DR Tx 'off' specs (comment 129, 130)

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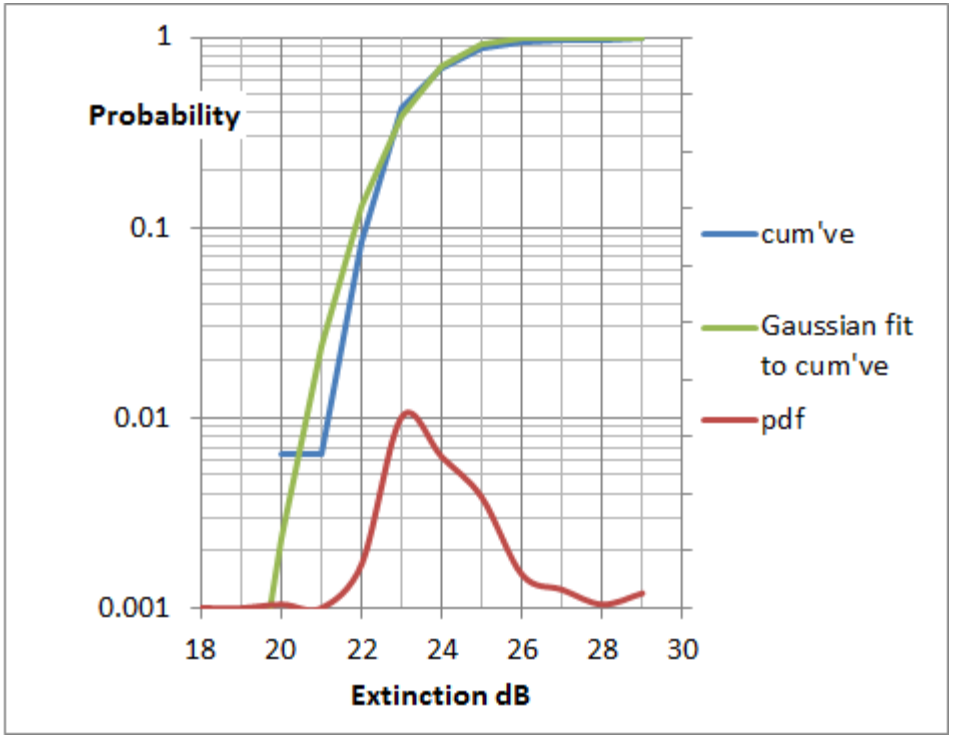
Tx 'off' spec for multi-lane SMF

- Global (all transmitters) Tx 'off' is required
  - easily met by turning off the master laser for PSM
- Individual Tx lane 'off' is optional
  - can't turn off master laser;
  - must use the extinction of an individual lane's modulator to attenuate the light on that lane in order to meet the Tx 'off' spec
  - The 802.3bs D3.0 Tx 'off' spec sets a per lane limit that is still hard to reach with a modulator that would otherwise be completely fit for purpose
  - While the single lane variants will have no issue meeting even a -30dBm spec, the single lane variants should be consistent with the multi-lane SMF PMDs
  - Aim: find a spec value that is viable

