13th INTERNATIONAL PARTICLE ACCELERATOR CONFERENCE

June 12-17, 2022

IMPACT FORUM
Muangthong Thani
Bangkok, Thailand

STUDENT POSTER SESSION GUIDE

Siam Photon

THAI SYNCHROTRON NATIONAL LAB

ScandiNova

TCEB
THAILAND CONVENTION & EXHIBITION BUREAU

Student Poster Session Guide

Synchrotron Light Research Institute
(Public Organization)

Student Poster Session

Hours & Location

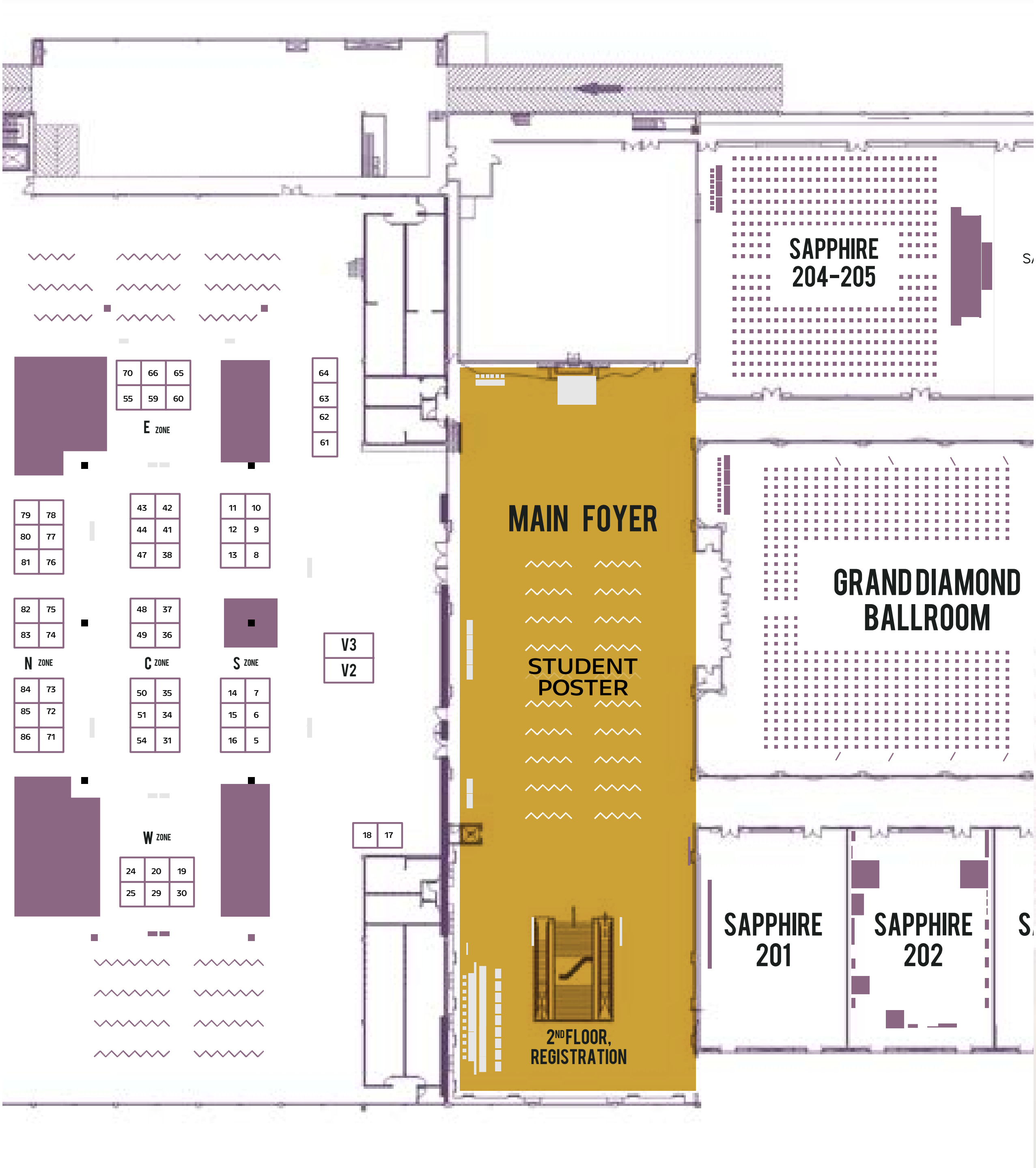
Sunday, June 12: 14:00 to 18:00 (setup: 13:30 – 14:00)

- The student poster session will be held on Sunday, June 12 at Main Foyer, in front of Grand Diamond Ballroom.
- Posters should be set up at 13:30–14:00.
- Students should present at their posters for presentation and interaction with judges and arrived conference delegates at 14:00–18:00.
- All students presenting a poster at the conference are encouraged to present their work in this session.
- All students receiving grants to attend the conference must present their works in this session and must submit contribution to the proceedings.
- Student posters are presented twice during the conference, once during the student poster session, and once during the standard poster sessions.

Prizes & Judging

- The student poster session is separate from the main poster session and is an opportunity to showcase your work. During the student poster session, posters will be evaluated for the Student Poster Prize by members of the IPAC'22 SPC, OC, and LOC. All students should attend their posters for interactions with judges and arriving conference delegates between 14:00 – 18:00.
- The evaluation committee will judge and decide the winners of two conference prizes for the best student posters, which will be awarded US $500. Main criteria for the best poster selection are presentation and clarity, the student's contribution, and scientific and technical merit. The prizes will be presented during the IPAC'22 Accelerator Prizes Special Session on Thursday, June 16, 2022.
- All delegates and exhibitors are encouraged to visit the student poster session.

Main Foyer for Student Poster Session



Student Grants Sponsors

The accelerator community and the organizing committee of the International Particle Accelerator Conference (IPAC) recognizes significant contribution of students. To support their development, it is crucial that they will be providing with opportunity to interact with their peers from different countries at conference. For this reason, this conference series co-ordinate with numerous organizations and institutes internationally to raise funds for the student support program. The profits from this conference series also goes towards this program.

IPAC'22 has raised THB 5,383,398 to support 71 students from 18 different countries (181 applicants from 23 countries) to attend the conference.

The generous sponsors for student grants this year are:

SUSPMF001

Supervised Machine Learning for Local Coupling Sources Detection in the LHC

Authors : Felix Soubelet, Tobias Hakan Bjorn Persson, Rogelio Tomas (CERN, Geneva), Elena Fol (CERN, Meyrin), Oznur Apsimon, Carsten Peter Welsch (Cockcroft Institute, Warrington, Cheshire)

Abstract Local interaction region (IR) linear coupling in the LHC has been shown to have a negative impact on beam size and luminosity, making its accurate correction for Run 3 and beyond a necessity. In view of determining corrections, supervised machine learning has been applied to the detection of linear coupling sources, showing promising results in simulations. An evaluation of different applied models is given, followed by the presentation of further possible application concepts for linear coupling corrections using machine learning.

SUSPMF002

Conceptual Design of the FCC-ee Beam Dumping System

Authors : Alexander Michael Krainer, Marco Calviani, Anton Lechner, Antonio Perillo-Marcone (CERN, Meyrin), Yann Dutheil, Francois- Xavier Nuiry (CERN, Geneva), Pablo Andreu Muñoz, Wolfgang Bartmann (CERN, Geneva 23), Rebecca Ramjiawan (JAI, Oxford)

Abstract The Future Circular electron-positron Collider (FCC-ee) will have stored beam energies of up to 20 MJ. This is a factor 100 higher than any current or past lepton collider. A safe and reliable disposal of the beam onto a beam dump block is therefore critical for operation. To ensure the survival of the dump core blocks, transversal dilution of the beam is necessary. To reduce the complexity of the system and guarantee high availability, an optimized, semi-passive beam dumping system has been designed. The main dump absorber design has been optimized following recent studies for high energy dump block materials for the LHC High Luminosity upgrade. First simulations regarding the radiation environment of the dumping system have been carried out, allowing the definition of preliminary constraints for the integration with respect to radiation sensitive equipment. The performance of the system has been evaluated using Monte- Carlo simulations as well as thermomechanical Finite-Element- Analysis to investigate potential material failure and assess safety margins. An experiment at the CERN HiRadMat facility has been carried out and preliminary results show good agreement with simulations.

SUSPMF003

Coupling Effects of Beam-Beam Interaction and Longitudinal Impedance

Authors : Chuntao Lin (University of Chinese Academy of Sciences, Beijing), Yuan Zhang (IHEP, Beijing), Kazuhito Ohmi (KEK, Ibaraki)

Abstract Recent studies have shown a novel coherent head-tail instability induced by beam-beam interaction with a large Piwinski angle. The instability has become an important issue during the designs of CEPC and FCC-ee. Simulations have further revealed that the longitudinal impedance has a strong impact on the beam stability, squeezing the horizontal stable tune area seriously. The "cross-wake force" has been introduced to represent beam-beam interaction. A mode coupling theory based on the localized wake (impedance) force has been developed to explain the instability. However, the theory did not consider the effects of longitudinal impedance. In this paper, we develop a new transverse mode coupling analysis method that could be used to study the beam- beam instability with and without longitudinal impedance. The result shows that the distortion of longitudinal phase space trajectory and the incoherent synchrotron tune shift induced by longitudinal impedance would reduce the stable tune area.

SUSPMF004

Investigation of Polarized Proton Spin Coherence Time at Storage Rings

Authors : Aleksei A. Melnikov, Yury Senichev (RAS/INR,Moscow), Evgeny Syresin (JINR/VBLHEP, Dubna, Moscow region), Alexander Aksentyev (RAS/INR, Moscow; MEPhI, Moscow)

Abstract The possibility of getting a 1000 s Spin Coherence Time (SCT) for deuterons has been shown experimentally at COoler SYnchrotron (COSY), accelerator at FZJ Jülich, Germany. Reaching high values of SCT for protons is more challenging due to a higher anomalous magnetic moment. Obtaining sufficient proton SCT is obligatory for planned Electric Dipole Moment (EDM) search experiments at COSY and the ProtoType EDM Ring (PTR). It has been shown that the second order momentum compaction factor (alpha1) has to be optimized along with chromaticities to get high SCT. Three families of sextupoles have to be used. The optimal values of chromaticities and alpha1 are discussed. The racetrack option of PTR is investigated.

SUSPMF005

Controlling Landau Damping via Feed-Down From High-Order Correctors in the LHC and HL-LHC Beam Optics

Authors : Joschua Dilly, Ewen Hamish Maclean, Rogelio Tomas (CERN, Geneva)

Abstract Amplitude detuning measurements in the LHC have shown that a significant amount of detuning is generated in Beam 1 via feed-down from decapole and dodecapole field errors in the triplets of the experiment insertion regions, while in Beam 2 this detuning is negligible. In this study, we investigate the cause of this behavior and we attempt to find corrections that use the feed- down from the nonlinear correctors in the insertion region for amplitude detuning.

SUSPMF006

Studies on Top-Up Injection Into the FCC-ee Collider Ring

Authors : Patrick James Hunchak (CLS, Saskatoon, Saskatchewan), Michael Hofer (CERN, Geneva), Yann Dutheil (CERN, Geneva 23), Rebecca Ramjiawan, Frank Zimmermann (CERN, Meyrin), Mark James Boland (CLS, Saskatoon, Saskatchewan; University of Saskatchewan, Saskatoon), Masamitsu Aiba (PSI, Villigen PSI)

Abstract In order to maximize the luminosity production time in the FCC- ee, top-up injection will be employed. The positron and electron beams will be accelerated to the collision energy in the booster ring before being injected with either a small transverse or longitudinal separation to the stored beam. Using this scheme essentially keeps the beam current constant and, apart from a brief period during the injection process, collision data can be continuously acquired. Two suitable schemes for FCC-ee have been identified in the past and are studied in further detail to find a suitable design for each of the four operation modes of the FCC-ee. In this paper, the integration into the collider ring is reviewed in view of changes of collider ring layout. Tracking studies are presented and the performance of the two schemes is compared.

SUSPMF007

Power Deposition Studies for Crystal-Based Heavy Ion Collimation in the LHC

Authors : Jean-Baptiste Potoine, Luigi Salvatore Esposito, Anton Lechner, Andreas Waets (CERN, Meyrin), Roderik Bruce, Rongrong Cai, Pascal Dominik Hermes, Stefano Redaelli (CERN, Geneva), Frederic Wrobel (IES, Montpellier)

Abstract The LHC heavy-ion program with 208Pb82+ beams is foreseen to benefit from a significant intensity upgrade in 2022. A performance limitation may arise from ion fragments scattered out of the collimators in the betatron cleaning insertion, which risk quenching superconducting magnets during periods of short beam lifetime. In order to mitigate this risk, an alternative collimation technique, relying on bent crystals as primary collimators, will be used in future heavy-ion runs. In this paper, we study the power deposition in superconducting magnets by means of FLUKA shower simulations, comparing the standard collimation system against the crystal-based one. The studies focus on the dispersion suppressor regions downstream of the betatron cleaning insertion, where the ion fragment losses are the highest. Based on these studies, we quantify the expected quench margin expected in future runs with 208Pb82+ beams.

SUSPMF008

Spectro-Temporal Properties of CHG Radiation

Authors : Arjun Radha Krishnan, Benedikt Büsing, Arne Held, Hubertus Kaiser, Shaukat Khan, Carsten Mai, Zohair Usfoor, Vivek Vijayan (DELTA, Dortmund)

Abstract The short-pulse facility at the 1.5-GeV synchrotron light source DELTA, operated by the TU Dortmund University, currently employs Coherent Harmonic Generation (CHG) to produce ultrashort radiation pulses in the vacuum ultraviolet regime. This is achieved via a laser-induced electron energy modulation and a subsequent microbunching in a dispersive section. It is possible to manipulate the spectro-temporal properties of the CHG pulses by varying the chirp of the seed laser pulses and the strength of the dispersive chicane. CHG spectra for different parameter sets were recorded and compared with the results of numerical simulations to reconstruct the spectra. The results of the studies will be presented.

SUSPMF009

Cooling Challenges in a NEG-Coated Vacuum Chamber of a Light

Authors : Saeid Talebi Motlagh, Amir Danaeifard, Javad Rahighi, Farhad Saeidi (ILSF, Tehran), Farhad Zamani (University of Kashan, Kashan)

Abstract In a light Source, unused synchrotron radiation is being distributed along the walls of the chambers. Due to the small conductance of the chambers, vacuum pumping is based on the distributed concept, and then non-evaporable getter (NEG) coating isextensively used. The vacuum chambers are made of copper alloys tube, and cooling circuits are welded to the chamber to remove the heat load from the radiation generated. Filler metal is used to create a brazed joint between the water cooling pipe and the vacuum chamber body. The thermal conductivity of the fillers is less than the vacuum chamber body. Moreover, the water velocity in the cooling pipe must be taken into account in thermal calculations.
In this paper, we study and investigate the effects of the filler metal and the cooling water velocity in cooling the chambers.

SUSPMF010

Undulator Tapering Studies of an Echo-Enabled Harmonic Generation Based Free-Electron Laser

Authors : Fabian Pannek, Wolfgang Carl Albert Hillert (University of Hamburg, Hamburg), Sven Ackermann, Lucas Schaper (DESY, Hamburg)

Abstract The free-electron laser (FEL) user facility FLASH at DESY is currently undergoing an upgrade which involves the transformation of one of its beamlines to allow for external seeding via so-called Echo-Enabled Harmonic Generation (EEHG). With this seeding technique it will be possible to provide stable, longitudinal coherent and intense radiation in the XUV and soft X-ray regime at high repetition rate. To ensure an efficient FEL amplification process, sustainable energy exchange between the electrons and the electromagnetic field in the undulator is mandatory. Adequate adjustment of the undulator strength along the beamline allows to compensate for electron energy loss and to preserve the resonance condition. The impact of this undulator tapering on the temporal and spectral characteristics on the EEHG FEL radiation at 4 nm is investigated by means of numerical simulations performed with the FEL code GENESIS 1.3, version 4. Different tapering methods are examined and it is shown that specific tapering of the undulator strength allows to exceed the FEL saturation power while maintaining a clear temporal and spectral shape of the FEL pulse.

SUSPMF011

Optical Simulation for Performance Prediction of X-Ray Optical Delay Line at European XFEL

Authors : Marziyeh Tavakkoly (EuXFEL, Schenefeld; University of Hamburg, Hamburg), Torsten Wohlenberg (DESY, Hamburg), Jan Grünert, Andreas Koch, Daniele La Civita, Mikako Makita, Michael Meyer, Marc Planas, Svitozar Serkez, Harald Sinn, Maurizio Vannoni (EuXFEL, Schenefeld)

Abstract X-ray Free Electron Lasers (XFELs) generate short and powerful radiation pulses allowing for a wide range of novel experiments. One of the experiments is two-color pump-probe spectroscopy using X-rays with controllable delay of two different wavelengths. In this work, we discuss the method for producing two-color pulses at the SASE3 soft X-ray beamline of the European XFEL. The technique is based on the installation of a Magnetic Chicane (MC), which delays the electron beam, and an Optical Delay Line (ODL) that delays the x-ray beam. In this paper, optical aspects of the project are investigated.

SUSPMF012

Design and Simulation of the MIR-FEL Generation System at Chiang Mai University

Authors : Supasin Sukara, Sakhorn Rimjaem (Chiang Mai University, Chiang Mai), Hideaki Ohgaki (Kyoto University, Kyoto)

Abstract At the PBP-CMU Electron Linac Laboratory, the system to generate MIR-FEL using the electron linac has been developed. In this contribution, the design and simulation results of the MIR- FEL generation system are presented. The system is designed as the oscillator-FEL type consisting of two mirrors and the 1.6-m permanent planar undulator. The middle of the undulator is determined as the laser beam waist. Both two mirrors are the concave gold-coated copper mirrors placed upstream and downstream the waist at the positions of 2.956 and 2.450 m, respectively. To simulate the FEL generation, the electron beam with maximum energy of 25 MeV is performed using the computer code GENESIS 1.3. As a result, the MIR-FEL pulses with the central wavelength range of 9.5 - 12.9 μm can be obtained from the undulator strength of higher than 0.75. This requires the electron beam with macro-pulses of at least 5 μs to saturate the FEL power with macro-pulse duration of about 1 μs. At the saturation point, the FEL micro-pulses have the FWHM duration in picosecond scale and the total energy of 0.3 - 0.4 μJ. The construction of the practical MIR-FEL system is conducted based on the results from this study.

SUSPMF013

Single Pass High Efficiency THz FEL

Authors : **Andrew Charles Fisher, Maximilian Patrick Lenz, Pietro Musumeci, Alexander Ody, Youna Park (UCLA, Los Angeles), Alex Murokh (RadiaBeam, Marina del Rey, California), Ronald Agustsson, Tara Campese (RadiaBeam, Santa Monica, California)**

Abstract Free electron lasers are an attractive option for high average and peak power radiation in the THz gap, a region of the electromagnetic spectrum where radiation sources are scarce, as the required beam and undulator parameters are readily achievable with current technology. However, slippage effects require the FEL to be driven with relatively long and low current electron bunches, limiting amplification gain and output power. We use a waveguide to match the radiation and e-beam velocities in a meter-long strongly-tapered helical undulator, allowing energy extraction from an ultrashort 200 pC 5.5 MeV electron beam. Measurements of the e-beam spectrum and THz FEL radiation indicated an average energy efficiency of 10%. We plan to significantly increase the efficiency by recirculating a portion of the radiation to seed subsequent passes as well as improve bunch compression.

SUSPMF014

Electro-Optic Sampling Based Characterization of Broad-Band High Efficiency THz-FEL

Authors : **Maximilian Patrick Lenz, Andrew Charles Fisher, Pietro Musumeci, Alexander Ody, Youna Park (UCLA, Los Angeles)**

Abstract Extremely high beam-to-radiation energy conversion efficiencies can be obtained in THz FEL when using a strongly tapered helical undulator in the zero-slippage regime where the radiation group velocity is matched by a circular waveguide to the electron beam longitudinal velocity in the undulator. In this paper we report on the first electro-optic sampling based measurements of the intense broadband THz-FEL radiation pulses generated in this regime. The THz field waveforms are reconstructed in the spatial and temporal domains by multi-shot and single-shot electro-optic sampling respectively. The field profiles are compared with the results of 3D self-consistent simulations and provide insights on the FEL dynamics in the deep non-linear regime.

