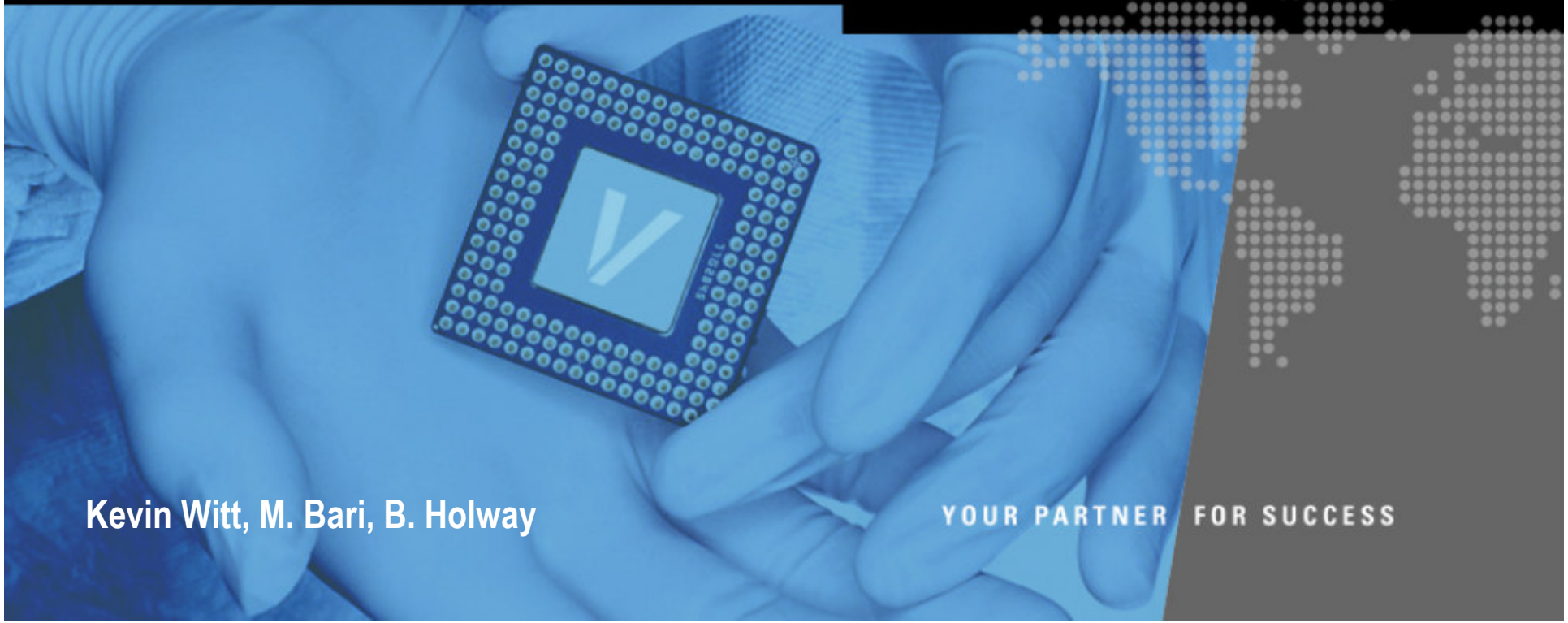
VITESSE

Test & Simulation Results in Support of SAS-2



Kevin Witt, M. Bari, B. Holway

YOUR PARTNER FOR SUCCESS

Test Results in Support of SAS-2

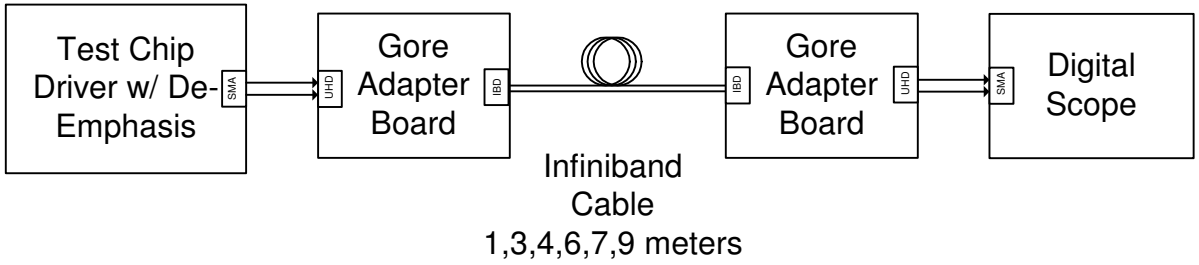
VITESSE

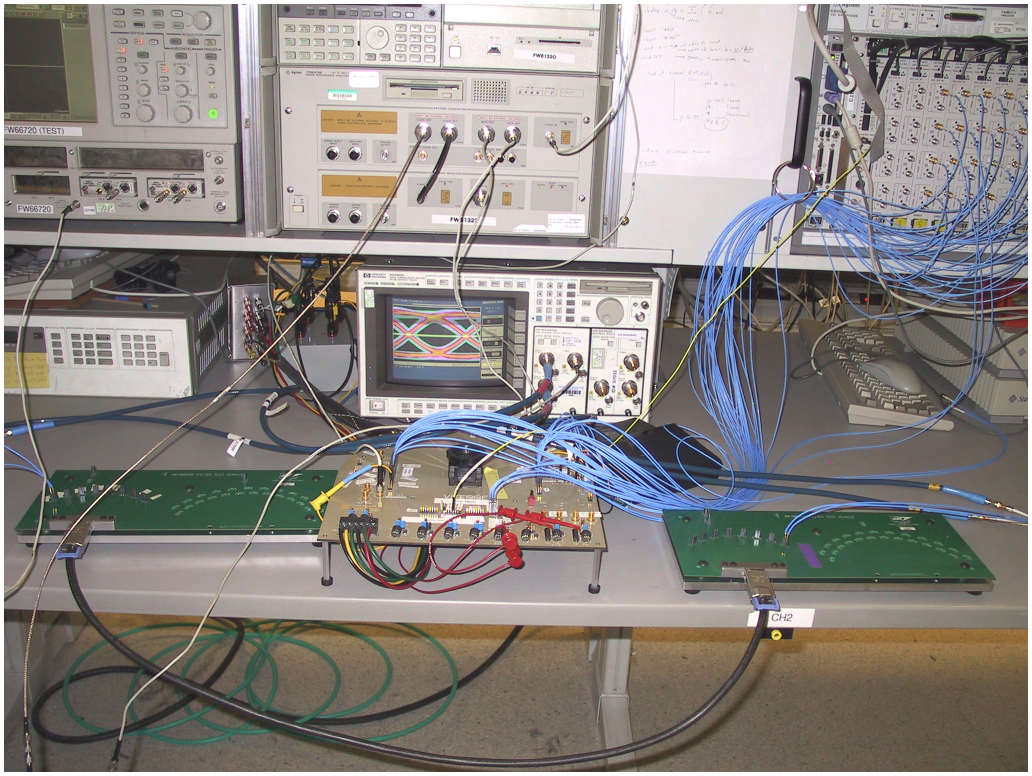
- Test Channels Investigated
  - Infiniband Cable links 1, 3, 5, 6, 7, & 9 meters with corresponding AWG of 26, 26, 28, 24, 24 & 24.
  - FR4 Micro strip Traces 5, 10, 20 & 25”
- Frequency of Operation
  - 3 and 6 Gbps
- Observations and Analysis
  - De-Emphasis Output Driver Test
    - O.13 um CMOS
  - Receiver Equalization Simulations (with optimal LMS coefficient)
    - Based on 10 Gbps design in 0.13 um CMOS

InfiniBand Data Collection Setup

VITESSE

- Test Configuration w/ InfiniBand Cable

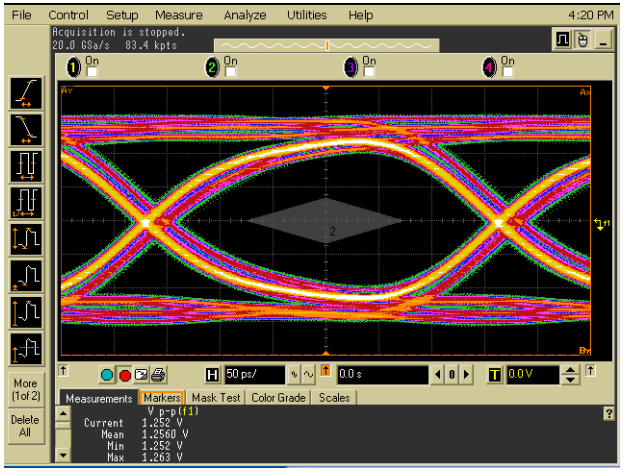




3G Test Results

VITESSE

- Test Results w/ InfiniBand Cable De-Emphasis Disabled (3Gbps)



