FELS OF EUROPE NEWS 1|17

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

A view of the photon tunnel during the ceremony. Credit: European XFEL

European XFEL officially begins commissioning phase

Around 350 guests from politics, administration, the diplomatic corps, scientists from around the world, and employees of European XFEL and its closest partner DESY celebrated the beginning of commissioning of the European XFEL on 6 October at its new campus in Schenefeld in the metropolitan area of Hamburg, Germany.

Katharina Fegebank, Senator for Science, Research, and Equality for the Free and Hanseatic City of Hamburg, and Dr. Piotr Dardziński, Under-Secretary of State of the Polish Ministry of Science and Higher Education, bolt in a section of beamline in the European XFEL tunnel together with European XFEL Director Prof. Massimo Altarelli, signifying the start of commissioning of the facility.
Credit: European XFEL

In one of the underground tunnels near the facility's experiment hall, representatives of the partner countries mounted an approximately two-metre-long beamline tube, as a symbolic act of installing one of the final still-missing pieces of the X-ray laser.

"Thanks to the very intense and highly competent work of the European XFEL staff, of the staff of the DESY accelerator division and of the partner laboratories, we are now ready to gradually switch on the whole facility, with the goal to start operation of the facility in the early part of 2017", Chairman of the European XFEL Management Board Massimo Altarelli said at the event. "I would like to thank all the people involved who are turning this long-standing dream of the science community into reality."

Claudio Masciovecchio, Michele Svandrlik

PhotonDiag2017 - Workshop on FEL Photon Diagnostics, Instrumentation, and Beamline Design

LCLS, the Linac Coherent Light Source of SLAC National Accelerator Laboratory, will in collaboration with Fels of Europe organize and host the third edition of the PhotonDiag workshop series - PhotonDiag2017 on May 1 -3, 2017. For the first time, Fels of Europe will sponsor the PhotonDiag award for scientific excellence in free electron laser photon diagnostics, instrumentation and beamline developments. The prize will be accompanied by a certificate and a monetary sum of 1000 euros.

The previous two editions of PhotonDiag have been successfully organized by DESY, Hamburg (PhotonDiag2010) and Elettra, Trieste (PhotonDiag2015) and have seen scientists and engineers, from all around the world, gathering together to discuss new optics and diagnostics developments as well as beamline and instrumentation design for free electron lasers (FEL).

In this third edition, the organizing committee would like to extend the invitation to, and enrich the audience with, representatives of the future diffraction limited storage rings (DLSR), or multi-bend achromat (MBA) storage rings, who will face, soon, the problems and needs the FEL community is facing now.

The workshop will be held at the SLAC campus, taking advantage of the large conference facilities and of the outdoor areas for social activities. Further information can be found here.

Daniele Cocco, LCLS

SwissFEL Inauguration

On the 5th of December 2016, the Paul Scherrer Institute PSI held an inauguration ceremony for its new large-scale research facility SwissFEL, with Johann N. Schneider-Ammann, President of the Swiss Confederation, in attendance. Scientific breakthroughs the Swiss free-electron X-ray laser is expected to generate will drive important developments in the areas of energy and environment, information technology, and health.

Read more

Mirjam van Daalen

Inauguration of the MAX IV Laboratory

On 21 June 2016 the MAX IV Laboratory was inaugurated during four days of festivities. Two days were devoted to visits for the open public. A "Science day" gave the users a first access and the fourth day encompassed the large inauguration ceremony followed by a party for the Staff in the evening. Today all accelerators are up running and the performance is being fine-tuned. First users will be welcomed on the 3 GeV during the winter.

The MAX-lab inauguration music Elysium by Mahan Moin, can be heard on Spotify and YouTube.

A video from the inauguration ceremony can be seen on YouTube.

Sverker Werin

The Swedish King (right), the Swedish Prime Minister Stefan Löfven (left) and the Director of MAX IV Laboratory Christoph Quitmann (the happy guy) have just symbolically closed the door to the MAX IV 3 GeV ring to enable start of operations. (Photo: Kenneth Ruona)

Short-wavelength, fully coherent Free Electron Laser light is now available

FERMI is the only short-wavelength seeded Free Electron Laser in the world, as other machines operate on the SASE principle (Self Amplified Stimulated Emission). The seeding process confers a number of desirable properties, such as wavelength stability, and above all, longitudinal coherence, which are not provided by SASE sources. Like SASE source, FERMI's light is transversely coherent. Longitudinal coherence implies that the electromagnetic oscillations of the light field have a well-defined phase relationship over the duration of the pulse. This is manifested as a narrow bandwidth, close to the Fourier limit, and is important in experiments where precise tuning is required. Until recently, there had been no experiment in which the longitudinal coherence of FERMI was exploited directly. Now, using the Low Density Matter beamline of FERMI, an international team has demonstrated that the light from FERMI is not only coherent, but multicolor pulses containing commensurate wavelengths retain mutual coherence between the wavelengths.

