Comparison of EDC-Enabled Link Performance using Measured Waveforms from 2.5G and 10G Lasers

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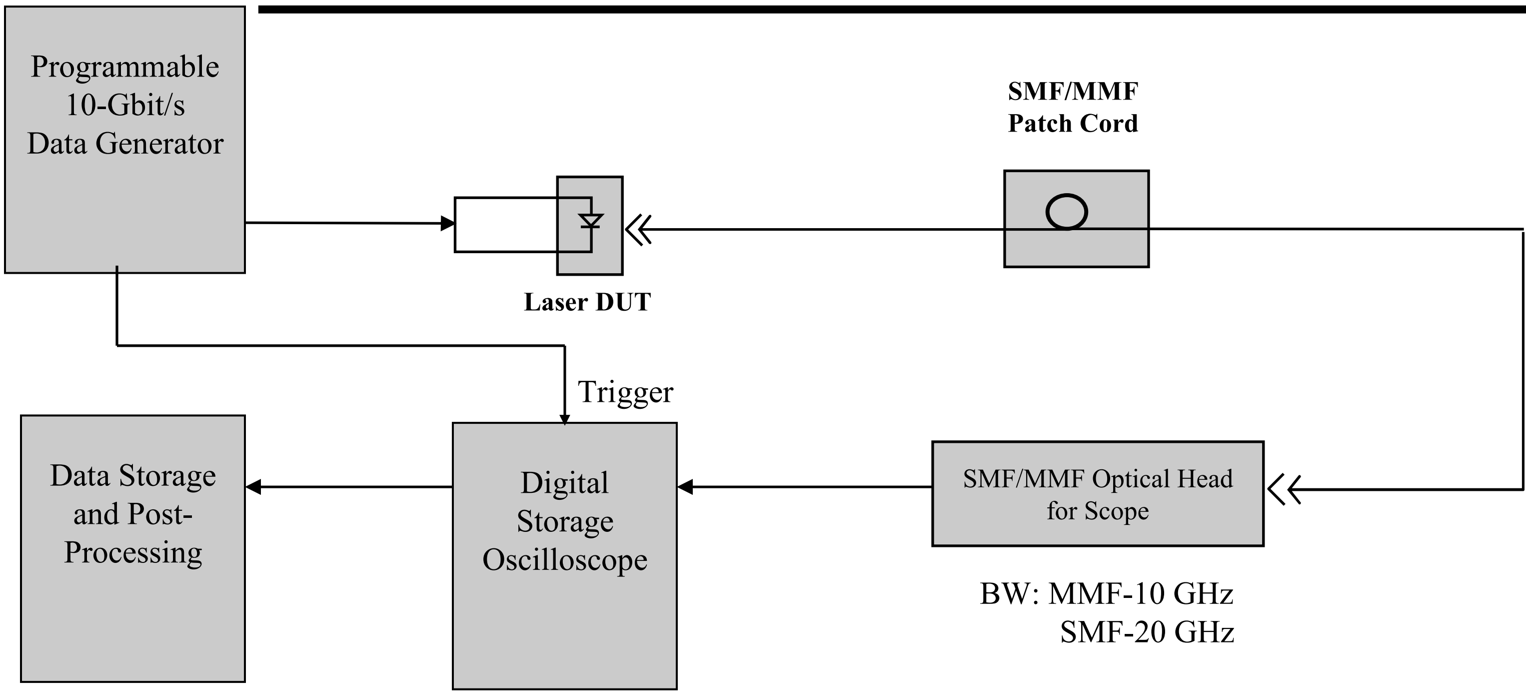
Motivation

