# 1060 nm MMF Core Diameter Considerations

Scott Bickham, Ph.D.
Vince Ferretti
Mike Ransford (presenter)

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# Supporters

- Jose Castro (Panduit)
- Roberto Rodes (Coherent)

# Purpose of the Contribution

Background

- Current IEEE 802.3ds discussions have largely focused on comparing 26um and 50um cores
- Additional analyses suggest that meaningful tradeoffs exist within a broader 25-29um design space

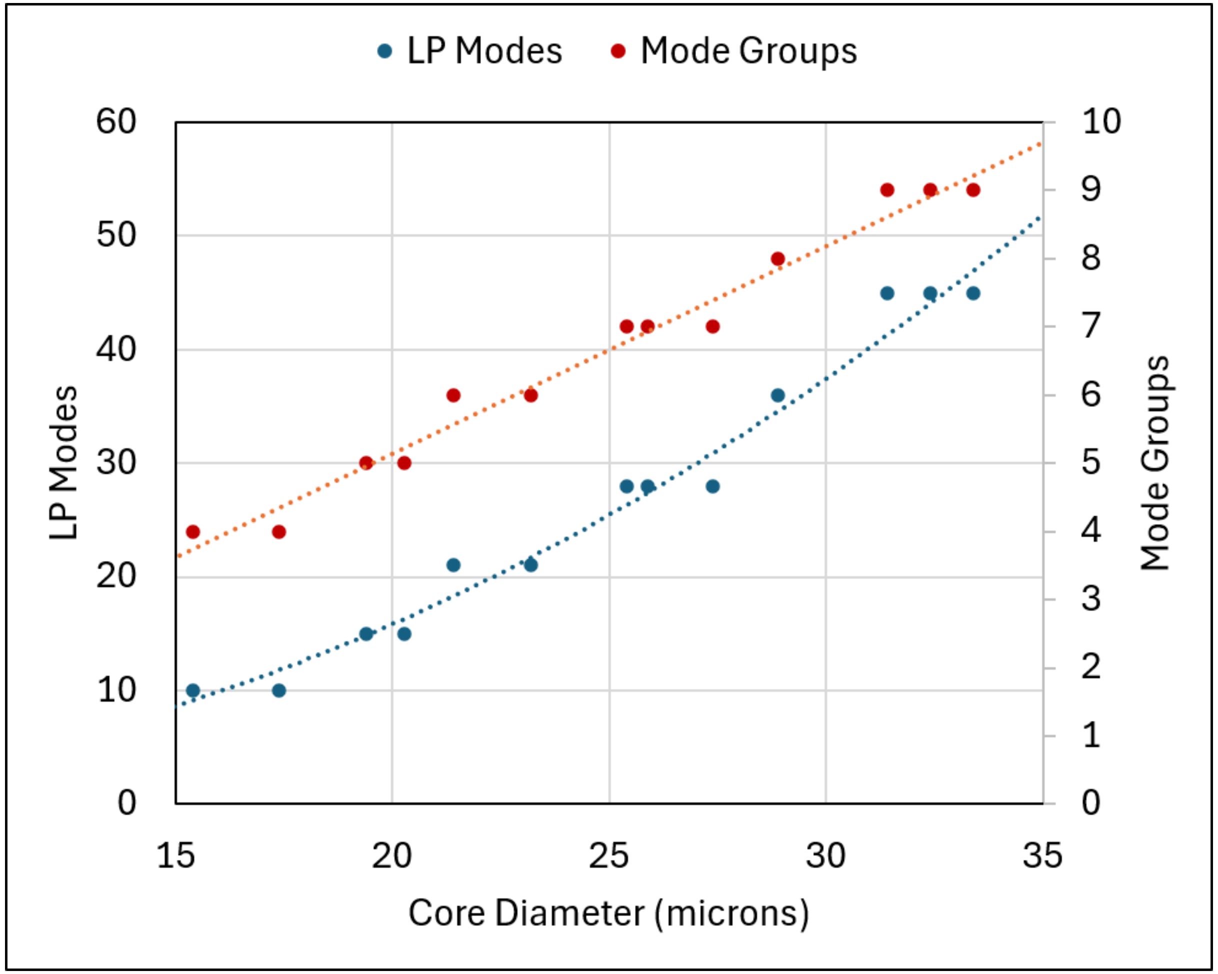
Objectives

- Highlight technical considerations associated with core diameter selection
- Illustrate potential benefits for cores larger than 26um
- Support maintaining flexibility while the 1060nm ecosystem matures

