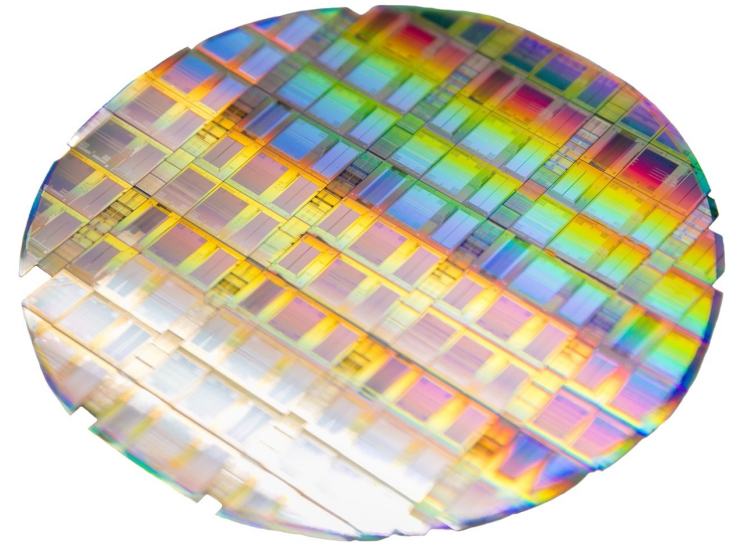




Photonic integrated circuits: from telecom to sensing

Christian Bosshard
Managing Director Swissphotonics

June 23, 2021



Courtesy: Ligentec

SWISS PHOTONICS: Mission



Swissphotonics Events

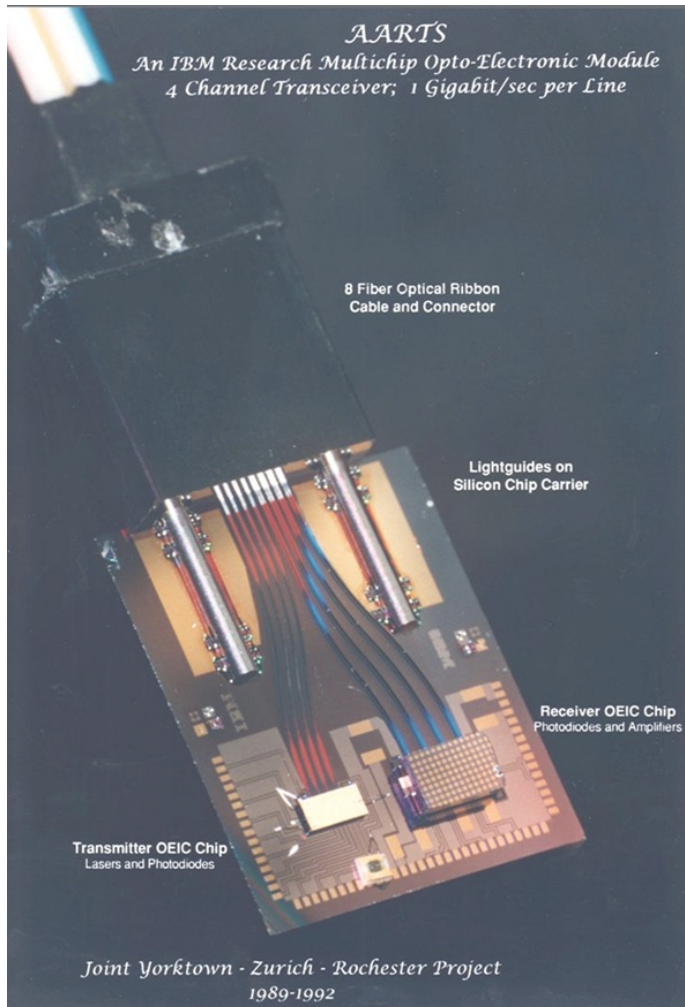
Mon, 14.06.2021 – Thu, 24.06.2021	LiM 2021, online
Wed, 23.06.2021	PIC, Overbooked
Thu, 24.06. – Fri, 25.06.2021	Swiss NanoConvention, online
Wed, 07.07.2021	MIC research day, Bern or online
Wed, 15.09.2021	Photonics 4 Masterpieces, Genève
Fri, 08.10.2021	EPC Photonics Industry Day, Lausanne

