EuroFEL NEWS 10|13

7th issue · www.eurofel.eu

Laying the SwissFEL foundation stone ceremony – from left to right: Mayor André Zoppi; President of the ETH Board Fritz Schiesser; President of the Cantonal Council Alex Hürzeler; PSI Director Joël Mesot; State Secretary Mauro Dell'Ambrogio; SwissFEL Project Leader Hans Braun and Marco Hirzel from the EquiFEL Suisse consortium.

SwissFEL Foundation Stone Ceremony

On the 3rd of July 2013, the SwissFEL foundation stone ceremony took place at the Paul Scherrer Institute. Around 130 guests from politics, science and industry participated. Beginning in 2016, SwissFEL will generate very short pulses of x-rays with the properties of laser light. "An extremely ambitious project," says PSI Director Joël Mesot, who opened the ceremony – one that places extremely high demands on the PSI and its partners and, which, thanks to the tireless efforts of the staff and the extensive support from politics, can build on a solid foundation.

During the official ceremony, an oak time capsule was filled and placed in the floor below the facility. The items preserved in the time capsule for posterity reflect the development of SwissFEL so far and are ranging from blueprints, to the minutes of the communal parliament and assembly meetings of the municipality of Würenlingen. A piece of slate engraved with the date 27/28 March 2007 also found its way into the capsule: that was when SwissFEL, which was still called PSI X-FEL at that stage, was incorporated into the ETH Board's strategic planning for the ETH Domain. More information at: *http://www.psi.ch/media/laying-of-the-corner-stone-for-the-new-large-scale-research-facility-swissfel*

The SwissFEL building will be delivered at the end of 2014. After that commissioning will take place and SwissFEL will have its first beam in 2016. The hard X-ray SwissFEL beamline "ARAMIS" (0.1 – 0.7 nm wavelength) will begin commissioning in mid-2016, with user operation in 2017 in two experimental stations. The third experimental station will go into operation at a later date, and the soft X-ray beamline "ATHOS" (0.7 – 7 nm wavelength) will come online in 2019. *MvD*

Science@FELs 2014

The Collaboration of European FEL and SPS Facilities announces the Science@FELs 2014.

The 2nd international Science@FELs Conference will take place from 14 - 17 September 2014 at Paul Scherrer Institute in Villigen, Switzerland.

This conference is a follow up of the Science@FELs 2012 jointly organized by DESY and the European XFEL in Hamburg, Germany, in July 2012 and will henceforth be organized regularly as an activity of the Collaboration of European FEL and SPS Facilities.

We invite you to participate in this conference and to pass this information to interested colleagues.

Further information regarding the conference can be found at: http://science-at-fels-2014.eurofel.eu/

IN THIS ISSUE

EuroFEL
FREE ELECTRON LASERS OF EUROPE

EuroFEL is part of the ESFRI Roadmap since 2006; its preparatory phase (IRUVX-PP) prepared the establishment of the EuroFEL Consortium to link FEL & SPS facilities in Europe closer together and was funded by the European Commission under FP7 from April 2008 to March 2011. Some results were taken up in the EC funded projects Pandata & PaNdataODI. EuroFEL became partner in the EC funded cluster of research infrastructures for synergies in physics-CRISP. *info@eurofel.eu*

Recently at the MAX IV Laboratory

In August, the Strategy Plan MAX IV Laboratory 2013 - 2026 for the development of the laboratory was finalized. In addition to completing the 3 GeV storage ring until the inauguration in June 2016 and a beamline program in several phases, there is also an outline for the MAX IV X-ray FEL. The preparation for the science and user case is starting now together with concept studies of the FEL itself. Assuming an application ca. 2016/2017, construction could begin 2018 and operation in 2021.

The 350 m long linac tunnel where installation of the 3 GeV linac is now completed (seen from the gun hall with the first bunch compressor).

