PAL POHANG ACCELERATOR LABORATORY

KOMAC Korea Multi-purpose Accelerator Complex

IRIS Institute for Rare Isotope Science

KAFAT Korea Association for Fusion Energy and Accelerator Technology

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Book of Abstracts

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Plenary Talk

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Recent Results of the J-PARC Linac Beam Commissioning

Author: Masashi Otani

The Japan Proton Accelerator Research Complex (J-PARC) linac has been operated with a design peak current of 50 mA since 2018, and several test operations have been performed at a higher peak current of 60 mA. Furthermore, an even higher beam current is being investigated for future projects at J-PARC. To achieve such high beam currents, it is essential to understand beam dynamics and minimize beam loss: minimizing beam extinction when generating intermediate beam pulses for injection into the downstream ring accelerator, and optimizing the lattice to control intra-beam stripping. In this talk, we present recent results from the beam commissioning in the J-PARC linac.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

Plenary Talk / 136

Application of ion irradiation for quantum computing: Implantation of nitrogen containing molecules and sulfur for the realization of spin qubit registers in diamond working at room temperature

Author: Max Kneiß[1]

Co-authors: Tobias Herzig [1]; Nicole Raatz [1]; Matthias Mendt [1]; Robert Karsthof [1]; Evgeny Kreißig [1]; Jan Meijer [2]; Marius Grundmann [2]

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[2] *(1) SaxonQ GmbH, (2) Felix Bloch Institute for Solid State Physics, Leipzig University*

The nitrogen vacancy (NV) center as spin defect in diamond is one of the only physical systems suitable for room temperature quantum computing [1], which might facilitate novel groundbreaking developments in the areas of e.g. drug research, energy harvesting or industrial process optimizations. For this, the electronic and nuclear spin of the negatively charged NV center and surrounding ^{13}C nuclear spins can be employed as qubit register [1]. Artificial creation of NV centers is possible by nitrogen ion implantation and subsequent annealing. Unfortunately, this process suffers from poor conversion yields of implanted nitrogen to NV centers of < 10% and charge state instabilities [2].

Employing the co-implantation of sulfur as donor and nitrogen containing species such as N, N_2 [3] or $C_5N_4H_n$ [4], we will show that the conversion yield can be drastically increased towards 90% enabling deterministic creation of NV centers [2] as prerequisite for the reliable fabrication of quantum registers. Additionally, the negative charge state is stabilized by the sulfur doping and coupled NV centers are realized for the application in large qubit register arrays. This patented technique lead to the development of the world's first mobile quantum computer working at room temperature whose operation principle will be presented. The heart of the processor is a 4-qubit quantum register consisting of an NV center and two ^{13}C nuclear spins coupled to it. Universal quantum gate operations and especially native multi-qubit gates can be performed with high fidelity and quantum entanglement will be demonstrated. Using an intuitive user interface, general quantum algorithms can be run on the processor which calibrates itself automatically.

[1] Pezzagna and Meijer, Appl. Phys. Rev. **8**, 011308 (2021)
[2] Lühmann *et al.*, Nature Comm. **10**, 4956 (2019)
[3] Dolde *et al.*, Nature Physics **9**, 139 (2013)
[4] Haruyama *et al.*, Nature Comm. **10**, 2664 (2019)

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG4. Applications of Particle Beams

Plenary Talk / **156**

Toward ultra-bright x-ray pulses at PAL-XFEL

X-ray free electron lasers (XFELs) have the remarkable ability to generate X-ray beams with intense peak brightness, full transverse coherence, and femtosecond-scale pulse durations [1]. However, the current standard method of operation, Self-Amplified Spontaneous Emission (SASE), is affected by issues such as noisy spikes in both time and spectrum, primarily due to electron beam shot noise. To address these challenges and achieve brighter, fully coherent FEL sources, self-seeding has emerged as a promising solution. At PAL-XFEL, a forward Bragg-diffraction (FBD) monochromator is employed to produce nearly fully coherent hard X-ray self-seeded (HXRSS) free-electron laser (FEL) pulses. These HXRSS FEL pulses demonstrate exceptional peak brightness and a narrow spectral width, delivering outstanding performance across a wide photon energy range, from 3.5 keV to 14.6 keV. These results provide valuable insights for the development of next-generation X-ray sources and their diverse applications [2]. In addition, self-seeding plays a key role in the generation of terawatt (TW)-scale X-ray pulses with femtosecond pulse durations and enhanced peak current using the enhanced SASE (ESASE) method, which incorporates laser-electron modulation. We will also discuss our future plans to develop a TW-scale XFEL using ESASE and self-seeding technologies for the second hard X-ray undulator beamline project (HX2) at PAL-XFEL.

References
[1] H.S. Kang, et al., Nat. Photon., 11 (11), 708-713 (2017).
[2] Inhyuk Nam, et al., Nat. Photon., 15 (6), 435-441 (2021).

Contribution track:

Paper submission Plan:

Best Presentation:

Facility Report Talk

Facility Report Talk / 150

Status of PLS-II and PAL-XFEL

Pohang Accelerator Laboratory operates PLS-II, a 3rd generation synchrotron radiation facility, and PAL-XFEL, a hard X-ray free-electron laser, and is constantly working to improve the performance of both accelerators. This year, we exchanged a SLED of PLS-II Linac to increase the energy gain for uninterrupted top-up mode operation. Since the middle of this year, we have provided a beam current of 300 mA for user service and successfully completed a mechanical study of 400 mA in PLS-II. At PAL-XFEL, we tried 24-hour beam time for the first time and conducted a de-chirper machine study to monitor the longitudinal beam characteristics of PAL-XFEL. In this presentation, we would like to report the recent status of PLS-II and PAL-XFEL.

Contribution track:

Paper submission Plan:

Best Presentation:

Facility Report Talk / 163

Operation Status of KOMAC Linac

Author: Hyeok-Jung Kwon[1]

[1] *Korea Atomic Energy Research Institute*

100 MeV proton linear accelerator (linac) has been operating since 2013 at Korea Multi-purpose Accelerator Complex (KOMAC). Nowadays, 4 beam lines are routinely used to supply proton beam to users. In addition, neutron beam line starts user service after pilot operation. In this paper, the activities of the KOMAC linac for last few years and upgrade plan of the linac are discussed.

This work was supported through KOMAC operation fund of KAERI by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (KAERI-524320-24).

Contribution track:

ICABU WG1. Accelerator Systems

Paper submission Plan:

Yes

Best Presentation:

No

Facility Report Talk / 145

Status of the RAON heavy ion accelerator

Authors: Dong-O Jeon[1]; Hyung Jin Kim[2]; Ji-Ho Jang[None]; Yujung Ahn[3]

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[2] *Insititute for Basic Science*

[3] *IBS*

Status of the Ar^{8+} beam commissioning and user service of the RAON is presented. Beam tuning was done with Ar^{8+} beam and test of experiment systems such as KoBRA and NDPS were done. And Ar^{8+} beam was provided for users of the KoBRA. Na^{5+} rare isotope beam from the ISOL was accelerated by the superconducting linac and used to test the experiment system.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Working Group

ICABU WG1 / 70

Non-Evaporable Getters Plasma Activation Study

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[2] *Pohang Accelerator Laboratory (PAL)*

Non-evaporable getters (NEG) are widely used in ultra-high vacuum (UHV) systems to improve vacuum quality by adsorbing gas molecules like hydrogen and carbon monoxide, which are commonly present in such systems. To function as a vacuum pump, NEG requires activation through specific processes. Traditionally, activation has been achieved by heating the NEG to high temperatures over extended periods, limiting its use to certain devices. In this study, we activated a commercial NEG pump (ST707 strip 30D, SAES Getters) using Krypton DC discharge plasma. Plasma activation was performed at lower temperatures and in a shorter time compared to thermal activation. We measured the pumping speeds for hydrogen and carbon monoxide under different activation conditions using the throughput method. The results show that the plasma-activated NEG pump has comparable pumping speeds to the heat-activated pump, with slightly higher pumping capacity observed in the plasma-activated case. In this presentation, we will discuss the experimental methods and results in detail.

Paper submission Plan:

No

Best Presentation:

Yes

Contribution track:

ICABU WG1. Accelerator Systems

ICABU WG1 / 100

Ultrafast Ferroelectric Based Tuning for Microphonics Suppression in SRF Cavities

Author: Chunguang Jing[1]

[1] *Euclid Techlabs LLC*

A tuner based on Low loss ferroelectric material exhibits extraordinary performance in the application of suppressing microphonics in SRF cavities. For many applications, this could reduce significantly RF power consumption of accelerators. With this presentation, we will demonstrate Euclid's fast ferroelectric tuning technology in RF power configurations that combine the RF power source (klystron) and the fast active tuner at the same cavity port. We considered a magic-T configuration that will allow its use with a single RF port connected to the cavity. We will report progress on this research topic.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU WG1 / 102

Overview of Structure Wakefield Acceleration at Argonne National Laboratory

Author: John Power[1]

[1] *Argonne National Laboratory*

Structure Wakefield Acceleration (SWFA) is a leading candidate among advanced acceleration concepts (AACs), offering a promising solution to overcome the limitations of traditional radiofrequency (RF) accelerators. By utilizing ultra-short microwave pulses (~10 ns) to drive advanced accelerating structures, SWFA aims to significantly increase accelerating gradients and enhance energy efficiency.

Research has focused on four principal technologies: the drive beam, main beam, wakefield structure, and facility design. Two SWFA schemes are currently being developed: the collinear wakefield accelerator (CWA), where the drive and main beams share the same path through the structure, and the two-beam accelerator (TBA), where the beams travel through separate structures.

Looking ahead, key research areas include the development of specialized wakefield structures, exploration of terahertz and sub-terahertz (THz) frequencies, and the study of RF breakdown physics. These efforts will help pave the way for large-scale applications, such as AAC-based compact light sources and linear colliders.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU WG1 / 6

The fabrication of the 1.3 GHz single-cell cavity using niobium materials with varied grain sizes

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[2] *KIMS*

[3] *Korea University*

As a part of research into the fabrication methods for superconducting radio frequency (SRF) cavities used in International Linear Collider (ILC), we have fabricated two 1.3 GHz single-cell cavities using niobium materials with different grain sizes; fine grain (ASTM 5-6) and medium grain (ASTM 0-3). Both cavities has been fabricated using identical manufacturing equipment to ensure process consistency. The half-cell parts of cavities have been formed using the same deep drawing dies and press machine. The machining and welding for assembly have been carried out using identical jigs and equipment. We present a comprehensive overview of the cavity fabrication processes in detail.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU WG1 / 20

Development of EPICS-based DAQ system for real-time data acquisition during beam and RF operation

Author: Young-gi Song[1]

Co-authors: Hae-Seong Jung [1]; Hyeok-Jung Kwon [2]; Jae-Ha Kim [1]; Sung-Yun Cho [1]

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[2] *Korea Atomic Energy Research Institute*

The data acquisition system is newly developed for more precise signal measurements in KOMAC 100 MeV linac. Beam and RF signals measured by the diagnostic equipment may be collected using various devices. While oscilloscopes are capable of precise signal analysis, it is difficult to collect synchronization data with other devices while operating large accelerators. The data acquisition system was intended to be applied to collect and share synchronization signals generated when the accelerator was operated. The measured beam and RF signals are graphically displayed in the operator's console room after the process of collection, averaging, and calibration by DAQ. The data may be stored for further reference and may be transmitted to the main console computer to access the control program for linac. In this paper, we report on the construction of integrated development for DAQ systems that can collect real-time beam current and RF signals.

This work has been supported through KOMAC of KAERI by MSIP (524320-24)

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU WG1 / 21

Beam Commissioning Results of the RAON Superconducting Linac with argon beams

Author: Ji-Ho Jang[1]

Co-authors: Dong-O Jeon [1]; Hyunchang Jin [2]; Hyung Jin Kim [1]; Jeongil Heo [1]; Bum Sik Park [1]; Jangwon Kwon [1]; Yujung Ahn [1]; Chang Seok Seo [1]; Chul Jin Choi [1]; Eun Hun Lim [1]; Sangyoon Bae [1]; Kyung Tae Seol [1]; Yoochul Jung [1]; Youngkwon Kim [1]; Hyojae Jang [1]; Heetae Kim [1]; Ju Wan Kim [1]; Joonsun Kang [1]; Hyungjoo Son [1]; Yeon Sei Chung [1]

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The low energy part of the superconducting linac has been developed in the first phase of RISP (rare-isotope science project). The installation of the linac was completed in 2021. The linac consists of two different types of superconducting cavities, QWR (quarter wave resonator) and HWR (half wave resonator). The QWR cryomodule has a single cavity. There are 2 different types of cryomodules in the HWR section, HWRA and HWRB. They have 2 and 4 cavities respectively. For transvers beam focusing, we used quadrupole doublets which are installed in the warm section between cryomodules. The initial beam commissioning of the superconducting linac started from October 6, 2022 using Ar^{9+} beams and the second one started from April 29, 2024 using Ar^{8+} beams. This work summaried the beam commissioning results of the RAON superconducting linac with argon beam.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG1. Accelerator Systems

ICABU WG1 / 140

Development and Application of C-band LINACs at DIRAMS Research Center

Authors: Manwoo Lee[1]; Heuijin Lim[1]

Co-authors: Hyun Kim [1]; Sang Jin Lee [1]; Sang Koo Kang [1]; Wung-Hoa Park [2]; Pikad Buaphad [1]; Kyoung Won Jang [1]; Dong Hyeok Jeong [3]

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[2] *Research Center, Dongnam Institute of Radiological & Medical Sciences*

[3] *Dongnam Institute of Radiological and Medical Sciences*

In 2015 and 2018, the Dongnam Institute of Radiological & Medical Sciences (DIRAMS) in Busan, Korea, developed 6-MeV and 9-MeV C-band electron linear accelerators (LINACs) for radiation therapy research. The DIRAMS is working on developing the domestic radiation therapy devices through the development of core parts of LINAC by establishing an precision processing system and a vacuum brazing system. Recently, in cooperation with PAL and KERI, it has succeeded in developing an electron gun for small accelerators and the alternative device of vacuum switch. For innovative FLASH-RT treatment in the radiotherapy field, the DIRAMS LINACs provide both conventional (<0.1 Gy/s) and ultra-high dose rate beams (>40 Gy/s) with monitoring the real-time dose using a transmission-type ionization chamber. This presentation will discuss the current status of DIRAMS LINACs, their medical applications, and new irradiation bunkers and support facilities established in 2024 for the optimization and industrialization of radiotherapy machine. (This work was supported by the Dongnam Institute of Radiological & Medical Sciences (DIRAMS) grant funded by the Korea government (MSIT). (No. 50493-2024))

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU WG2 / 27

Design of an X-ray Ionization Beam Profile Monitor for Korea-4GSR

Author: Woojin Song[1]

Co-authors: Garam HAHN [2]; Hyojung Hyun [3]; Kim Jehan [3]; Lim Jae-Hong [3]; Moses Chung [1]; Park Youngsung [3]; Seo Min-Ho [3]; Seonghan Kim [3]; Seungcheol Lee [3]; Sunmin Hwang

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A photon beam generated by the Insertion Device (ID) of a synchrotron light source can be contaminated by radiation from upstream and downstream bending magnets, leading to position measurement errors in blade-type monitors. The operation of the Korea-4GSR, which has extremely low emittance, is particularly sensitive to photon beam position variations, necessitating more accurate position measurements. To robustly measure the position and simultaneously obtain the profile of a photon beam in a non-destructive manner, we are developing an ionization profile monitor.
We designed a noble gas environment to ensure adequate signal strength and incorporated a defocusing electrode structure to fully utilize the relatively large active area of the readout. Since magnification in the defocusing field depends on the vertical position, we proposed a calibration method to correct the non-linearity, which we then verified through particle tracking simulation.

Best Presentation:

Yes

Paper submission Plan:

No

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU WG2 / 65

Beam dynamics study for RF tolerance estimation in Korea-4GSR

Authors: Eunkyoung Shin[1]; Ji-Gwang Hwang[1]

Co-authors: Bonghyuk Choi [2]; Hyunchang Jin [2]; Seunghwan Shin [2]

[1] *Gangneung-Wonju National University*

[2] *KBSI*

The RF cavities in the storage ring to compensate for the energy loss through synchrotron radiation have inevitable jitter as a technical limitation of the LLRF system. This jitter in phase and amplitude causes longitudinal oscillations of the electron beam stored in the storage ring, making it difficult to provide the synchrotron radiation reliably. With modern technology, phase and amplitude stability on the order of 10^-4 can be achieved, and this level is generally considered sufficient for reliable operation. We performed a beam physics study of the electron beam motion as a function of amplitude and phase jitter to define the tolerance of the LLRF system for stable operation at the Korea-4GSR accelerator, which has 10 RF cavities.

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU WG2 / 86

Updates of Korea-4GSR impedance modeling and instability studies

Author: Jimin Seok[1]

Co-authors: Gyeongsu Jang [1]; Hosun Choi [1]; Jaehyun Kim [2]; Jaeyu Lee [3]; Taekyun Ha [2]

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[3] *Pohang Accelerator Laboratory*

The small vacuum apertures in the 4th generation storage ring contribute significantly to beam instabilities, primarily caused by impedance. These instabilities are directly influenced by the bunch charge, which imposes a constraint on the maximum achievable beam current. The Korea-4th Generation Storage Ring (Korea-4GSR), currently under construction, aims to achieve a beam current of 400 mA. To reach this target, we have carried out comprehensive estimations and optimizations of the impedance in the current storage ring. In this presentation, we will discuss the impedance characteristics of the Korea-4GSR and analyze the associated beam instabilities.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU WG2 / 128

Development of High-Precision Beam Position Monitor for the Korea-4GSR project

Author: Siwon Jang[1]

Co-authors: DongCheol Shin [2]; Dotae Kim [2]; Bokkyun Shin [2]; Seohyeon An [2]

[1] *PAL*

[2] *Pohang Accelerator Laboratory*

The Korean 4GSR project is currently under construction in Ochang, South Korea, with the aim of achieving first beam commissioning in 2027.
Designed to achieve an emittance approximately 100 times smaller than that of third-generation synchrotron radiation storage rings, the project requires the development of several high-precision beam diagnostic devices. In particular, the beam position monitor (BPM) is aimed at reducing longitudinal wake impedance to suppress heating and beam instability. This paper discusses the development of two types of 4GSR BPM pick-up antennas: one utilizing a SiO2 glass insula-tor and another designed in a cone shape using Al2O3. We will also describe the performance of these designs through beam tests. Additionally, this paper provides an overview of the current development status of the BPM system for the 4GSR project.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU WG2 / 38

Measurement results of Ar^{8+} beam using diagnostic device during RAON commissioning

Author: eunhoon Lim[1]

[1] *Korea University*

The Rare-isotope Accelerator complex for ON-line experiment (RAON) is a heavy ion accelerator with a maximum beam power of 400 kW. The ion beam generated from the injector is accelerated in the SCL3 and then transmitted through the P2DT section to the KoBRA or NDPS laboratory. It is important to measure various beam parameters accurately not only for beam transmission without loss, but also as information to be provided to the user. For this purpose, various diagnostic devices such as Faraday cups and wire scanners are installed in the beam line. We performed diagnostic device measurements under various beam conditions. This presentation summarizes the results of the RAON diagnostic device measurements using Ar $^{8+}$ beams.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU WG2 / 91

Analysis of Tune Shift Dynamics Near the Third Integer Resonance

Author: Ki Moon Nam[None]

Co-authors: Moses Chung [1]; Yong Woon Parc [1]

[1] *POSTECH*

Resonance islands are phenomena utilized in various storage rings to split or separate charged particle bunches. A new Hamiltonian model has recently been proposed to describe these phenomena [K. M. Nam et al., Revised Hamiltonian near third-integer resonance and implications for an electron storage ring, Phys. Rev. Accel. Beams (2024)]. However, the dynamics of these phenomena, particularly turn-by-turn dynamics, have not been extensively studied. This study introduces the first Hamiltonian model that captures the dynamics of resonance islands near the third integer resonance. Our analysis of tune dynamics in the primary orbit reveals oscillatory behavior for small actions, with amplitude- and phase-dependent shifts that align with conventional theory after long-term averaging. In contrast, within the islands, tune and action variations are calculated as functions of the distance from the stable fixed point. The approximate solution shows that the tune stabilizes to a constant value after long-term averaging. These theoretical predictions are well supported by particle tracking results. This study provides the first comprehensive model and method for understanding resonance dynamics in both the primary orbit and the islands, offering a unified description of these phenomena.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU WG2 / 68

Development of FEL code to simulate the integrated undulator line

Author: Myunghoon Cho[1]

[1] *Pohang Accelerator Laboratory*

Simulator for Free Electron Laser (FEL) realizes exploring non-linear phenomena between electron beams and undulators. There are some FEL codes for different purposes, but most popular code is GENESIS1.3 pursuing the averaged-frequency scheme which has fast calculation speed and can show time profiles of FEL as well as spectral features. To simulate real FEL, users have to consider various situations such as undulator tapering, transport section, wakefields generated by an electon beam in a cavity, bunch compressor, phase shifters, quadrupoles, self-seeding, and do on. Each consideration has different physical background, so sometimes users suffer from implementing those scenarios.
In this presentation, we introduce a developed FEL code (CoFELIS stands for the COde of Free-Electron-Laser with Integrated Slices) including diverse functions. The CoFELIS includes diverse modules mentioned above and is bench-marked with GENESIS1.3 and SIMPLEX as well as measurements at PAL-XFEL facility. Basic FEL equations follow GENESIS1.3, but treatment of electron beam slices is different by loading all slices at once. To simulate especially PAL-XFEL facility, the electron beam input mimics the measured phase space of the electron beam and undulator tapering. The result well-matches with the measurements. Overall code design inspired from SIMPLEX which is really easy to use due to the Window-based GUI. But the CoFELIS is written in C language and run in Linux system. However the texted input-file is designed for easy implementation for diverse functions. The talk will close with future development.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU WG2 / 122

Study on Electron Injection in Laser Wakefield Acceleration with Plasma Structures of Metal-Layered Target

Authors: Hyeon Woo Lee[1]; Sang Yun Shin[1]; Seonghee Park[2]

[1] *Korea University Sejong*

[2] *Korea University*

Laser wakefield acceleration (LWFA) is a method for accelerating electrons injected into a cavity created by the ponderomotive force resulting from the interaction between a femtosecond laser and low-density plasma. Significant research has been conducted on plasma generation for this purpose, and LWFA using metal ablation targets stands out for achieving high vacuum and high repetition rates due to the small size of the generated plasma plume. Furthermore, the large quantity of injected electrons enables the production of high-flux electron beams.
Among the metals studied as targets, titanium is producing many ionized electrons near the optical axis of the main beam, resulting in high-flux electron bunches. However, due to the incomplete formation of the acceleration cavity, these electron bunches are not accelerated. To address this limitation, we propose a structured target using titanium and aluminum to increase the number of injected electrons and produce a monoenergetic electron beam.
When using a structured aluminum target with a thin titanium layer, electron acceleration was achieved at lower laser conditions than aluminum, resulting in high charge monoenergetic electron beams. Moreover, the thickness and position of the titanium layer were used to control the electron beam properties.
In this study, we used the CFD code FLASH to analyze the plasma density trends of the structured target, and further investigated laser wakefield acceleration in various structured plasma targets using the PIC code Smilei.
In the titanium-layer structure with lower-density titanium plasma, the charge amount was approximately 50% of that in the high-density titanium-layer structure. However, the energy spread remained similar at around 5.5%, and the beam was sustained for a longer

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU WG3 / 74

Industrial Research Application of PLS-II 8D beamline

Author: Yongjun Park[1]

Co-authors: Hyeong Ju Choi [1]; Kyunghyun Ku ; Hee-jin Kim [1]; Min Wook Pin [2]; Chang-Hwan Chang [2]

[1] *Pohang Accelerator Laboratory*

[2] *RIST*

The beamline of the PLS-II 8D port was first constructed in 2000 with the support of POSCO and the supervision of RIST, and has been in operation for 24 years.
As the beamline operation institute, RIST performs measurements utilizing synchrotron radiation requested by various industries including POSCO, and it is the only one beamline in PLS-II that is utilized more by industry than by universities or other research institutes.
Of course, general users also use some (30%) of the beamtime through the general proposal and review process.

