

Developing a Channel Model to Include Variance

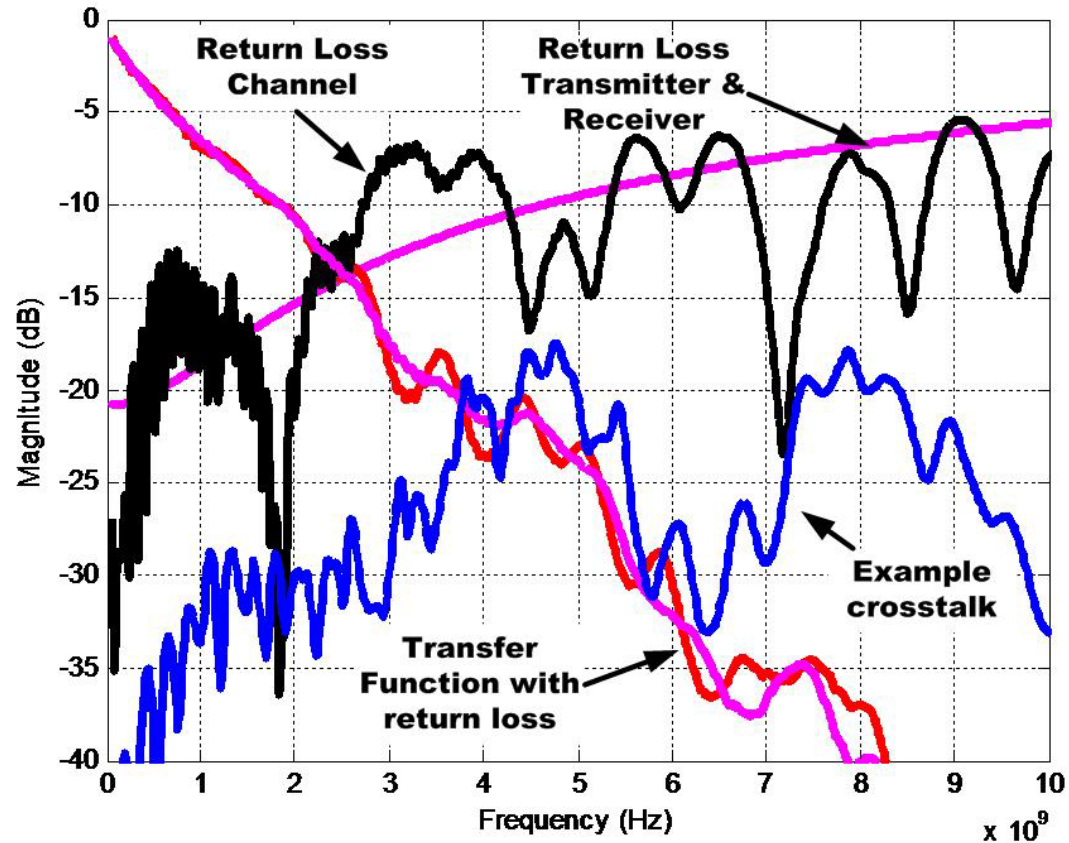
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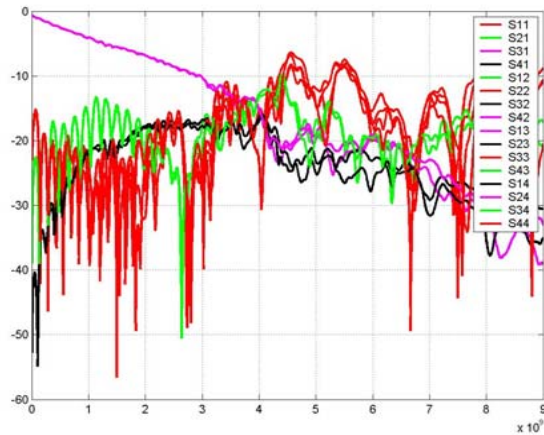
What is the Problem?



