SOLID OPTICS

Optical Transceiver Technology

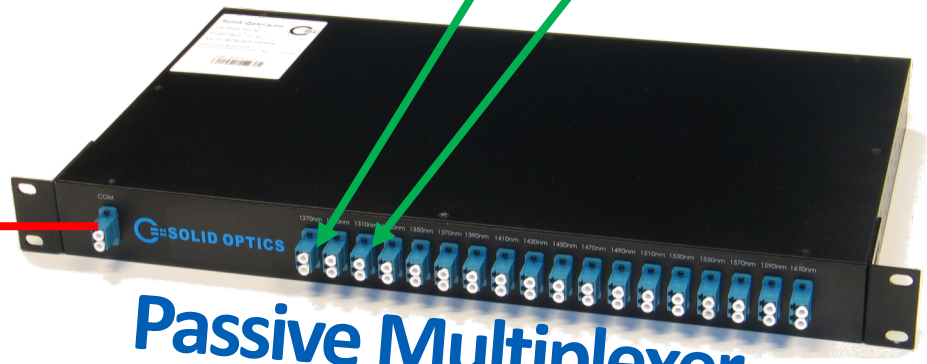
The Future of Passive Multiplexing & Multiplexing Beyond 10G

From 1G to 10G was easy
But beyond 10G?

