Proposals for two PMDs for 100G lambda

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IEEE 802.3 100 Gb/s Wavelength Short Reach PHYs Study Group
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Do we need two PMDs?

- There are different market needs as stated in swanson_100GSR_adhoc_01_040920
- Data shown in castro_100GSR_01a_0120 and parsons_100GSR_adhoc_01_021320 indicates that the bandwidth requirements for 30m and 50m are similar.
  - However, there are many other parameters in the optical channel to be considered.
- Data shown in bhatt_100GSR_adhoc_01a_050720 , a contribution based on link models, indicate that substantial improvement in component specs is required to reach ≥70 m.
- It is unlikely to have one PMD that achieve the lowest cost switch-to-server and higher performance for switch-to-switch interconnect.
- This contribution utilizes the link model and assumptions proposed in bhatt_100GSR_adhoc_01a_050720 to explore channel requirements for two PMD options:
  - Switch-to-server, ≤30m
  - Switch-to-switch, 80 m-100 m

Experiment for technology feasibility for >75m presented with worst-case compliant fiber MMF, but might require costly specs for laser

We do not need very high VCSEL bandwidth for short reaches

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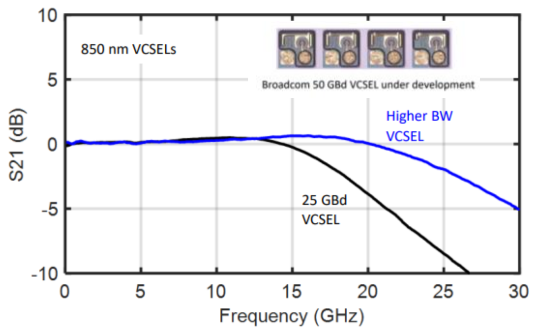
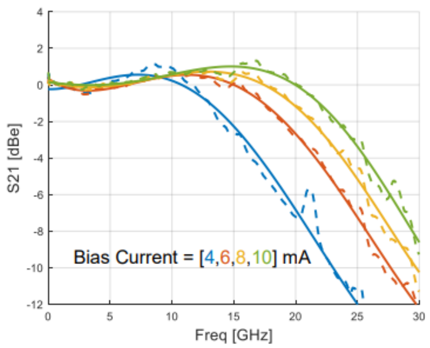
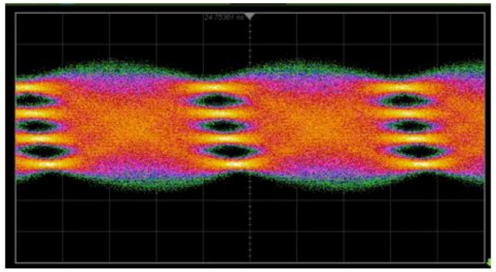
LINKS



