Curriculum Vitae:

I studied physics at the Technical University of Munich (TUM). For my diploma thesis, he joined Tobias Kippenberg at the Swiss Federal Institute of Technology Lausanne (EPFL), where I pioneered and established the Si_3N_4-based nonlinear integrated photonics platform for frequency comb generation. After my Physics diploma degree (hons.), I returned to his alma mater TUM and his mentor Reinhard Kienberger to pursue a PhD in attosecond physics in August 2012 to perform experiments at the solid-state attosecond photoemission beamline with resuting publications in Nature and PRL. Since February 2019, I have been a postdoctoral scholar in Prof. Tobias Kippenberg's Laboratory of Photonics and Quantum Measurements at EPFL, Switzerland (picture). I have demonstrated a novel approach for massively parallel coherent laser ranging using soliton microcombs, optical coherence tomography and integrated photonic circuit based parametric amplifiers. I am recipient of a *Marie Skłodowska-Curie Individual Fellowship* from the European Commission and an *Ambizione Fellowship* of the Swiss National Science Foundation. Currently, I have been warded Onsager Fellowship and Associate Professor position at the Norwegian University of Science and Technology (NTNU). Currently my research interests are the development and application of ultra-low loss nonlinear photonics based on novel material platforms such as lithium tantalate and gallium phosphide.

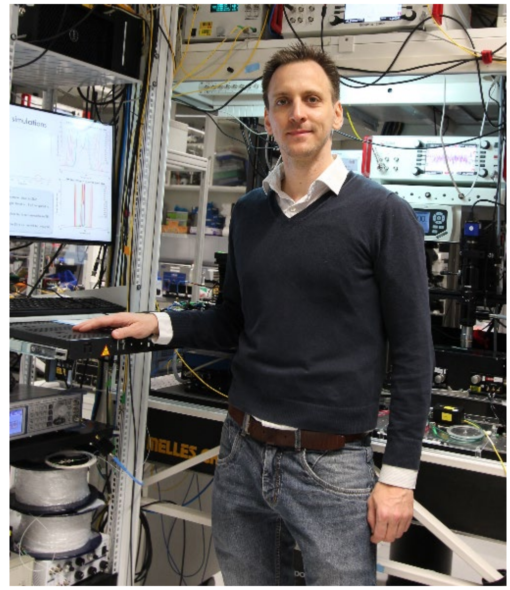

Figure 1: Johann Riemensberger in the lab at EPFL.

Personal Details:

Date of birth: 8 March 1987
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Norwegian University of Science and Technology
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Education:

10/2018	Ph. D. in Physics (Summa cum laude), Technical University of Munich, Germany Thesis: *Time-Frequency-Resolved Absolute Time Delay of the Photoelectric Effect* Advisor: Prof. Reinhard Kienberger Defense date: 19.10.2018
12/2011	Diploma in Technical Physics, Technical University of Munich, Germany Project: *Integrated silicon nitride based microresonators for frequency comb generation*
06/2006	Abitur at Oskar-Maria-Graf Gymnasium Neufahrn

Employment history:

03/2024 -	**Tenure Track Associate Professor** at Norwegian University of Science and Technology (NTNU), Norway
01/2022 – 12/2022	**Chief Technology Officer** at *Deeplight SA,* Switzerland Leading R&D of photonic integrated circuits for frequency-agile hybrid integrated laser systems, Preparation of research grant proposals Customer Engagement and sales
02/2019 – 09/2023	**Postdoctoral Scholar** at *Ecole Polytechnique Fédérale de Lausanne*, Switzerland Mentor: Prof. Tobias J. Kippenberg Soft- and hardware development of optical characterization setups for Microresonator resonator lattices for dissipative Kerr solitons generation, Electro-optical photonic integrated circuits

	Developed soliton microcomb technology and frequency agile optical microresonators for coherent laser ranging and OCT Day-to-day supervision of junior researchers
11/2018 – 01/2019	**Postdoctoral Scholar** at *Technical University of Munich,* Germany Advisor: Prof. Reinhard Kienberger
08/2012 – 10/2018	**Graduate Research Assistant** at *Technical University of Munich,* Germany Experiments and theoretical work on time-delays of the photoelectric effect Developed and deployed optical (vacuum) setups for femto- and attosecond lasers, time-resolved photoemission spectroscopy Advisor: Prof. Reinhard Kienberger
12/2010 – 05/2012	**Undergraduate Researcher** at Ecole Polytechnique Fédérale de Lausanne, Switzerland Developed, fabricated and deployed Si_3N_4 waveguide technology for optical frequency comb generation Advisor: Prof. Tobias J. Kippenberg
02/2010 – 04/2010	**Working student** at *Max-Plank Institute for Quantum Optics,* Garching, Germany Advisor: Prof. Reinhard Kienberger
07/2006 – 11/2010	**Intern and part-time developer** at MELSensor GmbH Developed MI400 and other high-temperature inductive sensor heads Developed interferometric calibration for AMCW LiDAR sensors Developed multimode fiber optic sensor for paint density monitoring

Professional Service:
Recurring Reviewer at *Nature*, *Nature Physics, Nature Communications* and other journals.

