PIE-D statistics Comparison Between Averaged Mode and Individual Mode Computation Method
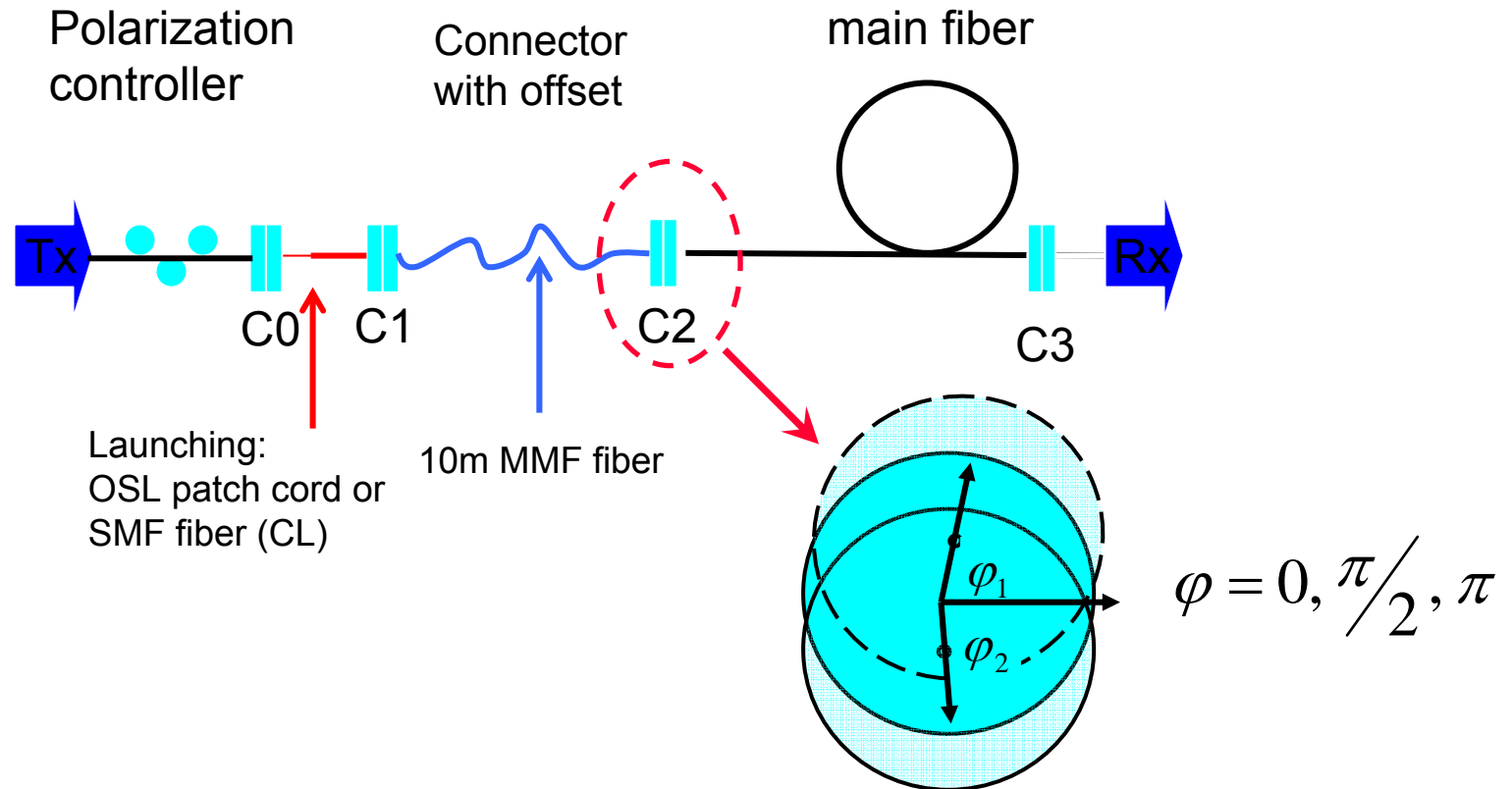
Presented by Yu Sun, Optium Corp

Supported by:

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Ali Ghiasi,	BroadCom
John Ewen,	JDSU
Gary Shaulov,	RSoft
Pete Hallemeier,	Optium Corp

Link setup

Polarization controller

Connector with offset

main fiber

Tx

C0   C1   C2   C3   Rx

Launching:
OSL patch cord or
SMF fiber (CL)

10m MMF fiber

φ_1

φ_2

$$\varphi = 0, \frac{\pi}{2}, \pi$$

Two connectors C1 and C2 are considered

| Worst case	7 μ m	7 μ m
Average case	5 μ m	5 μ m

Background

In Ottawa meeting, task 4 group discussed two method of how to simulation the connectors in multimode fiber link

