



Passage M1000

A 3D Photonic Interposer for AI

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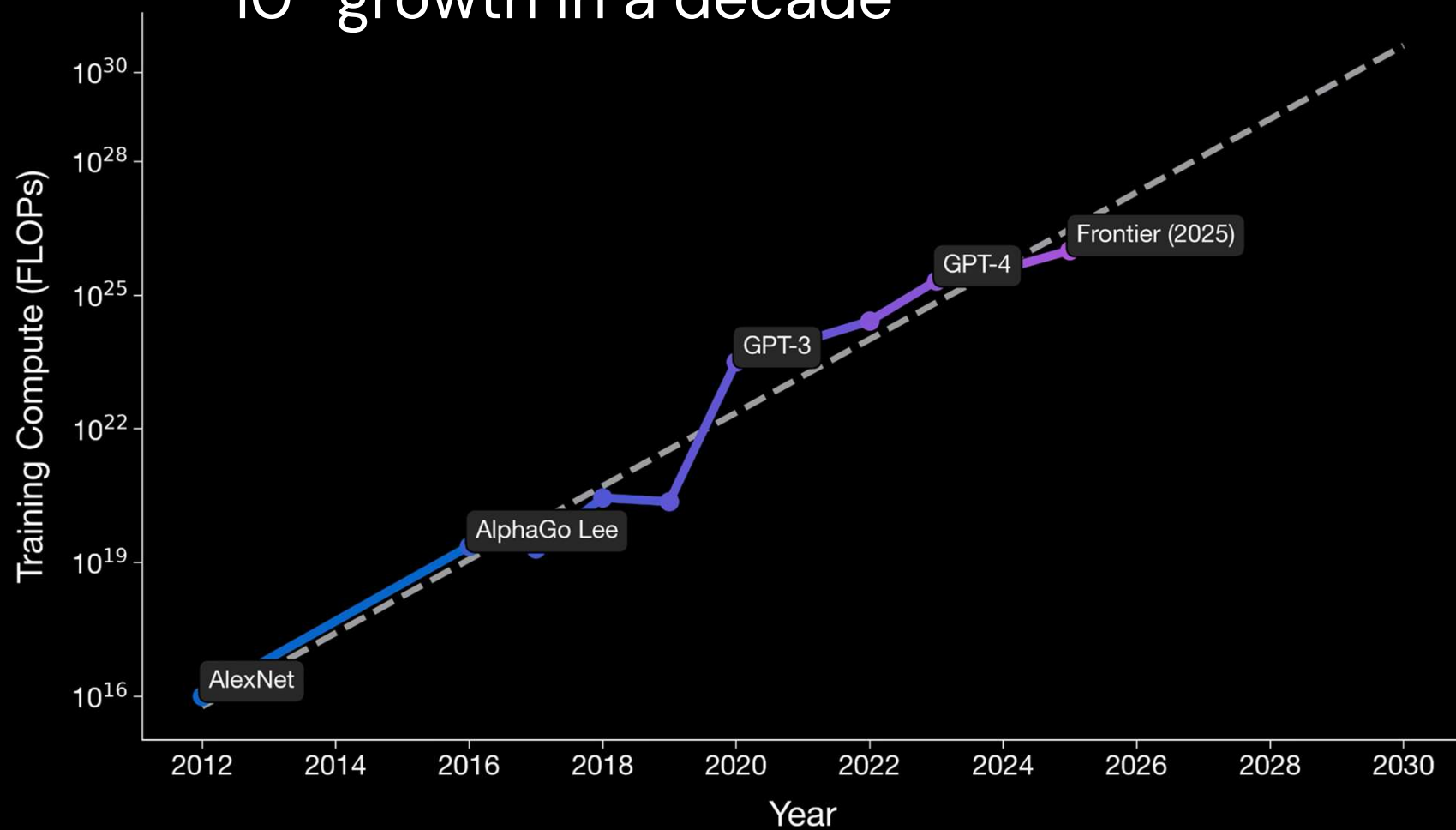
Hot Chips 2025



