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The 18th Particle Accelerator Conference

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ABSTRACTS

The American Physical Society

IEEE

16:55 MODL5 The 4-8 GHz Stochastic Cooling Upgrade for the Fermilab Debuncher
DAVID P. MCGINNIS - FNAL

The Fermilab Main Injector is projected to increase the antiproton production rate by a factor of three over the last FNAL Collider Run. To handle the increase in anitproton flux, the bandwidth of the FNAL Debuncher stochastic cooling systems will be increased from the present 2-4GHz to the 4-8 GHz band. In the 4-8 GHz band, the Debuncher beam pipe will become severely overmoded. These modes will prohibit wideband stripline pickup arrays from working. The new 4-8 GHz system will consist of narrowband slotted waveguide arrays. To cover the 4-8 GHz band, the system will be divided into 8 narrowband channels with each channel having a bandwidth of about 500 MHz. This paper will discuss the overall system design of the multiband cooling system. Parameters that will be discussed are the cooling rate, system power, signal to noise, band location and band gain.

17:07 MODL6 Coherent Mode of a High Intensity Beam in a Synchrotron
S. MACHIDA, KEK; M. IKEGAMI, JAERI; T. UESUGI, UNIVERSITY OF TOKYO

As one of major sources which limit the maximum number of particles in a high intensity proton synchrotron and storage ring, we are investigating a resonance crossing of coherent mode frequency depressed with space charge effects. In that analysis, periodic interactions of magnet errors and a beam-induced field with "a whole beam", not with individual particle play an important role in causing emittance growth and producing halos. In this paper, we will present the overview of its experimental study in HIMAC started recently and discuss some simulation results of coasting and bunched beams.

SESSION MOCR: SOURCES AND INJECTORS SESSION
Monday afternoon, 29 March 1999; Broadway Ballroom at 1:30;
Chair: Richard Sheffield, LANL

13:30 MOCR1 Recent Advances in Polarized Electron Sources (Invited)
CHARLES K. SINCLAIR, TJNAF

The experimental physics programs at a number of electron accelerator laboratories world wide require the delivery of high average current highly polarized electron beams for long periods of time. The polarized electron beams are produced by near bandgap photoemission from certain semiconductor photocathodes. The quantum efficiency of these photocathodes is inversely related to the total charge they have delivered. Recent developments in photocathode preparation, ultrahigh vacuum technology, lasers, and electron trajectory control have led to operationally reliable delivery of many hundreds of coulombs of polarized electrons to several experiments, at a rate up to 8 coulombs/day. Currently, photocathode operational lifetime is limited only by ion backbombardment. These recent developments will be described. Further gains in the high average current lifetime of these cathodes may be expected, which will have implications for electron gun development beyond polarized sources.

13:55 MOCR2 Self-Bunching Electron Guns. (Invited)
FREDERICK M. MAKO AND L. K. LEN *FM TECHNOLOGIES, INC., 10529-B BRADDOCK ROAD, FAIRFAX, VA 22032*

Several new approaches for the production of bunched electron beams will be presented. Many applications require higher power injectors or microwave sources. These requirements have created the need for higher emission current density electron guns with a means for bunching at the gun. Four different concepts will be presented. The first three guns utilize external methods of bunching: (1) field emission, (2) photoemission and (3) ferroelectric emission. The fourth concept is based on secondary emission and utilizes phase selection for self-bunching. Most of the presentation will concentrate on this fourth method of self-bunching electron guns. The self-bunching electron gun utilizes secondary emission and multipacting of electrons to generate naturally bunched electron beams with the use of microwave fields. This type of electron gun is called the Micro-Pulse Gun* or MPG. One wall of an rf cavity is made partially transparent to electrons but opaque to an input rf electric field in order to extract the beam. Self-consistent analytic theory and electomagnetic particle-in-cell simulations show that natural bunching occurs and one bunch is emitted every rf period. FMT has studied using simulation codes the resonant bunching process which gives rise to high current densities (up to 5 kA/cm^2), high charge bunches (up to 500 nC/bunch), and short pulses (1-100 ps) for frequencies from 1 to 12 GHz. The beam pulse width is nominally ~5% of the rf period. We have experimentally demonstrated, in a microwave cavity, self-bunching, cold electron emission, long life, and tolerance to contamination. Measurements of current density, bunch length and lifetime on L-band and S-band Micro-Pulse Guns will be presented.

* Micro-Pulse Gun work is supported by the U.S. Department of Energy.

14:20 MOCR3 Emittance Measurements of a Photocathode RF Gun with Variable Laser Pulse Shape *
M. HERNANDEZ J.F. SCHMERGE H. WINICK [1] D.A. REIS [2]

The need for a high brightness electron beam for the proposed Linac Coherent Light Source (LCLS) project at SLAC has led to the development of the Gun Test Facility (GTF) at SSRL. The design requirements for the LCLS are 1 nC of charge in a micro- bunch of 10 ps or less with a normalized rms emittance of 1 π mm-mr or better. The facility consists of a 1.6 cell S-band photocathode RF gun with cavity symmetrization, an emittance compensation solenoid, a single 3-meter SLAC S-band linac section, two XK-5 klystrons, and low and high energy diagnostic sections. The cathode drive laser is capable of producing both transversely and temporally shaped laser pulses. Simulations using a 1 nC bunch with 10 ps flat top temporal and 1 mm radius uniform transverse distribution indicate that the LCLS requirements can be met. Initial measurements at the GTF utilizing a copper cathode with a micro-bunch with 1 nC of charge with an unclipped Gaussian transverse distribution, have shown that lengthening the laser pulse from 5 ps to 9 ps FWHM led to a reduction in the normalized emittance. In order to increase the quantum efficiency of the system, the copper cathode will be replaced by a magnesium cathode. In this paper the results of emittance measurements as a function of laser pulse shape, laser injection phase and electron beam energy using both the copper and magnesium cathodes will be presented and discussed.

*Department of Energy Contract DE-AC03-76SF00515
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[2] University of Rochester Dept. of Physics and Astronomy, Rochester, NY 14627

14:32 MOCR4 Experimental Study of GaAs Photocathode Performance in RF Gun*.
A.V.ALEKSANDROV,N.S.DIKANSKY,P.V.LOGATCHOV,R.GROMOV, BINP.

A prototype of S band RF photogun with GaAs photocathode has been build and tested at Novosibirsk. The main goal of this prototype is to check a possibility of long time operation for GaAs photocathode in a strong accelerating field of RF cavity. The first experimental results concerning dark current and lifetime of GaAs photocathode in NEA condition under high RF power are presented. The dark current observed is much higher than predicted. Possible mechanism of large dark current from NEA surface is suggested and discussed.

our advantage the quantum effect to suppress beamstrahlung. We then present an integrated case study of a linear collider designed to take advantage of the quantum suppression. Monte Carlo simulations are carried out in steps from beam-beam interaction taking into account of all major QED processes, to generation of hadronic background events due to collisions of beamstrahlung photons, from simulation of detector environment to analysis of background effect on a particular experiment of particle physics. Our study indicates that QSB is indeed a promising IP approach for future linear colliders.

* This work was supported by the U.S. Department of Energy under contract No.DE-AC03-76SF00098.

14:45 TUCR5 Electron Beam Test Set-up for Beam-Beam Compensation

C.CRAWFORD, D.FINLEY, F.NIELL, J.SANTUCCI, A.SERY, V.SHILTSEV, FNAL; A.CHUPIRA, P.LOGATCHOV, A.SHARAPA, A.SHEMYAKIN, B.SKARBO, B.SUKHINA, BINP.

The electron beam test set-up for beam-beam compensation project is described. We discuss parameters of the electron beam, focusing of the beam by longitudinal magnetic field, the transporting system and its characteristics, the electron gun, modulator and collector, the tolerance of the mechanical mounting and optical solenoid field alignment, the beam diagnostic and control systems. The first results of the electron beam test are presented.

14:57 TUCR6 About the Energy Limit of Electrons in RF Linacs

A.N.OPANASENKO, NSC KIPT

It is shown that in high-energy electron rf-linacs based on periodical accelerating structures particles moving outside of the structure axis must radiate. This radiation is caused by transverse oscillations of the particles in transverse field of non-synchronous spatial harmonics inherent for the periodic accelerating structures. It is obtained that the radiation power emitted by the single electron is proportional to the square of its energy and distance from the structure axis. This circumstance leads to the principal limitation of the attainable energies of electrons in rf-linacs. The formula for the limit energy of a particle accelerated in the periodic rf structure is given. The possible magnitudes of the maximum achievable energy of electrons is stimated for the rf-linacs with parameters typical for the future linear TeV colliders. The possibility of the efficient conversion of rf power into the radiation in periodical accelerating structures for obtaining gamma-beams is discussed. For the typical operation mode of SLAC Linear Collider the estimation of the expected peak power of radiation is given.

SESSION TUDR: LINEAR COLLIDERS SESSION
Tuesday afternoon, 30 March 1999; Broadway Ballroom at 3:40;
Chair: Vladimir Balakin, BINP

15:40 TUDR1 Accelerator Physics Challenges for Linear Colliders (Invited)

T. RAUBENHEIMER, SLAC

16:05 TUDR2 Experience of Superconducting Cavity Operation in the TESLA Test Facility (Invited)

D. TRINES, DESY

A description of the TESLA Test Facility, which was set up at DESY by the TESLA Collaboration, will be given. Measurements of the superconducting 9-cell cavities in vertical and horizontal test cryostats will be presented, as well as the experience with the first two accelerator modules in the TTF Linac. The near term planning on the cavity R&D will be described.

16:30 TUDR3 The CLIC Study of a multi-TeV e Linear Collider

THE CLIC TEAM: R. BOSSART, H.H. BRAUN, G. CARRON, W. COOSEMANS, R. CORSINI, T.E. D'AMICO, J.P.DELAHAYE, J.C. GODOT, G. GUIGNARD, J. HAGEL, S. HUTCHINS, C.D. JOHNSON, E. JENSEN, M. LUONG, A. MILLICH, P. PEARCE, J.P. POTIER, A.J. RICHE, I. RINOLFI, D. SCHULTE, G. SUBERLUCQ, L. THORNDAHL, M. VALENTINI, D.J. WARNER, I. WILSON, W. WUENSCH, CERN; O. NAPOLY, CEA SACLAY, T. RAUBENHEIMER, R. RUTH, SLAC; I. SYRATCHEV, BINP.

The progress of the Compact LInear Collider (CLIC) study of a multi-TeV (0.5 - 5 TeV) high-luminosity (510^33 to 1.510^35 cm-2 sec-1) e linear collider based on Two-Beam Acceleration (TBA) is presented. The length and, in consequence, the cost of the overall complex is reduced by the use of high accelerating fields (150 MV/m), which are generated by specially damped 30 GHz normal-conducting accelerating structures. The large amount of RF power (400 MW/m) required to generate these high fields is provided by a novel RF power generating scheme which is potentially both cost and power efficient. After summarising the progress made in the developments of 30 GHz components and the performance obtained in the present phase of the CLIC Test Facility (CTF2), the design of a new test facility (CTF3), which will demonstrate the feasibility of the RF power generating scheme, is described.

16:42 TUDR4 The Next Linear Collider Machine Protection System*

C. ADOLPHSEN, J. FRISCH, R.K. JOBE, D. MCCORMICK, W.R. NELSON, T.O. RAUBENHEIMER, S. ROKNI, M.C. ROSS, P. TENENBAUM, D. WALZ, SLAC.

The Next Linear Collider (NLC) electron and positron beams are capable of damaging the linac accelerating structure and beamline vacuum chambers during an individual aberrant accelerator pulse. Machine protection system (MPS) considerations, outlined in this paper, have an impact on the engineering and design of most machine components downstream of the damping ring injector complex. The MPS consists of two functional levels. The first is a system that provides a benign, single bunch, low intensity, high emittance beam that will be used for commissioning and at any time that the integrity and the downstream component settings are in doubt. This level also provides for the smooth transition back and forth between high power operation and the benign diagnostic pilot bunch operation. The pilot bunch parameters in the main linac are estimated on the basis of the expected stress in the accelerator structure copper. Beam tests have been done at the SLAC linac to examine the behavior of the copper at the damage stress threshold. Typical pilot beam parameters (compared with nominal) are 1) 10 times reduced emittance, 10 times increased horizontal intensity and 1000 times increased vertical emittance. The second level is the primary protection against a single aberrant pulse. It's goal is to reduce the possibility that a substantial transverse field changes the trajectory of the high power beam from one pulse to the next. All devices that could produce such a field are 1) monitored by a fast response network and 2) have deliberately slowed response times. A 'maximum allowable interpulse difference' is evaluated for each such device as well as the beam trajectory monitors in each interpulse period.

* Work supported by the U.S. Department of Energy under Contract No. DE-AC03-76SF00515

16:55 TUDR5 Vertical Emittance in the KEK Accelerator Test Facility

T.OKUGI, T.HIROSE, Y.TAKAYAMA, TOKYO METROPOLITAN UNIVERSITY; H.HAYANO, K.KUBO, S.KURODA, T.NAITO, K.OIDE, K.TAKATA, SEISHI TAKEDA, N.TERUNUMA, N.TOGE, J.URAKAWA, T.MITSUHASHI, KEK; S.KASHIWAGI, THE GRADUATE UNIVERSITY FOR ADVANCED STUDIES; M.TAKANO, TOHO UNIVERSITY; F.ZIMMERMANN, SLAC;

MOP37 New Features in MEDM*

K. EVANS, JR., ANL

MEDM, which stands for Motif Editor and Display Manager, is the principal GUI interface to the EPICS control system. This paper describes new features that have been added to MEDM in the last two years. These features include editing features such as Undo, Snap to Grid, and many new options for placing, sizing ,and arranging objects. There are also new execute-time features such as a PV Info dialog box and a user-configurable Execute menu. There now exists an extensive Reference Manual and Help, both menu-driven and context-sensitive, which is implemented through a browser. Support for SciPlot, a public-domain Cartesian plot package to replace the commercial XRT/Graph package, and support for CDEV have been added with help from Jefferson Lab. A version of MEDM is available for Windows and Windows NT. Many bugs have been fixed, and crashes have been largely eliminated.

*Work supported by the U. S. Department of Energy, Office of Basic Energy Science, under Contract No. W-31-109-ENG-38.

MOP38 Using Xwin on Accelerator Controls

GE LEI, JIJIU ZHAO INSTITUTE OF HIGH ENERGY PHYSICS, P.R.CHINA

Xwin is a graphical user interface toolkit developed at the Institute of High Energy Physics of Chinese Academy of Scienses. It is used for constructing accelerator control applications. Based on X Window System and OSF/Motif, it provides functions to build windows, draw graphs, display scientific data. Using this toolkit, as well as the X Window System and Motif, the authors will present a method for controlling the accelerator through a graphical interface. The paper first introduces the graphical file format the authors defined to record the type, name and position of the magnets on a graph. Next, the application "wnpaint" that draws elements on a given background graph will be discussed. Finally, we introduce the application named "control-demo", that demonstrates how to ues a graph of an accelearator lyaout to control the accelerator itself.

* Work supported by the U.S. Department of Energy under Contract DE-AC05-84ER40150

MOP39 Automated Optimization Tuning Package for the SLC

P.GROSSBERG, N.PHINNEY, H.SMITH, SLAC

A linear collider requires precision optimization of multiple parameters to achieve peak performance. Of particular importance are emittance reduction throughout the accelerator and final tuning of the transverse beam size at the interaction point (IP). To facilitate this optimization at the SLC, a semi-automated software package was implemented. Emittance is measured non-invasively with sets of wire scanners at different phases which are located at several positions in the Linac or in the Final Focus. Beam size at the IP is measurementd by beam-beam deflection scans or indirectly by a luminosity monitor. Typically, the control to be optimized is an orthogonal, closed bump in the beam orbit used for global cancellation of wakefield tails. The SLC feedback system is utilized to implement and to close the bump. The control variable is automatically stepped through a range of values while measuring the resulting beam emittance or other signal. A parabolic fit to the data is performed and the optimal setting for the bump can them be implemented. History plots are available to track the corrections, fit parameters and other quantities of interest over long time periods. The system is database- driven to allow easy expansion and is layered on top of the existing Correlation Plot software. It has been implemented for the SLC Linac, injector and damping ring extraction region.

MOP40 Measuring the Betatron Phase Advance in PEP-II with 1000 Turn BPM Measurements *

T. HIMEL, L. HENDRICKSON, S. SMITH, M. ZELAZNY SLAC

The beam position monitor (BPM) system for the PEP-II accelerator at SLAC is capable of recording the beam position on 1000 consecutive turns. Following a method developed at CERN, we excite the beam at the tune frequency, fit the 1000 turn data to a sine wave and thus measure the betatron phase advance. These phase advance measurements are accurate to better than a degree. The sine fit is done by a DSP in the BPM processor so a complete measurement and calculation can be done in a few seconds. Using on-line software beta functions can be calculated from the phase advances. With these measurements BPM hardware problems become immediately evident. Beta beats are easily measured. The focusing errors caused by orbit offsets in sextupoles can be detected.

*Work supported by the U.S. Dept. Of Energy under contract number AC03-76SF00515

MOP41 VEPP-5 forinjector klystron gallery control system.

A.N. ALESHAEV, I.V. BELOUSOV, I.E. BORUNOV, R.G. GROMOV, K.V. GUBIN, A.A. NIKIFOROV

Control system for VEPP-5 forinjector klystron gallery is being presented. Basic goals, requirements and principles are described. The net of intellectual CAMAC-controllers, communicated by a special CAMAC-Ethernet interfase, is accepted as a optimal hardware design. The software and the net protocols are described. Present status and expluatation facilities are presented.

MOP42 MONITORING OF THE ELECTRON BEAM POSITION IN INDUSTRIAL LINACS.

V.N.BORISKIN, A.N.SAVCHENKO, V.I.TATANOV. NATIONAL SCIENCE CENTER, KHARKOV INSTITUTE OF PHYSICS AND TECHNOLOGY (NSC KIPT), UKRAINE

Recently the technological linear electron accelerators with the energy up to 10 and 25 MeV and the pulse current up to 1A have been developed and put into operation in the Scientific Research Complex "Accelerator" of the National Science Center, Kharkov Institute of Physics and Technology. The zone of the technological object irradiation by the accelerated electrons is created by the magnetic scanning system [2]. Wide-aperture (50 x 200mm) magnetic position monitor has been designed to control the electron beam position. Signals from the monitor are used in the accelerator control system [3].

[1] A.n.Dovbnya et al. Electron Linacs Based Radiation Facilities of Ukrainian National Science Center "KIPT / Bulletin of the American Physical Society, May 1997, V.42, No.3, p.1391."
[2] A.N.Dovbnya, et al. , "The Output Beam Scanning and Forming in the Multipurpose Electron Accelerators of KIPT", VANT, Series: Nucleic
Pgysics, 1997, Vol 1(28). p.114-121.
[3] V.N.Boriskin et al. Control system for a linear resonance accelerator of intense electron beams / Nucl. Instr. and Meth. in Ph ys. res A 352

MOP43 A System for Providing High Quality Triggers to Experimental Areas. *

M.P. FAHMIE LBNL

Many researchers require a high resolution trigger to synchronize their data gathering electronics with the arrival of a synchrotron radiation pulse at their target. At ALS, this requirement was initially satisfied in a case by case manner by running Heliax cables from the Accelerator Timing System [1] to the various experiment locations. This approach was less than ideal due to poor risetimes, cost and difficulty of running Heliax cables, and the inconvenience of fixed timing. A new system has been installed at ALS that provides the researcher with a high quality, adjustable delay fiducial trigger, and a low level sample of the Accelerator RF (499.66 Mhz). The Ring Orbit Clock (1.523 Mhz) is distributed from the Accelerator Timing System to the various experiment locations using inexpensive twisted pair cable, where it is processed by a Phase Locked Loop Multiplier and High Speed Logic to integrate out noise/jitter and to produce the desired signals. Local drivers provide the researcher with sharp edged robust triggers

bias power supplies is provided, the higher rf voltage will be obtained. With sweeping the frequency from 1MHz to 5MHz, this amplifier has generated the rf voltage up to 15kV at 2MHz. It mainly depends on the gain-frequency characteristics of a driver amplifier.The other with two 30kW class tetrodes (4CW30,000A) and the cavity were prepared for accelerating heavy ions at HIMAC. For this purpose, it is necessary to sweep the frequency over the wide range from 1MHz to 8MHz. It has generated the rf voltage up to 5kV at 3MHz.

MOP145 Operational Experience with Two Types of 2 MW HVDC Power Supplies on LEDA.*

J. BRADLEY III, D. REES, R. PRZEKLASA, LANL; N.C. JAITLY, G. SCHOFIELD, MAXWELL TECHNOLOGIES; M. SCOTT, CONTINENTAL ELECTRONICS

The high voltage DC power supplies are predicted to be the most expensive component of the accelerator at the Accelerator Production of Tritium (APT) plant. Two different types of candidate HV power supplies are being tested on the Low Energy Demonstration Accelerator (LEDA) at Los Alamos National Laboratory. The first type uses SCRs in a twelve pulse topology with a spark gap crowbar. The second type uses IGBTs in a Solid State Modulator topology without a crowbar. While both topologies have been proven in existing high voltage applications, both systems contain new features to improve performance and reliability that have advanced the state of the art in HVDC power supply design. LEDA is being used demonstrate the benefits of these features for the APT plant and evaluate their impact on power supply reliability, serviceability and cost. We present detailed measurements of total power supply efficiency and the effect each topology has on the power factor and harmonic input currents drawn from the local power distribution system in addition to operational performance with other accelerator systems.

* Work supported by the U.S. Department of Energy.

MOP146 A Universal Multi-Mode Filament Regulator for Hard Tubes

R.A.CHURCH, A.F.STEVENS, RAL

High power RF hard tubes, used to excite the resonant cavities of the Rutherford Appleton Laboratory's ISIS LINAC, have tended to fail prematurely as a result of low electron emission. A direct relationship between applied power and filament temperature exists and the Richardson-Dushman equation shows that for a small increase in filament temperature, a significant increase in the availability of electron emission occurs. The resulting increased depletion of filament carburization shortens the lifetime of the tube. This paper is concerned with the development of a universal filament management system to extend and predict the longevity of high power RF tubes. Real filament lifetime data implementing power control is also presented. Not only would this reduce capital costs but would promote a strategy whereby a scheduled tube replacement scheme could be implemented. In addition, it should be possible to determine the assertion that power control of thoriated tungsten filaments is superior to that of voltage control.

MOP147 Low-power Driver of the Cathode-follower RF System for a High-intensity Proton Synchrotron

Y. IRIE, S. TAKANO KEK

A new method is proposed to solve a power-consumption problem of the driver stage in the cathode-follower RF system. The driver voltage is directly supplied across the grid and cathode of the cathode-follower by means of an isolation transformer. The voltage gain is then a few tens of times higher than that of a conventional driver scheme. A low output impedance is preserved in this method. The model system has been tested under frequency modulation in the 1-3 MHz range at 40 Hz repetition; the output impedance is 30 ohms and the driver voltage 62 volts to produce 1.2 KV peak at the cavity gap. The design of a high-power RF system using the new method is in progress with a 240 KW triode. The frequency range from 2 to 6 MHz is intended for a second-harmonic RF system which will be installed at the ISIS synchrotron through collaboration between the Rutherford Appleton Laboratory, the Argonne National Laboratory and the KEK.

MOP148 Operation of the Powerful Hard Tube Modulators with an Artificial Former Line at the MMF DTL

L.N. KAZANSKIY, A.I. KVASHA, I.L. KORENEV, INSTITUTE FOR NUCLEAR RESEARCH, RAS, MOSCOW;

At the Moscow Meson Factory DTL RF system powerful anode modulators with hard vacuum tubes and partly discharge artificial former line (AFL) put into operation ten years ago. They have a few advantages compared to hard tube modulators with a capacity room such as: decrease of the capacities amount; limitation of the current in cases where in the modulator or RF power amplifier vacuum tubes break-downs occur; simplicity of the crow-bar realization. Some problems of crow-bar and high voltage supply up-grades are discussed. Particular attention is paid to matching of the modulator pulse length and the AFL time discharge. The more the last exceeds the modulator pulse length the more is an amplitude of oscillations in AFL during store of an AFL voltage after modulator pulse finishing. The oscillation frequency value depends on the AFL time discharge and at the MMF DTL RF system modulators do not exceed 2 kHz. The oscillations can lead to a false switching on crow-bar and they are the reason of the extra heat dissipation in cells of the AFL. Investigations and calculations in order to improve the operation of the hard tube modulators are performed.

MOP149 High Power Tube RF CW Modular Design Amplifiers for Accelerators

V. ARBUZOV, A. BUSHUEV, E. GORNIKER, A. KONDAKOV, V. PETROV,BINP

Characteristics, features and design of the multi-purpose high power amplifier stages for RF CW generators at the frequency of 180 MHz are described. Water cooling GU-101A tetrodes producing at SVETLANA, St. Petersburg are used in the stages. The modular principle of design permits to build RF power amplifiers with maximum output power from 150 to 600 kW from few standard units. The stage consists of one to four tetrode modules, one tuner and one coupler. These units can be easily connected each to other. As a result the output RF power is produced from one tube or combined from several tubes. The features of the stage provide operation in different RF systems for accelerators without circulators. A two-tube stage operated at VEPP-4 collider and a CW power of 300 kW was obtained. Now a four-tube stage drives five RF cavities of VEPP-4. A CW RF power of 500 kW was reached. RF power 1 Mw at VEPP-4 RF system is provided by power combining of two four-tube stages. The two-tube type of generator is used in Siberia-2 storage ring at Kurchatov Institute, Moscow. Two one-tube generators (130 kW for each) operate at the RF system of the Injector for Race-Track Microtron-Recuperator now. The same RF system operates at South Korea (KAERI, Taejon). Four-tube types of power amplifiers for RF system of the Race-Track Microtron-Recuperator for FEL are now under construction at BINP.

