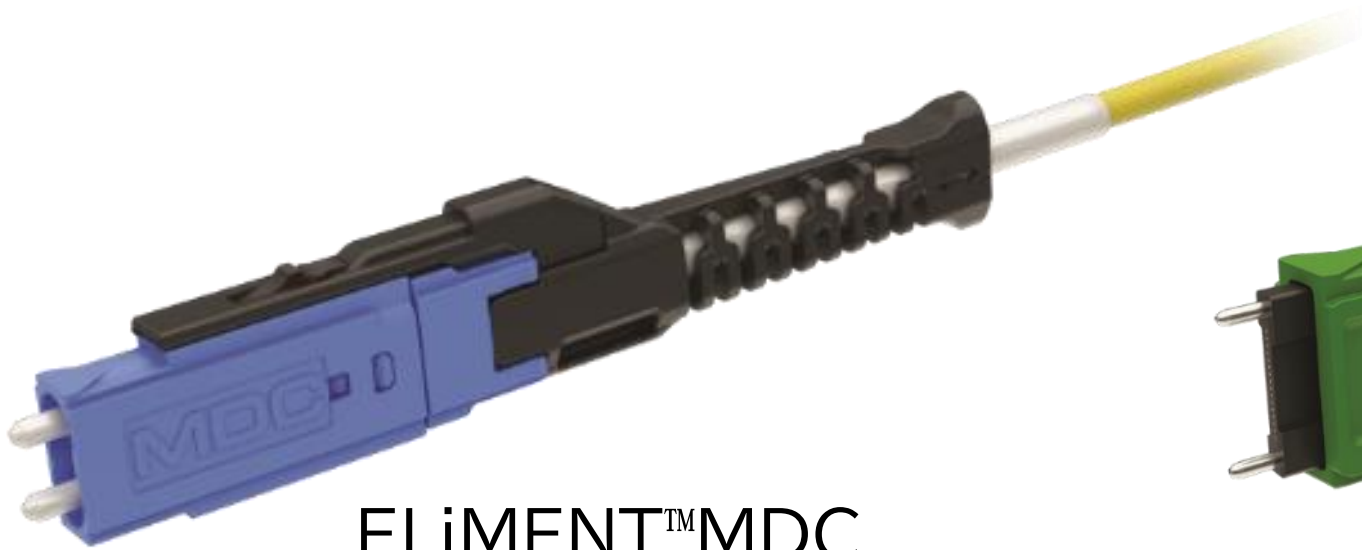


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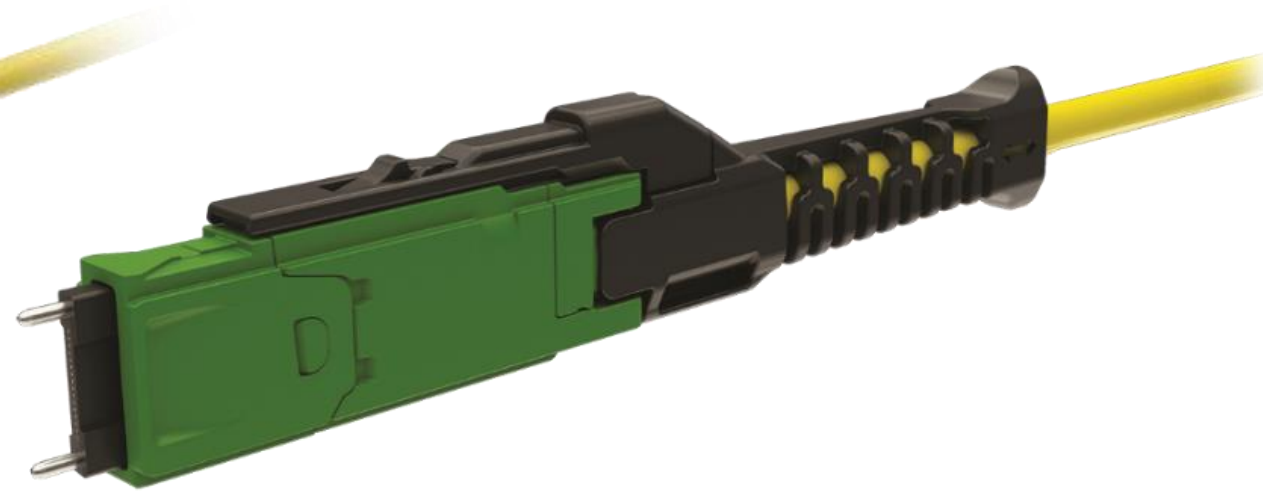
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Very Small Form Factor Connector

- ✓ USConec and Fujikura collaborate to develop next generation miniature optical connector (MMC/MDC) solutions



ELiMENT™ MDC



Mini-Multi-Connector

[ELiMENT™, a trademark of US Conec Ltd.](#)

Very Small Form Factor Connector

DirectConec™ push-pull boot for easy connector insertion and removal

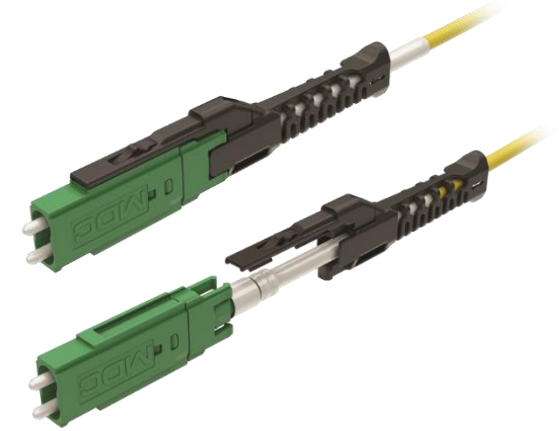


Optical Cable Outer Diameter
Max. 2.0 mm

SMF, MMF
APC polishing support

- **QSFP-DD/SFP-DD/OSFP MSA specified optical interface**
- **Complies with IEC standard insertion loss class B (max. value 0.25 dB @ $\geq 97\%$)**
- **Compliant with Telcordia GR-326 and TIA-568**
- **One-Click® for MDC/IBC™ Optical connector cleaner**

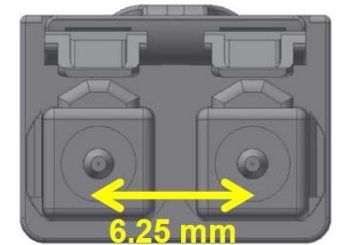
[ELiMENT™, a trademark of US Conec Ltd.](#)