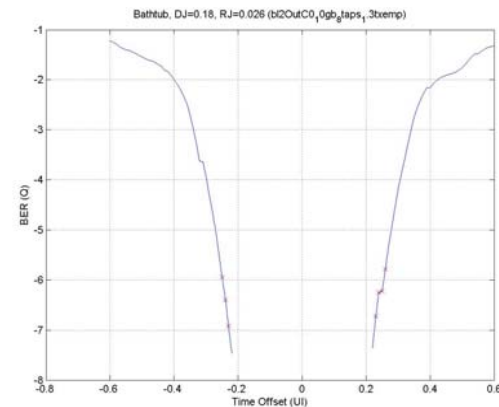
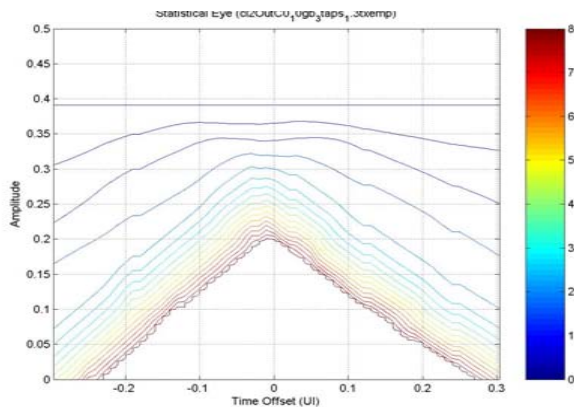
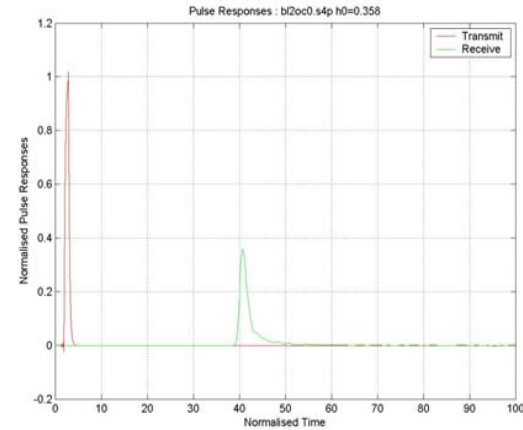
From DesignCon 2004 – “Channel Compliance Testing Utilizing Novel Statistical Eye Methodology,” Anthony Sanders, Infineon Technologies, Mike Resso Agilent Technologies, John D’Ambrosia, Tyco Electronics

