Journal of
Synchrotron
Radiation
ISSN 0909-0495

current events

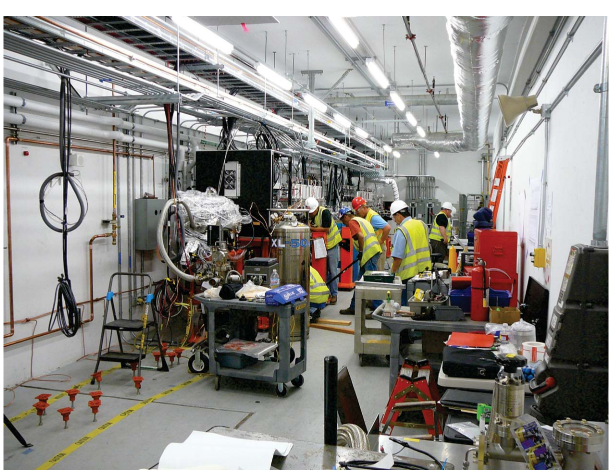
This section carries events of interest to the synchrotron radiation community. Works intended for this section should be sent direct to the Current-Events Editor (s.s.hasnain@liverpool.ac.uk).

First X-ray laser shines at Stanford

The world's first X-ray laser light at 1.5 Å was produced at Stanford's Linac Coherent Light Source (LCLS) at the end of April 2009 producing worldwide excitement for new scientific opportunities. 'This milestone establishes proof-of-concept for this incredible machine, the first of its kind', said Persis Drell, Director of Stanford Linear Accelerator Center (SLAC). Even in these initial stages of operation, the LCLS X-ray beam is brighter than any other human-made source of short-pulse hard X-rays. Initial tests produced laser light with a wavelength of 1.5 Å, or 0.15 nm, the shortest-wavelength highest-energy X-rays ever created by any laser. To generate that light, the team had to align the electron beam with extreme precision. The electron beam cannot deviate from a straight line by more than about 5 µm per 5 m, an astounding feat of engineering. 'This is the most difficult light source that has ever been turned on', said LCLS Construction Project Director John Galayda, 'It is on the boundary between the impossible and possible, and within two hours of start-up these guys (the accelerator operators) had it right on'.

Unlike conventional lasers, which use mirrored cavities to amplify light, the LCLS is a free-electron laser, creating light using free-flying electrons in a vacuum. The LCLS uses the final third of SLAC's two-mile linear accelerator to drive electrons to high energy and through an array of undulator magnets that steer the electrons rapidly back and forth, generating a brilliant beam of coordinated X-rays. In this milestone, LCLS scientists used only 12 of an eventual 33 undulator magnets to generate the facility's first laser light.

The LCLS team is now honing the machine's performance to achieve the beam quality needed for the first scientific experiments, scheduled to begin in September. The first science instrument AMO moved in on 3 June when the author was at LCLS. This installation marked a major milestone in preparing the LCLS for its first wave of users this September. SLAC also appointed Jo Stöhr as the Director of LCLS as well as the Associate Director of SLAC. The appointment marks the transition of LCLS from a construction project to a Science Facility. Jo is currently the Director of the Stanford Synchrotron Radiation Laboratory (SSRL), a post he took over from Keith Hodgson in October 2005. This is an exciting time for photon science at Stanford and we wish all of its staff and community congratulations and best wishes in some pioneering experiments.



First installations of equipment in the experimental area.

Jo Stöhr, just prior to addressing the LCLS staff on the news of his appointment.

UK moves forward with plans for New Light Source

Two important events took place recently that helped to develop plans for the UK's proposed New Light Source (NLS) facility (http://www.newlightsource.org/). The first was a meeting of ~140 scientists which took place on 24 April at the Royal Society in London. The second, on 4–5 June, was the first meeting of the project's International Technical Advisory Committee. The NLS is planned to be a light source producing high-intensity ultra-short pulses of coherent radiation across the spectral range from THz to soft X-rays, based on a combination of advanced conventional lasers and free-electron lasers (FELs). NLS will incorporate a high-repetition-rate seeded FEL. Following the publication of the science case for the new facility in October 2008 and its subsequent acceptance by the UK's Science and Technology Facilities Council, further design work was carried out and the purpose of the Royal Society's meeting was to update the wider scientific community on the exciting science that NLS will be able to carry out as well as to present an outline design for the facility so that the latest views can be considered during the refinement of the design. Jon Marangos (Imperial College), the NLS Project Leader, summarized the key new measurement capabilities that NLS will offer in (i) imaging nanoscale structures in their natural state with nanometre resolution (*e.g.* living cells), (ii) measuring structural dynamics underlying physical and chemical changes, (iii) capturing fluctuations in the properties of rapidly evolving systems (*e.g.* plasmas), (iv) measuring ultra-fast dynamics in multi-electron systems and at high X-ray intensity.

