

Proposed Reference Equalizer Change in Clause 122.8.5.4 (Part 2)

Trevor Chan, Xianxu Peng, Shaoyun Yi, and Winston Way
NeoPhotonics

Supporters

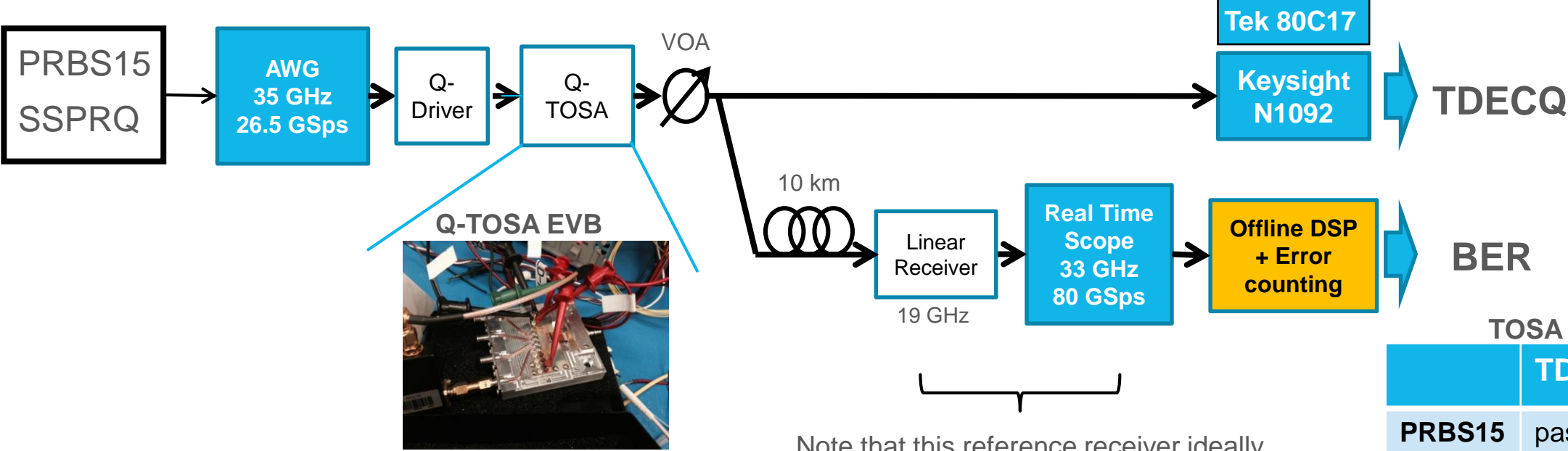
- Matt Traverso, Cisco
- Marco Mazzini, Cisco
- Sudeep Bhoja, InPhi
- Frank Chang, InPhi
- Pavel Zivny, Tektronix
- Kohichi Tamura, Oclaro

OUTLINE

In way_3bs_01_0517 we proposed to use 7 T-spaced equalizer, here we provide more test data to support our proposal.

- **Single-lane SSPRQ and PRBS15 TDECQ comparison via AWG**
 - Based on draft 3.2 reference equalizer
- **TDECQ test results with all lanes turned on and modulated**
 - In way_3bs_01_0517, TDECQ test was carried out one lane at a time
 - Based on draft 3.2 reference equalizer

