THAI
SYNCHROTRON
NATIONAL LAB

SYNCHROTRON LIGHT RESEARCH INSTITUTE

www.slri.or.th

ABOUT US

Synchrotron Light Research Institute

Synchrotron Light Research Institute (SLRI) is a public organization under supervision of the Ministry of Science and Technology, Thailand. The institute operates "Siam Photon Laboratory" (SPL), providing synchrotron radiation and total solutions for users from academic and industrial sectors. The wide spectral range of synchrotron light, with photon energies spanning from infrared to x-rays make it an indispensable investigating tool for a variety of applications. Currently, SPL utilizes 7 techniques with 11 experimental stations and 2 stand-alone industrial research labs ready to welcome both domestic and international users.

VISION

An excellence organization in synchrotron light technology supporting development of Thailand's economics and people's quality of life.

MISSION

1. Conducting research in synchrotron radiation and applications.
2. Providing service in synchrotron radiation and related technology.
3. Promoting knowledge transfer and learning in synchrotron technology.

SYNCHROTRON RADIATION

Synchrotron radiation is an electromagnetic wave, just like sunlight, that is emitted from relativistic charged particle, i.e. charged particle like proton or electron moving near the speed of light, under acceleration, for e.g. via a magnetic or an electric field. Synchrotron light received its name from the machine it was first discovered, in 1947, the 70 MeV synchrotron accelerator at the General Electric Research Laboratory in Schenectady, New York.

Characteristics of Synchrotron Radiation

Broad spectrum

The spectrum of synchrotron radiation generated from an electron storage ring is a broad continuous one, covering from very low energy range, in the infrared region, up to very high photon energy in the x-ray region. This flexibility in choosing suitable photon energy (tunability) for a particular type of experiment makes synchrotron light favorable for a wide variety of research studies.

High brightness

The generated synchrotron radiation is extremely bright, millions of times brighter than sunlight, and much brighter than light from conventional laboratory sources. This permits researchers to study extremely diluted samples, i.e. samples with very low concentration of constituent atoms, or weakly scattering crystals, with sufficient signal-to-noise ratio.

High degree of collimation

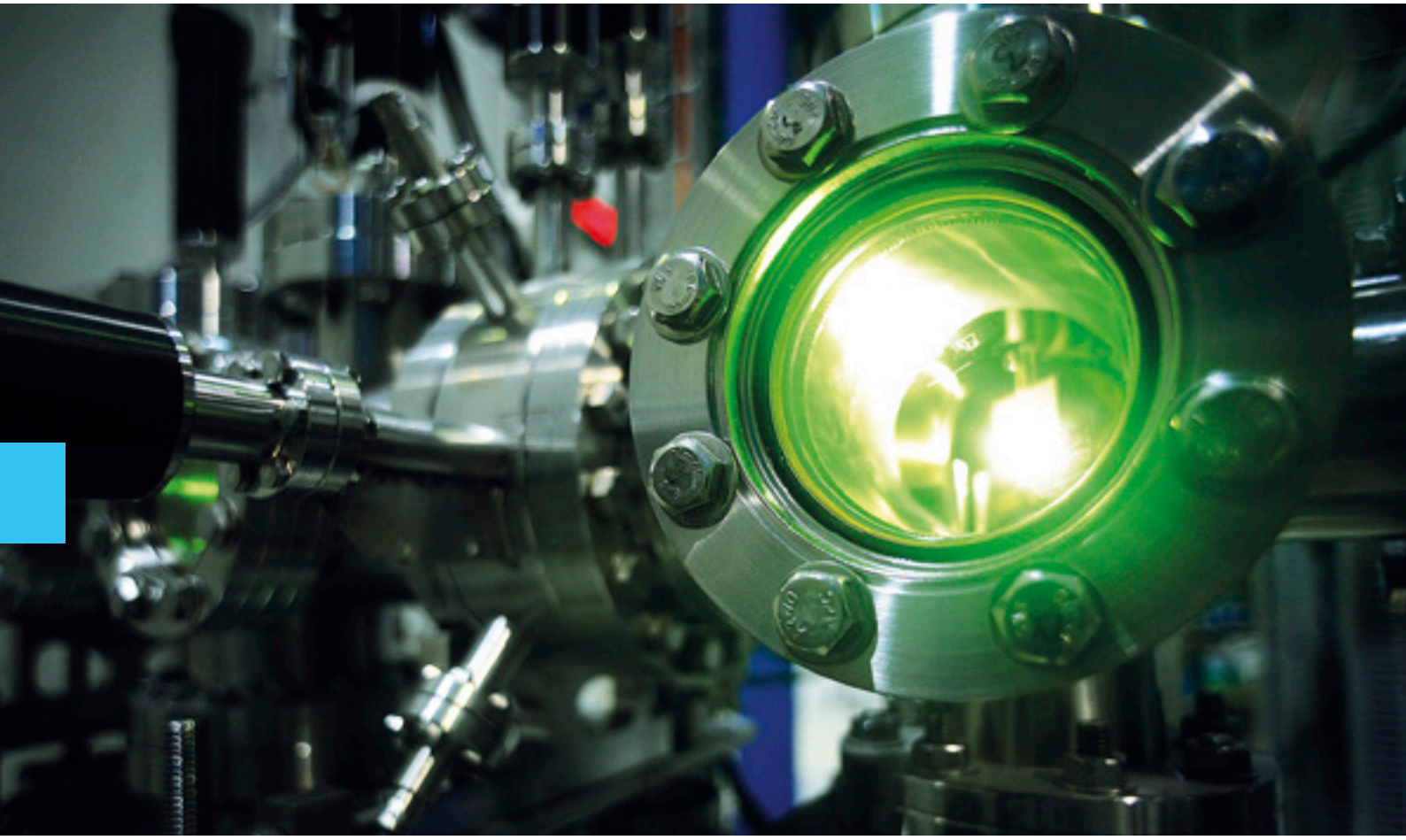
The synchrotron light is emitted from accelerated charged particle beam in a very narrow cone, enabling full use of the available photon flux.

