Security Level:

Study on Chromatic Dispersion on 25G NRZ in O-band

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Outline

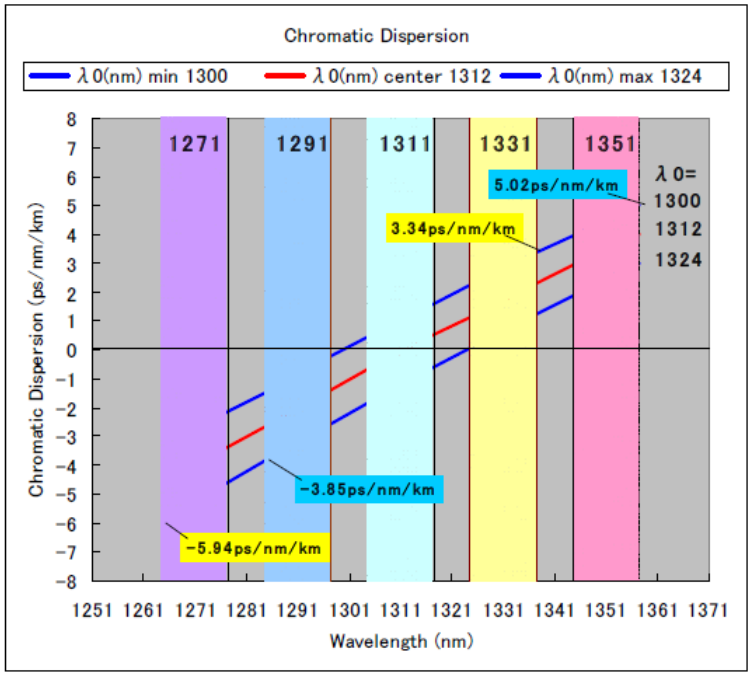
- Chromatic dispersion study limits
- 25Gb/s BER simulation over SSMF
  - A. near zero dispersion
  - B. O Band –
  - C. O Band +
- CD penalty after 20km SMF

Chromatic dispersion study limits

In the full O band (a relatively wide range of 100 nm), there is a large difference in chromatic dispersion.

$$\frac{\lambda S_{0\max}}{4}\left[1-\left(\frac{\lambda_{0\max}}{\lambda}\right)^4\right] \le D(\lambda) \le \frac{\lambda S_{0\max}}{4}\left[1-\left(\frac{\lambda_{0\min}}{\lambda}\right)^4\right]$$

$$S_{0\max} = 0.092\, ps/nm^2 \times km; \lambda_{0\max} = 1324nm; \lambda_{0\min} = 1300nm$$



***CD vs wavelength in the SSMF**

Full O band (1260-1360 nm)

- CD(Min): D = -6.35ps/nm·km
- CD (Max): D = 5.16 ps/nm·km

We selected 5 wavelengths

1) **For Zero dispersion**

λ = 1311.0 nm (D = 0.5 ps/nm·km)

2) **For O band−**

λ = 1264.5 nm (D = -5.94ps/nm·km)

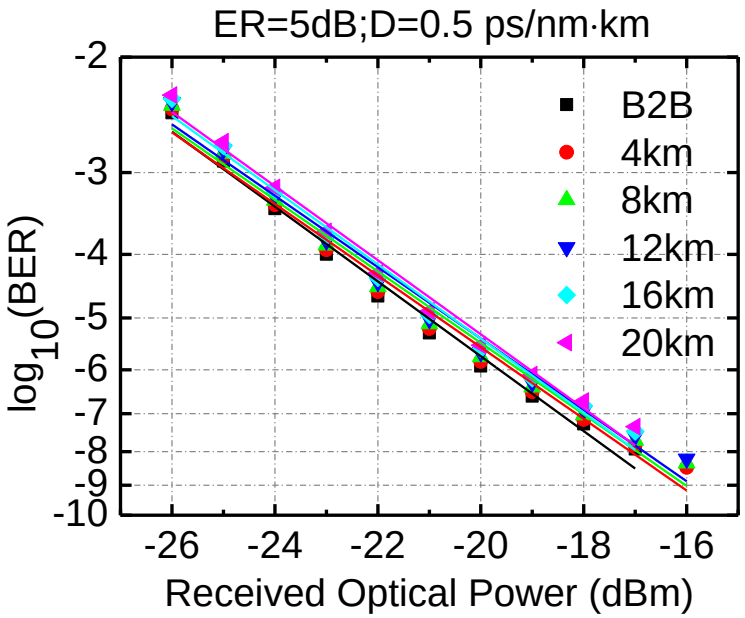
λ = 1284.5 nm (D = -3.85 ps/nm·km)

