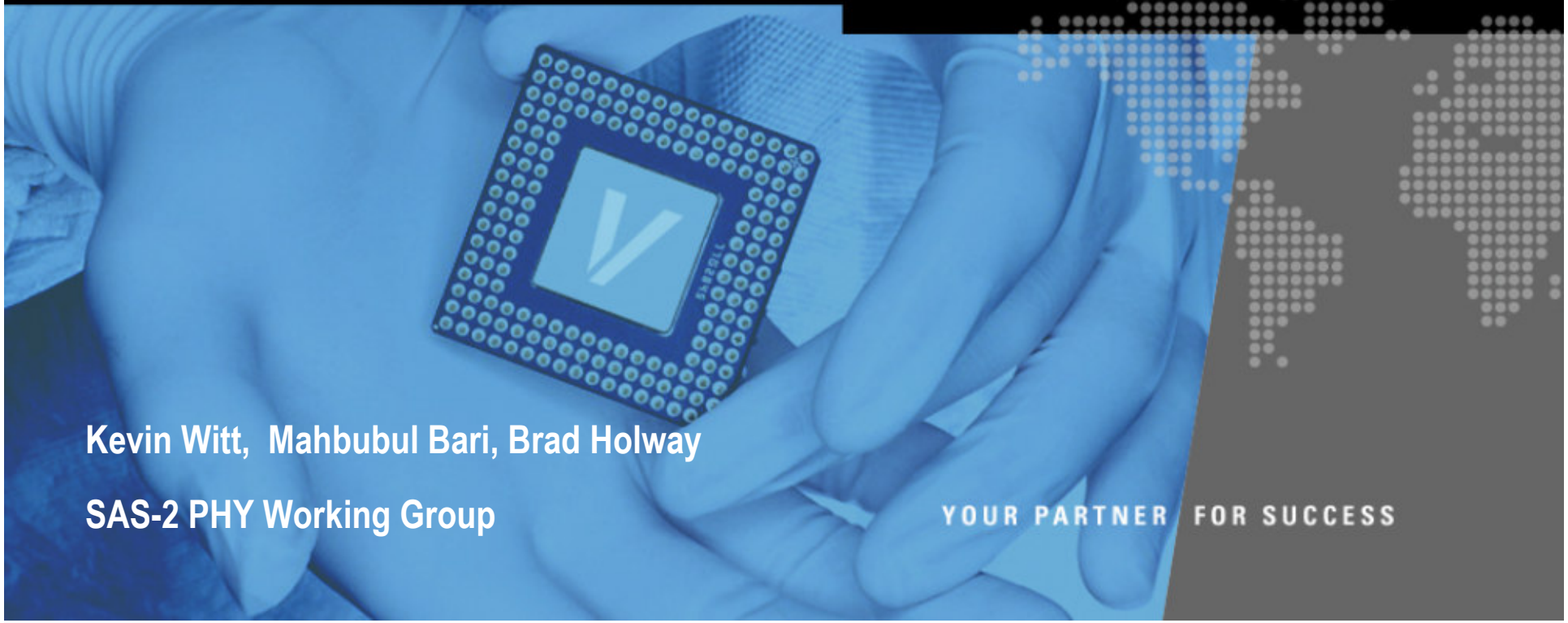
VITESSE

05-341r1: Updated Test and Simulation Results in Support of SAS-2



Kevin Witt, Mahbubul Bari, Brad Holway

SAS-2 PHY Working Group

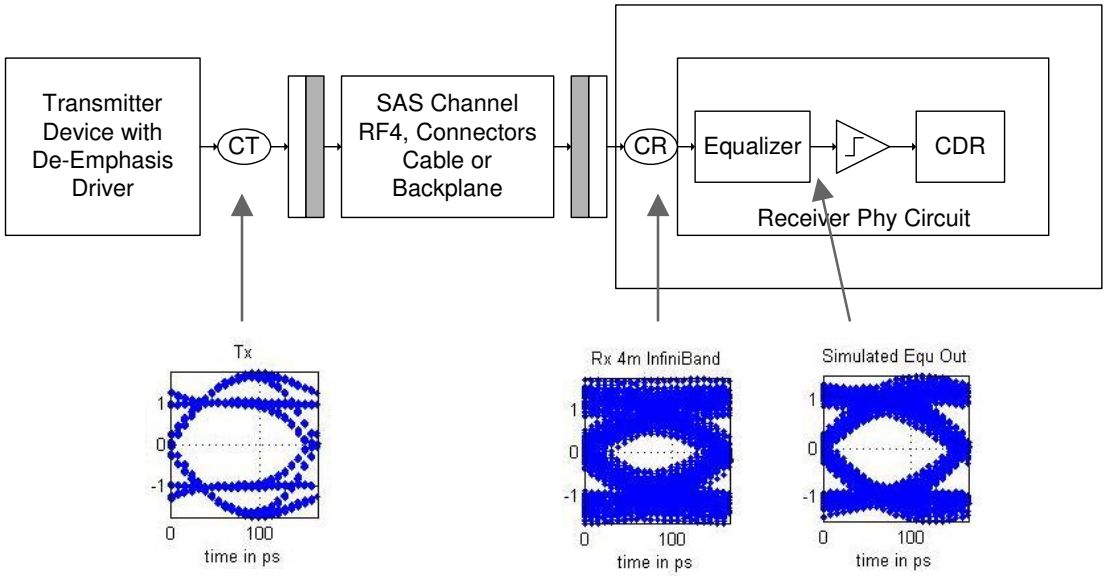
YOUR PARTNER FOR SUCCESS

Equalization Overview

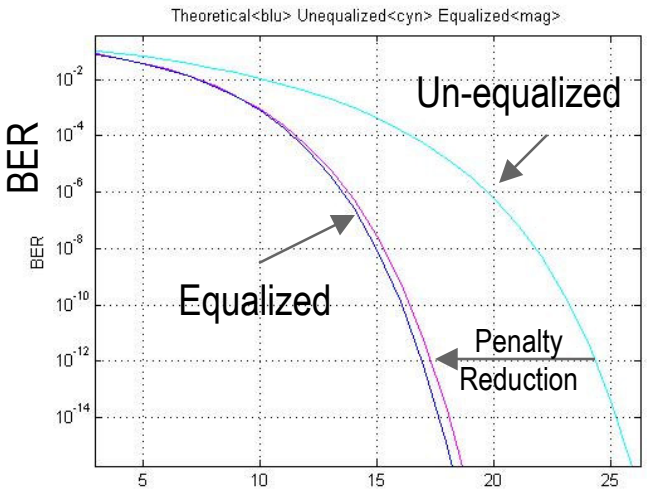
VITESSE

- Equalizers enable longer reach and higher data rates over band-limited channels.
- Transmitter De-emphasis and Receive Equalization (FFE/DFE) enhance the effective link margin by reducing the inter-symbol interference (ISI) penalty.
  - Eye opening / Q-factor is enhance
- The sensitivity and Link Margin of the link is enhanced.
  - ISI penalty is reduced

