



National Science Foundation - University of Padova

Workshop on **Quantum Information on a Chip**

Padua, 12-14 October 2015

Mario Dagenais (U Maryland), **Shaya Fainman** (UCSD), **Paolo Villoresi** (U Padova) **Co-Chairs**

Monday Oct. 12, 2015

University of Padua, Palazzo del Bò - Archivio Antico

Via 8 Febbraio 1848, 2, 35122 Padova PD

8:30am-10:30am

Opening session, (40 min)

Alessandro Paccagnella, *Pro-Rector University of Padova*, "Opening welcome address"

Dominique Dagenais, *National Science Foundation, USA*, "NSF welcome address"

Stefano Lami *Italian Embassy in US, I*, "Italian Embassy in US in the Quantum Information Cooperation"

Tommaso Calarco, *U Ulm, D - in teleconf*, "Fostering EC and USA cooperation on Quantum Information on a Chip"

Organizers introduction: "*Orientation for the attendees on workshop program*"

Viewpoint: Ian Walmsley, *U Oxford, UK*, "UK Quantum Initiative" (40 min)

Antonio Badolato, *U Rochester, USA*, "Chip-integrated nanophotonic structures for quantum devices" (20 min)

Paul S. Davids, *Sandia Labs, USA*, "Sandia's quantum chip-scale program" (20 min)

10:30am-10:50am

Coffee or Tea break

10:50am -12:30am

Viewpoint: Fabio Sciarrino, *Sapienza U Rome, I*, "Photonics Quantum Information on a chip" (40 min)

Dirk Englund, *MIT, USA*, "Quantum information processing with photons and spins on photonics integrated circuits" (20 min)

Tim Bartley, *U Paderborn, D*, "Integrated non-linear quantum optics " (20 min)

Jungsang Kim, *Duke U, USA*, "Ion trap quantum computers" (20 min)

12:30 - 2:00 pm

Lunch Break

2:00 - 4:00 pm

Eleni Diamanti, *Telecom Paris Tech, F*, "Continuous-variable quantum cryptography on silicon" (20 min)

Alexander V. Sergienko, *Boston U, USA*, "Second Order Nonlinear Processes and Linear Optics Circuits for Quantum Information Processing on a Chip" (20 min)

Alan Migdall, *NIST, USA*, "Number resolved detectors" (20 min)

Francesco S. Cataliotti, *U Firenze, I*, "Atom-chip for quantum information and simulation" (20 min)

Qingyuan Zhao, *MIT, USA*, "Superconducting nanowire single photon detectors" (20 min)

Kartik Srinivasan, *NIST, USA*, "Chip-scale frequency conversion interfaces for quantum emitters" (20 min)

4:00pm – 4:30 pm
Coffee or Tea break

4:30pm – 7:30pm

Viewpoint: Eli Yablonovitch, *UC Berkeley, USA*, “Control of light emission” (40 min)

Félix Bussi eres, *U Geneve, CH*, “Long-distance quantum communication with solid-state devices” (20 min)

Steven Rolston, *U Maryland, USA*, “Trapping atoms near nanofibers and waveguides” (20 min)

Zhiliang Yuan, *Toshiba Cambridge, UK*, - “Toshiba QKD system” (20 min)

Abijith Kowligy, *Northwestern U, USA*, “Quantum frequency conversion in nonlinear microcavities” (20 min)

Tommaso Lunghi, *U Nice, F*, “Hybrid integrated photonics platform for the generation of tunable heralded two-photon states” (20 min)

Davide Calonico, *INRIM Turin, I*, “Quantum Metrology and Sensing” (20 min)

Jorge Barreto, *U Bristol, UK*, “Fabrication technologies for quantum photonic devices” (20 min)

8:00 pm

Workshop dinner-buffet, Caff  Pedrocchi

Piano Concert by Dr. Luca Poletto: Piano Mirabilis - Homage to Franz Liszt

Tuesday Oct. 13, 2015

**University of Padua - Department of Information Engineering - Aula Magna
Building DEI/D - Via Gradenigo 6, 35131 Padova**