SUSPMF015

Simulations of the Suitability of a DC Electron Photogun and S-Band Accelerating Structure as Input to an X-Band Linac

Authors : **Scott David Williams, Roger Paul Rassool, Suzanne L. Sheehy, Geoffrey Taylor, Matteo Volpi (The University of Melbourne, Melbourne, Victoria), Rebecca Auchettl, Rohan Dowd (AS - ANSTO, Clayton)**

Abstract Work has been underway for some time to design a compact electron beamline utilising X-band linear accelerating structures in the new Melbourne X-band Laboratory for Accelerators and Beams (X-LAB). The original design utilised an S-band RF photogun as an input to a pair of high gradient X-band linear accelerating structures, but we have been motivated to investigate an alternative initial section to allow for initial testing. This will utilise a DC photogun and S-band accelerating structure similar to those used at the Australian Synchrotron. Simulation results incorporating space charge of a beamline composed of a DC photogun, S-band accelerating structures, and two high gradient X-band structures will be presented. These simulation results will be optimised for minimum emittance at the end of the beamline.

SUSPMF016

Development of a Detection System for Quasi-Monochromatic THz Pulse by a Spatially Modulated Electron Beam

Authors : Kota Murakoshi, Yuya Koshiba, Yuichi Tadenuma, Peng Wang, Masakazu Washio (Waseda University, Tokyo), Ryunosuke Kuroda (AIST, Tsukuba), Kazuyuki Sakaue (The University of Tokyo, Bunkyo)

Abstract We have studied the generation of the broadband THz pulse using a compact linear accelerator. The THz pulse is generated by control of an electron beam angle to Cherenkov radiation angle. In addition, we have succeeded in producing a quasi- monochromatic THz pulse by the spatially modulated electron beam by passing through a slit. This work aims to develop a detection system to elucidate the spectrum of the quasi- monochromatic THz pulse. To detect it stably in a noisy radiation environment, the stability of probe laser system for Electro Optic sampling and timing synchronization system are important. In this conference, the generation method of each THz pulses, the results of development of detection system, and future prospect will be reported.

SUSPMF017

Visualisation of Pareto Optimal Spaces and Optimisation Solution Selection Using Parallel Coordinate Plots

Authors : Samuel Smith, Robert Apsimon, Graeme Burt, Matthew Southerby (Cockcroft Institute, Lancaster), Sadiq Setiniyaz (Cockcroft Institute, Warrington, Cheshire; Lancaster University, Lancaster)

Abstract In this paper, we build on previous work where multi-objective genetic algorithms were used to optimise RF cavities using non- uniform rational basis splines (NURBS) to improve the cavity geometries and reduce peak fields. These optimisations can produce thousands of Pareto optimal solutions, from which a final cavity solution must be selected based on design criteria, such as accelerating gradient and power requirements. As all points are considered equally optimal, this can prove difficult without further analysis. Here we focus on the visualisation of the Pareto optimal points and the final solution selection process. We have found that the use of clustering algorithms and parallel coordinate plots (PCPs) provide the best way to represent the data and perform the necessary trade-offs between the peak fields and shunt impedance required to pick a final design.

SUSPMF018

Investigation of Polarization Dependent Thomson Scattering in an Energy-Recovering Linear Accelerator on the Example of Mesa

Authors : Christoph Lukas Lorey, Atoosa Meseck (KPH, Mainz)

Abstract At the Johannes Gutenberg University (JGU) in Mainz, a new accelerator is currently under construction in order to deliver electron beams of up to 155 MeV to two experiments. The Mainz Energy-recovering Superconducting Accelerator (MESA) will offer two modes of operation, one of which is an energy-recovering (ER) mode. As an ERL, MESA, with it's high brightness electron beam, is a promising accelerator for supplying a Thomson back scattering based Gamma source. Furthermore, at MESA, the polarization of the electron beam can be set by the injector. The aim of this work is to provide a concept and comprehensive analysis of the merit and practical feasibility of a Thomson backscattering source at MESA under consideration of beam polarization and transversal effects. In this paper, an overview and results of our semi analytical approach to calculate various Thomson back scattering light source scenarios at MESA will be given. Furthermore we will discuss the benefits of using polarized electrons in combination with a polarized laser beam.

SUSPMF019

Generation of Coherent THz Transition Radiation for Time Domain Spectroscopy at the PBP-CMU Electron Linac Laboratory

Authors : Siriwan Pakluea (Chiang Mai University, Chiang Mai), Sakhorn Rimjaem, Jatuporn Saisut, Chitrlada Thongbai (Chiang Mai University, Chiang Mai; ThEP Center, Bangkok), Monchai Jitvisate (Suranaree University of Technology, Nakhon Ratchasima)

Abstract The accelerator system at the PBP-CMU Electron Linac Laboratory is used to generate terahertz transition radiation (THz-TR). Due to broad spectrum, it can be used as the light source for THz time-domain spectroscopy (TDS) to measure both the intensity and phase of the THz signal. This contribution presents the generation of the THz-TR produced from 10-20 MeV electron beams and the system preparation for THz TDS. The electron bunches, which are compressed to have a length of femtosecond scale at the experimental station, is used to generate the THz-TR using a 45°-tilted aluminum foil as a radiator. The radiation properties including angular distribution, polarization and radiation spectrum are measured in the accelerator hall and at the TDS station. The radiation spectral range covers up to 2.3 THz with the peak power of 0.5 - 1.25 MW is expected. The effects of electron bunch distribution, divergence of the beam and influence of optical components on the radiation properties were studied. The results show that the considered effects have a significant impact on the TR properties. The Information will be used in the TR characterization that is needed to be interpreted carefully.

SUSPMF020

Field Enhanced, Compact S-Band Gun Employing a Pin Cathode

Authors : Reza Bazrafshan, Timm Rohwer (Deutsches Elektronen Synchrotron (DESY) and Center for Free Electron Science (CFEL), Hamburg), Nicholas Hill Matlis (CFEL, Hamburg), Moein Fakhari, Klaus Floettmann, Franz Kaernter (DESY, Hamburg)

Abstract S-band RF-guns are highly developed for production of low emittance relativistic electron bunches, but need powerful klystrons for driving. Here, we present the design and first experimental tests of a compact compact S-band gun, which can accelerate electrons up to 180 keV powered by only 10 kW from a compact rack-mountable solid-state amplifier. A pin-cathode is used to enhance the RF electric field on the cathode up to 100 MV/m as in large-scale S-band guns. An electron bunch is generated through photoemission off a flat copper surface on the pin excited by a UV laser pulse followed by a focusing solenoid producing a low emittance bunch with 0.1 mm mrad transverse emittance for up to 100 fC bunch charge. We are currently in the conditioning phase of the gun and first experiments show good agreement with simulations. The compact gun will serve three purposes: (i) it can be used directly for ultrafast electron diffraction; (ii) as an injector into a THz booster producing 0.3MeV to 2 MeV electron bunches for ultrafast electron diffraction; (iii) The system in (ii) serves as an injector into a THz linear accelerator producing a 20 MeV beam for the AXSIS X-ray source project.

SUSPMF021

CrYogenic Brightness-Optimized Radiofrequency Gun (CYBORG)

Authors : Gerard Emile Lawler, Atsushi Fukasawa, Nathan Majernik, Jake Riley Parsons, James Rosenzweig, Yusuke Sakai, Arathi Suraj (UCLA, Los Angeles, California)

Abstract Producing higher brightness beams at the cathode is one of the main focuses for future electron beam applications. For photocathodes operating close to their emission threshold, the cathode lattice temperature begins to dominate the minimum achievable intrinsic emittance. At UCLA, we are designing a radiofrequency (RF) test bed for measuring the temperature dependence of the mean transverse energy (MTE) and quantum efficiency for a number of candidate cathode materials. We intend to quantify the attainable brightness improvements at the cathode from cryogenic operation and establish a proof-of-principle cryogenic RF gun for future studies of a 1.6-cell cryogenic photoinjector for the UCLA ultra compact XFEL concept (UC-XFEL). The test bed will use a C-band 0.5-cell RF gun designed to operate down to 45 K, producing an on-axis accelerating field of 120 MV/m. The cryogenic system uses conduction cooling and a load-lock system is being designed for transport and storage of air-sensitive high brightness cathodes.

SUSPMF022

Performance Report of the SOLEIL Multipole Injection Kicker

Authors : Randy Ollier, Patrick Alexandre, Rachid Ben El Fekih, Alexis Gamelin, Nicolas Hubert, Marie Labat, Amor Nadji, Laurent Stanislas Nadolski, Marie-Agnès Tordeux (SOLEIL, Gif-sur-Yvette)

Abstract A Multipole Injection Kicker (MIK) was installed in a short straight section of the SOLEIL storage ring and successfully commissioned in 2021. A small horizontal orbit distortion in the micrometer range was achieved outperforming the standard bump-based injection scheme installed in a 12-m long straight section. Refined studies have been conducted to fully understand and further improve the performance of the device. Indeed, a novel generation of the MIK will be the key element for the injection scheme of the SOLEIL Upgrade. We report simulation studies and the latest MIK experimental performance. Both injected and stored beam-based measurements were performed using new types of diagnostics with turn-by-turn capability (Libera Brillance+ BPM, KALYPSO: 2x1D imaging). The residual perturbations on the beam positions and sizes were measured; the magnetic field of the MIK device was reconstructed. An unexpected kick was detected in the vertical plane and an active correction implemented to cancel the resulting perturbation.

SUSPMF023

Goubau-Line Set Up for Bench Testing Impedance of IVU32 Components

Authors : **Paul Ignatius Volz (HZB, Berlin), Atoosa Meseck (HZB, Berlin; KPH, Mainz)**

Abstract The worldwide first in-vacuum elliptical undulator, IVUE32, is being developed at Helmholtz-Zentrum Berlin. The 2.5 m long device with a period length of 3.2 cm and a minimum gap of about 7 mm is to be installed in the BESSY II storage ring. It will deliver radiation in the soft X-ray range to several beamlines. The proximity of the undulator structure to the electron beam makes the device susceptible to wakefield effects which can influence beam stability. A complete understanding of its impedance characteristics is required prior to installation and operation, as unforeseen heating of components could have catastrophic consequences. To understand and measure the IVU's impedance characteristics a Goubau-Line test stand is being designed. A Goubau-line is a single wire transmission line for high frequency surface waves with a transverse electric field resembling that of a charged particle beam out to a certain radial distance. A concept optimized for bench testing IVUE32-components will be discussed, microwave simulations will be presented together with first measurements from a test stand prototype.

SUSPMF024

Status and Powering Test Results of HTS Undulator Coils at 77 K for Compact FEL Designs

Authors : **Sebastian C. Richter (CERN, Geneva; KIT, Karlsruhe), Amalia Ballarino, Thomas Henricus Nes, Daniel Schoerling (CERN, Geneva), Axel Bernhard, Anke-Susanne Mueller (KIT, Karlsruhe)**

Abstract The production of low emittance positron beams for future linear and circular lepton colliders, like CLIC or FCC-ee, requires high-field damping wigglers. Just as compact free-electron lasers (FELs) require high-field but as well short-period undulators to emit high energetic, coherent photons.

Using high-temperature superconductors (HTS) in the form of coated ReBCO tape superconductors allows higher magnetic field amplitudes at 4 K and larger operating margins as compared to low-temperature superconductors, like Nb-Ti. This contribution discusses the development work on superconducting vertical racetrack (VR) undulator coils, wound from coated ReBCO tape superconductors. The presented VR coils were modularly designed with a period length of 13 mm. Powering tests in liquid nitrogen of multiple vertical racetrack coils were performed at CERN. The results from the measurements are presented for three VR coils and compared with electromagnetic simulations.

SUSPMF025

Hall Probe Magnetic Measurement of 50 mm Period PPM Undulator

Authors : Saif Mohd Khan, Ganeswar Mishra (Devi Ahilya University, Indore), Mona Gehlot (MAX IV Laboratory, Lund), Hussain Jeevakhan (NITTTR, Bhopal)

Abstract In this paper, we present the latest upgradation of Hall Probe magnetic measurement system. The Hall Probe measurement system is upgraded with position measuring detectors and 3D F.W. Bell Teslameter. The field integrals and the phase errors are calculated with a new user friendly MATLAB code. The integrated multipoles both normal and skew components are measured and discussed in the paper. The proposed activities on 300 mm length prototype asymmetric undulator and 50 mm quasi period, six period length at Laser Instrumentation and Insertion Device Application laboratory of Devi Ahilya Vishwa Vidyalaya (DAVV), Indore, India has been discussed and design components are presented.

SUSPMF026

Single-Sided Pumped Compact Terahertz Driven Booster Accelerator

Authors : Tobias Kroh, Reza Bazrafshan, Nicholas Hill Matlis (Deutsches Elektronen Synchrotron (DESY) and Center for Free Electron Science (CFEL), Hamburg), Moein Fakhari, Mikhail Pergament, Timm Rohwer, Mostafa Vahdani, Dongfang Zhang (CFEL, Hamburg), Franz Xaver Kaertner (Deutsches Elektronen Synchrotron (DESY) and Center for Free Electron Science (CFEL), Hamburg; The Hamburg Center for Ultrafast Imaging, University of Hamburg, Hamburg), Keigo Kawase (JAEA, Kizugawa)

Abstract Scaling the RF-accelerator concept to terahertz (THz) frequencies brings several compelling advantages, including compactness, intrinsic timing between the photoemission and driving field sources, and high field gradients associated with the short THz wavelength and high breakdown threshold. Recent demonstrations of such THz powered accelerators relied on two counter-propagating single-cycle THz pulses. However, to achieve high energy gains in the acceleration process high energy THz pulses are needed which in turn require complex optical setups. Here, we present on the development of a matchbox sized multi-layered accelerator designed to boost the 50 keV output of a DC electron gun to energies of ~400 keV that only requires a single THz pulse to be powered. An integrated tunable mirror inside the structure interferes the front of the driving THz pulse with its rear part such that the field in the interaction region is optimized for efficient acceleration. This reduces the complexity of the required optical setup. Such a compact booster accelerator is very promising as electron source in ultrafast electron diffraction experiments and as booster stage prior to THz based LINACs.

SUSPMF027

From Lossy THz Accelerating Waveguides to the Constant Gradient Design of a Dielectric Loaded Waveguide

Authors : Max Joseph Kellermeier, Thomas Vinatier (DESY, Hamburg), Ralph Wolfgang Assmann (DESY, Hamburg; LNF-INFN, Frascati), Wolfgang Carl Albert Hillert (University of Hamburg, Hamburg)

Abstract In recent years emerging high power THz sources advanced the high gradient acceleration of ultra-short bunches, towards new high brightness beams. So far, dissipation of power in the lossy accelerating structure is often considered as negligible which leads to the assumption of a constant accelerating field along the beam axis. In our treatment, finite conductivity of copper and dielectric loss is included in beam dynamics simulations of acceleration in a circular dielectric loaded waveguide. Apart from the reduced final energy especially the longitudinal focal point is affected by the modified field profile. Two approaches to overcome the effects are presented. The first one simply assumes a more powerful THz source to compensate the loss. In contrast, the second approach aims for recovering the ideal case by longitudinally tapering the cross section to achieve a constant gradient design. Regardless of the approach undertaken in future experiments, the power dissipation significantly increases the requirements of the driving THz source in terms of peak power or pulse length.

SUSPMF028

Optimized Dielectric Loaded Waveguide Terahertz LINACs

Authors : Mostafa Vahdani (CFEL, Hamburg; University of Hamburg, Hamburg), Moein Fakhari (DESY, Hamburg), Franz Xaver Kaertner (Deutsches Elektronen Synchrotron (DESY) and Center for Free Electron Science (CFEL), Hamburg; The Hamburg Center for Ultrafast Imaging, University of Hamburg, Hamburg)

Abstract Dielectric loaded waveguides (DLW) powered by multicycle terahertz (THz) pulses have shown promising performance as compact linear accelerators due to higher breakdown fields at THz frequencies compared to conventional RF components. By changing the dielectric dimensions one can control phase and group velocities of the THz pulse inside the DLW. Since optimum waveguide dimensions are dependent on initial electron energy, THz pulse energy, and etc., it is worthwhile to determine optimum values for different conditions to maximize final kinetic energy. In this work, we present a combined analytical/numerical guide to determine the optimum DLW parameters for single on- axis electron acceleration. We also introduce normalized graphic representations to visualize optimum designs for different initial electron and THz pulse energies.

SUSPMF029

Diagnosis of Transverse Emittance in Laser-Driven Ion Beam

Authors : Tatsuhiko Miyatake, Ibuki Takemoto, Yukinobu Watanabe (Kyushu University, Kasuga-Shi), Thanh-Hung Dinh, Kondo Kiminori, Kotaro Kondo, Kando Masaki, Masaharu Nishikino, Mamiko Nishiuchi, Kojima Sadaoki, Hironao Sakaki (National Institutes for Quantum and Radiological Science and Technology, Kyoto)

Abstract Research on laser-driven acceleration mechanisms is important to develop a next-generation compact accelerator. Especially, understanding transverse emittance is extremely important in determining the characteristics of the accelerated beam with a laser-driven acceleration mechanism. Some papers show the emittance of laser-driven protons so far, but parameters that contribute to an emittance have not been systematically diagnostics, so the emittance controlling methods have not been understood. Therefore, we plan to control the transverse emittance for establishing an ion accelerator with laser-driven acceleration mechanisms. We report on the diagnostics result of the correlation between the transverse emittance of laser-driven protons and various parameters of the laser or target.

SUSPMF030

Beam Dynamics and Drive Beam Losses Within a Planar Dielectric Wakefield Accelerator

Authors : Toby Joseph Overton (Cockcroft Institute, Warrington, Cheshire), Yuri Saveliev (Cockcroft Institute, Warrington, Cheshire; STFC/DL/ASTeC, Daresbury, Warrington, Cheshire), Thomas Hywel Pacey (STFC/DL/ASTeC, Daresbury, Warrington, Cheshire), Guoxing Xia (UMAN, Manchester)

Abstract Beam-driven dielectric wakefield accelerators (DWA) have the potential to provide accelerating gradients in the GV/m range. The transverse dynamics in such devices need to be understood to avoid instabilities over long transport distances and facilitate beam matching to specific applications (e.g. FELs). This presentation details simulation studies of the magnitude of beam-breakup instability (BBU) in planar dielectric lined waveguides (DLWs). These are for DWA drive beams, with high charge and momentum that can be produced at current facilities. Using a series of perpendicular DLW segments has been proposed to control instabilities over larger distances. Using self- developed software, the beam dynamics of a drive beam within a DLW are simulated and the magnitude of beam losses along a DLW of varying lengths calculated and beam quality preservation investigated. Methods to reduce transverse instabilities have been explored, and the impact of these on the length of a possible DWA acceleration stage are investigated. An acceleration stage with m-scale length, consisting of multiple alternating planar DLWs, is suggested and preservation of beam quality along this distance is shown.

SUSPMF031

Temporal and Spatial Characterization of Ultrafast Terahertz Near- Fields for Particle Acceleration

Authors : Annika Gabriel, Matthias Clemens Hoffmann, Emilio Alessandro Nanni, Mohamed Othman (SLAC, Menlo Park,California)

Abstract We have measured the THz near-field in order to inform the design of improved THz-frequency accelerating structures. THz- frequency accelerating structures could provide the accelerating gradients needed for next generation particle accelerators with compact, GV/m-scale devices. One of the most promising THz generation techniques for accelerator applications is optical rectification in lithium niobate using the tilted pulse front method. However, accelerator applications are limited by significant losses during transport of THz radiation from the generating nonlinear crystal to the acceleration structure. In addition, the spectral properties of high-field THz sources make it difficult to couple THz radiation into accelerating structures. A better understanding of the THz near-field source properties is necessary for the optimization of THz transport and coupling. We have developed a technique for detailed measurement of the THz near-fields and used it to reconstruct the full temporal 3D THz near-field close to the LN emission face. Analysis of the results from this measurement will inform designs of novel structures for use in THz particle acceleration.