Eye Opening Enhancement



Sensitivity Plot

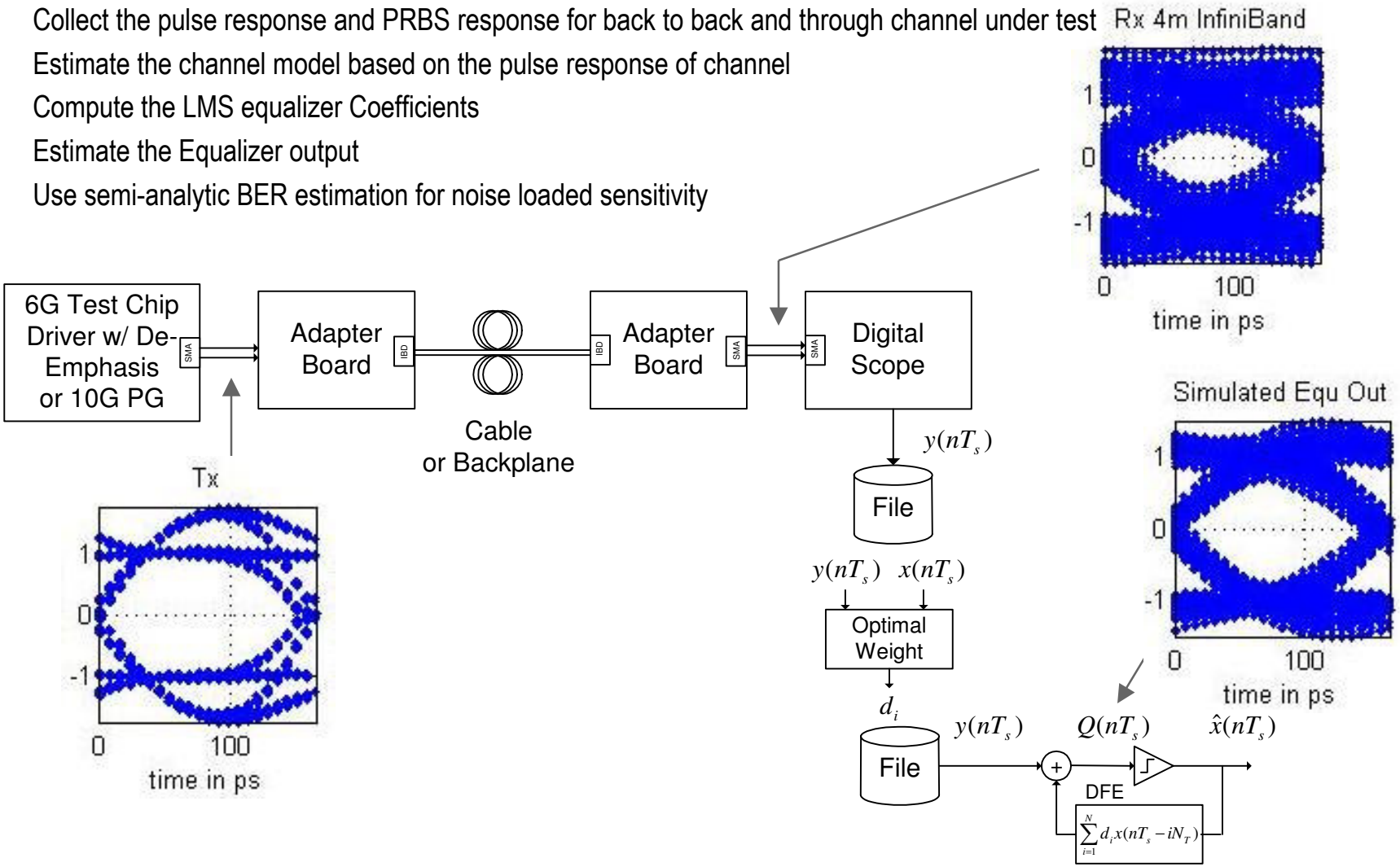


Equalization Simulation Methodology

VITESSE

DFE Simulation Methodology

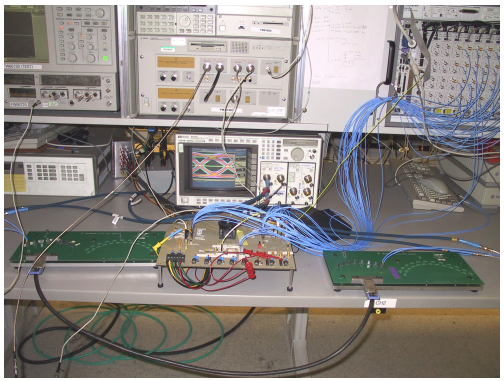
- Collect the pulse response and PRBS response for back to back and through channel under test
- Estimate the channel model based on the pulse response of channel
- Compute the LMS equalizer Coefficients
- Estimate the Equalizer output
- Use semi-analytic BER estimation for noise loaded sensitivity



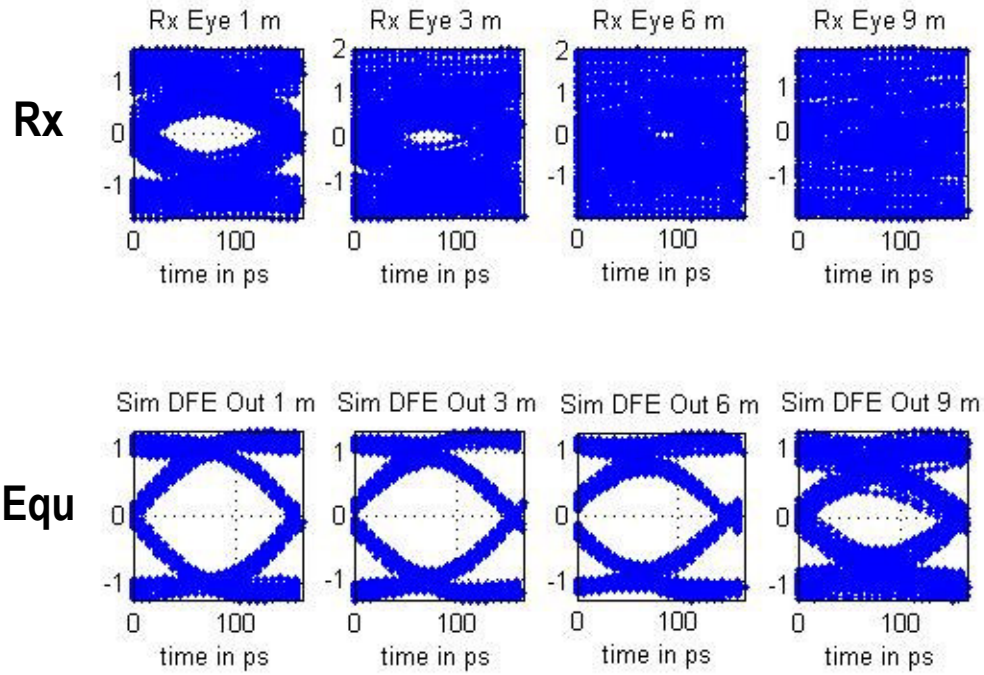
Need for Equalization in SAS-2

VITESSE

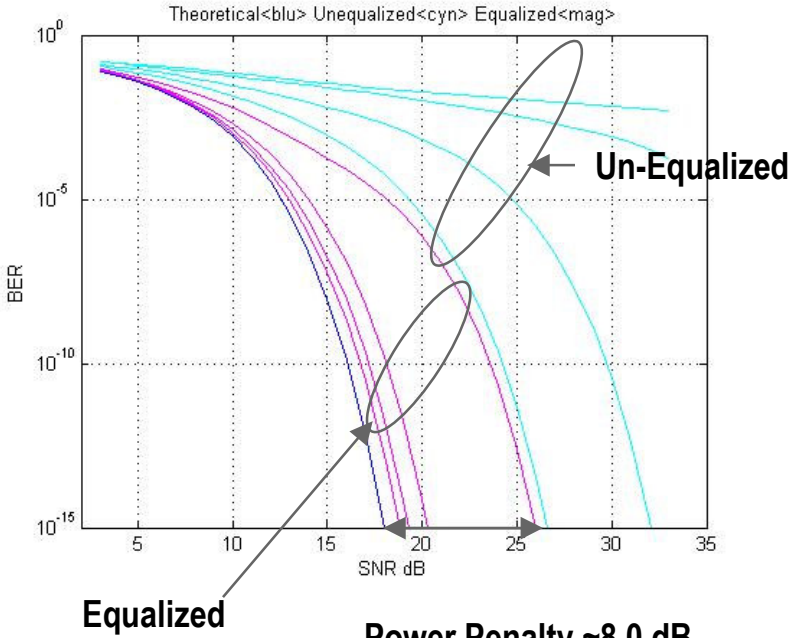
- External Infiniband Cable Example at 6Gbps
  - 10 meters for Rack to Rack interconnect will require equalization with SFF8484
    - Closed Rx eye @ 6m without Tx De-emphasis
  - Equalization will enable operation of these links up to 9 meters



Infiniband Eyes 1->9 meter (w/o De-Emphasis)



