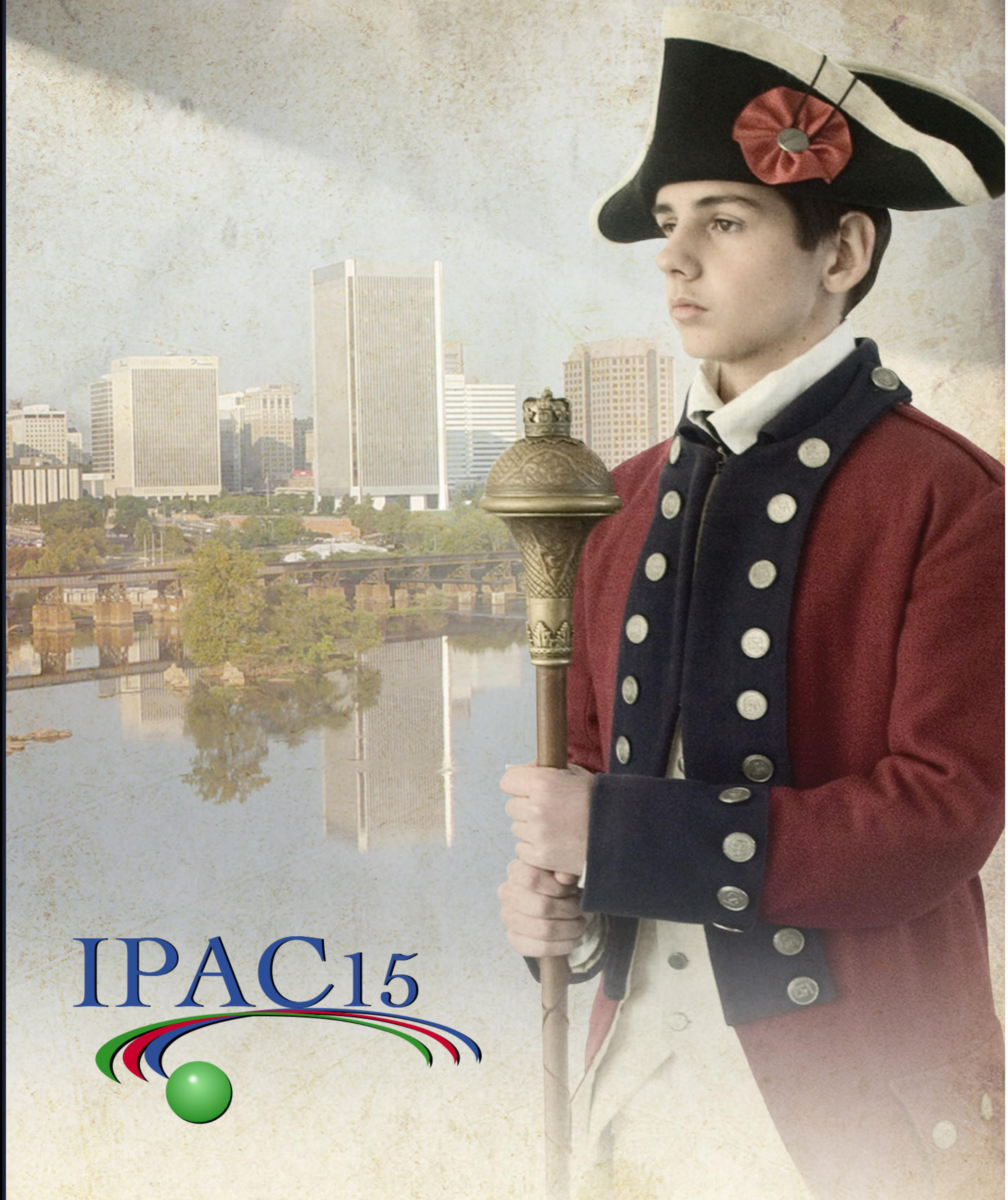
Student Poster Guide

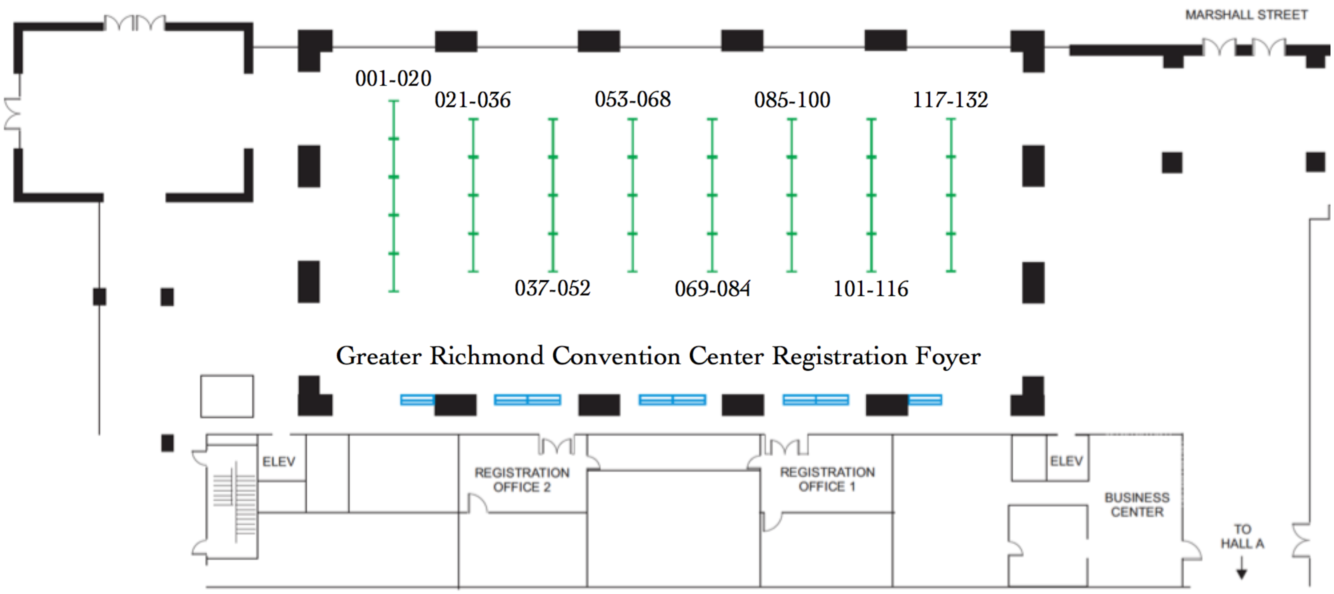
THE 6th INTERNATIONAL PARTICLE ACCELERATOR CONFERENCE

IPAC'15



IPAC15

Richmond, Virginia, USA
May 3-8, 2015



SPECIAL STUDENT POSTER SESSION

The special student poster session will take place in the Registration Lobby of the Convention Center during Delegate Registration on Sunday, May 3. Posters will be mounted from 13:30 and manned from 14:00 to 18:00. If the selection jury needs a longer time for judging, finalists will be asked to remain by their posters.

Members of the IPAC'15 SPC and OC will judge the posters and decide the winners of two conference prizes (each $500 and a prize certificate) for the best student posters, awarded to students for particularly meritorious work. The prizes will be presented during the Awards Session on Thursday, May 7.

All delegates are cordially invited to visit the student poster session during and after their registration. This student poster session is specifically designed to precede and lead into the conference welcome reception.

STUDENT PARTICIPATION SPONSORSHIP AT IPAC'15

The IPAC'15 Student Grant Program is sponsored (in alphabetical order) by: the American Physical Society Division of Physics of Beams (APS-DPB), the Asian Committee for Future Accelerators (ACFA), The European Physical Society Accelerator Group (EPS-AG with contributions from ALBA-CELLS, Centro Fermi, CERN, CNRS-IN2P3, DESY, Diamond, ESRF, GSI, HZB, IFIC, INFN, JAI, Max-Lab, PSI, and STFC/Cockroft Institute), the Fermi Research Alliance, Jefferson Science Associates, the National Science Foundation (NSF), and Institute of Modern Physics, Chinese Academy of Sciences (IMP).

001 : Numerical Modelling and Monte-Carlo Simulations of Beam Loss Monitor Signals as a Result of Macroparticle Interactions with High-Energy Proton Beams

Scott Rowan
CERN, Geneva
Authors: Scott Rowan, Andrea Apollonio, Bernhard Auchmann, Anton Lechner, Ondrej Picha, Ruediger Schmidt, Frank Zimmermann (CERN, Geneva)
Classification: 1: Circular and Linear Colliders

A known threat to the availability of the LHC, when operating at 6.5 TeV with reduced bunch spacing of 25 ns, is the increased probability of macroparticle (dust particles) interactions with the beam. Such an interaction produces particle showers that deposit energy in the superconducting magnets. As this could result in a magnet quench, the strategy is to detect the beam-losses with beam-loss monitors, and to trigger a preventative beam dump in the case that a threshold is exceeded. There have been a number of detailed FLUKA studies and beam-loss experiments to better understanding of such quench events, however, in order to understand the true extent of the threat and to study relevant mitigation strategies, a numerical model of macroparticle-to-beam interactions has been constructed, progressing on previous works. Furthermore, Monte-Carlo simulations are carried out with distribution functions for macroparticle size and location within a standard LHC arc cell. Subsequently each event is then categorized as either 'beam-dump', 'avoidable beam-dump' and or 'quench despite beam-dump'. This paper details the numerical model and the analysis and implications of the results.

002 : Study of Beam Background and MDI Design for CEPC

Teng Yue
IHEP, Beijing
Authors: Teng Yue (IHEP, Beijing)
Classification: 1: Circular and Linear Colliders

CEPC is a project designed to obtain a large number of Higgs events by keeping e+e- collisions at the center-of-mass energy of 240 GeV and deliver peak luminosity above 10^{34} cm^{-2} s^{-1} for each interaction point. The super high energy and the pretty high luminosity will bring some special background problems, which will exert difficulty on the MDI design and the detectors protection. In this article, I will show the simulation result of the main background sources at CEPC and give some suggestions on the MDI design and detectors protection.

003 : Modeling Crabbing Dynamics in an Electron-Ion Collider

Alejandro Castilla
ODU, Norfolk, Virginia
Jefferson Lab, Newport News, Virginia
DCI-UG, León
Authors: Alejandro Castilla (ODU, Norfolk, Virginia; Jefferson Lab, Newport News, Virginia; DCI-UG, León), Vasiliy Morozov (Jefferson Lab, Newport News, Virginia), Todd Satogata (Jefferson Lab, Newport News, Virginia; ODU, Norfolk, Virginia), Jean Roger Delayen (ODU, Norfolk, Virginia; Jefferson Lab, Newport News, Virginia)
Classification: 1: Circular and Linear Colliders

A local crabbing scheme requires $\pi/2$ (mod π) horizontal betatron phase advances from an interaction point (IP) to the crab cavities on each side of it. However, realistic phase advances generated by sets of quadrupoles, or Final Focusing Blocks (FFB), between the crab cavities located in the expanded beam regions and the IP differ slightly from $\pi/2$. To understand the effect of crabbing on the beam dynamics in this case, a simple model of the optics of the Medium Energy Electron-Ion Collider (MEIC) including local crabbing was developed using linear matrices and then studied numerically over multiple turns (1000 passes) of both electron and proton bunches. The same model was applied to both local and global crabbing schemes to determine the linear-order dynamical effects of the synchro-betatron coupling induced by crabbing.

004 : Simulation of Hollow Electron Lenses as LHC Beam Halo Reducers using MERLIN

Haroon Rafique
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Classification: 1: Circular and Linear Colliders

The Large Hadron Collider (LHC) and its High Luminosity (HL) upgrade foresee unprecedented stored beam energies of up to 700MJ. The collimation system is responsible for cleaning the beam halo and is vital for successful machine operation. Hollow Electron Lenses (HEL) are being considered for the LHC, based on Tevatron designs and operational experience, for active halo control. HELs can be used as soft scraper devices, and can operate close to the beam core without undergoing damage. We use the MERLIN C++ accelerator libraries to implement a HEL and examine the effect on the beam halo for various test scenarios.

005 : Study on Beam Dynamics of a Knot-APPLE Undulator Proposed for SSRF

Qinglei Zhang
SINAP, Shanghai
Authors: Qinglei Zhang, Bocheng Jiang, Shun-Qiang Tian, Manzhou Zhang, Zhentang Zhao, Qiaogen Zhou (SINAP, Shanghai)
Classification: 2: Photon Sources and Electron Accelerators

A new type of undulator, Knot-APPLE undulator, is proposed for SSRF as a solution to reduce the heat load of on-axis high harmonics without losing its capability of tuning synchrotron polarization. It will be applied for SSRF Photoemission Spectroscopy beamline (PES-beamline) in the near future. Impact of the undulator on the beam dynamics has been studied based on the 3D magnetic field model. Linear optics can be retained by quadrupole compensation within two adjacent cells. Dynamical aperture (DA) shrinkage has been found in the tracking and various kinds of methods has been tried to restore the DA such as sexupoles optimization, current strips compensation.

006 : Optics Compensation for Variable-gap Undulator Systems at FLASH

Tim Plath
Uni HH, Hamburg
Authors: Philipp Amstutz, Christoph Lechner, Tim Plath (Uni HH, Hamburg), Joern Boedewadt, Mathias Vogt (DESY, Hamburg), Sven Ackermann (DESY, Hamburg; Uni HH, Hamburg)
Classification: 2: Photon Sources and Electron Accelerators

Variable-gap undulator systems are widely used in storage rings and linear accelerators to generate soft- and hard x-ray radiation for the photon science community. For cases where the effect of undulator focusing significantly changes the electron beam optics, a compensation is needed in order to keep the optics constant in other parts of the accelerator. Since 2010, the free-electron laser (FEL) facility FLASH is equipped with two undulator sections along the same electron beamline. The first undulator is a variable-gap system used for seeding experiments, the second undulator is a fixed-gap system which serves the user facility with FEL radiation. Varying the gap in the first undulator will change the beam optics such that the FEL process in the second undulator is dramatically disturbed. For the correction of the beam optics an analytical model is used to generate feed forward tables which allows to make part of the beamline indiscernible for the subsequent sections. The method makes use of the implicit function theorem and can be used for any perturbation of the beam optics. Here, we present the method and its implementation as well as measurements performed at FLASH.

007 : Comparison of Bunch Compression Schemes for the AXXS FEL

Tessa Charles
Monash University, Clayton, Victoria
Authors: Tessa Charles, David Paganin (Monash University, Clayton, Victoria), Avni Aksoy (Ankara University, Golbasi / Ankara), Andrea Latina, Daniel Schulte (CERN, Geneva), Mark James Boland, Rohan Dowd (SLSA, Clayton)
Classification: 2: Photon Sources and Electron Accelerators

Different types of electron bunch compression schemes are compared for the AXXS FEL design study. The main linac for the proposed machine is based on CLIC x-band structures. This choice leaves several options for the bunch compression schemes which impact the injection system RF band. Both harmonic linearization and phase modulation linearization are considered and their relative strengths and weaknesses compared. Simulations were performed to compare the performance of an s-band injector with a higher harmonic RF linearization and an x-band injector. One motivation for the study is to optimise the length of the AXXS machine, allowing the linac to fit onto the proposed and also act as the injector to the existing storage ring at the Australian Synchrotron.

