

Luca Leggio

PhD in Optoelectronics

Born in Rome on July 15th, 1986
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Education

University Carlos III of Madrid (Madrid, Spain)

- 2017 PhD Marie Skłodowska-Curie in Electrical, Electronic and Automatic Engineering (Cum laude) – OILTEBIA Project

Thesis: *Design and development of a multi-wavelength optoacoustic system based on high-power diode laser sources. Optoacoustic signal generation with nanoparticles for biomedical applications.*

University of Roma Tre (Rome, Italy)

- 2012 Master's Degree in Telecommunications Engineering (110/110 cum laude)
- 2009 Bachelor's Degree in Electronic Engineering



Masters, Courses and Seminars

Polytechnic University of Madrid (Madrid, Spain)

- 2018 Master in development of Applications for Mobile Devices

Asociación Española de Programadores Informáticos (Madrid, Spain)

- 2017 Intensive Course of Java and SQLite
- 2017 Course of C/C++

ProCareLight (Castelldefels, Spain)

- 2023 Course of Laser Security (Standards EN60825 and EN207)



Prizes

- 2018 *Winner of Extraordinary Prize for the year 2017*: Doctoral Program in Electric, Electronics and Automatic Engineering (University Carlos III of Madrid, Madrid, Spain). This award is based on merits in scientific publications during the doctoral studies.



Employment history – Main experiences

10/2024-To Date: Centro de Láseres Pulsados (CLPU, Salamanca, Spain)

- *Scientist*

Design and build laboratory laser systems. My work bridges the gap between theory and reality, I use Python and Zemax to calculate and model laser parameters, then physically set up, align, and test those systems in the lab to deliver verified, data-backed results.

06/2023-05/2024: Basque Center for Applied Mathematics and University of the Basque Country (Bilbao, Spain)

- ***Post-doc fellowship in Industrial Laser Processing***

Design and implementation of novel control and manipulation techniques of guided quantum light fields in anti-resonant fibers. My experimental work essentially relied on the quantum light manipulation and confinement into exotic hollow-core anti-resonant optical fibers filled with gasses. I mainly performed the optical assembly and alignment, the control of devices by using Python code, the laser testing and, in general, the assembly of the whole setup.

01/2022-03/2023 : Laboratoire Hubert Curien (Saint-Etienne, France)

- ***Post-doc fellowship in Industrial Laser Processing***

From 01/2022 to 12/2022: Post-doc in the IMOTEP project which concerned the laser processing of different types of material surfaces using fast laser scanning devices, such as the galvo and the polygonal scanners. My work was to create micro- and nanostructures that confer specific characteristics the material (i.e., wettability, hydrophilicity, and hydrophobia). I used a femtosecond laser (from Amplitude Laser Group) and a galvo scanner for controlling the roughness on the surfaces of stainless-steel, titanium, brass and silver. In some occasions I also used a spatial light modulator for performing a beam shaping and optimizing the shape of the beam (i.e., top-hat and Bessel beams).

From 01/2023 to 03/2023: Post-doc in the VisioFem project which consists in the texturing of 3D metal surfaces by means of a femtosecond laser and in the reconstruction of the images of the created structures by means of a camera and algorithms based on the LIDAR technique, to recover information on the shape of the created structures according to the curvature and distance of the object.

2021: Institute of Astrophysics of Andalusia (Granada, Spain)

- ***Support engineer***

Support engineer in the Cosmic Dust Laboratory (CODULAB). The main research topic of this group was the examination of the scattering properties of several Mars-analog dust particles or porous aggregates using an aerosol generator that uses a continuous flow of samples. However, there is a need to suspend the sample in the air without the need for any support so as not to interfere with the measurements and avoid the loss of samples. In this way, the calculation of the scattering matrix would be more accurate. In this regard, my task was to build and test an acoustic levitator to allow 360° examination of the particles. Part of the work involved the design, mounting and testing of the acoustic levitator.

