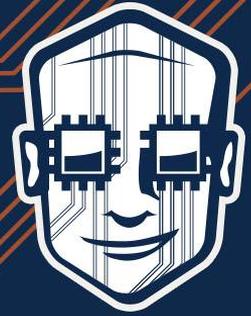


DESIGNCON[®] 2015



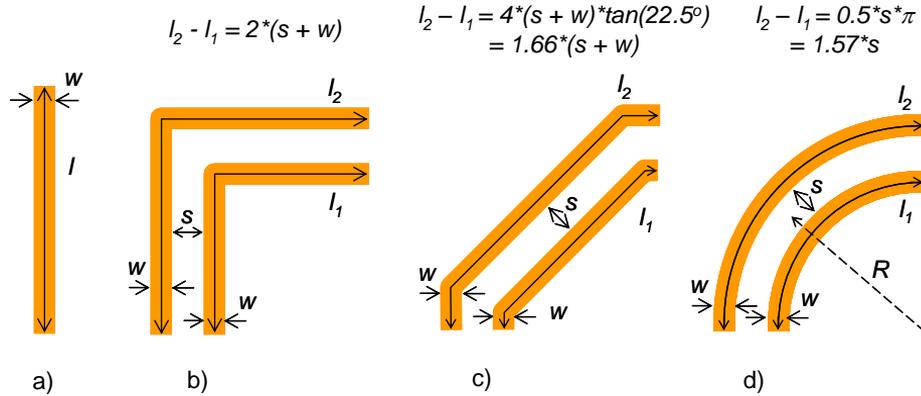
Shirin Farrahi, Vijay Kunda, Ying Li, Xun Zhang, Gustavo Blando,
Istvan Novak
Oracle Corp

Does skew really degrade
SerDes performance?

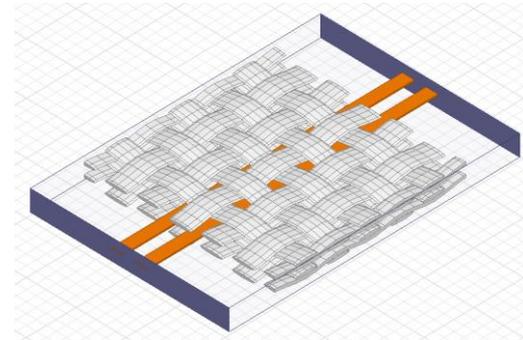
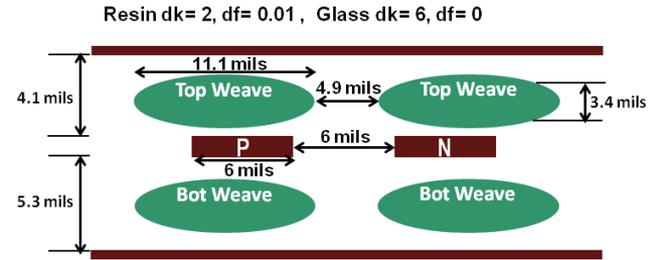
ORACLE[®]



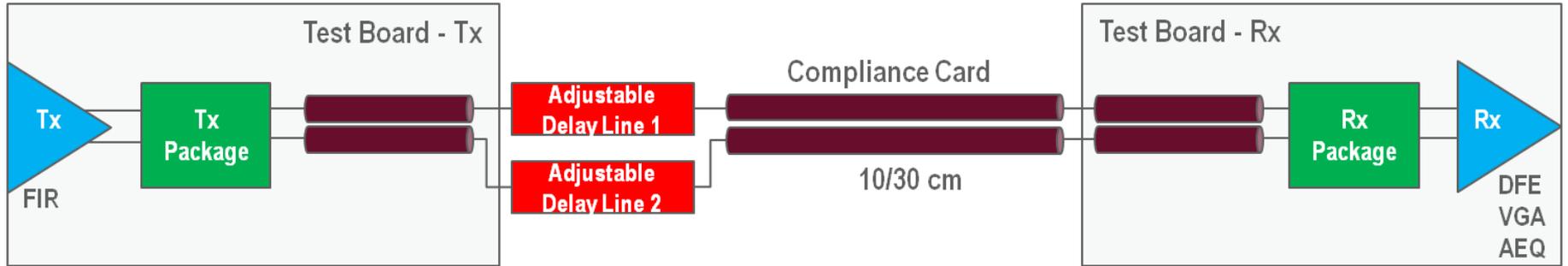
Motivation



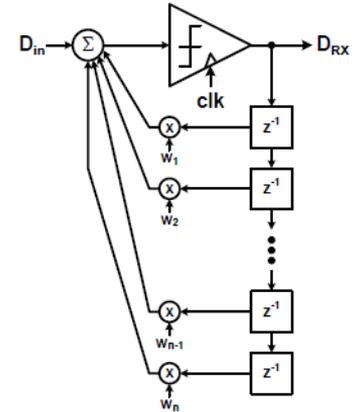
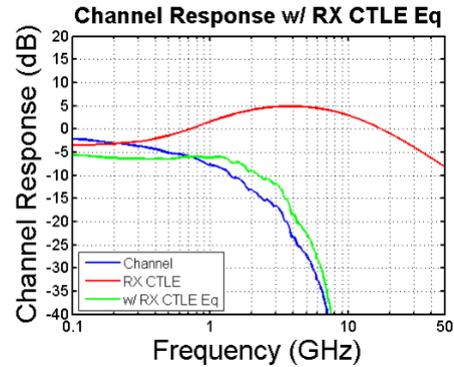
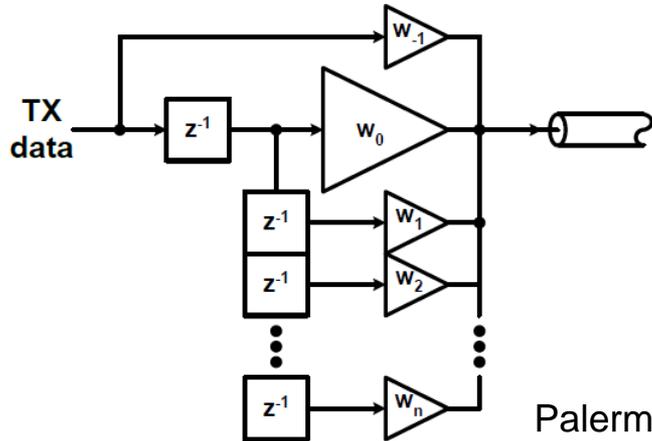
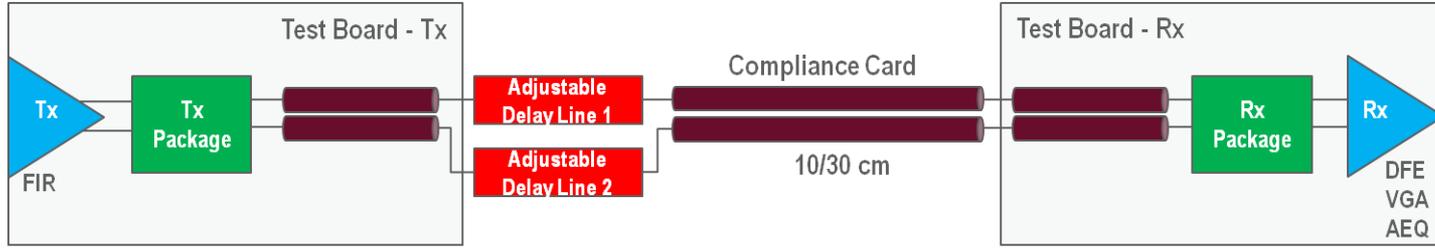
Kunz et al, DesignCon 2014