Richard Walker (Diamond Light Source), the NLS Accelerator Team Leader, presented an outline design of the facility which is based on a continuous-wave superconducting linear accelerator, to provide a high repetition rate of regularly spaced FEL pulses for optimized data collection and efficient synchronization to external lasers. He explained that the light source will have (i) high peak brightness ($>10^{11}$ photons pulse^{-1}) in the 50 eV–1 keV range and somewhat lower brightness harmonic radiation to 3 keV ($>10^{8}$ photons pulse^{-1}) and 5 keV ($>10^{6}$ photons pulse^{-1}), (ii) pulse duration ~20 fs for the 50 eV to 5 keV range synchronized to ultra-fast light sources covering THz–deep UV and (iii) 1 kHz repetition rate with even pulse spacing (increasing to 10–100 kHz in the future). This specification will be met by three types of radiation source: a suite of three seeded FELs covering the range from 50 eV to 1 keV in the fundamental, with overlapping tuning ranges as follows: FEL1: 50–300 eV, FEL2: 250–850 eV, FEL3: 430–1000 eV. Conventional laser sources will be synchronized to the FEL sources and would cover the range from 60 meV to 50 eV. Coherent THz/IR radiation from 20–500 mm will be generated by the electron beams after passing through each FEL, for optimal synchronization between the FEL pulse envelope and THz/IR field. The overall length of the facility would be around 600 m.

The first meeting of the Technical Advisory Committee (TAC) took place on 4–5 June at the Cockcroft Institute, Daresbury. The TAC, chaired by Joerg Rossbach of the University of Hamburg, comprises leading international experts in accelerator and FEL science including Henry Chapman (CFEL, Hamburg), Paul Emma (LCLS, SLAC) and Josef Feldhaus (FLASH, Hamburg). After an intensive day and a half meeting the TAC concluded that 'NLS will be a fascinating and unique new radiation source' and importantly that it contains 'an adequate balance of high-level state-of-the-art technology *versus* ambitious novel concepts'. The detailed input provided by the TAC is now being worked through for the Conceptual Design Report that is due at the end of this year.

Green light for MAX IV at Lund

On 27 April 2009, four Swedish organizations [Swedish Research Council, Lund University, Region of Skane and Vinnova (Swedish Governmental Agency for Innovation Systems)] together declared the launch of the MAX IV project by announcing the start of construction. The MAX IV facility will consist of two electron storage rings, operated at 1.5 and 3 GeV, and a common full energy linac injector. The two rings will cover a broad spectral range of high-brilliance radiation and the injector will, apart from its mission as a full energy injector for the storage rings, also provide short bunches for the generation of short X-ray pulses from a spontaneous emitter. The linac could eventually be used as the electron source for the generation of coherent radiation in phase 2 of the project. Ground breaking of the MAX IV facility is planned to take place next spring and the facility should be operational by early 2015. The MAX IV facility will be located ~2 km north-east of the existing MAX-lab facility, in the Brunnshog area.

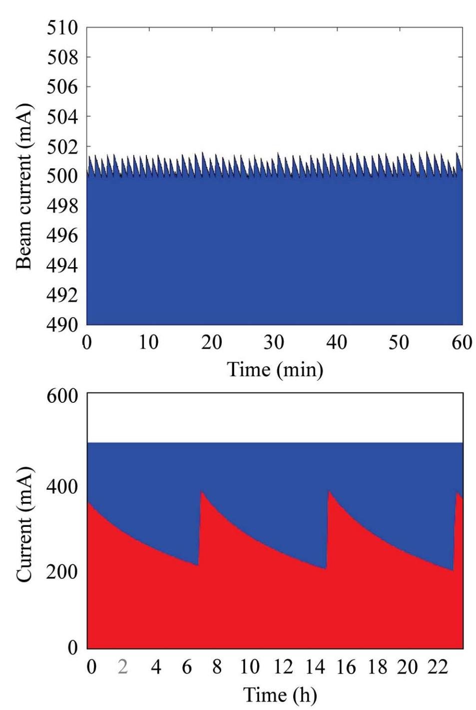
The 3 GeV magnet lattice consists of 20 seven-bend achromats with a circumference of 528 m. The bare lattice emittance is 0.33 nm rad and will be reduced to smaller numbers when insertion devices are added. There are 20 straight sections of length 5 m. The 300 m-long linac will also have an emittance of 0.33 nm rad and will be operated at 3 GHz with moderate field gradients (20 MV m^{-1}). The design work for the 1.5 GeV ring, which will have a circumference of ~95 m, is in progress.

