



Swiss Society for Photon Science

Newsletter May 2025, No. 5

Dear readers,

2024 has been a busy year for our board and many of our members because we were tasked by SCNAT under a mandate by the State Secretariat for Education, Research and Innovation to prepare an update to the Photon Science Community Roadmap for national and international research infrastructures. This document is tied to the four-year federal funding cycle and serves as a “bottom-up” input for the national strategy for research infrastructures. The final roadmap documents for photon science and six other thematic areas have been published by SCNAT on December 18th, 2024. Below, you can find a summary of the context of our roadmap document and the main recommendations the editorial team extracted from all the input. A link to the full document is provided for further reading.

I also would like to use this newsletter to announce our General Assembly 2025, which will be held in the Auditorium of PSI on August 28th, 2025, starting at 3 pm. The assembly meeting will start with scientific presentations on computational X-ray imaging and the current status of SLS 2.0 and SwissFEL. More details on our General Assembly can be found below.

This newsletter is concluded with an article by Michele Puppini about the Lausanne Centre for Ultrafast Science (LACUS). His overview provides insights into the history and technical capabilities of this shared ultrafast laser facility. LACUS is a pioneer in the domain of university-based shared laser laboratories in Switzerland. It provides access not only to multiple professorships within EPFL but also to other Swiss and even international users – the latter through the Lasers4EU consortium.

We hope you find this edition of the newsletter an interesting reading. We are looking forward to meeting you in person at our General Assembly in August.

Lukas Gallmann – President SSPh

News from the SSPh

General Assembly 2025 on August 28th – Save the date!

It is our pleasure to announce the General Assembly 2025. We will welcome you on August 28th, 2025 at 3 pm in the PSI Auditorium (<https://maps.app.goo.gl/gmWXLBJmp9VCMNE7A>). The event will start with scientific presentations: a talk by Prof. Manuel Guizar Sicaïros on computational X-ray imaging using ptychography and the new possibilities in this field enabled by the SLS 2.0 upgrade. This 45 min talk will be complemented by two shorter presentations on the current technical status of SLS 2.0 and SwissFEL.

Elections will be an important part of this year’s General Assembly with three of our current board members finishing their third and – as per our bylaws – last term. The current board members have

identified potential candidates to fill the vacancies. However, all of our members are invited to nominate additional candidates (send nominations to board@swissphotonscience.ch or use the registration form linked below).

After the scientific presentations and the General Assembly, we will offer an apéro. Please register here: https://swissphotonscience.ch/not_public/assembly_meeting_registration2. We look forward to seeing many of you at this essential meeting of our society.

Photon Science Community Roadmap completed

A major activity in 2024 for our board and many of our members has been the preparation of the most recent edition of the Photon Science Community Roadmap. This is a “bottom-up” document presenting the needs of the Swiss photon science community in terms of future national and international research infrastructures. Together with roadmaps from other disciplines it provides important community input for the Swiss Roadmap for Research Infrastructures 2027 that is prepared by the State Secretariat for Education, Research and Innovation (SERI) in view of the ERI Dispatch 2029–2032 to the Federal Council.

The 2024 update of all seven community roadmaps was coordinated by SCNAT under a mandate by SERI and executed by its member societies and commissions in the respective fields. For photon science, we have collected the scientific vision and needs of users of the national institution-based laser platforms, the synchrotron Swiss Light Source (SLS) and the X-ray free-electron laser SwissFEL, as well as of international photon science facilities with current Swiss participation (the European Synchrotron Radiation Facility, ESRF, and the European X-ray Free-Electron Laser, EuXFEL).



*The 2024 Photon Science Community Roadmap
(image source: SCNAT)*

The main recommendations can be summarized as follows:

- New photon science infrastructure: upgrade of the SLS beamline portfolio to make full use of SLS 2.0 and installation of third undulator line at SwissFEL with full control of pulse.
- Funding mechanism for medium-sized instrumentation and infrastructure that enhances flexibility at large-scale facilities and enables smaller-scale shared platforms at the institutions.
- Provide large-scale facilities with funds and support to cope with ever-increasing data management requirements and complexity.
- Continued support for SLS and SwissFEL to ensure their long-term competitiveness.
- Continued support for the international European X-ray Free-Electron Laser (EuXFEL) and European Synchrotron Radiation Facility (ESRF), which complement the Swiss sources and are used heavily by the Swiss community.

