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Breakthrough Technology for Optical Transmission

Simulation of polarization effect in a fiber link with offset connectors

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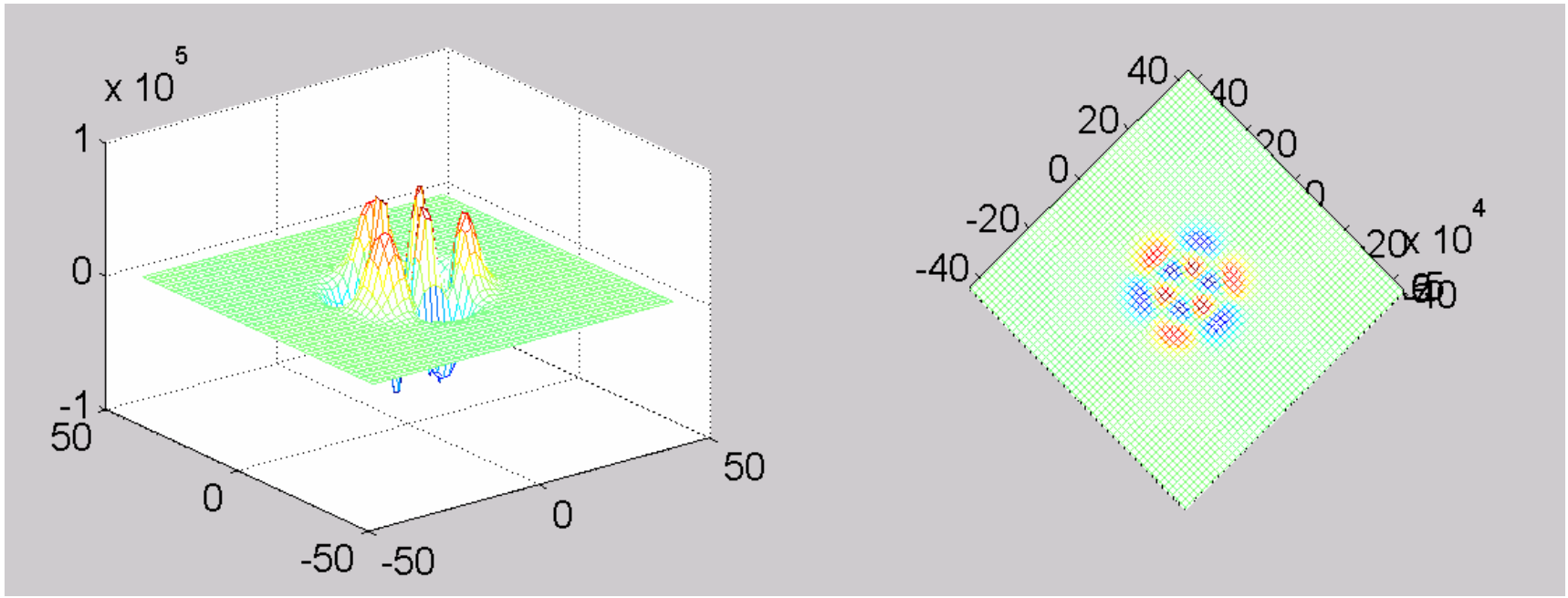
IEEE 802.3aq 10GBASE-LRM Task Force, July 13-14, 2004

Introduction

- As the increase of bit rate, the polarization effect plays a significant role in MMF system
- Changing polarization state of input beam causes the system performance to change dramatically
- The random nature of polarization state causes a modal noise process