3) **For O band+**

λ = 1337.5 nm (D = 3.34ps/nm·km)

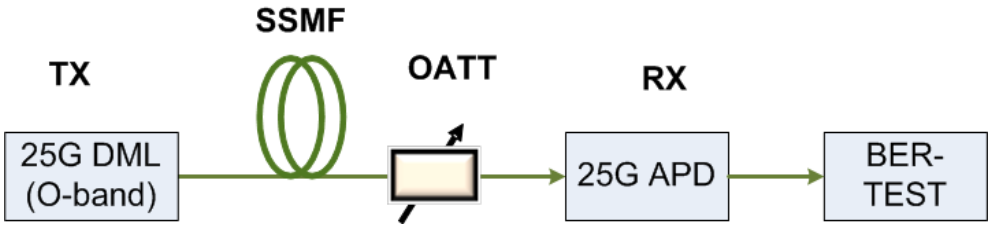
λ = 1357.5 nm (D = 5.02 ps/nm·km)

A. Near zero dispersion



λ=1311.0 nm

25 Gb/s BER simulation system:



The same system applies to the subsequent simulations.

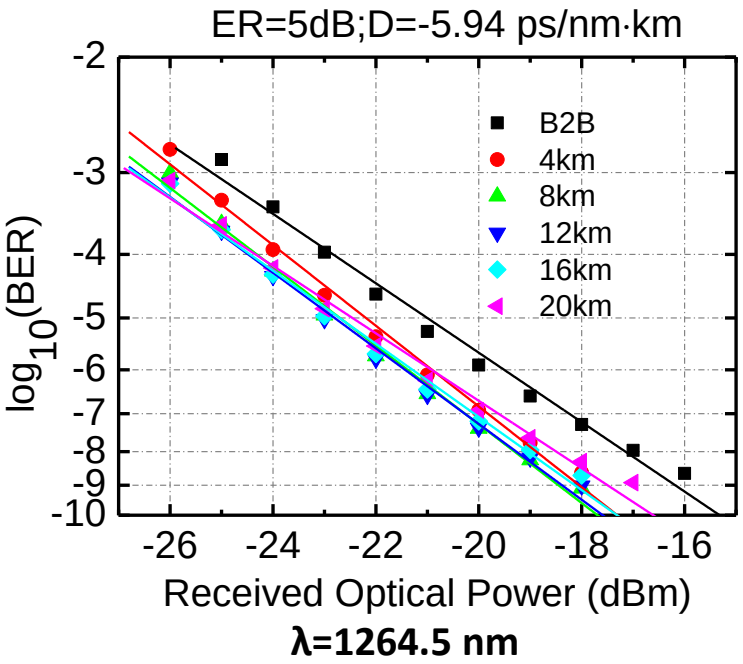
Cons:

1. **Around zero dispersion, the receiver sensitivity remains nearly unchanged as fiber length increases.**
2. **Around zero dispersion, the CD penalty is very small after 20 km SSMF. OK**
3. **There will be an ~30 dB power budget for 25G NRZ-DML. (The output power of DML is set to 5dBm)**