Experimental Setup 1 – Individual Lane Testing

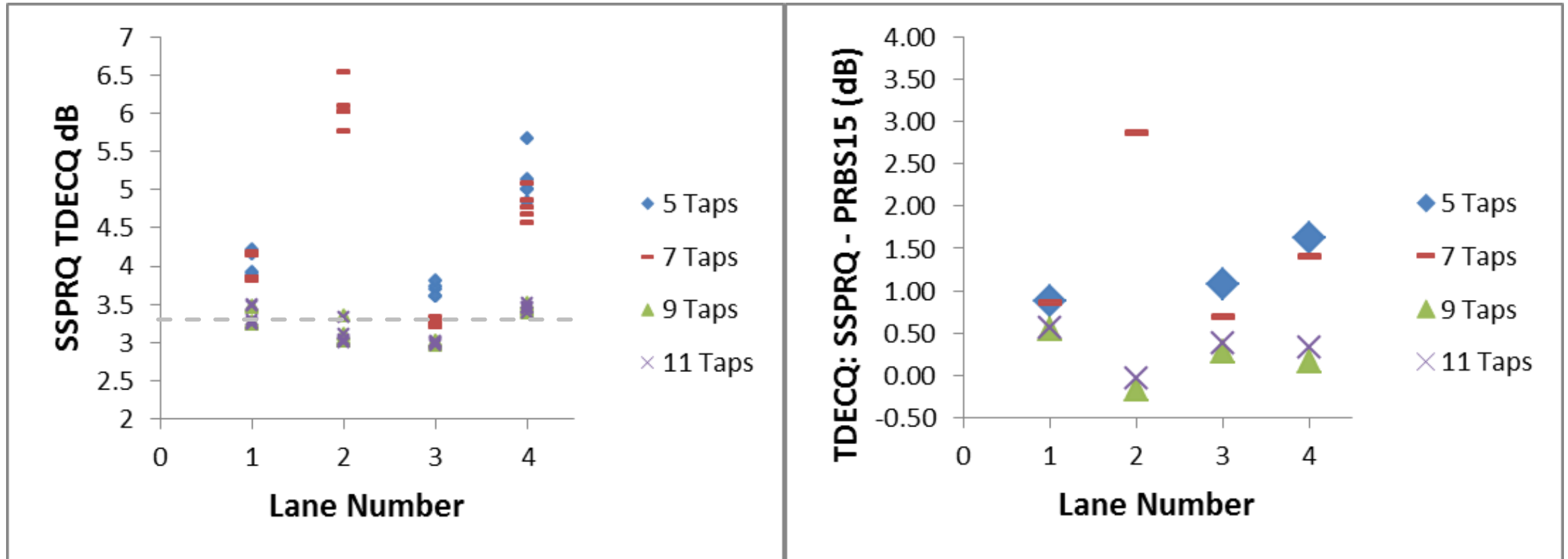


TOSA qualification

	TDECQ	BER
PRBS15	pass	pass
SSPRQ	Pass/fail	pass

Note that this reference receiver ideally should correspond to not only what is used in the TDECQ test equipment, but also to a worst-case inter-operable receiver. Here we are using a receiver/scope that is available in our lab. The total bandwidth is wider than 13.3GHz, which gives result that is equivalent to N1092 using longer taps.

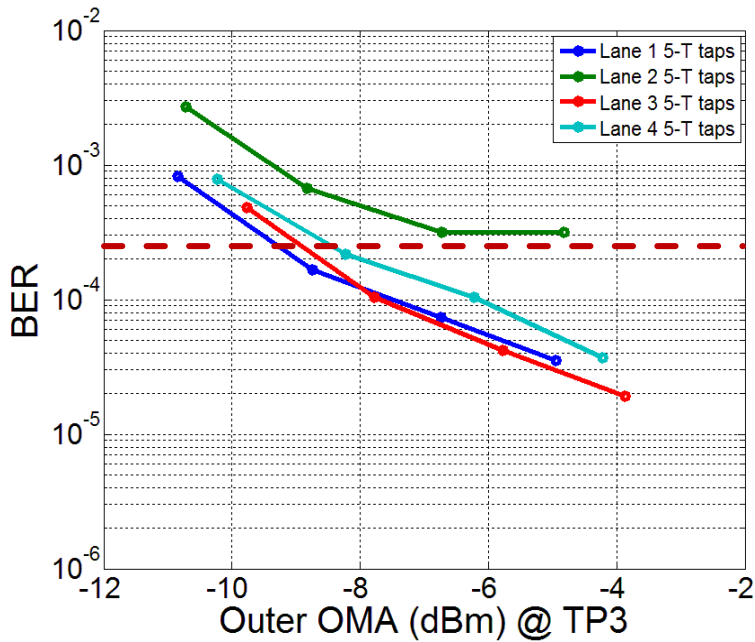
SSPRQ TDECQ, TDECQ (SSPRQ – PRBS15)



