



EPFL

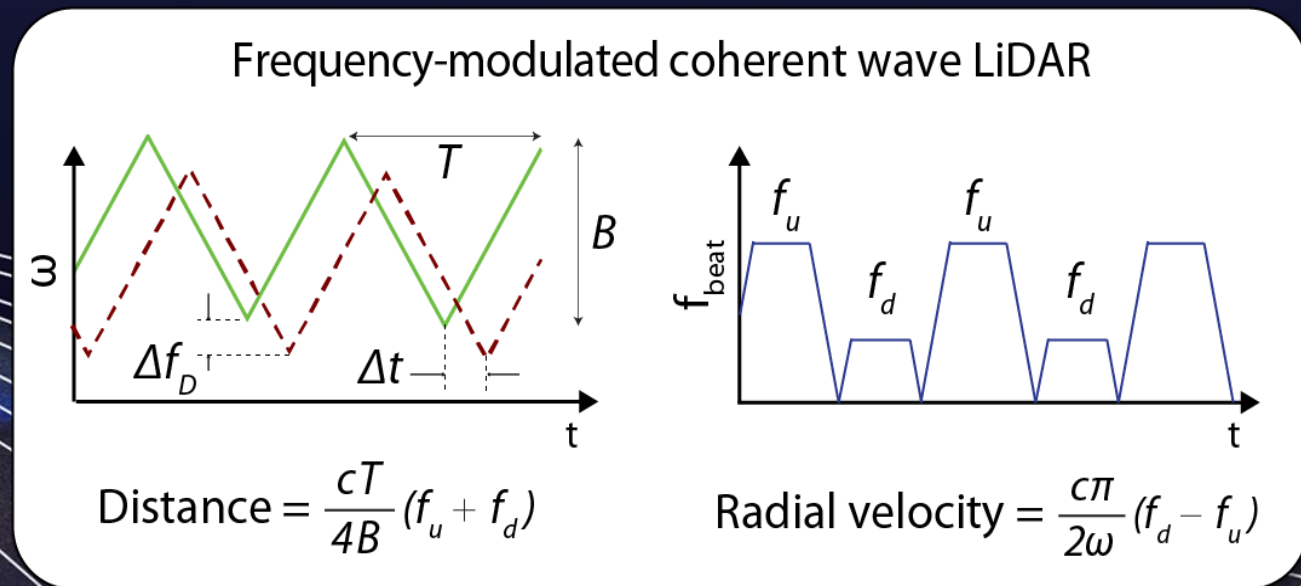
DEEPLIGHT™

EPIC Online Technology Meeting on LIDARs on Chips

Frequency-agile Photonic Integrated Lasers for Coherent Ranging

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23 October 2023
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FCMW LiDAR for the automotive industry