008 : Simulation and Analysis of Laser/Electron Beam interaction for use as a Free Electron Laser

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Authors: Joshua Einstein, Sandra Biedron, Henry Freund, Stephen Milton (CSU, Fort Collins, Colorado)
Classification: 2: Photon Sources and Electron Accelerators

Through the use of simulation tools and theoretical analysis techniques, the Free Electron Laser process is investigated for a wiggler that is generated by an ultrafast laser system. The development and availability of such systems allows for novel FEL designs due to the high peak power of such lasers. Even though such high powers are possible, difficulties arise due to inhomogeneity in the laser pulse. This project looks at simulation results for a system with a realistic laser pulse profile and looks in to the pulse-shape effects on various system parameters. Models are presented for the expected behavior with important parameters noted, as well as highlighting possible difficulties that might occur experimentally. While head-on interaction has been proven experimentally for the short wavelength regime, we believe that using a co-propagating laser can provide benefits that have currently been untested. This experimental setup is outlined in Lawler, J et al, and we are currently simulating how the use of an ultrashort laser pulse as an electromagnetic wiggler will affect characteristics of the output radiation.

009 : Optimization of an Improved SASE (iSASE) FEL

Lipi Gupta
Cornell University
Authors: Lipi Gupta (Cornell University (CLASSE), Ithaca, New York), Kun Fang, Juhao Wu (SLAC, Menlo Park, California)
Classification: 2: Photon Sources and Electron Accelerators

A Free Electron Laser (FEL) is the most powerful and brightest existing X-ray source providing angstrom and femtosecond resolution for scientific applications. Currently operating hard x-ray FELs are based on the Self-Amplified Spontaneous Emission (SASE) mechanism. However, a SASE FEL has limited temporal coherence. An improved SASE (iSASE) scheme was proposed and demonstrated which enhances the slippage between the FEL pulse and the electron beam via phase shifters to improve the FEL temporal coherence. The performance of an iSASE scheme depends on the configuration of the phase shifters. In this paper, we use a simulated annealing method and find the optimized phase shifter strength for an iSASE FEL.

010 : LCLS Injector Laser Modulation

Siqi Li
SLAC, Menlo Park, California
Authors: Siqi Li, Dorian Keith Bohler, Alan Stephen Fisher, Sasha Gilevich, Zhirong Huang, Alice Li, Daniel Ratner, Joseph Robinson, Feng Zhou (SLAC, Menlo Park, California), Ralph Fiorito, Eric Montgomery (UMD, College Park, Maryland)
Classification: 2: Photon Sources and Electron Accelerators

In the Linear Coherent Light Source (LCLS) at SLAC, the injector laser plays an important role as the source for the electron beam for the Free Electron Laser (FEL). The injector laser hits a copper photocathode which emits photo-electrons due to photo-electric effect. The emittance of the beam is highly related to the transverse shape of the injector laser. Currently the LCLS injector laser has hot spots that degrade the FEL performance. The goal of this project is to use adaptive optics to modulate the transverse shape of the injector laser, in order to produce a desired shape of electron beam. With a better electron shape, we can achieve lower emittance for the FEL and improve the FEL performance. We first present various options for adaptive optics and damage test results. Then we will discuss the shaping process as an iterative algorithm to achieve desired shape. The desired shape is characterized by Zernike polynomial deconstruction.

011 : Mixing and Space-Charge Effects In Free-Electron Lasers

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Authors: Eduardo Alcides Peter, Antonio Endler, Felipe Barbedo Rizzato (IF-UFRGS, Porto Alegre), Antonio de Padua Brito Serbeto (UFF, Niterói - RJ)
Classification: 2: Photon Sources and Electron Accelerators

Free-electron lasers are devices which efficiently convert the kinetic energy from a relativistic electron beam into electromagnetic radiation, amplifying an initial small sign. The present work revisits the subject of mixing, saturation and space-charge effects in free-electron lasers. Use is made of the compressibility factor, which proves to be a helpful tool in the related systems of charged beams confined by static magnetic fields. The compressibility allows to build a semi-analytical model and to perform analytical estimates of the elapsed time until the onset of mixing, which in turn allows to estimate the saturated amplitude of the radiation field. In addition, the compressibility helps to pinpoint space-charge effects and the corresponding transition from Compton to Raman regimes. The semi-analytical model and the particles simulations are compared, exhibiting a good agreement.

012 : A Research on the Reverse Tapering Method to Gain High Power Polarized Photon Beam with Fixed Wavelength

Chi Hyun Shim
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Authors: Chi Hyun Shim, In Soo Ko (POSTECH, Pohang, Kyungbuk), Jang Hui Han, Yong Woon Parc (PAL, Pohang, Kyungbuk)
Classification: 2: Photon Sources and Electron Accelerators

Polarization of soft X-ray photon can be controlled with combination between helical undulators and planar ones. We need to give a reverse tapering to the planar undulator to make microbunching in the electron beam. In this case, however, resonance wavelengths in each planar undulator are different each other. Therefore, proper initial undulator parameter has to be chosen according to tapering strength to obtain high power polarized photon beam with fixed wavelength. In this paper, method for choosing suitable reverse tapering is presented using simulation results of PAL-XFEL Soft X-ray case with 10 GeV electron beam energy.

013 : Cascaded High Gain Harmonic Generation based on Double-pulse Technique

Zhen Wang
SINAP, Shanghai
Authors: Zhen Wang, Chao Feng, Qiang Gu, Zhentang Zhao (SINAP, Shanghai), Lihua Yu (BNL, Upton, Long Island, New York)
Classification: 2: Photon Sources and Electron Accelerators

Cascaded high gain harmonic generation (HGHG) is the primary candidate for the generation of high power, full temporal coherent radiation at the wavelength of nanometer. However, the experimental results at the existing facility show large fluctuation of the output energy pulse at the second stage of cascading. In this paper, we study the scheme of double-pulse electron beams, which is helpful to increase the stability of pulse energy against the timing jitter. The method to generate double-pulse electron beams is shown in the paper and comparison between double-pulse scheme and standard cascaded HGHG is present base on three-dimensional start-to-end simulation to give a straightforward image on the obviously improvement of the FEL stability.

014 : Formation of Flat Beams with High Transverse Emittance Ratios at Fermilab's ASTA Facility

Aliaksei Halavanau
Northern Illinois University, DeKalb, Illinois
Authors: Philippe Regis-Guy Piot (Fermilab, Batavia, Illinois), Aliaksei Halavanau (Northern Illinois University, DeKalb, Illinois)
Classification: 2: Photon Sources and Electron Accelerators

Flat beams (beams with asymmetric transverse emittance partition) have useful applications in advanced acceleration concept, light sources and linear colliders. The production of flat beams from an angular-momentum-dominated beam produced in a photoinjector provides a simple and versatile technique. An experiment aimed at producing flat beam with very high eminence ratio (~500) is in preparation at ASTA. This paper describes numerical simulation and the experimental setup and diagnostics along with preliminary measurements.

015 : Lattice Design of Low Beta Function at Interaction Point for TTX-II

Tenghui Rui
TUB, Beijing
Authors: Tenghui Rui, Wenhui Huang (TUB, Beijing)
Classification: 2: Photon Sources and Electron Accelerators

TTX-II is a storage ring being designed at Accelerator Laboratory in Tsinghua University as the second phase of Tsinghua Thomson scattering x-ray source (TTX), to increase the average photon flux generated. To achieve a small beta function at the interaction point, four pairs of quadrupole magnets, whose focusing strengths are optimized, are added to the baseline. The lattice design is presented in this work.

016 : Progress on a Compact Accelerator Design for a Compton Light Source

Kirsten Deitrick
ODU, Norfolk, Virginia
Authors: Kirsten Deitrick, Jean Roger Delayen, Bamunuvita Randika Prasad Gamage, Geoffrey Arthur Krafft, Todd Satogata (ODU, Norfolk, Virginia)
Classification: 2: Photon Sources and Electron Accelerators

A compact Compton light source using an electron linear accelerator is in design at the Center for Accelerator Science at Old Dominion University and Jefferson Lab. We report on the current design, including beam properties through the entire system based on a full end-to-end simulation, compare current specifications to design goals, and target areas for improvement.

017 : Design of a Wavelength Tunable Coherent X-Ray Source

Jibong Hyun
Sokendai, Ibaraki
Authors: Jibong Hyun (Sokendai, Ibaraki), Masanori Satoh, Mitsuhiro Yoshida (KEK, Ibaraki), Ken Hayakawa, Yasushi Hayakawa, Takeshi Sakai, Toshinari Tanaka (LEBRA, Funabashi), Isamu Sato (Nihon University, Funabashi), Katsumi Endo (TOYAMA Co., Ltd., Zama-shi, Kanagawa)
Classification: 2: Photon Sources and Electron Accelerators

KEK, Nihon University and TOYAMA CO., Ltd. have been developing the compact shieldless coherent X-ray source that can change the X-ray energy (3-25keV). This X-ray is the Parametric X-ray radiation (PXR) generated by relativistic charged particles passed through a single crystal. It has features that are monochromaticity, coherence and diffraction large angle for the incident beam. These indicate to the possibility for the application to the medical treatment and diagnosis. Furthermore, we try to reduce the radiation which is mainly generated when the high energy beam is damped. This system consists of an accelerating, a decelerating structure and four bending magnets (theta: 90 degree). These structures are operated under low temperature to get the high Q-value for long beam pulse. PXR is generated by colliding with a single crystal after electron beam is accelerated up to 75 MeV. The bunch passed through the crystal is transported into a decelerator structure and then is decelerated to 3 MeV there. Q-magnets are arranged that dispersion function is zero except arc sections. We calculated the beam transport, PXR intensity and emittance blow up. We'll report these details.

018 : Calculation of Channeling Radiation Spectrum for High-Brightness Hard X-ray Production on Fermilab ASTA Photoinjector

Wade Rush
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Authors: Wade Rush, Jack Jicong Shi (KU, Lawrence, Kansas), Tanaji Sen (Fermilab, Batavia, Illinois), Philippe Regis-Guy Piot (Northern Illinois University, DeKalb, Illinois)
Classification: 2: Photon Sources and Electron Accelerators

A series of experiments for the production of high-brightness hard X-rays using channeling radiation will be conducted on Fermilab Advanced Superconducting Test Accelerator (ASTA) photoinjector with beam energy of 20 to 50 MeV . The goal is to create channeling radiation with a spectral brightness of about six orders of magnitude higher than previously achieved. To better understand the experimental measurement and to optimize the channeling radiation, the spectrum of the channeling radiation for the ASTA experiments has been studied numerically for various possibilities of the beamline parameters and the channeling direction. The calculation have been done with and without the planar channeling approximation (one- and two-dimensional calculation of the channeling radiation). Radiation line broadening mechanisms were considered. It is expected that preliminary experimental results will be available for a comparison with the calculation. Such a comparison study between the experiment measurements and model calculation will provide an understanding of the experimental limitations.

019 : Interaction Chamber Design of Sub-MeV Energy Continuously Tunable Laser-Compton Light Source Device (SINAP-III)

Hanghua Xu
SINAP, Shanghai
Authors: Hanghua Xu, Jianhui Chen, Gongtao Fan, Dong Wang, Hailong Wu, Benji Xu, Wang Xu (SINAP, Shanghai)
Classification: 2: Photon Sources and Electron Accelerators

Previously, fixed angle Laser-Compton Scattering (LCS) experiments have been conducted at the terminal of the 100MeV LINAC of the Shanghai Institute of Applied Physics, using SINAP-I and SINAP-II facility. Sub-MeV energy continuously tunable laser-Compton light source device (SINAP-III) is an updated facility that will allow the collision angle between the laser and electron beam continuously adjustable from 20 to 160 degrees. This new feature will enable convenient control on the peak energy of the generated X/γ ray, especially when the energy of electrons cannot be momentarily adjusted, e.g. on the storage ring. The well control of the status of LCS is necessary. An interaction chamber containing a rotatable structure that holds a series of plane mirrors and convex lens is presented to achieve it. This work is a summary of its design. The simulation of photon production's variation caused by the system errors is performed using a MC code. The accuracies of installation and adjustment of mirrors and lens are given according to the simulation results. The sizes of these optical devices are also optimized to make the chamber compact.

020 : The Generation of Highly Intense THz Radiation based on Smith-Purcell Radiation

Yuanfang Xu
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Authors: Yuanfang Xu, Zhigang He, Qika Jia, Weiwei Li (USTC/NSRL, Hefei, Anhui)
Classification: 2: Photon Sources and Electron Accelerators

A photocathode RF gun can generate trains of THz subpicosecond electron bunches by illuminating the cathode with trains of laser pulses. Let this electron bunches passes close to the surface of a lamellar grating, THz radiation will be emitted, which is the so-called Smith-Purcell Radiation (SPR). If the lamellar grating has a narrow groove, this radiation will be narrow-band. By choosing suitable parameter, the SPR frequency can be resonant with the electron bunches frequency, and then generate high intense, narrow band THz radiation.

021 : Study of Cs-Te Photocathode for RF Electron Gun

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Waseda University, Tokyo
Authors: Shuri Matsuzaki, Mariko Nishida, Kazuyuki Sakaue, Masakazu Washio (Waseda University, Tokyo), Hokuto Iijima (Tokyo University of Science, Tokyo)
Classification: 2: Photon Sources and Electron Accelerators

At Waseda University, we have been studying high quality electron beam with an rf electron gun. In recent accelerator study and application researches, high quality electron beam are strongly required. Photocathode is a key component to generate higher quality electron beam generation. Cs-Te photocathode shows high quantum efficiency (Q.E.) (~10%) and has long life time (~several months). From 2013, we built a photocathode evaporation chamber and started photocathode study. In this study, our purpose is to clarify their property and to establish an ideal evaporation recipe. We succeeded in producing high quality Cs-Te photocathode, and electron beam generated by our Cs-Te photocathode shows high charge (4.6nC/bunch) and high Q.E. (1.74%) in our rf electron gun. Furthermore, we found a Q.E. recovery after Cs deposition process and it causes higher Q.E. than usual due to, we believe, Cs deposition quantity or Cs deposition speed. Thus we are now surveying the optimum Cs evaporation parameters. In this conference, we will report a detail of our photocathode development system, the latest progress of optimization study of Cs-Te photocathode and future plans.

022 : Preparation of Polycrystalline and Thin Film Metal Photocathodes for Normal Conducting RF Guns

Sonal Mistry
Loughborough University, Leicestershre
Authors: Sonal Mistry (Loughborough University, Leicestershre), Michael Derek Cropper (Loughborough University, Loughborough, Leicestershire), Keith Middleman, Boris Leonidovich Militsyn, Tim Noakes, Reza Valizadeh (STFC/DL/ASTeC, Daresbury)
Classification: 2: Photon Sources and Electron Accelerators

A comparison of quantum efficiency (QE) and work function (wf) measurements of polycrystalline and thin film metal photocathodes for use in NCRF guns, similar to the S-band gun under development for CLARA project at Daresbury, are reported. Cu and Nb thin films were grown onto a Si substrate by magnetron sputtering and subsequently were prepared by annealing and Ar ion sputtering. To determine the surface chemistry, x-ray photoelectron spectroscopy was employed. QE measurements were enabled using a UV laser source giving 266 nm light. Wf measurements were carried out using a kelvin probe and ultraviolet photoelectron spectroscopy. Annealing the Cu thin film to 250°C yielded a QE of 1.2E-4; one order of magnitude higher than the QE for sputter cleaned and post annealed polycrystalline Cu. The optimum QE measurement for Nb thin film was 2.6E-4, which was found to be comparable to the results obtained for cleaned bulk Nb. Analysis of XPS data of these metals suggest surface composition and surface chemistry are main contributing factors to the QE and WF.