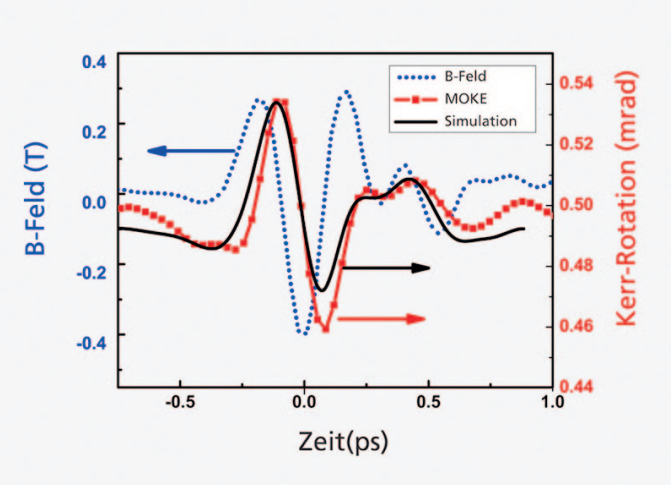
Between September 23 - 25 the MAX IV Laboratory user meeting was held in Lund. It attracted almost 300 participants to a comprehensive program including discussions on the future beamlines of the facility. During the first day a parallel workshop "2nd Workshop on the Science Case for Swedish X-ray Lasers" was held, organized by the steering committee for the science case for Swedish X-ray lasers with the chairman Per Jonsson (Lund University). The workshop attracted over 70 participants working in 6 breakout groups.

The workshop participants could also see and feel the completed accelerator tunnel (see photo) at the MAX IV facility along with the experimental hall for the Short Pulse Facility. The storage ring buildings are also well under way where the roof is currently being laid. *SW, CQ*

Magnetization Controlled at the Picosecond Range

A terahertz laser developed at the Paul Scherrer Institute in collaboration with Swiss industries makes it possible to control a material's magnetization at a timescale of picoseconds. In their experiment, the researchers shone extremely short light pulses from the laser onto a magnetic material, where the magnetic moments were all aligned in parallel. The light pulse's magnetic field was able to deflect the magnetic moments from their idle state in such a way that they exactly followed the change of the laser's magnetic field with only a minor delay. The terahertz laser used in the experiment is one of the strongest of its kind in the world. One special feature is the fact that it is phase-stable, which enables the exact change in the electrical and magnetic field within the individual pulses to be defined reliably for each laser pulse. As the majority of data is stored magnetically these days, the possibility to quickly change a material's magnetization is crucial for new, rapid storage systems. The researchers report on their results in the journal Nature Photonics.

More information at: *http://www.psi.ch/media/magnetisation-controlled-at-picosecond-intervals* *MvD*



A pulse from a terahertz laser (blue) controls the magnetization of a material: the magnetization (red-determined via the magneto-optic Kerr effect MOKE) follows the laser pulse's magnetic field with a slight delay.
The black curve shows the prediction of a computer simulation.

TELBE – a New Super-radiant THz Facility at ELBE

At the ELBE accelerator at the research center HZDR in Dresden, a new super-radiant THz facility is currently under commissioning. ELBE is a European-wide unique linear electron accelerator that allows operation in quasi-cw mode up to a maximum current of 1.6 mA, with bunch durations in the few ps regime and bunch charges of up to 100 pC enabled by superconducting radiofrequency (SRF) technology. It is currently operating as a multi-experiment facility for different electron-

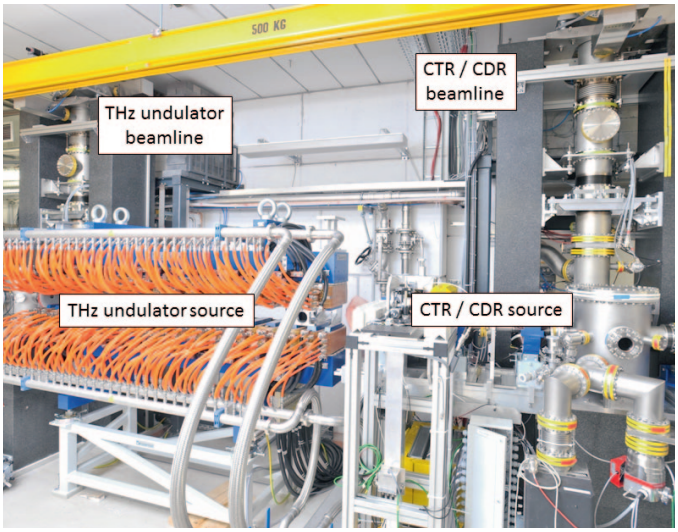
based secondary radiation sources which make use of the possibility to accelerate electron bunches up to 40 MeV at repetition rates adjustable between a few Hz and 13 MHz. The medium term goal is to complement the existing user facilities for experiments with positrons (pELBE), neutrons (nELBE), γ radiation (γELBE) and the THz FEL (FELBE) with a facility for research with high-field super-radiant THz pulses.