1G CWDM/DWDM

10G CWDM/DWDM

Dark Fiber



Passive Multiplexer

25G

40G

100G

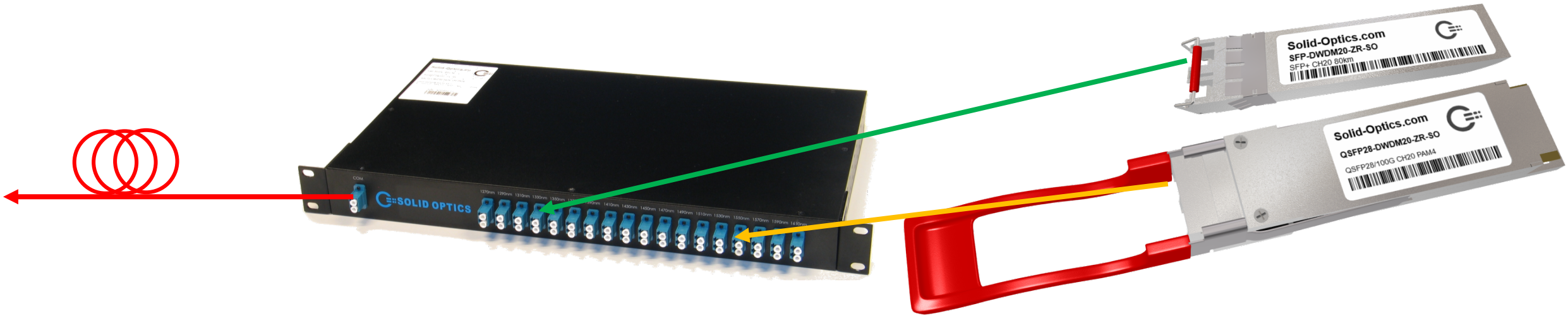
400G

Ingredients for Multiplexing

1) Dark Fiber

2) Multiplexers

3) Light : Transceivers

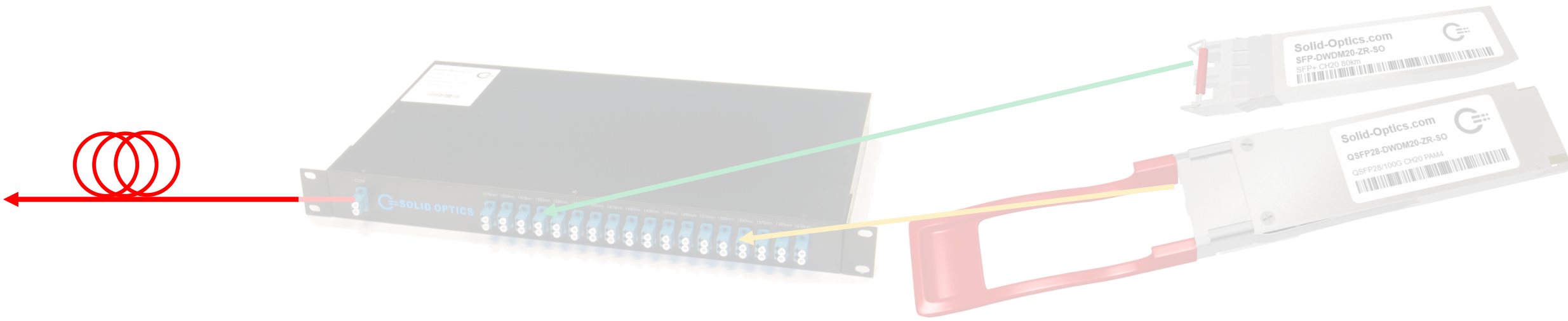


Ingredients for Multiplexing

1) Dark Fiber

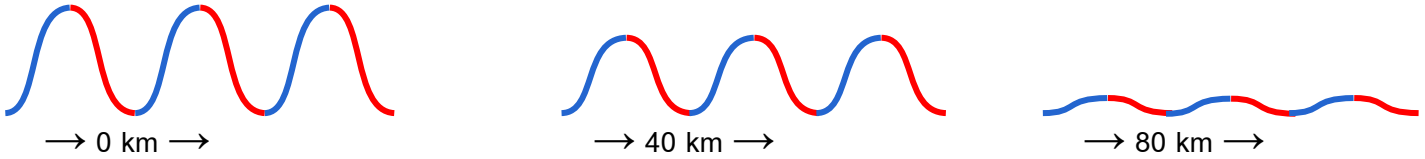
2 Multiplexer

3 Light + Transceiver

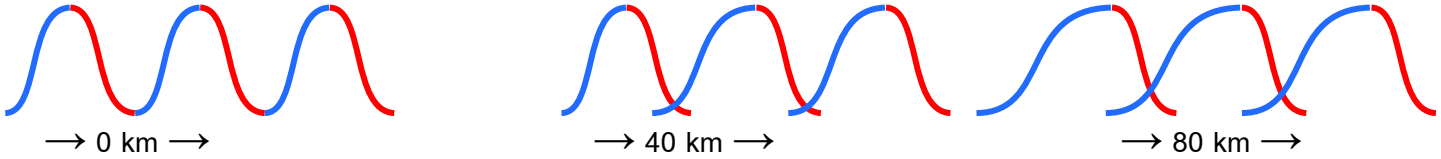


Dark Fiber

Attenuation



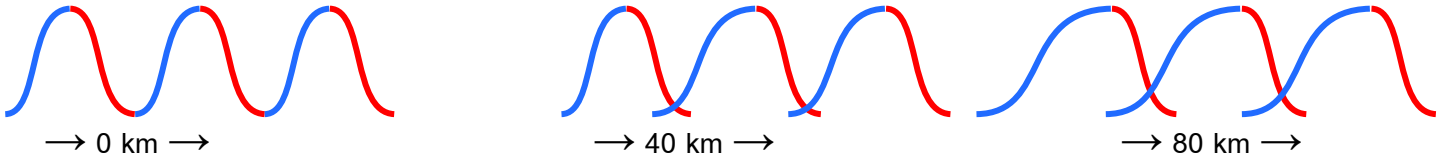
Dispersion



Dark Fiber

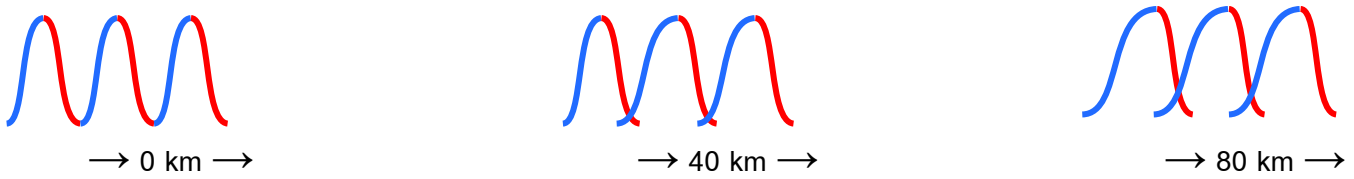
Dispersion

@1G



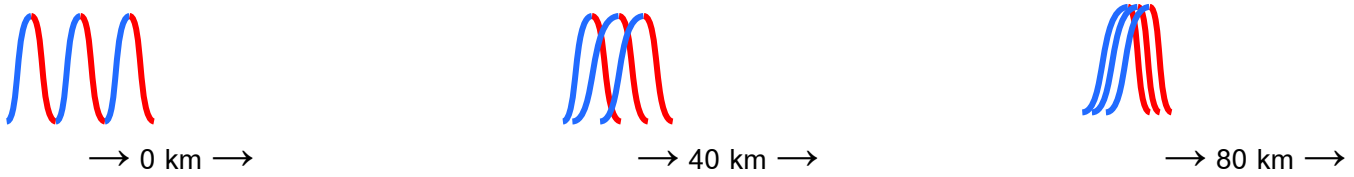
DWDM max 200km

@10G



DWDM max 80km

@25G

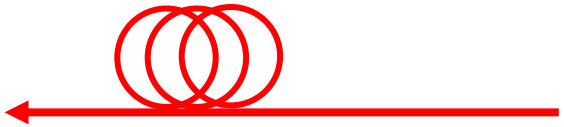


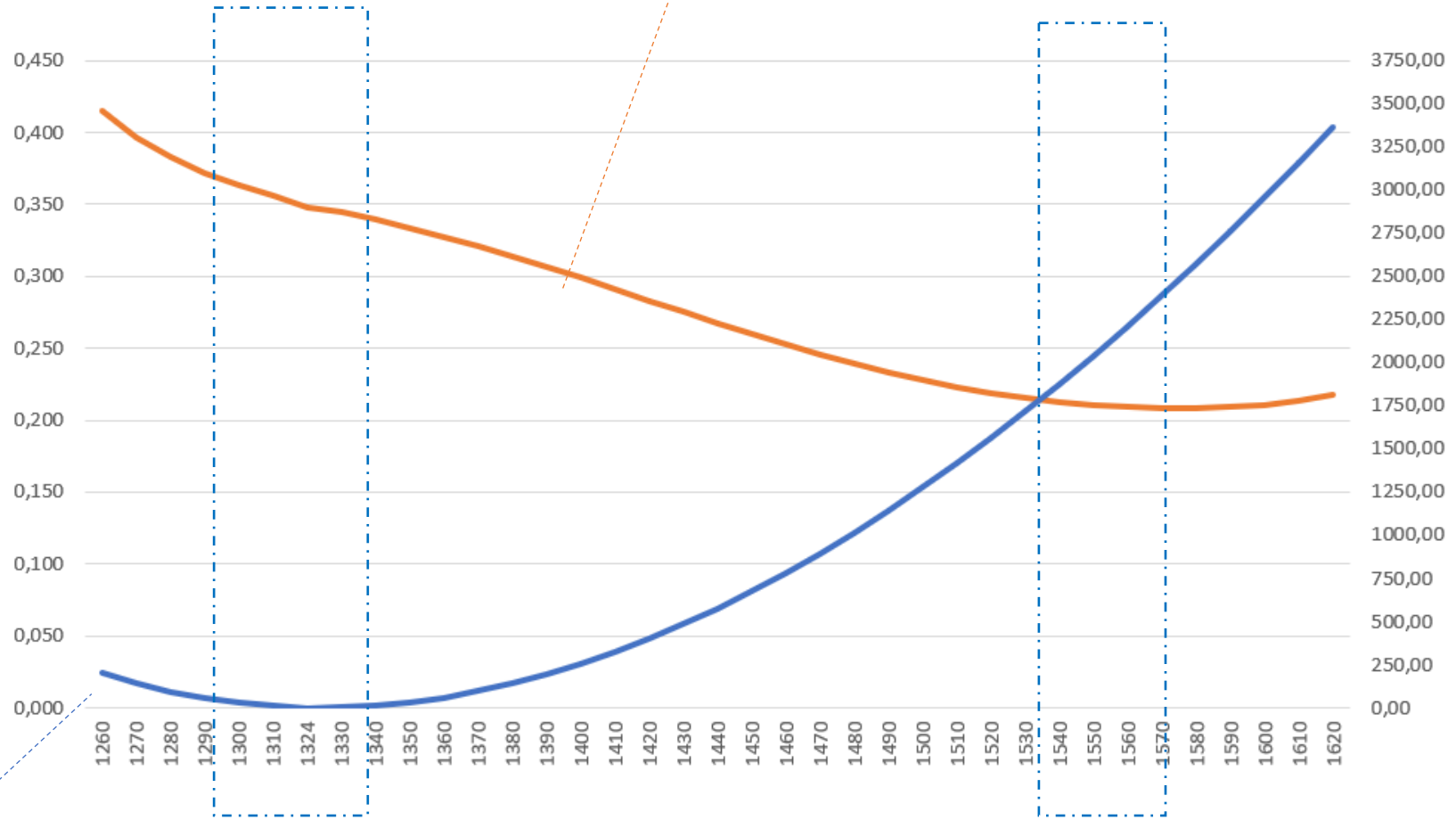
DWDM max 15km

Dark Fiber

Attenuation

→ 80 km →

