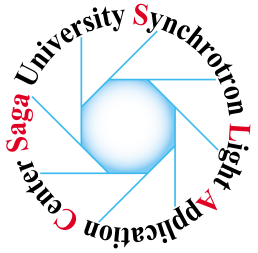
# Synchrotron Light Application Center
# Saga University



# About Us

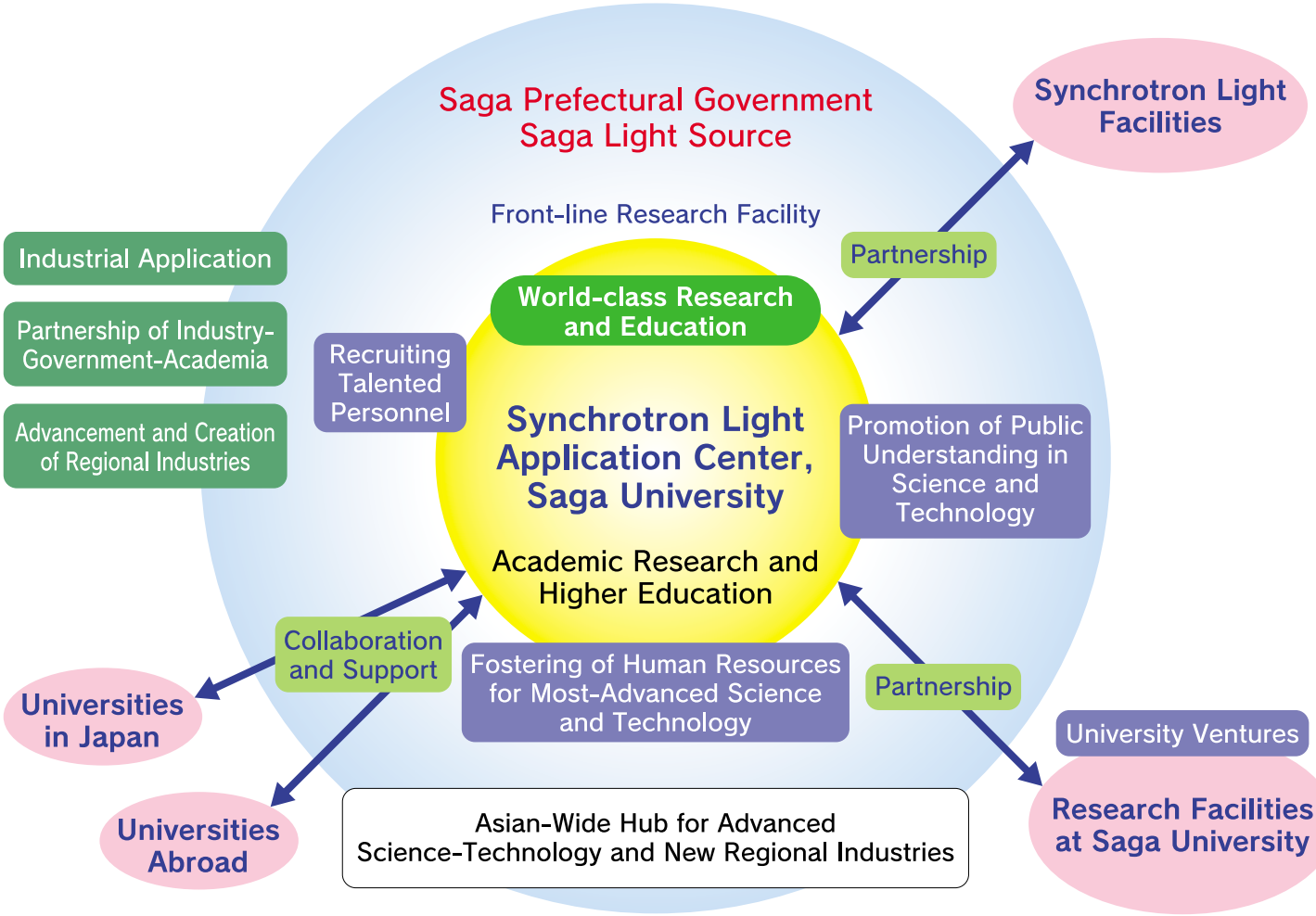
## Purpose of Establishment

Synchrotron Light Application Center, Saga University was established in 2001 in order to support the synchrotron light application project run by Saga prefecture on academic basis to serve as a regional research core and to conduct the cutting edge scientific research in the academic area.

The main objectives of the center include: fostering of human resources in science and technology, development of future technologies, exploitation of intellectual properties, creation of new industries, and advancement of regional industries through the promotion of advanced research.

