

# MWIS [æm-wi:dz]

A new Interconnect System in Motion @ Consortium On Board Optics

## Multimode Waveguide Interconnect System

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**HRS** HIROSE  
ELECTRIC  
CO.,LTD.

CONNECTING THE FUTURE

cobo

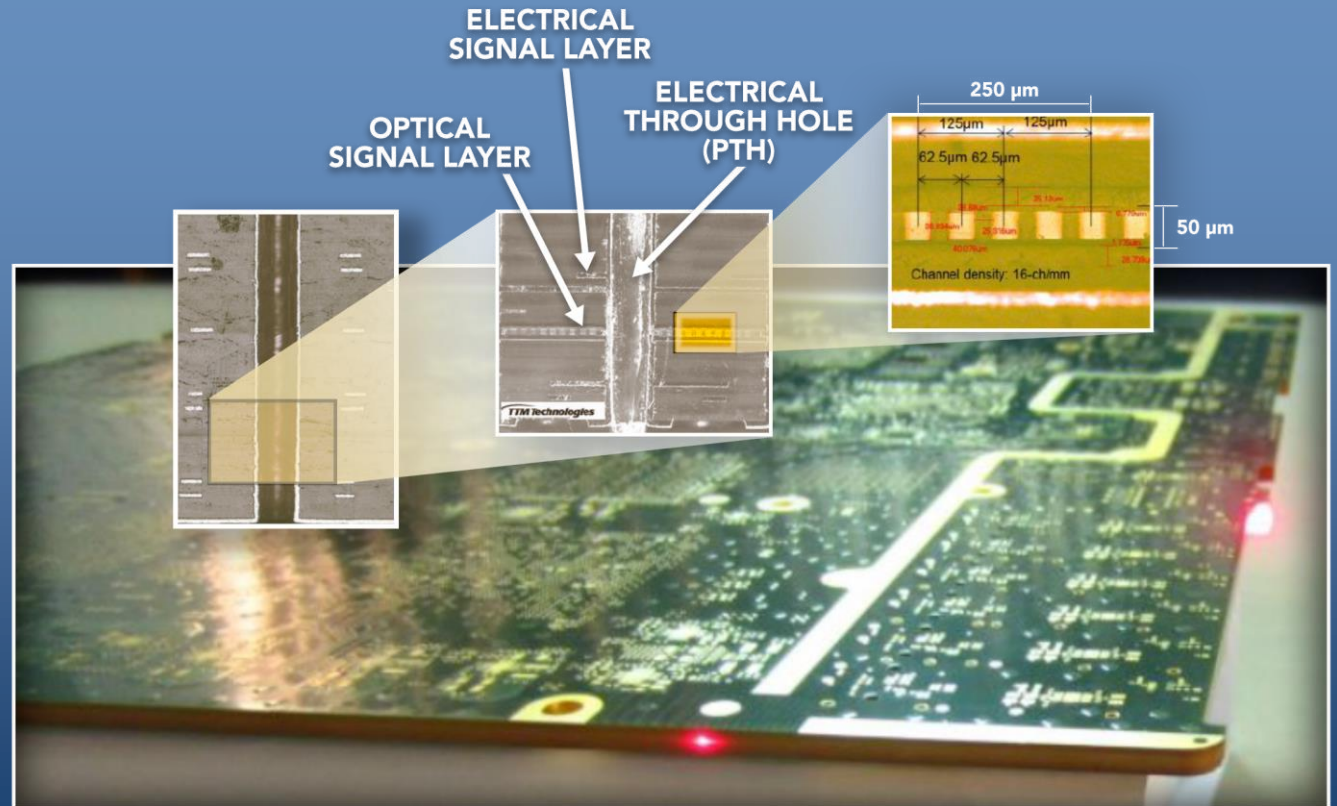
# Multi-mode Waveguide Interconnect System

## GOAL

1. High-Bandwidth
2. Power Efficiency

### Three fundamental building blocks:

- MA: Very thin EO and OE converters named MA (Media Adapter)
- MMWG: Embedded Optical Waveguide in PCB
- Existing copper SERDESEs with very short electrical trace to drive MAs