MOP150 High-Power Microwaves from Folded Waveguide Klystron

HAN S. UHM, AJOU UNIVERSITY

One disadvantage of conventional klystrons as an effective amplifier is their limited narrow-band operation. In order to develop a broad bandwidth amplifier, we investigate a folded waveguide klystron. The electron beam interacts periodically with the E-plane-bend of a folded rectangular waveguide. RF signals propagate through the folded waveguide, periodically interacting with a linear electron beam at the bend. A theory relating phase of the current modulation to the microwave phase is developed for the folded waveguide klystrons. The power transfer from the beam to microwave is described in terms of the propagation distance and phase shift of the energy modulations launched at gaps. It is shown that the phase difference between the current modulation and the induced voltage at the gaps is essential for efficient power transfer from the beam's kinetic energy to microwave field energy. The optimum value of the phase shift for maximum power transfer from

At the University of Maryland, we have been developing gyroklystrons for advanced electron-positron linear collider applications. We have recently achieved over 80 MW of peak power at 8.6 GHz with a three-cavity first-harmonic gyroklystron [1]. The interaction was observed between a 470 kV, 500 A annular, rotating beam and a sequence of TE01 coaxial cavities. The efficiency was about 32% and the gain was about 30 dB. We are currently testing a three-cavity tube which is designed to produce over 100 MW of power at 17.14 GHz with an efficiency of 40%. The input cavity is the same TE01 cavity used in the first harmonic experiment, but the buncher and output cavities are TE02 cavities which operate at twice the cyclotron frequency. In this paper we will describe the design of the circuit and detail the hot test results. We will also describe the designs of tubes which are capable of higher gain and higher rep-rate operation. Finally, we will detail our plans to drive an accelerator structure and our plans for a gyroklystron experiment at 35 GHz.

[1] W. Lawson, J. Cheng, M. Castle, B. Hogan, V. L. Granatstein, M. Reiser, and G. P. Saraph, "High Power Operation of a Three-Cavity X-Band Coaxial Gyroklystron," Phys. Rev. Lett., vol. 81, pp. 3030-3033 (1998).

MOP165 X-Band Magnicon Amplifier*

O.A. NEZHEVENKO, V.P. YAKOVLEV, J.L HIRSHFIELD, OMEGA-P, INC.; S.H. GOLD, A.W. FLIFLET, NRL; A.K. KINKEAD, SACHS-FREEMAN; R. TRUE, R. HANSEN, LITTON; E.V. KOZYREV, BINP

A progress report will be presented on an 11.424 GHz magnicon amplifier that is being assembled at NRL in a joint experiment with Omega-P, Inc. The design parameters are 61 MW, 61% efficiency, 62-dB gain, 1-μsec pulse width with a repetition rate of up to 10 Hz. The magnicon makes use of an ultrahigh convergence electron gun to produce a 480-kV, 210-A, sub-2-mm-diameter electron beam. Results of initial gun tests and beam measurements will be presented. Initial operation of the complete magnicon tube is scheduled for early 1999.

*Work supported by DoE, ONR, and a DoE SBIR grant to Omega-P, Inc.

MOP166 TRAVELING-WAVE ACCELERATING TEST STRUCTURE AT 34.3 GHz*

O.A. NEZHEVENKO AND V.P. YAKOVLEV, OMEGA-P, INC.

A future electron-positron linear collider with c.m. energy in the range of 3-5 TeV is understood to require an operating rf frequency in the range of 30-100 GHz. Higher operating frequency can lead to higher acceleration gradient, with a corresponding smaller accelerator length. This paper describes a test structure designed to determine the maximum achievable accelerating gradient for an operating frequency of 34.272 GHz. The 6-cm long test structure consists of 20 cells operating in the 2pi/3 traveling-wave mode. It is to be driven using a magnicon amplifier, designed and being built by Omega-P-Inc., with a design power of over 40 MW in a 1 microsec pulse. Preliminary calculations indicate that this should make it possible to test the structure to accelerating gradients over 300 MV/m.

*Research sponsored by US DoE Division of High Energy Physics.

MOP167 Multi-Megawatt W-Band RF Source Based on Eighth Harmonic Co-Generation*

CHANGBIAO WANG, O. A. NEZHEVENKO AND J. L. HIRSHFIELD, YALE UNIV. AND OMEGA-P, INC.

Co-generation is a harmonic conversion process in which gyroharmonic acceleration of an electron beam at a fundamental frequency gives rise to generation of coherent radiation at frequency m times the fundamental. Efficient 7th-harmonic co-generation can take place in a uniform cylindrical waveguide when the fundamental driving mode is TE_{11} and the harmonic mode is TE_{72} with m = 7 [1]. When both modes are traveling waves in the same waveguide, m-values are limited in order to preserve nearly synchronous group velocities, and gyroresonance occurs for both modes in the same magnetic field profile. Experiments are underway to demonstrate this process at 20 GHz [2]. If other values of m are of interest, the appropriate matching conditions can be met if a TE_{111} cavity is used to accelerate the beam, and an adjacent traveling-wave section of different radius is used to extract the harmonic radiation. Analysis of this process has been carried out for a TE_{111} cavity with R = 0.780 cm and L = 5.0 cm driven at 11.424 GHz and a TE_{81} mode traveling wave output section with radius $(j'_{81}/8j'_{11})R = 0.522$ cm, where the j'_{mn} are eigenvalues for TE_{mn} modes. Preliminary computations show that a cavity with unloaded Q of 5000 can accelerate a 61 A, 500 kV beam to 1.14 MeV with an efficiency of over 95%, when driven with 40 MW of rf power at 11.424 GHz. Harmonic power output at 91.4 GHz depends upon injected beam quality but, under realistic conditions, is predicted to exceed 15 MW. This harmonic amplifier should find application in testing high-gradient W-band accelerating structures.

*Research sponsored by DoE Division of High Energy Physics.
[1] C. Wang, J. L. Hirshfield and A. K. Ganguly, Phys. Rev. Lett. 77, 3819 (1996).
[2] M. A. LaPointe et al (this meeting).

MOP168 FEL-Oscillator for Feeding of High-Gradient Accelerating Structure*

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Millimeter-wave FEL-oscillator is one of a possible source of RF power for accelerating structures of future linear colliders with high energy gain [3]. JINR-IAP collaboration develops a high-efficiency single-mode FEL-oscillator with Bragg resonator and reversed guide field [4,5]. Output power of 40 MW at the frequency of 31 GHz with spectrum width 0.25% was registered in recent experiments using induction linac LIU-3000 (0.8 MeV, 200 A, 200 ns). In this paper we discuss technical solutions for providing of: - Frequency stability with accuracy better than 0.3%; - Precise frequency coincidence of the oscillator and the accelerating structure; - RF power transportation from the oscillator to the structure.

* This work is supported by grants 97-02-16643 and 97-02-17379 of Russian Foundation for Basic Research
[1] Joint Institute for Nuclear Research, Dubna, Russia
[2] Institute of Applied Physics, Nizhny Novgorod, Russia
[3] G.G. Denisov, V.L. Bratman, A.K. Krasnykh et al., "Problems of autobunching and phase stability for the TBA-driver: calculations and design for a modeling experiment" -Nuclear Instrum. and Meth., A358 (1995) 528-531.
[4] A.K. Kaminsky, A.A. Kaminsky, V.P. Sarantsev e

MOP169 Study of RF Components For JLC 2*2 DLDS

J.Q. WANG, Y.H. CHIN, S. KAZAKOV, S. YAMAGUCHI AND H. TSUTSUI, KEK

We have studied a multi-mode Delay Line Distribution System (DLDS) as the RF power distribution system from klystrons to RF structures for linear colliders. In particular, a 2*2 DLDS, which is simple but has good transmission efficieny, has been proposed and studied at KEK for Japan Linear Collider (JLC). We have designed RF components of a basic unit of a DLDS using the High Frequency Structure Simulation (HFSS) code. They include the TE01 extractor, the TE11 to TE01 convertor, and the TE11 to TE12 convertor for TE12 mode. HFSS calculation of the system, which consists TE01 extractor and TE11 to TE01 convertor, show that the transmission efficiency of each mode is better than 90%. The components, as well as the system is being studied experimentaly. A low power test model for the mode stability experiment in 55m long waveguide in DLDS is being developed.

Storage rings and accelerators in general could benefit from larger betatron tune spreads in order to increase the thresholds of various transverse instabilities. The disadvantage of nonlinear optical elements is that they create nonlinear resonances and, consequently, reduce the beam lifetime and increase loses. An "integrable" nonlinear optics lens is the solution to this problem. The difference between usual nonlinear structure and integrable one is in the existence of "regular" invariants of motion in the latter case which means the absence of stochastic motion and dynamic diffusion. Though this idea is straightforward, it is difficult to find consistent 2D magnetic configurations which meet the integrable motion conditions. One of the possible examples has been developed and presented in this paper. A special lens is proposed to produceparticles integrable nonlinear motion without resonances. This lens could be applied to the new generation of Spallation Neutron Sources, which require storage of high particle intensities, with very low losses.

* This research is sponsored by the Division of Materials Sciences, DOE, under contract DE-AC05-96OR22464 with LMER.

TUA52 On Possibilities to Raise the e-p Instability Threshold for the PSR.*

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The Los Alamos Proton Storage Ring has a fast instability that limits the proton beam intensity. A probable explanation of this instability is that there exists a large amount of electrons in the vacuum chamber. The electron interaction with the proton beam leads to a transverse mode coupling instability, similar to the two-stream plasma instability. A method to clear electrons from the proton beam using the electron parametric resonance is proposed. To accomplish this an RF cavity is proposed with a frequency of about 200 MHz and a moderate voltage of about a few tens of kV. Another method of a dynamical elimination of the instability threshold by an oscillating lens is presented.

* This research is sponsored by the Division of Materials Sciences, DOE, under contract DE-AC05-96OR22464 with LMER.

TUA53 A Transverse Feedback System Capable to Counteract the Strong Head-Tail Instability

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A simplified consideration is presented of the special transverse feedback system (recently proposed by V.Danilov and E.Perevedentsev), aimed at enhancement of the threshold of the strong head-tail instability. Its feature is that the frequency response should be limited to, say, one or two narrow bands, thus simulating in the feedback hardware one or two artificial oscillators coupled to the beam head-tail modes to be stabilized. Implementation of this approach in a realistic feedback system and the appropriate choice of its parameters is discussed, with the emphasis on simultaneous stability of many head-tail modes.

TUA54 Transverse Beam Motion on the Second Axis of the Dual Axis Radiographic Hydrodynamic Test Facility*

YU-JIUAN CHEN, GEORGE J. CAPORASO, ARTHUR C. PAUL (LLNL); WILLIAM M. FAWLEY (LBNL)

For the second-axis of the Dual-Axis Radiographic Hydrodynamic Test (DARHT-II) facility [1], a linear induction accelerator will generate a 4 kA, 20 MeV, 2 ms long electron current pulse with an energy variation no greater than 0.5%. Four 60 - 100 ns long current pulses out of this 2 ms long current pulse will be selected and delivered to an x-ray converter target. The radiographic performance of this facility requires these electron pulses to be focused to spots of order 1mm-diameter on Bremsstrahlung targets throughout the entire pulse duration of each current pulse. Therefore, the peak-to-peak transverse beam motion within each pulse has to be less than 1 mm. We have modeled the transverse beam motion from the DARHT-II injector exit to the x-ray converter target. The sources of transverse beam motion in the accelerator are injector noises, misalignments and energy variations. These sources lead to the beam breakup instability and corkscrew motion. The additional sources in the downstream beamline are misalignments, energy variations and beam induced transverse deflection in the kicker systems. Three simulation codes are used for the modeling: BREAKUP for transport in the accelerator, TRANSPORT to determine transformation matrices of the downstream beamline components, and KICKER to transport the BREAKUP outputs to the x-ray converter target through kicker systems. The corkscrew tuning-V algorithm is used to minimize the transverse beam motion in the BREAKUP and the TRANSPORT simulations. The simulation results will be presented.

* The work was performed under the auspices of the U.S. Department of Energy by LLNL under contract W-7405-ENG-48, and by LBNL under contract AC03-76SF00098.

[1] M. J. Burns, et. al., DARHT Accelerators Update and Plans for Initial Operation, this conference.

[2] Yu-Jiuan Chen, Nuclear Instruments and Methods in Physics Research A 398 (1997) p.139-146.

TUA55 Operational Experience with the PEP-II Transverse Coupled-Bunch Feedback Systems.*

W. BARRY, J. BYRD, J. CORLETT, D. LI, LBNL; J. FOX, M. MINTY, S. PRABHAKER, D. TEYTELMAN, SLAC.

Operational experience with the PEP-II high energy ring (HER) and low energy ring (LER) transverse coupled-bunch feedback systems is discussed. In particular, key performance data including beam transfer function measurements and modal growth and damping rate measurements are presented. In general, growth rates much greater than expected at very low currents have been observed. Results from experiments using the transverse and longitudinal feedback systems to determine the source of the fast instabilites are presented and discussed.

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TUA56 Beam Breakup Calculations for the Second Axis of DARHT*

W.M. FAWLEY, LBNL; YU-JIUAN CHEN, T.L. HOUCK, LLNL;

The accelerator for the second axis of the Dual Axis Radiographic Hydrodynamic Test (DARHT) facility will produce a 1-4 kA, 20-MeV, 2-μ s output electron beam with a design goal of less than 1000 π mm-mrad normalized transverse emittance and less than 0.5-mm beam centroid motion. In order to meet this goal, the beam transport must have excellent optics and the beam breakup instability (BBU) must be limited in growth. Using a number of simulation codes such as AMOS and BREAKUP, we have modeled the transverse impedances of the DARHT-II accelerator cells and the electron beam response to different transverse excitations such as injector RF noise, magnetic dipole fields arising from the 90-degree bend between the cathode stalk and insulator column, and downstream solenoid alignment errors. The very low Q (~2) predicted for the most important TM dipole modes has prompted us to extend the BREAKUP code to be able to use the dipole wakefields calculated by AMOS in addition to the most usual discrete frequency BBU mode model. We present results for the predicted BBU growth and the empirical sensitivity to various machine parameters.

*This work was performed under the auspices of the U.S. Dept. of Energy by LBNL under contract AC03-76SF00098 and by LLNL under contract W-7405-ENG-48.

TUA57 Search for the Electron-Cloud Effect in PEP-II. *

M. FURMAN, G. LAMBERTSON, M. ZISMAN, LBNL S. HEIFETS, J. SEEMAN, F. ZIMMERMANN, SLAC

Any intense, positively-charged beam of closely-spaced bunches in a circular accelerator is expected to give rise to an electron cloud in the vacuum chamber. The electrons are photoproduced as the synchrotron radiation from the beam strikes the vacuum chamber walls; in addition, secondary electrons are produced as the electrons "rattle around" the chamber under the influence of the positive beam. The electron cloud couples the transverse motion of successive bunches potentially leading

We have studied the methods for the estimation of a reference closed orbit of the storage ring in PLS using magnet misalignment data. The reference closed orbit was determined by (1) a smoothing analysis using a low-pass filter method, and (2) a close orbit distortion by MAD(methodical accelerator design) simulation using the real parameters such as magnet offsets. The relative positional errors of the storage ring magnets based on the estimated reference closed orbit were evaluated. The results of case studies on the comparison of smoothing analysis and MAD simulation are described in this presentation.

* This work is partially supported by the Korean Ministry of Science and Technology and by the Pohang Iron and Steel Company.

TUA133 Ground Motion Measurements for Fermilab Future Collider Projects

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We present results of wide-band ground motion measurements at the Fermilab site and at two deep tunnels in the Illinois dolomite, thought to be a possible geological environment of the Fermilab future accelerators.

TUA134 Alignment of the VISA Undulator

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The Visible-Infrared SASE Amplifier (VISA) undulator [1] was constructed of four 99-cm long segments, joined into a seamless, periodic structure. The entire undulator was housed within an aluminum vacuum chamber. Before assembly into the vacuum chamber, each undulator segment was set up on a pulsed-wire bench, to characterize the magnetic properties and to locate the magnetic axis of the FODO array [2]. Subsequently, the location of the magnetic axis, as defined by the wire, was referenced to tooling balls on each magnet segment by means of a straightness interferometer. After installation in the vacuum chamber, the four magnet segments were aligned with respect to themselves and globally to the beam line reference laser. A specially designed alignment fixture was used to mount one straightness interferometer each in both the horizontal and vertical plane of the beam. The straightness interferometers served as the tool to integrate measurements to the reference laser beam using a laser beam reference fixture and to the undulator axes by means of the tooling balls on the magnet segments. The goal of these procedures was to keep the combined rms trajectory error, due to magnetic and alignment errors, to 50 μm. This paper explains the conceptual alignment design, describes straightness interferometry and its intrinsic error sources, and presents the alignment steps performed to achieve the given tolerances.

This work was supported by the United States Department of Energy, Office of Basic Energy Sciences under contract No. DE-AC03-76SF00515.

[1] R. Carr et al.: The VISA Free Electron Laser, these Proceedings
[2] G. Rakowsky et al., Measurement and Optimization of the VISA Undulator, these Proceedings

TUA135 The SRRC-U9 Undulator Retraction System

T.E. DEHART, J.F. ZUMDIECK, A.S. VALLA[1], K.E. ROBINSON, STI OPTRONICS, INC.

The SRRC-U9 undulator system, recently completed for the Synchrotron Radiation Research Center, has many challenging requirements. Among those requirements is the ability to retract the undulator from the vacuum chamber quickly. It is also necessary to be able to remove the undulator and replace it without significant misalignment. The 9.5 metric ton undulator must have a repositioning accuracy within 150 μ m in the horizontal plane and 50 μ m vertically. Earthquake restraints must be provided which do not compromise the kinematic mounting of the undulator. Because of the very limited vertical envelope for the entire undulator system, the retraction system must achieve these operating characteristics in a vertical height of about 160 mm. We present the design philosophy and performance results of this system which can be applied to many accelerator applications.

[1] Presently at AVALLA Design, Inc.

TUA136 An Ogive Shaped Carbon-Carbon Composite Beam Stop

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An ogive shaped carbon-carbon (C-C) composite beam stop has been designed to replace the original nickel ogive beam stop for the Low Energy Development Accelerator (LEDA) of the APT (Accelerator Production of Tritium) project. The nickel beam stop has been used for initial testing of the 6.7 MeV, 100 mA cw proton beam from the APT RFQ (Radio Frequency Quadrupole). Because of activation concerns, another beam stop is needed for future tests on the first module of the Coupled-Cavity Drift-Tube Linac (CCDTL), which will increase proton beam energy to 10.4 MeV. The C-C ogive has been integrated into the nickel structure as a direct replacement. The design and fabrication of the C-C composite ogive beam stop will be presented. A review of the original nickel ogive design will also be presented, including performance during RFQ testing on LEDA.

* Work supported by DOE contract: DE-AC04-96AL89607

TUA137 A Room Temperature Test Bed for Evaluating 700-Mhz RF Windows and Power Couplers for the Superconducting Portion of the APT Linac

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Superconducting cavities are used in the high-energy portion of the Accelerator Production of Tritium (APT) linac to accelerate the beam to approximately 1700 MeV. To accelerate the 100 mA proton beam and to maintain the field levels in the cavity, up to 420 kW of CW (continuous wave) 700-MHz RF power needs to be delivered to the cavity. This is done using two RF window and power coupler assemblies that can each transmit 210 kW. To evaluate developing window-coupler designs, a Room Temperature Test Bed (RTTB) has been built that utilizes a room-temperature copper coupling cavity for mating two power couplers together. Several parameters are being tested such as: (1) power coupler matching, (2) maximum power handling, (3) RF losses in the power coupler, (4) SC RF Window/Power Coupler matching, and (5) Power Coupler/Cavity coupling adjustability. The RTTB is also meant to be a conditioning stand for window-coupler assemblies that will go on cryomodules. The design features of the coupling cavity, the test stand hardware, the vacuum system, and the test configuration layout shall be discussed.

* Work supported by DOE contract: DE-AC04-96AL8960

TUA138 Induction Cell Test of a High-Gradient Insulator*

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Lawrence Livermore National Laboratory and AlliedSignal Corporation have been developing periodic metallic-dielectric insulating structures, referred to as High-Gradient Insulators (HGIs). These HGIs have demonstrated superior voltage hold off in the presence of intense electron beams and improved rf impedance characteristics in cavity configurations. An interesting area for employment of the HGI is in high-current, electron-beam, induction accelerating cells. We are performing hot tests of an induction cell using a 1-MeV, 1-kA, 150-ns electron beam

mechanism is given and the test result of a modified kicker magnet is presented.

TUA160 HOMs Effects in the BEPC DC Seperator
J.P. DAI, X.D. CHAI, Z.T. ZHAO,IHEP
During the operation of BEPC, the cable isolation layer near the high voltage connector of the DC seperator is often melted which is probably caused by the HOMs. This paper presents the measurement results of the HOMs shunt impedances, the calculated power dissipated in the seperator and connector, and the analysis of the HOMs effects.

TUA161 Thermostabilisation system of VEPP-5 preinjector.
K.V.GUBIN, A.G.IGOLKIN, V.D.KHAMBIKOV, P.V.MARTYSHKIN
This paper is dedicated to the problem of thermostabilisation of VEPP-5 preinjector linear accelerator. The influence of heating effects on the bunch parameters are presented. Numerical criteria for optimisation of parameters are obtained as a results of the accelerator section heating regime analysis. Design of thermostabilisation system is discussed. Present status and explanation of a system prototype used as subsystem of preinjector prototype are presented.

TUA162 Performance test of 190MW Pulse Modulator using Inverter Power Supplies for SPring-8 Linac
T. HORI, H. YOSHIKAWA, T. ASAKA, H. SAKAKI, S. NAGASAWA, H. HANAKI AND H. YOKOMIZO
The 190MW test modulator which are 390kV peak beam voltage, 60pps pulse repetition rate, 2.2msec flat-top pulse width and less than 0.15%(FWHM) beam voltage stability has been tested for its performance at the klystron gallery in the SPring-8 LINAC. In order to make a pulse modulator more efficient, it should be improved that the cooling water capacity and a power factor of the inverter power supplies which is used for high voltage charging component of the PFN capacitors. This paper presents the recent of performance test for the test modulator after to be modified the cooling water system and the rectifier circuit of inverter power supplies.

TUA163 Development of a 50 kW CW L-Band Rectangular Window for Jefferson Lab FEL Cryomodule*
V. NGUYEN, H.L. PHILLIPS, AND J. PREBLE, JEFFERSON LAB
A 50 kW CW L-Band Rectangular Ceramic Window has been developed for the Jefferson Lab FEL quarter cryomodule. RF properties of the windows were optimized using high-frequency simulation codes and S-parameter measurements confirmed the predicted broad band matching properties of the structure. Metallized AL 995 alumina ceramic was brazed to a thin copper sleeve and the sleeve to a copper plated stainless steel flange. Losses in the metallization were removed efficiently by a water cooling circuit. High power tests in a resonant ring showed that the ceramic temperature rise was very low at 50 kW CW level.

*Work supported by the U.S. Department of Energy under contract DE-AC05-84-ER40150

TUA164 An R.F. Input Coupler System for the CEBAF Cryomodule Upgrade (Cavity Development Group)*
L. PHILLIPS, L. R. DOOLITTLE, J. MAMMOSSER, J. PREBLE, AND G. WU, JEFFERSON LAB;
Long-term plans for CEBAF at Jefferson Lab call for achieving 12 GeV in the middle of the next decade and 24 GeV after 2010. In support of those plans, an Upgrade Cryomodule capable of providing more than twice the voltage of the existing ones is under development. A new waveguide coupler system for the upgrade cryomodule has been designed and is currently being tested. This coupler, in contrast to the original CEBAF coupler, has a nominal external Q of 1.5 x 107, reduced sensitivity of external Q to mechanical deformation, reduced field asymmetry within the beam envelope, freedom from window arcing using a single window at 300K, and is optimized for an average traveling wave power of 8 KW. Design features and test data to date are reviewed.

*Work supported by the U.S. Department of Energy under contract DE-AC05-84-ER40150

TUA165 Accelerator Reliability Database
C. PIASZCZYK, NORTHROP GRUMMAN
Accelerator beam trips have been identified as a significant issue in the development of high power accelerator driven systems envisioned for transmutation of waste, energy multipliers, etc. where the accelerator must work in conjunction with a subcritical reactor. In order to design such systems with the high reliability required, a reliability database is being assembled. This paper provides a summary of progress in this effort to date.

TUA166 Control Technique of Electron Linear Accelerators by Temporal Modulation of Gun Electrons and Magnetron Microwave Pulses
D.I. MARTIN, A. JIANU, M. TOMA, C. OPROIU, S. MARGHITU
The data acquisition and control system for the electron linear accelerator ALID-7 of 5.5 MeV and 0.7 kW, built in Romania, used on pilot-scale radiation processing, is discussed. The system provides: personnel and sensitive devices protection against dangerous events; programmed interlocking and warning signals during accelerator operation; single electron pulses or electron pulse trains with small variations in pulse dose; control of electron pulses length and repetition rate, electron beam intensity, magnetron frequency, high voltage level on magnetron and electron-gun modulators, sweeping amplitude and frequency, conveyor velocity, irradiation time and electron pulses number; simultaneous electron beam and microwave treatment. An important feature of the installation is an original control technique for obtaining programmed beam single shots and pulse trains with programmed pulse number, pulse repetition frequency and pulse duration, from a diode gun linear accelerator, by discrete pulse temporal position modulation of the gun electron pulses and the magnetron microwave pulses. It is particularly useful for automatic control of absorbed dose rate level, irradiation process control as well as in pulse radiolysis studies, single pulse dose measurement or for research experiments where pulse-to-pulse reproducibility is required.