This new facility, called TELBE, will complement the frequency range available for users at ELBE down to the 0.1 THz regime. The ELBE accelerator is currently upgraded with a new SRF gun and a new electron beamline that will allow compressing and controlling electron bunches with charges up to 1nC down to a longitudinal dimension of less than 200 femtoseconds (fs) at a unique repetition of up to 500 kHz. Between January 2011 and January 2013 two super-radiant THz sources, two dedicated THz beamlines and one THz laboratory have been designed and constructed which in the short term is serving as a versatile endstation for THz based electron bunch diagnostics during the commissioning of the new fs electron bunch mode of operation of the ELBE accelerator. Despite the fact that only very limited beamtime was available in the first half of 2013 and that the new electron beamline is not fully completed, first THz pulses from the coherent transition radiation source were observed in March 2013. Subsequently the first pulses from the 8-period electromagnetic undulator source were observed in May 2013. The results of these first shifts, which have been performed within a multi-institutional collaboration involving colleagues from DESY and future users from the Free University of Berlin, will soon be published together with a detailed description of the TELBE design parameters. The first dedicated commissioning

Official inauguration of the ELBE accelerator upgrade on the 28.2.2013 (left to right: Prof. P. Joehnk, Dr. P. Michel (HZDR), S. Tillich (president of the state of Saxony) and Prof. R. Sauerbrey (HZDR)).

shifts, still operating at low charges in the sub 100 pC regime, will be performed in October and November 2013. In order to efficiently develop TELBE into a user facility for research with high transient THz fields, HZDR is collaborating with other laboratories working on the development of super-radiant THz sources such as DESY, KIT, PTB, Jefferson lab and SLAC. Furthermore a consortium of pilot user groups has been established, which is giving advice during and participates in the commissioning of the facility. Provided that the design parameters of pulse energies in the 100 µJ regime in the frequency range between 0.1 to 3 THz can be routinely reached, TELBE could operate as a user facility for high-field THz experiments from 2016. *MG*

Part of the multi-institutional THODIAC collaboration after observing the first THz pulses on 26.03.2013 (right to left: M. Kuntzsch (HZDR), N. Stojanovic (DESY), S. Kovalev (HZDR), T. Golz (DESY), B. Green (HZDR), M. Gensch (HZDR)).



View at the two new super-radiant THz sources in the new extension of the ELBE accelerator.

