Finisar®

Fiber Optic Solutions
for High-Speed Networks

# Transmitters for 10G-EPON

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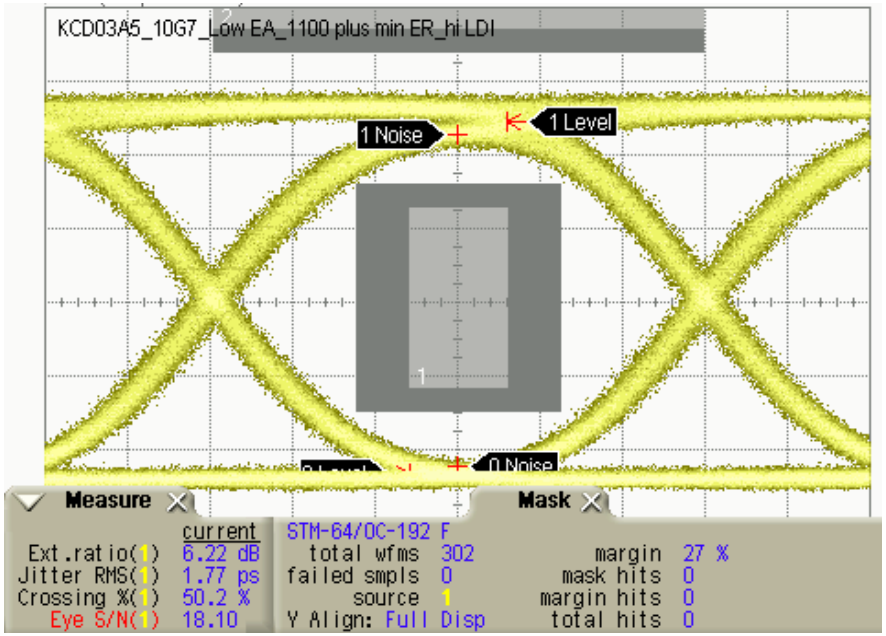
# EML Limitation: Distance vs. Power

- EML can meet 2-5 dBm requirement for 20 km reach
- EML cannot meet 60 km reach while having high 4 dBm output power:
  - For longer reach, EMLs are biased closer to the absorption edge to obtain negative alpha (negative transient chirp) for positive dispersion fiber, leading to lower output power
  - For shorter reach, EML can be biased away from the absorption edge: This leads to higher output power, less negative alpha, and lower ER




