IBM STG

4x 25Gb/s 100GBE Backplane Links

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Focus of the Study: 4x 25Gb/s 100GBE over Backplane Links

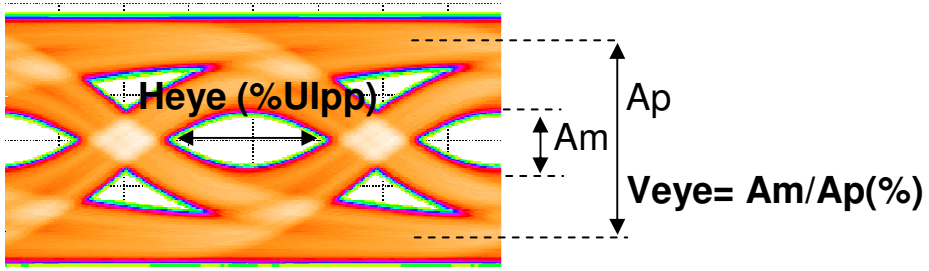
- Channels:
  - Tyco backplane channels
  - IBM measured backplane channels
  - http://grouper.ieee.org/groups/802/3/100GCU/public/channel.html
- Signaling schemes: NRZ
  - 25.78125Gb/s, 64b/66b coding without FEC
- Time domain Signal Integrity (SI) analysis
  - Comprehensive SI model (3-sigma worst case)
    - Based on actual implementation of a complete 4x lane 100GBE core

Time Domain SI Model

Transmitter Characteristics	Receiver Characteristics
▪ 1T FFE4 (2pre, 1 post) ▪ 900mVppd launch amplitude ▪ Analog front end loss and reflections (Simulated S-parameters)	▪ DFE15, 10dB Peaking amplifier ▪ 600mVppd AGC target at DFE summer output ▪ Analog front end loss and reflections (Simulated S-parameters) ▪ CDR actual behavior (includes algorithmic and quantization jitter)
Degradation Model	
▪ 350fs rms RJ, 10% DJ (sine PM), 2% DCD ▪ 2.75mV rms Gaussian noise ▪ 20mVppd minimum receiver latch overdrive ▪ 40mm package model (21mm 100Ohms differential Tline (loss:2.8dB @ 12.5GHz))	

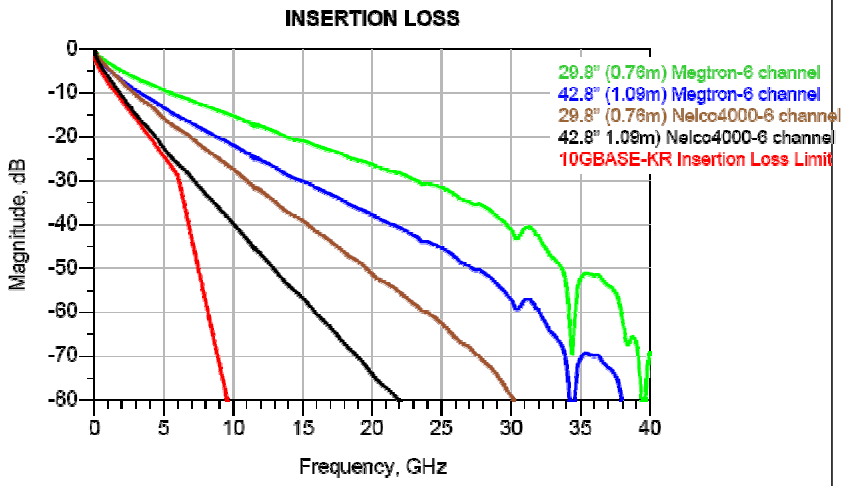
- **Simulation results**
  - Vertical and Horizontal eye opening margins at Rx sampling latch input, 1e-12 BER
  - 2.5M bits simulated, randomly generated,
  - 25.78125Gbaud