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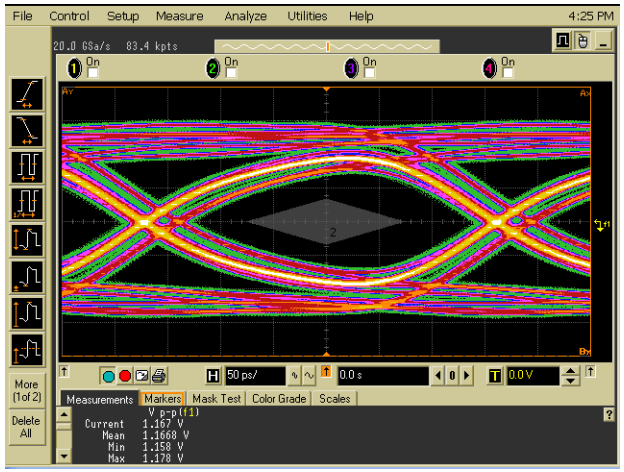

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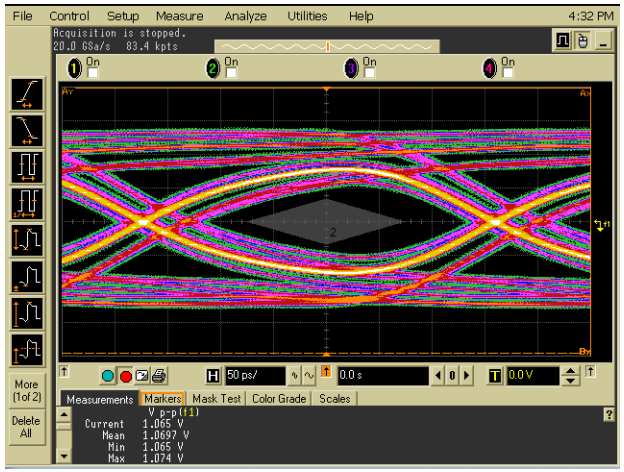

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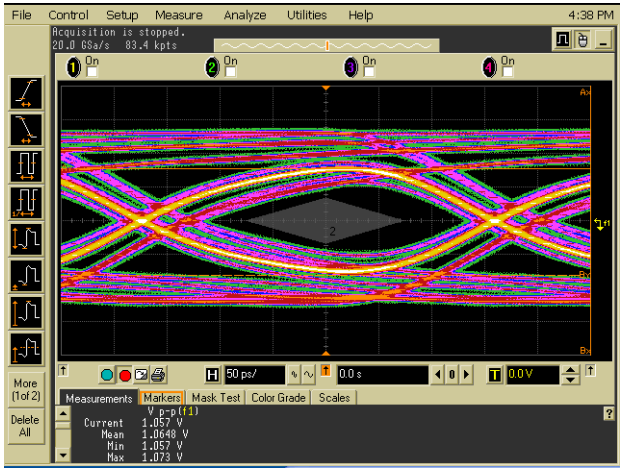
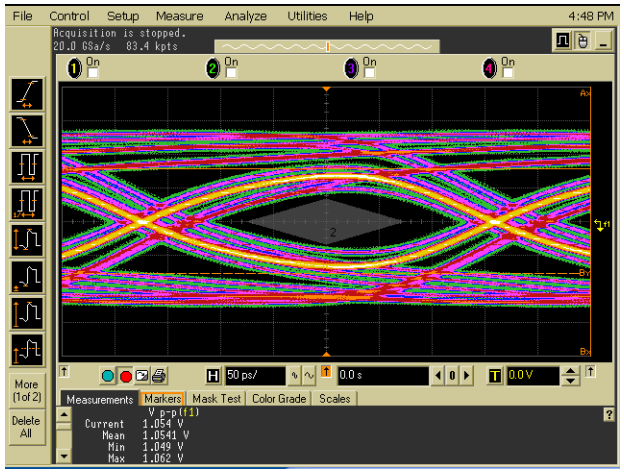


6m



7m

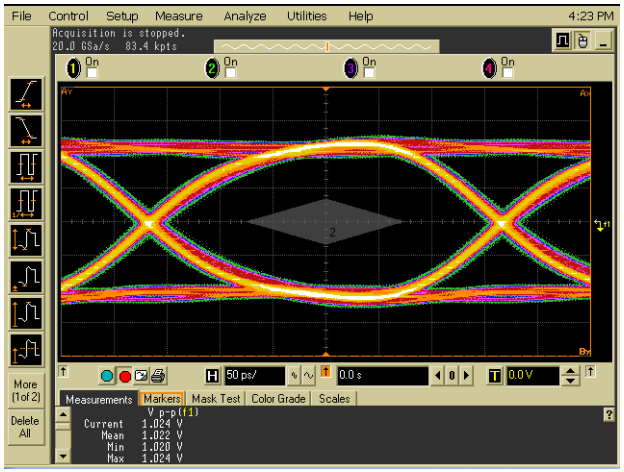
9m

Signal integrity issues at 3G require some equalization

3G Test Results

VITESSE

- Test Results w/ InfiniBand Cable De-Emphasis Enabled (3Gbps)



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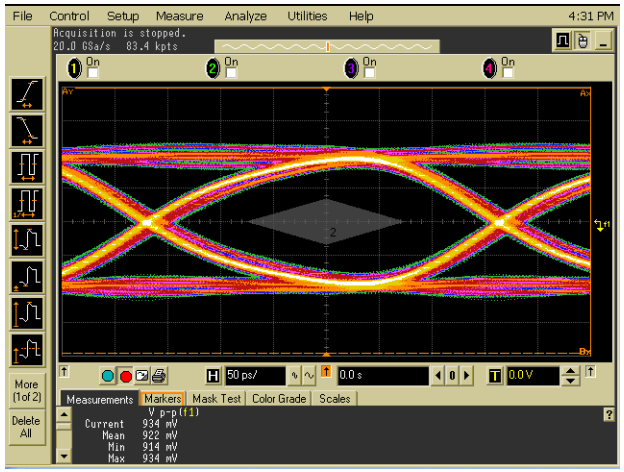
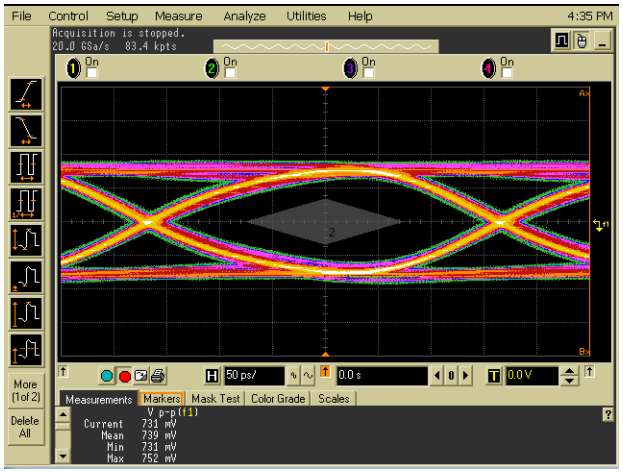


3m



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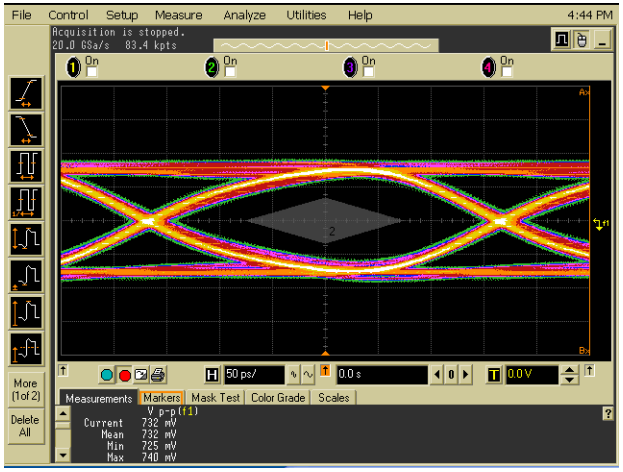

