Simulation of Link Performance using Measured Waveforms from 2.5G and 10G Lasers

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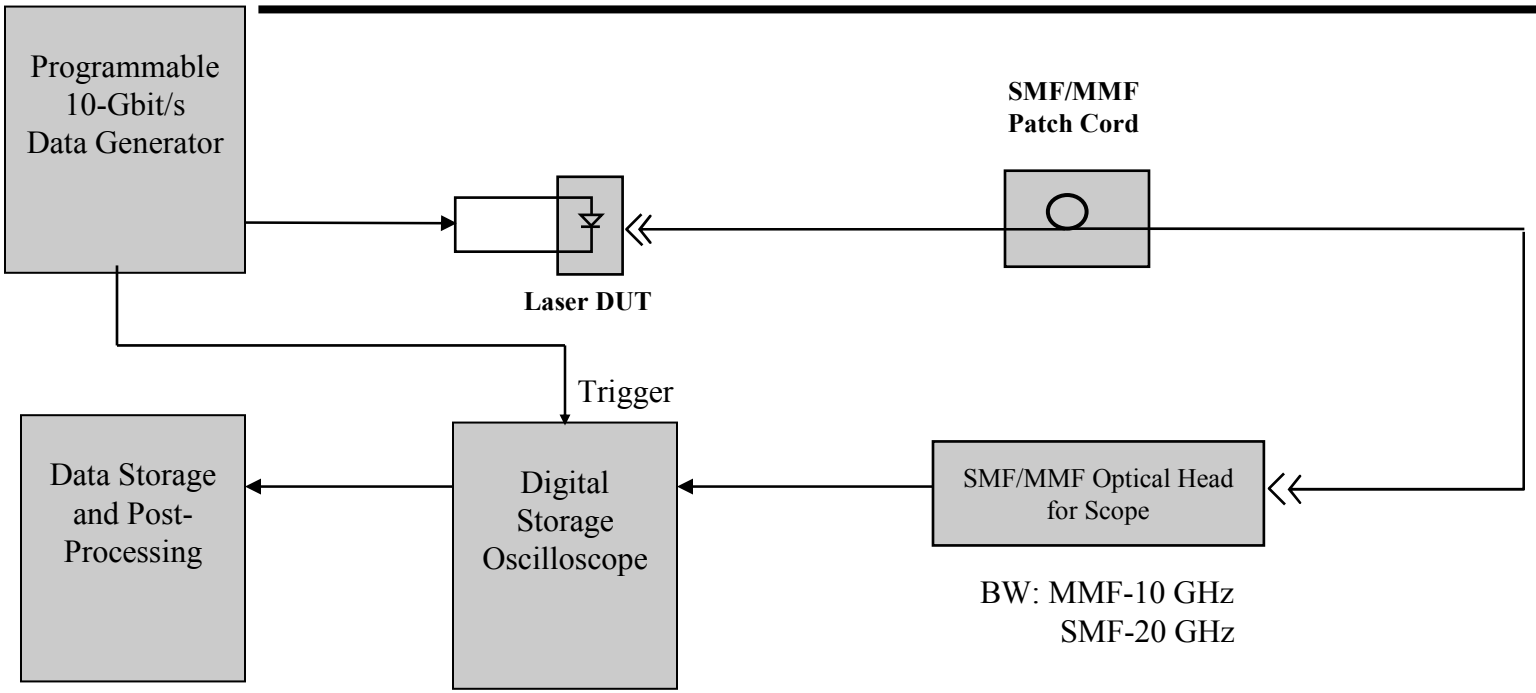
Motivation

