

PhD Position in femtosecond laser techniques: Femtosecond laser profiling & polishing of crystalline materials

Keywords: femtosecond laser, beam shaping, material processing, optics-grade polishing, fluorides, integrated optics, whispering gallery mode resonators, surface characterization, deep learning.

Institution:	FEMTO-ST Institute	Start Date:	October 1 st , 2025 or earlier
(CNRS, University M & L Pasteur)		Salary:	2200 €/month (gross)
Location:	Besançon, France	Duration:	3 years

Context:

This PhD position is part of **ANR project fs-WHIP**, which is concerned with developing the **next generation of whispering gallery mode resonators** (WGMRs). These components, based on the principle of total internal reflection wave-guiding inside a spherical or toroid shape, have received extensive interest in the past decades. Indeed, their high versatility offers potential use in many applications [1], including narrow-linewidth opto-electronic oscillators [2], integrated Sagnac gyrometers, **quantum optics** [3] and optical Kerr combs generation. Their use in **reservoir computing** [4] and photonic **neural networks** [5] is also extremely promising. Many of these applications require high-quality crystalline resonators with diameters in the 5-15 mm range, which are today mostly produced via **mechanical grinding** followed by several successive polishing steps.

To lift the severe limitations this process causes, we have recently **demonstrated** [6] the advantages of femtosecond laser machining by cutting and shaping WGMRs in CaF₂; after standard (abrasive) polishing, we obtained standard performances (intrinsic Q-factor 9.1 10⁸, measured by cavity ring-down) with **significantly reduced** processing times. ANR-funded project fs-WHIP will **go beyond these promising results** and lift the remaining limitations on WGMRs deployment on a larger scale, with both scientific and industrial applications in mind, while developing innovative methods and components in the process.

Project Description:

The PhD candidate will be the main **experimentalist** dedicated to fs-WHIP, in charge of developing femtosecond laser polishing of crystalline surfaces, a highly promising new technology. This work will involve **ultrafast lasers**, holographic **beam shaping** as well as time-controlled energy deposition (burst mode), and includes state-of-the art **machine-learning** assisted **surface metrology** and **real-time** control. This pioneering work opens opportunities for a career pursuit in both academia and industry.

Key Responsibilities:

- Main experimentalist: Exploring, enabling and validating femtosecond-laser polishing of crystalline substrates (including, but not limited to, fluorides);
- Surface characterization: In-situ and ex-post validation of polishing results;

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- **Collaboration & Teamwork:** interactions with modelling / theoretical aspects as well as potential end-users of custom WGMRs;
- **Machine-assisted process :** in liaison with local AI experts, streamlining of the polishing / characterization process;
- **Dissemination:** publication of key results in high-impact journals and international conferences. Patenting is also an option.

Qualifications:

- Educational background: Master's or Engineering degree (or equivalent) in Physics or Engineering, with a focus on Optics, Laser Physics, and Material Sciences;
- **Technical expertise:** Some practice in experimental optics is required, Ultrafast Optics greatly appreciated. Coding skills (Matlab, Python) are expected. Knowledge in Optical Surfaces metrology and/or Machine / Deep Learning a plus;
- **Soft skills:** Curiosity, tenacity, ability to integrate in a team are a must;

What We Offer:

- A fully-funded PhD position with a competitive salary;
- Access to cutting-edge facilities and experimental setups, including state-of-the-art femtosecond sources & beam-processing systems, as well as top-notch characterization equipment;
- A dynamic, friendly and inclusive work environment, located in a lovely small city;
- Opportunities for international collaborations and participation in conferences;
- Openings in both academic and industrial careers.

How to Apply:

Please submit the following documents to pierre-ambroise.lacourt@univ-fcomte.fr :

- A detailed CV/résumé, including academic achievements and publications (if applicable).
- 2. A cover letter outlining your motivations and relevant experience.
- 3. Optionally, one or two **support** letters or referral contact.
- 4. Transcripts of Bachelor's and Master's / Engineering degrees.

Contact Information:

For more information about the position or the project, please **contact** Pierre-Ambroise Lacourt at pierre-ambroise.lacourt@univ-fcomte.fr

References:

- V. S. Ilchenko, A. B. Matsko, "Optical resonators with whispering-gallery modes-part II: applications," IEEE J. Sel. Top. Quantum Electron. 12, 15–32 (2006).
- [2] A. Chiasera, Y. Dumeige, P. Féron, M. Ferrari, Y. Jestin, G. Nunzi Conti, S. Pelli, S. Soria, G. C. Righini, "Spherical whisperinggallery-mode microresonators," Laser Photon. Rev. 4, 457–482 (2010).
- [3] D. V. Strekalov, C. Marquardt, A. B. Matsko, H. G. Schwefel, G. Leuchs, "Nonlinear and quantum optics with whispering gallery resonators," J. Opt. 18, 123002 (2016).
- [4] H.L. Ren, Y.J Li, M. Li, MY. Gao, J. Lu, C.L. Zou, C.H. Dong, P.Q. Yu, X.N. Yang, Q. Wuan, "Photonic time-delayed reservoir computing based on series-coupled microring resonators with high memory capacity," Opt. Express 32, No. 7 (2024)
- [5] D. Brunner, L. Larger, M. C. Soriano, "Nonlinear photonic dynamical systems for unconventional computing," Nonlinear Theory and Its Applications IEICE (2022), DOI: 10.1587/nolta.13.26
- [6] P.-A. Lacourt, F. Courvoisier, J. Safioui, S. Diallo, R. Martinenghi, L. Furfaro, M. Jacquot, J.-M. Merolla, L. Froehly, L. Larger, "Femtosecond laser preforming of millimeter-scale whispering gallery mode resonant disks from crystalline substrates," Opt. Continuum, vol. 1, 7, pp.1489-1494, 2022

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