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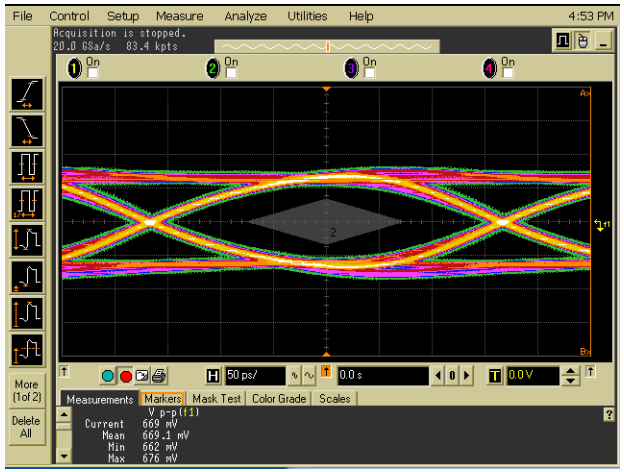

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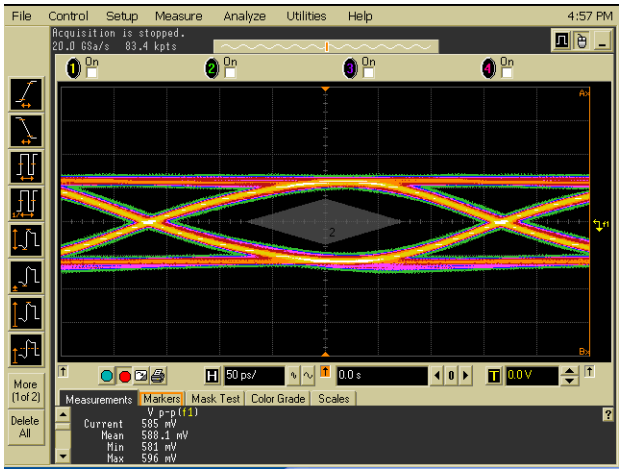


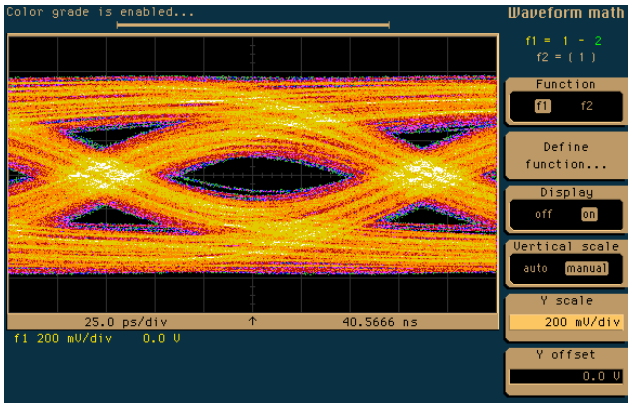
9m

Tx De-Emphasis works well at 3Gbps

6G Test Results

VITESSE

- Test Results w/ InfiniBand Cable De-Emphasis Disabled (6Gbps)



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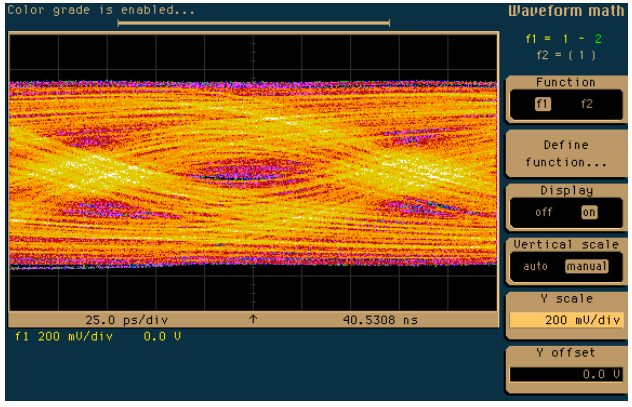

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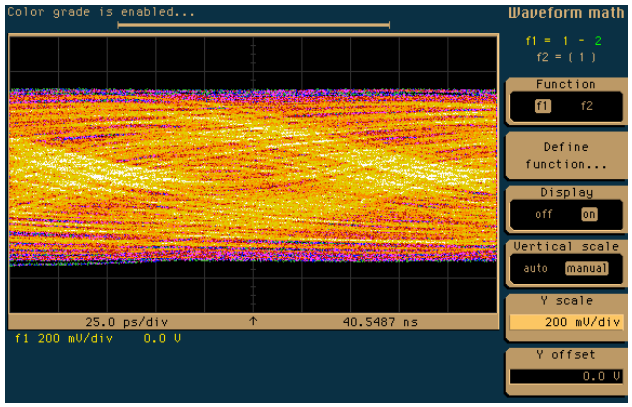

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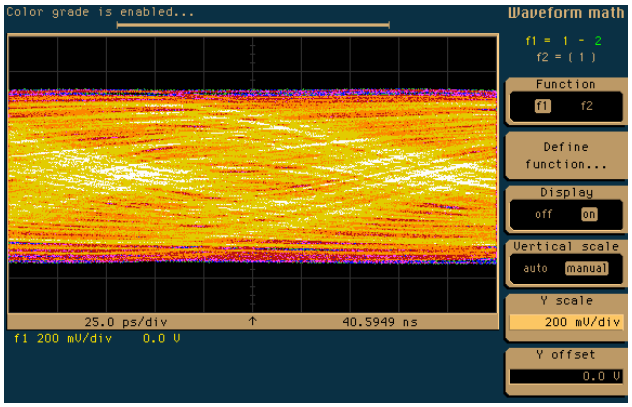

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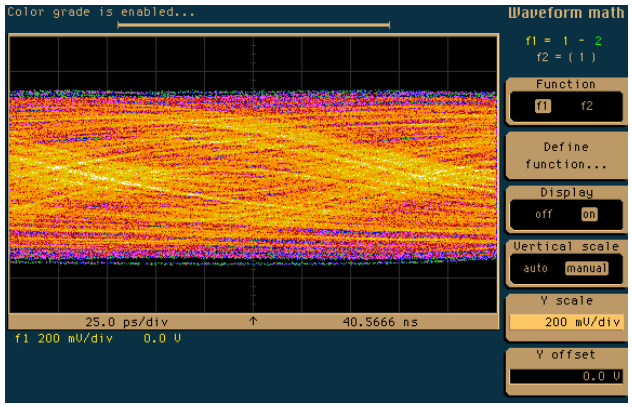

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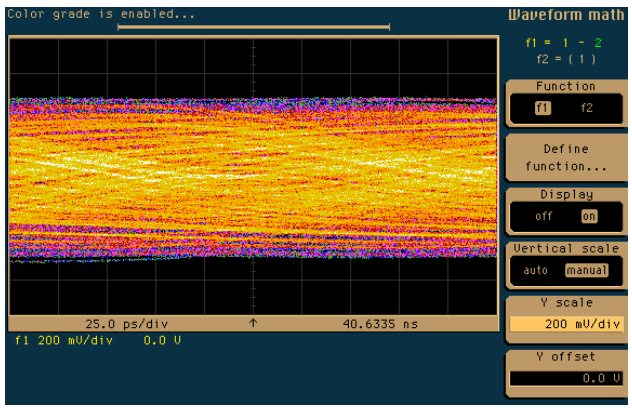


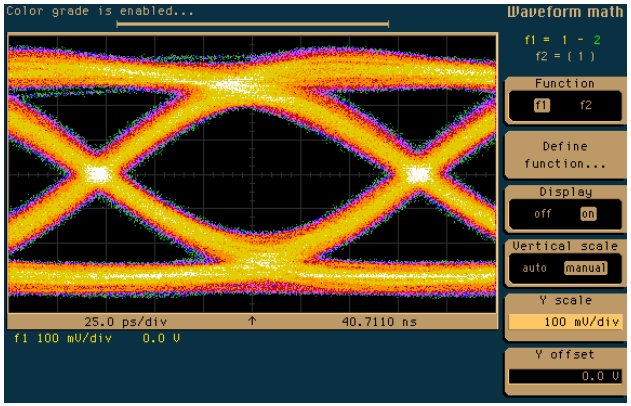
9m

Signal integrity issues at 6G are more interesting

6G Test Results

VITESSE

- Test Results w/ InfiniBand Cable De-Emphasis (1:0.5) Enabled (6Gbps)