SUSPMF032

Progress in Multi-MeV Energy Gain in a Relativistic Dielectric Laser Accelerator

Authors : Sophie Crisp, Alexander Ody (UCLA, Los Angeles), Pietro Musumeci (UCLA, Los Angeles, California)

Abstract We present progress and an experimental plan for multi-MeV relativistic energy gain in a dielectric laser-driven accelerator (DLA). Using a 780 nm, 100 fs pulse-front-tilted laser, we achieve interaction with 6 MeV electrons over a 4 mm long structure with 800 nm period. To compensate for resonant defocusing effects, the laser pulse is imprinted with a phase mask, applied by a Spatial Light Modulator, which uses alternating phase focusing (APF) to achieve stable beam transport. The DLA is mechanically mounted with a variable sized gap (600-1200 nm) in order to maximize transmission while maintaining high gradient within the channel. The combination of high interaction length and use of APF confines and accelerates the electrons by up to 3.5 MeV.

SUSPMF033

Theoretical Study of Laser Energy Absorption Towards Novel Bright Proton and Electron Sources

Authors : Iuliana Mariana Vladisavlevici, Emmanuel d'Humières (CELIA, Talence), Daniel Vizman (West University of Timisoara, Timisoara)

Abstract Our main goal is to describe and model the energy transfer from laser to particles, from the transparent to less transparent regime of laser-plasma interaction in the ultra-high intensity regime, and using the results obtained to optimize laser ion acceleration. We propose a theoretical model of energy transfer, assuming that most of the laser energy will be transferred to hot electrons. The model is further tested and corrected through 2D particle-in-cell simulations performed with SMILEI*. Varying the target density and thickness, we studied the optimal parameters for the maximum conversion efficiency of the laser energy to particles. We investigate a model for a near-critical density plasma between 0.5-20 nc (where nc = 1.1·10^21 cm^-3 is the critical density) driven by a laser pulse of intensity in the range 10^18-10^23 W/cm^2 and the pulse duration in the range 10- 100 fs. Theoretical modelling of the predominant laser-plasma interaction mechanisms predicts the particle energy and conversion efficiency optimization **,***. Our studies led to an optimization of the target areal density for maximizing proton acceleration for a laser intensity of 10^22 W/cm^2.

SUSPMF034

Developing Beam Options for Future Fixed Target Experiments in the CERN North Area Within the Framework of of the Conventional Beams Working Group of Physics Beyond Colliders

Authors : Carlo Alberto Mussolini (CERN, Geneva; JAI, Oxford), Dipanwita Banerjee, Johannes Bernhard, Nikolaos Charitonidis, Gian Luigi D'Alessandro, Alexander Gerbershagen, Bastien Rae, Silvia Schuh-Erhard (CERN, Geneva), Elisabetta Giulia Parozzi (CERN, Geneva; INFN MIB, MILANO; Universita Milano Bicocca, MILANO), Markus Brugger (CERN, Meyrin)

Abstract The Physics Beyond Colliders initiative at CERN aims to exploit the full scientific potential of the CERN accelerator complex and its scientific infrastructure for particle physics studies complementary to current and future collider experiments. Several experiments have been proposed to fully utilize and further advance the beam options for the existing fixed target experiments present in the North Experimental Area of the CERN SPS. We report here on progress with an RF-separated beam option for the AMBER experiment, following a recent workshop on this topic. In addition we will cover the status of studies for ion beams for the NA60+ experiment as well as those for high intensity beams for kaon physics and Feebly Interacting Particles searches. With the first beams available in 2021 after a long shutdown, several muon beam options could also be tested for the NA64mu, MUonE and AMBER experiments.

SUSPMF035

Magnetic Characterization of a Superconducting Transverse Gradient Undulator for Compact Laser Wakefield Accelerat-Driven FEL

Authors : Kantaphon Damminsek, Axel Bernhard, Anke-Susanne Mueller, Maisui Ning, Yimin Tong (KIT, Karlsruhe), Sebastian C. Richter (CERN, Geneva), Robert Rossmanith (DESY, Hamburg), Andreas Wolfgang Grau (KIT, Eggenstein-Leopoldshafen)

Abstract Combining a superconducting transverse gradient undulator (TGU) with a Laser Wakefield Accelerator (LWFA) is a potential key for realizing a very compact Free Electron Laser (FEL). A 40- period superconducting TGU has been fabricated and characterized at Karlsruhe Institute of Technology (KIT). The superconducting TGU has been commissioned off-line, step by step reaching its final operational parameters. A specially designed set-up for mapping the magnetic field in the TGU's extremely narrow gap has been installed, commissioned and employed for the magnetic characterization. In this contribution, we report on the operational experience of the TGU and on the magnetic characterization measurement. This work is supported by the BMBF project 05K19VKA PlasmaFEL (Federal Ministry of Education and Research) and the Development and Promotion of Science and Technology Talents Project (DPST).

SUSPMF036

The Propagation of Laser Accelerated Pulsed Beams in Underdense Plasma

Authors : Hao Cheng, Dongyu Li, Yuze Li, Chen Lin, Xueqing Yan, Yang Yan, Tong Yang (PKU, Beijing)

Abstract Laser ion acceleration has become a promising new compact accelerator due to its ultra-high field gradient and exceptional beam properties including low emittance, high intensity and short pulse duration*. To apply ion beam, it is previously focused by focusing elements, such as magnet quadrupoles**, solenoids***, and laser-triggered micro-lenses****. Plasma has also been considered as a capable medium for beam transport, which effectively neutralize the beam to relax space charge restriction and sustain large electromagnetic fields. We have performed 2D-PIC simulations to investigate interaction of pulsed proton beam with underdense plasma, focusing on the evolution of beam quality. An injection of pulsed proton beam into underdense plasma generates wakefields and spontaneous magnetic fields, which simultaneously effect the proton quality. The wakefields and the spontaneous magnetic fields continuously deflect the beam, resulting in much less increment of beam divergence in plasma than in vacuum. It indicates the feasibility and effectiveness of plasma as beam transport element for proton beam, greatly promoting the utilization of laser accelerated pulsed proton beam.

SUSPMF037

Beam Matching in an Elliptical Plasma Blowout Driven by Highly Asymmetric Flat Beams

Authors : Pratik Manwani, Havyn Skyler Ancelin, Nathan Majernik, James Rosenzweig (UCLA, Los Angeles, California), Monika Yadav (Cockcroft Inst itute, Warrington, Cheshire; The University of Liverpool, Liverpool; UCLA, Los Angeles, California), Gerard Andonian (RadiaBeam, Marina del Rey, California; UCLA, Los Angeles, California)

Abstract Beams having highly asymmetric emittance are foreseen at AWA and FACET facilities. The high aspect ratio produces a blowout region that is elliptical in cross section and this asymmetry in the ion column structure creates an asymmetry in the focusing in the two transverse planes. The ellipticity of the plasma blowout decreases with increase in the normalized peak current and gradually approaches an axisymmetric structure. A matching condition for the beam envelope inside the elliptical blowout is introduced. Simulations are performed to calculate the ellipticity of the resultant elliptical wakefield based on the initial beam parameters and are matched with analytical calculations. This work also explores the parameter space that would be achievable in the AWA and FACET facilities, and plasma profiles required to match these beams are discussed.

SUSPMF038

An Energy Dechirper for Laser-Accelerated Proton Based on Standing Wave Wakefield Superposition

Authors : Tong Yang, Hao Cheng, Yanlv Fang, Zhen Guo, Dongyu Li, Chen Lin, Minjian Wu, Yadong Xia, Xueqing Yan, Yang Yan (PKU, Beijing)

Abstract Proton beams originating from laser-plasma accelerators have broad energy spread*, which makes it difficult to preserve their high quality during transport to applications.Particularly, the pulse duration will increase. To improve on this, the study realized a scheme that applies an energy dechirper based on laser-driven wakefield. When axially side-by-side ultra-intensive laser pulses are injected into a plasma channel from the side of the channel, the axial wakefield in the plasma is in form of standing wave approximately. Two standing waves with a fixed spatial and temporal phase difference of pi/4 superimpose into a traveling wave form. The key of the scheme is that the traveling wave phase velocity can match with the velocity of multi-MeV proton beam. And under the velocity match condition, the proton beam incident axially into the plasma channel is set a positive energy chirp by the traveling wave wakefield. The paper presents initial simulation work to model this dechirper scheme. The energy dechirper offers the possibility of producing high power,quasimonoenergetic and sub-nanosecond proton pulses for ultra-fast science,ion fusion,quality transport and cascade acceleration.

SUSPMF039

Performance Characterisation of Ultra-Thin MgO Film on Metal Photocathodes

Authors : Christopher Benjamin (STFC/DL/ASTeC, Daresbury, Warrington,Cheshire; University of Warwick, Coventry), Lee Jones, TimNoakes (Cockcroft Institute, Warrington, Cheshire;STFC/DL/ASTeC, Daresbury, Warrington, Cheshire), LiamAnthony James Soomary (Cockcroft Institute, Warrington,Cheshire; STFC/DL/ASTeC, Daresbury, Warrington, Cheshire; TheUniversity of Liverpool, Liverpool), Hugh Michael Churn(STFC/DL/ASTeC, Daresbury, Warrington, Cheshire), Gavin Bell(University of Warwick, Coventry)

Abstract The performance expected from the next generation of electron accelerators is driving research into photocathode technology as this fundamentally limits the achievable beam quality. The performance characteristics of a photocathode are most notably; normalised emittance, brightness and energy spread*. These factors can be defined by surface properties of the cathode, including the work function (WF), the intrinsic emittance and the quantum efficiency (QE) of the photocathode. Ultra-thin Oxide films on metal substrates have been shown to lower the WF of the surface, enhancing commonly utilised metal photocathodes, potentially improving lifetime and performance characteristics**. The surface properties of ultra-thin MgO films grown on polycrystalline Cu and Ag photocathodes are investigated using; Scanning Tunnelling Microscopy (STM), X-Ray Photoelectron Spectroscopy (XPS) and QE measurements. Additionally, we measure the Transverse Energy Distribution Curves (TEDC) for these photocathodes under illumination at various wavelengths using ASTeC's Transverse Energy Spread Spectrometer (TESS)*** and extract the Mean Transverse Energy (MTE).

SUSPMF040

Commissioning of a High-Gradient X-band RF Gun Powered by Short RF From a Wakefield Accelerator

Authors : Wei Hou Tan (Northern Illinois University, DeKalb, Illinois), Darrell Scott Doran, Gwanghui Ha, Wanming Liu, John Gorham Power, Charles Whiteford, Eric Edson Wisniewski (ANL, Lemont, Illinois), Chunguang Jing (ANL, Lemont, Illinois; Euclid TechLabs, Solon, Ohio), Xueying Lu, Philippe Regis-Guy Piot (ANL, Lemont, Illinois; Northern Illinois University, DeKalb, Illinois), Sergey P. Antipov, Ernest William Knight, Sergey Vladimirovich Kuzikov (Euclid TechLabs, Solon, Ohio)

Abstract An important aspect toward producing bright electron beams consists in rapidly accelerating the beam to mitigate detrimental effects from space-charge effects. A high-gradient X-band (11.7- GHz) photoinjector developed by Euclid Techlabs, was recently commissioned at the Argonne Wakefield Accelerator (AWA). The system comprises a 1+1/2-cell RF gun powered by short RF pulses generated as a train of high-charge bunches from the AWA accelerator passes through a slow-wave power extraction and transfer structure. The RF photoinjector was reliably operated with electric fields in excess of 300 MV/m on the photocathode surface free of breakdown and with an insignificant dark-current level. We report on the RF-gun setup, commissioning, and the associated beam generation via photoemission. The experimental results are compared with numerical simulations when applicable.

SUSPMF041

Laser-Driven Plasma Nuclear Fusion Based on Nanowire Array Structure Using Kilojoule-ns-Scale Laser

Authors : Defeng Kong, Zhengxuan Cao, Wenjun Ma, Zhusong Mei, Zhuo Pan, Pengjie Wang, Shirui Xu, Xueqing Yan (PKU, Beijing)

Abstract Laser-driven nuclear physics has aroused extensive concerning. However, the obstacle of volumetric deposition for laser energy restricts the plasma temperatures for the nuclear reaction. Novel target structures are explored as a method to strengthen laser- plasma coupling and improve the production rate. Here we employ the ordered high aspect ratio deuterated polyethylene nanowire arrays which can extend penetration depth of laser into materials and increase laser absorption significantly. High energy density plasma for fusion has been provided by the radiation of the nanostructure with 1.8 kJ, 1 ns laser pulses focused to 10^15 W/cm^2. Plasma diagnosis indicate one order of magnitude enhancement of electron emissions and triple improvement of bremsstrahlung radiation emissions from the nanowire arrays compared to the flat targets, which shows the electric return currents and plasma collision heat the nanowires and cause wires to explode. It results in the generation of numerous neutrons from DD nuclear fusion with the yield of 10^6 per shot.

SUSPMF042

Performance of Automated Synchrotron Lattice Optimisation Using Genetic Algorithm

Authors : Xuanhao Zhang, Suzanne L. Sheehy (The University of Melbourne, Melbourne, Victoria)

Abstract Rapid advances in superconducting magnet and related accelerator technology opens many unexplored possibilities for future synchrotron designs. We present an efficient method to probe the feasible parameter space of synchrotron lattice configurations. Using this method, we can converge on a suite of optimal solutions with multiple optimisation objectives. It is a general method that can be adapted to other lattice design problems with different constraints or optimisation objectives. In this method, we tackle the lattice design problem using a multi- objective genetic algorithm. The problem is encoded by representing the components of each lattice as columns of a matrix. A large population of semi-randomly generated lattices are evolved over many generations using cross-over and random mutation operators. The lattices are ranked based on a fitness function that accounts for constraint violation and objective satisfaction. This new method is an improvement over the neural network based approach* in terms of computational resources. We evaluate the performance and limitations of this new method and discuss the potential to utilise this method in other lattice design applications.

SUSPMF043

The Zgoubidoo Python Framework for Ray-Tracing Simulations With Zgoubi: Applications to Fixed-Field Accelerators

Authors : Marion Vanwelde, Eustache Gnacadja, Nicolas Pauly, Eliott Ramoisiaux, Robin Tesse (ULB, Bruxelles), Cédric Hernalsteens (CERN, Meyrin; ULB, Bruxelles)

Abstract The study of beam dynamics in accelerators featuring main magnets with complex geometries such as Fixed Field Accelerators (FFAs) requires simulation codes allowing step-by- step particle tracking in complex magnetic fields, such as the Zgoubi ray-tracing code. To facilitate the use of Zgoubi and to allow readily processing the resulting tracking data, we developed a modern Python 3 interface, Zgoubidoo, using Zgoubi in the backend. In this work, the key features of Zgoubidoo are illustrated by detailing the main steps to obtain a non-scaling FFA accelerator from a scaling design. The results obtained are in excellent agreement with prior results, including the tune computation and orbit shifts. These results are enhanced by Zgoubidoo beam dynamics analysis and visualization tools, including the placement of lattice elements in a global coordinate system and the computation of linear step-by-step optics. The validation of Zgoubidoo on conventional scaling and non-scaling FFA designs paves the way for future uses in innovative FFA design studies.

SUSPMF044

Tune Control in Fixed Field Accelerators

Authors : Adam F. Steinberg, Robert Appleby (UMAN, Manchester), Suzanne L. Sheehy (The University of Melbourne, Melbourne, Victoria)

Abstract Fixed Field Alternating Gradient Accelerators have been proposed for a wide range of challenges, including rapid acceleration in a muon collider, and large energy acceptance beam transport for medical applications. A disadvantage of these proposals is the highly nonlinear field profile required to keep the tune energy- independent, known as the scaling condition. It has been shown computationally that approximately constant tunes can be achieved by addition of nonlinear fields that do not follow this scaling law, however the impacts of these nonlinearities are not well understood. Here, we apply the methods of Lie Algebra to nonlinearities in fixed field accelerators, to better characterise their impact on the tune and dynamic aperture. These results are verified by simulation using Zgoubi. As a model use case, we investigate the degree of tune compensation that can be achieved in a fixed field accelerator for ion cancer therapy.

SUSPMF045

Exploring Accelerators for Intense Beams With the IBEX Paul Trap

Authors : Jake Flowerdew (University of Oxford, Oxford), David John Kelliher, Shinji Machida, Suzanne L. Sheehy (STFC/RAL/ASTeC, Chilton, Didcot, Oxon)

Abstract The intensity frontier has called for new initiatives in hadron accelerator design in order to accommodate space charge dominated beams. Octupoles are often used to dampen beam instabilities caused by space charge, however the insertion of octupole magnets leads to a nonintegrable lattice which reduces the area of stable particle motion. One proposed solution is Quasi-Integrable optics (QIO), where the octupoles are inserted between a specially designed lattice called a T-insert. An octupole with a strength that scales as 1/ß3 is applied in the nonlinear region to create a time independent octupole field, leading to a lattice which is close to integrable and robust to small perturbations. IBEX is a Paul trap which allows the transverse dynamics of a collection of trapped particles to be studied, mimicking the propagation through multiple quadrupole lattice periods, whilst remaining stationary in the laboratory frame. In order to test QIO at the IBEX experiment, it has recently undergone an upgrade to allow for the creation of octupole fields. We present our recent commissioning results of the IBEX experiment along with our simulation results of our proposed experiment to test QIO.

SUSPMF046

Studies of ECR Plasmas and Material Modifications/synthesis Using Low Energy Ion Beam Facility at IUAC

Authors : Puneeta Tripathi, Pravin Kumar, Shushant Kumar Singh (IUAC, New Delhi)

Abstract The ECR ion sources are widely used to produce high intensities of highly charged positive ions*. To increase their performance further, several techniques are employed. The addition of lighter gas into the main plasma (so-called gas mixing) shows a substantial effect on the charge state distribution of highly charged ions. Although many theoretical models were used to explain this gas mixing effect, yet it is not fully understood. The low energy ion beam facility (LEIBF) at Inter-University Accelerator Centre (IUAC), New Delhi, India, which comprises a 10 GHz all-permanent magnet NANOGAN ECR source placed on a high voltage platform (400kV) has been used to develop several plasmas for the physical understanding of ions production and their confinement in a strong magnetic field**. Further, the LEIBF allows us to extract ion beams from the plasma in the energy range of a few keV to tens of MeV for novel ion-matter interaction experiments. In this paper, the charge state distribution studies (relevant to gas mixing effect) of various atomic species at optimized ion source tuning parameters along with results on materials synthesis/modification using ion beams will be discussed.

SUSPMF047

Horizontal Beam Response at Extraction Conditions at the Heidelberg Ion-Beam Therapy Centre

Authors : Edgar Cristopher Cortés García, Eike Feldmeier, Thomas Haberer (HIT, Heidelberg)

Abstract The Heidelberg Ion-Beam Therapy Centre's synchrotron makes use of the sextupole driven RF-KO method near the third-order resonance in order to slowly extract the beam that is delivered to the patients. The horizontal beam response of a coasting beam was studied experimentally and with simulations at extraction conditions in order to deduce regions of interest for an optimal excitation signal spectrum. Two narrow frequency regions were found were the beam reacts coherently. With these information an RF signal was proposed for the resonant slow extraction.

