Split-symmetric stressor, power and noise

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(typos corrected, file size reduced)

Relation between launch and received OMA

- Received OMA determined by transmitted OMA (assumed spec minimum), fiber attenuation, and connector losses
- Connector losses mainly caused by lateral offsets
- Need light near outside of fiber to get connector losses
- Need offset launch to get significant connector losses

Relation between launch and pulse shape

- For OM3, pulses are effectively always smooth
- For FDDI and OM2, pulses may be “split”
  - Characterised by dip in time domain or notch in frequency domain
  - With dual launch, split pulses are rare
- Strongly split pulses have TWDP >4.25 dB, therefore “out of spec”
- Believe most split pulses are from center launch
- Observe that split pulses are strongly associated with lower connector loss

D2.3 split-symmetric sensitivity is at a too-low OMA

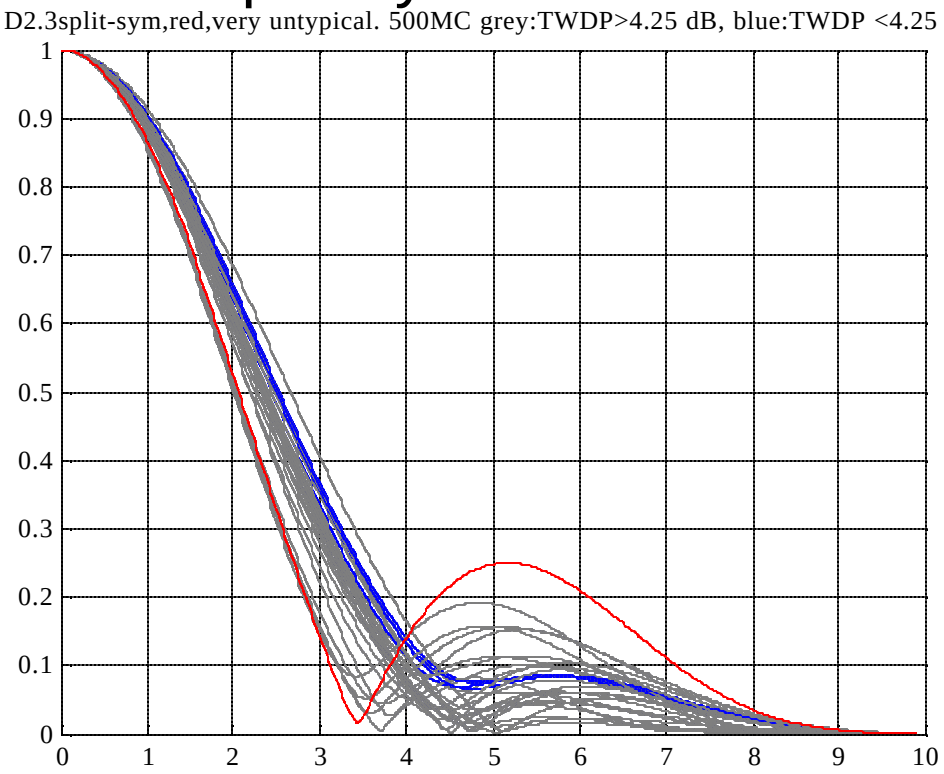
- Connector loss spec 1.5 dB
- Assume actual loss with offset launch can reach this
- Assume 2/3 is due to offset (calculated in following slides), 1/3 is parameter mismatch
  - Assume parameter mismatch loss is a constant 0.5 dB: over pessimistic but simple to calculate
- Offset induced loss with center launch is zero for single-mode spot size, maybe a little with worst case to D2.3 spec encircled flux

Relation between launch and modal noise

- Modal noise analysis says noise is caused by power fluctuating between propagation modes of fiber, AND these modes having different losses
- Cause of differential losses is connector losses, mainly caused by lateral offsets
- Need light near outside of fiber to get connector losses
- Need offset launch to get significant connector losses
- Can we have significant modal noise with center launch?