In the early stages of construction, equipment for XAFS measurements as well as XRD measurements were equipped, but due to the aging of the XAFS equipment, only XRD measurements have been performed recently.
Nowadays, due to the rapid development of the secondary battery industry, the demand for XAFS for the characterization of cathode materials, anode materials, and all-solid-state materials has also rapidly expanded, therefore latest high-spec XAFS equipment is being installed in the 8D beamline. We will demonstrate the performance of the equipment and beamline through standard sample data utilizing the newly purchased and installed XAFS equipment. Since the XAFS field is the field with the highest user demand, we plan to provide XAFS measurement equipment to general users through the consultation process.

We will share the measurement results of the powder X-ray diffraction standard samples to help you verify the performance of the beamline. The 8D beamline also has a Pilatus 3S 2M 2D X-ray detector, and is also performing in-situ measurements to analyze the properties of materials during the secondary battery charging and discharging process.
I will introduce the contents disclosed among the research on the utilization of synchrotron radiation in the industrial field being conducted at the whole PLS-II.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG3. Beamline and Instrumentation

ICABU WG3 / 88

The status of the GBAR experiment

Author: Bongho Kim[1]

[1] *CUP, IBS*

The GBAR experiment at CERN aims to measure the gravitational acceleration of antihydrogen at the terrestrial gravitational field.
The production of antihydrogen atom and antihydrogen ion by double charge exchange between antiproton beam and positronium cloud is a key step to produce ultra-cold antihydrogen atom.
The GBAR experiment has developed two antimatter beamlines: an antiproton beamline and a positron beamline, both operating in the keV kinetic energy range for the reaction.
The current status of this development will be presented in the talk.

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG3. Beamline and Instrumentation

ICABU WG3 / 111

Design of Initial Phase Beamlines at the Korea Fourth-Generation Storage Ring (Korea-4GSR)

Author: Jae-Hong Lim[1]

Co-authors: Daseul Ham [1]; Jehan Kim [1]; Jaeyong Shin [1]; Yong Sung Park [1]; Yeongsik Kim [1]; Mi-Jeong Kwak [1]; Ik Seon Kwon [1]; In-Hui Hwang [1]; Changwan Ha [1]; Byeong-Gyu Park [1]; Ji Hun Kim [1]; Jangwoo Kim [1]; Siwoo Noh [1]; Ki-jeong Kim [1]

[1] *Pohang Accelerator Laboratory, POSTECH*

Ten beamlines are proposed for the initial phase of operations at the new synchrotron facility of the Korea fourth-generation storage ring (Korea-4GSR). The beamlines include: ID03 Coherent X-ray Diffraction *for* Bragg coherent diffraction imaging and real-time micro X-ray diffraction; ID04 Coherent Small Angle X-ray Scattering *for* micro small- and wide-angle X-ray scattering (SAXS/WAXS) and X-ray photon correlation spectroscopy; ID10 Nanoprobe *for* multi-modal nanoprobe scanning with a sub-50 nm monochromatic X-ray probe; BM10 High Energy Microscopy *for* phase contrast imaging at 70-100 keV; ID21 BioPharma-BioSAXS *for* high-throughput solution SAXS; ID22 Bio Nano Crystallography *for* macromolecular crystallography of challenging biomolecules; ID23 Real-time X-ray Absorption Spectroscopy (XAS) *for* in-situ/operando XAS measurements and X-ray emission spectroscopy; ID24 Material Structure Analysis *for* high resolution powder diffraction and XAS; ID25 NanoARPES *for* nano- and micro-scale angle-resolved photoemission spectroscopy; and ID26 Soft X-ray Nanoprobe *for* X-ray photoelectron spectroscopy (XPS) and XAS using soft to tender X-rays. The beamlines are designed to extend and complement the capabilities of the existing beamlines at Pohang Light Source-II. This paper discusses their designs, performance estimation, and potential research applications.

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG3. Beamline and Instrumentation

ICABU WG3 / 125

Status of RFQ Cooler Buncher for rare isotope experiments with Isotope Separation On-Line system

Author: Seongjin Heo[1]

Co-authors: Kyoung-hun Yoo [1]; Jun-Young Moon [1]; Takashi Hashimoto [1]; Hee Joong Yim [1]; Jin Ho Lee [1]

[1] *IRIS*

The Isotope Separation Online (ISOL) system at the Institute for Rare Isotope Science (IRIS) has successfully produced several rare isotopes (RI). The surface ionized beams produced by the ISOL target were identified by the gamma spectrum measured on HPGe. The ISOL beam transport line was optimized using stable ion beams such as Cs, Na and Sn, and the RI beams were measured using a plastic scintillator and a micro-channel plate (MCP) detector. The Radio Frequency Quadrupole Cooler Buncher (RFQ-CB) and the Electron Beam Ion Source (EBIS) are used to transport the ISOL RI beam to the post-accelerator (SCL3) and experimental systems. Recently, an experiment to cool/bunch and charge breed the ISOL RI beam (25Na) and accelerate it at SCL3 was successfully performed. Commissioning is currently underway to send the ISOL RI beam to the MMS and CLS. This presentation will discuss the current status of the ISOL system and the RFQ CB for the RI experiment.

- max. 3000 characters

Best Presentation:

No

Contribution track:

ICABU WG3. Beamline and Instrumentation

Paper submission Plan:

No

ICABU WG3 / 33

Resonant X-ray Emission Spectroscopy studies for energy materials.

Author: Byeong-Gwan Cho[1]

Co-authors: In Hye Kwak [2]; Kyung-Tae Ko [3]; Seohyoung Chang [4]

[1] *KOREA BASIC SCIENCE INSTITUTE*

[2] *Korea Basic Science Institute (KBSI)*

[3] *Korea Basic Science Institute*

[4] *Chung-Ang Univ*

Advances in equipment have led to dramatic improvements in X-ray analysis, enabling the properties of photons after their interaction with matter to be analyzed in terms of size and energy. A representative technique is HERFD-XANES (High Energy-Resolved Fluorescence Detected –X-ray Absorption Near Edge Structures), which measures X-ray absorption spectral signals using a spectrometer that utilizes the energy decomposition of scattered X-rays. This technique achieves higher energy resolution than conventional absorption spectroscopy, allowing for the observation of unoccupied valence states. However, due to the nature of photons, the measured signal intensity is not large, making it known as a photon-hungry experiment. Additionally, as resolution increases, the signal decreases, which is a limiting factor in material analysis. To improve this, a higher flux of a more ideal light source is required.
We are attempting to obtain high-resolution spectra using HERFD-XANES and analyze the results. Here, we summarize the preliminary experimental results. Additionally, we will simulate the advantages of using a 4GSR light source, given its small emittance, in these experiments, and proceed with research on optical devices for future experiments based on theoretical criteria.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG3. Beamline and Instrumentation

ICABU WG3 / 41

Reconstruction of an External Beam PIXE Beamline Using 1.7 MV Tandem Accelerator

Author: Kye-Ryung KIM[1]

Co-authors: Yong-Sub CHO [1]; Han-Sung Kim [2]; Hyeok-Jung Kwon [3]; Young-gi Song [4]; Jae-ha Kim [4]; LEE Hanna [1]

[1] *KAERI*

[2] *Korea Atomic Energy Research Instituite*

[3] *Korea Atomic Energy Research Institute*

[4] *KOMAC/KAERI*

The external beam PIXE (Proton Induced X-ray Emission) is used to analyze the trace element of cultural heritage. The AGLAE (Accélérateur Grand Louvre d'analyse élémentaire) at the Louvre Museum in Paris, France is a representative example and it is dedicated to the study of cultural heritage. The Korea Atomic Energy Research Institute is working on reconstruction the external beam PIXE beamline based on the 1.7 MV Tandem accelerator for cultural heritage analysis mainly. The external beam PIXE beamline consists of a dipole magnet to adjust the beam direction from the Tandem accelerator, an quadrupole magnet set to adjust the beam size and shape, two micro slits to adjust the beam size, a beam window to exit proton beam to the air, a fast closing valve to protect the vacuum in case of destruction of the beam window, a stage to adjust the analysis position of the sample, and visible beam profile monitoring devices using BPM and CHROMOX plate. In this presentation, I would like to present the reconstruction results of the external beam PIXE beamline for cultural heritage analysis by the Korea Atomic Energy Research Institute.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG3. Beamline and Instrumentation

ICABU WG3 / 80

Fundamental Diagnostics Results of KOMAC 100 MeV Linac Neutrons Using Neutron Activation System

Author: Jeong-jeung Dang[1]

Co-authors: Jooyub Lee [2]; Junsik Kim [2]; Geehyun Kim [2]; Kyoung-Jae Chung [2]; DongHwan Kim [3]

[1] *Korea Institute of Energy Technology (KENTECH)*

[2] *Seoul National University (SNU)*

[3] *KAERI (KOMAC)*

The radiation effects and durability of materials, electronics and instruments to be used in high radiation fields, such as nuclear fusion reactors (DEMO) and Generation IV reactors, are critical research issues. For neutron irradiation tests and research, appropriate neutron facilities should be provided to simulate intensive nuclear fusion or fission neutrons. This study aims to provide an environment to conduct basic research by utilizing existing neutron sources based on accelerators instead of newly developing large-scale neutron source that require high costs. For this goal, neutron generation and transport simulation were performed, and fundamental diagnostic results of neutrons generated at the KOMAC 100 MeV linac were obtained using neutron activation system (NAS).

Contribution track:

ICABU WG3. Beamline and Instrumentation

Paper submission Plan:

Best Presentation:

ICABU WG4 / 53

RAON Beam Simulation Using Geant4

Authors: Kihyeon Cho[1]; Kyungho Kim[2]

[1] *KISTI*

[2] *Korea Institute of Science and Technology Information*

Geant4 was created for precise simulation of high-energy physics experiments to explore the origin of the universe. It provides various physical models of electromagnetic interactions between particles and matter compared to statistical processing of other simulations. In addition, it is widely used not only in the field of high-energy physics but also in various fields such as cosmic radiation research, astrophysics, and medical physics due to its many types of roles and flexibility. Let me present the current status and future plan of Geant4 applications for RAON beam. A study on Geant4 using beam simulation for RAON is introduced. In the fixed target experiment, secondary particles have been relatively little concentrated. Therefore, it needs to be studied. The simulation results between hydrogen fixed target and various heavy ion beam were compared with experimental data. To determine the optimized model which best describes the expected physical phenomena, we study various Geant4 physics models. Using the optimized model, we study physical properties of the primary proton beam and secondary heavy ion beam at the fixed target experiment. These results will help RAON experiment to get secondary particles.

Paper submission Plan:

Yes

Best Presentation:

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU WG4 / 93

The necessity of Medical Physics Research on Rare isotope Accelerator complex for ON-line experiments (RAON) Low-Energy Beamline for Biomedical Experiments

Author: CHAEEON KIM[1]

Co-authors: Ui-Jung Hwang [2]; Sanghoon Lee [3]; Sung Il Kim [3]; Yoonsun Chung [4]; Se Byeong Lee [3]

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[2] *Department of Radiation Oncology, College of Medicine, Chungnam National University*

[3] *Proton Therapy Center, National Cancer Center, Goyang, Korea*

[4] *Department of Nuclear Engineering, Hanyang University, Seoul, Korea*

Radiation plays a crucial role in modern civilization, with applications in medical diagnostics, treatment, and industry. Additionally, in the context of the space age, there is growing interest in understanding the biological effects of radiation on human health and organisms. The biological impact of radiation varies with particle size and charge, with greater biological effects observed from X-rays to protons and heavy ions. Many nations try to use heavy ions generated by large accelerators for biomedical research. In Korea, the low-energy beamline facility of the Rare isotope Accelerator complex for ON-line experiments (RAON) generates a wide spectrum of heavy ion beams, from protons to uranium.

However, RAON's low-energy beamline, which is called as KoBRA, is primarily designed for physical experiments. Thus, for biomedical research, additional experimental set-ups, as well as dose measurement and monitoring systems, are essential. This study seeks to characterize the heavy ions generated by KoBRA and propose advanced methodologies for dose measurement and monitoring systems necessary for conducting biomedical experiments.

The study involves analyzing the physical characteristics of low energy beam from KoBRA, including spot size, uniformity, and irradiation area, to determine optimal conditions for biomedical experiments. A comparison of RAON's heavy ion beams with domestic proton and heavy ion beam facilities will be conducted to propose an optimized research environment for biomedical studies.

Site inspections and technical data collection will be conducted at KoBRA to assess the current state of particle beam,including beam spot size, and uniformity. This study will also evaluate differences in beam energy, dose rates, and profiles compared to domestic proton facilities.

Based on the 2024 research demand survey for biomedical experiments utilizing KoBRA, methods for precise dose measurement and monitoring will be proposed. Optimal conditions for target installation and the necessary medical physics support for biomedical experiments will also be outlined.

Paper submission Plan:

Yes

Best Presentation:

Yes

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU WG4 / 83

Effects of proton irradiation on SnO2-based thin-film transistors

Author: Kim jeongtae[1]

Co-authors: Dong-Seok Kim [2]; Roy Byung Kyu Chung [3]

[1] *Kumoh National Institute of Technology, Korea Atomic Energy Reasarch Institute*

[2] *Korea Atomic Energy Research Institute*

[3] *Department of Electronic Materials Science and Engineering, Kyungpook National University*

Thin-film transistors (TFTs) are promising candidates for industrial and medical displays as well as in automotive and aerospace applications because they are cost-effective, low power consumption, high resolution and long lifespan [1]. In order to use it for space application, space radiation effects in TFTs must be evaluated. Therefore, there are many studies about radiation effects in TFTs based on IZO, ZnO, etc. [2-4]. SnO2-based TFT is attractive due to superior intrinsic electrical properties [5]. However, there was hardly research considering the radiation effects on SnO2-based TFT. In this study, we investigated the proton irradiation on the performance of SnO2-based TFT. The irradiated proton energy and fluence were 5 MeV and 1011 ~ 1011 cm-2, respectively. The threshold voltage of fabricated device was shift negatively by increasing proton fluences. We will analyze it to figure out the mechanism of this phenomenon.

Acknowledgments
This work was supported by the National Research Foundation of Korea(No. RS-2024-00432559, RS-2024-00437064) and the National Research Council of Science & Technology(NST) grant(No. CAP23031-200) by MSIT (Ministry of Science and ICT).

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[5] C. Park, et al., Mater. Today. Commun., 37, 107064 (2023)

Paper submission Plan:

Yes

Best Presentation:

Yes

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU WG4 / 107

Effects of He-ion beam implantation on physical properties of Si doped Ga2O3

Authors: Hyeyun Chung[1]; Hyoungjeen Jeen[2]; Jaehoon Jeong[1]; Jong Mok Ok[1]; Jung Seungho[1]; Sungkyun Park[1]; Yeongdeuk Mun[1]

[1] *Department of Physics, Pusan National University, Busan 46241, Korea*

[2] *Department of Physics, Pusan National UniversityDepartment of Physics, Pusan National University, Busan, 46241, Korea*

The space is under the influence of extremely low pressure, wide variation in temperature, and strong cosmic rays including particle-beam. It is well-known that cosmic rays often create malfunctions in electronics devices in the space shuttles via the cosmic-ray-induced damages on the chips. To prevent the errors associated with intense cosmic rays and find a way to maintain the device performance, the first step is to see the effect of particle-beam implantation on physical properties of electronic materials and devices. In the space, alpha particles (He2+) are about 10% of the particle-based cosmic rays. Thus, helium ion beam (He+) in Korea Multipurpose Accelerator Center (KOMAC) would be an ideal one to form the similar environment, since the beam dose is also be varied. In this presentation, we would like to present the effect of helium-ion beam on physical properties on wide-bandgap semiconductor Ga2O3 epitaxial thin films and devices. The growth condition is finely tuned to lead epitaxial synthesis of Ga2O3 and 1 wt% Si doped Ga2O3. The thin films were exposed to high-energy helium ion beam with different doses. Their optical, structural, and transport properties before and after the beam does are compared. By annealing in high vacuum, we also check whether or not the film can be recovered to the initial physical properties.

Paper submission Plan:

No

Best Presentation:

Yes

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU Poster

ICABU Poster Session - Board: `WG1-01` / **3**

Design improvements of Electron Gun for PAL Klystrons

Author: Sung-Ju Park[1]

[1] *Pohang Accelerator Laboratory*

Several prototype S-band pulsed klystrons for use in the Pohang Accelerator Laboratory (PAL) have been produced by a domestic company in collaboration with PAL. These klystrons stably produced the required output RF power at a low pulse repetition rate (< 30 Hz) but suffered from gun arcings at 60 Hz which is the operation rep. rate of the PAL-XFEL klystrons. We inspected the arcing spots on the focusing electrode of a failed klystron and found they were not located where the surface electric field was at its maximum. Simulation of particle trajectories in the gun region suggests that the gun arcing is initiated by the emission of electrons and proceeds with clumps emissions, possibly induced by the electrons hitting the anode plate. The gun arcing can also be initiated from the so-called triple point (TP) at the gun bottom, where a negative potential is established during high voltage (HV) operation. Electrons emitted from the TP can travel along the inner surface of the ceramic insulator and multiply until they reach the anode housing which is at the ground potential. Computation of the electric field distribution and electron trajectories under the electric field confirmed the possibility of gun arcing. In this article, we report on our analysis of the gun arcing mechanism and propose design improvements to eliminate it for stable operation at high repetition rates (e.g., 60 Hz).

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-02 / **4**

Modeling a Cosine-Theta Dipole Magnet with Flat-Shaped Superconducting Coils Using the Constant Perimeter Approach

Author: Geunmyeong Baick[1]

Co-authors: Woojin Song [2]; Garam HAHN [3]; Moses Chung [2]

[1] *Nanyang Technological University*

[2] *POSTECH*

[3] *Pohang Accelerator Laboratory, POSTECH*

The construction of magnets using High-Temperature Superconductors (HTS), such as REBCO, requires a specialized winding process due to their flat geometry. The "paper folding" method is implemented to address this issue, maintaining structural integrity by controlling the upper and lower perimeters of the winding magnet coil and preventing critical stress. A custom-made VPython code is employed to determine the optimal folding geometry. Initial conditions set the locations and angles of the two wings of the flat-shaped coil relative to the horizontal plane.

Superconducting magnets can generate stronger magnetic fields than their non-superconducting counterparts, offering significant advantages in applications such as compact particle accelerators and beam transport lines by reducing their sizes. Current designs of superconducting dipoles, particularly in the form of saddle coils, are based on winding around cylindrical tubes, but they often do not account for the twisting strain, which can be problematic for HTS magnets. In this work, we demonstrate a mitigation method for this strain issue.

We present recent progress in modeling a superconducting saddle coil, showcasing how to achieve optimal magnetic fields while maintaining strain within safe limits. This work extends beyond geometric modeling of magnet shapes to include the optimization of uniform magnetic fields inside a beampipe, ensuring effective strain compensation.

Paper submission Plan:

Best Presentation:

Yes

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-03 / **5**

Interlock system for the injector for RAON

Author: Yujung Ahn[1]

Co-author: Hyung Jin Kim [1]

[1] *Institute for Basic Science*

RAON (Rare Isotope Accelerator complex for On-line experiments) not only completed beam commissioning but also successfully provided its first user service for its low-energy section using an argon beam in 2024. Anticipating issues such as malfunctions in the vacuum gauge and pump during accelerator operation, both the alarm system for operators and the interlock system for equipment protection against unforeseen events were developed. This paper presents the logic designs and implementation details of the interlock system for the RAON injector. The interlock logic, based on EPICS sequencer functionality, is designed to collect signals related to equipment malfunctions or status anomalies and respond with predetermined protective sequences swiftly and efficiently. During the recent user service period, we confirmed the successful activation of the interlock system in response to a vacuum issue, marking its first operation under such conditions. We are currently refining the interlock system to address various scenarios in greater detail.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-04 / **9**

Reinstallation of heavy HWR-B Cryomodule for SCL3 beamline maintenance

Author: YangHo Lee[1]

Co-authors: ChulJin Choi [1]; HyungJoo Son [1]

[1] *IBS-IRIS*

This paper presents a case study on the reinstallation of heavy weight cryomodule (HWR-B #11) for the SCL3 beamline maintenance. Our HWR-B unit consists of a cryomodule and an associated warm-section (including a quadrupole magnet and a vacuum chamber) with a total weight exceeding 12.5 tons. After the initial beam commissioning, we found that certain low-efficiency modules required overhaul & repair to prepare for subsequent beam experiments.
In particular, the processes of disassembling a large HWR-B cryomodule from the beamline and moving it out of the underground accelerator tunnel needs very strict safety requirements and detailed planning and coordination among related systems and teams. To perform these tasks efficiently and safely, we prepared pre-designed tools and equipment, formed related work groups for collaboration, and performed preliminary work such as cutting VBx-CM pipes, separating various cables, cooling water pipes, and RF rigid coaxial transmission lines.
During the first stage of the maintenance procedure, the HWR-B #11 Cryomodule was safely removed from the SCL3 beamline using a specially designed moving wheel and then delivered to the contractor for overhaul. After the overhaul & test were completed, the HWR-B #11 Cryomodule was returned to the SCL3 tunnel and reinstalled into its original position in the beamline using the dedicated moving wheels and hydraulics. At this time, great care and attention was required to prevent steel frame overlap, quadrupole magnet contact, pipe-to-pipe impact, and cable breakage in the narrow space between the front and back of the HWR Cryomodule. This first in-house beamline maintenance experience provided valuable insight and expertise for the ongoing operation of an accelerator beamline.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-05 / **10**

Heat Dissipation Mechanisms of Superconducting Cavities

Author: Heetae Kim[1]

Co-authors: Juwan Kim [1]; Sungmin Jeon [2]; Yoochul Jung [1]

[1] *Institute for Rare Isotope Science*

[2] *Kyungpook National University*

The heat dissipation mechanisms in superconducting cavities are investigated. Liquid helium is used to remove the heat generated in these cavities. The properties of liquid helium and its heat removal efficiency are discussed. When RF power is applied to a superconducting cavity, heat dissipation occurs on the surface due to the surface resistance of the niobium (Nb) before X-ray generation. After X-ray generation, heat dissipation plays an important role in electron acceleration and X-ray production. Q-slope measurements for superconducting cavities are presented as a function of the accelerating electric field, and the dissipated RF power is shown as a function of the accelerating field.