SUSPMF048

Simulation of Heavy-Ion Beam Losses With Crystal Collimation

Authors : Rongrong Cai, Luigi Salvatore Esposito, Pascal Dominik Hermes, Stefano Redaelli, Philippe Schoofs (CERN, Geneva), Francesc Salvat Pujol (CERN, Geneva 23), Roderik Bruce, Anton Lechner (CERN, Geneva; CERN, Meyrin), Daniele Mirarchi (CERN, Geneva; The University of Manchester, Manchester), Marco D'Andrea (CERN, Geneva; Univ. degli Studi di Padova, Padova), Jean-Baptiste Potoine (CERN, Meyrin; IES, Montpellier)

Abstract With the higher stored energy envisioned for future runs and the challenging fragmentation characteristic of heavy ion beams in the LHC compared to proton beams, the need arises for even more performing collimation systems. One promising solution is crystal channeling, which is the baseline for heavy ion operation during LHC Run III and the HL-LHC upgrade. To investigate an optimal configuration for the collimation system, a well-tested simulation setup is required. This work uses the implementation of channeling and other coherent effects in the SixTrack-FLUKA Coupling simulation framework and compares simulated loss patterns with data from previous beam tests.

SUSPMF049

Algorithm to Mitigate Magnetic Hysteresis in Magnets With Unipolar Power Supplies

Authors : Jamiel Nasser, Richard Baartman, Oliver Karl Kester, Spencer Kiy, Thomas Planche, Stephanie Diana Rädel, Olivier Shelbaya (TRIUMF, Vancouver)

Abstract The effects of hysteresis on the fields produced by magnetic lenses are not accounted for in TRIUMF's models of the accelerators. Under certain conditions, such as quadrupoles with unipolar power supplies operating at low currents, these effects have introduced significant field errors with consequences upon tranverse tunes. To combat these uncertainties and make the fields more reproducible and stable, a technique new to TRIUMF has been implemented. This technique ramps the current cyclically about the desired setpoint to reach a reproducible field that is independent of its history. Results of magnetic measurements at TRIUMF using this technique are presented, as well as the expected improvements to the accuracy of the beam optics model, particularly for unipolar quadrupoles.

SUSPMF050

Machine Learning Based Surrogate Model Construction for Optics Matching at the European XFEL

Authors : Zihan Zhu, Ye Chen, Matthias Scholz, Sergey Tomin (DESY, Hamburg)

Abstract Beam optics matching is a daily routine in the operation of an X- ray free-electron laser facility. Usually, linear optics is employed to conduct the beam matching in the control room. However, the collective effects like space charge dominate the electron bunch in the low-energy region which decreases the accuracy of the existing tool. Therefore, we proposed a scheme to construct a surrogate model with nonlinear optics and collective effects to speed up the optics matching in the European XFEL injector section. This model also facilitates further research on beam dynamics for the space-charge dominated beam.

SUSPMF051

ENUBET's Multi Momentum Secondary Beam Line

Authors : Elisabetta Giulia Parozzi (Universita Milano Bicocca, MILANO), Nikolaos Charitonidis (CERN, Geneva), Giulia Brunetti, Francesco Terranova (INFN MIB, MILANO; Universita Milano Bicocca, MILANO), Fabio Pupilli (INFN- Sez. di Padova, Padova), Andrea Longhin (INFN- Sez. di Padova, Padova; Univ. degli Studi di Padova, Padova)

Abstract In order to study the remaining open questions concerning CP violation and neutrino mass hierarchy, as well as to search for physics beyond the Standard Model, future experiments require precise measurements of the neutrino interaction cross-sections in the GeV/c regime. The absence of a precise knowledge of the neutrino flux currently limits this measurement to a 10-20% uncertainty level. The ENUBET project is proposing a novel facility, capable of constraining the neutrino flux normalization through the precise monitoring of kaon decay products in an instrumented decay tunnel. The collaboration has conducted numerous studies using a beam-line with a central Kaon momentum of 8.5 GeV/c and a ±10% momentum spread. We present here the design of a new beam-line, broadening the range of Kaons to include momenta of 4, 6, and 8.5 GeV/c, thus allowing ENUBET to explore cross-sections over a much larger energy range. In this contribution, we discuss the status of this design, the optimization studies performed, the early results, and the expected performance in terms of kaon and neutrino rates. We also present the first estimations of the background expected to be seen by the experiment.

SUSPMF052

Wakefield Effects Evaluation on Nanometer Small Beam at KEK-ATF

Authors : Yuki Abe (Sokendai, Ibaraki), Kiyoshi Kubo, Toshiyuki Okugi, Nobuhiro Terunuma (KEK, Ibaraki; Sokendai, Ibaraki)

Abstract Accelerator Test Facility (ATF) is R&D facility to evaluate final focus technology for small beam required by ILC. The final focus beamline(ATF2) sets the goal to achieve 37 nm vertical beam size and 41 nm beam size had been demonstrated. Moreover, a significant intensity dependence on a nanometer beam size was observed and several studies of the wakefield had been conducted [*,**,***]. ATF2 is a proper beamline for wakefield studies with low emittance beam and nanometer resolution cavity BPMs and a nanometer beam size monitor. The simulation results were qualitatively cross-checked with experimental results and showed that the effects of some vacuum components and BPMs were significant. Further analysis of the wakefield will be done for flexible components (e.g. bellows). An upgrade of the ATF2 beamline is proposed by including minimization of the wakefield sources, to establish technologies for stable nanometer beam.

SUSPMF053

Design Optimization of 100 mA Superconducting Linac

Authors : Man Yi (IMP/CAS, Lanzhou)

Abstract Beam loss is a critical challenge in the physics design of high power superconducting proton linacs. The challenge is even more acute in linacs that feature high peak intensity and low energy, which has strong space charge effect and RF nonlinear force. In this paper, we study how to achieve a high transmission rate for beam halo particles, commonly a major source of beam loss, via beam halo matching and acceptance optimization. We employ this method of beam loss reduction to improve the physics design of a high power 100mA superconducting linac which has potential applications in high brightness neutron production.

SUSPMF054

A Design Study of Injector System for Synchrotron Light Source

Authors : Chanmi Kim, Eun-San Kim, Chong Shik Park (KUS, Sejong)

Abstract This work presents a design study of a 200 MeV electron linear accelerator consisting of an electron gun, bunchers, and accelerator structures. We aimed to design the linac with low emittance and low energy spread. A coasting beam from the thermionic electron gun is bunched using a series of buncher cavities, sub-harmonic buncher (SHB), a pre-buncher (PB), and a buncher. The bunched beam is then accelerated to 200 MeV with 4 cascaded accelerating structures. Two types of SHB cavities with an RF frequency of 500 MHz, elliptical cavity and coupled cavity, were considered to improve the bunching efficiency. We also investigated constant-gradient and constant-impedance types of 3 GHz multi-cell traveling wave resonators for following buncher cavities and accelerating structures. Depending on the type, the geometries of each TWR cavity were determined, and then the electromagnetic fields were calculated. RF powers and phases of each cavity along this linac system were optimized using beam dynamics simulation. Furthermore, the beam distributions in the transverse direction are adjusted using solenoid magnets in the low-energy section as well as quad triplets in the high-energy section.

SUSPMF055

Improved Low-Energy Optics Control for Transverse Emittance Preservation at the CERN Proton Synchrotron

Authors : Wietse Van Goethem, Foteini Asvesta, Hannes Bartosik, Alexander Huschauer (CERN, Geneva), Fanouria Antoniou (CERN, Meyrin)

Abstract Preservation of the transverse emittances across the CERN accelerator chain is an important requirement for beams produced for the Large Hadron Collider (LHC). In the CERN Proton Synchrotron (PS), high brightness LHC-type beams are stored on a long flat bottom for up to 1.2 seconds. During this storage time, direct space charge effects may lead to resonance crossing and subsequent growth of the transverse emittances. Previous studies showed an important emittance increase when the PS working point is moved near integer tune values. Subsequent simulation studies confirmed that this observation is caused by an interplay of space charge effects and the optics beatings induced by the Low Energy Quadrupoles (LEQ). A new optics configuration using these quadrupoles to reduce the optics beating and the emittance growth was developed and experimentally validated. The results of simulation and experimental studies are presented in this contribution.

SUSPMF056

Progress Towards Analytic Modelling of the VFFA

Authors : Max Emil Topp-Mugglestone (JAI, Oxford)

Abstract The Vertical Excursion Fixed-Field Alternating Gradient Accelerator is a novel concept in Accelerator Physics with wide- ranging applications across a number of different fields. In particular, it is being studied as a candidate for next-generation spallation sources, as well as in the context of rapid muon acceleration. However, the current understanding of the optics of this machine is still limited due to its unique magnetic fields, which result in strongly coupled optics due to both solenoid and skew quadrupole-like components in the magnetic fields. This poster aims to present first steps at understanding the behaviour of this machine from a Hamiltonian perspective, focusing on a large-ring regime such as might be applicable to the design of a muon collider. Under a set of appropriate approximations, it is now possible to predict the dependence of the tune of such a machine on the input parameters of the lattice, yielding vital first steps towards understanding this type of machine and developing efficient design and optimisation procedures.

SUSPMF057

Iron Yoke Effects in Quadrupole Magnets for High Rigidity Isotope Beams

Authors : David Greene, Yoonhyuck Choi, Jon DeKamp, Peter Ostroumov, Mauricio Portillo, John Wenstrom, Ting Xu (FRIB, East Lansing, Michigan), Shashikant L. Manikonda (AML, Melbourne, Florida)

Abstract Iron-dominated superconducting magnets are one of the most popular and most used design choices for superconducting magnetic quadrupoles for accelerator systems. While the iron yoke and pole tips are economic and effective in shaping the field, the large amount of iron also leads to certain drawbacks, namely, unwanted harmonics from the sextupole correctors nested inside of the quadrupole. Additional problems include the nonlinear field profile present in the high-field regime engendered by the presence of steel, and the mechanical and cryogenic design challenges of the entire iron yoke being part of the cold mass. The presented work discusses these effects and challenges by comparing an iron-dominated quadrupole model to an equivalent coil-dominated quadrupole model. The comparison of their respective magnetic harmonics, integrated strength, multipole effects, and mechanical challenges demonstrates that the coil-dominated design is a more favorable choice for select accelerator systems.

SUSPMF058

CW Polarized Positron Beams for 12 GeV CEBAF

Authors : Sami Habet, Ryan Michael Bodenstein, Alex Bogacz, Joseph Michael Grames, Alicia Hofler, Reza Kazimi, Yves Raymond Roblin, Riad Suleiman, Amy Sy, Dennis Turner, Yuhong Zhang (JLab, Newport News, Virginia),Eric Jean-Marie Voutier (LPSC, Grenoble Cedex), Fanglei Lin (ORNL RAD, Oak Ridge, Tennessee), Karl William Smolenski (Xelera Research LLC, Ithaca, New York)

Abstract Positron beams would provide new and meaningful probes for the experimental program at the Thomas Jefferson National Accelerator Facility (JLab), including but not limited to future hadronic physics and dark matter experiments. Critical requirements involve generating positron beams with a high degree of spin polarization, sufficient intensity and a continuous- wave (CW) bunch train compatible with acceleration to 12 GeV at the Continuous Electron Beam Accelerator Facility (CEBAF). To address these requirements, a polarized positron injector based upon the bremsstrahlung of an intense CW spin polarized electron beam is considered*. First a polarized electron beam line provides >1 mA of polarized electrons at ~120 MeV to a high-power target for positron production. Next, a second beam line collects, shapes and aligns the spin of positrons for users. Finally, the positron beam is matched into the CEBAF acceptance for acceleration and transport to the end stations with energies up to 12 GeV. An optimized layout to provide positrons beams with intensity >100 nA (polarized) or intensity >3 μA (unpolarized) will be discussed in this poster.

SUSPMF059

Cooling Performance in a Dual Energy Storage Ring Cooler

Authors : Bhawin Dhital (ODU, Norfolk, Virginia), Yaroslav Serg Derbenev, David Douglas, Andrew Hutton, He Zhang, Yuhong Zhang (JLab, Newport News, Virginia), Geoffrey Arthur Krafft (JLab, Newport News, Virginia; ODU, Norfolk, Virginia), Fanglei Lin, Vasiliy Morozov (ORNL RAD, Oak Ridge, Tennessee)

Abstract The longitudinal and transverse emittance growth in hadron beams due to intra-beam scattering (IBS) and all heating sources would deteriorate the luminosity in a collider. Hence, a strong hadron beam cooling is required to reduce and preserve the emittance. The cooling of high energy hadron beam is challenging. We propose a dual energy storage ring-based electron cooler that uses electron beam to extract heat away from hadron beam in the cooler ring while electron beam being cooled themselves by synchrotron radiation damping in the high energy damping ring. In this paper, we present a possible design of a dual energy storage ring-based electron cooler. Finally, the cooling performance is simulated using Jefferson Lab Simulation Package for Electron Cooling (JSPEC) for proton beams at the top energy of 275 GeV for Electron-Ion Collider.

SUSPMF060

Linac Optics Optimization With Multi-Objective Optimization

Authors : Isurumali Neththikumara (ODU, Norfolk, Virginia), Ryan Michael Bodenstein, Alex Bogacz (JLab, Newport News, Virginia), Todd Satogata (JLab, Newport News, Virginia; ODU, Norfolk, Virginia), Arthur Vandenhoeke (ULB, Bruxelles)

Abstract The beamline design of recirculating linacs requires special attention to avoid beam instabilities due to RF wakefields. A proposed high-energy, multi-pass energy recovery demonstration at CEBAF uses a low beam current. Stronger focusing at lower energies is necessary to avoid beam breakup(BBU) instabilities, even with this small beam current. The CEBAF linac optics optimization balances over-focusing at higher energies and beta excursions at lower energies. Using proper mathematical expressions, linac optics optimization can be achieved with evolutionary algorithms. Here, we present the optimization process of North Linac optics using multi-objective optimization.

SUSPMF061

Modeling a Nb3Sn Cryounit in GPT at UITF

Authors : Sunil Pokharel (ODU, Norfolk, Virginia), Alicia Hofler (JLab, Newport News, Virginia), Geoffrey Arthur Krafft (JLab, Newport News, Virginia; ODU, Norfolk, Virginia)

Abstract Nb3Sn is a prospective material for future superconducting RF (SRF) accelerator cavities.The material can achieve higher quality factors, higher temperature operation and potentially higher accelerating gradients (Eacc 96 MV/m) compared to conventional niobium. In this work, we performed modeling of the Upgraded Injector Test Facility (UITF) at Jefferson Lab utilizing newly constructed Nb3Sn cavities. We studied the effects of the buncher cavity and varied the gun voltages from 200-500 keV. We have calibrated and optimized the SRF cavity gradients and phases for the Nb3Sn five-cell cavities energy gains with the framework of General Particle Tracer (GPT). Our calculations show the beam goes cleanly through the unit. There is full energy gain out of the second SRF cavity but not from the first SRF cavity due to non-relativistic phase shifts.

SUSPMF062

Dynamic Aperture Studies for the Transfer Line From FLUTE to cSTART

Authors : Jens Schaefer, Bastian Haerer, Anke-Susanne Mueller, Alexander Ivanovich Papash, Robert Ruprecht, Marcel Schuh (KIT, Karlsruhe)

Abstract The compact Storage ring for Accelerator Research and Technology cSTART is a test facility for the application of novel acceleration techniques and diagnostics. The goal is to demonstrate storing the beam of a Laser Plasma Accelerator (LPA) for the first time in a compact circular accelerator. Before installing a LPA, the linear accelerator FLUTE will serve as a full energy injector for the compact storage ring, providing stable bunches with a length of a few femtoseconds. The transport of the bunches from FLUTE to the storage ring requires a transfer line which includes horizontal, vertical and coupled deflections which leads to coupling of the dynamics in the two transverse planes. In order to conserve the ultra-short bunch length during the transport, the transfer line relies on special optics which invokes high and negative dispersion. This contribution presents dynamic aperture studies based on six-dimensional tracking through the lattice of the transfer line.

SUSPMF063

Testing the Global Diffusive Behaviour of Beam-Halo Dynamics at the CERN LHC Using Collimator Scans

Authors : Carlo Emilio Montanari (Bologna University, Bologna; CERN, Geneva), Armando Bazzani (Bologna University, Bologna), Massimo Giovannozzi, Stefano Redaelli (CERN, Geneva), Arkadiusz Andrzej Gorzawski (University of Malta, Msida)

Abstract In superconducting circular particle accelerators, controlling beam losses is of paramount importance for ensuring optimal machine performance and an efficient operation. To achieve the required level of understanding of the mechanisms underlying beam losses, models based on global diffusion processes have recently been studied and proposed to investigate the beam-halo dynamics. In these models, the building block of the analytical form of the diffusion coefficient is the stability-time estimate of the Nekhoroshev theorem. In this paper, the developed models are applied to data acquired during collimation scans at the CERN LHC. In these measurements, the collimators are moved in steps and the tail population is re-constructed from the observed losses. This allows an estimate of the diffusion coefficient. The results of the analyses performed are presented and discussed in detail.

SUSPMF064

Third-order Resonance Compensation at the FNAL Recycler Ring

Authors : Cristhian Eduardo Gonzalez-Ortiz (MSU, East Lansing, Michigan), Peter Ostroumov (FRIB, East Lansing, Michigan), Robert Ainsworth (Fermilab, Batavia, Illinois)

Abstract The Recycler Ring (RR) at the Fermilab Accelerator Complex performs slip-stacking on 8 GeV protons, doubling the beam intensity delivered to the Main Injector (MI). At MI, the beam is accelerated to 120 GeV and delivered to the high energy neutrino experiments. Femilab's Proton Improvement Plan II (PIP-II) will require the Recycler to store 50% more beam. Simulations have shown that the space charge tune shift at this new intensity will lead to the excitation of multiple resonance lines. Specifically, this study looks at normal sextupole lines $3 Q_x=76$ and $Q_x+2Q_y=74$, plus skew sextupole lines $3 Q_y=73$ and $2 Q_x+Q_y=75$. Dedicated normal and skew sextupoles have been installed in order to compensate for these resonance lines. By measuring and calculating the Resonance Driving Terms (RDT), this study shows how each of the resonance lines can be compensated independently. Furthermore, this study shows and discusses initial investigations into compensating multiple lines simultaneously.

SUSPMF065

Plateau-Like Accelerating Wakefield for Electron-Witness-Bunch and Plateau-Like Decelerating Wakefield for Driver-Bunch in Plasma Wakefield Accelerator at High Transformer Ratio

Authors : Roman Ovsiannikov (KhNU, Kharkov), Iryna Pavlovna Levchuk (Yarovaya), Vasyl I. Maslov, Ivan N. Onishchenko (NSC/KIPT, Kharkov)

Abstract The efficiency of electron acceleration by a wakefield, excited in a plasma by an electron bunch, is determined by the transformer ratio*. The transformer ratio approximately can be defined as as the ratio the maximum accelerating field after after the drive-bunch to the maximum decelerating field inside drive-bunch. There is also the problem of maintaining the low emittance and low energy spread of the electron witness-bunch while maintaining the high transformer ratio and the accelerating gradient. In this report, numerical simulation by the 2d3v code LCODE solves the problem of the identical decelerating wakefield excitation for the whole long shaped drive-bunch and electron witness-bunch acceleration of low energy spread, small emittance and high charge by identical accelerating gradient for the whole witness- bunch with high transformer ratio and focusing both bunches**.

SUSPMF066

Design Optimisation Studies of Azimuthally Modulated RF Cavities

Authors : Laurence Matthew Wroe (JAI, Oxford), Robert Apsimon (Cockcroft Institute, Lancaster), Suzanne L. Sheehy (The University of Melbourne, Melbourne, Victoria)

Abstract In this paper, we discuss the scope and limitations of azimuthally modulated RF cavities that support modes with user-specified multipolar field contributions for practical application in particle accelerators. We present an example optimisation for cancelling unwanted transverse multipolar components in an accelerating RF cavity, outlining the methodology and evaluating 3D CST simulations, and also an analysis of the conditions governing forbidden and allowed modes in azimuthally modulated cavity designs.

