Newsletter

May 2017

QSIT Quantum Science and Technology

National Centre of Competence in Research

1. Scientific News

Nicolas Brunner's group and Hugo Zbinden's group, Geneva

Quantum randomness: more bits for less trust: We have recently demonstrated a new quantum random number generator (QRNG) which is simple to implement and achieves high bit rates, yet requires almost no trust in the devices used, leading to strongly improved security.

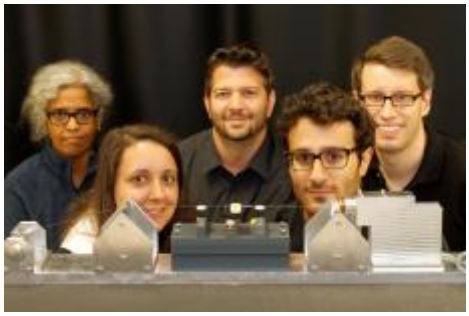
The QRNG is one of the most advanced quantum technologies and commercial devices are available today, but still require that one trusts their physical implementation. Remarkably, quantum physics allows certification of true randomness even when no trust is placed in the devices generating it. However, this device-independent setting is technologically challenging to realize, and current rates are too low to be practical. We have demonstrated a favorable balance between ease of implementation and high security. Our proof-of-principle experiment uses a simple setup with a laser and photodetector and achieves bit rates of 16 Mbits/sec, on par with commercial QRNGs. At the same time, it requires only very limited trust in the laser source, and no trust at all in the detector.

We have filed a patent application and will develop a demonstrator within a QSIT technology transfer project.

- J. B. Brask, A. Martin, W. Esposito, R. Houlmann, J. Bowles, H. Zbinden, N. Brunner, arXiv:1612.06566, to appear in *Phys. Rev. Applied*.

Christian Degen's, Manfred Sigrist's & Oded Zilberberg's groups, Zurich

Ultrasensitive hysteretic force sensing with parametric nonlinear oscillators: An interdisciplinary team of theoretical and experimental physicists at ETH Zurich (Ramasubramanian Chitra, Anina Leuch, Oded Zilberberg, Luca Papariello and Alexander Eichler) has discovered a peculiar feature in oscillations similar to that of a child's swing. As a result, they have succeeded in outlining a novel principle for small, high-resolution sensors, and have submitted a patent application for it.



- L. Papariell, O. Zilberberg, A. Eichler, R. Chitra: *Physcial Review E*, **94**, 022201, (2016) link
- R. Chitra, O. Zilberberg, P*hysical Review A* **92**, 023815, (2015), link
- in the news: ETH News, Electronic Specifier, Science daily, cleantech.ch

Klaus Ensslin's, Thomas Ihn's, Andreas Wallraff's, & Werner Wegscheider's groups, Zurich

Strong coupling cavity QED with gate-defined double quantum dots enabled by a high impedance resonator: One of the outstanding achievements of modern physics is the development of experimental methods for isolating, manipulating and controlling systems that display quantum-mechanical behaviour. Having a practical handle on quantum systems enables fundamental studies to test the often counter-intuitive predictions of quantum theory, but also provides the tools for novel technological applications in areas ranging from computation and communication to sensing. But whereas individual quantum technologies are getting increasingly mature, a current challenge is to construct hybrid devices that integrate several types of quantum systems in one experimental platform. Addressing this challenge, ETH physicists Anna Stockklauser, Pasquale Scarlino and their colleagues in the group of Andreas Wallraff have now teamed up with the fellow ETH groups of Thomas Ihn and Klaus Ensslin and of Werner Wegscheider to construct a device in which single electrical charges in a semiconductor are strongly coupled to a superconducting resonator that hosts photons – the 'quanta of light' – in the microwave-frequency range. The coupling between the two quantum systems is stronger than has been realized so far in any other hybrid system of this sort and

might pave the way to a wide spectrum of applications.
- A. Stockklauser, P. Scarlino, J. V. Koski, S. Gasparinetti, C. K. Andersen, C. Reichl, W. Wegscheider, T. Ihn, K. Ensslin & A. Wallraff, *Phys. Rev.* **X 7**, 011030 (2017), link
- accompanying synopsis in APS Physics
- in the news: D-Phys news

Tilman Esslinger's group, Zurich

Supersolid formation in a quantum gas breaking a continuous translational symmetry: Solid, liquid or gas – we encounter these three clearly defined states of matter every day. It is difficult to imagine that substances could simultaneously exhibit properties of two of these states. Yet, precisely such a phenomenon is possible in the realm of quantum physics, where matter can display behaviors that seem mutually exclusive.
Supersolidity is one example of such a paradoxical state. In a supersolid, atoms are arranged in a crystalline pattern while at the same time behaving like a superfluid, in which particles move without friction. ETH researchers have succeeded in realizing this strange state experimentally for the first time by coupling a Bose-Einstein condensate to two crossing high-finesse optical cavities.
- J. Léonard, A. Morales, P. Zupancic, T. Esslinger & T. Donner, *Nature* **543**, 2017 link
- in the news: ETH News, NZZ, Frankfurter Allgemeine Zeitung, Chemie.de, Spektrum der Wissenschaft, Phys.org, Süddeutsche Zeitung.

