

EBO MSA: Enabling Reliable and Interoperable Optical Connectivity for AI Data Centers

Richard Ward

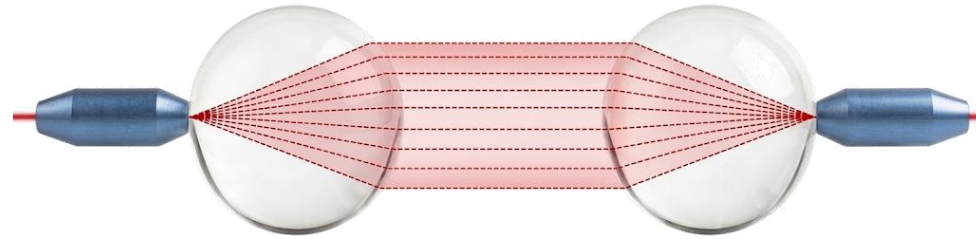
EBO MSA Co-Chair and Admin

3M, Xscape Photonics

Content and data included, with permission from:



EBO: Expanded Beam Optics intro



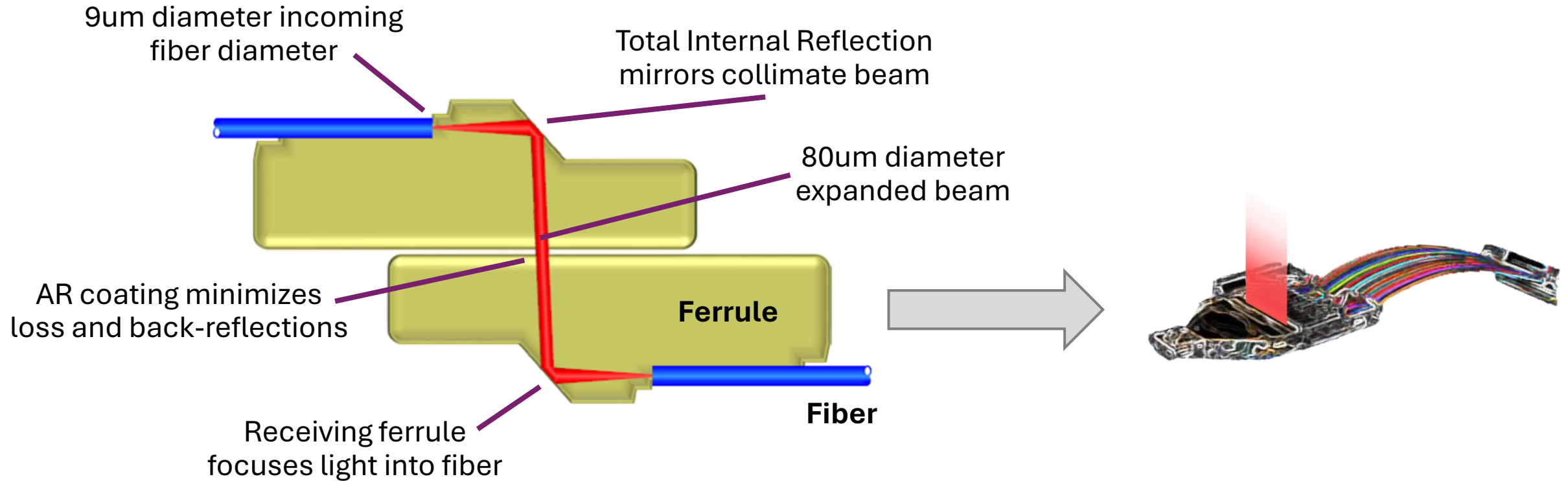
expand the beam

contract the beam

collimate across an air gap

- Developed in the 1970s for military use in harsh environments
- 1990s-2010s: evolved for heavy-duty industrial applications

