

# MMF Optimized for 1060 nm

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# Background

- MMF channels provide lower power consumption and greater resilience to contamination and misalignment than other short-reach technologies.
- However, data-rate growth has slowed compared with single-mode PMD options.
- Although 1060 nm VCSELs can potentially improve laser bandwidth and energy efficiency, standard OM4/OM5 fibers exhibit significantly lower modal bandwidth at 1060 nm, so a longer-wavelength-optimized fiber is required.
- This presentation reviews such fiber options, building on [castro\\_3ds\\_01\\_2601](#) and related discussions in [sun\\_e4ai\\_01\\_260224](#), and [ferretti\\_e4ai\\_01\\_260224](#), and intends to gauge group interest in pursuing this new fiber.

# Comparison of the MMF Options

Parameters at 1060 nm	Option A	Option B
Diameter	50 $\mu\text{m}$	$\sim 26 \mu\text{m}$
Modal Bandwidth @1060nm $\pm 10\text{nm}$	<del>3100 - 4700 MHz-km</del> $\geq 2000 \text{ MHz-km (30m)}$ $\geq 3800 \text{ MHz-km (50m)}$	
Modal-Chromatic BW at 50m and 30m	$\geq 90\%$ Nyquist @ peak wavelength	
Coupling to VCSEL / PD (Detectors)	Similar to OM4	Smaller lenses/tapers **
Connectivity	Robust to misalignment and contamination	Robust to misalignment and contamination relative to SMF
Development by fiber vendors	Simpler than Option B, since it only requires tuning the refractive-index profile	Changing the core diameter and the refractive-index profile is more complex
Standardization	Potentially faster (same OM4 diameter) but still need some work within the standards TIA/IEC.	More work within the standards TIA/IEC standards due to fiber diameter changes.
Advantages	Higher bandwidth, low CD	Higher bandwidth, low CD, potential for spatial multiplexing if implemented in MCF

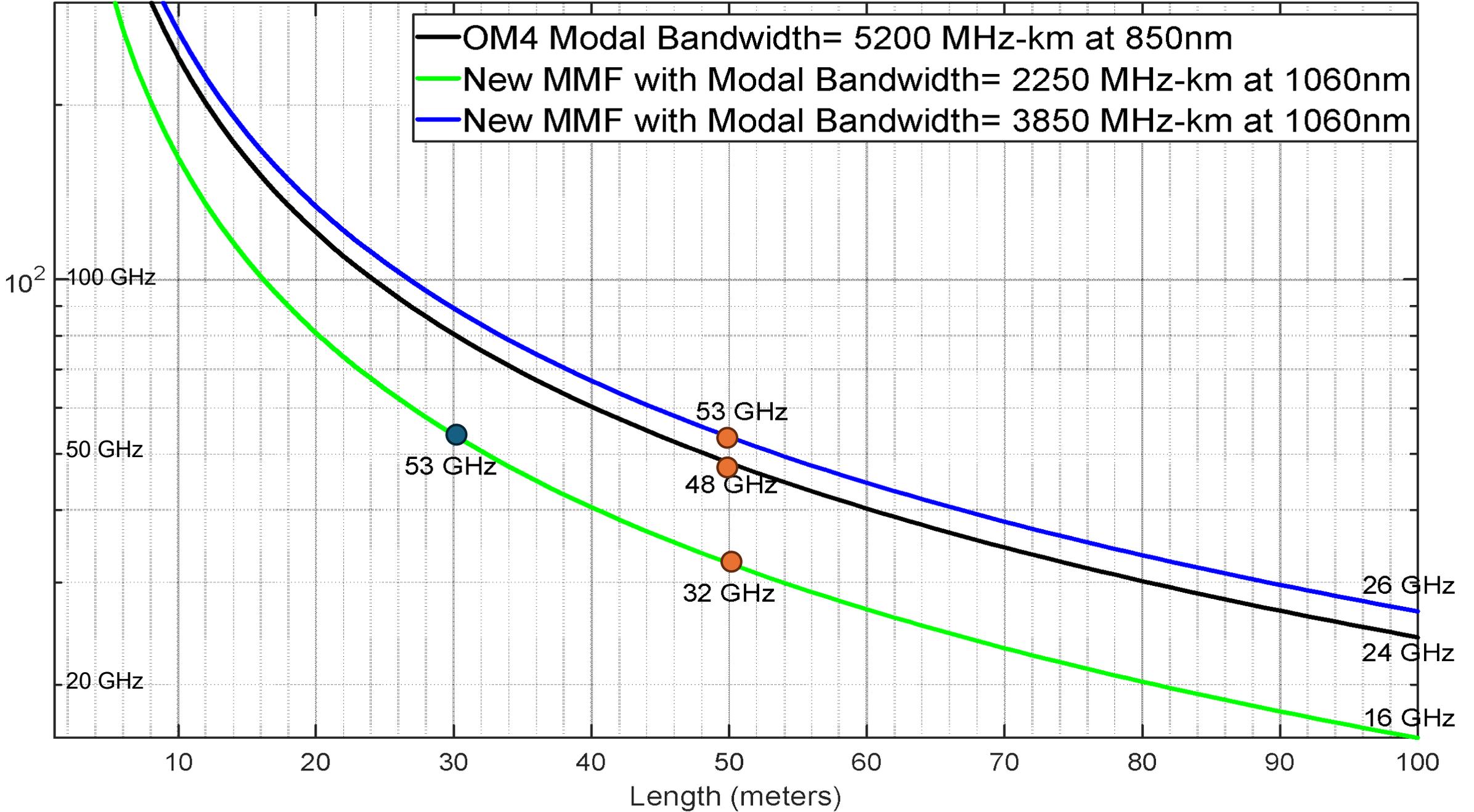
\*It depends on the channel bandwidth and distance targets, and on what is economically viable given the modal-bandwidth/yield trade-off.

