IBIC 2021

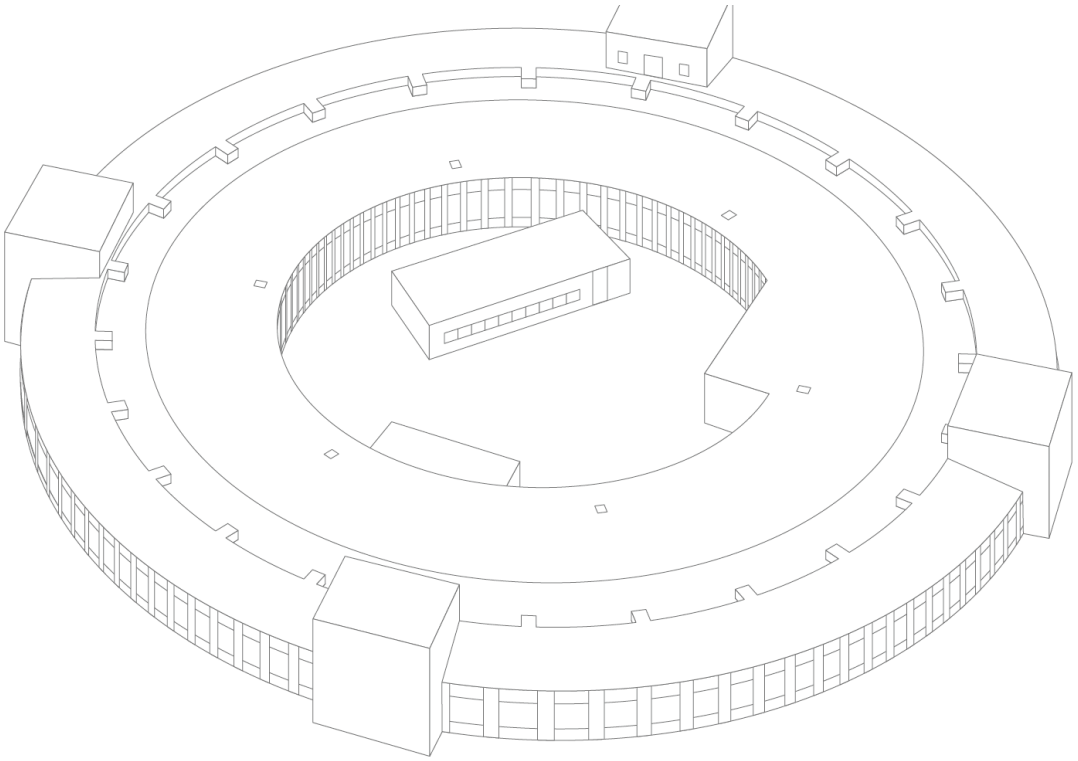
POHANG ACCELERATOR LABORATORY
Korea Atomic Energy Research Institute
RAON

International Beam Instrumentation Conference

13-17, Sep., 2021
Virtual Conference

Abstract Booklet

pal.postech.ac.kr/ibic2021



The electronic version of this booklet can be found at:
https://pal.postech.ac.kr/ibic2021

The open-source LaTeX template is available at
`https://github.com/maximelucas/AMCOS_booklet`

Contents

About

Welcome

On behalf of the organizing committee, I am pleased to welcome you to a virtual conference for the 10th International Beam Instrumentation Conference (IBIC 2021).

IBIC is a fruitful and successful gathering of the world's beam instrumentation community and it reflects the maturity of international collaboration in the field of beam instrumentation for accelerators. IBIC is dedicated to exploring the physics and engineering challenges of beam diagnostic and measurement techniques for particle accelerators worldwide. The conference program will include tutorials on selected topics, invited and selected talks, as well as poster sessions.

IBIC 2018 is hosted by the PAL, which is operating two large scale facilities: PLS-II and PAL-XFEL. PLS-II is the first 3rd generation synchrotron radiation facility in Korea, providing more than 4,800 hours of beam time per year. PAL-XFEL is the fourth hard X-Ray free-electron laser user facility in the world which was opened to the user in 2017.

We warmly welcome you to make part of IBIC 2021 and look forward to seeing you online.

Changbum Kim,
IBIC 21 Conference Chair

Scientific Program Committee

Adriana Wawrzyniak (Solaris)
David Gassner (BNL)
Jonah Weber (LBNL)
Kenichirou Satou (J-PARK)
Mario Ferianis (Elettra)
Patrick Krejcik (SLAC)
Thibaut Lefevre (CERN)
Victor Scarpine (FNAL)
Yongbin Leng (SSRF/SARI)
Changbum Kim (PAL)
Garam Hahn (PAL)
Junhui Yue (IHEP)
Kevin Jordan (JLab)
Nicholas Sereno (ANL)
Prapong Klysubun (SLRI)
Thomas Shea (ESS)
Volker Schlott (PSI)
Daniel Tavares (LNLS)
Hirokazu Maesaka (SPring-8)
Kay Wittenburg (DESY)
Lorraine Bobb (Diamond)
Nicolas Hubert (Soleil)
Steven Lidia (FRIB)
Ubaldo Iriso (ALBA)
Willem Blokland (ORNL)

Local Organising Committee

Changbum Kim (PAL)
Dong-Eon Kim (PAL)
Jaeyu Lee (PAL)
Do Tae Kim (PAL)
Garam Hahn (PAL)
Jinjoo Ko (PAL)
Dongjin Kim (PAL)
Hyojung Hyun (PAL)
Sukhyun Jin (PAL)

Editorial Team

Michaela Marx (DESY)
Volker RW Schaa (GSI)
Dong-Eon Kim (PAL)
Jaeyu Lee (PAL)
Ghyung Hwa Kim (PAL)

The conference proceedings will be published at the JACoW web site (http://www.jacow.org). The deadline for the submission /upload of contributions to the Proceedings of IBIC2021 was Wednesday, September, 8th, 2021, midnight (GMT+9). Authors with questions can communicate via e-mail with the editorial team.

Timetable

Monday, 13/Sep.

21:50–22:00	**Welcome Remarks**	
	I	[MOOA01] Present Status of PLS-II and PAL-XFEL by **Changbum Kim (PAL)**
	Moderator: Kevin Jordan (JLAB)	
22:00–22:20	K	[MOOB01] Ultra-fast line-camera KALYPSO for fs-laser-based electron beam diagnostics (Faraday Cup Award) by **Meghana Mahaveer Patil (KIT)**
22:20–22:40	I	[MOOB02] Recommissioning of the CERN Injector Complex Beam Instrumentation by **Raymond Veness (CERN)**
22:40–23:00	I	[MOOB03] Overview of RAON Beam Instrumentation System and Construction Status of the Low-Energy Linac by **Yeonsei Chung (IBS)**
23:00–23:10	**Break and Discussion (Group Photo)**	
	Moderator: Yongbin Leng (SSRF)	
23:10-23:20	C	[MOOB04] Summary of the ARIES Workshop on Materials and Engineering Technologies for Particle Accelerator Beam Diagnostic Instruments by **Peter Forck (GSI)**
23:20-23:40	I	[MOOC01] Fast Beam-Based Alignment Using AC excitations by **Zeus Marti (ALBA)**
23:40-23:50	C	[MOOC02] An Experimental Comparison of Single Crystal CVD Diamond and SiC Synchrotron X-Ray Beam Diagnostic by **Claire Houghton (DLS)**
23:50-24:00	C	[MOOC03] BPM System Development and Applications in Commission of SXFEL-UF by **Bo Gao (SARI-CAS)**
00:00–00:10	**Break and Discussion**	
00:10–01:00	**Poster session (MOPP)**	
01:00–02:00	**Social Activity (Mozilla Hubs)**	

I: Invited Oral, C: Contributed Oral, K: Keynote Lecture.

Tuesday, 14/Sep.

	Moderator: Lorraine Bobb (DLS)	
21:50–22:10	I	[TUOA01] Single-Crystal Diamond Pixelated Radiation Detector with Buried Graphitic Electrodes by **Christopher Bloomer (DLS)**
22:10–22:30	I	[TUOA02] Characterizing Ultralow Emittance Electron Beams using Structured Light Fields by **Andreas Seidel (Jena University)**
22:30–22:50	I	[TUOA03] Transverse Beam Emittance Measurement by Undulator Radiation Power Noise by **Ihar Lobach (FNAL)**
22:50–23:00	C	[TUOA04] Measurement and Reconstruction of a Beam Profile Using a Gas Sheet Monitor by Beam-Induced Fluorescence Detection in J-PARC by **Ippei Yamada (Doshisha University)**
23:00–23:10	**Break and Discussion**	
	Moderator: Ubaldo Iriso (ALBA)	
23:10-23:20	C	[TUOA05] Commissioning of Timepix3 Based Beam Gas Ionisation Profile Monitors for the CERN Proton Synchroton by **Swann Levasseur (CERN)**
23:20-23:30	C	[TUOA06] Two-Dimensional Beam Size Measurements with X-ray Heterodyne Near Field Speckles by **Mirko Siano (Università degli Studi di Milano)**
23:30-23:50	I	[TUOB01] Beam Loss Studies at the China Spallation Neutron Source by **Tao Yang (IHEP CSNS)**
23:50-24:00	C	[TUOB02] CMOS Based Beam Loss Monitor at the SLS by **Cigdem Ozkan Loch (PSI)**
00:00–00:10	**Break and Discussion**	
00:10–01:00	**Poster session (TUPP)**	
01:00–02:00	**Social Activity (Mozilla Hubs)**	

Wednesday, 15/Sep.

	Moderator: Kay Wittenburg (DESY)	
21:50–22:10	I	[WEOA01] Attosecond Pulse Diagnostics at the LCLS XLEAP by **Siqi Li (SLAC)**
22:10–22:30	I	[WEOA02] Temporal Streaking of Electron Beams in Any Transverse Plane with Femtosecond Resolution by **Pau González Caminal (DESY)**
22:30–22:50	I	[WEOA03] Real-Time Longitudinal Profile Measurement of Operational H- Beam at the SNS Linac Using a Laser Comb by **Yun Liu (SNS)**
22:50–23:00	C	[WEOA04] Bunch-Resolved 2D Diagnostics - Streaking Combined with Interferometry by **Marten Koopmans (HZB)**
	Moderator: Volker Schlott (PSI)	
23:10-23:20	C	[WEOA05] Visualizing Femtosecond Dynamics with Ultrafast Electron Probes through Terahertz Compression and Time-Stamping by **Mohamed Othman (SLAC)**
23:20-23:30	C	[WEOA07] Measurement of Bunch Length and Temporal Distribution Using Accelerating Radio Frequency Cavity in Low Emittance Injector by **Ji-Gwang Hwang (HZB)**
23:30-23:50	I	[WEOB01] Charge Measurements in SwissFEL and Results of an Absolute Charge Calibration Method by **Gian Luca Orlandi (PSI)**
23:50-24:00	C	[WEOB02] Commissioning of the Cryogenic Current Comparator (CCC) at CRYRING by **David Manuel Haider (GSI)**
00:00–00:10	**Break and Discussion**	
00:10–01:00	**Poster session (WEPP)**	
01:00–02:00	**Social Activity (Mozilla Hubs)**	

Thursday, 16/Sep.

	Moderator: Patrick Krejcik (SLAC)	
21:50–22:10	I	[THOA01] Commissioning and Performance of Beam Diagnostics in the FACET-II Beam Spectrometer by **Douglas Storey (SLAC)**
22:10–22:30	I	[THOA02] Non-Invasive Machine Parameters Measurement in a Storage Ring Based on Bunch-by-Bunch 3D Position Data Correlation Analyze by **Xingyi Xu (SINAP)**
22:30–22:40	C	[THOA03] Progress towards Machine Learning-Based Real-Time Non-Destructive Prediction of the Longitudinal Phase Space Evolution in a Particle Accelerator by **Claudio Emma (SLAC)**
22:40–23:00	I	[THOB01] Control of the Microbunching Instability and Stabilization of the THz Coherent Radiation by **Clement Evain (PhLAM/CERLA)**
23:00–23:10	**Break and Discussion**	
	Moderator: Jonah Weber (LBNL)	
23:10-23:30	I	[THOB02] High-Resolution, Low-Latency, Bunch-by-Bunch Feedback Systems for Nano-Beam Production and Stabilization by **Philip Burrows (JAI)**
23:30-24:00	K	[THOB03] Adaptive Control and Machine Learning for Particle Accelerator Beam Control and Diagnostics by **Alexander Scheinker (LANL)**
00:00-00:10	C	[FROA01] Identification of the Inter-Bunch and Intra-Bunch Beam Dynamics Based on Dynamic Modal Decomposition (DMD) by **Claudio Hector Rivetta (SLAC)**
00:10-00:30	I	[FROB01] RFSoCs in Beam Instrumentation Systems by **Eric Norum (LBNL)**
00:30–01:00	**Summary & Closing**	

List of Abstracts – Talks

Monday

MOOA, MOOB - 01 Overview and Commissioning

MOOA01	01 Overview and Commissioning

Present Status of PLS-II and PAL-XFEL

Speaker : Changbum Kim
Author(s) : Changbum Kim (PAL, Pohang)

International Beam Instrumentation Conference (IBIC) 2021 is hosted by Pohang Accelerator Laboratory (PAL) which has two major light source facilities in Korea. PAL is operating the upgraded Pohang Light Source (PLS-II) and X-ray free electron laser (PAL-XFEL) on its campus. PLS-II is a third-generation synchrotron radiation facility with 36 working beamlines. PAL-XFEL is a normal conducting hard X-ray FEL based on normal conducting technology, with two hard and one soft X-ray experimental station. In this presentation, the present status of PLS-II and PAL-XFEL will be introduced.

MOOB01 01 Overview and Commissioning

Ultra-fast line-camera KALYPSO for fs-laser-based electron beam diagnostics

Speaker : Meghana Mahaveer Patil
Author(s) : Meghana Mahaveer Patil, Erik Bruendermann, Michele Caselle, Andreas Ebersoldt, Stefan Funkner, Andreas Kopmann, Anke-Susanne Mueller, Michael Johannes Nasse, Gudrun Niehues, Micha Reissig, Johannes Leonhard Steinmann, Marc Weber, Christina Widmann (KIT, Karlsruhe)

A very common bottleneck for the study of the short electron bunch dynamics in accelerators is a detection scheme that can deal with their high repetition rates in the MHz range. However, commercially available cameras have a drawback in their acquisition rate, which is limited to a few hundred kHz. Hence, we have developed KALYPSO, an ultra-fast line camera capable of operating in the MHz regime. Its modular approach allows for the use of several sensors e.g. Si, InGaAs, PbS, PbSe to cover a wide range of spectral sensitivities. The KIT storage ring KARA (Karlsruhe Research Accelerator) is the first storage ring with a near-field single-shot electro-optical (EO) bunch profile monitor installed for the measurement of electron bunch dynamics in the longitudinal phase-space. Using electro-optical spectral decoding (EOSD) it is possible to imprint the bunch profile on chirped laser pulses and then read out by a spectrometer. In this contribution, an overview of the EOSD experimental setup and the detector system installed for longitudinal bunch studies as well as the recent development in diagnostics based on Artificial Intelligence (AI) will be presented.

MOOB02 01 Overview and Commissioning

Recommissioning of the CERN Injector Complex Beam Instrumentation

Speaker : Raymond Veness
Author(s) : Raymond Veness, Thibaut Lefevre (CERN, Meyrin)

During the last two years, the CERN injector complex has been completely renovated with the aim of providing high intensity and smaller emittance beams to the LHC. A new Linac providing H- has been constructed and major upgrades in the Proton Synchrotrons (PS Booster ring, PS ring and Super PS ring) have been performed. A full suite of new beam diagnostics has been implemented and commissioned. This includes fast wire scanners, beam gas ionization monitors, quadrupolar pick-ups and diamond beam loss detectors. New radiation-hard beam position monitoring system was also successfully deployed in the SPS. This talk will present an overview of the performance of the newly built instruments.

MOOB03 01 Overview and Commissioning

Overview of RAON Beam Instrumentation System and Construction Status of the Low-Energy Linac

Speaker : Yeonsei Chung
Author(s) : Yeonsei Chung (IBS, Daejeon)

RAON is a heavy ion accelerator for researches using Rare Isotopes (RI) as a major research facility in Korea. RAON uses both In-flight Fragmentation and Isotope Separation On-Line methods to provide various RI beams. The ultimate goal of the driver Linac of RAON is to accelerate uranium and proton beams up to 200 MeV/u and 600 MeV, with a maximum beam currents of 8.3 pA and 660 pA, respectively. After 9 years of RAON construction, commissioning of the low-energy Linac front-end system that consists of 14.5 GHz ion source, low energy beam transport, a 500 keV/u radio frequency quadrupole, and medium energy beam transport has been carried out since late 2020. And beam injection to the low-energy superconducting Linac is planned to start in December 2021. Here, we introduce RAON beam instrumentation and diagnostics systems as well as the construction status of the low-energy Linac.

MOOB04 01 Overview and Commissioning

Summary of the ARIES Workshop on Materials and Engineering Technologies for Particle Accelerator Beam Diagnostic Instruments

Speaker : Peter Forck
Author(s) : Peter Forck (GSI, Darmstadt), Ubaldo Iriso (ALBA-CELLS Synchrotron, Cerdanyola del Vallès), Owain Rhodri Jones, Raymond Veness (CERN, Meyrin), Gero Kube, Kay Wittenburg (DESY, Hamburg), Volker Schlott (PSI, Villigen PSI), Daniel Eakins (University of Oxford, Oxford)

ARIES* is an EU-sponsored programme for accelerator research and innovation. An international Workshop was held online as part of this programme in June 2021 on the topic of 'Materials and Engineering Technologies for Particle Accelerator Beam Diagnostic Instruments'. The aim of the Workshop was to bring together instrument designers, experts and industry and research groups to review the state of the art in the field, present designs and discuss future challenges, whilst also developing and strengthening collaborations between groups. There were sessions covering 'Instrument design and operation', 'Novel materials and applications' and 'New technology and components' over the three half-days of the on-line meeting. This paper will review the key topics presented at the workshop along with a summary of discussions held and proposed directions for future studies.

MOOC - 02 Beam Position Monitors

MOOC01 02 Beam Position Monitors

Fast Beam-Based Alignment Using AC Excitations

Speaker : Zeus Martí
Author(s) : Zeus Martí, Gabriele Benedetti, Ubaldo Iriso, Emilio Morales (ALBA-CELLS Synchrotron, Cerdanyola del Vallès), Andrea Franchi (ESRF, Grenoble)

Fast beam-based alignment (BBA) of BPMs and quadrupole magnets was evolved and demonstrated at ALBA*. A conventional BBA method makes a local bump, change quadrupole strength, and measure COD by the quadrupole, which is very time-consuming. However, the fast BBA using AC excitations of corrector magnets can quickly measure the displacement between a BPM and a quadrupole. In the case of ALBA, the BBA duration was reduced from 5 hours to 10 minutes. The accuracy was the same as the conventional BBA (10 um). This fast BBA method will help the alignment of BPMs in 3rd and 4th generation light sources.

MOOC02 02 Beam Position Monitors

An Experimental Comparison of Single Crystal CVD Diamond and SiC Synchrotron X-Ray Beam Diagnostics

Speaker : Claire Houghton
Author(s) : Claire Houghton (DLS, Harwell), Christopher Bloomer, Lorraine Bobb (DLS, Oxfordshire)

As synchrotron beamlines increasingly use micro-focus techniques with detectors sampling at kHz rates, the need for real-time monitoring of the beam position at similar bandwidths is vital. Commercially available single-crystal CVD diamond X-ray diagnostics are well established as excellent non-destructive monitors for synchrotron X-ray beamlines. Silicon carbide (SiC) X-ray beam position monitors (XBPMs) are a recent development with the potential to provide the same benefits of their diamond counterparts with larger useable apertures and lower cost. At Diamond Light Source a comparison between single-crystal CVD diamond and SiC XBPMs is underway. The diamond and SiC XBPMs are mounted in-line along the beam path, so that synchronous kHz measurements of the synchrotron X-ray beam motion can be measured. Several tests of the XBPM performance are presented: comparing kHz beam position measurements from the detectors, beam profile measurements, and signal uniformity across the face of the detectors. Each test is performed with varying bias voltages applied to the detectors. A discussion of the benefits and limitations of SiC and diamond XBPMs is included.

MOOC03 02 Beam Position Monitors

BPM System Development and Applications in Commission of SXFEL-UF

Speaker : Bo Gao
Author(s) : Bo Gao (SARI-CAS, Pudong, Shanghai), Jian Chen, Yongbin Leng (SSRF, Shanghai)

SXFEL is a soft X-ray free electron laser user facility that is current being commissioned in Shanghai. It is based on a 1.5 GeV normal conducting high gradient C-band (linear accelerator) LINAC and contains two FEL beamline, a seeded FEL beamline and a SASE beamline, and five experimental stations. The performance of X-ray FEL depends strongly on the quality of the electron beam and single shot stability. We have developed a BPM system including SBPM and CBPM. The resolution of SBPM is better than 4 micro meters, and the resolution of CBPM is better than 176 nm. Because of its excellent position resolution, it plays an important role in the SASE beamline commissioning. The beam adjusters rely on this system to find and maintain an ideal track, and complete the debugging of the SBP beamline within 21 days. This paper presents the system design, methods used to determine the resolution, the performance, and the applications of those BPMs.