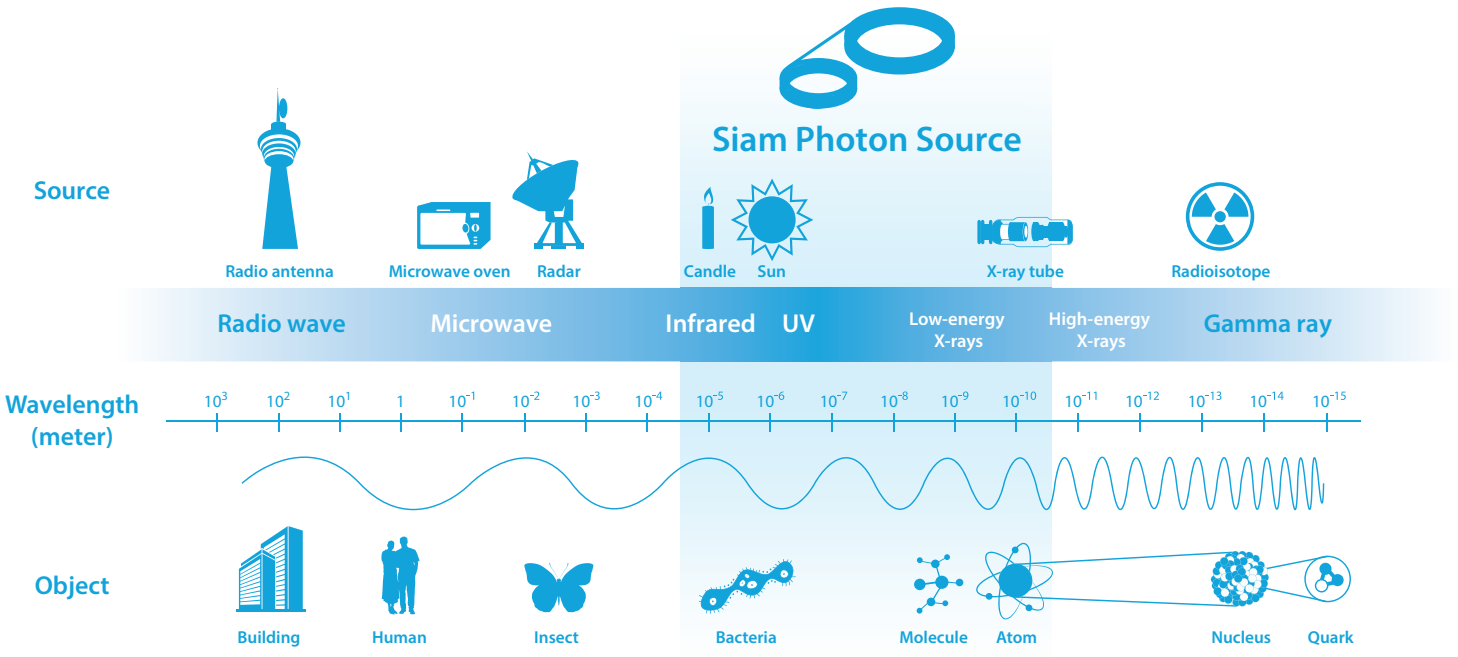
Well-defined polarization

Generated synchrotron light has well-defined polarization. Normal synchrotron radiation from bending magnets and planar insertion devices (special magnets that can be inserted into a storage ring) is linearly polarized, while circularly or elliptically polarized synchrotron light can be generated from specially designed insertion devices.

Pulsed time structure

Since synchrotron light is emitted by electron bunches circulating a storage ring, it has a similar pulsed time structure. This allows researchers to perform in-situ measurement, i.e. study the mechanism of a process as it is occurring, down to sub-nanosecond time scale resolution.