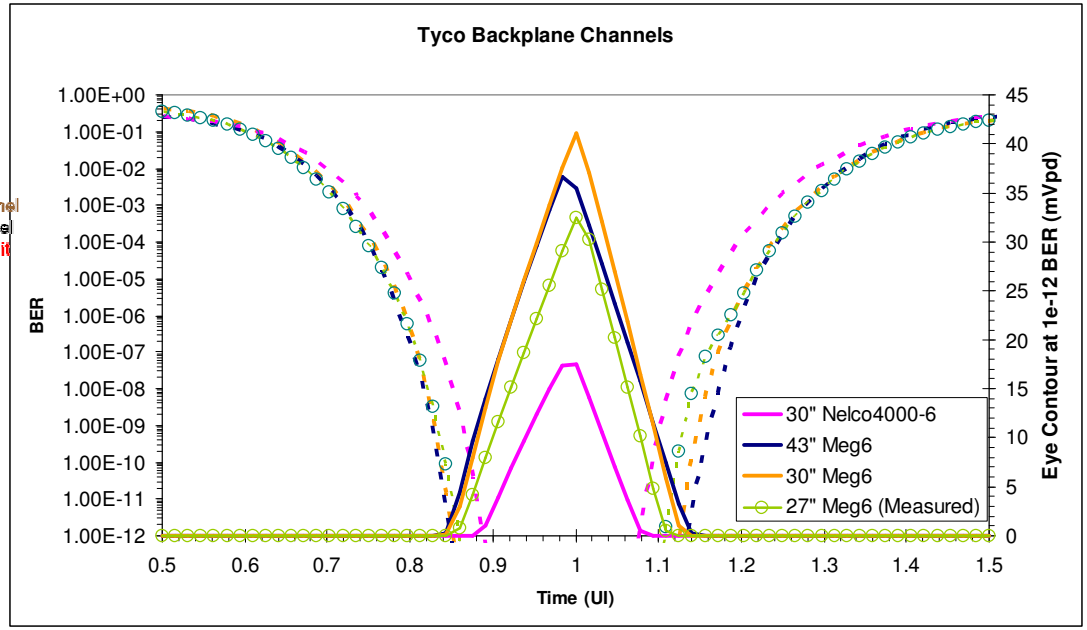
Equalized differential eye
as seen at the Rx latch input



Tyco Backplane Channels

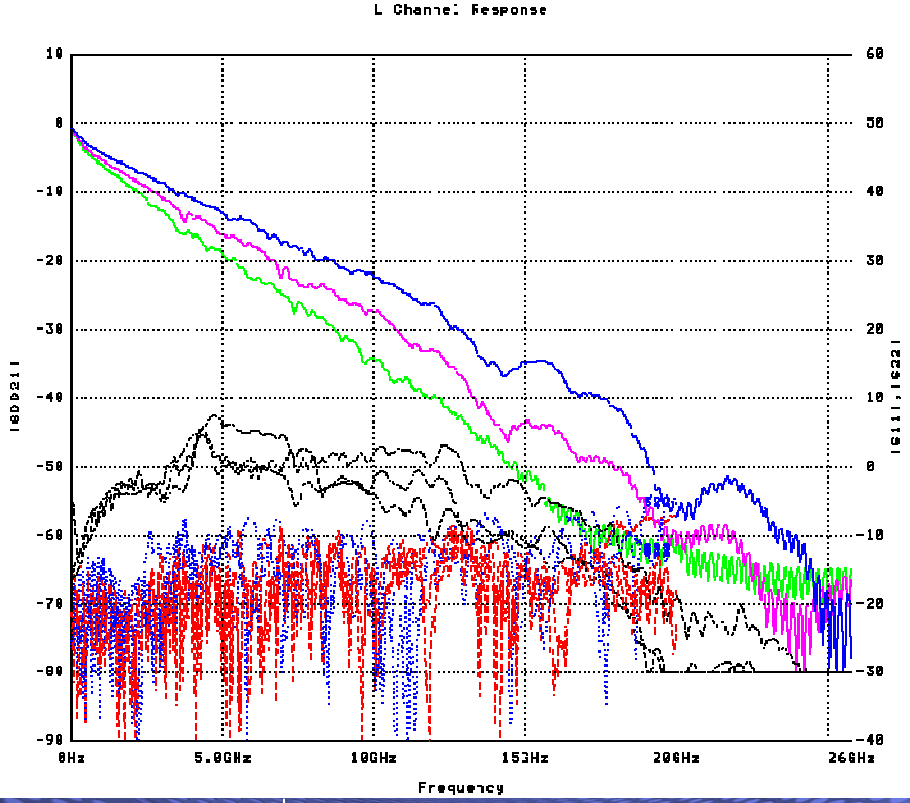
Channel (measured) shanbhag_02_0511.pdf	Loss (dB)	Signal / Xtalk 5 NEXT, 5 FEXT	Max Vert. Eye Margin (%Ap)	Max Horz. Eye Margin (%UIpp)	BER Floor
27" Meg-6	20.4	16.8	21	25	2e-45
Channels (simulated) shanbhag_03_0411.pdf	**Loss (dB)**	**Signal / Xtalk 8 NEXT, 8 FEXT**	**Max Vert. Eye Margin (%Ap)**	**Max Horz. Eye Margin (%UIpp)**	**BER Floor**
Meg-6 – 30"	19	27	27	27	8e-57
Meg-6 – 43"	27	22	26	29	3e-56
Nelco4000-6 – 30"	35	19	14	19	3e-30

