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shaping tomorrow with you

400G Discrete Multi-Tone PMD for 10 km SMF

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Introduction

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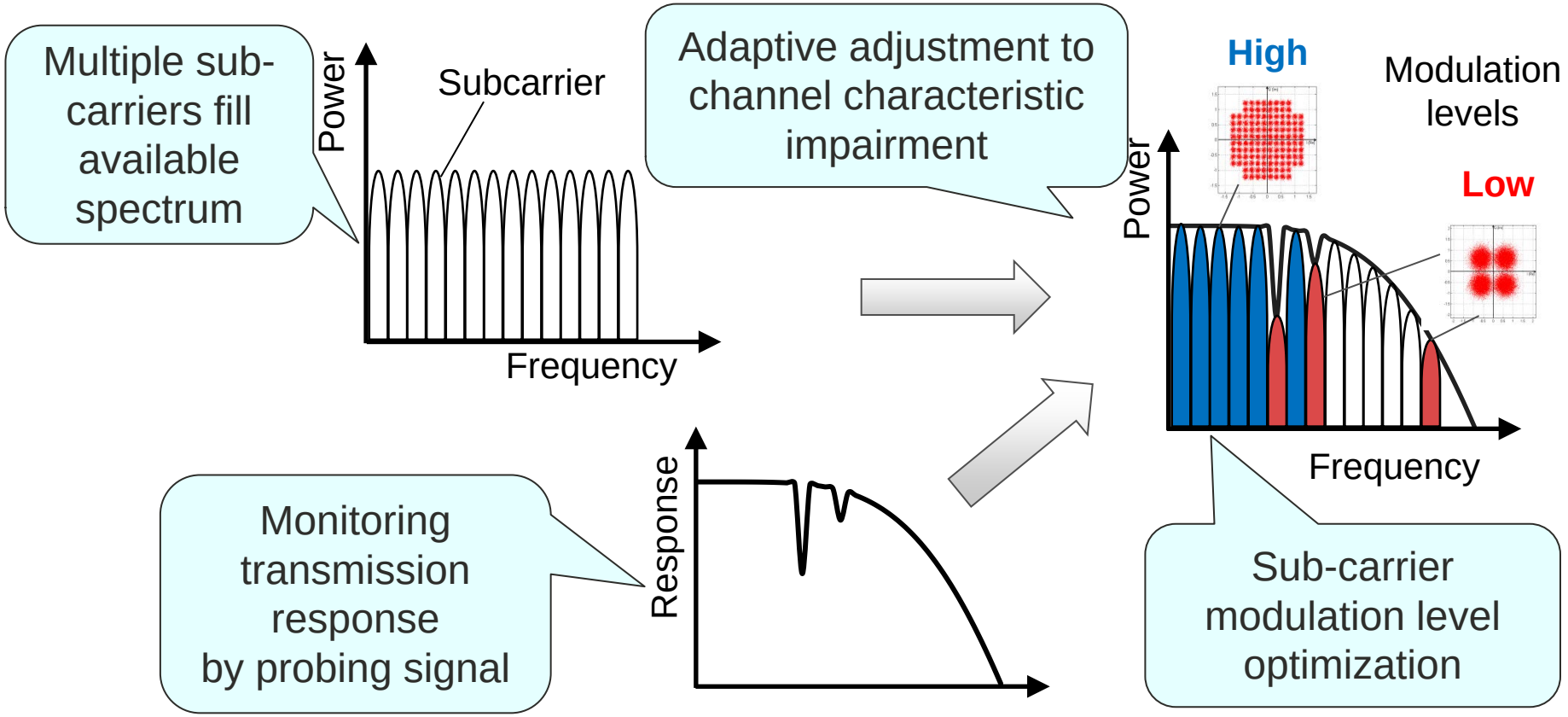
- We have shown feasibility of Discrete Multi-Tone (DMT) technology continuously and repeatedly from IEEE802.3bm.

