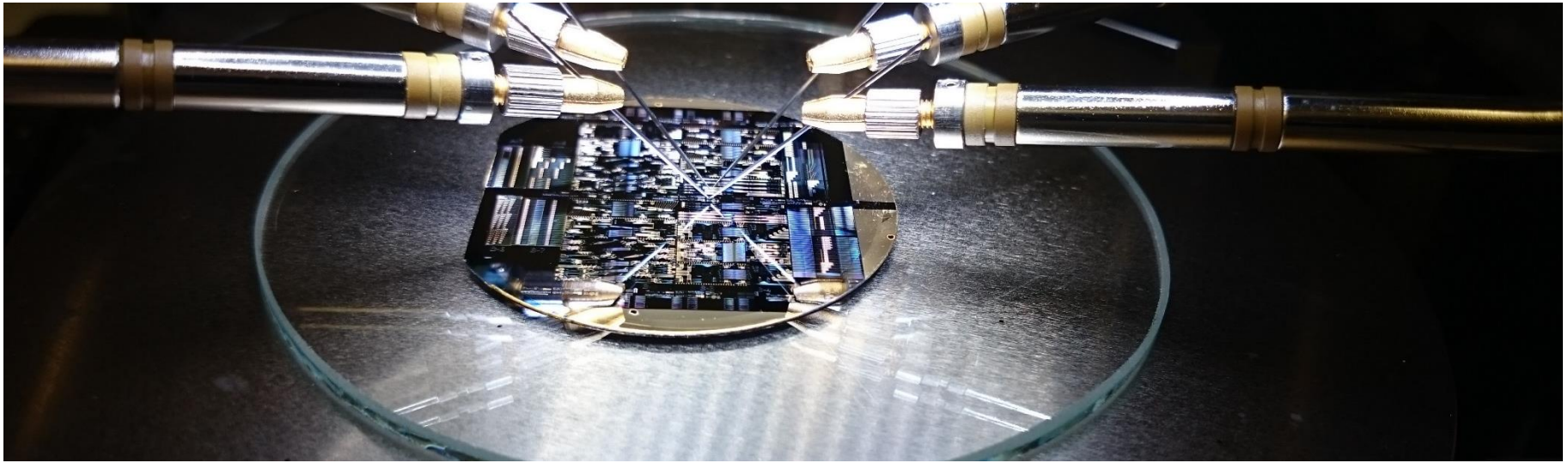
FRAUNHOFER HEINRICH-HERTZ- INSTITUTE

InP-based Photonic Integrated Circuits

EPIC Online Technology Meeting on Quantum Computing 19 May 2020



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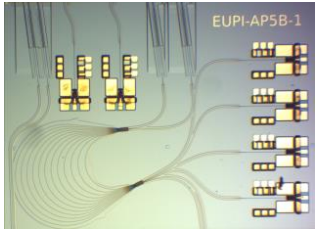
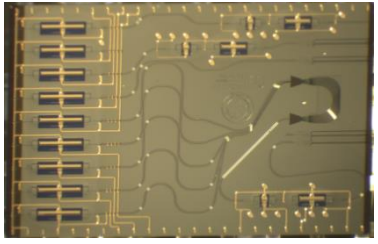
PIC Examples from HHI InP Foundry for Multiproject Wafers

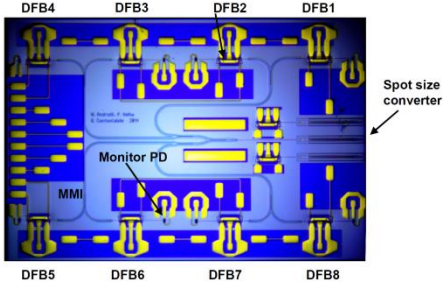
Usage both by industry and academia



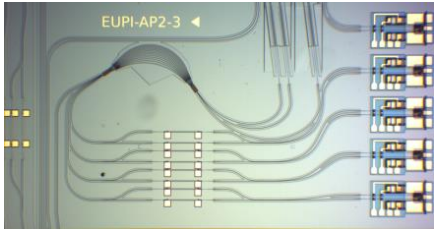
WDM receiver for FTTH
(Genexis)



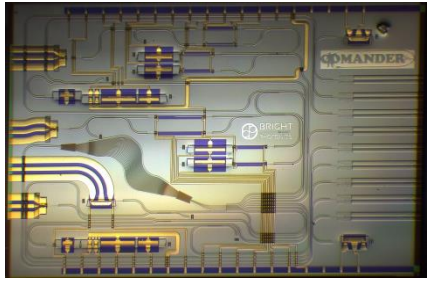
AWG-based harmonic mode-locked laser
(Chinese Acad. of Sciences)