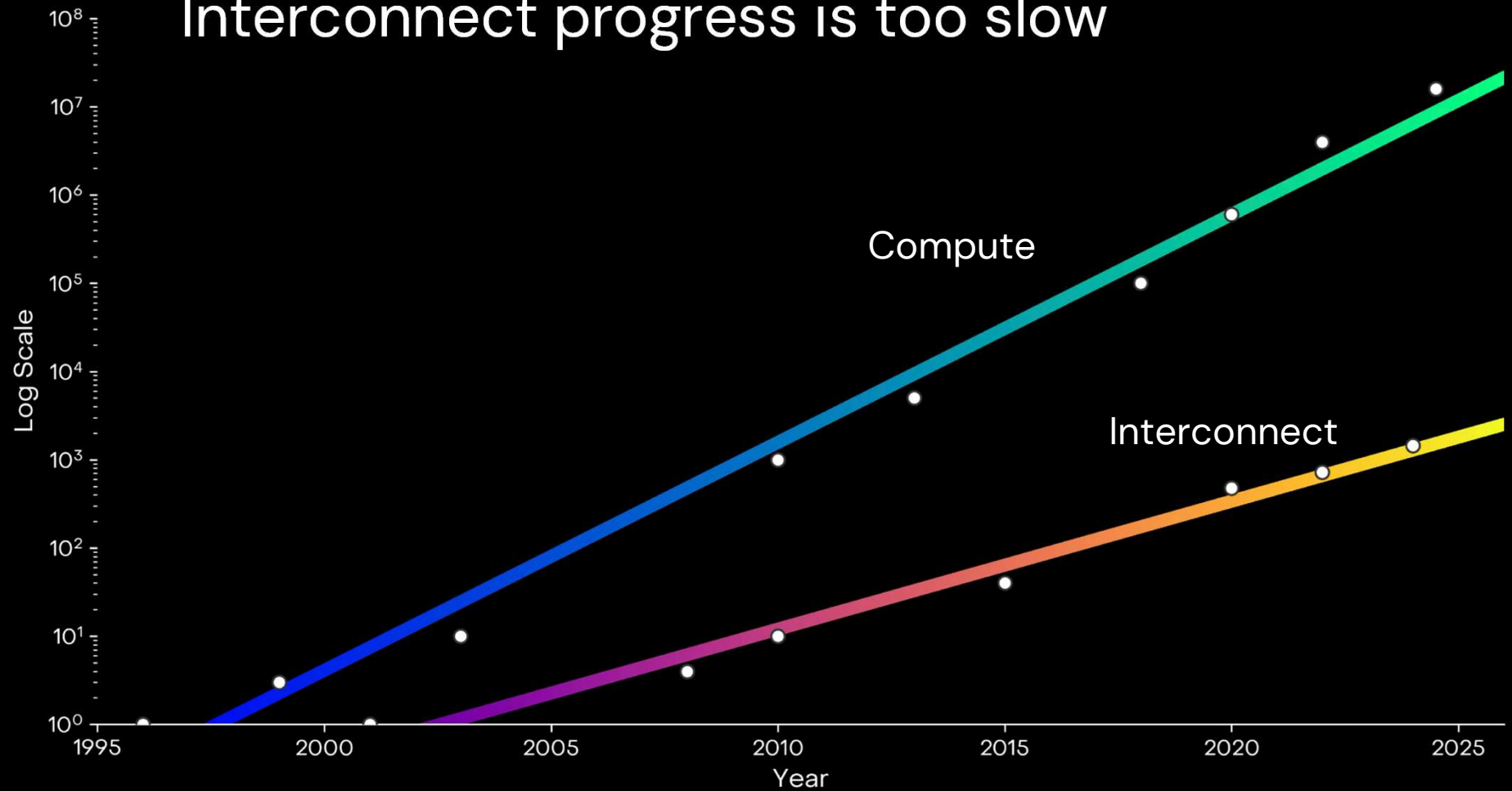
A decade of AI breakthroughs

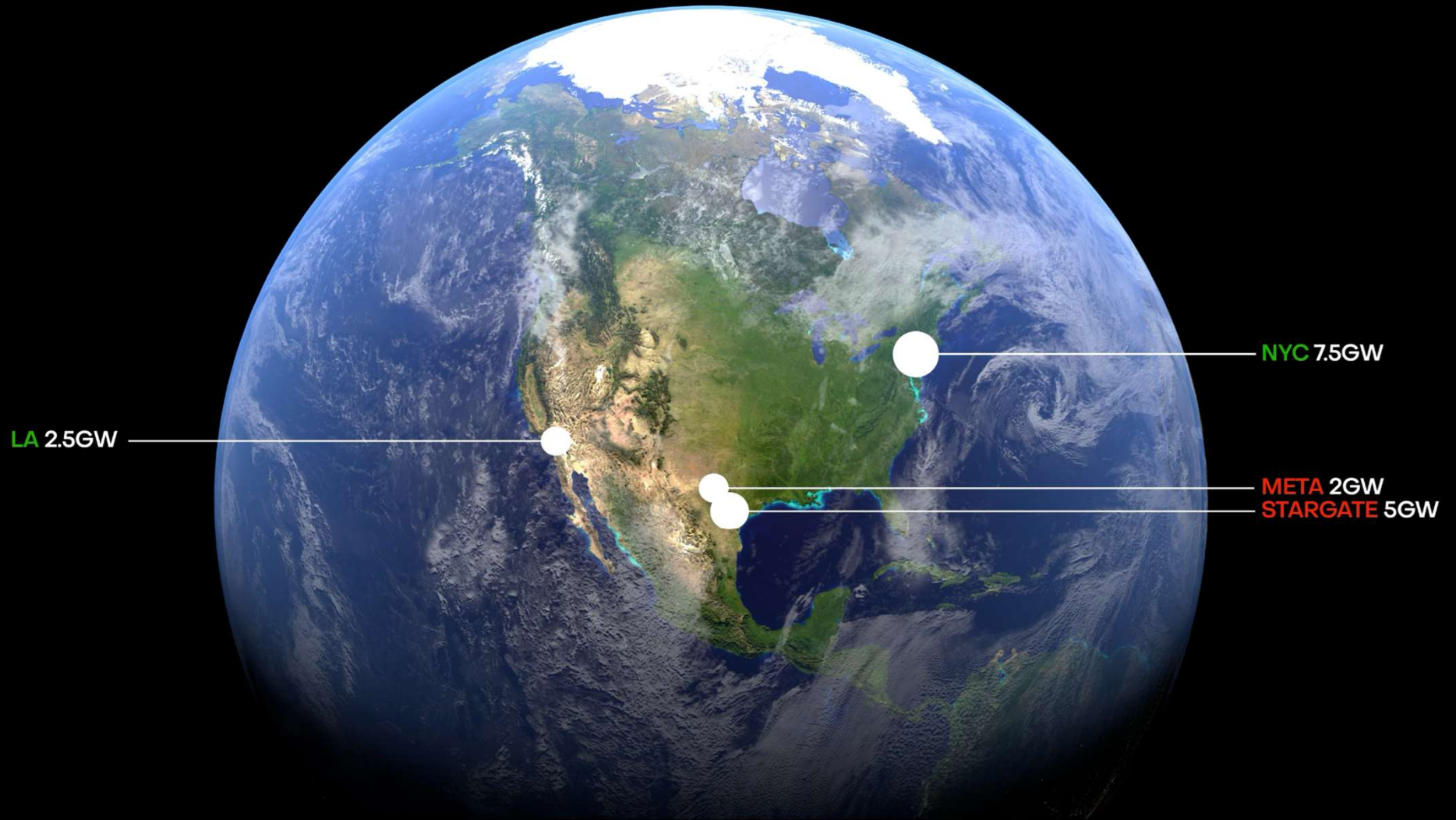


10^9 growth in a decade



Interconnect progress is too slow





The interconnect bottleneck

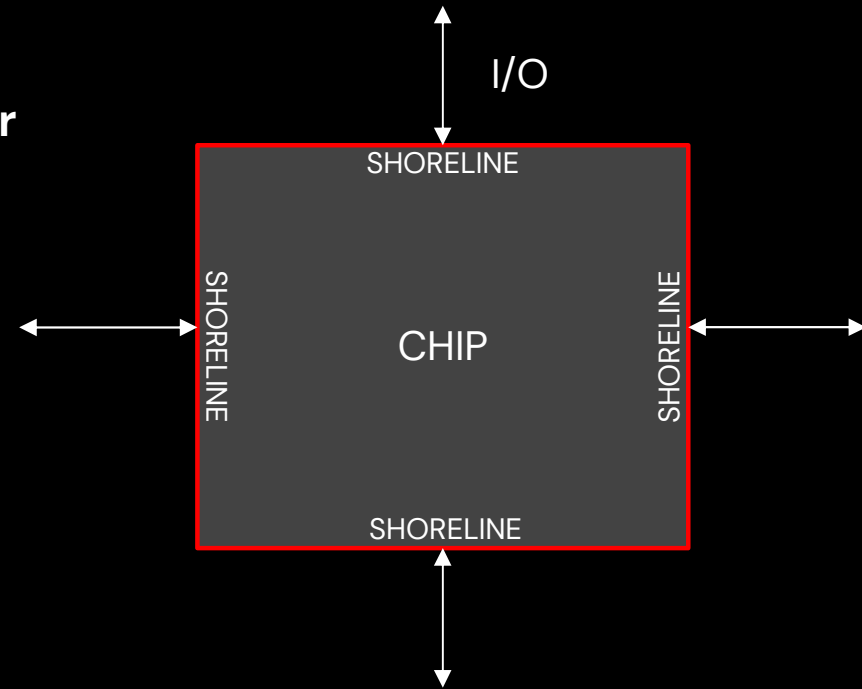
Communication happens at the chip **perimeter**

FLOPS $\propto$ Chip Area (L^2)

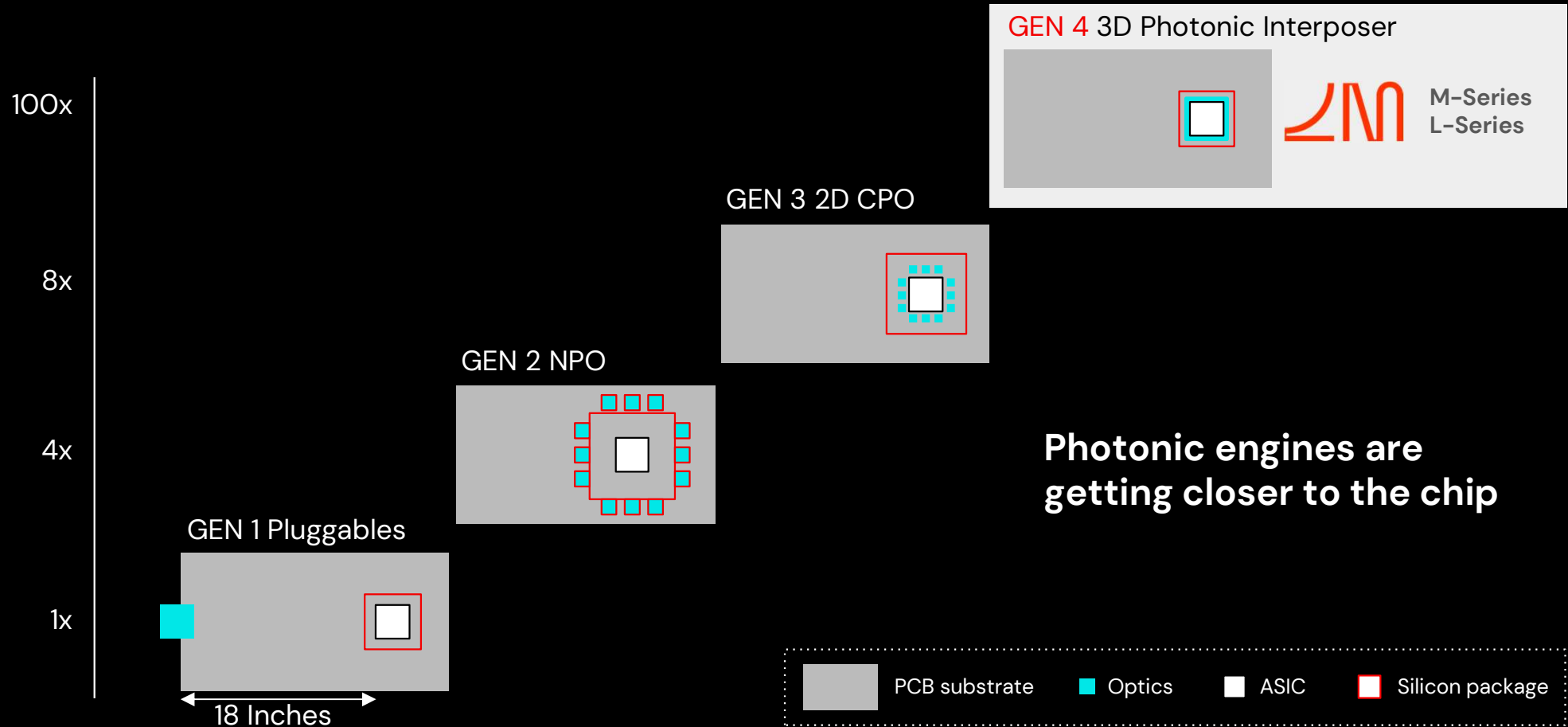
IO Bandwidth $\propto$ Chip Perimeter (L)

We need $>100\times$ the bandwidth.

A new paradigm is needed.



