Embedded Polymer Waveguide to Optical Fiber Interconnects

Creating the Optimal Link

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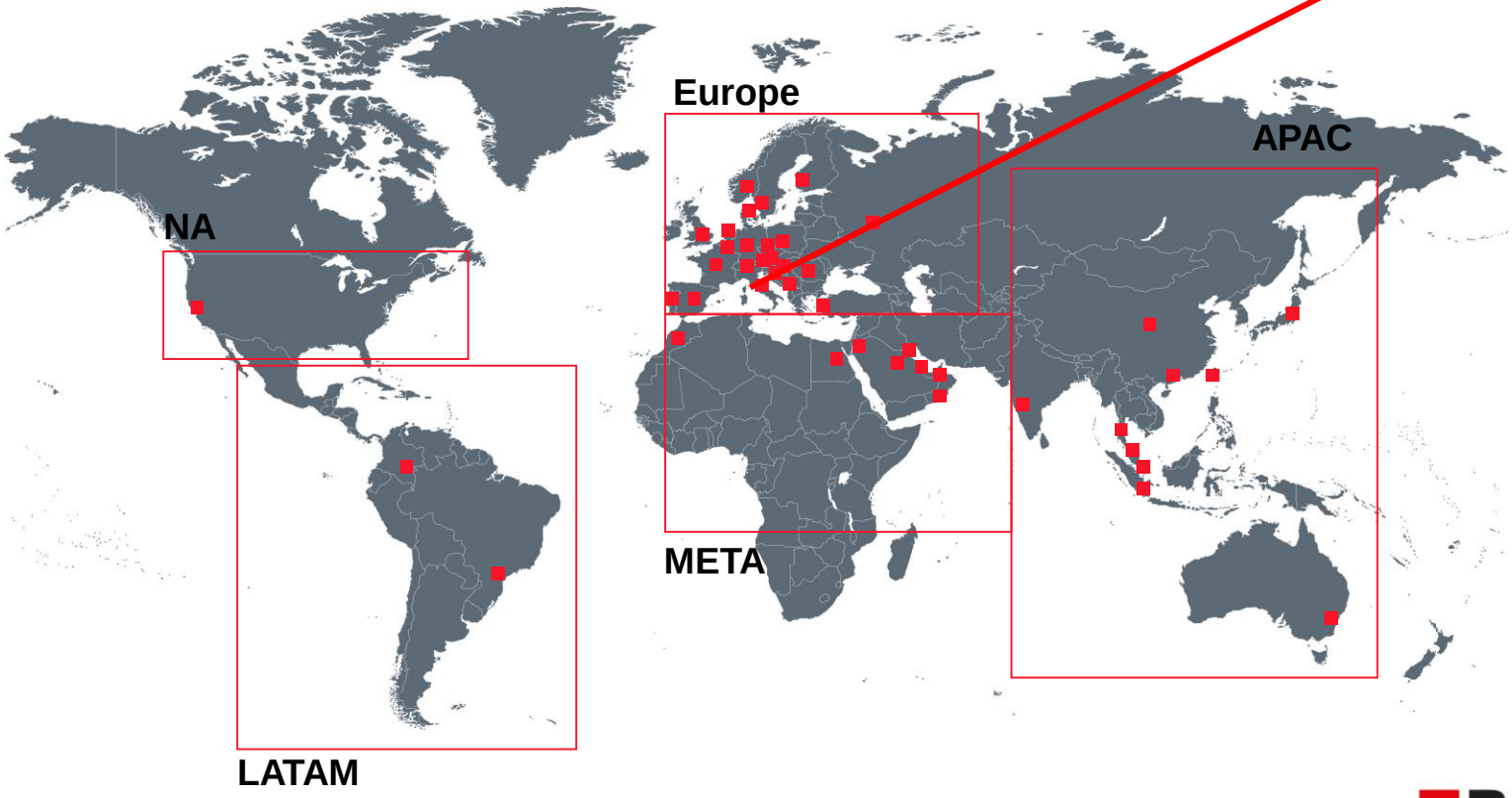
CTI – Corporate Technology & Innovation
Reichle & De Massari AG
Wetzikon, Switzerland

R&M

Reichle & De Massari AG

Privately Owned Company
Annual Revenue 2017 : 230 MCHF
Employees: >900
Headquarters : Switzerland



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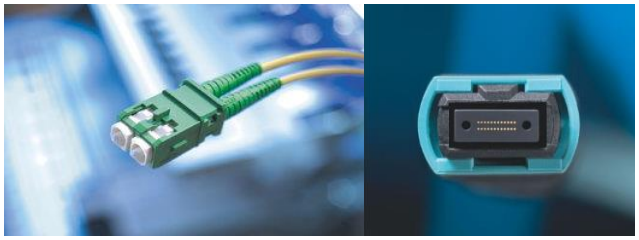
Reichle & De Massari AG

Complete cabling solutions for high-end communication networks in the fields of:

Connectivity and cabling (Fiber Optic and Electric)



Cable management

Complete layer 1 portfolio

Infrastructure Monitoring

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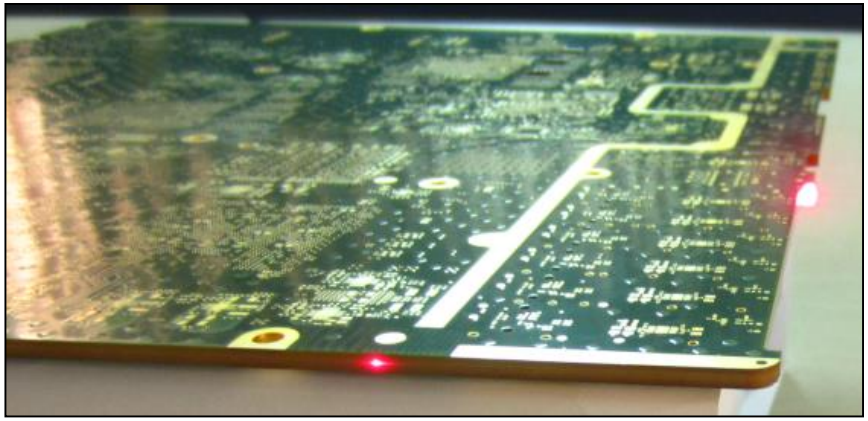
On-Board Optics & Collaboration Project RDM-TTM