Jérôme Faist's group, Zurich

Asymmetry in polariton dispersion as function of light and matter frequencies in the ultrastrong coupling regime: The authors used split ring resonators coupled to the cyclotron transition in a two-dimensional electron gas to show that the diamagnetic terms of an ultrastrongly coupled system lead to an asymmetry between the light and matter branches. They find, that the assumption of constant coupling rate Ω as function of detuning is not generally valid for the large frequency range relevant to ultrastrong coupling phenomena.
- Curdin Maissen, Giacomo Scalari, Mattias Beck and Jérôme Faist, *New J. Phys.* **19,** 043022, 2017, link

Coupling Surface Plasmon Polariton Modes to Complementary THz Metasurfaces Tuned by Inter Meta-Atom Distance: In a recent paper J. Keller demonstrate strong coupling between localized meta-atoms resonances and surface plasmon polaritons.
- Janine Keller, Curdin Maissen, J. Haase, G. L. Paravicini-Bagliani, F. Valmorra, J. Palomo, J. Mangeney, J. Tignon, S. S. Dhillon, G. Scalari, J. Faist, Adv. Optical Mater. 2017, 5, 1600884 link.

Anna Fontcuberta i Morral's group, Lausanne

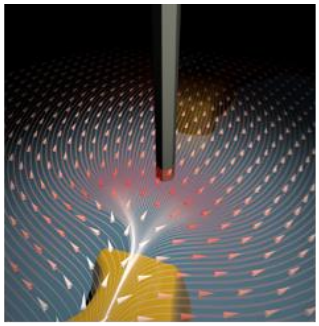
Semiconducting nanostructures and their properties: High-quality nanostructures are important building blocks for quantum science. InAs nanowire networks are particularly interesting for topological qubits based on Majorana Fermions. However, full control of the nanowire growth direction and crystal quality is required. We recently reported on the origin of formation and suppression of unwanted tilted NWs [1]. Furthermore, we also demonstrated a method to change the growth direction of these nanowires to create L-shaped nanostructures [2]. Alternatively, nanowire networks can be achieved by growth on position-controlled templates, an approach that we are exploring in collaboration with the Zumbühl group. Due to the need for high crystal quality, we are investigating the use of single-crystal GaAs nanomembranes as template structures. These nanomembranes recently allowed us to achieve optical properties comparable to the best-two dimensional layers and sensitivity to trace impurities [3].
[1] H. Potts, Y. van Hees, G. Tutuncuoglu, M. Friedl, J.-B. Leran, A. Fontcuberta i Morral (submitted)
[2] H. Potts, N. P. Morgan, G. Tutuncuoglu, M. Friedl, A. Fontcuberta i Morral, *Nanotechnology* **28**, 054001 (2017)
[3] Z. Yang, A. Surrente, G. Tutuncuoglu, K. Galkowski, M. Cazaban-Carrazé, F. Amaduzzi, P. Leroux, D. K. Maude, A. Fontcuberta i Morral, P. Plochocka, *Nano Letters* (just accepted)

Anna Fontcuberta i Morral's group, Lausanne, and Martino Poggio's group, Basel

Vectorial scanning force microcopy using a nanowire sensor: The authors demonstrate a new type of atomic force microscope (AFM) using nanowires (NWs) as tiny sensors. Unlike standard AFM, the NW-based technique enables measurements of both the size and direction of forces.

Self-assembled NW crystals can be grown into nearly defect-free nanomechanical resonators with exceptional properties, including small motional mass, high resonant frequency and low dissipation. Furthermore, by virtue of slight asymmetries in geometry, a NW's flexural modes are split into doublets oscillating along orthogonal axes. These characteristics make bottom-up grown NWs extremely sensitive vectorial force sensors. Taking advantage of its adaptability as a scanning probe, we demonstrate the use of a single NW to image a sample surface.

By monitoring the frequency shift and direction of oscillation of both modes as we scan above the surface, we construct a map of all spatial tip–sample force derivatives in the plane. Finally, we use the NW to image electric force fields distinguishing between forces arising from the NW charge and polarizability. This universally applicable technique enables a form of atomic force microscopy particularly suited to mapping the size and direction of weak tip–sample forces.



