



Nexus Photonics

# Photonics Integrated Circuits for Quantum and Beyond

FULLY INTEGRATED  UNPARALLELED PERFORMANCE

10/24/2023

Minh Tran, Director of Research  
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# Nexus Photonics: Who We Are



**CEO**  
Tin Komljenovic, PhD



**VP of Engineering**  
Chong Zhang, PhD



**Director of Research**  
Minh Tran, PhD



**Chairman**  
John Bowers, PhD



**Board Member**  
Frank Levinson, PhD

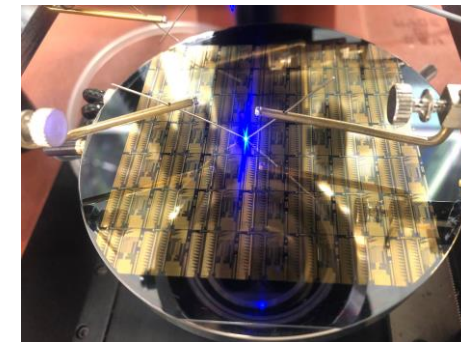
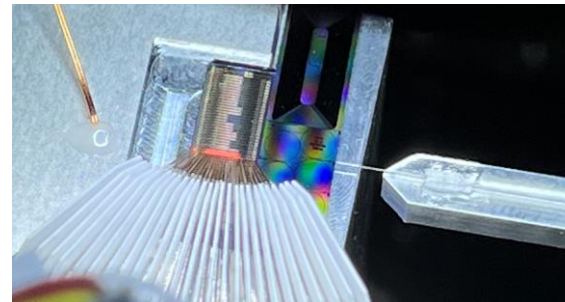
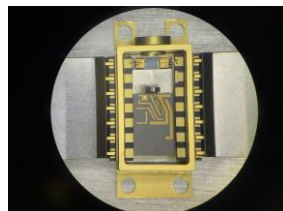
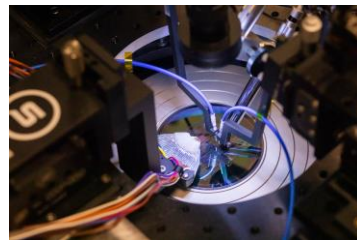
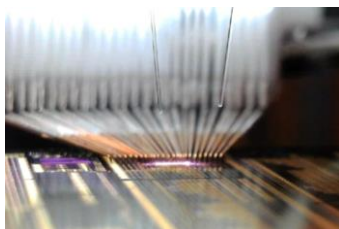
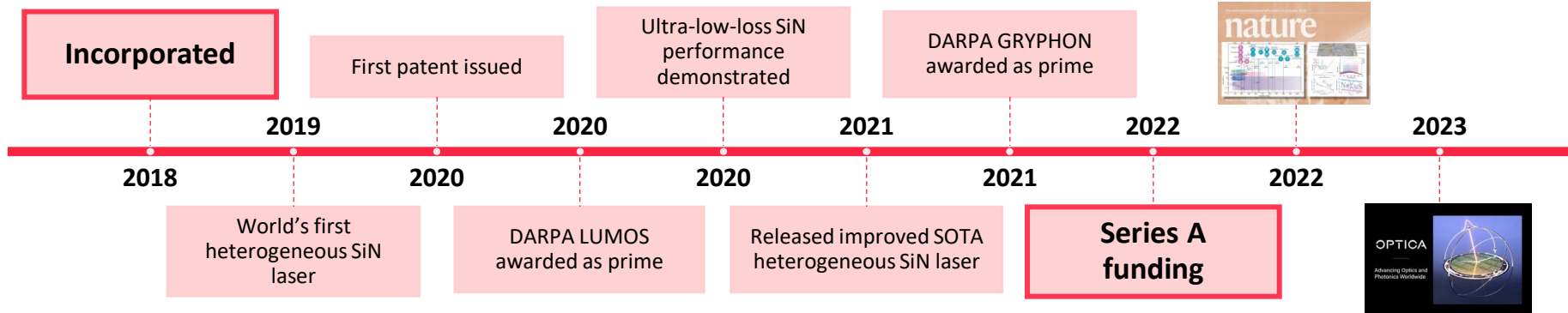


**Advisor**  
Charles Roxlo, PhD



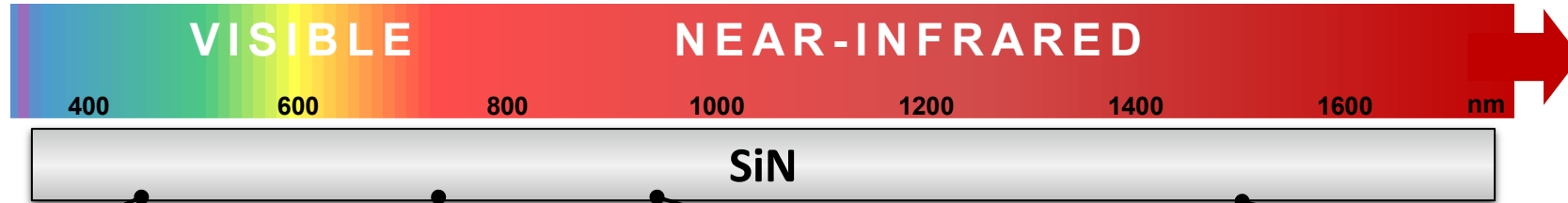
**Advisor**  
Rafik Ward, MBA

Co-founders of multiple successful enterprises including Finisar (IPO), Aurrion (acquired by Juniper), Aerius (acquired by FLIR), & Terabit (acquired by Ciena)



# Industry's **Only** Broadband Integrated Platform **with On-Chip Sources**

 HETEROGENEOUS SiN Platform

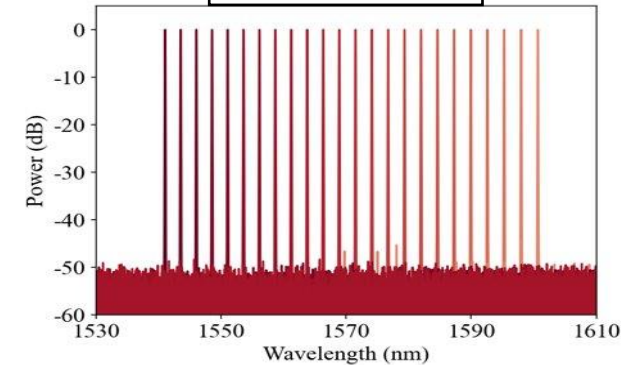
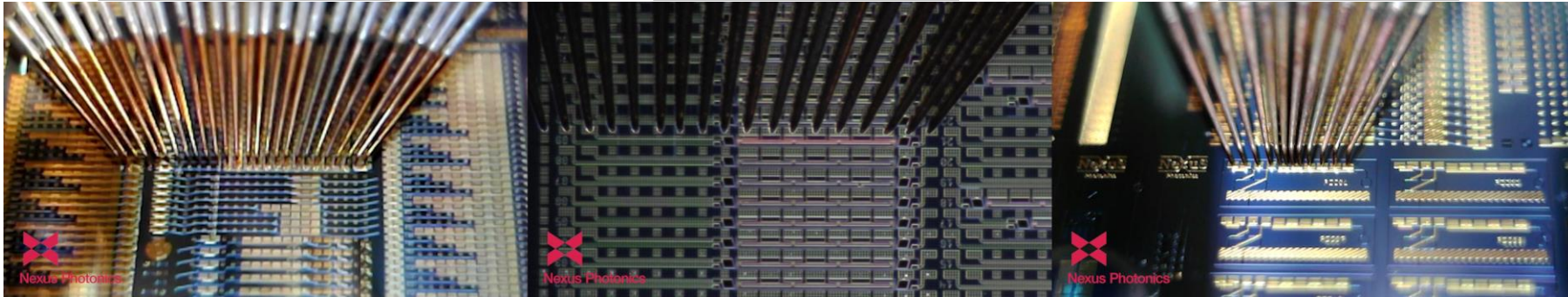