SUSPMF067

Parallelization of Radia Magnetostatics Code

Authors : Anushka Banerjee (SBU, Stony Brook, New York), Oleg Chubar (BNL, Upton, New York), Joel Chavanne, Gaël Le Bec (ESRF, Grenoble), Jonathan Edelen, Christopher Hall, Boaz Nash (RadiaSoft LLC, Boulder, Colorado)

Abstract Radia 3D magnetostatics code has been used for the design of insertion devices for light sources over more than two decades. The code uses the magnetization integral approach that is efficient for solving permanent magnet and hybrid magnet structures. The initial version of the Radia code was sequential, The initial version of the Radia code was sequential, its core written in C++ and interface in the Mathematica language. This paper describes a new Python-interfaced parallel version of Radia and its applications. The parallelization of the code was implemented on C++ level, following a hybrid approach. Semi-analytical calculations of interaction matrix elements and resultant magnetic fields were parallelized using the Message Passing Interface, whereas the parallelization of the "relaxation" procedure (solving for magnetizations in volumes created by subdivision) was executed using a shared memory method based on C++ multithreading. The parallel performance results are encouraging, particularly for magnetic field calculation post relaxation where a ~600 speedup with respect to sequential execution was obtained. The new parallel Radia version facilitates designs of insertion devices and lattice magnets for novel particle accelerators.

SUSPMF068

Investigating the Suppression of the Crab Cavity Noise Induced Emittance Growth From the Transverse Beam Impedance

Authors : Natalia Triantafyllou, Andrzej Wolski (The University of Liverpool, Liverpool), Fanouria Antoniou, Hannes Bartosik, Philippe Baudrenghien, Xavier Buffat, Rama Calaga, Yannis Papaphilippou (CERN, Meyrin), Themis Mastoridis (CalPoly, San Luis Obispo, California)

Abstract Crab Cavities are a key component of the High Luminosity LHC (HL-LHC) upgrade, as they aim to minimize the luminosity reduction caused by the crossing angle. Two superconducting crab cavities were installed in the Super Proton Synchrotron (SPS) at CERN in 2018 to test their operation in a proton machine for the first time. An important point to consider is the increase in transverse emittance induced by noise in the Low- Level RF (LLRF) system. During the first experimental campaign in 2018, the measured emittance growth was found to be a factor of 4 lower than predicted by the available analytical models. In this report, the effects of transverse beam impedance in the presence of CC LLRF noise on transverse emittance growth are presented and the results of the second experimental campaign, which took place in the SPS in 2021, are discussed.

SUSPMF069

Effect of the Betatron Coupling on the Beam Transverse Instabilities

Authors : Watanyu Foosang, Alexis Gamelin (SOLEIL, Gif-sur-Yvette)

Abstract The effect of the betatron coupling on the transverse instabilities is being studied currently at SOLEIL since it should modify, possibly increase, the instability thresholds which could be very low in the case of SOLEIL Upgrade. The coupling has an influence in particular on the mixing of the damping times, the chromaticities as well as the transfer of the impedance between the two transverse planes. Consequently, the damping time of the stabilizing mechanisms and the rise time of the instabilities are modified, so are the instability thresholds. This work presents simulation results obtained for the SOLEIL upgrade case on the beam transverse dynamics, transverse mode-coupling and head-tail instability in the presence of betatron coupling.

SUSPMF070

Microbunching Studies for the FLASH2020+ Upgrade Using a Semi- Lagrangian Vlasov Solver

Authors : Philipp Amstutz, Mathias Vogt (DESY, Hamburg)

Abstract Precise understanding of the microbunching instability is mandatory for the successful implementation of a compression strategy for advanced FEL operation modes such as the EEHG seeding scheme, which a key ingredient of the FLASH2020+ upgrade project. Simulating these effects using particle-tracking codes can be quite computationally intensive as an increasingly large number of particles is needed to adequately capture the dynamics occurring at small length scales and reduce artifacts from numerical shot-noise. For design studies as well as dedicated analysis of the microbunching instability semi- Lagrangian codes can have desirable advantages over particle- tracking codes, in particular due to their inherently reduced noise levels. However, rectangular high-resolution grids easily become computationally expensive. To this end we developed SelaV$_\mathrm{1D}$, a one dimensional semi-Lagrangian Vlasov solver, which employs tree-based domain decomposition to allow for the simulation of entire exotic phase-space densities as they occur at FELs. In this contribution we present results of microbunching studies conducted for the FLASH2020+ upgrade using SelaV$_\mathrm{1D}$.

SUSPMF071

Modeling and Mitigation of Long-Range Wakefields for Advanced Linear Colliders

Authors : Fabio Bosco, Martina Carillo, Lucia Giuliano, Mauro Migliorati, Andrea Mostacci, Luigi Palumbo (Sapienza University of Rome, Rome), Luigi Faillace, Anna Giribono (INFN/LNF, Frascati), Enrica Chiadroni, Bruno Spataro, Cristina Vaccarezza (LNF-INFN, Frascati), Obed Camacho (UCLA, Los Angeles), Atsushi Fukasawa, Nathan Majernik, James Rosenzweig (UCLA, Los Angeles, California)

Abstract The luminosity requirements of TeV-class linear colliders demand use of intense charged beams at high repetition rates. Such features imply multi-bunch operation with long current trains accelerated over the km length scale. Consequently, particle beams are exposed to the mutual parasitic interaction due to the long-range wakefields excited by the leading bunches in the accelerating structures. Such perturbations to the motion induce transverse oscillations of the bunches, potentially leading to instabilities such as transverse beam break-up. Here we present a dedicated tracking code that studies the effects of long-range transverse wakefield interaction among different bunches in linear accelerators. Being described by means of an efficient matrix formalism, such effects can be included while preserving short computational times. As a reference case, we use our code to investigate the performance of a state-of-the-art linear collider currently under design and, in addition, we discuss possible mitigation techniques based on frequency detuning and damping.

SUSPMF072

Beam Lifetime Measurements in Sirius Storage Ring

Authors : Murilo Barbosa Alves, Fernando Henrique de Sá, Lin Liu, Ximenes Rocha Resende (LNLS, Campinas)

Abstract Sirius is the new storage ring-based 4th generation synchrotron light source built and operated by the Brazilian Synchrotron Light Laboratory (LNLS) at the Brazilian Center for Research in Energy and Materials (CNPEM). In ultralow emittance storage rings such as Sirius, since the bunch charge density is typically high, the dominant contribution to the beam lifetime is due to large angle scattering between electrons within the same bunch, namely the Touschek effect. We used the strategy of storing simultaneously two single-bunches with different currents to measure their Touschek lifetime independently of other contributions to the total lifetime, such as gas scattering. The measurements were carried out in different conditions of transverse coupling, radiofrequency voltage and bunch current to characterize the dependence of beam lifetime on these parameters and to compare the experimental results with those expected from theory and simulations for Sirius.

SUSPMF073

Interplay between Space Charge and Intra-beam Scattering for the CERN Ion Injectors

Authors : Michail Zampetakis, Foteini Asvesta, Hannes Bartosik, Yannis Papaphilippou (CERN, Geneva), Fanouria Antoniou (CERN, Meyrin)

Abstract The CERN ion injectors, SPS and LEIR, operate in a strong space charge and intra-beam scattering regime, which can lead to degradation of their beam performance. To optimize machine performance requires thus to study the interplay of these two effects in combined space charge and intrabeam scattering tracking simulations. In this respect, the kinetic theory approach of intra-beam scattering has been implemented in pyORBIT and benchmarked against analytical models. First results of combined space charge and intra-beam scattering simulations for SPS and LEIR are presented in this contribution. The simulation results are compared with observations from beam measurements.

SUSPMF074

Studies on the Vertical Half-Integer Resonance in the CERN PS Booster

Authors : Tirsi Prebibaj, Fanouria Antoniou (CERN, Meyrin), Foteini Asvesta, Hannes Bartosik (CERN, Geneva), Giuliano Franchetti (GSI, Darmstadt)

Abstract Following the upgrades of the LHC Injectors Upgrade Project (LIU), the Proton Synchrotron Booster (PSB) at CERN successfully doubled the brightness of the delivered beams. The dynamic correction of the beta-beating induced by the injection chicane allowed stable operation closer to the half-integer resonance contributing to the above achievement. Ideally, injection above the half-integer resonance could further improve the beam brightness. In this context, a series of studies were initiated in order to characterize the effects of space charge when crossing the half-integer resonance. In this contribution, the first results of these investigations are reported.

SUSPMF075

Space Charge Analysis for Low Energy Photoinjector

Authors : Martina Carillo, Fabio Bosco, Enrica Chiadroni, Lucia Giuliano, Mauro Migliorati, Andrea Mostacci, Luigi Palumbo (Sapienza University of Rome, Rome), Luca Ficcadenti (INFN-Roma, Roma), Luigi Faillace (INFN/LNF, Frascati), Mostafa Behtouei, Bruno Spataro (LNF-INFN, Frascati), Obed Camacho (UCLA, Los Angeles), Atsushi Fukasawa, James Rosenzweig (UCLA, Los Angeles, California)

Abstract Beam dynamics studies are performed in the context of a C-Band hybrid photo-injector project developed by a collab- oration between UCLA/ Sapienza/INFN-LNF/RadiaBeam. These studies aim to explain beam behaviour through the beam-slice evolution, using analytical and numerical approaches. An understanding of the emittance oscillations is obtained starting from the slice analysis, which allows correlation of the position of the emittance minima with the slope of the slices in the transverse phase space (TPS). At the end, a significant reduction in the normalized emittance is obtained by varying the transverse shape of the beam while assuming a longitudinal Gaussian distribution. Indeed, the emittance growth due to nonlinear space-charge fields has been found to occur immediately after moment of the beam emission from the cathode, giving insight into the optimum laser profile needed for minimizing the emittance.

SUSPMF076

Prospects of Ultrafast Electron Diffraction Experiments in Sealab, Longitudinal Phase-Space Manipulation and Beam Stability

Authors : Benat Alberdi, Ji-Gwang Hwang, Axel Neumann, Jens Voelker (HZB, Berlin), Thorsten Kamps (HU Berlin, Berlin; HZB, Berlin)

Abstract Ultrafast Electron Diffraction (UED) is a pump-probe experimental technique that aims to image the structural changes that happen in a target structure due to photo- excitation. Development of UED capabilities is one of the main objectives at Sealab, a superconducting RF accelerator facility currently being commissioned in Helmholtz-Zentrum Berlin. The main beam-line is based on the SRF Photoinjector. In order to perform UED experiments, the optimization of temporal and spatial resolutions are of the utmost importance. These are governed by the minimum achievable bunch length, transverse emittance and beam stability. The composition of the SRF Photoinjector, which includes a superconducting RF gun and three superconducting booster cavities, offers superb flexibility to manipulate the longitudinal phase-space of the electron bunch. At the same time, the CW operation of the accelerator provides an enhanced beam stability compared to warm guns, together with a MHz repetition rate. This presentation aims to explain the different contributions to the temporal and spatial resolutions and understand the performance limits of the SRF Photoinjector to perform UED experiments.

SUSPMF077

A Path-Length Stability Experiment for Optical Stochastic Cooling at the Cornell Electron Storage Ring

Authors : Samuel Joseph Levenson, Matthew Benjamin Andorf, Ivan Vasilyevich Bazarov, Vardan Khachatryan, Jared Michael Maxson, David Rubin, Suntao Wang (Cornell University (CLASSE), Ithaca, New York)

Abstract To achieve sufficient particle delay with respect to the optical path in order to enable high gain amplification, the design of the Optical Stochastic Cooling (OSC) experiment in the Cornell Electron Storage Ring (CESR) places the pickup (PU) and kicker (KU) undulators approximately 80 m apart. The arrival times at the KU of particles and the light they produce in the PU must be synchronized to an accuracy of less than an optical wavelength, which for this experiment is 780 nm. To test this synchronization, a planned demonstration of the stability of the bypass in CESR is presented where, in lieu of undulators, an interference pattern formed with radiation from two dipoles flanking the bypass is used. In addition to demonstrating stability, the fringe visibility of the pattern is related to the cooling ranges, a critical parameter needed for OSC. We present progress on this stabilization experiment including the design of a second-order isochronous bypass, as well as optimizations of the Dynamic Aperture (DA) and injection efficiency.

SUSPMF078

Electron Beam Optimization for FLASH Radiotherapy Experiment at Chiang Mai University

Authors : Kanlayaporn Kongmali, Nopadol Kangrang, Sakhorn Rimjaem, Jatuporn Saisut, Chitrlada Thongbai (Chiang Mai University, Chiang Mai), Monchai Jitvisate (Suranaree University of Technology, Nakhon Ratchasima)

Abstract At present, one of diseases that kill many people worldwide is cancer. The FLASH radiotherapy (RT) is a promising cancer treatment under study. It involves the fast delivery of radiotherapy at much higher dose rates than those currently used in clinical practice. The very short time of exposure leads to the destruction of the cancer cells, while the nearby normal cells are less damaged as compared with conventional RT. This work focuses on study of FLASH-RT experiment using electron beams produced from the accelerator system at the PBP-CMU Electron Linac Laboratory. The structure and properties of our electron pulses with microbunches in picosecond time scale and macropulses in microsecond time scale match well to FLASH-RT requirement. To optimize the condition for experiment, the electron beam simulations are performed by varying energy, charge and bunch length. The study results show that the beams with energy of 6 - 25 MeV, macropulse of 1 - 4 ¿s, microbunch of 0.3 -1 ps, variable high current, and low emittance are well suit for FLASH-RT experiment. The optimized electron beam properties from this study will be used as the guideline for experiment preparation.

SUSPMF079

Relativistic Space-Charge Force Calculation by Interpolation-Based Treecode

Authors : Yi-Kai Kan (DESY, Hamburg), Franz Xaver Kaertner (Deutsches Elektronen Synchrotron (DESY) and Center for Free Electron Science (CFEL), Hamburg), Sabine Le Borne, Daniel Ruprecht, Jens-Peter Zemke (Hamburg University of Technology, Hamburg)

Abstract Space-charge effects are of great importance in particle accelerator physics. In the computational modeling, tree-based methods are increasingly used because of their effectiveness in handling nonuniform particle distributions and/or complex geometries. However, they are often formulated using an electrostatic force which is only a good approximation for low energy particle beams. For high energy, i.e., relativistic particle beams, the relativistic interaction kernel may need to be considered and the conventional treecode fails in this scenario. In this work, we formulate a treecode based on Lagrangian interpolation for computing the relativistic space-charge field. Two approaches are introduced to control the interpolation error. The first approach is based on the transformation of the particle beam to the rest-frame where the conventiona admissibility condition can be used. In the second approach, a modified admissibility condition is proposed for which the treecode can be used directly in the lab-frame. Numerical simulation results using both methods will be compared and discussed.

SUSPMF080

Spin-Tracking Simulations in a COSY Model Using Bmad

Authors : Maximilian Vitz (FZJ, Jülich)

Abstract The matter-antimatter asymmetry might be understood by investigating the EDM (Electric Dipole Moment) of elementary charged particles. A permanent EDM of a subatomic particle violates time reversal and parity symmetry at the same time and would be, with the currently achievable experimental accuracy, an indication for further CP violation than established in the Standard Model. The JEDI-Collaboration (Jülich Electric Dipole moment Investigations) in Jülich has performed a direct EDM measurement for deuterons with the so called precurser experiments at the storage ring COSY (COoler SYnchrotron). In order to understand the measured data and to disentangle an EDM signal from systematic effects, spin tracking simulations in an accurate simulation model of COSY are needed. Therefore a model of COSY was implemented using the software library Bmad. Systematic effects were considered by including element misalignments, effective dipole shortening and steerer kicks. These effects rotate the invariant spin axis additional to the EDM and have to be analyzed and understood. The most recent spin tracking results as well as the methods to find the invariant spin axis will be presented.

SUSPMF081

Studying Instabilities in the Canadian Light Source Storage Ring Using the Transverse Feedback System

Authors : Stephen Martens (University of Saskatchewan, Saskatoon), Drew Bertwistle, Mark James Boland (CLS, Saskatoon, Saskatchewan)

Abstract The Transverse Feedback system at the Canadian Light Source can identify, categorize, and mitigate against periodic instabilities that arise in the storage ring beam. By quickly opening and closing the feedback loop, previously mitigated instabilities will be allowed to grow briefly before being damped by the system. The resulting growth in the beam oscillation amplitude curve can be analyzed to determine growth/damp rates and modes of the coupled bunch oscillations. Further measurements can be collected via active excitement of modes rather than passive growth. These Grow/damp and Excite/Damp curves have been collected and analyzed for various storage ring beam properties, including beam energy, machine chromaticity, and in-vacuum insertion device gap widths.

SUSPMF082

Development of a New Clusterization Method for the GEM-TPC With Uranium Projectiles

Authors : Minna Luoma, Francisco Garcia, Raimo Turpeinen (HIP, University of Helsinki), Tobias Blatz, Holger Flemming, Klaus Götzen, Christos Karagiannis, Nikolaus Kurz, Sven Loechner, Chiara Nociforo, Christian Joachim Schmidt, Haik Simon, Bernd Voss, Peter Wieczorek, Martin Winkler (GSI, Darmstadt), Davit Chokheli (Georgian Technical University, Tbilisi), Tuomas Grahn, Sami Rinta-Antila (JYFL, Jyvaskyla)

Abstract The Facility for Antiproton and Ion Research FAIR, in Darmstadt Germany, will be one of the largest accelerator laboratories worldwide. The Superconducting FRagment Separator (Super- FRS)* is one of its main components. The Super-FRS can produce, separate and deliver high-energy radioactive beams with intensities up to 1e11 ions/s, covering projectiles from protons up to uranium and it can be used as an independent experimental device. The Gas Electron Multiplier-based Time Projection Chambers (GEM-TPC) in twin configuration is a newly developed beam tracking detector capable of providing spatial resolution of less than 1 mm with a tracking efficiency close to 100% at 1 MHz counting rate. The GEM-TPC (HGB4) was tested at the FRagment Separator (FRS), with 238U beam at 850 MeV/u. A new clusterization method was developed, for the first time and used for an analysis. This method allowed to access to waveforms of each strip signal within a single trigger in an event-by-event basis. The procedures involved in this method will be shown in details.

SUSPMF083

Characterization of the Electron Beam Visualization Stations of the ThomX Accelerator

Authors : Alexandre Moutardier, Christelle Bruni, Iryna Chaikovska, Sophie Chancé, Nicolas Delerue, Ezgi Ergenlik, Viacheslav Kubytskyi, Hugues Monard (Université Paris-Saclay, CNRS/IN2P3, IJCLab, Orsay)

Abstract We present the electron beam visualization stations of the ThomX Accelerator and present first measurement of their performances during the ThomX commissioning. ThomX is a 50- MeV-electron accelerator prototype which will use Compton backscattering to generate a high flux of hard x-rays. To characterize the beam an arm with several screens can be inserted in the beam trajectory. The screens available are a YAG:Ce screen, an Optical Transition Radiation (OTR) screen, a sapphire screen and a calibration target. The optical system is based on commercial lenses that have been reverse-engineered. The magnification of the optical system can be adjusted remotely using a motor and the lens can also be focused remotely. We report on the overall performances of the station as measured during the first steps of beam commissioning and on the optical system remote operations.

SUSPMF084

Single-Shot Time-Stretch Electro-Optic Sampling at the ELBE Coherent THz CDR Source

Authors : Christelle Hanoun, Serge Bielawski, Clement Evain, Eléonore Roussel, Christophe Szwaj (PhLAM/CERLA, Villeneuve d'Ascq), Pavel Evtushenko, Sergey Kovalev, Michael Kuntzsch, Anton Ryzhov, Christof Schneider (HZDR, Dresden)

Abstract Electro-optic sampling is a powerful diagnostic that is widely used for characterizing longitudinal electron bunch properties. It consists of recording the electric field created by the bunch, using an electro-optic crystal and a probe femtosecond laser. However several challenges still exist for achieving at the same time a large bandwidth, a long acquisition window, and single- shot operation at high repetition rate. Here we investigate a new measurement strategy that aims at high repetition rate (up to tens of millions of traces per second when needed) using the so- called photonic time-stretch technique, and that is also capable of high bandwidth by using the the recently introduced Diversity Electro-Optic Sampling (DEOS)*. We present the first tests of this design using THz pulses generated by the Coherent Diffraction Radiation (CDR) source of ELBE, at Helmholtz- Zentrum Dresden-Rosedorf (HZDR).

