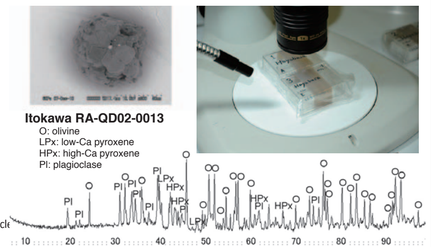
Research Highlights

The Photon Factory supplies highly-brillliant X-rays and VUV light, which provide the means to understand the basic structure and function of materials including condensed matter, biological systems, environmental and chemical materials and many others.

Analysis of asteroid Itokawa particles brought by Hayabusa

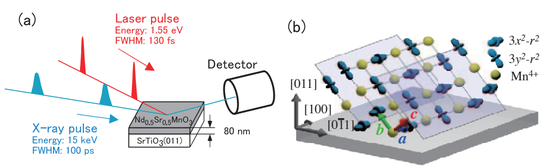
The early history of the small asteroid “Itokawa” has been uncovered by analyzing tiny granular samples brought back to the Earth by Hayabusa. It is suggested that Itokawa is similar in mineral composition to chondrite meteorites, the oldest and most primitive material in the solar system.



Microscopic view (upper left) and X-ray diffraction pattern (lower) of dust particle from asteroid Itokawa / T. Nakamura *et al.*, *Science,* **333**, 1113 (2011).

Hidden state revealed by time-resolved X-ray diffraction

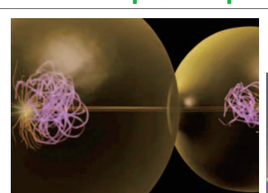
Perovskite manganese oxides show thermally induced structural phase transitions coupled with an insulator-to-metal transition. Picosecond time-resolved X-ray diffraction technique revealed that a charge and orbitally ordered “hidden state” which cannot reachable under thermal equilibrium conditions.

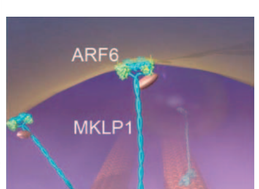


(a) Experimental setup and (b) orbital structures of the perovskite manganese oxides in the low-temperature / H. Ichikawa *et al.*, *Nature Materials,* **10**, 101 (2011).

Structural basis of a protein complex responsible for cytokinesis

Cytokinesis is the final stage of cell division, during which cells exhibit drastic morphological changes. Structure of Arf6-MKLP1 complex was determined and revealed that the complex plays a crucial role in cytokinesis by connecting the microtubule bundle and membrane at the cleavage plane.

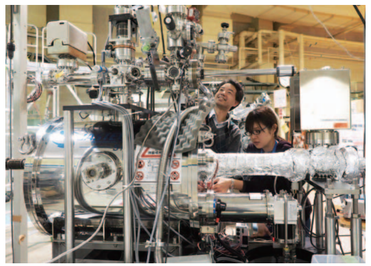




Cytokinesis and Arf6-MKLP1 complex connecting the microtubule bundle and membrane at the cleavage site / H. Makyio *et al.*, *EMBO J.*, **31**, 2590 (2012).

Using the Photon Factory

As a facility in the Inter-University Research Institute Corporation, the Photon Factory promotes a variety of synchrotron radiation research in material and life sciences. The Photon Factory is open to users at universities and public research institutions of all over the world as well as of Japan, at no charge. The number of active proposals is around 800 and the number of users is around 3000 per year. The Photon Factory also promotes an academic-industrial collaboration.



Education

The Photon Factory carries out graduate education in the School of High Energy Accelerator Science of the Graduate University for Advanced Studies (SOKENDAI). The Photon Factory also accepts graduate students from universities all over the Japan and the world to train them for the next generation.

