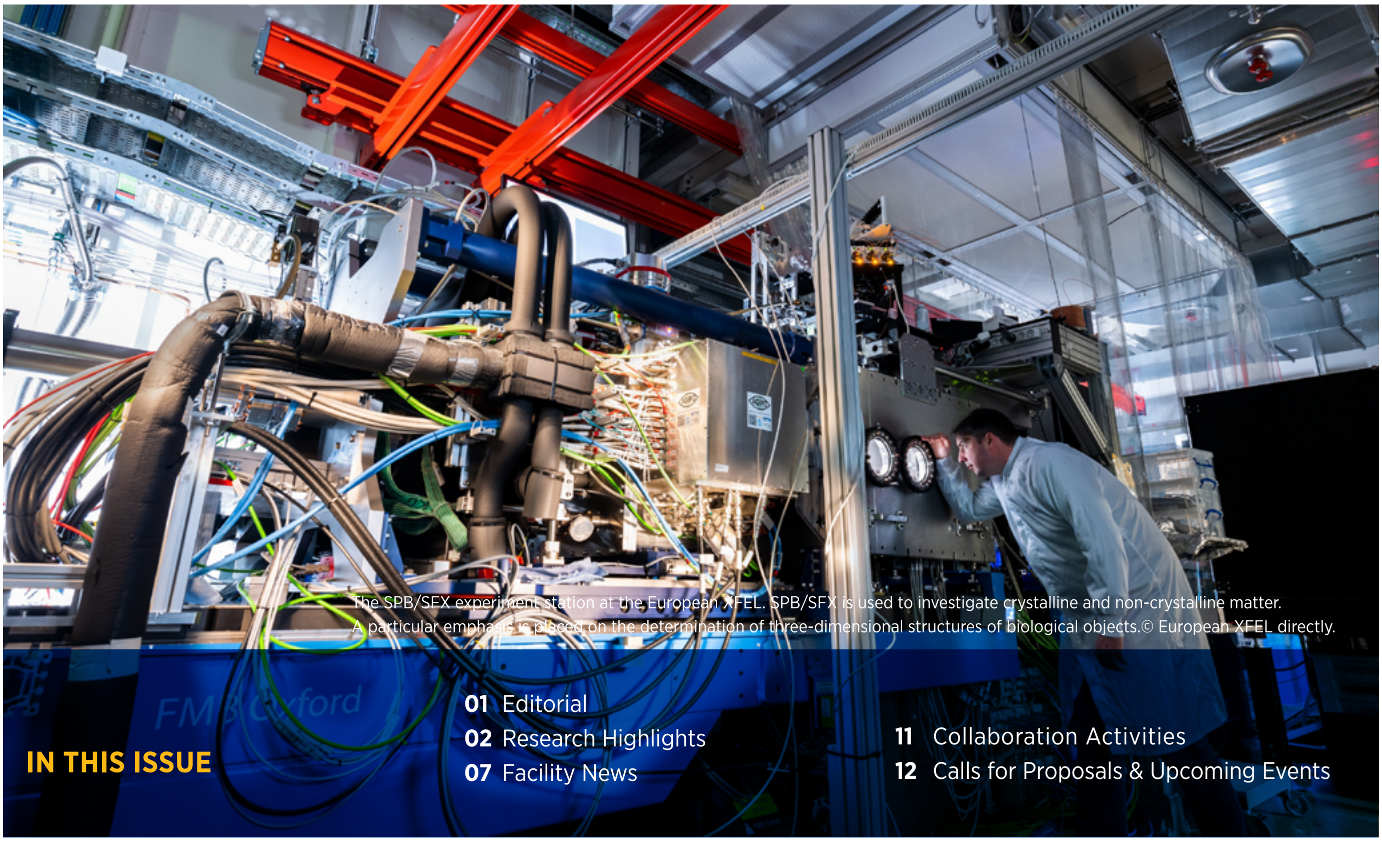
FELs OF EUROPE NEWS 1|23

13. ISSUE | www.fels-of-europe.eu



The SPB/SFX experiment station at the European XFEL. SPB/SFX is used to investigate crystalline and non-crystalline matter. A particular emphasis is placed on the determination of three-dimensional structures of biological objects.© European XFEL directly.

IN THIS ISSUE

EDITORIAL

In this first FELs OF EUROPE Newsletter of 2023 we would like to look back on the previous year and recall all the important events and achievements that were accomplished during a very challenging time. Despite all obstacles, we were able to successfully follow through on our plans and organize regular conferences and workshops. We paid particular attention to the education and promotion of young scientists, giving tutorials and awards during the SCIENCE@FELs and SRI conferences.

Last year, the FELs OF EUROPE also celebrated its 10th anniversary by organizing a dedicated session during the SCIENCE@FELs conference where we thanked all our colleagues who initiated and participated in the cooperation during this period. At this session, we presented an outlook for further development and strengthening of FELs OF EUROPE in the coming years. Last but not the least, excellent science was done at all facilities by representing members of the cooperation. Examples of these very important and exciting experiments will be given separately in this Newsletter.

Our achievements from the past year make us confident that 2023 will be another successful year for the cooperation, in which two major events will be organized by our partners. One of them is the “FELs of Europe Topical Workshop on Selected Problems in FEL Physics: from soft X-rays to THz” which will be held in Hamburg in November. This workshop will be a follow-up of the previous, very successful one organized in Dresden in April 2022. The second event is the “PhotonDiag” conference that will take place in Trieste.

Besides that, it has already been decided that the next SCIENCE@FELs conference, followed by “Forum on Advanced FEL Techniques”, will be organized in the spring of 2024 in Paris. The dates are still up for discussion but will be communicated on the homepage of the FELs OF EUROPE website shortly.

Needless to say, we will continue giving tutorials and awards to young scientists and you are sincerely invited to send in nominations regarding research performed at facilities of the FELs OF EUROPE partner institutions.

We are looking forward to a spectacular 2023 filled with success and new achievements!

FELs OF EUROPE

Serguei Molodtsov
Chair FELs OF EUROPE

FERMI

Ultrafast all-optical spin injection in silicon revealed at FERMI

Researchers around the world are developing a revolutionary and energy-efficient form of information technology that encodes digital data in electron spin, also known as spintronics. By combining semiconductors and ferromagnets, this technology has the potential to merge the memory and logic computing capabilities of magnetic-based storage devices with silicon-based logic transistors, leading to new computing paradigms and innovative spin-based multifunctional devices. Some of the main advantages of this technology include non-volatility, increased data processing speed, and reduced power consumption, which are all crucial steps towards the development of next-generation quantum computers.

In order to create spin-based electronics that have the potential to transform information technology, it is necessary to integrate silicon, the most common semiconductor, with spin functionality. While silicon is typically non-magnetic at equilibrium, it is possible to establish spin polarized currents in silicon through various methods such as the use of polarized light, hot electron spin injection, tunnel spin injection, Seebeck spin tunneling, and dynamical spin pumping. In general, spin polarized currents refer to the preferential alignment of the spin angular momentum of electrons in a particular direction.