The team is made up of researchers from Italy (Elettra-Sincrotrone Trieste, the Politecnico of Milano, and the IFN, IOM and ISM institutes of CNR), Japan (University of Tohoku), Russia (Lomonosov Moscow State University), USA (Drake University, Des Moines, Iowa) and Germany (Technical University of Berlin, Freiburg University, European XFEL, Max Planck Institute for Nuclear Physics, Heidelberg). They worked together to devise and perform an experiment in which FERMI was run in a special mode to produce two overlapping coherent beams of light, which then ionized a neon gas sample. Extensive calculations were required to predict both the machine performance, and the outcome of the experiment, whose results have been published in Nature Photonics [1]. In Figure 1 a schematic representation of the phase scan of the first and second harmonics is shown.

The two beams of light were first and second harmonics of the chosen wavelength, and the first harmonic ionized atoms by a two photon process, while the second harmonic ionized by a single photon process. If, and only if, the two colors are mutually coherent, the emitted photoelectrons may interfere. Mutual coherence means that the electromagnetic oscillations of the wavelengths have a definite phase, or temporal, relationship in a given pulse of light. Interference is observed as an asymmetric photoelectron angular distribution (PAD) - for single photon ionization, the PAD is always symmetric about the direction of propagation of the light. Moreover, when the phase was scanned, the asymmetry varied, as predicted by theory [2].

This kind of experiment has historically been performed with optical lasers [3], and is known as a Brumer-Shapiro type experiment [4]. However, it has not been demonstrated at the short wavelengths used here, 63 and 31.5 nm. The reason is that the relative phase of the two beams of light must be controlled with a temporal resolution much less than the period of the light, 100 attoseconds, and the techniques used for optical lasers do not work for short wavelength radiation. The experiment achieved a resolution of about 3 attoseconds, using an innovative phase tuning scheme devised by the FERMI machine physics staff. This excellent result promises well for extension of the technique to much shorter wavelengths.

Demonstration of multi-wavelength coherence and control of the phase opens up new possibilities for FEL research. Modern attosecond science with High Harmonic Generation lasers is based on control of amplitude and phase of multiple wavelengths. As well, the new method permits the manipulation of quantum systems with extreme temporal precision. K. Prince, C. Callegari

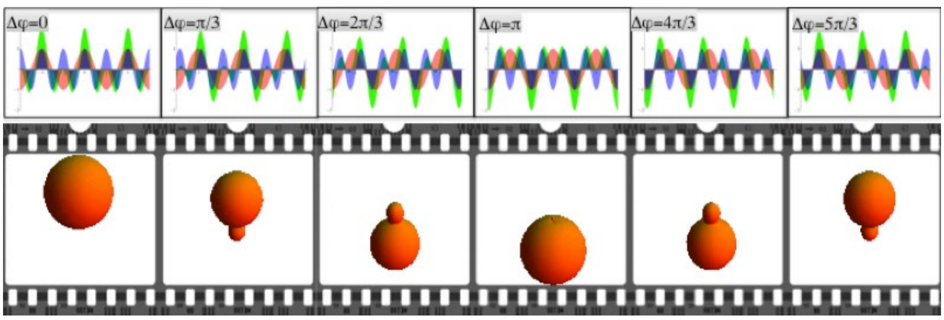
See also: www.medea-horizon2020.eu

[1] K. C. Prince, E. Allaria, C. Callegari, R. Cucini, G. De Ninno, S. Di Mitri, B. Diviacco, E. Ferrari, P. Finetti, D. Gauthier, L. Giannessi, N. Mahne, G. Penco, O. Plekan, L. Raimondi, P. Rebernik, E. Roussel, C. Svetina, M. Trovò, M. Zangrando, M. Negro, P. Carpeggiani, M. Reduzzi, G. Sansone, A. N. Grum-Grzhimailo, E.V. Gryzlova, S.I. Strakhova, K. Bartschat, N. Douguet, J. Venzke, D. Iablonskyi, Y. Kumagai, T. Takanashi, K. Ueda, A. Fischer, M. Coreno, F. Stienkemeier, E. Ovcharenko, T. Mazza, M. Meyer, "Coherent control with a short-wavelength Free Electron Laser" Nature Photonics 10, 176 (2016), DOI: 10.1038/NPHOTON.2016.13

[2] N. B. Baranova and B. Ya. Zel'dovich, "Physical effects in optical fields with non-zero average cube" J. Opt. Soc. Am. 8, 27–32 (1991).

[3] Y.-Y. Yin, C. Chen, D. S. Elliott, and A. V. Smith, "Asymmetric photoelectron angular distributions from interfering photoionization processes" Phys. Rev. Lett. 69, 2353 (1992).

[4] P. Brumer and M. Shapiro, "Control of unimolecular reactions using coherent light" Chem. Phys. Lett. 126, 541–546 (1986).



Top row: electric fields of the fundamental (red), second harmonic (blue), and their sum (green) at the phases indicated. Bottom row: Emission intensity of a p + d wave for the corresponding phases; the lobes represent the direction and intensity of emission.