No exposed optical fiber
Easy polarity conversion



ELiMent™ MDC

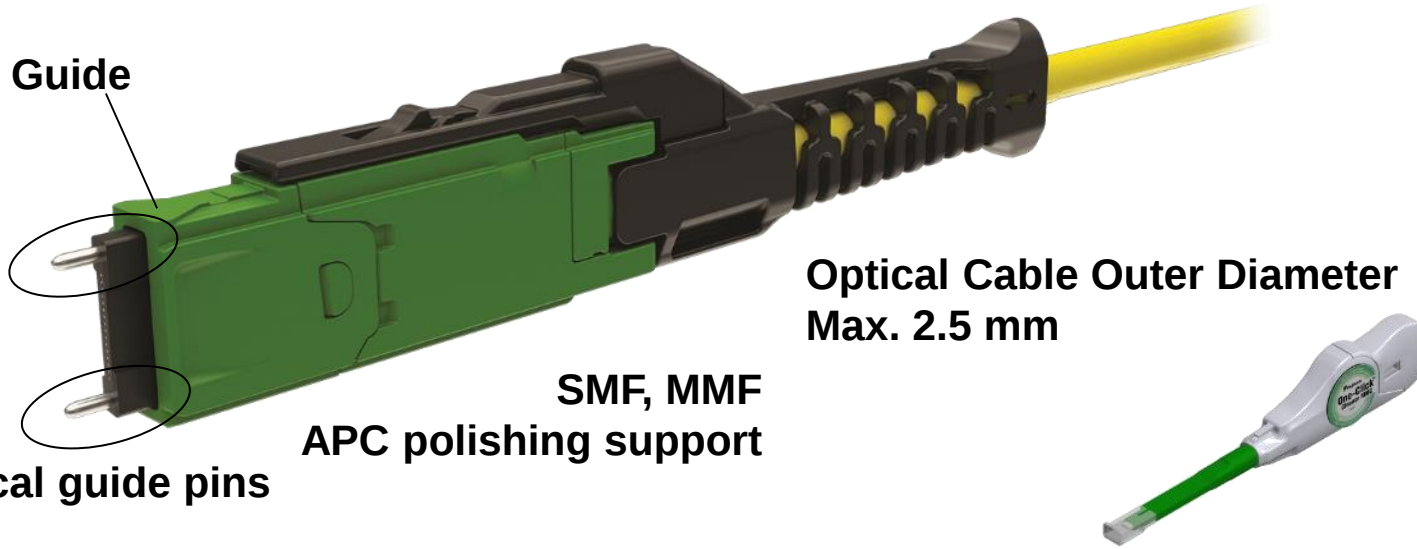


Duplex LC

**3x cabling port density over
the Duplex LC connector**

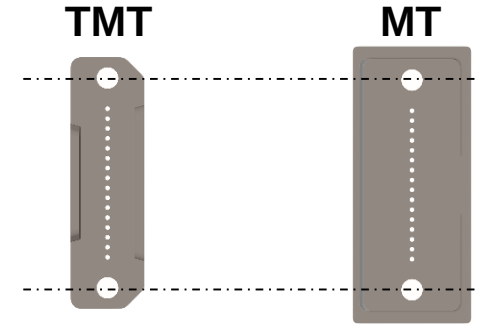
Very Small Form Factor Connector

DirectConec™ push-pull boot for easy connector insertion and removal

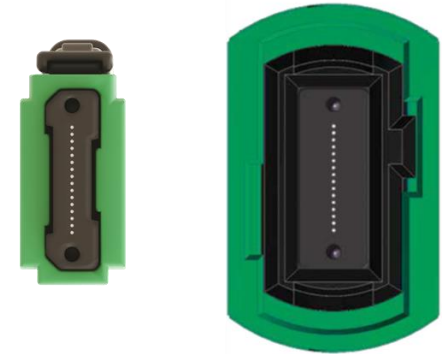


Optical Cable Outer Diameter
Max. 2.5 mm

- Low-loss, IEC Grade B insertion loss performance
- Compliant with Telcordia GR-1435 (expected)
- Standard cabling industry infrastructure support including IBC™/One-Click™ **cleaners, polishers, interferometers, and optical testing equipment**



- Proven conventional MT mechanical and fiber alignment structure
- Compatible with standard 250 micron OD and pitch optical fibers



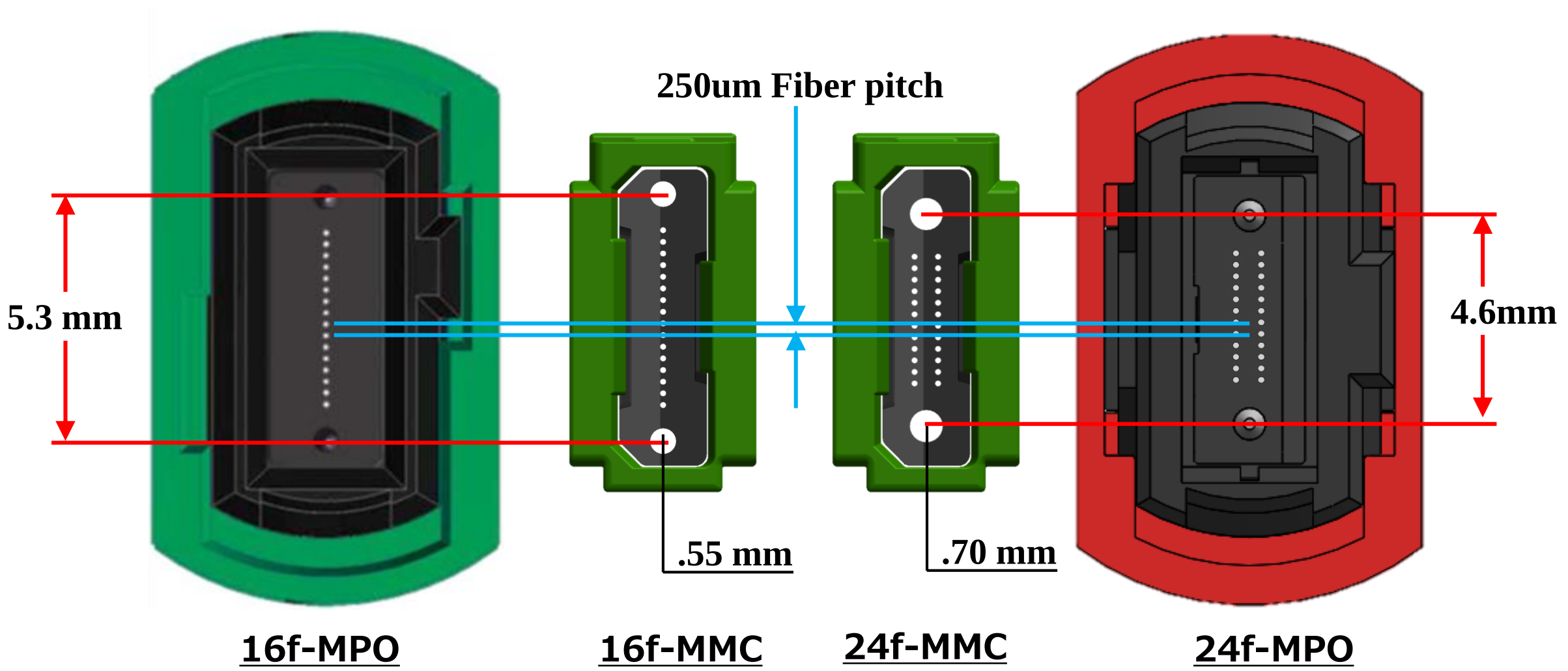
MMC

MPO

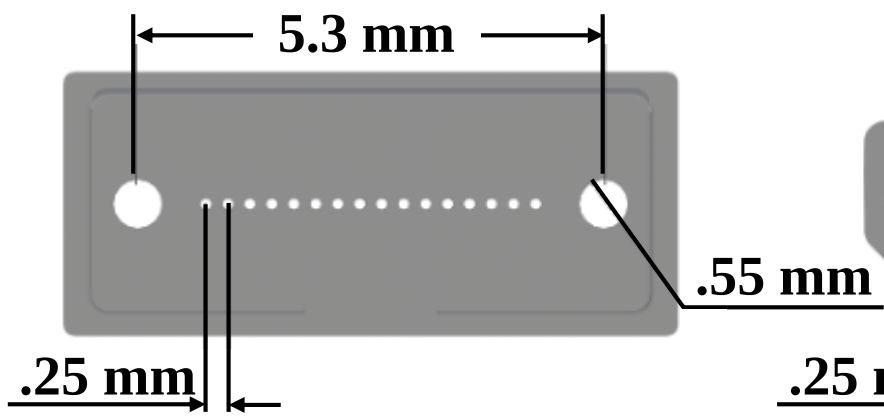
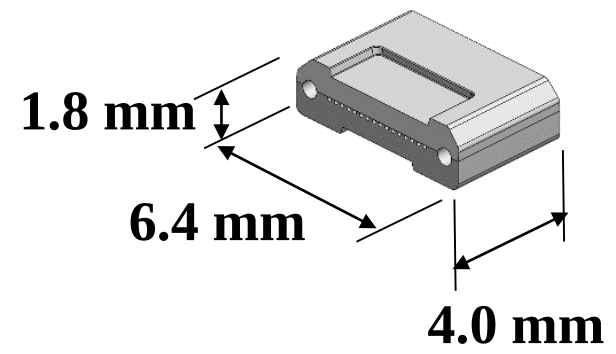
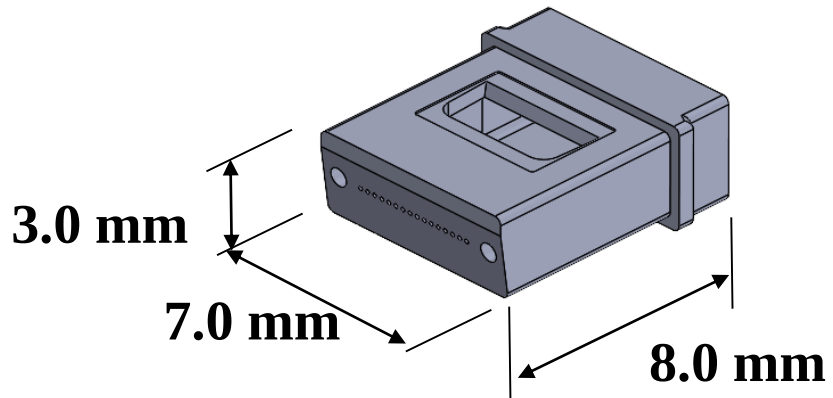
3x cabling port density over the MPO format

