The 1st Workshop for Future Science in Next Generation Synchrotron

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OSCO

Book of Abstracts

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Session 1: Construction Projects of 4th Generation Synchrotron (Chair: Moses Chung) / 18

Update on HEPS Progress

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The High Energy Photon Source (HEPS) is a green field 4th-generation light source. The construction of the High Energy Photon Source (HEPS) at the Chinese Academy of Sciences almost completed. The main achievement of 2025, all of the insertion devices have been installed and under the beamline commissioning. In this report, we'll give you the information about HEPS construction progress and accelerator and beamline commissioning results.

Session 2: Upgrade to 4th Gen. Synchrotron and Future Science (Chair: Hyunjung Kim) / 19

Advanced Photon Source Upgrade: Commissioning, Initial Science, and Future Outlook.

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The upgrade of the Advanced Photon Source (APS) was recently completed reducing the natural emittance of the APS storage ring from 3000 to 42 pm. This reduction greatly increases the coherent x-ray fraction at high energies providing unique opportunities for interrogating materials at nanometer length-scales with lens-less imaging techniques or exploring the dynamics of systems orders-of-magnitude faster than was previously possible. This talk will detail the APS's recent experience with commissioning of the new storage ring and the newly built beamlines optimized to exploit the high-energy coherence. The talk will also present some initial scientific results produced by APS beamlines over the past year, and an outlook for continued development of the APS accelerator and beamline portfolio.

Session 2: Upgrade to 4th Gen. Synchrotron and Future Science (Chair: Hyunjung Kim) / 20

From SPring-8 to SPring-8-II

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SPring-8 was inaugurated in 1997 as a large-scale 3rd generation synchrotron radiation (SR) facility, and has served a wide range of academic and industrial users for decades. However, the demand for advanced X-ray analysis has grown significantly, far exceeding the capabilities of the current facility. Furthermore, aging and loss of competitivity have become serious concerns. To achieve both a world-leading performance and high sustainability, we planned the SPring-8-II upgrade project [1], which was recently approved by the government in December 2024.
For the SPring-8 storage ring, we adopted a five-bend achromat lattice with a reduced beam energy of 6 GeV, allowing decrease of the emittance to 110 pm.rad and increasing the beam current to 200 mA while maintaining excellent stability [2]. As unique features, newly developed short-period in-vacuum undulators (IVU-II) are used to produce brilliant high-energy X-rays even at the lower beam energy [3]. Furthermore, four 30-m long straight sections (LSSs) will accommodate dumping wigglers to further reduce the emittance down to 50 pm.rad, as well as long IVU-IIs to generate hard X-rays with the highest brilliance among the 4th generation sources. The SACLA linac is used as a As a high-performance injector, allowing stable top-up operation and drastic reduction of the power consumption [4]. The world-leading technologies of X-ray optics and detectors (such as advanced KB mirrors and CITIUS), combined with massive supercomputing infrastructures in Japan, will fully exploit the capabilities of the new source.
For SPring-8-II, almost all accelerator components will be replaced, while the building including the ring tunnel and the experimental hall will remain in continuous use. Mass production of the components started in 2025. After a one-year shutdown and successive commissioning in FY2027-28, the user operation of SPring-8-II will start in 2029.
In this presentation, I will introduce the latest status of the SPring-8-II project, and the ongoing activities to fully utilize the new capabilities.

References
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Session 3: X-ray Imaging and Spectroscopy for Applied Science (Chair : Kyung-Wan Nam) / 21

multi-resolution tomography on large samples, the performances of the ESRF-EBS beamline BM18

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When discussing synchrotron phase-contrast imaging, the typical sample size is on the millimetre scale, and in a few cases, centimetres. Since 2000, the ESRF has made significant efforts to continuously increase the maximum size of samples that can be imaged.
In late 2018, the ESRF shut down to install the first high-energy fourth-generation storage ring: the Extremely Brilliant Source (EBS). Alongside the new machine, a series of new beamlines was planned. Among them, the BM18 project was selected. It was designed to reach metric-scale sample sizes while maintaining micron-level resolution by exploiting phase contrast with a polychromatic beam.
Imaging large samples using propagation-based phase contrast requires a large, high-energy beam with exceptional coherence and long propagation distances. Following this logic, the BM18 beamline was built on a bending magnet port of the new EBS machine, providing the smallest possible