023 : Development of Pulsed Multipole Magnet for Aichi SR Storage Ring

Keiya Ito
Nagoya University, Nagoya
Authors: Keiya Ito, Masahito Hosaka, Atsushi Mano, Takumi Takano, Yoshifumi Takashima, Naoto Yamamoto (Nagoya University, Nagoya), Kenji Hayashi, Masahiro Katoh (UVSOR, Okazaki)
Classification: 2: Photon Sources and Electron Accelerators

The Aichi synchrotron radiation (Aichi SR) center is an industrial oriented synchrotron light source facility. The electron energy and circumference of the storage ring are 1.2 GeV and 72 m. The natural emittance is 53 nm-rad. Since the pulsed multipole injection scheme provides great advantages for relatively smaller SR rings, we are developing a pulsed multipole injection system for Aichi SR storage ring. In this system, it is essential to minimize the perturbation to the stored beam. To realize the required performances, we have to minimize the residual field at stored beam position, taken into account the field generated by the copper current lead of the input terminal. In addition, we carried out the analytical calculation to estimate the magnet field due to the current lead and optimized the geometrical structure of them. Construction of the multipole magnet will be completed in March 2015 and the field measurement will be carried out in April. In this presentation, we report the detail of the magnet design and the measurement results of pulsed magnetic field for the manufactured magnet.

024 : Design and High Power Testing of Hybrid Photonic Band-Gap (PBG) Structure at 17 GHz

JieXi Zhang
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Authors: JieXi Zhang, Alan M. Cook, Brian Munroe, Michael A. Shapiro, Richard J. Temkin, Haoran Xu (MIT/PSFC, Cambridge, Massachusetts)
Classification: 3: Alternative Particle Sources and Acceleration Techniques

Due to frequency selectivity, photonic band-gap (PBG) structures continue to be promising candidates for high-gradient accelerator with excellent inherent wakefield suppression. Experiments at SLAC at 11.4 GHz have demonstrated operation of a single-cavity PBG structure at high gradient with low breakdown probability. Following these studies, a metallic PBG structure has been high power tested at MIT at 17.1 GHz to reach a maximum gradient of 89 MV/m at a pulse length of 100 ns and a breakdown probability of 0.1/pulse/m. We report results on a novel Hybrid metallic-dielectric PBG (HPBG) structure that contains a mixed lattice of sapphire rods in the interior and copper rods at the outer row. The C-axis of the sapphire rods is oriented parallel to the accelerator axis. Rods have been removed from the center to allow beam propagation and from the lattice to provide parasitic modes damping. The HPBG structure has been cold tested and shows a high Q resonance at 17.14 GHz. The first high power testing of the HPBG structure shows a breakdown rate of 0.13/pulse/m at a gradient of 8.8 MV/m for a 80 ns pulse length. Detailed results and breakdown damage will be presented.

025 : Generation and Radiation of PHz Ring-Liked Electron-Pulse Train

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NTHU, Hsinchu
Authors: Fu Han Chao, Chia-Hsiang Chen, Yen-Chieh Huang (NTHU, Hsinchu), Ping Jung Chou (NSRRC, Hsinchu)
Classification: 3: Alternative Particle Sources and Acceleration Techniques

In a superradiant FEL, the constructive interference of the radiation fields from a periodic electron-pulse train rapidly increases the radiation power at the harmonics of the pulse frequency with a narrow spectrum bandwidth. To generate radiation in the X-ray spectrum, the corresponding pulse frequency of the pre-bunched electron beam should be few tens or even few hundreds PHz. The repetition rate of electron pulses generated from an ordinary RF photoinjector is usually at 10-100 Hz. Even though a superconducting RF accelerator could further increase the repetition rate of electron pulses to few MHz, it is far below the pulse frequency required for a superradiant XFEL. In this paper, we study a technique to generate a PHz ring-like electron-pulse train from an RF photoinjector with a spatially modulated driver laser and a structured photocathode. Our simulation in PARMELA confirms the feasibility of generating such a structured electron-pulse train from the photoinjector. We present our study on the beam dynamics of the structured electron-pulse train during acceleration and the radiation behavior of it in the far field in comparison with that of an ordinary electron beam.

026 : Mode Transformation in Waveguide with Transversal Boundary Between Vacuum and Partially Dielectric Area

Aleksandra A. Grigorieva
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Authors: Aleksandra A. Grigorieva, Tatiana Yu. Alekhina, Sergey N. Galyamin, Andrey V. Tyukhtin (Saint-Petersburg State University, Saint-Petersburg)
Classification: 3: Alternative Particle Sources and Acceleration Techniques

One of promising methods in accelerator physics is wakefield acceleration in dielectric structures. One of difficulties of this technique is that existent dielectric structures are not long enough, and a future wakefield accelerator must have a lot of dielectric sections. As well, facilities on the base of dielectric structures are considered as promising for generation of terahertz radiation. In any case, we have to use structures with relatively small length. Thus, the problems of interaction of the fields with transversal boundaries have large important. We study a cylindrical waveguide with a vacuum part and a part having a vacuum channel and a dielectric layer. The problem is considered for the axially symmetrical incident mode (propagating or evanescent) in two cases: (1) the mode falls from the empty part of waveguide to the part with dielectric, and (2) the case of opposite propagation of the incident mode. Analytical investigation is performed and numerical algorithm is constructed. Typical numerical results illustrate reflection, transmission and transformation of modes. Further we consider the field of the particle bunch using the mode expansion technique.

027 : Initial EEX-based Bunch Shaping Experiment Results at the Argonne Wakefield Accelerator Facility

Gwanghui Ha
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Classification: 3: Alternative Particle Sources and Acceleration Techniques

A program is under development at Argonne National Laboratory to use an emittance exchange (EEX) beamline to perform longitudinal bunch shaping (LBS). The double dog-leg EEX beamline was recently installed at the Argonne Wakefield Accelerator (AWA) and the goals of the proof-of-principle experiment are to demonstrate LBS and characterize its deformations from the ideal shape due to higher-order and collective effects. The LBS beamline at the AWA consists of insert-able transverse masks mounted on an actuator and four quadrupoles (to manipulate the transverse phase space) before the EEX beamline, which consists of two identical dog-legs and a deflecting cavity. The mask and input beam parameters are varied during the experiment to explore the shaping capability and clarify the deformation sources and their mitigation. Progress on the commissioning of the LBS beamline, initial experimental data and benchmarks to GPT simulations will be presented.

028 : Interaction of a Volumetric Metallic Metamaterial Structure with a Relativistic Electron Beam

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Classification: 3: Alternative Particle Sources and Acceleration Techniques

We present the design of a volumetric metamaterial(MTM) structure built with a metallic cubic unit cell exhibiting negative dispersion in 3D momentum space. The operating frequency is scaled to 17 GHz. To model the dispersion learned from eigenmode simulation, we develop an effective medium theory with spatial dispersion. Spatial dispersion can have a substantial effect when the structure period is comparable with the wavelength. In our case, the correction from spatial dispersion makes a match between the analytical and numerical results. The interaction of a relativistic electron beam with an array of the unit cells is studied. Radiated energy loss is calculated with the effective medium model, and the beam-structure interaction frequencies agree with the CST result. An electron beam going through a prism-shaped structure generates backward radiation, and this property can be applied to particle diagnostics. This structure is also a candidate for MTM-based wakefield accelerators, since evidence of acceleration on a probe bunch by the wakefield of a driving bunch is found with the PIC code.

029 : Simulation of Laser Pulse Driven Terahertz Generation in Inhomogeneous Plasmas

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Classification: 3: Alternative Particle Sources and Acceleration Techniques

Intense, short laser pulses propagating through plasma generate THz radiation. Full format PIC simulations and theoretical analysis are conducted to investigate two mechanisms of ponderomotively driven THz radiation: transition radiation, and slow wave phase matching enabled by corrugated plasma channels. The first mechanism occurs as a laser pulse crosses a plasma boundary and is analogous to transition radiation emitted by charged particle beams. The THz radiation resulting from this transition radiation mechanism (TRM) is characterized by conical emission and a broad spectrum with the maximum frequency occurring near the plasma frequency. The second mechanism occurs in axially periodic plasma channels. These channels support electromagnetic modes with slow wave (Floquet-type) dispersion, which can be phase matched to the ponderomotive current. The slow wave phase-matched radiation (SWPM) is characterized by lateral emission and a coherent spectrum with sharp modes at frequencies associated with the channel.

030 : Loading of a Plasma Wakefield Accelerator Section Driven by a Self-Modulated Proton Bunch

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Classification: 3: Alternative Particle Sources and Acceleration Techniques

We investigate beam loading of a plasma wake driven by a self-modulated proton bunch using particle-in-cell simulations and parameters from the AWAKE project. We address the case of injection after the proton bunch has already experienced self-modulation in a previous plasma. Optimal parameters for the injected electron beam in terms of initial beam energy and beam charge density are investigated and evaluated in terms of energy transfer from the drive to the witness bunch, as well as witness bunch energy spread and emittance. An approximate modulated proton bunch is emulated in order to reduce computation time in the initial simulations. Optimal parameters from these pre-modulated proton bunch simulations are then used in a full simulation where the proton bunch is allowed to self-modulate, and where the electron bunch is injected when the proton bunch self-modulation is close to saturation.

031 : Positron Beam Excited Wakefields in an Ion-Wake Channel

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Classification: 3: Alternative Particle Sources and Acceleration Techniques

A positron-beam interacting with the plasma electrons drives radial suck-in, in contrast to an electron-beam driven blow-out in the over-dense regime, $n_b > n_0$. In a homogeneous plasma, the electrons are radially sucked-in from all the different radii. The electrons collapsing from different radii do not simultaneously compress on-axis driving weak fields. A hollow-channel allows electrons from its channel-radius to collapse simultaneously exciting coherent fields. Additionally, the low ion density in the hollow allows a larger focusing region. We have shown the formation of an ion-wake channel behind a blow-out electron bubble-wake. Here we explore positron acceleration in the over-dense regime comparing an optimal hollow-plasma channel to the ion-wake channel. The condition for optimal hollow-channel radius in this regime is determined. We also address the effects of a non-ideal ion-wake channel on positron-beam excited fields.

032 : High Reliability, Long Lifetime, Continuous Wave H- Ion Source

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Classification: 3: Alternative Particle Sources and Acceleration Techniques

Phoenix Nuclear Labs (PNL) is developing a high-current, long-lifetime negative hydrogen (H-) ion source in partnership with Fermilab as part of an ion beam injector for future Intensity Frontier particle accelerators. In this application, continuous output with long lifetime and high reliability and efficiency are critical. Existing ion sources at Fermilab rely on plasma-facing electrodes and are limited to lifetimes of a few hundred hours, while requiring relatively high gas loads on downstream components. PNL's H- ion source uses an electrodeless microwave plasma generator which has been extensively developed in PNL's positive ion source systems, demonstrating 1000+ hours of operation and >99% continuous uptime. A magnetic filter preferentially blocks energetic electrons produced in the plasma, while allowing cold electrons and fast neutrals through toward a cesiated surface converter to produce the desired H- ions, which are extracted into a low energy beam using electrostatic lenses. The design specifications are 5-10 mA of continuous H- current at 30 keV with $<$ 0.2 pi-mm-mrad beam emittance. Construction and testing of the H- ion source is underway at PNL.

033 : Design of a Microwave Frequency Sweep Interferometer for Plasma Density Measurements in ECR Ion Sources

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Classification: 3: Alternative Particle Sources and Acceleration Techniques

Electron Cyclotron Resonance Ion Sources (ECRIS) are among the candidates to support the growing request of intense beams of multicharged ions. Their further development is related to the availability of new diagnostic tools, nowadays consisting of few types only of devices designed on purpose for such compact machines. Microwave Interferometry is a non-invasive method for plasma diagnostics and represents the best candidate for the whole plasma density measurements. Interferometry in ECR Ion Sources is a challenging task due to their compact size. The typical density range of ECR plasmas (10^{11}-10^{12} cm^{-3}) causes the probing beam wavelength to be in the order of few centimetres, which is comparable to the chamber radius. The paper describes the design of a new microwave interferometer based on the so-called "frequency sweep" method: the density is here derived by the frequency shift of a beating signal obtained during the fast sweep of both probing and reference microwave signals; inner cavity multipaths contributions can thereby be suppressed by cleaning the spurious frequencies from the beating signal spectrum.

034 : A Transport Beam Line Solution for Laser-Driven Proton Beams

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Classification: 3: Alternative Particle Sources and Acceleration Techniques

Nowadays laser-target interaction represents a very promising field for several potential applications, from nuclear physics to medicine. However optically accelerated particle beams are characterized by an high peak current, a non shot-to-shot reproducibility and a wide energy and angular distribution. These features could be issues for many applications without a suitable transport beam line or a laser-target interaction optimization. In particular this contribution reports about a beam line solution, that will be one of the optional beam line of the hadrontherapy advanced example at the next Geant4 relise. The proposed beamline consist of two sections: a quadrupoles focusing device and an energy selector system. Different simulations have been performed using, as input, a typical laser-driven proton beam with different angular distributions. Reported data are related to the best configuration for the 5 MeV proton transmission, characterized by a 5% FWHM and a maximum divergence of 1 deg. The quadrupoles relative distances have been optimazed in order to have as output a controlled proton beam in terms of energy and angular distributions with the maximum transmission efficiency.

035 : Cathode Performance during Two Beam Operation of the High Current High Polarization Electron Gun for eRHIC

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Classification: 3: Alternative Particle Sources and Acceleration Techniques

Two electron beams from two activated bulk GaAs photocathodes were successfully combined during the recent beam test of the High Current High Polarization Electron gun for eRHIC. The beam test took place at Stangenes Industries in Palo Alto, CA, where the cathodes were placed in diagonally opposite locations inside the high voltage shroud. No significant cross talking between the cathodes was found for the pertinent vacuum and low average current operation, which is very promising towards combining multiple beams for higher average current. This paper details the preparation, transport and cathode performance in the gun for the combining test, including the QE and lifetimes of the photocathodes at various steps of the experiment.

036 : Analytical Study on Emittance Growth caused by Roughness of a Metallic Photocathode

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Authors: Zhe Zhang, Chuanxiang Tang (TUB, Beijing)
Classification: 3: Alternative Particle Sources and Acceleration Techniques

The roughness of a photocathode could lead to an additional uncorrelated divergence of the emitted electrons and therefore to an increased thermal emittance. We demonstrate an analytical method, which is inspired by the point spread function (PSF) that has been widely used in radiation imaging field, to accurately evaluate the emittance growth due to the random roughness of a real-life cathode. Both analytical and numerical studies are performed. Our analytical formulas clearly reveal the relationship between the surface roughness and the emittance growth. Both analytical and numerical results surprisingly show that in typical 3-D random surface case, the influence of the surface roughness on the emittance growth is much smaller than 2-D sinusoidal case, even with an external rf source of which the effective field strength is up to 120MV/m, the total emittance growth is still below 10%. It implies that, the large emittance growth (50% – 100%) observed on rough cathodes in some experiments which is generally believed to be the result of the electric field on the rough surface, might be due to some other reasons.

037 : Design of a Proton Travelling Wave Linac with a Novel Tracking Code

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Classification: 4: Hadron Accelerators

In the framework of the TULIP project, a non-relativistic proton linac based on high gradient backward travelling wave accelerating structures was designed using a novel 3D particle tracking code developed for this purpose. Together with the specific RF design approach adopted, the choice of a 2.9985 GHz backward travelling wave structure with 150° RF phase advance per cell was driven by the goal of reaching an accelerating gradient of 50 MV/m, which is more than twice that achieved so far. This choice dictated the need to develop a new code capable of tracking charged particles through travelling wave structures which were never used before in proton linacs. Nevertheless the new code has the capability of tracking particles through any kind of accelerating structure, given its real and imaginary electromagnetic field map. After an introduction on the code features and benchmarking, the linac optimization and design are presented. This project opens a completely new field in the design of compact linac for proton therapy, possibly leading to cheap and widespread single room facilities for cancer treatment.