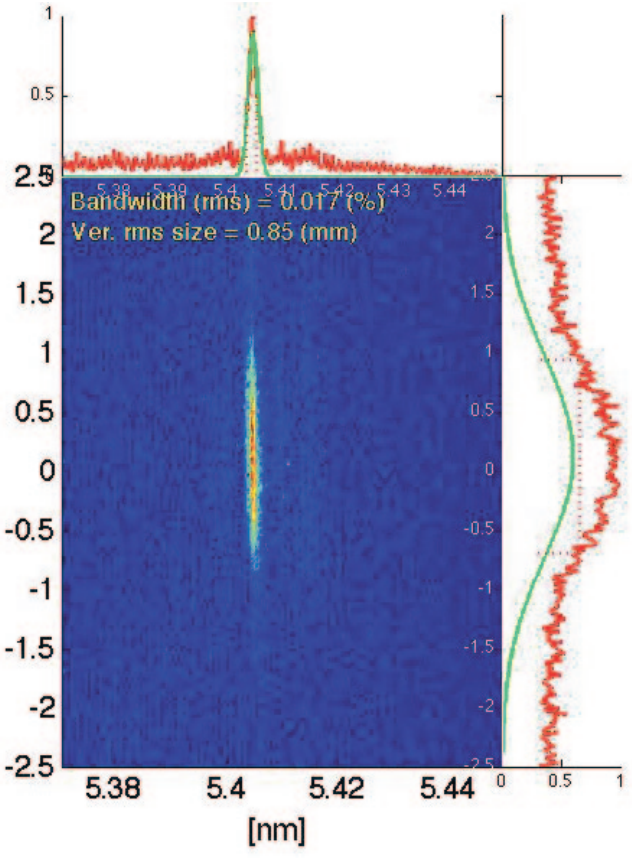
Recent Updates on FERMI

Between December 3rd, 2012 and March 6th, 2013, FERMI welcomed the first users, selected after the first call for proposals. 1120 hours of beamtime on the FEL-1 beamline were provided to 12 different experiments on all three experimental stations (DiProI, LDM and EIS-TIMEX) with wavelengths ranging between 65 nm and 20 nm. FEL tunability and variable polarization (circular, linear horizontal and vertical) were extensively used. Two color experiments were performed by using a double-seed laser pulse to generate two FEL pulses separated by up to 800 fs. In this case the FEL provides both the pump and the probe pulse. Furthermore, in February a portion of the seed laser was made available in the experimental hall as user laser for pump-probe experiments. The feedback from the users is generally very positive, they expressed their satisfaction for the excellent performance of the FEL and for the high quality experiments they could perform.

The commissioning of FEL-2 continued in March and June 2013, where the wavelength of operation was extended down to 4 nm and below, demonstrating that an externally seeded FEL is capable of reaching the soft X-ray range of the spectrum. An example of a spectrum measured at 5.4 nm is given in the figure. To achieve the shorter wavelengths it was necessary to increase the linac energy, from the previously available 1.2 GeV up to 1.5 GeV, corresponding to 1.4 GeV in conditions of FEL operation (i.e. including energy losses due to off crest operation of two linac sections for electron bunch compression and the X-band cavity for phase space linearization). The linac energy was increased by an extensive RF conditioning activity in May, essentially by fully activating the energy doubling cavities (SLED). At the same time the machine repetition rate was increased to 50 Hz; the linac operated at this repetition rate during the RF conditioning, while it was reduced back to 10 Hz for the FEL commissioning, in order to increase the linac reliability for the FEL operation at the higher energy and to reduce some expected cathode aging which was observed on the new 50 Hz gun. In the future, the linac energy will be extended further to 1.5 GeV in FEL operating condition mode in order to increase the FEL gain in the shortest wavelength range (at and below 5 nm).

Commissioning of FEL-2 in fresh-bunch mode was accomplished by investigating the amplification of several different harmonics, in both stages. As an example, the second stage was tuned at harmonic numbers m = 2, 3, 4 or 6, depending on the harmonic number in the first stage, to eventually reach the 18th and the 24th harmonic of the seed laser. In October 2012 a first campaign of studies was carried out at 1.0 GeV to reach the wavelength of 10.8 nm, as reported in the 6th issue of this Newsletter. Later, the beam energy was increased to 1.2 GeV to access to shorter wavelengths, such as n = 8, m = 6, so the 48th harmonic of the seed laser, namely 5 nm. Finally, the linac beam energy of 1.5 GeV was reached, i.e. 1.4 GeV optimized for FEL operation. In this condition FEL spectra at the wavelength of 4.09 nm with pulse energies of the order of 1 μJ were measured. The measurements revealed good spectral stability. Purity of the second stage spectra was sensitive to the initial seed laser power. During optimization of the entire system, the first stage output energy was set at a level of a few μJ.

FEL-2 commissioning will continue in September 2013, while in October the second user experimental period on FEL-1 will start and it will continue until July 2014. *MS*



Single shot spectrum of FERMI FEL-2 operated at 5.4 nm

European XFEL Reaches Major Construction Milestone

In June 2013, the European XFEL reached a major milestone with the completion of underground construction. 300 invited guests, including scientists and politicians, celebrated the event in Schenefeld, Schleswig-Holstein, where the facility's main research campus will be located. The underground facilities

include a 4500 m² experiment hall in Schenefeld, a smaller hall in Hamburg-Osdorf, the entrance hall and injector complex in Hamburg-Bahrenfeld and a system of tunnels extending 5.8 km between the different sites.

Since the completion of the tunnels in 2012, construction has focused on completing the experiment hall in Schenefeld, the underground halls at the sites where the X-ray beam will split, and the installation of technical infrastructure in the accelerator tunnel and in the buildings on the Bahrenfeld site. The next goals are the construction of aboveground buildings and preparations for the first test beam. The electron injector will be housed at the DESY campus in Bahrenfeld, and the electrons will be brought to high energies by the 2000 m long superconducting accelerator. The accelerator modules are in-kind contributions from several shareholder countries, and scientists are moving forward with calibrations on each one. Infrastructure for the electron injector is currently being installed. At the same time, scientists at European XFEL are continuing work on magnetic measurements and tuning of the undulators; on the development and construction of the instruments, detectors, the IT environment, and further equipment; and on the research on X-ray optics.