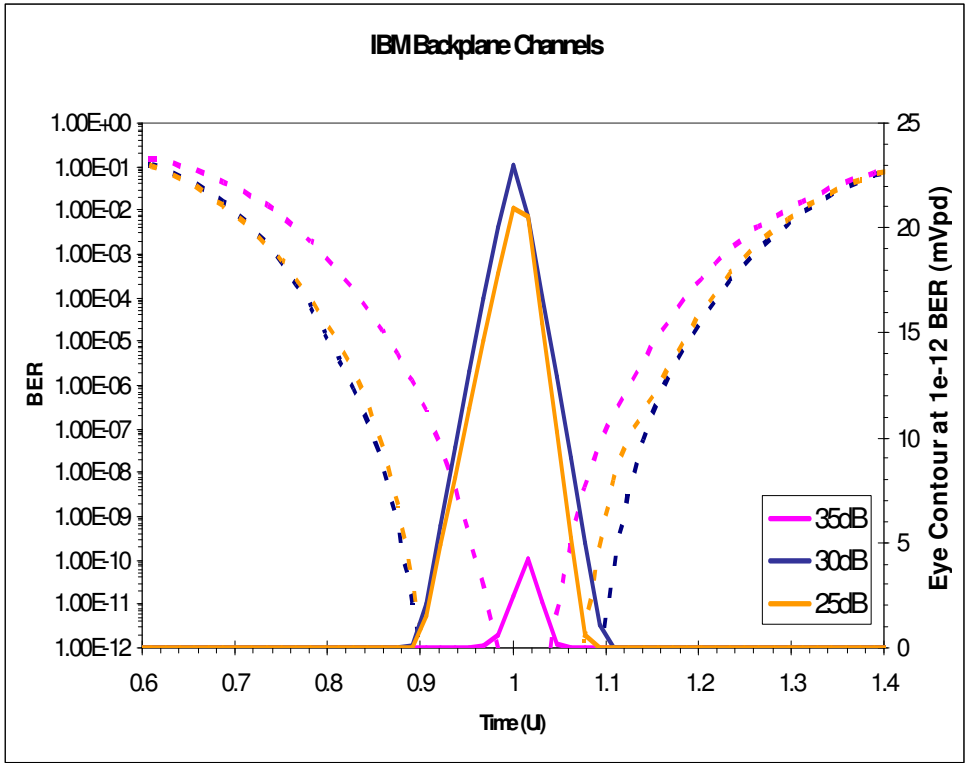




IBM Experiment Backplane Channels

Channels (Measured) Patel_01_0511.pdf	Loss (dB)	Signal / Xtalk 8 NEXT, 8 FEXT	Max Vert. Eye Margin (%Ap)	Max Horz. Eye Margin (%UIpp)	BER Floor
26" Meg-6	26dB	19	14	21	8e-33
26" Meg-6/IS415	30dB	19	16	23	1e-35
32" Meg-6/IS415	37dB	20	4	4	8e-16