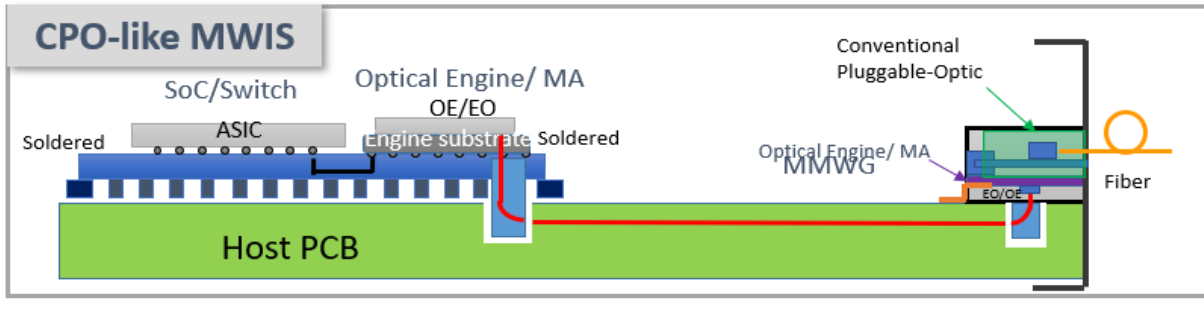
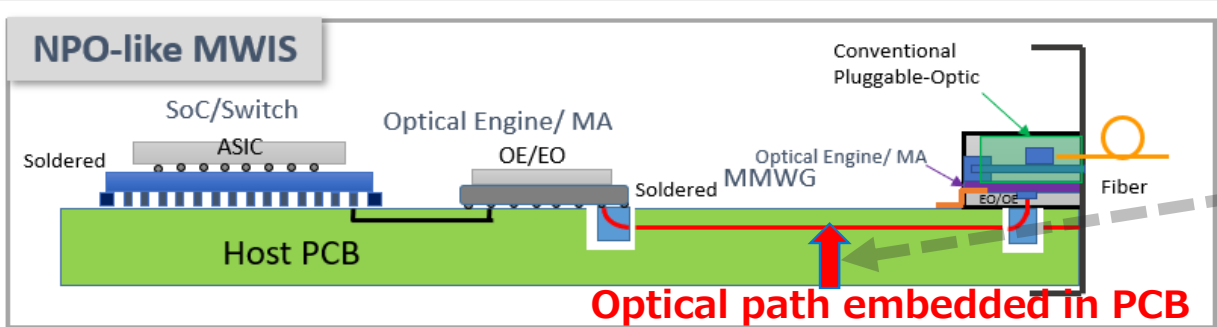
Matured MMWG Technology Embedded in Multi-Layered PCB (by Courtesy of TTM Inc.)

Source : COBO MWIS Whitepaper

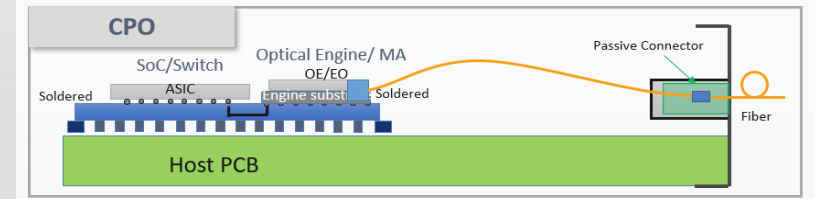
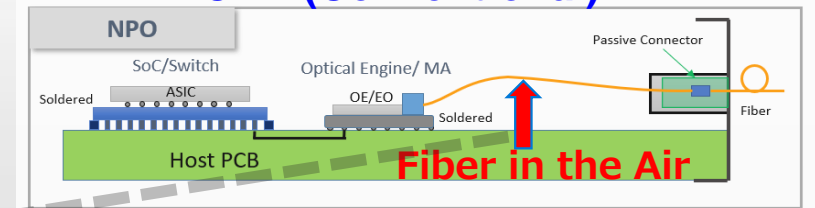
- MA Termination: Optical waveguide is always terminated by a pair of MAs ( $MA_{TX}$  and  $MA_{RX}$ )
- Electrical Interface: From SERDES to MAs, it allows very short, or zero copper trace
- MA Structure: MA consists of 'Thin' optical engine with optical waveguide connector
- The channel performance of the bandwidth and power consumption will be assessed in the electrical domain with the optical channel inclusive.