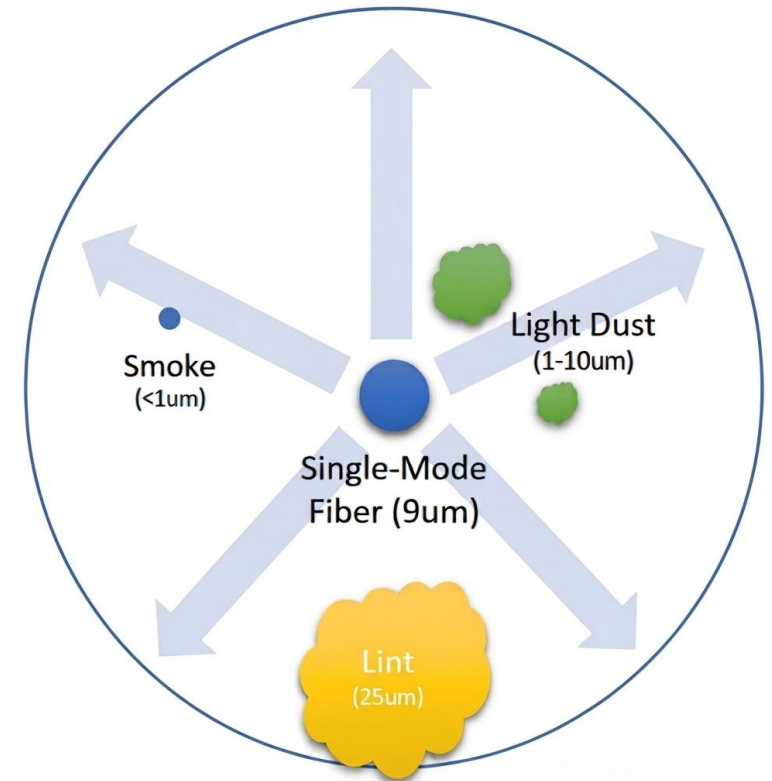
Modern EBO Technology for data-centers



This is a specific example of a number of different styles available

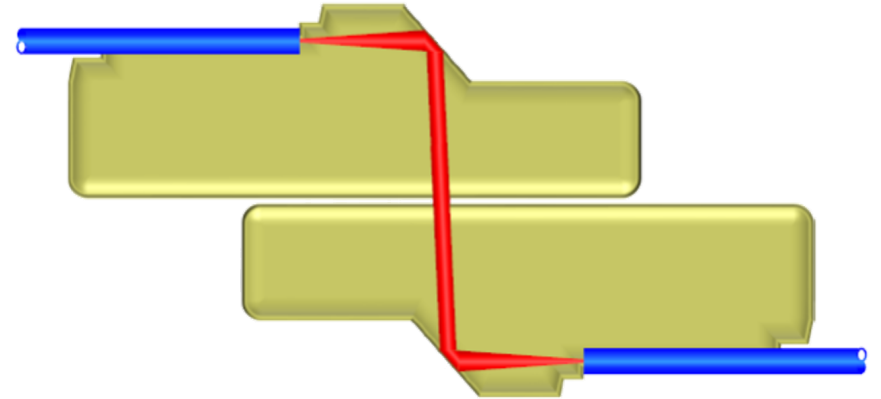
EBO advantages for modern data-centers I

- Reduces sensitivity to dust and debris
- Insertion Loss and Return Loss stability
- Eliminates burn out at high power levels



EBO advantages for modern data-centers II

- Light confined to the connector
 - Increased eye safety
 - Resistance to handling contamination
- Air gap gives non-contact durability
 - Long-term stability
 - ~20x reduction in mating force



Hyperscaler View

Fouled connectors as high blast-radius failure mode

...need to eliminate this as a point of failure

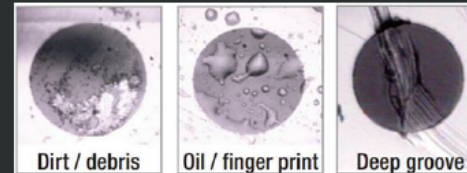
409.6 Tbps CPO switch
512 ports 800G DR4
512x 8-fiber physical contact connectors
512 x 8 = 4096 potential SPOFs at box level