For more details on these points and the rationale behind them, please consult the full document available for download at https://scnat.ch/en/uuid/i/fb490ce4-ea8e-5abc-9143-061bf41ed2f6-Photon_Science_Community_Roadmap_2024.

We would like to thank everyone who has contributed to this document for their time and for sharing their vision for the future of photon science in Switzerland.

The Lausanne Centre for Ultrafast Science.

Introduction:

The time-domain approach to the study of physical phenomena was revolutionized by femtosecond lasers, which have become widespread tools in research institutions. Thanks to their compactness ("table-top") and relative affordability, these tools are also available to universities and small-scale laboratories. However, despite these technical advances, the ever-increasing sophistication of ultrafast experiments makes it difficult for non-dedicated or newly established research groups to rapidly acquire sufficient know-how and instrumentation.

The mission of the Lausanne Centre for Ultrafast Science, based at the École Polytechnique Fédérale de Lausanne (EPFL), is to facilitate the development of new instruments and to provide access to advanced, state-of-the-art ultrafast experiments to users within the ETH domain, Swiss universities, and beyond. Hosted by the School of Basic Sciences at EPFL (see Fig. 1), the centre was founded in 2016 by Prof. Majed Chergui, bringing together multiple existing laboratories focused on physical chemistry and materials science.

Since 2020, the centre has been led by Prof. Fabrizio Carbone, who has broadened its focus to incorporate advanced ultrafast electron scattering methods. The centre now features three advanced instruments, which are described in this brief overview. These instruments were created with initial funding from the Swiss National Science Foundation and the European Research Council.



Figure 1 The location of the LACUS centre, a virtual tour of the laboratory is available at the following link: https://schools-virtualtour.epfl.ch/01_epfl_ecublens/14_epfl_lacus/index.html.

The centre is currently supported by and serves multiple groups based at EPFL. It is also open to transnational access thanks to the Lasers4EU network, which funds user experiments through a peer-reviewed proposal evaluation system. The LACUS facility is located on the main EPFL campus and is part of the institute's network of facilities, including crystal growth and characterization, advanced electron microscopy, and large clean rooms for nanofabrication.

Scientific offer and recent output:

In materials, the interplay between the lattice, the electronic states, and the spins determines complex phase diagrams with new applications. It is of foremost importance to be able to observe a system with multiple probes, sensitive to each one of these degrees of freedom. Three main end stations (see fig. 2) can be used at LACUS by users for material science research:

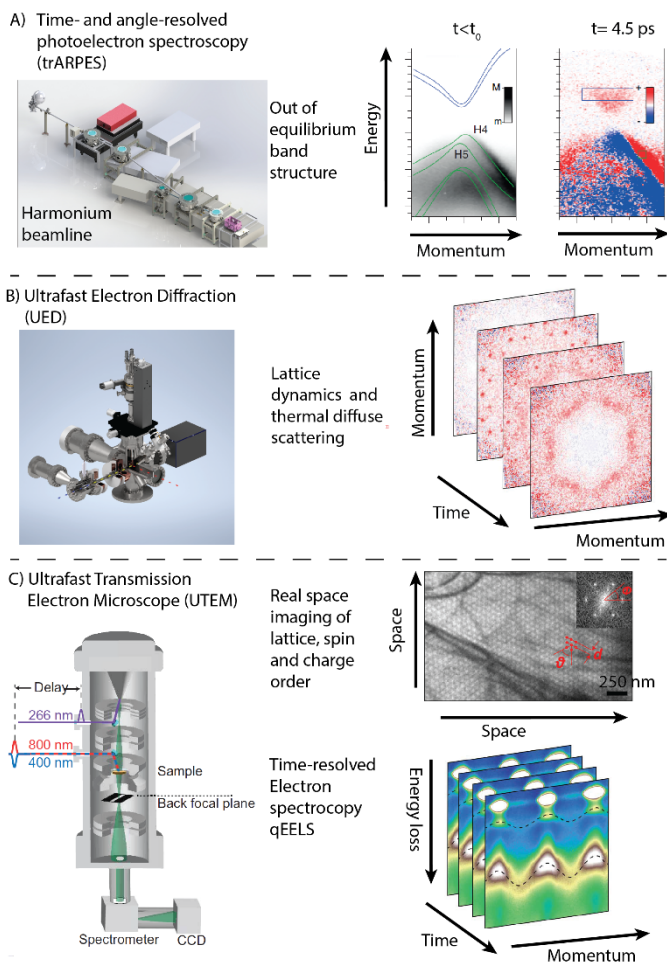


Figure 2 A) trARPES facility, in the inset the band structure of Tellurium is shown before and 4.5 ps after photoexcitations. B) UED experiments, inset: Variation of the electron diffraction pattern of graphite as a function of time, showing non thermal phonon population C) TEM experiments, upper panel: imaging of the skyrmion lattice in FeGe,

A. *Electronic states:* Time- and angle-resolved photoelectron spectroscopy (trARPES) provides access to the electronic band structure in the time domain.

The trARPES end station is operated in collaboration with Prof. H. Dil and Prof. H. Rønnow. Two complementary XUV sources are available for trARPES experiments: *Harmonium* (6 kHz, 15-100 eV [1]) and *Yperion* (1 MHz, 9-11 eV [2]). The technique is ideally suited to study the coupling of lattice vibrations with specific electronic states [3], to reveal the unoccupied states of a material [4] and to study the renormalization of bands induced by light [5]. The harmonium beamline also includes a free end station, which is available for extreme ultraviolet (XUV) spectroscopy and metrology experiments.

B. *Lattice dynamics:* Electrons with energies of tens of kiloelectronvolts have extremely short wavelengths, allowing the crystalline lattice structure to be probed via diffraction. An ultrafast electron diffractometer [6], operating both in reflection and transmission, is available to users at the facility. The machine is equipped with a state-of-

the-art hybrid pixel electron detector, enhancing its sensitivity for pump-probe experiments, to study photon-induced phase transitions [7] and collective excitations in materials via thermal diffuse scattering [8].

C. *Real space imaging and spectroscopy of collective modes*: experiments can be performed on an ultrafast transmission electron microscope [9], equipped with an electron energy loss spectrometer and recently upgraded with a novel hybrid pixel detector. This flexible instrument allows for a variety of imaging modes with nanometer resolution, including magnetic imaging via Lorentz microscopy [10]. The instrument is also capable of momentum-resolved electron energy loss spectroscopy, thereby providing access to the energy dispersion of collective modes in the sample [8].

Developments of new tools:

The LACUS center collaborates with several groups within the EPFL, providing access to ultrafast lasers to develop new analytical methods, or to perform experiments in new regimes.

Ultrafast diagnostics for fusion applications:



The Swiss Plasma Center (SPC) is the largest institution for plasma physics research in Switzerland. The SPC and LACUS are jointly developing a new diagnostic technique to determine hydrogen densities in plasmas under environmental conditions similar to those found in nuclear fusion reactors. The method is based on measuring the fluorescence of hydrogen atoms following two-photon absorption of ultrashort deep-UV pulses (fsTALIF), generated by a Ti:Sapphire femtosecond laser amplifier provided by the LACUS Centre, customized for this application.

Mid-infrared control of quantum materials

Intense mid-infrared (MIR) pulses are ideal for imposing strong periodic electric field in a material, with minimal electronic heating. In this regime, light can interact with materials generating novel phases with no equilibrium analogue. The ensuing effects can produce measurable changes in the electronic structure or can break the lattice symmetry in nontrivial ways. The centre is working in collaboration with Prof. Jotzu of the Dynamics of Quantum Materials Laboratory and Paul Scherrer Institute to equip the experimental end stations with MIR pulse generation.

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