# Embedded Optical Path

## C2M MWIS

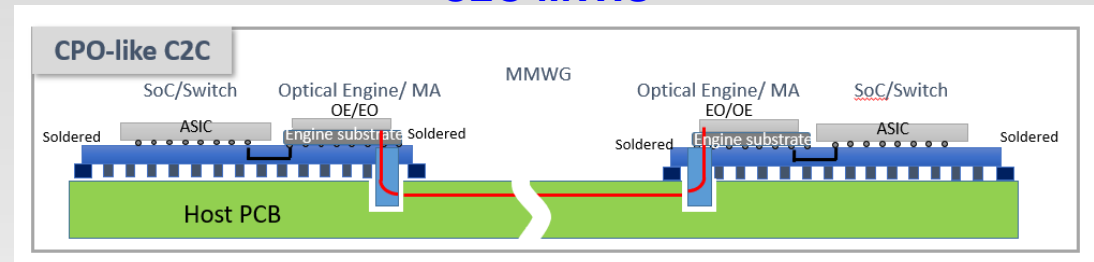


## C2M (Conventional)



## C2M Conventional

## C2C MWIS



# Bare Minimum MWIS Channel Model

## Two Questions:

- Can power savings be achieved by adding OE/EO?
- How much bandwidth will be expected with MM waveguide rather than SM?

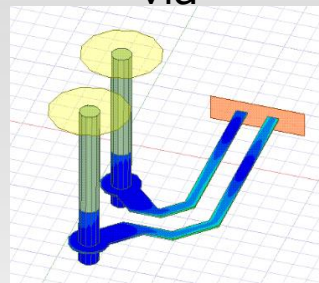
## Copper Channel Model



connector



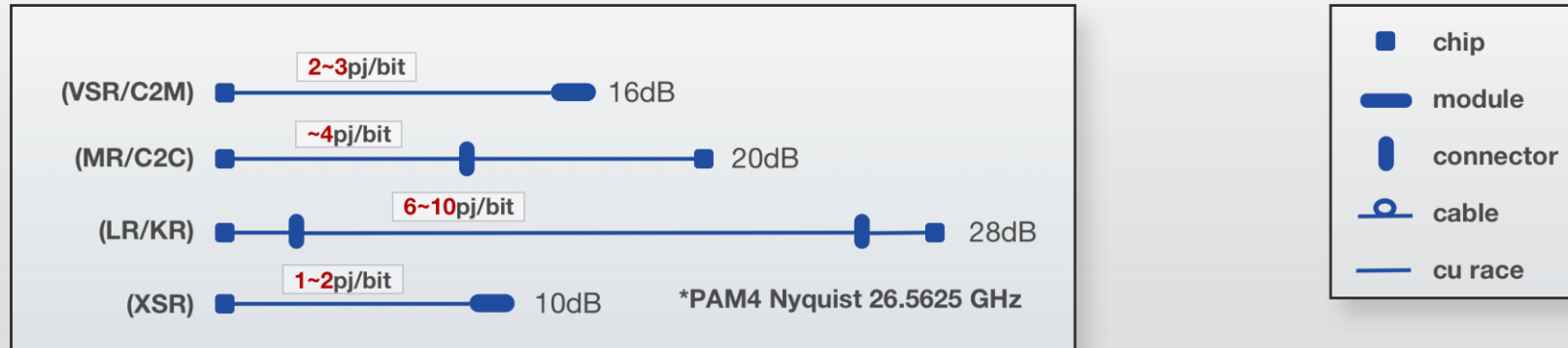
via



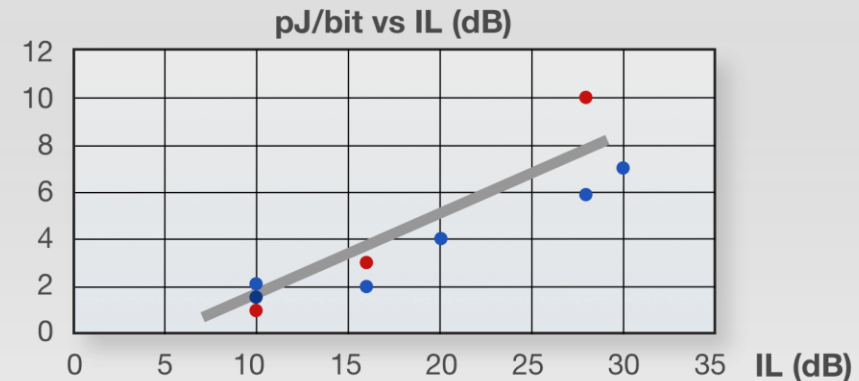
❖  $IL \uparrow$  power  $\uparrow$   
❖ #of Taps  $\uparrow$  power  $\uparrow$