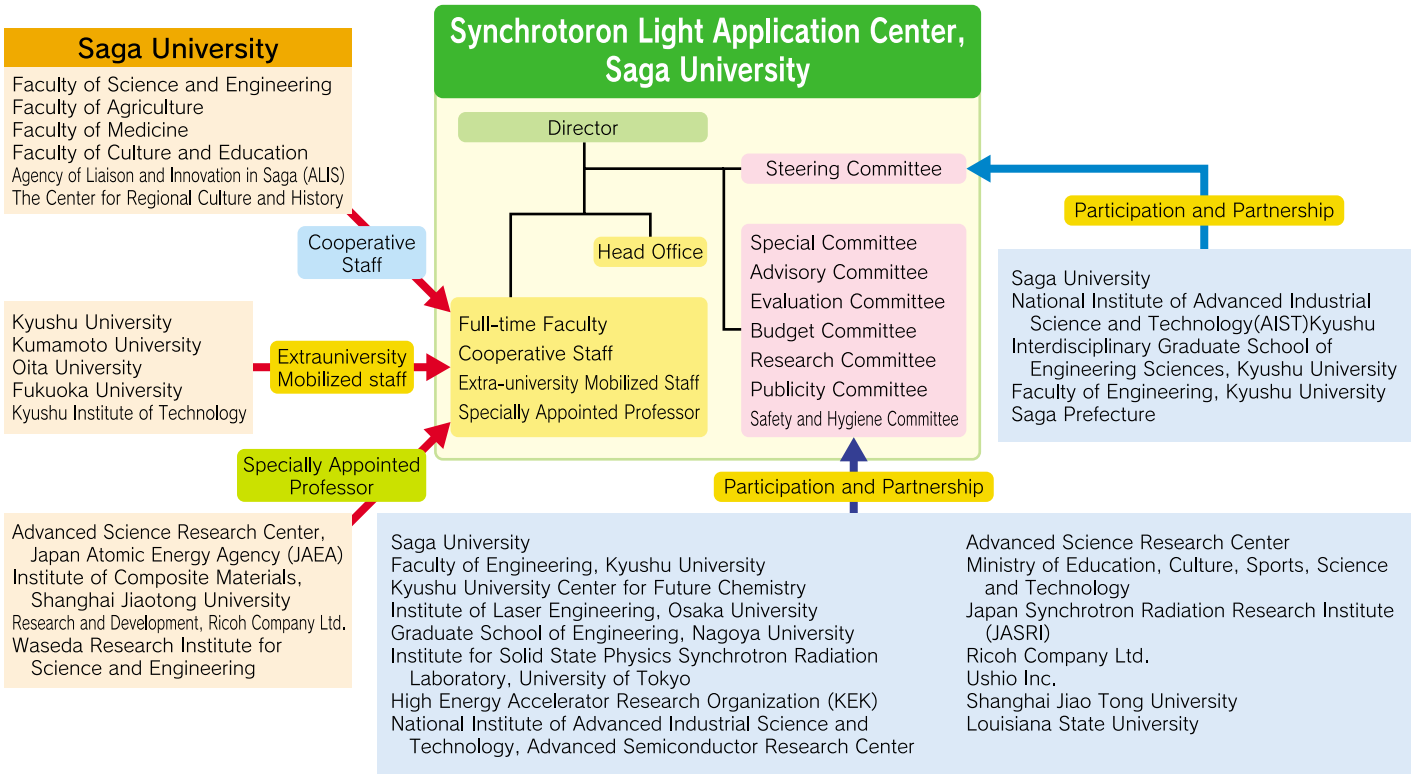
## Functions and Relationship of the Center

### Intelligent Center Collaborating with the Local Government through Educational and Research Activity




- Contribution to Local Revitalization through Cooperation and Support of Kyushu Synchrotron Light Research Center
- Joint Research Center in Kyushu area and Surrounding Asian Countries Using Synchrotron Light
  → Joint Research with Universities, Industries and Public Agencies
- Advancement of Research in Synchrotron Light Application and R & D of Advanced Science and Technology
- Development of Future Human Resources in Synchrotron Light Application and Promotion of Public Understanding in Science
- Cooperation of Industry-Government-Academia Aiming for Advancement and Creation of Regional Industries

## Governing Structure




## Educational Activities

We, at Synchrotron Light Application Center, have been providing lectures on synchrotron light and its applications for undergraduate and graduate students since the foundation.
We are accepting students for graduation work from department of electrical and electronic engineering and from department of physics to provide frontier practical education related to synchrotron light.

Regular study meetings, in which students take turns to report and discuss what they have learnt

Outdoor activities as a part of a training aiming to nurture a scientific mind and to develop a sense of observation

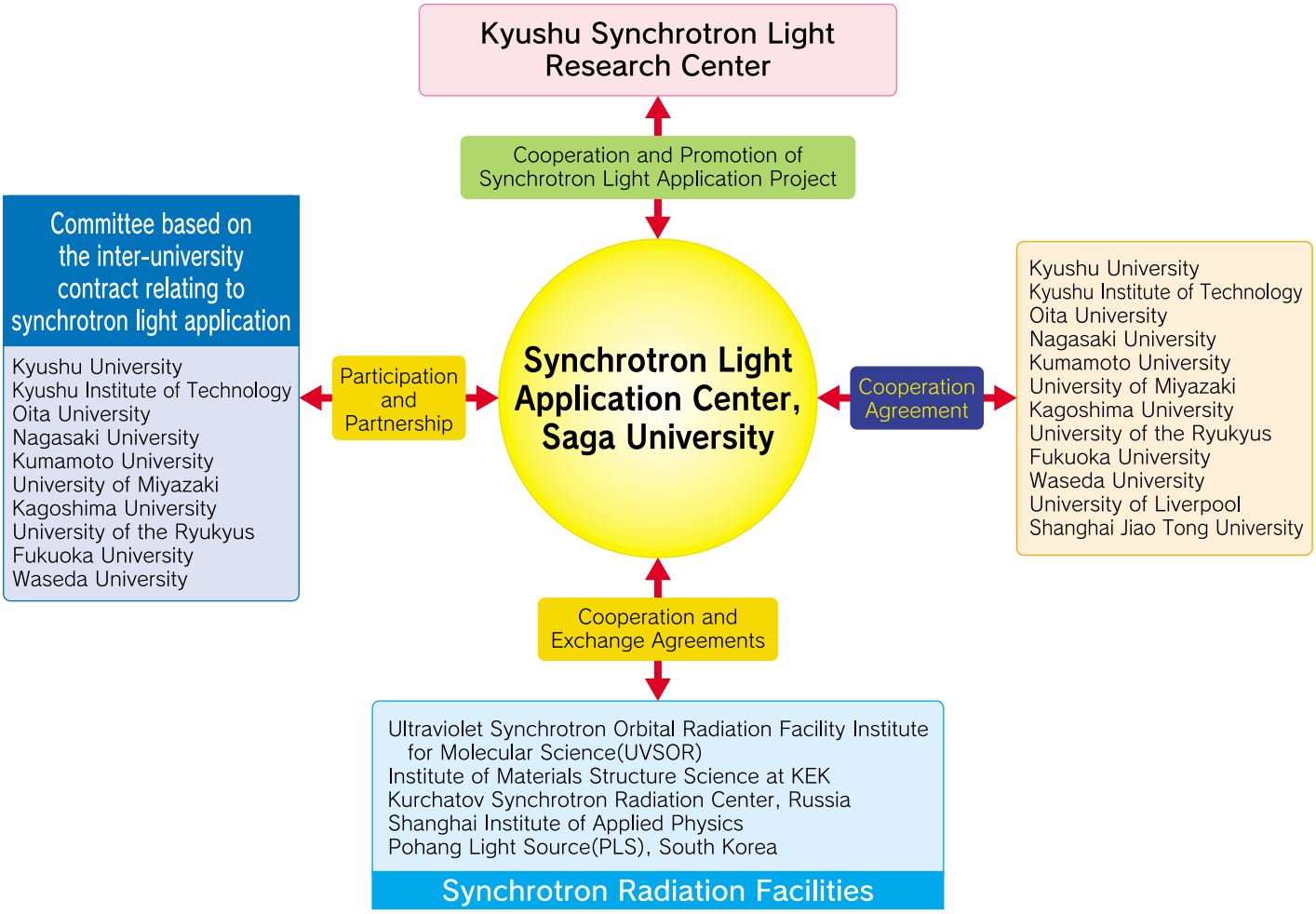
Monthly get-togethers to celebrate special days for the members

