XFEL Project

X-ray Free Electron Laser
Pioneering a new generation of sciences for the 21st century

http://www.riken.jp/XFEL/

XFEL Heralds the Dawn of a New Era in Science

RIKEN established the SPring-8 Joint Project for XFEL to construct an X-ray free electron laser (XFEL) in collaboration with JASRI*. The XFEL will enable major progress in the structural analysis of proteins and the development of new materials, helping create new fields of science.

*Japan Synchrotron Radiation Research Institute

Milestones

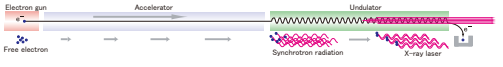
2005 Manufacture of the 250 MeV prototype begins
2006 Success in laser oscillation of 49 nm UV rays in the prototype
2007 XFEL facility construction begins
2008 XFEL User Promotion Projects and User Projects open to the Public

Future Plans

2009 Complete construction of the building housing the light source and all related equipment
2010 Complete construction of experiment/research building
2010-2011 Achieve XFEL laser oscillation Open facility for use

What is an X-ray Free Electron Laser?

To date, it has been difficult to reach the short X-ray wavelengths needed for microscopic observation at atomic resolution with conventional lasers using stimulated emission or higher harmonics generated by non-linear processes. One way of reaching the X-ray region is to use free electrons in an accelerator to produce coherent X-ray photons from electron-photon interactions in a long undulator.



A beam of electrons is accelerated to 8 GeV - near the speed of light - and passes through a series of permanent magnets with alternating polarity called undulators. These sinusoidally deflect the electrons' path with their magnetic fields, generating light. This light and the electron beam then repeatedly reinteract in the undulator, generating the free electron laser beam.


The SCSS test accelerator, a prototype for the XFEL

Technologies for a Compact XFEL

A compact XFEL has been attained by new technologies developed in Japan. These technologies will also contribute to its stable operation. Smaller facilities are generally more cost-effective and take less time to complete.

Although XFEL facilities are under construction in the United States and Europe, the length of the Japanese XFEL, 700 m, is 1/3-1/4 of theirs. This reduction in size was made possible with three unique technologies developed in the RIKEN SPring-8 Center : a single crystal CeB6 thermionic electron gun, a high-frequency (C-band) accelerator, and an in-vacuum undulator.


Thermionic electron gun

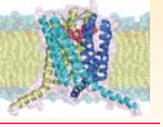

C-band accelerator tube


In-vacuum undulator

XFEL New Sciences and Technologies to Create

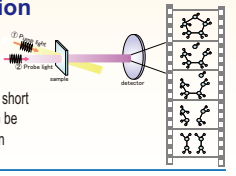
Protein Structure Analysis

Structure analysis of protein molecules at atomic resolution clarifies their function, thus creating products with new functions in biology and pharmacy.
In particular, XFEL will have a capability of imaging atoms as a microscope, and it will show structuresof proteins which are difficult to crystallize.



Ultra-fast Observation

Femtosecond XFEL pulses can probe ultra-fast movement of materials.
Chemical reactions can be filmed with short pulses from XFEL. These pictures can be used to better understand processes in fuel and solar cells.



Imaging Technology

Coherent X-ray imaging using XFEL is a promising tool for atomic-level resolution microscopy for various materials.
Our goal is high resolution imaging of live cells using the extreme intensity and coherence of the XFEL.
It will also be a powerful tool for observation of specific cells, such as cancer.