Pros

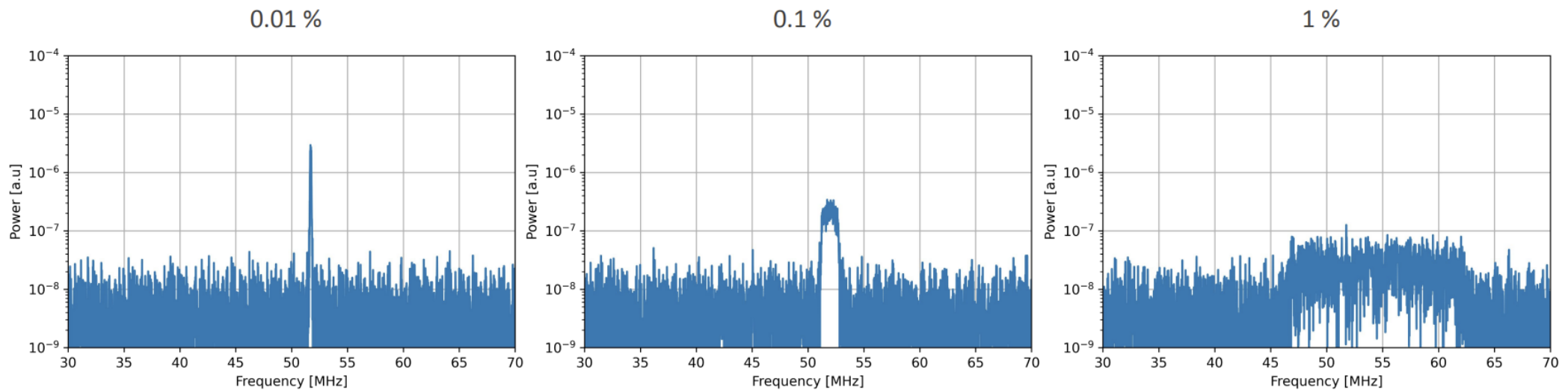
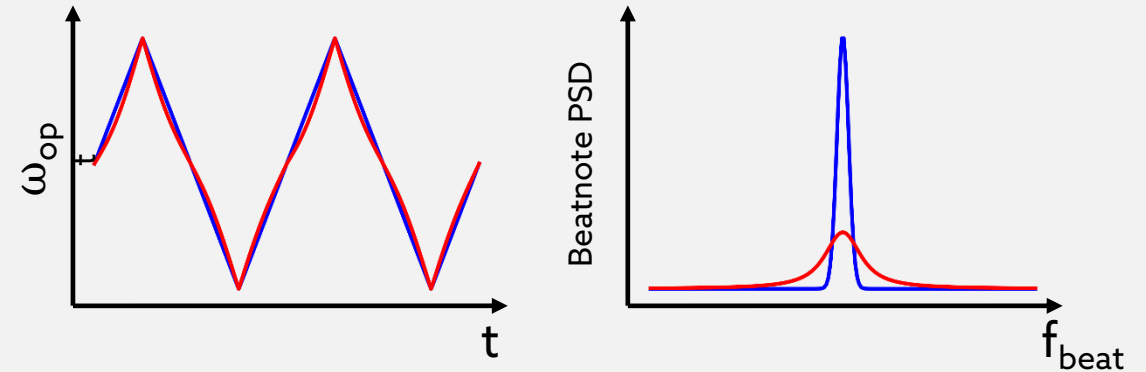
- 4D LiDAR
- Higher receiver sensitivity
- Long-range
- Minimized interference
- Ambient light rejection