With the underground construction of the European XFEL finished, about 300 guests from politics, academia, administration, and business gathered to celebrate and visit the facilities in Schenefeld on 6 June 2013.

As for the aboveground buildings, there will be one over nearly every underground hall. The headquarters for the facility will be built on top of the experiment hall in Schenefeld. The buildings at the other end, in Bahrenfeld, have been completed and are being fitted with cooling pipelines, klystrons, wave guides, and electronics. Other buildings, such as the one in Osdorfer Born – roughly midway on the tunnel complex, are also nearing completion. If all continues to go on schedule, the European XFEL employees will move to Schenefeld in 2015, with users beginning work in the experiment hall in 2016.

Several collaborations have been fruitful and instructive to European XFEL's own continuing progress. The partnership with European XFEL's largest shareholder, DESY, continues to be very strong, with their key work on the electron injector and the accelerator modules. The assembly of the facility would not be possible without the in-kind contributors, who have constructed and delivered parts of instruments, accelerator modules, modulators, and many other important elements. Research on the instruments, optics, accelerators, and beamlines of the European XFEL benefits from these partnerships, such as with LCLS in Stanford, California, and SACLA in Harima, Japan. Additionally, in mid-2013, the company signed a memorandum of understanding with Lawrence Berkeley National Laboratory in California that allows the two laboratories to work together on free-electron lasers, beam transfer, and X-ray optics systems.

As milestones continue to be met and scientists and engineers look to the next steps, European XFEL continues to be a major source of excitement in the field. *JP, SM*

Topping-Out Ceremony of FLASH2 Experimental Hall

On 25 September 2013 the builder, the company and the architects celebrated the completion of the roof structure of the new FLASH2 experimental hall. The construction started in January 2013 and will be finished early 2014. The tunnel for the FLASH2 undulators and additional buildings for the seed laser, power supplies and cooling water supply have been completed in spring 2013 and are currently equipped with components. Meanwhile the construction of the electron beamline in the extraction area and the first part of the FLASH2 tunnel is finished including all components needed to switch the electron beam to FLASH2. The final construction in the FLASH2 tunnel is now proceeding independently of FLASH1 operation. Commissioning

Topping-out ceremony of the FLASH2 experimental hall on 25 September 2013

of FLASH2 with electron beam will start in February 2014. After realignment of the FLASH1 undulators which had moved due to the construction of the FLASH2 buildings, FLASH1 is now back in operation. The fifth user period on FLASH1 will start on 4th November 2013 and end in December 2014. From 2015 onwards both FEL beamlines, FLASH1 and FLASH2, will be scheduled for user experiments in parallel operation. *JF*

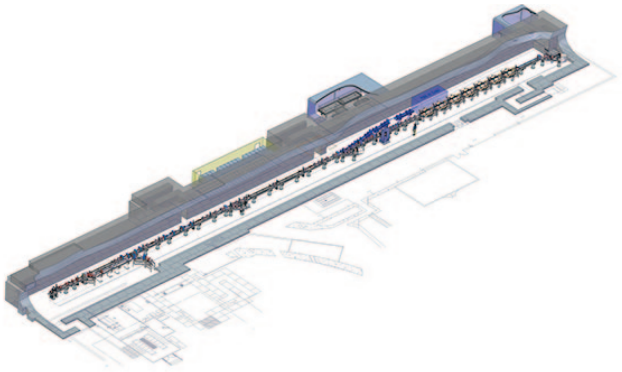
Officials of DESY and the construction company after the topping-out ceremony on 25 September 2013.

Aerial view of FLASH in early August 2013 including the new FLASH2 tunnel and the experimental hall

Conceptual Design Report of CLARA Test Facility

The Conceptual Design Report (CDR) of the proposed new Free Electron Laser Test Facility, CLARA, has now been published by STFC.