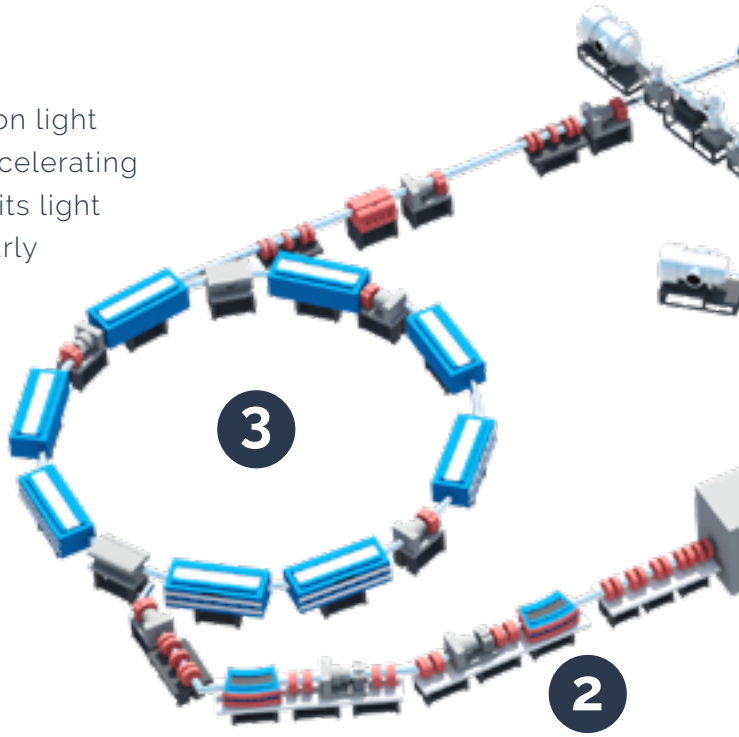




Electromagnetic Spectrum

SYNCHROTRON RADIATION GENERATION

Synchrotron radiation facility, or synchrotron light source, produces synchrotron light by accelerating charged particle, mostly electron due to its light weight, thus making it easier to accelerate, to nearly the speed of light. These relativistic electrons are then deflected by a magnetic field, causing them to lose some of their energy in the form of an electromagnetic wave, i.e. synchrotron light, in the direction tangential to their orbit. The generated light is then transported to an experimental station via a photon beamline.



COMPONENTS OF SIAM PHOTON SOURCE

1. Electron gun

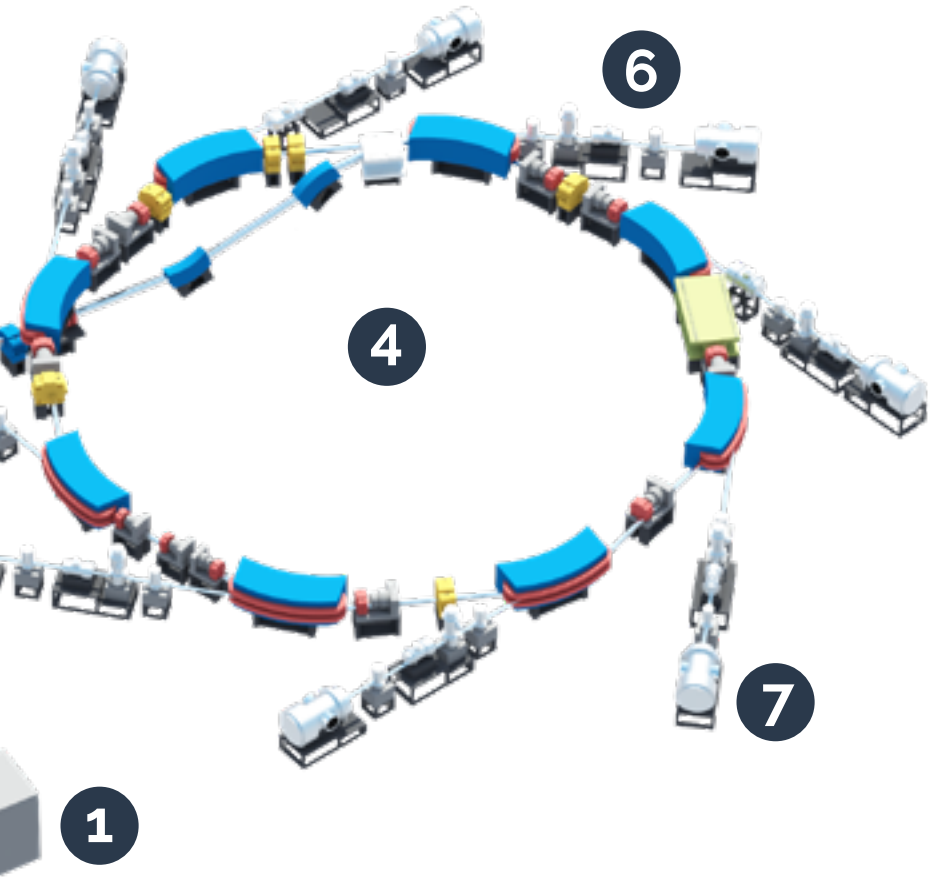
Electron beam is produced by the electron gun via thermionic process, that is, the gun filament is heated by the applied electric current causing electrons to be released. These electrons are then 'pulled' toward the linear accelerator by an applied electric field.

2. Linear accelerators

Electron beam from the electron gun is then accelerated by two 20 MeV (20 million electron volts) linear accelerators, or linacs for short. After passing through the two accelerating structures, the 40 MeV electrons then enter the booster synchrotron via the low-energy beam transport line (LBT) for further acceleration.

3. Booster synchrotron

The booster synchrotron accelerates 40 MeV low energy electrons to 1.2 GeV (1.2 billion electron volts). Each round an electron circulates in the booster ring it gains incremental energy through applied radio wave inside the radio-frequency (RF) cavity. To attain 1.2 GeV energy electrons must circulate approximately 9 million turns in the booster, although the whole process lasts merely 1.2 seconds.



7. Experimental stations

Experimental station is where the sample to be studied is located. A great number of measurements and experiments can be set up to utilize the generated synchrotron radiation. Data from the interaction processes between light and matter is then collected for subsequent analyses. Measurement techniques utilizing synchrotron radiation have been proven to be invaluable in researches in a wide variety of disciplines, including physical science, biological science, materials science, agriculture, archaeology, environmental science, among others.

4. Storage ring

Storage ring functions as electron storage and a synchrotron light producer. It consists of various types of magnet responsible for electron movement in a desirable position inside a vacuum tube. The electrons then get accelerated by moving through a bending magnet, forcing them to release energy in a form of electromagnetic wave, so called synchrotron light, into the beamlines.

5. Insertion device

Insertion devices are specially designed magnetic systems installed or 'inserted' into the electron storage ring to produce synchrotron radiation with specific properties. These magnets are able to generate synchrotron light with higher brightness, or higher energy, or both. They can also be designed to produce synchrotron light with specific polarization, i.e. circular or elliptical polarization.

