Giorgio Tortarolo

Doctor of Philosophy

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Education

Ph.D Degree
Genoa, Italy

Istituto Italiano di Tecnologia, University of Genoa
March 2020

- **Thesis @ IIT**: Laser Scanning Microscopy with SPAD Array Detector: Towards a New Class of Fluorescence Microscopy Techniques
- **Advisor**: Dr. Giuseppe Vicidomini
- **Final Grade**: Excellent

M.Sc. in Bioengineering
Genoa, Italy

University of Genoa
November 2015

- **Thesis @ IIT**: Modular Integration of a STED Imaging System into a Custom Confocal Microscope
- **Advisors**: Prof. Marco Fato, Dr. Giuseppe Vicidomini, Prof. Alberto Diaspro
- **Final Grade**: 110 / 110 cum laude, right of publication

B.Sc. in Biomedical Engineering
Genoa, Italy

University of Genoa
December 2009

- **Thesis @ IIT**: Development and Validation of Microcontact Printing Techniques to Pattern Neuronal Cell Cultures on Microelectrode Arrays
- **Advisors**: Prof. Sergio Martinoia, Dr. Luca Berdondini
- **Final Grade**: 110 / 110 cum laude

Experience

Post Doctoral Fellowship
Genoa, Italy

Istituto Italiano di Tecnologia
April 2020 to date

- **Project**: Implementation of an Adaptive Single Molecule Tracking system

Fellowship
Genoa, Italy

Istituto Italiano di Tecnologia
November 2019 - March 2020

- **Project**: Design and development of real-time, feedback based control systems

Ph.D Program in Bioengineering and Robotics
Genoa, Italy

Istituto Italiano di Tecnologia, University of Genoa
November 2016 - November 2019

- **Research Activity**: Development of Super-Resolution Microscopy Techniques
- **Department**: Dipartimento di Informatica, Bioingegneria, Robotica e Ingegneria dei Sistemi (DIBRIS)
- **Research Group**: Molecular Microscopy and Spectroscopy

Company Internship
Champaign, Illinois, USA

ISS Inc.
September 2016

- **Project**: Design and development of a novel commercial STED microscope

Internship
Genoa, Italy

Istituto Italiano di Tecnologia
February 2016 - August 2016

- **Project**: Fourier Ring Correlation Analysis

M.Sc. Program in Bioengineering
Genoa, Italy

University of Genoa
September 2013 - November 2015

- **Major**: Neuroengineering and Neurotechnologies

Full-Time Employment
Genoa, Italy

Blutec Chemicals
January 2010 - October 2015

- Workflow design and management

Publications

- C. J. R. Sheppard, M. Castello, G. Tortarolo, T. Deguchi, S. V. Koho, G. Vicidomini, and A. Diaspro (2020). Pixel reassignment in image scanning microscopy: a re-evaluation, *Journal of the Optical Society of America A*, 37(1):154-162.

- M. Castello†, G. Tortarolo†, M. Buttafava, T. Deguchi, F. Villa, S. Koho, M. Oneto, S. Pelicci, L. Lanzanò, P. Bianchini, C. J. R. Sheppard, A. Diaspro, A. Tosi, and G. Vicidomini (2019). A robust and versatile platform for image scanning microscopy enabling super-resolution FLIM, *Nature Methods*, 16(2):175–178.

- G. Tortarolo, Y. Sun, K. Teng, Y. Ishitsuka, L. Lanzanò, P. R. Selvin, B. Barbieri, A. Diaspro and G. Vicidomini (2019). Photon-separation to enhance the spatial resolution in pulsed STED microscopy, *Nanoscale*, 11:1754-1761.

- S. Koho, G. Tortarolo, M. Castello, T. Deguchi, A. Diaspro, G. Vicidomini (2019). Fourier Ring/Shell Correlation measures dramatically simplify complex image restoration methods in fluorescence microscopy, *Nature Communications*, 10:3103.

- I. Coto, M. Castello, G. Tortarolo, N. Jowett, A. Diaspro, L. Lanzanò, G. Vicidomini (2019) Efficient two-photon excitation stimulated emission depletion nanoscope exploiting spatiotemporal information, *Neurophotonics*, 6(4):045004.

- G. Tortarolo†, M. Castello†, A. Diaspro, S. Koho and G. Vicidomini (2018). Evaluating image resolution in stimulated emission depletion microscopy, *Optica*, 5(1):32-35.

