Dr. Daniel Brunner
CNRS chargé de recherche de classe normale (CRCN)
Date of birth: 25/04/1981 (male)
Citizenship: German

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I.   Scientific education, background and focus

Academic degrees:

- **17/01/2019: Habilitation à diriger des recherches** (HDR), Université Bourgogne-France-Comté. Jury members: **Prof Gigan, Sylvain** (Sorbonne Université, Laboratoire Kastler-Brossel, Ecole Normale Supérieure, Rapporteur); **Prof Psaltis, Demetri** (EPFL, Swizterland, Rapporteur), **Prof Pipa, Gordon** (Osnabrueck University, Germany, Rapporteur); **Dr. Bernal, Maria-Pilar** (DR, CNRS, Président du jury); **Prof Larger, Laurent** (University Franche-Comté, membre du jury).

- **05/2010: PhD in physics** at the Heriot-Watt University, Edinburgh. Title of Thesis: "Laser spectroscopy of coherent quantum states in single quantum dots", Thesis Advisor: Prof **R.J. Warburton**. Various distinctions and awards on department, university and national level.

- **05/2006: Master of physics in optoelectronics and lasers**, Heriot-Watt University, Honours of the first class.

- **07/2005: Pre-diploma in physics** (comparable to Bachelor degree), Karlsruhe Institute of Technology, Karlsruhe, Germany.

Competitions for research positions:

- **2015: Concours chargés de recherche** (CR) **CNRS**, with project on photonic Neural Networks. **Ranked first on national list.**

- **2015: Programa Estatal Juan de la Cierva Incorporación.** Ministry of competitiveness, Spain, 3 years postdoctoral funding including support for research. **Evaluated 100/100 points and first on national ranking**. Position turned down after 4 months due to CNRS CR position obtained in same year.

- **2014: Postdoctoral research fellowship**, University of the Balearic Islands, Spain. Ranked first, for 2 year fellowship.

- **2011: Marie Skłodowska-Curie intra-European fellowship**, research project on photonic reservoir computing.

International mobility:

- **2015 – in France:** Permanent CNRS researcher position (CR).

- **2010 – 2015 in Spain:** Postdoctoral fellow and researcher at IFISC, University of the Balearic Islands, Palma de Mallorca.

- **2005 – 2010 in Scotland, UK:** Master in Optoelectronics and lasers from 2005-2006, from 2006-2010 PhD. Both at Heriot-Watt University, Edinburgh.

- **2001 – 2005 in Germany:** Physics diploma course at Karlsruhe institute of Technology.

Research themes:

The theme of my work is best characterized by my interest in concepts which leverage novel physics for information processing. I focus on photonic technology for Neural Network as well as quantum computing and studied numerous systems such as quantum dots, semiconductor lasers and spatial light modulators.

- **Modelling, simulation and analytical techniques:** My objective is always to pair experimental physics / engineering with simulations and theory. I have applied quantum-optical modelling, a wide range of nonlinear dynamics models, more specifically Ikeda and semiconductor delay systems. In recent years my focus are analytical techniques for noise propagation in Neural Networks. All these theoretical / numerical activities are reflected in various scientific articles.

- **Metrology techniques:** I am expert in numerous experimental techniques. I have experience in confocal fluorescent, resonant and dark-field spectroscopy in cryogenic settings. I have developed phase-space tomography of semiconductor lasers by introducing realtime and high-bandwidth heterodyne spectroscopy. Each of these techniques were crucial in accessing new experimental regimes to provide previously unattainable insights.

- **Technology:** Recently I have lead the development of 3D printed photonic waveguide architectures based on sub-micron two photon polymerization. My group has demonstrated the first 3D integrated network of complex optical splitters, and we are worldwide the leader in this field. 3D photonic integration is essential for a scalable photonic Neural Network processor.

Key words section 8:

- **Photonics:** Photonic is the overarching theme of my entire research career, and I explored numerous areas within this field including spectroscopy, nonlinear dynamics and photonic information processing.

- **Micro systems:** The newest addition to my portfolio is the development of new integration technology based on two photon polymerization for next generation 3D integrated photonic circuits.

Free key words:

- **Photonic artificial intelligence:** Neural Networks are the driving force behind modern artificial intelligence concepts. Neural Network hardware benefits immensely from parallelism, which makes photonics a highly promising integration strategy. Photonic Neural Networks are heavily investigated since ~1980, and I am part of a European collective that revived the field around 2012 by introducing new Neural Network concepts to photonics. I have published some of the highest cited publications in the field and have pioneered multiple concepts.

- **Nonlinear systems:** Nonlinear dynamics are the underlying property if countless technological applications ranging from ultra-fast photonics, chaotic dynamics and encryption, stabilization and control system all the way to novel photonic information processing. Due to this high relevance I have made nonlinear dynamics one of the pillars of my research.
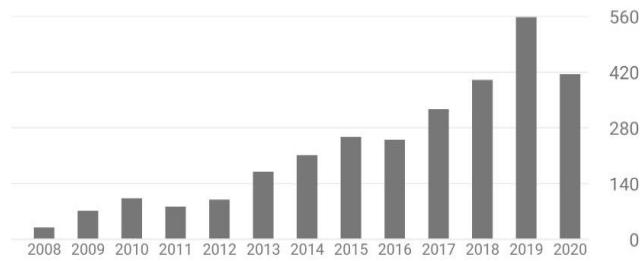
II.   Scientific production

I have obtained a permanent CNRS position in October 2015. Combined with the outstanding local support and mentoring, this has allowed me to develop and consolidate my own research theme within the photonic Neural Network community. **In the 5 years as a permanent CNRS scientist**, I have established myself as the local responsible for photonic Neural Networks and as a globally recognized leader in the field, which is due to (i) my scientific publications, and (ii) my high level of activity as organizer of international conference and community building events. This recognition can quantitatively and quantitatively be appreciated by my outstanding track record of invited presentation as well as collaboration with leading researchers with the highest level of affiliation (ENS, EPFL,Yale, TU-Berlin).

I have published 54 articles in international, peer-reviewed scientific journal. >90 % have been published in the upper quartile of impact as classified by ISI/Web of Knowledge, creating ~1900 (ISI) or ~3000 (Google scholar) citations, yielding an H-index of 18 (ISI) and 20 (Google scholar) only 9 years after my PhD. The highest impact publications are in prestigious

Citations per year as given by google scholar

journals such as *Nature*, *Science*, *Reviews in Modern Physics*, *Physical Review Letters*, *Optica*, *Nature Communications* and *Nature Machine Intelligence*. In the past year, I edited a book on photonic Neural Networks, de Gruyter. I have given 43 invited presentations at prestigious international conferences and seminars. I received invitations throughout my entire scientific career, most importantly, at strongly increased frequency for multiple high-impact events in my time as an independent group lead (since 10.2015). In 2018, I have initiated and co-organized the first international conference specifically dedicated to interdisciplinary aspects of Neural Network hardware ("Cognitive Computing: merging concepts with hardware"). I was guest editor for special issues in IEEE-JSTQE as well as Nanophotonics, and I am Managing Editor at Nanophotonics. I was part of the organizing committee of the IEEE Rebooting Computing 2019 Conference, 2020 SPIE Optics and Photonics conferences, and have organized 6 international workshops.