Honors, Awards and Fellowships:

2019	Dissertation Prize of the Bund der Freunde der Technischen Universität München.
2019-2021	Marie Skłodowska Curie Individual Fellowship (MSCA-IF)
2021-2023	Ambizione Fellowship SNSF
2024-2030	Onsager Fellowship NTNU

Community Service:
Voluntary Firefighter, Gemeinde Eching 2003 – 2019

Languages:
German (C2), English (C2), French (A1)

Software Skills:
Python, Matlab, Lumerical, Comsol Multiphysics, Labview, Adobe Illustrator, Solidworks, MS Office

Patents:
- A. Kartouzian, F. Mohateb, U.Heiz, K. Oberhofer, **J. Riemensberger** H. Iglev, R.Kienberger; Verfahren zur Enantiomerenanreicherung, *Patent Nr. DE 10 2018 117 346,* filed 7.19.2018, granted 19.9.2019
- H. Iglev, H. Oliver, R. Kienberger, A. Schletter, M. Wurzer, **J. Riemensberger**; Multicolor optical resonator for imaging methods, *EP 18 205 407.2,* filed 9.11.2018
- A. Lukashchuk, **J. Riemensberger**, T.J. Kippenberg; Optical frequency comb based parallel FM LiDAR, *PCT/EP2019/082307,* filed 22.11.2019
- G. Lihachev, H. Tian, A. Siddarth, **J. Riemensberger**, T. Kippenberg, S. Bhave; Electrically tuneable optical resonator on a chip for fast tuneable integrated lasers, *PCT/EP2021/056338,* filed 12.3.2021

- G. Lihachev, H. Tian, A. Siddarth, **J. Riemensberger**, T. Kippenberg, S. Bhave; Method for operating a frequency agile tunable self-injection locking laser system and self-injection locking laser system, *PCT/EP2021/080646,* filed 16.12.2021
- A. Lukashchuk, **J. Riemensberger**, T.J. Kippenberg; Method and setup for light detection and ranging, *PCT/EP 2021/086510, filed 17.10.2021*

Funded Research Projects:

4/2019 – 4/2021	**Marie Skłodowska Curie Individual Fellowship (MSCA-IF)** Title: Developement of compact single-cycle light sources (CoSiLiS) Role: Main Applicant Host: Prof. Tobias Kippenberg Ecole Polytechnique Fédérale de Lausanne, Switzerland Laboratory of Photonics and Quantum Measurement (LPQM)
10/2021 – 10/2023	**SNSF Ambizione Fellowship** Title: Ultra-low loss nonlinear photonic integrated circuits for novel applications in optical telecommunication and metrology Role: Principal Investigator Host: Prof. Tobias Kippenberg Ecole Polytechnique Fédérale de Lausanne, Switzerland Laboratory of Photonics and Quantum Measurement (LPQM)
5/2023 –	**EIC Transition Open** Title: High-density lithium niobate integrated photonics Role: Principal Investigator Luxtelligence SA, Switzerland

Full publication list:

[1] Voltage-tunable OPO with an alternating dispersion dimer integrated on chip, D. Pidgaiko, A. Tusnin, **J. Riemensberger**, A. Stroganov, A. Tikan, T.J. Kippenberg, *Optica* **10**,11 1582-1586 (2023)

[2] Chaotic microcomb inertia-free parallel ranging, A. Lukashchuk, **J. Riemensberger**, A. Stroganov, G. Navickaite, T. J. Kippenberg, *APL Photonics* **8**, 056102 (2023)

[3] Ultrafast tunable lasers using lithium niobate integrated photonics, V. Snigirev, A. Riedhauser, G. Lihachev, **J. Riemensberger**, R.N. Wang, C. Möhl, M. Churaev, A. Siddharth, G. Huang, Y. Popoff, U. Drechsler, D. Caimi, S. Hönl, J. Liu, P. Seidler, T.J. Kippenberg, *Nature* **615**, 411–417 (2023)

[4] Chaotic micro-comb based parallel ranging, A. Lukashchuk, **J. Riemensberger**, A. Tusnin, J. Liu, T.J. Kippenberg *Nature Photonics* **17**,814–821 (2023)

[5] Dissipative solitons and switching waves in dispersion folded Kerr cavities, M.H. Anderson, A. Tikan, A. Tusnin, **J. Riemensberger,** R.N. Wang, T.J. Kippenberg, Physical Review X **13**,011040 (2023)

[6] A heterogeneously integrated lithium niobate-on-silicon nitride photonic platform, M. Churaev, A. Riedhauser, R.N. Wang, C. Möhl, T. Blésin, M.A. Anderson, V. Snigirev, A. Siddharth, Y. Popoff, D. Caimi, S. Hönl**, J. Riemensberger**, J. Liu, P. Seidler, T.J. Kippenberg, Nature Communications, **14**,3499 (2023)

[7] High-density lithium niobate photonic integrated circuits, Z. Li, R.N. Wang, G. Lihachev, Z. Tan, V. Snigirev, M. Churaev, N. Kuznetsov, A. Siddharth, M.J. Bereyhi, **J. Riemensberger**, T.J. Kippenberg *Nature Communications* **14,**4856 (2023)

[8] A photonic integrated continuous-travelling-wave parametric amplifier**, J. Riemensberger,** N. Kusnetzov, J. Liu, J. He, R.N. Wang, T.J. Kippenberg, *Nature* **612**, 56–61 (2022),