26.5 GHz VCSEL

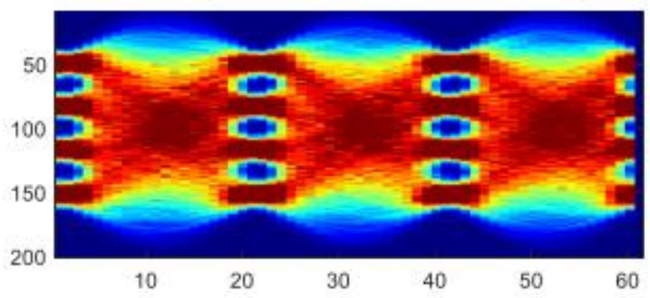


24 GHz VCSEL



TDECQ: 3.7 dB

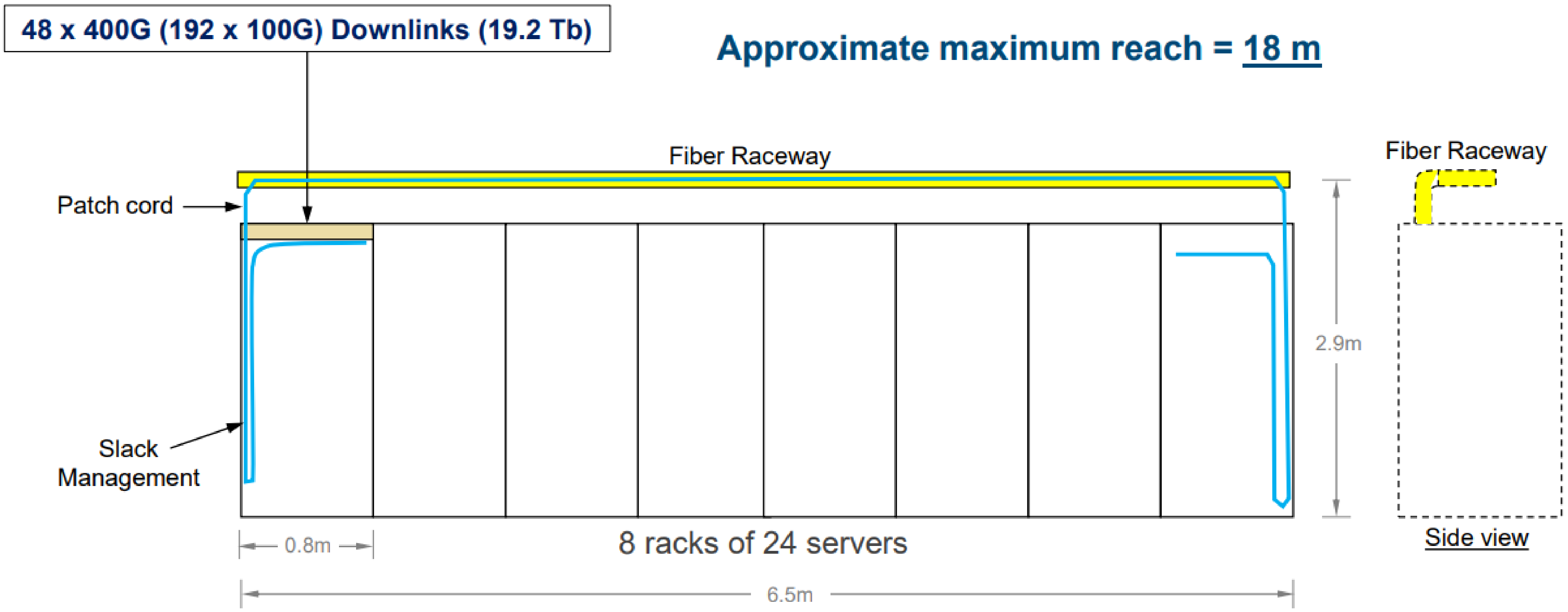
Eye for 106Gbps 75 meters



Eye for 100Gbps 100meters

Switch-to-server channel: reaches

256 x 100GbE switch to server channel reach



pimpinella_100GSR_01b_0120

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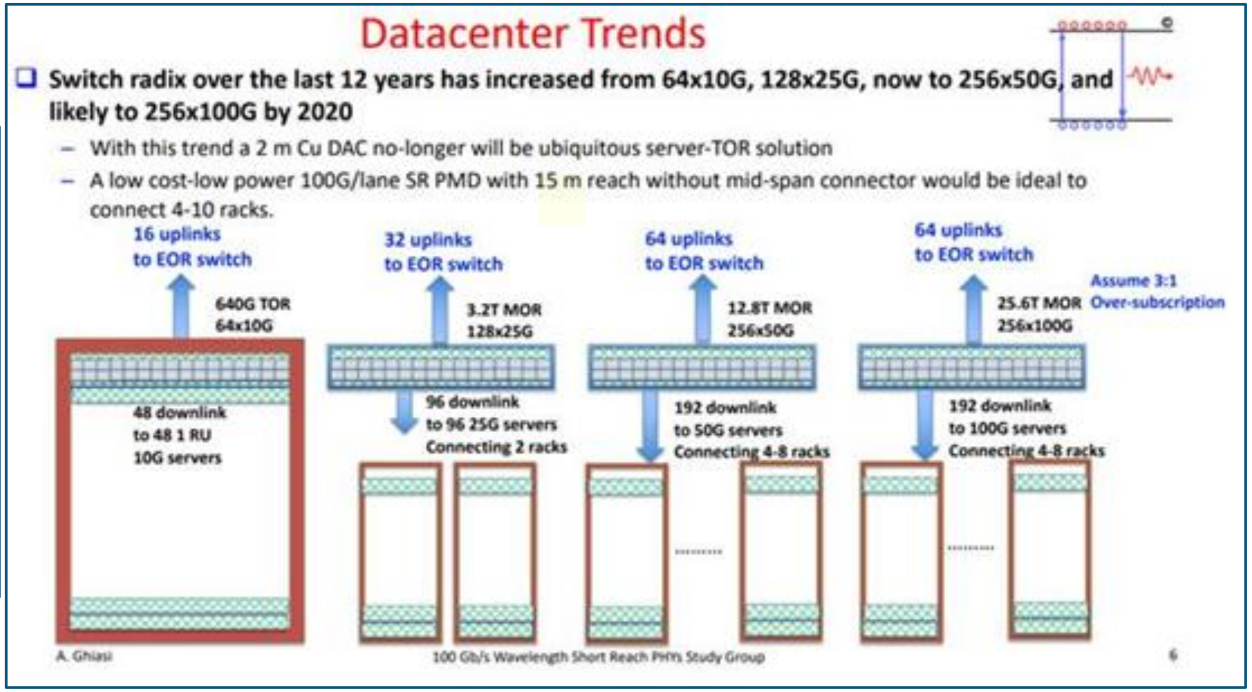
Switch-to-server channel: reaches

Some data might suggest that majority of the reaches might require ≤ 20 m. Other studies indicates that 30 m, will be needed. We do not know the reach distribution for the shorter reaches.

Survey of DC connections in China

- For China market, datacenter operators stated their existing deployments and expectations in the ODCC DCCNG project (http://www.ieee802.org/3/ad_hoc/ngrates/public/19_09/guo_bwa_01_0919.pdf).
  - Server to ToR connection:
    - 5m within cabinet; a small number of cross-rack interconnects up to 20m.
    - For 100G access, due to constraints of distance and deployment (the diameter becomes thicker, the degree of buckling and the compatibility interoperating testing between vendors become complicated), server connections may turn to AOC or multi-mode transceivers.
  - ToR to T1 switch connection:
    - 50m reach would cover a large percentage of their ToR to T1 switch links: 80%, 40%,100% and 100% by some large operators (http://www.ieee802.org/3/cfi/1119_1/CFI_01_1119.pdf)
    - 70m and 100m is preferred depending on cost-efficiency.

bruckman_100GSR_01_0120



Why not relax tolerances for reaches up to 20 m (likely the majority) so they can use least expensive VCSELs?
Reaches with 30 m can use the same VCSELs but with OM4 fiber.
We will explore this option in slides 8-12