Proposal

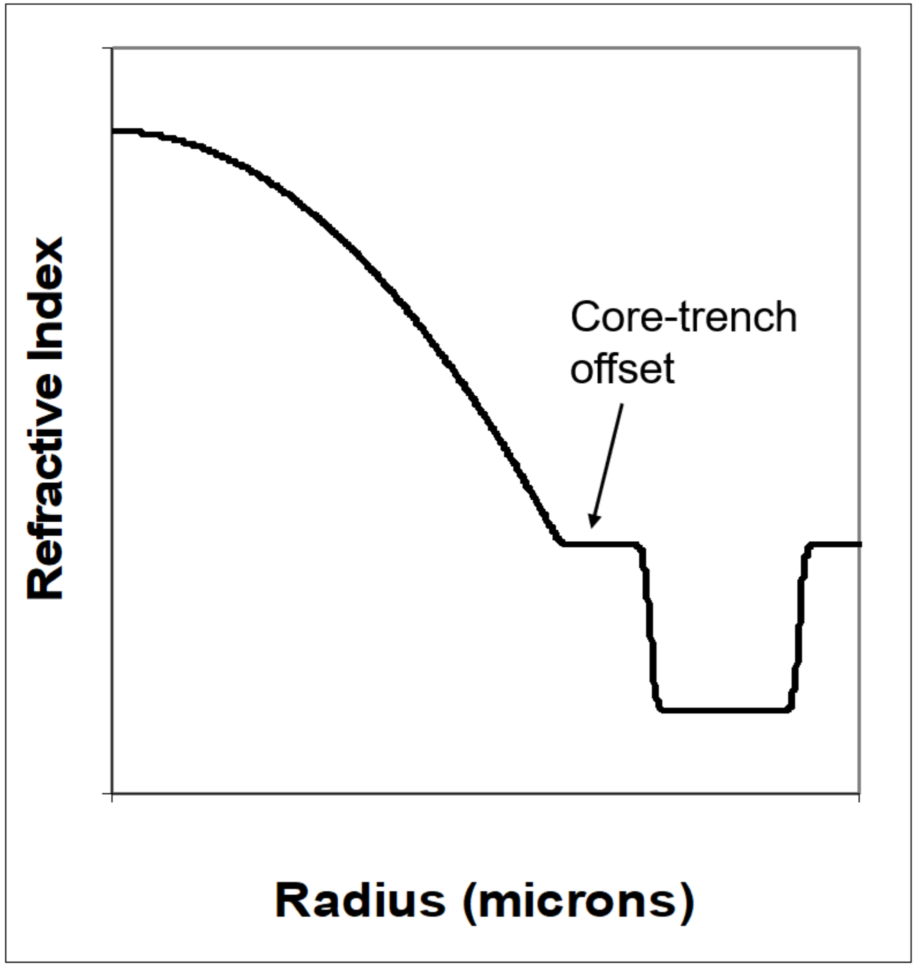
- Suggest using a nominal core diameter range of 27um +/- 2 um at this stage of the draft
- Preserve compatibility with the data presented thus far and avoid excluding other technically viable solutions.