GaN

GaAs

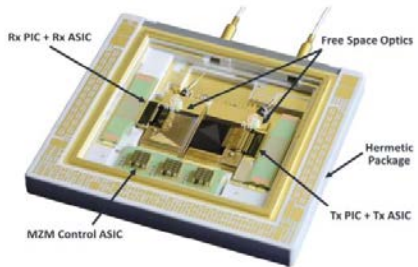
GaAs

InP

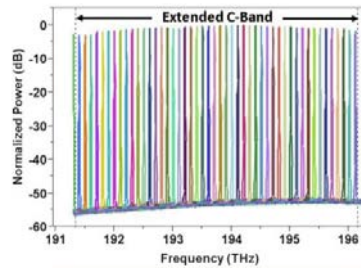


# Integrated Photonics

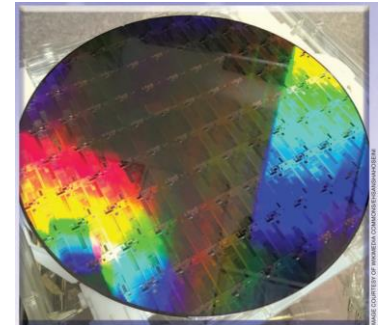
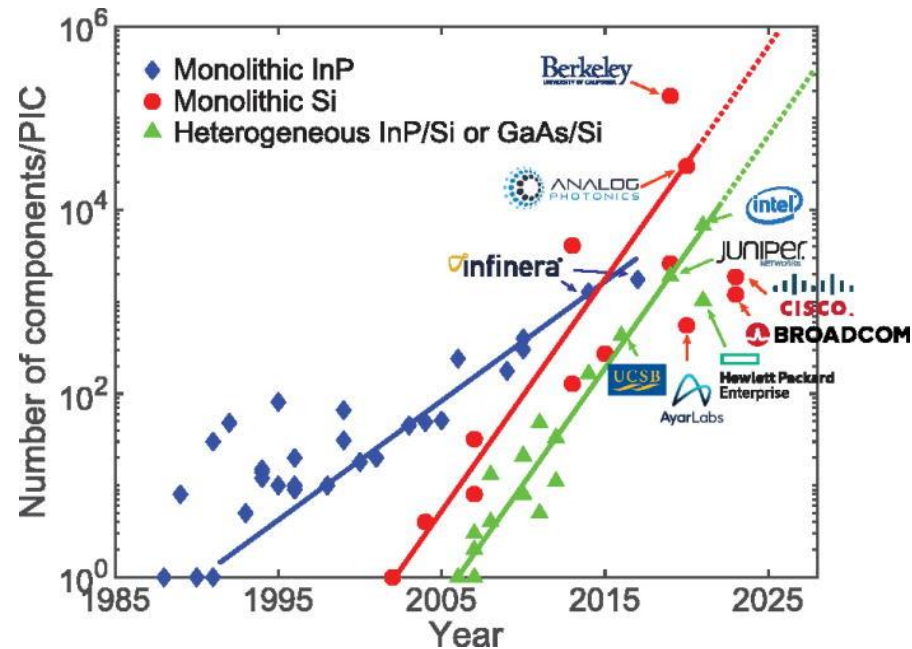
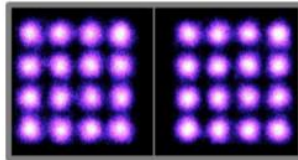
- Historically focused on telecom/datacom
  - Strong focus on 1310 nm and 1550 nm



Infinera



44GBaud, 16-QAM



Intel® Silicon Photonics 100G LR4 QSFP28 Optical Transceiver  
Read the product brief



Intel® Silicon Photonics 200G FR4 QSFP56 Optical Transceiver  
Read the product brief



Intel® Silicon Photonics 400G DR4 QSFP-DD Optical Transceiver  
Read the product brief

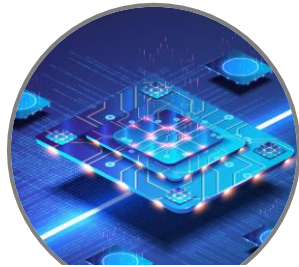
Intel

Margalit et al, *Appl. Phys. Lett.* 118, 220501 (2021)

# Emerging Applications for Integrated Photonics



AR/VR



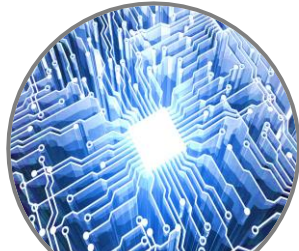
Quantum



PNT



Drone/Robot



AI



Healthcare

## Requirement

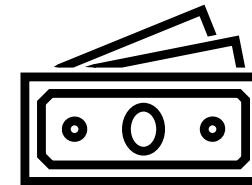
- Operation from UV to IR
- Small and light
- High performance and power efficiency
- Full photonic integration with on-chip sources