038 : Proposal for a 72.75 MHz RFQ for the LINCE Accelerator Complex

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Classification: 4: Hadron Accelerators

The LINCE facility front-end includes a 72.75 MHz normal-conducting RFQ designed to achieve 450 keV/u output energy for ions with A/Q from 1 to 7 in about 5 m length. The vanes have been electromagnetically designed to accommodate dedicated windows producing effective separation of the resonance modes in an octagonal-shaped resonator and to reduce the overall transverse dimensions. This article outlines the optimization of the quality factor of the cavity by using numerical methods for electromagnetic and thermal calculations, as well as particle tracking studies to optimize bunching and acceleration. Experimental RF tests carried out on a prototype resonator are also discussed.

039 : Development of a 325 MHz Ladder-RFQ of the 4-Rod Type

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Classification: 4: Hadron Accelerators

For the research program with cooled antiprotons at FAIR a dedicated 70 MeV, 70 mA proton injector is required. In the low energy section, between the Ion Source and the main linac an RFQ will be used. The 325 MHz RFQ will accelerate protons from 95 keV to 3.0 MeV. This particular high frequency for an RFQ creates difficulties, which are challenging in developing this cavity. In order to define a satisfactory geometrical configuration for this resonator, both from the RF and the mechanical point of view, different designs have been examined and compared. Very promising results have been reached with a ladder type RFQ, which has been investigated since 2013. We present recent 3D simulations of the general layout and of a complete cavity demonstrating the power of a ladder type RFQ as well as measurements of a 0,8 m prototype RFQ, which was manufactured in late 2014 and designed for RF power and vacuum tests. We will outline a possible RF layout for the RFQ within the new FAIR proton injector and highlight the mechanical advantages.

040 : Optimization of Orbits, SRF Acceleration, and Focusing Lattice for a Strong-Focusing Cyclotron

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Classification: 4: Hadron Accelerators

The strong-focusing cyclotron is a high-current proton/ion accelerator in which superconducting rf cavities are used to provide enough energy gain per turn to fully separate orbits, and arc-shaped beam transport channels are located in the sector dipole aperture to provide strong focusing of all orbits. An optimization method has been devised by which the orbit separations can be adjusted to provide sufficient separation while maintaining isochronicity on all orbits. The transport optics of the FD lattice is also optimized to provide stable transport and to lock the betatron tunes to a favorable value over the full range of acceleration.

041 : CADS 650 MHz beta=0.63 Elliptical Cavity Study and Design

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Classification: 4: Hadron Accelerators

China is developing the Accelerator Driven Sub-critical System (ADS), whose objective is the safe disposal of nuclear waste and provision of electric power. The option to accelerate the proton bunch in the medium energy range is to utilize the 650 MHz β=0.63 and the β=0.82 superconducting cavity. A 650 MHz β=0.63 superconducting cavity was studied and designed for the energy range from 180 MeV to 360 MeV. The radio-frequency properties, damping of the higher order modes, multipacting and mechanical features of this cavity have been discussed and the design is presented.

042 : Towards an RF Wien-Filter for EDM Experiments at COSY

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Classification: 4: Hadron Accelerators

The JEDI Collaboration (Jülich Electric Dipole Moment (EDM) Investigations) is developing tools for the measurement of permanent EDMs of charged, light hadrons in storage rings. While the standard model prediction for the EDM gives unobservably small magnitudes, a non-vanishing EDM can lead to a tiny build-up of vertical polarization in a beforehand horizontally polarized beam. This requires a spin tune modulation by an RF Dipole without any excitation of beam oscillations . In the course of 2014, a prototype RF ExB-Dipole has been successfully commissioned and tested. To determine the characteristics of the device, the force of a radial magnetic field has been canceled out by a vertical electric one. In this configuration, the dipole fields form a Wien-Filter that directly rotates the particles' polarization vector. We verified that the device can be used to continuously flip the vertical polarization of a 970 MeV/c deuteron beam without exciting any coherent beam oscillations. For a first EDM Experiment, the RF ExB-Dipole in Wien-Filter Mode is going to be rotated by 90° around the beam axis and will be used for systematic investigations of sources for false EDM signals.

043 : Tracking Simulations towards EDM Measurements at COSY

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Classification: 4: Hadron Accelerators

Electric Dipole Moments (EDMs) violate parity and time reversal symmetries. Therefore, direct measurements of charged particles' EDMs would be a strong hint for physics beyond the Standard Model. The JEDI collaboration investigates the feasibility of such measurements for protons, deuterons, and Helium-3 in storage rings. Precursor studies are performed at the existing conventional Cooler Synchtrotron COSY in Jülich. A measurement time of about 1000 seconds is proposed. This requires a setup providing a long spin coherence time in the plane perpendicular to the invariant spin axis. During the measurement run, it is planned to use radiofrequency devices to create an EDM related signal. The contribution of imperfections, which could mimic such a signal, is explored in beam and spin dynamics simulations. The software framework COSY INFINITY is used to calculate transfer maps of the magnets and performs long term tracking studies. Recent efforts extend the code by the EDM contribution to spin motion and by the calculation of time-dependent maps required for tracking in non-static fields. These enhancements are benchmarked with analytical predictions and with test measurements at COSY.

044 : LEBT Dynamics and RFQ Injection

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Classification: 4: Hadron Accelerators

The Low Energy Beam Transport (LEBT) section at the accelerator-driven neutron source FRANZ consists of four solenoids, two of which match the primary proton beam into the chopper. The remaining two solenoids are intended to prepare the beam for injection into the RFQ. In the first commissioning phase, the LEBT was successfully used to transport a 14 keV He+ beam at low intensities. In the next commissioning phase, the beam energy is currently being increased to the RFQ injection energy of 120 keV. In the upcoming step, the intensity will be increased from 2 mA to 50 mA. Beam dynamics calculations include effects of different source emittances, position and angle offsets and the effects of space charge compensation levels. In addition, the behaviour of the undesired hydrogen fractions, H2+ and H3+, and their influence on the performance within the RFQ is simulated.

045 : Massless Beam Separation System for Intense Ion Beams

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Classification: 4: Hadron Accelerators

The ExB chopper in the Low Energy Beam Transport (LEBT) section of the accelerator-driven neutron source FRANZ will form the required pulses with a repetition rate of 257 kHz out of the primary 120 keV, 50 mA DC proton beam. A following beam separation system will extract the deflected beam out of the beamline and minimize the thermal load by beam losses in the vacuum chamber. To further avoid an uncontrolled production of secondary particles, a novel massless septum system is designed for the beam separation. The septum system consists of a static C-magnet with optimized pole shapes, which will extract the beam with minimal losses, and a magnetic shielding tube, which will shield the transmitted pulsed beam from the fringing field of the dipole. The magnetic field and the beam transport properties of the system were numerically investigated. A main deflection field of about 250 mT was achieved, whereas the fringing field was reduced to below 0.3 mT on the beam axis at 60 mm distance from the dipole. With this settings, the beam was numerically transported through the system with minimal emittance growth. Manufacturing of the septum system has started.

046 : SPS-to-LHC Transfer Lines Loss Map Generation Using PyCollimate

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Classification: 4: Hadron Accelerators

The Transfer Lines (TL) linking the Super Proton Synchrotron (SPS) to the Large Hadron Collider (LHC) are both equipped with a complete collimation system to protect the LHC against mis-steered beams. During the setting up of these collimators, their gaps are positioned to nominal values and the phase-space coverage of the whole system is checked using a manual validation procedure. In order to perform this setting-up more efficiently and more reliably, the simulated loss maps of the TLs will be used to validate the collimator positions and settings. In this paper, the simulation procedure for the generation of TL loss maps is described, and a detailed overview of the new scattering routine (PyCollimate) is given. Finally, the results of simulations and measurement are compared.

047 : Tomography of Horizontal Phase Space Distribution of a Slow Extracted Proton Beam in the MedAustron High Energy Beam Transfer Line

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Classification: 4: Hadron Accelerators

The MedAustron accelerator is dedicated to medical therapy with proton and carbon ion beams and research. A phase-shifter-stepper module as proposed by M. Benedikt et.al. is located in the high energy beam transfer line connecting the synchrotron and the irradiation rooms. This module is composed of six quadrupole magnets powered by independent power supplies. Its function is to adapt the horizontal phase advance in the extraction line and the vertical beta function at the irradiation point in the irradiation rooms. The slow-extracted beam has a non-gaussian phase space distribution in the plane of extraction (horizontal plane) called "bar of charge", caused by the nature of a third order slow resonant extraction. Using the phase-shifter-stepper to rotate the bar in horizontal phase space and measuring the profiles downstream the module, the particle density distribution can be computed by a tomography algorithm. The setup of the measurement as well as tomograms using different reconstruction algorithms are presented. Furthermore this method was used to verify the telescope setup of the transfer line, projecting optical parameters from one point in the transfer line to another.

048 : Simulation Studies of Plasma-based Charge Strippers for Heavy Ion Beams

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Classification: 4: Hadron Accelerators

Charge stripping of intense heavy ion beams is a major challenge in current and future linear heavy ion accelerators. Conventional stripping techniques are limited in their applicability, e.g. solid carbon foils suffer from short lifetimes at high intensities. One possible alternative is the use of a plasma as a stripping medium, which the presented work focuses on. The main goal of the studies is the prediction of the final charge state distribution of the ion beam. Rate equations were implemented numerically, taking into account different models for ionization, recombination and energy loss processes. The limits and applicability of simplified models, e.g. for ionization cross sections, are discussed. First quantitative results are presented in form an overview of the charge state distributions of different - conventional and novel - charge stripping media. Furthermore comparisons are performed with charge state distributions obtained from different pinch experiments at GSI. Future studies intend to include detailed models for the plasma conditions and beam optics. This includes, e.g., the implosions process of pinch plasmas and the detailed plasma parameters along the beam axis.

049 : Uniformization of the Transverse Beam Profile by a New Type Nonlinear Magnet

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Classification: 5: Beam Dynamics and EM Fields

The uniform particle beam is desirable in many beam applications. One method to get this type of beam distribution is using octupoles, but loss of particles in the halo will be produced by this method. To reduce the beam loss, a new type of magnet is proposed in this paper. The field in the middle region of the new type magnet is similar to the octupole magnet field, but the rate of rise decline quickly in the edge. So that the particle in the edge experience a lower magnet field, and this would result in less particle loss. We also add a mechanical structure on the new type magnet to make it possible to adjust the size of middle region. So that the magnet can adapt to different transverse dimensions of the beam, and this would further reduce particle loss. Some numerical simulations have been done respectively with octuples and the new type of magnet. The simulation results show that the new type of magnet could get the uniform distribution of particle beam with less particle loss. We are processing a magnet now, and an experiment to test the magnet will be arranged on CPHS.

050 : Optics Measurement using the N-BPM Method for the ALBA Synchrotron

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Classification: 5: Beam Dynamics and EM Fields

The N-BPM method recently developed for the LHC has significantly improved the precision of optics measurements which are based on beam position monitor (BPM) turn-by-turn data. The main improvement is owed to the consideration of correlations for statistical and systematic error sources, as well as increasing the amount of BPM combinations for one measurement. We present how this technique can be applied at light sources like ALBA, and compare the results with other methods.

051 : Towards Ultra-Low beta* in ATF2

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Classification: 5: Beam Dynamics and EM Fields

The Accelerator Test Facility 2 (ATF2) has already demonstrated the feasibility of Final Focus Systems based on the local chromaticity correction scheme and its focusing capabilities by reaching a vertical beam size at the virtual Interaction Point (IP) of less than 50 nm. The value of the chromaticity in ATF2 is comparable with the expected chromaticity in ILC, but 4 times lower than in a design of CLIC. ATF2 gives the unique possibility to test operation at CLIC chromaticity values by reducing the vertical beta function at the IP by a factor of 4 (the inverse proportionality of chromaticity with beta function value at IP is assumed). The experience collected in this way would be beneficial for both ILC and CLIC projects. Simulations show that the multipolar errors and Final Doublet fringe fields spoil the IP beam sizes at ATF2. Either increasing a value of the horizontal beta function or installing a pair of octupole magnets mitigate the impact of these aberrations. This paper summarizes the studies towards the realization of the ultra-low beta* optics in ATF2 and reports on the progress of the construction of the octupoles.

052 : Experiments and Simulations in Support of Octupole Lattice Studies at the University of Maryland Electron Ring

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Classification: 5: Beam Dynamics and EM Fields

We present plans for a nonlinear lattice at the University of Maryland Electron Ring (UMER). Conventional corrective sextupoles and octupoles are perturbations to a linear lattice, which can lead to chaotic regions in phase space and loss of dynamic aperture. Theory predicts that a strong nonlinear lattice can limit resonant behavior without reducing dynamic aperture if nonlinear magnets are employed in a way that preserves integrability or quasi-integrability. We discuss plans for a quasi-integrable octupole lattice, based on the work of Danilov and Nagaitsev. We use the Elegant code to find a nonlinear lattice solution, modifying the UMER FODO lattice to accommodate octupoles. We also use Elegant to estimate the octupole-induced tune spread, and the WARP PIC code to simulate the proposed lattice with space charge and predict experiment sensitivity. We also discuss preliminary phase space mapping experiments with the existing FODO lattice, which will be used to characterize the octupole lattice. Finally, we discuss improvements to the ring in support of octupole lattice experiments, including generation and detection of low-current ($v/v0 \sim 0.96$) beams.

053 : Proposed Cavity for Reduced Slip-stacking Loss

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Classification: 5: Beam Dynamics and EM Fields

This paper employs a novel dynamical mechanism to improve the performance of slip-stacking. Slip-stacking in an accumulation technique used at Fermilab since 2004 which nearly double the proton intensity. During slip-stacking, the Recycler or the Main Injector stores two particles beams that spatially overlap but have different momenta. The two particle beams are longitudinally focused by two 53 MHz 100 kV RF cavities with a small frequency difference between them. We propose an additional 106 MHZ 20 kV RF cavity, with a frequency at the double the average of the upper and lower main RF frequencies. In simulation, we find the proposed RF cavity significantly enhances the stable bucket area and reduces slip-stacking losses under reasonable injection scenarios. We quantify and map the stability of the parameter space for any accelerator implementing slip-stacking with the addition of a harmonic RF cavity.

054 : Influence of the Alignment of the Main Magnets on Resonances in the CERN Proton Synchrotron

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Classification: 5: Beam Dynamics and EM Fields

During the Long Shutdown 1 seven out of the one hundred combined function PS main magnets were removed from the tunnel to conduct maintenance. After reinstallation, the main magnets were aligned to the reference positions and within the first week of operation of the accelerator, a beam-based re-alignment campaign was performed to reduce the excursions of the closed orbit. In order to further investigate and understand the source of betatronic resonances, which, already in 2011, were found to be excited by the bare machine, tune diagram measurements before and after this beam-based magnet alignment were conducted. In both cases the same resonances as in 2011 were found to be present; however, after the alignment, an overall increase of their strengths was observed. In this paper we present the corresponding measurement results and discuss the direct impact on the daily operation of the accelerator.

055 : Single and Multi-bunch End-to-end Tracking in the LHeC

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Classification: 5: Beam Dynamics and EM Fields

The LHeC study aims at delivering an electron beam for collision with the LHC proton beam. The current baseline design consists of a multi-pass superconductive energy-recovery linac operating in a continuous wave mode. The high current beam (~100 mA) in the linacs excites long-range wake-fields between bunches of different turns, which induce instabilities and might cause beam losses. PLACET2, a novel version of the tracking code PLACET, capable to handle recirculation and time dependencies, has been employed to perform the first LHeC end-to-end tracking. The impact of long-range wake-fields, synchrotron radiation, and beam-beam effects has been assessed. The simulation results and recent improvements in the lattice design are presented and discussed in this paper.