Partner Events/Calls

Mon, 14.06. – Thu, 17.06.2021	LEF Bricks, online
Wed, 16.06.2021	COMSOL Day: Optics & Photonics, online
Fri, 25.06.2021	EU Call ACTPHAST4R, hurry up
Tue, 29.06.2021	Additive Manufacturing, online
Mon, 02.08. – Thu, 05.08.2021	IPS 23, Lausanne
Wed, 24.11.2021	CSEM #SheCanSTEM, Bern

Mission: Improve competitiveness of our members by strengthening the innovation forces to secure and grow industrial workplaces

Photonic integrated circuits (PICs): a long history



OEIC, 1989

C. Madsen and G. Lenz, "Optical allpass filters for phase response design with applications for dispersion compensation," *IEEE Photon. Technol. Lett.*, vol. 10, pp. 994-996, 1998.

C. Madsen, G. Lenz, A. Bruce, M. Cappuzzo, L. Gomez, and R. Scotti, "Integrated tunable allpass filters for adaptive dispersion and dispersion slope compensation," *IEEE Photon. Technol. Lett.*, vol. 11, pp. 1623-1625, 1999.

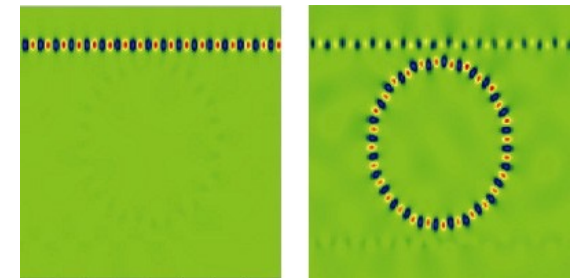
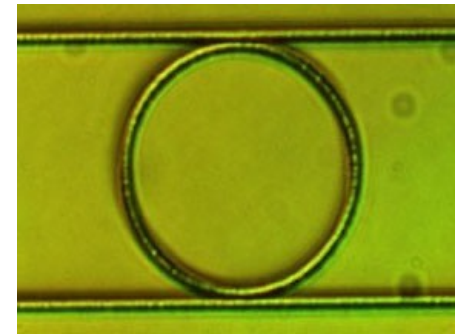
C. K. Madsen, S. Chandrasekhar, E. J. Laskowski, K. Bogart, M. A. Cappuzzo, A. Paunescu, L. W. Stulz, and L. T. Gomez, "Compact integrated tunable chromatic dispersion compensator with a 4000 ps/nm tuning range," *Optical Fiber Communication*, PD9, 2001.

F. Horst, C. Berendsen, R. Beyeler, G.-L. Bona, R. Germann, H. W. M. Salemink, and D. Wiesmann, "Tunable ring resonator dispersion compensators realized in high-refractive-index contrast SiON technology," *European Conference on Optical Communication*, PD, 2000.

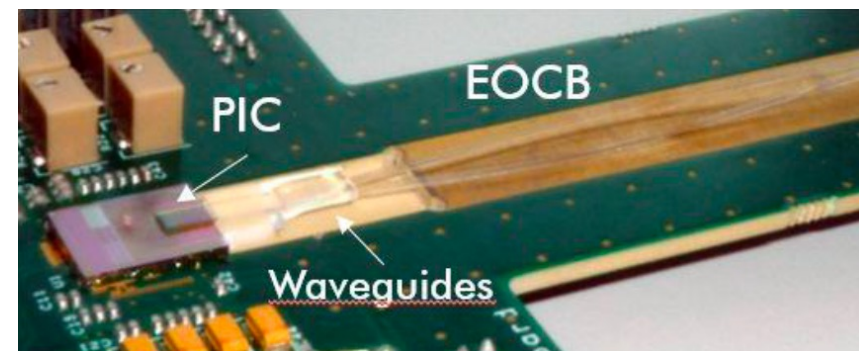
K. O. Hill, B. Malo, F. Bilodeau, and D. C. Johnson, "Photosensitivity in optical fibers," *Ann. Mater. Sci.*, vol. 23, pp. 125-127, 1993.

