XLAUI/CAUI Electrical Specifications

IEEE 802.3ba
Munich
May 13 2008

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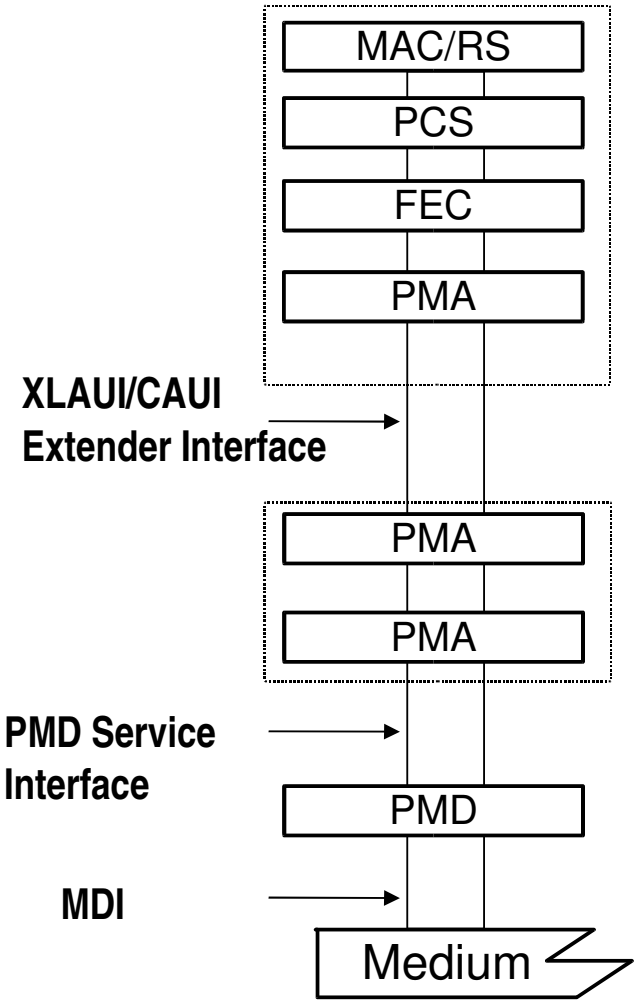
Overview

- XLAUI/CAUI interface
- Application of XLAUI/CAUI
- Learning form XFP and SFP+
- Optimized electrical interface for XLAUI/CAUI
- Channel data for Fr4-8 and Fr4-13
- Channel simulation

XLAUI/CAUI Interface

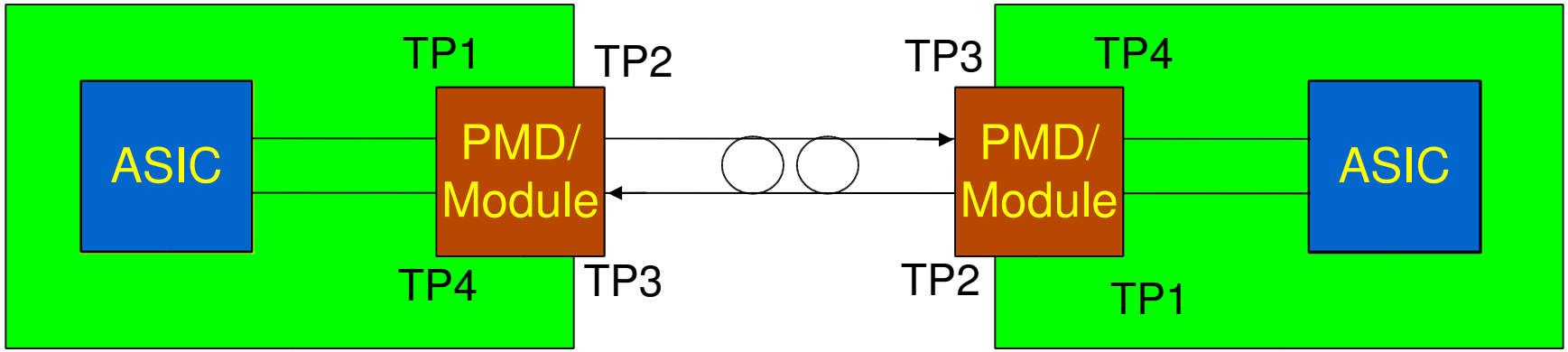
- Simple, low power chip to chip or chip to module interface.
  - Simplifies ASIC SerDes by not requiring to support TP1/TP4 requirements for all PMD's.
- Retimed interface with relax jitter budget and ASIC friendly.
- Take advantage of pre-emphasis to increase PCB loss with simple CDR receiver.
- Operate over ~8" FR4-8 stripline or ~12" FR4-13 stripline.
- XLAUI/CAUI will be the bolting point for future PMDs based on 25 GBd.



