Design study for optimized receptacle based launch condition

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Receptacle based launch

- No patch cord – all conditioning inside transceiver
- Should work for 50 and 62.5um – single solution
- Withstand 4-5um misalignments
- Maintain at least 500Mhz km for installed base
- DMD in fiber makes this hard to achieve with current solutions

What is DMD?

•Different modes propagate with different delay times

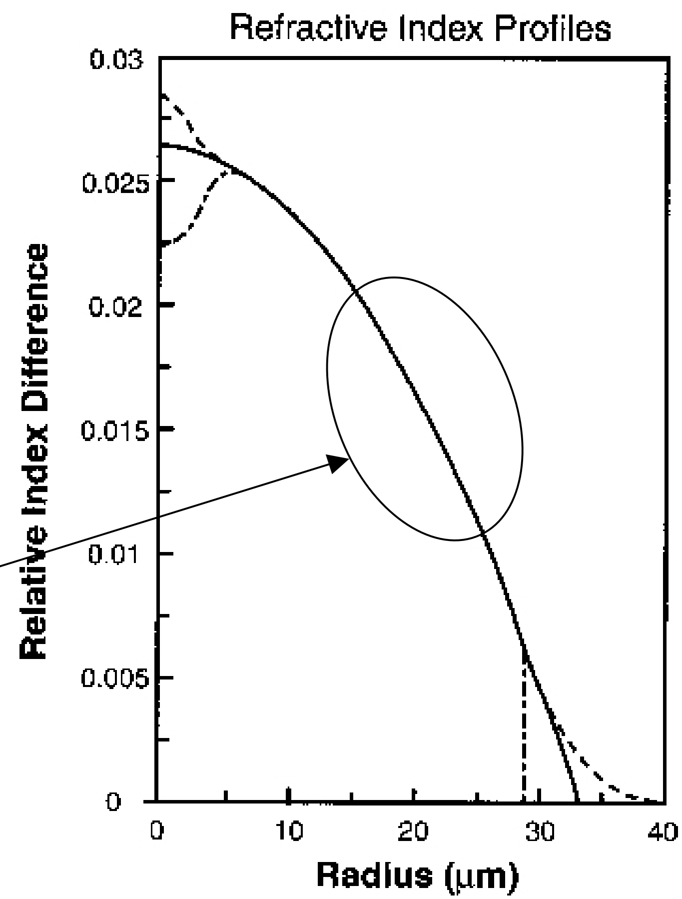
- •causes pulse spreading
- •reduces bandwidth

•Due to index variations from the "ideal"

•Variations at the center and edge of core

•Mid-radius very close to "ideal"