Very Small Form Factor Connector

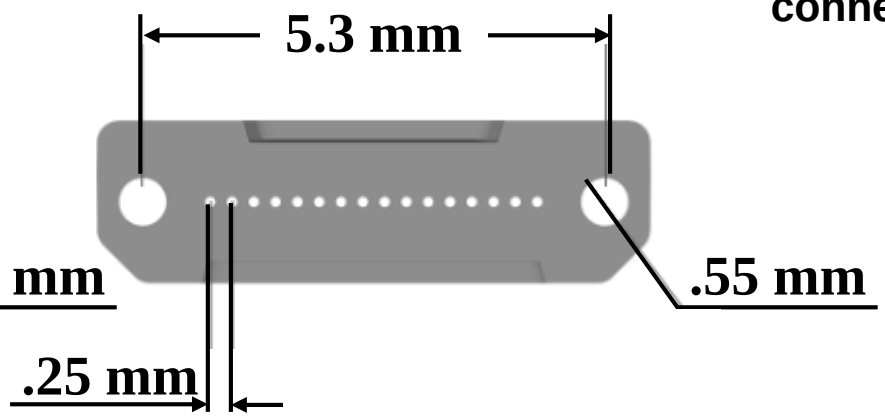
➤ MMC was designed to be fully compatible pin and fiber alignment with MPO format



Very Small Form Factor Connector

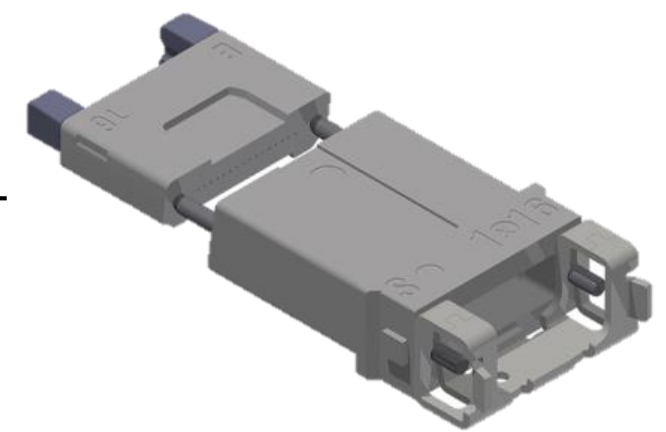


MT ferrule



TMT ferrule

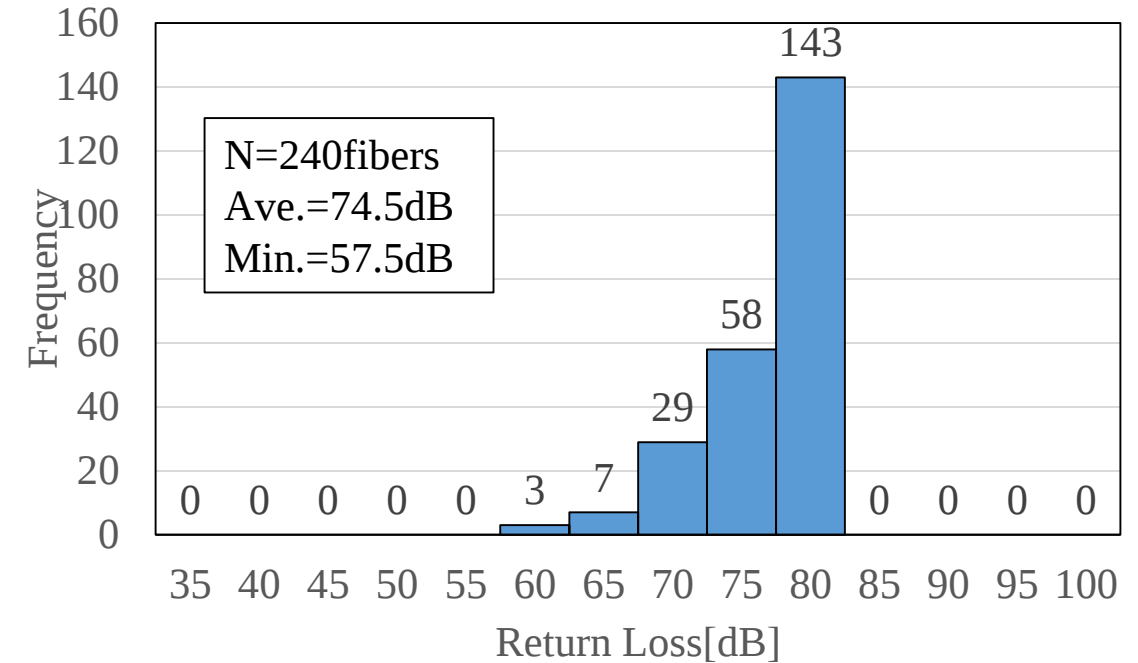
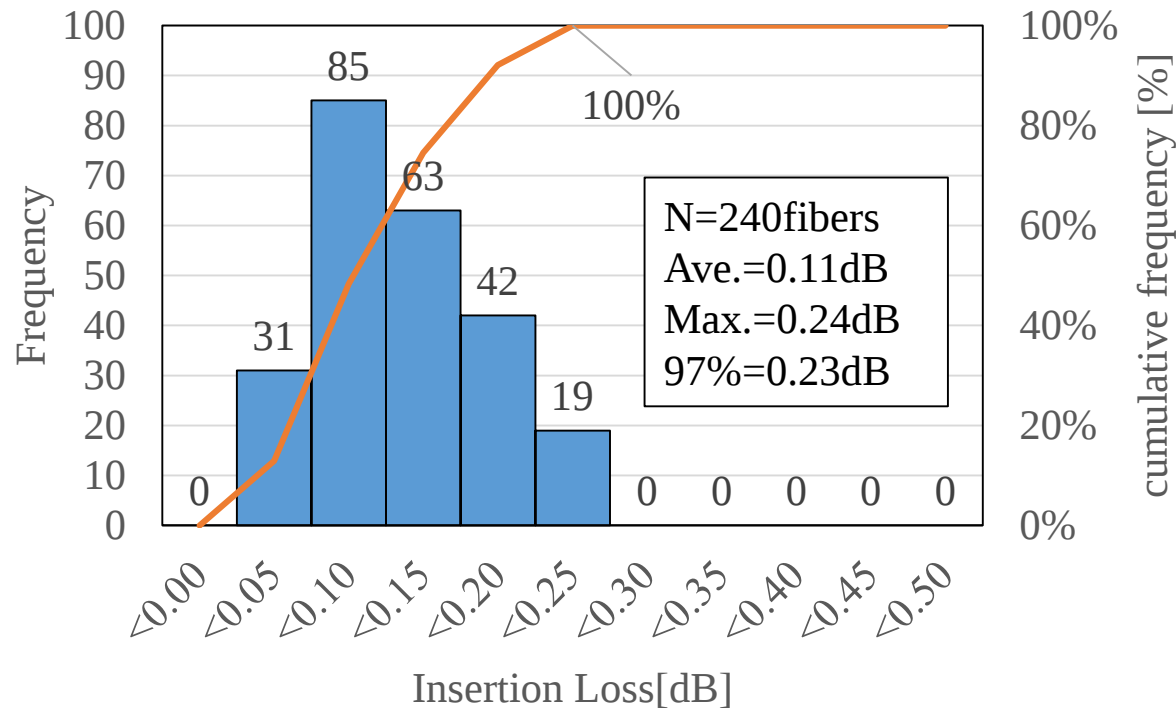
- Proven alignment structure of MT-16 and Intermateable with MT-16 technology
- 16 fibers at 250 micron pitch.
- Compatible with 250, 200, and 165 micron fibers.
- Ideal for on-board fiber management, as well as transceivers and hardened connector embodiments.