Current solutions have

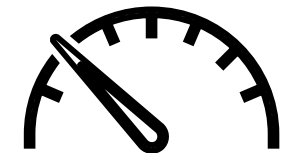


Source: Xanadu

**Large SWaP**

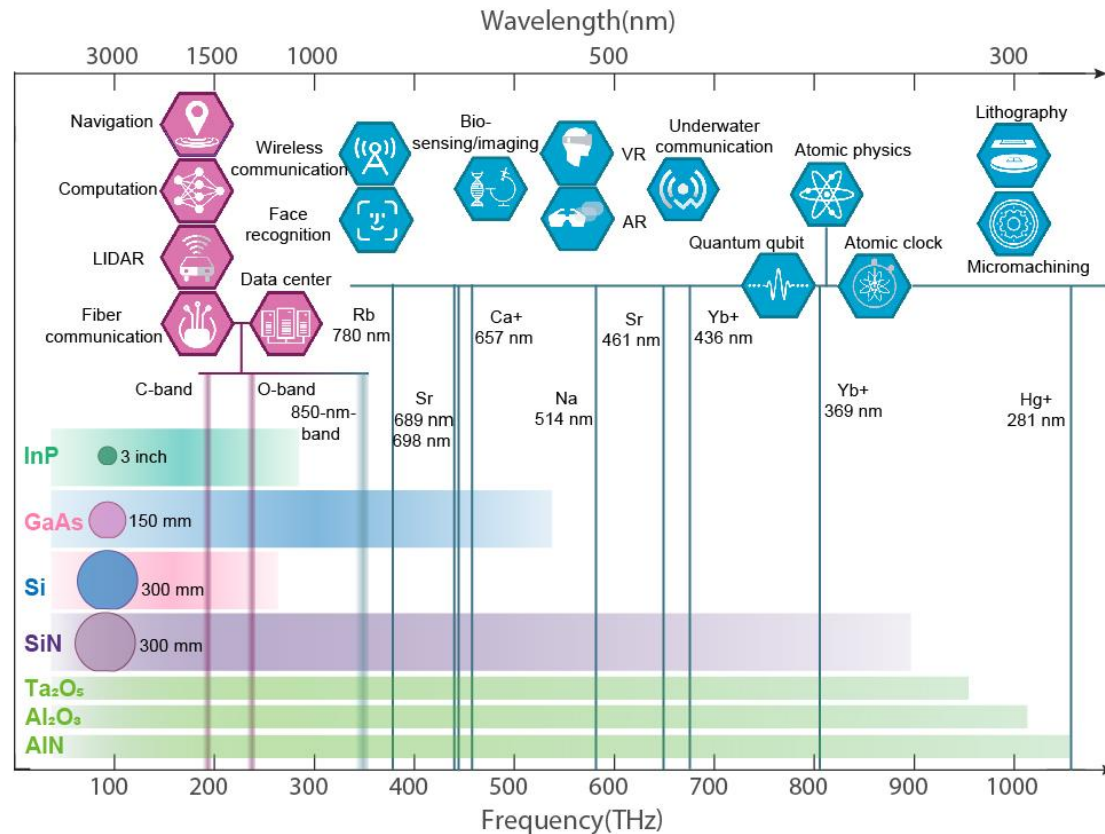


**High Cost**

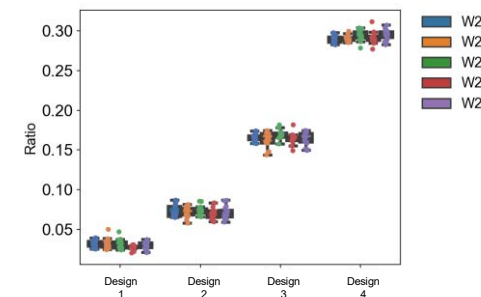
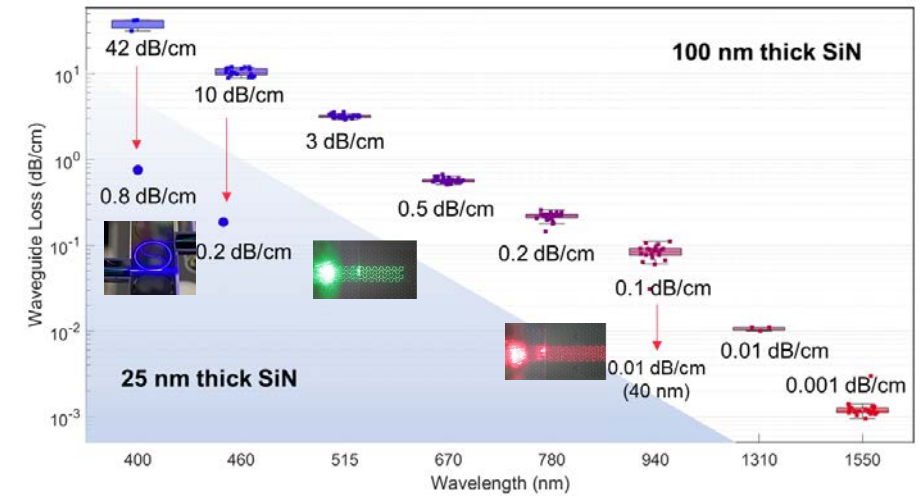


**Poor Performance**

# Extending the Spectrum of Integrated Photonics



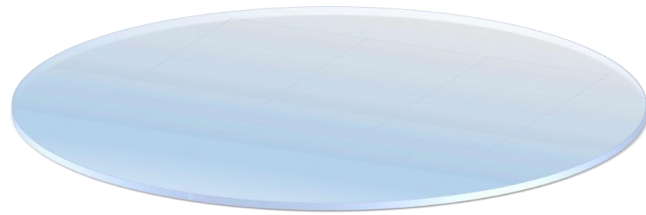
## Silicon Nitride waveguide



- CMOS compatible
- Ultralow loss
- Highly uniform
- High power handling
- Low thermal noise

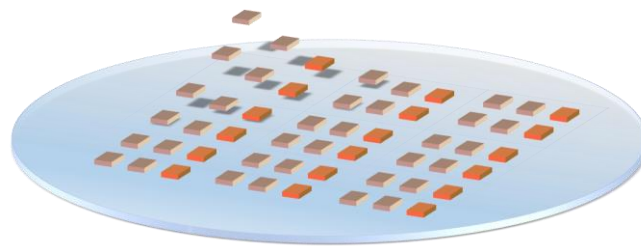
# Heterogeneous Integration

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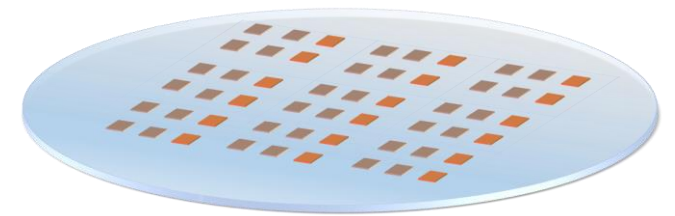
1. Passive process