Tx 'off' power spec

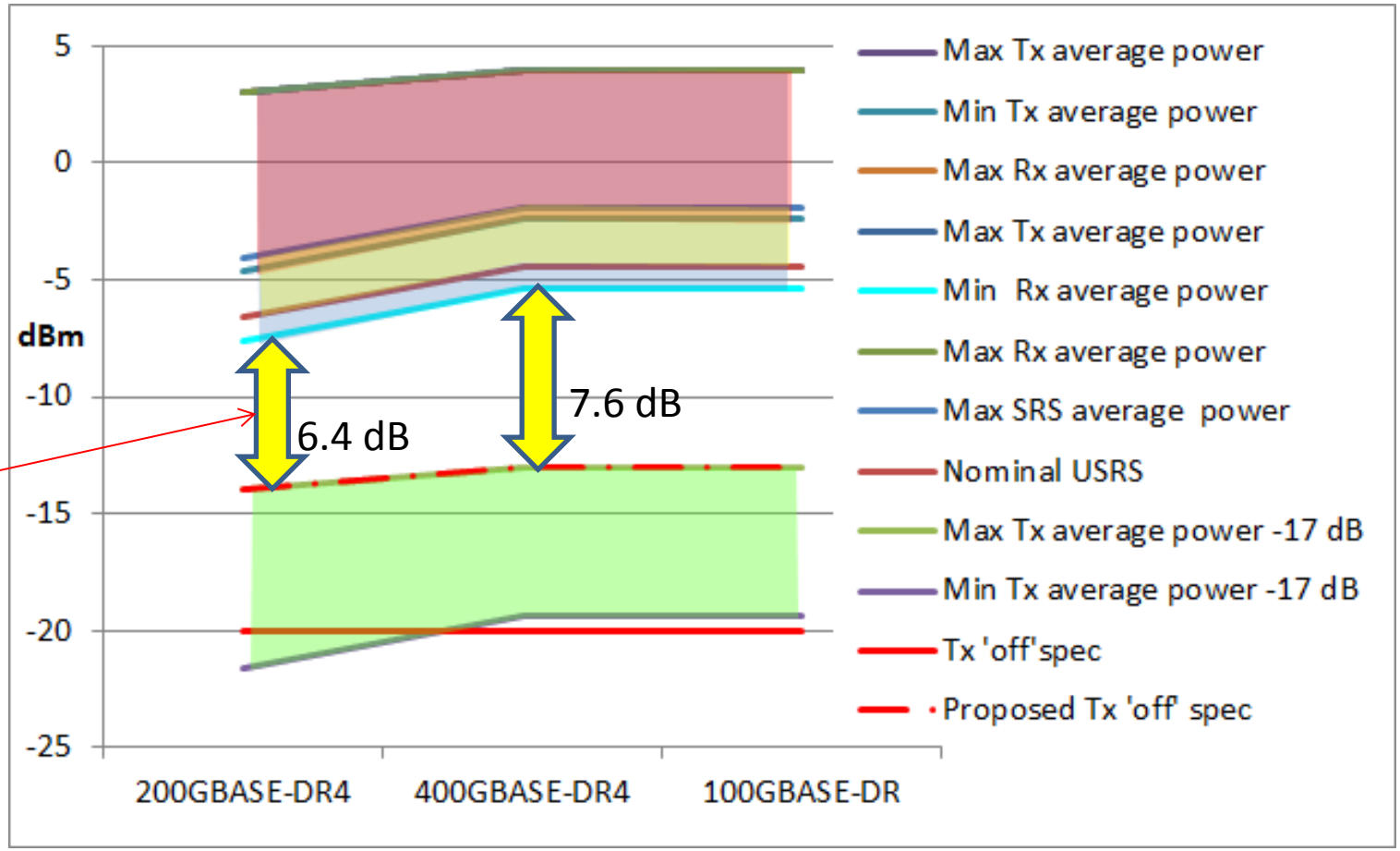
- DC modulator extinction data, 3 temperatures, 4 lanes, ~13 devices:

~99.8% yield for
20 dB DC Extinction



- The Tx average power 'uses up' 3 dB of ER (quadrature bias)
- The rest of the ER can be used to attenuate the power of individual lanes.