A combined scattering and spectroscopic analysis on single clusters at FLASH uncovers intricate nanoplasma heating

Atomic clusters in the gas phase are fascinating nanoscale laboratories for studying laser-matter interactions across all wavelength regimes from the infrared to the x-ray region. So far, however, the interpretation of spectroscopic features in laser-cluster experiments has been complicated by the unavoidable averaging over both the cluster size distribution and the laser intensity profile. A new quality of analysis is achieved when employing intense short-wavelength pulses from extreme ultraviolet (XUV) and X-ray free-electron lasers as they permit a combined analysis of single clusters: In parallel to the spectroscopic analysis of interaction residuals, a 'photograph' of the cluster is taken by simultaneously recording the elastically scattered light. As both target size and local laser intensity are encoded in the shape and brightness of the diffraction image, this approach solves the averaging problem of gas-phase cluster experiments. This single-shot technique was exploited to analyze ionic residuals of xenon clusters under intense XUV pulses from FLASH, leading to the observation of a so far unnoticed heating mechanism based on recombination in the cluster nanoplasma.

In the experiment, the single-shot diffraction images have been measured in parallel to ion time-of-flight data to study nanoplasma dynamics induced in single xenon clusters by intense XUV pulses. The cluster size and FEL intensity were inferred for each shot from the single-cluster scattering patterns. From the corresponding size-tagged single-cluster ion spectra we could extract the kinetic energy distribution for each charge state separately. One particularly striking observation is the rather narrow kinetic energy distribution of the residual ions. The average kinetic energy per average charge state was found to be more than an order of magnitude higher than expected and slow ions are virtually absent, though being expected to dominate the signal for our scenario.

The physical picture that explains these discrepancies is connected to energy redistribution processes accompanying the massive electron-ion recombination in the dense nanoplasma. Due to the hydrodynamic pressure from hot nanoplasma electrons, the surface ions of the cluster are quickly expelled (see sketch) and the temperature of the nanoplasma electrons is reduced due to expansion cooling – similar to the adiabatic expansion of a gas. According to this picture, the kinetic energy of the nanoplasma electrons is transferred predominantly to ions at the cluster surface, with expected ion energies per charge state of roughly the initial electron temperature. At the same time, ions in the inner core are screened by the plasma electrons and are thus less efficiently accelerated. As a result, inner ions have much more time to recombine eventually to neutral xenon atoms. Each electron recombining with an ion via three-body-recombination releases its residual kinetic energy plus its binding energy to the remaining nanoplasma electrons. In consequence, the plasma temperature increases (or decreases less rapidly), providing additional energy that is released to the emitted surface ions.

This identified redistribution of energy can be seen as 'recombination heating'. When accounting for recombination processes in theoretical modelling of the dynamics, for example via atomistic simulations of the electron and ion dynamics in the nanoplasma, the observed characteristic features of the 'recombination heating' can be explained, i.e.(i) the peaked ion energies, (ii) the absence of slow ions, and (iii) an increased average ion kinetic energy. The fundamental understanding of energy transfer processes in laser-induced nanoplasmas has implications for many fields ranging from matter under extreme conditions to biophysics, aerosol science, and X-ray imaging of nanoparticles. Daniela Rupp, Thomas Fennel

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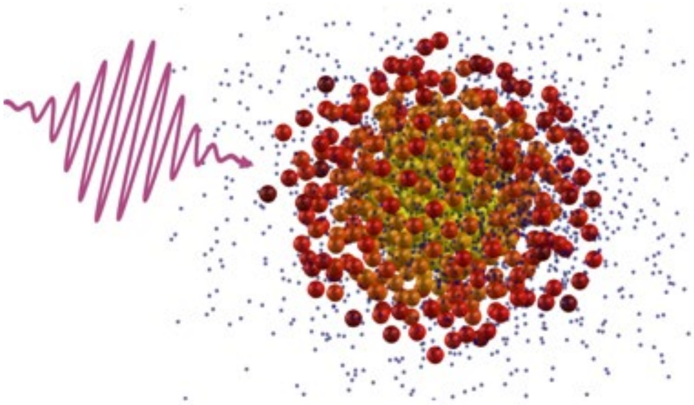
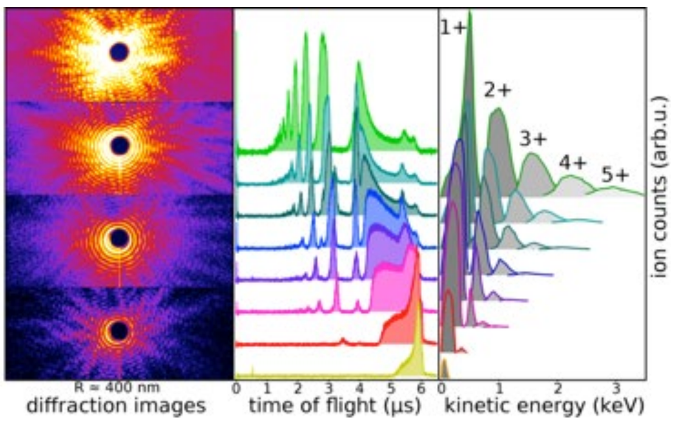
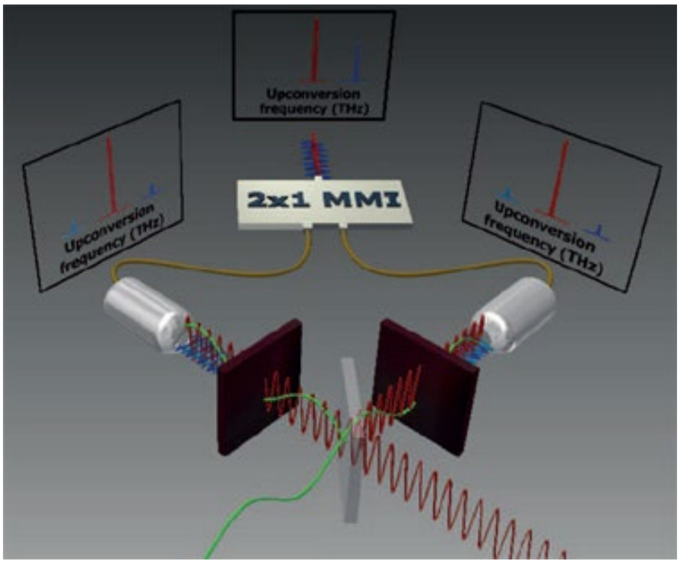
Original publication:
'Recombination-enhanced surface expansion of clusters in intense soft X-ray laser pulses', Phys. Rev. Lett. 117, 153401 (2016);
https://doi.org/10.1103/PhysRevLett.117.153401





