Valeria Cimini

Curriculum Vitae

Expertise in quantum optics and quantum information. My research projects are focused on quantum metrology and on the employment of machine learning techniques for quantum state characterization. I have had experience in various research groups in Europe developing a strong attitude to team work.

Research activity

Feb 2021–Present **Postdoctoral researcher - ARC Fellow**, *Amaldi Research Center*, University of Rome *La Sapienza*.
Topics: Quantum metrology in the continuous variable regime. My research focuses on the study of Quantum Metrology protocols mainly in the context of optical phase estimation. I exploit both single-photon states and squeezed light to overcome the classical precision limit. With the aim to achieve the ultimate bound of precision, I developed adaptive protocols both in a single parameter and multi-parameter regime to mitigate the effects of experimental noise in the measurement.

2017–2021 **PhD in Material Science, Nanotecnologies and Complex Systems**, *Roma Tre* University.
I received my PhD degree in the new quantum optics group of Rome, supervised by Prof. Marco Barbieri. My thesis title is: *"New Methods of Data Analysis for Quantum Metrology"*. The aim of my research is to demonstrate the enhancement obtained using quantum resources in the measurement process. On one hand I studied it on an applicative point of view, developing a prototype of an optical quantum sensor, calibrated via an artificial neural network algorithm. On the other hand, I pursued also a more fundamental study concerning the wave function collapse of a coherent state during the measurement process. During my PhD I have carried out different experiments on these topics.

Sep – Dec 2019 **PhD visiting period**, *Laboratorie Kastler Brossell*, University of Paris *La Sorbonne*.
During my visiting period at LKB I worked with the group of Prof. Valentina Parigi and Prof. Nicolas Treps. Here, I focused my studies on continuous variable states. In particular I have developed a machine learning based algorithm for the detection of quantum features in multi-mode optical squeezed states generated in their laboratories.

2016–2017 **Research activity**, *Ronald Hanson group in QuTech*, University of Delft.
My research was focused on the development of a multi-node quantum network using nitrogen-vacancy (NV) defect centres in diamond as its fundamental units.

Education

2014–2016 **Master of Physics**, *University of Rome*, *La Sapienza*, final grade 110/110 cum laude.
Specialization in Physics of Matter. For my Master thesis I studied and experimentally implemented, under the supervision of Prof. Paolo Mataloni, the violation of a multipartite Bell's inequality using hyperentangled and cluster photons states manipulated in an integrated photonics circuits.

2011–2014 **Bachelor of Physics**, *University of Rome*, *La Sapienza*, final grade 110/110 cum laude.
For my bachelor's thesis I studied the theory of quantum teleportation analyzing three different experimental realizations of it.

2006–2011 **High School**, *Liceo* Aristotele, Rome, High school leaving qualification in scientific studies (PNI), final grade 100/100.

Experience

Teaching activity

Mar - Jul 2019 **Teaching Assistant of Prof. F. Bruni of Physics course for Architecture**.
Roma Tre University

Oct 2018 - Jan 2019 **Teaching Assistant of Prof. C. Meneghini of Physics course for Biology**.
Roma Tre University

Jan - Jun 2017 **Teaching Assistant of Prof. R. Hanson of Quantum Mechanics course for Physics**. TU Delft University

Invited talks

10 Dec 2021 **SPIE event**, *Young researcher in photonics*, University of Trento, Italy.
Talk title: "Introduction to quantum optical metrology and multiparameter estimation"

Conferences: contributed talks, posters, and attendance

1-5 Nov 2021 **QIM VI**, *Quantum Information and Measurement*, Online Conference.
Talk title: "Single-photon calibration of an integrated multiarm interferometer via neural networks"

1-5 Mar 2021 **MLQ2021**, *Machine Learning for Quantum 2021*, Online Conference.
Talk title: "Classification of multimode states through artificial neural networks"

3-6 Feb 2020 **FQST2020**, *National Institute of Informatics*, Tokyo, Japan.
Talk title: "Characterization of Quantum States by Neural Networks"

13-15 Nov 2019 **GDR IQFA-X**, *CNRS Headquarters*, Paris, France.
Talk title: "Tracking enzymatic activity with quantum light"

29 Nov 2019 **PQC 2019**, *University of Paris La Sorbonne*, Paris, France.

9-12 Sep 2019 **IQIS2019**, *University of Milan Statale*, Milan, Italy.
Talk title: "Tracking enzymatic activity with quantum light"

23-27 Jun 2019 **CLEO EU**, *ICM Centre of the Munich Trade Fair Centre*, Munich, Germany.
Talk title: Use of optical quantum sensors to study chemical processes

4-6 Apr 2019 **QIM V**, *University of Rome La Sapienza*, Rome, Italy.
Poster

10-13 Jul 2018 **QCUMbER**, *University of Oxford*, Oxford, United Kingdom.