Tuesday

TUOA - 03 Transverse Profile and Emittance Monitors

TUOA01 03 Transverse Profile and Emittance Monitors

Single-Crystal Diamond Pixelated Radiation Detector with Buried Graphitic Electrodes

Speaker : Christopher Bloomer
Author(s) : Christopher Bloomer, Lorraine Bobb (DLS, Oxfordshire), Mark Newton (University of Warwick, Coventry)

A new type of transmissive pixel detector has been developed for synchrotron radiation diagnostics at Diamond Light Source. A thin single-crystal CVD diamond plate is used as the detector material, and a pulsed-laser technique has been used to write conductive graphitic electrodes inside the diamond plate. Instead of using traditional electrodes formed from a layer of surface metallisation, the graphitic electrodes are buried under the surface of the diamond and result in an all-carbon imaging detector. Within the instrument's transmissive aperture there are no surface structures that could be damaged by exposure to radiation beams, and no surface metallization that could introduce unwanted absorption edges. The instrument has successfully been used to image the X-ray beam profile and measure the beam position to sub-micron accuracy at 100 Hz at Diamond Light Source. A novel modulation lock-in technique is used to read out all pixels simultaneously. Presented in this work are measurements of the detector's beam position resolution and intensity resolution. Initial measurements of the instrument's point-spread-function are also presented and are compared to numerical simulations of the detector performance. These numerical simulations are used to identify potential improvements to the electrode geometry to improve the spatial resolution of similar future detectors. The instrument has application in both synchrotron radiation instrumentation, where real-time monitoring of the beam profile is useful for beam diagnostics and fault-finding, and particle tracking at colliders, where the electrode geometries that buried graphitic tracks can provide increase the charge collection efficiency of the detector.

TUOA02 03 Transverse Profile and Emittance Monitors

Characterizing Ultralow Emittance Electron Beams using Structured Light Fields

Speaker : Andreas Seidel
Author(s) : Andreas Seidel (IOQ, Jena), Jens Osterhoff (DESY, Hamburg)

Novel schemes for generating ultralow emittance electron beams have been developed in past years and promise compact particle sources with excellent beam quality suitable for future high-energy physics experiments and free-electron lasers. Current methods for the characterization of low emittance electron beams such as pepperpot measurements or beam focus scanning are limited in their capability to resolve emittances in the sub 0.1 mm mrad regime. Here we propose a novel, highly sensitive method for the single shot characterization of the beam waist and emittance using interfering laser beams. In this scheme, two laser pulses are focused under an angle creating a gratinglike interference pattern. When the electron beam interacts with the structured laser field, the phase space of the electron beam becomes modulated by the laser ponderomotive force and results in a modulated beam profile after further electron beam phase advance, which allows for the characterization of ultralow emittance beams. 2D PIC simulations show the effectiveness of the technique for normalized emittances in the range of 0.01 to 1 mm mrad.

TUOA03 03 Transverse Profile and Emittance Monitors

Transverse Beam Emittance Measurement by Undulator Radiation Power Noise

Speaker : Ihar Lobach
Author(s) : Ihar Lobach (University of Chicago, Chicago, Illinois), Kwang-Je Kim (ANL, Lemont, Illinois), Valeri Lebedev, Sergei Nagaitsev, Alexander Leonidovich Romanov, Giulio Stancari, Alexander Valishev (Fermilab, Batavia, Illinois), Aliaksei Halavanau, Zhirong Huang (SLAC, Menlo Park, California)

Generally, turn-to-turn power fluctuations of incoherent spontaneous synchrotron radiation in a storage ring depend on the 6D phase-space distribution of the electron bunch. In some cases, if only one parameter of the distribution is unknown, this parameter can be determined from the measured magnitude of these power fluctuations. In this contribution, we report the results of our experiment at the Integrable Optics Test Accelerator (IOTA) storage ring, where we carried out an absolute measurement (no free parameters or calibration) of a small vertical emittance (5–15 nm rms) of a flat beam by this new method, under conditions, when the small vertical emittance is unresolvable by a conventional synchrotron light beam size monitor. This technique may be particularly beneficial for existing state-of-the-art and next generation low-emittance high-brightness ultraviolet and x-ray synchrotron light sources.

TUOA04 03 Transverse Profile and Emittance Monitors

Measurement and Reconstruction of a Beam Profile Using a Gas Sheet Monitor by Beam-Induced Fluorescence Detection in J-PARC

Speaker : Ippei Yamada
Author(s) : Ippei Yamada (Doshisha University, Kyoto)

A high-intensity beam accelerator requires a non-destructive beam profile monitor since a destructive monitor, such as a wire-scanning-type profile monitor, may be broken by deposited energy. We have been developing a non-destructive transverse beam profile monitor using a gas sheet. The sheet-shaped gas flow is formed by a technique of rarefied gas dynamics and enables two-dimensional profile measurement. One of the issues on development of the profile monitor based on beam-gas interaction is reconstruction of the beam profile from the obtained signal by the monitor. Our gas sheet monitor captures the beam-induced fluorescence using an image intensifier and a CCD camera. Photons produced by beam-gas interaction are integrated along the normal direction of the detector; the luminous intensity distribution of the obtained image can be written as an integral of the product of the sheet-gas density distribution and the beam profile. To solve the equation and reconstruct the profile, the sheet-gas density distribution needs to be measured. The gas density distribution was quantified using an electron beam narrow enough as compared with the beam whose profile needs to be measured. The narrow electron beam induces local photon emission from the gas sheet, and the gas density distribution can be measured by scanning the electron beam position on the gas sheet while monitoring the photon signal intensities. An advantage of this measurement method of the gas density distribution is the obtained distribution includes the sensitivity distribution of the detector, such as a CCD camera and an image intensifier. The measured gas density distribution including the sensitivity distribution was applied to the profile reconstruction of 3 MeV, 60 mA negative hydrogen ion beam in J-PARC Linac, and the beam profile was successfully obtained.

TUOA05 03 Transverse Profile and Emittance Monitors

Commissioning of Timepix3 Based Beam Gas Ionisation Profile Monitors for the CERN Proton Synchroton

Speaker : Swann Levasseur
Author(s) : Swann Levasseur (CERN, Geneva 23), Hampus Sandberg, Dominique Bodart, Steen Jensen, Gerhard Schneider, James William Storey (CERN, Geneva), Raymond Veness (CERN, Meyrin), Kenichirou Satou (KEK, Ibaraki), Stephen Michael Gibson (Royal Holloway, University of London, Surrey), William Bertsche (UMAN, Manchester)

A pair of operational Beam Gas Ionisation (BGI) profile monitors was installed in the CERN Proton Synchrotron (PS) at the beginning of 2021. These instruments use Timepix3 hybrid pixel detectors to continuously measure the beam profile throughout the cycle in the horizontal and vertical planes. In the weeks following their installation, both BGI's were commissioned in situ by equalizing and tuning the thresholds of the Timepix3 detectors. First measurements were taken during the beam commissioning period, demonstrating the operational readiness of the instruments. Sextupolar components originating from the magnetic shield in the vertical BGI magnet were later discovered and required compensation to reduce their effect on the PS beams. With the compensation in place, operational measurements could be started and provided new insights into the dynamics of the PS beam cycles.

TUOA06 03 Transverse Profile and Emittance Monitors

Two-Dimensional Beam Size Measurements with X-ray Heterodyne Near Field Speckles

Speaker : Mirko Siano
Author(s) : Mirko Siano, Luca Teruzzi (Università degli Studi di Milano, Milano), Ubaldo Iriso, Andriy Nosych, Eduardo Solano, Laura Torino (ALBA-CELLS Synchrotron, Cerdanyola del Vallès), Alexander Goetz, Stefano Mazzoni (CERN, Geneva), Daniele Butti, Thibaut Lefevre, Georges Trad (CERN, Meyrin), Bruno Paroli, Marco Alberto Carlo Potenza (Universita' degli Studi di Milano INFN, Milano)

We report on 2D beam size measurements with a novel interferometric technique named Heterodyne Near Field Speckles, capable of resolving few-micrometer beam sizes. It relies on the interference between the weak spherical waves scattered by a colloidal suspension and the intense transilluminating X-ray beam. Fourier analysis of the resulting speckles enables full 2D coherence mapping of the incoming radiation, from which the beam sizes along the two orthogonal directions are retrieved. We show experimental results obtained with 12.4 keV X-rays at the NCD-SWEET undulator beamline at ALBA, where the vertical beam size has been changed between 5 and 15 micrometers by varying the beam coupling. The results agree well with the estimated beam sizes from the pinhole calculations. Finally, we discuss recent investigations on alternative targets aimed at improving the signal-to-noise ratio of the technique.

TUOB - 04 Beam Loss Monitors and Machine Protection

TUOB01	04 Beam Loss Monitors and Machine Protection

Beam Loss Studies at the China Spallation Neutron Source

Speaker : Tao Yang
Author(s) : Tao Yang (IHEP CSNS, Guangdong Province)

The China Spallation Neutron Source (CSNS) had generated the neutron beam by the spallation reaction of 1.6-GeV protons striking on the tungsten target in August 2017, and now its beam power is 100 kW and repetition rate 25 Hz. Beam loss detection is one of the most important issues in any accelerator, whether for the machine protection or the fine-tuning of the accelerator to reduce the induced radioactivity. The beam loss monitor (BLM) system at the CSNS is composed of 168 ionization chamber (IC) type BLMs and 15 plastic-scintillator based BLMs along the beam line in the CSNS. The IC is the dominant type of the BLMs used at the CSNS, and most of IC type BLMs is filled with Ar/N2 mixture gas (70%:30% by volume), several filled with Xe or BF3 gas. This paper mainly focuses on the IC-type BLMs, and detailed beam loss experiments and FLUKA simulations for the CSNS BLM system will be presented.

TUOB02 04 Beam Loss Monitors and Machine Protection

CMOS Based Beam Loss Monitor at the SLS

Speaker : Cigdem Ozkan Loch
Author(s) : Cigdem Ozkan Loch, Rasmus Ischebeck, Anna Maria Magdalena Stampfli (PSI, Villigen PSI)

For several years, the SLS storage ring was not equipped with any loss monitors; hence, any understanding of the operational losses, accidental losses, or manual beam dumps was missing. Initially, a long quartz fiber (350 m) was installed around the ring to locate losses, and read out with a photomultiplier tube. With the long fiber, we garnered some understanding yet, it was not easy to locate the position of the losses. Hence, we opted for scintillator based fiber loss monitors, installed in certain location. All the fibers are read out together with a single CMOS based 2.3MP camera. A device was built for 28 channels. 10 fibers were connected and are located in the injection kicker in the booster to ring transfer line and three Arcs storage ring. With these loss monitors, we were able to detect and locate the position of losses due to injection and sudden beam dumps or losses. In this poster, we will introduce the concept and the components of this monitor, and present the data processing algorithm that allow us to locate and track the losses in the SLS storage ring.

Wednesday

WEOA - 05 Longitudinal Diagnostics and Synchronization

WEOA01	05 Longitudinal Diagnostics and Synchronization

Attosecond Pulse Diagnostics at the LCLS XLEAP

Speaker : Siqi Li
Author(s) : Siqi Li (SLAC, Menlo Park, California)

The XLEAP capabilities at the SLAC LCLS facility recently demonstrated the generation of attosecond X-ray free-electron laser (FEL) pulses*. This presents new challenges in beam measurements and diagnostics. In this talk I will discuss the production and measurement of XLEAP pulses with angular streaking using a circularly polarized laser**.

WEOA02	05 Longitudinal Diagnostics and Synchronization

Temporal Streaking of Electron Beams in Any Transverse Plane with Femtosecond Resolution

Speaker : Pau González Caminal
Author(s) : Pau González Caminal, Richard D'Arcy, (DESY, Hamburg)

The PolariX TDS is a novel polarisable transverse-deflection structure operating in the x-band frequency regime, enabling temporal streaking of electron beams in any transverse plane with femtosecond resolution. With this feature it becomes possible to measure slice emittance in both x y, tomographically reconstruct the 3D beam distribution, and record the beam's phase space with all correlations up to 5D (x,x¿,y,y¿,t) ¿ all using a single cavity. This functionality provides the opportunity to precisely characterise ultra-short beams at both conventional and novel facilities where beam quality and axial symmetry are essential for high-fidelity, high-gradient acceleration. The PolariX system was designed and manufactured by an international collaboration of scientists from CERN, DESY, and PSI. The prototype cavity has been installed and commissioned at the beam-driven plasma-wakefield facility FLASHForward at DESY with further cavities being installed at the FLASH2 (DESY), SwissFEL (PSI), and ARES (DESY) facilities. This presentation will introduce the collaborative foundation of the project with a focus on experimental results from commissioning with beam at FLASHForward, as well as first femtosecond-resolution measurements of plasma-accelerated beams (FLASHForward) and observations of free-electon lasing (FLASH2).

WEOA03 05 Longitudinal Diagnostics and Synchronization

Real-Time Bunch Shape Measurement of Operational H- Beam at the SNS Linac Using a Laser Comb

Speaker : Yun Liu
Author(s) : Yun Liu (ORNL, Oak Ridge, Tennessee)

We demonstrate a novel technique to measure the bunch shapes of an operational hydrogen ion (H-) beam in a nonintrusive, real-time fashion. The measurement is conducted based on the photoionization of the ion beam with a phase modulated laser comb ¿ pico-second laser pulses with controllable temporal structure. The effect of the limited ion beam size on the measurement accuracy is discussed and a mitigation approach is proposed and experimentally verified. The measurement technique has been applied to a 1-GeV, 1.4-MW H- beam at the Spallation Neutron Source (SNS) high energy beam transport (HEBT). Bunch shapes of the neutron production H- beam at different locations have been successfully measured.

WEOA04 05 Longitudinal Diagnostics and Synchronization

Bunch-Resolved 2D Diagnostics - Streaking Combined with Interferometry

Speaker : Marten Koopmans
Author(s) : Marten Koopmans, Ji-Gwang Hwang, Andreas Jankowiak, Markus Ries, Gregor Schiwietz (HZB, Berlin)

Due to the complexity of the filling pattern in the BESSY II electron-storage ring, bunch-resolved diagnostics are required for machine commissioning and to ensure the long-term quality and stability of operation. Low-alpha operation and a possible BESSY VSR upgrade, in addition, demand bunch-length measurements with picosecond resolution. Therefore a dedicated beamline equipped with a fast streak camera was set up and successfully commissioned. Couplings between time- and space-coordinates do also call for bunch-selective and correlated multi-parameter detection methods. Thus, the same beamline and the streak camera have been made capable of direct beam-profile imaging and interferometry of the vertical beam size using the X-ray blocker bar method *,**. Dependent on the polarization choice of visible light one may switch between these diagnostic methods. With this additional transverse dimension in the streak-camera image, bunch-resolved 2D measurements are possible. In the vertical direction the characteristic dip in the center of the image by the pi-polarized synchrotron radiation can be observed at the streak camera and used to extract bunch resolved information about the vertical beam size. The streak camera measurements are validated with direct imaging measurements from a regular CCD at the beamline. The results are converted into absolute values by diffraction simulations and by comparison to beam size measurements with the BESSY II pinhole monitors.

WEOA05 05 Longitudinal Diagnostics and Synchronization

Visualizing Femtosecond Dynamics with Ultrafast Electron Probes Through Terahertz Compression and Time-Stamping

Speaker : Mohamed Othman
Author(s) : Mohamed Othman (SLAC, Menlo Park, California)

Visualizing ultrafast dynamics at the atomic scale requires time-resolved pump-probe characterization with femtosecond temporal resolution. For single-shot ultrafast electron diffraction (UED) with fully relativistic electron bunch probes, existing techniques are limited by the achievable electron probe bunch length, charge, and timing jitter. We present the first experimental demonstration of pump-probe UED with THz-driven compression and time-stamping that enable UED probes with unprecedented temporal resolution. This technique utilizes two counter-propagating quasi-single-cycle THz pulses generated from two OH-1 organic crystals coupled into an optimized THz compressor structure. Ultrafast dynamics of photoexcited bismuth films show an improved temporal resolution from 178 fs down to 85 fs when the THz-compressed UED probes are used with no time-stamping correction. Furthermore, we use a novel time-stamping technique to reveal transient oscillations in the dynamical response of THz-excited single-crystal gold films previously inaccessible by standard UED, achieving a time-stamped temporal resolution down to 5 fs.

WEOA07 05 Longitudinal Diagnostics and Synchronization

Measurement of Bunch Length and Temporal Distribution Using Accelerating Radio Frequency Cavity in Low Emittance Injector

Speaker : Ji-Gwang Hwang
Author(s) : Ji-Gwang Hwang (HZB, Berlin), Yosuke Honda, Tsukasa Miyajima (KEK, Ibaraki)

We demonstrate an experimental methodology for measuring the temporal distribution of picosecond level electron bunch with low energy using radial electric and azimuthal magnetic fields of an accelerating (TM 01 mode) radio frequency (RF) cavity that is used for accelerating electron beams in a linear accelerator. In this new technique, an accelerating RF cavity provides a phase-dependent transverse kick to the electrons, resulting in the linear coupling of the trajectory angle with the longitudinal position inside the bunch. This method does not require additional devices on the beamline since it uses an existing accelerating cavity for the projection of the temporal distribution to the transverse direction. We present the theoretical basis of the proposed method and validate it experimentally in the compact-energy recovery linac accelerator at KEK. Measurements were demonstrated using a 2-cell superconducting booster cavity with a peak on-axis accelerating field (E0)of 7.21 MV/m.

WEOB - 06 Beam Charge and Current Monitors

WEOB01 06 Beam Charge and Current Monitors

Charge Measurements in SwissFEL and Results of an Absolute Charge Calibration Method

Speaker : Gian Luca Orlandi
Author(s) : Gian Luca Orlandi, Paolo Craievich, Micha Markus Dehler, Rasmus Ischebeck, Fabio Marcellini, David Staeger (PSI, Villigen PSI)

A comparative measurement campaign of the beam charge was carried out at SwissFEL using the following instruments: Faraday-Cup (FC), Wall-Current-Monitor (WCM), Integrating-Current-Transformer (Bergoz Turbo-ICT-2) and cavity Beam-Position-Monitor (BPM). The goal of the measurement campaign was to determine an absolute charge measurement method for a general purpose of instrument calibration and machine routine operation. Results of the absolute charge calibration method proposed for SwissFEL will be presented.

WEOB02 06 Beam Charge and Current Monitors

Commissioning of the Cryogenic Current Comparator (CCC) at CRYRING

Speaker : David Manuel Haider
Author(s) : David Manuel Haider, Andreas Reiter, Marcus Schwickert, Thomas Sieber, Furkan Ucar (GSI, Darmstadt), Max Stapelfeld (FSU Jena, Jena), Thomas Stoehlker (GSI, Darmstadt; HIJ, Jena; IOQ, Jena), Volker Tympel (HIJ, Jena), Matthias Schmelz, Ronny Stolz (IPHT, Jena), Vyacheslav Zakosarenko (IPHT, Jena; Supracon AG, Jena), Herbert De Gersem, Nicolas Marsic, Wolfgang F.O. Müller (TEMF, TU Darmstadt, Darmstadt)

Accurate non-destructive measurement of the absolute intensity of weak ion beams (< 1 uA) in storage rings is often restricted to special beam conditions and, even then, is associated with large uncertainties and tedious calibration procedures. However, experiments with rare ions in particular depend on excellent current resolution. In order to make these beams accessible, the Cryogenic Current Comparator (CCC) monitors deviations of the DC beam current on a scale of nA and compares the signal to a calibrated reference current. At the heavy-ion storage ring CRYRING at GSI a CCC prototype for FAIR was installed and first results of the commissioning are reported here. Preceding the operation with beam, a careful design of the beamline helium cryostat was required to provide the stable cryogenic environment needed for CCC operation. Mechanical and electro-magnetic perturbations that interfere with measurement of the beam's faint magnetic field are suppressed by the internal structure of the system and a superconducting magnetic shield, while the remaining interference can be filtered with adequate signal processing. In this way, a current resolution in the nA range was demonstrated.

Thursday

THOA - 07 Machine Parameter Measurements

THOA01 01 Overview and Commissioning

Commissioning and Performance of Beam Diagnostics in the FACET-II Beam Spectrometer

Speaker : Douglas W Storey
Author(s) : Douglas W Storey (SLAC, Menlo Park, California)

The FACET-II facility has begun beam delivery to the experimental user area and the suite of instrumentation in the spectrometer beamline following the experimental area is currently being commissioned. The performance of these diagnostics systems will be described, including the single shot "butterfly" emittance diagnostic that will be key to demonstrating emittance preservation of mm-mrad emittances in plasma wakefield acceleration experiments. Additionally, the gamma ray diagnostics will be discussed that will be used to assess the beam dynamics of low emittance beams in plasmas and to characterize beam-plasma filamentation instabilities.

THOA02 07 Machine Parameter Measurements

Non-Invasive Machine Parameters Measurement in a Storage Ring Based on Bunch-by-Bunch 3D Position Data Correlation Analyze

Speaker : Xingyi Xu
Author(s) : Xingyi Xu (SINAP, Shanghai; SSRF, Shanghai; University of Chinese Academy of Sciences, Beijing), Yongbin Leng (SSRF, Shanghai)

In order to improve machine performance, the machine parameters of the storage ring (including optics parameters and insert devices parameters, etc.) need to be accurately measured. It is difficult to measure them with traditional methods during the user operation run. The behaviour of each bunch in the ring will not be exactly the same, but has its own personality (different transverse positions, longitudinal phases and different bunch charges). If the bunch-by-bunch 3D position can be accurately measured, every individual bunch can be used as probes to extract the dynamics parameters of the storage ring. Based on a broadband oscilloscope with a high sampling rate, a bunch-by-bunch three-dimensional parameter measurement system was built at the Shanghai synchrotron radiation facility(SSRF). The measurement uncertainty of longitudinal phase is less than 0.2 ps, the uncertainty of transverse position is less than 10 um and the charge uncertainty is 0.3% under the condition that the bunch charge is 600 pC. A general software package was developed to process the bunch signals and extract bunch parameters. The functions of this software package mainly include three-dimensional position, charge extraction, refilled charge signal stripping, and cable reflection signal stripping. Using this software package, the injection transient process was studied and the momentum contraction factor, dispersion function, and longitudinal damping oscillation parameters measurement were realized during the normal operation at SSRF. Because the software package does not require special acquisition equipment and does not have strict requirements on the state of the accelerator, the software package can be widely used in the bunch-by-bunch measurement of all ring accelerators.