TUA167 MAGNETIC FIELD DISTRIBUTION MEASUREMENT BY VIBRATING WIRE STRAIN GAUGE
ARUTUNIAN S.G., DOBROVOLSKI N.M., EGIAZARIAN S.L., MAILIAN M.R., SINENKO I.G., VASINYUK I.E. YEREVAN PHYSICS INSTITUTE ALIKHANIAN BR. ST. 2, 375036, YEREVAN, ARMENIA
The interaction between the weighed sample (permanent magnet) and magnetic field provide possibility to measure the magnetic field gradient. Such a procedure were done by developed vibrating wire strain gauge with normalized resolution better than 1E-5 . The measured force was converted into own resonanse frequency of the wire. A comlete PC-aided system for such spatial distribution measurements is designed and manufactured. The measurements were done by scanning of magnetic fields along the vertical axis using probe from known materials (calibration were done by Hall probes).

TUA168 A New Window Coating System and a New Window for the ALS*
C.C.LO, JIM JULIAN, KEN BAPTISTE AND BRIAN TAYLOR, ADVANCED LIGHT SOURCE DIVISION, LAWRENCE BERKELEY NATIONAL LABORATORY, 1 CYCLOTRON ROAD, BERKELEY, CALIFORNIA. USA 94720
A new window Titanium Nitride coating system has been developed to coat a newly designed window for the Storage Ring RF System in the Advanced Light Source. A bell jar large enough to accommodate the 15cm(D)x53cm(L)tubular ceramic window is used for a vacuum chamber. Methodical procedures are employed to ensure the chamber is

The powerful (6.0*10E9W) pulse generator with target parameters 150 kV, 37 kA and duration of the pulse 150 ns was described in article [1]. The magnetic cores from amorphous alloys with ratio Br/Bs more than 0.9 were used as the key elements in two magnetic switches of the generator. We have achieved the designed parameters. The researches on improvement of electrical durability of installation, researches of losses in cascades of the generator have been carried out. The greatest attention was devoted to the research and modernization of the second step of the compression circuit of the generator. Especially we have researched the inductance of the second step in order to reduce rise time of the pulse. We managed to receive the rise time of the pulse (at a level from 0.1 up to 0.9) about 40 ns.

[1] G.Mamaev et al. MRTI RAS, Proc. PAC'97, p. 1311

TUP5 A High Voltage Power Supply for Diagnostic Neutral Beam Injector.

A. MEDVEDKO, YU. EVTUSHENKO, V. KOLMOGOROV, BINP-NOVOSIBIRSK;

A high voltage power supply (HVPS) with 10 to 60 kV tunable output voltage, 3A maximal current for the Diagnostic Neutral Beam Injector is described. HVPS consist of 6 identical cells including the PWM IGBT - inverter, high voltage transformer and rectifier. Each cell produces up to 10 kV of output voltage, all the outputs are connected in series. High voltage part of cells are placed into SF6 isolating gas filled tank with 0.5 bar over pressure. External clock is used to determine mode of HVPS operation: as pulsed mode with 1 msec minimal pulse duration (less than 100 msec pulse rise time) and up to 5 sec continuous mode. The output voltage stability better than 1% is determined by special circuitry. Fast protection system allows to use HVPS under the condition with unlimited number of sparks in load. HVPS is arranged with the slow ramp of the input current to avoid the current shocks in mains.

TUP6 A PULSED MODULATOR POWER SUPPLY FOR THE g-2 MUON STORAGE RING INJECTION KICKER*

J-L. MI, Y.Y. LEE, W.M. MORSE, C. PAI, G.C. PAPPAS, L. ROBERTS, R.T. SANDERS, Y.K. SEMERTZITS, D. WARBURTON, R. ZAPASEK, AGS DEPARTMENT, BROOKHAVEN NATIONAL LABORATORY, UPTON, NY, 11973-5000

This paper describes the pulse modulator power supplies used to drive the kicker magnets that inject the muon beam into the g-2 storage ring that has been built at Brookhaven. Three modulators built into coaxial structures consisting of a series circuit of an energy storage capacitor, dumping resistor and a fast thyratron switch are used to energize three to charge the capacitor to 95kV. The dumping resistor shapes the magnet current waveform to a 400 nanosecond half-sine to match the injection requirements. This paper discusses the modulator design, construction and operation.

* Work performed under the auspices of the U.S. Department of Energy

TUP7 Preliminary Results of the MEBT Chopper Pulser Development for SNS*

J.F. POWER, S. S. KURENNOY, LANL

The SNS linac must produce a precisely chopped beam for proper injection into the storage ring. This chopping will be done in the 2.5 MeV MEBT with a fast risetime pulser and travelling-wave deflector system. With a RFQ operating frequency of 402.5 MHz, it is desirable for the chopper to have risetimes and falltimes less than 2.5 ns to prevent partially-chopped micropulses of beam from being accelerated. The present MEBT design requires bipolar, 900-volt pulses, to drive a 50-ohm-impedance deflection structure. A proof-of-principle chopper driver is being developed using readily available FET devices and driver circuits. The status and present results of this effort are presented.

* Work supported by the U.S. Department of Energy

TUP8 Solid State Modulator Applications In Linear Accelerators

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Diversified Technologies, Inc. (DTI) has developed a line of versatile, high voltage, high power solid state switches and modulators which have the potential to significantly enhance the performance and reliability of future linear accelerator RF systems. The core technology comprising these modulators and switches is a patented approach to combining discrete solid state devices in series and parallel. This technology enables a wide variety of accelerator power switching applications to be addressed by configuring a small set of solid state, highly reliable switch modules. Key advantages of this technology over conventional power switching techniques, such as thyratrons, PFNs, switch tubes, etc., include higher reliability, higher efficiency, increased pulse flexibility, and significantly reduced infrastructure requirements. The performance of this technology will be illustrated through examples of operating solid state systems over a range of 1 kV to 140 kV, from 1 A to 2000 A, at PRFs from DC to 200 kHz. Specific accelerator applications to be presented include: • Line-type and hard tube modulator replacement, • Cathode and mod-anode modulation, • Fast protection circuits (e.g., crowbar replacement), and • Very high voltage (500+ kV) operation with pulse transformers. This paper will also address the operational experience (performance, reliability, etc.) obtained to date with these modulators in existing accelerators and related RF power systems.

TUP9 A Solid State Induction Modulator for SLAC SLC

*R.L. CASSEL, G.C. PAPPAS, M.N. NGUYEN, J.E. DELAMARE SLAC,

-The Next Linear Collider accelerator proposal at SLAC requires a high efficiency, highly reliable, and low cost pulsed-power modulator to drive the 500KV, 230A X band klystrons. With a pulse width of less than 1.5 microseconds, it is difficult for the present SLAC type modulator with conventional pulse transformer to have a high efficiency due primarily to the inherently slow rise and fall time of the video pulse. The proposed induction modulator utilizes a pulse transformer similar to an induction accelerator driven by Solid State high voltage IGBTs. The performance of the IGBTs, induction cores and a low voltage model will be discussed as well as the design, and construction of a prototype modulator capable of driving up to 8 of the X band klystrons.

*Work supported by DOE, contract DE-AC03-76SF00515

TUP10 Fast, High Voltage Thyratron Driver*

M. N. NGUYEN, SLAC

As part of an improvement project on the linear accelerator at SLAC, it was necessary to replace the original thyratron trigger generator, which consisted of two chassis, two vacuum tubes, and a small thyratron. All solid-state, fast risetime, high voltage pulse generators, therefore, have been developed and built for the 244 modulators. The rack mounted, single chassis generator employs a unique way to control and generate pulses through the use of a fast turn-on asymmetric SCR, a PFN, a fast pulse transformer, and a small magnetic switch. The resulting output pulse is 2 kV peak into 50 Ohms load with a pulse width of 1.5 uS FWHM at 180 Hz. The pulse risetime is less than 25 nS with less than 200 pS rms jitter. Various techniques are used to protect the SCR from being destroyed by reverse currents and over voltages due to thyratron breakdown. The end-of-the- line-clipper detection circuit is also integrated into this chassis to interrupt the modulator triggering in the event a high percentage of line reflections occurred. In several years of operation, the pulse generators have shown a significant increase in performance and reliability in comparison with the original thyratron driver.

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TUP16 Design Optimization and Construction of the Thyratron/PFN based Cost Model Modulator for the NLC
ROLAND KOONTZ, SAUL GOLD, ANATOLY KRASNYKH, JOHN EICHNER
As design studies and various R&D progress on Next Linear Collider systems, much R&D work is being done on X-Band klystron development, and development of pulse modulators to drive these X-Band klystrons. A workshop on this subject was held at SLAC in June of 1998. Several avenues of R&D were proposed using solid state switching, induction linac principles, high voltage hard tubes, and a few more esoteric ideas. An optimized version of the conventional thyratron-PFN-pulse transformer modulator for which there is extensive operating experience is also a strong candidate for use in the NLC. Such a modulator is currently under construction for base line demonstration purposes. The performance of this "Cost Model" modulator will be compared to other developing technologies. Important parameters include initial capital cost, operating maintenance cost, reliability, maintainability, power efficiency, in addition to the usual operating parameters of pulse flatness, timing and pulse height jitter, etc. will be considered in the choice of a modulator design for the NLC. The poster and paper will update the progress on this "Cost Model" modulator design and construction.

TUP17 Trigger Control and Fault Reaction Circuitry for the Solid-State Switch Modulator Deck System at the MIT Bates Linear Accelerat
C. WOLCOTT, R. CAMPBELL, A. HAWKINS, W. NORTH, L. SOLHEIM, A. ZOLFAGHARI, MIT.
This paper describes the trigger control and fault reaction circuitry for the new solid-state switch modulator at the MIT Bates Linear Accelerator Center. A new cathode-switching, solid-state switch modulator has replaced the old vacuum-tube technology modulator, therefore this circuitry has been designed and built to replace the old trigger control circuitry. Whereas the old modulator used a start signal to commence its pulses and a separate stop signal to end its pulses, the new system uses a single gate signal to control the modulator pulse. The trigger control circuit is a stand-alone control unit that operates in a local (manual) mode, or a remote mode where the accelerator-control computer is able to turn triggers on or off (enable the triggers), reset the unit, and send the gate signal that triggers the modulator pulses. The unit also contains its own oscillator to run a transmitter locally. There is no microprocessor fault control of the transmitter. The trigger control chassis receives all necessary signals from the transmitter and performs all necessary trigger control and fault reaction functions by itself. These fault reactions include turning off the solid-state switch, firing the crowbar, or simply lighting LEDs. The trigger control circuitry then sends report signals to the accelerator-control computer, which relates the transmitter status to the accelerator operators.

TUP18 Status Of The Solid-State Modulator Deck For The MIT-Bates S-Band Transmitter
A. ZOLFAGHARI, R. CAMPBELL, A. HAWKINS, W. NORTH, L. SOLHEIM, C. WOLCOTT, MIT.
This paper describes the status of the solid-state cathode-switching modulator upgrade project at the MIT Bates Linear Accelerator. Last year a prototype modulator system was built and tested successfully in one of the Bates RF transmitters. This year the emphasis has been on a full-scale implementation of the concept that will eventually extend to all twelve of the high-power klystron RF power amplifiers. A new modulator design has been completed, including replacing the water-cooling of the Litton Beam Switch Tubes (BSTs) with oil-cooling; a compact, current-regulated power supply for the BST focus solenoids; a highly-precise, low-ripple power supply for the BST modulating anodes; an adjustable, inrush-current-limited filament supply for the BSTs; and an upgraded solid-state switch that uses Insulated-Gate Bipolar Transistors (IGBTs) rated at 1700V instead of 1200V (reducing the switch-module count from seven to five), and has improved (third-generation) gate-drive circuitry. Six full sets of the aforementioned subassemblies have been manufactured and delivered, and construction of the first switch-tube deck has been completed. One transmitter has been tested with the new system. A large improvement of the RF system output has been observed, and the reliability of the RF transmitters is expected to be greatly enhanced.

TUP19 Particle Expulsion from Intense Beams Perturbed by Gluckstern Modes [*]
SEAN STRASBURG, RONALD C. DAVIDSON
The effect of self-consistent eigenmodes of a Kapchinskij-Vladimirskij (KV) constant-focused, cylindrically symmetric beam equilibrium (Gluckstern modes) on beam quality and particle confinement is analytically and numerically explored. First, these modes, causing time-dependent forces in the beam interior, can nonresonantly excite particles to higher energies. This enables edge particles, from near the beam surface, to escape when they would otherwise remain indefinitely confined. The combination of external nonlinearities and time-dependent forces can then cause these particles to chaotically access large regions of phase space outside the beam. Second, while individual modes are either bounded away from resonance with the betatron frequency, or have zero resonance strength at resonance, differences between multiple mode frequencies very closely approach the resonance condition for limited parameter values of the self-field perveance, focusing strength, and equilibrium beam radius, affecting the entire beam core. In addition, Gluckstern modes can also be extended to the periodic focusing case and resonances with the applied-field frequencies explored. The additional frequency allows an exact resonance condition, and complex focusing waveforms further extend the range of parameter values which participate in resonance. Finally, KAM surfaces are an important ideal measure of particle confinement: the first closed surface after the beam edge is an indication of whether particles resonantly or nonresonantly expelled from the beam core can make contact with the wall structure. The radius of this first barrier to further excursion is numerically determined as a function of system parameters and mode amplitude and number.

[*] Research supported by the U.S. Department of Energy and the U.S. Department of Defense.

TUP20 Simplified Theory of the Head-Tail Instability of Colliding Bunches
E.PEREVEDENTSEV, BINP;
A theoretical model is suggested to incorporate in a simplified manner both the conventional head-tail effect in a single bunch (due to impedance elements in the machine), and the linear part of the coherent beam-beam interaction, with the account of the finite bunch length. Their combined action results in a possible instability of some of the head-tail modes in this linearized beam-beam system. Handy formulas are presented for the modes' tuneshifts and increments, including the influence of chromaticity; relevance to the reality and possible cures of this instability are discussed.

TUP21 Characteristics and Possible Cures of the Head-Tail Instability of Colliding Bunches
E. PEREVEDENTSEV, A. VALISHEV, BINP;
A space-time-domain theoretical study is presented of the possible coherent beam-beam instability of the head-tail type, due to the combined effect of the impedance elements in the machine, and linearized coherent beam-beam interaction. Head-tail mode spectra are obtained and compared to simulation results. Possible ways to stabilize the beam-beam system are studied in simulation, including optimal choice of the chromaticity and the effect of anharmonicity.

TUP22 On Self-Consistent Dynamical Beta-Functions of Colliding Beams
A. OTBOYEV, E. PEREVEDENTSEV, BINP;
Linearizing the incoherent beam-beam interaction in the weak-strong approach, one gets dynamical beta-functions due to the weak beam focusing distortion coming from the strong bunch. In the strong-strong

approach such a distortion acts mutually on the colliding bunches, resulting in a self-consistent solution(s). Splitting of the solutions into multiple ones means possibility of beam size blow-up in one of the colliding bunches, known as the flip-flop effect. The paper presents analytical estimates of the beam-beam parameter threshold, characteristic for such transitions in various conditions, with the emphasis on the case of round colliding beams. The role of finite length of the colliding bunches is discussed.

TUP23 Transformation of the Beam Envelopes in the Flat-to-Parallel Beam Transformer

E. PEREVEDENTSEV, BINP;

Recently an optical system to transform the flat beam into a parallel one was proposed by Ya.Derbenev, with the relevance to the high energy electron cooling. Starting with an attempt of generalization of the known optical solution, the paper presents the effect of this beam transformer onto the second moments of the beam distribution in two (coupled) degrees of freedom. The result can be nicely expressed in terms of the 4-dimensional phase space, and the corresponding formalism of 2-dimensional beam envelope functions with the complete account of the coupling is used. Specific examples of optics of the flat-to-parallel beam transformer are studied in view of its implementation

TUP24 Methods and Complex of Programs for Radiating Particle 3DoF Nonlinear Dynamics Analysis

Y.ALEXAHIN, JINR

A complex of programs is described which is based on the Lie-transform perturbation theory for non-autonomous non-Hamiltonian systems and: i) finds transformation to normal form of the dynamical variables up to the third order in the perturbation parameter (with some limitations) in machines as complicate as LEP or HERA-e; ii) computes detuning coefficients and resonance strengths with account of nonlinearity in the synchrotron radiation force; iii) finds radiating particle phase space distribution by solving the Fokker-Planck equation with account of nonlinear coupling. In contrast to programs based on a 1-turn map normalization it: i) permits to analyze the structure of particular resonance driving terms; ii) can operate with nonlinear element strengths in symbolic form; iii) gives the transformation generating function all over the lattice which may be important for analysis of the off-resonance "smear" and nonlinear emittance production. Presently the programs are implemented as Mathematica notebooks which generate analytical expressions and perform on their basis numerical calculations using linear eigenfunctions output by MAD. Example of application of the described methods in the HERA-e low emittance lattice study is given.

TUP25 Correction of the Betatron Coupling by Local Orbit Cross Talk

A. LOULERGUE, J. PAYET, CEA

Analytical expressions, in presence of skew quadrupoles errors, have been derived to estimate the betatron coupling contribution to the vertical beam size and emittance. The treatment of the betatron coupling is based on the matrix transport perturbation and related eigen vectors. The advantage of this approach is to be free of the usual resonant approximation and to allows a compact formulation of the vertical emittance. In addition, this approach gives a fast analytical statistical analysis. From this analytical expressions, we propose a new scheme of the betatron coupling correction also based on the closed cross orbit correction. This method, called local cross orbit correction, improve the correction of the betatron coupling with few judicious measurements. It allows also to fully uncoupled the beam locally on the lattice.

TUP26 The Effect of Nonlinear Synchrotron Motion on the SOLEIL Energy Acceptance.

A. NADJI, J.-L. LACLARE, M.-P. LEVEL, A. MOSNIER, P. NGHIEM, PROJET SOLEIL

The lengthening of the trajectory is determined by the momen compaction factor (α) and the betatron oscillation contribution tern C/C). When the first order term of the momentum compaction factor is small, the second order term (α_2) and Δ C/C have to be included in longitudinal equations of motion. In this case, the RF bucket f changes and the energy acceptance can be significantly reduced. leads to a decrease in Touschek beam lifetime. In this paper we show the value of α_2 in the standard low emittance lattice of SOLEIL is l and can reduce the energy acceptance of the machine. We discuss magnitude of this reduction and the difficulties encountered minimizing the value of α_2 in the case of a low emittance lattice. We show that the effect of betatron oscillations is canceled when chromaticities are corrected to zero.

TUP27 Optimization of DAFNE Beam-Beam Performance.

M. ZOBOV, M.E. BIAGINI, C. BISCARI, A. DRAGO, A. GHIGO, S. GUIDUCCI, G. MAZZITELLI, C. MILARDI, M.A. PREGER, F. SANNIBALE, M. SERIO, G. VIGNOLA LNF-INFN D. SHATILOV BINP

The Phi-Factory DAFNE is an electron-positron collider designed reach the luminosity of $5.2*10^{32}$ cm^{-2} s^{-1} at the energy of the F resonance (1020 MeV c. m.). In order to achieve the design luminos high current multibunch electron and positron beams are stored in t separate rings and collide in two common interaction regions. Since beams arrive at the interaction points from different rings, a care longitudinal timing and a precise transverse scan of the colliding bunc are necessary to optimize the collider luminosity. In this paper describe luminosity measurement techniques employed in DAFN discuss measures aimed to maximize the luminosity and report achieved results. The experimental data are compared with the results numerical simulations.

TUP28 Dynamic Aperture Study at DAFNE Main Rings.

M.E. BIAGINI, M. ZOBOV LNF-INFN

The dynamic aperture has been studied and measured in the DAFNE P Factory in Frascati, both for electron and positron ring. A dynan aperture correction with sextupoles has been carried out in order optimize the beam lifetime. Comparison with simulations for differ working points are presented, including tune shifts with parti amplitudes and momentum.

TUP29 Computing Transfer Functions of Multipole Devices directly from Magnetic Field Data, including Fringe Field Effects and Highe Order Aberrations.

R.M.G.M. TRINES, J.I.M. BOTMAN, S.J.L. VAN EIJNDHOVEN, T.J. SCHEP [1], H.L. HAGEDOORN, EINDHOVEN UNIVERSITY OF TECHNOLOGY (TUE);

The scalar and vector potentials of a magnetic multipole device a described in terms of magnetic field measurements gathered on either cylindrical surface or a median plane [2]. Fringe field effects a multipole contributions of arbitrary order, as well as the discrete nature the field measurements, are taken into account. This description has be used to calculate the transfer function of the device, directly in terms the field measurements. The method as described in this paper can applied to single beam guiding elements as well as to clusters elements, and can be extended to calculate the transfer function for complete beam line setup or a storage ring. The accuracy of the results only limited by the accuracy of the field measurements.

[1] Also FOM Institute for Plasma Physics "Rijnhuizen", The Netherlands

[2] R. Trines et al., Proc. EPAC 1998, p. 1969.

TUP30 Studies on imperfections in the SLS storage ring

MICHAEL BOEGE, ANDREAS STREUN, MARC MUNOZ, PSI

Studies on linear and nonlinear imperfections in the SLS storage ring a presented. The influence of spurious vertical dispersion and linea

coupling on the vertical emittance and possible correction schemes are discussed. The deterioration of the Dynamic Aperture caused by higher order multipoles is quantified based on three dimensional field calculations for the storage ring magnets. Furthermore the influence of ground waves on the orbit stability is analyzed.

TUP31 Diffusion mechanism of particle beams in the presence of phase modulation in double rf systems

M. BALL, J. BUDNICK, C.M. CHU, K.M. FUNG, B. HAMILTON, D. JEON, X. KANG, L.L. KIANG, S.Y. LEE, A. PEI, T. SLOAN (IUCF)

Mechanism of phase dilution is studied by phase modulation on the secondary rf system or the primary rf system. The beam profiles is measured vs time during the phase modulation at the IUCF Cooler Ring. From the experimental data, we can extract diffusion constant, damping rate of the electron cooling, and dynamics of particle diffusion in the chaotic sea through numerical simulations. We find that particles move dominantly along the separatrix of major parametric resonances. Then they diffuse into the chaotic sea. This gives rise to anomalous diffusion characteristics observed in experiements.

TUP32 Diffusion of particles trapped in resonance islands

W.C. HSI, C.M. CHU, K.K. LIANG, S.Y. LEE, K.M. FUNG (INDIANA UNIVERSITY)

Data of earlier experimental measurements at the IUCF Cooler Ring on particles trapped in the fourth order resonance islands will be reanalyzed. In the presence of tune modulation, the rate of particle diffusion out of the separatrix will be discussed. The beam particles are observed to split into beamlets in the betatron phase space along the separatrix causing severe decoherence of the BPM signal. Our data, compared with numerical and theoretical analysis are used to determine the resonance strength, source of nonlinear terms, and dynamics of particle motion in the phase space.

TUP33 Resonance approach to the dynamic aperture evaluation for synchrotron light sources

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At synchrotron light sources main nonlinear perturbation is caused by chromaticity compansating sextupoles. For this case a resonace approach to avaluate the dynamic aperture is presented. Including of the high order resonances provides expressions which are valid for rather large betatron tune region. An estimation of the main perturbation harmonics amplitudes with basic accelerator parameters (horizontal emittance, natural chromaticity and tune) is presented.

TUP34 Using MARYLIE with the Particle Beam Optics Laboratory*

G. H. GILLESPIE, B. W. HILL, M. C. LAMPEL, H. MARTONO, J. M. MOORE [1] AND A. J. DRAGT [2].

A MARYLIE module has been developed for the Particle Beam Optics Laboratory (PBO Lab). MARYLIE is an optics code based on a Lie algebra formulation of charged particle trajectory calculations and is particularly useful for particle tracking and for the analysis of linear and nonlinear lattice properties. The PBO Lab provides an intelligent graphic user interface based upon the Multi-Platform Shell for Particle Accelerator Related Codes, a software framework developed specifically to support accelerator modeling, simulation and training. Transport element icons are selected from a palette and assembled into beamlines by graphical construction. Optical cells and lattices composed of element groups may be defined as sublines, and elements or sublines can be replicated using an alias element. An icon-based description of MARYLIE commands and procedural processes has also been developed. The icon-based beamlines and commands generate entries for the MARYLIE Master Input File (MIF). Frequent computations are encapsulated into interactive commands which create the needed entries in the MIF, call MARYLIE to execute the required computations, and then return output data to the graphic interface for display. Use of the PBO Lab MARYLIE module is described and illustrations from the Windows95 implementation are presented.

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TUP35 Frequency maps of LHC models

YANNIS PAPAPHILIPPOU, CERN, CH-1211 GENEVA 23, SWITZERLAND

The Frequency Map Analysis method is applied in models of LHC optics versions 5 and 6 in order to study their non-linear dynamics. The maps present a global picture of the resonance structure of the phase space. They enable us to view the dangerous zones tracing the limits of the dynamic aperture. This approach, assisted by detailed resonance analysis, is used as a guide for exploring possible correction schemes, which are subsequently verified by long-term tracking.

TUP36 Measurement of Resonance Driving Terms from Turn-by-Turn Data

X. ALTUNA, G. ARDUINI, C. ARIMATEA, R. BARTOLINI, A. BEURET, E. CARLIER, K. CORNELIS, J. DE~VRIES, D. DUCHASTELLE, H. JAKOB, L. JENSEN, L.H.A. LEUNISSEN, A. MOSTACCI, C. OLIVEIRA, E. OZTURK, Y. PAPAPHILIPPOU, G. ROBIN, M. ROYER, F. SCHMIDT

It has been shown that the Fourier analysis of recorded turn-by-turn tracking data can be used to derive resonance terms of an accelerator. Beside the resonance driving terms, the non-linear one-turn map can be obtained with all non-linearities arising from magnetic imperfections and correction elements. This could be interesting for the LHC which will be a machine that is dominated by strong non-linear fields. The methods works very well for tracking data and is expected to work equally well for turn-by-turn beam data. The precision to which these terms can be determined relies on the frequency analysis tool. To demonstrate the feasability of the method, measurements of real accelerators are presented in which the beam is kicked once and the beam oscillations are recorded over several thousand turns. Besides the tune, the strengths of resonance driving terms have been measured and the results are compared with numerical calculations.