Addressed WG

- Polymer multimode waveguides with square cross-section.
- Arrays of 12 waveguides per group
- MPO grid compatible



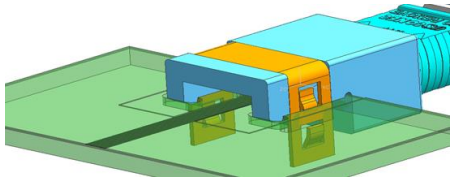
- Product with optical layers (Line Card)
  - 20 electrical layers with 1 optical layer
  - Dimension (WxH): 277 x 312 mm (10”x12”)
  - Material: EMC EM-285 HF
  - Thickness: 2.8mm (+/- 0.300)mm

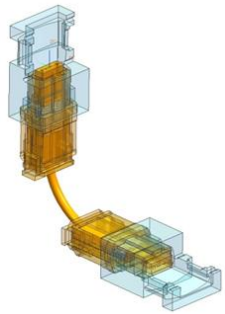
Target Performance

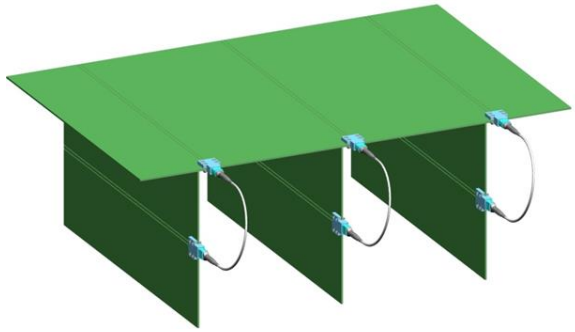
- Connector loss ≤ 1dB per channel
- Stable IL values for at least 10 mating cycles
- Stable for subsequent electronics soldering process

Main Challenges

- Alignment
- Different materials (core refraction index, hardness)
- Mechanical Stability







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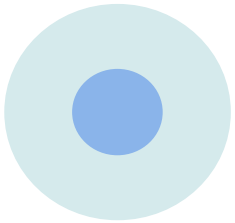
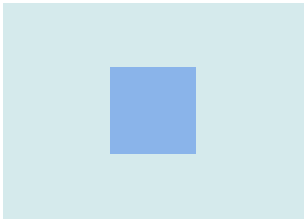
On Board Optics – Interface to MT



λ = 850 nm

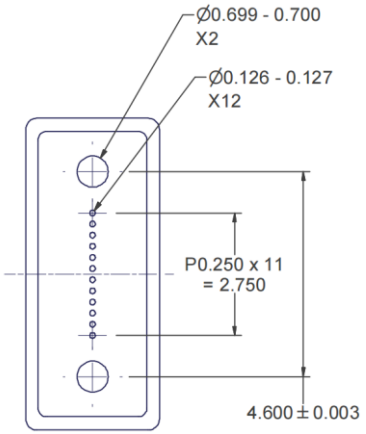


Multimode Fiber (OM4)
Core diameter 50 µm
Graded index glass core
Young's Modulus 50-90

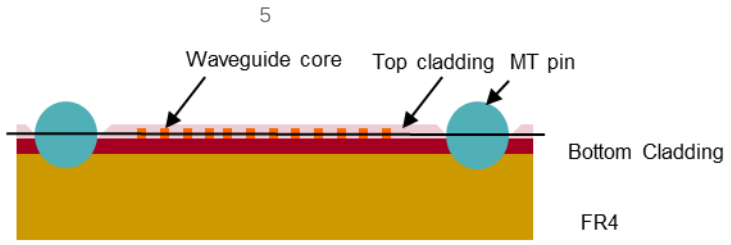
Multimode Waveguide
Core dimension: 50 x 50 µm
Step index polymer core
Young's Modulus 2-4

Addressed WG

- Polymer multimode waveguides with square cross-section.
- Arrays of 12 waveguides per group
- MPO grid compatible



- Fiber eccentricity to < 3 µm
- Reference is center point between MT pins



- Waveguide position is arbitrary and must be referenced to rigid fiber array via MT pins

Mechanical stability an issue for repeated mattings

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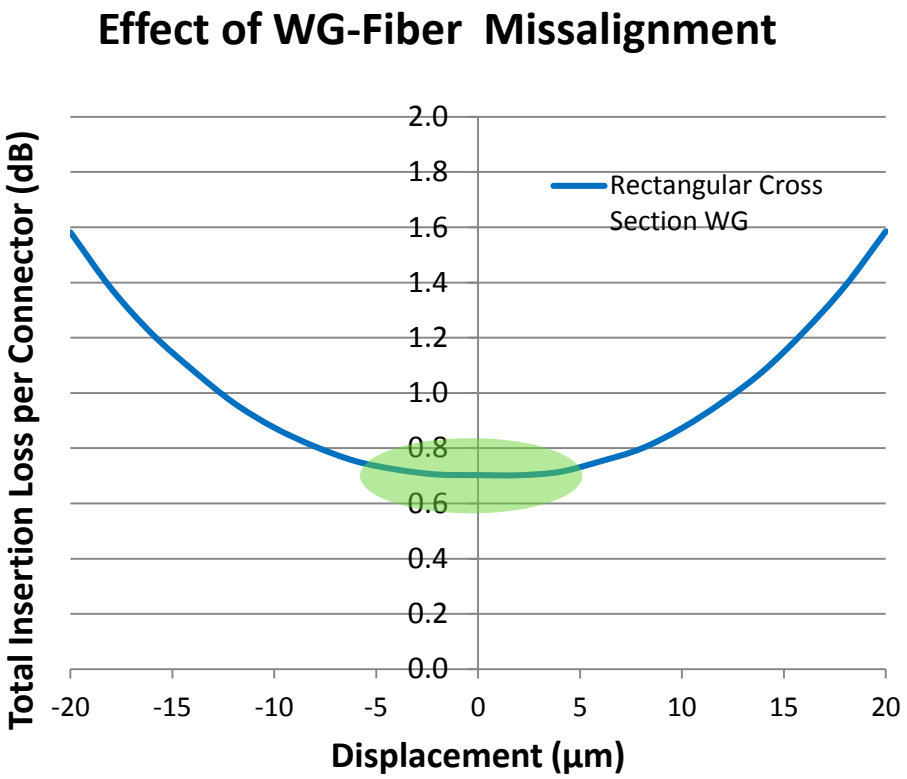
Alignment Tolerance for Rectangular Cross Section WG