- We are convinced that DMT is emerging technology for 400GbE, mainly by its robustness for optical and electrical components frequency response.

- In this presentation, we will introduce our recent experimental result of 116 Gbps DMT to realize 4λ 400GbE. And we demonstrate sufficient loss budget for 10 km PMD based on this experimental result.

Discrete Multi-Tone(DMT) Introduction

- Widely used in xDSL systems (ADSL, HDSL)
  - High spectral efficiency and cost effectiveness
- Adaptive bit and power allocation for each subcarrier
  - Optimization from SNRs of the transmitted probing signal

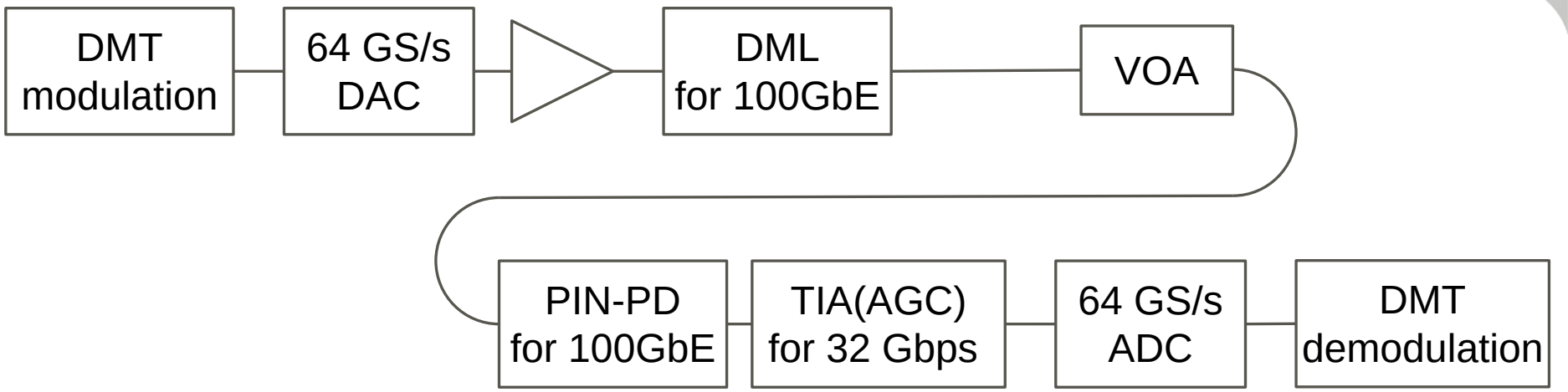


DMT Protocol Details

100G Lane bit rate	B_R	116.0156 Gbps*1
Sample rate	$F_S = B_R/2$	58.0078 GS/s
Number of subcarriers	$N_{FFT}/2$	256
Subcarrier spacing	ΔF	113.2965 MHz
Highest subcarrier	$F_S/2$	29.0039 GHz
Cyclic prefix Length	CP	16