see ganga_01_0508.pdf for XLAUI and CAUI layer definition

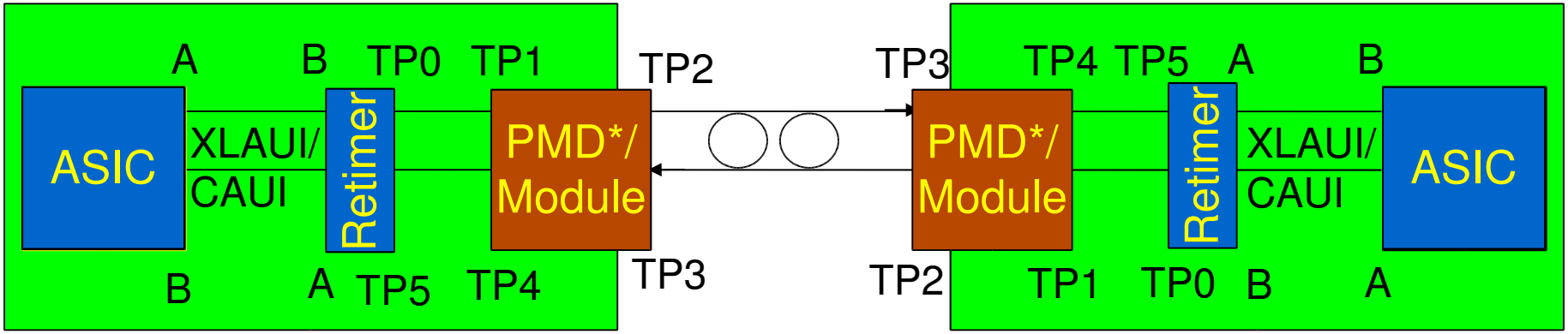
Application Not Using XLAUI/CAUI

- **ASIC capable of interfacing with the PMD are not required to use the XLAUI/CAUI retimer, see petrilla_01_0508.pdf.**
- **Likely scenario are:**
  - **A simplified ASIC supporting single PMD type**
  - **ASIC SerDes support all PMDs when the technology is mature and there is little power penalty (i.e. SFP+ now).**