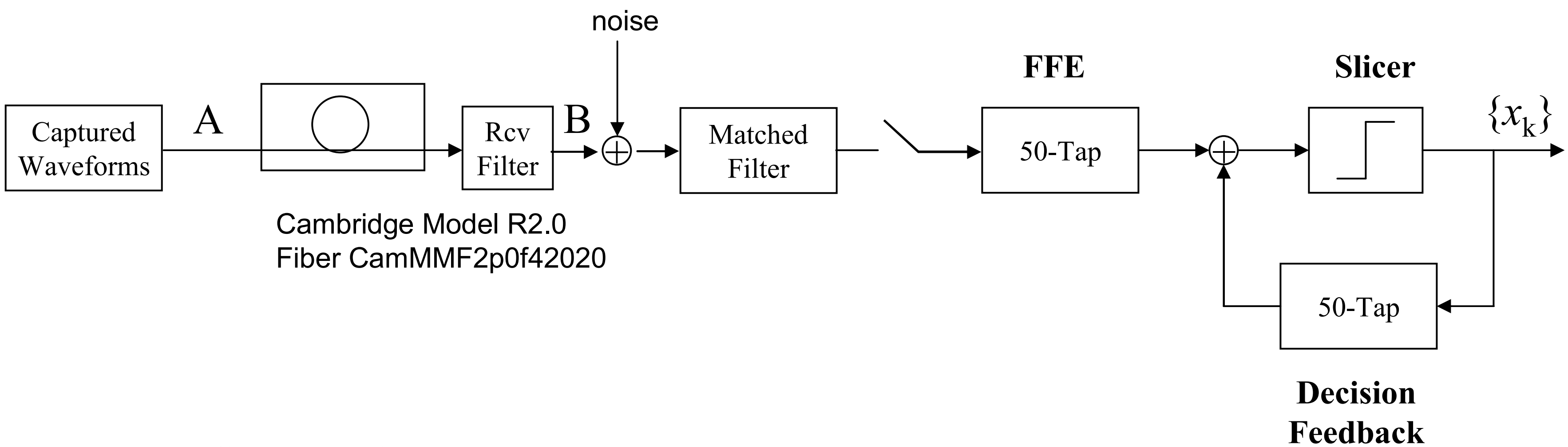
- Interest in relaxing TP-2 test to allow greater flexibility in transmitter design choices
- Simulation has shown promising results
- Desire to explore feasibility using measured data from commercially available lasers with different nominal speeds
- Fiber propagation is simulated to allow generation of worst-case fiber effects
- Results shown for a single “bad” fiber

Data Capture



- Lasers modulated at 10 Gbps
- 127-bit pseudo-random sequence, averaged over 16 or 64 frames
- Used two DUTs: 2.5G FP and 10G FP
  - Each laser run at two different extinction ratio/OMA combinations

Simulation



- Eye diagram points: A, B
- Cambridge R2.0 model
  - Same fiber as used in earlier analysis (lobel_1_0804.pdf), but that analysis used Cambridge R1.0 model
- Receive filter is BT with 7.5 GHz BW
- Ideal matched filter
- Pulse response estimated at point B using best linear fit
- Equalizer taps computed based on estimated pulse response