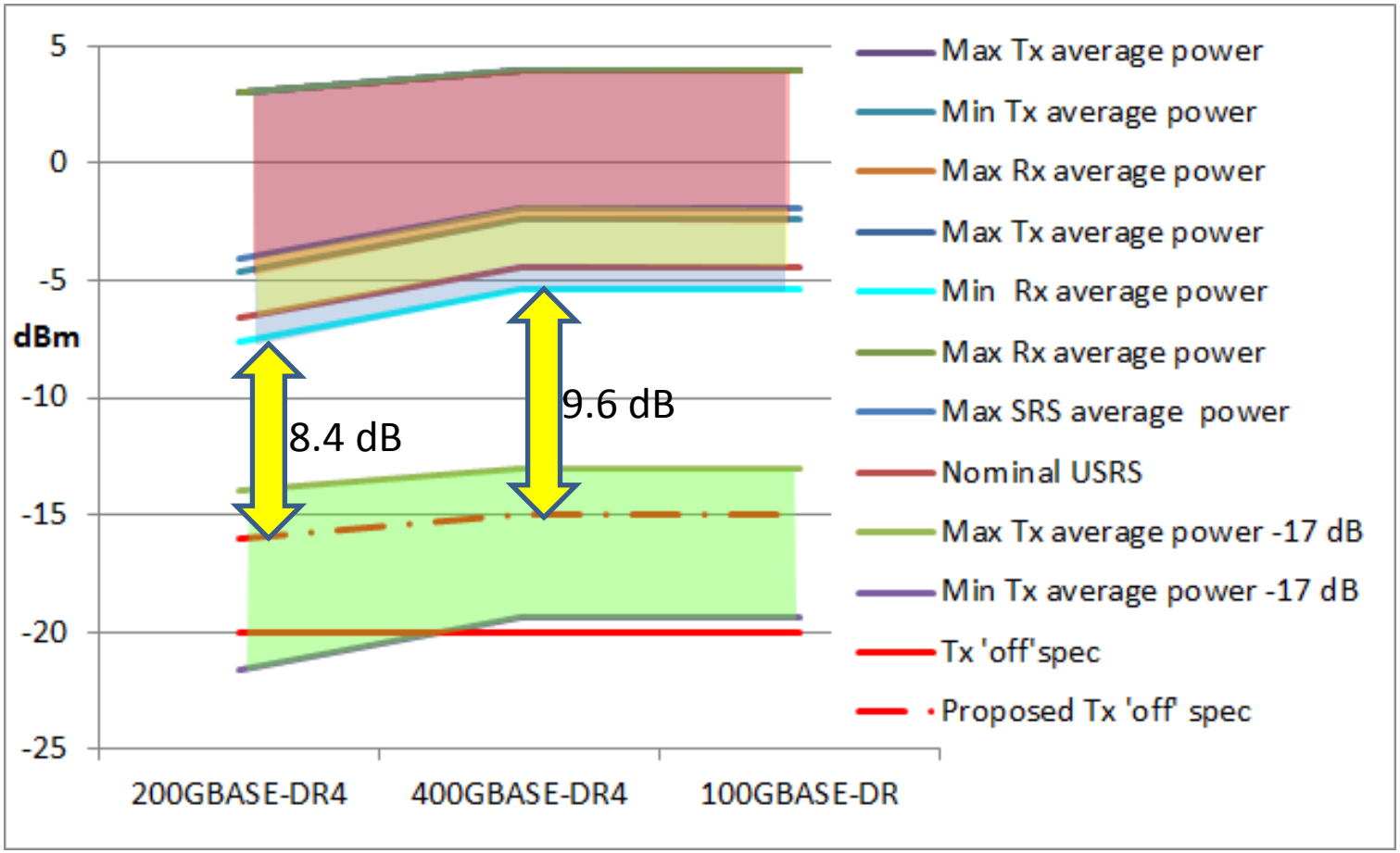
200G DR4, 400G DR4 & 100G DR specs, proposal 1: -14, -13 and -13 dBm Tx 'off' spec



6 dB seems too tight

20 dB min extinction from modulator would allow 17 dB reduction in average Tx power