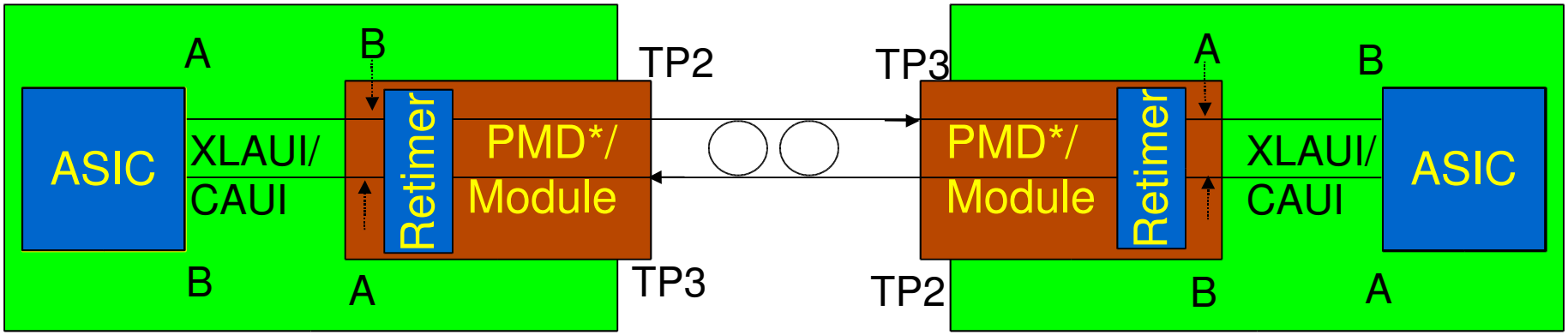


Application XLAUI/CAUI Extender for Front Ports

- **Application with Retimer on the host PCB (QSFP/CSFP)**

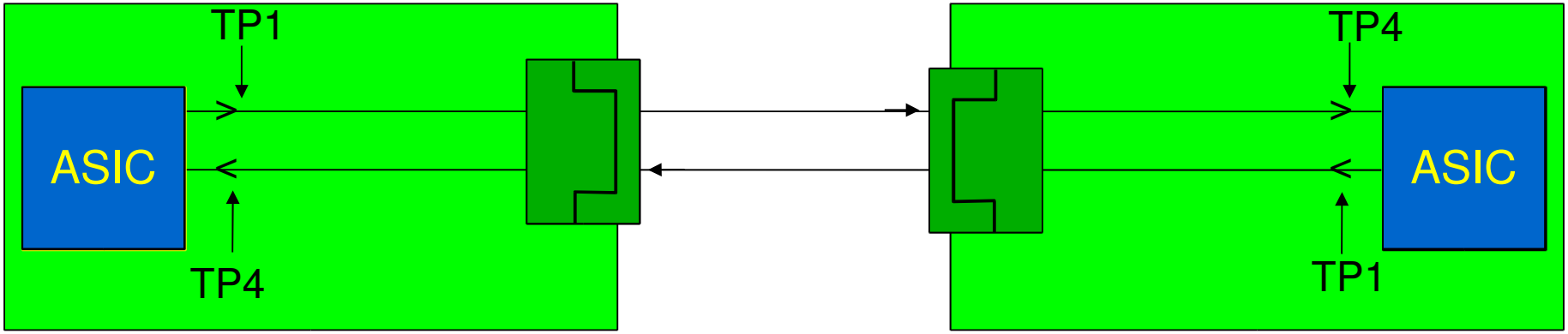


- **Application with Retimer in the module (QFP/CFP)**

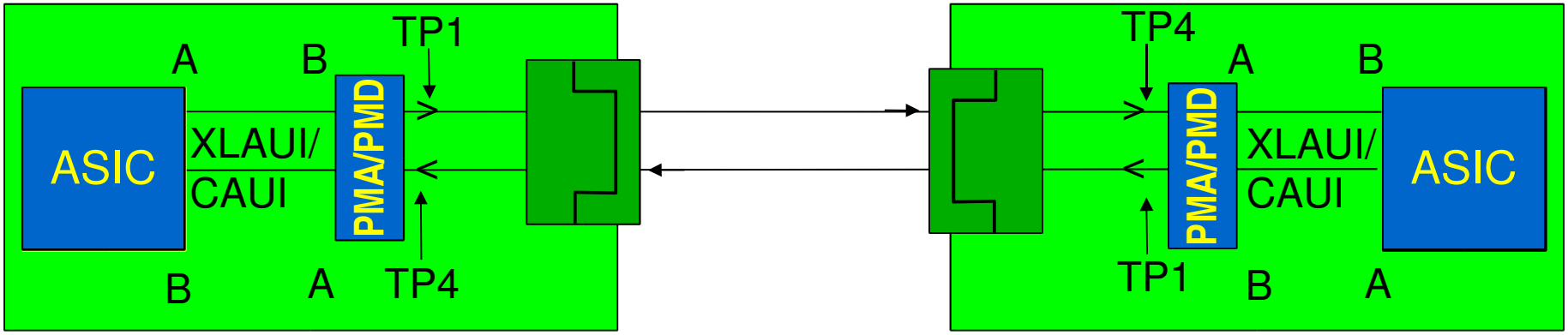


Application XLAUI/CAUI Extender for Backplane Ports

- **Backplane application without XLAUI/CAUI Retimer**



- **Backplane application with XLAUI/CAUI Retimer**

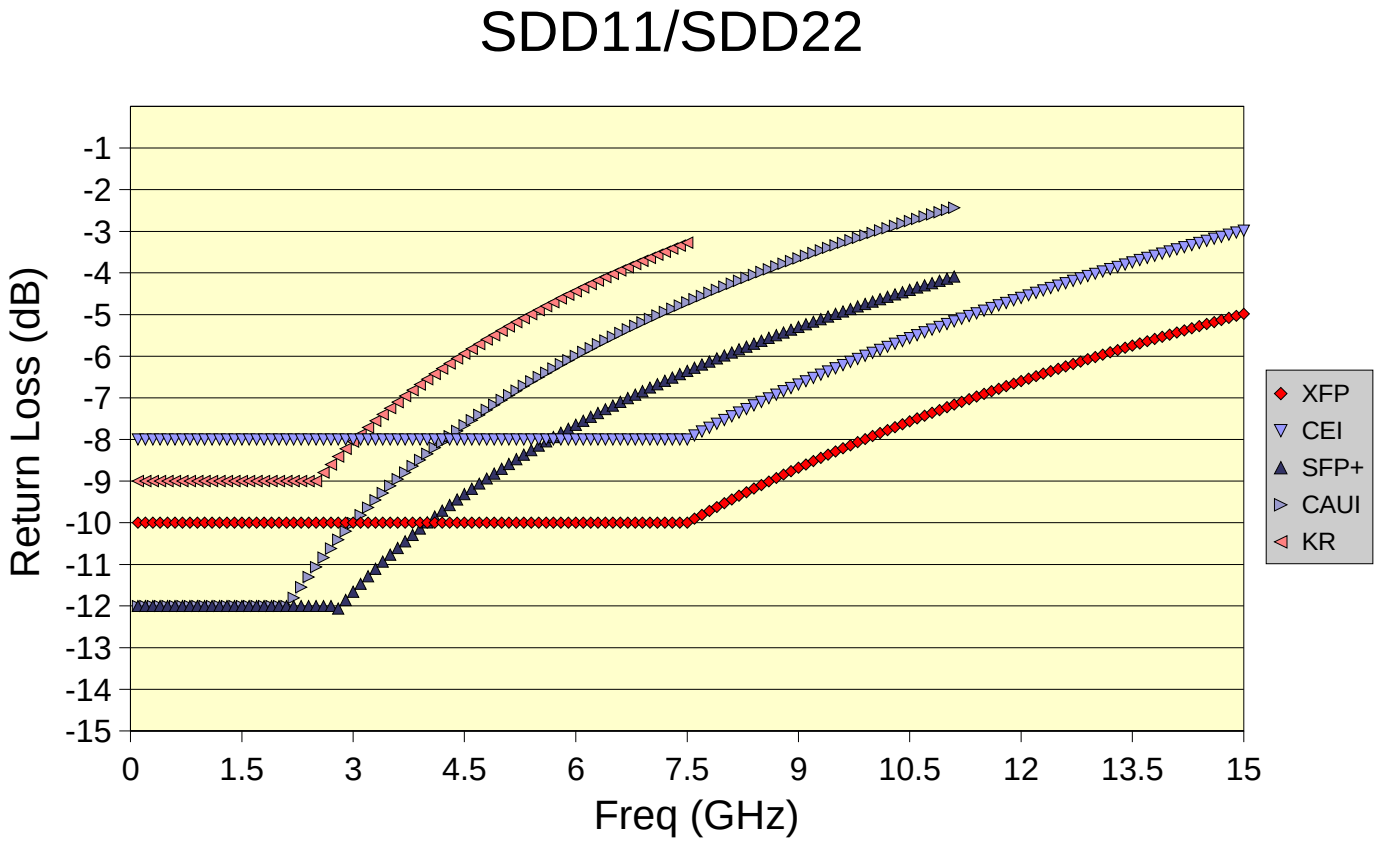


XLAUI/CAUI Electrical Interface

- **XFI has very stringent SDD return loss -10 dB up to 7.5 GHz up to 7.5 GHz, CEI more relax with -8 dB up to 7.5 GHz.**
  - **Flat return loss up to 7.5 GHz is not physical, too tight at high frequency, but too loose at the low frequency!**
  - **The proposed XLAUI/CAUI specifications is based on SFF-8431 with corner frequency pulled back to 2.125 GHz from 7.5 GHz but with improved return loss up to 2.125 GHz.**
- **XFI/CEI have very stringent common mode return loss -6 dB up to 15 GHz.**
  - **The proposal here is for SCC to follow SDDxx – 3 dB.**
  - **SCC for the receiver is not required as it limits the implementation.**
- **XFI and SFI allocate only 6 dB of channel loss at ½ the baudrate which has either limited the host PCB and/or material**
  - **The proposed channel increases the loss at ½ the Baudrate to 8 dB for more flexible PCB design.**