Nowadays, considerable effort is dedicated on achieving spin-polarized currents in silicon using injection of super-diffusive spin currents from a ferromagnetic contact triggered by ultrafast optical pulses. This concept is schematically illustrated in Fig. 1a. First, laser-excited electrons in the ferromagnetic metal, nickel for the case of our experiment, undergo strongly asymmetric spin diffusion, which in turn leads to a spin diffusion (j_s) away from the irradiated region. Such spin diffusion removes angular momentum from the irradiated area, which rapidly demagnetizes, namely in less than 150 fs (gray to red arrows). As the super-diffusive current tunnels the Schottky potential energy barrier at the Ni/Si interface, a spin-polarized current is then injected in the semiconductor and, in turn, transient magnetization (M_{js}) is induced.

In our work, we have investigated the spin injection in silicon by means of a pump-probe experiment, in which the optical pump pulse triggers the super-diffusive spin current and the probe FEL pulse, whose photon energy is tuned to either Ni or Si core resonances, follows the ultrafast evolution of the magnetization in nickel and silicon.

Sensitivity to magnetization is obtained by measuring the angular Kerr rotation of the photon polarization resulting from the interaction of the photon pulse with the magnetic sample. The dynamic variation of the Kerr rotation, or time-resolved magneto-optical Kerr effect (TR-MOKE), has been measured using the extreme ultra violet Wollaston-like polarimeter (TONIX) in operation at the MagneDyn beamline for magneto-dynamics studies at the FERMI FEL.

The schematic of the experiment is sketched in Fig. 1b. The sample consists of a 10 nm nickel film deposited on a Si(111) substrate by means of laser pulsed deposition. The nickel film has been capped with a silver layer for preventing oxidation. To control the smoothness of the interface and limit the formation of nickel silicides at the ferromagnet/silicon interface, the Si surface was passivated by deposition of ultrathin Si_3N_4 layer. Cross sectional TEM analysis confirmed the good quality of the interface. The optical pump (yellow pulse) was an 80 fs, 800 nm pulse, whose intensity is almost completely absorbed in the nickel layer. The FEL pulses tuned at the Ni (red pulse) and Si (blue pulse) edges follows the variation in time of the Kerr rotation of the photon polarization induced by the dynamics of the magnetization in the Ni and Si layers, respectively.

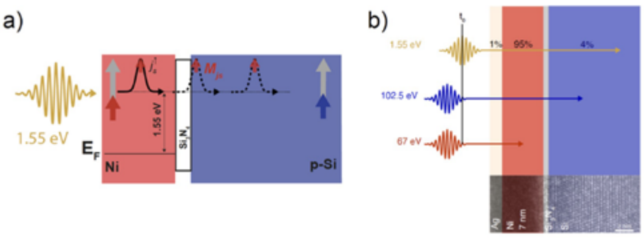


Fig. 1: a) The optical generation of spin polarized superdiffusive currents across a ferromagnetic/semiconductor interface is illustrated. b) the principles of TR-MOKE experiment are illustrated together with a cross-section TEM image describing the quality of the Ni/Si interface.

In conclusion, the importance of our work is twofold: on the one hand, we have directly accessed the ultrafast transient spin diffusion from a metallic ferromagnet to the silicon semiconductor. On the other hand, this investigation was made possible by extending the MOKE spectroscopy to the time domain and to the EUV photon energy range. This demonstrates the robustness of time-resolved MOKE spectroscopy as a tool for tackling open problems in the field of magneto-dynamics. In perspective, by injecting and detecting spin-polarized currents in semiconducting materials, one could combine magnetic storage with electronic readout in a single semiconductor device, resulting in a number of obvious benefits.

Marco Malvestuto

Original publication:
S. Laterza, A. Caretta, R. Bhardwaj, R. Flammini, P. Moras, M. Jugovac, P. Rajac, M. Islam, R. Ciancio, V. Bonanni, B. Casarin, A. Simoncig, M. Zangrando, P. Ribic, G. Penco, G. de Ninno, L. Giannessi, A. Demidovich, M. Danailov, F. Parmigiani, M. Malvestuto, *"All-optical spin injection in silicon investigated by element specific time-resolved Kerr effect"*, Optica 9 (11), (2022); Doi: 10.1364/OPTICA.471951

FLASH

Tracking Charge in Motion. Femtosecond electronic movies of light-excited nucleobases

Nature is rich in molecules that absorb light and transform it into other forms of energy like chemical bonds, charge separation or simply heat. The conversion process involves a complex interplay of the electrons, which initially absorb the light energy, and the nuclei, which change their positions in reaction to the electronic excitation. Observing the molecular dynamics separately from the electronic or nuclear perspective deepens our understanding of photoenergy conversion and thus brings us closer to designing absorbing molecules to achieve a certain photochemical process. Time-resolved x-ray photoelectron spectroscopy (XPS) studies at FLASH allow reconstructing valence charge at the probed atom, thus creating an electronic molecular movie [1].

We have concentrated on x-ray probing of photoinduced dynamics of nucleobases in several studies [2,3]. These molecules strongly

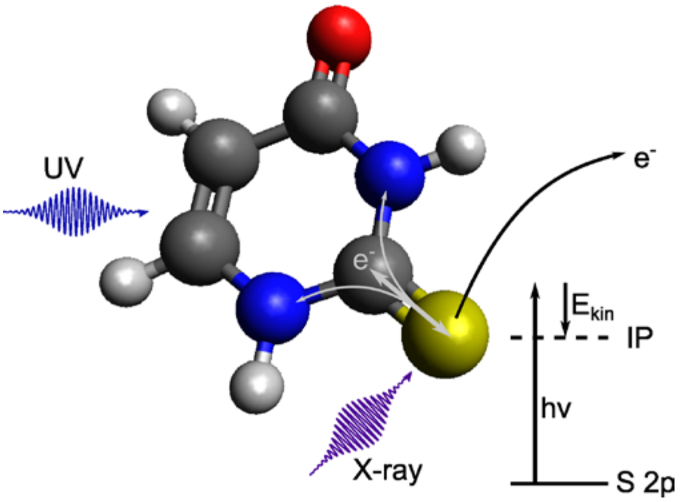


Fig. 1: 2-Thiouracil is UV excited, initiating a charge flow away from the sulfur atom (yellow). A soft X-ray pulse from FLASH, tuned on the sulfur 2p core electrons, ionizes the excited molecule. The electrons are emitted with a distinct kinetic energy, which is shifted by the valence charge on the sulfur atom.

interact with ultraviolet (UV) light, and the absorbed energy is converted completely into heat, protecting from UV-induced bond changes. The substitution of only one oxygen atom by a sulfur atom changes this conversion dramatically, leading to the conversion of photoenergy into spin excitations [4]. This is also of practical relevance, as thionucleobases are common medications, for instance in immunosuppression. This case provides an interesting ground for understanding how molecular modifications change the dynamics and energetic outcome of photoexcitation.