# SERDES of 100Gbps/lane power efficiency

(CEI5.0/ 802.3ck)

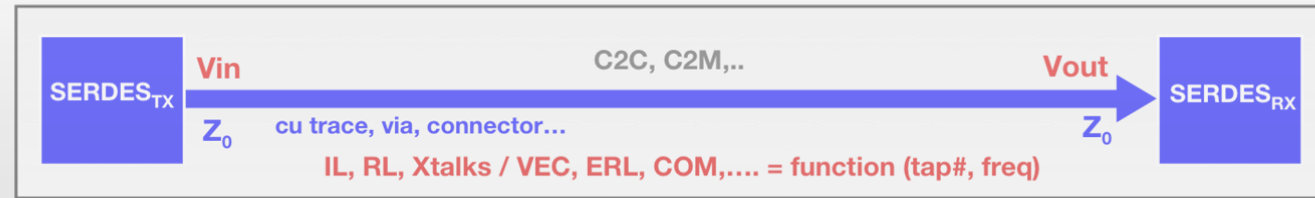


**EPB (Energy per Bit) vs SERDES subclasses length for 100G/lane technologies\*:**  
**EPB Slope = ~ 0.35pJ/bit/dB**

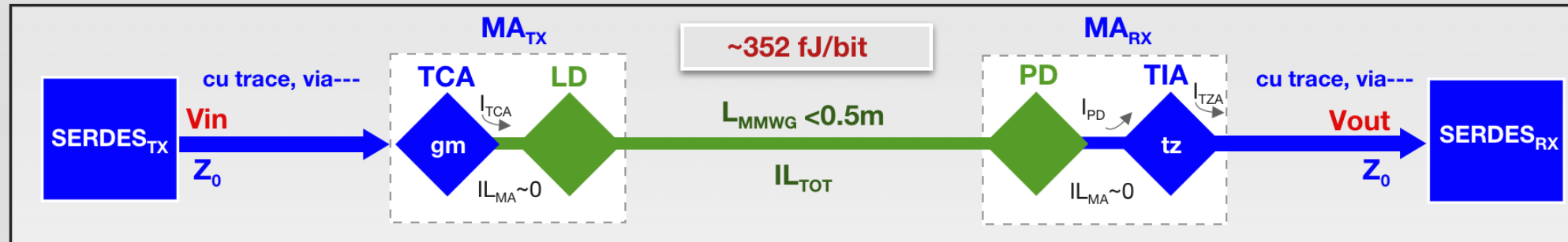


# Power Efficiency

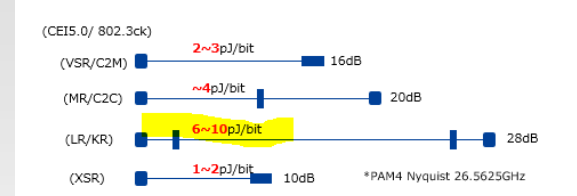
Copper Channel Model



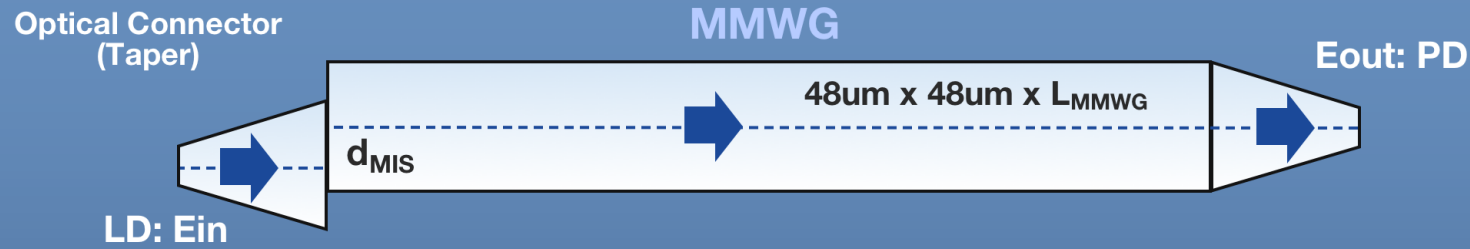