Statistical Eye Methodology

Frequency Data



Pulse Response

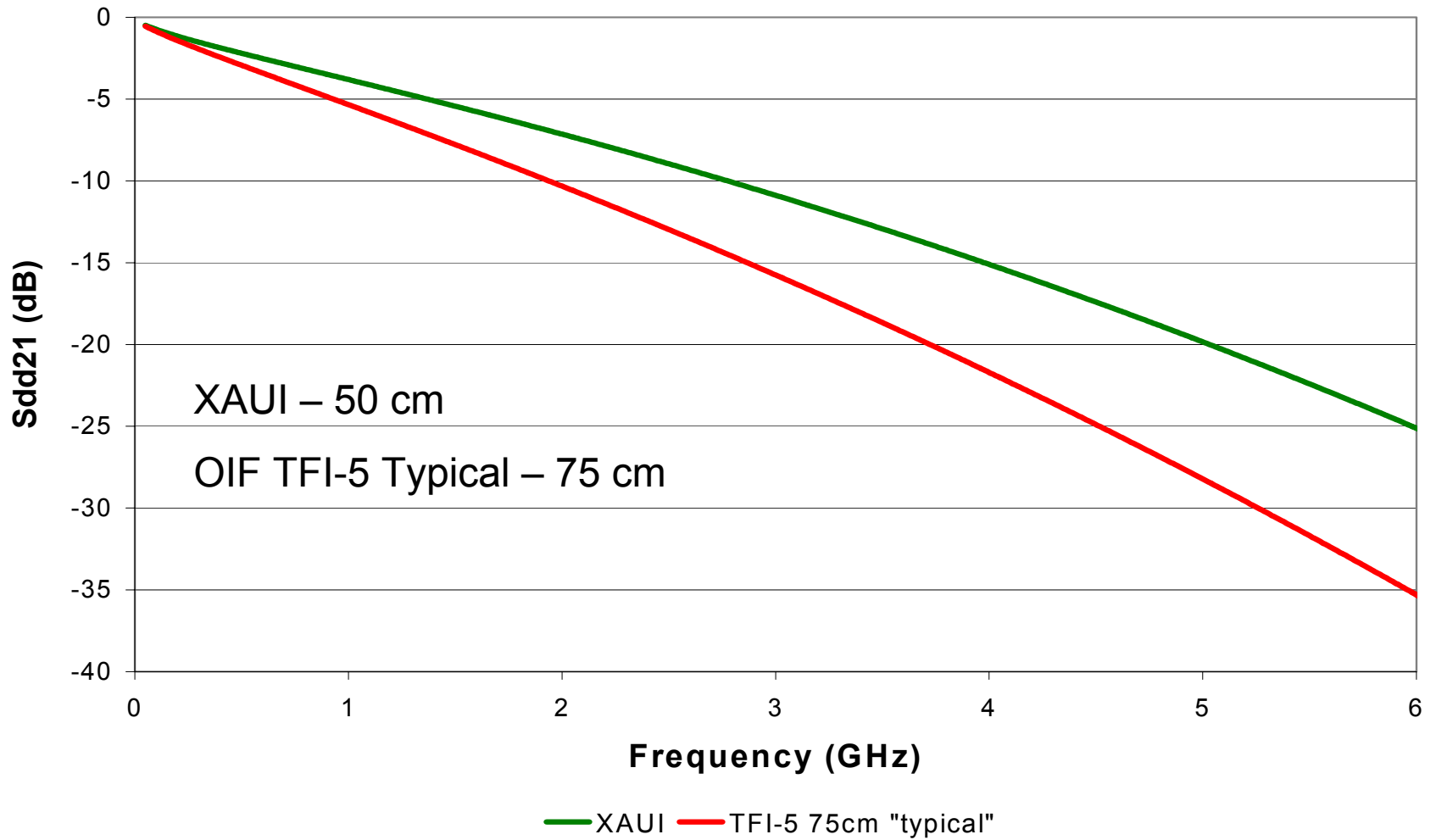


Statistical Eye