TUP37 Effects of sextupole time dependence on the LHC dynamic aperture.

F. SCHMIDT, F. ZIMMERMANN

A primary concern regarding the LHC dynamic aperture is the time dependence of persistent-current sextupole fields in the superconducting magnets. Decaying slowly during injection, these fields are reinduced rapidly at the start of the acceleration ('snap-back'). If uncompensated, they would cause a chromaticity change by some 130 units. We investigate how this time dependence and different ramp rates affect the stability of particle motion, considering both a simplified model and the full scale LHC lattice, and we evaluate the efficiency of different correction schemes.

TUP38 Optimisation of the LHC dynamic aperture via the phase advance of the arc cells

F. SCHMIDT, A. VERDIER , CERN

The phase advances of the arc cells of storage rings are traditionally chosen to be simple fractions of π in order to take advantage of second order achromats they constitute. For LHC, such a choice is not relevant because of the existence of high order systematic multipole components in the main dipoles. In this case it is better to choose the phase advances to cancel the driving term for the largest possible number of non-linear reasonances, which is straightforward for an ensemble of identical cells. For an actual LHC arc which contain dispersion suppressors, this choice is much less obvious. It is discussed in this paper and first results showing an improvement of the dynamic aperture are given.

The temperature of the vacuum chamber in the storage ring of Taiwan Light Source(TLS) is monitored by placing 80 RTD sensors along the accelerator. The temperature reading of the vacuum chamber is affected by the synchrotron radiation emitted by the electron beam and the energy loss due to the longitudinal wake fields. The synchrotron radiation and the longitudinal wake fields result in a different dependence of temperature rise on the beam current respectively. Using the temperature readings of the vacuum chamber in the storage ring of TLS, one can identify the possible components which contribute to the accelerator impedance.

TUP56 The Ion Produced Transverse Instibilities in SRRC Storage Ring

J. C. LEE, SRRC

The ions captured by the electron beam potential can introduce transverse instabilities and deteriorate the beam quality. For SRRC storage ring , the transverse instabilities due to trapped ions are found since commissioning and affect the beam performance. In this paper, we summarizes the measurements of transverse instabilities which related to the ions. The efforts used to reduced this instabilities is also presented in the paper.

TUP57 Investigation of Ion Effects in the SRRC Storage Ring by Venting H2 Gas

J. C. LEE, SRRC

The instabilities produced by ions are one of the issues in the electron storage ring. At SRRC, H2 ion is the dominate species. Comparing with other species of ions, H2 ions are uneasy to be trapped from the conventional ion points of view for its small atomic mass. While H2 ions could introduced fast beam ion instabilities. In order to understand more details of the ion produced instabilities in the ring, H2 gas was intentionally vented into the ring chamber. In this paper, the instabilities related to H2 ions are described and the physics is also discussed.

TUP58 Simulation studies of Coupled-bunch Instability in the Fermilab Main Injector*

C. M. BHAT, FNAL

The Fermilab Main Injector (FMI) is a multi-purpose proton synchrotron. It is designed to provide very high intensity proton beam (up to 3E13 protons in 504 bunches) for further acceleration in the Tevatron, as well as 120 GeV beam for a variety of fixed target programs including NuMI. The Main Injector will also provide slip stacked high intensity proton bunches (viz., 1E13 protons in 84 bunches and up) at 120 GeV for pbar production. The accelerator consists of 18 rf cavities which operate at a harmonic number 588. These cavities are known to have many higher ordered resonances~[1]. Longitudinal coupled-bunch instability induced by excitation of these resonances, may limit the maximum attainable beam intensity in the Main Injector. We have performed simulation studies of the longitudinal coupled bunch instability for different FMI operating conditions. The study indicated that the beam emittance growth is not significant (<25%) in the case of 84 bunches (with 6E10 p/bunch). However, if the Main Injector is filled with 504 bunches, considerable emittance dilution is observed in the bunches in the tail.

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@ Author would like to thank Jim. MacLachlan for help with ESME and acknowledge the participation of F. Rivera, during the initial stage of this study.

[1]J. Dey and D. Wildman, Higher Order Modes of the Main Cavity at Fermilab, Proceedings of the IEEE, 06/96, pp 1675.

TUP59 Strong Head-Tail Instability due to Electron Beam of Beam-Beam Compensation Setup.

A.BUROV, BINP; V. DANILOV, ORNL; V.SHILTSEV, FNAL

We study stability of antiproton beam interacting with an electron beam in an "electron lens" setup for beam-beam compensation in the Tevatron collider. Electron space charge forces cause transverse "head-tail" coupling within antiproton bunch which may lead to a transverse mode coupling instability. We present a theory, analytical studies and numerical simulations of this effect. An estimate of threshold longitudinal magnetic field necessary to avoid the instability is given and the treshold dependence on electron and antiproton beam parameters is studied.

TUP60 Instabilities in the SNS*

M. BLASKIEWICZ

The Spallation Neutron Source will have a D.C. beam current of 20 A at extraction, making it one of the worlds most intense accelerators. Coherent instabilities are of major concern and efforts to predict beam behavior are described.

* Work supported by United States Department of Energy

TUP61 Nonlinear Accelerator Problems via Wavelets: 1. Orbital Motion in Storage Rings.

A.FEDOROVA, M.ZEITLIN, IPME RAS; Z.PARSA, BNL

This is the first part of our presentations in which we consider applications of methods from wavelet analysis to nonlinear accelerator physics problems. This is continuation of our results which were presented to PAC'97, EPAC'98, Santa Barbara Workshop. Our approach is based on methods provided possibility to work with well-localized in phase space bases, which gives the most sparse representation for the general type of operators and good convergence properties in any functional space. Consideration of orbital dynamics of a particle in storage rings is based on variational approach to polynomial (in dynamical variables) approximation (up to octupoles) and allows us to control contribution from each scale of underlying multiresolution expansion. Also we consider the kick approximation by generalization of such construction for the case of variable (localized) coefficients.

TUP62 Nonlinear Accelerator Problems via Wavelets: 6. Quantization and Quasiclassics via Wavelets.

A.FEDOROVA, M.ZEITLIN IPME RAS, Z.PARSA BNL

This is the sixth part of our presentations in which we consider applications of methods from wavelet analysis to nonlinear accelerator physics problems. This is continuation of our results which were presented to PAC'97, EPAC'98, Santa Barbara Workshop. Our approach is based on methods provided possibility to work with well-localized in phase space bases, which gives the most sparse representation for the general type of operators and good convergence properties in any functional space. We consider quantum dynamics via quantization of the symbols and by using Moyal brackets. We use fast wavelet transform approach for constructing the most sparse representation of the corresponding operators and their compositions, which represent RHS of quasiclassical and quantum Liouville equations.

TUP63 Nonlinear Accelerator Problems via Wavelets: 7. Invariant Calculations in Hamiltonian Problems.

A.FEDOROVA, M.ZEITLIN IPME RAS, Z.PARSA BNL

This is the seventh part of our presentations in which we consider applications of methods from wavelet analysis to nonlinear accelerator physics problems. This is continuation of our results which were presented to PAC'97, EPAC'98, Santa Barbara Workshop. Our approach is based on methods provided possibility to work with well-localized in phase space bases, which gives the most sparse representation for the general type of operators and good convergence properties in any functional space. We consider dynamical problems via coadjoint orbit picture, semiproducts and metaplectic structure. We construct symplectic, Poisson and quasicomplex structures using generalized wavelets and non-

coupling and potential well distortion, was then solved by using the step function technique for the expansion of the radial function, as proposed by Oide and Yokoya. For illustration, the effect of the resonant frequency of a broadband resonator in the SOLEIL storage ring was studied. When the resonator frequency is much higher than the bunch spectrum width, azimuthal mode coupling can occur before radial mode coupling. When the resonator frequency is lower, radial mode coupling comes usually first, but two or more bunchlets are produced at relatively low current. The diffusion process between the bunchlets, which leads to the well-known saw-tooth behaviour, originates actually from a fast growing microwave instability.

TUP79 On the Longitudinal Microwave Instability in Electron Storage Rings *

B. PODOBEDOV, S. HEIFETS SLAC

Beam behavior at nonlinear stages of the microwave instability is extremely difficult to describe analytically. On the other hand this is a subject of considerable interest since a variety of nonlinear effects has been observed experimentally, some of them strong enough to deteriorate the storage ring performance. In this paper we define several mechanisms leading to the microwave instability, discuss their intensity thresholds, and outline the ways to describe the nonlinear regime. We further proceed with this regime using a resonant solution as a base for our treatment. We iteratively solve the linearized Vlasov equation modifying the slow zeroth Fourier component of the distribution function and the kernel of the dispersion equation at every step.

* Work supported by Department of Energy contract DE-AC03-76SF00515

TUP80 Simulation of the Longitudinal Microwave Instability in Storage Rings by Multiple Methods *

B. PODOBEDOV, S. HEIFETS SLAC, A. NOVOKHATSKI [1] TU DARMSTADT

Microwave instability is still one of the least understood phenomena in storage ring beam dynamics. Analytic treatment based on the analysis of the Fokker-Planck equation is limited in scope calling for effective computational methods to describe the instability. At present there are several numerical approaches to the problem. Each one, however, has its drawbacks and limitations and cannot be trusted unconditionally. In this paper we compare three numerical methods, namely linearized Vlasov equation approach, direct particle tracking, and, finally, finite-difference solution of the Fokker-Plank equation. Simulations are done for the broad band resonator impedance model with different parameters to address several mechanisms of instability like radial mode coupling, monopole mode excitation, etc. The results from the three methods are compared and conclusions on their applicability are drawn.

* Work supported in part by DOE contract DE-AC03-76SF00515 (SLAC)

[1] On Leave from BINP, Novosibirsk

TUP81 Longitudinal Dynamics of Femtosecond e-beams in the Storage Ring*

Y. WU, V. N. LITVINENKO, DUKE UNIVERSITY

Femtosecond electron bunches are important for a number of applications from femtosecond light sources to colliders. The microwave instability remains an obstacle for generating sub-picosecond bunches in today's storage rings. We have proposed to apply strong longitudinal focusing to the electron beam to overcome the microwave instability in the storage ring. In this paper, we present the recent simulation results confirming the suppression of the microwave instability. The coherent radiation plays a major role in the longitudinal dynamics of femtosecond bunches. This effect has been included in our self-consistent simulation model. In addition, simulation results of short electron bunches with 10 to 100 fs durati are presented for both the stable and unstable cases.

*Work supported by ONR grant N00014-941-0818.

TUP82 High Energy Beam-Beam Effects in CLIC

D. SCHULTE, CERN

In order to achieve high luminosity, the Compact Linear Collider (CL has to be operated in the high-beamstrahlung regime at centre-of-m energies in the few TeV range. Beam-beam effects for this case simulated. The dependence of luminosity, luminosity spectrum a background conditions on the different beam parameters is investigat In particular the effect of beam size, waist shift and offsets considered; as well as the background due to beamstrahlung a secondary electro-magnetic and hadronic processes.

TUP83 Measurement of the cross section for electron capture from pair production in heavy ion interactions and its consequences for luminosity lifetimes in ion colliders

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The limitation of the luminosity lifetime in high energy heavy i colliders like RHIC or LHC operating in ion mode is set by the very lar cross section of beam -- beam interactions. One of the domina processes at relativistic energies is electron capture from pair producti in the strong electromagnetic field provided by the high -Z ions. T capture cross sections for PB 82+ interacting with a number of light a heavy solid targets have been measured using one of the high ener resolution 158 GeV/nucleon beams at CERN. Gas targets Ar, Kr, and X have also been used, which gives the possibility to eliminate the effect ionization of excited states and to measure the total capture cross sectio which are more directly relevant for the operation of colliders. The resu are discussed in terms of beam lifetimes for RHIC and LHC obtain using logarithmic extrapolations of the measurements to t corresponding collider energies.

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TUP84 Beam-Beam Studies for the LHC

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We use a fully self-consistent, strong-strong, beam-beam code to stud dipole and quadrupole coherent beam-beam effects at the LHC. In particular application we study the influence of sweeping one beam in small circle around the other as a diagnostic tool for keeping the beams collision.[1] Emittance blow-up of the beams is examined as a functio of bunch current and amplitude of the circular sweep.

[1]W.C. Turner et. al., "Instrumentation for Absorbers in High Luminosity Insertions of LHC", presented at this conference.

TUP85 The Effect of the Beam-Beam Interactions.on the Dynamic Aperture of the LHC at Collision

N. GELFAND, C. JOHNSTONE, T. SEN AND W. WAN FERMILAB, P.O. BOX 500, BATAVIA, IL 60510

The dynamic aperture of the LHC at collision energy is limited by th field errors in the IR quadrupoles. being built at FNAL. The 300micro radian crossing angle, incorporated in the design to reduce the effect the long-range beam beam interactions, enhances the effect of th multipoles on the dynamic aperture. We have investigated the possibilit of a different crossing angle with a more accurate modelling of the long

determined through synchrotron radiation damping. Thus, the field quality of the accelerator magnets can in principle be relaxed and/or the correction systems may be more lenient. This may not be the case for a low field VLHC, where the emittances must be preserved throughout the entire acceleration process. In this paper we present and discuss designs for modular accelerator correction sections which can be inserted into the arcs as required to perform standard tuning operations. These modules also contain space for power and cryo feeds or other special beam diagnostics or instrumentation. With this modular design, matched to the arc FODO structure, the placement of these insertions can be modified to accomodate above ground features and tunnel access points.

* Work supported by the U.S. Department of Energy under Contract No. DE-AC02-76CHO3000.

TUP94 Beam-Beam Study on Beijing Electron Positron Collider

S.WANG, S.FANG AND C.ZHANG

The systematic study on beam-beam effects which come from performing of mini-beta scheme of Beijing Electron Positron Collider(BEPC) is made. For performing mini-beta colliding on BEPC, high RF voltage is supplied for shortening the bunch length, but the high RF voltage results in the luminosity decrease, and this is the special phenomenon of beam-beam on BEPC, which limit the performance of mini-beta scheme. The work is aiming to explain the special phenomenon and overcome it. The conclusion of theoretic analysis, simulation and machine study is that, for BEPC, the bunch length influence the beam-beam interaction mainly through the "hourglass" effect and averaging over the betatron phase during the collision, and these two contrary effects make the luminosity be maximum only when bunch-length/beta-y is near the optimal value,and so the problem of luminosity decrease due to high RF voltage can be resolved.

[1] Y.Wu,G.Li and A.Xiao, A proposed Mini-beta scheme for BEPC, Proceeding of the Workshop on BEPC Luminosity Upgrades,Beijing,June,1991.
[2] S.Krishnagopal and R.Siemann,Bunch Length Effect in the Beam Beam Interaction,Physical Review D,Volume 41,No.7,1990.

TUP95 Progress at CRYRING and its Superconducting Electron Cooler

H. DANARED FOR THE CRYRING GROUP, MANNE SIEGBAHN LABORATORY

The status of CRYRING is reviewed, in particular that of the new ECR injector and of a gas-jet target for atomic collision physics, as well as the continuing work of transporting, storing and diagnosing weak beams of exotic molecular ions. The superconducting electron cooler has been in operation for more than one year, and results from measurements of cooling forces, cooling times and electron temperatures are reported.

TUP96 Optical Notch Filter for the Stochastic Cooling System of COSY

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Two cooling methods are installed in the cooler synchrotron COSY. The electron cooler is used for stacking and cooling of proton beams with energies between 45 MeV and 180 MeV. After commissioning last year the stochastic cooling system became a standard tool for beam cooling in the momentum range of 1.5-3.3 GeV/c. The stochastic cooling pickups also serve for precision measurements of the chromaticity. One advantage of COSY is the possibility to set up different machine settings in a 'supercycle'. Internal experiments can take data below, close at and far above the threshold in one supercycle. The transversal stochastic cooling system has been updated using the COSY software timing system to allow cooling in all three experiments. For longitudinal cooling a new notch-filter has been fabricated. The delay-line of the notch-filter has been replaced by an optical delay line. We will present the charateristics of the optical notch-filter and the beam quality enhancement for an internal gas target using the longitudinal cooling system with the new notch-filter. In order to use the longitudinal cooling in a supercycle the optical delay-line has been further improved. A part of the optical signal path is carried free through an air section. This section is adjusted according to the beam travelling time with the aid of a motordriven prism.

TUP97 Electron Cooling Assisted Beam Accumulation in the Heavy Ion Synchrotron SIS by Repeated Multiturn Injection

M. STECK, L. GROENING, K. BLASCHE, H. EICKHOFF, B. FRANCZAK, B. FRANZKE, T. WINKLER, GSI DARMSTADT; V.V. PARKHOMCHUK, BINP NOVOSIBIRSK

Electron cooling of the ion beam after multiturn injection allows beam accumulation in the heavy ion synchrotron SIS. The accumulation technique is based on a fast reduction of the horizontal emittance. The system has been optimized for maximum accumulation rate. For ions with charge number larger than 60 an increase of the intensity in one synchrotron pulse by one order of magnitude in 5 seconds has been demonstrated. The maximum ion current of about 7 mA at the injection energy 11.4 MeV/u is limited by the high phase space density of the cooled ion beam. For highly charged ions recombination with the electrons in the cooler limits the possibility to accumulate over extended time periods. Systematic measurements of the recombination rate for different charge states show a strong enhancement compared to theoretical calculations. Proper selection of the most favorable charge state of the required ion species results in the achievement of the maximum beam intensity.

TUP98 Electron Cooling for Tevatron with 100 Bunches

A. BUROV, J. MARRINER, FNAL

Electron cooling of the antiprotons in the Recycler is discussed for 100 Tevatron bunches scenario. The cooling process of the new and recycled antiprotons was simulated by means of stochastic cooling and electron cooling codes. The requirements on the electron beam and its optimal parameters are presented.

TUP99 Suppression of Bunch Transverse Instabilities by the Chamber Asymmetry

A. BUROV, FNAL; V. DANILOV, ORNL

Axial asymmetry of a vacuum chamber cross-section could depress the wake functions. Besides, it gives rise to wake forces causing betatron tune shift of the tail particles. In the result, the bunch transverse instabilities could be significantly suppressed.

TUP100 Slotted Waveguide Slow-Wave Stochastic Cooling Arrays

DAVID MCGINNIS

The slotted waveguide slow-wave stochastic cooling arrays are an integral part of the 4-8 GHz Debuncher Upgrade at FNAL. Unlike the standard array of stripline electodes, these structures are designed to work when the beam pipe can support many microwave modes. The design theory and beam measurement results of this new type of pickup structure will be presented in this paper.

TUP101 Modeling the Muon Cooling Channel Using Moments*

B. A. SHADWICK, J. S. WURTELE, UCB; A. M. SESSLER, C. M. CELATA, AND P. B. LEE, LBNL;

Using a moment formalism[1,2] we model beam transport in the muon collider cooling channel. This model contains much of the physics we believe to be relevant to muon cooling: ionization energy loss, Landau straggling and multiple scattering. Space charge forces are currently neglected but can, in principle, be added to the model. Previously, this model has been shown to closely agree with particle tracking[1] and the

permanent magnets for both mirror and hexapole magnetic fields, has been successfully in operation. Another compact type [2] was also developed by the E-arena group at KEK-IPNS, whose special feature is to realize core heating with a second Bernstein mode through adjusting the minimum field by an auxilliary solenoid placed at the midpoint of the ECR plasma chamber. However, the compact type has limitations to controlling the magnetic field configuration for confining the ECR plasma. To overcome limited control parameters, we are in the process of designing a compact ECR ion source. The main feature consists in three auxilliary solenoids placed at the injection, midpoint, and extraction sides of the chamber. The solenoid at the extraction side is synchronized with the pulsed microwave power in order to control the maximum field at the extraction. All the three solenoids are also synchronized with the pulsed microwave power to control total confinement fields. The microwave frequency is tunable in the range of 12 to 14.5 GHz lying in the Ku band. We shall present the design report concerning the field mapping and mechanical design.

[1] P. Sortais, Nucl. Instr. Methods B98, 508 (1995)
[2] E. Tojyo et al., Rev. Sci. Instrum. 69, 715 (1998)

WEA7 Some Remarks to Construction of ECR Ion Source Hexapoles.*

J. PIVARC, SLOVAK ACADEMY SCI[1]; J. PIVARC, JR., MARTIN LUTHER U.[2]; M.N. EL-SHAZLY, JINR[3];

This paper gives performance data for construction of suitable hexapoles for Electron Cyclotron Resonance Ion Sources (ECRIS). Permanent magnets are made from NdFeB magnetic material. The main attention is given to hexapoles with inner diameters of 3.6 cm and 7 cm at different hexapole thicknesses of 1.3-6 cm. Some remarks to construction of such type hexapoles are presented.

*This work was supported by VEGA L3 Ltd., Zahradnicka 21, SK-821 74 Bratislava, Slovak Republic.
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WEA8 Results of the Reconstructed MEDEBIS

R.BECKER,H.HOELTERMANN,M.KLEINOD

The electron beam ion source (EBIS) can deliver sufficiently short and intense pulses of fully stripped light ions for the single turn injection into a dedicated synchrotron for hadron therapy. The technology of such a MEDEBIS resembles travelling wave tubes used in satellites and can also be designed for lifetimes up to ten years. In a first setup using a normal conducting solenoid of 0.75 T and a trap length of 0.25 m the source delivered high charge states of light ions like Oxygen 8+,7+,6+ and Carbon 6+,5+ [1]. The fast ion extraction in less than 2 μs is realised through a special electrostatic structure providing a pulsed extraction potential gradient along the axis of the whole ion trap. The first results were very promising, but the residual gas pressure in the ionisation region was too high to make use of a sufficiently long confinement time in order to reach full abundance of bare nuclei. For the reconstructed MEDEBIS the inner two windings of the solenoid were drilled out to allow for a vacuum tube of about twice the diameter with better conductance. Together with the implementation of NEG-getter material the residual gas pressure should be lowered sufficiently to reach the required yield of the fully stripped ions. Iron disks of high permeability have been added at both ends of the solenoid to increase the homogeneity of the magnetic field as well as to reduce the field in the gun and collector regions for a higher focused current density in the trap region. The new MEDEBIS is under test and new experimental results will be presented.

[1]O.Kester,R.Becker,and M.Kleinod, Rev.Sci.Instrum.67,1165(1996)

WEA9 Results of Beam Tests on a High Current EBIS Test Stand.*

J. ALESSI, E. BEEBE, S. BELLAVIA, A. HERSHCOVITCH, A. KPONOU, A. PIKIN, K. PRELEC, BNL; G. KUZNETSOV, BINP;

At Brookhaven National Laboratory there is an R&D program to design an Electron Beam Ion Source for use in a compact ion injector to be developed for the relativistic heavy ion collider, RHIC. The BNL effort is directed at developing an EBIS with intensities of 3 x 10^9 particles/pulse of ions such as Au^{35+} and U^{45+}, and requires an electron beam on the order of 10A. The construction of a test stand (EBTS) with the full electron beam power and 1/3 the length of the EBIS for RHIC is nearing completion. Initial commissioning of the EBTS will be made during November 1998 with multi-ampere pulsed electron beams with duration ~ 100ms, d.c. electron beam operation, and trapping and extraction of ions formed from a uniformly distributed gas introduced into the source. Details of the EBTS construction will be described and the results of the initial testing program will be presented.

*Work performed under the auspicies of the U.S. Department of Energy

WEA10 Electrostatic Oscillations into the Plasma Drift Channel of e-MEVVA Ion Source*

T.V.KULEVOY, ITEP

ITEP Electrostatic oscillations into plasma chamber of e-MEVVA ion source resulted by the electron beam were investigated. The plasma waveguide mode as well as the thin beam mode were investigated. The condition of electrostatic oscillations instability were found for both mode. The results of the investigation were used for analytical treatment of experimental data obtained at the ITEP e-MEVVA.

* Work supported by the U.S. Department of Energy of Material Support Agreement No:6444850 for contract No. W-7405-ENG-48

WEA11 First Test Results on the Trapped Ion Source

A. BOGGIA, G.BRAUTTI, A. RAINO', DIPARTIMENTO DI FISICA AND INFN-BARI V. VALENTINO, V. VARIALE, INFN-BARI

Recently the detailed design and the construction problems of a Trapped Ion Source (TIS) have been presented in ref.[1],[2]. In practice, TIS can be seen as a modified version of an Electron Beam Ion Trap (EBIT) or of an Electron Beam Ion Source (EBIS). The main new feature of TIS, with respect to an EBIS (or EBIT), is the transverse ion confinement given by a quadrupolar field instead of the electron beam space charge. One can foresee that TIS could overcome some drawbacks of the EBIS (or EBIT) making it a more flexible device. In this paper will be presented the first test results of TIS both in its rf part and in its electron beam transport part.

[1] G. Brautti, A. Boggia, A. Raino', V. Valentino, V. Variale Trapped ion source Proc. PAC97 VANCOUVER (1997).
[2] G. Brautti, A. Boggia, A. P Errico, A. Raino', V. Valentino, V. Variale Study of a trapped ion source Proc. EPAC98 Stoccolma (Svezia) (1998)

WEA12 Extractor for Heavy Ion Fusion Volume Source*

O.A. ANDERSON, LBNL

Previously, surface-production ion sources have been used for heavy ion fusion (HIF) drivers because they deliver low ion temperature. A typical design, ELISE [1], specifies 0.8 A of K+ per beamlet; the required surface area is large, so it may not be easy to obtain uniform emission, especially over a long period of operation. In contrast, volume sources (e.g., 0.8 A of Ar+) should give good uniformity over long times, but they deliver warmer ion beams, several tenths of an eV or more. They can produce large current densities and thus could in principle equal or exceed the brightness of surface sources, but conventional extractor designs run into voltage breakdown limitations and cannot easily produce the required current rise time (about one microsecond). An improved two-stage extractor utilizing concentric ring preaccelerators, recently described for another application [2], can overcome these volume-extraction problems. Fast beam switching is done within the small ring

WEA59 The Operation of the BNL Gun-IV Photocathode RF Gun at the Advanced Photon Source*

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At the Advanced Photon Source (APS), a free-electron laser based on the self-amplified spontaneous emission (SASE) process is nearing completion. Recently, an rf photoinjector gun system was made available to the APS by Brookhaven National Laboratory (BNL). It will be used to provide the high-brightness, low-emittance, and low-energy spread electron beam required by the SASE-FEL theory. A Nd:Glass laser system, capable of producing a maximum of 500 mJ of UV in a 1-10 ps pulse at 10 Hz serves as the photoinjector's drive laser. This drive laser is timing stabilized to the APS-linac rf system. Here, the design and commissioning of the rf photoinjector gun system and its associated laser system will be presented.