We utilize FLASH as an ultrafast camera providing snapshots of the UV-triggered electron motion in 2-thiouracil. As shown in Fig. 1, a UV pulse starts the molecular dynamics by inducing electronic motion and coupled changes in the molecular geometry. An X-ray pulse from FLASH probes the electron dynamics by emitting photoelectrons. We concentrate on the sulfur 2p core emission. The energy needed to eject the 2p electrons and thus their kinetic energy depends on the local valence electron charge at the sulfur atom [5]. Thus, time-resolved XPS can be used to map the valence electron dynamics after UV excitation with high spatial fidelity due to the tight core electron localization.

Figure 2a shows the changes in the kinetic energy of the ejected sulfur core electrons. Right after UV excitation, the electron kinetic energy diminishes, indicating a UV-induced flow of valence electrons away from sulfur. At about 300 fs after UV excitation, the electron kinetic energy shifts again towards higher kinetic energies, showing that valence electrons turn partially back to the sulfur. The oscillation repeats afterward. The calculated molecular valence charge maps, showing a difference in charge between UV-excited and non-excited molecules, confirm the observation. The UV irradiation induces a periodic flow of charge from the sulfur to the molecular ring and back with the experimentally observed period. The valence charge oscillation is induced by changes in the nuclear structure driving the molecule coherently through different electronic states.

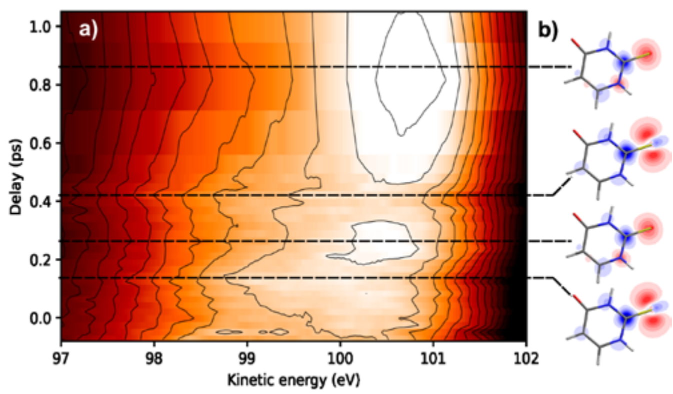


Fig. 2: a) The photoelectron spectrum shows a shift to lower kinetic energies indicating a higher binding energy after UV excitation. On top of the signal, small modulations can be seen which we attribute to periodic changes of the electronic state. 5: b) Charge difference map, with and without UV excitation, at different times after UV excitation. Red indicates less electrons, blue more. The valence charge on the sulfur atom oscillates, which is visualized by the measured oscillations in the core electron kinetic energy.

Our results show that we can image the electronic motion on a femtosecond level from the local perspective of a single atom within the molecule. This information is required to understand the conversion of light energy within molecules. In the future, we will extend this study to observe several atoms within one molecule, thus obtaining a complete molecular electronic movie.

Dennis Mayer
Markus Gühr

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FLASH

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FELIX Laboratory

Infrared spectroscopy sheds light on the formation of complex organics in space

Polycyclic aromatic hydrocarbons (PAHs), in principle large molecules made up from fused benzenoid rings, are produced as toxic pollutants on Earth in combustion processes. In space, they are among the most complex organic molecules detected, and represent a major reservoir for cosmic carbon. However, their formation pathways in cold regions of the universe remain elusive: recent astronomical detections show that current astrochemical models drastically underestimate the abundance of aromatic molecules in cold molecular clouds. These molecular clouds are the birthplaces of new stars and planets, and the detailed study of their chemistry allows astronomers to better understand the process of star and planet formation.

Researchers at HFML-FELIX have now provided novel experimental evidence for alternative formation routes of PAHs in cold environments of the universe. The team set out to study a specific class of reactions, those between a cationic and a neutral molecule. In a pathfinder study they investigated the reaction of the monocyclic pyridine cation with neutral acetylene (C_2H_2). For this, a cold ion-trap instrument stationed at one of the FELIX end stations (collaboration with Prof. S. Schlemmer, University of Cologne) was used which mimics the cold and dilute conditions of molecular clouds. Mass-spectrometric studies showed that larger molecules, corresponding to two added acetylene units, are indeed efficiently formed. However, by only detecting the mass of a certain molecule, no information on its structure can be obtained. Was the product indeed a PAH, or just a pyridine with some dangling acetylene units?

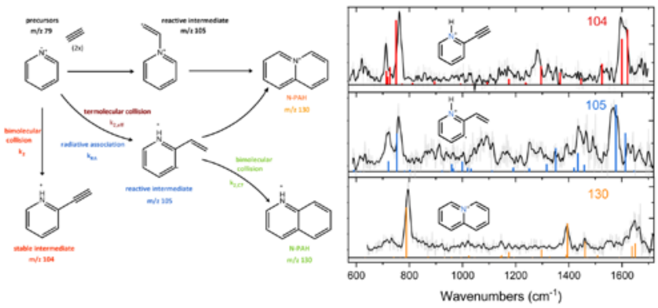


Fig. 1 Schematic reaction scheme from monocyclic pyridine radical cation to the polycyclic quinolizinium (left), as elucidated by FELIX infrared spectroscopy of the reaction intermediates and the final product (right).