[9] Ultralow-noise frequency-agile photonic integrated lasers, G. Lihachev*, **J. Riemensberger*,** W. Weng*, J. Liu, H. Tian, A. Siddharth, V. Snigirev, R.N. Wang, J. He, S.A. Bhave, T.J. Kippenberg, *Nature Communications* 13, 1 (2022)

[10] Dual chirped microcomb-based parallel ranging at megapixel-line rates, A. Lukashchuk, **J. Riemensberger,** M. Karpov, J. Liu, T.J. Kippenberg, *Nature Communications 13, 1* (2022)

[11] Near ultraviolet photonic integrated lasers based on silicon nitride, A. Siddharth, T. Wunderer, G. Lihachev, A.S. Voloshin, C. Haller, R.N. Wang, M. Teepe, Z. Yang, J. Liu, **J. Riemensberger**, N. Grandjean, N. Johnson, T.J. Kippenberg *APL Photonics* 7, 4 (2022)

[12] A photonic integrated circuit–based erbium-doped amplifier, Y. Liu*, Z. Qiu*, X. Yi, A. Lukashchuk, **J. Riemensberger**, M. Hafermann, R. N. Wang, C. Ronning, T.J. Kippenberg, *Science* 376, 6599 (2022)

[13] Protected generation of dissipative Kerr solitons in supermodes of coupled optical microresonators, A. Tikan, A. Tusnin, **J. Riemensberger**, M. Churaev, X. Ji, K.N. Komagata, R.N. Wang, J. Liu, T.J. Kippenberg, *Science Advances* 8, 13 (2022)

[14] Compact, spatial-mode-interaction-free, ultralow-loss, nonlinear photonic integrated circuits, X. Ji, J. Liu, J. He, R.N. Wang, Z. Qiu, **J. Riemensberger**, T.J. Kippenberg, *Communications Physics 8, 13* (2022)

[15] Dissipative Kerr solitons in a photonic dimer on both sides of the exceptional point, K. Komagata, A. Tusnin, **J. Riemensberger**, M. Churaev, H. Guo, A. Tikan, T. J. Kippenberg, *Communications Physics* 4, 159 (2021)

[16] Laser soliton microcombs heterogeneously integrated on silicon, C. Xiang, J. Liu, J. Guo, L. Chang, R. N. Wang, W. Weng, J. Peters, W. Xie, Z. Zhang, **J. Riemensberger**, J. Selvidge, T.J. Kippenberg, J.E. Bowers, *Science* 373, 99-103 (2021)

[17] Soliton microcomb based spectral domain optical coherence tomography, P. Marchand, J.C. Skehan, **J. Riemensberger**, J.-J. Ho, M.H.W. Pfeiffer, J. Liu, C. Hauger, T. Lasser, T.J. Kippenberg, *Nature Communications* 12, 427 (2021)

[18] Emergent Nonlinear Phenomena in a Driven Dissipative Photonic Dimer, A. Tikan, **J. Riemensberger**, K. Komagata, S. Hönl, M. Churaev, C. Skehan, H. Guo, R. N. Wang, J. Liu, P. Seidler, T. J. Kippenberg, *Nature Physics* 17,604-610 (2021)

[19] Massively parallel coherent laser ranging using soliton microcombs, **J. Riemensberger**, A. Lukashchuk, M. Karpov, W. Weng, E. Lucas, J. Liu, T.J. Kippenberg, *Nature* 581, 164-170 (2020)

[20] Photonic microwave generation in the X- and K-band using integrated soliton microcombs, J. Liu , E. Lucas, A. Raja, J. He, **J. Riemensberger**, R.N. Wang, M. Karpov, H. Guo, R. Bouchand, T.J. Kippenberg, *Nature Photonics* 8 468-491 (2020)

[21] Understanding laser desorption with circularly polarized light, F. Ristow, J. Scheffel, X. Xu, N. Fehn, K. E. Oberhofer, **J. Riemensberger**, F. Mortaheb, R. Kienberger, U. Heiz, A. Kartouzian, H. Iglev, *Chirality* 32, 12, pp. 1341-1353 (2020)

[22] Attosecond Dynamics of sp-band Photoemission, **J. Riemensberger**, S. Neppl, D. Potamianos, M. Schäffer, M. Schnitzenbaumer, M. Ossiander, A. Guggenmos, U. Kleineberg, P. M. Echenique, F. Allegretti, D. Menzel, J. Barth, A. G. Borisov, A. K. Kazansky, R. Kienberger, and P. Feulner, *Phys. Rev. Lett.* 123, 176801 (2019)

[23] Enantiospecific Desorption Triggered by Circularly Polarized Light, F. Mohateb, K. Oberhofer, **J. Riemensberger**, F. Ristow, R. Kienberger, U. Heiz, H. Iglev, A. Kartouzian*, Angewandte Chemie* 58, 44 15685-15689 (2019)

[24] Few-Femtosecond Wave Packet Revivals in Ozone, T. Latka, V. Shirvanyan, M. Ossiander, O. Razskazovskaya, A. Guggenmos, M. Jobst, M. Fieß, S. Holzner, A. Sommer, M. Schultze, C. Jakubeit, **J. Riemensberger**, B. Bernhardt, W. Helml, F. Gatti, B. Lasorne, D. Lauvergnat, P. Decleva, G. J. Halász, Á. Vibók, and R. Kienberger, *Phys. Rev. A* 99, 063405 (2019)

