| No | Topics for Ph.D. Thesis by SLRI (August 2022) | Supervisor |
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| 1 | **Development of synchrotron-based advanced measurement techniques**<br><br>**Scope:**<br>The outcome of this project is a successful implementation of a synchrotron-based measurement technique that is prominent and new to the SLRI. The research involves development of relevant mechanical design, electronic and control systems, and the design of the experiments to demonstrate its capability. Scope of the project could range from an implementation of a new data collection algorithm, development of an operando/in-situ system for existing measurement techniques at the SLRI, development of coupling lab-based characterization tools to the synchrotron beamlines, to an implementation of a new characterization technique. Beam time at the SLRI beamlines such as x-ray absorption spectroscopy, x-ray imaging and x-ray scattering beamlines will be allocated to the project for the required experiments. The Ph.D candidates will be working alongside the SLRI beamline scientists for their projects as well as various works at the beamline. Upon completion of this project, the candidate will have good understanding of relevant synchrotron techniques and beamline instrumentation and able to work independently in research projects and beamline development projects. | Dr. Prae Chirawatkul<br>Dr. Supagorn Rugmai<br>Dr. Wantana Klysubun<br>Dr. Chatree Saiyasombat<br>Dr. Yingyot Poo-arporn<br>Dr. Narong Chanlek<br>Dr. Pinit Kidkhunthod<br>Dr. Siriwat Soontaranon<br>Dr. Suttipong Wannapaiboon<br>Dr. Chomphunuch Songsiriritthigul<br>Dr. Sirinart Srichan<br>Dr. Supinya Nijpanich |

| No | Topics for Ph.D. Thesis by SLRI (August 2022) | Supervisor |
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| 2 | **Development of AI for atomic and molecular structural analyses with X-Ray Diffraction and X-ray Scattering** | Dr. Supagorn Rugmai<br>Dr. Chatree Saiyasombat<br>and SLRI researchers |
| | **Scope:**<br>As most synchrotron-related techniques are novel experiment which produce big experimental data full of electronic, structural, and molecular information, the scope of this subject aim to understand how to collect, manage and clean big data and be able to successfully create project to analyze these data with artificial intelligence techniques such as machine learning. Ph.D candidates will be working with real data produced from experiment in SLRI and build up AI model to analyze and extract information out of experimental data. Upon completion of this project, the candidate will have good understanding of relevant synchrotron techniques and successfully create or develop AI project to be able to analyze or predict the electronic, structural, or molecular information of target samples. The candidates also are able to work independently in research projects concerning on AI, Machine Learning big data technology. | |

| No | Topics for Ph.D. Thesis by SLRI (August 2022) | Supervisor |
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| 3 | **Development of X-ray lenses for nano-beam**<br>**Scope:**<br>For a few decades, most of the advancements in materials science have relied a lot on material characterizations in nanoscale. Among the engineering developments which aim to improve the spatial resolution of scientific tools to nanometer-scale, those at synchrotron facilities have succeeded in producing X-ray beam with the size down to less than 10 nanometers, allowing several modern synchrotron techniques to investigate inhomogeneity of materials leading to novel information that benefit research from many different fields. Fresnel's zone plates, which is the diffractive X-ray focusing elements, are probably the most common choice in focusing soft X-ray and medium-energy X-ray. Compared to the others, zone plate setups are compact and can thus be integrated to most end-stations at existing beamlines and also for the future beamlines operating at the new 3 GeV SPS-II Synchrotron which is planned to be built in the near future.<br>This project is of interest for Ph.D. students/candidates who would like to work on the micro and nanofabrication techniques. We are looking for a motivated student, with clean room basic knowledge; the student will be involved in the design and fabrication of Fresnel's zone plates on a silicon wafer, as well as choice of materials to be patterned, collaborating with SLRI beamline scientist and the experts from other modern synchrotron facilities. Based on the results, the students will be able to participate in the optimization of the Fresnel's zone plates to be applied in the new 3 GeV SPS-II Synchrotron beamlines. | Dr. Pattanaphong Janphuang<br>Dr. Chanan Euaruksakul and SLRI researchers |

