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Current events

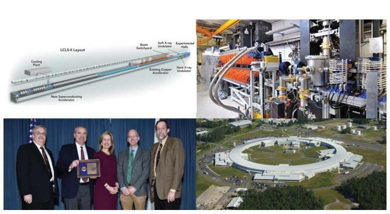
1. US Department of Energy award recognizes National Synchrotron Light Source II project – NSLS-II ramping up operations and science programs

At the annual Department of Energy (DOE) Project Management workshop in Arlington, Virginia, USA, on 23 March 2016, Deputy Secretary of Energy Elizabeth Sherwood-Randall presented the Secretary's Award of Excellence to the National Synchrotron Light Source II (NSLS-II). This is the highest honour awarded annually for a project in the DOE complex. NSLS-II was recognized for being completed ahead of schedule, under budget, and with an expanded scope. At the same event, DOE Brookhaven Site Office Manager Frank Crescenzo was named the Federal Project Director of the Year for his leadership of and dedication to the NSLS-II project.

The NSLS-II is now ramping up accelerator operations and the science programs on the beamlines. The NSLS-II 3 GeV accelerator now routinely operates at 250 mA in top-off mode; and during machine studies on 18 April 2016, the accelerator successfully stored 400 mA. The emittance, achieved last year, is 0.9 nm rad in the horizontal and 6 pm rad in the vertical, and the initial stability goals have also been achieved.

Seven beamlines are currently running general user programs and are continuing to bring new capabilities to the user community with ongoing science commissioning activities. These include the Hard X-ray Nano-probe (3-ID), Coherent Hard X-ray Scattering (11-ID), Coherent Soft X-ray Scattering (23-ID-1), Soft X-ray Spectroscopy and Polarization (23-ID-2), X-ray Powder Diffraction (28-ID), Inelastic X-ray Scattering (10-ID) and Sub-micron Resolution X-ray Spectroscopy (5-ID). Four other beamlines, including Inner-Shell Spectroscopy (8-ID), Life Science X-ray Scattering (16-ID), Frontier Micro-focusing Macromolecular Crystallography (17-ID-2), and Highly Automated Macromolecular Crystallography (17-ID-1), have observed 'first light', and are actively in the technical commissioning phase. These beamlines will begin science commissioning later this year. Three more beamlines plan to observe first light in the summer of 2016, including Electron Spectro-Microscopy (21-ID), X-ray Footprinting for In Vitro and In Vivo Structural Studies of Biological Macromolecules (17-BM), and Integrated In Situ and Resonant Hard X-ray Scattering (4-ID). Beamlines for Complex Materials Scattering (11-BM) and Tender Energy X-ray Absorption Spectroscopy (8-BM) should start commissioning in the fall of 2016. Soon afterwards, the Soft Matter

Frank Crescenzo and John Hill accepted the Secretary's Award of Excellence on behalf of the NSLS-II team. Pictured from left to right: Dr Phil Kraushaar, NSLS-II Program Manager, BES/SC; Mr Frank Crescenzo, Federal Project Director; Elizabeth Sherwood-Randall, Deputy Secretary of Energy; Dr John Hill, NSLS-II Director, BNL; and Dr Erik Johnson, NSLS-II Deputy Director for Construction, BNL.



The National Synchrotron Light Source–II at Brookhaven National Laboratory.

Interface (12-ID) and Soft Inelastic X-ray Scattering (2-ID) beamlines will observe first light.

By the end of 2016, NSLS-II will have 18 beamlines operating and commissioning, with 10 others under development and planned for user operations by 2019–2021.

2. Major upgrade at SLAC

In early April, construction began on a major upgrade at the Department of Energy's SLAC National Accelerator Laboratory. The project, known as LCLS-II, will greatly increase the power and capacity of SLAC's Linac Coherent Light Source (LCLS) for experiments that sharpen the view of how nature works on the atomic level and on ultrafast timescales. The project will add a second X-ray laser beam that is 10000 times brighter, on average, than the first one and fires 8000 times faster, up to a million pulses per second.

'LCLS-II will take X-ray science to the next level, opening the door to a whole new range of studies of the ultrafast and ultrasmall', said LCLS Director Mike Dunne. 'This will tremendously advance our ability to develop transformative technologies of the future, including novel electronics, life-saving drugs and innovative energy solutions.'

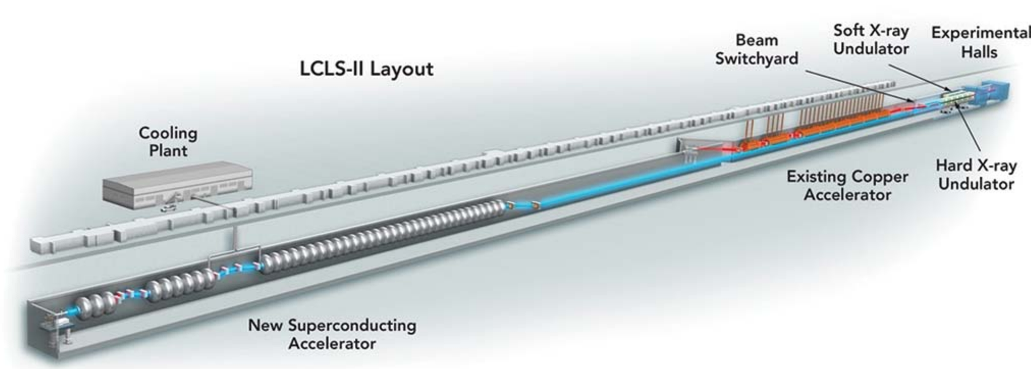
SLAC Director Chi-Chang Kao said, 'Our lab has a long tradition of building and operating premier X-ray sources that help users from around the world pursue cutting-edge research in chemistry, materials science, biology and energy research. LCLS-II will keep the US at the forefront of X-ray science.'