19-20 Jun 2017 **SpinNano Project meeting with industry**, *Technical University of Delft*, Delft, Netherlands.
Talk title: Quantum networks with NV centers

27-31 Mar 2017 **NanoFront Winter Retreat**, Courchevel, France.

17-18 Jan 2017 **Physics@Veldhoven**, Veldhoven, Netherlands.

6-10 Jul 2015 **PIQUE**, *University of Rome La Sapienza*, Rome, Italy.

List of Publications

Peer Reviewed Publications

[22] A. Chiuri, I. Gianani, **V. Cimini**, L. De Dominicis, M. G. Genoni and M. Barbieri, *Ghost imaging as loss estimation: Quantum versus classical schemes.* Phys. Rev. A 105, 013506 (2022).

[21] I. Gianani, F. Albarelli, A. Verna, **V. Cimini**, R. Demkowicz-Dobrzanski, and M. Barbieri, *Kramers–Kronig relations and precision limits in quantum phase estimation.* Optica 8, 1642-1645 (2021).

[20] **V. Cimini**, F. Albarelli, I. Gianani, and M. Barbieri. *Semiparametric estimation of the Hong-Ou-Mandel profile.* Phys. Rev. A 104, L061701, (2021).

[19] I. Gianani, F. Albarelli, **V. Cimini**, and M. Barbieri. *Experimental function estimation from quantum phase measurements.* Phys. Rev. A 103, 042602, (2021).

[18] **V. Cimini**, E. Polino, M. Valeri, I. Gianani N. Spagnolo, G. Corrielli, A. Crespi, R. Osellame, M. Barbieri, and F. Sciarrino. *Calibration of Multiparameter Sensors via Machine Learning at the Single-Photon Level.* Phys. Rev. Applied 15, 044003, (2021).

[17] **V. Cimini**, M. Barbieri, N. Treps, M. Walshaers, and V. Parigi. *Neural networks for detecting multimode Wigner-negativity.* Phys. Rev. Letters, 125, 160504, (2020).

[16] I. Gianani, Y.S. Teo, **V. Cimini**, H. Jeong, G. Leuchs, M. Barbieri, and L.L. Sanchez-Soto. *Compressively certifying quantum measurements.* PRX Quantum, 1, 020307 (2020).

[15] **V. Cimini**, I. Gianani, M.F. Sacchi, C. Macchiavello, and M. Barbieri. *Experimental witnessing of the quantum channel capacity in the presence of correlated noise.* Phys. Rev. A, 102, 052404 (2020).

[14] I. Gianani, D. Farina, M. Barbieri, **V. Cimini**, V. Cavina, and V. Giovannetti. *Discrimination of thermal baths by single qubit probes.* Phys. Rev. Research, 2, 033497 (2020).

[13] **V. Cimini**, S. Gherardini, M. Barbieri, I. Gianani, M. Sbroscia, L. Buffoni, M. Paternostro, and F. Caruso. *Experimental characterization of the energetics of quantum logic gates.* npj Quantum Information, *in press* (2020).

[12] F. Saltarelli, **V. Cimini**, A. Tacchella, A. Zaccaria, and M. Cristelli. *Is Export a Probe for Domestic Production?* Frontiers in Physics 8,180 (2020).

[11] **V. Cimini**, M. G. Genoni, I. Gianani, N. Spagnolo, F. Sciarrino, and M. Barbieri. *Diagnosing imperfections in quantum sensors via generalized Cramér-Rao Bounds.* Phys. Rev. Applied, 13 (2), 024048, (2020).

[10] **V. Cimini**, I. Gianani, F. Piacentini, I. Degiovanni, and M. Barbieri. *Anomalous values, Fisher information, and contextuality, in generalized quantum measurements.* Quantum Science and Technology, 5, 2, 025007, (2020).

[9] **V. Cimini**, I. Gianani, N. Spagnolo, F. Leccese, F. Sciarrino, and M. Barbieri. *Calibration of quantum sensors by neural networks.* Phys. Rev. Letters, 123, 230502, (2019).