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| 4 | **Studies of collective bunch instabilities in electron storage rings** | Dr. Somjai Chunjarean<br>Dr. Thanapong Phimsen<br>and SLRI researchers |
| | **Scope:**<br>Collective effects are caused by the interactions between charged particles (electrons) and their surroundings. However, electrons can also interact with themselves leading to space charge effects and with their surrounding creating electromagnetic fields called wake fields. The wake field can be a cause of a longitudinal and transverse instabilities resulting in an ultimate electron beam current. It became more significant limitations to the achievable a high beam current at low beam emittance. To enhance the stored electron beams and improve a machine performance, studies on coupled-bunch instabilities and their effect on synchrotron light source operation and performance both with uniform filling pattern and non-uniform filling pattern are required. In the longitudinal case, coupled-bunch instabilities driven by the Higher Order Modes (HOMs) of the RF-cavity will be investigated, while in the transverse case numerical simulations with a particle tracking code for self-consistent simulations of collective effects driven by short and long-range wake fields will be complemented.<br>This project will focus on all these bunch stabilities and aim to enhance the brightness of synchrotron light. We are looking for students who have good motivation to learn in multi-particle beam dynamics, simulations with some codes. | |

| No | Topics for Ph.D. Thesis by SLRI (August 2022) | Supervisor |
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| 5 | **Studies of longitudinal dynamics of Landau cavity in electron storage ring** | Dr. Thanapong Phimsen and SLRI researchers |
| | **Scope:**<br>In synchrotron light source, the beam lifetime is one of the important beam parameters. In low-emittance storage ring of the third-generation light sources, the beam lifetime is usually dominated by Touschek scattering. In this study, the beam dynamics of the harmonic cavity will be investigated. The parameters of both active and passive operation will be optimized to cancel the slope of RF voltage and lengthen the bunch. The requirement and bunch lengthening effect of harmonic cavity will be estimated using analytical model with active mode operation. In passive operation, the harmonic voltage is generated from the beam itself. The Touschek lifetime increases are estimated for optimum and non-optimum voltage flattening. A tolerance of the operation will be studied in case that there is an imperfection on harmonic voltage via shunt impedance or beam current, and also a shift on detuning angle. Transient beam loading effect generated by the non-uniform filling pattern causes a variation of harmonic phase and reduces the lengthening effect as well as bunch lengthening effect crucially. The transient loading effects have been investigated using developed tracking code for uniform filling cases and a non-uniform filling cases. An increase of synchrotron frequency spread due to nonlinearity of the voltage giving to the bunch will be studied by using tracking simulation. The effect caused by reduction of harmonic voltage generated by lengthened bunch distribution is also estimated by applying iteration method to both analytical model and tracking code simulation. | |

| No | Topics for Ph.D. Thesis by SLRI (August 2022) | Supervisor |
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| 6 | **Studies of low-emittance beam injection efficiency of 4$^{th}$ generation synchrotron light source** | Dr. Thakonwat Chanwattana<br>Dr. Siriwan Jummunt<br>and SLRI researchers |
| | **Scope:**<br>Modern synchrotron light sources have been designed in order to achieve low electron beam emittance resulting in high photon beam brightness particularly at X-ray wavelengths. 4$^{th}$ generation synchrotron light sources focus on design of storage rings based on multi-bend achromat (MBA) lattices which enables a reduction of electron a few orders of magnitude compared to 3$^{rd}$ generation synchrotron light sources. Electron beam motion in a storage ring is affected by dynamic effects leading to large amplitude oscillations. Dynamic aperture, which is the border accommodating electron beam stable orbits in a storage ring, is significant for determining electron beam injection efficiency and lifetime of stored electron beam. A challenge in the design of MBA storage rings is to achieve lower beam emittance with sufficient dynamic aperture. Beam injection into a low-emittance storage ring with low dynamic aperture has been extensively studied based on different beam injection schemes and techniques aiming to achieve high injection efficiency. This research covers both theoretical analysis and numerical simulations for the studies of beam injection. There are many codes for particle accelerator simulations available for beam injection simulations. Skills related to programing, numerical simulations, and particle beam dynamics should be built and developed in this study. | |