THOA03 05 Longitudinal Diagnostics and Synchronization

Progress Towards Machine Learning-Based Real-Time Non-Destructive Prediction of the Longitudinal Phase Space Evolution in a Particle Accelerator

Speaker : Claudio Emma
Author(s) : Claudio Emma, Owen Convery, Auralee Edelen, Mark Hogan (SLAC, Menlo Park, California)

We discuss progress towards the implementation of machine learning based real-time prediction of the Longitudinal Phase Space (LPS) evolution in a particle accelerator*. This work focuses specifically on the implementation of three separate longitudinal phase space virtual diagnostics at the FACET-II accelerator facility: one at the exit of the photoinjector, one after the second bunch compressor and one and the end of the linac before the experimental area. We present simulation results describing the simultaneous prediction of the LPS in a single-bunch and two-bunch mode of operation and discuss design choices for the machine learning architecture selected for the LPS prediction task**. Finally we discuss initial experimental deployment of the virtual diagnostics in regular accelerator operations.

THOB - 08 Feedback Systems and Beam Stability

THOB01 08 Feedback Systems and Beam Stability

Control of the Microbunching Instability and Stabilization of the THz Coherent Radiation

Speaker : Clement Evain
Author(s) : Clement Evain, Serge Bielawski (PhLAM/CERLA, Villeneuve d'Ascq)

PhLAM laboratory team has demonstrated the possibility to control the multibunching instability that appears spontaneously when the number of electrons in a bunch exceeds a threshold value (typically few mA). By measuring the amplitude of THz emission created by the bunch structure appearing with this instability, and by modulating correspondingly the amplitude of the frequency applied on RF cavity (to change the bunch length), the THz coherent radiation can be stabilized. The method is inspired by control of chaos techniques which aims at stabilizing an unstable and unpredictable state thanks to feedback loop. Feasibility experiment conducted at Synchrotron SOLEIL showed that the stabilization process is efficient up to 9.15 mA. This major achievement is a first step toward strong THz coherent sources in storage rings. Next challenges are the extension of the control to higher current.

THOB02 08 Feedback Systems and Beam Stability

High-Resolution, Low-Latency, Bunch-by-Bunch Feedback Systems for Nano-Beam Production and Stabilization

Speaker : Philip Burrows
Author(s) : Philip Burrows, Douglas Robert Bett, Neven Blaskovic Kraljevic, Talitha Bromwich, Glenn Brian Christian, Colin Perry, Rebecca Ramjiawan (JAI, Oxford)

High-precision intra-bunch-train beam orbit feedback correction systems have been developed and tested in the ATF2 beamline of the Accelerator Test Facility at the High Energy Accelerator Research Organization in Japan. Two systems are presented: 1) The vertical position of the bunch measured at two beam stripline position monitors (BPMs) is used to calculate a pair of kicks which are applied to the next bunch using two upstream kickers, thereby correcting both the vertical position and trajectory angle. This system was optimized so as to stabilize the beam offset at the feedback BPMs to better than 350 nm, yielding a local trajectory angle correction to within 250 nrad. Measurements with a beam size monitor at the focal point (IP) demonstrate that reducing the trajectory jitter of the beam by a factor of 4 also reduces the observed wakefield-induced increase in the measured beam size as a function of beam charge by a factor of c. 1.6. 2) High-resolution cavity BPMs were used to provide local beam stabilization in the IP region. The BPMs were demonstrated to achieve an operational resolution of 20 nm. With the application of single-BPM and two-BPM feedback, beam stabilization of below 50 nm and 41 nm respectively has been achieved with a closed-loop latency of 232 ns.

THOB03 08 Feedback Systems and Beam Stability

Adaptive Control and Machine Learning for Particle Accelerator Beam Control and Diagnostics

Speaker : Alexander Scheinker
Author(s) : Alexander Scheinker (LANL, Los Alamos, New Mexico)

In this tutorial, we start by reviewing some topics in control theory, including adaptive and model-independent feedback control algorithms that are robust to uncertain and time-varying systems, and provide some examples of their application for particle accelerator beams at both hadron and electron machines. We then discuss recent developments in machine learning (ML) and show some examples of how ML methods are being developed for accelerator controls and diagnostics, such as online surrogate models that act as virtual observers of beam properties. Then we give an overview of adaptive machine learning (AML) in which adaptive model-independent methods are combined with ML-based methods so that they are robust for and applicable to time-varying systems*. Finally, we present some recent applications of AML for accelerator controls and diagnostics. In particular we present recently developed adaptive latent space tuning methods and show how they can be used as virtual adaptive predictors of an accelerator beam's longitudinal phase space as well as all of the other 2D projections of a beam's 6D phase space**,***. Throughout the tutorial we will present recent results of various algorithms which have been applied at the LANSCE ion accelerator, the EuXFEL and LCLS FELs, the FACET plasma wakefield accelerator facility, the NDCXII ion accelerator, and the HiRES compact UED.

Friday

FROA - 08 Feedback Systems and Beam Stability

FROA01 08 Feedback Systems and Beam Stability

Identification of the Inter-Bunch and Intra-Bunch Beam Dynamics Based on Dynamic Modal Decomposition (DMD)

Speaker : Claudio Hector Rivetta
Author(s) : Claudio Hector Rivetta (SLAC, Menlo Park, California), Themis Mastoridis (CalPoly, San Luis Obispo, California), John Fox (Stanford University, Stanford, California)

The quantification of the Inter-bunch and Intra-bunch beam dynamics is important to define monitoring and operation tools in accelerators as well as to design model-based controllers to stabilize the transversal and longitudinal beam motion*. Presently, analysis tools and control designs are based on simplified models, where their parameters are estimated based on beam measurements. In this work, data-driven models are estimated without preliminary model assumptions of the beam dynamics. The technique uses Dynamic Modal Decomposition (DMD), to estimate the model and reduce it to the dominant modes present in the beam dynamics that are important to capture to design monitoring tools and controllers. The DMD technique is developed as a method to decompose complex dynamics, such as the inter-bunch / intra-bunch dynamics, into simple representations based on spatiotemporal coherent structures. It is an equation-free, data-driven method capable of providing an accurate decomposition of the beam motion. This paper will present the decomposition-reduction technique and apply it for the case of the beam dynamics identification. It will illustrate with examples the models extracted from measurements of the longitudinal inter-bunch dynamics in accelerators and transverse intra-bunch dynamics in circular machines.

FROB - 09 Data Acquisition and Processing Platform

FROB01	09 Data Acquisition and Processing Platforms

RFSoCs in Beam Instrumentation Systems

Speaker : Eric Norum
Author(s) : Eric Norum (LBNL, Berkeley, California)

RFSoCs are new devices that integrate digital systems (programmable logic, embedded processors, etc.) with high speed ADCs and DACs, all on a single chip. This talk could include: - Brief introduction to RFSoC technology - Current target applications and development efforts in the beam instrumentation community - Future of RFSoC technology and relevant applications

List of Abstracts – Posters

Monday & Tuesday

MOPP01 01 Overview and Commissioning

Overview of Beam Instruments at the Prototype Front-End Linac for Chinese Accelerator-Driven Subcritical System (CiADS)

Presenter : Yong Zhang
Author(s) : Yong Zhang, Ze Du, Kewei Gu, Long Jing, Li Li Li, ZhiXue Li, Ruixia Tian, Yuan Wei, Junxia Wu, Hong Ming Xie, Jia Yin, Guangyu Zhu (IMP/CAS, Lanzhou)

The prototype front-end superconducting proton LINAC (CAFe) for the China Accelerator Driven Subcritical System (CiADS) has been constructed since 2011. After ten years hard work, in February of 2021, this LINAC reached its design goal with the successful commissioning of a 10 mA, 205 kW continuous-wave (CW) proton beam with the energy of 20 MeV. CAFe's beam availability during long-term, high-power operation was measured to be 93- 96%, indicating high reliability: 12 hours of operation at 174 kW / 10 mA and 108 hours at 126 kW / 7.3 mA. To reach this final goal, challenges must be overcome including beam-loss control and detection, heavy beam loading and rapid fault recovery. During the whole process, beam instruments played a key point to overcome all those challenges. The beam diagnostics team delivered a comprehensive suite of instrumentation that supported the machine commissioning and operations, provided relevant feedback and beam interlock signal of the accelerator operation as well. A suite of instrumentation was commissioned and performed that includes a variety of current monitors, normal and cold capacitive BPMs, transverse and longitudinal profile monitors, multi-slit and single-slit scanning emittance stations, time-of-flight and magnetic field related energy and energy spread measurements, beam loss monitors and a target imaging system as well. The commissioning results and performance of these systems will be described, as well as the current and beam loss measurement for fast machine protection with the responding time of less than 10 us. Also the ten year's lessons learnt will be described.

MOPP03 01 Overview and Commissioning

SOLEIL Upgrade Project and Foreseen Beam Instrumentation

Presenter : Nicolas Hubert
Author(s) : Nicolas Hubert, Aurelien Bence, Romain Broucquart, Moussa El Ajjouri, Marie Labat, Dominique Pedeau, Jean-Paul Ricaud (SOLEIL, Gif-sur-Yvette)

SOLEIL Synchrotron has an upgrade plan to replace its storage ring by a new one based on multi-bend (7/4BA) achromat lattice. The Conceptual Design Report (CDR) has been published recently and the Technical Design Report (TDR) phase should be finished mid-2023 for a dark period planned from mid-2026 to beginning of 2028. For the beam instrumentation, most of the equipment will have to be replaced, to overcome cases of electronics obsolescence and to fulfil the new tight requirements. Among them, the most challenging ones are the micron resolution transverse beam size measurement, the beam position monitoring and the stability feedbacks. The present machine will be used to validate some prototypes and it is planned to upgrade part of the diagnostics ahead of the dark period to speed-up the commissioning of the new storage ring. This paper will present the diagnostics systems that are foreseen for the SOLEIL upgrade project.

MOPP04 01 Overview and Commissioning

Conceptual Design Overview of the Electron Ion Collider Instrumentation

Presenter : David Gassner
Author(s) : David Gassner, Kirsten Angelika Drees, Thomas Hayes, Charles Hetzel, Douglas Holmes, Robert Hulsart, Patrick Inacker, Chuyu Liu, Robert Michnoff, Michiko Minty, Christoph Montag, Danny Padrazo Jr, Matthew Paniccia, Vadim Ptitsyn, Vahid Houston Ranjbar, Medani Prasad Sangroula, Peter Thieberger, Erdong Wang, Ferdinand J. Willeke (BNL, Upton, New York), Jonathan Bellon, Alexei Blednykh (Brookhaven National Laboratory (BNL), Upton, New York), Leo Bob Dalesio (Osprey DCS LLC, Ocean City)

A new high-luminosity Electron Ion Collider (EIC) is being developed at Brookhaven National Laboratory (BNL). The team has recently competed the conceptual design phase. The EIC will be an upgrade to the existing RHIC facility. In addition to upgrading the existing hadron storage ring instrumentation, new electron accelerator subsystems that include a 400 MeV Linac, rapid-cycling synchrotron, electron storage ring, and a strong hadron cooling facility will all have new instrumentation systems. An overview of the conceptual design of the beam instrumentation will be presented.

MOPP05 01 Overview and Commissioning

The Frascati Beam Test Facility New Line: From Design to Beam Commissioning.

Presenter : Claudio Di Giulio
Author(s) : Claudio Di Giulio (INFN/LNF, Frascati (Roma)), Bruno Buonomo, Fabio Cardelli, Domenico Di Giovenale, Luca Gennaro Foggetta (INFN/LNF, Frascati)

The request of beam time for a long-time experiment and the contemporary request to provide beam time to the detector developers community, drive the INFN to invest in the commissioning of new beam line test facility. In this work we describe the necessary step followed from the design to the commissioning of the new beam line in the Frascati Beam Test Facility.

MOPP06 01 Overview and Commissioning

Beam Performance Analysis According to Voltage Changes of Ion Source Extraction of Electrostatic Accelerator for BNCT

Presenter : Hyunwoo Jung
Author(s) : Hyunwoo Jung (Tongmyong University, Busan), Bong Hwan Hong, Chawon Park (KIRAMS, Seoul)

The types of accelerators used in BNCT(Boron neutron capture therapy) systems worldwide are classified as cyclotrons, LINACs, and electrostatic accelerators. The cyclotron-based BNCT system is undergoing clinical trial approval. In order to develop BNCT, the efficiency of the electrostatic accelerator ion source is important. In particular, it should be possible to maintain the optimal beam current by controlling the extraction, plasma, filament, and arc of the ion source. A set value is required for the desired beam current. In this article, the performance of the beam current was confirmed by changing the extraction voltage using the ion source of the KIRAMS's static accelerator. In this experiment, plasma voltage, bias voltage, and extraction voltage were set as fixed values. After the extraction voltage was set to 2 kV, the beam current was set to 1 mA, 1.5 mA, 2 mA, 3 mA for each experiment. After that, the data was extracted by adjusting the extraction voltage by 0 - 0.2 kV. The extracted data result shows how the output beam current changes when the extraction voltage changes.

MOPP07 02 Beam Position Monitors

Robust Beam Position Monitor for MYRRHA 17-100MeV section

Presenter : Mohammed Ben Abdillah
Author(s) : Mohammed Ben Abdillah (Université Paris-Saclay, CNRS/IN2P3, IJCLab, Orsay)

MYRRHA (Multi-Purpose Hybrid Research Reactor for High-Tech Applications) aims to demonstrate the feasibility of high-level nuclear waste transmutation at industrial scale. MYRRHA Facility aims to accelerate 4 mA proton beam up to 600 MeV. 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. MINERVA is the first phase of MYRRHA. It includes several sections allowing beam acceleration up to 100 MeV. A BPM prototype was realized for the single spoke section (17 MeV-100 MeV). 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.

MOPP08 02 Beam Position Monitors

Design of a Cavity Beam Position Monitor for the FLASH 2020+ Undulator Intersection Project at DESY

Presenter : Dirk Lipka
Author(s) : Dirk Lipka (DESY, Hamburg)

The FLASH 1 beamline at DESY will be upgraded from fixed to variable gap undulators in the next years. For this the vacuum beamline has to be adapted. This reduces the inner diameter compared to the existing chamber. The vacuum components should fit to the new dimension to minimize transitions and therefore reduce wakefields which could interact with the electron beam and disturb the SASE effect. The electron beam position in the intersection of the undulators should be detected with a high resolution and a large charge dynamic range. Cavity BPMs are known to fulfill these requirements. The existing design with 10 mm inner diameter for the Eu-XFEL is reduced to 6 mm. Additional improvements are: widening of the dipole resonator waveguide to adapt to the dipole mode and antenna transmission. The resonator frequency of 3.3 GHz and loaded quality factor of 70 are maintained to use electronic synergies to other projects. The design considerations and simulation results of the cavity BPM will be presented.

MOPP09 02 Beam Position Monitors

Research on the Optimal Amplitude Extraction Algorithm for Cavity BPM

Presenter : Jian Chen
Author(s) : Jian Chen, Yongbin Leng, Tong Wu, Yimei Zhou (SSRF, Shanghai), Shanshan Cao, Bo Gao (SARI-CAS, Pudong, Shanghai)

The wake field of different modes of cavity BPM carries different bunch information, the amplitude and phase of the signals of different modes can be extracted through the signal processing method to obtain the characteristic parameters of the source bunch. In the application of bunch charge and position measurement, the accurate amplitude extraction method for cavity BPM signal is the primary issue to be considered when designing the data acquisition and processing system. In this paper, through theoretical analysis and numerical simulation, it is proved that the optimal algorithm of amplitude extraction for CBPM exists, and the dependence between the data processing window size and the decay time of the cavity BPM under the optimal design is given. In addition, the relationship between the optimized amplitude extraction uncertainty and the noise-to-signal ratio, sampling rate of data acquisition and processing system, and the decay time of the cavity BPM is also proposed, which can also provide clear guidance for the design and optimization of the CBPM system.

MOPP10 02 Beam Position Monitors

Observation of Wakefield Effects with Wideband Feedthrough-BPM at the Positron Capture Section of the SuperKEKB Injector Linac

Presenter : Muhammad Abdul Rehman
Author(s) : Muhammad Abdul Rehman, Tsuyoshi Suwada (KEK, Ibaraki)

At the SuperKEKB e+/e- injector linac, positrons are generated by striking electron beam at the tungsten target. The secondary electrons are also produced during positron creation and accelerated in the positron capture. A new wideband feedthrough-BPM system is developed for synchronous detection of secondary produced electron and positron beams with temporal separation of 180 ps. When e+/e- bunches pass through the accelerating structure, they generate wakefields. These wakefields can be directly observed with the feedthrough-BPM. A simulation study also has been carried to validate the observed wakefield effects with the feedthrough-BPM. The effects of wakefields on beam parameters and positions will be reported in this paper.

MOPP12 02 Beam Position Monitors

Development of an X-band CBPM Prototype for SHINE

Presenter : Shanshan Cao
Author(s) : Shanshan Cao (SARI-CAS, Pudong, Shanghai), Ruitao Jiang, Yongbin Leng, Renxian Yuan (SSRF, Shanghai)

SHINE is a newly proposed high-repetition-rate X-ray FEL facility and will be used to generate brilliant X-rays between 0.4 and 0.25 keV. To guarantee the high performance of FEL light pulses, it put a strict requirement on the monitoring of electron bunch trajectory. The position resolution of each bunch at the undulator section is required to be better than 200 nm at a bunch charge of 100 pC. The cavity beam position monitor (CBPM) is widely used in FEL facilities for its unique high resolution and high sensitivity. The output signals of an ideal pillbox cavity are proportional to the resonant frequency. Compared with the C-band cavity, the X-band cavity is expected to have a higher signal-to-noise ratio which is especially helpful at low bunch charge. Therefore, an X-band CBPM prototype is developed for SHINE. This paper will focus on the difficulties encountered during the design and production process and the solutions.

MOPP13 02 Beam Position Monitors

Design and Measurement of Independent Support for BPM at HLS

Presenter : Chuhan Wang
Author(s) : Chuhan Wang, Bao-gen Sun, Tianyu Zhou (USTC/NSRL, Hefei, Anhui)

The beam orbit stability is an important indicator to measure the stability of the synchrotron radiation source. There are two main factors that affect the stability of the beam orbit. One is the vibration of the ground and other systems, which requires highly mechanically stable support. One is due to synchrotron radiation and changes in ambient temperature, the other is the vibration of the ground and other systems, which requires highly mechanically stable support. From the perspective of thermal stability and vibration stability, the support was designed and optimized. A series of simulation, including finite element analysis (FEA), measurement and analysis have been done upon the support to make sure it can meet the requirements of the beam orbit stability at HLS ¿.

MOPP14 02 Beam Position Monitors

Precise Single Bunch Measurements using Fast RF Switches

Presenter : Weixing Cheng
Author(s) : Weixing Cheng, Adam Brill (ANL, Lemont, Illinois)

To measure the swap-out injection/extraction bunches of the APS-U storage ring, single-pass Beam Position Monitor (BPM) electronics will be installed in the first sectors after the injection, with fast RF switches. The fast RF switch will select a bunch signal to be processed by the single pass BPM electronics, and have the remaining bunches processed by the regular BPM electronics. In addition to measuring the swap-out bunch during injection, the setup will be able to carry out various other measurements of any selected single bunch (or bunches). This paper presents the performance of the fast RF switches and related electronics.

MOPP15 02 Beam Position Monitors

Wire Test of Large Type BPM for P2DT in RAON

Presenter : Jangwon Kwon
Author(s) : Jangwon Kwon, Yeonsei Chung, Gi-Dong Kim, Hyung-Joo Woo (IBS, Daejeon), Eunhoon Lim (Korea University Sejong Campus, Sejong)

RAON (Rare isotope accelerator complex for On-line experiments) is accelerator to accelerate heavy ion such as uranium, oxygen, and proton. At P2DT(Post to Driver linac Transport line) section where is located between SCL3 and SCL2, particle beam would be higher charge state by stripper. In bending area in P2DT, BPM(Beam Position Monitor) should accept the beam that has large size (10 cm) horizontally. Required BPM transverse position resolution is 150 um. We simulated Large type BPM with CST particle studio. Fabricated LBPM was tested on the developed wire test bench that could move BPM for width of ±80 mm, height of ±40 mm with manual steering knob.

MOPP16 02 Beam Position Monitors

Current Status of Elettra 2.0 eBPM System

Presenter : Gabriele Brajnik
Author(s) : Gabriele Brajnik, Raffaele De Monte (Elettra-Sincrotrone Trieste S.C.p.A., Basovizza), Manuel Cargnelutti, Peter Leban, Peter Paglovec, Borut Repic (I-Tech, Solkan)

In the last years, there has been a growing interest in using the pilot-tone technique for long-term stabilization of electron beam position monitors in synchrotrons. At Elettra, after an internal development, the effectiveness of this approach was proven with tests in the laboratory and on the storage ring. The pilot-tone scheme will be adopted for the eBPMs that will equip Elettra 2.0, the low-emittance upgrade of the present machine. In order to support the development, industrialisation and production of the overall system, a partnership with Instrumentation Technologies has been signed. With the extensive experience with the Libera instruments, the company will be engaged in improving the BPM system developed by Elettra and getting it ready for serial production. This paper presents the current status of the BPM system, with an emphasis on the efforts done to improve the key performance of the system and to address its weaknesses (e.g. enhancing single bunch response and low currents sensitivity) within the industrialisation process, with the goal to get to a reliable system, easy to maintain and that meets the multiple project requirements for the new storage ring, the booster, the pre-injector and the transfer lines.