[25] Absolute Timing of the Photoelectric Effect, M. Ossiander*, **J. Riemensberger***, S. Neppl, M. Mittermair, M. Schäffer, A. Duensing, M. S. Wagner, R. Heider, M.Wurzer, M. Gerl, M. Schnitzenbaumer, J.V. Barth, F. Libisch, C. Lemell, J. Burgdörfer, P. Feulner, R. Kienberger, *Nature* 561, 374-378 (2018)

[26] Ultrafast quantum control of ionization dynamics in krypton, K. Hütten, M. Mittermair, S. O. Stock, R. Beerwerth, V. Shirvanyan, **J. Riemensberger**, A. Duensing, R. Heider, M. S. Wagner, A. Guggenmos, S. Fritzsche, N.M. Kabachnik, R. Kienberger, and B. Bernhardt, *Nature Communications* 9, 719 (2017)

[27] Chromium/scandium multilayer mirrors for isolated attosecond pulses at 145 eV, A. Guggenmos, M. Jobst, M. Ossiander, S. Radünz, **J. Riemensberger**, M. Schäffer, A. Akil, C. Jakubeit, P. Böhm, S. Noever, B. Nickel, R. Kienberger, and U. Kleineberg, *Optics Letters* 40, 12, pp. 2846 (2015)

[28] Dynamics of Kerr Frequency Comb Formation in Microresonators, T. Herr, **J. Riemensberger,** C. Wang, K. Hartinger, E. Gavartin, R. Holzwarth, M. L. Gorodetsky, T. J. Kippenberg, *Nature Photonics* 6, 480-487 (2012)

[29] Dispersion engineered high-Q silicon Nitride Ring-Resonators via Atomic Layer Deposition, **J. Riemensberger,** K. Hartinger, T. Herr, V. Brasch, R. Holzwarth, T.J. Kippenberg, *Optics Express* 20, 25, pp. 27661-27669 (2012)

Preprints:

[1] Frequency agile photonic integrated external cavity laser, G. Lihachev, A. Bancora, V. Snigirev, H. Tian, **J. Riemensberger**, V. Shadymov, A. Siddharth, A. Attanasio, R.N. Wang, D. Visani, A. Voloshin, S. Bhave, T.J. Kippenberg, *arXiv:2303.00425* (2023)

[2] Fundamental charge noise in electro-optic photonic integrated circuits, J. Zhang, Z. Li, **J. Riemensberger**, G. Lihachev, G. Huang, T.J. Kippenberg, arXiv:2308.15404 (2023)

[3] Lithium tantalate electro-optical photonic integrated circuits for high volume manufacturing, C. Wang, Z. Li, **J. Riemensberger,** G. Lihachev, M. Churaev, W. Kao, T. Blesin, X. Ji, A.Davydova, Y. Chen, X. Wang, K. Huang, X. Ou, T.J. Kippenberg arXiv:2306.16492 (2023)

[4] Hertz-linewidth and frequency-agile photonic integrated extended-DBR lasers, A. Siddarth, A. Attanasio, G. Lihachev, J. Zhang, Z.Qiu, S. Kenning, R.N. Wang, S.A. Bhave, **J. Riemensberger,** T.J. Kippenberg, arXiv:2306.03184 (2023)

[5] A fully hybrid integrated Erbium-based laser, Y. Liu, Z. Qiu, X. Ji, A. Bancora, G. Lihachev, **J. Riemensberger,** R.N. Wang, A. Voloshin, T.J.Kippenberg, arXiv:2305.03652 (2023)

[6] Soliton Microcomb Generation in a III-V Photonic Crystal Cavity, A. Nardi, A. Davydova, N. Kuznetsov, M. H. Anderson, C. Möhl, **J. Riemensberger,** P. Seidler, T. J. Kippenberg, arXiv:2304.12968 (2023)

Conference Talks:

[1] Oral presentation titled: “Broadband and high-gain traveling-wave optical parametric amplification in a Gallium Phosphide photonic integrated circuit” at *CLEO US San Jose* – 5/2024

[2] Invited talk titled: “Ultra-low loss photonics for optical amplification, frequncy comb generation, and frequency-agile low noise lasers” at *CLEO US San Jose* – 5/2024

[3] Keynote talk titled: “Next Generation Integrated Photonic Circuits” at *OSA Sensing Congress Munich – 8/2023*

[4] Invited talk titled: “Next Generation Integrated Photonic Circuits” at *META2023 Paris – 7/2023*

[5] Oral presentation titled “Lithium-niobate-based narrow-linewidth integrated lasers with petahertz frequency tuning rate” at *OFC2023 San Diego – 03/2023*

[6] Invited talk titled “Lasers and frequency combs for massively parallel photonic integrated LiDARs” at *IPC2022 Vancouver – 11/2022*

[7] Oral presentation titled “Time-Continuous Travelling-Wave Optical Parametric Amplification in a Photonic Circuit” at *ECOC2022 Basel – 09/2022*

[8] Oral presentation titled “Continuous-wave travelling wave optical parametric amplification on a photonic chip” at *CLEO US San Jose* – 5/2022

