

## CURRICULUM VITAE

Francesco Saverio Pavone

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- Biosketch

Francesco Saverio Pavone is directing a research group working in the field of biophotonics on single molecule biophysics, microscopy imaging-spectroscopy techniques, biomedical imaging, laser manipulation of bio-samples.

In particular, he is developing new microscopy techniques for high resolution and high sensitivity imaging, and for laser manipulation purposes. These techniques have been applied both for single molecule biophysics, single cell imaging and optical manipulation. Tissue imaging is another research area developed, where non-linear optical techniques have been applied for skin and neural tissue imaging also in-vivo.

Pavone is authors of many international papers and editor of international books. He has more than 100 invited talk and he is editors of international journals. He coordinates several European projects and he has organized several international congresses; he is also director of the European Laboratory for Non Linear Spectroscopy in Florence, winner of a European Research Council Advanced Grant and has an *h-index* equal to 37.

- Current Positions

2000- Head of Biophysics Area, European Laboratory for Non-Linear Spectroscopy (LENS), University of Florence, Italy  
2006- Full Professor of Physics of the Matter, Department of Physics and Astronomy, University of Florence, Italy  
2014- Director of the European Laboratory for Non-Linear Spectroscopy (LENS), University of Florence, Italy  
2015 Coordinator of the joint research activity LENS-IBM “ClicOnLab”  
2016- President of HBP Italy (*Human Brain Project* European Flagship)  
2017- Member of the National Commission for the evaluation of the “abilitazione nazionale” in experimental physics of Matter

- Previous Positions

1991-1997 Researcher officer, University of Florence  
1997-1998 Maitre de Conférences Associé au Collège de France (within the Scholarship College de France assigned to Claude Cohen Tannoudji, Nobel prize 1997), experimental work at the Ecole Normale Supérieure (ENS), Paris, France  
1998-2001 Associate Professor in Physics of the Matter, Department of Physics and Astronomy, University of Perugia, Italy

2001-2006 Associate Professor in Physics of the Matter, Department of Physics and Astronomy, University of Florence, Italy

- Education

1989 Master Degree in Physics, University of Florence, Italy

1990-1993 Post graduate specialisation in Optics, National Institute of Optics, Florence, Italy

2016 Certificate for animal experimentation (Felasa B equivalent), UNIL D'Origny, Geneva, Switzerland

- Fellowships and Awards

2012 First prize, "Best Innovation by a Multilateral project, organisation or Company", European Photonics Innovation, Innovation village at Photonics Europe, Brussels.

2016 European Research Council Advanced Grant winner ("Brainbit")

2016 Fellow member of SPIE (International Society for Optics and Photonics)

2016 Elected for the Class of the College of Fellows of the American Institute for Medical and Biological Engineering (AIMBE)

2017 Elected for the Florence Academic Leader Programme 2017 "Florence Ambassador".

- Evolution of the Scientific Research

I started my scientific career in 1990 in the field of precision spectroscopy and atomic physics for testing QED in atomic systems and measuring physical constants (PRL 73, 42, 1994; PRL 82, 1112, 1999). I moved to Paris in 1997 to work at the Ecole Normale Supérieure in Paris on laser cooling of Helium in the group of Prof. Claude Cohen Tannoudji, Nobel Prize 1997 (EPJ D Vol.7, 311, 1999; EPJ. AP, 69, 2001). In November 1998 I became associate professor in Perugia and I started to set-up new experiments in the field of Biophysics with my own group. Since then, I have been working in the field of single molecule imaging and manipulation, advanced microscopy techniques.

- Teaching Activities

1998–2001 Basic Physics, Biotechnology Classes– University of Perugia, Italy

2001- Basic Physics, Biotechnology Classes– University of Florence, Italy.

2001- Laser and Applications, Physics Master Course – University of Florence, Italy.

2001- Biomedical Optics, Physics Master Course – University of Florence, Italy.

- Professional Societies Affiliations

Optical Society of America (OSA), The International Society for Optical Engineering (SPIE), Society for Neuroscience (SfN).

