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40Gbit/s Transmission over OM3 Duplex Fiber

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Support

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40Gbit/s on Duplex OM3

- „Consider as part of the 40G MMF objective both a multi-fiber and a duplex fiber“ (barbieri_01_0108.pdf)

- Purpose: "maximum compatibility with the installed base“ (HSSG PAR A) (agenda_01_0307.pdf)

- Upgrade of existing Duplex OM3 Fiber links is possible

- Scenario
  - Use of duplex OM3 fiber for 40GBit/sec transmission
  - Parallel transmission with 2x 20 Gbit/s with NRZ
  - as CWDM with 840nm and 860nm on one OM3

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Straw Poll #14

- Minutes IEEE 802.3ba Task Force
  May 13-16, 2008, Munich, Germany
  (minutes_01_0508_unapproved.pdf)

Should we continue to work on a proposal for a full duplex 40GBE and100GBE MMF PMD solution as in “kropp_01_0508.pdf”.

Yes: 37

No: 13

Approximate Room Count: 108

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Channel Spacing for Uncooled Operation

- **à** WDM Channel Spacing: 18nm

- **à** Total width of operating wavelength window: 9nm
  - Temperature drift of laser (0.07nm/°K)
    operating temperature 0°-85°C: 6nm
  - Manufacturing tolerance of wavelength 3nm

- **à** Channel separation between windows: 9nm
  - easy to reach with standard technology
  - Low cost optical WDM filters are possible

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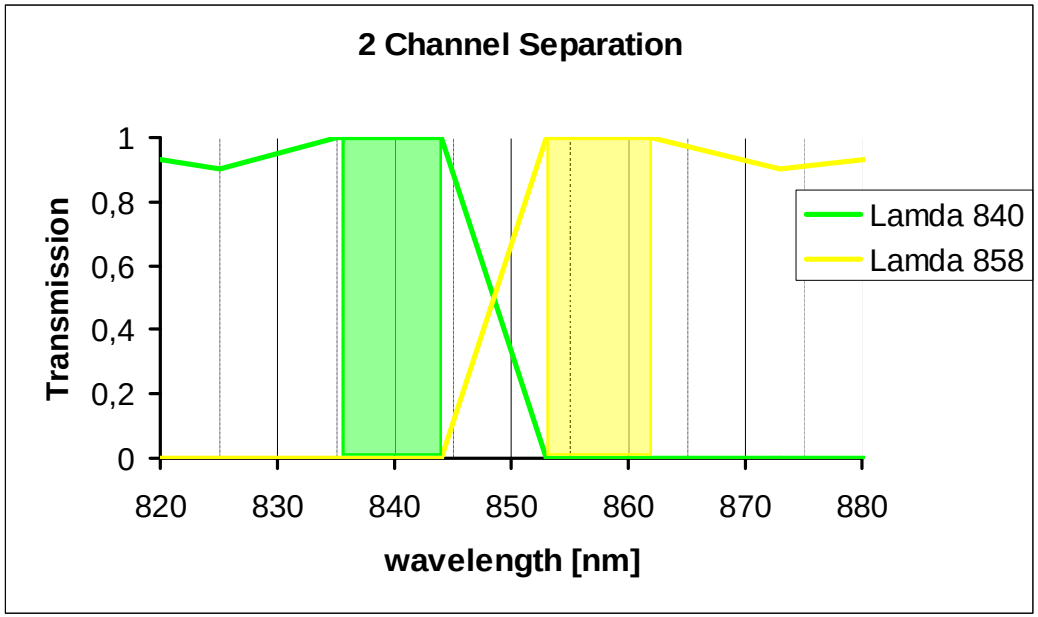
2x20G: Simple WDM Filter

- Channel 1: 840nm (-5nm, +4nm)
- Channel 2: 858nm (-5nm, +4nm)
- One edge WDM filter only
- Moderate spectral edge characteristic is necessary
- Filter can be manufactured by standard Thin Film Technology (Reference: e.g. Cube Optics AG)