# Collaboration with Other Research Institutions

## Cooperation and Exchange Agreements with Japanese and Overseas Research Institutions

The center have been promoting cooperation with other research institutions, mainly with universities in Kyushu area, to achieve the following goals.

1. Development of Synchrotron Light Application Center, Saga University
2. Joint development of academic beamlines
3. Education related to synchrotron light application research
4. Promotion of research of synchrotron light application




## Inter-University Coordination Conference on Synchrotron Light Application

Ten national and public universities in Kyushu area have concluded cooperation agreements on education and research to establish a framework for cooperation of research and development. Coordination conferences are held to promote the research.


## International Cooperation on Synchrotron Light Application Research

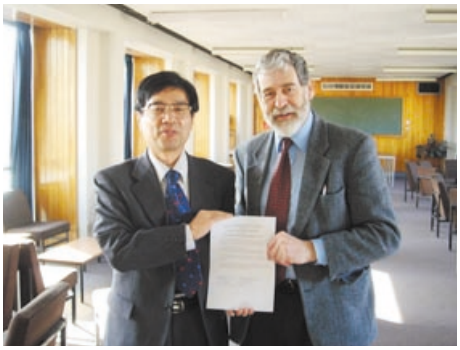
We have concluded cooperation and exchange agreements with research institutes around the world to work together and to promote the front-line research and development of synchrotron light application.

Joint seminars are held to report the findings of the research providing opportunities for exchanging information and for discussion on further developments.

Joint Seminars with Kurchatov Institute (Russia)

Joint Seminars
with Shanghai Institute of Applied Physics (China)

Joint Seminars
with Shanghai Jiao Tong University (China)



Coorporation agreement
with University of Liverpool

# Utilization of Synchrotron Radiation

## About our Facilities: SAGA Light Source (SAGA-LS)

### Basic Parameters

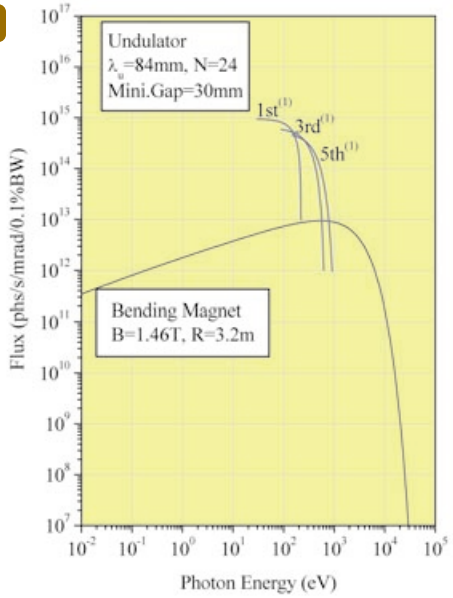
**Storage Ring**

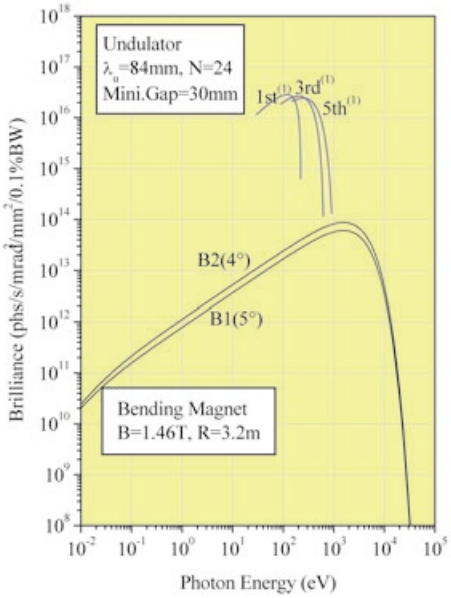
- Beam Energy : 1.4 GeV
- Max. Beam Current : 300 mA
- Circumference : approx. 75.6 m
- Critical energy : 1.9 keV
- Emittance : 25.1 nm-rad

**Beam Size (at coupling 10%)**

- Straight Section : Horiz. 581 μm Vert. 156 μm
- Bending magnet : Horiz. 180 μm Vert. 115 μm