Infiniband Sensitivity

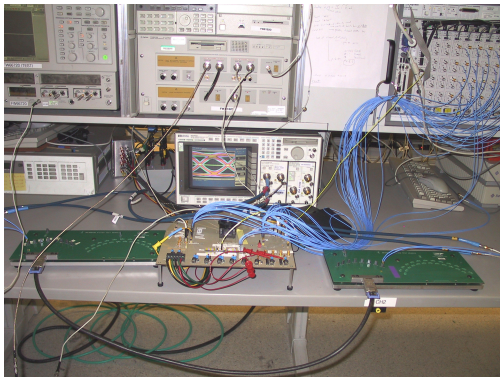


Power Penalty ~8.0 dB @ 1e-15

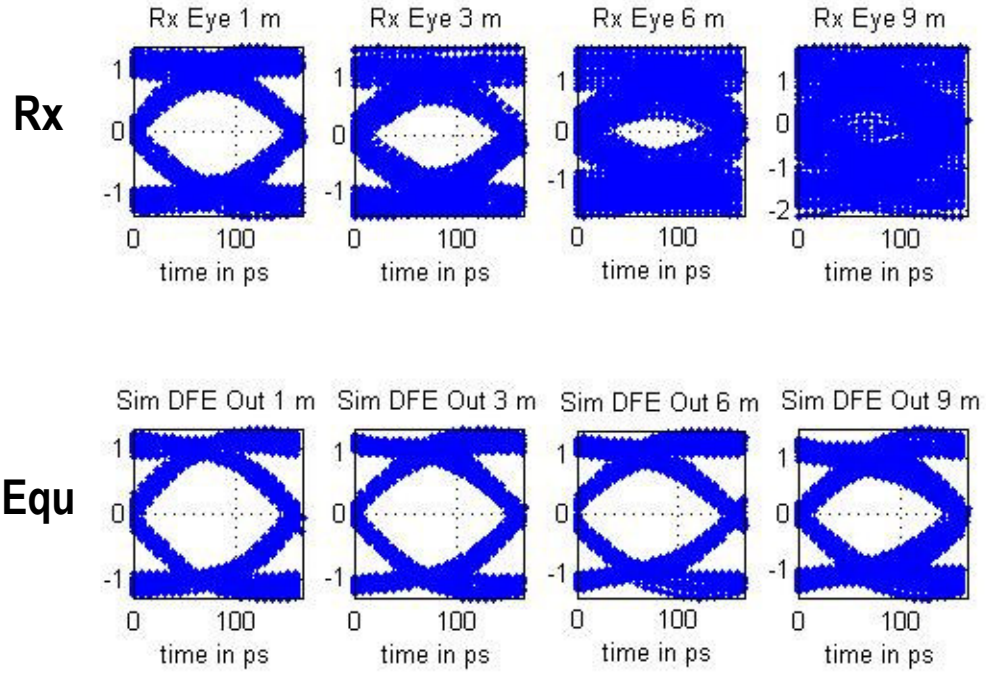
Need for Equalization in SAS-2

VITESSE

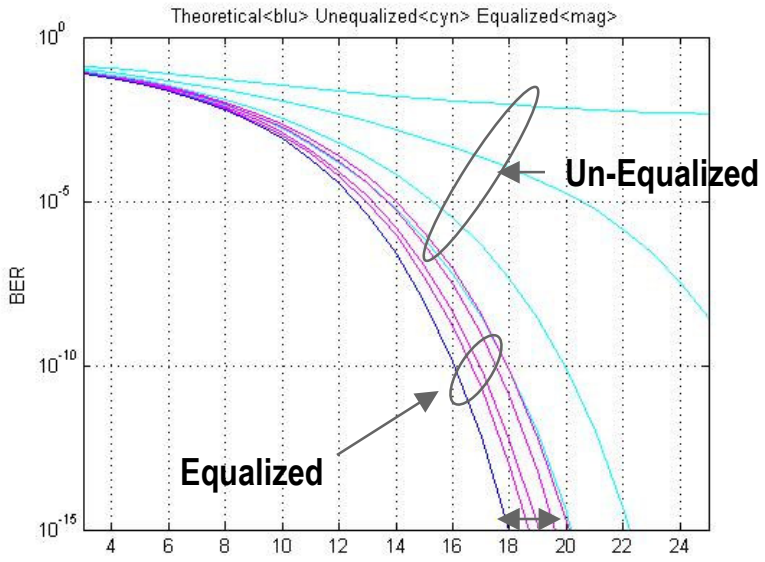
- External Infiniband Cable Example at 6Gbps
  - 10 meters for Rack to Rack interconnect will require equalization with SFF8484
    - Closed Rx eye @ 9m with Tx De-emphasis
  - Tx De-Emphasis reduces the power penalty



Infiniband Eyes 1->9 meter (w/ De-Emphasis)