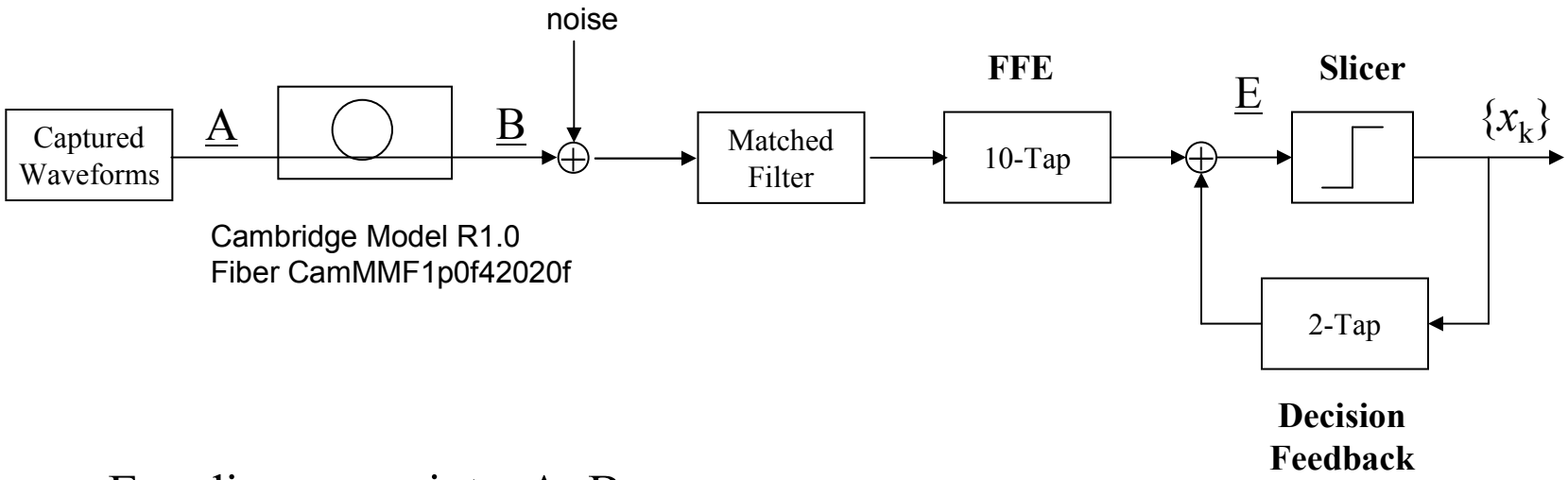
- Interest in using lower cost components with EDC to achieve 10 Gbps
- Simulation has shown promising results
- Desire to explore feasibility using measured data from commercially available lasers
- Fiber propagation is simulated to allow generation of worst-case fiber effects
- Results shown for a 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 R1.0 model, brick wall at 20 GHz
  - Same fiber as used in earlier analysis (lobel_1_0804.pdf)
- Ideal matched filter
- Pulse response estimated at point B using best linear fit
- Equalizer taps computed based on estimated pulse response