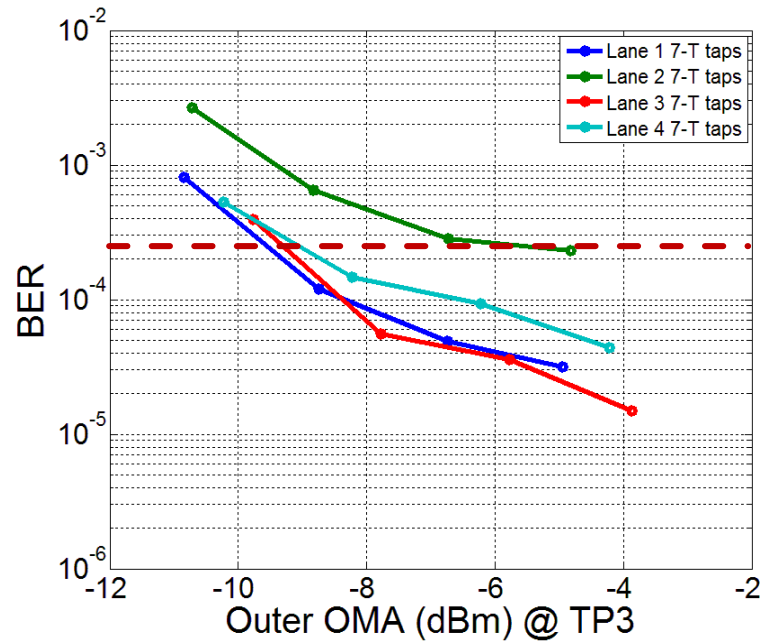
- 9 T-taps greatly improve the SSPRQ TDECQ results
- With 9 T-taps, SSPRQ TDECQ approaches that of PRBS15 within 0.5dB