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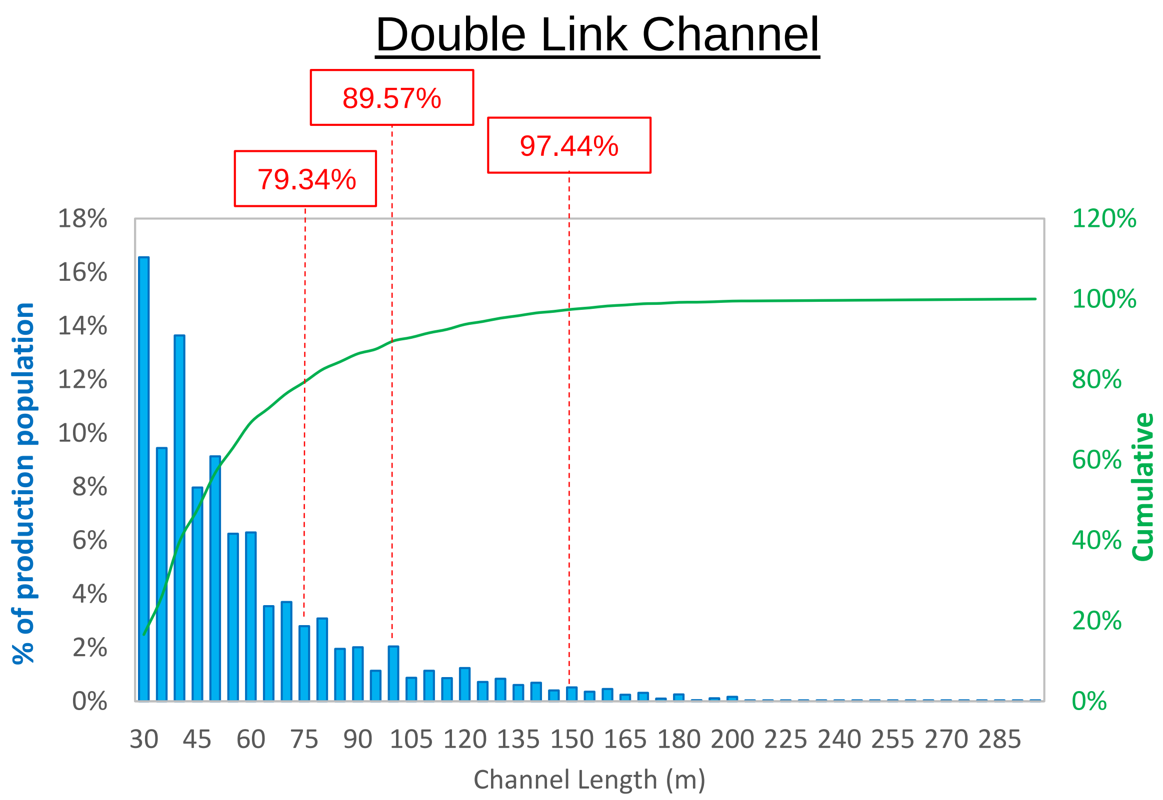
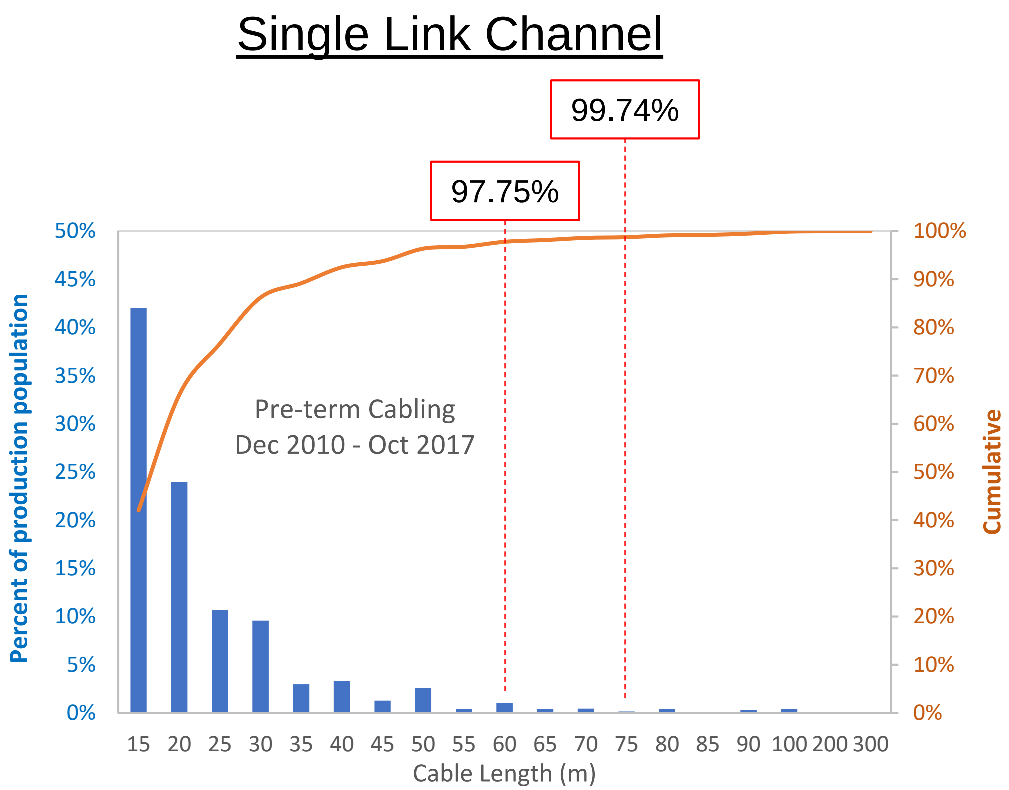
Switch-to-switch channel: reaches
– Pre-term cabling shipped from Dec 2010 to Oct 2017





- 50 m supports 57% of the channels
- 70 m supports 77% of the channels
- 80 m supports 85% of the channels

- 50 m supports 96.3% of the channels
- 70 m supports 98.6% of the channels

pimpinella_100GSR_01b_0120

Switch-to-server : Explored Options

- Two options evaluated for switch-to-server
- Assumptions to be used in link model

Option 1 : Current Objective

Parameters assumed for current objective:

VCSELs with Spectral Width (SW)= 0.5 nm,

VCSEL bandwidth (BW) =25GHz

RIN_{12} OMA = -131 dB/Hz

Tx_OMA = 0.6 dB,

Rx sensitivity shown in ***bhatt_100GSR_adhoc_01a_050720***
Rx BW= 26.26 GHz

FFE 9 taps

Optical link:
30 m over OM3
50 m over OM4

Option 2

Parameters assumed for current objective:

VCSELs with Spectral Width (SW)= 0.65 nm,

VCSEL bandwidth (BW) =23GHz

RIN_{12} OMA = -131 dB/Hz

Tx_OMA = 0.6 dB,

Rx sensitivity shown in ***bhatt_100GSR_adhoc_01a_050720***
Rx BW= 26.26 GHz

FFE 9 taps

Optical link:
20 m over OM3
30 m over OM4

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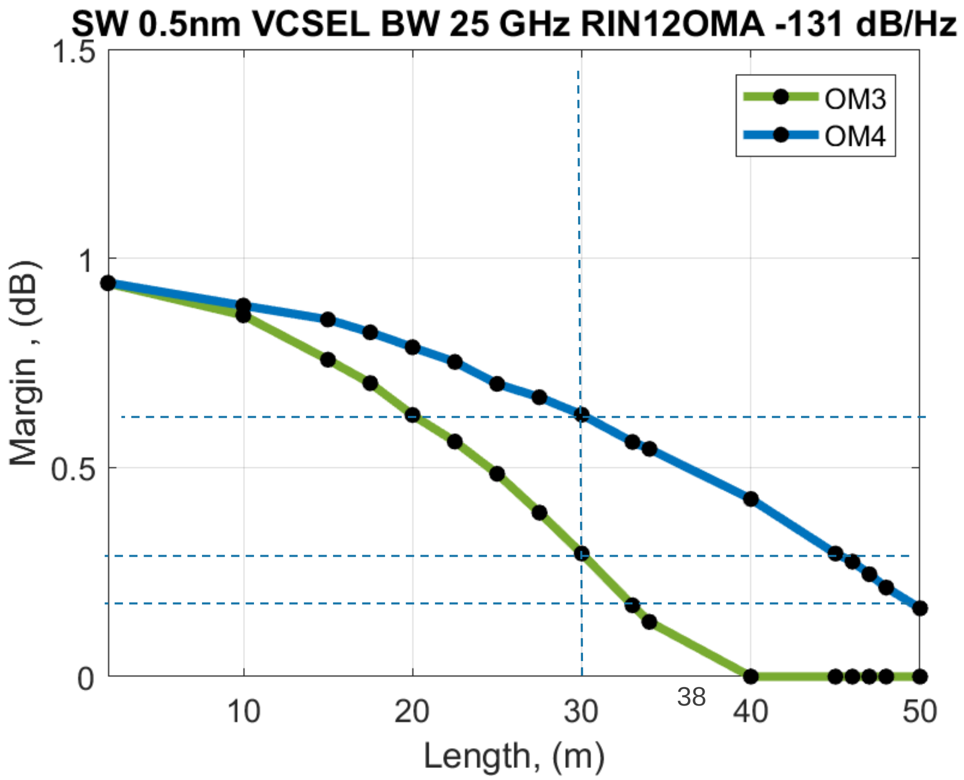
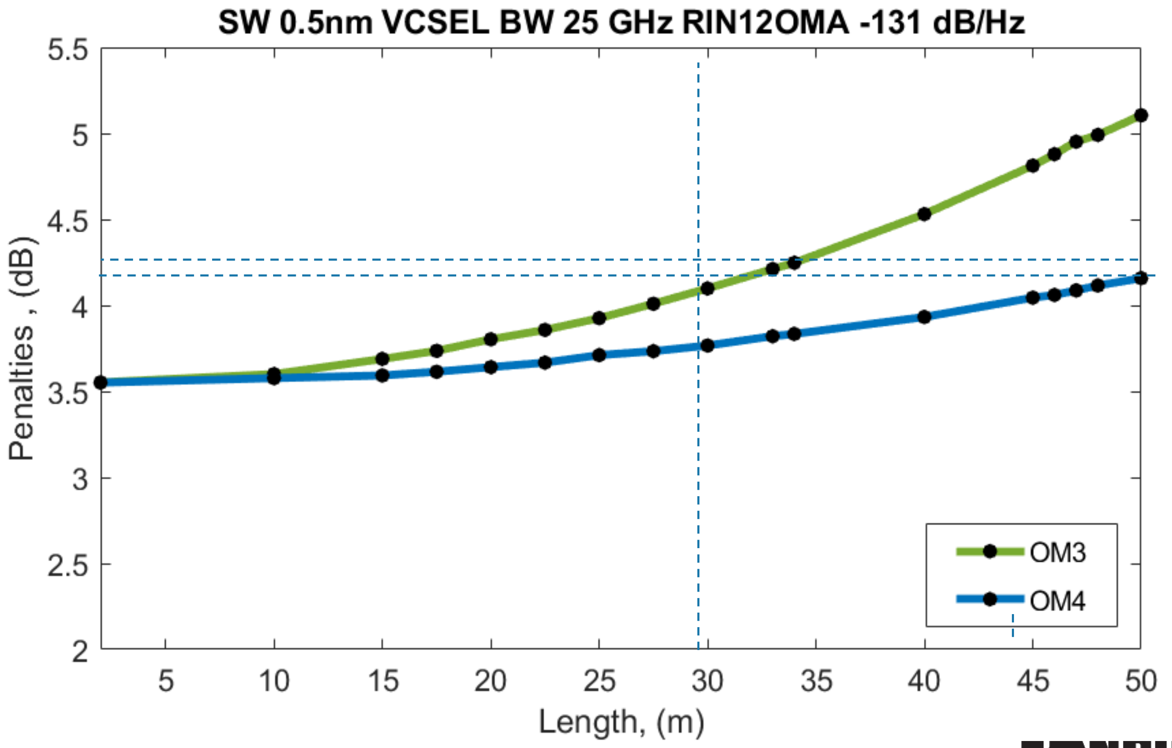
Switch-to-server Option 1 : Margins & Penalties

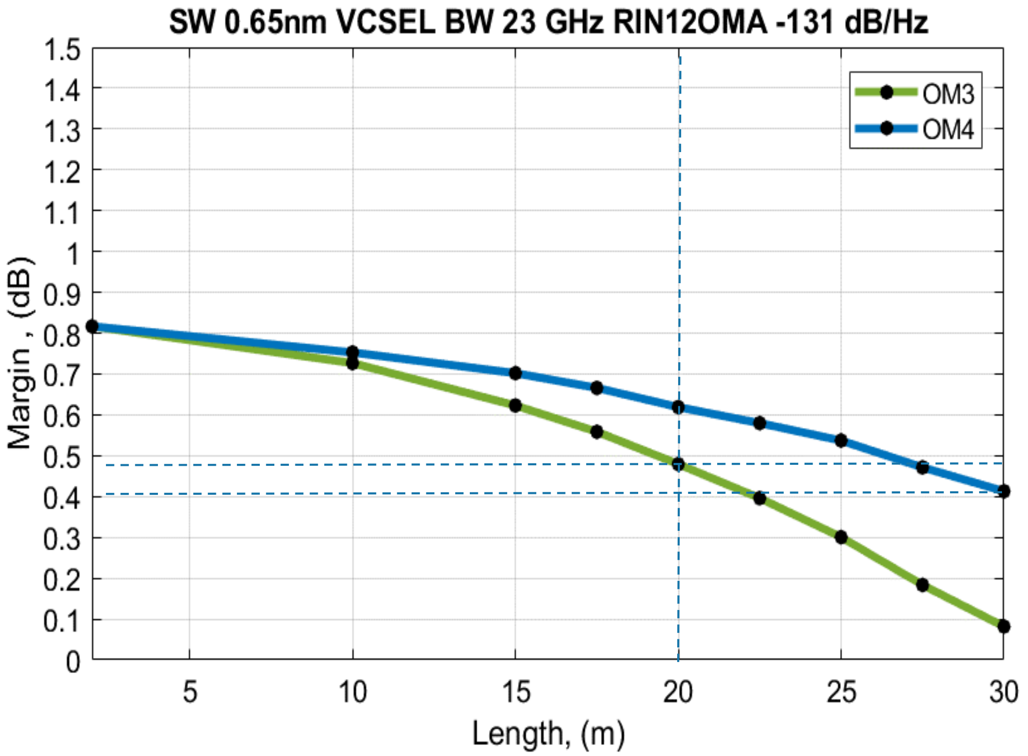
- VCSELs with Spectral Width (SW) = 0.5 nm, bandwidth (BW) 25 GHz and RIN_{12} OMA = -131 dB/Hz (3 dB lower than the one used in 802.3 cm).
- OM3: 30 m with a margin of ~0.29 dB, 38 m with zero margin
- OM4: 30 m with a margin of ~0.6 dB
- OM4: 50 m with a margin of ~0.17 dB, 60 m with zero margin