| No | Topics for Ph.D. Thesis by SLRI (August 2022) | Supervisor |
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| 7 | **Development of advanced photon detectors**<br><br>**Scope:**<br>Photon detectors are one of the most common parts in many scientific devices as there are many analytical methods that rely on light interactions with substance, resulting in the information which are carried by the photons that let investigators understand the nature of materials and many mechanisms that can be detected by appropriate photodetectors. The detectors can come in many forms, depending on the energy range of detection, energy and spatial resolutions, the sensitivity, and the signal to noise ratio requirement. Performance of synchrotron techniques rely immensely on the availability of high-performance photon detectors and the developments of the most advanced photon detectors often succeed under involvements and collaborations with researchers working at synchrotron and high-energy physics facilities.<br>The project is of interest for Ph.D. students who are interested in electronic devices, especially photodetectors. They will work under supervision of experts in microfabrication and beamline scientists who use photon detectors with synchrotron techniques. The candidates should have a background in electronic engineering, microfabrication, or photonics. Candidates who have physics background who are interested in device engineering are also encouraged to apply. | Dr. Chanan Euaruksakul<br>Dr. Pattanaphong Janphuang<br>and SLRI researchers |

| No | Topics for Ph.D. Thesis by SLRI (August 2022) | Supervisor |
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| 8 | **Development of pulse magnets for high energy electron synchrotron** | Dr. Prapaiwan Sunwong and SLRI researchers |
| | **Scope:**<br>Pulse magnets are required for injection and extraction of electron beam in the synchrotron light source. The injection and extraction scheme usually includes a combination of septa and kicker magnets. These magnets produce rectangular field pulses or sinusoidal field pulses with the pulse duration in the range of micrometers and the flat-top width in the range of nanometers. Design and fabrication of the pulse magnets require an intensive knowledge of accelerator physics, electromagnetism, electrical and design engineering. Several simulation softwares can be used for the magnet design, including Opera-3D, SolidWorks and ANSYS. The aim of this project is to design, fabricate and commissioning of a pulse magnet for high energy electron synchrotron. | |

| No | Topics for Ph.D. Thesis by SLRI (August 2022) | Supervisor |
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| 9 | **Development of ultra-high stability power supply**<br>**Scope:**<br>Operation of particle accelerators in synchrotron radiation machines needs extremely precise power supplies (PS). Stringent demands must be fulfilled for design consideration such as stability, efficiency, accuracy, and electromagnetic compatibility. Specifically, for the magnet power supplies controlling the electron beam to attain desired characteristics with high stability, electrical specifications, and functional modes necessary to set up the high-performance power supplies must be addressed. In addition, to achieve ultra-high stability of the modern power supplies, both analog and digital control design and algorithm implementation are extremely mandatory with highly flexible control structures and monitoring capability. The PhD candidates will be working alongside the SLRI experienced engineers and researchers for their projects by designing and developing such a power supply for accelerator applications. Necessary simulation and real-world implementation (both hardware and software designs) are performed for practical purposes during their study.<br>**Tools to be used**: High-performance computer, simulation software, embedded controller boards (FPGA/microcontrollers), data acquisition modules.<br>**Skill required**: Programming/coding skill. Knowledge of electronic and electrical engineering/power electronics/digital signal processing/control system engineering is preferable. | Dr. Roengrut Rujanakraikarn and SLRI experienced staffs |