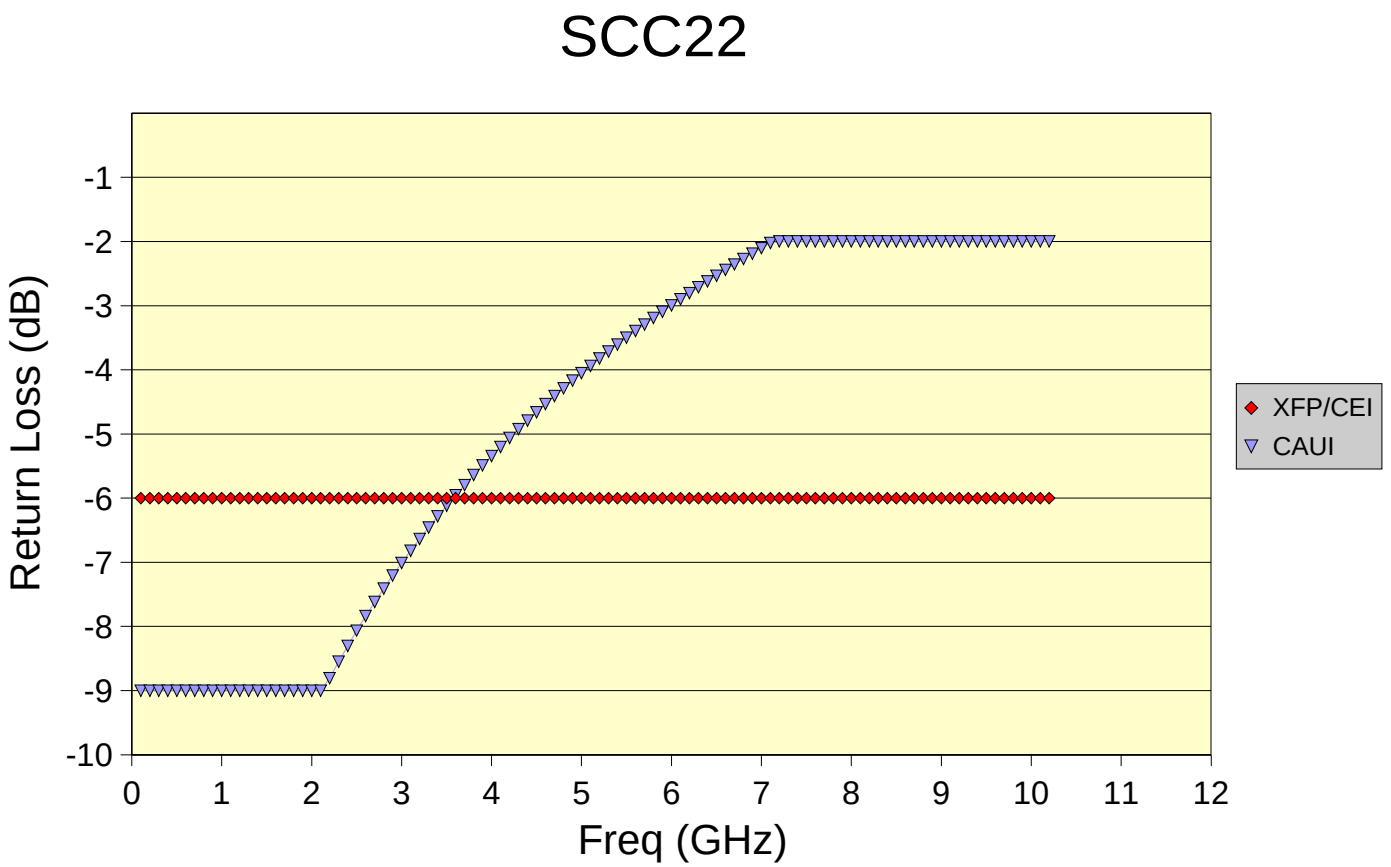
XFI, CEI, SFP+, CAUI Return Losses

- **Physical limitation of the IC parasitics makes it difficult to meet XFI return loss, CEI is too loose at low frequency.**
  - **This proposal uses 8.5 SFP+ Host return loss s4p available asT11-838v0.**
    - **-12 dB up to 2.125 Ghz, -6.5 + 13.33LOG10(f/5.5) from 2.125 Ghz to 11.1 GHz.**