**Scalable**  
100-300 mm wafer process



2. III/V bonding

**Highly uniform**  
Advanced-lithography defined alignment (<100 nm)



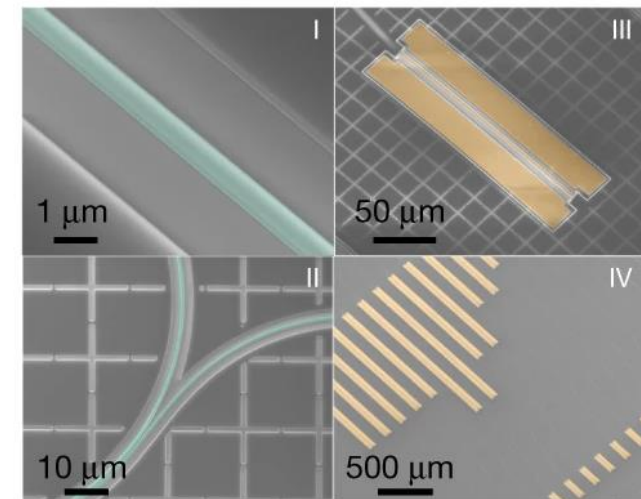
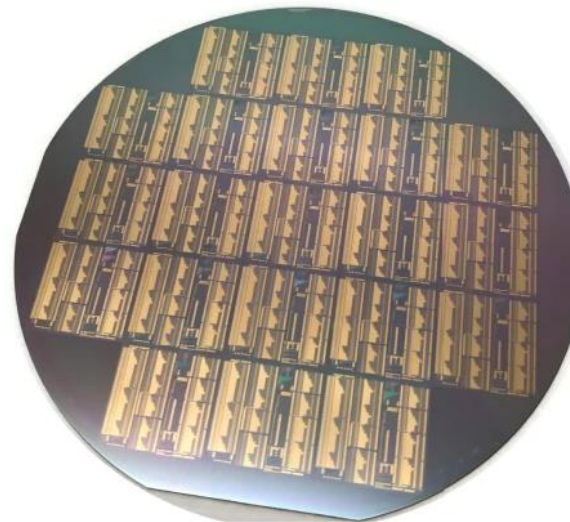
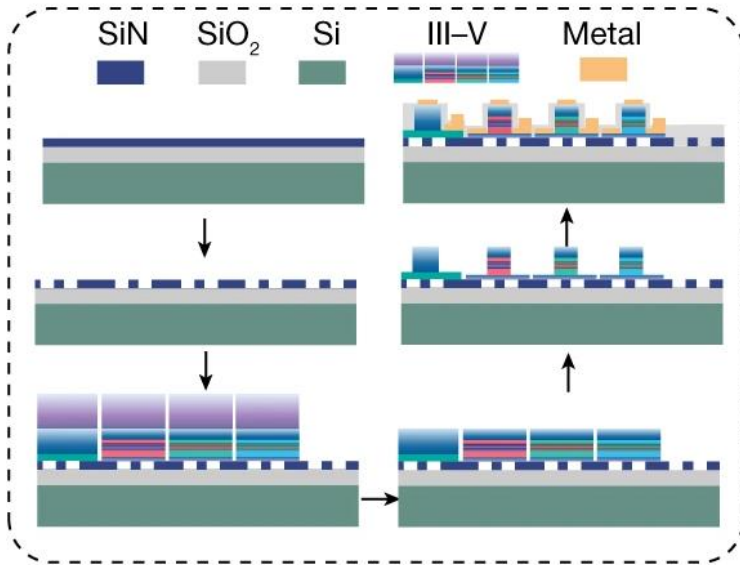
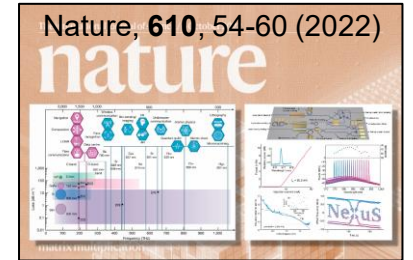
3. III/V process + BEOL

**Flexible**  
Supports multiple materials & functionalities

# Nexus Heterogeneous Integration

Nexus' proprietary integration technology

- Supports direct heterogeneous integration of materials with large difference in refractive indices - e.g. SiN and GaAs/InP, or LiNbO3 and GaAs/InP

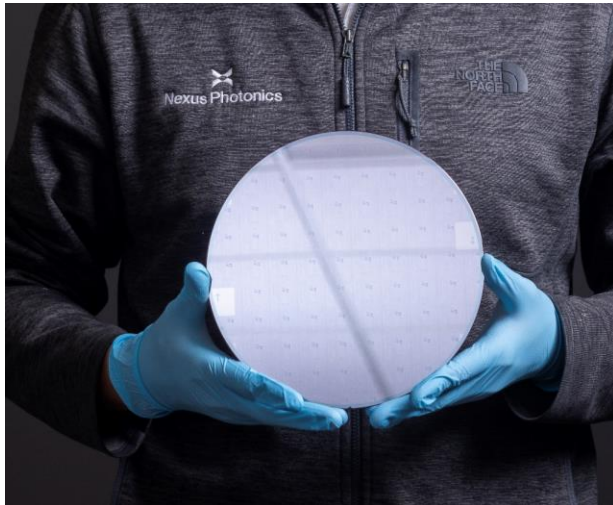




# Heterogeneous Integration and Manufacturing

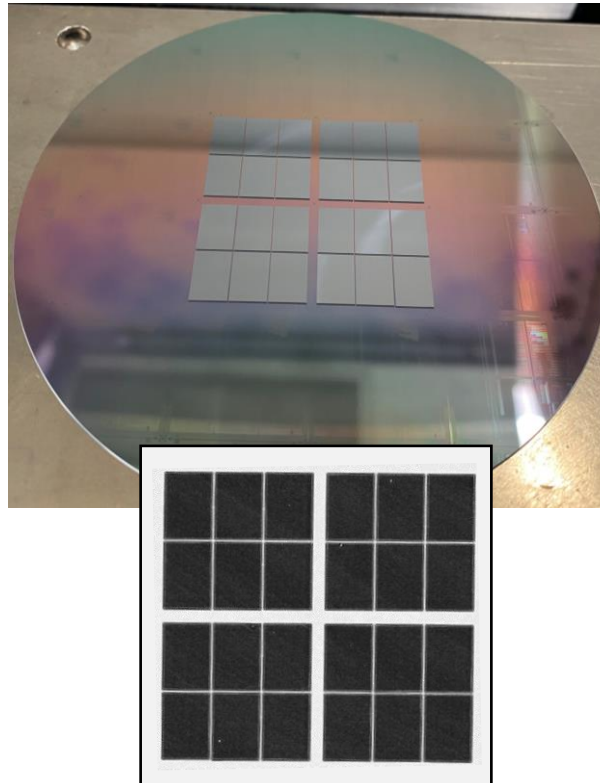
## FOUNDRY

CMOS process



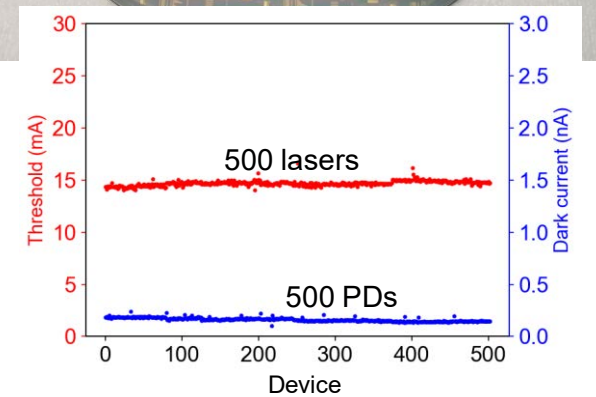
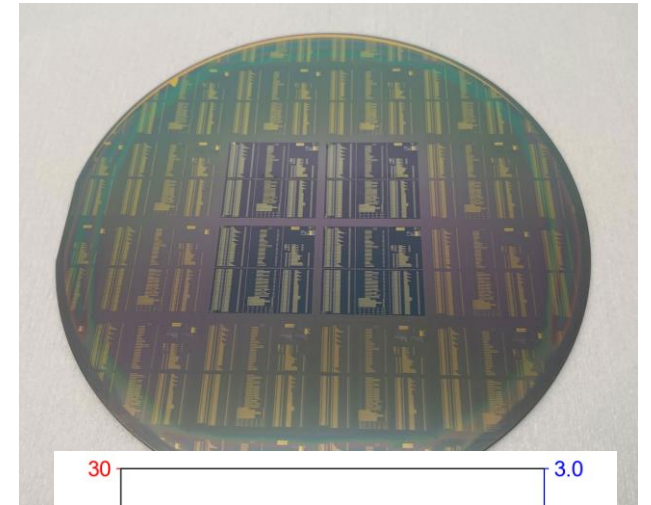
## CONTRACT MANUFACTURER