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-06 / **11**

Design and Experiment of a 28 GHz 10 kW Gyrotron System for Electron Cyclotron Resonance Ion Source

Author: Jonggi Hong[1]

Co-authors: Byung-Hyun Shin [1]; Jang-Hee Yoon [1]; Jiho Lee [2]; Jin Yong Park [1]; Jung-Woo Ok [1]; Seoung Jun Kim [1]; Taekyu Lee [1]

[1] *Korea Basic Science Institute*

[2] *Pusan National University*

In order to deliver the microwave power from gyrotron oscillator to an electron cyclotron resonance ion source (ECRIS) for simultaneously producing high current and highly charged ions, a 28 GHz 10 kW gyrotron system was designed. The microwave power from 28 GHz gyrotron installed in Korea Basic Science Institute (KBSI) were measured using a dummy load from 0.5 kW to 10 kW with frequency variation from 27.9740 GHz to 27.9893 GHz. The dummy load was developed for gyrotron test. The gyrotron oscillator of transmission system operates in continuous wave (CW) mode with the smoothly regulated output power. In order to transfer microwaves into an ion source with low power loss, low mode conversion and low reflected power, a microwave power transmission line was designed. Also, we installed a DC break in microwave transmission line so that the gyrotron system is electrically insulated from ion source with high voltage platform. The design of 28 GHz 10 kW gyrotron system and experimental results of waveguide components will be reported in this paper.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-07 / **12**

Development of Cryostat with Radiation Shielding for 28 GHz Superconducting Electron Cyclotron Resonance Ion Source

Author: Jonggi Hong[1]

Co-authors: Byung-Hyun Shin [1]; Jang-Hee Yoon [1]; Jiho Lee [2]; Jin Yong Park [1]; Jung-Woo Ok [1]; Seoung Jun Kim [1]; Taekyu Lee [1]

[1] *Korea Basic Science Institute*

[2] *Pusan National University*

The BIBA (Busan Ion Beam Accelerator) is a compact linear accelerator facility using the 28 GHz SC-ECRIS (Superconducting Electron Cyclotron Resonance Ion Source) at the KBSI (Korea Basic Science Institute). The SC-ECRIS is designed to operate at 28 GHz with up to 10 kW of microwave power. During the operation of the SC-ECRIS, a large amount of X-rays is produced due to the high-energy electrons confined within the plasma. The emitted X-rays are absorbed by the cold mass of the superconducting magnet, leading to additional heat load on the cryostat system of SC-ECRIS. Therefore, the development of radiation shielding is essential to prevent a degradation in cryostat performance. In this paper, the effects of various radiation shielding materials under different conditions were compared and analyzed through simulations to evaluate their performance. Furthermore, X-ray spectra were measured using a Cd-Zn-Te detector combined with a collimator to analyze the X-ray emission during the operation of a 28 GHz SC-ECRIS. As a result, the cryostat with radiation shielding was fabricated, and it was confirmed that the radiation shielding performance is sufficient to ensure stable operation of the cryostat system.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-08 / **15**

Development of a 500 MHz High-Power Solid State Power Amplifier (SSPA) Based on GaN Transistors

Authors: Hyojin Kim[None]; Sehwan Park[1]

Co-authors: Bonghyuk Choi [2]; Insoo Park [1]; Mujin Lee [1]; Yongseok Lee [1]; Youngdo Joo [1]; Yuncheol Kim [1]

[1] *PAL*

[2] *KBSI*

Recently, the adoption of Solid State Power Amplifier (SSPA) has been increasing in major accelerators worldwide, replacing tube amplifiers such as Klystron and IoT. This study aims to develop a GaN (Gallium Nitride) transistor-based High power SSPA as a domestic product that can be used as a key component in high-power RF amplifiers for Korea's 4th Generation Synchrotron Radiation Accelerator. In collaboration with domestic manufacturers capable of producing GaN transistors, we developed a prototype SSPA system with control performance equivalent to that of a future 150 kW SSPA, along with a high-efficiency 5 kW RF module. The research focused on optimizing the characteristics of GaN transistors to ensure the efficiency and performance of the SSPA, and to verify control features such as interlock and interface functions. This study is expected to contribute to the future production of high-power SSPA as domestic products, enabling cost competitiveness, fast delivery, and efficient maintenance. Furthermore, the SSPA system can be customized to meet the performance requirements of various research applications, making it adaptable for use in diverse studies.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-09 / **16**

Implementation of EPICS based Control System for RFT-30 Cyclotron

Author: YOUNG BAE KONG[1]

Co-authors: Jong Chul Lee [1]; Jin Sik Ju [1]; Min Goo Hur [1]; Jeong Hoon Park [1]

[1] *KAERI*

An RFT-30 cyclotron is a 30 MeV proton accelerator for radioisotope(RI) production and fundamental research. In this work, we have implemented the Experimental Physics and Industrial Control System(EPICS) based control system for the RFT-30 cyclotron. We have replated the old relay based manual control system with new PLC based automated control system.
The EPICS IOC(Input Output Controller) server for PLC is constructed with s7nodave, which is a device support based on ASYN and communicates with the PLCs. A client program is made of control system studio(CSS). The proposed EPICS control system can enhance the performance of the cyclotron system and then provides the human operator with easy and stable operation for the RFT-30 cyclotron.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-10 / **17**

Implementation of LLRF System for RFT-30 Cyclotron

Author: YOUNG BAE KONG[1]

Co-authors: Jong Chul Lee [1]; Jin Sik Ju [1]; Jeong Hoon Park [1]; Min Goo Hur [1]

[1] *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 implemented automatice LLRF control program for the RFT-30 cyclotron. The LLRF program captures the monitor signals from the RF system and then decides the optimal parameters for the RF system control. When the AUTOTUNE mode is configured, the LLRF program automatically controls the RF system based on the parameters. The proposed LLRF system can enhance the stability of the RF system and then provides the human operators with easy operation for the RFT-30 cyclotron.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-11 / **22**

Evaluation of Plasma Behavior in an 14.5 GHz ECR Ion Source in RAON

Author: JEONGIL HEO[1]

Co-author: Hyung Jin Kim [1]

[1] *Institute for Basic Science*

RAON (Rare isotope Accelerator complex for ON-line experiments) is a heavy ion accelerator under construction in Daejeon, South Korea. RAON plans to operate a 28 GHz Electron Cyclotron Resonance Ion Source (ECRIS) with a fully superconducting magnet and is currently operating a 14.5 GHz ECR ion source with a fully permanent magnet. The 14.5 GHz ECRIS was manufactured by PANTECHNIK and installed in our beamline in September 2020. The initial beam conditioning of RAON was conducted using the 14.5 GHz ECR ion source with $^{40}Ar^{9+}$ and $^{40}Ar^{8+}$ beams. During extended beam extraction experiments in the ion source, signals indicating changes in the ECR plasma were observed, despite no alterations in various parameter settings. To analyze the causes of these plasma changes, experiments were conducted to evaluate the effects of gas injection rate and RF power. This paper discusses the results of these experiments.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-12 / **23**

Development of a Web-Based KOMAC Operational Logbook System

Author: Sung-Yun Cho[1]

Co-authors: Hae-Seong Jeong [1]; Hyeok-Jung Kwon [2]; Jae-ha Kim [1]; Young-gi Song [1]

[1] *KOMAC/KAERI*

[2] *Korea Atomic Energy Research Institute*

KOMAC operates a 100 MeV proton linear accelerator and began providing beam services in 2013. Throughout its operation, various issues have occurred, and they have been addressed. Each machine manager was recorded by individual operators, mostly manually, which made it difficult to retrieve past records for reference when similar issues occurred. Moreover, as 24-hour shift operations are set to begin, the need for a systematic logging system has become increasingly important. To address this, a logbook system optimized for the KOMAC operational environment was developed. We developed the system using a web interface, which is easily accessible and allows for rapid development. Additionally, a database-driven logbook system was implemented to provide a search engine for efficient retrieval of essential information related to issues. The developed logbook system also features a one-click function to load information on the current accelerator operating status, which assists in logbook creation. This paper introduces the developed logbook system and explains future development plans.

This work has been supported through KOMAC of KAERI by MSIP (524320-24)

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-13 / **24**

Development of LDMOS-based Solid-State Power Amplifiers for the heavy ion accelerator

Author: Sangyoon Bae[1]

Co-authors: Doyoon Lee [1]; Hyungjin Kim [1]; Kitaek Son [1]; Kyungtae Seol [1]

[1] *IBS/IRIS*

Construction of a heavy ion accelerator facility is currently underway to support various scientific studies in fields such as nuclear physics, materials science, and medicine. The heavy ion accelerator is primarily composed of the SCL3 section for low-energy acceleration and the SCL2 section for high-energy acceleration. Currently, beam extraction and application experiments have been conducted in the low-energy acceleration section, and the construction of the high-energy acceleration device is in progress. SCL3 consists of 22 quarter wave resonators (QWR) with a superconducting acceleration cavity frequency of 81.25 MHz and 102 half wave resonators (HWR) operating at 162.5 MHz. SCL2 comprises 213 single spoke resonators (SSR) with a frequency of 325 MHz.
The SCL3 superconducting acceleration cavity can deliver up to 4 kW of RF power to the acceleration cavity using a high-power solid-state power amplifier (SSPA) based on LDMOS (Lateral Double-Diffused Metal Oxide Semiconductor) technology. The key components of the SSPA include the main transistor, a bidirectional coupler for RF input power monitoring, attenuator, limiter to prevent over-input, ultra-short MMIC, driving amplifier, 4-way input power divider, 4-way output power combiner, circulator, and dummy load. The basic principle of the high-power amplifier applied to the 81.25 MHz and 162.5 MHz acceleration cavities is the same, but there are differences in components such as the circulator and RF combiner.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-14 / **30**

Design and Beam Off-Line Performance Evaluation of the Machine Protection System for the RAON

Author: eunsang kwon[1]

Co-authors: Hoyoung Yoo [2]; Hyun Man JANG [1]; Mijeong Park [3]; Sang-Gil Lee [4]

[1] *institute for basic science*

[2] *Chungnam National University*

[3] *IBS/IRIS*

[4] *IRIS/IBS*

The RAON is a sophisticated system designed for advanced scientific experiments using high-energy particle beams. These high-power beams pose significant risks, potentially causing equipment damage and safety hazards. To mitigate these risks, a reliable Machine Protection System (MPS) is essential for ensuring the safe operation of the accelerator. The RAON MPS was developed with three primary objectives: preventing equipment damage due to beam loss, ensuring the safety of superconducting cavities, and providing a rapid beam shutdown mechanism. The system is designed to respond within 50μs to prevent damage from high-power beams. This paper presents the design of the RAON MPS and evaluates its performance through beam off-line tests. The results show that the MPS can shut down the beam within 3μs of a fault signal, well within the design target of 10μs. These findings confirm the system's reliability in safeguarding the accelerator and highlight potential areas for further system improvements to enhance operational efficiency.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-15 / **31**

Status of Dipole-Quadrupole (DQ) magnet design for Korea 4GSR

Author: Inwoo Chun[1]

Co-authors: Beom Jun Kim [2]; Garam HAHN [3]; Young Gyu Jung [4]; Dong-Eon Kim [5]

[1] *Pohang Acceleration Laboratory (PAL)*

[2] *Pohang Accelerator Laboratory*

[3] *Pohang Accelerator Laboratory, POSTECH*

[4] *Pohang Accelerator Laboratory (PAL)*

[5] *PAL*

The 4th generation multipurpose synchrotron radiation accelerator has been under development in Korea since 2021. This light source targets electron beam emittance less than 60 pm, a circumference of about 800 m, and electron beam energy of 4 GeV. It aims for 40 beamlines for multipurpose industry, and scientific applications. The accelerator uses various magnets in the storage ring, including conventional magnets, longitudinal gradient bending magnets (LGBM), and combined function dipole-quadrupole magnets (DQ). In this study, the design of the DQ magnet is studied and an optimal pole profile is determined.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-16 / **32**

Development of a 20 kW High-Power Combiner Using the Gysel Combiner Method

Author: Ki Taek Son[1]

Co-authors: Kyungtae Seol [1]; Sangyoon Bae [1]; Do Yoon Lee [1]; Hyungjin Kim [1]

[1] *IBS/IRIS*

The RAON facility, operated by the Institute for Basic Science (IBS) in Daejeon, is a state-of-the-art accelerator complex designed for advanced research on rare isotopes. To accelerate various ions, RAON employs multiple cavity types. Among these, the 81.25 MHz superconducting Radio Frequency Quadrupole (RFQ) cavity is crucial for the initial acceleration of ion beams. Efficient RF power delivery to this RFQ cavity is provided by Solid State Power Amplifiers (SSPAs), supplying a total RF power of 150 kW.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-17 / **46**

Test and Operation of the RF Reference System for the RAON Low-energy Superconducting Linac

Author: Kyungtae Seol[1]

Co-authors: Doyoon Lee [1]; Hyungjin Kim [1]; Kitaek Son [1]; Sangyoon Bae [1]

[1] *IBS/IRIS*

The heavy-ion accelerator of the Institute for Rare Isotope Science (IRIS) has been developed and beam commissioning for the low energy superconducting linear accelerator (SCL3) has been performed. There are three types of SRF cavity, which are 81.25 MHz quarterwave resonator (QWR), 162.5 MHz half-wave resonator (HWR), 325 MHz single-spoke resonator (SSR). There are 22 QWRs and 102 HWRs in the low-energy superconducting linac (SCL3), and 69 SSR1s and 144 SSR2s in the high-energy superconducting linac (SCL2). The RF reference distribution system must deliver a phase reference signals to all low-level RF (LLRF) systems and BPM systems with low phase noise and low phase drift. The frequencies of RISP linac are 81.25MHz, 162.5MHz and 325MHz, and there are 130 LLRF systems and 60 BPMs respectively for SCL3, and 240 LLRF systems and 70 BPMs for SCL2. 81.25 MHz signal is chosen to the reference frequency, and 1-5/8“rigid coaxial line is installed with temperature control. This paper describes the design, test results and operation during the beam commissioning of the low-energy superconducting linac.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-18 / **49**

Implementation of the Control Systems for the 1.7 MV Tandem Accelerator and beamlines at KOMAC

Author: Jae-ha Kim[1]

Co-authors: Hyeok-Jung Kwon [2]; Kye-Ryung KIM [3]; Sung-yun Cho [1]; Yong-Sub CHO [3]; Young-gi Song [1]

[1] *KOMAC/KAERI*

[2] *Korea Atomic Energy Research Institute*

[3] *KAERI*

KOMAC has been operating the 1.7 MV tandem accelerator, and has recently been improving the layout of the accelerator and beamline with the goal of establishing a PIXE system for cultural heritage analysis. Additionally, A distributed control system was implemented to enhance the stability of the control system, as replacing the previous centralized control system. The user interface has also been improved for operator convenience, and a beam characteristics analysis application has been developed to ensure precise analysis of the accelerator and beam characteristics. This paper will describe the implementation of the control system for the 1.7 MV tandem accelerator and various beamlines.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-19 / **54**

4GSR Storage Ring Permanent Magnet Dipole(LGBM)

Author: Beom Jun Kim[1]

Co-authors: Dong-Eon Kim [2]; Garam HAHN [3]; Inwoo Chun [4]; Min Jae Kim [5]; Woulwoo Lee [2]; Yoongeol Choi [5]; Young Gyu Jung [5]

[1] *Pohang Accelerator Laboratory*

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[5] *Pohang Accelerator Laboratory (PAL)*

The 4GSR storage ring in South Korea has an electron energy of 4 GeV and is composed of 28 cells. Each cell contains 4 longitudinal gradient bending magnets (LGBMs), with a total of 112 LGBMs arranged in the ring. All LGBMs are manufactured based on Sm2Co17 permanent magnets, requiring approximately 4 tons of permanent magnet material. Sm2Co17 was selected for its higher temperature stability compared to NdFeB, and the design also includes additional temperature compensation features. The magnetic field of the LGBM varies from 0.15 T to 0.73 T along a distance of approximately 2 meters in the electron beam path. Each LGBM consists of 5 independent dipoles, with different sizes and magnetic fields. This paper focuses on the parameters and mechanical design details of the LGBMs.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-20 / **56**

Conceptual Design of HTS Saddle Coil Winding Machine with 5-axis Robotic Arm

Author: Garam HAHN[1]

[1] *Pohang Accelerator Laboratory, POSTECH*

This report details the design and fabrication of an HTS saddle coil winding machine, composed of a 2-axis linear stage and a 3-axis robotic arm. The study focuses on implementing a winding motion of a bobbin that consistently maintains the direction vector of the HTS wire during unwinding and winding processes, which is then parameterized for control. Inputting a 3D winding model achievable with sheet-type wire into the algorithm yields control variables for the motor and stage. For saddle coil winding of a specific scale, torque and stress analysis, accounting for gravity and acceleration, was conducted to optimize the specifications of the winding machine's motors and harmonic drives. The optimization process determined the arrangement and driving directions of components such as the robotic arm, linear stages, and tensioner. We showcase the currently manufactured winding machine and provide details on the implementation plan for a feedback system to correct motion errors and mechanical vibrations occurring during the winding process.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-21 / **58**

Development of mitigation system of vacuum breakdown using external magnetic fields

Author: Jungbae Bahng[1]

[1] *Kangwon national university hospital*

This study focuses on the development of a system to mitigate vacuum breakdown in high-energy ion beam extraction systems using external magnetic fields. Vacuum breakdown tends to occur more frequently in environments where electric and magnetic fields coexist, presenting a significant challenge in accelerator technology. To address this issue, our research conducted both theoretical and experimental investigations to overcome the voltage limits associated with vacuum breakdown. During the second year of the project, we optimized electrode configurations and analyzed magnetic field distributions to control electron emission and movement, effectively suppressing vacuum breakdown. The outcomes of this research contribute to advancements in plasma applications and accelerator component development, with promising implications for various industrial applications.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-22 / **63**

Implementation and low power test of 3rd harmonic cavity proto type for Korea-4GSR

Authors: Yuncheol KIM[1]; Yongseok Lee[1]

Co-authors: Youngdo Joo [1]; Insoo Park [1]; Sehwan Park [1]; Mujin Lee [1]; Hyojin Kim [1]; Bonghyuk Choi [2]

[1] *PAL*

[2] *KBSI*

Korea 4th Generation Synchrotron Radiation Accelerator(Korea-4GSR), aim to achieve a 4GeV ultra-low emittance beam with a current of up to 400 mA to enhance beam brightness. However, lowering the beam emittance increases the electron density within the bunch, which in turn reduces the beam lifetime due to Touschek scattering and intra-beam scattering. Therefore, to reduce the electron density within the bunch, we considered the application of a normal conducting 3rd harmonic cavity with a 1.5 GHz operating frequency and proceeded with prototype development. The developed harmonic cavity was designed based on the Spanish ALBA model, with design modifications for cooling and mechanical parts. In this presentation, the design, fabrication, and low power test results of the harmonic cavity were described. With future performance validation and improvements, it is anticipated that this cavity could be utilized not only in the 4GSR but also in other accelerators with similar specifications.

Contribution track:

ICABU WG1. Accelerator Systems

Paper submission Plan:

Best Presentation:

ICABU Poster Session - Board: WG1-23 / **72**

Development of the Cavity Resonance Control System for Low-energy Superconducting Linac at RAON Accelerator

Author: Hyojae Jang[1]

Co-author: Youngkwon Kim [2]

[1] *Institute for Basic Science*

[2] *IBS*

Recently the installation and first beam commissioning of the low energy section (SCL3) of a heavy ion accelerator RAON has been finished. The operating RF frequency for SCL3 are 81.25 MHz and 162.5 MHz. Each cavity will be controlled independently to accommodate the acceleration of the various A/q ions. All cavities in RAON SCL3 are the superconducting cavities and the planned beam current is not so high, the control bandwidth which is defined by the loaded Q of the power coupler are not wide relatively. Also there is a slow cavity resonance frequency drift caused by the LHe pressure long-term drift, etc. For the stable RF operation, it is required to measure the shifted cavity resonance frequency and to keep the cavities near to the operating RF frequency. We developed a cavity resonance control system for RAON SCL3. The shifted cavity resonance frequency is measured by the LLRF and this information are sent to the tuner control system and it controls the slow tuner to tune the cavities. In this presentation the status and test result of cavity resonance control system for RAON SCL3 will be described

Contribution track:

ICABU WG1. Accelerator Systems

Paper submission Plan:

Best Presentation:

ICABU Poster Session - Board: WG1-24 / **75**

Infrastructure Design for RAON Beam Operation Information Transmission

Author: Mijeong Park[1]

Co-authors: Sang-Gil Lee [1]; Eunsang Kwon [1]; Hyunman Jang [1]

[1] *IBS/IRIS*

The RAON (Rare Isotope Accelerator complex for ON-line experiments) in South Korea is a facility designed to accelerate heavy ions and produce rare isotopes for research purposes. The control system at RAON utilizes the Experimental Physics and Industrial Control System (EPICS) as its core framework. Since the control network is a closed system isolated from external networks within the facility, a separate screen transmission system is necessary to share accelerator operation data developed with EPICS to another building via an external network. This paper explains the development of an EPICS-based control system for transferring operational information, the setup of the screen transmission infrastructure, and the operational results of the infrastructure observed during the recent beam operation period.

Contribution track:

ICABU WG1. Accelerator Systems

Paper submission Plan:

Best Presentation:

ICABU Poster Session - Board: WG1-25 / **76**

Design of a compact gantry with high energy acceptance for carbon-ion cancer therapy

Author: bonghoon Oh[1]

Co-author: Jinjoo Ko [2]

[1] *korea university*

[2] *Korea university*

We presented gantry design with compact size and high energy acceptance satisfying rotation invariant condition. three identical 90 degree superconducting canted cosine theta (CCT) bending magnets (BMs) was used in a gantry to make gantry size be small, however, one BM have reverse bending angle. For high energy acceptance, low dispersion should be maintained through a gantry, therefore, alternating-grediant quadrupole coils was introduced in each 90 degree BM. Because rotator beam line was not intorduced in this gantry, point-to-parallel imaging in the entire gantry is satisfied to ensure rotation invariant optics. Downstream scanning method is adapted in this gantry in order to ensure small nonlinear beam dynamics in a last BM by making the BM's bore radius be small. 90 degree CCT BM design was not fullfilled yet and it wii be future work.

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-26 / **78**

LLRF integrated control system for continuous beam provision of RAON heavy ion accelerator

Author: Sang-Gil Lee[1]

Co-authors: Hyun Man JANG [2]; Mijeong Park [3]; Yeonsei Chung [4]; eunsang kwon [2]

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RAON is Korea's heavy ion accelerator, which will begin its first test run in 2022, complete the test run in the SCL3 section in 2023, and is currently conducting experiments to provide beams to users in 2024.
LLRF, which controls the RF in the SCL3 section of the RAON heavy ion accelerator, was configured and 102 modules were installed, but there was a problem in that the control state of each device could not be maintained for more than a certain period of time, and maintenance of the control mode due to RF Down failed, resulting in beam loss of more than 5 minutes. A situation arose where provision was difficult. To solve this problem, we configured LLRF control logic using S/W techniques and created a system that integrated controls all LLRFs in the SCL3 section. The integrated control system controls the LLRF, improving quick recovery and response time to failure, and through this, it was possible to obtain a beam provision time of about 20 minutes or more.

Contribution track:

ICABU WG1. Accelerator Systems

Paper submission Plan:

Best Presentation:

ICABU Poster Session - Board: WG1-27 / **82**

Mass production and performance test of SCL3 cryomdoule for RAON

Author: Youngkwon Kim[1]

Co-authors: Hyojae Jang [2]; Jaehee Shin [1]; Jong Wan Choi [1]; Moo Sang Kim [1]; Yong Woo Jo [1]; Yoochul Jung [1]

[1] *Institute for Rare Isotope Science, IBS*

[2] *Institute for Basic Science*

The Rare isotope Accelerator Complex for ON-line Experiments (RAON) has been built for providing beam of exotic rare isotope of various energies at the Institute for Basic Science (IBS). The low energy linac (SCL3) is composed of 22 Quarter wave resonator (QWR) cryomodules and 34 Half wave resonator (HWR) cryomodules. The total number of QWR and HWR cavities are 22 and 106, respectively. The performance test of the cryomodules were done in the SRF test facility. The main factor for the acceptance was the total thermal load of cryomodule. The requirement of the total thermal load of QWR cryomodule, HWR cryomodules A and HWR cryomdoules B were 20 W at 4.2 K, 14 W at 2.05 K and 26 W at 2.05 K, respecvitely. Also, the characteristics of cavities such as df/dp and LFD with tuner in the cryomodule, Qext's of power coupler and pick-up coupler were measured and the operation test of tuner were done. In this paper, the whole procedure of performance test and test results are reported in detail.

