Plenary Talk

PT – 1

Taiwan Photon Source: Advances in Accelerator Technology, Beam Utilization, and Future Perspectives

Jui-Che Huang (NSRRC, Taiwan)
Meng-Fan Luo (NSRRC, Taiwan)

The Taiwan Photon Source (TPS), a 3 GeV synchrotron light source at the National Synchrotron Radiation Research Center, supports research through X-ray diffraction, imaging, and spectroscopy. This presentation highlights developments in accelerator technology and scientific applications, outlining how facility improvements expand experimental capabilities and strengthen engagement with academic and industrial users. On the accelerator front, operation at the target of 500 mA has been achieved alongside continuous improvements in beam stability, reliability, and operational sustainability. Developments include bunch lengthening by a harmonic cavity, transparent injection utilizing a non-linear in-vacuum kicker, cryogenic short-period undulators, as well as EPUs tailored to diverse photon requirements. The proposed TPS-II upgrade targets substantially lower emittance to deliver brighter coherent radiation in the X-ray region.
Scientific applications span structural biology, biomedical imaging, energy materials, and semiconductor research. Complementary techniques enable investigations across length scales, from molecular structures to cellular organization and material microstructures. Operando measurements provide insight into evolving chemical states and structural changes, supporting studies of catalysts and energy conversion materials. Industrial collaboration, interdisciplinary beamline access, and user training further broaden the scientific reach of TPS. By connecting accelerator performance with experimental needs, TPS developments aim to improve measurement quality, enable demanding experiments, and support a growing user community while preparing the facility for future scientific opportunities and industrial challenges.

E-mail: huang.juiche@nsrrc.org.tw

PT – 2

Automated Commissioning and AI-Assisted Operation for SRF Systems: Studies at HIAF-iLinac and European XFEL

Lijuan Yang (Institute of modern physics)
Feng Qiu (Institute of modern physics)
Yuan He (Institute of modern physics)
Zheng Gao (Institute of modern physics)
Zhijun Wang (Institute of modern physics)
Julien Branlard (Deutsches Elektronen-Synchrotron DESY)

Commissioning and operation of large-scale superconducting radio-frequency (SRF) systems involve repetitive procedures and complex fault diagnosis, creating a growing demand for automated and intelligent operational tools. This work presents recent developments in automated commissioning and AI-assisted fault diagnosis for SRF systems, with applications at HIAF-iLinac and European XFEL. An automation framework based on EPICS and Phoebus has been developed for cavity conditioning, cavity loading, and RF measurements. By integrating predefined operational workflows, real-time device monitoring, safety interlocks, and automatic responses to abnormal conditions, the framework improves commissioning efficiency and consistency while reducing operator workload. These applications are being deployed across multiple accelerator projects at the Institute of Modern Physics, including HIAF, CIADS, and IP-SAFE.

In parallel, AI-based fault diagnosis methods are being developed to enhance the reliability and intelligence of SRF operation. By combining expert knowledge with machine learning, a fault classification method has been established that can distinguish eight types of SRF cavity faults with approximately 95% accuracy under continuous-wave operation. A similar approach has also been adapted to the pulsed SRF systems at European XFEL, achieving 100% accuracy in quench identification on the evaluated dataset. These results demonstrate the potential of combining domain expertise with AI techniques for reliable fault identification across different SRF operating modes. Together, automated commissioning and intelligent fault diagnosis provide complementary capabilities toward more efficient, reliable, and ultimately autonomous operation of large-scale SRF accelerator systems.

E-mail: yanglijuan@impcas.ac.cn

PT – 3

Osprey: Agentic AI for Scientific Infrastructure

Thorsten Hellert (Advanced Light Source (ALS), LBNL, USA)

Agentic AI systems that connect language models to live control systems are starting to change how large scientific facilities are operated. This talk presents Osprey, a framework developed at Berkeley Lab that turns a plain-language request into a planned, operator-approved sequence of data retrieval, control-system interaction and analysis, and that has been deployed at the Advanced Light Source and other DOE accelerator facilities. I will describe how the agent works out which part of the machine an operator means, how it plans and executes multi-stage tasks against a production control system, and how safety constraints are enforced and tested before the agent is allowed near the machine. I will close on what a shared, portable platform means for new and upgraded facilities, and where it still falls short.

E-mail: thellert@lbl.gov

PT-4

How EBS changed what science is possible

Gema Martinez-Criado (ESRF)

The new generation of synchrotron sources represents far more than an incremental upgrade of existing facilities: it fundamentally redefines the science that can be undertaken. Drawing on the experience of the Extremely Brilliant Source (EBS) at the ESRF, this talk will show how a decisive advance in coherence, stability and speed marks a transition from signal-limited science, in which observation was constrained by what could be detected, to physics-limited science, in which it becomes possible to observe what actually exists. The combination of substantially brighter and more coherent beams, nanometre-scale stability and considerably faster detectors has rendered routine a range of experiments that were previously inaccessible. This shift will be illustrated through several new experimental regimes. Materials can now be examined grain by grain, following in real time how they deform, grow and fail under realistic conditions. Whole human organs can be imaged at cellular resolution, placing disease in a complete three-dimensional context. Chemical processes can be observed in motion, capturing what genuinely occurs within batteries, electrolysers and catalysts while in operation. Finally, extremely weak signals can be made visible, giving access to subtle effects in living tissue and in quantum materials that were hitherto too faint or too complex to measure. Rather than focusing on a single technique, the talk will offer a broad perspective on how these advances connect fundamental understanding with real-world applications. It will conclude by looking ahead to the ESRF Long-Term Scientific Plan 2026-2035, which builds on the EBS investment through a phased evolution of the accelerator, the beamline instrumentation and the digital infrastructure, and by considering what this means beyond the ESRF, as a blueprint for the next generation of light sources and for the opportunities they open for science and innovation across Europe.

E-mail: gmartine@esrf.fr

PT-5

SNS Electrical Power Conversion Equippment Operational Status

Dave Anderson (Retired (SNS/ORNL))
Yugang Tan (SNS (Spallation Neutron Source) / ORNL (Oak Ridge National Laboratory))
Jared Walden (SNS (Spallation Neutron Source) / ORNL (Oak Ridge National Laboratory))pp

The Spallation Neutron Source (SNS) began user operations in 2006 following extensive commissioning of the accelerator and its supporting systems. The Electrical Power Conversion (EPC) systems were originally specified or designed by several national laboratories and manufactured by multiple vendors. These systems include Low Energy Beam Transport (LEBT) chopper pulsers, High Voltage Converter Modulators (HVCMs), DC magnet power supplies, and injection and extraction kicker power supplies. During the early years of operation, various equipment issues resulted in significant downtime. Through a series of prioritized upgrades, design improvements, and reliability enhancements, these issues were systematically resolved. EPC equipment availability reached 98% in 2011 and has remained at a consistently high level since then. This presentation reviews the operational history and current status of the EPC systems and highlights recent, ongoing and planned upgrades to support reliable future SNS operations

E-mail: tany@ornl.gov

PT-6

When Particles Meet Power Devices: Proton and Neutron Induced Destruction of SiC MOSFETs

COQ GERMANICUS, rosine (Université de Caen- CRISMAT UMR6508)

Nowadays, wide bandgap (WBG) semiconductor devices are widely adopted in power conversion systems for their superior efficiency, integration and power density. Among WBG materials, Silicon Carbide (SiC) is already deployed and used across a wide range of applications, and its use is now being explored for demanding environments such as electric aircraft, space and satellite systems, where radiation effects on device reliability become a critical design consideration. This talk presents a European experimental and simulation investigation on Single Event Burnout (SEB) in SiC MOSFETs under proton and neutron irradiations, combining experiments with Monte Carlo and microelectronic device simulations.

Neutron irradiation was performed at ChipIr (Rutherford Appleton Laboratory, UK), an atmospheric-like neutron beam with an energy spectrum extending up to 800 MeV and an acceleration factor of ~10^9 compared to the real atmospheric flux. Proton irradiation was carried out at the RADiation Effects Facility (RADEF), Accelerator Laboratory, University of Jyväskylä, Finland, using a monoenergetic 53 MeV beam.

To understand the underlying mechanisms, a Monte Carlo code was used to determine the distribution of secondary ions generated by neutron-nucleus reactions with Si and C at 50-200 MeV, identifying the species most responsible for device failure. The real device structure, characterized at the die level, was reproduced in the microelectronic device simulation tool and coupled with a drift-diffusion/heat-transport model to map electric field and temperature across impact positions and incidence angles within the SEB-sensitive zone inside the device.

In addition, post-irradiation failure analysis of the device at the die level was performed to reconstruct the physical sequence leading to the SEB destruction, supporting the simulation findings. Together, these results provide risk maps and mechanistic insight to guide the design of radiation-hardened SiC power devices for avionic and space environments.

This study highlights how dedicated accelerator facilities, through tailored beam energies and accelerated flux conditions, provide an indispensable means of reproducing real-world radiation environments for power device qualification.

E-mail: rosine.germanicus@unicaen.fr

Facility Talk

FT – 1

Status of PLS-II, PAL-XFEL, and PAL-EUV

Changbum Kim (PAL)

Pohang Accelerator Laboratory (PAL) operates the third-generation synchrotron radiation facility PLS-II, the hard X-ray free-electron laser PAL-XFEL, and the compact synchrotron radiation source PAL-EUV for EUV generation. To enhance facility performance and operational reliability, PAL continues to implement targeted upgrades across these accelerators. This year, a superconducting cryomodule with a vacuum leak in the insulation vacuum was replaced with a spare module, completing preparations for high-current operation of PLS-II. At PAL-XFEL, a dechirper for transverse beam deflection and a slotted foil installed in the bunch compressor were applied to support high-harmonic FEL generation. PAL-EUV, constructed for research on photoresists, masks, and pellicles relevant to semiconductor manufacturing, is currently under commissioning for user service. This presentation summarizes the current operational status and recent performance-improvement activities of PLS-II, PAL-XFEL, and PAL-EUV.

E-mail: chbkim73@gmail.com

FT – 2

Status and Outlook of the RAON Accelerator Facility

Yeonsei Chung (Institute for Rare Isotope Science, IBS)

RAON is a heavy-ion accelerator facility in Korea designed to provide a wide range of stable and rare isotope beams for nuclear physics and other scientific research. Following the successful commissioning of the low-energy superconducting linac (SCL3) and the ISOL system, RAON has been providing beams for user experiments while continuously improving its operational stability and performance. This presentation will provide an overview of the current operational status, recent achievements, and ongoing efforts to improve beam availability, reliability, and user services. Recent progress in ISOL operations and user beam delivery, along with selected experimental results, will also be briefly presented. Finally, future plans for facility upgrades and enhanced beam capabilities will be discussed.

E-mail: yschung@ibs.re.kr

FT – 3

Korea Light Source (KLS): Current Status and Future Plans

Hyunchang Jin (KBSI)

The Korea Light Source (KLS), formerly known as Korea-4GSR, is a national fourth-generation synchrotron light source under construction in Ochang, Korea. The project is led by the Korea Basic Science Institute (KBSI) in partnership with the Pohang Accelerator Laboratory (PAL). KLS is based on a 4 GeV, 800 m storage ring with a hybrid multi-bend achromat lattice, designed to reach a very low emittance of 62 pm·rad. It will provide X-rays more than 100 times brighter than existing third-generation sources, with high coherence, allowing researchers to study materials at the nanoscale in real time. With the main design work completed and the groundbreaking held in July 2026, the project has now moved into full-scale construction and the manufacturing of key accelerator components. Ten beamlines will be built in the first phase, and the facility is scheduled for completion by the end of 2029. In this presentation, we report the current status of the project, outline the construction schedule and key milestones, and discuss how KLS will support research in areas such as semiconductors, batteries, and drug development.

E-mail: hcjin98@kbsi.re.kr

FT - 4

Current status of SNUH Heavy Ion Therapy Gijang Center

Jong Min Park (SNUH Heavy Ion Therapy Gijang Center)

FT – 5

Operational Status and Future Plan of KOMAC

Han Sung Kim (KAERI)

The Korea Multipurpose Accelerator Complex (KOMAC) has operated a 100-MeV proton linear accelerator (linac) since 2013, providing proton beams for a broad range of scientific and industrial applications through four user beamlines. To address the increasing demand for higher-energy proton beams and to broaden the scope of accelerator-based applications, an upgrade of the existing linac to 200 MeV is being pursued. The proposed upgrade comprises an additional 200-MeV accelerating section, two dedicated beamlines with target stations, an expansion of the accelerator facility, and associated upgrades to supporting utilities. The extended accelerator is based on a normal-conducting separated drift tube linac (SDTL) structure, selected to provide a reliable and technically robust solution while avoiding the complexity associated with superconducting systems. The two downstream beamlines are intended to support advanced irradiation applications, including space-radiation effects testing and terrestrial radiation-environment studies. In parallel with the conceptual design, pilot R&D activities are being conducted to validate key technologies and reduce technical risks associated with the upgrade, including RF system development, accelerating-structure fabrication, and beam-dynamics optimization. This work reviews the current operational status of the KOMAC 100-MeV proton linac and presents the ongoing R&D activities supporting technical realization of 200 MeV upgrade.

E-mail: kimhs@kaeri.re.kr

Working Group -1

IT-1

PRISM Alliance: Industrializing High-Temperature Superconducting Magnet Technologies for Accelerator Applications

Jaemin Kim (Standard Magnet Inc.)
Jonghoon Yoon (Standard Magnet Inc.)
Wonseok Jang (Standard Magnet Inc.)
Kideok Sim (SuperGenics Co., Ltd.)
Kyunghan Chun (PowerNix Co., Ltd.)
Suhong Ryu (Dae Hong Electric Co., Ltd.)
Seungyong Hahn (Seoul National University)

The Project for Research and Innovation in Superconducting Magnet (PRISM) is a national initiative in Korea that develops high-temperature superconducting (HTS) magnet technologies through coordinated efforts among academia, research institutes, and industry. Building on the no-insulation (NI) winding technique and the magnet design methodologies established at Seoul National University, PRISM has developed a set of master coil types (solenoid, toroid, racetrack, and saddle). These coil geometries form the basis of HTS magnets for a wide range of applications, including accelerator magnets that require high field strength, compact size, and thermal stability.

To translate these research outcomes into practical systems, the PRISM Alliance was established as an industrial consortium that covers magnet design, conductor and cable manufacturing, cryogenic system integration, and power infrastructure. Standard Magnet Inc., together with its partners, offers a development path that runs from conductor characterization and coil design to magnet fabrication, current lead and cable development, and system-level testing.

This presentation introduces the technical capabilities and collaborative structure of the PRISM Alliance, with a focus on their relevance to accelerator technology. We discuss how HTS magnet technologies developed for demanding applications such as fusion and power systems can be adapted for accelerator magnets, high-current conduction-cooled operation, and related science infrastructure. We also present our international R&D activities and invite collaboration with accelerator laboratories and institutions toward the industrial supply of HTS magnet systems.

E-mail: jmkim@standardmagnet.com

IT-2

SLS 2.0: Upgrade, Commissioning, and Early Operation of the Upgraded Swiss Light Source

KALLESTRUP, Jonas (Paul Scherrer Institute)

The Swiss Light Source (SLS) at the Paul Scherrer Institute has recently completed the SLS 2.0 upgrade, replacing the original storage ring with a new seven-bend achromat lattice incorporating longitudinal-gradient and reverse-bend magnets to achieve substantially lower emittance and transform the facility into a fourth-generation synchrotron light source. This presentation provides an overview of the project and the recommissioning of the accelerator complex following the upgrade. Key commissioning milestones, operational challenges and lessons learned are discussed.
Finally, the current status of SLS 2.0 and the first experience gained during routine operation are presented.

E-mail: rosine.germanicus@unicaen.fr

CT-1

RF Overdrive Protection Device for the Superconducting RF System in PLS-II

Mujin LEE (Pohang Accelerator Laboratory)
MINWOO KIM, sehwan Park (Pohang Accelerator Laboratory)

The PLS-II storage ring employs a superconducting RF (SRF) system for energy compensation. The SRF system enables higher RF gradients and improved efficiency, thereby increasing the available beam energy and power. However, the SRF system is susceptible to RF overdrive, which can cause RF breakdown or damage to the system. To mitigate the risk, an RF Overdrive Protection Device has been implemented and installed in the PLS-II storage ring. This paper presents the implementation and operation of the protection device, including potential scenarios leading to RF overdrive, its design, and actual cases in which the device successfully prevented RF overdrive.

E-mail: mujimuji@postech.ac.kr

IT-3

The development and applications of superconducting linear accelerators at IMP

Zhijun Wang (Institute of Modern Physics, Chinese Academy of Sciences)

Since 2011, the Institute of Modern Physics, Chinese Academy of Sciences (IMP, CAS) has been committed to Accelerator Driven Subcritical System (ADS) research. As a critical subsystem, the superconducting linear accelerator has achieved remarkable accomplishments and progress. To meet the ADS system's requirements for high-power and high-reliability proton beams, the team has conducted innovative research on beam dynamics optimization and simulation, failure compensation, and reliability enhancement of core equipment. Relevant research results have been applied to facilities including the high-intensity heavy-ion linear accelerator, isotope mass-production technology research platform, and ADS demonstrator. This report presents the development and applications of superconducting linear accelerators at IMP.

E-mail: wong@impcas.ac.cn

IT-4

Recent Progress in the Development of the Nonlinear In-Vacuum Kicker at NSRRC

Che-Kai Chan (National Synchrotron Radiation Research Center (NSRRC))
Chin-Chun Chang (National Synchrotron Radiation Research Center (NSRRC))
Bo-Ying Chen (National Synchrotron Radiation Research Center (NSRRC))
Chyi-Shyan Fann (National Synchrotron Radiation Research Center (NSRRC))
Chun-Shien Huang (National Synchrotron Radiation Research Center (NSRRC))
Fu-Yuan Lin (National Synchrotron Radiation Research Center (NSRRC))
Hao-Wen Luo (National Synchrotron Radiation Research Center (NSRRC))
Chih-Sheng Yang (National Synchrotron Radiation Research Center (NSRRC))
Chih-Sheng Yang (National Synchrotron Radiation Research Center (NSRRC))
Chin-Kang Yang (National Synchrotron Radiation Research Center (NSRRC))

A nonlinear in-vacuum kicker (NIK) has been developed for the Taiwan Photon Source (TPS) to minimize stored-beam disturbance during injection. The NIK employs a ceramic core with copper coils inside a titanium vacuum chamber, generating a strong nonlinear magnetic field for the injected beam while maintaining a nearly field-free region for the stored beam.

A 5 μm titanium coating was optimized, achieving a resistivity of 6.64×10^{-7} Ω•m and thickness uniformity within 5%. Magnetic-field measurements showed good agreement with simulations. Prototype commissioning revealed beam-induced heating and thermal outgassing, motivating a water-cooled upgrade. Following baking and non-evaporable getter (NEG) activation, the upgraded NIK achieved a vacuum pressure in the 10^{-10} mbar range, while water cooling introduced no significant magnetic-field distortion.

These results demonstrate the feasibility of the NIK design and the effectiveness of the water-cooled upgrade for future TPS operation.

E-mail: ckchan@nsrrc.org.tw

CT – 2

Progress on the Construction of the Large-Scale Helium Cryogenic System at IMP

Jun Wen (Institute of Modern Physics, Chinese Academy of Sciences)
xiaofei niu (Institute of Modern Physics, Chinese Academy of Sciences)

The Institute of Modern Physics (IMP), Chinese Academy of Sciences, has undertaken the construction of helium cryogenic systems for multiple large-scale superconducting accelerator facilities, some of which have been completed and put into operation, while others are still under construction. This paper first presents an overview of the cryogenic systems that have been completed or are under construction at IMP, including their refrigeration capacity, service objectives, and operational status. Taking the cryogenic system of the China initiative Accelerator Driven System (CiADS) as a representative example, the key design aspects of its large-scale helium cryogenic system are introduced in detail, including the thermodynamic process design, the helium cryogenic distribution system, cryostats, cryogenic transfer lines, and the control and protection system. In addition, the major technical challenges encountered during commissioning and operation, together with the corresponding solutions, are summarized, and future plans for the construction of large-scale cryogenic systems are discussed. The engineering practices presented here can serve as an important reference for the design and construction of cryogenic systems for large superconducting accelerator facilities worldwide.

E-mail: wenjun@impcas.ac.cn

CT - 3

Development of pneumatic frequency tuner for RAON 162.5MHz HWR cryomodule

Giyeol Han (IRIS)
Hyojae Jang
Seojeong Kim
Youngkwon Kim (Institute for Basic Science)

The superconducting half-wave resonators (HWR) at low energy accelerator of RAON are equipped with mechanical frequency tuners driven by cryogenic motors to adjust the cavity resonance frequency to the operating frequency of 162.5 MHz. The existing tuner employs a screw-driven lever mechanism that converts the rotational motion of the motor into axial displacement of the cavity beam ports, providing a desired tuning range of approximately 100 kHz. However, several operational issues have been observed, including mechanical vibrations during motor operation, stuck between the screw and spindle nut, and frequency shifts in adjacent cavities due to mechanical cross-talk. To address these issues and improve the operational reliability and maintainability of the tuner system, a pneumatic tuner using a helium-gas-driven bellows actuator has been developed as an alternative to the existing cryogenic motor-driven mechanism.

The pneumatic tuner was designed to reuse the existing HWR tuner lever assembly while minimizing the need for cryomodule disassembly and modifications to the cavity beam port flanges. The feasibility of replacing the existing actuator was evaluated through disassembly tests and interference checks using three-dimensional CAD models. Numerical simulations were performed to evaluate the force transmission characteristics, structural integrity, and thermal loads under cryogenic conditions. The pneumatic tuner system was designed to limit the additional heat load to the 2 K region to approximately 0.2 W. Additional cleaning ports and heaters were also incorporated into the design to mitigate potential blockages caused by moisture freezing inside the gas lines. Two types of pneumatic bellows with outer diameters of 50 mm and 70 mm were fabricated to evaluate the tuning range and operational stability. A test system consisting of proportional control valves, pressure transducers, and a control driver was developed to regulate the helium gas supply and exhaust flow.

Room-temperature tests of the fabricated pneumatic tuner demonstrated a maximum tuning range of approximately 146 kHz at an applied pressure of 3 bara using the 70 mm bellows, with a pressure-to-frequency tuning sensitivity of approximately 49 Hz/mbar. The measured tuning range exceeds the design requirement of 100 kHz. In addition, 1,000 full-range actuation cycles were performed over a pressure range of 0–3 bar. No significant change in tuning sensitivity or gas leakage was observed after the cycling test, demonstrating stable and repeatable operation of the pneumatic tuner.

E-mail: gyhan@ibs.re.kr

Working Group -2

IT – 1

Commissioning simulation of the KLS storage ring

Jaehyun Kim, Gyeongsu Jang (Pohang Accelerator Laboratory)
Hyunchang Jin (RISP/IBS)
Junha Kim, Jaeyu Lee, kimoon Nam, Jimin Seok (Pohang Accelerator Laboratory)

Gyeongsu Jang, Hyunchang Jin, Junha Kim, Jaeyu Lee, kimoon Nam, Jimin Seok
We present a start-to-end commissioning simulation of the KLS storage ring, a 4th-generation light source currently under construction in Ochang, Korea. Featuring a 62-pm emittance based on a hybrid multi-bend achromat (HMBA) lattice, the storage ring is highly sensitive to magnet misalignment and field errors. In this work, realistic commissioning procedures were iteratively simulated using up-to-date machine error tolerances. The workflow incorporates first-turn trajectory steering, closed-orbit correction, and linear optics restoration via LOCO. Ensemble-based statistical evaluations show that the ring performance meets the requirements for reliable user operation.

E-mail: picoma@postech.ac.kr

CT-1

Simulation study of vertical emittance blow-up in the KLS storage ring

Junha Kim (POSTECH)
Gyeongsu Jang (POSTECH)
Jimin Seok (POSTECH)
kimoon Nam (POSTECH)
Moses Chung (POSTECH)
Jaehyun Kim (POSTECH)

Vertical emittance blow-up can improve beam lifetime in low-emittance electron storage rings. Pulse picking by resonant excitation (PPRE) uses a kicker driven near a betatron resonance to increase the emittance of a selected bunch. This study applies the same excitation principle to vertical emittance control in the Korea Light Source (KLS) storage ring.
To investigate resonant vertical emittance control at different stored beam currents, we perform particle-tracking simulations at 100 mA and 400 mA, including amplitude-dependent tune shifts, higher-order chromaticity, and wakefield effects. Frequency scans near the vertical betatron resonance and its synchrotron sidebands are combined with variations in kicker strength and vertical chromaticity to examine the conditions for target emittances of 10 pm·rad at 100 mA and 15 pm·rad at 400 mA. In addition to emittance growth and beam size, we evaluate how fluctuations in effective emittance and the centroid-to-beam-size ratio change as more turns are averaged.

E-mail: joonha9609@postech.ac.kr

IT -2

Novel LWFA-driven crystal-based source of ɣ-radiation, positrons and neutrons

Alexei Sytov (INFN Ferrara Division)
Hyeon Myung Jeong (Ulsan National Institute of Science and Technology (UNIST))
Leejin Bae (Gwangju Institute of Science and Technology, Institute for Basic Science)
Iryna Chaikovska (CNRS/IJCLab)
Hyoeun Choi (Ulsan National Institute of Science and Technology (UNIST))
Gianfranco Paternò (INFN Ferrara Division)
Laura Bandiera (INFN Ferrara Division)
Inhyuk Nam (Ulsan National Institute of Science and Technology (UNIST))

This work [1] presents a compact laser-driven source of ɣ-rays and secondary particles that combines laser-plasma wakefield acceleration (LWFA) with oriented crystalline targets. Relativistic electrons aligned with major crystallographic directions undergo coherent interactions with the crystal lattice, giving rise to channeling radiation [2] and coherent bremsstrahlung [3] and substantially enhancing photon emission compared with randomly aligned crystals. The resulting increase in photon yield enhances positron production through electron-positron pair creation and neutron production through photonuclear reactions. Furthermore, coherent bremsstrahlung in thin diamond crystals enables the generation of tunable, quasi-monochromatic ɣ-radiation, while the ultrashort duration of LWFA electron bunches supports very high peak brilliance.
Using Geant4 [4] and the G4ChannelingFastSimModel [5], we simulate 300 MeV, 1 GeV, and 3 GeV LWFA electron beams incident on oriented tungsten crystals. These simulations predict up to a twofold enhancement in ɣ-ray, positron, and neutron yields relative to randomly aligned crystals. Finally, we discuss possible pathways toward the first experimental demonstration of this compact, ultrafast source concept.

A. Sytov et al. arXiv:2609.40005v1
M.A. Kumakhov, Phys. Lett. A 57(1), 17 (1976).
B. Ferretti, Nuovo Cimento 7, 118 (1950).
S. Agostinelli et al., Nucl. Instrum. Meth. A 506, 250-303 (2003).
A. Sytov et al. J. of Korean Phys. Soc. 83, 132-139 (2023).

E-mail: alexei.sytov@cern.ch

CT -2

Beam Extraction and Current Optimization of a 5 MeV Microtron for a Compact THz Free-Electron Laser

Myungjin Bae (University of Science & Technology, Korea Atomic Energy Research Institute)
Sangyoon Bae (Rare Isotope Accelerator Complex for ON-line Experiment)
Kyu-Ha Jang (Korea Atomic Energy Research Institute)
Young Uk Jeong (University of Science & Technology, Korea Atomic Energy Research Institute)
Hyun Woo Kim (Korea Atomic Energy Research Institute)

A compact S-band microtron is being developed at the Korea Atomic Energy Research Institute (KAERI) as the electron beam source of a terahertz free-electron laser (THz FEL). The microtron uses a 2.8005 GHz RF cavity driven by a magnetron and accelerates electrons to about 5 MeV through eight orbital turns. The macropulse length of the electron beam is 5 μs. To increase the extracted beam current, the position of the extractor and the position of the electron gun-accelerating cavity-magnetron assembly were adjusted. In addition, the stray magnetic field was compensated using correction coils. After these adjustments, the macropulse-average beam current measured at the extractor entrance reached about 51 mA. The beam current after extraction is about 44 mA, which is above the design target of 40 mA. The transverse beam profile of the extracted electron beam was measured using a YAG screen and a quadrupole magnet. The measured beam profile was compared with the electron beam conditions required for THz FEL operation. Further measurements of the energy spread and emittance will be performed after the beam transport line to the undulator is completed.

E-mail: yujung@kaeri.re.kr

IT-3

High-Yield K10 Beamline Design for Next-Generation Hadron Physics

Ji-Gwang Hwang (Kangwon National University)
K10 collaborators

Next-generation hadron physics experiments at the J-PARC Hadron Experimental Facility extension demand high-intensity and high-purity secondary kaon K^- beams. Delivering adequate kaon flux at high momentum is fundamentally challenged by the rapid in-flight decay and stringent solid-angle/momentum acceptance constraints of long secondary beamlines, as well as the intrinsic transmission loss in conventional RF separators. In this work, we present an advanced optical design for the K10 beamline featuring multi-objective numerical lattice optimization and a novel 2D RF separation scheme. First, numerical optimization contracted the beamline length by over 13% to mitigate in-flight kaon decay while achieving a 4-fold enhancement in total acceptance compared to the baseline design.
Furthermore, to eliminate the intrinsic 30% kaon loss from zero-crossing in conventional 1D separators, we introduce a circularly polarized 2D RF deflecting system. By driving orthogonal dipole modes with a 90° phase shift, the deflecting field maps kaons into a hollow donut ring while focusing pions onto the central axis. Tracking simulations confirm that pairing this scheme with a central pin stopper achieves 100% lossless kaon transmission and effective anti-proton suppression, substantially boosting kaon yield and purity within the existing S-band infrastructure.

E-mail: hwang@kangwon.ac.kr

IT-4

Design of a Beam Permit and Machine Protection System for the CiADS

Wenjuan Cui,Hai Zheng,Jiaming Wang,Junliang Du,Zhijun Wang
Institute of Modern Physics, Chinese Academy of Sciences
Lanzhou/Gansu, China
Email: wenjuancui@impcas.ac.cn

The China initiative Accelerator Driven Subcritical System (CiADS) employs a 500 MeV, 5 mA continuous-wave superconducting proton linac to drive a subcritical reactor. Beam continuity directly governs reactor thermal stability and facility availability. Conventional “trip-on-doubt” protection safeguards equipment but causes many unnecessary beam interruptions, unsuited to CiADS operation.

