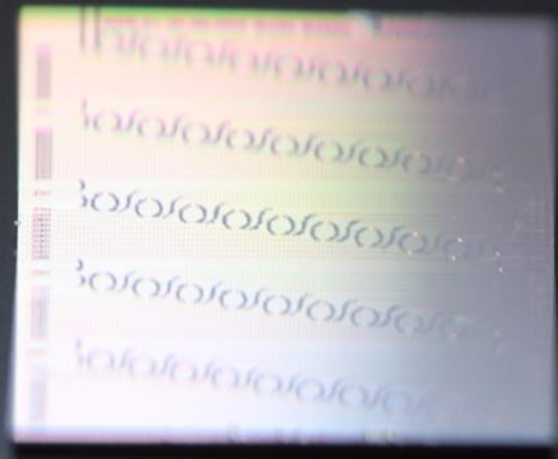



PIC packaging for nonlinear photonics

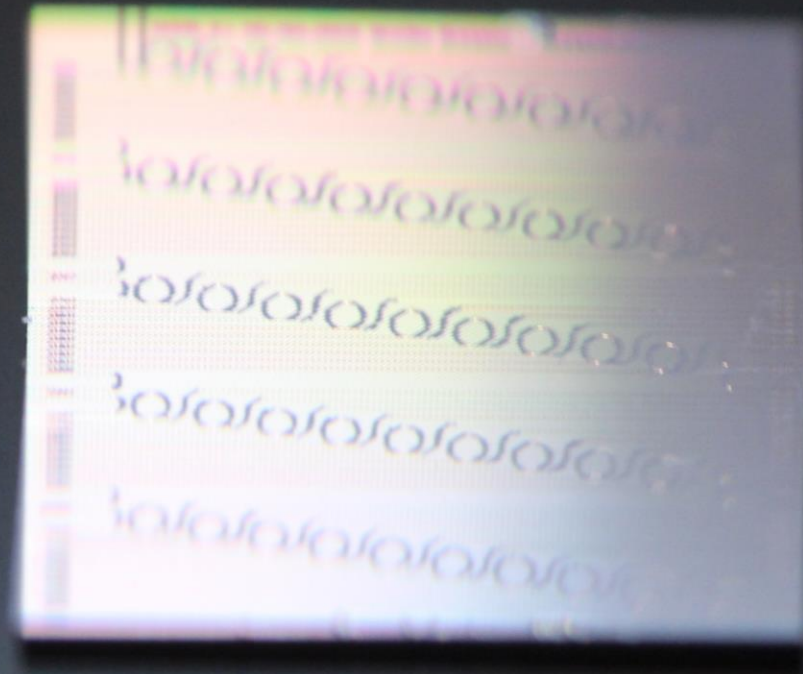


Johana Bernasconi, PhD

Lead Engineer

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Chip-scale comb lasers



Optical interconnects



LiDAR



5G/6G



Optical computing

- Low SWaP
- Mass manufacturability
- Compatibility with standards

Optical interconnects

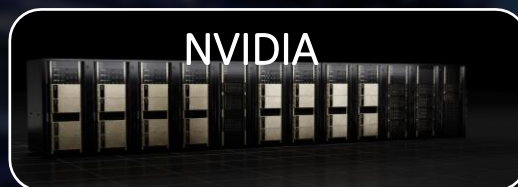
- World exchanges >300 exabytes every month
- Cloud computing and LLM training requires fabric bandwidth scaling up to 10x / year

Data Centers



Hyperscale Data Center
10 Pb/s
100,000 Lasers

HPC clusters



EOS Supercomputer
20 Pb/s
200,000 Lasers

Solutions

- Higher modulation speed
- Modulation formats
- **Comb lasers**



Scalable and low-power optical interconnects
for extreme-bandwidth communications

Established 2022

18 employees (9 PhDs)