The promise of silicon photonics

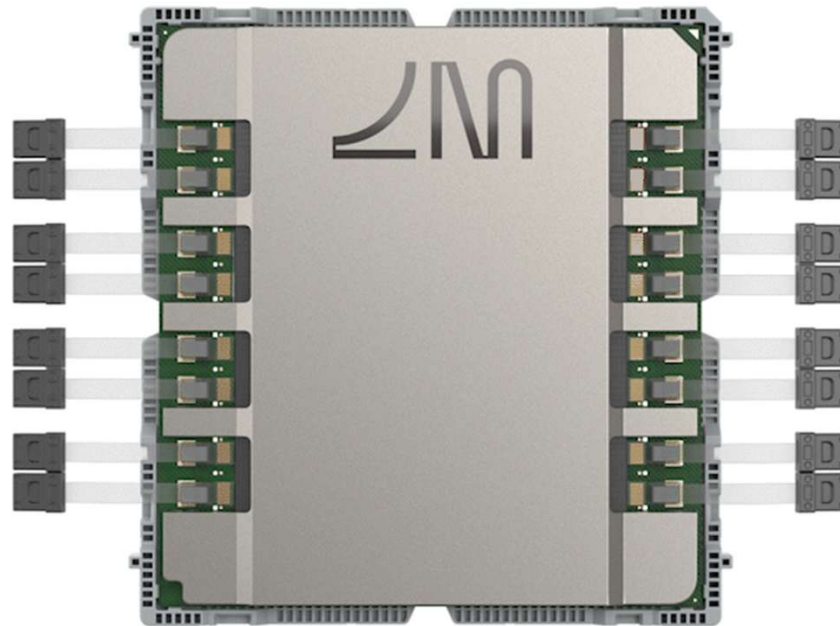


Our Solution

Passage M1000
3D Photonic Interposer

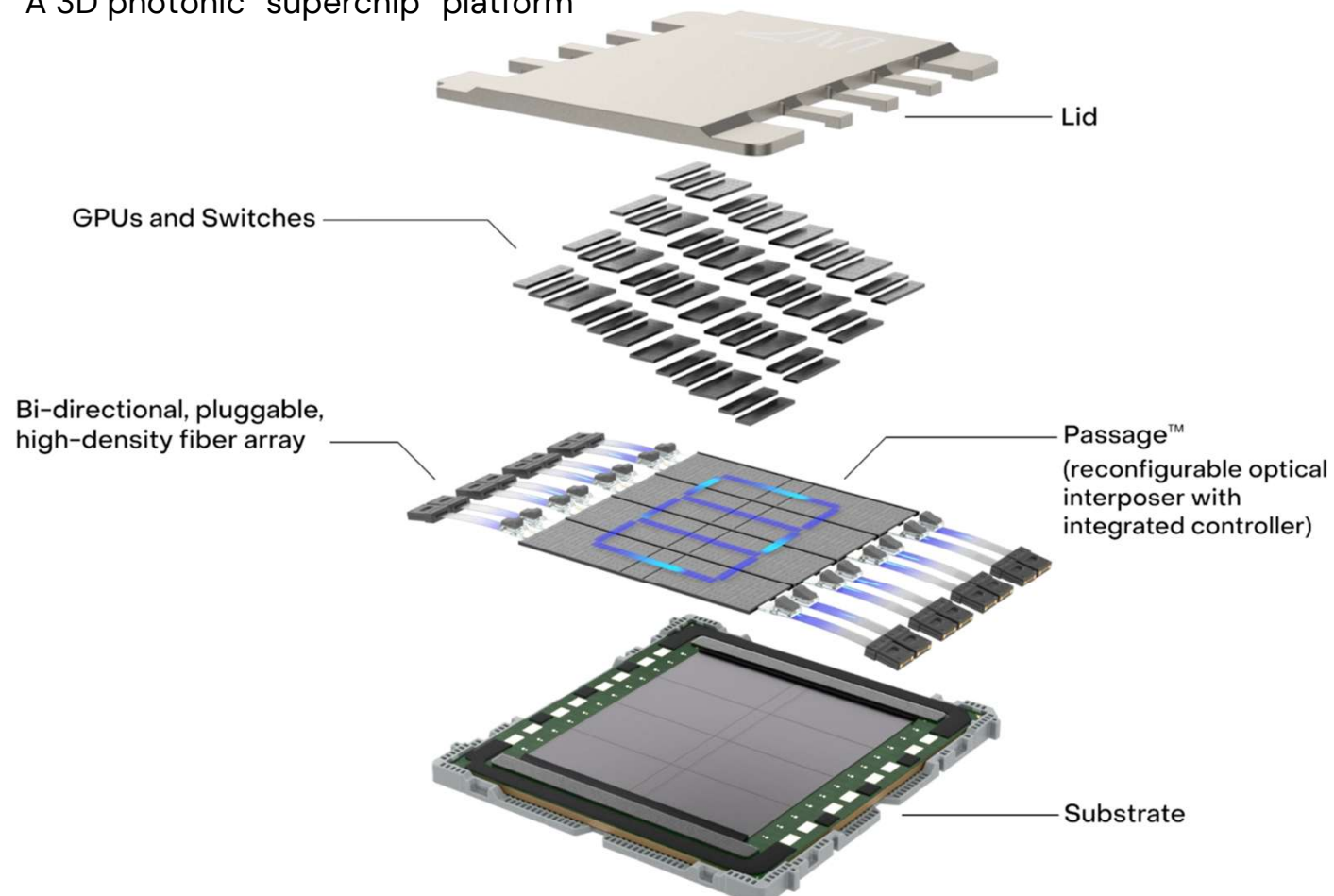
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A 3D photonic "superchip" platform

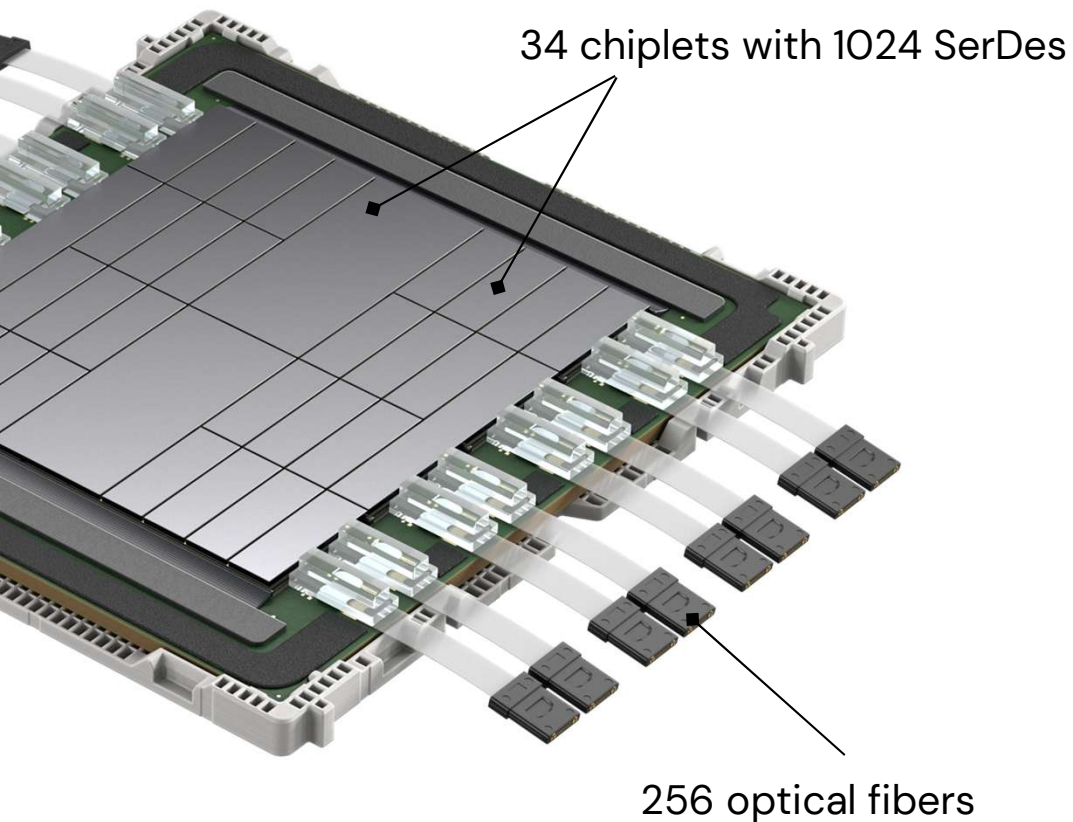


Passage M1000

A 3D photonic “superchip” platform



Unprecedented performance and scale

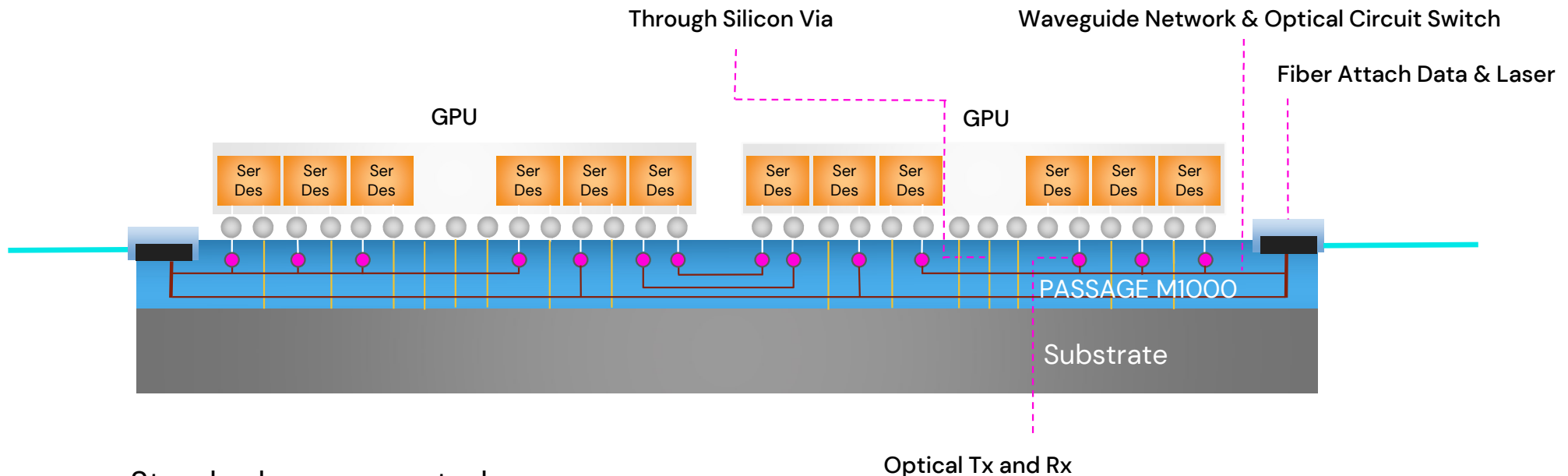


Specifications	
Bandwidth (Tx + Rx)	Up to 114 Tbps
# of SerDes	1024
Silicon die Complex	4,000 mm ²
Power delivery	>1.4 W/mm ² density
Fibers	256
Redundancy	Optical circuit switching

Platform deep dive

Architecture, performance,
and key features.

3D stacking requires compact optical Tx and Rx



Standard processes today

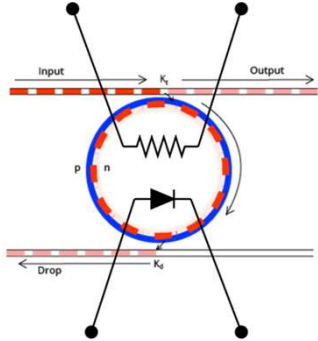
Bump pitch: $\sim 120 \mu\text{m}$

Bump size: $\sim 80 \mu\text{m}$

Area for a transmitter/receiver: 0.015 mm^2

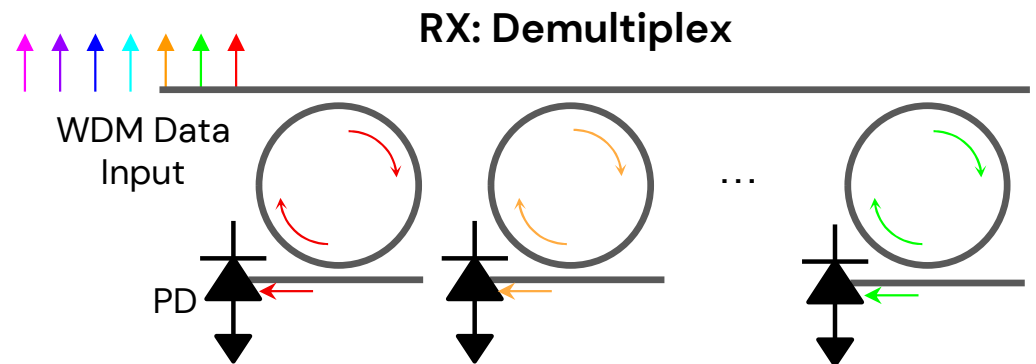
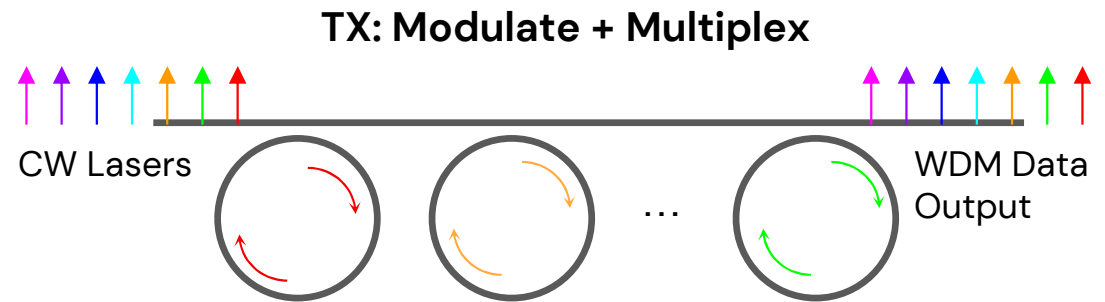
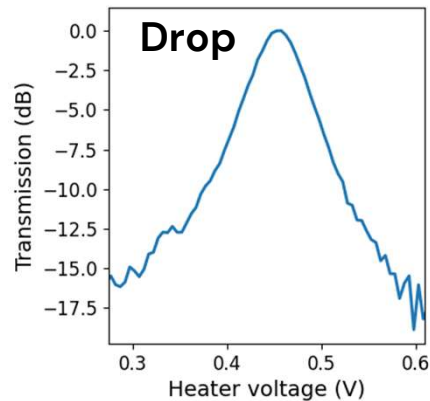
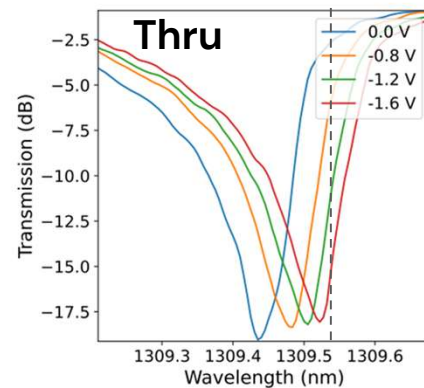
The heart of the engine: silicon microrings

