Elettra Sincrotrone Trieste

Doctoral Research Associate in the MSCA Doctoral Network Qu-Atto (Quantum information science and Ultrafast nonlinear coherent control at the ATTOsecond timescale)- Pos. DC10

Deadline: 7 November 2024
Ref: DB/24/48

Background

Elettra Sincrotrone Trieste is an international multidisciplinary research center operated as a user facility, featuring a 2.0/2.4 GeV, third-generation synchrotron light source (Elettra), a free-electron laser source (FERMI) and a variety of support laboratories. The extremely high quality of the machines and beamlines has set new performance records and has been producing results of great scientific and technological interest.

In order to allow the laboratory to remain competitive in the next 20 years, an entirely new source - Elettra 2.0 - belonging to the new generation of storage rings (DLSR or Diffraction Limited Storage Ring) is being developed. The new source will exhibit a major increase in the brilliance and coherence fraction of the photon beams. The Elettra 2.0 optics is based on our enhanced symmetric six bend achromat structure (S6BA-E) with a 12-fold symmetry and an emittance of 200 pm-rad at 2.4 GeV. The new structure creates also straight sections in the arcs permitting the installation of additional insertion devices, thus increasing the number of beamlines. Existing beamlines will have to be upgraded and new beamlines developed to take full advantage of the characteristics of Elettra 2.0. The new machine is scheduled for commissioning in the second half of 2026.

FERMI will also be upgraded to FERMI 2.0 with the objective of extending its spectral range to the oxygen K-edge and beyond. This FERMI 2.0 upgrade will take place in two phases, interleaved with the Elettra 2.0 upgrade. The first phase, consisting of an increase in beam energy and the conversion of FERMI FEL-1 to an echo-enabled harmonic generation scheme (EEHG), has been completed. The final upgrade of FERMI 2.0 is intended to begin after the completion of the Elettra 2.0 upgrade.

Seehttp://www.elettra.eufor more information.

Beamline/Activity/Project description

Mastering the interaction between electromagnetic radiation and matter is a fundamental step for unravelling the internal structure and processes of simple and complex materials. Research in this field has led to countless technological applications, and more are expected with the advent of novel quantum technologies. From the rules of quantum mechanics, novel phenomena emerge, such as entanglement and non-local interactions, that have no classical counterparts. Over the last decades, intense, ultrashort laser sources have been developed, leading on the one hand to the generation of (classically described) coherent states of light with extremely high peak power and intensity, and on the other hand to extremely short pulses. The quantum description of light is at the basis of quantum information science, which has primarily focused on states of light characterized by only a few photons. The Physics Nobel Prizes awarded to Agostini, Krausz and L'Huillier in 2023 *for experimental methods that generate attosecond pulses of light for the study of electron dynamics in matter* , and to Aspect, Clauser and Zeilinger in 2022 *for experiments with entangled photons, establishing the violation of Bell inequalities, and pioneering quantum information science* , attest to the importance of these research fields. Their natural evolution is attosecond strong-field quantum optics, having the goals of: mastering quantum states of light characterized by a large number of photons; applying the concepts of entanglement and decoherence in quantum systems (such as molecules) undergoing ultrafast electronic and nuclear dynamics.Attosecond pulses are generated using table-top femtosecond lasers driving the process of high-harmonic generation (HHG). Recently seeded free-electron lasers (FELs) operating in the XUV range such as FERMI have demonstrated the ability to produce intense, fully coherent pulses as well as trains of attosecond pulses, with unprecedented intensity and greater flexibility towards the synthesis of tailored waveforms. The capabilities of the EEHG scheme are under study: on the one hand it is an ideal playground to explore the solutions that will be implemented for the upgrade of the second FERMI line, FEL-2. On the other hand, the EEHG scheme can decouple the effects of the energy modulations induced by the seed from those due to pre-existing non-idealities of the electron beam. The EEHG configuration provides an unprecedented control of the light properties inherited from the two seeds, which will be exploited for improved multicolor pulse generation, chirped pulse amplification, or the generation of trains of attosecond pulses.The two scientific objectives of

the QU-ATTO Network are: 1) to merge the field of quantum optics with attosecond physics through experiments based on, and advanced theoretical descriptions of, the quantum state of light associated with intense laser fields. 2) to leverage the unique capabilities offered by recent advances in seeded FELs and HHG-based sources to demonstrate the coherent control of electronic dynamics in systems of increasing complexity. A pivotal objective is to provide the Doctoral Candidates (DCs) with a multifaceted scientific training that enhances their practical and theoretical understanding of research across quantum information and attosecond science. DCs will receive an inter-disciplinary and inter-sectoral comprehensive research training that will be contributed by leading universities and research centers, and by key-player companies.The training provided within the QU-ATTO network will empower DCs to become versatile professionals capable of bridging the gap between scientific research and its practical applications. Seehttps://quatto.eufor more information.