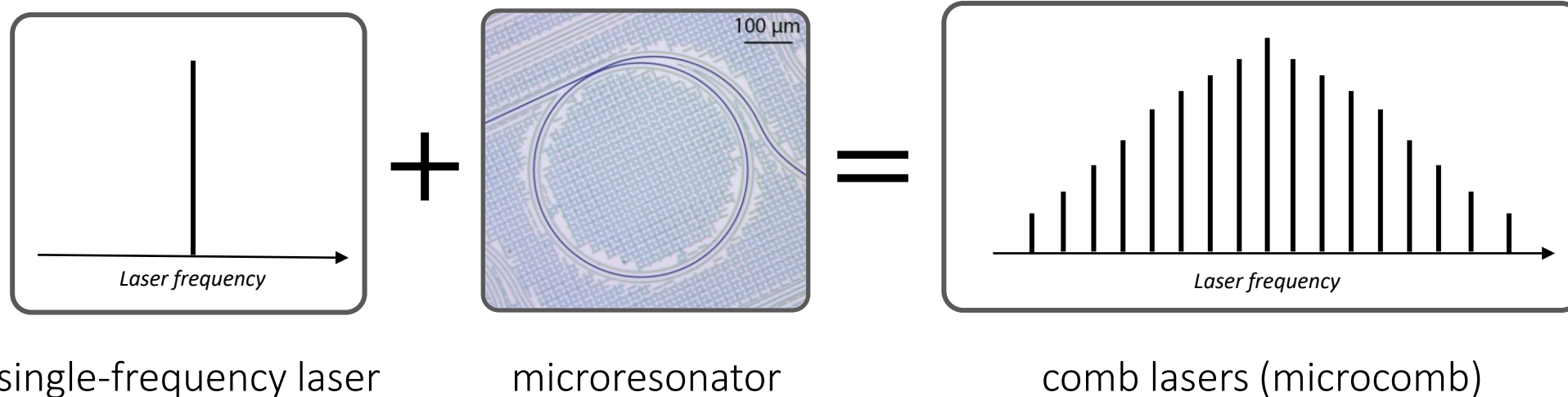
State-of-the art photonics with partners



Supported and backed by



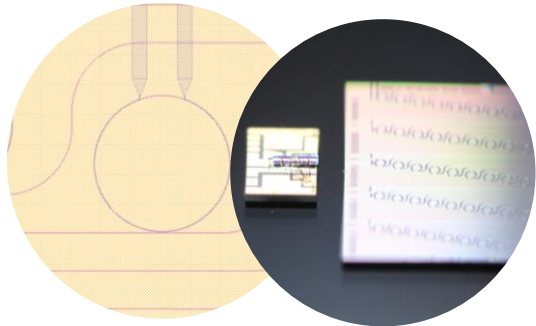
Comb laser technology



Enlightra's combs are based on the light conversion in a laser-driven nonlinear optical microresonators

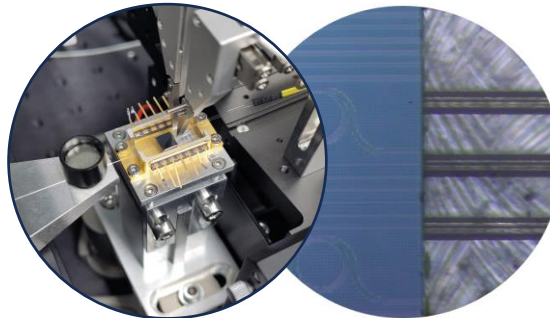
Enlightra's tech stack

Integrated photonics portfolio



- Verified designed blocks
- FEM/FTDT simulations
- Broadband PIC characterization

Photonic packaging



- Proprietary PIC packaging process
- Excellent power and temperature handling
- Thermal cycling and aging testing with thermal chamber

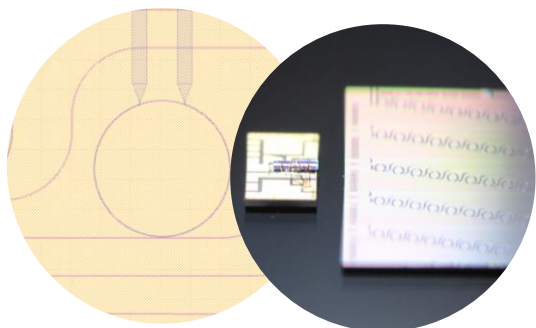
System integration



- PICs system integration into turnkey device
- Complex system-on-a-chip development with multiple photonic platforms.