This work presents a beam permit and hierarchical machine protection scheme balancing machine safety and beam availability. Two-tier protection logic is implemented: before beam operation all prerequisite conditions are verified — vacuum, insertion devices, valves, personnel safety, chopper, magnets and RF systems; during operation faults are handled differentially, recoverable faults such as cavity arcing and transient disturbances receiving a short interruption and automatic recovery, and severe irreversible faults receiving protective outputs such as beam blocking and chopper shutoff.

The core innovation is that cavity or magnet power supply trips do not directly revoke the beam permit. Beam abort is triggered only when beam diagnostics confirm genuine beam loss or when beam power and energy at the reactor exceed the allowed range. Cavity and magnet safety is handled by inter-system interlocks such as RF interlocks and quench protection, the global beam interlock focusing on beam-loss risk.

The system builds a heterogeneous dual-link architecture on fail-safe hard-wired fiber and a White Rabbit (WR) real-time network, both capable of microsecond-scale beam cut-off. Meanwhile, the WR network carries timestamped fault packets for fault classification and state snapshot. The two links are fully heterogeneous to mitigate common-cause failures. The supervisory layer is physically separated from interlock paths, so Ethernet outages cannot compromise protection. The scheme thus reduces unnecessary beam interruptions without lowering safety.

CT-3

Improving RF Measurement Reliability and Understanding Performance-Limiting Factors in RAON SSR1 Cavities

YooLim Cheon (Institute for Rare Isotope Science)
Sungmin Jeon (Department of Physics, Kyungpook National University, Daegu, Republic of Korea)
Youngkwon Kim (Institute for Basic Science)
Juwan Kim (IBS)
Hyojae Jang Eunsol Go (IBS)
Giyeol Han, Junwoo Lee (IBS)
Heechul Park, Moo Sang Kim, Jong Wan Choi, Jangwon Han (IBS)
Seojeong Kim (IBS)

The 325 MHz single-spoke resonator (SSR1) cavity, developed for the high-energy superconducting linac of RAON, is the world's first balloon-type single-spoke cavity. Recently, three prototype SSR1 cavities demonstrated excellent RF performance, supported by improvements in cavity fabrication, surface treatment, and clean assembly processes.
In addition to achieving high cavity performance, improving the reliability of RF measurements and understanding performance-limiting factors are essential for further SRF cavity development. In particular, RF measurement uncertainties, multipacting and field emission (FE) characteristics, and the effects of ambient magnetic fields and cryogenic cooldown conditions on the quality factor (Q_0) require systematic investigation. This paper will present the recent vertical test results of the SSR1 cavities, focusing on improved RF measurement procedures to minimize uncertainties, the relationship between surface treatment, multipacting behavior, and FE performance, and a statistical analysis of Q_0 variations under different ambient magnetic field conditions. These studies aim to improve the reliability of SRF cavity performance evaluation and provide insights into further optimization of SSR1 cavity performance for the RAON high-energy linac.

E-mail: cheonyoo@ibs.re.kr

CT - 4

Fabrication and Procedure Improvement of SSR1 Superconducting Cavities for RAON

Eunsol Go a, Giyeol Han a, Jangwon Han a, Yoo Lim Cheon a,
Junyoung Yoon a, Seojeong Kima, Jun Woo Lee a,
Jong Wan Choi a, Moo Sang Kim a, Sungmin Jeon b, Hyojae Jang a,
Heechul Park a, Juwan Kim a, Seong Jin Lee a, Youngkwon Kim a,
Jaehyung Lee a,
a Institute for Rare Isotope Science (IRIS), Institute for Basic Science (IBS), 1 Gukjegwahak-ro, Yuseong-gu, 34000 Daejeon
b Department of Physics, Kyungpook National University, 80 Daehak-ro, Buk-gu, 41566 Daegu
*E-mail : esgo@ibs.re.kr
*Keywords : Single Spoke Resonator, Superconducting linear accelerator, bubble streak, Cavity, vertical testing

The single spoke resonator 1 (SSR1) is a superconducting RF cavity designed for the front-end of the high-energy linear accelerator of the Rare Isotope Accelerator complex for ON-line experiments (RAON). Four pre-production SSR1 cavities were developed to establish reliable fabrication and processing procedures for future mass production. During development, several issues affecting cavity performance were identified, including surface etching, particle contamination, and variations in RF performance.
To address these issues, systematic improvements were implemented in buffered chemical polishing (BCP), high-pressure rinsing (HPR), and clean assembly procedures. Rotational BCP with an external cooling system was introduced to suppress bubble-induced surface streaks and improve etching uniformity. In addition, HPR conditions and ultrapure water quality control were improved to minimize particle contamination during rinsing. The clean assembly procedure was also refined by establishing a dedicated bottom-up assembly sequence with clean PTFE caps, minimizing particle ingress during cavity handling. Following these improvements, the cavities demonstrated significantly enhanced RF performance in vertical tests, achieving quality factors exceeding 1.0 × 1010 at the target accelerating gradient of 7.9 MV/m.

The measured X-ray dose was also substantially reduced compared with cavities processed using previous procedures, indicating effective suppression of field emission. The established procedures provide a technical foundation for future SSR1 cavity mass production and cryomodule development for the RAON high-energy superconducting linac.

Acknowledgement
This work was supported by the National Research Foundation of Korea (NRF) funded by Ministry of Science and ICT(RS-2022-00214790)

Working Group - 3

IT-1

Persistence of local atomic configurations in amorphous silica captured by low-dose electron correlation microscopy

Jongchul Jeon (Korea Research Institute of Standards and Science)
Ji-Hwan Kwon (Korea Research Institute of Standards and Science)
Joohyun Lee (Korea Research Institute of Standards and Science)
Sooheyong Lee (Korea Research Institute of Standards and Science)
Sang-Hyeok Yang (Korea Research Institute of Standards and Science)

Understanding the temporal stability of local atomic configurations in disordered solids requires probing dynamics at atomic length scales. We use low dose high-Q electron correlation microscopy to measure time-resolved structural relaxation in amorphous silica. Two-time correlation analysis demonstrates stationary, non-aging dynamics across the measurement window. The intermediate scattering functions display stretched-exponential relaxation, reflecting dynamical heterogeneity across a broad distribution of local potential energy barriers. With increasing scattering vector Q, the relaxation time τ(Q) transitions from a steep collective decay at low Q into a finite high-Q plateau. This crossover identifies the elementary lifetime of local atomic arrangements, establishing that high-Q electron speckle dynamics directly reveal the persistence time of local configurations in amorphous networks.

E-mail: sooheyong@gmail.com

IT-2

From Accelerator Beam to Useful Neutrons : Beamline and Instrumentation Considerations for Accelerator-Based Neutron Sources

Myungkook Moon (KAERI)

Accelerators provide well-controlled charged-particle beams, but converting these beams into useful neutron fields requires a separate set of technologies involving target systems, shielding, moderation, beam transport, diagnostics, detectors, and application-specific instrumentation. Therefore, the performance of an accelerator-based neutron facility cannot be determined by accelerator parameters alone.

This talk will discuss the key beamline and instrumentation considerations required for neutron production and utilization. Particular attention will be given to the selection and engineering of neutron-producing targets as a function of proton energy, including lithium, beryllium, tungsten, and tantalum. Practical issues such as neutron yield, heat deposition, cooling, radiation damage, activation, target lifetime, shielding, and maintenance will be addressed. The roles of moderators, reflectors, collimation, filters, beam shaping, neutron diagnostics, time-of-flight techniques, detectors, and data acquisition will also be discussed.

Examples from compact accelerator neutron sources, cyclotron-based systems, and higher-energy proton accelerators will be used to illustrate how the optimum target and beamline configuration changes with beam energy, beam power, neutron spectrum, and intended use. Experience from neutron imaging and irradiation studies will further demonstrate that high neutron yield alone does not necessarily result in a high-quality or useful neutron beam.

The main message is that accelerator technology and neutron beamline technology are closely connected but require different expertise. A successful accelerator-based neutron facility should therefore be designed as an integrated system in which the target, moderator, shielding, beamline, diagnostics, detector, and application requirements are considered from the beginning.

E-mail: moonmk@kaeri.re.kr

CT-1

X-ray nanoprobe characterization of functional materials at ESRF ID16B

Eunyoung Choi (ESRF - The European Synchrotron)
Rémi Tucoulou (ESRF- The European Synchrotron)
Julie Villanova (ESRF- The European Synchrotron)

The ID16B beamline, at the European Synchrotron Radiation Facility (ESRF), is a hard X-ray nanoprobe dedicated to 2D or 3D analysis. It enables, among others, correlative nanoscale mapping by combining scanning X-ray fluorescence (XRF), X-ray-excited optical luminescence (XEOL), and X-ray absorption near-edge structure (XANES) at sub-100 nm resolution, offering a versatile approach for probing property relationships in diverse functional materials. In this work, we will present examples illustrating this multimodal approach for different material systems: In Copper(Cu)-implanted Methylammonium lead iodide (MAPbI3) single crystals, correlated XRF-XEOL mapping is utilised to investigate how the metal implantation contributes to localized optical luminescence features within single crystals. Furthermore, Cu K-edge XANES probes the local electronic behaviors of the Cu-implanted single crystals.

- In Ruthenium (Ru)-based oxygen evolution reaction (OER) catalysts for water splitting, Ru Kedge XANES is used to examine oxidation-state variations across a composition series of catalysts, aiming to correlate these variations with catalytic activity.

E-mail: eunyoung.choi@esrf.fr

IT-3

Detector and DAQ Systems at RAON's Low-Energy Facility

Kwang-Bok Lee[1,*], Minsik Kwag[1,2], Dong Geon Kim[1], Kyoungho Tshoo[1],
Geonhee Oh[1], Cheolmin Ham[1,2],
Jae Cheon Kim[1], Eunhee Kim[1], Mijung Kim[1], Seong Jae Pyeun[1],
Changwook Son[1], CheongSoo Lee[1],
Sinchul Kang[1], and Sangjin Lee[1]
[1]Institute for Rare Isotope Science, Institute for Basic Science, Daejeon 34000, Republic of Korea
[2]Department of Basic Science, University of Science and Technology (UST), Daejeon, Republic of Korea
*E-mail: kblee@ibs.re.kr

The low-energy experimental area of RAON, operated by the Institute for Rare Isotope Science (IRIS) of the Institute for Basic Science, hosts KoBRA (Korea Broad Acceptance Recoil Spectrometer & Apparatus) [1] for rare isotope beam experiments and NDPS (Nuclear Data Production System) [2] for neutron production. Both facilities have successfully completed their first beam commissioning, and their detector and data acquisition (DAQ) systems are operating well. This talk presents these systems together with their commissioning results.

The DAQ is being converted from conventional analog TDC/ADC modules to waveform digitizers. At KoBRA, digitizer readout has already been applied to the parallel plate avalanche counter (PPAC) detectors, which improved their performance [3]. At NDPS, EJ-301 liquid scintillators were read out with digitizer-based pulse shape discrimination (PSD), which gave good neutron/gamma separation. Converting all detector channels to digitizer readout is expected to shorten event-processing time and reduce system dead time. We report the status of this transition and how the subsystems are integrated through triggering and synchronization. We further outline plans to introduce AI-assisted tools for DAQ configuration, monitoring, and data analysis.

We also present ongoing work on Doppler correction for in-beam gamma-ray spectroscopy. This work employs machine-learning-based pulse shape analysis (e.g., Gaussian process regression and convolutional neural networks) of HPGe clover detectors [4], together with 3D position-sensitive CdZnTe (CZT) detectors [5], to reconstruct gamma-ray interaction positions event by event. To this end, the first in-beam test using the Ar(d,p) Ar reaction is scheduled at KoBRA in November 2026.

Acknowledgements

This work was supported by the Institute for Basic Science (IBS-I001-D1) and the National Research Foundation of Korea (NRF) grant funded by the Ministry of Science and ICT (2013M7A1A1075764, RS-2023-00282876).

References

[1] K. Tshoo et al., Nucl. Instrum. Methods Phys. Res. B 541, 56 (2023).
[2] C. Ham et al., Nucl. Instrum. Methods Phys. Res. B 541, 363 (2023).
[3] G. Oh et al., Prog. Theor. Exp. Phys. 2026, 093H02 (2026).
[4] C.E. Svensson et al., Nucl. Instrum. Methods Phys. Res. A 540, 348 (2005).
[5] Z. He et al., Nucl. Instrum. Methods Phys. Res. A 422, 173 (1999).

IT-4

Neutron Fluence and Spectrum Measurements at the KRISS Monoenergetic Neutron Fields

Young Soo Yoon (KRISS(Korea Research Institute of Standards and Science))

The Korea Research Institute of Standards and Science (KRISS) operates monoenergetic neutron reference fields based on the $D(d,n)^3He$ and $T(d,n)^4He$ reactions at a 400 kV electrostatic accelerator, producing neutrons at 2.5 MeV and 14.8 MeV. These fields serve as national references for calibrating neutron detectors and dosimeters, and they are increasingly utilized for radiation hardness testing of semiconductors and electronic components. Their reliable use requires that the neutron fluence, its energy distribution, and the contribution of neutrons scattered from the target assembly and the surroundings be characterized with well-understood detector systems.

This talk presents the neutron measurement techniques established and under development at the KRISS facility. For fluence determination and real-time beam monitoring, long counter detectors are utilized. A proton recoil telescope has studied for the neutron fluence measurements through the n-p elastic scattering cross section. A Bonner sphere spectrometer equipped with an SP9 spherical ^3He proportional counter is used to fluence measurements. A Cs_2LiYCl_6:Ce (CLYC) scintillation detector is being applied to fast-neutron spectroscopy via the $^{35}Cl(n,p)$ reaction, with digital pulse-shape discrimination to separate neutron and gamma-ray events. A neutron time-of-flight measurement system is also under development to directly separate source neutrons from scattered neutrons and to measure the energy spread of the monoenergetic fields.

The complementary roles of these systems, and their applicability to neutron measurements at other accelerator-based facilities, will also be discussed.

IT-5

Current Status of the RAON ISOL System

Yeong Heum Yeon (IBS/IRIS)
Jinho Lee (Institute for Rare Isotope Science, Institute for Basic Science)
Jae-Won Jeong ((Institute for Rare Isotope Science, Institute for Basic Science))
Wongjoo Hwang ((Institute for Rare Isotope Science, Institute for Basic Science))
SeongJin Heo (IBS)
Kyounghun Yoo ((Institute for Rare Isotope Science, Institute for Basic Science))
Ha-Na Kim ((Institute for Rare Isotope Science, Institute for Basic Science))
Dong Joon Park ((Institute for Rare Isotope Science, Institute for Basic Science))
Takashi Hashimoto ((Institute for Rare Isotope Science, Institute for Basic Science))
Jaehong Kim (Institute for Rare Isotope Science (IRIS), Institute for Basic Science (IBS), Daejeon, Korea)
Jun-Young Moon ((Institute for Rare Isotope Science, Institute for Basic Science))
Hee-Joong Yim ((Institute for Rare Isotope Science, Institute for Basic Science))

The Isotope Separation On-Line (ISOL) system at RAON has completed commissioning and now delivers radioactive ion beams (RIBs) for experiments. Its driver is a 70 MeV proton cyclotron (35–70 MeV, up to 750 μA), accepted in October 2022, which feeds remotely handled target-ion source (TIS) modules. Downstream are a pre-mass separator, an RI identification station, an RFQ cooler-buncher, an EBIS charge breeder and an A/q separator.

Since the first RI production in March 2023, a surface ion source has produced Li, Na and Al isotopes from a low-density SiC target and Cs and Ba isotopes from a LaC2 target. Short-lived isotopes such as 24mNa (T1/2 = 20 ms) and 27Na (T1/2 = 301 ms) were observed, which shows that Na is released quickly from the target. Al yields, however, were several orders of magnitude below calculated values, because Al forms stable carbide compounds in SiC. A resonance ionization laser ion source (RILIS) produced 22,23,27,28Mg, with 23Mg reaching about 108 pps, and extracted Al beams in May 2026. A FEBIAD plasma ion source installed in the TIS module delivered stable beams in December 2025.

A charge-bred 25Na5+ beam was post-accelerated by SCL3 to 16.4 MeV/u and transported to KoBRA. This demonstrated the full chain from isotope production to post-acceleration and delivery to experiments. On-line mass

measurements of Na, Mg and Al isotopes with an MR-TOF mass spectrograph reached a mass resolving power of about 1.9 × 105. TiC, Ta and actinide (UCx/ThCx) targets are being developed, and RIBs from a ThCx target are planned for 2027.

E-mail: yhyeon@ibs.re.kr

Working Group -4

IT – 1

Cyclotron production challenges of Ac-225 from Ra-226 at QST

Jun Ichinose
National Institutes for Quantum Science and Technology (QST), Japan

Radiation therapy has been one of the standard cancer treatments alongside surgery, chemotherapy, and immunotherapy. Specifically, external beam radiation therapy—where protons, neutrons,gamma rays, or heavy charged particles are delivered from outside the body to a well-defined target,such as a solid tumor—is widely known. Likewise, when the irradiation target is clear and limited, sealed radioactive sources—often called seeds or capsules—can be implanted inside the body in a procedure known as brachytherapy, which is considered effective for non-metastatic prostate cancer, for example.
Similar to brachytherapy, another form of internal radiation therapy is targeted radionuclide therapy(TRT) using unsealed radioactive sources. Examples include the oral administration of 131I capsules for the treatment of thyroid cancer, or the administration of 177Lu-labeled PSMA-targeting radiopharmaceuticals for the treatment of metastatic prostate cancer. In recent years, however, the field has shifted toward the administration of radiolabelled drugs using alpha-emitting radionuclides, which offer significantly higher cytotoxic potential. The world's first approved alpha-emitting radiopharmaceutical, Xofigo, in a form of chloride compound of 223Ra shows significant efficacy, and more recently, the development of drugs labelled with 225-Ac (T1/2 = 10 d) has become a rapidly expanding global endeavor.
Consequently, the global demand for 225Ac has surged dramatically, driven by growing interest from both academic institutions and pharmaceutical industries. This rapid increase has led to serious supply
shortages, making 225Ac not only expensive but also difficult to obtain. As a result, developing reliable ways to produce 225Ac has become a hot topic in nuclear engineering and industry. One major challenge is that 225Ac production requires the use of 226Ra, a relatively scarce adionuclide (T1/2 = 1600 a)—a radioactive material that is difficult to handle safely and requires strict controls. To address this, our team has developed a method that uses a particle accelerator to irradiate 226Ra, as well as a series of chemical separation and purification steps to extract high-quality 225Ac suitable for medical use. In addition to these production technologies, we have worked on

establishing safety measures for the handling of 226Ra and its progeny, as well as eveloping practical activity measurement and dose calibrator calibration methods.

This presentation will provide an overview of our recent activities related to 225Ac production, radiochemical purification, radiation safety, and dose calibrator calibration at QST.

E-mail: ichinose.jun@qst.go.jp

CT-1

Feasibility study of Tandem targets for the production of ^{229}Th

Vivek Chavan[2,3], Jaehong Kim[2,3], Baek Beom Yeol[2], Dan Hye Gil[2], Taeksu Shin[2,3]

1. Center for Exotic Nuclear Science (CENS), Institute for Basic Science (IBS), Daejeon, Korea
2. Institute for Rare Isotope Science (IRIS), Institute for Basic Science (IBS), Daejeon, Korea
3. TOPTIER Project, Institute for Rare Isotope Science (IRIS), Institute for Basic Science (IBS), Daejeon, Korea

^{225}Ac is one of the candidates for targeted alpha therapy. There are three main routes for producing ^{225}Ac: decay of ^{229}Th, irradiation of ^{226}Ra with a proton beam, and spallation of ^{232}Th. Spallation of thorium produces ^{227}Ac, whereas ^{225}Ac obtained from the decay of ^{229}Th is free from ^{227}Ac. Also, ^{229}Th is part of a ^{229}Th/^{225}Ac generator. However, the limited availability of ^{229}Th necessitates finding alternative production routes. One such route is proton irradiation of ^{232}Th using a cyclotron. As mentioned by Griswold et al., the contribution to the cumulative ^{232}Th(p,x)^{229}Th reaction cross section comes mainly from ^{232}Th(p,4n)^{229}Pa below 30 MeV and above 30 MeV from ^{232}Th(p,p3n)^{229}Th reaction [1]. The tandem targets will consist of two thorium targets, each of 3 mm in thickness. The target facing the beam will be used for ^{225}Ac and ^{229}Th production, whereas the second target will be used for ^{229}Th only. The first target will be irradiated in the energy range of 50-70 MeV, where the ^{227}Ac impurity is very low. The second target will be irradiated with a 20-50 MeV proton beam. So, in the present work, a systematic evaluation procedure using PHITS for ^{229}Th production with tandem targets and the 70 MeV RAON cyclotron at IRIS will be presented. In the case of target 1, ^{229}Th can be recovered by passing the thorium fraction through anion-exchange resin in 8 M HNO_3 after sufficient cooling. The recovery of ^{229}Th from thorium target 2 will be carried out either by separating ^{229}Pa from HCl using anion-exchange resin (^{229}Th can be recovered for further use) or by the method mentioned for target 1. Irradiation at 20-70 MeV with tandem targets will increase the production yield of ^{229}Th.

Reference: Griswold et al. Phy. Rev. C 98 (2018) 044607

E-mail: vrchavan@ibs.re.kr

CT – 2

Mass and Half-Life Distributions of Products Generated by 40–70 MeV Proton Irradiation of a Thorium-232 Target

Jaehong Kim (Institute for Basic Science)
Beomyeol Baek (Institute for Basic Science)
Danhye Gil (IBS)
Kyoungyong Noh (Nuclear Engineering Serves & Solutions)
Taeksu Shin (Institute for Basic Science (KR))
Heejoong Yim (Institute for Basic Science)

Proton-induced reactions of a ^{232}Th target produce numerous radionuclides through fission, spallation, fragmentation, and particle-emission processes. At 70 MeV, the activity distribution shows two broad peaks in the intermediate-mass region and a lower yield near the central mass region, representing the characteristic asymmetric-fission pattern of thorium. Products remaining near the target mass are mainly associated with spallation and successive nucleon-emission reactions. The half-life distribution extends over many orders of magnitude, indicating the simultaneous production of short-lived nuclides responsible for high initial activity and long-lived residual nuclides relevant to radionuclidic purity, radiation safety, and waste management. This study aims to analyze changes in product distributions as the incident proton energy increases from 40 to 70 MeV. The comparison will examine total fission yield, positions and widths of the fission-product peaks, light-to-heavy fragment yield ratios, residual heavy-nuclide production, and half-life-dependent activity. The results will clarify the energy-dependent reaction mechanisms and support the selection of irradiation conditions that enhance desired radionuclide production while limiting unwanted radioactive impurities.

This work was supported by INNOPOLIS (RS-2026-25506728) and by the National Research Foundation of Korea through the TOPTIER program (RS-2024-00436392), funded by the Ministry of Science and ICT, Republic of Korea.

E-mail: jhkim68@ibs.re.kr

IT-2

Edge Termination Design for Radiation -Hardened SiC Power Devices : Proton-Induced TID and SEB Analysis

Ogyun Seok (Pusan National University)

SiC power devices are promising for space power systems, but energetic protons degrade them through cumulative total ionizing dose (TID), which builds positive fixed charge (QF) in the field oxide, and through single-event burnout (SEB). In this work, 1.2-kV SiC test element groups with RA-JTE, MFZ-JTE, and FLR edge terminations were evaluated under both conditions.

The devices were irradiated with 45-MeV protons up to 1×10^{14} cm^{-2} for TID and with 100-MeV protons at 60–90% of the breakdown voltage (BV) for SEB. The results were analyzed by FIB-SEM and by TCAD including incomplete ionization of Al acceptors.

Under TID, RA-JTE showed a BV change of only −0.56%, compared with −6.08% for MFZ-JTE and +15.22% for FLR, because its P^+ rings suppressed QF-induced field crowding at the main junction. Under SEB conditions, burnout occurred mainly at or above 1.1 kV, leaving a subsurface SiC cavity. With incomplete ionization, the peak electric field moved into the field oxide (12.8–16.5 MV/cm), and peak lattice temperatures of 1309–1352 K appeared near the main junction.

RA-JTE showed the most stable BV and the lowest simulated peak field and temperature among the three structures. It is therefore a promising edge termination for radiation-hardened SiC power devices.

E-mail: ogseok@pusan.ac.kr

CT – 3

Feasibility of AI Agent-Assisted Enhancement of Therapeutic Efficacy and Indication Expansion in Accelerator-Based Boron Neutron Capture Therapy (AB-BNCT)

Byung Ho Choi (Gachen Univ. Gil Medical Center / DAWONMEDAX Co., Ltd)
Jaewon Choi (DAWONMEDAX Co., Ltd)
Sang June Jeon (DAWONMEDAX Co., Ltd)
Dongsu Kim (DAWONMEDAX Co., Ltd)
Hyo Jung Seo (Gachon University Gil Medical Center / DAWONMEDAX Co., Ltd)
Jungyu Yi (DAWONMEDAX Co., Ltd)

Boron neutron capture therapy (BNCT) selectively destroys tumor cells through the high linear-energy-transfer (LET) particles released when boron-10 (10B) captures a thermal neutron. Using hospital-based accelerator neutron sources, BNCT has successfully treated malignant brain tumors and recurrent head and neck cancers, and it was approved in Japan in 2020. However, the current protocol, comprising an epithermal neutron beam, intravenous boronophenylalanine (BPA) or sodium borocaptate (BSH), and Monte Carlo macrodosimetric treatment planning, leaves considerable room for improvement. This study examines whether the computational algorithms and computing power of AI agents can address these limitations of complexities with multi-parameters and non-linearity issues in five areas. First, we propose replacing macrodosimetry based on fixed biological effectiveness factors with a microdosimetric approach that uses LET and DNA double-strand break yields from the track-structure code Geant4-DNA to derive cell-survival probabilities in near cell-sized voxels. Second, we construct a pharmacokinetic model of the cellular 10B distribution and couple it, together with the in-body neutron spectrum, to the microdosimetric calculation. Third, we explore AI-assisted design and preclinical evaluation of third-generation boron agents with higher tumor uptake and tumor-to-normal-tissue ratios than BPA and BSH. Fourth, we evaluate an interchangeable moderator to tailor the epithermal spectrum to tumor depth and the muti irradiation ports, improving tumor-cell kill while reducing normal-tissue damage in established indications. Fifth, we assess delivering cold neutrons from an accelerator-based source through a catheter-type neutron guide to treat deep-seated cancers of the pancreas, liver, and lung. These approaches could improve the therapeutic efficacy by the precision of BNCT dosimetry and broaden its clinical indications by the beam delivery controls.

E-mail: byhchoi@byungho.net

CT-4

Evaluation of Skin-Sparing Effects Using a FLASH Electron LINAC in a Canine Model: A Pilot Clinical and Molecular Study

Tosol Yu (Dongnam Institute of Radiological & Medical Sciences)
Tae Sung Hwang (Gyeongsang National University)
Dong Hyeok JEONG (Dongnam Institute of Radiological & Medical Sciences)
Kyoung Won Jang (Dongnam Institute of Radiological & Medical Sciences)
Manwoo Lee (Dongnam Institute of Radiological & Medical Sciences)
Heuijin Lim (Dongnam Institute of Radiological & Medical Sciences)

FLASH radiotherapy (FLASH-RT), delivered at ultra-high dose rates, has demonstrated potential to reduce radiation-induced normal tissue toxicity. The research LINAC at the DIRAMS (Dongnam Institute of Radiological & Medical Sciences) is capable of delivering electron beams at both conventional (<0.1 Gy/s) and ultra-high (> 40 Gy/s) average dose rate, with an instantaneous dose rate of up to
Gy/s through precise control of the pulse modulator using a single-board computer. This pilot study evaluated skin reactions and molecular responses after FLASH-RT in two beagles previously included in conventional radiotherapy (CONV-RT) studies. Historical CONV-RT consisted of 48 Gy in 12 fractions using 6 MeV electrons. FLASH-RT was delivered to separate skin sites as 28.16 Gy in three fractions or 20.28 Gy in a single fraction at 129.57–138.86 Gy/s. Skin reactions were followed for up to 1.5 years, with molecular assessment using TUNEL staining and RT-qPCR. FLASH-RT produced milder skin reactions, without desquamation and with less hyperpigmentation, particularly after single-fraction treatment. Molecular findings suggested attenuated inflammation and earlier repair-related responses. These preliminary observations support the potential of electron FLASH-RT to improve skin tolerance and inform its clinical translation.
(This work was supported by the DIRAMS grant funded by the Korea government (MSIT) under grant 50704-2026.)

E-mail: tosolyu@dirams.re.kr

CT – 5

Future RAON Experiments from Accelerator to Quantum Many-Body Science in the Era of AI, HPC, and Quantum Computing

Kihyeon Cho (Korea Institute of Science and Technology Information)

The Rare Isotope Accelerator complex for ON-line experiments (RAON) is entering a new era of rare-isotope science with the operation of the Superconducting Linac 3 (SCL3) and its associated rare-isotope production and experimental systems. Stable heavy-ion acceleration has been successfully demonstrated at SCL3. The ISOL facility and experimental systems, including KoBRA, NDPS, MMS, and CLaSsy, provide new opportunities to integrate accelerator and detector measurements with advanced computational methods.

High-performance computing (HPC) enables high-fidelity simulations of nuclear structure, reactions, beam transport, and detector responses. Artificial intelligence (AI) can complement these calculations through surrogate models, parameter inference, and uncertainty quantification. Surrogate models are fast machine learning models trained on high-fidelity simulations. These AI methods can accelerate comparisons between theoretical predictions and experimental data. Key applications include AI-assisted spectral analysis for CLaSsy, particle identification at KoBRA, and neutron-gamma discrimination at NDPS.