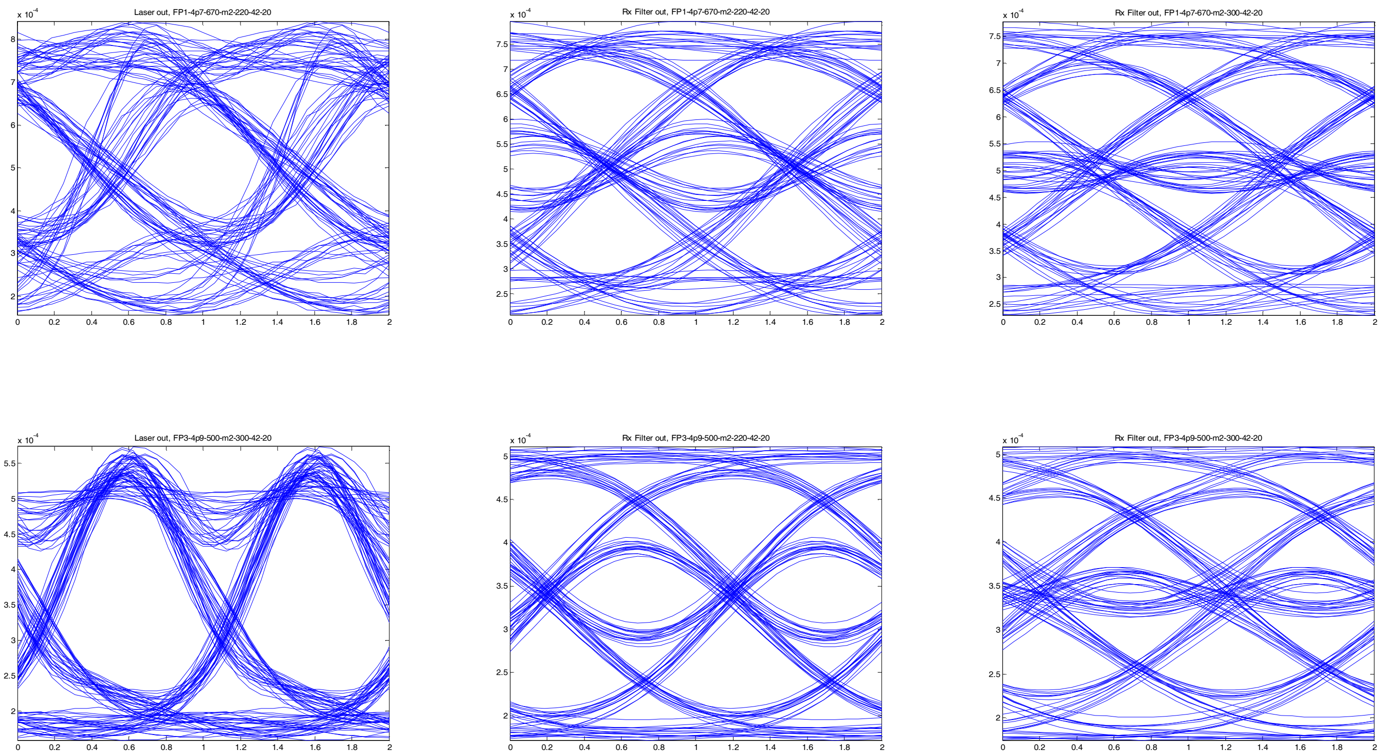
Eye Diagrams

Out of laser | 220m | 300m

Laser/ER(db)/OMA(dBm)

2.5G/4.7/-1.8

10G/4.9/-2.9



Penalty Calculations

- Penalty vs 10G rectangular pulse matched-filter bound
  - Same reference as PIE-D
  - Finite-length feed-forward (50), feedback (50) sections
- Penalty computed four ways:
  - PIE-D
    - Based on linear channel assumption and estimated pulse response
    - Treats ISI as Gaussian
  - Analytic Finite
    - Approximates PIE-D using very long finite-length equalizer
    - Based on linear channel assumption and estimated pulse response
  - Linear, Semi-analytic
    - Linear approximation to waveform based on estimated pulse response
    - Computes BER for each ISI pattern and averages over all ISI patterns
  - Measured, Semi-analytic
    - Semi-analytic using measured waveform as propagated through simulated channel
    - Includes all laser nonlinearities

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Penalties (dBo), 220m

Laser/ER(dB)/OMA(dBm)	PIE-D	Analytic Finite	Linear Semi-Analytic	Measured Semi-Analytic
2.5G/3.5/-2.9	2.6	2.6	2.6	3.2
2.5G/4.7/-1.8	2.6	2.6	2.6	3.3
10G/4.9/-2.9	2.6	2.6	2.6	3.1
10G/5.5/-2.5	2.7	2.7	2.7	3.1

Penalties(dBo), 300m

Laser/ER(dB)/OMA(dBm)	PIE-D	Analytic Finite	Linear Semi-Analytic	Measured Semi-Analytic
2.5G/3.5/-2.9	3.8	3.8	3.8	4.3
2.5G/4.7/-1.8	3.7	3.7	3.8	4.5
10G/4.9/-2.9	3.9	3.9	3.9	4.3
10G/5.5/-2.5	3.9	3.9	3.9	4.3

Summary

Average penalties, measured waveforms

220 m	
2.5G	3.3 dB
10G	3.1 dB

300 m	
2.5G	4.4 dB
10G	4.3 dB

- .1-.2 dB penalty using low-speed laser
  - For the two lasers under test, the particular fiber simulated
- .4-.8 dB penalty between PIE-D based on linear fit and simulation using measured laser output
- Results show that very different waveforms at laser output can result in very similar penalties after fiber propagation and EDC
  - More work needed using other fibers, lasers