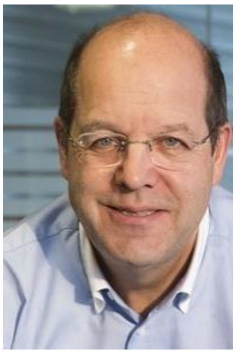
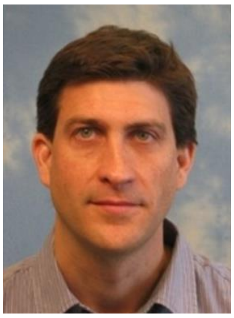
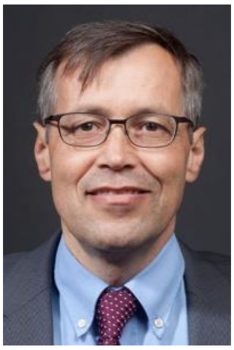
Optical Computing - Speaker

Workshop on Optical Computing: current / emerging approaches & applications
Wednesday, 14 April 2021

Moderators

 **Dr. Christoph S. Harder**	**President Swissphotonics, 8832 Wollerau SZ** www.swissphotonics.net | harder@swissphotonics.net Dr. Christoph S. Harder received the ETH Diploma in 1979 and the Master and PhD in EE in 1980 and 1983 from Caltech, Pasadena, USA. He is cofounder of the IBM Zurich Laser Diode Enterprise which pioneered the first 980nm high power pump laser for telecom optical amplifiers and laser diodes for industrial and consumer applications with ultrahigh reliability. He is the recipient of a Fulbright scholarship and the OSA Fellow recognition. Christoph is now heading a consulting company and is cofounder of Swissphotonics and has been its president for the last few years. He has published more than 100 papers and 20 patents and has held a variety of staff and management positions at ETH, Caltech, IBM, Uniphase, JDS Uniphase, Nortel and Bookham and has volunteered on society boards and committees.
 **Prof. Dr. Christophe Moser**	**Laboratory of Applied Photonics Devices LAPD, EPFL, 1015 Lausanne VD** lapd.epfl.ch | christophe.moser@epfl.ch Dr. Christophe Moser is Associate Professor of Optics and the Section Director in the Microengineering department at Ecole polytechnique fédérale de Lausanne EPFL. He obtained his PhD at the California Institute of Technology in optical information processing in 2000. He co-founded and was the CEO of Ondax Inc (acquired by Coherent Inc.), Monrovia California for 10 years before joining EPFL in 2010. His current interests are ultra-compact endoscopic optical imaging through multimode fibers, multimode fiber lasers, retinal imaging and additive manufacturing via volumetric 3D printing with light. He is the co-founder of Composyt light lab in the field of head worn displays in 2014 (acquired by Intel Corp), Earlysight SA and Readily3D. He is the author and co-author of 75 peer reviewed publications and 45 patents.
 **Dr. Christian Bosshard**	**Manager Swissphotonics and Vice-President Center Muttenz CSEM SA, 4132 Muttenz BL** www.csem.ch|bosshard@swissphotonics.net Dr. Christian Bosshard received his degree in Physics (1986) and his doctorate (1991, Silver medal award) from ETH. Christian is a Fellow of the Optical Society of America (OSA), managing director of the Swissphotonics technology network, board member of EPIC, and member of the Board of Stakeholders of Photonics21.

Spreakers

Prof. Dr. Sylvain Gigan

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Dr. Sylvain Gigan is Professor of Physics at Sorbonne Université in Paris, and group leader in Laboratoire Kastler-Brossel, at Ecole Normale Supérieure (ENS, Paris). His research interests range from fundamental investigations of light propagation in complex media, biomedical imaging, computational imaging, signal processing, to quantum optics and quantum information in complex media, and optical computing.