Terahertz communication component demonstrated at FELIX

Wireless high-speed data communication using terahertz (THz) carrier frequencies allows data rates beyond 100 Gbit/second. A difficulty in the implementation of THz radiation is the substantial free-space loss as a result of the distance to the source and atmospheric attenuation (rain and fog). A promising solution is the use of the radio-over-fiber backbone network where THz signals are transported over long distances through optical fibers and only wirelessly transmitted over a relatively short distance at the beginning and the end of the connection.
At megahertz and gigahertz frequencies, optical single-sideband (OSSB) modulators are utilized in radio-over-fiber networks to mitigate the effect of chromatic dispersion-induced propagation losses in optical fibers. Simple modulation of laser light generates two sidebands (at different wavelengths) that interfere with another in the fiber, thereby scrambling the information which is sent through the fiber. OSSB modulation is a method to prevent the scrambling of information by selectively extinguishing one sideband. An OSSB modulator at THz frequencies forms an experimental challenge, especially for broad bandwidth operation.
Scientists at the Radboud University's FELIX infrared free electron laser laboratory have developed and demonstrated a scheme for THz OSSB generation for free space radiation between 0.3 and 1.0 THz using a specially designed dichroic beamsplitter for THz and optical radiation and a planar light-wave circuit with multimode interference structures. The THz OSSB modulator has no frequency dependent tuning element over this THz region.



The setup is shown in the figure. The THz wave (from the FLARE beam line at FELIX; shown in green) and the optical laser (red) are both split in half by a beam splitter (grey plane), providing the necessary phase shifts of the waves. The laser light is mixed with the THz radiation in electro-optical crystals (brown planes), and subsequently two sidebands (blue waves) are generated in each crystal. The optical light (carrier and sidebands) in both branches is coupled into fibers and combined in the multimode interference structure (MMI). The result is that one sideband extinguishes while the intensity of the other sideband is increased by a factor four, solving the problem of THz signal distortion in the optical fiber network.

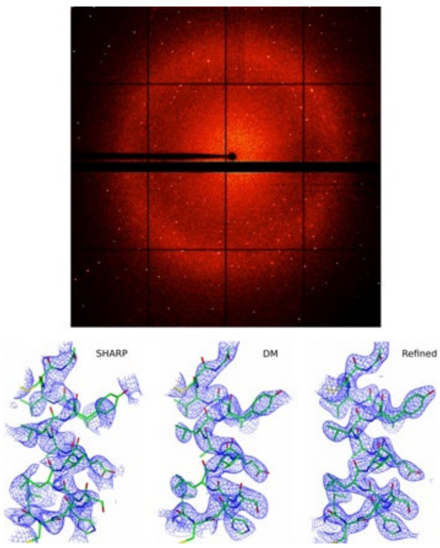
G. Berden

Reference:

"An ultrawide-bandwidth single-sideband modulator for terahertz frequencies"; A.S. Meijer, G. Berden, D.D. Arslanov, M. Ozerov, R.T. Jongma, W.J. van der Zande, Nature Photonics 10, 740-744 (2016)
Doi: 10.1038/nphoton.2016.182