MOPP17 02 Beam Position Monitors

Beam Position Detection of a Short Electron Bunch in Presence of a Longer and More Intense Proton Bunch for the AWAKE Experiment

Presenter : Eugenio Senes
Author(s) : Eugenio Senes, Michal Krupa, Stefano Mazzoni (CERN, Geneva), Wilfrid Farabolini (CEA-DRF-IRFU, ; CERN, Meyrin), Antonio Gilardi (CERN, Geneva; University of Napoli Federico II, Napoli), Thibaut Lefevre, Manfred Wendt (CERN, Meyrin), Philip Burrows, Collette Pakuza (JAI, Oxford; Oxford University, Oxford, Oxon)

The AWAKE experiment studies the acceleration of electrons to multi-GeV levels driven by the plasma wakefield generated by an ultra-relativistic and high intensity proton bunch. The proton beam, being considerably more intense than the co-propagating electron bunch, perturbs the measurement of the electron beam position achieved via standard techniques. This contribution shows that the electrons position monitoring is possible by frequency discrimination, exploiting the large bunch length difference between the electron and proton beams. Simulations and a beam measurement hint, the measurement has to be carried out in a frequency regime of a few tens of GHz, which is far beyond the spectrum produced by the 1ns long (4 sigma Gaussian) proton bunch. As operating a conventional Beam Position Monitor (BPM) in this frequency range is problematic, an innovative approach based on the emission of coherent Cherenkov Diffraction Radiation (ChDR) in dielectrics is being studied. After describing the monitor concept and design, we will report about the results achieved with a prototype system at the CERN electron facility CLEAR.

MOPP19 02 Beam Position Monitors

Development of a Pass-Through Diagnostic for Next-Generation XFELs Using Diamond Sensors

Presenter : Isleydys Silva Torrecilla
Author(s) : Isleydys Silva Torrecilla, Bryce Jacobson, James MacArthur, Diling Zhu (SLAC, Menlo Park, California), Jen Bohon, John Smedley (LANL, Los Alamos, New Mexico), Eric Gonzalez, Simone Michele Mazza, Rene Padilla, Emma K. Potter, Eric Ryan, Bruce Schumm, Michal Tarka (SCIPP, Santa Cruz, California), Nora Peak Norvell (UCSC, Santa Cruz, California)

FELs deliver rapid pulses on the femtoseconds scale, and high peak intensities that fluctuate strongly on a pulse-to-pulse basis. The fast drift velocity, and high radiation tolerance properties of CVD (chemical vapor deposition) diamonds, make these crystals a good candidate material for developing a multi-hundred MHz pass-through diagnostic for the next generation of XFELs. Commercially available diamond sensors work as position-sensitive pass-through diagnostics for nJ-level pulses from synchrotrons. Supported by the University of California and the SLAC National Laboratory, a collaboration of UC campuses and National Laboratories have developed a new approach to the readout of diamond diagnostic sensors designed to facilitate operation for FEL-relevant uJ and mJ pulses. Single-crystal diamond detectors have been tested on the XPP endstation of the Linac Coherent Light Source beam at SLAC. We present results on the linearity and charge collection characteristics for different electrode configurations, and explore the dependence on the density of deposited charge. We also discuss how these results direct the group¿s continuing RD towards even faster and higher-intensity diamond-based beam diagnostics.

MOPP20 02 Beam Position Monitors

Beam Position Monitor Calibration by Rapid Channel Switching

Presenter : Robert Hulsart
Author(s) : Robert Hulsart, Robert Michnoff, Sergei Seletskiy, Peter Thieberger (BNL, Upton, New York)

One of the requirements for electron cooling at RHIC is a small relative angle between the ion and electron beams as they co-propagate. In order to maximize beam overlap, BPM measurements of either beam must be very accurate. Achieving this accuracy requires good electronic calibration of the associated cables and RF components, due to their inherent imperfections. Unfortunately, these are typically frequency dependent, especially in the RF filter and amplifier stages. The spectral content of the ion vs. electron bunch signals varies significantly, presenting a calibration challenge, even when using the same sampling channels. A scheme of rapidly swapping the BPM signals from the pickup electrode between the two signal cables (and sampling channels), using switches installed near the BPM was implemented to combat these calibration issues. Bias in each signal path appears as an offset which has an equal and opposite component when the cables are reversed. Taking the average of the two measurements with the channels in normal and reverse positions reduces this offset error. Successful transverse cooling of the RHIC ion beam has been verified after using this switching technique to calibrate the BPM electronics for each type of beam. Details of the processing hardware and switch control methodology to achieve this result will be discussed.

MOPP21 02 Beam Position Monitors

Research on Resolution of Orbit based on Clustering Analysis and BP Neural Network in SSRF

Presenter : Ruitao Jiang
Author(s) : Ruitao Jiang (SSRF, Shanghai)

Keeping the beam current's normal motion is an important mission for Shanghai Synchrotron Radiation Facility (SSRF). So the Orbit (rms)x/y is an main parameter for SSRF's running. However, the orbital resolution has been constrained by the accuracy of acquired data. To eliminate BPM's failure causing the inaccurate orbital resolution, the work based on clustering analysis and BP neural network to removed the abnormal BPM and recalculate the resolution of orbit. Data came from the machine research. The analysis results showed that the rms value of orbit is 100.75±6.87 um (x direction) and 14.9±0.6 um (y direction) using all BPM's data but the recalculate value is 98.03±6 um (x direction) and 2.6±0.4 um (y direction) when eliminate the data of faulty BPM. The analysis result indicated that the method can optimize the resolution of orbit and next work is further to evaluate the orbital resolution with more operation data.

MOPP22 02 Beam Position Monitors

Signal Analysis and Detection for the BPMs of the LHC Hollow Electron Lens

Presenter : Georgios Bantemits
Author(s) : Georgios Bantemits (CERN, Geneva 23), Adriana Rossi, Manfred Wendt (CERN, Meyrin)

The Large Hadron Collider (LHC) at CERN will be equipped with a hollow electron lens (HEL) to improve the collimation efficiency of the transverse beam tails for high intensity beam after the LHC high luminosity upgrade. A precise alignment of the two beams is essential for the HEL functionality, with the 7 TeV proton beam in the center, and a 10 keV, high intensity circular electron beam coaxial surrounding the proton beam. The absolute and relative transverse positions of both beams will be monitored with two stripline BPMs location in the HEL, followed by a narrowband signal detection system. This paper summarizes the analysis of the expected proton and electron beam signals, including laboratory measurements, with aim of a narrowband diode-detection read-out electronics as BPM signal processor.

MOPP23 02 Beam Position Monitors

Commissioning of ALPS, the New Beam Position Monitor System of CERN's Super Proton Synchrotron

Presenter : Andrea Boccardi
Author(s) : Andrea Boccardi, Manoel Barros Marin, Thierry Bogey, Athanasios Topaloudis, Manfred Wendt (CERN, Geneva 23), Verena Kain, Kevin Shing Bruce Li (CERN, Geneva), Joel Albertone, Patrycja Ada Malinowska (CERN, Meyrin)

The Super Proton Synchrotron (SPS) is both, the final machine in the pre-accelerator chain of the Large Hadron Collider (LHC) at CERN, and a machine providing several experiments with proton and ion beams. In the framework of CERN's LHC Injectors Upgrade (LIU) project, aimed at improving the performances of the pre-accelerators in view of the high-luminosity upgrade of the LHC, the Beam Position Monitor (BPM) system of the SPS was redesigned during Run 2 of the LHC and deployed during the subsequent Long Shutdown 2 (LS2). This new system is called ALPS (A Logarithmic Position System) and acquires the signals from some 240 BPMs. It is designed to improve the system's reliability and reduce the required maintenance with respect to its predecessor. During the restart of the SPS in 2021, the BPM system was a key element of the fast recommissioning of the machine, proving the validity of the chosen design approach and pre-beam commissioning strategy. This paper aims to illustrate the design choices made for ALPS, the strategy for commissioning it with beam in parallel with the machine restart, the commissioning procedure and the results obtained.

MOPP24 02 Beam Position Monitors

Signal Processing Architecture for the HL-LHC Interaction Region BPMs

Presenter : Douglas Robert Bett
Author(s) : Douglas Robert Bett (JAI, Oxford), Andrea Boccardi, Irene Degl'Innocenti, Michal Krupa, Manfred Wendt (CERN, Geneva)

In the HL-LHC era, the Interaction Regions around the ATLAS and CMS experiments will be equipped with 24 new Beam Position Monitors (BPM) measuring both counter-propagating beams in a common vacuum chamber. Numerical simulations proved that, despite using new high-directivity stripline BPMs, the required measurement accuracy cannot be guaranteed without bunch-by-bunch disentanglement of the signals induced by both beams. This contribution presents the proposed signal processing architecture, based on direct digitisation of RF waveforms, which optimises the necessary computing resources without a significant reduction of the measurement accuracy. To minimise the number of operations performed on a bunch-by-bunch basis in the FPGA, some of the processing takes place in the CPU using averaged data.

MOPP25 02 Beam Position Monitors

Harmonic based Beam Position Measurements on Debunched Beams

Presenter : Michele Bozzolan
Author(s) : Michele Bozzolan (CERN, Geneva)

Often the beam position is measured (e.g. in LINACs) with a BPM operating on one strong harmonic component present in the beam signal. This approach has limitations once the beam gets debunched and the harmonic component drop. Nevertheless, from a signal processing point of view the signal to noise ratio can be still acceptable in highly debunched beams, leading, in principle, to a reasonable, even if degraded, position measurement. A simplified beam transport model developed for the CERN transport-line between Linac 4 and the PS Booster (PSB) demonstrates that the degradation of the harmonic signal contents is neither linear, nor monotonic since the harmonic components can vanish at certain locations and the detection of the beam position based on a particular harmonic is not reliable nearby those locations.

MOPP26 02 Beam Position Monitors

Performance of BPM Readout Electronic Based on Pilot-Tone Generator and a Modified Libera Spark at ALBA

Presenter : Laura Torino
Author(s) : Laura Torino, Ubaldo Iriso (ALBA-CELLS Synchrotron, Cerdanyola del Vallès)

As many synchrotron radiation source, ALBA is also going through an upgrade project. At the same time, the world of BPM electronic is evolving fast to keep up with the stringent requirement of new facilities. In order to follow the situation closely and develop know how for the future, we decided to install and test a BPM readout system composed by a Pilot-Tone generator, developed by Elettra, and a modified Libera Spark, by Instrumentation Technology in our storage ring. We compare position measurement results and stability with the ones obtained by our standard Libera Brilliance and a Libera Brilliance+ electronics.

MOPP27 02 Beam Position Monitors

EPU-PBPM with CVD-diamond Blade at PLS-II

Presenter : Jinjoo Ko
Author(s) : Jinjoo Ko, Taekyun Ha, Garam Hahn, Dotae Kim, Seunghwan Shin (PAL, Pohang)

All 18 photon beam position monitors (PBPM) installed on the PLS-II are tungsten blade types. The elliptical polarized undulator (EPU) has the characteristic that the spatial profile of the beam varies depending on the polarization mode. This is related to the thermal load of the blade and therefore changes in blade material are inevitable on fixed blades. In this paper, we analyze power density and flux density according to EPU mode and describe the process of installing new PBPM with CVD-diamond blades on the PLS-II EPU beamline for the first time.

MOPP28 02 Beam Position Monitors

Experimental Test of 8-Channel-Stripline BPM for Measuring the Momentum Spread of the Electron Beam at Injector Test Facility of Pohang Accelerator Laboratory

Presenter : Chang-Kyu Sung
Author(s) : Chang-Kyu Sung, Moses Chung, Seong-Yeol Kim (UNIST, Ulsan), Changbum Kim, Inhyuk Nam (PAL, Pohang)

A stripline beam position monitor has been developed with 8 feedthroughs in order to non-destructively measure the momentum spread of an beam. The beam momentum spread causes the variation of transverse beam width at a dispersive section and can be detected by the multipole moment based analysis of the beam-induced electromagnetic field. The feasibility of such a device has been tested with electron beam generated in the beamline of Injector Test Facility (ITF) at Pohang Accelerator Laboratory (PAL). The result of beam test will be presented and the future plan for an application to bunch compressors at X-ray Free Electron Laser (XFEL) of PAL will be followed.

MOPP29 02 Beam Position Monitors

Design and Optimisation of Beam Position Monitor for Siam Photon Source II Storage Ring

Presenter : Sakdinan Naeosuphap
Author(s) : Sakdinan Naeosuphap (Synchrotron Light Research Institute (SLRI), Muang District), Porntip Sudmuang (SLRI, Nakhon Ratchasima)

The Beam Position Monitors (BPMs) for the new Thailand synchrotron light source, Siam Photon Source II (SPS-II), has been designed utilizing as the essential tool for diagnosing the position of the beam in the storage ring. Its design with four-button type BPM has been optimized to obtain the high precision of position data in normal closed orbit and feedback mode as well as turn by turn information. We calculate feedthroughs capacitance, sensitivities, induced power on a 50 Ohm load, and intrinsic resolution by using Matlab GUI developed by ALBA, to find the appropriate position, thickness, and gap of the BPM button. Extensive simulation with the electromagnetic simulation tool CST Particle Studio was also performed to investigate the dependence of the induced BPM signal, wakefield, Time Domain Reflectometry (TDR), and power loss on different BPM geometry.

MOPP30 02 Beam Position Monitors

Tests of the New BPM Long Term Drift Stabilization Scheme Based on External Crossbar Switching at PETRA III

Presenter : Gero Kube
Author(s) : Gero Kube, Frank Schmidt-Foehre, Kay Wittenburg (DESY, Hamburg), Ales Bardorfer, Luka Bogataj, Manuel Cargnelutti, Peter Leban, Peter Paglovec, Borut Repic (I-Tech, Solkan)

The PETRA IV project at DESY aims to upgrade the present synchrotron radiation source PETRA III at DESY into an ultralow-emittance source which will be diffraction limited up to X-rays of about 10 keV. Using a multi bend achromat lattice, the small PETRA beam emittance translates directly into much smaller beam sizes at the insertion device source points, thus imposing stringent requirements on machine stability. In order to measure beam positions and control orbit stability to the requisite level of accuracy, a high resolution BPM system will be installed which consists of about 700 individual monitors with the readout electronics based on MTCA.4 as technical platform. In order to fulfill the requested long-term drift requirement to be less than 1 micron over a period of seven days, due to the PETRA-specific machine geometry the BPM cable paths have to be stabilized in addition. To achieve this demand, the well proven concept of crossbar switching was extended such that the analogue switching part is separetd from the read-out electronics and brought as close as possible to the BPM pickup. This contribution summarizes first proof-of-principle measurements which were performed in the lab and at PETRA III using a modified Libera Brilliance+ with external switching matrix. These measurements indicate that the concept of external switching works well and that the performance of this modified test setup fulfills the specifications.

MOPP31 02 Beam Position Monitors

Preliminary Studies for the SOLEIL Upgrade Beam Position Monitors

Presenter : Moussa El Ajjouri
Author(s) : Moussa El Ajjouri, Filipe Alves, Alexis Gamelin, Nicolas Hubert (SOLEIL, Gif-sur-Yvette)

Synchrotron SOLEIL is preparing a machine upgrade based on multibend achromat lattice with a drastically reduced horizontal electron beam emittance (<100 pmrad). Foreseen quadrupole and sextupole strengths will impose a small vacuum chamber diameter and the future Beam Position Monitors (BPM) will have a 16 mm inner diameter (circular shape). To minimize the BPM contribution to the longitudinal impedance, and induced heating on their mechanics, the feedthrough and button shapes must be optimized. This paper summarizes the systematic electromagnetic simulations that have been carried on in order to distinguish the effect of single dimension changes (such as button thickness and shape, ceramic thickness and diameter) on the amplitudes and frequency position of the resonances. It also introduces the preliminary BPM design for the SOLEIL upgrade project.

MOPP33 02 Beam Position Monitors

BPM System for the PIP2 Injector Test Facility

Presenter : Nathan Eddy
Author(s) : Nathan Eddy (Fermilab, Batavia, Illinois)

A new BPM system was used for commissioning and operation of the PIP2 Injector Test Facility. The system of 13 warm and 12 cold BPMs was based upon custom 250 MS/s digitizers controlled and readout over gigabit ethernet by a single multi-core rackmount server running linux. The system provided positions, intensity, and phase for each bpm as a pulse average or pulse waveform from 10 us to 4 ms at a 20 Hz pulse repetition rate.

MOPP34 02 Beam Position Monitors

Performance of the SLAC-PAL-Vitzrotech X-band Cavity BPMs in the LCLS-II Undulator Beam Lines

Presenter : Christopher Dennis Nantista
Author(s) : Christopher Dennis Nantista, Sonya Hoobler, Patrick Krejcik, Dennis Martinez-Galarce, Bobby McKee, Michael Rowen, Andrew Young (SLAC, Menlo Park, California), Changbum Kim (PAL, Pohang)

The hard X-ray and soft X-Ray undulator beamlines of the LCLS-II X-ray FEL incorporate dozens of X-band RF beam position monitors for accurate tracking of the electron beam trajectories and Beam-Based Alignment. For this crucial function, a design was jointly developed between PAL and SLAC, consisting of a monopole reference cavity and a dipole position cavity, with signals coupled out through coaxial vacuum feed-throughs. For the relatively large quantity needed, the production of completed units was contracted to the Korean company, Vitzrotech, who developed the manufacturing processes to successfully fabricate the needed quantity. Herein, an overview is given of the production experience, tuning, installation, and performance of these devices.

MOPP35 02 Beam Position Monitors

Commissioning and Results of SPIRAL2 BPMs

Presenter : Christophe Jamet
Author(s) : Christophe Jamet (GANIL, Caen)

The construction of a new accelerator is always an opportunity to implement new developments and meet challenges. The BPM diagnostics, installed in the linac of the SPIRAL2 accelerator, and the associated instrumentation are part of these developments. BPM instrumentations are, of course, used to measure positions and phases of ion beams but also transverse shapes, called ellipticity, as well as the beam velocity. Specifications involve knowing and calculating the sensitivities in position and in ellipticity as a function of the beam velocities. These impose small amplitude differences between channels, which require precise calibration of electronics cards. The modelling and analysis of the BPM behaviour according to the beam velocity are explained in the document as well as technical solutions, modifications and improvements, an analysis of the results and the evolutions in progress.

MOPP36 02 Beam Position Monitors

Comparison of Two Long Term Drift Stabilization Schemes for BPM Systems

Presenter : Frank Schmidt-Foehre
Author(s) : Frank Schmidt-Foehre, Gero Kube, Kay Wittenburg (DESY, Hamburg)

A future upgrade of synchrotron radiation sources at DESY will most likely be in need to produce much smaller beam sizes at the insertion device source points for generation of desirable small beam emittances. In order to measure according beam positions and to control orbit stability to the corresponding level of accuracy, a future high-resolution BPM system has to deliver the necessary requirements on machine stability. This needs to enable long-term drift requirements of even less than 1 micron beam position deviation per week. To cope for general machine topologies (symmetric vs asymmetric), very low long-term drift requirements of BPM parameters will typically need a compensation of BPM cable parameter drifts. This paper discusses a comparison of two common compensation schemes using different signal conditioning features, typically needed at asymmetric machine topologies with long BPM cable paths. Certain measurements needed to ensure critical aspects of the different schemes are explained.

MOPP37 08 Feedback Systems and Beam Stability

KEK LUCX Facility Laser Transport Line Alignment Automatization

Presenter : Konstantin Popov
Author(s) : Konstantin Popov (Sokendai, Ibaraki), Alexander Aryshev, Nobuhiro Terunuma, Junji Urakawa (KEK, Ibaraki)

KEK LUCX facility* is a linear accelerator devoted to the beam instrumentation RDs for present and future accelerator systems and colliders. Parameters of electron beam generated by laser-driven photocathode-equipped gun are sensitive to laser wavelength, laser pulse intensity, duration (RMS), spot size (RMS) and spot position on the photocathode. Typically, tuning of such generation schema requires stable laser pulse generation and shaping, alignment of the laser transport line (LTL) and final focus optical system. Conventional diagnostics along LTL may include CCD cameras for position and profile tuning and monitoring including that at the virtual cathode position. An approach to achieve laser spot size and position with the high level of stability and reproducibility on the photocathode is associated with the implementation of geometric optics based software protocol which allows for automatic- or semi-automatic alignment of entire LTL. This approach was developed and applied for KEK LUCX RF gun LTL alignment. It employs two CCD cameras**, motorized mirrors and optical telescope designed for laser pulse delivery to the photocathode. The report shows the system stability and repeatability results, as well as commissioning technical notes.

MOPP38 08 Feedback Systems and Beam Stability

An Automatic Focalization System for Enhanced Radioisotope Production with Solid Targets

Presenter : Pierluigi Casolaro
Author(s) : Pierluigi Casolaro, Saverio Braccini, Gaia Dellepiane, Philipp Häffner, Isidre Mateu, Naomi Voeten, Elnaz Zyaee (AEC, Bern), Paola Scampoli (AEC, Bern; Naples University Federico II, Napoli)

A research program aimed at the production of novel radioisotopes for theranostics is ongoing at the 18 MeV Bern medical cyclotron laboratory equipped with a solid target station, based on the bombardment of isotope enriched materials in form of compressed 6 mm diameter pellets. To accomplish this challenging goal, accurate knowledge of beam energy, positioning and focusing as well as production cross sections is crucial. Investigations are carried on to assess all these items. In particular, an automatic compact focalization system was conceived and constructed to optimize the irradiation procedure. It is based on a 0.5 m long magnetic system, embedding two quadrupoles and two steering magnets, and a non-destructive beam monitoring detector located in front of the target. The profiles measured by the detector are elaborated by a feedback optimization algorithm that acts on the magnet and keeps the beam focused on target to enhance the production yield. Following the first successful functional tests, the preliminary results on the production of medical radioisotopes are presented.