X-ray source from the new lattice. The source is an 11 cm-long tripole wiggler with a peak field of 1.56 T. The beamline is 220 meters long, with the sample located 174 meters from the source, producing a beam of 320 × 17 mm² at the sample position. The average detected energy can be routinely tuned between 40 and 250 keV using more than a hundred of different polished filters, with specific configurations reaching up to 300 keV. The experimental hutch is 45 meters long, allowing for a maximum sample-to-detector distance of 36 meters. Thanks to the extremely small angular source size, coherence and geometric blurring are never limiting factors on BM18.
The multi-resolution strategy is implemented via a girder that can host up to nine detectors, covering pixel sizes from 0.65 µm to 120 µm. the latest generations of indirect detectors —mostly designed in-house —are a key factor in its ongoing success. Configurations can be recorded for rapid setup changes.
From 2022 to 2024, the beamline operated with a small tomograph capable of handling samples up to 30 kg, 30 cm in diameter, and 50 cm in height. Since October 2024, a large tomograph has been operational, able to accommodate samples up to 300 kg, 1.4 meters in diameter, and 2.3 meters tall —while still providing sub-micron resolution, even under maximum load.
The beamline is now fully operational. In addition to industrial activities (accounting for about 25% of the beamtime), BM18 supports a wide range of academic research. Key areas include biomedical imaging (notably the Human Organ Atlas project), cultural and natural heritage (including palaeontology), materials science, and geosciences. The BM18 team continues to develop the beamline every day, the beamline is still far from its limits !

Session 3: X-ray Imaging and Spectroscopy for Applied Science (Chair : Kyung-Wan Nam) / 22

Lithium-ion Battery Dynamics: From Single Particles to Cells

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Lithium-ion batteries (LIBs) are at the forefront of energy storage innovation, playing a crucial role in electrification and climate change mitigation. The electrochemical performance of LIBs is governed by the intricate movement of lithium ions across multiple length scales—from atomic-scale lattice structures to microscale porous electrodes and full-cell architectures. Each electrode consists of densely packed particles, each with distinct crystallographic structures and surface properties, contributing to complex, heterogeneous lithium transport behavior.
In this talk, I will demonstrate how advanced analytical techniques provide unprecedented insights into these hierarchical, multiscale dynamics within operating batteries. By bridging nanoscale ion transport with macroscopic electrochemical responses, we reveal how these phenomena impact key performance metrics, including charge-discharge efficiency, capacity degradation, and thermal stability. Understanding these mechanisms is essential for optimizing next-generation battery materials and designs to enhance safety, longevity, and overall performance.

Session 3: X-ray Imaging and Spectroscopy for Applied Science (Chair : Kyung-Wan Nam) / 23

Advancements in Spectroscopy Techniques at the APS-U Beamline S-25

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The new APS-U beamline S-25 is set to revolutionize advanced spectroscopies by utilizing the APS upgrade, which provides brighter beams with reduced divergence. This enhancement will significantly improve X-ray collection capabilities through our 100mm and 300mm KB mirror systems, facilitating advanced spectroscopy and imaging. In addition to conducting X-ray absorption measurements on dilute systems, the spectroscopy group has introduced two innovative spectrometers: one dedicated to high energy resolution fluorescence detection (HERFD) and another featuring a large crystal array for simultaneous multiple-edge X-ray emission spectroscopy. The development of a new X-ray Raman Scattering microscope is underway, designed to measure low energy edges such as C, O, and N using 10 KeV X-rays for in-situ and operando studies. Furthermore, the spectroscopy group is leading efforts to integrate Bluesky/Orphyd controls with EPICS, aiming to automate processes with a user-friendly interface. These advancements and their implications will be discussed.

Session 5: Soft X-ray Spectroscopy for Material Science (Chair: Ki-Jeong Kim) / 24

Recent advances in ambient pressure XPS

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The emergence of ambient pressure XPS (AP-XPS) clearly put a new road map on the world of surface science. The combination of differential pumps and electrostatic lens system enables the operation of XPS measurements possible under elevated pressure condition, even at the pressure of 1 Bar and beyond. Since its first demonstration at ALS in 2001, the community of AP-XPS rapidly grew and all major synchrotron facilities around the world run AP-XPS endstations. At the same time, the application of AP-XPS has expanded to the fields of surface catalysis, environmental science, energy material researches, and beyond.
In this talk, I will discuss the latest developments in AP-XPS techniques, along with the challenges and prospects for the future. Also, I will share our recent results of ferroelectric materials using hard X-ray AP-XPS.

Session 5: Soft X-ray Spectroscopy for Material Science (Chair: Ki-Jeong Kim) / 25

Eli Rotenberg (ALS-U)

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Beamline 7.0.2 –MAESTRO(Nano-ARPES)

Session 4: X-ray Crystallography for Bio-Science (Chair : Sun-Shin Cha) / 26

Structural basis for the recognition of type-2 N-degron substrate by PRT1 E3 ubiquitin ligase

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PROTEOLYSIS1 (PRT1), an N-recognin of Arabidopsis thaliana, has a specificity for recognizing the N-terminal aromatic hydrophobic residue (Tyr/Phe/Trp) of its substrates, subsequently degrading them through ubiquitylation. Here, I represent the complex structures of the ZZ domain of A. thaliana PRT1 (PRT1ZZ) with bulky hydrophobic N-degron peptides. Unlike other ZZ domains, the binding site of PRT1ZZ has a novel structure organized into two hydrophobic regions. The N-terminal aromatic residues of N-degron interact hydrophobically with Ile333 and Phe352 in the flexible loops, which undergo dramatic conformational change. A third N-degron residue participating in the hydrophobic network with N-recognin was also identified. Moreover, the ubiquitylation assay of PRT1 using the N-terminal tyrosine-exposed substrate BIG BROTHER showed that the tandem RING organization in PRT1 is critical for its robust activity. Therefore, the current study expands our knowledge of the structural repertoire in the N-degron pathway and provides insights into the regulation of E3 ubiquitin ligases containing tandem RING domains.