•If one could propagate in mid-radius region DMD can be decreased

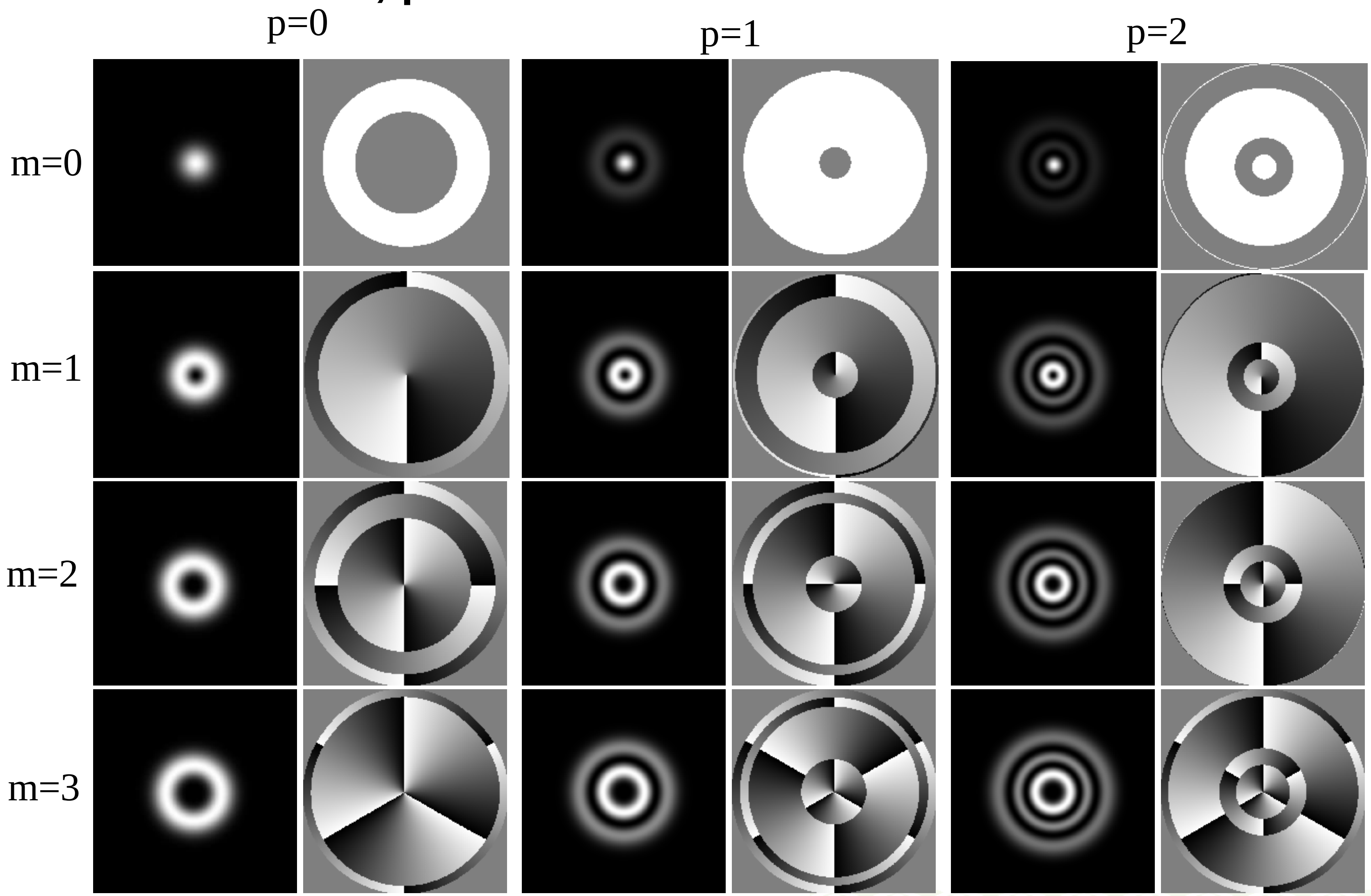


Cunningham & Lane, <u>Gigabit Ethernet Networking</u>, pp. 354-355

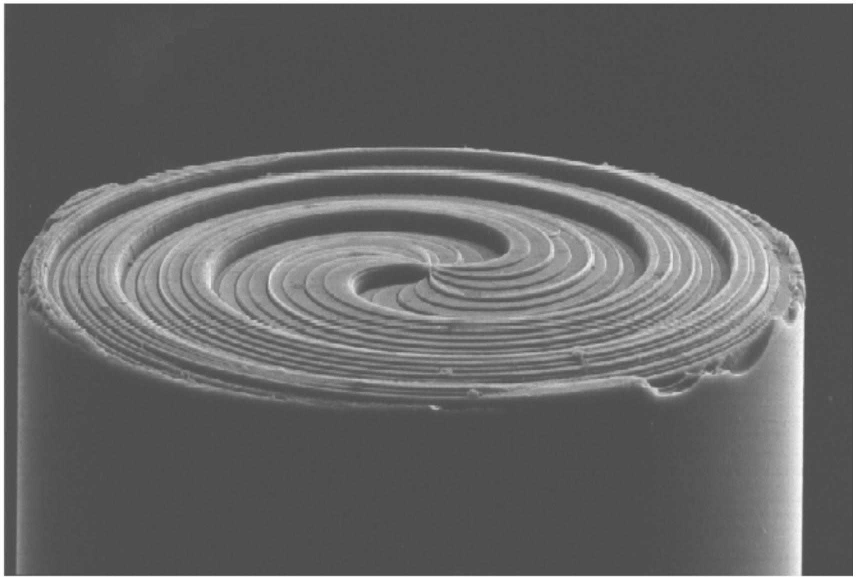
MMF modes (intensity and phase)

Solve for modes in cylindrical coordinates

m is r mode number, p is theta mode number



Vortex diffractive on a 125 μm fiber stub



m=2

- Proven technology
- Has been integrated into transceivers for several years
- Meets IEEE encircled flux specifications