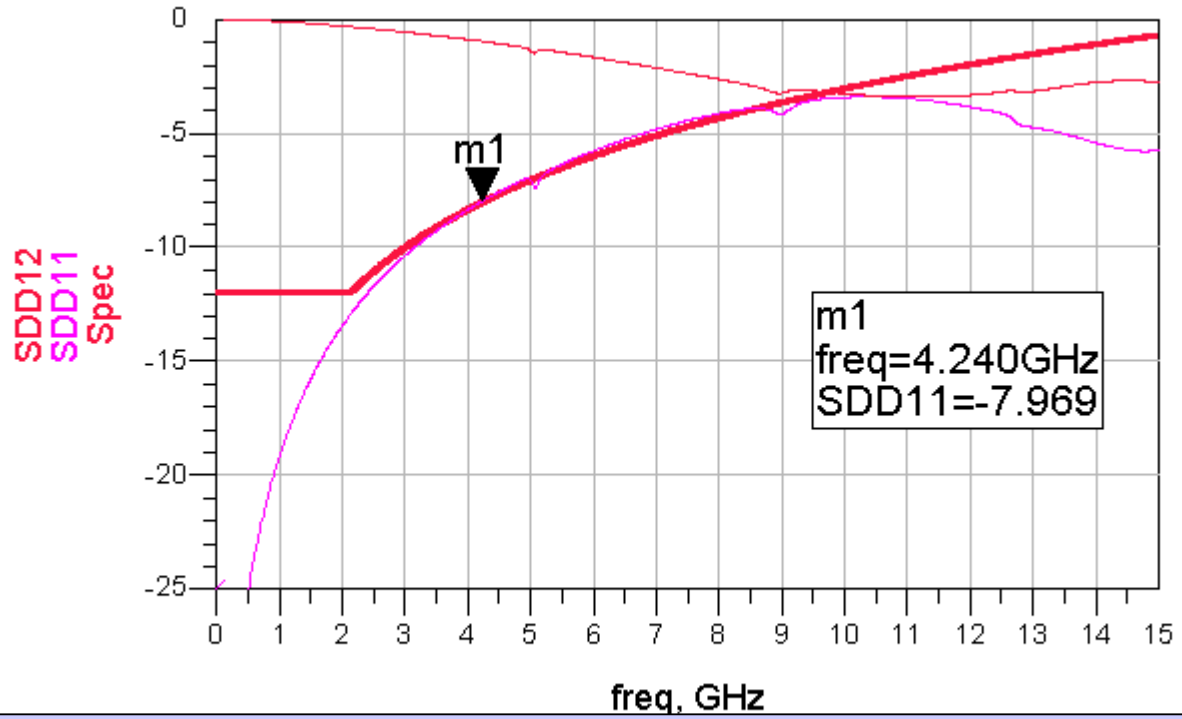
XFI, CEI, and CAUI/XLAUI RL

- **XFP/CEI common mode more difficult than SDD and not practical!**
- **SFP+ defines SCC to follow the SDD mask but 3 dB worse:**
  - **-9 dB from 0.1 to 2.125 Ghz, (-3.5 + 13.333LOG10(f/5.5)) from 2.125 to 7.1 Ghz, -2 from 7 to 11.1 GHz.**



RX/TX Chip Return Loss

- **CAUI SDDxx mask overlayed on top of the 8.5Gig SFP+ Host return loss, s4p file is available from T11 website as T11-838v0.**



SDD Mask=-12 if <2.125 GHz else -6.5 + 13.33*LOG10(f/5.5), where f is in GHz

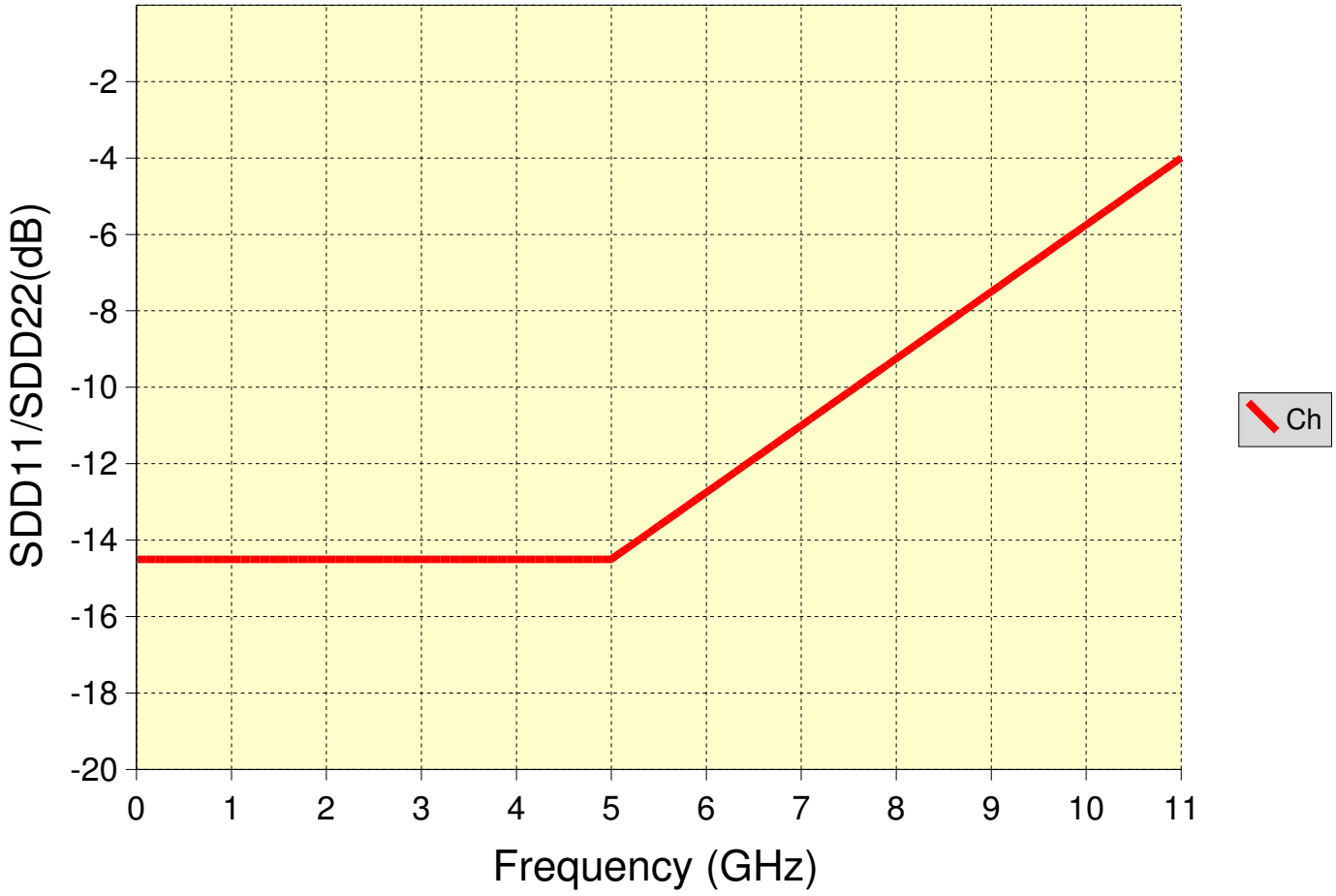
XLAUI/CAUI Channel Loss Budget

- **XFI, SFP+, and CEI 11G-SR operate only over ~6” of FR4-8 stripline**
- **The proposed channel loss for XLAUI/CAUI increases the loss to 8 dB at ½ the baudrate to allow up to 8” of FR4-8 stripline traces with one connector for more flexible host design.**
  - **Use of transmit pre-emphasis and more relaxed jitter allows increasing the channel loss budget.**

Parameters	*Ch Loss @5.5 Gig*	*Units*
Channel Loss SDD21 Including Up to One Connector	8[1]	dB
Penalty for Reflections and Other Penalty	3	dB
Total Loss	11	dB
1. SDD21=-0.137 – 1.073*SQRT(f) – 1.08*f, f unit is in Ghz.		

