IBIC2023

SASKATOON

CANADA

12th International Beam Instrumentation Conference

September 10-14, *2023*

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About

Welcome

Dear Colleagues,

I am excited to welcome you to Saskatoon, Canada, for the 12th International Beam Instrumentation Conference (IBIC2023). IBIC2023 is being hosted by the Canadian Light Source (CLS), at TCU Place in beautiful downtown Saskatoon, September 10th - 14th, 2023. The Canadian Light Source is Canada's national synchrotron light source facility which is located on the grounds of the University of Saskatchewan. The CLS has a third-generation 2.9 GeV storage ring which has supported user operations since 2005. Our scientific program focuses on health, agriculture, energy and the environment, and advance materials.

Saskatoon is a city of approximately 300,000 people located on the South Saskatchewan River. Saskatoon is located in Treaty 6 territory which is the traditional homeland of the Metis. This, budget-friendly city, known as the “city of bridges”, exudes welcoming vibes. Our city slogan is “Saskatoon Shines” and this is definitely true. Saskatoon is one of the sunniest places in Canada, enjoying over 2200 hours of sunlight every year. On Saskatchewan’s license plates you will see the slogan “Land of Living Skies”. The inspiration for this slogan comes from the awe-inspiring sunrises and sunsets, and the spectacular northern lights that we experience. We really do have something for everyone. Saskatoon has seen amazing evolution in the craft beer and spirits industry with a focus on locally grown ingredients such as Saskatoon berries, which are native to the region.

We hope you enjoy your stay in Saskatoon. We look forward to engaging with you and making IBIC2023 a memorable event!

Tonia Batten
Conference Chair
Scientific Program Committee Chair

Saskatoon Shines!

Committees

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Editorial Team

JACoW Editorial Team

Author Information

Paper Submission

Authors will be kept updated on the status of their uploaded papers either by checking the status screen or by logging in to their IBIC2023 SPMS account. Color codes will be used to indicate the current editor status of papers. Note that, before the paper is completely ready to be published in the Proceedings, the author must have a green indication by an Editor. If the paper is being presented as a poster, it must also be additionally approved by the Poster Session Manager.

Paper acceptance

Green: The paper has adhered to the template and format guidance, and is ready to be published in the Proceedings.

Yellow: Changes have been made to the paper. The author must contact the proceedings office at the Conference so that the modified version can be proof-read.

Red: There is a major problem with the paper, such as one of the source files being corrupt. The author must contact the proceedings office to arrange to see an Editor to correct this.

Poster Instructions

The Poster Sessions will take place from Monday to Wednesday in the afternoons. Posters must be mounted by 10:00 on the day of presentation and must be removed at the end of the session. Mounting material will be provided.

Poster Rules

Since no contributions are accepted for publication only, any paper not presented at the conference will be excluded from the proceedings. Furthermore, the organisers reserve the right to reject publication of papers that were not properly presented in the poster session. Manuscripts of contributions to the proceedings (or large printouts of them) are not considered as posters and papers presented in this way will not be accepted for publication. There will be a designated “poster police” to verify that posters have been displayed during the relevant poster session and posters should be manned for the entire poster session. Papers for posters that are not displayed for the full poster session will not be published in the proceedings.

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Code of Conduct

The IBIC2023 organizing committee is committed to providing a safe working environment, and promoting respect, equity and balance. IBIC2023 is also committed to upholding the highest ethical standards in all of its activities. We expect conference attendees to comply with applicable laws and to conduct themselves responsibly, ethically and with integrity.

This conference attendee Code of Conduct ("Code") outlines the principles and standards that IBIC2023's attendees are required to follow and uphold whilst attending the conference.

Compliance with this Code is mandatory for all attendees. IBIC2023 expects attendees to comply with both the letter and the spirit of this Code. Conduct that is illegal, dishonest or unethical constitutes a breach of this Code, whether or not the conduct is specifically addressed in this Code.

Compliance with Laws

Attendees must ensure that all of their activities comply with the applicable laws, rules and regulations of the Province of Saskatchewan and the laws of Canada.

Respect and Diversity

Attendees must act in a manner characterized by respect for the dignity of every individual. Attendees must respect the diversity of others with whom they interact, including conference staff and other attendees. This shall include respect for differences such as gender, race, colour, age, disability, sexual orientation, gender expression, ethnic origin, religion and any other characteristic protected by applicable laws.

Harassment

Acts or threats of harassment will not be tolerated and relations with IBIC2023 personnel and other attendees shall be conducted in a respectful and cooperative manner. Attendees must not engage in nor tolerate any harassment, violence, intimidation, retaliation, discrimination, or other disrespectful or inappropriate behavior.

Violence

Acts or threats of physical violence and intimidation will not be tolerated. Engaging in violence or threatening or intimidating behavior may result in termination of access to the IBIC2023 or immediate removal from IBIC2023 property, as deemed appropriate by the organizing committee. All reported incidents shall be forwarded to the proper authorities for investigation.

Compliance

Failure to comply with this Code may result in termination of access to IBIC2023.

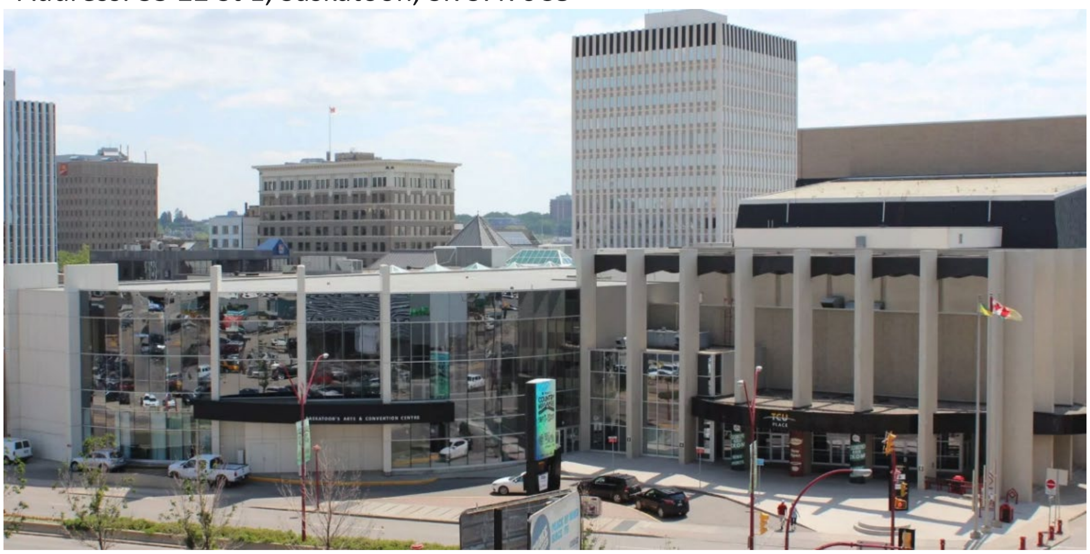
Attendees have the responsibility to report any known or suspected violations of any applicable laws and/or any non-compliance with this Code to IBIC2023's organizers in a timely manner.

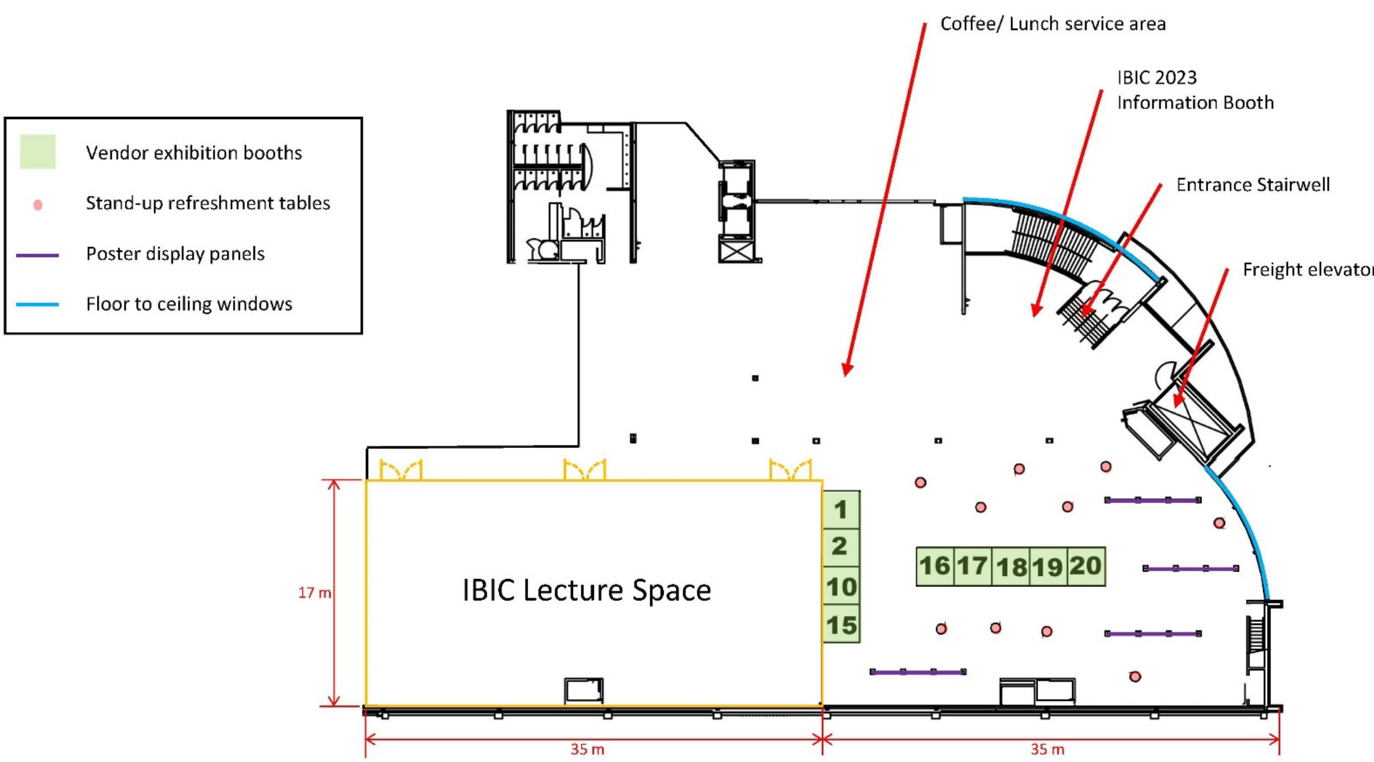
Attendees may address all notifications under, and any questions relating to the interpretation or application of, this Code to IBIC2023's organizers at ibic2023@lightsource.ca.

Conference Venue

IBIC 2023 is being hosted at TCU Place, in downtown Saskatoon.

Address: 35 22 St E, Saskatoon, SK S7K 0C8





Social Program

The welcome reception is being hosted at Remai Modern. The Remai Modern is an internationally acclaimed are gallery provide both Canadian and Saskatchewan perspective on global modern and contemporary art movements through a mix of regional, national and international programs.

Address: 102 Spadina Crescent E, Saskatoon, SK S7K 0L3

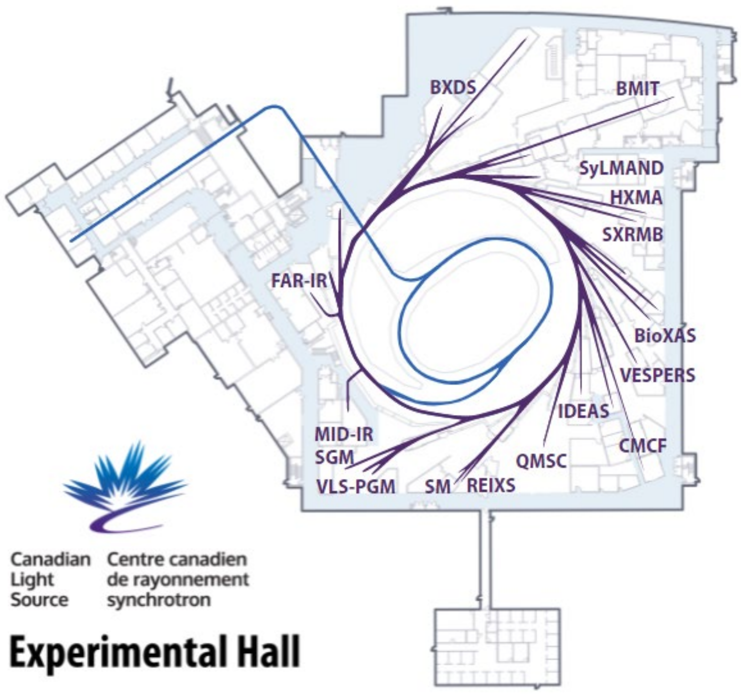
The conference banquet will be hosted at Champêtre County. This is a wild west themed special event venue offering catering and themed activities that will leave you with an inner peace, having experienced the simpler things in life, while learning about Saskatchewan and the prairies in a unique way.

Address: Box 12, St-Denis, SK S0K 3W0

We will also be offering a tour of the Canadian Light Source (CLS), which is a 3rd generation synchrotron. Since the start of user operations in 2005, CLS has enabled over 4,000 scientists from and from 41 countries, to publish over 6,000 scientific papers highlighting discoveries in a wide variety of fields. The CLS has also contributed to over 850 international scientific collaborations.

As the only synchrotron in Canada it is one of the largest science projects in Canada's history. More than 1,000 academic, government and industry scientists from around the world use the CLS every year.

Address: 44 Innovation Blvd. Saskatoon, SK S7N 2V3



Programme: Monday, September 11th

9:00 **Session 1 - Overview and Commissioning**
Tonia Batten (CLS): Welcome and Opening Remarks
Robert Edward Laxdal (TRIUMF): Overview of Canadian Accelerators
Iryna Chaikovska (Université Paris-Saclay): Commissioning of ThomX Compton Light Source

10:10 **Group Photo**

10:50 **Faraday Cup Award – Sponsored by Dimtel**
Yun Liu (ORNL)**:** Laser Wire Based H-Beam Longitudinal Profile Measurement at the SNS Superconducting Linac

11:20 **Session 2 - Feedback Systems and Beam Stability**
Idris Kempf (Diamond): Fast Orbit Feedback for Diamond-II
Pavana Sirisha Kallakuri (APS): Coupled Bunch Mode Zero Correction Within the Orbit Feedback Bandwidth
Romain Bronès (Soleil): SOLEIL New Platform for Fast Orbit Feedback

13:30 **Session 3 - Beam Position Monitors**
Danny Padrazo Jr. (BNL): The Art of Sensing Beam Orbits in Mile-Long Accelerators on a Nanometer Scale
Eugenio Senes (CERN): Dielectric Pick-up for Short Bunches
Boris Keil (PSI): Development of the SLS 2.0 BPM System
Gero Kube (DESY): A MTCA Based BPM-System for PETRA IV
Michael Bree (CLS): Canadian Light Source Beam Position Visualization Tool

15:30 **Industry Introductions**

16:00 **Poster Session**

Canadian Light Source | Centre canadien de rayonnement synchrotron

IBIC2023

University of Saskatchewan

Programme: Tuesday, September 12th

9:00 **Session 1 - Overview and Commissioning**
Gaku Mitsuka (KEK): Beam Instrumentation Challenges for High-Energy and Low-Emittance Beam at SuperKEKB
Irena Dolenc Kittelmann (ESS): Beam Instrumentation Performance During Commissioning of the ESS LINAC
Gorkem Turemen (TENMAK-NUKEN): An Experimental Setup for PIXE Analysis in a Medical Cyclotron at TENMAK-NUKEN

10:50 **Session 2 - Longitudinal Diagnostics and Synchronization**
Nicole Hiller (PSI): Overview of Beam Diagnostics for Different Accelerator Types: Longitudinal Profile
Tsuyoshi Suwada (KEK): First Direct Measurement of Electron and Positron Bunch Characteristics during Positron Capture Process at the Positron Source of the SuperKEKB B-Factory
Jinguo Wang (SARI-CAS)**:** Sub-20 fs Synchronization Between Mode-Locked Laser and Radio Frequency Signal

13:30 **Session 3 - Beam Loss Monitors and Machine Protection / Beam Charge and Current Monitors**
Jeremy Mock (SLAC): Commissioning of the LCLS-II Machine Protection System for MHz CW Beams
Michelle A. Ibrahim (Fermilab): FPGA Architectures for Distributed ML Systems for Real-Time Beam Loss De-Blending
Pascal Dominik Hermes (CERN): Collimator Scan based Beam Halo Measurements in LHC and HL-LHC
Timmy Lensch (DESY): Comparison of Different Bunch Charge Monitors Used at the ARES Accelerator at DESY
Ruiyang Qiu (IHEP): Low Intensity Beam Current Measurement of the Associated Proton Beam Line at CSNS

15:30 **Industry Introductions**

16:00 **Poster Session**

Canadian Light Source | Centre canadien de rayonnement synchrotron

IBIC2023

University of Saskatchewan

Programme: Wednesday, September 13th

9:00 **Session 1 - Longitudinal Diagnostics and Synchronization**
Garam Hahn (PAL): Online Bunch Length Monitoring for Storage Ring using a Fast Photodiode
Erik Mansten (MAX IV): The MAX IV Transverse Deflecting Cavity
Rahul Yadav (IMP, TU Darmstadt): THz Antenna-Coupled Zero-Bias Schottky Diode Detectors for Particle Accelerators

10:50 **Session 2 - Data Acquisition and Processing Platforms**
David Beauregard (CLS): Overview of Current and Future Platforms for Big Experiments/Different Types of Machines
Philipp Niedermayer (GSI): Software Defined Radio Based Feedback System for Transverse Beam Excitation
Robert Michnoff (BNL): Beam Instrumentation Hardware Architecture for Upgrades at the BNL Collider-Accelerator Complex and the Future Electron Ion Collider

13:30 **Session 3 - Transverse Profile and Emmitance Monitors**
Ondrej Sedlacek (CERN): Gas Jet-Based Fluorescence Profile Monitor for Low Energy Electrons and High Energy Protons at LHC
Bokkyun Shin (PAL): Development of a Precise 4D Emittance Meter Using Differential Slit Image Processing
Emma Buchanan (CERN): Radiation Hard Beam Profile Monitors for the North Experimental Beamlines CERN

15:00 **Poster Session**

16:30 **Departure for Conference Dinner at Champêtre County**

21:30 **Return from Conference Dinner**

Canadian Light Source / Centre canadien de rayonnement synchrotron — IBIC2023 — University of Saskatchewan

Programme: Thursday, September 14th

9:00 **Session 1 - Data Acquisition and Processing**
Carolina Bianchini Mattison (SLAC): LCLS-II Timing System and Synchronous Bunch Data Acquisition
Longwei Lai (SARI-CAS): A Novel Cavity BPM Electronics for SHINE Based on RF Direct Sampling and Processing
Wang Tian (IMP/CAS): The Development of a 128-Channel Ultra-Low Noise Trans-Impedance Amplifier System

10:50 **Session 2 - Machine Parameter Measurement**
Alexander V. Aleksandrov (ORNL): 6D and High Dynamic Range Measurements of Hadron Beam Phase-Space
Shinnosuke Kato (KEK): Machine Learning-Assisted Beam Operation at SuperKEKB and Linac at KEK
Kacper Lasocha (CERN): Analysis of the Transverse Schottky Signals in the LHC
Junhui Yue (IHEP): Invitation to IBIC 2024
Tonia Batten (CLS): Concluding Remarks and Closing of IBIC 2023.

13:30 CLS Tour: Transportation departs from and returns to conference venue
Departs 13:30 – Returns 15:20
Departs 14:30 – Returns 16:20
Departs 15:30 – Returns 17:20

Canadian Light Source / Centre canadien de rayonnement synchrotron — IBIC2023 — University of Saskatchewan

MO1 – Monday Session 1

Chair: T. Batten (CLS)

MO1I00 **Opening of IBIC 2023**

09:00 ***T. Batten*** *(CLS)*

Welcome to Saskatoon, Canada for the 12th International Beam Instrumentation Conference.

MO1I01 **Overview of Canadian Accelerators**

09:10 ***R.E. Laxdal****, S.L. Liu (TRIUMF) T. Batten, R. Beauregard (CLS)*

MeV class accelerators were introduced in Canada in 1947 with the commissioning of the world's first microtron producing 4.6 MeV electrons. Through the early years a variety of machines were realized driven by, primarily, sub-atomic physics science pursuits. Two main centres of accelerator activity have emerged in Canada; at TRIUMF in Vancouver and CLS in Saskatoon. A number of smaller accelerators dot the country for medical and other applications. Industrial companies have formed to supply accelerators or accelerator sub-systems. The talk will give a brief historical overview of accelerator development in Canada, describe the present status and provide an overview of future initiatives.

MO1I02 **Commissioning of ThomX Compton Light Source**

09:40 ***I. Chaikovska*** *(Université Paris-Saclay, CNRS/IN2P3, IJCLab) N. Hubert (SOLEIL)*

ThomX is a compact Compton scattering source designed to demonstrate the production of hard X-rays with a flux of 10^{11}-10^{13} ph/s. The 50 MeV electron beam has been recently injected and stored in the 18 m circumference storage ring and interaction with the 100 kW laser in the Fabry-Perot cavity is foreseen for 2023, for the production of the first X-rays. Commissioning results and beam instrumentation will be presented.