# The number of modes supported by a MMF core increases quadratically with the core diameter

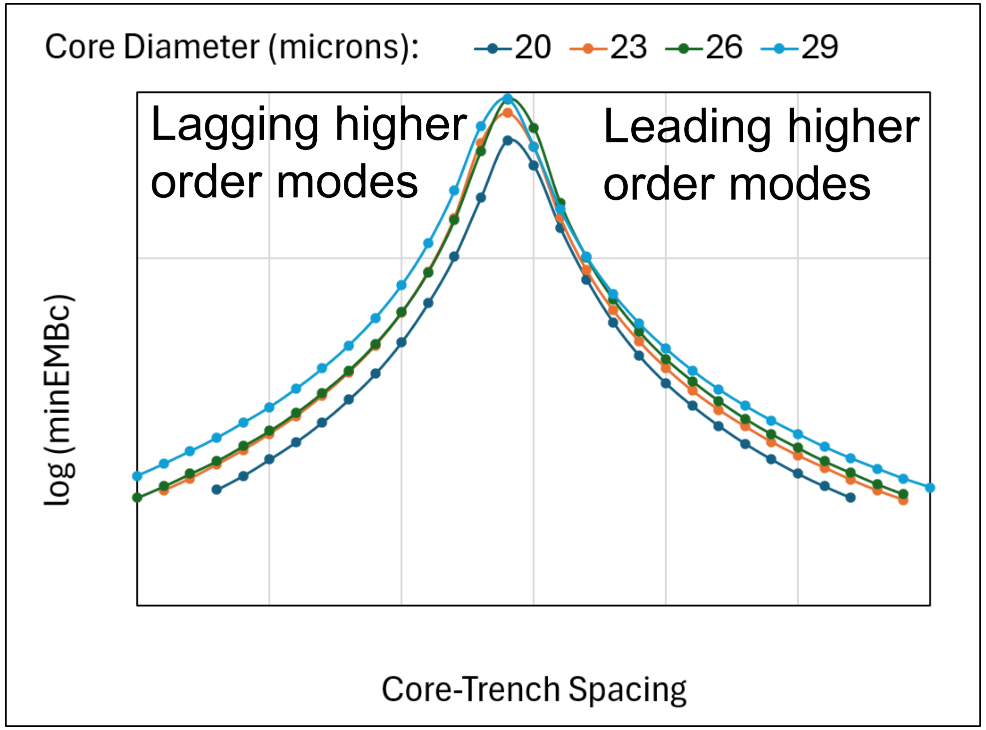



- At 1060 nm, a 26 μm core supports 28 LP modes and 7 mode groups.
- A 29 μm core supports 36 modes – a 30% increase over the 28 modes supported by a 26 μm core.
- The MMF with the larger core diameter will function more like a conventional MMF, with more modes to carry the optical signal.
- The larger core diameter will also improve coupling efficiency.