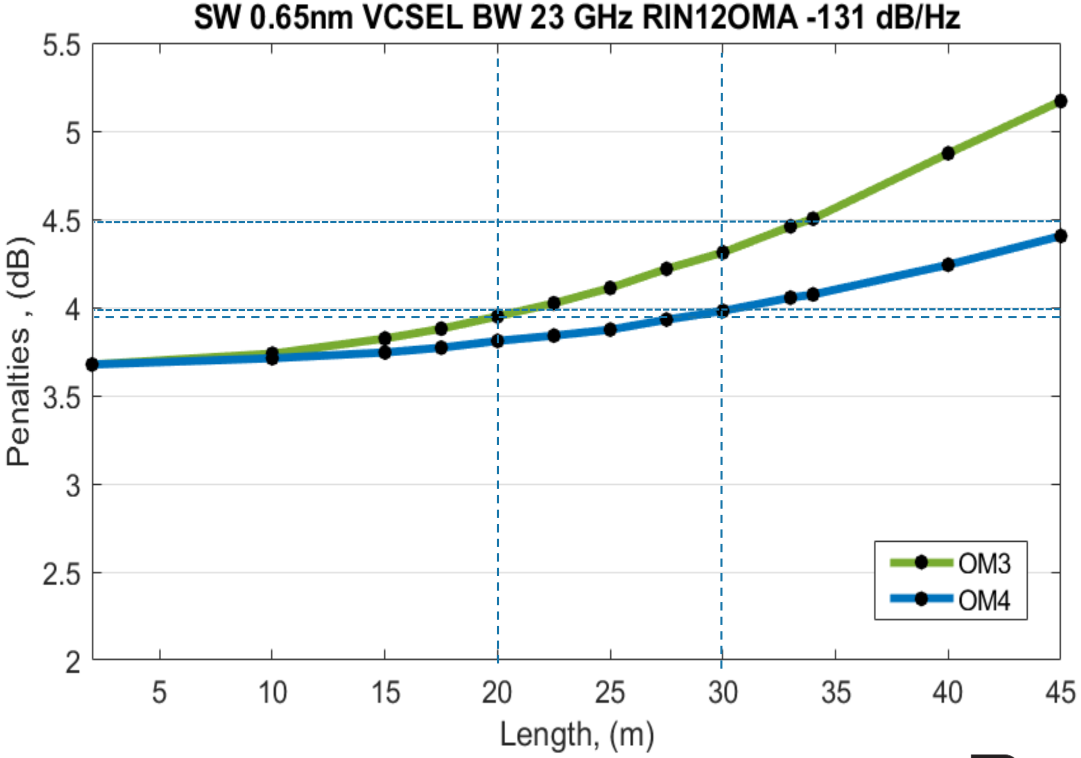




Switch-to-server Option 2 : Margins & Penalties

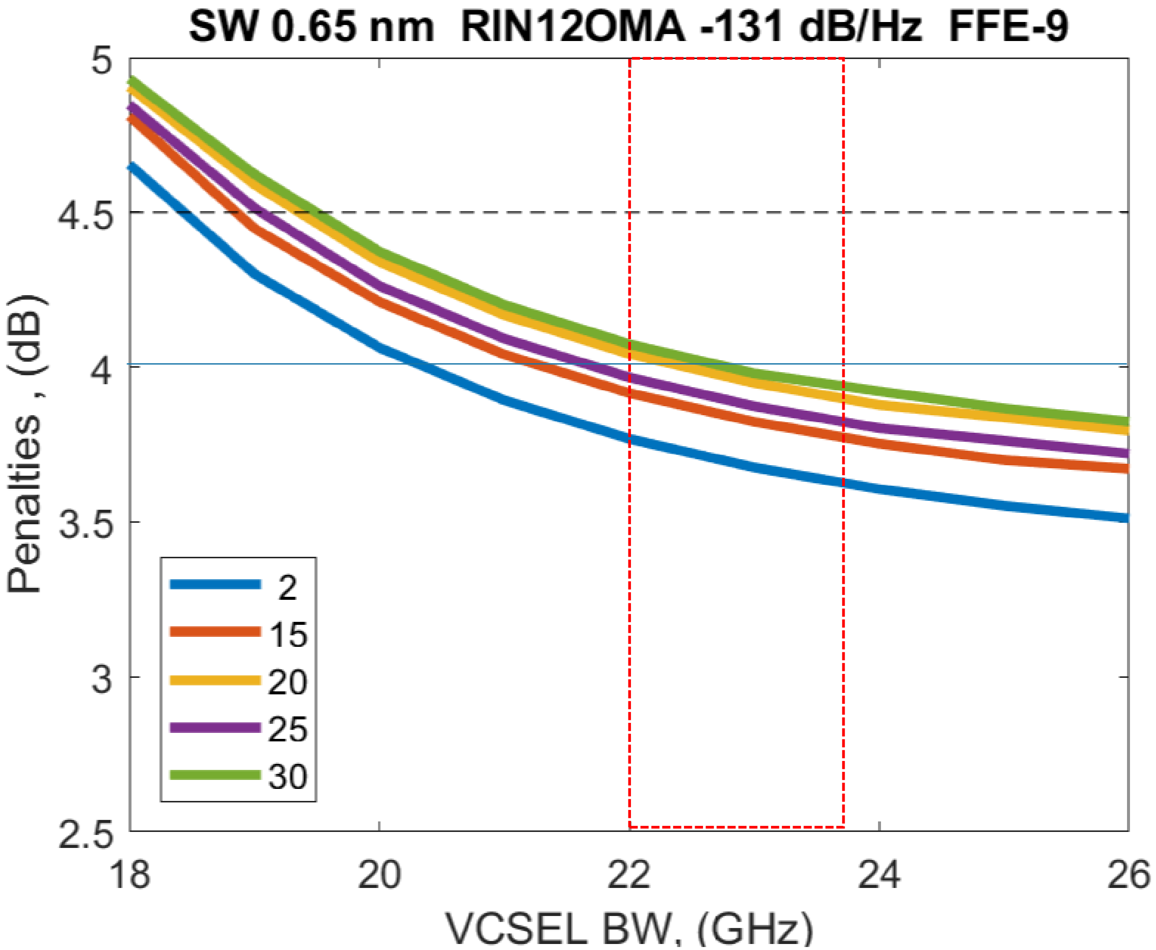
- VCSELs with Spectral Width (SW) = 0.65 nm, bandwidth (BW) =23GHz and RIN_{12} OMA of = -131 dB/Hz (3 dB lower than the one used in 802.3 cm).
- OM3: 20 m with a margin of ~0.48 dB, 35 m with zero margin
- OM4: 30 m with a margin of ~0.41 dB, 46m with zero margin