[9] Invited talk titled “Soliton microcombs and nonlinear integrated photonics for coherent LiDAR” at *MEFISTA ITN Workshop,* 10/2021

[10] Invited talk titled “Single-pixel massively parallel coherent LiDAR using on dual soliton microcombs” at *2021 Conference on Lasers and Electro-Optics Europe, 6/2021*

[11] Invited talk titled “Soliton microcombs for massively parallel coherent 3D imaging” at *Automotive Sensors & Electronics: LIDAR, Radar and Camera Online Summit,* 2/2021

[12] Invited talk titled “Soliton Microcombs for Massively Parallel FMCW LIDAR” at Automotive LiDAR conference 2020, Detroit – 9/2020

[13] Oral presentation titled “Massively Parallel Coherent LiDAR Using Dissipative Kerr Soliton Generation in Integrated Microresonators” at CLEO Pacific Rim – 8/2020

[14] Oral presentation titled “Massively parallel coherent LiDAR using dissipative Kerr solitons” at *CLEO: Science and Innovations* – 5/2020

[15] Invited talk titled “Soliton microcombs for LIDAR” at *Photonics West*, San Francisco – 2/2020

[16] Invited talk titled “Absolute photoemission time delays from elemental surfaces and adsorbates” at *Nano- And Ultrafast Surface Sciences (NUSS) Symposium*, Munich – 9/2019

[17] Oral presentation titled: “Band structure influence in high-energy attosecond photoemission spectroscopy” *ATTO 2017 Xi’An* – 7/2017

[18] Oral presentation titled “Energy-dependent photoemission delays from the (0001) surface of magnesium” at *Ultrafast Surface Dynamics 10*, Inzell – 6/2017

[19] Oral presentation titled “Excitation energy dependent attosecond photoemission timing in tungsten” at *2015 Conference on Fundamental Science (CLEO)*, San Jose – 5/2015

[20] Oral presentation titled “Photoactive metal-organic nanoarchitectures on surfaces: Probing ultrafast intramolecular charge dynamics” at *2013 Workshop on Quantum Materials*, Stuttgart – 12/2013

[21] Oral presentation titled “Phase noise and dispersion in integrated silicon nitride based Kerr-Comb generators” at *2012 Conference on Lasers and Electro Optics (CLEO),* San Jose – 5/2012

Research Highlights:

A photonic integrated continuous-travelling-wave parametric amplifier, J. Riemensberger**,** N. Kusnetzov, J. Liu, J. He, R.N. Wang, T.J. Kippenberg, *Nature* 612, 56–61 (2022),

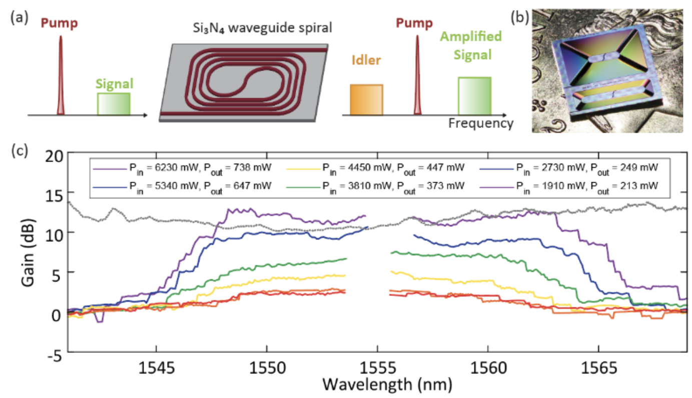

Figure 2: (a) Concept of Kerr-parametric amplification in photonic integrated waveguide spiral, (b) Photograph of 2m long spiral on 3x5mm^2. (c) Amplification Spectrum for varying pump power (colored) and transmission loss (grey) demonstrating net gain fiber-chip-fiber

The development of erbium-doped-fiber-based optical amplifiers has revolutionized optical communications, which are today ubiquitously used in virtually all sensing and communication applications of coherent laser sources. Another way to amplify optical signals is to utilize the Kerr nonlinearity of optical fibers or waveguides via parametric processes. Such parametric amplifiers of travelling continuous wave have high peak gain, broadband gain spectrum tailored via dispersion control, and offer the ability of phase-sensitive (i.e. noiseless) amplification. Here we demonstrate a chip-based travelling-wave optical parametric amplifier with net signal gain in the continuous-wave regime. Using ultralow-loss, dispersion-engineered, meter-long, Si_3N_4 photonic integrated circuits that are tightly coiled on a chip of 5×5 mm2 size , we achieve a continuous parametric gain of 12 dB that exceeds both the on-chip optical propagation loss and fiber-chip-fiber coupling losses in the telecommunication C-band. **Contribution:** Designed and performed experiments, data analysis, and wrote the manuscript with input from all authors.