MWIS Channel Model



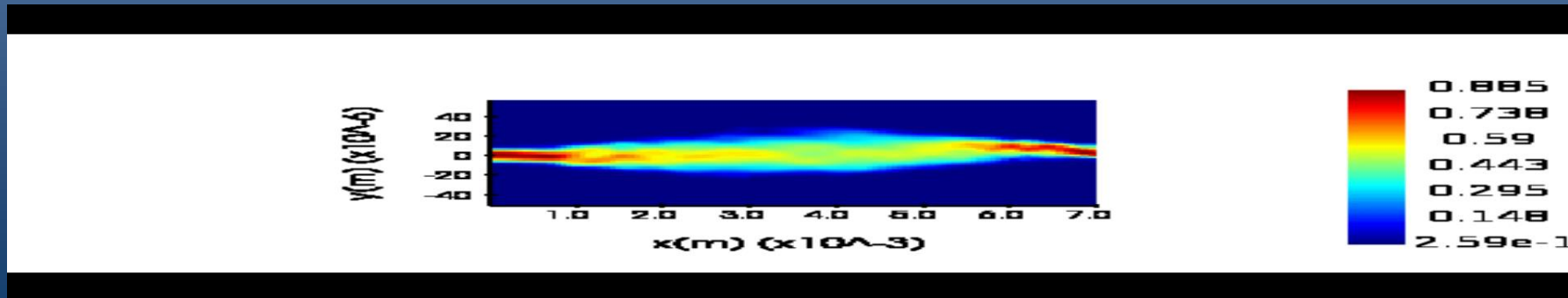
From previous chart EPB Slope = 0.35pJ/bit/dB  
 Example : 1dB copper for MWIS with pair of MAs will consume  
 0.7 (= 0.35+0.352) pJ/bit vs 6~10pJ/bit of LR



# MMWG Design Process



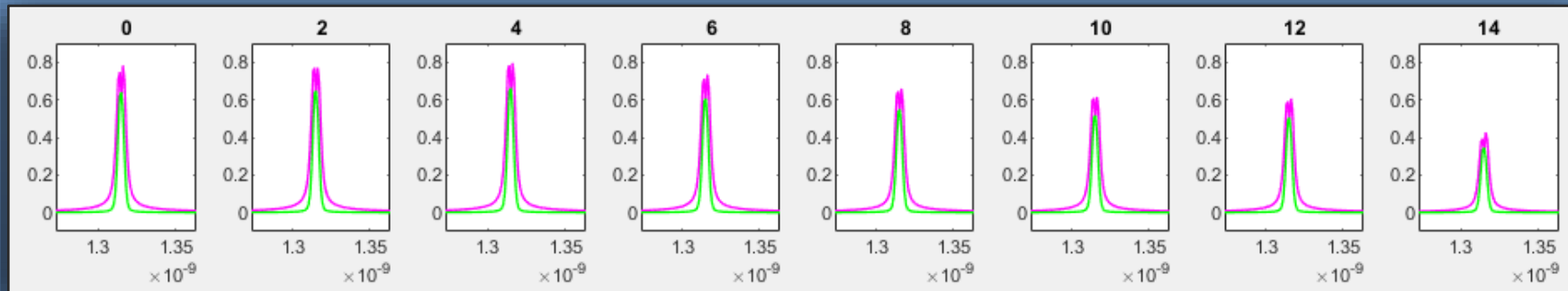
1. Extracting Optical S-Parameter to get Ein vs Eout (S21)
2. Apply practical misalignment condition  $d_{MIS} > 0$