Test setup



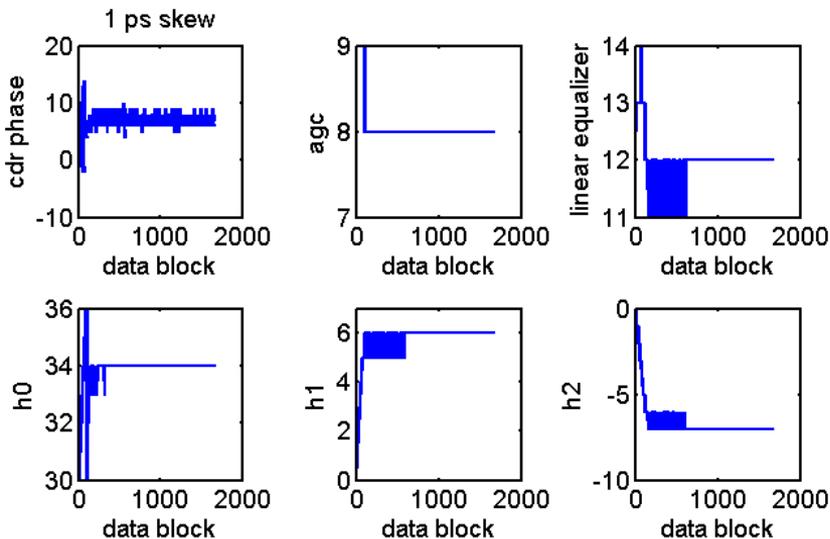
Test setup



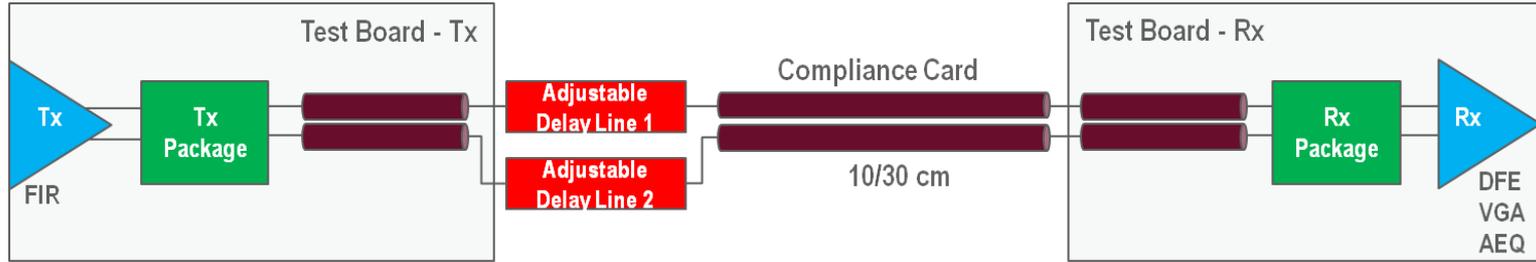
Palermo, Sam, 2014, Course Notes, ECEN720

SerDes driver and receiver

- Driver FIR settings fixed
- Receiver settings adaptive



Adjustable delay lines

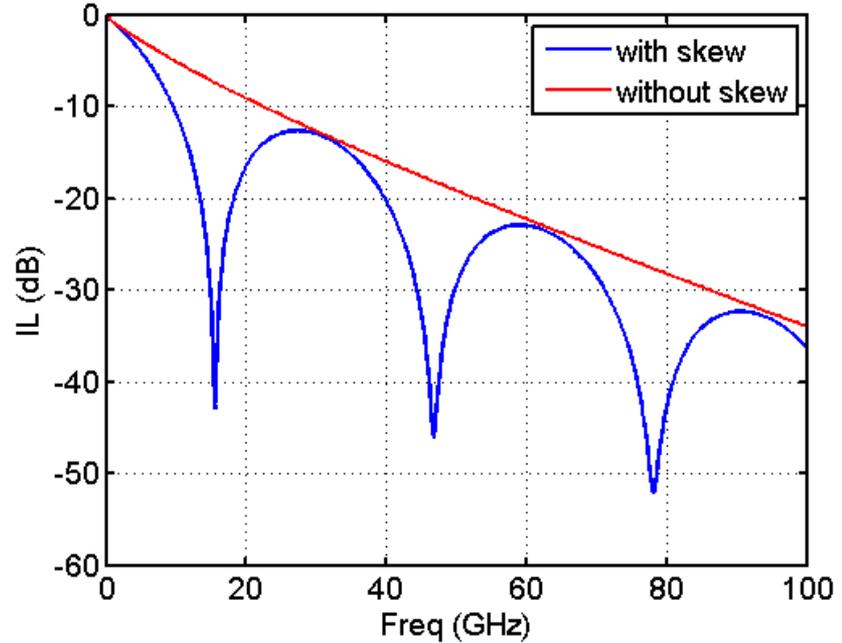
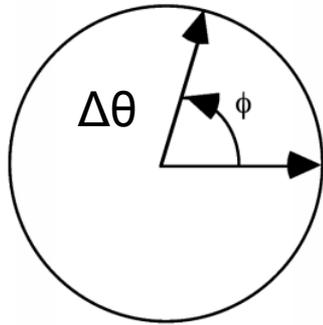


Differential IL due to skew

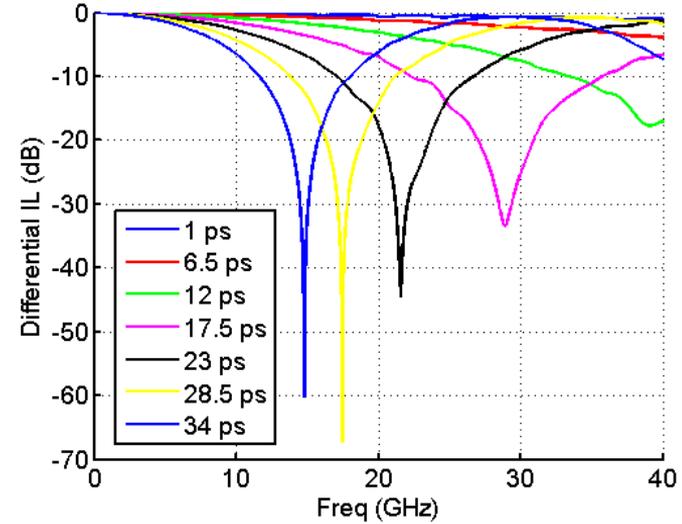
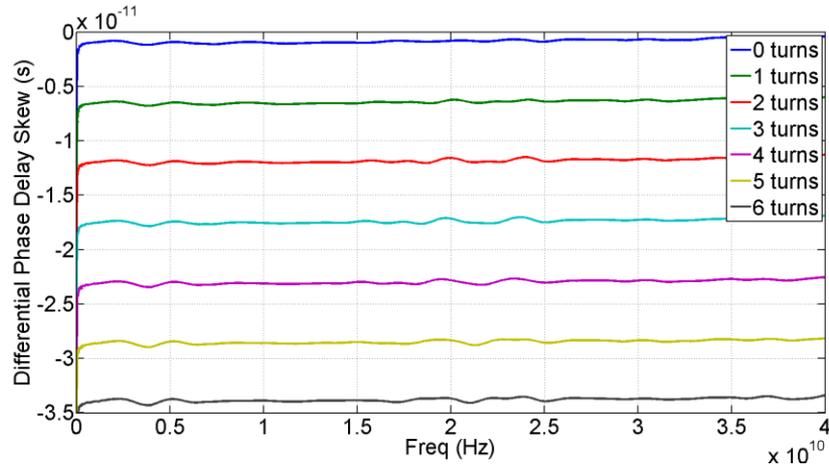
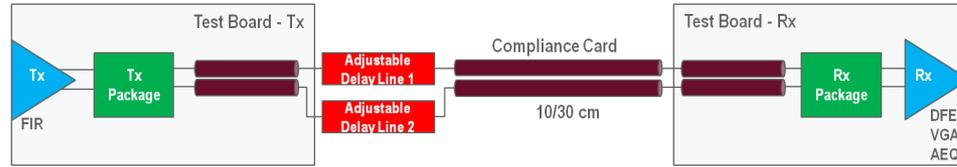


