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

October 2022 **Research starting grant** , *Università degli Studi di Roma La Sapienza*, Rome, Italy.
Modelling of magnetized targets for applications on inertial confinement thermonuclear fusion.

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 **Postdoctoral researcher**, *Dipartimento SBAI, Università degli Studi di Roma La Sapienza*, Rome, Italy.
Modelling and simulation of plasmas produced by lasers for inertial confinement fusion and high energy densities physics. Focus on magnetohydrodynamics modelling with lagrangian code.

2019–2020 **Postdoctoral researcher**, *Université de Bordeaux, CNRS, CEA, CELIA*, Bordeaux, France.
Preparation of experiments and diagnostics for matter under extreme conditions relevant for shock ignitions. Experiments are based on X-ray imaging (in absorption and phase-contrast mode) and spectroscopy (emission and absorption). The preparation and analysis of the experimental data involve the use of computational tools and the development of new ones.

2014–2018 **Graduate researcher**, *Empa, Federal Institute for Material Science and Technology*, Dübendorf, Switzerland.
Development of spectroscopy and imaging X-ray diagnostics for plasma and material in extreme conditions.

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.

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

2023 EPS 2023 49^{th} European Conference on Plasma Physics, Bordeaux (France), **invited**: ICF diagnostics, synthetic x-ray

2022 ECLIM 2022 36^{th} European Conference on Laser Interaction with Matter, Frascati (Italy), talk: X-ray synthetic diagnostics for laser-driven implosions

2022 DDFIW 2022 17^{th} Direct Drive and Fast Ignition Workshop, Madrid (Spain), talk: MHD upgrade of DUED code for simulation of magnetised laser fusion targets

2020 HTPD 2020 23^{rd} High Temperature Plasma Diagnostics, Santa Fe (USA), **invited**: Development of X-ray Phase Contrast Imaging for HED physics

2019 IFSA 2019 11^{th} International Conference on Inertial Fusion Sciences and Applications, Osaka (Japan), talk: X-ray imaging of an expanding titanium wire heated by laser-generated fast electrons

2019 DDFIW 2019 15^{th} Direct-Drive and Fast-Ignition Workshop, Rome (Italy), talk: Phase-Retrieval code for X-ray Phase Contrast Image of laser-driven shock-wave

2018 Laserlab-Europe User Meeting 2018, Paris (France), **invited**: Quantitative X-ray Phase-Contrast Imaging of a laser-driven shock-wave

2017 IFSA 2017 10^{th} 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), talk: Spectral characteristic of a pseudo spark plasma source for phase contrast imaging

2014 17^{th} 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] A. Bose, J. Peebles, C. A. Walsh, J. A. Frenje, N. V. Kabadi, P. J. Adrian, G. D. Sutcliffe, M. Gatu Johnson, C. A. Frank, J. R. Davies, R. Betti, V. Yu. Glebov, F. J. Marshall, S. P. Regan, C. Stoeckl, E. M. Campbell, H. Sio, J. Moody, A. Crilly, B. D. Appelbe, J. P. Chittenden, S. Atzeni, F. Barbato, A. Forte, C. K. Li, F. H. Seguin, and R. D. Petrasso. "Effect of Strongly Magnetized Electrons and Ions on Heat Flow and Symmetry of Inertial Fusion Implosions". In: *Physical Review Letters* 128.19 (May 2022), p. 195002. ISSN: 0031-9007. DOI: 10.1103/PhysRevLett.128.195002.

[2] 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.

[3] 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.

[4] 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.

[5] O. N. Rosmej, X. F. Shen, A. Pukhov, L. Antonelli, F Barbato, M. Gyrdymov, 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.

[6] 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.

[7] L. Antonelli, J. Trela, F. Barbato, G. Boutoux, Ph. Nicolaï, 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.

[8] 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.

[9] 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.

[10] 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.

[11] 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.

[12] 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.

[13] 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.

[14] G. Cristoforetti, A. Colaïtis, L. Antonelli, S. Atzeni, F. Baffigi, D. Batani, F. Barbato, G. Boutoux, R. Dudzak, P. Koester, E. Krousky, L. Labate, Ph. Nicolaï, 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.

[15] 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.

[16] 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.

[17] M. Ruiz-Lopez, F. Barbato, Y. Ekinci, 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.

February 8, 2023