P802.3cs Chromatic Dispersion Considerations

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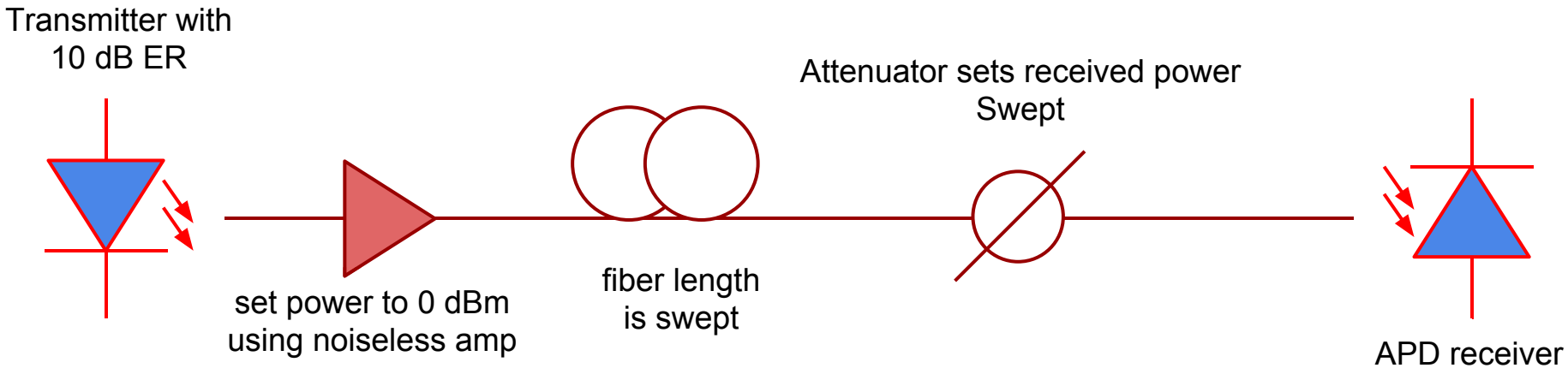
Overview

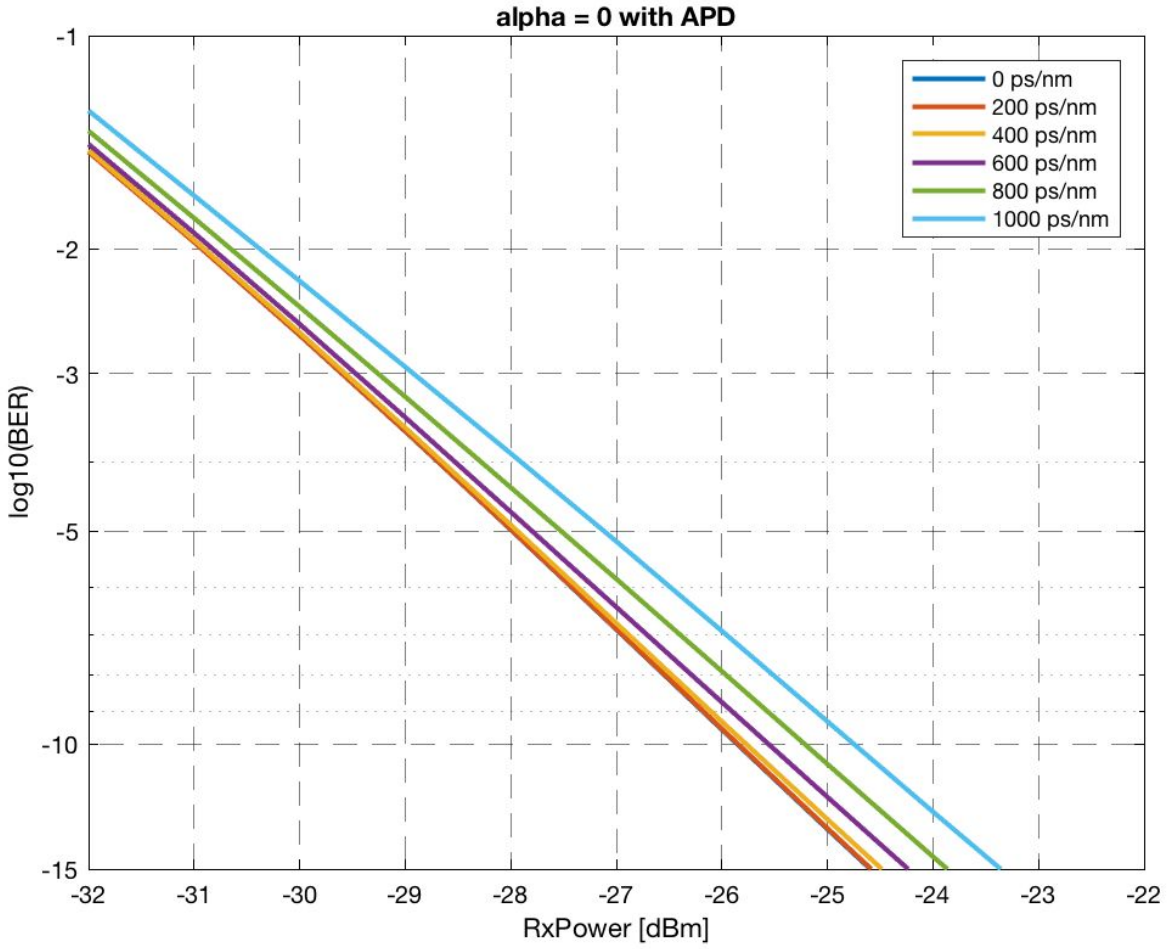
- VPI simulations were used to quantify the tolerance to chromatic dispersion of transmitters with different alpha parameters
  - Modulation depth set to 0.9 for all cases
- Simulated values for downstream
  - -0.5, 0.0, +0.5, 1.0
  - APD receiver assumed
- Simulated values for upstream
  - 0.0, 1.0, 2.0, 3.0, 4.0
  - APD with optical pre-amplification considered