$$S_{dd12} = |IL| \cos\left(\frac{\Delta\theta}{2}\right) e^{j\theta}$$

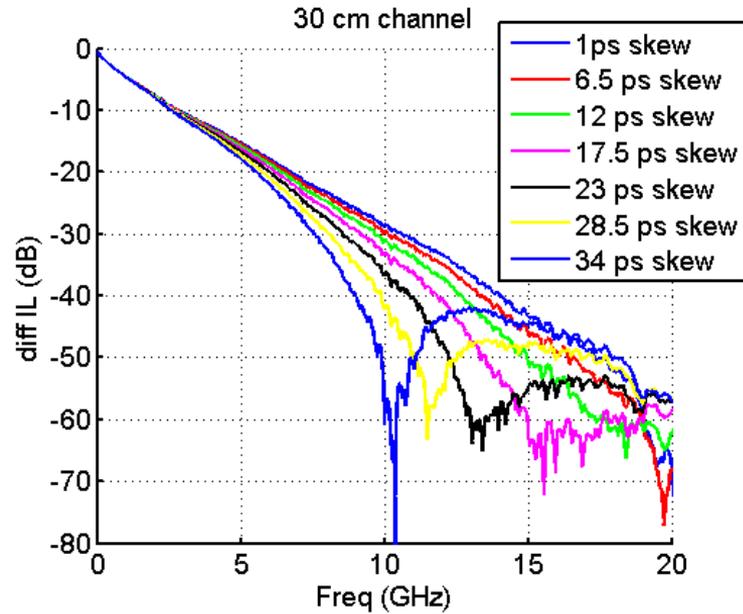
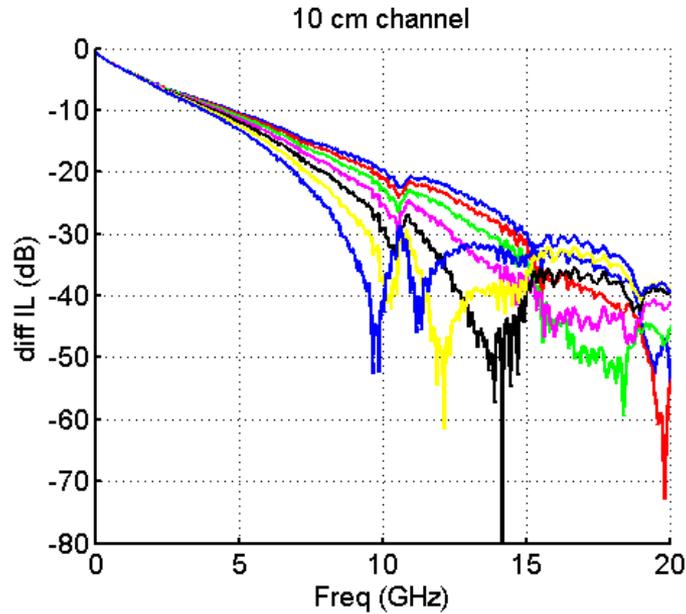
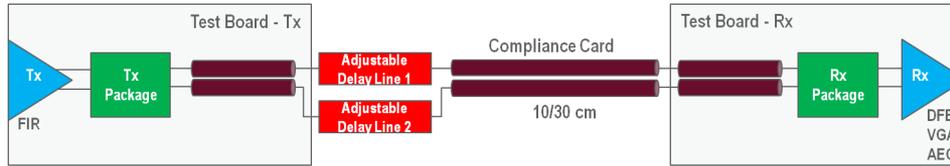
$$f = \frac{2n - 1}{2\Delta t}$$



Adjustable delay lines



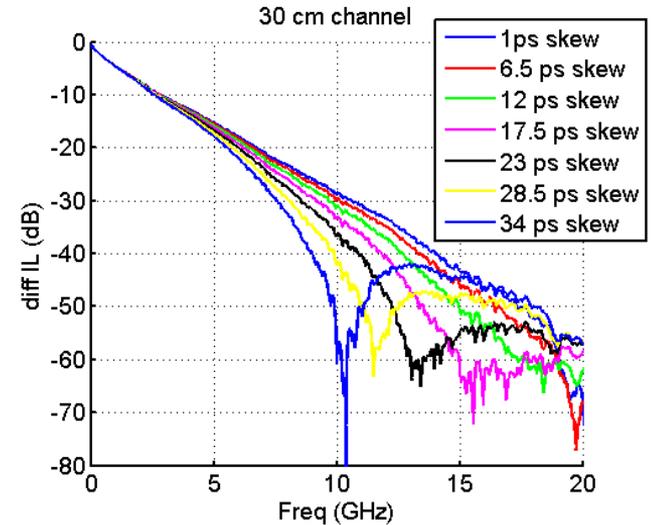
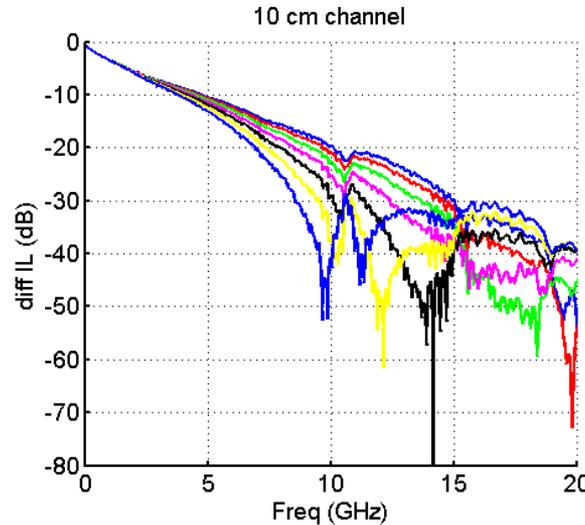
Channel measurements



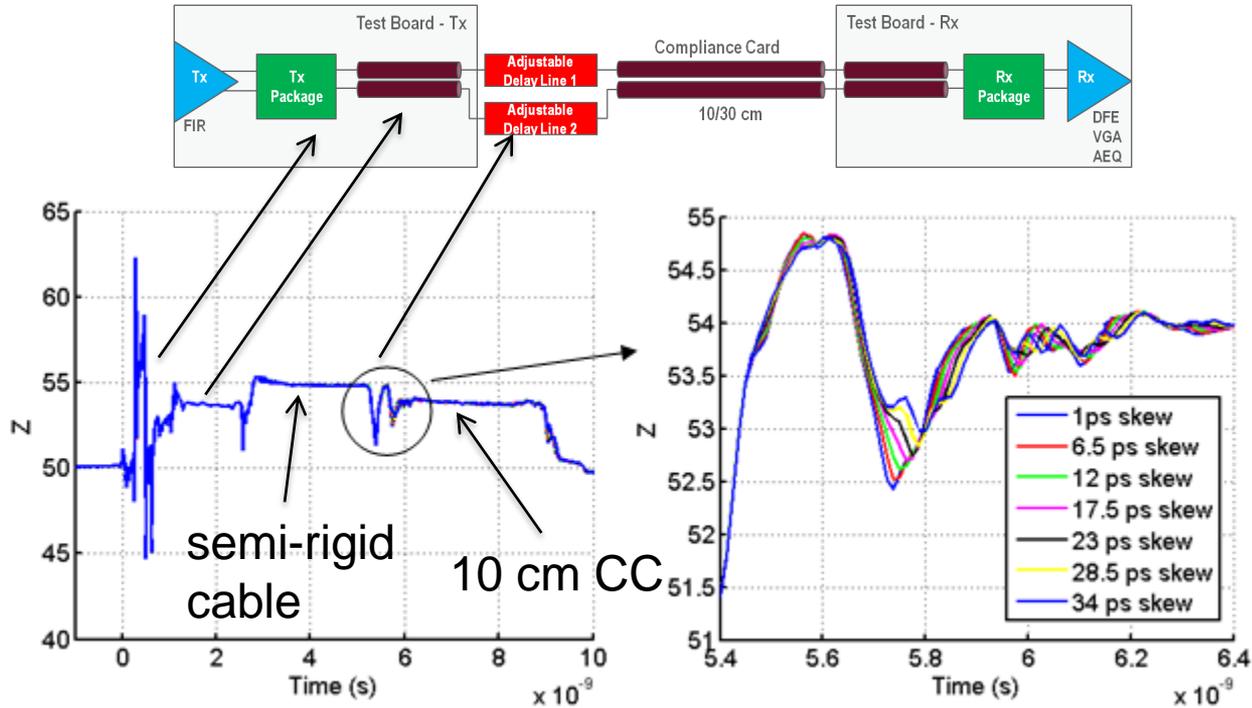
Channel measurements



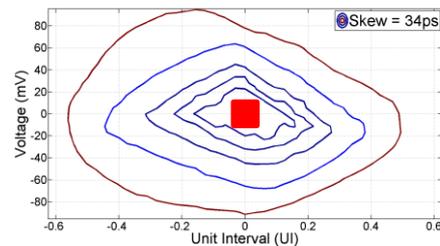
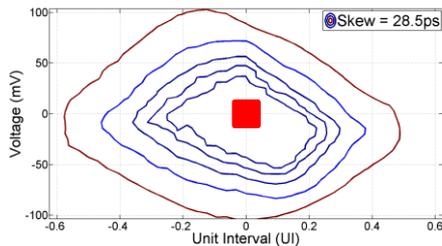
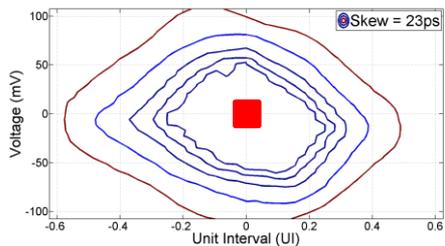
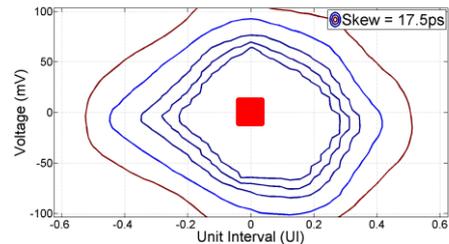
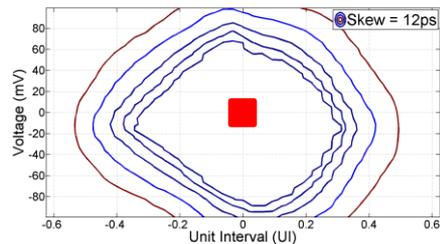
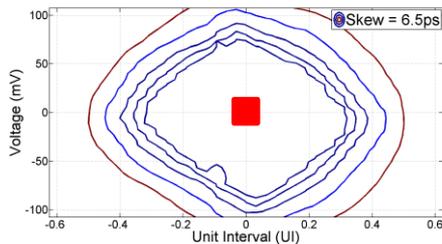
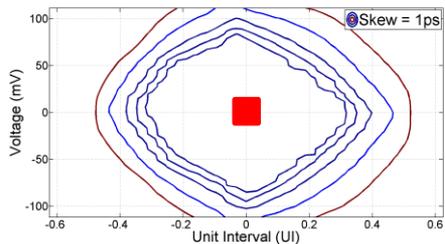
Four cases:
Each length
at 12.8 Gbps and
19.2 Gbps