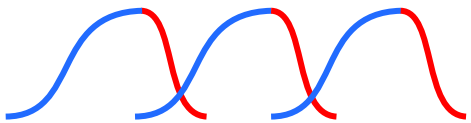




1310nm Window

1550nm/DWDM

Dispersion



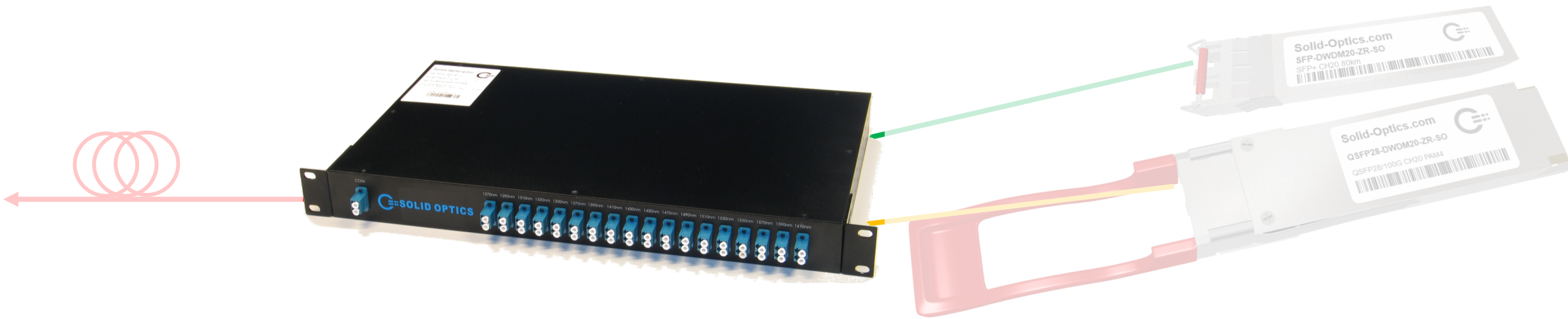
→ 80 km →

Ingredients for Multiplexing

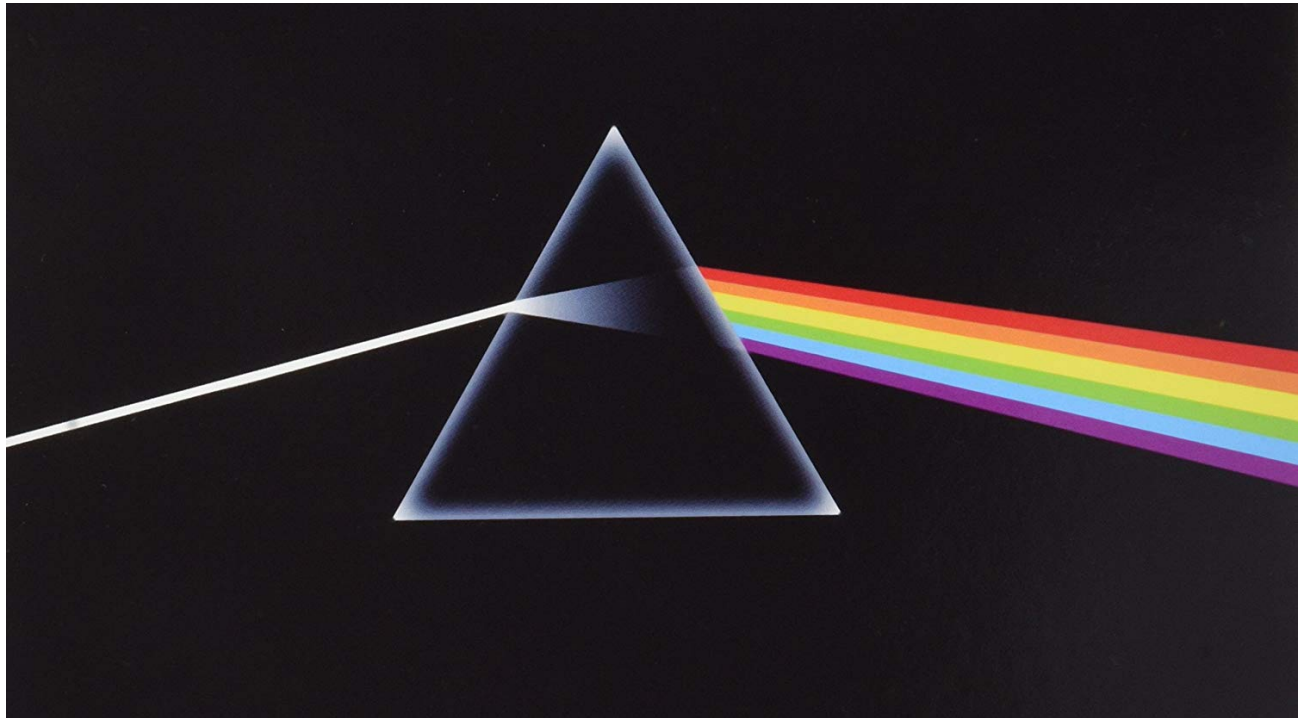
1 Dark Fiber

2) Multiplexers

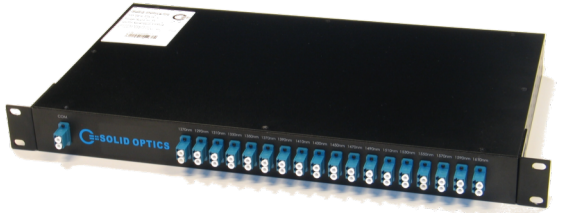
3 Light + Transceiver



Passive Mux



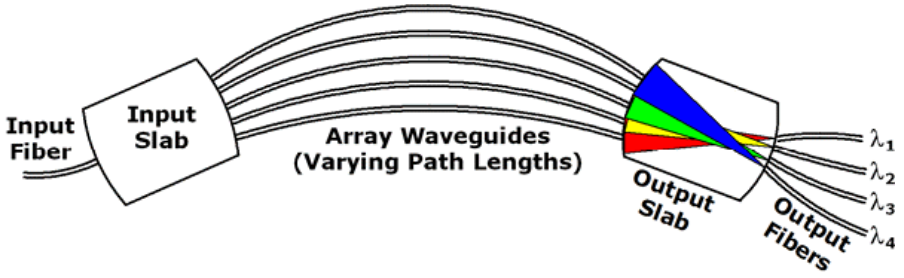
Multiplexers



2 types

- Cascaded TFF

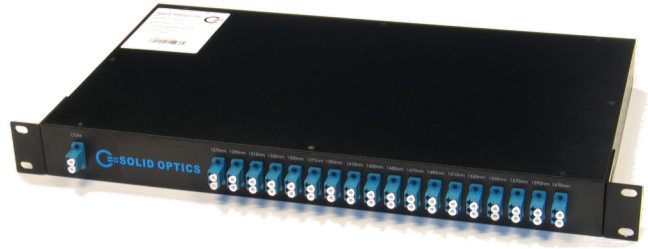
- AWG



95% of all Communication

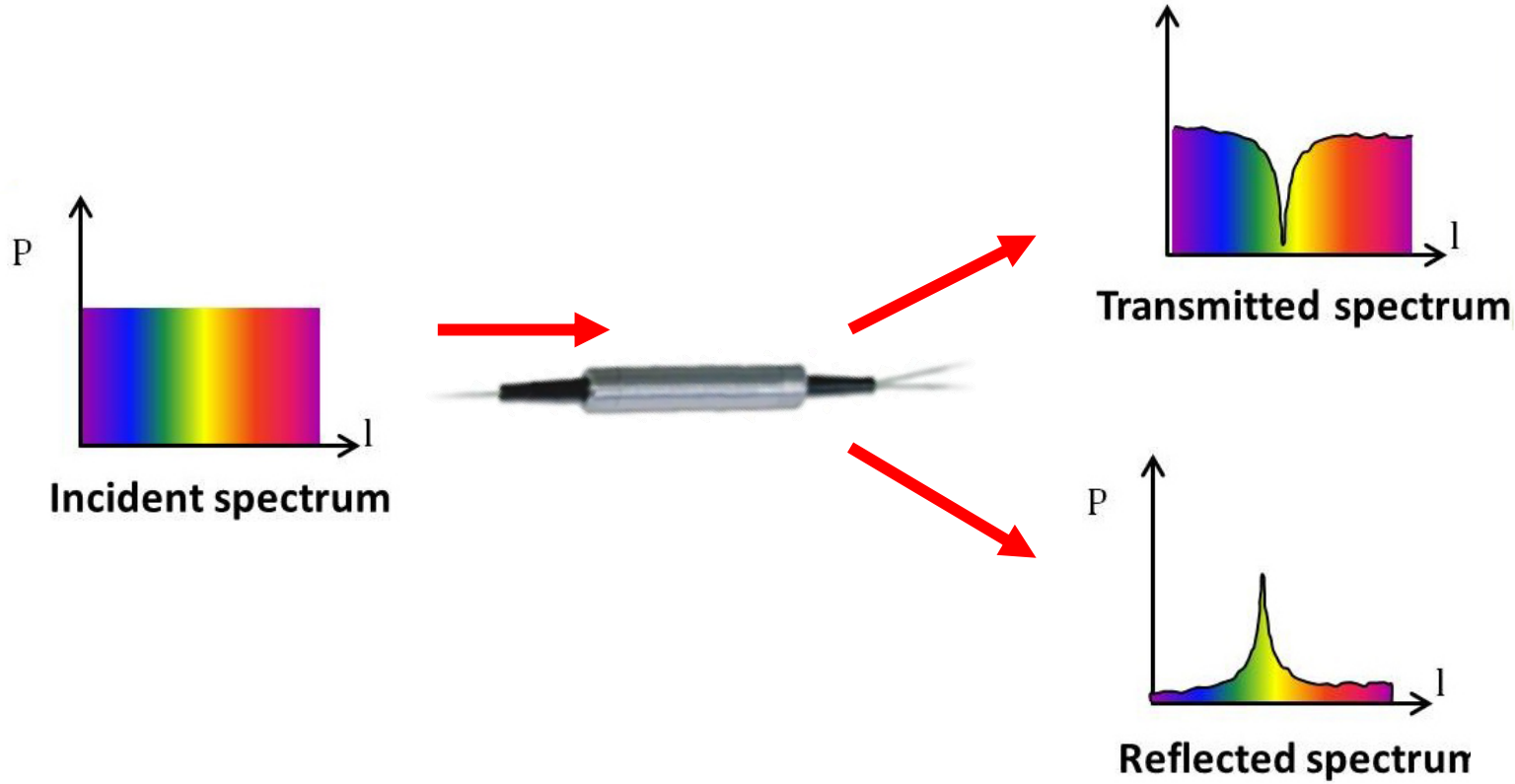
-Larger Multiplexers such as 40Ch/96Ch

Multiplexers

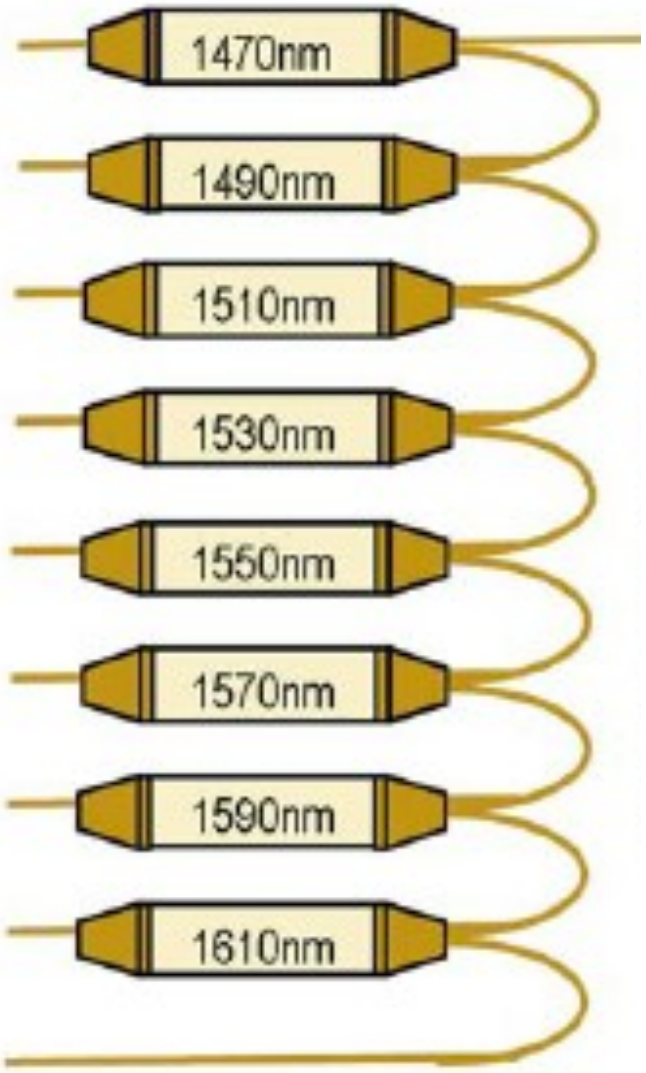


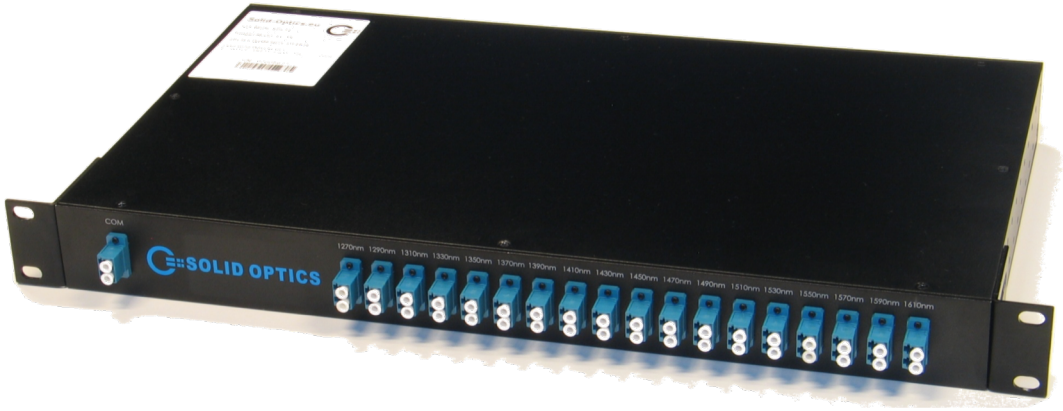
TFF: Thin film filter

- Metal or glass tubes 2cm*4mm
- 3 fibers: com / color / reflect
- Each tube has 0.3dB loss
- 95% of Muxes & OADM