Downstream assumptions

- A high extinction ratio is needed since the signal is boosted by amplifier
  - External modulation will offer higher extinction ratios at 10 Gb/s
- A low or negatively chirped EA modulators are possible because of the lower required transmit power
- ONU receiver will be an APD

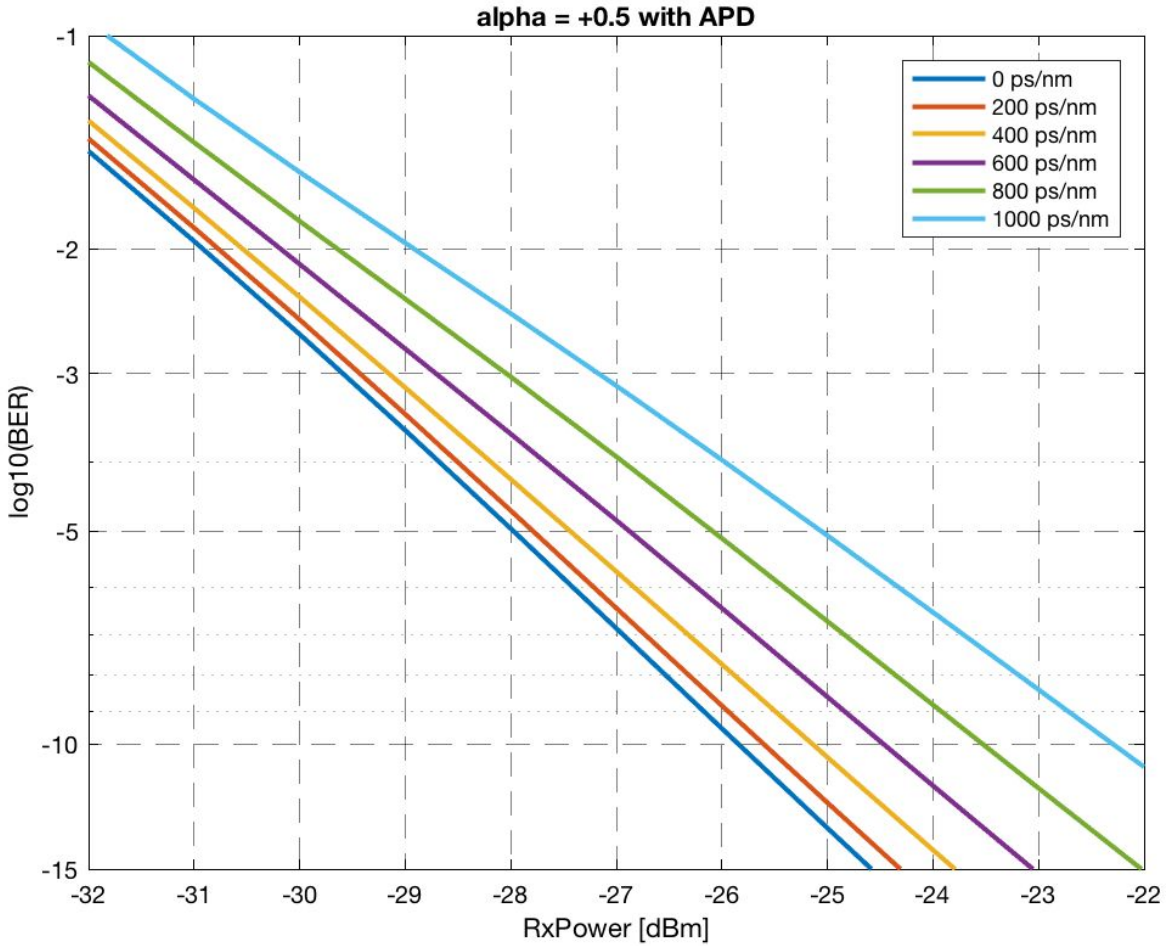


Downstream - APD receiver [alpha=0]