SUSPMF085

Transverse Excitation and Applications for Beam Control

Authors : Philipp Niedermayer, Rahul Singh (GSI, Darmstadt)

Abstract Transverse excitation of stored particle beams is required for a number of applications in accelerators. Using a time-varying, transverse electric field with a dedicated frequency spectrum, the amplitude and coherence of betatron oscillations can be increased in a controlled manner. This allows for determination of the betatron tune from turn-by-turn position measurements, control of transverse beam shapes, as well as extraction of stored beams. For studies of beam excitation, a flexible signal generator is being developed. It is planned to be a multi-purpose device for applications in beam diagnostics and control. An approach with a software-defined radio (SDR) is chosen, which allows for configurable signal characteristics and tuneable spectra. To determine appropriate excitation spectra, studies of particle dynamics in presence of excitation are being carried out. Nonlinear fields are also incorporated to account for beam extraction conditions, which affect the oscillation frequency spectra due to transient detuning effects compared to the linear case.

SUSPMF086

Comparative Study of Broadband Room Temperature THz Detectors for High and Intermediate Frequency Response

Authors : Rahul Yadav, Sascha Preu (IMP, TU Darmstadt, Darmstadt), Andreas Penirschke (THM, Friedberg)

Abstract Room temperature terahertz (THz) detectors based on Field effect transistors (FETs) and Zero-Bias Schottky diodes (SD) are prominent members for the temporal-spatial characterization of the picosecond scale pulses generated at particle accelerators. However, it has been observed that post detection electronics currently limit the performance. The comparative study of THz detectors both at higher and intermediate frequency is done to understand their frequency response. The investigation is carried out using table top THz systems and commercially available sources. In this paper we present high frequency and intermediate frequency (IF) response of FETs and Zero-Bias Schottky THz detectors. Obtained IF frequency results are helpful for understanding and designing the optimized IF circuitry to go higher IF bandwidths.

SUSPMF087

Electro-Optical Bunch Diagnostics Using an Optimized Laser Spectrometer

Authors : Carsten Mai, Marcel Kebekus, Shaukat Khan, Vivek Vijayan (DELTA, Dortmund), Edmund Blomley, Erik Bründermann, Michele Caselle, Stefan Funkner, Anke-Susanne Mueller, Gudrun Niehues, Micha Reissig, Johannes Leonhard Steinmann, Christina Widmann (KIT, Karlsruhe)

Abstract With electro-optical spectral decoding (EOSD) ultra-short temporal bunch structures can be diagnosed in single-shot acquisition. The technique uses a bunch-induced modulation of the spectrum of a reference laser pulse. At DELTA, the 1.5-GeV electron storage ring operated as a synchrotron light source by TU Dortmund University in Germany, an energy modulation of a short slice of the electron bunch is generated in a laser-electron interaction. Converting the energy modulation to a density modulation allows the coherent emission of ultrashort vacuum ultraviolet pulses as well as short pulses in the THz regime. A setup based on EOSD to analyze the temporal profile of the modulated bunches is currently under development in Dortmund. For the analysis of the laser pulse spectrum with high resolution, recently, two different laser spectrometers for EOSD setups were commissioned.
The spectrometers were tested using the near- field EOSD setup at the KIT storage ring KARA (Karlsruhe Research Accelerator) in short-bunch mode. The acquisition of the laser spectra was performed with the ultra-fast line-array detector KALYPSO. First data measured at KARA using the new diagnostics are presented.

SUSPMF088

5D Tomography of Electron Bunches at ARES

Authors : Sonja Jaster-Merz, Reinhard Brinkmann, Florian Burkart, Thomas Vinatier (DESY, Hamburg), Ralph Wolfgang Assmann (DESY, Hamburg; LNF-INFN, Frascati)

Abstract The ARES linear accelerator at DESY aims to deliver stable and well-characterized electron bunches with durations down to the sub-fs level. Such bunches are highly sought after to study the injection into novel high-gradient accelerating structures, test diagnostics devices, or perform autonomous accelerator studies. For such applications, it is advantageous to have a complete and detailed knowledge of the beam properties. Tomographic methods have shown to be a key tool for beam phase space reconstruction. Based on these techniques, a novel diagnostics method is being developed to resolve the full 5-dimensional phase space (x,x',y,y',z) of bunches including their transverse and longitudinal distributions and correlations. In simulation studies, this method shows an excellent agreement between the reconstructed and the original distribution for all five planes.Here, the 5-dimensional phase space tomography method is presented using a showcase simulation study at ARES.

SUSPMF089

Comparative Study of Broadband Room Temperature THz Detectors for High and Intermediate Frequency Response

Authors : Youming Deng (SINAP, Shanghai), Yongbin Leng, Xingyi Xu (SSRF, Shanghai)

Abstract These will cause transient beam loading effects along the bunch train. A passive third harmonic cavity was installed at SSRF in July 2021 during II renovation. Based on a high-resolution bunch-by-bunch three dimensional measurement system, the beam loading effect of third harmonic cavity with different currents and fill pattern was observed and verified. Compared with the traditional longitudinal diagnostics tools, such as camera, the system has higher measurement accuracy and can capture and record much longer data. Moreover, the bunch charge and three-dimensional position can be measured simultaneously by the system. By correlation analysis, the difference coming from bunch parameters can be removed, which makes the beam loading effects more apparent. With the help of the system, the key parameters such as the synchronous phase, synchronous tune and damping parameter are observed and analyzed. This will help the scholars of SSRF and other accelerators with harmonic cavities to adjust and optimize the parameters of harmonic cavities and conduct relevant beam dynamics research.

SUSPMF090

Analysis of Synchronous Oscillation Damping of Storage Ring Based on Wavelet Analysis Method

Authors : Xing Yang (SINAP, Shanghai), Xingyi Xu (SINAP, Shanghai; University of Chinese Academy of Sciences, Beijing), Yongbin Leng (SSRF, Shanghai)

Abstract The synchronous oscillation damping of the storage ring of accelerator equipment is an important part of accelerator research. In the past analysis, the process was regarded as a superposition of a sine function and an exponential decay function. However, further analysis showed that the two fixed parameters Function superposition cannot describe all the physical information. The frequency of the sine function and the attenuation factor of the exponential decay function will change significantly over time. In this article, the change of this parameter over time is studied, and the data of the Shanghai Light Source storage ring is analyzed using this method, and some results are obtained.

SUSPMF091

Study of Beam Loss Localization With a Cherenkov Beam Loss Monitor in the CLEAR Facility at CERN

Authors : Sara Benitez Berrocal (CERN, Geneva 23), Pierre Korysko (CERN, Geneva), Ewald Effinger, Jose Carlos Esteban Felipe, Wilfrid Farabolini, Anders Toft Lernevall, Belen Salvachua (CERN, Meyrin), Minsi Chen (University of Huddersfield, Huddersfield)

Abstract A Cherenkov Beam Loss Monitor prototype, based on optical fibers, is being developed in order to measure beam losses in the CERN Super Proton Synchrotron. Several testing campaigns have been planned to benchmark the simulations of the system and test the electronics in CLEAR test facility. During the first campaign*, the Cherenkov light capture phenomenon and the photodetector characterization were studied. Cherenkov Beam Loss monitors are detectors capable of monitoring losses along long distances continuously. The localization of the particle losses shower, with a high longitudinal resolution is calculated from the timing resolution of the signal generated by the photosensors coupled at both ends of the optical fiber. The experimental results of an OBLM installed in CLEAR facility are reported in this paper.

SUSPMF092

Linearity and Response Time of the LHC Diamond Beam Loss Monitors in the CLEAR Beam Test Facility at CERN

Authors : Sara Morales Vigo (CERN, Geneva 23; Cockcroft Institute, Warrington, Cheshire; The University of Liverpool, Liverpool), Wilfrid Farabolini (CERN, Geneva; CEA-DRF-IRFU,), Luke Aidan Dyks, Pierre Korysko (CERN, Geneva; Oxford University, Oxford, Oxon), Eva Calvo Giraldo, Ewald Effinger, Anders Toft Lernevall, Belen Salvachua, Christos Zamantzas (CERN, Meyrin), Carsten Peter Welsch, Joseph Wolfenden (Cockcroft Institute, Warrington, Cheshire; The University of Liverpool, Liverpool)

Abstract Chemical Vapour Deposition (CVD) diamond detectors have been tested during the Run 2 operation period (2015-2018) as fast beam loss monitors for the Beam Loss Monitoring (BLM) system of the Large Hadron Collider (LHC) at CERN. However, the lack of raw data recorded during this operation period restrains our ability to perform a deep analysis of their signals. For this reason, a test campaign was carried out at the CLEAR beam test facility at CERN with the aim of studying the linearity and response time of the diamond detectors against losses from electron beams of different intensities. The signal build-up from multi-bunched electron beams was also analyzed. The conditions and procedures of the test campaign are explained, as well as the most significant results obtained.

SUSPMF093

Energy Spectrum and Emittance Measurements of Electron Beam for Producing MIR-FEL at PBP-CMU Electron Linac Laboratory

Authors : Pitchayapak Kitisri, Kittipong Techakaew (Chiang Mai University, Chiang Mai), Sakhorn Rimjaem (Chiang Mai University, Chiang Mai; ThEP Center, Bangkok)

Abstract At the PBP-CMU Electron Linac Laboratory, we aim to produce a mid-infrared free-electron laser (MIR-FEL) for pump-probe experiments in the future. The electron beam is generated from a radiofrequency (RF) thermionic gun with a 1.5-cell cavity before going to an alpha magnet. In this section, the beam is filtered out by using energy slits. The survived beam is then accelerated by an RF linear accelerator (linac) with 86 cylindrical cells to get higher energy. This work focuses on the measurements of energy spectrum and emittance of electron beam for producing the MIR-FEL. Since our bunch compressor (BC) is achromat system, the spectrum of electron beam is measured before the beam travels to the BC by using a dipole and a faraday cup with a slit. After the BC, the transverse emittance is measured with the quadrupole scan technique before it travels to the undulator. The Astra code is used to investigate all aforementioned processes as well as to design the measuring systems. The design results including systematic error of the measuring systems will be presented in this contribution. These results can guide us for the system construction as well as the beam operation guiding.

SUSPMF094

Systematic Study of Measuring Systems for Electron Beam Energy, Energy Spread and Emittance of the Accelerator System at the PBP-CMU Electron Linac Laboratory

Authors : Kittipong Techakaew, Sakhorn Rimjaem (Chiang Mai University, Chiang Mai)

Abstract The linear accelerator system at the PBP-CMU Electron Linac Laboratory is used to produce electron beam with suitable properties for generating coherent THz radiation and MIR FEL. Optimization of machine parameters to produce short electron bunches with low energy spread and low transverse emittance was focused in this study. We conducted ASTRA simulations including 3D space charge algorithm and 3D field distributions for RF gun and all magnets to develop measuring systems. Electron beam energy and energy spread were investigated downstream the RF gun and the linac using an alpha magnet and a dipole spectrometer, respectively. The transverse beam emittance was studied using the quadrupole scan technique. By filtering proper portion of electrons before entering the linac, the beam with average energy of 20 MeV and energy spread of 0.1- 1% can be achieved for a bunch charge of 100 pC.
The systematic error is less than 10% for measuring average energy and energy spread while it is less than 31% for measuring emittance when placing the screen of at least 1.0 m behind the scanning quadrupole magnet. The results of this study were used to develop the measuring setups in our system.

SUSPMF095

A Beam Position Monitor for Electron Bunch Detection in the Presence of a More Intense Proton Bunch for the AWAKE Experiment

Authors : Collette Pakuza, Philip Burrows (JAI, Oxford; Oxford University, Oxford, Oxon), Roberto Corsini, Wilfrid Farabolini, Michal Krupa, Thibaut Lefevre, Stefano Mazzoni, Eugenio Senes, Manfred Wendt (CERN, Geneva)

Abstract The Advanced Proton Driven Plasma Wakefield Experiment (AWAKE) at CERN uses 6 cm long proton bunches at 400 GeV beam energy, extracted from the Super Proton Synchrotron (SPS) to drive high gradient plasma wakefields for the acceleration of electron bunches to 2 GeV within 10 meter length. Knowledge and control of the position of both beams is crucial for the operation of the experiment. Whilst the current electron beam position monitoring system at AWAKE can be used in the absence of the proton beam, the proton bunch signal dominates when both particle bunches are present simultaneously. A new technique based on the generation of Cherenkov diffraction radiation (ChDR) in a dielectric material placed in close proximity to the particle beam has been designed to exploit the large bunch length difference of the particle beams at AWAKE, 200 ps for protons versus a few ps for electrons, such that the electron signal dominates. Hence, this technique would allow for the position measurement of a short electron bunch in the presence of a more intense but longer proton bunch. The design considerations, numerical analysis and plans for tests at the CLEAR facility at CERN will be presented.

SUSPMF096

Simulation of Concrete Shielding Activation for Proton Therapy Systems Using BDSIM and FISPACT-II

Authors : Eliott Ramoisiaux, Eustache Gnacadja, Nicolas Pauly, Robin Tesse, Marion Vanwelde (ULB, Bruxelles), Cédric Hernalsteens (CERN, Meyrin; ULB, Bruxelles), William Shields (JAI, Egham, Surrey), Stewart Boogert, Laurence James Nevay (Royal Holloway, University of London, Surrey)

Abstract Proton therapy systems are used worldwide for patient treatment and fundamental research.
A well-known drawback is the secondary particles generation when the beam interacts with the energy degrader. Interactions can also occur at undesirable locations along the transport beamline. For compact systems, this poses new challenges for the shielding design and the activation computation. We propose a novel methodology to seamlessly simulate all the processes relevant for the evaluation of the activation. A realistic model of the system is developed using Beam Delivery Simulation (BDSIM), a Geant4-based particle tracking code that allows a single model to simulate primary and secondary particle tracking as well as all particle- matter interactions. The secondary particles fluxes extracted from the simulations are given to the FISPACT-II code that computes the activation by solving the rate equations. This approach is applied to the Ion Beam Applications (IBA) Proteus®ONE (P1) system and the shielding of the proton therapy research centre of Charleroi, Belgium. Results show the evolution of the clearance level and the long-lived nuclides concentrations through the facility lifespan.

SUSPMF097

Vacuum Control System Upgrade for ALPI Accelerator

Authors : Giovanni Savarese, Loris Antoniazzi, Damiano Bortolato, Andrea Conte, Fabio Gelain, Davide Marcato, Carlo Roncolato (INFN/LNL, Legnaro (PD))

Abstract The vacuum system of ALPI accelerator includes about 40 pumping groups based on turbomolecularpumps. The instrumentation of the accelerators complex is mainly the one installed in 90s, with consequent maintenance issues. The control and supervision systems were developed in the same period by an external company, which produced custom solutions for the HW and SW parts. Control devices are based on custom PLCs, while the supervision system is based on C and C#. The communication between the field and the supervisor is composed of multiple levels: RS-232 standard is used to transfer control parameter from the field devices up to custom multiplexers; RS- 485 transmission is used from the multiplexers to two PC servers covering different sections of the installation; while Ethernet, is used to connect the servers and the operation console. Obsolescence and rigidity of the system, deficit of spare parts and impossibility of reparation or modification without external support, required a complete renovation of the vacuum system and relative controls in the next years. This paper describes the adopted strategy and the implementation status.

SUSPMF098

KEK LUCX Facility Laser-to-RF&RF-to-RF Stability Study and Optimization

Authors : Konstantin Popov (Sokendai, Ibaraki), Alexander Aryshev, Nobuhiro Terunuma, Junji Urakawa (KEK, Ibaraki)

Abstract KEK LUCX facility* is a linear accelerator devoted to the beam instrumentation R&Ds for present and future accelerator systems and colliders including ILC. According to the ILC TDR**, it is necessary to achieve RF-gun Laser-to-RF&RF-to-RF phase stability of 0.35°(RMS) and amplitude stability of 0.07%(RMS) with implementation of the Digital LLRF feedback based on commercially available FPGA board and digital trigger system. As the first step to achieve ILC stability level at KEK-LUCX facility, present Laser-to-RF&RF-to-RF phase and amplitude jitters were measured using time- and frequency-domain techniques. After that, jitter influence on beam parameters after RF-gun and main solenoid magnet was simulated with ASTRA tracking code*** and results were cross-checked during LUCX facility beam operation. Finally, stable digital trigger system and digital LLRF feedback based on SINAP EVG&EVR and RedPitaya SIGNALlab- 250 modules were implemented. This report demonstrates the results of Laser-to-RF&RF-to-RF phase and amplitude jitter measurements cross-checked with ASTRA simulation and real beam parameters measurements before and after LUCX facility stabilization.

SUSPMF099

Machine Learning-Based Control for HoM Reduction and Emittance Preservation in a TESLA-Type Cryomodule at FAST

Authors : Jorge Alberto Diaz Cruz (SLAC, Menlo Park, California; UNM-ECE, Albuquerque), Dean Richard Edstrom, Alex Lumpkin, Randy Michael Thurman-Keup (Fermilab, Batavia, Illinois), Auralee Edelen, Bryce Jacobson, John Sikora (SLAC, Menlo Park, California)

Abstract Low emittance electron beams are of high importance at facilities like the Linac Coherent Light Source II (LCLS-II) at SLAC. Emittance dilution effects due to off-axis beam transport or a TESLA-type cryomodule (CM) have been shown at the Fermilab Accelerator Science and Technology (FAST) facility. The results showed the correlation between the electron beam-induced cavity high-order modes (HOMs) and bunch-by-bunch centroid slewing and oscillation downstream of the CM. Mitigation of emittance dilution can be achieved by reducing the HOM signals. Here we present a Machine Learning-based controller for HOM signal reduction. The control actuators are the steering magnets, vertical and horizontal, upstream of the CM. Results of the controller performance at the FAST facility are presented. The preliminary results presented here will inform the LCLS-II injector commissioning and will serve as a prototype for HOM reduction and emittance preservation.

SUSPMF100

A Novel Method for Detecting Anomalous Loss Patterns in the LHC

Authors : Loic Coyle, Frederic Blanc, Tatiana Pieloni (EPFL, Lausanne), Daniele Mirarchi (CERN, Geneva), Anton Lechner, Matteo Solfaroli Camillocci, Jorg Wenninger (CERN, Meyrin)

Abstract Understanding and mitigating particle losses in the Large Hadron Collider (LHC) is essential for both machine safety and efficient operation. Abnormal loss distributions are telltale signs of abnormal beam behaviour or incorrect machine configuration. By leveraging a novel data-driven method of detecting anomalous loss distributions during machine operation has been developed. An unsupervised neural network anomaly detection model was trained on operational, stable beam, Beam Loss Monitor (BLM) data acquired during the operation of the LHC. This model is capable of successfully identifying anomalous events, including Unidentified Falling Object (UFO) loss showers that have previously gone undetected with the currently implemented UFO detection algorithm. Unsupervised data-driven models, such as the one presented, could lead to significant improvements in the autonomous labelling of abnormal loss distributions, ultimately bolstering the ever ongoing effort towards improving the understanding and mitigation of these events.

SUSPMF101

Novel Approaches for Classification and Forecasting of Time Series in Particle Accelerators

Authors : Sichen Li, Andreas Adelmann, Jochem Snuverink (PSI, Villigen PSI)

Abstract Particle accelerator interruptions, called interlocks, lead to abrupt operational changes and a substantial loss of beam time despite being necessary safety measures. Novel time series classification approaches are applied to decrease beam time loss in the High- Intensity Proton Accelerator complex by forecasting interlock events. The forecasting is performed through binary classification of single timestamps as well as windows of multivariate time series, with methods ranging from Lasso models based on statistical Two Sample Test, to Recurrence Plots followed by Convolutional Neural Network*. A continuous evaluation metric, Beam Time Saved in any given time, is established with preliminary experiments showing that interlocks could be circumvented by reducing the beam current. Preliminary results show that the interlock-to-stable classifier can potentially increase the beam time by up to 6 minutes in a day.