Looking toward future RAON experiments, the Superconducting Linac 2 (SCL2) and in-flight (IF) fragment separator will extend the accessible region toward more neutron-rich and exotic nuclei. The combination of large-scale HPC simulations and AI-based surrogate models could support accelerator tuning, isotope-yield prediction, detector optimization, and experimental design.

We therefore propose a RAON-HPC-AI-QC framework in which HPC serves as the computational backbone and AI accelerates prediction and experiment-theory feedback. Quantum computing (QC) provides a complementary, longer-term approach to selected nuclear many-body problems through hybrid quantum-classical algorithms. This integrated framework establishes a pathway from current RAON experiments toward the future exploration of exotic nuclei and quantum many-body science.

ACKNOWLEDGMENTS: We thank Kyungho Kim, Youngman Kim, Young-Ho Song, Ik Jae Shin and Myugkuk Kim. This research is supported by the major institutional R&D program, KISTI (K26L1M2C3, N25NM055-26). This study was also supported by the National Supercomputing Center with supercomputing resources and technical support (KSC-2022-CHA-0003, KSC-2023-CHA-0005, KSC-2024-CHA-0001 and KSC-2025-CHA-0004).

E-mail: cho@kisti.re.kr

Abstract for Poster Presentation

WG 1

PO – 01

Design and Preliminary Evaluation of Extraction System and Pulsed Power Supply for the KLS Booster Ring

KIM, sang-hee (Pohang Accelerator Laboratory)
LEE, Jaeyu (Pohang Accelerator Laboratory)
SHIN, Seunghwan (KBSI)

Rapid-cycling booster synchrotrons that ramp beam energy by large factors before extraction face a design choice: build a high-current extraction kicker rated for full extraction rigidity, or exploit existing beam optics to relax hardware requirements. For the 4 GeV KLS booster (200 MeV to 4 GeV, ramping ratio 20), we demonstrate the viability of this approach. By exploiting the defocusingquadrupole component inherent in the combined-function bending magnets, a modest 3.000 mrad kick, equal to the storage-ring injection kick, is amplified to a horizontal offset approaching the beam-stay-clear requirement at the extraction septum. This result is derived from a drift-bend-drift beam-optics model, and a corresponding pulsed power supply is developed: a series-LC resonant circuit delivering a 5 kA, sub-5 μs half-sine pulse with rise time below 2 μs. The model is validated against the operating PLS-II kicker through waveform comparison (predicted $\tau \approx 6.84$ μs vs. measured 6.80 μs; 0.62% deviation) and by empirical determination of system inductance ($L_{sys} \approx 1.14$ μH) via ring-down measurement. A field-reliability upgrade of the thyratron grid-1 trigger circuit, combining a π-type LC low-pass network with an IEC 60664-1-compliant insulation redesign, prevented the recurrence of transient-voltage-suppressor failures across deployed modulators. Contrasting thyratron versus IGBT degradation, cathode erosion versus thermal-cycling fatigue, a hydrogen thyratron is shown to suit KLS's low-duty-cycle top-up operation (duty factor 1/60), with an expected lifetime exceeding the facility's operational horizon and gas-reservoir degradation as the practical determinant of tube replacement. These results define a hardwareefficient, single-kicker extraction scheme transferable to other rapid-cycling booster synchrotrons in top-up mode.

E-mail: ksangh@postech.ac.kr

PO – 02

Design study of 350 MeV cyclotron superconducting magnet for Carbon therapy

GAD, Khaled (SungKyunGwan university)
CHAI, Jong-Seo (SungKyunGwan university)

The design of a superconducting cyclotron magnet, especially intended for high-energy applications such as a 350MeV/u hadron therapy cyclotron for carbon ions (^12 C^(6+)), demands stringent control over the magnetic field profile. The magnet must strictly adhere to an isochronous field distribution to maintain a constant ion revolution frequency despite relativistic mass increases during acceleration. This document presents a robust, fully automated optimization framework that combines analytical modeling, iterative 2D Poisson-based magnetic field simulations, correction techniques, field harmonics analysis, tune optimization through spiral angle adjustment, and concludes with the automated generation of an optimized 3D magnet structure, ready for finetuning via 3D finite-element simulations (TOSCA).

E-mail: khaled.gad@live.com

PO – 03

Development status of an LEBT Chopper for KOMAC

SeokHo MOON (KOMAC/KAERI), Seunghyun LEE(KOMAC/KAERI),
Han-Sung KIM (KOMAC/KAERI), Hyeok-Jung KWON (KOMAC/KAERI)

The LEBT chopper is a important component in the Low Energy Beam Transport (LEBT) section of proton accelerators, primarily utilized for pulse operation, regulating beam pulse length and enable Machine Protection System (MPS) functionality. Currently, the Korea Multi-purpose Accelerator Complex (KOMAC) operates its LEBT without a chopper, leading to several operational constraints during beam operation. To resolve these limitations, the chopper tailored for the KOMAC LEBT was designed and fabricated. Prior to its installation into the 100-MeV proton linear accelerator, initial operation test are planned on the Beam Test Stand (BTS). This presentation reports on the design specifications, fabrication, and current status of the LEBT electric chopper system.

E-mail: msh3069@kaeri.re.kr

PO – 04

Development of power couplers for single spoke resonators in Institute for Rare Isotope Science

Junyoung YOON (Institute for Rare Isotope Science)
YooLim CHEON (Institute for Rare Isotope Science)
Heejin DO (Institute for Rare Isotope Science)
Yong Woo JO (Institute for Rare Isotope Science)
Eiji KAKO (KEK)
Youngkwon KIM (Institute for Basic Science)
Do Yoon LEE (Institute for Rare Isotope Science)
Huiseong SON (Institute for Rare Isotope Science)

A cryomodule incorporating single-spoke resonators (SSRs), fundamental power couplers (FPCs), and tuners is currently under development for the SCL2 project. The SSR FPCs employ coaxial capacitive coupling structures based on conventional 3-1/8-inch EIA 50-Ω coaxial transmission lines, with a single ceramic window without TiN coating. High-power RF tests were performed in standing-wave (SW) mode using 20-kW, 325-MHz solidstate power amplifiers (SSPAs). The SW test configuration provides RF conditions similar to those encountered during cavity conditioning prior to beam operation and allows the position of the maximum electric field along the power coupler to be adjusted using movable shorts. For the high-power RF tests, two power couplers were connected to a test cavity under high vacuum. The test setup was equipped with various diagnostic instruments, including arc detectors, power meters, temperature sensors, and electron pickups. A dedicated interlock system based on vacuum, arc, and electron monitoring was implemented to protect the ceramic RF windows during high-power operation. High-power RF tests were conducted up to 7 kW at 325 MHz in SW mode to evaluate the performance of the fabricated power couplers. In this presentation, we present the high-power RF test setup, conditioning procedure, interlock system, and experimental results obtained in SW mode using movable shorts.

E-mail: jyyoon@ibs.re.kr

PO – 05

Experimental and multi-physics evaluation for separated drift tube linac tank

Sungbin Park(KAERI (KOMAC)), Seunghyun LEE(KAERI (KOMAC)),
Han-Sung KIM(KAERI (KOMAC)), Hyeok-Jung KWON (KAERI (KOMAC))

To accommodate a 200 MeV energy upgrade at the Korea Multi-purpose Accelerator Complex (KOMAC), a separated drift tube linac (SDTL) configuration is under evaluation. This study focuses on the first tank of the SDTL under operating conditions. The DT and tank wall are evaluated separately to assess their respective structural integrity. For the DT, which incorporates isolated cooling pathways in its central and peripheral sections for efficient thermal management, both experimental and computational approaches are employed. A transparent acrylic prototype is used for flow visualization and pressure-drop measurements, while coupled electromagnetic, thermal, and structural analyses are performed to predict the associated frequency detuning. For the tank wall, thermal deformation and the resulting frequency detuning are evaluated computationally. By separately evaluating the DT and tank wall, this study provides an integrated assessment of the thermal and structural factors contributing to frequency detuning in the SDTL cavity and supports the assessment of its operational feasibility for the 200 MeV upgrade.

E-mail: sbpark95@kaeri.re.kr

PO – 06

Design and Experimental Verification of a 50-kW Cavity Combiner for High-Power RF Solid-State Amplifiers

Bu-Gi Kang, Jung-Hyun Song, Hyun-Wook Lee (RFHIC)

Solid-state power amplifiers (SSPAs) are increasingly replacing traditional vacuum tubes in modern accelerator RF systems due to their modularity and reliability. For the 150-kW RF system of the Ochang multipurpose synchrotron radiation source, three 50-kW SSPA modules are required, with each 50-kW unit integrating ten 5-kW SSPA modules. In this study, we present the design, fabrication, and high-power verification of a 10-way cavity combiner that successfully scales 5-kW inputs to a 50-kW output while ensuring high isolation and robust fault tolerance.

Unlike conventional Wilkinson combiners, which are susceptible to cascade failures from reflected power during module faults, the proposed 10:1 cylindrical cavity combiner operates in the TM resonant mode to minimize direct coupling between adjacent ports. Fabricated with oxygen-free high thermal conductivity (OFHC) copper and equipped with integrated water-cooling channels for continuous high-power thermal management, the combiner demonstrated excellent small-signal performance at 499.59 MHz: an insertion loss of < 0.11 dB, a phase deviation of ±0.35°, and an isolation of > 20 dB.

High-power continuous wave (CW) testing confirmed stable 50-kW normal operation. To evaluate the fault tolerance essential for accelerator run-time, module failure scenarios were simulated by physically opening one and two input ports. The total output power gracefully degraded to 45.2 kW (1-port open) and 39.0 kW (2-ports open), matching theoretical predictions. Over a 1-week continuous CW run under fault conditions, both temperature and power remained highly stable without causing RF reflection damage to adjacent channels. These results validate the combiner's excellent isolation and reliability. Future work will focus on the full 150-kW system integration and verification under realistic beam-loading conditions.

E-mail: bgkang@rfhic.com

PO – 07

HPRF system for injector section of RAON low-energy superconducting linac

Kyungtae Seol (IBS (Institute of Basic Science))
Sangyoon Bae (IRIS / IBS)
Hyungjin Kim (IRIS / IBS)
Kitaek Son (IRIS / IBS)

The low-energy superconducting linear accelerator (SCL3) constitutes the front-end of the RAON accelerator chain and plays a crucial role in determining the overall beam quality and stability. Beam commissioning of the SCL3, which includes an injector section, quarter-wave resonators (QWRs), and half-wave resonators (HWRs), has been conducted and beam is also being provided to selected users. There are an radio-frequency quadrapole (RFQ) and four rebunchers of the medium-energy beam transporter (MEBT) in the injector section, which are normal conducting cavities of 81.25 MHz. The high-power RF solid-state power amplifiers (SSPAs) for the injector, which are a 150 kW SSPA for the RFQ and 20 kW, 4 kW*2, 15 kW SSPAs for the MEBT, have been operated for the beam operation. The system consists of 5 kW high power amplifiers (HPA), 5 kW high power circulators, high-power combiners, power distribution units, an EPICS controller, and cooling water manifolds. Each 5 kW amplifier is constructed from 1 kW power amplifier modules utilizing LDMOS FETs. This paper presents the details and test results of the high power RF SSPA system for the injector of the SCL3.

This work was supported by the National Research Foundation of Korea (NRF) funded by the Ministry of Science and ICT (2013M7A1A1075764).

E-mail: ktseol@ibs.re.kr

PO – 08

Development and Operation of 4 kW RF Solid State Power Amplifiers for the SCL3 QWR and HWR Cavities of the RAON Heavy Ion Accelerator

Ki taek Son (Institute for Basic Science)
Sangyoon Bae (IRIS / IBS), Hyung Jin Kim (IRIS / IBS)
Kyungtae Seol (IBS (Institute of Basic Science))

The SCL3 superconducting linac of RAON uses QWR cavities at 81.25 MHz and HWR cavities at 162.5 MHz. Each cavity is driven by one 4 kW CW solid-state power amplifier (SSPA). 128 SSPAs were built and installed in the SCL3 gallery, two per 19-inch rack with water cooling. Each SSPA delivers 4 kW CW into any VSWR with more than 50 % efficiency, using four MRF1K50H LDMOS pallets and circulator protection. All units were installed by May 2020 and have supported beam operation since 2023.
This poster shows the development history, the rack and RF structure, and three operation issues with their fixes: particles in the cooling water, circulator water dummy load failure, and control board noise.

E-mail: skt1385@ibs.re.kr

PO – 09

Design and Development of a Nanosecond Electron Gun for Pulse Radiolysis

Jungho Mun (Korea Atomic Energy Research Institute)
Moonsik Chae (Korea Atomic Energy Research Institute)

Jungho Mun, Hoje Kwon, Kyung min Oh, Jae Hyeon Kim, and
Moonsik Chae (KAERI)
Korea Atomic Energy Research Institute
Deadeok-Daero, 989-111, Yuseong-Gu, Deajeon, 305-353, Korea

Pulse radiolysis is a powerful technique for investigating the initial kinetics and mechanisms of radiation-induced chemical and biological reactions by irradiating samples with high-energy ultrashort radiation pulses and observing transient intermediates using time-resolved spectroscopy. This method enables the direct investigation of ultrafast processes on the ns–μs timescale, including electron transfer, radical formation, and decay dynamics, making it an essential tool in radiation chemistry, materials science, and life science research.

At the Advanced Radiation Technology Institute of KAERI (Korea Atomic Energy Research Institute), a short-pulse electron accelerator system for pulse radiolysis experiments is being developed by upgrading an existing electron irradiation accelerator. The objective of this development is to reduce the electron-beam pulse width from approximately 20 μs to below 1 μs, with the ultimate goal of achieving nanosecond-scale pulse operation at an energy of approximately 10 MeV.

A thermionic electron gun employing an EIMAC Y-845 cathode (CPI Inc.) was designed and ``voltages on electron emission characteristics and beam quality were investigated, and the electron gun was optimized for efficient beam extraction and downstream beam transport. Based on the simulation results, fabrication of the electron gun is currently underway. Experimental testing will be conducted to evaluate the electron emission and beam characteristics.

E-mail: jhmun@kaeri.re.kr

PO – 10

First Xenon and Krypton Beam Extraction Results at RAON Using the 14.5 GHz ECR Ion Source

Jeongil Heo, Eunhun Im, Bumsik Park, Sukjin Choi and Inseok Hong
(Institute for Basic Science)

The Supernanogan 14.5 GHz electron cyclotron resonance ion source (ECRIS) has been operated at RAON since 2020 for beamline commissioning and ion beam production. Beam extraction and optimization studies have been performed for protons, deuterons, 16O, 22,20Ne, and 40Ar by varying major operating parameters, and stable conditions for beam delivery have been established. In 2026, xenon and krypton beam extraction experiments were carried out to expand the available ion species and investigate highly charged heavy-ion production. Because natural xenon and krypton contain multiple isotopes and oxygen is used as a support gas, several ion species have similar or overlapping mass-to-charge ratios, resulting in complex beam spectra. In addition, the permanent-magnet configuration of the Supernanogan limits optimization through magnetic-field variation. Therefore, microwave frequency tuning was investigated as an alternative method to modify the ECR resonance condition under a fixed magnetic field. This paper presents the xenon and krypton beam extraction results and discusses the effects of microwave frequency on beam current and charge-state distribution, together with future optimization strategies.

E-mail: jiheo@ibs.re.kr

PO – 11

Development of a Multichannel Electron Fluence Measurement System for Radiation Hardness Evaluation of Space Solar Cells

Huisu Kim (Korea Atomic Energy Research Institute)
Youn-Mook Lim (Korea Atomic Energy Research Institute)),
Byungnam Kim (Korea Atomic Energy Research Institute)),
Junyoung Kang (Advanced Radiation Technology Institute (ARTI), Korea Atomic Energy Research Institute (KAERI)),
Jin-Mun Yun (Korea Atomic Energy Research Institute)

A multichannel electron fluence measurement system was developed for integration with a 1–2.5 MeV DC electron accelerator to support radiation hardness evaluation of space solar cells.
The system uses six aluminum rods as charge collectors and a National Instruments data acquisition system to acquire voltage signals. LabVIEW-based software implements signal correction, current integration, and electron fluence calculation using the integrated charge and the corresponding collection area.
Enclosure temperature monitoring, beam dump control, and data logging were integrated into the system. An eight-hour continuous software operation test confirmed stable data logging and consistent processing intervals.
The system provides a basis for monitoring electron fluence during solar-cell irradiation. Future work will include calibration at different electron energies and evaluation of electrical characteristics before and after irradiation to support analysis in terms of 1 MeV equivalent electron fluence.

E-mail: huisukim8563@kaeri.re.kr

PO – 12

A Method for Reconstructing Historical Accelerator Alignment Network Data Using SpatialAnalyzer

Dae-Il Kim (KOMAC, KAERI)

Accurate alignment and long-term position management of accelerator components require the continuous utilization of survey network data accumulated during accelerator construction and operation. At KOMAC, Axyz software was used for accelerator alignment and surveying from 2012 to 2018, and network measurement data were accumulated during this period. However, differences in data structures and measurement information between Axyz and SpatialAnalyzer (SA), which is currently used for alignment and survey analysis, make it difficult to directly utilize these historical data in the current analysis environment. The existing Axyz data do not explicitly contain the laser tracker positions for individual measurement stations. Therefore, the historical laser tracker positions were calculated using the coordinates and measurement information of common reference points contained in the measurement data. The calculated tracker positions and the original measurement data were then converted into a format compatible with SpatialAnalyzer and implemented in the SA Simulator. Subsequently, the data analysis tools in SpatialAnalyzer were used to establish an analysis procedure for reconstructing the historical alignment network and generating network data from the archived measurements. In this paper, a data conversion and processing method for reconstructing and analyzing historical Axyz network measurement data in the SpatialAnalyzer environment is presented.

* This work has been supported through KOMAC operation fund of KAERI by Ministry of Science and ICT, the Korean government (KAERI ID no. : 524320-26)

E-mail: dikim@kaeri.re.kr

PO – 13

Analysis of Cavity Higher-Order Modes (HOMs) and Beam Instabilities in an S-band Pulsed Klystron

Sung-Ju Park (PAL)

The resonant-cavity higher-order modes (HOMs) of the S-band pulsed klystron used in the PAL linear accelerator are surveyed by eigenmode analysis, S-parameter analysis, beam-based measurement (BBM) by particle-in-cell (PIC) simulation, and full-structure PIC simulation, and the possibility of beam instabilities, including beam break-up (BBU), is evaluated. The fundamental of each cavity is identified as a TM010-like monopole and the lowest deflecting mode as a TM110-like dipole (the BBU candidate); the measured BBM peaks agree with the eigenmode values to within 0.3% ($\Delta f \leq 9$ MHz). Comparing the BBM-based HOM frequencies against the electron-beam bunching harmonic and sideband lines yields no coincidence within $|\Delta f| \leq 10$ MHz; the near-match (10 -50 MHz) modes are limited to two cases, cav3 M6/M7 (6127.7 MHz ↔ 2f0+fq) and cav4 M4/M5 (5352.6 MHz ↔ 2f0−fq). For these, a convective amplification chain − sideband drive → detuned response → transverse kick → transport in the solenoidal focusing field → downstream re-drive − is evaluated quantitatively; even with conservative representative values the excitation is transferred at most once (between the near-degenerate cav3-cav4 pair) and cannot be re-established at the output cavity, and the impact on the output-RF amplitude and phase is bounded below −55 dBc. It was found that the BBU-relevant TM110 dipoles sit in a spectral gap at least 462 MHz away from the bunching lines and lie below the beam-tube cutoff, trapped in their home cavities. For the above-cutoff closed-loop candidate, the cav3-cav4 M6/M7 pair near 6.15 GHz, a state-consistent complex loop-transfer formulation and a direct procedure for evaluating the backward modal transfer are presented. PIC simulations with full rf pulse length (4 μs) run shows no phase-locked or exponentially growing component at the cav3/cav4 frequencies and no temporal runaway.

E-mail: sjpark@postech.ac.kr

PO – 14

Higher-Order-Mode Coupling for Plasma Processing of a RAON Single-Spoke Resonator

Junsik Kim[1], Muhyeop Cha[1], Yoo-Lim Cheon[2], Kyoung-Jae Chung[1]*
[1]Department of Nuclear Engineering, Seoul National University
[2]Institute for Rare Isotope Science, Institute for Basic Science.
*Corresponding author: jkjlsh1@snu.ac.kr

Plasma processing is an in-situ method for removing hydrocarbon contaminants from the niobium surfaces of superconducting radio-frequency (SRF) cavities. However, the fundamental power coupler of the RAON single-spoke resonator (SSR) has significant impedance mismatch at room temperature for the fundamental mode (325 MHz) making efficient plasma ignition challenging. Recent studies have demonstrated that higher-order modes (HOMs) with stronger RF coupling can ignite plasma in the cavity with lower input RF power. In this work, we investigate suitable HOMs of the RAON SSR for plasma processing. The resonant frequencies, coupling coefficients, and electric-field distributions of candidate HOMs were calculated using CST Microwave Studio, and RF measurements were conducted using a vector network analyzer (VNA) for comparison. The simulated and measured resonant frequencies and coupling coefficients are compared to identify suitable HOMs for plasma processing in the SSR cavity. In addition, RF power will be applied to the selected HOMs to experimentally determine the input power threshold required for plasma ignition.

E-mail: junkim@snu.ac.kr

PO – 15

Progress of the Vacuum System for the High-Energy Linear Accelerator Section in RAON

Myung Ook Hyun (Rare Isotope Science Project / IBS)
Sukjin Choi (IBS)
Hyungjoo SON (Institute for Basic Science)

At the end of the 2020, the Rare Isotope Science Project (RISP, currently IRIS) in the Institute for Basic Science (IBS), Daejeon, South Korea, decided to divide the construction of superconducting (SC) linear accelerator (linac) system into two regions, the low-energy (SCL3) and the high-energy (SCL2) SC linac. Now, SCL3 construction was finished by the end of 2022 and low-energy beam experiments were supplied properly. And the SCL2 is now preparing for the construction, evaluating SC cavity prototypes. This paper explains about the progress of the vacuum system for the SCL2, including assembly process and inspection.

E-mail: atikus43@ibs.re.kr

PO – 16

Current Progress in the Design of a Superconducting RF Cavity for EUV Energy Recovery Linacs

Minseo Jung (Pohang University of Science and Technology)

An energy recovery linac (ERL) is a type of accelerator in which the energy of an electron bunch is recovered through deceleration in the linac after radiation generation. This energy recovery makes the ERL highly energy-efficient while maintaining high beam current and superior beam quality. Owing to these advantages, ERLs are promising light sources for extreme ultraviolet (EUV) photolithography.

EUV photolithography is an important procedure for semiconductor fabrication. An EUV-ERL can produce higher EUV power than conventional lithography method, and is more cost-efficient for both construction and maintenance. Due to these benefits, EUV-ERLs can be an attractive candidate for next generation light sources for lithography.

Superconducting RF cavities are key elements for efficient energy recovery. To design the superconducting cavity, several factors for both fundamental and higher-order modes (HOMs) should be optimized simultaneously to prevent quenching, field emission, or beam breakup (BBU) instability.

In this study, we report on the recent progress in the design of a 7-cell L-band (1.3 GHz) superconducting cavity for EUV-ERLs. A multi-objective Bayesian optimization (MOBO) was employed to enhance the cavity performance at the fundamental mode by tuning the geometry of both end cells. After the process, the end cell was optimized for minimization of shunt impedance of HOMs. Furthermore, the dimensions and positions of the beamline absorber and hook coupler were optimized for effective HOM damping.

E-mail: msjeong@postech.ac.kr

PO – 17

Design and Eddy-Current Shielding Analysis of the In-Vacuum Thin Septum Magnet for KLS

Seohyeon An (Pohang Accelerator Laboratory)
Geon Hee Choi (Korea Basic Science Institute)
Garam Hahn (Kangwon Nat'l Univ.)
Beom Jun Kim (Pohang Accelerator Laboratory)
Dong-Eon Kim (Pohang Accelerator Laboratory)

An in-vacuum thin septum magnet (BTSTNS) is being developed for off-axis injection into the 4 GeV storage ring of the Korea Light Source (KLS). The eddy-current magnet has a 1 mm copper septum blade, a 13 mm gap, and a 0.5 m laminated core, designed to produce 0.667 T with a 6.9 kA, 16.7 μs half-sine pulse at 2 Hz. Three features dominate its design: the short pulse, the proximity of the stored beam to the blade, and the ultra-high-vacuum environment. So that the flux fully penetrates each lamination within the pulse ($t/2\delta \approx 0.8$ at the equivalent frequency of 30 kHz), 0.1 mm silicon-steel laminations with inorganic insulation are selected. Two-dimensional transient eddy-current simulations, including the conducting enclosure and aluminum beam chamber, predict a peak gap field of 0.677 T, approximately 1.5% above the design value. In the baseline model, the leakage field at the stored beam peaks about 40 μs after the pulse starts, reaching several millitesla, with a decay tail extending over tens of milliseconds. Replacing 0.2–0.4 mm of copper on the stored-beam side of the blade with a high-permeability sheet, within the 1 mm blade envelope, reduces the peak leakage by more than two orders of magnitude in the linear model, but lengthens the decay tail. Eddy currents concentrate the flux near the sheet surface, where saturation may limit the shielding performance. This effect requires further evaluation with a nonlinear model. The copper coating needed on the beam-facing surface and a candidate fabrication route for the laminated core, using die-punching and adhesive-free stacking, are also discussed.

E-mail: ash0425@postech.ac.kr

PO – 18

Coupler Tuning of an HEM_{11} Transverse Deflecting Cavity: Effect of Shorting-Plunger Position

Geunwoo Kim (POSTECH)
Moses Chung (POSTECH)
KwangHoon Kim (Pohang Accelerator Laboratory)
Yong-jung Park (Pohang Accelerator Laboratory)
Chang-Ki Min (Pohang accelerator laboratory)

An HEM_{11} transverse deflecting cavity (TDC) maps bunch arrival time to transverse position for longitudinal beam diagnostics. Manufacturing tolerances motivate low-power input-coupler tuning before high-power conditioning. A conventional input-coupler tuning method, known as the Kyhl method, compares the input reflection phases obtained by successively shorting the coupler cell and the adjacent cell at their centers, treating each detuned state as an effective termination. However, for the 11-cell S-band HEM_{11} TDC studied here, cell-centered shorting does not reproduce the matched-coupler phase relation at the $2\pi/3$ operating frequency. An analysis based on Slater's perturbation theorem predicts a larger response to a small metallic perturbation near the iris than at the cell center. Indeed, CST simulations of the inserted plunger show stronger field distortion at the iris. Therefore, we move the two shorting positions to adjacent iris centers while retaining the Kyhl phase comparison. Driven simulations performed with CST Studio Suite yield reflection phases of 61.98°, -3.28°, and -64.93° at the $2\pi/3$, midpoint, and $\pi/2$ reference frequencies, respectively, which closely match the target values of 60°, 0°, and -60°. CST simulations further give midpoint-frequency phase separations of 88.5° and 161.2° for cell- and iris-centered shorting, respectively; the latter is closer to the 180° target. Taken together, the simulated phase responses indicate that iris-centered shorting provides a more suitable Kyhl tuning reference for the investigated HEM_{11} cavity.

E-mail: geunwoo@postech.ac.kr

PO – 19

Magnetic Characterization of KLS Storage Ring Prototype Magnets Using a PCB Rotating-Coil System

Seohyeon An (Pohang Accelerator Laboratory)
Yoon Geol Choi (Pohang Accelerator Laboratory)
Young Gyu Jung (Pohang Accelerator Laboratory)
Beom Jun Kim (Pohang Accelerator Laboratory)
Dong Eon Kim (Pohang Accelerator Laboratory)
Min Jae Kim (Pohang Accelerator Laboratory)
Seungcheol Lee (Pohang Accelerator Laboratory)
Woul Woo Lee (Pohang Accelerator Laboratory)

Pohang Accelerator Laboratory (PAL) has performed magnetic measurements of eleven prototype magnet types for the Korea Light Source (KLS) storage ring using a printed circuit board (PCB) rotating-coil system. The magnets comprise five quadrupoles (Q11, Q12, Q31, Q32, and Q51), three sextupoles (S31, S32, and S33), one octupole (O31), and two combined-function dipole-quadrupoles (DQ31 and DQ32). Measurements characterized excitation curves, integrated multipole coefficients, and higher-order harmonic content over a range of excitation currents. Repeatability was evaluated using 10 repeated measurements per magnet. The relative standard deviation of the principal multipole coefficient ranged from 3.5×10^{-6} to 1.7×10^{-4}, with the quadrupole coefficient used for the combined-function magnets. Additional measurements examined the multipole response to auxiliary trim-coil excitation where available. This poster presents the measurement approach, excitation characteristics, harmonic spectra, and repeatability results across the eleven magnet types. These results provide a basis for refining magnetic measurement procedures and supporting quality verification of subsequent production magnets for the KLS storage ring

E-mail: ygchoi@postech.ac.kr

PO – 20

Magnetic Field Measurement Results of Center Bend Magnets for Korea Light Source

Seungcheol Lee (Pohang Accelerator Laboratory)
Seohyeon An (Pohang Accelerator Laboratory)
Yoon Geol Choi (Pohang Accelerator Laboratory)
Young Gyu Jung (Pohang Accelerator Laboratory)
Beom Jun Kim (Pohang Accelerator Laboratory)
Dong-Eon Kim (Pohang Accelerator Laboratory)
Min Jae Kim (Pohang Accelerator Laboratory)
Woul Woo Lee (Pohang Accelerator Laboratory)

The Center Bend Magnet (CBM) in the Korea Light Source (KLS) storage ring bends the electron beam trajectory and serves as a source of synchrotron radiation. This study presents the magnetic field characterization of CBMs, focusing on field quality and consistency among magnets. Hall probe measurements were used to evaluate magnetic field centers, excitation characteristics, integrated magnetic fields, effective magnetic lengths, and transverse field uniformity. Variations in magnetic field centers and integrated magnetic fields were quantified across the magnets, and magnetic saturation near the nominal operating current was analyzed. Repeated measurements under identical conditions were conducted to evaluate repeatability. All CBMs satisfied the transverse field uniformity requirement within the good field region specified in the Technical Design Report. These results provide a quantitative basis for assessing magnet fabrication quality and supporting installation and operation in the KLS storage ring.