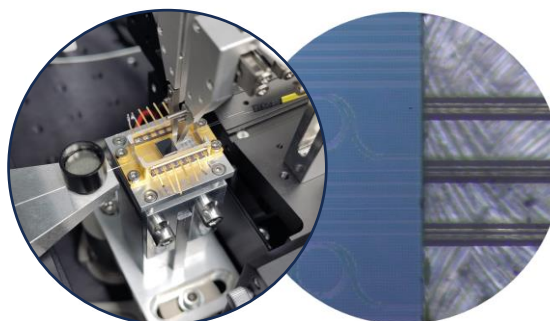
Enlightra's tech stack

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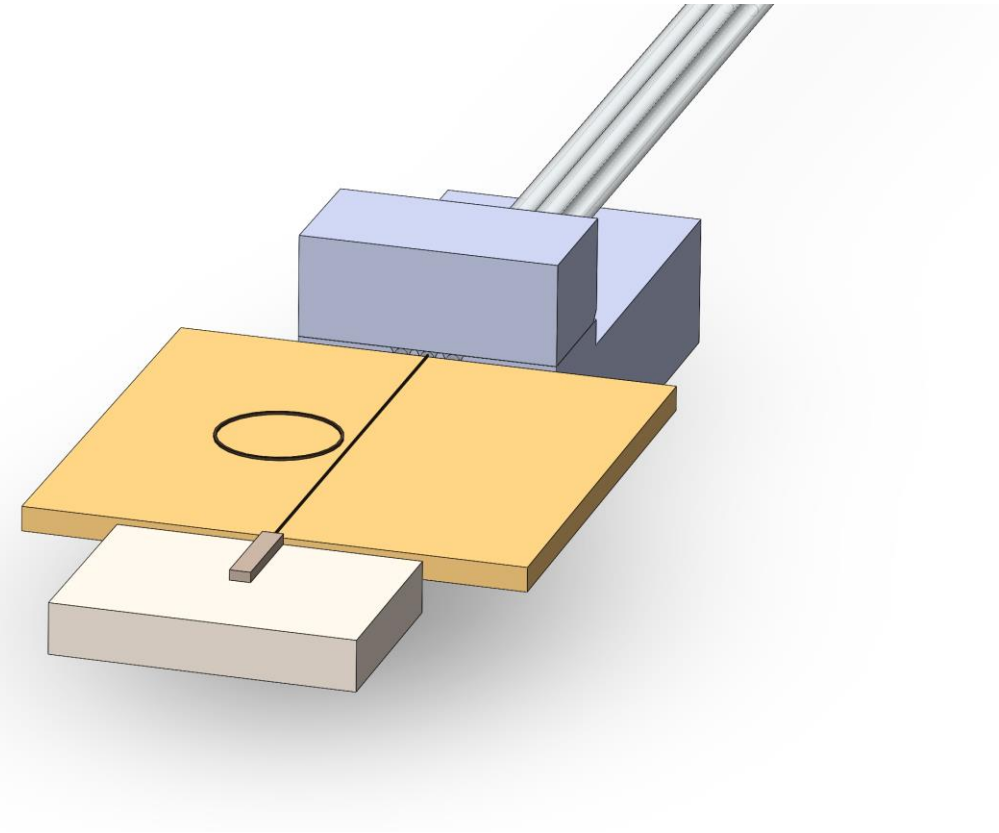


- PICs system integration into turnkey device
- Complex system-on-a-chip development with multiple photonic platforms.