Channel measurements

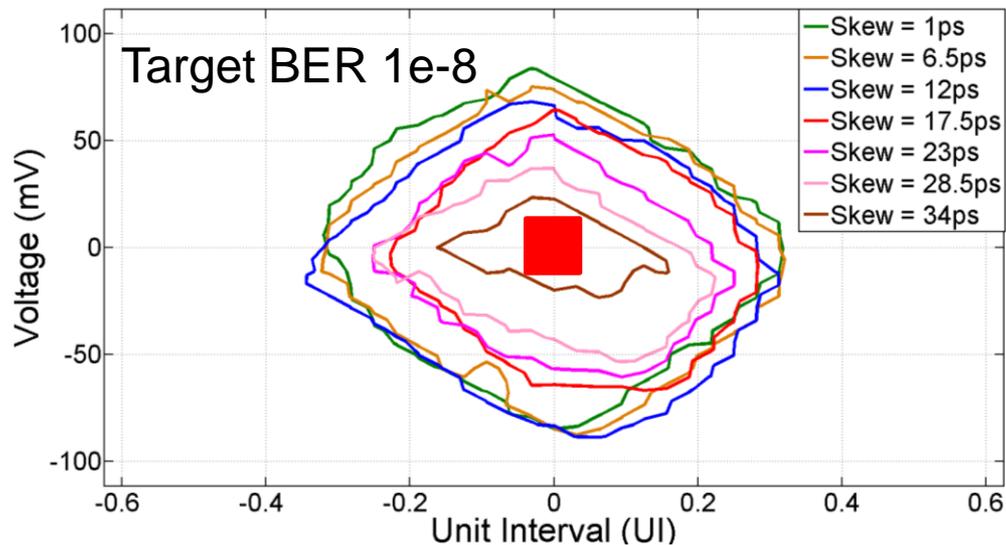
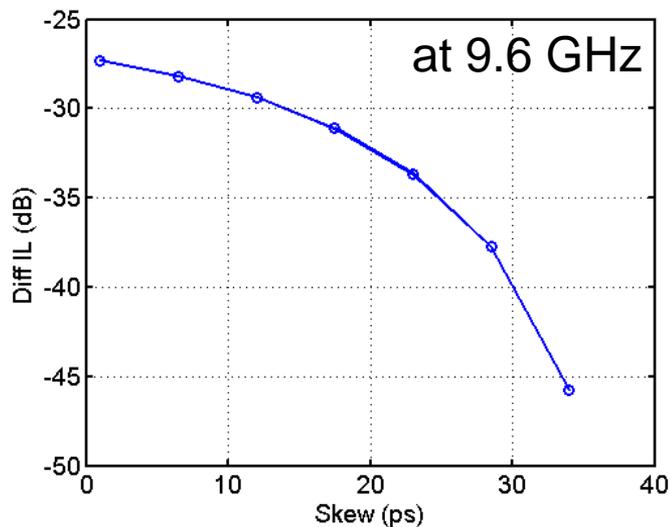


Eye measurements



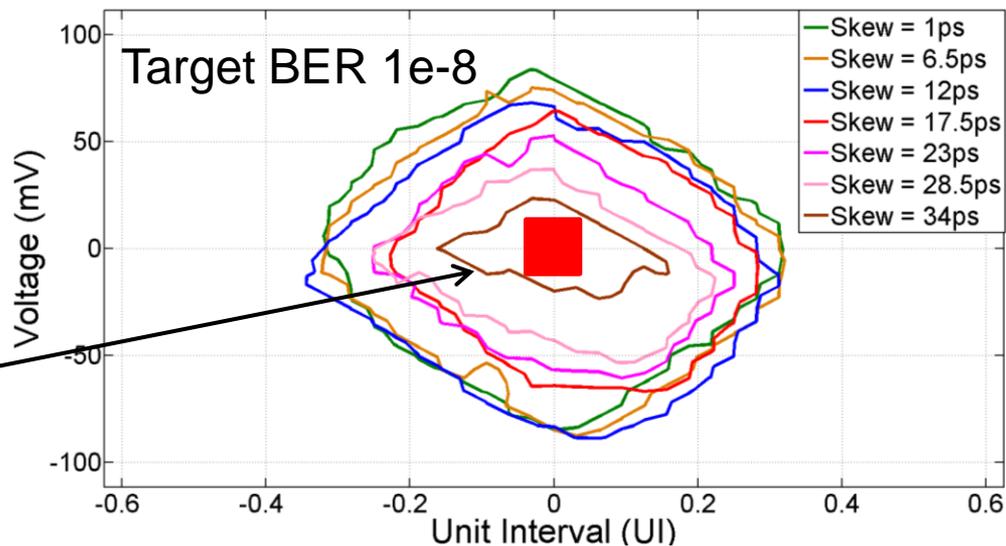
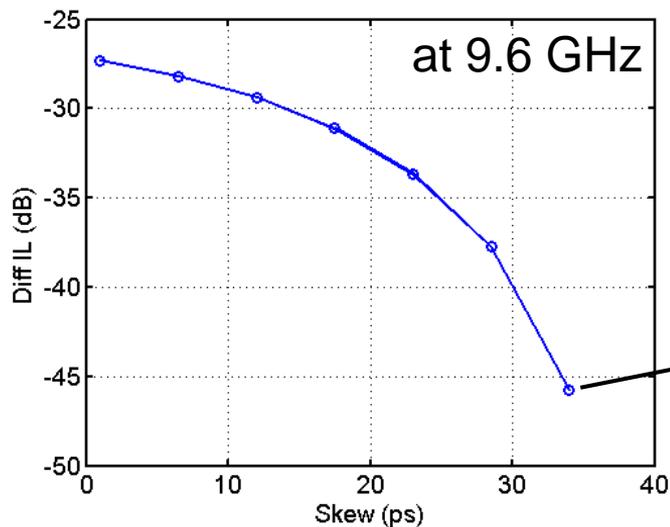
19.2 Gbps, 30 cm channel

Eye measurements



19.2 Gbps, 30 cm channel

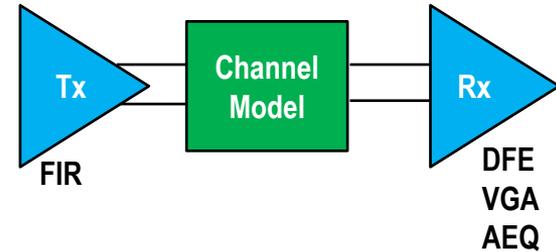
Eye measurements



19.2 Gbps, 30 cm channel

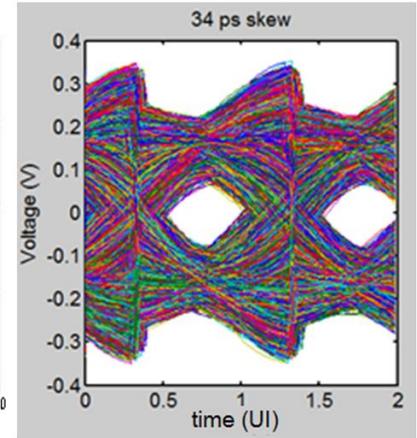
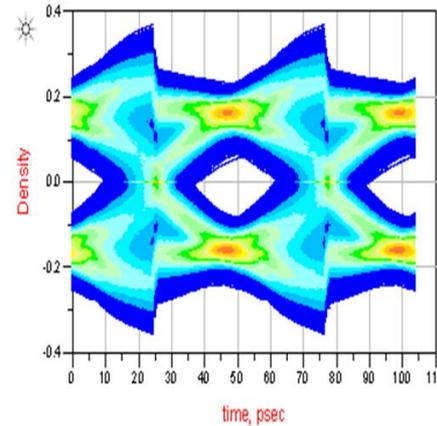
Simulations

- IBIS-AMI model of driver and receiver
- Measurement channel models
- Custom-built Matlab-based simulator