A single fouled physical contact connector can cause the entire switch to be RMA'd

- This is a common failure mode in data centers – transceivers or fibers frequently swapped due to connector endface damage



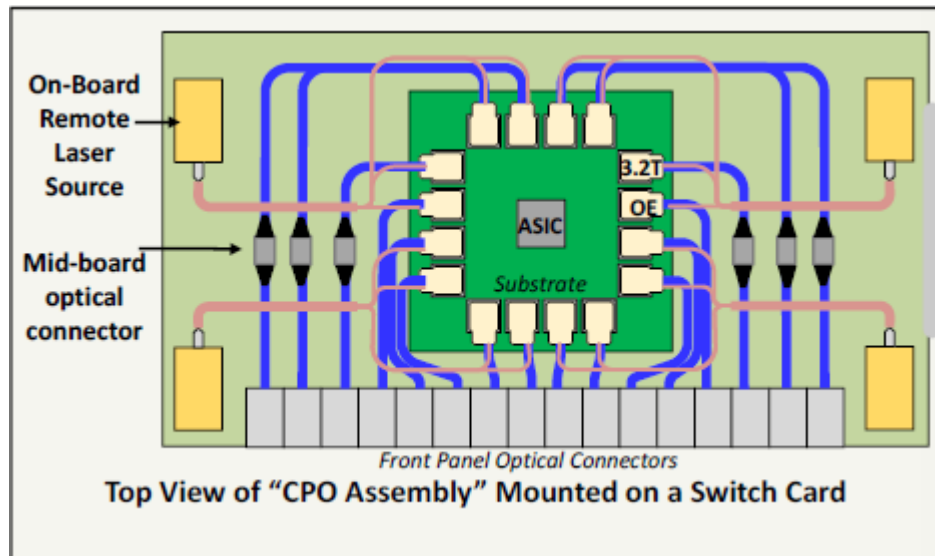
Source: Nvidia



Expanded beam connector technologies eliminate this failure mode since they don't make physical contact (and enable immunity to dust, debris, and other contaminants)!