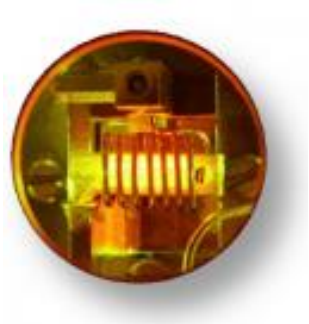
A nanowire sensor measures size and direction of forces. (Image: University of Basel, Department of Physics)

- Nicola Rossi, Floris R. Braakman, Davide Cadeddu, Denis Vasyukov, Gözde Tütüncüoglu, Anna Fontcuberta i Morral & Martino Poggio, *Nature Nano*, advanced online publication 2016, link
- in the news: Uni Basel News, NZZ 18.10.2016, IDW

Nicolas Gisin's group, Geneva

Physical Review Letters, Editors' suggestion

Multi-mode and long-lived quantum correlations between photons and spins in a crystal: The ability to generate quantum correlations between photons and excitations in matter is a key resource for quantum repeaters and quantum networks. Photons are ideal carriers of quantum information, while matter excitations (e.g. spins) can act as long-duration quantum memories to establish heralded entanglement between remote locations. Solid-state devices are gaining interest as potential quantum nodes, as these are interesting for future large-scale deployment of quantum technologies.



In this work researchers from University of Geneva have taken an important step towards a solid-state quantum repeater. They demonstrated quantum correlations between collective spin-wave excitations in a $Eu^{3+}:Y_2SiO_5$ crystals and single photons at 580 nm, with a storage time of the spin component approaching 1 ms. The researchers also demonstrated that up to 10 spin-wave modes, each quantum correlated to a photon, could be stored simultaneously. This unique ability of temporal multiplexing will be important for increasing the speed of future quantum repeaters.

- Cyril Laplane, Pierre Jobez, Jean Etesse, Nicolas Gisin, and Mikael Afzelius, to appear in PRL (2017), link

Nicolas Gisin's group, Geneva and Nicolas Sangouard's group, Basel

Demonstration of light-matter micro-macro entanglement: So far, quantum mechanics has been able to predict the behavior of microscopic systems with unprecedented accuracy. Intensive efforts are now devoted to the study of quantum phenomena at the macroscopic scale. In a collaboration between the universities of Basel and Geneva, we have shown in 2013 how to create photonic entanglement between two optical modes, the first one filled with a microscopic photon number and the second one involving two superposed states that are macroscopically distinct. In a recent publication in Physical Review Letters, we have reported on the storage of this photonic state in an ensemble of atoms trapped in a solid, hence demonstrating micro-macro light-matter entanglement.

- Alexey Tiranov, Jonathan Lavoie, Peter C. Strassmann, Nicolas Sangouard, Mikael Afzelius, Félix Bussières, and Nicolas Gisin, *Phys. Rev. Lett.* **116**, 190502 (2016), link

Sebastian Huber's group, Zurich

Learning phase transitions by confusion: Extracting meaningful data from complex systems is a daunting task. In interacting quantum-many-body systems, we typically rely on pre-defined measurements, where we hope that they capture the relevant physics. For fractional quantum Hall states that might be a transport measurement, whereas for a strongly interacting quantum gas we may resort to density snapshots. While these probes can be well motivated by the nature of the phase we want to understand, they typically largely oversimplify our view on these systems. After all, the complexity of quantum many-body physics certainly surpasses the power of a small set of observables.

With our recent work, we introduced a new variant of supervised machine-learning that allows us to extract the existence and location of a phase transition in an arbitrary physical system. Moreover, our algorithm can work on any type of input data (any collection of numerical or experimental measurements) and does not require prior knowledge of the system. In particular, our method was shown to be able to find topological, disorder-induced, or traditional finite temperature phase transition.

- E. P. L. van Nieuwenburg, Y.-H. Liu, S. D. Huber *Nature Physics* **13**, 435, 2017 link
- in the news: ETH News

Atac Imamoglu's group, Zurich

Realization of a cascaded quantum system: heralded single photon absorption by a single-electron charged quantum dot: In the context of quantum networks, the ability to faithfully transfer a quantum state from one node to another is of key importance. We have demonstrated heralded absorption of single photonic qubits, generated by a neutral quantum dot, by a single-electron charged quantum dot located 5 m away. The electron spin of the target dot after the state transfer exhibits strong correlations with the absorbed photon state.

- A. Delteil, Z. Sun, S. Fält, A. Imamoğlu, *Phys. Rev. Lett*. **118**, 177401 link
- Viewpoint in *Physics*, **10,** 42, 2017 link

Electrically tunable artificial gauge potential for polaritons: Artificial gauge fields promise a route to controlling topological properties of photonic systems but have only been realized by static design. In this work, we report that perpendicular electric and magnetic fields can affect dynamically controlled artificial gauge potentials for exciton polaritons.

- H.-T. Lim, E. Togan, M. Kroner, J. Miguel-Sanchez, A. Imamoğlu, *Nat. Com.* **8**, 14540 (2017) link
- in the news: ETH news

Fermi polaron-polaritons in charge-tunable atomically thin semiconductors: The dynamics of a mobile quantum impurity in a degenerate Fermi system is a fundamental problem in many-body physics. Due to their large binding energy, excitons interacting with the electron gas of a doped transition metal dichalcogenide monolayer can be described as solid particles and constitute an ideal system to study quantum impurities. Using cavity spectroscopy, we observe two absorption resonances in monolayer $MoSe_2$, which both show a sizable normal mode splitting. This rules out their usual identification as exciton and trion but demonstrates that the elementary optical excitations in this new material system are attractive and repulsive polarons.

