

Francesco Barbato

Curriculum Vitae

Personal information

ORCID <https://orcid.org/0000-0002-3005-2173>

Education

2014–2019 **PhD, Science**, *UZH University of Zürich*, Zürich, Switzerland, 07/2014 – 05/2019.

Thesis title "In-Line phase-contrast imaging of laser-driven shock-waves in polystyrene using laser-plasma source"

2010–2013 **Master's Degree, Physics**, *University of Roma Tor Vergata*, Roma, Italy, 09/2010 – 05/2013.

Nuclear and particle Physics

Thesis title "High resolution X-ray Spectroscopy of laser produced plasma"

2007–2010 **Bachelor's Degree, Physics**, *University of Roma Tor Vergata*, Roma, Italy, 09/2007 – 09/2010.

Thesis title "Transport property at low temperature of carbon fibre and nano-tubes"

Schools participation

June 2019 **Short-pulse lasers and applications school**, *University of Bordeaux*, Bordeaux, France.

Theory and applications of short-pulse lasers.

August 2018 **Soft skills for graduate students: Communication Skills for Leaders**, *University of Zurich, University of Bern and BSP International AG*, Zurich, Switzerland.

Make familiar with the tasks and tools of a leader

January 2015 **OPCPA training course**, *Institut d'Optique d'Aquitaine*, Talence, France.

Non-linear optics and parametric processes (SHG, OPO, OPA, OPCPA)

August 2013 **International School of Quantum Electronics**, *Ettore Majorana Foundation and centre for scientific culture*, Erice, Italy.

Atoms and Plasmas in super intense laser field

Grants

- March 2019 **PhD mobility grant**, *Cluster of Excellence LAPHIA (from the IdEx University of Bordeaux, France)*, Bordeaux, France.
The motivations of the grant were the improvement of the simulations tools for phase-contrast imaging and the relative analysis code based on the phase-retrieval plus tomographic reconstruction algorithm. Both codes were tested on experimental data acquired during the past experimental campaigns.

Experience

Vocational

- 2021–Present **Post-Doc**, *Università di Roma “La Sapienza”*, Roma, Italy.
2019–2020 **Post-Doc**, *Université de Bordeaux, CNRS, CEA, CELIA*, Bordeaux, France.
2014–2018 **PhD student**, *Empa, Federal Institute for Material Science and Technology*, Dübendorf, Switzerland.

Teaching

- 2018 **Teaching assistance**, *Physical Chemistry Class*, University of Zürich, Zürich, Switzerland.
2011 **Laboratory teaching assistant**, *Physics Laboratory Class*, University of Roma Tor Vergata, Roma, Italy.

Principal investigator

- 2019 **X-ray absorption spectroscopy of a titanium wire isochorically heated by laser-accelerated electrons**, *GSI, PHELIX (Petawatt High Energy Laser for Heavy Ion Experiments)*, Darmstadt, Germany.

Participation in experimental campaigns

- 2020 **Quantifying Turbulent Rayleigh-Taylor mixing with X-Ray Phase Contrast Imaging**, *LLE (Laboratory for Laser Energetics), OMEGA*, Rochester, USA.
2020 **Laboratory investigation of dust charging and destruction in shocked plasma**, *RAL-Central Laser Facility, Vulcan TAW*, Didcot, United Kingdom.
2019 **X-ray Phase-Contrast Imaging of Strong Shocks in Foam Targets**, *LLE (Laboratory for Laser Energetics), OMEGA*, Rochester, USA.
2019 **High resolution phase contrast imaging of strong shock-cloud interactions**, *RAL-Central Laser Facility, Vulcan TAW*, Didcot, United Kingdom.
2018 **HotEScale-J-18A, Hot electron scaling in shock ignition relevant conditions, Joint shot OMEGA 60 and OMEGA EP**, *LLE (Laboratory for Laser Energetics), OMEGA*, Rochester, USA.
2018 **Experimental platform to characterize temperature and density of a Titanium wire isochorically heated by laser-accelerated electrons – test of a novel approach to study EOS in the WDM regime**, *GSI, PHELIX (Petawatt High Energy Laser for Heavy Ion Experiments)*, Darmstadt, Germany.

- 2017 **Phase contrast Imaging of a shock wave**, *GSI, PHELIX (Petawatt High Energy Laser for Heavy Ion Experiments)*, Darmstadt, Germany.
- 2017 **Laser-driven shock wave study**, *PALS (Prague Asterix Laser System)*, Prague, Czech Republic.
- 2016 **L and M-edges X-ray absorption spectroscopy of solid and liquid sample**, *ELETTRA synchrotron*, Trieste.
- 2014 **Shock waves and hot electrons generation and propagation in Shock Ignition regime**, *PALS (Prague Asterix Laser System)*, Prague, Czech Republic.