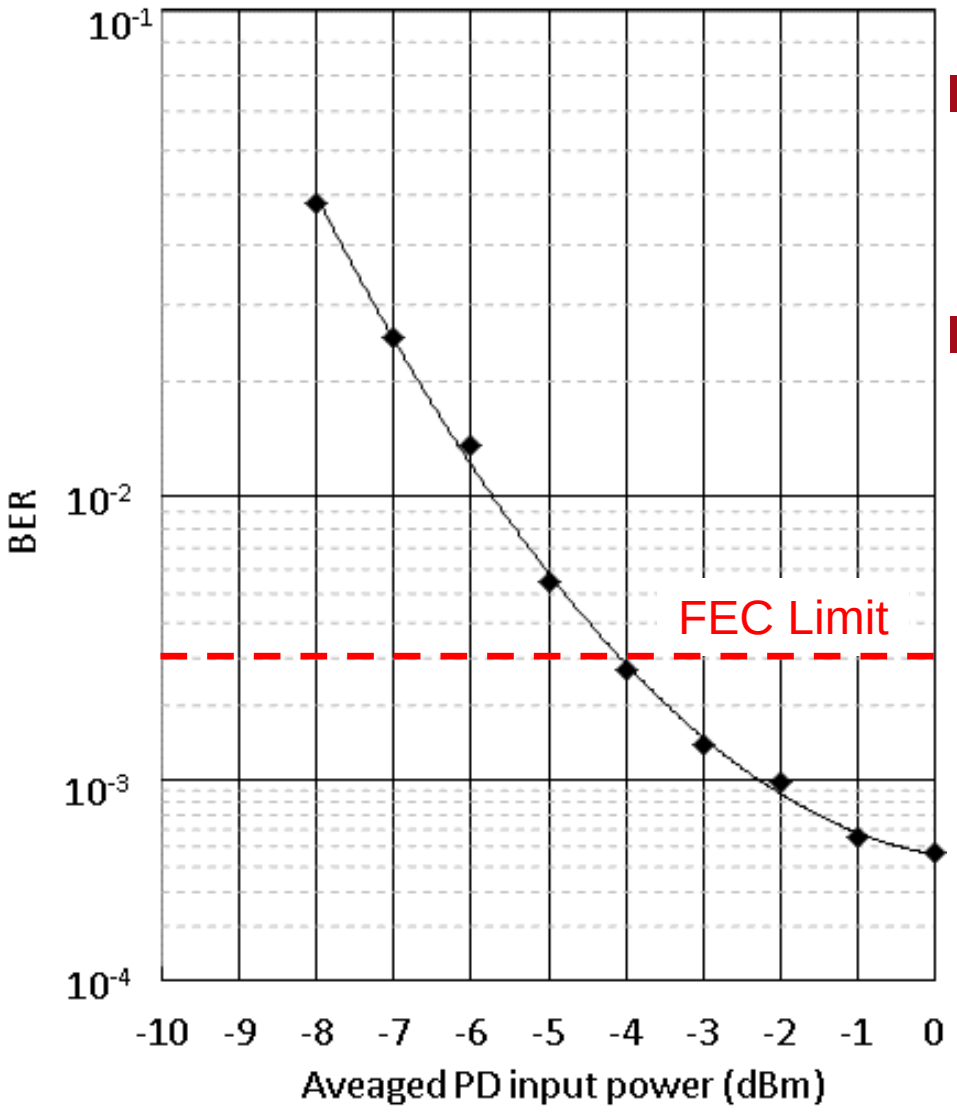
*1 103.125 Gbps + 12.5 % overhead for FEC