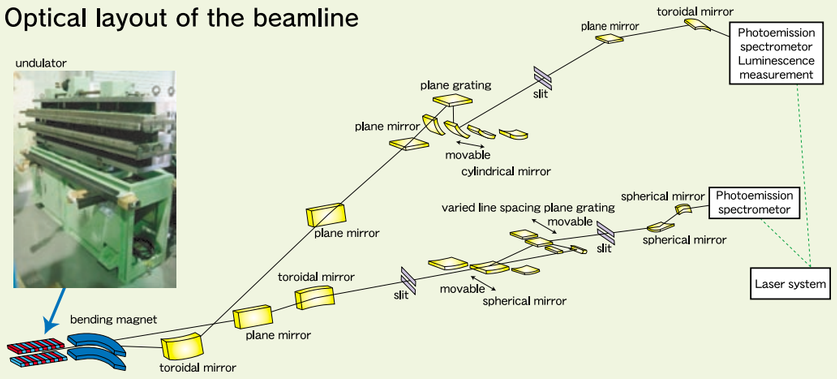
### Light Spectrum

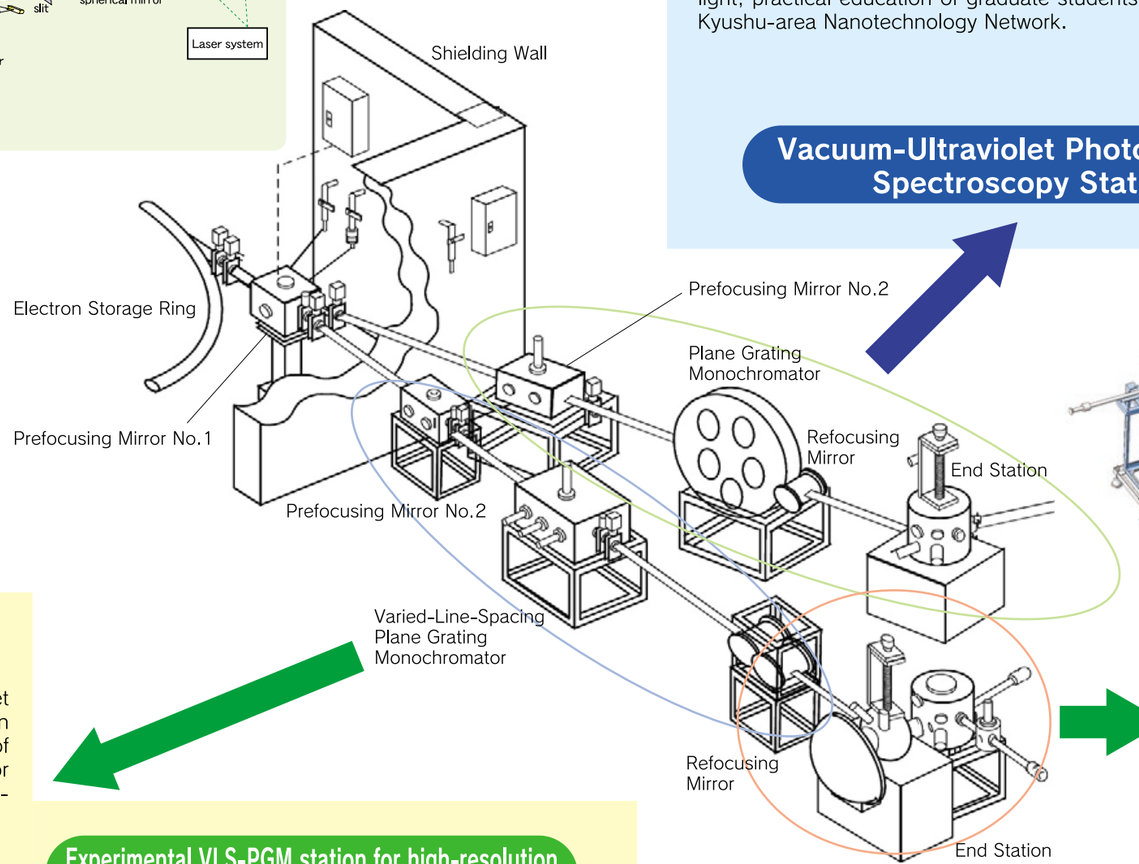


# Beamline for nano-scale surface and interface dynamics research

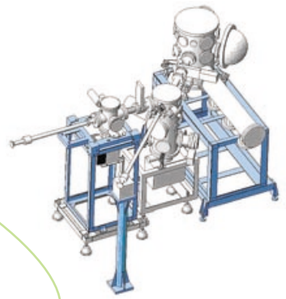
## Optical layout of the beamline



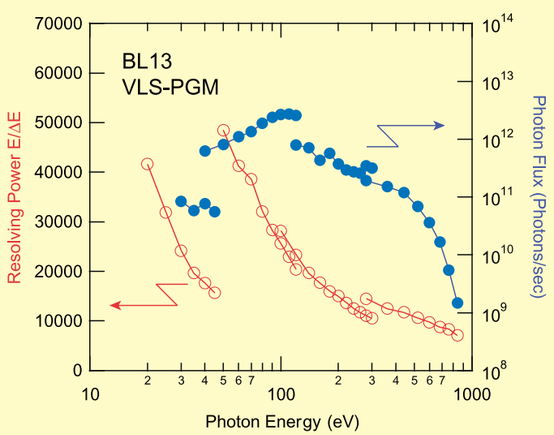

## Vacuum-Ultraviolet Photoemission Spectroscopy Station

This is an experimental station that utilizes vacuum-ultraviolet photoemissions and soft X-rays generated through polarized electromagnets. The spectroscopy can be used for the energy range of 2～120 eV by switching five spherical mirrors and three plane diffraction gratings. It is design to achieve high photon flux of $10^{9}$～$10^{11}$ photon/sec through its special optical design, i.e. without entrance slits. The endstation is equipped with photoelectron spectrometer. The station is used for a wide variety of purposes including UPS measurement by combination of synchrotron and laser light, practical education of graduate students and giving support for Kyushu-area Nanotechnology Network.