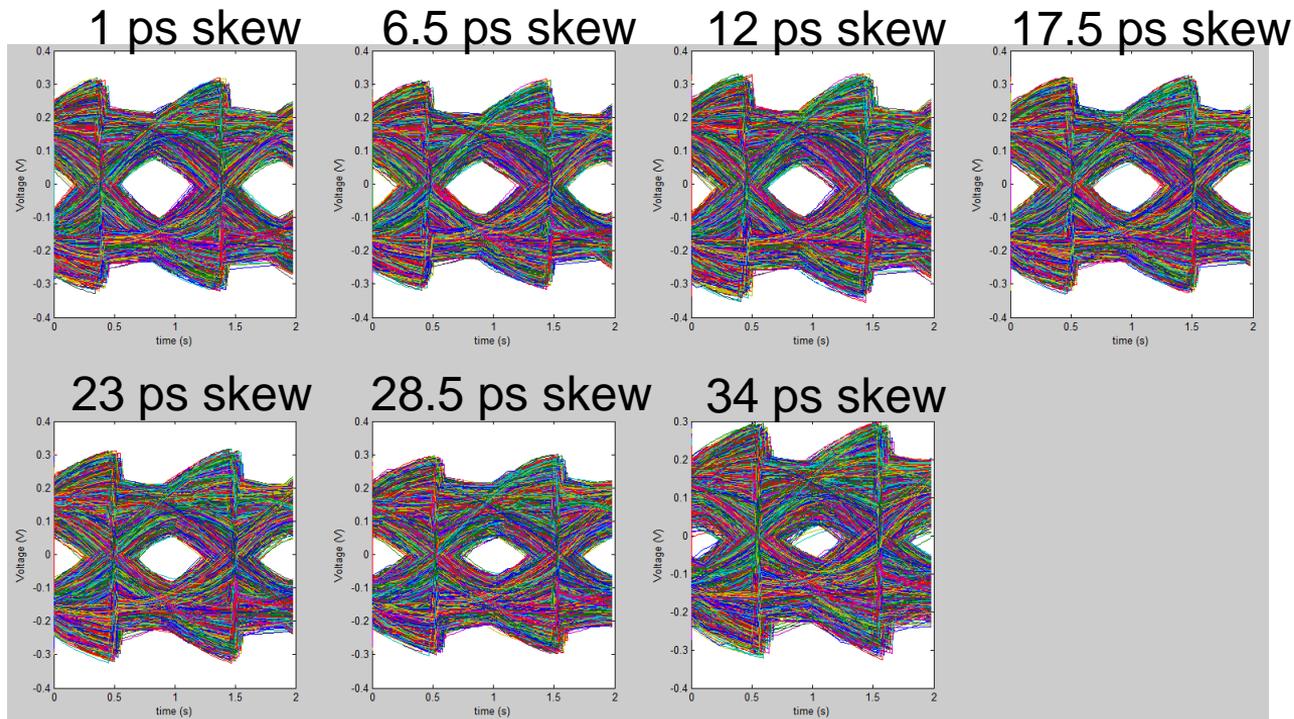


Simulations

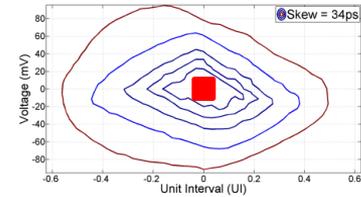
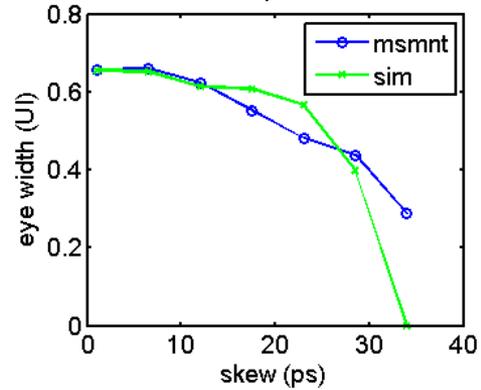
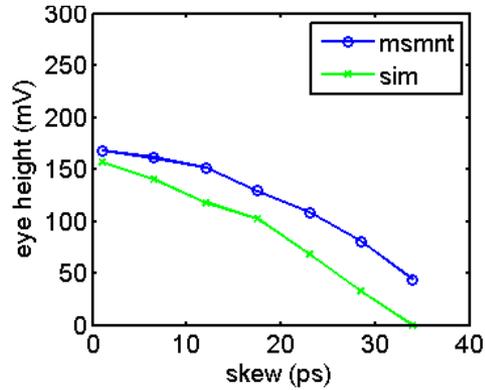
- IBIS-AMI model of driver and receiver
- Measurement channel models
- Custom-built Matlab-based simulator



Simulated eyes 19.2 Gbps, 30 cm channel

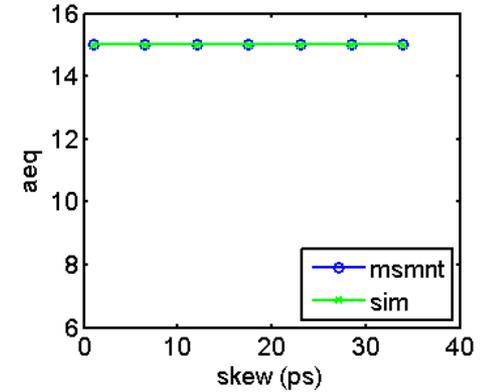
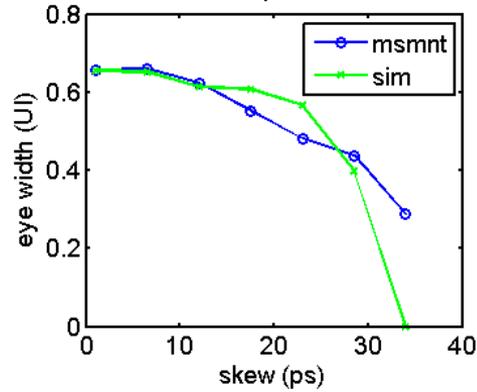
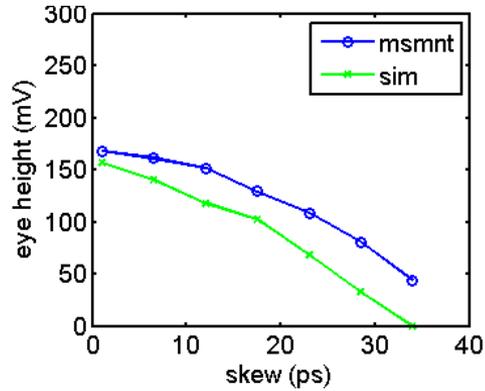


Measurement vs simulation trends



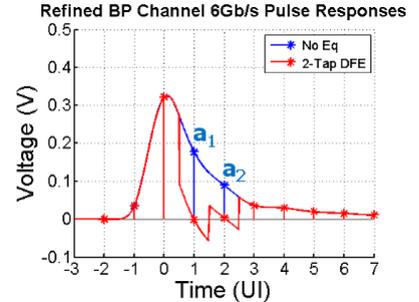
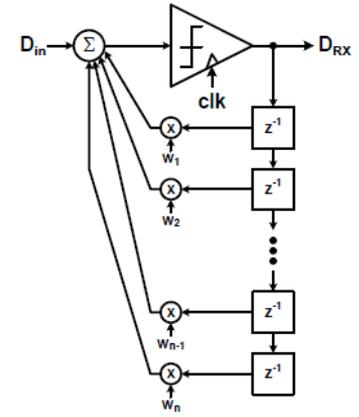
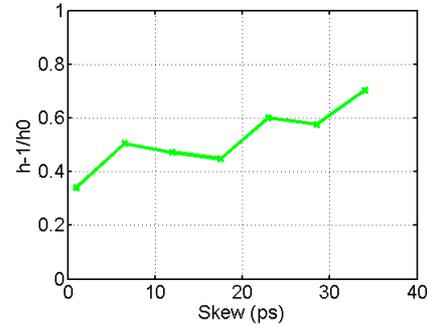
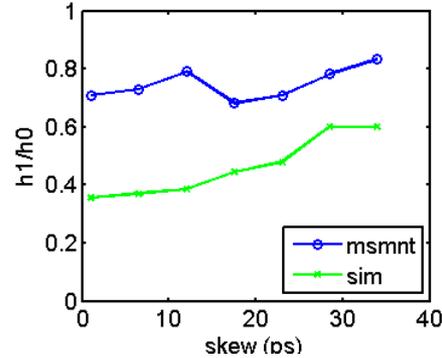
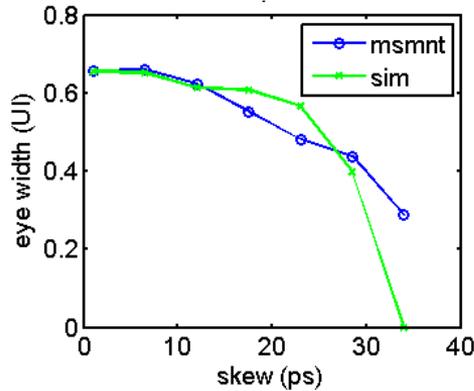
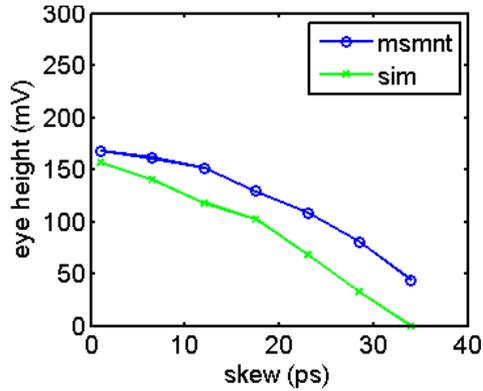
19.2 Gbps, 30 cm channel