Modal fields at the fiber interface



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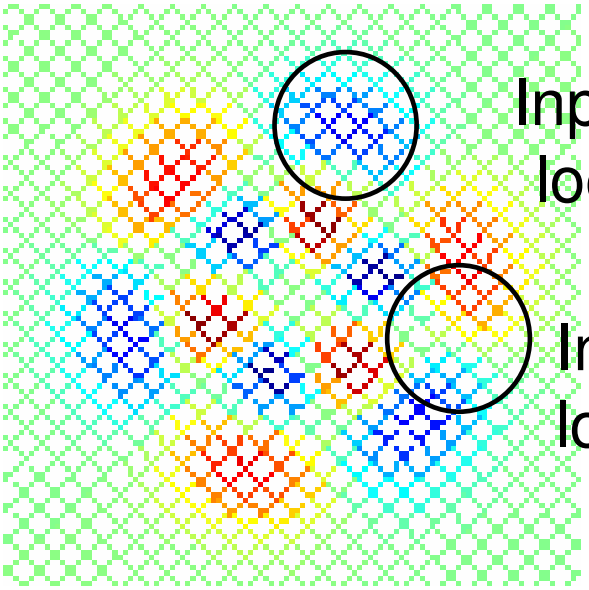
Power coefficient calculation example

Power coefficient (PC) *c* is the overlap integral of modal field $\Psi(r)\cos(l\phi)$ and input optical field



Input beam location 1 ⇒ c_1

Input beam location 2 ⇒ c_2

$$c_1 \neq c_2$$

PC of each mode depends on with input beam location and its diameter.

Impulse response is overlap of different modes and varies accordingly

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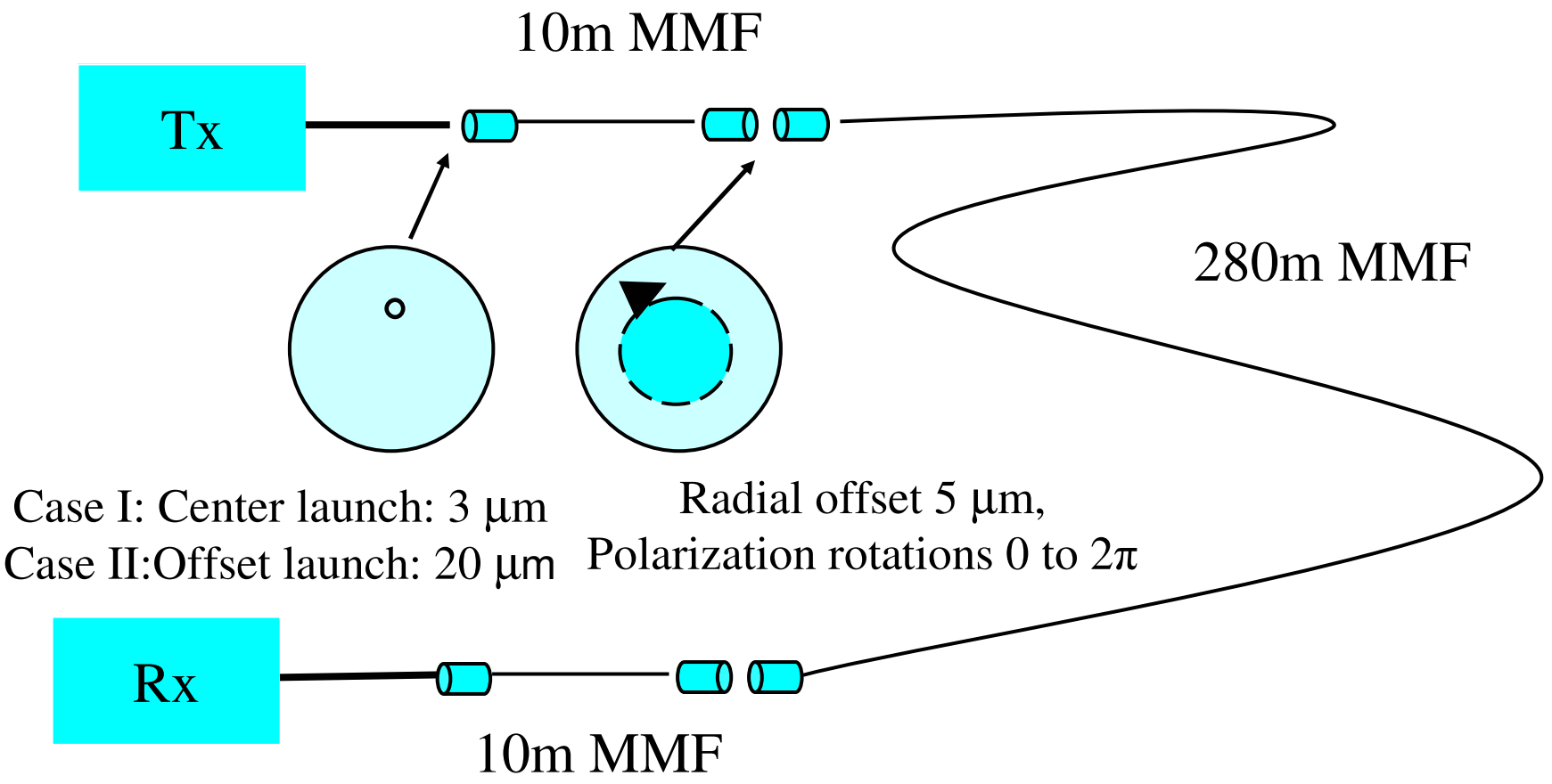
Simulation set up