Cons

- Narrow laser linewidth necessary
- High chirp linearity necessary

Homodyne FMCW signal detection at 250 m

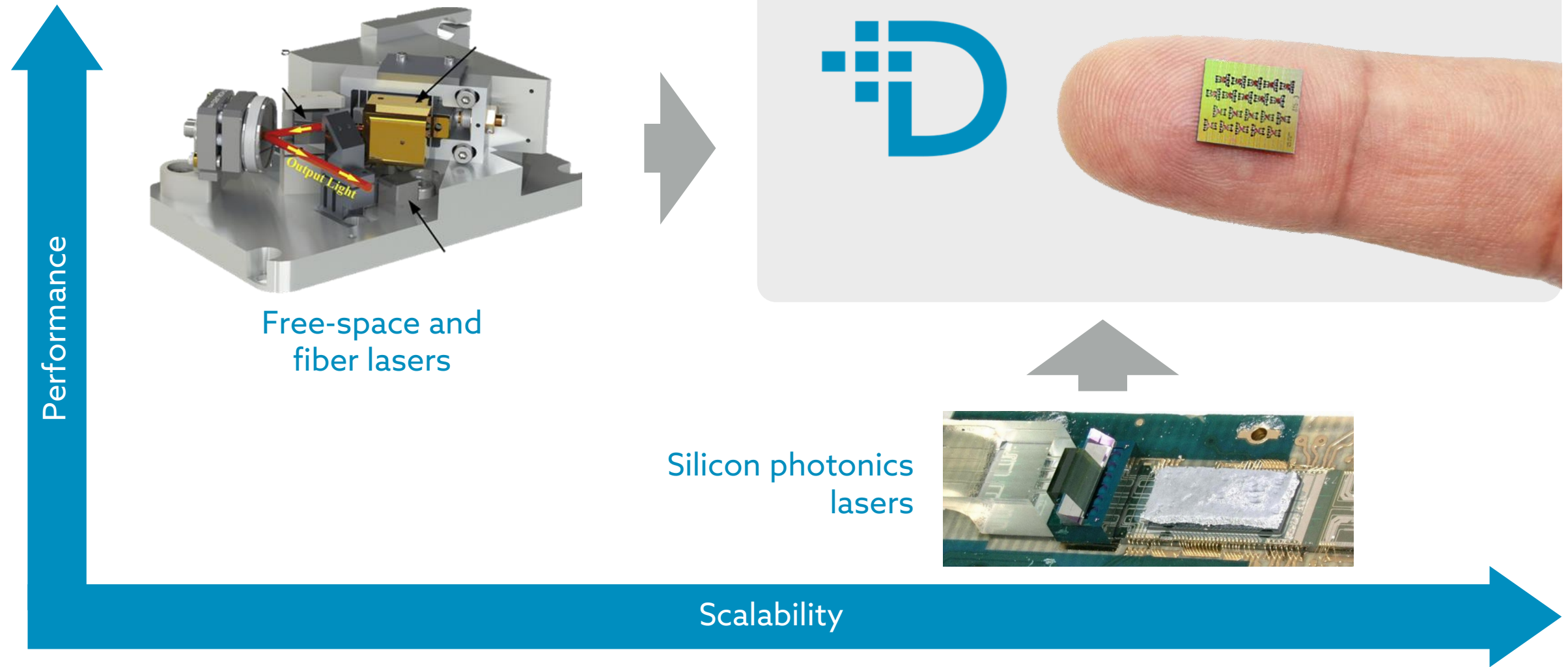
- High linearity is needed
- Linearization could help
- The laser becomes expensive