Editorial work:

- **Managing editor** *Nanophotonics*, May 2019 until present. https://nanophotonics-journal.com/editorial-board/
- **Editor special issue** on "Photonics for computing and computing for photonics" in *Nanophotonics* (202): https://nanophotonics-journal.com/issues/volume9/volume9_issue13/
- **Editor for book** "Photonic Reservoir Computing: Optical Recurrent Neural Networks," De Gruyter (2019): https://doi.org/10.1515/9783110583496
- **Guest editor special issue** on "Photonics for Deep Learning and Neural Computing" in *IEEE JSTQE* (2019): https://ieeexplore.ieee.org/xpl/tocresult.jsp?isnumber=8764697

Publications:

2020

1. Genty, G.; Salmela, L.; Dudley, J.M.; **Brunner, D.**; Kokhanovskiy, A.; Kobtsev, S.; Turitsyn, S.K.; "Machine Learning and Applications in Ultrafast Photonics," accepted for publication *Nature Photonics* (2020).
2. Dinc, N. U.; Psaltis, D.; **Brunner, D.**; "Optical Neural Networks: The 3D connection," accepted for publication in special EOS issue of *Photonique*. arXiv.org:2008.12605
3. Moughames, J.; Porte, X.; Jacquot, M.; Larger, L.; Kadic, M.; **Brunner, D.**; "3D printed multimode-splitters for photonic interconnects," *Optical Materials Express* **10**, 2952 (2020).
4. Heuser, T.; Pflüger, M.; Fischer, I.; Lott, J. A.; **Brunner, D.**; Reitzenstein, S.; "Developing of a photonic hardware platform for brain-inspired computing based on 5X5 VCSEL arrays," *JPhys Photonics* **2**, 044002 (2020). DOI: 10.1088/2515-7647/aba671.
5. Antonik, P.; Marsal, N.; **Brunner, D.**; Rontani, D.; "Bayesian optimisation of large-scale photonic reservoir computers," accepted for publication in *Cognitive Computation*. arXiv:2004.02535.
6. **Brunner, D.;** Marandi, A.; Bogaerts, W.; Ozcan, A.; "Editorial: Photonics for computing and computing for photonics", *Nanophotonics* **9**, special issue: Photonics for computing and computing for photonics (2020). DOI: 10.1515/nanoph-2020-0470 .
7. Andreoli, L.; Porte, X.; Chrétien, S.; Jacquot, M.; Larger, L.; **Brunner, D.**; "Boolean learning under noise-perturbations in hardware neural networks," *Nanophotonics* **9**, special issue: Photonics for computing and computing for photonics (2020). DOI: 10.1515/nanoph-2020-0171.
8. Pierangeli, D.; Marcucci, G.; **Brunner, D.**; Conti, C.; "Noise-enhanced spatial-photonic Ising machine," *Nanophotonics* **9**, special issue: Photonics for computing and computing for photonics (2020). DOI: 10.1515/nanoph-2020-0119.

9. Moughames, J.; Porte, X.; Thiel, M.; Ulliac, G.; Jacquot, M.; Larger, L.; Kadic, M.; **Brunner, D.**; "Three-dimensional waveguide interconnects for scalable integration of photonic neural networks," *Optica* **7**, 640 (2020). DOI: 10.1364/OPTICA.388205.
10. Prucnal, P.R.; Shastri, B.J.; Fischer, I.; **Brunner, D.**; "Introduction to JSTQE Issue on Photonics for Deep Learning and Neural Computing," *IEEE Journal of Selected Topics in Quantum Electronics* **26**, 2965384 (2020). DOI: 10.1109/JSTQE.2020.2965384.

2019

1. Froehly, L.; Courvoisier, F.; **Brunner, D.**; Larger, L.; Devaux, F.; Lantz, E.; Dudley, J. M.; Jacquot, M.; "Advancing Fourier: space–time concepts in ultrafast optics, imaging, and photonic neural networks ," *Journal of the Optical Society of America A* **36**, C69 (2019). DOI: 10.1364/JOSAA.36.000C69.
2. Semenova, N.; Porte, X.; Andreoli, L.; Jacquot, M.; Larger, L.; **Brunner, D.**; "Fundamental aspects of noise in analog-hardware neural networks," *Chaos* **29**, 103128 (2019). DOI: [10.1063/1.5120824](10.1063/1.5120824).
3. Antonik, P.; Marsal, N.; **Brunner, D.**; Rontani, D.; "Human actions recognition with a large-scale brain-inspired photonic computer," *Nature Machine Intelligence* **1**, 530–537 (2019). DOI: [10.1038/s42256-019-0110-8](10.1038/s42256-019-0110-8).
4. **BOOK**: "PHOTONIC RESERVOIR COMPUTING (Optical Recurrent Neural Networks)". Editors: **Brunner, D.**; Soriano, M.C.; Van der Sande, G.; De Gruyter (2019). link to publisher.
5. Chembo, Y.K.; **Brunner, D.**; Jacquot, M.; Larger, L.; "Optoelectronic oscillators with time-delayed feedback," *Reviews of Modern Physics* **91**, 035006 (2019). DOI: 10.1103/RevModPhys.91.035006.
6. Maktoobi, S.; Froehly, L.; Anreoli, L.; Porte, X.; Jacquot, M.; Larger, L.; **Brunner, B.**; "Diffractive coupling for photonic networks: how big can we go?," *IEEE Journal of Selected Topics in Quantum Electronics* **26**, 7600108 (2020). DOI: 10.1109/JSTQE.2019.2930454.
7. Penkovsky, B.; Porte, X.; Jacquot, M.; Larger, L.; **Brunner, B.**; "Coupled nonlinear delay systems as deep convolutional neural networks," *Physical Review Letters* **123**, 054101 (2019). DOI: 10.1103/PhysRevLett.123.054101.

2018

1. Penkovsky, B.; Larger, L.; **Brunner, B.**; "Efficient design of hardware-enabled reservoir computing in FPGAs," *Journal of Applied Physics* **124**, 162101 (2018). DOI: [10.1063/1.5039826](10.1063/1.5039826)
2. **Brunner, D.;** Penkovsky, B.; Marquez, B. A.; Fischer, I.; Larger, L.; "Tutorial: Photonic neural networks in delay systems," *Journal of Applied Physics* **124**, 152004 (2018). DOI: [10.1063/1.5042342](10.1063/1.5042342).
3. **Brunner, D.**; Penkovsky, B.; Levchenko, R.; Schöll, E.; Larger, L.; Maistrenko, Y.; "Two-dimensional spatiotemporal complexity in dual-delayed nonlinear feedback systems: Chimeras and dissipative solitons," *Chaos* **28**, 103106 (2018). DOI: [10.1063/1.5043391](10.1063/1.5043391)
4. Heuser, T.; Große, J.; Kaganskiy, A.; **Brunner, D.**; Reitzenstein, S.; "Fabrication of dense diameter-tuned quantum dot micropillar arrays for applications in photonic information processing," *APL Photonics* **3**, 116103 (2018). DOI: [10.1063/1.5050669](10.1063/1.5050669)
5. Bueno, J.; Maktoobi, S.; Froehly, L.; Fischer, I.; Jacquot, M.; Larger, L.; **Brunner, D.**; "Reinforcement learning in a large-scale photonic recurrent neural network," *Optica* **5**, 756 (2018). DOI: 10.1364/OPTICA.5.000756
6. Marquez, B. A.; Larger, L.; Jacquot, M.; Chembo, Y. K.; **Brunner, D.**; "Dynamical complexity and computation in recurrent neural networks beyond their fixed point," *Scientific Reports* **8**, 3319 (2018). DOI: [10.1038/s41598-018-21624-2](10.1038/s41598-018-21624-2)

2017

1. **Brunner, D.**; Jacquot, M.; Fischer, I.; Larger, L.; "Photonic networks for Neuromorphic Computing," *Frontiers in Optics* 2017, OSA Technical Digest, paper FTh2E.3. DOI: [10.1364/FIO.2017.FTh2E.3](10.1364/FIO.2017.FTh2E.3)
2. Hicke, K.; **Brunner, D.**; Soriano, M. C.; Fischer, I.; "Role of dynamical injection locking and characteristic pulse events for low frequency fluctuations in semiconductor lasers," *Chaos* **27**, 114307 (2017). DOI: [10.1063/1.5006945](10.1063/1.5006945)
3. Tchawou Tchuisseu, E. B.; Gomila, D.; **Brunner, D.**; Colet, P.; "Effects of dynamic-demand-control appliances on the power grid frequency," *Phys. Rev. E* **69**, 022302 (2017). DOI: 10.1103/PhysRevE.96.022302
4. **Brunner, D.**; Jacquot, M.; Fischer, I.; Larger, L.; "A complex network of 1600 holographically coupled opto-electronic oscillators: network dynamics and utilisation for reservoir computing," 2017 European Conference on Lasers and Electro-Optics and European Quantum Electronics Conference, paper CD_10_4. DOI: 10.1109/CLEOE-EQEC.2017.8086462

5. Bueno, J.; **Brunner, D.**; Soriano, M. C.; Fischer, I.; "Photonic Information Processing at 20GS/s rates based on Semiconductor Lasers with Delayed Optical Feedback ," 2017 European Conference on Lasers and Electro-Optics and European Quantum Electronics Conference, paper CD_P_38. DOI: 10.1109/CLEOE-EQEC.2017.8086565

6. Van der Sande, G.; **Brunner, D.**; Soriano, M. C.; "Advances in photonic reservoir computing," *Nanophotonics* **6**, 561-576 (2017). DOI: 10.1515/nanoph-2016-0132