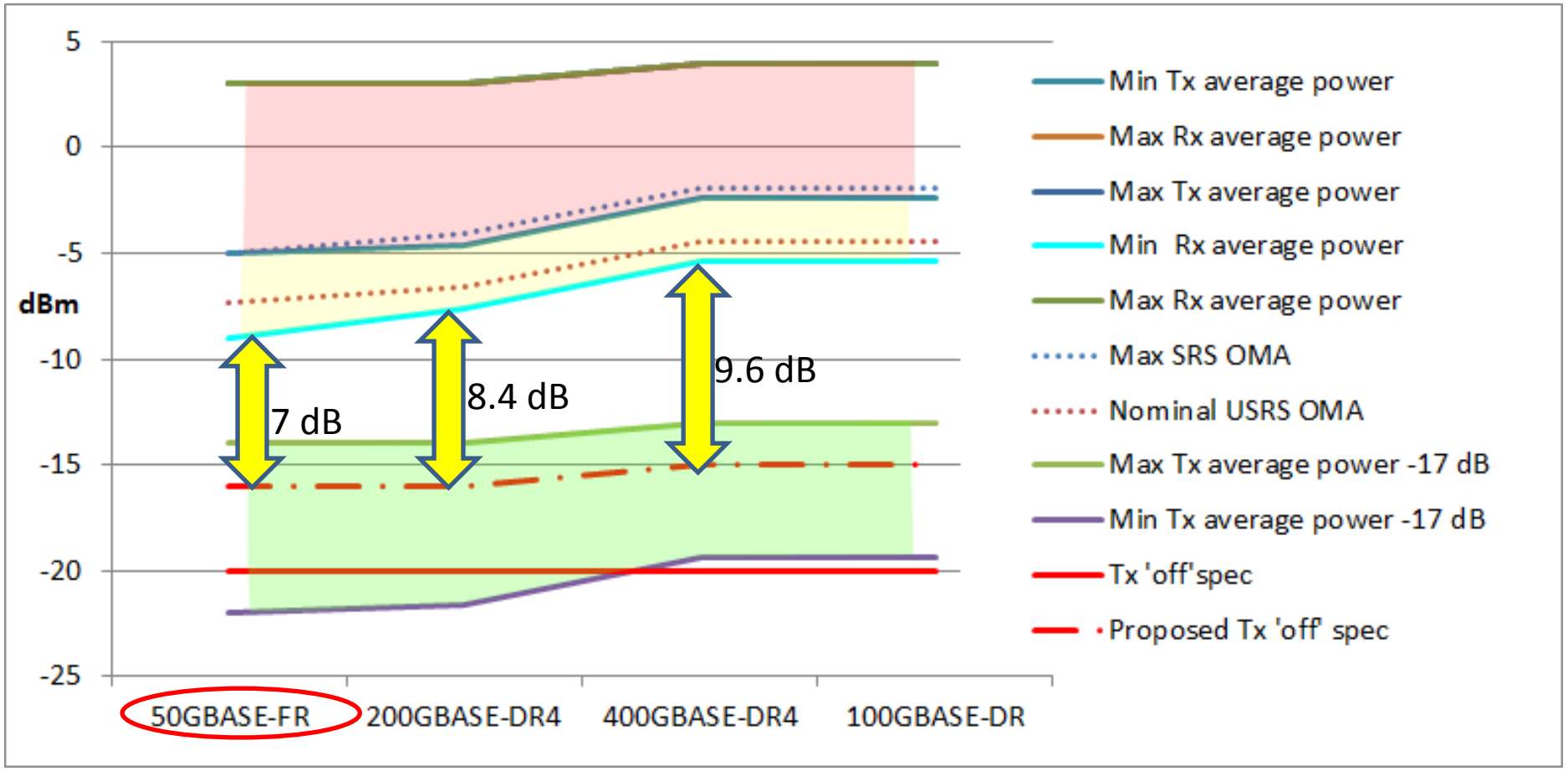
200G DR4, 400G DR4 & 100G DR specs proposal 2: -16, -15 and -15 dBm Tx 'off' spec



20dB min extinction from modulator would allow 17 dB reduction in average Tx power

Meeting Tx 'off' spec relies on controlling lane to lane Tx average power per lane