E-mail: sclee@postech.ac.kr

PO – 21

Optimization of Acceleration Electrode Geometry for Spatially Controlled Ion Beam Extraction in a Three-Electrode System

Jiseong Nam (Seoul National University)
Kyoung-Jae Chung (Seoul national university)

A three-electrode ion beam extraction system is widely used in precision surface treatment and ion beam etching because it allows independent control of ion beam energy and focusing characteristics. Electrode geometry is a key factor in beam performance because it determines the electric-field distribution, which governs both the plasma meniscus and extracted ion trajectories. However, conventional electrode geometry optimization is generally limited to a predefined geometric parameter, such as electrode thickness, tilt angle, and aperture size. In this study, we use axisymmetric ion beam simulations to optimize the acceleration electrode geometry by treating its boundary coordinates as design variables to achieve a target focal position and beam radius. Stepwise optimization is also conducted to analyze how different regions of the acceleration electrode influence beam focusing. The proposed approach enables direct determination of electrode geometry from target beam characteristics without relying on predefined geometric parameters.

E-mail: sungasunny@snu.ac.kr

PO – 22

Design Study of a Plasma Flood Gun for Beam Neutralization Applications

Bohyun Chung, Soobin Lim, Seok Kwan Lee, Seung Jeong Noh, Bongki Jung
(Q-Beam Solution Inc.)

High-current ion beams may experience increased beam divergence and degraded transport performance due to space-charge effects during their transport. Electron-supply-based beam neutralization has been widely considered as an effective approach to mitigate these effects, and a plasma flood gun (PFG) has attracted attention as a device capable of generating and supplying low-energy electrons to the beamline.

In this study, a design study of a PFG for beam neutralization applications was conducted. The PFG was proposed to generate electrons through plasma discharge and supply them to the beam transport region. Furthermore, its applicability as an electron source for future beam neutralization studies was investigated. Key design parameters, including the plasma generation method, electron extraction structure, installation configuration and operating conditions, were considered to establish the conceptual design of the system.

In addition, diagnostic approaches for evaluating electron supply characteristics and beam transport behavior were reviewed. Measurement methods for analyzing the interaction between the supplied electrons and the beam, which would serve as a basis for future performance evaluation and neutralization studies, were considered.

This work focuses on the conceptual design and feasibility assessment of a PFG before experimental performance verification. The results are expected to provide fundamental information for future studies on beam neutralization and charged-particle beam transport.

This work was supported by the National Research Foundation of Korea(NRF) grant funded by the Korea government(MSIT) (No. RS-2026-25546768).

E-mail: infoh@qbeamsol.com

PO – 23

Improvement of RFQ Vane Cooling-Channel Machining through Machining Sequence Modification

Kyunghyun Kim (KOMAC,KAERI)
Han Sung Kim (KOMAC,KAERI)
Hyeok-Jung Kwon (KOMAC,KAERI)

Reliable machining of internal cooling channels is essential for fabricating radio-frequency quadrupole (RFQ) vanes. This study presents a machining sequence modification implemented during the fabrication of a 350 MHz four-vane RFQ at the Korea Multi-purpose Accelerator Complex (KOMAC). In the original sequence, rough machining of the copper vanes preceded cooling-channel gun drilling. The cooling channels were located close to the inner vacuum surface, leaving a thin wall between the intended drilling path and this surface after rough machining. Gun drilling proceeded from both ends to a depth of approximately 55 cm from each end. Inspection revealed that a cooling channel had broken through the inner vacuum surface. As drilling progressed, the drill tip was suspected to deviate toward the thin-wall region, ultimately causing breakthrough. To address this problem, the machining sequence was revised to perform gun drilling on the copper blanks before rough machining, retaining more material around the drilling path. No cooling-channel breakthrough was observed in the vanes fabricated using the revised sequence, and subsequent rough machining was completed successfully. RFQ fabrication, including section brazing, was subsequently completed, and preparations for commissioning are underway. These results demonstrate the effectiveness of the revised machining sequence in preventing the observed breakthrough defect during RFQ vane fabrication.

E-mail: kimkh@kaeri.re.kr

PO – 24

Design Considerations of Pre-Bunching System at RAON LEBT

Jangwon Kwon (IRIS / IBS)
Dong Hyun Kwak (Korea Atomic Energy Research Institute)
Sungjune Lee (korea university)
SeokHo Moon (KAERI)

RAON is a heavy-ion accelerator facility that delivers various ion beams to low-energy experimental systems. A pre-bunching system consisting of a fast chopper and a double-gap buncher (DGB) reduces the beam repetition rate and bunch length for time-of-flight experiments. The system is designed for ion beams with A/q from 1 to 7 and repetition rates from 200 kHz to 2.03125 MHz. A two-channel function generator synchronized to a 10 MHz reference provides the DGB RF signal and the fast-chopper gate. The DGB signal passes through an RF amplifier, directional coupler, and helical LC tank with variable capacitance. Offline tests produced up to 6.1 kVpp at the DGB electrode. The maximum chopper frequency is evaluated from the capacitive load, switching voltage, pulser power, and HVPS current. A six-channel oscilloscope monitors the RF, chopper, timing, and beam signals. This poster presents the system configuration and design considerations for operation with various ion species.

E-mail: jwkwon@ibs.re.kr

PO – 25

Magnetic Field Simulation of the Magnet System for the Backup ECR Ion Source at IRIS

Bum-Sik Park (IBS)
Jeongil Heo (Institute for basic science)
Eunhun Im (Institute for Basic Science)
Sukjin Choi (IBS)
In-Seok Hong (Institute fo Basic Science)

A new electron cyclotron resonance (ECR) ion source is under development at the Institute for Rare Isotope Science (IRIS) to improve accelerator availability and reliability by serving as a backup for the existing 14.5 GHz ECR ion source. The new ion source will utilize a magnet system previously fabricated under a separate R&D program. However, a numerical model for evaluating its magnetic field characteristics is not currently available. In this study, a three-dimensional magnetic field model was developed to investigate the magnetic field distribution of the magnet system. The magnetic fields generated by the superconducting solenoid coils and permanent hexapole magnets were calculated. The simulation results were compared with measured magnetic field data to evaluate the accuracy of the model. The developed model is expected to provide a useful basis for evaluating magnetic field configurations and establishing operating conditions for the backup ECR ion source at IRIS.

This work was supported by the Rare Isotope Science Project of Institute for Basic Science funded by Ministry of Science and ICT and NRF of Korea (2013M7A1A1075764)

E-mail: bspark@ibs.re.kr

PO – 26

Dimensional Sensitivity and Tuning Strategy for Stop-Band Closure in a Compact C-band On-Axis Coupled Linac

Pikad Buaphad*, Wung-Hoa Park, Sang Jin Lee, Dong Hyeok Jeong, Heuijin Lim, Hyun Kim, Sang Koo Kang, Kyoung Won Jang and Manwoo Lee
Research center, Dongnam Institute of Radiological and Medical Sciences, Busan 46033, Korea

We previously reported on the sensitivity of the accelerating-cell (ACA) resonance to dimensional tolerances in the compact C-band (5712 MHz) electron linear accelerator under development at DIRAMS. In an on-axis coupled structure, however, the π/2-mode frequencies of the accelerating cell (fa) and the coupling cell (fc) must be equal to close the stop band in the dispersion curve. This work therefore extends the analysis to the coupling cell (CAC). According to a CST sensitivity study of the unit cell, fa is governed primarily by the accelerating-cell radius (Ra) and nose length (g) (−0.267 and −0.249 MHz/μm), whereas fc is governed by the coupling-cell length (Lc), coupling-cell radius (Rc), and coupling-slot width (Hs) (+0.262, −0.228, and −0.195 MHz/μm). Guided by this study, the fabricated unit cells were dimensionally profiled by laser triangulation and cold-tested in both ACA and CAC configurations. The measured ACA π/2-mode frequency agreed with simulation to within 0.4 ± 0.7 MHz, whereas the measured CAC π/2-mode frequency was 8.3 ± 0.9 MHz lower than simulated. This mismatch is attributed not to fabrication error but to a gap between the cavity plate and the end plate. With the measured gap included in the model, the simulated and measured CAC frequencies of the prototype cavities agreed closely. Based on these findings, we propose a tuning sequence that brings fa and fc into coincidence. (This work was supported by the DIRAMS grant funded by the Korea government (MSIT) under grant 50704-2026.)

Keywords: C-band linac, On-axis coupled structure, Stop band, Cold test, Frequency tuning, Sensitivity analysis, CST simulation

Email: buappika86@dirams.re.kr

Fax: +82-51-720-5397

PO – 27

Development of a Statistical Tool for Accelerator Downtime Analysis

Nam-Hoon Lee, Sung-Youn Cho, Ji-Hwan Ma, Dae-Il Kim, Sang-Pil Yun, Hyeok-Jung Kwon
Korea Multi-purpose Acclerator Complex,
Korea Atomic Energy Research Institute

Downtime during accelerator operation is a major factor that reduces machine availability and affects stable accelerator operation. Therefore, Tracking of downtime events and analyze the causes are important for maximizing machine availability. In this study, a statistical tool based on historical downtime records collected during accelerator operation. The tool provides weekly and monthly statistics and trends of downtime to be analyzed for individual equipment. In addition, detailed information, including the cause of each event, problem resolution and relevant data, can be recorded for each downtime event. These records can be used when the same or similar faults, supporting fast problem resolution. This paper presents the developed tool provides an effective means of fault tracking, helping to identify recurring problems and weaknesses in accelerator systems and supporting maintenance and operational improvements.

This work was supported through the KOMAC operation fund of KAERI by Korean government (MSIT, KAERI ID:524320-26)

E-mail: nhl@kaeri.re.kr

PO – 28

Recent Progress in Geodetic Survey and Precision Alignment Activities at RAON

Jongdae Joo (Institute for Rare Isotope Science, Institute for Basic Science)
Jaehyun Cho (Institute for Rare Isotope Science, Institute for Basic Science)
Changseog Seo (Institute for Rare Isotope Science, Institute for Basic Science)
Myung Ook Hyun (Institute for Rare Isotope Science, Institute for Basic Science)
Hyungjoo Son (Institute for Rare Isotope Science, Institute for Basic Science)
Sukjin Choi (Institute for Rare Isotope Science, Institute for Basic Science)

With the low-energy linac SCL3 and the ISOL facility now in routine operation, survey and alignment work at RAON has to fit into brief shutdowns, and responsibility for the reference network is moving from an external contractor to the in-house team. This poster reviews the current state of that work, from the facility network down to individual beamline components. The survey control network, consisting of about 700 floor and 500 wall monuments, was set up in 2019 and re-observed every year through 2023. To streamline the network update, the measurement procedure is being refined by optimizing the instrument station layout, comparing combinations of instruments, and studying vibration in the accelerator tunnel. On the component side, the alignment of the cyclotron and the ISOL beamline devices was measured with respect to the survey network. Devices outside tolerance were realigned, and the remaining realignment of the cyclotron and its beamline, scheduled for October 2026, will be reported in this poster. Open issues and the planned in-house procedure are also discussed.

E-mail: joojd@ibs.re.kr

PO – 29

Action-Based Framework for RF Power Loss in Superconducting Cavities

Heetae Kim (IBS)
Juwan Kim (IBS)

RF power loss in superconducting RF cavities can be described by combining an action-based formulation of the electromagnetic field and superconducting condensate with dissipative mechanisms. This work develops such a framework for 325 MHz niobium single-spoke resonators. The conservative action describes superconducting screening and electromagnetic energy storage, while dissipative contributions represent quasiparticle losses, residual resistance, trapped magnetic flux, and other RF loss mechanisms. The measured Q0-Eacc behavior of SSR2 cavities is used to interpret the evolution of effective RF surface loss with accelerating field. This framework provides a unified connection between superconducting electrodynamics, surface resistance, RF power dissipation, and experimentally observed cavity performance.

E-mail: kimht7@ibs.re.kr

PO – 30

Component-Level Static Thermal Load Analysis of Prototype SSR2 Cryomodule for RAON

Seojeong Kim, Giyeol Han, Yongkwon Kim (Institute for Basic Science)

This study presents a comprehensive component-level analysis of the static thermal loads in the Prototype SSR2 cryomodule for RAON. Conductive heat transfer was evaluated for individual cryomodule components at three operating temperature levels of 2 K, 5 K, and 50 K. In addition, internal radiative heat transfer was considered for components with opposing surfaces, including bellows, flanges, and superconducting cavities. Component-specific boundary conditions were established based on the thermal anchor temperatures along the corresponding heat transfer paths, and numerical simulations were performed using the ANSYS Steady-State Thermal module. The calculated thermal loads were integrated to determine the total static heat loads at each temperature level, and the contributions of individual components were quantitatively compared. The dominant heat leak paths were identified, and the relative contributions of conductive and radiative heat transfer were evaluated to characterize the thermal load distribution within the cryomodule. These results provide a detailed understanding of the static thermal load characteristics of the SSR2 cryomodule and establish a quantitative basis for evaluating its thermal design, cryogenic cooling requirements and the minimum required intrinsic quality factor (Q0) of the superconducting cavities.

E-mail: jinlx@ibs.re.kr

PO – 31

Modeling and Simulation of a Triode Electron Gun with a Hot Cathode for Medical and Industrial Electron Accelerators

Sang Koo Kang, Manwoo Lee, Sang Jin Lee, Pikad Buaphad, Wung-Hoa Park, Hyun Kim, Kyoung Won Jang, Dong Hyeok Jeong and Heuijin Lim*
(Dongnam Institute of Radiological & Medical Sciences)

The design and thermal analysis of a high-power triode electron gun for medical and industrial electron accelerators were conducted. The electron gun incorporates a dispenser cathode, and the electrode configuration was designed to achieve the required beam characteristics. Particle simulations accounting for space-charge effects were then performed to investigate the electron beam behavior and optimize the electrode geometry with respect to beam current, beam diameter, beam envelope, and waist position. In addition, thermal analysis was performed considering heat transfer through conduction, thermal radiation, and external convection under operating conditions. In particular, the temperature distributions of the electrodes surrounding the cathode and the heat-shield structures were analyzed to evaluate the thermal stability and structural suitability of the electron gun. The results of this study provide a technical basis for the engineering design and fabrication of high-power triode electron guns.

This research was supported by the FLASH: one second radiation therapy funded by Korea Research Institute of Standards and Science (KRISS – 2026 – KP2026 – 0003(DIRAMS 51512-2026).

E-mail: heuijin@dirams.re.kr

PO – 32

Experimental Modal Analysis and Vibration Amplification Assessment of a KLS Storage Ring Girder with Simulated Magnet Loading

Juhwan Yoon (Pohang University of Science and Technology)
Moses Chung (POSTECH)
Taekyun Ha (Pohang Accelerator Laboratory)
Gwang-Wook Hong (Pohang Accelerator Laboratory)
Jeongyeong Kim (Pohang Accelerator Laboratory)

The Korea Light Source (KLS) storage ring requires a mechanically stable girder structure to maintain precise magnet alignment and support stable operation with micrometer-scale electron beam sizes. Experimental modal analysis (EMA) is an effective method for characterizing structural dynamics by identifying natural frequencies, damping ratios, and vibration modes. However, previous modal measurements of the KLS prototype girder were limited to its bare configuration, leaving the dynamic characteristics under magnet loading experimentally uncharacterized. This study proposes an impact-test-based EMA of the prototype girder equipped with dummy masses representing the magnet loading conditions. An instrumented impact hammer, accelerometers, and a synchronized data acquisition system will be used to measure excitation forces and vibration responses at selected locations and directions on the girder. Frequency response functions (FRFs) will be assessed to identify dominant natural frequencies, damping ratios, and representative vibration modes within the limitations of the measurement configuration. In addition, a floor-induced vibration amplification test will be conducted to investigate vibration transmission from the supporting floor to the girder system. Hammer impacts applied to the adjacent floor will generate vibration responses, which will be measured simultaneously at the floor reference locations, girder supports, girder structure, and dummy masses. Frequency-dependent response ratios at selected girder locations relative to the floor reference will be evaluated to investigate vibration transmission and amplification under the applied floor-impact excitation.

The results are expected to provide experimental data on the modal characteristics and vibration transmission behavior of the girder under simulated magnet loading. These findings will serve as a basis for subsequent assessments of mechanical stability and magnet vibration in the KLS storage ring.

E-mail: yoonics@postech.ac.kr

PO – 33

Magnetic Tuning of a Longitudinal Gradient Bending Magnet for the Korea Light Source

Jongmo Hwang (Korea Basic Science Institute, Phoang Accelerator Laboratory)
Dong-Eon Kim (Phoang Accelerator Laboratory)
Seohyeon An (Phoang Accelerator Laboratory)
Seungcheol Lee (Phoang Accelerator Laboratory)
Bumjun Kim (Phoang Accelerator Laboratory)

For a longitudinal gradient bending magnet (LGBM), matching the total bending strength does not fully assess the condition of the magnet since the gradient of the magnet is different along the beam path. The longitudinal distribution of the magnetic field along the modules must also be controlled. This study presents a measurement and tuning strategy for the LGBM2 of the Korea Light Source (KLS), using the bending angle and apex position as simultaneous adjustment targets. The apex is defined by the intersection of the extended outgoing trajectories, and both targets are evaluated from the first and second integrals of measured field profiles. Experimentally determined responses of tuning bolts distributed across five Sm_2Co_{17} modules are combined to select mechanical settings, which are refined through repeated field measurements.
This approach translates trajectory requirements into local magnetic corrections. To maintain consistent measurement conditions, Hall-probe measurements are calibrated against nuclear magnetic resonance measurements. The study establishes a systematic procedure for adjusting both bending strength and longitudinal field distribution before installation of permanent magnet base LGBM in a storage ring.

E-mail: hjm1137@kbsi.re.kr

PO – 34

Preliminary Characterization of Orientation-Dependent Mechanical and Microstructural Properties of Niobium Sheets for SRF Cavities

Jangwon Han, Eunsol Go, Giyeol Han, Youngkwon Kim
Institute for Rare Isotope Science, Institute for Basic Science,
Daejeon 34000, Korea

Niobium (Nb) is widely used in superconducting radio-frequency (SRF) cavities owing to its excellent superconducting properties. Buffered chemical polishing (BCP) is commonly employed to remove surface layers and prepare Nb cavity surfaces. However, non-uniform material removal can occur during chemical surface treatment, motivating further investigation into the intrinsic material characteristics that may influence surface processing behavior. In this study, Nb sheet specimens extracted along the longitudinal, diagonal, and transverse directions are investigated to characterize their orientation-dependent mechanical properties and microstructural features. Tensile testing is performed to evaluate the mechanical response of the specimens, while microstructural and crystallographic analyses are conducted to characterize grain morphology and crystallographic orientation. The relationships between specimen orientation, mechanical behavior, and microstructural characteristics are then examined to identify potential sources of material anisotropy. The findings are expected to provide a fundamental basis for future studies investigating the relationship between the intrinsic characteristics of Nb sheets and material removal behavior during BCP processing for SRF cavity applications.

E-mail: khanjw85@ibs.re.kr

PO – 35

Enhancing the Robustness of FPGA-Based Frequency-Sweep Control for Pulse-Droop Compensation in the KAERI Proton Linac HVCM

Haeseong Jeong (KOMAC/KAERI)
Han Sung Kim (KOMAC/KAERI)
Hyeok-Jung Kwon (KOMAC/KAERI)
Young-Gi Song (KOMAC/KAERI)

The 100-MeV proton linear accelerator at the Korea Multi-purpose Accelerator Complex (KOMAC) of the Korea Atomic Energy Research Institute (KAERI) employs a High Voltage Converter Modulator (HVCM) to generate high-voltage pulses for accelerator operation. The HVCM comprises three interleaved full-bridge inverter phases, designated as A, B, and C. Phase A serves as the timing reference for frequency-sweep control, while phases B and C maintain predefined timing relationships relative to phase A.

Frequency-sweep control compensates for voltage droop during the HVCM output pulse. However, asynchronous frequency-selection commands may be applied during an active switching cycle, causing inconsistent gate timing among the interleaved phases. This issue is particularly relevant during the transition from the pulse-rise overshoot-suppression interval to normal frequency-sweep operation.

In this work, the frequency-sweep control logic of a domestically developed HVCM controller was improved using VHDL. External frequency-selection signals were synchronized with the system clock and filtered to reject short transient changes. The switching-frequency and associated phase settings were updated together only at a predefined boundary marking the start of a complete phase-A switching cycle. This approach coordinates frequency changes across the three interleaved phases while preserving the existing pulse-rise overshoot-suppression sequence.

The revised VHDL logic was verified through logic synthesis and implemented in the domestically developed controller of the M04 HVCM, which is currently in operation. Operational results confirmed a stable transition to frequency-sweep operation without the previously observed gate-timing disturbance. These results demonstrate a practical improvement in the timing consistency and operational robustness of HVCM frequency-sweep control.

E-mail: myihahaha@gmil.com

PO – 36

Design of Automated Heater Startup and Activation Sequencing for 350 MHz Klystrons at the Korea Multi-purpose Accelerator Complex (KOMAC)

Jongin Wang
(KOMAC, Korea Atomic Energy Research Institute, Gyeongju 38180, Korea)
Hae-sung Jung
(KOMAC, Korea Atomic Energy Research Institute, Gyeongju 38180, Korea)
Young-Gi Song
(KOMAC, Korea Atomic Energy Research Institute, Gyeongju 38180, Korea)
Han-Sung Kim
(KOMAC, Korea Atomic Energy Research Institute, Gyeongju 38180, Korea)
Hyeok-Jung Kwon
(KOMAC, Korea Atomic Energy Research Institute, Gyeongju 38180, Korea)

Reliable klystron startup requires controlled cathode warm-up and verification of vacuum, cooling, and focusing magnet systems. Manual operation across multiple tubes creates repetitive workloads and challenges in maintaining consistent startup and recovery procedures. We present the design of KHAN (Klystron Heating and Activation Nexus), an automation framework for nine 350 MHz E37621 klystrons in a proton linac. The proposed design couples existing variable autotransformers to closed-loop stepper motors and incorporates a three-stage heater ramp with individually configurable voltage increments, current limits, and settling intervals. Voltage and current measurements, together with independent position feedback, determine conditions for cathode heating and subsequent warm-up process. The monitoring scheme covers thermocouple signals, currents from two ion pumps, and operating parameters of three focusing magnet power supplies. Explicit operating states coordinate initial startup, standby-to-operation transitions, prescribed warm-up, magnet activation, controlled shutdown, and recovery after an interlock trip. Restart decisions use heater power continuity and warm-up history, while fault reset remains separate from permission to restore power. The control architecture separates fast protective actions from slower sequencing and EPICS supervisory functions, with response-time requirements derived from the manufacturer's protection modes. The proposed operating algorithms and system configuration provide a structured basis for reproducible klystron operation and traceable fault recovery. Future work will include fabrication, bench testing, and subsequent in situ commissioning to evaluate protection response times and operational performance.

E-mail: jwang@kaeri.re.kr

PO – 37

Development and Performance Evaluation of the RF and Event Timing System for the PAL-EUV Accelerator

Kook-Jin Moon (Pohang Accelerator Laboratory)
Jun Ho Ko (PAL, POSTECH)
MINWOO KIM (POHANG ACCELERATOR LABORATORY)
Juho Hong (Pohang Accelerator Laboratory (PAL))

An RF and event timing system was developed for the PAL-EUV accelerator to synchronize the photocathode gun laser, linear accelerator, booster ring, and storage ring. The system employs a common master oscillator, RF distribution and phase-locked frequency synthesis for generating synchronized RF signals, while event generators, fan-outs, and receivers provide coordinated timing signals and triggers. The synchronization performance was evaluated through laboratory measurements of relative RF-to-trigger timing stability. The measurements demonstrated picosecond-level timing stability under controlled conditions. The implemented system has supported accelerator commissioning, including beam injection into the booster ring, transfer to the storage ring, and successful observation of EUV radiation. This work presents the system architecture, implementation, and experimental performance.

E-mail: kookjine@unist.ac.kr

PO – 38

Analysis of X-ray-Based Field Enhancement Factor Distortion in RAON Half-Wave Resonators

Sungmin Jeon (Department of Physics, Kyungpook National University)
Yoochul Jung, Heetae Kim, Juwan Kim (IBS)

Field emission (FE) is a major performance limitation in superconducting RF cavities. It was also one of the critical issues in the vertical tests (VT) of the RAON half-wave resonators (HWRs). In VT, the field enhancement factor is often extracted from the measured X-ray dose rate. However, the measured dose rate depends not only on the emitter itself but also on the emitter position, the materials between the X-ray source and the detector, and the type and response of the detector. In this study, it is investigated which of these factors distort the X-ray-based β.

The X-ray dose rate at the VT facility was reconstructed by combining CST particle tracking, Geant4 bremsstrahlung simulation, attenuation through the cavity wall and cryostat layers, and the dose response of the survey meter. The materials between the source and the detector reduced the magnitude of the dose rate but had a negligible effect on the extracted β. In contrast, the emitter position, which determines the impact energy of the FE electrons, strongly affected β.. To quantify this effect, the recovery ratio was defined as the ratio of the X-ray-based β extracted from the reconstructed dose rate to the β set in the reconstruction. In the reconstruction, the X-ray-based β was always smaller than the set β, and the recovery ratio ranged from about 0.9 to 0.3 depending on the emitter position. For 30 measured HWRs, the median ratio of X-ray-based to Q_0-based β was 0.82, which suggests that the emitters are located mainly in the high-energy-gain regions of the beam cup and beam sphere.

E-mail: jsminhi@ibs.re.kr

PO – 39

Development of a segmented capillary plasma source with controlled density down-ramps for laser-plasma acceleration

Junyeong Jeong, Inhyuk Nam
(Ulsan National Institute of Science and Technology (UNIST))

Control of the longitudinal plasma density profile is critical for laser-plasma accelerator experiments, especially for injection in confined plasma channels. To address this, we developed a segmented capillary discharge plasma source for generating controlled plasma density down-ramps and investigated its characteristics theoretically and experimentally. A narrow orifice between the capillary sections generates a localized pressure transition, producing a longitudinal density down-ramp inside the channel. CFD simulations and analytical modeling were performed to investigate pressure-gradient formation and flow choking. The resulting density down-ramps were experimentally verified using optical emission spectroscopy under discharge conditions. This approach provides a flexible platform for generating and controlling localized plasma density down-ramps for laser-wakefield acceleration experiments.
The proposed source was further tested in LWFA experiments at GIST/IBS, demonstrating its practical applicability as a density-tailored plasma source for plasma accelerator experiments.

E-mail: jjy6330@gmail.com

PO – 40

Efficient multi-GeV electron beam acceleration from density downramp injection with two-stage, intentionally mismatched channels

Hyeon Myeong Jeong, Junyeong Jeong, Inhyuk Nam
(Ulsan National Institute of Science and Technology)

Laser wakefield acceleration can produce multi-GeV electron beams over centimeter-scale distances at the plasma densities in order of 10^{17} cm^{-3} in preformed plasma channels [1]. While controlled injection is key to efficient, high-quality beams for applications such as compact X-ray free-electron lasers and secondary particle sources, the large matched spot size of the channel limits the laser intensity and the lower density increases injection threshold. Multi-GeV beams especially reaching up to 10 GeV have therefore relied on petawatt-class lasers [2,3]. Using particle-in-cell simulations, we investigated density down-ramp injection in a two-region plasma channel with intentionally mismatched spot sizes: relativistic self-focusing in an oversized, high-density first region localizes injection at the down-ramp, and a narrower, low-density second region is matched to the self-focused spot size. A 200-TW laser pulse produces a quasi-monoenergetic 5.1 GeV, 55 pC electron bunch with a 1.3% energy spread and a normalized emittance of 1.2 mm·mrad. Increasing the first-region density raises the injected charge from 80 to 320 pC, whereas increasing the second-region density lowers it and yields up to 5.6 GeV with a 0.7% energy spread at approximately 20 pC. The laser-to-beam efficiency reaches approximately 5%, with an effectiveness factor [4] comparable to sub-GeV experiments.

[1] Rev. Mod. Phys. 81, 1229 (2009).
[2] Phys. Rev. Lett. 122, 084801 (2019).
[3] Phys. Plasmas 32, 053102 (2025).
[4] Phys. Plasmas 31, 080702 (2024).

E-mail: hmjeong21@unist.ac.kr

Abstract for Poster Presentation

WG 2

PO – 01

Design of Branch Line for the Second Hard X-ray FEL Line of PAL-XFEL

Hoon HEO (PAL)
Haeryong YANG (PAL)

PAL-XFEL. one of hard X-ray free electron laser facilities in the world, has one hard X-ray undulator line to generate from 2.5 keV to 15 keV photons and one soft X-ray undulator line for 0.25 keV to 1 keV. Recently, PAL-XFEL is under upgrading project to construct the second hard X-ray FEL line by branching new a undulator line which covers 2.5 keV to 10 keV but especially focused on tender X-ray range FEL service. To do that, it is essential to design a branch line not to terrifying its beam properties such as energy spread and beam emittance as small as possible. In this paper we present the designed layout and discuss its beam simulation results.

E-mail: heohoon@postech.ac.kr

PO – 02

Online Neutron Fluence Monitoring with SiPM Bias Current at KOMAC

Jun Hyung Park, Geonwoo Song, Seungwon Yeo and Shin Hyung Kim*
Department of Physics, Kyungpook National University, Daegu 41566, South Korea

Online monitoring of neutron fluence is important for beam diagnostics and radiation monitoring at accelerator facilities. In this study, the bias current of Hamamatsu S14161 SiPMs was monitored during pulsed neutron irradiation at the Korea Multi-purpose Accelerator Complex (KOMAC) to evaluate its potential as an online indicator of accumulated neutron exposure. The current was continuously recorded through the power supply and compared with the accumulated neutron fluence estimated from the irradiation conditions. Measurements at different beam repetition rates showed a consistent increase in current with accumulated exposure and comparable responses at similar total fluence. Post-irradiation current evolution was also examined to assess recovery effects. These results support the feasibility of using SiPM bias-current readback as a simple online neutron fluence monitoring technique in accelerator-based irradiation environments.