056 : Beam Impedance Optimization of the TOTEM Roman Pots

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Classification: 5: Beam Dynamics and EM Fields

The TOTEM experiment has been designed to measure the total proton-proton cross section and to study elastic and diffractive scattering at the LHC energy. The measurement requires detecting protons at distances as small as 1 mm from the beam centre: TOTEM uses Roman Pots (RP), movable beam pipe insertions, hosting silicon detectors. In the first period of running of the LHC no problems were detected with retracted Roman Pots and during insertions in special runs; however, during close insertions to highest intensity beam, impedance heating has been observed. After the LS1 the LHC beam current will increase and the equipment that can interact with the beam needed to be optimized. A new version of the RP has been optimized in view of beam coupling impedance with the help of CST Particle Studio; a prototype has been used to test the simulation results in the laboratory with wire and probe measurements. Furthermore, in both the old and the new RPs, new ferrites have been installed. The new ferrite material has a higher Curie temperature than the one used before LS1 and a thermal treatment at 1000°C has been applied to reduce the outgassing.

057 : Instability Thresholds and Tune Shift Estimation for Sirius

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Classification: 5: Beam Dynamics and EM Fields

In this work we present the estimation of longitudinal and transverse instabilities thresholds and tune shifts for Sirius, using time and frequency domain codes which take into account the effect of the bunch by bunch feedback system, quadrupolar impedances from undulators chambers, tune spreads and non-uniform filling pattern on the beam stability. Also, preliminary studies of ion instabilities and mitigation possibilities will be discussed.

058 : CSR Induced Microbunching Gain Estimation including Transient Effects in Transport and Recirculation Arcs

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Classification: 5: Beam Dynamics and EM Fields

The coherent synchrotron radiation (CSR) of a high brightness electron beam traversing a series of dipoles, such as transport or recirculation arcs, may result in the microbunching instability (μBI). To accurately quantify the direct consequence of this effect, we further extend our previously developed semi-analytical simulation [C. -Y. Tsai et al., FEL Conference 2014 (THP022)] to include more relevant coherent radiation models than the steady-state free-space CSR impedance, such as the entrance and exit transient effects, which derive from upstream beam entering to and exiting from individual dipoles and propagating across the elements to downstream straight sections. Then we semi-analytically solve the linearized Vlasov equation for the amplification factor. The resultant gain functions and spectra for our example lattices are presented and compared with particle tracking simulation. Some underlying physics with inclusion of these effects are also discussed.

059 : Comparison of Measurements and Simulations for Single Bunch Instability at Diamond

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Classification: 5: Beam Dynamics and EM Fields

The single bunch dynamics in the Diamond storage ring has been analysed with a multiparticle tracking code and compared with the results of a wealth of diagnostics, including streak camera, Schottky diodes and FTIR spectra. The interplay of various wakefield sources has been studied and it has been found that the THz spectrum can be reproduced in many cases with simple impedance models, both below and above the bursting threshold.

060 : Secondary Electron Yield Measurement and Electron Build-up Simulation at Fermilab

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Classification: 5: Beam Dynamics and EM Fields

An upgrade to the Fermilab injector complex is planned to increase the number of particles per bunch to about three times the present level so as to provide increased intensity for the neutrino physics program. This increase would place the Main Injector (MI) and the Recycler Ring (RR) in a parameter regime where other storage rings have experienced electron cloud effects. Simulations have been done in the past to assess the magnitude of electron cloud effects under various conditions in the MI[ref]. These simulations have been extended to the Recycler Ring, which is now being used to temporarily store the proton beam. A summary of the new simulation results obtained with the code POSINST[], and certain benchmarks against measurements are reported. Results for the RR are also compared to those for the MI.

061 : Simulations and Measurements of Longitudinal Coupled-Bunch Instabilities in the CERN PS

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Classification: 5: Beam Dynamics and EM Fields

Within the LHC Injectors Upgrade (LIU) project the beam intensity is expected to double for LHC-type beams in the CERN PS. A known limitation to achieve the required high intensity is caused by longitudinal coupled-bunch oscillations above transition energy. The unwanted oscillations induce large longitudinal emittance and bunch-to-bunch intensity variations not compatible with the specifications of the future LHC-type beams. A longitudinal damper to suppress these instabilities has been installed and is going to be commissioned. A measurement campaign of coupled-bunch oscillations has been launched to substantiate the extrapolations and predictions for the future HL-LHC-type beams and to determine the maximum intensity that could be provided to the LHC. In parallel, simulations with a new longitudinal multi-bunch tracking code have been performed to understand and predict the machine behaviour in the parameter space of LIU. These simulations also serve as an auxiliary tool for the commissioning and the operation of the feedback system.

062 : Longitudinal Injection Schemes For the CERN PS Booster at 160 MeV Including Space Charge Effects

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Classification: 5: Beam Dynamics and EM Fields

In the frame of the LHC Injectors Upgrade project, the CERN PS Booster will be equipped with a H- inj system at 160 MeV to tailor the initial transverse and longitudinal profiles. We are here reviewing the different multi-turn longitudinal injection schemes, from the beam dynamics point of view, taking into account the needs of the large variety of the PSB users, spanning in intensity from 5e9 to about $1.6\text{x}10^{13}$ protons per bunch. The baseline of the longitudinal injection has always been the longitudinal stacking with central energy modulation: this scheme has the advantage of filling uniformly the RF bucket and mitigate transverse space charge, but it requires at least 40 turns of injection. A simpler injection protocol without energy modulation is also analyzed to find the optimum initial conditions in terms of bucket filling and reduction of transverse and longitudinal space charge effects, with the advantage of minimizing the number of turns for the LHC beams. Simulations with space charge of the longitudinal capture process from different Linac4 trains are presented to fix possible longitudinal injection scenarios during the future commissioning and operation with Linac4.

063 : Simulation of Beam-Induced Plasma for the Mitigation of Beam-Beam Effects

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Classification: 5: Beam Dynamics and EM Fields

One of the main challenges in the increase of luminosity of circular colliders is the control of the beam-beam effect. In the process of exploring beam-beam mitigation methods using plasma, we evaluated the possibility of plasma generation via ionization of neutral gas by proton beams, and performed highly resolved simulations of the beam-plasma interaction using SPACE, a 3D electromagnetic particle-in-cell code. The process of plasma generation is modeled using experimentally measured cross-section coefficients and a plasma recombination model that takes into account the presence of neutral gas and beam-induced electromagnetic fields. Numerically simulated plasma oscillations are consistent with theoretical analysis. In the beam-plasma interaction process, high-density neutral gas reduces the mean free path of plasma electrons and their acceleration. A numerical model for the drift speed as a limit of plasma electron velocity was developed. Simulations demonstrate a significant reduction of the beam electric field in the presence of plasma. Simulations using fully-ionized plasma have also been performed and compared with the case of beam-induced plasma.

064 : RFQ Beam Dynamics Design of PKUNIFTY Upgrade

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Classification: 5: Beam Dynamics and EM Fields

The PKUNIFTY (Peking University neutron imaging facility), a RFQ based neutron source, aims to develop medical and industrial applications. During the past 3 years operation, some problems have appeared, such as RF sparking for the RFQ high power operation, full power level instability of RF transmitter, and the misalignment of RFQ electrodes assembling and deformation. The PKUNIFTY upgrade try to adopt a modest inter-voltage beam dynamics, the stronger mini-vane copper plated stainless electrodes to decrease the deformation. A unique beam dynamics design of 201.5 MHz RFQ of PKUNIFTY, which accelerates 60 mA of D+ from 50 keV to 1.6 MeV at 10% duty factor, has been performed in this study. The D+ time-averaged current will be about 5 mA on the 10% duty factor. The source will deliver a fast neutron yield of 2.0×10^{12} (n/sec), which is about 10 times higher than the current status.

065 : Simulation of Laser Cooling of Heavy Ion Beams at High Intensities

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Classification: 5: Beam Dynamics and EM Fields

In the past the principle of Doppler laser cooling was investigated and verified in storage rings in the low energy regime. Within the FAIR project the laser cooling will be applied to high intensity and high energy beams for the first time. The laser cooling results in a further increase of the longitudinal phase space density and in non-Gaussian longitudinal beam profiles. In order to ensure stable operation and optimize the cooling process the interplay of the laser force and high intensity effects has to be studied numerically. This contribution will identify constrains of the cooling scheme for an efficient reduction of momentum spread. For high beam energies the scattering of photons has to be treated stochastically instead of using averaged forces. The modeling of the laser force in a particle in cell tracking code will be discussed.

066 : EEX Beam Line Design In THU Accelerator Lab

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Classification: 5: Beam Dynamics and EM Fields

Emittance exchange (EEX) provides a novel tool to enhance the phase space manipulation techniques. Based on Tsinghua Thomson scattering experimental platform, this study presented a beam line design for exchanging the transverse and longitudinal emittance of an electron bunch. This beam line consists of a 2.856 GHz half-one-half cell deflecting cavity with no axis offset and two doglegs. In this paper, by optimizing the beam envelope parameter for Tsinghua Thomson scattering source, we report the theoretical analysis and a good particle tracking simulation result about emittance exchange and longitudinal shaping.

067 : Status of the Robinson Wiggler Project at the Metrology Light Source

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Classification: 5: Beam Dynamics and EM Fields

The Metrology Light Source (MLS), situated in Berlin (Germany) is owned by the Physikalisch-Technische Bundesanstalt and was built / is operated by the Helmholtz-Zentrum Berlin. It is an electron storage ring operating from 105 MeV to 630 MeV and serves as the national primary source standard from the near infrared to the extreme ultraviolet spectral region. The lifetime at the MLS is dominated by the Touschek effect. By installing a Robinson Wiggler, the bunches can be lengthend, as damping is transferred from the longitudinal to the horizontal plane. A considerable increase in lifetime seems achievable, while preserving the source size. The status of the project will be presented together with studies on dynamic aperture effects and synchrotron radiation characteristics of the device.

068 : Beam Dynamics Studies to Develop a High-Energy Luminosity Model for the LHC

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Classification: 5: Beam Dynamics and EM Fields

Luminosity, the key figure of merit of a collider as the LHC, depends on the brightness of the colliding beams. This makes the intensity dependent beam-beam effect the dominant performance limiting factor at collision. The parasitic interactions due to the electromagnetic mutual influence of the beams in the interaction region of a collider induce a diffusive behaviour in the tails of the beam. The evolution of charge density distribution is studied to model the beam tails evolution in order to characterize beam lifetime and luminosity. To achieve this, tools are developed for tracking distributions of arbitrary number of single particles interacting with the opposing strong-beam, to analyse the halo formation processes due to the combined effect of beam-beam and machine non-linearities. This paper presents preliminary results of the simulations, both for the LHC Run I and nominal LHC parameters. The former will be used to benchmark simulations while the latter aims at supporting luminosity estimate for the Run II.

069 : Analytical Approach to the Beam-Beam Interaction with the Hourglass Effect

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The HL-LHC upgrade will allow higher luminosities to be reached in the LHC. To achieve higher luminosities the β-function at the IP is decreased, which in turn will result in the hourglass effect becoming more prominent as the transverse bunch sizes become comparable to the length of the bunch. This effect reduces the luminosity since not all particles in the bunch will collide at the minimum IP. The standard derivation of the electric and magnetic fields of the beam-beam interaction is that undertaken by Bassetti and Erskine. The derivation by Bassetti Erskine does not include a coupling between bunch planes. When the transverse bunch sizes are comparable to the length of the bunch the magnitude of the transverse kick will be dependent on the longitudinal position. Currently only numerical methods are available to evaluate this effect. Here a theoretical framework is outlined that provides an analytical approach to derive the electric field for the beam-beam interaction with a coupling between the transverse and longitudinal planes.

070 : Smooth Fast Multipole Method for Space Charge Tracking: An Alternate to Particle-In-Cell

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Classification: 5: Beam Dynamics and EM Fields

The fast multipole method (FMM) algorithm was developed by Greengard and Rokhlin in 1987. As one of the top ten algorithms of the 20th century, it has been applied in a wide range of fields. The FMM complexity is O(N), where N is the number of articles, allowing for large-scale simulations. However, it includes all the two-body collisional forces, in contrast to other methods such as the popular particle in-cell (PIC) methods. While collisionality can be very important, many applications require only the mean field effects. PIC is frequently used in this regime. Due to recent concerns of unphysical effects of grids, interpolation and other approximations in PIC codes, an alternative based on different underlying assumptions would prove enlightening. For these cases, a smoothed or softened FMM using a Plummer-like smoothing parameter holds much promise. Unfortunately, the original FMM based on analytic expansions of the 1/r-like potentials does not allow for Plummer softening. We present our new soft-FMM employing differential algebras (DA) to obtain the modified expansions. We also compare the performance of the smoothed DA-FMM with examples from PIC simulations.

071 : Start-to-end Simulation of Free-electron Lasers

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Classification: 5: Beam Dynamics and EM Fields

Start-to-end (S2E) modeling of free-electron lasers (FELs) normally requires the use of multiple codes to correctly capture the physics in each region of the machine. Codes such as PARMELA, IMPACT-T or MICHELLE may be used to simulate the injector. From there the linac and transport line may be handled by codes such as DIMAD, ELEGANT or IMPACT-Z. Finally, at the FEL a wiggler interaction code such as GENESIS, GINGER, or MINERVA must be used. These codes may be optimized to work with a wide range in magnitude of macro-particle numbers (from 10^4-10^8 in different codes) and have different input formats. It is therefore necessary to have translator codes to provide a bridge between each section. It is essential that these translators be able to preserve the statistical properties of the bunch while raising or lowering the number of macro-particles used between codes. In this work we show a suite of such translators designed to facilitate S2E simulations of an FEL with a new wiggler code, MINERVA, and use these codes to provide benchmarking of MINERVA against other common wiggler simulation codes.

072 : Nonequilibrium Phase Transitions in Crossed-Field Devices

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Classification: 5: Beam Dynamics and EM Fields

This work presents a fully kinetic description to model the electron flow in the electronic crossed-field configuration observed in a smooth-bore magnetron. Through this model, it has been observed that, according to the electromagnetic field, the injection temperature and the charge density, the electron flow can be classified in two different stationary modes: magnetic insulation mode where most of the electrons returning to the cathode after a transient time and Child-Langmuir mode where most of the electrons reach the anode after a transient time. Focusing on magnetic insulated mode, it has been found that charge density and injection temperature define whether electrons are accelerated (accelerating regime) or decelerated (space-charge limited regime) on the cathode. Besides, when the injection temperature is relatively low (high), a small charge increase causes (does not cause) an abrupt transition between accelerating and space-charge limited regime. Basing on the results, it was possible to identify a critical temperature that separates abrupt and continuous behavior. The results have been verified by using self-consistent computer simulations.

073 : SPACE Code for Beam-Plasma Interaction

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Classification: 5: Beam Dynamics and EM Fields

Understanding interactions of highly relativistic particle beams with plasma is important for many applications, in particular for muon beam phase space cooling and suppression of beam-beam interaction. We have developed novel algorithms for the electromagnetic particle-in-cell (EM-PIC) code SPACE for the simulation of beam-plasma interaction. The algorithms include atomic processes in the plasma, repetitive multiple beam injection, proper boundary conditions, an efficient method for highly-relativistic beams in non-relativistic plasma, and efficient data analysis and visualization algorithms based on the Lorentz transform between moving and stationary frames that transform particle data to the same physical time. Plasma chemistry algorithms implement atomic physics processes such as the generation and evolution of plasma, recombination of plasma, and electron attachment on dopants in dense neutral gas. Benchmarks and successful experimental validation are also discussed.

074 : High-current RFQ Design Study on RAON

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Classification: 6: Instrumentation, Controls, Feedback, Operations

Rare isotope Accelerator Of Newness (RAON) heavy ion acceleator has been designed as a facility for a rare isotepe accelerator of the Rare Isotope Science Project (RISP). RAON provides 400 kW CW heavy ion beams from proton to uranium to support researches in various science fields. The RAON system consists of a few ECR ion source, low energy beam transport systems (LEBTs), CW radio frequency quadrupole (RFQ) accelerators, a medium energy beam transport and superconducting linac. We present the design study of the RFQ accelerator from 30 keV/u to 2.0 MeV/u of deuteron beam with meeting a requirement of over 15 mA beam at the target. We optimized the normal conducting CW RFQ accelerator that has a high transmission and a low longitudinal emittance. In this paper, we will present the design result of RFQ beam dynamics studies and its thermal and mechanical analysis.