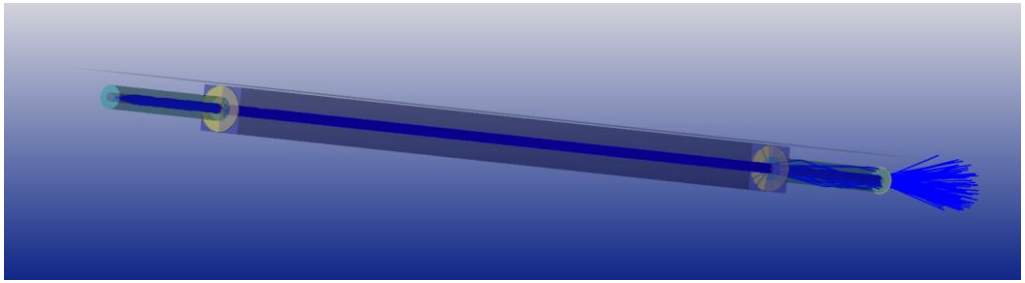
R&M Specs

- Excess loss < 0.5 dB in all channels
- Mating cycles > 20
- Transferable process for assembly house
- Connector able to withstand soldering

Requires

- Lateral Alignment Tolerance < 5 µm
  - XYZ translations
  - 3 Angle tolerances accumulate
  - Fiber array eccentricity 3 µm
  - WG array eccentricity 3 µm
- Physical Contact
- Heat resistance materials

Very Challenging for Passive Alignment!



- Cross section mismatch penalty: ~ 0.5 dB
- WG end face quality factors: polish, perpendicularity

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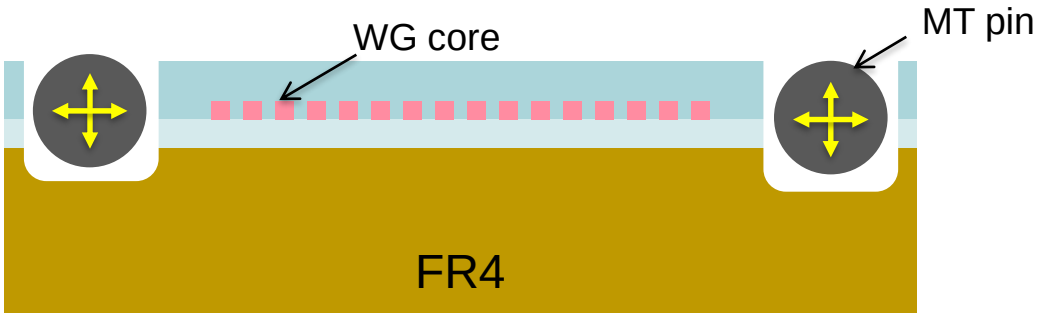
R&M Approach

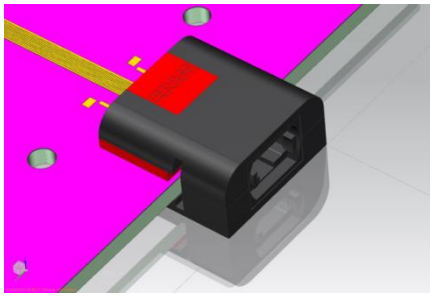
- Active alignment of reference pins to board



- 6 degrees of freedom alignment
- Pins cured into position

- Connector Design

  Standard force for an MPO connector is ~ 2N per fiber
  - Modified adapter
    - protects waveguide front face from plastic deformation or fractures within waveguide core due to stress
    - Equalizes the ferrule force upon the edge of the board
    - Controls contact angle
    - Ensures physical contact