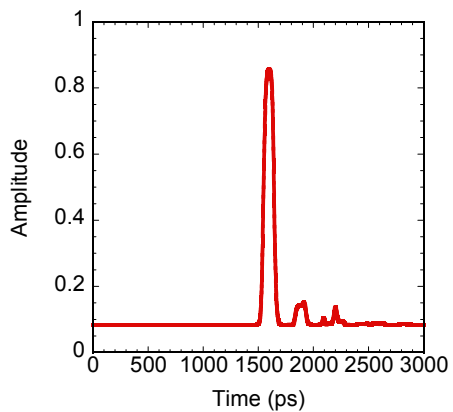|	Averaged mode	Individual mode
Mixing among modal groups	None	None
Mode mixing in one modal group	100%	none
Transfer matrix of connectors	$N \times N$ Number of modal groups	$M \times M$ Number of modes
Dependency of connector rotation	no	yes

Background

Comparison of pulse responses from one fiber
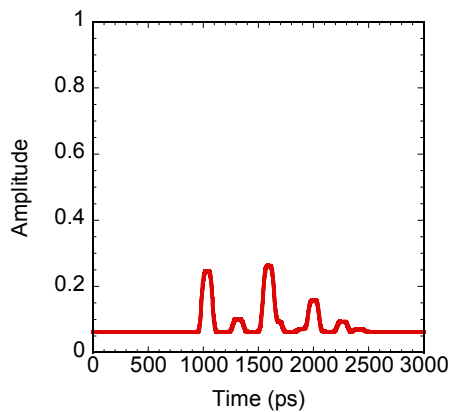
Results of averaged mode method
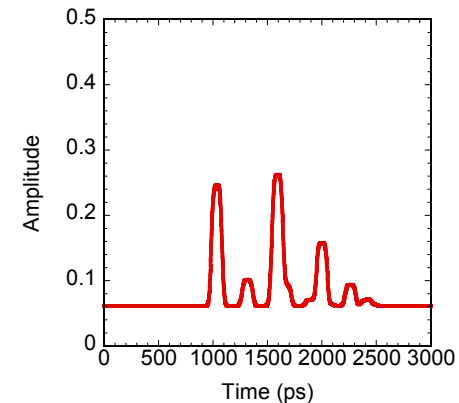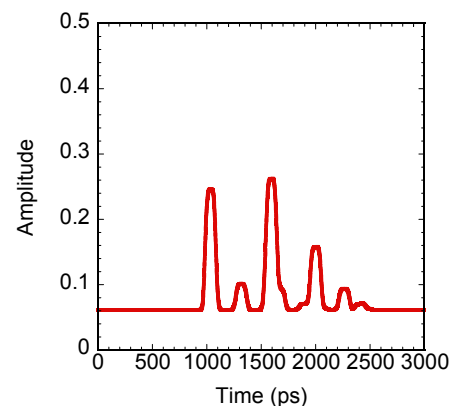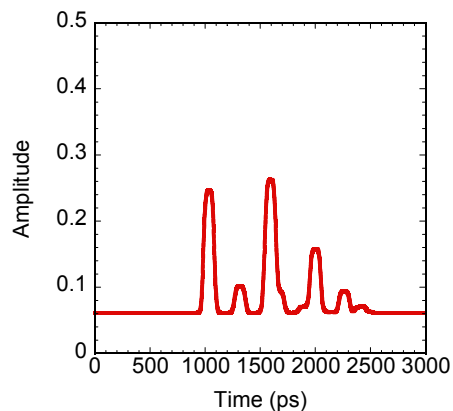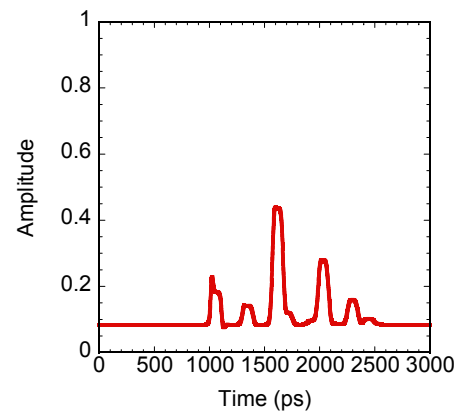