XLAUI/CAUI Channel Return Loss Requirement

- **Ch=-14.5 from 0.01 to 5 GHz and -23.25*8.75*(f/5), where f is in GHz.**



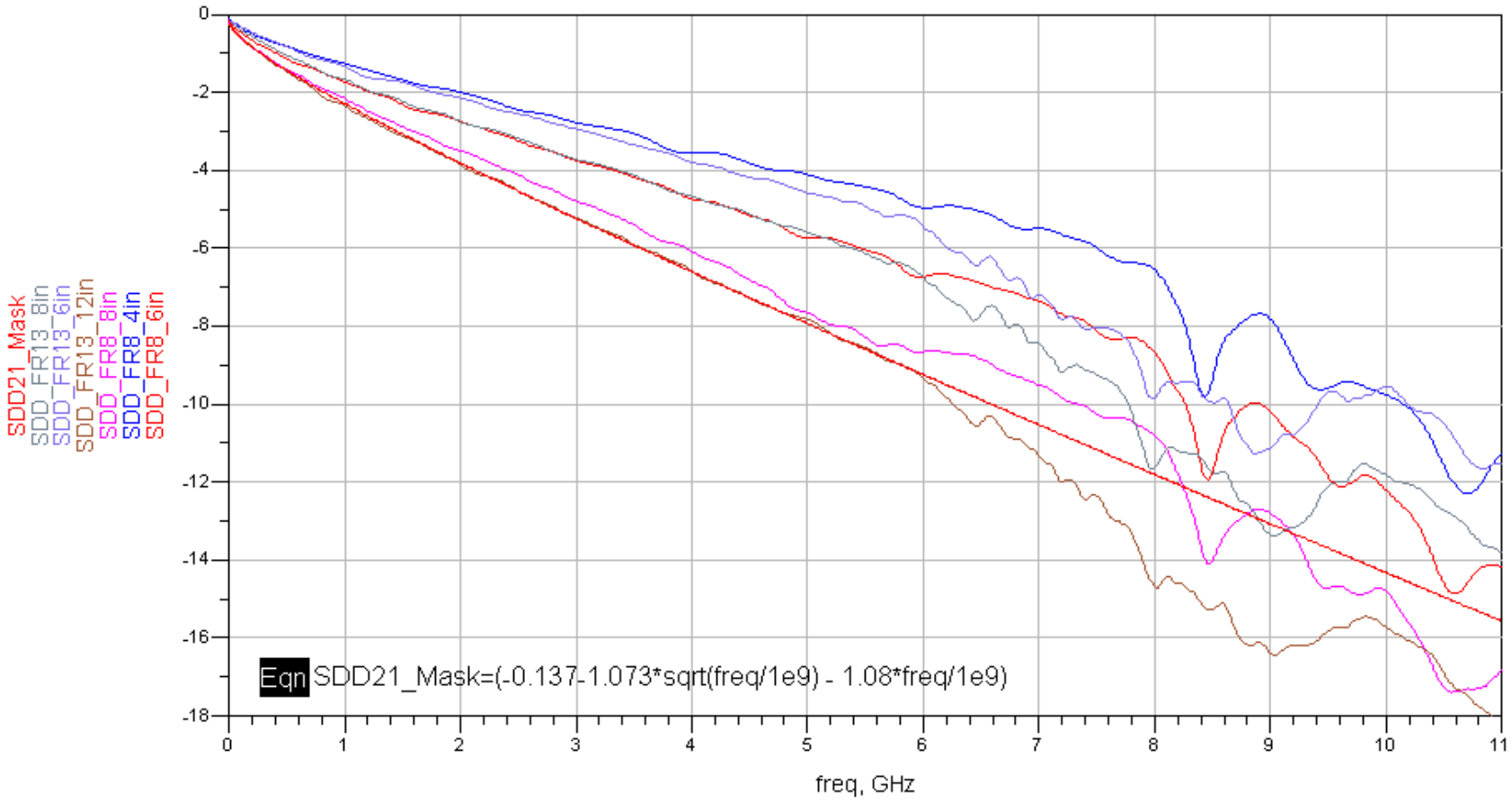
Channel Description

- **All channels were measured with SFF-8083 connector.**
- **FR4-13 channels have two 15 mils via stubs.**
- **FR4-8 channels has one 13 mils via stub plus the SMA stub.**

Legend	Description
SDD21_Mask	Proposed XLAUI/CAUI Channel
SDD_FR13_6in	FR4-13 Stripline with 5 mil wide traces 150 mm long
SDD_FR13_8in	FR4-13 Stripline with 5 mil wide traces 200 mm long
SDD_FR13_12in	FR4-13 Stripline with 5 mil wide traces 250 mm long
SDD_FR8_4in	FR4-8 Stripline with 5 mil wide traces 100 mm long
SDD_FR8_6in	FR4-8 Stripline with 5 mil wide traces 150 mm long
SDD_FR8_8in	FR4-8 Stripline with 5 mil wide traces 200 mm long

XLAUI/CAUI Channel Model

- **Channel model based on 8” of 5.5 mils FR4-8 striplines or about 12” of 5.5 mils FR4-13 striplines**



XLAUI/CAUI Transmitter Electrical Specifications (Point A)