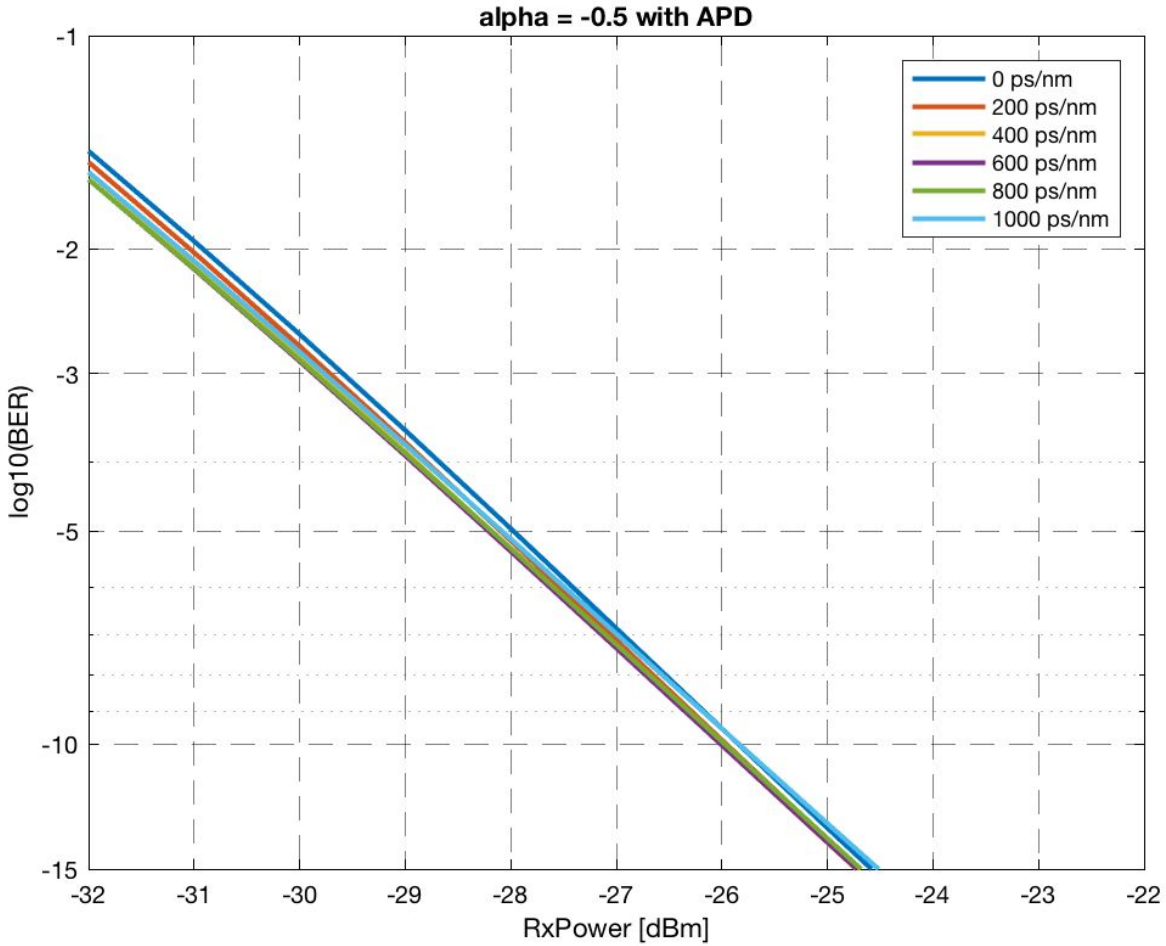
- 1000 ps/nm of chromatic dispersion results in around 0.6 dB penalty at BER=10^{-3}
- 1000 ps/nm is around:
  - 58 km in the C-band
  - 53 km in the L-band
- No DCM needed if OLT transmitters are chirpless EMLs

Downstream - APD receiver [alpha=0.5]



- 1000 ps/nm of chromatic dispersion results in around 2.5 dB penalty at BER=10^{-3}
- 400 ps/nm results in around 0.5 dB penalty
- 400 ps/nm is around:
  - 23 km in the C-band
  - 21 km in the L-band
- Will require DCM for longer lengths at EML with alpha=0.5