E-mail: shinhyung@knu.ac.kr

PO – 03

Development of a signal converter for the timing and control systems of the Siam Photon Source I

PHACHEERAK, Wiwek
(Synchrotron light Research Institute (Public Organization))
KWANKASEM, Apichai
(Synchrotron Light Research Institute)
PHIO-ON, NONTHANAN
(Synchrotron Light Research Institute (Public Organization))

Reliable operation of the Siam Photon Source I (SPS-I) synchrotron light source requires precise coordination among multiple subsystems using different signal standards, including TTL, LVTTL, and optical signals. To reduce reliance on high-cost imported equipment, a domestic signal converter was developed and integrated with the SPS-I timing and control system. The device consists of two custom-designed circuit boards interfaced with a Red Pitaya module. The input board converts optical, TTL, LVTTL, and manual push-button signals into LVTTL, while the Red Pitaya provides programmable pulse-width and signal-delay control. The output board converts the processed signals into the required TTL, LVTTL, or optical formats. The circuits were designed using KiCad and implemented using optical receivers, high-speed operational amplifiers, Schmitt-trigger buffers, and MOSFET switches. Prototype testing using a signal generator, optical source, and oscilloscope demonstrated successful signal conversion with a 500 μs pulse width and 100 μs delay. The results confirm that the developed converter achieves the required timing and signal-format conversion while reducing procurement costs and enhancing in-house technical capabilities. Future work will focus on integrating the system into a standard 1U, 19-inch rack enclosure for SPS-I deployment.

E-mail: nonthanan@slri.or.th

PO – 04

Non-collinear Laser Interaction on Microbunching Efficiency in EEHG

Eunkyoung Shin (Kangwon National University at Gangneung)
Ji-Gwang HWANG (Kangwon National University at Gangneung)

This study investigates the effects of a non-collinear seed laser geometry on electron phase-space dynamics and microbunching efficiency. A finite crossing angle causes both a reduction in the effective laser electric field and a transverse angular kick. While the former can be compensated by increasing the laser power, the latter induces transverse-longitudinal phase-space smearing that irreversibly degrades high-harmonic bunching. Particle-tracking simulations for 1.49 nm soft X-ray generation quantify this degradation and establish the allowable laser incidence angle. Although optimization of the dispersion strength (R56) can partially mitigate the degradation, the results demonstrate that minimizing the crossing angle is essential for maintaining high-harmonic bunching efficiency in storage-ring-based light sources.

E-mail: shinek@kangwon.ac.kr

PO – 05

Practical Operating Window for Femtosecond Pulse Radiolysis Using a MeV UED

Hyun Woo Kim (Korea Atomic Energy Research Institute)
In Hyung Baek (Korea Atomic Energy Research Institute)
Jun Heo (Korea Atomic Energy Research Institute)
Kyu Ha Jang (Korea Atomic Energy Research Institute)
Kitae Lee (Korea Atomic Energy Research Institute)
Key Young Oang (Korea Atomic Energy Research Institute)

A MeV ultrafast electron diffraction beamline can potentially be extended to pulse-radiolysis experiments if sufficient excitation density can be delivered while preserving femtosecond temporal resolution. In this work, the accessible operating range of the 3.1 MeV KAERI UED beamline was evaluated through ASTRA simulations for bunch charges between 0.1 and 1.0 pC. The existing beamline layout was retained, while the solenoid and downstream quadrupole triplet were varied to control longitudinal compression and transverse focusing. The calculations reveal a clear competition between electron fluence and bunch duration. When the beam was focused for maximum fluence, the fluence increased from approximately 60 to 168 pC/mm² as the bunch charge increased, while the bunch duration increased from about 62 to 91 fs. Under a fluence requirement of 40 pC/mm², a minimum bunch duration of 38.7 fs was obtained at 0.4 pC. Conversely, imposing a 50 fs bunch-duration limit allowed a maximum fluence of 106.1 pC/mm² at 0.8 pC. These results define a practical operating window for adapting the existing UED electron source to femtosecond pulse-radiolysis measurements with ultrathin liquid targets.

E-mail: baboon8412@gmail.com

PO – 06

Beam-Optics Control of Terahertz Streaking for Ultrafast Electron Beam Diagnostics

Hyun Woo Kim (Korea Atomic Energy Research Institute)
In Hyung Baek (Korea Atomic Energy Research Institute)
Jun Heo (Korea Atomic Energy Research Institute)
Kyu Ha Jang (Korea Atomic Energy Research Institute)
Kitae Lee (Korea Atomic Energy Research Institute)
Key Young Oang (Korea Atomic Energy Research Institute)

Terahertz (THz) streaking is a promising technique for characterizing the temporal properties of ultrashort electron bunches with femtosecond-scale resolution. In this study, we investigate the use of downstream quadrupole optics to modify the spatial mapping of the THz-induced transverse deflection. A quadrupole focusing the beam in the horizontal plane simultaneously defocuses the streaking plane, thereby increasing the temporal separation of electrons at the detector. The corresponding changes in streaking sensitivity, transverse beam size, and electron density at the detector were evaluated using beam-dynamics simulations. The dependence of the streaking enhancement on quadrupole strength and position was investigated, and singleand two-quadrupole configurations were compared. The results indicate that downstream beam optics can provide an additional degree of freedom for improving THz-based temporal diagnostics without increasing the THz field strength.

E-mail: baboon8412@gmail.com

PO – 07

Development of Integrated Control Program for RFT-30 Cyclotron

Young Bae Kong(KAERI), Jong Chul Lee(KAERI), Jin Sik Ju(KAERI),
Dong Hyun Kwak(KAERI), Min Goo Hur (KAERI), Jeong Hoon Park(KAERI)

An RFT-30 cyclotron is a 30 MeV proton accelerator for radioisotope (RI) production and fundamental research. A Low Level RF (LLRF) system is used for the stable control of the cyclotron RF system. In this work, we have developed integrated control system for the RFT-30 cyclotron. The control program aims to solve the issues of the existing technology by providing an real time monitoring, multi-level alarm, LLM based control, RAG based knowledge responses, and data logging into a single web platform. The proposed control system can enhance the stability of the cyclotron and then provides the human operators with easy operation for the RFT-30 cyclotron.

E-mail: ybkong@kaeri.re.kr

PO – 08

A Tilted Ion Beam Profile Measurement System with Segmented Wall Collector and Electronics

Young Seok Hwang[1]*, Jaekwon Suk[1], Yang In Mok[1], Chan Young Lee[1], Jun MoK Ha[1], Sunmog Yeo[1], Jun Kue Park[1] and Myung-Hwan Jung[1]
[1]Korea Atomic Energy Research Institute (KAERI), 181 Mirae-ro, Gyeongju, 38180, Republic of Korea.
*Corresponding author: hys@kaeri.re.kr

This study proposes a novel beam diagnostic technique designed to measure ion beam tilt, a parameter that is challenging to determine using conventional wire-type beam profile monitors (BPMs). Conventional wire-type BPMs measure the beam intensity distribution along the X and Y axes as a wire scans across the beam, allowing for the determination of beam position, width, and profile. However, if the beam's central axis is tilted relative to the reference axis but still yields an identical cross-section at the measurement plane, the resulting X and Y profiles appear identical. Consequently, conventional profile data alone is insufficient to identify the direction and magnitude of the beam tilt.

To overcome this limitation, we developed an advanced BPM by segmenting the collector electrode. The signals are separated and processed through two preamplifiers, and the total signal is reconstructed using a summation circuit. By analyzing the signal differentials from each segmented collector, the proposed system can simultaneously extract the conventional X-Y beam profile and precisely determine the direction and degree of the beam tilt. Currently, this system is being developed to build an AI-based operation platform for the optimization of extraction, acceleration, and beam optics relying on beam profile data.

E-mail: hys@kaeri.re.kr

PO – 09

Calibration of the PAL-XFEL Photoinjector Model via Bayesian Target-Vector Optimization Using Solenoid Scan data

One Jang (Pohang Accelerator Laboratory),
Moses CHUNG (Pohang Accelerator Laboratory),
Seongyeol KIM (Pohang Accelerator Laboratory),
Haeryong YANG (Pohang Accelerator Laboratory)

A reliable photoinjector simulation is essential for accurately reproduce the beam parameters at the injector exit. However, discrepancies between particle tracking simulation results and experimental measurements can limit the predictive capability of simulation models. In this work, we extend a Bayesian optimization-based calibration framework to the IMPACT-T model of the PALXFEL injector using ground truth simulated solenoid scan responses. The calibration compensates for deviations between nominal model parameters and actual machine conditions by optimizing simulation parameters to reproduce the measured beam responses. To improve the computational efficiency of the calibration, Bayesian target-vector optimization (BTVO) is employed to reduce the number of expensive particle tracking simulations required for model matching. BTVO uses the individual components of the target and simulated output vectors to efficiently infer the machine input parameters corresponding to the measured beam responses. The calibrated IMPACT-T model is expected to better represent the measured behavior of the actual injector and provide a reliable basis for future surrogate model development.and simulated output vectors to efficiently infer the machine input parameters corresponding to the measured beam responses. The calibrated IMPA'CT-T model is expected to better represent the true physical behavior of the actual injector and provide a reliable basis for future surrogate model development.

E-mail: jjangone111@postech.ac.kr

PO – 10

Signal-Based Blade Placement for the PLS-II 3A Photon BPM #25

Donghyun Song (Pohang Accelerator Laboratory)
Woosung Cho (Pohang Accelerator Laboratory),
Siwon Jang (Pohang Accelerator Laboratory),
Changbum Kim (Pohang Accelerator Laboratory),
Dotae Kim (Pohang Accelerator Laboratory),
Mungyung Kim (Pohang Accelerator Laboratory)

A four-blade Photon Beam Position Monitor(PBPM) is being designed for PLS-II beamline 3A, served by an in-vacuum undulator (0.9 T, 3 GeV, 400 mA). The tungsten blades were placed by their signal, not at a prescribed fraction of the peak power density. The photon spectrum 14 m from the source, calculated with SPECTRA, was weighted by the tungsten photoabsorption coefficient as a photoemission proxy. This weighting emphasizes low-energy photons, which spread more vertically. As a result, the signal map is elongated vertically, unlike the power density, and most of the signal comes from soft X-rays. Each blade was modeled as a line integral over this map, beam motion as a rigid shift, and the position from the normalized difference Δ/Σ. As the readout noise is unknown, a grid of blade placements was compared under current-proportional and fixed noise. The placement with the smallest worst-case loss in position resolution, relative to the best placement, was chosen (minimax regret). Compared with the best placement on the 10–12% power-density contour, the chosen layout collects more signal and has a smaller worst-case loss. The peak power density on the blades stays well below the 70 W/mm² design reference. The resulting blade gap, its sensitivity and linearity, and its robustness to the model assumptions are presented.

E-mail: songdonghyun@postech.ac.kr

PO – 11

Improvement of Rotating-Wire Beam Profile Monitoring with Digital Signal Acquisition and Processing at KOMAC

In Mok Yang[1]*, Jaekwon Suk*[1]; Yong Seok Hwang[1]; Chan Young Lee[1]; Jun MoK Ha[1]; Sunmog Yeo[1], Jun Kue Park[1] and Myung-Hwan Jung[1]
[1]Korea Atomic Energy Research Institute (KAERI), 181 Mirae-ro, Gyeongju, 38180, Republic of Korea.
*Corresponding author : inmok91@kaeri.re.kr

*Keywords : ion beam, beam profile monitoring, beam diagnostics, signal processing

A rotating-wire Beam Profile Monitor (BPM) is used to monitor the transverse shape and position of the ion beam in the ion implanter at KOMAC(the Korea Multi-purpose Accelerator Complex). Conventionally, the BPM signals have been monitored as waveforms on an oscilloscope. We acquired the BPM signals using an NI 9215 module with a cDAQ platform and processed them using a LabVIEW-based program. We applied signal fitting to the measured signals to construct a two-dimensional approximation of the transverse beam profile. The processed signals allowed the beam profile to be reliably reconstructed and clearly visualized, including its position and distribution. The developed system enables digital acquisition, processing, and visualization of the BPM signals. The beam profile information is intended to be integrated into the main control system for beam transport optimization and automated beam tuning, providing reliable beam diagnostic data for future AI-based operation of the ion implanter.

PO – 12

Maximum Entropy Tomography of the 4D Transverse Phase Space Distribution at the CAFe2 Accelerator

Liwen Liu (Institute of Modern Physics, Chinese Academy of Sciences)
Moses Chung (POSTECH)
Zhijun Wang (Institute of Modern Physics, Chinese Academy of Sciences),
Jonathan C. Wong (Institute of Modern Physics, Chinese Academy of Sciences)

This work presents an experimental reconstruction of the complete 4D transverse phase space distribution (x,x',y,y') based on the maximum entropy tomography (MENT) method using 2D measured profiles. To obtain the full beam distribution in the 4D transverse phase space, we developed a reconstruction algorithm grounded in the MENT approach, which reconstructs the 4D distribution from 2D profile measurements. Experiments were carried out at the superconducting heavy-ion accelerator CAFe2 at the Institute of Modern Physics, Lanzhou, China, where we successfully reconstructed the 4D transverse phase space distribution of 1.33 MeV protons in the medium-energy beam transport (MEBT) section of CAFe2. The numerical solution was obtained iteratively, with convergence to the maximum entropy 4D distribution that satisfies all imposed constraints. Using mutually perpendicular slit and wire scans, we acquired planes containing coupling information, enabling the successful reconstruction of the complete 4D distribution, including coupling effects.

E-mail: liuliwen@impcas.ac.cn

PO – 13

PHITS Monte Carlo Simulation of X-ray Spectrum and Dose Distribution Depending on Target Materials for a 10 MeV Electron Accelerator

Junyoung Kang (Advanced Radiation Technology Institute (ARTI), Korea Atomic Energy Research Institute (KAERI))
Cheolmin Ham (Institute for Rare Isotope Science, Institute for Basic Science)
HUISU KIM (Korea Atomic Energy Research Institute)
Byungnam Kim (Korea Atomic Energy Research Institute))
Youn-Mook Lim (Korea Atomic Energy Research Institute))
Jin-Mun Yun (KAERI)

To enhance the design efficiency of a 10 MeV electron accelerator-based X-ray irradiation system, we comparatively analyzed the X-ray energy spectra and spatial dose distribution characteristics across different converter target materials using the PHITS Monte Carlo code. This computational study precisely tracked the energy distribution of forward bremsstrahlung photons generated when a 10 MeV electron beam strikes four target materials with distinct atomic numbers and densities: aluminum (Al), titanium (Ti), tantalum (Ta), and tungsten (W). Going beyond a comparison of total conversion yields, we demonstrated through 2D and 3D dose mapping visualizations how differences in the physical properties of each material influence beam hardening phenomena and radiation field spreading. Moreover, by quantifying the lateral fluence profiles and depth-dose curves at the final irradiation plane for each material, we secured foundational design data for selecting optimal target materials tailored to specific irradiation objectives in 10 MeV X-ray irradiation facilities.

E-mail: jykang@kaeri.re.kr

PO – 14

Multibunch Operation of the KLS Linac at Different Bunch Charges: Beam Dynamics Optimization and Beam Loading

Woo Jun Byeon, Sung-Ju Park, Namseok Go, Sang-Hee Kim, Soung-Soo Park, Yong Jung Park, Juho Hong, Chang-Ki Min* (Pohang Accelerator Laboratory)

Multibunch operation of the Korea Light Source (KLS) linear accelerator (linac) was studied for 64-bunch trains with approximately 2 ns spacing at bunch charges of 46.9 and 10 pC. The linac operating parameters were determined through single-bunch simulations using the particle-tracking code ASTRA (A Space Charge Tracking Algorithm). At 46.9 pC, ASTRA was coupled to a multiobjective genetic algorithm to optimize radio-frequency (RF) phases, the solenoid field, and quadrupole gradients. The optimized beam had a mean kinetic energy of 202.0 MeV, horizontal and vertical normalized root-mean-square (rms) emittances of 0.885 and 0.851 mm·mrad, and an intrabunch rms energy spread of 41.8 keV. At 10 pC, the solenoid field was scanned while retaining the RF phases and quadrupole gradients from the 46.9 pC case. A solenoid field value satisfying the same limits on exit beam energy, transverse size and divergence, and bunch length was selected. The beam loading model used a reference gun exit kinetic energy of 4 MeV and an RF input power of 22.4 MW per accelerating structure. The intrabunch energy spread from ASTRA was assumed to be the same for all bunches at each charge and combined with the calculated bunch-to-bunch mean energy variation. The estimated total relative rms energy spreads were 0.18% and 0.045%, respectively, normalized to 200 MeV. At 46.9 pC, bunch-to-bunch mean energy variation dominated the total energy spread. Both estimates satisfy the KLS linac requirement of $\leq$0.3% under the modeled conditions.

This research was supported in part by the Korean Government(MSIT: Ministry of Science and ICT)

E-mail:minck@postech.ac.kr

PO – 15

Temporal Beam Distribution Measurement Utilizing a 16-Channel Wideband Button BPM

Wookhee Choi (Kangwon National University)
Jangwon Kwon (Institute for Basic Science)
Ji-Gwang Hwang (Kangwon National University)

We have developed a 16-channel wideband button beam position monitor (BPM) originally intended for transverse beam profile measurements. In this study, we propose a novel approach that leverages its wideband characteristics to measure the temporal distribution of the beam. To achieve this, the characteristic impedance and electromagnetic responses of the button were first investigated using CST microwave simulations. Concurrently, experimental measurements were performed to establish the frequency response and signal acquisition characteristics of the digitizer (sampling oscilloscope). Furthermore, a preliminary signal processing algorithm was implemented, utilizing frequency response deconvolution and inverse fast Fourier transform (FFT) to accurately reconstruct the original temporal beam profile. This study establishes a comprehensive foundation—combining hardware characterization and computational signal recovery—for future temporal beam diagnostics using multi-channel wideband BPM systems.

This research was supported in part by the Korean Government(MSIT: Ministry of Science and ICT)

E-mail: isulbaby3@kangwon.ac.kr

PO – 16

Beam Matching Study for the KOMAC 200 MeV Upgrade

Jiyoung Choi (POSTECH)
Moses Chungi (POSTECH)
Seunghyun Lee (KAERI)
SeokHo Moon (KAERI)

The KOMAC proton linac upgrade from 100 to 200 MeV requires a matching section between the existing drift tube linac (DTL) and the proposed separated drift tube linac (SDTL). The proposed section includes a 45° bending magnet and two bunchers. To provide space for beam diagnostics, a drift section may need to be lengthened, potentially affecting beam transport and matching. In this study, beam transport in the reference layout and a layout with an extended drift section are simulated using the TraceWin code. The beam envelopes along the matching section, together with the Twiss parameters and rms emittances at the SDTL entrance, are compared between the two layouts. The comparison will help assess whether the drift section can be extended to provide space for beam diagnostics while maintaining the required matching conditions at the SDTL entrance. Finally, potential transverse and longitudinal beam diagnostic suites that can be implemented in the matching section are discussed.

E-mail: cjy8807@postech.ac.kr

PO – 17

Sensitivity of Weak-Strong Steady-State Microbunching to Modulation Errors

youngmin park (POSTECH)
Moses Chung (POSTECH)

Steady-state microbunching (SSMB) is a promising approach for generating high-power coherent EUV radiation in electron storage rings. In this work, the recently proposed Weak-Strong SSMB scheme is numerically reproduced using particle tracking, with emphasis on longitudinal phase-space evolution, bunch compression, and high-harmonic bunching in the final-focus section. Based on the reference EUV parameters, the effects of imperfect modulation cancellation are further investigated by introducing amplitude and phase errors in the reverse modulation. The resulting changes in the longitudinal beam distribution and bunching performance are evaluated over multiple turns. Finally, the tracked particle distributions will be used in SPECTRA to examine the corresponding coherent EUV radiation characteristics.

E-mail: pym102048@postech.ac.kr

PO – 18

Full 4D Beam Phase-Space Reconstruction from Slit-Screen Measurements via the Principle of Maximum Entropy

Daon Lee (KNU)
Jiyoung Choi (POSTECH)
Moses Chung (Pohang University of Science and Technology)
Yu Du (Institute of Modern Physics, Chinese academic of Sciences)
Liwen Liu (Institute of Modern Physics, Chinese Academy of Sciences)
Jonathan C. Wong (Institute of Modern Physics, Chinese Academy of Sciences)

Emittance is a key parameter that characterizes beam quality and its behavior under given optics. Conventional emittance measurement methods estimeate the RMS phase space properties from beam profiles and therefore provide limited information about non-Gaussian structures. To overcome this limitation, tomography techniques have often been introduced to reconstruct the phase space distribution using projection data measured at various phase space angles. In this study, we reconstruct the detailed phase space distribution using the Maximum Entropy Theory (MENT) with data from the slit based Virtual Pepper-Pot (VPP) diagnostics at the Beam Test Stand (BTS) of the Korea Multipurpose Accelerator Complex (KOMAC). To avoid nonlinear effects such as space charge, which can occur in conventional multi-optics tomography when the measurement point and the reconstruction point are different, a single-optics configuration is established using a fixed quadrupole setting. In this configuration, angular projection data are obtained by introducing the Additional Diagonal Scan (ADS) method. To optimize the additional diagonal slit angles, an f-divergence is calculated to quantify the difference between projection data obtained at different angles. Using X-suite simulations, the proposed method is quantitatively evaluated in terms of total variation distance (TVD) and emittance error.

E-mail: dlgustlrzz1@gmail.com

PO – 19

Beam Dynamics Simulation of the RAON P2DT Using Xsuite Framework

Changsun Na (POSTECH)
Moses Chung (POSTECH)
Donghyun Kwak
Jangwon Kwon (Institute for Basic Science)

The Post-Linac to Driver Linac Transport (P2DT) of RAON is a 180° beam transport section connecting SCL3 and SCL2. Previous beam-dynamics and beam-optics studies of the P2DT employed accelerator simulation codes such as ELEGANT, GICOSY and TRACK. In this study, the existing RAON P2DT lattice was modeled using Xsuite, a Python-based framework for accelerator beam-dynamics simulations. Its Python-based environment provides flexibility in modifying simulation models and parameters and facilitates integration with external tools for data analysis and optimization.

Beam dynamics simulations were first performed for the previously studied uranium-beam condition of approximately 18.5 MeV/u. The Xsuite model was validated by comparing the simulation results with those reported in previous P2DT studies, including beam envelopes, emittance, phase-space distributions, and other beam-optics characteristics. The validated model was then applied to a 17.5 MeV/u uranium-beam condition currently under consideration for RAON operation, and the corresponding beam-dynamics characteristics were investigated.

Furthermore, the validated Xsuite-based P2DT model was applied to a feasibility study of CPU-BSM-based longitudinal bunch-shape tomography. Compared with an interceptive fast Faraday cup (FFC), the non-interceptive CPU-BSM has the advantage of reducing beam-induced vacuum disturbances and avoiding repeated mechanical insertions. Finally, we discuss extending the model to simulate beam interactions with intercepting components (e.g., stripping foils, gas strippers, collimators, targets, and beam dumps) using the Xcoll package.

E-mail: changsun@postech.ac.kr

PO – 20

Experimental and Numerical Study of 6.5 MeV Electron Beam Transport

Heejin Cho (Korea University)
KeonHo Kim (Korea University)
Bong hoon Oh (Korea University)
Seong Hee Park (Korea University)

A 6.5 MeV electron beam from a microtron is transported through bending and quadrupole magnets toward the undulator section. In this work, electron beam transport was studied using beam profile measurements and OptiMX calculations. Transverse beam profiles were measured at two positions for different magnet settings, and changes in beam position and size were examined. The measured magnet settings were then applied to OptiMX to calculate the beam envelope and dispersion along the transport path. The measured beam profiles and calculated beam parameters were compared for magnet settings.

E-mail: 2022010711@korea.ac.kr

PO – 21

Beam Profile Measurement Using a V-Shaped Multi-Separation Double Slit in SR Interferometry

규철 김 (Kangwon National University)
Siwon Jang (PAL)
Woojin Song (POSTECH)
Ji-Gwang Hwang (Kangwon National University)

In modern storage rings, transverse beam sizes are often smaller than the diffraction limit of visible-light optical systems. While diffraction-based techniques or shorter-wavelength radiation are used to overcome this, they typically lose phase information, complicating accurate beam profile reconstruction. Consequently, reconstructing profiles solely from fringe visibility requires time-consuming repeated measurements by scanning slit separations or wavelengths. To avoid these iterative scans, our previous study integrated multiple slit separations into a single aperture using an asymmetric stepped slit; however, its lack of a common optical axis introduced artifactual phase offsets in the interferograms.

To resolve this, we fabricated a symmetrical, laser-machined V-shaped slit. Its continuously varying separation allows for the single-shot acquisition of interferograms across multiple spatial frequencies. Following wave-optics simulations to verify the reliable extraction of visibility and fringe phase under Pohang Accelerator Laboratory (PAL) 1B beamline conditions, beam experiments were conducted using the V-slit. The spatial coherence and phase information extracted from the single-shot interferograms successfully reconstructed the beam size and transverse profile. Ultimately, this proposed method significantly reduces measurement time and minimizes errors induced by temporal beam fluctuations.

E-mail: gyuriezmann@kangwon.ac.kr

PO – 22

Deep Learning-Based Phase-Space Reconstruction Using Gaussian Mixture Parameterization in the RAON LEBT

Woo Hyeong Kim (Kangwon National University)
Eunhun Im (Institute for Basic Science)
Jangwon Kwon (Institute for Basic Science)
Ji-Gwang Hwang (Kangwon National University)

The transverse phase-space distribution is a fundamental parameter that dictates the ultimate beam quality and performance of a particle accelerator. In the low-energy beam transport (LEBT) section of the Rare isotope Accelerator complex for ON-line experiments (RAON), characterizing this distribution is critical; however, direct measurements using an Allison scanner are too time-consuming to support real-time accelerator tuning and operation. To overcome this limitation, we present a virtual diagnostic tool that reconstructs the projected phase spaces, and, relying solely on 1D wire-scanner profiles.

Rather than processing high-dimensional images, both the measured profiles and the target phase-space distributions are parameterized using Gaussian mixture models (GMM). The deep neural network is trained to predict a compact set of mixture parameters, from which essential beam moments—such as normalized emittance, Twiss parameters, and beam centroids—can be derived analytically. Because a single spatial profile lacks angular information, the network utilizes a set of profiles acquired at varying electrostatic quadrupole settings, with reconstruction accuracy systematically improving as more settings are incorporated.

Furthermore, a graphical user interface is under development to facilitate practical application by accelerator operators. Ongoing work is focused on enhancing model robustness, evaluating extrapolation capabilities, and benchmarking the virtual diagnostics against empirical Allison-scanner measurements.

E-mail: whkim1357@kangwon.ac.kr

PO – 23

Beam Dynamics Impact of Tunable Permanent Magnet Quadrupoles in Fourth-Generation Storage Rings

Junwon Choi (POSTECH)
Moses Chung (POSTECH)
Ji-Gwang Hwang (Kangwon National University)

Fourth-generation storage rings use multi-bend achromat (MBA) lattices to achieve low emittance, and these lattices require many high-gradient quadrupole magnets with substantial power and cooling demands. Permanent magnet quadrupoles (PMQs) provide strong focusing in a compact form without power supplies or cooling systems, making them a promising option for reducing the power consumption of such rings. In a previous study, we designed a tunable PMQ for a fourth-generation storage ring with a maximum field gradient of 71.7 T/m and tuning range of about 36%. For the 104 mm mechanical-length design, the largest integrated higher-order multipole component, B6/B2, is at the 10^{-5} level at a reference radius of 3 mm, more than one order of magnitude below the field-quality tolerance. However, field quality alone does not indicate how the PMQ affects the beam, because small field errors and fringe fields accumulate as particles circulate over many turns. In this study, we extend the PMQ design to several magnetic lengths and incorporate these PMQs into two lattices: a simple model lattice designed for this study and a publicly available lattice of an operating fourth-generation light source. Instead of the original quadrupole models defined in these lattices, we represent the PMQs by their three-dimensional field maps in tracking simulations, including the fringe-field region and higher-order harmonics. For each lattice, we compare the original and PMQ-based models in terms of linear optics and nonlinear beam dynamics, and also perform error studies. Through this comparison, we evaluate how the PMQ's three-dimensional field distribution affects storage ring beam dynamics and extend the previous magnet-design study to the accelerator level.

E-mail: cjw6954@postech.ac.kr

#69

PO – 24

Transition and Implementation of an Accelerator Timing System from the MRF VME-Based EVG/EVR-230 to the MTCA-Based EVM/EVR-300

Young-Gi Song (KOMAC/KAERI)
Hyeok-Jung Kwon (KOMAC/KAERI)
Jae-Ha Kim (KOMAC/KAERI)
sungyun cho (KOMAC/KAERI)

The accelerator timing system is essential for precise synchronization and trigger signal generation for RF and other major accelerator devices. At KOMAC, the existing MRF VME-based EVG/EVR-230 system has been used for accelerator operation. However, the discontinuation of these products is expected to cause difficulties in maintenance and spare-part procurement. In addition, a new timing system is required as a preliminary step toward the development of a future 200 MeV accelerator.
In this study, a next-generation timing system based on the MicroTCA platform, using the EVM-300 and EVR-300, was developed to replace the existing system and support future accelerator expansion. An EPICS IOC environment based on Linux and mrfioc2 was configured, and basic system functions, including event transmission between the EVM and EVR, trigger generation according to event codes, and frequency division, were tested and verified. The developed system provides a basis for replacing the existing timing system and establishes the technical foundation and operational experience required for the future implementation of a 200 MeV-class accelerator timing system.