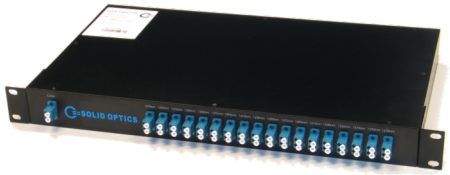


Multiplexers

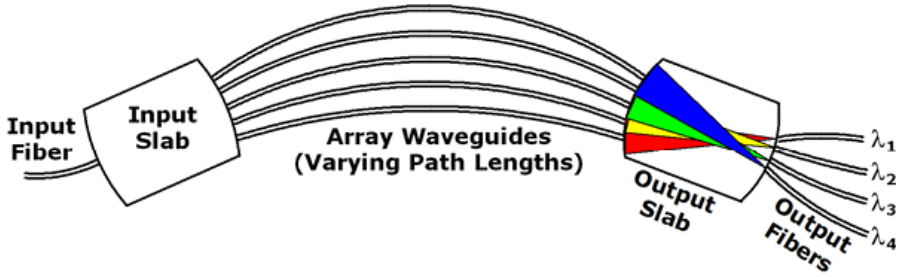




Multiplexers



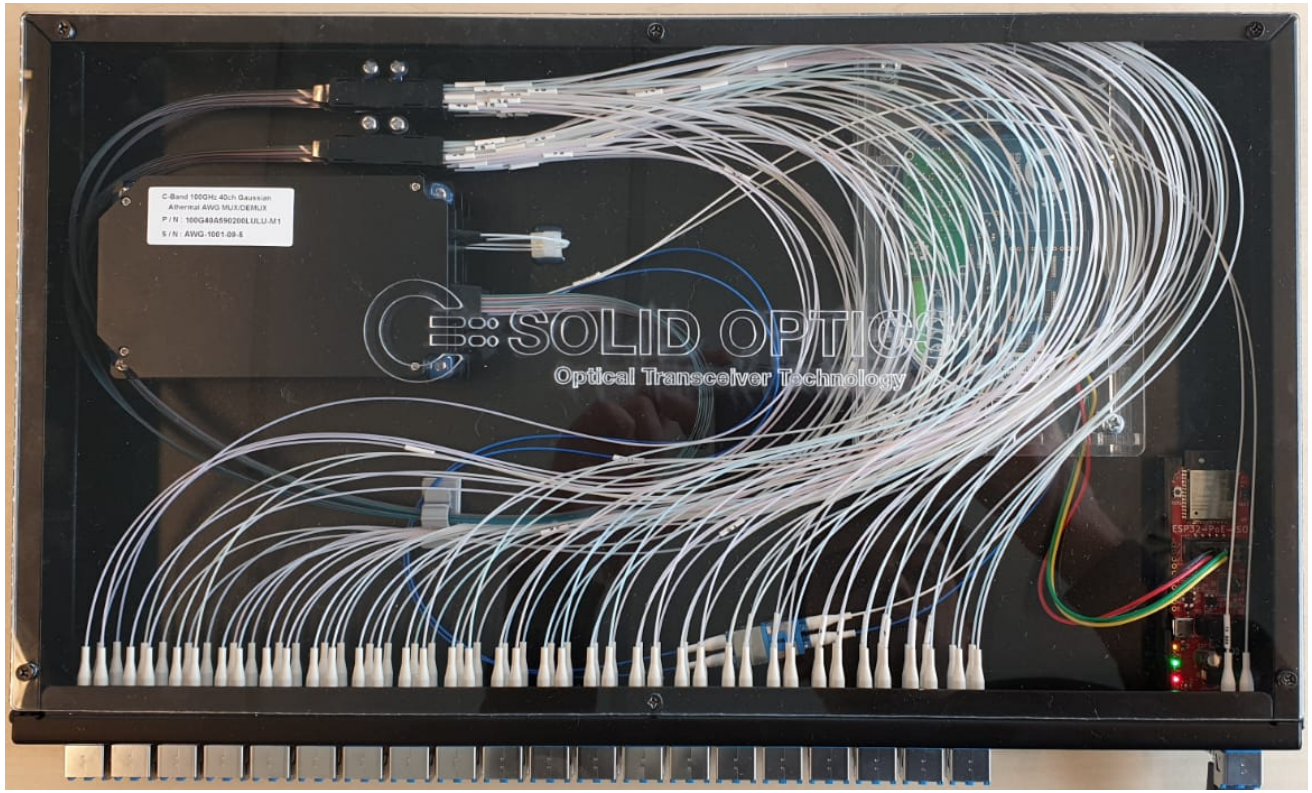
AWG: arrayed wave grading



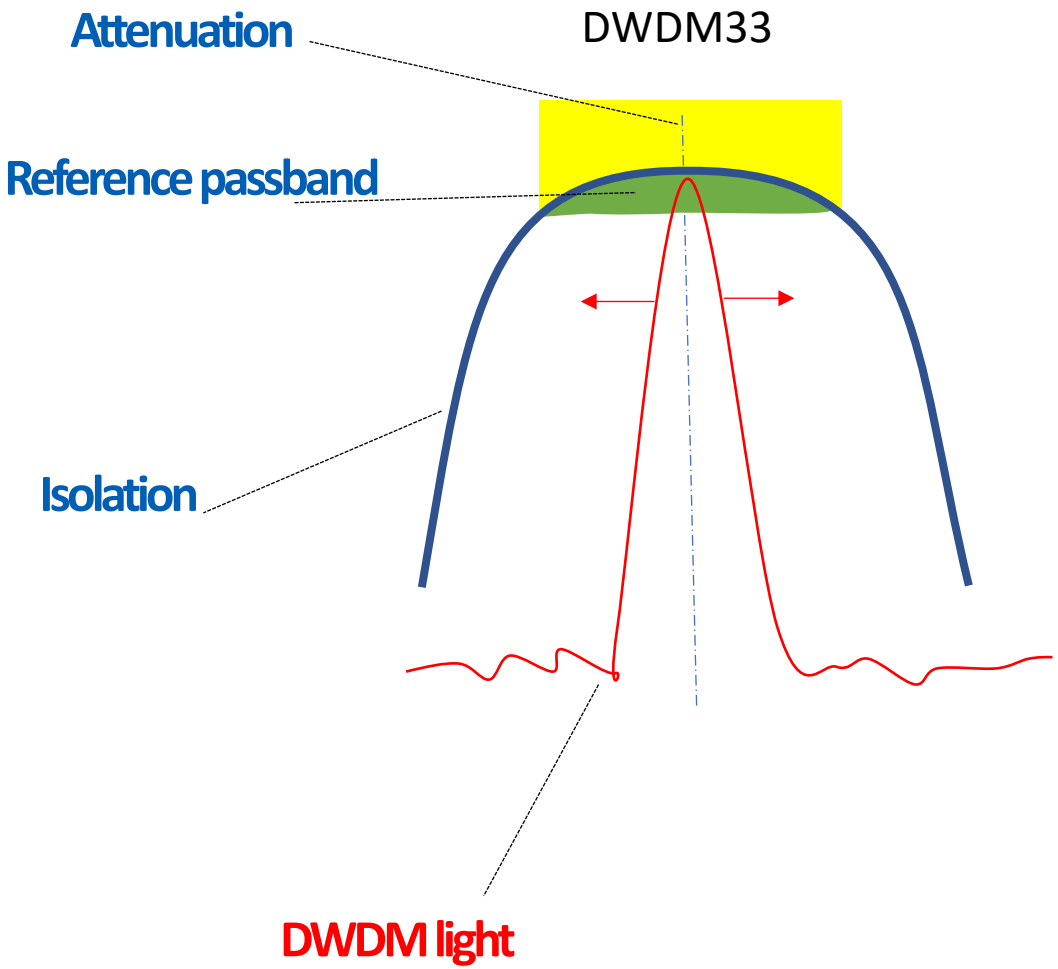
-Larger muxes such as 40Ch/96Ch

-Lower loss

-Insertion loss 40ch = 3.0dB



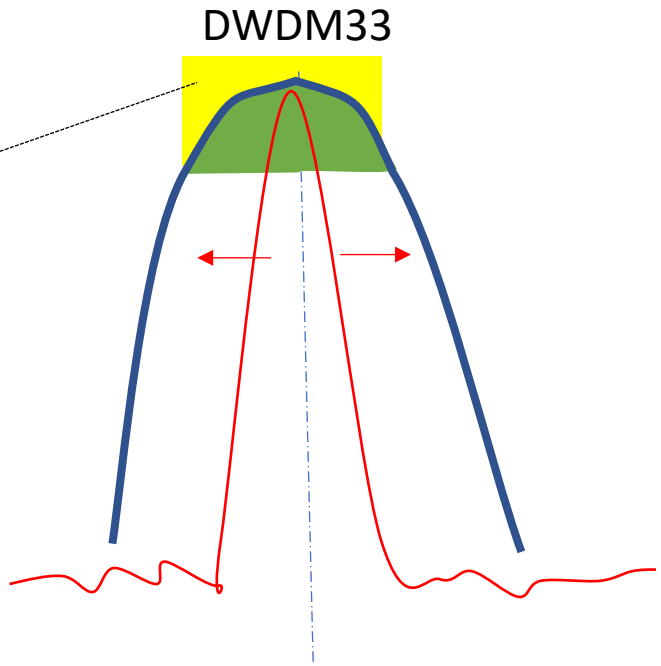
Transmission Window AWG



Gaussian Fit

Low attenuation

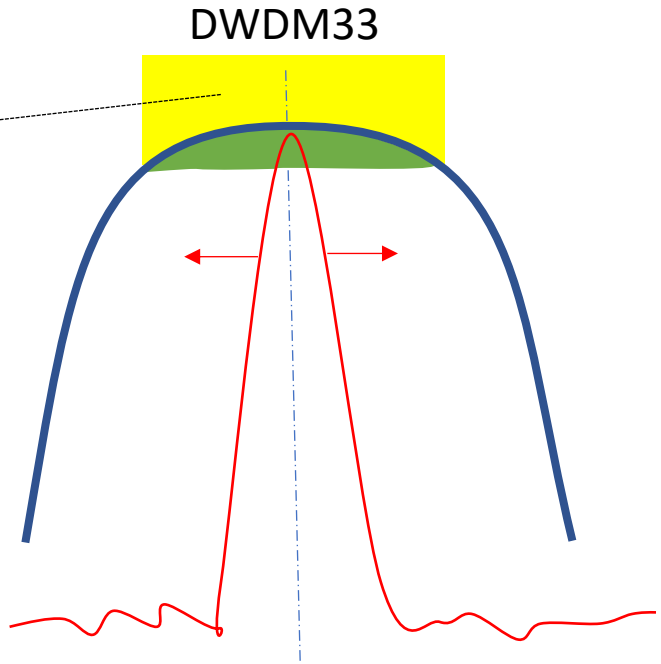
Small passband



Flat Top

Higher attenuation

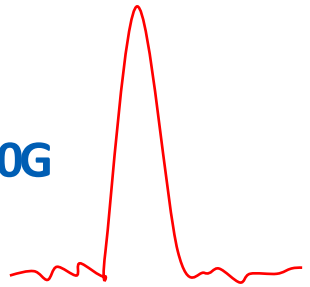
Wide passband



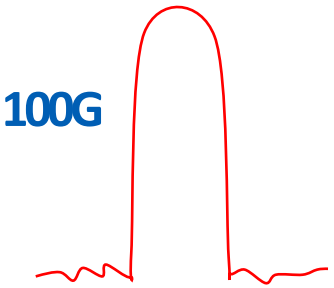
ALL TFF is Flat top

Transmission Wave Types

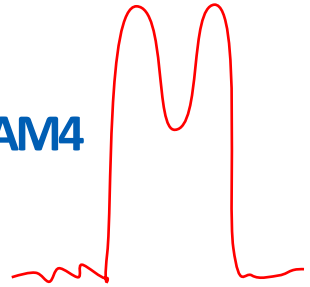
DWDM 10G