| No | Topics for Ph.D. Thesis by SLRI (August 2022) | Supervisor |
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| 10 | **Advanced control system with unified classical, modern, and AI-based approaches**<br><br>**Scope:**<br>Particle accelerators are machines used for increasing the energy of charged particles for use in various applications in many fields. The operation of these machines generally requires the monitoring and control of many system parameters. This is achieved with the distributed control system comprising different interconnected hardware and software control system layers covering different subsystems of accelerators like injector, transport lines, storage ring, and beam lines. The main requirement is that all the sub-system operations are to be performed in a synchronized and/or sequential manner. Classical and modern multivariable control algorithms have been constantly implemented in the closed-loop control schemes to control the machines. With the time-and-frequency domain designs and trade-off between disturbance rejection and noise attenuation, these control algorithms have been successfully applied to the machines. Nowadays, machine stability and timing in modern accelerators have become increasingly stringent, the signal processing and control algorithms must meet these demanding requirements. With the advancement of the computing hardware and modern software architecture, it is possible and challenging to apply complex Artificial Intelligence algorithms together with the control and signal processing algorithms to the closed-loop control of the machines. The PhD candidates will be working by designing an AI-based controller together with the new and/or existing feedback control algorithms for subsystem(s) of the accelerator machine. Both simulation and real-world implementation (hardware and software designs) are performed for practical purposes during their study.<br>**Tools to be used**: High-performance computer, FPGA controller boards, microcontrollers, single-board computers.<br>**Skill required**: Programming/coding skill. Knowledge of signals and systems/control system engineering/machine learning is preferable. | Dr. Roengrut Rujanakraikarn and SLRI researchers |

| No | Topics for Ph.D. Thesis by SLRI (August 2022) | Supervisor |
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| 11 | **Development of Radio Frequency amplifier system**<br><br>**Scope:**<br>The RF systems of the Siam photon source is supplied by the high-power RF amplifier. The present RF amplifier is based on the solid-stage device technology. Amplifier was procured from international company. There are several spare parts, RF boards and modules required to be spared at SLRI to maintain the reliability of this RF amplifier. To be able of design and fabricate this high-power RF amplifier will benefit the cost of maintenance and operation. Aiming of this project is to design and fabricate RF amplifier boards, then combining a low-power RF board into the high-power RF amplifier. This includes the design of RF components, such as RF splitter, RF combiner, RF circulator. RF testing and measurements will be also performed to ensure the efficiency and reliability of the whole RF amplifier. Control system of this RF amplifier is foreseen to be included in the project. Testing of the developed system can be done with the RF system testing station at SLRI.<br><br>**Tools to be used:** the RF circuit design tools, RF components design tools (CST Studio Suite). RF measuring tools are also available at SLRI.<br><br>**Skill to be built:** Candidate will gain skill and knowledge of the RF circuit design and microwave engineering. Programing and controlling skills will also gain during the process of building the control of the amplifier system. | Dr. Somjai Chunjarean and SLRI researchers |

| No | Topics for Ph.D. Thesis by SLRI (August 2022) | Supervisor |
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| 12 | **Development of Low Level Radio Frequency system**<br>**Scope:**<br>The RF systems of the Siam photon source is controlled by the Low-Level Radio Frequency (LLRF) control system. The present LLRF is based on the FPGA. This is a turnkey product from company. To be able of programing and diagnose the whole RF system, the project of self-developed LLRF based on FPGA is established. This will design the system based on the present and future FPGA platform. Aiming is to build the LLRF from the FPGA products in the market, programing using our owned developed algorithm. This included data acquisition both ADC and DAC of the RF signals, the digital RF signal processing. Testing of the developed system can be done with the RF system testing station at SLRI.<br>**Tools to be used:** the FPGA programing in which come together with the FPGA module. FPGA boards and modules will be procured for the project.<br>**Skill to be built:** Candidate will gain skill and knowledge of the FPGA programing/coding, FPGA structures and circuit design. Controlled algorithm and application to real systems will be acquired during the process of building the system. | Dr. Somjai Chunjarean and SLRI researchers |

| No | Topics for Ph.D. Thesis by SLRI (August 2022) | Supervisor |
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| 13 | **Autonomous control for Radio Frequency control system** | Dr. Roengrut Rujanakraikarn and SLRI researchers |
| | **Scope:**<br>Radio frequency (RF) is one of the systems in a synchrotron radiation facility of the Siam Photon Source (SPS). This dynamical system is highly complex due to its high-dimensional parameter space and dynamic nature. Instability of the RF system can easily affect the operation of the machine if improper control algorithm is not carefully designed and implemented. In addition, to achieve desired controlled behavior of the machine, accelerator parameters tuning for optimal performance can be challenging. These characteristics makes it potentially suited for a reinforcement learning (RL) approach that learns to make sequences of optimal decisions under parameter uncertainty in this dynamical system. Recent developments in RL have shown promising result in control system applications. The PhD candidates will be working by designing an AI-based agent using Deep RL approach (RL coupled with deep neural networks for continuous state and action-space representation) that can teach itself how to learn optimal control policies and implementing controller for the RF system. The goal of the controller implementation is to reduce the machine tuning time without any input or supervision from a human and ultimately achieve a near-autonomous control scheme.<br>**Tools to be used**: High-performance computer, FPGA controller boards, microcontrollers, single-board computers (for direct implementation of the control, signal processing, and machine learning algorithms).<br>**Skill required**: Programming/coding skill. Knowledge of control system engineering/machine learning is preferable. | |