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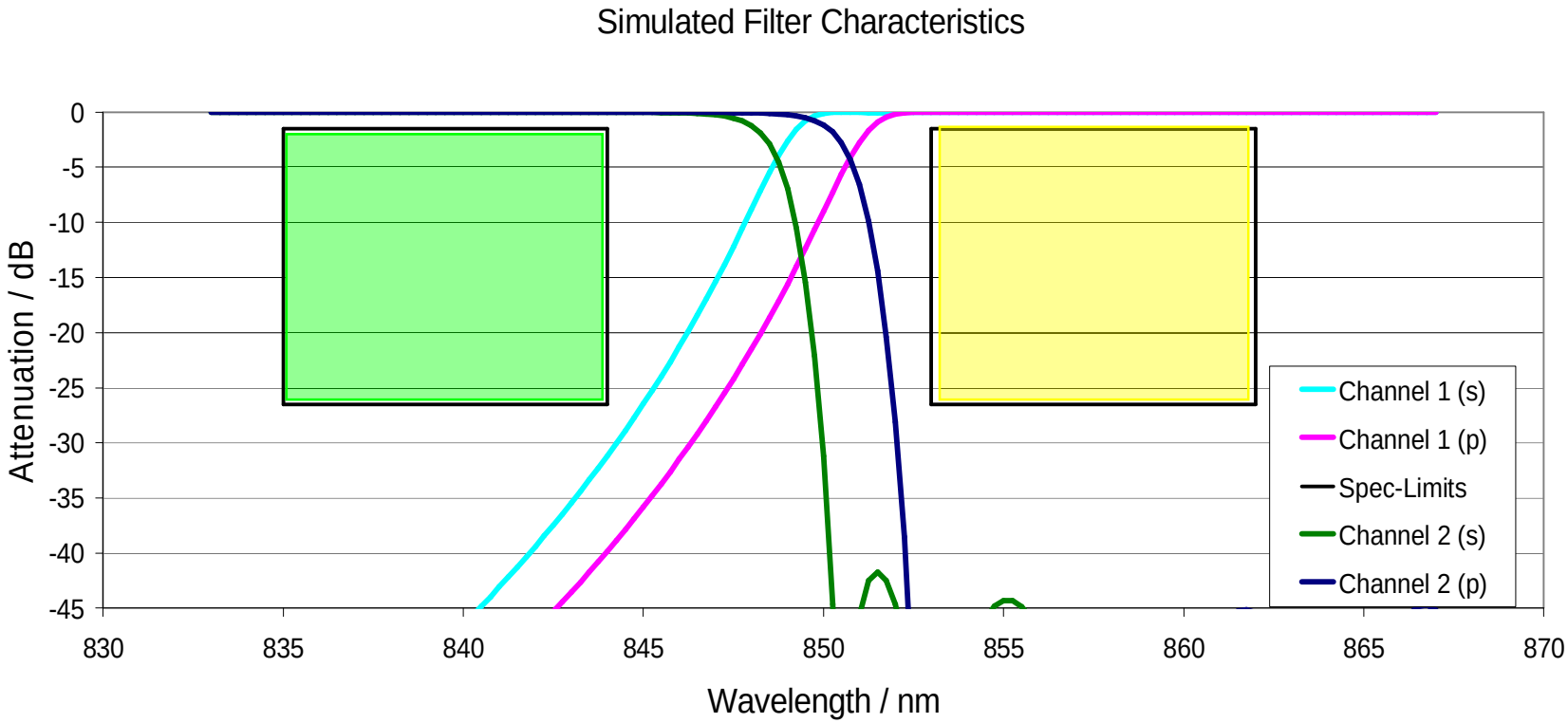
WDM Filter Performance



Filter characteristics simulated for a 840nm/858nm OSA (Cube Optics AG)