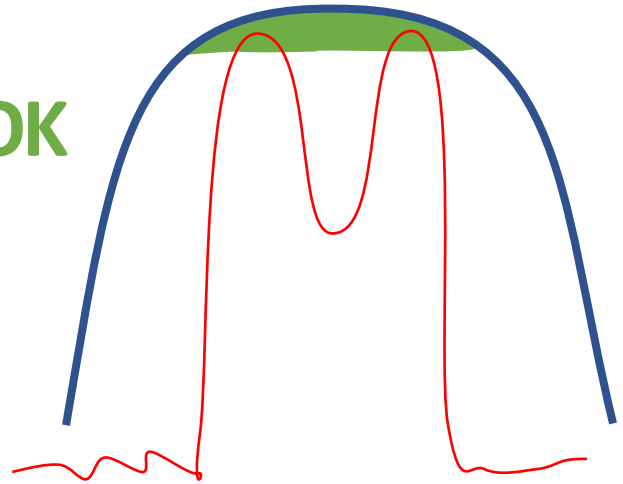
Coherent 100G



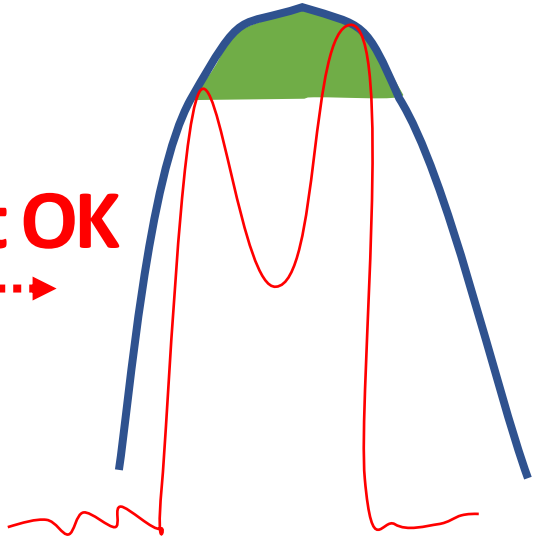
DWDM PAM4



Flat Top: OK



Gaussian Fit not OK

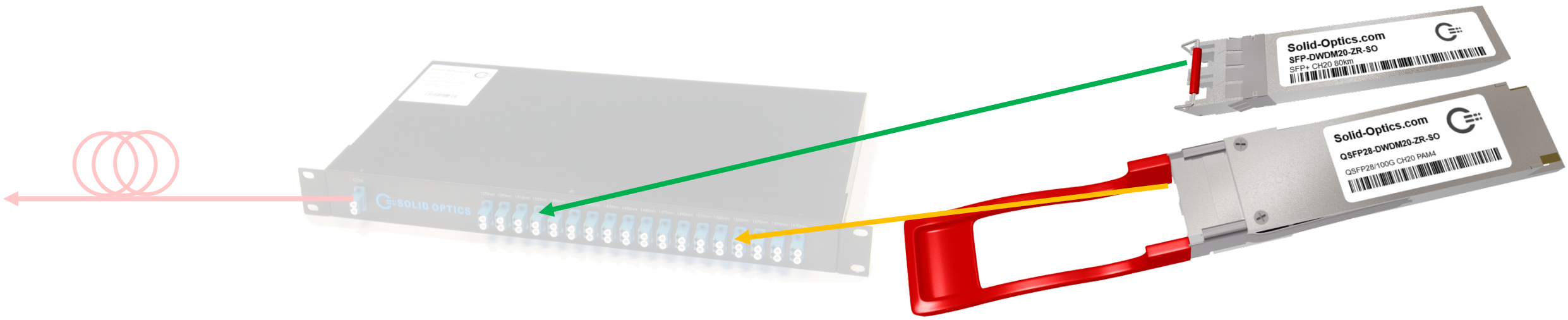


Ingredients for Multiplexing

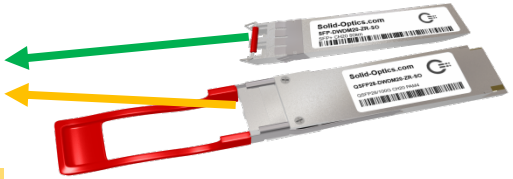
1 Dark Fiber

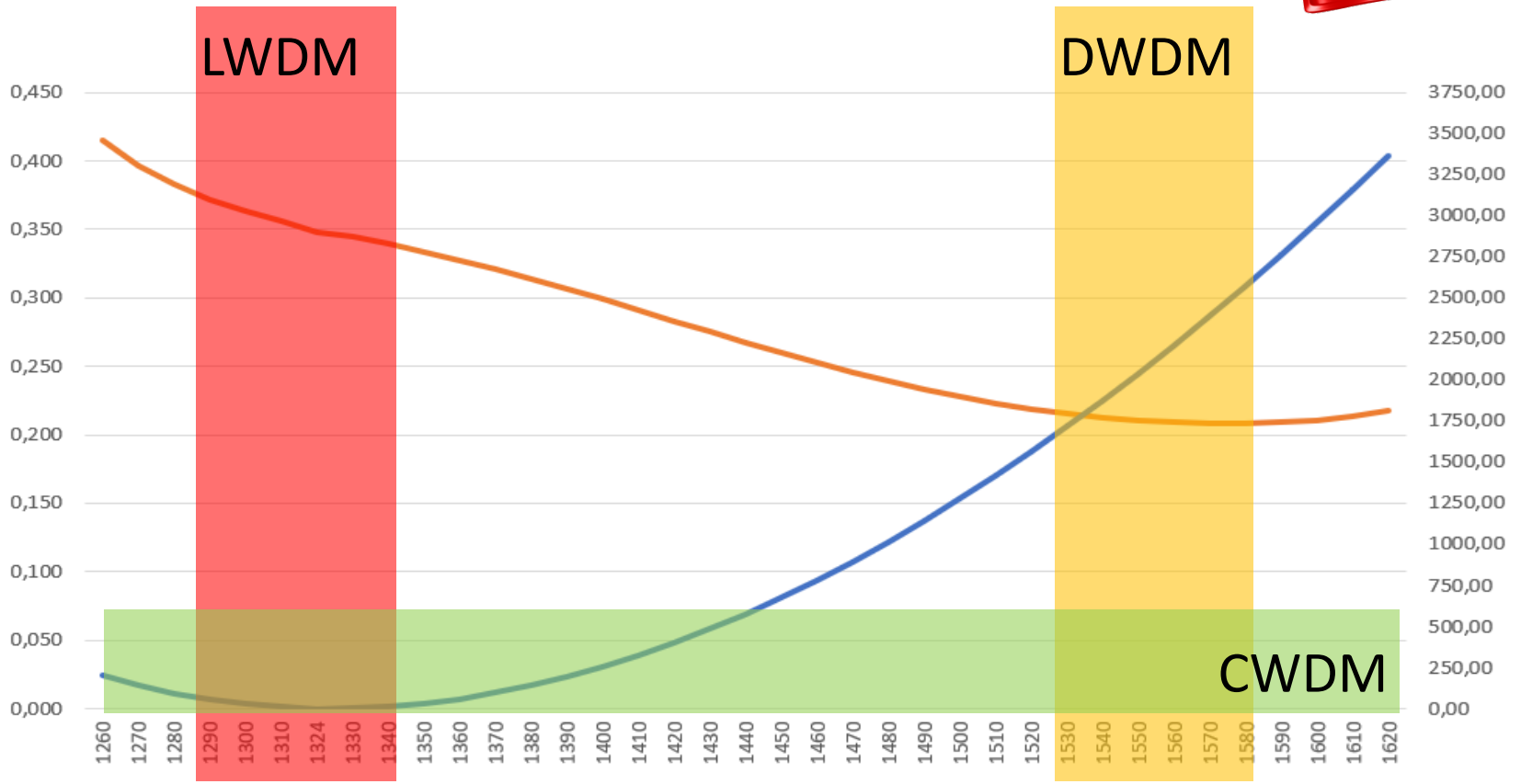
2 Multiplexer

3) Light: Transceivers



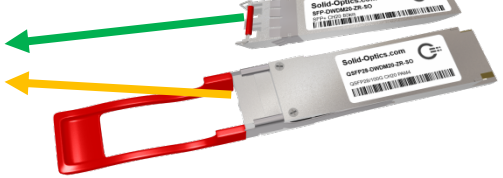
ITU Grids





	Attenuation	Dispersion	10G	25G/100G
DWDM	Low	High	80km	15km
LWDM	High	Low	40km	40km

LWDM Multiplexing



New ITU Band

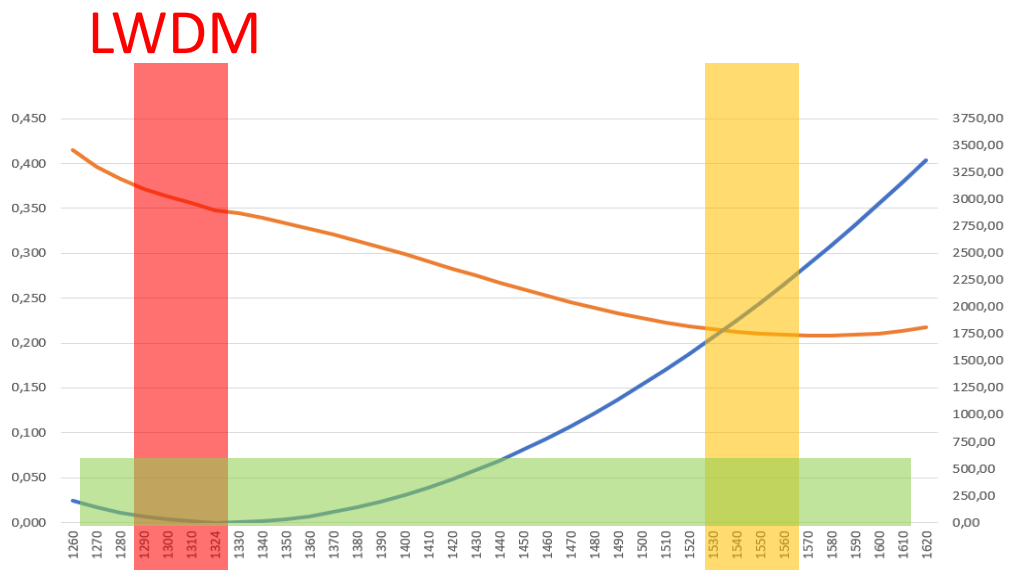
-8 Channels in the 1310nm band

-8 x 25G Multiplexing up to 40km

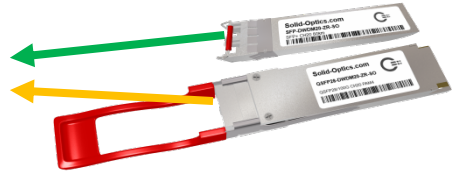
-Regular optics and regular passive muxes