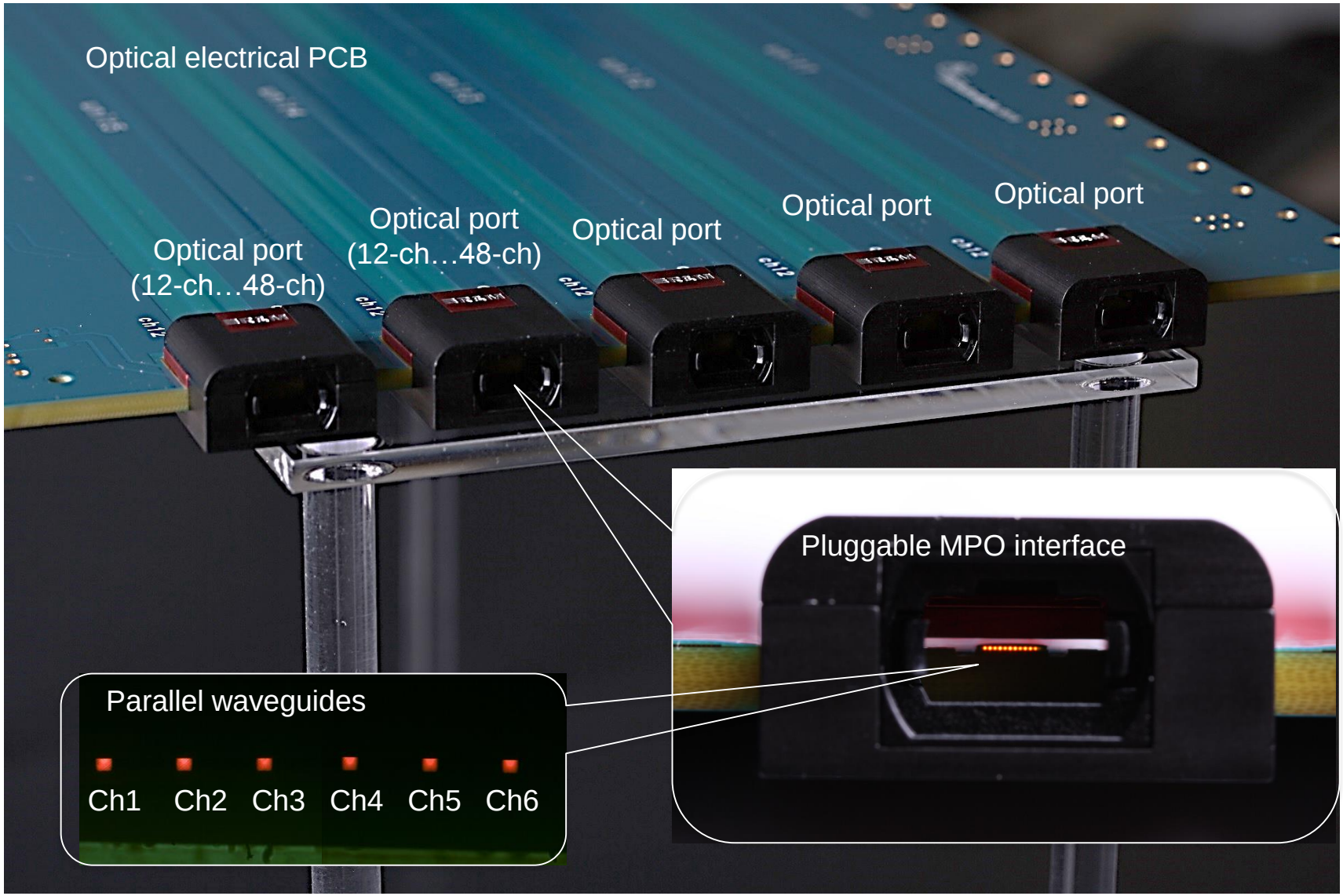


Patent Pending

- Assembly Process
  - Tools and process developed at R&M
  - Transferable to assembly house

Next steps:
External footprint reduction
Further automation of assembly

Passive Waveguide Backplane Evaluation Card



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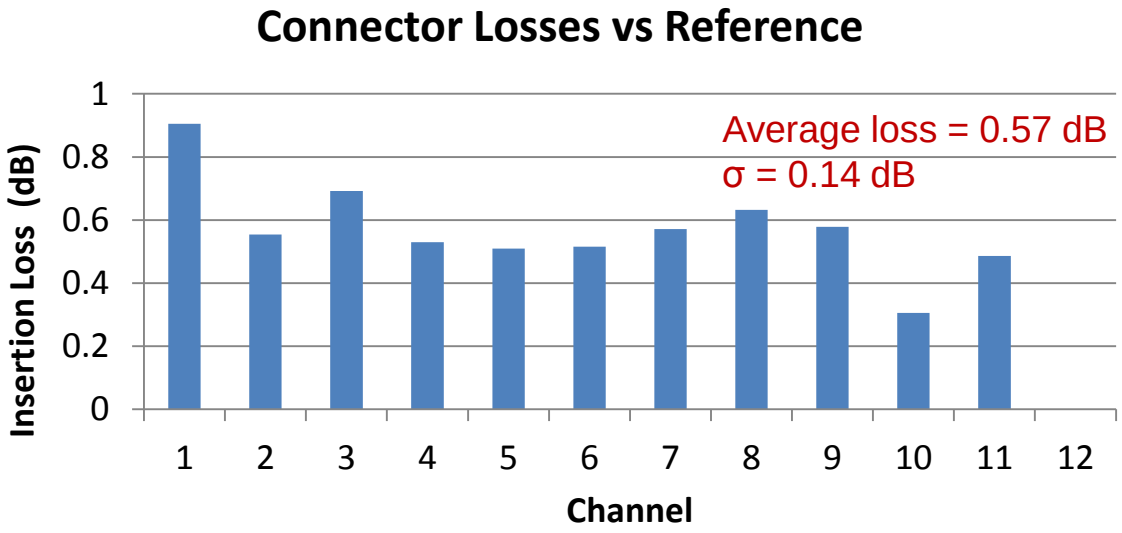
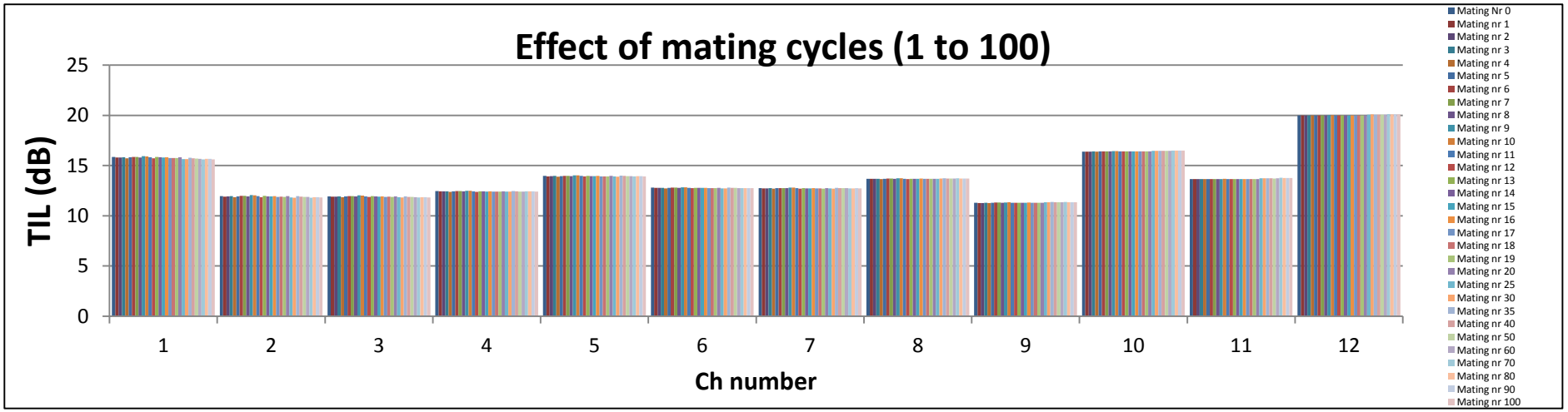
Results