Switch-to-server Option 2: VCSEL Bandwidth

- This link is sensitive to VCSEL bandwidth, but less sensitive to spectral width.
  - Up to 0.65 nm spectral width, and bandwidth between 22-24 GHz should suffice to close the link.
  - Additional margins, ~0.5 dB are initially considered over TDECQ 4.5 dB
  - VCSEL can use higher bias current, (since more SW is allowed) to provide the required bandwidth.



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Switch-to-server : Comparison

- Switch-to-server is very cost sensitive and due to the short reach the dominant cost is likely to be in the transceivers.
- Both shown options can work for 30 m. Option 1 will work also for 50 m.
- Option 2 will require VCSELs with relaxed Spectral Width and Bandwidth tolerances.
- The specs for both options are significantly different.
- Can Option 2 produce significant cost advantages?

Option 1: Current Objective

Parameters assumed for current objective:

VCSELs with Spectral Width (SW)= 0.5 nm,

VCSEL bandwidth (BW) =25GHz

RIN_{12} OMA = -131 dB/Hz

Tx_OMA = 0.6 dB,

Rx BW= 26.26 GHz

FFE-9

Rx sensitivity shown in ***bhatt_100GSR_adhoc_01a_050720***
Optical link:

30 m over OM3
50 m over OM4

Option 2

Parameters assumed for option 2:

VCSELs with Spectral Width (SW)= 0.65 nm,

VCSEL bandwidth (BW) =23GHz

RIN_{12} OMA = -131 dB/Hz

Tx_OMA = 0.6 dB,

Rx BW= 26.26 GHz

FFE-9

Rx sensitivity shown in ***bhatt_100GSR_adhoc_01a_050720***
Optical link:

20 m over OM3
30 m over OM4

Switch-to-switch : Options to Explore

- Options to evaluate for switch-to-switch
- For now we should evaluate different options to achieve max. reach
- Economics of the options will determine feasibility
- Focus on the OM4 fiber reach for now

Option 1 : Current Objective (≥50 m)

Assumed parameters:

VCSELs with Spectral Width (SW)= 0.5 nm,

VCSEL bandwidth (BW) =25 GHz

RIN_{12} OMA = -131 dB/Hz

Tx_OMA = 0.6 dB,

TDECQ = 4.5 dB

Rx BW= 26.26 GHz

FFE-9

Rx sensitivity shown in ***bhatt_100GSR_adhoc_01a_050720***

Optical link:

50 m over OM4

Options to consider

Assumed parameters:

VCSELs with Spectral Width (SW)= 0.4 nm - 0.45 nm,

VCSEL bandwidth (BW) =25 GHz -26 GHz

RIN_{12} OMA = -132 dB/Hz

Tx_OMA = ≤ 1.6 dB,

TDECQ ≥ 5 dB

Rx BW= 26.26 GHz

FFE-9

Rx sensitivity shown in ***bhatt_100GSR_adhoc_01a_050720***

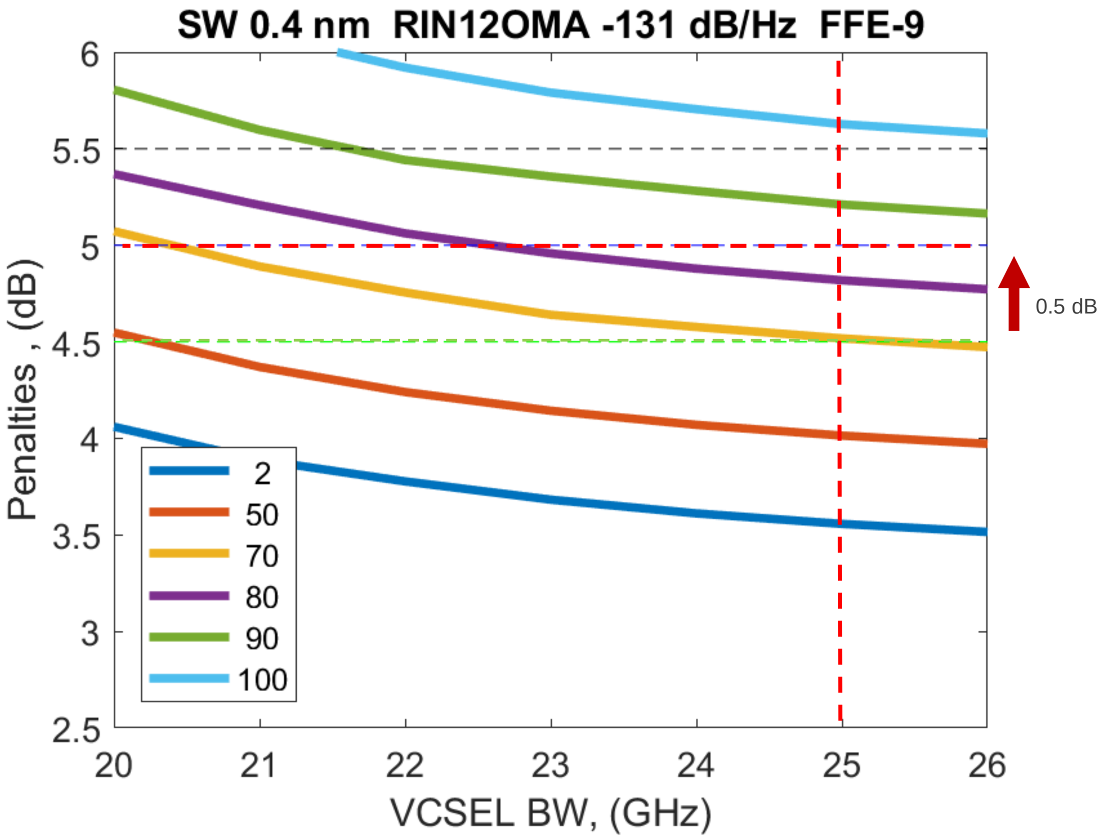
Optical link:

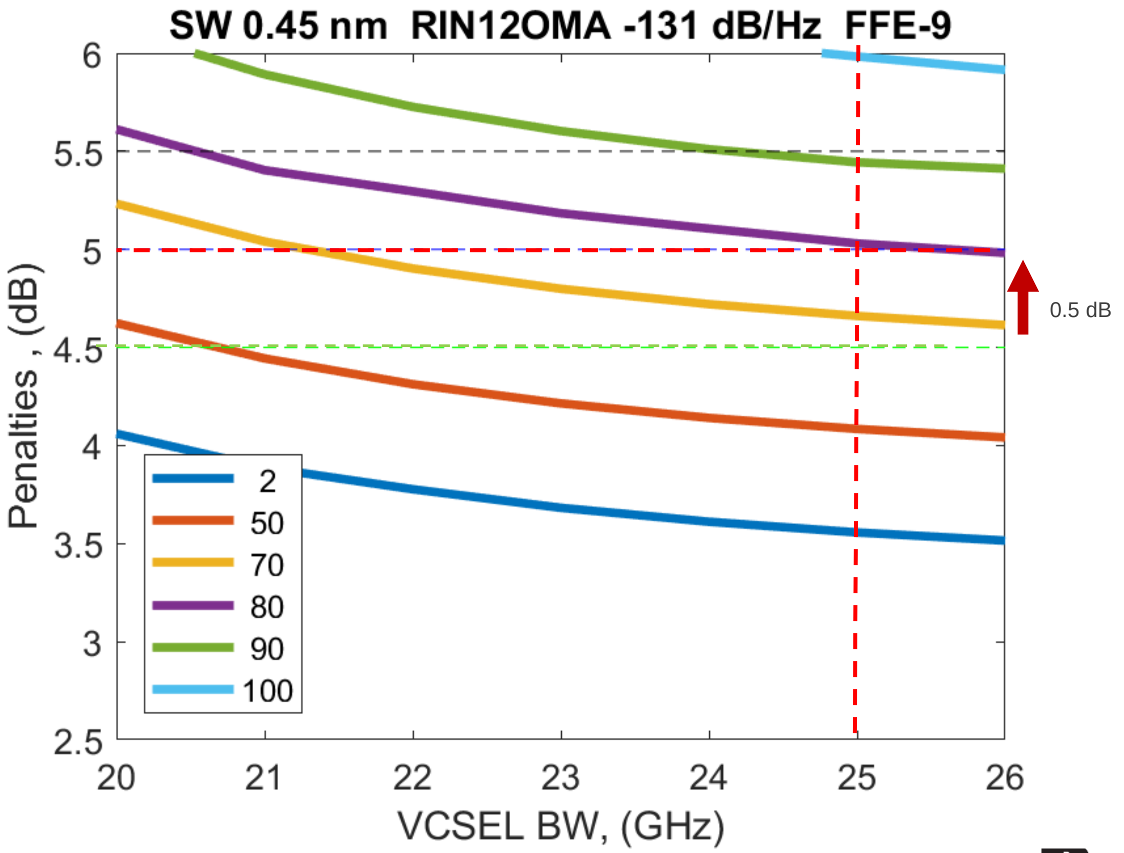
≥80 m over OM4

The max. reach of Option 1 with assumed parameters < 60m (see slide 9)

Switch-to-switch: VCSEL bandwidth

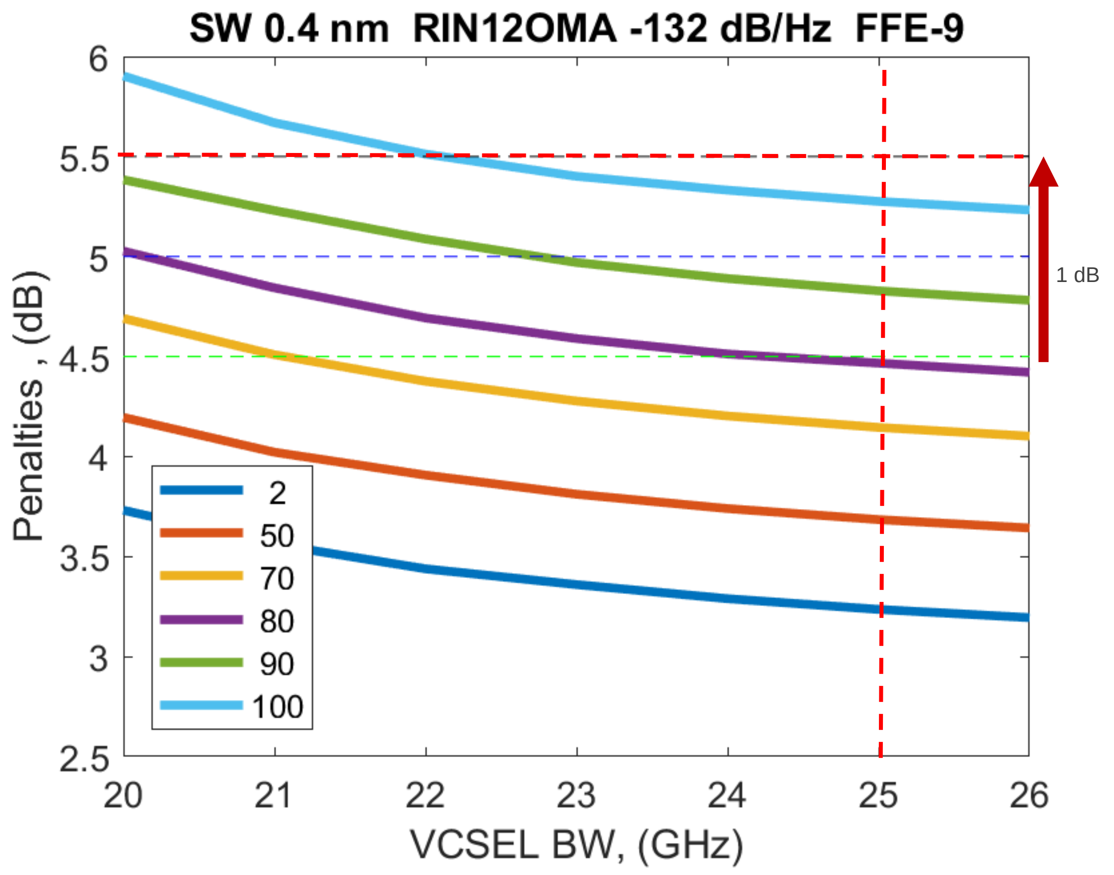
- A target 80 m over OM4 with $TDECQ_{max}$ of 5 dB requires Tx_OMA=1.1 dBm
  - TDECQ computation to be redefined to FFE with ≥ 5 taps and 80 m
- SW of 0.4 nm improve margins