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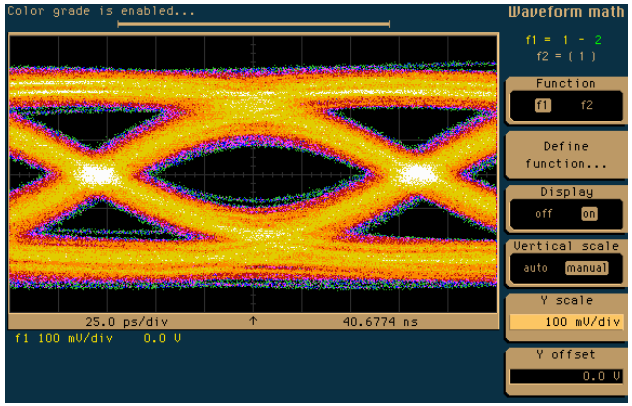

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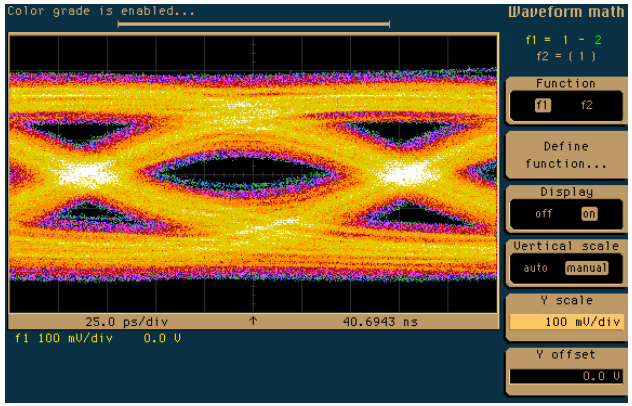

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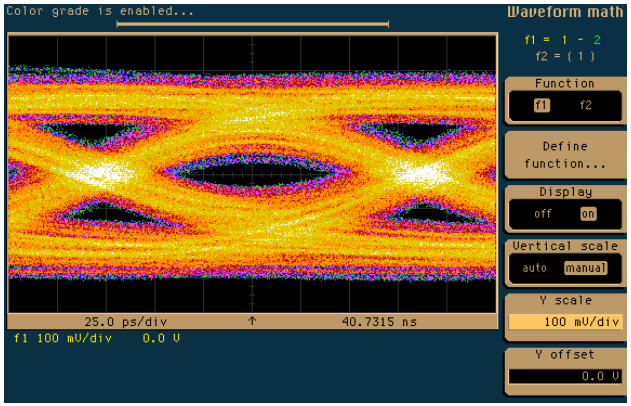

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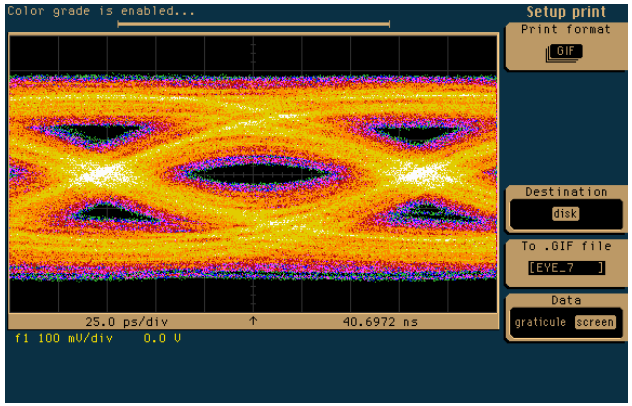

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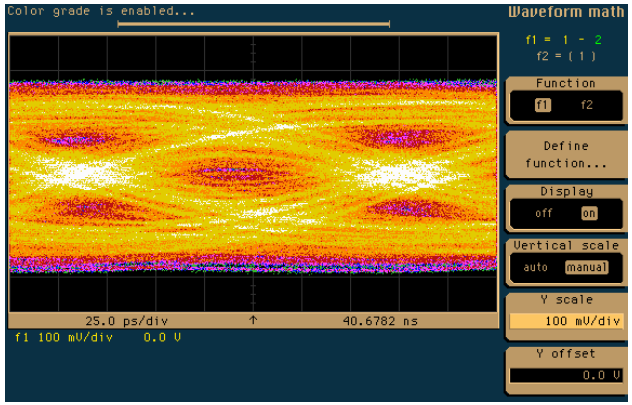


9m

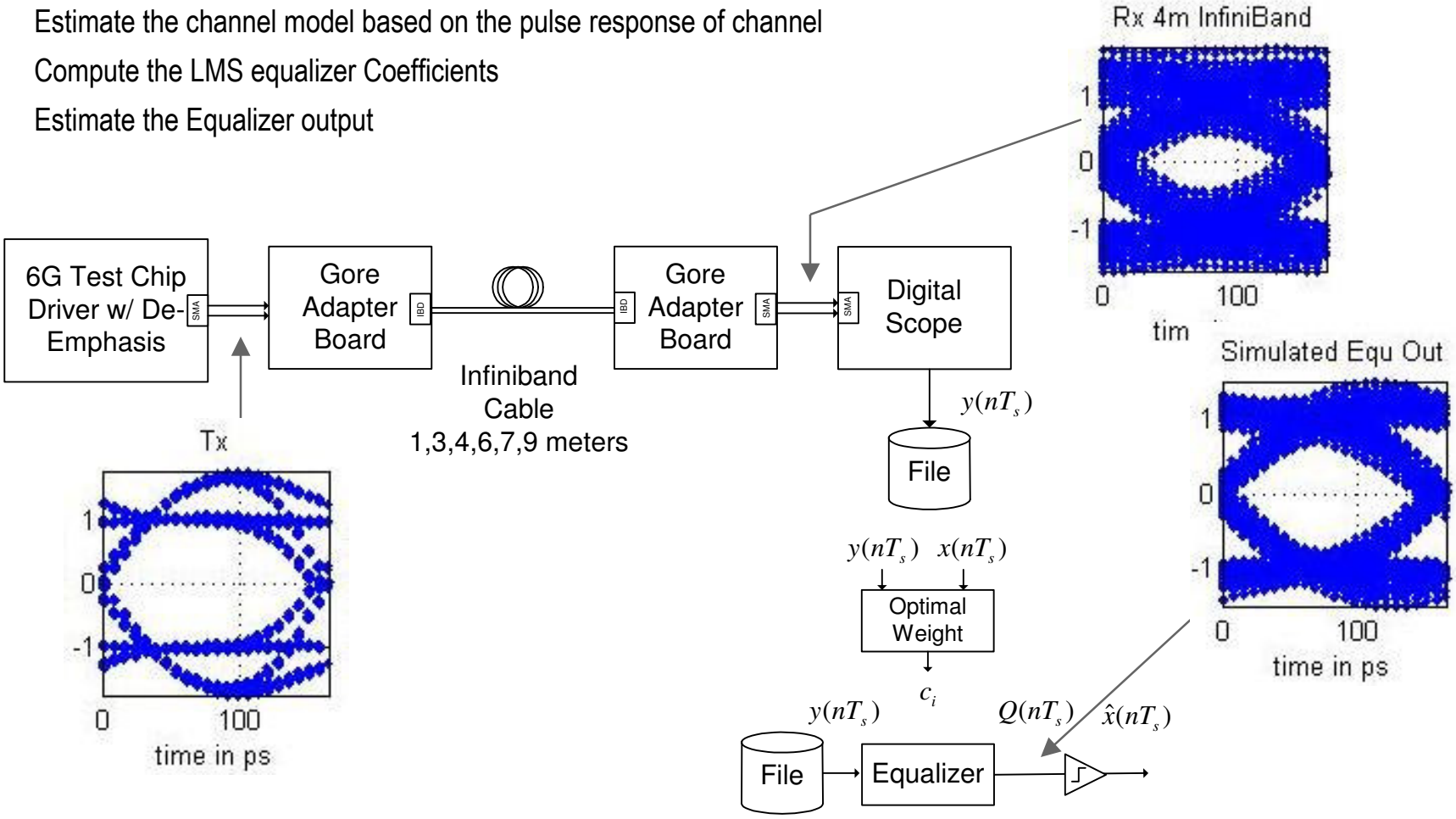
Tx De-Emphasis only is not enough!