BER Bathtub Curve

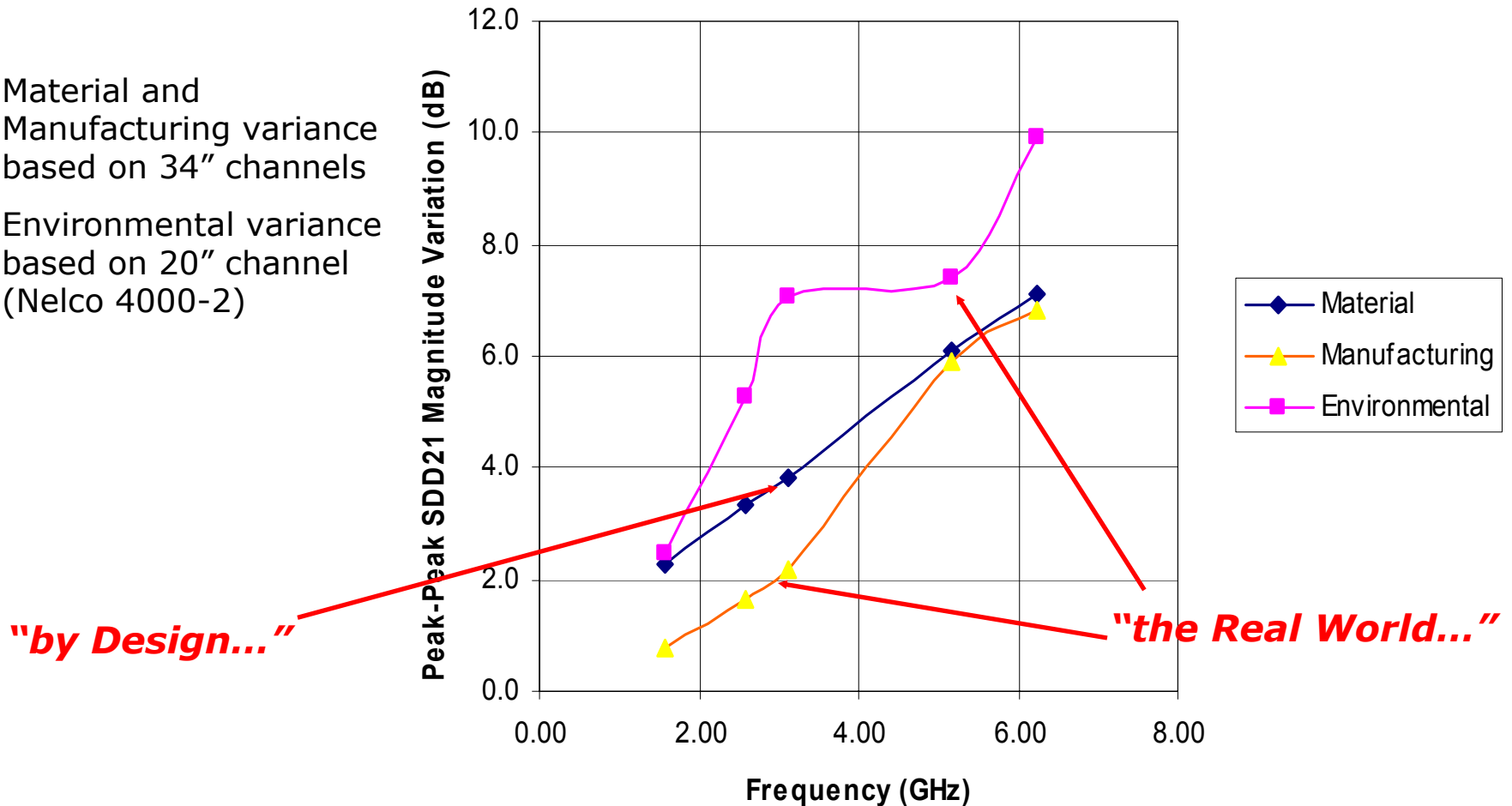
Note – Technique Developed by Anthony Sanders, Infineon Technologies