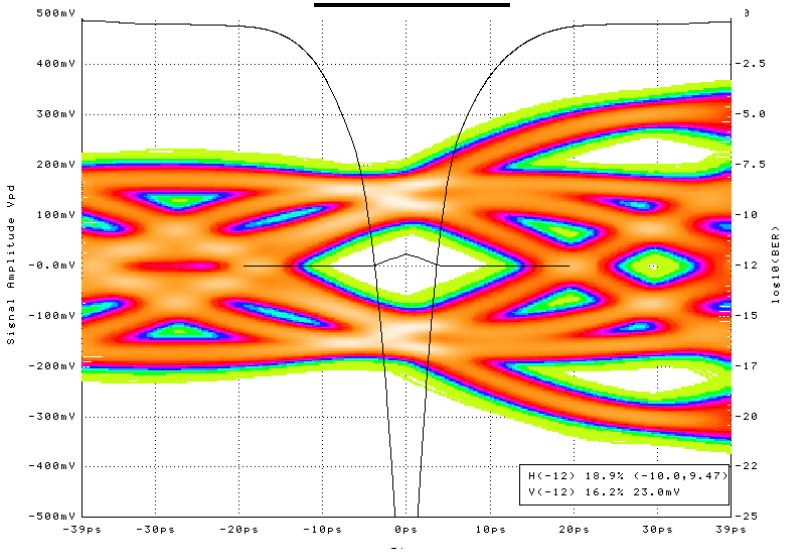




Summary

- Demonstrated technical feasibility of signaling across <=30dB of channel loss
  - Achieved low BER across a measured backplane channel which has 30dB of loss at 12.9GHz

