Optical Testing Using Block Error Ratio Method

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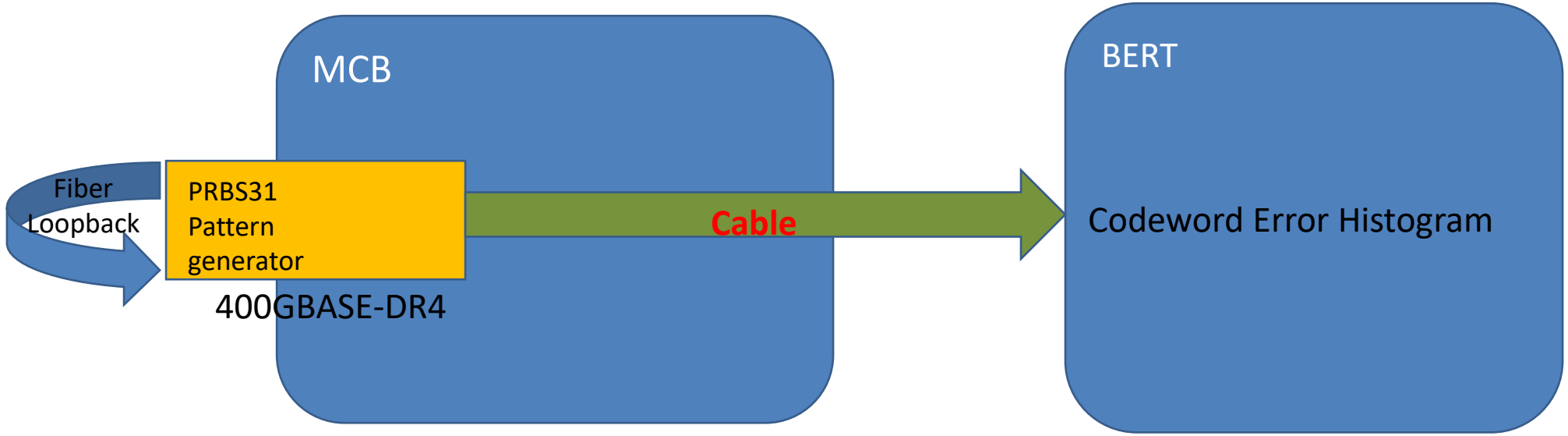
Introduction

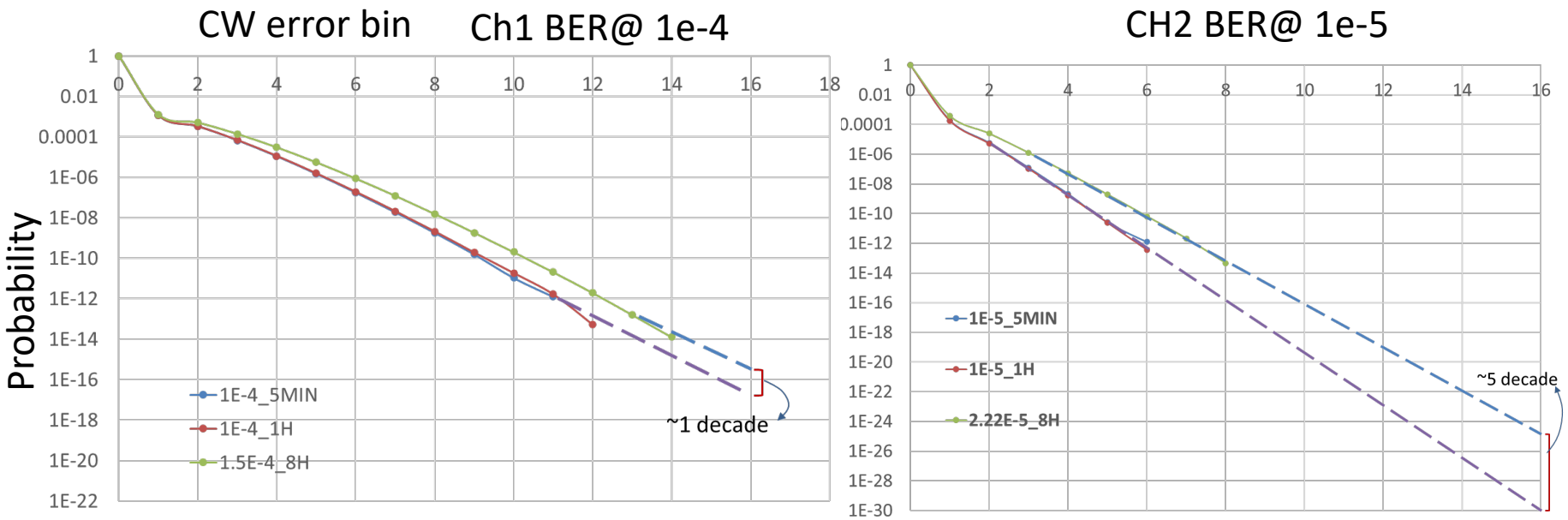
- 802.3dj TF has adopted a new metric Block Error Ratio to evaluate link reliability, along with testing method of such metric.
- Since Draft 1.1, the block error ratio has taken over BER's role as defining receiver sensitivity (RS) and Stressed Receiver Sensitivity (SRS). This change is new to the optical community. Digesting is still in progress.
- In September, mi_3dj_01a_2409 discussed the changes to evaluation system of optics. Three points were raised:
  - The disrupted relation between Rx performance (RS) and Tx performance (TECQ/TDECQ) ---still unclear
  - The existence of a curve like BER-Power curve to assist characterization of optics and both design stage and at manufacturing. In December, stassar_3dj_optx_01a_241219 also pointed out the formation of a Block error ratio – optical power curve is still unknown.
  - Testing set up, system architect and AUI – mostly solved
- This contribution takes a closer look at using block error ratio for optics testing and share the observations.