## Varied-Line-Spacing Plane Grating Monochromator

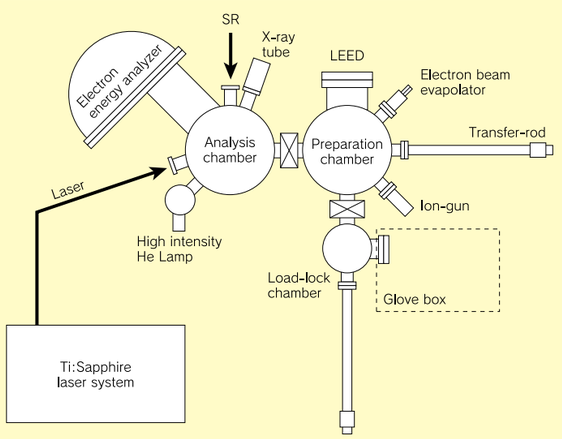
The beamline is designed for brilliant vacuum-ultraviolet and soft X-ray beam generated by an undulator installed in the straight section. It achieves the high photon flux of $10^{10}$-$10^{12}$ photon/sec and resolving power 10,000 for wide range of energy 90-800 eV by using the varied-line-spacing plane grating.

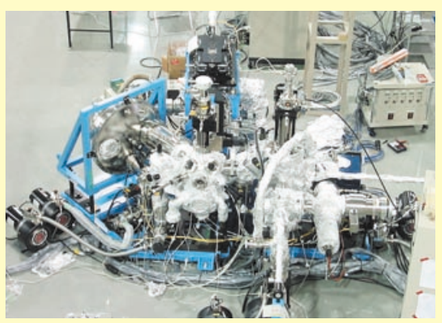



## Experimental VLS-PGM station for high-resolution photoemission spectroscopy using VUV and SX

## Experimental Station for High-Resolution Angle-Resolved Photoemission Spectrometer

The device consists of three parts: Load-Lock chamber, preparation chamber and photoelectron spectroscopic analysis chamber. It is a highly advanced system that allows the fabrication of nano-thin films and surface samples and also the high energy and angular resolution photoelectron spectroscopic analyses on site. It also allows the time-resolved measurement by combining with short pulse lasers.

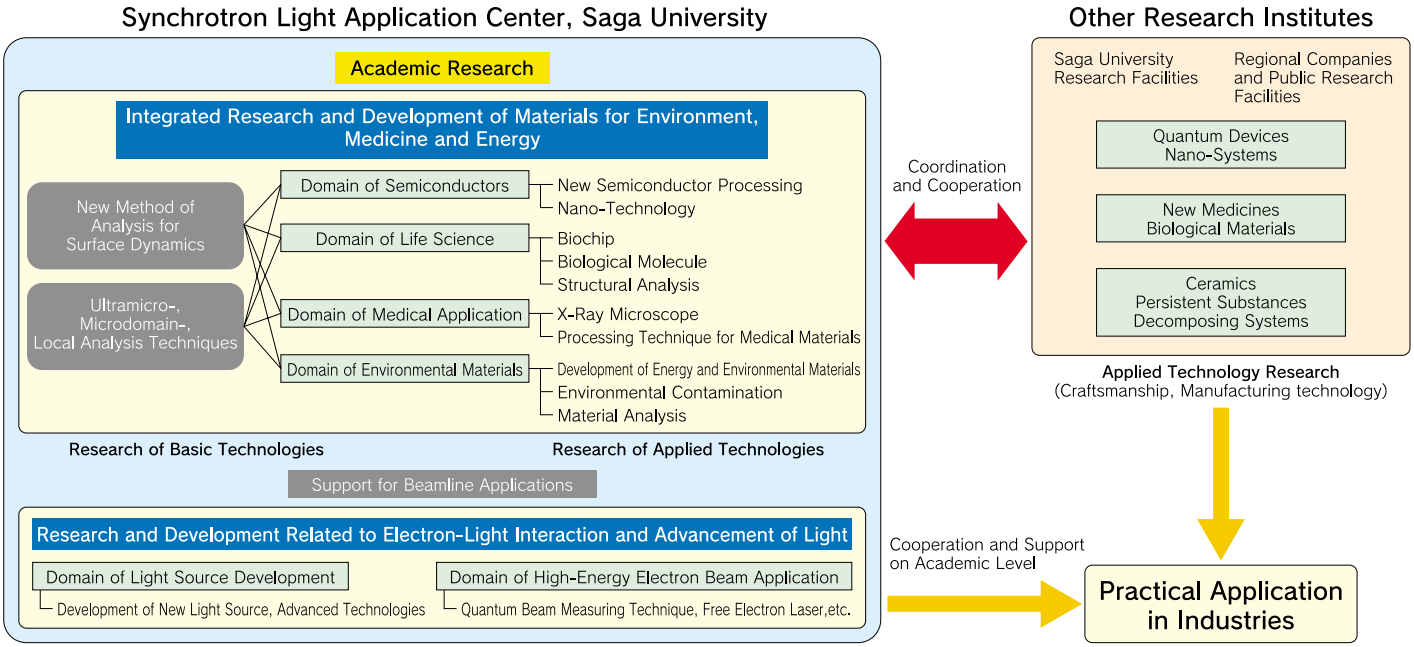


# Themes of Research –Toward Creation of University-Launched New Industries Using Synchrotron Light–

Under the theme "Integrated research and development using biomaterials and semiconductors for environment, energy and medicine" we aim to contribute to the development of advanced science and technology in the area of nano-technology, bio-technology, material science for environment, solutions to energy problems and Information technology (IT) of the 21st century. Furthermore, we aim to become a world-class academic research core, a regional intelligent center and a site for cooperation of industry-government-academia to promote creation of new industries.

