SACLA

SACLA launched user operations in March 2012, marking the world's second XFEL facility for users, following LCLS. The inaugural user group was led by Dr. Hideo Ago from RIKEN SPring-8 Center, which started single-shot, damage-free protein structural analysis using conventional X-ray crystallography. The total user time during fiscal year 2012 was 3,150 hours (out of 7,000 hours of total operation time). SACLA plans to steadily increase user time over the next five years to achieve a tentative goal of 4,000 hours of user time (out of 6,000 hours of total operation time). The most exciting SACLA capabilities for users have been its high shot-by-shot stability in the pointing direction, spatial profile, laser wavelength and intensity. Although SACLA started user operations with a single X-ray FEL beamline and one low-energy spontaneous beamline, most users have focused operations on the X-ray FEL since it can deliver higher energy laser photons than LCLS.

Through our experience with user operations, it has become clear that the scientific fields requiring XFEL are much more widespread than what a single facility, or even more than ten facilities, can accommodate. Therefore, it is feasible for SACLA and LCLS to avoid overlapping their respective targeted fields. Even with new facilities coming on-line, such as European, SWISS, and PAL XFELs, it would not be difficult to minimize overlapping of targeted fields if we choose to do so.

Unfortunately, our selection of machine technology does not allow us to achieve very high pulse energy for single pulses, as that would certainly destroy samples and might even deteriorate optical elements. Rather than striving for higher pulse energy, we have decided to develop high-performance focusing systems that can produce much higher power density. A Kirkpatrick-Baez (KB) focusing mirror with elliptically figured mirrors has been working effectively, offering a 1 μm × 1 μm focal spot with a working distance exceeding 1000 mm. A two-stage KB mirror offers a 50 nm × 50 nm focal spot inside the SACLA-SPring-8 Experimental Facility where the SACLA and SPring-8 X-ray beams intersect. The extremely high photon flux density generated by this focusing method has been used to conduct research on nonlinear X-ray optics as well as on high-energy-density science.

Over the past year, SACLA has developed now-standard experimental techniques for XFEL, including Coherent Diffraction Imaging; Ultra-Fast Tracking of gas, liquid, and solid-phase materials; and X-ray Quantum Optics. SACLA has also been developing X-ray image sensors with a fast read-out. The integration of X-ray optics, such as focusing systems, sample manipulation systems, detectors and data analysis systems, is progressing to improve capabilities for user experiments.

After the successful self-seeding at LCLS, SACLA decided to follow the same seeding scheme. A small chicane was prepared by moving one undulator unit after the most downstream one to install transmission crystal optics for seeding. Tests of seeding operations will be conducted in the latter half of 2013. Also, high-efficiency seeding with laser higher harmonics has been demonstrated at the SCSS prototype EUV FEL, which will be relocated to the SACLA undulator hall in a couple of years.

Last, but not least, we are sad to announce the sudden loss of Dr. Mitsuru Nagasono, who was responsible for SCSS experiments. We miss him and wish him and his family peace.

Tetsuya Ishikawa