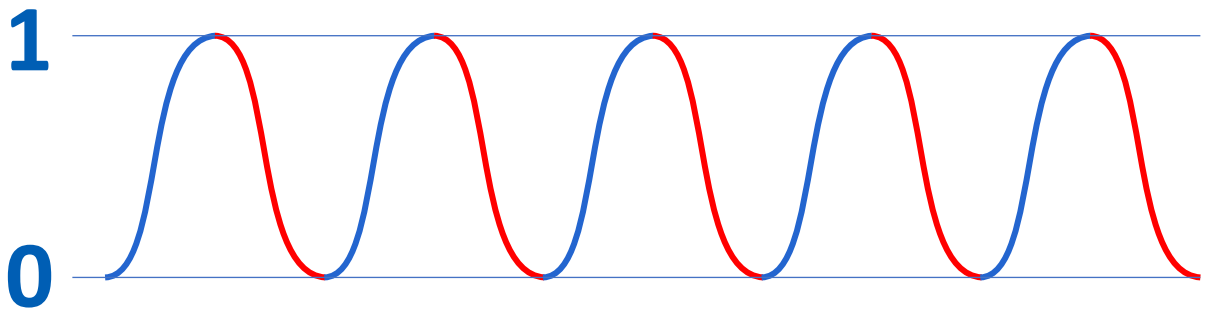
-Possible 8x 100G up to 15km (future)