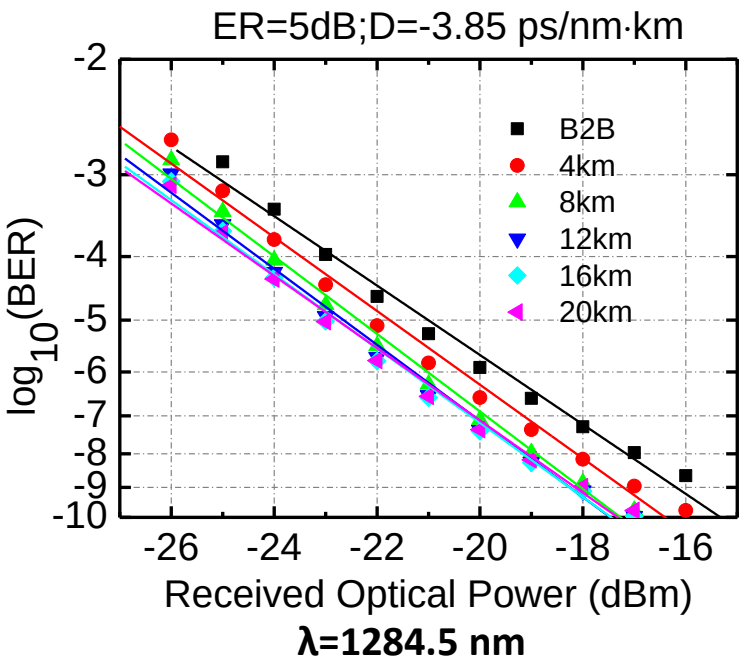
Note: Simulation setup

1. TX: 25G DML
   -Chirp α: 3.5
   -ER: ~5dB
2. RX: 25G APD
3. Modulation: NRZ

B. O band−



λ=1264.5 nm



λ=1284.5 nm

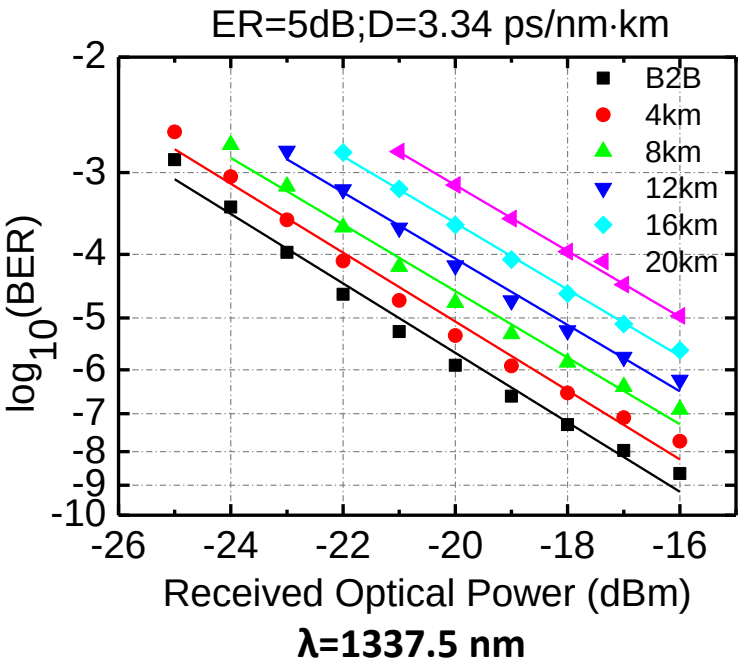
Cons:

1. **Around O band−, receiver sensitivity increases as fiber length increases.**
2. **Around O band−, the dispersion penalty is negative and will be within 2dB after 20 km SSMF. OK**