Bonding



## FOUNDRY


III/V process



# Resulting Advantages

**Size**


**Incumbent Solution**  
Performance requires bulky solution



600 mm

➔

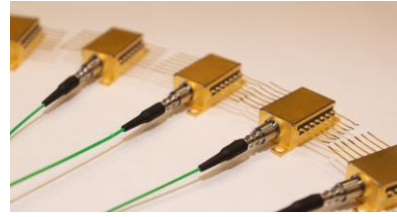
**Nexus**  
Same/better performance  
200x smaller



3 mm

**Cost**

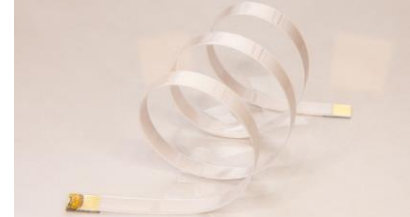
**Incumbent Solution**  
Bulky, more expensive solution



*Legacy packaging: complex, hermetic sealing drives high costs*

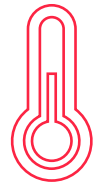
➔

**Nexus**  
Same performance at a fraction of the cost




*Low-cost packaging: dielectric encapsulated by default*

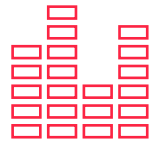
**Performance**




**Highest operational temperature**  
(185 °C lasing)



**High-efficiency**  
(>25% wall-plug efficiency)

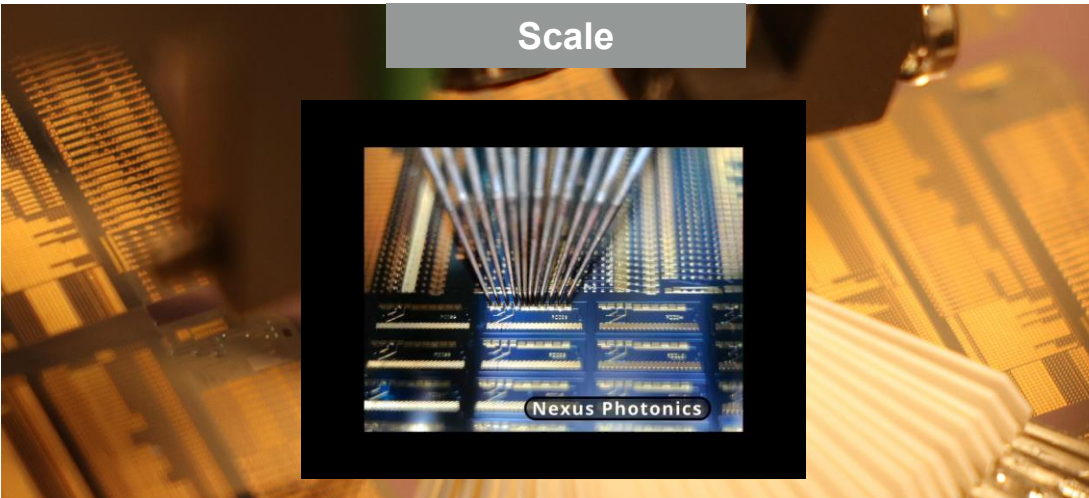


**Quietest chip-scale lasers**  
(<100 Hz)



**Wide operational range**  
(10 THz single device, 240+ THz platform)

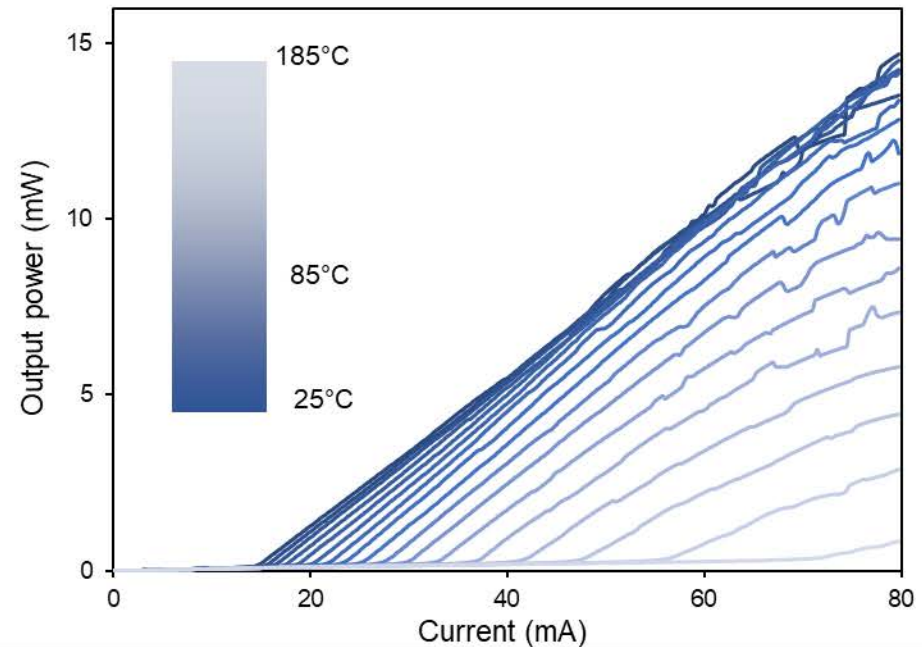
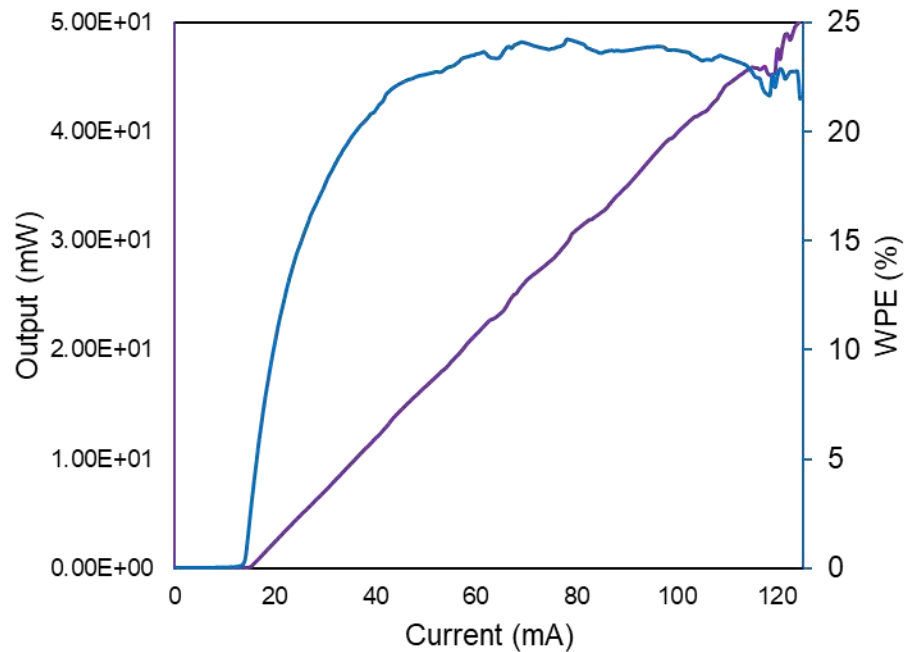
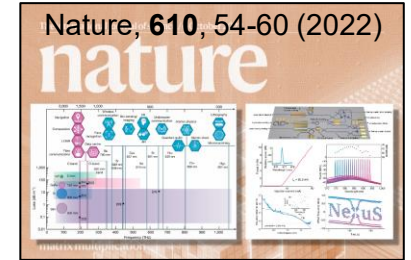
**Scale**