Challenges of PIC packaging

- Maximizing light inside the chip for non-linear processes
- Edge coupling (multiple wavelengths)
- Components with different mode field diameters
- Fabrication limit for on-chip tapers

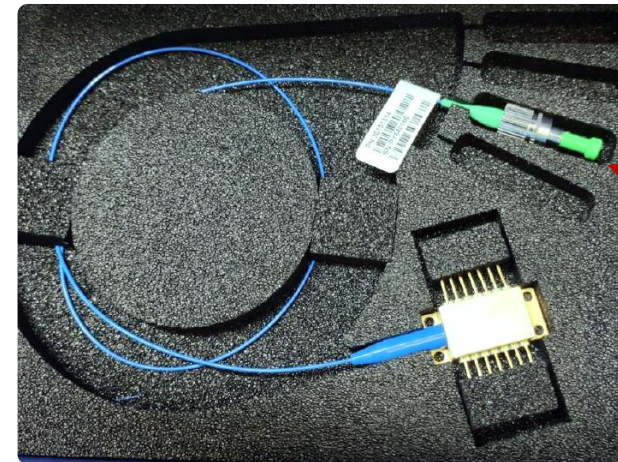
→ **Sub- μm alignment, requires active alignment**



Requirements on the optical package

- Environment : temperature variations 15°C-80°C
- High optical power
- Mechanical stability (with temperature changes)
- Heat extraction from the laser diode
- Thermal stability inside the package (for stable frequency)

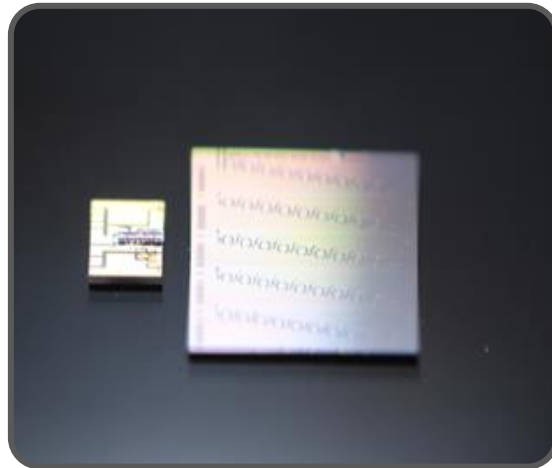
→ Require simulation, experimental tests and fast prototyping cycles



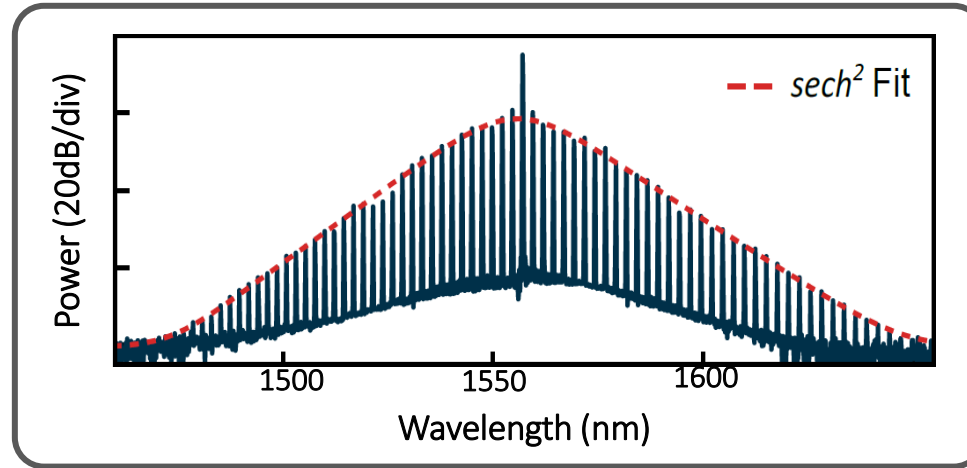
Fibre coupled to the outside world
→ direct link to sensitive alignment spot