11-Sep-23 10:50 – 12:30	Plenary

MO2 – Monday Session 2

Chair: N. Hubert (SOLEIL)

MO2I01 10:50 **Non-interceptive Beam Diagnostics in a H^- Linac During Operations Using Laser Comb and Virtual Slit**

Y. Liu, W. Blokland (ORNL)

Several novel techniques have been recently developed for laser wire based non-interceptive H^- beam diagnostics. A laser comb – ultrashort laser pulses with macropulse structure – was implemented and used for measuring time-resolved profiles/emittances from a single scan. A virtual slit technique was demonstrated for the precise measurement of short bunches formed in the superconducting linac. Both techniques have been applied to measuring parameters of neutron production H^- beam at the linac of the Spallation Neutron Source. Key components in the implementation and operation of the laser comb and virtual slit will be described. Applications of the measurement results to the accelerator physics study will also be discussed.

MO2I02 11:20 **Fast Orbit Feedback for Diamond-II**

I. Kempf, M.G. Abbott, L. Bobb, G.B. Christian (DLS) S. Duncan (University of Oxford) G. Rehm (HZB)

The electron beam stability is critical for 4th generation light sources. As opposed to 10% of beam size up to 140 Hz at Diamond, advances in detector speed and resolution at Diamond-II increase the stability requirements to 3% up to 1 kHz. This paper presents a novel control methodology for the fast orbit feedback at Diamond-II, which will stabilise the beam using two arrays of 252 slow and 144 fast correctors and 252 beam position monitors at 100 kHz. In contrast to existing approaches that separate slow and fast feedback loops, our approach is based on a two-matrix factorisation called the generalised singular value decomposition (GSVD), which decouples the system into 144 two-input modes controlled by slow and fast magnets and 108 modes controlled by slow magnets only. The GSVD-based controller is implemented in the existing Diamond storage ring using a centralised communication architecture, such as planned for Diamond-II. We present results from the Diamond storage ring and simulation, which confirm that the proposed approach meets the target specification for Diamond-II.

MO2C03 11:50 **Coupled Bunch Mode Zero Correction within the Orbit Feedback Bandwidth**

P.S. Kallakuri, A.R. Brill, J. Carwardine, L. Emery, N. Sereno (ANL)

The fast orbit feedback (FOFB) bandwidth for Advanced photon source upgrade (APS-U) will be DC-1 kHz and the synchrotron frequency will be between 100-560 Hz. This frequency overlap places coupled bunch mode 0 (CBM0) induced horizontal orbit motion inside the orbit feedback bandwidth, potentially affecting our ability to achieve beam stability goals. Longitudinal feedback kicker is not strong enough to damp CBM0 oscillations. We developed new beam-based feedback method to suppress CBM0 oscillations with low level RF phase as actuator. It uses existent FOFB framework with no changes to the feedback algorithm. Effectiveness of this method is verified using present APS operations lattice where synchrotron frequency is outside orbit feedback bandwidth. In the present work, low alpha lattice is created to emulate APS-U setting where synchrotron frequency is inside the orbit feedback bandwidth. Experiments with this lattice successfully demonstrated CBM0 correction within FOFB bandwidth. Combined operation of orbit feedback and CBM0 correction is stable, and CBM0 oscillations are damped. We achieved better orbit motion suppression and corrector drive efforts are reduced as well.

MO2C04 12:10 **SOLEIL New Platform for Fast Orbit Feedback**

R. Bronès, A. Bence, J. Bisou, N. Hubert, D. Pédeau, G. Pichon (SOLEIL)

SOLEIL is upgrading its Fast Orbit Feedback platform to withstand coming obsolescence of electronic BPM and future evolutions of the machine. This new platform has to be compatible with current boundary devices such as BPM electronics or corrector power supplies, but it also shall evolve to interface future versions of these systems. A MTCA based platform was designed and installed. It is integrated in the control system by mean of a OPCUA server, and care has been taken to seamlessly toggle the closing of the feedback loop on the former or new FOFB platform. This paper will present the first tests and results conducted to commission this new system.

MO3 – Monday Session 3

Chair: K. Satou (KEK)

MO3I01 13:30 **The Art of Sensing Beam Orbits in Mile-long Accelerators on a Nanometer Scale**

D. Padrazo Jr *(BNL)*

The "eyes" that enable us to see the particle beams are called Beam Position Monitors. BPM design is based on detection of electric fields of the bunches passing through electrodes located inside the vacuum chamber. The weak electric signals are filtered, amplified and digitized to provide us with the orbit data. The progress with advancing the BPM accuracy, sensitivity, speed and data volume has escalated manyfold in the last few decades following the rapid growth of capabilities of the modern electronics. In my presentation I will go over the basic principles, the history and the future prospects of BPM diagnostics for particle accelerators. Concurrently I will introduce our home-grown solution for NSLS-II RF BPMs and present the accomplishments to date, experience from operations and studies and an outlook at the future developments in both Analog and Digital domains of our devices. NSLS-II has 250 BPMs that include several generations and our units demonstrate an outstanding level of both reliability and performance.

MO3I02 14:00 **Dielectric Pick-Up for Short Bunches**

E. Senes, *T. Lefèvre (CERN)*

Novel acceleration schemes pose new challenges to the beam instrumentation required. This contribution presents a novel device to measure the beam position, enabling the discrimination of different co-propagating beams. The method leverages the characteristic properties of the Coherent Cherenkov-Diffraction Radiation (ChDR) emitted from dielectric inserts in the beampipe. The beam discrimination is performed in the frequency domain, exploiting the bunch length difference of the two beams. This device was developed for the AWAKE experiment, where not only an electron beam co-propagates with a more intense proton beam, but also traditional pickups are impacted by the environment polluted with spurious charges from the plasma. The electron beam discrimination takes place in a narrow band around 30 GHz. The overall design and results from the AWAKE experiment are presented. The utilisation of coherent ChDR to distinguish different co-propagating beams is a substantial novelty in the field, pushing the instruments capabilities for novel accelerating technologies, such as plasma-based accelerators.

MO3C03 14:30 **Development of the SLS 2.0 BPM System**

B. Keil, *R. Ditter, F. Marcellini, G.M. Marinkovic, J. Purtschert, M. Rizzi, M. Roggli, X. Wang (PSI)*

After more than 20 years of operation, the storage ring of the Swiss Light Source (SLS) will be replaced. The new ring called SLS 2.0 will have 40 times higher brilliance than SLS, thanks to an innovative low-emittance magnet lattice and a beam pipe with smaller aperture. For SLS 2.0, the ageing SLS BPM electronics will be incrementally replaced for the whole accelerator, including linac, booster, transfer lines and storage ring. This contribution presents the development status and latest prototype test results of the SLS 2.0 BPM system, including BPM pickups, mechanics, and electronics.

MO3C04 **A MTCA Based BPM-System for PETRA IV**
14:50
*G. **Kube**, H.T. Duhme, F. Schmidt-Föhre, K. Wittenburg (DESY) A. Bardorfer, L. Bogataj, M. Cargnelutti, P. Leban, M.O. Oblak, P. Paglovec, B. Repicˇ (I-Tech)*
The PETRA IV project aims to upgrade the present PETRA III synchrotron into an ultra low-emittance source. The small emittances translate directly into much smaller beam sizes, thus imposing stringent requirements on the machine stability. In order to measure beam positions and control orbit stability to the level of 10% of beam size and divergence, a high resolution BPM system will be installed which consists of 788 individual monitors with the readout electronics based on MTCA.4. In order to fulfil the long-term drift requirement (<1 µm over 7 days), several analog, digital and SW parts were taken from the Libera Brilliance$^+$ and a new RTM module has been developed to be used as BPM electronics RFFE. In addition, its analogue RF switch matrix used for long-term stabilization was separated and placed close to the BPM pickup, hence enabling an additional stabilization of the RF cables. At present, a fully populated MTCA crate with 6 AMC boards for the readout of 12 BPMs is installed at PETRA III and is extensively being tested. This contribution summarizes the latest beam measurements, demonstrating the high performance of the BPM system and the external stabilization concept.

MO3C05 **Canadian Light Source Beam Position Visualization Tool**
15:10
*M. **Bree**, T. Batten, J.M. Vogt (CLS)*
The CLS Orbit Correction (OC) system acquires, collates, and publishes storage ring beam centroid position information from 48 beam position monitors (BPMs) at a rate of 1000 samples per second. We present a "Storage Ring Beam Position Visualization Tool" that computes and displays dynamic Fast Fourier Transforms (FFTs) and Cumulative Power Spectral Densities (CPSDs) for all BPMs in real-time using full resolution data. The computed FFTs and CPSDs can be plotted in various combinations and in waterfall plots that allow visualization of changes over long periods of time. In addition, correlations between all BPM channel combinations are computed and ranked. Data from any two BPM channels can be selected for plotting in two dimensions wherein correlations are visually apparent. Computed CPSDs are further binned and published in scalar EPICS PVs which are archived for further analysis. Preliminary results from the Beam Position Visualization Tool have proven useful in characterizing beam position noise at the CLS.

MO3I06 **Industry Introductions**
15:30
*S. **Carriere** (CLS)*
Industry Introductions

MOP — Monday Poster Session

MOP001 **Current Status of the HESR Beam Instrumentation**

C. Böhme *(FZJ) A.J. Halama, V. Kamerdzhiev, G.K. Koch, K. Laihem, K. Reimers (GSI)*

The High Energy Storage Ring (HESR), within the FAIR project, will according to current planning provide anti-proton beams for PANDA and heavy ion beams for i.a. the SPARC experiment. Manufacturing for most of the envisaged beam instrumentation devices in vacuum is completed and testing is well underway. The overall status update of the beam instrumentation devices is presented, with a focus on the test-bench results of the BPMs. In addition, the planned future timeline of the HESR beam instrumentation is briefly reported.

MOP002 **MiniBEE - Minibeam Beamline for Preclinical Experiments**

J. Reindl*, G. Datzmann, G. Dollinger, J. Neubauer, A. Rousseti (Universität der Bundeswehr Muenchen) J. Bundesmann, A. Denker, A. Dittwald, G. Kourkafas (HZB) G. Datzmann (Datzmann Interact & Innovate GmbH) A. Denker (BHT)*

Spatial fractionated radiotherapy using protons, so-called proton minibeam radiotherapy (pMBT) was developed for better sparing of normal tissue in the entrance channel of radiation. Progressing towards clinical use, pMBT should overcome current technical and biomedical limitations. This work discusses a preclinical pMBT facility, currently built at the 68.5 MeV cyclotron at the Helmholtz Zentrum Berlin. The goal is to irradiate small animals using focused pMBT with a sigma of 50 µm, a high peak-to-valley dose ratio at center-to-center distance as small as 1 mm and beam current of 1 nA. A first degrader defines the maximum energy of the beam. Dipole magnets and quadrupole triplets transport the beam to the treatment room while multiple slits properly form the transverse beam profiles. A high magnetic field gradient triplet lens forms the minibeams in front of the target station and, scanning magnets are used for a raster scan at the target. An additional degrader, positioned close before the focusing spot and the target, further reduces the energy, forming a spread-out Bragg peak. A small animal radiation research platform will be used for imaging and positioning of the target.

MOP003 **Design of HEPS Storage Ring Beam Instrumentation**

J.H. Yue*, J.S. Cao, Y.Y. Du, J. He, F. Liu, X.Y. Liu, Z. Liu, Y.H. Lu, H.Z. Ma, Y.F. Sui, L. Wang, S.J. Wei, T.G. Xu, Q. Ye, L. Yu, W. Zhang, Y. Zhao, D.C. Zhu (IHEP) A.X. Wang (USTC/NSRL)*

HEPS is a fourth generation light source which has horizontal emittance around 34pm.rad to gain the high brilliance photon beam, this ultra-low emittance brings many engineering challenges for beam instrumentation. The resolution of the beam position measurement and the beam size measurement is need to reach sub-micro meter. The large current and multi-bunches need bunch by bunch feedback system to cure instabilities. This paper will present an overview of beam instrumentation

MOP004 **Design and Study of Cavity Quadrupole Moment and Energy Spread Monitor**

Q. Wang*, Q.Y. Dong, L.T. Huang (DICP) Q. Luo (USTC/NSRL)*

A nondestructive method to measure beam energy spread using the quadrupole modes within a microwave cavity is proposed. Compared with a button beam position monitor (BBPM) or a stripline beam position monitor (SBPM), the cavity monitor is a narrow band pickup and therefore has better signal-to-noise ratio (SNR) and resolution. In this study, a rectangular cavity monitor is designed. TM220 mode operating at 4.76 GHz in the cavity reflects the quadrupole moment of the beam. The cavity plans to be installed behind a bending magnet in Dalian Coherent Light Source (DCLS), an extreme ultraviolet FEL facility. In this position, the beam has a larger dispersion, which is beneficial to measure the energy spread. A quadrupole magnet, a fluorescent screen, and a SBPM with eight electrodes is installed near the cavity for calibration and comparison. The systematic framework and simulation results are also discussed in this paper.

MOP006 **Design Overview of the Electron Storage Ring Instrumentation System for Hefei Advanced Light Factory**

B. G. Sun*, Y.B. Leng, Y. Liang, P. Lu, Q. Luo, L.L. Tang, A.X. Wang, J. Wang, T.Y. Zhou, Z.R. Zhou (USTC/NSRL)*

The Hefei Advanced Light Factory (HALF) is a diffraction-limited storage ring with a beam energy of 2.2 GeV. Based on the beam related technical parameters and requirements provided by the physical design of the HALF storage ring, the storage ring beam instrumentation system mainly includes beam position measurement system, DC current measurement system, bunch-by-bunch beam current measurement system, tune measurement system, beam profile measurement system, bunch length measurement system, bunch-by-bunch feedback system, fast orbit feedback system, BPM displacement measurement system, and beam loss measurement. An overview of the design of the storage ring instrumentation system will be presented.

MOP007 **Experimental Verification of the Coherent Diffraction Radiation Measurement Method for Longitudinal Electron Beam Characteristics**

R. Pana´s, *A.I. Wawrzyniak (NSRC SOLARIS) A. Curcio (LNF-INFN) K. Łasocha (CERN)*

This paper presents a natural extension of prior theoretical investigations regarding the utilization of coherent diffraction radiation for assessing longitudinal characteristics of electron beams at Solaris. The study focuses on the measurement results obtained at the linac injector of the Solaris synchrotron and their analysis through a theoretical model. The findings are compared with previous estimates of the electron beam longitudinal profile. This paper contributes to the future diagnostics at the first Polish free electron laser (PolFEL) project, where it will be used for the optimization of particle accelerator performance.

MOP008 **Consideration of Beam Instrumentation for SOLARIS Linac Upgrade**

A.I. Wawrzyniak, *A.M. Marendziak, R. Pana´s, J.J. Wiechecki (NSRC SOLARIS) A. Curcio (LNF-INFN)*

SOLARIS linac currently operates at 540 MeV and is used as an injector to the storage ring, where after the accumulation the energy is ramped up to 1.5 GeV via two active RF cavities. Top-up injection would be of extreme benefits for user operation, therefore a new 1.5 GeV linac is being designed. The idea is to replace the current machine without infrastructural interventions in terms of tunnel expansion. Performed studies demonstrate that the best solution is provided by a Hybrid S-band/C-band LINAC. One of the main goals is to achieve bunch compression below the picosecond level and low-emittance beams for a future short-pulse facility or a Free Electron Laser. Within this presentation the results of performed simulations will be presented together with the concept of different diagnostics as BPMs, current transformers, YAG screens, coherent diffraction radiation monitor distribution.

MOP009 **A Snapshot of CERN Beam Instrumentation R&D Activities**

T. Lefèvre, *D. Alves, A. Boccardi, S. Jackson, F. Roncarolo, J.W. Storey, R. Veness, C. Zamantzas (CERN)*

The CERN accelerator complex stands out as an unique scientific tool, distinguished by its scale and remarkable diversity. Its capacity to explore a vast range of beam parameters is truly unparalleled, spanning from the minute energies of around a few keV and microampere antiproton beams, decelerated within the CERN antimatter factory, to the 6.8 TeV high-intensity proton beams that race through the Large Hadron Collider (LHC). The Super Proton Synchrotron (SPS) ring plays also a crucial role by slowly extracting protons at 400 GeV. These proton currents are then directed toward various targets, generating all sorts of secondary particle beams. These beams, in turn, become the foundation of a diverse fixed-target research program, enabling scientific exploration across a wide spectrum. Moreover, as CERN looks ahead to future studies involving electron-positron colliders, the development of cutting-edge diagnostics for low emittance, short electron pulses is also underway. This contribution serves as a snapshot, shedding light on the main R&D initiatives currently underway at CERN in the field of beam instrumentation.

MOP010 **Diagnostics for a High Emittance and High Energy Spread Positron Source**

N. Vallis, *P. Craievich, R.F. Fortunati, R. Ischebeck, E. Ismaili, P.N. Juranicˇ, F. Marcellini, G.L. Orlandi, M. Schaer, R. Zennaro, M. Zykova (PSI)*

This paper is an overview of a diagnostics setup for highly spread e^+e^- beams, to be installed at the PSI Positron Production (P^3 or P-cubed) experiment. To be hosted at the SwissFEL facility (PSI, Switzerland) in 2026, P^3 is e^+ source demonstrator designed to generate, capture, separate and detect nano-Coulombs of secondary e^+ and e^- bunches, in spite of their extreme tranverse emittance and energy spread. The experiment will employ an arrangement of broadband pick-ups (BBPs) to detect simultaneously the time structure of secondary e^+e^- bunches. A spectrometer will follow the BBPs and deflect the e^+ and e^- onto two unconventional faraday cups that will measure their charge. In addition, the energy spectrum of e^+ and e^- distribution will be reconstructed through scintillating fibers.

MOP011 **Safety Considerations for Shield Door Control Systems**

H.A. Watkins, *W.C. Barkley, C.D. Hatch, D. Martinez, D. Rai, E.I. Simakov (LANL)*

The Accelerator Operations and Technology division is upgrading the control system for a 33-ton shield door that will be used when the Cathodes and RF Interactions in Extremes (CARIE) accelerator begins operations. The door was installed in the 1990’s but safety standards such as ISO 13849-1 have since emerged which provide safety requirements and guidance on the principles for the design and integration of safety-related parts of a control system. Applying this standard, a safety controller, safety relays and a light curtain barrier have been added to eliminate injury and exposure of personnel to potential hazards during door operations.

MOP012 **Design Status of the Electron-Ion Collider Beam Instrumentation**

D.M. Gassner, *B. Bacha, G. Bassi, K.A. Drees, S.H. Hafeez, D. Holmes, R.L. Hulsart, P. Inacker, C. Liu, R.J. Michnoff, M.G. Minty, D. Padrazo Jr, M.C. Paniccia, I. Pinayev, J.A. Pomaro, A.C. Pramberger, M.P. Sangroula, P. Thieberger, E. Wang, F.J. Willeke (BNL) J.R. Bellon, A. Blednykh, C. Hetzel, F. Micolon, C. Montag, V. Ptitsyn, V.H. Ranjbar (Brookhaven National Laboratory (BNL), Electron-Ion Collider)*

The Electron Ion Collider (EIC) is being built at Brookhaven National Laboratory (BNL). Early preliminary design phase efforts are underway. In addition to upgrading the existing RHIC instrumentation for the EIC hadron storage ring, new electron accelerator subsystems that include a 400 MeV Linac, rapid-cycling synchrotron, electron storage ring, and a strong hadron cooling facility will have all new instrumentation systems. The scope of the instrumentation includes devices to measure beam position, loss, current, charge,

tune, transverse and longitudinal profiles, emittance, and crabbing angles. A description of the planned instruments and the present design status will be presented.

MOP013 **Development of New Pickup Measuremnt System (Schottky and Position) for MedAustron**

***M. Wolf**, M. Cerv, C. Kurfürst, S. Myalski, M. Repovž, C. Schmitzer (EBG MedAustron) A. Bardorfer, B. Baricˇevicˇ, P. Leban, P. Paglovec, M. Škabar (I-Tech)*

The MedAustron Ion Therapy Centre is a synchrotron-based particle therapy facility located in Lower Austria, which delivers proton and carbon ion beams for cancer treatments. Currently the facility treats over 400 patients per year and is expected to double this number in the future. Six years since the start of clinical operation, MedAustron is experiencing end-of-life issues concerning the digital Low Level RF components in the injector and the synchrotron. Replacements for these applications are under development and the chosen hardware is suitable to also update multiple beam diagnostic devices in the facility. Main targets for updates are the Schottky monitors, which were never properly integrated into the MedAustron Control system and the position pickup measurement system, which currently does not support turn by turn measurements. Comparison measurements with other state of the art diagnostic devices are ongoing to demonstrate the capabilities of the generic hardware. Furthermore, these measurements should show the increased usability and diagnostic potential compared to the legacy devices.

MOP015 **RF Calibration and Distribution devices for SPIRAL2 BPMs**

***C. Jamet**, T. Andre, P. Legallois, S. Leloir, C. Potier de courcy (GANIL)*

In order to achieve the required measurement accuracy for the SPIRAL2 BPMs in positions, ellipticities and phases, new RF Calibration and Distribution devices were developed, tested and installed on the SPIRAL2 Facility in 2022. Accuracy measurements depends on gain and phase differences of the 4 BPM measurement channels. In order to compensate analogic differences, digital corrections are applied in function of the calibration results. One of the main objectives was to automate the different steps of the calibration process in order to reduce the calibration time and avoid cable connections and disconnections. The second objective was to distribute RF reference signals to all BPM electronics cards with the same amplitudes and phases. This document describes technical solutions and qualifications performed, explains the calibration process, corrections and results obtained.