E-mail: sungyun@kaeri.re.kr

PO – 25

Beam Diagnostics Development for Transverse Beam Characterization at KOMAC BTS

Seunghyun Lee (KAERI)
SeokHo Moon (KAERI)
Han Sung Kim (KAERI)
Hyeok-Jung Kwon (KOMAC,KAERI)

The Beam Test Stand (BTS) at KOMAC is a specialized facility designed to develop beam diagnostic methods for the 100 MeV proton linear accelerator. The primary objectives of the BTS are to enhance the performance of the linear accelerator and to provide high-quality beam services to users. At the BTS, a range of beam diagnostic tools have been developed specifically for the transverse characterization of the beam. These include an Allison scanner for low-energy beam analysis, a slit emittance meter for precise emittance measurements, and a virtual pepperpot for comprehensive 4D beam phase space measurements. This paper presents an overview of the beam diagnostics development at the BTS and reports on the results obtained from the transverse beam characterization measurements.

E-mail: shl@kaeri.re.kr

PO – 26

Design of an Computed Tomography Optical Emission Diagnostic System for a RAON Single-Spoke Resonator Cavity Plasma

MuHyeop Cha(Seoul Nat'l Univ.), Junsik Kim(KOMAC/KAERI),
Jiseong Nam(Seoul Nat'l Univ.), Yoo-Lim Cheon (Institute for Basic Science),
Kyoung-Jae Chung*(Seoul Nat'l Univ.)

Plasma surface treatments are used to improve the performance of superconducting radio-frequency cavities by reducing hydrocarbon contamination. Its application to complex single-cell geometries such as single-spoke resonators requires careful selection of the plasma discharge location. Although resonant electric-field distributions can indicate potential ignition regions, they do not fully describe plasma behavior. This work investigates the feasibility of reconstructing the spatial distribution of optical emission, with the aim of guiding the design of an optical diagnostic system for the RAON SSR cavity. Candidate line-of-sight (LOS) configurations are examined with consideration of the cavity geometry and simulated electric-field distributions of selected higher-order modes (HOMs) identified as candidates for plasma ignition.

* This work was supported by the National Research Foundation of Korea(NRF) funded by Ministry of Science and ICT(RS-2022-00214790)

E-mail: cmh71317@snu.ac.kr

PO – 27

Generation of X-ray FELs using Bayesian Optimization at PAL-XFEL

Chang-Kyu Sung (Pohang Accelerator Laboratory)
Myung-Hoon Cho (Pohang Accelerator Laboratory)

X-ray free-electron lasers (XFELs) are highly complex radiation source driven by large-scale accelerator composed of numerous systems, including low-level radio-frequency (LLRF) systems, high-power RF sources, electromagnets, undulators, and beam diagnostics system. To generate high-performance FEL radiation, therefore, a large number of accelerator components must be precisely controlled and optimized. At PAL-XFEL, the accelerator is routinely tuned by operators on a weekly basis to maintain stable FEL performance for user experiments. Although the tuning procedure has been well-systematized based on operational experience, optimizing numerous machine components remains time-consuming, and the tuning performance can depend on the experience of individual operators. To improve the efficiency and performance of FEL tuning, a well-established Bayesian optimization (BO) method was applied at PAL-XFEL. As a preliminary result, comparable FEL performance was achieved using the BO method with a shorter optimization time than that required by the conventional tuning process. In this presentation, we report the implementation, experimental setup, and preliminary results of Bayesian optimization applied to FEL tuning at PAL-XFEL.

E-mail: csung@postech.ac.kr

PO – 28

Implementation of Rapid Recovery Systems for Continuous Operation of the KOMAC Control System

SungYun Cho*, Jae-Ha Kim, Young-Gi Song, Hyeok-Jung Kwon
(Korea Multi-purpose Accelerator Complex,
Korea Atomic Energy Research Institute, Gyeongju, Korea)

KOMAC operates a 100-MeV proton linear accelerator providing proton beams to users. Its control system is based on the Experimental Physics and Industrial Control System (EPICS), with Input/Output Controllers (IOCs) and applications for accelerator operation running on servers. As these servers have aged, unexpected hardware faults have occurred. Spare servers are kept for such cases, but moving a failed IOC to one requires rebuilding it for a different OS and updating libraries, which delays recovery. To minimize downtime, a recovery method suited to each layer was applied. For IOCs, a GitLab-based CI/CD pipeline was linked with a dedicated recovery server. Whenever an operating IOC is pushed to GitLab, the runner on the recovery server rebuilds it with the latest changes on a prebuilt EPICS environment, so no rebuild is needed when a fault occurs. The service is restored immediately by starting the IOC on the recovery server, and is switched back once the operating server is ready. For larger applications, some of which handle large volumes of data, the BackupXcelerator backup solution was introduced. It backs up the OS area as an image and the DATA area on a file basis, so a failed server can be restored on a new server with its original environment. A backup server and its replica, each with 68 TB of storage, back up about 10 major services weekly (DATA) and monthly (full), retaining the three latest images. Recovery tests showed that the OS area is restored within about one hour. This paper introduces these systems for continuous operation of the KOMAC control system.

E-mail: sungyun@kaeri.re.kr

PO – 29

A Proposed Offset-Based Correction Strategy for Combined-Function Bending Magnet Errors

Gyeongsu Jang (POSTECH)
youngmin park (POSTECH)

Orbit response matrix measurements in the EUV storage ring revealed a significantly suppressed horizontal response compared with the lattice prediction. Analysis showed that field errors in combined-function bending magnets generate large horizontal orbit distortions, reducing the effectiveness of horizontal correctors. To compensate for these errors, an offset-based correction strategy is proposed using intentional transverse alignment of selected bending magnets. Numerical studies were carried out to determine the required offset. The results indicate that the proposed method can effectively mitigate orbit distortion and improve horizontal correction capability, providing a practical tool for commissioning.

E-mail: jkskid@postech.ac.kr

PO – 30

Ground-Motion-Induced Photon Beam Instability and Response-Based Correction Feasibility in Korea Light Source Beamlines

Jinjoo Ko (Korea Basic Science Institute)
Gyeongsu Jang (Pohang Accelerator Laboratory)
Byeong-Gwan Cho (Korea Basic Science Institute)
Seunghwan Shin (Korea Basic Science Institute)
Hyunchang Jin (Korea Basic Science Institute)

Ground motion can affect photon beam stability in low-emittance synchrotron light sources through mechanical perturbations of beamline optical components. For the Korea Light Source (KLS), frequency-dependent ground-motion data were applied to two representative nanoprobe beamlines, and the resulting photon beam centroid fluctuations were evaluated using ray-optics simulations. The analysis showed that photon beam motion can be amplified after a long drift section, particularly at the entrance of the final-focusing Kirkpatrick-Baez (KB) mirrors. To investigate local beam-position correction, small angular perturbations were applied to high-heat-load mirrors (HHLMs) upstream of the secondary source aperture. The horizontal centroid at the KB entrance showed a clear linear response to the HHLM2 angle, whereas the vertical centroid response to the HHLM1 angle was weaker and less consistent. Based on these response characteristics, the potential for reducing ground-motion-induced centroid fluctuations through upstream mirror angular correction was evaluated. The results demonstrate the feasibility of response-based local beam-position stabilization.

E-mail: kopearl1@kbsi.re.kr

PO – 31

Ion Beam Energy Measurements Using Time-of-Flight Technique at RAON

Cheolmin Ham (Institute for Basic Science)
Donghyun Kwak (Korea Atomic Energy Research Institute)
Jaesung Kim (Institute for Basic Science)
Geonhee Oh (Institute for Basic Science)
Dong Geon Kim (Institute for Rare Isotope Science, Institute for Basic Science)
Seong Jae Pyeun (Institute for Rare Isotope Science, Institute for Basic Science)
Minsik Kwag (Institute for Rare Isotope Science, Institute for Basic Science)
Kwang-Bok Lee (Institute for Rare Isotope Science, Institute for Basic Science)
Jang-Won Kwon (Institute for Basic Science)
Jaehyun Cho (Institute for Basic Science)
Jongdae Joo (Institute for Rare Isotope Science, Institute for Basic Science)
Hyungjoo SON (Institute for Basic Science)
Kyoungho Tshoo (Institute for Basic Science)

Accurate beam energy determination is essential for performing precise experiments, including cross-section measurements. We developed a Capacitive Pick-Up type Bunch Shape Monitor (CPU-BSM)[1] as a diagnostic tool for measuring the longitudinal bunch shape of ion beams. In addition to bunch shape monitoring, the CPU-BSM can be used to determine ion beam energy using the time-of-flight (TOF) technique by measuring the time difference between signals from two CPU-BSMs.
Using this method, beam energy measurements were performed in the KoBRA beamline at RAON with 20Ne and 40Ar ion beams delivered from SCL3. In this presentation, we introduce the CPU-BSM, describe the TOF-based beam energy measurement method, and present the beam energy measurement results obtained at the KoBRA beamline.

Reference [1] D. Kwak et al., Prog. Theor. Exp. Phys. (2025) 073G01.

Acknowledgements This work was supported by the Institute for Basic Science (IBS-I001-D1) and the National Research Foundation funded by the Ministry of Science and ICT of the Republic of Korea (RS-2023-00282876, RS-2026-25548890).

E-mail: cmham@ibs.re.kr

PO – 32

Physics-Informed Residual Gaussian Process Modeling for Resonant-Frequency Prediction of a Superconducting Half-Wave Resonator

Jinbaek Choe (Korea Institute of Energy Technology (KENTECH))
Jeong-jeung Dang (Korea Institute of Energy Technology (KENTECH))

Machine-learning-based surrogate models can reduce the computational cost of electromagnetic simulations in superconducting half-wave resonator (HWR) design. However, conventional data-driven models must learn the entire relationship between geometric parameters and resonant frequency directly from simulation data, without explicitly incorporating the underlying resonant physics. In this study, a physics-informed residual modeling framework was investigated to separate the global physics-based frequency trend from the remaining geometry-dependent correction. An equivalent LC-resonator baseline derived from an ideal coaxial Transverse Electromagnetic (TEM) approximation was used as the physics-based prior, while automatic relevance determination Gaussian process regression (ARD-GPR) was trained to predict the residual between the calibrated LC baseline and CST simulation results. Five effective-length candidates were evaluated using ten fixed frequency-stratified train/validation splits within the modeling domain below 400 MHz. Among them, the effective-length candidate corresponding to the axial half-length of the HWR showed the best average validation performance. The calibrated physics-informed residual model showed lower root mean square error (RMSE) and mean absolute error (MAE) than raw ARD-GPR across the repeated validation splits. In addition, the residual model without affine calibration also outperformed raw ARD-GPR, indicating that the improvement was not solely attributable to calibration. These results suggest that the LC baseline provides a useful representation of the global resonant-frequency trend, allowing ARD-GPR to focus on the remaining geometry-dependent correction rather than learning the entire geometry-to-frequency relationship directly. This separation of physics-based trend and data-driven correction provides a physically interpretable surrogate-modeling framework for HWR resonant-frequency prediction.

Acknowledgement
This work was supported by the National Research Foundation of Korea (NRF) funded by the Ministry of Science and ICT(RS-2022-00214790).

E-mail: jjdang@kentech.ac.kr

PO – 33

Numerical Computation of Multi-Time Intensity Correlations in Superradiant Bursts from Atomic Ensembles

Jeong-Wan Park (Korea University)
Seong Hee Park (Korea University)

Superradiant bursts from inverted atomic ensembles, such as those created by XFEL inner-shell photoionization, are initiated by quantum vacuum fluctuations, so their timing and intensity vary from shot to shot even under identical pumping. Multi-time intensity correlations measured over many shots encode these fluctuations, but their interpretation is not straightforward: timing jitter alone can produce either positive or negative correlations, depending on where the two times lie relative to the burst profile. Moreover, the exponential growth of the Hilbert space with emitter number has prevented exact calculations at realistic ensemble sizes. Using a stochastic approach we have developed that overcomes this exponential cost, we calculate the multi-time intensity correlations of superradiant bursts for hundreds of emitters and show how timing and amplitude fluctuations appear in the two-time correlation map. While XFELs currently remain almost the only X-ray laser sources, such an analysis of collective effects can help assess the feasibility of compact X-ray sources based on atomic superradiance and identify effective routes toward them.

E-mail: merrypark3@gmail.com

PO – 34

Separation of Beam Lifetime Contributions during Top-Up Operation at PLS-II

Ki Moon Nam (KBSI)
Gyeongsu Jang (Korea Basic Science Institute)
Jimin Seok (Korea Basic Science Institute)
Junha Kim (Korea Basic Science Institute)
Hyunchang Jin (Korea Basic Science Institute)
Jaehyun Kim (Pohang Accelerator Laboratory)

Separating beam lifetime into individual loss contributions is important for identifying beam-loss mechanisms and improving storage-ring operation. Based on the two-bunch method, we investigate lifetime decomposition using the current difference between the bunch train and the isolated camshaft bunch in the PLS-II hybrid filling pattern. Archived bunch-current and bunch-length measurements are used to estimate Touschek and current-independent loss contributions during top-up operation. Locally decreasing current intervals are selected to reduce the influence of injection transients on the fitted decay rates. We present the analysis method and comparisons with the archived total lifetime. This study aims to support beam-loss diagnosis and lifetime optimization during the commissioning of KLS.

E-mail: ngw5756756@kbsi.re.kr

PO – 35

Development of RF Instability Monitoring for KOMAC Proton Linac Operation

Ji-hwan Ma, Sang-Pil Yun, Dae-Il Kim, Nam-Hoon Lee, Hyeok-Jung Kwon 1
Korea Multi-purpose Accelerator Complex,
Korea Atomic Energy Research Institute, Gyeongju 38180

The KOMAC proton linac accelerates protons using a 350 MHz radio-frequency (RF). RF must stay stable for the beam to be accelerated and transported without loss. However, momentary RF instability lowers the beam transmission rate, and no system existed to monitor and quantify its timing and frequency in real time. A real-time monitoring system was developed in Python. Connected to the control system through EPICS, it counts an instability event whenever the monitored signal leaves its normal operating range. It displays the live value, event counts in 10-minute bins, and summary statistics, and automatically exports a weekly Excel report with the full event list and a day-by-hour table. In this paper, the developed system quantifies how often and when RF instability occurs, providing objective data for stable accelerator operation.

This work was supported through the KOMAC operation fund of KAERI by Korean government (MSIT, KAERI ID:524320-26)

E-mail: jhma@kaeri.re.kr

PO – 36

Phase-Independent Amplitude Calculation for Accurate Beam Position Measurement in BPMs

GwangUk PARK (IRIS / IBS)
Ji Gwang Hwang (Kangwon National University)
Jangwon Kwon (IRIS / IBS)

The RAON BPM acquires RF signals containing an 81.25 MHz fundamental component and its second and third harmonics over a measurement window of approximately 1 μs, and calculates the signal amplitudes measured at each electrode and the beam position using these amplitudes.

The signals are undersampled at 93.976 MS/s so that each harmonic component is placed at a distinct alias frequency, and 96 samples are used so that each aliased component contains approximately an integer number of cycles within the measurement window of approximately 1 μs.

Under these conditions, when amplitudes are calculated using statistical methods such as RMSE or peak values, the calculated amplitudes exhibit peak-to-peak variations of approximately 12–15% relative to their mean value depending on the phase of the original signal. When phase differences exist between channels due to cables and signal processing circuits, and the sampling phase varies, the calculated beam position can fluctuate even if the actual beam position remains constant.

Therefore, an amplitude calculation method with low phase dependence is required for accurate beam position measurement. In this study, we present a method applying IQ demodulation and near-integer-period sampling conditions to minimize phase-dependent amplitude variations compared with statistical amplitude calculation methods.

E-mail: xmas0902@ibs.re.kr

PO – 37

Preliminary Experimental Study of Stopping Criteria for Longitudinal Phase Space Tomography at PAL-XFEL

Moses Chung (POSTECH)
Geunwoo Kim (POSTECH)
Chang-Kyu Sung (Pohang Accelerator Laboratory)

Longitudinal phase space (LPS) characterization is essential for understanding electron bunch properties and tuning linear accelerators. LPS tomography reconstructs the distribution by scanning a booster cavity phase and measuring momentum profiles with a downstream dipole spectrometer. Conventional iterative reconstruction often terminates at a fixed iteration number or when changes in the reconstructed image fall below a prescribed threshold. However, numerical convergence alone does not establish whether further iterations recover beam structure or amplify measurement fluctuations. In this study, we investigate the feasibility of angle-wise, interleaved k-fold cross-validation (CV) as a stopping criterion, using experimental phase-scan data acquired at PAL-XFEL. Entire momentum profiles at selected RF phases are withheld for validation, while reconstruction uses the remaining profiles. The stopping iteration is selected from the minimum mean validation error, and the final reconstruction uses all measured profiles. Unlike image convergence, CV evaluates the prediction of profiles at withheld RF phases without requiring a known LPS distribution. The comparison examines how the two stopping criteria affect the central correlated structure, longitudinal and momentum profiles, and low-intensity components under the same preprocessing, forward model, reconstruction domain, and initial distribution. This experimental study assesses the practical value of prediction-based stopping for limiting noise-induced fluctuations in LPS reconstruction.

E-mail: geunwoo@postech.ac.kr

PO – 38

Implementation of an Intelligent Fault Diagnosis Framework for Quadrupole Magnets within the 100-MeV Proton Linac Based on a Differentiable Beam Dynamics Model

Donggun Lee
(Department of Energy Engineering, Korea Institute of Energy Technology)
Jeong-jeung Dang*
(Department of Energy Engineering, Korea Institute of Energy Technology)

In high-intensity proton linacs, it is essential to minimize beam loss and maintain precise control. However, existing multi-particle tracking codes are based on non-differentiable, sequential numerical analysis on CPUs, which fundamentally restricts the use of fast, gradient-based optimization. To overcome this limitation, this study adopts Cheetah, a differentiable beam dynamics engine built on PyTorch. Adiabatic damping, dynamic magnetic rigidity, and space charge effects were incorporated into the virtual model to ensure its physical consistency. Building on this differentiable architecture, we further propose a diagnostic framework that identifies physical faults within a large-scale quadrupole magnet array using observations from the end of the linac alone. The framework uses the L-BFGS algorithm to inversely solve for configurations that reproduce the observed beam error states in the virtual model. However, because observations are limited to a single end point, phase degeneracy inevitably arises, in which different combinations of magnet errors result in identical beam states. This mathematical non-uniqueness was mitigated through sparsity-promoting optimization and a ranking-based diagnostic metric, enabling the successful identification of faults involving a partial reduction in magnetic field strength. However, for open-circuit faults, identification accuracy remained limited, as such faults lie relatively far from the nominal state in phase space. Future work will therefore build on the differentiable beam dynamics environment developed in this study to develop a reinforcement learning-based diagnostic approach capable of also addressing various magnet errors or malfunction.

Acknowledgement

This work was supported by the National Research Foundation of Korea (NRF) funded by the Ministry of Science and ICT(RS-2026-25583624).

E-mail: 20230260@kentech.ac.kr, *jjdang@kentech.ac.kr

PO – 39

Commissioning Progress of In-Flight Rare-Isotope Beam Production and Post-Accelerated ISOL Beam Delivery to KoBRA at RAON

Dong Geon Kim (IRIS/IBS)
Kwang-Bok Lee (IRIS/IBS)
Seong Jae Pyeun (IRIS/IBS)
Minsik Kwag (IRIS/IBS)
Mijung Kim (IRIS/IBS)
Jae Cheon Kim (IRIS/IBS)
Changwook Son (IRIS/IBS)
Geonhee Oh (IRIS/IBS)
Cheolmin Ham (IRIS/IBS)
Eunhee Kim (IRIS/IBS)
Sinchul Kang (IRIS/IBS)
Cheong Soo Lee (IRIS/IBS)
Sangjin Lee (IRIS/IBS)
Kyoungho Tshoo (IRIS/IBS)

Rare-isotope (RI) beams provide unique opportunities to investigate nuclear structure, nuclear reactions, and nuclear astrophysics far from the valley of stability. To support scientific and applied programs, the RAON accelerator complex at the Institute for Rare Isotope Science (IRIS), Institute for Basic Science (IBS), has been constructed to deliver RI beams through two complementary production schemes: isotope separation
on-line (ISOL) and in-flight (IF) production. Commissioning progress of two rare-isotope (RI) beam routes with the KoBRA separator at RAON will be reported.

E-mail: kdgeon79@ibs.re.kr

PO – 40

Non-Invasive 2D Transverse Beam Profile Reconstruction Using a 16-Channel Button BPM System and Physics-Informed Neural Networks

Ji-Gwang Hwang (Kangwon National University)
Wookhee Choi (Kangwon National University)
Woohyung Kim (Kangwon National University)
Jangwon Kwon (IRIS / IBS)

Non-destructive, real-time monitoring of transverse beam profiles is essential for optimizing beam transport and minimizing beam loss in high-intensity particle accelerators. While conventional Beam Position Monitors (BPMs) primarily measure beam centroids, extracting two-dimensional spatial distributions remains challenging due to the weak sensitivity of higher-order multipole fields. In this study, we present a machine learning framework to reconstruct 2D transverse beam profiles using a compact 16-channel BPM system, consisting of two 8-button BPMs separated by a 7.5 cm drift space with a 22.5 deg relative azimuthal rotation. By decomposing the 16 electrode signals into monopole, dipole, quadrupole, and higher-order multipole moments alongside cross-correlated outer products, a dual-head Physics-Informed Neural Network (PINN) directly infers the beam centroids and multi-scale spatial envelope parameters. Quantitative evaluations across 1,000 distorted test beams demonstrate high fidelity in reconstructing beam centroids, RMS sizes, x-y coupling correlations, and detailed shape metrics including FWHM, kurtosis, and Wasserstein distances.

E-mail: hwang@kangwon.ac.kr

PO – 41

Study of Transient Beam Loading Effects for Fill Patterns in the Korea Light Source Using the Coupled Haïssinski Equation

Jimin Seok, Gyeongsu Jang, Jaehyun Kim (Pohang Accelerator Laboratory)
Junha Kim, kimoon Nam (Pohang Accelerator Laboratory)

In storage rings with nonuniform bunch filling, transient beam loading induces bunch-to-bunch variations in the cavity voltage and synchronous phase, which in turn distort the longitudinal bunch profiles. For the Korea Light Source (KLS), a third-harmonic cavity for bunch lengthening is under consideration, and if a passive harmonic cavity is adopted, transient beam loading becomes a critical factor, since the harmonic voltage is excited entirely by the beam and is therefore directly affected by the fill pattern. We investigate transient beam loading in the KLS by solving the coupled Haïssinski equation self-consistently for arbitrary fill patterns, both with the main cavities alone and with an additional passive harmonic cavity. The solver is benchmarked against multi-particle tracking with elegant, showing good agreement in the bunch-by-bunch centroid and length. Fill patterns with different gap lengths and bunch train structures are compared, and the dependence of the synchronous phase spread and bunch length variation along the train on the gap configuration is presented. In particular, the passive harmonic cavity is found to significantly enhance the bunch-to-bunch variations. These findings provide input both for selecting fill patterns and for the harmonic cavity design decision for KLS.

E-mail: jseok@postech.ac.kr

PO – 42

Taper-Assisted Beam Entrance Matching and Centering in a THz-Driven Dielectric Laser Undulator

KeonHo Kim (Korea University)
Seong Hee Park (Korea University)
Jinjoo Ko (Korea Basic Science Institute)

The dielectric laser undulator (DLU) is a promising approach for developing compact radiation sources. Electromagnetic fields driven by laser or terahertz (THz) pulses in dielectric structures generate undulator-like transverse motion in relativistic electron beams. In conventional DLU configurations, the electron beam trajectory is displaced from the structural axis. The undulator parameter Kcan be adjusted by changing the drive-field amplitude. However, when the beam is not properly centered, an increase in the offset of the oscillation center leads to a corresponding displacement of the radiation center.

In this study, we introduce a tapered structure at the entrance of a 400-GHz THz-driven DLU to correct the transverse offset and align the beam oscillation with the undulator axis. The structure consists of 0.75 mm unit blocks, giving an effective undulator period of 6.75 mm. The tapered section uses an aperiodic 3+7+7+5+2 block sequence with a total length of 18 mm, followed by a regular periodic section.

Particle-tracking simulations for a 318 MeV electron beam show that, without the taper, the beam oscillates about a horizontal position of approximately −1.58 μm relative to the structural axis. The tapered entrance section corrects this initial offset. These modifications keep the lateral vibration amplitude at approximately 1.5 μm and shift the center of vibration from approximately −1.58 μm to −0.28 μm along the structural axis over a 60 mm interaction length. However, a progressive drift of the oscillation center in the x direction persists as the beam propagates through the subsequent periodic section, resulting in a residual offset downstream. To mitigate this drift, we are currently investigating structural modifications through electromagnetic-field analysis and particle tracking. These modifications include a modular dielectric-block configuration with adjustable inter-block spacing and the insertion of porcelain or metallic components between the blocks.

E-mail: rmsghektzja@korea.ac.kr

PO – 43

Design and Experimental Validation of a White-Beam Profile Monitor for Synchrotron Radiation

Woojin Song (PAL)
Garam Hahn (KNU)
Sun Min Hwang (PAL)
Hyo Jung Hyun (PAL)
Seong Han Kim (PAL)
Jae Hong Lim (PAL)
Yong Sung Park (PAL)

A non-invasive White-Beam Profile Monitor (WBPM) was developed for simultaneous photon beam profile and position measurements at synchrotron radiation sources. The monitor employs a dual-electrode extraction structure and a microchannel plate (MCP)/phosphor-screen readout system. Its spatial resolution was evaluated through electric-field analysis and particle-tracking simulations, considering field distortion, intrinsic MCP resolution, and photo-ion thermal spread. For a xenon gas environment under the PLS-II insertion-device source, the predicted spatial resolution was approximately 95 μm. A prototype with independent horizontal and vertical monitors was tested at the PLS-II beamline using a broadband white-beam component. The measured beam profiles were reasonably reproduced by convolving screen-monitor profiles with the predicted point spread function. A beam position resolution of 29 μm was achieved with a 300 ms exposure time. These results demonstrate the feasibility of non-invasive white-beam profile monitoring and its potential application to online photon diagnostics at low-emittance storage rings.

E-mail: songwj@postech.ac.kr

PO – 44

Beam Dynamics Analysis of the KLS Booster Synchrotron During Injection and Energy Ramping

Hyunchang Jin (KBSI)
Jaehyun Kim (PAL)
Yumi Lee (KBSI)
Seong Hee Park (Korea University)

The Korea Light Source (KLS) is a fourth-generation diffraction-limited storage ring (DLSR) light source currently under construction in the Republic of Korea. The KLS facility comprises an injector system consisting of a compact 200 MeV linear accelerator (linac) and a booster synchrotron, as well as a 4 GeV storage ring designed to produce electron beams with an ultra-low emittance of less than 1 nm·rad. The booster synchrotron, based on a FODO lattice, plays a crucial role in meeting the beam requirements of the storage ring. Therefore, detailed beam dynamics studies are required to evaluate the linac-to-booster injection efficiency and the beam dynamics during energy ramping in the booster synchrotron. This study investigates the effects of eddy currents on particle motion, beam acceptance, and the overall performance of the booster synchrotron.

E-mail: ymlee812@kbsi.re.kr

PO – 45

Photon-Energy-Segmented Undulator Tapering for Wide-Range User Operation of the Soft X-ray Line at PAL-XFEL

Chi Hyun Shim (Pohang Accelerator Laboratory)
Myung-Hoon Cho (Pohang Accelerator Laboratory)
Hoon Heo (Pohang Accelerator Laboratory)
Gyujin Kim (Pohang Accelerator Laboratory)
Seongyeol Kim (Pohang Accelerator Laboratory)
Chang-Kyu Sung (Pohang Accelerator Laboratory)
Haeryong Yang (Pohang Accelerator Laboratory)

The soft X-ray line of PAL-XFEL provides a wide photon energy range by changing the undulator gap at a fixed electron beam energy, allowing users to tune the photon energy themselves. Because the optimal taper varies considerably over this range, no single taper configuration can cover it. As a result, undulator tapering has so far not been offered in user operation. We present a photon-energy-segmented tapering scheme in which the operating range is divided into intervals, each with a pre-optimized taper configuration that is applied automatically when the photon energy enters the interval. Experimental results show improved FEL performance compared with untapered operation across the tested range, demonstrating that tapering can be provided while preserving user-controlled photon energy tuning.

E-mail: sch0914@postech.ac.kr

PO – 46

Longitudinal Wakefield Analysis of Electron Injection in Ti-Al Structured Target LWFA

Hyeon Woo Lee (Dept. of Accelerator Science, Korea University Sejong)
Sang Yun Shin (Dept. of Accelerator Science, Korea University Sejong)
Seong Hee Park† (Dept. of Accelerator Science, Korea University Sejong)

Laser wakefield acceleration using a Ti-Al structured target (LWFA-TA) is investigated with particular emphasis on the role of the electron-density ratio between the Ti and Al layers in determining electron injection and subsequent acceleration. Previous studies using an Al-Ti-Al structured target showed that the Ti layer can substantially modify the wakefield through localized electron injection, beam loading, and density-transition-induced cavity deformation. Based on these observations, the present study examines how variations in the Ti-to-Al electron-density ratio alter the wake-cavity structure and longitudinal electric field in the TA configuration.

Different density ratios produce distinct field distributions near the Ti-Al transition, resulting in different electron trapping and injection behaviors. To identify the role of the longitudinal field in electron trapping, the evolution of the accelerating field is analyzed together with cavity deformation, electron trajectories, and the timing and position of injection. The resulting trapped charge and beam characteristics are compared for different density conditions. Particular attention is given to the relationship between density-transition-induced field modification and the formation of a stable accelerating phase.

E-mail: hwoo257@korea.ac.kr, shpark7@korea.ac.kr†

PO -47

Transport-Free Tomography of High-Dimensional Phase Space in Linacs

Chun Yan Jonathan Wong
(Institute of Modern Physics, Chinese Academy of Sciences)

Phase space tomography that relies on beam transport requires accurate knowledge of the transport map between reconstruction and measurement locations. In practice this map is often imperfectly known: space charge creates a self-consistency problem, and field uncertainties further degrade reconstruction fidelity. Transport-free tomography circumvents these difficulties by reconstructing high-dimensional phase space from single-optics, single-location measurements, eliminating the need for modeled transport and relaxing demands on the upstream beamline. We discuss measurement schemes that extract sufficient cross-plane data, and show how high-dimensional geometry tools can guide the choice of device and measurement parameters to minimize sensitivity to errors. Maximum entropy tomography is established as an effective method for reconstructing high-dimensional distributions from measured projections. We also calibrate f-divergences to quantify differences between distributions, enabling systematic verification and interpretation of the results.