SSPRQ BER Test Results

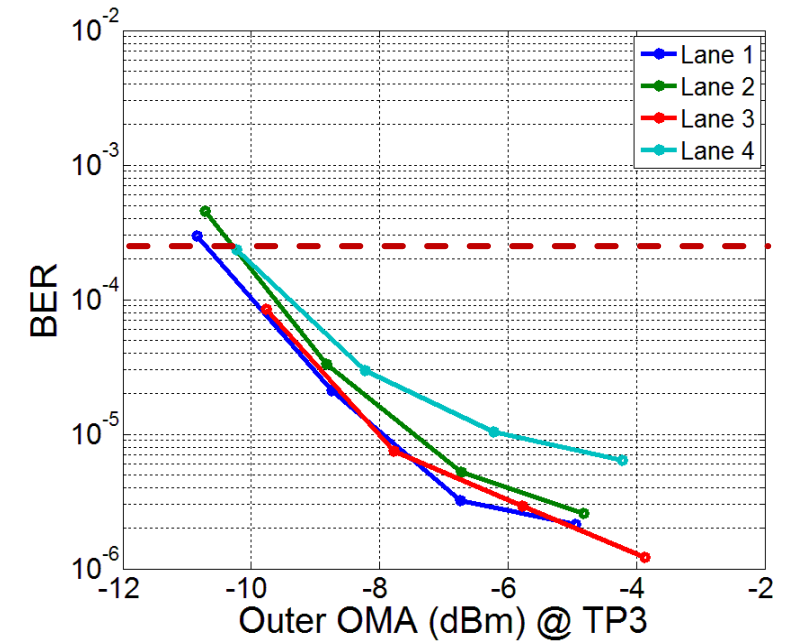
SSPRQ 5 Taps



SSPRQ 7 Taps



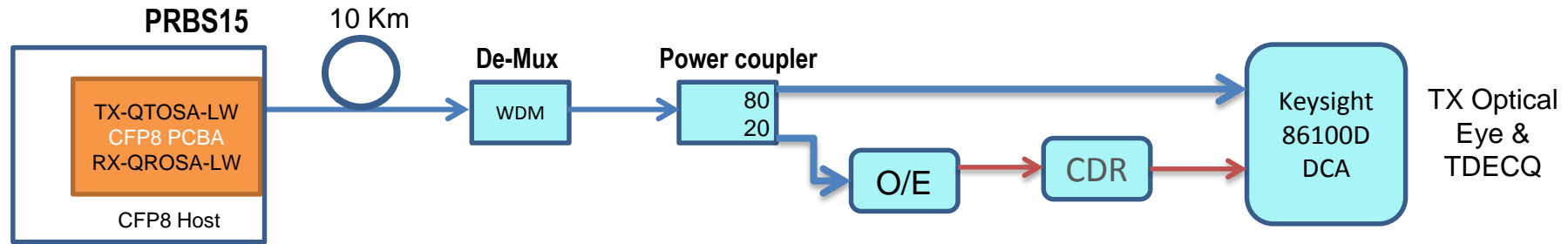
SSPRQ 10 Taps



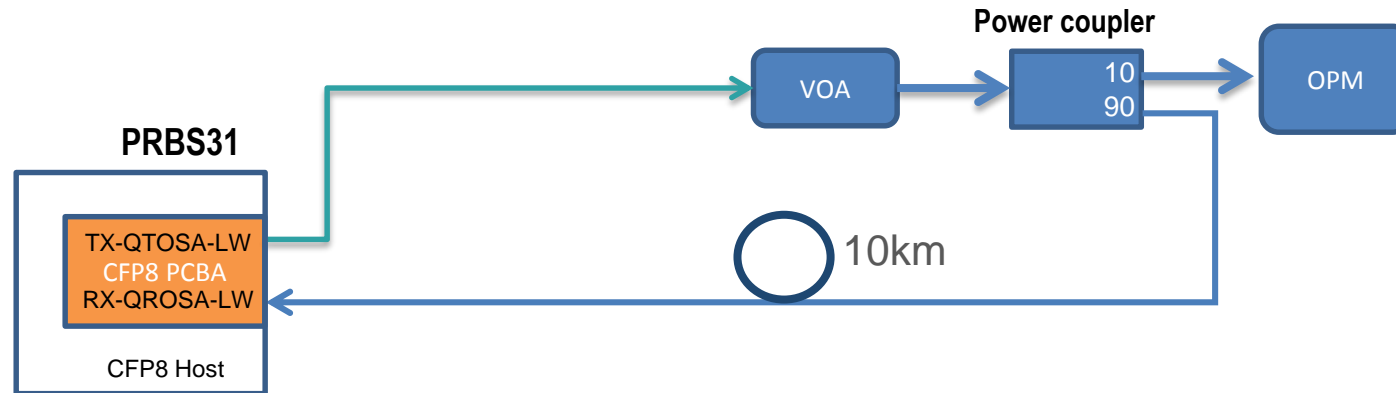
> 7 T-taps make a significant difference in BER