Infiniband Sensitivity



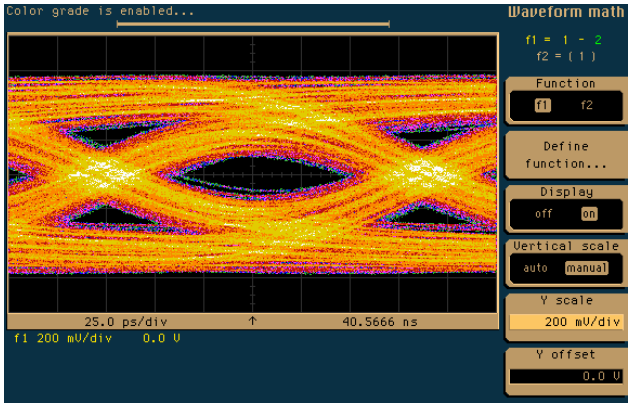
Power Penalty ~2.0 dB @ 1e-15

Infiniband Links without Tx De-Emphasis

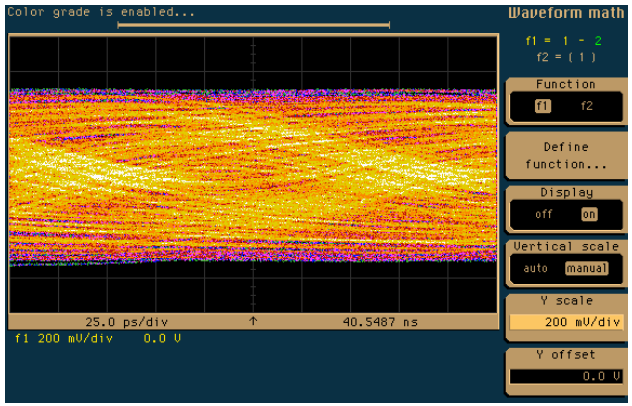
VITESSE

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

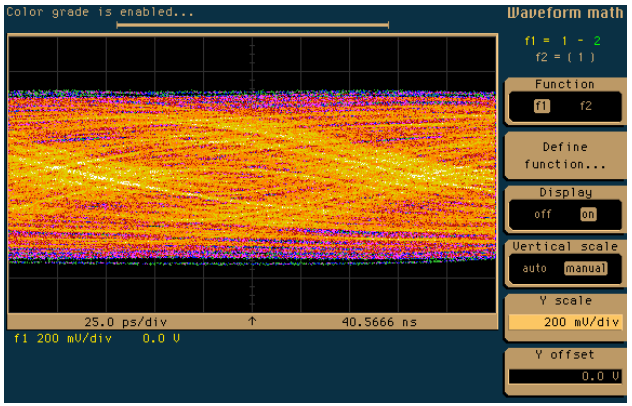
1m



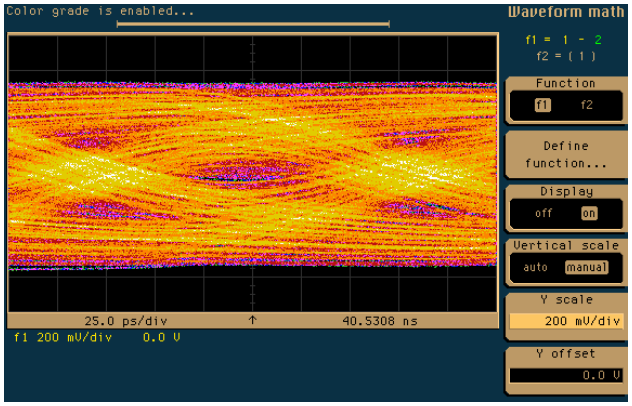
4m



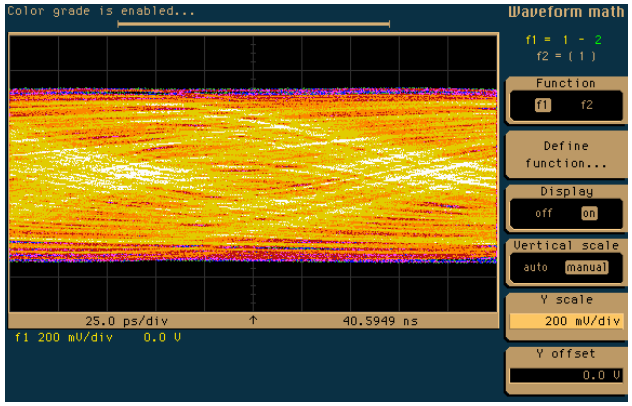
7m



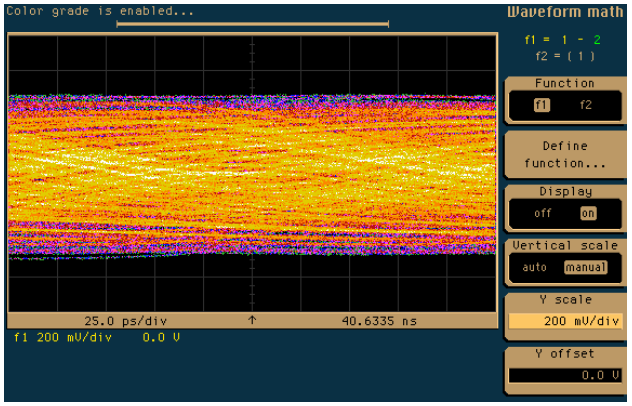
3m



6m



9m



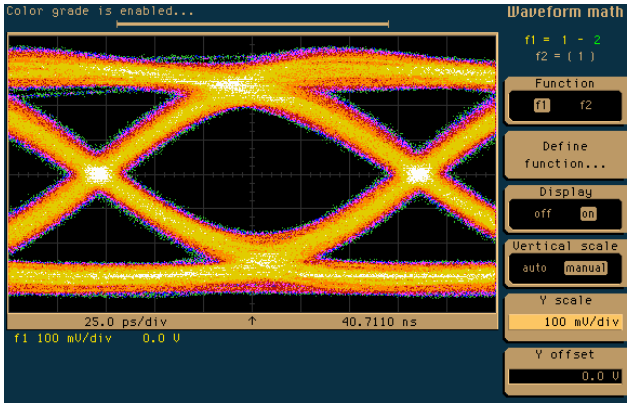
Signal integrity issues at 6G are more interesting

Infiniband Links with Tx De-Emphasis

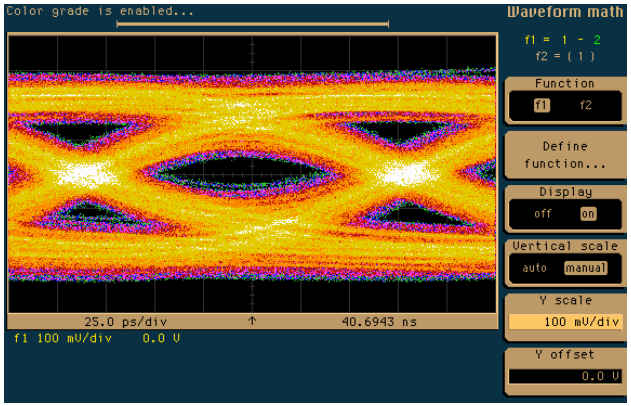
VITESSE

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

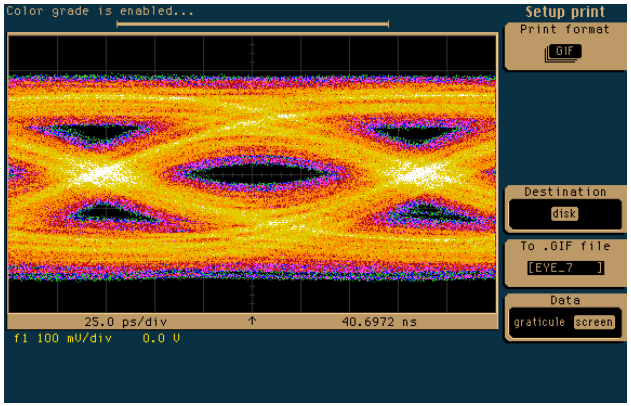
1m



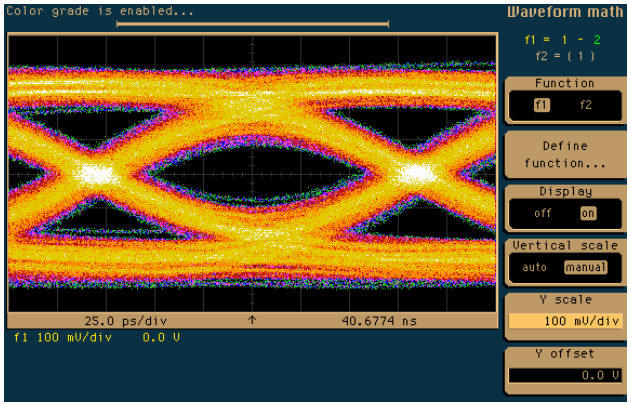
4m



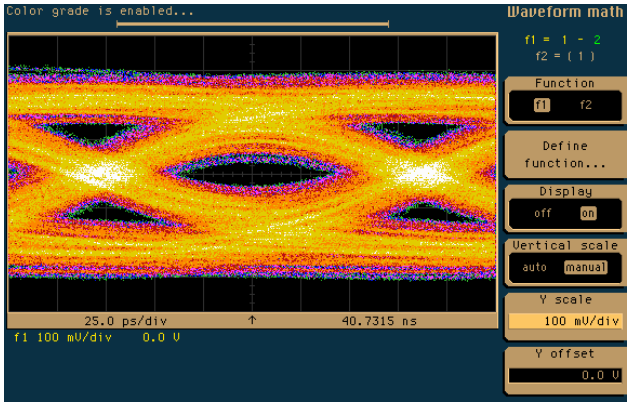
7m



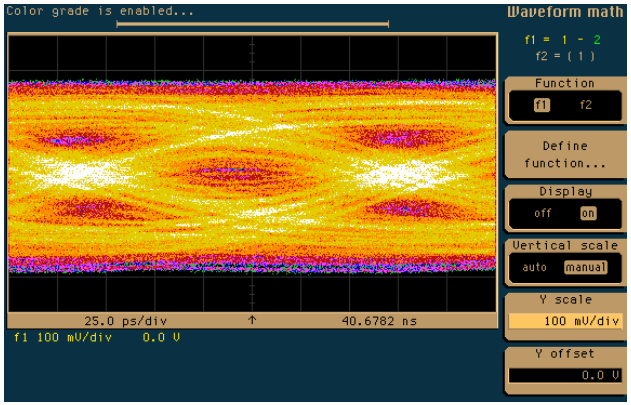
3m



6m



9m

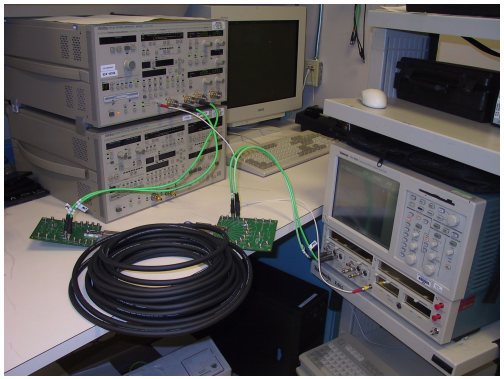


Tx De-Emphasis only is not enough!