6. Photon beamlines

Synchrotron light is carried to the experimental stations via photon beamlines. Two most important components of a photon beamline are the monochromator and focusing elements. Mirrors are used to focus the photon beam to a small area of interest while retaining the available photon fluxes. Monochromator is used to select the photon energy suitable for a particular experiment. Each beamline has different components and setups depending on the photon energy range to be used and type of experiment to be carried out.

PHOTON BEAMLINES

BL7.2W: MX
Micromolecular Crystallography

Structural investigation of proteins, enzymes and viruses

BL6: DXL
Deep X-ray Lithography

Fabrication of high-aspect-ratio microstructures

BL5.2: XAS
X-ray Absorption Spectroscopy (SUT-NANOTEC-SLRI)

Chemical and structural investigation of materials

BL5.3: XPS
X-ray Photoelectron Emission Spectroscopy (SUT-NANOTEC-SLRI)

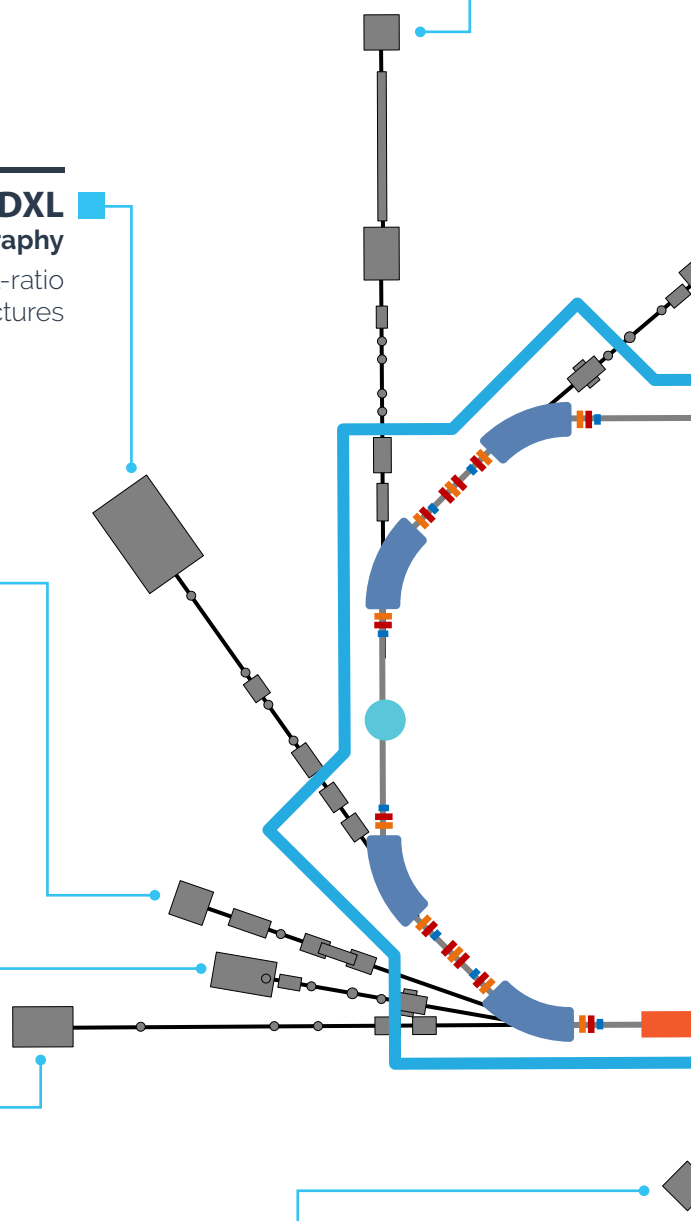
Surface, interface, and thin-film researches
Material science

BL5.1: XAS ASEAN
X-ray Absorption Spectroscopy

Chemical and structural investigation of materials (IAEA supports)