Ultra-compact, high-speed, WDM-friendly



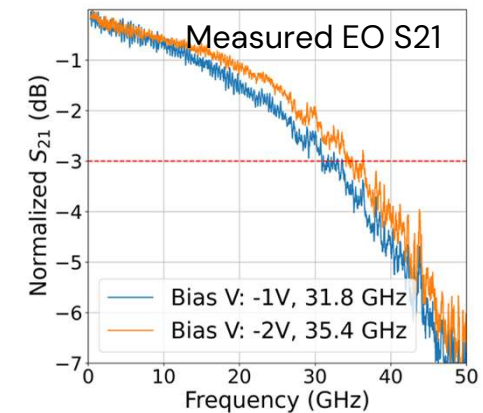
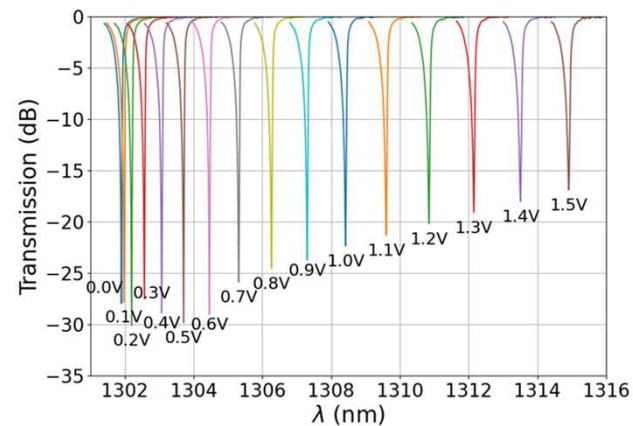
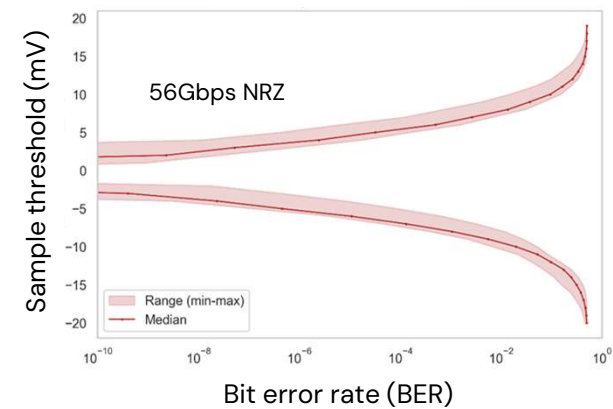
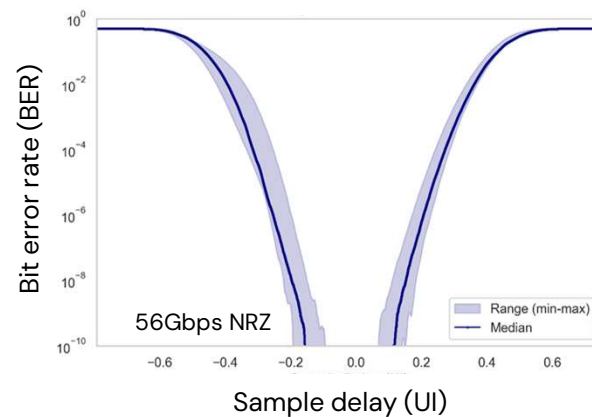
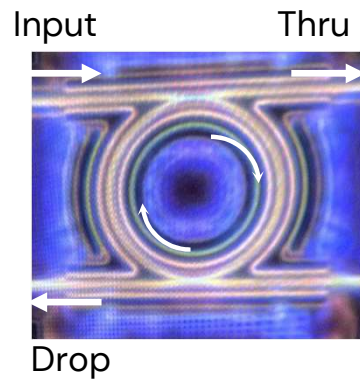
Diameter ~ 15 μ m

Resistive heater
for tuning
Depletion PN junction
for modulation

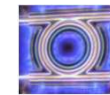
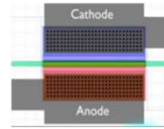


Ultracompact transmitter and receiver

Microrings with inductorless driver and analog front end enable **0.006 mm²** Tx + Rx area.

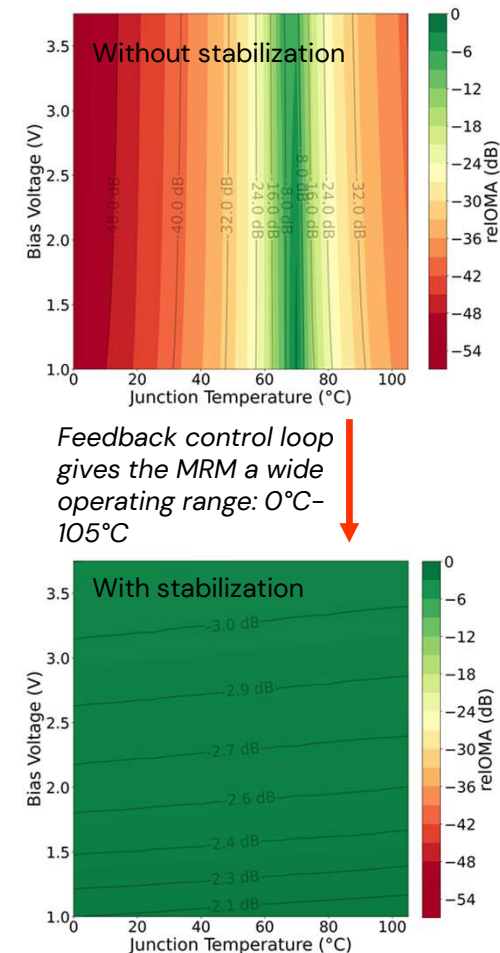


Why rings are revolutionizing photonics



Metric	MZM [1]	SiGe/Ge EAM [2, 3]	MRM [4]
3D-CPO compatible?	No, too large. >1000μm	No, too large. 50–100μm	Yes, ~15μm in diameter.
Need another multiplexer?	Yes	Yes	No, already a multiplexer
Thermal stability	Stable, only thermal gradient between the two arms affect.	Stable with feedback loop. Modulation is temperature dependent.	Stable with feedback loop. Transmission depends on ring resonance.
Power consumption [5]	~50 mW	~10 mW	~1 mW
Transmitter penalty	<5 dB	<10 dB	<5 dB
Optical bands	O-band & C-band	C-band only	O-band & C-band

- [1] M. Streshinsky, et al. Opt. Express 21, 30350–30357 (2013).
 [2] J. Fujikata, et al., Opt. Express 31, 10732–10743 (2023).
 [3] Y. Liu, et al., PRJ 8, 1474 (2023).
 [4] E. Timurdogan, et al. Nature Communications 5, 4008 (2014).
 [5] DAB Miller, et al. Opt. Express 20, A293–A308 (2012).



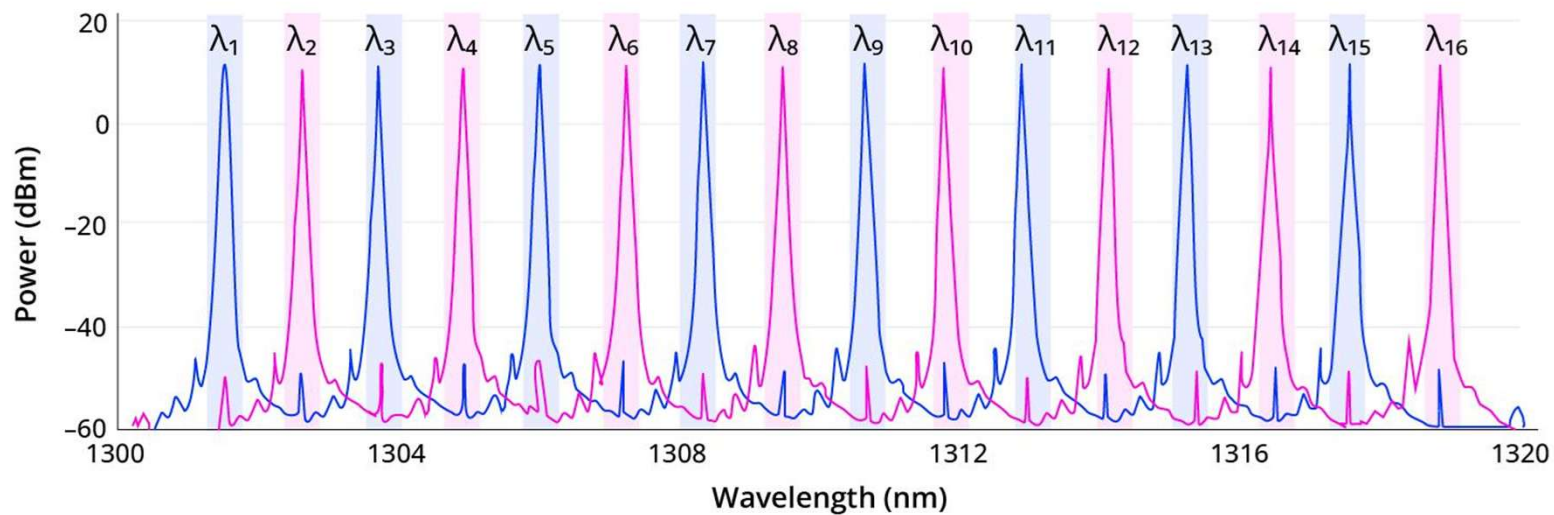
Note: "Relative OMA" (relOMA) is relative to 1 mW laser into the MRM.