7. Bueno, J.; **Brunner, D.**; Soriano, M. C.; Fischer, I.; "Conditions for reservoir computing performance using semiconductor lasers with delayed optical feedback," *Optics Express* **25**, 2401-2412 (2017). DOI: 10.1364/OE.25.002401

8. **Brunner, D.**; Luna, R.; Delhom i Latorre, A; Porte, X.; Fischer, I.; "Semiconductor laser linewidth reduction by six orders of magnitude via delayed optical feedback," *Optics Letters* **42**, 163-166 (2017). DOI: 10.1364/OL.42.000163

2016

1. **Brunner, D.**; Reitzenstein, S.; Fischer, I.; "All-Optical Neuromorphic Computing in Optical Networks of Semiconductor Lasers," *2016 IEEE INTERNATIONAL CONFERENCE ON REBOOTING COMPUTING* (ICRC). DOI: 10.1109/ICRC.2016.7738705

2. Marquez, B. A.; Larger, L.; **Brunner, D.**; Chembo, Y. K.; Jacquot, M.; "Interaction between Lienard and Ikeda dynamics in a nonlinear electro-optical oscillator with delayed bandpass feedback," *Phys. Rev. E* **94**, 062208 (2016). DOI: 10.1103/PhysRevE.94.062208

3. Porte, X.; Soriano, M. C.; **Brunner, D.**; Fischer, I.; "Bidirectional private key exchange using delay-coupled semiconductor lasers," *Optics Letters* **41**, 2871 (2016). DOI: 10.1364/OL.41.002871

↑ **Started CNRS position** ↑

2015

1. Soriano, M.C; **Brunner, D.**; Escalona-Moran, M.; Mirasso, C.R.; Fischer, I.; "Minimal approach to neuro-inspired information processing," *Frontiers in computational Neuroscience* **9**, 68 (2015). DOI: 10.3389/fncom.2015.00068

2. **Brunner, D.**; Fischer, I.; "Reconfigurable semiconductor laser networks based on diffractive coupling," *Optics Letters* **40**, 3854-3857 (2015). DOI: 10.1364/OL.40.003854

3. Ortín, S.; San-Martín, D.; Pesquera, L.; Soriano M.C.; **Brunner, D.**; Fischer, I.; Mirasso, C.R.; Gutiérrez, J.M.; "A Unified Framework for Reservoir Computing and Extreme Learning Machines based on a Single Time-delayed Neuron," *Scientific Reports* **5**, 14945 (2015). DOI: 10.1038/srep14945

4. **Brunner, D.**; Soriano, M. C.; Porte, X.; Fischer, I.; "Experimental phase-space tomography of semiconductor laser dynamics," *Physical Review Letters* **115**, 053901 (2015). DOI: 10.1103/PhysRevLett.115.053901

5. Soriano M.C.; **Brunner, D.**; Escalona-Morán, M.; Mirasso, C.R.; Fischer, I.; "Minimal approach to neuro-inspired information processing, under review," *Frontiers in Computational Neuroscience* **9**, 68 (2015). DOI: 10.3389/fncom.2015.00068

2014

1. Porte, X; D'Huys, O; Jüngling, T; **Brunner, D.**; Soriano, M. C.; Fischer, I.; "Autocorrelation properties of chaotic delay dynamical systems: A study on semiconductor lasers," *Phys. Rev. E.* **90**, 052911 (2014). DOI: 10.1103/PhysRevE.90.052911

2. Houel, J.; Prechtel, J. H.; **Brunner, D**.; Kuklewicz, C. E.; Gerardot, B D.; Stoltz, N. G.; Petro, P. M.; Warburton; "High-resolution measurement of coherent population trapping of a single hole-spin in an InGaAs quantum dot using optical absorption spectroscopy," *Phys. Rev. Lett.* **112**, 107401 (2014). DOI: 10.1103/PhysRevLett.112.107401

2013

1. Kuhlmann, A.V.; Houel, J.; **Brunner, D.**; Ludwig, A.; Reuter, D.; Wieck, A.D.; Warburton, R.J.; "A dark-field microscope for background-free detection of resonance fluorescence from single semiconductor quantum dots operating in a set-and-forget mode," *Review of Scientific Instruments* **84**, 073905 (2013). DOI: 10.1063/1.4813879

2. **Brunner, D.**; Soriano, M. C.; Fischer, I.; "High-Speed Optical Vector and Matrix Operations Using a Semiconductor Laser*," IEEE Photonics Technology Letters* **25**, 1680. (2013). DOI: 10.1109/LPT.2013.2273373

3. Hicke, K.; Escalona, M.; **Brunner, D.**; Soriano, M.C.; Fischer, I.; Mirasso, C.; "Information Processing using transient Dynamics of semiconductor lasers subject to delayed feedback,"

IEEE Journal of Selected Topics in Quantum Electronics **19** , 1501610 (2013). DOI: 10.1109/JSTQE.2013.2241738

4. **Brunner, D.**; Soriano, M.C.; Mirasso, C.; Fischer, I.; "Parallel photonic information processing at GByte/s data rates using transient states," *Nature Communications* **4**, 1364 (2013). DOI: 10.1038/ncomms2368
5. Soriano, M. C.; Ortín, S.; **Brunner, D.**; Larger, L.; Mirasso, C. R.; Fischer, I.; Pesquera, L.; "Optoelectronic reservoir computing: tackling noise-induced performance degradation," *Optics Express* **21**, 12 – 20 (2013). DOI: [10.1364/OE.21.000012](10.1364/OE.21.000012)

2012 and previous

1. **Brunner, D.**; Porte, X.; Soriano, M.C.; Fischer, I.; "Real-time frequency dynamics and high-resolution spectra of a semiconductor laser with delayed feedback," *Scientific Reports* **2**, 732 (2012). DOI: 10.1038/srep00732
2. Larger, L.; Soriano, M.C.; **Brunner, D.**; Appeltant, L.; Gutierrez, J.M.; Pesquera, L.; Mirasso, C.R.; Fischer, I.; "Photonic information processing beyond Turing: an optoelectronic implementation of reservoir computing," *Optics Express* **20**, 3241 – 3249 (2012). DOI: [10.1364/OE.20.003241](10.1364/OE.20.003241)
3. Gerardot, B.D.; Barbour, R.J.; **Brunner, D.**; Dalgarno, P.A.; Badolato, A.; Stoltz, N.; Petroff, M.P.; Houel, J.; Warburton, R.J.; " Laser spectroscopy of individual quantum dots charged with a single hole," *Applied Physics Letters* **99**, pp. 243112 (2011). DOI: [10.1063/1.3665951](10.1063/1.3665951)
4. Kloeffel, C.; Dalgarno, P.A.; Urbaszek, B.; Gerardot, B.D.; **Brunner, D.**; Petroff, P.M.; Loss; D.; Warburton, R.J.; "Controlling the Interaction of Electron and Nuclear Spins in a Tunnel-Coupled Quantum Dot," *Physical Review Letters* **106**, pp. 046802 (2001). DOI: 10.1103/PhysRevLett.106.04680
5. **Brunner, D**; Gerardot, B.D.; Dalgarno. A.; Stoltz, N.G.; Petroff, M.P.; Warburton, R.J.; "Optical Manipulation Of A Single Spin In A Quantum Dot," *Journal of Physics Conference Series* 2010.
6. **Brunner, D.**; Gerardot, B.D.; Dalgarno, P.A.; Wust, G.; Karrai, K.; Stoltz, N.G.; Petroff, P.M.; Warburton, R.J.; "A Coherent Single-Hole Spin in a Semiconductor," *Science* **325**, pp. 70 – 72 (2009). DOI: 10.1126/science.1173684
7. Gerardot, B.D.; **Brunner, D.**; Dalgarno, P.A.; Karrai, K.; Badolato, A.; Petroff, P.M.; Warburton, R.J.; "Dressed excitonic states and quantum interference in a three-level quantum dot ladder system," *New Journal of Physics* **11**, 013028 (2009), DOI: [10.1088/1367-2630/11/1/013028](10.1088/1367-2630/11/1/013028)
8. Dalgarno, P.A.; McFarlane, J.; **Brunner, D.**; Lambert, R.W.; Gerardot, B.D.; Warburton, R.J.; Karrai, K.; Badolato, A.; Petroff, P.M.; "Hole recapture limited single photon generation from a single n-type charge-tunable quantumdot," *Applied Physics Letters* **92**, 193103 (2008). DOI: [10.1063/1.2924315](10.1063/1.2924315)
9. Gerardot, B.D.; **Brunner, D.**; Dalgarno, P.A.; Ohberg, P.; Seidl,S.; Kroner, M.; Karrai, K.; Stoltz, N.G.; Petroff, P.M.; Warburton, R.J.; "Optical pumping of a single hole spin in a quantum dot," *Nature* **451**, 441 (2008). DOI: 10.1038/nature06472