Downstream - APD receiver [alpha=-0.5]



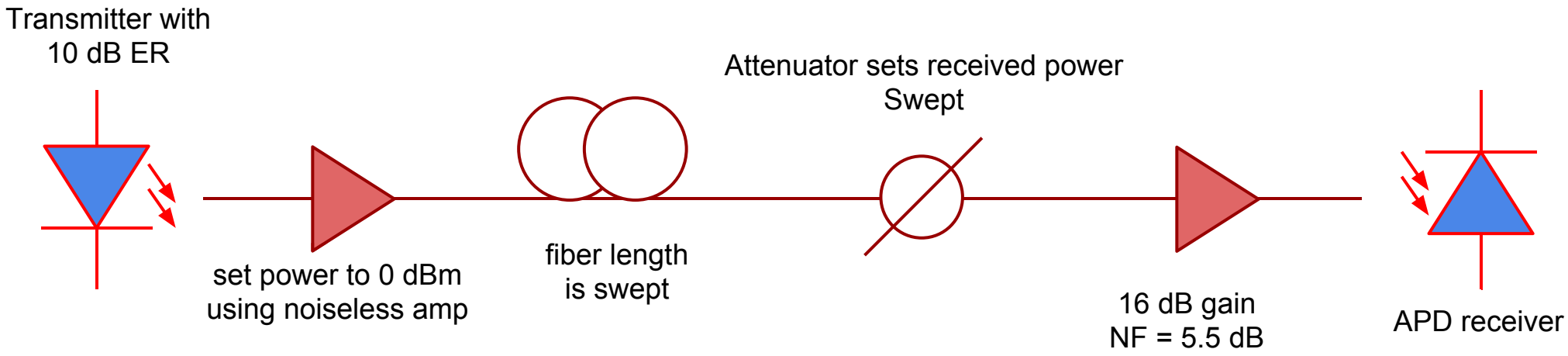
- Sensitivity gain for all residual dispersion >0
- Peak gain at 600 ps/nm
- No DCM needed if OLT transmitters are specified to be negative chirp
- Potentially made possible by the lower output power required (boosted by EDFA)

Downstream results

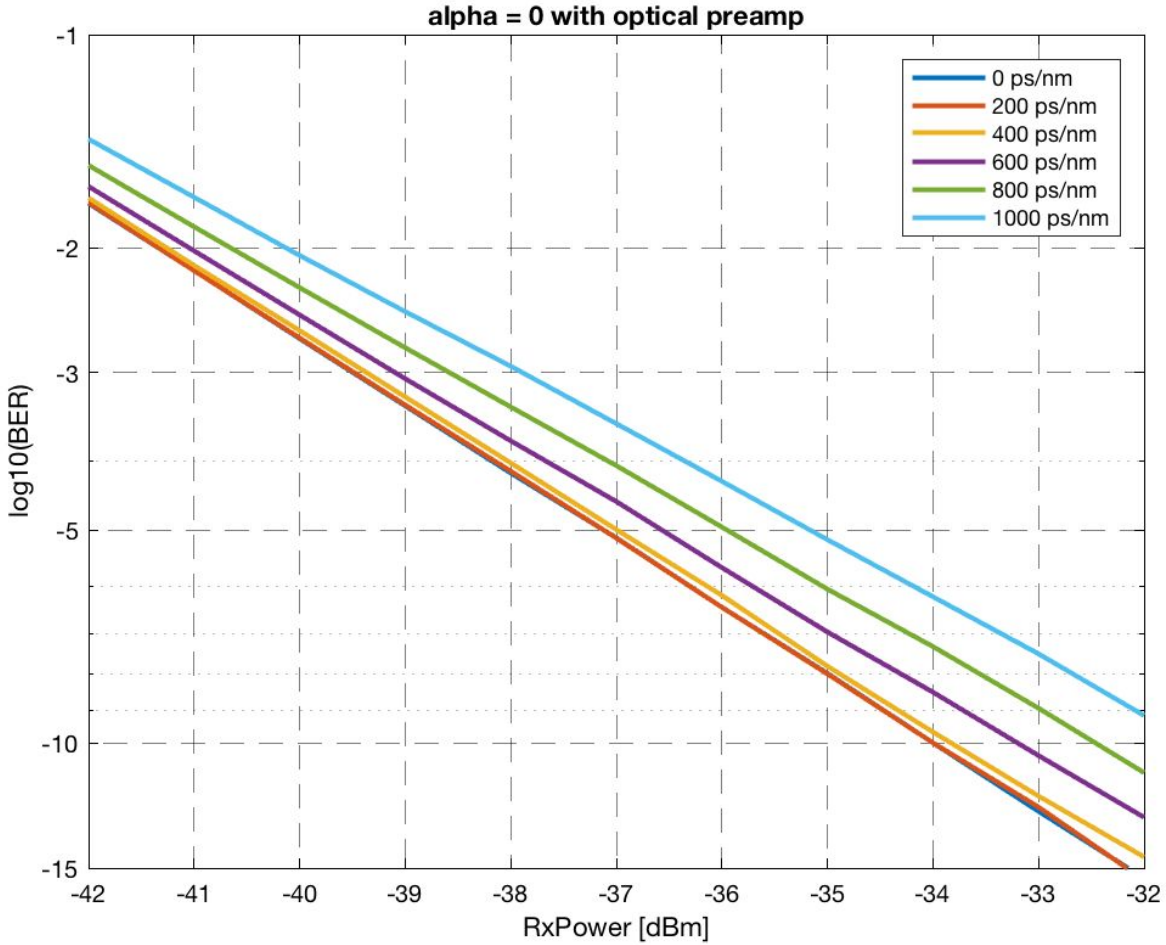
- A low or negatively chirped EA modulator will have small or negligible penalties from chromatic dispersion
- A DCM will not be needed on the downstream direction if the chirp OLT transmitter’s chirp is negative
- Positively chirped OLT transmitters can be enabled by using a DCM to compensate for the chromatic dispersion in longer links

