First Year Report

PhD course in Physics and Nanosciences

Alessandro Zunino

supervised by Dr. Martí Duocastella

Scientific activity

During the first year of the PhD course I mainly contributed in designing, building and characterizing a new Acousto-Optofluidic (AOF) device. It is a water-filled acoustic resonant cavity in which we drive ultrasound waves, capable to diffract light into multiple beamlets. Adjusting amplitude, frequency, or phase of the driving signal it is possible to tune multi-focus distributions with sub-microsecond control. Laser writing of materials is normally performed by the sequential scanning of a single focused beam across a sample. This process is time-consuming and it can severely limit the throughput of laser systems in key applications such as surgery, microelectronics, or manufacturing. Therefore, our research team developed a parallelization strategy based on the AOF device. This latter, when combined with sample translation, leads to high-throughput laser processing thanks to the dynamic beam-shaping. As a proof of concept, we locally modified the morphological and wettability properties of metals, polymers, and ceramics. Our results illustrate how acousto-optofluidic systems are powerful tools for subtractive manufacturing, with potential future impact in fields such as additive manufacturing, imaging and optical trapping.

Conferences and Schools

- **Machine Learning Crash Course 2019**

  17-21 June 2019, Genoa (Italy)

- **14th School on Acousto-Optics and Applications**

  24-27 June 2019, Torun (Poland) – Speaker

- **38th International Congress on Applications of Lasers & Electro-Optics**

  7-10 October 2019, Orlando (Florida, USA) – Speaker

Courses

Attended

- **Electronics and Data Acquisition**

  Prof. Fontanelli & Prof. Musico (exam passed)

- **Quantum Optics**

  Prof. Ferraro (exam passed)

- **Optofluidics and Electrofluidics for Lab-on-a-Chip**

  Prof. Surdo (exam passed)

- **Laser and Applications**

  Prof. Duocastella (exam passed)

To attend

- **Applied Optics**

  Prof. Repetto

Publications

Journal papers

- A. Zunino, S. Surdo, and M. Duocastella. Dynamic multi-focus laser writing with acousto-optofluidics. *Advanced Materials Technologies*, 2019 (In publication)

Conference proceedings

- A. Zunino, S. Surdo, and M. Duocastella. Design, implementation, and characterization of a fast acousto-optouidic multi-focal laser system. In *14th School on Acousto-Optics and Applications*, 2019 (In publication)

- S. Surdo, A. Zunino, A. Diaspro, and M. Duocastella. Acoustically shaped laser light as an enabling technology for industry 4.0. In *2019 II Workshop on Metrology for Industry 4.0 and IoT (MetroInd4.0 IoT)*, pages 360–364, June 2019

Other activities

- **Didactic Tutor:** General Physics 1

  From April to July 2019