*Work supported by U.S. Department of Energy, Office of Basic Energy Sciences, under Contract No. W-31-109-ENG-38.

WEA60 First Results of the Fermilab High-Brightness Photo-injector

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A high-brightness RF photo-injector is being constructed at Fermilab. It was designed to produce a 14-18 MeV electron beam in a pulse train of up to 800 electron bunches, each with 8 nC of charge, 3.5 ps RMS bunch length, and a transverse emittance of

WEA61 Design and Construction of a High Charge and High Current 1 - 1/2 Cell L-band RF Photocathode Gun

M.E.CONDE, W.GAI, R.KONECNY, J.G.POWER, P.SCHOESSOW, ANL

The Argonne Wakefield Accelerator has been successfully commissioned and used for conducting wakefield experiments in dielectric loaded structures and plasmas. Although the initial wakefield experiments were successful, higher drive beam quality would substantially improve the wakefield acceleration results. In this report we present a new 1-1/2 cell L-band photocathode design. This gun will produce 50 - 100 nC beam with 2 - 4 ps rms pulse length and normalized emittance less than 100 mm mrad. Numerical simulations of the beam dynamics and the status of construction will be presented.

WEA62 Current Status of the Drossel Project - a Superconducting RF Gun

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The main goal of the Drossel collaboration [4] is to develop a low emittance, high average current, cw electron injector [5] suitable for the ELBE project [6,7]. The injector is based on a photocathode RF gun with a superconducting cavity. A half-cell 1.3GHz superconducting niobium cavity incorporated with a normal conducting cathode unit was designed and produced at BINP to check the basic design concepts. Cold RF tests of the cavity at T=2K were successfully carried out at DESY TTF. A preparation chamber for producing Cs2Te photolayers was built. An UV Nd:YLF laser for activating the photocathode layer will be provided by MBI. For the beam tests a horizontal cryostat from Stanford University [8] will be modified with the support of ACCEL.

[1] Forschungszentrum Rossendorf, Postfach 510119, 01314 Dresden, Germany
[2] ACCEL Instruments GmbH, 51429 Bergisch Gladbach, Germany
[3] Max-Born-Inst., Rud. Chaus., 6, 12489 Berlin, Germany
[4] D.Janssen et al., Proc. PAC 1997, p. 2838
[5] V.Volkov et al., Proc. PAC 1997, p. 2799
[6] F.Gabriel ed., FZR Internal Design Report, Dresden, 1995
[7] D.Janssen and P.vom Stein, Nucl. Instr.&Meth., A380, 1996, p. 497
[8] HEPL, Stanford Univ., Stanford, CA 94305, USA

WEA63 All-Solid-State Picosecond Laser System for Photocathode RF Gun*

F. SAKAI, M. YOROZU, Y. OKADA, A. TSUNEMI, Y. AOKI, J.YANG, A. ENDO, SUMITOMO HEAVY INDUSTRIES, LTD.

Technologies to obtain high brightness electron bunches with a low emittance and a short duration have been studied with photocathode RF guns using short pulse lasers in order to apply for new technologies, X-ray generation by Compton scattering, laser wake-field accelerator, FEL and so on. The performance of the photoinjector is strongly dependent on the characteristics of the driver laser. The injection system with a compact all solid-state LD-pumped picosecond Nd:YLF or Nd:YAG laser and the optical system to the RF gun was developed. The laser system composes of a passive mode-locked oscillator, a regenerative amplifier, a main amplifier and harmonic generation crystals. Additional pulse compressor to about five picoseconds pulse duration of te fundamental was also designed with a fiber as a stretcher and the gratings as a compressor. This laser system pumped by laser diodes has some advantages, the low energy fluctuation, increased lifetime and a compact system. The energy fluctuation of 4th harmonic was around 2%. The timing stabilizer system controlling the laser cavity length with the difference error signal of the laser output and the drive RF made timing jitter to sub-picosecond. The optical system with an image relay and a skew grating for the laser injection to the gun was designed. The design and the performance of the laser injection system for RF photocathode will be presented. This work is supported by New Energy and Industrial Technology Development Organization (NEDO) in Japan.

WEA64 A Comparison Between the Perfomance of Split and Integrated RF Photoinjectors

J. B. ROSENZWEIG, S. ANDERSON, X. DING AND L. SERAFINI*

RF photoinjectors, the present source of choice for production of ultra-high brightness electron beams, have two basic design types: split, in which a short, high gradient rf gun is followed by a a drift and a booster linac, and a lower gradient integrated photoinjector, in which the linac acceleration is connected directly to the gun. The first type is represented at UCLA by the Neptune photoinjector, the second by the newly constructed S-band PWT photoinjector. We examine, through simulation and theory, the relative merits of each type of injector, both from the point of view of the beam physics (ability of the source to produce high currents and low emittances), and of relativetechnical advantages.

*INFN-Milano, Univ. Milan.

WEA65 The Effects of RF Asymmetries on Photoinjector Beam Quality

J. B. ROSENZWEIG, S. ANDERSON, X. DING, AND D. YU*

A general multipole-based formalism to study the effects of RF asymmetries on the production of ultra-high brightness beams is presented, which employs both analytical and computational techniques. These field asymmetries, which can cause the degradation of the beam emittance due to time dependent and nonlinear focusing effects. Two cases of interest are examined: the dipole asymmetry produced by a coupling slot in a standard high gradient rf gun, and the higher multipole content introduced by the support/cooling rods in a PWT structure. Practical implications of our results, as well as comparison to cold test and beam-based experimental tests, are discussed.

*DULY Research

WEA66 Optimal Scaled Photoinjector Designs for FEL applications

J. B. ROSENZWEIG, S. ANDERSON, X. DING, C. PELLEGRINI, AND G. TRAVISH*, UCLA

Much of the research and development surrounding the effort to create X-ray FELs based on the SASE process has centered on the creation of ultra-high brightness electron beam sources. The sources for existing short wavelength FEL designs, which employ RF photoinjector technology, have all been specified to contain 1 nC of charge. We show, by scaling existing designs, that this constraint causes the maximum beam brightness to be found when the rf wavelength is shortened to X-band. If, instead of holding the charge constant, we assume a certain RF wavelength device and then scale the charge, notable improvements in the beam brightness, and thus the FEL performance, are found. Charge scaling assumes that the density and aspect ratio of the beam stays constant as the charge is changed. If we relax the requirement of a constant aspect ratio in order to maximize the beam current and brightness by shortening the beam pulse, we find that the pulse lengthening due to space charge eventually brings this effort to a stop. The results of this investigation and their impact on SASE FEL design is discussed.

*APS, ANL.

WEA67 Effect of RF Focussing in High Gradient RF Guns

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It is generally adopted that an RF gun requires a DC magnetic focussing to produce a low emittance electron beam. In this report an effect of RF focussing in the first half-cell of RF gun [3] is studied. Beam parameter sets for the ELBE project [4] and for TESLA [5] are considered. The first half-cell shape is optimized for each beam parameter set to provide minimum emittance. The other 3 cells have TESLA geometry.

[1] Forschungszentrum Rossendorf, Postfach 510119, 01314 Dresden, Germany
[2] ACCEL Instruments GMBH, Friedr.-Ebert Str., 1, 51429 Bergisch Gladbach, Germany
[3] V.Volkov et al., Proc. PAC 1997, p. 2799
[4] D.Janssen, P.vom Stein, Nucl. Instr. and Meth., A380, 1996, p. 497
[5] B.Aune, EPAC 96

WEA68 Instrumentation Concepts for Absorbers in High Luminosity Insertions of LHC

W.C. TURNER, E.H. HOYER, J.LUDVIG, P.F. MANFREDI, J.E. MILLAUD, D.R. NYGREN, LBNL; N.V.MOKHOV, FNAL;

The high luminosity of LHC requires forward absorbers in IR's 1 and 5 to prevent collision fragments from quenching superconducting magnets and to localize the induced radioactivity. In this paper we examine the feasibility of turning this liability into a useful storage ring operations tool by installing radiation hard instrumentation in the front quadrupole (TAS) and neutral particle (TAN) absorbers. Parameters that can be measured include luminosity, beam-beam separation at the IP, rms transverse beam size at the IP, beam-beam crossing angle and transverse position of the IP. The signals could be used for bringing the beams into initial collision and for nulling beam-beam separation to optimize the integrated luminosity of a storage cycle. Particular attention has been given to gas ionization chamber instrumentation with the possibility of bunch by bunch measurements. Other possibilities are being examined. Integration times, sources of background, problems of radiation damage and induced radioactivity will be discussed.

WEA69 A closed orbit measurement with the NSRL BPM system

JUNHUA WANG, YAN.YIN[1], JINGYI LI, ZUPING LIU, BAOGEN SUN, GUICHENG WANG, JINHONG LIU, NSRL, UNIVERSITY OF SCIENCE & TECHNOLOGY OF CHINA, HEFEI, ANHUI 230029

A closed orbit measurement with the NSRL BPM system. J.WAN Y.YIN[1], J.LI, Z.LIU, B.SUN, G.WANG, J.LIU NSRL, University Science & Technology of China, Hefei, Anhui 230029, The be position monitor system (BPM) for NSRL electron storage ring ha resolution of 10 microns with an accuracy of 50 microns, which adequate for beam position measurement and the closed orbit correcti The paper describes the closed orbit measurement performed by above BPM system.

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WEA70 Beam Position Measurements for LEDA/APT: FIRST BEAM RESULTS

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It is necessary to build a set of Beam Position Monitors (BPMs) for Low-Energy Demonstration Accelerator (LEDA) for the Accelera Production of Tritium (APT) project. The BPMs will be used determine the transverse position of the beam distribution centroid a the beam's trajectory angle. The BPMs will be microstriplines about t to three inches in length and operating at 350 MHz. Using a log-ra technique and a new log amplifier made by Analog Devices, it is possi to run Heliax cable from the stripline straight into the VXI proces board. The board will contain the log amplifier and any necessary anal processing, a digitizing section, and the main processor. The ma processor consists of dual TMS320C40 Digital Signal Processing (DS chips and is used to complete the log-ratio processing technique as w as any offset correction for the log amplifier. This paper reports preliminary data taken from the LEDA experiment. It also contai analysis and simple conclusions drawn from such data about t performance of the BPM system.

WEA71 Reduction of X-BPM Systematic Errors by Modification of Lattice in the APS Storage Ring*

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With recent developments, the X-ray beam position monitors (X-BPM are capable of making accurate photon position measurements down submicron level. The true performance of X-ray beam position monito when installed on the insertion device beamline is, however, severe limited due to the stray radiation travelling along the beamline th contaminates the insertion device photons. The stray radiation emanat from upstream and downstream dipole magnet fringe fields, fro steering correctors, and from sextupoles and quadrupoles with offs trajectories. While significant progress has been made at the APS usi look-up tables derived from translation stage scans to compensate for th effect, performance of ID X-BPMs to date is at the 10- to 20-micr level. A research effort, presently underway to address this issu involves the introduction of a chicane into the accelerator lattice to ste the stray radiation away from the X-ray BPM blades. A horizont parallel translation of the insertion device allows only ID photons ar radiation from two nearby correctors to travel down the beamlin simplifying the radiation pattern considerably. A detailed ray tracin analysis has shown that stray radiation gets displaced by up to 2 c horizontally at the X-BPM locations so that it can be easily maske Results from such a modified lattice, implemented for one of th insertion devices, are reported here.

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WEA124 Application Limit of SR Interferometer for Emittance Measurement

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Recently, the SR interferometer (Synchrotron Radiation interferometer) has been developed for the emittance measurement. The SR interferometer measures the spatial coherence of the bending magnet radiation. According to the van Cittert Zernike theorem, which is the basis of the coherence theory, the spatial coherence is given by the two dimensional Fourier transformation of the intensity distribution on the light source. In other words, the intensity distribution can be obtained by measuring the spatial coherence. By applying this to the bending magnet radiation, the electron beam size can be estimated. With the beta function, the dispersion function and the energy spread, which can be measured or calculated within some accuracy, the electron beam emittance is obtained. To derive the van Cittert Zernike theorem, it is supposed that the light source (electron beam) is at rest and the radiation field emitted by each point source (a single electron) is spherical wave. These situations are not held for the bending magnet radiation and it is not clear whether the van Cittert Zernike can be applied in this case. In order to solve this problem, we construct a new theorem to calculated the spatial coherence of the bending magnet radiation. We take into account of the effect of the field depth, the Twiss parameters and the dispersion. The conditions under which the van Cittert Zernike theorem can be applied, namely the electron beam size can be directly calculated, are derived in the horizontal and vertical directions. We find that these conditions are well-satisfied at KEK-ATF. However, the aperture of the SR extraction line is too narrow, nearly 5 mm in the vertical direction, that the spatial coherence might change due to the diffraction. We show that this situation must occur at ATF, actually.

[1] T. Mitsuhashi et al, Proc. 11th symposium on Accelerator Science and Technology, 441 (1997)
[2] Y. Takayama and S. Kamada, KEK Preprint 98-116 (1998)

WEA125 Recent progress in emittance control of the photoelectron beam using transverse laser shape modulation and tomography technique.

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A low emittance beam is very important for many applications, such as short-wavelength Free-Electron Lasers. A diagnostic that provides detailed information on the density distribution of the electron bunch in multi-dimensional phase-space is an essential tool for obtaining small emittance at a reasonable charge. Accurate phase space reconstruction and an analysis using a transport line with nine focusing magnets and techniques to control the optical functions and phases was demonstrated in previous publication. Relatively long time of measurements (approximately 30 minutes) was improved by installing all probes into each quadrupole magnet. This eliminated necessity to degauss all quadrupoles between each measurement points. Additional phase control of RF system and driving laser should also improve confidence in 5 dimensional phase space reconstruction.

WEA126 Simultaneous Measurement of Electron Beam Size and Divergence with an Undulator*

X. YANG, A.H. LUMPKIN, ANL

Most measurements of storage ring beam emittance are based on beam size or divergence measurements, using synchrotron radiation imaging techniques. The emittance is obtained with additional measurement of beta functions at the source point. While measurements of both beam size and divergence have been reported, few were performed simultaneously. We report the design of the APS diagnostic undulator beamline for just that purpose. A thin silicon crystal monochromator is used to measure the divergence down to 3 μ rad (1 μ rad with the third harmonic). X rays transmitted through the crystal are used by a pinhole camera to measure the beam size at the same time, at a resolution of 60 μ m. Initial data from the beamline will be presented.

*Work supported by the U.S. Department of Energy, Office of Basic Energy Sciences, under Contract No. W-31-109-ENG-38.

WEA127 Improvements To The Fermilab Ionization Profile Monitor Systems *

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The Ion Profile Monitor Systems have been studied in the Fermilab Tevatron, Main Injector, and Booster accelerators. These systems capture 64K samples of both horizontal and vertical profiles at a turn by turn sample rate. Some early results have revealed various systematic problems and where improvements in the present system can be accomplished. Identification of these systematics and improvements planned for these systems are described. An entirely new design is planned which incorporates a magnetic field and can collect electrons instead of ions. In addition, selective gating of the top microchannel plate in a 2 plate system will allow us to minimize saturation and charge depletion problems.

* Work supported by the U.S. Department of Energy under Contract No.DE-AC02-76CH03000

WEA128 Measurements of Beam Characteristics by Transition Radiation at BFEL

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BFEL is a RF linac-based IR free electron laser. After lasing to saturation in 1993, continuous efforts to improve its performance were made. In order to upgrade the beam diagnostic system, we chose transition radiation as the main diagnostic tools. With different experimental set-up, the electron beam profiles, transverse emittance, beam energy can be obtained on-line using optical transition radiation. In this paper, we present the results of OTR beam measurements performed at BFEL. Future developments include further observations of the coherent transition radiation to determine the micro-bunch length.

WEA129 Non-destructive diagnostic for a longitudial charge distribution of an ultrarelativistic electron bunch monitoring.

A.V. ANTOSHIN, P.A. BAK, N.S. DIKANSKY, K.V. GUBIN, M.B. KORABELNIKOV, P.V. LOGATCHEV, S.V. SHIYANKOV, A.A. STAROSTENKO, V.S. TUPIKOV.

In this paper we present the method of the ultrarelativistic electron bunch longitudial charge distribution monitoring, using a testing across-directed electron beam. Design and the main parameters of the diagnostic device are described. The status and the first experimental results are presented.

WEA130 Impulse magnet of positron source with adiabatic field decreasing.

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Positrons produced in conversion target material occupy a large space volume in a transverce angle and energy. A pulsed magnet produces adiabatically decreased longitudinal magnetic field with a necessary profile along its axis. To enlarge a positrons number of forinjector complex a strong magnetic field is required. A special design of such impulse device which allows to achive a necessary strong of field is considered. Also field profile tests and operation parameters are presented.

WEA131 Bunch Length Measurements using a Martin Puplett Interferometer at the TESLA Test Facility Linac

CH. BERGER [1], B. LEISSNER [1], R. SIEDLING [1], M. TONUTTI [2], RWTH AACHEN; M. GEITZ, G. SCHMIDT, P. SCHMUESER [3], DESY [4];

WEA155 TOMOGRAPHIC RECONSTRUCTION OF TRANSVERSE PHASE SPACE FROM TURN-BY-TURN PROFILE DATA

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Tomographic methods have the potential for useful application in beam diagnostics. The tomographic reconstruction of transverse phase space density from turn-by-turn profile data has been studied with particular attention to the effects of dispersion and chromaticity. It is shown that the modified Algebraic Reconstruction Technique (ART) that deals successfully with the problem of non-linear motion in the longitudinal plane cannot, in general, be extended to cover the transverse case. Instead, an approach is proposed in which the effect of dispersion is deconvoluted from the measured profiles before the phase space picture is reconstructed using either the modified ART algorithm or the inverse Radon Transform. This requires an accurate knowledge of the momentum distribution of the beam and the modified ART reconstruction of longitudinal phase space density yields just such information. The method has been tested extensively with simulated data. The results, together with some preliminary measurements, are presented.

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WEA156 Performance of the Electron Beam Diagnostics at Jefferson Lab's High Power Free Electron Laser*

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In this paper the performance and current status of the electron beam diagnostic complement for Jefferson Lab's IRFEL are summarized. In addition, measurement results from the FEL beam are presented. Diagnostic devices include optical transition radiation beam viewers, both stripline and button beam position monitors, multislit beam emittance measuring devices, coherent synchrotron and transition radiation bunch length monitoring devices, and synchrotron light cameras for measuring the beam profile at high average power. Update rates of order 1 sec or shorter have been achieved. All devices are controlled through an EPICS control system.

*This work supported by U. S. DOE Contract No. DE-AC05-84ER40150,
the Office of Naval Research, the Commonwealth of Virginia, and the Laser Processing Consortium.

WEA157 Proton Bunch Measurement in HERA

W. KRIENS, DESY

In order to supervise the longitudinal matching at transfer of protons from PETRA and to detect the distortion of the longitudinal emittance due to excitation during ramping, a wall current monitor signal is analysed using a 1 GHz bandwidth digitizing oscilloscope with a special fast frame trigger feature. For this purpose a trigger generator has been developed to meet the requirements for stability and flexibility. A description of the arrangement and recent measurements at HERA will be presented.

WEA158 Laser Processing Experiments For Beam-Target Interaction Issues

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Backstreaming ions are possible candidates to perturb the stability of the pulsed electron beam spot size, needed for high resolution X-ray facilities. Surface contaminants have been studied experimentally on a test bench at Claude BERNARD University in Lyon, using a technique based on the measurement of the working function of photo-emission, driven by a 266nm YAG laser. Recommandations on target material choices, material processing and surface cleaning procedures can be drawn from these results. A UV laser was then installed on the PIVAIR facility at CESTA in order to test the effectiveness of laser induced target desorption and to understand the plasma layer formation time scale dependence on an experimental basis.

WEA159 New Technique for Absolute Beam Energy Calibration in e+/e- Accelerators.

G.YA.KEZERASHVILI AND N.YU.MUCHNOI BINP

A new method for absolute beam energy calibration is suggested. The method is based on the angular properties of the Compton backscattering of laser photons on the high-energy electron beam. Under reasonable gamma-ray beam detector requirements, it posesses absolute accuracy for the electron beam energy measurement about 0.01%.

WEA160 High Precision Electron Beam Diagnostics System for High Brightness Beams

S.D.NELSON, T. FESSENDEN, Y.J.(JUDY) CHEN, C. HOLMES, LLNL; N. SELCHOW, RMC CORP.

As part of the effort to develop a multi-axis electron beam transport system using stripline kicker technology for DARHT II [1] and potential AHF [2] applications, it is necessary to precisely determine the position and extent of long high energy beams (6 - 40 MeV, 1 - 4 kA, 2 microseconds) for accurate position control. The kicker positioning system [3] utilizes shot-to-shot adjustments for reduction of relatively slow (

*This work was performed under the auspices of the U.S. Department of Energy by LLNL, under contract W-7405-ENG-48.

[1] Second axis of the Dual Axis Radiographic Hydrodynamic Test facility located at Los Alamos National Laboratory
[2] Advanced Hydrotest Facility
[3] Y. J. (Judy) Chen, ``Precision fast kickers for kiloampere electron beams," 1999 Particle Accelerator Conference (PAC99), New York, New York, USA, March 29 - April 2, 1999.

WEA161 Nanosecond Diagnostics of High Intensity Proton Beam with the Wall Current Monitor on Moscow Meson Factory Linac

A.V.NOVIKOV-BORODIN, INR RAS

The nanosecond impulse formattion of the high intensity (~100mA) proton beam of the Moscow meson factory Linac is necessary for neutron physics experiments and the Storage ring operation. The diagnostics of such impulses with a few nanoseconds rise and fall times and with an impulse length from few nanoseconds to few microseconds is needed. The Wall Current Monitor (WCM) applied for this purpose in the 750 keV linear accelerator beam transport line is described. The WCM bandwidth is from 50 kHz to 1 GHz. The device construction and experimental results are presented. The method of the precise injector energy measurements with the help of WCM is described and discussed.

WEA162 Recalibration of a Wall-Current Monitor Using a Faraday Cup for the KEKB Injector Linac

T. SUWADA, S. OHSAWA, K. FURUKAWA, N. AKASAKA, AND K. OIDE, KEK

Recalibration of a wall-current monitor (WCM) was performed using a Faraday cup (FC) for single-bunch electron beams with a pulse width of 10 ps at the KEKB injector linac. It is strongly required to obtain the precise beam-injection rate to the KEKB rings, and, furthermore, to estimate the amount of a beam-charge loss. A bench calibration for the WCMs was performed using fast test pulses with a width of nanoseconds, and the calibration coefficients were derived from the pulse-height response of the monitor depending upon the pulse width. It is, however, difficult to directly obtain the calibration coefficient for single-bunch beams, because the direct generation of such extremely fast test pulses is not very easy. One of the author has tentatively derived calibration coefficients for a 10-ps pulse width from extrapolation based on the results of the bench calibration. It is, however, not sufficiently accurate to estimate them by this extrapolation method, because the WCM has a strong frequency response and a beam-position dependence for shorter pulses. This is the reason why the recalibration is necessary. The WCM was precisely recalibrated by a beam test using the FC with an error of

A.SHCHERBAKOV, A.TARASENKO, YU.TELEGIN, A.ZELINSKY, NSC KIPT, KHARKOV, UKRAINE

The multifunctional accelerator-storage ring complex ASC with electron energy of up to 2 GeV, presently under construction at Kharkov Institute of Physics and Technologies, is low emittance high brilliance synchrotron radiation light source. After successful completion of the building project the prototyping of magnetic elements for the storage ring are produce. The designing of projects and modelling of elements of vacuum system and RF system are in progress. The design and construction of ingector system and insertion devices are in progress. This paper describes the status of the project.

WEP61 Beam Orbit Stability at Taiwan Light Source

K. T. HSU, C.C. KUO, C.H. KUO, H.P. CHANG, CH. WANG, J.R. CHEN, K.K. LIN, AND R.C. SAH, SRRC

Beam orbit stability has been one of the major accelerator improvement programs at the SRRC since the storage ring started to be operational in 1993. In the past years, several tasks have been carried out to tackle the orbit stability problems, e.g., the air and cooling water temperature regulation, the electrical and electronic noise reduction, the orbit feed-forward and feedback systems, etc. This paper presents the current status of the beam orbit stability at the SRRC storage ring TLS.

WEP62 Lattice Study with Superconducting Bending Magnets in SRRC Storage Ring

M. H. WANG, C. C. KUO, SRRC

In order to increase the flux of higher energy photon for 1.5 GeV SRRC storeage ring, the feasibility to replace one or three central conventional bending magnets of the TBA lattice by superconducting bending magnets are investigated. In this report, we present the lattice design and beam dynamics effects with these superconducting magnets.

WEP63 Preliminary Transverse and Longitudinal Phase Space Study at TLS

K. T. HSU, JENNY CHEN, C. H. KUO, K. H. HU, K. K. LIN, SRRC

Turn-by-turn beam position monitors and phase detectors have been implemented recently for Taiwan Light Source (TLS). Transverse as well as longitudinal phase space exploration has been proceed using turn-by-turn beam position and phase measurement in single bunch mode. Single bunch longitudinal beam transfer function measurement is also performed with various excitation amplitudes. Preliminary results of the study will present at the conference.