-Used in Korea a lot for 5G deployment



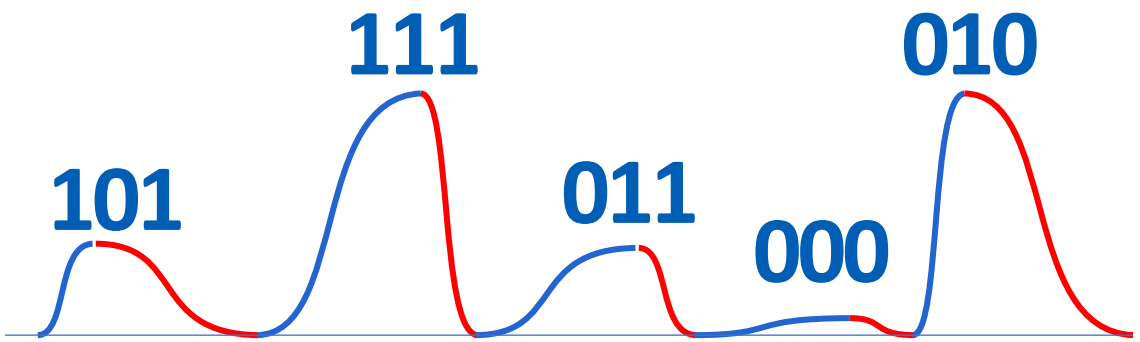
How to send more data with same signal





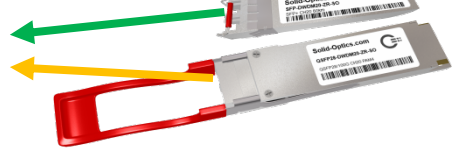
10G Signal speed with 10G data

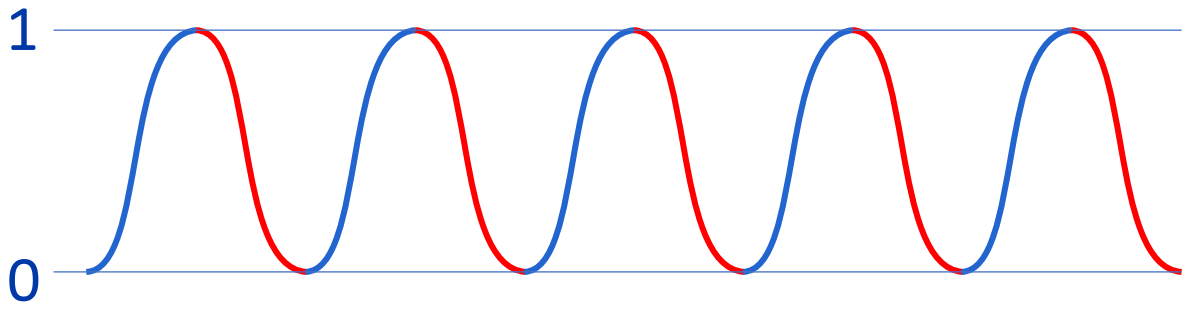
Modulation

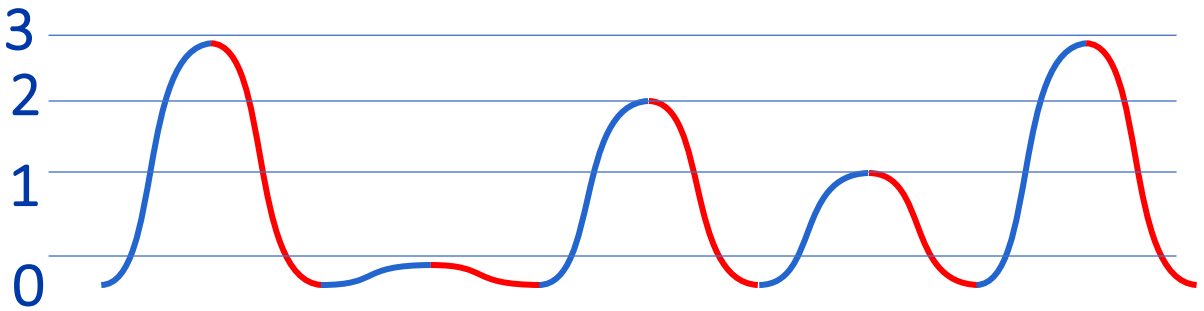


10G Signal with 100G data

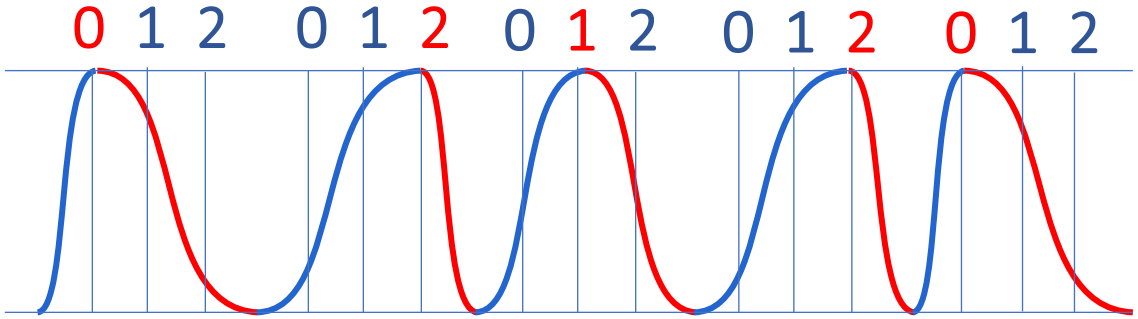
Modulation = More info per bit signal





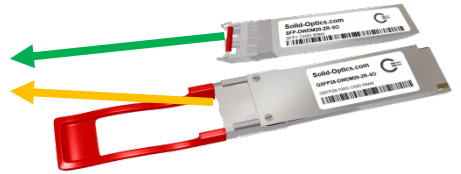


Amplitude



Phase

Modulation = more info per bit signal



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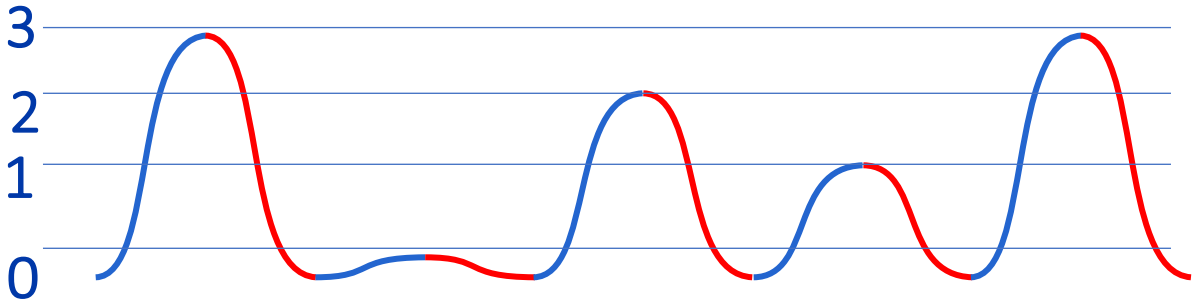
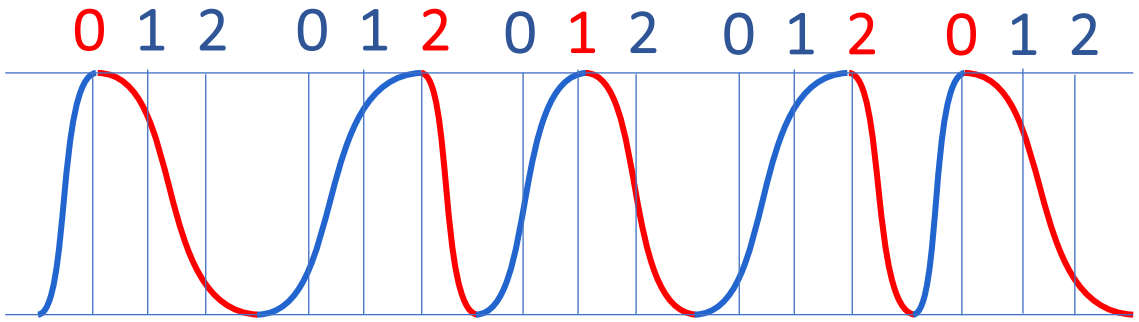
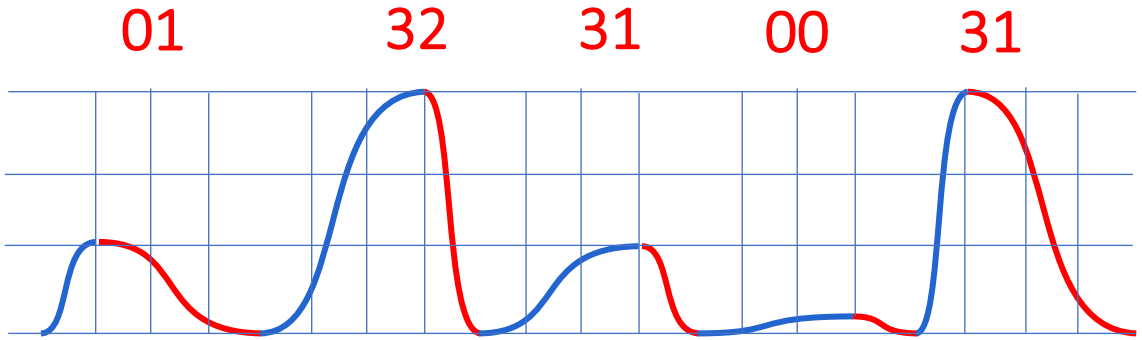
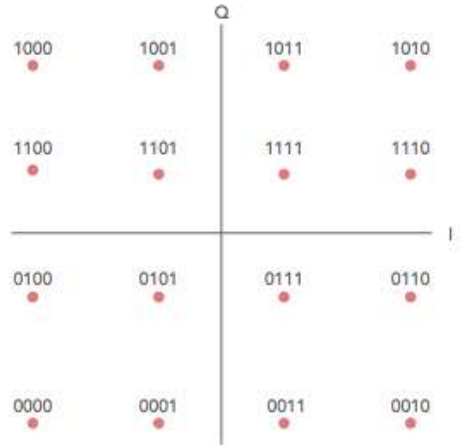


Amplitude



Phase

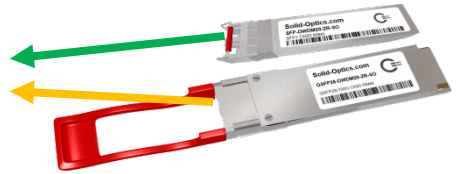


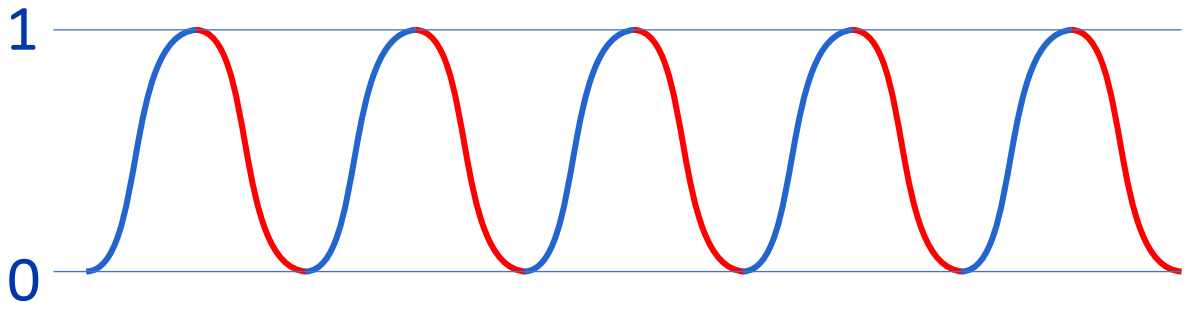


16QAM

32QAM

Modulation & Coherent 100G





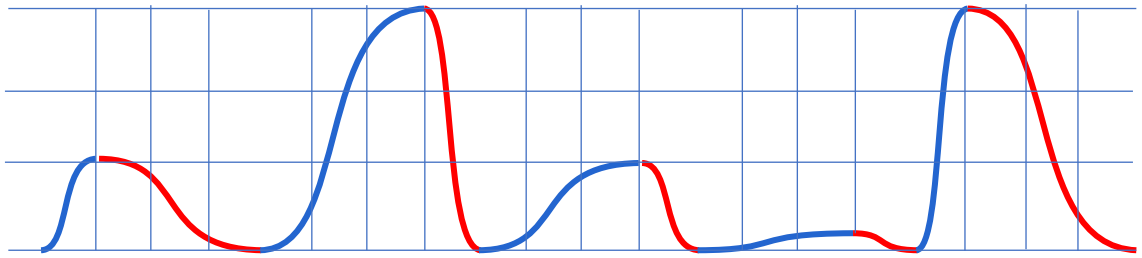
DSP chip

Needs a lot of processing power = Watts

Example CFP2-DCO = 20 Watts

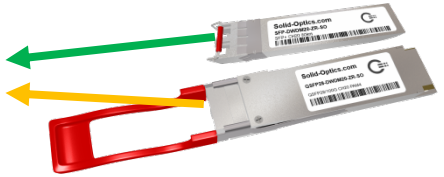
QSFP28 is 4.5W so cannot work

Extra “active box” for the CFP2-DCO



16QAM = 100G

QSFP28 DWDM



100G DWDM in QSFP28

PAM4 modulation

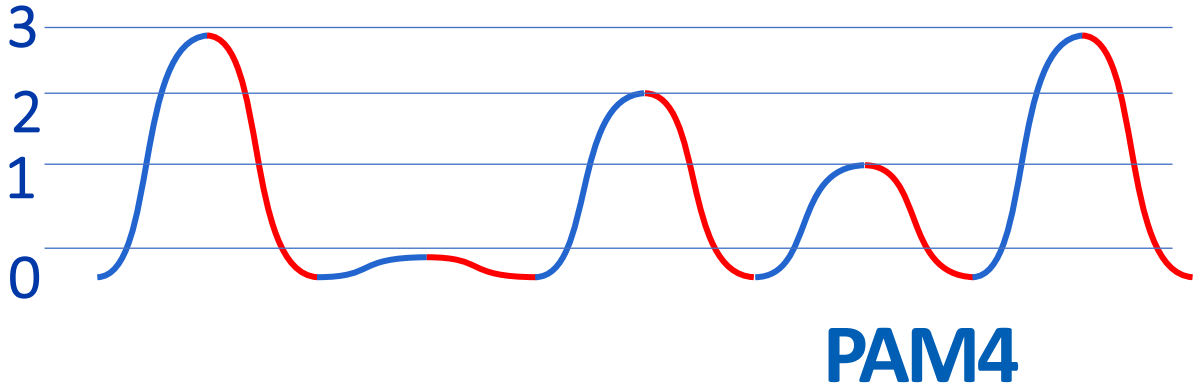
Due to modulation no optical power budget