First protein structure solved using the JUNGFRAU detector

JUNGFRAU is a charge-integrating, two-dimensional pixel detector developed at the Paul Scherrer Institut for use at free-electron lasers, in particular SwissFEL, and synchrotron light sources. On the 10th October, the first protein crystallography experiment using the JUNGFRAU detector, was performed at the beamline X06SA (PXI) of the Swiss Light Source by the members of the Protein Crystallography and Detectors groups at PSI. Diffraction from single, native insulin crystal was recorded on two JUNGFRAU modules consisting of one million pixels in total. The data were of excellent quality, as judged by the overall crystallographic data statistics. It was possible to perform de novo structure determination from this data using single-wavelength anomalous diffraction phasing method. This result demonstrates that the quality of diffraction data recorded using the JUNGFRAU detector is sufficient for obtaining accurate measurements of Bragg peak intensities, which were necessary for successful structure solution. Mirjam van Daalen



The Soft X-ray Laser at MAX IV

A Soft X-ray Laser (SXL) beamline has been proposed at the MAX IV facility. The initiative was taken by Anders Nilsson from Stockholm University in the fall of 2015 by the formation of a working group with representatives from most major Swedish universities aimed at developing a science case for the SXL. A workshop [1] devoted to SXL science, organized in Stockholm in March 2016, stimulated the development of the science case which has recently been finalized [1]. The workshop was attended by several key persons of the international FEL community and furthermore demonstrated a very strong interest for a SXL at MAX IV by the large number of Swedish participants (more than 100 scientists).

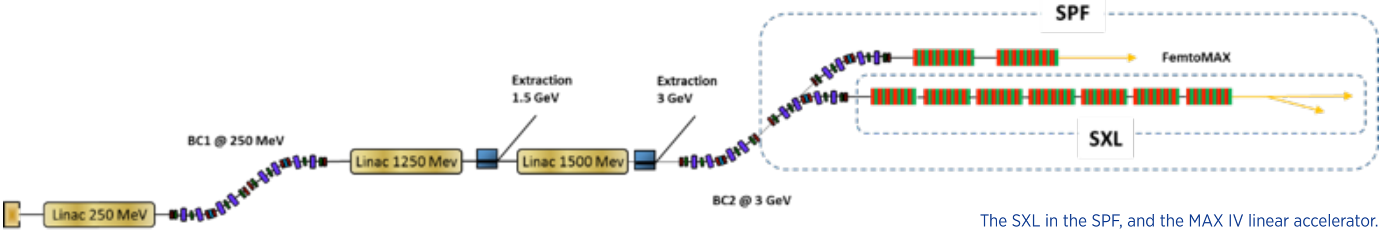
The SXL will make use of the existing linac, which is designed to provide electron bunches with a maximum energy of 3 GeV to the storage rings and the Short Pulse Facility (SPF) of MAX IV (see Fig. 1). Since a X-ray FEL has been part of the MAX IV long-term plan from the beginning, the linac is also prepared to deliver appropriate electron bunches for the SXL, which will produce intense, ultrashort and coherent soft X-ray pulses.

Initially the SXL will operate in SASE mode with two-pulse and two-color options, but several upgrades are foreseen in a second stage, such as external seeding and attosecond pulse generation. The envisioned output from the SXL is coherent, high peak-power pulses of <100 fs duration in the 0.25-1 keV photon-energy range, at 100 Hz repetition rate. These properties make it complementary to the FemtoMAX beamline of the SPF, which will also produce ultrashort pulses, but which is an incoherent source operating at photon energies of 1.8-20 keV. The unique environment provided by the proximity to the other beamlines of MAX IV is an important asset of the SXL compared with other FELs, which allows the exchange of ideas, experimental setups, and algorithms, specifically for imaging experiments. Another unique feature will be the availability of pump sources covering the full spectral range between THz and soft X-rays. For this purpose, the close collaboration with the Lund Laser Centre (LLC) and the Stockholm-Uppsala FEL Centre (SUFEL) will be essential, in particular with respect to the experience of high-order harmonic generation for creating ultrashort pulses in the VUV and XUV spectral region possessed by LLC, and the THz and X-ray region by SUFEL.

The soft X-ray region envisioned for the beamline enables access to many important absorption edges (e.g. C, N, O, and 3d transition metals) and permits the use of powerful spectroscopic techniques such as XAS, XES, XMCD, as well as imaging methods and coherent techniques such as XPCS, in a time-resolved manner. Combined with spectrally broad pumping capabilities a new understanding of many important scientific topics will be possible in fields such as atomic and molecular science, chemistry, condensed matter physics, and life science.

Peter Salèn

[1] https://indico.maxiv.lu.se/event/141/



The SXL in the SPF, and the MAX IV linear accelerator.

SUFEL

The Stockholm-Uppsala Centre for FEL research (SUFEL) was founded in 2006 as a collaboration between three leading Swedish universities: the Royal Institute of Technology (KTH), Stockholm University (SU), and Uppsala University (UU), and with Mats Larsson from Stockholm University as director. The primary objective of SUFEL is to be an active and visible partner for research at, and development of, FEL facilities. In this spirit SUFEL has obtained a broad competence in both the scientific and technical aspects of FEL research, as well as in the long (THz) and short (X-ray) wavelength regions. The most recent activities have been the development of a White Paper for an accelerator-based strong-field THz light source, and currently SUFEL is involved in the work with the proposed Soft X-ray Laser (SXL) beamline at MAX IV. More information about SUFEL can be found at www.frielektronlaser.se.