IBM 28G NRZ Core (3-sigma model)
BER: 1e-35



30dB Backplane Channel

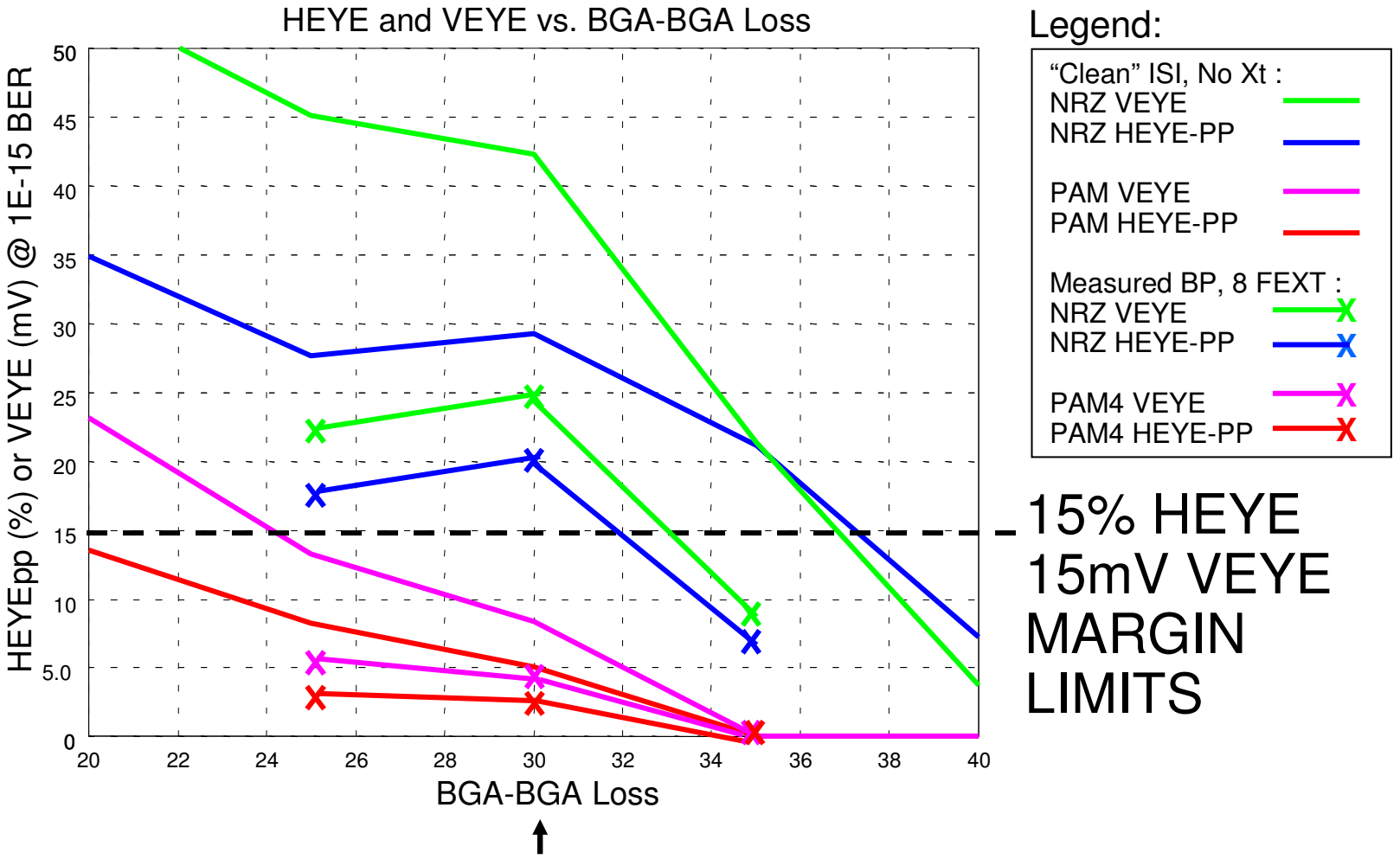
26" Meg-6/IS415 Patel_01_0511.pdf	**Max Vert. Eye Margin (%Ap)**	**Max Horz. Eye Margin (%UIpp)**
Eye Margins at 1e-12 BER	16	23
Eye Margins at 1e-15 BER	13	16
Eye Margins at 1e-17 BER	11	14

Proposal

- A 4-lane 100 Gb/s PHY for operation over copper traces as described in (shanbhag_03_0411.pdf, shanbhag_02_0511.pdf, Patel_01_0511.pdf) which have a maximum channel loss of <= 30dB at 12.9GHz
  - Need to also define max ILD and ICN