- Measured with EF
- Referenced vs single channel basis
- Includes losses of 1 MPO cable



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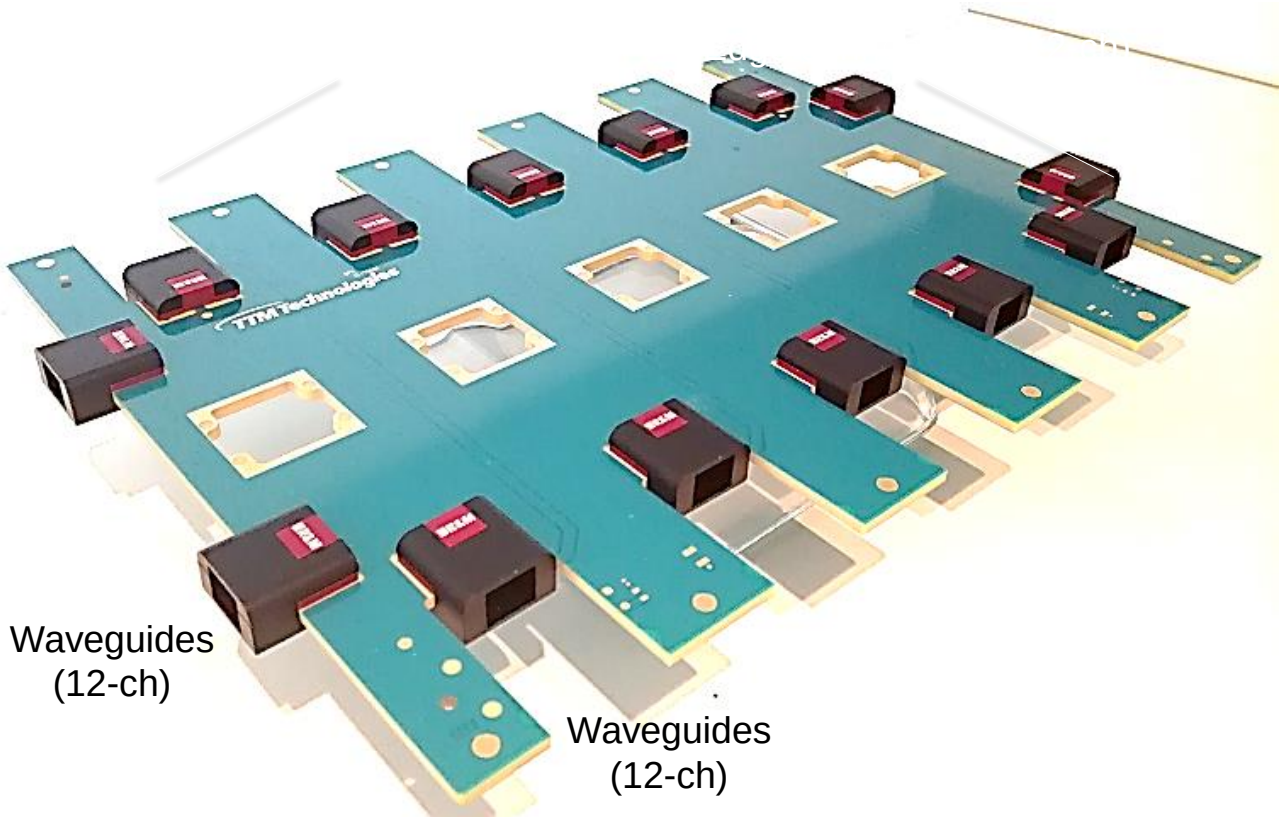
Embedded Waveguide PCBs for On-Board Optics

Evaluation Platform : Passive Waveguide Backplane PCB



- Passive backplane with 60 polymer waveguides in port/to/port 12-ch links
- All WG channels terminated by RdM's WG connectors
- Waveguides embedded part of PCB stack
- Pluggable connector interface

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Demo booth #334

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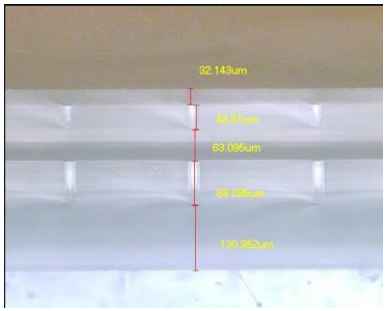
Current Work in Dual-Layer Waveguides

Development of multilayer (dual-layer) OPCBs

- MM Dual-WG OPCB development
  - First dual-layer units complete
    - Varying core sizes: width 20’ 35’ 50’ 60 µmx height 45-90µm
    - Excellent layer-to-layer registration < +/-5µm
    - 2L OPCB fabrication in 16”x20” production panel