Nonlinearity: 0.01%, 0.1% and 1%
Laser linewidth: 1 kHz

Frequency sweep: 10 kHz
Chirp range: 1 GHz

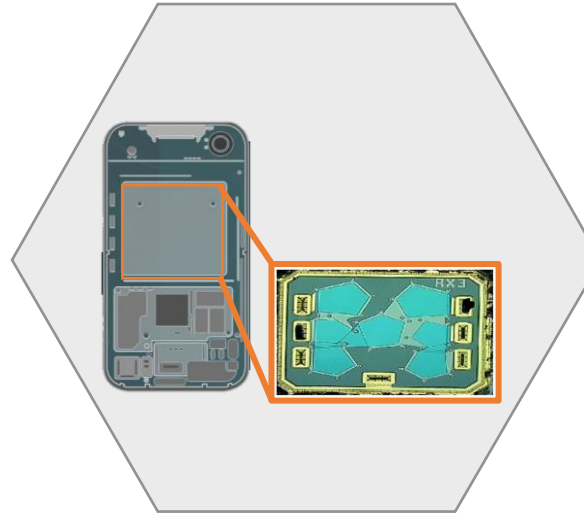
Technology Gap



Our technology

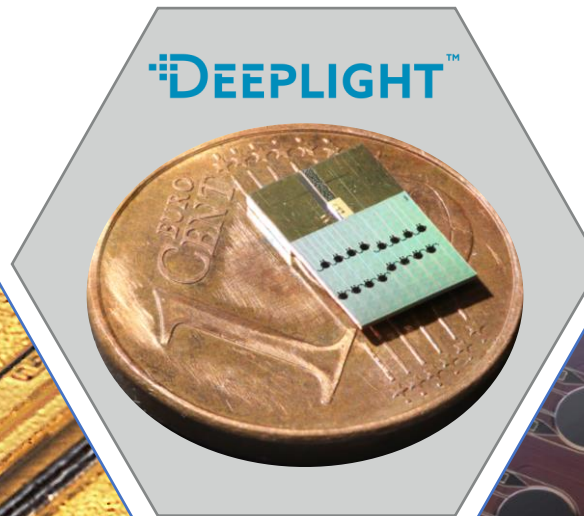
10 IP families, including:
Patent No. 10,191,215 B2
Patent No. 10,923,874
PCT/EP2019/082307
PCT/EP2021/056338
PCT/ PCT/IB2022/052668

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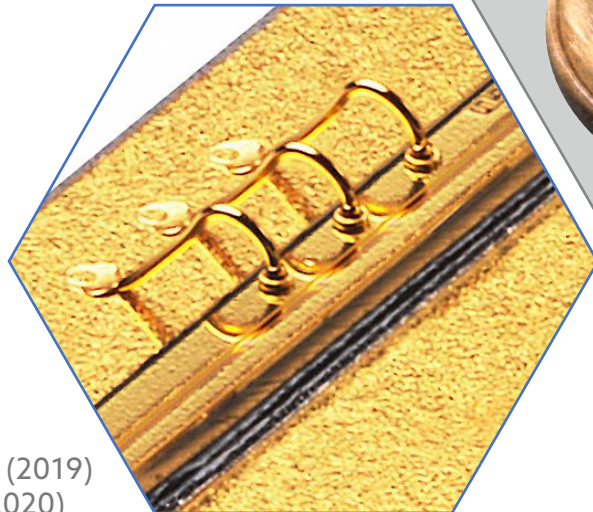
100x faster:
MEMS-based
monolithical
peizoelectric
actuator

Liu et al., Nature 583.7816, 2020
Hao et al., Nature Comm. 11.1, 2020
Lihachev et al. Nat Commun 13.3522, 2022

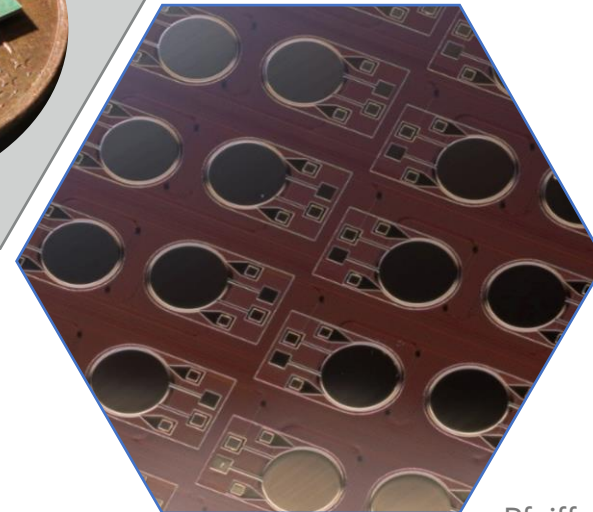


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Many wavelengths:
III-V gain media,
active optical device



Raja et al., TJK Nature Comm. 10.1 (2019)
Shen et al., TJK Nature 582.7812 (2020)
Voloshin et al., Nat Commun 12.235, 2021



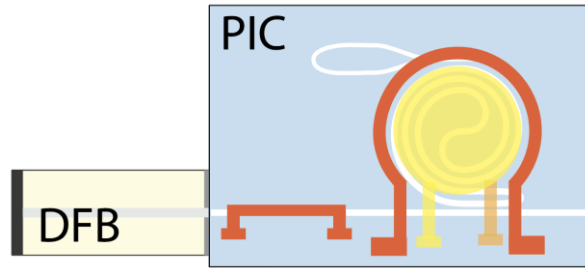
10x lower noise:
ultra-low loss
Si₃N₄ platform