Invited only - talks, seminars:

2020

1. **Brunner, D.**; Andreoli, L.; Porte, X.; Semenova, N.; Jacquot, M.; Chretien, S.; Reitzenstein, S.; Kadic, M.; Larger, L.; "General considerations for (photonic) neural networks implemented in hardware." Leipzig University, 7th of July 2020, Leipzig, Germany.
2. **Brunner, D.**; Moughames, J.; Porte, X.; Thiel, M.; Larger, L.; Jacquot, M.; Kadic, M.; "3D integrated photonic interconnects for scalable Neural Networks," CLEO , 15th of May 2020, San Jose, USA.
3. **Brunner, D.**; Jacquot, M.; Chretien, S.; Reitzenstein, S.; Larger, L.; "Photonic reservoir computing and general considerations for photonic neural networks," ORC/ZI "in absentia" colloquium, 27th of April 2020, University of Southampton, UK.
4. **Brunner, D.**; Andreoli, L.; Porte, X.; Semenova, N.; Jacquot, M.; Chretien, S.; Reitzenstein, S.; Kadic, M.; Larger, L.; "General considerations for (photonic) neural networks implemented in hardware." Yale University, 11th of February 2020, New Haven, USA.
5. Moughames, J.; Porte, X.; Thiel, M.; Larger, L.; Jacquot, M.; Kadic, M.; **Brunner, D.**; "Size scalable integration of photonic neural networks," SPIE Photonics West, 3rd of February 2020, San Francisco, USA.
6. Moughames, J.; Porte, X.; Thiel, M.; Larger, L.; Jacquot, M.; Kadic, M.; **Brunner, D.;** "Towards scalable Photonic Neural Networks," Physics of Quantum Electronics, 5-10th January 2020, Snowbird, USA.

2019

1. **Brunner, D.;** Andreoli, L.; Porte, X.; Jacquot, M.; Reitzenstein, S.; Larger, L.; "Greedy Boolean learning in large photonic neural networks: empirical findings of convergence and scaling," Active Matter and Artificial Intelligence, 2nd of October 2019, CECAM-EPFL, Lausanne, Switzerland.
2. **Brunner, D.;** Andreoli, L.; Porte, X.; Jacquot, M.; Larger, L.; "Photonic neural networks scalable in size and learning effort," ECOC, 22nd of September 2019, Dublin, Ireland.
3. **Brunner, D.;** Andreoli, L.; Porte, X.; Semenova, N.; Jacquot, M.; Chretien, S.; Reitzenstein, S.; Larger, L.; "General considerations for neural networks implemented in hardware," ML Photonica, 26th of August 2019, Belgrade, Serbia.
4. **Brunner, D.;** Andreoli, L.; Chretien, S.; Jacquot, M.; Larger, L.; "General considerations for neural networks implemented in hardware," V Workshop on Dynamical Systems and Brain-Inspired Information Processing, 30th of July 2019, Konstanz, Germany.
5. **Brunner, D.;** Andreoli, L.; Chretien, S.; Jacquot, M.; Larger, L.; "Scaling and cost-function topology of evolutionary Boolean learning in hardware," OSA Nonlinear optics topical meeting (NLO), 16th of July 2019, Waikoloa Village, Hawaii, USA.
6. **Brunner, D.;** Andreoli, L.; Porte, X.; Maktoobi, S.; Jacquot, M.; Chretien, S.; Reitzenstein, S.; Larger, L.; "Photonics for neural networks and evolutionary boolean learning", CLEO-Europe / EQEC, June 23rd 2019, Munich, Germany.
7. **Brunner, D.;** Maktoobi, S.; Andreoli, L.; Porte, X.; Jacquot, M.; Reitzenstein, S.; Larger, L.; "Limits and Applications of Diffractive Coupling", OSA Mathematics in Imaging 2019, 26th of June 2019, Munich, Germany.
8. **Brunner, D.;** Andreoli, L.; Chretien, S.; Jacquot, M.; Larger, L.; "Scaling and cost-function topology of evolutionary Boolean learning in hardware," International Work-Conference on Artificial Neural Networks (IWANN), 12th of June 2019, Gran Canaria, Spain.
9. **Brunner, D.;** Andreoli, L.; Chretien, S.; Jacquot, M.; Larger, L.; "Scaling and cost-function topology of evolutionary Boolean learning in hardware," Bits and Brains Workshop (KNAW), 18th of April 2019, Dutch National Academy of Science, Amsterdam, Holland.
10. **Brunner, D.;** Andreoli, L.; Maktoobi, S.; Jacquot, M.; Larger, L.; "Greedy Learning in a Large Scale Photonic Network," Neuro-inspired Computation Course, 23rd of March 2019, University of Tokyo, Japan.
11. **Brunner, D.;** Andreoli, L.; Maktoobi, S.; Jacquot, M.; Larger, L.; "Reinforcement Learning in a Large Scale Photonic Network" CNC 2019, 20th of March 2019, Atsugi, Japan.
12. **Brunner, D.**; Andreoli, L.; Maktoobi, S.; Bueno, J.; Jacquot, M.; Fischer, I.; Larger, L.; "Reinforcement Learning in a Large Scale Photonic Network" SPIE Photonics West, 6th of February 2019, San Francisco, USA. **Keynote**.

2018
1. **Brunner, D.**; Jacquot, M.; Fischer, I.; Reitzenstein, S.; Larger, L.; "Reinforcement Learning in a Large Scale Photonic Network," LAOP, 15th of November 2018, Lima, Peru.
2. **Brunner, D.**; Jacquot, M.;Larger, L.; "Tutorial: Reservoir Computing," Spintronics meets Neuromorphics (Spice), 11th of October 2018, Mainz, Germany.
3. **Brunner, D.;** Jacquot, M.; Fischer, I.; Larger, L.; "Reinforcement Learning in large scale parallel photonic Reservoirs," CLEO Pacific Rim, 1st of August 2018, Hong Kong, China.
4. **Brunner, D.**; Jacquote, M.; Fischer, I.; Larger, L.; "Learning in large scale parallel photonic Reservoirs," Novel frontiers of optics for computing Workshop, Japanese Science and Technology Agency, 18th June 2018, Tokyo, Japan.
5. **Brunner, D.;** "Towards next generation learning in photonic systems", École polytechnique fédérale de Lausanne, 8th May 2018, Lausanne, Switzerland.
6. **Brunner, D.;** "Reinforcement Learning in a Large Scale Photonic Network", Max Planck Institute For Microstructure Physics, 24th January 2018, Halle, Germany.
7. **Brunner, D.;** "Towards Photonic Networks of Micropillar Lasers for Neuromorphic Computing ", Physics of Quantum Electronics, 7-12th January 2018, Snowbird, USA.

2017
1. **Brunner, D.;** "Large scale spatio-temporal networks of nonlinear oscillators for neuromorphic computing," Dynamical Systems and Brain-inspired Information Processing, 6th October 2017, Konstanz, Germany.
2. **Brunner, D;** "Photonic networks for Neuromorphic Computing," Frontiers in Optics, 21st September 2017 Washington DC, USA.
3. **Brunner, D.;** "High performance neuromorphic computing in random photonic networks," Bernstein Conference, 12th September 2017, Göttingen, Germany.
4. **Brunner, D.**; Reitzenstein, S.; Fischer, I.; "Neuromorphic Computing using networks of quantum dot emitters," Dynamical Systems and Brain Inspired Computing Workshop, 31st May 2nd June 2017, Université Libre de Bruxelles, Brussels, Belgium.

5. **Brunner, D.;**"Large scale spatio-temporal networks of nonlinear oscillators for neuromorphic computing," CNOD Workshop, 18-19th May 2017, Université Côte d'Azur, Sophia Antipolis, France.
6. **Brunner, D.;** "Photonic networks for the implementation of Neural Networks," Seminar presentation ETH Zürich, 21st March 2017, Zürich, Switzerland.