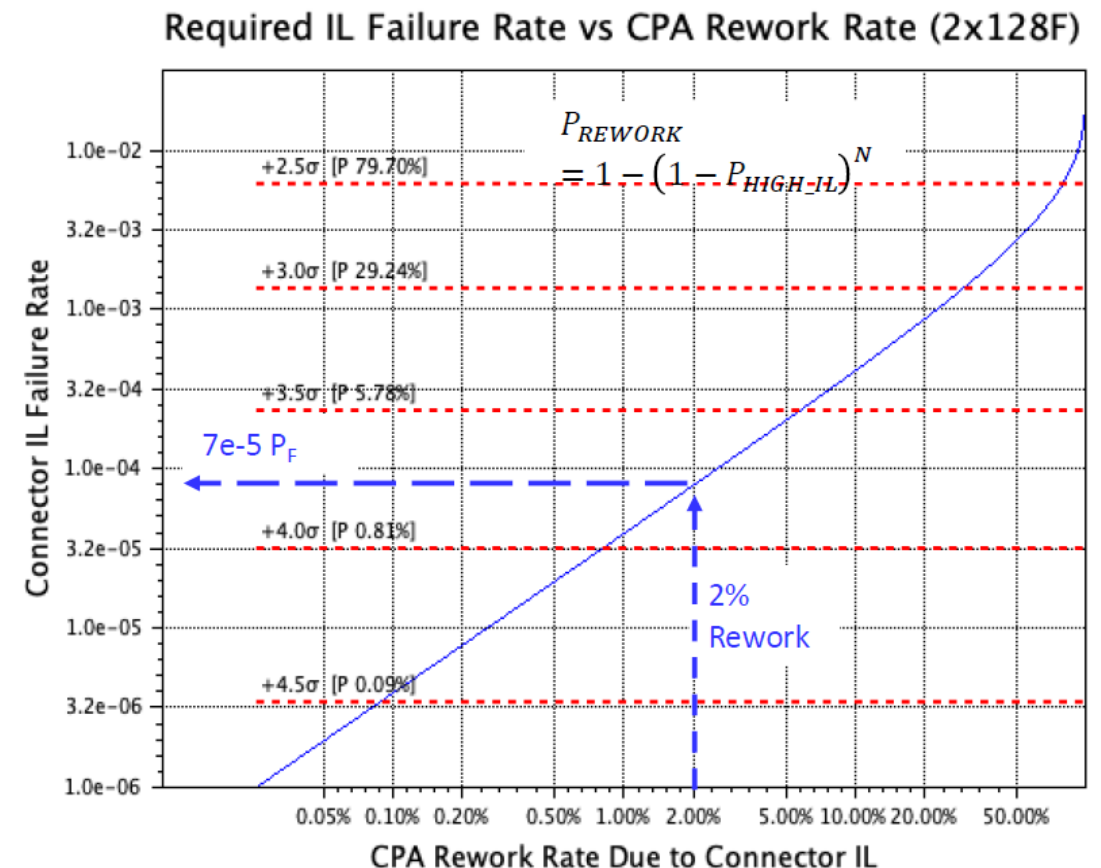
System Yield vs Rework



Example:

Number of Fibers for 51.2T Ethernet Switch Card with 100G Lanes

	DR (PSM)	FR4 (CWDM)
# Tx Fiber connections	512	128
# Rx Fiber connections	512	128
# Laser PM Fiber connections	64	32
Total Fiber Connections	1088	288
Assumed 3 σ first pass fiber connection yield	99.865%	99.865%
First Pass Board Fiber Assembly Yield	23.0%	67.8%



For example, a 2% max CPA rework rate requires a first-mate IL failure probability for each fiber connection of $P_F \sim 7e-5$ for the 51.2T FR4 scenario

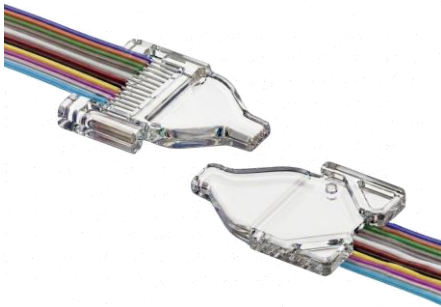
The acceptable rework rate drives the acceptable first pass connector IL limit

Data Center Maintenance

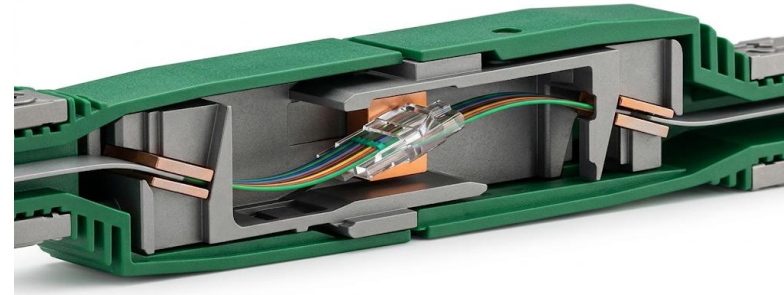
- ~80% of network issues are cleaning related
- ~95% of maintenance requests are for cleaning