Pfeiffer et al., Optica, 2018
Liu et al., Nature Comm. 12.1, 2021

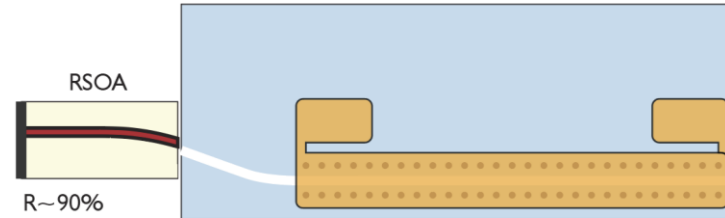


Deeplight's laser concepts

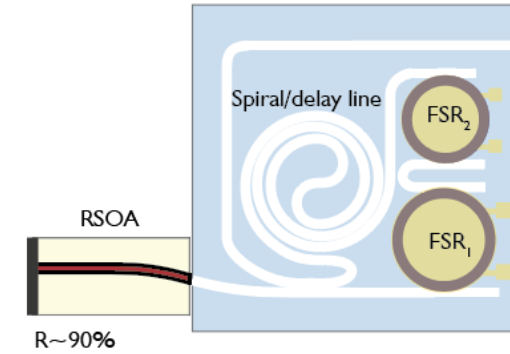
Self-injection locking (SIL) of DFB/FP diodes



Extended Distributed Bragg Reflector (E-DBR) laser



External cavity laser (ECL)



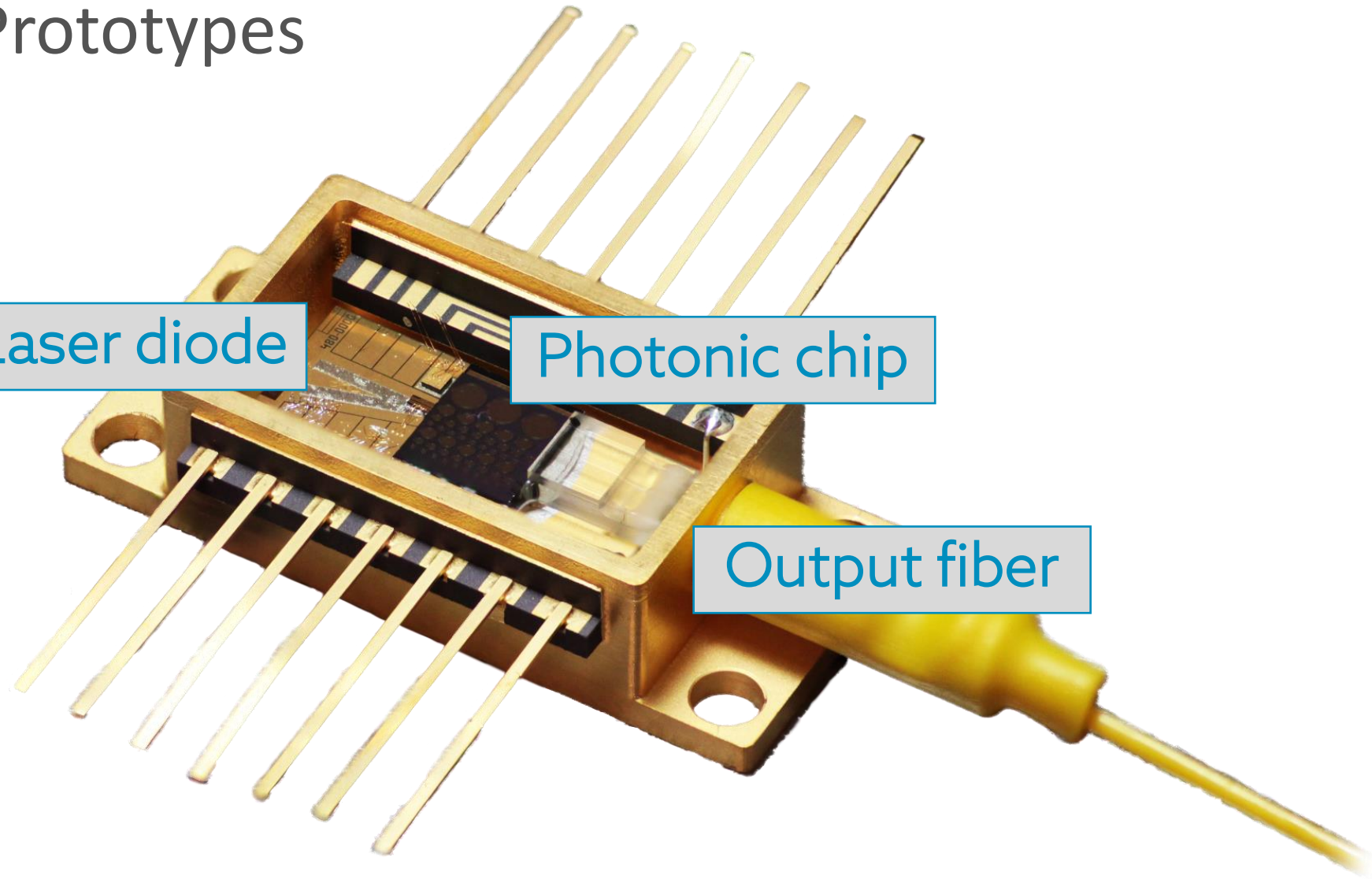
	SIL	E-DBR	ECL
Compatible with low-cost RSOA/FP	yes	yes	yes
Fast 1-5 GHz tuning (BW: 10 MHz)	yes	yes	yes
Fast >5 GHz tuning	no	no	yes
Slow 10-50 GHz tuning	no	yes	yes
Wide wavelength tuning	no	no	yes
Mega-pixel rate (2.8 MPix/s)	yes	no	no