- Organisation of international workshops

2000 Hydrogen Atom II: precise physics of simple atomic systems, 1-3 June Castiglione della Pescaia, Italy

2008 New Frontiers in Micro and Nano photonics, 23-26 April, Florence

2013 European Congress on Biomedical Optics, 12-16 May, Munich

2013 EuroBioImaging Stakeholder meeting, 25-26 November, Heidelberg

2014 Laserlab JRA (EU Infrastructure Network Meeting), 13 May, Munich, Germany

- 2014 Photonics West, 1-6 February, San Francisco, USA
- 2014 Photonics Europe, 14-17 April, Bruxelles, Belgium.
- 2015 Board of Directors meeting Human Brain Project, 3-4 June, Florence
- 2015 Laserlab JRA (EU Infrastructure Network Meeting), 19 May, Florence, Italy
- 2015 Optics and the Brain, OSA, 12-15 April, Vancouver, Canada
- 2015 Photonics West, 7-12 February, San Francisco, USA
- 2016 Photonics Europe, 4 -7 April, Bruxelles, Belgium
- 2016 Optics and the Brain, OSA, 25-28 April, Fort Lauderdale, Florida, USA
- 2016 Photonics West, 1-6 February, San Francisco, USA
- 2016 First Open Day of the H2020 Flagship Human Brain Project (HBP), 12 October 2016  
Florence, Italy
- 2016 H2020 Flagship HBP Summit 2016, 13-15 October 2016, Florence, Italy
- 2017 Photonics West, 28 January - 2 February, San Francisco, USA
- 2017 Optics and the Brain, OSA, 2-5 April, San Diego, USA.
- 2017 European Congress on Biomedical Optics, ECBO, 25-29 June, Munich, Germany.

- Institutional Responsibilities

- 1999 - 2000 Scientific Director, Atomic and Molecular Physics section, LENS, University of Florence, Italy.
- 2007-2012 Director of International PhD, LENS, University of Florence, Italy
- 2009- Southern Europe node leader of worldwide network “Biophotonics4Life”.
- 2011- Director of the Italian National Flagship “Nanomax”.
- 2011-2016 President of the non-profit foundation “ICON foundation – International Center of Computational Neurophotonics”, participated by LENS, University of Florence and IBM.
- 2013- Member of the European Commission panel of experts on behalf of the Italian Ministry of Education and Research for the ERC-MSCA-FET projects.
- 2014- Director of the European Laboratory for Non Linear Spectroscopy
- 2016- Member of the National Committee for the “abilitazione scientifica nazionale” of the physics of matter

- Service Activities

- 2006- Member of Editorial Board of “Wiley – Journal of Biophotonics”, U.S.A.
- 2008- Member of Editorial Board of “EPFL – Frontiers in Neuroengineering”, Switzerland.
- 2008- Member of Scientific Board of SICI, fondo “Toscana Innovazione”, Italy.
- 2008- Member of Editorial Board of the journal “Hi Tech Dermo”, Italy.
- 2011- Referee panel member for the National Sciences and Engineering Research Council of Canada, Canada.
- 2011- Referee panel member for the Agence Nationale de la Recherche, France.
- 2012 Referee panel member for the Deutsche Forschungsgemeinschaft (DFG), Germany
- 2012- Member of the Scientific Advisory Board of the “France-BioImaging infrastructure, France.
- 2012- Member of the Scientific Board of Cineca, HPC Center, Italy.
- 2013- Member of Editorial Board of “Journal of Innovative Optical Health Sciences”, China.
- 2013- Member of Editorial Board of “Neurophotonics” journal, SPIE, U.S.A.
- 2014- Vice Chair of European COST Action BM1401 Raman4Clinics, Bruxelles.
- 2014- Member of Editorial Board of “Journal of Biomedical Photonics and Engineering”, Russia.
- 2014- Member of Advisory Board Business of “Brain Challenge”, White House Initiative, U.S.A.
- 2014- Member of the International Science Committee (ISC) of Australian Research Council of Excellence for Nanoscale BioPhotonics (CNBP), Australia.
- 2017 Referee panel member for the Deutsche Forschungsgemeinschaft (DFG), Germany.
- 2017 Expert review committee for Canada Foundation for Innovation (CFI), Toronto.