- C.J.R. Sheppard, M. Castello, G. Tortarolo, G. Vicidomini, A. Diaspro (2017). Image formation in image scanning microscopy, including the case of two-photon excitation, *Journal of the Optical Society of America A*, 34(8):1339-1350.

- M. Castello†, G. Tortarolo†, I. Coto Hernandez, T. Deguchi, A. Diaspro, and G. Vicidomini (2017). Removal of anti-Stokes emission background in STED microscopy by FPGA-based synchronous detection, *Review of Scientific Instruments*, 88:053701.

- S. Pelicci, G. Tortarolo, G. Vicidomini, A. Diaspro, L. Lanzanò (2020). Improving SPLIT-STED super-resolution imaging with tunable depletion and excitation power, *Journal of Physics D: Applied Physics*, accepted.

- I. Coto, L. Lanzanò, M. Castello, N. Jowett, G. Tortarolo, A. Diaspro, G. Vicidomini (2018). Improving multiphoton STED nanoscopy with separation of photons by LIfetime Tuning (SPLIT), *Multiphoton Microscopy in the Biomedical Sciences XVIII, SPIE BIOS, vol. 10498, conference proceeding.*

- Y. Sun†, G. Tortarolo†, K. W. Teng, Y. Ishitsuka, U. C. Coskun, S. J. Liao, A. Diaspro, G. Vicidomini, P. R. Selvin, B. Barbieri (2017). A novel pulsed STED microscopy method using FastFLIM and the phasor plots, *Multiphoton Microscopy in the Biomedical Sciences XVII, SPIE BIOS, vol. 10069, conference proceeding.*

Preprints

- M. Buttafava, F. Villa, M. Castello, G. Tortarolo, E. Conca, M. Sanzaro, S. Piazza, P. Bianchini, A. Diaspro, F. Zappa, G. Vicidomini, A. Tosi (2020). SPAD-based asynchronous-readout array detectors for image-scanning microscopy, *arXiv*, 2002.11443.

- S.V. Koho†, E. Slenders†, G. Tortarolo, M. Castello, M. Buttafava, F. Villa, E. Tcarenkova, M. Ameloot, P. Bianchini, C.J.R. Sheppard, A. Diaspro, A. Tosi, G. Vicidomini (2019). Easy two-photon image-scanning microscopy with SPAD array and blind image reconstruction, *Biomedical Optics Express*, under revision.

- G. Tortarolo, M. Castello, S. Koho, G. Vicidomini (2019). Synergic Combination of Stimulated Emission Depletion Microscopy with Image Scanning Microscopy to Reduce Light Dosage, *BioRxiv*, https://doi.org/10.1101/741389.

Oral Contributions and Posters

- G. Tortarolo, M. Castello, S. Koho, E. Slenders, A. Rossetta, M. Oneto, S. Pelicci, L. Lanzanò, A. Diaspro, and G. Vicidomini (2020). Time-resolved (STED) image scanning microscopy with a SPAD array, *talk, Focus on Microscopy 2020, Osaka (cancelled).*

- G. Tortarolo, M. Castello, S. Koho, E. Slenders, A. Rossetta, A. Diaspro, and G. Vicidomini (2019). Fluorescence Laser Scanning Microscopy with SPAD Array: Exploiting the Extra Spatial And Temporal Information, *poster, Seeing is Believing 2019, EMBL Heidelberg.*

- G. Tortarolo, M. Castello, S. Koho, L. Pesce, M. Oneto, S. Pelicci, L. Lanzanò, A. Diaspro, and G. Vicidomini (2019). Stimulated Emission Depletion Image Scanning Microscopy with a SPAD Array, *talk, Focus on Microscopy 2019, London.*

- G. Tortarolo, M. Castello, M. Buttafava, T. Deguchi, F. Villa, S. Koho, P. Bianchini, C. J. R. Sheppard, A. Diaspro, A. Tosi, and G. Vicidomini (2018). Point-Scanning Microscopy with single-photon Detector Array, *talk, Workshop on Single Molecule Spectroscopy, Berlin.*

- G. Tortarolo, M. Castello, C. J. R. Sheppard, S. Koho, A. Diaspro, G. Vicidomini (2017). Fourier Ring Correlation as a tool to assess effective resolution in point scanning microscopy, *talk, Focus on Microscopy 2017, Bordeaux, France.*

Editorial Activities

- Referee for Optics Letters and PLOS ONE journals.