200G DR4 **& 50G FR**, 400G DR4 & 100G DR specs proposal 2: -16, -15 and -15 dBm Tx 'off' spec



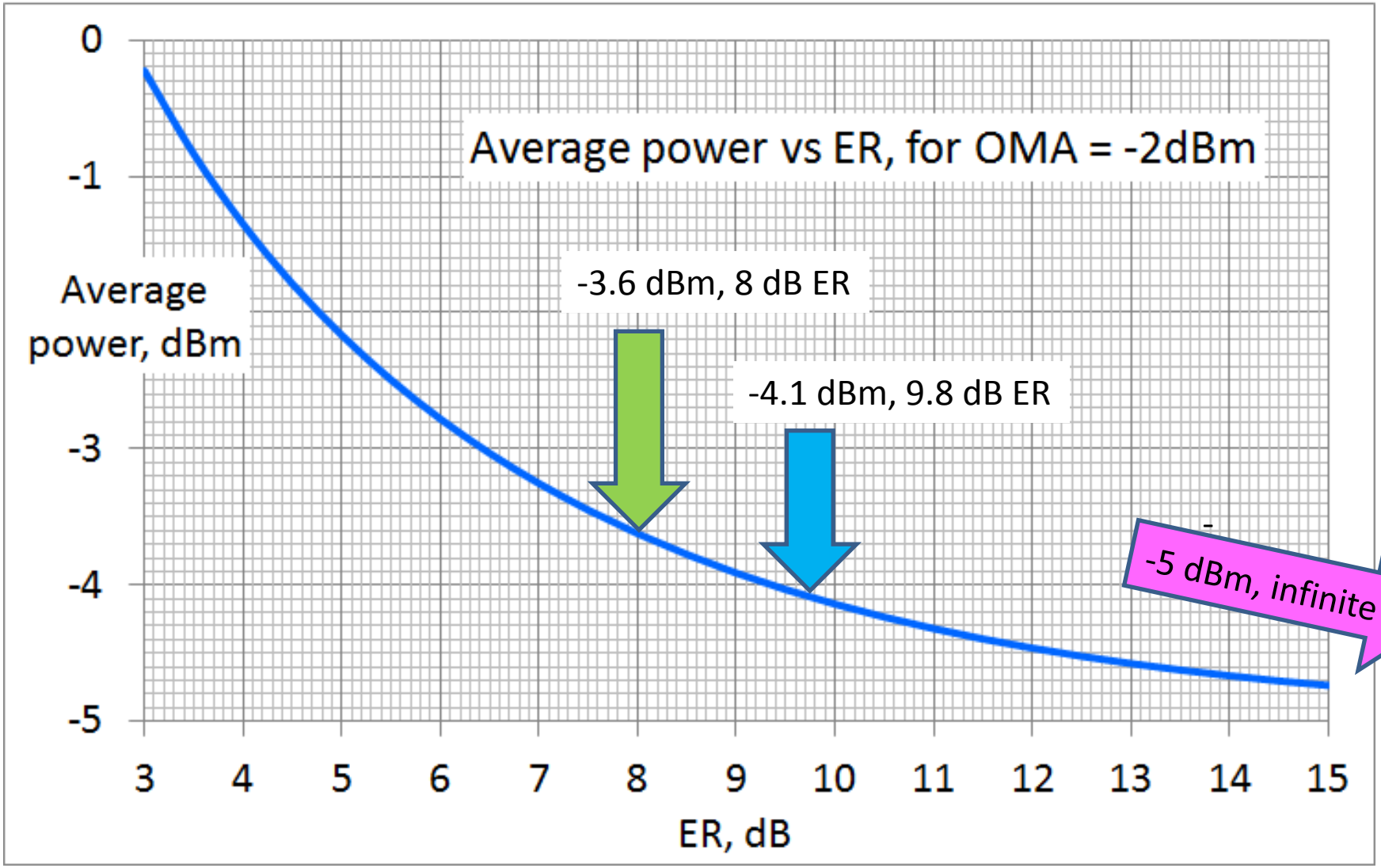
20 dB min extinction from modulator would allow 17 dB reduction in average Tx power