Job description

In the framework of the QU-ATTO project, the main objective of the Doctoral Candidate at Elettra (project position DC10) will be to obtain a PhD in physics at the University of Trieste through the following research activities:

1. Participate in machine studies of the newly installed Echo Enabled Harmonic Generation seeding mechanism on the FEL-1 line at Elettra Sincrotrone Trieste.

2. Study the problem of generating multiple frequencies in High Gain Harmonic Generation and in Echo Enabled Harmonic Generation.

3. Participate in machine physics experiments dedicated to the study of echo-enabled harmonic generation of phase-locked multiple frequencies.

4. Participate in the organization, machine preparation and execution of experiments implementing frequency synthesis for the generation of specific waveforms such as trains of attosecond pulses both in High Gain Harmonic Generation and in Echo Enabled Harmonic Generation.

Qualifications

A Master Degree or equivalent in physics is required, with a documented background in ultrafast lasers, free-electron lasers, electrodynamics and relativity, or related fields.

Basic knowledge of programming (C, Matlab, or Python) and/or numerical methods in electrodynamics will be considered as a valuable asset.

We welcome applications from doctoral candidates fulfilling the following criteria:

1. Any nationality is acceptable, but the applicant must not have resided or carried out his/her main activity (work, studies, etc.) in Italy for more than 12 months in the 36 months immediately before their recruitment date. Time spent as part of a procedure for obtaining refugee status under the Geneva Convention (1951 Refugee Convention and the 1967 Protocol), compulsory national service and/or short stays such as holidays are not considered as part of the above 36 month period.

2. Must meet the entry requirements for PhD enrolment, i.e., he/she must hold a 2nd Level Master Degree (120 ECTS + 180 ECTS in a bachelor degree) or a Single Cycle Degree (minimum 300 ECTS), or a comparable university degree (Second Cycle qualification) in physics or related disciplines.

3. Must not have a doctoral degree at the date of the recruitment. Researchers who have successfully defended their doctoral thesis, but who have not yet formally been awarded the doctoral degree will not be considered eligible.

4. Must be proficient in the English language (if not native speaker). English proficiency of short-listed applicants shall be assessed during the selection interview.

5. Must be aware of and adhere to the principles set out in the Commission Recommendation on the European Charter for Researchers.

6. Must be available to enroll ina 3-year full-time PhD program in physics atthe University of Trieste.

General information

The deadline for the submission of the application is November 7, 2024.

The appointment envisioned is a fixed term contract with a duration of 36 months.

Applications should include the full curriculum vitae (including publications, if any), a motivation letter, the names and contact information (including electronic mail) of at least one person who has agreed to provide references, english certificate (if not native speakers) and copies of degree and academic transcripts (with grades and rankings), for both the Bachelor's and Master's degrees. Academic records not written in English should be accompanied by a translation into English (it can be either an official translation or self-translation).

The ranking of eligible candidates resulting from this selection procedure may be used for additional appointments within the following 24 months.

The interviews may be held via video conferencing.

For more information, please contact Luca Giannessi (email:luca.giannessi@elettra.eu).

Permanent employees of Elettra Sincrotrone Trieste S.C.p.A. and employees or former employees of any Italian Public Entity who have exercised authority over Elettra Sincrotrone Trieste S.C.p.A. or have negotiated with Elettra - Sincrotrone Trieste S.C.p.A. within the last three years will be excluded from the present selection procedure, in accordance with the provisions of article 21 of the Italian legislative decree no. 39/2013 and in conjunction with article 53 (subsection16ter) of Italian legislative decree no. 165/2001.We thank all applicants in advance.

To apply for this position please visit the following link:
https://www.elettra.trieste.it/it/about/careers/working-withus.html?id=4221