EBO based systems have shown an ~85% reduction in Install and Clean time

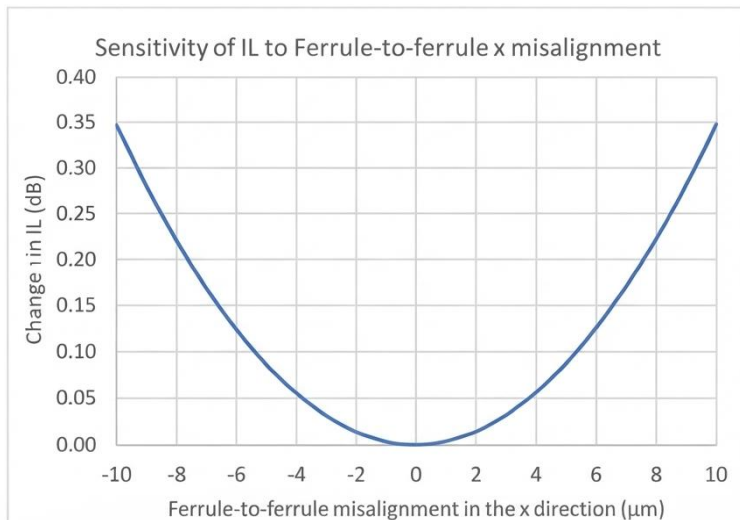
Reliable Ferrule Attachment



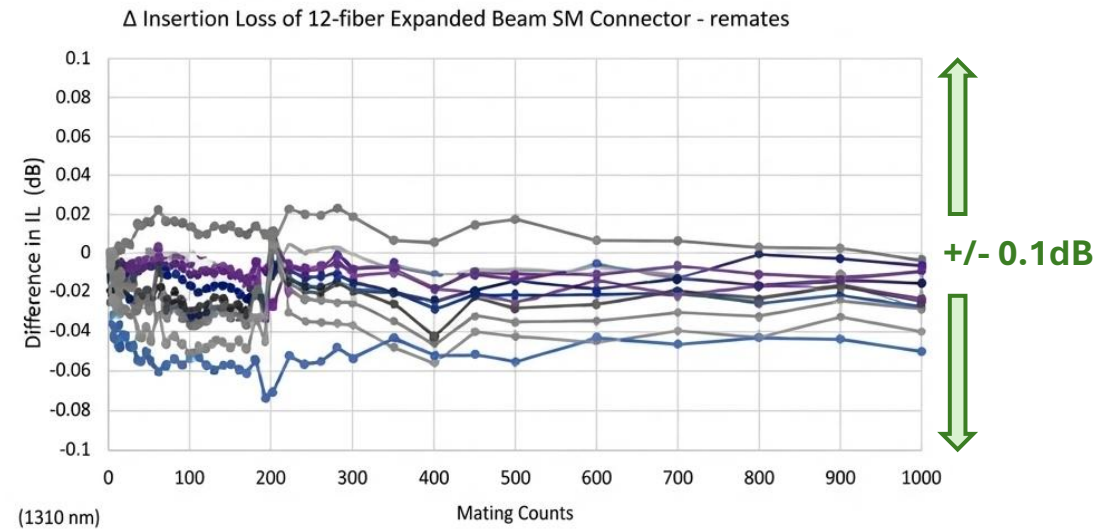