Meeting Tx 'off' spec relies on controlling lane to lane Tx average power per lane very closely

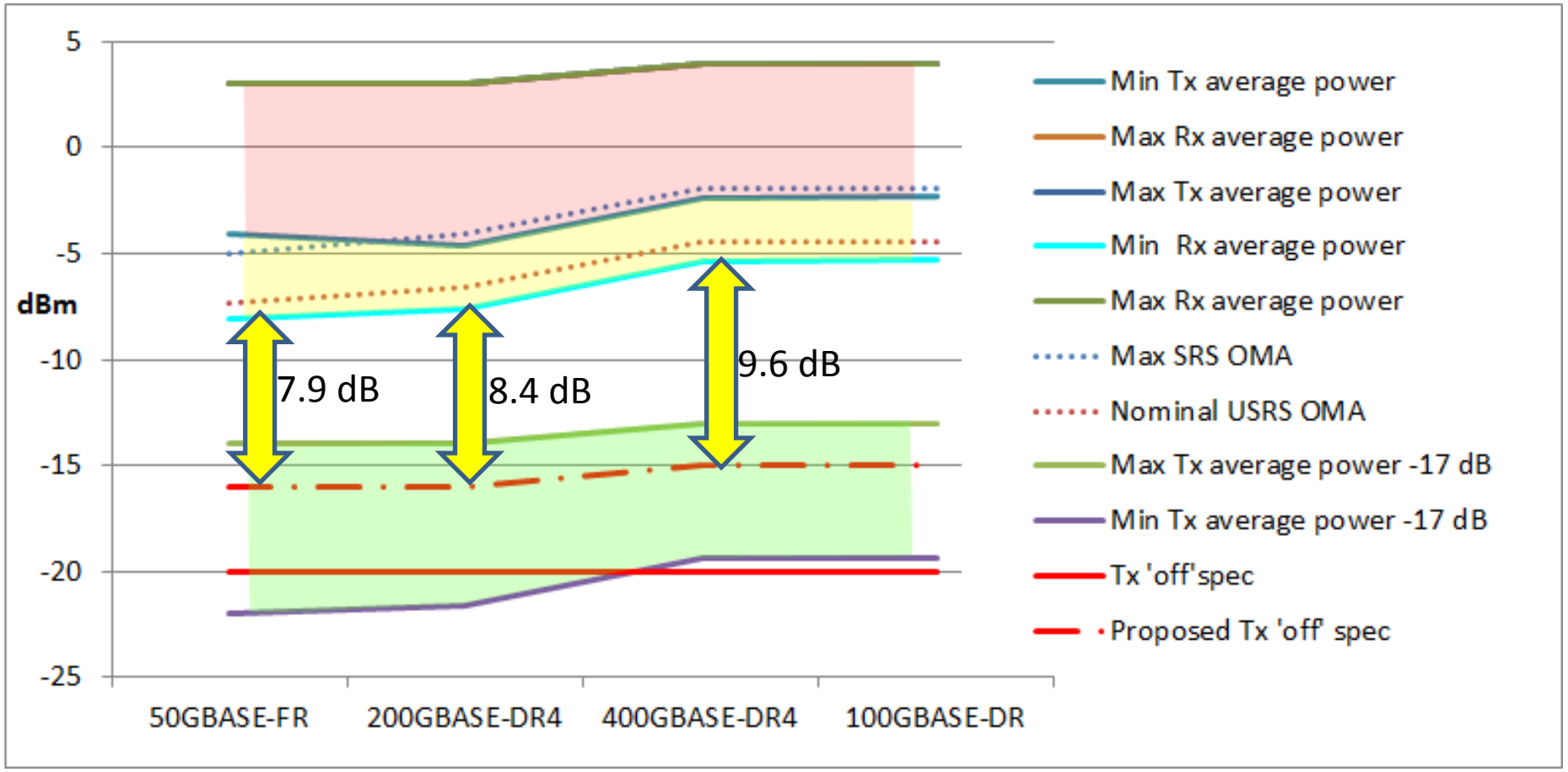
Helpful changes to 50GBASE-FR

- 50GBASE-FR has lower Tx average launch power (min) than 200GBASE-DR4, and a 1 dB larger channel loss, resulting in a lower 'Average received power (min)' spec. But 50GBASE-FR and 200GBASE-DR4 have the same max Tx average power.
  - The result is a narrower gap between achievable Tx'off' and 'Average received power (min)'.
- To widen the gap between the 'Average received power each lane (min)' and the Tx'off' spec:
  - Other DR and DR4 PMD specs have calculated the min Tx average power from the min Tx OMA and an assumed max ER of 9.8 dB.
    - 50GBASE-FR uses an infinite ER assumption.
  - **Option 1**: For 50GBASE-FR, **use same assumed 9.8 dB ER** as other PMDs, to raise the min Tx average power from -5 dBm to -4.1 dBm.
    - 'Average received power each lane (min)' would increase to -8.1 dBm.
  - **Option 2**: Use a higher **assumed ER of 8 dB** for 50GBASE-FR: raises the min Tx average launch power from -5 dBm to -3.6 dBm, and increases the 'Average received power' to -7.6 dBm, i.e. **same value as for 200GBASE-DR4**.