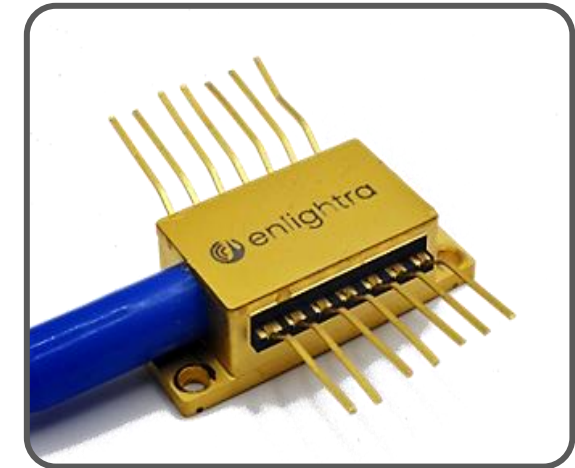
Comb laser integration achievements



- Single wavelength laser chip
- Non-linear effect in the SiN chip
- Wafer-scale manufacturability



- 10 – 1000 GHz line spacings
- 1 kHz linewidth (white noise)
- High coherence of comb lines
- O-band, C-band
- Extremely broadband (no gain limitation)



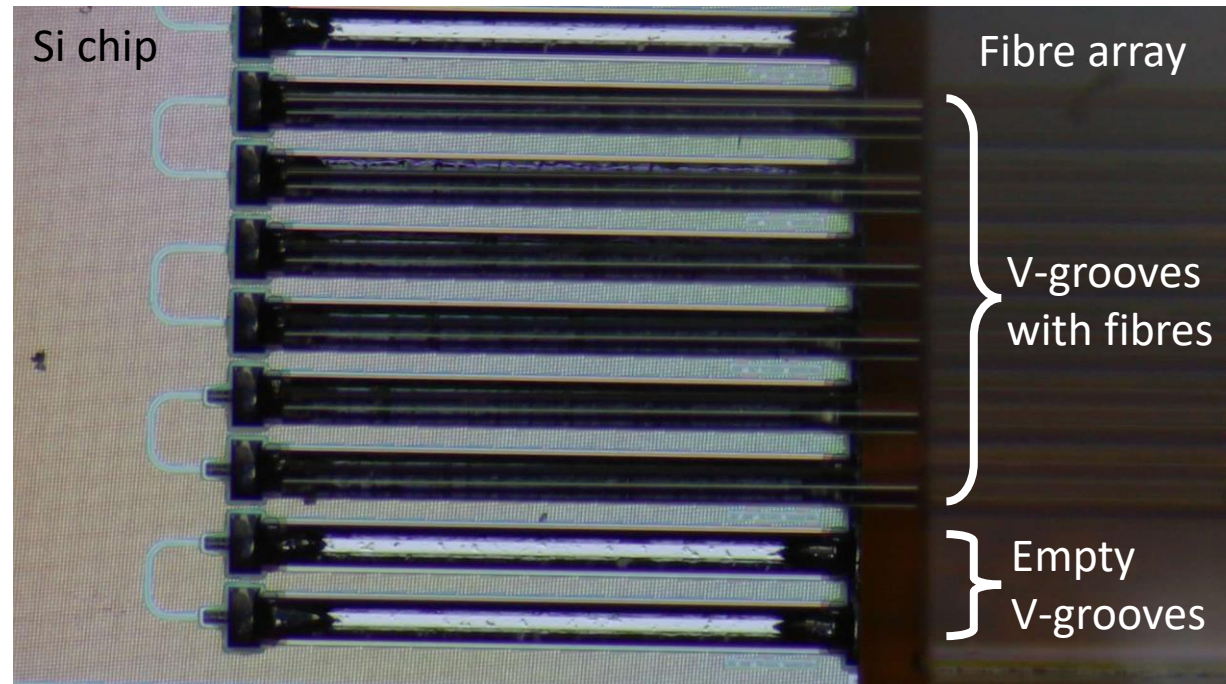
- Butterfly form-factor
- Stable during temperature swing 15°C ... 60°C
- Successfully shipped to clients

Work in progress: towards large(r) volume

From small volume to large volume + **everything in between:**

- Passive alignment (e.g V-groove)
- Automation
- Repeatability of the performance