Experimental Setup 2 – All 4 lanes of a Q-TOSA turned ON

TDECQ



**BER
vs
OMA**



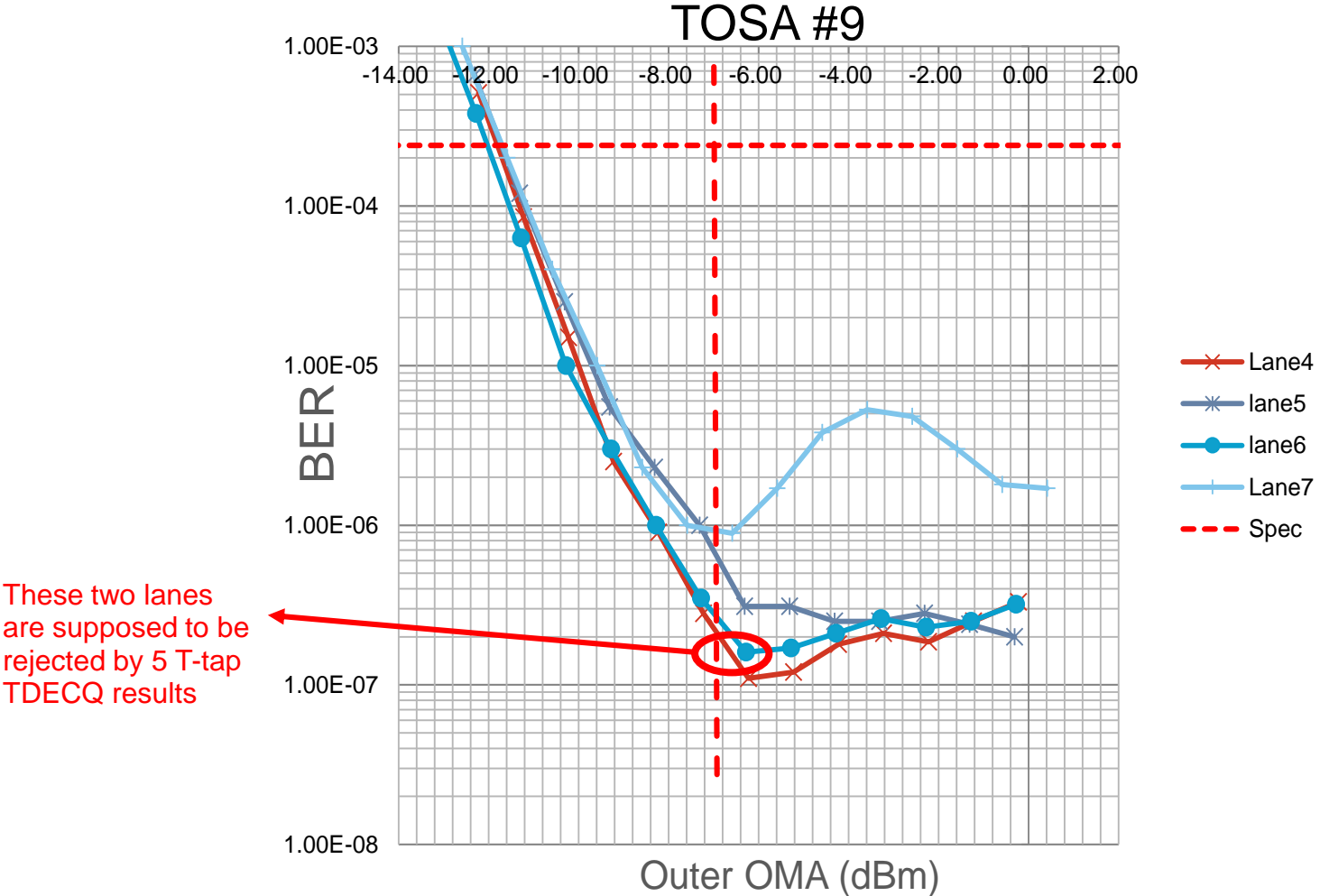
PRBS15 TDECQ (13.3GHz anti-aliasing filter)

All lanes ON and modulated

Lane	5T	7T	9T
4	3.32	2.88	2.86
5	2.72	2.65	2.4
6	3.68	3.01	2.36
7	2.51	1.98	2.04

5 T-taps would reject two lanes
7 T-taps would pass all lanes

PRBS15 – BER vs OMA (all lanes ON) after 10km SMF



Used digital PAM4 chip on CFP8 PCB

All lanes pass with sufficient margin

Summary

- **SSPRQ TDECQ with 9 T-spaced equalizer approaches that of PRBS15 TDECQ within 0.5dB**
- **SSPRQ BER improves significantly with > 7 T-taps**
- **7 T-taps with PRBS15 or 9 T-taps with SSPRQ can ensure no good TOSAs (which pass PRBS31 BER test with sufficient margin) are thrown away by TDECQ tests**
 - 8 independent PRBS15 is readily available in PAM4 chips today, while setting up 8-ch SSPRQ via arbitrary waveform generator is extremely expensive → How can this problem be solved in production test stations if SSPRQ must be used?
- **5 T-taps in draft 3.2 is not enough for either PRBS15 or SSPRQ test pattern**
- **Suggest inviting analog PAM4 chip designers to come to IEEE802.3bs and present their reason why the equalizer tap numbers is limited to 5**