| No | Topics for Ph.D. Thesis by SLRI (August 2022) | Supervisor |
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| 14 | **Design and fabrication of Radio Frequency harmonic cavity for electron storage ring** | Dr. Somjai Chunjarean and SLRI researchers |
| | **Scope:**<br>Synchrotron Light Research Institute (SLRI) operate Siam photon source, which has storage ring to store electron beam for generating synchrotron radiation. There are instabilities affect electron stored in the ring. Using harmonic cavity in storage ring would benefit of curing or reducing these instabilities. Project aims of studying effects of using harmonic cavity to an instabilities of electron beam in storage ring. Physics design of the cavity including the engineering design. Fabrication of the cavity is included in scope of the project. RF properties measurements will be performed together with the RF conditioning of this cavity. Installation and testing inside storage ring is foreseen to include in the project.<br>**Tools to be used**: the Super Fish code and CST Studio Suite for RF design, Engineering study and design will be done with SolidWorks. RF measuring tools is ready at SLRI.<br>**Skill to be built:** Candidate will gain skill and knowledge of the RF structure design and microwave engineering. Knowledge about electromagnetic simulation using commercial and/or open access codes, Python and Matlab programing and coding skill will be acquired. In addition, RF and microwave measurements and RF measuring tools experiences and skill will be acquired. | |

| No | Topics for Ph.D. Thesis by SLRI (August 2022) | Supervisor |
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| 15 | **Development of RF-shield bellow for low impedance electron storage ring**<br>**Scope:**<br>For new generation synchrotron light source, an instability caused by Wakefield generated from vacuum components must be concerned. Bellow has been used to accommodate long thermal expansions of the beam pipes and be one of the Wakefield sources. In this project, the bellow with RF shield which contain a high frequency shield structure inside will be designed. The impedance from the designed bellow will be investigated to optimize the design. The key design parameters of an RF shield structure are the contact force between a pair of fingers and the width and length of the slit between adjacent fingers. While the former is decided by the wall beam current and wall electric field, the latter is dependent on the Higher Order Modes (HOM). The bellow will be fabricated and tested both by heating and impedance measurement. | Dr. Thanapong Phimsen<br>Dr. Somjai Chunjarean<br>and SLRI researchers |

| No | Topics for Ph.D. Thesis by SLRI (August 2022) | Supervisor |
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| 16 | **Development of high field gradient accelerating structure for industrial applications**<br>**Scope:**<br>The industrial application is one of the key applications of electron linear accelerators. An accelerating part is the most crucial component of an electron linear accelerator in order to increase energy of the electrons up to 10 MeV with high current. In design and development of a high field gradient in normal conducting linear structures is a key issue in physics research and other applications at high energy electron. One of the important effects that occurs during deliver a high RF power into the linear accelerator is RF breakdown leading to limitations on acceleration and performance of the accelerator. This research focuses on the physical and engineering design of the high-gradient accelerating structure section without RF breakdown phenomena. These phenomena also require a detailed study on the dedicated developed systems. The design and simulation of the linear accelerator frequently use tool codes to perform physics and engineering results as CST-MWS, ASTRA, Pamela which are used to model electromagnetic field for acceleration in the accelerator structure and follow all electron trajectories in these fields to achieve a right mode of acceleration The thermal analysis and the vacuum performance are studied as well with ANSYS. In order to guarantee with achieving a high-performance of high-field gradient linear accelerator, the beam dynamics of the electron beam are studied and simulated by using particle accelerator codes. | Dr. Somjai Chunjarean, Dr. Siriwan Jummunt and SLRI researchers |