The CDR, which has been written by accelerator scientists and engineers from ten UK laboratories, institutes, and universities, describes an exciting and ambitious new accelerator test facility for the UK which will be capable of testing many 4th and 5th generation light source techniques and technologies. It is envisioned that the principal aim of CLARA will be the demonstration of ultra-short photon pulse production using novel FEL schemes which have been proposed but not yet proven in practice. In order to achieve this vision, CLARA must be able to implement advanced techniques, such as laser seeding, laser-electron bunch manipulation, and femtosecond synchronisation. These can only be achieved by developing a state-of-the-art accelerator with the capability to drive current FEL designs thus ensuring that the UK has all the skills required should it choose to develop its own future FEL facility. The design is flexible and able to operate in a number of different modes to ensure that it is able to adapt to new schemes as they are proposed in the future. The project has now entered the detailed technical design phase which includes specifying the first accelerating section which is expected to be ready to be installed towards the end of 2014. Since CLARA is intimately linked to the existing VELA facility, much of the essential infrastructure for the project already exists. This will significantly reduce the time required to implement CLARA in full. It is believed that within 3 years of funding, it would be possible to procure and install all of the equipment and commence beam commissioning. All colleagues from around the world are welcome to join the project, or simply to learn more about it, by contacting the project leader, Jim Clarke (*jim.clarke@stfc.ac.uk*) at Daresbury Laboratory.



The full report can be downloaded at: *http://www.stfc.ac.uk/ASTeC/resources/PDF/CLARA_CDRv2.pdf* *JC*

Whitebook on European FEL Science

In response to a request by the Steering Committee of the Collaboration of European FEL and SPS Facilities, an overview of selected scientific applications of X-ray and IR free electron lasers is being collected and published by a group of editors in the form of a Whitebook. Bruce Patterson (PSI) is leading the effort, and the other board members are Josef Feldhaus (DESY), Michael Meyer (European XFEL), Fulvio Parmigiani (Elettra/ FERMI) and Manfred Helm (Dresden-Rossendorf). The level and format of the Whitebook will be similar to those of the SwissFEL Science Case *(http://www.psi.ch/swissfel/CurrentSwissFELPublicationsEN/SwissFEL_Science_Case_small.pdf)* – i.e., it will be directed toward first year graduate students in chemistry, physics and biology, and it will comprise approximately 100 double-column pages, with color illustrations. The document will begin with a general introduction, which will be followed by eight thematic chapters on: photo-induced dynamics of small quantum systems, time-resolved molecular spectroscopy and catalysis, coherent imaging and nano-crystallography, biochemical dynamics, ultrafast magnetism, time-resolved spectroscopy of semiconductors and correlated electron materials, non-linear X-ray science and non-equilibrium dynamics. Each of these chapters will discuss relevant time and length scales and X-ray techniques and will focus on a few high-profile applications. In addition, several "information boxes" will present related topics in a self-contained manner. The document will end with conclusions and recommendations and an appendix on FEL technology. The goal date for the printed version, which will be produced at PSI, is spring 2014. BP

Seeding Expert Group Kick-off Meeting at Soleil

The formation of expert groups within the FEL and SPS collaboration is the continuation of a process that was established during the IRUVX-PP project, the preparatory phase of EuroFEL. A "seeding experts" group, including representatives from the main FEL laboratories and facilities in Europe, was established with the aim of promoting the exchange of ideas, expertise and technology, and minimize duplication of work. The group is coordinated by Luca Giannessi and is presently composed of representatives of the main European facilities active in this field: CLARA (STFC), European XFEL, FERMI (Elettra), FLASH (DESY), LUNEX5 (SOLEIL), MAX IV Laboratory, SPARC_LAB (CNR, ENEA, INFN, Un. of T. Vergata, Un. of Roma 1, Un. Milan) and SwissFEL (PSI).

During the last week of June the first meeting of the European Seeding Experts Group was held at SOLEIL (Paris). The main purpose of the meeting was the definition of a coordinated work plan with a time span of two years. The meeting was prepared by a number of teleconferences and contacts between the group members, where the main areas of interaction were identified. Presentations from facility representatives introduced the selected topics, each one constituting an opportunity for future joint work. At the end of the meeting, the conveners had the opportunity of visiting the Soleil storage ring and the femto-slicing installation, on which first experiments are foreseen in December.