MOP016 **Development of a Beam Position Monitor for MYRRHA High Energy Beams**

***S.M. Ben Abdillah**, F. Fournier, O. Pochon (Université Paris-Saclay, CNRS/IN2P3, IJCLab) A. Bechtold (NTG Neue Technologien GmbH & Co KG)*

MYRRHA (Multi-Purpose Hybrid Research Reactor for High-Tech Applications) aims to demonstrate the feasibility of high-level nuclear waste transmutation at industrial scale. The accurate tuning of LINAC is essential for the operation of MYRRHA and requires measurement of the beam transverse position and shape, the phase of the beam with respect to the radiofrequency voltage with the help of Beam Position Monitor (BPM) system. MYRRHA is divided in three phases, the first phase, called MINERVA, includes several sections allowing beam acceleration up to 100 MeV. The second phase includes a High Energy Beam Transport (HEBT) line connects to two users facility. A BPM prototype was realized for the HEBT line. This paper addresses the design, realization, and calibration of this BPMs and its associated electronics. The characterization of the beam shape is performed by means of a test bench allowing a position mapping with a resolution of 0.02 mm.

MOP017 **Eletronic Test Bench for the Validation of MYRRHA BPM Acquisition Systems**

***S.M. Ben Abdillah**, F. Fournier (Université Paris-Saclay, CNRS/IN2P3, IJCLab)*

MYRRHA (Multi-Purpose Hybrid Research Reactor for High-Tech Applications) aims to demonstrate the feasibility of high-level nuclear waste transmutation at industrial scale. Beam Position monitors are key elements in many accelerators. for instance, once BPMs are installed along a linear accelerator or a storage ring, they remain inaccessible for any validation of updated or rejuvenated electronics. This paper addresses this issue with the realisation of an electronic test bench simulating the outputs signals of BPM electrodes for a given beam energy, phase and position. the bench is realized for MYRRHA BPMs and it offers simulated beams with a position precision down to 50 µm and phase precision down to 0.5° on a wide range.

MOP018 **Beam-diagnostic and T0 System for the mCBM and CBM Experiments at GSI and FAIR**

***A. Rost**, A. Senger (FAIR) T. Galatyuk, M. Kis, J. Pietraszko, J.T. Thaufelder, F. Ulrich-Pur (GSI) T. Galatyuk, V. Kedych, W. Krüger (TU Darmstadt)*

The Compressed Baryonic Matter (CBM) experiment at the Facility for Antiproton and Ion Research (FAIR) in Darmstadt requires a highly accurate beam monitoring and time-zero (T0) system. This system needs to meet the requirements of the CBM time-of-flight (ToF) measurement system for both proton and heavy ion beams, while also serving as part of the fast beam abort system. To achieve these goals, a detector based on chemical vapor deposition (CVD) diamond technology has been proposed. In addition, new developments using Low Gain Avalanche Detectors (LGADs) are currently under evaluation. This contribution presents the current development status of the beam detector concept for the CBM experiment.

MOP019 **First Test with uTCA based Cavity BPM Electronics at FLASH**

***B. Lorbeer**, H.T. Duhme, I. Krouptchenkov, T. Lensch, D. Lipka, M. Werner (DESY)*

The European X-ray free-electron laser (E-XFEL) and the FLASH2020+ project for the free electron laser Hamburg (FLASH) at DESY in Hamburg, Germany foresee several machine upgrades in the years to come. At FLASH a whole undulator section in a shutdown starting in summer 2024 and finishing in autumn 2025 is going to be rebuild. Existing button beam position monitors installed in this section of the machine do not deliver sufficient signal strength for future required resolution specification and orbit feedback optimization for machine operation. The resolution limitations will be overcome by replacing the button-based beam position monitors with in-house developed cavity beam position monitors and compact microTCA based radio frequency receiver read-out electronics. The measurement system has been tested and evaluated in a test setup at FLASH.

MOP021 **New Beam Position Monitor System for PETRA IV**

***J.L. Lamaack** (University of Hamburg) A. Bardorfer, L. Bogataj, M. Cargnelutti, P. Leban, M.O. Oblak, P. Paglovec, B. Repicˇ (I-Tech) H.T. Duhme, G. Kube, F. Schmidt-Föhre, K. Wittenburg (DESY)*

The PETRA IV project at DESY aims to upgrade the present synchrotron radiation source PETRA III into a source of ultra-low emittance with target emittance of 20 pmrad. The small beam emittance translates directly into much smaller beam sizes of about 7,µm horizontally and 3,µm vertically at insertion device source points, thus imposing stringent requirements on the machine's stability. In order to measure beam position and control orbit stability to the required level of accuracy, a high-resolution BPM system consisting of 790 individual monitors will be installed. Its readout electronics will be based on MTCA.4 as a technical platform. To fulfill the long-term drift requirement (<1 µm over 7 days), the concept of crossbar-switching was extended in such a way that the RF switch matrix is separated from the readout electronics and placed as close to the BPM pickup as possible, therefore enabling additional stabilization of the RF cables. At present, a fully populated MTCA.4 crate with 6 AMC boards for the readout of 12 BPMs is installed at PETRA III and extensively tested. This contribution summarizes the latest measurements of the long term stability.

MOP022 **Replacement of the Single-Pass BPM System with MicroTCA.4-based Versatile Electronics at SPring-8**

***H. Maesaka**, N. Hosoda, S. Takano (RIKEN SPring-8 Center) H. Dewa, T. Fujita, N. Hosoda, **H. Maesaka**, M. Masaki, S. Takano (JASRI)*

We have developed MicroTCA.4-based versatile BPM readout electronics for the SPring-8 upgrade project, SPring-8-II. The input signals are processed by an rf front-end rear transition module (RTM) with band-pass filters, amplifiers, and step attenuators and digitized by 16-bit 370 MSPS high-speed digitizers on an advanced mezzanine card (AMC). The field-programmable gate array (FPGA) on the AMC calculates both single-pass and COD beam positions. The current BPM system at SPring-8 consists of approximately twenty single-pass dedicated BPMs and over two hundred other COD dedicated ones. In advance of SPring-8-II, so far, we renewed half of the single-pass dedicated BPM electronics to the MicroTCA.4. A graphical user interface (GUI) for the new BPM system was also developed and ready for tuning. The single-pass BPM resolution was confirmed to be better than 100 um for a 100 pC single bunch, sufficient for SPring-8-II. The other existing single-pass BPM electronics will also be renewed this summer. The full renewal of remaining COD dedicated BPM electronics to the versatile MicroTCA.4 ones is planned in the subsequent years before the construction of SPring-8-II.

MOP023 **The Conceptual Design Study for New BPM Signal Processing System of J-PARC MR**

***K. Satou**, T. Toyama, S. Yamada (KEK)*

The BPM signal processing system, which is19 years old system, have been suffering from gain fluctuation due to contact resistance of the mechanical gain selector, communication disruption caused by an unstable contact of a card edge connector. In addition, it has a difficulty of repairments because some on-board parts have already reached end of product-life cycle, and some units have been in unusable situation. Presently, we are on the beam power upgrade campaign to 1.3 MW by increasing beam bunch current and shortening the MR operation cycle, and precise beam tunings would require massive waveform data processing and transfer to a storage than the present system. For this, we have been developing the system based on the 10 GbE optical link. The ADC board which is under development would perform direct sampling using the third harmonic of RF. The digital IQ demodulation technique is used to extract the baseband oscillation from the raw data. The obtained raw waveform as well as closed orbit data would be stored in the data storage system. In the presentation, we will report on the progress of development aimed at operation in 2025 and the conceptual design of the new system.

MOP024 **The Design and Optimization of Digital Beam Position Monitor Processor in HEPS**

***Y.Y. Du**, J.S. Cao, Z. Liu, Y.F. Sui, S.J. Wei, Q. Ye, J.H. Yue (IHEP)*

The Digital Beam Position Monitor (DBPM) is an important component of the High Energy Photon Source (HEPS). This article mainly introduces the design and development of the digital beam position measurement system based on the main indicators of HEPS, including the overall architecture design of the system, digital electronics design, RF electronics design, and the exposition of core algorithm design. It also provides a detailed performance comparison between the two versions of electronic design before and after optimization, including performance indicators such as flow-dependent, long-term stability, and position resolution. In laboratory testing, under the condition of an input signal of 499.8 MHz and K factor is 8.26, the position resolution per turn by turn (TBT) is less than 1 μm, the fast orbit position resolution (FA) is less than 100 nm, and the closed orbit position resolution (SA) is less than 10 nm. The beam current-dependence and long-term stability are significantly better than the previous version, and the test results meet the design requirements of the High Energy Photon Source.

MOP025 **Beam Position Monitors for the HEPS**

***J. He**, J.S. Cao, Y.Y. Du, Y.F. Sui, T.G. Xu, J.H. Yue (IHEP)*

At the High Energy Photon Source (HEPS), a high orbital stability of typically 10 % of the beam size and angular divergence must be achieved, which implies that the beam orbit must be stabilized to the sub-micrometer level. A button and stripline beam position monitor (BPM) were designed based on the analytical formulas and CST simulations results. The results of electromagnetic field simulations revealed how various mechani- cal errors, such as button size and location accuracy, as well as the related button capacitance, exert different influences on the beam position measurement. The performance of an actual BPM pickup was measured, along with an assessment of the error on the beam position measurement. Additionally, a wakefield analysis, including an investigation of trapped resonant modes and related thermal deformation, was conducted. The characteristic impedances of the stripline were designed to be 50 Ω and confirmed by measurements. The position sensitivity, position resolution, capacitance and the electro-mechanical offsets were measured using the Lambertson method, and the calibration coefficients were measured using a stretched wire.

MOP026 **A Novel BPM Machine Center Calibration Method Based on Laser Ranging**

***X.H. Tang**, J.S. Cao, Y.Y. Du, J. He, Y.F. Sui, J.H. Yue (IHEP)*

Determining the mechanical center of the beam position monitor(BPM) has been a difficulty for BPM calibration. To solve this problem, a method of positioning the BPM mechanical center based on laser ranging is proposed. This method uses high-precision antenna support as the core locating datum, and high-precision laser ranging sensors(LRSs) as the detection tool. By detecting the distances from the LRSs to the antenna support and the distances from the LRSs to the BPM, the mechanical center of the BPM can be indirectly determined. The theoretical system error of this method is within 20 μm, and the experimental results show that the measurement repeatability is less than 40 μm, This method has low cost and fast speed, which can be used for large-scale calibration.

MOP028 **The Design of Button Beam Position Monitor for Shenzhen Innovation Light-Source Facility**

***T. Yu** (IASF)*

Shenzhen Innovation Light-source Facility (SILF) is a brand new project supported by the Chinese government to build a 4th generation synchrotron radiation source whose storage ring is so-called diffraction-limited. The beam design is that the emission is less than 100 pm · rad, and the beam instability is less than 10% of the beam spot. Therefore, the revolution of the beam position monitor (BPM) needs to be less than 0.12 μm for closed orbit detection. In order to achieve such excellent resolution, the signal-to-noise ratio of the BPM output signal in the 10 MHz bandwidth is required to be better than 66 dB. After the finite element numerical analysis, the diameter of the pickup electrode will be 8 mm, and the gap between the electrode and the vacuum chamber will be 0.3 mm.

MOP029 **A Novel Design of a Dielectric-filled Cavity BPM for HUST-PTF**

***J.Q. Li**, J. Wang (HUST) K. Fan (Huazhong University of Science and Technology, State Key Laboratory of Advanced Electromagnetic Engineering and Technology,)*

To guarantee proton therapy safety and effectivity, non-invasive beam diagnostic 'NBD' devices are mandatory to precisely monitor the beam parameters during patient treatment. However, the clinical proton beams have characters of low currents and frequencies, which impose challenges for the design to improve the diagnosis resolution. A dielectric-filled racetrack cavity-type BPM has been studied deeply to compact its size while maintaining high diagnosis sensitivity. Moreover, the cross-talk between X and Y directions is effectively suppressed to ensure the diagnosis precision. The simulation and calculation results show that the cavity BPM has sufficient position sensitivity and signal-to-noise ratio. The signal-to-noise ratio can ba as large as 16.2 even when the beam intensity is 0.35 nA. The design studies results show that the dielectric-filled racetrack cavity is a potential candidate for a non-destructive beam position detector in HUST-PTF.

MOP030 **Developments of 4GSR BPM Electronics**

***S.W. Jang**, G. Hahn, J.Y. Huang, C. Kim, D. Kim, G. Kim, B.K. Shin, D.C. Shin, D. Song (PAL) W.J. Song (POSTECH)*

The emittance of the 4th-generation storage ring (4GSR) to be constructed in Cheongju-Ochang, Korea, is expected to be approximately 100 times smaller than the existing 3rd-generation storage ring. With the decrease in emittance, more precise beam stabilization is required. To meet this requirement, the resolution of the beam position monitor (BPM) system also needs to be further improved. We have conducted research and development on the electronics of the BPM system for the 4GSR storage ring. In order to perform fast orbit feedback in the 4GSR storage ring, we need to acquire turn-by-turn beam position data, with a desired beam position resolution of 1 µm. Additionally, prototypes of the bunch-by-bunch monitoring system are being developed for the transverse feedback system and longitudinal feedback system. The internally developed electronics are intended to be modified for future use as monitors for multi-bunch beam energy measurements at the end of the linear accelerator, by adjusting the logic accordingly. In this presentation, we will describe more details of the current status of the development of the beam position monitor electronics for the 4GSR in Korea.

MOP031 **A Study Into the Long-Term Stability of Front End X-Ray Beam Position Monitor Support Columns at Diamond Light Source**

***C.E. Houghton**, C. Bloomer, L. Bobb, D. Crivelli, J.E. Melton, H. Patel (DLS)*

Sand-filled steel columns are used at Diamond Light Source to support front end X-ray beam position monitors. This approach is chosen due to the relatively large thermal mass of the sand being considered useful to reduce the rate at which expansion and contraction of the column occurred as the storage ring tunnel temperature varied, particularly during machine start-up. With the higher requirements for mechanical stability for the upcoming Diamond-II upgrade, there is now a need to assess and quantify the current system's impact on X-ray beam movement. A study of thermal and mechanical stability has been carried out to quantify the stability performance of the front end X-ray beam position monitor's columns and the impact that column motion may have on the X-ray beam position measurement. Measurements have been made over a range of different timescales, from 250 Hz up to 2 weeks. The measured stability of the support column is presented, showing that it meets our Diamond-II stability requirements. A comparison of the stability of the column with and without a sand filling is presented.

MOP032 **One Dimensional Beam Position Monitor Prototype using Incoherent Cherenkov Diffraction Radiation**

***A.J. Clapp** (Royal Holloway, University of London) L. Bobb, G. Cook (DLS) P. Karataev (JAI)*

This paper proposes a novel advancement in both the studies of Cherenkov diffraction radiation (ChDR) and beam instrumentation. The proposed beam position monitor (BPM) consists of two identical fused Silica prism radiators, with a fibre collimator attached to each one, which in turn are connected to a photodetector via a series of optical fibres. The setup will be implemented into the booster to storage ring transfer line at Diamond Light Source – an electron light source with 3 GeV beam energy. The prototype proposed aims to test the feasibility of a full BPM utilising ChDR. If proven to be fully realisable, optical rather than capacitive BPM pickups could be more widely distributed. The paper will include the complete design and preliminary results of a one-dimensional BPM, utilising the ChDR effect.

MOP033 **1L Target Harp Diagnostic Display Tool**

***A.D. Walker**, E.L. Kerstiens (LANL)*

The Los Alamos Neutron Science Center (LANSCE) completed upgrades to its 1L Target Facility, which included installing the new Mark IV target assembly. This added a third tungsten target located upstream of the other two targets. Prior to Mark IV, beam centering on target was achieved by using thermocouples mounted to the quadrants and center of the upper target coolant chamber. It is slightly offset from center of the old upper target and it shadows several of the thermocouples previously used to center beam on target. This required adjustments to the diagnostic tools utilized to monitor position of the H^- beam that is being delivered to the 1L target. The original display included the thermocouple readouts and displayed a visual beam profile and position taken from an upstream harp. With some of the thermocouples now being shadowed, an image overlay was added to show where the harp's measured beam position is relative to both the upper and middle targets. This gives the beam operations team an additional level of awareness when it comes to thermocouple temperatures, beam steering, and beam tuning. Details of the display tool and its associated upgrades are presented.

MOP036 **A New Approach for Cls Future Orbit Correction System Driven by Neural Network**

***S. Saadat**, M.J. Boland (CLS) M.J. Boland (University of Saskatchewan)*

The Orbit Correction System (OCS) of the CLS comprises 48 sets of BPMs. Each BPM has the ability to measure the position of the beam in both the X-Y directions and can record data at a rate of 900 times per second. The Inverse Response Matrix is utilized to determine the optimal strength of the 48 sets of orbit correctors in both the X-Y directions, in order to ensure that the beam follows its desired path. The Singular Value Decomposition function is replaced by a neural network algorithm to serve as the brain of the orbit correction system in this study. The training model's design includes three hidden layers, and within each layer, there are 96 nodes. The neural network's outputs for regular operations in CLS exhibit a Mean Square Error of 10^{-7}.

Various difficult scenarios were created to test the OCS at 8.0 mA, using offsets in different sections of the storage ring. However, the new model was able to produce the necessary Orbit Correctors signals without any trouble.

MOP037 **Tune Feedback at the Canadian Light Source**

W.A. Wurtz, *C.K. Baribeau, A.M. Duffy (CLS)*

In order to maintain good injection efficiency for top-up operation at the Canadian Light Source, we must keep the betatron tunes constant even as changes in insertion device fields cause the tunes to vary. To meet this requirement, we implemented a tune feedback system. We measure the tunes at a rate of 1 Hz using Dimtel bunch-by-bunch systems. The transverse feedback function of the bunch-by-bunch systems provides tune measurements without disturbing the electron beam. We adjust two quadrupole families at a rate of 0.25 Hz to control the horizontal and vertical tunes. In this article we describe the tune feedback system, its development and its performance. The system has proven to be very robust, enabling reliable top-up operation.

MOP038 **Development and Implementation of an Active Beam-Stabilization System for Electron-Induced Fission Experiments at the S-Dalinac**

D. Schneider, *M. Arnold, J. Birkhan, U. Bonnes, A. Brauch, M. Dutine, R. Grewe, L.E. Jürgensen, N. Pietralla, F. Schließmann, G. Steinhilber (TU Darmstadt)*

The r-process fission cycle terminates the natural synthesis of heavy elements in binary neutron-star mergers. Fission processes of transuranium nuclides will be studied in electrofission reactions at the S-DALINAC. Due to the minuscule fissile target, the experimental setup requires an active electron-beam-stabilization system with high accuracy and a beam position resolution in the submillimeter range. In this contribution, requirements and concepts of this system regarding beam-diagnostic elements, feedback control and readout electronics are presented. The usage of a beam position monitor cavity and optical transition radiation targets to monitor the required beam parameters will be discussed in detail. Additionally, various measurements performed at the S-DALINAC to assess requirements and limits for the beam-stabilization system will be presented. Finally, the option of using advanced machine learning methods such as neural networks and agent-based reinforcement learning will be discussed.

MOP039 **Multi-Bunch Feedback Detector Electronics Using Direct Sampling Analog-to-Digital Converters for the Synchrotron Radiation Source PETRA IV**

S. Jabłoński, *H.T. Duhme, U. Mavricˇ, S. Pfeiffer, H. Schlarb (DESY)*

PETRA IV, a new fourth generation synchrotron radiation source planned at DESY, will require a transverse multi-bunch feedback (T-MBFB) system to damp transverse instabilities and keep the beam emittance low. The critical part of the T-MBFB is a detector that must measure bunch-by-bunch, i.e. every 2 ns, beam position variations with the resolution not worse than 1 µm for the dynamic beam range of s´1 mm. In this paper, we present the conceptual design of the T-MBFB detector from the beam position pickups to the direct sampling ADCs. We analyse the noise sources limiting the detector resolution and present measurement results based on the evaluation modules.

MOP041 **Modified Fast Orbit Feedback Controller for Disturbance Attenuation in Long Straights for Diamond-II**

S. Banerjee, *M.G. Abbott, L. Bobb, I. Kempf (DLS) , I. Kempf (University of Oxford)*

At Diamond Light Source, the fast orbit feedback (FOFB) uses one array of correctors and the controller is designed using the internal model control (IMC) structure. The Diamond-II upgrade will introduce an additional array of fast correctors and a new controller that is designed using the generalised modal decomposition, increasing the overall closed-loop bandwidth from 140 Hz to 1 kHz. Although simulation results have shown that the resulting beam displacement is within specification in all straights, they have also shown that the performance on long straights is limited, particularly in the vertical plane. In this paper, the controller is tuned in order to increase the FOFB performance in long straights by introducing a mode-by-mode regularisation parameter. The performance of the controller beyond 1 kHz is assessed using new disturbance data and a new measurement noise model, showing that the Diamond-II performance criteria are met, even in the presence of measurement noise.

MOP043 **Using Lag Compensator in Orbit Feedback**

I. Pinayev *(BNL)*

Growing demand on the beam orbit stability requires higher loop gain within the operational bandwidth. Increasing the gain leads to the increase of the unity gain frequency and creates problems with systems stability due to the additional phase shifts caused by the trims (power supplies, eddy currents in vacuum chambers, etc.) and filtering of beam position data. Conventionally employed systems have 20 dB/decade slope near the unity gain providing 90 degrees phase shift which is sufficient for stability. Utilizing one or more lag compensators allows to increase the gain at low frequencies while keeping phase margin acceptable. The paper provides more details on the proposed solution as well as simulations of how the transients will be modified.