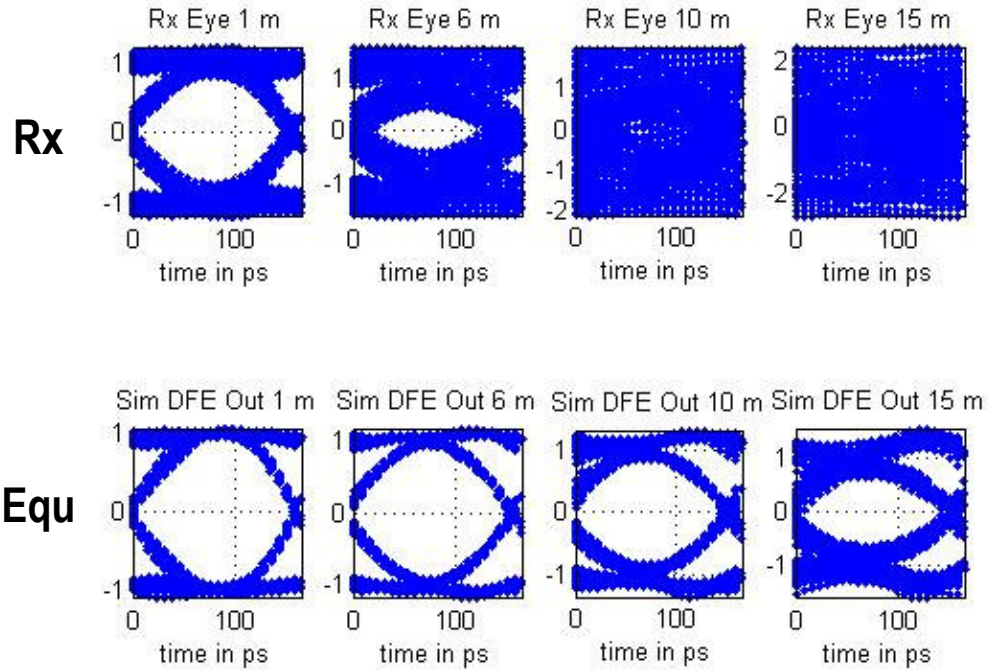
Need for Equalization in SAS-2

VITESSE

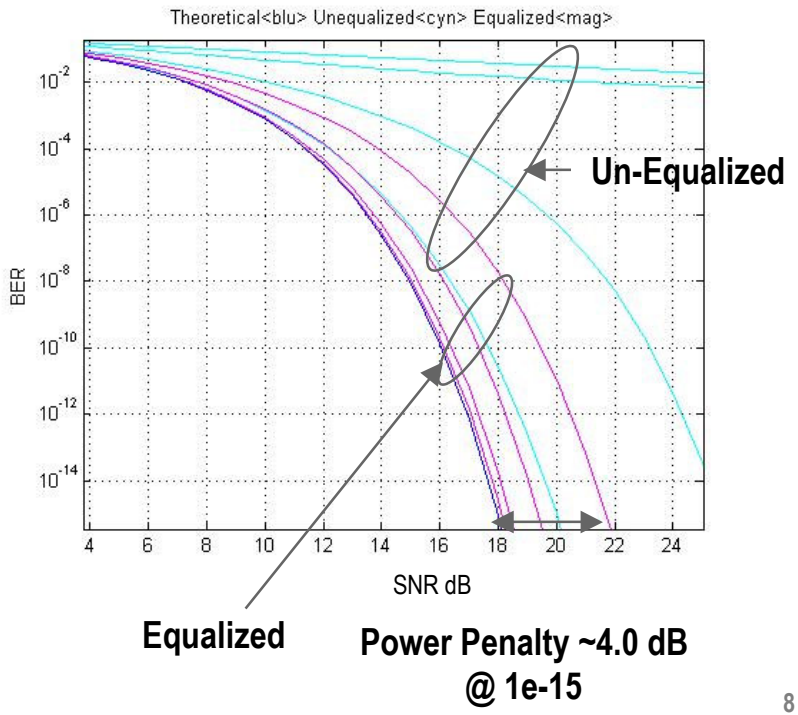
- External Molex iPASS™ Cable Example at 6Gbps
  - 10 meters for Rack to Rack interconnect will require equalization with SFF8088
    - Closed Rx eye @ 10m without Tx De-emphasis
  - Equalization will enable operation of these links at 10 meters with margin



iPASS™ Eyes 1->15 meter (10G PG w/o De-Emphasis)



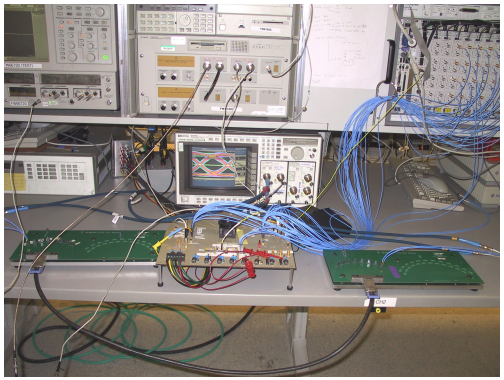
iPASS™ Sensitivity



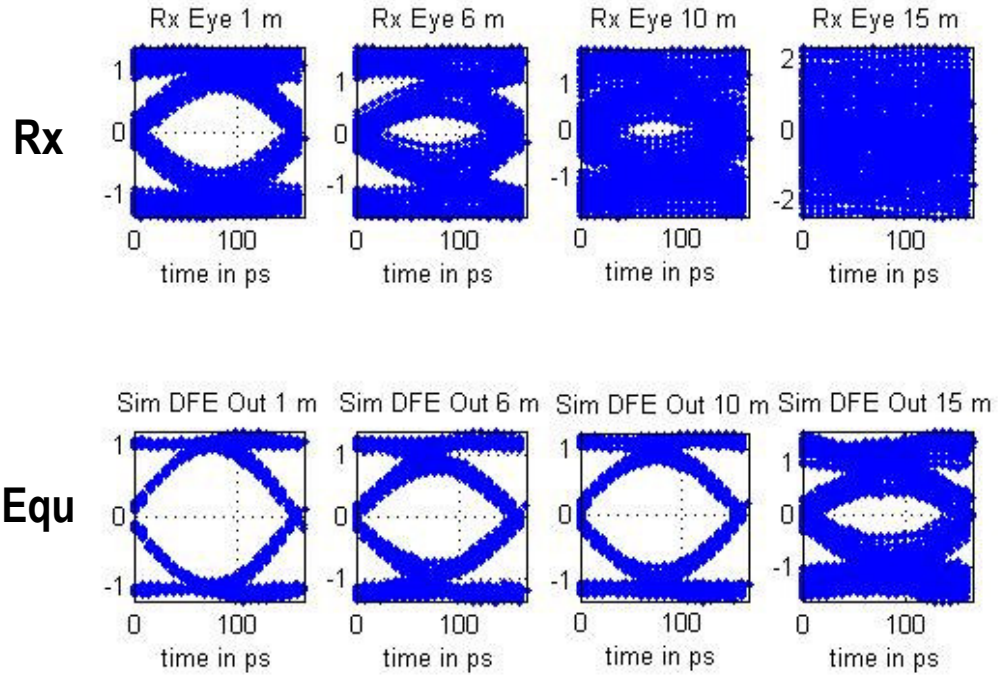
Need for Equalization in SAS-2

VITESSE

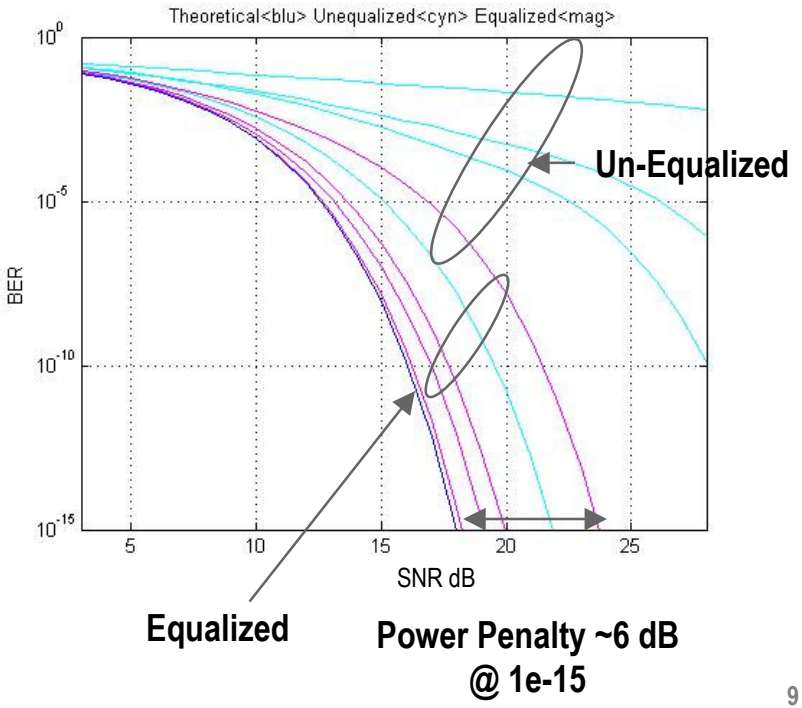
- External Molex iPASS™ Cable Example at 6Gbps
  - 10 meters for Rack to Rack interconnect will require equalization with SFF8088
    - Nearly Closed Rx eye @ 10m without Tx De-emphasis
  - Equalization without De-emphasis will enable operation of these links at 10 meters with margin



iPASS™ Eyes 1->15 meter (Test Chip w/o De-Emphasis)