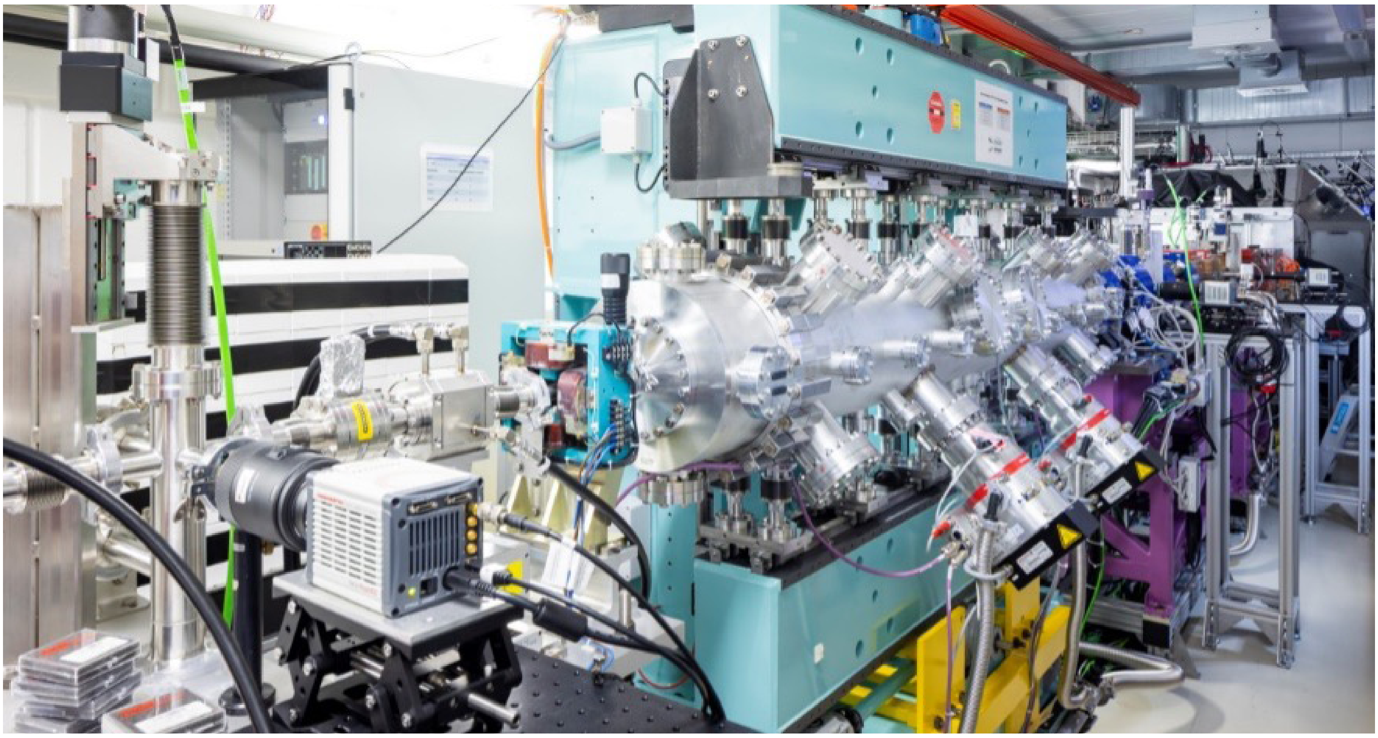
The research team succeeded to answer this question by combining their low-temperature kinetic studies with in-situ infrared spectroscopic probing using the FELIX free-electron laser. Only this unique combination provided the unambiguous experimental proof for the formation of the polycyclic quinolizinium from a monocyclic precursor. Furthermore, spectroscopic identification of reaction intermediates allowed to disentangle competing formation pathways, providing information beyond purely mass-spectrometric and computational studies. The observed quinolizinium belongs to an astronomically interesting but experimentally little studied class of PAHs, and the obtained spectroscopic data can thus act as a basis for future astronomical observations aimed to unravel the formation of PAHs in space, e.g., with the recently launched James Webb Space Telescope.

Sandra Brünken

Original publication:
Low-temperature nitrogen-bearing polycyclic aromatic hydrocarbon formation routes validated by infrared spectroscopy
Daniël B. Rap, Johanna G.M. Schrauwen,
Aravindh N. Marimuthu, Britta Redlich, Sandra Brünken
Nature Astronomy (2022)
DOI: https://www.nature.com/articles/s41550-022-01713-z

SOLEIL / HZDR

Laser plasma acceleration based seeded Free Electron Laser

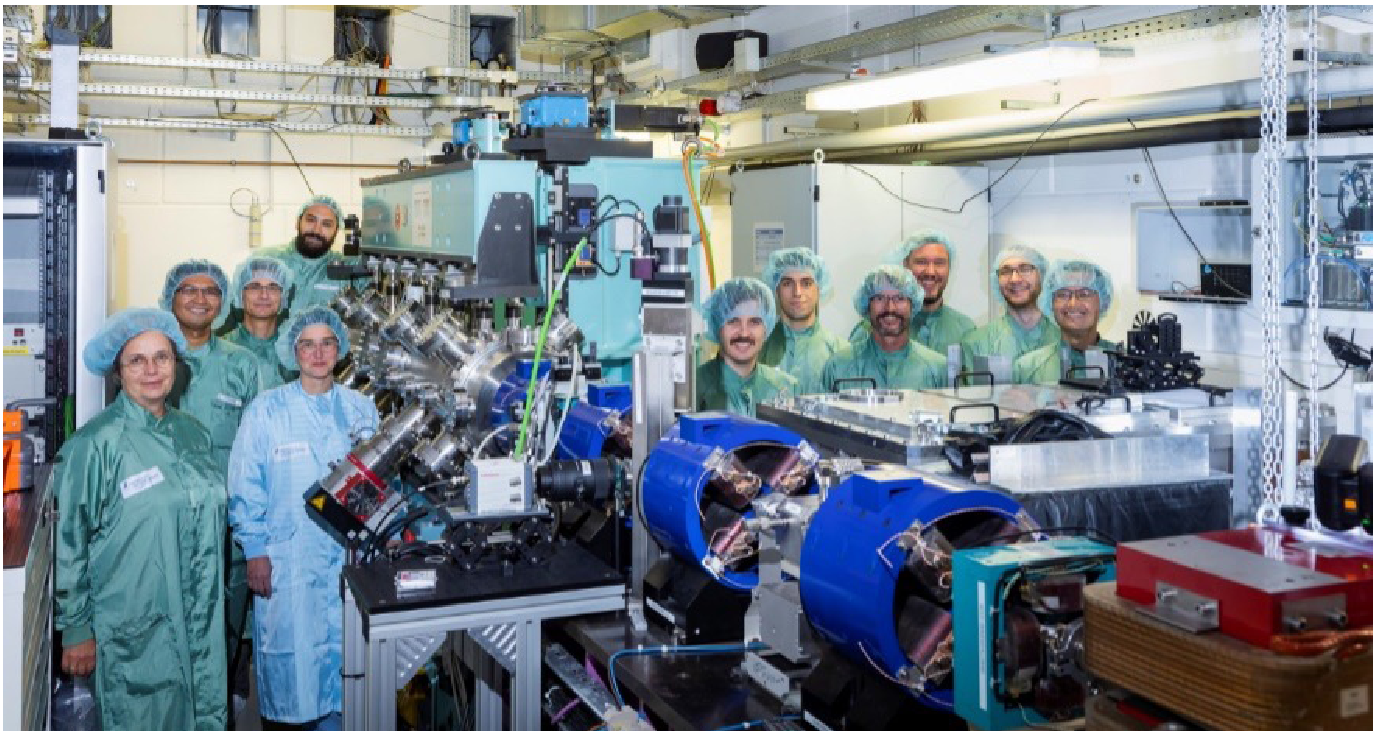


The COXINEL free-electron laser (FEL) line from SOLEIL converts the electron pulses generated by the high-power laser DRACO at HZDR into light flashes: undulator (foreground); metallic beam chamber for the DRACO laser (background). Source: HZDR/Sylvio Dittrich.