Input beam: Gaussian, 9 μm FWHM

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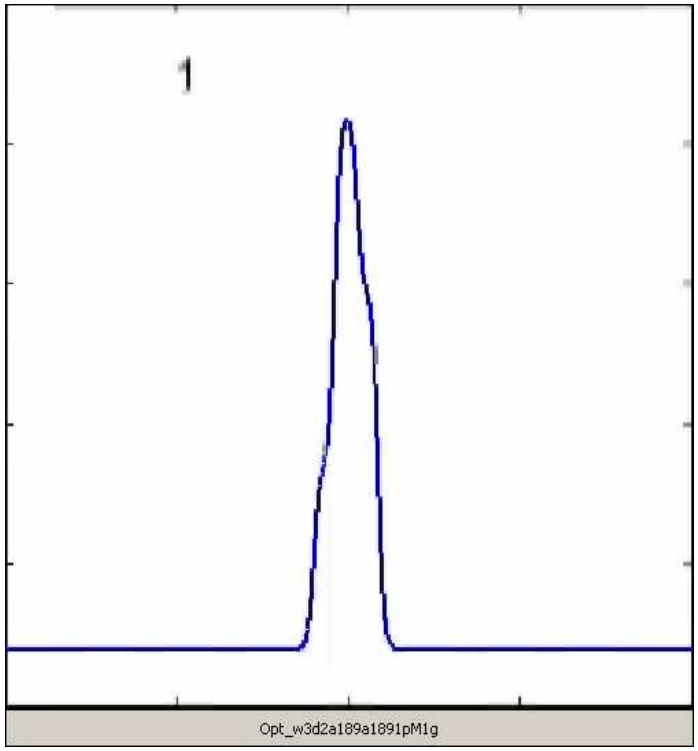
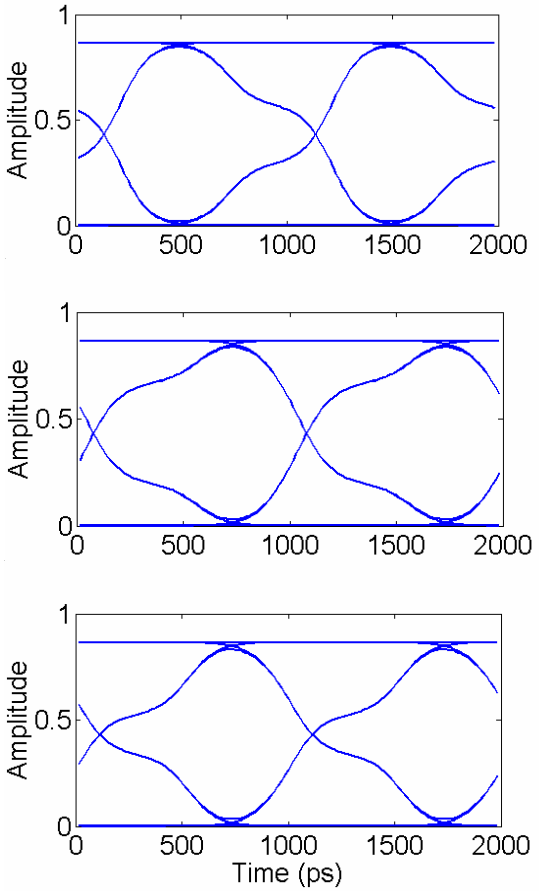
Pulse responses of 1Gb/s system





Angle 1

Angle 17

Angle 40

Polarization effect does not degrade the system performance significantly. It is negligible.