MOPP39 08 Feedback Systems and Beam Stability

The Design of a Fast Orbit Feedback System for Hefei Advanced Light Facility

Presenter : Yunlong Li
Author(s) : Yunlong Li, Bao-gen Sun (USTC/NSRL, Hefei, Anhui)

In order to improve the stability of the beam orbit, the fast orbit feedback system (FOFB) is employed to eliminate the undesirable interference from various sources. The paper will present the design of the design of the global Fast Orbit Feedback for Hefei Advanced Light Facility (HALF). The FOFB system aims to stabilize the electron beam position towards an ideal electron beam orbit. The FOFB system employs high-speed board series PXIe-7902 board of National Instruments (NI) to realize the design of the communication controller (CC) and the algorithm calculation. The PXIe-7902 called cell has a built-in Xilinx Virtex-7 586T and 24 two-way digital channels. Which allows connecting 12 Liberal BPMs at most to receive the beam position values. A two-tier communication architecture is applied in the CC design. The beam position monitors are directly connected to cell and do not communicate each other. Which liberates the tasks of BPMs and make the task concentrated on the cell. The correction output is connected to the power supply to adjust the correctors to reach beam stability.

MOPP40 08 Feedback Systems and Beam Stability

Design of Transverse Feedback Kickers for the HEPS Storage Ring

Presenter : Xiaoyu Liu
Author(s) : Xiaoyu Liu (IHEP)

The High Energy Photon Source (HEPS) is a 6 GeV synchrotron radiation light source being built in Beijing, China. The electron beam inside the storage ring is designed to run with ultra-low emittance. To ensure high beam quality, the coupled bunch instabilities need to be carefully investigated and controlled, therefore an effective feedback system is essential. Stripline electrodes will be used in HEPS storage ring as transverse feedback kickers. Besides, a tune kicker is designed to measure tune and clean undesired buckets. This paper will introduce the design of these kickers, which mainly includes the optimization of the shunt impedance and reflection parameters within the working bandwidth. The shunt impedance simulated by numerical code HFSS is well coincident with the theoretical results.

MOPP41 08 Feedback Systems and Beam Stability

A New Digital SSB Longitudinal Feedback System for the Fermilab Booster

Presenter : Nathan Eddy
Author(s) : Nathan Eddy (Fermilab, Batavia, Illinois)

The Booster Longitudinal Mode Feedback System has been upgraded to single sideband system with improved ability to measure Beam Transfer Function for each mode. The new system provide feedback via either dedicated mode cavites or via the Booster RF system. It also provides diagnostic capabilities for tracking the sidebands of any Booster mode after transition crossing.

MOPP42 08 Feedback Systems and Beam Stability

Several Key Circuit Designs in HEPS-FOFB

Presenter : Zhe Xin Xie
Author(s) : Zhe Xin Xie, Mingtao Kang, Zhencheng Mu (IHEP CSNS, Guangdong Province), Daoyuan Wang (DNSC, Dongguan), Dapeng Jin, Lei Zeng, Yuliang Zhang, Peng Zhu (IHEP, Beijing)

The bunch size of HEPS is up to micrometer level, so it is very vulnerable to external interference. FOFB(Fast Orbit Feedback) is used to counteract external interference and improve beam quality. HEPS Fofb independently developed hardware equipment, used to collect 576 BPM data, and then distributed to 192 fast corrector power supply after matrix operation and PI operation. Fofb is divided into 16 sub-sites, each sub-site uses a single circuit main board, each site processes 36 BPM data, 24 (X Y axis) corrector power supply. Two Xilinx FPGA chips are mounted on the circuit board, one is for high-speed data processing,the other is network transmission and low-speed data processing. Because the single board processing business is very large, there are more than 15 channels of high current and low noise power supply, more than 60 channels of low jitter clock, and tens of centimeters of 10Gbps high-speed transmission path. This paper will introduce the simulation and design of power supply, clock and high-speed transmission in detail.

MOPP43 08 Feedback Systems and Beam Stability

A New Interactive, Intelligent and Automatic Control System for the INFN-LNS Accelerators and Beamlines

Presenter : Gianfranco Vecchio
Author(s) : Gianfranco Vecchio, Salvatore Aurnia, Salvo Cavallaro, Benedetto Filippo Diana, Enrico Furia, Salvatore Pulvirenti, Antonio Domenico Russo (INFN/LNS, Catania)

A new automatic and intelligent Control System was build at Istituto Nazionale di Fisica Nucleare - Laboratori Nazionali del Sud (INFN-LNS) to control and monitor the accelerators and the beamlines. We built an interactive synoptic panel, a web application and a mobile app that communicate with each other. Moreover, a new protocol for the message exchange between the field devices and the control user interfaces was adopted, by using an in-memory nosql database (Redis) as message broker. Several tools allow the calculation of the beam intensity and the automatic acquisition of the beam contour for future beam replication. In addition, a relational database is used to store all the machine and beamlines parameters every day for each experiment. All these data feed an artificial intelligence system that will allow automatic control of the beam transport and its steady state stability.

MOPP44 08 Feedback Systems and Beam Stability

Analysis of Multi-Bunch Instabilities at Alba Using a Transverse Feedback System

Presenter : Ubaldo Iriso
Author(s) : Ubaldo Iriso, Thomas Friedrich Günzel (ALBA-CELLS Synchrotron, Cerdanyola del Vallès)

Since 2015 Alba is equipped with a transverse bunch by bunch feedback system, which not only damps the transverse coupled bunch instabilities in the machine, but also allows the impedance characterization of the storage ring. This characterization is produced by an internal sequence, which is programmed to excite and measure the growth and damping rates of each of the multi-bunch modes. This paper describes the measurement technique, presents the studies carried out to characterize the machine and different movable systems like the scrapers or in-vacuum undulators. Results are compared with the transverse impedance spectra obtained from computer simulations.

Tuesday & Wednesday

TUPP01 03 Transverse Profile and Emittance Monitors

The Applications of Machine Learning in Slit Scan Emittance Measurements

Presenter : Shuai Ma
Author(s) : Shuai Ma, Andre Arnold, Anton Ryzhov, Jochen Teichert, Rong Xiang (HZDR, Dresden), Jana Schaber (HZDR, Dresden; TU Dresden, Dresden)

The electron beam transverse projected emittance is one of the importance parameters to a photoinjector. Two traditional emittance measurement techniques are curried out widely in photoinjectors beamline, quadrupole scan and slit scan. Comparing the quadrupole scan, the slit scan can give the details of the electron beam phase space, which is useful for studying and understanding the beam dynamics. The ELBE SRF Gun diagnostics beamline was built science 2008 and both of two techniques were used to measure beam emittance. From 2019, to optimize beam parameters for users more effectively, a new fast slit scan system was built, which is based on a mask with one 100 um width slit, a fast motor, two cameras and a control and data analysis software. In one experiment, about one hundred images will be captured in 5 to 15 seconds. In traditional data analysis method, the image processing is time-consuming to reduce noise and make sure the emittance accuracy. Even so, the dark current noise still cannot be avoided in low bunch charge. The deep learning method is advanced to image processing and has potential application in this field to reduce the noise effectively and give a more accuracy emittance of the beam. The applications of deep learning in slit-scan images processing can be classified into two classes: images classification network and regression network.

TUPP02 03 Transverse Profile and Emittance Monitors

The Multi-Purpose Iris Diaphragm E-Beam Apparatus Series - Halo Detector

Presenter : Ao Liu
Author(s) : Ao Liu, John Rison Callahan (Euclid TechLabs, Solon, Ohio), Jiahang Shao (ANL, Lemont, Illinois)

Non-Gaussian beam distributions around the Gaussian core can be formed in an accelerator in both the transverse and longitudinal directions. Since there are no clearly defined criteria to distinguish the halo from the core, the measurement of the halo structure without affecting the core is challenging. Previously, a novel design of an iris diaphragm detector for transverse beam halo distributions and transverse profile (iris diaphragm e-beam apparatus series - halo, or IDEAS-halo) was reported by Euclid Techlabs*. This multi-purpose design not only measures the transverse beam distribution but may also work as a tunable collimator or an adjustable BPM. In this paper, the newest version of the IDEAS-halo and beam experiments using the 2 MeV electron beam at the AWA Cathode Teststand (ACT) of ANL, and the 600 keV "brazeless" compact accelerator beam at Euclid are discussed.

TUPP03 03 Transverse Profile and Emittance Monitors

Particle and Photon Beam Measurements Based on Vibrating Wire

Presenter : Suren Arutunian
Author(s) : Suren Arutunian, Gevorg Harutyunyan, Ella Lazareva, Ashot Margaryan (ANSL, Yerevan), Moses Chung, Donghyun Kwak (UNIST, Ulsan)

The instrumentation introduced herein is based on high-quality vibrating wire resonator, in which the excitation of wire oscillation is made through the interaction of the wire current with a permanent magnetic field. The high sensitivity of the oscillation frequency to the wire temperature allows the resonator to be used for measuring charged-particle/X-ray/laser/neutron beam profiles with wide dynamic range. The beam flux falling on the wire increases its temperature from fractions of mK to hundreds of degrees. Another application method is to use the vibrating wire as a moving target, in which signals created at beam interaction with the wire are measured synchronously with the wire oscillation frequency. This method allows to effectively separate the background signals. Also, the well-defined (in space) and stable (in time) form of the wire oscillation allows the vibrating wire to be used directly as a miniature scanner for measuring thin beams. The latter two methods enable a significant reduction in scanning time compared to the original thermal-based method.

TUPP04 03 Transverse Profile and Emittance Monitors

Experiments with Diamond Beam Halo Monitor

Presenter : Sergey Vladimirovich Kuzikov
Author(s) : Sergey Vladimirovich Kuzikov, Sergey P. Antipov, Pavel Avrakhov, Ernest William Knight (Euclid TechLabs, Solon, Ohio), John Gorham Power, Jiahang Shao (ANL, Lemont, Illinois)

We propose diamond as a radiation hard material which can be used to measure the flux of passing particles based on a particle-induced conductivity effect. Our diamond beam halo monitor is based on a microwave measurement of the change in the resonator coupling and eigen frequency. For measurements we put a sensitive diamond sample in a resonator that intercepts the halo. By measuring the change in RF properties of the resonator, one can infer the beam halo parameters scanning across the beam to map its transverse distribution. In first experiments we used a Vertical Beam Test Stand, delivered DC electron beam of the 20-200 keV energy with the current up to 50 ¿A, to characterize several diamond samples. We have also designed and fabricated a scanning diamond X-band resonator, which was tested at Argonne Wakefield Accelerator (AWA). In experiments at AWA we studied sensitivity and resolution of our monitor based on a single crystal diamond using multi-MeV, 1 pC - 500 pC picosecond electron bunches.

TUPP05 03 Transverse Profile and Emittance Monitors

Space-Charge Effects in Ionization Beam Profile Monitors

Presenter : Vladimir Shiltsev
Author(s) : Vladimir Shiltsev (Fermilab, Batavia, Illinois)

Ionization profile monitors (IPMs) are widely used in accelerators for non-destructive and fast diagnostics of high energy particle beams. At high beam intensities, the space-charge forces make the measured IPM profiles significantly different from those of the beams. We analyze dynamics of the secondaries in IPMs and develop an effective algorithm to reconstruct the beam sizes from the measured IPM profiles. Efficiency of the developed theory is illustrated in in application to the Fermilab 8 GeV proton Booster IPMs and 70 MeV/c IOTA proton ring.

TUPP06 03 Transverse Profile and Emittance Monitors

Simulation of a Quad-Silts Interferometer for Measuring the Transverse Beam Size in HLS-II

Presenter : Sanshuang Jin
Author(s) : Sanshuang Jin (USTC/NSRL, Hefei, Anhui)

In this paper, a quad-slits interferometer using visible light is designed to measure the transverse beam size of Hefei Light Source-II (HLS-II). According to the beam parameters of the B7 source point, the preliminary simulation results are obtained by using the Synchrotron Radiation Workshop (SRW) code. Furthermore, the core parameters of the quad-slits components in the interferometer are optimized. Among, the optimum slits-separations of dH and dV are acquired to be 6.0 mm and 10.0 mm, respectively. It is shown that the simulated results are consistent with the theoretical values, which provides a reference value for performing the related experiments in the future.

TUPP07 03 Transverse Profile and Emittance Monitors

Development of a Multi-Camera System for Tomography in Beam Diagnostics

Presenter : Adem Ateş
Author(s) : Adem Ateş, Ulrich Ratzinger (IAP, Frankfurt am Main)

Embedded visual systems in industry lead to advancements of single board computers and single board cameras. Due to the lower power consumption and high flexibility of these miniature devices, a multi-camera system can be developed more effectively. A prototype of a beam-induced residual gas fluorescence monitor (BIF) has been developed and successfully tested at the Institute of Applied Physics (IAP) of the Goethe University Frankfurt. This BIF is based on a single-board camera inserted into the vacuum. The previous promising results led to the development of a multi-camera system with 11 cameras. One of the advantages of integrating such a system into the vacuum is the small form factor, allowing this detector to be integrated in regions that are difficult to access. The overall goal is to study the beam with tomography algorithms at a low energy beam transport section. We hope to reconstruct an arbitrary beam profile intensity distribution without assuming a gaussian beam.

TUPP08 03 Transverse Profile and Emittance Monitors

Beam Experiment of Wire Scanner Prototype for SHINE

Presenter : Jun Wan
Author(s) : Jun Wan (SINAP, Shanghai), Fangzhou Chen, Jie Chen, Bo Gao, Yongbin Leng (SSRF, Shanghai)

Beam experiment of the wire scanner prototype was carried out in soft X-ray free electron laser (SXFEL) for functional verification. In this paper, the design and optimize of the wire scanner is mentioned, the beam test was conducted on the Shanghai Deep ultraviolet free electron laser (SDUV-FEL) facility [1]. Beam loss signal processors including broadband oscilloscope and homemade ADC acquisition card have been used to evaluate the system performance as well. The beam experimental result, which matched with FLUKA and ANSYS simulation, will be presented and discussed in this paper.

TUPP09 03 Transverse Profile and Emittance Monitors

Proposal of an Interferometer for Beam Size Measurement Based on RC Focusing Mirror

Presenter : Liangwei Sun
Author(s) : Liangwei Sun, Qing Luo (USTC/NSRL, Hefei, Anhui)

In the measurement of the transverse beam size of the synchrotron beam, we often use the interferometry to measure the beam size.The conventional interferometer is mainly composed of double slits and focusing lens, but the lens will inevitably produce chromatic aberration,For the Hefei Light Source HLS II, this paper proposes to replace the first focusing lens in the original interference light path with an RC structure focusing mirror. The second single lens is replaced with a doublet lens to reduce dispersion and geometric aberration without changing the optical axis of the optical path.So as to improve the imaging quality of the optical path.

TUPP10 03 Transverse Profile and Emittance Monitors

Development of a Beam Halo Monitor at Diamond Light Source

Presenter : Emily Howling
Author(s) : Emily Howling (DLS, Harwell), Lorraine Bobb (DLS, Oxfordshire)

A beam halo monitor is under development at Diamond Light Source. It is an optical system that uses visible synchrotron radiation to image the beam halo. In this paper, the design of the monitor is presented, including the inclusion of a Lyot stop system to reduce diffraction effects. Images of the beam halo under typical accelerator conditions and during beam injection are analysed. These results will aid in understanding the impact of the reduced dynamic aperture of the Diamond-II accelerator.

TUPP11 03 Transverse Profile and Emittance Monitors

Emittance Measurement Algorithm and Application to HIMM Cyclotron

Presenter : Yongchun Feng
Author(s) : Yongchun Feng, Ruishi Mao (IMP/CAS, Lanzhou)

HIMM, a Heavy Ion Medical Machine, developed by Institute of Modern Physics, has been under operation since April 2020. The beam emittance of the cyclotron exit is measured with the most often used technique, i.e. slit-grid, Q-scan and 3-grid at a dedicated beam line which is not the actual HIMM optical line. The high speed data acquisition architecture is based on FPGA, and motion control system is constructed based on the NI module. The data post processing and emittance calculation based on Python with self-developed algorithm, including Levenberg'Marquardt optimization algorithm, thick lens model, dispersion effect correction, error bar fit, mismatch check, image denoise and zero-thresholding calculation, are shown in details. Finally, the data obtained from cyclotron are analyzed in this paper as well.

TUPP12 03 Transverse Profile and Emittance Monitors

Development of a Pepper Pot Emittance Measurement Device for the HIT-LEBT

Presenter : Rainer Cee
Author(s) : Rainer Cee, Eike Feldmeier, Thomas Haberer, Andreas Peters, Jochen Schreiner, Tim Winkelmann (HIT, Heidelberg), Christoph Dorn (GSI, Darmstadt)

The Heidelberg Ion Beam Therapy Centre (HIT) is a synchrotron based medical accelerator facility for the treatment of cancer patients with ions. Since the first treatment in November 2009 about 7000 patients have been irradiated with protons or carbon ions. In 2010 HIT started the operation of a test bench with a setup comparable to the LEBT at the accelerator. Since 2013 the test bench serves as a common low energy beamline of Siemens Healthcare and HIT with components from both partners. In parallel to ion source and RFQ research and development we have experimented with our proprietary pepper pot device. We plan to install the final version of the pepper pot into the LEBT and use the measured beam distributions for the design of a new RFQ. With the recent redesign of the mask-target assembly we have increased the active area of the device and generated a possibility for an accurate pixel calibration by a specialised calibration mask. Our tool PePE (Pepper Pot Emittance Evaluation) offers different approaches for the reconstruction of the 4D emittance parameters from the raw image. The evaluation process was validated by a pepper pot image generated from a simulated beam with known properties.

TUPP13 03 Transverse Profile and Emittance Monitors

Beam Profile Monitor Design for a Multipurpose Beam Diagnostics System

Presenter : Ali Reza Najafiyan
Author(s) : Ali Reza Najafiyan, Fereydoon Abbasi (Shahid Beheshti University, Tehran), Shahin Sanaye Hajari (IPM, Tehran), Farshad Ghasemi (NSTRI, Tehran)

Beam diagnostic tools are the key component of any accelerator.They provide the way to measure beam parameters in order to monitor the accelerator performance. The beam profile is a bridge to other beam parameters such as transverse position, size, divergence and emittance. Depending on the characteristics of the beam, there are different tools and methods for monitoring the beam profile. A suitable diagnostic tool for measuring the beam profile with high resolution is scintillator view screens which is one of the oldest and most precise tools. This paper presents the beam profile monitor design for a multipurpose beam diagnostic system. This system is aimed to measure the beam profile, transverse parameter, energy spectrum and current. The concerning issues in the beam profile monitor design such as image resolution, radiation damage and scintillator temperature distribution have been discussed.

TUPP14 03 Transverse Profile and Emittance Monitors

Commissioning of the SEM-Grid Monitors for ELENA

Presenter : Mark McLean
Author(s) : Mark McLean (CERN, Geneva 23), Jean Cenede (CERN, Geneva), Gerard Tranquille (CERN, Meyrin), Masaki Hori (MPQ, Garching, Munich)

ELENA is a compact ring for cooling and further deceleration of 5.3 MeV antiprotons deliveredby the CERN Antiproton Decelerator. It decelerates antiprotons to a minimum energy of100 keV, creating special challenges for the beam instrumentation. These challenges havebeen addressed by an extremely sensitive SEM-Grid monitor which is also compatible with theUHV requirements of ELENA. Since November 2019 ELENA's H-ion source has been used totest the SEM-Grid monitors and since July 2020 the monitors have been used to commissionthe ELENA transfer lines. In this paper a summary of the features of the SEM-Grid will begiven, and an overview of the commissioning activities. A technique for testing the integrity ofan inaccessible pickup wire will also be described.

TUPP15 03 Transverse Profile and Emittance Monitors

4D Beam Tomography at the UCLA Pegasus Laboratory

Presenter : Veronica Guo
Author(s) : Veronica Guo, Paul Elliot Denham, Pietro Musumeci (UCLA, Los Angeles)

We present an algorithm to tomographically reconstruct the 4D phase space of a beam distribution of a high brightness electron beam, based on the use of two screens placed at the beginning and the end of a beamline containing a normal and a skew quadrupole triplet to arbitrarily rotate the phase space. After sampling the initial spatial profile using a macroparticle distribution, we iteratively update the initial momentum space until convergence is achieved with the image recorded at the second screen. This process is repeated with various quadrupole current settings. The algorithm is benchmarked against GPT simulations, and then implemented at the UCLA Pegasus beamline to optimize the phase space distribution for future high speed electron microscope experiments.

TUPP16 03 Transverse Profile and Emittance Monitors

The First Beam Experiment Result of the Protype of Wire Scanner for SHINE

Presenter : Fangzhou Chen
Author(s) : Fangzhou Chen, Jie Chen, Bo Gao, Yongbin Leng (SSRF, Shanghai), Jun Wan (SINAP, Shanghai)

As a kind of quasi-non-destructive beam size monitoring, SHINE will employ dozens of wire scanners. The preliminary study is confronted with motion control difficulty. To reduce the ultrahigh coordinate about wire movement with beam loss data acquisition, a new method has been proposed in the SXFEL test platform. The strategy is utilizing the beam jitter, which is of the same magnitude with the beam size. Combine with the jitter of the beam position, we move tungsten wires in a few of different position to realize the measurement. This paper will present our experiment design as well as a furthermore plans about the prototyping design.

TUPP17 03 Transverse Profile and Emittance Monitors

Fast Measurements of the Electron Beam Transverse Size and Position on SOLEIL Storage Ring

Presenter : Marie Labat
Author(s) : Marie Labat, Aurelien Bence, Nicolas Hubert, Dominique Pedeau (SOLEIL, Gif-sur-Yvette), Michele Caselle, Meghana Mahaveer Patil (KIT, Karlsruhe)

On SOLEIL storage ring, three beamlines are dedicated to electron beam diagnostics: two in the X-ray range and one in the visible range. The visible range beamline uses the synchrotron radiation which is emitted in one of the ring dipoles and further extracted by a slotted mirror operated in surf-mode (surfing on the upper part of the synchrotron layer). The radiation in the visible range is then transported towards a diagnostic hutch in the experimental hall, allowing electron beam imaging at the source point onto a standard CCD camera. In the perspective of prototyping works for the eventually forthcoming upgrade of SOLEIL, and for the on-going commissioning of a new Multipole Injection Kicker (MIK), we recently installed in this hutch two new branches ended by two new cameras (a KALYPSO system and a standard CMOS camera). We report in this paper the optimization we performed on the mirror mode of operation, as well as on spectral filtering, polarization selection, image plane location, fast acquisition tools, to improve the resolution and increase the speed of our initial transverse beam size measurement at source point.