BL4.1: IR
Infrared Spectroscopy

Biomedical and biological science
Environmental science



BL8: XAS

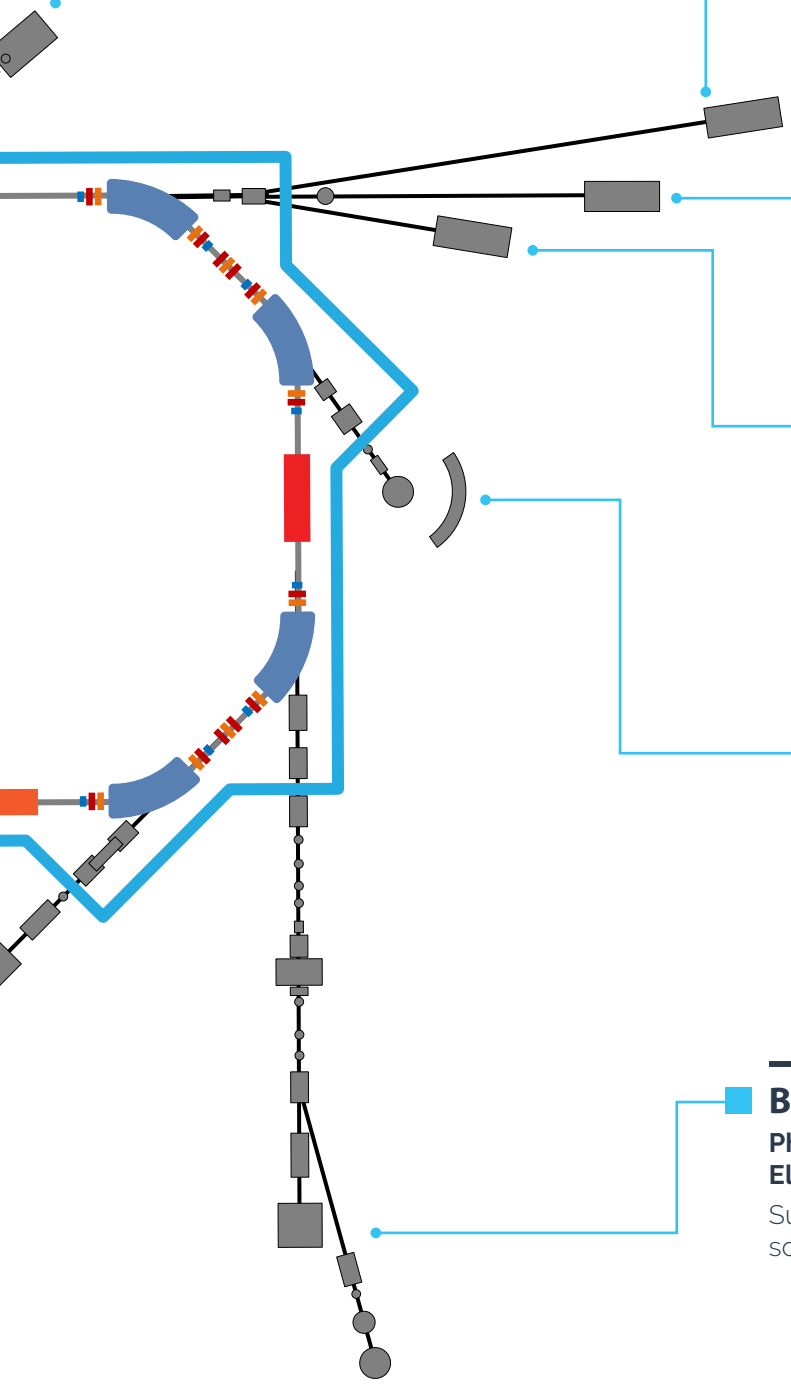
X-ray Absorption Spectroscopy and Full-field X-ray Fluorescence Imaging

Chemical and structural investigation of materials, Archaeology, Environmental

BL1.1W:

Multiple X-ray Texhniques

Crystalline phase purity and compositions elemental analysis, chemical specification, and structural investigation of materials



BL1.2W: XTM

X-ray Tomographic Microscopy

2D and 3D microscopy and imaging

BL1.3W: SAXS/WAXS

Small Angle X-ray Scattering / Wide Angle X-ray Scattering

Nano-structural investigation of materials
Nanoparticle size and morphology

BL2.2: TRXAS

Time-Resolved X-ray Absorption Spectroscopy

In-situ chemical and structural investigation of materials

BL3.2U:

Photoemission Spectroscopy & Photoemission Electron Spectroscopy

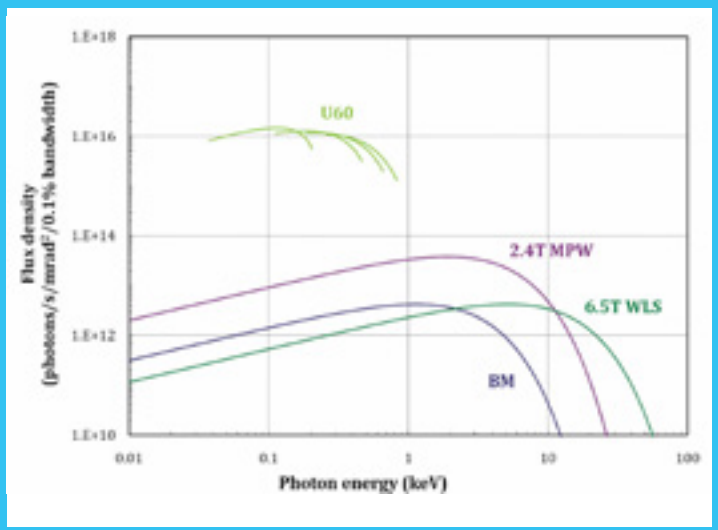
Surface, interface, and thin-film researches Material science

SIAM PHOTON SOURCE

The main component of Siam Photon Source is the 1.2 GeV electron storage ring. The maximum stored beam current is 150 mA. The beam emittance is 41 nm-rad, and the beam lifetime is approximately 12 hours at 100 mA. Since the energy of the SPS booster was only 1.0 GeV, the energy of the beam needed to br ramped up to 1.2 GeV in the storage ring after each injection. However, since the SPS booster energy has recently been upgraded to 1.2 GeV, the beam will soon be injected to the storage ring at full energy, and the ramping process will no longer be necessary, Currently, there are 3 insetion devices (IDs) installed in the ring, i.e. a permanent magnet planar undulator, a 2.4T hybrid multipole wiggler (MPW), and a 6.5T superconducting wavelength shifter (WLS).