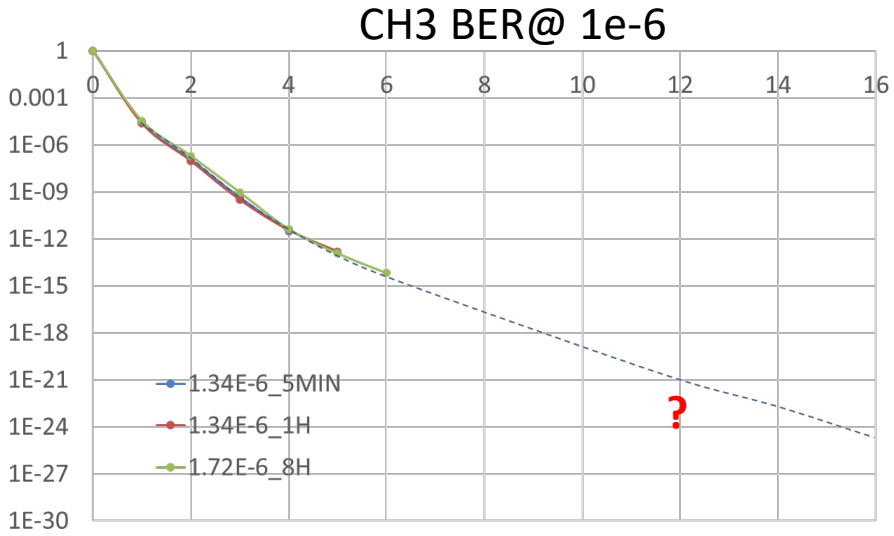
Testing setup

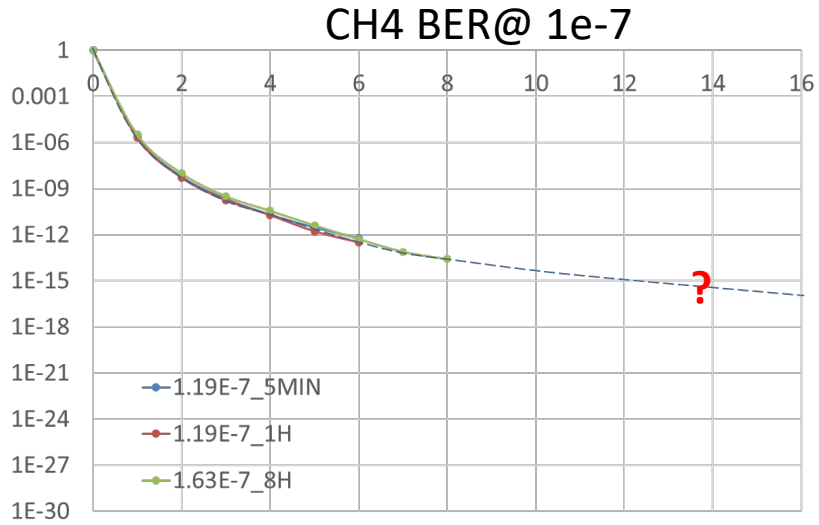
- A 400GBASE-DR4 module was tested under breakout mode, i.e. a single 100G/L channel was tested. A BERT was used to collect the codeword error ratio.
- The goal is to mimic the behavior of single lane block error ratio testing at PMA .
- The module was tested with a MCB and in loop-back setup.