R. Adar, C. H. Henry, R. C. Kistler, and R. F. Kazarinov, "Polarization independent narrow band Bragg reflection gratings made with silica-on-silicon waveguides," *Appl. Phys. Lett.*, vol. 60, pp. 1779-1781, 1992.

L. Eldada and L. W. Shacklette, "Advances in polymer integrated optics," *IEEE J. Sel. Top. Quant. Electron.*, vol. 6, pp. 54-68, 2000.



Ring resonators, CSEM 2003



PIC direct on-board coupling, vario-optics 2020

Photonic integrated circuits

- **Miniaturized** (size, weight, power, cost) classical optical systems with **increased** performance.
- **Precise** waveguide geometries for mode engineering, novel material integration, **resonance** enhancement through ultra-high quality factors **and more**
- **High speed** telecom transceivers are already based on PIC technologies
- Next generation **LiDAR** sensors and the first photonic **quantum computers** are likely based on PICs as well.
- **Fast-growing** market with annual growth rates **above 25%**. Expectation: about 1.5 billion USD by 2023.

SWSSPHOTONICS PIC workshop

- Switzerland has a **leading edge** in this exciting field
- Exchange on how **PICs enable novel solutions** and applications in the field of sensing, metrology, nonlinear optics and quantum technologies.
- Support common **R&D developments**

Increasing material selection

Property	Si	SiN	LiNbO ₃ (LNOI)	InP
Refractive index in the NIR	~3.8	~2.1	~2.2	~3.1
Transparency window (μm)	1.1 to 9	0.25 to 8	0.35 to 5.5	0.9 to 2
Bandgap (eV)	1.14	~5 (pseudo)		
Linear waveguide loss (db/cm)	0.1-3	~0.01	< 0.1	1.5-3
Two-photon loss	high	very low	very low	high
Intrinsic EO coefficient	-	-	~31 pm/V	-

- Organic materials, BaTiO₃, SiC,...