Backup

Uncoded Backplane Channel Loss Limits

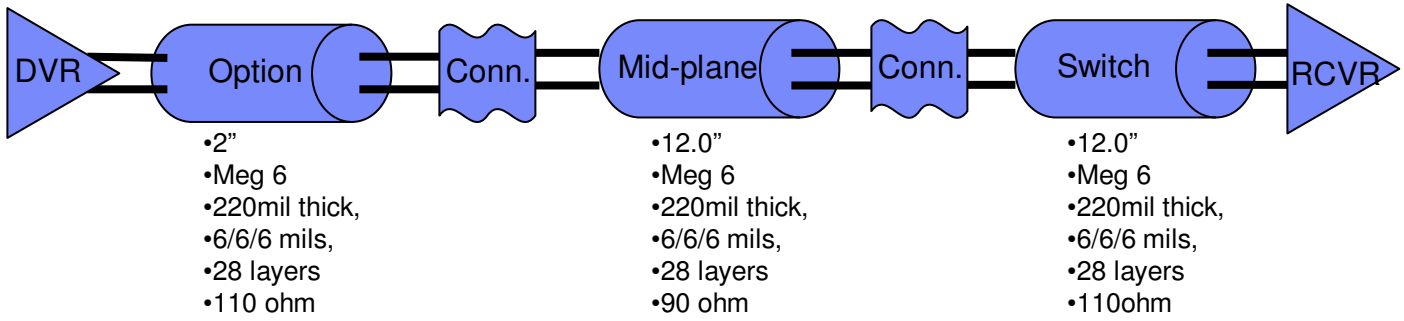


Recommended 30dB BGA-BGA Loss Limit

IBM Experimental Test Fixture Backplane Channels

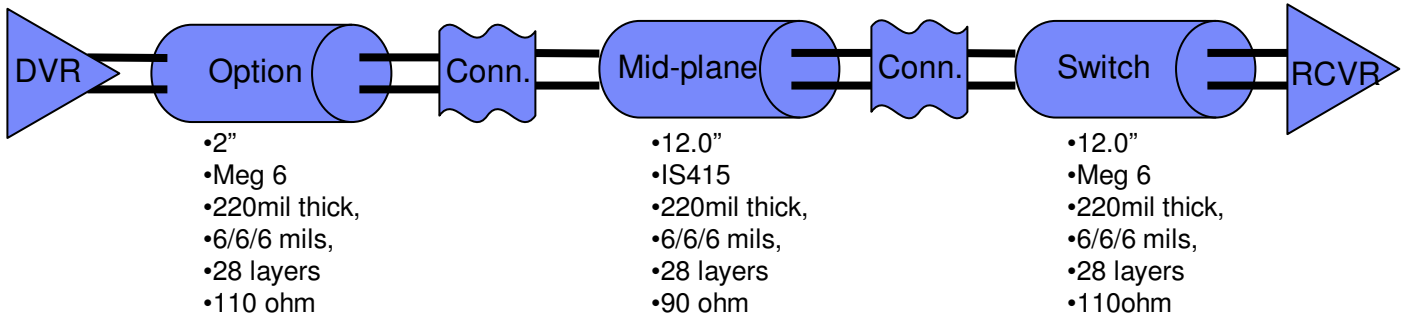
25dB Loss Channel

THRU.s4p
FEXT1.s4p FEXT5.s4p
FEXT2.s4p FEXT6.s4p
FEXT3.s4p FEXT7.s4p
FEXT4.s4p FEXT8.s4p



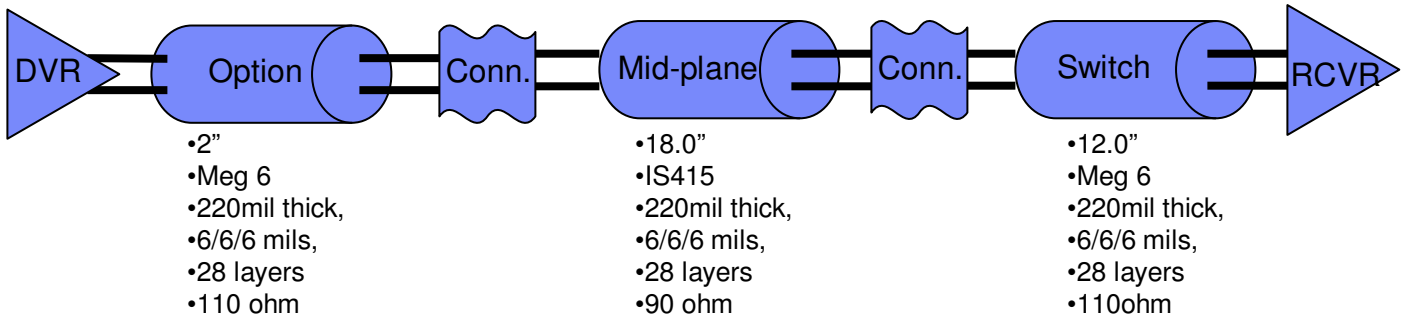
30dB Loss Channel

THRU.s4p
FEXT1.s4p FEXT5.s4p
FEXT2.s4p FEXT6.s4p
FEXT3.s4p FEXT7.s4p
FEXT4.s4p FEXT8.s4p



35dB Loss Channel

THRU.s4p
FEXT1.s4p FEXT5.s4p
FEXT2.s4p FEXT6.s4p
FEXT3.s4p FEXT7.s4p
FEXT4.s4p FEXT8.s4p



Typical Production Design Build Construction: 10% impedance tolerance, Standard Copper Foil, Backdrill 10mil +/- 10mil