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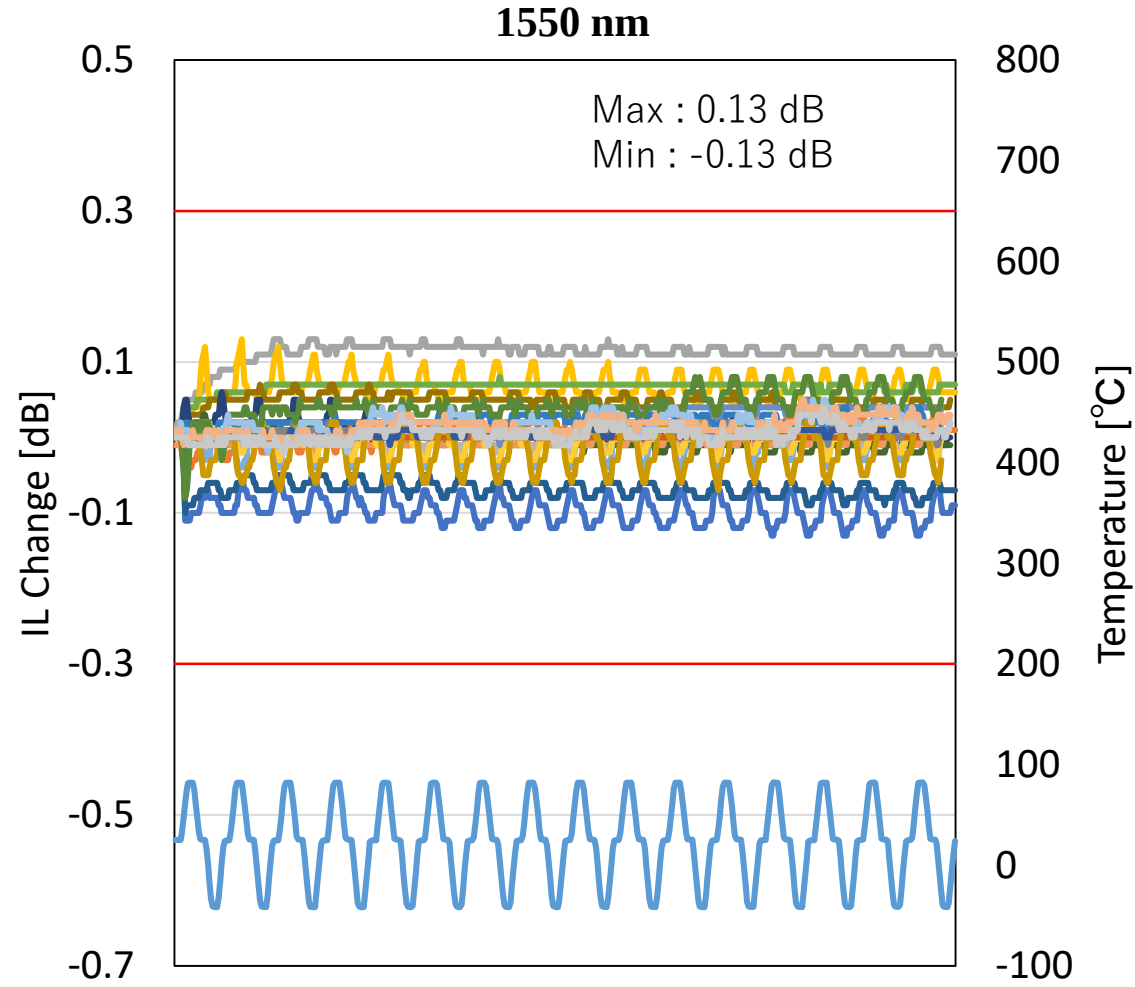
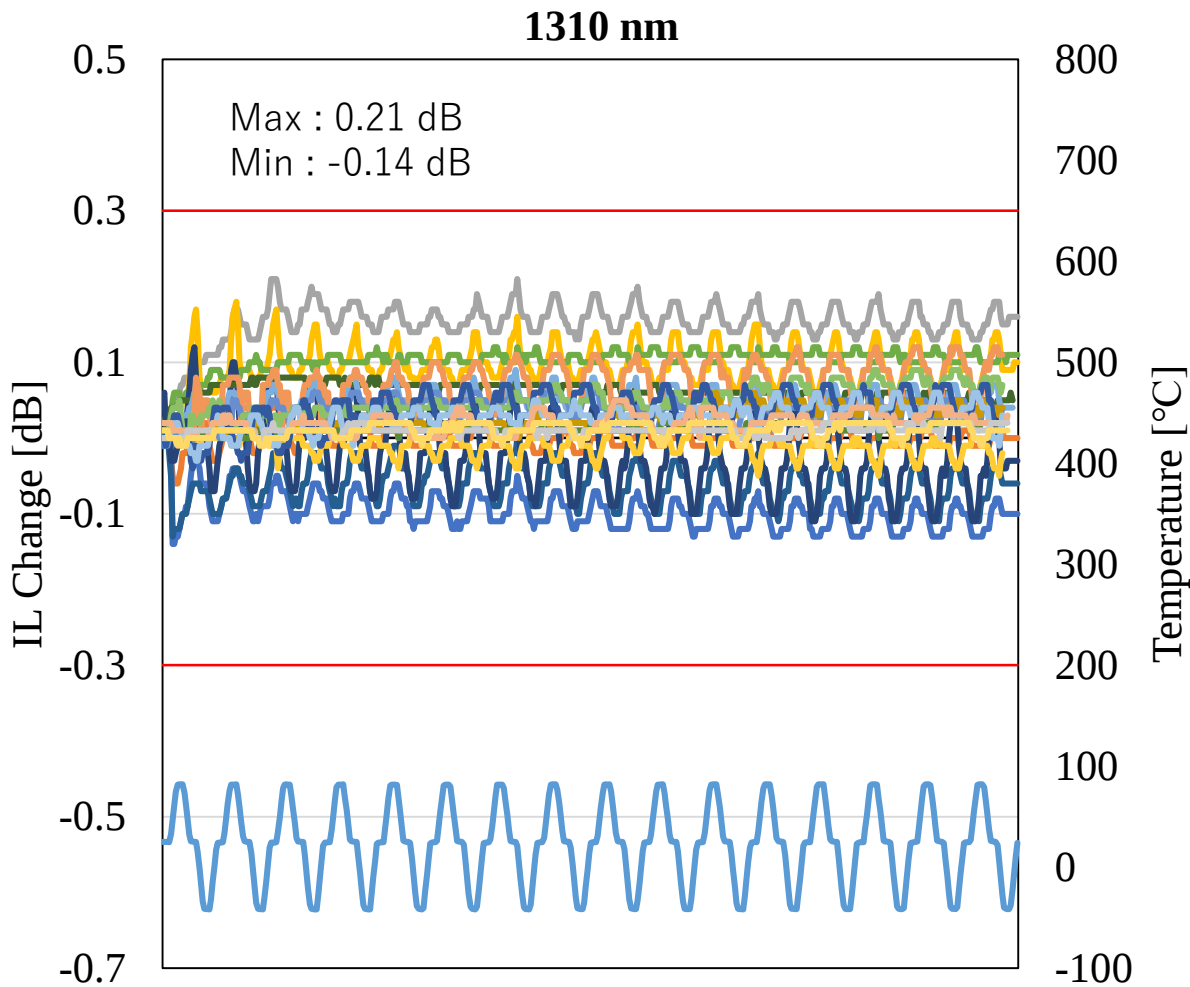
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Optical performance 1x16 MMC, 1310nm



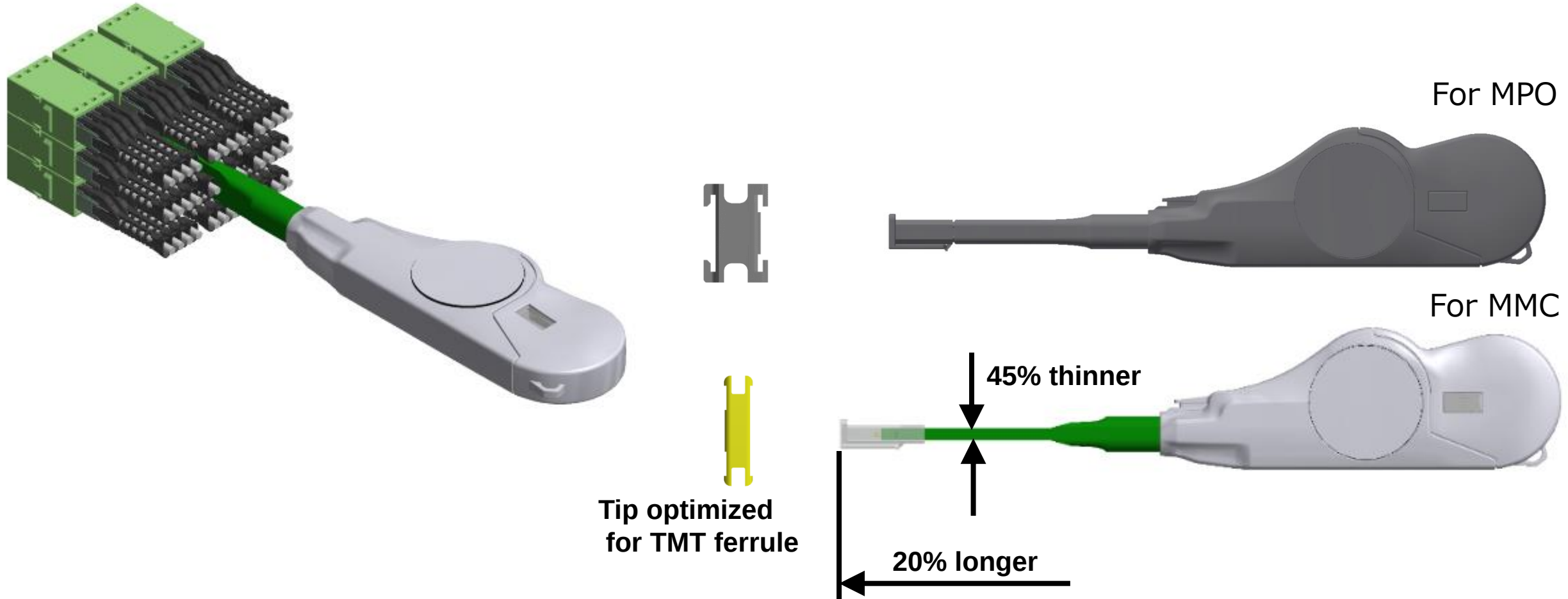
- N ...Sample size of fibers
- Ave. ...Average of all IL and RL measurements
- Max. ...Maximum value of all IL measurements
- <97%. ...Value that ranks 97% in the IL measurement data sorted from the smallest to the largest
- Min. ...Minimum value of all RL measurements