2017 Member of board “Struttura di progetto scientifica” of the Italian Human Technopole.

- Major Collaborations

Graham Knott, EM correlation imaging, EPFL, Lausanne, Switzerland

Vincenzo de Paola, in vivo two photon imaging, Imperial College, London, UK

Leslie Loew, Voltage Sensitive Dye detection, Univ. Connecticut, Philadelphia, USA

Katsu Sato, spinal cord development, University of Tokyo, Japan

Henry Markram, simulation of the brain, EPFL, Lausanne, Switzerland

Renzo Guerrini, epileptic disease of human brain, Meyer Hospital, Florence, Italy

Thomas Knopfel, electrical activity detection in Brain, Imperial College, London, UK

Karl Zilles and Katrin Amunts, fiber connections in whole brain, Jülich Center, Germany

Bradley Hyman, single cell activity in whole mouse brain, Massachusetts General Hospital, Harvard, USA

Bruno Weber, vasculature mapping in whole brain, ETH, Zurich, Switzerland

- Research Team

Pavone is the leading scientist of the LENS’ Biophysics Area, characterized by a strong multidisciplinary: physicists, biologists, engineers, biotechnologists, and chemists work under Pavone’s supervision, in close cooperation with medical doctors.

The research activities are distributed over 9 labs (see below, ‘Research labs’); Pavone’s overall coordination and supervision is based on his abilities to evenly distribute duties and devolve responsibilities to all members of staff, in order to contribute to their professional training and their career improvement.

The scientific staff are more than 30 people in total, in constant growth, ranging from undergraduate students to researchers coming from the National Council of Research, other University Departments, and research institutions from different parts the world.

- Research activity

The research activity focuses mainly on six topics:

- neurophotonics
- single molecule biophysics
- single cell manipulation and imaging
- biomedical imaging
- tissue imaging
- biosensing

High sensitivity and high co-localization experiments are performed to track single molecules with nanometer accuracy by mean of high sensitivity fluorescence detection and active trapping stabilization methods.

In order to shed light onto some fundamental aspects of biological processes (transcription, protein synthesis, DNA replication, virus infections, cells interaction, exocytosis, muscle contractions, etc.), manipulation tools such as optical and magnetic tweezers are used.

Optical manipulation methods like laser nanosurgery and micro trapping are employed to investigate particular features in cells and tissues.

Nonlinear microscopy techniques including two-photon fluorescence microscopy and second-harmonic generation microscopy are developed and used in *ex vivo* and *in vivo* clinics measurements ranging from neuroscience to dermatology. Also, light-sheet based microscopy techniques are used to study whole brain micron-scale neuroanatomy.

- Research labs

In the space of 14 years' time Pavone has set up from scratch 3 labs at LENS, 4 labs at the University of Florence, 2 in University Hospital in Florence, 1 at the National Institute of Optics (INO) and 1 lab at Light4Tech srl (L4T, [www.light4tech.com](http://www.light4tech.com)), a small hi-tech company developing optical high tech solutions. He is also currently coordinating the activity of the ClicOnLab, a joint Laboratory between LENS and IBM Italy working on Cognitive Computing tool development.

The institutional distribution of these facilities clearly shows Pavone's pivotal role amidst academy, research bodies of various kind, industrial partners, and hospitals, not to mention his managerial and scientific drive in the ICON Foundation.

The LENS labs are equipped with multiple optical tweezers apparatuses, single-molecule 3D tracking systems, a STED/Resolft system, a multicolor light-sheet microscope, a custom-made total internal reflection microscope for bio sensing applications and a multicolor confocal microscope.

The UNIFI labs feature a light-sheet confocal microscope, random-access multi-photon systems, and nano surgery multi-photon systems.

Both clinical labs make use of a multidimensional multi-photon mobile custom-made microscope, a multi-dimensional spectroscopic endoscope and L4T-developed prototype of a polarization-sensitive dermoscope.

The lab at L4T uses and refines its own prototypes, such as supercontinuum generation apparatuses, optical coherent tomography apparatuses, compact random-access solutions, a multi-photon-multi-spot system and a LED device for optical haemostasis.

The INO lab is equipped with an infrared spectrometer for tissues, and the 2 ICON labs which will soon be started will work on technological solutions for industrial biomedical.