Upstream assumptions

- ONU transmitter is required to be relatively high power >2 dBm @ 10 Gbps
  - No booster amplifier on the ONU side
- DML lasers are preferred for low cost and higher launch power
- OLT receiver will contain an optical preamplifier

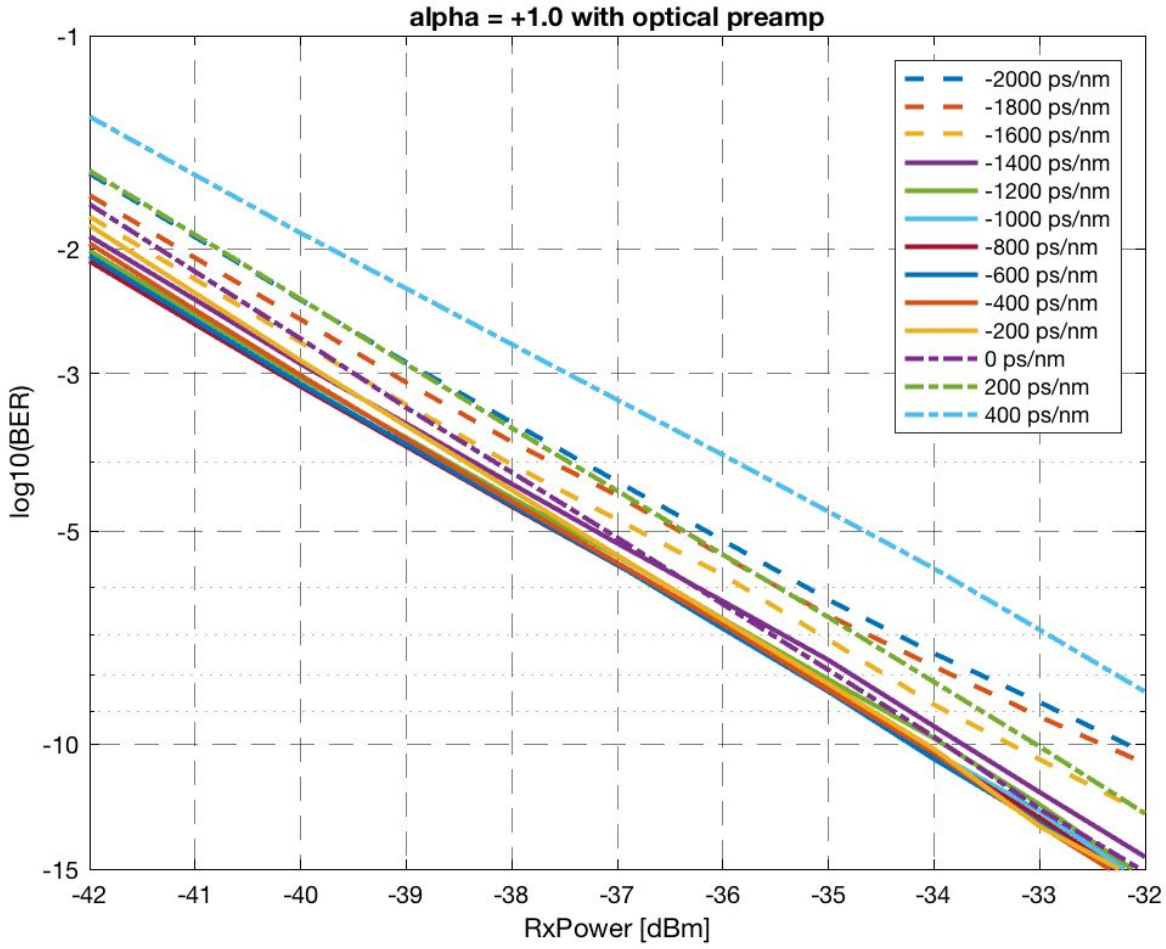


Upstream - optically preamplified [alpha=0]