CER collected at different time length

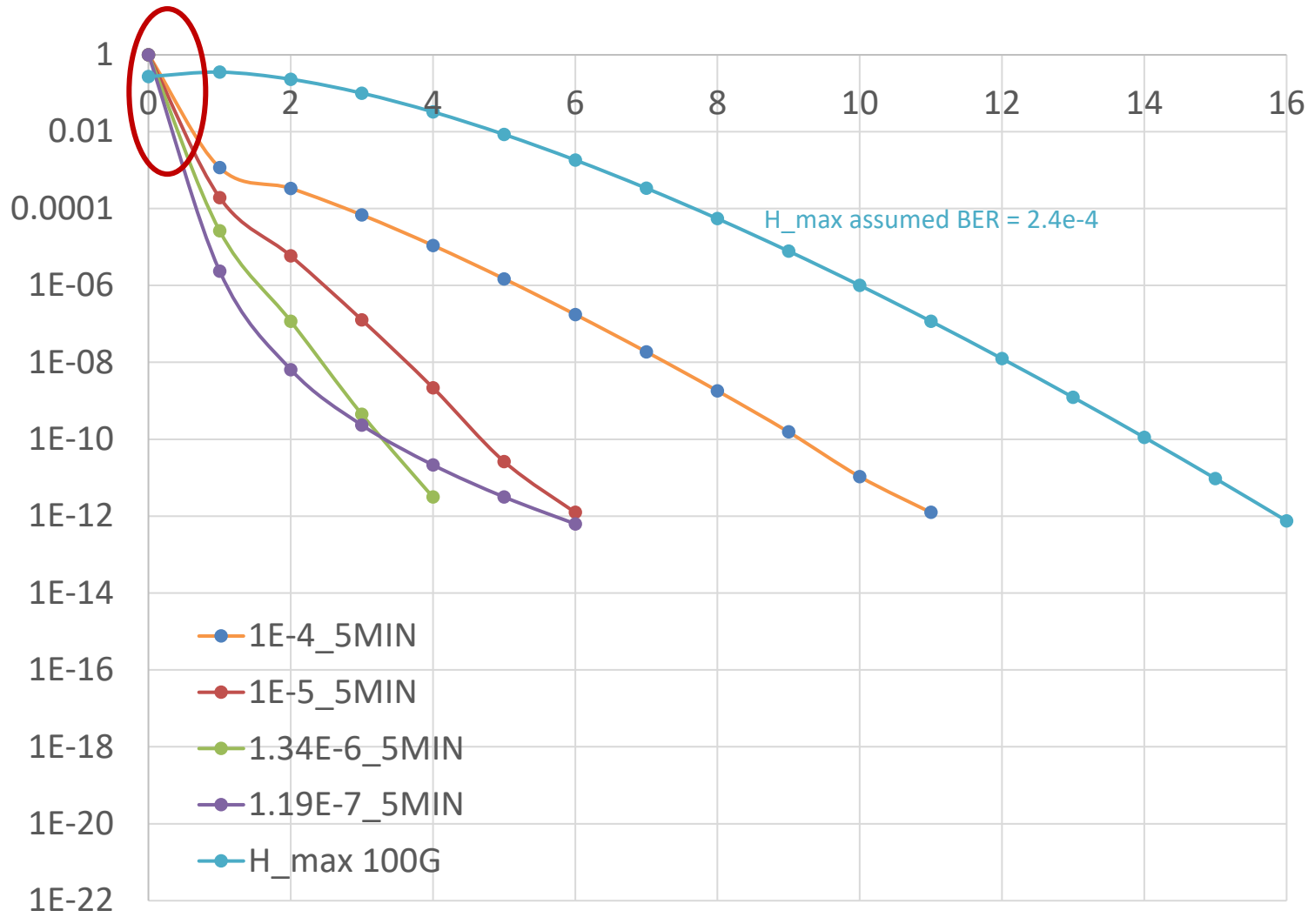




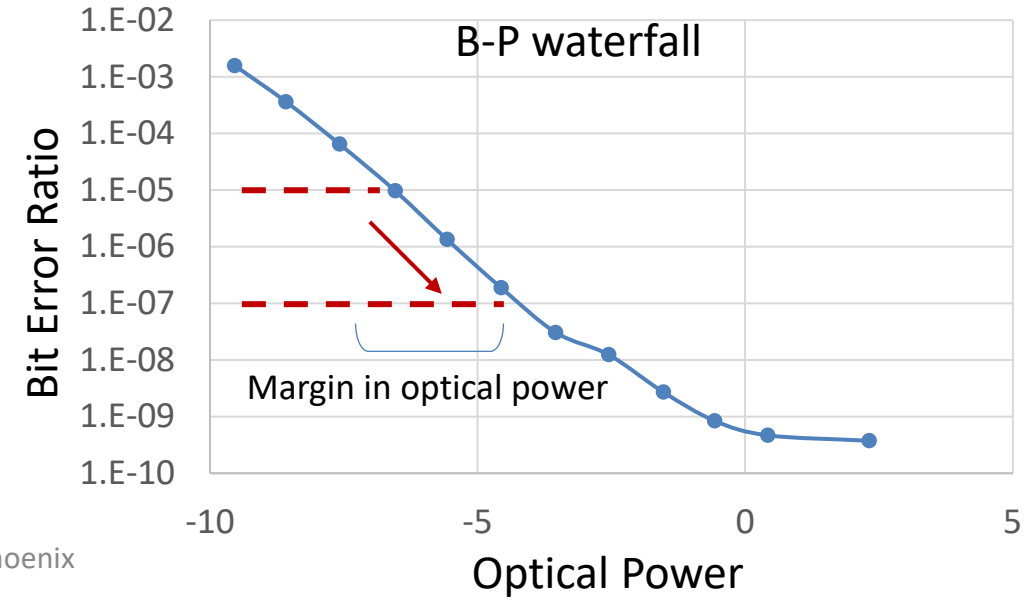


- 4 different lanes for each chart
- Different BER were achieved by adjusting OMA
- At low BER 1e-4 and 1e-5, longer collect time of 8h had impact on the histogram shape, while 1h and 5mins showed little difference. Longer collect time of 8H also provide more measured data points than 1h and 5mins
- At higher BER, histogram data points become un-measurable after Bin6. Extrapolating to Bin16 as required to calculate block error ratio could be difficult.
- This test doesn't count in the 4 CW convolving effect. CER are collected continuously instead of 1 out of 4 test blocks. So 5 mins would be equivalent to 20mins by the definition of Block error testing. Note any one of these curves = only 1 data point in the BP curve