WEP64 Status of the Taiwan Light Source

C.C. SAH, J.R. CHEN, P.J. CHOU, AND K.K. LIN

The Taiwan Light Source(TLS) is a third-generation synchrotron light source located at the Synchrotron Radiation Research Center in Taiwan. The TLS is now operating routinely for user experiments, and the highest priorities are increasing user beam time, increasing machine reliability , and improving the stability of the stored electron beam. Many current machine upgrades are intended to improve beam stability: the longitudinal feedback system, orbit feedback systems, radiofrequency-system improvements (better higher-order-mode performance), and utilities upgrades. In addition, a major improvement program to increase the stored beam current is being planned.

WEP65 The Operational Status of PLS

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The Pohang Light Source has been operating successfully at 2.0 GeV. But now the energy can be raised upto 2.5 GeV by energy ramping in the storage ring. The operational status of PLS is presented including 2.5 GeV operation. Beam parameters such as emittance, lifetime have been been measured at a few energy levels. The measured results are presented and discussed with emphasis on their energy dependence.

WEP66 Orbit Correction in the LNLS UVX Electron Storage Ring.

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The orbit measurement and correction system of the LNLS synchrotron light source is presented. Recent changes to the system including the addition of 12 new vertical correctors and the use of 16 bit DACs to control the corrector magnet power supplies have improved the vertical orbit repeatability from fill to fill from 100 mm to less than 5 mm. We report on the results of experiments performed to determine the causes of slow orbit drifts as well as orbit fluctuations and the measures taken to minimize these effects.

WEP67 Status of KSRS

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Kurchatov Synchrotron Radiation Source (KSRS) is preparing to start regular experiments with synchrotron radiation (SR) from 2.5 GeV electron storage ring SIBERIA-2. Four SR beamlines with 5 experimental stations will be available in 1999. Achieved parameters of KSRS storage rings SIBERIA-1 and SIBERIA-2 are described. Modern status of accelerator systems, operational parameters and future plans are given.

WEP68 Status and perspectives of superconductive in-vacuum microundulators

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Microundulators in general enable to boost the photon energy for a given synchrotron radiation source and/or allow the use of beams with lower energy for obtaining a given spectrum. They also allow to build short undulators with many periods with the result that the linewidth is small. Superconductive microundulators can reach high magnetic fields and, in addition, the photon energy be altered electrically, even with high frequencies. Both BNL and FZK investigated superconductive undulators after several institutions proposed and developed in the 80's microundulators with permanent magnets. Recently a 3.8 mm period length, 100 period long superconductive in-vacuum undulator was built at FZK and was successfully tested at the Mainz microtron MAMI with a 855 MeV, 50 A cw beam. The emitted photon energy was 1.8 keV. Based on this breakthrough Accel Instruments joined efforts to develop and offer superconductive in-vacuum undulators. The first one, now under construction, will be available and tested mid 2000. This undulator is tailored to the needs of single-pass accelerators and linear FEL's. In addition a design study for a superconductive microundulator suitable for the needs of a third generation storage ring light source is under way. The existing in-vacuum undulator use NbTi superconductors since they are easy to handle. In the future other types of superconductors including high temperature superconductors might be used. Means of controlling the spectrum and the direction of polarization will be outlined. Due to the high versatility and the unique beam properties superconductive microundulators might become a new source for brilliant, tunable and polarization controlled synchrotron radiation.

WEP69 Status of the accelerator for the 2.7 GeV light source ANKA in Karlsruhe

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ANKA is a new 2.7 GeV synchrotron light source at the Forschungszentrum (Research Center) Karlsruhe, Germany. The light source will be mainly used for LIGA and the application of microstructure techniques. ANKA has a circumference of 110.4 m and the DBA structure will allow to operate the storage ring with a variable

* Work supported by the U.S. Department of Energy, Office of Basic Energy Sciences, under Contract No. W-31-109-ENG-38.
[1] M. Xie, Proc. 1995 Part. Accel. Conf., 183.

WEP100 Calculations of the Self-Amplified Spontaneous Emission Performance of a Free-Electron Laser*

R.J. DEJUS ANL; O.A. SHEVCHENKO, N.A. VINOKUROV BINP

The linear integral equation based computer code, which was recently developed at Argonne National Laboratory, was used to calculate the self-amplified spontaneous emission (SASE) performance of the free-electron laser (FEL) being built at Argonne. Signal growth calculations under different conditions, for estimating tolerances of actual design parameters, will be presented. The radiation characteristics are discussed in detail and calculations based on an ideal undulator magnetic field and a real measured magnetic field will be compared and discussed.

* Supported in part by the U.S. Department of Energy, BES, under contract no. W-31-109-ENG-38.

WEP101 Coherent Spontaneous Emission in High Gain Free-Electron Lasers*

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We investigate the short pulse effects in self-amplified spontaneous emission, especially the role of coherent spontaneous emission (CSE) in the start and the evolution of the free-electron laser (FEL) process. When the FEL interaction is negligible, we solve the one-dimensional Maxwell equation exactly and clarify the meaning of the slowly varying amplitude and phase approximation. In the exponential gain regime, we solve the coupled Vlasov-Maxwell equations for a bunched electron beam and compare the analytical solution with the result of a 1-D time-dependent simulation that takes CSE into account. In the nonlinear regime, we employ the benchmarked code to study the radiation pulse structure and the existence of superradiance.

Work supported by the U. S. Department of Energy, Office of Basic Energy Sciences, under Contract No. W-31-109-ENG-38.

WEP102 Low Signal FEL Gain: Analysis, Simulation and Measurement

M. ZOLOTOREV, H. CHONG, E. GLOVER, P. HEIMANN, R. SCHOENLEIN, A. ZHOLENTS, LBNL

We derive a compact analytical expression for a low signal FEL gain including 3D effects and compare it with computer simulations and measurements performed at the Advance Light Source. We describe an experimental set-up and measurement technique.

WEP103 A Non-Intercepting Electron Beam Diagnostic Using Coherent Off-Axis Undulator Radiation

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A promising technique for characterizing short electron bunches is to observe coherent off-axis undulator radiation (COUR) from a short diagnostic undulator. Typically the on-axis undulator radiation is incoherent, but at angles of a few degrees, the wavelength of the emitted radiation may be comparable to the length of a short electron bunch and thus coherence effects emerge. Due to such coherence effects, the intensity of the emitted radiation may change by up to a factor of 10^9 as the angle of observation is increased. The radiation becomes coherent in a way that depends on the length and structure of the electron bunch. Since observing COUR disturbs the electron bunch negligibly, the diagnostic is non-disturbing. This non-disturbing diagnostic would be useful in applications where the length of short electron bunches is critical, such as SASE FELs and linear colliders. For example, the performance of a SASE FEL could be optimized in real time. We present the complete theory for the description of COUR, including near-field effects. We present calculations showing the expected outcome of a COUR experiment, and we describe an experiment that is planned for the Source Development Laboratory at Brookhaven National Lab.

WEP104 Beam Quality Measurement of 100 MeV Test Linac

H. S. KANG, J.-Y. CHOI, S. H. NAM, AND S. S. CHANG, PAL

The 100-MeV Test Linac was constructed for the high brightness applications such as free electron laser and coherent radiation generation experiment at PAL. The linac consists of a thermionic RF-gun, an alpha magnet, two accelerating structures, and a beam analyzing magnet. The RF-gun is one-cell cavity with a tungsten dispenser cathode of 3 mm diameter, and the longitudinal matching from the RF-gun to the first accelerating structure is done by the alpha magnet. The RF frequency is 2856 MHz, and a SLAC 5045 klystron feeds RF power to two accelerating structures and the RF-gun. In the initial beam test the achieved beam energy and current were 75 MeV and 30 mA, respectively. The longitudinal acceptance measurement with the alpha magnet is done to minimize energy spread, and the bunch length was measured with a streak camera by using OTR (Optical Transition Radiation). In this paper, the beam quality measurement results are described in detail together with the detailed descriptions of the machine.

* Work supported by the Ministry of Science and Technology of Korea and POSCO

WEP105 Initial Results from the DUV-FEL Linac Commissioning

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The DUV-FEL linac (formerly known as the Source Development Lab) at BNL is currently being commissioned. The linac consists of a 1.6 cell RF photocathode gun driven by a short pulse Ti:Sapp laser, four 2856 MHz SLAC linac tanks, and a four magnet pulse-compression chicane situated between linac tanks 2 and 3. The maximum energy of the linac is 210 MeV. It produces a single bunch per RF pulse at a 10 Hz rate. The design parameters specify normalized RMS emittance of 5 pi mm-mrad at a peak current of 100 A from the photocathode. The bunch is then compressed a factor of 10-20, producing 1-2 kA peak current. Emittance after the pulse compressor is expected to degrade due to coherent synchrotron emission. We present initial measurements of these beam parameters along with the current status of the facility.

WEP106 Physics design of the DUV-FEL linac.

W.S. GRAVES BNL

The DUV-FEL linac is designed to produce short, high current electron beam pulses for high-gain, single-pass free electron lasers. An analytical model of the evolution of the beam's RMS envelope from photocathode through the bunch compressor is presented and compared with PARMELA simulations. The linac is currently being commissioned and the model predictions are compared to measurements as they become available.

WEP107 Output power and pulse length control in an X-ray FEL

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The X-ray FELs being developed at SLAC, DESY and other laboratories has applications in research on materials, biological systems, solid state physics, quantum electrodynamics and chemistry. These applications will use the coherence, tunability and sub-picosecond pulse length, to image, study the dynamics of processes at the femtosecond time scale, and explore non linear physics. These different applications require X-ray pulses with different intensity and pulse length. In this paper we will show how, for a given X-ray FEL system, these quantities can be controlled by changing the characteristics of the electron pulse produced by the electron source at the linac entrance. In this way the output intensity and the pulse length can be changed by about one order of magnitude. We will discuss examples based on the LCLS.

[3] P.L.Anthony et al. Phys. Rev. Lett. 75, 1949 (1995)
[4] N.F.Shul'ga, S.P.Fomin, JETP 86, 32 (1998).

THA91 The Computer Code for Investigation of the Multipactor Discharge in RF Cavities

L.V. KRAVCHUK, G.V. ROMANOV, S.G. TARASOV, V.V. PARAMONOV, INR OF THE RAS, MOSCOW

During long-term INR activity in the development and construction of accelerating structures, special code has been developed for numerical simulations of the multipactor discharge in RF-structures. Using the real electromagnetic field distribution (calculated with modern 2D or 3D software) in the cavity with complicated boundary shape, the code directly simulates electron trajectories. Special implementations have been developed for the investigation of the discharge phase stability. The spread of secondary emission electrons also may be considered. During experience, results of the discharge simulations have been compared with experimental data, showing good coincidence. In this report we describe the particularities of the code, possibilities ans realisation. The results of simulations in accelerating cavities also are presented.

THA92 VIT 030 - the special code for computer simulation of the RF process in linear accelerators.

V.PODLEVSKIH,BINP;

This paper presents the analysis of algoritm and description of the special code for computer simulation of the RF process in linear accelerator. This program may be used for preliminary analysis of the RF process, RF system setup and monitoring.

[1]A.V.Aleksandrov et al.,"Electron-positron preinjector of VEPP-5 complex". Proc.1996 of the XVIII Int.Linear Acc.Geneva, Switzerland.Pp.821-823.

THA93 External Data Interface Tools for the Particle Beam Optics Laboratory

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An external data interface (EDI) tool has been developed for the Particle Beam Optics Laboratory (PBO Lab). The PBO Lab application [1] provides an environment for the graphical set up of beamline models and execution of multiple optics programs which are implemented as Application Modules in a single user-friendly graphic interface shell. The EDItool supports the import and export of beamline model parameters, as well as diagnostic data generated from the different Application Modules. A variety of data exchange capabilities are provided, including a basic implementation using ASCII text files. However, one new EDI tool is described here which supports dynamic data exchange with MATLAB. In addition to the dynamic exchange of beamline model parameters and computational diagnostics, this tool also supports an integrated simulation loop. This allows the user to modify beamline model parameters and specify the execution of PBO Lab Application Modules in a loop that is externally controlled from MATLAB using C or FORTRAN MEX files, or MATLABM files.

[1] G. H. Gillespie and B. W. Hill, Nucl. Inst. Meth. Phys. B 139, 478-480 (1998).

THA94 New Mathematical Optimization Models for RFQ Structures.

B.I.BONDAREV, A.P.DURKIN, MOSCOW RADIATECHNICAL INSTITUTE; A.D.OVSYANNIKOV, ST.PETERSBURG STATE UNIVERSITY;

Beam dynamics optimization problems of RFQ accelerating structures are considered. Simple beam models based on longitudinal motion of particles inside equivalent running wave were used for definition RFQ channel similarity. The obtained equations are used for formulation and discussion of optimization task and methods. An appropriate mathematical control model is suggested. It allows to optimize simultaneously a program motion and an ensemble of perturbed motions. This approach was used for optimization RFQ channel.

THA95 On the Relativistic Extension of the Stern-Gerlach Effect*

W. W. MACKAY, BNL, UPTON NY

The Stern-Gerlach effect has been verified at low energies; however, for relativistic velocities, the vast literature contains conflicting and ambiguous results, in part due to an attempt to invoke generalized covariance techniques. In the hope of clarifying the problem, I outline a derivation which takes the simple force in the particle's rest system and transforms it to the laboratory where the particle is moving, rather than try to guess a generalized covariant expression. This method still maintains covariance. Of particular interest is the case of the longitudinal component of force on a particle which is longitudinally polarized. The force in this case is found to be proportional to γ; however, when integrating the energy increase through a TE rf cavity, it is found that the energy shift is roughly proportional to $1/\gamma$. For static magnetic gradients, such as from the ends of a solenoid, the energy increase from the gradient at one end of the solenoid is canceled by the opposite gradient at the other end. As a result this enhancement by a factor of γ in the force does not appear to be terribly useful in the longitudinal case for particle accelerators.

* Supported in part by the RIKEN and the DOE.

THA96 ON THE INVARIANT MOMENTUM HYPOTHESIS AT EXTREMELY LARGE VELOCITIES

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In a recent work[1], assuming the constant velocity of light (c), we showed the existence of a generalized group of quantized space and time transformations. Lorentz transformations are included in this group for the special case of zero uncertainty. These transformations, however, can be applied for travelling objects at subluminal or superluminal velocities, with good agreement with subluminal phenomena. In this work, starting from the hypothesis of the invariancy of the subluminal momentum, proposed by Einstein, and using these new transformations we demonstrated that the momentum as a function of the velocity has a divergence to plus (+) infinity when the velocity is increased towards c, and to minus (-) infinity when the velocity is decreased from superluminal values to c. It is observed that the limit of the invariant momentum is zero for superluminal velocities. The kinetic energy, calculated from the invariant momentum, demonstrated a continuous dependence on velocity, implying the inexistence of a rest energy of the travelling object. For small (Newtonian) and medium velocities (relativistic) the results also show good agreement with the observed subluminal phenomena. For velocities close to c, the divergence of the limits to plus and minus infinity, respectively, lead to a new hypothesis for the existence of a limit for the kinetic energy of objects travelling at the velocity of light.

[1] V.Baranauskas, Solution to the Einstein and Poincare Paradox of Superluminal Addition of Velocities, Proceedings of the EPAC-98.

THA97 TO THE QUANTUM LIMITATIONS IN BEAM PHYSICS

ALEXANDER.A. MIKHAILICHENKO, CORNELL UNIVERSITY

The conditions reviewed for degeneration in an electron bunch, treated as a Fermi gas. Some comparison made for photoinjectors and storage rings. In some cases the quantum limitations are very close.

THA98 Quantum Aspects of Accelerator Optics

S.A. KHAN, INFN-PADOVA

Present understanding of accelerator optics is based mainly on classical mechanics and electrodynamics. In recent years quantum theory of charged-particle beam optics has been under development. In this paper the newly developed formalism is outlined with examples and applications to accelerator optics.

THA99 On Landau Scenariou Of Chaotization For Beam Distribution

Z. PARSA BNL*, V. F. ZADOROZHNY NASU**

We examine a problem in nonlinear dynamics in which both regular and chaotic motions are possible. Thus we deal with some of the fundamental theoretical problems of accelerator physics, mathematics theory of dynamical systems, and other fields of physics. The focus is on the appearance of chaos in a beam distribution. A study of the problem is based on two observation: First, Using Lyapunov method and its extension we obtain solutions of partial differential equations [1,2]. Using this approach we discuss the problem of finding a solution of Vlasov-Poisson equation, i.e., some stationary solution where we consider magnetic field as some disturbance with a small parameter ε=e/cm. Thus we have found the solution of Vlasov equation in the form $F=F_0+\varepsilon F_1+\varepsilon^2 F_2+...$, where F_0 is a solution of Vlasov-Poisson equation. The second observation is that physical chaos is weakly-* limit of, well known, the Landau bifurcation's. This fact we have proved using ideas on the Nature of Turbulence [3].

* Work supported by the U.S. Department of Energy under Contract Nos. DE-AC02-98CH10886. **Inst. of Cybernetics

[1] V. I. Zubov, Integral Equations for the Lyapunov Function, Soviet Dokl. Vol. 42, N2, p.535-537 (1991).
[2] Z. Parsa, V. Zadorozhny, Proc. 5th International workshop: Beam Dynamics & Optimization, St. Petersburg, Russia (1998).
[3] D. Ruller, F. Takens, on the Nature of Turbulence, common. Math. Phys., 20, 167-192, Springer-Verlag (1971).

THA100 Synchrotron motion under the influence of noise.

M.P.ZORZANO, H.MAIS, DESY

The longitudinal beam dynamics in storage rings under the influence of noise is studied with the help of the Fokker-Planck equation. Various models such as one-rf and two-rf systems with white or coloured noise are discussed and the corresponding Fokker-Planck equations are solved numerically.

THA101 Scattering Matrix Approach to Investigating the Beam--Cavity Interaction in the NLC Accelerating Structure

V. DOLGASHEV, BINP; K.L.F. BANE, Z. LI, K. KO, SLAC;

In designing the accelerating structure of the NLC linac one needs a method of accurately determining the strength of the beam--cavity interaction, and in particular that of the transverse wakefields. A scattering matrix approach to this problem complements those of equivalent circuit models and direct finite element calculation. We begin by comparing, for a slightly simplified model of the NLC structure---the so--called detuned structure (DS)---, the scattering matrix results with those of the other methods. We then use this method to estimate the effects of cell-to-cell misalignments. Such misalignments change the transverse wakefields, and also result in a transverse kick to the bunch even from the monopole mode, due to breaking of cylindrical symmetry in the structure. Finally, a future goal is to be able to use the scattering matrix formalism to model the more complicated NLC damped, detuned structure (DDS), and we present here some preliminary results toward this goal.

THA102 Tuning Possibilities of the Longitudinal Beam Shape of a Racetrack Microtron

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The beam shape in the longitudinal phase plane at the extraction point of an RTM strongly depends on the choice of the stable phase of the accelerating cavity. This is due to the fact that the main longitudinal focusing force is the derivative of the accelerating potential with respect to time (or phase). Furthermore, this focusing force is applied to the electron beam each turn, such that the output beam shape in the longitudinal phase plane is significantly affected. This effect can for instance be used in order to minimize the bunch length or the ener spread of the output beam of the RTM. For this paper we have used lay-out of the Eindhoven RTM for the calculations of the stable-pha variations, which have been studied in linear approximation. The stal phase area for this RTM equals 18 degrees. It will be shown that stab phase variations in the order of 1 degree already have a significant imp on the longitudinal beam shape. Furthermore, some remarks are made the consequences of non-linear beam dynamics in relation to stab phase-variations.

THA103 Bunch Shapes in the National Synchrotron Light Source VUV Ring

N. TOWNE

For bunches stretched with a higher-harmonic cavity, longitudinal bun shapes are influenced by small variations in the potentials wells of t buckets of the bunch train. This paper discusses three things that pertu the bunch shapes in the NSLS VUV ring: higher-order modes (HOM) the main cavity, the effect of unfilled buckets on the RF fields in t accelerating modes of the two cavities, and the -90° (non-optim phase of the harmonic cavity maintained by the RF controls [1]. T suppression of the lowest-lying HOM in an experiment using l feedback applied to two HOM damping-probe ports is described a results of calculations of the effect of unfilled buckets are give Measured bunch shapes are shown and discussed.

[1] R. Biscardi, S. L. Kramer, and G. Ramirez, Nuclear Instruments and Methods in Physics Research A 366, p. 26-30 (1995).

THA104 Study of the BESSY II Beam Lifetime*

S. KHAN, BESSY;

The beam lifetime is one of the key parameters of a third generati synchrotron light source. This paper presents lifetime measuremer under variation of the transverse aperture, momentum acceptance, bea current etc. in order to study the different lifetime limiting effects. Elas (Coulomb) scattering, inelastic scattering (Bremsstrahlung) a intrabeam scattering (Touschek effect) are discussed and compared theoretical model predictions.

* Funded by the Bundesministerium fuer Bildung, Wissenschaft, Forschung und Technologie (BMBF) and the Land Berlin.

THA105 Effect of RF Phase Modulation near the Integer or the One-Third Parametric Resonance on the Longitudinal Emittance

F. ORSINI, CEA/DSM/DAPNIA; A. MOSNIER, SOLEIL

Aiming at increasing the beam life time, RF phase modulation near t integer or the one-third parametric resonance has been experimental investigated in various electron storage rings. Since the eventual bene of this technique depends greatly on the ring parameters, we studied t effect of such a modulation at different higher order resonances and f different RF parameters on the longitudinal emittance. Theoritic predictions and results of simulation are compared and discussed.

THA106 Experiment of RF Voltage Modulation at SRRC

M.H. WANG, W.K. LAU, C.C. KUO, K.T. HSU, P.J. CHOU, J.C. LEE, PEACE CHANG, SRRC

The effects of RF voltage modulation on longitudinal beam dynami were studied experimentally at SRRC by using a streak camera syste The characteristics of parametric resonance in single bunch is measur and compared with the theoretic analysis. The formation of beamlets the bunch helps to damp the coupled bunch oscillation. This property w employed to provide a stable beam in user's shift at SRRC.

THA107 Rf Manipulations In The Fermilab* Main Injector

I. KOURBANIS, D. WILDMAN

Fermilab's Main Injector has to operate in a variety of modes in the sco of Run II.The modes of operation include antiprotonstacking, delivery intense proton bunchesfor collider operation and recycling

WEP135 Powerful High Frequency Electron Accelerators Type ILU and Their Application in Research and Industry.

V. L. AUSLENDER, BINP

The ILU electron accelerators are the pulse high frequency powerful machines designed for long reliable operation. They work in the energy range from 0.5 to 6-8 MeV and have average beam power of up to 50 kW. Some models of ILU machines are described. The examples of the applications of these machines for the researches in the biology, in the solid state physics and in high temperature solid state chemistry are given. The ILU machines were initially designed concerning the real needs of operation in industry, and now they are used in various production lines. The technological lines for production of cables, wires, tubes, polyethylene film, for sterilization of disposable medical goods, etc., are described.

WEP136 Multi-beam Electron Accelerator for Industrial Applications

G.V. DOLBILOV, G.I. DOLBILOVA, A.A. FATEEV, I.M. HOKHLOV, I.N. IVANOV, N.I. LEBEDEV, A.V. MAZHULIN, V.A. PETROV, JINR; T. RUSKOV, INRNE

This report describes the design of a multi-beam accelerator optimized for electron beam processing. Parameters of the accelerator are: 600 keV accelerating voltage, 30 kW average output power, 0.5 A peak current, 10-20 μs pulse duration and 10-20 kHz repetition rate. λ/4 coaxial spiral-line resonator serves as a high voltage supply. Electron beams are generated by a mosaic cold cathode and accelerated in vacuum diode. Each electron beam is delivered into the air via individual output window. Such a multi-cathode, multi-window design allows one to reduce the energy loss in the extraction system and increases the reliability of the accelerator.

WEP137 Conceptual Design of 10MeV, 100kW CW Electron Accelerator for Industrial Application

H. J. KWON, Y. H. KIM, Y. H. KIM, H. S. KIM, S. H. KIM, K. H. CHUNG, SEOUL NATIONAL UNIVERSITY

The application fields of intense gamma-ray or X-ray for industrial purpose are expanding. And electron beam accelerator which can generate X-ray whose dose rate is equivalent to the effect of several MCi gamma-ray source is a major candidate as a intense X-ray source. 10MeV, 100kW CW electron accelerator (Fantron-I) is conceptually designed for X-ray source to irradiate food, forest products and so on. Electron beams are accelerated twenty times through two coaxial cavities with TM010 mode by means of bending magnet located outside the cavity. The resonant frequency of the cavity is about 200MHz and the phase of one cavity is 180 degree shifted from that of the other. Higher order modes (HOM) which may cause beam instability are analyzed. The design parameters of bending magnets and focusing magnets are determined from the results of beam dynamics analysis, especially magnetic flux density and location of each bending magnet are carefully adjusted to synchronize the beam with the accelerating field. In this paper, characteristics and overall conceptual design of the Fantron-I are presented.

WEP138 Design of Radially Focused Uniform X-ray Source

Y. H. KIM, H. J. KWON, Y. H. KIM, H. S. KIM, S. H. KIM, K. H. CHUNG, SEOUL NATIONAL UNIVERSITY

The 10 MeV, 100 kW electron accelerator (FANTRON-I) is being developed by Seoul National University (SNU). The X-ray generated by the accelerated electron beam will be used in sterilizing the agricultural, forest and aquatic products. For the effective irradiation, the safety of the irradiated products and high performance of the irradiation, the homogeneous irradiation is needed. The designed target is mainly featured by the radially focused uniform X-ray. The diameter of irradiation hole is about 1 m. And the generated X-ray emitted toward the center of the irradiation hole with uniform distribution along the circumference. The nonuniformity of the radiation is designed to be less than 15%. To generate the radially focused uniform X-ray, the accelerated electron beam must be focused radially on the target that is the outer shell of the irradiation hole with high uniformity. In addition the electron beam must be injected in the normal direction on the surface of target because in the angular distribution of bremsstrahlung intensity of the incident electrons which are accelerated up to 10 MeV, the intensity of electron incident angle is dominant. The basic principle of targetary is deflecting electron beam with proper magnetic field configuration. To find such configuration a series of numerical analyses are performed. This paper includes the requirements and design results of the radially focused uniform X-ray source.