The laser discovery followed by the Free Electron Laser (FEL) invention led to the advent of X-ray fully tunable coherent radiation opening new areas for matter investigation with high temporal and spatial resolution. The parallel development of high accelerating gradient Laser Plasma Accelerator (LPA) [1] (0.1 – 10 GeV energy, kA peak current, ultra-short bunches, 1mm.mrad normalized emittance beams) open hopes from them to drive free electron lasers (FEL) light sources [2]. A first FEL amplification driven by an LPA was achieved at a wavelength of 27 nm at SIOM (China) [3] in the Self Amplified Spontaneous Emission regime. Such a configuration still lacks longitudinal coherence. We here report on a first demonstration of an LPA driven Free Electron Laser [4] with the COXINEL line implemented at Helmholtz-Zentrum Dresden-Rossendorf deploying high quality electron produced by the 100 TW class arm of the DRACO laser [5] at 270 nm.

The COXINEL line was designed by Synchrotron SOLEIL in the frame of an ERC Advanced Grant COXINEL (PI M. E. Couprie) considering 200-400 MeV beams with 1 % energy spread, 1 mrad divergence, 1 µm size and 4 kA peak current [6]. It was first implemented in Laboratoire d'Optique Appliquée (LOA) (Salle Jaune) where the LPA electrons were produced and accelerated in the frame of an ERC Advanced Grant X-FIVE (PI V. Malka) [7]. COXINEL line enables to rapidly mitigate the electron divergence via strong focusing using adjustable permanent magnet quadrupoles [8], to stretch longitudinally the electron bunch in a magnetic chicane and reduce the slice energy spread, and to match the beam focusing inside an undulator synchronously with the light progress via a second set of quadrupoles [6]. The beam transport was mastered [9] and the undulator spontaneous emission has been controlled [10]. The electron beam performance at LOA not reaching the targeted one and being not sufficient to achieve lasing, the line has been moved in October 2021 to Helmholtz-Zentrum Dresden-Rossendorf (HZDR) where high quality electrons are produced [5] (see Fig. 1). The LPA is operated in a tailored self-truncated ionization-induced injection scheme [5], where beam loading limits the energy spread [11]. The LPA gas-density profile is directly shaped at the accelerator exit to induce a plasma lens effect, resulting in electron beams with high spectral charge density. Such an electron beam has been transported along the line in Dec. 2021, and undulator spontaneous emission has been characterized. In Feb. 2022, first FEL tests were carried out with a seed prepared by HZDR. The FEL has been achieved in the seeded configuration at 270 nm, where the FEL wavelength has been controlled, taking advantage of the energy and wavelength chirps of both the electron and the seed laser beams [12]. Phase-locked interference fringes between the seed and the FEL pulses were observed, as an evidence of the longitudinal coherence. Such a laser plasma-driven FEL in the seeded configuration demonstrated by the international collaboration (Synchrotron SOLEIL, HZDR, with LOA and PhLAM) (see Fig. 2) sets a major milestone for the advanced accelerator physics community that have been dreaming about realizing such an FEL for years. Through the HZDR-SOLEIL experiment, a tremendous

SOLEIL / HZDR



Together with colleagues from Synchrotron SOLEIL, LOA, PhLAM and HZDR, the German-French team succeeded for the first time in generating well-controllable free-electron laser via plasma acceleration (Dr. Marie-Emanuelle Couprie, Dr. Arie Irman, Prof. Ulrich Schramm, Dr. Marie Labat, Dr. Armin Ghaith, Dr. Maxwell LaBerge, Dr. Driss Oumbarek-Espinos, Dr. Jurjen Couperus Cabadağ, Patrick Ufer, Dr. Yen-Yu Chang; from left to right)/ Source: HZDR/Sylvio Dittrich.

progress for this field is now achieved. But before a LPA-based FEL can be put to practical use, there are still various challenges to overcome. For example, while the setup in Dresden was able to generate UV pulses, research requires high-intensity X-ray pulses - for which the electrons would have to be accelerated to much higher energies. This is already demonstrated in principle with plasma acceleration, but so far, besides the stability, the quality of the electron bunches is to be improved for an X-ray FEL. There is hope brought by a new generation of high-power lasers. If the endeavor succeeds, laser plasma based free-electron lasers could become available to the community.

Marie- Emmanuelle Couprie

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EUXFEL

European XFEL celebrates five successful years of user operation

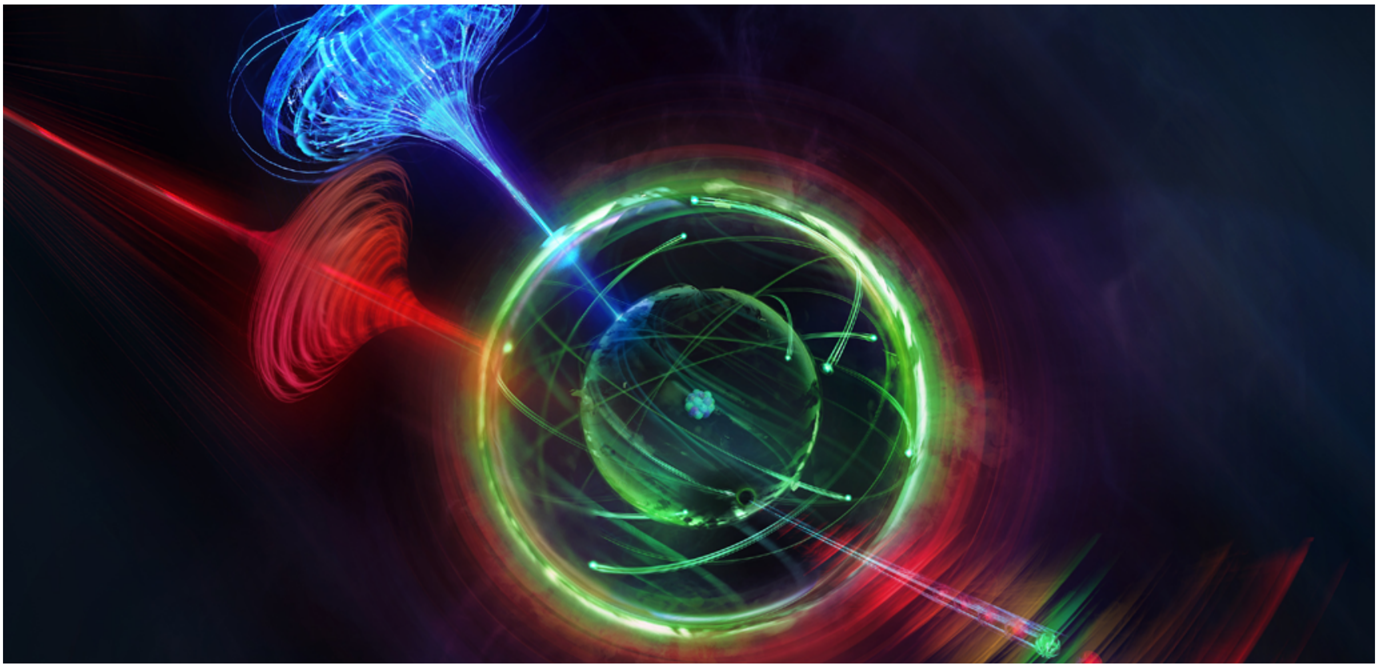


Fig. 1 An ultrashort X-ray pulse and an optical laser pulse interact simultaneously with a neon atom. The X-ray pulse removes an electron from the inner electronic shell and, due to the electromagnetic field of the optical laser that is present at the moment of ionization, the outcoming electron is modulated in energy.
Copyright: illustratoren.de / Tobias Wuestefeld in cooperation with European XFEL.