2016
1. **Brunner, D.;** Penkovskyi, B.; Maistrenko, Y.; Larger, L.; "Space-Time analogy in Delay Systems for Chimera States and Reservoir Computing," NOLTA 2016, 27-30th November 2016, Yugawara, Japan.
2. **Brunner, D.;** Reitzenstein, S.; Fischer, I.; "All-Optical Neuromorphic Computing in Optical Networks of Semiconductor Lasers," IEEE International Conference on Rebooting Computing, 17-19th October 2016, San Diego, USA.
3. **Brunner, D.;** "Towards the Creation of Cognitive Devices and the Role of Photonics," Max Planck Institute of Microstructure Physics, 21.09.2016, Halle, Germany.
4. Fischer, I.; Reitzenstein, S; **Brunner, D.;** "Neuromorphic Computing using networks of quantum dot emitters," Beyond von Neumann Workshop,18-21st May 2016, Harnack-Haus Berlin, Germany.

↑ **Started CNRS position** ↑

2014
1. **Brunner, D.;** Fischer, I.; "Photonic Reservoir Computing," Advanced Laser Technologies 2014 (**ALT2014**) 06-10.10.2014, Cassis, France.
2. **Brunner, D.;** Fischer, I.; "All-optical RC using an array of lasers," 2014 International Symposium on Nonlinear Theory and its Applications (**NOLTA2014**) 14-18.08.2014, Luzern, Switzerland.

2013 and previous
1. **Brunner, D.;** Fischer, I.; "All-optical RC using an array of lasers," Scientific workshop "**Experimental reservoir computing**" 14-15.02.2013, Besançon, France.
2. **Brunner, D.;** Soriano, M. C.; Mirasso, C. R.; Fischer, I.; "High speed, high performance all-optical information processing utilizing nonlinear optical transients," **CLEO Europe** 12-16.05.2013, Munich, Germany.
3. **Brunner, D.;** "Photonic information processing based on Reservoir computing," **Lindau Nobel Laureate Meetings** 01-06.07.2012, Lindau, Germany. Participation suggested by Marie Curie Society.
4. **Brunner, B.;** Gerardot, B. D.; Dalgarno, P. A.; et al.; "Optically Manipulating and Probing Hole-Spin in a Single Quantum Dot," **Solid State Based Quantum Information Processing**06-03.07.2009, Herrsching, Germany.
5. **Brunner, D.;** Gerardot, B. D.; Dalgarno, P. A.; et al.; "Coherent hole spin in a semiconductor," **International Conference on Quantum Engineering** 14-19.06.2009, Monte Verità, Switzerland.
6. **Brunner, D.;** Gerardot, B. D.; Dalgarno, P. A.; et al.; "Hole-spin initialization in single quantum dots with high fidelity," **QD2008** 11-16.05.2008, Gyeongju, Republic of Korea.

Third-Party Funding since CNRS position:

- **H2020 ITN POST-DIGITAL:** 549 k€ local budget, **principle investigator**, running 04/2020 – 03/2024.
- **H2020 Marie Skłodowska-Curie Actions**, MUTLPLY: 97 k€ local budget, **mentoring scientist** for NEWRONS project of Dr. Porte, running 02/2018 – 08/2021.
- **ANR ANACONDA:** 160 k€ local budget, **principle investigator**, running 2020-2024.
- **Volkswagen foundation NeuroQNet I&II:** 629 k€ local budget, **principle investigator**, running 2016 – 2022.
- **French-Russian Vernadski** PhD grant: 45 k€ local budget, **mentoring scientist** of Mrs. Semenova, running 10/2018 – 09/2021.
- **RES-TOP, Region Bourgogne France-Comte**: 40 k€ local budget, **principle investigator**, running 09/2018 – 08/2021.
- **LEARN-RC, Region Bourgogne France-Comte**: 28 k€ local budget, **principle investigator**, running 10/2018 – 12/2019.

- **DEMO3, Labex-Action**: 41 k€ local budget, **principle investigator**, running 02/2018 – 01/2019.
- **ANR BIPHOPROC II**: 160 k€ local budget, **co-principle investigator**, running 2018 – 2020.

Funding proposals currently under evaluation:

- **ERC-2020-COG, INSPIRE, principle investigator and coordinator**. Global budget: 2 M€. Invited to interview for second final evaluation.
- **H2020-FETOPEN-2018-2020, 3D-POC, principle investigator and coordinator,** other participants: Prof Demetri Psaltis, EPFL, Switzerland; Prof Sylvain Gigan, LKB, France; Prof Martin Ziegler, Technical University Illmenau, Germany; Prof Ibrahim Abdulhalim, Ben Gurion University, Israel; Dr. Michael Thiel, CTO Nanoscribe, Germany. Global budget: 3 M€, local budget: 0.9 M€.
- **H2020-FETOPEN-2018-2020, ICING, principle investigator,** other participants: Prof Guy Van der Sande, VUB, Belgium; Prof Tias Guns, VUB, Belgium; Prof Peter Bienstman, Gent University, Belgium; Prof Claudio Conti, Sapienza University, Italy; Dr. Thomas van Vaerenbergh, Hewlett Packard, USA; Prof Roberta Zambrini, CSIC, Spain. Global budget: 3.6 M€, local budget: 0.4 M€.
- **H2020-FETOPEN-2018-2020, DEEP OPTICS, principle investigator,** other participants: Prof Giovanni Volpe, Gothemburg University, Sweden; Prof Fabrice Raineri, CNRS-C2N, France; Prof Gordon Pipa, University of Osnabrueck, Germany; Prof de Rossi, Thales, France; Dr. Jonathan Steckle, STMicroelectronics, France; Prof Laurent Daudet, Lighton, France; Global budget: 3.7 M€, local budget: 0.5 M€.
- **H2020-FETPROACT-2018-2020, EuroPNet, principle investigator and coordinator**, other participants: Prof Alessio Micheli, Universita di Pisa, Italy; Prof Ingo Fischer, IFISC (CSIC), Spain; Prof Perter Bienstman, Genth University, Belgium; Prof Giovani Volpe, Gothenburg University, Sweden; Prof Sergei Turitsyn, Aston Institute of Photonics Technology, UK; Prof Demetri Psaltis, EPFL, Switzerland; Prof Sylvain Gigan, LKB, France; Prof Stephan Reitzenstein, TU Berlin, Germany; Prof Laurent Daudet, Lighton, France; Dr. Jonas Anderson, Syntronic, Sweden. Global budget: 4 M€, local budget: 0.7 M€.

Prizes, awards and distinctions:

- **2020: Emerging Leaders 2021** – Journal of Physics: Photonics, Institute of Physics (IoP). This prize showcases outstanding work from a select number of the most promising early-career researchers in the field of photonics (official description of award).
- **2010: IoP Roys prize** for best submitted thesis in area of semiconductor physics, annual and UK-wide.
- **2010: MacFarlane** award of Heriot-Watt University for best PhD thesis. This prize is awarded once per year and includes all PhD thesis submitted in any of the Universities scientific disciplines.
- **2010: Annual thesis award**, School of engineering and physical sciences, Heriot-Watt University. This prize is awarded once per year among all PhD thesis submitted within the department.
- **2008: Second year PhD student award** of the department of Engineering and Physical science, Heriot-Watt University.
- **2007: First year PhD student award** of the department of Engineering and Physical science, Heriot-Watt University.

III.   Scientific activity inside FEMTO-ST:

My scientific objective:

My goal is preparing and creating a breakthrough for photonic Neural Networks: The motivation and appeal of photonic Neural Networks has been widely known and acknowledge since decades. However, researchers were so far not successful in developing a hardware platform which is competitive in terms of integration, practicality, Neural Network size and programmability / controllability. My goal is to develop:

     i.   Hardware concepts for fully implementing connections and neurons of Neural Networks in scalable and parallel hardware.

     ii.   To implement modifiable network connections based on physical mechanisms which allow embedding Neural Network training fully in hardware (in situ).

     iii.   To develop Neural Network concepts which are suited for hardware implementation. Current concepts have mostly been developed with digital hardware in mind, and the full hardware implementation of a Neural Network severely restricts the success of such methods.

     iv.   To understand the role and relevance of noise in hardware Neural Networks. The human brain is a highly noisy environment, yet it still outperforms our essentially noise-less digital Neural Networks in almost any aspect. A better understanding of the underlying principles will be essential for future generations of high-performance Neural Network hardware.