[8] **V. Cimini**, M. Mellini, G. Ramponi, M. Sbroscia, L. Leoni, M. Barbieri, and I. Gianani. *Adaptive Tracking of Enzymatic Reactions with Quantum Light.* Optics Express, 27, 35245, (2019) - Selected as Editor's Pick - Press release OSA and ANSA.

[7] **V. Cimini**, I. Gianani, M. Sbroscia, J. Sperling, and M. Barbieri. *Measuring Coherence of Quantum Measurements.* Phys. Rev. Research 1, 033020 (2019).

[6] **V. Cimini**, I. Gianani, L. Ruggiero, T. Gasperi, M. Sbroscia, E. Roccia, D. Tofani, F. Bruni, M. A. Ricci, and M. Barbieri. *Quantum sensors for dynamical tracking of chemical processes.* Phys.Rev. A 99, 053817 (2019).

[5] M. A. Ciampini, A. Geraldi, **V. Cimini**, C. Macchiavello, J. E. Sipe, Ma. Liscidini, and P. Mataloni. *Stimulated emission tomography: beyond polarization.* Opt. Lett. 44, 41-44 (2019).

[4] E. Roccia, **V. Cimini**, M. Sbroscia, I. Gianani, L. Ruggiero, L. Mancino, M. G. Genoni, M. A. Ricci, and M. Barbieri. *Multiparameter approach to quantum phase estimation with limited visibility.* Optica 5, 1171-1176 (2018).

[3] M. Sbroscia, I. Gianani, E. Roccia, **V. Cimini**, L. Mancino, P. Aloe, and M. Barbieri. *Assessing frequency correlation through a distinguishability measurement.* Opt. Lett. 43, 4045-4048 (2018).

[2] L. Mancino, M. Sbroscia, E. Roccia, I. Gianani, **V. Cimini**, M. Paternostro and M. Barbieri. *Information-reality complementarity in photonic weak measurements.* Phys. Rev. A 97, 062108 (2018).

[1] M. A. Ciampini, C. Vigliar, **V. Cimini**, S. Paesani, F. Sciarrino, A. Crespi, G. Corrielli, R. Osellame, P. Mataloni, M. Paternostro and M. Barbieri. *Experimental nonlocality-based network diagnostics of multipartite entangled states.* Scientific Reports, 7, 17122 (2017).

Preprints

[2] **V. Cimini**, E. Polino, F. Belliardo, F. Hoch, B. Piccirillo, N. Spagnolo, V. Giovannetti, and F. Sciarrino. *Non-asymptotic Heisenberg scaling: experimental metrology for a wide resources range.* arXiv: 2110.02908 (2021).

[1] I. Gianani, I. Mastroserio, L. Buffoni, N. Bruno, L. Donati, **V. Cimini**, M. Barbieri, F. S. Cataliotti, F. Caruso *Experimental quantum embedding for machine learning* arXiv: 2106.13835 (2021).

Awards

2011–2014 Tuition fees exemption as an excellent student.

2012–2014 Percorso d'eccellenza – The University Excellence Group. I was selected, among the best 30 students in the bachelor's degree program, for the high grade average of exams, to a program for excellent students.

Technical skills

Strong expertise in design and realization of optical apparata (interferometers, single-photon sources, metrology devices). Strong expertise in theoretical and experimental quantum optics, both in discete and continuous variable regime ($N00N$ and squeezed states of light), and quantum information. Specialization in quantum metrology: during my PhD I have carried out multiple experiments on optimal interferometric phase estimation using quantum states of light, developing also adaptive and multiparameter estimation techniques.
Simulations; Data analysis; Machine learning algorithms.

03/09/2020 **Machine learning course certification** – Stanford University via *Coursera*
Machine learning algorithms, Linear and Logistic regression, Artificial Neural Networks

28/02/2020 **OSA reviewer certification**

Programs Mathematica, Matlab, Microsoft Office, Labview. Graphic design (Blender).

Languages C-language, Python, LaTeX

Systems Linux, Macintosh, Windows

Community Service

Referee for peer-reviewed journals:
– New Journal of Physics (IOPScience)
– npj Quantum Information (Nature)
– Science Bullettin (Elsevier)
– IEEE Transactions on Quantum Engineering

Guest editor for peer-reviewed journals:
– Special Issue: The Interplay between Photonics and Machine Learning (Photonics MDPI)

Languages

Italian **Mother Tongue**

English **Upper Intermediate**

French **Basic**