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Galileo

# The INO 2018 Annual Symposium: Extreme Light-Matter Interactions

Area della Ricerca CNR, via Moruzzi 1, 56124 Pisa (I)  
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Organizer: National Institute of Optics of the National  
Research Council (CNR-INO), Sede Secondaria di Pisa

**Abstract.** The Annual Symposium of the National Institute of Optics is a two-day meeting that brings together researchers from all the Units of the Institute to present their latest findings and engage new collaborations.

The 2018 INO Symposium had a special focus on extreme light-matter interactions and the European Extreme Light Infrastructure (ELI), a large-scale European Project promoted by Gérard Mourou, 2018 Nobel Laureate in Physics, who was also a special guest of the event, participating in the launch of the new ILIL-PW laser installation at INO-Pisa.

**Keywords.** Strong field laser physics, Quantum gases, Microscopy, Optics, Metrology, Quantum optics, Sensors and devices, Vision, Health, Spectroscopy, Interferometry.

## [General introduction]

Each edition of the INO Symposium is conceived to address an emerging scientific or technological aspect of relevance for the range of activities of the Institute. The 2018 Symposium was focused on the extreme light-matter interaction, a topic that is attracting major attention world-wide due to the great scientific output obtained in the past decades which has brought the EU to engage in the construction of the Extreme Light Infrastructure (ELI). ELI is currently entering the commissioning phase with many European countries involved in operations at the three main sites in the Czech Republic, Romania and Hungary, with a range of user laser installations featuring extremely high peak power lasers for the development of laser-driven radiation sources, attosecond science and nuclear physics.

CNR has been a leading contributor to ELI since the initial concept. INO has been promoting extreme light-matter interaction studies through the ILIL-PW upgrade of the Intense Laser Irradiation Laboratory in Pisa, to expand its capabilities and enter the sub-petawatt level required to access the ultra-relativistic interaction regime and to support the most advanced plasma-based high gradient acceleration schemes. The 2018 INO Symposium gave the opportunity to introduce the new installation to the wider community and to discuss scientific challenges in the field.



Figure 1. Prof. Gérard Mourou, 2018 Nobel Laureate in Physics, during his overview keynote presentation on high-intensity lasers and applications at the 2018 INO Symposium in Pisa.

The 2018 edition had 171 registered participants, 109 of whom from different territorial units of INO and 62 from other research institutions, university and 15 high tech companies, also supporting the Symposium. Welcome addresses were given by **Domenico Laforenza**, President of the Pisa CNR Research Campus, the largest CNR Campus in Italy with over 1000 employees, hosting over 15 CNR institutes and other institutions. **Paolo de Natale**, INO Director, and **Leonida A. Gizzi**, head of the Pisa Unit, gave the introductory address to the Symposium Scientific Programme, presented the main research topics of INO in Pisa, and introduced the new ILIL-PW laser installations. Other key collaborating institutions were also represented, with **Francesco Fuso**, assistant-Director of the Physics Department of the University of Pisa and **Marco Grassi**, Director of the Pisa Section of the National Institute for Nuclear Physics. Other institutions were also

represented and these included the NEST Laboratory of Scuola Normale Superiore (SNS), the Medical Physics and Radioprotection Unit of the S. Chiara Hospital in Pisa and the Italian Navy CISAM Institute. All of them pointed out the many links and collaborations existing with INO, allowing a fruitful sharing of knowledge and merging of abilities that are essential for undertaking successful research projects.

The focus of the Symposium and the launch of the new installation were marked by plenary talks given by two special guests, namely **John Collier**, the Director of the Central Laser Facility at the **Rutherford Appleton Laboratory** in Didcot (UK), and **Gerard Mourou**, father of the ELI project, Director of the IZEST programme at **Ecole Polytechnique** (France) and 2018 Nobel Laureate in Physics. These talks highlighted the technological developments emerging from applications of extreme light-matter interactions and the future perspectives for fundamental science and physics with extreme lasers. This year's Nobel Prize, awarded to Arthur Ashkin for optical tweezers and their application to biological systems, and jointly to Gérard Mourou and Donna Strickland for their method of generating high-intensity, ultra-short optical pulses, is a great acknowledgement of the innovation in laser science, technology and applications. Interestingly, the innovations introduced by Gérard Mourou and Donna Strickland were extensively applied for the development of new particle acceleration concepts like laser-based particle acceleration in plasmas and compact secondary radiation sources. These are the key topics of the Intense Laser Irradiation Laboratory at the National Institute of Optics in Pisa. The participation of Prof. Collier and Prof. Mourou were the perfect prelude to the official launch of a new laser installation developed in Pisa to match the effort of the European ELI infrastructure. The launch was also hosted by **Corrado Spinella**, Director of the SFTM Department of CNR, **Carlo Rizzuto**, ELI General Director, and **Sandro de Silvestri**, Professor at Milan Polytechnic and leading member of the ELI delivery consortium.