Last but not least, Recently Pavone has realized a joint lab with IBM at LENS working on cognitive computing solution to manage big data.

- Grants

Active

FIRB/Ministry of Education, University and Research: *from single molecules to whole animal model: an integrated approach to the study of intra and inter cellular signalling*, 2012-2016, EUR 310.994.

Human Brain Project H2020 Flagship of European Commission RUP, 2013-2016, EUR 187.500.

NanoMAX, Italian Flagship, *Live imaging*, 2011-2018, EUR 766.000.

LightPatch, Eranet-project European Commission, 2014-2016, EUR 120.000.

EuroBioImaging, Ministry of Education, University and Research: *advanced microscopy*, 2015-2016, EUR 210.000.

Human Brain Project H2020 Flagship of European Commission SGA1, 2016-2018, EUR 1.668.100,00.

ERC Advanced, European Research Council Grant: 2016-2021, EUR 2.500.000.

### Past

EuTrigTreat/European Commission Grant: *Research on cardiac dynamics and arrhythmias*, 2009-2015, EUR 189.000.

Bioptical/Joint Research Activity: *Integrated Infrastructure Initiative European Commission*, 2012-2015, EUR 92.554.

SMAG/Tuscany Region Grant: *Sviluppo e realizzazione di sistemi di Imaging multimodale*, 2013-2015, EUR 106.000.

### • Patents

- Bibliographic data: WO2008006405 – Application Number: WO2006EP64224 20060713 – Priority Number: WO2006EP64224 20060713 – Inventors: M. Galimberti, F.S. Pavone – Applicants: Light4Tech Firenze Srl, M. Galimberti, F.S. Pavone - *Apparatus for real-time three-dimensional laser scanning microscopy, with detection of single- and multi-photon fluorescence and of higher order harmonics*.
- Bibliographic data: WO2009066264 – Application Number: WO2008IB54895 20081121 – Priority Number: IT2007FI00260 20071121 – Inventors: M. Galimberti, F.S. Pavone – Applicants: Light4Tech Firenze Srl, M. Galimberti, F.S. Pavone - *Device to illuminate an object with a multispectral light source and detect the spectrum of the emitted light*.
- Italian Patent pending n. 102016000132604 - "Sistema e metodo di misura della focalizzazione di uno strumento ottico") - 30/12/2016. Applicants: LENS (40%), UNIFI (30%) e CNR (30%). Inventors: L. Silvestri, M.C. Muellenbroich, L. Sacconi e F.S. Pavone.

### • Publications

Most relevant publications Peer - Reviewed Journal.

1. R. Cicchi, F. Rossi, D. Alfieri, S. Bacci, F. Tatini, G. De Siena, G. Paroli, R. Pini, F. S. Pavone, *Observation of an improved healing process in superficial skin wounds after irradiation with a blue-LED haemostatic device*, Journal of Biophotonics, Vol. 9 Issue: 6 Pages: 645-655, DOI: 10.1002/jbio.201500191, 2016, JUN ([full text](#))
2. C. Crocini, C. Ferrantini, M. Scardigli, R. Coppini, L. Mazzoni, E. Lazzeri, J. M. Pioner, B. Scellini, A. Guo, L. S. Song, P. Yan, L. M. Loew, J. Tardiff, C. Tesi, F. Vanzi, E. Cerbai, F. S. Pavone, L. Sacconi, C. Poggesi, *Novel insights on the relationship between T-tubular defects and contractile dysfunction in a mouse model of hypertrophic cardiomyopathy*, Journal of molecular and cellular cardiology, Vol. 91, pages: 42-51, DOI: 10.1016/j.yjmcc.2015.12.013, 2016, February ([full text](#))
3. L. Gardini, M. Capitanio, F. S. Pavone, *3D tracking of single nanoparticles and quantum dots in living cells by out-of-focus imaging with diffraction pattern recognition*, Scientific Reports - Nature, Vol. 5, article number: 16088, doi: 10.1038/srep16088, 2015, 3 November.
4. A. L. Allegra Mascaro, L. Sacconi, L. Silvestri, G. Knott, F. S. Pavone, *Multi-modal optical imaging of cerebellum in animals*, Cerebellum, Vol. 15, Issue 1, Pages: 18-20 Special Issue: SI, DOI: 10.1007/s12311-015-0730-4, 2016, February.