Environmental Testing



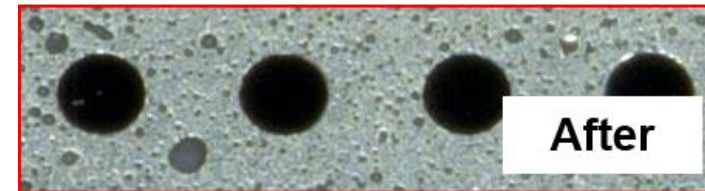
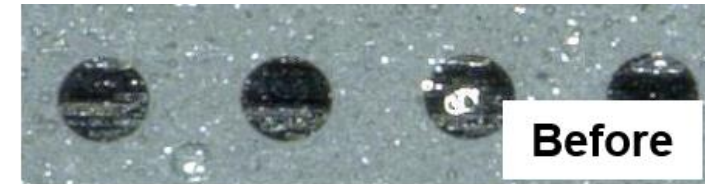
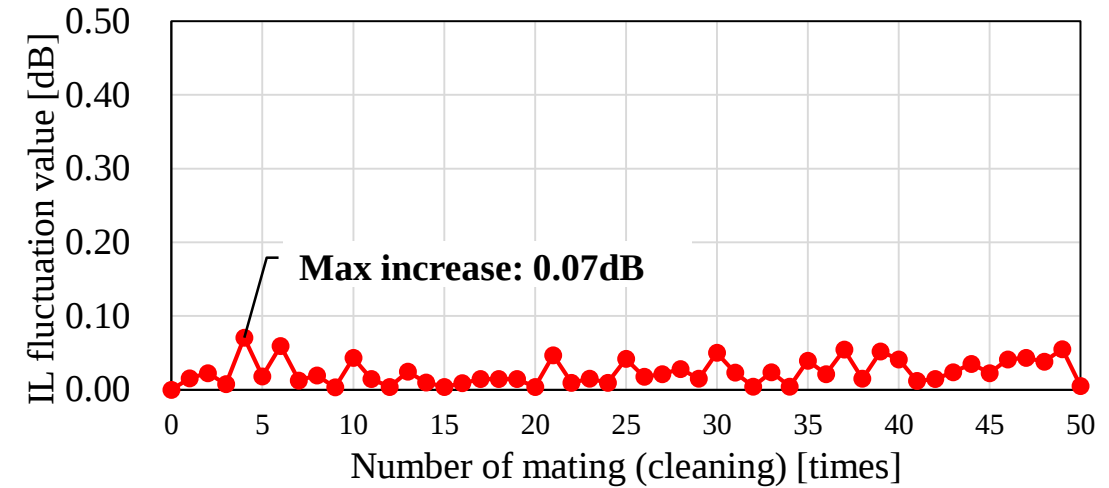
Structure and Design : MMC Cleaner