Equalization Simulations

VITESSE

Equalizer Simulation Methodology

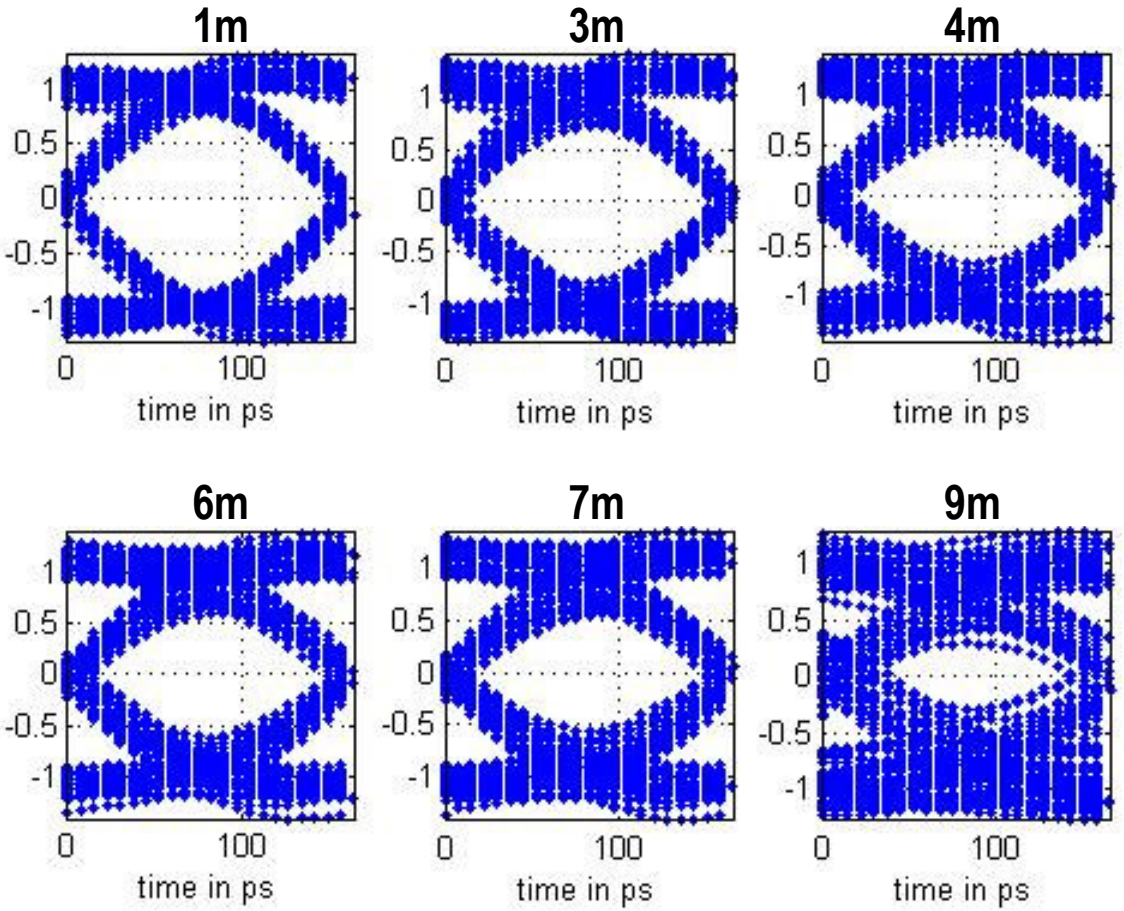
- Collect the pulse response and PRBS response for back to back and through channel under test
- Estimate the channel model based on the pulse response of channel
- Compute the LMS equalizer Coefficients
- Estimate the Equalizer output



6G Simulation Results

VITESSE

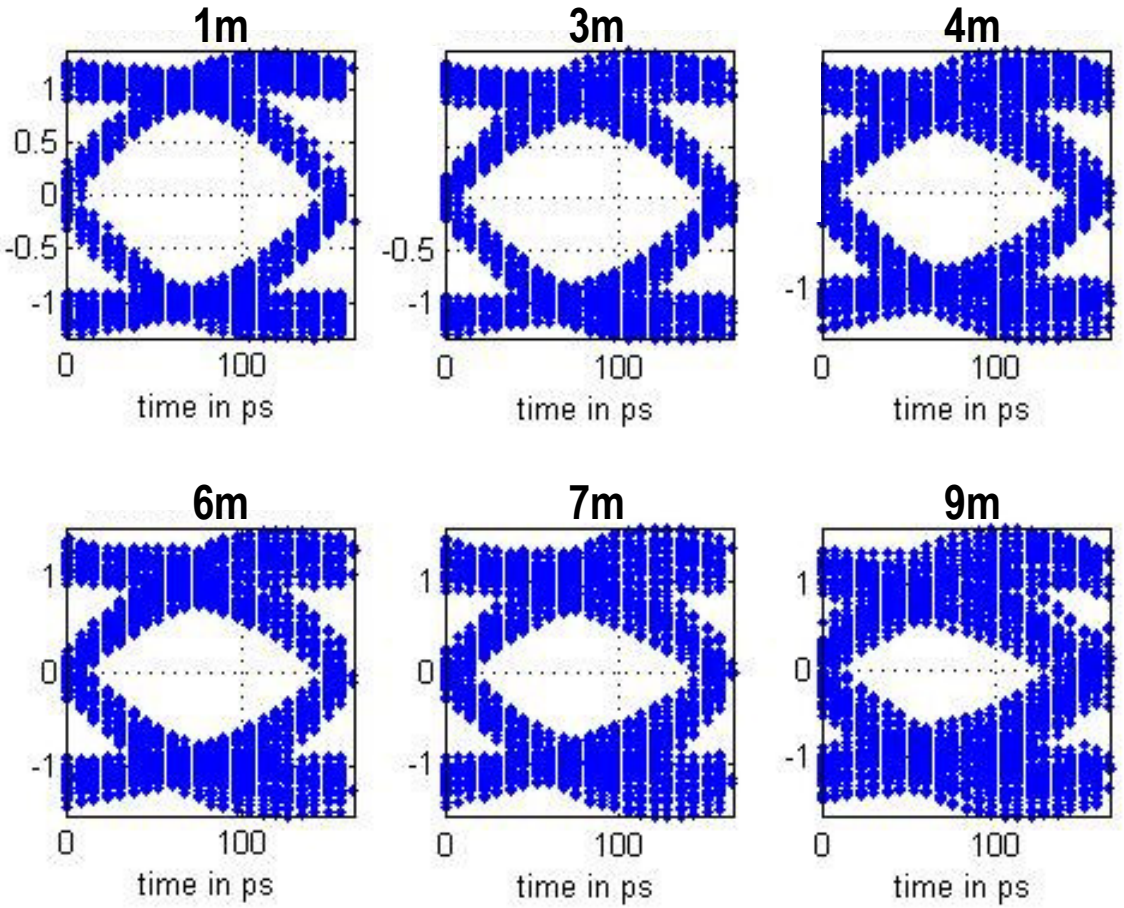
- Equalizer Simulation Results w/ InfiniBand Cable De-Emphasis Disabled