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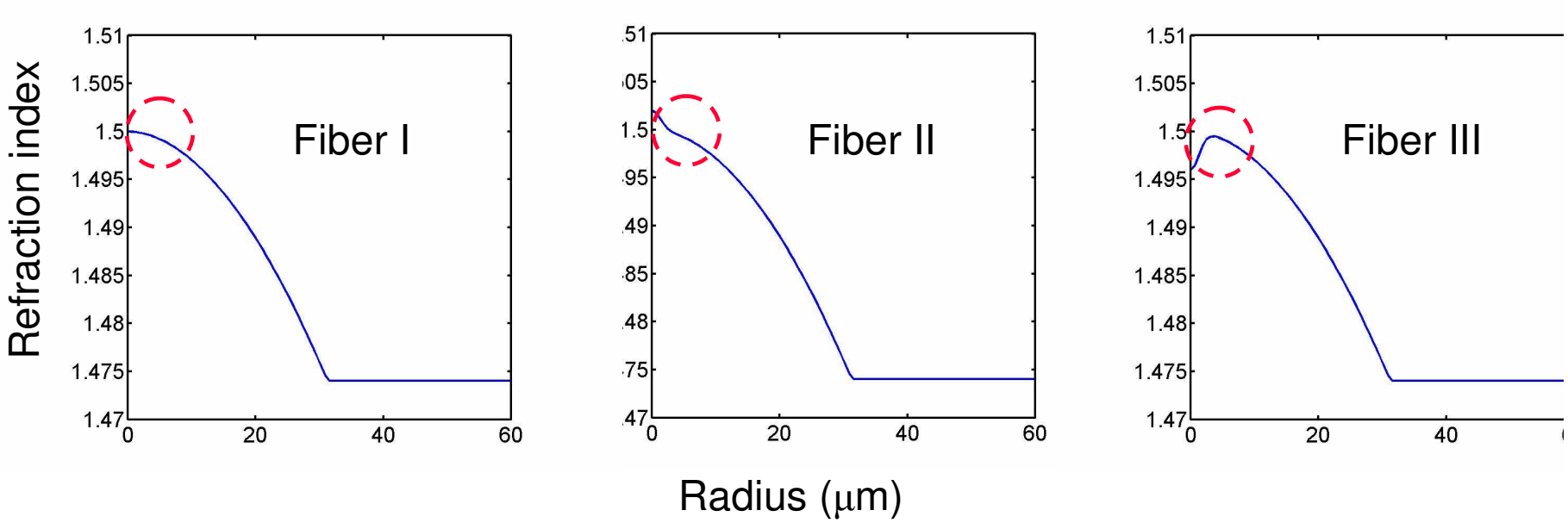
Index profile

The index profiles come from Cambridge 81 profiles



The only difference of three indexes are at the center

$\alpha = 1.89$

Index profile determines:

1. Spatial distribution of modal fields
2. Group velocity of each mode

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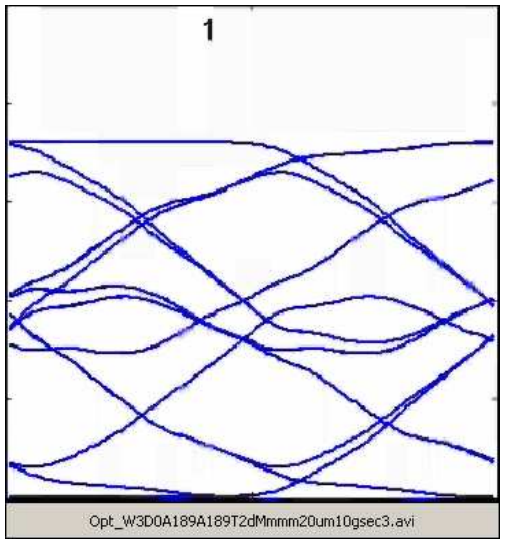
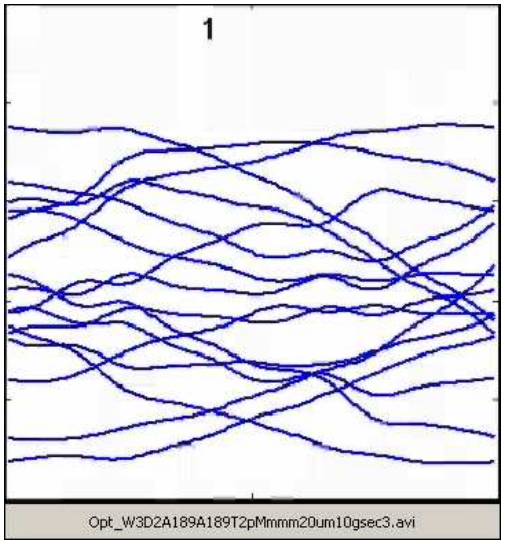
10Gb/s 20 µm input offset system

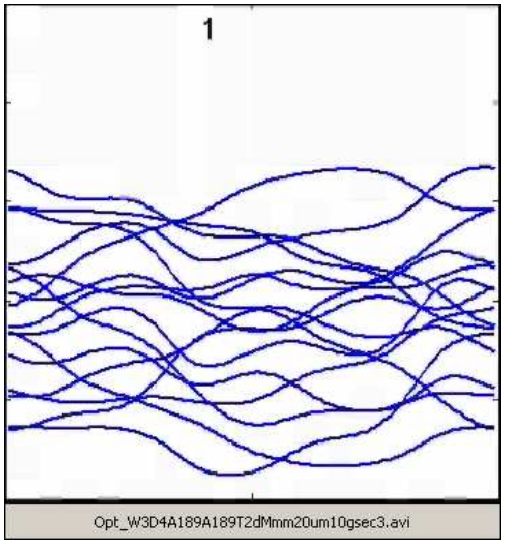
Fiber I



Fiber II



Fiber III



1. Offset launch excites large number of modes.
2. DMD induced pulse broadening degrades system performance
3. Large input offset and misalignment of connectors cause modal selective loss

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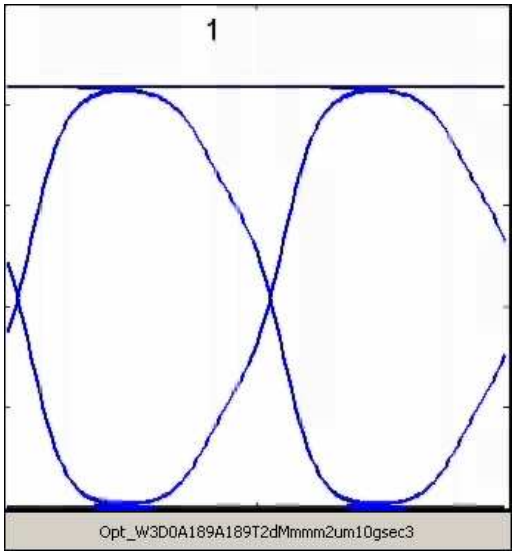
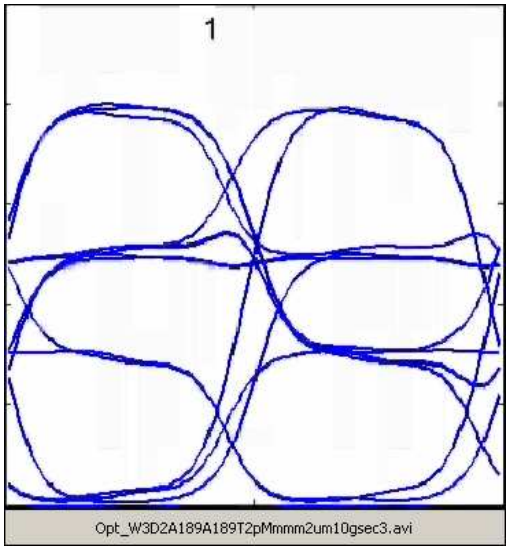
10Gb/s center launch system