Industry Baseline Channel Models



Variation Summary

- Material and Manufacturing variance based on 34" channels
- Environmental variance based on 20" channel (Nelco 4000-2)

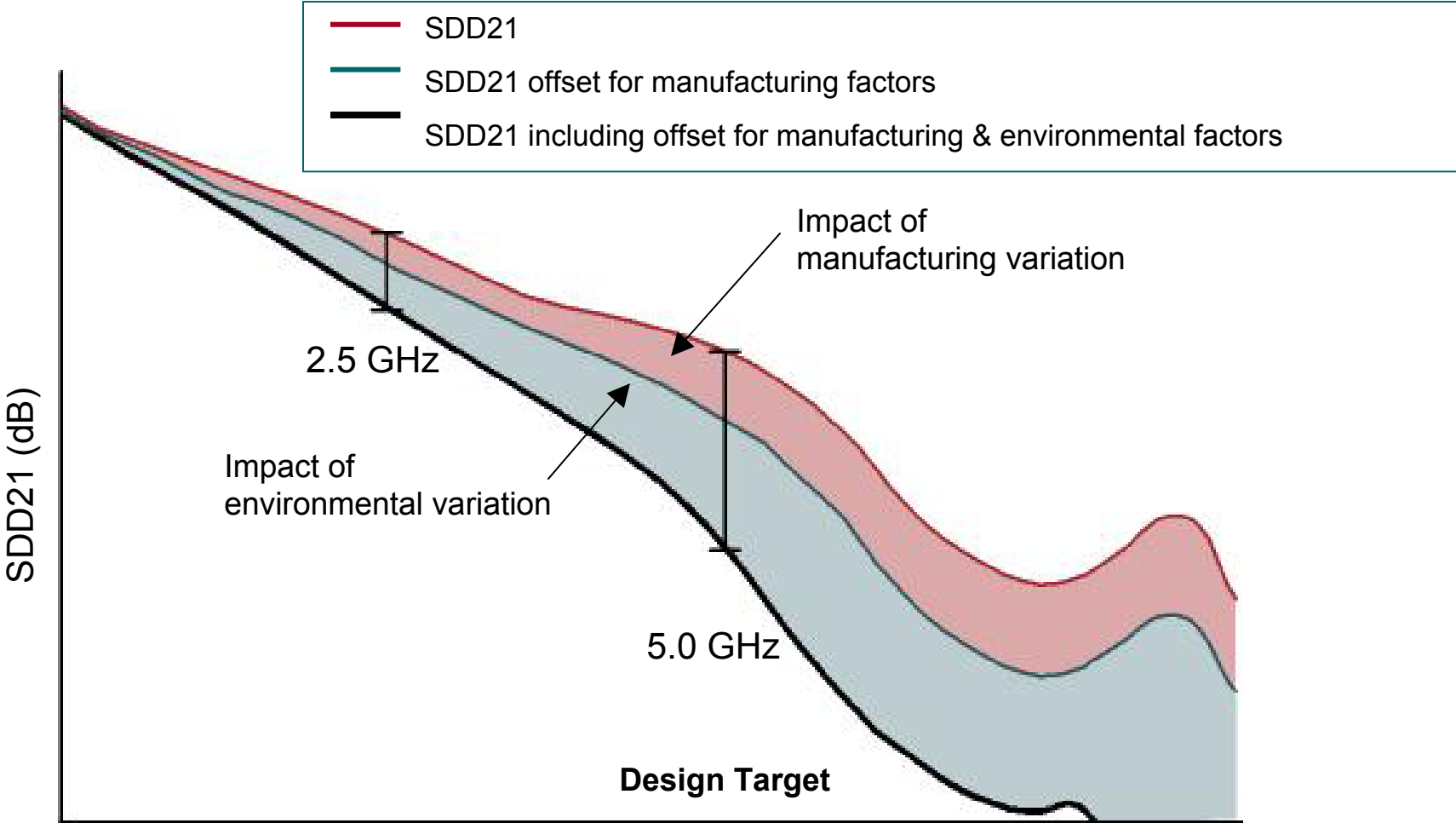


Additional PWB Material Data

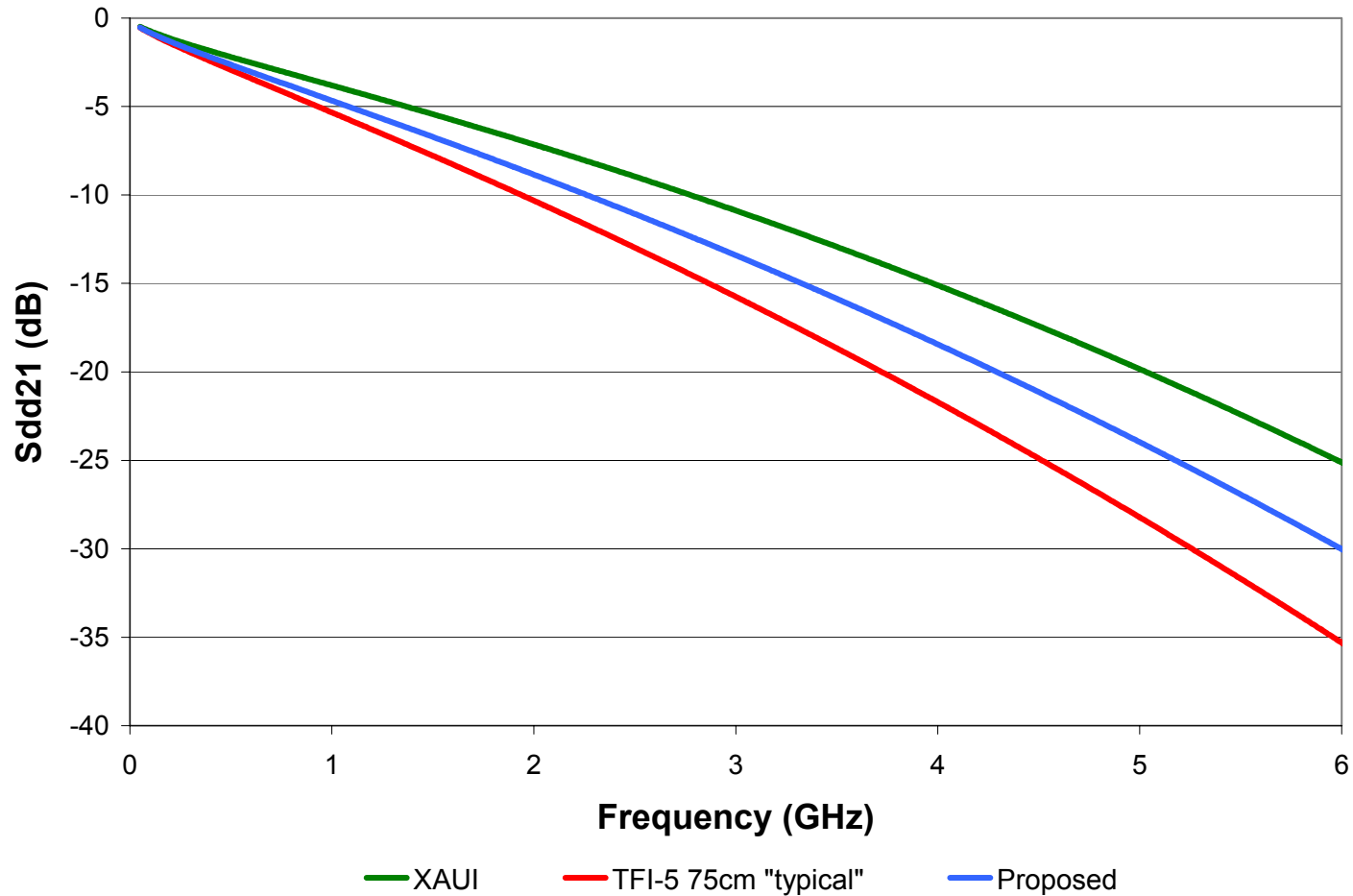
- Materials used from Park Nelco and other PWB material vendors
- All of the laminates tested had about 40% resin content
- All df measurements are at 10 GHz
- Split Post Cavity test method to show the impact of moisture on a number of different materials
- Test data obtained from -
 1. As received – Samples were etched to remove the copper and allowed to equilibrate to room temperature.
 2. After baking – Samples were baked for 24 hours at 125°C to remove moisture that they may have been absorbed during etching and/or the equilibration process.
 3. After Pressure Cooker Testing (PCT) – Samples are tested after being subjected to a 60 minute dwell in an 1 ATM pressure cooker.