- M. Sidler, P. Back, O. Cotlet, A. Srivastava, T. Fink, M. Kroner, E. Demler, A. Imamoğlu, *Nature Physics* **13**, 255 (2016), link
- in the news: ETH news, Chemie.de

Tobias Kippenberg's group, Lausanne

Quantum reservoir for microwaves: Engineered dissipation can be used for quantum state preparation. This is achieved with a suitably engineered coupling to a dissipative cold reservoir usually formed by an electromagnetic mode. Similarly, in the field of cavity electro- and optomechanics, the electromagnetic cavity naturally serves as a cold reservoir for the mechanical mode.

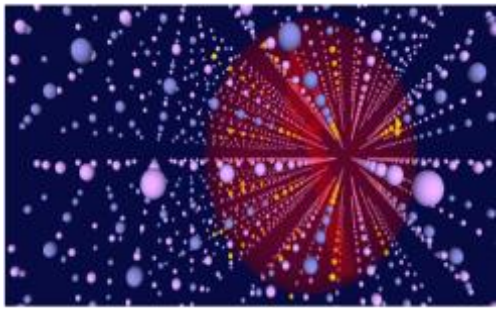
In our recent work, we realized the opposite scenario and engineered a mechanical oscillator cooled close to its ground state into a cold dissipative reservoir for microwave photons. This was achieved in a superconducting microwave optomechanical system by engineering the mechanical dissipation rate to exceed that of the microwave mode. By tuning the coupling to this dissipative mechanical reservoir, we demonstrated dynamical backaction control of the microwave field, leading to stimulated emission and maser action using the mechanical oscillator as the gain medium. Below the masing threshold, we implemented a large-gain, phase-preserving amplifier that operates with added noise 0.87 quanta (or a factor of two) above the quantum limit.

Our work demonstrated that the mechanical reservoir for light can function as a useful quantum resource. Generally, such engineered mechanical dissipation extends the toolbox of quantum manipulation techniques of microwave fields and constitutes a new ingredient for optomechanical protocols.

- L. D. Tóth, N. R. Bernier, A. Nunnenkamp, A. K. Feofanov, T. J. Kippenberg, *Nature Physics*, advanced online publication 15.5.2017, link
- in the news: EPFL news, rdmag, nanowerk, eurekalert, sciencenewsline, phys.org

Daniel Loss', Martino Poggio's & Richard J. Warburton's groups, Basel

Role of the electron spin in determining the coherence of the nuclear spins in a quantum dot: A huge effort is underway to develop semiconductor nanostructures as low-noise qubits. A key source of dephasing for an electron spin qubit in GaAs and in naturally occurring Si is the nuclear spin bath. The electron spin is coupled to each nuclear spin by the hyperfine interaction. The same interaction also couples two remote nuclear spins via a common coupling to the delocalized electron. It has been suggested that this interaction limits both electron and nuclear spin coherence, but experimental proof is lacking. We show that the nuclear spin decoherence time decreases by two orders of magnitude on occupying an empty quantum dot with a single electron, recovering to its original value for two electrons. In the case of one electron, agreement with a model calculation verifies the hypothesis of an electron-mediated nuclear spin–nuclear spin coupling. The results establish a framework to understand the main features of this complex interaction in semiconductor nanostructures.



Art view of a semiconductor InAs/GaAs quantum dot (In, Ga and As respectively in yellow, blue and purple). Two remote nuclear spins (yellow arrows) are coupled via the spin of an electron delocalized over the quantum dot (red). (Image: University of Basel, Department of Physics)

- G. Wüst, M. Munsch, F. Maier, A. V. Kuhlmann, A. Ludwig, A. D. Wieck, D. Loss, M. Poggio & R. J. Warburton, *Nature Nanotechnology* 11, 885–889 (2016), link
- in the news: Basel Uni News, idw-Informationsdienst Wissenschaft

Lukas Novotny's group, Zurich

Quantum light from water: In this work, we report on a novel source for the generation of quantum correlated photon pairs - liquid water. The photon pairs are generated in a process known as Stokes-anti-Stokes (SaS) correlated Raman scattering. In SaS a incident laser photon generates a molecular vibration as well as a Stokes photon. The same molecular vibration subsequently interacts with a second laser photon to produce the anti-Stokes photon. We find that the photon pairs generated by water are of unprecedented purity compared to photon pairs generated by previously studied materials. The purity of photon pairs is reflected by the violation of the Cauchy-Schwarz inequality by more than five orders of magnitude.
- M. Kasperczyk, F. S. de Aguiar Júnior, C. Rabelo, A. Saraiva, M. F. Santos, L. Novotny, and A. Jorio, *Phys. Rev. Lett.* **117**, 243603 (2016), link