MOP044 **"Instantaneous"Lifetime Measurement in Storage Ring with Top-Up**
I. Pinayev *(BNL)*
Top-up operation becomes routine in the light sources. The goal of the top-up operation is to keep the current of the circulating beam stable to avoid variations of the heat load on the beamline optics. It is also considered for the electron-ion collider to maintain the polarization of the electron beam. Frequent re-injection makes measurement of the beam lifetime very difficult if possible. Since, only part of the bunch train is refreshed during the injection cycle then the distribution of the bunch charges in the train has a characteristic saw-tooth distribution. The slope of saw tooth and step in the bunch charge distribution is defined by the lifetime and filling frequency. Both parameters can be used for the measurement. The data for processing can be obtained either from fast current transformer or from the raw ADC signal from beam position monitor. In this paper we present the theoretical considerations as well as experimental data from NSLS-II storage ring.

MOP045 **Robust Emittance Measurements**
I. Pinayev *(BNL)*
The quadrupole scan is commonly used for measurement of beam emittance. The found dependence of the beam size vs. quadrupole strength is fitted with parabola, which coefficients are used for emittance calculations. The measurement errors can cause substantial variations in the emittance value. Sometimes the fitted parabola has negative minimum value, making impossible emittance calculation. We propose more robust data processing using weighted fit for parabola or modifying the quadrupole scan procedure. The experimental results are presented.

MOP046 **Measurement of Slice Emittance with Deflecting Cavity and Slit**
I. Pinayev *(BNL)*
Coherent Electron Cooling experiment carried out at RHIC requires small slice emittance of 15 MeV electron beam with high peak current. In this paper we describe the system for slice emittance measurement utilizing transverse deflecting cavity and slit. The image of the beam passing through the slit is used to measure slice intensity and angular divergence. Beam size at slit location is measured using scan of the beam across the slit with trim. The angular kick by the trim is taken into the account during calculations. Data processing and the experimental results are presented.

TU1 – Tuesday Session 1

Chair: A.I. Wawrzyniak (NSRC SOLARIS)

TU1I01 09:00 **Beam Instrumentation Challenges for High-Energy and Low-Emittance Beam at SuperKEKB**

G. Mitsuka *(KEK) K. Satou (J-PARC, KEK & JAEA)*

The SuperKEKB electron-positron collider, which started the commissioning in February 2016, is a luminos- ity frontier machine for the search for new physics. In this presentation, we review the main challenges we face for the high-energy and low-emittance beam at SuperKEKB, fast and low-noise beam-orbit feedback system, X-ray beam-profile monitors for measurements for the beam size of ≤10 µm, novel diamond mirrors with extremely high thermal conductivity for extracting synchrotron radiation, and various type's beam loss diagnostics for the identification or possibly early detection of sudden beam losses. This presentation includes future directions of the R&D—X-ray interferometry for micron-level beam size measurements and fast optics measurements with the gated turn-by-turn BPMs—towards next-generation light source facilities and high-energy colliders.

TU1I02 09:30 **Beam Instrumentation Performance During Commissioning of the ESS Normal Conducting LINAC**

I.D. Kittelmann*, R.A. Baron, E.C. Bergman, E.M. Donegani, V. Grishin, H. Hassanzadegan, H. Kocevar, N. Milas, R. Miyamoto, M. Mohammednezhad, D. Noll, K.E. Rosengren, T.J. Shea, R. Tarkeshian, C.A. Thomas, F. Nilen (ESS)*

Once constructed, the European Spallation Source (ESS) will be a 5MW pulsed neutron source based on a 2 GeV proton linac delivering 2.86 ms long pulses at a 14 Hz repetition rate. This paper focuses on the beam instrumentation performance during the recent linac beam commissioning up to drift tube linac (DTL) tank 4 with 74 MeV output energy. Instrumentation and measurement results will be presented for beam parameters such as current, position, energy, emittance and beam loss.

TU1C03 10:00 **An Experimental Setup for PIXE Analysis in a Medical Cyclotron at TENMAK-NUKEN**

G. Türemen*, S. Bulut, U. Kaya, D. Porsuk, N.O. Serin, E. Yeltepe (TENMAK-NUKEN)*

A 30 MeV IBA (Ion Beam Application S.A., Belgium) cyclotron is operated at TENMAK-NUKEN for producing medical radioisotopes with three beamlines and a fourth beamline is dedicated for research purposes. The minimum energy of extracted proton beam from cyclotron is 15 MeV. There is no facility in Türkiye for applying ion beam analysis techniques (IBA) currently. These techniques generally require 1-5 MeV proton beam energy. An energy degrader system was designed and installed on the R&D beamline for this purpose. The degrader system is capable of decreasing the energy down to 1 MeV with pA to uA current levels. A high vacuum irradiation chamber is designed and installed at the end of the beamline. The chamber has ports to install several types of detectors for different IBA techniques. This work includes the description of the setup and preliminary PIXE measurements.

12-Sep-23 10:50 – 12:30	Plenary

TU2 – Tuesday Session 2

Chair: P. Krejcik (SLAC)

TU2T01 10:50 **Overview of Beam Diagnostics for Different Accelerator Types: Longitudinal Profile**

N. Hiller, *V. Schlott (PSI)*

A tutorial on longitudinal beam diagnostics systems for different accelerator types.

TU2I02 11:40 **First Direct Measurement of Electron and Positron Bunch Characteristics during Positron Capture Process at the Positron Source of the SuperKEKB B-Factory**

T. Suwada *(KEK)*

Electron (e-) and positron (e+) bunch characteristics were directly measured for the first time using wideband beam monitors (WBMs) and a detection system at the e^+ source of the SuperKEKB B-factory. Both secondarily-generated e^- and e^+ bunches after the e±production target were clearly identified in their dynamical capture process at locations of the WBMs under two-bunch acceleration scheme. Not only the longitudinal but also transverse bunch characteristics, the time intervals between the e^- and e^+ bunches, the bunch lengths, transverse bunch positions, and bunch charges were simultaneously separately measured for each bunch as functions of the capture phase to investigate their dynamical capture process. The results show that quite symmetric dynamical behaviors for the e^- and e^+ bunch characteristics were clearly observed. The new WBMs open up a new window for direct measurements of both the e^- and e^+ bunches during their dynamical capture process and in the optimization procedure of the e^+ bunch intensity in multidimensional parameter spaces at any e^+ sources. The historical backgrounds for introducing and implementing the new WBMs are also described in this report.

TU2C03 12:10 **Sub-20 fs Synchronization Between Mode-Locked Laser and Radio Frequency Signal**

J.G. Wang *(SARI-CAS)*

The femtosecond synchronization and distribution system of Shanghai soft X-ray free-electron laser facility(SXFEL) and Shanghai high repetition rate XFEL and extreme light facility (SHINE) are based on the optical pulse trains generated by passively mode-locked lasers. The passively mode-locked laser has ultralow noise in the high offset region(<5 fs, [1 kHz-1 MHz]). In this paper we report precise synchronization of a 216.6 MHz passively mode-locked laser to a ultralow phase noise microwave source. Adopting RF-based phase-locked loop scheme, absolute jitter of the phase locked passively mode-locked laser is less than 20 fs integrated from 10 Hz to 1 MHz.

TU3 — Tuesday Session 3

Chair: K. Wittenburg (DESY)

TU3I01 **Commissioning of the LCLS-II Machine Protection System for MHz CW Beams**

13:30 ***J.A. Mock**, A.S. Fisher, R.T. Herbst, P. Krejcik, L. Sapozhnikov (SLAC)*

Beam power at the LCLS-II linac and FEL can be as high as several hundered kW with CW beam rates up to 1 MHz. The new MPS has a latency of less than 100 µm to prevent damage when a fault or beam loss is detected. The MPS architecture encompasses the multiple FEL beamlines served by the SC linac and can mitigate a fault in one beamline without impacting the beam rate in a neighboring beamline. The MPS receives inputs from various devices including loss monitors and charge monitors as well as magnet power supplies and BPMs to pre-emptively turn of the beam if a fault condition is detected. Link nodes distributed around the facility gather the input data and stream it back to a central processor that signals other link nodes connected to beam rate control devices. Commmissioning and experience with the new system will be described.

TU3C02 **FPGA Architectures for Distributed ML Systems for Real-Time Beam Loss De-Blending**

14:00 ***M.A. Ibrahim**, J.M.S. Arnold, M.R. Austin, J.R. Berlioz, P.M. Hanlet, K.J. Hazelwood, J. Mitrevski, V.P. Na- gaslaev, A. Narayanan, D.J. Nicklaus, G. Pradhan, A.L. Saewert, B.A. Schupbach, K. Seiya, R.M. Thurman- Keup, N.V. Tran (Fermilab) J.YC. Hu, J. Jiang, H. Liu, S. Memik, R. Shi, A.M. Shuping, M. Thieme, C. Xu (North- western University)*

The Real-time Edge AI for Distributed Systems (READS) project’s goal is to create a Machine Learning (ML) system for real-time beam loss de-blending within the accelerator enclosure, which houses two accelerators: the Main Injector (MI) and the Recycler (RR). In periods of joint operation, when both machines contain high intensity beam, radiative beam losses from MI and RR overlap on the enclosure£s beam loss monitor-ing (BLM) system, making it difficult to attribute those losses to a single machine. Incorrect diagnoses result in unnecessary downtime that incurs both financial and experimental cost. The ML system will automatically disentangle each machine£s contributions to those measured losses, while not disrupting the existing operations-critical functions of the BLM system. Within this paper, the ML models, used for learning both local and global machine signatures and producing high quality inferences based on raw BLM loss measurements, will only be discussed at a high-level. This paper will focus on the evolution of the architecture, which provided the high-frequency, low-latency collection of synchronized data streams to make real-time inferences.

TU3C03 **Collimator Scan Based Beam Halo Measurements in LHC and HL-LHC**

14:20 ***P.D. Hermes**, M. Giovannozzi, C.E. Montanari, S. Morales Vigo, S. Redaelli, B. Salvachúa (CERN) M. Rakic (EPFL)*

Measurements in the CERN Large Hadron Collider (LHC) have indicated that the population of the transverse beam halo is greater than that of a Gaussian distribution. With the upcoming High Luminosity upgrade (HL-LHC), the stored beam energy in the beam halo could become large enough to threaten the integrity of the collimation system. Considerable efforts during the ongoing LHC Run 3 are dedicated to characterising the transverse beam halo, and its diffusion properties, after the LHC Injector Upgrade (LIU) in preparation for HL-LHC operation. Given the unprecedented stored beam energies of about 400 MJ, presently achieved at the LHC, and about 700 MJ planned at the HL-LHC, conventional measurements are difficult. Halo and diffusion measurements are currently based on collimator scans, where robust collimators are inserted in steps into the circulating beam halo. In this contribution, we present techniques for halo characterisation employed in LHC and compare results obtained from such measurements in LHC Run 2 and the ongoing LHC Run 3. We present plans for measurements in the remainder of LHC Run 3 and describe expected challenges for halo quantification in HL-LHC.

TU3I04 **Comparison of Different Bunch Charge Monitors Used at the ARES Accelerator at DESY**
14:40

__T. Lensch__, D. Lipka, Re. Neumann, M. Werner (DESY)

The SINBAD (Short and INnovative Bunches and Ac-celerators at DESY) facility, also called ARES (Accelerator Research Experiment at SINBAD), is a conventional S-band linear RF accelerator allowing the production of lowcharge ultra-short electron bunches within a range of currently 0.01 pC to 250 pC. The R&D accelerator also hosts various experiments. Especially for the medical eFLASH experiment an absolute, non-destructive charge measurement is needed. Therefore different types of monitors are installed along the 45 m long machine: A new Faraday Cup design had been simulated and realized. Further two resonant cavities (Dark Current monitors) and two beam charge transfomers (Toroids) are installed. Both, Dark Current Monitors and Toroids are calibrated independently with laboratory setups. At the end of the accelerator a Bergoz Turbo-ICT is installed. This paper will give an overview of the current installations of charge monitors at ARES and compare their measured linearity and resolution.

TU3C05 **Low Intensity Beam Current Measurement of the Associated Proton Beam Line at CSNS**
15:10

__R.Y. Qiu__, W.L. Huang, F. Li, M.A. Rehman, Z.X. Tan, Zh.H. Xu, R.J. Yang, T. Yang (IHEP CSNS) M.Y. Liu, L. Zeng (IHEP) Q.R. Liu (UCAS)

The Associated Proton beam Experiment Platform (APEP) beamline is the first proton irradiation facility to use naturally-stripped protons which come from H^- beams interacting with the residual gas in the linac beampipe at CSNS. The stripped beam current, which is in the order of 0.1% of the original H^- beam and approximately 10 mi-croamperes, should be measured precisely to provide the proton number for irradiation experiments. Therefore, a low-intensity beam current measurement system was developed with considerations to eliminate the external interferences. An anti-interference design is adopted in this system with an elaboration of probes, cables and electronic low-noise technology to minimize the impact of environmental noise and interferences. This improves the signal-to-noise ratio and enables a more precise measurement of the microampere-level pulsed beam cur-rent. The system was installed and tested during the summer maintenance in 2021 and 2022. It shows a good agreement with the measurement of the Faraday cup.

TU3I06 **Industry Introductions**
15:30

__S. Carriere__ (CLS)

Industry Introductions

TUP — Tuesday Poster Session

TUP002 **Development of Bunch Position Monitors to Observe Sudden Beam Loss of SuperKEKB Rings**

M. Tobiyama, *H. Ikeda, G. Mitsuka (KEK)*

In the SuperKEKB rings, we have encountered extremely-fast beam losses occurring primarily within one to two turns in some parts of the bunch train. Such 'sudden beam loss' induced severe failure in the vertical collimator heads, quenches on the superconducting final quadrupoles, and damage on the Belle II detector in some cases. Thus it is essential to investigate the cause and take countermeasures. This paper presents the phenomena clarified by the bunch current and position monitor of the bunch feedback system. The upgrade plan for the existing monitor, and recently developed simple monitors installed in the suspected area is also introduced.

TUP003 **Preliminary Test of New Beam Loss Monitor System for KOMAC 100 MeV Linac**

S.P. Yun, *D.-H. Kim, H.S. Kim, H.-J. Kwon, S. Lee, Y.G. Song (KOMAC, KAERI)*

A 100 MeV proton linac at KOMAC have been used the in-house fabricated the beam loss monitor system to monitor the beam loss. The old beam loss monitor system use the scintillation detector and proportional counter as beam loss detector and consisted of the dedicated high voltage power supply and ADC(analog to digital converter). 20 beam loss detector was installed at the 100 MeV DTL and 100 MeV proton beamline. But any beam loss monitor did not installed at the low energy DTL linac due to the low radiation level. The new beam loss monitor system was introduced to more sensitive monitoring at the low energy DTL linac. The new BLM system, the power supply and ADC integrated in to one unit, was more compact compare to the old system. The new system have the fast response scintillation detector and the versatile read-out electronics. In this paper, the preliminary test results of the new BLM system and the beam loss monitoring at the low energy DTL linac.

TUP004 **Detector Response Studies of the ESS Ionization Chamber**

I. Dolenc Kittelmann, *V. Grishin (ESS)*

The European Spallation Source (ESS), currently under construction in Lund, Sweden, will be a pulsed neutron source based on a proton linac. The ESS linac is designed to deliver a 2GeV beam with peak current of 62.5mA at 14 Hz to a rotating tungsten target for neutron production. One of the most critical elements for protection of an accelerator is a Beam Loss Monitoring (BLM) system. The system is designed to protect the accelerator from beam-induced damage and unnecessary activation of the components. The main ESS BLM system is based on ionization chamber (IC) detectors. The detector was originally designed for the LHC at CERN resulting in production of 4250 monitors in 2006-2008. In 2014-2017 a new production of 830 detectors with a modified design was carried out to replenish spares for LHC and make a new series for ESS and GSI. This contribution focuses on the results from a measurement campaigns performed at the HRM (High-Radiation to Materials) facility at CERN, where detector response of the ESS type IC has been studied. The results may be of interest for other facilities, that are using existing or plan to use new generation of LHC type IC monitors as BLM detectors.

TUP005 **Commissioning the Beam-Loss Monitoring System of the LCLS Superconducting Linac**

A.S. Fisher, *N. Balakrishnan, G.W. Brown, E.P. Chin, W.G. Cobau, J.E. Dusatko, B.T. Jacobson, S. Kwon, J.A. Mock, J. Park, J. Pigula, E. Rodriguez, J.I.D. Rudolph, D. Sanchez, L. Sapozhnikov, J.J. Welch (SLAC)*

A 4 GeV superconducting linac has been added to the LCLS x-ray FEL facility at SLAC. Its 120 kW, 1 MHz beam requires new beam-loss monitors (BLMs) for radiation protection, machine protection, and diagnostics. Long radiation-hard optical fibres span the full 4 km from the electron gun of the SC linac to the final beam dump. Diamond detectors at anticipated loss points provide local protection. Detector signals are continuously integrated with a 500-ms time constant and compared to a loss threshold. If crossed, the beam is halted within 0.1 ms. Commissioning began in March 2022 with the 100 MeV injector and with RF process- ing of the cryomodules. At IBIC2022 last September, we presented commissioning results from the injector BLMs. In October, the beam passed through the full linac and the bypass transport line above the LCLS cop- per linac, stopping at an intermediate dump. In August it continued through the soft x-ray undulator and achieved first lasing. Here we present BLM commissioning at energies up to 4 GeV and rates up to 100 kHz. We discuss measurements and software using the fast diagnostic-waveform output to localize beam losses and to detect wire-scanner signals.

TUP006 **Simulation and Shot-by-Shot Monitoring of Linac Beam Halo**

***A.S. Fisher**, M. Bai, T. Frosio, A. Ratti, J. Smedley, J. Wu (SLAC) I.S. Mostafanezhad, B. Rotter (Nalu Scientific, LLC)*

FELs require a reproducible distribution of the bunch core at the undulator entrance for robust and reliable lasing. However, various mechanisms drive particles from the core to form a beam halo, which can scrape the beampipe of the undulator and damage its magnets. Collimators can trim the halo, but at the 1-MHz repetition rate of SLAC's LCLS-II superconducting linac, the collimator jaws can be activated and damaged. The Machine Protection System (MPS) can detect excessive radiation and halt the beam, but repeated MPS trips lead to significant downtime. Halo control begins by studying its structure, formation, and evolution, using a sensitive halo monitor. To that end, we are developing a pixellated diamond sensor. Diamond offers a dynamic range of up to 7 orders of magnitude, extending from the edge of the core to the faint halo expected at greater distances. Nalu Scientific has developed fast electronics for high-rate shot-by-shot readout. Initial tests are starting with a prototype 16-pixel sensor at the beam dump of SLAC's FACET-II test facility. The tests and simulations will guide more elaborate sensor designs.

TUP007 **Use of the ISAC-II Flight Time Monitors toward Automated Tuning**

***S. Kiy**, P.M. Jung, T. Planche, O. Shelbaya, V.V. Verzilov (TRIUMF)*

A time-of-flight system has been in use at ISAC-II since 2006 for the phasing of cavities and accurate ion beam velocity measurements across the nuclear chart. This system is heavily relied upon as the primary energy-time domain diagnostic downstream of the ISAC-II linac. Ongoing High Level Applications (HLA) development at TRIUMF has enabled the use of new methods that are being applied to these measurements - both for processing and automation of data acquisition. An update will be provided on operational experience with the system over the past 10 years including its recent re-calibration and error analysis. A brief summary of the current HLA framework will be given, including the python-based analysis of beam profiles, to extract statistics, and the data collection pipeline, featuring a task queue, to handle long running processes. Finally, the way in which these developments enable beam-based calibration of cavity parameters and a shift to model-based tuning methods is discussed.

TUP008 **Recording Series of Coherent Thz Pulse Shapes with Up to 88 MHz Repetition Rate at Soleil, Using Photonic Time-Stretch**

***C. Szwaj**, S. Bielawski (PhLAM/CERLA) J.B. Brubach, M. Labat, L. Manceron, P. Roy (SOLEIL) C. Evain, M. Le Parquier, E. Roussel (PhLAM/CERCLA)*

Recording THz signals in single-shot is required in various accelerator applications, including real-time stud- ies of electron bunch shapes, and user-applications employing coherent THz synchrotron radiation. For this purpose, many accelerator facilities have implemented laser-based measurement systems known as electro-optic detection. This consists of 'imprinting' the unknown terahertz waveform on a shot laser pulse, that is subsequently analyzed. Few years ago a new variant of this method, time-stretch electro-optic detection, has been introduced with the aim to cope with high repetition-rate machines. We present the current record in repetition rate (up to 88 MHz), that has been obtained at the AILES beamline of the SOLEIL facility. We also present the projects aiming at reaching long recording windows and/or high bandwidth using time-stretch, as well as the expected fundamental trade-offs linked to the quest for high repetition rate.

TUP009 **Bunch Length Measurement System Downstream the Injector of the S-DALINAC**

***A. Brauch**, M. Arnold, M. Dutine, J. Enders, R. Grewe, L.E. Jürgensen, N. Pietralla, F. Schlie mann, D. Schneider (TU Darmstadt)*

The S-DALINAC is a thrice recirculating electron accelerator for high resolution electron scattering experiments with a continuous-wave beam at a frequency of 2.9972(1) GHz. Short bunches are crucial to enable tuning of the machine for operation as an energy-recovery linear accelerator. Currently, measurements of this beam parameter are accomplished by using the radio-frequency zero-crossing method: here, a momentum spread chirp is induced and the transverse beam profile in a downstream located dispersive section is measured with a scintillating screen providing an upper limit of the bunch length. Since this method is time consuming, a new setup for these measurements using a streak camera is developed. Optical transition radiation from an aluminum-coated Kapton target is used to map the bunch length information to a light pulse which enables an accurate measurement compared to a scintillating screen. The light pulse can then be evaluated with the streak camera by projecting its length onto the transverse dimension on a phosphor screen. This contribution will present the current status of the measurement setup as well as its design and properties.