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-28 / **84**

Development and Performance Testing of a 1.2 MV DC Power Supply for an Electrostatic Tandem Proton Accelerator in Accelerator-Based Boron Neutron Capture Therapy

Author: Chawon Park[1]

[1] *Korea Institute of Radiological & Medical Sciences (KIRAMS)*

Accelerators have now become the main source of epi-thermal neutrons for clinical BNCT applications. The electrostatic tandem proton accelerator system, designed to produce H^- ions, removes two electrons using an argon gas stripping system located on the high-voltage deck. The resulting protons are then accelerated, representing a significant advancement in generating high flux neutrons through collisions with targets like lithium for medical applications. To maintain the proton accelerator, key accomplishments in this process include the generation and continuous operation of a high-voltage DC power supply at 1.2 MV and 45 mA for more than 30 minutes. We present the development and performance testing of a 1.2 MV high-voltage direct current (DC) power supply housed within an SF_6 gas insulating chamber. This power supply is intended for use in an electrostatic tandem proton accelerator, which serves as a key component of an accelerator-based boron neutron capture therapy (BNCT) system. The DC power supply system incorporates an enhanced Cockcroft-Walton (CW) rectifier stage and includes a realistic load resistance. Final testing was successfully conducted in an SF_6-filled tank, which involved comparing analog voltage and current signals with their digitally converted values, among other evaluations. Our goal was to achieve voltage stability at 1.2 MV within 0.025%, but the system demonstrated even greater stability than targeted. Performance tests conducted in both atmospheric and SF_6 gas environments confirmed stable operation of the power supply at up to 0.5 MV/20 mA in the atmosphere and 1.2 MV/45 mA in SF_6 gas, despite challenges such as corona discharge and electrical arcing in the atmospheric setting. The developed high-voltage DC power supply system can enhance BNCT systems by providing stable operation and generating high-current proton beams, which can lead to improved treatment outcomes.

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-29 / **85**

Recent Progress in Off-line Test Facility Experiments for the RAON ISOL Ion Sources

Author: Je Hwan Han[1]

Co-authors: Dong-Joon Park [2]; Hyung Joo Woo [2]; Jae-Won Hwang [2]; Jinho Lee [2]; Kyounghun Yoo [2]; Moses Chung [3]; Wonjoo Hwang [2]; Yeong-Heum Yeon [2]

[1] *Institute for Rare Isotope Science / Ulsan National Institute of Science and Technology*

[2] *Institute for Rare Isotope Science*

[3] *POSTECH*

At the Rare Isotope Accelerator complex for ON-line experiments (RAON), the Isotope Separation ON-Line (ISOL) facility utilizes three types of ion sources to produce Rare Isotope (RI) beams for various research purposes. The RAON ISOL RI beam was commissioned by producing Na, Al, and Li-ion beams with a surface ion source. Beam tests using the Resonant Ionization Laser Ion Source were also successfully conducted. In addition, we are currently developing a new plasma ion source, the Forced Electron Beam Induced Arc Discharge (FEBIAD) ion source. [1]

An ISOL Off-line Test Facility (OLTF) was re-installed. This OLTF consists of the target/ion source and front-end system, ion beam optics and diagnostic systems, a dipole magnet, vacuum system, and control system. The OLTF provides an environment for independent testing and optimization of the ion source. We have completed testing the performance of the OLTF using a surface ion source. The data and experience gained from this testing process will be invaluable for improving and optimizing the FEBIAD ion source at the RAON ISOL facility (RISFAC).

The existing FEBIAD ion source has thermal issues due to its high operating temperatures, leading to performance degradation and stability problems. We have developed a new structure for the FEBIAD ion source to address these issues. The redesigned FEBIAD ion source incorporates effective thermal distribution and expansion mechanisms, enabling stable operation even at high temperatures. We will test whether the FEBIAD ion source operates stably at high temperatures in the OLTF and evaluate how high temperatures affect its performance, making improvements as needed.

After conducting the FEBIAD ion source test using the OLTF, the ISOL RI beam experiment will combine with the uranium carbide target starting in mid-2025. The RISFAC will then be able to supply users with various neutron-rich RI beams using three types of ion sources.

Paper submission Plan:

No

Best Presentation:

Yes

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-30 / **87**

Understanding Superconducting Cavities with the Least Action Principle

Author: Heetae Kim[1]

[1] *Institute for Rare Isotope Science, Institute for Basic Science, Daejeon 34000, Republic of Korea*

The least action principle is applied to better understand superconducting cavities. This principle, which is fundamental to forces such as electromagnetic forces, is used to derive the equations of motion. By applying the least action principle, heat dissipation in superconducting cavities is analyzed. When RF power is applied to a superconducting cavity, heat dissipation occurs within the cavity. Quantum effects in superconducting cavities are also explored, with particular attention to the quantization of the quality factor.

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-31 / **89**

Nanosecond laser pulse train generation with fs timing and beam diameter controls.

Author: Namseok Go[1]

Co-authors: Chang-Ki Min [1]; Woojun Byeon [1]; Tae Kyun Ha [1]

[1] *Pohang Accelerator Laboratory*

The design of a robust laser pulse train generation applicable to RF photocathode guns is described, which is based on a beam splitter and combiner method. A high-power single laser pulse is used as an input, and the generated 64 pulses have 2 ns intervals synchronized to 500 MHz RF reference. Another reference optical oscillator synchronized to the RF reference is used to diagnose and control the timing of each pulse with fs resolution. The lattice parameter is tuned to obtain the desired beam diameter and power density profile of the train.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-32 / **90**

Improvement of Resonance Frequency Control Mode in Resonance Control Cooling System at KOMAC

Author: Kyunghyun Kim[1]

Co-authors: Hansung Kim [1]; Hyeok-Jung Kwon [2]

[1] *KAERI*

[2] *Korea Atomic Energy Research Institute*

A 100-MeV proton accelerator is under operation at Korea Multi-purpose Accelerator Complex (KOMAC). The resonance control cooling system (RCCS) has provided the cooling water to drift tube linac (DTL). The resonance frequencies of the DTL tanks are controlled by using the RCCS, installed at every DTL tank. RCCS has two operation modes including the constant temperature mode and the resonance frequency control mode. The control modes must be improved continuously for stabilizing the radio frequency. In this paper, the preparations for improvement of the RCCS control mode are described.

This work was supported through the KOMAC operation fund of KAERI by Korean government (MIST, KAERI ID: 524320-24)

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-33 / **109**

Development Status of new 3-MeV RFQ for KOMAC

Author: Han-Sung Kim[1]

Co-author: Hyeok-Jung Kwon [2]

[1] *Korea Atomic Energy Research Instituite*

[2] *KAERI*

A 3-MeV RFQ for KOMAC has been operated for almost 20 years and its performance has been degraded gradually in terms of arcing and beam transmission. We have designed new RFQ with some modifications to replace the current one. Main features of modifications include longer gentle buncher section, which results in better stability at high current. In addtion, we determined to remove resonant coupling plate located in the middle of the cavity and reduce the number of section from 4 to 3. Main parts of the RFQ are under fabrication and the final assembly by using vacuum brazing will be conducted in-house. The details of the development status of the new RFQ for KOMAC will be given in this presentation.

*This work has been supported through KOMAC operation fund by MSIT.

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-34 / **110**

Design Consideration of the Power Couplers for the Single-Spoke Resonators in Institute for Rare Isotope Science

Author: Junyoung Yoon[1]

Co-authors: Yong Woo Jo [2]; Yoochul Jung [1]; Youngkwon Kim [2]

[1] *Institute for Rare Isotope Science*

[2] *Institute for Rare Isotope Science, IBS*

A heavy-ion accelerator facility was constructed for the Rare Isotope Science Project (RISP) at the Institute for Rare Isotope Science (IRIS) in Daejeon, Korea. A cryomodule with quarter-wave resonators (QWRs) and half-wave resonators (HWRs) was installed in the SCL (Superconducting Linac) 3 tunnel, and the initial beam commissioning using argon beams has been completed. Additionally, a cryomodule with single-spoke resonators (SSRs), power couplers, and tuners is currently under development for the SCL2 project. The geometry of the power couplers for the SSRs is a coaxial capacitive type based on a conventional 3-1/8 inch Electronic Industries Alliance (EIA) coaxial transmission line with a single ceramic window. A multi-physics analysis, incorporating electromagnetic, thermal, and mechanical aspects, was conducted to evaluate the design of the power coupler for the SSRs. This paper presents the results of the multi-physics analysis and the current design status of the power coupler for the SSRs.

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-35 / **112**

Performance study of high heating power magnetron through special combination of a solid-state pulse modulator and an external heating power supply

Authors: Hyun Kim[1]; Heuijin Lim[1]

Co-authors: Sang Jin Lee [1]; Sang Koo Kang [1]; Wung-Hoa Park [1]; Pikad Buaphad [1]; Kyoung Won Jang [2]; Dong Hyeok Jeong [3]; Manwoo Lee [1]

[1] *Dongnam Institute of Radiological & Medical Sciences*

[2] *Dongnam Istitute of Radiological & Medical Sciences*

[3] *Dongnam Institute of Radiological and Medical Sciences*

At the Research Center of Dongnam Institute of Radiological & Medical Sciences (DIRAMS), C-band LINACs have been developed and operated. A C-band magnetron with 45 kV and 80 A will be used in the next DIRAMS LINAC, and it requires the standalone test before integration. For quality control and quality assurance, a C-band magnetron test bench has been designed and built, consisting of a magnetron (5712±10 MHz), a directional loop-coupler, a 4-port circulator, three dummy loads, a rotary joint, RF waveguides, a water-cooling system, a high-voltage pulse modulator (50 kV, 120 A), a high-power heating system (570 VA), a control and monitoring system etc. However, since the heating power of this magnetron is approximately three times higher than the existing one (200 VA), an external heating power supply providing 570 VA was specially designed and implemented to operate in conjunction with the solid-state pulse modulator. The solid-state pulse modulator with the external heating power system was tested with the resistive load systems. The magnetron test was completed on the test bench and performance were verified using a spectrum analyzer. (This work was supported by the Dongnam Institute of Radiological & Medical Sciences (DIRAMS) grant funded by the Korea government (MSIT). (No. 50493-2024))

Paper submission Plan:

Yes

Best Presentation:

Yes

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-36 / **119**

Analysis of Field Emission Characteristics in Superconducting Cavities

Author: Sungmin Jeon[1]

Co-authors: Heetae Kim [2]; Juwan Kim [3]; Yoochul Jung [3]

[1] *Kyungpook National University*

[2] *Institute for Rare Isotope Science, Institute for Basic Science, Daejeon 34000, Republic of Korea*

[3] *Institute for Rare Isotope Science*

Field emission is one of the limitations of the performance of accelerating cavities, especially for superconducting cavities. Reducing electron loading caused by field emission electrons is one of the most important tasks in constructing a superconducting accelerator. Identifying the location of the field emission site can be helpful in this process. In the mass production step of superconducting cavities, it is impossible to install diagnostic equipment, such as X-ray mapping systems and temperature mapping systems. A power meter and a single X-ray detector were mainly used to measure the performance of the superconducting cavities. In this study, an idea for estimating the position of the field emission site is proposed. Using the obtained quality factors, field enhancement factors and onset accelerating fields of field emission were obtained for 33 cavities. From this information, changes in the location of the primary field emission site were confirmed during the field emission conditioning process.

Paper submission Plan:

No

Best Presentation:

Yes

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-37 / **127**

Design of Fast Bunch Switching Line in PAL-XFEL

Author: Hoon Heo[1]

[1] *Pohang Accelerator Laboratory, POSTECH*

We present the conceptual design for the fast bunch switching line in PAL-XFEL. Currently we are servicing both hard X-ray line and soft X-ray line by switching the single bunch's direction in the rate of 30 Hz. Considering the method of ATHOS line in SwissFEL, we have designed a fast kicker line which are possible to send bunches in 60 Hz to the both lines by separating two- bunches generated by two UV pulses. In this presentation, we will show basic concept and preliminary design for the kicker system.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-38 / **132**

Electromagnetic analysis of accelerating cell for 200 MeV separated drift tube linac in KOMAC

Author: Sungbin Park[1]

Co-authors: Han-Sung Kim [2]; Hyeok-Jung Kwon [3]

[1] *Korea atomic energy research institute*

[2] *Korea Atomic Energy Research Instituite*

[3] *Korea Atomic Energy Research Institute*

Electromagnetic analysis is conducted to derive optimum design of the accelerating cell for 200 MeV separated drift tube linac (SDTL). First, 2D analysis is conducted utilizing Poisson-Superfish code. To derive accelerating cell design for efficient acceleration and preventing breakdown, optimum parameters are investigated pursuing maximized effective shunt impedance (ZTT) with Kilpatrick factor under 1.5. Based on the parameters found in 2D analysis, 3D analysis including stem and slug tuner is conducted utilizing CST Microwave studio. Adjusting length and position of slug tuner, resonance frequency is tuned for the targeted value and average axial electric field in each cell is tuned less than 1% variation.

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-39 / **133**

Design of the Korea-4GSR Machine Interlock System

Author: Yunho Kim[1]

Co-authors: Jinsung Yu [1]; Seung-Hee Nam [1]; ryu yeunchan [2]; sohee park [3]

[1] *Pohang Accelerator Laboratory*

[2] *Pohang Acclerator Labatory*

[3] *pohang accelator laboratory*

MIS (Machine Interlock System) for Korea-4GSR is a system that prevents operations that may cause harm to related devices when a malfunction or a harmful situation occurs in each device configured throughout the accelerator during accelerator operation. It is an essential element of accelerator operation. MIS is classified by area, level, and device according to each accelerator operation policy and aims to protect each device. In the MPS (Machine Protection System), MIS mainly covers signals with relatively slow response speeds and low importance among various classifications of signals. For signals generated by an interlock situation, which are recognized by the central device from local devices and transmitted to the final destination, differences in speed exist depending on the route. However, MIS is designed with minimized signal routes so that the difference in speed by signal will be minimal. The controller of MIS is a PLC (Programmable Logic Controller), which is widely used in various fields of industry and experimental physics. Since various PLC guidelines are provided for securing system reliability and responding to failures, configuring a more robust system is more accessible with PLC than with other types of controllers. MIS is basically configured to ensure high availability by considering device failure situations (PLC product failure, power outage, etc.). In addition, a high-reliability design is essential, considering the safety and reliability of the data. The connection between the Central and Local PLC uses industrial Ethernet protocols such as Profinet to intimately exchange data. It also features the ability to provide services for users by linking with EPICS IOC.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-40 / **134**

Design of the Korea-4GSR Timing system

Author: sohee park[1]

Co-authors: Seung-Hee Nam [2]; Jinsung Yu [2]; Yunho Kim [2]; ryu yeunchan [3]

[1] *pohang accelator laboratory*

[2] *Pohang Accelerator Laboratory*

[3] *Pohang Acclerator Labatory*

The event timing system is a system that coordinates and synchronizes events in a precise order over time, and provides precise timing to local devices installed in the 4GSR. The system consists of one Event Master (EVM), multiple Event Fanouts (EVF), and multiple Event Receivers (EVR), and each local device receives event, trigger, and time stamp information from the EVR. The event timing output signals provided to the local devices are provided as TTL signals or optical signals. If the local device receives an event as an optical signal, the local device receives both the event information and the time stamp. However, the EVR must be embedded in the local device. To facilitate the configuration of local devices with built-in EVR, a protocol developed by Micro Research Finland (MRF) is used. This protocol allows to utilize the EVR FPGA IP functionality and the functionality within commercial equipment (e.g. I-Tech Libera Brilliance+ BPM).

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-41 / **137**

Design of the Korea-4GSR Fast Orbit Interlock system

Author: Jinsung Yu[1]

Co-authors: Seung-Hee Nam [1]; Sohee Park [2]; Yunho Kim [1]; ryu yeunchan [3]

[1] *Pohang Accelerator Laboratory*

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[3] *Pohang Acclerator Labatory*

The new 4th Generation Synchrotron Radiation source (4GSR) will be built in Ochang, South Korea. The Fast Orbit Interlock system (FOI) refers to a system in which the beam detects a normal orbit departure situation inside the storage ring and triggers an interlock signal during accelerator operation. The core of this system is to quickly judge the situation and stop the beam quickly because the out of orbit of the beam during accelerator operation causes peripheral failure and radiation emission over the allowable amount. The system will collect and compute data at 375 kHz intervals, report progress in the design, which includes a series of processes to protect peripherals in case of beam orbital departure.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-42 / **138**

Commissioning of the RAON RFQ for User Proposals and Experiments

Author: Bum-Sik Park[1]

Co-authors: Hyung Jin Kim [2]; Jang Won KWON [3]; Ji-Ho Jang ; Yeonsei Chung [4]

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[2] *Insititute for Basic Science*

[3] *IBS*

[4] *RISP/IBS*

The Institute for Rare Isotope Science (IRIS) received beam time proposals from domestic users in Korea at the end of last year. The primary beams to be delivered will be Ne-20 and Ar-40, accelerated by the low energy superconducting linac SCL3 to peak currents of ˜40 uA at energies below ˜20 MeV/u. Through review of proposals by the committee, two representative experiments will be accomplished first, and experiments will be conducted in order of priority. In this paper, we report on the current status of the RFQ and the operating conditions for user proposals.

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)

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-43 / **141**

Muon linac for the muon g-2/EDM experiment at J-PARC

Author: Masashi Otani[None]

The muon g-2/EDM experiment at J-PARC (E34) aims to measure muon g-2 and EDM with unprecedented low-emittance muon beam realized by acceleration of thermal muons. The muon linac accelerates muons from thermal energy (25 meV) to 212 MeV with electro-static extraction and four different radio-frequency cavity: RFQ, IH-DTL, DAW-CCL, and disk loaded structure. We succeeded in accelerating muons using the radio-frequency accelerator for the first time, and are now fabricating actual acceleration cavities. In this talk, current status of the developments of will be presented.

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-44 / **146**

Development of a Prototype Fast Orbit Feedback System for the 4GSR.

Author: Seung-Hee Nam[1]

Co-authors: Jinsung Yu [1]; Sohee Park [2]; Yunho Kim [1]; ryu yeunchan [3]

[1] *Pohang Accelerator Laboratory*

[2] *Pohang Accelator Laboratory*

[3] *Pohang Acclerator Labatory*

This study aims to develop a prototype Fast Orbit Feedback System (FOFB) to improve beam orbit stability in the 4th generation synchrotron radiation facility. The FOFB system is designed to detect subtle beam orbit deviations in real time and quickly correct them, ensuring high-precision beam stability. The system's hardware and software are currently under development, with a focus on high-speed data processing, network communication, and real-time control algorithms. The system is designed to offer improved accuracy and response time compared to existing technologies, and its performance will be evaluated in future experiments. This research is expected to provide a critical technological foundation for maintaining stable beam orbits in accelerator facilities.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG1. Accelerator Systems

ICABU Poster Session - Board: WG1-45 / **148**

Brazing Characteristics on Vertical Joints with Silver Copper Eutectic Alloy Ag72Cu28 for RFQ Section Brazing Stage

Author: Kyunghyun Kim[1]

Co-authors: Han-Sung Kim [2]; Hyeok-Jung Kwon [3]

[1] *KAERI*

[2] *Korea Atomic Energy Research Instituite*

[3] *Korea Atomic Energy Research Institute*

A 100-MeV high power proton linac has been operated and used for user service since 2013 at KOMAC. The 100-MeV linac consists of an ion source, low energy beam transport, 3-MeV radio frequency quadrupole (RFQ) and drift tube linac. 3-MeV RFQ has a critical role in focusing and bunching the beam with acceleration from 50 keV to 3 MeV. The RFQ has been operated over 20 years considering the first commissioning in early 2004. The performance of the RFQ showed gradual degradation with low beam transmission efficiency. So new RFQ fabrication is considered to replace the existing RFQ. RFQ fabrication procedure is complicated including two stages of brazing for plug and section with heat treatments. The section brazing requires lots of metal fillers which are vertically inserted into the joint of sections. The failure of brazing is critical damage on the RFQ fabrication process. Therefore, we prepared the specimen for investigating the brazing characteristic. This paper explains the brazing characteristics of the vertical joint based on the specific brazing condition during the section brazing stage.

This work was supported through the KOMAC operation fund of KAERI by Korean government (MIST, KAERI ID: 524320-24)

Contribution track:

ICABU WG1. Accelerator Systems

Paper submission Plan:

Yes

Best Presentation:

No

ICABU Poster Session - Board: WG1-46 / **161**

Mechanical behavior of synchrotron accelerator storage ring girder system based on gravity load and vibration Energy

Authors: Gwang-Wook Hong[1]; Hong-Gi Lee[1]; Seungha Shin[1]; Taekyun Ha[1]

[1] *Pohang Accelerator Laboratory (PAL)*

The next-generation synchrotron accelerator requires a configuration of high-precision electromagnets, undulators, vacuum chambers, and monitoring devices. The accelerators currently under development demand the capability to control electron beams at the micro level with exceptional precision. Alongside the advancement of high-precision acceleration devices, developing a stable girder system to support these devices is essential. This girder system must accommodate the extensive 800 m circumference required by the synchrotron accelerator and be capable of responding appropriately to real-time changes associated with the high energy of 4 GeV. Furthermore, it must provide mechanical support without deformation to accommodate various electromagnets, vacuum chambers that serve as pathways for the electron beams, and devices for monitoring the electron beams. Additionally, the system should be capable of addressing ground irregularities and assembly stability concerns during accelerator installation. This study investigates the stability assurance methods for the girder system through static and vibration analyses aimed at reliably supporting the next-generation synchrotron accelerator.

Contribution track:

ICABU WG1. Accelerator Systems

Paper submission Plan:

Yes

Best Presentation:

No

ICABU Poster Session - Board: WG1-47 / **162**

Fault Detection using Pulse Reconstruction with CVAE in the KOMAC High-power Systems

Author: Gi Hu Kim[1]

Co-authors: DongHwan Kim [1]; Hae-Seong Jeong [2]; Han-Sung Kim [3]; Hyeok-Jung Kwon [4]

[1] *Korea Atomic Energy Research Institute (KAERI)*

[2] *KOMAC/KAERI*

[3] *Korea Atomic Energy Research Institiute*

[4] *Korea Atomic Energy Research Institute*

Conditional Variational Auto-Encoder (CVAE) model is applied to detect faults in the pulse waveform signals from the KOMAC High Voltage Converter Modulator (HVCM) and Klystron. Based on the CVAE model previously studied for anomaly detection of HVCM in SNS accelerator, we tuned the model and hyperparameters by considering features of the KOMAC data. Experimental results confirmed that the distribution of normal signals was effectively learned, as demonstrated through visualizations using t-SNE, boxplots, and KDE plots. In terms of the distribution function of the deep learning model, faults were detected through the difference in reconstruction error between normal and abnormal signals. These results can be used to develop an anomaly detection system to increase operation rate of the KOMAC accelerator.