Experimental Setup



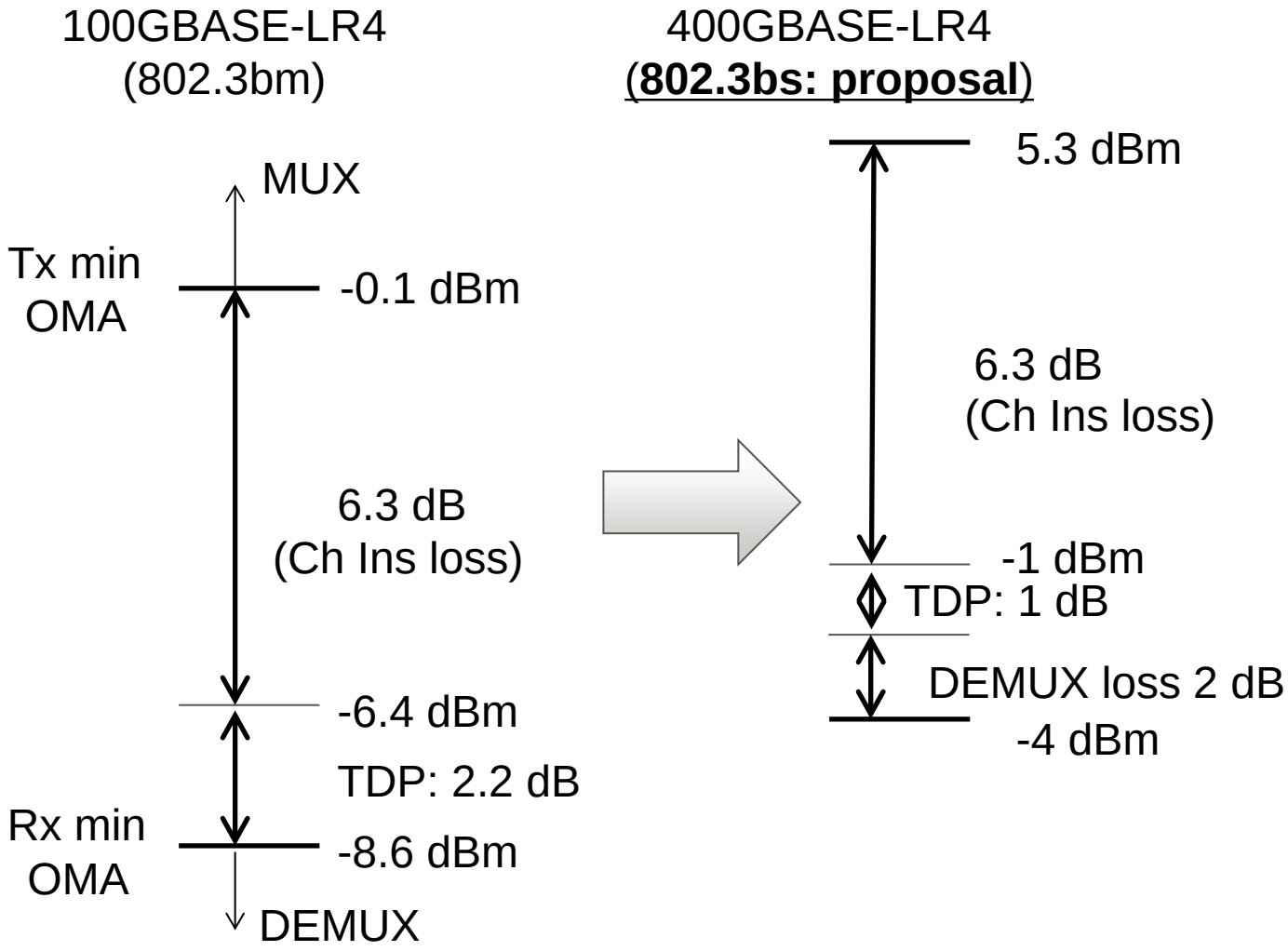
- 116 Gbps DMT sensitivity is measured with market available components including DAC and ADC.
- 64 GS/s DAC and ADC with evaluation boards are used.
- FEC: BCH(9193,8192)

Experimental Result



- For BCH(9193,8192), BER = 3.0E-3 is required for 1.0E-15 corrected BER.
- Better than -4 dBm sensitivity is confirmed.

Link Budget Consideration



This link budget is based on the experimental result using available components.

Conclusion

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Demonstrated sufficient loss budget for 10 km 400GbE (4 x 116 Gbps) PMD with DMT

Thank you

Appendix: Standard trend for Laser safety

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- ✓ Standard group: IEC TC76 WG5
- ✓ Related standards
  IEC 62805-1(Part1):Equip classification & requirements
  IEC 62805-2(Part2): Optical fiber communications

- ✓ Part1 : under revision for Ed3 “C7 problem”
  1300nm SMF Class1:
  L=3.9*10exp(-4)*C4*C7(C4=5, C7=8)
  =15.6mW (+12dBm)
  C7→ 8+10EXP(0.04* (λ-1250nm)) [Revision point]
  λ=1270nm(Worst) → L> 20dBm
  It will be discussed in Tokyo meeting (Nov2014)

- ✓ Part2: 1300nm SMF Class1 → +14.1dBm (Be in mind)
  (Distance:70mm, Aperture 7mm)