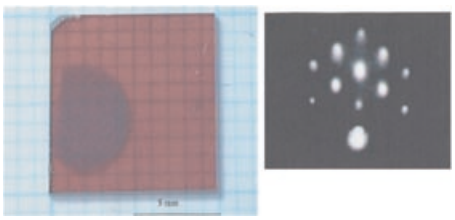
## Our Research Themes and Roles




## Planned Beamlines

### (1) Beamline for Research and Development of Nano-Scale Semiconductor devices

This will be used for developing non-thermal processing of semiconductors by using synchrotron light with large photon energy, which is an essential fundamental technology for processing of next generation semiconductors. It will also be used for research and development of new devices with nano-scale processes and next generation semiconductors.



Left: An image of ZnTe thin film grown by metalorganic vapor phase epitaxy using synchrotron light-excitation process. Right: An image of reflection high energy electron diffraction (RHEED).

### (2) Beamline for Biotechnology and Medical Research

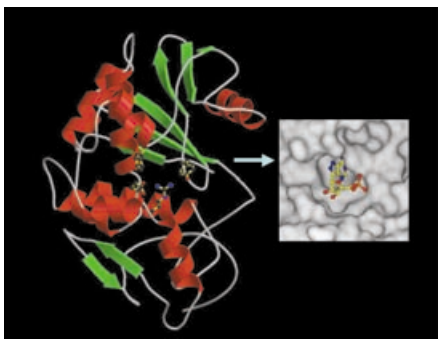
Free electron laser and near-infrared through mid-infrared light provided by synchrotron are useful for decomposition of environmental toxic chemicals such as dioxin and for medical application including dental surgery and isotope separation of Si and C etc. The beamline will be used for the research and development of these medical applications.

### (3) Beamline for Analysis of Environmental and Energy Materials (XAFS,XRF)

Use of synchrotron light enables us to analyze the structure of various small substances such as metal, ceramics, high-polymer materials, biological samples, meteorite and so on. This will allow us to elucidate the environmental distribution of harmful rare elements and the source of contamination. For instance, we will be able to investigate the material circulation and environmental detoxification mechanism in the Sea of Ariake. It can also be used for non-destructive inspection of archaeological artifacts and cultural assets such as pottery, for providing the explanation of the taste of water and liquors by elucidation of microscopic structure of water and also for development of new energy materials.

### (4) Beamline for Crystal Structure Analysis of Proteins

Use of synchrotron light allows us to study the three dimensional structures of biological substances such as protein and its complex with related active substances at the atomic scale. The results of the research are expected to be useful for effective applications to food, medicine, chemical manufacturing and environmental analyses and detoxification.



Structure of he Anti-Viral Protein PAP-S1 from Pokewood Seeds

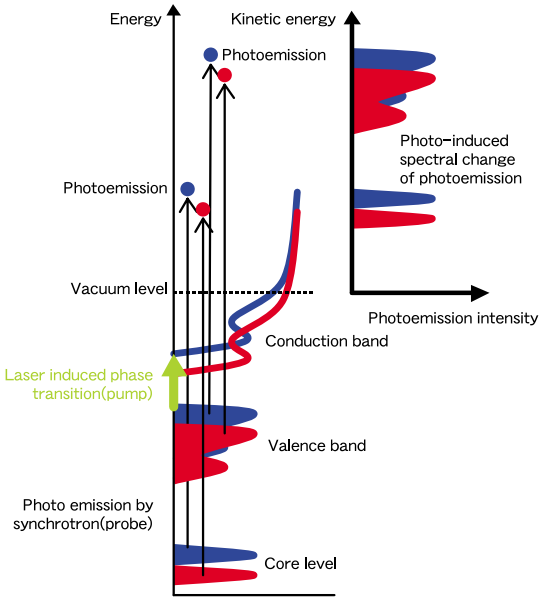
Right panel: Substrate Analog Formycin 5-Monophosphate Bound to the Active Site

# Examples of Recent Findings

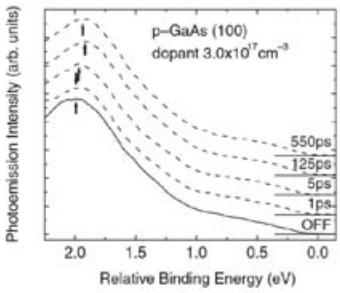
## Development of New Analyzing Method for Surface Dynamics Measurement

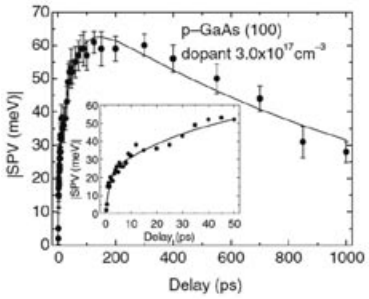
New spectroscopic method is developed by combining the synchrotron and the laser light, which enables to analyze the electronic states of surface and interface of semiconductors and organisms. The method allows us to obtain essential information in studies of optics, energy, environment, biotechnology, nano-materials and new materials.

