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PICs-based comb lasers for data communication

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The need: more bandwidth

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

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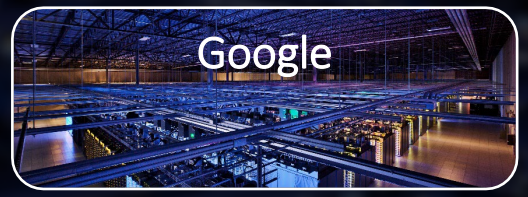
Data Centers



Hyperscale Data Center
10 Pb/s
100,000 Lasers

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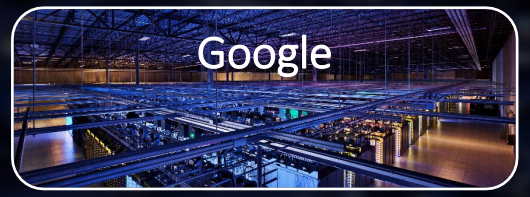

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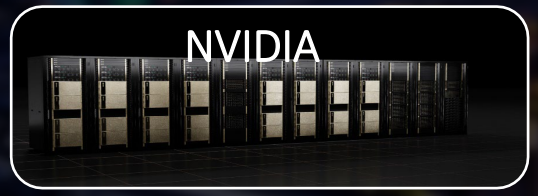
HPC clusters



EOS Supercomputer
20 Pb/s
200,000 Lasers

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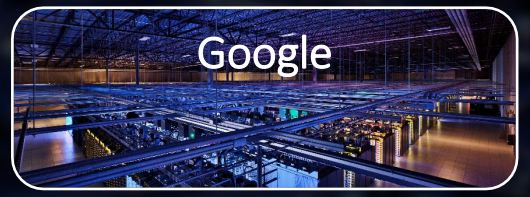

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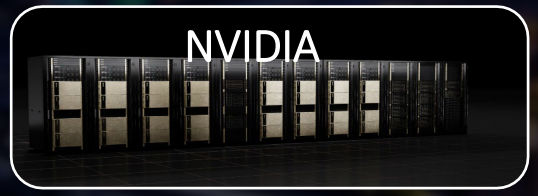

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20 Pb/s
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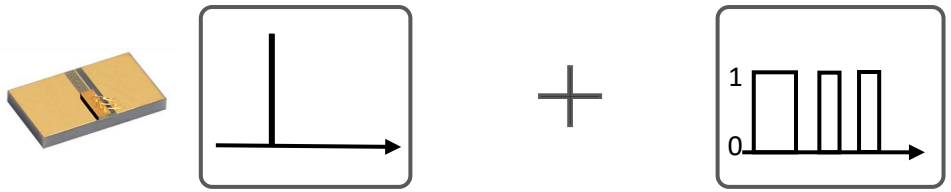
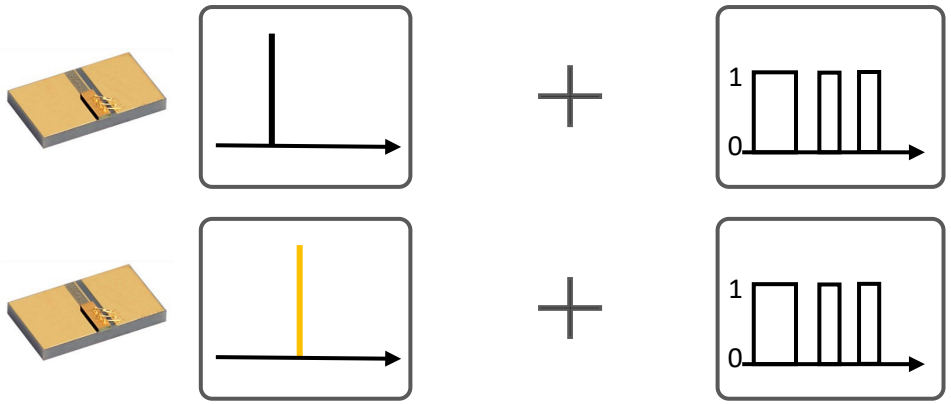
The solution