International collaboration

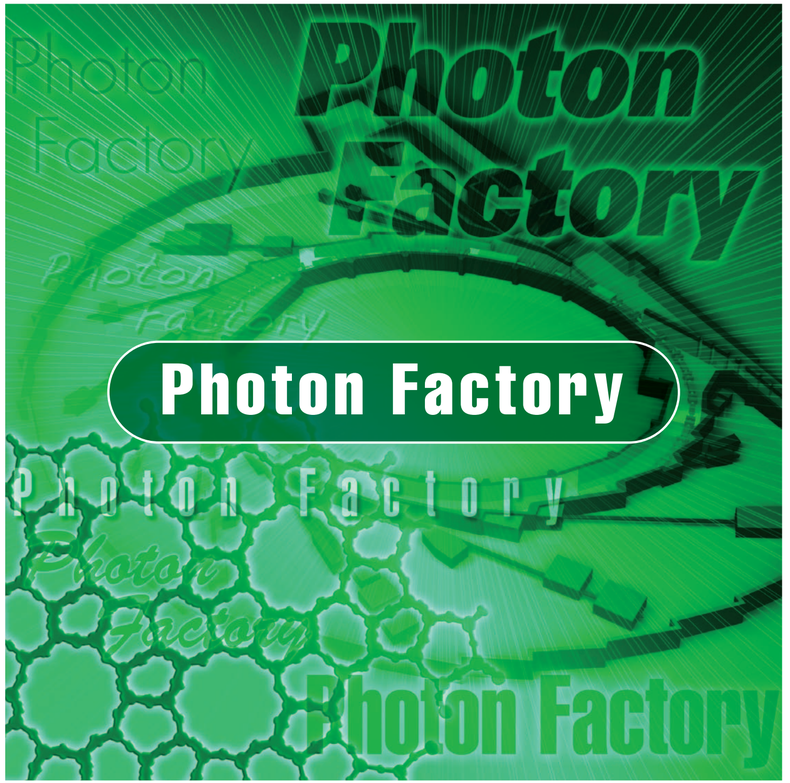
The Photon Factory has been working on international research collaboration, especially in the Asia-Oceania region. The Australian Beamline at the Photon Factory was operated from 1992 to 2013. It contributed to cutting-edge research conducted by Australian researchers and to the establishment of the Australian Synchrotron. The Indian Beamline was build in 2009, which allows fundamental research by Indian researchers. The Photon Factory also contributes to the construction of the SESAME accelerator in the Middle East and African Light Source (AfLS) Project.

Photon Factory

https://www2.kek.jp/imss/pf/ (in Japanese) **https://www2.kek.jp/imss/pf/eng/** (in English)

Inter-University Research Institute Corportaion
High Energy Accelerator Research Organization (KEK)
Oho 1-1, Tsukuba, Ibaraki 305-0801, Japan

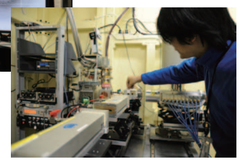
Mar. 2018



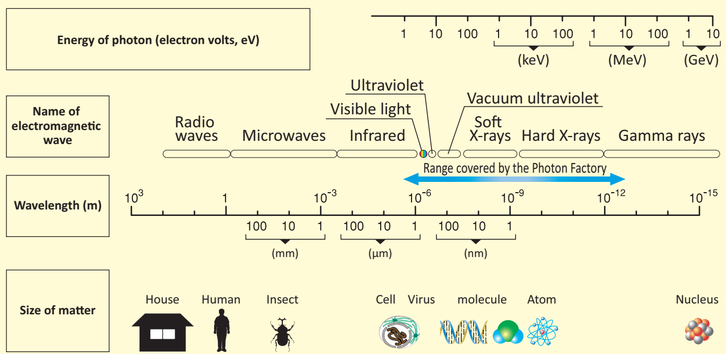
Inter-University Research Institute Corporation
High Energy Accelerator Research Organization (KEK)

Photon Factory, a light source for material and life sciences

The Photon Factory is an accelerator-based light source facility, as a part of the High Energy Accelerator Research Organization (KEK), Japan. The Photon Factory operates two storage rings, the 2.5-GeV PF ring and the 6.5-GeV PF Advanced Ring (PF-AR). The Photon Factory supplies brilliant X-rays and VUV light, which provide the means to understand the function of materials and life.