6G Simulation Results

VITESSE

- Equalizer Simulation Results w/ InfiniBand Cable De-Emphasis Enabled

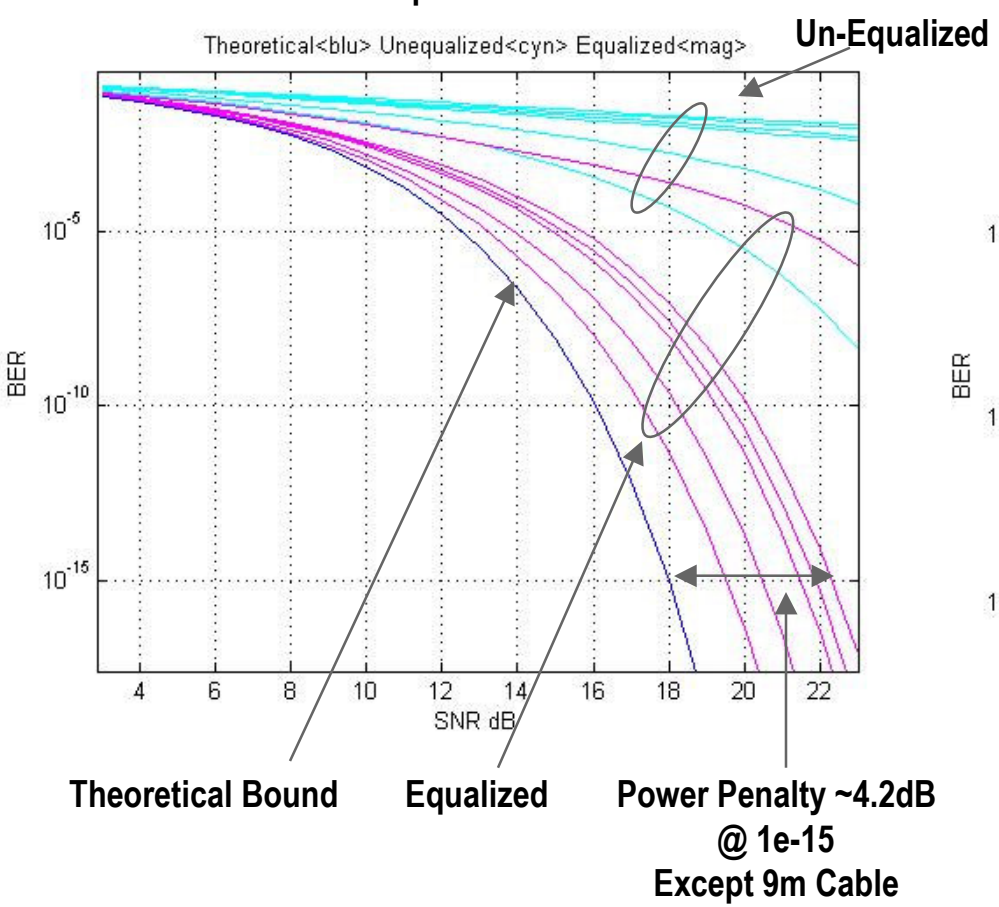


6G Simulation Results

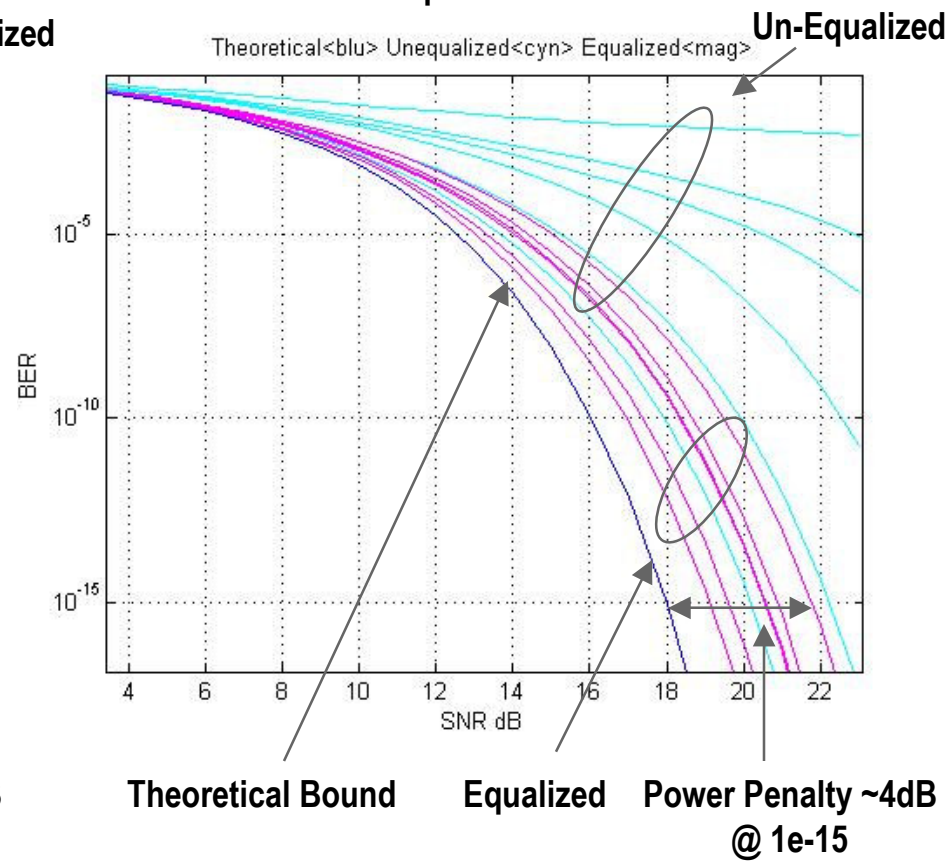
VITESSE

- Simulation Results w/ InfiniBand Cable Summary
  - Semi-analytic BER Estimation
  - 1, 3, 4, 6, 7 & 9 meter Cables

De-Emphasis Disabled



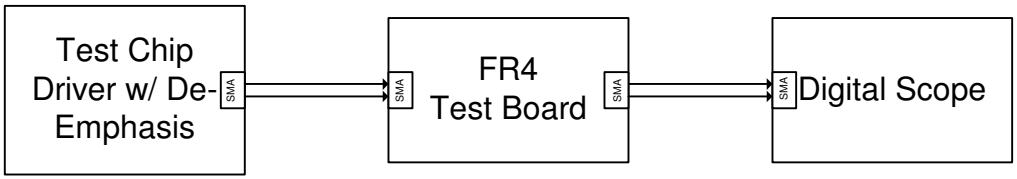
De-Emphasis Enabled

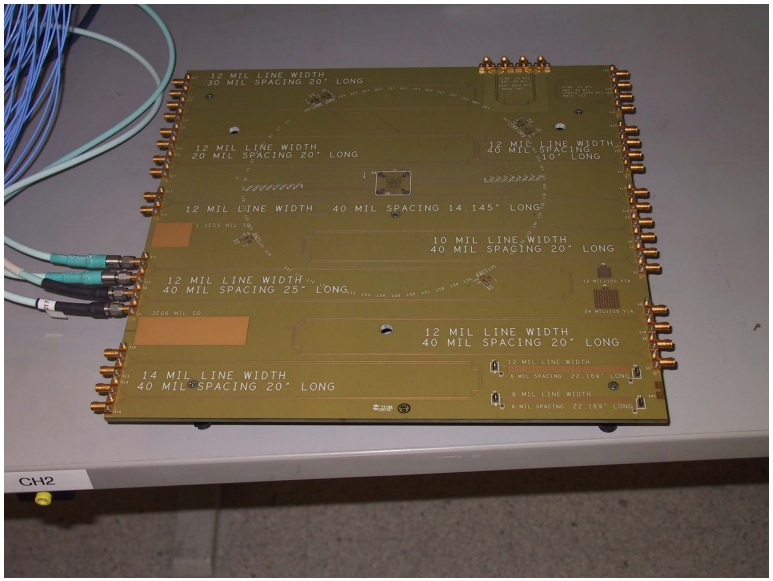


FR4 Data Collection Setup

VITESSE

- Test Configuration w/ FR4 Test Board





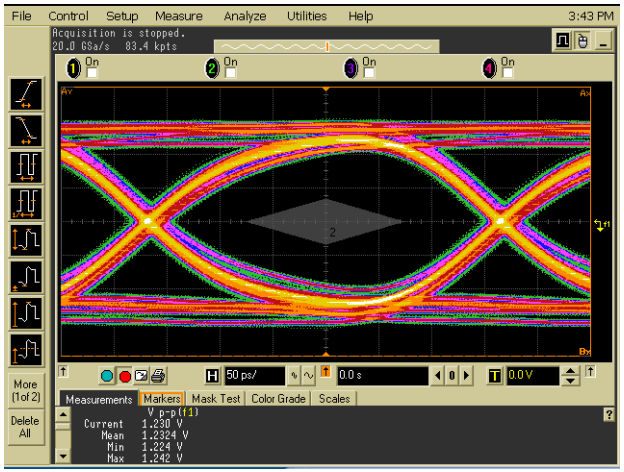
FR Test Board
Micro Strip
½ Oz Cu
100ohm Diff
12mil traces
40mil spacing
8mil above Gnd Plane