# State-of-the-Art Performance

## 9xx-nm lasers

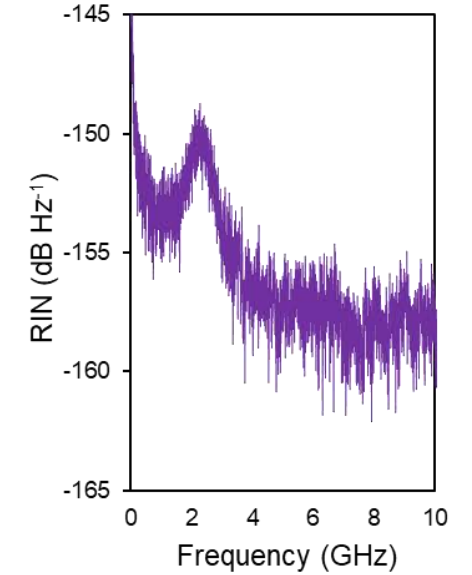
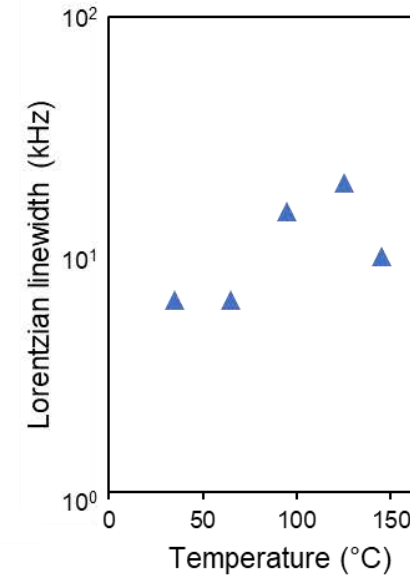
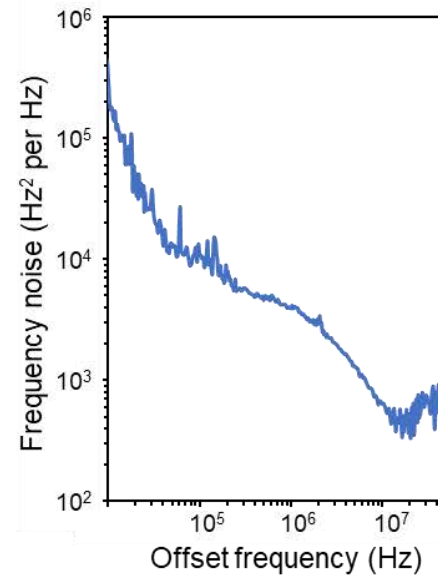
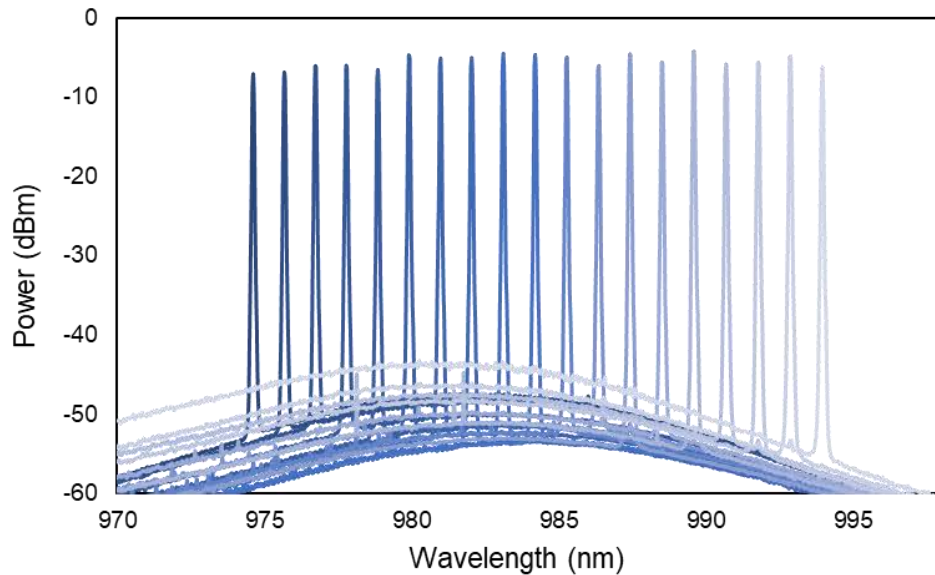
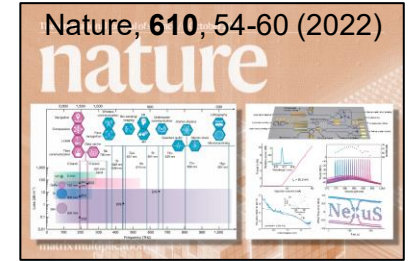
- Low threshold, high WPE
- 185 °C laser operation
- Power measured in SiN waveguide