Cooling mechanical oscillators by coherent control: Here we controllably couple two orthogonal Eigenmodes of a mechanical oscillator - namely an optically levitated nanoparticle. The coupling is achieved by periodically modulating the polarization angle of the laser forming the optical trap. Following this scheme, we demonstrate sympathetic cooling of oscillation mode by coupling it to a feedback-cooled mode. Moreover, we show that coherent control allows us to transfer energy from one mode to the other.
- M. Frimmer, J. Gieseler, and L. Novotny, *Phys. Rev. Lett.* **117**, 163601(2016), link

Antenna-coupled tunnel junctions: In this book chapter, we review the development of light emission from inelastic electron tunneling (LEIT) from its initial discovery forty years ago to the recent demonstration of optical antennas coupled to tunnel junctions. We thoroughly discuss a theoretical model describing our current understanding of the physics involved in LEIT. A outlook on the prospects and challenges of LEIT as a driving source for optical antennas is given.
- M. Parzefall, P. Bharadwaj, L. Novotny, in *Quantum Plasmonics*, S.I. Bozhevolnyi et al. (eds.), Springer Series in Solid-State Sciences **185** (2017), link

Nicolas Sangouard's group, Basel

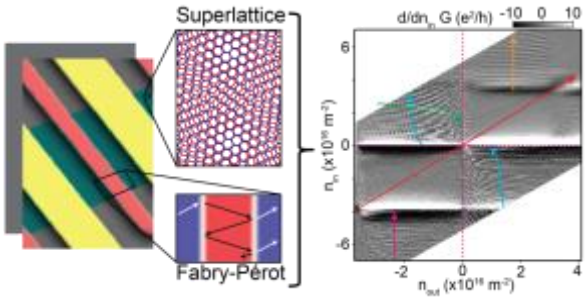
Generation of single photons with highly tunable wave shape: The tunability of the photon duration is an important feature for a single photon source in quantum communications tasks, especially when one has to interface different devices within a quantum network. Together with Prof. H. de Riedmatten from ICFO in Spain, we have demonstrated a tunable source of single photons from a cold atomic ensemble, showing a tunability of the photon duration across more than 3 orders of magnitude up to 10 microseconds. These photons can address many different devices including ions in traps, or optomechanical systems which have a sharp energy structure. This opens up an avenue for the implementation of hybrid quantum networks where one takes the best of various systems for high rate long distance quantum communications. Applications such as quantum networks are the targeted outcome of the EU commission launching a 1 billion Euro flagship initiative for quantum technologies. We look forward to more results from harnessing quantum phenomena, with the ramp-up phase beginning next year.

- Pau Farrera, Georg Heinze, Boris Albrecht, Melvyn Ho, Matías Chávez, Colin Teo, Nicolas Sangouard, Hugues de Riedmatten, arXiv:1601.07142 (*Nature communications*, in press)

Christian Schönenberger's group, Basel

Confining electrons by band structure engineering: Semi-transparent interfaces are essential building blocks of graphene based electronic interferometers, and have been realized using pn junctions so far. Scientists at the University of Basel have shown, that semi-transparent interfaces can also be engineered by locally gated graphene/hBN Moiré superlattices. The superlattices were formed by precisely aligning the graphene and hBN crystal structure.

To confirm the confinement by semi-transparent interfaces electronic cavities were constructed. They observed Fabry-Perot oscillations, which proved both the confinement and the high device quality. Using the Fabry-Pérot oscillations further insight was given into the yet not fully known band-structure of graphene in the presence of a Moiré superlattice.



- C. Handschin, P. Makk, P. Rickhaus, M.H. Liu, K. Watanabe, T. Taniguchi, K. Richter and C. Schönenberger *Nano Lett.,* **17**, 328, (2016), link.

Hugo Zbinden's group, Geneva

24-hour relativistic bit commitment: Bit commitment is a cryptographic scheme which allows one to commit to a bit value while keeping it hidden to others, with the ability to reveal it later, but without changing it. For a long time, it was believed that bit commitment might be possible in a provably secure way using quantum communication. Unfortunately, it turned out that this is not possible, however, security can be achieved using relativistic constraints. Taking advantage of recent theoretical progress, we realized experimental bit commitment over 24 hours, in contrast to a fraction of a second achieved earlier. This work, published in PRL, where it also appeared as a Focus story, has subsequently generated quite a bit of interest in the media for the general public.

- Ephanielle Verbanis, Anthony Martin, Raphaël Houlmann, Gianluca Boso, Félix Bussières, and Hugo Zbinden, *Phys. Rev. Lett.* **117**, 140506 (2016), link
- Focus story: *Physics* **9**, 114, Sept. 2016, link
- Research highlights: *Nature* **538,** Oct. 2016 link
- Physics today: link

2. Technology Transfer

qstarter awards 2016: The fourth qstarter awards took place on January 23, 2017, at the Villa Hatt in Zurich. Following concise pitch talks, the inventors discussed intensely their projects with representatives of QSIT's industry partners during a buffet lunch. The winners were:

- **Michael Steinacher** for Low Noise / Low Drift - Differential Amplifier
- **Vijay Jain and Felix Tebbenjohanns** for High power laser intensity stabilizer
- **James Wootton** for Quantum error correction: Decodoku