Massively parallel coherent laser ranging using a soliton microcomb
J. Riemensberger, A. Lukashchuk, M. Karpov, W. Weng, E. Lucas, J. Liu and T. J. Kippenberg, *Nature* **581**, 164-170 (2020)

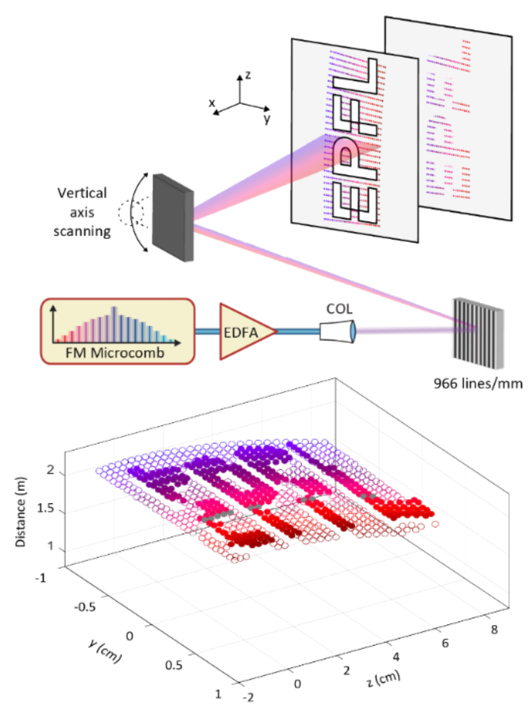

Figure 3: Top: Setup for proof-of-principle parallel coherent laser ranging. The target is composed from two sheets of papers spaced by 10 cm with the EPFL Logo cut-out from the front sheet. Bottom: Ranging result clearly showing cm-level precision. Colors indicate different comb teeth.

Coherent ranging, also known as frequency-modulated continuous-wave (FMCW) laser-based light detection and ranging (lidar)1 is used for long-range three-dimensional distance and velocimetry in autonomous driving. Soliton microcombs promise to revolutionize integrated photonic metrology, spectroscopy and sensing. In this work, it was shown that a single soliton micorcomb can drive up to 30 individual coherent laser distance and velocity measurement channels in parallel when driven with a single coherent and chirped pump laser. In-depth characterization of the chirp transduction from the pump laser to the soliton sidebands was carried out using heterodyne spectroscopy. **Contribution**: Built LiDAR setup, developed linearization and measurement code and analyzed data. Wrote the manuscript with contributions from co-authors.

Dual chirped microcomb based parallel ranging at megapixel-line rates, A. Lukashchuk, J. Riemensberger, M. Karpov, J. Liu & T.J. Kippenberg, *Nature Communications* 13, 3280 (2021)

State-of-the-art coherent single laser-detector architectures reach hundreds of kilopixel per second sampling rates, while emerging applications - autonomous driving, robotics, and augmented reality - mandate megapixel per second point sampling to support real-time video-rate imaging. We overcome the challenge and report a hardware-efficient swept dual-soliton microcomb technique that achieves coherent ranging and velocimetry at megapixel per second line scan measurement rates with up to 64 optical channels. Multiheterodyning two synchronously frequency-modulated microcombs yields distance and velocity information of all individual ranging channels on a single receiver alleviating the need for individual separation, detection, and digitization. **Contribution:** Contributed to experimental measurements, data analysis, and contributed to writing the manuscript.

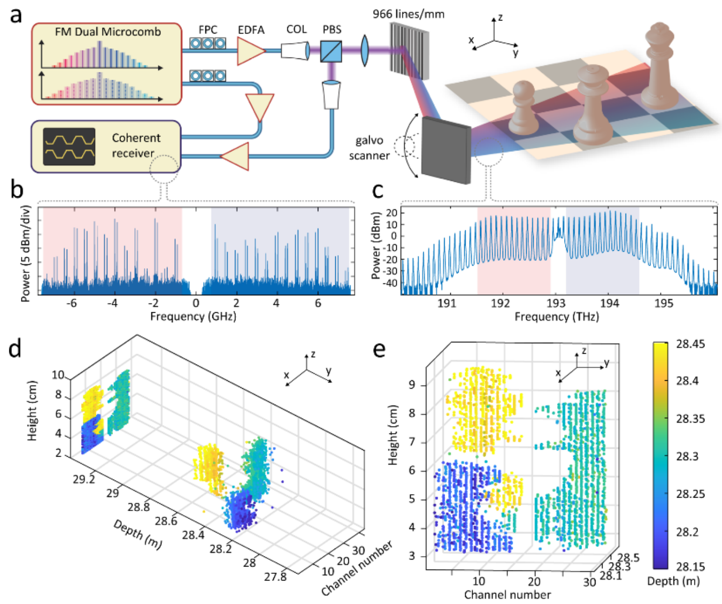

Figure 4: a) Experimental setup of dual-comb massively parallel FMCW LiDAR using multiheterodyne detection. b,c) Multiheterodyne and optical spectra containing ranging information for 28 pixels. d,e) Point cloud of chess figures.

Ultralow-noise frequency-agile photonic integrated lasers, G. Lihachev*, J. Riemensberger*, W. Weng*, J. Liu, H. Tian, A. Siddharth, V. Snigirev, R.N. Wang, J. He, S.A. Bhave, T.J. Kippenberg, *Nature Communications* 13, 3522 (2022)

The emergence of ultra-low loss integrated photonic devices, i.e. linear propagation loss less than 1 dB/m open new possibilities for the creation and operation of highly stable lasers. Here based on the self-injection locking technique, we show a hybrid integrated compact diode laser source with comparable phase noise to state-of-the-art low noise CW fiber lasers. We monolithically integrate a piezoelectric thin film to endow the laser source with frequency agile tuning and perform a proof-of-concept FMCW LiDAR experiment with the source. **Contribution:** Designed and performed phase noise measurement and FMCW LiDAR, data analysis, and contributed to writing the manuscript.