- Higher modulation speed
- Modulation formats
- **Multiple wavelengths**

Multiple wavelengths: status



Multiple wavelengths: status



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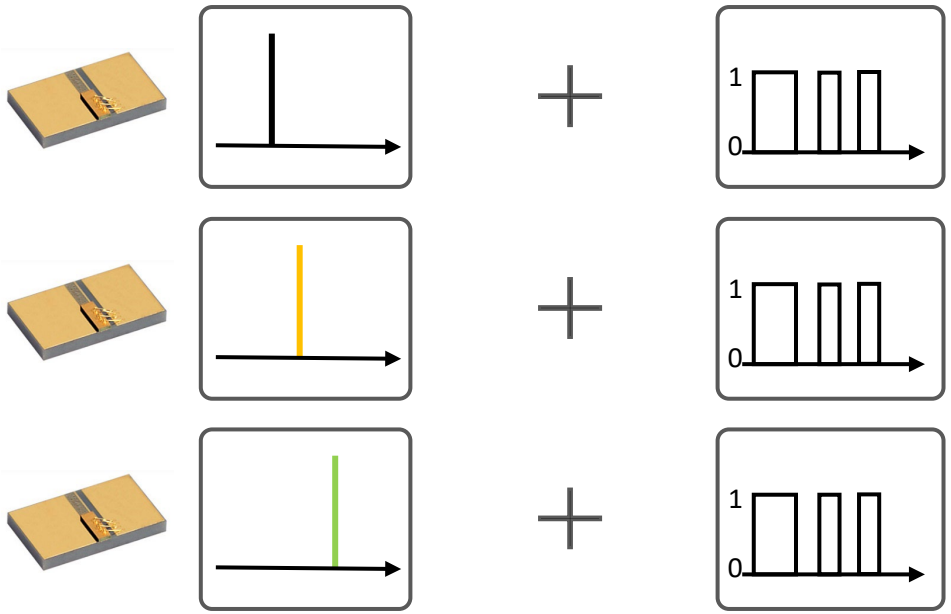

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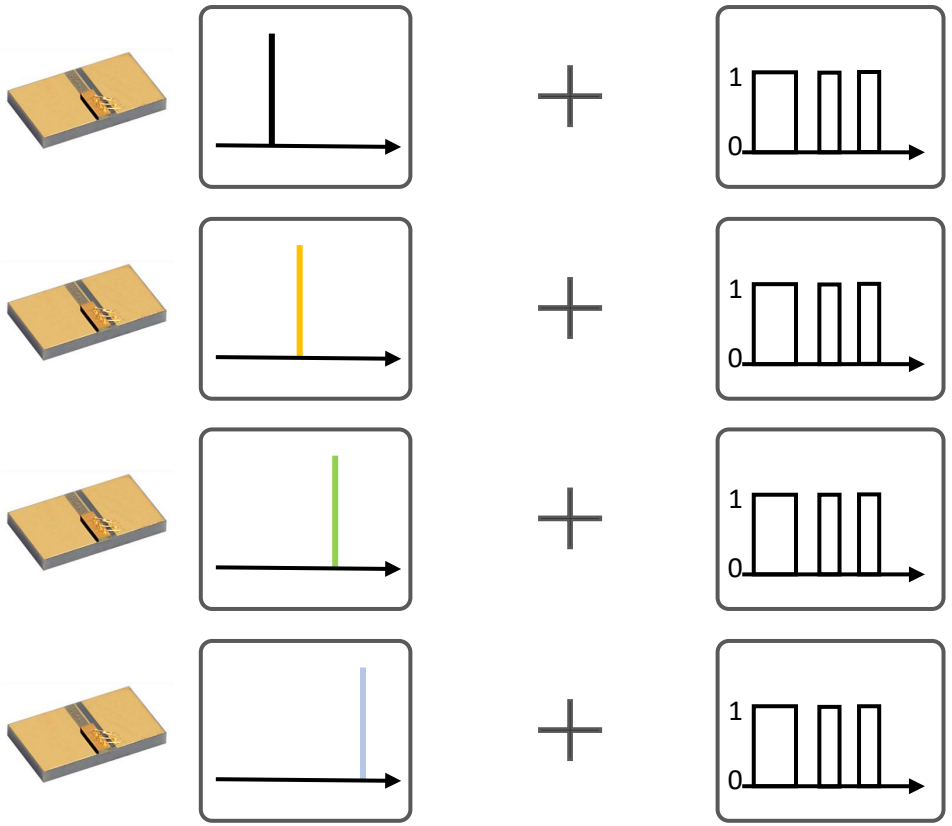