Guide™: External WDM laser

Up to 16 wavelengths per fiber, 200 GHz grid

16 fiber output

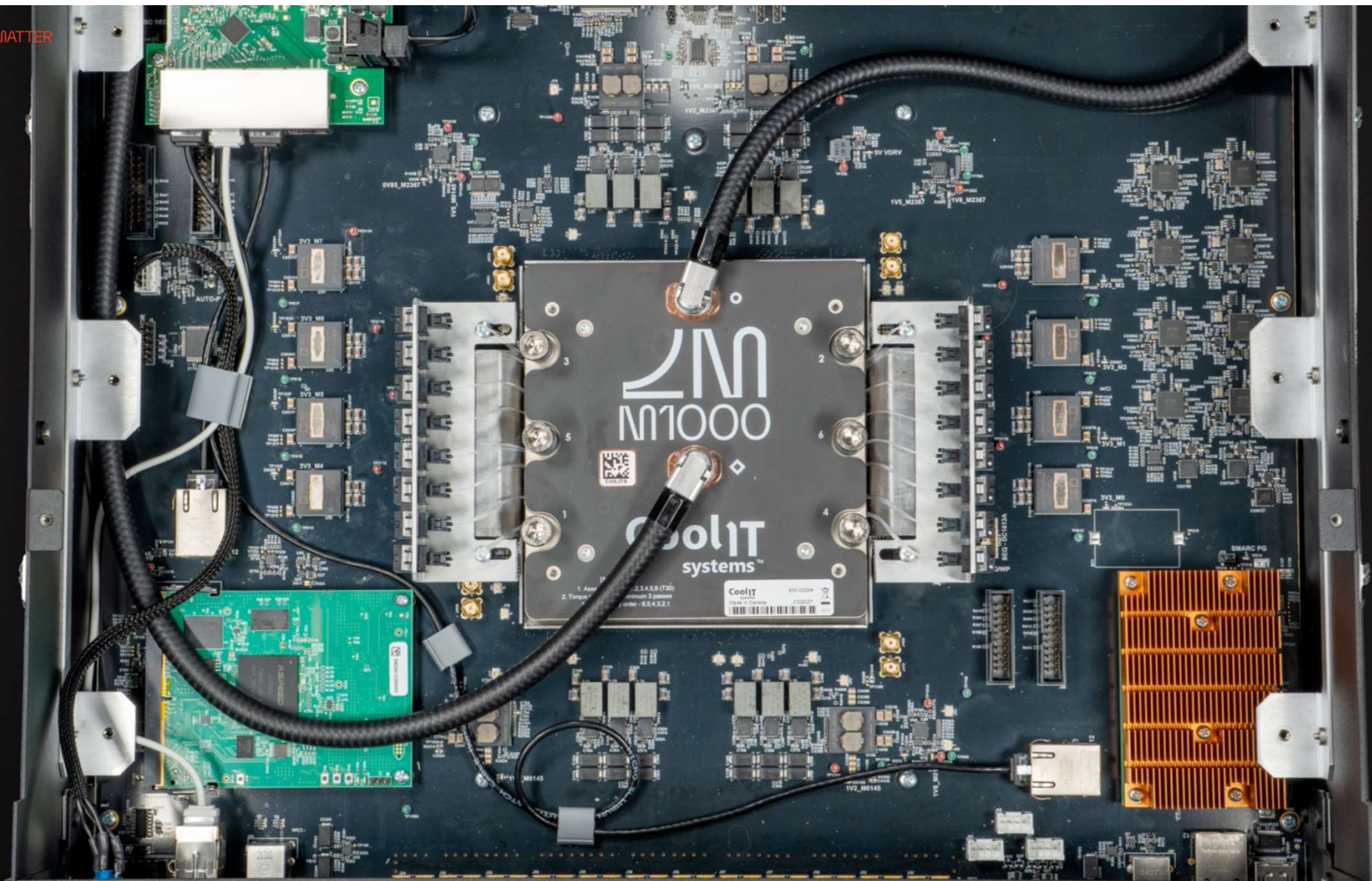
Optimized for microring modulator Tx architectures