Spatiotemporal time-series prediction using scattering-based optical reservoir computing

Optics is increasingly considered for machine learning, in particular inference, thanks to its intrinsic scalability, speed, and low consumption. Free space implementation are particularly interesting, for instance to implement convolutions or Fourier Transforms. Meanwhile, light propagation of complex media has evolved as a very active field, in particular for imaging. It has been shown that the propagation of a laser through a complex disordered medium is akin to a large size random matrix multiplication, an operation ubiquitous in many instances of signal processing and machine learning . We have recently studied how to exploit such optical implementation of random matrix multiplication for several applications. First, it can be used for classification, but I will focus my presentation on reservoir computing, where the random matrix acts as random weights in a recurrent neural networks, which can be exploited for large scale time-series prediction.Thanks to the large scale nature of the multiply scattering medium, we were able for the first time to implement not just time-series prediction, but a large scale spatiotemporal chaotic systems, the Kuramoto-Sivashinsky equations, similar to turbulence flow, and predict it for several Lyapunov times.

Dr. Daniel Brunner

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Dr. Daniel Brunner is a CNRS researcher with the FEMTO-ST, France. His interests include novel computing using quantum or nonlinear substrates with a focuses on photonic neural networks. He received several University and the IOP’s 2010 Roys prize, edited one Book and two special issues, has presented his results 40+ times upon invitation and has published 50+ scientific articles.

Towards 20 GHz realtime neural network processors via semiconductor lasers

Neural networks differ from classical, algorithmic computing in a number of fundamental aspects. These differences result in equally fundamental, severe and relevant challenges for neural network computing using current computing substrates. Neural networks urge for parallelism across the entire processor and for a co-location of memory and arithmetic, i.e. beyond von Neumann architectures. I will discuss how a fully parallel and fully implemented photonic neural network can be realized using spatially distributed modes of an efficient and fast semiconductor laser. Importantly, all neural network connections are realized in hardware, and the processor produces results without pre- or post-processing. Such a system is scalable to large sizes, to bandwidths in excess of 20 GHz and has the potential to surpass electronic neural networks in energy efficiency.

Prof. Dr. Wolfram Pernic

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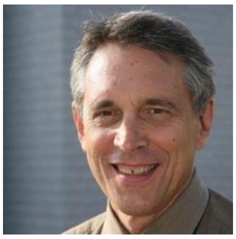
Dr. Wolfram Pernice received the Dipl. Ing. degree in Microsystems Technology from the University of Freiburg im Breisgau D in 2004 and a PhD in Electrical Engineering from the University of Oxford in 2007. After postdoctoral training at Yale University in Prof. Hong Tang’s group, he joined the Karlsruhe Institute of Technology (KIT) in 2011 as an Emmy-Noether research group leader in 2011. Since 2015 he is a full professor of physics at the University of Münster. His research interests cover single photon detectors, circuit optomechanics and integrated optics, as well as computational electrodynamics and on-chip non-linear optics.

Towards brain-inspired photonic computing

Photonic integrated circuits allow for designing computing architectures which process optical signals in analogy to electronic integrated circuits. Therein electrical connections are replaced with photonic waveguides which guide light to desired locations on chip. Through near-field coupling, such waveguides enable interactions with functional materials placed very close to the waveguide surface. This way, photonic circuits which are normally passive in their response are able to display active functionality and thus provide the means to build reconfigurable systems. By integrating phase-change materials nonvolatile components can be devised which allow for implementing hardware mimics of neural tissue. Here I will present our efforts on using such a platform for developing optical non-von Neumann computing devices. In these reconfigurable photonic circuits in-memory computing allows for overcoming separation between memory and central processing unit as a route towards artificial neural networks, which operate entirely in the optical domain.