WEP139 Electron Accelerating Installations with Local Biological Shielding for Applied Purposes.

G.I.BATSKIKH, G.L.MAMAEV, A.V.MISCHENKO, V.M.PIROZHENKO, MRTI RAS

The use of the local shielding for electron accelerators considerably extends the capabilities of its application for various purposes, because they can operate in ordinary working rooms. So there is no need to construct special buildings with cumbersome shielding. Since the cost of local shielding depends on its sizes, the compact accelerators have developed in the MRTI. Three accelerating installations are presented in the report: 8 MeV installation for custom inspection of large cargo containers, 5 MeV installation for sterilization of medical instruments, infectious waste, conservation food etc., and 200 keV installation for industrial techniques.

WEP140 Compact Pulse Electron Accelerator for Radiation Processing of Materials

S. KRYLOV, T. LATYPOV, G. MAMAEV, S. MAMAEV, V.PIROZHENKO, S.POUTCHKOV, I.SELEZNEV, I. TENYAKOV, MRTI RAS; A.KOROLEV, K.SIMONOV, ISTOK

The installation has been designed for processing different materials with the electron beam. The beam is generated by the sealed-off electron gun of unique design and is extracted to the irradiation area through thin Ti foil with 20*10 cm2 area. The electron energy is up to 200 kV, pulse beam current - 7 A. The processing is performed in nitrogen. Maximum pulse dose rate is 5*10E4 kGy/sec. The installation has compact high-voltage pulse power supply, self-contained water cooling, and handy control with the beam parameters regulation within broad ranges. The installation, except the computer, is packaged in one cabinet with 2*0.7*0.7 m3 dimensions. The installation has its own radiation shielding and is safe to use: the radiation dose at any place outside the cabinet is near the background radiation level.

WEP141 The High Voltage Accelerator "Electron-10" for Two-Side Irradiation of Flexible Materials

D.S.VALTMAN, A.S.IVANOV, E.K.NIKIFOROV, V.P.OVCHINNIKOV, M.P.SVININ, N.G.TOLSTUN

The "Electron-10" accelerator is meant for two-side irradiation of various flexible materials which radiation modification has found wide application in an industry. The two-side irradiation is optimum from the point of view of uniformity of distribution of the absorbed doze in material and use of the accelerated electron beam energy. With energy of the accelerated electrons regulated within the limits of 0.5-0.75 MeV the accelerator allows to process up to 3 mm thick polymer materials. Rated power of the accelerator is 50 kW, width of a processable material - 0.8-1.5 m. The accelerator is equipped with metal local radiation shielding and is oriented horizontally, that allows to place it practically in any industrial premises, since its height does not exceed 1.8 m. There not any lifting mechanisms are required during operation service of the accelerator. Three copies of the accelerator are made now, the first two of them are meant for soft rubber roof manufacturing, and third one - for the foamed polyethylene manufacturing line. The report contains the description of the accelerator and its basic characteristics.

WEP142 Application of Low Energy Electron Beams for Technology and Medicine.

B. BOGDANOVITCH, V. SENIOUKOV, MEPHI[1]; A. KOROLIOV, K. SIMONOV, STATE CONCERN "ISTOK"[2];

The results of the smooth apprximation are compared with the computer simulation of the three dimensional ion dynamics in linac.

THA114 3D Modeling of Ion Ribbon Beam Focusing and Acceleration in Undulator Linac

E.S. MASUNOV, S.M. POLOZOV, A.S. ROSHAL, MEPHI

One of the possible versions of undulator linear accelerator (UNDULAC-E) for ion ribbon beam is discussed. The influence of fundamental and higher space harmonics of RF and electrical undulator fields on beam dynamics in UNDULAC-E is analysed. The computer 3D simulation of the ribbon beam dynamics is fulfilled. The dependencies of the output current, energy and phase distributions, transverse emittance and other characteristics of the accelerated ion beam upon the undulator structure, configuration amplitude and harmonic content of the electrical field, the ribbon input dimensions, input energy and velocity spread of ions are investigated. The results are compared with the beam dynamics in effective 3D potential, describing for smooth approximation particle motion in the zero RF field harmonic and the first harmonic of the electrical field. The possibility of simultaneous acceleration of both positive and negative ions with the identical charge to mass ratio in UNDULAC-E is studied.

THA115 Phase Conjugate Beam Optics *

J.T. ROGERS, LABORATORY OF NUCLEAR STUDIES, CORNELL UNIV.

We describe a beamline device (a "phase conjugation" element) which reverses the sign of the transverse momenta of the beam particles. If the phase conjugation element is preceded by a set of beamline elements and followed by an identical set of elements in reverse order, the trajectory in the second set of elements is identical to that in the first, but is time-reversed. In this way, nonlinearities in one part of the accelerator may be cancelled against the same nonlinearities in another part. We present an implementation of the phase conjugation element using solenoid magnets and RF cavities in the TE_{011} mode. The phase conjugation element has a variety of applications, described here, to nonlinearity correction and chromaticity correction in storage and damping rings.

* Supported by the National Science Foundation.

THA116 Simulation of Crossing of Depolarizing Resonances including Effects of Synchrotron Radiation in ELSA

C. STEIER, M. HOFFMANN, D. HUSMANN, BONN UNIVERSITY

At the 3.5 GeV electron stretcher ring ELSA a polarized electron beam for external fixed target experiments is produced in a dedicated source for polarized electrons (with a GaAs-AlGaAs superlattice photocathode). Subsequently it has to be accelerated in two circular accelerators crossing several depolarizing resonances. At energies above 1.5 GeV the effects of synchrotron oscillations and synchrotron radiation have a strong impact on the crossing of depolarizing resonances. This prevents the use of adiabatic crossing techniques at these energies. To study the effects in more detail and to test possible correction methods a spintracking program (SPTRACK) was written that includes the effects of synchrotron radiation and synchrotron oscillations by using a full tracking of the motion in the longitudinal phasespace. The implemented calculation method is described in detail and results are compared to measurements at ELSA.

THA117 Restrictions on Electric Dipole Moment Measurement at Storage Rings

I.A.KOOP, YU.M.SHATUNOV, A.N.SKRINSKY, BINP;

Systematical restrictions on the particle's EDM measurement at storage rings are discussed, which come from spin and orbit dynamics in the magnetic and electric guiding fields. Tolerances on alignment of the machine elements are given.

THA118 A Calculation of the Dynamic Aperture for the LHC*

NORMAN M. GELFAND, FERMI NATIONAL ACCELERATOR LABORATORY

The dynamic aperture for version 5.1 of the LHC lattice has b estimated using the tracking code Tevlat. Magnetic field errors, in form of high order multipoles for the interaction region (IR) quadrupo were included in the tracking. This version of the lattice has a (crossing angle of 300μ r at IR1 and IR5. One hundred different set multipole errors were generated using the standard LHC error tables. dynamic aperture is expressed in terms of the σ of the b corresponding to a normalized beam emittance of 3.75mm mr. With c short term tracking the combined effect of the multipoles and the cross angle is to reduce the average (over the 100 set of multipole coffecie dynamic aperture to ~ 11.4 +/- 1.2 σ.

Supported in part by the United States Department of Energy under contract DE-AC02-76CH03000.

THA119 Particle dynamics in low-energy travelling-wave linacs

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In this paper, we present the particle dynamics in low-energy travelli wave linear accelerators, applying analytical theory, based Hamiltonian mechanics, and numerical simulations, performed commercially available codes. The paper is an extension on earlier wo presented at the EPAC98. Cylinder co-ordinates are used and solenoi magnetic fields are incorporated. The Hamiltonian equations of mot are given and examples of calculations are presented and compared numerical simulations, yielding excellent agreement between b approaches.

THA120 IR Optics for the Tevatron C0 Straight

J.A. JOHNSTONE, FNAL

In addition to the existing collision points at B0 and D0, a b-phys interaction region is planned for the C0 straight section. Design of the optics is complicated by several factors: the space consumed by detector, which is considerably more than that of the CDF and detectors; the desire to use existing spare Tevatron quadrupoles, wh does not include the high gradient style employed in the other two I and; the provision of sufficient space to accomodate the electrosta separators necessary to bring the beams into collision at the IP. An optics design is presented here which satisfies these constraints. Based doublet final focussing, at the IP $\beta^* \eta^* = \eta^{*\prime} = 0$.

THA121 The Dynamical States of the System by the Localized Wak Force

SOON-KWON NAM, KANGWON NATIONAL U.; C. ZHANG, IHEP E. S. KIM, LBNL

We examine the dynamical states of the system by the localized wa forces in the storage ring. We have investigated the dynamical states the particle distribution in the parameter ranges of the wake for strength, damping time and synchrotron tune. The influence parameters on the stable equilibrium states and the transition of the sta in the storage ring is presented by the extended model of a combinati of a constant, delta and delta prime wake functions. The multiparti tracking is also examined.

THA122 Bunch Energy Loss in Cavities: Dependence on Beam Velocity*

S.S. KURENNOY, LANL

Proton or H⁻ linacs accelerate particles through the wide range of t particle velocities. For intense beams, and especially wh superconducting cavities are used, a detailed knowledge about how t beam energy loss depends on the beam velocity $\beta=v/c$, and what part the lost energy remains in the cavity, is required to calculate the cavi heat load. Using a frequency-domain approach, we calculate the bun energy loss as a function of β for a few particular cases. We are most

in the 50x50 GeV Higgs Factory can be controlled, and stable beam dynamics can be obtained.

[1] W.-H. Cheng, A.M. Sessler and J.S. Wurtele, LBNL-39642 (1996)
[2] A.W. Chao, Physics of Collective Beam Instabilities in High Energy Accelerators, (John Wiley & Sons, 1993)
[3] Status of Muon Collider Research and Development and Future Plans, to be submitted to Phys. Rev. Special Topics:Accelerators and Bemas.

THP45 Transverse Instability in 50x50 GeV Muon Collider Ring
EUN-SAN KIM[1], ANDREW M. SESSLER[2], JONATHAN S. WURTELE[1,2] [1] DEPARTMENT OF PHYSICS, UNIVERSITY OF CALIFORNIA AT BERKELEY [2] LBNL
The intense bunch called for in the muon collider design[1] will be subject to transverse instability. It has been suggested that BNS damping be used to control the instability. The operation of BNS damping in a ring is examined numerically using a model impedance and a simplified model of the beam-beam tune shifts and synchrotron motion.The simulation is an extension of one previously described[2].

[1] Status of Muon Collider Research and Development and Future Plans, to be submitted to Phy. Rev. Special Topics: Accelerators and Bemas
[2] Wen-Hao Cheng, A.M. Sessler and J.S. Wurtele, EPAC96, p.1081-1083

THP46 An analysis of BNS damping techniques in storage rings and colliders*
G. PENN, J. WURTELE, UC BERKELEY / LBNL CBP
Transverse instabilities in linacs can be controlled by BNS damping, in which the transverse oscillation frequency is chirped from the head to the tail of the bunch. It has been suggested that this technique could be applied to quasi-isochronous rings, such as are proposed for a muon collider. The efficacy of BNS damping in the presence of synchrotron motion and the beam-beam interaction is investigated with a reduced phase space model, taking averages over transverse coordinates and with proscribed longitudinal synchrotron motion. Pertinant questions are what magnitude and structure of tune shifts are sufficient to prevent the growth of transverse displacements of the beam in the presence of synchrotron oscillations, and the severity of any short term amplification of off-axis displacements.

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THP47 Evolution of the Muon Energy Spread Caused by the Interaction with Counter Rotating Bunch in the Low Energy Muon Collider
R. PALMER, BNL; A. ZHOLENTS, LBNL
Low energy muon collider is being designed to operate with a small energy spread of muons ~3x10-5 that is needed for a direct measurement of the resonance crossection of a low mass Higgs boson. However, the interaction of muons with counter rotating bunch near the IP introduce the unwanted growth of the energy spread. The analysis of this energy growth and means to control it is a subject of this paper

THP48 The Design of a Liquid Lithium Lens for a Muon Collider
A. HASSANEIN, J. NOREM, C. REED, ANL: R. PALMER, BNL; G. I. SILVESTROV, T. A. VSEVOLOZHSKAYA, BINP; V. BALBEKOV, D. NEUFFER, S. O?DAY, A. TOLLESTRUP, P. SPENTZOURIS, P. LEBRUN, FNAL
The last stage of ionization cooling for the muon collider requires a multistage liquid lithium lens. This system uses a large (0.5 MA) pulsed current through liquid lithium to focus the beam while energy loss in the lithium removes momentum which will be replaced by linacs. The beam optics are designed to maximize the 6 dimensional transmission from one lens to the next while minimizing emittance growth. The mechanical design of the lithium vessel is constrained by a pressure pulse due to the sudden ohmic heating, and minimizing th stress on the Be window. We describe beam optics, the liquid lithiu vessel, Lithium pumping, power supplies, as well as the overa optimization of the system.

THP49 Lattice Design for a 50 on 50 GeV Muon Collider *
C. JOHNSTONE, W. WAN, FNAL; A. GARREN[1];
Two modes are being considered for a 50 on 50 GeV muon collider: or being a high-luminosity ring with broad momentum acceptance (dp/p ~ 0.12%, rms) and the other lower luminosity with narrow momentu acceptance (dp/p of ~ 0.003%, rms). To reach the design luminosities, th value of beta at collision in the two rings must be 4 cm and 13 cn respectively. In addition, the bunch length must be held comparable t the value of the collision beta to avoid luminosity dilution due to th hour-glass effect. To assist the rf system in preventing the bunch fro spreading in time, the constraint of isochronicity is also imposed on th lattice. Finally, the circumference must be kept as small as possible t minimize luminosity degradation due to muon decay. Two lattice desig will be presented which meet all of these conditions. Furthermore, th lattice designs have been successfully merged into one physical ring wit mutual components; the only difference being a short chicane required t match dispersion and floor coordinates from one lattice into the other.

* Work supported by the Universities Research Association, Inc., under contract DE-AC02-76CH00300 with the U.S. Department of Energy
[1] LBNL and U. Of California at Los Angeles

THP50 Fixed Field Circular Accelerator Designs *
A. GARREN[1], C. JOHNSTONE, W. WAN, FNAL;
The rapid rate and cycle time required to efficiently accelerate muon precludes conventional circular accelerators. Recirculating linacs provid one option, but the separate return arcs per acceleration pass may prov costly. Recent work on muon acceleration schemes has concentrated o designing fixed-field circular accelerators whose strong superconductin fields can sustain a factor of 4 increase in energy from injection t extraction. A 4 to 16 GeV fixed-field circular accelerator has bee designed which allows large orbit excursions and the tune to vary as function of momentum. Acceleration is .6 GeV per turn so the entir cycle consists of only 20 turns. In addition two 16 to 64 GeV fixed-fiel circular accelerators have been designed which are more in keeping wit the traditional Fixed Field Alternating Gradient machines[2]. In this wor all three machine designs are described. Tracking results of one of th machines are presented.

* Work supported by the Universities Research Association, Inc. under contract DE-AC02-76CH03000 with the U.S. Department of Energy
[1] LBNL and the University of California at Los Angeles
[2] K. R. Symon, MURA-KRS-6 (MURA-43) (1954); K. R. Symonm L. W. Jones, L. J. Laslett and K. M. Terwilliger, Phys. Rev. 103, 1837 (1956).

THP51 Large Acceptance Muon Storage Rings for Neutrino Production: Lattice Design *
C. JOHNSTONE, FNAL; B. AUTIN, CERN;
The possibility of achieving the high muon fluxes suggested in recen work on muon colliders has revived interest in the idea of using muor storage rings for neutrino production. Through proper design of the lattice, a significant fraction of the stored muons can be converted into ar intense, low-divergence beam of neutrinos. This work examines the incorporation of a long, high-beta straight section for production o neutrino beams into a lattice which is otherwise optimized for transverse and longitudinal admittance. (The ring must be able to accept a very large-emittance, large-momentum spread muon beam.)

* This work was performed at the Fermi National Accelerator Laboratory, which is operated by Universities Research Association, under contract DE-AC02-76CH03000 with the U.S. Department of Energy.

THP52 Neutrino-Induced Radiation at Muon Colliders *
N.V. MOKHOV, A. VAN GINNEKEN, FNAL
At high-energy muon colliders, intense highly collimated neutrino beams are created from muon decays causing significant radiation problems even at very large distances from the collider ring. Detailed Monte Carlo simulations of the neutrino interactions and their progeny have been performed using the MARS code with a newly developed weighted neutrino interaction generator. Dose distributions are calculated in a human tissue-equivalent phantom irradiated with a neutrino beam (100 MeV - 10 TeV) for a bare phantom, a phantom embedded in several shielding materials and for a phantom at various distances behind a shield. The distance from the collider ring (up to 60 km) at which the tolerable annual dose limit can be met is calculated for 0.5, 1, 2, 3 and 4 TeV muon colliders. The possibility to mitigate the problem via beam wobbling is investigated.

* Work supported by the U. S. Department of Energy under contract No. DE-AC02-76CH03000

THP53 Collective instabilities of the 50-50 GeV muon collider ring
K.Y. NG, FERMILAB*
The 50-50 GeV muon collider ring is isochronous and about 350~m in circumference. There are two bunches of rms length 4 cm, each containing $4x10^{12}$ μ^+ or μ^-. The coupling impedances of the ring are estimated. The longitudinal and vertical collective instabilities are investigated and their cures discussed.

*Operated by the Universities Research Association, under contract with the US Department of Energy.

THP54 Longitudinal Motion and Ionization Cooling
DAVID V. NEUFFER, FNAL
Recent studies of the μ+-μ- collider concept rely on ionization cooling to increase the phase space density of the μ beams to collider intensities. However this process does not cool the beam longitudinally, and energy straggling within ionization cooling absorbers keeps the beam energy spread relatively large. Emittance exchange with cooled transverse space is required, as well as careful matching of the longitudinal phase space to a reaccelerating rf bucket. The beam dynamics difficulties associated with the emittance exchange process, the large momentum spread optics, and rf capture and leakage are presented. Guidelines toward optimal 6-D phase space cooling are discussed.

THP55 Muon Collection Channel Simulation Studies
A. VAN GINNEKEN AND D. NEUFFER, FERMILAB
Results of Monte Carlo simulations of the processes in the collection channel for a muon collider are presented. In the simulations, Pions are produced in a target, captured and then transported within solenoid focusing systems where they decay into muons. Muon yield and phase space characteristics at the end of the channel can be improved bu placing RF cavities and absorbers along the channel as well as by providing a supplemental toroidal field along with the absorbers. Results for a sample of such scenarios are presented. In addition, the problem of extracting the muon beam from the collection channel into a cooling system is studied.

THP56 Design and Simulation studies of an Ionization Cooling channel using lithium lenses and solenoid transport channels.
PANAGIOTIS SPENTZOURIS AND DAVE NEUFFER, FNAL
The present designs for a high luminosity muon collider rely on ionization cooling to compress the beam phase-space volume. In this presentation, we discuss the performance of an ionization cooling application based on current currying lithium rod active lenses and solenoid transport channels. The design procedure and criteria are discussed, and the results of a detailed simulation of this channel are presented. The simulation is based on the three dimensional tracking code, GEANT, commonly used in High Energy Physics, which includes very accurate modeling of muon interactions in matter.

THP57 Multichannel System for Highly Polarized Muon Beam Production
G.I.SILVESTROV, A.N.SKRINSKY, V.A.TAYURSKY, T.A.VSEVOLOZHSKAYA, BINP
An efficient forming of quasi-monoenergetic pion beams, necessary for production of highly polarized muons, is achieved only by sufficiently small transverse emittance of pions in dispersion plane. To satisfy this requirement by very large phase volume of produced pions we consider their multichannel collection with making use of evident anisotrpy in distribution of phase density of pions, collected at large angle from long thin target. The multichannel collection by vertical liquid metal jet target is fulfilled with strongly astigmatic optical system, composed of successive short and long focus wedge lenses. Such lenses provide one dimensional focusing of particles in momentum range 100-300 MeV/c and angular range 36° in horizontal plane and 50° (from 10° to 60° to the beam axis) in vertical. In each of ten channels the dispersion function is created in horizontal plane, where the source size is defined by a small transverse size of target. A system of septum magnets devides each beam in 10 parts with 10% energy spread, and directs them to decay channels. After decay channels the energies of muon beams are made equal each other by means of acceleration or degrading in lithium degraders, and ionization cooling of the beams is worked out in several steps. After each step the beams are joined two by two. A few final beams are turned through 180 degrees, directed to the center of system and joined in one.

THP58 Liquid Lithium Lens with High Magnetic Field
B.F.BAYANOV, V.P.BELOV, A.D.CHERNIAKIN, G.I.SILVESTROV, BINP
Here we discuss the development of the lithium lens of 20 mm diameter and 150 mm length with liquid lithium pumped through. Design of the lens body together with matching transformer and pumping system (electromagnetic pump, static pressure control and flux meter) is described. Power supply for the lens provides the current pulse amplitude up to 1 MA by 300 mks duration. Results of testing of lens operation at magnetic field up to 13T are presented.

THP59 Liquid Metal Jet Targets for Muon Colliders
V.P.BELOV, A.D.CHERNIAKIN, V.N.KARASYUK, G.I.SILVESTROV, A.N.SKRINSKY, BINP
For pion production in muon collider projects the targets are developed in a form of cylindrical jet of liquid metal with high density - the lead or copper and gold alloys with low melting temperature. Target device for multichannel system for production of highly polarized muon beams is described. The target is a vertical cylindrical jet of liquid metal, freely flowing from conic nozzle. Experimental results are presented on liquid lead jet forming with open inlet and outlet surfaces. For horizontal cylindrical jets the magnetic compression method is under development, providing a high velocity of liquid metal flow. The power supply for magnetic compression is described, and experimental results on jet forming are presented.

THP60 Final Stage of Muon Beam Cooling
G.I.SILVESTROV, A.N.SKRINSKY, T.A.VSEVOLOZHSKAYA, BINP
We consider the final stage of ionization cooling of muons, realized with the use of bent current-carrying lithium-beryllium rods, providing an optimum correlation between the cooling rates in all three directions and minimum final value of 6-dimensional emittance. The matching of lattice functions in a rod with those in accelerating structure is fulfilled with short lithium lenses at the exit and entrance to the next section, while the focusing by acceleration - with plasma lenses. By rather moderate parameters such lenses, having the focal distance linearly dependent on muon momentum, provide an efficient focusing with minimum chromatic aberration.

@Authors would like to thank Steve Werkema for providing Accumulator Ring parameters.
[1] J.D. Bjorken and S. Mtingwa, Part. Accel., 13, p. 115, (1983).

THP88 Power Supply System for Superconducting Magnets at KEKB-IR

T.OZAKI, A.AKIYAMA, T.OGITSU, N.OHUCHI, TA.KUBO, K.TSUCHIYA, T.NAKAMURA AND M.YOSHIDA, ACCELERATOR LABORATORY, KEK

In KEKB, a pair of superconducting magnets is installed symmetrically with respect to the interaction region (IR). Two quadrupole magnets (QCS) are prepared to focus the beams, two compensation solenoid coils are to shield the magnetic field of the solenoid of the BELLE detector, and 6 correction coils (H-dipoles, V-dipoles, skew quadruploes) are to steer the beams. The QCSs are excited in series by the main power supply (P.S.) with the rating of 3500 A and 15 V. The P.S. which consist of 12-pulse phase-controlled rectifies followed by a passive and an active filter is recycled from TRISTAN.The interface circuit was modified for the ARCNET control in stead of the CAMAC. A bipolar 40 A auxiliary P.S. is connected to the QCS-R magnet. Such a connection produces a balance tuning between two QCS magnets. The compensation solenoids are individually excited by the compact switch-mode P.S.s with 650 A. The inductance of the solenoids are 1.44 H and 0.9 H so that the time constants of the load are 173 s and 82 s, respectively. The 50 A switch-mode P.S.s for correction coils have relay contactors in order to change the polarity.These P.S.s are operated by computers via VME-ARCNET.The computer control program is developed using EPICS. These P.S.s are also operating under a safety system. Each P.S. has a slow-stop mode and a fast-stop mode. The QCS P.S. has a thyristor switch which quickly intercept the dc current in the case of any quench trouble within 1 ms. The others have DCCBs which operate within 50 ms. In this paper, the details concerning the power supplies and their control will be described.

(1)T.Ozaki,A.Akiyama,T.Ogitsu,N.Ohuchi,Ta.Kubo,K.Tsuchiya and M.Yoshida:Proceedings of the 11th Symposium on Accelerator Science and Technology (1997) pp383-385

THP89 Construction of Helical Magnets for RHIC

E. WILLEN, M. ANERELLA, J. ESCALLIER, G. GANETIS, A. GHOSH, R. GUPTA[1], A. JAIN, E. KELLY, A. MARONE, G. MORGAN, J. MURATORE, A. PRODELL, AND P. WANDERER, BNL

Helical magnets are required in RHIC to control proton spin in a program for polarized proton colliding beam experiments. The basic construction unit is a superconducting magnet producing a four tesla dipole field that rotates through 360 degrees in a length of 2.4 meters. These magnets are assembled in groups of four to make four Snakes that control spin in the lattice and eight Rotators that orient spin at two collision points. A collaboration with the Japanese institute RIKEN is providing financial support to carry out the program. After a successful R&D program to validate the design, the magnets are in the construction phase. The design of the magnets will be reviewed, the construction approach will be described, and test results from the first completed units will be presented.