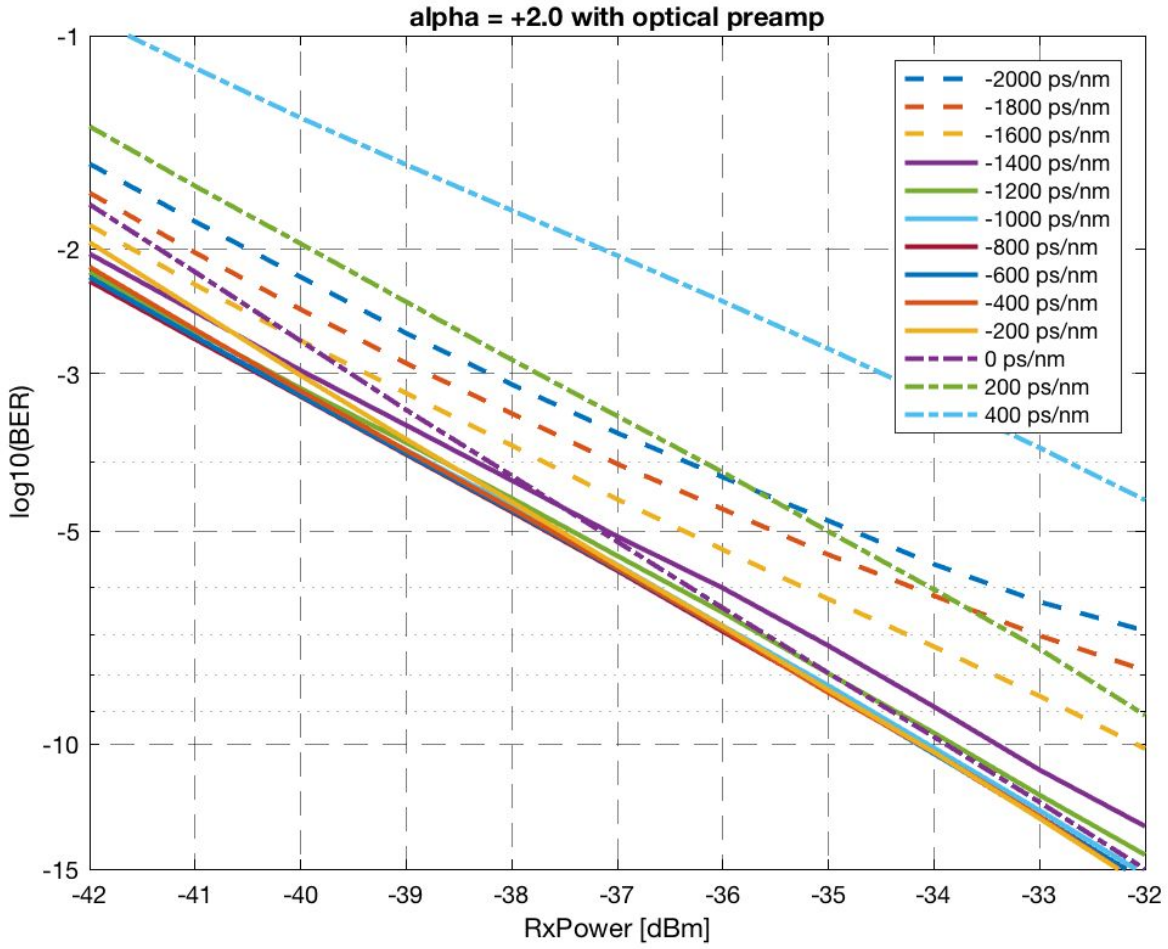
- 1000 ps/nm of chromatic dispersion results in around 1.6 dB penalty at BER=10^{-3}
- 1000 ps/nm is around:
  - 58 km in the C-band
  - 53 km in the L-band
- Optical preamplification makes system more susceptible to CD
- DCM is needed even for chirpless receiver

Upstream - optically preamplified [alpha=1.0]