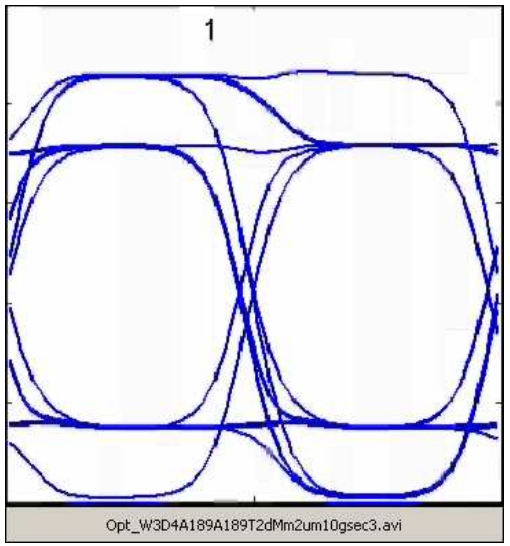
Fiber I



Fiber II



Fiber III



1. Center launch excites few lower order modes
2. The system performance is sensitive to polarization variations
3. The modal selective loss due to misalignment of connectors is negligible

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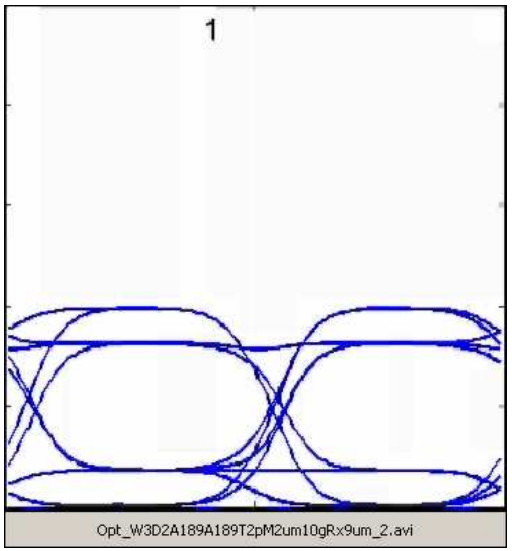
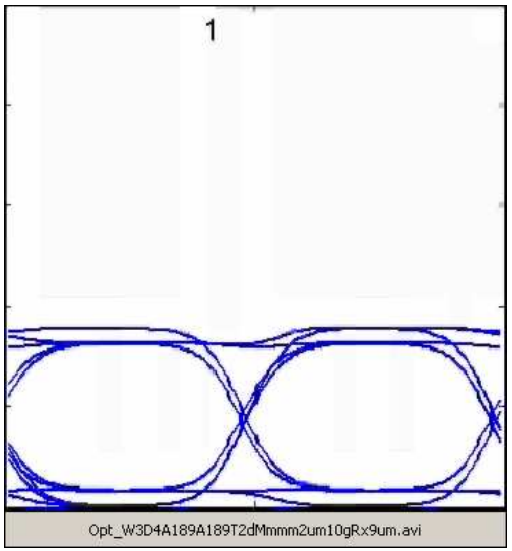
10Gb/s center launch with mode filtering