5. M. Locatelli, M. Ravaro, S. Bartalini, S. Consolino, M. S. Vitiello, R. Cicchi, F. S. Pavone, P. De Natale, *Real-time terahertz digital holography with a quantum cascade laser*, Scientific Reports - Nature, Impact Factor: 5.57, Vol. 5, Art. n. 13566, doi: 10.1038/srep13566, 2015, August 28.
6. I. Costantini, J. P. Ghobril, A. P. Di Giovanna, A. L. Allegra Mascaro, L. Silvestri, M. C. Mullenbroich, L. Onofri, V. Conti, F. Vanzi, L. Sacconi, R. Guerrini, H. Markram, G. Iannello, F. S. Pavone, *A versatile clearing agent for multi-modal brain imaging*, Scientific Reports – Nature, Vol. 5, Art. N. 9808, DOI: 10.1038/srep09808, 2015, May.
7. M. Asllani, J. D. Challenger, F. S. Pavone, L. Sacconi, D. Fanelli, *The theory of pattern formation on directed networks*, Nature Communications, Vol. 5, p. 4517, DOI: 10.1038/ncomms5517, 2014, July 31.
8. C. Ferrantini, R. Coppini, L. Sacconi, B. Tosi, M. L. Zhang, G. L. Wang, E. de Vries, E. Hoppenbrouwers, F. S. Pavone, E. Cerbai, C. Tesi, C. Poggesi, H. E. D. J. Ter Keurs, *Impact of detubulation on force and kinetics of cardiac muscle contraction*, The Journal of general Physiology, Vol. 143, Issue 6, pp. 783- 797, DOI: 10.1085/jgp.201311125, 2014, May 26.
9. L. Silvestri, L. Sacconi, F. S. Pavone, *Correcting spherical aberrations in confocal light sheet microscopy: A theoretical study*, Microscopy Research and Technique, Vol. 77, Issue 7, pp. 483- 491, DOI: 10.1002/jemt.22330, 2014, January 3.
10. A. L. Allegra Mascaro, P. Cesare, L. Sacconi, G. Grasselli, G. Mandolesi, B. Macof, G. W. Knottf, L. Huangg, V. De Paolag, P. Stratab, F. S. Pavone, *In vivo single branch axotomy induces GAP-43-dependent sprouting and synaptic remodeling in cerebellar*, Proc. Nat. Acc. Sci. U.S.A., Vol. 110, Issue 26, pp. 10824- 10829, DOI: 10.1073/pnas.1219256110, 2013, June 25.
11. M. Calamai, F. S. Pavone, *Partitioning and confinement of GM1 ganglioside induced by amyloid aggregates*, FEBS Letters, Vol. 587, n. 9, pp. 1385- 1391 DOI: 10.1016/j.febslet.2013.03.014, 2013, May 2.
12. C. Laperchia, A. L. Allegra Mascaro, L. Sacconi, A. Andrioli, A. Mattè, L. De Franceschi, G. Grassi Zucconi, M. Bentivoglio, M. Buffelli, F. S. Pavone, *Two-photon microscopy imaging of thy1GFP-M transgenic mice: a novel animal model to investigate brain dendritic cell subsets in vivo*, Plos one, Vol. 8, n. 2, art. N. 56144, DOI: 10.1371/journal.pone.0056144, 2013, February 7.
13. L. Silvestri, A. L. Allegra Mascaro, L. Sacconi, F. S. Pavone, *Advanced optical techniques to explore brain structure and function*, Journal of Innovative Optical Health Sciences, Vol. 6, n. 1, pp. 1230002- 1230017, DOI: 10.1142/S1793545812300029, 2013, January 31.
14. P. Yan, C. D. Acker, W. Zhou, P. Lee, C. Bollensdorff, A. Negrean, J. Lotti, L. Sacconi, S. D. Antic, P. Kohl, H. D. Mansvelder, F. S. Pavone, L. Loew, *Palette of fluorinated voltage-sensitive hemicyanine dyes*, Proc. Nat. Acc. Sci. U.S.A., Vol. 109, n. 50, pp. 20443- 48, DOI: 10.1073/pnas.1214850109, 2012, December 11.
15. M. Capitano, M. Canepari, M. Maffei, D. Beneventi, C. Monico, F. Vanzi, R. Bottinelli, F. S. Pavone, *Ultrafast force-clamp spectroscopy of single molecules reveals load dependence of myosin working stroke*, Nature Methods 9, Vol. 9, n. 10, pp. 1013–1019, DOI: 10.1038/nmeth.2152, 2012, October.
16. L. Sacconi, C. Ferrantini, J. Lotti, R. Coppini, P. Yan, L. M. Loew, C. Tesi, E. Cerbai, C. Poggesi, F. S. Pavone, *Action potential propagation in transverse-axial tubular system is impaired in heart failure*, Proc. Nat. Acc. Sci. U.S.A., pp. 5815- 5819, DOI: 10.1073/pnas.1120188109, 2012, March 26.
17. L. Silvestri, A. Bria, L. Sacconi, G. Iannello, F.S. Pavone, *Confocal light sheet microscopy: micron-scale neuroanatomy of the entire mouse brain*, Optic Express, Vol. 20, pp. 20582- 98, DOI: 10.1364/OE.20.020582, 2012, August 27.
18. M. Calamai, F. S. Pavone, *Single molecule tracking analysis reveals that the surface mobility of amyloid oligomers is driven by their conformational structure*, J. Am. Chem. Soc., Vol. 133, Issue 31, pp. 12001- 12008, DOI: 10.1021/ja200951f, 2011, August 10.
19. A. L. Allegra Mascaro, L. Sacconi, F. S. Pavone, *Multi-photon nanosurgery in live brain*, Front. Neuroenerg., vol. 2, p. 21, DOI: 10.3389/fnene.2010.00021, 2010, July 30.
20. V. Nucciotti, C. Stringari, L. Sacconi, F. Vanzi, L. Fusi, M. Linari, G. Piazzesi, V. Lombardi, F. S. Pavone, *Probing myosin structural conformation in vivo by second-harmonic generation microscopy*, Proc. Natl. Acad. Sci. U. S. A., Vol. 107, Issue 17, pp. 7763- 68, DOI: 10.1073/pnas.0914782107, Epub, 2010, April 12.
21. D. Rutkauskas, H. Zhan, K. S. Matthews, F. S. Pavone, F. Vanzi, *Tetramer opening in LacI-mediated DNA looping*, Proc. Natl. Acad. Sci. U S A., Vol. 106, Issue 39, pp. 16627- 32, DOI: 10.1073/pnas.0904617106, 2009, September 29.

