SACLA Lased:

SACLA Achieves Laser Amplification at 10 keV, Will Open for International Research March 2012

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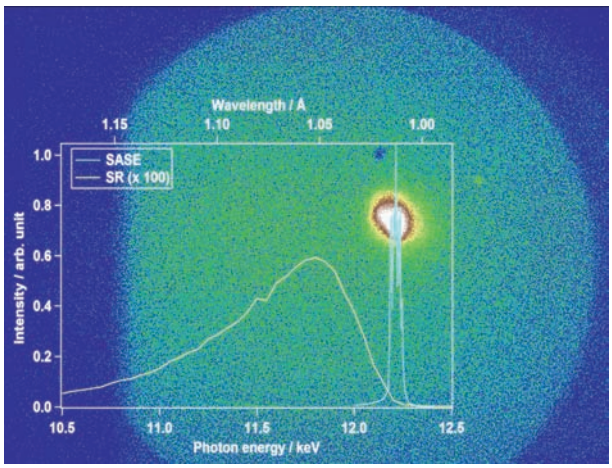
On June 7, the Japanese hard X-ray free electron laser (XFEL) SPring-8 Angstrom Compact free electron LAser (SACLA) reached laser amplification at 10 keV photon energy. This is the second time in the world in which amplification at this scale has been achieved; it is an accomplishment which was first attained by the XFEL of Linac Coherent Light Source (LCLS) at SLAC National Accelerator Laboratory in the United States.

SACLA has utilized a novel concept of Self-Amplified Spontaneous Emission (SASE) XFEL. In order to obtain the high density electron bunch required by the SASE operation, a thermionic electron gun of single-crystal cathode followed by several RF cavities with increasing frequency for velocity bunching replaced the conventional laser-RF electron gun which is used at both LCLS and FLASH (Free-Electron Laser in Hamburg) at DESY (Deutsches Elektronen-Synochrotron). A high gradient accelerator using C-band RF (5.712 GHz) curtails the total length of the linear accelerator in comparison with the S-band (2.856 GHz) for LCLS and L-band (1.3 GHz) for FLASH.

Another key difference between SACLA and other facilities can be seen in the length of SACLA. SACLA was designed to compose of a 400 meter long, 8 GeV linear accelerator and a 90 meter long undulator with an 18 millimeter magnetic period. Even with additional space for user experimentation, the total facility length is only 700 meters, which is much more compact in comparison to LCLS and the European XFEL project at DESY.

However, the most significant difference between SACLA and the systems present at LCLS and FLASH lies in SACLA's undulator concept. The originating idea for the SACLA project arose as we considered both the benefits and drawbacks of using in-vacuum undulators developed at SPring-8 instead of conventional out-of-vacuum undulators used in both LCLS and FLASH. Since we have, in principle, no limit in the gap of magnetic poles of in-vacuum undulator, we can reduce the magnetic period of undulator. This reduction enables us to reduce the electron beam energy required to obtain fixed wavelength laser photons from the undulator, because the photon wavelength emitted by undulators is proportional to the magnetic period of undulators and inverse proportional to the square of the electron beam energy.

Located in the same site as SPring-8, a third-generation synchrotron radiation facility, SACLA's linear accelerator will be used as a low emittance electron beam injector to the SPring-8 storage ring. Both SACLA's XFEL beam



Tetsuya Ishikawa is the director of RIKEN Harima Institute in which SPring-8 (3rd generation synchrotron radiation facility), SACLA (XFEL facility) and RIKEN SPring-8 Center (RSC) are located. He is also the director of RSC and the Chief Scientist of Coherent X-Ray Optics Laboratory in the RSC. His research field is X-Ray Optics and their applications.

and SPring-8's undulator X-rays can then be guided on to the same sample to conduct, for example, XFEL-pump and SPring-8-probe type experiments.

We assembled all the hardware of SACLA in February 2011. The initial electron beam commissioning resulted in the confirmation of 0.8 Å spontaneous X-rays from the undulator with an 8 GeV electron beam in March 2011. The fact that we have reached lasing after only three months of electron beam commissioning indicates (i) the validity of the basic design concept of SCSS (SPring-8 Compact SASE Source) as well as the experience accumulated during the operation of SCSS prototype machine, (ii) the certainty of the components development, design, fabrication, installation, alignment and tune-up and (iii) the adequacy of the beam commissioning strategy, meaning that the project has moved ahead with extraordinary smoothness.

We are continuing the commissioning of SACLA in order to deliver a higher intensity and shorter wavelength X-ray laser with higher stability. SACLA will be open for international public users by the end of 2011 fiscal year, i.e., March 2012. Calls for proposals will be announced soon.

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