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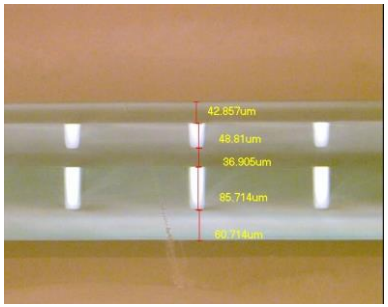

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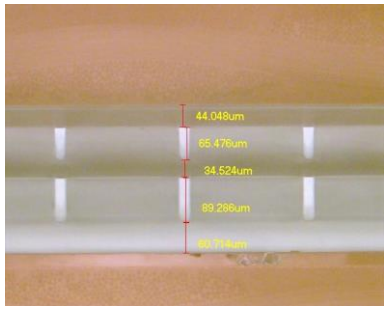

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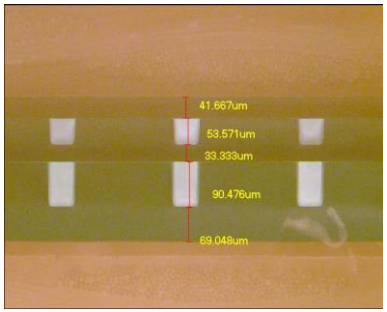

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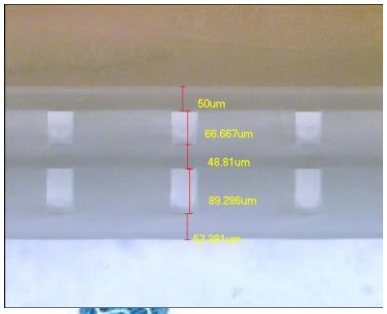

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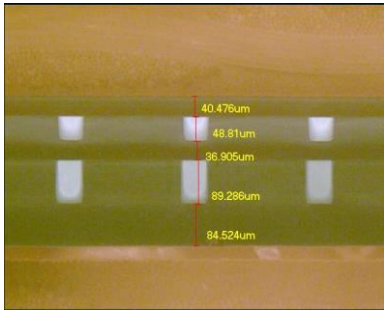

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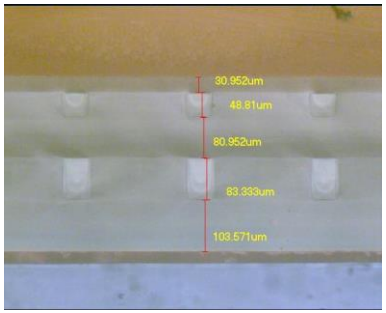

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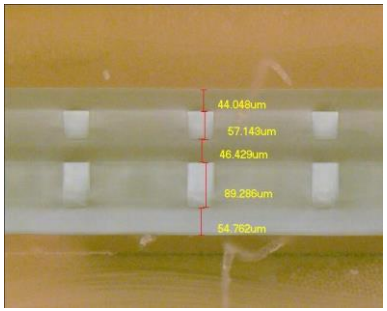
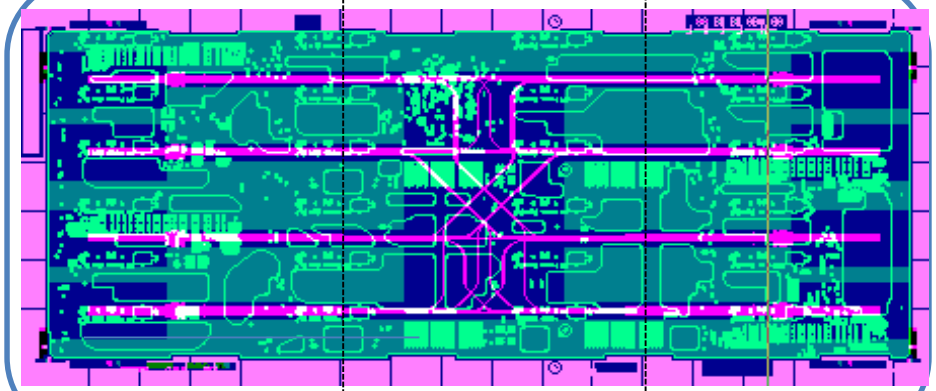


i

PhoxDem09.04MPX – 18L+2Opt Embedded WGs

PhoxDem09.04 Application Demonstrator

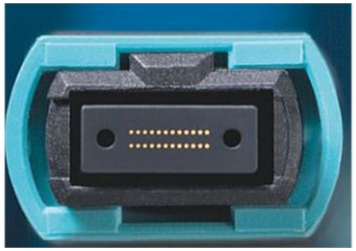
Photonic Midplane with E-WG Shuffle Routing