2022 marks five successful years of user operation at European XFEL. More than 1550 users from 31 countries performed over 200 experiments at the facility this year, despite the persistence of on-going COVID-19 restrictions limiting in-person gatherings. European XFEL also delivered an unprecedented 8000 hours of beamtime.

In October, European XFEL also started with the commissioning of a new instrument: the soft x-ray port (SXP). The instrument is an extension of European XFEL's soft x-ray capabilities, and will allow users to bring and temporarily establish their own experiment setups. First experiments at SXP will begin in 2023, starting with the demonstration of time and angle-resolved photoelectron spectroscopy (TR-XPES) on solids. This technique, in combination with the European XFEL's ultrashort pulses, will enable experiments that provide an advanced understanding of the electronic, magnetic as well as the chemical and atomic structure properties of solid materials.

In addition to SXP, the experimental hall at European XFEL hosts a total of six fully operational instruments. The capabilities available at European XFEL enable experiments in fields such as biochemistry, medicine, nanotechnology, material science, quantum physics and energy technology. European XFEL also aims to solve some of the biggest challenges facing global society, from health, to climate, to environment and energy, to digitalisation. The following highlights shine a light on some of the experiments performed over the last year.

In an experiment at European XFEL's small quantum systems (SQS) instrument, a research team from European XFEL and DESY demonstrated the best time resolution reported to-date in a pump-probe experiment at an X-ray free-electron laser facility. The experiment at SQS consisted of measuring the "duration" of an instantaneous effect that occurs when an atom is ionized by X-rays in the presence of an optical laser. The researchers achieved a time resolution of around 15 femtoseconds, on the timescale at which the atoms in a material react. The results open up the possibility of conducting experiments with unprecedented time resolution, meaning that scientists could make molecular movies of ultrafast processes that were previously inaccessible.

A study led by Stockholm University, the University of Tübingen, the University of Siegen and European XFEL has identified a new way of probing protein dynamics using the materials imaging and dynamics (MID) instrument. Typically, the combination of high pulse rates and high energy radiation from XFELs can damage proteins or cause them to react. By lowering the X-ray radiation dose and frequently moving the protein samples, the researchers identified a way of probing the dynamics of the proteins before damage sets in, alongside measuring the impact of the X-ray beam on the motion of the proteins. The technique, megahertz X-ray photon correlation spectroscopy (MHz-XPCS), could open new applications in health and pharmaceuticals.

In another research highlight, an international collaboration developed a new technique for tracking the reactions of proteins, potentially paving the way to better treatments for disease. The technique, multi-hit serial femtosecond crystallography (SFX), was developed by a team of over 50 researchers led by La Trobe University. The researchers used the Single Particles, Clusters, and Biomolecules & Serial Femtosecond Crystallography (SPB/SFX)

Painting by European XFEL artist-in-residence Alona Kubasova showing Leading Scientist Ulf Zastrau at the HED instrument. (artist in residence at European XFEL).

instrument to demonstrate the new technique, which aims to hit a single biological sample twice with the X-ray beam in less than a microsecond while keeping the target intact. This allows scientists to monitor the reactions of proteins as they move, on sub-microsecond time scales. Multi-hit SFX is particularly useful for studying molecules undergoing irreversible processes, which cannot be measured using synchrotrons or lab-based X-ray sources. As 2022 draws to a close, European XFEL looks back at a successful year despite particularly difficult circumstances: the war in Ukraine, and the ongoing COVID-19 pandemic. In particular, we highlight the compassion of our staff in supporting refugees of the war through volunteering. We were also happy to be able to host 30 refugees in our Guest House on site. Though difficult circumstances persist, the facility remains optimistic for the year ahead, hoping to increase the available beamtime for users, as well as increasing the number of users who can visit our campus.

Anita Mary Chandran

STFC

UK XFEL Conceptual Design and Options Analysis underway

UK Research and Innovation has released £3.2m to fund a UK XFEL Conceptual Design and Options Analysis as part of a major investment in future UK research and innovation infrastructures. This new study, which started on 1st October 2022 and will run for three years, will evaluate a number of options to enable UK researchers' access to next generation XFEL capability as articulated in the UK XFEL Science Case. As well as evaluating a new facility based in the UK, the study will also evaluate the options of investing in overseas facilities to enhance their current capabilities and capacity.

Following the announcement, the project team, largely based at STFC Daresbury Laboratory, has developed a detailed plan and timeline. The science team, which drafted the Science Case, has already been expanded and engagement with the facility designers has stepped up to discuss in detail the capabilities that UK researchers require from a next generation XFEL. The project was formally launched at a public event at the Royal Society in London on 30th January 2023. Reports on the launch have been published in Physics World and Chemistry World. A series of workshops on the science and technology that will enabled by a next generation XFEL will be held around the UK over the next two years to inform the refresh of the science case and to ensure the facility designers fully understand the user requirements