Prototypes

Laser diode

Photonic chip

Output fiber



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Competitors



Fiber lasers



Planar waveguide lasers

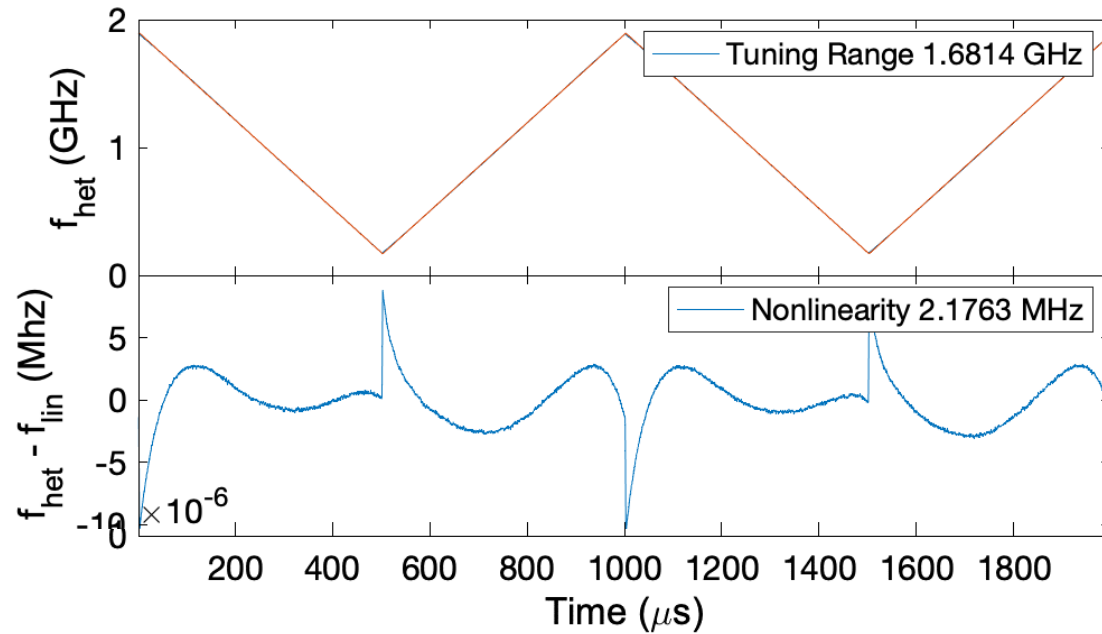
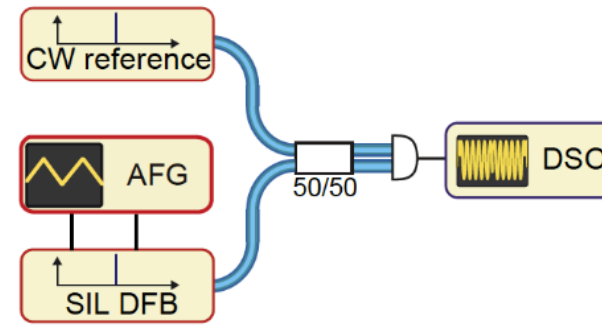