SUSPMF102

Electron Temperature Measurements in a Hydrogen-Filled Capillary

Authors : Sahar Arjmand (INFN/LNF, Frascati)

Abstract The research concerns experimental and theoretical studies on a plasma source for plasma-based accelerators (PBAs). The interest for compact accelerators , overcoming the gigantism of the conventional (RF) accelerators, is growing in High Energy Physics. The accelerating gradients of such plasma-based devices can attain the GV/m scale. The activity of the SPARC_LAB test-facility concerns the development of the above-mentioned devices, based on gas-filled capillary. Several inlets feed the capillary with a neutral gas (Hydrogen), which is ionized by a high-voltage (HV) discharge. Electron density and temperature have been measured as a function of time through the Stark broadening profiles of suitable emission lines.

SUSPMF103

Systematic Investigation of Flux Trapping Dynamics on Samples

Authors : Felix Kramer, Sebastian Keckert (HZB, Berlin), Oliver Kugeler (BESSY GmbH, Berlin; HZB, Berlin), Jens Knobloch (BESSY GmbH, Berlin; HZB, Berlin; University of Siegen, Siegen)

Abstract Trapped magnetic flux in superconducting cavities can significantly increase the surface resistance, and thereby limiting their performance. To reduce trapped flux in cavities, a better understanding of the fundamental mechanism of flux trapping is vital. With our newly developed system we measure magnetic flux density at 15 points just above a niobium sheet of dimensions (100 x 60 x 3)mm with a time resolution of up to 2 ms. This setup allows us to control parameters like the temperature gradient, and cooldown rate independently of each other, as well as the magnitude and direction of an external magnetic field. We present data gathered of a single crystal sample as well as ¿large-grain¿ samples consisting of two grains with a grain boundary in the middle. Our data suggests that not only the temperature gradient but also the cooldown rate has an effect on trapped flux. Also there seems to be a non-trivial relationship between trapped flux and magnitude of applied field.

SUSPMF104

Cavity Designs for the Ch3 to Ch11 and Bellow Tuner Investigation of the Superconducting Heavy Ion Accelerator Heliac

Authors : Thorsten Conrad, Marco Busch, Holger Podlech, Malte Schwarz (IAP, Frankfurt am Main), Markus Basten, Manuel Heilmann, Anna Rubin, Alexander Schnase, Stepan Yaramyshev (GSI, Darmstadt), Winfried A. Barth, Florian Dirk Dziuba (GSI, Darmstadt; HIM, Mainz), Viktor Gettmann, Thorsten Kuerzeder, Simon Lauber, Julian Arthur List, Maksym Miski-Oglu (HIM, Mainz), Kurt Aulenbacher (HIM, Mainz; IKP, Mainz)

Abstract New CH-DTL cavities designs of the planned Helmholtz Linear Accelerator (HELIAC) are developed in collaboration of HIM, GSI and IAP Frankfurt. The linac, operated in cw-mode with a final energy of 7.3 MeV/u, is intended for various experiments, in particular with heavy ions at energies close to the Coulomb barrier for research on SHE. Twelve sc CH cavities are foreseen, divided into four different cryostats. Each cavity will be equipped with dynamic bellow tuner. After successful beam tests with CH0, CH3 to CH11 are being designed. Based on the experience gained so far, optimization will be made, which will lead to both an increase in performance in terms of reducing the peak fields limiting superconductivity and a reduction in manufacturing costs and time. In order to optimize manufacturing, attention was paid to design many parts of the cavity, such as lids, spokes, tuner and helium shell, with the same geometrical dimensions. In addition, a tuner test rig was developed, which will be used to investigate the mechanical properties of the bellow tuner. For this purpose, different simulations were made in order to realize conditions as close as possible to reality in the test rig.

SUSPMF105

A New High Vacuum Furnace for SRF R&D

Authors : Rezvan Ghanbari, Christopher Bate, Marc Wenskat (DESY, Hamburg), Wolfgang Carl Albert Hillert (University of Hamburg, Hamburg)

Abstract A new vacuum furnace has been designed and purchased by the University of Hamburg and is operating in an ISO5 cleanroom. This furnace can anneal single-cell TESLA cavities, made of Niobium, at temperatures up to 1000°C and under a pressure of less than 10-7mbar or in a nitrogen atmosphere of up to 10- 2mbar. We will lay out the underlying design ideas, based on the gained experience from our previous annealing research, and present the commissioning of the furnace itself. Additionally, we will show for the first time the results of sample and cavity tests after annealing in the furnace. This will be accompanied by an overview of the intended R&D process and scientific questions to be addressed.

SUSPMF106

Commissioning of a New Magnetometric Mapping System for SRF Cavity Performance Tests

Authors : Jonas Christian Wolff, Juergen Eschke, Andre Goessel, Detlef Reschke, Lea Steder, Lennart Trelle (DESY, Hamburg), Wolfgang Carl Albert Hillert (University of Hamburg, Hamburg)

Abstract Magnetic flux trapped in the Niobium bulk material of superconducting radio frequency (SRF) cavities degrades their quality factor and the accelerating gradient. The sensitivity for flux trapping is mainly determined by the treatment and the geometry of the cavity as well as the Niobium grain size and orientation. To potentially improve the flux expulsion characteristics of SRF cavities and hence the efficiency of future accelerator facilities, further studies of the trapping behavior are essential. For this purpose a magnetometric mapping system to monitor the magnetic flux along the outer cavity surface of 1.3 GHz TESLA-Type single-cell SRF cavities has been developed and is currently in the commissioning phase at DESY. Contrary to similar approaches, this system digitizes the sensor signals already inside of the cryostat to extensively reduce the number of required cable feedthroughs. Furthermore, the signal-to-noise ratio and consequently the measuring sensitivity can be enhanced by shorter analog signal lines, less thermal noise and the Mu-metal shielding of the cryostat. In this contribution the design and first performance test results of the mapping system are presented.

SUSPMF107

PEALD SIS Studies for SRF Cavities

Authors : Isabel González Díaz-Palacio, Robert Blick, Wolfgang Carl Albert Hillert, Andreas Stierle, Robert Zierold (University of Hamburg, Hamburg), Arno Jeromin (DESY Nanolab, Hamburg), Thomas Keller (DESY, Hamburg), Marc Wenskat (DESY, Hamburg; University of Hamburg, Hamburg)

Abstract Recent technological advances and material treatments have pushed Nb SRF cavities to their maximum RF performance. A novel approach for overcoming this limitation, which takes advantage of RF field only penetrates into the superconductor at a certain distance called London penetration depth, is nano- structuring multilayers with PEALD (plasma-enhanced atomic layer deposition). SIS (superconductor-insulator-superconductor) multilayers provide magnetic screening of the bulk Nb cavity, increasing the field at which the vortex penetration starts, and higher quality factor. ALD is closely related to chemical vapor deposition and bases on sequential self-limit gas-solid surface reactions facilitating conformal coatings with sub-nm precision even on complex substrates such as the interior of a cavity. As a preliminary study for SIS SRF cavities, we investigated the AlN- NbTiN/NbN multilayers grown by PEALD. Different compositions, thicknesses, and post-deposition thermal treatments have been investigated. The characterization results of superconducting properties, elemental composition, crystallinity, and cross-section are shown in this contribution.

SUSPMF108

HOM Coupler Design and Optimization for the FCC-ee W Working Point

Authors : Sosoho-Abasi Udongwo, Ursula van Rienen, Shahnam Zadeh (Rostock University, Rostock), Rama Calaga (CERN, Meyrin)

Abstract The Future Circular electron-positron Collider (FCC-ee) is planned to operate with beam energies from 45.6 to 182.5 GeV and beam currents from 5.4 to 1390 mA. The purpose is to study the properties of the Z-, W- and Higgs boson and the top and anti- top quarks in four operation points. The beam current of 147 mA of the W working point requires particular care to string damp HOMs. This paper proposes 2-cell 400 MHz SRF cavities with improved damping as an alternative to the baseline 4-cell cavities for this working point. The resulting impedance of the HOM-damped cavity is then calculated and compared with the impedance budget.

SUSPMF109

Combined In-Situ QEXAFS and XRD Investigations on Nb-Treatments in N2 Gas-atmospheres at Elevated Temperatures

Authors : Patrick Rothweiler, Franz Eckelt, Dirk Lützenkirchen-Hecht, Sebastian Paripsa, Lukas Voß (University of Wuppertal, Wuppertal)

Abstract Thin polycrystalline Nb metal foils were treated in N2 gas atmospheres at elevated temperatures of 900 °C up to 1200 °C. A combination of transmission mode Quick X-ray absorption spectroscopy (QEXAFS) at the Nb-K-edge and X-ray diffraction (XRD) used in parallel were used to investigate changes in the atomic short and long-range structure of the bulk Nb-material in- situ. A dedicated high-vacuum heating cell with a base pressure of 10^(-6) mbar was used to perform the heat treatments under vacuum and nitrogen gas atmosphere. The treatments typically included (i) a preheating at 900 °C under high-vacuum, (ii) a treatment in 3 mbar nitrogen gas at the desired temperature and (iii) a cooldown to room temperature under vacuum conditions. The QEXAFS and XRD data were collected in parallel during the entire process with a time resolution of 4 s. While the samples treated at 900 °C show the typical N-uptake to the octahedral interstitial sites, the samples treated at higher temperatures show the growth of distinct niobium nitride phases. The results will be discussed in more details during the conference.

SUSPMF110

Analysis of Low RRR SRF Cavities

Authors : Katrina Howard, Young-Kee Kim (University of Chicago, Chicago, Illinois), Daniel Bafia, Anna Grassellino (Fermilab, Batavia, Illinois)

Abstract Recent findings in the superconducting radio-frequency (SRF) community have shown that introducing certain impurities into high-purity niobium can improve quality factors and accelerating gradients. Success has been found in nitrogen-doping, infusion of the native oxide into the niobium surface, and thin films of alternate superconductors atop a niobium bulk cavity. We question why some impurities improve RF performance while others hinder it. The purpose of this study is to characterize the impurity profile of niobium with a low residual resistance ratio (RRR) and correlate these impurities with the RF performance of low RRR cavities so that the mechanism of recent impurity-based improvements can be better understood and improved upon. We have found behavioral similarities between low RRR cavities and to high RRR cavities that are weakly nitrogen-doped. Additionally, we performed surface treatments such as low temperature baking and nitrogen-doping on low RRR cavities to evaluate how the intentional addition of more impurities to the RF layer affects performance. The results of this study have the potential to unlock a new understanding on SRF materials.

SUSPMF111

CVD Nb3Sn-on-Copper SRF Accelerator Cavities

Authors : Gabriel Gaitan, Peter Nitcholas Koufalis (Cornell University (CLASSE), Ithaca, New York), Matthias Liepe (Cornell University,Ithaca, New York; Cornell University (CLASSE), Ithaca, New York), Victor Arrieta, Shawn Rex McNeal (Ultramet, Pacoima, California)

Abstract Nb3Sn is the most promising alternative material for achieving superior performance in Superconducting Radio-Frequency (SRF) cavities, outstripping the conventional Nb cavities now used in accelerators. Chemical vapor deposition (CVD) is an alternative to the predominantly used vapor-diffusion-based Nb3Sn growth technique and it might allow reaching superior RF performance at reduced cost. Ultramet is an industry leader in the manufacture of refractory metal and ceramic components by CVD. In collaboration with Cornell University and supported through DOE SBIR awards, Ultramet has developed CVD processes and CVD reactor designs for coating of SRF cavities with Nb and Nb3Sn thin films. In this paper, we present our latest work on CVD Nb3Sn-on-copper SRF cavities, including detailed RF performance test results from two 1.3 GHz SRF cavities.

SUSPMF112

Status Update on Cornell's SRF Compact Conduction Cooled Cryomodule

Authors : Neil Anthony Stilin, Adam Holic, Matthias Liepe, Tim O'Connell, James Sears, Valery D. Shemelin, Jessica Turco (Cornell University (CLASSE), Ithaca, New York)

Abstract A new frontier in Superconducting RF (SRF) development is increasing the accessibility of SRF technology to small-scale accelerator operations which are used in various industrial or research applications. This is made possible by using commercial cryocoolers as a cooling source, which removes the need for expensive liquid cryogenics and their supporting infrastructure. Cornell University is currently developing a new cryomodule based on a conduction cooling scheme. This cryomodule will use two pulse tube cryocoolers in place of liquid cryogenics in order to cool the system. A new 1.3 GHz cavity has been designed with a set of four niobium rings welded at the equator and irises which allow for a direct thermal link between the cavity and cryocooler cold heads. The cavity will use two coaxial RF input couplers capable of delivering up to 100 kW total RF power for high-current beam operation. This coupler design was modified from the Cornell ERL injector couplers, including simplifications such as removing the cold RF window and most outer bellows, while retaining inner bellows for adjustable coupling.

SUSPMF113

Next Generation SRF Cavities at Cornell University

Authors : Nicole Verboncoeur, Matthias Liepe, Thomas Oseroff, Liana Shpani, Zeming Sun (Cornell University (CLASSE), Ithaca, New York)

Abstract Our goal is to develop new materials and protocols for the growth and preparation of thin-film and layered superconductors for next generation SRF cavities with higher performance for future accelerators. We are working primarily with Nb3Sn to achieve this goal, as well as other materials which aim to optimize the RF field penetration layer of the cavity. This contribution gives a general update on our most recent cavity test results. A deeper insight into RF loss distribution and dynamics during cavity testing is gained using a new global high- speed temperature mapping system (T-Map).

SUSPMF114

Magnetic Field Mapping of 1.3 GHz Superconducting Radio Frequency Niobium Cavities

Authors : Ishwari Prasad Parajuli, Alexander Gurevich (ODU, Norfolk, Virginia), Gianluigi Ciovati, Jean Roger Delayen (JLab, Newport News, Virginia; ODU, Norfolk, Virginia)

Abstract Niobium is the material of choice to build superconducting radio frequency (SRF) cavities, which are fundamental building blocks of modern particle accelerators. These cavities require a cryogenic cool-down to ~2 - 4 K for optimum performance minimizing RF losses on the inner cavity surface. However, temperature-independent residual losses in SRF cavities cannot be prevented entirely. One of the significant contributor to residual losses is trapped magnetic flux. The flux trapping mechanism depends on different factors, such as surface preparations and cool-down conditions. We have developed a diagnostic magnetic field scanning system (MFSS) using Hall probes and anisotropic magneto-resistance sensors to study the spatial distribution of trapped flux in 1.3 GHz single-cell cavities. The first result from this newly commissioned system revealed that the trapped flux on the cavity surface might redistribute with increasing RF power. The MFSS was also able to capture significant magnetic field enhancement at specific cavity locations after a quench.

SUSPMF115

Design Study of High Efficiency Klystron for CEPC LINAC

Authors : Zhandong Zhang (IHEP, Beijing; UCAS, Beijing;Université Paris- Saclay, CNRS/IN2P3, IJCLab, Orsay), Munawar Iqbal (IHEP,), Yunlong Chi, Dong Dong, Guoxi Pei, Shengchang Wang, Ouzheng Xiao, Zusheng Zhou (IHEP, Beijing), Shu Zhang (IHEP, Beijing; UCAS, Beijing)

Abstract The injector linear accelerator (LINAC) for the CEPC requires a higher efficiency klystron with 80MW output power than S-band 65MW pulsed klystron currently operated on BEPCII LINAC to reduce energy consumption and cost. The efficiency is expected to improve from the currently observed 42% to more than 55% and output power will be improved from 65MW to more than 80MW with same operation voltage. In this paper, BAC bunching mechanism is applied for klystron efficiency improvement. The optimization of the gun and solenoid parameters is completed in 2-D code DGUN and 3-D code CST. The preliminary optimization of the cavity parameters is also completed in 1-D disk model based AJDISK code and will be further checked by 2-D EMSYS code and 3-D CST code. Finally, new klystron prototype will be fabricated in Chinese company after design parameters are determined.

SUSPMF116

Ferrite Specification for the Mu2e 300 kHz and 4.4 MHz AC Dipole Magnets

Authors : Keegan Harrig, Eric Prebys (UCD, Davis, California), Luciano Elementi, Chris C. Jensen, Howard Pfeffer, Dean Alan Still, Iouri Terechkine, Steven J. Werkema, Mayling Wong (Fermilab, Batavia, Illinois)

Abstract The Mu2e experiment at Fermilab will measure the rate for neutrinoless-conversion of negative muons into electrons with never-before-seen precision. This experiment will use a pulsed 8 GeV proton beam with pulses separated by 1.7 μs. To suppress beam induced backgrounds to this process, a set of dipoles operating at 300 kHz and 4.4 MHz have been developed that will reduce the fraction of out-of-time protons at the level of 1E-10 or less. Selection of magnetic ferrite material for construction must be carefully considered given the high repetition rate and duty cycle that can lead to excess heating in conventional magnetic material. A model of the electromagnetic and thermal properties of candidate ferrite materials has been constructed. Magnetic permeability, inductance, and power loss were measured at the two operating frequencies in toroidal ferrite samples as well as in the ferrites from which prototype magnets were built. Additionally, the outgassing rates of the ferrite material was measured to determine vacuum compatibility. The outcome of this work is a detailed specification of the electrical and mechanical details of the ferrite material required for this application.

SUSPMF117

Non Linear Phenomena Studies in High-Gradient RF Technology for Hadrontherapy at IFIC

Authors : Pablo Martinez-Reviriego, Cesar Blanch Gutierrez, Daniel Esperante Pereira, Juan Fuster, Nuria Fuster-Martinez, Benito Gimeno, Daniel Gonzalez-Iglesias, Pablo Martín-Luna (IFIC, Valencia)

Abstract High gradient accelerating cavities are one of the main research lines in the development of compact linear colliders. However, the operation of such cavities is currently limited by non-linear effects that are intensified at high electric fields, such as dark currents and radiation emission or RF breakdowns. A new normal-conducting High Gradient S-band Backward Travelling Wave accelerating cavity for medical application (v=0.38c) designed and constructed at CERN is being tested at IFIC. In this poster, we present experimental measurements and simulation results on breakdown analysis and dark current and radiation studies, in order to improve our understanding in such effects. The final objective consists of studying the viability of using this techniques in linear accelerators for hadrontherapy treatments in hospitals.

SUSPMF118

Radiation Load Studies for the FCC-ee Positron Source with a Superconducting Matching Device

Authors : Barbara Humann (TU Vienna, Wien; CERN, Meyrin), Andrea Latina, Yongke Zhao (CERN, Geneva), Anton Lechner (CERN, Meyrin), Bernhard Auchmann, Jaap Kosse (PSI, Villigen PSI), Iryna Chaikovska, Salim Ogur (Université Paris-Saclay, CNRS/IN2P3, IJCLab, Orsay)

Abstract For an electron-positron collider like FCC-ee, the production of positrons plays a crucial role. One of the design options considered for the FCC-ee positron source employs a superconducting solenoid made of HTS coils as an adiabatic matching device. The solenoid, which is placed around the production target, is needed to capture positrons before they can be accelerated in a linear accelerator. A superconducting solenoid yields a higher peak field than a conventional-normal conducting magnetic flux concentrator, therefore increasing the achievable positron yield. In order to achieve an acceptable positron production, the considered target is made of tungsten-rhenium, which gives also a significant flux of un-wanted secondary particles, that in turn could generate a too large radiation load on the superconducting coils. In this study, we assess the feasibility of such a positron source by studying the heat load and long- term radiation damage in the superconducting matching device and surrounding structures. Results are presented for different geometric configurations of the superconducting matching device, considering different drive beams energies (6 GeV and 20 GeV electrons).

SUSPMF119

Spallation Target Optimization for ADS by Monte Carlo Transport Codes

Authors : Mustafa Mumyapan (SKKU, Suwon)

Abstract Accelerator Driven Systems are advanced systems for the use of Thorium as fuel, aiming to reduce nuclear waste through transmutation. The spallation target, which is responsible for producing neutrons, is one of the main parts of the ADS system. In this research, neutronic parameters of spallation targets consisting of several materials LBE, Mercury, Lead, Mercury on the cylindrical, box, and conic shapes using Monte Carlo codes (FLUKA, PHITS, MCNPX) was investigated. Energy Deposition and spallation neutron yield of spallation target with different shapes and dimensions have been calculated to optimization of the target. According to the results, the neutron yield values from MCNPX and PHITS are similar and it's close to the experimental result. On the other hand, the error rate of the values in FLUKA is higher.