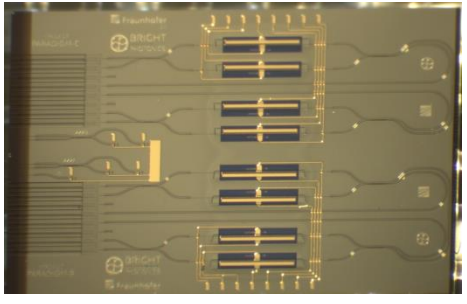
Multi-Wavelength transmitter
(Scuola Superiore Sant´Anna)



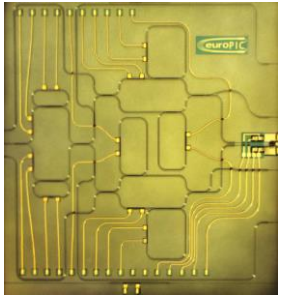
FBG-readout
(Fibresensing)



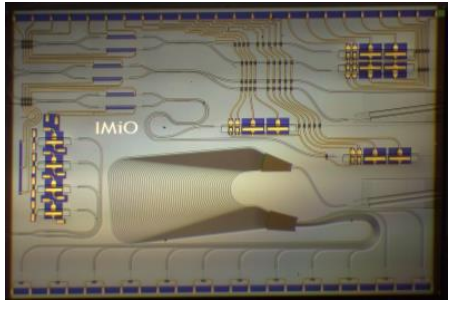
Integrated Tunable Filter
(EU Commander)



5Gb/s Optical Flip-Flop Chip
(Uni Thessaloniki)



Optical frequency discriminator
(U Valencia/VLC)



Photonic integrated interrogator
for fiber-optic sensor networks
(Uni Warsaw)

PARADIGM

euroPIC European manufacturing platform for Photonic Integrated Circuits

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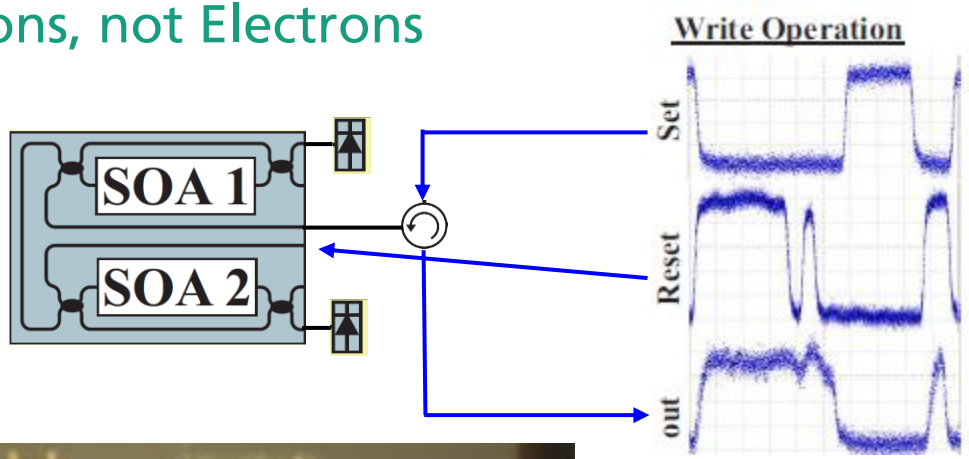
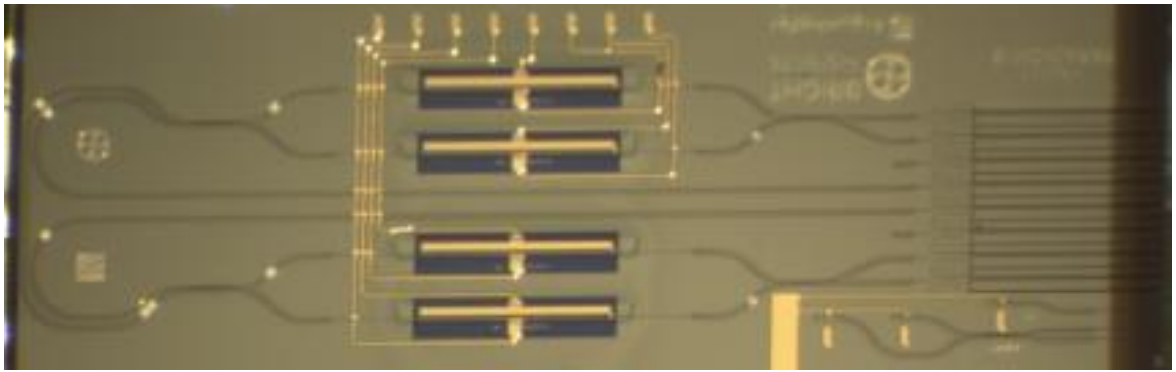
All-Optical Memory

Flip-Flops Based on Photons, not Electrons





BRIGHT Integrated PHOTONICS

ARISTOTLE UNIVERSITY OF THESSALONIKI

G. Mourgias-Alexandris, et al., “All-optical 10Gb/s ternary-CAM cell for routing look-up table applications,” *Opt. Express,* Mar. 2018.