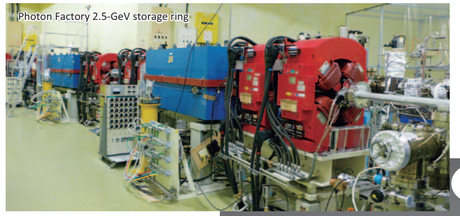
Electromagnetic Spectrum



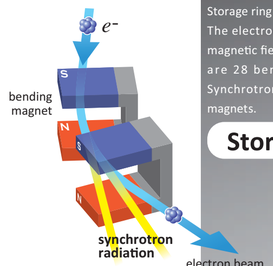
What are the properties of light from the Photon Factory?

When charged particles move in a circular orbit at speeds close to the speed of light, photons are emitted in the forward direction. This radiation is called as synchrotron radiation (SR). The properties of the synchrotron radiation are;

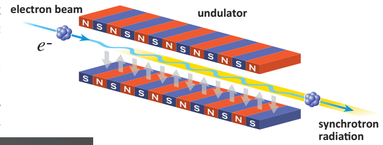
- ➢a continuous spectrum from ultraviolet to X-rays, allowing an energy-tunable light source
- ➢highly collimated light
- ➢highly polarized light
- ➢pulsed light with the pulse widths about 100 picoseconds



The experimental hall spread outward the storage ring is a venue for research of materials and life sciences.



Storage ring is a light source accelerator of ring shape. The electron beam is bent into a circular path by a magnetic field produced by a bending magnet. There are 28 bending magnets in 2.5-GeV PF ring. Synchrotron radiation is emitted from all of these magnets.



Undulator is an equipment for increasing brightness of synchrotron radiation. It consists a succession of magnets of alternating polarity and is used as being inserted at the straight section between bending magnets. The light produced by each magnetic pair interferes each other and gets incredible brightness. In-vacuum undulator developed at the Photon Factory enables us to get highly brilliant X-ray beam by strong magnetic field. Now this type of undulator has become a worldwide standard.
The Photon Factory had upgraded to increase the number of straight sections available for undulators in 2005 and new beamlines with brighter light have been constructed every year since then.


Alignment of an in-vacuum undulator

Experimental Hall

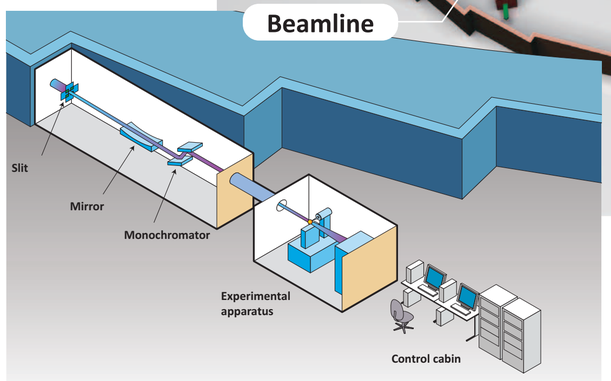
Storage Ring

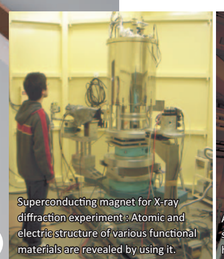
Undulator

Looking into the Photon Factory

Light produced by a storage ring is introduced to experimental apparatuses by "beamlines". There are many common components called “optics” in beamline for arranging the light, such as "slit" to cut it, "mirror" to focus it and "monochromator" to get only specific wavelength of it.

Beamline

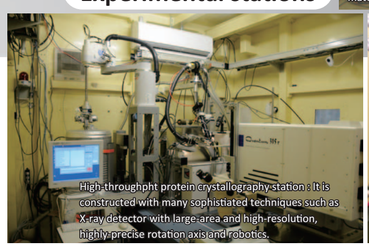



Superconducting magnet for X-ray diffraction experiment : Atomic and electric structure of various functional materials are revealed by using it.


Angle-resolved photoelectron spectrometer with large hemispherical electron analyzer.

Experimental stations

Materials interact with light by many ways. The light diffracted or transmited, fluorescent X-rays or emited electrons are detected by "detectors" to know how and what interaction takes place between photons and materials. There are various types of experimental apparatuses in the Photon Factory.


High-throughpht protein crystallography station : It is constructed with many sophistiated techniques such as X-ray detector with large area and high-resolution, highly-precise rotation axis and robotics.


Florescent XAFS station: Atomic and electric structure of non-crystalline materials can be elucidated.