Results of individual mode method

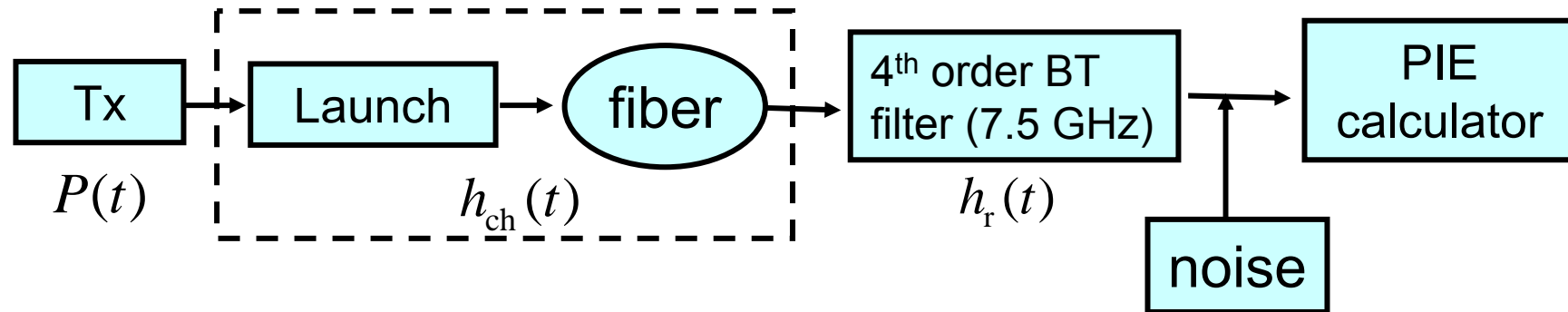Rotation 1   Rotation 2   Rotation 3

PIE calculation

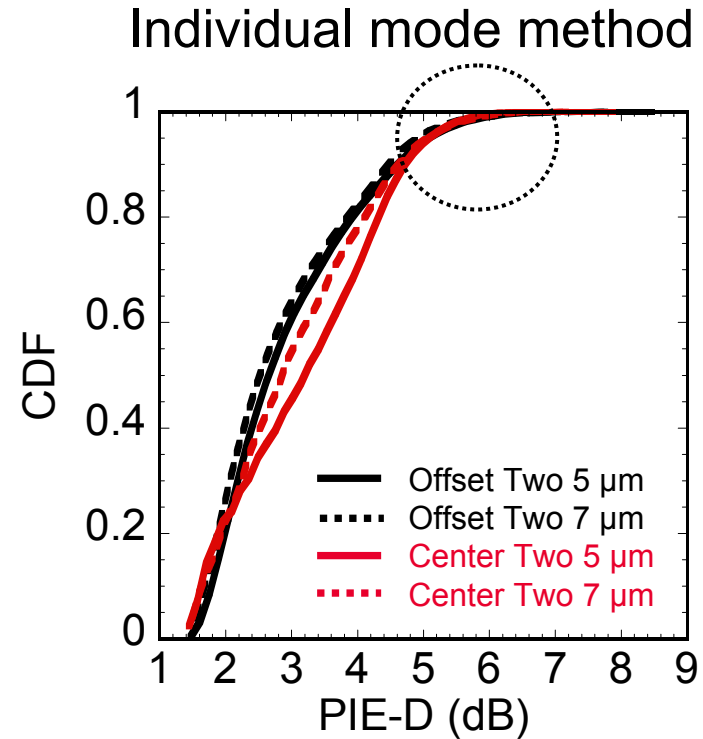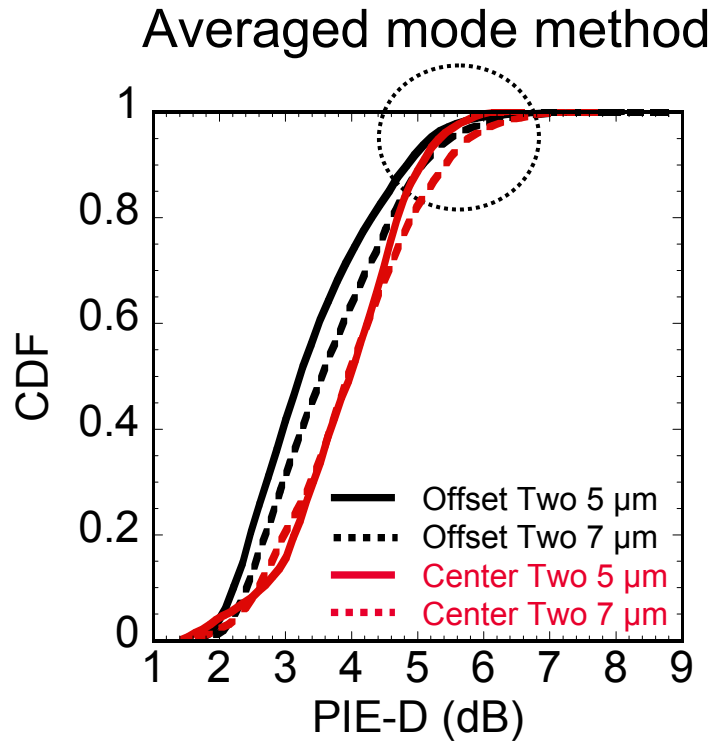- Channel is simulated using MGP and GEN54YY delay set