- The MMC Cleaner is designed to clean high-density connectors one port

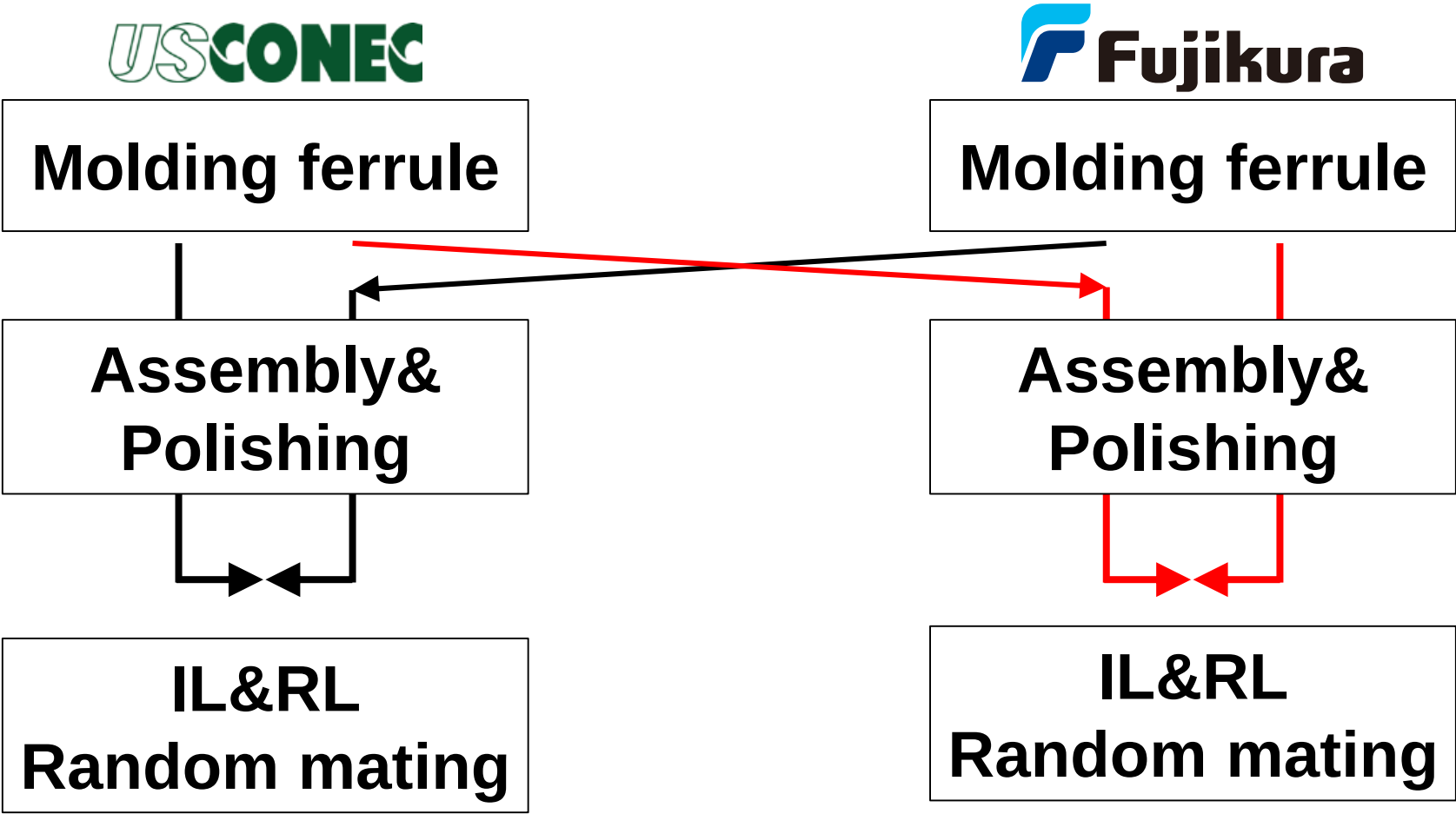


Mechanical Testing

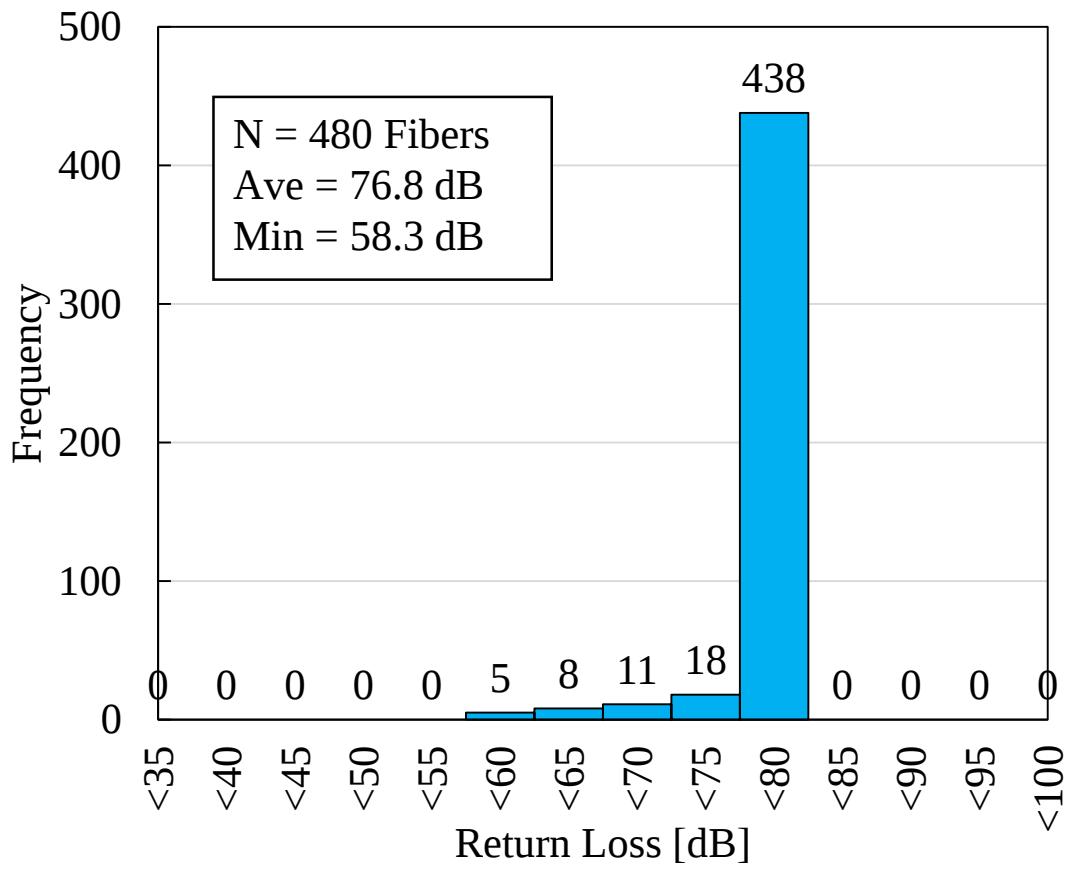
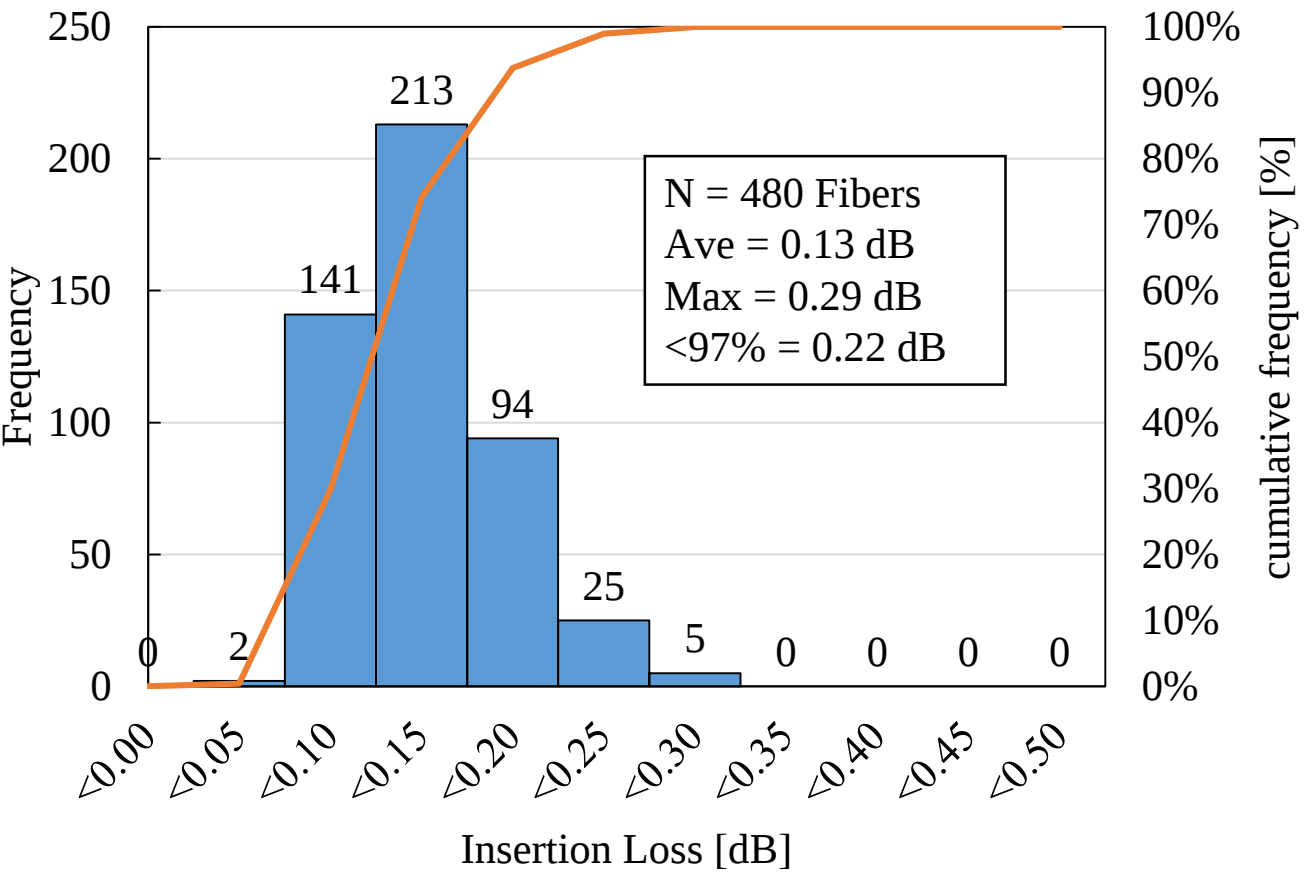
Test		Criteria	Results
Vibration		$IL \leq 0.8 \text{ dB}$ $IL \text{ change} \leq 0.3 \text{ dB}$ $RL \geq 50 \text{ dB}$	$IL \leq 0.35 \text{ dB}$ $IL \text{ change} \leq 0.25 \text{ dB}$ $RL \geq 55.3 \text{ dB}$
Flex		$IL \leq 0.8 \text{ dB}$ $IL \text{ change} \leq 0.3 \text{ dB}$ $RL \geq 50 \text{ dB}$	$IL \leq 0.51 \text{ dB}$ $IL \text{ change} \leq 0.16 \text{ dB}$ $RL \geq 56.4 \text{ dB}$
Twist		$IL \leq 0.8 \text{ dB}$ $IL \text{ change} \leq 0.3 \text{ dB}$ $RL \geq 50 \text{ dB}$	$IL \leq 0.50 \text{ dB}$ $IL \text{ change} \leq 0.01 \text{ dB}$ $RL \geq 56.3 \text{ dB}$
Transmission with Applied Load	Measure w/Load (0deg)	- After test $IL \leq 0.8 \text{ dB}$ $IL \text{ change} \leq 0.3 \text{ dB}$ $RL \geq 50 \text{ dB}$ - During Applied Load $IL \text{ change} \leq 0.5 \text{ dB}$ $RL \geq 50 \text{ dB}$	- After test $IL \leq 0.50 \text{ dB}$ $IL \text{ change} \leq 0.08 \text{ dB}$ $RL \geq 66.3 \text{ dB}$ - During Applied Load $IL \text{ change} \leq 0.09 \text{ dB}$ $RL \geq 66.4 \text{ dB}$
	Measure w/Load (90deg)	- After test $IL \leq 0.8 \text{ dB}$ $IL \text{ change} \leq 0.3 \text{ dB}$ $RL \geq 50 \text{ dB}$ - During Applied Load $IL \text{ change} \leq 0.5 \text{ dB}$ $RL \geq 50 \text{ dB}$	- After test $IL \leq 0.59 \text{ dB}$ $IL \text{ change} \leq 0.09 \text{ dB}$ $RL \geq 66.6 \text{ dB}$ - During Applied Load $IL \text{ change} \leq 0.04 \text{ dB}$ $RL \geq 66.2 \text{ dB}$
Impact		$IL \leq 0.8 \text{ dB}$ $IL \text{ change} \leq 0.3 \text{ dB}$ $RL \geq 50 \text{ dB}$	$IL \leq 0.58 \text{ dB}$ $IL \text{ change} \leq 0.16 \text{ dB}$ $RL \geq 62.1$
Durability		$IL \leq 0.8 \text{ dB}$ $IL \text{ change} \leq 0.3 \text{ dB}$ $RL \geq 50 \text{ dB}$	$IL \leq 0.18 \text{ dB}$ $IL \text{ change} \leq 0.07 \text{ dB}$ $RL \geq 68.1$



