

# Silicon Photonic Integration of DWDM and Mode-Division Multiplexing for Advancing Multi-Dimensional Data Transmission

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**Abstract:** We demonstrate an innovative integration of DWDM and Mode-Division Multiplexing, enabling multi-dimensional transmission with 8 wavelengths and 4 modes. The packaged photonic chip demonstrates a remarkable 512 Gbps aggregate bandwidth with a BER < 1e-9.

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## 1. Introduction

In the rapidly evolving landscape of data centers and high-performance computing driven by AI/ML tasks, the demand for cutting-edge optical solutions has surged. Our innovative fusion of Dense Wavelength Division Multiplexing (DWDM) and Mode-Division Multiplexing (MDM) achieves unparalleled performance, extending extreme parallelism across wavelengths and modes. In this work, we leverage our DWDM devices that not only provide exceptional total bandwidth but also set new benchmarks for energy efficiency [1]. Additionally, we seamlessly integrate MDM, at the forefront of advancements in foundry-based silicon photonic integrated circuits, providing a new dimension in overall transmission capacity by multiplexing encoded light onto orthogonal modes of a waveguide [2, 3]. Our demonstration of this cutting-edge technology is embodied in our packaged photonic chip, showcasing a remarkable 512 Gbps aggregate bandwidth with a BER < 1e-9.

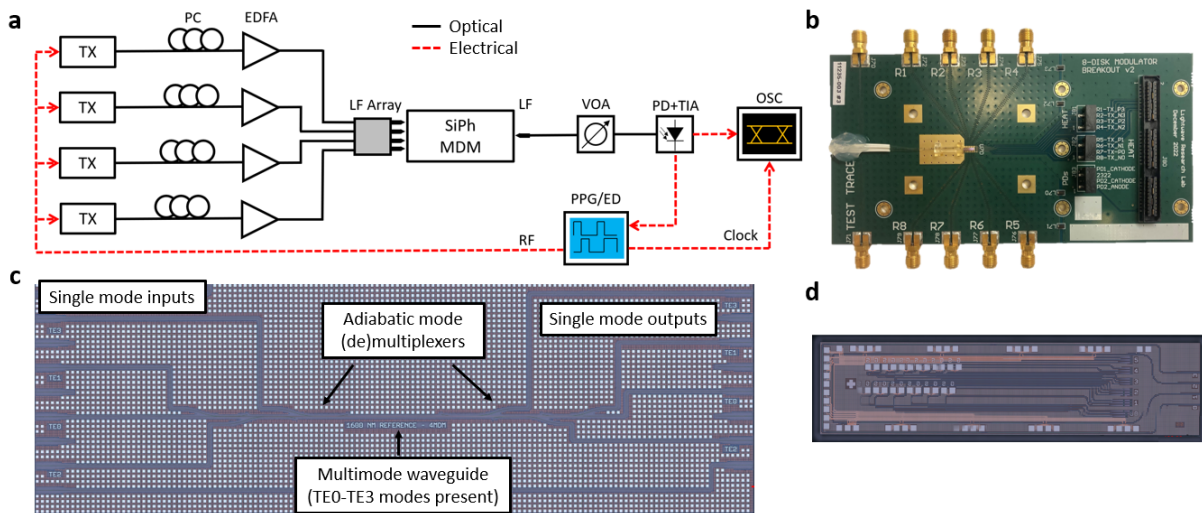


Fig. 1. (a) Experimental setup for DWDM/MDM demonstration. TX, Transmitter; PC, Polarization Control; EDFA, Erbium-Doped Fiber Amplifier; LF, Lensed Fiber; VOA, Variable Optical Attenuator; PD, Photodiode; TIA, Transimpedance Amplifier; OSC, Oscilloscope; PPG, Pulse Pattern Generator; ED, Error Detector. (b) Packaged custom microdisk modulators. RF wirebonds and traces allow high-speed testing and DC wirebonds allow thermal control. (c) Micrograph of SiPh mode-division multiplexer and demultiplexer. Adiabatic couplers and multimode waveguide at center, edge couplers located on left and right sides of PIC. (d) Micrograph of modulator PIC packaged in (b).