Participants at the kick-off meeting (from left to right: F. Villa, J. Bödewadt, E. Roussel, G. Geloni, A. Petralia, C. Szway, M. Labat, M. E. Couprie, J. Clarke, E. Allaria, L. Giannessi, S. Werin)

The planned activities include: at SPARC, the installation of a Delta-type short-period (14 mm) undulator and the continued study of multi-electron-bunch operation for the generation of trains of ultra-short pulses from both a seeded and a non-seeded FEL amplifier; at European XFEL, the development of self-seeding; at FERMI, the investigation of micro-bunching instability and the measurement of the pulse lengths from seeded FELs, as well as the generation of multiple FEL pulses for pump-and-probe experiments; at FLASH, seeding an FEL amplifier with high harmonics generated in gas and with the echo enabled harmonic generation technique; at SOLEIL, femto-slicing; at MAX IV, a high harmonics in gas seeding experiment. MEC, LG

Pulse Length Measurement Expert Group Kick-off Meeting at DESY

The Kick-off meeting of the recently established Pulse Length Measurement Expert Group took place from 10 -11 June 2013 at DESY, Hamburg, with over 20 participants including representatives from Elettra, European XFEL, PSI, SOLEIL and

Participants of the PLM Kick-off meeting at DESY, Hamburg.

DESY. This initial meeting was aimed to give the participants an opportunity to present on-going activities related to the pulse duration measurements at FELs and synchrotron slicing facilities. Different measurement approaches ranging from THz streaking, optical-XUV cross-correlations to different autocorrelation schemes to electron pulse duration diagnostics were discussed. Many common topics of interest for joint research activities were identified and collaborations for actual measurement campaigns were formed. This group is coordinated by Stefan Düsterer from FLASH, DESY. *SD*

12th SC meeting of the Collaboration of European FEL and SPS Facilities

The 12th Steering Committee meeting of the Collaboration of European FEL and SPS Facilities took place on 26 – 27 September 2013 at MAX IV, Lund, Sweden.

After presenting recent developments, on-going activities and future plans at their facilities, the SC members discussed extensively the implications of the recent report of the Assessment Expert Group about the readiness for implementation of EuroFEL as a distributed research infrastructure according to the definition of ESFRI, as well as possibilities for EU funding based on the first informal draft of the H2020 Work Programme 2014 – 2015. It was agreed to give highest priority to strengthening the Collaboration and enhancing its visibility both at the European and international level.

The SC reviewed the on-going collaboration activities, including the expert groups on seeding and pulse length measurement, the white paper and the preparation of the Science@FELs conference 2014 at PSI on 14 – 17 September 2014. It was agreed to expand the pulse duration expert group with a sub-group on fs-timing and synchronization and to include a networking session for students at the Science@FELs 2014. *CI*

The SC members during their visit of the MAX IV construction site

CALL FOR PROPOSALS

3rd Call for Users Experiments at the FEL1 of the FERMI@Elettra
Deadline: 31st October 2013
https://www.elettra.trieste.it/userarea/fermielettra-call-for-proposals.html

Application for Beamtime
FEL at the ELBE radiation source at the HZDR in Dresden-Rossendorf
Deadline: 4th November 2013
http://www.hzdr.de/db/Cms?pOid=13509&pNid=471

UPCOMING EVENTS

MEADOW 2013 - Metrology, Astronomy, Diagnostics and Optics Workshop
28 – 30 October 2013, Venue: Trieste, Italy
Registration and abstract submission deadline: 13th September 2013.
http://www.elettra.trieste.it/Conferences/2013/MEADOW/

Coherent X-ray Spectroscopy (COX) Workshop
2 – 3 December 2013, Venue: Trieste, Italy
Registration deadline: 4th November 2013
http://www.elettra.trieste.it/Conferences/2013/COX/

Faraday Discussion 171: Emerging Photon Technologies for Chemical Dynamics
9 – 11 July 2014, Venue: Sheffield, UK
Oral abstract deadline: 21st October 2013
http://www.rsc.org/ConferencesAndEvents/RSC-Conferences/FD/FD171/

IMPRINT
Publisher: EuroFEL, chaired by Josef Feldhaus, Deutsches Elektronen-Synchrotron DESY | Notkestr. 85 | 22607 Hamburg | Germany
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Images: PSI (Cover image), Annika Nyberg MAX IV, PSI (pg. 2), M. Gensch, Olliver Killig, HZDR (pg. 3), Fermi (pg. 4), J. Piergrossi XFEL.EU, DESY (pg. 5), DESY, XFEL.EU, STFC (pg. 6), SOLEIL, DESY (pg. 7), Cletus Itambi, DESY (pg. 8)