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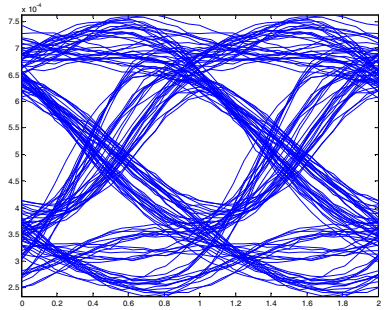
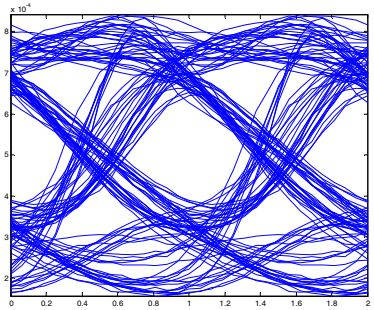
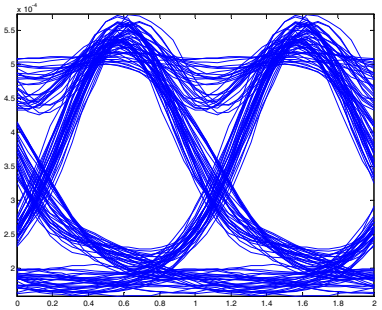
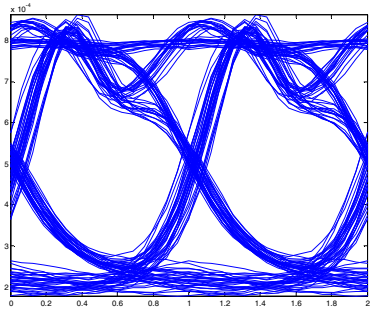
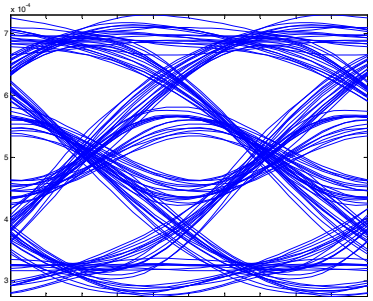
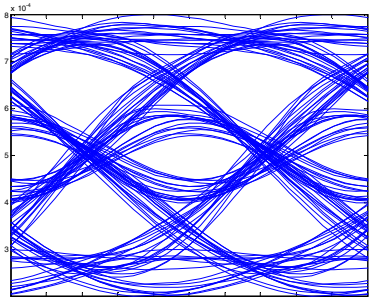
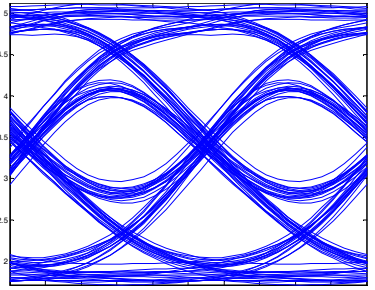
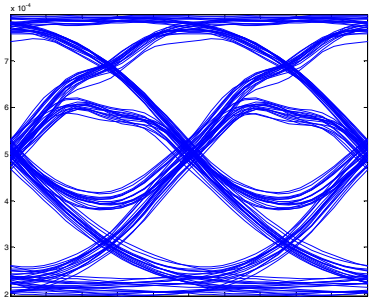
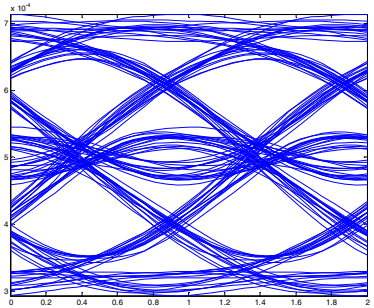
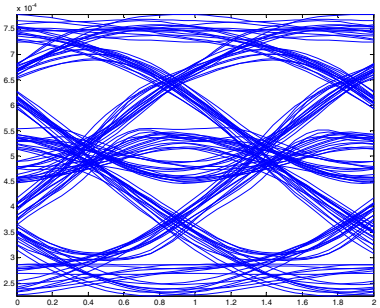
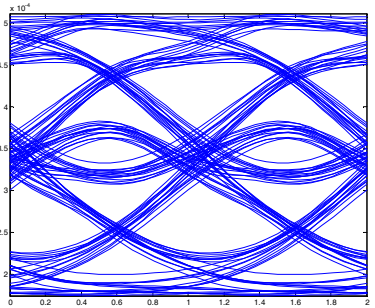
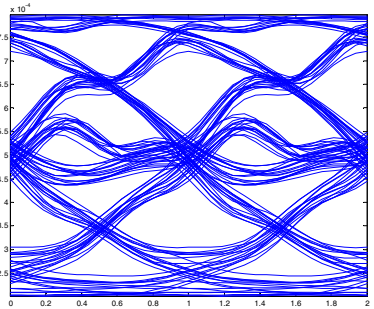
Eye Diagrams

Laser/ER(db)/OMA(dBm)

	2.5G/3.5/-2.9	2.5G/4.7/-1.8	10G/4.9/-2.9	10G/5.5/-2.5
Out of laser				
220m				
300m				

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Penalty Calculations

- Penalty vs 10G rectangular pulse matched-filter bound
  - Same reference as PIE-D
  - Finite-length feed-forward (10), feedback (2) sections
- Penalty computed three ways:
  - Analytic
    - Analytic calculation based on linear channel assumption and estimated pulse response
    - Treats ISI as Gaussian
  - 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-analytical
    - 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)	Analytic	Linear Semi-Analytic	Measured Semi-Analytic
2.5G/3.5/-2.9	3.0	2.7	3.1
2.5G/4.7/-1.8	2.9	2.6	3.2
10G/4.9/-2.9	2.4	2.4	2.9
10G/5.5/-2.5	2.5	2.5	2.8

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Penalties(dBo), 300m

Laser/ER(dB)/OMA(dBm)	Analytic	Linear Semi-Analytic	Measured Semi-Analytic
2.5G/3.5/-2.9	4.1	3.9	4.3
2.5G/4.7/-1.8	4.1	3.9	4.5
10G/4.9/-2.9	3.8	3.7	4.0
10G/5.5/-2.5	3.7	3.7	3.9

Summary

Average penalties, measured waveforms

220 m	
2.5G	3.2 dB
10G	2.8 dB

300 m	
2.5G	4.4 dB
10G	4.0 dB

- .4 dB penalty using low-speed laser
  - For the two lasers under test, the particular fiber simulated
- <.5 dB penalty between analytic prediction and simulation using measured laser output
- More work needed using other fibers, lasers
  - Results thus far are encouraging