**EML optimized for high power**

**Output Power = 4.5 dBm**

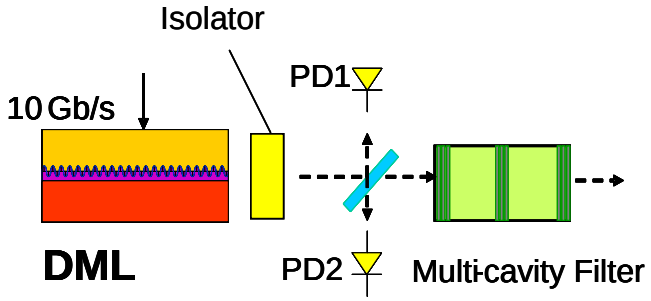
**Extinction Ratio = 6.2 dB**

**Mask Margin = 27%**

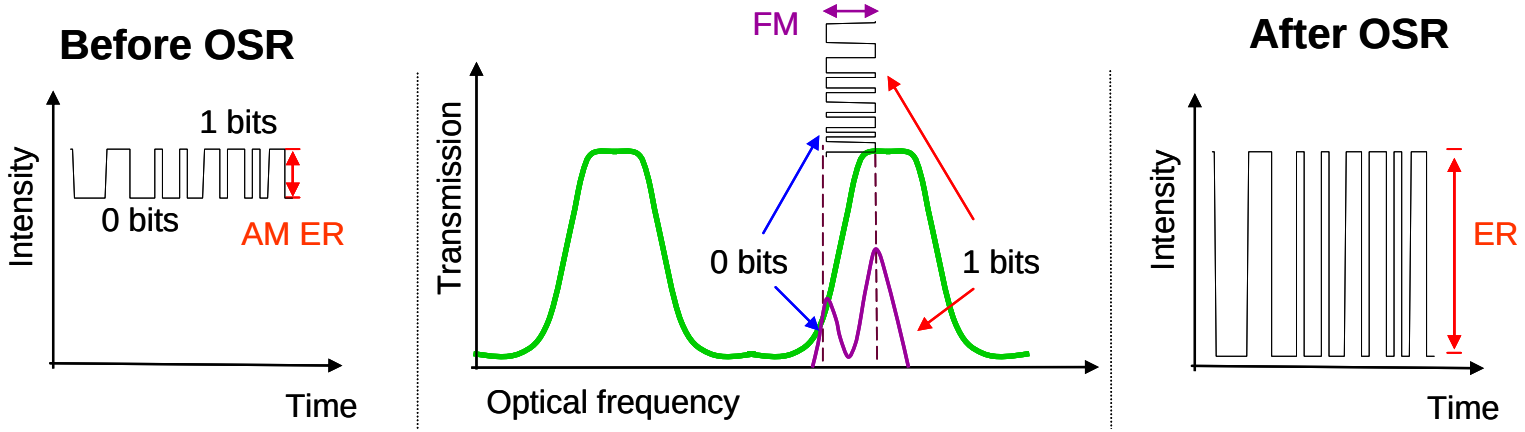
**Bit Rate = 10.7 Gb/s**

# What is CML?

- Chirp Managed Laser = Directly Modulated Laser + Passive Optical Filter
- Laser biased high → FSK mode
- Directly Modulate Laser generates FM
  - Extinction Ratio = 1-2 dB
- Filter converts FM to AM
  - Extinction Ratio = 10-12 dB