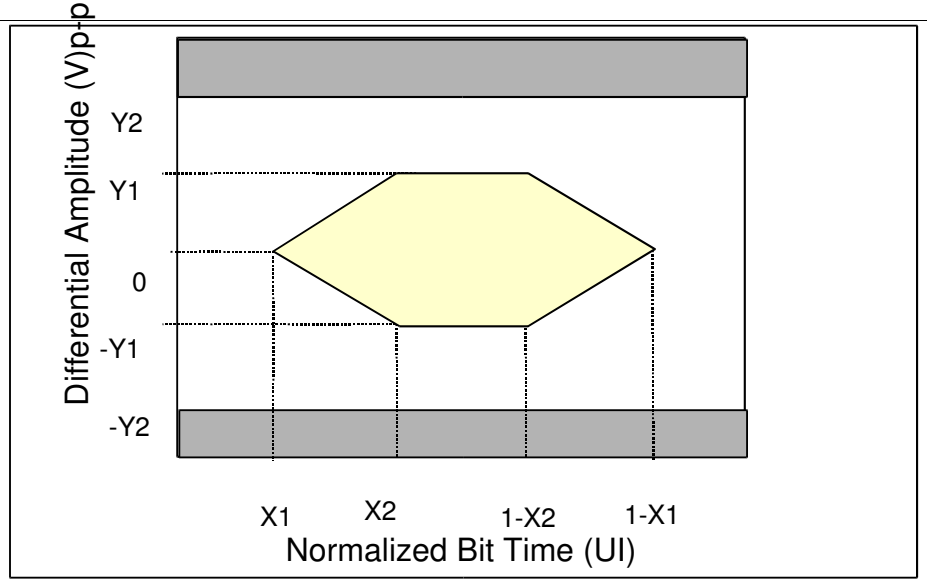
- **Starting with SFF-8431 specification at A**

Parameter	*Symbol*	*Conditions*	*Min*	*Typ*	*Max*	*Units*
Differential Output Voltage, p-p	Vdiff				see [1]	mV
Termination Mismatch		at 1 MHz			5	%
Output AC Common Mode Voltage (RMS)	Vcm				15	mV
Output Rise and Fall time (20% to 80%)	t_{RH}, t_{FH}		24			ps
Differential output S-parameters	SDD22	0.01 to 2.125 GHz			-12	dB
for		2.125-11.1 GHz			*[2]	dB
Common Mode Output S-parameters	SCC22	.01-2.125 GHz			-9	dB
		2.125-7.1 GHz			* [3]	dB
		7.1-11.1 GHz			-2	dB

1. **Must meet eye mask parameter Y1 and Y2.**
2. **SDD22(dB) = -6.5 + 13.33*LOG10(f/5.5), f is given in GHz**
3. **SCC22(dB)= -3.5 + 13.33*LOG10(f/5.5), f is given in GHz**

XLAUI/CAUI Transmit Eye Mask (Point A)

Parameter	*Symbol*	*Conditions*	*Min*	*Typ*	*Max*	*Units*
Determinstic Jitter					0.17	UI
Total Jitter	TJ				0.32	UI
Eye Mask	X1				0.16	UI
Eye Mask	X2				0.38	UI
Eye Mask	Y1				180	mV
Eye Mask	Y2				350	mV



XLAUI/CAUI Receiver Electrical Specifications (Point B)

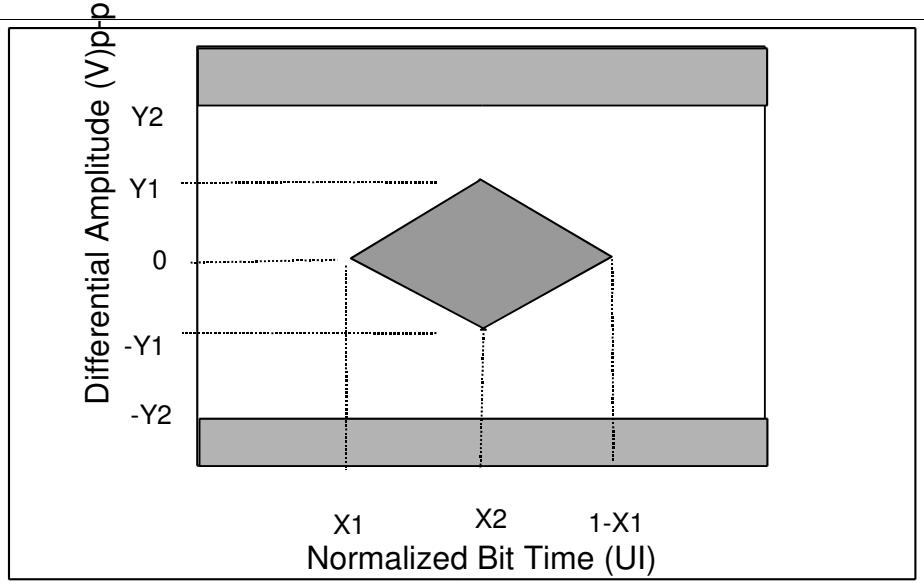
- **Starting with SFF-8431 Receiver specification**

Parameter	*Symbol*	*Conditions*	*Min*	*Typ*	*Max*	*Units*
Differential Input Voltage , Differential p-p	Vdiff	see 1	110		850	mV
Output AC Common Mode Voltage (RMS)	Vcm		20			mV
Output Rise and Fall time (20% to 80%)	t_{RH}, t_{FH}		24			ps
Differential output S-parameters	SDD11	0.05 to 2.125 GHz			-12	dB
		2.125-11.1 GHz			*[2]	dB
Differential to Common Mdoe Input Conversion S-parameters	SCD11	0.01-11.1 GHz			-15	

1. **Max value is 850 mV for compatablity with TP4 see petrila_01_0508.pdf**
2. **SDD22(dB) = -6.5 + 13.33*LOG10(f/5.5), f is given in GHz.**

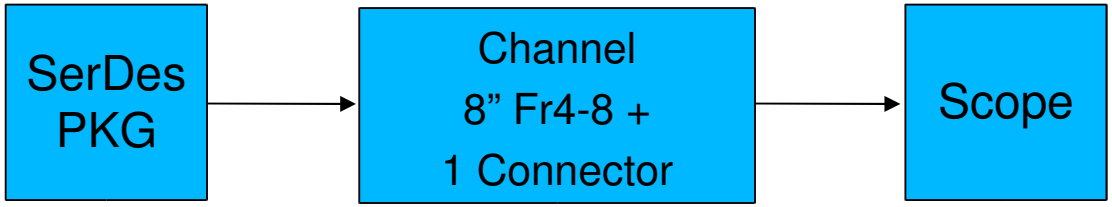
XLAUI/CAUI Receive Eye Mask Specifications