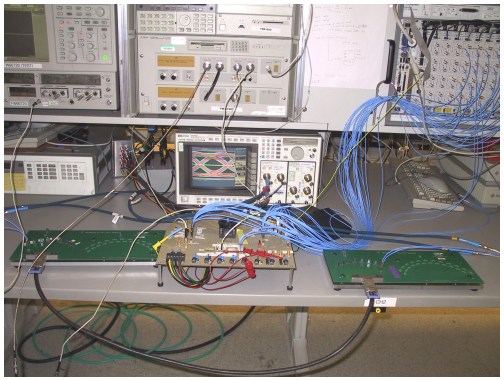
iPASS™ Sensitivity



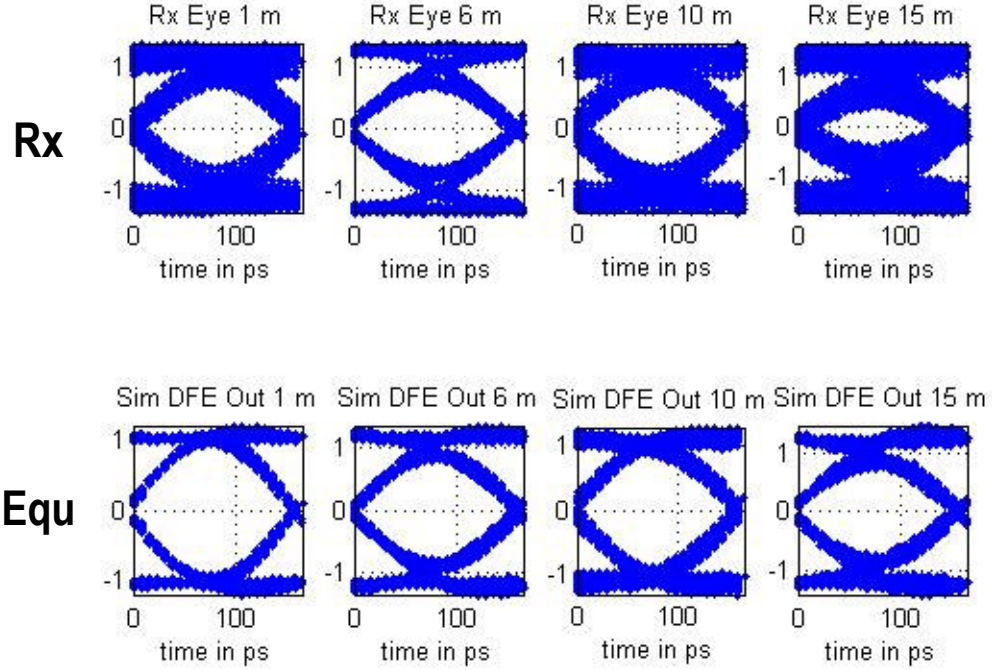
Need for Equalization in SAS-2

VITESSE

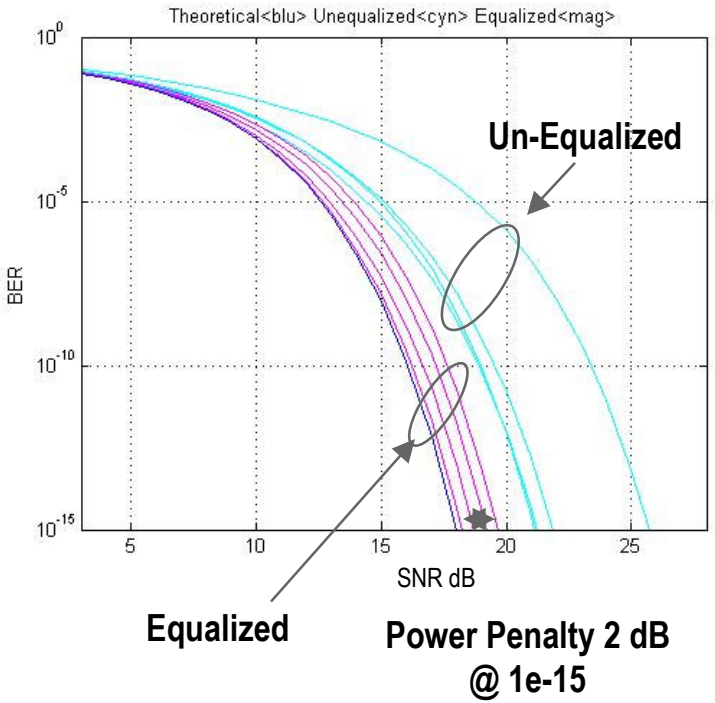
- External Molex iPASS™ Cable Example at 6Gbps
  - 10 meters for Rack to Rack interconnect will required equalization with SFF8088
    - Open Rx eye @ 10m with Tx De-emphasis
  - Equalization with De-emphasis will enable operation of these links at 15 meters with margin



iPASS™ Eyes 1->15 meter (Test Chip w/ De-Emphasis)



iPASS™ Sensitivity

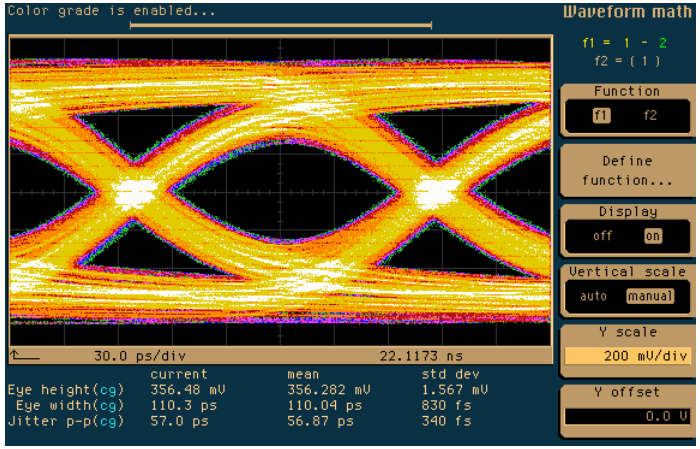


iPASS™ Links without Tx De-Emphasis

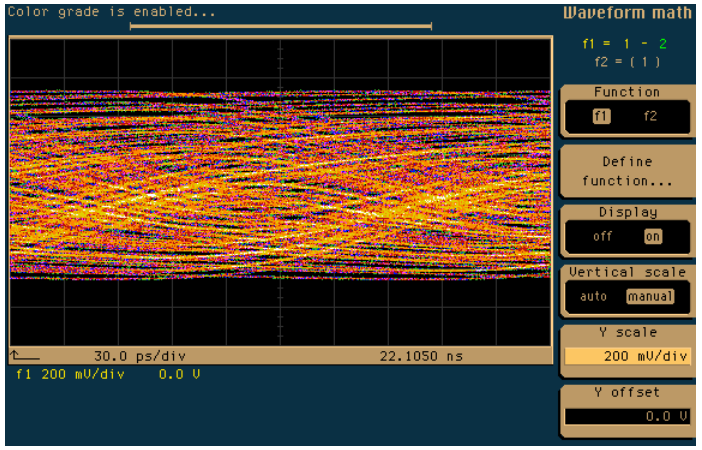
VITESSE

- Test Results iPASS™ Cable De-Emphasis Disabled (6Gbps) (Updated in Rev 1)