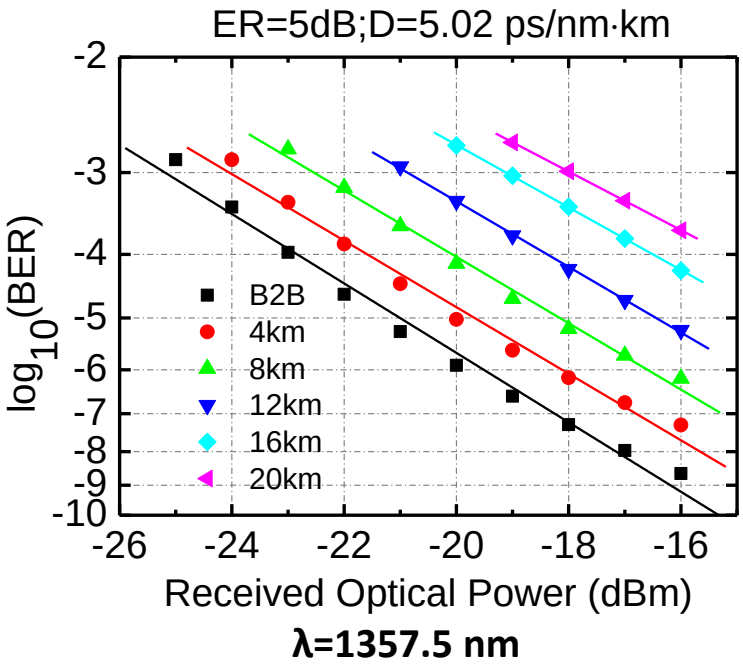
Note: Simulation setup

1. TX: 25G DML
   -Chirp α: 3.5
   -ER: 5dB
2. RX: 25G APD
3. Modulation: NRZ

C. O Band+



λ=1337.5 nm



λ=1357.5 nm

Cons:

1. **Around O band+, the receiver sensitivity will decreases as fiber length increases.**
2. **Around O band+ ,the dispersion penalty is large and will exceed 2dB after 20 km SMF. Not OK**

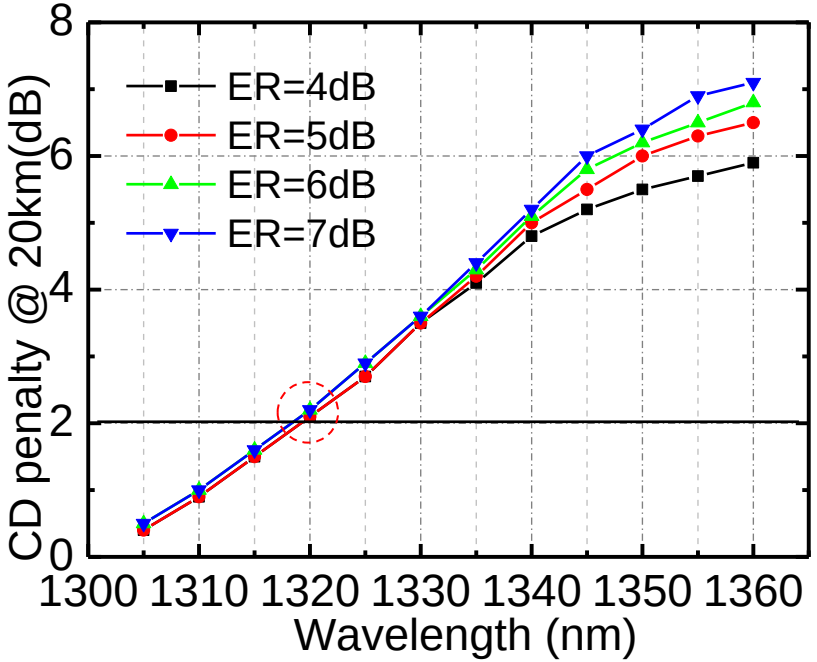
Note: Simulation setup

1. TX: 25G DML
   -Chirp α: 3.5
   -ER: ~5dB
2. RX: 25G APD
3. Modulation: NRZ

CD penalty in O band+ after 20km SSMF

	ER (dB)			
	4	5	6	7
ROF @ (B2B) BER = E-3 / dBm	-23.7	-24.8	-25.6	-26.4
wavelength where CD penalty = 2dB after 20 km SMF	~1320 nm			

***Note:** The zero dispersion wavelength, λ_0, corresponds to λ_{min} = 1300 nm, with a CD penalty ≈ 0 dB.*



Cons:

1. **The receiver sensitivity will decrease as the extinction ratio increases.**
2. **There still exits a CD penalty (> 2 dB) after 20 km SMF for different ER.**
3. **In the O band+, when D > 3 ps/nm·km (λ > 1330 nm), the CD penalty will increase as extinction ratio increases.**

Summary

1. There can be a ~30 dB power budget for 25G NRZ-DML. (ER ≥ 5dB)
2. The CD penalty is small (< 2dB) at near zero dispersion and the lower end of the O band (O band−).
3. The CD penalty at the high end of the O band (O band+) is excessive for a 25G DML and will need mitigation.
4. For the O band+, there still exits a large CD penalty (> 2dB) after 20 km SMF for different ER, and the CD penalty will increase as extinction ratio increases when D > 3 ps/nm·km (λ > 1330nm).

Thank you

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