- Composite pulse response $h(t) = p(t) * h_{ch}(t) * h_r(t)$

- Input pulse: Gaussian with 47.1 ps rising time (20% - 80%)

- Noise is a constant (bhoja_1_0704.pdf)

$$\sigma^2 = 10^{(\text{ESNR - 2*optical dispersion penalty})/10}, \text{where}$$

$$\text{ESNR} = 17\text{dB} \ (\text{BER} = 10^{-12});$$
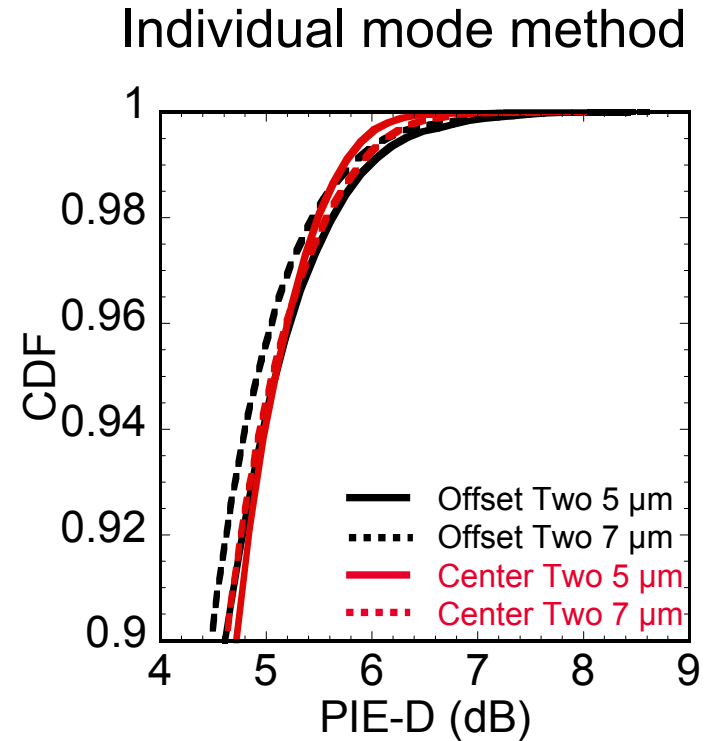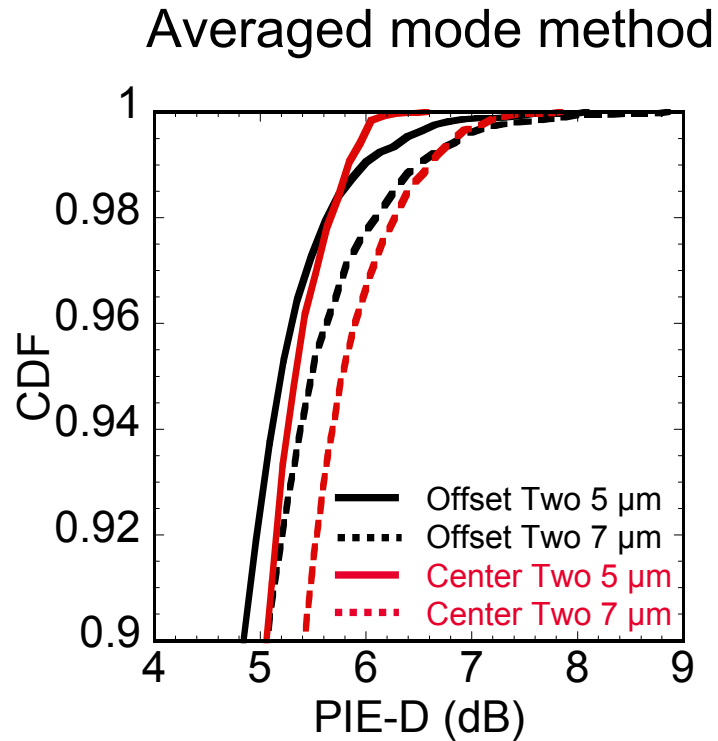
$$\text{optical dispersion penalty} = 6\text{dBo}$$