df @ 10 GHz	Full Range	Range of Variation	Park Nelco		
			As Received	After Baking	After PCT
High Tg Fr-4	0.0110 - 0.0180	0.007	0.0120	0.0110	0.0180
High Speed/Low Loss	0.0071 - 0.0110	0.0019 - 0.0025	0.0072	0.0071	0.0090
Mid Tg Halogen Free	0.0110 - 0.0280	0.007 - 0.017	0.0130	0.0130	0.0200
PTFE	0.0006 - 0.0120	0.0002 - 0.011	0.0006	0.0006	0.0008

Implementation Channel

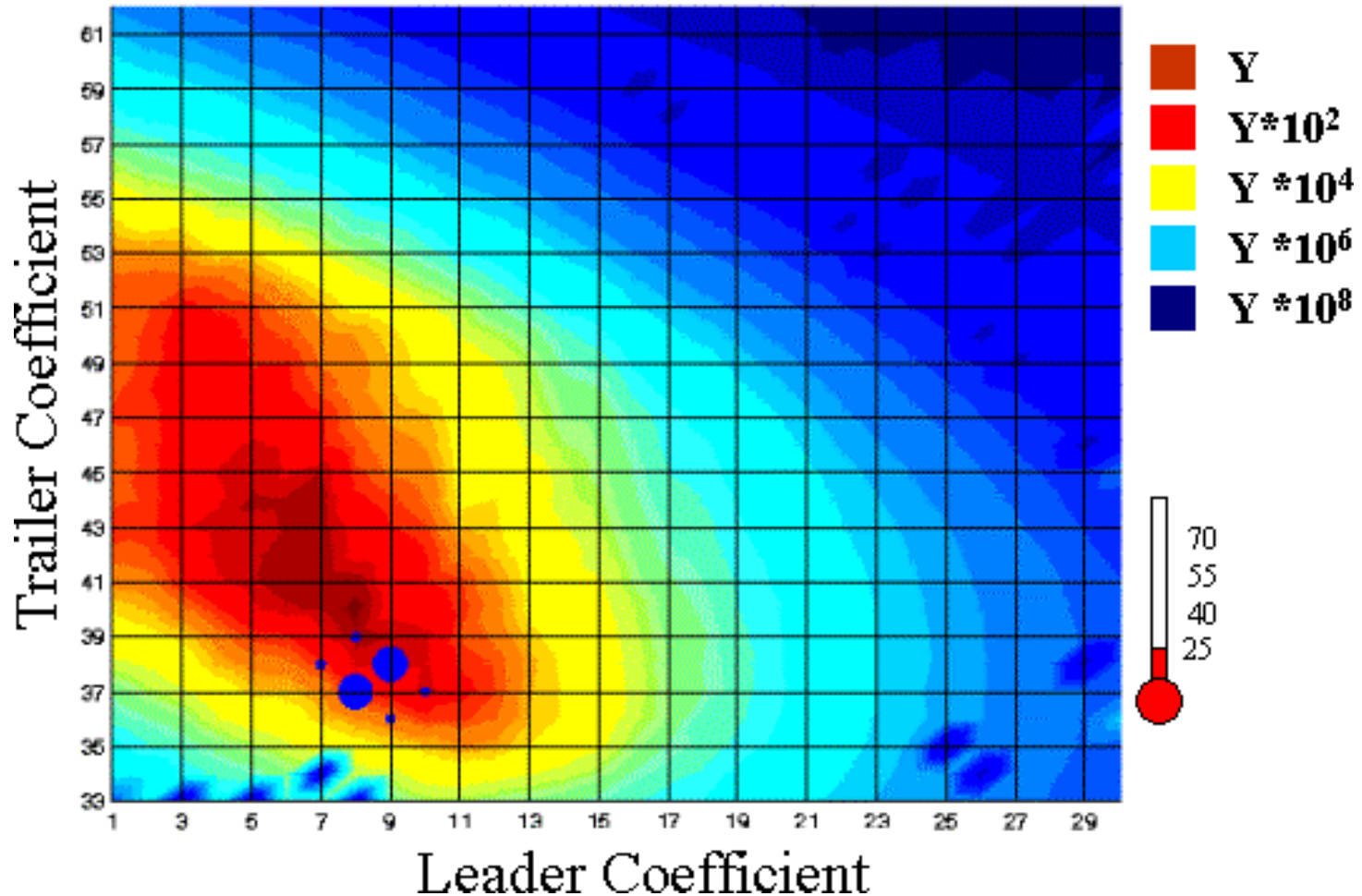


Proposed Informative Model



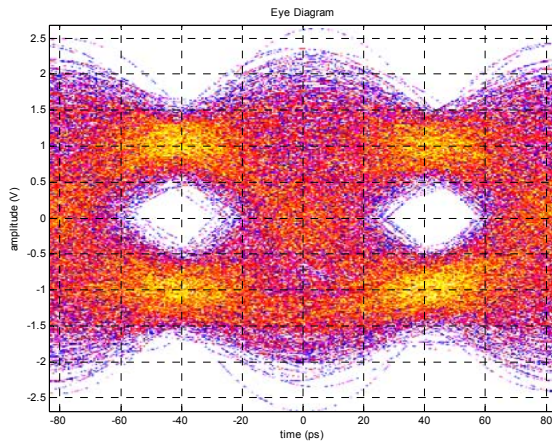
Impact of Temperature— The Power of Continuous Adaptation

Surface Plot of BER Vs. Coefficient Space

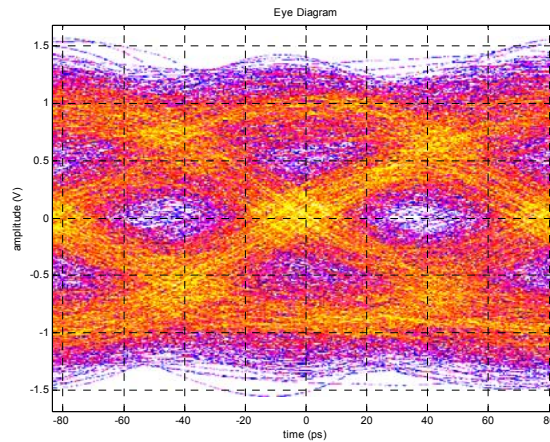


Data Courtesy of Accelerant Networks

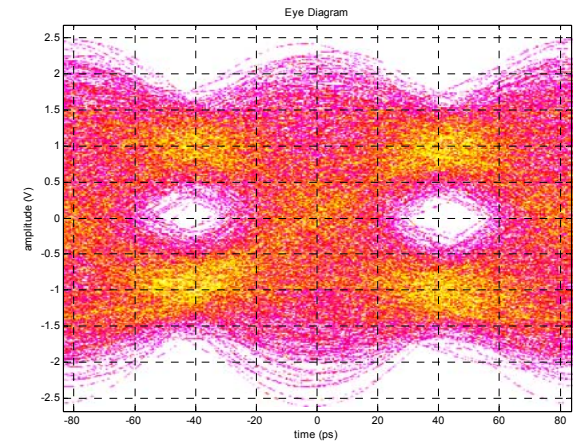
12 Gbits/s Binary Operation @ 20"