[1] Presently at LBNL

THP90 Rotation Angle of a Helical Dipole

T. TOMINAKA, M. OKAMURA, RIKEN; T. KATAYAMA, CENTER FOR NUCLEAR STUDY, SCHOOL OF SCIENCE, UNIVERSITY OF TOKYO

The relation between the rotation angle and the cancellation of the integral of transverse field along the beam axis is investigated. First of all, the simple optimization method for the full-size helical dipoles is studied on the assumption of the linearized relation for the beam axis coordinate dependence of the dipole field and the phase of the dipole field. In this analysis, the optimum length of the helical dipole is calculated as a function of the phase changing rate of dipole in the end, which can not be simply predicted. This optimization method is not so accurate for the real estimation, but it is understandable and effective for the rough estimation. Secondly, the optimization method for the helical dipoles with the known end is studied. Actually, the optimized length for the full-size helical dipoles is obtained for the measured field of the prototype helical coil. In addition, the field integral along the beam axis is estimated for the full-size helical dipoles consisting of the optimized helical body portion and the non-symmetric ends of the prototype helical coil.

THP91 Magnetic Field Shimming, Measurement and Control for the BNL Muon (g-2) Experiment

S.I. REDIN, BNL/YALE U.;

An ultraprecise superferric magnet, 14 m in diameter, was built for the muon (g-2) experiment currently in progress at Brookhaven National Laboratory. The principal quantities to measure in the experiment are the frequency of (g-2) oscillations and the average magnetic field, which imply stringent requirements on the homogeneity of the magnetic field as well as on the precision of its measurement and control system. A number of shimming techniques were, and are used to improve the homogeneity of magnetic field integrated in azimuth to the 10^{-6} level across the circular beam aperture of 9 cm diameter. An advanced NMR system is used for mapping and monitoring of the field to acieve the required fractional precision of 10^{-7}. Radial component of the field is measured by a Hall probe device with a precision of ~ 5 cdot 10^{-6}, which is one of the most precise measurements with Hall probes. Hall probes were also used for measurements of highly nonuniform magnetic fields near the beam injection point and in the region of straw chambers used for decay electron tracking.

THP92 DX Magnet R&D, Prototype Construction and Series Production*

J. SCHMALZLE, M. ANERELLA, G. MORGAN, J. MURATORE, G. GANETIS, A. JAIN, P. WANDERER BNL

The RHIC DX dipole magnet has a bore of 180 mm, an overall length of 4.0m, a nominal operating field of 4.28 T and a coil pre-load of 28 kpsi. A brief R&D program using short coil sections was used to verify the insulation scheme, to make sure the required coil pre-load could be achieved and to monitor the load loss over time. A full length prototype magnet was built and tested, to verify the design, test out the tooling, fine tune the assembly procedures and to measure the field quality and quench performance. Changes were incorporated after each phase. This report will describe each phase, including the problems encountered and the lessons learned and will list the resulting changes made to the magnet design and assembly procedures. Critical data from subsequent production magnets will also be included.

* Work supported by the U.S. Department of Energy under Contract No.DE-AC02-98CH10886 (BNL)

THP93 Quench Performance and Field Quality of DX Dipoles for RHIC*

A. JAIN, J. MURATORE, M. ANERELLA, G. GANETIS, A. MARONE, G. MORGAN, A. PRODELL, J. SCHMALZLE, R. THOMAS, P. WANDERER, BNL

DX dipoles are located on each side of the six intersection regions of RHIC. Both beams pass through these dipoles, necessitating an aperture of 18 cm. All DX dipoles were tested at 4.35K for quench performance, and trained successfully to at least a 10% margin above the operating field (4.3 T at 6.6kA). Field quality in these dipoles was measured at 50A-7kA using a rotating coil of 6.85 cm radius. The measured harmonics were corrected for offsets of the measuring coil from the magnetic axis, determined by powering the magnets in a quadrupole configuration. In some magnets, a pronounced, unexpected current dependence was seen in alternate skew harmonics above ~6kA. This could be explained by a small (~0.5 mm) relative motion between the magnet and the measuring coil at high fields. Field quality was also

THP149 Analytic Fits to Hysteretic Fields in Main Injector Dipoles, Quadrupoles and Sextupoles *

B.C. BROWN, C.M. BHAT, H.D. GLASS, D.J. HARDING, P.S. MARTIN, D.F. ORRIS, K. TROMBLY-FREYTAG, D.G.C. WALBRIDGE, FNAL

Using the automated measurement system at the Fermilab Magnet Test Facility, measurements of the magnet strengths of dipoles, quadrupoles, and sextupoles for the Fermilab Main Injector have been made using a variety of current excitation ramp histories on a few magnets of each design. The resulting field strength data are examined with emphasis on hysteretic and saturation contributions which modify the dominant linear behavior. A simple analytic model provides a description of the strength to better than 0.1% accuracy. A simpler data set from production measurements is fit using the same model but fixing some parameters which are not studied by the production measurement sequence. The parameters available for Main Injector operation will be reported. Characteristics of hysteretic fields will be related to materials properties and design fields of the magnets.

* Work supported by the U.S. Department of Energy under contract No. DE-ACO2-76CH03000.

THP150 Analytic Fits to Hysteretic Fields in Fermilab Antiproton Source Quadrupoles *

B.C. BROWN, S. ASSADI, H.D. GLASS, D.J. HARDING, P.S. MARTIN, D.F. ORRIS, K. TROMBLY-FREYTAG, D.G.C. WALBRIDGE, S.J. WERKEMA, FNAL

Using the automated measurement system at the Fermilab Magnet Test Facility, measurements have been made of the magnet strengths of quadrupoles designed for the Fermilab P-Bar source and used there and in beam transfer lines. An analytic model of the measured fields suitable for use in controlling the magnet current during antiproton deceleration is fit to the resulting data. Prescriptions for magnet current changes are described which permit beamline magnets to be set and reset to required strengths while avoiding hysteretic uncertainties. Comparison are made with results for other magnet designs.

* Work supported by the U.S. Department of Energy under contract No. DE-ACO2-76CH03000.

THP151 Strength and Shape of the Magnetic Field of the Fermilab Main Injector Dipoles*

D.J. HARDING, B.C. BROWN, J. DIMARCO, H.D. GLASS, P.S. MARTIN, P.O. MAZUR, C.S. MISHRA, D.F. ORRIS, J.W. SIM, J.C. TOMPKINS, K. TROMBLY-FREYTAG, D.G.C. WALBRIDGE, J.C. TOMPKINS, FERMI NATIONAL ACCELERATOR LABORATORY, P.O. BOX 500, BATAVIA, IL 60510 USA

Measurements of 230 6-meter and 136 4-meter dipoles constructed for the Fermilab Main Injector were carried out as part of the magnet production effort. An automated measurement system provided data on magnetic field strength and shape using several partially redundant systems. Results of these measurements are available for each individual magnet for use in accelerator modeling. In this report we will summarize the results on all of the magnets to characterize the properties which will govern accelerator operation.

* Work supported by the United States Department of Energy under contract No. DE-AC02-76CH03000

THP152 Optical alignment of solenoid field in the beam-beam compensation device.

CURTIS CRAWFORD, ANDREY SERY, VLADIMIR SHILTSEV, BORIS SUKHINA

The guiding solenoidal magnetic field of the beam-beam compensation device should be carefully aligned with respect to the straight trajectory of the antiproton beam. An optical method allowed to measure the direction of the magnetic field, the results of the measurements and of the further field correction are presented in the paper.

THP153 Computer Generated End Shims for Recycler Ring Magnets

G.W. FOSTER, C.N. BROWN, J.T. VOLK, G.P. JACKSON

The procedure for automatically producing customized end shims for Recycler Antiproton Storage Ring gradient magnets is describ Magnets were first measured with a harmonics probe. The observed fi defects were then fed into a spreadsheet program which generated toolpath code for a numerically-controlled milling machine wh produced individually customized end shims that eliminated measured defect. Field defects through decapole were corrected to accuracy (limited by the reproducibility of the measurement apparatus) a few x 10-5.

THP154 Measurements of a Crenelated Iron Pole Tip For The VLHC Transmission Line Magnet

G.W. FOSTER, V. KASHIKHIN, P. DIMARCO, P. SCHLABACH

Field quality measurements on a crenelated iron pole tip are described the Transmission Line Magnet of the VLHC are described. In t technique, the pole shape of every tenth-or-so lamination in the mag contains a concave depression. This reduces the average iron density the center of the pole tip, thereby allowing the pole to saturation m uniformly and reducing the "saturation sextupole" of conventional ir magnets. Gradient shifts due to saturation in gradient magnets can also reduced. A high current test stand was built to test this technique and develop the iron shape for the Transmission Line Magnet for the VLH Results and comparisons with calculations are described.

THP155 Nb_3Al Conductor Development for the Low-Field VLHC Magnet.*

E.BARZI, G.W.FOSTER, E.MALAMUD, P.O.MAZUR, FNAL; M.WAKE, KEK

The Very Large Hadron Collider (VLHC), under consideration f construction at Fermilab in the next 1-2 decades, is a 100 TeV cm collider. The single most costly item in the VLHC is the magnet a R&D is underway on several possible magnet designs. A low-field (2 superferric magnet, sometimes called a transmission line magnet, may the most cost effective route to the VLHC. Although NbTi is now t cheapest superconductor measured in cost/kA-meter, Nb_3Al has t potential advantage that it remains superconducting at high temperature. It may be particularly suited to the single "turn" and lo straight lengths of the transmission line design. The combination of t simple magnet design and the higher strain tolerance (than Nb_3Sn) allo a simple process of cable fabrication, reaction, and magnet assembl Sumitomo Electric Inc. is producing Nb_3Al conductor for the low-fie magnet program. The R&D program will be presented and initial te results will be reported.

* Operated by Universities Research Association under contract to the U.S. Department of Energy

THP156 Precision Magnetic Elements for the SNS Storage Ring.*

G. DANBY, C. GARDNER, J. JACKSON, C. SPATARO, BNL

The SNS project is characterized by extremely high beam intensi delivered on target. This translates into a 1 GeV storage ring lattice [with large component aperture requirements in order to minimize bea loss. As a result, the ratio of magnetic lengths to aperture is unusuall small in all ring elements. Moreover, as known from high-intensity AG Booster operation, minimizing beam loss requires magnets of hig optical purity in combination with a flexible system of various lattic correction elements. In this paper we describe the magnet desig parameters of the ring dipoles and the variety of short quadrupoles, plu the correction elements with particular emphasis on minimizin aberrations due to end effects. The relevant lattice design parameters an magnetic tolerance requirements will also be described.

* Work supported by the U.S. Department of Energy under contract No. DE-AC02-98CH10886 (BNL).

[1] Spallation Neutron Source Design Manual, June 1998.

are both at least an order of magnitude smaller than their absolute offsets. The described method has been inserted into the code MUSTAFA [1], for numerical checks and tracking of the resulting emittance in the CLIC main linac.

[1] G. Guignard,J. Hagel, Report CERN-SL-98-02 AP (1998)

FRA9 Two-Frequency Beam-Loading Compensation in the Drive-Beam Accelerator of the CLIC Test Facility

M. VALENTINI, H.H.BRAUN, CERN

The CLIC Test Facility (CTF) is a prototype two-beam accelerator, in which a high-current "drive beam" together with deceleration structures is used to generate the RF for the main beam accelerator. The drive-beam accelerator consists of two S-band structures which accelerate a train of 48 bunches spaced at 10 cm, with a total charge of 640 nC. The substantial beam loading is compensated by operating these two structures at 7.81 MHz above and below the bunch repetition frequency, respectively. This introduces a change of RF phase from bunch to bunch, which leads, together with off-crest injection into the accelerator, to an approximate compensation of the beam loading. Due to the sinusoidal time-dependency of the RF field, an energy spread of about 7% remains in the bunch train. A set of idler cavities is under construction and will be installed to reduce this residual energy spread further. In this paper, the considerations which motivated the choice of the parameters of the beam loading compensation system are presented, and the experimental results discussed.

FRA10 Beam Dynamics Studies in the TESLA Superconducting Linac

S. FARTOUKH, A. MOSNIER, O. NAPOLY, CEA/SACLAY

The preservation of the very small transverse emittance, $\gamma\varepsilon_y = 3 \times 10^{-8}$ m, required by the set of high luminosity parameters proposed for for the TESLA superconducting linear collider, is investigated. For given alignment tolerances (magnets, cavities and BPMs), and given orbit correction methods (one to one, ballistic), the emittance growth is calculated by combining the single and multibunch wakefields with the chromatic effects. The influence of Lorentz force cavity detuning, RF-steering in the cavities and earth curvature, is also included.

FRA11 Trapped Modes In TESLA-Cavities *

F. MARHAUSER, P. HUELSMANN, I. HERWIG, H. KLEIN

In every linear collider scheme wakefield effects are a severe problem to overcome. A consequence of these effects is the deterioration of the beam due to long range wakefields. In the TESLA linear collider scheme it is foreseen to damp those wakefields by HOM-dampers mounted to the beam pipes on both ends of the TESLA-cavities. This HOM-damper scheme is based on the assumption, that coupling of the wakefields to those HOM-couplers is ensured. No HOM-damper is foreseen for the TESLA-cavity itself. Therefore modes, which are localized (trapped) more or less within the TESLA-cavity, are only weakly or even not damped. Typically trapped modes have very small shunt impedances only, but due to their large number and their ability of energy accumulation they are an considerable additional heat load for the helium cryostat. The usual TESLA-cavity has 9 almost equally shaped cells except the end cells due to the presence of the beam pipes. But trapped modes are caused by the non periodic behaviour of the TESLA-cavity-beam pipe-channel. Consequently trapped modes within the TESLA-9-cell cavity and within the beam pipes are expected. To prove the existence of these modes RF-measurements with a 9-cell copper cavity with beam pipes and numerical calculations with MAFIA have been done within the frequency region from 1,3-10 GHz.

* Work supported by DESY/Hamburg, BMBF under contract 06OF841 and Graduierten-Kolleg "Physik und Technik von Beschleunigern" of the Deutschen Forschungsgesellschaft

FRA12 TESLA Beam Delivery System Update

R. BRINKMANN, N. WALKER, DESY; P. EMMA [1], O. NAPOLY, CEA/SACLAY

The beam delivery system (BDS) of the TESLA superconducting linear collider has been recently adapted to the set of high luminosity parameters proposed for TESLA. We review the current status of the lattice design and optics studies. The beam diagnostics requirements and tuning methods are presented together with their expected performance in terms of luminosity stabilization.

[1] on leave from SLAC

FRA13 The Wake-fields and Loss Factors in Superconducting Accelerating cavities for TESLA Electron Collider.

EUGENIUSZ PLAWSKI

The TESLA Test Facility (TTF) is already in its final stage of assembling.The superconducting accelerating cavities attained the planned for collider accelerating fields of 25 MV/m. Nevertheless, the problem of cost reduction of future TESLA collider is still actual. The problem is continuously studied in DESY; the first propositions were signalled at several TESLA Meetings and lastly reported also at the PAC97 Conference[1]. In the frame of scientific international cooperation the part of the work concerning the wake- field generation in new shape structure was done at our Institute. Here,in this report the calculated longitudinal and transvere loss factors in the proposed by DESY team new cavities are compared with the corresponding values[2] in cavities currently used in TTF.

[1] J.Sekutowicz, D.Proch, C.Teng, Report at PAC97,May12-16,1997. see also Internal Report,DESY M97-10, August,1997.

[2] E.Plawski, "Wake-field Induced by Electron Beam Passing through the TESLA Accelerating System", DESY, June,1997, TESLA 97-12.

FRA14 The first wakefield test on the C-band choke-mode accelerating structure

T. SHINTAKE, H. MATSUMOTO, N. AKASAKA, M. YOSHIDA KEK; T. SLATON, C. ADOLPHSEN SLAC

In the future e+e- linear colliders, the transverse wakefield control is essential to achieve high luminosity with multi-bunch beam at the interaction point. The C-band accelerating structure is under development [1-4], which uses the choke-mode cavity for the HOM-damping (SiC rf absorbing material is used) and J-shaped coupler for symmetric drive at the coupler cell, the RF-BPM for the beam-based alignment. A very strong HOM-damping is expected. The damping performance of the wakefield power and the BPM performance will be tested with beam at ASSET in SLAC. The paper will report development details and the experimental results.

[1] http://www.c-band.kek.jp/
[2] T. Shintake et.al., LINAC98, Aug. 23-28, 1998, Chicago, U.S.A, KEK Preprint 98-139
[3] N. Akasaka et. al., LINAC98, Aug. 23-28, 1998, Chicago, U.S.A., KEK Preprint 98-142
[4] H. Matsumoto et. al., LINAC98, Aug. 23-28, 1998, Chicago, U.S.A., KEK Preprint 98-143

FRA15 Development of The X-Band RF Power Source For JLC

Y. H. CHIN, M. AKEMOTO, S. FUKUDA, S. MATSUMOTO, S. MICHIZONO, H. MIZUNO, K.TAKATA, N. TOGE, S. TOKUMOTO, H. TSUTSUI, S. YAMAGUCHI, AND J. WANG, KEK; S. KAZAKOV; BINP

In this paper, we summarize our activities on X-band RF power source development for the Japan Linear Collider (JLC) project. First, we have designed and tested a solenoid-focused klystron at 11.424 GHz with a pulse length of 1.5 ms and with an efficiency of 47%. A periodic permanent magnet (PPM) klystron, the first in that kind at KEK, is also under development in collaboration with SLAC. In parallel to this

activity, another PPM klystron has been developed and remodeled in collaboration with BINP. Second, a new RF window with 100-MW power-handling capability has been designed and tested. It utilizes the TW mixed mode (TE11 and TM11 modes) to reduce the surface field at the brazing edge of the ceramic. The cold model test shows a low electric field at the brazing point as predicted by HFSS calculations. The high power model is now in manufacturing and the testing will start soon. Third, the Blumlein modulator was upgraded to produce a pulse with 2 ms flat top and 200 ns rise time at 550 kV output voltage. Fourth, the multi-mode 2x2 DLDS (Delay Line Distribution System) pulse compression system has been designed, and its basic unit was manufactured and tested for proof of the principle. The measurement results show that the system works well with a high power distribution efficiency. The so-called mode stability experiment is also under preparation in the ATF linac tunnel in collaboration with SLAC. This experiment is aimed for examination of the stability of linearly-polarized TE12 mode in a 55m long wave guide, a key issue in the present configuration of multi-mode DLDS. Details of these developments and measurement results are presented.

FRA16 Challenge to a Straight Structure for X-band Linear Collider

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The structure of the X-band main linac for the linear collider requires a stringent straightness of the order of several microns. Especially the misalignment from cell-to-cell to twenty cells should be minimized. An one-shot bonding technology has been studied at KEK aiming at this requirement. Two 1.3m long detuned structues have been made with a gentle bow of 20 microns based on the diffusion bonding technique. Recently the same technology was applied to the main body bonding of 1.8m long damped-detuned structure, DDS3. It resulted in a much larger bow but still showed a feasibility of the technique to reach the requirement. Therefore, the technique is being refined and now we are trying to obtain a better performance in the fabrication of the main body of the round DDS structure, RDDS1. Design considerations, the base for the technique and the present progress are discussed.

FRA17 SLAC High Gradient Testing of a KEK X-Band Accelerator Structure.*

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The high accelerating gradients required for future linear colliders demands a better study of field emission and RF breakdown in accelerator structures. Changes in structure geometry, vacuum pumping, fabrication methods, and surface finish can all potentially impact the conditioning process, dark current emission, and peak RF power handling capability. Recent tests at SLAC of KEK?s ?M2? travelling wave x-band accelerator section provides an opportunity to investigate some of these effects by comparing its performance to previously high power tested structures at SLAC [1,2]. In addition to studying ultimate power limitations, this test also demonstrates the use of computer automated conditioning to reach practical, achievable gradients.

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[1] J. Wang et al, "High Gradient Experiments on NLCTA Accelerator Structures," SLAC-PUB-7243.

[2] C. Adolphsen et al, "RF Processing of X-Band Accelerator Structures in the NLCTA," this conference.

FRA18 Accelerator Structures R&D for Linear Colliders*

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For more than ten years, we have been working on R&D for x-band accelerator structures for future linear colliders. There are two main challenges: one is suppression of dipole deflecting modes in order to preserve low emittance for multi-bunch beam, another is to operate at high gradient in order to optimize the linac length and cost. Several types of Detuned (DS) and Damped Detuned Structures (DDS) have been successfully designed and fabricated. They have been experimentally tested in both low power and high power to characterize their mechanical and electrical properties. Recently we are developing a new type damped detuned structure with optimized round-shaped cavities (RDDS), which will lead to the final design for NLC main linac structure. This paper introduces the structure special specifications, design principle and methods, fabrication procedures. The measurement technologies and results for quality control and electrical properties including both accelerating mode and wakefields of higher order modes (HOM) are presented. Some key components like accelerator cells, RF couplers and high order mode couplers are discussed. Also, the structures high power performance is evaluated.

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FRA19 A compact RF power coupler for the NLC Linac

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A high power RF coupler connecting WR90 rectangular waveguide to the disc loaded waveguide accelerating structures of NLC is described. The coupler design is symmetric and free of beam deflecting field components. It makes an efficient electrical match between the rectangular waveguide power feed and the accelerator structure while keeping electrical surface field enhancement low. Electrical and mechanical design of the coupler are presented as well as quantitative comparisons between numerical simulation and low power cold test models.

FRA20 The Next Linear Collider Damping Ring Complex*

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We report progress on the design of the Next Linear Collider (NLC) Damping Rings complex (DRC) [1]. The purpose of the DRC is to provide 120Hz, low emittance electron and positron bunch trains to the NLC linacs. It consists of two 2 GeV main damping rings, one positron pre-damping ring, two pairs of bunch and energy compressor systems and interconnecting transport lines. The 2 main damping rings store up to 0.8A in 3 trains of 95 bunches each and have normalized extracted beam emittances of $\gamma\varepsilon_x$ = 3 mm-mrad and $\gamma\varepsilon_y$ = 0.03 mm-mrad. The preliminary optical design, performance specifications and tolerances are given in [1]. Key subsystems include 1) the 714MHz RF system [2], 2) the 60ns risetime injection / extraction pulsed kicker magnets [3], 3) the 40 m wiggler magnet system, 4) the arc and wiggler vacuum system, 5) the radiation management system, 6) the beam diagnostic instrumentation, 7) special systems used for downstream linac machine protection and 8) feedback-based stabilization systems. Experience at the SLAC Linear Collider has shown that the NLC damping rings will have a pivotal role in the operation of the high power linacs. Their dynamics and instabilities will determine the design choices made for the NLC machine protection system. This paper includes a summary overview of the DRC

diodes etc.) alters the directions of discharging and charging of the resonant capacitance. The all system is powered by low voltage DC power supply(-ies), the high voltage needed by the varying current in the load inductance is automatically generated. A method of making the load current fall fast by using series/parallel of capacitors is also proposed. In the latter section, one example is given which is calculated by MICRO-CAPIII program. And the curves of the capacitor voltage and the load current of some cycles in transient period obtained by the calculation are overlapped in one diagram. Then, the process of the high voltage automatic generation and the steady cycle emerging are clear at a glance.

FRA167 The Second Example of a Capacitor Commutation Charging Type of Resonant Power Supply for Synchrotron Ring Magnets

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As the second example of a Capacitor Commutation Charging Type of Resonant Magnet Power Supply for Syn-chrotron Ring Magnets (CCCRPS)[1], in this paper the power supply for a 500 MeV synchrotron at ANL [2] is designed again using the idea of CCCRPS, given four design schemes whose load current wave forms are different : with zero flat bottom and without flat top, with non-zero flat bottom and without flat top, with non-zero flat bottom and with flat top and sine-wave with DC bias.

FRA168 The Third Example of a Capacitor Commutation Charging Type of Resonant Power Supply for Synchrotron Ring Magnets

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As the third design example of a Capacitor Commutation Charging Type of Resonant Magnet Power Supply for Synchrotron Ring Magnets (CCCRPS)[1], this paper using the parameters of the Main Ring Magnet Power Supply for the KEK 12 GeV Proton Synchrotron[2] designs a slow cycle synchrotron magnet power supply whose load current is with non-zero flat bottom and flat top, given two design schemes in which the circuit is same, only are same circuit parameters different.

FRA169 The Fourth Example of a Capacitor Commutation Charging Type of Resonant Power Supply for Synchrotron Ring Magnets

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As the fourth design example of a Capacitor Commutation Charging Type of Resonant Magnet Power Supply for Synchrotron Ring Magnets (CCCRPS)[1], this paper describes a design scheme of the magnet power supply of a large synchrotron accelerator[2]. The load current wave with a flat bottom and with a flat top, and the fall time is about a third of rise time.A reference DC voltage power supply is used for pre-charging the resonant capacitance and limiting its charging voltage.

FRA170 High Efficiency Linear Mode Power Supply with a Pre-regulator Controlled by Keeping Constant Rds of MOSFET

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In Synchrotron Radiation Research Center (SRRC) more than ninety linear power supplies with 100 ppm long-term stability are served for correction magnets. To increase the well-known efficiency problem of linear power supply, inside a customer-made bipolar linear power supply a homemade pre-regulator circuitry is in series in front of power stage. By using constant Vds controlled pre-regulator, the power consumption of linear power supply itself could be reduced and the efficiency changes with respect to the output power. On the other hand, with constant Rds controlled pre-regulator, the efficiency is even higher and is the ratio of load resistance and Rds. Design and performance of the pre-regulator circuitry will be demonstrated.

FRA171 An Electron Gun Power Supply.

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A high voltage power supply with up to 300 kV DC output voltage and 50 mA average current is described. The Electron Gun Power Supply consist of high voltage transformer - rectifier tank and IGBT - based AC voltage source. Transformer - rectifier tank includes 12 sections of secondary coils and rectifiers connected in series. Rectifier output to Electron Gun connection is realized with using of a coaxial cable. Tank is filled with SF6 isolating gas under pressure. AC voltage source operates at 400 Hz frequency. It is built as IGBT resonant type inverter with Pulse-Width Modulation for stabilizing and tuning of the output voltage level. The Power Supply is supplied with overvoltage, overcurrent and voltage breakdown protection circuits. Design, interesting circuitry parts, tests and operation results are presented.