D2.3 split-sym (red) very unrealistic: notch too deep, bounce-back too high

Plot shows the responses with notch deeper than 11 dBo up to 5.15625 GHz
500 MC sims, FDDI, 1-1-220, dual launch
Note how unusual frequency notches like this are



Repeat with 5000 simulations and zoom in: D2.3 split-sym (red) very unrealistic: notch too deep, bounce-back too high

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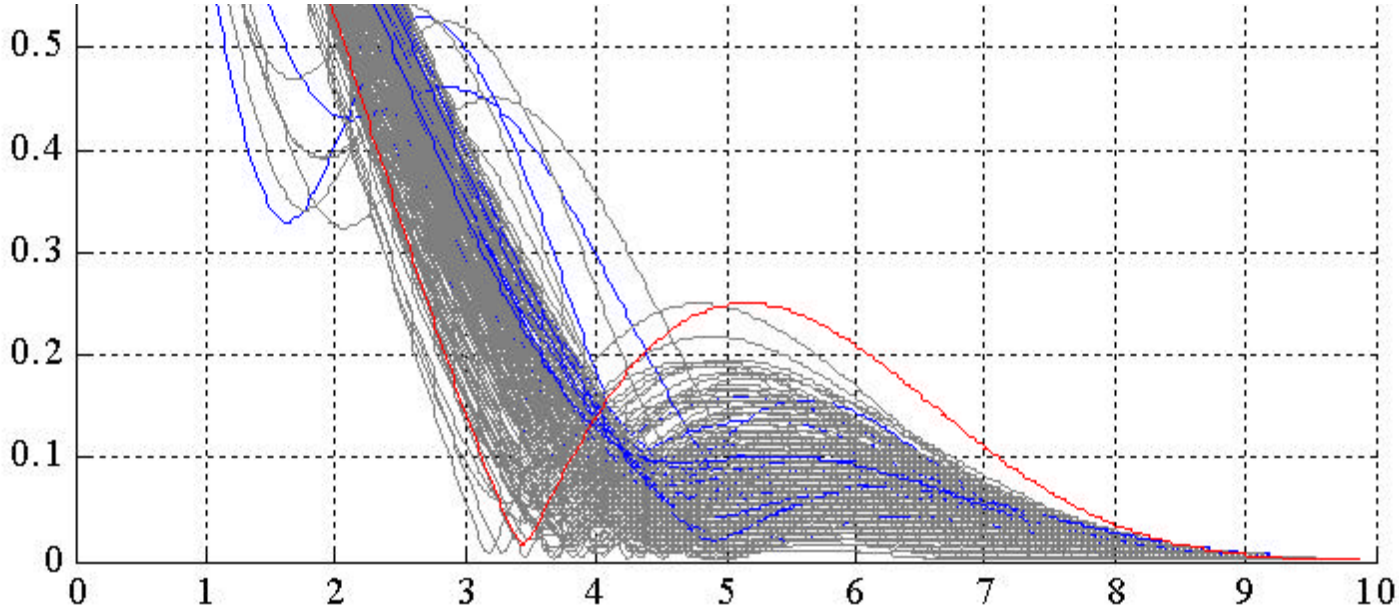
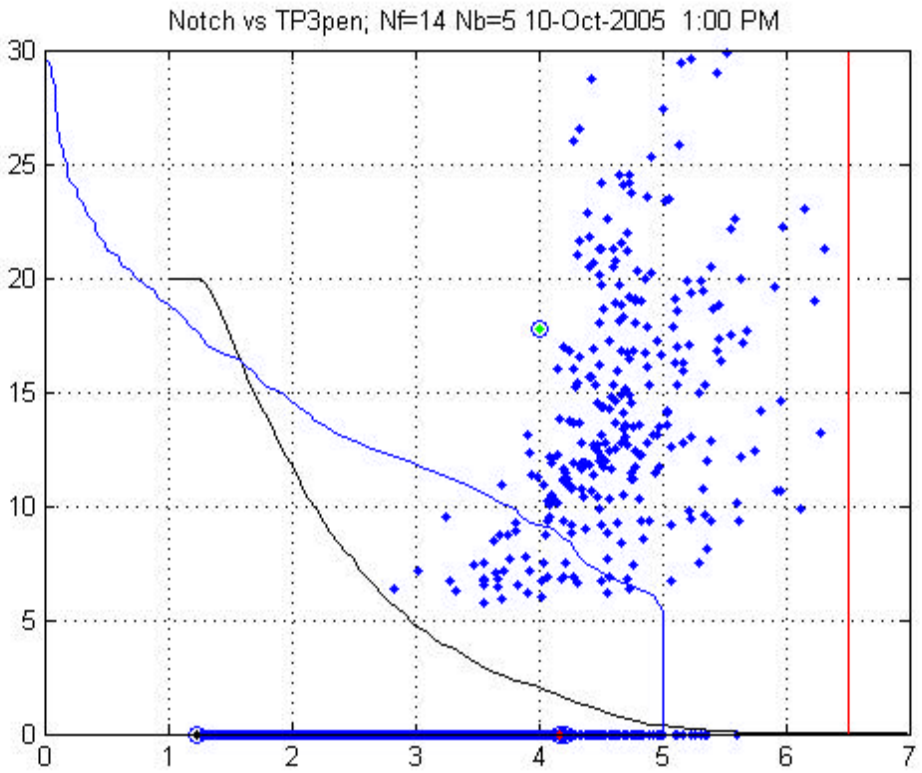