TUP010 **Intermediate Frequency Circuit Components for Integration of on-Chip Amplifier With THz Detectors**

***R. Yadav**, S. Preu (IMP, TU Darmstadt) A. Penirschke (THM)*

The Zero-Bias Schottky Diode (ZBSD) and field effect transistor (TeraFET) based Terahertz (THz) detectors become more and more important for beam diagnosis and alignment at THz generating accelerator facilities. The roll- off factor of the detectors at higher THz frequencies requires wide-band amplifiers to enhance the IF signal from a few µW to nW well above the noise floor of the following post detection electronics. Connecting external amplifiers to the detectors via rf cables would enhance the signal losses even further and degrade the signal to noise ratio (SNR). In order to maximize the SNR, it is necessary to have on-chip amplifier integrated in the intermediate frequency (IF) circuit of the detector in the same housing. In this work, we present the design and parametric analysis of components for transition to an IF circuit, which will be integrated in the ZBSD and TeraFET on chip with amplifier in the same housing. The design analysis has been done to find the optimal parameters. The broader IF circuit will enhance the detector resolution to capture pulses in the picosecond range with the help of fast post detection electronics.

TUP011 **Geometry Study of an RF-Window for a GHz Transition Radiation Monitor for Longitudinal Bunch Shape Measurements**

***S. Klaproth**, A. Penirschke (THM) H. De Gersem (TEMF, TU Darmstadt) R. Singh (GSI)*

GHz transition radiation monitors (GTRs) can be used to measure longitudinal beam profiles even for low β beams. In comparison to traditional methods e.g., Fast Faraday Cups (FFCs) and Feschenko monitors, GTRs are a non-destructive measurement method and are able to resolve bunch-by-bunch longitudinal profiles at the same time. In our case, we plan to measure the transition radiation outside the beam line through an RF-window with an 8 GHz broad band antenna. At the border of the RF-window the transition radiation is partially reflected propagating in the beam line backwards. In this contribution, we show a study of different geometries to suppress reflections generated at the transition to the RF-window. For higher permittivity the strength of these reflections becomes stronger, simultaneously reducing the measurable signal strength at the antenna. Secondly the RF-window material must be UHV usable and should be durable like Alumina or Peek.

TUP012 **First Measurements of an Electro-Optical Bunch Arrival-Time Monitor Prototype with PCB-Based Pickups for ELBE**

***B.E.J. Scheible**, A. Penirschke (THM) W. Ackermann, H. De Gersem (TEMF, TU Darmstadt) M.K. Czwalinna, T.A. Nazer, H. Schlarb, S. Vilcins (DESY) M. Freitag, M. Kuntzsch (HZDR)*

A vacuum sealed prototype of an electro-optical bunch-arrival-time monitor has been commissioned in 2023. It comprises of a pickup-structure and a low-pi-voltage ultra-wideband traveling wave electro-optical modulator. The stainless-steel body of the pickup structure is partially produced by additive manufacturing and comprises four pickups as well as an integrated combination network on a printed circuit board. This novel design aims to enable single-shot bunch-arrival-time measurements for electron beams in free-electron lasers with single-digit fs precision for low bunch charges down to 1 pC. The theoretical jitter charge product has been estimated by simulation and modeling to be in the order of 9 fs pC. The new prototype is tailored for validation experiments at the ELBE accelerator beamline. In this contribution first measurement results are presented.

TUP013 **Diversity Enhanced Electro-Optic Sampling at EuXFEL**

***B. Steffen**, M.K. Czwalinna (DESY) S. Bielawski, Q. Demazeux, C. Evain, E. Roussel, C. Szwaj (PhLAM/CERLA)*

Electro-optical detection has proven to be a valuable technique to study temporal profiles of THz pulses with pulse durations down to femtoseconds. Recently, a numerical reconstruction strategy called DEOS (Diversity Electro-Optical Sampling) proved to be much more efficient in retrieving ultrafast input signals. First tests at the European X-ray FEL (EuXFEL) in Hamburg show a 200 fs temporal resolution over more than 10 ps recording length. This technique, however, requires to measure both orthogonal polarizations of the sampling laser pulse simultaneously. Further adaptations to the existing design of the compact EOD bunch length monitor are needed to fully implement the new measurement strategy, which will be presented in this paper.

TUP014 **Design and Test of a Prototype 324 MHz RF Deflector in the Bunch Shape Monitor for CSNS-II Linac Upgrade**

***W.L. Huang**, F. Li, J. Peng, R.Y. Qiu, Zh.H. Xu, R.J. Yang, T. Yang (IHEP CSNS) M.Y. Liu, X.Y. Liu, Y.F. Sui, L. Zeng (IHEP) Q.R. Liu (UCAS)*

During the upgrade of linac in CSNS-II, the beam in-jection energy will increase from 80.1 MeV to 300 MeV and the beam power from 100 kW to 500 kW. A combined layout of superconducting spoke cavities and elliptical cavities is adopted to accelerate H^- beam to 300 MeV. Due to a ∼10ps short bunch width at the exit of the spoke SC section, the longitudinal beam density distribution will be measured by bunch shape monitors using low energy secondary emission electrons. As the most important part of a bunch shape monitor, a prototype 324MHz RF deflector is designed and tuned on the basis of a quasi-symmetric $\lambda/2$ 325 MHz coaxial resonator, which was fabricated for the C-ADS proton accelerator project. Preliminary parameters of the bunch shape monitor are presented. Simulation of the RF deflector and test results in the laboratory are described and analysed.

TUP016 **The Upgrade of the Light Pulse Picking System at HLS-II**

***J. Wang**, P. Lu, B.G. Sun, L.L. Tang, Y.K. Zhao, T.Y. Zhou, Z.R. Zhou (USTC/NSRL)*

In 2009, the light pulse picking system was built to pick a single synchrotron radiation light pulse from 45 light pulses so that it can be used for researching the longitudinal bunch characteristics at HLS. The optical system was operating well, but the optical pulse picking width was 9.8 ns, which is greater than the bunch interval of 4.9 ns. Therefore, the signal-to-noise ratio of the system is not good enough. The HLS-II light source refers to the machine upgrade project of HLS in 2014. After that, the longitudinal beam characteristics was changed. Therefore, the synchrotron light pulse picking system with better performance has been developed to meet the needs of beam diagnosis and longitudinal beam dynamics research.

12 Sep – Tue

TUP018 **Longitudinal Parameter Measurement System Based on Time-Frequency Domain Joint Analysis**

HS. Wang *(SSRF)*

This paper proposes a novel technique for measuring longitudinal bunch length by performing spectral anal- ysis on the beam signals to extract the bunch length information for each bunch and each turn. A high-speed oscilloscope is used to capture original button signal with more than 7000 turns information and an offline Python script is used to retrieve bunch length and phase information. A streak camera is used to calibrate the transfer function of the acquisition system. Experiments were carried out at the Shanghai Synchrotron Radiation Facility and the Hefei Light Source by capturing the electrode signals with an oscilloscope during single bunch injection and harmonic cavity tuning in the storage ring. The calibrated longitudinal bunch length measurement system yielded favorable results, with a larger dynamic range and higher time resolution compared to the streak camera. In the future, the system has the potential to be transplanted into a processor to achieve online longitudinal beam measurement for each bunch.

TUP019 **Femtosecond Relativistic Electron Bunch Compression and Diagnosis using Terahertz-driven Resonators**

Y. Xu*, K. Fan, Z. Liu, Y. Song, C.-Y. Tsai (HUST) L.X.F. Li (Private Address)*

Ultrafast electron beams lengthening and time jitter severely degrade the temporal resolution in electron-laser applications, such as ultrafast electron diffraction (UED). In recent years, terahertz-driven devices have shown great potential in beam manipulation and diagnostics. This paper reports an all-optical method for compressing and characterizing a 3 MeV electron beam using single-cycle terahertz radiation. A THz buncher longitudinally compresses the electron beams, and the resulting shortest bunch length and arrival time are measured using a transverse THz field in a downstream terahertz slit. Particle tracking simulation shows that the bunch is compressed more than 13 times from 54 fs to 4 fs, and the arrival time jitter is reduced from 100 fs to 21 fs. This method effectively manipulates the beam longitudinal phase space, compresses the beam length, and suppresses the time jitter. It is expected to significantly impact ultrafast science and be applied in other accelerator applications.

TUP020 **Development of Stripline Fast Faraday Cup at MEBT of RAON**

J.W. Kwon*, G.D. Kim, H.J. Woo (IBS) E.H. Lim (Korea University Sejong Campus)*

RAON (Rare isotope accelerator complex for On-line experiment) is an accelerator that accelerates heavy ions such as uranium, oxygen, and protons. In the MEBT section, the ion beam is accelerated and focused by RFQ, has bunch structure with a period of 81.25 MHz, and has an energy of 507 keV/u. To measure the shape of a beam, the transverse and longitudinal profiles should be obtained using beam diagnostic device. To measure bunch lengths of less than 1 ns, 50 Ω matched stripline type fast faraday cup was fabricated and the signal was amplified by a 4 GHz broadband signal amplifier with a gain of 42 dB. The amplified signal was measured using an oscilloscope with a high sampling frequency of 25 GSPS and a wide frequency bandwidth of 4 GHz. The developed fast faraday cup was installed at the end of the MEBT in front of SCL3. This poster describes the design of a stripline fast faraday cup and the results of measuring the bunch length at a MEBT section using Ar^{9+} at 30 μA current.

TUP021 **Development of the RF Phase Shifter with Femtosecond Time Delay Resolution for the PAL-XFEL Laser System**

D.C. Shin*, H.-S. Kang, G. Kim, C.-K. Min, G. Mun (PAL)*

We introduce the RF Phase Shifter (RPS) developed in the Pohang Accelerator Laboratory X-ray Free-Electron Laser (PAL-XFEL) to control the timing of optical laser system. This equipment is designed to finely adjust the timing of laser pulses with femtosecond scale by manipulating the phase of the RF reference using a couple of Direct Digital Synthesizer (DDS) devices. Furthermore, it is designed with low phase noise and low phase drift features in order to minimize the impact on the system in an open-loop operation. Currently these units are installed at the Injection site, Hard X-ray and Soft X-ray Beamline. They are implemented for the feedback control of the photocathode gun phase at the Injector and for the use in pump-probe experiments at the Beamlines. This paper describes the design, fabrication, and experimental results of the RPS, as well as its usage status at PAL-XFEL.

TUP022 **Characterisation of Cherenkov Diffraction Radiation Using Electro-Optical Methods**

A. Schloegelhofer*, T. Lefèvre, S. Mazzoni, E. Senes (CERN) L. Duvillaret (KAPTEOS)* ***A. Schloegelhofer*** *(TU Vienna)*

The properties of Cherenkov diffraction radiation (ChDR) have been studied extensively during the recent years to be exploited for non-invasive beam diagnostic devices for short bunches. The dependence of charge and the influence of the bunch form factor on the coherent part of the radiated spectrum have been demonstrated and studied in the past. However, the actual field strength of coherent ChDR as well as its study in time domain need further investigation. In this contribution we are using electro-optical techniques to investigate and quantify these parameters. The electro-optical read-out brings the advantage of high bandwidth acquisition and insensitivity to electromagnetic interference, whereas at the same time a large fraction of the acquisition setup can be installed and operated outside of the radiation controlled areas. We will present experimental results from the CLEAR facility at CERN as well as simulations of the peak field of the temporal profile of beam-generated ChDR pulses.

TUP023 **Application of a Camera Array for the Upgrade of the AWAKE Spectrometer**

***E. Senes**, S. Mazzoni, M. Turner, G. Zevi Della Porta (CERN) D.A. Cooke, F.E. Pannell, M. Wing (UCL)*

The first run of the AWAKE experiment successfully demonstrated the acceleration of an electron beam in the plasma wakefields of a relativistic proton beam. The planned second run will focus on the control of the emittance of accelerated electrons, requiring an upgrade of the existing spectrometer. Preliminary measurements showed that this might be achieved by improving the resolution of the scintillator and with a new design of the optical system. This contribution discusses the application of a digital camera array in close proximity of the spectrometer scintillator, to enable the accelerated electron beam emittance measurement.

TUP026 **Bunch Compressor Monitors for the Characterization of the Electron Bunch Length in a Linac-Driven FEL**

***G.L. Orlandi** (PSI)*

The lasing performance of a Free Electron Laser (FEL) strongly relies on a precise characterization of the electron bunch length and on the control and stabilization of the bunch compression settings of the machine under normal user operations. In a FEL driver linac, the so-called Bunch Compressor Monitors (BCMs) normally ensure the non-invasive monitoring of the electron bunch length. BCMs, being sensitive to the temporal coherent threshold of the radiation energy emitted by the electron beam crossing the last dipole of a magnetic chicane or a holed diffraction screen just downstream, can provide a bunch length dependent signal resulting from the integration of the detected radiation pulse energy over the acceptance frequency band of the detector. Thanks to the non-invasiveness, BCMs are primary diagnostics in a FEL to stabilize the bunch compression by feeding back the RF settings of the accelerating structure. In this contribution, we present a formal method to determine an absolute measurement of the electron bunch length from the analysis of a BCM signal.

TUP027 **Microbunching of Thermionic Cathode RF Gun Beams in the Advanced Photon Source S-Band Linac**

***J.C. Dooling**, A.R. Brill, N. Kuklev, I. Lobach, A.H. Lumpkin, N. Sereno, Y. Sun (ANL)*

We report on measurements of beams from thermionic cathode (TC) rf guns in the Advanced Photon Source S-Band Linac. These measurements include the macropulse out of both new and existing TC guns as well as the observation of microbunching within the micropulses of these beams. A gun chopper limits the macropulse FWHM duration to the 10-ns range. Our objectives were to analyse the new TC gun and investigate microbunching within a TC-rf-gun-generated beam. Our diagnostics elucidated longitudinal beam structures from the ns to the fs time scales. Coherent transition radiation (CTR) interferometers responding to far-infrared wavelengths were employed after each compression stage to provide the autocorrelations of the sub-ps micropulse durations. The first compression stage is an alpha magnet and the second a chicane. A CCD camera was used to image the beam via optical transition radiation from an Al screen at the end of the linac and also employed to measure coherent optical transition radiation (COTR) in the visible range. The COTR diagnostic observations, implying microbunching on a fs time scale, are presented and compared with a longitudinal space-charge impedance model.

TUP028 **Collimator Irradiation Studies at the Advanced Photon Source**

***J.C. Dooling**, W. Berg, M. Borland, J.R. Calvey, L. Emery, A.M. Grannan, K.C. Harkay, Y. Lee, R.R. Lindberg, G. Navrotski, V. Sajaev, N. Sereno, J.B. Stevens, Y.P. Sun, K.P. Wootton (ANL) N.M. Cook (RadiaSoft LLC) D.W. Lee, S.M. Riedel (UCSC)*

We present results from a recent collimator irradiation experiment conducted in the Advanced Photon Source (APS) storage ring. This experiment is the third in a series of studies to examine the effects of high-intensity electron beams on potential collimator material for the APS-Upgrade (APS-U). The intent here is to determine if a fan-out kicker can sufficiently reduce e-beam power density to protect horizontal collimators planned for the APS-U storage-ring. The fan-out kicker (FOK) spreads the bunched-beam vertically allowing it to grow in transverse dimensions prior to striking the collimator. In the present experiment, one of the two collimator test pieces is fabricated from oxygen-free copper; the other from 6061-T6 aluminum. As in past studies, diagnostics include turn-by-turn BPMs, a diagnostic image system, fast beam loss monitors, a pinhole camera, and a current monitor. Post-irradiation analyses employ microscopy and metallurgy. To avoid confusion from multiple strikes, only three beam aborts are carried out on each of the collimator pieces; two with the FOK on and the other with it off. Observed hydrodynamic behavior will be compared with coupled codes.

TUP029 **A Hybrid Approach to Upgrade Hardware for the Proton Storage Ring Fast Kicker**

***TR. Ramakrishnan**, J.I. Duran, H.A. Watkins (LANL)*

The Los Alamos Neutron Science Center (LANSCE) Proton Storage Ring (PSR) needs precise timing to ensure successful extraction of the bunched protons. The current control system's hardware is obsolete and unmaintainable. The task was to replace the 1980's era CAMAC control and timing system for the PSR extraction kickers. This included a system which halts charging of the kickers after a duration without firing to prevent equipment damage. A hybrid approach was taken to integrate a Berkeley Nucleonics Corporation (BNC) pulse generator that was controlled by a soft input/output controller (IOC) and National Instrument compact Reconfigurable Input/Output (cRIO) IOC. This allowed for flexibility and modularity of the software and hardware development. This approach built the framework to streamline robust deployment of hybrid systems and develop a solution for upgrades of other LANSCE kickers.

TUP030 **Proposal for a Low-Cost Wakefield Deflector for CW X-ray FEL Operation**

***D.K. Bohler**, P. Krejcik, A.A. Lutman, A. Novokhatski (SLAC)*

SLAC National Accelerator Laboratory is undertaking a project to develop a dielectric wakefield deflector with the goal of enhancing Free-Electron Laser (FEL) operational modes and providing comprehensive bunch diagnostics. The project aims to re-establish and optimize the Fresh-slice operation modes in the recently upgraded Soft X-ray Line (SXR) of the LCLS, a scheme noted for its success in delivering femtosecond, high-power double-pulses within the SXR wavelength range and contributing significantly to research published in high-impact journals. The novel wakefield deflector design incorporates an L-shaped bar and a dielectric wakefield deflector using an anodized aluminum bar, drawing from the successful approaches of teams at DESY and PSI. This single straight, rectangular aluminum L-shaped bar, coated with an aluminum oxide dielectric layer, represents a marked improvement over previous corrugated metal jaw designs. Furthermore, this project explores the potential of this passive streaker as a diagnostic tool for electron bunch phase space, promising exciting advancements in the field of accelerator technologies

TUP031 **Beam Test of a Harmonic Kicker Cavity**

***M.W. Bruker**, J.M. Grames, J. Guo, J. Musson, S.A. Overstreet, G.-T. Park, T.E. Plawski, M. Poelker, R.A. Rimmer, H. Wang, C.M. Wilson, S. Zhang (JLab) M.H. Pablo, B.F. Roberts, D. Speirs (Electrodynamic)*

A harmonically resonant kicker cavity designed for beam exchange in a circulator cooler was built and successfully tested at the Upgraded Injector Test Facility (UITF) at Jefferson Lab. This type of cavity is being considered for the injection scheme of the Rapid Cycling Synchrotron at the Electron-Ion Collider, where the spacing of neighboring bunches demands very short kicks. Operating with five transversely deflecting modes simultaneously that resonate at 86.6 MHz and consecutive odd harmonics thereof, the prototype cavity selectively deflects 1 of 11 electron bunches while leaving the others unperturbed. An RF driver was developed to synthesize phase- and amplitude-controlled harmonic signals and combine them to drive the cavity while also separating the modes from a field-probe antenna for RF feedback and dynamic tuning. Beam deflection was measured by sweeping the cavity phase; the deflection waveform agrees with expectations, having sub-nanosecond rise and fall times. No emittance increase is observed. Harmonically resonant cavities like the one described provide a new capability for injection and extraction at circulators and rings.

TUP034 **Axial Cryogenic Current Comparator (CCC) for FAIR**

***L. Crescimbeni**, D.M. Haider, M. Schwickert, T. Sieber, T. Stöhlker (GSI) D.M. Haider (TEMF, TU Darmstadt) M. Schmelz, R. Stolz, V. Zakosarenko (IPHT) F. Schmidl, V. Tympel (FSU Jena) T. Stöhlker (IOQ) T. Stöhlker, V. Tympel (HIJ) V. Zakosarenko (Supracon AG)*

The Cryogenic Current Comparator (CCC) is a superconducting device based on an ultrasensitive SQUID (fT range). Measuring the beam's azimuthal magnetic field, it provides a calibrated non-destructive measurement of beam current with a resolution of 10 nA or better, independent from ion species and without tedious calibrations procedure. The non-interceptive absolute intensity measurement of weak ion beams (<1 μA) is essential in heavy ion storage rings and in transfer lines at FAIR. With standard diagnostics, this measurement is challenging for bunched beams and virtually impossible for coasting beams. To improve the performance of the detector several upgrades are under study and development: One is the investigation of a new type of CCC using an alternative magnetic shield geometry. The so-called 'axial' geometry will allow for much higher magnetic shielding factor, an increased pick-up area, and a lower low frequencies noise component. Further improvements and optimizations of the detector will be presented. The CCC will be tested on the beamline at the end of 2023 allowing to define the best possible version for FAIR.