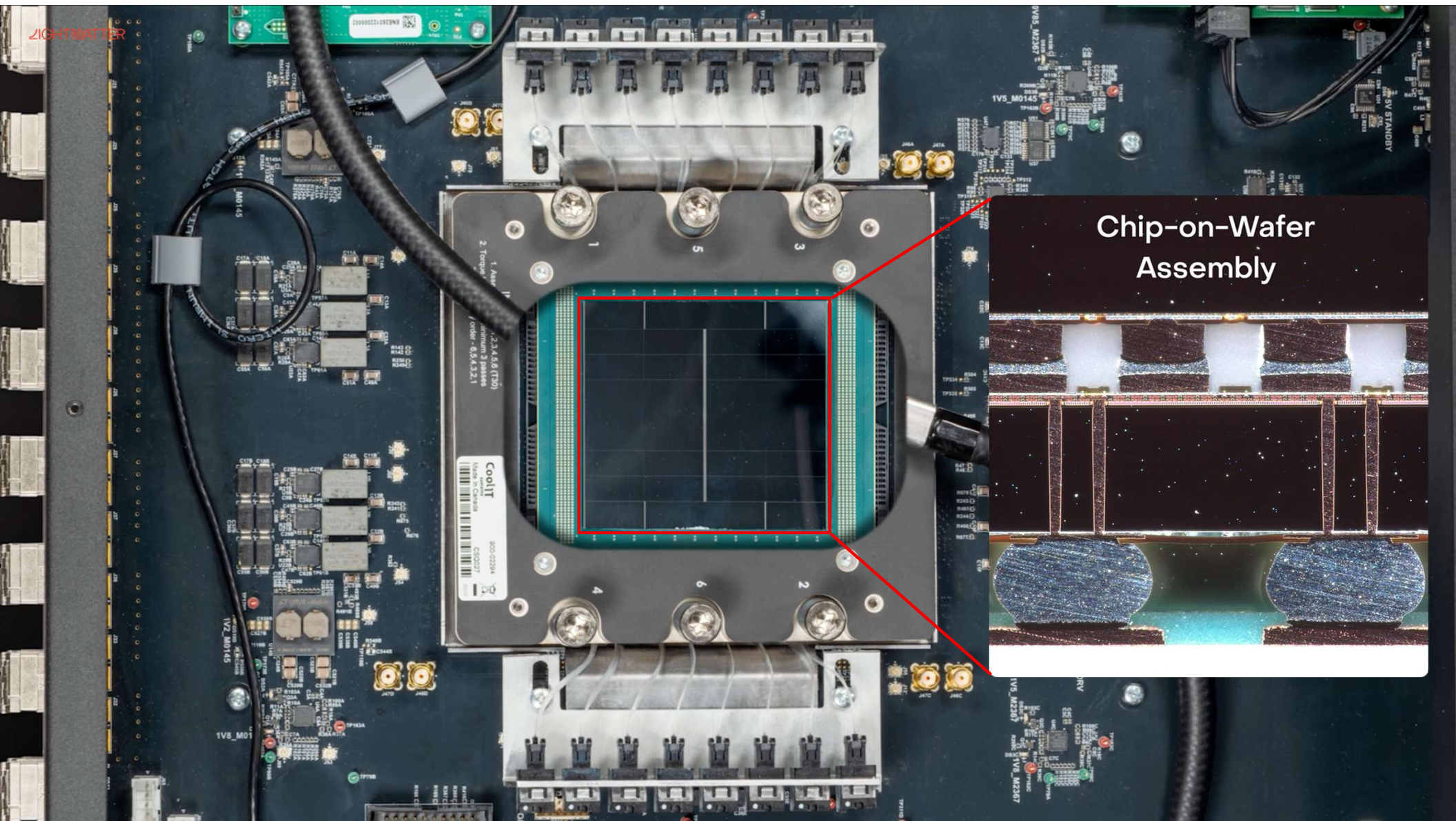


— Tx 1 → Rx 2
— Tx 2 → Rx 1

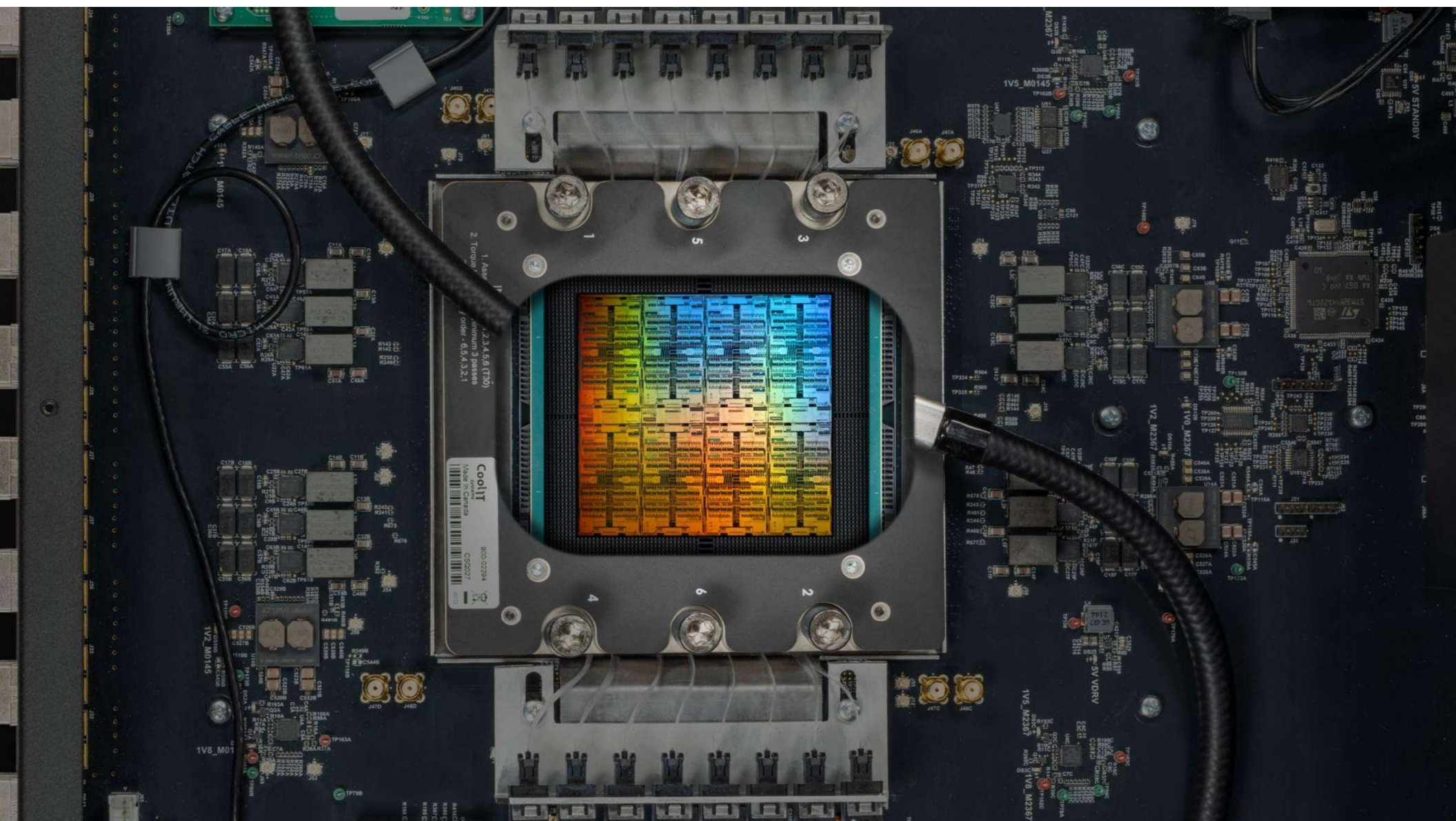
A complete
reference platform





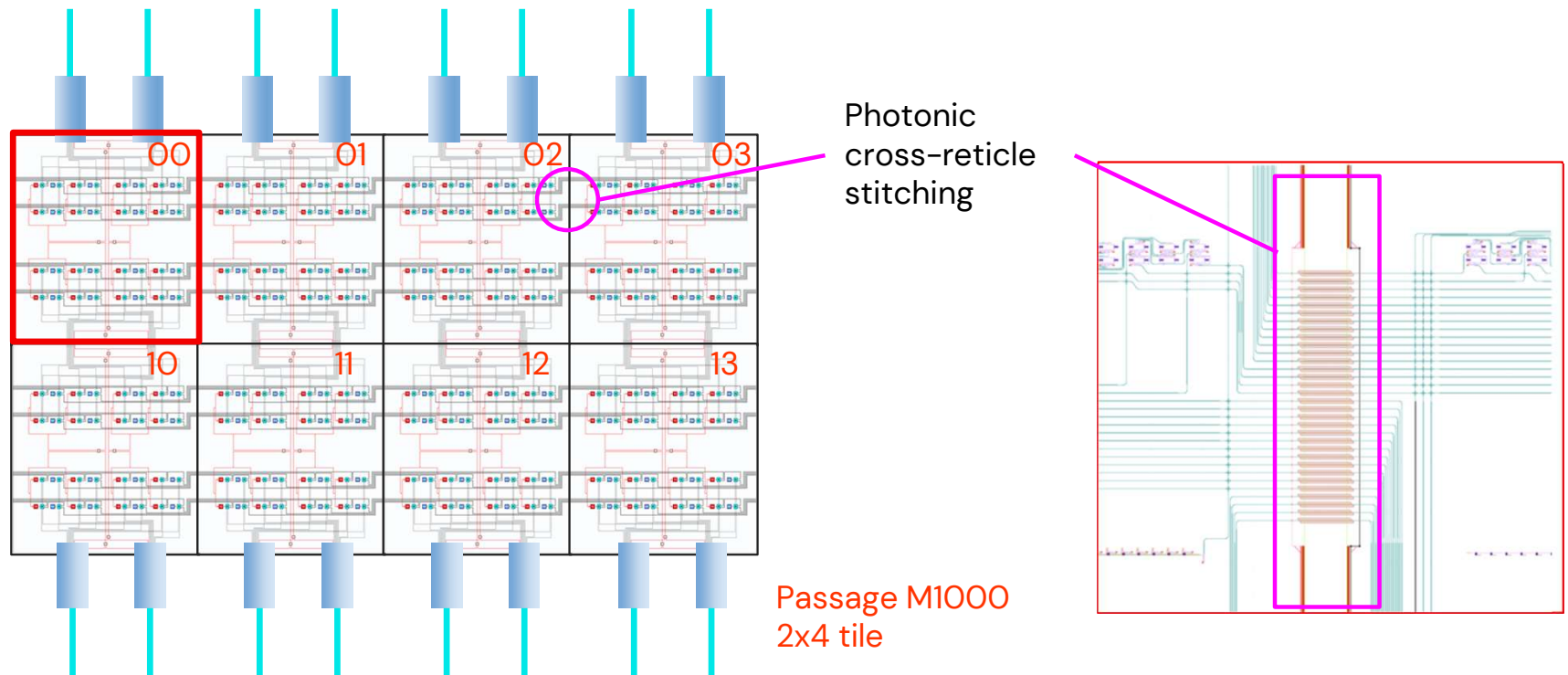


Chip-on-Wafer
Assembly



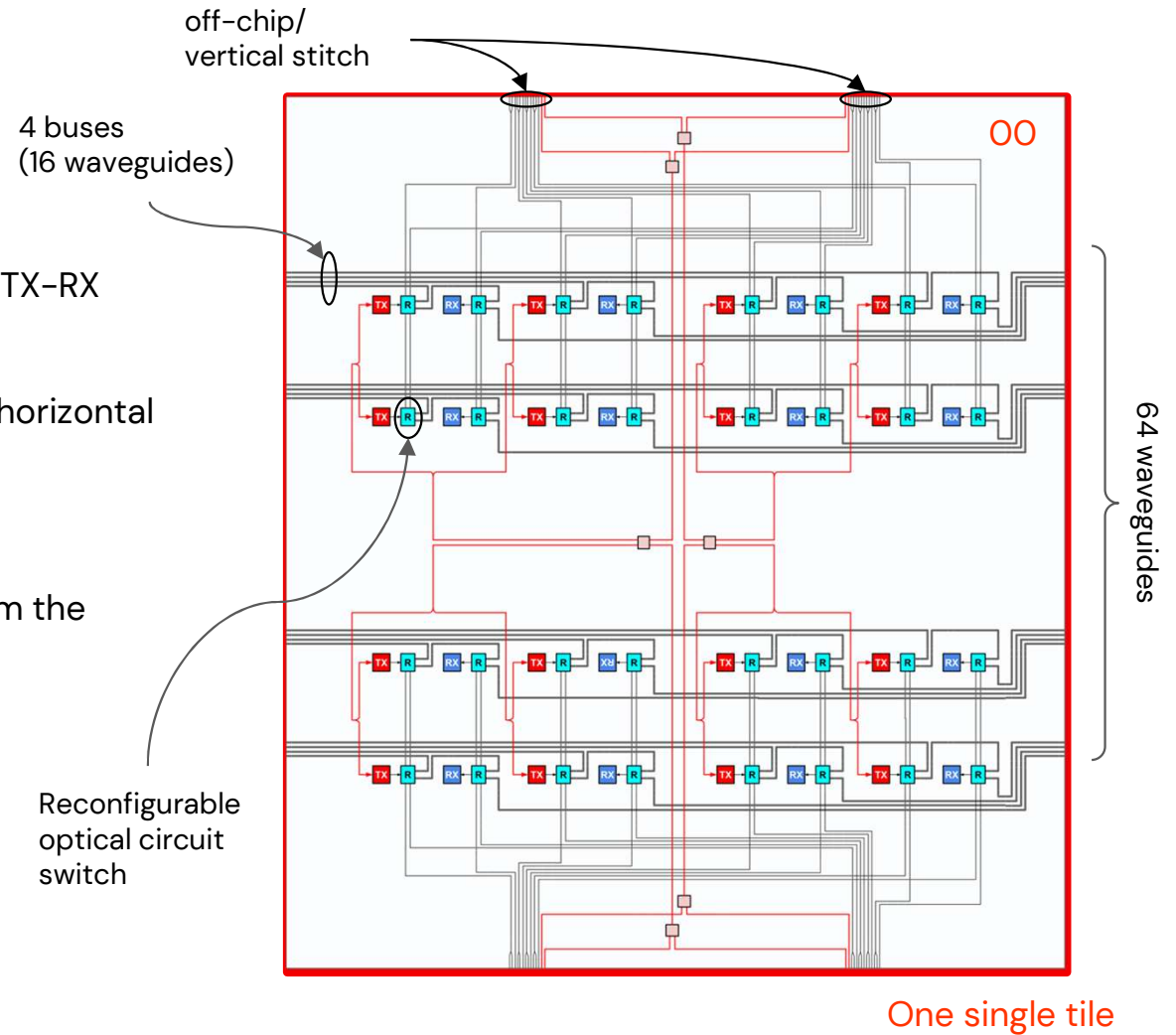
Reconfigurable connectivity

A dynamic, programmable optical fabric in the 2x4 tile design

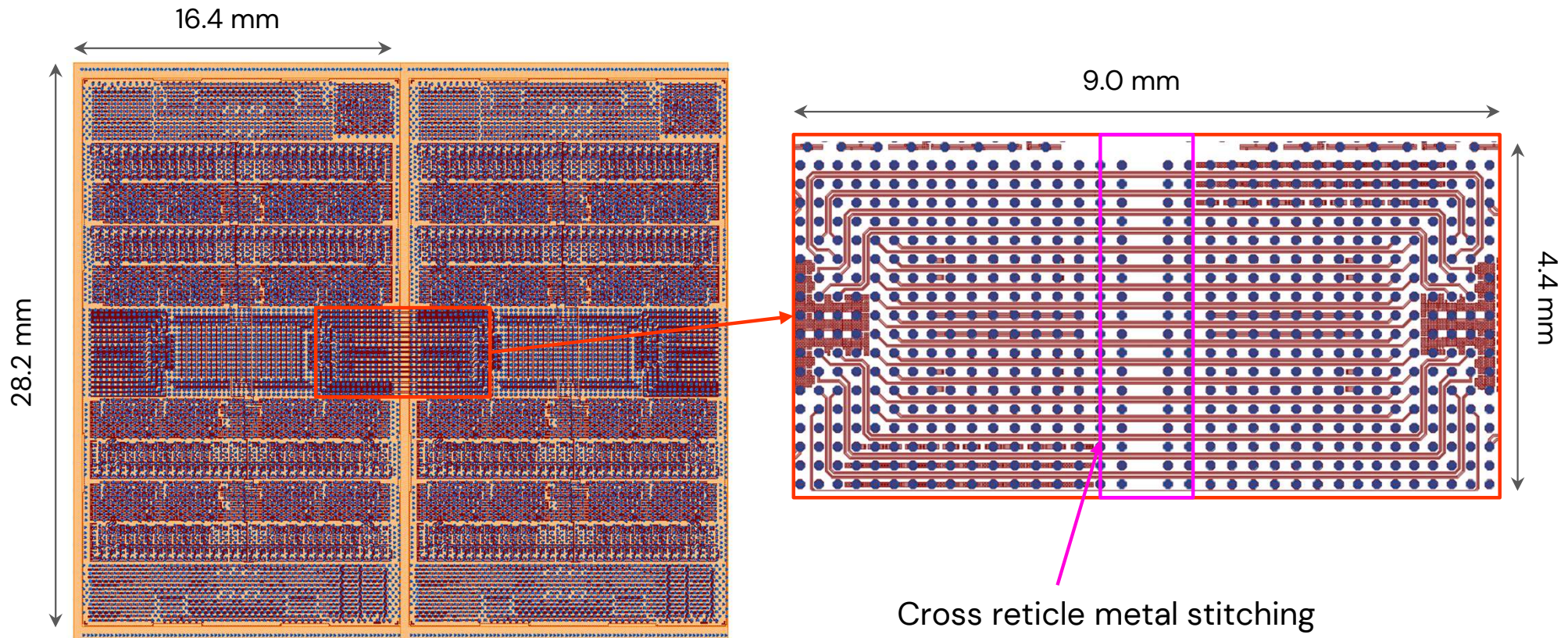


Tile design

- 16 horizontal buses
- Each bus supports up to 2 full-duplex TX-RX links:
 - 8λ @ 56Gbps/ λ per link
- Each TX bank can also talk across the horizontal tile edge to:
 - RX bank on adjacent tile
 - Off-chip
- Each RX bank can receive off-chip from the horizontal tile edge



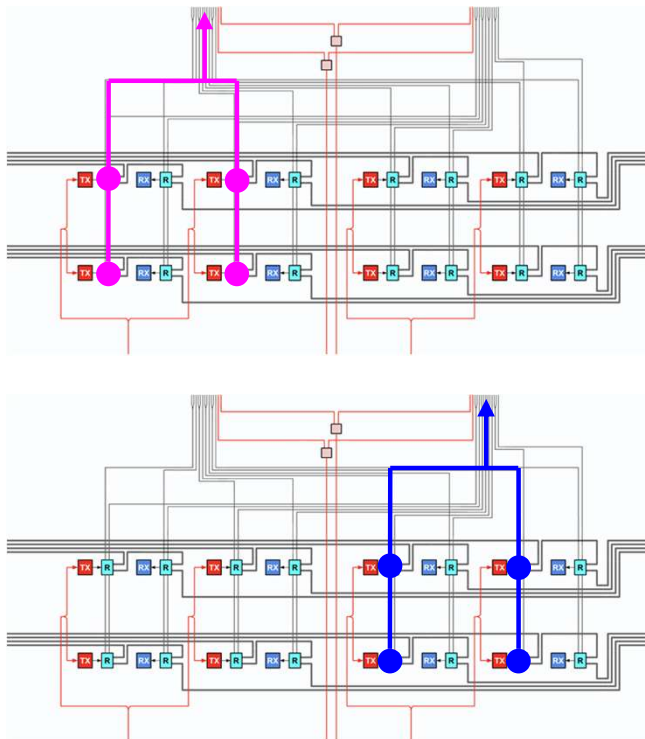
Neighboring tiles can also communicate electrically



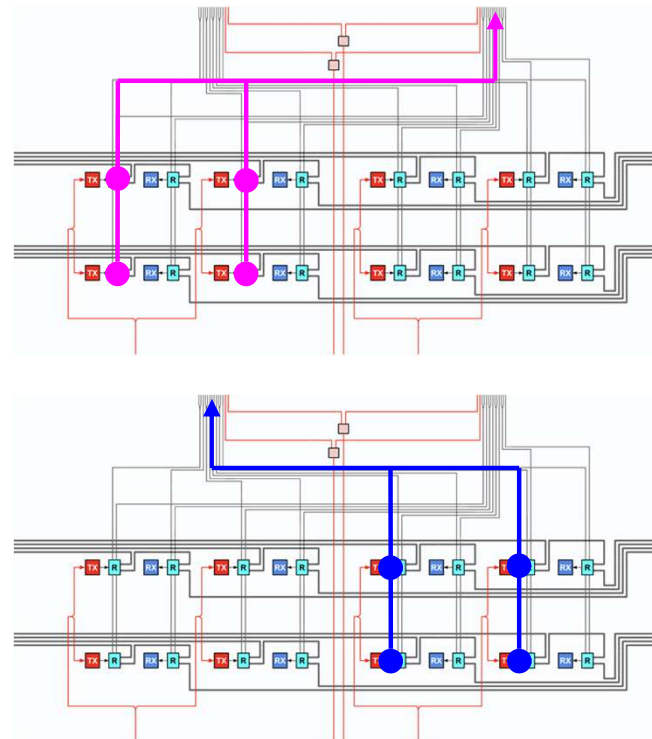
Resilience through optical circuit switching

Fiber attach redundancy allows users to route around failures

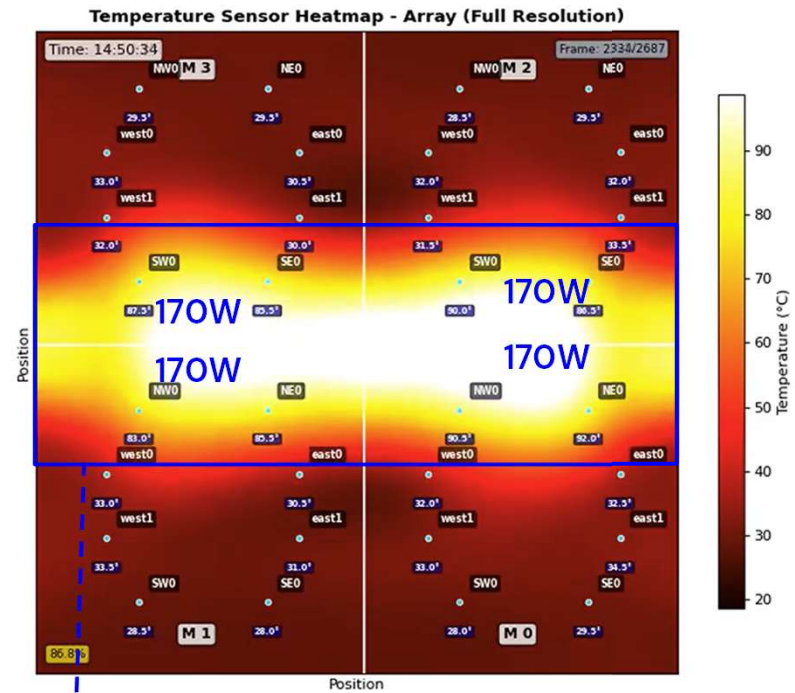
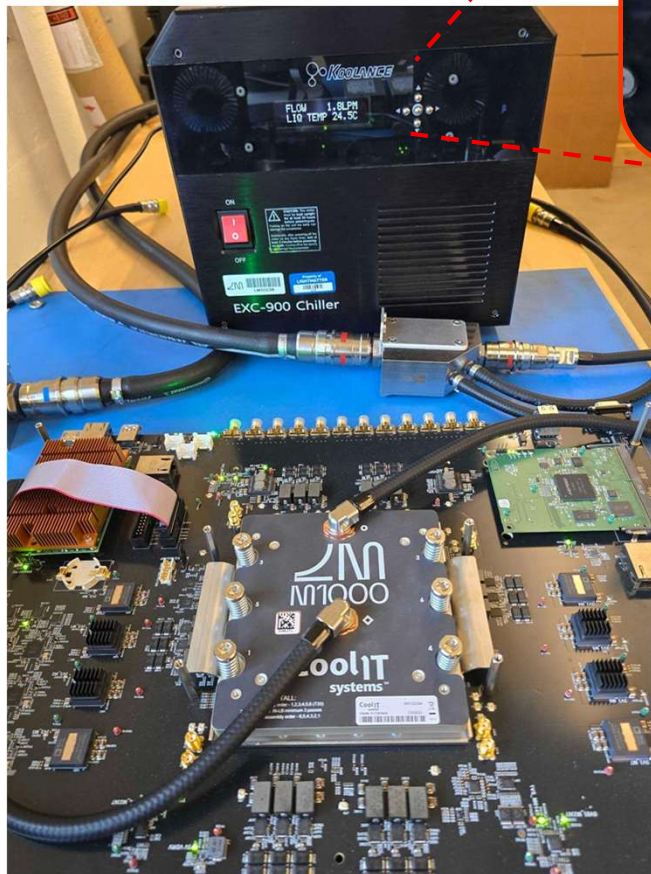
Option A (default):



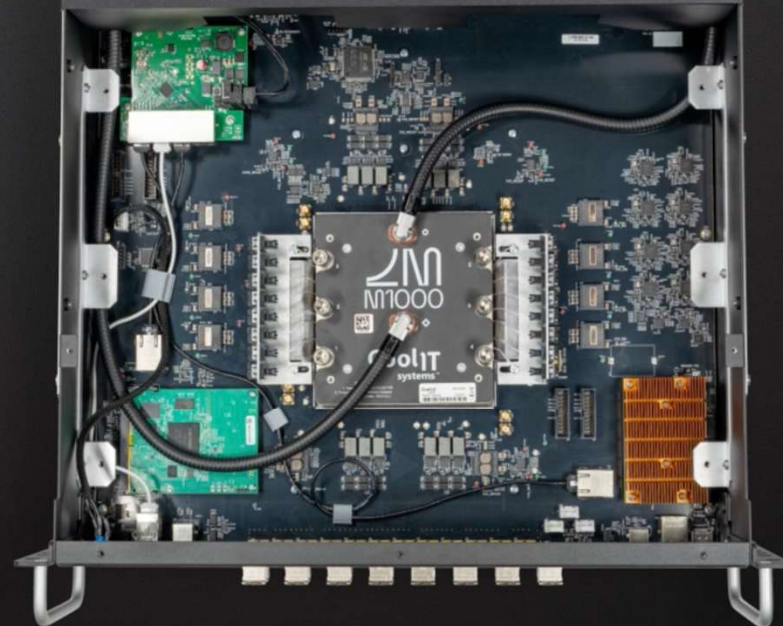
Option B (backup):