**Chirp Managed Laser**



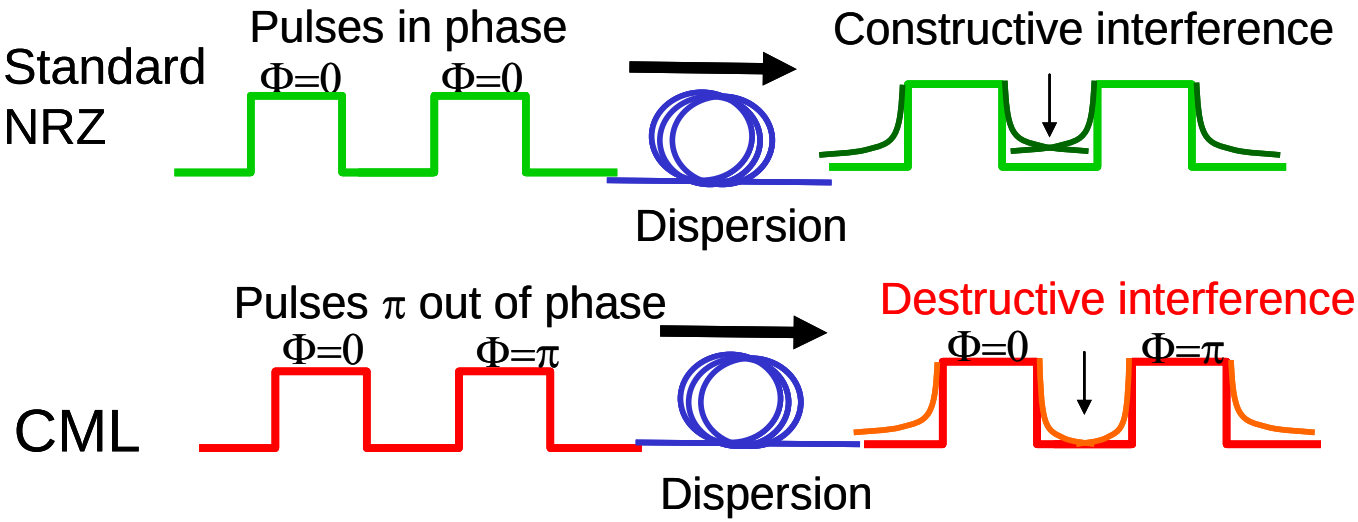

**Optical Spectrum Reshaper**

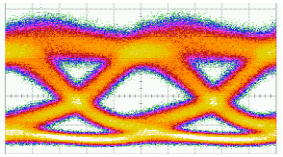
# How CML mitigates dispersion

- With standard NRZ driver: *No pre-distortion*
- Adiabatic Chirp to ~ ½ the bit rate→ 5 GHz for 10 Gb/s
- →CML Phase Rule:

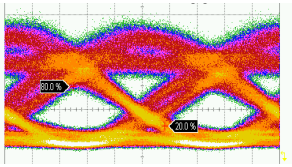
**1 bits separated by odd # of 0 bits are π out of phase**

- Destructive interference of 1 bits in the middle 0 bit slot keeps eye open after fiber dispersion
- Similar to optical duo-binary modulation
- > 250 km transmission without DCF or EDC, with Standard Receiver