SPS storage ring specifications

Parameter	Value
Energy	1.2 GeV
Stored current	150 mA
Emittance	41 nm-rad
Lifetime @ 100 mA	12 hours
Circumference	81.3 m
Injection energy	1.0 GeV

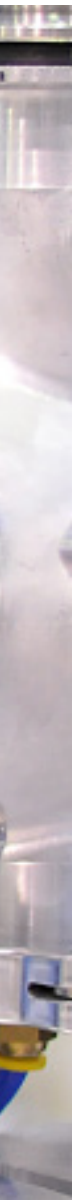


SPS spectrum

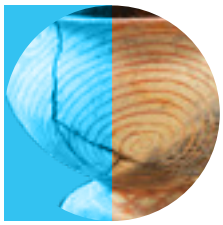
SPS BEAMLINES

Beamline specifications

BeamLine	Technique	Photon Energy	Energy Resolution	Applications / Research Field
BL1.1W: Multiple X-ray Techniques	X-ray Absorbtion Spectroscopy X-ray Diffraction	4 -18 keV	$1x10^{-4}$	Chemical and structure investigation of meterials
BL1.2W: XTM	X-ray Imaging and Microtomography	white beam 2-18 keV	NA	Internal structure investigation of materials
BL1.3W: SAXS/WAXS	Small Angle X-ray Scattering / Wide Angle X-ray Scattering	6-9 keV	$1x10^{-2}$	Nano-structure investigation of meterials, nanopaticle size analyses
BL2.2: TRXAS	Time-Resolved X-ray Absorption Spectroscopy	4-12 keV	$1x10^{-1}$	In-situ chemical and structural investigation of materials
BL3.2Ua: PES	Photoemission Electron Photoemission	40-160 eV / 220-1040 eV	$1x10^{-4}$	Surface, interface and thin-film researches, materials science
BL3.2Ub: PEEM	Photoemission Electron Microscopy	40-160 eV / 220-1040 eV	$1x10^{-4}$	Thin film and surface science, imagimg with μ -XAS Technique
BL4.1: IR	Infrared Microscopy and Imaginig	0.01-0.05 eV	NA	Biomedical and biological science, food and agricutural science, polymer science, material science
BL5.2: SUT-NANOTEC-SLRI XAS	X-ray Absorption Spectroscopy	1.25-12.1 keV	$2x10^{-4}$	Chemical and structural investigation of materials
BL6: DXL	Deep X-ray Lithography	white beam 2-8 keV	NA	Fabrication of high-aspect-ratio microstructures (HARMS)
BL7.2: MX	Macromolecular Crystallography	5-20 keV	NA	Structural biology
BL8: XAS	X-ray Absorption Spectroscopy	1.25-12.7 keV	$1.3x10^{-4}$ - $5.4x10^{-4}$	Chemical and structure investigation of materials



SYNCHROTRON APPLICATIONS



ARCHAEOLOGY

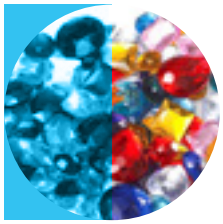
AGRICULTURE

POLYMER

ENVIRONMENT

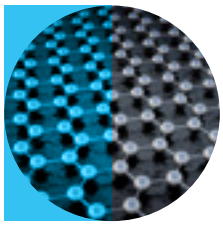
INDUSTRY

MEDICINE



GEMS

FORENSIC SCIENCE



MATERIAL SCIENCE

INNOVATION

RESEARCH HIGHLIGHTS

POTENTIAL TREATMENT OF BREAST CANCER WITH PROTEIN FROM SILKWORM

Even though breast cancer is not fatal in and of itself, it has the possibility to spread beyond the breast to other parts of the body, which makes it lethal. Scientists always look for new treatments other than the conventional ones, e.g. radiation, chemotherapy, and surgery, that possess undesirable side effects. Scientists from Science Department, Kasetsart University and SLRI have been investigating protein extract from silkworm Chrysalis as a possible cure for breast cancer. By using infrared spectromicroscopy, they discovered that cancer cell typed MCF7 (human breast adenocarcinoma cell line) can be restrained by this particular type of protein extract. This discovery can potentially lead to a new and better treatment for breast cancer, one that is without adverse side effects.

COCO PEAT AS METAL-CONTAMINATED WASTEWATER TREATMENT

Coco peat, or coir pith, is the spongy material found inside a coconut between the outer husk and the inner hard shell. We can find the coco peat as a by-product from mattress factories, left after the coir fiber is extracted for use as padding. Scientists found that it contains high amount of lignin (36%) and cellulose (44%), and has the potential for treatment of polluted water, more specifically, for removing both chromium and nickel from electroplating wastewater. At SLRI, a team of researchers from King Mongkut's University of Technology Thonburi found that most of the chromium bound on coir pith was changed from a previously toxic to a non-toxic

form. Moreover, the team was able to significantly increase its nickel adsorption ability by chemical treatment. This finding paves a way for a cheap and eco-friendly solution for wastewater treatment.

DISCERNING CHICKEN MEAT WITH PROTEIN ANALYSIS

Korat chicken is famously known for its firm and moist texture. Besides, compared to meat from other chicken breeds, Korat chicken meat contains less fat and carbohydrate, rendering it more preferable among health-conscious consumers. At SLRI, scientists employed infrared spectroscopy as a tool for proving the authenticity of the Korat chicken meat against those of other breeds by looking at the signature of proteins in the meat. The method, which can be done quickly while not as expensive as the others, was found to be highly accurate.

INVESTIGATING CONTAMINATION OF SULFUR IN SOIL

Environmental samples such as soil usually contain a large variety of electronic oxidation states, or 'forms', of sulfur. As each of these forms behaves differently regarding its biological, chemical, geological, and physical reactions, it is desirable for environmental scientists to be able to accurately determine the form of sulfur in soils. The ability to do so is invaluable for the investigation of soil pollution and contamination. A group of researchers from Technische Universität München, Germany, together with SLRI team, have looked into the method to identify the form of sulfur in soil samples. The scientists found that with suitable measurement setup such as the one at SLRI together with appropriate data analytical methods, they can accurately identify quantitatively the forms of sulfur in soil to within ±5 to 10%.