Contribution track:

ICABU WG1. Accelerator Systems

Paper submission Plan:

Yes

Best Presentation:

Yes

ICABU Poster Session - Board: WG1-48 / **164**

Radiation Shielding Aspects and Monte Carlo Analysis of the 4th Generation Storage Ring in Korea

Author: Mahdi Bakhtiari[1]

Co-authors: Nam-Suk Jung [2]; Hee-Seock Lee [1]

[1] *Pohang Accelerator Laboratory, POSTECH, South Korea*

[2] *Pohang Accelerator Laboratory / POSTECH*

The 4^{th} Generation Storage Ring (4^{th} GSR) facility has been under development in Korea since July 2021. Storage ring has a circumference of 799.297 m with a beam emittance of 62 pm.rad. It will operate with a stored electron energy of 4 GeV and a current of 400 mA. The facility includes a 200-MeV Linac operating at 2 Hz, a booster ring, and a storage ring (SR), both housed within the same tunnel.
In previous work, bulk shielding calculations were performed using the semi-empirical SHIELD11 code [1]. This work used FLUKA to accurately determine SR tunnel shielding structure, assuming a 90% injection efficiency into SR at 4 mA/2min. Electron beam loss scenarios were divided into two types normal and abnormal losses. Since electron beam injection from Linac to booster, beam extraction from booster, and injection from booster to SR are close to each other, shielding calculations were classified into injection and non-injection areas, where specific thicknesses considered for each area. In injection area, normal operation beam loss scenarios included uniform beam loss over SR and booster ring, as well as losses at injection and extraction septa between Linac, booster, and SR. The total dose rate was calculated by summing the dose rates from these scenarios. FLUKA results confirmed that tunnel shielding structure effectively keeps the dose rate within dose limits. Appropriate shielding criteria were determined based on Nuclear Safety Act in Korea and the ALARA principle. These simulations aim to provide an overall radiological framework for shielding the 4^{th} GSR in Korea under current designed conditions.

This research was supported in part by the Korean Government MSIT (Multipurpose Synchrotron Radiation Construction Project).

[1] N. S. Jung, Radiation Shielding Evaluation of 4^{th} Generation Storage Ring in Korea, 11th International Workshop on Radiation Safety at Synchrotron Radiation Sources (RadSynch23), ESRF, France (2023).

Contribution track:

ICABU WG1. Accelerator Systems

Paper submission Plan:

Yes

Best Presentation:

No

ICABU Poster Session - Board: WG2-01 / **115**

Study on improving Fluence measurement accuracy with real-time monitoring using in-air AC Current Transformer

Authors: Yu-Mi Kim[1]; Eun-Joo Oh[None]; Young-Seok Hwang[None]

[1] *Korea Atomic Energy Research Institute (KAERI)*

In Korea Multi-purpose Accelerator Complex (KOMAC) of Korea Atomic Energy Research Institute (KAERI), a proton LINAC for 20 MeV and 100 MeV is in operation and provides the proton beam for various applications since 2013. To measure the Fluence at the sample location, a collimator and a Faraday cup were placed forward and backward and their charges were measured using digital current Integrators. Once the correlation factor was obtained from the collimator and Faraday cup measurements, we could monitor the collimator in real time and measure the actual fluence being irradiated into the sample. In such a measurement system, the Fluence value has a low accuracy due to the pulse-to-pulse variation of the linear accelerator. Therefore, we developed an ADC system using In-air ACCT to increase Fluence accuracy while monitoring in real-time. This ACCT is a non-destructive particle beam diagnostic method without perturbation of the proton beam. Also, it has the advantage of having a fast response characteristic.
In this presentation, the details of the test result of the ADC system using in-air ACCT will be presented.

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-02 / 7

Characterization of Electron Beam Transverse Emittance at PAL-eLABs Using the Quadrupole Scan Technique

Author: Hee-Won Lee[1]

Co-authors: Chang-Kyu SUNG [2]; Moses Chung [3]

[1] *Dankook University*

[2] *Pohang Accelerator Laboratory, POSTECH*

[3] *POSTECH*

The dynamics of charged particle beams in an accelerator can be understood by examining their behavior in phase space, where particles are distributed according to their position and momentum. The emittance, defined as the area (or volume in higher-dimensional cases) of phase space, is a key parameter in characterizing beam quality. For instance, transverse emittance has a significant impact on the lasing performance at Free-Electron Laser (FEL) facilities. Therefore, measuring emittance is crucial for understanding the properties of an accelerated beam and evaluating its quality.

Various instruments have been developed to determine beam emittance, including the slit-scanner, the pepper-pot device for single-shot measurements, the virtual pepper-pot for higher-dimensional cases, and the quadrupole magnet scan technique. The quadrupole magnet scan method involves varying the field strength of a quadrupole magnet while using a screen monitor to measure changes in the transverse beam distribution. This method is both simple and convenient for emittance measurement.

In this study, we utilized the quadrupole magnet scan technique to characterize the emittance of an electron beam generated by the photoinjector at PAL-eLABs., a small-scale yet versatile accelerator R&D facility located at the Pohang Accelerator Laboratory (PAL).

Paper submission Plan:

Best Presentation:

Yes

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-03 / **8**

Optimization of Beam Quality Along the Second Hard X-ray Beamline at PAL-XFEL: A Study Using the Simplex Method and Bayesian Optimization

Author: Won Jang[1]

Co-authors: Seongyeol Kim [2]; Moses Chung [3]

[1] *University of Seoul*

[2] *Pohang Accelerator Laboratory, POSTECH*

[3] *POSTECH*

The Pohang Accelerator Laboratory X-ray Free Electron Laser (PAL-XFEL) generates an electron beam with high peak current and low emittance, achieving an energy of up to 11 GeV. From this electron beam, hard X-rays are produced, covering a photon energy range from 2.2 keV to 15 keV. Recently, a second hard X-ray beamline, known as the HX2 beamline, has been proposed. To ensure that the HX2 beamline does not spatially overlap with the existing HX1 beamline, a dog-leg beam transport line is being considered. It is essential to carefully design the dog-leg to preserve key beam parameters, such as transverse emittance, during beam transport.

To achieve this goal, we focus on optimizing the beamline using numerical algorithms and particle tracking simulations. In this study, we utilized the simplex method, a standard feature in the Elegant simulation software, alongside Bayesian Optimization (BO) for the optimization process. BO is particularly useful for complex optimization problems, especially when dealing with limited data. We anticipate that BO will be an effective optimization method due to the many parameters and intensive computations involved in our simulation. Finally, by comparing the results of these two methods, we will highlight the advantages of BO in handling complex optimization tasks.

Paper submission Plan:

Best Presentation:

Yes

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-04 / **14**

Design and Optimization Study of the linac for Fourth generation storage ring Using MOGA

Author: Chanmi Kim[1]

Co-authors: Chang-Ki Min [2]; Changbum Kim [1]; Chong Shik Park [3]; Sung-Ju Park [1]; WooJun Byeon [1]

[1] *Pohang Accelerator Laboratory*

[2] *PAL*

[3] *Korea University, Sejong*

In the development of the linac for fourth generation storage ring, we conducted a comprehensive beam dynamics simulation to optimize the design of the injector system. To achieve this, we employed the Multi-Objective Genetic Algorithm (MOGA) to improve the linac operation parameters. The primary objectives of this optimization study were to minimize energy spread and transverse emittance at the end of the linac. We also considered design constraints related to beam size, bunch length, transmission rate, and average energy. We could design the linac
requirement for beam parameters at the end of linac. We performed an error study to assess whether the design selected through MOGA was operationally acceptable. This research aims to enhance the efficiency and performance of the linac for the fourth generation storage ring, contributing to its successful operation in the field of synchrotron radiation science.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-05 / **18**

P - Modeling and Simulation of Carbon Dioxide Plasma in RF Ion Sources Performance for Ion Beam Applications

Author: Sae-Hoon Park[1]

Co-authors: Seung-Won Lee [1]; Yu-Seok Kim [1]

[1] *Dongguk University*

RF driven plasma, characterized by its simple structure and high plasma density, is advantageous for various applications such as ion beam implantation and ion mass spectrometry. To support these purposes, modeling different ion beams within the RF ion source is essential for conducting simulation studies and predicting its plasma conditions. This study investigated the characteristics of carbon dioxide plasma produced through inductive coupling. A 2D axisymmetric strucure was defined to simulate the production of carbon and oxygen in an RF ion source, using numerical plasma simulation code. The plasma was modeled using the plasma module of COMSOL Multiphysics, integrating diverse reaction data. The simulation was performed using COMSOL code to calculate carbon and oxygen plasma parameters, and the resulting data will be adapted for use in ion beam extraction modeling. This study was involved in deriving the optimal parameters and conditions for plasma discharge phenomenon and ion beam application.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-06 / **26**

Simulation result of button type Beam Position Monitor based on beam energy of RAON

Author: Jang Won KWON[1]

[1] *IBS*

RAON is a multipurpose accelerator facility that can accelerate various heavy ion beams and rare isotope beams. The maximum energy of the uranium beam at the end of SCL3 is 18.5 MeV/u, 0.2 beta, and the maximum energy of the proton beam would be higher than uranium beam. 54 button beam position monitors with an inner diameter of 40 mm were manufactured for use at SCL3, and the BPMs installed on the beamline after SCL3 have an inner diameter of 50 mm or 60 mm depending on the installed location. The signals induced at each electrode of the button type BPM according to the beam energy were obtained as a result of the CST simulation. The BPM Electronics was developed to measure the position using the IQ method for the 1st, 2nd, and 3rd harmonic frequencies of 81.25 MHz among the signals generated from the button electrodes. In this poster, we describe the results of position calculation according to beam energy obtained using the same method as the electronics algorithm using the signals from the electrodes of BPM based on the CST simulation results.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-07 / **39**

Development Status of Beam Loss Monitor for Korea 4GSR

Authors: Bokkyun Shin[1]; Donghyun Song[1]; Dotae Kim[1]; Garam HAHN[2]; Gyujin Kim[1]; Seohyeon An[1]; Siwon Jang[3]

Co-authors: Changbum Kim [1]; DongCheol Shin [1]; JungYun Huang [1]; Woojin Song [4]

[1] *Pohang Accelerator Laboratory*

[2] *Pohang Accelerator Laboratory, POSTECH*

[3] *PAL*

[4] *POSTECH*

The Beam Loss Monitor (BLM) is crucial for protecting accelerator components from high-energy ionizing radiation unexpectedly generated around the beam path. We have developed a cost-effective BLM for the new-generation synchrotron, Korea 4GSR. The BLM is utilized organic scintillator blocks, optical fibers, and a CMOS camera, to determine the location of beam loss with a low temporal resolution of 2~10 ms. The scintillation blocks installed along the beam path emit visible light proportional to the ionization energy transferred from the beam loss radiation. The light emitted from each detector is transmitted through optical fibers and collected into bundles to form a 2D fiber cross-section array, which is imaged by the digital CMOS camera at a sampling speed of 100 Hz. Additionally, the DAQ includes an LED for detector and cable testing. The performance of this BLM is currently testing at PLS-II. Six detectors are installed near the beam chamber, and the DAQ is set at a device shed, these are connected by a maximum 72 meter optical fiber. This presentation will provide details of the system's development, along with preliminary test results from the PLS-II facility.

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-08 / **48**

Analysis of multipole components in the electromagnets of next-generation storage rings and beam dynamics in storage rings

Authors: DongHyuck Kim[1]; Ji-Gwang Hwang[1]

Co-author: Junwon Choi [1]

[1] *Gangneung-Wonju National University*

The recently introduced 4th-generation storage ring (4GSR) requires not only a higher magnetic field gradient compared to the sextupole and octupole magnets used in existing 3rd-generation synchrotron accelerators, but also utilizes magnets with complex magnetic field distributions, such as Longitudinal Gradient Bending magnets, which significantly differ from hard-edge models. These complex magnetic field variations typically generate unwanted multipole components. In storage rings, even small multipole components can have a significant impact on the beam due to the continuous motion of the electron beam. Therefore, it is essential to calculate the multipoles from the three-dimensional magnetic field distribution of the designed magnets and apply this analysis to beam physics research to precisely evaluate the effects on the beam. In this study, we analyze the multipole components based on the three-dimensional magnetic fields calculated using the OPERA3D code and investigate methods to track the beam.

Paper submission Plan:

Yes

Best Presentation:

Yes

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-09 / **67**

A Space Charge Compensation Study for Matched Positive Ion Beams in a Low-Energy Beam Transport Line

Author: Emre Cosgun[1]

Co-authors: DongHwan Kim [2]; SeokHo Moon [2]; Moses Chung [3]; MinSup Hur [1]

[1] *UNIST*

[2] *KAERI (KOMAC)*

[3] *POSTECH*

This study investigates the space-charge neutralization of a positive ion beam by electrons generated during ionization as the beam passes through injected gas. A three-dimensional electrostatic particle-in-cell (PIC) simulation is employed to model this process. Various types of injected gases are considered, and their effects on the transient times for space-charge compensation (SCC) are compared. Secondary electrons and ions, produced through collisions between the ion beam and the neutral gas along the beam's path, are introduced into the simulation using a Monte Carlo generator. These secondary particles contribute to the overall space charge, which combines with the primary ion beam's space charge. The injection and accumulation of secondary electrons and ions are time-dependent and continue until the total space charge density reaches saturation. The study focuses on a 2.4-meter low-energy beam transport (LEBT) line equipped with two solenoid magnets at the KOMAC Beam Test Stand (BTS) facility. Typically, the proton beam energy is 25 keV, with a peak beam current between 10 and 15 mA. The experiment explores the speed and degree of SCC by varying the gas injection conditions. The results of this study are compared with beam simulations that include the generation and tracking of secondaries, providing a unique understanding of the transport of low-energy ion beams and their matching into the RFQ.

Paper submission Plan:

Best Presentation:

Yes

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-10 / **69**

Optimization of Korea-4GSR Booster Lattice for Increasing Dynamic Aperture Using Multi-Objective Genetic Algorithm

Author: JunHa Kim[None]

Co-authors: G.S Jang [1]; Jaehyun Kim [2]; Jaeyu Lee [1]; Jimin Seok [3]; Moses Chung [4]

[1] *Pohang Accelerator Laboratory*

[2] *Pohang Accelerator Laboratory (PAL)*

[3] *PAL*

[4] *POSTECH*

The Korea-4GSR is an upcoming diffraction-limited synchrotron light source designed to provide X-rays with a brightness up to 100 times greater than existing sources. While a photocathode electron gun was initially selected based on the operational success of PAL-XFEL, a thermionic electron gun is also being considered to enhance operational stability. However, this transition results in an electron beam size approximately four times larger at the point of injection into the Booster, bringing it close to the original off-momentum dynamic aperture and potentially reducing injection efficiency.
To address this issue, we propose further optimizing the Booster lattice to expand the off-momentum dynamic aperture, thereby improving injection efficiency. This optimization will be performed using a multi-objective genetic algorithm (MOGA).

Paper submission Plan:

Best Presentation:

Yes

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-11 / **92**

Simulation Study of Ion Effects in Korea-4GSR

Author: Ki Moon Nam[None]

Co-authors: G.S Jang [1]; Hyunchang Jin [2]; Jaehyun Kim [3]; Jaeyu Lee [1]; Moses Chung [4]; Seunghwan Shin [2]

[1] *Pohang Accelerator Laboratory*

[2] *KBSI*

[3] *PAL*

[4] *POSTECH*

The Korea-4th generation storage ring (Korea-4GSR), with an energy of 4 GeV, a circumference of 800 meters, a multi-bend achromat (MBA) structure, and an emittance of 60 pm·rad, is designed for a high-performance synchrotron light source. To ensure stable and efficient functioning of the 4GSR, mitigating the impact of ion effects—which can lead to fast beam-ion instability (FBII), emittance growth, and reduced beam lifetime—is crucial, especially in low-emittance machines where these effects can severely degrade performance. In this study, we analyze the influence of ion effects on the Korea-4GSR using ELEGANT simulations. Given the well-known ion effects in storage rings, our focus is on evaluating how varying fill patterns and gas pressures affect beam stability in the specific environment of the Korea-4GSR. The results indicate that ion effects can indeed lead to beam instabilities under certain conditions. However, by adjusting operational settings, such as fill patterns and vacuum conditions, these effects can be mitigated, resulting in more stable beam performance.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-12 / **98**

Estimation of collimator performance for the Korea-4GSR

Author: GYEONGSU JANG[1]

Co-authors: Jaehyun Kim [2]; Jaeyu Lee [1]; Jimin Seok [3]; Jun Ha Kim [2]

[1] *Pohang Accelerator Laboratory*

[2] *Pohang Accelerator Laboratory (PAL)*

[3] *PAL*

One of the purposes of employing the collimator in the storage ring is to protect the machine device from the damage by intentionally blocking it. Particularly, the power density of the damage increases in the fourth-generation storage rings as the emittance of the ring is dramatically reduced. In this paper, the collimator performance is estimated for the Korea-4GSR. The study indicates that the collimator can effectively defend the machine devices from the electron beam collision.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-13 / **99**

A Comparative Analysis of Neutron Flux from p(7Li,n)7Be and 7Li(p,n)7Be Reactions for the Neutron Radiography Facility of BIBA by Using MCNP6.2 Code

Author: Taekyu Lee[1]

Co-authors: Seoung Jun Kim [2]; Jin Yong Park [2]; Jung-Woo Ok [2]; Jonggi Hong [2]; Jang-Hee Yoon [2]; Byung-Hyun Shin [2]

[1] *Korea Basic Science Institue(KBSI)*

[2] *Korea Basic Science Institute*

BIBA (Busan Ion Beam Accelerator) is a compact linear accelerator that utilizes a 28 GHz superconducting electron cyclotron resonance ion source (SE-ECRIS) at the KBSI (Korea Basic Science Institute). The primary purpose of BIBA is to produce neutrons for high-resolution radiography and the implantation of multi-charged heavy ions. To operate the neutron radiography facility at BIBA, the ion beam must be accelerated to several MeV/u and interact with a target to generate high-intensity fast neutrons. In conventional quasi-mono-energetic neutron sources, neutrons are produced isotropically through direct reactions on nuclei, such as d(d,p)n or 7Li(p,n)7Be. However, this results in only a fraction of the emitted neutrons being available for irradiating samples, while the majority contributes to the background. To address this issue, natural collimation of neutron beams is employed using inverse kinematics reactions, such as p(7Li,n)7Be, where the projectile is significantly heavier than the target. In this study, we used the MCNP6.2 code to compare the neutron flux from 7Li(p,n)7Be and p(7Li,n)7Be reactions and to evaluate the effectiveness of the inverse kinematics method. The results indicated that the inverse kinematics method is more effective for establishing a compact linear accelerator of neutron radiography facility. In the near future, technical design work on the accelerator, high-power targetry, and target station will be required, and securing core technologies will be essential for the successful launch of BIBA's neutron radiography facility.

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-14 / **103**

Parameter Optimization of Passive Harmonic Cavity and Analysis of Robinson Instability based on the PLS-II Lattice

Authors: Moses Chung[1]; Yong Woon Parc[1]; Youngmin Park[None]

[1] *POSTECH*

In synchrotron light sources, Higher Harmonic Cavities (HHCs) are employed to increase the bunch length, thereby reducing Touschek scattering and enhancing beam lifetime. This is particularly critical in 4th generation light sources, where the electron beam size is reduced to the diffraction limit of the photon beam. Typically, a Passive Harmonic Cavity (PHC) is tuned to a frequency higher than the fundamental mode resonant frequency to achieve bunch lengthening. However, this tuning can induce Robinson instability, potentially degrading beam quality.

This paper presents an analysis of bunch lengthening using a 3rd harmonic cavity for the 3 GeV 3rd generation synchrotron light source, PLS-II, and proposes optimized PHC parameters. Additionally, a modified equation for Robinson instability, which incorporates damping effects, is derived to demonstrate a stable operational method.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-15 / **104**

Simulation Study of LINAC with Thermionic Gun for Fourth-Generation Storage Ring

Author: Woo Jun Byeon[1]

Co-authors: Chang-Ki Min [1]; Namseok Go [2]; Chanmi Kim [2]; Taekyun Ha [3]; Sung-Ju Park [2]

[1] *PAL*

[2] *Pohang Accelerator Laboratory*

[3] *Pohang Accelerator Laboratory (PAL)*

We conducted the design and simulation study of a 200-MeV linear accelerator (LINAC) utilizing a thermionic gun, proposed as the injector system for a fourth-generation storage ring. The LINAC configuration consists of a thermionic DC gun, a sub-harmonic buncher (SHB), a buncher, and four accelerating tubes. Beam dynamics simulations were performed using PARMILA to optimize the system, with a focus on minimizing both beam size and energy spread, for a beam charge of 1 nC. Detailed simulation results will be provided in the presentation.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-16 / **108**

Design and simulation of an iris-loaded RF deflecting cavity for the PAL-eLABs

Author: Geunwoo Kim[None]

Co-authors: Chang-Ki Min [1]; Kwanghoon Kim [2]; Yong-jung Park [2]; Moses Chung [3]

[1] *PAL*

[2] *Pohang Accelerator Laboratory*

[3] *POSTECH*

Accurate temporal resolution in beam diagnostics is crucial for obtaining a precise longitudinal beam profile. A transverse deflecting cavity, used as a longitudinal beam profile monitor, is a suitable instrument for achieving this requirement by inducing a transverse kick to a bunch. The induced transverse field deflects the bunch in the transverse direction, allowing the time profile to be captured on an observation screen. Notably, the deflecting cavity can achieve femtosecond temporal resolution, while a streak camera typically provides only picosecond resolution. We have designed a transverse deflecting cavity consisting of an iris-loaded RF waveguide structure for the electron Linear Accelerator for Basic science (eLABs) facility at the Pohang Accelerator Laboratory (PAL). Detailed electromagnetic simulations were performed to analyze the cavity's performance and confirm its parameters. Here, we describe the designed cavity's features and present the simulation results.

Paper submission Plan:

No

Best Presentation:

Yes

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-17 / **113**

A New Simulation Framework for Optimizing Beam Dynamics and Analyzing Data in High Current Cyclotrons

Author: Chong Shik Park[1]

[1] *Korea University, Sejong*

This paper presents the development of a simulation framework designed for beam dynamics simulations and data analysis in high current cyclotrons. Cyclotrons, used in applications such as particle physics and medical isotope production, require precise and efficient simulation tools to optimize beam performance and ensure operational accuracy. The proposed framework integrates advanced computational algorithms with a user-friendly interface to facilitate detailed modeling of beam trajectories, magnetic field interactions, and particle dynamics within high current cyclotron systems. It utilizes high-performance computing techniques to handle complex simulations and large datasets, providing robust tools for real-time analysis and visualization. Key features of the framework include customizable simulation parameters, automated data processing pipelines, and advanced statistical analysis capabilities. This development aims to enhance the accuracy of cyclotron beam dynamics predictions and streamline data analysis workflows, ultimately contributing to improved cyclotron design and operational efficiency.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-18 / **114**

Optimization of Booster to Storage Ring Transport Using Nonlinear Kicker Magnet: A Simulation Study

Author: Chong Shik Park[1]

[1] *Korea University, Sejong*

This study investigates beam dynamics simulation and optimization of the booster ring to storage ring transport line using a nonlinear kicker magnet (NKM). Employing the Accelerator Toolbox (AT), we developed a custom NKM element module to enhance the simulation of beam dynamics. Our approach involves optimizing lattice functions within the booster ring to improve the transport efficiency to the storage ring. The study focuses on computing injection efficiencies with the NKM to achieve optimal beam transfer and minimize losses. The integration of the custom module with AT enables precise control and adjustment of nonlinear magnetic effects, contributing to improved performance and stability of the injection process. The results demonstrate significant advancements in optimizing the lattice configuration and enhancing overall injection efficiency, providing valuable insights for future accelerator design and operation.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-19 / **123**

Eddy current effect in a booster ring of Korea-4GSR

Authors: Ji-Gwang Hwang[1]; Yumi Lee[2]

Co-authors: Hyunchang Jin [3]; Jaehyun Kim [4]; Seunghwan Shin [3]

[1] *Gangneung-Wonju National University*

[2] *Korea University*

[3] *KBSI*

[4] *Pohang Accelerator Laboratory (PAL)*

Since the strength of the booster magnets changes during the energy ramping process, it creates the inevitable eddy currents in a metal chamber. The eddy current generates a relatively weak sextupole-field component but causes a non-negligible effect due to the significantly long physical length of the bending magnet. These effects can be estimated as chromaticity by integrating the time-varying sextupole components in the case of variable separation between each axis valid. The change of the chromaticity introduces the dynamic aperture reduction, resulting in crucial beam loss, so it demands a precise evaluation with 6D simulation. In this presentation, we will present the result of 6D simulations and the methods we used to calculate chromaticity.