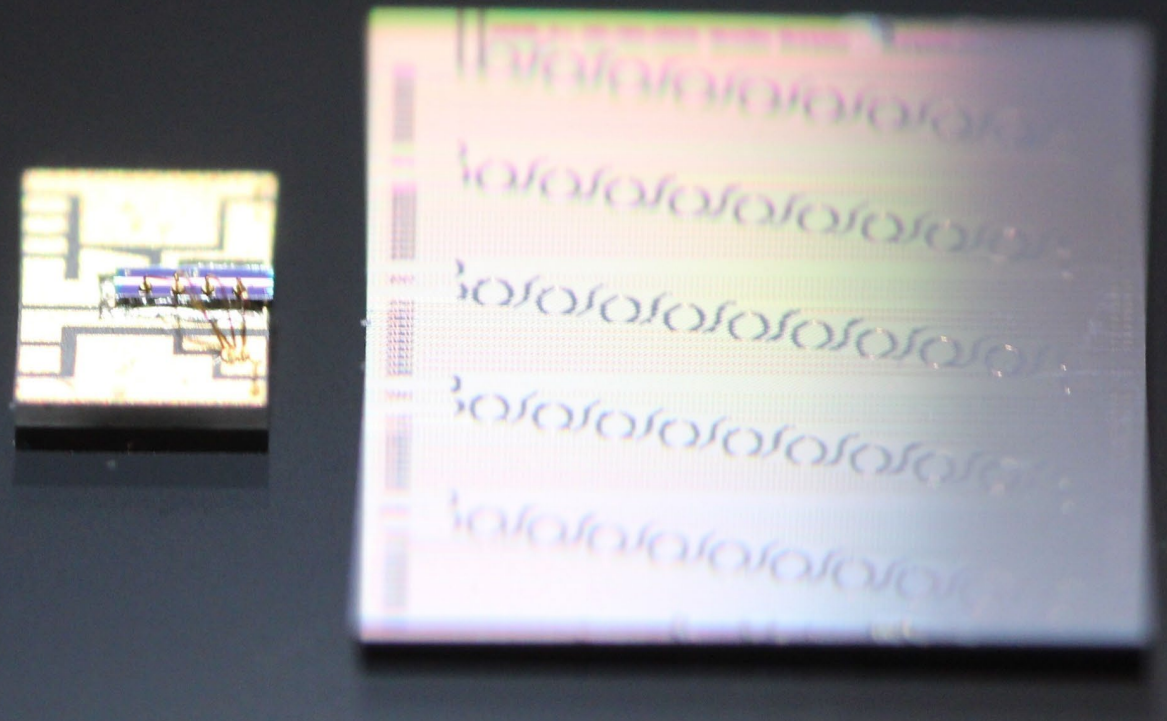
[…]

Array of 8-16 lasers have been successfully integrated into products

Bottlenecks:

- Distinguish each laser line
- Difficult to stack more

Coherent comb lasers



Optical interconnects

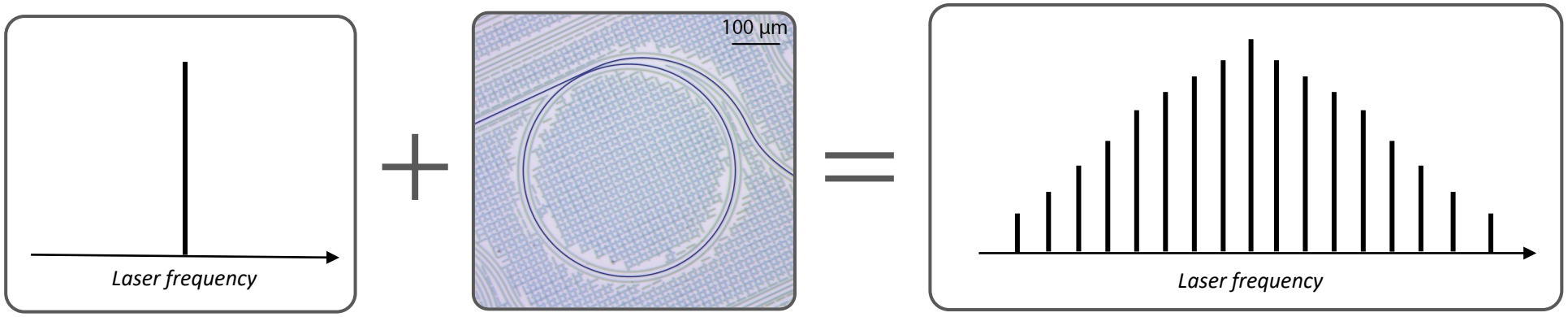
LiDAR

5G/6G

Optical computing

- Low SWaP
- Mass manufacturability
- Compatibility with standards

Coherent comb laser technology



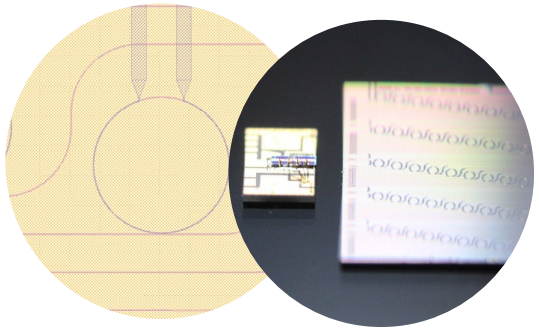
single-frequency laser microresonator comb lasers (microcomb)