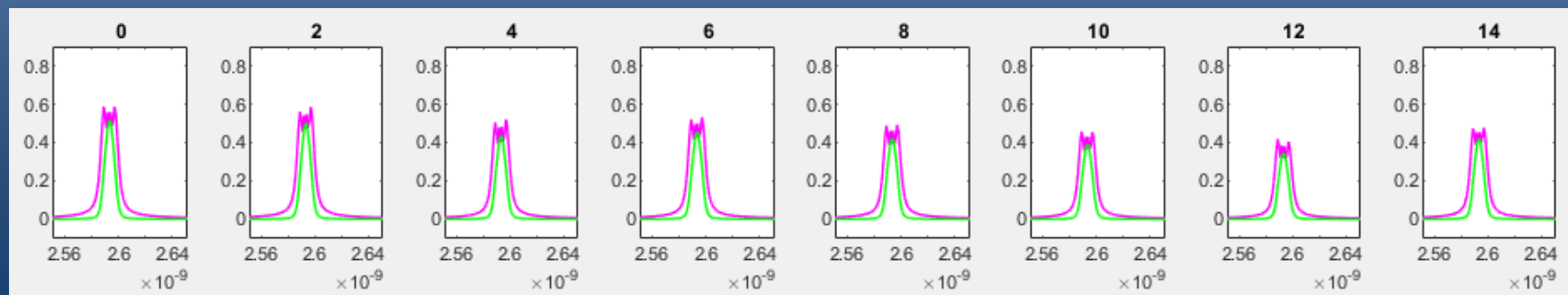


# Finite Impulse Response vs $d_{MIS}$ ( $\mu\text{m}$ )

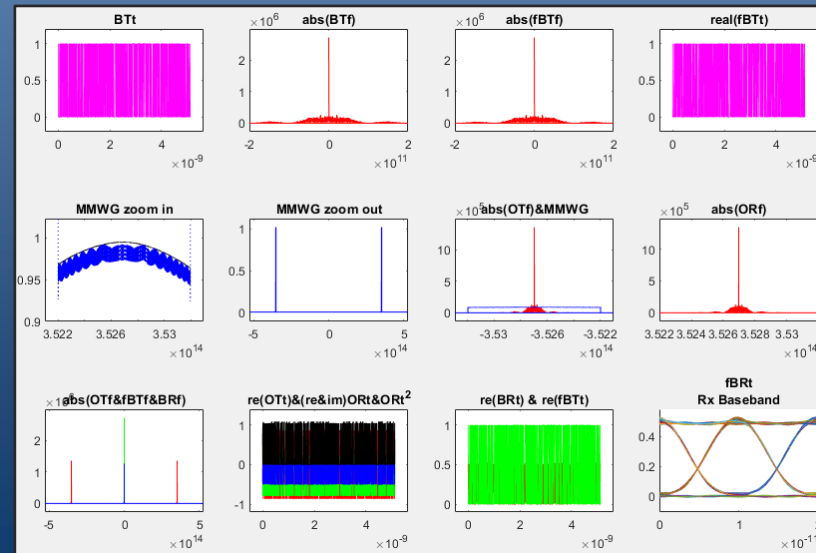
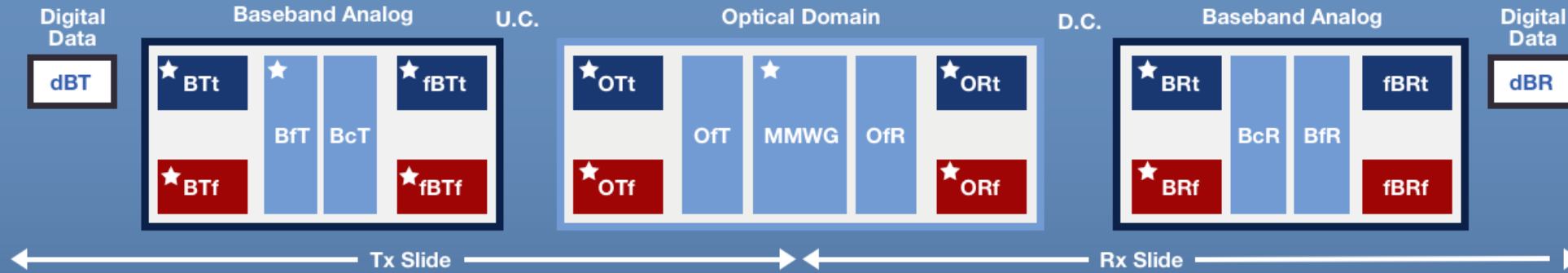
$L_{MMWG} = 250\text{mm}$