Prof. Dr. Demetri Psaltis

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Dr. Demetri Psaltis is Professor of Optics and the Director of the Optics Laboratory at the EPFL. He was a professor at the California Institute of Technology from 1980 to 2006. He moved to EPFL in 2007. His research interests are imaging, holography, biophotonics, machine learning, nonlinear optics, electrolysis for hydrogen production and optofluidics. Dr. Psaltis is a fellow of the IEEE, the Optical Society of America, the European Optical Society and the Society for Photo-optical Systems Engineering. He received the International Commission of Optics Prize, the Humboldt Award, the Leith Medal, the Gabor Prize and the Joseph Fraunhofer Award/Robert M. Burley Prize .

Scalable Optical Learning Operator: SOLO
I will describe how a multimode fiber can function as a computational element when high energy pulses propagate though it. The nonlinear transformation of spatial information inserted at one end of the fiber yields a representation at the other end of the fiber that proves effective in the context of machine learning. We have implemented several learning tasks using this approach and obtained competitive accuracy compared with state-of-the are deep neural networks but at a dramatically better power consumption and/or speed.

Dr. Bert Offrein

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Dr. Bert Offrein received his Ph.D. degree in nonlinear integrated optics from the University of Twente (NL) in 1994. He then joined IBM Research - Zurich and contributed to establishing and commercializing adaptive integrated optical technology for DWDM networks. From 2004 to 2016, Bert Offrein was managing the photonics group, addressing optical interconnects for computing systems. Since 2016, he is leading the neuromorphic devices and systems group, focussing on novel hardware for neural networks. Bert Offrein is a principal research staff member at IBM Research and the co-author of over 150 publications and the co-inventor of 35 patents.

Analog photonic accelerators for neuromorphic computing
In memory computing and analog signal processing are some of the performance and power consumption bottlenecks in today's computing systems. Examples of photonic subsystems for convolutional and synaptic signal processing will be presented and discussed.

Dr. Laurent Daudet

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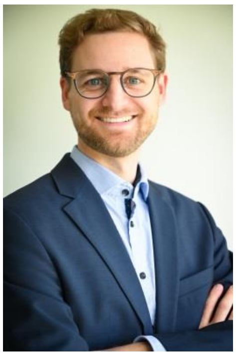
Dr. Laurent Daudet, currently CTO and Co-Founder at LightOn, is a recognized expert in signal processing. On leave from his Professorship at the Université de Paris, he has co-authored more than 200 publications and several patents. He is a graduate in physics from Ecole Normale Superieure in Paris, and holds a PhD in Applied Mathematics from Marseille University.

Unlocking Transformative AI with photonic computing
Recent large-scale AI models, in the wake of OpenAi's GPT-3 model for NLP, offer tremendous potential for applications. However, training such models requires massive amounts of computing resources, already challenging the capacity of some of the largest supercomputing architectures. In this talk I will present LightOn's view on how future AI hardware should be designed, to address some of the hardest computing challenges, such as language models, recommender systems, or graph neural networks. In particular, I will discuss how LightOn Optical Processing Units (OPUs) can be seamlessly integrated into a variety of hybrid photonics / silicon pipelines implementing state-of-the-art Machine Learning algorithms.



Dr. Michael Geiselmann

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Dr. Michael Geiselmann studied physics and engineering at University Stuttgart and Ecole Centrale Paris. After his PhD at ICFO in Barcelona in 2014 he joined the laboratory of Prof. Kippenberg at EPFL in Lausanne, where he advanced frequency comb generation on integrated silicon nitride chips towards applications and was involved in several international research projects. In 2016, he co-founded Ligentec SA and brought the company to the international stage of photonic integration.

Photonic Integrated Circuits for Quantum Computing
Photonic Integration, where light is processed on a chip is a fast growing sector. Originally boosted by telecom application, photonic integrated circuits nowadays have a huge potential not only for communication, but also for new applications such as LiDAR, new space and quantum communication and computation. In this talk I will give an introduction about Photonic Integrated Circuits PIC and the potential application on photonics in computing. I will show examples how quantum states can be generated in a PIC and how a quantum computer can be setup.