Parameter	*Symbol*	*Conditions*	*Min*	*Value*	*Max*	*Units*
non-EOJ Jitter (TJ – ISI)	DJ	Corner Frequncy>4 MHz			0.42	UI
Total Jitter	TJ	Corner Frequncy>4 MHz			0.62	UI
Eye Mask	X1				0.31	UI
Eye Mask	X2			0.5		UI
Eye Mask	Y1		55			mV
Eye Mask	Y2				425*	mV
*same as SFP+						

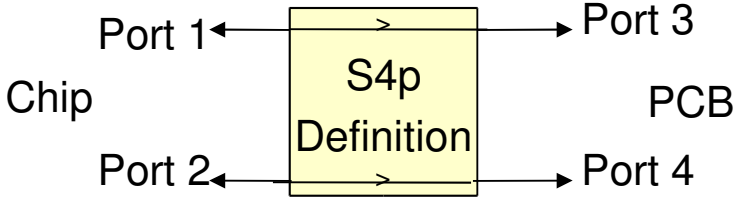


Link Simulation Setup

- **Host SerDes package model was cascaded with the channel**
  - **SerDes random jitter, SerDes DJ, and connector crosstalk are not included in the simulation.**

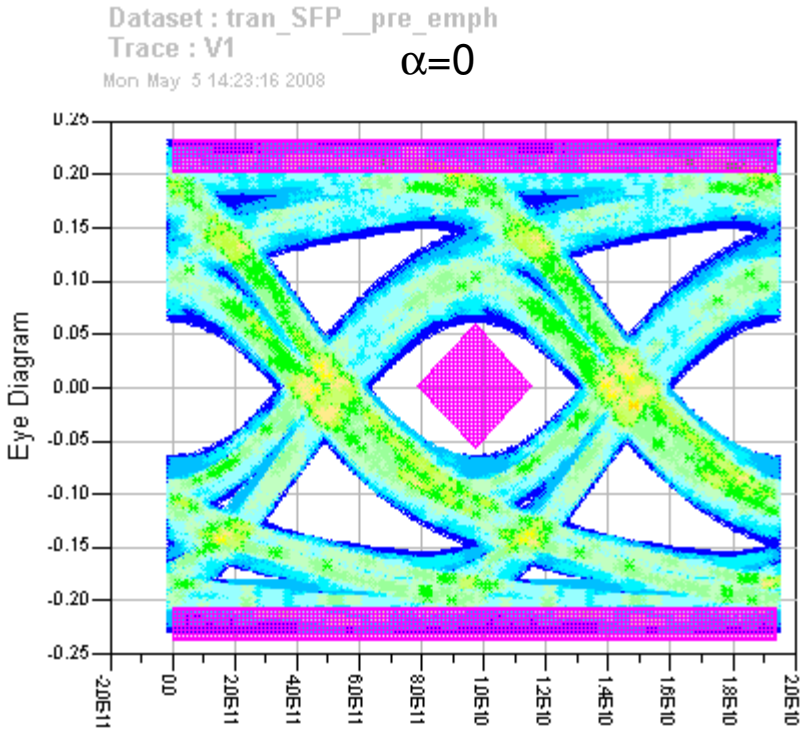


S4P File Definition for Host and Module S-parameters

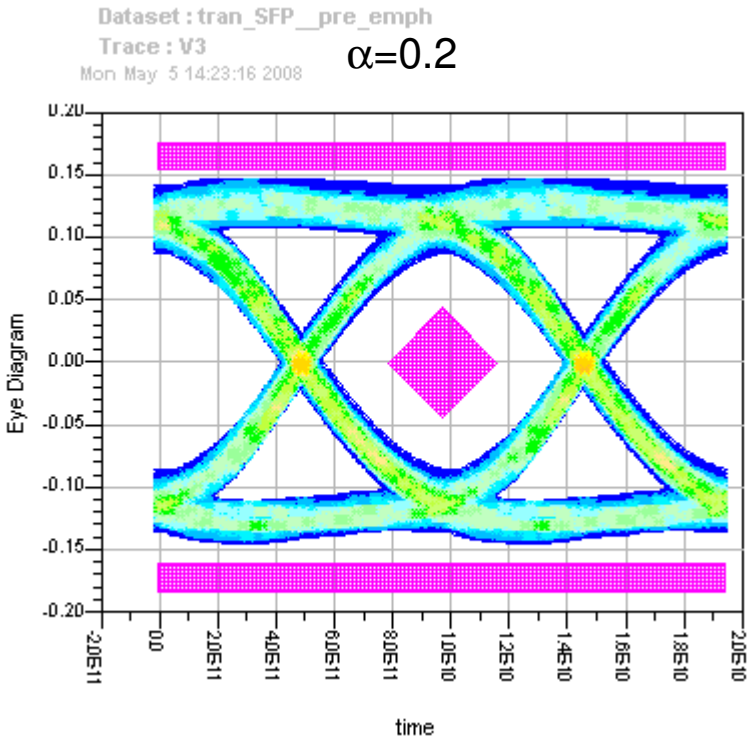


Channel Simulation

- **Output eye digram for the 8 in Fr4-8 stripline with and without pre-emphasis.**
  - **Does not include crosstalk, phase noise, etc.**



DJ~28 ps



DJ~10 ps

Conclusion

- Based on the ASIC power dissipation concern of supporting all PMDs, this proposal use a simple SerDes interface like XFI on the ASIC for “Media Extender”.
  - Lowest power dissipation for the ASIC and flexible.
  - ASIC may choose to support the PMD interface.
- XALUI/CAUI electrical interface leverage XFI and SFI works, but with several key improvements:
  - Channel length increased to 8” of FR4-8 or 12” of Fr4-13 by levering pre-emphasis
  - Return loss based on SFI which is more ASIC friendly than XFI.
- Assuming the PMD interface will use the same return loss and electrical level, then OEM may decide to use a retimer only if they can't meet the jitter requirement at TP1/TP4.