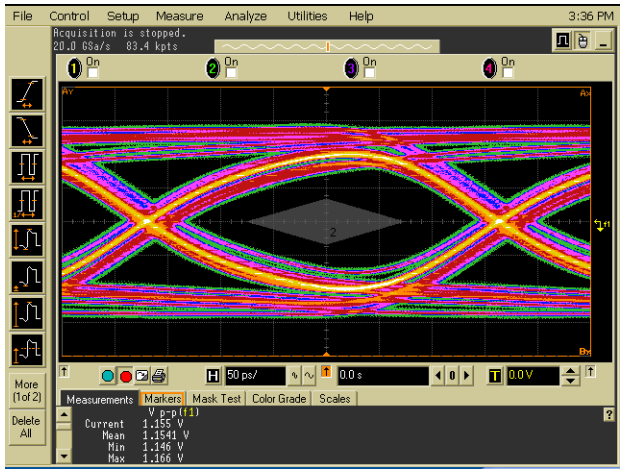
3G Test Results

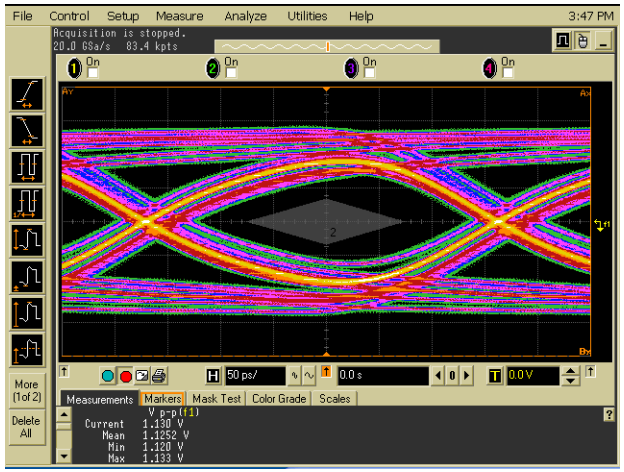
VITESSE

- Test Results w/ FR4 (3Gbps)

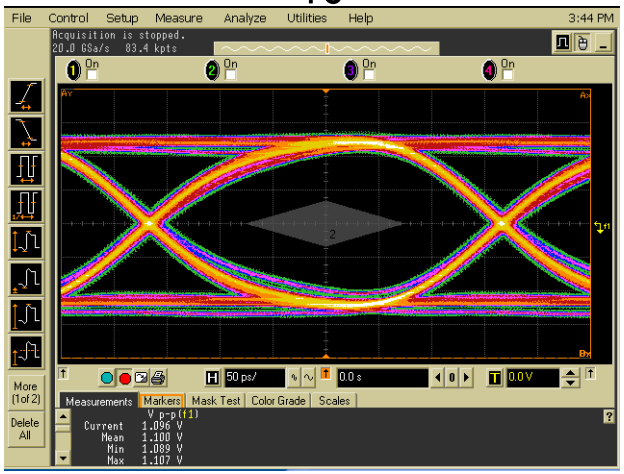
16” **De-Emphasis Disabled** 26” 31”

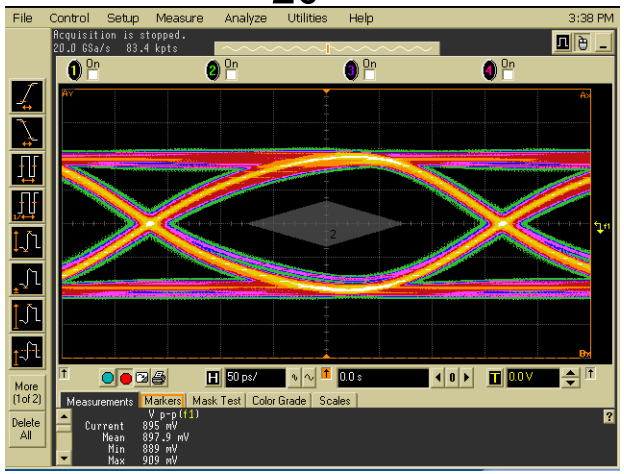


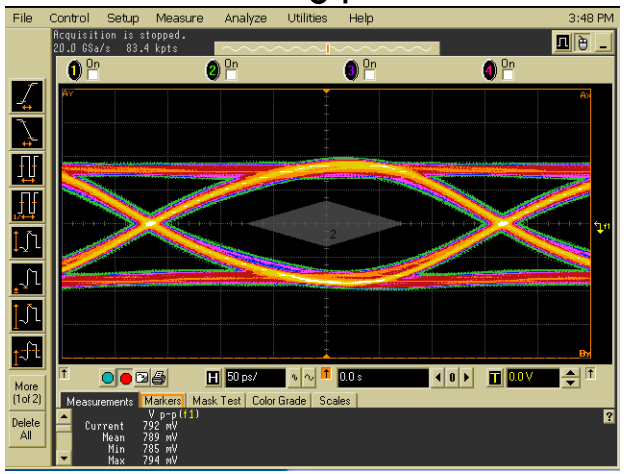




16” **De-Emphasis Enabled** 26” 31”







Signal integrity issues at 3G require some equalization, De-Emphasis works

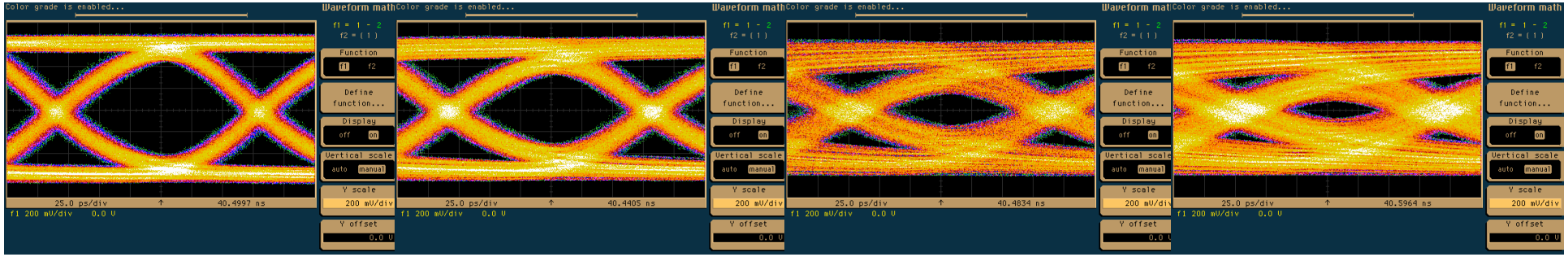
6G Test Results

VITESSE

- Test Results w/ FR4 (6Gbps)

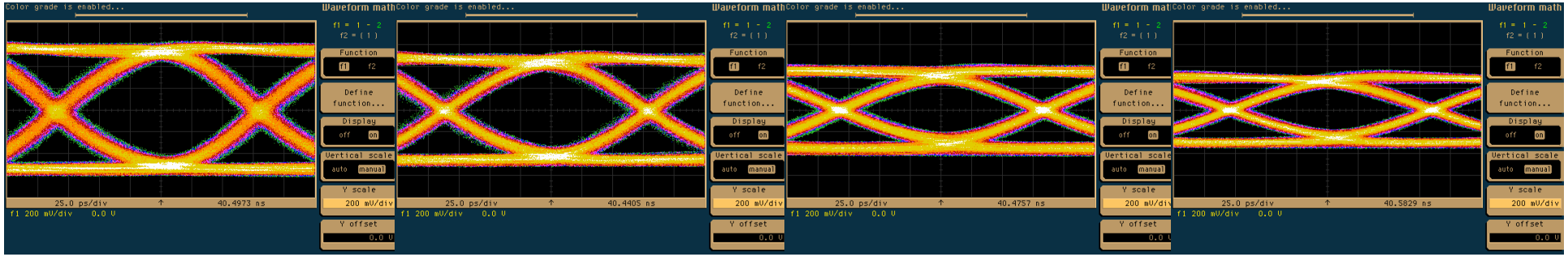
De-Emphasis Disabled

5” 10” 20” 25”



De-Emphasis Enabled

5” 10” 20” 25”