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

[Insert complicated equation here…]

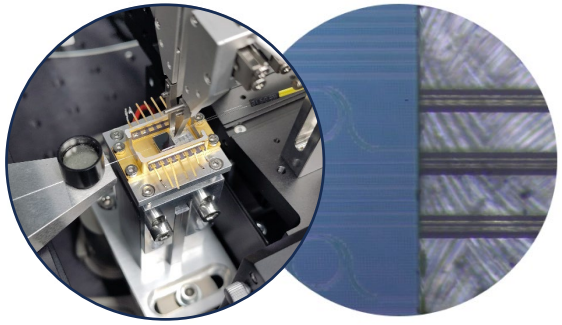
Enlightra’s tech stack

PIC design and characterization



- Integrated photonic portfolio
- FEM/FTDT simulations
- Broadband PIC characterization (O- and C-band)

Photonic packaging



- Proprietary PIC packaging process
- Good power and T° handling
- Aging with thermal chamber

System integration

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

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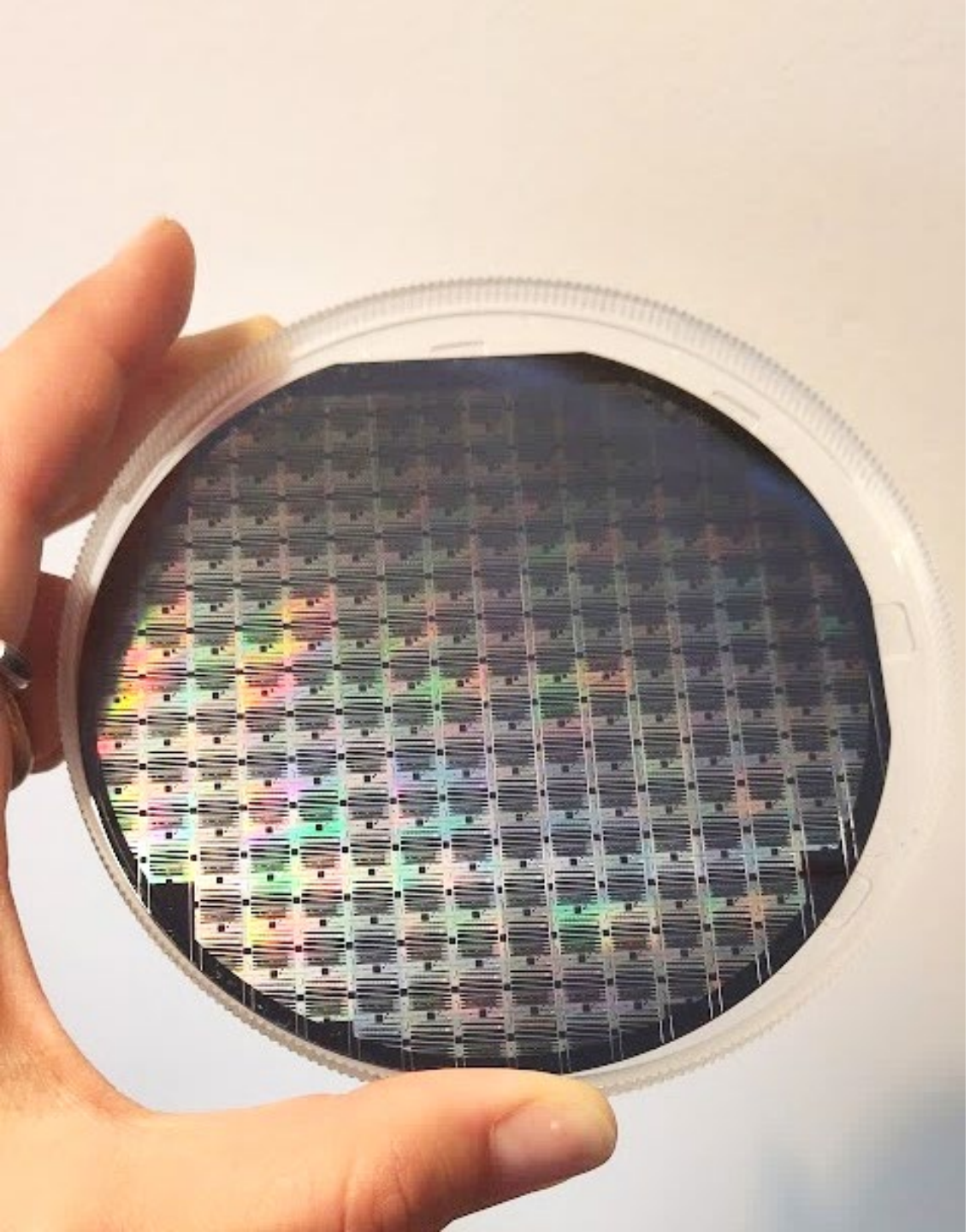
Challenges