| No | Topics for Ph.D. Thesis by SLRI (August 2022) | Supervisor |
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| 17 | **Development of sub-micron resolution Synchrotron X-ray Tomography system**<br>**Scope:**<br>Development of innovative materials is not only the creative, functional design and the environmentally friendly production, but also requires the technology to characterize and assess the quality of the materials at sub-micron resolution. X-ray tomographic imaging is one of assessment tools that provides a non-destructive visualization of interior details in the materials in three-dimension. A tomographic system requires a highly intensive X-ray source, a precision rotation stage, and a fast X-ray detector, as well as a computational system that allows for a rapid data acquisition and image processing. The PhD project is aimed to develop a high-performance X-ray tomography system that utilizes the brightness and broad-ranged X-ray energy generated from Siam Photon Source (SPS) to achieve the sub-micron resolution. The research involves relevant mechanical design, image processing coding, electronic and control systems, and the design of the experiments to demonstrate the imaging system performance. The PhD candidates will be working alongside the SLRI beamline scientists and engineers for their projects. Successful PhD candidates will have a comprehensive understanding of synchrotron instrumentation design and be able to combine several academic disciplines or professional specializations in an approach to the research topic. | Dr. Supagorn Rugmai and SLRI researchers |

| No | Topics for Ph.D. Thesis by SLRI (August 2022) | Supervisor |
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| 18 | **Development of Synchrotron X-ray Fluorescence system for quantitative measurements of trace elements in solid and liquid** | Dr. Supagorn Rugmai and SLRI researchers |

**Scope:**

The expeditious growth of modern industry as well as the exacerbate human activities leave various harmful residues into environment, which consequently leads to serious pollutions. Understanding, screening, and fast detection of elemental compositions, and trace heavy metal contaminations in such environmental samples would be beneficial to avoid the widespread distribution and later solve the problems. In addition, the existance of trace elements in materials could alter their physicochemical properties and emerge novel characteristic features of materials aiming for such specific applications. X-ray fluorescence (XRF) spectroscopy is one of the potential techniques for characterization of elemental compositions. XRF requires less sample preparation and can be applied for various types of samples including solid, liquid, and slurry. In addition, XRF provides availability for fast screening and database for quality and quantity control.

This project aims to develop the apparatus for XRF experiments to quantify the concentrations of elements in materials. The participants will involve in the design of the automatic sample measurement system, for example a motorized multi-sample holder, a vacuum sample chamber, a user-friendly Labview-based program for the automatic data collection. The participants will join the beamline scientists to test the XRF measurement system, perform experiments, and do quantitative XRF analysis using fundamental parameter (FP) method. Over the course of the project, the participants will independently engage in a synchrotron development similar to that of beamline scientists and will have a good understanding of beamline instrumentation, control system, and XRF data analysis.

| No | Topics for Ph.D. Thesis by SLRI (August 2022) | Supervisor |
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| 19 | **Development of high field in-vacuum permanent magnet wiggler for high intensity hard x-ray generation**<br>**Scope:**<br>In-vacuum permanent magnet wiggler is an insertion device used for high intensity hard x-ray generation in the modern synchrotron radiation machine. The development of this device incorporates various aspects of knowledge including synchrotron radiation generation, magnetic field calculation and measurement, magnet fabrication, vacuum system design, high precision mechanical and control system, etc. The aim of the project is to produce a prototype in-vacuum wiggler used for the 3 GeV synchrotron machine. Several tools required for the project are available at the Synchrotron Light Research Institute (Public Organization), such as Mathematica and Radia software for magnetic field simulation. Helmholtz coil, flip coil, and hall probe for magnetic field measurement. Computer and software for engineering drawing and simulation of heat load/structural deformation. During the research, the student will develop variety of skills required to build the in-vacuum permanent magnet wiggler. This includes physics and engineering of synchrotron radiation generation. Magnetic field system starting from the design, simulation, fabrication, and measurement. Ultra-high vacuum system and high precision assembly and control of the in-vacuum permanent magnet wiggler device. | Dr. Siriwat Soontaranon<br>Dr. Supagorn Rugmai<br>and SLRI researchers |