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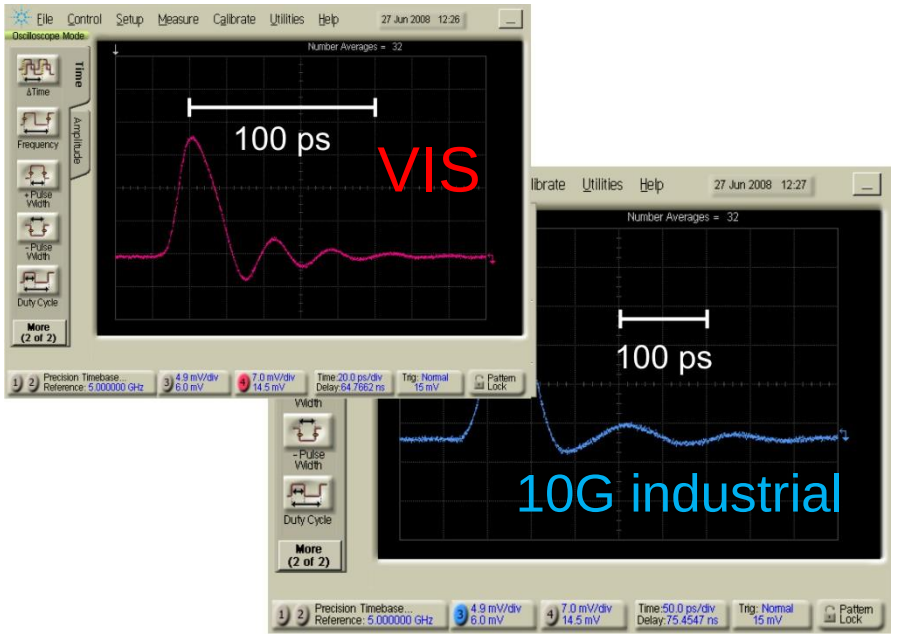
Fast 850 nm photodetectors



- à 850 nm range
- à 50 µm MMF coupled (Fiber Length: 1 m. Fiber Connector: FC/APC)
- à 9 ps rise time (10%-90%)
- à 30 GHz amplitude FFT bandwidth
- à >0.4 A/W responsivity

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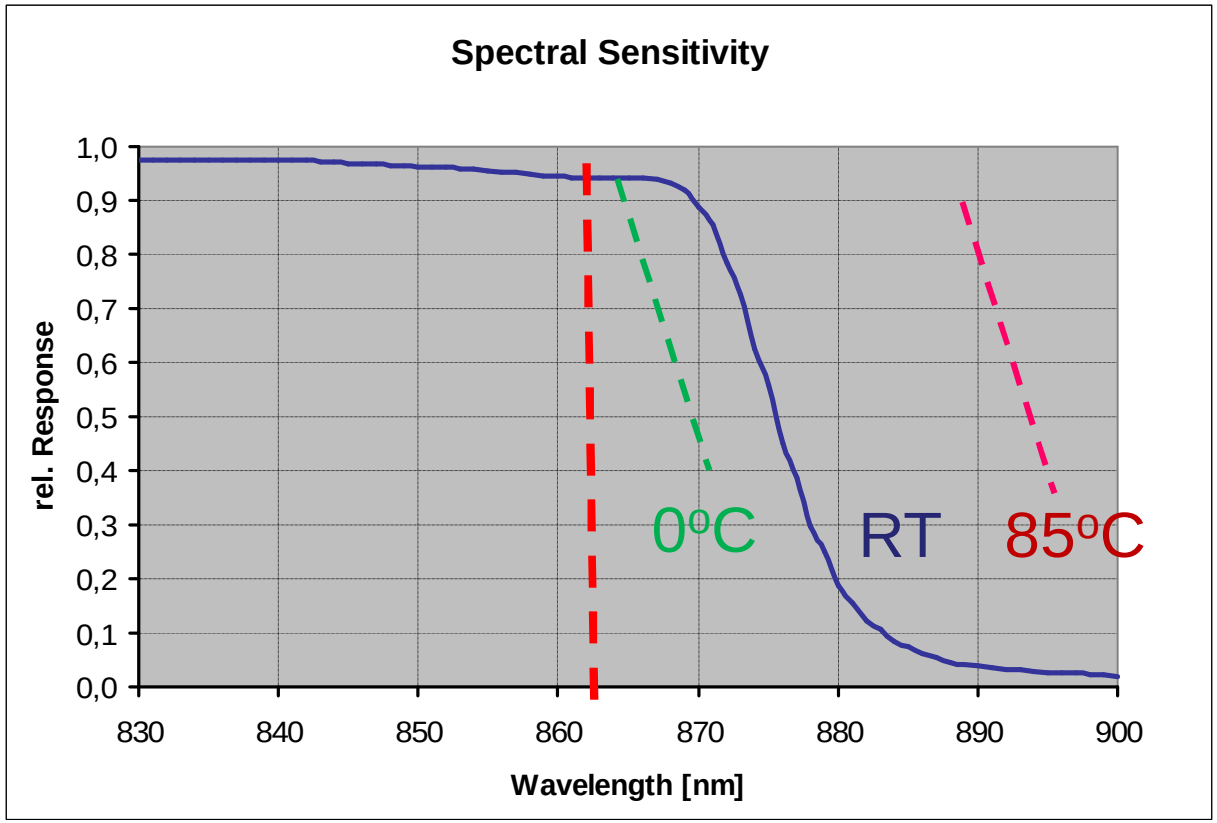
Spectral Response of fast PD