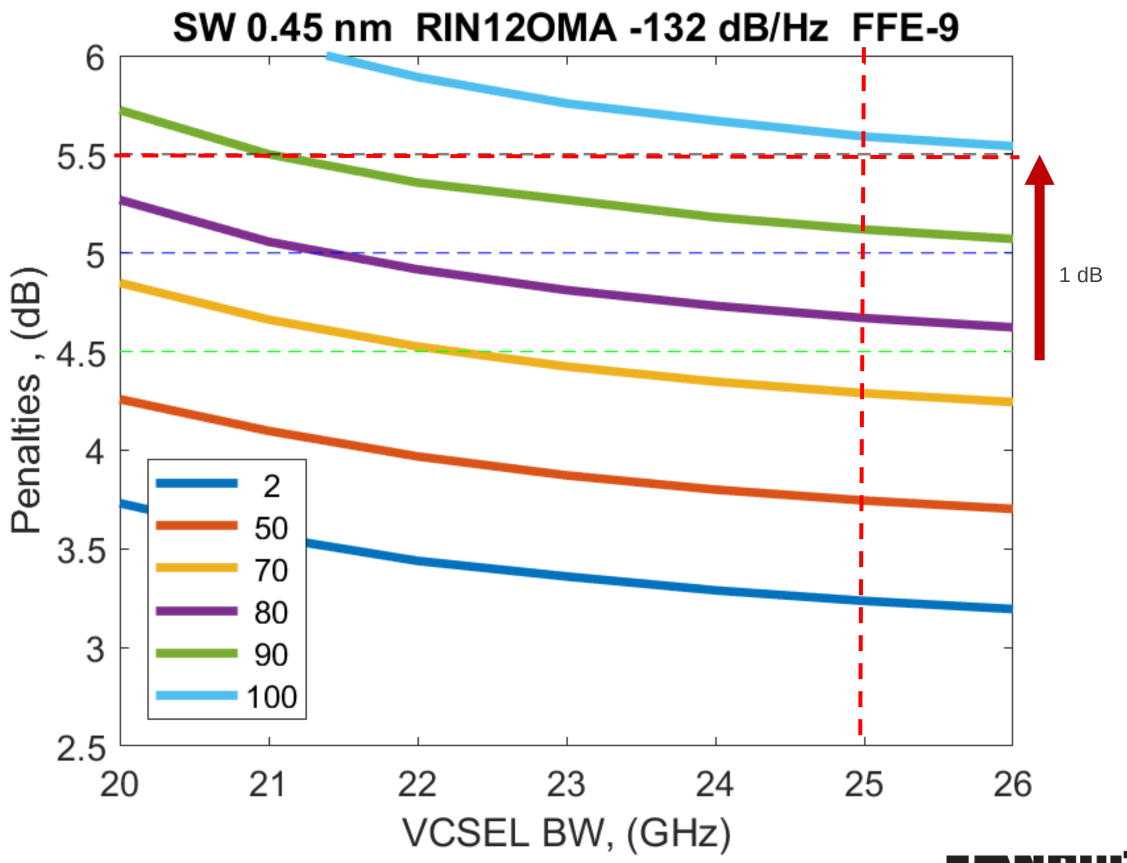




Switch-to-switch: VCSEL bandwidth

- A target 100 m over OM4 with $TDECQ_{max}$ of 5.5 dB requires Tx_OMA=1.6 dBm
  - TDECQ computation to be redefined to FFE with ≥ 7 taps
- SW of 0.4 nm needed





Switch-to-switch Channel: Comparisons

- Based on the model assumptions, 80 m reach with 1.5 dB Connector loss over OM4 requires:
  - ≤0.42 nm spectral width
  - ≤-131 dB/Hz RIN_{12} OMA
  - TDECQ=5 dB
  - Tx_OMA of 1.1 dBm

- Based on the model assumptions, 100 m reach with 1.5 dB Connector loss over OM4 requires:
  - ≤0.4 nm spectral width
  - ≤-132 dB/Hz RIN_{12} OMA
  - TDECQ=5.5 dB
    - Note precedent, FC-PI-7 used VCSELs with TDECQ max= 5.5 dB, at 28.9 GBaud.
  - Tx_OMA of 1.6 dBm, or a *1 dB connector loss* channel link with Tx_OMA ~1.1 dBm

- Option 1, reach is below 60 m , and improvements to achieve longer reaches can impact on the cost for switch-to-server link.

Summary & Discussion

- To better address the market needs we need to have two PMDs for switch-to-server and switch-to-switch.
  - Accelerate development of switch-to-server with perhaps todays' technology.
    - RIN improvement to be considered by manufacturers
  - Evaluate carefully the maximum reach supported by manufacturing in 2022 for switch-to-switch interconnections.
- Initial proposal for two PMDs:
  - switch-to-server 30m (two options, which one can produce less expensive channels)
    - Option 1, current option, 30m using OM3 (50m using OM4)
    - Option 2 provide relaxed VCSEL tolerances for,
      - ≤ 20m OM3, (aligned to lowest cost considerations from *nering_100GSR_01_0120* and others)
      - ≤ 30m using OM4
      - If cost is low enough, it could replace the need for AOCs
  - switch-to-switch interconnections for ≥ 80m
    - Intend to cover >80 % of use switch-to-switch interconnection use cases
- RIN is a critical parameter based on model, specially for switch to switch.
- Need more experimental study to validate modeling assumptions.