T=40 °C & 20% RH



T=85 °C & 85% RH
Non-reoptimized

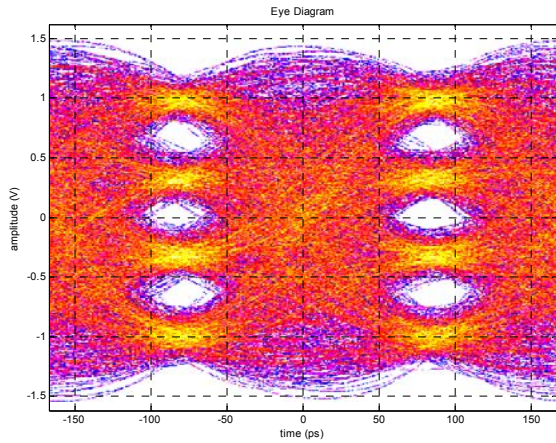


T=85 °C & 85% RH
Reoptimized

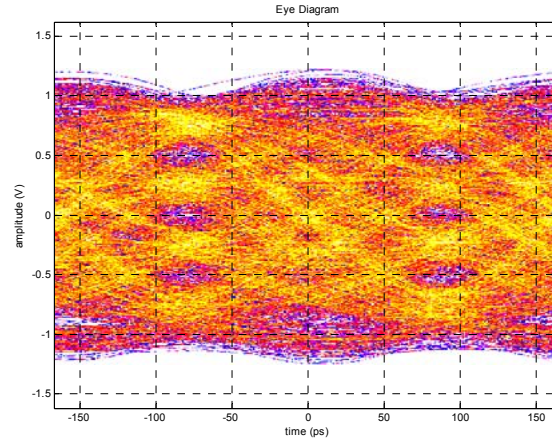
Uses measured channel performance at environmental conditions cited

Mathematical Model - 11 tap FIR transmitter and an 8 tap DFE
Doesn't go into implementation issues in device

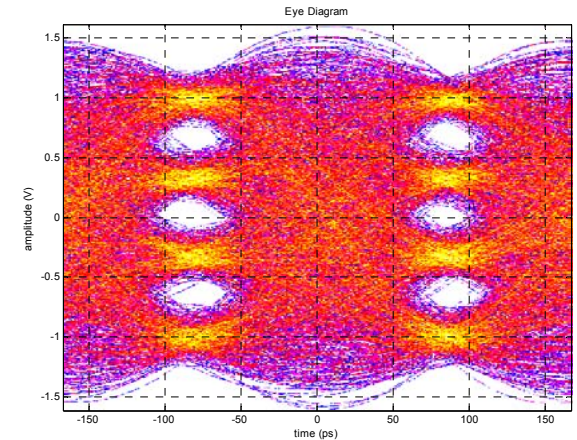
12 Gbits/s PAM-4 Operation @ 20"



40 °C & 20% RH



85 °C & 85% RH
Non-reoptimized



85 °C & 85% RH
Reoptimized

Uses measured channel performance at environmental conditions cited

Conclusions

- Use StatEye concept for channel compliance
 - Amplitude and phase
 - Includes xtalk
 - Includes return loss (device & channel)
- Develop new informative channel model between XAUI and TFI-5 typical

$$|S_{21}(f)| \leq -20 \log(e) [a_1 f^{0.5} + a_2 f + a_3 f^2]$$

- $a_1 = 6.5e-6$, $a_2 = 3.0e-10$, $a_3 = 3.2e-20$
- Use Implementation Channel Concept
 - Work Group to determine mfg variance
 - Work Group to determine environmental variance
- Adaptation necessary to deal with channel variance