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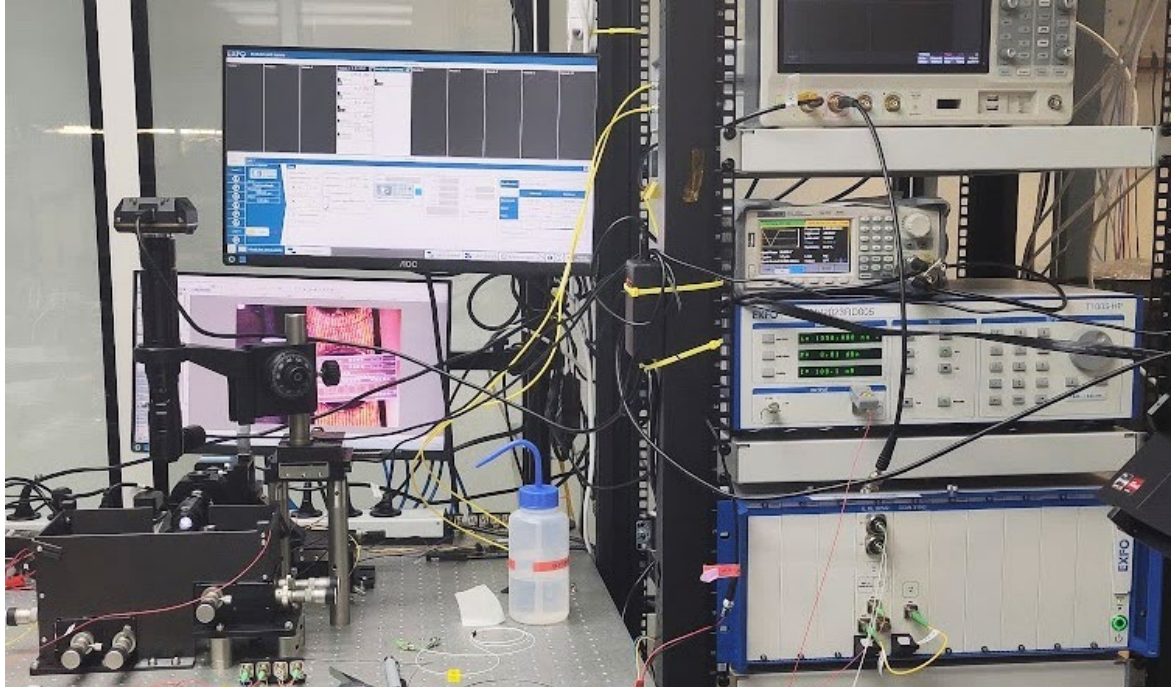
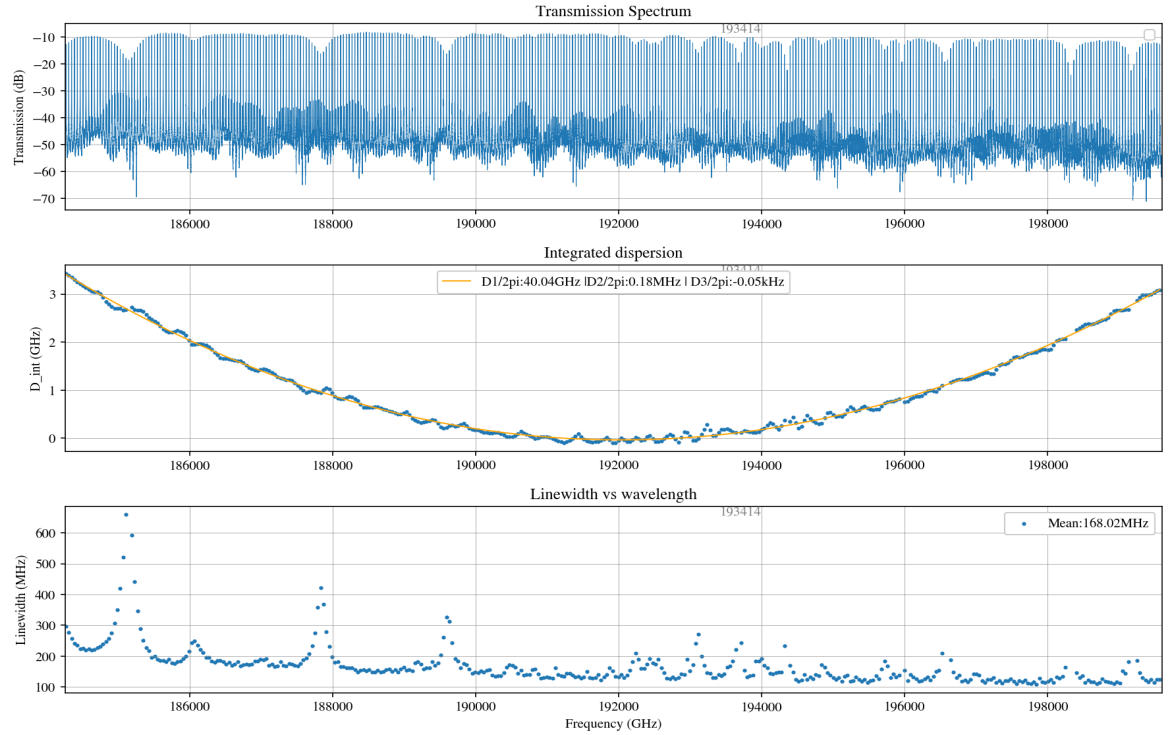
PIC design