### High-Resolution Time- and Angle-Resolved Photoemission Spectroscopy by Combination of the Synchrotron and the Laser Light

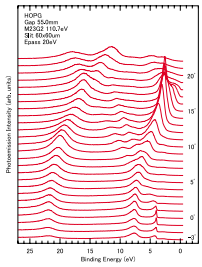



### Ultrafast Time-Resolved Measurement of Surface Photovoltage (SPV) of Semiconductors

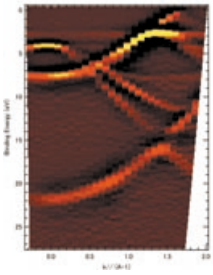



### Angle-Resolved Photoemission Spectra of Highly Ordered Pyrolytic Graphite (HOPG)



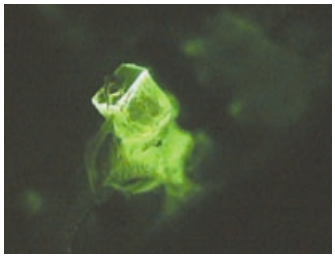
### Band Dispersion of HOPG



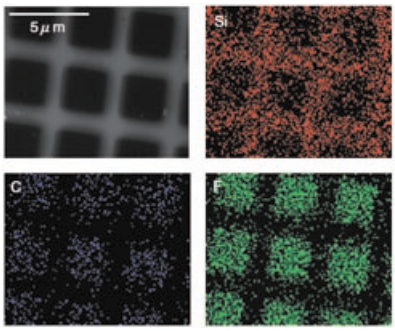
## Development of New Functional Light Devices and Micro/Nano Scale Processing Techniques

We are developing functional light-emitting/receiving devices with new materials and micro/nano scale processing techniques by utilizing photoexcitation process by synchrotron light and the analyzing techniques.

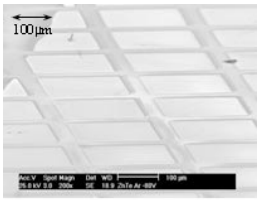
### Green-Light-Emitting Device

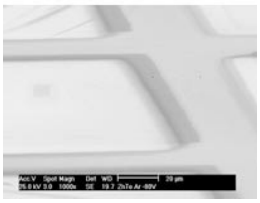


### Optical Fabrication of Teflon

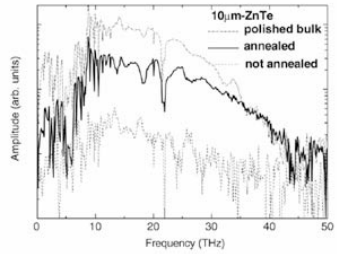



### Light Etching of ZnTe

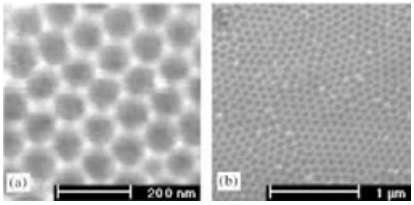


### Terahertz Device



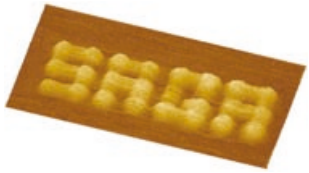

### Nanopore Formation Technology




### Thin-Film Solar Cells

### Formation of Three-Dimensional Structure Using Thick Photoresist


### Nano-Scale Cathode Oxidization Patterning



# Initiative Research and Development Through Regional Partnership

## Cooperative Project with the Ministry of Education, Culture, Sports, Science and Technology (2005-2007)

Initiative Engineering Research Through Coalition with Saga Prefecture Utilizing Synchrotron Light

**Promotion of Strategic Research Project**
Engineering Research of Semiconductors, Nano- and Bio- Technologies

Synchrotron Light Application Center, Saga University

Kyushu Synchrotron Light Research Center

Academic Applied Research

- Semiconductor Nanostructures
- Organic Molecule
- Advanced Process

Semiconductors, Biotechnology Manufacturing Technology System Construction

- Brilliance Upgrade of Light source
- Micro Beam
- Creation of Industries

Light Source, Industrial Technology

Faculty of Engineering, Kyushu University

Fostering of Human Resources, Development of New Technologies, Formation of Intelligent Center, Creation of New Industries, Advancement of Regional Industries

## Cooperative Project with the Ministry of Education, Culture, Sports, Science and Technology (2008-)

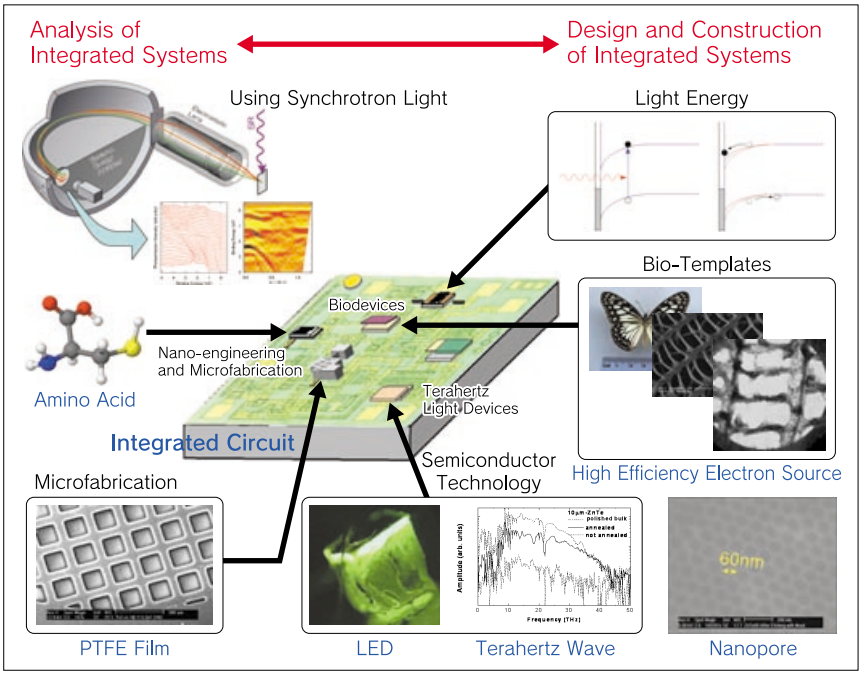
Research and Development of Innovative Bio-, Nano- and Environmental Technologies Using Synchrotron Light through Wide-Range Cooperation and Integration

**Construction and Application of New Nano- and Bio- Integration Systems**

**Surface and Interface Analysis Group**
Establishing New Analyzing Method

Designs, production and feedback from the analyses allows us to construct new nano-bio systems with innovative functions.