Needs Amplification = EDFA to work

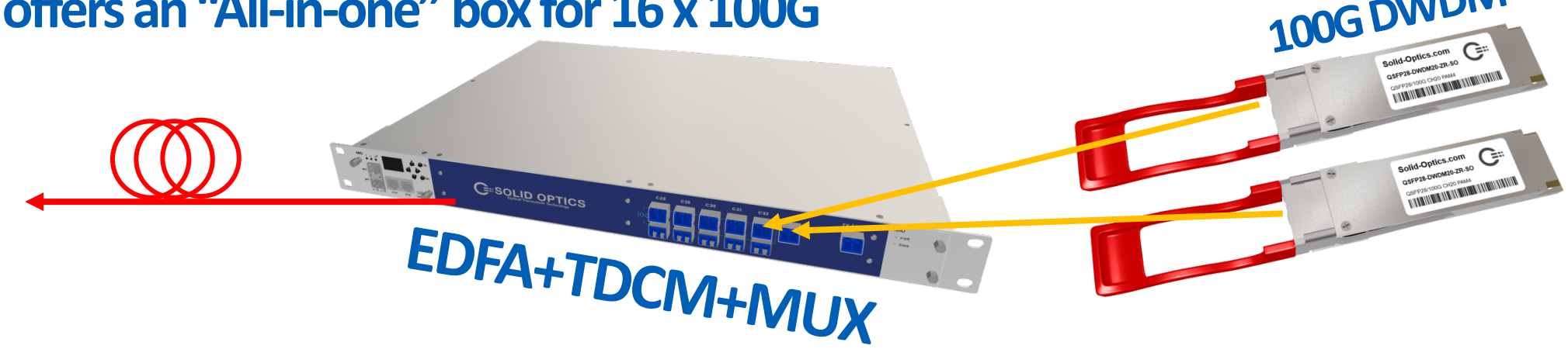
PAM4 needs Dispersion Compensation

Cheapest and easiest 100G Multiplexing method

Microsoft pushed this product

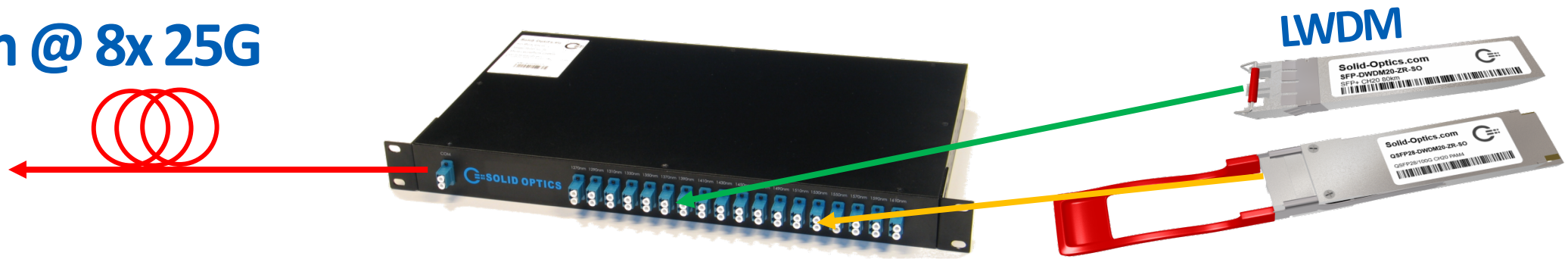


Solid Optics offers an “All-in-one” box for 16 x 100G



Summary

LWDM / 40km @ 8x 25G

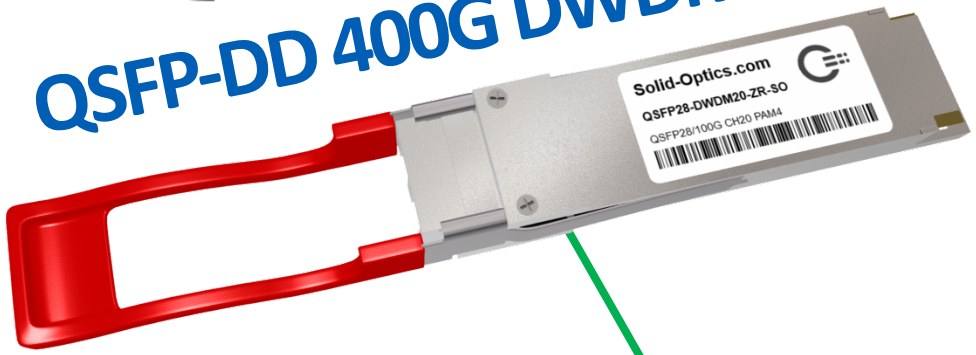


QSFP28 / 80km @ 100G

CFP2-DCO / 120km @100G

400G ZR is Coming !!

QSFP-DD 400G DWDM



1G DWDM ZR

10G DWDM ZR

400G DWDM ZR

(EDFA Needed)

Dark Fiber

Passive Multiplexer

Additional Hints with 100G

RS-FEC

Should match on both sides

Cisco

switch# configure terminal

switch(config)# interface ethernet1/2,Ethernet 18/12

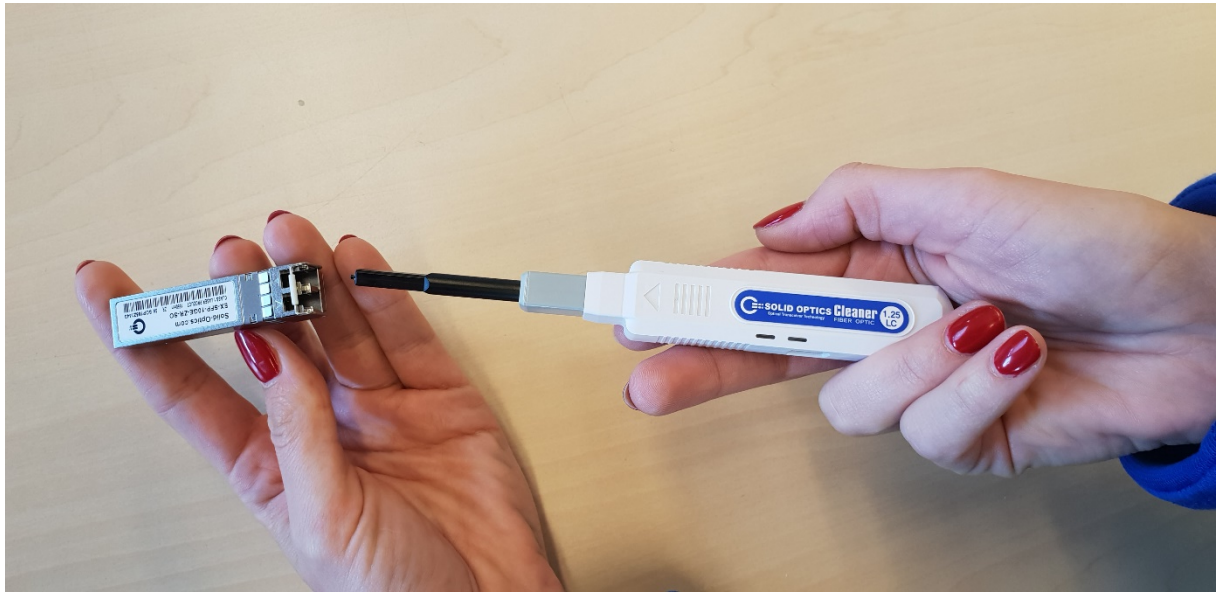
switch(config-if-range)# fec cl91

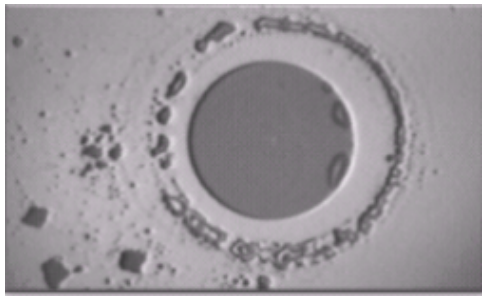
switch(config-if-range)# exit

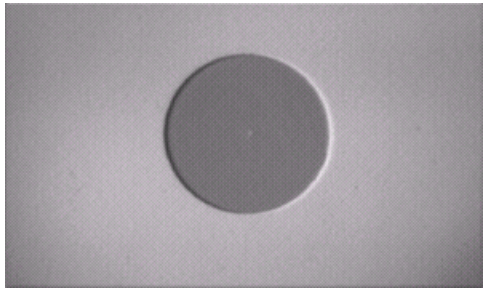
switch(config)# copy running-config startup-config

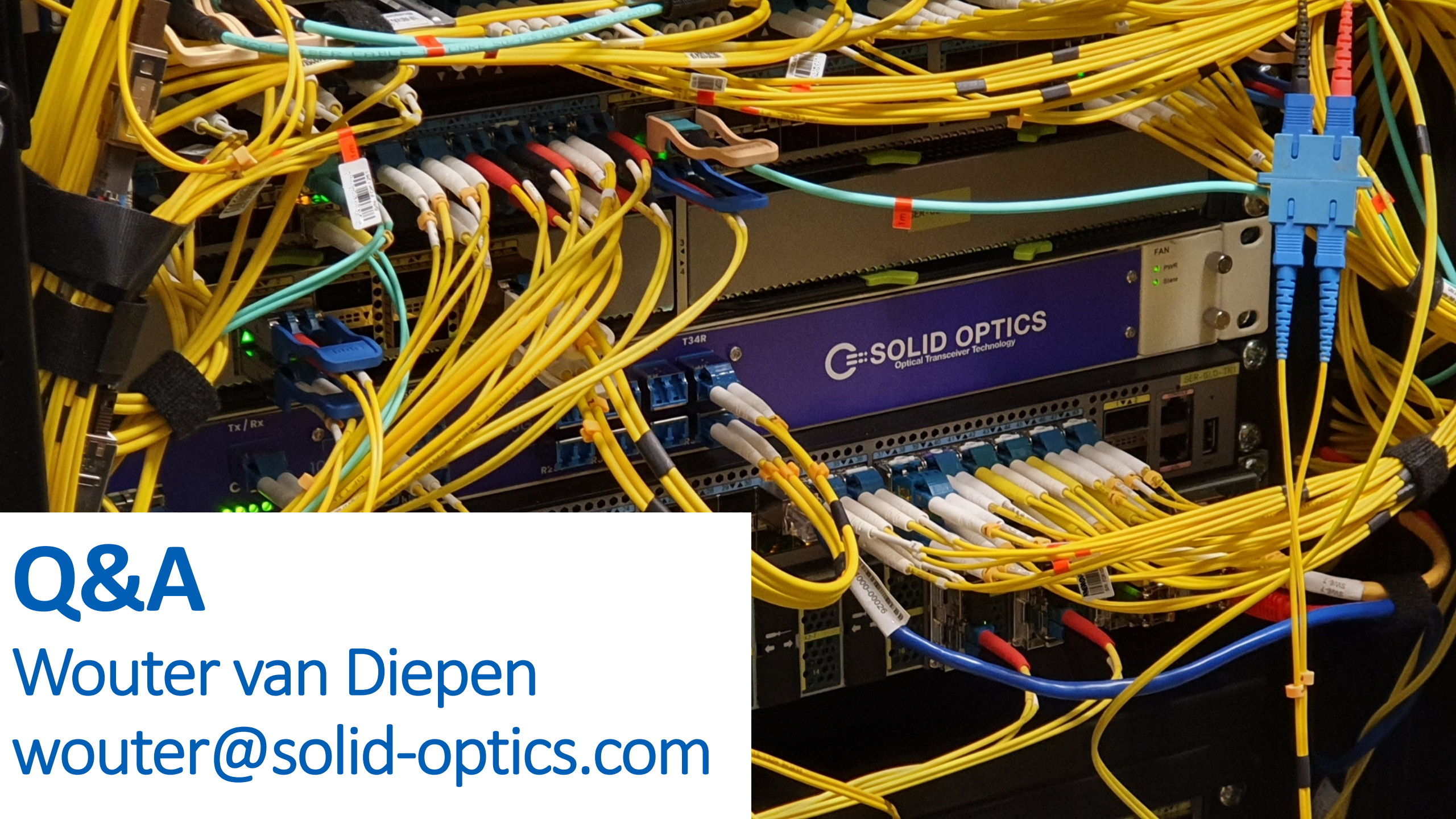
switch(config)# exit

CLEAN









Q&A

Wouter van Diepen
wouter@solid-optics.com