Project XFEL

For many years, scientists have used basic laser technology to generate shorter wavelength coherent radiation to explore the nano-world. But scientists have long dreamed of a new generation of laser-like X-rays to further their exploration. Although research to attain shorter wavelength lasers was initiated soon after the invention of visible lasers in the 1960s, scientists found it extremely difficult to adapt conventional laser technologies (based on atomic or molecular energy levels) to reach the X-ray region. Free electron lasers (FEL), initially proposed in the 1970s, were regarded as a potential technology for producing X-ray lasers. But the difficulty in devising an optical cavity with high reflectivity mirrors in the X-ray region prevented scientists from developing a working model. In the 1990s, the discovery of the SASE (self-amplified spontaneous emission) concept provided a promising breakthrough.

At the end of the last decade, a project for constructing an X-ray coherent light source (now known as a Linac Coherent Light Source, or LCLS) at the SLAC, was proposed. Another project proposed in Germany was based on superconducting linac technology. During the planning stages of these projects, SPring-8 scientists were asked to participate in the workshops because SPring-8 had just completed a 1-km beamline for coherent hard X-rays and a 27-m long undulator, both of which might prove useful for providing a SASE source. At the workshops we found a unique means of producing SASE-XFEL by using the in-vacuum undulator developed at the SPring-8. The shorter magnetic period achievable by using the in-vacuum undulator would help us to produce hard X-rays with relatively lower electron energy, potentially reducing the linac length. Using a higher frequency (C-band) high gradient accelerator unit could lead to even further reduction of the linac length.

We proposed a new type of SASE-XFEL source called the "SPring-8 Compact SASE Source" (SCSS), based on the concept of the lower energy and the higher gradient linac working together with the shorter undulator to contribute to significant reduction of the facility length. During 2001-2003, we developed critical components for the SCSS including a low-emittance thermionic e-gun. In 2004, we published a conceptual design report for XFEL and in 2005, we began construction of a 1/32 scale prototype of an FEL.

Our project was selected as one of Japan's five Key Technologies of National Importance. An XFEL based on an 8 GeV linac is now under construction with completion expected in 2010. RIKEN and JASRI set up a joint project team for the construction of the XFEL. Comprehensive discussions on applications for the XFEL are currently underway, under the initiative of MEXT, which includes many potential users of the XFEL.

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