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-20 / **126**

Optimizing beam configuration and envelope to maximize the wakefield generated by sub-THz Power Extraction Tube

Author: Minkyu Seo[1]

Co-authors: Keonho Kim [2]; Gwanghui Ha [3]; Seonghee Park [2]; Hyungsub Kong [4]; Jonghyun Kim [4]; Jina Kim [4]; Hojae Kwak [4]; Seunghwan Kim [4]; Seunghwan Shin [5]; John Power [6]; Gongxiaohui Chen [6]

[1] *Korea University, Sejong*

[2] *Korea University*

[3] *Northern Illinois University*

[4] *PAL*

[5] *KBSI*

[6] *ANL*

To maximize the wake field, we have to minimize the beam loss and adjust the bunch timing.
First, for minimizing the beam loss, it is essential to manage the beam size and the slope.
To prevent a loss from the beam pipe, we have to minimize the beam size.
Additionally, if the slope is too steep, then the particles may collide to beam pipe and be lost.
Therefore, it's important to avoid making the slope too steep.
Second, we have to match the bunch timing to get the maximum decelerate phase through the structure. So that we can maximize the wake field.
In this paper we try to make the beam size small enough to transport without loss by adjusting the strength and the position of the focusing element.
Also, we optimize the gun phase and the beam timing to match the bunch timing.
We use the General Particle Tracer(GPT) for the simulation.

Paper submission Plan:

No

Best Presentation:

Yes

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-21 / **130**

Bunch lengthening due to dual harmonic cavities of different orders in PLS-II

Author: Jun-hyoung Kim[None]

Co-authors: Moses Chung [1]; Yong Woon Parc [1]

[1] *POSTECH*

A double RF system, which consists of a main cavity and its higher harmonic cavity (HHC), is used to increase the bunch length and enhance beam lifetime. This system provides Landau damping and suppresses collective instabilities, thereby improving the beam quality. First, we review the optimal conditions for bunch lengthening using a single HHC, based on the RF parameters of PLS-II. Next, we discuss the optimal conditions for bunch lengthening in the presence of two HHCs of different orders. Our results show that the bunch lengthening factor increases as an extra HHC is added to the double RF system. Since an active cavity offers advantages in bunch lengthening compared to a passive cavity, this study assumes that all the cavities are operated in active mode.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-22 / **131**

Electron bunch shaping by laser heater for redueced XFEL pulse duration

Author: KOOKJIN MOON[1]

Co-authors: Myunghoon Cho [2]; Seong-Hoon Kwon [3]; Chang-Kyu SUNG [2]; Chi Hyun Shim [2]; Seongyeol Kim [2]; Haeryong Yang [2]

[1] *PAL, POSTECH*

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The pulse duration of the X-ray free-electron laser (XFEL) relies on the pulse duration of the electron bunch. The energy distribution of the electron bunch can be manipulated by using the laser heater in the purpose of generating attosecond pulse duration electron bunch current profile. Therefore, the resultant electron bunch current profile after the bunch compressor chicanes is programmable by the laser parameters. We performed the electron bunch shaping by using the laser heater and observed the resultant FEL signal at PAL-XFEL Soft X-ray beamline. The experimental results are compared with the ELEGANT and GENESIS simulations results for elucidating the physical features.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-23 / **147**

Development of an Absolute Coordinate Calibration Device for Beam Profile Monitor

Author: Juhwan Yoon[1]

Co-authors: Ga Ram Han [2]; Moses Chung [1]; Woojin Song [1]

[1] *POSTECH*

[2] *Pohang Accelerator Laboratory (PAL)*

Beam profile monitors (BPRMs) based on fluorescent screen plates have been widely used in various accelerator facilities due to their intuitive structure and convenient camera-based readout system. However, calibration methods to correct the complex measurement errors caused by factors such as the misalignment of screen, distance variations from the camera, and assembly tolerances with actuators have not yet been well developed. We have developed a device capable of performing absolute coordinate calibration for the beam image on the screen, using the ends of the beam pipe flange as reference points. This device consists of a two-axis motorized linear stage, two pairs of precision grid glass plates, a digital camera, and a BPRM chamber support. By utilizing geometrically well-aligned grid plates and a camera, we derived a method to get a perspective calibration matrix that maps the projected coordinates of the BPRM screen onto a 2D raster image. By applying this matrix, we were able to accurately obtain both the absolute central position and the shape of the beam in precise coordinates. In this presentation, we will showcase the development process of the device, the numerical model, and the measurement results.

Paper submission Plan:

Yes

Best Presentation:

Yes

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

ICABU Poster Session - Board: WG2-24 / **159**

Two-stage amplification of hard X-ray FEL using fresh-slice with wakefield from corrugated structure

Author: Chang-Kyu SUNG[1]

Co-author: Myunghoon Cho [1]

[1] *Pohang Accelerator Laboratory*

The world's brightest x-ray pulses are generated in a range of photon energy from 0.25 keV to 20 keV, and used for many scientific applications at PAL-XFEL. The self-amplified spontaneous emission, so-called SASE, mechanism is the simplest process for producing the high-brightness x-ray pulses. In the SASE mechanism, electron beams are accelerated to GeV energies and radiate the free-electron lasers (FELs) within periodic magnetic fields of an undulators. The FELs are then amplified, as the electron and the radiation fields interact through multiple undulators, to high intensity of approximately the millijoule. Typically, the quality of electron beams determines that of FEL output, for example, the FEL pulse length coincides with the electron bunch length. Since success of achieving bright XFELs, significant efforts have been made to increase the x-ray pulse power by reducing the pulse length while keeping its intensity. Works by LCLS and SwissFEL have demonstrated that the pulse power of XFELs can be significantly enhanced using a transversely tilted beam and producing FELs with specific bunch slices selectively through multi-stage undulator section. However, those efforts have so far been devoted for the soft x-ray FELs (up to 1.0 keV). In the PAL-XFEL, we applied the scheme to the hard x-ray FELs (2.47 keV) and enhanced the average pulse power by ~60 % compared to the SASE FEL. In this poster, we present the experimental procedure and results.

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

Paper submission Plan:

No

Best Presentation:

No

ICABU Poster Session - Board: WG2-25 / **160**

Phase space tomography with wire scanner at KOMAC BTS

Authors: SeokHo Moon[1]; Seung-Hyun Lee[1]; DongHwan Kim[1]; Han-Sung Kim[1]; Hyeok-Jung Kwon[1]; Jeong-jeung Dang[2]

[1] *KAERI (KOMAC)*

[2] *Korea Institute of Energy Technology (KENTECH)*

Beam diagnostics are a crucial aspect of accelerators, as they allow for the assessment of the current beam state and facilitate beam adjustments accordingly. Consequently, numerous beam diagnostic techniques have been developed and employed over time. However, many diagnostic methods provide only zero-dimensional or one-dimensional data. Although there are several techniques for two-dimensional or higher-dimensional measurements, they often require specialized equipment. To address this challenge, we are researching tomography methods. Tomography can generate two-dimensional data from one-dimensional profile data. This presentation will explain the tomography diagnostic method currently being studied at KOMAC's BTS and discuss the results of initial experiments.

Contribution track:

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

Paper submission Plan:

No

Best Presentation:

No

ICABU Poster Session - Board: WG3-01 / **28**

Implementation of high power RF auto start logic for 100 MeV proton linac at KOMAC

Author: Hae-Seong Jeong[1]

Co-authors: Sung-yun Cho [1]; Jae-ha Kim [1]; Young-gi Song [1]; Seong-Gu Kim [1]; Kyung-Hyun Kim [1]; Hyeok-Jung Kwon [2]

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[2] *Korea Atomic Energy Research Institute*

KOMAC (Korea Multi-purpose Accelerator Complex) of KAERI has operated the 100 MeV proton linear accelerator since 2013. To accelerate the proton beam, the high power RF is delivered to the cavities using 1.6 MW, 350 MHz klystrons.
KOMAC has started 24-hour user service since August 2024. In order to reduce the operational burden on accelerator operators, we have developed a system that can automatically boost high power RF. In addition, in the event of an unexpected stop of the high power RF system, the status of the RF system and accelerator system can be self-diagnosed to automatically resume high power RF operation. This system was named auto start logic at KOMAC, and this auto start logic includes the klystron automatic operation, modulator automatic operation, and high power RF automatic operation.
In this paper, the algorithm of auto start logic is presented with a sequence flow chart. And experimental results tested at the high power RF system of 100 MeV linac are also introduced.

This work was supported through the KOMAC operation fund of KAERI by Korean government (MSIT, KAERI ID:524320-24)

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG3. Beamline and Instrumentation

ICABU Poster Session - Board: WG3-02 / **29**

Magnetic field measurement status of magnets for the Korea-4GSR storage ring

Author: Yoongeol Choi[1]

Co-authors: Beom Jun Kim [2]; Dong-Eon Kim [3]; Ga Ram Han [1]; Min Jae Kim [1]; Woulwoo Lee [3]; Young Gyu Jung [1]

[1] *Pohang Accelerator Laboratory (PAL)*

[2] *Pohang Accelerator Laboratory*

[3] *PAL*

The 4GSR storage ring, with a 4 GeV electron energy, is designed with 28 cells based on the hybrid 7-bend achromat lattice concept. Compared to third-generation synchrotron radiation accelerators, it offers 100 times higher brightness and achieves an exceptionally low beam emittance of less than 100 pm·rad. To meet these specifications, each cell is equipped with a longitudinal gradient bend magnet (LGBM) and a reverse bend magnet (RB), with a central bend magnet (CB) located at the center for generating a harder X-ray source. This paper describes the magnetic field measurement system for the CB and LGBM used in the storage ring, along with the measurement results. The field mapping system utilizes a SENIS 3-axis hall probe sensor (I3C-03C10L-B02T0K5J) to minimize planar effects. The X, Y, and Z axis movements of the hall probe are controlled by linear and stepper motors, ensuring an accuracy within 5 μm. This system is capable of measuring the magnetic field within a 3D space of 400 mm x 200 mm x 3200 mm.

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG3. Beamline and Instrumentation

ICABU Poster Session - Board: WG3-03 / **71**

Antiproton beam manipulation for the GBAR experiment

Author: Byungchan Lee[1]

Co-author: Kwanhyung Park [1]

[1] *Seoul National University*

The interaction between antimatter with gravitational fields remains a fundamental question in physics. The GBAR experiment aims to measure the gravitational acceleration of antihydrogen atoms in a terrestrial gravitational field. Achieving precise measurements requires the production of ultra-cold antihydrogen atoms. A key milestone in the GBAR experiment is the production of antihydrogen ions, which allows for the creation of ultra-cold antihydrogen atoms by cooling the ions and subsequently neutralizing them. Antihydrogen atoms and ions are produced by the interaction between a positronium cloud and an antiproton beam. The antiproton beam is decelerated using a drift tube decelerator, and a Penning-Malmberg trap equipped with a superconducting solenoid is used to capture and manipulate the beam, enhancing the production rate of antihydrogen atoms. In this presentation, we discuss recent experimental results on antiproton beam trapping, cooling, compression, and extraction.

Paper submission Plan:

No

Best Presentation:

Yes

Contribution track:

ICABU Poster Session - Board: WG3-04 / **95**

Optimizing Electron Beam Orbit and Injection Stability for Compact Synchrotron Light Sources

Author: Keonho Kim[1]

Co-authors: Heejin Cho [1]; Heonwoo Lee [1]; Sangyun Shin [1]; Seonghee Park [1]

[1] *Korea University*

We are working on creating a small synchrotron light source for desktop applications using laser-driven electron acceleration. Our system includes a ring-shaped dipole with a block-shaped permanent magnet to reduce cost and weight. In our initial analysis, we found that minimizing electron beam divergence angles improves orbit stability. We also discovered that modulating the peak magnetic field can enhance stability without the need for additional quadrupoles. CST simulations showed us that the magnetic field within the ring-shaped dipole varies along the orbit due to its unique geometry. One of our main challenges is ensuring stable electron beam injection into the dipole, and to address this, we are using sequential magnetic elements designed to guide and stabilize the injected beam's orbit. This paper outlines our design and optimization efforts to achieve stable beam orbits during injection.

Paper submission Plan:

No

Best Presentation:

Yes

Contribution track:

ICABU WG3. Beamline and Instrumentation

ICABU Poster Session - Board: WG3-05 / **117**

Apparent Anti-resonance in X-ray Fluorescence Spectroscopy

Author: Deok-Yong Cho[1]

[1] *Jeonbuk National University*

X-ray fluorescence has been widely utilized in synchrotron X-ray spectroscopies including X-ray absorption or emission spectroscopy. The fluorescence yield (FY) counts the emitted X-rays originated from elastic or inelastic processes, and the intensity profile of the FY signal as a function of the X-ray energy contains the information on chemical states and excited electronic structure of the specimen. Interestingly, it is often observed particularly for certain narrow energy range in the metal L-edge X-ray absorption spectra that such fluorescence signals become very weak or even appear to be negative (lower than the background level). The weakness in FY signal can be explained by over-absorption (or self-absorption) effect. However the apparently negative resonance has not been addressed well. In this presentation, I would like to argue that an interference between the sharp absorption resonance and the background signals can induce such apparent anti-resonance (dips) particularly for localized orbital states in highly concentrated atomic species as in transition metal compound single crystals.

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG3. Beamline and Instrumentation

ICABU Poster Session - Board: WG3-06 / **121**

Current status of CLaSsy for the laser spectroscopy at RAON

Author: Chaeyoung Lim[1]

Co-authors: Sung Jong PARK [2]; Kyoungho TSHOO [2]; Jung Bog KIM [3]; Dong Geon KIM [2]; Junho Won [4]; Jeongsu Ha [4]; Hoon YU [5]; Taeksu SHIN [2]; Donghyun KWAK [2]; Cheolmin HAM [2]; Seoung Jae PYEUN [2]; Eun San KIM [6]

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CLaSsy is an experimental setup designed for laser spectroscopy of radioactive isotopes at the RAON ISOL facility of the Institute for Rare Isotope Science (IRIS). Laser spectroscopy provides model-independent determinations of nuclear ground state properties, such as mean-square charge radii and electromagnetic moments. Recently, we successfully obtained a spectrum of Kr ions using collinear laser spectroscopy. The Kr ion beam is produced by an offline source, which is a hot cathode plasma ion source. The ion beam was neutralized by passing it through a charge exchange cell filled with Rb vapor before interacting with the laser. The fluorescence generated during resonance was measured with a photomultiplier tube to obtain the spectrum. Instead of scanning the laser frequency, we stabilized it and continuously varied the ion beam's speed using an external electric field prior to neutralization to obtain the spectrum. In this presentation, the status and test results of CLaSsy will be described.

Paper submission Plan:

No

Best Presentation:

Yes

Contribution track:

ICABU WG3. Beamline and Instrumentation

ICABU Poster Session - Board: WG3-07 / **118**

Simulation-driven Design for Increasing Neutrons with The Low Dispersion Using Neutron Supermirrors

Author: Yongsik Jang[1]

Co-author: Sang-Jin Cho [2]

[1] *Korea Multi-purpose Accelerator Complex, Korea Atomic Energy Research Institute*

[2] *Neutron Science Division, Korea Atomic Energy Research Institute*

A beam from cold neutron sources or X-ray sources spread out radially from the source. These beams have a high divergence angle and the flux decreases inversely with distance. In order to analyze the structure of material, the beam must be sent to a sample at a distance. At this time, a long measurement time is required due to the low flux of the beam. Moreover, except for a few neutron imaging instruments, most neutron spectrometers require low dispersion neutrons, so the dispersion angle must be suppressed. However, focusing the beam with an elliptical or parabolic mirror increases the divergence angle, and decreasing the divergence angle with a collimator reduces the flux. Hence, it is necessary to design a neutron guide that convert the high dispersion angle of neutrons to a low angle. In this report, we will present a design for increasing neutrons with the low dispersion using a sophisticated arrangement of neutron supermirrors coated with different M-values. By inserting three types of mirrors with different installation angles into the horizontal plane of the neutron guide tube, neutrons with a dispersion angle of 0 to 1 degree can be converted to 0 to 0.5 degrees.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG3. Beamline and Instrumentation

ICABU Poster Session - Board: WG3-08 / **124**

Development of a Segmented Capillary for Inner Plasma Density Control and High Repetition-Rate Plasma Generation in Wakefield Acceleration Experiments

Author: Junyeong Jeong[1]

Co-authors: Inhyuk Nam [2]; Moses Chung [3]

[1] *UNIST*

[2] *Pohang Accelerator Laboratory (PAL)*

[3] *POSTECH*

To address the limitations of conventional RF acceleration methods, plasma wakefield acceleration techniques and the development of suitable plasma sources have been actively pursued for decades. While there has been considerable progress, there still remain issues such as poor beam quality, and structural limitations that impede high repetition-rate beam acceleration.
Various methods have been proposed to enhance beam quality by controlling the plasma density distribution within the capillary plasma source. On the other hand, a major challenge to achieving high repetition rates in beam acceleration lies in the difficulty of increasing gas injection rates. This problem could be alleviated through continuous gas injection. Nevertheless, none of these methods can be fully implemented with the traditional simple capillary design.
Recognizing these technical limitations, we propose a segmented capillary, which divides the conventional capillary into sections based on functionality. By modifying the internal cylindrical shape of the capillary, we demonstrated through numerical simulations that a certain degree of density control is achievable, and we confirmed the formation of a stepwise plasma density distribution through direct plasma density measurements. We also indirectly verified this feature by observing improved beam quality in laser-driven wakefield acceleration experiments. Additionally, we designed a specialized structure that enables continuous gas injection while minimizing its impact on the high vacuum outside the capillary. Experimental validation of this new structure's effectiveness is currently underway.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG3. Beamline and Instrumentation

ICABU Poster Session - Board: WG4-01 / **19**

Evaluation of Chemical Pretreatment Methods using Accelerator Mass Spectrometry for Environmental Sample Analysis

Author: Seung Won Lee[1]

Co-authors: Sae-Hoon Park [1]; Yu-Seok Kim [1]

[1] *Dongguk University*

In Accelerator Mass Spectrometry (AMS) laboratories, chemical pretreatment is essential for reducing sample contamination and enhancing data reliability. Specifically, in radiocarbon dating with AMS, chemical pretreatment is used to remove carbonates and humic acids, allowing for more precise measurement of sample data. This chemical pretreatment has been used for traditional sample measurement and is currently applied to environmental samples. This study evaluated the chemical pretreatment with comparing three distinct approaches using AMS, and its measurement data are discussed in this paper.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU Poster Session - Board: WG4-02 / **40**

Exploration of single-atom alloy nanocatalysts for high-performance ammonia electrooxidation

Author: Juhyun Cho[1]

Co-author: Sang-il Choi [2]

[1] *Department of Chemistry and Green-Nano Materials Research Center, Kyungpook National University*

[2] *Department of Chemistry and Green-Nano Materials Research Center, Kyungpook National University, Daegu 41566, Korea*

The global warming crisis, largely driven by rising carbon dioxide emissions, necessitates innovative solutions to mitigate its impact. Among the promising strategies under investigation is the utilization of ammonia fuel cells or ammonia electrolytic cells. Ammonia, a carbon-free substance with a higher energy density than hydrogen, offers significant advantages in terms of handling and transport. Unlike traditional energy systems that rely on organic materials and produce carbon dioxide as a byproduct, ammonia-based systems are inherently eco-friendly. However, a major challenge in optimizing ammonia fuel cells is the instability of the anodic ammonia oxidation reaction (AOR). The catalyst required for this reaction is susceptible to poisoning from nitrogen-based intermediates, such as adsorbed nitrogen (Nads) and adsorbed nitric oxide (NOads). This poisoning effect hampers the efficiency and longevity of the catalyst. Recent research has explored the introduction of transition metals into the catalyst matrix as a potential solution to this issue. Transition metals like Ni and Cu have shown promise in enhancing the stability of the catalyst by mitigating the effects of poisoning. Although the precise mechanisms by which these metals improve resistance to poisoning are not fully understood, their beneficial impact is well-documented. In our research, we have examined the effects of incorporating various transition metals at the atomic level onto platinum nanocubes. By testing these modified catalysts, we aim to better understand their effectiveness in facilitating the ammonia oxidation reaction and improving overall performance. This approach could provide a significant advancement in the development of more efficient and durable ammonia-based energy systems.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU Poster Session - Board: WG4-03 / **35**

Enhancing Alkaline Hydrogen Evolution Reaction Performance via Controlling Surface Distortion of FeRu Nanoparticles

Author: Gwanho Lee[1]

Co-author: Sang-il Choi [1]

[1] *Department of Chemistry and Green-Nano Materials Research Center, Kyungpook National University, Daegu 41566, Korea*

Rational design of electrocatalysts, including an increased catalytic surface area, a unique surface structure, and improved conductivity, for facilitating the hydrogen evolution reaction (HER) is emerging as an important issue. In this work, we consider the engineering of catalyst surfaces as an effective and feasible way to accelerate the HER kinetics. By etching the surface Fe of FeRu alloy nanoparticles (NPs) using hydrofluoric acid (HF), a distorted catalytic surface of FeRu NPs was formed. The distorted surface of the HF-treated FeRu NPs was successfully analyzed by X-ray absorption spectroscopy, high-resolution photoemission spectroscopy, and electrochemical absorption/desorption experiments. The electrocatalytic HER activity of the HF-treated FeRu NPs demonstrated that surface distortion enhances the water dissociation reaction and the electron transfer rate. As a result, the surface-distorted FeRu NPs improved HER performances in alkaline media compared to the pristine FeRu alloy NP/C, commercial Ru/C, and the state-of-the-art Pt/C catalysts.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU Poster Session - Board: WG4-04 / **44**

Comparative analysis of delivered and planned doses in target volumes for lung stereotactic ablative radiotherapy

Author: GEUM BONG YU[1]

Co-authors: Chang Heon Choi [2]; Hak Jae Kim [3]; Jung-in Kim [2]; Seonghee Kang [2]; Seungwan Lee [4]