I have identified these sub-objectives as the main limitations for a revolution in Neural Network computing hardware, and in my group we investigate and develop strategies in all three areas.

Progress of research project and significant results since CNRS CR position:
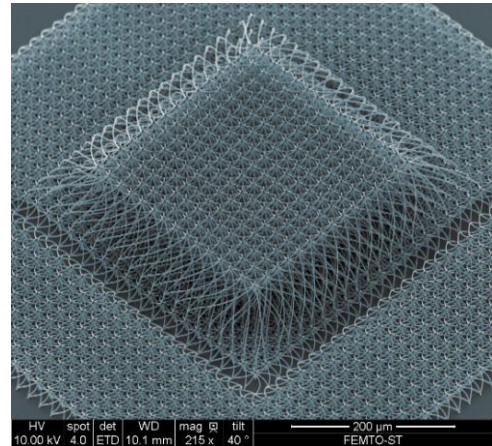
- **Advanced photonic neurons for artificial intelligence**: Due to the newly gained independency with my CR position I diversified to new high performance hardware in photonics Neural Network. I explored the bandwidth limit of semiconductor lasers [Bueno, et al., Optics Express (2017), 70 citations], developed in a collaboration spectrally homogenous arrays laser for 2D photonic neuron arrays [Heuser, et al., APL Photonics (2018), 8 citations] and dense VCSEL arrays [Hesuer, et al., *Journal of Physics: Photonics* (2020)]. I implemented photonic Neural Networks in spatial light modulators [Bueno, et al., *Optica* (2018), 100 citations] and [Antonik, et al., *Nature Machine intelligence* (2019), 14 citations]. I wrote a review [Van der Sande, et al., *Nanophotonics* (2017), 126 citations] and tutorial paper [Brunner, et al., *Journal of Applied Physics* (2018), 37 citations] and a review paper [Genty, et al., *Nature Photonics* (2020), accepted for publication].

- **Learning in (photonic) hardware:** Learning in hardware Neural Networks is a major challenge. One has no access to all parameters and states of the ultra-high dimensional Neural Network and such systems exhibit noise. I have demonstrated programmable Boolean learning based on digital micro-mirror arrays [Bueno, et al., *Optica* (2018), 100 citations]. The demonstrated concept allows linearly scalable learning with networks of previously unreported size and established an excellent benchmark system for fundamental research into learning in hardware Neural Networks. This major breakthrough allows me to explorer numerous fundamental aspects of photonic Neural Networks such as advanced learning algorithms, learning in integrated photonic systems and the effects of noise

in hardware Neural Networks. My results have created a **new collaboration with Prof Claudio Conti, Sapienza University, Rome**, a world leader in nonlinear optics and unconventional applications to information processing [Pierangeli, et al., *Nanophotonics* (2020), 5 citations].

- **Development of 3D photonic integration platform**: A fundamental property of Neural Networks are, no surprise: they are networks. A principle aspect of networks is that the number of potential connections scales quadratic with the number of network nodes (neurons). The consequence is that integration in 2D using standard lithography fails as it is not scalable in size. Together with the FEMTO-ST MIMENTO cleanroom facility (RENATEC) I have pioneered the 3D fabrication of complex integrated circuits [Moughames, et al., *Optica* (2020), 3 citations] and [Moughames, et al., *Optical Materials Express* (2020), pre-production]. This is an entirely new approach to circuit integration and enables me to establish myself in a world leading position in terms of photonic integration technology and integrated photonic Neural Networks. This work has already enabled me to establish an **extremely exciting collaboration with the group of Prof Demetri Psaltis at the EPFL**, the founder of the photonic Neural Networks field [Dinc, et al., *Photonique special issue with EOS* (2020), pre-production].

Future research perspective:

The field of photonic Neural Networks has experienced an explosion of attention in the past years. The current predictions in terms of unsustainable energy consumption and the disappointingly low speed of current Neural Network hardware suggest that the relevance of my field will increase even further in the future. I am at a leading position within this field thanks a large network of collaborators and due to the early stage I joined efforts in this direction. Numerous fundamental challenges (new photonic neurons, integrated networks, learning techniques) have been or are currently being addressed. However, the field is still very young, and a very wide range of fundamental and applied research aspects remain. The future perspective of my research axis is therefore excellent, and I will continue to further advance hardware concepts, integration / fabrication techniques and the understanding of fundamental challenges for Neural Network hardware. Of highest priority are, first, the demonstration of a fully implemented hardware Neural Network based on integrated photonic technology. Multiple individual components and aspects have been shown in such platforms, yet never neuron, connections, information in and output in the same substrate and fully in real time. Second is the demonstration of in-situ learning in hardware, which achieves competitive performance in common benchmark tests.

Once these fundamental challenges are overcome, the field will most likely focus on technological applications as well as a more high-level of description ('programming') of photonic hardware Neural Networks. This provides an extremely long last perspective of my research. In addition, the developed tools are not limited and can be applied to several other areas within novel computing or photonic technology in general. A continuous evaluation of my research focus will therefore be important in the future.

Supervision activity:

In my 5 years as a CNRS researcher I have officially supervised 12 PhD students and 4 postdocs, one of which (Mr. Stark) was in collaboration with IBM Zurich (Prof Bert Offrein). Furthermore, I am acting as an external advisor for two PhD students, one at CEA (Dr. Christian Gamra, Dr. Marc Duranton), one in Thales (Dr. Alfredo Di Rossi). All graduated PhD students have found postdoc positions at highly prestigious international Universities or as employees in companies within the field of photonics. In my

own group I actively work towards an improved gender balance, and in have employed 4 female and 5 male PhD students.

- **Postdocs:**
    - Dr. Javier Porte – Marie-Curie fellowship, ongoing.
    - Dr. Jonny Moughames, ongoing.
    - Dr. Bicky Marquez, until 2017.
    - Dr. Bogdan Penkovsky, until 2017.
- **PhD students:**
    - Dr. (Mr.) Julian Bueno, now post-doc in Strathclyde University, UK.
    - Dr. (Mrs.) Bicky Marquez, now post-doc in Queens University, Canada.
    - Dr. (Mr.) Bogdan Penkovsky, now postdoc Paris Saclay, France.
    - Dr. (Mrs.) Sheler Maktoobi, now Research & Development Engineer at Opa-Opticad, Foucault, France with CDI contract.
    - Mr. Louis Andreoli, to defend in December 2020.
    - Mr. Pscal Stark, co-supervison IBM Zurich, to defend beginning 2021.
    - Mrs. Nadezhda Semenova, to defend end 2021
    - Mr. Vladimiar Semenov, to defend end 2021
    - Mr. Anasl Skalli, to defend end 2023
    - Mr. Adria Grabulosa, to defend end 2023
    - Mrs. Ria Talukder, to defend end 2023
    - Mr. Daniel Hesslow, co-supervison with Lighton, to defend end 2023.
- 5 Master students
- 4 Erasmus students
- 2 Summer project students

Presentations by my mentored PhD students and postdocs:

For PhD student it is an essential academic exercise to present their research results at national and international conferences. Furthermore, such events are fundamental for creating their future network of collaborators. I therefore strong encourage students to participate at conferences, which has resulted in a number of invited talks (7) and seminars (2) by students and postdocs.

2020
1. **Semenova, N.**; Porte, X.; Jacquot, M.; Larger, L.; Brunner, D.; "Noise propagation in feedforward and reservoir neural networks," SPIE Optics & Photonics - digital forum (2020).
2. **Semenov, V.**; Porte, X.; Jacquot, M.; Larger, L.; Abdulhalim, I.; Brunner, D.; "Optically addressed spatial light modulators for photonic neural network implementations," SPIE Optics & Photonics - digital forum (2020).