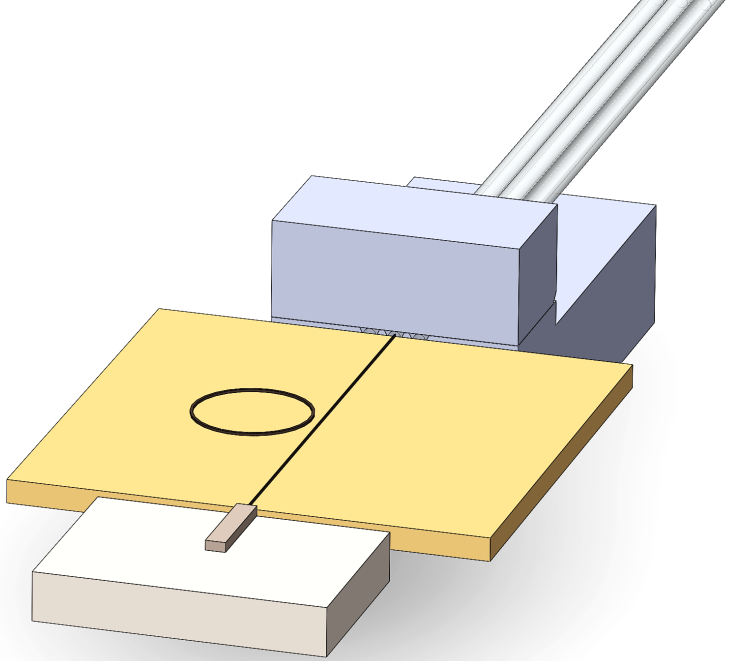
- Heavy simulations and computations
- Fabrication tolerances and critical dimensions limit the design
- Fabrication processes available (material, layers, metallization)
- Design space is expensive
- Long iteration cycles: “fab time”
- MPWs (multi-projects wafer) run at set dates
- Material quality variation can happen