2020: University of La Sapienza (Rome, Italy)

- ***Post-doc in Laser Technology (research grant)***

Post-doc in the European Project WAVESCOPE: built-up of a wavefront shaping system based on a femtosecond laser and a spatial light modulator for fiber optic 3-photon microscopy and endoscopy. This project was oriented to investigate the self-control of the spatial quality of optical beams in multimode nonlinear optical fibers. The approach used was to exploit the intensity-dependent refractive index of optical fibers to recover the spatial beam quality of a multimode wave.

The objective of the project was to develop a new multimode fiber-based device for scanning 3D samples with micrometer resolution by using ultrashort high peak power optical pulses between visible and near-infrared range, whereby fiber nonlinearity provides a robust compensation of temporal and spatial dispersion, thus preventing information spreading in time domain, and beam quality loss in the spatial domain. My task in this project was to provide technical and scientific support to the assembly of the system, such as purchase and mounting of lenses and of a phase modulator, alignment of optical fibers, and maintenance of femtosecond laser source.

05/2019-01/2020: University of Minho (Braga, Portugal)

- **Optical Engineer**

Technical support for the Portuguese project “*In vivo biometric and optical changes of the crystalline lens with accommodation and its impact in subjective retina image quality-LensUM*”. The aim of this project was to investigate the effects of eye accommodation, consisting in the focusing of objects at different distances, in the retina image quality. The responsible of eye accommodation is the crystalline lens that changes its curvatures depending on the object distance. In the long run, eye accommodation leads to deterioration of sight, resulting in myopia, astigmatism, or presbyopia. In order to investigate the effect of the accommodation, an aberrometer was used. The aberrometer is composed of different optical elements, among which a light source, several lenses, a deformable mirror, and a Hartmann-Shack sensor that measures the eye aberrations comparing the light wavefront reflected from the eye with a reference ideal wavefront. In this project, my task was to optimize the aberrometer that is used to measure the eye aberrations of different human subjects, chosen as a reference for scientific divulgation purposes. My work consisted in the following tasks: optical alignment, purchase of optical elements, optimization of the optical system and of the software used for image detection, and image processing.

01/2014–09/2017: University Carlos III of Madrid (Madrid, Spain)

- **PhD Student (Marie Skłodowska-Curie fellowship)**

Participation in European project OILTEBIA (Optical Imaging Laser Techniques for Biomedical Applications).

I developed a diode laser-based system coupled to optical fibers for optoacoustic endoscopy. I analyzed the optoacoustic response of different kinds of nanoparticles by using high-power diode lasers (wavelengths: 870 nm, 905 nm, and 980 nm) and 532 nm/1064 nm Nd:YAG laser coupled to optical fibers with 200/400- μ m core diameter. I achieved the optical coupling of a multi-wavelength system (808 nm, 880 nm, 910 nm, 940 nm, and 980 nm) based on high-power diode laser bars in a 400- μ m optical fiber by using the software Zemax, fulfilling the requirements of size and coupling efficiency for optoacoustic endoscopy. The use of realistic optical elements such as fast-axis collimation lenses, beam twisters and dichroic mirrors has been determinant to the achievement of efficient fiber coupling.

I improved professional skills to present in public in several conferences (Rio de Janeiro and Munich (SPIE, 2015), San Francisco (SPIE, 2016 and 2017) and Bruxelles (SPIE, 2016), Warsaw (CPPTA, 2016), and workshops in several institutions participating to OILTEBIA project. After getting PhD in September 2017, I remained until April 2018 to finish some works that were later published.

11/2012-12/2013: Telecom ParisTech (Paris, France)

Participation in European project LEXNET (Low electromagnetic fields EXposure NETworks)



Language skills

Italian (Mother tongue)
Spanish (Advanced)
English (Upper-intermediate)
French (Lower-intermediate)
Portuguese (Elementary)



Software and programming skills

Expert: ZEMAX, MATLAB
Fairly competent: CST Microwave Studio
Competent: Mathematica, Java, Android Studio, XCode/Swift
Advanced beginner: LT Spice, CAD, Python
Novice: C/C ++