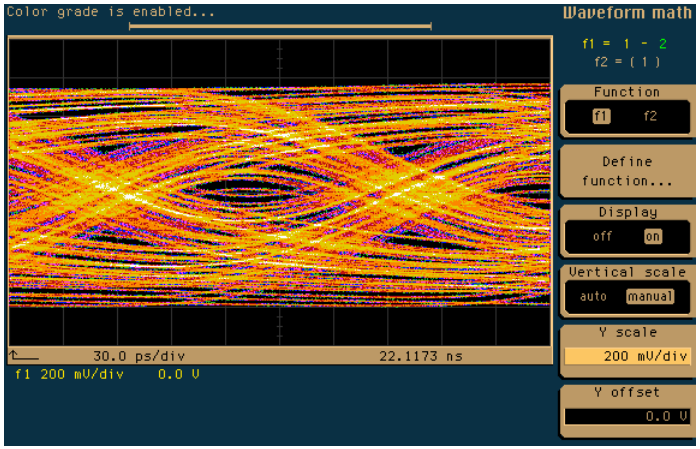
1m



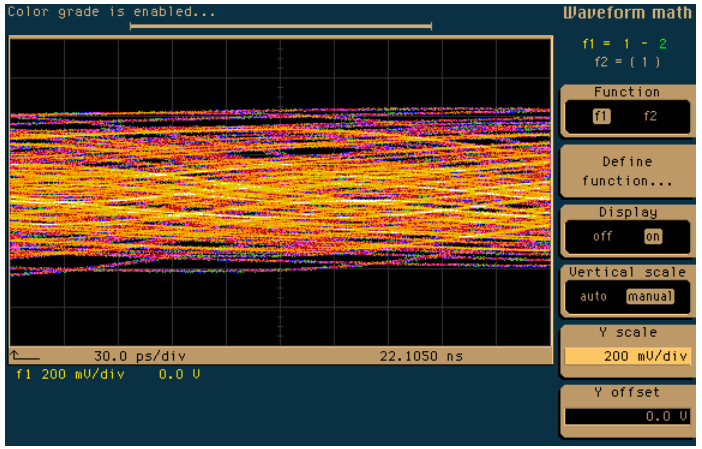
10m



6m



15m



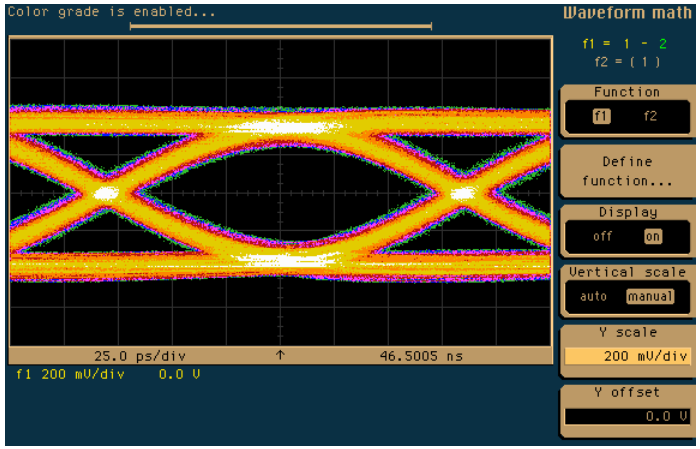
Signal integrity issues improved with iPASS™ Cables compared to InfiniBand

iPASS™ Links with Tx De-Emphasis

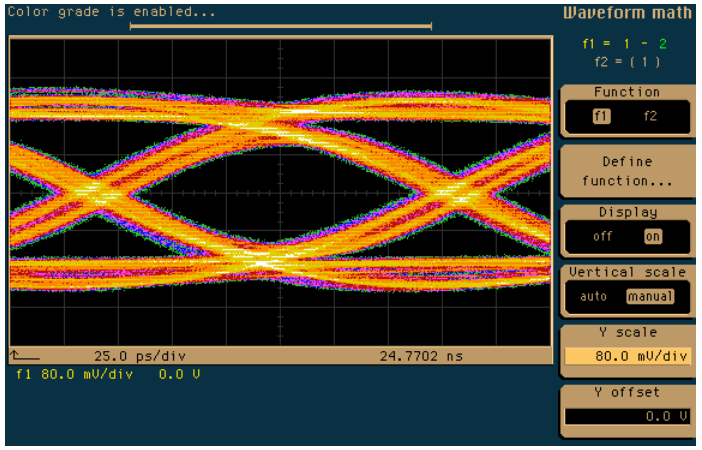
VITESSE

- Test Results iPASS™ Cable De-Emphasis Enabled (6Gbps) (Updated in Rev 1)