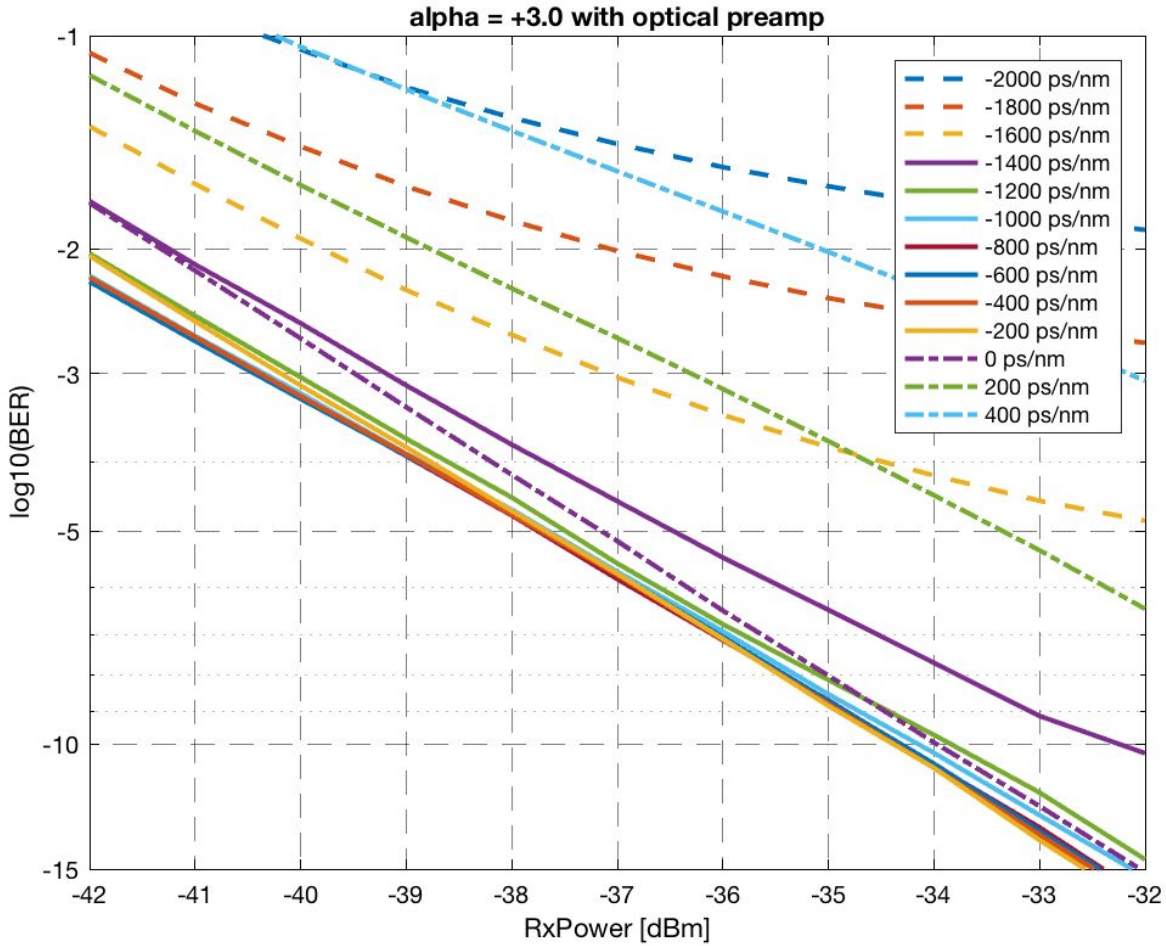
- <0.5 dB penalty difference for residual dispersions of -1400 ps/nm and -200 ps/nm at BER=10^{-3}
- 1200 ps/nm is around:
  - 70 km in the C-band
  - 63 km in the L-band
- A single DCM design can satisfy all link lengths if the chirp is <+1.0

Upstream - optically preamplified [alpha=2.0]