The scientific programme of the Symposium was dense and dazzling, with a presentation on ceramic solid-state lasers by Barbara Patrizi, which links with the future of plasma acceleration and controlled injection discussed by Paolo Tomassini and with the generation of quadratic frequency combs by Simona Mosca and frequency combs in the THz region by Saverio Bartalini. The latest scanning ion-conductance microscopy technique to characterize cell-based drug delivery was presented by Elisabetta Tognoni, followed by an update on the recent successful realization of a quantum degenerate Bose gas of Dysprosium atoms, peculiar for their strong magnetic dipolar interactions, by Eleonora Lucioni. More on BEC was presented by Gabriele Ferrari, who reported recent results from the observation of spin superfluidity in a Bose gas mixture, and by Elettra Neri, reporting on a new Chromium-Lithium ultra-cold Fermi mixture.

The recent fruitful investigation into the role of laser-plasma interaction in the shock ignition of laser fusion was discussed by Gabriele Cristoforetti, followed by

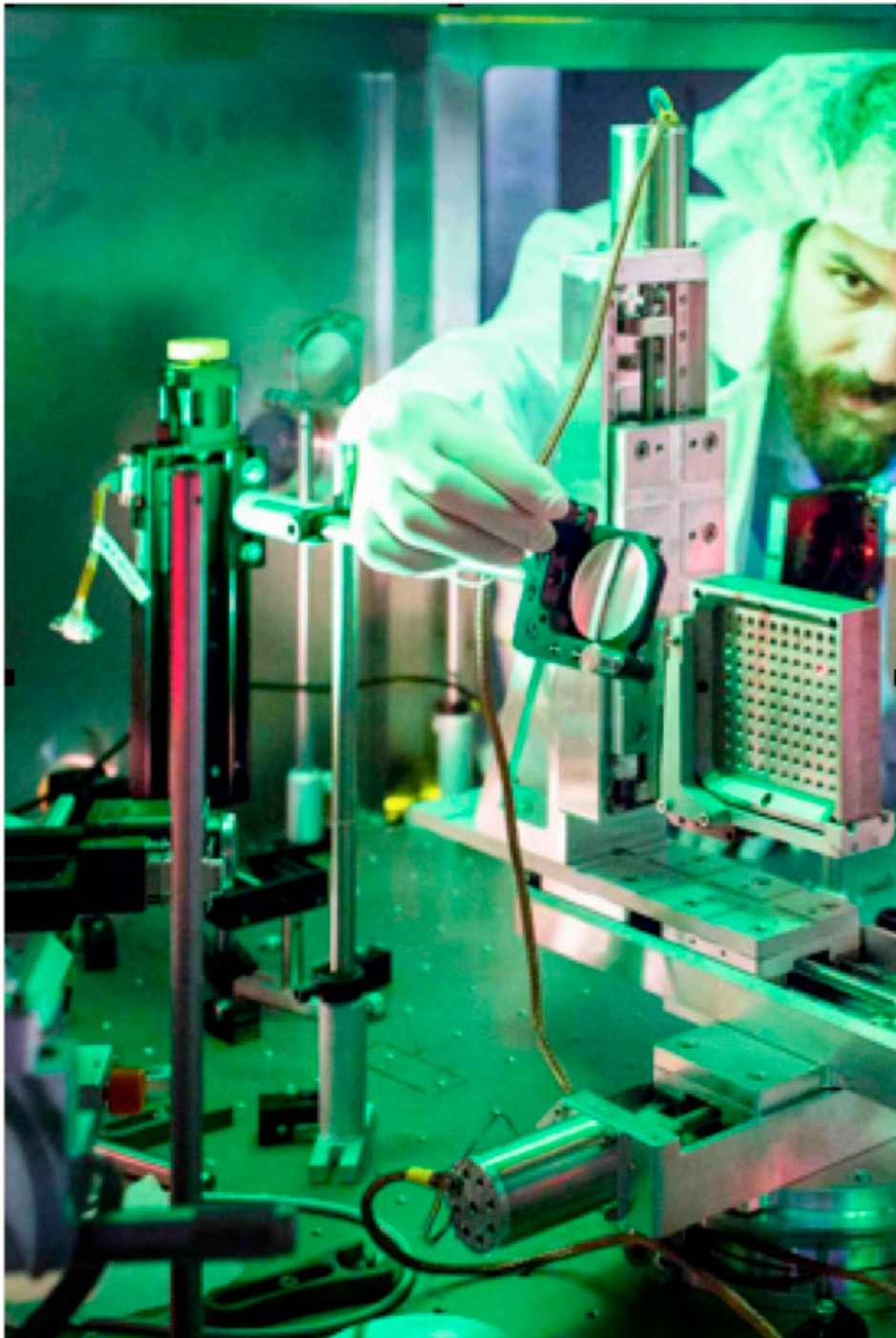


Figure 2. The new ILIL-PW installation at the INO-Pisa. A view of the inside of the vacuum experimental chamber for the high-energy laser-plasma accelerator.



Figure 3. Group photo during the launch of the ILIL-PW installation at INO Pisa. From left, Carlo Rizzuto, Gérard Mourou, John Collier, Domenico Laforenza, Antonio Rizzo, Paolo De Natale, Corrado Spinella and Leonida A. Gizzi.

Daniele Martella, who presented an update on the application of liquid crystalline networks in regenerative medicine.

A highlight of the Symposium was the presentation by Franco Bedeschi of INFN-Pisa who reported on the status of a new experiment,  $g-2$ , at the Fermi National Accelerator Laboratory (USA) aimed at the high-precision measuring of the anomalous magnetic moment of the muon, where a collaboration with INO researchers is in place for the realization of a laser calibration system. This, along with the long-standing collaboration on laser-plasma acceleration, is a great example of a productive collaboration between the two institutions, which is yielding scientific results and further joint projects.