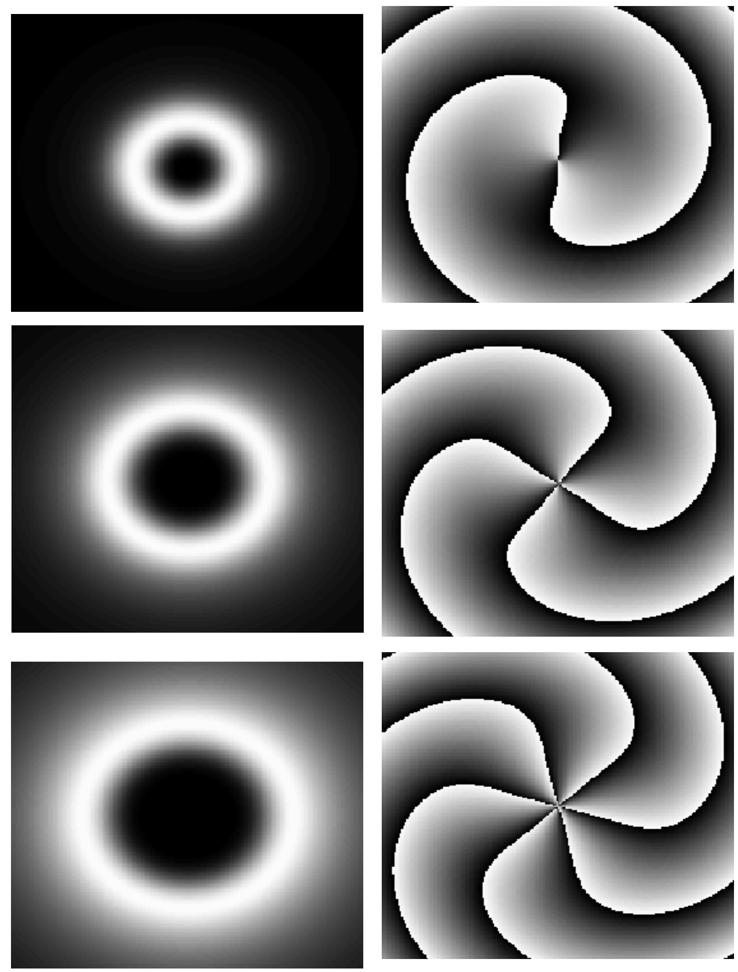
Vortex launch is very similar to modes of MMF