Jim Clarke

FELIX Laboratory

FELIX free electron laser: Extension of the wavelength range realized

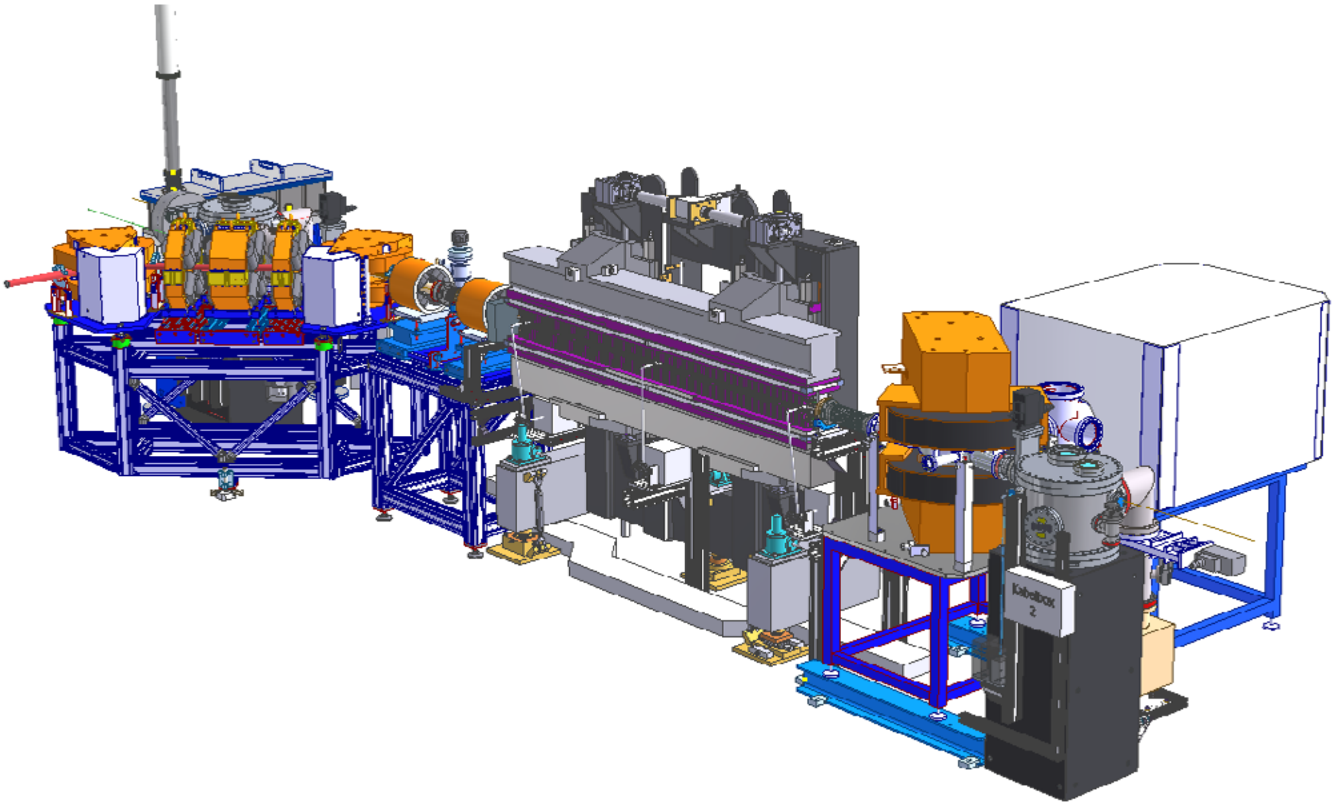


Fig. 1 Overview technical drawing of the novel FELIX-2 laser undulator and resonator.

Begin May, a brand-new undulator produced its first light at HFML-FELIX, thereby extending the tuning range of the FELIX-2 beamline to 3 micron.The free electron lasers at Radboud University in Nijmegen, the Netherlands, provide high-intensity, widely tunable and ultra-short pulse radiation in the infrared and terahertz spectral range. Until now, the suite of four free electron lasers covered a wavelength range from 5 to 1500 µm. Pulse duration and micropulse energy vary with wavelength but range typically between 1-50 ps and 5-50 µJ.

After a period of design and construction in collaboration with colleagues at the Fritz-Haber Institute in Berlin, during a 6-week reconstruction period the FELIX technology team has installed and commissioned the undulator and renewed the FEL laser cavity. With the new FELIX-2 undulator, the wavelength coverage is extended to 3 micron and an increase in stability is realize by the novel cavity design - a significant upgrade to exploit FELIX further by expanding its spectroscopic capability.