# State-of-the-Art Performance

## Widely-tunable lasers

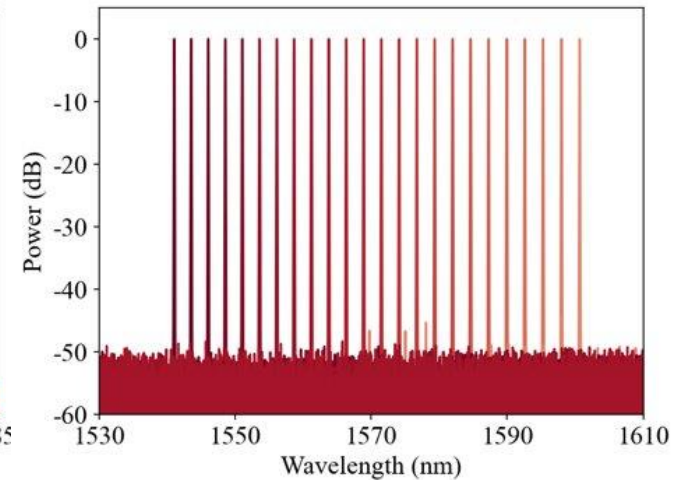
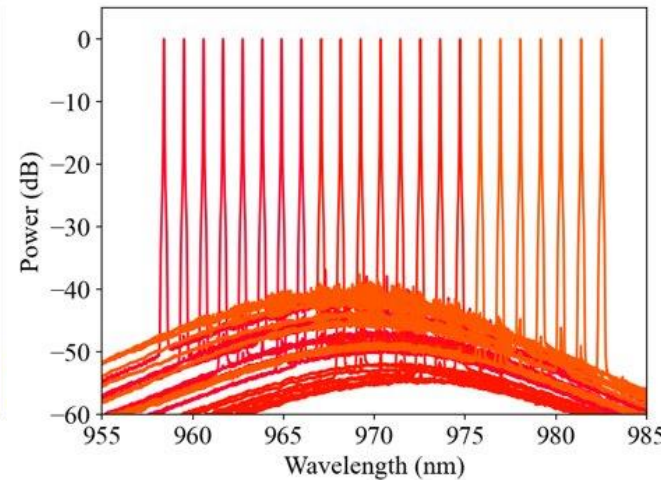
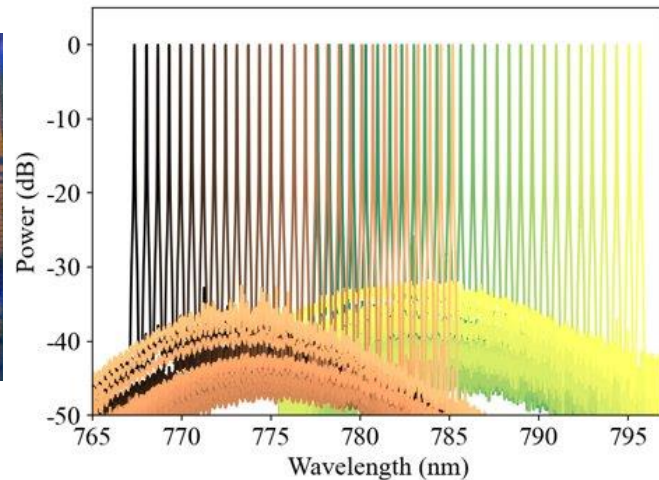
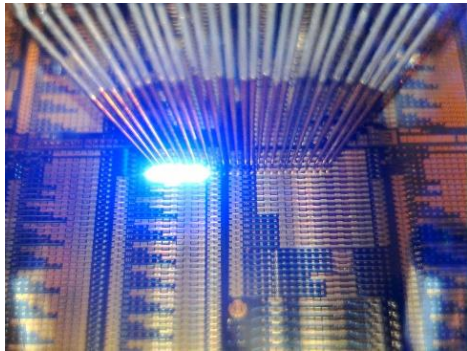
- kHz-level linewidth (even at elevated temperatures)
- Low-RIN
- High-temperature operation

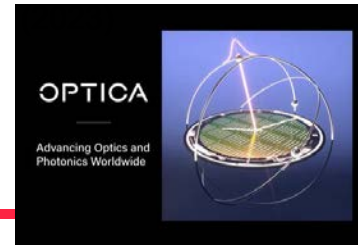


# State-of-the-Art Performance

“Wavelength by design”, with InP/GaAs/GaN directly integrated on SiN

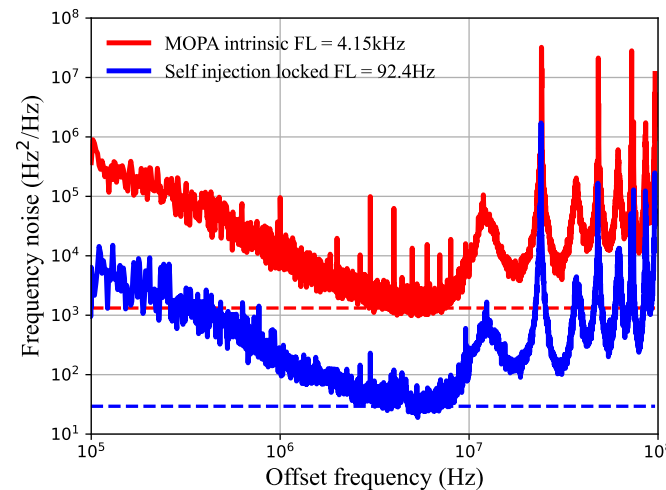
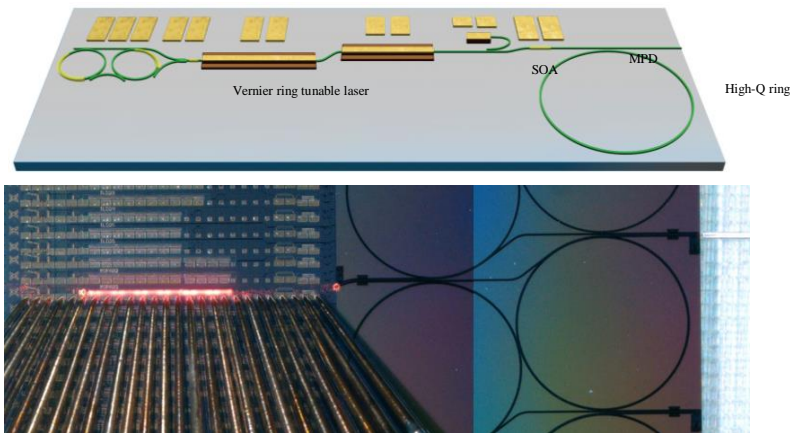
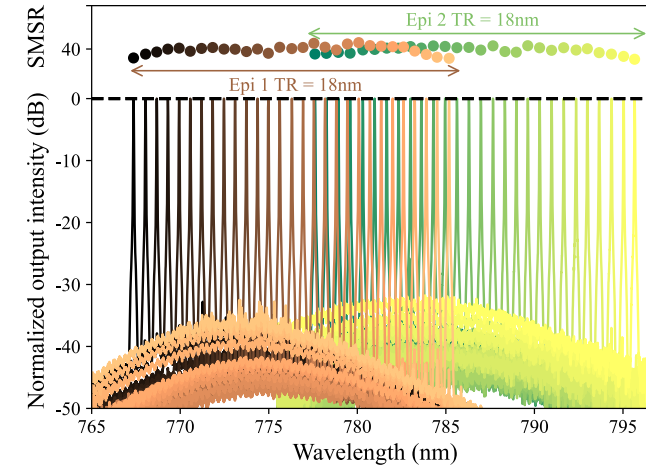
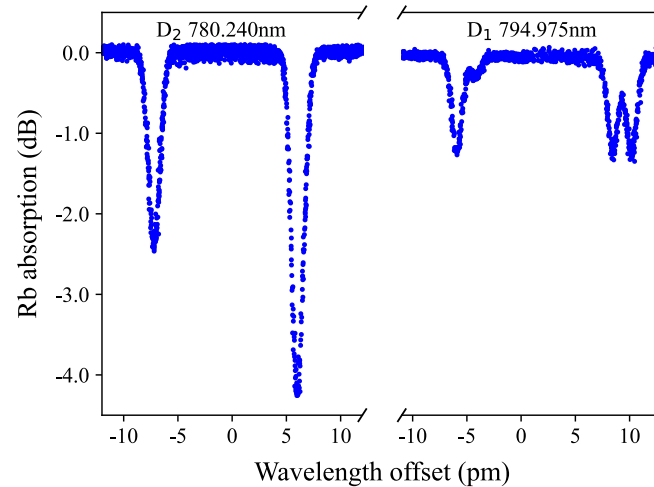
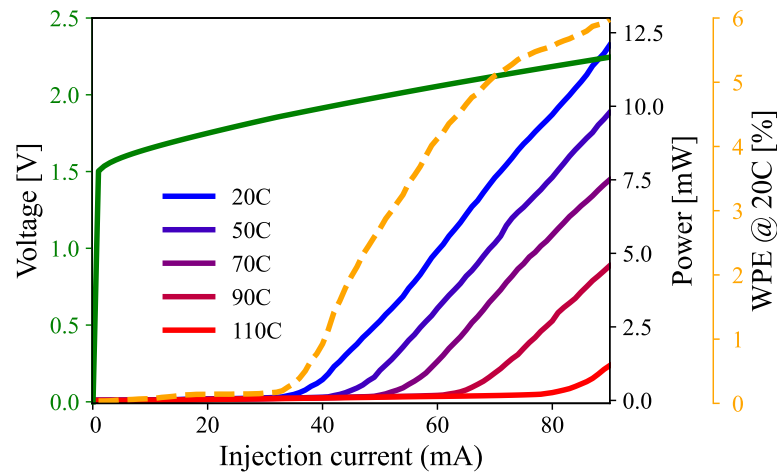
- Covering from visible to IR
- Multiple wavelengths could be integrated on the same chip