Computer skills

- Languages Python, FORTRAN (parallel computation with OpenMP), C, MatLab, LabVIEW, ROOT
- SO Windows, Linux (Fedora and Ubuntu distributions)
- Software Microsoft Office, Latex, Adobe Illustrator, FLYCHK, Fluka, Version control (e.g. Git)

Contributions at international Conferences

- 2020 HTPD 2020 23rd High Temperature Plasma Diagnostics, Santa Fe (USA), **invited**: Development of X-ray Phase Contrast Imaging for HED physics
- 2019 IFSA 2019 11th International Conference on Inertial Fusion Sciences and Applications, Osaka (Japan), oral presentation: X-ray imaging of an expanding titanium wire heated by laser-generated fast electrons
- 2019 DDFIW 2019 15th Direct-Drive and Fast-Ignition Workshop, Rome (Italy), oral presentation: Phase-Retrieval code for X-ray Phase Contrast Image of laser-driven shock-wave
- 2018 Laserlab-Europe User Meeting 2018, Paris (France), oral invited: Quantitative X-ray Phase-Contrast Imaging of a laser-driven shock-wave
- 2017 IFSA 2017 10th International Conference on Inertial Fusion Sciences and Applications, Saint-Malo (France), poster: Experimental in-line Phase-Contrast Imaging (PCI) of a shock wave
- 2016 Swiss Chemical Society Fall Meeting 2016, Zürich (Switzerland), poster: Table-top pseudo spark XUV source for energy dispersive absorption spectroscopy
- 2016 NCCR MUST (Molecular Ultrafast Science and Technology) meeting 2016, Engelberg (Switzerland), poster: Suitability of a table-top pseudo-spark source for high energy resolution off resonance spectroscopy (HEROS)
- 2015 COST Meeting (Action MP1203): Modeling X-ray interaction with matter at very high flux for 3D imaging and damage creation, Madrid (Spain), oral presentation: Spectral characteristic of a pseudo spark plasma source for phase contrast imaging
- 2014 17th International Congress on Plasma Physics, Lisbon (Portugal)
- 2014 COST meeting LMJ, Bordeaux (France)
- 2013 FISMAT 2013 Italian National Conference on Condensed Matter Physics, Milan (Italy), poster: X-ray diagnostics of dense laser-produced plasmas

2013 3rd International Conference Frontiers in Diagnostic Technologies for plasma, fusion research, astrophysics, nuclear particle physics, accelerators, laser, medical equipment and industrial applications, Frascati (Italy), poster: X-ray high resolution spectroscopy for laser produced plasma