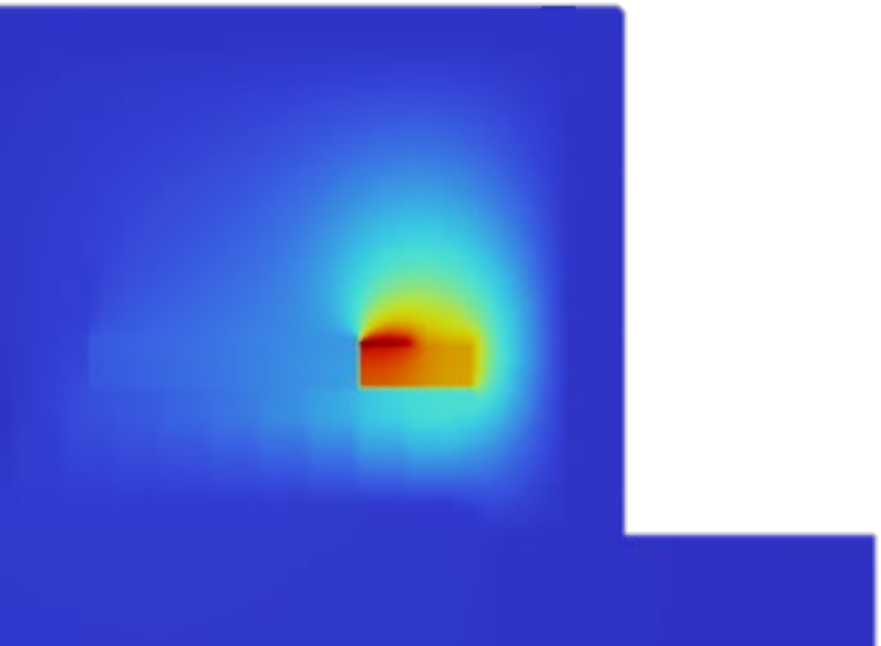
PIC characterization

- Metrology for PICs is not standardized (uncertainty assessment)
- Establishing a minimum set of metrics/tests
- Developing processes and building a database
- Optimizing the through-put
- Define a min. set of chips to characterize
- Develop automation at die level (single chip)
- Wafer-level testing is expensive









PIC packaging

- Maximizing light inside the chip for non-linear processes → Sub- µm alignment
- Edge coupling (multiple wavelengths)
- Components with different mode field diameters
- Able to sustain high optical power
- Mechanical stability
- Environment : temperature variations 15-80°C → stable frequency
- Wafer-level packaging : micro-transfer printing, chip bonding

System integration

- Use off-the-shelf electronics
- PCB design and layout
- Co-integration of electronics and optical parts (using mechanics)
- Put everything into an external laser source / transceiver form factor

Achievements

- Coherent comb laser in a butterfly form-factor
- First sells of beta systems in 2023
- First demo for O-band in 2024
- Beta system at customer stable for >2000h

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

- Established 2022
- 21 employees

SAMSUNG imec EFFECT PHOTONICS

- State-of-the art photonics with partners

European Commission | Horizon 2020 European Union funding for Research & Innovation

Innosuisse

DARPA GRYPHON esa European Space Agency QSIT Quantum Science and Technology National Centre of Competence in Research

- Supported and backed by

Y Combinator intel Ignite

Contact us!

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Partners

Customers

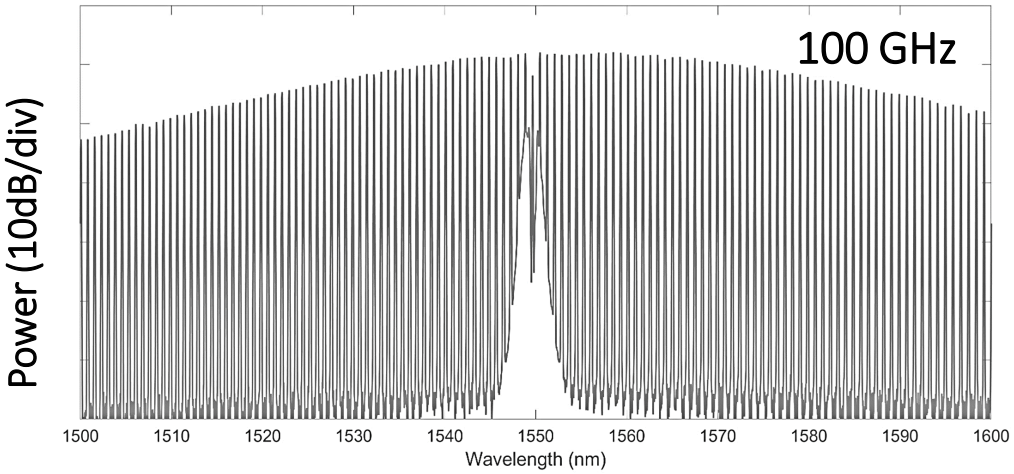
Join the Team

EFTF 2024
June 25-27 • Neuchâtel • Switzerland
37th European Frequency and Time Forum