8:30am-10:50am

Viewpoint: Steve Beaumont, *U Glasgow, UK*, “Quantum Imaging” (40 min)

Roberto Osellame, *Photonics and Nanotechnologies Institute - CNR, Milan, I*, “Photonic circuits for quantum computing” (20 min)

Edo Waks, *U Maryland, I*, “Spin-photon interactions on a semiconductor chip for quantum photonics” (20 min)

Andreas Wallraff, *ETH Zurich, CH*, “Digital simulations of spin models with circuit QED” (20 min)

Ania Bleszynski-Jayich, *UC Santa Barbara, USA*, “Nitrogen vacancy centers in diamonds” (20 min)

Pablo A. Postigo, *Instituto de Microelectr nica de Madrid, ES*, “Playing with single photons on the micron scale using photonic crystals and quantum dots” (20 min)

10:50am-11:10am

Coffee or Tea break

11:10am -1:10pm

Viewpoint: Marko Loncar, *Harvard U, USA*, “Diamonds: Quantum Engineers Best Friend” (40 min)

Margherita Mazzera, *ICFO, ES* - Integrated quantum memories (20 min)

Maiken Mikkelsen, *Duke U, USA*, “Ultrafast single photon emission from quantum dots coupled to plasmonic nanocavities” (20 min)

Peter Lodahl, *U Copenhagen, DK*, “Photonic quantum-information processing with quantum dots” (20 min)

Daniele Bajoni, *U Pavia, I*, “Generation of entangled photons in silicon chips” (20 min)

1:10 – 2:15 pm

Lunch Break

Discussion sessions – Point of view of Scientific Topics

Including: Quantum Computation, Communication, Metrology, Sensing and Imaging on a Chip

Objectives: gather the actual topics promising and worthy for funding that shall be included in the 10 years roadmap on the Quantum Information of a Chip

PRODUCE e-WRITTEN SYNTHESIS to be included in the final document

2:15 – 3:45 pm	Computation on a Chip Moderator: Sciarrino	
Participants	All	
3:45pm - 4:15pm	Coffee or Tea break	
4:15pm - 6:15 pm	Communication and QKD on a Chip Moderator: Diamanti Aula Magna	Quantum Metrology and Sensing on a Chip Moderator: Migdall Room 201
Participants	Loncar Bartley Badolato Bajoni Sciarrino Yuan Bussières Srinivasan Yablonovich Bleszynski-Jayich Englund Waks Kumar	Beaumont Sergienko Osellame Postigo Calonico Rolston Kowligy Lunghi Cataliotti Wallraff Kim Davis Zhao

Wednesday Oct. 14, 2015

**University of Padua - Department of Information Engineering - Aula Magna
Building DEI/D - Via Gradenigo 6, 35131 Padova**

Discussion sessions – Point of view of Technologies and Applications

**Including: generation and detection of single photons, integration technologies, error correction,
Secure Communications, Computation and Imaging on a Chip**

8:30 – 10:30 am	Generation and detection of single photons Moderator: Bajoni Felix Bussières : <i>The Nanoscale Quantum Optics EU COST Action</i>	
Participants	All	
10:30pm - 11:00pm	Coffee or Tea break	
11:00am - 1:00 pm	Integration technologies, Nonlinear effects Moderator: Badolato Aula Magna	Applications Avenues, Imaging Moderator: Calonico Room 201
Participants	Loncar Bartley Bajoni Sciarrino Yuan Diamanti Bussières Srinivasan Yablonoich Bleszynski-Jayich Englund Waks Kumar	Migdall Beaumont Sergienko Osellame Postigo Rolston Kowligy Lunghi Cataliotti Wallraff Kim Davis Zhao