This year, we welcomed CEO Dr. Urs Matter and Dr. Nikola Pascher from Nanosurf. We are honored to add Nanosurf to our distinct industry board represented by Sensirion, Zurich Instruments, ABB, Nanonis SPECS and IDQuantique. From the Swiss National Science Foundation, we also welcomed Thomas Griessen as our guest. qstarter

Exhibitions and fairs: IRsweep successfully attended two exhibitions in Spring 2017 with the support of our NCCR and the SNSF.
SPIE Photonics West in San Francisco provided IRsweep the ideal testbed for the launch of their latest product the IRspectrometer. And the Hannover Industry Fair surprised them with the ability to connect to all the customer segments for the IRcell and to further develop the business in the area of spectroscopy. In the meantime, the company was able to win the ESA BIC Switzerland program and is also selected in the top 10 of the W.A. de Vigier price to be awarded in May.

Hannover Messe,
ESA BIC Switzerland,
IRsweep

3. Equal Opportunity

INSPIRE Potentials – QSIT Master Internship Award: A QSIT initiative to enhance the place for women in science. The INSPIRE Potentials Master internship award aims at attracting excellent female students who will conduct their Master thesis in a laboratory belonging to the NCCR QSIT network.
We proud to announce the following awardees:
November 2016:
Do Thi Xuan Hung (MSc thesis in J. Home's group)
Irene Sánchez Arribas (Novotny)
August 2016:
Nadine Leisgang (Warburton)
Lena Barhta (Esslinger)
Giulia Tenasini (Morpurgo)
Giulia Di Iorio (Zardo)
May 2016:
Lea Ghisalberti (Fontcuberta)
Chiara Decaroli (Huber)

The next deadline for applications is July 15, 2017. Please find all details for the application procedure at the QSIT webpage.

Women's lunch meetings: The next lunch meeting will take place on Tuesday, May 30, 12:00, at ETH-Hönggerberg, HPF E 20. **Nikola Pascher**, PhD, will report on her experiences as Senior Research Scientist at Nanosurf.

QSIT Women Networking in Zurich: Generally, a small group of scientists in physics and other related research fields ("the more the merrier") meets over lunch to discuss both academic and non-academic issues in a relaxed setting. The events are organized by Chiara Decaroli (Jonathan Home's group) and Aline Ramires (Junior fellow at the ITS). More information may be found at this link.

4. Promotions and Awards

28.3.2017: Two QSIT PIs receive an ERC Advanced Grant. For both scientists, this is their second such grant. **Tilman Esslinger** for his project entitled: Mass, heat and spin transport in interlinked quantum gases. **Frédéric Merkt** receives the grant for the project: Cold Ion Chemistry: Experiments within a Rydberg Orbit. ERC Press release, ETH News

10.3.2017: **Vadim Geshkenbein** has been promoted to Adjunct Professor at ETH Zurich. His research focuses on statistical physics, superconductors, and quantum systems. ETH News

10.3.2017: **Christian Degen**, has been promoted to Associate Professor of Spin Physics. His research aims at combining magnetic resonance with atomic force microscopy. ETH News

March 2017: **Christophe Galland**, Ambizione fellow in the group of Tobias Kippenberg is now SNSF assistant professor at EPFL, heading the Laboratory of Quantum Nano-optics, link

15.2.2017: **Patrick Maletinsky** holds the Georg-H.-Endress-position as an Assistant Professor at the Department of Physics of the University of Basel since February 2012. He has been promoted by the university council to **associate professor** effective February 1st, 2017. University of Basel

7.2.2017: **Christa Flühmann** (Home group) and A**nton Potocnik** (Wallraff group) won the two poster prizes at the 635th WE-Heraeus Seminar: Scalable Architectures for Quantum Simulation, Jan.29 – Feb.2 2017, Bad Honnef, Germany, link

20.1.2017 **Gustavo Villares** (Faist group) was awarded an ETH medal for outstanding PhD thesis entitled "Quantum cascade frequency combs for spectroscopy".

11.1.2017: **Daniel Loss** wins the King Faisal International Prize for his pioneering work in the theory of spin dynamics and spin coherence in quantum dots showing promise for practical applications in spin quantum computers. Webpage of the KFIP, Uni Basel News

19.12.16: An ERC Consolidator Grant is awarded to **Giacomo Scalari** (Faist group). His research addresses frequency combs, which act as rulers in the frequency domain and can measure the frequency of electromagnetic radiation very precisely. ERC Communication

9.12.2016: The ETH Board appointed **Jonathan Home** as Associate Professor of Experimental Quantum Information, ETH News, netzwoche

30.11.2016: **Hugo Zbinden** is awarded the Greinacher Preis for his groundbreaking work in the field of quantum optics and quantum cryptography, which is used in the context of the company ID Quantique. Greinacher Preis

14.11.2016: The ETH Zurich Latsis Prize 2016 goes to **Jonathan Home** for his studies at the frontier between quantum and classical physics using individual charged atoms that he controls with high precision. ETH News

Fall 2016: **Heidi Potts** presented her work at Stanford University and the MRS Fall meeting in Boston and was nominated for the best poster award.