- à Sufficient spectral width up to 865 nm for the standard 0-85°C VCSEL transceiver operation range

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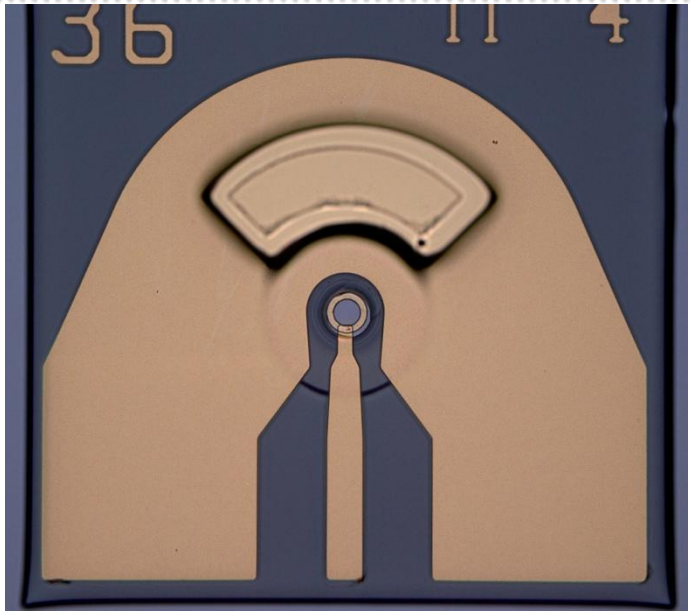
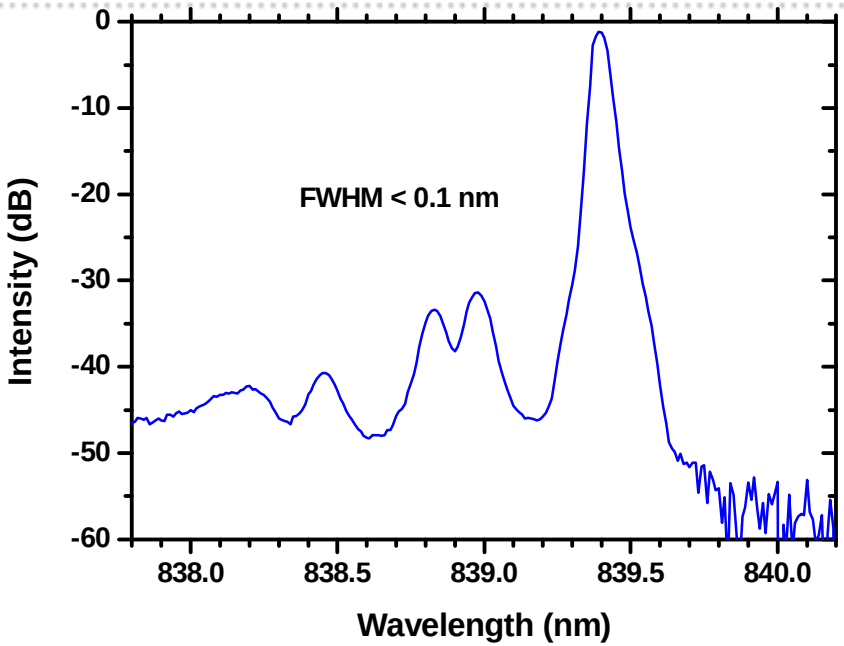
High-performance VCSELs