Comparison of PIE-D

Averaged mode method

Individual mode method

99 percentile of two methods under different offset combinations

	Offset		Center	
	two 5 um	two 7 um	two 5 um	two 7 um
Averaged mode method	6.001	6.539	5.84	6.67
Individual mode method	6.045	5.829	5.76	5.93

Comparison of PIE-D

Averaged mode method   Individual mode method

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Conclusion

1. In general, the averaged mode method (TIA) is more pessimistic than individual mode method

2. The 99% coverage of two methods is very close in the average offset case

3. Thought the detailed impulse response characteristics resulting from the two computational methods are different, they will draw the same conclusion based on 99 percentile value

Back Up

Calculation of MGP (Averaged mode method)
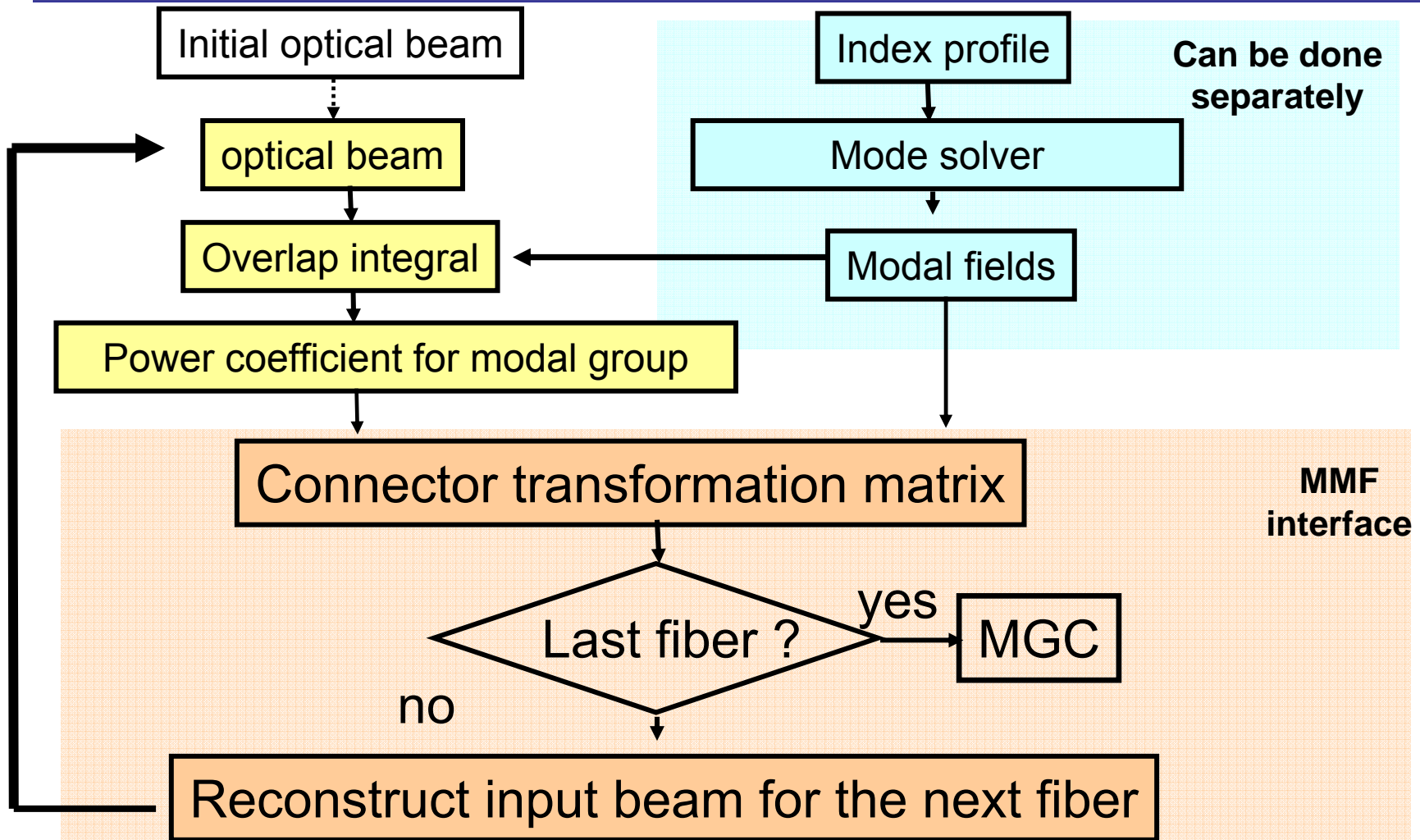
Calculation of MGP (Individual mode method)