Another highlight of the Symposium was the presentation by Jacopo Catani of the many examples of successful technological transfer of INO scientific results. In this context, great interest was generated by the presentations of Camilla Baratto on recent results on individual nano and micro ZnO wires for gas sensing applications, Giacomo Inero on high-resolution spectroscopy in the 1-10 microns, Gianluca Gagliardi on progress in liquid droplet whispering-gallery-mode



Figure 4. Group photo of the INO Symposium 2018.

microresonators, Nicole Fabbri on the control of diamond spin-qubits for quantum information and sensing, and Maja Colautti reporting on integrated organic molecules for quantum technologies.

The presentations on multidisciplinary applications given by Jana Striova, who discussed the INO contributions to E-RIHS, the European research infrastructure for heritage science, by Luca Labate, who gave an overview of innovative biomedical applications of high intensity laser-driven particle and radiation sources at the ILIL Laboratory, and by Gianluca di Natale, reporting on the Antarctic far infrared Earth Explorer campaign also had a major impact. Lastly, the European framework of these and other initiatives was reported by Anna Pelagotti, of DG CONNECT in Brussels, who gave a perspective of the opportunities within the Photonics platform and the H2020 programme.

Before the closing remarks, an Award Ceremony took place, to acknowledge the three winners among the young poster first authors. The BEST POSTER award, sponsored by MKS-OPHIR, was assigned to Elettra Neri, INO-Sesto; the TECHNOLOGY BREAKTHROUGH award, sponsored by MKS-OPHIR was awarded to Federica Baffigi and the APPLIED SCIENCES Journal Award was awarded to Michele De Regis.

A final “tasty” note on the Symposium banquet held in the magnificent Villa di Corliano, in the quiet countryside between Pisa and Lucca, was that participants were able to enjoy excellent food and taste local wine while discussing science and conceiving new collaborations!