VIS VCSEL Chip

- à Ultra-narrow spectral width at an output power > 1mW
- à Single oxide confined aperture design
- à PRBS 2^7-1 Error-free transmission at 20 Gb/s
- à Just an example of recently reported 850 nm VCSELs up to 25-35Gb/s (Finisar/IBM, UCSB, Chalmers University,…)

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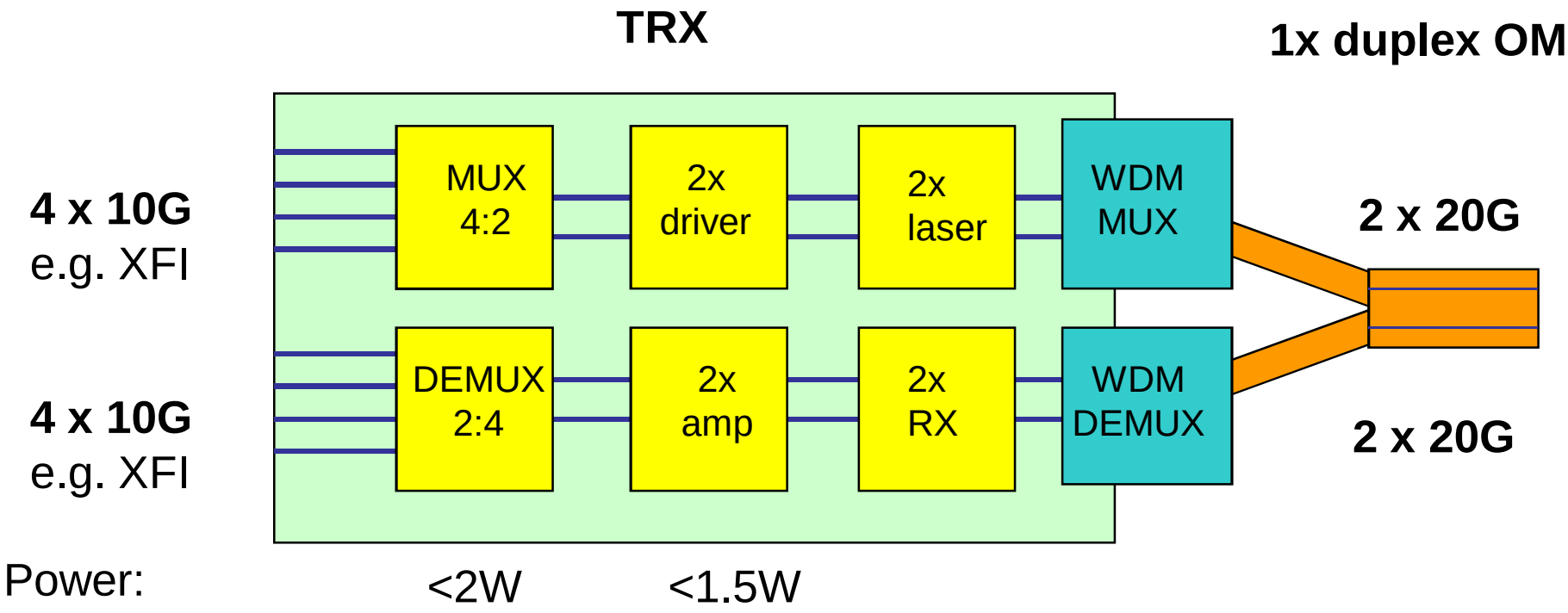
2 + 2 WDM for 40Gbit/s



Electrical MUX and DEMUX:

- à simple one stage devices with low power consumption and low cost
- à built on CMOS or BiCMOS technology
- à 4x25Gbit/s development includes the functional blocks for 2x20Bbit/s