7.9.2016: **Jean Phillippe Brantut** receives an ERC Starting Grant entitled: Devices, engines and circuits: quantum engineering with cold atoms, EPFL News.

1.9.2016: Start of the "Laboratory for quantum gases" at EPFL led by **Jean Philippe Brantut**. He was appointed Tenure Track Assistant Professor at EPFL by the ETH Board in March 2016, and has started his research group in September 2016. Press release.

5. Recent Events

http://www.nccr-qsit.ethz.ch/news/conferences-events.html

May 4, 2017,
Swiss Quantum Day
Bern
The Swiss Quantum Day aimed at preparing the Swiss stakeholders to the FET Flagship, gathering together near 100 participants from research, companies and government bodies active in the field. The event informed on the Flagship initiative and showed Swiss research and innovation excellence. The interplay of national and European instruments was discussed with contributions from the European Commission, the UK and the Netherlands.

The morning session was dedicated to the presentation of the FET Quantum Flagship and the Swiss excellence in research and innovation in quantum technologies. In the afternoon session, the technology transfer aspects of quantum technologies in the private sector were discussed. link, on Twitter

February 1 – February 3, 2017
QSIT General Meeting
Waldhotel, Arosa
This year more than 200 QSIT enthusiasts attended the 7th NCCR QSIT General Meeting at the Waldhotel National in Arosa.
The program included three invited talks: In our technology transfer session Sadik Hafizovic, CEO Zurich Instruments gave a talk entitled: "Zurich Instruments - Startup in a Saturated Market?" Furthermore, two associate QSIT members introduced their research groups, namely Thierry Giamarchi from the University of Geneva whose presentation had the title "Cold atoms and condensed matter: A love story?" and Oded Zilberberg from ETH Zurich who talked on "Electronic, atomic, and photonic quantum engineered systems".
Furthermore the program of the General Meeting covered 20 talks by young scientist from all across the network. The participants took the chance to discuss with their colleagues during plenty of time in two poster sessions. A new record of 65 posters were presented giving an overview of the research covered in the NCCR QSIT. In addition, there were many opportunities to make new contacts in the evening and during social events. Link.
For the first time since many years (we count 11 years that QSIT researchers meet in Arosa) the ski race had to be canceled because of bad weather conditions. What a pity!

Jan. 30 – Feb.1, 2017
QSIT Winter School
Waldhotel, Arosa
The 6th QSIT Winter School featured as usual six lectures, this year presented by Joe Renes (Quantum information), Christopher Eichler (Superconducting quantum circuits), Mikael Afzelius (Long-distance quantum communication), Tobias Donner (Cold atoms), James Wootton (Topological insulators), and Alberto Morpurgo (Quantum physics with 2D materials). At the poster session on Monday evening 21 posters were presented by the young students. The Winter School was very well attended with 66 participants. Link

Jan. 25 & Feb. 8, 2017
QSIT Career Building Workshop
THERE IS A LIFE AFTER THE PhD
ETHZ & EPFL
In this career-building workshop Anna Fontcuberta i Morral gave a short presentation with some reflections. This was followed by an interactive session with questions and discussions about the PhD itself and what it means a 'good' career.

January 11, 2017
Parametric Phenomena Workshop
ETH Zurich
Organizers: Alexander Eichler and Oded Zilberberg
There are many groups within QSIT who use parametric driving to amplify, cool, squeeze, couple or otherwise manipulate resonating systems. However, despite the ubiquitous nature of parametric phenomena there appears to be no framework to promote exchange of knowledge between different fields.
The idea behind the workshop was to learn new parametric techniques from each other. Researchers from very different backgrounds came together and presented applications of parametric processes in their respective fields, made their specific application understandable to a general physics audience, and each talk was followed by an open discussion. Link

Nov 20-23, 2016
ETHZ visit of HUJI & Weizmann
Jerusalem and Rehovot, Israel
Together with a group of physicists, ETH president Lino Guzzella visited the Quantum Information Science Center of the Hebrew University of Jerusalem and the Weizmann Institute of Science in Rehovot, near Tel Aviv. The visit was a further step towards strengthening international exchange in the field of quantum science. D-PHYS News, program.

6. Outreach

February 2017 - **Switzerland at the quantum crossroads:** A document describing the Swiss quantum activities and perspectives prepared under the leadership Andreas Fuhrer from IBM. The document is meant to inform the public and our politicians about upcoming opportunities as well as public and private investment in this field for Switzerland. The document descries the landscape of quantum science and technology in Switzerland as well as perspectives for future developments especially in view of the upcoming EU flagship on "quantum technologies".

The document was endorsed by more than 150 persons in the field.
Webpage, document, endorsements.

December 2016: In December, the Laboratory of Semiconductor Materials (**Anna Fontcuberta**'s group) was part of the "Journée des gymnasiens" and organized lab visits for 30 high-school students.