# Core Diameter Influences Sensitivity to Fiber Design Parameters

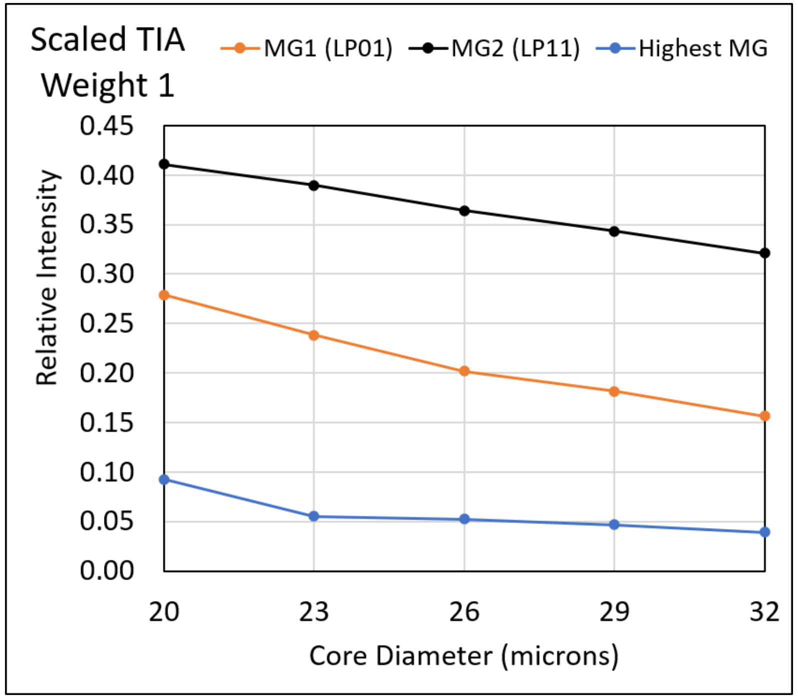


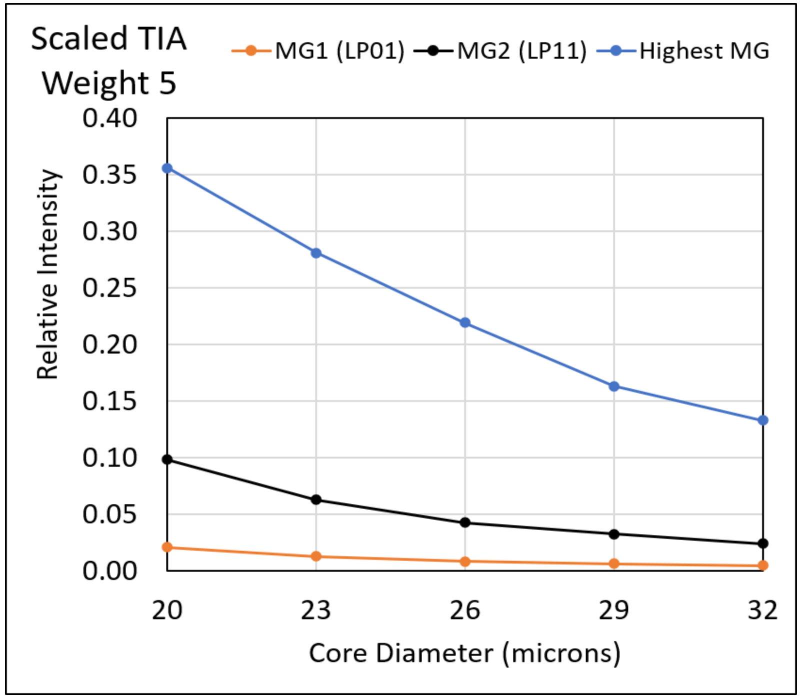

- As with 50 μm MMF, the width of the offset between the graded index core and the trench needs to be optimized and controlled during the manufacturing process to improve bend performance and increase bandwidth.
- The 29 μm design exhibits reduced sensitivity to variations in this parameter compared with smaller core diameters as shown below.