50GBASE-FR 'Average launch power, min' vs ER at -2 dBm OMA

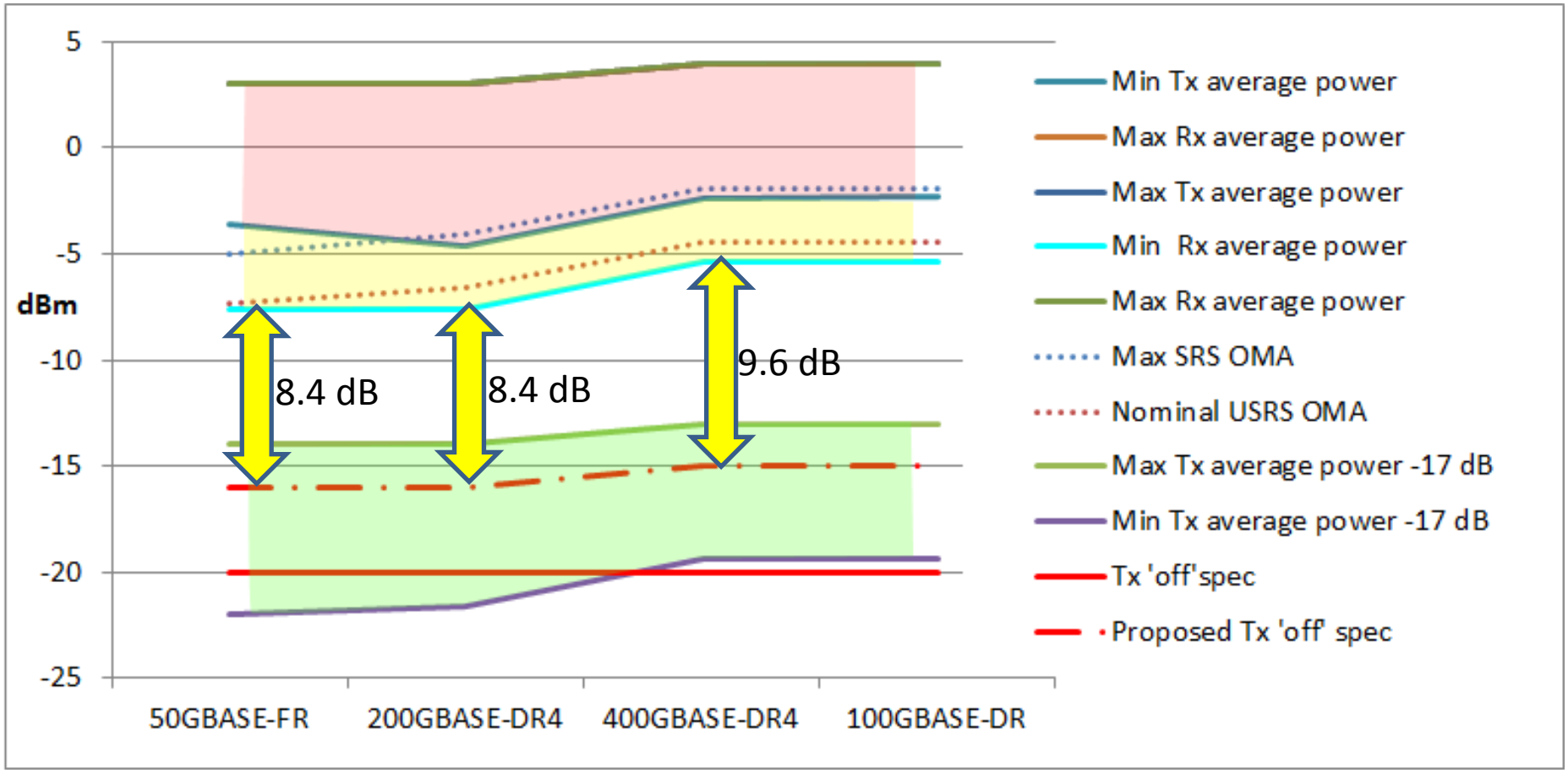


200G DR4 **& option 1 50G FR**, 400G DR4 & 100G DR specs proposal 2: -16, -15 and -15 dBm Tx 'off' spec



20 dB min extinction from modulator would allow 17 dB reduction in average Tx power
Meeting Tx 'off' spec relies on controlling lane to lane Tx average power per lane

200G DR4 **& option 2 50G FR**, 400G DR4 & 100G DR specs proposal 2: -16, -15 and -15 dBm Tx 'off' spec



20 dB min extinction from modulator would allow 17 dB reduction in average Tx power
Meeting Tx 'off' spec relies on controlling lane to lane Tx average power per lane

Conclusion

- Based on the measured data, 17 dB is the minimum extinction available to turn down Tx average power on a per lane basis.
  - The available modulator extinction is still much higher than required to generate a high quality optical PAM4 signal.
  - Tx 'off' spec = -20dBm cannot be achieved reliably on a lane by lane basis