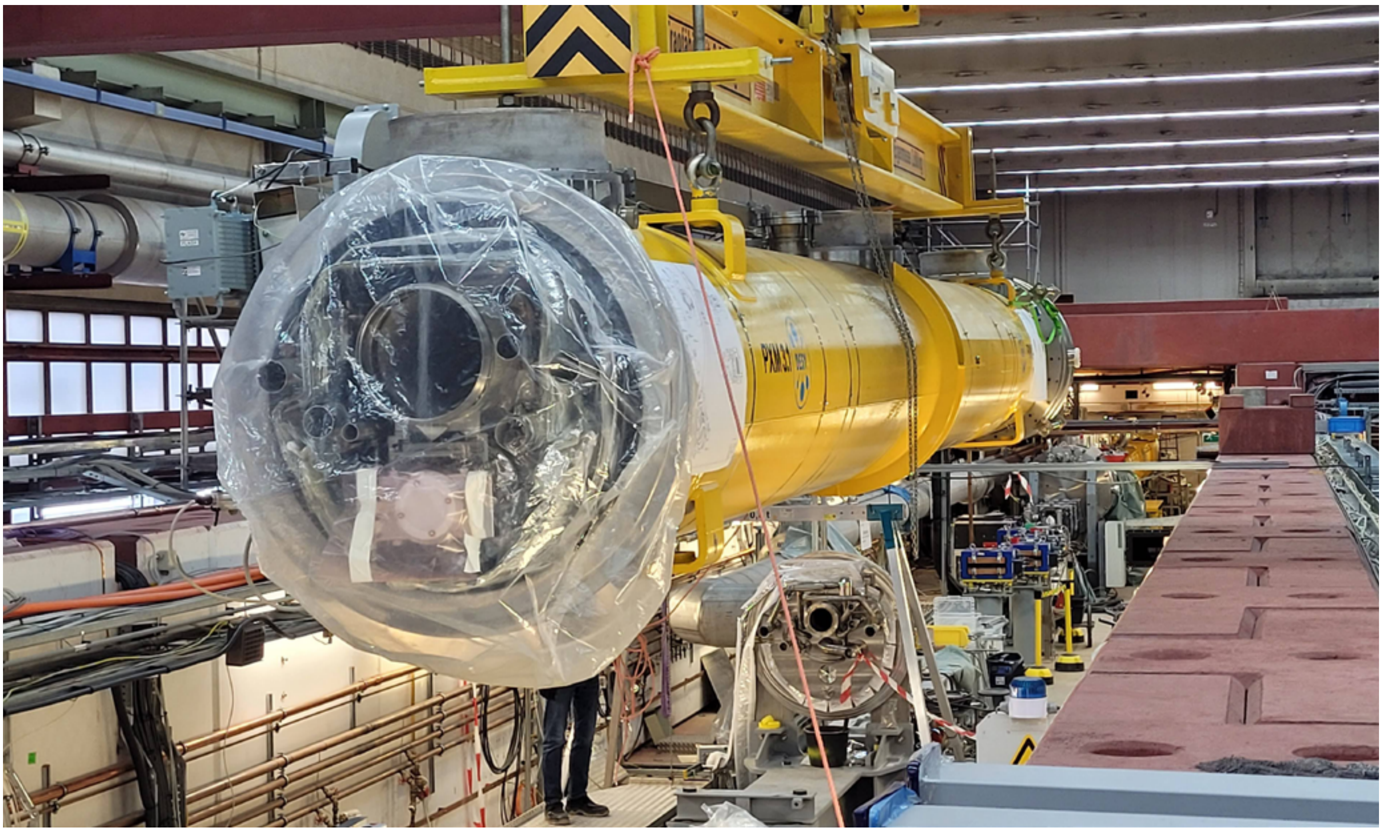
Britta Redlich

FLASH restarts user operation with new and improved features for users

With the successful completion of a 9-month shutdown and installation period focussing on upgrading the superconducting linear accelerator, the FLASH facility commenced operation in fall 2022. Already the first user experiment at the beginning of November benefited from energies higher than ever before available at FLASH. While the photoinjector and first acceleration module with attached phase space lineariser stayed mostly untouched during the shutdown, the complete part up to modules ACC4 and 5 had been removed. The empty space was then refilled with new components. Among these are a laser heater, which allows controlling the sliced energy spread of the electron beam and thus reduces fluctuations of the current imprinted by the so called microbunching instability, and fast orbit correctors, which allow to homogenise the electron beam trajectories at full MHz repetition rate. Both of these upgrades are expected to result in more stable conditions for user experiments and are expected to become available after finishing their commissioning in early 2023. Additionally two new accelerating modules have been installed boosting the energy of FLASH by an additional 100 MeV and extending the maximum beam energy to 1.35 GeV which in turn allows for user experiments in the sub 4 nm regime. Here, the first demonstration has already been performed during the very first user beamtime week after the shutdown where the machine was operated at an energy of about 1290 MeV allowing to generate a photon beam of 3.7 nm wavelength at FLASH1 while supplying a small bandwidth (0.3%) soft x-ray beam of 4 nm to the FLASH2 user experiment.

The FLASH facility will operate in the current configuration for the next 1.5 years allowing to fully develop the latest upgrades and bring the electron beam to perfection for the upcoming transformation of FLASH1 to an externally seeded beamline. The second shutdown will start in mid 2024 with completely removing the existing FLASH1 beamline to allow for the required infrastructure changes at the accelerator tunnel. The latter than is repopulated with a completely newly designed beamline delivering highly stable Fourier-limited pulses at 1MHz repetition rate to users starting end of 2025.

Lucas Schaper



New accelerating module being hovered to its destination in the accelerator tunnel. Compared to the original modules the new ones support an increased accelerating gradient and thus will allow an by 100 MeV increased energy gain.

Science@FELs 2022

The 2022 Science@FELs conference was held at DESY and European XFEL in Hamburg in September 2022 with nearly 150 participants in attendance from 12 countries. It is held every two years by FELs of Europe, a collaboration of the free electron laser facilities in Europe, and has evolved into one of the most important international meetings in FEL science. This year also marks the 10th anniversary of the FELs of Europe collaboration.

Praveen Maroju being awarded the FEL Science and Applications prize by Serguei Molodtsov, scientific director of European XFEL and chair of the Management Board of the Steering Committee of the FELs of Europe cooperation. Photograph by Holger Weigelt, DESY.

Josef Feldhaus (formerly DESY), first FELs of Europe Chair on how it all began.

Following the online conference in 2020, it was exciting to welcome so many visitors in person again in Hamburg and discuss recent achievements and developments in FEL science and applications. The conference addressed a diverse range of topics from biology and chemistry, to theory and FEL engineering. To bring PhD students and young postdocs into the field, the conference started out with three dedicated expert tutorials for young researchers, as has become a tradition in this conference series. The programme was completed by tours of FLASH, the soft X-ray FEL at DESY, and by an in-person poster session and reception held at European XFEL accompanied by tours of the EuXFEL experimental hall.
Science at FELs represents a unique opportunity to gather the expertise of the community, and work together to tackle the big challenges facing FEL science today. To acknowledge the exciting contributions of the next generation, Fels of Europe presents the FEL Science and Applications prize to a young researcher under 35. This year's FEL Science and Applications prize has been awarded to Praveen Maroju from the University of Freiburg. Maroju's work primarily focuses on generating and characterising attosecond-duration pulses at soft X-ray free electron laser (FEL) facilities.

The community finally seeing each other again in person.

The conference was followed by an expert workshop - the 'Forum on Advanced FEL Techniques' - which aimed at bringing together experts and FEL users to support collaboration and coordination between facilities and user groups.

For further information, please check the conference website: www.desy.de/scienceatfels2022

Elke Ploenjes-Palm

FELs of Europe Tutorials 2022

At the Science@FELs conference series, the programme always starts out with focus tutorials led by eminent FEL scientists and specifically addressing younger members of the FEL community. The tutorials introduce hot topics in the field of FEL science with larger depth than usually possible in conference talks.
Since these tutorials were always well received in the community, FELs of Europe, together with the LEAPS Strategy Group SG2 on FELs, in 2021 – during the pandemic - has started a regular online tutorial series for young scientists in the field. The tutorials, which are organized by DESY and European XFEL, take place on the first Monday of about every other month at 17:00 (CET). At the Science@ FELs 2022 conference, three focus tutorials could be followed both, in person at DESY and also online. Many of the tutorials have been taped and can be made available upon interest.
We are looking forward to an exciting programme also in 2023. Please register for the events at: www.desy.de/foetutorials

Elke Ploenjes-Palm

About FELs of Europe

FELs OF EUROPE is an initiative of the ESFRI projects EuroFEL and European XFEL. It is a collaboration of all free electron laser (FEL) facilities in Europe, with the goal to meet technological and scientific challenges of these novel and rapidly developing technologies, and to provide a worldwide unique, pan-European research infrastructure that enables exploiting the full scientific potential of these unique accelerator based short-pulse light sources. The collaboration includes 14 facilities in 10 countries.

All members are either operating or developing free electron laser (FEL) facilities and/or advanced short-pulse light sources (SPS), based on accelerator technologies. Due to their unique properties, these light sources provide a step change in the ability to address research needs across the disciplines of physics, chemistry, materials, and life sciences. FELs will improve our understanding of processes on a molecular level, leading to development of new materials and methods for tomorrow's technological advancement, clean environment, sustainable energy, and health care.

FELs OF EUROPE will facilitate the enhancement and exploitation of the full scientific potential of FELs in an efficient way by promoting joint technical development and collaborating closely with users and related communities. It will promote efficient open access to the research infrastructure and optimal conditions for users.

More info at: www.fels-of-europe.eu

CURRENT AND UPCOMING CALLS FOR PROPOSALS

www.fels-of-europe.eu/user_area/call_for proposals

For experiments at FERMI
Deadline: 31 May 2023
For experiments at FELBE
Deadline: 20 March 2023
For experiments at FELIX
Deadline: 15 May 2023
For experiments at SwissFEL
Deadline: 15 March 2023
For experiments at FLASH
Deadline: Not yet defined

UPCOMING EVENTS

Webinar Series in 2023:
Follow the announcements on
https://www.fels-of-europe.eu/

Ultrafast X-Ray Summer School (UXSS),
at Center for Free-Electron Laser Science
in Hamburg
June 12-16 2023

HFML-FELIX user meeting, June 13-15th
https://www.ru.nl/hfml-felix/news-events/news/news/hfml-felix-user-meeting-2023-take-place-june-13-15/

PhotonDiag Conference 2023 organized by Elettra at ICTP Triëst
12-14 September 2023

Science@FELs Conference - organized by Soleil and Sorbonne University
17-21 June 2024

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