References

- Dr. Stefan Wabnitz / stefan.wabnitz@uniroma1.it
Professor at University La Sapienza of Rome
- Prof. Cyril Mauchlaire / cyril.mauchlaire@univ-st-etienne.fr
Researcher at Laboratoire Hubert Curien
- Dr. Horacio Lamela Rivera / horacio@ing.uc3m.es
Professor at University Carlos III of Madrid



Research achievements

Articles in international peer-reviewed journals

L. Leggio, O. de Varona, and E. Dadrasnia, “A Comparison between different schemes of microwave cancer hyperthermia treatment by means of left-handed metamaterial lenses,” *Progress in Electromagnetics Research*, Vol. 150, 73-87, 2015.

L. Leggio, E. Dadrasnia, and O. de Varona, “Microwave focusing within arbitrary refractive index media using left-handed metamaterial lenses,” *Progress in Electromagnetics Research M*, Vol. 45, 51-58, 2016.

M. Sánchez, S. Rodríguez, L. Leggio, S. Gawali, D. Gallego, and H. Lamela “Beam profile improvement of a high-power diode laser stack for optoacoustic applications,” *International Journal of Thermophysics*, 38 (48), 2017.

L. Leggio, S. Gawali, D. Gallego, S. Rodríguez, M. Sánchez, G. Carpintero, and H. Lamela, “Optoacoustic response of gold nanorods in soft phantoms using high-power diode laser assemblies at 870 and 905 nm,” *Biomedical Optics Express* 8(3), 1430-1440, 2017. Erratum published on November 1st, 2017.

L. Leggio, D. Gallego, R. Arroyo, S.B. Gawali, S. Rodriguez, M. Sánchez, G. Carpintero, and H. Lamela, “Accurate determination of gold nanorods concentrations from optoacoustic signals detected at 870 nm and 905 nm by using high-power diode lasers with fast switching electronics,” *Progress in Electromagnetic Research B*, Vol. 78, 143–154, 2017.

J. Hu, D. Romero, D. Tsoutsis, L. Leggio, F. Rivero, E. Martín, R. Aguilar, J. A. Sánchez-Gil, H.L. Ramírez, D. Gallego, H. Lamela, P. Rivera, F. Alfonso, J. García, and D. Jaque, “Invited Article: Experimental evaluation of gold nanoparticles as infrared scatterers for advanced cardiovascular optical imaging,” *APL Photonics*, Volume 3, Issue 8, 080803, 2018.

N.O. Moussa, T. Mansuryan, C. Hage, M. Fabert, K. Krupa, A. Tonello, M. Ferraro, L. Leggio, M. Zitelli, F. Mangini, A. Niang, G. Millot, M. Papi, S. Wabnitz, and V. Couderc “Spatiotemporal beam self-cleaning for high-resolution nonlinear fluorescence imaging with multimode fibres,” *Scientific Reports*, Volume 11,18240, 2021.

L. Leggio, S.B. Gawali, D. Gallego, B. Wiśniowski, and O. de Varona “Fiber-coupling optical system for high-power and multi-wavelength diode laser bars oriented to integrated biomedical imaging systems,” *Results in Optics*, Volume 4, 100100, August 2021.

L. Leggio, D. Gallego, S.B. Gawali, B. Wiśniowski, and O. de Varona “Beam-shaping design for multi-wavelength diode laser stack system coupled into optical fiber for biomedical applications,” *Results in Optics*, Volume 5, 100150, December 2021.

L. Leggio, Y. Di Maio, A. Pascale-Hamri, G. Egaud, S. Reynaud, X. Sedao, and C. Mauchlairst “Ultrafast laser patterning of metals commonly used in medical industry: surface roughness control with energy gradient pulse sequences,” *Micromachines*, Volume 14, No. 2, 251, January 2023.

T. Gonzalez-Raya, A. Mena, M. Lazo, L. Leggio, D. Novoa, M. Sanz, “Entanglement transfer during quantum frequency conversion in gas-filled hollow-core fibers,” *APL Photonics*, Volume 10, Issue 4, 041302, 2025.