On November 30, 2016 one of the largest quantum physics experiments took place. The "BIG Bell Test" is a worldwide "citizen science" project, coordinated by the Institute of Photonic Sciences, which intends to carry out a set of simultaneous quantum physics experiments in eleven different labs around the world, including the Quantum Device Lab, **Andreas Wallraff**'s research group. To be successful at least 30'000 people were supposed to generate random sequences of "zeros" and "ones" by playing a video game.

The video game, More information on the "Big Bell Test", ETH news article, NZZ online, Computerworld.

10.11.2016 - within the framework of the ETH Zukunftstag - a group of 10 children visited **Lukas Novotny**'s group at ETH Zurich. Under the guidance of PhD students and postdocs the children engaged in several experiments related to the topic "photonics".

4.8.2016: In an interview at Radio Télévision Suisse **Nicolas Gisin** discusses the quantum teleportation phenomena and its influence to future quantum technologies. RTS-link at 19:09

1.8.2016: **Nicolas Gisin** was invited by his home village Veyrier to give a talk on quantum teleportation and technology transfer for the Swiss national day on August 1st.

7. Mini-sabbaticals

Each PhD student and post-doc associated with the NCCR QSIT has the opportunity to work one week per year in another NCCR group of his/her choice. This step will promote collaboration and exchange between the younger researchers and will also serve the purpose of general education. These research stages will be centrally financed by the NCCR and are open for all young researchers working on NCCR-related projects in the participating research groups, even if NCCR resources do not directly provide the salary of these researchers.

8. For your agenda

http://www.nccr-qsit.ethz.ch/news/conferences-events.html

June 12 – 14, 2017
QSIT Junior Meeting link
Passugg, GR, Switzerland
Organized by Heidi Potts & Luca Francaviglia, EPFL

June 18 – 21, 2017: Summer school
June 22 – 23, 2017: Workshop
Solstice of Foundations link
ETH Zurich, Switzerland
Organized by Lidia del Rio

August 20 – 25, 2017
Frontiers in Quantum Nanophotonics link
Congressi Stefano Franscini, Monte Verità, Switzerland

September 2 – 8, 2017
Bose-Einstein Condensation Conference link
Sant Feliu de Guixols, Spain

September 4 – 8, 2017
School on recent trends in light-matter interaction LIGHTMATTER 2017 link
EPFL, Lausanne

November 16 – 17, 2017
NCCR QSIT Site Visit
ETH Zurich, Hönggerberg

November 20 –23, 2017
Synthetic dimensions in quantum engineered systems link
Organized by Oded Zilberberg

November 29 – 30, 2017
Careers in Science: academia **and beyond** link
Geneva, Campus Biotech

February 5 – 7, 2018
QSIT Winter School
Waldhotel, Arosa

February 7 – 9, 2018
QSIT General Meeting
Waldhotel, Arosa

May 27 – June 6, 2018
Quantum Systems and Technology
Monte Verità, Ascona

9. New Collaborators

Raphaëlle Delagrange joined Christian Schönenberger's group as a post-doc in November 2016, after defending her PhD at Paris-Sud University about superconducting proximity effect in carbon nanotubes. In Basel, she keeps working on electronic transport in carbon nanotubes as well as in graphene, where she aims at engineering helical states.

Since August 2016 **David Indolese** is a PhD student in the Schönenberger group, in which he wrote his master thesis on dynamical spin injection into graphene. He works on the engineering of topological states in graphene superconducting hybrids devices.

Felice Appugliese is working as a PhD student in J. Faist's group on ultrastrong coupling at THz frequencies and transport in 2D electronics systems

Shima Rajabali is working as a PhD student in J. Faist group on ultrastrong coupling in graphene.

Lea Ghisalberti received the "Inspire Potential" award for her Master thesis in 2016 and is now continuing to do her PhD in Anna Fontcuberta's group.

Aymeric Deltail is working as a post-doc in Ataç Imamoglu's group where he performs experimental research on spin-photon interface and quantum information protocols with self-assembled quantum dots. He previously did his PhD in University Paris 7 where he studied strong light-matter coupling in many-body systems.

Olivier Faist joined the quantum photonics group for his master's thesis which he is now extending as a scientific collaborator. His work focuses on non-classical photon statistics states of exciton polaritons.

Patrick Knüppel started his PhD in the group of Atac Imamoglu in February 2017 after completing his MSc in physics at ETH Zürich. He will work on polaritons in the Quantum Hall regime and investigate optical signatures of integer and fractional states.

Yuta Tsuchimoto joined the quantum photonics group for his doctorate in May 2016 after completing his MSc in Electronic chemistry a t Tokyo Institute of Technology. He is working on a quantum interface between single optical and microwave photons.

Giorgio Nicoli did his master studies at Milano and his master thesis at ETH Zurich and worked on coupled cavity-dot systems. Since May 2017 he is a PhD student in the Ensslin/Ihn group and will work on quantum structures in the fractional quantum Hall regime.