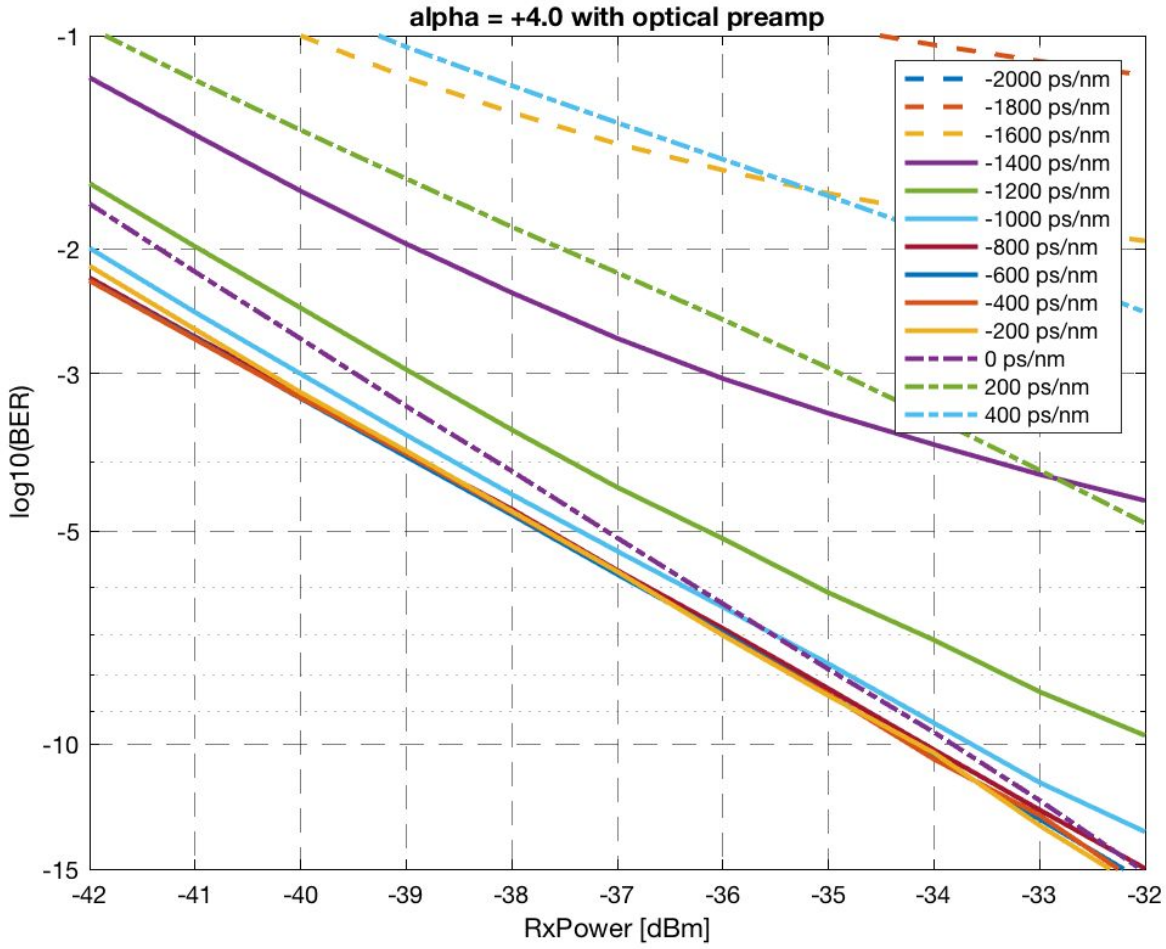
- <0.5 dB penalty difference for residual dispersions of -1400 ps/nm and -200 ps/nm at BER=10^{-3}
  - Penalty outside this range increases faster than alpha=+1.0 transmitter
- 1200 ps/nm is around:
  - 70 km in the C-band
  - 63 km in the L-band
- A single DCM design can satisfy all link lengths if the chirp is <+2.0

Upstream - optically preamplified [alpha=3.0]



- <0.5 dB penalty difference for residual dispersions of -1200 ps/nm and -200 ps/nm at BER=10^{-3}
- 1000 ps/nm is around:
  - 58 km in the C-band
  - 53 km in the L-band
- A single DCM design can satisfy all link lengths if the chirp is <+3.0

Upstream - optically preamplified [alpha=4.0]



- <0.5 dB penalty difference for residual dispersions of -1000 ps/nm and -200 ps/nm at BER=10^{-3}
- 800 ps/nm is around:
  - 47 km in the C-band
  - 42 km in the L-band
- Either two DCM parts or a tunable DCM will be required if the ONU transmitter has alpha = ~4.0

Downstream results

- For the upstream, chromatic dispersion compensation is likely to be needed.
- A DCM may be a good option as it can compensate for all channels
- One single DMC part can compensate for 0-50 km transmission lengths if chirp can be kept to be <+3 (alpha).
- If alpha>3.0, two DCM parts may be needed and links be engineered
- DCM module will need to compensate for >60 km of S-SMF fiber
  - Optimal sensitivity is when the link is overcompensated by 15-40 km for positively chirped transmitters

Conclusions

- Downstream seems possible without the use of DCMs using zero or negatively chirped OLT transmitters
- DCMs are likely to be needed for upstream direction
  - 0.5 dB penalty window is > 50 km for alpha <3.0 ONT transmitters

Thank you