TUP035 **Multi-Tile Zinc-Oxide-Based Radiation-Hard Fast Scintillation Counter for Relativistic Heavy-Ion Beam Diagnostics: Prototype Design and Test**

***M. Saifulin**, P. Boutachkov, C. Trautmann, B. Walasek-Höhne (GSI) E.I. Gorokhova (GOI) P. Rodnyi, I.D. Venevtsev (SPbPU) C. Trautmann (TU Darmstadt)*

This contribution summarizes the design and performance test of a prototype radiation-hard fast scintillation detector based on the indium-doped zinc oxide ceramic scintillator, ZnO(In). The prototype detector has been developed for use as a beam diagnostics tool for high-energy beam lines of the SIS18 synchrotron at the GSI Helmholtz Center for Heavy Ion Research GmbH. The new detector consists of multiple ZnO(In) scintillating ceramics tiles stacked on the front and back sides of a borosilicate light guide. The performance of the detector was tested in comparison to a standard plastic scintillation detector with 300 MeV/u energy 40Ar, 197Au, 208Pb, and 238U ion beams. The investigated prototype exhibits 100% counting efficiency and radiation hardness of a few orders of magnitude higher than the standard plastic scintillation counter. Therefore, it provides an improved beam diagnostics tool for relativistic heavy-ion beam measurements.

TUP036 **Cryogenic Current Comparators as Low Intensity Diagnostics for Ion Beams**

***T. Sieber**, L. Crescimbeni, D.M. Haider, M. Schwickert, T. Stöhlker (GSI) D.M. Haider, N. Marsic (TEMF, TU Darmstadt) M. Schmelz, R. Stolz, V. Zakosarenko (IPHT) F. Schmidl (FSU Jena) T. Stöhlker (IOQ) T. Stöhlker, V. Tympel (HIJ) J. Tan (CERN) V. Zakosarenko (Supracon AG)*

The Cryogenic Current Comparator (CCC) is a SQUID based superconducting device for intensity measurement, firstly proposed as a beam diagnostics instrument in the 90s at GSI. After prove of principle the CCC was introduced into other facilities, attesting great potential for high resolution measurements but at the same time considerable mechanical and cryogenics challenges and costs. In the course of plannings for FAIR the CCC has been revitalized. Systematic investigations started, involving commercially available SQUID sys- tems, which led to improvements of detector and cryostat. The developments resulted in nA spill measure- ments at GSI (2014) followed by the installation of a CCC in CERN Antiproton Decelerator (AD), which has in the meantime become a key instrument. Since then optimization of the device is ongoing, with respect to various operating conditions, system robustness, current resolution and last but not least system costs. Alternative CCC versions with improved magnetic shielding have been developed as well as 'Dual Core' versions for background noise reduction. We give an overview of CCC optimization and development steps, with focus on applications at GSI and FAIR.

TUP037 **Charge Measurement With Resonators at Ares**

__D. Lipka__, T. Lensch, Re. Neumann, M. Werner (DESY)

The ARES facility (Accelerator Research Experiment at SINBAD) is an accelerator to produce low charge ultrashort electron bunches within a range of currently 0.5 pC to 200 pC. Especially for eFLASH experiments at ARES an absolute, non-destructive charge measurement is required. To measure an absolute charge of individual bunches different types of monitors are installed. A destructive Faraday Cup is used as reference charge measurement device. To measure the charge non-destructively 2 Toroids, 1 Turbo-ICT and 2 cavity monitors are installed. The latter system consists of the cavity, front-end electronics with logarithmic detectors and µTCA ADCs. The laboratory calibration of the cavity system is performed by using an arbitrary waveform generator which generate the same waveform like the cavity with beam. This results in a nonlinear look-up table used to calculate the ADC amplitude in charge values independent of beam-based calibration. The measured charges from the cavity monitors agree very well within few percent in comparison with the Faraday Cup results.

TUP038 **BCM System Optimization for ESS Beam Commissioning through the DTL Tank4**

__H. Hassanzadegan__, R.A. Baron, S. Gabourin, H. Kocevar, M. Mohammednezhad, J.F.J. Murari, S. Pavinato, K.E. Rosengren, T.J. Shea, R. Zeng (ESS) K. Czuba, P.K. Jatczak (Warsaw University of Technology, Institute of Electronic Systems)

The ESS BCM system is not only used for beam measurement but it also plays an important role for machine protection particularly in the normal-conducting part of the linac. During the previous beam commissionings to the MEBT and DTL1 FCs and before the cavities were fully conditioned, RF breakdowns and other types of discharges in the cavities had a major impact on beam availability due to the Fast machine protection functions of the BCM. Following an investigation on the root cause of the beam trips, the configuration of the machine protection functions was modified to improve beam availability in the more recent beam commissioning to the DTL4 FC. In addition to this, some optimizations were made in the BCM system to improve beam measurement, and a few more functions were added based on new requirements. This paper reports on these improvements and the results obtained during the beam commissioning through the DTL4.

TUP040 **CHG0 to HERO - An Update to the Fermilab Booster DCCT**

__E. B. Milton__ (Fermilab)

The Booster complex at Fermi National Accelerator Laboratory uses a DC Current Transformer (DCCT) in conjunction with analog circuitry to measure intensity of the circulating beam during the acceleration cycle. This measurement is affectionately known as Charge Zero (CHG0). This platform has been updated to a Bergoz New Parametric Current Transformer (NPCT) and FPGA Data Acquisition System that digitally normalizes beam current to provide a High-quality E12 Read Out (HERO) for the PIP-II era.

TUP041 **APS Upgrade Radiation Safety Beam Current Interlock**

__R.T. Keane__, K.C. Harkay, N. Sereno (ANL) A. Caracappa, C. Danneil, K. Ha, J. Mead, D. Padrazo Jr (BNL)

The Advanced Photon Source upgrade (APS-U) Multi-Bend Acromat (MBA) storage ring utilizes on-axis swap-out injection requiring up to 20nC charge per electron bunch. Enforcement of radiation safety limits for the new storage ring will be accomplished by a new beam charge monitor interlock that accumulates beam charge measurements in the Booster-to-Storage ring (BTS) transfer line and disables injection when the charge limit over a preset time period is exceeded. The new interlock is based on the existing APS Beam Shut-Off Current Monitor (BESOCM), and incorporates significant improvements over the existing system. New features include use of direct digitization and FPGA processing, extensive remote monitoring capabilities, expanded self-test and fail-safe functions, and the ability to adjust settings and monitor status remotely via EPICS. The new device integrates a test pulse (self-check) feature that verifies the integrity of the integrat- ing beam current transformer (ICT) and cable system used to detect the beam signal. This paper describes the new BTS interlock (BESOCM) design and presents results of bench test and in-machine evaluation of the prototype and production units.

TUP042 **Nano-Amp Beam Current Diagnostic for Linac-to-ESA (LESA) Beamline**

S.T. Littleton *(Stanford University) , A.S. Fisher, C. Huang, T.O. Raubenheimer (SLAC)*

The LESA beamline is designed to transport dark current from the LCLS-II and LCLS-II-HE superconducting linacs to the End Station A for various fixed target experiments. The primary experiment is expected to be the Light Dark Matter eXperiment (LDMX) which required beam currents of a few pA. The operation of the beam line much be parasitic to the LCLS-II / LCLS-II-HE FEL operation. The dark current in the LCLS-II is expected to be at the nA-level which will be below the resolution of most of the LCLS-II diagnostics (it will be degraded before the experiments as necessary). This paper will describe a possible non-destructive diagnostic using synchrotron radiation that could be applied at multiple locations along the LCLS-II and the LESA beamline.

TUP043 **Beam Diagnosis Control System Upgrade Based on EPICS at RAON**

E.H. Lim*, E.-S. Kim (Korea University Sejong Campus) G.D. Kim, J.W. Kwon, H.J. Woo (IBS)*

The Rare-isotope Accelerator complex for ON-line experiment (RAON) is a heavy ion accelerator with a maximum beam power of 400 kW. RAON is equipped with various diagnostic devices, including the Faraday Cup, Wire Scanner, and Beam Viewer, for measuring beam characteristics. EPICS is used for integrated control of driving devices such as motors and air cylinders and data collection devices, and performs sequential operations according to an algorithm written in SEQUENCER. As beam commissioning operation progressed, various improvement requirements were identified. Algorithms have been upgraded to provide error signals and prevent collisions between devices, ensuring stability. In this paper, we present the RAON's upgraded diagnostic control system.

TUP044 **The Digital Signal Processing Chain of the CERN LIU Wire Scanners**

D. Belohrad *(European Organization for Nuclear Research (CERN)) J. Emery, J.C. Esteban Felipe, A. Goldblatt, A. Guerrero, M. Martin Nieto, F. Roncarolo (CERN)*

Between 2019 and 2023, as part of the LHC Injectors Upgrade (LIU), a major renovation of the CERN wire scanners (BWS) was performed. The main driving force was to prepare the wire scanners for the High-Luminosity LHC (HL-LHC), during which the instantaneous luminosity is expected to double, to around $5\times10^{34}\mathrm{cm}^{-2}\mathrm{s}^{-1}$. In 2021 seventeen LIU BWSs were installed in the CERN PS complex and the SPS. Additionally, two BWSs were installed in the LHC, at the end of 2022, to be ready for the 2023 LHC run. The aim of the contribution is to describe in detail the technical implementation of the digital signal acquisition (DAQ) and data processing of the newly installed BWSs. Particular attention is given to the design of the analogue front-end, signal conversion, and data processing chain – providing raw data for the profile reconstruction. The synchronisation of the incoming digitised signal with the machine timing is also a focus point, as it differs significantly between the PS complex on the one hand and the LHC and SPS on the other hand. In conclusion we present beam measurements, and discuss the limitations of the algorithms used.

TUP045 **Real Time Momentum Spread Measurement of the CERN Antiproton Decelerator Beam**

P. Freyermuth*, B. Dupuy (CERN)*

Constant optimisation and diagnostics of the cooling processes in the CERN antiproton decelerator (AD) relies on a de-bunched beam momentum spread real time measurement. This article will describe the renovation of the acquisition chain of the longitudinal Schottky diagnostics in the AD, using standard CERN hardware and software to maximize reliability, ease maintenance, and meet the requirements for standard operational tools. The whole chain, from the pick-up to the operation software applications will be described with emphasis on the implementation of the data processing running on the front-end computer. Limitations will also be discussed and outlook for further development given.

TUP046 **Status of the RFSoC-based Signal Processing for the Multi-bunch Feedback and Filling Pattern Measurement in the SLS 2.0**

P.H. Baeta Neves Diniz Santos *(PSI)*

Having effectively evaluated the RF System-On-Chip (RFSoC) as a suitable technology for the SLS2.0 Filling Pattern Feedback (FPFB) and Multi-bunch Feedback (MBFB) [1], our current focus lies in realizing and expanding the required real-time Digital Signal Processing (DSP) algorithms on an RFSoC evaluation board. This contribution outlines the present status of our feedback systems, including recent outcomes derived from testing prototypes both in the laboratory and with beam signals at the storage ring.

WE1 – Wednesday Session 1

Chair: J.H. Yue (IHEP)

WE1I01 09:00 **Online Bunch Length Monitoring for Storage Ring using a Fast Photodiode**

G. Hahn, C. Kim, D. Kim (PAL) J.-G. Hwang (HZB) W.J. Song (POSTECH)

Providing bunch lengths and a filling pattern of the bunch train in real-time is one of the important challenges in beam instrumentation of the 3rd generation light source. In particular, the time length and intensity information of the synchrotron light is useful to beamlines and their users who perform time-resolved experiments. We developed an online monitoring system that can measure bunch lengths and a filling pattern simultaneously by directly observing the synchrotron radiation with a picosecond-resolution photodiode and high input-analog-bandwidth digitizer. A Gaussian deconvolution method to restore the original waveform of synchrotron radiation using the system impulse response function was developed and adopted. In this paper, we present the experimental setup, signal processing method, and several machine study results in detail using the fast photodiode in the PLS-II

WE1I02 09:30 **The MAX IV Transverse Deflecting Cavity**

E. Mansten, S. Thorin (MAX IV Laboratory, Lund University)

The first streaked electrons in the new MAX IV Transverse deflecting cavity (TDC) were just achieved. The TDC consists of two 3 m long transverse deflecting RF structures, operating at S-band, with possibility to ad- just the polarization of the deflecting fields. The TDC will use an energy doubling system (SLED) to increase the field in the cavities and along with a large beta function through the structure and a small beta focus at the detector, this will produce a time resolution of 1 fs. The first results of measurements are believed to be achieved within the next few months.

WE1C03 10:00 **THz Antenna-Coupled Zero-Bias Schottky Diode Detectors for Particle Accelerators**

R. Yadav, S. Preu (IMP, TU Darmstadt) J.M. Klopf, M. Kuntzsch (HZDR) A. Penirschke (THM)

Semiconductor-based broadband room-temperature Terahertz (THz) detectors are well suitable for beam diagnosis and alignment at accelerator facilities due to easy handling, compact size, no requirement of cooling, direct detection and robustness. Zero-Bias Schottky Diode (ZBSD) based THz detectors are highly sensitive and extremely fast, enabling the detection of picosecond scale THz pulses. This contribution gives an overview of direct THz detector technologies and applications. The ZBSD detector developed by our group has undergone several tests with table-top THz sources and also characterized with the free-electron laser (FEL) at HZDR Dresden, Germany up to 5.56 THz. In order to understand the rectification mechanism at higher THz frequencies, detector modelling and optimization is essential for a given application. We show parametric analysis of a antenna-coupled ZBSD detector by using 3D electromagnetic field simulation software (CST). The results will be used for optimization and fabrication of next generation ZBSD detectors, which are planned to be commissioned at THz generating FEL accelerator facilities in near future.

WE2 – Wednesday Session 2

Chair: W. Blokland (ORNL)

WE2T01 10:50 **Overview of Current and Future Platforms for Big Experiments/Different Types of Machines**

R. Beauregard *(CLS)*

Many facilities are in the process of or considering moving towards MTCA platforms for future diagnostics systems. Talk could highlight what progress has been made for various diagnostics systems such as multi-bunch feedback, BPMs and orbit feedback etc., as well as future plans. Development of firmware to support diagnostics applications. Could consider benefits and constraints in the perspective of operation of diagnostics on accelerators. Should be applicable to all types of machine; linear, circular, hadron, electron.

WE2C02 11:40 **Software Defined Radio Based Feedback System for Transverse Beam Excitation**

P.J. Niedermayer*, R.N. Geißler, R. Singh (GSI)*

Controlling stored beams in particle accelerators requires specially designed RF signals, such as needed for spill control via transverse excitation. The software-defined radio (SDR) technology is adopted as a low cost, yet highly flexible setup to generate such signals in the kHz to MHz regime. A feedback system is build using a combination of digital signal processing with GNU Radio and RF Network-on-Chip (RFNoC) on a Universal Software Radio Peripheral (USRP). The system enables digitization of signals from particle detectors and direct tuning of the produced RF waveforms via a feedback controller – implemented on a single device. To allow for triggered operation and to reduce the loop delay to a few ms, custom OOT and RFNoC blocks have been implemented. This contribution reports on the implementation and first test results with beam of the developed spill control system.

WE2C03 12:00 **Beam Instrumentation Hardware Architecture for Upgrades at the BNL Collider-Accelerator Complex and the Future Electron Ion Collider**

R.J. Michnoff*, L. DeSanto, C.M. Degen, S.H. Hafeez, R.L. Hulsart, J.P. Jamilkowski, J. Mead, K. Mernick, G. Narayan, P. Oddo, M.C. Paniccia, J.A. Pomaro, A.C. Pramberger, J.C. Renta, F. Severino (BNL) D.M. Gassner (Brookhaven National Laboratory (BNL), Electron-Ion Collider)*

Many beam instrumentation systems at Brookhaven National Laboratory's Collider-Accelerator complex are over 20 years old and in need of upgrading due to obsolete components, old technology and the desire to provide improved performance and enhanced capabilities. In addition, many new beam instrumentation systems will be developed for the future Electron Ion Collider (EIC) that will be housed in the existing Relativistic Heavy Ion Collider (RHIC) tunnel. A new BNL designed custom hardware architecture is planned for both upgrades in the existing facility and new systems for the EIC. A general-purpose carrier board based on the Xilinx Zynq Ultrascale$^+$ System-on-Chip (SoC) will interface with a family of application specific daughter cards to satisfy the requirements for each system. This paper will present the general architecture that is planned, as well as details for some of the application specific daughter cards that will be developed.

WE3 – Wednesday Session 3

Chair: L. Bobb (DLS)

WE3I01 13:30 **Gas Jet-Based Fluorescence Profile Monitor for Low Energy Electrons and High Energy Protons at LHC**

O. Sedláčˇek, *A.R. Churchman, A. Rossi, G. Schneider, C.C. Sequeiro, K. Sidorowski, R. Veness (CERN) M. Ady, M. Sameed (European Organization for Nuclear Research (CERN)) P. Forck, S. Udrea (GSI)* ***O. Sedláčˇek***, *O. Stringer, C.P. Welsch, H.D. Zhang (The University of Liverpool)* ***O. Sedláčˇek***, *O. Stringer, C.P. Welsch, H.D. Zhang (Cockcroft Institute) A. Webber-Date (Cockcroft Institute, University of Liverpool)*

The ever-developing accelerator capabilities of increasing beam intensity, e.g. for High Luminosity LHC (HL-LHC), demand novel non-invasive beam diagnostics. As a part of the HL-LHC project a Beam Gas Curtain monitor (BGC), a gas jet-based fluorescence transverse profile monitor, is being developed. The BGC uses a supersonic gas jet sheet that traverses the beam at 45° and visualizes a two-dimensional beam-induced fluorescent image. The principle of observing photons created by fluorescence makes the monitor insensitive to present electric or magnetic fields. Therefore, the monitor is well suited for high-intensity beams such as low-energy electron beam of Hollow Electron Lens (HEL), and HL-LHC proton beam, either as a profile or an overlap monitor. This talk will focus on the first gas jet measured transverse profile of the 7 keV hollow electron beam. The measurements were carried out at the Electron Beam Test Stand at CERN testing up to 5 A beam for HEL. A comparison with Optical Transition Radiation measurements shows consistency with the BGC results. The BGC installation of January 2023 at LHC is shown, including past results from distributed gas fluorescence tests.

WE3C02 14:00 **Development of a Precise 4d Emittance Meter Using Differential Slit Image Processing**

B.K. Shin, *G. Hahn (PAL) M. Chung, C.K. Sung (UNIST)*

We have developed a highly precise 4D emittance meter for X-Y coupled beams with 4D phase-space (x-x', y-y', x-y', y-x') which utilizes an L-shaped slit and employs novel analysis techniques. Our approach involves two types of slit-screen image processing to generate pepper-pot-like images with great accuracy. One which we call the "differential slit" method, was developed by our group. This approach involves combining two slit-screen images, one at position x and the other at position x + the size of the slit, to create a differential slit image. The other method we use is the "virtual pepper-pot (VPP)" method, which combines x-slit and y-slit images to produce a hole (x,y) image. By combining that hole images, we are able to take extra x-y' and y-x' phase-space. The "differential slit" method is crucial for accurately measuring emittance. Through simulations with 0.1 mm slit width using Geant4, the emittance uncertainties for a 5 nm rad and 0.2 mm size electron beam were 5% and 250% with and without the "differential slit", respectively. In this presentation, we provide a description of the methodology, the design of slit, and the results of the 4D emittance measurements.

WE3C03 14:20 **Radiation Hard Beam Profile Monitors for the North Experimental Beamlines CERN**

E. Buchanan *(European Organization for Nuclear Research (CERN)) J. Cenede, S. Deschamps, W. Devauchelle, A. Frassier, J.N.G. Kearney, R.G. Larsen, I. Ortega Ruiz (CERN)*

A new radiation hard profile monitor is being researched and developed for the North Area Beamlines at CERN. The monitor must have a spatial resolution of 1 mm or less, an active area of 20 x 20 cm, a low material budget (~0.3%) and be operational in a beam that has a maximum rate of ~$2x10^{11}$ p/s in the full energy range of 0.5 — 450 GeV/c. The current focus is the study of different detection mediums: silica optical fibres (Cherenkov radiation), glass capillaries filled with liquid scintillator, and hollow core optical fibres filled with scintillation gasses. Prototypes of the different fibre candidates have been tested with an Ultra-High Dose Rate electron beam, a low intensity hadron beam and will be tested with a high intensity hadron beam during summer 2023. The key properties to compare between the different fibres are the light yield and radiation tolerance. In parallel, the performance of the fibres is being tested for their compatibility of use for FLASH medical therapy applications.

WEP – Wednesday Poster Session

WEP001 **Non-invasive Profilers for the Cold Part of ESS Accelerator**

J. Marroncle, *P. Abbon, F. Belloni, F. Benedetti, T. Hamelin, J.-Ph. Mols, L. Scola (CEA-DRF-IRFU) B. Bolzon, N. Chauvin, D. Chirpaz-Cerbat, M. Combet, M.J. Desmons, Y. Gauthier, C. Lahonde-Hamdoun, Ph. Legou, O. Leseigneur, Y. Mariette, M. Oublaid, G. Perreu, F. Popieul, B. Pottin, Y. Sauce, J. Schwindling, F. Senée, O. Tuske (CEA-IRFU) I. Dolenc Kittelmann, A.A. Gevorgyan, H. Kocevar, R. Tarkeshian, C.A. Thomas (ESS)*

Several Non-invasive Profile Monitors are being in-stalled along the accelerator to support the commissioning, tuning and operation of the powerful proton based ESS linear accelerator. In the low energy parts of the ESS linac (3.6 MeV to 90 MeV), the residual gas pressure is high enough to measure the transverse beam profile by using fluorescence induced by the beam on the gas molecules. However, in the ESS linac sections above 90 MeV, protons are accelerated by superconductive cavities working at cryogenic temperatures and high vacuum. Therefore, the signal based on the fluorescence process is too weak, while ionization can counteract this drawback. We have provided five IPM (Ionization Profile Monitors) pairs for energies ranging from 100 to 600 MeV. The design of such monitors is challenging due to weak signal (as a result of high proton energy and low pressure $<10^{-9}$ mbar), tight space constraints inside the vacuum chamber, space charge effect, ISO-5 cleanliness requirement, and electrode polarization at ± 15 kV. This publication will detail the development we followed to fulfil the ESS requirements.