- Tx 'off' specs of **-16 dBm** for 200GBASE-DR4 and 50GBASE-FR, and **-15 dBm** for 400GBASE-DR4 and 100GBASE-DR, allow Tx 'off' spec to be met reliably if lane to lane variation can be controlled to better than 4 dB average output on any lane.
  - If the 50GBASE-FR specs are adjusted to make the min average received power -7.6 dBm, the same as for 200GBASE-DR4, this would leave >8 dB between the min average received power spec and Tx 'off' spec.

Proposed changes to 802.3cd and 802.3bs

- In Table 139-6, change the Average launch power of OFF transmitter from -20 dBm to -16 dBm.
- In Table 139-4, change -20 dBm to -16 dBm
  - Similar changes proposed for 200GBASE-DR4 to set Tx 'off' and Signal detect specs to -16 dBm.
- In Table 140-4, change -20 dBm to -15 dBm
- In Table 140-6, change the Average launch power of OFF transmitter from -20 dBm to -15 dBm.
  - Similar changes proposed for 400GBASE-DR4 set Tx 'off' and Signal detect specs to -15 dBm.
- In Table 139-7 change the Average received power (min) spec from -9 dBm to -7.6 dBm.
- In Table 139-6 change the Average launch power (min) spec from -5 dBm to -3.6 dBm.