# A Case for Quantum: PICs for Rubidium

Fully integrated PICs with on-chip lasers operating at 780 nm wavelength range at high temperature



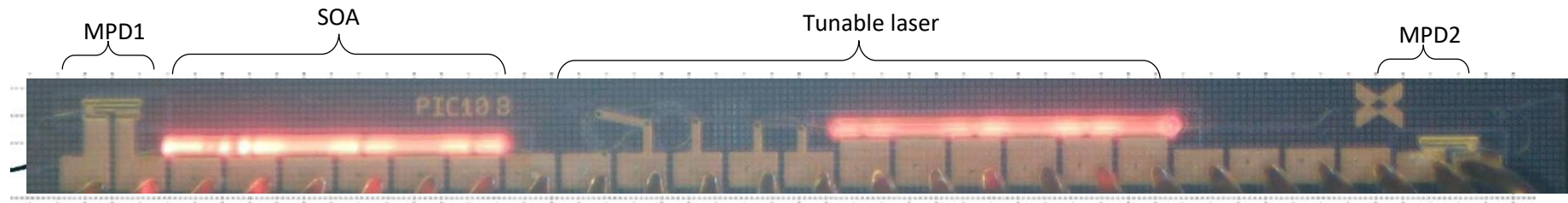
## Ultra-low noise

- ~kHz range intrinsic
- <100 Hz when injection-locked to SiN resonators

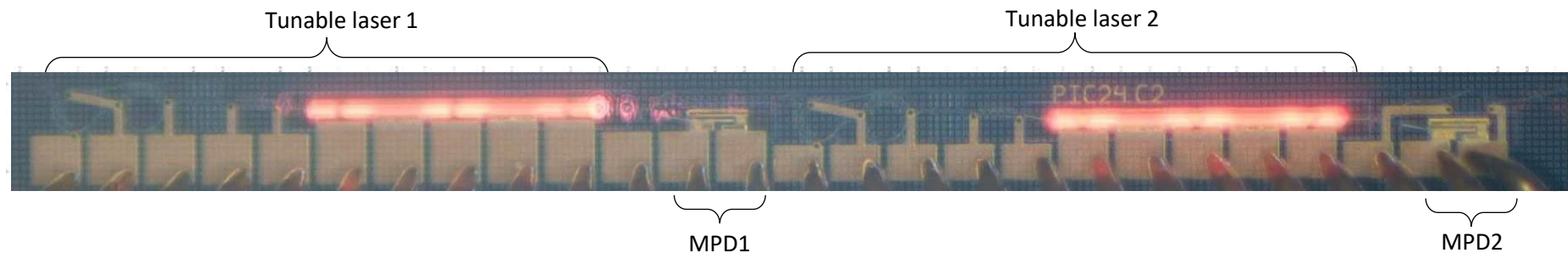
# Much More than just “A laser”

**Advanced PICs** with customized functions and components integrated on a single chip

**Example 1: Tunable laser source with amplifiers, photodetectors and multiple optical IOs (<2.5 mm<sup>2</sup>).**



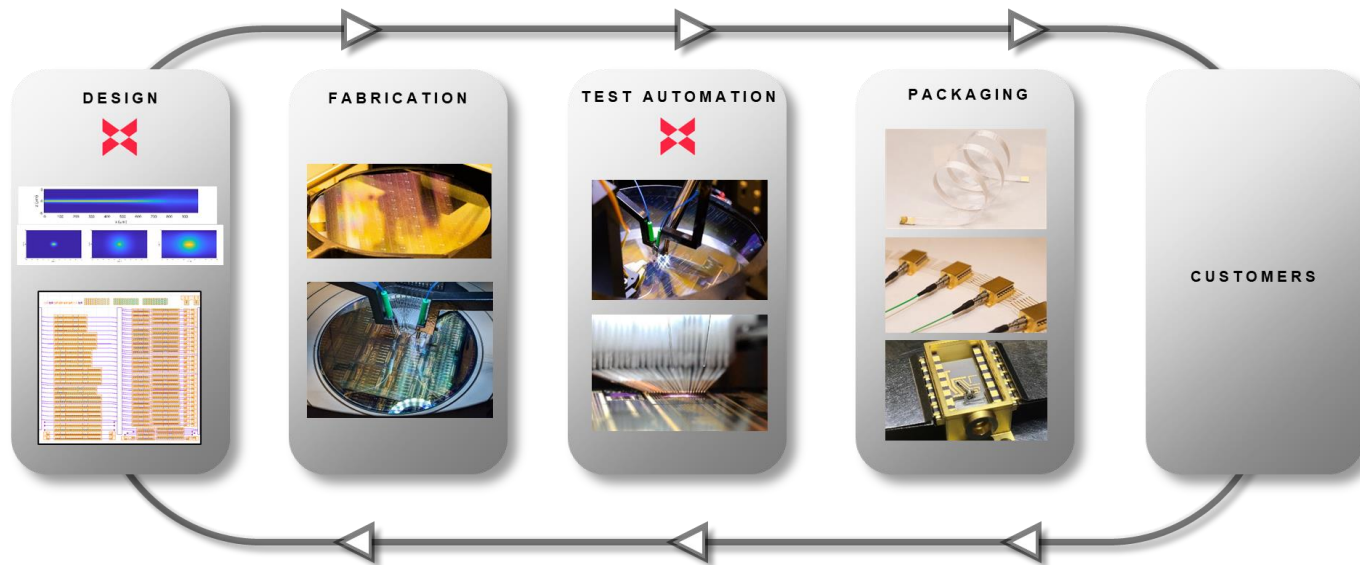
**Example 2: Multiple lasers (various wavelength) with photodetectors and modulators (<2.5 mm<sup>2</sup>)**



**More complexed/advanced PICs can be designed based on application**

# Working with Nexus

Interested in lasers and PICs? Reach out to us



**Standard process / Customer process**

Utilizing US-based commercial foundries

**Nexus Photonics** is a platform company that designs, develops, and produces (customer specific) photonic integrated circuits.

Our transformative technology offers our partners **unparalleled performance** at a **significantly lower cost** and **smaller footprint** to the current market alternatives.