Backup Slides

PRBS15 vs SSPRQ TDECQ Test Results (Lanes 1 & 2)

Lane 1 PRBS15

PRBS15 TDECQ	5 Taps	7 Taps	9 Taps	11 Taps
Meas 1	3.1	3.04	2.76	2.76
Meas 2	3.12	3.09	2.76	2.75
Meas 3	3.01	3	2.65	2.63
Meas 4	3.05	3.03	3.17	3.14
Meas 5	3.33	3.32	2.62	2.6
Average	3.12	3.10	2.79	2.78
Standard Deviation	0.12	0.13	0.22	0.22



SSPRQ

SSPRQ TDECQ	5 Taps	7 Taps	9 Taps	11 Taps
Meas 1	3.88	3.85	3.28	3.29
Meas 2	4.15	4.13	3.46	3.47
Meas 3	3.86	3.8	3.23	3.23
Meas 4	4.21	4.17	3.48	3.49
Meas 5	3.92	3.85	3.23	3.25
Average	4.00	3.96	3.34	3.35
Standard Deviation	0.16	0.18	0.12	0.12

Lane 2 PRBS15

PRBS15 TDECQ	5 Taps	7 Taps	9 Taps	11 Taps
Meas 1	3.32	3.3	3.15	3.06
Meas 2	3.27	3.27	3.65	3.41
Meas 3	3.3	3.11	2.98	2.93
Meas 4	3.25	3.13	3.43	3.2
Meas 5	3.39	3.31	3.12	3.02
Average	3.31	3.22	3.27	3.12
Standard Deviation	0.05	0.10	0.27	0.19



SSPRQ

SSPRQ TDECQ	5 Taps	7 Taps	9 Taps	11 Taps
Meas 1		6.01	3.05	3.03
Meas 2		6.02	3.1	3.1
Meas 3		5.76	3.01	3
Meas 4		6.53	3.02	3.01
Meas 5		6.1	3.34	3.33
Average	#DIV/0!	6.08	3.10	3.09
Standard Deviation	#DIV/0!	0.28	0.14	0.14

PRBS15 vs SSPRQ TDECQ Test Results (Lanes 3 & 4)

Lane 3 PRBS15

PRBS15 TDECQ	5 Taps	7 Taps	9 Taps	11 Taps
Meas 1	2.59	2.52	2.7	2.6
Meas 2	2.56	2.54	2.61	2.51
Meas 3	2.63	2.55	2.77	2.61
Meas 4	2.65	2.61	2.75	2.66
Meas 5	2.65	2.62	2.73	2.64
Average	2.62	2.57	2.71	2.60
Standard Deviation	0.04	0.04	0.06	0.06



SSPRQ

SSPRQ TDECQ	5 Taps	7 Taps	9 Taps	11 Taps
Meas 1	3.6	3.25	2.99	2.98
Meas 2	3.7	3.24	2.96	2.96
Meas 3	3.6	3.2	3.02	3.02
Meas 4	3.74	3.32	3.01	3
Meas 5	3.8	3.31	3	3
Average	3.69	3.26	3.00	2.99
Standard Deviation	0.09	0.05	0.02	0.02

Lane 4 PRBS15

PRBS15 TDECQ	5 Taps	7 Taps	9 Taps	11 Taps
Meas 1	3.53	3.45	3.25	3.11
Meas 2	3.57	3.4	3.18	3.07
Meas 3	3.53	3.48	3.2	3.09
Meas 4	3.18	3.08	3.25	3
Meas 5	3.69	3.53	3.54	3.27
Average	3.50	3.39	3.28	3.11
Standard Deviation	0.19	0.18	0.15	0.10



SSPRQ

SSPRQ TDECQ	5 Taps	7 Taps	9 Taps	11 Taps
Meas 1	4.84	4.57	3.39	3.38
Meas 2	5.01	4.85	3.47	3.46
Meas 3	5.01	4.67	3.44	3.45
Meas 4	5.67	5.08	3.51	3.51
Meas 5	5.13	4.77	3.42	3.43
Average	5.13	4.79	3.45	3.45
Standard Deviation	0.32	0.19	0.05	0.05