075 : Automated Transverse Beam Emittance Measurement using a Slow Wire Scanner at the S-DALINAC

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Classification: 6: Instrumentation, Controls, Feedback, Operations

The superconducting linear accelerator S-DALINAC of the TU Darmstadt provides electron beams of up to 130 MeV in cw mode. It consists of a 10 MeV injector and a 40 MeV main linac, both equipped with elliptical cavities operating in liquid helium at 2 K at a frequency of 3 GHz. The final energy is reached by using up to two recirculation paths. In order to improve beam simulations, it is planned to monitor the transverse beam emittance at different locations along the beam line. A system of slow wire scanners in combination with quadrupole variation is foreseen to accomplish this task. For a first test a wire scanner was installed in the 250 keV section behind the thermionic electron gun of the S-DALINAC. A procedure to automatize measurements was developed and integrated in the EPICS-based control system. We will show the status of the work on the automatized control and the results of first emittance measurements. A report on the future plans will be given.

076 : Status of Fast Luminosity Monitoring Using Diamond Sensors For SuperKEKB

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Classification: 6: Instrumentation, Controls, Feedback, Operations

The SuperKEKB e+e- collider aims to reach a very high luminosity of 8 10^{35} cm-2s-1, using strongly focused ultra-low emittance bunches colliding every 4ns. A fast luminosity monitoring system is required for luminosity feedback and control in the presence of dynamic imperfections, as well as for luminosity optimisation. A relative precision of about 10^{-3} in 1ms is specified, which can be achieved thanks to the very large cross-section of the radiative Bhabha process at zero degree scattering angle. The technology used is based on diamond sensors, to be placed just outside the beam pipe, downstream of the interaction point, at locations with event rates consistent with the aimed precision and small enough contamination from single-beam particle losses. We will present estimates of the precisions which can be effectively reached considering several beam-pipe geometries and materials at the selected location, along with a preliminary study of single beam losses expected at the detector location. The status of on-going testing and preparation of the first diamond sensor and fast readout electronics to be used in the single beam commissioning phase will also be reported.

077 : A Multi-band Single Shot Spectrometer for Observation of mm-Wave Bursts at Diamond Light Source

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Classification: 6: Instrumentation, Controls, Feedback, Operations

Micro-bunch instabilities (MBI) have been detected at many light sources across the world. The radiation bursts produced as a result of this instability occur in the millimetre wavelength regime. In order to understand more about the mechanism of MBI and improve the accuracy of simulations, more information is needed about the dynamics and spectral content of the radiation. A single shot spectrometer has therefore been developed to investigate this instability at Diamond Light Source. Due to their low noise, ultra-fast response and excellent sensitivity, Schottky detector diodes are employed. Currently, six Schottky detectors are in place covering a range of 33-500 GHz. Unlike previous measurements at Diamond, each of the Schottky detectors has been characterised thus allowing the results obtained to be more easily compared to simulations. In this paper, we present the calibration of each Schottky detector in the spectrometer, the first results of tests with beam, as well as future plans for the spectrometer.

078 : Fast Kicker

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Classification: 6: Instrumentation, Controls, Feedback, Operations

Pulsed deflecting magnet project was worked out in BINP. The kicker design task is: impulsive force value is 1 mT*m, pulse edge is 5 ns, and impulse duration is about 200 ns. The unconventional approach to kicker design was offered. The possibility for set of wires using instead of plates using is considered. This approach allows us to reduce the effective plate surface. In this case we can decrease effects related to induced charges and currents. In the result of modelling optimal construction was developed. It includes 6 wires. The magnet aperture is about 5 cm. Calculated field rise time (about 1.5 ns) satisfies the conditions. Induced current effect reducing idea was confirmed. For configuration with 3 wires pair (with cross section of 2 mm) induced current in one wire is about 10% and in the wall is about 40%. However for design with plates current is about 40% and 20% respectively. Obtained magnet construction allows controlling of high field homogeneity by changing currents magnitudes in wires. In general we demonstrated the method of field optimization. Optimal kicker design was obtained. Wires using idea was substantiated.

079 : Design of Advanced Electron Beam Diagnostic System for S-band and X-band Industrial/Medical RF Linacs

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Classification: 6: Instrumentation, Controls, Feedback, Operations

At Korean Atomic Energy Research Institute (KAERI), we have been developing S-band (=2856 MHz) and X-band (=9300 MHz) RF electron linear accelerators (linacs) for industrial and medical applications. The electron beams can be accelerated up to 25 MeV by an S-band or X-band accelerating structure. To measure various electron beam parameters of the industrial and medical electron linacs, a specially designed advanced beam diagnostic system with a chicane, two current transformers (CTs), three imaging systems, a Faraday cup, a solenoid, a transverse deflecting structure (TDS), two beam position monitors (BPMs), and three steering magnets was developed. In this paper, we describe the advanced beam diagnostic system to measure various beam parameters such as transverse beam size, beam emittance, beam current, beam position, energy, energy spread, and bunch length automatically with EPICS, MATLAB, and MATLAB Channel Access (MCA).

080 : Investigation of Continuous Scan Methods For Rapid Data Acquisition

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Classification: 6: Instrumentation, Controls, Feedback, Operations

It is common practice to perform spatial data acquisition by automatically moving components to discrete locations and then measuring data with the system at rest. While effective, scanning in this manner can be time consuming, with motors needing to accelerate, move, and decelerate at each location before recording data. Information between data points can be missed unless fine grid scans are performed, which further increases scan time. With continuous scanning the data stream is recorded while components continue to move which eliminates the need to start and stop motors. Recent advances in commercial hardware and software allow continuous scan capability for a wide range of applications. To compare scanning performance, various experimental setups were examined in continuous and discrete scan modes. The advantages and limitations of each are presented.

081 : Distributed Beam Loss Monitor Based on the Cherenkov Effect in Optical Fiber

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Classification: 6: Instrumentation, Controls, Feedback, Operations

A distributed beam loss monitor based on the Cherenkov effect in optical fiber has been implemented for the VEPP5 electron and positron linacs and the 510 MeV damping ring at the Budker INP. The monitor operation is based on detection of the Cherenkov radiation generated in optical fiber by means of relativistic particles created in electromagnetic shower after highly relativistic beam particles (electrons or positrons) hit the vacuum pipe. The main advantage of the distributed monitor compared to local ones is that a long optical fiber section can be used instead of a large number of local beam loss monitors. In our experiments the Cherenkov light was detected by photomultiplier tube (PMT). Timing of PMT signal gives the location of the beam loss. In the experiment with 20 m long optical fiber we achieved 3 m spatial resolution. To improve spatial resolution optimization and selection process of optical fiber and PMT are needed and according to our theoretical estimations 0.5 m spatial resolution can be achieved. We also suggest similar techniques for detection of electron (or positron) losses due to Touschek effect in storage rings.

082 : Development of Wideband BPM for Precise Measurement of Internal Bunch Motion

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Classification: 6: Instrumentation, Controls, Feedback, Operations

To suppress intra-bunch oscillations and to reduce particle losses, the intra-bunch feedback (IBFB) system has been developed in 2014 for the J-PARC Main Ring (MR). A new BPM was also installed to the MR for the IBFB system. This BPM has a sufficient frequency response and position sensitivity(up to 1.5GHz within 15% fluctuation). However, a better performance may be needed in future for more precise analysis of internal motions (e.g. due to an electron cloud). We report the development of the BPM and precise measurement results of the BPM characteristics. We also report simulation studies of the digital equalizer which helps to reconstructs the beam shape from beam signals.

083 : Bunch Length Measurement of Femtosecond Electron Beam by Monitoring Coherent Transition Radiation

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Classification: 6: Instrumentation, Controls, Feedback, Operations

Ultrashort electron bunches with durations of femtoseconds and attoseconds are essential for time-resolved measurements, including pulse radiolysis and ultrafast electron microscopy. However, generation of the ultrashort electron bunches is commonly difficult because of bunch length growth due to space charge effect, nonlinear momentum dispersion and so on. Several bunch length measurement methods for the ultrashort electron beams have also been considered so far, which have not been established yet. In this study, the femtosecond electron beams were generated using a laser photocathode radio-frequency gun linac and a magnetic bunch compressor. The bunch length measurement was carried out using a Michelson interferometer based on monitoring coherent transition radiation (CTR), which is characterized by square modulus of the Fourier transform of the longitudinal bunch distribution. Analyzing the experimentally obtained interferograms of CTR, the electron beams with the average duration of 5 fs were generated and measured successfully at the condition of bunch charge of 1 pC. Consideration of the longitudinal bunch shapes was also carried out using the Kramers-Kronig relation.

084 : Emittance and Optics Measurements on the Versatile Electron Linear Accelerator at Daresbury Laboratory

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Classification: 6: Instrumentation, Controls, Feedback, Operations

The Versatile Electron Linear Accelerator (VELA) is a facility designed to provide a high quality electron beam for accelerator systems development, as well as industrial and scientific applications. Currently, the RF gun can deliver short (of order 100 fs) bunches with charge in excess of 350 pC at 4.5 MeV/c beam momentum. Measurement of the beam emittance and optics in the section immediately following the gun is a key step in tuning both the gun and the downstream beamlines for optimum beam quality. We report the results of measurements (based on quadrupole scans) indicating normalised emittances between 1 and 2 μm at low bunch charge, and discuss the potential impact of space charge effects on emittance measurements at higher bunch charge.

085 : Radiation of a Bunch Moving in the Presence of a Bounded Planar Wire Structure

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Classification: 6: Instrumentation, Controls, Feedback, Operations

Three-dimensional and planar periodic structures can be used for non-destructive diagnostics of charged particle bunches. Here we consider the semi-infinite planar structure comprised of thin conducting parallel wires. If the period of the structure is much less than the typical wavelength of the electromagnetic field, then the structure's influence can be described with help of the averaged boundary conditions. We study radiation of a charged particle bunch with small transversal size and arbitrary longitudinal one in two cases: (i) the bunch moves orthogonally to the grid at some distance from the edge and (ii) it moves along the edge of the grid. The problems are solved analytically. In both cases the bunch generates a surface wave which contains the information about the size of the bunch. The shape of the surface waves is similar to the radiation generated in the presence of 3D periodical wire structures, however planar structure is simpler for use in accelerating system. Some typical numerical results for bunches of various shapes are given.

086 : Electron Bombardment of ZnTe EO Bunch Charge Detector for Signal Lifetime Studies in Radiation Environment

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Authors: Joel Elwin Williams, Sandra Biedron, Stephen Milton (CSU, Fort Collins, Colorado), Stephen Vincent Benson, Shukui Zhang (Jefferson Lab, Newport News, Virginia)
Classification: 6: Instrumentation, Controls, Feedback, Operations

Electro-optic detection of bunch charge distribution utilizing the nonlinear Pockel's and Kerr effect of materials has been implemented at various facilities as a method of passive detection for beam preservation throughout characterization. Most commonly, the inorganic II-VI material ZnTe is employed due to it's strong Pockel's EO effect and relatively high temporal resolution (~90 fs). Despite early exploration of radiation damage on ZnTe in exploration of semi-conductor materials in the 1960's, full characterization of EO response over radiation lifetime has yet to be performed. The following poster presents ZnTe crystal characterization studies throughout radiation exposure at various energies and dosages by analyzing the changes in index of refraction including bulk uniformity, and THz signal response changes.

087 : Control System for FRANZ

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Classification: 6: Instrumentation, Controls, Feedback, Operations

The Frankfurt Neutron Source at the Stern- Gerlach Zentrum (FRANZ) will use the reaction of 7Li(p,n)7Be to produce an intense neutron beam. The neutron energy will be between 10 and 500 keV depending on the primary proton beam, which is variable between 1.8 and 2.2 MeV. A volume type ion source will be used to deliver a 120 keV proton beam with currents up to 200 mA. Like any other facility, FRANZ will need a powerful and reliable control system that also allows monitoring the whole accelerator target areas and experiments. Also interlock and safety systems have to be included to protect personnel from radiation hazards associated with accelerator operations and accompanying experiments. The FRANZ control system is still under development. The ion source will be the first element to be controlled, and to gain experience. A test ion source will be used for testing and examining the performance of this control system. In this paper, the plasma properties, filament ageing and an internal control loop for stable beam production with respect to controlling issues will be discussed.

088 : An Electron Beam SNS Foil Test Stand

Eric Barrowclough
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Classification: 6: Instrumentation, Controls, Feedback, Operations

Diamond foils are used at the Spallation Neutron Source (SNS) as the primary strippers of hydride ions. A nanocrystalline diamond film, typically 17x45 mm with an aerial density of 0.35 mg/cm^2, is deposited on a corrugated silicon substrate by plasma-assisted chemical vapor deposition. After growth, 30 mm of the silicon substrate is etched away, leaving a freestanding diamond foil with a silicon handle that can be inserted into SNS for operation. An electron beam test facility was constructed to study stripper foil degradation and impact on foil lifetime. The electron beam capabilities include: current up to 5 mA, focused spot size of 0.30 mm^2, and rastering in the x- and y-directions. A 30 keV and 1.6 mA/mm^2 electron beam deposits the same power density on a diamond foil as a 1.4 MW beam on SNS target. Rastering of the electron beam can expose a similar area of the foil as SNS beams. Experiments were conducted using the foil test stand to study: foil flutter and lifetime; effects of corrugation patterns, aerial densities, crystal size (micro vs. nano), and boron doping; temperature distributions and film emissivity; and conversion rate of nanocrystalline diamond into graphite.

089 : Development of EPICS Accelerator Control System for Advanced Electron Beam Imaging System

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Authors: Hui Su Kim, Jong-Seo Chai (SKKU, Suwon), Yujong Kim (KAERI, Dae-jeon), Byeong-No Lee, Seung Hyun Lee (KAERI, Dae-jeon; SKKU, Suwon), Hyung Dal Park, Jinku Son, K. Song (KAERI, Daejon), Pikad Buaphad, Siyoung Ryooo (RTX, Daejeon)
Classification: 6: Instrumentation, Controls, Feedback, Operations

A KAERI-SKKU-SFA-RTX EPICS collaboration team has been developing an advanced automatized electron beam imaging system with EPICS, MATLAB, and MATLAB Channel Access (MCA) for KAERI medical/industrial S-band and X-band RF electron linear accelerators. To measure transverse electron beam size and emittance automatically, a Prosilica CCD camera with the GigE interface and an OTR screen were used. For automatized image capturing at a given current of a magnet power supply, EPICS and MATLAB communicate through MCA. In this paper, we describe EPICS accelerator control system for the advanced electron beam imaging system.

090 : Identification of Intra-Bunch Transverse Dynamics for Model Based Wideband Feedback Control at CERN Super Proton Synchrotron

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Classification: 6: Instrumentation, Controls, Feedback, Operations

Multi-input multi-output (MIMO) feedback design techniques can be helpful to stabilize intra-bunch transverse instabilities induced by electron-clouds or transverse mode couplings at the CERN Super Proton Synchrotron (SPS). These techniques require a reduced order model of intra-bunch dynamics. We present linear reduced order MIMO models for transverse intra-bunch dynamics and use these models to design model based MIMO feedback controllers. The effort is motivated by the plans to increase currents in the SPS as part of the HL-LHC upgrade. Parameters of the reduced order models are estimated based on driven beam SPS measurements. The effect of noise, external driving signals and MIMO model order on the robustness of reduced order models is studied. Uncertainty in the reduced order models induces constraints on performance and robustness of the model based controllers. We also study the performance and the robustness of different types of controllers in the presence of model uncertainties. We evaluate the controller performance using macro particle simulation codes (CMAD and HEADTAIL) and beam measurements of the feedback system in operation from SPS machine development studies.