TUPP18 03 Transverse Profile and Emittance Monitors

Commissioning of the LHC Injectors Upgrade BWS

Presenter : Jonathan Emery
Author(s) : Jonathan Emery, William Andreazza, Salvatore Di Carlo, Jose Carlos Esteban Felipe, Aurélie Goldblatt, Dmitry Gudkov, Ana Guerrero, Stephen Jackson, Guillaume Olivier Lacarrere, Miguel Martin Nieto, Arnaud Thomas RINALDI, Federico Roncarolo, Raymond Veness (CERN, Meyrin), David Belohrad (CERN, Geneva)

A novel generation of fast Beam Wire Scanners (BWS), developed in the framework of the LHC Injectors Upgrade (LIU), has been recently deployed in the 3 LHC injector synchrotrons, accelerating protons from 160 MeV to 450 GeV, during the 2019-2020 LHC long shutdown. The monitors feature high precision motor controller, high resolution wire position monitoring and wide dynamic range secondary particles detectors. This contribution will document the commissioning of the 17 new systems during the accelerator complex restart in 2021, which is an exciting and challenging phase in the life cycle of an instrument. A summary of the so far achieved levels of reliability, reproducibility, detectors/DAQ bandwidth and overall accuracy, will be used to revisit the options for further improving the systems' performance in the future.

TUPP19 03 Transverse Profile and Emittance Monitors

Proposed Research With Microbunched Beams at LEA

Presenter : Alex Lumpkin
Author(s) : Alex Lumpkin, William Berg, Jeffrey Craig Dooling, Yine Sun, Kent Peter Wootton (ANL, Lemont, Illinois), Donald Rule (Private Address, Silver Spring), Alex Murokh (RadiaBeam, Santa Monica, California), Pietro Musumeci (UCLA, Los Angeles, California)

One of the advantages of relativistic electron beams with microbunching at UV to visible wavelengths is the potential to generate coherent optical transition radiation (COTR) at a metal foil for diagnostics purposes. A significant microbunching fraction of at least 10% is expected for the case of a seed laser at 257.5 nm copropagating with a 343-MeV electron beam through a modulator undulator (3.2 cm period) at the Linac Extension Area (LEA) at Argonne National Laboratory. Diagnostic plans have been made for the COTR based-characterization of the microbunched beam size (100 microns), divergence (sub-mrad), microbunching fraction, spectrum, and bunch length (sub-ps), as well as coalignment of the laser pulse and electron beam as previously described**. For that case, COTR enhancements over OTR of more than seven million were calculated, and we expect a similar enhancement of coherent optical diffraction radiation (CODR). Thus, we propose the modification of the microbunching diagnostics station to support initial (CODR) experiments with beam transit through an aperture in a metal screen or near a metal edge at the second screen position of the interferometer. We would explore whether the coherence function for CODR provides a complementary beam size monitor and whether COTR and CODR interferences from the two interferometer screens provide divergence and pointing information.

TUPP20 03 Transverse Profile and Emittance Monitors

Electromagnetic Field Simulation and Optimization for the RCS IPM in CSNS

Presenter : Mengyu Liu
Author(s) : Mengyu Liu (IHEP, Beijing), Weiling Huang, Jilei Sun (IHEP CSNS, Guangdong Province)

Ionization profile monitors (IPMs) are widely used in high energy hadron accelerators for nondestructive beam profile measurement. The secondary particles generated by the ionization of the residual gas are collected and amplified by MCP, the output signal of which is sensitive to the influence of external disturbances dominated by the effect of space-charge. Thus the beam profile distortion should be studied primarily. Current profile correction method is mainly the commissioning of the electric field and magnetic field inside the RCS IPM to suppress the distortion. Here we verify the distortion process of the detected result through theoretical analysis and simulation, then optimize the configuration of electric field and magnetic field setting for the measurement of the CSNS-RCS IPM.

TUPP21 03 Transverse Profile and Emittance Monitors

The HL-LHC Beam Gas Vertex Monitor - Performance and Design Optimisation Using Simulations

Presenter : Bernadette Kolbinger
Author(s) : Bernadette Kolbinger, Owain Rhodri Jones, Thibaut Lefevre, Andreas Salzburger, Raymond Veness, Christos Zamantzas (CERN, Meyrin), Robert Kieffer, James William Storey (CERN, Geneva), Helene Guerin (CERN, Meyrin; Royal Holloway, University of London, Surrey), Stephen Michael Gibson (Royal Holloway, University of London, Surrey)

The Beam Gas Vertex (BGV) instrument is a novel non-invasive beam profile monitor and part of the High Luminosity Upgrade of the Large Hadron Collider (LHC) at CERN. Its aim is to continuously measure emittance and transverse beam profile throughout thewhole LHC cycle, which has not yet been achieved by any other single device in the machine. The BGV consists of a gas target and a forward tracking detector to reconstruct tracks and vertices resulting from beam-gas interactions. The beam profile is inferred from the spatial distribution of the vertices, making it essential toachieve a very good vertex resolution. Extensive simulation studies are being performed to provide a basis for the design of the future BGV.Thegoal of the studyis to ascertain the requirements for the tracking detector and the gas target within the boundaryconditions provided by the feasibility of integrating it into the LHC, budget and timescale.This contribution will focus on the simulations of the forward tracking detector. Based on cutting-edge track andvertex reconstruction methods, key parameter scans and their influence on the vertex resolution will be discussed.

TUPP22 03 Transverse Profile and Emittance Monitors

New CERN SPS Beam Dump Imaging System

Presenter : Stephane Burger
Author(s) : Stephane Burger (CERN, Geneva)

As part of the LHC injector Upgrade (LIU), the CERN SPS is now equipped with a new Beam Dumping System (SBDS) designed to cope with the high power beams foreseen for the High Luminosity LHC (HL-LHC) era. Before reaching the dump, the proton beam (from 26 to 450 GeV) is vertically kicked and then diluted passing through a series of horizontal and vertical bumps. This prevents the dump damage, by reducing the power density per surface unit. The quality of each dump event must be recorded and verified and all parameters of the SBDS are logged and analysed from the so-called Post-Mortem dataset. An essential part of the verification is performed by a beam imaging system based on a Chromox screen imaged on a digital camera. The desired availability level (100%, to protect the dump) and the harsh radiation environment made the design extremely challenging. For example, it implied the need for a 17 m long optical line made of high-quality optical elements, a special camera shielding (to minimise single event upsets) and a generally careful design accounting for maintenance aspects, mainly related to expected high activation levels. After giving an overview of the whole imaging system design with details on the chosen layout and hardware, this paper will discuss the DAQ and SW architecture, including the automatic, on-line, image selection for validating every dump event. This will be complemented with experimental results demonstrating the performance and reliability achieved so far.

TUPP23 03 Transverse Profile and Emittance Monitors

A Beam Diagnostics System of Electron Beam Melting for Additive Manufacturing

Presenter : Rafet Kavak
Author(s) : Rafet Kavak, Emre Durna, Mustafa Gökhan Sanal, Mustafa Murat Sezer (ASELSAN A.S., Ankara)

Electron beam melting has been used recently in additive manufacturing by various researchers. In those electron beam melting applications, the electron energy can be 60 to 100 keV, the beam current can be around 10 mA to 100 mA, and the beam spot size can be as small as 200 µm according to electron energy and beam current. Those parameters can result in very high beam power densities. The diagnostics of this powerful beam can be quite a problematic issue. As the electron beam current required for the application is quite similar to DC current, fast undestructive current measurement techniques for current beam profile and beam position are very limited in performance. Therefore, some destructive techniques to measure current and other beam properties are essential. As part of the beam diagnostics for electron beam melting application for additive manufacturing, the authors proposed a complete beam diagnostics system to measure the electron gun's capabilities and associate electromagnetic lens systems. The following properties have been diagnosed as part of this research work: i) Beam Current, ii) Beam Spot size for enlarged and focused beams, iii) Scanning velocity of the deflected beam, iv) Profile of the beam. The authors proposed methods to measure focused beam spot size and deflected beam scanning velocity using Secondary Emission Grid Sensors. Moreover, the authors proposed a new technique to measure beam profile using consecutively placed several copper plates with beam guiding holes of various diameters. The proposed beam profile measurement method effectively determines the useful beam radius for metal powder melting properties specifically to additive manufacturing applications.

TUPP24 03 Transverse Profile and Emittance Monitors

Development of a Profile Monitor Using OTR and Fluorescence for Injected Beams in J-PARC Main Ring

Presenter : Yoshinori Hashimoto
Author(s) : Yoshinori Hashimoto, Takeshi Nakamura, Takeshi Toyama (KEK, Tokai, Ibaraki), Yoichi Sato, Masaki Tejima (J-PARC, KEK JAEA, Ibaraki-ken), Toshiyuki Mitsuhashi, Masahiko Uota (KEK, Ibaraki), Hiroshi Sakai (Mitsubishi Electric System Service Co., Ltd, Tsukuba)

A two-dimensional beam profile monitor having a high dynamic range approximately six orders of magnitude by using of Optical Transition Radiation (OTR) and fluorescence screens has been operated in the injection-beam transport (3-50BT) line of the J-PARC main ring (MR) [1]. This device contributes to the diagnosis of beam core and halo of intense proton beams before injection to MR, particularly measurement of beam cut effects by beam collimators located in upstream of the device is useful for beam shaping. We have been developing the second device to be installed into MR for diagnosing on injected beams. By using the both of first and second devices, beam core and halo can be diagnosed in different phases. Moreover, by using the second device, beam profiles including halo can be measured with circulating beams in almost twenty turns after injection. This measurement allows us to diagnose beam cut effect by the MR beam collimators by observing beam halo phase space distribution. Property tests of the device have been conducted at a test bench to install it in the ring. In the structure of the device, its longitudinal coupling impedance close to 10 ohm (by Z/n value) is an issue, especially due to high-frequency resonance in the in-vacuum optical system and the target section by beam wake fields. As a countermeasure, we have been studying the absorption of the power of such high frequency resonances up to about 1 GHz using SiC. We have been studying to keep the coupling impedance as low as possible. In a current simulation, we obtained the result that the impedance can be reduced to about 0.5 ohm or less. At the end of this fiscal year, we plan to conduct a characteristic test with SiC mounted device. In this presentation, we will discuss the characteristics of the developing device to be put in the ring and the simulation result of suppressing the coupling impedance.

TUPP25 03 Transverse Profile and Emittance Monitors

Beam Profile Measurements Utilizing an Amplitude Modulated Pulsed Fiber Laser at PIP2IT

Presenter : Victor Scarpine
Author(s) : Victor Scarpine, Raul Campos, Nathan Eddy, Brian Fellenz, Timothy W. Hamerla, Jinhao Ruan, Alexei Semenov, David Slimmer, Randy Michael Thurman-Keup (Fermilab, Batavia, Illinois), Mathias El Baz (Université Paris-Saclay, CNRS/IN2P3, IJCLab, Orsay)

Fermilab is undertaking the development of a new 800 MeV superconducting RF linac to replace its present normal conducting 400 MeV linac. The PIP-II linac consists of a warm front-end generating 2 mA of 2.1 MeV H- followed immediately by a series of superconducting RF cryomodules to 800 MeV. To limit the potential damage to the superconducting RF cavities, PIP-II will utilize laser-based monitors to obtain beam profiles via photoionization. This paper will present the results of transverse and longitudinal beam profile measurements using a prototype profile monitor that was tested with 2.1 MeV H- beam at the PIP-II Injector Test (PIP2IT) accelerator. This prototype profile monitor utilizes a high repetition rate fiber laser and fiber optic transport into the PIP2IT enclosure. In addition, results will be shown of narrow-band electron detection from amplitude modulated laser pulses.

TUPP28 03 Transverse Profile and Emittance Monitors

Real-Time Beam Detection and Tracking From Pinhole Imaging System Based on Machine Learning

Presenter : Andriy Nosych
Author(s) : Andriy Nosych, Ubaldo Iriso (ALBA-CELLS Synchrotron, Cerdanyola del Vallès)

At ALBA Synchrotron each of the two in-air pinhole imaging systems is able to see up to 6 beam images at once due to specific pinhole grid setup placed in the path of the X-ray fan. Each beam image has its own properties, such as pinhole H and V size, its point spread function (PSF) and copper filter attenuation, all of which impact the source beam size calculation. Until recently, all these parameters were observed and controlled manually. An artificial neural net (ANN) is pointed at these beam images and is trained to recognize which one it is looking at in real time, with the end goal to automate the whole beam image analysis process.

TUPP30 03 Transverse Profile and Emittance Monitors

Fast Scanning Diamond Detector for Electron Beam Profile Monitoring

Presenter : Valeriy Konovalov
Author(s) : Valeriy Konovalov (Applied Diamond, Inc., Wilmington, Delaware), Steven Bellavia, Jean Clifford Brutus, Robert Michnoff, Toby Allen Miller, Peter Thieberger (BNL, Upton, New York)

Recently new high energy electron cooling beam projects, CeC and LEReC, were proposed at Brookhaven National Laboratory as part of a future electron-ion collider. Efficient electron cooling requires a high quality, high power electron beam with tight parameters (energy and space trajectory). In order to achieve and maintain the required parameters and stability of the electron beam, its parameters have to be continuously monitored and feedback control has to be developed. However, existing detectors are not suitable for invasive profile measurements of powerful continuous wave (CW) electron beams. As a result, the beam profile of powerful CW electron beams is currently monitored in low repetition pulsed mode and assumed to remain the same in CW mode. The first prototype of a fast scanning diamond beam profile detector (DBPD) suitable for invasive high power CW electron beam core profile measurements in transmittance mode was developed. It consists of a multi-strip solid state diamond detector to scan with high speed (up to 1 m/s) and precision (about 5 um) through the core of an electron beam. The diamond sensor was made from a thin pc-CVD diamond plate with highly B-doped CVD diamond conductive strips. Transient currents from the multi-strip detector were measured with fast digitizing electrometers. Successful operation of the DBPD was demonstrated for pulsed (5 Hz) and CW (78 kHz) CeC beams, including the detector's ability to withstand a 20 sec insertion into the CW CeC beam core. The X-Y beam spatial profile was measured in one scan. Thermal modeling demonstrated a manageable thermal impact even from a relatively long (up to 2 min) insertion of the diamond sensor into the CW CeC core. Electrical impedance modeling of the detector and vacuum chamber assembly demonstrated minimal impact on beam line impedance with diamond sensor insertion.

TUPP31 04 Beam Loss Monitors and Machine Protection

Design and Numerical Investigations of Scintillation Beam Loss Monitor for PolFEL

Presenter : Roch Kwiatkowski
Author(s) : Roch Kwiatkowski, Maciej Krakowiak, Slawomir Mianowski, Robert Nietubyc, Jarosław Szewiński (NCBJ, Swierk/Otwock), Adriana Izabela Wawrzyniak (NSRC SOLARIS, Krakow)

The Beam Loss Monitor (BLM) system is used mainly for machine protection and is particularly important in the case of high energy density of accelerated beam, when such a beam could lead to serious damages in the case of uncontrolled loss. The Polish Free Electron Laser, PolFEL, will be equipped with linear superconducting accelerator operating in continuous wave regime. The maximum energies of electrons will be equal to about 180 MeV, or 270 MeV for 2nd phase of operation. The beam charge, pulse width and repetition rate will be in the range of 100-250 pC, 0.1-10 ps and 50 kHz respectfully. Operational parameters of PolFEL linear accelerator induced needs to install and operate the BLM system. One of the type of BLMs is based on the scintillation detectors. Such a system is characterized by, e.g.: high sensitivity, fast response, broad gain range and relatively low cost. Another important feature of such setup is the option of checking the operation of detector by using the integrated LED. The BLM concept for PolFEL is based on several scintillation probes placed along the linear accelerator. The paper reports on numerical investigation of electron and X-ray radiation induced during fast electron losses. We also present design of BLM detectors and results of first tests of a prototype on the linear electron accelerator at Solaris research centre.

TUPP32 04 Beam Loss Monitors and Machine Protection

The Beam Loss Monitoring System after LHC Injectors Upgrade at CERN

Presenter : Mathieu Saccani
Author(s) : Mathieu Saccani (CERN, Geneva), William Vigano, Christos Zamantzas (CERN, Meyrin)

The LHC Injector Upgrade project aims to increase the brightness of the beams available and improve the efficiency of the whole accelerator chain. The Beam Loss Monitoring (BLM) system is a key element of CERN's accelerator instrumentation for beam optimisation and machine protection by producing continuous and reliable beam loss measurements while ensuring safe operation. The new BLM system for the LHC Injectors aimed to provide faster measures with a higher dynamic range, to install more detectors along the beamlines and to give the operator more flexible use. A review will be given on the versatility provided by the system to cover requirements from various accelerators and their transfer lines, focusing on the measurements and the operational scenarios.

TUPP33 04 Beam Loss Monitors and Machine Protection

Beam Loss Signal Calibration for the LHC Diamond Detectors During Run 2

Presenter : Belen Salvachua
Author(s) : Sara Morales Vigo (CERN, Geneva), Eva Calvo Giraldo, Ewald Effinger, Belen Salvachua, Christos Zamantzas (CERN, Meyrin)

Chemical Vapour Deposition (CVD) diamond detectors can be used as fast beam loss monitors in particle accelerators. In the Large Hadron Collider (LHC) at CERN, they are installed in the betatron collimation region, a high-radiation environment. In addition to their high-radiation tolerance, their main advantage is a time resolution of 1 ns which makes possible not only turn-by-turn, but also bunch-by-bunch loss measurements. An analysis of the LHC diamond beam loss monitor signals recorded during the last months of Run 2 (September 2018-November 2018) is presented with the aim of obtaining a signal-to-beam loss calibration.

TUPP34 04 Beam Loss Monitors and Machine Protection

Methodology, Characterisation and Results From the Prototype Beam Loss Monitoring ASIC at CERN

Presenter : Francesco Martina
Author(s) : Francesco Martina (CERN, Geneva 23; Cockcroft Institute, Warrington, Cheshire; The University of Liverpool, Liverpool), Luca Giangrande, Pedro Vicente Leitao (CERN, Geneva), J. Kaplon, Christos Zamantzas (CERN, Meyrin), James Bradley (The University of Liverpool, Liverpool), Carsten Peter Welsch (The University of Liverpool, Liverpool; Cockcroft Institute, Warrington, Cheshire)

The characterisation of novel beam loss monitoring front-end converters, based on radiation-hardened application-specific integrated circuits (ASIC), is undergoing at CERN. An effective analysis of the newly developed ASICs performance plays a key role in their candidacy for the future installation in the HL-LHC complex. This work introduces the latest test-bench architecture, used to characterise such a device, together with the variety of audits involved. Special focus is given on the verification methodology of real-time data acquisition and measurements, in order to allow a detailed study of the conversion capabilities, the evaluation of the device resolution and the linearity response. Finally, the first results of post-irradiation measurements are also reported.

TUPP35 04 Beam Loss Monitors and Machine Protection

New Applications and Studies With the ESRF Beam Loss Monitoring at Injection

Presenter : Elena Buratin
Author(s) : Elena Buratin, Nicolas Benoist, Nicola Carmignani, Friederike Ewald, Jean-Luc Pons, Kees Bertus Scheidt (ESRF, Grenoble)

More than one year after the commissioning of the ESRF's new Extremely Brilliant Source (EBS), the Beam Loss Detectors (BLDs) are continuing to be used for extensive applications and studies, notably at injection. A total of 144 BLDs and 36 associated Libera Beam Loss Monitors (BLMs) are distributed in the EBS ring and the Booster. These BLDs allow to measure slow losses during user-mode operation and fast losses at injection, with a sub-orbit-turn time resolution. In this paper these fast beam loss dynamics are presented at injection for different lattice parameters, collimator-settings and beam conditions. We will also show the excellent correlation with results obtained from the injection efficiency diagnostic and the bunch length acquired with the Streak Camera.

TUPP36 04 Beam Loss Monitors and Machine Protection

Application of the CORIS360 Gamma-Ray Imager at a Light Source

Presenter : Yaw-Ren Eugene Tan
Author(s) : David Boardman, Lachlan Chartier, Mathew Charles Guenette, Jayden Ilter, Geoff Watt (ANSTO, Menai, New South Wales), Yaw-Ren Eugene Tan (AS - ANSTO, Clayton)

The CORIS360 is a gamma-ray imager developed at Australian Nuclear Science and Technology (ANSTO) for identifying and localising sources of radiation typically from gamma emitting radionuclides. The low EMI and low noise power supply features of the imaging technology have enabled it to have a low energy detection threshold and to detect photons as low as 20 keV. This report shall present the initial measurements performed at the Australian Synchrotron, in the storage ring and beamlines, where the imager is able to detect radiation from all sources of synchrotron radiation (dipole, wiggler and undulator). The radiation imaging results from the injection system and scrapers (to dump the stored beam) will be discussed. Future developments for imaging in pulsed radiation environments and time varying environments will also be discussed.

TUPP37 04 Beam Loss Monitors and Machine Protection

Machine-Learning Based Temperature Prediction for Beam-Interceptive Devices in the ESS Linac

Presenter : Elena Maria Donegani
Author(s) : Elena Maria Donegani (ESS, Lund)

'Where there is great power [density], there is great responsibility*.' The concept holds true especially for beam-intercepting devices for the ESS linac commissioning. In particular, beam-intercepting devices will be subject to challenging beam power densities, stemming from proton energies up to 2 GeV, beam currents up to 62.5 mA, pulses up to few milliseconds long, and repetition rates up to 14 Hz. Dedicated Monte Carlo simulations and thermo-mechanical calculations are necessarily part of the design workflow, but they are too time-consuming when in need of rapid estimates of temperature trends. In this contribution, the usefulness of a Recurrent Neural Network (RNN) was explored in order to forecast (in few minutes) the bulk temperature of beam-interceptive devices. The RNN was trained with the already existing database of MCNPX/ANSYS results from design studies. The feasibility of the method will be exemplified in the case of the Insertable Beam Stop within the Spoke section of the ESS linac.