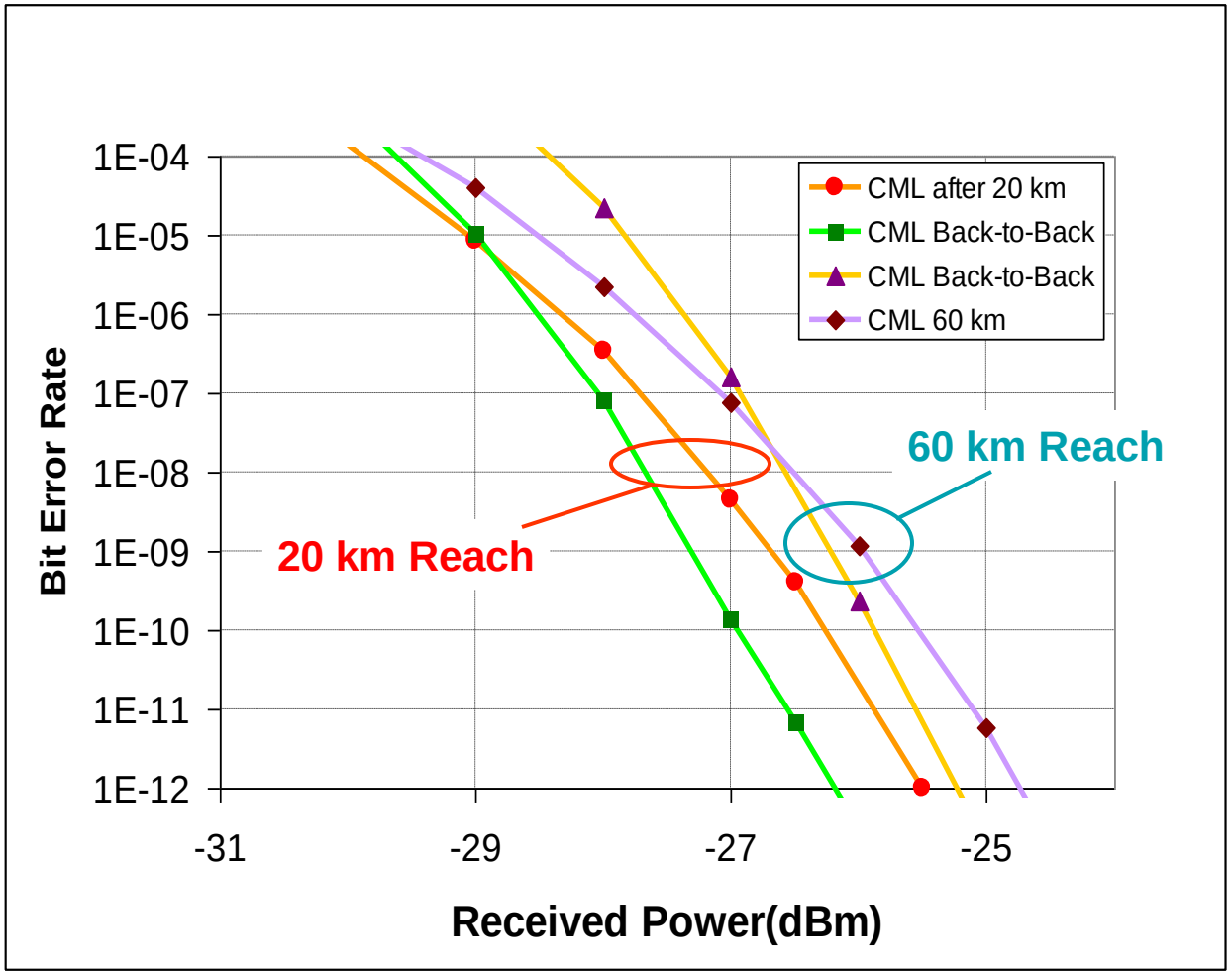



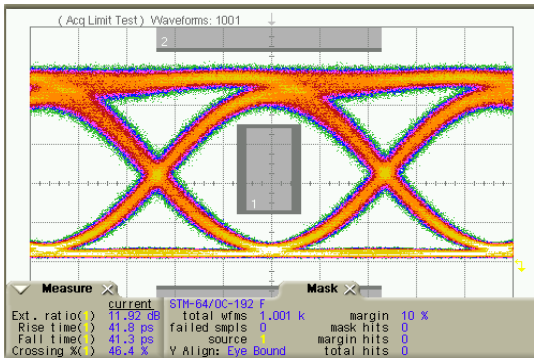
**EML @ 80 km**



**CML @ 200 km**

# CML for Long Reach: Power = 9.0 dBm



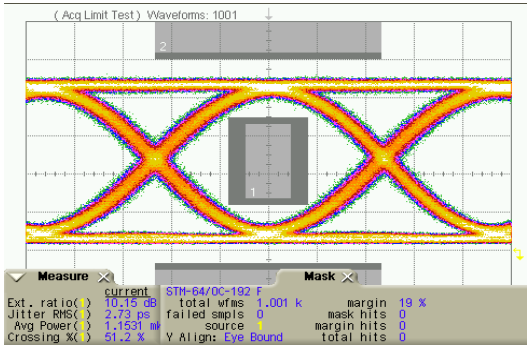

**DM80 CML Setup for 20 km:**

**Output Power = 9.03 dBm**

**ER = 10.3 dB**

**Mask Margin = 10%**

**Bit Rate = 10.7 Gb/s**




**DM80 CML Setup for 60 km:**

**Output Power = 9.03 dBm**

**ER = 10.15 dB**

**Mask Margin = 19%**

**Bit Rate = 10.7 Gb/s**

# CML vs EML Comparison

| | CML | EML |
|---|---|---|
| **Output Power** | 5-9 dBm | 2-5 dBm |
| **Rise/Fall Time** | Longer | Shorter |
| **Mask Margin** | Lower | Higher |
| **Max Reach** | > 60 km | 40 km |
| **ER with BT filter on** | Lower | Higher |
| **Power Consumption** | Lower | Higher |
| **Cost** | 200% | 100% |

- CML is a candidate for PR(X)40 applications
- Cost maybe a concern

# 10G-EPON Transmitters

- PR(X)30 ~ +2 to +5dBm output power; 29dB Max IL
  - EML
- PR(X)40 ~ +5 to +9dBm output power; 33dB Max IL
  - CML
  - EML + SOA
  - DML + SOA
    - With transient chirp reduction design, good for 20km applications
    - Lab result shows >10dBm output power
- Long Reach Applications – 60km
  - CML