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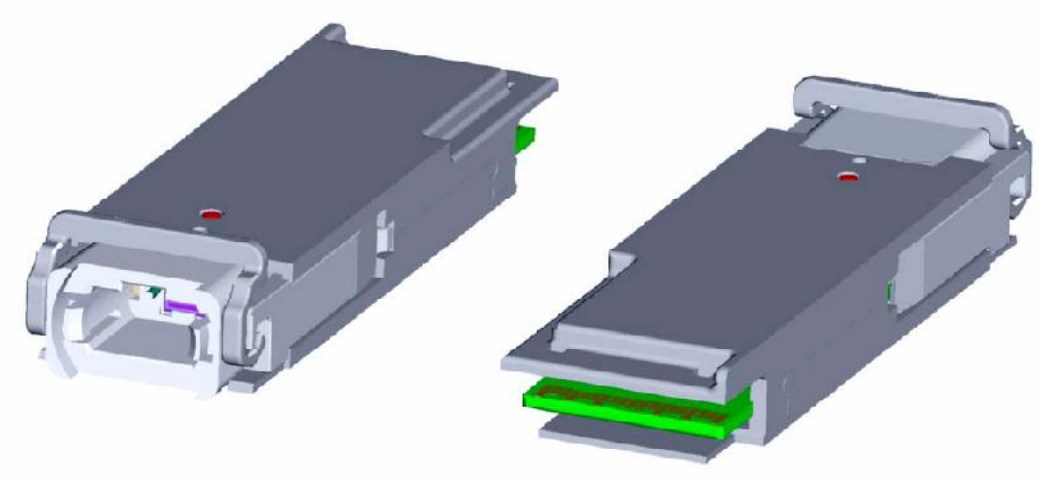
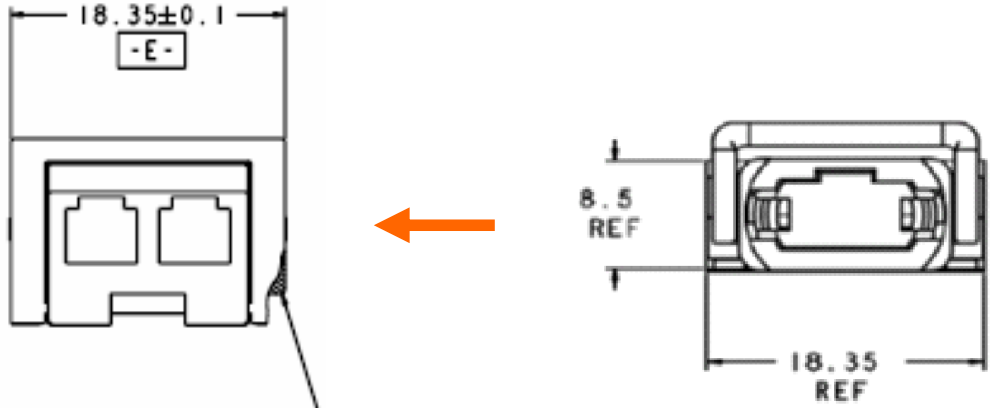
Housing Concept

Use the overall Formfactor of the QSFP

. . . .



. . . but take the front plate with two LC-ports from the XFP



à QSFP supports 3.5W power dissipation

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OM3 Link- Scenario: 20 Gbit/s

- Fiber: OM3 Fiber

  used with a restricted launch condition according to 10 GbE Standard

  used effective Modal Bandwidth: 1900 MHz·km because of slightly extended spectral range of 835nm to 862nm

- Transmitter: wavelength 835 nm - 862 nm,
  $\Delta\lambda$ = 0.45 nm (rms spectral width), T_r, T_f = 15 ps;
  OMA power min. = -3.8 dBm; ext. Ratio min. = 3.0 dB;
  det. jitter = 5 ps; RIN = -130 dB/Hz