\*\*Photodetector with smaller diameter improve bandwidth. Assuming PD diameter of 20 microns and 26-micron diameter fiber can potentially interface directly with small or no lenses.

# The Case for Small-Core 1060 nm MMF (Option B)

- Sustainable Economics for Fiber Producers
  - Smaller-core fiber ( $\approx 26 \mu\text{m}$ ) uses less Ge than  $50 \mu\text{m}$  fiber, reducing cost and price variability in a context of rising Ge prices and growing demand for optical network infrastructure.
  - Lower chromatic dispersion at 1060 nm allows a relaxed modal bandwidth specification while maintaining total bandwidth equivalent to OM4, improving manufacturing yield and reducing cost.
- Impact on Transceiver Cost
  - VCSELs  $> 940 \text{ nm}$  and GaAs-substrate PDs can be implemented as flip-chip devices with integrated substrate lenses at small incremental cost, offering packaging advantages in linear and 2D arrays..
  - The smaller core of Option B simplifies coupling to high-speed photodetectors — both top-illuminated and substrate-lens-illuminated — with active diameters below  $20 \mu\text{m}$ .
  - Simple validation of transceivers (linear) for short reaches (only TECQ needed for  $\approx 10 \text{ m}$  cases)
- Roadmaps and Future PMD Generations
  - Enables longer reaches and a broader operational wavelength window with reduced eye-safety concerns.
  - The smaller core facilitates future integration into multicore fiber (MCF), enabling compact, high-density solutions for AI scale-up and scale-out networks.

# Modal-Chromatic 3dBe, VCSEL Spectral Width 0.45 nm



# Discussion

- VCSELs and MMF operating at 1060 nm could potentially provide energy-efficient and economically viable short-reach links for AI scale-up and scale-out applications.
- The options presented include fibers with 50  $\mu\text{m}$  and  $\sim 26 \mu\text{m}$  core diameters.
  - A smaller-core fiber ( $\sim 26 \mu\text{m}$ ), optimized for 1060 nm, could provide additional benefits such as easier coupling to photodiodes and potentially lower fiber cost relative to 50  $\mu\text{m}$ -core MMF.
  - However, a smaller-core MMF may increase the complexity of fiber development, testing, and standardization.
- Presenter preference is **Option B**, which could enable future MCF-MMF implementations for high-density installations and spatial multiplexing, enhancing bandwidth while maintaining key MMF advantages (relaxed tolerances / robustness to contamination).
- Would the group support moving forward with a 1060 nm optimized MMF **Option B** and the related standardization effort?