Soliton microcomb based spectral domain optical coherence tomography, P.J. Marchand, J. Riemensberger, J.C. Skehan, J.J. Ho, M.H.P. Pfeiffer, J. Liu, C. Hauger, T. Lasser & T.J. Kippenberg, *Nature Communications,* 12, 427 (2021)

Spectral domain optical coherence tomography (OCT) is a widely employed, minimally invasive bio-medical imaging technique, which requires a broadband light source, typically implemented by super-luminescent diodes. We characterized the exceptional noise properties of our source (in comparison to conventional OCT sources) and demonstrate that the soliton states in microresonators exhibit a residual intensity noise floor at high offset frequencies that is ca. 3 dB lower than a traditional OCT source at identical power, and can exhibit significantly lower noise performance for powers at the milli-Watt level. Moreover, we demonstrate that classical amplitude noise of all soliton comb teeth are correlated, i.e., common mode, in contrast to superluminescent diodes or incoherent microcomb states, which opens a new avenue to improve imaging speed and performance beyond the thermal noise limit. **Contribution:** Designed and performed noise and correlation measurement, data analysis, and contributed to writing the manuscript.

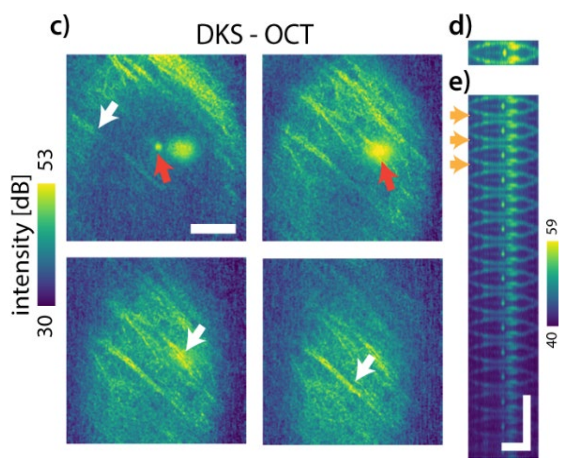

Figure 5: Enface images at different depths of a slice of mouse brain tissue were obtained with a dissipative Kerr soliton (DKS) source

A photonic integrated circuit–basederbium-doped amplifier, Y. Liu, Z. Qiu, X. Ji, A. Lukashchuk, J. He, J. Riemensberger, M. Hafermann, R.N. Wang, J. Liu, C. Ronning, T.J. Kippenberg

Erbium-doped fiber amplifiers revolutionized long-haul optical communications and laser technology. Erbium ions could provide a basis for efficient optical amplification in photonic integrated circuits but their use remains impractical as a result of insufficient output power. We apply ion implantation to ultralow–loss silicon nitride (Si_3N_4) photonic integrated circuits, which are able to increase the soliton microcomb output power by 100 times, achieving power requirements for low-noise photonic microwave generation and wavelength-division multiplexing optical communications. Our photonic integrated circuit–based erbium-doped waveguide amplifier can provide >145 mW on-chip output power and >30 dB of small-signal gain. **Contribution:** Contributed to photonic circuit design and design of experiments.

Emergent Nonlinear Phenomena in a Driven Dissipative Photonic Dimer, A. Tikan, J. Riemensberger, K. Komagata, S. Hönl, M. Churaev, C. Skehan, H. Guo, R. N. Wang, J. Liu, P. Seidler, T. J. Kippenberg, *Nature Physics* 17, 604-610 (2021),

First experiments explored the generation of DKS in photonic dimers, i.e. dual coupled microresonators, where coherent soliton generation in hybridized modes was observed in the first time. Novel emergent phenomena such as the formation of incommensurate dispersive waves and their breathing were observed experimentally. Further emergent nonlinear phenomena such as soliton hopping, i.e. periodic or chaotic transfer of energy between spatially separated resonators, was predicted numerically and is the focal-point of currently ongoing work in the host group on more complex systems such as linear microresonator chains and square and triangular lattices. **Contribution:** Designed and performed experiments, data analysis, and jointly wrote the manuscript with AT.

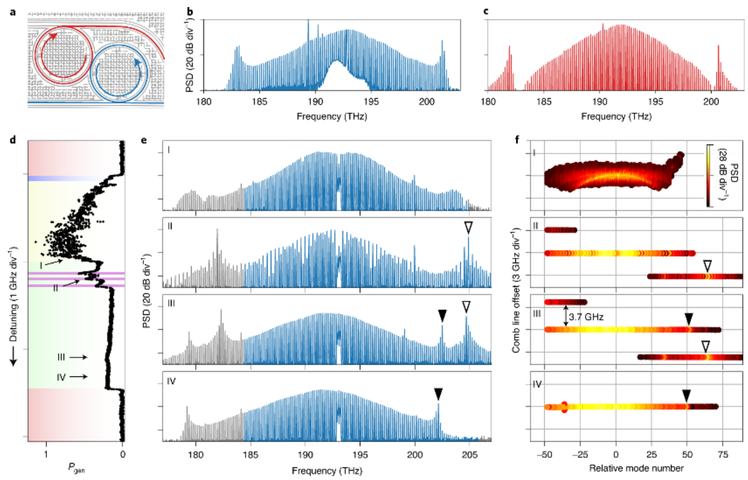

Figure 6: Soliton generation in coupled Si_3N_4 resonators and generation of higher order dispersive waves and subcombs.