[1] *Seoul Medical Center*

[2] *Seoul National University Hospital*

[3] *Seoul National University*

[4] *Konyang University*

Background: Adaptive therapy has been enormously improved based on the art of generating adaptive computed tomography (ACT) from planning CT (PCT) and the on-board image used for the patient setup. Exploiting the ACT, this study evaluated the dose delivered to patients with non-small-cell lung cancer (NSCLC) patients treated with stereotactic ablative radiotherapy (SABR) and derived relationship between the delivered dose and the parameters obtained through the evaluation procedure.
Methods: SABR treatment records of 72 patients with NSCLC who were prescribed a dose of 60 Gy (Dprescribed) to the 95% volume of the planning target volume (PTV) in four fractions were analysed in this retrospective study; 288 ACTs were generated by rigid and deformable registration of a PCT to a cone-beam CT (CBCT) per fraction and the dose delivered to the patient was estimated.
Results: The prescribed dose was confirmed to be fully delivered to the tumor (internal target volume, ITV). Multiple linear regression analysis between the obtained parameters and the dose delivered to 95% volume of the PTV (D95%) revealed four PTV parameters [Warpmean, DSC, ΔHI, Dmean] and the PTV D95% to be significantly related. The ACT cases of high ΔHI were caused by higher values of the Warpmean and DSC from the deformation image registration. The mean values of PTV D95% and Warpmean showed significant differences depending on the lung lobe where the tumour was located.
Conclusions: Evaluation of the dose delivered dose to patients with NSCLC treated with SABR using ACTs confirmed that the prescribed dose was accurately delivered to the ITV. However, for the PTV, certain ACT cases characterised by high HI deviations from the original plan demonstrated variations in the delivered dose. These variations may arise from factors such as patient setup during treatment.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU Poster Session - Board: WG4-05 / **45**

Role of Grain Boundaries in Oxygen Reduction Reaction within Pt-Co Nanowires

Author: jungki Kim[1]

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[1] *kyungpook national university*

[2] *Department of Chemistry and Green-Nano Materials Research Center, Kyungpook National University, Daegu 41566, Korea*

In this research, we explore the effect of grain boundaries (GBs) on the oxygen reduction reaction (ORR) in Pt-Co nanowires. Grain boundaries are imperfections in crystal structures and are typically considered highly active sites for various electrochemical processes. However, our results indicate that GBs in bimetallic Pt-Co alloys may not be beneficial. To investigate this, we synthesized Pt-Co nanowires containing GBs (Pt-Co GB-NWs) and single-crystalline Pt-Co nanowires without GBs (Pt-Co SC-NWs) as model catalysts, ensuring both types had comparable Pt/Co ratios, diameters, and Pt-rich surface structures, differing only in the presence of GBs. Through in-operando coupled plasma mass spectroscopy, we discovered that GBs in Pt-Co nanowires accelerate the leaching of Co atoms during the activation process. Furthermore, Pt-Co GB-NWs, which exhibited more Co leaching, demonstrated only half the ORR activity compared to Pt-Co SC-NWs. This suggests that GBs serve as defect sites that disrupt the surface alloy composition during ORR. These findings imply that preserving the crystal-structural integrity could be a promising strategy to enhance the ORR performance of Pt-based alloy materials, especially in one-dimensional structures such as nanotubes and nanowires

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU Poster Session - Board: WG4-06 / **57**

Measurement of Proton-Induced Reaction Cross-Sections on Natural Titanium and Vanadium with 100 MeV Protons

Author: Myung-Hwan Jung[1]

Co-authors: Hye-Min Jang [1]; Jun Kue Park [2]; Sung-Chul Yang [1]; Won-Je Cho [1]

[1] *Korea Atomic Energy Research Institute*

[2] *Korea Multi-purpose Accelerator Complex, Korea Atomic Energy Research Institute, Gyeongju, Gyeongbuk, 38180, Republic of Korea*

Abstract: This study investigates the cross-sections of proton-induced nuclear reactions on natural titanium (natTi) and natural vanadium (natV) using a 100 MeV proton beam. The experiments were conducted over an energy range from 97.5 MeV to 62 MeV. The primary objective was to measure the production cross-sections of various isotopes, including 43K, 44m,46,47,48Sc, and 48V, which were commonly observed from both target materials. Additionally, the isotope 51Cr was specifically measured from the natV samples. The cross-sections were determined using the stacked-foil activation technique followed by high-resolution gamma-ray spectrometry to identify and quantify the radioactive products. The obtained cross-sectional data are crucial for enhancing the understanding of nuclear reaction mechanisms and for applications in fields such as nuclear medicine, radiation shielding, and material science. The results were also compared with existing nuclear data libraries and theoretical models to validate the experimental methodology and to provide comprehensive nuclear data for these reactions.

Acknowledgement: This work was supported by the National Research Foundation of Korea (NRF) grant (No.2021M2E7A1079041) and the KOMAC (Korea Multi-purpose Accelerator Complex) operation fund of KAERI (Korea Atomic Energy Research Institute), which is funded by the Korean government-MSIT (Ministry of Science and ICT).

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU Poster Session - Board: WG4-07 / **61**

MCNP Calculation of Cherenkov Radiation for Dosimetry of Ultra-High Dose Rate FLASH Beams

Authors: Dong Hyeok Jeong[1]; Kyoung Won Jang[2]

Co-authors: Heuijin Lim [1]; Hyun Kim [1]; Manwoo Lee [1]; Pikad Buaphad [1]; Sang Jin Lee [1]; Sangkoo Kang [1]; Wunghoa Park [1]

[1] *Dongnam Institute of Radiological & Medical Sciences*

[2] *Dongnam Istitute of Radiological & Medical Sciences*

FLASH radiotherapy is an innovative treatment technique that delivers extremely high dose rates of radiation over a very short time, effectively destroying tumor cells while minimizing damage to healthy tissues. Cherenkov radiation, which is produced when high-speed electrons pass through a medium, could play a crucial role in dose distribution and real-time monitoring during FLASH radiotherapy. The objective of this study is to utilize MCNP (Monte Carlo N-Particle) calculations to model the generation and distribution of Cherenkov radiation and explore its potential application in real-time monitoring and dose assessment in FLASH radiotherapy. The MCNP calculation shows a strong correlation between the occurrence and distribution of Cherenkov radiation and the dose distribution in FLASH radiotherapy. These findings will suggest that Cherenkov radiation can be a valuable tool for real-time monitoring of the delivered dose, ensuring accurate and safe treatment. Furthermore, the study is anticipated to provide detailed guidelines for experimental validation and clinical implementation based on the simulation results. (This work was supported by the Dongnam Institute of Radiological & Medical Sciences (DIRAMS) grant funded by the Korea government (MSIT). (No. 50493-2024))

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU Poster Session - Board: WG4-08 / **66**

Temperature Dependence of Strain-Induced Modulation on Magnetic and Orbital Properties in Ferromagnetic Insulating La0.88Sr0.12MnO3 Thin Films

Authors: Byung-Jun Hwang[1]; Younghak Kim[1]

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The functional perovskite La1-xSrxMnO3 (LSMO) is extensively researched for its applications in green-energy storage, high-temperature oxygen sensors, catalysts, and memory devices. LSMO exhibits various exotic phases due to competing physical parameters and internal degrees of freedom. Notably, the ferromagnetic insulating (FMI) phase of LSMO has been less studied compared to its ferromagnetic metallic phase. To examine the relationship between crystal structure and magnetism in FMI LSMO, La0.88Sr0.12MnO3 thin films were grown on two different substrates, (001) SrTiO3 and (001) (LaAlO3)0.3(Sr2AlTaO6)0.7, using pulsed laser deposition. The strain-induced effects with temperature dependence on magnetic and orbital properties were investigated using X-ray magnetic circular dichroism (XMCD) and X-ray linear dichroism (XLD) measurements. XMCD results showed a decrease in the absolute values of XMCD with increasing temperature in both systems, consistent with previous SQUID magnetization measurements. As temperature rose, the spin magnetic moment (ms) exhibited relatively larger changes compared to the orbital magnetic moment (mo), indicating a dominant spin contribution to the temperature dependence of XMCD. These findings underscore the importance of strain engineering in tuning the magnetic and orbital properties of LSMO thin films. The strain-tuned structure-property relationship of FMI LSMO plays a crucial role in manipulating properties in the FMI regime, paving the way for the development of advanced functional materials for future electronic devices

Paper submission Plan:

No

Best Presentation:

Yes

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU Poster Session - Board: WG4-09 / **43**

Measurement and analysis of three-dimensional magnetic field distribution of prototype compact permanent magnet for C-band magnetron

Author: Wunghoa Park[1]

Co-authors: Dong Hyeok Jeong [1]; Heuijin Lim [1]; Hyun Kim [1]; Kyoung Won Jang [1]; Manwoo Lee [1]; Pikad Buaphad [1]; Sang Jin Lee [1]; Sang Koo Kang [1]

[1] *Dongnam Institute of Radiological & Medical Sciences*

We have researched a structure designed to enhance magnetic field strength using a CST program and have fabricated a mock-up magnet (M-magnet) with neodymium magnets. The field strength of the M-magnet is measured using a Gauss meter (TM-197, Tenmars, Taiwan) at 1 mm intervals. The position is precisely controlled by the 3D-magnetic field scanning system and a LabVIEW program developed in DIRAMS (Dongnam Institute of Radiological and Medical Sciences). The magnetic field data obtained with the scanning system were reconstructed into 3D images using Python code. This measured result of the distributed magnetic field will contribute to the permanent magnet fabrication for the C-band magnetron.

Paper submission Plan:

Best Presentation:

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU Poster Session - Board: WG4-10 / **77**

Calculation of optimal shielding thickness for a LINAC-based prototype self-shielded X-ray irradiator for radiotherapy research

Authors: Dong Hyeok Jeong[1]; Kyoung Won Jang[1]

Co-authors: Heuijin Lim [1]; Hyun Kim [1]; Manwoo Lee [1]; Pikad Buaphad [1]; Sang Jin Lee [1]; Sang Koo Kang [1]; Wung-Hoa Park [1]

[1] *Research Center, Dongnam Institute of Radiological & Medical Sciences*

To apply the C-band accelerator technology to medical devices in Dongnam Institute of Radiological and Medical Sciences (DIRAMS), a prototype 4 MV X-ray irradiator for preclinical radiotherapy research is developing. This irradiator is characterized by having the entire accelerator structure and irradiation device built into a single square body, and in this study, an optimal shielding structure was designed to minimize external leakage radiations. The leakage radiation dose emitted to the outside of the irradiator body was calculated through MCNPX® code calculations and the optimal shielding thicknesses for important points inside the body were determined. Through this process, the shielding thickness was determined at an appropriate location so that the amount of leakage radiation around the irradiator body was within 0.5% of the irradiated dose to the biological target. (This work was supported by the DIRAMS grant funded by the Korea government (MSIT) (No. 50493-2024).)
Keywords: x-ray irradiator, leakage radiation, shielding

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU Poster Session - Board: WG4-11 / **79**

A Simple Daily QA Method for PBS Proton Therapy Using Patterned Phantoms and EBT3 Film

Author: Young Kyu Lee[1]

Co-authors: Chankyu Kim [2]; Dongho Shin [2]; Haksoo Kim [2]; Jong Hwi Jeong [2]; Se Byeong Lee [2]; Wonjoong Cheon [3]; Young Kyung Lim [2]; Young-Nam Kang [1]

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Purpose
This study aimed to develop an efficient daily quality assurance (QA) program for pencil beam scanning (PBS) proton therapy, using custom-designed patterned phantoms and EBT3 film to measure and visually confirm proton range and spot position.

Methods
Two polymethylmethacrylate (PMMA) phantoms were used: a spiral step pattern for proton range verification and a round pattern for spot position verification.
For range measurements, the step pattern phantom with EBT3 film evaluated five proton beam energies (103-200 MeV). Sensitivity was assessed by varying measurement depth and spot position by ±0.1cm and ±0.2cm.
Spot position verification used the round pattern phantom at 119 MeV with 140 MU and 280 MU at 10 cm depth. The phantom was shifted ±2mm laterally. Irradiated films were scanned and analyzed to detect spot position changes.

Results
The step pattern method visually differentiated proton range variations across energies. Grayscale analysis of irradiated films showed distinct patterns corresponding to depth and position variations, allowing easy identification of range deviations.
In round pattern experiments, clear changes in beam profile graphs were observed with 2mm offsets. Spot position changes were more pronounced at 280 MU compared to 140 MU, suggesting increased MU enhances verification accuracy.

Conclusion
This QA method using patterned phantoms and EBT3 film enables quick, accurate verification of proton range and spot position in PBS proton therapy. The round pattern phantom showed high sensitivity for spot position verification, indicating effectiveness for daily QA.
As heavy ion therapy systems are introduced, this patterned phantom technique could be adapted for developing Daily QA protocols. This approach offers a time-efficient alternative to complex measurement techniques, suitable for routine QA checks in both proton and heavy ion therapy.

Paper submission Plan:

Yes

Best Presentation:

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU Poster Session - Board: WG4-12 / **37**

Vertically Aligned β-NiOOH Nanosheet as Highly Active and Stable Catalytic Sites for Oxygen Evolution Reaction in Alkaline Media

Authors: Jeonghyeon Kim[1]; Sang-Il Choi[1]

[1] *Kyungpook National University*

The long-term stability of Ni-based catalysts, employed in the anode of anion exchange membrane water electrolyzers (AEMWE), has been a persisting concern. In this work, through a simple and powerful electrochemical anodization process, vertically aligned β-NiOOH atomic sheets (vertical-β-NiOOH) grown on Fe-doped Ni nanoplates (FeNi nanoplates) as a solution are offered. The HRTEM and in-situ XAFS results revealed well-created vertical-β-NiOOH on the surface of FeNi nanoplates with Ni^{4+} active phase. This innovative electrocatalyst demonstrates sustained stability of constant current density for over 120 days during the oxygen evolution reaction. The zero-gap AEMWE cell harnessing the anodized FeNi nanoplates achieves a remarkable current density of 2.26 A cm^{-2} at 1.80 V with an energetic efficiency of 85.1%.

Paper submission Plan:

Best Presentation:

Yes

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU Poster Session - Board: WG4-13 / **47**

Boosted Ethanol Electrooxidation Using Rh Single Atom Decorated Pt Nanocubes

Author: Saehyun Park[1]

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[2] *Department of Chemistry and Green-Nano Materials Research Center, Kyungpook National University, Daegu 41566, Korea*

Direct ethanol fuel cells (DEFCs) are increasingly garnering attention as portable power sources, owing to their superior mass-energy density compared to hydrogen and lower toxicity relative to methanol. Despite these advantages, achieving full electrooxidation of ethanol to produce 12 electrons per molecule remains a significant challenge, leading to suboptimal fuel utilization efficiency. In this study, we present a novel electrocatalyst composed of unalloyed, partially oxidized Rh single atoms dispersed on the surface of Pt nanocubes. This catalyst facilitates the complete oxidation of ethanol to CO2 at an unprecedentedly low potential of 0.35 V. Through in situ X-ray absorption fine structure (XAFS) measurements and density functional theory (DFT) calculations, we demonstrate that the Rh single-atom sites are pivotal in promoting C–C bond cleavage and efficiently removing *CO intermediates. This work not only elucidates the crucial role of unalloyed, partially oxidized single-atom catalysts (SACs) in the ethanol oxidation reaction (EOR) but also introduces a distinctive single-atom strategy that leverages low-coordination active sites on shape-controlled nanocatalysts. This approach offers a promising pathway to enhance both the activity and selectivity of complex catalytic reactions.

Paper submission Plan:

No

Best Presentation:

Yes

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU Poster Session - Board: WG4-14 / **59**

Structurally denatured BSA using small-angle X-ray scattering

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[3] *Pohang Accelerator Laboratory (PAL), Division of Advanced Nuclear Engineering (DANE), Pohang University of Science and Technology (POSTECH)*

[4] *Center for Accelerator Physics and Engineering (CAPhE), Department of Physics and Division of Advanced Nuclear Engineering (DANE), Pohang University of Science and Technology (POSTECH)*

We employed small-angle X-ray scattering (SAXS) to investigate the conformational transitions of bovine serum albumin (BSA) across a wide range of urea concentrations (0–8 M). By constructing three-dimensional (3D) ab initio models using GASBOR, we described the structural evolution of BSA from its native state to denatured and unfolded conformations. By integrating size exclusion chromatography and SAXS (SEC-SAXS), we accurately isolated elution profiles corresponding to monomeric BSA, even under conditions of conformational polydispersity at high urea concentrations (5–8 M). Detailed analysis yielded precise measurements of the radius of gyration (Rg) and maximum dimension (Dmax) derived from the pair distance distribution function P(r). Our results revealed that BSA maintains its native conformation at low urea concentrations (0–3 M), undergoes partial denaturation at 4 M urea, and fully unfolds at concentrations of 5–8 M. These findings offer valuable insights into the relationship between structural stability and protein function, contributing to a deeper understanding of protein folding and stability under denaturing conditions.

Paper submission Plan:

Yes

Best Presentation:

Yes

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU Poster Session - Board: WG4-15 / **25**

Study of improved Surface Conductivity of Ceramics by Ion Implantation

Author: jae seok Lim[1]

Co-authors: bom sok kim [2]; myung jin kim [2]

[1] *Radpion Inc., Hanbat national university*

[2] *Radpion Inc.*

Currently, ceramic materials are used in various areas such as the machinery and semiconductor industries. However, the accumulation of static electricity on the ceramic surface causes defects in peripheral devices and semiconductor wafers. To prevent this, a conductive ceramic material capable of preventing static electricity is produced by mixing carbon nanotubes or metal powder with ceramics, but it is very expensive and has disadvantages such as non-uniformity in conductivity and changes in the properties of the material. This study investigates the principle of preventing static electricity in ceramics by ion implantation, where the electrical resistance of the ceramic surface decreases when ion implantation is performed using plasma treatment with a neutral gas.

The principle of improving the electrical conductivity of ceramic surfaces when plasma gas ion beams were implanted into ceramic surfaces has not been studied yet. However it was expected that gas ions accelerated with high energy would change the structure of the ceramic surface to form new bonds. In order to analyze and prove this phenomenon, 1E+14 to 1E+16 nitrogen gas ions accelerated to 50 keV were implanted into Al2O3 ceramics, respectively. To investigate the surface structural changes induced by ion implantation, the following surface analyses were conducted. XPS was utilized for bonding structure analysis, RBS was employed to verify the implanted ion dose, and SIMS was used to obtain depth profiles. Based on these analytical data, the principle of preventing static electricity in ceramics through ion implantation was investigated.

Paper submission Plan:

Yes

Best Presentation:

Yes

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU Poster Session - Board: WG4-16 / **96**

Effect of carbon-ion range by different stopping-power tables calculated in Geant4

Author: Sung Hyun Lee[1]

Co-authors: Hyeongmin Jin [1]; Jaeman Son [1]; Jong Min Park [1]; Kyung Su Kim [1]; Seonghee Kang [1]; Chang Heon Choi [1]

[1] *Seoul National University Hospital*

We evaluated the difference in the range of carbon ions in water according to the difference in the stopping-power table using Geant4 toolkit. In Geant4 toolkit, pristine carbon beams were simulated to be incident on the virtual water phantom for each therapeutic kinetic energy of carbon ions. In the case of the stopping-power table that is involved in energy loss among electromagnetic physics models, the stopping-power values of the ICRU49 report are used when the ion is less than 2 MeV/u, and the stopping-power values from the ICRU report 73 (ICRU73) or ICRU report 90 (ICRU90) are used when the ion exceeds 2 MeV/u. We evaluated the difference in the range of carbon ions according to the stopping-power values from ICRU73 and ICRU90. In addition, we were also able to calculate the stopping-power table provided by MSTAR or SRIM by substituting the values of the existing ICRU table. The difference in the range of carbon ions according to each different stopping power table can be confirmed to be within a few mm. It was confirmed that the difference in range due to the difference in stopping power is mostly contributed by the low kinetic energy part, and the user's awareness of which stopping power table to select and perform the simulation is required.

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU Poster Session - Board: WG4-17 / **97**

Initial operation of vacuum brazing system for manufacturing small accelerator components built at DIRAMS

Authors: Manwoo Lee[1]; Sangkoo Kang[1]

Co-authors: Dong Hyeok Jeong [2]; Heuijin Lim [1]; Hyun Kim [3]; Kyoung Won Jang [1]; Wunghoa Park [1]

[1] *Dongnam Institute of Radiological & Medical Sciences*

[2] *Research Center, Dongnam Institute of Radiological and Medical Sciences*

[3] *Research Center, Dongnam Institute of Radiological & Medical Sciences*

The Dongnam Institute of Radiological and Medical Science (DIRAMS) has built and operates the C-band electron LINACs for preclinical study and is currently conducting research focusing on core components of C-band electron LINACs for development and commercialization of radiotherapy machine. A vacuum brazing system was built to develop core vacuum components such as electron guns and waveguides designed by DIRAMS. The vacuum brazing system consists of a high temperature vacuum chamber, a high output heating power supply, a water-cooling system and a temperature control system etc. The working zone with a uniform temperature of the vacuum chamber is 40 cm in height and 30 cm in diameter. The vacuum chamber is heated with molybdenum wires and is designed to heat up to 1000℃ considering that the melting point of the silver alloy for welding is about 800℃. The vacuum chamber is equipped with a rotary pump and a turbo pump to create a high vacuum environment of 10-7 Torr. The overview of the brazing system and process in the DIRAMS will be presented.

(This work was supported by the Dongnam Institute of Radiological & Medical Sciences (DIRAMS) grant funded by the Korea government (MSIT) (No. 594932024).

Paper submission Plan:

Yes

Best Presentation:

Yes

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU Poster Session - Board: WG4-18 / **101**

Enhancing Dose Uniformity in Passive Scattering Proton Therapy for Small Tumors via Beam Current Modulation

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Co-authors: Jungwon KWAK [2]; Dongho SHIN [3]; Sung Yong PARK [4]

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[2] *Asan Medical Center*

[3] *National Cancer Center*

[4] *National Cancer Centre Singapore*

Proton therapy reduces radiation dose to normal tissues compared to X-ray therapy, thanks to the Bragg peak's physical properties, thereby minimizing radiotherapy side effects. However, in passive scattering proton therapy, using small apertures to treat small tumors leads to deterioration of dose uniformity within the spread-out Bragg peak (SOBP) region. This study aims to improve dose uniformity in the compromised SOBP when employing small-diameter proton beams. We investigated the characteristics of small-diameter scattering beams using multiple small-diameter blocks and developed new beam current modulation (BCM) parameters to compensate for SOBP degradation. By modifying the beam intensity data in the BCM file, we successfully enhanced dose uniformity in the SOBP for small fields. Our results demonstrate that the modified BCM effectively optimizes dose distribution in small fields. This novel approach shows promise for treating small tumors and enhancing the precision of proton radiosurgery, potentially improving patient outcomes.

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (RS-2023-00253710).