2019
1. **Porte, X.**; Andreoli, L.; Chretien, S.; Jacquot, M.; Larger, L.; Brunner, D.; "Greedy Reinforcement Learning in Large Photonic Neural Networks", I**nvited Presentation**, The International Conference on Hybrid Photonics and Materials, Naxos/Greece (2019).
2. **Porte, X.**; Holzinger, S.; Kreinberg, S.; Schlottmann, E.; Heuser, T.; Große, J.; Andreoli, L.; Jacquot, M.; Larger, L.; Reitzenstein, S.; Brunner, D.; "Optical coupling of quantum-dot micropillar lasers with application to neuromorphic computing", **Invited Presentation**, European Semiconductor Lasers Workshop, Cork/Ireland (2019).
3. **Porte, X.**; Andreoli, L.; Jacquot, M.; Larger, L.; Brunner, D.; "Reservoir-size dependent learning in analogue neural networks", Oral Presentation, ICANN 2019: Workshop and Special Sessions, Munich/Germany (2019).
4. **Andreoli, L.**; Porte, X.; Heuser, T.; Große, J.; Jacquot, M.; Chretien, S.; Reitzenstein, S.; Larger, L.; Brunner, D.; "Greedy Boolean Learning in Photonic Recurrent Neural Networks,**" Invited Presentation**, European Materials Research Society September 28th 2019, Warsaw, Poland.
5. **Porte, X.**; Andreoli, L.; Chretien, S.; Jacquot, M.; Larger, L.; Brunner, D.; "Greedy Boolean Learning in Photonic Recurrent Neural Networks", **Invited Presentation**, ML-Photonica 2019: Machine Learning with Photonics, Belgrade/Serbia (2019).
6. **Porte, X.**; Andreoli, L.; Heuser, T.; Große, J.; Jacquot, M.; Chretien, S.; Reitzenstein, S.; Larger, L.; Brunner, D.; "Greedy Boolean Learning in Photonic Recurrent Neural Networks",

Oral Presentation, Workshop on Dynamical Systems and Brain-Inspired Information Processing, Konstanz/Germany (2019).

7. **Andreoli, L.**; Porte, X.; Semenova, N.; Jacquot, M.; Larger, L.; Brunner, D.; "Noise and Consistency of Analogue Spatio-Temporal Photonic Neural Networks," Poster Presentation, Workshop on Dynamical Systems and Brain-Inspired Information Processing, Konstanz/Germany (2019).

8. **Andreoli, L.**; Porte, X.; Jacquot, M.; Larger, L.; Brunner, D.; "Scaling laws and topology-properties of Boolean greedy learning in photonic neural networks," Oral presentation, CLEO Europe - EQEC June 23rd 2019, Munich, Germany.

2018

1. **Andreoli, L.**; Samenova, N.; Samenov, V.; Maktoobi, S.; Jacquot, M.; Fischer, I.; Larger, L.; Brunner, D.; "Impact and mitigation of noise in analogue spatio - temporal neural network", Cognitive Computing - merging concepts with hardware, **Invited presentation (upgrade)**, 19th of December 2018, Hannover, Germany.

2. **Maktoobi, S.**; Andreoli, L.; Froehly, L.; Jacquot, M.; Brunner, D.; "Scalable Optical Neural Network via Diffractive Coupling," Cognitive Computing - merging concepts with hardware, 19th of December 2018, Hannover, Germany.

3. **Andreoli, L.**; Samenova, N.; Samenov, V.; Maktoobi, S.; Jacquot, M.; Fischer, I.; Larger, L.; Brunner, D.; "Impact and mitigation of noise in analogue spatio - temporal neural network", NOLTA, 4th of September 2018, Terragona, Spain.

4. **Maktoobi, S.**; Froehly, L.; Jacquot, M.; Larger, L.; Brunner, D.; "Diffractive coupling for large scale photonic Reservoir Computers," OSA Advanced Photonics Congress, 2-5 July, 2018, Zürich, Switzerland.

5. **Penkovsky, B.**; Larger, L.; Maistrenko, Y.; Brunner, D.; "Nonlinear Delayed-feedback Systems: Complex Patterns And Neuromorphic Computing", Paris Sud University, **Invited seminar**, June 8, 2018, Paris, France.

6. **Penkovsky, B.**; Larger, L.; Brunner, D.; "Efficient Neuromorphic Hardware Design", BioComp, poster, June 4-6, 2018, Bordeaux, France.

7. **Penkovsky, B.**; Larger, L.; Maistrenko, Y.; Brunner, D.; "Nonlinear Delayed-feedback Systems: Complex Patterns And Neuromorphic Computing", ZEA-2, **invited seminar**, May 15, 2018, Juelich, Germany.

8. **Maktoobi, S.**; Froehly, L.; Jacquot, M.; Brunner, D.; "Diffractive Coupling for Optical Neural Network ", 6th International symposium in Optics and its Applications, Poster presentation, 17-20th February 2018, Trento, Italy. **Best poster presentation award.**

2017

1. **Maktoobi, S.**; Froehly, L.; Jacquot, M.; Brunner, D.; "Diffractive Coupling in Optical Network", Photonics Day, 1st December 2017, Dijon, France.

2. **Marquez, B. A.**; Suarez-Vargas, J.; Larger, L.; Jacquot, M; Chembo, Y. K.; Brunner, D.; "Embedding in Neural Networks: A-Priori Design of Hybrid Computers for Prediction", 2017 IEEE International Conference on Rebooting Computing (ICRC), Oral presentation, 7-10 November 2017, Washington DC, USA.

3. **Maktoobi, S.**; Froehly, L.; Jacquot, M.; Brunner, D.; "Diffractive Coupling for Optical Neural Network", workshop FEMTO-ST, 23rd November 2017, Besancon, France.

4. **Penkovsky, B.**; Larger, L.; Brunner, D.; "Network dynamic emulated by large delay systems: From brain-inspired computing to chimera states", PhysCon 2017, **Invited presentation**, July 18, 2017, Florence, Italy.

5. **Maktoobi, S.**; **Andréoli, L.;** Reitzenstein, S.; Froehly, L.; Jacquot, M.; Brunner, D.; "Neuromorphic Computing using QD-Networks NeuroQNet", BioComp Summer School, Poster presentation, 25th June –1st July 2017, Roscoff, France.

6. **Penkovsky, B.;** Brunner, D.; Larger, L.; Maistrenko, Y.; "Chimera States in Nonlinear Systems with Delayed Feedback" at "Complex patterns on networks", Dynamics Days Europe, June 6, 2017, Szeged, Hungary.

7. **Penkovsky, B.**; "Ma thèse en 180 secondes" ("Three minute thesis"), the regional final of the University of Bourgogne Franche-Comté, April 4, 2017, Dijon, France.

8. **Marquez, B. A.**; Larger, L.; Jacquot, M; Chembo, Y. K.; Brunner, D.; "Synchronization and memory in neural networks beyond their fixed point", Rencontre du Non-Lineaire, 27-19 March 2017, Paris, France.

2016

1. **Marquez, B. A.**; Larger, L.; Brunner, D.; Chembo, Y. K.; Jacquot, M; "Interaction between Liénard and Ikeda dynamics in a nonlinear electro-optical oscillator with delayed feedback," Dynamics of Delay Equations, Theory and Applications WIAS, 12-14 October 2016, Berlin, Germany.

2. **Penkovsky B.**; Larger, L.; Brunner, D.; "Towards a Brain-Inspired Computer With a Delay Dynamics", GDR BioComp, October 11, 2016, INSA Lyon, France.
3. **Marquez, B. A.**; Larger, L.; Jacquot, M; Chembo, Y. K.; Brunner, D.; "State-space prediction in Reservoir Computing", GDR BioComp, October 11, 2016, INSA Lyon, France.
4. **Penkovsky B.**; Brunner, D.; Maistrenko Y.; Larger, L.; "Laser Delay Dynamics For Information Processing" TU Berlin, **Invited presentation**, July 13, 2016, Berlin, Germany.
5. **Penkovsky B.**; Brunner, D.; Larger, L.; "FPGA-Based Reservoir Computing", FEMTO-ST, Oral presentation, July 1, 2016, Besançon, France.
6. **Penkovsky B.**; Brunner D.; Larger, L.; "Toward New General-Purpose Processor With Nonlinear Transient Computing", Dynamics Days Europe, Oral presentation, June 9, 2016, Corfu, Greece.
7. **Marquez, B. A.**; Larger, L.; Brunner, D.; Chembo, Y. K.; Jacquot, M; "Bifurcation of spiral-shaped patterns in the phase space of a nonlinear delayed electro-optic system", Dynamics Days Europe, Oral presentation, June 9, 2016, Corfu, Greece.
8. **Penkovsky B.**; Larger, L.; "A New Architecture For a General-Purpose Microprocessor", RNL, Poster presentation, March 15, 2016, Paris, France.

Laboratory internal collaborations:

- **Prof Muamer Kadic, FEMTO-ST MN2S department.** Our collaboration focuses on the migration of two photon polymerization techniques to photonic integration. Prof Kadic is an expert in the field of micro and nano-scale additive manufacturing, and this collaboration has already resulted in a large number of invited talks, papers (Optica, Optical Material Express) and project applications to H2020-FET-OPEN and H2020-ERC-COG calls.