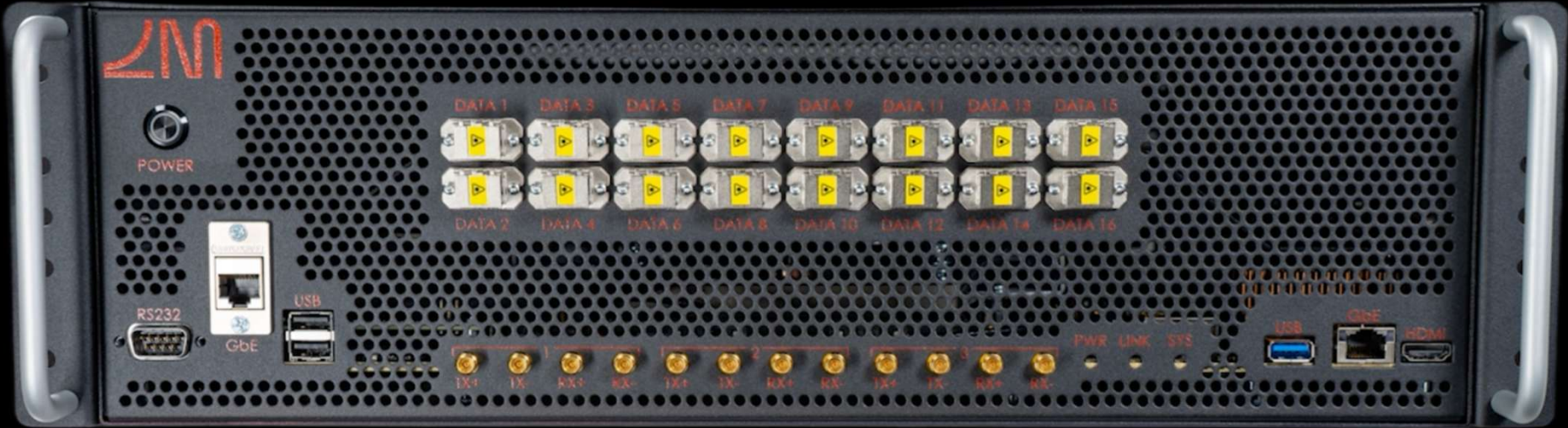


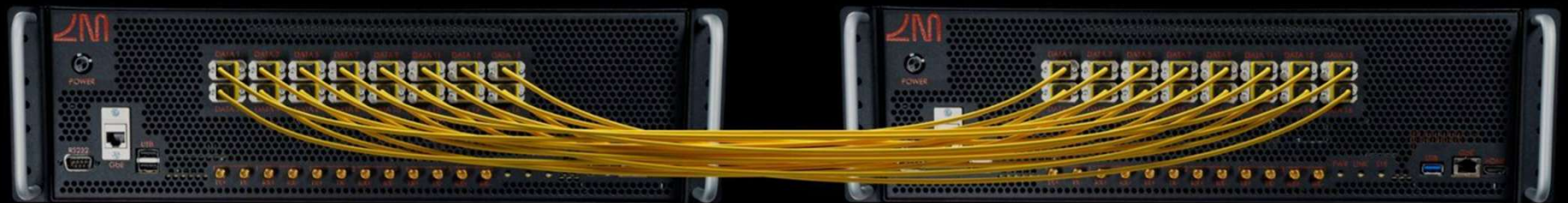
Power delivery and thermal load



369mm² thermal test chip, power density 1.47W/mm².
 Passage TSVs support >2.5A/mm².







Bandwidth density leadership

SerDes eye diagrams

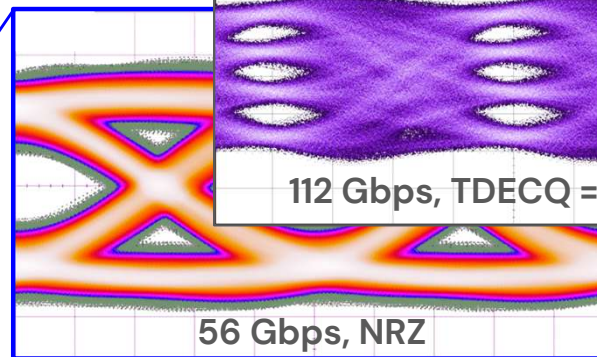
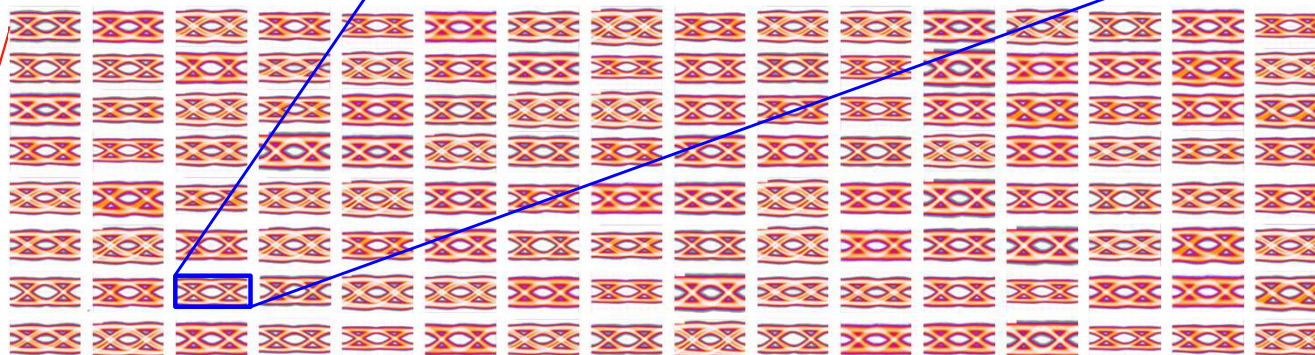
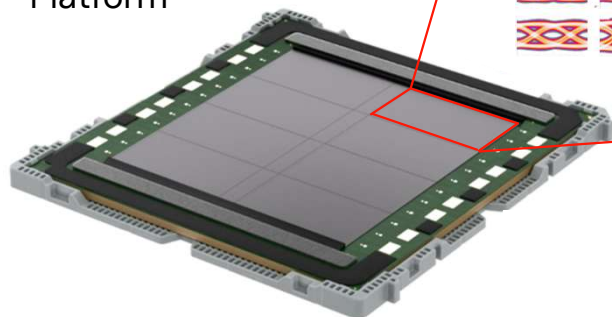
PAM4 also enabled

112 Gbps, TDECQ = 0.83 dB

56 Gbps, NRZ

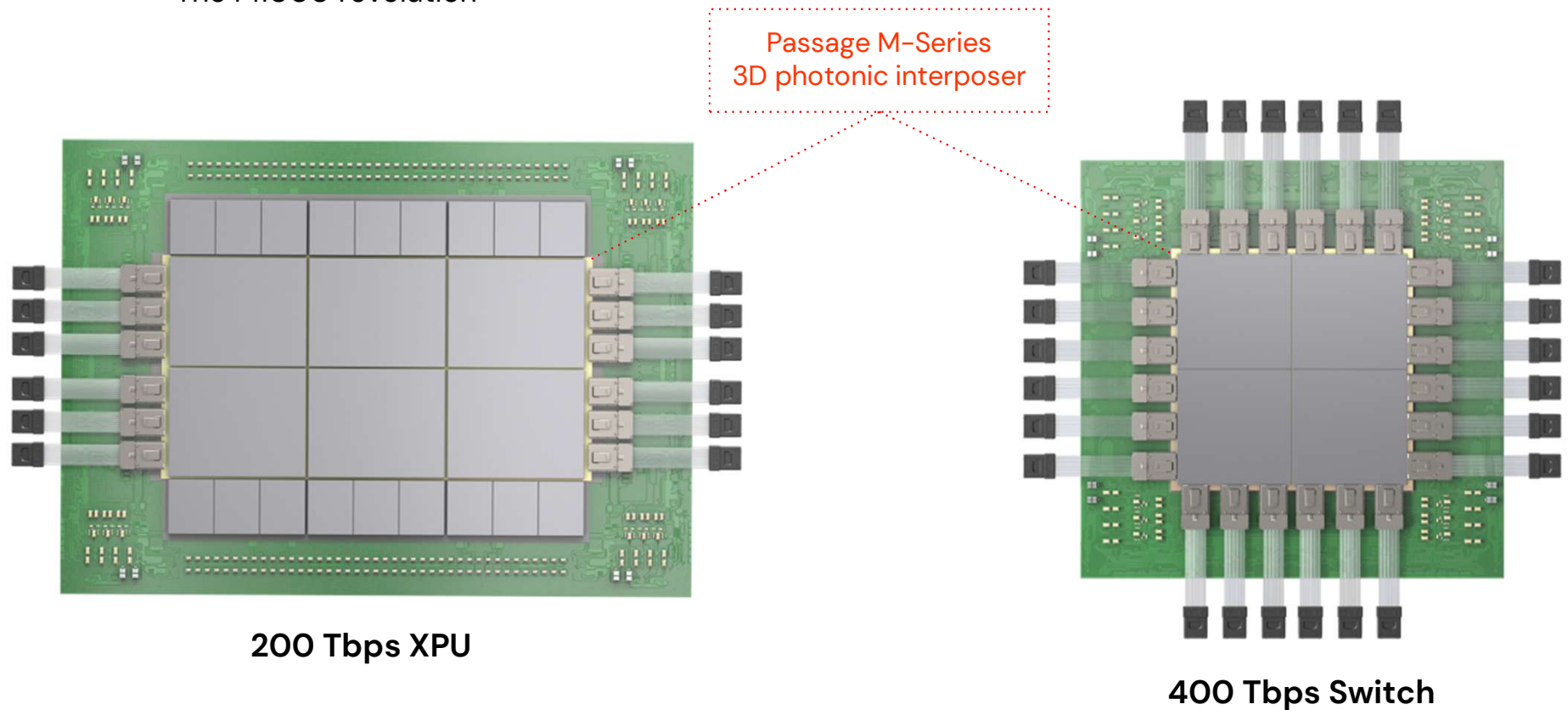
128 SerDes per tile

Passage M1000
Platform



3D Interposer scale-up and out to 1M nodes

The M1000 revolution



Optimized end-to-end and production-ready