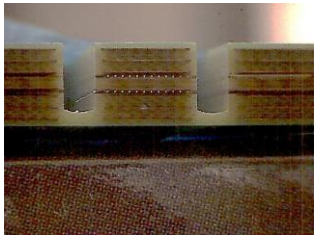


Optical waveguide shuffle network

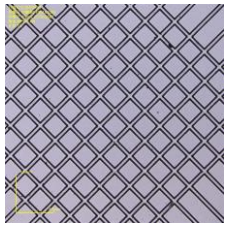
Dual layer WG construction

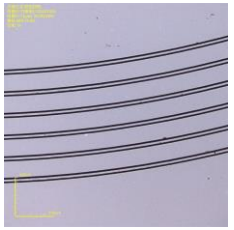
Dual layer WG connector IO



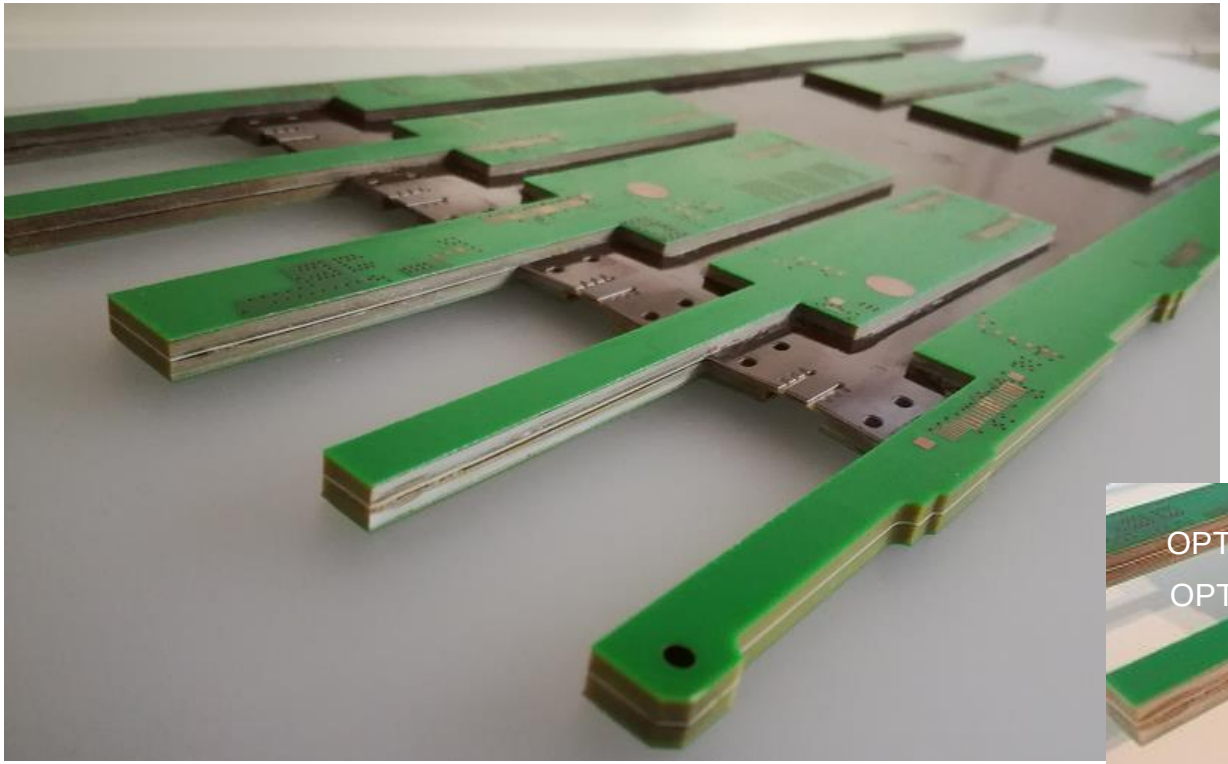


Perfect shuffle WG routing



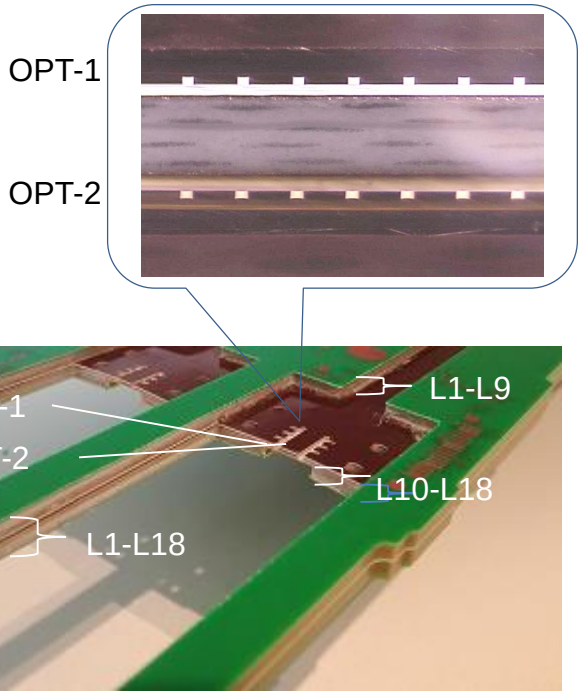


Application Prototype: Optical/Electrical Midplane 18L+ 2 Opt WGs



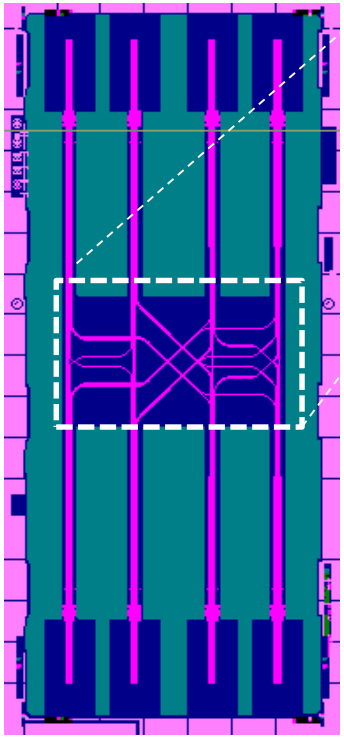
Waveguides revealed with multilevel recess cavities to visualize embedded WGs in 18L stack