EBO 12f ferrule



Mated EBO 12f connector



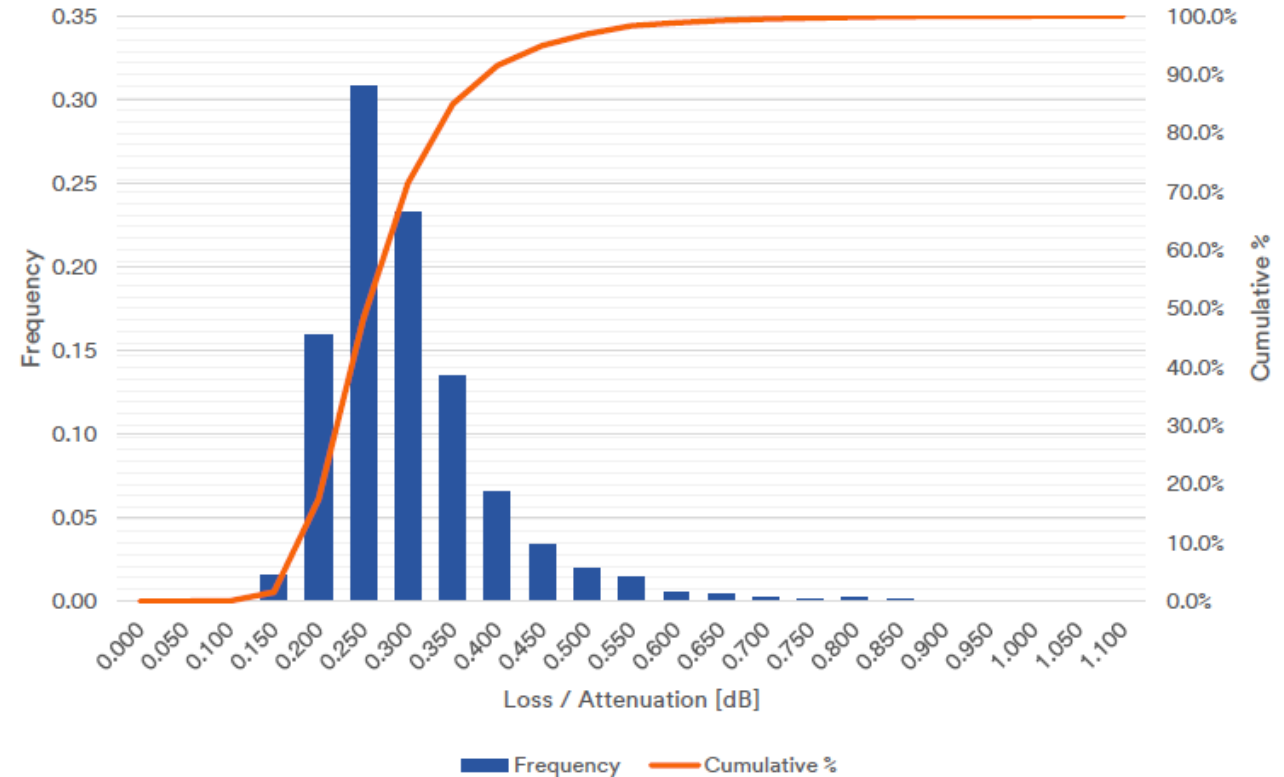
Sensitivity of IL w.r.t. ferrule-to-ferrule lateral misalignment in the x direction