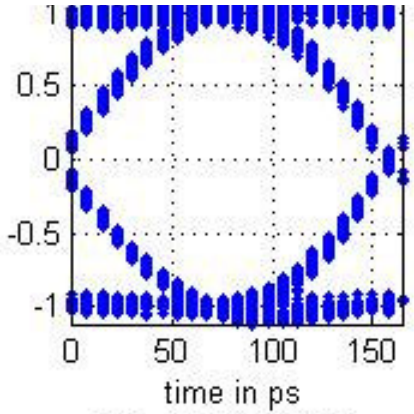
Signal integrity issues at 6G can be solved with De-Emphasis alone

6G Simulation Results

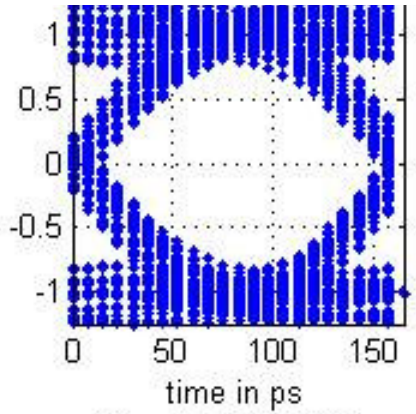
VITESSE

- Simulation Results FR4 De-Emphasis Disabled
  - Receiver Equalization also works instead of De-Emphasis

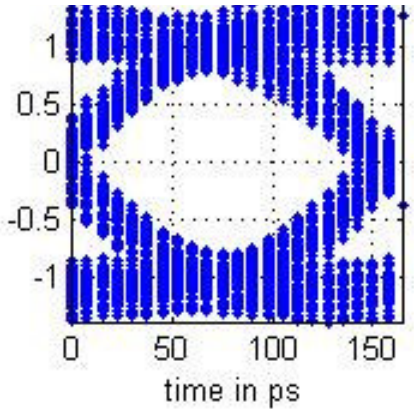
5”



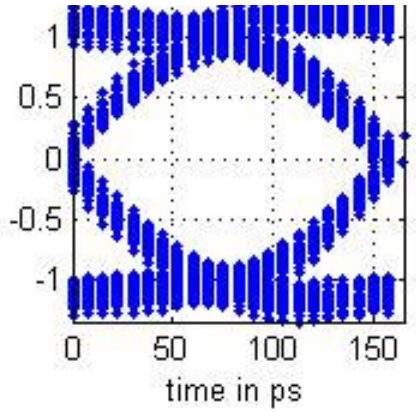
10”



20”



25”

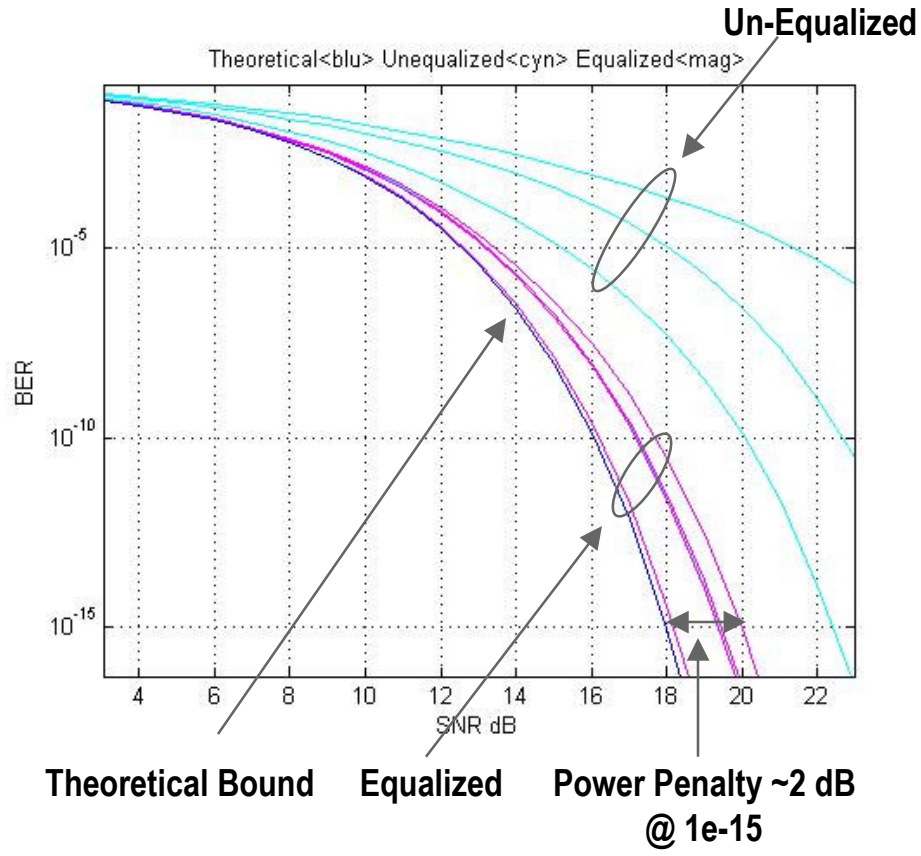


6G Simulation Results

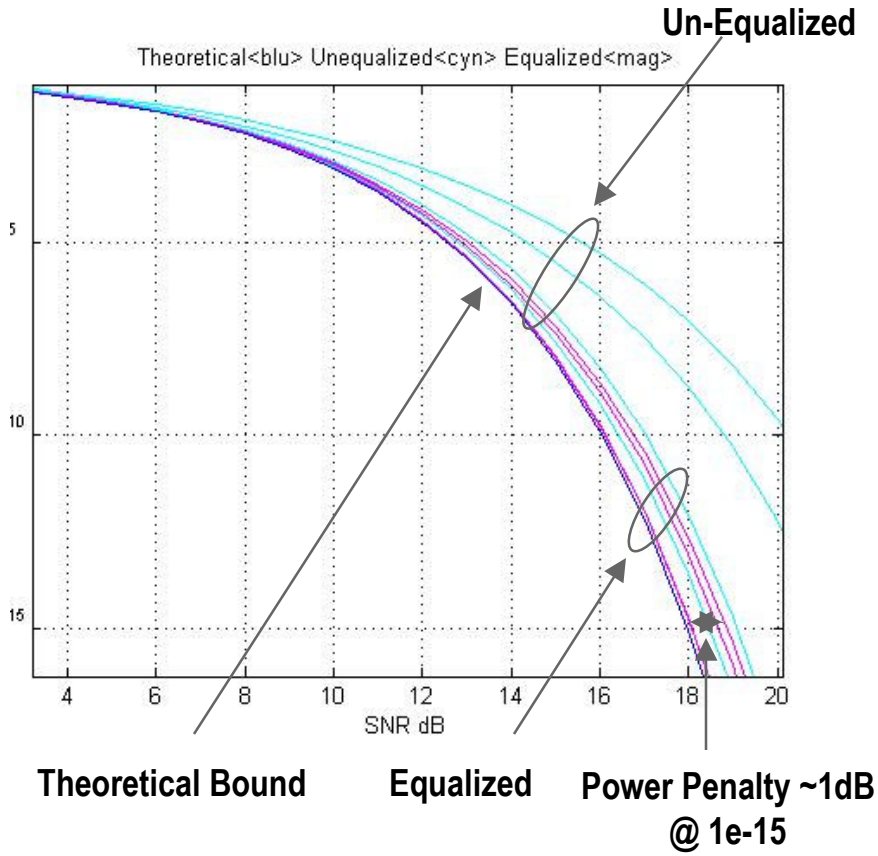
VITESSE

- Simulation Results w/ FR4 Summary
  - Semi-analytic BER Estimation
  - 5, 10, 20 & 25 inches FR4

De-Emphasis Disabled



De-Emphasis Enabled



Summary

VITESSE

Limitations of Analysis

- Links do not have near or far end crosstalk
- Optimal LMS Coefficients used in Equalizer
- Effects of Jitter neglected
- Implementation penalty due to Non-Idealities neglected

Summary

- The FR4 channels investigated can be equalized with De-emphasis alone
- Equalization will be required for robust 6 Gbps Operation on longer Infiniband Cable
- A combination of De-Emphasis and Receive Equalization looks promising for all channel considered.
- The required Receiver Equalization and De-Emphasis Driver have been implemented in 0.13 um CMOS with power consumption comparable to the 3G Phy.