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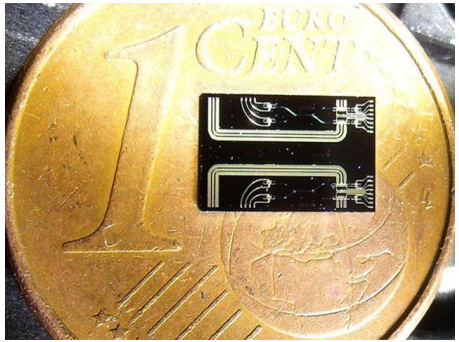
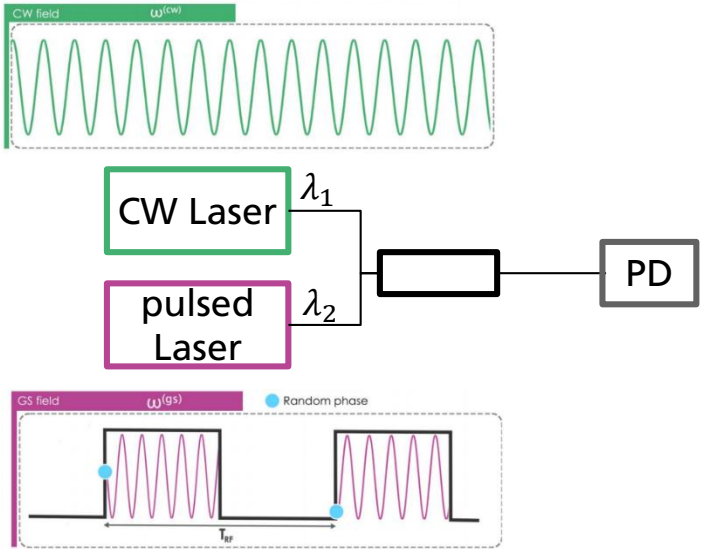
Quantum Entropy

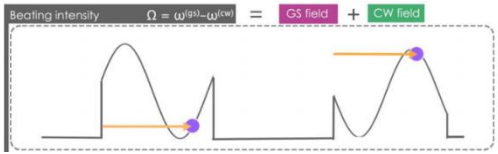
Randomness Guaranteed by Quantum Mechanics

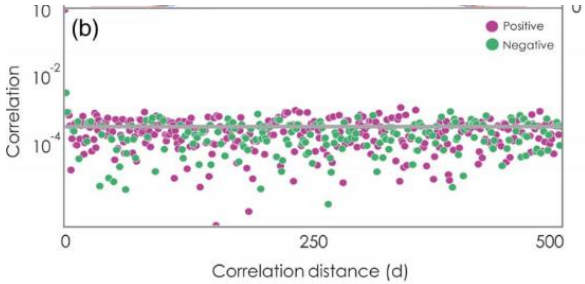




Phase noise of laser gets imprinted on phase noise of beat signal.

Phase of beat signal gives entropy





QUSIDE

C. Abellan et al., "Quantum entropy source on an InP photonic integrated circuit for random number generation" Optica, Sep. 2016.