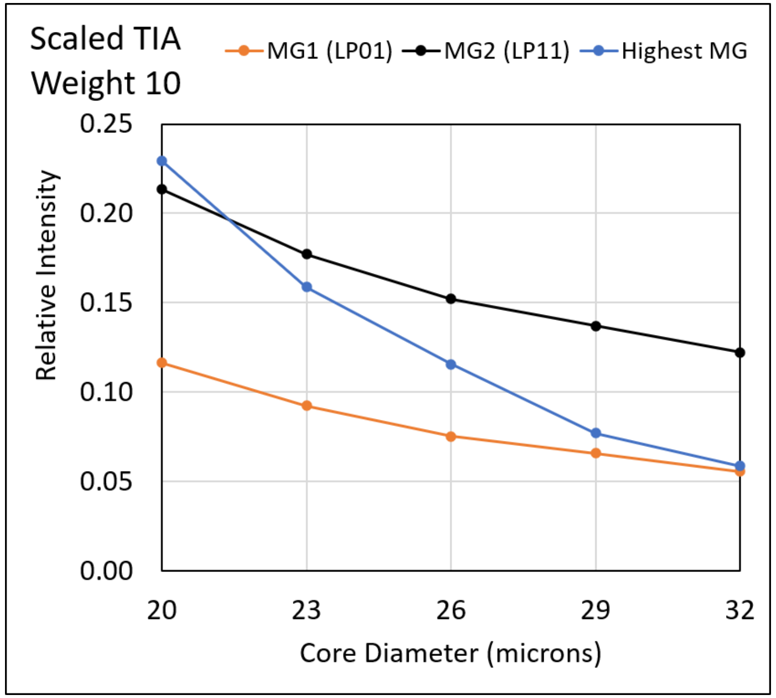


# Dependence of Mode Group (MG) Power on Core Diameter

- DMD weights have not yet been standardized for smaller 20-30 $\mu$m core diameter MMFs at 1060 nm, but we can use the IEC 60793-1-49 scaled from 50 $\mu$m to the smaller core diameters to investigate bandwidth sensitivity.
- The plots below show that a hot-inside launch (source weight 1) will couple increasingly more power into the LP01 and LP11 modes as the core diameter decreases, making the EMB more sensitive to profile errors in the centerline region.
- Hot-outside launches (e.g. source weights 5 and 10) will couple more power into the higher-order mode groups, making the larger core diameter designs less sensitive to variations in the shape of the core-clad interface.
- These observations illustrate potential robustness tradeoffs with diameter selection but do not necessarily identify an optimum