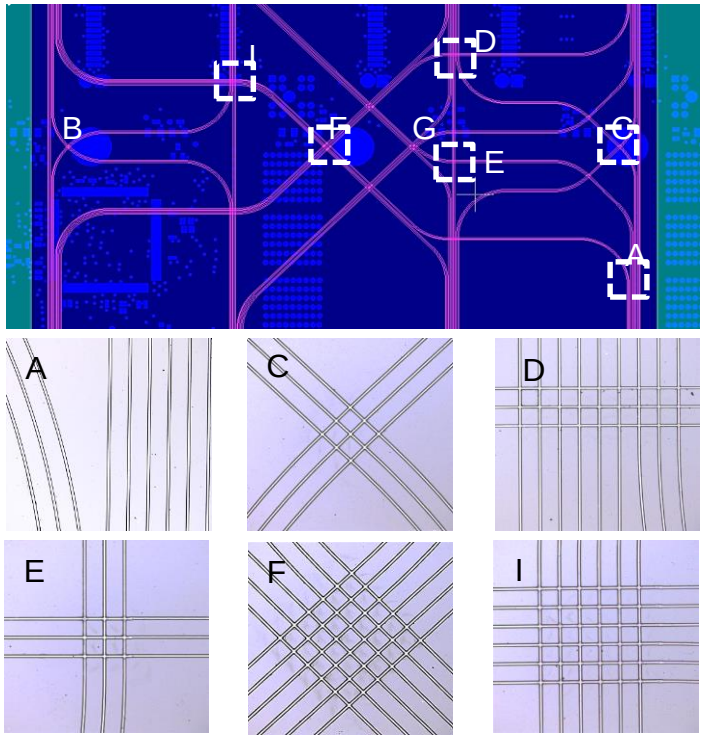
Dual layer waveguide structure

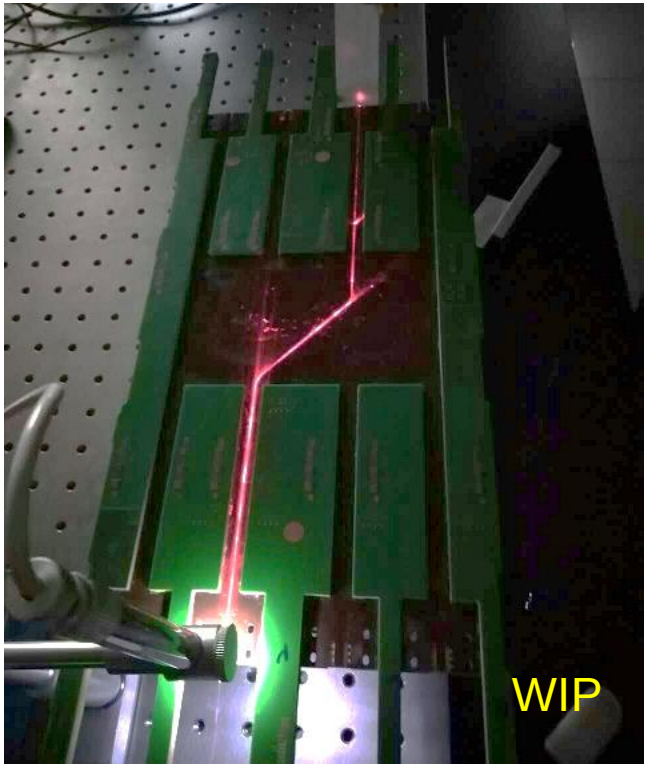


Shuffle Midplane with Polymer Routing Network

- Integrated photonic layers part of internal PCB layers
- Registration between optical layers < 5µm (500µm vertical pitch)







RDM Connector and Process is compatible with double layer and potentially with SM waveguides

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Summary

- R&M has designed, produced and tested an MT compatible connector for polymer waveguides on rigid PCB
- We demonstrated an average loss of 0.57 dB for the DUT including one MPO cable
- We demonstrated 100+ connection cycles without degradation of the optical performance
- Our connector places minimum requirement on the referencing of the waveguides within the OPCB
- The RDM on board connector and process is compatible with a dual-layer OPCB
- Our active process is transferable to assembly and large scale production

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Multi Fiber Connector for On-Board Optics

Contact Information

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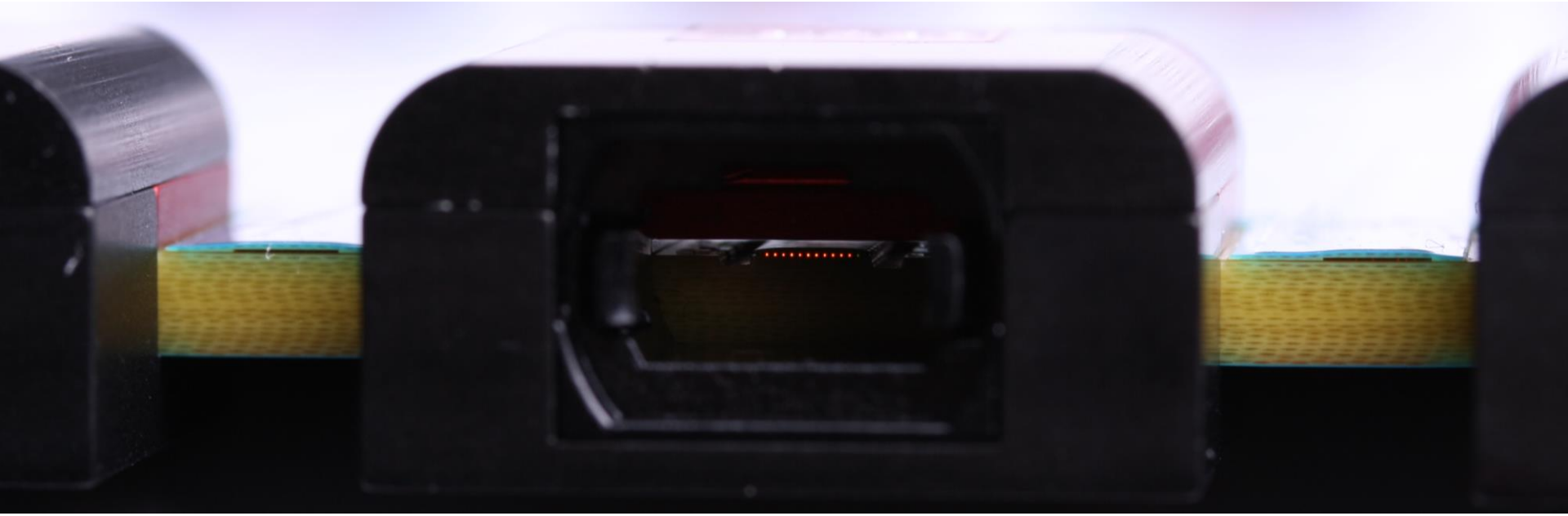

Access – Fiber to the Board