- Connectors: 1.5 dB loss by connectors

- Receiver: Bandwidth = 15 GHz; sensitivity OMA = -11.1 dBm

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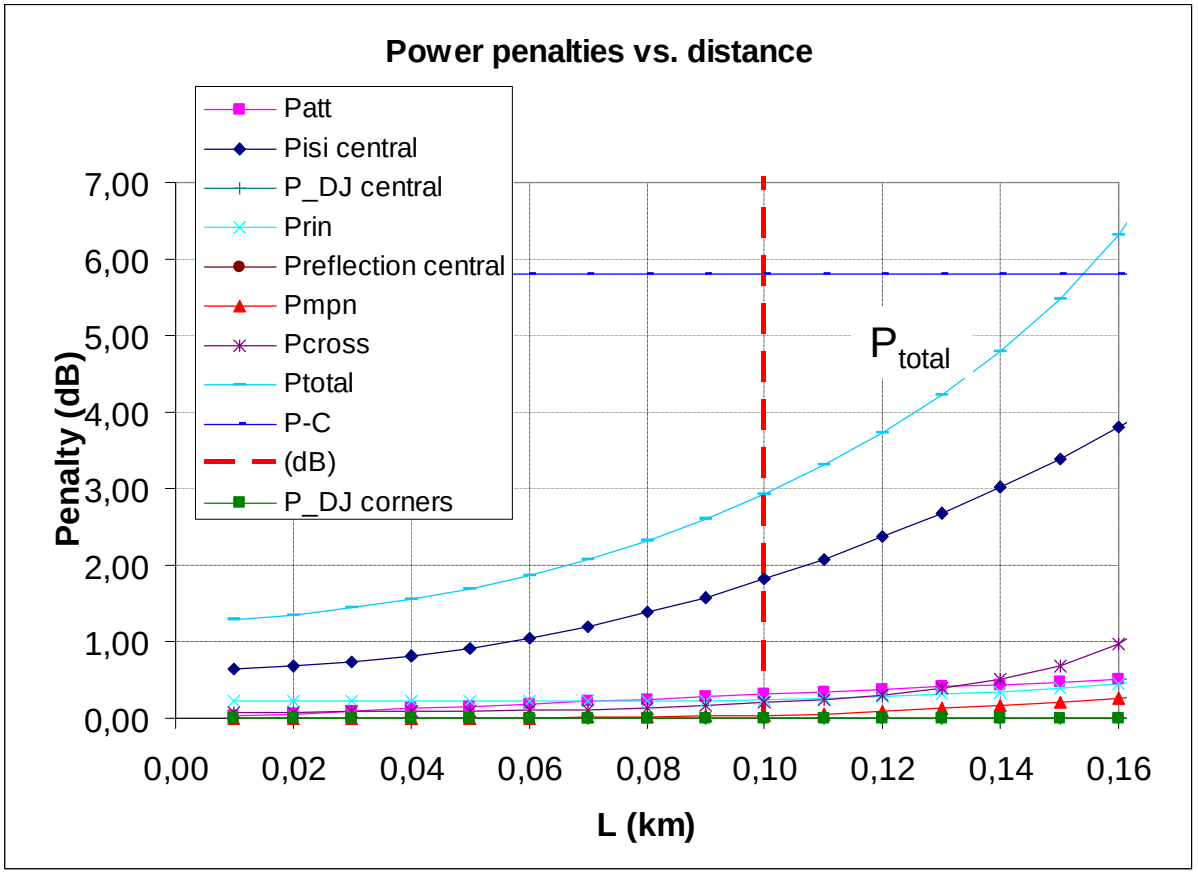
OM3 Link Simulation



- à OM3 fiber with RML condition (similar to 10 GbE
- à Total Power Budget 7.3 dB
- à Link length: > 100 m
- à Power margin: 2.9 dB

à >100 m distance feasible with OM3 fiber

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OM4 Link- Scenario: 20 Gbit/s

- Fiber: OM4 Fiber

  used with a restricted launch condition according to 10 GbE Standard

  used effective Modal Bandwidth: 3900 MHz·km because of slightly extended spectral range of 835nm to 862nm

- Transmitter: wavelength 835 nm - 862 nm,
  $D\lambda$ = 0.35 nm (rms spectral width), T_r, T_f = 15 ps;
  OMA power min. = -3.8 dBm; ext. Ratio min. = 3.0 dB;
  det. jitter = 5 ps; RIN = -130 dB/Hz