SUSPMF120

Proposal of a VHEE Linac for FLASH radiotherapy

Authors : Lucia Giuliano, Fabio Bosco, Daniele De Arcangelis, Luca Ficcadenti, Daniele Francescone, Gaia Franciosini, Mauro Migliorati, Luigi Palumbo, Vincenzo Patera (Sapienza University of Rome, Rome), Maria Giuseppina Bisogni, Fabio Di Martino, Jake Harold Pensavalle (INFN-Pisa, Pisa), David Alesini, Alessandro Gallo, Alessandro Vannozzi (INFN/LNF, Frascati), Giuseppe A. Pablo Cirrone, Giacomo Cuttone, Giuseppe Torrisi (INFN/LNS, Catania), Vincent Favaudon, Annalisa Patriarca (Institut Curie- Centre de Protonthérapie d'Orsay, Orsay), Sophie Heinrich (Institut Curie, Orsay), Mostafa Behtouei, Bruno Spataro (LNF- INFN, Frascati), Andrea Mostacci (LNF-INFN, Frascati; Sapienza University of Rome, Rome)

Abstract Translation of electron FLASH radiotherapy in clinical practice requires the use of high energy ac- celerators to treat deep tumours and Very High Electron Energy (VHEE) could represent a valid technique to achieve this goal. In this sce- nario, a VHEE FLASH linac is under study at the University La Sapienza of Rome (Italy) in collaboration with the Italian Institute for Nuclear Research (INFN) and the Curie Insti- tute (France). Here we present the preliminary results of a compact C-band system aiming to reach an high accelerating gradient and an high pulse current necessary to deliver high dose per pulse and ultra-high dose rate required for FLASH effect. We propose a system composed of a low energy high current injector linac followed by a modular section of high accelerating gradient structures. CST code is used to define the required LINAC¿s RF parameters and beam dynamics simulations are performed using T-Step, ASTRA and GPT tracking codes.

SUSPMF121

Post-Acceleration of Laser Driven Ion Beams Using Slow Wave Structures

Authors : Yuze Li, Hao Cheng, Dongyu Li, Chen Lin, Minjian Wu, Xueqing Yan, Yang Yan, Tong Yang (PKU, Beijing)

Abstract Significant progress has been made in laser-driven ion acceleration*. The laser energy is first absorbed by electrons. Charge separation can produce acceleration field with TV/m gradient, generating protons with cut off energy up to ~80 MeV** in TNSA mechanism. However, the energy conversion efficiency is relatively low (0.05-5%), due to electrons motion produced EMPs. A method was put forward to post-accelerate laser-driven beams by reutilization of the EMPs energy***. A coil attached to the target acted as a slow wave structure which synchronized the EMP with protons. The traveling field of EMP can further accelerate and focus ions. Since the dispersive nature of helical coil, the electric wave form is constantly changing

****. we present a modified slow wave structure. Theoretical models are built to verify the validity of this improvement scheme. The dispersion relation show this structure is free of dispersion. This work has been verified using PIC simulations. The waveform remains unaltered, which means the acceleration path can be made longer. Through this method the proton energy is hopeful to exceed 100 MeV in high power PW laser and the efficiency can be further raised.

SUSPMF122

Development of Magnetic Harmonics Measurement System for Small Aperture Magnets

Authors : Jongmo Hwang, Jungbae Bahng (Korea University Sejong Campus, Sejong), Eun-San Kim (KUS, Sejong)

Abstract Storage ring has been improved to achieve high brightness of x- ray light source by making beam size and beam emittance smaller and enlarging the beam intensity. To achieve requirements such as a small beam emittance, the magnets need to have a larger magnetic field gradient and complex function with small aperture size. Since the complex structure and small beam size accompany with large errors in beam dynamics by high order field distortion of the magnets, it is important to measure the harmonics of the magnet in order to measure and improve it. Traditional field measurement methods such as hall probe and rotating loop have difficulty in measuring the harmonics of a magnet with a small aperture due to restrictions that physical size of the hall sensor and loop-card respectively.

We developed Single Stretched Wire (SSW) method for the magnetic field measurement method on a small aperture magnet, in particular harmonics of the magnet. The system consists of a thin wire, accurate actuator system, and voltmeter. We describe the development of the SSW system and the result of the performance test by using our system in this paper.

SUSPMF123

CFD Studies of the Convective Heat Transfer Coefficients and Pressure Drops in Geometries Applied to Water Cooling Channels of the Crotch Absorbers of ALBA Synchrotron Light Source

Authors : Stefania Grozavu, Gustavo Adolfo Raush (ESEIAAT, Terrassa), Joan Josep Casas, Carles Colldelram, Marcos Quispe (ALBA- CELLS Synchrotron, Cerdanyola del Vallès)

Abstract Currently, the storage ring vacuum chambers of ALBA are protected by 156 crotch absorbers made of copper and Glidcop. After more than 10 years of operation as a third-generation light source, the ALBA II project arises, aiming to transform this infrastructure into a fourth-generation synchrotron. This introduces new challenges in terms of the thermal and mechanical design of the future absorbers. The absorbers' cooling channels consist of a set of 8-mm-diameter holes parallel to each other drilled in the body of the absorbers. In each hole, there is a 6x1 mm stainless steel concentric inner tube coiled in helical wires, whose aim is to improve the heat transfer. The convective heat transfer coefficients used for the original design of the absorbers come from experimental correlations from the literature, which are limited to a few geometric variations. In this work, CFD studies of the convective heat transfer coefficients and pressure drops in the known cooling channels arecarried out, as well as new proposed variations of the geometry that have not been reported in the literature. This information will be useful for the sizing of the new absorbers for the ALBA II project.

SUSPMF124

Design of a Proton Therapy Eye Treatment Nozzle Using a Cylindrical Beam Stopping Device for Enhanced Dose Rate Performances

Authors : Eustache Gnacadja, Nicolas Pauly, Eliott Ramoisiaux, Robin Tesse, Marion Vanwelde (ULB, Bruxelles), Cédric Hernalsteens (CERN, Meyrin; ULB, Bruxelles)

Abstract Proton therapy is a well established treatment method for ocular cancerous diseases. General-purpose multi-room systems which comprise eye-treatment beamlines must be thoroughly optimized to achieve the performances of fully dedicated systems in terms of depth-dose distal fall-off, lateral penumbra, and dose rate. For eye-treatment beamlines, the dose rate is one of the most critical clinical performances, as it directly defines the delivery time of a given treatment session. This delivery time must be kept as low as possible to reduce uncertainties due to undesired patient movement. We propose an alternative design of the Ion Beam Applications (IBA) Proteus Plus (P+) eye treatment beamline, which combines a beam-stopping device with the already existing scattering features of the beamline. The design is modelled with Beam Delivery SIMulation (BDSIM), a Geant4- based particle tracking and beam-matter interactions Monte- Carlo code, to demonstrate that it increases the maximum achievable dose rate by up to a factor 3 compared to the baseline configuration. An in-depth study of the system is performed and the resulting dosimetric properties are discussed in detail.

SUSPMF125

Slow Extraction Modelling for NIMMS Hadron Therapy Synchrotrons

Authors : Rebecca Louise Taylor (CERN, Geneva), Jaroslaw Pasternak (Imperial College of Science and Technology, London), Elena Benedetto, Mariusz Sapinski (SEEIIST, Geneva)

Abstract The Next Ion Medical Machine Study (NIMMS) is an umbrella R&D programme for CERN accelerator technologies targeting advanced accelerator options for proton and light ion therapy. In collaboration with the European program HITRIplus, one area of study is slow extraction, required to deliver a uniform beam spill for radiotherapy treatment. Several techniques use the third- order resonance to extract hadrons; these include betatron core driven extraction, radiofrequency knock-out, and quadrupole sweeping. Flexible simulations tools using these techniques were prepared and initially benchmarked with results from the literature that used the Proton-Ion Medical Machine Study (PIMMS) design - as utilized by CNAO and MedAustron. The limits of the current PIMMS design were then pushed to evaluate its compatibility to deliver >10x higher intensity ion beams, and using faster extraction regimes.

SUSPMF126

Design of the 590mev Proton Beam Line for the Proposed TATTOOS Isotope Production Target at PSI

Authors : Marco Hartmann, Daniela Candida Kiselev, Davide Reggiani, Mike Seidel, Jochem Snuverink, Hui Zhang (PSI, Villigen PSI)

Abstract IMPACT (Isotope and Muon Production with Advanced Cyclotron and Target Technologies) is a proposed initiative envisaged for the high-intensity proton accelerator facility (HIPA) at the Paul Scherrer Institute (PSI). As part of IMPACT, a radioisotope target station, TATTOOS (Targeted Alpha Tumour Therapy and Other Oncological Solutions) will allow the production of terbium radionuclides for therapeutic and diagnostic purposes. The proposed TATTOOS beamline and target will be located near the UCN (Ultra Cold Neutron source) target area, branching off from the main UCN beamline. In particular, the beamline is intended to operate at a beam intensity of 100 μA, requiring a continuous splitting of the main beam via an electrostatic splitter. Realistic beam loss simulations to verify safe operation have been performed and optimised using Beam Delivery Simulation (BDSIM), a Geant4 based tool enabling the simulation of beam transportation through magnets and particle passage through the accelerator. In this study, beam profiles, beam transmission and power deposits are generated and studied.

SUSPMF127

A Novel Method of Emittance Matching to Increase Beam Transmission for Cyclotron Based Proton Therapy Facilities

Authors : Vivek Maradia (PSI, Villigen PSI; ETH, Zurich), Antony John Lomax, David Meer, Serena Psoroulas, Jacobus Maarten Schippers, Damien Charles Weber (PSI, Villigen PSI)

Abstract In proton therapy, high dose rates can reduce treatment delivery times, allowing for efficient mitigation of tumor motion and increased patient throughput. With cyclotrons, however, high dose rates are difficult to achieve for low-energies as, typically, the emittance after the degrader is matched in both transversal planes using circular collimators, which does not provide an optimal matching to the acceptance of the following beamline. Transmission can however be substantially improved by transporting maximum acceptable emittances in both orthogonal planes, but at the cost of gantry angle-dependent beam shapes at isocenter. Here we demonstrate that equal emittances in both planes can be recovered at the gantry entrance using a thin scattering foil, thus ensuring gantry angle-independent beam shapes at the isocenter. We demonstrate experimentally that low-energy beam transmission can be increased by a factor of 3 using this approach compared to the currently used beam optics, whilst gantry angle-independent beam shapes are preserved. We expect that this universal approach could also bring a similar transmission improvement in other cyclotron-based proton therapy facilities.

SUSPMF128

Monte Carlo Simulation of Electron Beam in Phantom Water for Radiotherapy Application

Authors : Pittaya Apiwattanakul (Chiang Mai University, Chiang Mai), Sakhorn Rimjaem (Chiang Mai University, Chiang Mai; ThEP Center, Bangkok)

Abstract Radiotherapy (RT) is an effective treatment that can control the growth of cancer cells. There is a hypothesis suggests that secondary electrons with an energy of a few eV produced from RT play an important role on cancer¿s DNA strand break. In this study, the Monte Carlo simulation of electron beam irradiation in phantom water is performed to investigate the production of low- energy electrons. Electron beams produced from an RF linac are used in this study. The accelerator can generate the electron beam with adjustable energy of up to 4 MeV and adjustable repetition rate of up to 200 Hz. With these properties, the electron dose can be varied. We used ASTRA program to simulate the beam dynamics in the accelerator and GEANT4 program for studying interactions of electrons in water. The energy of electrons decreases from MeV scale to keV-eV scale as they travel in the water. From simulations, the dose distribution and depth in phantom water were obtained for the electron dose of 1, 3, 5, 10, 25, and 50 Gy. Further study on effect of low- energy electron beam with these dose values on cancer DNAs will be performed with GEANT4-DNA simulation.

SUSPMF129

Performance Study of the NIMMS Superconducting Compact Synchrotron for Ion Therapy with Strongly Curved Magnets

Authors : Hannah Norman, Robert Appleby (UMAN, Manchester), Mikko Karppinen (CERN, Geneva), Maurizio Vretenar (CERN, Meyrin), Hywel Owen (Cockcroft Institute, Warrington, Cheshire; STFC/DL/ASTeC, Daresbury, Warrington, Cheshire), Elena Benedetto (SEEIIST, Geneva; TERA, Novara; CERN, Meyrin), Suzanne L. Sheehy (The University of Melbourne, Melbourne, Victoria)

Abstract Delivery of heavy, charged particle therapy currently utilises normal conducting magnet based accelerators, predominantly synchrotrons. For the future generation of clinical facilities, the footprint of such accelerators needs to be reduced while adopting beam intensities above 1 × 1010 particles per spill for more efficient, effective treatment. The Next Ion Medical Machine Study (NIMMS) is investigating the feasibility of a compact (27m circumference) superconducting synchrotron, based on 90- degree alternating-gradient, canted-cosine-theta (CCT) magnets to meet these criteria. The understanding of the impact of higher order field multipoles of these magnets on the beam dynamics of the ring is crucial to the effective optimisation of the design and to assess its performance for its suitability for treatment. In this paper, we analyse the electromagnetic model of a superconducting magnet to extract its non-linear components and fringe fields. Preliminary assessment of the effect of such nonlinearities is performed using MADX/PTC. Further scope, involving cross-referencing with other particle tracking codes, is discussed.

SUSPMF130

Ripple Pattern Formation on Silicon Carbide Surfaces by Low-Energy Ion-Beam Erosion

Authors : Divya Gupta, Sanjeev Aggarwal (Kurukshetra University, Kurukshetra), Gajigatte Umapathy (IUAC, New Delhi), Rahul Singhal (Malviya Institute of Technology, Jaipur)

Abstract A versatile air insulated high current medium energy 200 kV Ion Accelerator has been running successfully at Ion Beam Centre, Kurukshetra University, India for carrying out multifarious experiments in material science and surface physics. Ion beam induced structures on the surfaces of semiconductors have potential applications in photonics, magnetic devices, photovoltaics, and surface-wetting tailoring etc. In this regard, silicon carbide (SiC) is a fascinating wide-band gap semiconductor for high-temperature, high-power and high- frequency applications. In the present work, fabrication of self- organized ripple patterns is carried out on the SiC surfaces using 80 keV Ar+ ions for different fluences at oblique incidence of 500. Studies demonstrate that ripple wavelength and amplitude, ordering and homogeneity of these patterns vary non-linearly with argon ion fluence. The ripples tend to align themselves parallel to the projection of the ion beam direction. The evolution of such surface structures is explained with the help of existing formalisms of coupling between surface topography and preferential sputtering.

SUSPMF131

Design and Parameterization of Electron Beam Irradiation System for Natural Rubber Vulcanization

Authors : Pitch Wongkummoon, Nopadol Kangrang, Sakhorn Rimjaem, Jatuporn Saisut, Chitrlada Thongbai (Chiang Mai University, Chiang Mai), Michael W. Rhodes (IST, Chiang Mai)

Abstract Electron beam irradiation is a process to modify or improve the properties of materials with less chemical residue. In natural rubber vulcanization, a proper electron absorbed dose is about 50-150 kGy. In this study, the experimental station is designed to investigate the deposition of the electron beam in natural rubber. Electron beams generated from an RF linac are used in this study. This accelerator can generate the beam with energies in the range of 1-4 MeV and an adjustable repetition rate of up to 200 Hz. We can optimize these parameters to maximize the throughput and uniformity of electron dose in the vulcanization. The simulation results from GEANT4 were used to narrow down the appropriate parameters in the experiment. In the early stage of the study, water was used as a sample instead of natural rubber. The dose distribution was obtained by placing a B3 film dosimeter under a water chamber. The water depth was varied from 0.5 to 2.0 cm. The simulation results provide the dose distribution to compare with the experimental results. In a further study, the beam irradiation in natural rubber with these optimal parameters and vulcanization tests will be performed.

SUSPMF132

Design of Radiation Shielding for the PBP-CMU Electron Linac Laboratory

Authors : Phanthip Jaikaew (Chiang Mai University, Chiang Mai), Sakhorn Rimjaem (Chiang Mai University, Chiang Mai; ThEP Center, Bangkok)

Abstract At the PBP-CMU Electron Linac Laboratory, we aim to generate the coherent terahertz radiation and mid-infrared free-electron lasers. The accelerator system can produce electron beam with maximum energy of up to 25 MeV. During the accelerator operation, it is possible to generate bremsstrahlung photons and neutrons when electrons hit beam dump or vacuum chambers. The radiation shielding is therefore essentially important. The study of radiation generation and design of radiation shielding are conducted and presented in this work. To investigate the radiation dose rate and obtain the design of radiation shielding, the geometry of our accelerator hall was implemented into the Monte-Carlo simulation program GEANT4. The study results including radiation dose map and design of local shielding for the specific parts of the system will be addressed in this contribution. With this design the radiation dose rate outside the accelerator hall is as small as 1 uSv/year. From the results, we purpose the shielding design to control the dose rate to the safety limit as stated by IAEA regulation.

SUSPMF133

Design of Linac Based Neutron Source

Authors : Nirupama Upadhyay, Sajeev Sakai Chacko (University of Mumbai, Mumbai), Abhay Deshpande, Tanuja Sushant Dixit, Ramamoorthy Krishnan (SAMEER, Mumbai)

Abstract Neutron sources are of great utility for various applications, especially in the fields of nuclear medicine, nuclear energy and imaging. At SAMEER, we have designed a linear electron accelerator based neutron source via photo-neutron generation. The accelerator is a 15 MeV linac with both photon and electron mode and is capable of delivering high beam current to achieve beam power of 1 to 2 kW. Efforts are in place to achieve further higher beam powers. 15 MeV electrons are incident on a bremsstrahlung target followed by a secondary target to achieve neutrons. To further optimize and enhance the neutron yield, backing material is provided. In this paper, we present the simulation of (e, g) and (g, n) processes using the Monte Carlo code FLUKA. The optimization of Tungsten as the convertor target whereas of the Beryllium as the neutron target is discussed in detail. We have explored various backing materials in order to optimize the total neutron yield as well as the thermal neutron yield. The simulation results have been considered for the finalisation of all material parameters for the set-up of this neutron source activity.

SUSPMF134

High Transport Efficiency and Tunable Beamline for Laser Plasma Accelerator

Authors : Yang Yan, Hao Cheng, Dongyu Li, Yuze Li, Chen Lin, Minjian Wu, Xueqing Yan, Tong Yang, Zhong Xi Yuan, Kun Zhu (PKU, Beijing)

Abstract A beamline is required to focus proton beams produced by laser plasma accelerator to high charge density spots for practical applications. The Compact LAser Plasma Accelerator (CLAPA) coupled with an image-relaying beamline has been built at Peking University*. While the collection section of this beamline is an electromagnetic quadrupole (EMQ) triplet with certain aperture, more than 71% of the protons are lost in the inlet end face or vacuum tube wall of triplet due to their own divergence angles**. Here we show the development of a high transport efficiency and tunable beamline by adding two permanent magnet quadrupoles (PMQs) in front of the triplet. PMQs with magnetic field strengths of 200 and 120T/m respectively have larger collection angle of about ±70mrad. Genetic algorithm (GA) is applied to design the system with goal of the highest transport efficiency. As a result, by monitoring PMQs' relative positions and EMQs' currents, the focusing energy is able to be adjusted ranging from 2 to 10 MeV, and the transport efficiency is about twice as high as only collected by EMQ triple.

IPAC22

STUDENT POSTER SESSION GUIDE

13th

INTERNATIONAL PARTICLE ACCELERATOR CONFERENCE

June 12-17, 2022

IMPACT FORUM
Muangthong Thani
Bangkok, Thailand

Siam Photon

THAI SYNCHROTRON NATIONAL LAB

ScandiNova

TCEB
THAILAND CONVENTION & EXHIBITION BUREAU