**Device Development Group**
Designing and Production of Functional Devices




**Future Societies and Innovative Technologies that Activate the Local Communities**

- Light Energy Bioenergy
- Accelerator Science High-Intensity Emitter
- Environmental Electronic Materials Optical Functional Memory
- Next-Generation Communications Hazardous Material Sensor
- Biomolecule Bioelectronics
- Biomedical Materials Food Sensor

Examples of Field of Application of Integrated Systems

# Support for Creation of Innovation and Diverse Research Projects based on Frontier Research

## "Nanotechnology Network" Innovative Creation Project through Shared Research Facilities of Ministry of Education, Culture, Sports, Science and Technology (2007-2011)

**Kyushu-area Nanotechnology Network ～Supporting Nanometrology and Analyses Using Synchrotron Light Radiation～**

We have experience with photoelectroscopic analysis of material surfaces and with new spectroscopic method by combination of the synchrotron and the laser light. By providing the experience we give support for the Nanotechnology Network with Kyushu University as core institution.

1. New method for the Analysis of Electronic States of Photo-Functional Materials
2. Photoelectroscopic Analysis of Material Surface

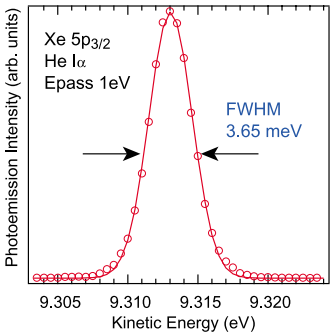
**Devices**

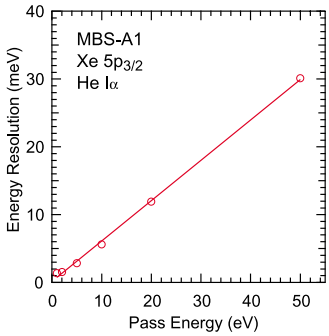
For Online Analysis (Saga University Beamline)
- Photoemission Spectrometer (Hemispherical Analyzer)
- Plane Grating Monochromator (PGM)
- Laser system (Ti:Sapphire)

For Offline Analysis
- Scanning Probe Microscope
- Laser Micro-Raman Spectrometer

**[How to Apply]**

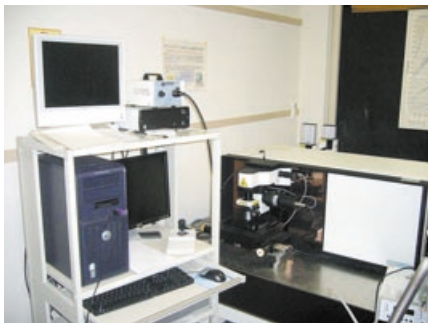
We accept all proposals through Kyushu-area Nanotechnology Network.
Access the following webpage:
http://nanoscience.cstm.kyushu-u.ac.jp/





Scanning Probe Microscope


Laser Micro-Raman Spectrometer


Saga University Beamline

## Research Project Operating on Various Competitive Research Funding

- Ministry of Education, Culture, Sports, Science and Technology Grant-in-Aid for Scientific Research

  (2005-2007) [Development of Excited States Analysis by Combination of Soft X-Ray and Laser]
  2007 [Research on Building of Everberating Furnace and Techniques of Casting Iron Cannons by Saga Domain]

- Ministry of Education, Culture, Sports, Science and Technology Grant-in-Aid for Scientific Research on Priority Areas
  (2002-2005) [Role of Saga Domain in Early Years of Science and Technology Development in Japan]

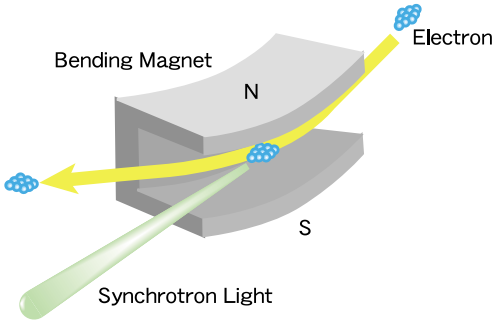
- Regional Redevelopment Consortium Research and Development Project by Ministry of Economy, Trade and Industry
  (2004-2005) [Development of High Efficiency Pure Green Light Emitting Diodes based on ZnTe]
  2007 [Development of Photodesorption Mass Spectroscope Using Extreme Ultraviolet Light]

- New Energy and Industrial Technology Developing Organization (NEDO)
  Industrial Technology Research and Development Projects
  (2005-2007) [Development of High Efficiency Pure Green Light Emitting Diodes by Low-Cost Fabrication Approach]

Projects by Fukuoka Industry Science Technology Foundation, etc.

## What is Synchrotron light?

When an electron is accelerated to close to the speed of light and is forced to change its direction by strong magnetic field, light is emitted in the tangential direction along the orbit of the electron. The light radiated in this way is called “synchrotron light”. This artificial light has many special features: wide range of wavelength (far-infrared to hard X-ray). ultra brightness, high directivity, and short pulsation.




**Contact**

## Synchrotron Light Application Center, Saga University

1 Honjo, Saga 840-8502, Japan URL: http://www.slc.saga-u.ac.jp/ email: slcenter@ml.cc.saga-u.ac.jp
phone: +81-952-28-8854 fax: +81-952-28-8855

**Synchrotron Light Application Center Tosu Branch, Saga University at SAGA Light Source**
8-7, Yayoigaoka, Tosu, Saga 841-0005, Japan phone/fax: +81-942-82-8052

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