TUPP40 07 Machine Parameter Measurements

Bunch Extinction Measurements at PIP2IT

Presenter : Mathias El Baz
Author(s) : Mathias El Baz (Université Paris-Saclay, CNRS/IN2P3, IJCLab, Orsay), Brian Fellenz, Gregory Warren Saewert, Victor Scarpine, Alexander V. Shemyakin, Randy Michael Thurman-Keup (Fermilab, Batavia, Illinois)

The PIP2 particle accelerator is a new upgrade to the Fermilab accelerator complex, featuring an 800-MeV H-superconducting linear accelerator that will inject the beam into the present Fermilab Booster. A test accelerator known as PIP-II Injector Test (PIP2IT) has been built to validate the concept of the front-end of such a machine. One of the paramount challenges of PIP2IT was to validate the bunch by bunch chopping system in the Medium Energy Beam Transport (MEBT). This paper aims to present the direct extinction measurements at PIP2IT and their analysis. These measurements have been taken by two Resistive Wall Current Monitors (RWCM) and recorded by a high bandwidth oscilloscope.

TUPP41 07 Machine Parameter Measurements

Machine Learning Methods for Single Shot RF Tuning

Presenter : Johan Sven Lundquist
Author(s) : Johan Sven Lundquist (ESS, Lund)

The European Spallation Source, currently under construction in Lund, Sweden, will be the world's most powerful neutron source. It is driven by a proton linac with a current of 62.5 mA, 2.86 ms long pulses at 14 Hz. The final section of its normal-conducting front-end consists of a 39 m long drift tube linac (DTL) divided into five tanks, designed to accelerate the proton beam from 3.6 MeV to 90 MeV. The high beam current and power impose challenges to the design and tuning of the machine and the RF amplitude and phase have to be set within 1% and 1 degrees of the design values. The usual method used to define the RF set-point is signature matching, which can be a challenging process, and new techniques to meet the growing complexity of accelerator facilities are highly desirable. In this paper we study the use of ML to determine the RF optimum amplitude and phase, using a single pass of the beam through the ESS DTL1 tank. This novel method is compared with the more established methods using scans over RF phase, providing similar results in terms of accuracy for simulated data with errors. We also discuss the results and future extension of the method to the whole ESS DTL.

TUPP42 07 Machine Parameter Measurements

Goubau-Line Set Up for Bench Testing Impedance of IVUE32 Components

Presenter : Paul Ignatius Volz
Author(s) : Paul Ignatius Volz, Atoosa Meseck (HZB, Berlin)

IVUE32 is the world first elliptical in-vacuum undulator, being developed at HZB. With a period length of 32 mm and a minimum gap of 7 mm, the 2.5 m long insertion device (ID) will be installed in the BESSY II storage ring, delivering soft X-rays to several beam lines. In-vacuum undulators put complex structures in close proximity of the particle beam which makes them susceptible to wake field effects. These effects can cause beam instabilities and unwanted heating of undulator components, possibly damaging them. Therefore understanding the impedance characteristics of the device prior to installation is paramount. Numerical studies, e.g. CST simulations of such complex structures become very resource intensive for high frequencies, making the ability to bench test such a device invaluable. A Goubau line is a single wire transmission line for high frequency surface waves that can mimic the transverse electric field of a charged particle beam out to a certain distance, allowing for impedance measurements of IDs outside of the working accelerator. The status of a Goubau-line set up, optimized for measuring IVUE32-components, will be presented.

TUPP43 07 Machine Parameter Measurements

Design of a Multi-Layer Faraday Cup for Carbon Therapy Beam Monitoring

Presenter : Kai Tang
Author(s) : Kai Tang, Ruishi Mao, Zhiguo Xu, Tiecheng Zhao, Zulong Zhao, Kai Zhou [on leave] (IMP/CAS, Lanzhou)

Because of determining the depth of Bragg Peak of carbon therapy beam, range and energy are very important parameters. In order to measure those parameters rapidly, we design a multi-layer Faraday cup(MLFC). Simulation of carbon beam with energy from 80 MeV/u to 430 MeV/u in water and Cu are given in this paper. A prototype has 110 channels have been developed. Each consists of a 40 copper foil and 600 FR4 plate. A 128 channels electronics was used to measurement the deposited ions in each copper foil. A first beam test result and analysis will also be given in this paper.

TUPP44 07 Machine Parameter Measurements

Design of Hydrostatic Level System at APSU Storage Ring

Presenter : Weixing Cheng
Author(s) : Weixing Cheng, Constantine Nicholas Karas, Suyin Grass Wang (ANL, Lemont, Illinois)

A hydrostatic level system (HLS) has been designed for the Advanced Photon Source Upgrade (APS-U) storage ring in order to characterize the relative floor motion along each insertion device front end (IDFE) and the global floor motion of the storage ring tunnel. Three HLS sensors will be installed alongside each IDFE. Two sensors will be mounted near the ID BPMs, which are located at either end of the ID. The third HLS sensor will be mounted on the floor near the FE xBPM, about 20 meters away from the source point. The water network of the 35 IDFEs are connected via valves to form a global network around the 1.1 km storage ring tunnel. The HLS will measure the vertical floor displacement at 110 locations. Combined with the highly stable BPM/xBPM stands, the HLS can better characterize the electron and photon beam long-term stability. The HLS design is based on a two-pipe system for easy installation in tight spaces. In this paper, we present the design of the HLS system and preliminary performance of the first article units.

Wednesday & Thursday

WEPP01 05 Longitudinal Diagnostics and Synchronization

Longitudinal Impedance Measurements with Streak Camera at BEPC II Electron Storage Ring

Presenter : Dechong Zhu
Author(s) : Dechong Zhu (IHEP, Beijing)

The bunch length of the electron beam at BEPC II is measured by using a dual sweep streak camera at the visible light diagnostic beamline. The impedances estimated by a series R+L impedance model. The resistive impedance of R=446±21¿ is obtained by measuring the loss factor from the measured synchronous phase advancing with a streak camera. An inductance impedance of L=21.9±1.8nH has been estimated by measuring single bunch lengthening with beam current. Both loss factor and inductance are close to the impedance budget. Besides, the streak camera is also used to measure the synchronous phase at low current as RF voltage changing from 0.85MV to 1.65MV.

WEPP02 05 Longitudinal Diagnostics and Synchronization

Time Domain Photon Diagnostics for the Advanced Photon Source Upgrade

Presenter : Kent Peter Wootton
Author(s) : Kent Peter Wootton, Weixing Cheng, Glenn Decker, Soonhong Lee, Nicholas Sereno, Bingxin Yang (ANL, Lemont, Illinois)

With swap-out injection and a third-harmonic bunch lengthening cavity, time domain diagnostics will be beneficial tools in for optimisation of the Advanced Photon Source Upgrade electron storage ring. In the present work, we present plans for time-domain X-ray and visible photon diagnostics for the Advanced Photon Source Upgrade. Particular emphasis is given to implementation of visible light streak cameras and X-ray bunch purity monitors as time domain photon diagnostics.

WEPP03 05 Longitudinal Diagnostics and Synchronization

Terahertz Diagnostic for the Advanced Photon Source Particle Accumulator Ring

Presenter : Kent Peter Wootton
Author(s) : Kent Peter Wootton, William Berg, Soonhong Lee, Nicholas Sereno, Johannes Leonhard Steinmann (ANL, Lemont, Illinois)

Electron beam microbunching instabilities can present operational limits on the practical operation of storage ring accelerators. In the present work, we outline components of a synchrotron radiation diagnostic beamline for the Advanced Photon Source Particle Accumulator Ring operating at frequencies up to approximately 1 THz.

WEPP04 05 Longitudinal Diagnostics and Synchronization

Schottky Signal From Distributed Orbit Pick-Ups

Presenter : Ole Marqversen
Author(s) : Ole Marqversen (CERN, Geneva 23), Steen Jensen (CERN, Geneva)

In the CERN ELENA ring, intended for deceleration of antiprotons, longitudinal Schottky signal is obtained by summing up the electrostatic pick-ups (PUs) that are in parallel used to measure the closed orbit. The signals from the individual PUs are 'phase-moved' to one common position in the machine and added in time domain. In this contribution the theoretical phase compensation is calculated and compared to measurements. It is shown that cross correlation between the Schottky noise from the individual pick-ups can be used to find the correct phase compensation for optimal signal to noise gain, and the signal to noise (SNR) gain is evaluated. This SNR gain is shown to follow expectations of square root the number of PUs used. Capability of the system to handle both bunched and un-bunched low intensity (3·107 H- @ 100keV / 144kHz) beam of ELENA is confirmed by the measurement results. Inter bunch phase correlation is briefly addressed, as in the case of the fully filled machine Schottky signal at multiple of the RF harmonic is adding up 'phase correct' in phase to a relatively large signal, whereas at non-RF harmonics the signal adds up (not fully) destructively, which can be helpful in applications where the coherent beam signal dominates the spectrum i.e. limits dynamic range.

WEPP05 05 Longitudinal Diagnostics and Synchronization

Two Color Balanced Optical Cross Correlator to Synchronize Distributed Lasers in Sub 10 Fs Level for SHINE Project

Presenter : Chunlei Li
Author(s) : Chunlei Li, Lie Feng, Bo Liu, Jinguo Wang (SARI-CAS, Pudong, Shanghai), Xingtao Wang, Wenyan Zhang (Shanghai Advanced Research Institute, Pudong, Shanghai)

Shanghai soft X ray free electron laser (SXFEL) and the planned Shanghai high repetition rate XFEL and extreme light facility (SHINE) generate X ray light pulses in femtosecond range. For photo-injector driver laser, machine operation modes by means of laser seeding, and time resolved pump-probe experiments it is crucial to synchronize various laser systems to the master reference laser with a long term stability of better than 10 fs. For this purpose a two color balanced optical cross correlator is under developing.In this paper, we report on the progress of the devel-opment of a background free two color balanced cross correlator to synchronize 800 nm slave laser to 1550 nm master laser. The synchronization system is being tested under a commercial Ti:sapphire oscillator and 1550 nm fiber laser.

WEPP06 05 Longitudinal Diagnostics and Synchronization

Observation and Analysis of Island Phenomenon Using Streak Camera at the HLS-II Ring

Presenter : Yunkun Zhao
Author(s) : Yunkun Zhao, Sanshuang Jin, Ping Lu, Bao-gen Sun, Ji-gang Wang, Fangfang Wu, Tianyu Zhou (USTC/NSRL, Hefei, Anhui)

In the early experimental measurement using the radio-frequency (RF) phase modulation method to study the longitudinal beam characteristics of the Hefei Light Source-II (HLS-II), we found that the longitudinal beam bunch distribution under different modulation frequencies and modulation amplitudes have great difference. In order to be able to further analyze the relationship between modulation frequency and amplitude and island size, the streak camera is exploited to effectively observe the longitudinal beam profile and distribution in single bunch mode. This is of certain significance for us to investigate the impact of radio-frequency (RF) noise, machine maintenance and debugging.

WEPP07 05 Longitudinal Diagnostics and Synchronization

Proposal of a New Bunch Length Monitor

Presenter : H.X. Tuo
Author(s) : H.X. Tuo, Bao-gen Sun, Qian Wang (USTC/NSRL, Hefei, Anhui)

Bunch length is one of the important longitudinal parameters of beam current. The beam current can be better monitored by measuring the bunch length. A new single cavity bunch monitor is proposed which based on the principle of bunch length measurement. The coupling structure of the monitor consists of two filters. Coaxial low pass filter is used to couple out low frequency signals and higher frequency signals are coupled with a band pass waveguide filter. According to the beam characteristics of the National Synchrotron Radiation Laboratory based on the tunable infrared laser energy chemistry research large-scale experimental device (FELiChEM), we simulated measurement in CST. The simulation results show that the monitor can measure the bunch length of the FELiChEM device very well. The relative error of simulation measurement is less than 3%.

WEPP08 05 Longitudinal Diagnostics and Synchronization

Femtosecond Fiber Link Stabilization for SHINE Project

Presenter : Lie Feng
Author(s) : Lie Feng, Chunlei Li, Bo Liu, Jinguo Wang (SARI-CAS, Pudong, Shanghai), Xingtao Wang, Wenyan Zhang (Shanghai Advanced Research Institute, Pudong, Shanghai)

The upcoming Shanghai high repetition rate XFEL and Extreme light facility (SHINE) project has a high precision requirement for the timing synchronization system on femtosecond timescale over more than 3-km long optical fiber links. For this purpose, we setup the fiber link stabilization units to stable a long-distance polarization maintaining (PM) fiber link using balanced optical cross-correlators. In this paper, the current development progress and measurement results of the fiber link stabilization will be reported.

WEPP09 05 Longitudinal Diagnostics and Synchronization

The Development of Bunch Length Monitor Based on CSR for SXFEL

Presenter : Lianfa Hua
Author(s) : Lianfa Hua (SSRF, Shanghai)

The Shanghai soft X-ray Free-Electron Laser facility (SXFEL) will be opened to user at the end of this year. In order to ensure the stable FEL generation, on-line single-shot and nondestructive bunch length monitors utilizing coherent synchrotron radiation (CSR) were installed after each of two bunch compressors (BC1, BC2). We have tested CSR monitor after BC1 when bunch length range from 1ps to 2 ps and calibrated with TDS stalled downstream. The results show that the monitor is capable of measuring picosecond bunch length with a precision of less than 10%.

WEPP10 05 Longitudinal Diagnostics and Synchronization

Development of an on-Line Bunch Length Monitoring System at PLS-II Using an Ultrafast Photodiode

Presenter : Woojin Song
Author(s) : Woojin Song (POSTECH, Pohang), Ji-Gwang Hwang (HZB, Berlin), Taekyun Ha, Garam Hahn, Youngdo Joo, Dotae Kim, Yong-Seok Lee (PAL, Pohang)

Users of time-resolving experiments at 3rd generation synchrotron light sources deem online bunch length and filling pattern monitoring as an important real-time diagnostic. We developed an on-line monitoring system that can measure bunch lengths and filling pattern using a photodiode, a wideband pre-amplifier, and a sampling digitizer. Two different methods were evaluated to reconstruct the bunch lengths: Gaussian deconvolution method as an approximation scheme and Fourier analysis as a method to restore the original signal by using the power transmission characteristics of the electronic devices in the system, including a bias-tee, a wideband amplifier, cables, and the photodiode. A bunch lengthening experiment has been conducted to compare and verify the results of those two methods of the photodiode and the result of the streak camera images by changing the overall gap voltage of the superconducting RF cavities. In this paper, we elaborate upon the said photodiode-based measurement techniques, and present the experimental results.

WEPP11 05 Longitudinal Diagnostics and Synchronization

Broadband Characterization of a Compact Zero-Bias Schottky Diode Detector With a Continuous Wave THz System

Presenter : Rahul Yadav
Author(s) : Rahul Yadav, Sascha Preu (IMP, TU Darmstadt, Darmstadt), Andreas Penirschke (THM, Friedberg)

Over the last few decades several types of Terahertz (THz) detectors have been developed to maturity, paving the way for various potential applications such as diagnostics of THz generation at particle accelerators. An important class are zero-biased Schottky diode THz detectors that are frequently applied at accelerator facilities [*] for operation at room temperature. Zero-biased Schottky diode THz detectors [**,***] are having lower noise compared to biased ones due to the absence of shot noise. Here we demonstrate the sensitivity of Schottky detectors using a commercial continuous wave photomixing THz system as source. Both, a commercially available as well as a research-grade compact quasi-optical detector with improved video bandwidth are compared from 0.05 to 1.2 THz in terms of sensitivity. At 1 THz, the research grade quasi optical detector shows 7 dB higher dynamic range than the commercial one.

WEPP12 05 Longitudinal Diagnostics and Synchronization

Modal Analysis of Electromagnetic Couplings Between SMA-Feedthrough Electrode and Beam for Wideband Beam Monitor

Presenter : Tsuyoshi Suwada
Author(s) : Tsuyoshi Suwada (KEK, Ibaraki)

The direct simultaneous detection of electron (e-) and positron (e+) bunch signals was successfully performed for the first time by a wideband beam monitor at the positron capture section of the SuperKEKB factory. This monitor can measure a time interval between the e- and e+ bunches, their bunch lengths, bunch intensities, and transverse beam positions, depending on the phase of accelerating structures. For this purpose, a new beam monitor with wideband pickups simply using SMA feedthroughs and a wideband detection system based on a fast and real-time oscilloscope was developed to investigate their capture process at the capture section and to maximally optimize the e+ intensity. The required specification for the new monitor is to simultaneously detect the e+ and e- bunches generated in the capture section within the resolution of pico-second level with a sufficient dynamic range in the time-interval and bunch-length measurements. Thus, the wideband detection system is required for this purpose. In this report, the basic design and results based on a modal analysis of electromagnetic couplings between the SMA-feedthrough electrode and a beam are in detail given along with some obtained performance.

WEPP13 05 Longitudinal Diagnostics and Synchronization

Bunch Arrival Time Measurement System Test at Shine

Presenter : Yimei Zhou
Author(s) : Yimei Zhou, Jian Chen, Yongbin Leng (SSRF, Shanghai), Shanshan Cao (SARI-CAS, Pudong, Shanghai)

To achieve high-precision synchronization between electron bunches and seeded lasers, a femtosecond resolution bunch arrival time measurement system (BAM) is required at SHINE (Shanghai High repetition rate XFEL aNd Extreme light facility). The bunch signal from a GHz-bandwidth cavity monitor is mixed with a reference signal from the device synchronization clock in the RF front-end. Then, the generated IF signal is collected by the digital acquisition system. In the pre-research stage, four sets of cavity monitors with different frequencies and load quality factors and three sets of analog front-ends with different schemes were performed, but now only one monitor with the attenuation time constant of 200 ns was installed for beam experiment testing. The system can measure the bunch charge, bunch arrival time, and bunch flight time. The first results will be presented in this paper.

WEPP14 05 Longitudinal Diagnostics and Synchronization

Bunch Compression Monitors Based on Coherent Diffraction Radiation at European XFEL

Presenter : Christopher Gerth
Author(s) : Christopher Gerth, Nils Maris Lockmann (DESY, Hamburg)

Bunch compression monitors (BCMs) based on the detection of coherent diffraction radiation have been installed at the European XFEL at each of the three bunch compression stages for a beam-based stabilisation of the accelerating phases as well as monitoring of the bunch lengths. The monitor systems comprise zero-bias Schottky and pyro-electric detectors in combination with low and high pass filters. The detector responses and filters are matched to the spectral ranges of the coherent part of the emitted diffraction radiation which is given by the particular bunch lengths after each bunch compression stage. In this paper, we describe in detail the experimental setup of the BCMs. The last BCM has been calibrated with the help of a transverse deflecting structure to establish a (rms) bunch length monitor in the range of a few tens of femtoseconds, and results from compression scans are presented. To enable operation at 4.5 MHz, which is the highest bunch repetition rate of the superconducting linear accelerator, a correction method for the signal pile-up of the pyro-electric detectors has been applied.

WEPP15 05 Longitudinal Diagnostics and Synchronization

Proposal for Longitudinal Profile Diagnostics for Optical Stochastic Cooling of Stored Electrons in the IOTA Ring

Presenter : Alex Lumpkin
Author(s) : Alex Lumpkin, Jonathan Jarvis, Valeri Lebedev (Fermilab, Batavia, Illinois)

One of the predicted signatures of successful optical stochastic cooling (OSC) in the Fermilab Integrable Optics Test Accelerator (IOTA) ring is reduction of the bunch length. The IOTA OSC experiment is designed for a low nominal beam current (0.1 microAmps of 100-MeV electrons) to reduce intrabeam scattering (IBS), and during cooling, OSC is expected to reduce the bunch length from 200 ps to 130 ps*. These equilibrium bunch lengths can be measured using a streak camera and the optical synchrotron radiation (OSR) generated in a ring dipole by the circulating beam. A similar measurement was previously performed at the Advanced Photon Source with a Hamamatsu C5680 synchroscan streak camera operating at 117.3 MHz**. In this case, synchronous summing of OSR resulted in a bunch length measurement of 276 ± 30 ps using only 57 electrons circulating at 425 MeV. At IOTA, an existing streak camera has been modified to operate at the 11th harmonic of the ring's revolution frequency of 7.50 MHz and has been installed on an OSR port in support of the OSC experiments. The integrated system will have sufficient sensitivity and resolution for measuring the evolution and equilibrium values of the bunch length during OSC experiments.

WEPP16 05 Longitudinal Diagnostics and Synchronization

Comparison of Feschenko BSM and Fast Faraday Cup With Low Energy Ion Beams

Presenter : Rahul Singh
Author(s) : Rahul Singh, Winfried A. Barth, Peter Forck, Simon Lauber, Maksym Miski-Oglu, Thomas Reichert, Thomas Sieber (GSI, Darmstadt), Victor Scarpine, Alexander V. Shemyakin, Ding Sun (Fermilab, Batavia, Illinois)

A comparison between the two types of longitudinal bunch shape detectors was recently performed at cw Demonstrator project at GSI. One of the monitor uses the time to space conversion by means of secondary electrons emitted from a wire correlated to a RF deflector* while the other is a 50 ohm terminated Fast Faraday Cup (FFC) design available on loan from Fermilab**. 1.4 MeV/u He1+ beam with 0.1 mA average current was utilized for this comparison. Two bunchers upstream of the detectors were used to vary the bunch shapes. The promising, consistent results will be discussed in this contribution.