- **Intensity and phase at fiber plane**

$m = 2$

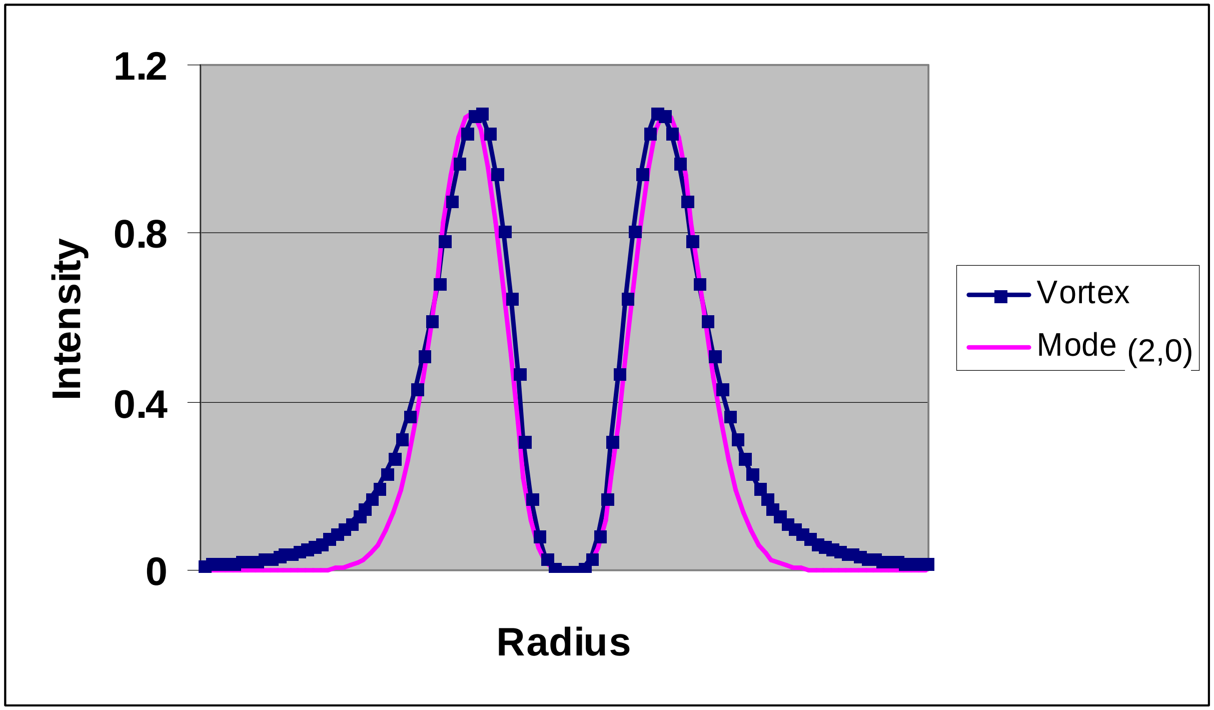
$m = 4$

$m = 6$



E. Johnson, J. Stack, C. Koehler, Light Coupling by a Vortex Lens into Graded Index Fiber, Journal of Lightwave Tech., Vol. 19, No. 5, pp. 753-758, May 2001

Mode Based Description

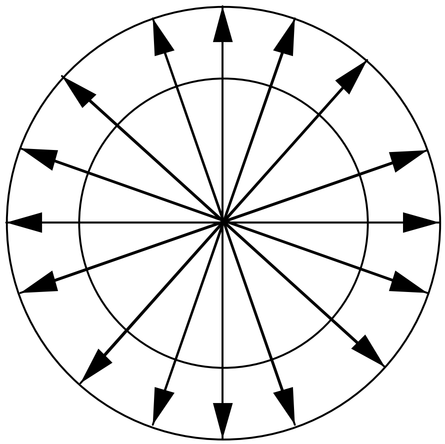


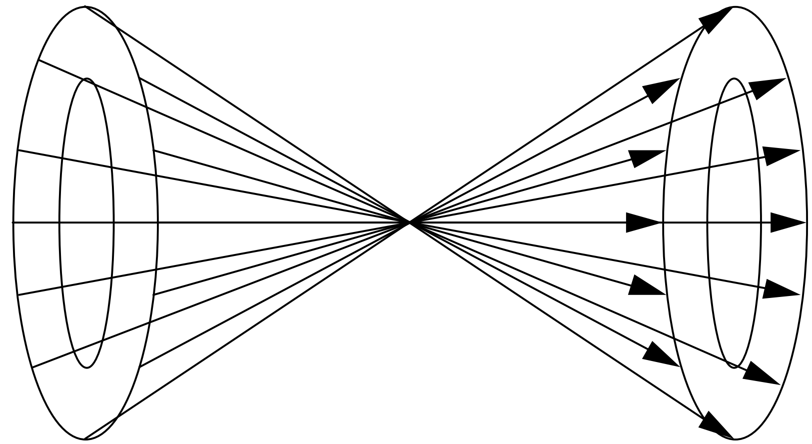
- Example shows close match to one specific mode
- Vortex launch can match to one mode or a group of modes
- More control over which modes are excited

Ray Trace based description

Donut launch

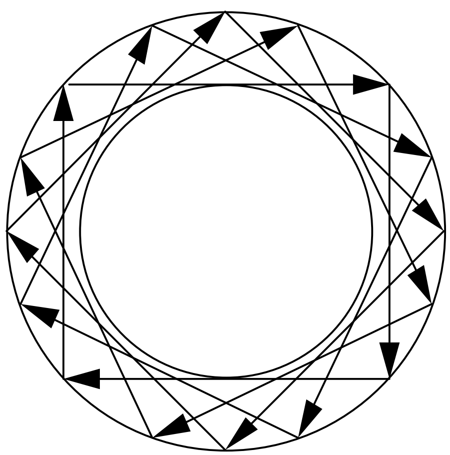
Donut rays
do not map to
fiber modes.
Can cross the
Core center.