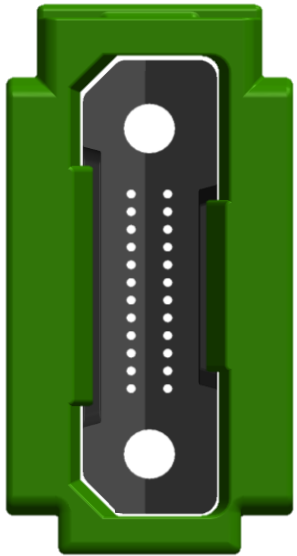
Intermateability - condition



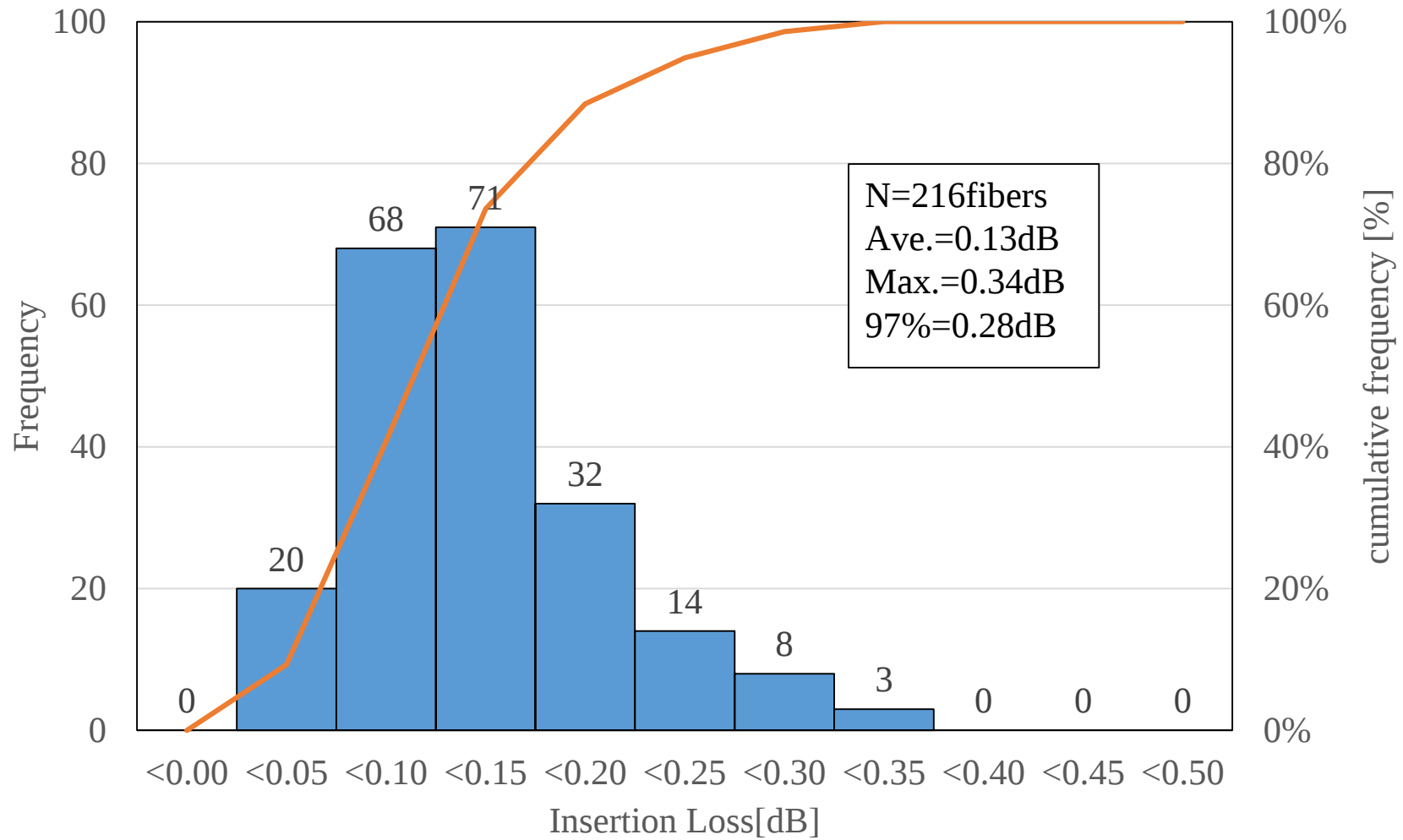
Intermateability - Results



Preliminary 2-row MMC results



24f-MMC

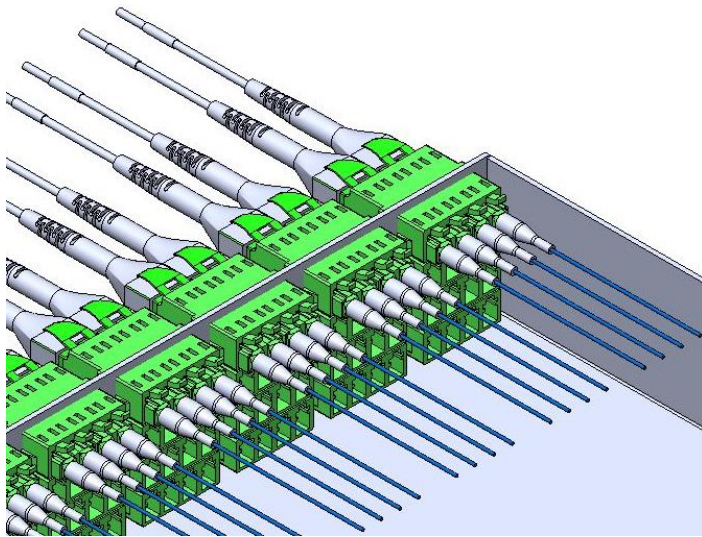


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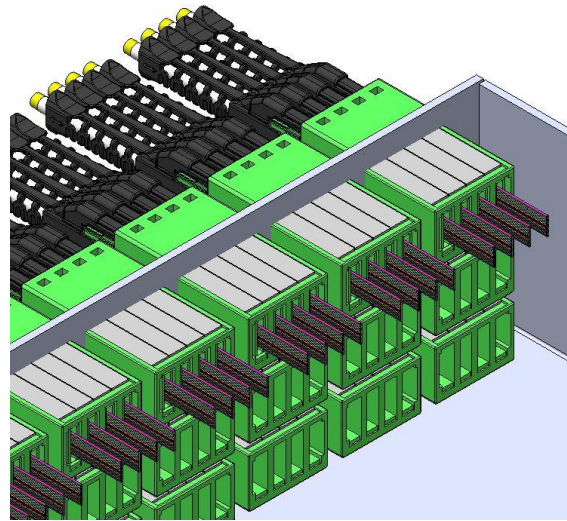
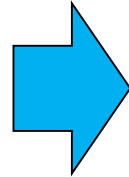
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MMC Jr. (Inside Box) and Bundled Connector (Patch)

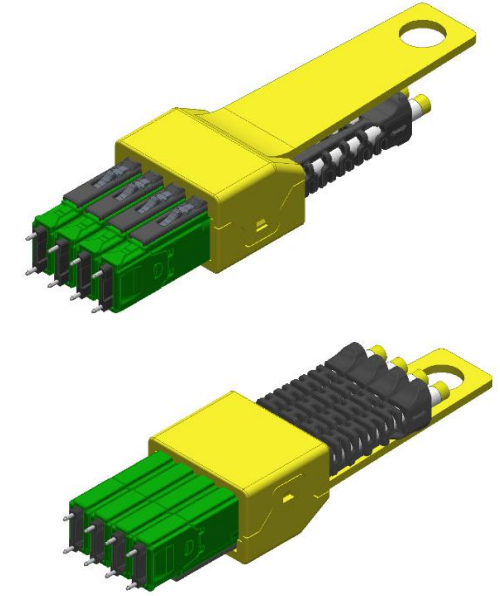
- ✓ Much more fiber density inside box application compare with LCs or MPOs
- ✓ More room to manage fibers inside box
- ✓ Bundled MMC connector for easy to operate outside box patching



Conventional LC



MMC Jr.