PROVENANCE OF BAN CHIANG POTTERIES

Ban Chiang is universally recognized as the most important prehistoric archaeological site in Southeast Asia, dating back approximately 3,500 years. It indicates the existence of prehistoric civilization performing agriculture and farming. Its importance was recognized by UNESCO and was designated as the UNESCO 359th World Heritage Site in 1992. Its most famously known artifacts are the pottery vessels with beautiful, intricate patterns. Due to their exquisiteness they gain popularity among collectors, and can be found exhibited in museums worldwide. However, its popularity inevitably leads to forgery. At the request from Fine Arts Department of Thailand, SLRI succeeded in identifying nondestructively authentic pieces from their replicated counterparts by employing XANES and SR-XRF techniques to investigate 3d transition metals on the painted and unpainted areas of the pottery.

ALTERING THE COLOR OF FRESHWATER PEARL

Despite having better mortality rate and cultured period, freshwater pearl is not as precious as its saltwater counterpart due to inferior aesthetic appearance. To increase its commercial value, synchrotron X-rays were applied to alter the color of freshwater cultured pearl from plain white to exotic gold. The improved appearance increases its market value considerably. Not only can we change the color of the pearl, X-ray lithography technique can also be employed to create intricate and customizable golden pattern on the pearl.

IMPROVING MATERIALS

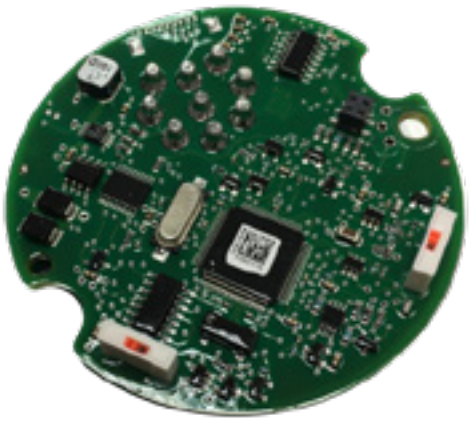
SCG Chemicals is one of the largest integrated petrochemical companies in Asia and a key manufacturer supplying full range of petrochemical products including polymers. To improve its various polymer and plastic products in order to meet the increasing requirement of the customers, the company conducts research which look into molecular structure of the materials with the help of synchrotron light. Changes on molecular level under changing conditions, such as stress and temperature, were also investigated at SLRI. The knowledge obtained was crucial for the development of better quality materials.

SOLVING GOLF GRIP PRODUCTION

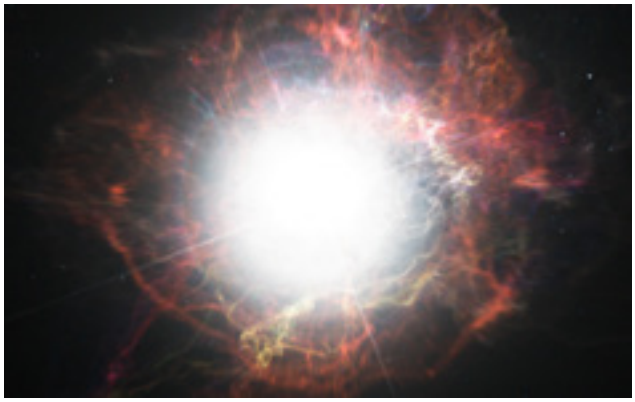
Eaton Industries Ltd. is the world's largest manufacturer of golf grips, with manufacturing and distribution facilities on five continents. Over 65 years, the company's division Golf Pride is globally recognized as the number one choice in grips. During the development of a new product, the company and a team of SLRI scientists joined force to solve a problem related to chemical formula used in production process by infrared technique. The resulting improved formula increases market opportunity of more than 100 million Thai baht while reduces manufacturing waste worth up to 28 million Thai baht per year.

SUPPORTING SEMICONDUCTOR FABRICATION INDUSTRY

Benchmark Electronics, Inc. is the manufacturer of electronic components, offering high-quality, high-reliability products. When suspicious issues arise during manufacturing process, factual cause needs to be accurately identified. In a collaborative research, SLRI helped the company analyze oxidation, corrosion, and contamination on semiconductor components to identify the possible contributing factors. The findings helped the company appropriately adjust its manufacturing process at the correct production stage.