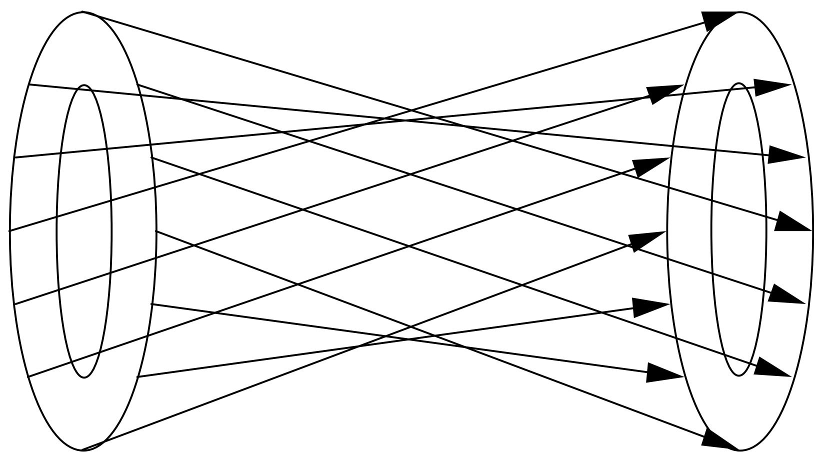




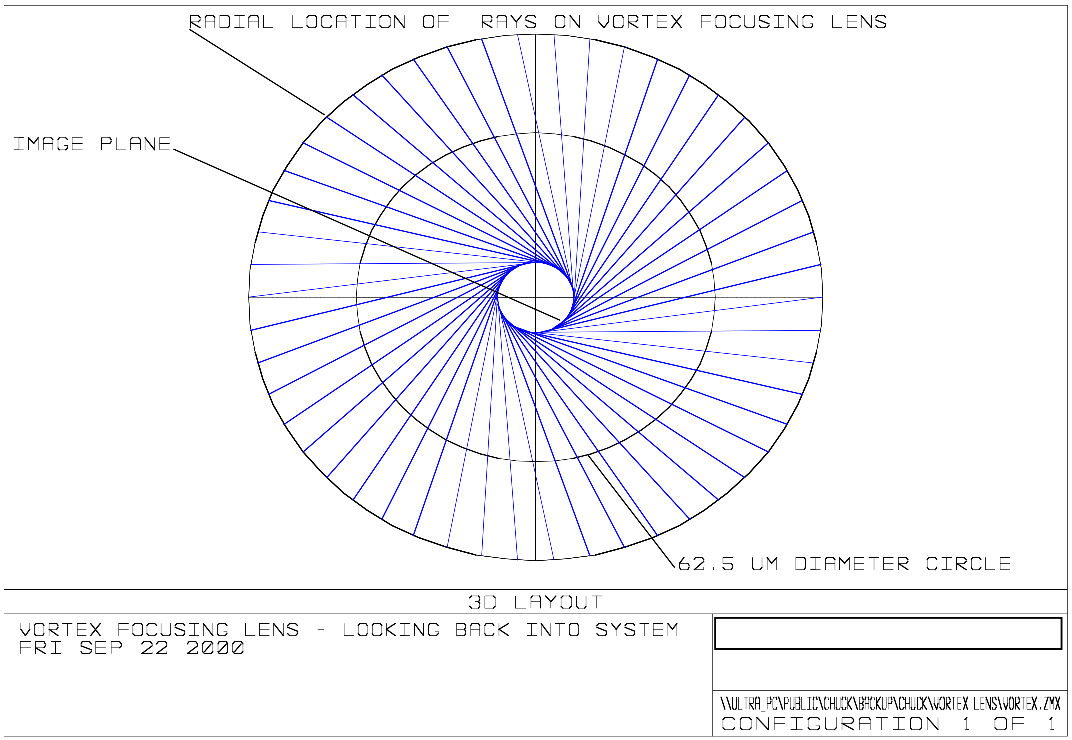
Vortex launch

Vortex rays
map to fiber
skew rays
which don't
cross the
core center





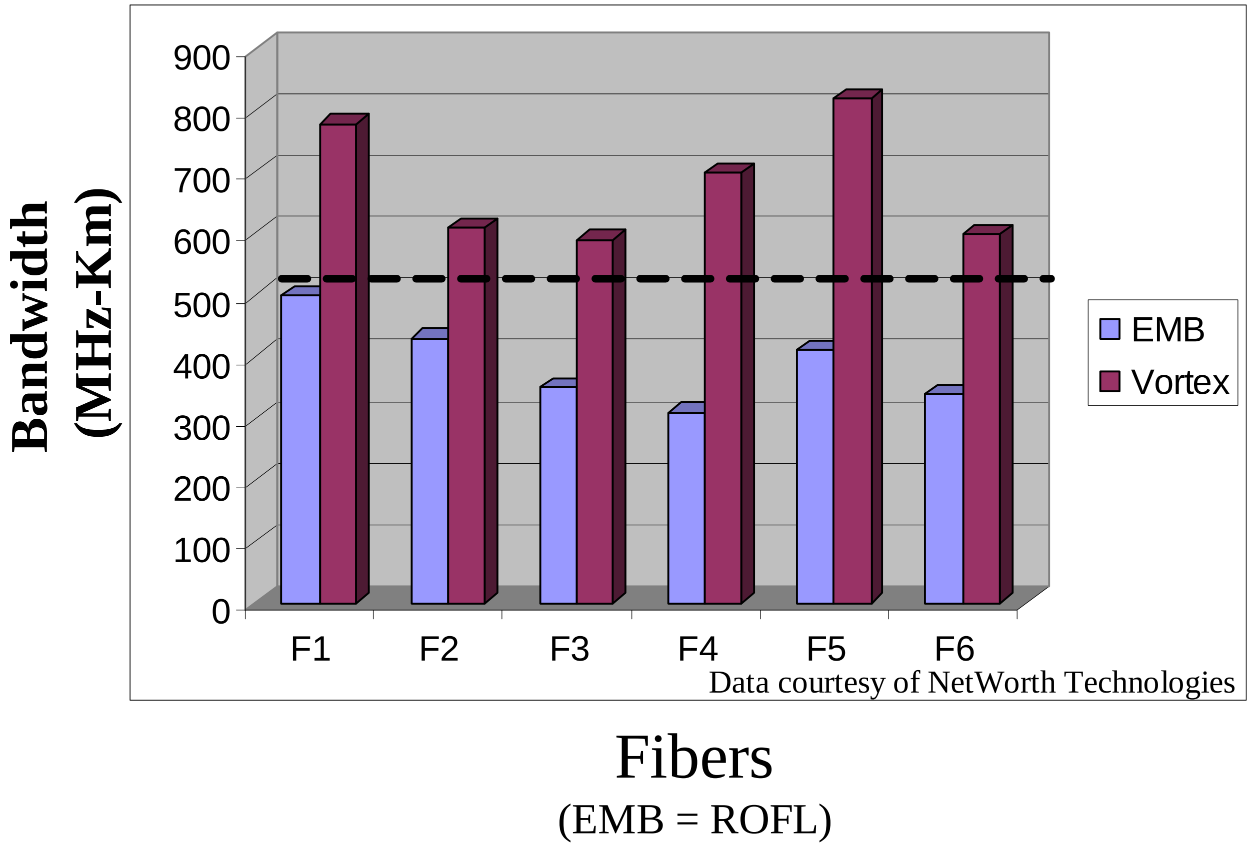
Skew Angle Verification: Ray Trace of Vortex Diffractive



•Shows rays traveling from lens through a length of MM fiber

•Rays do not cross the center

Experimental results on worst case 62.5µm fibers at 850 nm



- BW gain of 1.5 to 2

Comparison of possible launch conditions

- OFL launches into very large number of modes
- OSL launches into ~61 modes
  - BW equal to OFL BW
- Vortex could launch into a single mode
  - Very high BW
  - Sensitive to alignment and fiber bending/vibrations (mode mixing)
- Launch to a set of modes
  - Small enough to have high BW
  - Large enough to be insensitive to mode mixing

- **Previous work suggests that vortex launch can provide higher BW than OFL**
- **More rigorous understanding needed**
- **Therefore a design study has been started to determine value of this type of launch for 10GMMF**
- **Inputs from this group would be welcomed**

Plan for studying launch condition

- Use Cambridge “81 fiber study” from GBE OSL on vortex launch
  - Determine optimum launch condition
  - Determine guaranteed bandwidth for fiber set
  - Analyize with respect to lateral tolerance
    - Accounts for misalignment to fiber
    - Fiber connector offsets
    - Core to sleeve offsets
  - Targets
    - Single design for 62.5 and 50um
    - At least 5um tolerance
    - >500Mhz km BW
- DOC manufacture optimum design
- Finisar will test the lenses
- Report findings to IEEE 10GMMF

Vortex Publications

- E. Johnson, J. Stack, C. Koehler, *Light Coupling by a Vortex Lens into Graded Index Fiber*, Journal of Lightwave Tech., Vol. 19, No. 5, pp. 753-758, May 2001
- Christopher L. Coleman, Ye Christine Chen, Xu Wang, Hudson Welch, Bob TeKolste, *Diffractive optics in a parallel fiber transmitter module*, Diffractive Optics and Micro-Optics Conference, Tucson, Az, June 6, 2002, DThB4-1
- Jared Stack, Modal Beam Condition for Enhanced MMF Bandwidth, TIA FO 2.2.1 Presentation, Boulder CO, September 29, 2000