Absolute timing of the photoelectric effect
M. Ossiander*, J. Riemensberger*, S. Neppl, M. Mittermair, M. Schäffer, A. Duensing, M. S. Wagner, R. Heider, M. Wurzer, M. Gerl, M. Schnitzenbaumer, J. V. Barth, F. Libisch, C. Lemell, J. Burgdörfer, P. Feulner and R. Kienberger, *Nature* 561, 374-377 (2018)

Absolute attosecond chronoscopy, i.e. the measurement of time between photoabsorption and photoemission, has not been feasible with sufficient resolution to systematically study the attosecond timescale dynamics of the photoelectron excitation, transport and release. A new technique, the "Atomic Chronoscope Method", was developed in this work and implemented. Herein, carefully prepared sub-monolayers of heavy atoms featuring weakly bound core-orbitals are adsorbed on metallic surfaces. Thus for the first time, the absolute time delay of the photoelectric effect has been measured with sufficient precision to challenge developing theories of the underlying attosecond dynamics. **Contribution**: Co-first author. Performed solid-state measurements and data analysis. Contributed to writing of the manuscript.

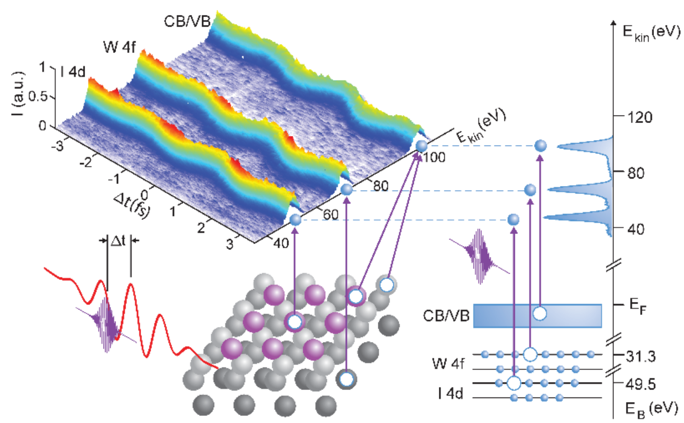

Figure 7: Schematic illustration of attosecond streaking spectroscopy on adsorbate covered surfaces. Bottom: The W(110) crystal (grey) with saturated monolayer of iodine adatoms (purple) is irradiated by XUV (purple) and NIR (red) pulses with controlled time delay Δt.

Attosecond Dynamics of sp-Band Photoexcitation

J. Riemensberger, S. Neppl, D. Potamianos, M. Schäffer, M. Schnitzenbaumer, M. Ossiander, C. Schröder, A. Guggenmos, U. Kleineberg, D. Menzel, F. Allegretti, J. V. Barth, A. G. Borisov, P. M. Echenique, and A. K. Kazansky, R. Kienberger, and P. Feulner, *Physical Review Letters* **123,** 176801 (2019)

This work reports measurements of the temporal dynamics of the valence band photoemission from the magnesium (0001) surface across the resonance of the $\bar{\Gamma}$ surface state at 134 eV and link them to observations of high-resolution synchrotron photoemission and numerical calculations of the time-dependent Schrödinger equation using an effective single-electron model potential. Our approach to rigorously link excitation energy-resolved conventional steady-state photoemission with attosecond streaking spectroscopy reveals the connection between energy-space properties of bound electronic states and the temporal dynamics of the fundamental electronic excitations underlying the photoelectric effect. **Contribution**: Performed measurements and analyzed data. Performed state-dependent numerical calculations. Wrote the manuscript with contributions from co-authors.

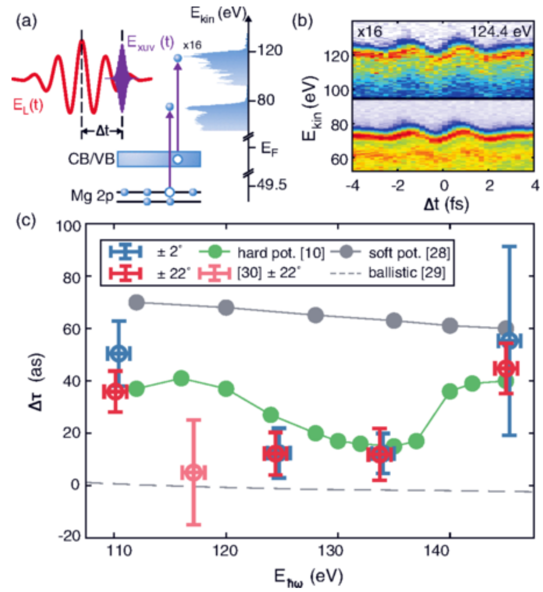

Figure 8: (a) Schematic of the attosecond streaking spectroscopy. (b) Attosecond streaking spectrogram (c) Energy-dependent relative attosecond time delays Δτ of the Mg 2p core level.