Awards

• Travel Award, *EMBL Workshop on Single Molecule Spectroscopy, Heidelberg, Germany, 2019.*

• Master Degree Award for the thesis "Modular Integration of a STED Imaging System into a Custom Confocal Microscopy", *Società Italiana di Ottica e Fotonica, Italian Branch of the European Optical Society, 2016.*

Teaching and Supervision Activities

• Lecturer and teacher for the course "STED microscopy: from imaging to fluorescence correlation spectroscopy", *5th NIC@IIT advanced practical workshop/school, Genoa, December 2018.*

• Teacher for the course "Confocal, ISM and STED": theoretical and practical aspects of optical super-resolution microscopy techniques, *4th NIC@IIT advanced practical workshop/school, Genoa, November 2017.*

• Teacher for the course "Image Scannning Microscopy": detailed insight about the ISM framework, *3rd NIC@IIT advanced practical workshop/school, Genoa, December 2016.*

• Supervision of one Ph.D. student in Single Molecule Tracking (Andrea Bucci, 1st year) and real-time control systems.

Patent and Know-How License

• G. Vicidomini, M. Castello, G. Tortarolo, A. Tosi, M. Buttafava, F. Villa, P. Bianchini, A. Diaspro, C. J. R. Sheppard (2019). Time-resolved imaging method with high spatial resolution, *Patent pending, international publication number WO2019/145889 A1.*

• G. Vicidomini, G. Tortarolo, M. Castello, L. Lanzanò, P. Bianchini, A. Diaspro(2019). Stimulated Emission Depletion (STED) super resolution fluorescence microscopes, *Know-how licensed to ISS.*

Main Projects

• Design and Implementation of an optical, real-time, feedback based Single Molecule Tracking (SMT) system based on the Single Photon Avalanche Diode (SPAD) array detector - *with Andrea Bucci*. Within the context of a confocal laser scanning microscopy architecture, the SMT platform allows to extensively track a fast target molecule in 3D, exploiting the Field Programmable Gate Array (FPGA) technology.

• Implementation of the robust and versatile Image Scanning Microscopy (ISM) platform based on the SPAD array detector - *with Dr. Marco Castello*. The platform leverages the spatial and temporal distributions of the fluorescence emission light, opportunely sampled by the SPAD array detector and by the custom-made acquisition architecture, to improve traditional confocal and fluorescence lifetime imaging.

• Combination of the ISM platform with Stimulated Emission Depletion (STED) and two-photon (2P) microscopy - *with Dr. Marco Castello and Dr. Sami Koho*. The Adaptive Pixel Reassignment (APR) algorithm allows to reduce the light dosage necessary to achieve a target resolution, thus lowering the risk of photo-damaging the observed sample.

• Enhancement of the spatial resolution of a pulsed STED microscope by the temporal analysis of the perturbed fluorescence decay. The additional STED laser beam induces a spatio-dependent variation of the natural fluorescence decay of the observed molecules: it is thus possible to distinguish the fluorescence photons likely to be originated at the center and at the periphery of the observation volume.

• Development of the Fourier Ring Correlation (FRC) analysis, to quantitatively evaluate the spatial resolution of point-scanning microscopy images - *with Dr. Marco Castello*. The independent noise realisations of two measurements of the same object are exploited by a correlation algorithm in the Fourier space, to access the effective cut-off frequency, i.e., the minimum frequency at which the images are dominated by noise.

Skills

• **Computer skills**. Good programming experience in Labview FPGA, Labview, Matlab and C#.

• **Data analysis**. Data representation and analysis packages (Origin, ImageJ), image deconvolution, image denoising and fluorescence lifetime analysis.

• **Laboratory skills**. Experience with optics and electronics lab tools; good expertise and knowledge of classical fluorescence microscopy techniques (wide-field, confocal and two-photon excitation) and modern super-resolution microscopy techniques (stimulated emission depletion, image scanning microscopy); familiarity with stochastic switching techniques.

• **Detection systems**. Avalanche photodiodes, photomultipliers (analog and single-photon counting), CCD cameras, time correlated single photon counting cards, single photon avalanche diode arrays.

• **Languages**. Italian (mother tongue) and English.