E-mail: wong@impcas.ac.cn

Abstract for Poster Presentation

WG 3

PO – 01

Phase-separated aerogel with photon cage structure enables efficient and complementary X-ray absorption

Shisen Li (Department of Marine Design Convergence Engineering, Pukyong National University, Busan 48513, Republic of Korea)
Yinghui Wang (Key Laboratory of Flexible Electronics (KLOFE) & Flexible Electronics (Future Technologies) & Institute of Advanced Materials (IAM), Nanjing Tech University, 30 South Puzhu Road, Nanjing 211816, China)
Beomgyeong Seo (Department of Materials System Engineering, Pukyong National University, Busan 48513, Republic of Korea)
Joonhwan Kim (Department of Materials System Engineering, Pukyong National University, Busan 48513, Republic of Korea)
Nazmul Hossain (Department of Marine Design Convergence Engineering, Pukyong National University, Busan 48513, Republic of Korea)
Shanmugam Mahalingam (Institute of Energy Transport and Fusion Research, Pukyong National University, Busan 48513, Republic of Korea)
Junghwan Kim (Department of Marine Design Convergence Engineering, Pukyong National University, Busan 48513, Republic of Korea & Department of Materials System Engineering, Pukyong National University, Busan 48513, Republic of Korea & Institute of Energy Transport and Fusion Research, Pukyong National University, Busan 48513, Republic of Korea)

Traditional lead-based materials are becoming increasingly inadequate for advanced radiation protection. The development of high-performance lead-free shielding materials is essential to promote the safer and more efficient use of X-rays. In this study, the effect of the complementary K-edges of Cs3Bi2I9 and Gd on X-ray absorption is investigated. Gd is strategically incorporated into an aerogel through a phase-separation strategy to form a unique “photon-cage” structure. Subsequently, polydimethylsiloxane encapsulation provides the aerogels with excellent mechanical properties and thermal stability. Finally, Cs3Bi2I9 nanomaterials are introduced to produce a photon-cagestructured X-ray-shielding aerogel. This structure effectively prolongs photon residence time and promotes multiple internal scattering events, thereby effectively trapping and absorbing X-ray photons. The fabricated aerogels exhibit excellent X-ray shielding efficiencies, ranging from 76.4 to 97.3% in the 40–120 kV energy range. These findings offer a promising pathway for the development of flexible, high-efficiency, and lead-free X-ray-shielding materials.

E-mail: shisenli@126.com (First author)
Yinghui Wang: yhwang0803@126.com, Beomgyeong Seo: tjqjarud17@naver.com
Joonhwan Kim: ggea1234@pukyong.ac.kr,Nazmul Hossain: islamrony250@gmail.com
Shanmugam Mahalingam: shanmugam.mr3@gmail.com
Junghwan Kim*: junghwan.kim@pknu.ac.kr (Corresponding author)

PO – 02

Stretchable TPU Films Incorporating Double-Shell Core-Shell Nanoparticles for Efficient X-ray Radiation Shielding

Nazmul Hossain* (Department of Marine Design Convergence Engineering, Pukyong National University, Busan 48513, Republic of Korea)
Shisen Li (Department of Marine Design Convergence Engineering, Pukyong National University, Busan 48513, Republic of Korea)
Beomgyeong Seo (Department of Materials System Engineering, Pukyong National University, Busan 48513, Republic of Korea)
Joonhwan Kim (Department of Materials System Engineering, Pukyong National University, Busan 48513, Republic of Korea)
Shanmugam Mahalingam (Institute of Energy Transport and Fusion Research, Pukyong National University, Busan 48513, Republic of Korea)
Junghwan Kim# (Department of Marine Design Convergence Engineering, Pukyong National University, Busan 48513, Republic of Korea, Department of Materials System Engineering, Pukyong National University, Busan 48513, Republic of Korea, Institute of Energy Transport and Fusion Research, Pukyong National University, Busan 48513, Republic of Korea)

Conventional lead-based radiation shielding materials are associated with high density and toxicity, which limits their suitability for next-generation radiation protection systems. Therefore, the development of lightweight, flexible, and lead-free shielding materials has become increasingly important. In this study, we incorporated Bi@W-Sn core-double-shell nanoparticles into a stretchable thermoplastic polyurethane (TPU) matrix to develop an efficient, mechanically adaptable Xray shielding film. The unique core-double-shell structure provides enhanced photon interactions and synergistic X-ray attenuation within the polymer matrix. The fabricated Bi@W-Sn/TPU film exhibited excellent shielding performance, achieving attenuation rates of 97.15%-63.46% over a tube-voltage range of 40-120 kV at a thickness of only 4 mm. These results demonstrate that the Bi@W-Sn/TPU composite is a promising candidate for flexible, lightweight, and efficient lead-free X-ray shielding applications.

E-mail: *Presenting author: nazmulh@pukyong.ac.kr,
#Corresponding author: junghwan.kim@pknu.ac.kr

PO – 03

A Beam Operation Log Analysis Tool for the RAON Accelerator

Jehyeong Yu[1], Ho Nam Park[1], Young Soo Jang[1], Chul Jin Choi[2]
[1]MKV Co.,Ltd., [2]Institute for Rare Isotope Science, Institute for Basic Science

Since July 2025, MKV Corporation has been engaged in the operation and monitoring of the RAON accelerator through an operation service contract. To log and manage daily accelerator beam operations, we introduced ‘MKV Pencil’. With the continuous accumulation of daily logs, analyzing the data for monthly reporting became essential. In this poster, we introduce ‘MKV Analyzer’, which automatically processes the accumulated data for monthly beam reports. This system is expected to significantly improve the efficiency, accuracy, and ease of operation service management.

E-mail: sbb2005@naver.com

PO – 04

Passive Attenuator-Based Directional Response Enhancement in Multi-Channel Gamma-Ray Detectors

Jinhong Kim (Dongnam Institute of Radiological & Medical Sciences)
Kyoung Won Jang* (Dongnam Institute of Radiological & Medical Sciences)

Compact scintillator-based gamma-ray detectors offer high detection efficiency, but obtaining directional information remains challenging, and conventional collimation reduces sensitivity. This study investigated passive lead attenuators for encoding directional information in the relative responses of multiple scintillator channels. MCNP simulations were performed for a four-channel GAGG detector with a Tc-99m source, comparing several lead-rod configurations with a non-attenuated reference. Performance was evaluated based on angle-dependent variations in normalized channel responses and overall detector response. A four-rod arrangement between adjacent scintillators provided the best balance between response-pattern separability and detector response among the evaluated configurations. At an azimuthal angle of 0°, the average response-weighted change in the normalized channel pattern was approximately 58% greater than that of the reference. This arrangement also retained approximately 16% higher overall detector response than a more strongly attenuating alternative. These simulation results suggest that passive attenuator arrangements can enhance directional encoding in compact multi-channel gamma-ray detectors while limiting the loss of detector response. (This work was supported by the Dongnam Institute of Radiological & Medical Sciences(DIRAMS) grant funded by the Korea government (MSIT) (No. 50591-2026))

E-mail: kko988@hotmail.com

PO – 05

Monitoring and Characterization of FLASH Electron Beams from the DIRAMS Research LINAC Using Beam-Current Transformers

Kyoung Won Jang (Dongnam Institute of Radiological & Medical Sciences)
JEONG YEON LEE (Dongnam Institute of Radiological & Medical Sciences)
Pikad Buaphad (Dongnam Institute of Radiological & Medical Sciences)
Dong Hyeok JEONG, Sangkoo Kang (Dongnam Institute of Radiological and Medical Sciences)
Manwoo Lee (Dongnam Institute of Radiological & Medical Sciences)
SangJin Lee (Dongnam Institute of Radiological&Medical Sciences)
Heuijin Lim, Wung-Hoa Park (DIRAMS Research Center)
hyun kim (Dongnam Institute of Radiological & Medical Sciences)

An ultra-high dose rate (UHDR) electron irradiation platform for FLASH research was established at the Research Center of the Dongnam Institute of Radiological & Medical Sciences (DIRAMS) through upgrades to a research linear accelerator (LINAC) and the development of a dedicated electron-scattering device. In this study, beam-current transformers (BCTs) were used to monitor FLASH electron beams generated by the DIRAMS research LINAC and characterize their pulse-by-pulse properties. The frequency components of the signals from the two BCT channels were analyzed using the fast Fourier transform (FFT), and several low-pass filters were evaluated for high-frequency noise suppression. Pulse width was determined as the full width at half maximum (FWHM) of the BCT waveforms. The CH2/CH1 signal ratio was compared with energy-related parameters obtained from film-based percentage depth dose (PDD) measurements. The BCT signals provided pulse-by-pulse information on relative beam output and pulse width. The CH2/CH1 signal ratio showed a correlation with the PDD-derived energy parameters, indicating that the relative responses of the two BCT channels reflected energy-related changes under the investigated beam conditions. BCT-based monitoring enabled pulse-by-pulse characterization of the DIRAMS FLASH electron beam and provided information on its output, temporal structure, and energy-related characteristics. (This research was supported by KRISS-2026-KP2026-0003(DIRAMS 51513-2026).)

E-mail: kko988@hotmail.com

PO – 06

Rutherford-Scattering Beam Normalization for the 21Na+p Elastic-Scattering Experiment at RAON

D.Y. Choi,1,2 J. W. Lee,1 S. Ahn,1 S. Cha,1 A. Chekhovska,1 G. M. Gu,1,3 C. Ham,4,5 K. I. Hahn,1
S. Han,1 S. Kang,4 D. Kim,2 D. G. Kim,4 D. G. Kim,4 M. Kim,1,2 M. Kim,4 S. Kim,1 S. H. Kim,3,6
Y. J. Kim,1 M. S. Kwag,4,5 K. B. Lee,4 T. Lokotko,1 Z. Luo,1 A. Mukherjee,1 G. Oh,4
X. Pereira Lopez,1 S. J. Pyeun,4 C. Son,4 H. Watanabe,1 J. Won,1 and H. J. Yim4
1Center for Exotic Nuclear Studies, Institute for Basic Science, Daejeon 34126, Republic of Korea
2Department of Science Education, Ewha Womans University, Seoul 03760, Republic of Korea
3Department of Physics, Sungkyunkwan University, Suwon 16419, Republic of Korea
4Institute for Rare Isotope Science, Institute for Basic Science, Daejeon 34000, Republic of Korea
5Department of Basic Science, University of Science and Technology (UST), Daejeon 34113, Republic of Korea
6Institute of Basic Science, Sungkyunkwan University, Suwon 16419, Republic of Korea1

Accurate determination of the incident beam intensity is essential for extracting reaction cross sections from nuclear experiments. Among various methods of determining the beam intensity, Rutherford scattering provides a useful beam-normalization method since its well-known differential cross section allows the incident beam intensity to be inferred from only a fraction of the particles scattered into a detector. This method has been used in previous nuclear-reaction experiments. For example, Folden et al. demonstrated an online Rutherford-scattering method for beam-dose measurements, in which fluctuations in accelerator current are directly reflected in the measured yield [1]. Similar applications of Rutherford scattering to radioactive-beam normalization have also been reported [2,3].

We performed the beam-intensity measurement using Rutherford scattering in the recent KO-25-20 experiment at the Korea Broad acceptance Recoil spectrometer and Apparatus (KoBRA) of the Rare isotope Accelerator complex for ON-line experiments (RAON). A 21Na beam was delivered onto a CH2 target for the elastic-scattering measurement, and a 197Au target was placed 50 cm downstream to monitor the beam intensity. The 21Na ions Rutherford-scattered from the Au target were detected by a silicon strip detector placed further downstream. The average beam intensity was extracted from the strip-by-strip yields using the Rutherford differential cross section, the 197Au target areal density, the geometrical solid angle of each strip, and the acquisition time. The measured angular distribution was in good agreement with the Rutherford calculation. The extracted intensity was consistent with the on-target intensity estimated from the beam profile and intensity measured by an upstream PPAC, together with the collimator transmission. The detailed experimental setup and analysis will be presented.

[1] C. M. Folden III et al., “Development of the MARS separator for heavy element studies”, Nucl.
Instrum. Methods Phys. Res. A 678, 1-7 (2012).
[2] K. Y. Chae et al., “First experimental constraints on the interference of 3/2+ resonances in the
18F(p,α)15O reaction”, Phys. Rev. C 74, 012801(R) (2006).
[3] C. M. Deibel et al., “First measurement of the 33Cl(p,α)30S reaction”, Phys. Rev. C 84, 045802
(2011).
[4] D. G. Kim et al., “Beam commissioning of the KoBRA in-flight fragment separator at RAON”,
Nucl. Instrum. Methods Phys. Res. B573, 166043 (2026)

E-mail: kko988@hotmail.com

PO – 07

Radionuclide-Specific Dynamic Inventory for Membrane State Diagnosis and Regeneration Control in Radioactive Liquid Waste Treatment

Danhye Gil[1], Wongu Youn[1], Byungju Lim[2], Jaekyeong Lee[3], Sungsop Lim[3], Yongheum Jo[4], Taehoon Lee[5]

1. Institute for Basic Science (IBS), Daejeon, Republic of Korea
2. Korea Institute of Machinery and Materials (KIMM), Daejeon, Republic of Korea
3. VICTEX Co., Ltd., Incheon, Republic of Korea
4. Hanyang University, Seoul, Republic of Korea
5. Sungkyunkwan University, Suwon, Republic of Korea

Conventional membrane monitoring relies mainly on hydraulic indicators such as transmembrane pressure and flux, which do not directly describe radionuclide retention, release, or breakthrough. This study proposes a radionuclide-specific approach for membrane state diagnosis and regeneration control using dynamic inventory, radionuclide recovery during regeneration, and permeation behavior. Radionuclide activity or concentration and corresponding flow information are acquired from the feed, permeate, and concentrate streams. For each target radionuclide, the inventory within the membrane system is estimated from the time-integrated balance between inflow and outflow, with radioactive decay and parent-daughter ingrowth considered when relevant. Radionuclide amounts recovered during backpulse regeneration and chemical cleaning are compared with the corresponding pre-regeneration and residual inventories to calculate recovery fractions. Combined with a permeation indicator, these parameters distinguish reversible accumulation, strongly bound accumulation, and breakthrough or loss of membrane selectivity. The diagnosed state can guide the selection of operational responses, including backpulse, clean-in-place treatment, permeate isolation or recycle, and membrane-integrity verification. Radionuclide information may be obtained by in-line monitoring or off-line HPGe gamma-ray spectrometry.

This work was supported by INNOPOLIS (RS-2026-25548468) and by the Institute for Basic Science (IBS-I001-D1) funded by the Ministry of Science and ICT (MSIT).

E-mail: gil@ibs.re.kr

PO – 08

Adaptive Reliability Assessment of 225Ac Activity Quantification Using Multiple Daughter Radionuclides and HPGe Gamma-Ray Spectrometry

Danhye Gil, Wongu Youn, Jaehong Kim, Inseok Hong
Institute for Basic Science (IBS), Daejeon, Republic of Korea

Accurate quantification of 225Ac by gamma-ray spectrometry is commonly performed using emissions from its daughter radionuclides because direct gamma-ray emission from the parent is limited for routine high-precision analysis. However, chemical separation or purification can disturb parent-daughter equilibrium, and the different ingrowth behaviors of 221Fr and 213Bi may lead to inconsistent parent-activity estimates, particularly shortly after separation. This study proposes an adaptive measurement framework for assessing the reliability of 225Ac activity quantification using independent estimates derived from multiple daughter radionuclides. High-purity germanium (HPGe) spectra are used to estimate 225Ac activity independently from 221Fr and 213Bi, while measurement uncertainties and sample-history information are incorporated to evaluate their compatibility. A time-dependent reference trajectory based on radioactive decay and ingrowth is used to distinguish expected disequilibrium from measurement-related discrepancies, including insufficient counting statistics, spectral interference, and geometry or efficiency deviations. Based on the diagnosed condition, the framework selects an appropriate follow-up action, such as additional ingrowth time, extended counting, alternative gamma-line analysis, or verification of measurement geometry and efficiency. Candidate actions are compared in terms of expected uncertainty and additional measurement time, and newly acquired spectra are re-evaluated in a closed-loop manner. A representative 225Ac–221Fr–213Bi case demonstrates the distinction between ingrowth-limited and counting-limited conditions. The proposed framework provides a systematic metrological basis for reliable 225Ac quantification in isotope production, separation, purification, and quality-control application\s.

This work was supported by INNOPOLIS (RS-2026-25548468, RS-2026-25506728) and by the Institute for Basic Science (IBS-I001-D1) funded by the Ministry of Science and ICT (MSIT).

E-mail: gil@ibs.re.kr

PO – 09

Two-sided Neutron and Gamma-Ray Shielding Optimization Using a Genetic Algorithm for Electronics in the TR102 Proton Irradiation Facility

Gwang-il Jung*, Young-Seok Hwang, Jeonghyeon Kim, Jae Hyun Lee, Sung-Gu Kim, YuMi Kim, Myung-Hwan Jung
Korea Atomic Energy Research Institute (KAERI), 181 Mirae-ro, Gyeongju, 38180, Republic of Korea.

TR102 is a low-flux proton irradiation facility capable of delivering 10^6 – 10^8 protons/cm^2 per pulse, mainly used for radiation effects testing of semiconductor devices. Secondary neutrons and gamma ray produced when protons are stopped in the aluminum collimator and beam dump are a major cause of degradation of nearby electronics. In this study, the radiation field generated by 100 MeV proton beams was simulated with the Monte Carlo code MCNP, and the neutron and gamma-ray distribution in the facility as well as the dose at the electronics position were evaluated. Subsequently, for a two-sided shield to reduce radiation damage to electronics, a genetic algorithm (GA)-based shielding optimization was performed using three materials – borated polyethylene (BPE), high density polyethylene (HDPE), and lead (Pb) – with a shielding consisting of two layers per side (four layers in total), a total thickness limited to 40 cm, and the objective of minimizing the total dose to electronics. This paper presents the evaluation of the unshielded radiation field, together with the results of the GA-based two-sided shielding optimization in terms of the total dose reduction at the electronics position and the resulting layer material and thickness arrangement.

E-mail: jkii0607@kaeri.re.kr

PO – 10

Contribution of Spatially Localized Scattered Primary Electrons to BSE Signals in Atmospheric SEM

MuHyeop Cha(Seoul national university), Jiseong Nam(Seoul national university), Kyoung-Jae Chung*(Seoul national university)

Atmospheric scanning electron microscopy (A-SEM) enables specimen observation at atmospheric pressure, but electron scattering in the membrane and gas complicates the interpretation of backscattered-electron (BSE) image signals. Previous approaches have emphasized the unscattered primary-beam fraction as an indicator of high-resolution imaging capability, assuming that scattered electrons form a broad skirt whose contribution to local image contrast is negligible. In this work, we extend the estimation of the useful BSE signal by including spatially localized scattered primary electrons in the core population and distinguishing their BSE contribution from that of halo primary electrons. Using Geant4 simulations, we evaluate how A-SEM geometry affects the relative BSE contributions of unscattered, localized scattered, and halo primary electrons.

* This work was supported by the Research of Improving Secondary Electron Collection Efficiency in Scanning Electron Microscope through COXEM Co.,Ltd.

E-mail: cmh71317@snu.ac.kr

PO – 11

A Project Management Framework for BEMCal and GEM+μRWELL R&D in the International Collaboration for the EIC ePIC Detector

Yangho Lee (Institute for Basic Science)
Yeonsei Chung (Institute for Basic Science)

The Electron-Ion Collider(EIC) is a next-generation research facility currently under development in the United States, designed to study the structure of nucleons and atomic nuclei through electron-ion collisions. The ePIC(Electron-Proton/Ion Collider Detector) is being developed through an international collaboration involving multiple nations, with South Korea participating via in-kind contributions. To facilitate smooth international cooperation, an International Cooperative Research and Development Agreement(iCRADA) has been signed between government agencies, establishing a legally binding framework for the partnership.

Among the detector systems considered for South Korea's participation, the Barrel Electromagnetic Calorimeter(BEMCal) and the GEM+μRWELL detector were selected as key development areas. The BEMCal is designed to measure the energy of electrons and photons, while the GEM+μRWELL detector is used to track charged particles. The development process for these detectors encompasses design, research and development(R&D), prototyping, performance testing, mass production, quality assurance, delivery, installation, and integration into the ePIC detector.

Given that these activities span approximately seven years and involve numerous domestic institutions and international partners, a systematic project management framework is essential. This study develops a project management framework for South Korea's EIC detector development program, based on the Earned Value Management(EVM) concepts utilized in large-scale projects by the U.S. Department of Energy(DOE). This framework monitors project progress by integrating scope, schedule, budget, technical milestones, and risks. This study aims to establish a systematic and practical project management system to support Korea's contributions to the EIC detector program. This initiative is expected to facilitate effective collaboration among the EIC(BNL), research institutions(IBS), and domestic universities, while contributing to the successful development, fabrication, installation, and integration of the BEMCal and GEM+μ RWELL detectors.

E-mail: yhlee@ibs.re.kr

PO – 12

Characterization of RF-induced X-ray Emission from KOMAC DTL Tank

Gyuhaeng Jo, Sungbing Park, Namhoon Lee, Jihwan Ma, Han-Sung Kim,
Hyeok-Jung Kwon*
(Korea Multi-purpose Accelerator Complex,
Korea Atomic Energy Research Institute,
181, Mirae-ro, Gyeongju-si, Gyeongsangbuk-do, Republic of Korea)
Junsik Kim
(Department of Nuclear Engineering, Seoul National University,
1, Gwanak-ro, Gwanak-gu, Seoul, Republic of Korea)

Pilot research and development for the upgrade of the proton accelerator to 200 MeV is being conducted at KOMAC (Korea Multi-purpose Accelerator Complex), whose scope includes the construction of a room for four separated drift tube linacs (SDTLs). Since the DTL tanks emit bremsstrahlung X-rays with energies of a few hundred keV due to electrons generated by field emission under RF operation, the SDTL room must ensure compliance with the annual occupational dose limit, which is 20 mSv/yr for occupationally exposed workers. Thus, establishing additional shielding walls around the SDTLs must be incorporated into the SDTL test room design. To optimize the geometry and material composition of the shielding walls, it is necessary to obtain the X-ray energy spectrum of the planned SDTLs. Therefore, X-ray measurements at the KOMAC DTL tank by exploiting an HPGe detector were conducted in this study to acquire reference data on the SDTL X-rays. In addition, Monte Carlo simulations of the DTL tank were carried out to verify the accuracy of the detection results. These experimental results indicate that the KOMAC DTL103 tank, with an approximate maximum gap voltage of 700 kV, emits X-rays with an average energy of 125 keV.

This work was supported through KOMAC operation fund of KAERI (KAERI ID no.524320-26) funded by MSIT (Ministry of Science and ICT).

E-mail: hjkwon@kaeri.re.kr

PO – 13

Soft X-ray Spectral Unfolding of a Cold-Cathode X-ray Tube Using Filtered Silicon Photodiodes

Ookjin Choi
YeongHwan Choi (Seoul National University)
Kyoung-Jae Chung (Seoul national university)

The responses of Z-pinch X-ray diagnostics depend on photon energy and exposure time, so they must be verified and calibrated with a pulsed X-ray source in a similar energy band. Since DC X-ray sources cannot reproduce pulsed conditions and laser-produced plasma sources require large facilities, a compact cold-cathode X-ray tube generating short X-ray pulses by field emission is a practical laboratory-scale alternative. To use this tube as a calibration source, its X-ray spectrum under pulsed operation must be characterized. This study aims to validate a spectral unfolding method using a single-channel detector system consisting of a filter and a silicon photodiode, and to apply the validated method to pulsed operation of a commercial cold-cathode X-ray tube. Under DC operation, the unfolded spectrum will first be compared with a reference spectrum measured using a silicon drift detector (SDD) to assess the accuracy of the reconstruction. The method will then be applied to obtain the soft X-ray spectrum under pulsed operation as a function of the applied voltage.

E-mail: chldnrwls1@snu.ac.kr

PO – 14

Evaluation of SRIM-Based Energy Estimation at the Sample Position for Low-Energy Proton Beams by Comparison with Direct Measurements

Seong-Gu Kim (KAERI)
Young Seok Hwang (KAERI)
Gi Wan Jeon (KAERI)
Gwangil Jung (KAERI)
Myung-hwan Jung (KAERI)
Jeonghyeon Kim (KAERI)
Yu-Mi Kim (KAERI)
Jaehyun Lee (KAERI)

The proton energy at the sample position is an important irradiation parameter. At the 20 MeV proton beam target room of the Korea Multi-Purpose Accelerator Complex (KOMAC), the beam energy downstream of the beam exit window is measured using a multilayer Faraday cup (MLFC). The energy at the sample position is then estimated with SRIM by accounting for energy losses in air and an aluminum degrader. In this study, we will directly measure the energy of a 10 MeV proton beam at the sample position and compare it with the SRIM estimate for the same position. We will examine the difference between the two results and the repeatability of the measurements. Based on this comparison, we will use the same SRIM-based energy estimation method to determine the aluminum degrader thickness and sample position needed to obtain a target proton energy of 5 MeV. This study aims to evaluate the current energy estimation procedure and provide data for setting the irradiation conditions of a 5 MeV proton beam.

E-mail: ksgk2@kaeri.re.kr

PO – 15

Comparative Evaluation of Secondary Radiation for the Replacement of an Al Collimator with HDPE at the KOMAC TR102 Proton Irradiation Facility

Jeonghyeon Kim*, Gwang-il Jung, Seong-Gu Kim, Jaehyun Lee, Yu-Mi Kim, Young-Seok Hwang and Myung-Hwan Jung
Korea Atomic Energy Research Institute (KAERI), 181 Mirae-ro, Gyeongju, 38180, Republic of Korea.

The TR102 low-flux beamline at the Korea Multi-purpose Accelerator Complex (KOMAC) uses a collimator to confine the proton beam to the required irradiation area. However, interactions of incident protons with the collimator and the beam dump generate secondary neutrons and gamma rays that may affect nearby electronics. To reduce residual dose rates associated with its activation, the existing 4-cm-thick aluminum (Al) collimator was replaced with an 8-cm-thick high-density polyethylene (HDPE) collimator. Because this change in collimator configuration may also alter secondary neutron and gamma-ray fluxes during irradiation, its effects were evaluated by comparing the Al and HDPE configurations.
Using the Monte Carlo N-Particle (MCNP) code, the TR102 target room was modeled for a 100 MeV proton beam. Collimator aperture sizes of 20, 15, 10, and 5 cm were considered, and secondary neutron and gamma-ray fluxes were calculated at the target and electronics locations for both configurations. This paper presents variations in secondary radiation with aperture size and provides a basis for assessing the suitability of HDPE as a replacement for the Al collimator in TR102.

E-mail: jhkj4855@kaeri.re.kr

PO – 16

Online Monitoring System for Pulse-by-Pulse Beam Charge Acquisition in FLASH electron LINAC

Hyun Kim, Heuijin Lim, Kyoung Won Jang, Dong Hyeok Jeong, Wung-Hoa Park, Pikad Buaphad, Sang Jin Lee, Sang Koo Kang, and Manwoo Lee*
Research center, Dongnam Institute of Radiological and Medical Sciences, Busan 46033, Korea

FLASH radiotherapy research requires accurate measurement of the beam charge delivered in each individual pulse, as biological responses are influenced by dose per pulse and dose rate. This study presents the development and commissioning of a beam-charge acquisition system for electron LINAC at the DIRAMS. Two beam current transformers (BCTs) are installed in air downstream of the beam exit window. The BCT1 is positioned immediately after the exit window and serves as the machine-side reference, whereas BCT2 is located downstream of the flattering foil, immediately upstream of the irradiation position, to monitor the beam charge delivered toward the irradiation target. Signals from both BCTs are digitized using a PXIe-5162 module in a PXIe-1082 chassis and controlled by a PXIe-8881 controller. The system operates at a sampling rate of approximately 100 MS/s, corresponding to a temporal resolution of 9.6 ns per sample. The monitoring system is developed for different operating modes: a continuous-run mode provides real-time monitoring of the charge of individual pulses without data storage for beam tuning, while a pulse-run mode acquires a predefined number of pulses and stores both raw waveform and pulse-by-pulse charge data. Stable acquisition was demonstrated at pulse repetition rates of up to 250 Hz for runs of 1000 pulses. A BCT-based online monitoring system has been successfully implemented and is currently acquiring beam data in real time during LINAC operation. The high-speed data processing algorithm is being further optimized through real-time pedestal subtraction, high-frequency noise suppression and minimization of processing time.
(This research was supported by KRISS – 2026 – KP2026 – 0003(DIRAMS 51513-2026).

Keywords: beam current transformer, per-pulse charge measurement, PXIe digitizer, LabVIEW data acquisition, self-triggering, FLASH radiotherapy

E-mail: kh2532@naver.com

PO – 17

AI-Assisted Robotic Laser Profiling for RF Cavity Localization and Geometric Inspection

Wung-Hoa Park, Heuijin Lim, Sang Jin Lee, Hyun Kim, Sang Koo Kang,
Kyoung Won Jang, Dong Hyeok Jeong, Pikad Buaphad, Jeong Yeon Lee, Manwoo Lee
(Research Center, Dongnam Institute of Radiological and Medical Sciences,
Busan, Korea.)

Precise geometric inspection of accelerating structures is essential before and after vacuum brazing, yet conventional 2D measurement systems require the structure to be moved, and their curved, reflective copper surfaces hinder non-contact measurement. We present the first step toward a robot-based non-contact 3D measurement system in which a six-axis robot moves the sensor around a vertically fixed accelerating structure. The system combines a Keyence LJ-X8080 line laser profiler (Z range ±20.5 mm, X width up to 39 mm, Z repeatability 0.5 μm) with a ZEUS ZRA-0514N six-axis robot (repeatability ±0.02 mm). AI analyzes initial surface-height data to locate the cavity and estimate its center and diameter, and the robot then positions the profiler to acquire cross-sectional profiles. The system is being applied to C-band (5712 MHz) OFHC copper half-cells, whose nose, depth, and diameter all fall within the profiler's measurement range. Preliminary profiles showed the main cavity features, while steeply sloped regions require further investigation.