1,000 remates (no cleaning)
showing $< \pm 0.1$ dB variation

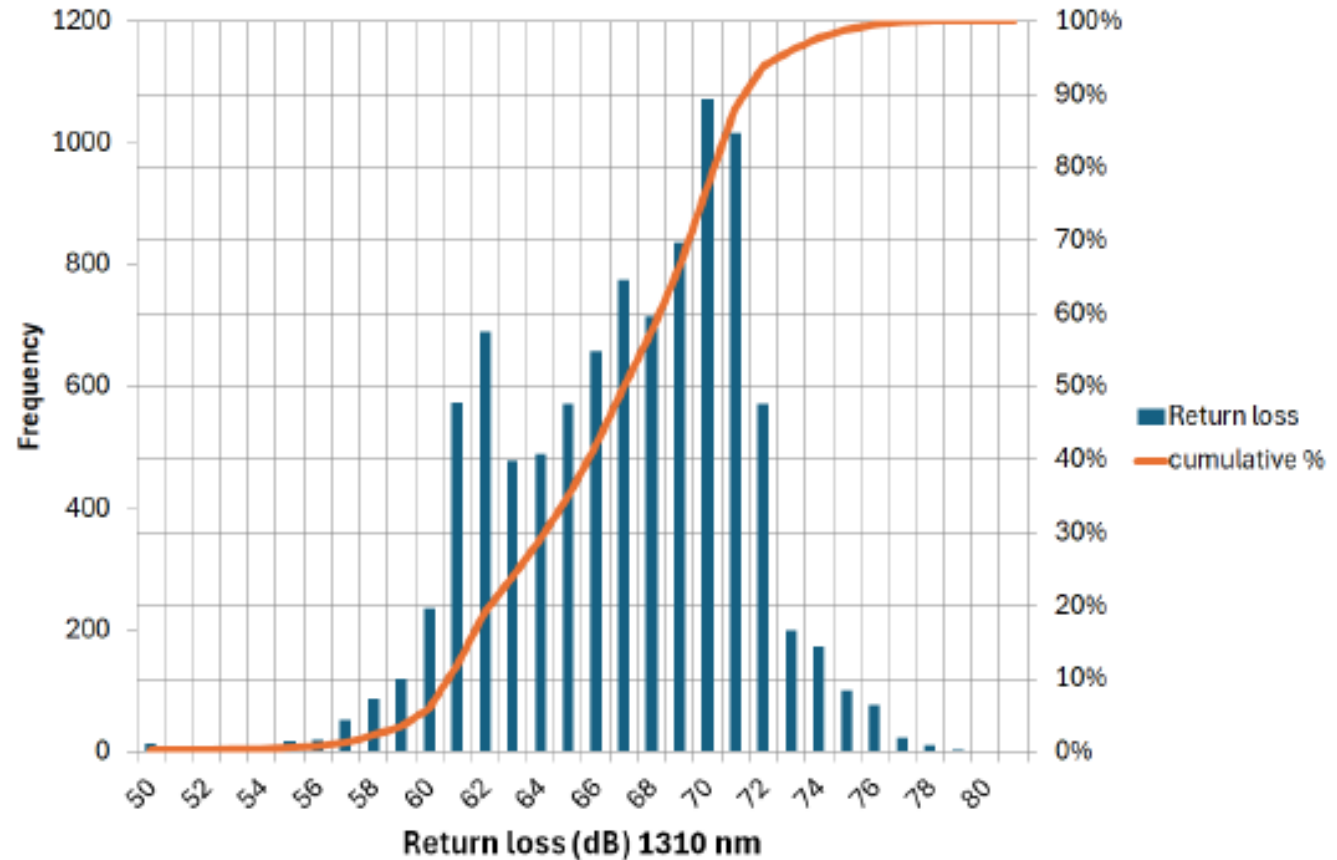
Insertion Loss

- Random mate test
 - 552 connector pairs
 - 8832 data points
- 97% (IEC) of channels <0.55dB
- 99.2% of channels <0.7dB
- Average IL 0.32dB



Return Loss

- 16f SM 9600 channels
- Average RL 66.7dB
- 99% of channels >55dB



EBO MSA: Leadership Team

Created Mar 2026 to meet customer demand of interoperable EBO technology connectors for supply chain stability with Specifications

- Chair
 - Mark Filer, Oracle
- Co-Chair and Admin
 - Richard Ward, 3M, Xscape Photonics
- Editors
 - Tiger Ninomiya, Amphenol
 - Adam Broughton, Sumitomo
 - Max Omodaka, Senko

Current membership (57): 9 “end-users”; 48 “vendors”

AMD ARISTA CISCO HPE Meta Microsoft nexthop ai NVIDIA ORACLE

3M ati ACES Accelink AFL Amphenol APERION TECHNOLOGIES BellWether BKSTEC

OXDC CHANT SINCERE CO., LTD. Celestica CREDO EZconn FIT FOXCONN 鴻海科技集團 Gen

Genuine optics Goeroptics HFCL HUAMAI 华脉 JE JPC connectivity LINTES LOTES

LUXGLO LUXSHARETECH LUXVISIONS mixx molex O-Net Technologies Rosenberger Pan-International

Samba PHOTONICS LAB SENKO Advanced Components SHIJIA SP SOURCE PHOTONICS STU SUMITOMO ELECTRIC LIGHTWAVE STE TERAADYNE TERAHOP

TIME Interconnect Limited LFC viaPhoton VSD X SCAPE PHOTONICS YOKOGAWA ZHAOLONG Cables & Interconnects

Current range of connectors

- Members vote on specific connectors to develop and contribute design specifications (18 types under discussion)
- Design Roadmap
 - 128f (8x16f) Design Specification underway
 - 16f MPO Design under discussion on Specification
 - 16f VSFF Planned
 - ELSFP Planned

Thank you

Membership information can be found at ebomsa.org

Questions can be addressed to Richard Ward / admin@ebomsa.org