22. L. Sacconi, J. Mapelli, D. Gandolfi, J. Lotti, R. P. O'Connor, E. D'Angelo, F. S. Pavone, *Optical recording of electrical activity in intact neuronal networks with random access second-harmonic generation microscopy*, *Optic Express*, Vol. 16, Issue 19, pp. 14910- 21, DOI:10.1364/OE.16.014910, 2008, September 15.
23. L. Sacconi, R. P. O'Connor, A. Jasaitis, A. Masi, M. Buffelli, F. S. Pavone, *In vivo multi- photon nanosurgery on cortical neurons*, *J. Biomed. Opt.*, Vol. 12, pp. 50502, DOI: 10.1117/12.761588, 2007, January 20.
24. M. Capitanio, M. Canepari, P. Cacciafesta, V. Lombardi, R. Cicchi, M. Maffei, F. S. Pavone, R. Bottinelli, *Two independent mechanical events in the interaction cycle of skeletal muscle myosin with actin*, *Proc. Natl. Acad. Sci. U.S.A.*, Vol. 103, Issue 1, pp. 87- 93, DOI: 10.1073/pnas.0506830102, 2006, January 3.
25. L. Sacconi, M. D'Amico, F. Vanzi, T. Biagiotti, R. Antolini, M. Olivotto, F. S. Pavone, *Second harmonic generation sensitivity to transmembrane potential in normal and tumor cells*, *J. Biomed. Opt.*, Vol. 10, Issue 2, DOI: 10.1117/1.1895205, 2005, March.