AEQ saturating



19.2 Gbps, 30 cm channel

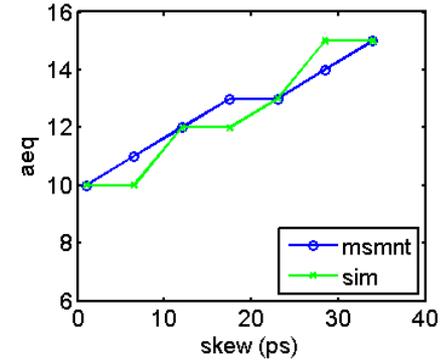
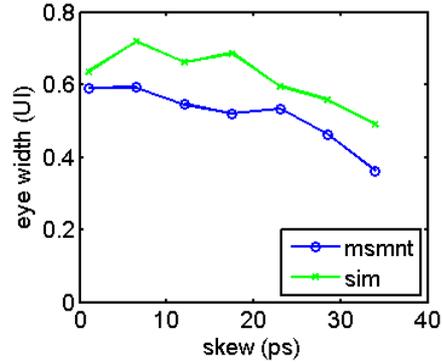
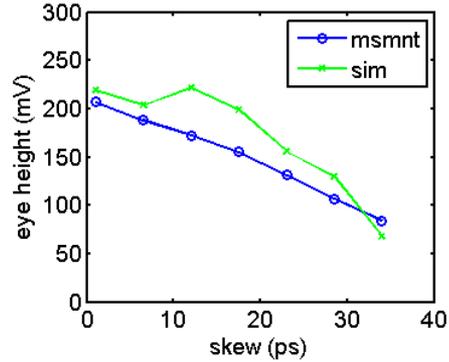
DFE operation



19.2 Gbps, 30 cm channel

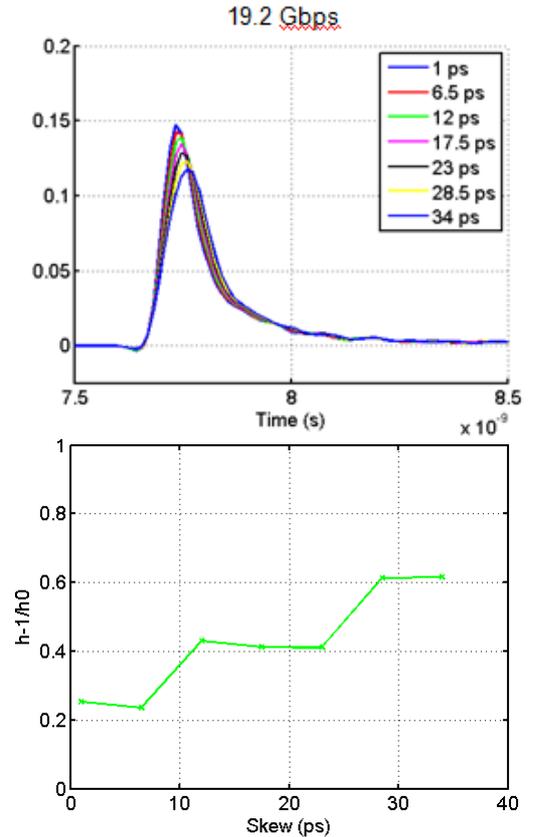
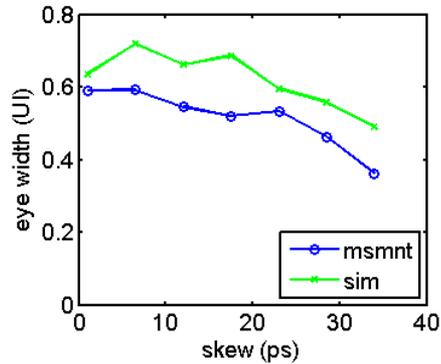
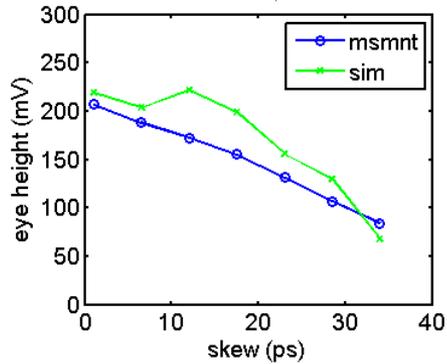
Palermo, Sam, 2014
Course Notes, ECEN720

AEQ not saturating



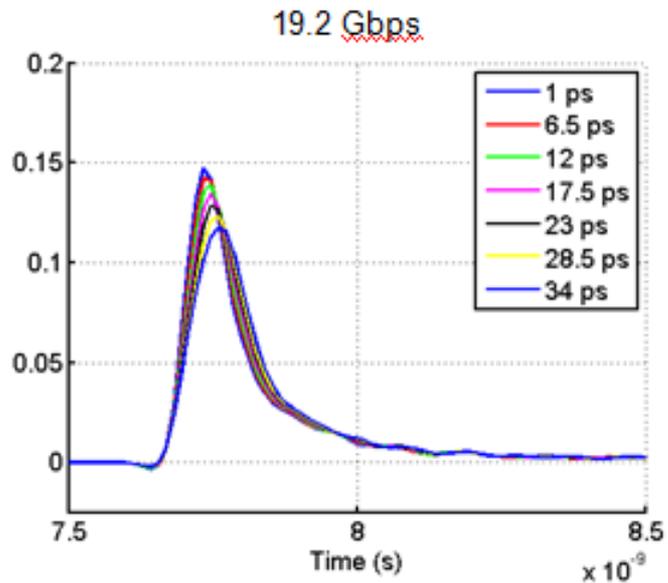
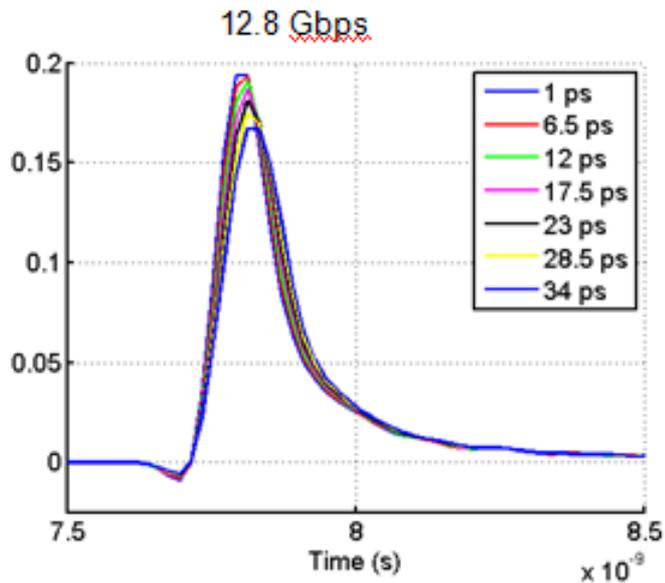
19.2 Gbps, 10 cm channel