091 : Preliminary Hardware Implementation of Compensation Mechanism of Superconducting Cavity Failure in C-ADS Linac

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Classification: 6: Instrumentation, Controls, Feedback, Operations

For the proton linear accelerators used in applications such as ADS, due to the nature of the operation, it is essential to have beam failures at the rate several orders of magnitude lower than usual performance of similar accelerators. In order to achieve this extremely high performance reliability requirement, in addition to hardware improvement, a failure tolerant design is mandatory. A compensation mechanism to cope with hardware failure, mainly RF failures of superconducting cavities, will be in place in order to maintain the high uptime,short recovery time and extremely low frequency of beam loss. The hardware implementation of the mechanism poses high challenges due to the extremely tight timing constraints, high logic complexity, and mostly important, high flexibility and short turnaround time due to varying operation contexts. We will explore the hardware implementation of the scheme using fast electronic devices and Field Programmable Gate Array (FPGA). In order to achieve the goals of short recovery time and flexibility in compensation algorithms, an advanced hardware design methodology including high-level synthesis will be used.

092 : Machine Protection Systems and Impact on Beam Availability and Accelerator Reliability

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Classification: 6: Instrumentation, Controls, Feedback, Operations

As accelerator-driven facilities (ADF) have developed over time, from serving only the physicists responsible of building it to becoming user facilities, where researchers come from external laboratories to conduct research, the demands on beam availability and accelerator reliability have increased significantly. In addition, current and future high-power particle accelerators need to be able to interrupt beam operation within timescales of a few microseconds to avoid beam-induced damage of equipment. These demands require a sophisticated Machine Protection System (MPS). Over the last decades, the level of complexity and performance of the MPS have developed. This paper studies how some of the ADF around the world develop and use their MPS in order to reduce damage to and downtime of the machine. The findings are categorized and generalized to accelerator-driven facilities, with emphasis on proton accelerators. Based on this, the paper is concluded with recommendations for a future superconducting proton accelerator.

093 : Present and Future Optical-to-Microwave Synchronization Systems at REGAE Facility for Electron Diffraction and Plasma Acceleration Experiments.

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Authors: Mikheil Titberidze, Florian Josef Gruener, Andreas R. Maier (CFEL, Hamburg; Uni HH, Hamburg), Benno Zeitler (CFEL, Hamburg), Matthias Felber, Klaus Floettmann, Thorsten Lamb, Uros Mavric, Jost Mueller, Holger Schlarb, Cezary Sydlo (DESY, Hamburg), Sascha Epp (MPSD, Hamburg), Ewa Janas (Warsaw University of Technology)
Classification: 6: Instrumentation, Controls, Feedback, Operations

Relativistic Electron Gun for Atomic Explorations (REGAE) is a Radio Frequency (RF) driven linear accelerator. It uses frequency tripled short photon pulses ($\sim$ 35 fs) from the Titanium Sapphire (Ti:Sa.) Laser system in order to generate electron bunches from the photo-cathode. The electron bunches are accelerated up to $\sim$ 5 MeV kinetic energy and compressed down to sub-10 fs using the so called ballistic bunching technique. REGAE currently is used for electron diffraction experiments (by Prof. R.J.D. Miller's Group). In near future within the collaboration of Laboratory for Laser- and beam-driven plasma Acceleration (LAOLA), REGAE will also be employed to externally inject electron bunches into laser driven linear plasma waves. Both experiments require very precise synchronization (sub-50 fs) of the photo-injector laser and RF reference. In this paper we present experimental results of the current and new optical to microwave synchronization systems in comparison.

094 : Initial Experimental Results for a Machine Learning-based Temperature Control System for an RF Gun

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Authors: Auralee Edelen, Sandra Biedron, Stephen Milton (CSU, Fort Collins, Colorado), Brian Edward Chase, Darren James Crawford, Nathan Eddy, Dean Richard Edstrom, Elvin Robert Harms, Jinhao Ruan, James K Santucci, Pierpaolo Stabile (Fermilab, Batavia, Illinois)
Classification: 6: Instrumentation, Controls, Feedback, Operations

We present initial experimental test results for a machine learning-based control system being developed in collaboration between Colorado State University (CSU) and the Fermi National Accelerator Laboratory. This controller combines a machine learning-based model and a predictive control algorithm to enable a shorter settling time and more accurate temperature regulation for a normal conducting RF gun. This represents one component of an ongoing effort to develop machine learning-based control techniques specifically to address control challenges found in particle accelerator systems.

095 : RF Power Distribution Optimization over Multiple Klystrons in a Linear Accelerator

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Authors: Amin Rezaeizadeh, Roger Kalt, Thomas Schilcher (PSI, Villigen PSI), Roy Smith (Automatic Control Laboratory, Zurich)
Classification: 6: Instrumentation, Controls, Feedback, Operations

A Linac including several klystrons can be viewed as a virtual RF station with a certain accelerating voltage in amplitude and phase. In order to increase the RF stability as well as the efficiency, it is preferable to operate each klystron close to its saturation. The saturating power is determined by the high voltage setting of the klystron. In the current contribution, an optimization scheme is developed which minimizes the high voltages of klystrons, while keeping the total beam energy constant. Since the breakdown rate of klystrons are related to the high voltage level, the proposed optimization reduces the probability of breakdowns.The approach is based on a convex optimization which uses the klystron curves and the energy gain of each station to minimize the high voltages subjected to constraints on the limits and the total energy gain of the Linac. The proposed method has been successfully tested at the SwissFEL test facility. The experimental results show that if one of the stations fails to deliver the power, the optimization redistributes the high voltages over other stations so the energy loss is compensated by increasing the power of the remaining klystrons.

096 : 3 GHz Single Cell Cavity Optimization Design

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Authors: Luca Garolfi, Mohamed El Khaldi (LAL, Orsay)
Classification: 7: Accelerator Technology

In order to develop a high gradient S-band accelerating structure, an optimized travelling wave (TW) single-cell cavity operating at the frequency of 2998.55 MHz at 30 C with 2pi/3 phase advance, is proposed. Starting from the well-known accelerating cells design developed by LAL and SLAC for linear accelerators; it is possible to improve the main RF parameters, such as quality factor, shunt impedance and group velocity, by choosing a suitable shape of the inner surface. Despite the surface electric field being considered as the only main quantity limiting the accelerating gradient; the importance of power flow has resulted from high-gradient experimental data. In this context, the modified Poynting vector quantity can be considered as a new RF breakdown constraint depending on an iris shape. RF simulations have been carried out with HFSS and CST MWS. Simulations results have shown an optimal RF characteristics.

097 : Harmonic Resonant Kicker Design for the MEIC Electron Circular Cooler Ring

Yulu Huang
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Classification: 7: Accelerator Technology

Bunched-beam electron cooling of the high-energy ion beam emittance is a crucial technology for the proposed Medium energy Electron Ion Collider (MEIC) to achieve its design luminosity. A critical component is a fast kicker system in the Circular Cooler Ring (CCR) that periodically switches electron bunches in and out of the ring from and to the driver ERL. Compared to a conventional strip-line type kicker, a quarter wave resonator (QWR) based deflecting structure has a much higher shunt impedance and so requires much less RF power. The cavity has been designed to resonate simultaneously at many harmonic modes that are odd-integer multiples of the fundamental mode. In this way the resulting waveform will kick only a subset of the circulating bunches. In this presentation, analytical shunt impedance optimization, the electromagnetic simulations of this type of cavity, as well as tuner and coupler designs to produce 5 odd and 5 even harmonics of 47.63MHz will be presented, in order to kick every 10th bunch in a 476.3 MHz bunch train.

098 : Breakdown Characterization in 805 MHz Pillbox-like Cavity in Strong Magnetic Fields

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Authors: Alexey Kochemirovskiy, Daniel Bowring (Fermilab, Batavia, Illinois)
Classification: 7: Accelerator Technology

RF Breakdown in strong magnetic fields has a negative impact on a cavity's performance. The MuCool Test Area at Fermilab is the facility that allows us to study the effects of static magnetic field on RF cavity operation. As a part of this research program, we have tested an 805 MHz pillbox-like cavity in external magnetic fields up to 5T. The special properties of the cavity, including 15 cm accelerating gap, operating rep rate of 1 Hz to avoid heating and limited number of breakdown events to avoid unrecoverable damage, resulted in unique observed breakdown pattern. We present the analysis of breakdown damage distribution and propose the hypothesis to explain certain features of this distribution. Results confirm our basic model of breakdown in strong magnetic fields. The dark current simulation was carried out in ACE3P and compared to theoretical calculation of electron trajectories inside the cavity.

099 : Observation of Dark Current Dependence on Stored Energy in an L-Band RF Gun

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Authors: Jiahang Shao, Huaibi Chen, Jiaru Shi, Dan Wang (TUB, Beijing), Manoel Conde, Darrell Scott Doran, Wei Gai, Wanming Liu, John Gorham Power, Charles Whiteford, Eric Edson Wisniewski (ANL, Argonne, Illinois), Sergey P. Antipov, Sergey Baryshev, Chunguang Jing, Jiaqi Qiu (Euclid TechLabs, LLC, Solon, Ohio), Faya Wang, Liling Xiao (SLAC, Menlo Park, California)
Classification: 7: Accelerator Technology

A pin cathode has been installed into an L-band photocathode gun to study the influence of stored energy on field emission. The stored energy was varied by tuning the recess of the cathode in order to have the same E-field on the cathode tip. We have observed 5 times difference of dark current level at the same E-field, while by varying the stored energy by three fold. Dynamics study reveals the difference is not caused by transmission, but by emission process itself. We'll present experiment results and discuss possible mechanisms about the phenomena.

100 : RF Modulation Studies on the S-Band Pulse Compressor

Guan Shu
Institute of High Energy Physics
Authors: Guan Shu (Institute of High Energy Physics (IHEP), Chinese Academy of Sciences, Beijing), Fengli Zhao (IHEP, Beijing)
Classification: 7: Accelerator Technology

An S band SLED-type pulse compressor has been manufactured by IHEP to challenge the 100 MW maximum input power, which means the peak power around the coupling irises is about 500 MW at the phase reversal time. In order to deal with the breakdown problem, the dual side-wall coupling irises model was used. To further improve the reliability at very high power, RF phase modulation (PM) with flat-top output is considered. By using the CST Microwave Studio (MWS) transient solver, a new method was developed to simulate the time response of the pulse compressor. In addition, the theoretical and experimental results of the PM theory are also presented in this paper.

101 : Development of Non-resonant Perturbation Method for Tuning Traveling Wave Deflecting Structures

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Authors: Jianhao Tan, Wencheng Fang, Qiang Gu, Zhentang Zhao (SINAP, Shanghai), Dechun Tong (TUB, Beijing)
Classification: 7: Accelerator Technology

For traveling wave accelerating structures, the tuning method assisted by bead pull technique based on non-resonant perturbation field distribution measurement has been widely used. Long periodic traveling wave deflecting structure, which operating at HEM11 mode, is difficult to use non-resonant perturbation method, and a improved method has been developed for measuring and tuning by "cage" type perturbing object at SINAP. The measurements on x-band traveling wave deflecting structure are presented in this paper.

102 : High Gradient Tests of the Five-cell Superconducting RF Module with a PBG Coupler Cell

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Classification: 7: Accelerator Technology

We present experimental data for the 5-cell superconducting radio-frequency (SRF) accelerating module incorporating a photonic band gap (PBG) cell with couplers. The purpose of the PBG cell is to achieve better higher order mode (HOM) damping which is vital for preserving the quality of high-current electron beams in novel SRF accelerators. Due to its great HOM damping potential, a superconducting multi-cell cavity with a PBG damping cell is an attractive option for high-current linacs. One example is a proposed harmonic cavity for eRHIC used to linearize the electron bunch phase space. First, we will describe how an intentionally uneven gradient profile will help us ensure equal probability of quenching in every cell and allow for a higher accelerating gradient. We will then discuss fabrication steps of the complex five-cell Niobium module. Finally, we will report experimental data for the high gradient tests at temperatures of 4K and 2K conducted at Los Alamos National Lab and compare it to previous results obtained for single PBG cells.

103 : Origin of Trapped Flux Caused by Quench in Superconducting Niobium Cavities

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Classification: 7: Accelerator Technology

One of the known basic phenomena in SRF cavities is the degradation of their quality factor (increase in dissipation) caused by quench. The accepted explanation is based on the magnetic flux, which gets trapped at the quench location, and is the cause of the subsequent higher local dissipation, which is recoverable only by warming up the cavity above Tc=9.25K. While the effect was known for the past several decades, where exactly this additional magnetic flux is coming from remains unclear. Several possibilities have been proposed including the static ambient magnetic field, RF field, and the additional field generated during quench by thermal currents. In this contribution we clearly demonstrate by a series of targeted experiments, that most of the trapped magnetic flux after quench originates from the ambient magnetic field, and therefore quench degradation can be improved by magnetic shielding and/or active fields compensation.

104 : Update on Nitrogen Doping at Cornell: Quench Studies and Sample Analysis

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Classification: 7: Accelerator Technology

Recently, nitrogen-doping has emerged as a promising preparation method for SRF cavities to reach higher intrinsic quality factors than can be reached with typical cavity preparation. Nitrogen-doped cavities prepared at Cornell have shown quality factors higher than $4x10^{10}$ at 2.0 K and 16 MV/m. While Q results have been very exciting, a reduced quench field currently limits nitrogen-doped cavities with quench typically occurring between 15 and 25 MV/m. Here we report on recent results from Cornell on single-cell and 9-cell cavities, focusing on maximum and critical fields. We discuss quench studies that have been completed using temperature mapping, present measurements of the RF critical field, and report on measurements of critical fields on nitrogen-doped samples using a PPMS.

105 : Recent Studies on the Current Limitations of State-of-the-Art Nb3Sn Cavities

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Classification: 7: Accelerator Technology

Recent advances in the study of Nb3Sn at Cornell University have yielded single-cell cavities that show excellent performance without the limiting Q-slope seen in previous work. This performance has been shown to be repeatable across multiple cavities. However, they are still limited by a quench field of approx. 16 MV/m as well as residual resistance. In this work we discuss possible causes for the most recent limitations as well as present the latest results of experiments carried out on both these Nb3Sn single cell cavities as well as on flat Nb3Sn-coated plates for use in Cornell's sample host cavity.

106 : The Development of Cavity Frequency Tracking Type RF Control System for SRF-TEM

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Classification: 7: Accelerator Technology

Superconducting accelerating cavities used in high-energy accelerators can generate high electric fields of several 10 MV/m by supplying radio frequency waves (RF) with frequencies matched with resonant frequencies of the cavities. Generally, frequencies of input RFs are fixed, and resonant frequencies of cavities that are fluctuated by Lorentz force detuning and Microphonics are corrected by feedbacks of cavity frequency tuners and input RF power. Now, we aim to develop the cavity frequency tracking type RF control system where the frequency of input RF is not fixed and consistently modulated to match the varying resonant frequency of the cavity. In KEK (Tsukuba, Japan), we are developing SRF-TEM that is a new type of transmission electron microscope using special-shaped superconducting cavity. By applying our new RF control system to the SRF-TEM, it is expected to obtain stable accelerating fields so that we can acquire good spatial resolution. In this presentation, we will explain the required stabilities of accelerating fields for SRF-TEM and the feasibility of SRF-TEM in the case of applying the cavity frequency tracking type RF control system.