Peter Salén

FLASH is now FLASH1 plus FLASH2

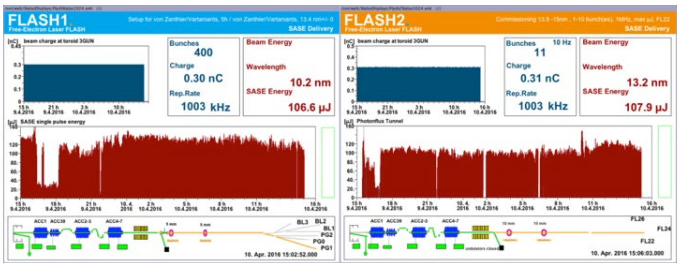
Since April 2016, DESY's free-electron laser FLASH is serving two user experiments in parallel operation. Two undulator lines send FEL pulse-trains into the experimental hall "Albert Einstein" (FLASH1) and the new hall "Kai Siegbahn" (FLASH2). Immediately, a first record was set: On April 9, FLASH delivered 4000 pulses per second with up to 140 µJ per pulse to an experiment at FLASH1 and at the same time 110 pulses per second with about 100 µJ each for FLASH2 (see figure 1). In parallel with this successful start of doubled user operation, the setup of the technical infrastructure in the FLASH2 hall is still ongoing and is meanwhile nearly completed for the first two beamlines as shown in figure 2. FL24 features an open port for user provided endstations, while FL26 has a permanent endstation, the reaction microscope (REMI) of the group of R. Moshammer, Max-Planck Institute for Nuclear Physics, Heidelberg.

At FL24, installation of Kirkpatrick-Baez focusing optics supplied by Elettra starts in the FLASH shutdown in December 2016 and commissioning of the KB-optics is planned for spring 2017. In autumn 2017, a grazing-incidence split-and-delay line developed by the group of H. Zacharias, University Münster will complete this beamline. It will facilitate XUV-XUV pump-probe experiments covering the entire wavelength range of FLASH2. In 2016 the REMI endstation at FL26 has already been used for three experimental campaigns employing back-reflecting split multilayer optics for XUV-XUV pump-probe studies. In summer 2017, a grazing incidence split-and-delay mirror unit with integrated focussing will be added in front of the REMI. This new unit will again allow working at variable wavelengths and then REMI users can also exploit the fast wavelength tunability of the variable gap undulators at FLASH2. An optical laser for pump-probe experiments will be installed at FLASH2 by the end of 2017. An 80 m^2 laser hutch, including a large air conditioning installation has already been equipped with the necessary laser tables, while the laser itself is being configured and tested in a separate laboratory.

In addition to the first regular user operation, FLASH2 with its variable gap undulators is presently extensively used to explore a large variety of new FEL schemes. Among these are, frequency doubling, a harmonic lasing self-seeded (HLSS) FEL, tests of harmonic afterburner undulator configurations and a number of different approaches involving tapering of the undulators. Two recent achievements were a new short wavelength record for FLASH2 in the fundamental at 3.5 nm, and, at 13 and 20 nm wavelength peak pulse intensities of 1mJ obtained using tapering. Many of these exploratory schemes hold great promise for future user operation.

FLASH is now running in regular half-year periods with two calls for proposals per year with deadlines 1 April and 1 October. Given all boundary conditions for parallel user operation of FLASH1 and FLASH2, it is presently possible to schedule about 1/3 more experiments. With additional endstations, the pump probe laser at FLASH2 and future machine upgrades, in particular variable gap undulators at FLASH1, it will be possible to double the user capacity at FLASH while substantially widening the FEL parameter space.

Elke Plönjes, Rolf Treusch



Screenshot of parallel user operation at FLASH1 and FLASH2.Following the machine setup (lower intensity at left), stable operation was achieved, only interrupted at FLASH2 by the machine protection system.

View of beamlines FL26 (left) and FL24 (right) in the FLASH2 experimental hall "Kai Siegbahn" in early April 2016.

European XFEL starts final push toward user operation

The European XFEL is setting the stage for its first users. Commissioning has officially started, with scientists and engineers preparing the many components along the 3.4-km long X-ray FEL facility for the first electron and X-ray beams. User operation is expected to begin in late summer 2017.

In September, DESY completed the installation of the facility's linear accelerator. In October, European XFEL celebrated the start of commissioning, with representatives of partner countries mounting a missing two-metre-long beamline tube in a symbolic act. A major part of the commissioning process is cooling the superconducting electron accelerator to -271°C, its operating temperature. In early 2017, scientists expect to deliver the first electrons through the accelerator.

Beyond the accelerator, adjustments and final installations in the first of three undulators to be used at the facility, the optical components such as superflat mirrors, and the vacuum beamline are being made. The safety infrastructure, including interlocks for the tunnels, is also being finalized and tested.