Fiber II



Fiber III



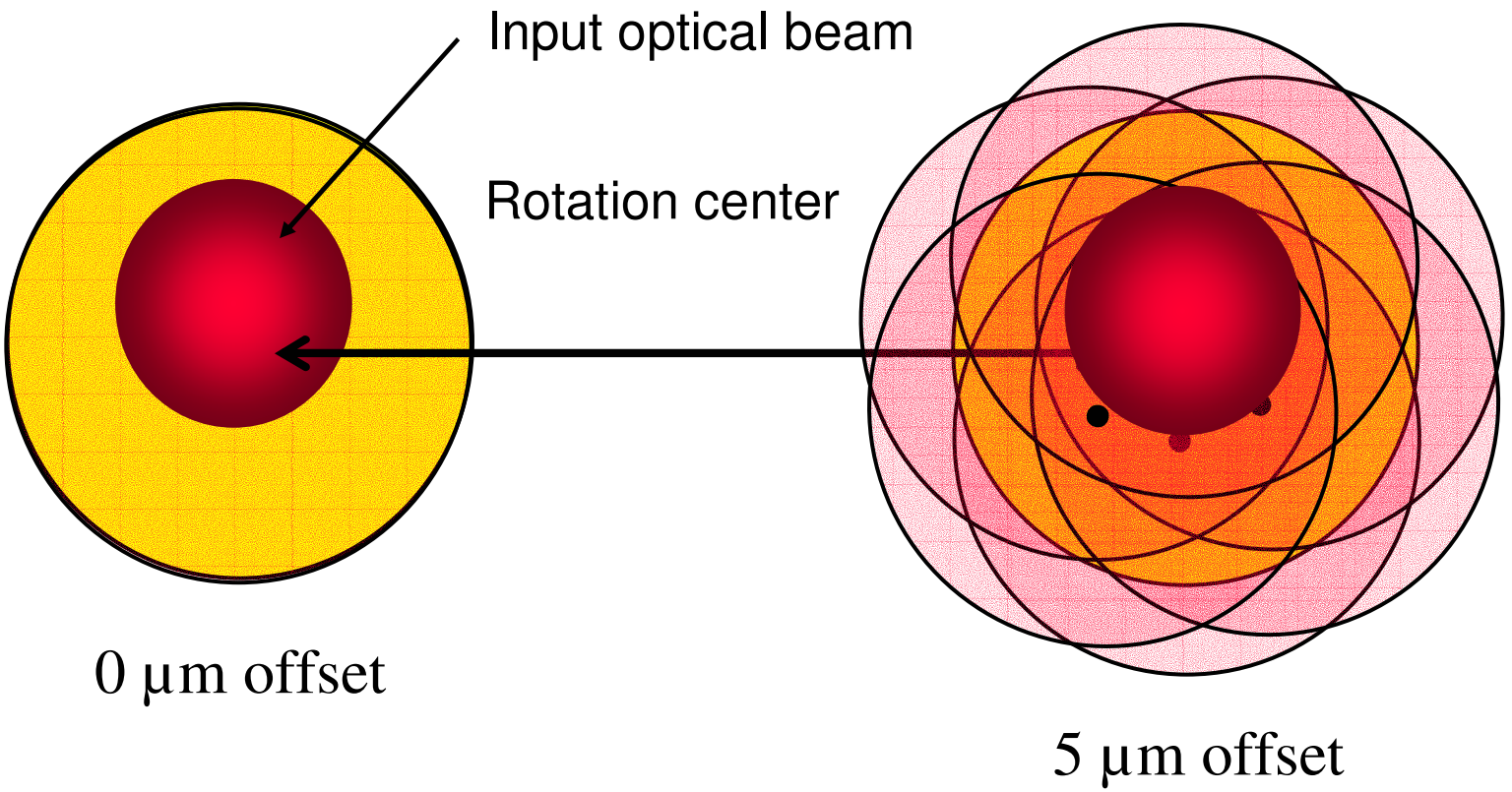
1. Few lower order modes are detected after mode filtering
2. Mode filtering induces modal selective loss
3. Mode filtering improves system performance of difficult fiber channels
4. Fibers with peaked center are the most challenging ones for mode filtering

Conclusion

- Rotating the modal field is equivalent to changing the polarization state of input beam
- 10 Gb/s system is more sensitive to the polarization caused parameter variation than 1 Gb/s system
- Offset launch is less sensitive to the polarization variation, however, the pulse broadening degrades system performance
- Modal filtering with center launch provide significant improvements for difficult fiber channels

Offset between MMF

Please click the circle on the right to play the animation



Offset between MMF includes radium offset (5 µm) and rotations around fiber center