WEP002 **Study of Visible Synchrotron Radiation Monitor on SOLEIL Booster**

A. Moutardier, *G. Cauchon, M. Chevrot, Z. Fan, N. Hubert, K,S. Kubsky, M. Labat, M. Thomasset (SOLEIL)*

In the scope of SOLEIL II, the booster must also be upgraded to reduce from 130 to 5 nm·rad the emittance of the beam delivered to the ring. Control of the emittance in the booster will become crucial to ensure the nominal performance of the storage ring injection. The SOLEIL I booster is already equipped with a Visible Synchrotron Radiation Monitor (MRSV). This equipment, made of an extraction mirror and a simple optical system, was originally planned to be used only for beam presence verification but has not been used routinely for operation since the commissioning in 2005. The control and acquisition systems had to be refreshed to be usable again and allow the beam size measurement along the booster energy ramp. The extraction mirror was replaced due to unexpected degradation leading to a second spot appearing on the camera. This paper traces back the MRSV upgrades from understanding the cause of mirror degradation until mirror replacement and the first proper beam visualisation, achieved at the beginning of 2023.

WEP005 **The Incoherent Depth of Field Effect for Bean Halo Observation with Coronagraph**

T.M. Mitsuhashi, *H. Ikeda, G. Mitsuka (KEK)*

The incoherent depth-of-field due to the instantaneous opening angle of dipole SR will reduce the spatial coherence of SR in horizontal direction in the beam size measurement by using interferometry. This reduction of spatial coherence is due to both of apparent change of the beam profile due to field depth and intensity distribution in the aperture. In the case of beam profile measurement by imaging system, observed beam profile will deform and produce a beam tail in asymmetric manner by this effect. This apparent change of beam profile, especially extra beam tail in one side has certain influence for beam halo measurement using the coronagraph, because it has a large dynamic range of 6 order magnitude. Since the magnitude of asymmetric tail is proportional to bending radius, this effect is larger in large high energy physics machine which has a long bending radius. This effect is theoretically studied and compare with coronagraph measurement result of beam halo in the SuperKEKB. As a conclusion, this effect is very small and not observable in the coronagraph measurement at SuperKEKB.

WEP006 **Development of Pepper-pot Emittance Monitor for High-intensity Ion Beam Accelerated by RIKEN AVF Cyclotron**

Y. Kotaka, *N. Imai, K. Kamakura, Y. Sakemi, H. Yamaguchi (CNS) K. Hatanaka (RCNP) J. Ohnishi (RIKEN Nishina Center)*

At the Center for Nuclear Study of the University of Tokyo, the measurement of Electric Dipole Moment of Francium (Fr) is underway with the world highest precision. Fr is generated by nuclear fusion reaction by irradiating gold with oxygen ion beam accelerated by RIKEN AVF Cyclotron. The required beam intensity is 18 eμA or more. However, the average beam transport efficiency drops to be around 66 % as the beam intensity exceeds 10 eμA. To solve the problem, a pepper-pot emittance monitor (PEM) for high-intensity beams has been developed. Referencing the PEM used for the injection beams of AVF Cyclotron, we have developed three additional items. The first is reducing the radiation damage to a camera, which is placed away from the beamline. The distance between the camera and PEM is 2.2 m, and the average image position accuracy of 0.15 mm is achieved. The second is the angular accuracy suitable for the accelerated beam. The required angular accuracy is estimated to be less than 0.3 mrad. A beam test for the first and second items is planned. The third is a beam shutter system to prevent PEM from heating due to beam. The measurement time by the system reaches 0.27 seconds now.

WEP007 **Beam Profile Measurement using Helium Gas Light Emission and BEPM for Superheavy Element Search Experiment**

***T. Watanabe**, O. Kamigaito, T. Nishi, A. Uchiyama (RIKEN Nishina Center) T. Adachi, B. Brionnet, K.M. Morimoto (RIKEN) A. Kamoshida (National Instruments Japan Corporation) K. Kaneko, R. Koyama (SHI Accelerator Service Ltd.)*

The newly constructed superconducting linear accelerator (SRILAC) is now in operation with the aim of discovering new superheavy elements and advancing the production of medical radiation isotopes. Because it is crucial to extend the durability of the expensive Cm target for as long as possible, these experiments require the accelerated V beam to be sufficiently widened. To this end, a helium gas light emission monitor (HeLM) has been introduced to measure the beam profile. Because He gas flows within the target chamber, by capturing the light emitted from He gas with a CCD camera, the beam profile can be obtained nondestructively and continuously. These measurements are handled through programming in LabVIEW, with analyzed data integrated into an EPICS control system. A method to estimate the beam envelope has been recently developed by leveraging the measured quadrupole moments with beam energy position monitors (BEPMs), and incorporating calculations of the transfer matrix. The synergistic use of HeLM and BEPM plays a useful role in accurately controlling the beam size at the Cm target.

WEP009 **Emittance Measurement of RF Ion Source in CSNS**

***F. Li** (IHEP CSNS)*

The emittance reflectes the quality of the beam which is an important parameter of ion source. Oscillation of emittance and Twiss parameters in the negative ion (H-) beam is measured by application of a double-slit emittance monitor located at the RFQ entrance. The systematic error was valued in emittance measurement of CSNS RF ion source. This article mainly discussed the measurement accuracy and reliability of the double-slit emittance meter. Therefore it is shown that the working principle, mechanical disign, electronics and the application in CSNS RF ion source were introduced.

WEP011 **A Preliminary Design of Bunch-by-bunch 3D Positions Measurement**

***R.Z. Wu**, P. Lu, B.G. Sun, L.L. Tang, D.Y. Wang, Y.K. Zhao (USTC/NSRL)*

The decrease of beam emittance in the 4th generation light source greatly increases the electron density, thus the wakefields and beam impedance in the storage ring are significantly enhanced, resulting in various beam instabilities. Therefore, it is necessary to observe the transient state of beams using the bunch-by-bunch technique, so as to dig into these instabilities. Here a three-dimensional (3D) positions measurement instrument is designed based on data synchronization module (DSM) to acquire the transverse positions and longitudinal phases of beams in real-time.

WEP012 **A Compact IPM Capable of Measuring Two-Dimensional Profiles with the Constraint Magnet and Multi-channel Acquisition Electronics**

***H.M. Xie** (IMP/CAS)*

A compact IPM structure is proposed and developed for the HIAF project (High Intensity Heavy-ion Accelerator Facility), which is capable of measuring both horizontal and vertical profiles by simply changing the E-field. Its installation space is reduced to be only half comparing to that of a conventional IPM. A ceramic substrate PCB coated with copper anodes is used to collect electrons after the MCP output. A 64-channel data acquisition system based on the trans-impedance amplifier, ADC, FPGA and ARM is developed as well with a fast response of 1 MHz. To decrease the trajectory distortion during the electron collection, a bipolar magnet with a square shape is designed to correct the horizontal or vertical profile errors. In summer 2021, the compact IPM had been tested in Low Energy Accelerator Facility at IMP (LEAF, IMP) with the 0.5 MeV/u carbon beams. It obtains the profiles successfully in both directions. And the comparison between an upstream wire scanner and the IPM has also been done. Additionally, the magnet field shows a significant suppression effect during the signal collection. Despite some minor discrepancies, the beam experiments show a reasonable and good result.

WEP013 **Quality Assurance of Proton Beam Profile Using Phosphor Screen and TE-Cooled CMOS Camera**

***G.I. Jung** (Korea Atomic Energy Research Institute (KAERI)) Y.S. Hwang, Y.J. Yoon (KOMAC, KAERI)*

The KOMAC (Korea Multi-purpose Accelerator Complex) has operated 100-MeV proton linear accelerator and provide high flux proton beam at the TR103, a general purpose irradiation facility. To uniformly irradiate the sample with protons, it is important to confirm the beam profile uniformity through the quality assurance (QA) process. Recently, for real-time and in-situ proton beam profile monitoring at the TR103, P43 phosphor screen and TE-cooled CMOS camera were introduced and tested. The camera captured images of the emitted light as protons with energy of 15, 42, 100 MeV were incident. A software for selecting beam profile image and post-processing of image data such as background subtraction, image smoothing, geometrical correction, selecting Region Of Interest (ROI) and X-Y coordination was developed using Python. Measured beam profiles using phosphor screen and cooled camera were compared to Gafchromic film. The linearity between light output and beam flux were measured. In this study, we will discuss the test results of proton beam profile measurement using phosphor screen and TE-cooled CMOS camera for introduction to quality assurance process at the TR103.

WEP014 **Measuring Electromagnet Polarity Using Magnetic Remanence**

K.P. Wootton *(ANL)*

Large accelerator systems typically include many individually powered electromagnets. An important activity prior to commissioning with beam is verifying that the polarity of the installed magnets matches the design lattice. In the present work, we motivate the measurement of magnet polarity in a manner that is electrically safe, by measuring the magnetic remanence of iron yokes of normal conducting electromagnets. This has been used to confirm the polarities of iron-dominated dipole and quadrupole electromagnets at the Linac Extension Area at the Advanced Photon Source.

WEP015 **Synchrotron Light Monitor for the Advanced Photon Source Booster Synchrotron**

K.P. Wootton*, W. Berg, W.P. Burns III, J.R. Calvey, J.C. Dooling, L. Erwin, A.H. Lumpkin, N. Sereno, S.E. Shoaf, S.G. Wang (ANL)*

A new synchrotron light monitor has been tested for the booster synchrotron of the Advanced Photon Source. Visible light synchrotron radiation is collected by a mirror on a path tangential to the electron beam orbit, and directed to an optical imaging system and camera. This is planned to be a non-intercepting, transverse beam-size monitor even with the higher stored beam charges ($\sim$17 nC) needed for the Advanced Photon Source Upgrade. In the present work, we describe the present synchrotron radiation diagnostic layout. An analysis of the synchrotron radiation power on the mirror, the optical layout with components, and features of the control system will be presented.

WEP016 **Beamline for Time Domain Photon Diagnostics at the Advanced Photon Source Upgrade**

K.P. Wootton*, W.X. Cheng, G. Decker, N. Sereno, F. Westferro (ANL)*

Time domain photon diagnostics are proposed for electron beam characterisation and operation of the Advanced Photon Source Upgrade storage ring. In the present work, we present updated status on the time-domain X-ray and visible photon diagnostic beamline for the Advanced Photon Source Upgrade. We outline design influences leading to the proposed beamline layout, in particular long-term maintenance and commonality with other beamlines at the Advanced Photon Source.

WEP017 **Electron Beam at the Advanced Photon Source Linac Extension Area Beamline**

K.P. Wootton*, W. Berg, M. Borland, A.R. Brill, J.M. Byrd, S. Chitra, J.T. Collins, J.C. Dooling, J.N. Edwards, L. Erwin, G.I. Fystro, T. Grabinski, M.J. Henry, E.E. Heyeck, J.E. Hoyt, S.H. Lee, J. Lenner, I. Lobach, A.H. Lumpkin, A. Puttkammer, V. Sajaev, N. Sereno, Y. Sun, J. Wang, S.G. Wang, A. Zholents (ANL)*

The Linac Extension Area has been developed into a beamline area for testing accelerator components and techniques. Beginning commissioning activities in February 2023, we have delivered the first electron beam to the Linac Extension Area at the Advanced Photon Source at 425 MeV. In the present work, we outline the stages of re-commissioning the electron beamline. We summarise measurements of the electron beam transport through the accelerator. We outline scenarios used to verify the adequacy of radiation shielding of the beamline, and measured shielding performance.

WEP018 **Simulation of Oscillating Arm Wire Monitor Mechanics Driven by a Stepper Motor**

R. Dölling *(PSI)*

The present oscillating arm wire monitors at HIPA operate with wire speeds of 0.75 m/s. Based on basic dynamic simulations of mechanics and motor, we discuss possible variants of this design using stepper motors in open loop control. The results suggest that 4 m/s can be reached with sufficient position resolution, when using a predefined step sequence customized to the mechanics. This speed should be sufficient to measure the full proton beam current in the injection line.

WEP019 **Study of Single Wire Scanner Monitor for FETS-FFA Test Ring**

E. Yamakawa*, S. Machida, A. Pertica, D.W. Posthuma de Boer (STFC/RAL/ISIS) Y. Ishi (Kyoto University, Research Reactor Institute) A.P. Letchford (STFC/RAL) T. Uesugi (Kyoto University, Institute for Integrated Radiation and Nuclear Science)*

To confirm the use of Fixed Field Alternating gradient accelerator (FFA) as a high power pulsed neutron spallation source, a prototype called FETS-FFA is studied at Rutherford Laboratory (RAL). A single Wire Scanner Monitor (WSM) is planned to be used to measure a beam position and a beam profile in the ring. One of the concerns of this monitor is the thermal damage on the Carbon Nano Tube (CNT) wire due to high energy deposition of low energy proton beam in FETS-FFA (3 - 12 MeV). Furthermore, to measure a beam profile during beam acceleration in the ring, a diameter of CNT wire needs to be smaller than the orbit displacements in turns. To confirm whether a single WSM is suitable for FETS-FFA ring, two different beam tests were performed at RAL and at the Institute for Integrated Radiation and Nuclear Science, Kyoto University (KURNS). Both measurements demonstrated that the single WSM is applicable for FETS-FFA ring if the diameter of CNT is smaller than the orbit separation in turns. In this paper, the detail of the design study of the single WSM as well as the performance tests are presented.

WEP020 **Performance Evaluation of GAGG+ and Tungsten Carbide Blades in an X-ray Pinhole Camera**

S.B. Burholt*, L. Bobb, N. Vitoratou (DLS)*

At Diamond Light Source two X-ray pinhole cameras are used to measure the transverse profile of the 3 GeV electron beam. The current pinhole assembly is formed using tungsten blades with chemically etched shims to produce a 25 µm x 25 µm aperture and the imager incorporates a 0.2 mm LuAG:Ce scintillator. Tungsten carbide is a machinable high-Z material which at millimetre thicknesses is opaque to X-rays. With a slight change in pinhole design, similar to that already in place at the ESRF, tungsten carbide blades could offer a well-controlled aperture size for the pinhole camera with simpler assembly. Further to this, improvements to the photon yield of scintillators mean that the new scintillator GAGG+ has an almost two fold increase in yield compared to the current LuAG: Ce scintillator. An evaluation of the tungsten carbide blades and GAGG+ scintillator is presented.

WEP021 **100Hz X-ray Beam Profile Measurements from a Transmissive CVD Diamond Detector**
C. Bloomer, *L. Bobb (DLS) M.E. Newton (University of Warwick)*
A non-destructive CVD diamond X-ray beam imaging monitor has been developed for synchrotron beamlines. The device can be permanently installed in the X-ray beam path and is capable of transmissively imag- ing the beam profile at 100 frames per second. The response of this transmissive detector at this imaging rate is compared to synchronously acquired images using a destructive fluorescent screen. It is shown that beam position, size, and intensity measurements can be obtained with minimal disturbance to the transmit- ted X-ray beam. This functionality is beneficial to synchrotron beamlines as it enables them to monitor the X-ray beam focal size and position in real-time, during user experiments. This is a key enabling technology that would enable live beam size feedback, keeping the beamline's focusing optics optimised at all times. Ground vibrations (10-20Hz) can cause movement of focusing optics and beamline mirrors, which disturb the X-ray beam and reduce the ultimate quality of the sample-point beam. This instrument can detect this beam motion, enabling the source to be more easily determined and mitigations to be put in place.

WEP022 **Target Multiwire for the Fermilab Booster Neutrino Beamline**
R.M. Prokop *(Fermilab)*
The Booster Neutrino Beamline experiment requested a new secondary electron emission multiwire profile monitor installation. The device had to be durable in high radiation conditions and mounted within a large 10 foot airtight steel fixture for installation near the beam target. Previous iterations of multiwire suffered radiation damage to both the connectors and wires. To ensure accurate horizontal and vertical beam profile measurements, an updated design was proposed, designed, and constructed. The new BNB multiwire utilizes 3 mil diameter gold-plated tungsten sense wires soldered to vertical and horizontal Alumina-96 ceramic planes, 50 wires per plane. Radiation hard Kapton insulated 30 gauge wires carry the output signals. Profiles are readout through charge integrator scanner electronics. This paper will detail the design and functionality of the BNB target multiwire and present relevant beam profile data.

WEP023 **Progress on an Electron Beam Profile Monitor at the Fermilab Main Injector**
R.M. Thurman-Keup, *T.F. Folan, M.W. Mwaniki, S. Sas-Pawlik (Fermilab)*
The current program at Fermilab involves the construction of a new superconducting linear accelerator (LINAC) to replace the existing warm version. The new LINAC, together with other planned improvements, is in support of proton beam intensities in the Main Injector (MI) that will exceed 2 MW. Measuring the transverse profiles of these high intensity beams in a ring requires non-invasive techniques. The MI uses ionization profile monitors as its only profile system. An alternative technique involves measuring the deflection of a probe beam of electrons with a trajectory perpendicular to the proton beam. This type of device was installed in MI and initial studies of it have been previously presented. This paper will present the status and recent studies of the device utilizing different techniques.

WEP024 **A Simulation of the Photoionization of H^- Together With the Subsequent Tracking of the Liberated Electrons**
R.M. Thurman-Keup, *M. El Baz, V.E. Scarpine (Fermilab)*
The Proton Improvement Plan - II (PIP-II) is a new linear accelerator (LINAC) complex being built at Fermilab. It is based on superconducting radiofrequency cavities and will accelerate H^- ions to 800 MeV kinetic energy before injection into the existing Booster ring. Measurements of the profile of the beam along the LINAC must be done by non-intercepting methods due to the superconducting cavities. The method chosen is photoionization of a small number of H^- by a focused infrared laser, aka laserwire. The number of ionized electrons is measured as a function of laser position within the H^- beam. To aid in the design of the collection mechanism, a simulation was written in MATLAB with input from the commercial electromagnetic simulation, CST. This simulation calculates the number and positions of the liberated electrons and tracks them through the magnetic collection and H^- beam fields to the collection point. Results from this simulation for various points along the LINAC will be shown.

WEP025 **A Study of the Gain of Microchannel Plates in the Ionization Profile Monitors at Fermilab**
R.M. Thurman-Keup, *C.E. Lundberg, D. Slimmer, J.R. Zagel (Fermilab)*
One of the on-going issues with the use of microchannel plates (MCP) in the ionization profile monitors (IPM) at Fermilab is the significant decrease in gain over time. There are several possible issues that can cause this. Historically, the assumption has been that this is aging, where the secondary emission yield (SEY) of the pore surface changes after some amount of extracted charge. Recent literature searches have brought to light the possibility that this is an initial 'scrubbing' effect whereby adsorbed gasses are removed from the MCP pores by the removal of charge from the MCP. This paper discusses the results of studies conducted on the IPMs in the Main Injector at Fermilab.

WEP027 **Status of Gas Sheet Monitor for Profile Measurements at FRIB**

***A. Lokey**, S.M. Lidia (FRIB)*

We report on the status of work on a non-invasive profile monitor under development for use at the Facility for Rare Isotope Beams (FRIB), a heavy-ion LINAC which produces high-intensity, multi-charge state beams. The measurement will be made by collecting photons generated at the interaction point of the beam and a collimated molecular gas curtain. These photons will be collected with an intensified camera system, generating a two dimensional image and allowing for measurements of profile, beam halo, and other properties more prevalent at specific locations of interest, such as charge state spread after folding segment bends. Included will be ongoing design specifications, simulation results, and discussion of measurement techniques for acquiring signal from the device.

WEP028 **LANSCE High Density Emittance Instrumentation System**

***L.S. Montoya**, S.A. Baily, S.M. Johnson, H.L. Leffler, H.A. Watkins, D.D. Zimmermann (LANL)*

The Los Alamos Neutron Science Center (LANSCE) is currently upgrading the existing emittance stations with a high-density instrumentation system for emittance measurements in the low energy beam transport region. Emittance measurements were obtained using obsolete legacy equipment. For motion control a switching station with a mechanical mux to switch actuators was used. This caused a single point of failure for all emittance stations and is becoming increasingly unreliable. For data acquisition, two sets of signal conditioning and digitizers were employed and had to be shared between 7 emittance stations. Physical cable swapping was necessary when taking measurements from station to station. A system was developed using dedicated Quad Actuator Controller (QAC) chassis, capable of driving four (4) actuators, and dedicated data acquisition (DAQ) chassis capable of signal conditioning and digitizing up to 80 channels simultane- ously. Details of the system development are presented.

WEP029 **LANSCE QAC/DAQ Wire Scanner Instrumentation Upgrade**

***L.S. Montoya**, S.M. Johnson, H.A. Watkins, D.D. Zimmermann (LANL)*

High density instrumentation has been developed to upgrade wire scanner beam diagnostic capability in all areas downstream of the Coupled Cavity LINAC (CCL). Transverse beam profile measurements were originally obtained using legacy electronics known as Computer Automated Measurement and Control (CAMAC) crates. CAMAC has become obsolete, and a new wire scanner diagnostic system was developed as a replacement. With high wire scanner device density located in each area, instrumentation was developed to meet that need along with the ability to interface with legacy open-loop controlled actuators and be forward compatible with upgraded closed-loop systems. A high-density system was developed using a Quad Actuator Controller (QAC) and Data Acquisition (DAQ) chassis that pair together using a sequencer when taking measurements. Software improvements were also made, allowing for full waveform functionality that was previously unavailable. Deployment of 52 wire scanner locations in 2022 increased device availability and functionality across the facility. Hardware and software design details along with results from accelerator beam measurements are presented.