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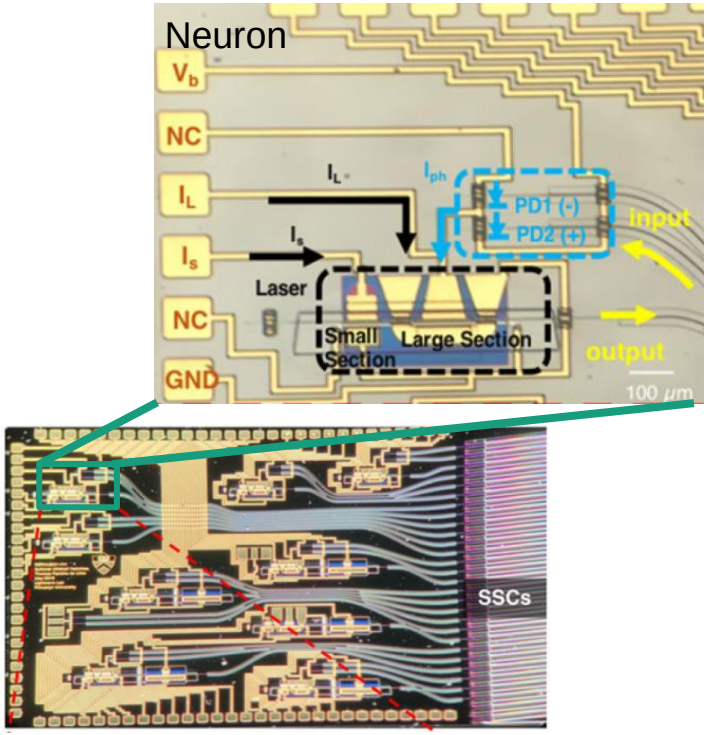
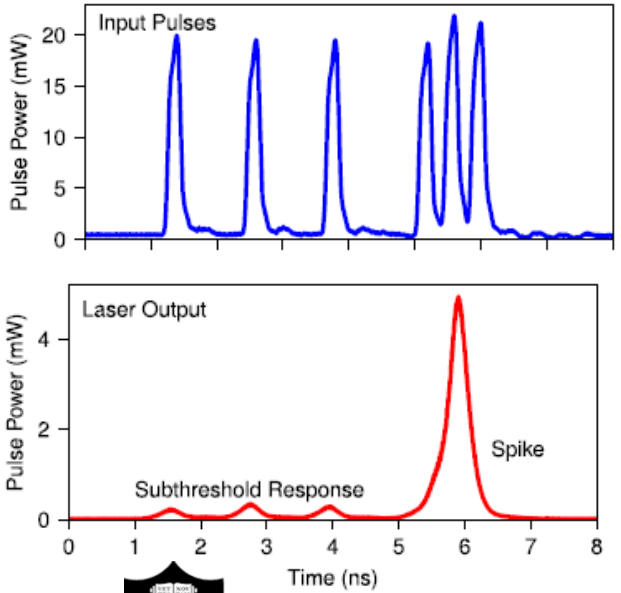
All-Optical Neuron for Computing

Breaking von-Neumann Bottlenecks



spikes encode the timing between input pulses



H.-T. Peng et al. “Neuromorphic Photonic Integrated Circuits” *IEEE JSTQE*, 2018

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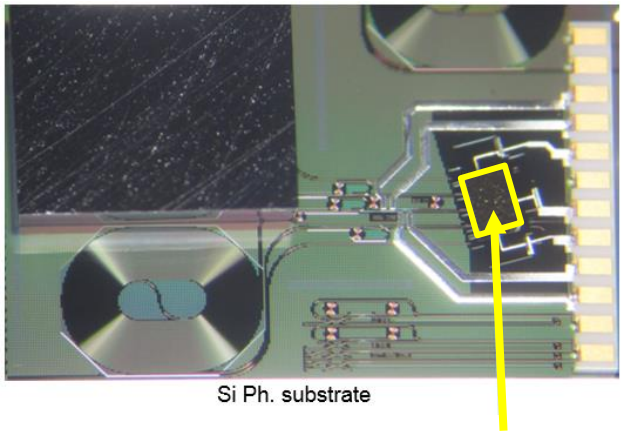
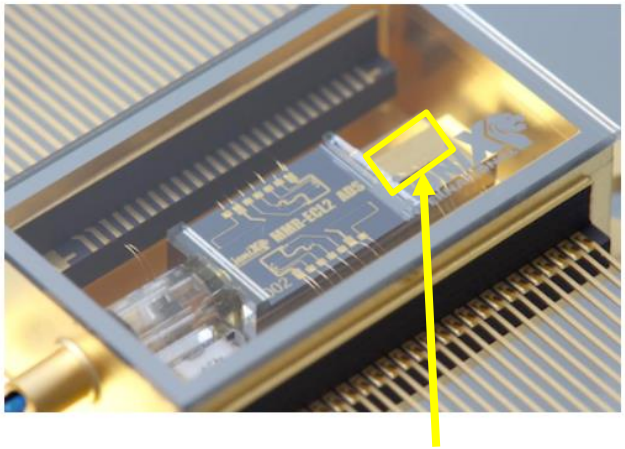
Hybrid Integration to Low Loss Platforms

HHI-Laser integrated into Silicon Photonics platforms of IBM, Lionix

methane sensor
IBM (USA)



290 Hz linewidth laser
Lionix (NL, 2017)



M. Theurer et al., Flip-Chip Integration of InP to SiN Photonic Integrated Circuits, IEEE J. LIGHTWAVE TECHNOLOGY, VOL. 38, NO. 9, MAY 2020

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Summary

- Several decades experience in Photonic Integration
- InP monolithic PIC platform: cointegrate sources, waveguides and detectors
- InP sources / low loss waveguide coupling
- Polymer PICs

- We are very much interested in common research projects in Quantum Computing
- Also in non-quantum, optical computing

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