- **Prof John Dudley, FEMTO-ST Optics department.** We have submitted an ANR project in the field of complex photonics and machine learning, and have co-authored a review paper, which now is accepted for publication in Nature Phonics.

- **Prof Cecil Pera, FEMTO-ST Energy department.** Within the framework of the ANR-BIPHOPROC project me and Prof Larger disseminated the concept of reservoir computing to the FEMTO-ST electrical engineering and hydrogen energy group.

- **Dr. Gwenn Ulliac, FEMTO-ST MIMENTO.** This collaboration focuses on the technical aspects of 3D photonic integration inside the technical infrastructure of the MIMENTO clean room (RENATCE network). Dr. Ullica is an essential ingredient for our success in the 3D micro-fabrication and helped in the teaching and formation of postdoctoral researchers working on the subject.

National and international collaborations:

- **Prof Demetri Psaltis, EPFL, Swizterland.** Common project applications (FET-Open), research collaboration in 3D additive nano-fabrication, one shared article, numerous to come in 2021.

- **Prof Stephan Reitzenstein, TU Berlin, Germany.** Two international projects funded by the Volkswagen foundation. Scientific collaboration on advanced semiconductor sources for photonic Neural Networks. Common applications to projects (FET-Proactive). Three publications so far, numerous to come in 2021.

- **Prof Claudio Conti, Sapienza University, Italy.** Common project applications (FET-Open). Collaboration on novel computing concepts using spatially extended nonlinear photonic systems. One shared publication, numerous to come in 2021.

- **Prof Giovanni Volpe**, Gothenburg University, Sweden. Organization of international conferences, common project application (FET-Proactive) and the active exploration of combining bio-photonic techniques with our recent work. First publication to be expected in 2021.

- **Prof Damien Rontani, Supelec, Metz, France.** Scientific collaboration with a focus on learning in spatial-light modulator based photonic Neural Networks. Three publications.

- **Prof Ingo Fischer, CSIC, Spain.** Numerous scientific project (Volkswagen, PICS) and applications (FET-Open, FET-Proactive). Numerous scientific publications.

Dr. Daniel Brunner, CNRS researcher (CRCN), FEMTO-ST

- **Prof Hui Cao, Yale, USA.** The scientific collaboration is regarding novel semiconductor sources and a shared experiment. My group is about to receive a first collection of devices. First publication can be expected in 2021.

IV.   Administration and management of research:

Research animation and organization inside community

I am highly involved in the animation of research within my community. Already as postdoc I organized the first European workshop (NOLTA conference, 2012, Palma de Mallorca, workshop on photonic reservoir computing), and since then I have continued along this road.

- **2012: Photonic Reservoir Computing Workshop during NOLTA conference.** This was the first workshop organized within Europe on the photonic Reservoir Computing scheme which was attended by all main actors within the community.
- **2016: BEYOND von Neumann architecture/bottleneck" –Brain inspired computing** in collaboration with Prof Stuart Parkin, Director Max-Planck Institute for Microstructure Physics. I was organizer and initiator of this 2 day high profile workshop with over 60 participants and 10 invited speakers. Speakers from Germany, France, Belgium, Spain, USA, Canada and Singapore made this a very international event: https://www.mpi-halle.mpg.de/191469/beyond-von-neumann-computing
- **2017: Workshop and student Post-presentation PICS project.** In the framework of a CNRSA-PICS project, held together with the IFISC, Palma de Mallorca, I organized a one day workshop with speakers from both institutes, followed by a post session organized by the PhD students of both institutes and in collaboration with the local OSA and IEEE student chapters.
- **2018: COGNITVE COMPUTING: Merging concepts and Hardware** in collaboration with **Prof Herbert Jaeger**, **Prof Gordon Pipa** and **Prof Stuart Parkin**. This was the first international conference bringing theoretical neuroscientists, computer engineers, physicists and cognitive scientists together to establish a new cognitive hardware community. The conference was an incredible success (I am still being contacted if we will organize it again – which we will after COVID-19 has calmed down) with 120 participants and 10 highest profile international speaker: http://www.cognitive-comp.org/
- **2019: V Workshop on Dynamical Systems and Brain-Inspired Information Processing** I organized this workshop together with **Prof Ludmilla Grigoryeva**, **Prof Juan-Pablo Ortega** and **Prof Josef Teichmann**. Speakers were invited from Germany, France, Belgium, Asutria, Portugal, Spain, Italy, Czech Republic, USA, Canda, Islrael, and we had over 50 participants. https://www.gsds.uni-konstanz.de/tt8ftuxr56xq3ybzwr/grigoryeva/2019-workshop-on-dynamical-systems-and-brain-inspired-information-processing/
- **2019: Frontiers in Photonics**, FEMTO-ST, co-organized with **Prof John Dudley** and **Prof Maxime Jacquot.**
- **2019: Organizing committee of IEEE Rebooting Computing Conference**.
- **2020: Workshop on photonic Neural Networks** during SPIE Photonics West within Simulation of nonlinear photonic community. Co-organized with **Prof Kathy Lüdge**, TU-Berlin, Germany.
- **2020: Emerging Topics in Artificial intelligence, SPIE Optics and Photonics**. Together with **Prof Giovanni Volpe**, **Prof Aydogan Ozcan** and **Prof Joana Pereira** I organized a 3 days conference in within the SPIE Optics and Photonics meeting. We had around 70 virtual presentations and a large number of participants.
- **2020: Photonic Neural Network special session in DFG spring meeting.** Workshop cancelled due to COVID-19 situation.
- **2020: Organizing committee of conference on Coherent Network Computing**, Israel. The first event (https://www.jst.go.jp/impact/hp_yamamoto/cnc2019/index.html) was organized around the community of Prof Yoshi Yamamoto, and the second edition was to take place in

the Weizmann University, Israel, organized by Prof Nir Davidson. Event cancelled due to COVID-19.

- **2019, 2020: Technical program committee CLEO/US, OSA**. FS 5: Nonlinear Optics and Novel Phenomena committee.
- **2020: Technical program committee CLEO/Europe EQEC.** EJ: "Theoretical and Computational Photonics and Optical Computing" committee.

Evaluation of research

I am very active and involved in the evaluation of research on the national and international level:

- PhD defence committees
    - **2015: Dr. Piotr Antonik**, supervised by Prof Serge Massar, ULB Brussels.
    - **2018: Dr. Axel Dolcemascolo**, supervised by Dr. Stephane Barland, INL, Nice.
    - **2020: Dr. Matthias Freiberger**, supervised by Prof Peter Bienstman, Ghent University.
    - **2020: Jeremy Vatin** (10/202), supervised by Prof Damien Rontani, Supelec Metz.
    - **2020: I was evaluator for an EPFL full professor position**, serving as external expert.

- Reviewer of manuscripts (only period 2017-2020)
    - **Nature**: twice in 2020, once in 2019,
    - **Nature Photonics**: twice in 2020, one in 2019, 3 times in 2017.
    - **Nature Communications**: twice in 2020, once in 2019, twice in 2018
    - **Physical Review X**: 2020,
    - **Others**: 15 times in 2020, 31 times in 2020, 14 times in 2018.

- Reviewer of research projects:
    - **ERC**: 2020 one synergy grant proposal, 2019 starting grant proposal.
    - **ANR**: twice in 2020;
    - **Canadian research Council** (NSERC): Once in 2020 (Banting fellowship), once in 2019 (Brockhouse Canda prize), once in 2017.
    - **Dutch research Council** (NOW): once in 2020, once in 2019, once in 2018.
    - **German research council** (DFG): once in 2020, twice in 2019.
    - **Polish academy of science**: once in 2019.
    - **Swiss national science foundation** (FNSNF): once in 2017.

Teaching activity

- I am teaching each year for PICS master course (Photonics, Micronanotechnology, Time-Frequency Metrology, and Complex Systems) of the EIPHI Graduate School. My courses are 'advanced numerical methods for nonlinear differential equations' (2017), and 'Neural Networks and complex systems' (2017, 2018, 2019, 2020). Both courses are usually between 15 and 20 hours of teaching.
- I organized a two-day intensive training course for ARDUINO programing.
- In June 2020 I gave a virtual class for the master of Machine Learning at the University of Pisa.