Languages

English **Fluent**
Italian **Mother tongue**

Publications in peer review journals

- [1] F. Barbato, S. Atzeni, D. Batani, and L. Antonelli. "PhaseX: an X-ray phase-contrast imaging simulation code for matter under extreme conditions". In: *Optics Express* 30.3 (2022), p. 3388. ISSN: 1094-4087. DOI: 10.1364/OE.448479.
- [2] A. S. Martynenko, S. A. Pikuz, L. Antonelli, F. Barbato, G. Boutoux, L. Giuffrida, J. J. Honrubia, E. Hume, J. Jacoby, D. Khaghani, K. Lancaster, P. Neumayer, O. N. Rosmej, J. J. Santos, O. Turianska, and D. Batani. "Role of relativistic laser intensity on isochoric heating of metal wire targets". In: *Optics Express* 29.8 (2021), p. 12240. ISSN: 1094-4087. DOI: 10.1364/OE.415091.
- [3] G. Rigon, B. Albertazzi, T. Pikuz, P. Mabey, V. Bouffetier, N. Ozaki, T. Vinci, F. Barbato, E. Falize, Y. Inubushi, N. Kamimura, K. Katagiri, S. Makarov, M. J.E. Manuel, K. Miyanishi, S. Pikuz, O. Poujade, K. Sueda, T. Togashi, Y. Umeda, M. Yabashi, T. Yabuuchi, G. Gregori, R. Kodama, A. Casner, and M. Koenig. "Micron-scale phenomena observed in a turbulent laser-produced plasma". In: *Nature Communications* 12.1 (2021), p. 2679. ISSN: 2041-1723. DOI: 10.1038/s41467-021-22891-w.
- [4] O. N. Rosmej, X. F. Shen, A. Pukhov, L. Antonelli, F. Barbato, M. Gyrdaymov, M. M. Günther, S. Zähter, V. S. Popov, N. G. Borisenko, and N. E. Andreev. "Bright betatron radiation from direct-laser-accelerated electrons at moderate relativistic laser intensity". In: *Matter and Radiation at Extremes* 6.4 (2021), p. 048401. ISSN: 2468-2047. DOI: 10.1063/5.0042315.
- [5] L. Antonelli, F. Barbato, D. Mancelli, J. Trela, G. Zeraouli, G. Boutoux, P. Neumayer, S. Atzeni, A. Schiavi, L. Volpe, V. Bagnoud, C. Brabetz, B. Zielbauer, P. Bradford, N. Woolsey, B. Borm, and D. Batani. "X-ray phase-contrast imaging for laser-induced shock waves". In: *EPL (Europhysics Letters)* 125.3 (2019), p. 35002. DOI: 10.1209/0295-5075/125/35002.
- [6] L. Antonelli, J. Trela, F. Barbato, G. Boutoux, Ph. Nicolai, D. Batani, V. Tikhonchuk, D. Mancelli, A. Tentori, S. Atzeni, A. Schiavi, F. Baffigi, G. Cristoforetti, S. Viciani, L. A. Gizzi, M. Smid, O. Renner, J. Dostal, R. Dudzak, L. Juha, and M. Krus. "Laser-driven strong shocks with infrared lasers at intensity of 1016 W/cm²". In: *Physics of Plasmas* 26.11 (2019), p. 112708. DOI: 10.1063/1.5119697.
- [7] D. Batani, L. Antonelli, F. Barbato, G. Boutoux, A. Colaïtis, J.-L. Feugeas, G. Folpini, D. Mancelli, Ph. Nicolai, J. Santos, J. Trela, V. Tikhonchuk, J. Badziak, T. Chodukowski, K. Jakubowska, Z. Kalinowska, T. Pisarczyk, M. Rosinski, M. Sawicka, F. Baffigi, G. Cristoforetti, F. D'Amato, P. Koester, L.A. Gizzi, S. Viciani, S. Atzeni, A. Schiavi, M. Skoric, S. Gus'kov, J. Honrubia, J. Limpouch, O. Klimo, J. Skala, Y.J. Gu, E. Krousky, O. Renner, M. Smid, S. Weber, R. Dudzak, M. Krus, and J. Ullschmied. "Progress in understanding the role of hot electrons for the shock ignition approach to inertial confinement fusion". In: *Nuclear Fusion* 59.3 (2019), p. 032012. DOI: 10.1088/1741-4326/aaf0ed.
- [8] G. Cristoforetti, L. Antonelli, D. Mancelli, S. Atzeni, F. Baffigi, F. Barbato, D. Batani, G. Boutoux, F. D'Amato, J. Dostal, R. Dudzak, E. Filippov, Y. J. Gu, L. Juha, O. Klimo, M. Krus, S. Malko, A. S. Martynenko, Ph. Nicolai, V. Ospina, S. Pikuz, O. Renner, J. Santos, V. T. Tikhonchuk, J. Trela, S. Viciani, L. Volpe, S. Weber, and L. A. Gizzi. "Time evolution of stimulated Raman scattering and two-plasmon decay at laser intensities relevant for shock ignition in a hot plasma". In: *High Power Laser Science and Engineering* 7 (2019), e51. DOI: 10.1017/hpl.2019.37.