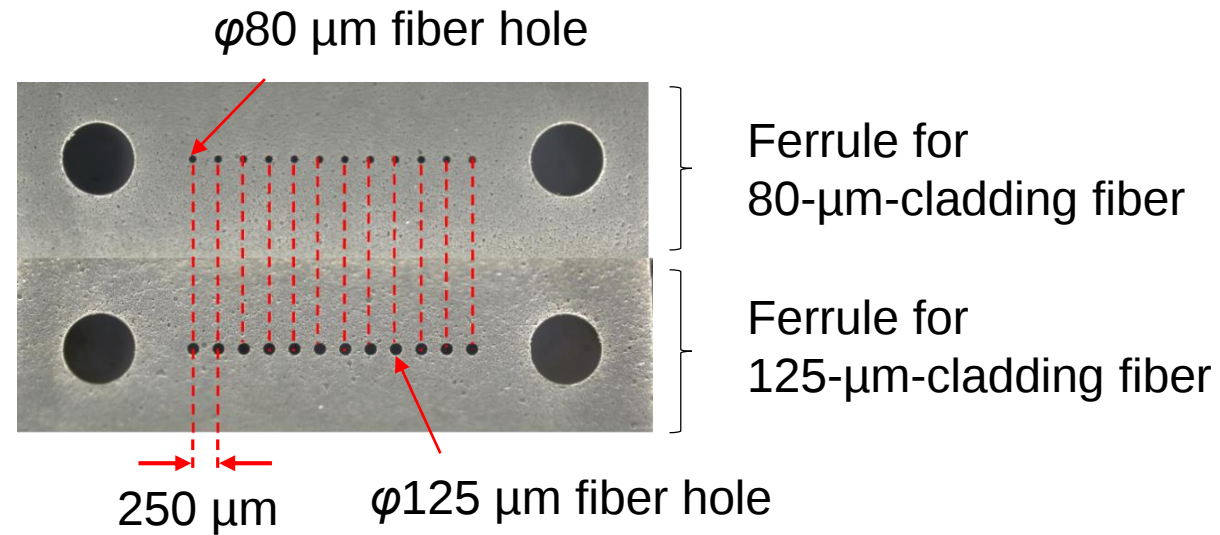
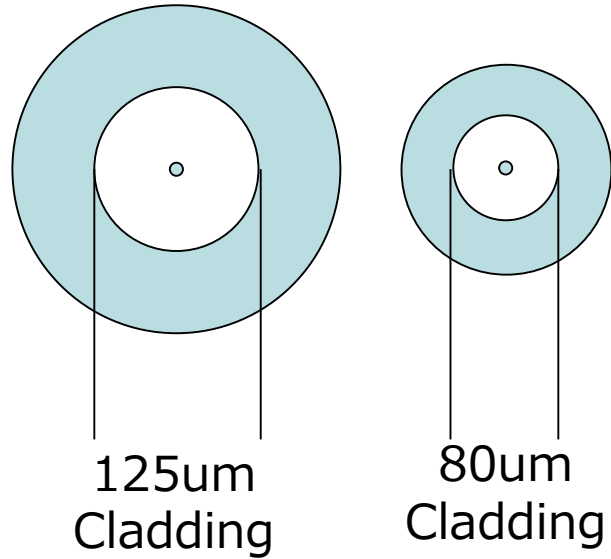


Bundled MMC Connector

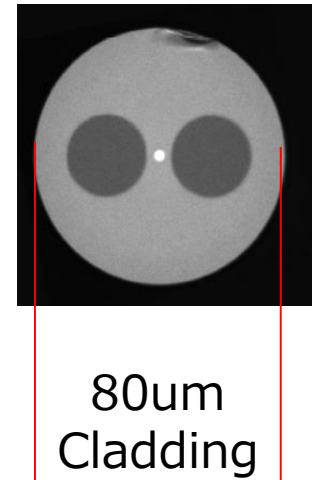
Much more room to manage fibers inside box

Reduced Cladding Fibers Support

- ✓ MT ferrule base connector interface compatibility between conventional 125um cladding/250um pitch and 80um/250um pitch
- ✓ 80um PM fiber available with multiple MFD design for external light source



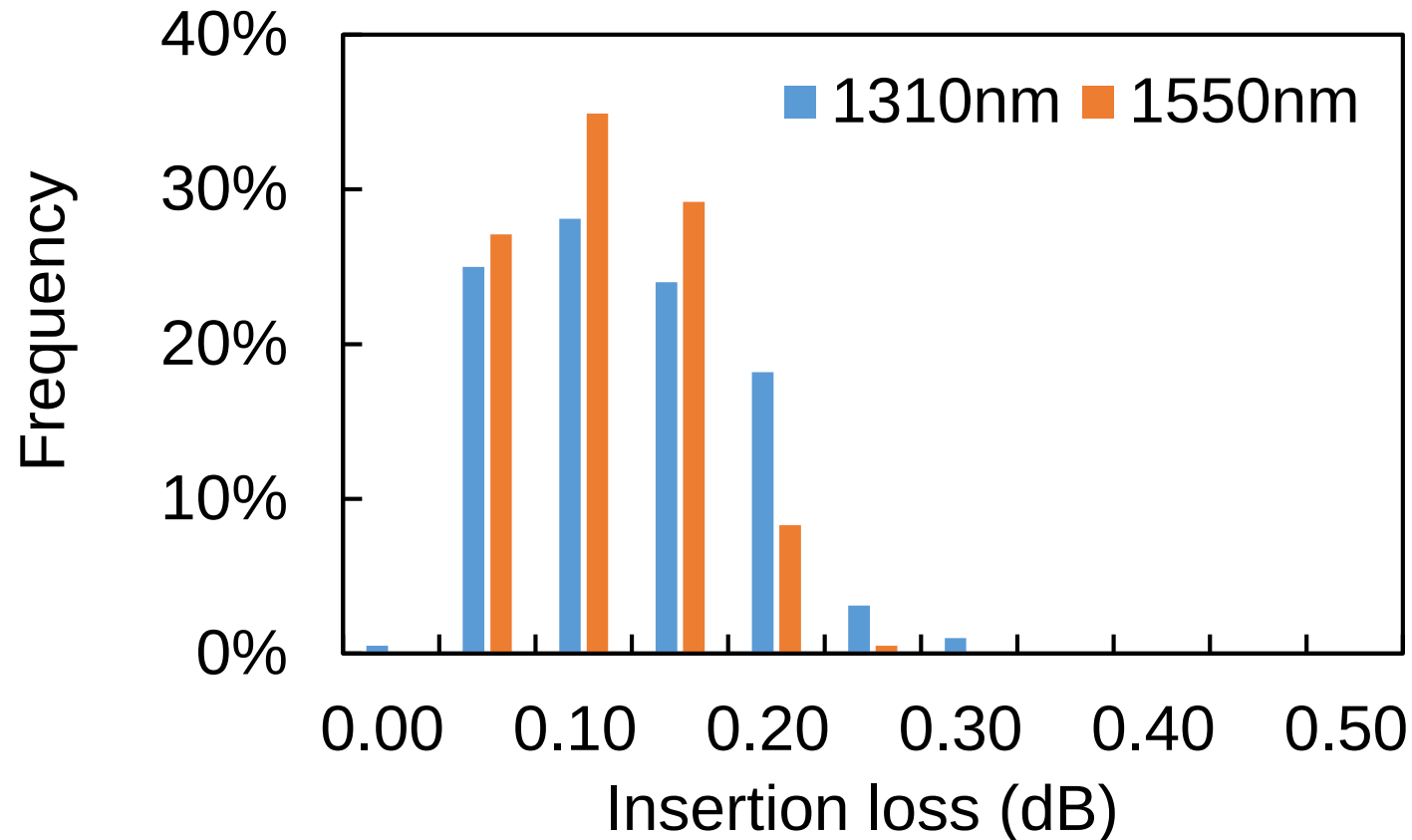
Endface Microscopic Image,
Conventional size MT,
80um cladding (top), 125um cladding(bottom)



PM Fiber Endface
80um Cladding

Reduced Cladding Fibers Support

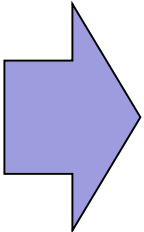
Intermateability, 125um fiber to 80um SM fiber connection, conventional 12MT



Reduced Cladding Fibers Support with MMC

- ✓ Benefit of reduced cladding fiber MMC connector as CPO interface:
Supporting near future higher densities Si-Photonics interface
Supporting external laser light source by reduced cladding PM fiber

	Conventional 125um Cladding, 250um pitch	Reduced 80um Cladding, 250um pitch
1x16f		
2x12f		
2x16f		



<250um pitch for single
raw 24f
or future higher
densities
e.g. 2x24f

Summary

- 1. Very small form factor connector like as MMC will be suitable for 102.4Tbps or above optical switch box interface**
- 2. Reduced cladding (i.e. 80um diameter) fiber supports future high density Si-Photonics chip**
- 3. Fiber system from 80um to 125um can be seamlessly designed not only with SM signal fiber, but also with PM light source fiber with 250um fiber pitch**

Shaping the future with “tsunagu” technology.



Optical Component Division



<http://www.opticalcomponent.fujikura.com/>