ISI due to h_{-1}



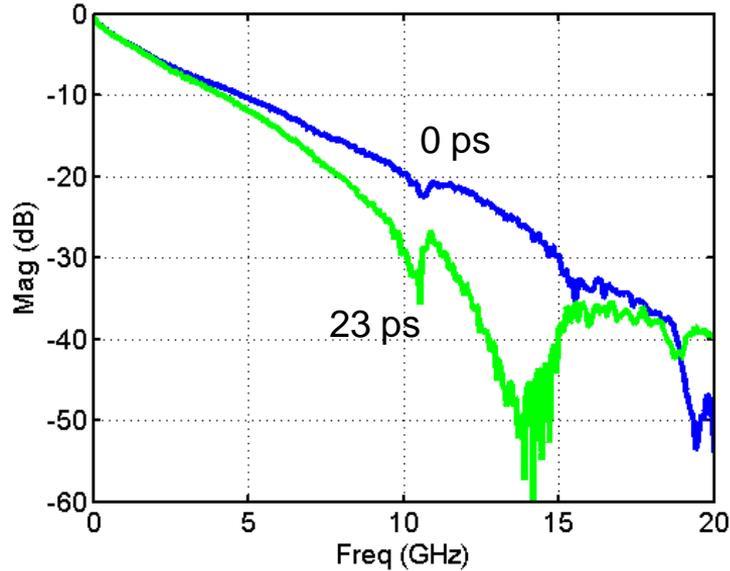
19.2 Gbps, 10 cm channel

Simulated pulse responses

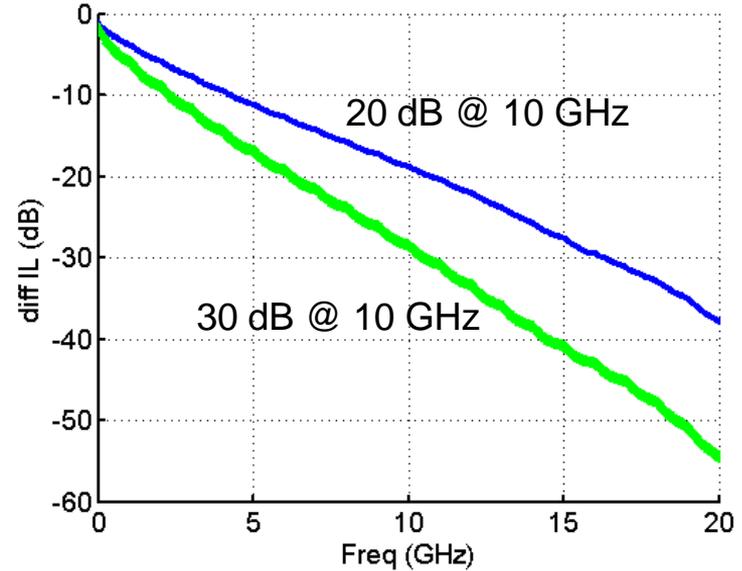


Skew vs insertion loss

With skew

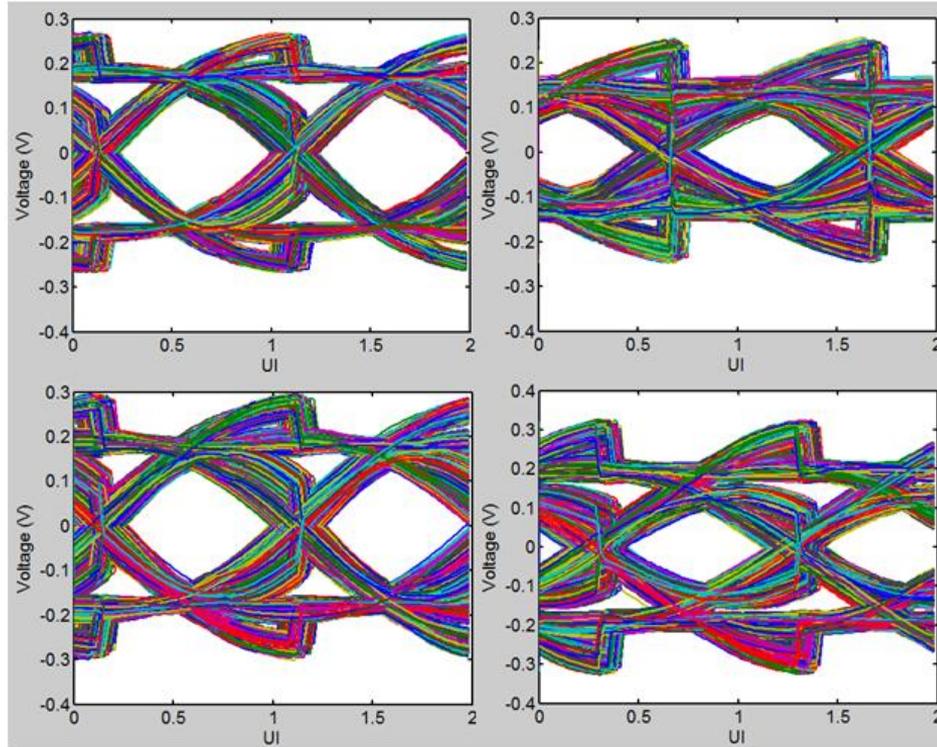


No skew but increased IL



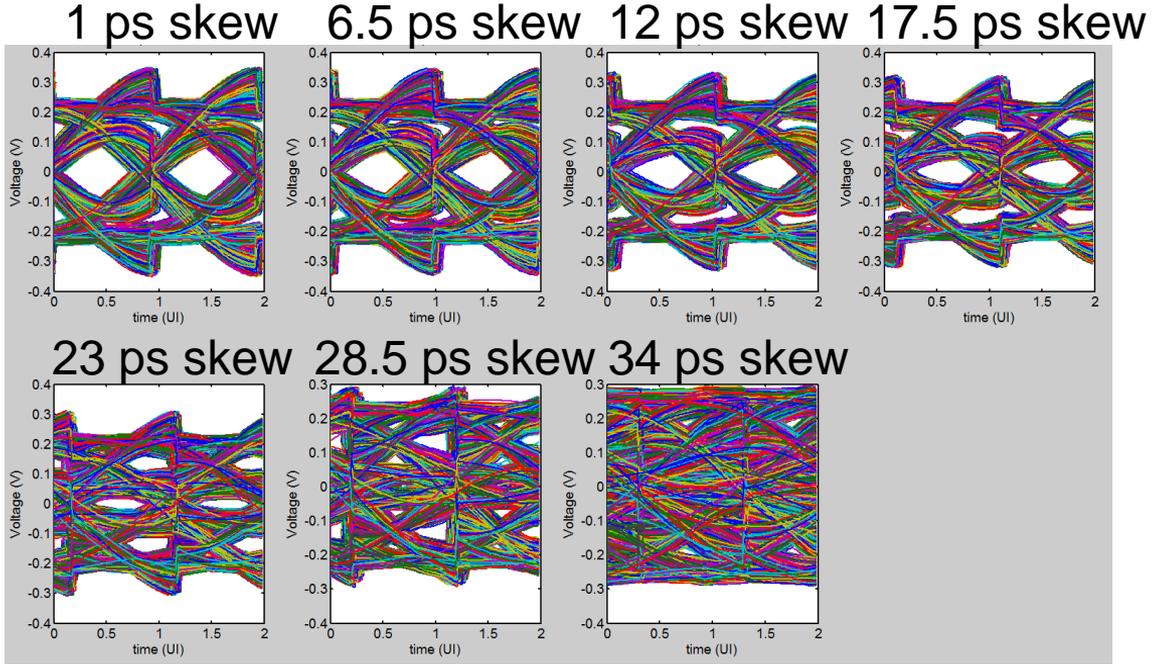
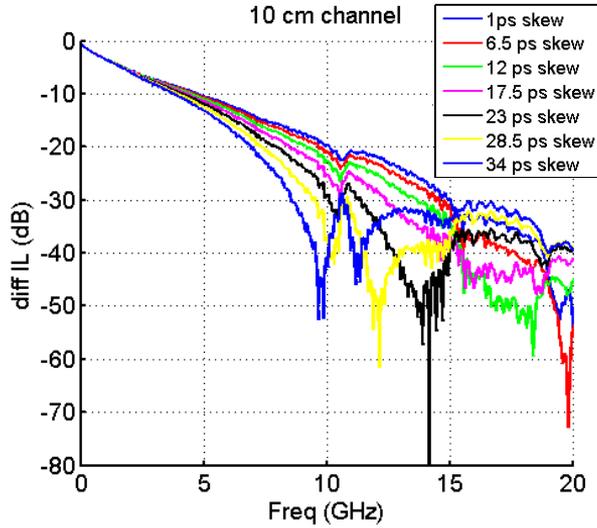
Skew translates to insertion loss

20 to 30 dB
diff IL

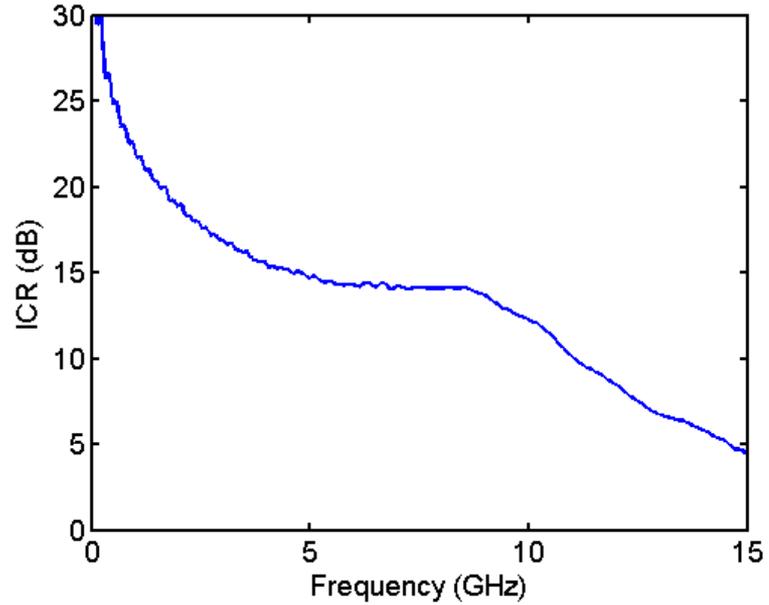
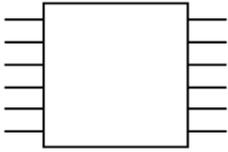