- [9] F. Barbato, S. Atzeni, D. Batani, D. Bleiner, G. Boutoux, C. Brabetz, P. Bradford, D. Mancelli, P. Neumayer, A. Schiavi, J. Trela, L. Volpe, G. Zeraouli, N. Woolsey, and L. Antonelli. "Quantitative phase contrast imaging of a shock-wave with a laser-plasma based X-ray source". In: *Scientific Reports* 9.1 (2019), pp. 1–11. DOI: 10.1038/s41598-019-55074-1.
- [10] M Afshari, L Antonelli, F Barbato, G Folpini, K Jakubowska, E Krousky, O Renner, M Smid, and D Batani. "Semi-analytical approaches to study hot electrons in the shock ignition regime". In: *Physics of Plasmas* 25.12 (2018), p. 122702. DOI: 10.1063/1.5046725.
- [11] G. Cristoforetti, L. Antonelli, S. Atzeni, F. Baffigi, F. Barbato, D. Batani, G. Boutoux, A. Colaitis, J. Dostal, R. Dudzak, L. Juha, P. Koester, A. Marocchino, D. Mancelli, Ph. Nicolai, O. Renner, J. J. Santos, A. Schiavi, M. M. Skoric, M. Smid, P. Straka, and L. A. Gizzi. "Measurements of parametric instabilities at laser intensities relevant to strong shock generation". In: *Physics of Plasmas* 25.1 (2018), p. 012702. DOI: 10.1063/1.5006021.
- [12] Y. Arbelo, F. Barbato, and D. Bleiner. "He-doped pseudospark as a home-lab XUV source beyond the beamtime bottleneck". In: *Plasma Sources Science and Technology* 26.3 (2017), p. 035005. DOI: 10.1088/1361-6595/aa595d.
- [13] G. Cristoforetti, A. Colaitis, L. Antonelli, S. Atzeni, F. Baffigi, D. Batani, F. Barbato, G. Boutoux, R. Dudzak, P. Koester, E. Krousky, L. Labate, Ph. Nicolai, O. Renner, M. Skoric, V. Tikhonchuk, and L. A. Gizzi. "Experimental observation of parametric instabilities at laser intensities relevant for shock ignition". In: *EPL (Europhysics Letters)* 117.3 (2017), p. 35001. DOI: 10.1209/0295-5075/117/35001.
- [14] M. Camplani, A. Malizia, M. Gelfusa, F. Barbato, L. Antonelli, L.A. Poggi, J.F. Ciparisse, L. Salgado, M. Richetta, and P. Gaudio. "Image computing techniques to extrapolate data for dust tracking in case of an experimental accident simulation in a nuclear fusion plant". In: *Review of Scientific Instruments* 87.1 (2016), p. 013504. DOI: 10.1063/1.4939458.
- [15] F. Barbato, L. Ciannbella, P. Gaudio, R. Montanan, M. Richetta, and L. Antonelli. "Physical Simulation of plasma-tungsten interaction in NFR". In: *METALLURGIA ITALIANA* 7-8 (2015), pp. 17–24.
- [16] M. Ruiz-Lopez, F. Barbato, Y. Ekinici, and D. Bleiner. "Extreme Ultraviolet Stokesmeter for Pulsed Magneto-Optics". In: *Photonics*. 2(1). 2015, pp. 241–255. DOI: 10.3390/photonics2010241.

Publications in conference proceedings

- [1] S. Atzeni, F. Barbato, and A. Forte. "Fluid modeling of laser-driven implosion of magnetized spherical targets". In: *47th EPS Conference on Plasma Physics, EPS 2021* 2021-June.1 (2021), pp. 105–108.
- [2] F. Barbato, D. Batani, D. Mancelli, J. Trela, G. Zeraouli, G. Boutoux, P. Neumayer, S. Atzeni, A. Schiavi, L. Volpe, V. Bagnoud, C. Brabetz, B. Zielbauer, P. Bradford, N. Woolsey, B. Borm, and L. Antonelli. "Propagation-based imaging phase-contrast enhanced imaging setup for single shot acquisition using laser-generated X-ray sources". In: *Journal of Instrumentation* 14.03 (Mar. 2019), pp. C03005–C03005. DOI: 10.1088/1748-0221/14/03/C03005.
- [3] O. Sambalova, Y. Arbelo Pena, R. Delmelle, C. Cirelli, B. Patterson, F. Barbato, D. Bleiner, and A. Borgschulte. "X-ray absorption spectroscopy probing hydrogen in metals". In: *X-ray Lasers and Coherent X-ray Sources: Development and Applications*. Vol. 10243. International Society for Optics and Photonics. 2017, 102430P. DOI: 10.1117/12.2264972.

- [4] F. Barbato and D Bleiner. "Plasma-Source High-Resolution XUV Spectroscopy as Complementary to Beamlines Limitations". In: *International Conference on X-ray Lasers*. Springer. 2016, pp. 29–35. DOI: 10.1007/978-3-319-73025-7_5.
- [5] F. Barbato, D. Scarpellini, A. Malizia, P. Gaudio, M. Richetta, and L. Antonelli. "X-ray High-resolution Spectroscopy for Laser-produced Plasma". In: *Physics Procedia* 62 (2015), pp. 84–91. DOI: 10.1016/j.phpro.2015.02.015.
- [6] P. Gaudio, A. Malizia, M. Camplani, F. Barbato, L. Antonelli, M. Gelfusa, M. Del Vecchio, L. Salgado, C. Bellecci, and M. Richetta. "Shadowgraph technique applied to STARDUST facility for dust tracking: first results". In: *Physics Procedia* 62 (2015), pp. 97–101. DOI: 10.1016/j.phpro.2015.02.017.
- [7] A. Malizia, M. Camplani, M. Gelfusa, L. Antonelli, F. Barbato, M. Vecchio, M. Richetta, L. Salgado, C. Bellecci, and P. Gaudio. "Optical techniques to study the dust resuspension problem in case of LOVA: Comparison of results obtained with PIV and Shadowgraph". In: *41st EPS conference on plasma physics, berlin, Germany*. 2014.

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