- Connectors: 1.5 dB loss by connectors

- Receiver: Bandwidth = 15 GHz; sensitivity OMA = -11.1 dBm

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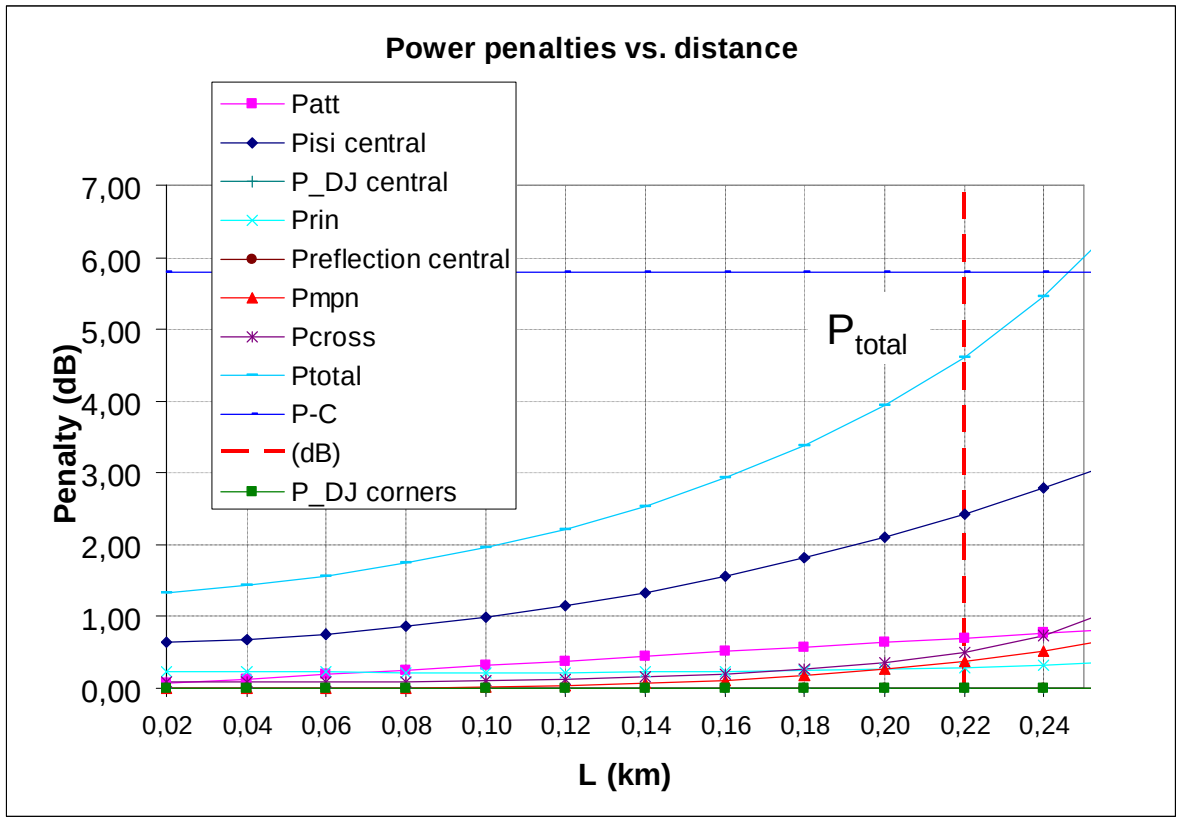
OM4 Link Simulation



- à OM4 fiber with RML condition (similar to 10 GbE)
- à Total Power Budget 7.3 dB
- à Link length: 220 m
- à Power margin: 1.2 dB

à 220 m distance seems possible with OM4 fiber

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Cost Estimation of Link

4 x 10Gbit/s parallel	Relative Cost	2 x 20Gbit/s WDM	Relative Cost
4x TIA	1	2x TIA + DEMUX	1.5
4x Driver	1	2x Driver + MUX	1.5
OSA assembly 4+4	1	OSA WDM assembly 2+2	2
4x Laser / 4x PD	1	2x Laser / 2x PD	0.7
electronic assembly	1	electronic assembly	1.3
PMD Package	1	PMD Package	1
Fiber ribbon	1	Duplex fiber	0.4
Weighted average at similar volumes	1x		1x

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Summary for 40Gbit/s on duplex OM3

- à 2x20Gbit/s PMD for 100 m transmission with 40G over OM3 is feasible
- à similar cost and slightly higher power compared to 4x10G parallel
- à no extra development for electrical 2x20Gbit/s MUX/DEMUX required

moreover

- à standard OM3 duplex fibers can be used
- à possible upgrade of existing duplex OM3 fiber links
- à link length of 220m can be reached on OM4 fiber
- à PMD with the form factor of the QSFP but with the front surface of the XFP can be applied
- à will further benefit from Fibre Channel standard FC16G adoption (2009): high-speed ICs and VCSELs
- à future option for 4x25Gbit/s upgrades for duplex OM3 links

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Thank You !