Courtesy: CSEM

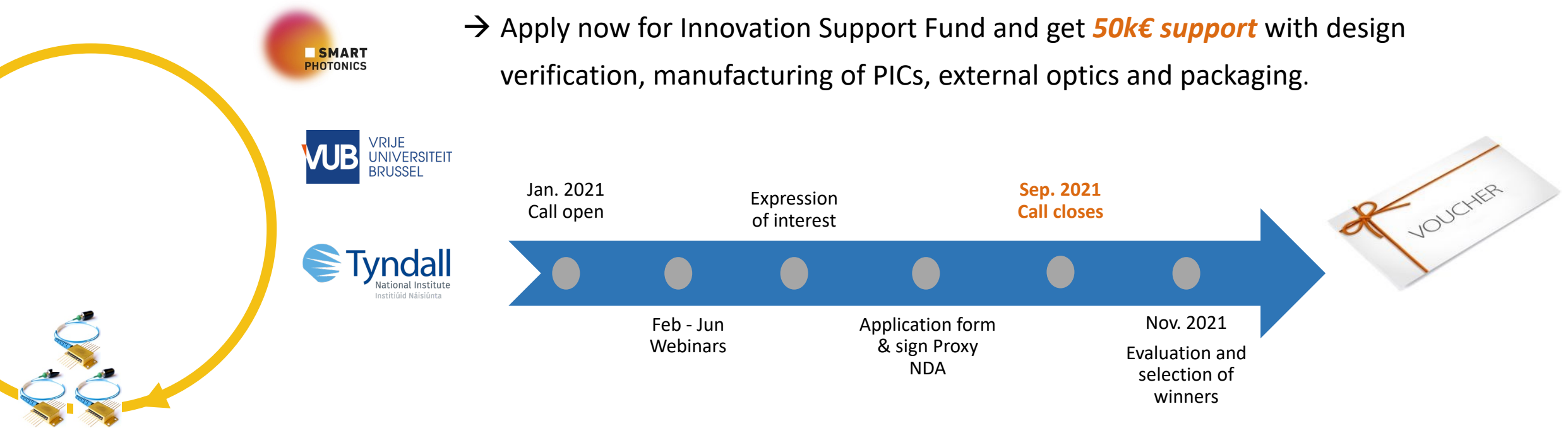
SWISSPHOTONICS PIC workshop

- Marco Mayer, Hamamatsu: **Needs** of the industry
- Prof. Dr. Niels Quack, EPFL: PICs and **MEMS**
- Dr. Thomas Hessler, Ligentec SA: **Silicon Nitride** based PICs
- Prof. Dr. Rachel Grange, ETH: **Electro-optic** integrated platform
- Dr. Stefan Abel; Lumiphase AG: **BaTiO₃** based PICs
- Prof. Dr. Tobias Kippenberg, EPFL: Nonlinear **Hybrid** Integrated Photonics
- Dr. Claudia Hössbacher, Polariton Technologies AG: **Plasmonics** based PICs
- Dr. Victor Brasch, CSEM SA: Supporting a **Swiss PIC ecosystem**
- Tobias Müller, Aixemtec GmbH: **Assembly** and **integration**

Open-Innovation Photonics pilot for NW Europe

- Contribute to increase maturity and scaling of open access InP PICs.
- Establish an open innovation environment for InP PIC technology
- Provide technology support to SMEs looking to mature their PIC-based products

→ Apply now for Innovation Support Fund and get **50k€ support** with design verification, manufacturing of PICs, external optics and packaging.



More information: www.oip4nwe.eu/vouchers

Contact: voucher@oip4nwe.eu

Join our events

A Little Inside Photonics: Weekly lunch online meeting

Without our live events, the regular vividly exchange between applied science and industry is missing. Therefore, we invite you to an informal chat among experts and friends.

Bring your own sandwich and drink, join and leave at your discretion. Your suggestions for topics are welcome.

Every Thursday noon

12:00 Zoom Check-in
12:15 Chat
13:00 End

Join us online

<https://us02web.zoom.us/j/83097348768?pwd=N0dkZUhkdjdmQ2eXl3MUpsU2F1bnFrUT09>

Meeting-ID: 830 9734 8768
Code: 724861



Moderators

- Dr. Christoph Harder
- Dr. Christian Bosshard
- Experts for hot topics

Language: English

Topics:

- Exchange news from the world of Photonics
- Information on associations (EPIC, OIDA, Photonics21)
- Information on EU projects (BestPhorm21, Carla, PhotonHub Europe)
- Innosuisse programs
- Hot topics by (international) experts
- General Q&A

Contact:

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Weekly Online Yoga

During 60 minutes we practice yoga (asanas) calmly and consciously, focus our attention on our breath and do something good for ourselves. We strengthen not only our body, but also our mind. Yoga increases stamina, joy of life and gives us inner peace and strength. You can look forward to a powerful, beneficial and relaxing lunch break.

Every Tuesday noon

12:00 Checkin, chatting with others
12:15 Start Yoga session
13:05 Final 5-10 minute relaxation period (Savasana)
13:15 End

Join us online

<https://us02web.zoom.us/j/83280489189?pwd=SzVhQ0tVczZ0bXhEZWw5RHp6WUwkdWZmc09>

Meeting-ID: 832 8048 9189
Kenncode: 278137



- Free Yoga session
- For Swissphotonics members only

Wear comfortable clothes, do not practice with a full stomach and make sure you have a gym mat or yoga mat ready at home. You are also welcome to take pillows and blankets with you.

www.f-360.ch

Contact: Dr. Christoph Harder
harder@swissphotonics.net