On the ground floor of the facility's headquarters and directly above the experiment hall, the laboratories where users will prepare their samples are being outfitted. They will include wet and dry labs for biology, chemistry, and physics sample preparation. Other labs for detectors, optical lasers, and sample environment will have cleanrooms that will be used for both tailoring systems to users' needs and for performing facility research and development.

In the underground experiment hall, the first two scientific instruments, SPB/SFX (for single-particle imaging and nanocrystallography) and FXE (for ultrafast chemistry) are being put together in their hutches on one of the facility's hard X-ray beamlines. Pump–probe optical lasers for the instruments are also being installed, and the IT infrastructure and control systems are being tested and put into place. Meanwhile, work is ongoing on the European XFEL's other two starting beamlines, which will open for users over the course of 2017 and into 2018. The facility is expected to reach full operational capacity with 4000 hours of user service in 2019.

To accommodate the users, construction work on a guesthouse and canteen will start in 2017. The European XFEL User Office is finalizing plans on user support and the first call for proposals. SPB/SFX and FXE held early user workshops on 28–29 November and 1–2 December, respectively. Each attracted about 100 scientists from around the world who are interested in performing the first experiments at the facility. At the workshops, the participants learned about the instruments' early parameters and could discuss the foundations of the first proposals, which they will be able to submit in early 2017.

Bernd Ebeling, Serguei Molodtsov

The FXE early user workshop participants on 1 December. Credit: European XFEL

Work on one of the facility's photon beamlines. Credit: European XFEL

EUCALL finishes first year, bearing new technologies

Project successes include new open-source simulation program

The European Cluster of Advanced Laser Light sources (EUCALL), a European Union-funded project that aims to foster links between accelerator- and laser-driven X-ray facilities, has completed the first year of its three year project period. The project successfully met all twenty of its milestones for the year, producing a new open-source tool for experiment simulations and developing specifications for several pieces of new scientific equipment.
Within the EUCALL project, which launched in October 2015 and is coordinated by European XFEL, the accelerator-driven and the laser-driven X-ray sources of Europe collaborate for the first time in a comprehensive way on technical, scientific, and strategic issues. EUCALL involves approximately 100 scientists from European XFEL, DESY and Helmholtz Zentrum Dresden-Rossendorf in Germany, ESRF in France, Elettra Sincrotrone Trieste in Italy, MAX IV Laboratory/Lund University in Sweden, PSI in Switzerland, and ELI in the Czech Republic, Hungary, and Romania. The project also involves the previously established scientific networks FELs of Europe and Laserlab Europe.

A first result is a simulation platform called SIMEX. Compiled from existing simulations, SIMEX integrates different steps of many types of X-ray investigations. SIMEX allows scientists to simulate single-particle imaging, as well as various types of scattering and spectroscopy, and to tailor each to the characteristics of any synchrotron or free-electron laser. Planned add-ons are simulated X-ray analysis of laser-excited matter and recently developed plasma-driven accelerator experiments. The program was released in April 2016 and is successfully being applied to scientific cases.

Other EUCALL milestones reached in the past year were specifications for a standardised sample delivery system to be used at all participating EUCALL facilities, as well as a design report for a new transparent X-ray intensity monitor. The X-ray monitor is based on the design of a xenon-based intensity monitor that is currently used at DESY's FLASH FEL and will be capable of dealing with both the hard X-rays to be delivered by the European XFEL as well as the ultrashort soft X-ray and ultraviolet pulses to be generated at the ELI facilities. The first prototype will be tested during 2017.

In its first report, EUCALL's Scientific Advisory Committee stated that the project's successful approach should be continued beyond its initial three-year scope. "The technical developments in the EUCALL project are not only relevant for the facilities that are directly involved, but are of significant importance to other light sources that could profitably be involved on rather short notice, for example LCLS", the committee reported.

"The EUCALL project brings together experts from different types of light sources", said Thomas Tschentscher, European XFEL scientific director and EUCALL's project director. "The exchange of know-how and the joint developments provide new impulses to the individual light sources, and also pave the way towards new science and technology applications."

We would like to inform the readers of FELs of Europe newsletter that a page exists on the EUCALL website which provides links to all of the regular newsletters of each of EUCALL's partners and direct links to their subscription pages, as well as links to their social media channels and to any upcoming events:
www.eucall.eu/outreach

EUCALL has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654220.

Graham Appleby

EUCALL's project participants gathered at the Annual Meeting 2016 at HZDR.

Science@FELs 2016 conference

The Science@FELs 2016 conference has been organized by Elettra Sincrotrone Trieste in the city of Trieste on September 5th to 7th in collaboration with FEL's of Europe and Laserlab pan-European research infrastructures. The aim of the meeting was to highlight the main scientific achievements obtained by using free electron laser (FEL) sources during the last years, as well as to stimulate more extensive cross-fertilizations and collaborations between the scientific community working with FELs and the numerous, multi-disciplinary communities of scientists working in lab-scale lasers facilities.