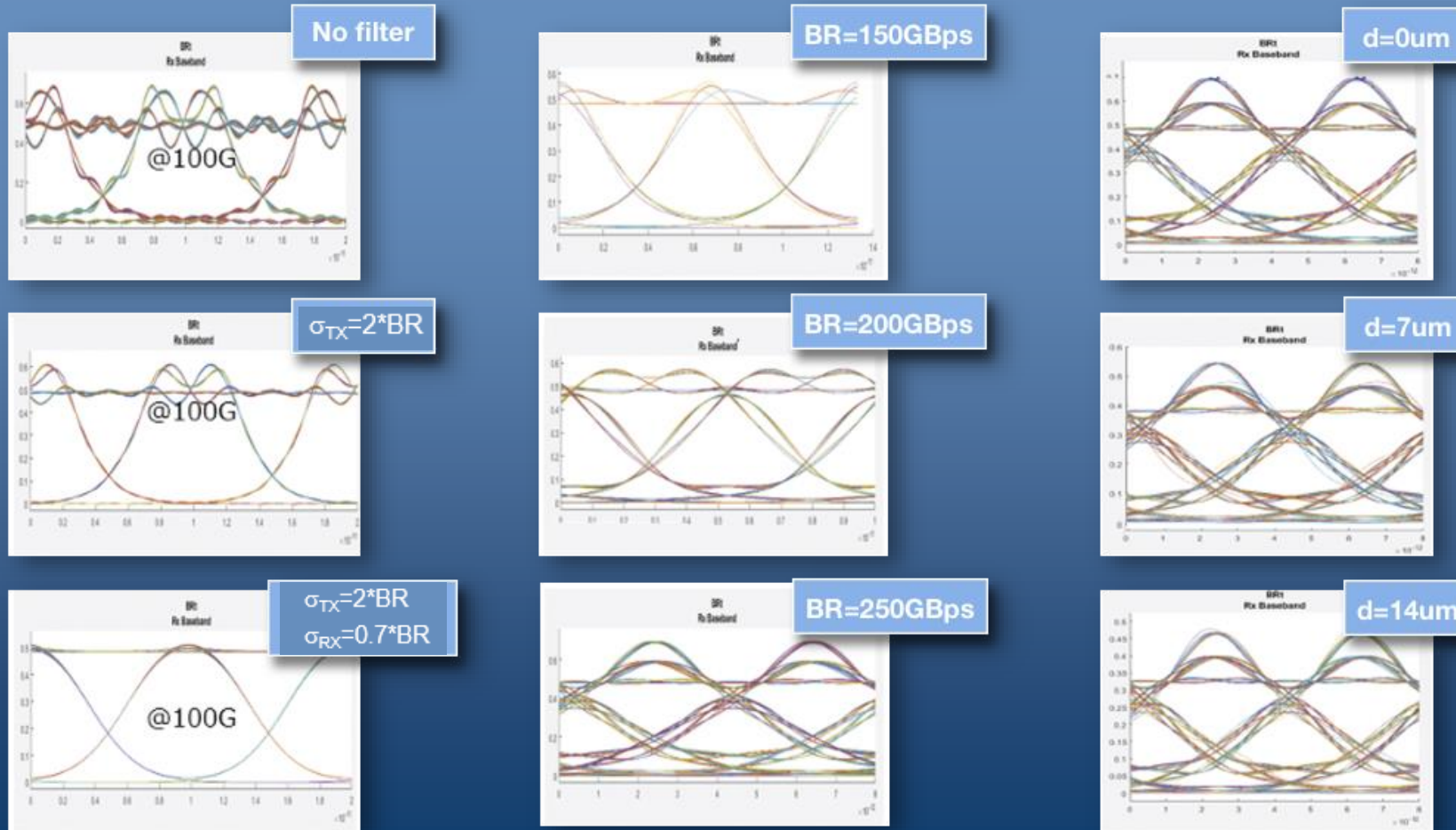
$L_{MMWG} = 500\text{mm}$



# Link Modeling & Simulation



# Eye Diagrams



- ❑ PCB embedded, optical Multimode Waveguide with the very thin EO and OE converter called MA (Media Adaptor), together with the very short copper trace forms a newly proposed interconnect system called MWIS (Multimode Waveguide Interconnect System)
- ❑ MWIS architecture has been reviewed as a future proof solution of a new PCB interconnect system in the power consumption and bandwidth breakthrough perspective
  - MWIS channel can be implemented with extremely lower energy consumption even with the addition of eo/oe module
  - Optical S21 is extracted with misalignment variation and reviewed through the channel Impulse Response to assess the modal impairment
  - Eye diagram with linear electrical filter shows promising results however NLTV filters can be further applied as an encouraging next topic where Electrically equivalent S21 is to be formulated for standard and industry activity.
  - With the SERDES for MWIS channel, there seems no fundamental bandwidth limit up to Lightwave carrier frequency (200~300Thz)