(This work was supported by the DIRAMS grant funded by the Korea government (MSIT) under grant 50704-2026.)

E-mail: whpark92@gmail.com

PO – 18

Neutron Spectrometry of AmBe, DD and DT Sources Using an EJ-301 Liquid Scintillator

Geonhee Oh (IBS/IRIS)
Cheolmin Ham (Institute for Basic Science)
Kwang-Bok Lee (IBS/IRIS)
CheongSoo Lee (IBS/IRIS)
Shinchul Kang (IBS/IRIS)
Dong Geon Kim (Institute for Rare Isotope Science, Institute for Basic Science)
Young Soo Yoon (KRISS)
JoongHyun Kim (KRISS)
Jungho Kim (KRISS)
Hyeonseo Park (KRISS)
YoungOuk Lee (KAERI)
Kyoungho Thsoo (IBS/IRIS)

The Neutron-induced nuclear Data Production System (NDPS) at RAON provides neutron fields up to several tens of MeV for nuclear data measurements, and a spectrometer validated against reference fields is required to characterize them. We report neutron spectrometry of AmBe, DD (2.8 and 3.2 MeV) and DT (14.6 and 14.8 MeV) reference fields at KRISS using a 2″ × 2″ EJ-301 liquid scintillator. Light output was calibrated with gamma-ray Compton edges, and the resolution was determined from the edge widths. Neutron events were selected by pulse-shape discrimination. The response matrix was generated with PHITS, with the proton light-output function constrained by the DD/DT data, and pulse-height distributions were unfolded with the GRAVEL algorithm (UMG 3.3) from a flat initial spectrum. The unfolded AmBe spectrum follows the ISO 8529-1 reference spectrum, and the DD and DT spectra are compared with KRISS MCNPX reference spectra. Refolding the solutions reproduces the measured pulse-height distributions within integrated absolute differences of 0.5–4.6%. Combining the absolute response with the acquisition time gives detector-position fluence rates; for AmBe, the rate in 2.025–11 MeV is 89.3 cm^{-2} s^{-1}, 2.2% below the isotropic point-source estimate from the certified emission rate at 85 cm. Application of the procedure to the white neutron field of NDPS and the required extension of the response model above 20 MeV are discussed.

E-mail: geonheeoh@ibs.re.kr

PO – 19

Simulation and Experimental Study for the Improvement of the RIID at the IRIS ISOL Facility

Youngjae Lee, Hee-Joong Yim (IRIS/IBS)
Hee-Joong Yim (Institute for Rare Isotope Science, Institute for Basic Science)

Tape stations are widely employed in nuclear physics laboratories for the measurement and study of radionuclides. A tape station, referred to as RIID, is installed at the ISOL facility in IRIS. To enable timing measurements and reduce background contributions, an upgrade of the existing system is required. Geant4-based Monte Carlo simulations were carried out to evaluate the current setup and to investigate the effects of detector geometry on system performance. In addition, timing data from the detectors were acquired and analyzed to investigate appropriate coincidence conditions for background reduction. This presentation introduces the experimental setup of RIID and presents simulation results on detector response and background contributions, along with experimental results from timing and coincidence measurements.

E-mail: ylee@ibs.re.kr

Abstract for Poster Presentation

WG 4

PO – 01

Mass and Half-Life Distributions of Products Generated by 40–70 MeV Proton Irradiation of a Thorium-232 Target

Jaehong Kim[1,2], Beomyeol Baek[1], Danhye Gil[1], Kyoungyong Noh[3],
Heejoong Yim[1,2], Taeksu Shin[1,2]

1. Institute for Rare Isotope Science (IRIS),
Institute for Basic Science (IBS), Korea
2. TOPTIER Project, Institute for Rare Isotope Science (IRIS),
Institute for Basic Science (IBS), Korea
3. Nuclear Engineering Serves & Solutions, Daejeon, Korea

Proton-induced reactions of a ^{232}Th target produce numerous radionuclides through fission, spallation, fragmentation, and particle-emission processes. At 70 MeV, the activity distribution shows two broad peaks in the intermediate-mass region and a lower yield near the central mass region, representing the characteristic asymmetric-fission pattern of thorium. Products remaining near the target mass are mainly associated with spallation and successive nucleon-emission reactions. The half-life distribution extends over many orders of magnitude, indicating the simultaneous production of short-lived nuclides responsible for high initial activity and long-lived residual nuclides relevant to radionuclidic purity, radiation safety, and waste management. This study aims to analyze changes in product distributions as the incident proton energy increases from 40 to 70 MeV. The comparison will examine total fission yield, positions and widths of the fission-product peaks, light-to-heavy fragment yield ratios, residual heavy-nuclide production, and half-life-dependent activity. The results will clarify the energy-dependent reaction mechanisms and support the selection of irradiation conditions that enhance desired radionuclide production while limiting unwanted radioactive impurities. This work was supported by INNOPOLIS (RS-2026-25506728) and by the National Research Foundation of Korea through the TOPTIER program (RS-2024-00436392), funded by the Ministry of Science and ICT, Republic of Korea.

This work was supported by INNOPOLIS (RS-2026-25506728) and by the National Research Foundation of Korea through the TOPTIER program (RS-2024-00436392), funded by the Ministry of Science and ICT, Republic of Korea.

E-mail: jhkim68@ibs.re.kr

PO – 02

Low-energy proton irradiation of Fe_3O_4@SiO_2 core-shell nanoparticles: Probing iron reduction in lunar glass analogues

Eunju KIM (Seoul National University of Science & Technology)
Yae-Eun KIM (Seoul National University of Science & Technology)
Jaehwan KIM (Korea institute of Geoscience and mineral resources)

Solar-wind-driven modification of iron-bearing lunar materials is considered an important contributor to space weathering, yet the influence of surrounding silicate matrices on iron reduction remains insufficiently constrained under low-energy, low-fluence proton irradiation. Here, Fe_3O_4@SiO_2 core-shell nanoparticles with nominal silica shell thicknesses of 3 and 18 nm were prepared as simplified analogues of iron-bearing lunar glass spherules and subjected to accelerator based proton irradiation. Transmission electron microscopy was used to characterize the core-shell structures, and Fe 2p X-ray photoelectron spectroscopy was employed to examine irradiation induced changes in iron oxidation states. Based on the fitted Fe^{2+} and Fe^{3+} components across both spin-orbit regions, the relative Fe^{2+} spectral contribution increased from 37.2% to 61.4% for the 3-nm-shell particles and from 34.0% to 53.9% for the 18-nm-shell particles following irradiation.

These changes are consistent with partial reduction of ferric iron, with a larger apparent increase in the ferrous contribution observed for the thinner silica shell. The results suggest that silica encapsulation may modulate the redox response of iron oxide to proton irradiation, motivating further investigation of hydrogen transport, irradiation-induced defects, and oxygen redistribution.

This study demonstrates the utility of low-energy proton beams and structurally controlled core-shell analogues for probing irradiation-associated iron redox changes relevant to lunar space weathering.

E-mail: eunjukim@seoultech.ac.kr

PO – 03

Monte Carlo simulation of a bending magnet based upward vertical electron beam irradiation device for preclinical research

[1]Kyoung Won Jang, [1]Heuijin Lim, [1]Manwoo Lee, [1]Wung-Hoa Park,
[1]Jeung Kee Kim, [1]Dong Hyeok Jeong
(Research Center, Dongnam Institute of Radiological and Medical Sciences, Busan, Korea. [1])

The research center at the Dongnam Institute of Radiological and Medical Sciences (DIRAMS) conducts cell and animal based preclinical studies using an electron linear accelerator (LINAC). The electron beam irradiation system primarily consists of a 6 MeV LINAC and an electron beam scattering head. However, since current LINAC deliver a horizontal beam, there are difficulties in dose delivery when irradiating cells cultured in dishes. In this study, a 270-degree bending magnet device was designed using the mcnp® Monte Carlo code to redirect a horizontally incident electron beam into an upward vertical direction. The electromagnet, designed for an initial electron beam energy of 5 MeV with a a full width half maximum (FWHM) of 25%, had a radius of 7.5 cm, and the magnetic field strength was approximately 0.3 Tesla. Monte Carlo calculation results showed that the electron beam passed through the vertically positioned beam head and successfully reached the cultured cells in the dish. Although the electron beam flux decreased to 70.1% of that of a horizontal beam without an electromagnet, it remained sufficient for cell irradiation.

(This work was supported by the DIRAMS grant funded by the Korea government (MSIT) under grant 50704-2026.)

E-mail: physics@dirams.re.kr

PO – 04

Material-Dependent Ion-Implantation Response Studied by Dynamic BCA Simulation (SDTrimSP): 28Si Self-Implantation and N+ Implanted Al2O3

Chan Young Lee, Suk Jaekwon, Ha Jun Mok, Hwang Young Seok, Yang In Mok, Yeo Sunmog, Park Jun Kue and Jung Myung-hwan
Korea Atomic Energy Research Institute (KAERI), 181 Mirae-ro, Gyeongju, 38180, Republic of Korea.
*Corresponding author: chlee@kaeri.re.kr
*Keywords : Dynamic BCA simulation (SDTrimSP, High-fluence ion implantation, Surface composition evolution

Ion implantation at the high fluences used in practical ion-beam processing continuously modifies the composition and surface position of the target. The widely used static binary-collision-approximation (BCA) code SRIM, however, assumes a fixed target and therefore cannot capture this fluence-dependent evolution. Here we employ the dynamic BCA code SDTrimSP, which updates the target composition and surface position at each fluence step, to model two contrasting systems (an elemental semiconductor and a binary oxide insulator) and compare each prediction with experiment. For 45 keV 28Si+ self-implantation into natural Si to 2.63 x 10^18 cm^-2, relevant to isotopic purification for spin-qubit devices, the simulation predicts a near-surface 28Si-enriched layer (29Si+30Si ~0.2%) extending to ~130 nm, well beyond the implant range estimated by static SRIM; the predicted plateau and its steep decay to the natural composition agree with SIMS depth profiles. For 100-200 keV N+ implantation into alpha-Al2O3, the simulation predicts preferential oxygen sputtering that progressively lowers the surface O/Al ratio below the stoichiometric 1.5 while the ratio beneath the surface remains near 1.5; this Al-enriched surface is consistent with the measured transition of the initially insulating surface to a conducting state (surface resistance ~10^3 ohm). Together, these results show that dynamic BCA simulation provides an experimentally supported description of high-fluence implantation that static codes cannot offer.

E-mail: chlee@kaeri.re.kr

PO – 05

Controlled Degradation of Silk Using a 2.5 MeV Electron Beam for Cultural Heritage Conservation

Jin-Mun Yun*, Huisu Kim, Youn-Mook Lim, and Byungnam Kim
Advanced Radiation Technology Institute (ARTI), Korea Atomic Energy Research Institute (KAERI),
29 Geumgu-gil, Jeongeup-si, Jeonbuk-do, Republic of Korea

The mechanical mismatch between new silk fabrics and aged painting substrates is a concern in cultural heritage conservation. This study investigated electron beam irradiation as a method for modifying silk intended for restoration applications. Silk samples were irradiated using a 2.5 MeV electron accelerator at absorbed doses of 3,000–7,000 kGy, with and without water. Irradiation-induced changes were examined by tensile testing, scanning electron microscopy, Fourier transform infrared spectroscopy, thermogravimetric analysis, X-ray diffraction, colorimetry, and water contact angle measurements. Tensile strength decreased markedly with increasing absorbed dose, whereas scanning electron microscopy revealed no obvious fiber breakage under the conditions examined. Infrared spectral changes indicated chemical modification of the silk, consistent with irradiation-induced degradation. Colorimetric measurements showed changes in brightness and yellowness, while contact angle measurements indicated generally increased surface wettability. A deviation from the wettability trend at the highest dose warrants further examination. These results demonstrate that electron beam irradiation can reduce the mechanical strength of silk while largely retaining its observable fiber morphology. The findings support the potential of electron beam processing for preparing silk restoration materials, with dose selection guided by the balance between mechanical weakening, optical appearance, and surface wettability. Compatibility with aged artworks remains to be validated.

E-mail: yjm90@kaeri.re.kr

PO – 06

Long-term monitoring of $\Delta^{14}C$ using AMS in Gyeongju, South Korea (2018-2026)

Seung-Won Lee (Dongguk University WISE)
Yu-Seok Kim (Dongguk University WISE)
Sae-Hoon Park (Dongguk University WISE)

Accelerator mass spectrometry (AMS) is one of the most precise analytical tools for radiocarbon measurement and has been widely applied to environmental studies. In this study, radiocarbon in leaves collected in Gyeongju, South Korea, was analyzed using AMS during 2018-2026. Annual variations in $\Delta^{14}C$ were evaluated to examine changes over the study period. The annual $\Delta^{14}C$ records provide information on temporal variations in the regional environment and demonstrate the applicability of AMS radiocarbon measurements for long-term environmental monitoring.

E-mail: 26adrds@naver.com

PO – 07

Photoluminescence of Property Changes in ZnO Following Nitrogen Ion Implantation

BomSok Kim (Radpion Inc.)
JaeWon Choi (Radpion Inc.)
MyungJin Kim (Radpion Inc.)

Ion implantation is a method for modifying the properties of semiconductor thin films, and photoluminescence (PL) provides an optical approach to examining the associated changes. In this study, we performed preliminary PL measurements of nitrogen-ion-implanted ZnO thin films to investigate optical characteristics relevant to implantation-induced property changes. The work focused on measuring and comparing PL spectra from implanted films and an unimplanted reference, together with evaluating the optical measurement configuration.

ZnO samples were implanted with nitrogen ions at 20 keV and fluences of 1 × 1014, 1 × 1015;, and 1 × 1016; ions/cm², with an unimplanted sample serving as a control. A 275 nm ultraviolet light-emitting diode was used as the excitation source. A bandpass filter centered at 266 nm was installed in the excitation path, and a longpass filter transmitting wavelengths above 395 nm was used in the detection path to reduce the contribution of excitation light to the measured signals. The excitation spectrum and background signals were also measured as part of the preliminary assessment of the measurement conditions.

PL spectra were recorded using a spectrometer. Spectra of the unimplanted and implanted samples were compared to examine emission intensity and spectral shape in relation to the implantation conditions. The spectroscopic measurements were also compared to examine signal detection and the influence of background signals. In addition, an optical configuration incorporating ultraviolet excitation, wavelength-selective filters, and spectroscopic detection was designed for integration with a vacuum ion-implantation chamber. This presentation describes the preliminary experiments and comparative measurements conducted to examine property changes in ion-implanted ZnO thin films through their PL signals.

E-mail: chjw109@naver.com

PO – 08

Current status of fabricating the ^{28}Si enriched layer using ion implantation method

Jaekwon Suk*, In Mok Yang, Jun Mok Ha, Yong Seok Hwang, Jun Kue Park, Chan Young Lee, Myung-Hwan Jung, Sunmog Yeo
Particle Beam Research Division, Korea Atomic Energy Research Institute
*jksuk@kaeri.re.kr

Silicon-based quantum devices have recently attracted significant attention because they are easy to fabricate and possess excellent quantum properties. It has been reported that isotopes within silicon with nuclear spins reduce the coherence time of silicon-based quantum devices. In silicon-based quantum devices, silicon-28 enrichment is a key technology that can significantly enhance device performance. Silicon-28 enrichment can be carried out using centrifugation, laser isotope separation, ion implantation, and other methods. Although centrifugation and laser isotope separation have many advantages, they are not currently being actively studied due to regulatory and efficiency issues. We have been conducting research on the fabrication of silicon-28 enriched layers using ion implantation method since last year. We have derived ion beam implantation conditions favorable to concentration and are improving the ion implantation device to suit them. Currently, silicon-28 is concentrated to about 97% by ion implantation, and defects caused by the ion implantation were attempted to be eliminated through a heat treatment process.

PO – 09

Study on the Formation of Heterogeneous Interfaces via Metal Ion Implantation and Cu Sputtering to Prevent Delamination in TGV Metallization

Woo Seong Jeong, Min Kyo Jeong, Bom Sok Kim, Myung-Jin Kim
(Radpion Inc., Korea)

In the TGV (Through Glass Via) metallization of glass substrates for next-generation 3D packaging, achieving uniform deposition in high-aspect-ratio (AR ≥ 10) micro-vias and preventing delamination at the glass-copper (Cu) interface remain critical challenges. To resolve these issues, we propose a novel integration process that forms a functional heterogeneous interface by implanting metal ions into the glass surface prior to Cu sputtering. TRIM simulations and MEIS measurements cross-validated the formation of a gradual mixing layer up to a depth of approximately 30 nm. This mixing layer maximizes chemical bonding during subsequent sputtering, effectively suppressing delamination and securing excellent interfacial adhesion even in AR ≥ 10 structures. Furthermore, SEM analysis confirmed Cu deposition thicknesses of ~850 nm on the surface and ~200 nm on the via cross-section, and the electrical continuity of the metal layer penetrating the TGV was successfully verified. These findings provide a crucial foundation for commercializing glass substrate packaging. Based on this, a mass-production system capable of processing 510 × 515 mm large-area substrates is currently under construction.

[Acknowledgment] This work was supported by the Tech Incubator Program for Startup (TIPS) grant funded by the Ministry of SMEs and Startups (MSS, Republic of Korea) (Project No. RS-2026-25543153).

E-mail: wsjeong@radpion.com

PO – 10

Current Status of a High-Energy Neutron Energy and Dosimetry System at the KOMAC 100 MeV Proton Beam Dump Facility

Gi Wan Jeon, Young Seok Hwang, Gwang-il Jung, In Mok Yang, Jun Mok Ha, Jeonghyeon Kim, Seong-gu Kim, Jaehyun Lee, and Myung-Hwan Jung*
(Particle Beam Research Division, Korea Atomic Energy Research Institute (KAERI), 181 Mirae-Ro, Geonchon-Eup, Gyeongju-Si 38180, Republic of Korea)

This study presents the current development of a neutron energy and dosimetry system utilizing the 100 MeV proton accelerator at the Korea Multi-purpose Accelerator Complex (KOMAC). To effectively utilize secondary neutrons generated during the primary beam disposal, a dedicated neutron irradiation room was established around the copper beam dump. Simulation results demonstrate that the energy distribution of the high-energy neutrons, produced upon the 100 MeV proton beam's impingement on the copper dump, extends up to 100 MeV. The 100 MeV neutron spectrum closely resembles the `ratios of terrestrial cosmic-ray neutrons within that specific energy regime. For real-time dose monitoring inside the neutron target room, a plastic scintillator-based system has been installed. Furthermore, a measurement system utilizing Pulse Shape Discrimination (PSD) technology has been implemented to accurately characterize the neutron energy spectrum and spatial distribution. To further improve measurement precision, a Helium-3 (3He) detector is scheduled for future deployment.

E-mail: jgw23@kaeri.re.kr (speaker),
jungmh80@kaeri.re.kr (corresponding author)

PO – 11

Track-Averaged LET Measurement Using Faraday Cup and Integral Depth-Dose Distribution in Therapeutic Proton Beam

Sung Hun Kim[1], Sang-il Pak[3], Chae-Eon Kim[2], Sanghoon Lee[2], Sangheon Hyun[2], Dongho Shin[2], and Se Byeong Lee[2]*

[1]Department of Radiation Oncology, Yonsei University College of Medicine, Seoul, Republic of Korea
[2]Proton Therapy Center, National Cancer Center, Goyang, Republic of Korea
[3]Pusan National University Yangsan Hospital, Yangsan, Republic of Korea

Introduction: Linear energy transfer (LET) is a key physical quantity for modelling the relative biological effectiveness (RBE) in particle therapy. The dose-averaged LET (LETd) is commonly used in RBE models; however, LETd-based models have a limitation because the RBE decreases above approximately 100 keV/μm, which can lead to an overestimated RBE. Therefore, the track-averaged LET (LETt) is worth investigating as a basis for RBE models, particularly for heavy-ion therapy, yet experimental methods for LETt remain limited. In this study, we determined LETt in a therapeutic proton beam from the charge collected by a Faraday cup (FC) and a measured integral depth-dose (IDD) distribution. The reproducibility and accuracy of the method were evaluated against Monte Carlo (MC) simulation.

Materials and Methods: Measurements were performed with a single Bragg peak proton beam with a physical range of approximately 321.3 mm in water, delivered in double-scattering mode by a 230 MeV cyclotron (C235, Ion Beam Applications S.A., Belgium) at the National Cancer Center Korea (NCCK). A brass FC (12.57 cm in diameter, 6.35 cm thick) was placed behind phantoms of various thicknesses, which were changed for each of 21 measurement points covering water-equivalent depths of 16.4 to 401.2 mm. At each depth, the charge was measured three times with the same monitor units, and the averaged charge was normalized to its maximum value to obtain the relative proton fluence (ΦFC). The IDD was measured in a water phantom using a large-area plane-parallel ionization chamber (PTW 34070 Bragg peak chamber). MC simulations of the same beam were performed to calculate the proton fluence, IDD and LETt in water. LETt was derived as $LETt(z) = \alpha \cdot IDD(z)/\Phi FC(z)$.

Here, α is a normalization factor determined from the present data by matching the FC-derived LETt to the MC value at the entrance. Because this formulation assumes that the FC charge is proportional to the primary proton fluence, LETt was evaluated at the 13 measurement depths from the entrance (16.4 mm) to the Bragg peak (318 mm), where primary protons dominate the FC signal.

Results: From the entrance to the Bragg peak, the relative standard deviation of the three repeated FC measurements was below 0.8% at 11 of the 13 depths and within 2.7% at all depths, and the FC-derived fluence agreed with the MC primary proton fluence within 4% of the maximum fluence. Beyond the Bragg peak, however, a residual FC signal was observed, whereas the MC primary proton fluence decreased to nearly zero. This indicates that the FC signal in the distal region is dominated by non-primary contributions, which supports restricting the LETt evaluation to depths up to the Bragg peak. The FC-derived LETt increased from 0.45 keV/μm at the entrance to 2.71 keV/μm at the Bragg peak, closely following the MC LETt curve. The FC-derived LETt was systematically lower than the MC LETt, which is likely attributable to differences in how secondary particles are accounted for in the measurements and in the MC reference. The measured IDD showed a higher peak-to-plateau ratio than the MC IDD, possibly because part of the laterally scattered secondary-particle dose was not collected by the Bragg peak chamber, whereas the FC-derived fluence was slightly higher than the MC primary proton fluence because the FC also collects secondary charged particles. Over the 12 evaluated depths excluding the normalization depth, the difference from the MC LETt was −0.09 ± 0.04 keV/μm on average (maximum −0.18 keV/μm), corresponding to a relative difference of −8.5 ± 2.6% (maximum −11.3%).

Conclusion: The combination of FC charge and a measured IDD enabled reproducible LETt determination from the entrance to the Bragg peak, agreeing with the MC LETt within 0.18 keV/μm. The difference from the MC LETt can be further reduced by accounting for secondary particles consistently in the IDD and fluence measurements and in the MC reference. Future work will focus on quantifying the secondary-particle contribution to the FC signal for the distal region and extending the method to carbon-ion beams toward LETt-based RBE modelling.

E-mail: shkim4249@yuhs.ac

PO – 12

Safety Assessment of a Research Facility for Ac-225 Production via Proton Irradiation of Th-232

Beomyeol Baek (Institute for Basic Science)
Danhye Gil (Institute for Basic Science)
Hyejin Cho (Institute for Basic Science)
Min-Ji Kim (Institute for Basic Science)
Jaehong Kim (Institute for Basic Science)
Inseok Hong (IBS)

The Institute for Rare Isotope Science (IRIS) is currently conducting a project focused on the production of high-purity Ac-225 using a thorium (Th-232) target, as well as the development of radiopharmaceuticals labeled with this isotope. Recently, targeted alpha therapy (TAT) using Ac-225 has gained significant interest due to its impressive clinical results. The Ac-225 radioisotope decays into Bi-209 by emitting four alpha and two beta particles with a half-life of 9.9 days, which is suitable for medical applications. For research involving the production of Ac-225, the safety of the facilities must be assessed, and authorization must be obtained through a review by the regulatory authority in accordance with the domestic Nuclear Safety Act. IRIS is equipped with a high-power cyclotron (IBA) with a proton energy of 70 MeV and a beam current of 0.75 mA. The thorium target is inserted into a device installed inside the cyclotron room and then irradiated with protons. As this project is currently in its initial research phase, all processes are planned to be handled manually. Therefore, this study aims to provide the necessary data for facility safety assessments using Monte Carlo simulations. Specifically, it evaluates parameters such as the required cooling time for irradiated target removal, the required shielding thickness of transport container and separation process, and the inventory of various radionuclides generated within the target.

E-mail: bybaek@ibs.re.kr

PO – 13

Characterization of neutron energy and angular distributions at the NDPS of RAON using the activation foil technique

Beomyeol Baek (Institute for Rare Isotope Science, Institute for Basic Science)
Danhye Gil (Institute for Rare Isotope Science, Institute for Basic Science)
Cheolmin Ham (Institute for Rare Isotope Science, Institute for Basic Science, epartment of Basic Science, University of Science and Technology)
Inseok Hong (Institute for Rare Isotope Science, Institute for Basic Science)
Sinchul Kang (Institute for Rare Isotope Science, Institute for Basic Science)
Dong-Geon Kim (Institute for Rare Isotope Science, Institute for Basic Science)
Eunhee Kim (Institute for Rare Isotope Science, Institute for Basic Science)
Jaecheon Kim (Institute for Rare Isotope Science, Institute for Basic Science)
Jaesung Kim (Institute for Rare Isotope Science, Institute for Basic Science)
Jinhong Kim (Department of Nuclear Engineering, Seoul National University)
Jongwook Kim (Institute for Rare Isotope Science, Institute for Basic Science)
Mijung Kim (Institute for Rare Isotope Science, Institute for Basic Science)
Minsik Kwag (Institute for Rare Isotope Science, Institute for Basic Science / Department of Basic Science, University of Science and Technology)
Donghyun Kwak (Institute for Rare Isotope Science, Institute for Basic Science / Korea Atomic Energy Research Institute)
Cheongsoo Lee (Institute for Rare Isotope Science, Institute for Basic Science)
Jinho Lee (Institute for Rare Isotope Science, Institute for Basic Science)
Kwang-Bok Lee (Institute for Rare Isotope Science, Institute for Basic Science)
Sangjin Lee (Institute for Rare Isotope Science, Institute for Basic Science)
Young-Ouk Lee (Institute for Rare Isotope Science, Institute for Basic Science / Korea Atomic Energy Research Institute)
Geonhee Oh (Institute for Rare Isotope Science, Institute for Basic Science)
Seongjae Pyeun (Institute for Rare Isotope Science, Institute for Basic Science)
Hyung-Jin Shim (Department of Nuclear Engineering, Seoul National University)
Changwook Son (Institute for Rare Isotope Science, Institute for Basic Science)
Kyoungho Tshoo (Institute for Rare Isotope Science, Institute for Basic Science)

The Rare Isotope Accelerator complex for On-line experiments (RAON) is a heavy-ion accelerator facility in Korea that delivers both stable and rare isotope beams. Among its experimental systems, the Nuclear Data Production System (NDPS) supplies neutron beams for nuclear data measurements and a range of other applications. At NDPS, neutrons are produced by bombarding

graphite or tantalum targets with a 40Ar beam of approximately 18 MeV/u. To characterize these neutrons, the neutron fluence and energy spectrum were measured using the activation foil technique. Multiple foils with different energy sensitivities were employed to reconstruct the neutron energy distribution, and they were positioned at angles from 0° to 90° relative to the beam axis to determine the angular dependence of the neutron fluence. This presentation reports the measured energy and angular distributions of the neutrons produced from each target by the 40Ar beam.

E-mail: sckang@ibs.re.kr

PO – 14

X-ray Spectroscopic Investigations of Physical Properties Modifications in Ferrites Induced by Electronic Excitations Generated Using 160 MeV Ni12+ ions

Chandra Shekhar Joshi (Korea Institute of Science and Technology, Seoul)
R C Srivastava (GB Pant University of Agriculture and Technology, Pantnagar, Uttarakhand)
Keun Hwa Chae (Advanced Analysis and Data Centre, Korea Institute of Science and Technology, Seoul, South Korea)

Present study investigates the effects of 60 MeV Ni12+ ion irradiation on the structural, elastic, local electronic and magnetic characteristics of Mn0.25Co0.75Fe2O4 (MCF) nanoparticles. The MCF nanoparticles were synthesized using citric acid assisted sol-gel auto-combustion method and subsequently annealed at 400 0C. The annealed nanoparticles were irradiated with Ni12+ ions at fluences of 5 x 1012 and 1 x 1013 ion/cm2 to investigate irradiation induced modifications. X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR) and field emission scanning electron microscopy (FESEM) confirmed the formation of single phase cubic closed packed spinel structure of MCF nanoparticles that remained stable after irradiation, with lattice parameter ranging from 8.3670 - 8.390 Å. However, other structural parameters exhibited variations, which may plausibly be attributed to the latent track formation and localized thermal effects associated with ion irradiation and potentially promoting crystallite growth and modifying strain. The crystallite size and lattice strain varied with irradiation fluence, while FESEM micrographs revealed the formation of agglomerated nanoparticles. Pronounced changes in the local environment of Mn ions was observed through the critical investigation of local electronic environment analyzed with the help of synchrotron X-ray absorption fine structure analysis. Furthermore, vibrating sample magnetometer (VSM) measurements revealed substantial modification in magnetic properties including saturation magnetization, coercivity and magnetic anisotropy. These variations may also be associated with irradiation induced variation in cation distribution, surface spin disorder and domain wall pinning effects. Overall, the findings demonstrate that high energy Ni12+ ion irradiation provides a potential route for tailoring the structural, electronic and magnetic characteristics of MCF nanoparticles through defects engineering. Such irradiation induced modifications may have the potential for optimizing spinel ferrites for applications in spintronics, magneto-optical devices and high-density magnetic data storage.

Keywords: SHI; Spinel ferrite, XAS; XPS; Electronic Structure; Magnetic properties.

E-mail: 026126@kist.re.kr