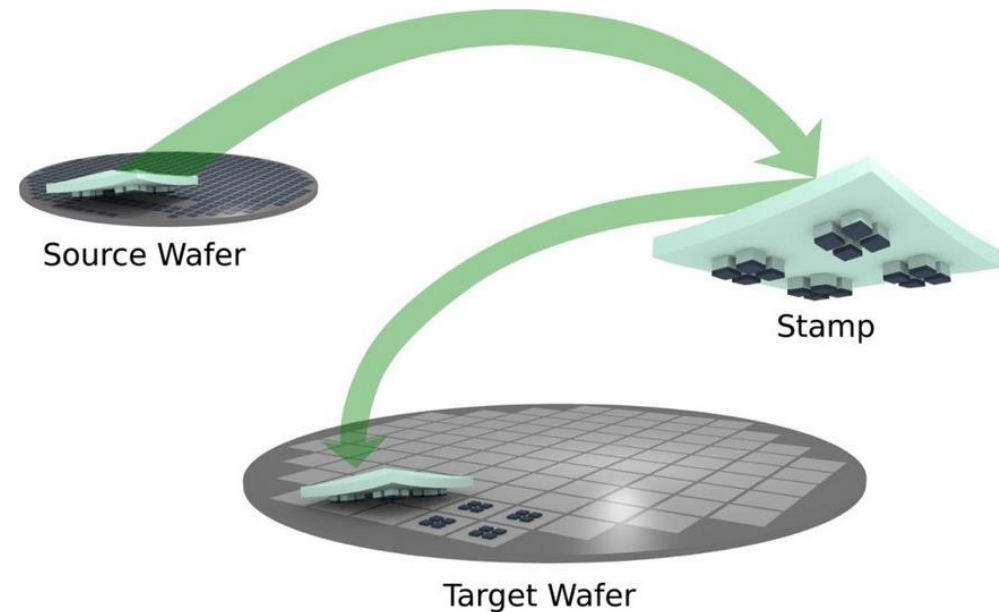
Passive alignment with Si on-chip V-groove



Upcoming: large volume integration

Challenges of heterogeneous integration

- Finding the right method:
 - monolithical integration by epitaxial growth
 - flip chip of dies
 - wafer-level bonding
 - micro-transfer printing
- Compatibility with foundries
- Requirements (alignment tolerance, environment, heat transfer)



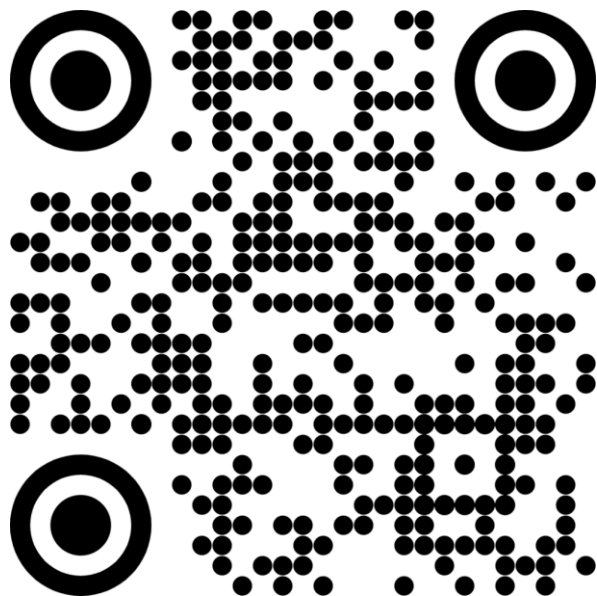
MTP process: M-Engine< HORIZON-EIC-2023-TRANSITION-01

Conclusion

- PIC packaging is technically challenging
- PIC packaging for large volume is not state-of-the-art
- Gap between low-volume to high volume/wafer-level
- Choosing between the different solutions for large volume integration and packaging is complex



Contact us!



johana.bernasconi@enlightra.com

Partners

Customers

Join the Team

Tabletop Comb Laser



- Shipped since the beginning of 2023
- Tabletop turnkey device
- 100 – 400 GHz spacing
- >2000h non-stop operation (at customer site)