1:00 – 2:00 pm

Lunch Break

2:00 – 3:30 pm

Joint session: Report by the Moderators of the Discussion Tables

3:30 - 4:00 pm

Coffee or Tea break

4:00 – 5:30 pm

Joint session: Roadmapping of Quantum Information on a Chip

Tommaso Calarco, *U Ulm - in telecon from Brussels*, “On the way ahead on Quantum Information in Europe”

Conclusions

End of the workshop

The financial support from AFOSC to EC participants is kindly acknowledged

Local Organization: QuantumFuture Research Group, U Padova

quantumfuture.dei.unipd.it - paolo.villoresi@dei.unipd.it

Participants List

EU Participants

1. Ian Walmsley, U Oxford, - Overview of Research on Quantum Information in the UK
2. Steve Beaumont, U Glasgow, - Overview of Research in Quantum Imaging in the UK
3. Tim Bartley, U Paderborn, D
4. Zhiliang Yuan - Toshiba QKD system
5. Fabio Sciarrino, U Sapienza, Rome I - Quantum Information with integrated photonics
6. Tommaso Lunghi, U Nice, F - Hybrid integrated photonics platform for the generation of tunable heralded two-photon states
7. Davide Calonico, INRIM - I, Quantum Metrology and Sensing
8. Francesco S. Cataliotti, LENS, Florence, I - Quantum Simulation and Control with Degenerate Atoms
9. Eleni Diamanti, ParisTech, F - Continuous-variable quantum cryptography on silicon
10. Roberto Osellame, INO-CNR Milan, I - Femtosecond laser direct writing of photonic circuits: a new way to integrated quantum devices
11. Peter Lodahl, U Copenhagen, DK - *Photonic quantum-information processing with quantum dots*
12. Pablo A. Postigo, IMM Madrid, ES, Playing with single photons on the micron scale using photonic crystals and quantum dots
13. Daniele Bajoni, U Pavia, I - Generation of entangled photons in silicon chips
14. Félix Bussi eres, U Geneve, CH - *Long-distance quantum communication with solid-state devices*
15. Andreas Wallraff ETH, CH *Photons, Qubits and Computers - A Quantum Mechanics Lab on a Chip*
16. Margherita Mazzera, ICFO, ES *Integrated quantum memories*
17. Jorge Barreto, U Bristol, UK, *Fabrication technologies for quantum photonic devices*

US participants

1. Marko Loncar, Harvard U, "Quantum Photonic Networks in Diamond".
2. Antonio Badolato, U of Rochester, "On-chip non-classical light sources".
3. Kartik Srinivasan, NIST Gaithersburg, "Chip-Scale Frequency Conversion Interfaces for Quantum Emitters".
4. Alan Migdall, NIST Gaithersburg, "Number Resolved Detectors".
5. Dirk Englund, MIT, "Quantum Information Processing Using Active Silicon Photonics Integrated Circuits".
6. Jungsang Kim, Duke University, "Ion trap Quantum Computers".
7. Steven Rolston, U of Maryland, "Trapping Atoms near Nanofibers and Waveguides",
8. Paul S. Davids, Sandia Lab, "Sandia's quantum chip-scale program".
9. Eli Yablonovitch, UC Berkeley, "Control of light emission".
10. Alexander Sergienko, Boston U, "Second Order Nonlinear Processes and Linear Optics Circuits for Quantum Information Processing on a Chip".
11. Abijith Kowligy, Northwestern U, "Quantum Frequency Conversion in Nonlinear Microcavities".
12. Ania Bleszynski-Jayich, UC Santa Barbara, "Nitrogen Vacancy Centers in Diamonds".
13. Maiken Mikkelsen, Duke University, "Control of Spin for light-matter interactions in nanoscale photonic structures".
14. Qingyuan Zhao, MIT, "Superconducting nanowire single photon detectors"
15. Edo Waks, U of Maryland, "Spin-photon interactions on a semiconductor chip for quantum photonics"
16. Prem Kumar, DARPA, observer