Correlation of notch depth vs. PIE(14,5)

D2.3 split sym (circled green dot) falls outside the range of 5000 simulations (FDDI grade, dual launch, 1-1-220)

Depth of notch (dBo)

Histograms scaled to 5, 20 do not agree with Ewen model but this does not invalidate conclusions about correlation



PIE(14,5) (dBo)

D2.3 split-sym stressor is not representative of simulated fiber channels, and at wrong power level

- Not even representative of the notched responses that are found in simulations
- To extreme, too “clean”
- “Sensitivity” at power level too low by >~1 dB

Correlation of frequency notch to connector loss

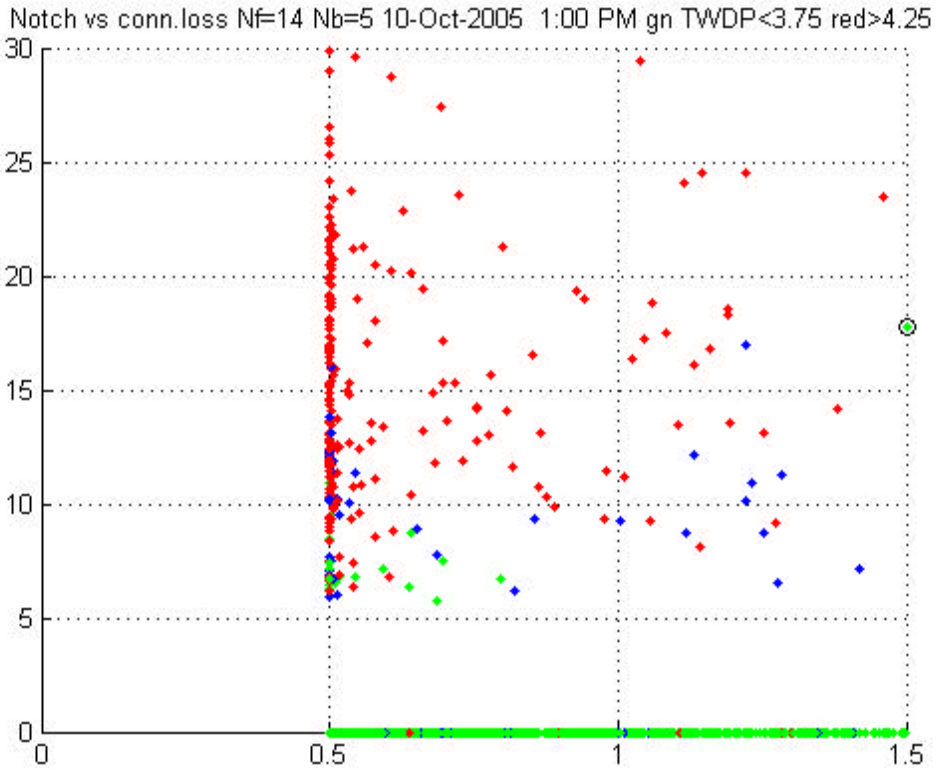
From 5000 MC sims, FDDI, 1-1-220, dual launch

Green dots: “easy”, blue: near spec limit: red: too high TWDP, out of spec
Most responses are monotonic

Also note blue and green dots do not show high connector loss and deep notch simultaneously

Circled green dot is freq notch in D2.3 stressor. It’s not representative of challenging simulated links (blue dots)

Depth of notch (dBo)



Connector loss (dBo)