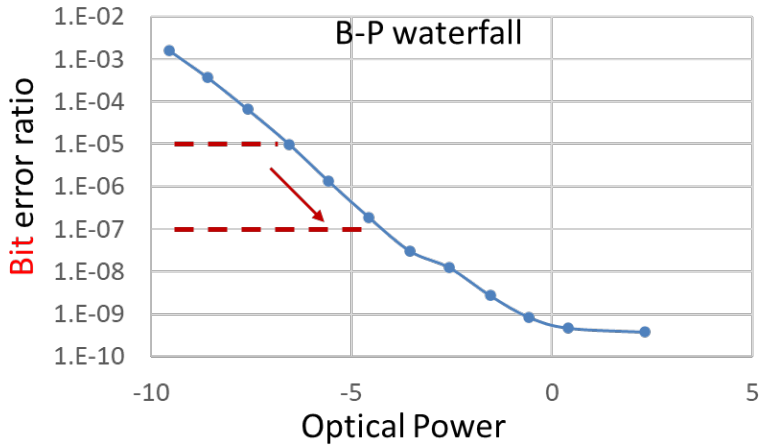
CER histogram vs the Block Error Mask



- K=0 needs to be excluded from the mask test, as barrie_3dj_optx_01a_250109 suggested and Comment 180
- Difficult to quantitatively evaluate the performance evolution over optical power, as the B-P waterfall used to show.
- Also difficult to visualize the performance margin.
- Does provide the benefit of showing error distribution. The 1e-7 histogram showed tipping tail→helpful in the design stage. However, should this channel be considered compliant?

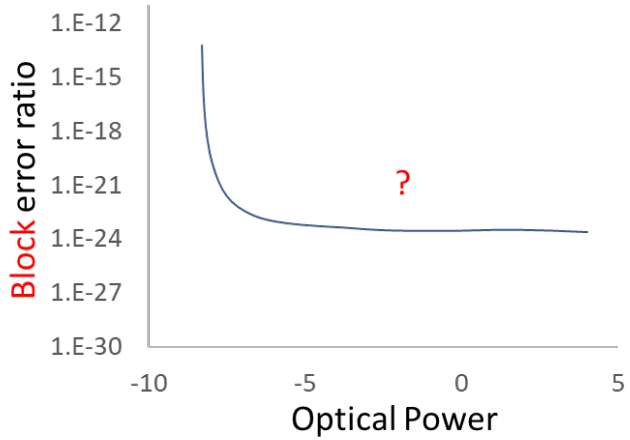


From BER to Block Error Ratio



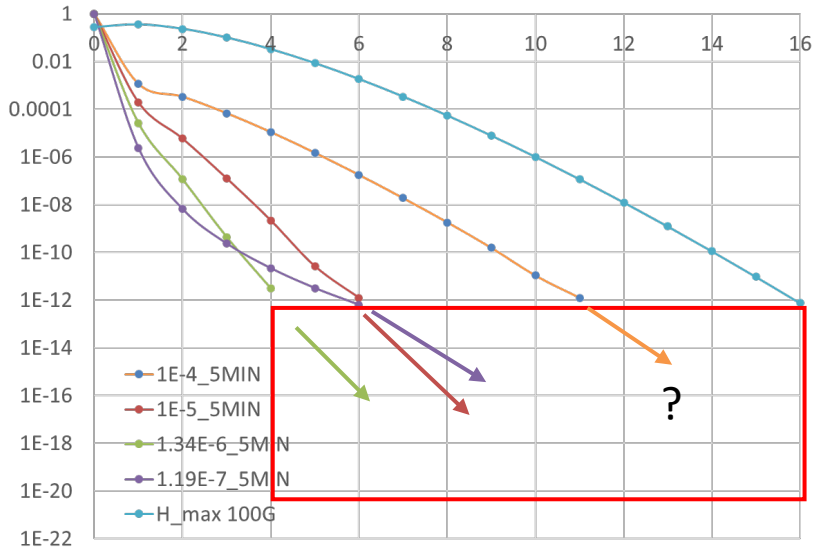
Can we create a mapping

Block Error Ratio



$$H(16) = \sum_{j=0}^{16} H_x(j)H_y(16-j) + \sum_{j=1}^{16} H_x(j)\left(\sum_{i=17-j}^{16} H_y(i)\right)$$

Measured Histogram of all 16 bin



To extrapolate the missing bins

- **Based on theoretical model**→ missing the purpose of using block error method: uder random error assumption BER is good enough
- **Use the measured data**→ challenge to find a reasonable line shape. In practice the source of non-ideality in error distribution is complex, varies design by design, even module by module

Summary of observations

- Duration of CW Error data collection does impact the resulting histogram, at least at low BER, which is where we define the standard.
  - Impact to cost and testing time
  - Impact to confidence to data
- Block error histogram mask seems align with current testing strategy in use by vendors and required by customer, a good information added to the standard
- However, histogram mask is a qualitative metric, rely on judgement of experience to estimate DUT performance margin.
- A quantitative metric is still needed. Block error ratio should serve the purpose, but may find difficulty in practice.
- Further investigation is needed regarding the new metric system.