WEP030 **First Results for a 50 MeV Beam Induced Fluorescence Monitor for Beam Profile Measurements**

***G.B. Rosenthal**, J.I. Anderson, A. Cao, E. Cramer, G. Gordon, K. Kuhn, O.O. Ledezma Vazquez, J. Lopez, S. Lynam, J.B. Ringuette, L. Szeto, J. Zhou (Nusano) B. Bob, E.F. Dorman, R.C. Emery (University of Washington Medical Center)*

Nusano is developing a 50 MeV alpha (4He++) particle accelerator, primarily to produce medical radionuclides. The accelerator produces an average current of 3 mAe with 20 mAe average macro pulse current. This results in an average beam power of 75 kW, and an average beam power within the macro pulse of 500 kW. The beam profile at the exit of the DTL is approximately gaussian with a diameter (FWHM) of about 3 mm. Designing diagnostics for this beam is challenging, as any diagnostics that intercept beam will receive a very high heat load. A BIFM (Beam Induced Fluorescence Monitor) is being developed to measure beam profiles. Nitrogen gas is leaked into the beamline. Excitation of the nitrogen by beam particles is captured using an image intensifier. The signal generated is directly proportional to the beam current. A prototype system has been constructed and tested on a lower intensity alpha beam. First results indicate we can measure beam profile to a 100 µm accuracy. Production system is currently being designed.

WEP031 **Image Acquisition System for the Injection Dump at the Spallation Neutron Source**

***W. Blokland** (ORNL) N.J. Evans, A.R. Oguz, W.D. Willis (ORNL RAD)*

We describe the Image Acquisition system for the Injection Dump. This system visualizes the different beamlets, on the vacuum window after the H^- beam is stripped of its electrons by two stripper foils. One beamlet is from H^- with its electrons stripped by the first foil and the second beamlet has it final electron stripped by the second foil. We used the PXI platform to implement the data-acquisition including timing decoder. We describe the hardware and software for the system. We use a standard non-radhard GigE camera to acquire the image from the luminescent coating on the dump vacuum window. To lower the radiation damage to the camera, we shield it with stainless steel blocks. We present radiation measurements before and after shielding. We also show the radiation damage over time to estimate the camera's lifetime.

WEP033 **A Schottky Tune Meter for the Fermilab Mu2E Delivery Ring**

***V.E. Scarpine**, B.J. Fellenz, A. Semenov, D. Slimmer (Fermilab)*

The Mu2E experiment will measure the ratio of the rate of the neutrinoless, coherent conversion of muons into electrons as a measure of Charged Lepton Flavor Violation. As part of the Mu2E experiment, a proton storage ring, called the Delivery Ring, will utilize resonant extraction to slow-spill protons to the experiment. To regulate and optimize the Delivery Ring resonant extraction process, a fast tune measurement scheme will be required. This Mu2E tune meter will measure the average tune and the tune spectrum, in multiple time slices, through the entire resonant extraction cycle of nominally 43 msec. The Mu2E tune meter utilizes vertical and horizontal 21.4 MHz Schottky detector resonant pickups, taken from the decommissioned Tevatron, as well as its receiver electronics. This paper will present the design of this Schottky tune meter as well as tune measurements from the Mu2E Delivery Ring.

WEP034 **Effect of Longitudinal Beam-Coupling Impedance on the Schottky Spectrum of Bunched Beams**

***C. Lannoy**, D. Alves, K. Łasocha, N. Mounet (CERN) **C. Lannoy**, T. Pieloni (EPFL)*

Schottky spectra can be strongly affected by collective effects, in particular those arising from beam-coupling impedance when a large number of bunch charges are involved. In such conditions, the direct interpretation of the measured spectra becomes difficult, which prevents the extraction of beam and machine parameters in the same way as is usually done for lower bunch charges. Since no theory is yet directly applicable to predict the impact of impedance on such spectra, we use here time-domain, macro-particle simulations and apply a semi-analytical method to compute the Schottky spectrum for various machine and beam conditions, such as the ones found at the Large Hadron Collider. A simple longitudinal resonator-like impedance model is introduced in the simulations and its effect studied in different configurations, allowing preliminary interpretations of the impact of longitudinal impedance on Schottky spectra.

WEP035 **Statistical Properties of Schottky Spectra**

***C. Lannoy**, D. Alves, K. Łasocha, N. Mounet (CERN) **C. Lannoy**, T. Pieloni (EPFL)*

Schottky signals are used for non-invasive beam diagnostics as they contain information on various beam and machine parameters. The instantaneous Schottky signal is, however, only a single realisation of a random process, implicitly depending on the discrete distribution of synchrotron and betatron amplitudes and phases among the particles. To estimate the expected value of the Schottky power spectrum, and reveal the inner structure of the Bessel satellites described by the theory, the averaging of instantaneous Schottky spec- tra is required. This study describes this procedure quantitatively by analysing the statistical properties of the Schottky signals, including the expected value and variance of Schottky power spectra. Furthermore, we investigate how these quantities evolve with the number of particles in the bunch, the observed harmonic of the revolution frequency, the distribution of synchrotron oscillation amplitudes, and the bunch profile. The theoretical findings are compared against macro-particle simulations as well as Monte Carlo computations.

WEP036 **Non-destructive BPM-Based Energy Measurement of the CLS Linac**

***H. Shaker**, A. Bertwistle, E.J. Ericson, Y. Yousefi Sigari (CLS) E. Soltan, Y. Yousefi Sigari (University of Saskatchewan)*

There is a plan in the Canadian Light Source (CLS) to replace the current Linac with a new one from Research Instruments GmbH in mid-2024. The first straight section of LTB (Linac-To-Booster) was upgraded to have two BPMs with a 4.79m drift between them, and two phosphor screens were replaced by YAG screens. A new BPM and a YAG-based screen station upgraded the following 90-degree achromat beamline. These upgrades help us to measure the current and future Linac beam parameters, including the beam twiss parameters, energy, and energy spread. In this paper, we discussed how we could use these three BPMs for non-destructive energy measurement, which will be a part of the active energy correction system.

WEP037 **Design and Simulation of the High-Sensitivity Tune Measurement System Based on Diode Detection at HIAF**

***N.Y. Na**, L.F. Lin, Z.S. Zhang (SCNU) Y.Y. Wang, Y.L. Yang, Z.L. Zhao, G. Zhu (IMP/CAS)*

A high-sensitivity tune measurement system have been developed for the Booster Ring (BRing) and Spectrometer Ring (SRing) of the High-Intensity heavy-ion Accelerator Facility (HIAF). The beam signal induced by the BPM bipolar plate is amplified by the measurement system via a preamplifier, and then fed through the direct diode detection circuit to the spectrometer for Fourier analysis to calculate the tune fraction. Simulation results show a signal-to-noise ratio of approximately 50 dB without beam excitation. The new system is more sensitive to the detection of tuned fractions than conventional electronic storage ring tuning measurement systems and is simple and does not require beam excitation. This paper presents the design of HIAF tune measurement system, especially on front-end electronics design and the simulation results.

WEP038 **Development of the Prototype for Measuring Beam Position and Orbit Tilt Based on Cavity BPM for the SHINE**

***J. Chen**, F.Z. Chen (SSRF) S.S. Cao (SARI-CAS) Y.B. Leng (USTC/NSRL)*

In recent decades, the high-gain free-electron lasers (FELs) based on linear accelerator has been successfully developed around the world. Advanced beam diagnostics and feedback technology is one of the key factors to further improve the performance of such facilities. Both the beam position deviation and orbit tilt will weaken the interaction between electron beam and photon beam in the undulator, and affected the FEL radiation performance severely. According to the physical requirements of the SHINE, this paper proposes a method based on the measurement results of a single cavity BPM, which can simultaneously achieve the in-suit measurement of beam position deviation and orbit tilt, thus opening up a new way to improve the efficiency of FEL radiation. The working principle, the development of the verification prototype and the preliminary beam experiments will also be presented in this paper. Under the bunch charge of 100 pC, the beam experiment results show that the prototype has a resolution of better than 13.3 µrad for the beam orbit tilt measurement, which can be applied to the SHINE after optimization.

WEP039 **Operation Performance Evaluation of Accelerator Based on Cluster Analysis of Bunch-by-Bunch Diagnostic Data**

***X. Yang** (SINAP) Y.B. Leng (USTC/NSRL) Y.M. Zhou (SARI-CAS)*

In order to improve the operating performance of the particle accelerator, it is better to develop a toolkits to monitor and analyze the sub-health state of the facility in addition to ensuring the stability of basic parameters such as beam current, life, transverse size, longitudinal length and orbit. The 3D bunch-by-bunch position measurement system combined with cluster analysis is a feasible solution for this requirement. HOTCAP is a general solution, which is based on high-speed oscilloscope and developed by SSRF, can deliver charge and absolute 3D position information bunch-by-bunch. Clustering analysis is a method for multidimensional data with complex structure. The data can be aggregated and discover the dependencies between data items. After the SSRF bunch-by-bunch measurement system is put into operation, the data of injection and steady-state operation are continuously accumulated. From it, many information including 3D positions, 3D tunes, filling pattern, refilled charge and the 3D damping times can be extracted. In this paper, based on the operational data of SSRF and the cluster analysis, operational status of the storage ring and injector is evaluated.

WEP042 **Implementation of Transimpedance Analog Front-End (AFE) Card for Los Alamos Neutron Science Center (LANSCE) Accelerator Wire Scanners**

***D. Rai**, S.A. Baily, A.J. Braido, J.I. Duran, L.S. Kennel, H.L. Leffler, D. Martinez, L.S. Montoya, D.D. Zimmermann (LANL)*

The Los Alamos Neutron Science Center's (LANSCE) Accelerator Operations and Technology division group executed a project that implemented a new analog front-end card (AFE) for their wire scanner's Data Acquisition (DAQ) system. The AFE accommodates the signal amplification and noise reduction needed to acquire essential measurement data for beam diagnostics for the LANSCE accelerator. Wire Scanners are electro-mechanical beam interceptive devices that provide cross-sectional beam profile measurement data fitted to a Gaussian distribution that provides beam shape and position information. The beam operators use the beam shape and position information to adjust parameters such as acceleration, steering and focus on delivering an optimized beam to all targets. The project implemented software and hardware that eliminated the dependency on legacy systems and consolidated various AFE designs for diagnostics systems into a single design with 11 gain settings ranging from 100nA to 40mA at 10V full scale to accommodate future applications on other diagnostic systems.

WEP043 **New Picosecond Timing System for the ELBE Accelerator**

***M. Kuntzsch**, M. Justus, A. Schwarz, K. Zenker (HZDR) L. Krmpotic´, U. Legat, Ž. Oven, L. Perusko, U. Rojec (Cosylab)*

The CW electron accelerator ELBE is in operation for more than two decades. The timing system has been patched several times in order to meet changing requirements. In 2019 the development of a new timing system based on Micro Research Finland Hardware has been started which is designed to unify the heterogeneous structure and to replace obsolete components. In spring 2023 the development of the software has been accomplished, which included the mapping of operation mode and different complex beam patterns onto the capabilities of the commercial platform. The system generates complex beam patterns from single pulse, to macro pulse and 26 MHz cw operation including special triggers for diagnostics and machine subsystems. The contribution will describe the path from requirements to development and commissioning of the new timing system at ELBE.

WEP044 **Key Factors and Drivers for Utilizing Machine Learning in Experimental Data Analysis: A Case Study of Synchrotron Experimental Data**

A. Khaleghi, *M. Akbari (ILSF) , H.H. Haedar, K. Mahmoudi (IKIU)*

Concurrently with the application of AI and Machin learning (ML), their remarkable influences are being observed. This study reviews the use of ML in analyzing experimental data, focusing on synchrotron data. It explores key factors and drivers shaping the application of ML in this context. The research model employs a forward-looking approach, aiming to advance ML in experimental data analysis. The study addresses challenges unique to synchrotron data, such as high dimensionality, complexity, large volume, noise, and uncertainty. Advanced techniques like dimensionality reduction, pattern recognition, anomaly detection, and predictive modeling are introduced as novel approaches. Results highlight the potential of ML in improving performance and obtaining more accurate outcomes in synchrotron data analysis. In conclusion, this research offers valuable insights and proposes strategies to enhance the analysis of synchrotron experimental data using ML. Identified drivers and research trends benefit synchrotron analysis and other scientific disciplines. The discussion explores broader implications and future directions for utilizing ML in experimental data analysis.

WEP045 **Harnessing the Power of Emerging Technologies: Data Science and Synchrotron Advancing Scientific Discoveries**

A. Khaleghi, *M. Akbari (ILSF) H.H. Haedar, K. Mahmoudi (IKIU)*

This research review explores the impact of data science and synchrotron technology as emerging technologies in scientific research. The research model begins with an overview of the significance of data science and synchrotron technology in advancing scientific discoveries. The research methodology involves a comprehensive analysis of interdisciplinary applications in materials science, structural biology, and environmental science. By employing data science techniques, including machine learning and statistical modeling, researchers can effectively analyze the complex datasets generated by synchrotron facilities. The results obtained from this integration showcase accelerated scientific discoveries and the emergence of new phenomena. The research concludes with a discussion on the challenges related to data quality and accessibility to synchrotron facilities, while also highlighting future advancements and emerging trends in data science and synchrotron technology. This research review underscores the transformative impact of these emerging technologies and their potential to reshape the landscape of scientific research.

WEP046 **Progress on Distributed Image Analysis from Digital Cameras at ELSA using the RabbitMQ Message Broker**

D. Proft, *K. Desch, T.J. Gereons, S. Kronenberg, A. Spreitzer, M.T. Switka (ELSA)*

In the course of modernization of camera based imaging and image analysis for accelerator hardware and beam control at the ELSA facility, a distributed image processing approach was implemented, called FGrabbit. We utilize the RabbitMQ message broker to share the high data throughput from image acquisition, processing, analysis, display and storage between different work stations to achieve an optimum efficacy of the involved hardware. Re-calibration of already deployed beam profile monitors using machine vision algorithms allow us to perform qualitative beam photometry measurements to obtain beam sizes and dynamics with good precision. We describe the robustness of the calibration, image acquisition and processing and present the architecture and applications, such as the programming- and web-interface for machine operators and developers.

WEP047 **Development of Beam Monitoring Pixel Sensor and High Speed X-Ray Detector Based on 56000 Frames Per Second Readout Chip**

Y. Nakaye *(Rejected)*

It has been more than ten years since HPAD (Hybrid Pixel Array Detectors) had been widely utilized as X-ray diffraction and imaging detectors. Due to limitations of the fabrication process, most HPADs are made with monolithic sensor and tiled readout ICs. In conventional HPAD, there were so-called 'inter-chip pixels' on the edges of readout ICs. These inter-chip pixels have 1.5 times or even wider width and/or height than non-inter-chip pixels. We have successfully dealt with this inter-chip pixel problem by use of re-distribution layer on the Silicon sensor. So, in our new detector, non-uniformity in a single sensor module is eliminated. This new detector is designed based on UFXC32k IC designed by AGH University of Science and Technology and named XSPA Detector Series. XSPA Series are aiming not only for X-ray imaging but also for time-resolved X- ray measurements. Thanks to its high count-rate and fast operation capability combined with our high data throughput backend circuits, XSPA Series are capable of up to 56 kfps full-frame operation. We are working on beam position and intensity monitor based on the XSPA Series. Results from its preliminary tests will be presented.

14-Sep-23 09:00 – 10:20	Plenary

TH1 – Thursday Session 1

Chair: V.E. Scarpine (Fermilab)

TH1I01 09:00 **LCLS-II Timing System and Synchronous Bunch Data Acquisition**

P. Krejcik, *C. Bianchini Mattison*, *M. Weaver (SLAC)*

The new timing system for the LCLS-II SC linac and FEL meets the challenging requirements for delivering multiple interleaved timing patterns to a number of different destinations at rates up to 1 MHz. The timing patterns also carry information on bunch charge and beam energy to prevent inadvertent selection of beam dumps beyond their rated beam power. Beamline instruments are equipped with a timing receiver that performs bunch-by-bunch synchronous data acquisition based on the timing pattern for that location. Data is buffered in on-board memory for up to 10^6 machine pulses (1 second at 1 MHz). The large data volume can be locally processed and and analysed before transmission to clients on the network. Commissioning and experience with the new system will be presented.

TH1I02 09:30 **A Novel Cavity BPM Electronics for SHINE Based on RF Direct Sampling and Processing**

L.W. Lai *(SARI-CAS)*

A few years ago, the research of RF direct sampling and processing on beam diagnostics began for SHINE. For the first time, we developed a C band direct RF sampling beam signal processor as new technology exploration. The processor consisting of four channels of 9GHz bandwidth 2.6GSPS ADCs and a SoC FPGA. A novel cavity BPM electronics based on the processor is built and tested on SXFEL, and no frequency synthesizer and mixing modules are needed, which is unlike the typical heterodyne receiver structure. The amplitude relative error is about 7×10^{-4} which is better than the required 1×10^{-3} on cavity BPM system. This is just the first application, and more potential beam diagnostic applications based on the processor will be carried out to obtain more meaningful measurements, including stripline BPM, cold button BPM on FEL and button BPM on storage ring.

TH1C03 10:00 **The Development of a 128-Channel Ultra-Low Noise Trans-Impedance Amplifier System**

W. Tian *(IMP/CAS)*

A new 128-channel readout electronics system is designed for the bunch-by-bunch profile measurement of High-Intensity Heavy-ion Accelerator Facility (HIAF), and Booster Ring (BRing). This system consists of 128 ultra-low noise analog front-ends (AFE), 16 8-channel 60 Msps simultaneous sampling analog-digital conversions (ADC), 8 Kintex-7 field-programmable gate arrays (FPGA), and a Zynq FPGA. It is capable of monitoring weak current signals of 50 nA-50 uA with an analog bandwidth of 10 MHz. The Kintex-7 FPGA is an intermediate buffer stage, designed to decode the ADC's serial output data, and to perform digital signal processing algorithms. Finally, the Zynq FPGA performs data aggregation, beam profile fitting, and data interaction with the host computer. During offline tests, the effective number of bits (ENOB) is better than 12 bits, and the nonlinearity is less than 0.2% on a full scale. Finally, the system is deployed for the beam profile measurement. The obtained peak value shows a good proportionality with the beam intensity increment, and all the electronics' properties achieve reasonable and excellent performance.

14-Sep-23 10:50 – 12:30	Plenary

TH2 – Thursday Session 2

Chair: P. Forck (GSI)

TH2I01 10:50 **6D and High Dynamic Range Measurements of Hadron Beam Phase-Space**

A.V. Aleksandrov *(ORNL)*

Over last several years, the SNS Beam Instrumentation Group has made significant progress in developing instrumentation to measure and characterize hadron beam distribution with accuracy and resolution sufficient for model-based understanding and mitigation of beam loss in high power hadron linacs. This includes measurement of the beam distribution in high dimensional phase-space to provide realistic initial conditions for particle tracking, and high dynamic range to measure the beam halo. This presentation will describe the latest results from the SNS Beam test facility: measurement of the 6-dimensional phase space with dynamic range sufficient to reveal features not previously observed; 2-dimensional phase-space measurements with 10^6 dynamic showing emergence of the beam halo; and, in between, the 5-dimensional measurements with sufficient dynamic range and resolution to generate realistic distribution of 10-100 million particles for tracing codes.

TH2C02 11:20 **Machine Learning-Assisted Beam Operation at SuperKEKB and Linac at KEK**

G. Mitsuka*, N. Iida, S.K. Kato, T. Natsui, M. Satoh (KEK)*

Hundreds to thousands of tuning parameters must be optimized for each operating condition to obtain the best performance from an accelerator. In the past, experts made decisions based on their experience on which tuning parameters contributed the most to the performance and adjusted them sequentially. On the other hand, accelerator tuning approaches based on machine learning, which has become much easier to handle, have been studied intensively in recent years. We have been developing a beam-tuning tool based on Bayesian optimization for boosting the SuperKEKB accelerator. In this presentation, we will report on the latest status of the beam test of the positron-beam-yield maximization and dispersion tuning at the KEK injector as the first development step.

TH2C03 11:40 **Analysis of the Transverse Schottky Signals in the LHC**

K. Łasocha*, D. Alves (CERN)*

Schottky-based diagnostics are remarkably useful tools for the non-invasive monitoring of hadron beam and machine characteristics such as the betatron tune and the chromaticity. In this contribution recent developments in the analysis of the transverse Schottky signals measured at the Large Hadron Collider will be reported. A fitting-based technique, where the measured spectra are iteratively compared with theoretical predictions, will be presented and benchmarked with respect to the previously known methods and alternative diagnostic.

TH2I04 12:00 **Invitation to IBIC 2024**

J.H. Yue *(IHEP)*

The Organizing Committee of the next IBIC conference invites everybody to Beijing, China to attend the 13th International Beam Instrumentation Conference.

TH2I05 12:10 **Closing of IBIC 2023**

T. Batten *(CLS)*

Summary and closing of 12th International Beam Instrumentation Conference.

Boldface papercodes indicate primary authors

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