1 to 23 ps
skew

Higher data rate: 25 Gbps

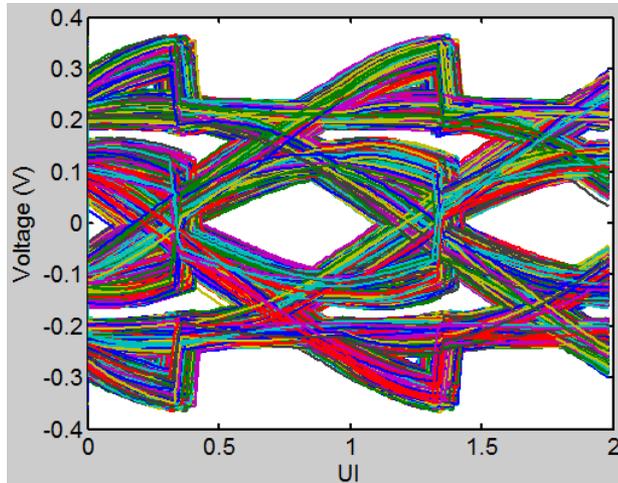


Crosstalk and skew

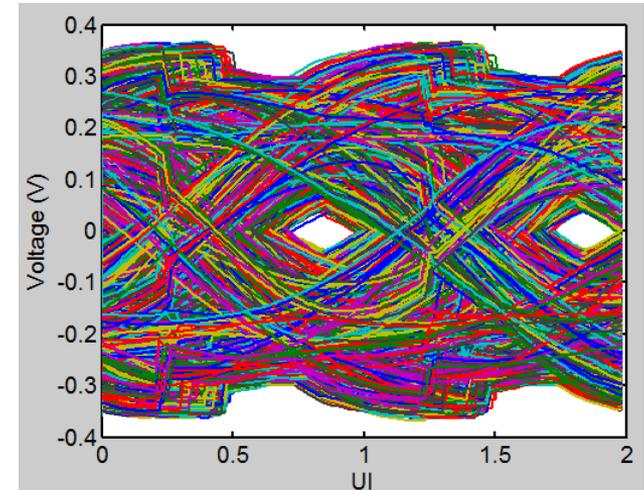


Crosstalk and skew

Without XT

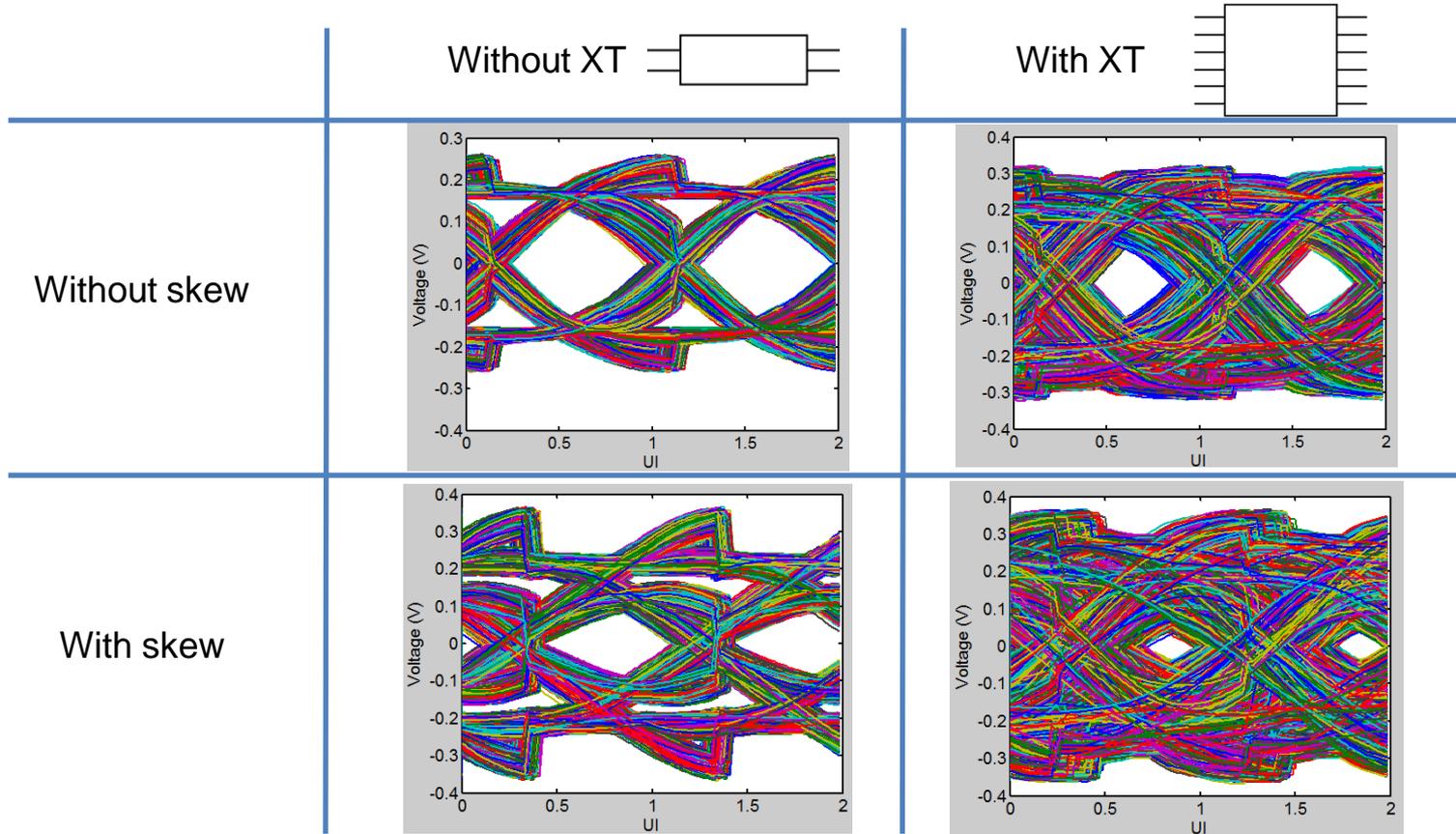


With XT

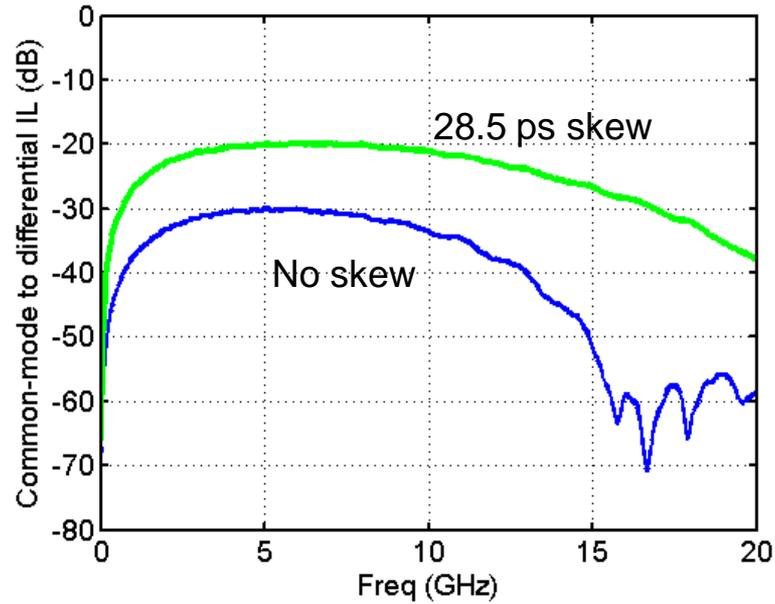


At 19.2 Gbps, 10 cm channel, 28.5 ps skew, added XT results in **58 %** decreased margins!

Crosstalk and skew



Crosstalk and skew



Conclusions

- Significant amounts of skew can be tolerated by SerDes equalization techniques
- As a first order, skew can be treated as insertion loss
- The effects of skew are worse with XT

Acknowledgements

- Seyla Leng
- Jae Young Choi
- Eben Kunz
- Laura Kocubinski