MC cumulative histograms

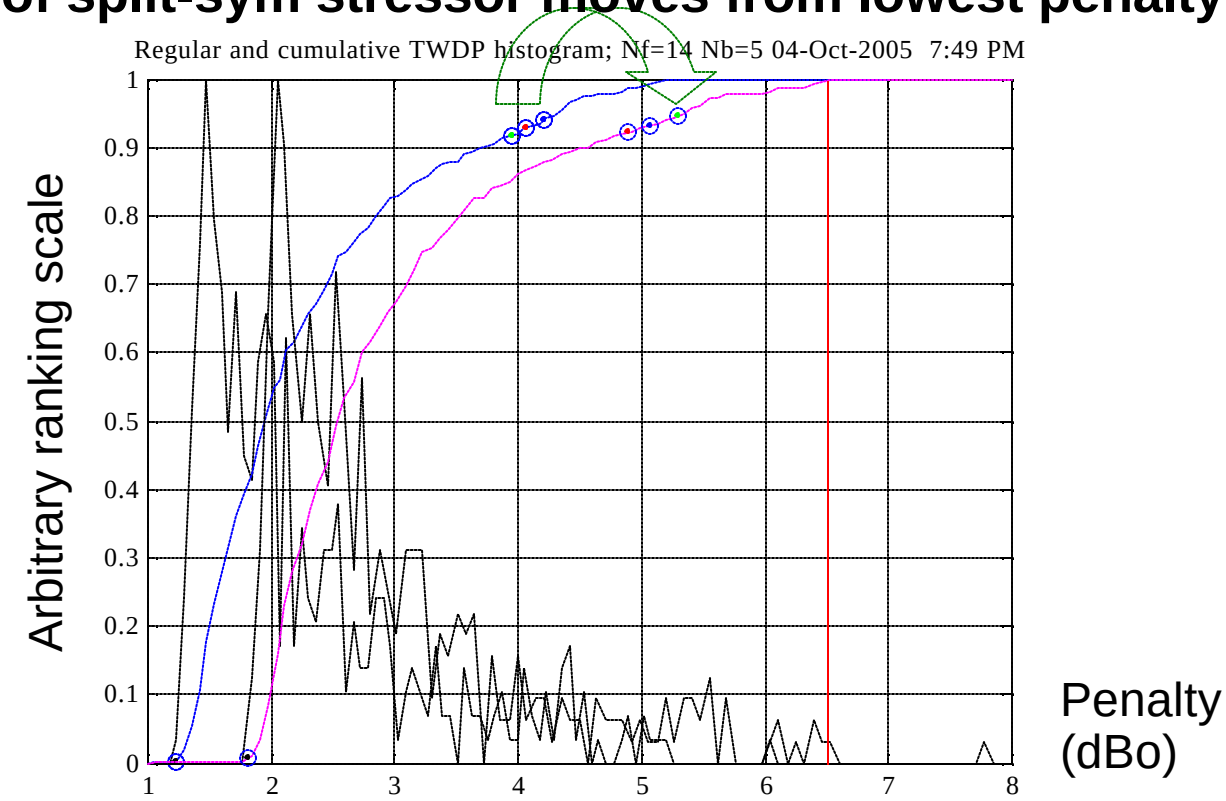
From 500 MC sims, FDDI, 1-1-220, dual launch. 14+5 equalizer

Blue cumulative histogram: without transmitter noise
Magenta cumulative histogram: with Qsq ~22.5

Circled points per D2.3:
red: precursor, green: split-symmetric, blue: post-cursor

Cumulative histograms show near constant offset as expected

BUT ranking of split-sym stressor moves from lowest penalty to highest



D2.3 split-sym stressor is at wrong power level, is not a representative response, AND is more difficult than intended

- Also may have too much noise loading
- Correcting these things will leave coverage where we thought it was
- Still worst-casing transmitter RIN (and OMA, and Rx stressed sensitivity) – still conservative

Proposed actions

1. Raise OMA by 1 dB for split-sym sensitivity to reflect strong correlation between notched response and connector loss
2. Find a new split-sym stressor with notch at 75th %ile of TWDP-on-limit channels (no need to “worst case” the same cause twice)
   Expect this to be 12 to 13 dBo in freq domain
3. Confirm new stressor is fair to different equalizers per Ewen methodology
   (I couldn’t do this step!)
4. Confirm new stressor is no more than 0.1 dB higher in %ile when noise loaded than any of three stressors without noise loading
5. Consider reducing noise loading for split-sym stressor
   e.g. halve or remove modal noise component of Qsq

Proposed changes to optical power windows

Red shows proposed changes to Tx power window, bearing in mind reduced channel loss