The fast evolving development and operation of the FEL sources are definitely going to enable the successful implementation of sophisticated experiments, nowadays feasible only with optical lasers, at wavelengths shorter than the optical regime. Such a spectral range, that is the extreme ultraviolet (EUV) and the x-ray regime, can add elemental and chemical state specificity to those experimental approaches, e.g. by exciting and/or probing electronic transitions from selected core levels. Such a situation represents an unprecedented opportunity to bring into the x-ray science concepts and methods from the scientific community working with optical lasers. The large participation of this community to the conference, endorsed by the collaboration with Laserlab, was fundamental to define the future directions of many FEL-based research activities. During the 32 talks, the poster sessions and the round tables more than 150 participants were able to discuss and devise the new research trends based on the exploitation of coherent, ultrafast sources (both optical and x-ray ones).

The contributions from the FEL community were reaching the main research streams of FEL based science, ranging from atomic and molecular physics to warm dense matter and from nonlinear spectroscopy to single-shot diffraction from biomolecules. The success of these pioneering studies delineates a general consensus in following the route of multi-pulse experiments (combining both optical and FEL sources), nonlinear optics and single-shot approaches in biomolecules. This would allow the development of advanced experimental tools, which may have a tremendous impact in the study of a large array of phenomena, ranging from nano-dynamics in complex materials to ultrafast charge and energy transfer processes and from the determination of the structure of biomolecules to the understanding of their functions in biological conditions.
The research performed using FERMI, the only seeded FEL facility operating in the EUV and soft x-ray regime, under continuous development at the Elettra Sincrotrone Trieste, has been extensively presented in several oral contributions, emphasizing the uniqueness of FERMI in terms of adapting and controlling the intensity, energy, polarization, timing and phase of the FEL pulses. In particular it has been discussed how FERMI can be exploited to carry out wave-mixing experiments, routinely performed in the optical regime but never demonstrated in the XUV domain. In this context both experimentalists and theoreticians showed the potential of coherently excite the system under investigation and then probe it using a different beam. This will indeed open up the possibility to probe energy and charge transfer dynamics in a variety of domains, ranging from photovoltaics to topologically disordered systems, such as glasses and liquids. The possibility to control the

relative phase between two different FEL pulses has been also discussed with the future engagement in the study of Wigner times and multidimensional spectroscopy.

Table top laser research was also broadly presented and highlights were coming from HHG laser based ARPES used, for instance, to study the quasiparticle dynamics over the entire Brillouin Zone of complex materials. Femtosecond Stimulated Raman Scattering was demonstrated to be an extremely useful tool in the study of sub-picosecond energy flow in photoexcited myoglobin and visualizing excited state dynamics of conjugated molecules. Optical laser were shown to be the technique of choice to investigate time domain quantum physics or to control electron motions in atoms and molecules.

The progress in coherent diffraction imaging has been presented during the workshop and the advantages coming by the use of the XFEL source, soon available for users, have been pointed out. In this framework the "FEL Science and Applications" prize has been awarded to Dr. K Ayyer, a young scientist from the Center for Free Electron Laser Science (CFEL), a joint enterprise of DESY, the Max Planck Society (MPG) and the University of Hamburg, for his novel methodology developed for macromolecular diffractive imaging using imperfect crystals. In brief, his work hypothesizes that the chief disordering mechanism in a crystal is translational, so that the molecular orientations are preserved even when they have random displacements relative to the crystal lattice. The diffraction at large angles is then well approximated as an incoherent sum of continuous, single-molecule patterns. Dr. K. Ayyer developed the reconstruction algorithm for combining Bragg and continuous intensity data, demonstrating in his pioneering work (K. Ayyer et al., Nature 530, 202, 2016) that poorly diffracting crystals may actually be a good way to align molecules and that the disorder that prevents the formation of high-resolution Bragg peaks might give rise to an incoherent sum of aligned single-molecule diffraction.

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CURRENT AND UPCOMING CALLS FOR PROPOSALS

for Experiments at FELBE for the beamtime period August 2017 – January 2018
Deadline: 26th April 2017
www.hzdr.de

The Flash proposal deadlines
1st April and 1st October (every year)

Call for proposals for FELIX
15th May 2017

UPCOMING EVENTS

PhotonDiag2017
Workshop on FEL Photon Diagnostics, Instrumentation, and Beamline Design
1st–3rd May 2017

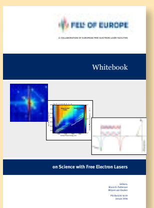
MAX IV Laboratory User Meeting (UM17)
13th–15th March 2017
www.maxiv.lu.se

The next generation for Low Density Matter (NGLDM) – workshop on AMO and cluster research at MAX IV
Dates: 15th–17th March 2017
www.maxiv.lu.se

3rd International Conference on Tomography of Materials and Structures
Lund, Sweden, 26th–30th June 2017
www.maxiv.lu.se

Future of Science at FLASH - Opportunities with a cw XUV and soft x-ray FEL
25th–27th September 2017

2nd EUCALL Annual Meeting in Grenoble
7th–9th June 2017
www.eucall.eu



Whitebook on Science with Free Electron Lasers Now available as PDF on:
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