Conference proceedings

L. Leggio, O. de Varona, P. Escudero, G. Carpintero, M. Osiński, and H. Lamela, “A compact multi-wavelength optoacoustic system based on high-power diode lasers for characterization of double-walled carbon nanotubes (DWCNTs) for biomedical applications,” *SPIE Proceedings, Biophotonics South America, Rio de Janeiro, Brazil*, Volume 9531, 05/2015.

L. Leggio, O. de Varona, P. Escudero, G. Carpintero, M. Osiński, and H. Lamela, “Improvement of signal-to-noise ratio of optoacoustic signals from double-walled carbon nanotubes by using an array of dual-wavelength high-power diode lasers,” *SPIE Proceedings, Opto-Acoustic Methods and Applications in Biophotonics II, Munich*, Volume 9539, 06/2015.

L. Leggio, D. Gallego, S.B. Gawali, E. Dadrasnia, M. Sánchez, S. Rodríguez, M. González, G. Carpintero, M. Osiński, and H. Lamela, “Optoacoustic response from graphene-based solutions embedded in optical phantoms by using 905-nm high-power diode-laser assemblies,” *Photonics West, Photons Plus Ultrasound: Imaging and Sensing 2016, San Francisco, CA, USA*, *SPIE Proceedings* 9708, 2016.

L. Leggio, D. Gallego, S.B. Gawali, M. Sánchez, S. Rodriguez, M. Osiński, J. Sacher, G. Carpintero, and H. Lamela, “System analysis of wavelength beam combining of high-power diode lasers for photoacoustic endoscopy,” *Photonics Europe, Micro-Optics, Brussels, Belgium*, *SPIE Proceedings* 9888, 2016.

S.B. Gawali, L. Leggio, M. Sánchez, S. Rodríguez, E. Dadrasnia, D. Gallego, and H. Lamela, “Combining high power diode lasers using fiber bundles for beam delivery in optoacoustic endoscopy applications,” *Photonics Europe, Semiconductor Lasers and Laser Dynamics VII, Brussels, Belgium*, *SPIE Proceedings* 9892, 2016.

L. Leggio, B. Wiśniowski, S.B. Gawali, S. Rodríguez, M. Sánchez, D. Gallego, G. Carpintero, and H. Lamela, “Multi-wavelength photoacoustic system based on high-power diode laser bars,” *SPIE Proceedings* 10064, 1006441, 2017.

S. Gawali, L. Leggio, C. Broadway, P. González, M. Sánchez, S. Rodríguez, and H. Lamela, “Image reconstruction algorithms with wavelet filtering for optoacoustic imaging,” *SPIE Proceedings*, 2016.

M. Sánchez, S. Rodríguez, S.B. Gawali, L. Leggio, D.C. Gallego, H. Lamela, “Cost-effective optoacoustic system based on the combination of high-power diode lasers,” *SPIE Proceedings* 10064, 100644F, 2017.

S. Rodríguez, M. Sánchez, L. Leggio, S.B. Gawali, D.C. Gallego, and H. Lamela, “Optoacoustic system based on 808-nm high energy short pulse diode laser stacks,” *SPIE Proceedings*, 2017.

M. Zitelli, F. Mangini, M. Ferraro, L. Leggio, A. Tonello, V. Courdec, S. Wabnitz et al, “Nonlinear multimode fiber optics: recent advances,” *2nd International Conference on Optics and Photonics, NICE*, 2020.

M. Zitelli, M. Ferraro, F. Mangini, L. Leggio, D. S. Kharenko, A. Niang, A. Tonello, V. Couderc, T. Hansson, and S. Wabnitz, “Spatiotemporal guided bullets in multimode fiber,”

Nonlinear Frequency Generation and Conversion: Materials and Devices XX, Proceedings Volume 11670, 2021.

T. Gonzalez-Raya, L. Leggio, A. Mena, D. Novoa, and M. Sanz, “Tavis-Cummings model for frequency up-conversion in gas-filled anti-resonant hollow-core fibers,” Advanced Photonics Congress 2024, Technical Digest Series, *Optica Publishing Group*, 2024.