The performance of the facility is in many respects expected to be second to none. The small emittance of the 3 GeV ring is unprecedented and will offer a very high brilliance. The high performance of the facility is a result of an unorthodox design. Small solid iron magnets offer high multipole field strengths which result in a compact lattice design. The small emittance of the 3 GeV ring lattice is achieved by using a large number of bending magnets (140) rather than aiming towards the theoretical minimum emittance solution.

Further excitement was added in Lund when, on 28 May 2009, at a meeting of research ministers in Brussels, the Swedish candidacy to build the European research facility European Spallation Source (ESS) received support from a clear majority. Sweden was supported by seven countries, Germany, France, Poland, Denmark, Norway, Estonia and Latvia, with a further two, Italy and Switzerland, voting with the majority. One country supported another candidate country. Sweden had proposed co-location of the ESS to MAX IV in Lund in a manner similar to the ESRF and ILL in Grenoble.

ALS upgrades to 500 mA top-up operation

The Advanced Light Source (ALS) in Berkeley has started full user operation after the upgrade with a machine current of 500 mA where top-up operation is ensuring very stable user beam (see figure below). This is the largest upgrade since the ALS was originally commissioned in 1993. With this upgrade, the ALS has become the highest-current multi-GeV electron storage ring where top-up operation is available for users. The top-up operational mode allows frequent injection of electron beam into the storage ring, resulting in an almost constant current while keeping user-beam shutters open at all times. This mode presents several important advantages for users. Instead of having multiple injections of a large number of electrons in a short time period followed by uninterrupted beam decay over the course of 8 h, a small number of electrons are added to the storage ring approximately every 30–60 s. The near-constant beam current enhances the flux and brightness of the radiation while simultaneously improving the thermal stability of the machine and its beamlines.



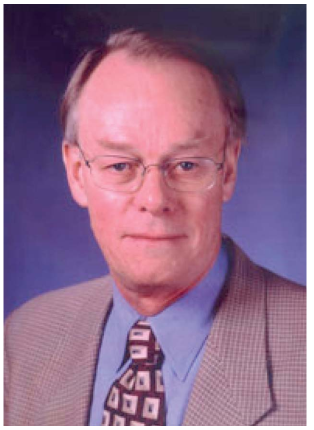
Lower panel: the beam current history prior to top-up operation (red) and with top-up operation (blue). With top-up injection, the current appears steady at 500 mA. Top panel: top-up on an expanded scale.

Compared with pre-top-up operation, top-up at 500 mA doubles the time-averaged current, which increases the photon flux at the ALS by a factor of two. Concurrently with the top-up upgrade, the vertical emittance was decreased by a factor of five to 30 pm rad by adjusting skew quadrupole strengths. This has increased the soft X-ray undulator brightness by a factor of eight. The installation of newer insertion devices with smaller gaps will provide additional gains. In terms of stability it is estimated that, by eliminating the current dependence of beam-position monitors and by reducing the thermal motion of magnets, girders *etc*., the medium-term orbit drift has been reduced by a factor of two to three. On top of that, user beamlines might profit by the steady heat load improving thermal stability in beamline components. Finally, it is of advantage to many users that they no longer need to normalize their measurement data to incoming photon flux, reducing noise and systematic errors.

Wayne Hendrickson appointed NSLS-II Associate Project Director for Life Sciences

Wayne A. Hendrickson, a long-time NSLS structural biology user, University Professor at Columbia University, and Investigator with the Howard Hughes Medical Institute, has been appointed Associate Project Director for Life Sciences at NSLS-II. Wayne established a beamline at NSLS-I for MAD experiments in the mid 1980s.

In this new role, Wayne will develop and establish the life sciences program at the new facility by developing the strategic plans for the use of NSLS-II in life sciences research; coordinating with the life sciences community and representing its needs; communicating with potential funding agencies; representing the needs of life sciences in the design and construction of NSLS-II; and overseeing the development, construction and operation of life sciences facilities (including beamlines) at NSLS-II. Lisa Miller, the NSLS Life and Environmental Science Division Head, will serve as deputy.



Wayne Hendrickson.

Wayne Hendrickson joined the Department of Biochemistry and Molecular Biophysics at Columbia in 1984 where he was named the Violin Family Professor of Physiology and Cellular Biophysics in 2008. Wayne's contributions in stereochemically restrained refinement (*PROLSQ*), the multiwavelength-anomalous-diffraction (MAD) method, selenomethionyl proteins, and instrumentation for MAD are widely recognized. He also serves on advisory bodies for various scientific organizations, is a founding editor of *Current Opinion in Structural Biology* and of *Structure*, and he is a founder of SGX Pharmaceuticals. He has received the Aminoff Prize of the Royal Swedish Academy of Sciences, the Gairdner International Award and the Harvey Prize of the Technion – Israel Institute of Technology. Hendrickson is also a Fellow of the American Academy of Arts and Sciences and a member of the National Academy of Sciences.