Session 4: X-ray Crystallography for Bio-Science (Chair : Sun-Shin Cha) / 27

Advancing macromolecular structure determination with microsecond X-ray pulses at a 4th generation synchrotron

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Serial macromolecular crystallography (SMX) has become a powerful method for resolving the structures of biological macromolecules at room temperature (RT). Although microfocus beamlines at third-generation synchrotrons are instrumental, their data acquisition is typically limited to the millisecond scale due to constraints in photon flux and detector speed. The newly developed ID29 beamline at the European Synchrotron Radiation Facility (ESRF)—a flagship of the Extremely Brilliant Source (EBS) upgrade—was purpose-built to leverage the capabilities of this fourth-generation source. As the first beamline dedicated to room-temperature serial microsecond crystallography (RT-SμX) with true microsecond X-ray pulses, ID29 features a compact, flexible diffractometer that supports rapid sample exchange and accommodates multiple solid supports and three types of high-viscosity extruders (HVEs). Our study highlights the critical integration of pulsed beams, the fast JungFrau4M detector, and synchronized data acquisition systems for effective RT-SμX experiments. The unique beam properties of the new ESRF source enable microsecond time-resolved crystallography, yielding high-quality electron density maps from relatively few merged frames. These advances position RT-SμX at ID29 as a model for future applications at upcoming fourth-generation synchrotron facilities worldwide.

Session 6: Advanced Coherent X-ray Scattering (Chair: Seo Hyoung Chang) / 28

Coherence application beamline P10 and the future upgrade to CAB

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The Coherent Application Beamline P10 at PETRA III is dedicated for coherent X-ray scattering and imaging experiments. P10 with two experimental hutches offers various experimental setups specialized for X-ray photon correlation spectroscopy (XPCS), Bragg CDI and holo-tomography (HT).

The new Coherent Application Beamline (CAB) is planned for future 4th generation synchrotron radiation source - PETRA IV. CAB will host state-of-art XPCS and holo-tomography experiments. Increased brightness of PETRA IV will allow CAB to investigate dynamical phenomena via XPCS in previously inaccessible regions in the space and time and offer 3D holographic tomography beyond current limitations in resolution.

Session 6: Advanced Coherent X-ray Scattering (Chair: Seo Hyoung Chang) / 29

Seeing Disorder through Coherence: Extreme Light on Complex Matter

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The emergence of enhanced transverse coherence in X-rays has significantly expanded their applicability to structural investigations beyond well-ordered systems. When coherent X-rays scatter from disordered or random specimens, they produce characteristic speckle patterns in the diffraction images. These speckles encode rich information about structural disorder and fluctuations. By utilizing short-wavelength X-rays, finer structural features—down to the atomic scale—can be resolved through speckle analysis.
Coherent diffraction imaging (CDI) techniques, combined with advanced phase retrieval algorithms, enable the reconstruction of real-space images or charge density distributions directly from these speckle patterns, without the need for image-forming lenses. Since their initial demonstration at second-generation synchrotron sources, coherent imaging methods have undergone rapid development, now capable of resolving nanoscale structural details and capturing ultrafast dynamics on femtosecond timescales.
The arrival of fourth-generation synchrotron sources, with significantly enhanced brightness and coherence, is expected to usher in a new era of coherent X-ray science—one focused on disordered systems and far-from-equilibrium phenomena. In this talk, we will review the fundamental principles of coherent X-rays, present recent advances in coherent imaging techniques, and discuss emerging perspectives and opportunities in the study of structural disorder and ultrafast dynamics.

Session 7: Status of Phase-I 10 Beamline Projects (Chair: Changyong Song) / 32

Probing Materials with Advanced X-ray Spectroscopy.

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Material Science

Session 7: Status of Phase-I 10 Beamline Projects (Chair: Changyong Song) / 33

Nanoscale Probes in the Soft X-ray Regime: nanoARPES and Soft X-ray nanoprobe

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Coherent X-ray Science

Session 7: Status of Phase-I 10 Beamline Projects (Chair: Changyong Song) / 34

Design Strategies and Progress of Coherence Beamlines at Korea-4GSR for Advanced Science.

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Bio-Science and Imaging

Session 7: Status of Phase-I 10 Beamline Projects (Chair: Changyong Song) / 35

Construction and utilization of Korea-4GSR's life science and imaging beamline.

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Soft X-ray Science

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