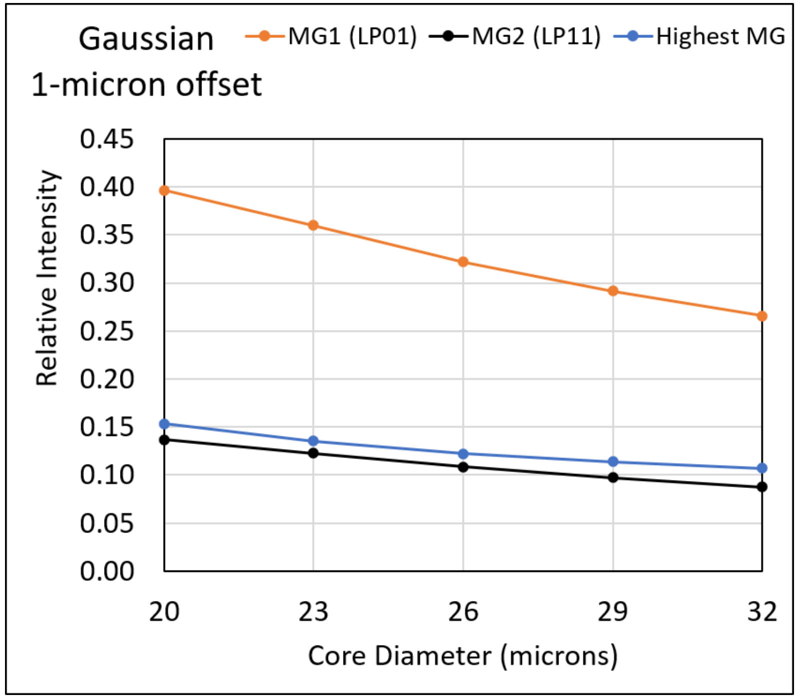


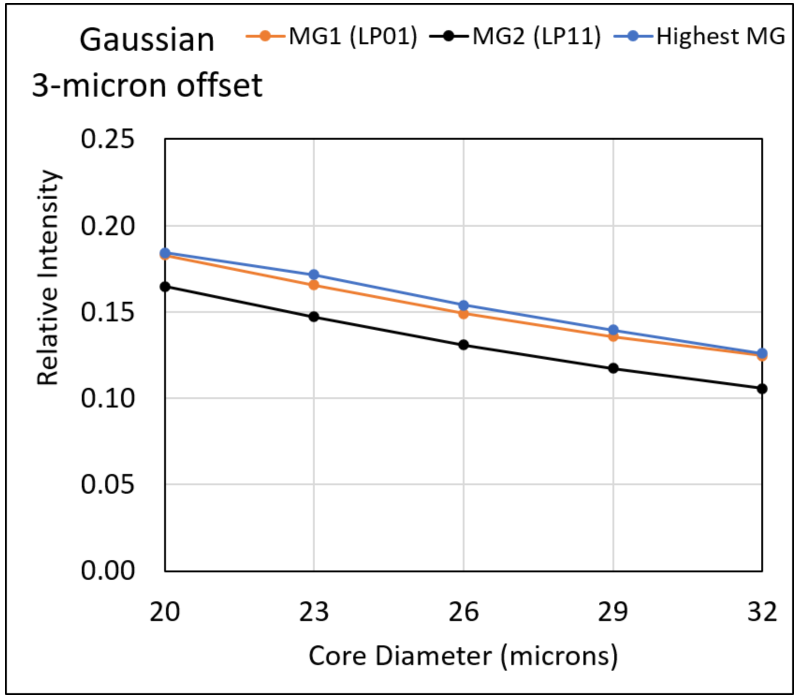



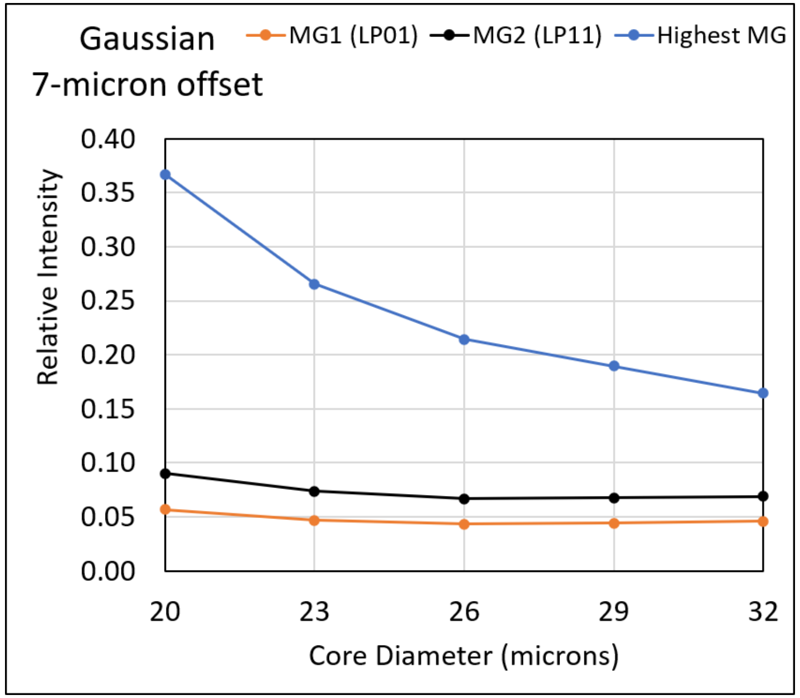



# Dependence of Mode Group Power on Core Diameter

- We also derived a trial set of weight functions to simulated a Gaussian launch with an effective MFD close to that of standard single-mode fiber and variable offsets in the 1-7 μm range.
- The results are similar to those obtained using the IEC weights: the larger core diameter will help distribute the signal over more modes, increasing the robustness to variations in the refractive index of the fiber as well as the launch conditions from the VCSEL.



# Conclusions

Key Observations

- Increasing the core diameter can increase the number of supported modes by ~30%
- Larger core diameters distribute power across additional mode groups
- Analysis indicates reduced sensitivity to launch conditions, refractive index profile variations, core-trench spacing considerations, and coupling conditions
- 29um core diameter may provide improved coupling efficiency and increased design robustness in comparison with 26um core diameter

Recommendations

- Support a nominal core diameter range of 27um n+/- 2um at this stage of the draft.
- Revisit the optimum diameter as additional VCSEL, fiber, and system level data become available
- Encircled flux values should be scaled as $EF_{new} = EF_{50um}$ * CoreDiameter / 50

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