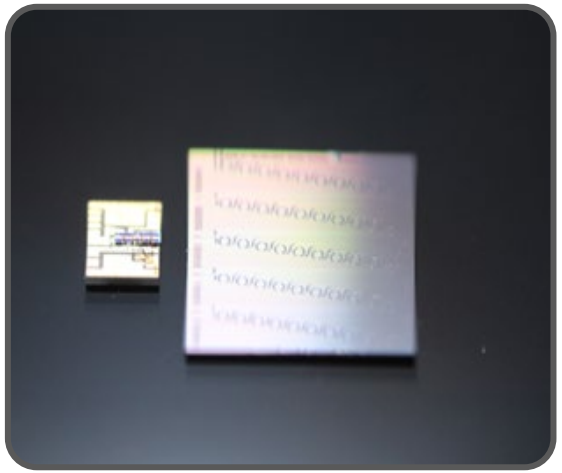
50th Anniversary
ECOC2024
FRANKFURT

Tabletop Comb Laser

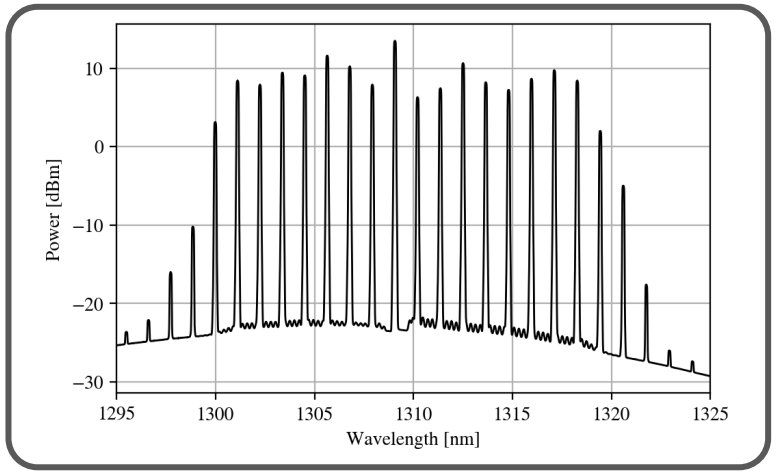
- Shipped since the beginning of 2023
- Tabletop turnkey device
- 100 – 400 GHz spacing
- >2000h non-stop operation (at customer site)



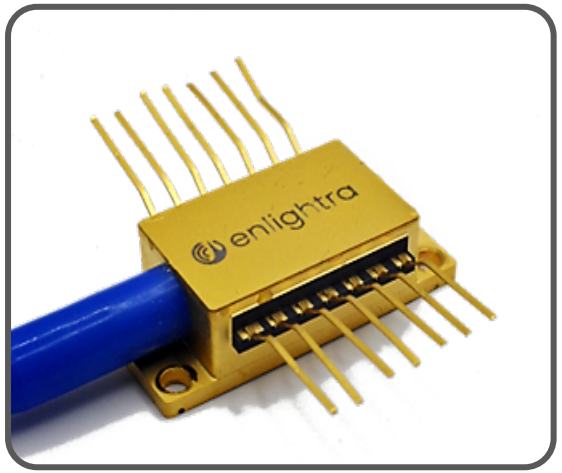
Comb laser integration achievements



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



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

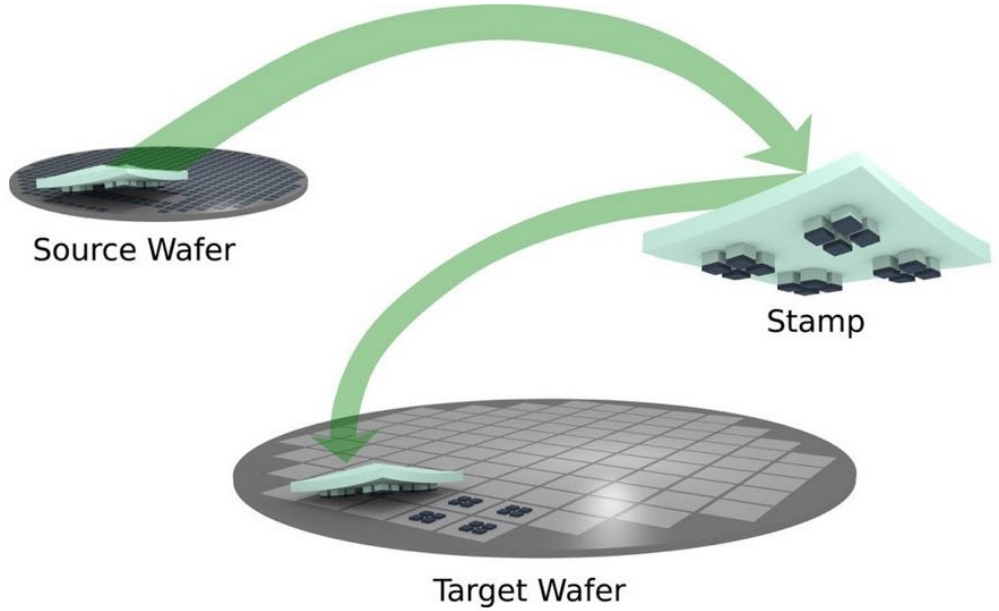


- Butterfly form-factor
- 1 kHz linewidth (white noise)
- Stable during temperature swing 10 … 60^{o}C

Large volume packaging

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