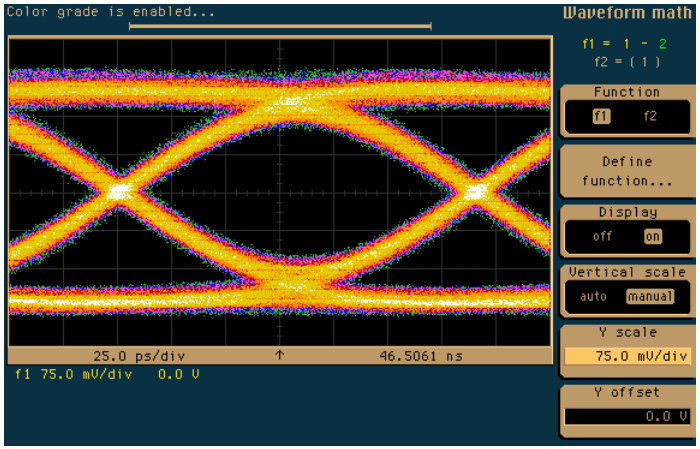
1m



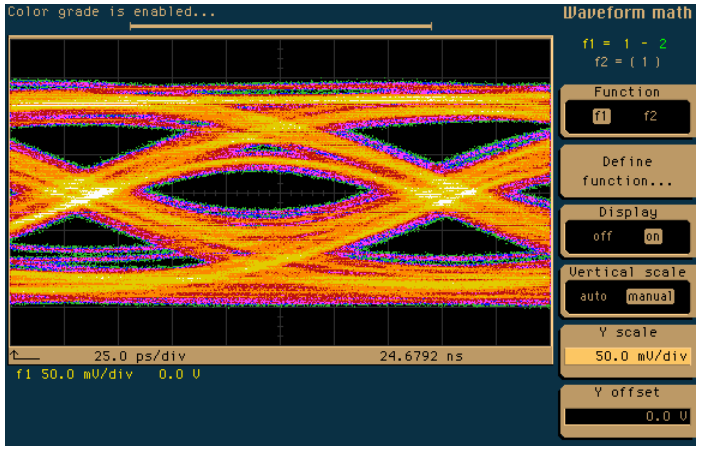
10m



6m



15m

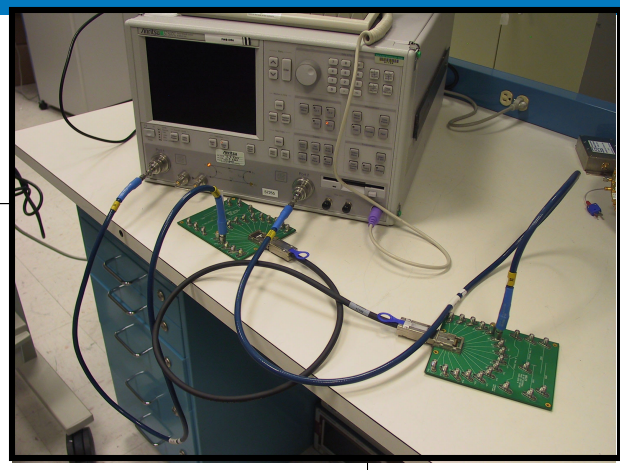


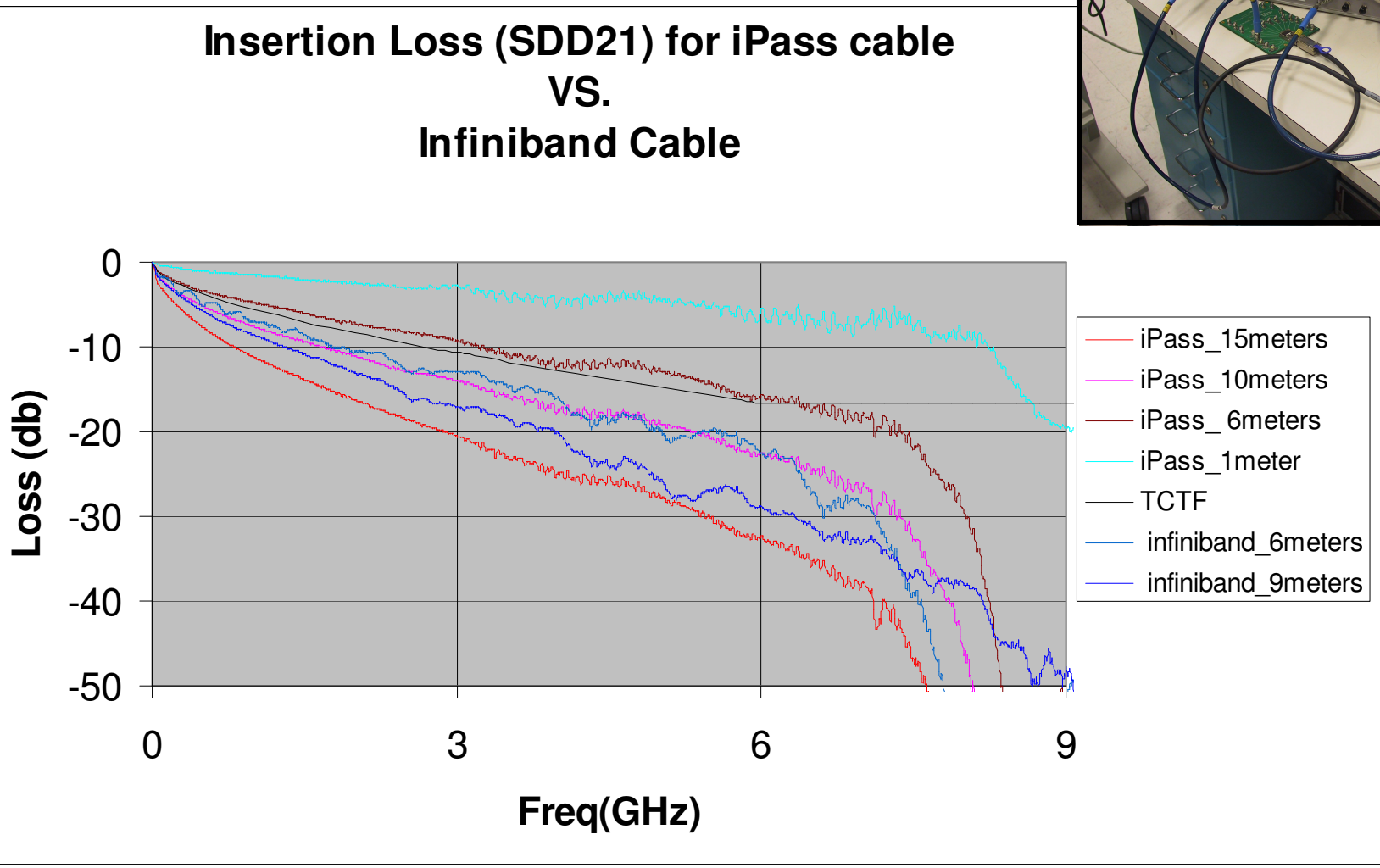
iPASS™ and Tx De-Emphasis Enable 10m Operation

Insertion Loss of Infiniband and iPASS™

VITESSE

- SDD21 compared to extended TCTF
  - iPASS™ at 10m is comparable to Infiniband at 6m

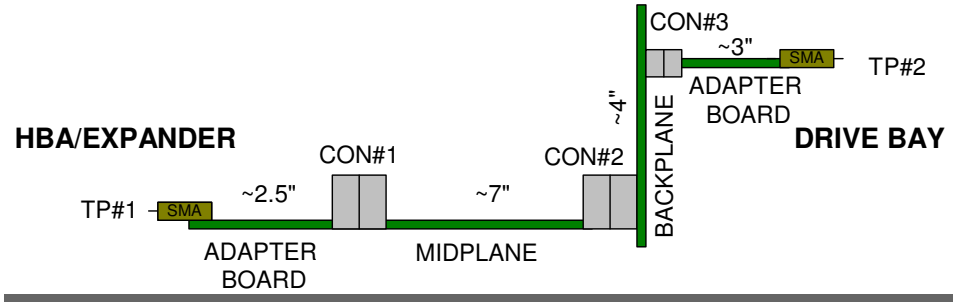


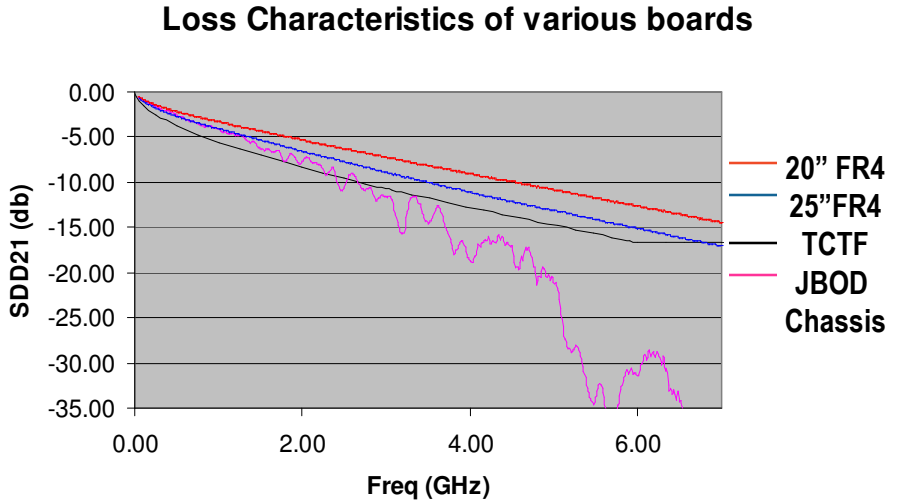


HBA/Expander to mid-plane to back-plane to drive Example

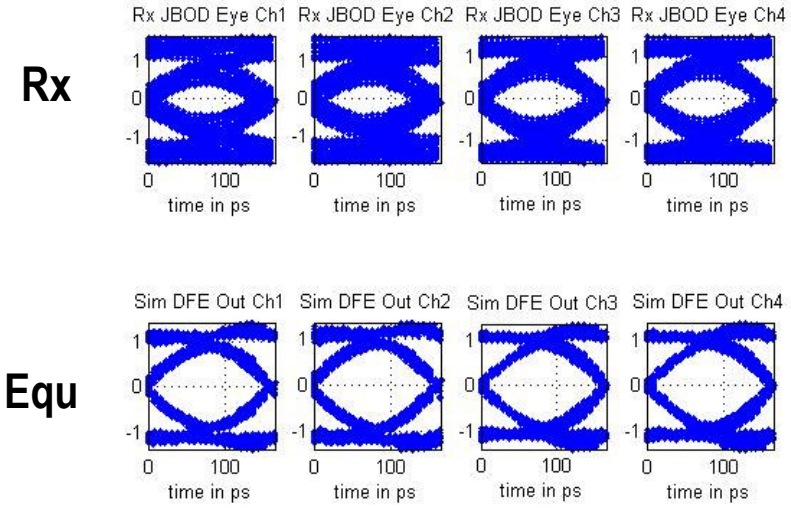
VITESSE

- Typical JBOD Chassis example at 6Gpbs
  - 15->16” FR4 & 3 Connectors (< 1m target)
  - Equalization may be needed to mitigate ISI with existing designs.
  - Adaptive equalization reduces Power Penalty by > 6dB

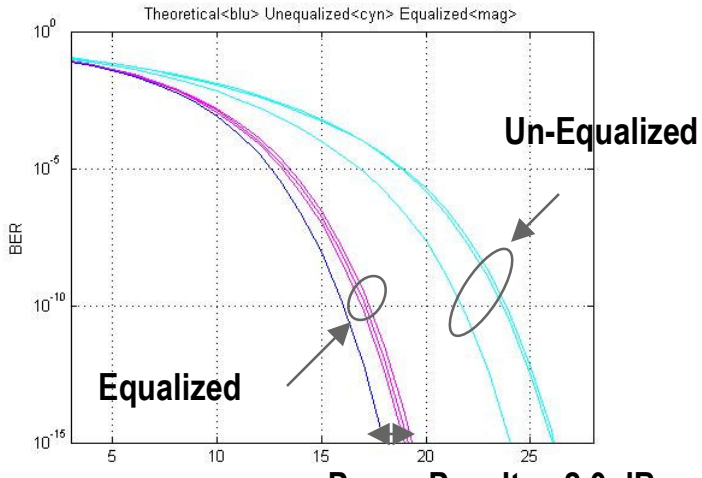




JBOD Eyes



JBOD Sensitivity



Power Penalty ~2.0 dB @ 1e-15

Feasibility of Adaptive Equalizers for SAS-2

VITESSE

Summary

- Tx / Rx equalization reduces ISI penalty in SAS-2 Links
- Equalization will be required for SAS-2 External Links at 10 meters.
  - iPASS™ superior to InfiniBand for 6 Gpbs links.
  - External links of 10m can be supported with Tx De-Emphasis or Rx equalization
  - External links of 15m may be feasible with Tx De-Emphasis & Rx equalization
- Tx Pre-Emphasis and/or Rx Equalization will be required for SAS-2
  - External Links at 10 meters
  - Internal HBA/Expander-Midplane-backplane-drive