107 : Exploration of a Multi-fold Symmetry Element-loaded Superconducting Radio Frequency Structure for Reliable Acceleration of Low- and Medium-beta Ion Species

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IMP, Lanzhou
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Classification: 7: Accelerator Technology

Reliable acceleration of low- to medium-beta proton or heavy ion species is needed for future high current superconducting radio frequency accelerators. Due to the high-Q nature of a superconducting RF resonator, it is sensitive to many factors such as loading variation (from either the accelerated beam or from parasitic field emitted electrons), mechanical vibration, and liquid helium bath pressure fluctuation etc. To increase the stability against those factors, a mechanically strong and stable RF structure is desirable. Guided by this consideration, multi-fold symmetry element-loaded superconducting radio frequency structures, cylindrical tanks with multiple (n>=3) rod-shaped radial elements, are being explored. The top goal of its optimization is to improve mechanical stability, a natural consequence of this structure is a lowered ratio of the peak surface electromagnetic field to the acceleration gradient as compared to the traditional spoke cavity. A disadvantage of this new structure is an increased size for a fixed resonant frequency and geometric beta. This paper describes the optimization of EM design and mechanical analysis for such a structure.

108 : Temperature Mapping of Nitrogen-doped Niobium Superconducting Radiofrequency Cavities

Junki Makita
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Authors: Junki Makita (ODU, Norfolk, Virginia), Gianluigi Ciovati, Pashupati Dhakal (Jefferson Lab, Newport News, Virginia)
Classification: 7: Accelerator Technology

It was recently shown that diffusing nitrogen on the inner surface of superconducting radiofrequency (SRF) cavities at high temperature can improve the quality factor of the niobium cavity. However, a reduction of the quench field is also typically found. To better understand the location of rf losses and quench, we used a thermometry system to map the temperature of the outer surface of ingot Nb cavities after nitrogen doping and electropolishing. Surface temperature of the cavities was recorded while increasing the rf power and also during the quenching. The results of thermal mapping showed no precursor heating on the cavities and quenching to be ignited near the equator where the surface magnetic field is maximum. Hot-spots at the equator area during multipacting were also detected by thermal mapping.

109 : Hc2 Measurements of Nb3Sn and Nitrogen-Doped Niobium Using Physical Property Measurement System

James Thomas Maniscalco
Cornell University
Authors: James Thomas Maniscalco, Daniel Leslie Hall, Matthias Liepe, Sam Posen (Cornell University (CLASSE), Ithaca, New York)
Classification: 7: Accelerator Technology

The measurement of the upper critical field of a type-2 superconductor, Hc2, is an important step in determining its superconducting properties, and therefore its suitability as a material in SRF cavities. However, measuring Hc2 directly can be challenging, as performing electrical measurements causes changes in the very properties one seeks to measure. We present a method for extracting Hc2 from resistivity measurements made near the transition temperature for varied applied fields and excitation currents. We also present results of these measurements made on Nb3Sn and nitrogen-doped niobium.

110 : Gradient-limiting Mechanism in Nitrogen Doped Cavities

Martina Martinello
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Authors: Martina Martinello, Mattia Checchin, Anna Grassellino, Alexander S Romanenko (Fermilab, Batavia, Illinois)
Classification: 7: Accelerator Technology

Nitrogen doping results in ultra-high quality factors in SRF niobium cavities but currently achievable gradients in doped cavities are, on average, somewhat lower than in EP/120C baked cavities. The origin of this difference is explored in the reported work by detailed temperature mapping studies on several single cell nitrogen doped cavities.

111 : Engineering Study of Crab cavity HOM Couplers for LHC High Luminosity Upgrade

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Classification: 7: Accelerator Technology

The LHC is planning to employ crab cavities for the high luminosity upgrade. Old Dominion University and SLAC National Laboratory are developing the crab cavity completed with the HOM damping couplers. The HOM couplers are coaxial type and perform over broad band up to 2 GHz. The amount of extracted power requires active cooling using liquid helium. The electromagnetic study has provided expected power dissipation on the coupler. Correlations between the fabrication tolerance and its damping performance have been studied and the results are providing guidelines on how to manufacture the HOM couplers. This paper summarizes the engineering studies; mechanical strength as a part of pressure system, thermal stability, and fabrication method to ensure the required tolerance.

112 : Superconducting Coatings Synthesized by CVD/PECVD for SRF Cavities

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Classification: 7: Accelerator Technology

Bulk niobium cavities are widely employed in particle accelerators to create high accelerating gradient despite their high material and operation cost. In order to reduce this cost, thin layer of niobium are deposited on a copper cavity, which has lower material cost with higher availability and more importantly higher thermal conductivity. The coating of superconducting cavities currently is synthesized by PVD method which suffers from lack of conformity. By using chemical vapour deposition (CVD) and plasma enhanced chemical vapour deposition (PECVD) it is possible to deposit thin Nb layers uniformly with density very close to bulk material. This project explores the use of PECVD / CVD techniques to deposit metallic niobium on copper using $NbCl_5$ as precursor and hydrogen as a coreagent. The samples obtained were then characterized via SEM, TEM, SAD, XRD, XPS, and EDX as well as assessing their superconductivity characteristics (RRR and Tc.) All the samples deposited are superconductive and polycrystalline; the sample obtained with CVD measured RRR=31 and Tc=7.9 K, while the sample obtained with PECVD exhibited RRR=9 and Tc= 9.4 K. In both cases the films grew in a (100) preferred orientation.

113 : Suppression of Higher Order Modes in an Array of Cavities Using Waveguides

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Classification: 7: Accelerator Technology

In the frameworks of the High Luminosity LHC upgrade program an application of additional harmonic cavities operating at multiplies of the main RF system frequency of 400 MHz is currently under discussion. A structure consisting of two 800 MHz single cell superconducting cavities with grooved beam pipes coupled by drift tubes has been suggested for implementation. However, if we increase the number of single cells installed in one cryomodule in order to decrease the number of transitions between "warm" and "cold" parts of the collider vacuum chamber, we will face the problem of damping of higher order modes (HOM) trapped between the cavities. In order to solve this problem the methods of HOM damping with rectangular waveguides connected to the drift tubes have been investigated and compared. In this paper we describe the results obtained for arrays of 2, 4 and 8 cavities.

114 : Physical Vapour Deposition of Thin Films for Use in Superconducting RF Cavities

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Classification: 7: Accelerator Technology

The production of superconducting coatings for radio frequency cavities is a rapidly developing field that should ultimately lead to acceleration gradients greater than those obtained by bulk Nb RF cavities. Optimizing superconducting properties of Nb thin-films is therefore essential. Nb films were initially deposited by magnetron sputtering in pulsed DC mode onto Si (100) and MgO (100) substrates. The study then progressed to films deposited by high impulse magnetron sputtering (HiPIMS) onto Si (100), MgO (100) and polycrystalline Cu. The films can be characterised using scanning electron microscopy, x-ray diffraction and DC SQUID magnetometry.

115 : Experiment on High Power RF Generation at W-band Based on Wakefield Excited by Electron Bunch Train

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Classification: 7: Accelerator Technology

We report on the RF generation experiment at 91 GHz based on the wakefield of a periodic metallic structure excited by electron bunch train at the AWA facility. The frequency of the bunch train is 1.3 GHz, we have measured the 70th harmonic frequency signal with the harmonic mixer in the heterodyne way. With 75 MeV, with ~5 nC charge in a single bunch and up to 8 sub bunches in the train, the RF pulse length changes from 3~10 ns, and the RF power reaches above 10 MW. We have also measured the energy spectrum of 4 bunch case, experiment result shows good agreement on the analysis and simulation. Demonstrated the theory on the middle range wake (wake from head bunch to the tailing bunch), which has a linear decrease for travelling wave power extractor structure (PETs).

116 : Stripline Kicker for Integrable Optics Test Accelerator

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Classification: 7: Accelerator Technology

We present a design of a stripline kicker for Integrable Optics Test Accelerator (IOTA). For its experimental program IOTA needs two full-aperture kickers, capable create an arbitrary controllable kick in 2D. For that reason their strengths are variable in a wide range of amplitudes up to 16 mrad, and the pulse length 100 ns is less than a revolution period for electrons. In addition, the kicker has a physical aperture of 40 mm for a proposed operation with proton beam, and an outer size of 70 mm to fit inside existing quadrupole magnets to save space in the ring. Computer simulations using CST Microwave Studio show high field uniformity and wave impedance close to 50 Ω.

117 : IOT Use as a Power Source for a Linear Accelerating Structure

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Classification: 7: Accelerator Technology

Nowadays the interest of using compact and high efficiency power sources called Inductive Output Tubes (IOT) for feeding accelerating structures with the required pulsed power around 1MW is increasing. In this article are presented results of the beam dynamics and geometry calculations for the L-band IOT and, due to the fact that it is cheaper and faster to make tests with S-band smaller geometry, S-band IOT. Different concepts of the cavity have been proposed, but the most efficient has been chosen for making an aluminium model and testing it. The layout of the generator cell with biperiodic bucnher cells has been investigated. The hybrid structure composed from the generator cell and the compact SW accelerating section is proposed.

118 : Effects of Plasma Processing on SEY of Niobium Samples

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Classification: 7: Accelerator Technology

Impurities deposited on the surface of Nb during both the forming and welding of the cavities, add to the imperfections of the sheet metal, which then affects the overall performance of the cavities. This leads to a drop in the Q factor and limits the maximum acceleration gradient achievable, per unit length of the cavities. The performance can be improved either by adjusting the fabrication and preparation parameters, or by mitigating the effects of fabrication and preparation techniques used. We have developed the experimental setup to determine Secondary Electron Yield (SEY) from the surface of Nb samples. Our aim is to show the effect of plasma processing on the SEY of Nb. The setup measures the secondary electron energy distribution at various incident angles, as measured between the electron beam and the surface of the sample. SEY has been determined on non-treated and plasma treated surface of Nb samples. The comparison will be presented at the conference.

119 : Optimization Design of Ti Cathode in Ceramic Pipe Film Coating Based On the Simulation Result of CST

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Classification: 7: Accelerator Technology

The injection chamber at Hefei Light Source II (HLS II) consists of four ceramic vacuum chambers whose inner surface were coated with TiN thin film. The cross section of ceramic pipes is special racetrack structure. In order to improve the uniformity of the film, the structure of the cathode Ti plate needed to be optimized. In this article, CST PARTICLE STUDIOTM software had been used to simulate the influence of different target structure on discharge electric field distribution and electrons trajectories. Furthermore, the reliability of the simulation were analysed compared with the experimental results. Also, we put forward the optimization design of Ti cathode structure which could satisfy the requirement of uniformity of the thin film.

120 : Research Development of High Precision Installation and Survey system for HEPS

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Classification: 7: Accelerator Technology

High Energy Photon Source (HEPS) is a proposed 5 GeV third generation light source with high brightness and ultra-low emittance. Because the measurement error of the traditional optical survey method in the girder and magnet installation can't meet the tight alignment tolerance, the installation and alignment will not rely on laser tracker and some other optical survey instruments. So HEPS is developing the research of high precision installation and survey system which is consists of the auto-tuning girder design based on beam alignment and vibrating wire alignment technique based on magnetic measurement. On the base of high alignment accuracy of multipole magnets and in addition to the auto-tuning girders, improving the accuracy of the final positioning of magnet, the beam with high quality will be got. This paper introduces the research development of installation and survey system in storage ring of HEPS.

121 : Single Shot Multi-MeV Ultrafast Electron Diffraction on VELA at Daresbury

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Classification: 8: Applications of Accelerators, Tech Transfer, and Industrial Relations

Accelerator based Ultrafast Electron Diffraction (UED) is a technique for obtaining static structures and for studying sub-100 fs dynamic structural changes on the atomic scale. In this paper we present the first electron diffraction results obtained from the VELA accelerator in 2014. The accelerator was operated to provide typically 4MeV/c electron bunches. Diffraction patterns were observed with $\ll$1 pC transported to the detection screen. Single shot and multi-shot accumulated diffraction data are presented from single crystal and polycrystalline samples, including Au, Al, Pt and C. Contamination of the diffraction pattern with dark current contributions is an issue. A variable size aperture directly in front of the sample offers some mitigation, but at the expense of reduced charge contributing to the diffraction pattern. We discuss future developments for electron diffraction on VELA including further beam optimization, measurement of bunch length with a newly installed Transverse Deflecting Cavity, and the planned developments for pump-probe studies.

122 : Simulations Study for Self-modulation Experiments at PITZ

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Classification: 3: Alternative Particle Sources and Acceleration Techniques

Self-modulation (SM) of proton beams in plasma has recently gained interest in context with the ongoing PWFA experiment of the AWAKE collaboration at CERN. Instrumental for that experiment is the SM of a proton beam to generate bunchlets for resonant wave excitation and efficient acceleration. A fundamental understanding of the underlying physics is vital, and hence an independent experiment has been set up at the beamline of the Photo Injector Test Facility at DESY, Zeuthen Site (PITZ), to study the SM of electron beams in a plasma. This contribution presents simulation results on SM experiments at PITZ using the particle-in-cell code HiPACE. The simulation study is crucial to optimize the beam and plasma parameters for the experiment. Of particular interest is the energy modulation imprinted onto the beam by means of the generated wakefields in the plasma. With the support of simulations the observation of this information in the experiment can be used to deduce key properties of the accelerating electric fields such as their magnitude and their phase velocity, both of significant importance for the design of self-modulated plasma-based acceleration experiments.

123 : A Compact X-ray Source Based on a Low-energy Beam-driven Wakefield Accelerator

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Classification: 3: Alternative Particle Sources and Acceleration Techniques

Accelerator-based X-ray sources have led to many scientific breakthroughs. Yet, their limited availability in large national laboratory settings due to the required infrastructure is a major limitation to their disseminations to a larger user community. In this contribution we explore the use of a low-energy electron beam produced out of a photoinjector coupled to a dielectric structure to produce a higher energy (≈10-20 MeV) beam via a beam-driven acceleration scheme. The accelerated beam can then be used to produce X-ray via inverse Compton scattering. This paper discusses the concept and presents start-to-end simulations of the proposed setup.

124 : Stripping of High Intensity Heavy Ion Beams in a Pulsed Gas Stripper Device at 1.4 MeV/u

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Classification: 4: Hadron Accelerators

As part of an injector system for FAIR, the GSI UNILAC has to meet high demands in terms of beam brilliance at a low duty factor. To accomplish this goal an extensive upgrade program has started. To increase the beam intensity behind the UNILAC, it is aimed to increase the efficiency of the 1.4 MeV/u gas stripper. A modification of the stripper setup was developed to replace the N2-jet with a pulsed gas injection, synchronized with the transit of the beam pulse. The pulsed gas injection lowers the gas load for the differential pumping system, rendering possible the use of other promising gas targets. In recent measurements the performance of the modified setup was tested using an 238U-beam with various stripper media, including H2, He, and N2. The data provide a systematic basis for an improved understanding of slow heavy ions passing through gaseous media. The stripping performance of the current N2-jet was excelled by using H2 at increased gas densities, enabled by the new pulsed gas cell.

125 : Development of a Single-Pass Amplifier for an Optical Stochastic Cooling Proof-of-Principle Experiment at Fermilab's IOTA facility

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Classification: 5: Beam Dynamics and EM Fields

Optical stochastic cooling (OSC) is a method of beam cooling which is expected to provide cooling rates orders of magnitude larger than ordinary stochastic cooling. Light from an undulator (the pickup) is amplified and fed back onto the particle beam via another undulator (the kicker). Fermilab is currently exploring a possible proof-of-principle experiment of the OSC at the integrable-optics test accelerator (IOTA) ring. To implement effective OSC a good correction of phase distortions in the entire band of the optical amplifier is required. In this contribution we present progress in experimental characterization of phase distortions associated to a Titanium Sapphire crystal laser-gain medium (a possible candidate gain medium for the OSC experiment to be performed at IOTA). We also discuss a possible option for a mid-IR amplifier.