External cavity lasers

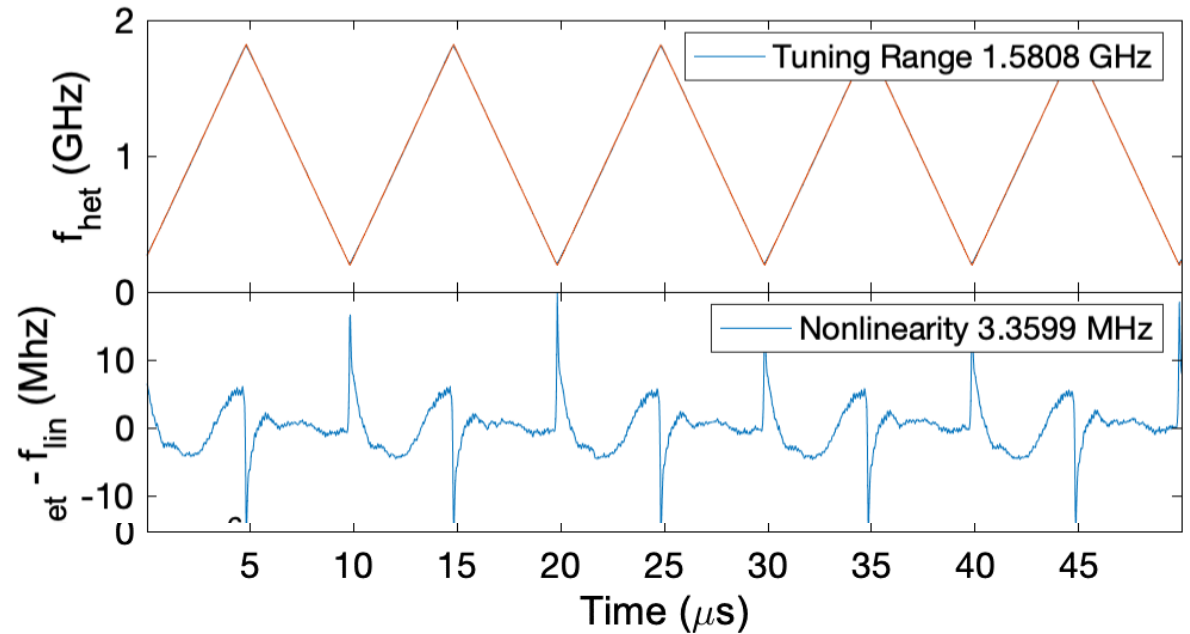
Custom projects to develop additional functionality on a chip

Prototype DLT-FT-1550

Time-resolved heterodyne beat-note measurement with a reference laser



Sweep rate: 1 kHz
RMS nonlinearity: 0.13%



Sweep rate: 100 kHz
RMS nonlinearity: 0.21%