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU Poster Session - Board: WG4-19 / **120**

Development of Multi-Purpose Metal Ion Source for Use of Different Materials Bonding

Author: BomSok Kim[1]

Co-authors: JaeKeun Kil [2]; MyungJin Kim [1]

[1] *Radpion Inc.*

[2] *RADPION Inc.*

Radpion Inc. is a company that develops and sells ion sources, ion implantation devices, and technologies. It succeeded in industrialization by developing the surface electrostatic prevention technology for plastic and ceramic parts using gas ion implantation technology and devices. Recently, the need for bonding different materials in 5G/6G antennas and heat dissipation substrates is increasing, and our company is trying to solve it by using a metal ion beam. In the case of existing metal ion sources, the fraction of extracted metal ions is low, so it can be used for research purposes, but it is difficult to apply them industrially. The method of making metal ions varies depending on the type of metal ion source, but our company uses the sputtering method to increase the sputtering power density of several w/cm2 to several tens w/cm2 to increase the ion fraction of the sputtered metal by more than 10 times compared to the existing method, and is developing an ion source that can be used industrially by extracted metal ions of 20 keV and a diameter of 100mm. Currently, the initial metal ion source was developed and RBS(Rutherford backscattering spectrometry) analysis is being conducted on the investigated sample. Detailed data will be presented

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU Poster Session - Board: WG4-20 / **142**

Dosimetric Evaluation of Large-area Proton Minibeam Radiation Therapy System for Clinical Applications

Author: Jusung Kim[1]

Co-authors: Chankyu Kim [2]; Dohyeon Kim [3]; Dongho Shin [2]; Hak Soo Kim [1]; Hojin Kim [4]; Jong Hwi Jeong [2]; Kwanghyun Jo [5]; Kyeongyun Park [6]; Myeongsoo Kim [7]; Sang Hyoun Choi [8]; Se Byeong Lee [2]; Tae Hyun Kim [1]; Ui-Jung Hwang [9]; Young Kyung Lim [2]

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Methods: The large-area (30x40 cm2) pMBRT system was designed to encompass the entire brain in CSI. The system included a multi-slit collimator(MSC), a depth-dose modulator(lead scatterers), a neutron absorber, a range shifter, and a rectangular snout. The MSC generates a set of narrow minibeams due to 1.5 mm-wide slits, and the depth-dose modulator converts minibeams into a broad beam in the tumor. The peak dose uniformity and the peak-to-valley dose ratio(PVDR) values of the minibeams were measured using radiochromic films with air gap 1 cm and 11 cm from the isocenter. the depth-dose modulator was evaluated with varying the scatterer thickness, such as 0.5 mm and 1 mm to adjust PVDR value in a phantom.
Results: The pMBRT system was successfully installed into a pencil beam scanning nozzle at our proton therapy facility. It showed wide lateral beam profiles over 38 cm. The measured peak dose uniformity of the minibeams was less than 7% at overall phantom depth and air gap. PVDR values exceeding 15 were measured at the phantom surface with 170 MeV pMBRT case without scatterer. As the scatterer was thicker, the PVDR was decreased at shallower depth. The depth-dose modulator adjusted the PVDR in depth to achieve uniform dose in the target region.
Conclusions: The pMBRT system with a large-area MSC has been developed and its dosimetric properties have been evaluated. Its field size was large enough to cover the entire brain in CSI. The peak dose uniformity of the large-area pMBRT system showed good dose uniformity across the entire beam irradiation area. The large-area pMBRT system showed high PVDR values at the phantom surface, and the depth-dose profile could be modulated to form a uniform dose in the target with the scatterer and
air gap between the phantom surface and the front end of the system

Paper submission Plan:

Yes

Best Presentation:

No

Contribution track:

ICABU WG4. Applications of Particle Beams

ICABU Poster Session - Board: WG4-21 / **165**

A Study on Enhancing Multi-Radioisotope Identification in CsI(Tl) Gamma Spectra Using 2D Convolutional Neural Networks

Author: Yong Hyun KIM[1]

Co-authors: Hee-Seock Lee [1]; Yong Kyun Kim [2]; Chan Joong Kim [2]

[1] *Pohang Accelerator Laboratory, POSTECH, South Korea*

[2] *Hanyang university*

Radio-Isotope Identification (RIID) using Convolutional Neural Networks (CNNs) has been actively studied for their ability to identify key gamma-ray spectrum features. Our research team enhanced RIID performance by innovatively transforming traditional 1D gamma spectra from CsI(Tl) scintillator measurements of radioisotopic mixtures into 2D image data for CNNs training [1]. To improve model generalization, this study incorporated random background noise, gain shifts, and count variations into the dataset. RIID performance was then compared between models trained with 1D and 2D inputs across varying gain shift and count levels.

Experimental setup involved acquiring spectra at 20℃ from eight target radioisotopes, including 241Am, 57Co, 137Cs, 60Co, 22Na, 133Ba, 109Cd, and 54Mn, as well as background sources 226Ra, 232Th, 40K, and depleted uranium. Spectra for 232Th and 40K were generated via Monte Carlo simulation based on gamma energies and intensities obtained from IAEA Nuclear Data. Individual spectra were normalized to a maximum intensity and assigned random weights to create composite spectra with radioisotopic mixtures. To account for temperature-induced channel shifts, gain variations from -10% (0℃) to +10% (35℃) relative to 20℃ were applied randomly to the composite spectra. The total spectrum count was set between 1,000 and 20,000, with random counts assigned to each channel according to its probability distribution.

The model trained with 2D data was evaluated against the model trained with 1D data regarding gain shift and count changes, using mean square error (MSE) between target and predicted values as a performance metric. Across all radioisotopes, the MSE for the 2D model trained with 2D averaged $(1.02\pm0.05)\times10^{-3}$, approximately 2.3 times smaller than that for the model trained with 1D, which was $(2.33\pm0.22)\times10^{-3}$. This 2D image-based CNN approach improves RIID accuracy, reliability, and generalization in varied conditions.

Reference:

[1] Kim, Yong Hyun, et al., Radiation Physics and Chemistry 210 (2023): 111054.

Contribution track:

ICABU WG4. Applications of Particle Beams

Paper submission Plan:

No

Best Presentation:

No

KOPUA

KOPUA / 62

Development of flexible radiation detector based of nanomaterials

Author: Jeong Min Park[1]

Co-authors: Chang Goo Kang [1]; Su Jin Kim [1]; Yongsu Lee [1]

[1] *Korea Atimoc Energy Research Institute*

Organic scintillators are widely used in nuclear and particle physics, as well as homeland security applications, due to their low cost and ease of fabrication. However, their application is limited by their low effective atomic number, reducing detection efficiency for high-energy X-rays and γ-rays. To improve this, studies have explored incorporating nanocrystals into organic scintillators. As nanocrystal size increases, the emission wavelength shifts from blue to red, and the high atomic number (Z) of nanocrystals enhances X-ray/γ-ray absorption.
Flexible scintillators offer additional advantages by conforming to irregular surfaces, making them suitable for applications in medical imaging, wearable technology, and non-rigid systems.
In this study, we fabricated flexible scintillators using poly(methyl methacrylate) (PMMA) and nanocrystals for X-ray detectors. The radioluminescence and sensitivity properties of these scintillators were investigated and will be presented.

Contribution track:

KOPUA

Paper submission Plan:

Best Presentation:

KOPUA / 64

Transient superhydrophilic surface modification of polyimide by metal ion beam irradiation

Author: Sunmog Yeo[1]

Co-authors: YoungJun Yoon [2]; Giwan Jeon [3]

[1] *Korea Atomic Energy Research Institute*

[2] *Andong National University*

[3] *KAERI*

Polyimide is commonly used as a substrate for flexible electronic devices because of its excellent thermal, physical, and electrical properties. To enhance the adhesion between substrates and electrodes, it is necessary to improve the hydrophilic properties of the polyimide. Various surface treatments such as plasma treatment, laser ablation, and ultraviolet treatments, have been applied for this purpose. In this study, we demonstrated that Cu and Ti ion beam irradiation can temporarily create a superhydrophilic surface on polyimide after irradiation. When Cu or Ti ions bombarded the polyimide, the contact angle changed systematically with the beam current density and over time. We present AFM data for polyimide irradiated with Cu and Ti ions at different beam current densities and discuss the possible mechanisms behind the changes in the contact angle.

Contribution track:

KOPUA

Paper submission Plan:

Best Presentation:

KOPUA / 139

Proton fusion reactions under high temperature: Finding a new sun

Author: Seung Jeong Noh[1]

Co-author: Bo-Hyun Chung [2]

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According to the Big Bang theory, the universe began about 14 billion years ago, and light elements such as hydrogen and helium were created after several minutes of the universe's beginning. Inside the sun, proton fusion reactions under high temperature and high pressure generate 400 YJ (yotta-joules, 10**24 joules) of energy per second, which is about 700,000 times the amount of global energy consumed per year, and only one-2.2 billionth of it reaches the earth's atmosphere. In the view of carbon neutrality and energy challenges, 'plan A' for the first half of the 21st century (2006-2056) and 'plan B' for its second half (2056-2106) are discussed, which were proposed by professors Robert H. Socolow and Stephen W. Pacala at Princeton University. The related innovative energy sources are also discussed.

Paper submission Plan:

No

Best Presentation:

No

Contribution track:

KOPUA

KOPUA / 50

Synthesis of ZnO Thin Films Using the Sol-Gel Method and Ion Beam Irradiation

Authors: Gi Wan Jeon[1]; Jun Kue Park[1]

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ZnO thin films are semiconductor films used in LEDs. Using the sol-gel method, a ZnO precursor solution is prepared and deposited via spin-coating. Subsequent heat treatment at temperatures above 200℃ results in the formation of ZnO thin films. However, when utilizing ZnO thin films on flexible substrates, the temperature cannot exceed 200℃. Additionally, ZnO thin films produced at 200℃ contain residual organic compounds, necessitating heat treatment above 300℃. To address this issue, we propose the fabrication of ZnO thin films using ion beam irradiation. This method aims to achieve high-temperature annealing effects on the surface and verify the synthesis of ZnO thin films. Furthermore, techniques such as FT-IR will be employed to analyze the composition of residual organic materials and compare the differences with conventional methods.

Paper submission Plan:

Best Presentation:

Contribution track:

KOPUA

KOPUA / 73

Structural Control and Electrical Property Modulation of γ-GeSe via Ion Beam Implantation

Author: Joong-Eon Jung[1]

Co-authors: Joonho Kim [1]; Kihyun Lee [1]; Kwanpyo Kim [1]

[1] *Yonsei University*

γ-GeSe, a newly discovered hexagonal polymorph from the group IV–VI monochalcogenides, has attracted significant attention due to its unique bonding configuration and high electrical conductivity by Ge vacancies. This material exhibits intriguing metallic behavior, making it a promising candidate for electronic and thermoelectric applications. In this study, we investigated the structural control and electrical property changes in γ-GeSe through ion beam implantation of Mn, Cr, and Ti. We implanted Mn, Cr, and Ti ions at energies of 20-30 keV with fluences of 1E14 to 1E16 ions/cm², resulting in the amorphization of the upper tens of nanometers of γ-GeSe. By annealing, we successfully controlled the recrystallization of this amorphous layer to form either γ-phase or α-phase GeSe, depending on the conditions, enabling the creation of heterostructures. The effects of this structural control on the electrical properties of γ-GeSe are currently under investigation, with potential implications for advanced semiconductor applications.

Contribution track:

KOPUA

Paper submission Plan:

Best Presentation:

KOPUA / 129

Defects engineering in shallow acceptors in $Zn_{0.8}Al_{0.2}O$ alloy via N^+ ion beam irradiation

Author: Jun Kue Park[1]

Co-authors: Yu-Mi Kim [2]; Gi Wan Jeon [3]; Jae Kwon Suk [1]; Sunmog Yeo [4]; Weon Sik Chae [5]

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Here, we find that N^+ ion beam irradiation with an energy of 40 keV may create oxygen-related shallow acceptors in $Zn_{0.8}Al_{0.2}O$ alloy. After the N^+ beam irradiation with a fluence of 1×10^{16} ions/cm^2 (N16) a newly emerged signal with g=2.007 in electron spin resonance (ESR) spectroscopy corresponds to a longer decay time τ=15.6 ns in time-resolved photoluminescence spectroscopy and is then assigned to oxygen interstitial acceptors which have activation energy in a range of 26±3 meV to 38±5 meV. No hyperfine peaks in the ESR spectra may exclude the defects from N-related acceptors, although we irradiated N^+ ions into the samples. In x-ray photoelectron spectroscopy, we find the peak shift towards higher energy, indicative of the complete oxidation of the N16 films from the Zn 2p peaks. In this heavily doped alloy, the amorphous structure may be found in the samples before and after irradiation, allowing us to some new defects introduced by ion beam irradiation.

Paper submission Plan:

No

Best Presentation:

Yes

Contribution track:

KOPUA

KOPUA / 143

Reduced Set-Shifting Processing Speed in Male Rats Following Exposure to Low (10 cGy) Doses of Proton Radiation

Authors: Hui Ho Vanessa Chang[1]; Gyutae Kim[1]; Kyu-Sung Kim[2]; Richard A. Britten[3]

[1] *Inha University*

[2] *Inha University Hospital*

[3] *Old Dominion University*

Space radiation (SR) exposure poses a threat to astronaut health, including the central nervous system, during long-duration space missions. Previous animal studies have demonstrated a range of cognitive impairments following exposure to mission-relevant doses (<25 cGy) of various energetic SR particles. One such impairment involves SR-induced attenuation of attentional set-shifting ability, a key function in decision-making that enables the selection of relevant features. However, the impact of the most abundant SR component—protons—on attentional set-shifting performance remains unexplored.

Accordingly, we evaluated attentional set-shifting performance in rats exposed to low (10 cGy) doses of 100 MeV/n protons (LET = ~0.6 keV/μm), both alone and in combination with hypergravity. Our findings indicate that exposure to 10 cGy protons, either alone or in combination with hypergravity, significantly impaired attentional set-shifting performance. Specifically, proton exposure resulted in a higher mean correct latency (MCL), which is a measure of the processing speed during set-shifting tasks. No significant difference was observed between the performance of rats exposed to protons alone versus those exposed to protons and hypergravity.

Overall, our findings show the effect of proton exposure on the ability of rats to inhibit habitual responses and learn new response-outcome contingencies. Our results are consistent with findings in medulloblastoma patients exposed to proton therapy, who exhibit a similar significant loss of processing speed. The operational significance of the SR-induced loss of processing speed needs to be further determined. However, should similar effects be induced in astronauts exposed to galactic cosmic rays, these data suggest a reduced ability to execute tasks when dealing with complex situations.

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Contribution track:

KOPUA

KOPUA Poster

KOPUA Poster Session - Board: KOPUA-01 / **55**

Effect of proton-beam irradiation on cell survival of MCF-7 and its chemo-resistant subgroups

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Proton beam (PB) therapy is gaining popularity for breast cancer treatment because of its enhanced coverage and potential to minimize late toxicities. The dose and volume of PB irradiation are closely associated with improved breast cancer survival. We aimed to investigate the impact of PB irradiation on the survival of the human breast cancer cells MCF-7 and their resistance to doxorubicin(MCF-7-DR) and paclitaxel (MCF-7-PR). Cells exposed to 0.5, 2, 4, or 8 Gy of PB irradiation showed a signifcant decrease in the survival of parent cells, even at 2 Gy, indicating therapeutic efcacy. Conversely, drug-resistant cells exhibited notable cytotoxicity at 4 and 8 Gy, which were above the daily recommended dose. Mechanistically, PB irradiation signifcantly altered the DNA repair proteins RAD51, Ku80, and survivin and cleaved PARP in MCF-7 cells compared to chemo-resistant cells, except for RAD51 and Ku80. In addition, cell-cycle regulators and MAPK expression were notably altered by PB irradiation compared to MCF-7-DR and PR cells, underscoring the importance of tailoring PB irradiation for enhanced efcacy against chemo-resistant breast cancer. These fndings suggest that PB irradiation downregulated RAD51 and Ku80, the potent DNA repair markers, underscoring its potential therapeutic efficacy in treating chemo-resistant breast cancer cells.

Keywords : Proton-beam irradiation ·Breast cancer cells ·Anticancer drug resistance ·DNA repair · Cell death

Paper submission Plan:

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Contribution track:

KOPUA

KOPUA Poster Session - Board: KOPUA-02 / **60**

Inhibitory Effect of Proton Beam Irradiation on Metastatic Cancer Metabolism of Human Colorectal Adenocarcinoma Cells

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Proton beam therapy has recently been used to improve local control of tumor growth and reduce side effects by decreasing the global dose to normal tissue. However, the regulatory mechanisms underlying the physiological role of proton beam radiation are not well understood, and many studies are still being conducted regarding these mechanisms. To determine the effects of proton beams on mitochondrial biogenesis, we investigated: mitochondrial DNA (mtDNA) mass; the gene expression of mitochondrial transcription factors, functional regulators, and dynamic-related regulators; and the phosphorylation of the signaling molecules that participate in mitochondrial biogenesis. Both the mitochondrial DNA/nuclear DNA ratio and the mitochondria staining assays showed that proton beam irradiation increases mitochondrial biogenesis in 12-O-tetradecanoylphorbol-13-acetate-induced aggressive HT-29 cells. Simultaneously, proton beam irradiation increases the gene expression of the mitochondrial transcription factors PGC-1α, NRF1, ERRα, and mtTFA, the dynamic regulators DRP1, OPA1, TIMM44, and TOM40, and the functional regulators CytC, ATP5B, and CPT1-α. Furthermore, proton beam irradiation increases the phosphorylation of AMPK, an important molecule involved in mitochondrial biogenesis that is an energy sensor and is regulated by the AMP/ATP ratio. Based on these findings, we suggest that proton beam irradiation inhibits metastatic potential by increasing mitochondrial biogenesis and function in TPA-induced human colorectal adenocarcinoma cells.

Paper submission Plan:

No

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Contribution track:

KOPUA

KOPUA Poster Session - Board: KOPUA-03 / **36**

Dysprosium-Doped Lithium Borate Glass for Dosimetry Applications

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Lithium borate glass and Dysprosium (Dy^{3+}) ions are well-suited for radiation dosimetry due to their atomic numbers, which closely resemble that of human tissue, and the superior light emission properties of Dy^{3+} ions. Lithium borate glass with a composition (mol%) of (50-X)li2CO3: 50B203: XDy2O3 where X is 0.1%, 0.5% and 1% were prepared by conventional melt quenched technique. Properties analyzed include structural, physical, X ray luminescence, optical, photoluminescence (PL), and thermoluminescence (TL). The XRD spectra display broad humps without any sharp crystallization peaks, indicating that the glass samples are amorphous in nature. X ray luminescence shows a strong peak at 575nm because of 4F9/2 → 6H13/2 transition and the second most intense peak at 484nm is due to 4F9/2 → 6H15/2 transition. PL excitation spectra show seven sharp peaks due to 4f - 4f transition of Dy^{3+} ions and emission spectra exhibit two strong bands centered at 484 nm (blue) and 575 nm (yellow). The PL intensity for both the blue and yellow peaks of these glasses is increased under 248 nm laser excitation. The transmittance spectra were also analyzed to better understand the absorption characteristics of these glasses. Our findings emphasize the distinctive properties of Dysprosium-doped lithium borate glasses, making them valuable for various applications, particularly in radiation physics and dosimetry. This research enhances the understanding of the behavior of Dysprosium-doped lithium borate glass under various excitation sources, emphasizing its potential applications in fields like radiation physics and dosimetry.

Paper submission Plan:

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Yes

Contribution track:

KOPUA

KOPUA Poster Session - Board: KOPUA-04 / **34**

Study on the electrical property of He ion-irradiated thin film superconductor MgB_2

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Magnesium diboride (MgB_2) is a conventional superconductor that has high critical temperature (T_c ~ 39 K) and current density (J_c), making it a promising candidate for various applications [1]. Ion irradiation on MgB_2 thin films induces disorder through atomic lattice displacement, which reduces T_c [2,3]. In this study, we investigated the influence of He ion irradiation on the MgB_2 thin films with thicknesses of 170 nm and 570 nm, under various irradiation doses. The changes in crystallinity and superconducting transition temperature of irradiated MgB_2 thin films were observed by x-ray diffraction (XRD) and electrical resistivity measurements, respectively. Our results showed that all main peaks in the XRD patterns shifted due to He ion irradiation. As the dose increased, T_c systematically decreased. However, even at the highest dose (4.8×10^{16} ions/cm^2), T_c remains significant, around 8 K, which suggests that the superconductivity of MgB_2 thin films remains robust despite the disorder induced by He ion irradiation. Furthermore, we will discuss the recovery of T_c through thermal annealing on the irradiated MgB_2 thin films.

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KOPUA

KOPUA Poster Session - Board: KOPUA-05 / **94**

Proton Irradiation Influence on Metal-Insulator Transition of VO2

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The impact of proton irradiation on the metal-insulator transition (MIT) of Vanadium dioxide (VO_2) was investigated through in-situ X-ray absorption fine structure (XAFS) and electrical resistance measurements. VO_2 films, approximately 100 nm thick, were fabricated using DC-sputtering deposition techniques. Protons with energies of 100 and 200 keV and fluxes of 10^14 and 10^16 protons/cm² were vertically irradiated at KOMAC. A pristine VO_2 film exhibited the MIT at approximately 72.5℃ during heating. The transition temperature (Tc) of proton-irradiated VO_2 films with 100 keV energy and 1014 protons/cm² flux was around 75℃, while for the same energy but with 10^16 protons/cm² flux, it was 52.5℃. The Tc of the proton-irradiated VO_2 film with 200 keV energy and 10^13 protons/cm² flux was 77.5℃. XAFS measurements at the V K edge revealed the presence of V-V dimers in all VO_2 films in the metallic phase. The XAFS analysis indicated significant differences in the local structural properties around the V atom in the proton-irradiated VO_2 films, compared to the pristine VO_2, potentially influencing the Tc of VO_2. This study highlights the potential of proton irradiation techniques in tailoring the transition temperature of VO_2 films.

Paper submission Plan:

No

Best Presentation:

Yes

Contribution track:

KOPUA

KOPUA Poster Session - Board: KOPUA-06 / **106**

Thermal stability of the nitrogen-implanted CeFe12 thin films

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In our previous study, we showed that CeFe12 thin films exhibit enhanced magnetism when implanted with nitrogen ion beam. Since this nitridated CeFe12 can be a candidate for next-generation permanent magnets, it is necessary to test thermal stability of the nitridated CeFe12. In this presentation, we performed vacuum annealing on the same ion implanted CeFe12 thin films at 300℃, 500℃, and 700℃, respectively to find thermal stability of the films. The surface morphology of the CeFe12 thin films before and after the vacuum annealing is monitored by atomic force microscopy. The structural changes were confirmed by X-ray diffraction. Especially, we found that the magnetism decreased after vacuum annealing in the elevated temperatures by nearly 84%.

Paper submission Plan:

Yes

Best Presentation:

Yes

Contribution track:

KOPUA

KOPUA Poster Session - Board: KOPUA-07 / **116**

Development and Characterizations of 3D Printed Plastic Scintillators for High Dose Rate Proton Beam

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3D printing technology can fabricate three-dimensional objects based on layers and is applied across various fields such as biotechnology, medicine, industry, education, and space, etc. This study aimed to produce a scintillator resin capable of detecting radiation using commercial resins for DLP 3D printers. The commercial resin used was a transparent acrylic resin (Acryl Resin Pro, Anycubic Co.) with a density of 1.1 g/cm^3, viscosity of 70 mPa·s, and hardness of 79 (Shore D). A scintillator resin was manufactured by mixing 1.0 wt% PPO organic scintillator, 5.0 wt% MMA, and the commercial acrylic resin. This resin was used to print cylindrical 3D plastic scintillator radiation sensors using a commercial 3D DLP printer (Anycubic Photon M3 Max, Anycubic Co.).
The emission wavelength spectrum of the printed 3D-printed plastic scintillator ranges from 350 to 700 nm, with peaks at 411 nm and 497 nm, which match well with the quantum efficiency of photomultipliers. The scintillator shows excellent linearity in absorbed dose and measurement data (R-squared 0.998) and shows no dose rate effect in the range of 1 nA to 6 μA for a 45 MeV proton beam from KRISS MC-50 cyclotron. However, due to the low optical output of the sensor, it is limited for measuring low-dose gamma rays or X-rays. Nonetheless, it may be useful for measuring high-dose radiation or high-energy proton radiation. The 3D-printed plastic scintillator has the advantage of being similar to the human body in atomic number and density, making it beneficial for radiation dose measurement. Therefore, when used on the human body, it could assist in evaluating the volumetric dose to organs or targets and may be useful for measuring various types of non-standardized and complex radiation types.

Paper submission Plan:

Yes

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No

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KOPUA