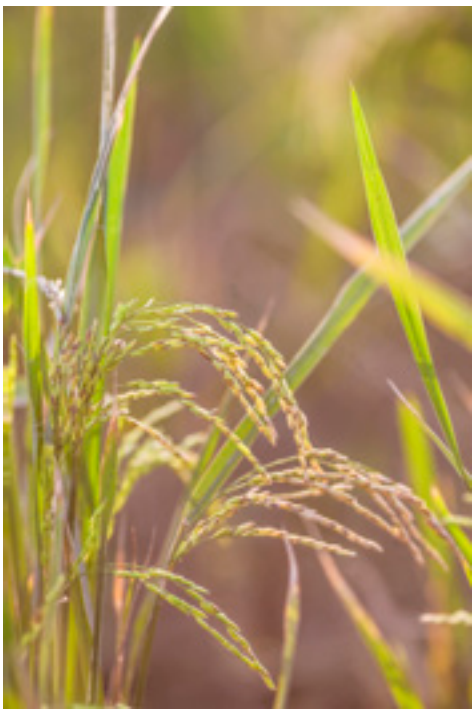
INVESTGATING INTERSTELLAR DUST



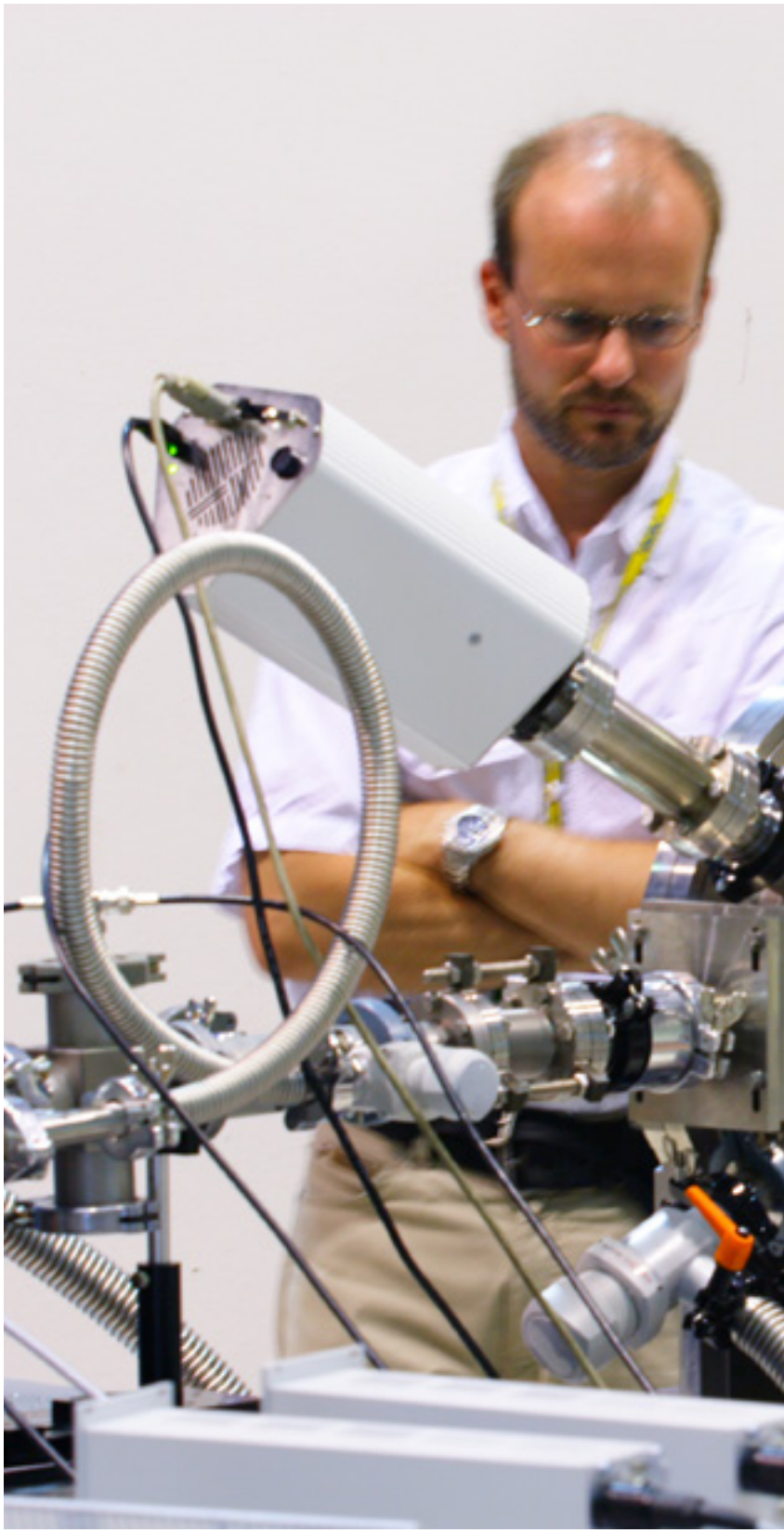
Dr. Bruce Ravel and a team of physicists from National Institute of Standards and Technology (NIST), United States, are on a mission with the National Aeronautics and Space Administration (NASA) to study interstellar dust, the composition of which will give an insight into the origin and the evolution of the universe. The space telescope Chandra, officially known as Chandra X-ray Observatory (CXO) was launched into space back in July 1999. As it traversed through space, the on-board spectrometer measured the spectrum of these interstellar dust and sent the data back to earth. The scientists also collected spectrum of various elements found on earth at SLRI BL8 and use them to compare with the ones received from Chandra. The elemental composition of the space dust is known when there is a match between the two. The team were able to collect more than 150 spectrum from over 30 elements, resulting in an exceptional database for astronomical study.

DEVELOPMENT OF STRESS-TOLERANT THAI JASMINE RICE

Thai Jasmine rice gains its worldwide popularity due to its unique, subtle floral fragrance, and distinctive, slightly sweet flavor. The rice, like other crops, can be subjected to 'stress' due to its surrounding environment, for example, draught. To develop Thai Jasmine rice with stress tolerance, a researcher from Kasetsart University studied enzymes in Aldo-keto reductases (AKRs) superfamily, which catalyze a wide variety of carbonyl compounds generated during stress period to corresponding alcohols. AKR was crystallized at SLRI and X-ray diffraction experiment was performed at BL7.2W: Macromolecular Crystallography (MX) to investigate the role of AKR in the detoxification process. Obtained information which includes the molecular structure and the function of AKR in Thai jasmine rice will be crucial for the future development of stress-tolerant rice.



HOW TO APPLY FOR BEAMTIME AT SPL



FOLLOW THE STEP

1. Go to http://beamapp.slri.or.th
2. Log in with username and password (New users need to register before log-in)
3. Sign in with username and password
4. Complete a registration form
5. Submit a project proposal
6. For more information, please go to www.slri.or.th or contact User Office at useroffice@slri.or.th

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