With favourable 'Critical Decisions 2 and 3 (CD-2/3)' in March, DOE has formally approved construction of the USD 1 billion project, which is being funded by DOE's Office of Science. SLAC is now clearing out the first third of the linac to make room for the superconducting accelerator, which is scheduled to begin operation in the early 2020s. In the meantime, LCLS will continue to serve the X-ray science community, except for a construction-related six-month downtime in 2017 and a 12-month shutdown extending from 2018 into 2019. With the upgrades that are now moving forward, Dunne said, SLAC will have an X-ray laser facility that will enable groundbreaking research for years to come.

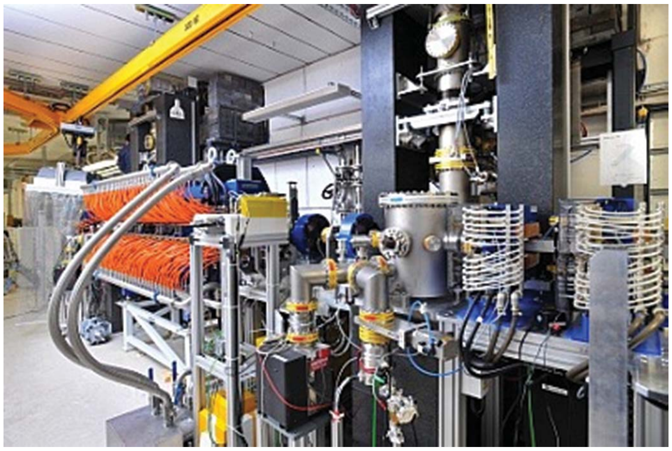
The new X-ray laser will work in parallel with the existing LCLS, with each occupying one-third of SLAC's 2 mile-long linear accelerator tunnel. Together they will allow researchers to make observations over a wider energy range, capture detailed snapshots of rapid processes, probe delicate samples that are beyond the reach of other light sources and gather more data in less time, thus greatly increasing the number of experiments that can be performed at this pioneering facility.

3. New compact Terahertz light source

Scientists at the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) in Germany have constructed a prototype facility for research with high Terahertz (THz) fields. The performance of this facility, named TELBE, was successfully tested by conducting a time-resolved pilot experiment. The achieved THz fields exceed those of existing THz sources at similar repetition rates by orders of magnitude, although TELBE has not yet reached its design parameters. The resonances of many



The future LCLS-II X-ray laser (blue, at left) is shown alongside the existing LCLS (red, at right). LCLS uses the last third of SLAC's 2 mile-long linear accelerator – a hollow copper structure that operates at room temperature and allows the generation of 120 X-ray pulses per second. For LCLS-II, the first third of the copper accelerator will be replaced with a superconducting one, capable of creating up to 1 million X-ray flashes per second. [SLAC National Accelerator Laboratory.]



View of the two THz sources at the ELBE accelerator. The pulses from the diffraction radiator source (right) and from the undulator source (orange part) are transported into the laboratory on the roof by two optical beamlines. [Photograph courtesy of HZDR/F. Bierstedt.]

important fundamental excitations in solids are in the THz frequency range. Intense specifically shaped THz pulses can be utilized to manipulate materials properties on ultra-fast timescales selectively as several groundbreaking experiments in the past years have shown. Existing THz sources have so far failed to provide optimal parameters for many of the envisioned investigations, *e.g.* by providing only moderate repetition rates.

A collaboration of experts from Deutsches Elektronen-Synchrotron (DESY), Karlsruhe Institute of Technology (KIT), SLAC National Accelerator Laboratory, and the European XFEL now demonstrated that intense THz pulses can be generated at unprecedented repetition rates utilizing a very compact, quasi-CW linear electron accelerator. The concept combines superconducting radio-frequent accelerator technology with the super-radiant THz emission principle. Two of the results are of particular importance. Firstly, it could be shown that multiple THz sources can be operated in parallel by one accelerator. Thereby future user facilities, like TELBE itself, can provide multiple user groups with individually adjustable THz pulses. Secondly, during the pilot experiments a timing accuracy between the THz pulses and external laser systems in the 10 fs regime was demonstrated routinely [Green *et al.* (2016), *Sci. Rep.* **6**, 2016, doi:10.1038/srep22256]. The facility will start 'friendly user' operation for a limited number of proposals in the summer of 2016.