WEPP17 05 Longitudinal Diagnostics and Synchronization

Uncertainty Quantification and Robustness of Particle Accelerator Machine-Learning Based Models

Presenter : Owen Convery
Author(s) : Owen Convery, Adi Hanuka (SLAC, Menlo Park, California), Yarin Gal, Lewis Smith (Oxford University Press (Oxford Electronic Publishing), Oxford)

Virtual Diagnostic (VD) is a computational tool built using deep learning that can be used to predict diagnostic outputs*. VDs are especially useful in systems where measuring outputs is invasive, limited, costly or runs the risk of modifying the output. In experiments with large ramifications, it is important to quantify the uncertainty of each prediction. Given out-of-distribution inputs (e.g. using the same machine in a different operation mode), it is also necessary to understand how robust the VD model is and how well it generalizes on unfamiliar data. In this work**, we use various compositions of neural networks to explore and enhance prediction uncertainty and robustness on data sets gathered from SLAC National Laboratory. We aim to accurately and confidently predict the longitudinal phase space images of electron beams. The ability to make informed decisions under uncertainty and limited computational power is crucial for reliable deployment of scalable deep learning tools on safety-critical systems such as particle accelerators.

WEPP18 05 Longitudinal Diagnostics and Synchronization

New X-band RF Deflector for Femtosecond Diagnostics of LCLS-II Beams

Presenter : Valery Dolgashev
Author(s) : Valery Dolgashev, Harmanpreet Bassan, Shantha Condamoor, Andrew Haase, Patrick Krejcik, Timothy John Maxwell, Juwen W. Wang (SLAC, Menlo Park, California)

An X-band transverse deflector has been successfully developed for femtosecond electron and x-ray pulse temporal diagnostic at the LCLS [1]. The working frequency for the deflector is 11.424 GHz. New free electron laser LCLS-II has two undulator beamlines, one Soft-X-Ray and another Hard-X-Ray. The Hard-X-Ray line uses two one-meter long X-band deflectors for beam diagnostics. We have designed, build, installed and commissioned another, 1.5 meter long X-band deflector in the Soft-X-Ray beam line. Both Hard-X-Ray and Soft-X-Ray deflectors share one klystron. RF power is transmitted from a 50 MW klystron to a tunnel in an overmoded circular waveguide and then directed to either of the deflectors using a remotely controlled RF switch. The power split ratio could be changed arbitrarily, and both deflectors could work simultaneously. In this article, we provide details on the development and commissioning of the new deflector.

WEPP19 05 Longitudinal Diagnostics and Synchronization

Bunch Arrival-Time Measurements with Rod-Shaped Pickups on a Printed Circuit Board for X-Ray Free-Electron Lasers

Presenter : Bernhard Erich Jürgen Scheible
Author(s) : Bernhard Erich Jürgen Scheible, Andreas Penirschke (THM, Friedberg), Marie Kristin Czwalinna, Holger Schlarb (DESY, Hamburg), Wolfgang Ackermann, Herbert De Gersem (TEMF, TU Darmstadt, Darmstadt)

The all-optical synchronization system implemented in the European X-ray free-electron laser (EuXFEL) is to receive an upgrade. The modifications are intended to allow operation with consistently high accuracy in a 1 pC mode, which is required for various user experiments. The lower charges, e.g. a factor of 20, lead to a reduced signal yield and thus decreased resolution. A significant potential for improvement was identified in the pickup structure and the transmission network, which provide the transient voltage signal to subsequent parts of the synchronization system. The objective of a broadband pickup structure with short signal paths, large active surface and minimum aperture diameter could be achieved by connecting rod-shaped pickups to a combination network on a printed circuit board, which will be mounted in the beamline vacuum. In this contribution the proposed design is introduced and the expected transient analyzed by electromagnetic field simulations.

WEPP20 05 Longitudinal Diagnostics and Synchronization

Design of the Bunch-Length Monitors for the New Superconducting LCLS Linac

Presenter : Emmanuel Aneke
Author(s) : Emmanuel Aneke, Alan Stephen Fisher, Bryce Jacobson, Timothy John Maxwell, Leonid Sapozhnikov (SLAC, Menlo Park, California)

The LCLS x-ray free-electron laser at SLAC uses the third km of the original 3-km copper linac. We are now installing LCLS-II, a superconducting linac that replaces the first km. Two undulators, for hard and soft x rays, will be driven by bunches from either linac. One of the solutions developed at SLAC involves a pyroelectric detector, which converts the infrared emitted by the electron bunch into voltage by measuring fast changes in the temperature of the detecting crystal. Not only are the pyrodetectors used at SLAC but also a method with gap diodes. The radial electric field produced by the bunches leaks through a ceramic gap in the beampipe and is collected by a horn antenna and conveyed through a one millimeter waveguide. The waveguides act as a filter, only passing shorter wavelengths and a zero-bias Schottky diode measures the power. In both methods, a portion of the spectral energy emitted by the bunch is intercepted. After normalizing to differentiate between bunches of the same length with different charge, the detected signal is sensitive to only changes in bunch length. This poster discusses the mechanics and optics behind the LCLS-II bunch length monitors operations and plans for collaboration.

WEPP21 05 Longitudinal Diagnostics and Synchronization

High Resolution Bunch Arrival Time Monitor Based on Sagnac Interferometer

Presenter : Jinguo Wang
Author(s) : Jinguo Wang (SARI-CAS, Pudong, Shanghai)

Based on an sagnac interferometer detection scheme, a Bunch Arrival-time Monitor (BAM) is under study at Shanghai soft X-ray Free Electron Laser (SXFEL) to meet the high-resolution requirements of the measurement of bunch arrival time. In this paper, we present the basic working principle and the design of the BAM system.

WEPP23 06 Beam Charge and Current Monitors

Design of Wall Current Monitor in BRing at HIAF*

Presenter : Peilin He
Author(s) : Peilin He, Xincai Kang, Xiaotao Liu, Ruishi Mao, Zhiguo Xu, Yongliang Yang (IMP/CAS, Lanzhou)

The Wall Current Monitor (WCM) can monitor the lon-gitudinal beam shape, beam stability, beam longi-tudinal emittance and intensity, which has been ap-plied widely in the laboratories of high-current proton accelerators. Many accelerators such as CERN-PS, CERN-CLIC, J-PARC and CSNS-RCS have designed different WCMs according to their respective accelera-tor beam parameters. In order to provide the high-intensity heavy-ion accelerator facility (HIAF)-BRing high-frequency system of with the intensity of each harmonic beam to compensate for wake field; and to observe the changes of the bundle length during the injection, acceleration, and extraction of the bundle, it is planned to place a WCM in HIAF-BRing. According to physical requirements, the lower limit of the WCM work-ing bandwidth is expected to reach 10kHz, and the upper limit can reach 100MHz. According to this bandwidth re-quirement, a WCM structure is designed, and its theoretical bandwidth is 2kHz 400MHz, which fully meets the de-mand. This article gives a detailed and comprehensive in-troduction to the overall design of this WCM, the selection of various components, design calculations and related simulation calcula-tions. At present, the WCM has com-pleted the pro-curement and processing of various compo-nents, while offline and online testing has not been carried out owing to time constraints. It is expected to be in-stalled on the Heavy Ion Research Facility in Lanzhou-Cooling Storage Ring (HIRFL-CSR) for online testing in August.

WEPP24 06 Beam Charge and Current Monitors

PSB H0-H- Monitor Calibration and Commissioning

Presenter : Araceli Navarro Fernandez
Author(s) : Araceli Navarro Fernandez (CERN, Geneva), Federico Roncarolo (CERN, Meyrin)

During the LHC Long Shutdown 2 (LS2), the H- LINAC4 replaced the proton LINAC2 as Proton Synchrotron Booster (PSB) injector. In each of the four PSB rings, the injection region was upgraded to accommodate the necessary elements for a proper H- charge exchange injection systems. Four internal beam dumps (one per ring), installed downstream the stripping foil, block the unstripped H- particles not injected in the ring. The H0-H- monitors consists in 4 titanium plates placed few centimetres upstream of the dump, intercepting partially stripped H0 or not stripped H- ions. They allow a continuous monitoring of the stripping efficiency and, connected to an interlock system, block the injection process in case of heavy degradation or breakage of the foil, which would heavily damage the dumps. The contribution will focus on the commissioning and operation these new systems. This will include the calibration campaigns, performed by comparison to beam current transformers during special periods with low intensity beams and no stripping foils. During normal operation it was already possible to monitor stripping inefficiencies below 1% and compare different beams and stripping foil types.

WEPP25 06 Beam Charge and Current Monitors

Design of a Dielectric-Filled Cavity Beam Current Monitor for HUST-PTF

Presenter : Jiqing Li
Author(s) : Jiqing Li, Qushan Chen (HUST, Wuhan), Kuanjun Fan (Huazhong University of Science and Technology, Hubei)

A dedicated proton therapy facility, HUST-PTF (Huazhong University of Science and Technology Proton Therapy Facility) is being developed in Wuhan. With respect to the proton therapy facility, non-destructive beam diagnostic devices are essential to guarantee the online measurement during the patient treatment. In order to meet the clinical requirement, the proton beam current varies from the 0.35-5 nA. Extremely low beam intensity is a great challenge to non-destructive beam current detection. Conventional beam current monitors used in proton therapy facility, ionization champers, will cause beam scattering and the monitor activation, etc. To mitigate this issue, we design a non-invasive beam current monitor based the principle of dielectric-filled reentrant cavity. The fundamental mode of the cavity was employed as the working mode and its working frequency of 146 MHz was matched to the second harmonic of the pulse rate. The CST Microwave Studio was used for electromagnetic modeling and design parameters optimization. We evaluated the effect of the different proton energy due to the degrader on the output signal. The electronics based on a commercial lock-in amplifier is proposed to perform the demodulation of induced signal and we evaluated the signal-to-noise ratio and the beam current resolution. The results of the design studies show that the dielectric-filled cavity resonator is a potential candidate for non-destructive beam current detection in HUST-PTF.

WEPP26 06 Beam Charge and Current Monitors

Development of the Ion Beam Diagnostic System for BIBA using 28 GHz ECRIS at KBSI

Presenter : Jonggi Hong
Author(s) : Jonggi Hong (KBSI, Gangseo-gu, Busan), Seong Jun Kim, Jung-Woo Ok, Jin Yong Park (Korea Basic Science Institute, Busan)

Busan Ion Beam Accelerator (BIBA) is a compact linear accelerator facility using the 28 GHz Electron Cyclotron Resonance Ion Source (ECRIS) at Korea Basic Science Institute (KBSI). For utilization of ion beam, an ion implantation system has been developed to use a multi-charged state ion beams produced by 28 GHz ECRIS. Recently, the low energy beam transport (LEBT) system for BIBA has been re-designed taking into account the fringe effect of magnet to match the ion beam for ion implantation as well as for input beam for the accelerator such as Radio-Frequency Quadrupole (RFQ). The beam diagnostic system for monitoring such as current, position, profile, emittance and beam loss are also required for operating and improving accelerator system. In this paper, we report the result and design of ion beam diagnostics system to measure various beam parameters of the beam current, profile, and emittance.

WEPP27 09 Data Acquisition and Processing Platforms

High Speed Parallel Digital Signal Processing Structure in Bunch-By-Bunch Position Measurement based on FPGA

Presenter : Ruizhe Wu
Author(s) : Ruizhe Wu, Ping Lu, Bao-gen Sun, Leilei Tang (USTC/NSRL, Hefei, Anhui)

In storage ring, the measurement of bunch-by-bunch positions can help to obtain abundant beam dynamics characteristic information, diagnose the instability of beam motion and provide a basis for the suppression of instability.However, the measurement of bunch-by-bunch requires one analog-to-digital converter (ADC) with high sampling rate and one processor with fast digital signal processing (DSP)ability. With the development of electronics, high sampling rate ADCs are no longer a problem. Therefore, high-speed DSP has become the key. In this paper, a parallel digital signal processing architecture based on polyphase decomposition is proposed. This architecture realizes the GHz DSP speed on the programmable gate array (FPGA), which can be used as the infrastructure of high-speed DSP in the bunch-by-bunch position measurement system.

WEPP28 09 Data Acquisition and Processing Platforms

Sub-Ns Single-Particle Spill Characterization for Slow Extraction

Presenter : Timo Milosic
Author(s) : Timo Milosic, Peter Forck, Rahul Singh (GSI, Darmstadt)

With the recent developments on improving spill quality at GSI/FAIR, appropriate measurement devices have come into focus again. In contrast to commonly used scaler-based approaches where events at a certain sample frequency are counted, we present a measurement concept resolving single event detector timestamps in the sub-ns regime leveraging a well established off-the-shelf TDC VMEbus module. This allows for high resolution time structure information with respect to the ring RF as well as valuation of inter-particle separation distributions. This yields insightful information for specific experiments at GSI whose efficiencies are heavily limited by pile-ups and detector dead times. We will present the concept of the measurement setup and exemplary data taken in recent campaigns in context of spill microstructure improvements for slow extraction.

WEPP31 09 Data Acquisition and Processing Platforms

Web-Based Software Development for Failure Prediction in Commercial Cyclotrons Used in Medical Applications

Presenter : Ana Garcia-Tabares
Author(s) : Ana Garcia-Tabares, Fernando Berdascas Julián (BPT, Madrid)

Radioisotopes used for PET and SPECT diagnostics are commonly produced using commercial cyclotrons. These accelerators are equipped with online monitoring instrumentation that allows the machine to be operated within the safety margins defined by the manufacturer. However, the probabilities of cyclotron failure cannot be estimated simply by online data logging but must be supplemented by a long-term data-driven analysis and storage system. The low level of development of the analysis and storage systems makes it difficult to optimize the preventive maintenance schedule and makes it almost impossible to prevent failures. Beta Pharma Technologies (BPT) has developed a web-based big data software, which in combination with a database, bridges the gap in storage and analytics capabilities of the current cyclotron software. This software analyzes the evolution of the cyclotron in the medium-long term, extracting statistical information and correlation between the different parameters of the cyclotron. To validate the method, BPT has used the software intensively to analyze the big data generated by various commercial cyclotrons. This article shows that by analyzing logged data using analysis tools the cyclotron failure can be identified before the actual machine failure. Additionally, the data analysis carried out using this methodology allows optimizing the material resources and the workers' exposure time.

WEPP32 09 Data Acquisition and Processing Platforms

Tests of Digital BPM Signal Processor for SHINE

Presenter : Longwei Lai
Author(s) : Longwei Lai (SARI-CAS, Pudong, Shanghai)

Digital signal processors that can handle 1 MHz bunch rate BPM signal processing has been developing for SHINE. Two different processors have been developed at the same time, including an intermediate frequency signal processor with maximum sampling rate 1000 MHz, which can be used in common BPM applications; and a direct RF sampling processor, which can directly sample the C band cavity BPM signal without analog down-conversion modules and greatly simplifies the cavity BPM system. This paper will introduce the tests of the processors.

WEPP33 09 Data Acquisition and Processing Platforms

Multi-Image Beam Synchronous Data Acquisition System for FACET-II

Presenter : Spencer Jake Gessner
Author(s) : Spencer Jake Gessner (SLAC, Menlo Park, California)

The Facility for Advanced Accelerator Experimental Tests (FACET) at SLAC utilizes over 80 digital cameras to monitor and diagnose particle beams and laser systems. The cameras are part of the EPICS control system and run on areaDetector IOCs. Experiments at FACET acquire data from multiple cameras simultaneously. This presents a challenge because the data rate easily exceeds 10 Gbps for multiple cameras operating at 10-30 Hz, thus preventing data acquisition via Channel Access. Our system avoids this problem by writing the images to a local shared hard drive. Critically, we make use of the SLAC EVG-EVR timing system to coordinate image acquisition and ensure synchronicity across multiple cameras. The image acquisition features are combined with SLAC's Beam Synchronous Acquisition (BSA) features for a unified data acquisition framework.

WEPP34 09 Data Acquisition and Processing Platforms

Towards Single Shot X-ray Absorption Spectroscopy Using the Broadband Emission at the SwissFEL Aramis Undulator

Presenter : Panagiota Bougiatioti
Author(s) : Panagiota Bougiatioti, Yunieski Pena Arbelo, Camila Bacellar Cases da Silveira, Claudio Cirelli, Christian David, Pavle Juranic, Gregor Knopp, Karol Jan Nass, Sven Reiche, Yohei Uemura, Joan Vila Comamala (PSI, Villigen PSI), Christopher Milne (EuXFEL, Schenefeld)

X-ray absorption spectroscopy (XAS) is a powerful tool for the investigation of the electronic and structural environment of the absorbing atom. The high element specificity of XAS is gained by photon energies around resonant absorption edges of the probed material. Dynamics on a femtosecond timescale can be accessed with time resolved XAS (TR-XAS) using a laser to photo-excite the sample and intense femtosecond X-ray pulses from a free-electron laser to probe with XAS. A primary drawback to the implementation of TR-XAS at X-ray free-electron lasers is the general requirement to scan the photon energy for obtaining the spectrum. Moreover, fluctuations of the X-ray spectrum and intensity due to the self-amplified stimulated emission lead to normalization problems. To tackle these issues we propose a novel scheme for TR-XAS using a broadband emission mode of the Aramis undulator at SwissFEL providing dE/E = 2% bandwidth, which is sufficient to cover a XAS spectrum. By utilizing a transmission grating, the chirped beam is split into 1st, 0th and -1st orders having similar intensity. By placing a sample in the 1st or -1st diffraction order we can record sample and reference signal in order to normalize intrinsic spectral and intensity fluctuations on a shot-to-shot basis. The beams are sent onto a single shot spectrometer that uses the <111> reflection from a strongly bent thin Si crystal, in order to characterize the broadband, chirped emission of every free-electron laser shot. In this contribution, we present a quantitative data analysis and compare the shot-to-shot normalization method with the conventional data analysis without beam splitting, showing a significant improvement of the data quality in the first case. We show XAS measurements at the Nickel K-edge on thin foils and Nickelsulfamate solutions. The presented experiments form the basis for future time-resolved research comprising more advanced diffractive x-ray optics, as well as pump-probe schemes.

WEPP35 09 Data Acquisition and Processing Platforms

Epics Control System for RAON Diagnostics

Presenter : Eunhoon Lim
Author(s) : Eunhoon Lim (Korea University Sejong Campus, Sejong)

RAON has various diagnostic devices for measuring beam characteristics, such as Faraday Cup, Wire Scanner, and Beam Loss Monitor, etc. Each device is driven by PLC system and acquires current data with a DAQ based uTCA system. All the parameters are controlled by EPICS as process variables (PV) and monitored on GUI of CS-Studio. PVs of PLC and DAQ were named according to the RAON naming convention. Epics sequences are written in finite state machine code to work diagnostic device sequentially. Below we show the working principle of the epics based diagnostics devices control system and measurement results.

WEPP36 09 Data Acquisition and Processing Platforms

Study of Solutions for Interfacing ILSF Beam Diagnostics Tools to Control System

Presenter : Pedram Navidpour
Author(s) : Pedram Navidpour, Fatemeh Ahmad Mehrabi, Samira Mohammadi Alamouti (ILSF, Tehran)

There is an ongoing study at Iranian Light Source Facility (ILSF) aims to determine control solutions for a variety of diagnostics tools that will be placed at various locations around the facility. In this paper an overview of the possible solutions with a focus mostly on the low-level part of the control system (i.e. EPICS) is reported.

WEPP37 09 Data Acquisition and Processing Platforms

BUNCH-BY-BUNCH 3D MEASUREMENT SYSTEM IN HLS-II

Presenter : Ruizhe Wu
Author(s) : Ruizhe Wu, Ping Lu, Bao-gen Sun, Leilei Tang, Yigang Wang, Fangfang Wu, Zeran Zhou (USTC/NSRL, Hefei, Anhui)

In order to improve the performance of Hefei Light Source (HLS-II), it is necessary to study various problems of nonlinear beam dynamics in the storage ring, so as to optimize the beam filling mode and injection mode, and then improve the intensity and brightness of HLS-II. In beam dynamics, bunch-by-bunch can provide detailed information of beam bunches and help beam researchers to study the problems of beam bunches deeper. Therefore, HLS-II diagnostics group has developed an on-line bunch-by-bunch three-dimensional measurement system based on high bandwidth and high speed oscilloscope.

WEPP38 09 Data Acquisition and Processing Platforms

Development of a Data Acquisition System for Real-Time Beam Monitoring of Flash Ion Beam

Presenter : Sang Hyoun Choi
Author(s) : Sang Hyoun Choi, Dong Hyun An, Kun Uk Kang, Geun-Beom Kim, Jeong Hwan Kim, Tae-Keun Yang (KIRAMS, Seoul), Hong Suk Jang (KIRAMS/KHIMA, Seoul)

Our research team is developing and constructing a high-energy ion beam irradiation device capable of ultra-high dose rates for biomedical research in connection with the main accelerator of RAON (Rare isotope accelerator complex for ON-line experiments). In this ion beam irradiation line, an x, y scanner will be installed in the active scanning type research beam delivery line. In order to measure the beam current, profile, and position before and after scanning, it is necessary to develop a system that can monitor the ultra-high dose rate ion beam in real time. The objective of this study is to develop and verify a data acquisition system that can measure the position and intensity of a flash ion beam in real time. To measure the accumulated detector current and beam profile using a charge integrator, output terminals of 128 channels for X and Y were fabricated. The detector current amount of each 128 channels was measured in units of 100 us for a pre-programmed time, and the beam intensity was set to store negative charge in the data memory inside the FPGA every 30 us. Also, center, sigma, and sum values can be calculated based on the output of 128 channels for each x and y axis. In order to evaluate the usefulness of the manufactured DAQ, the measurement response of the intensity charge integrator, noise according to the gain setting, response, and the measured value of the strip charge integrator according to the gain setting were tested, and it was confirmed that it is suitable for monitoring the ultra-high dose rate ion beam. It is expected that the DAQ system manufactured in this study can be used not only for the RAON ion beam currently under construction, but also for the flash electron beam accelerator. In the future, it will be conduct the test verification with a two-dimensional array type ion chamber in flash radiation.

List of Authors

Sponsors


bergoz
INSTRUMENTATION


INSTRUMENTATION
TECHNOLOGIES


dimtel


struck innovative
systeme


I.T.S
Best Innovation, Most Support


MiTeGen
www.mitegen.com