C 345(04)
T-69

HEACC'98

XVII International Conference on High Energy Accelerators

September 7 - 12, 1998, Dubna

Abstracts

HEACC'98

XVII International Conference on High Energy Accelerators
September 7-12, 1998, Dubna

Programme Advisory Committee

Skrinsky A. (Chairman)	BINP
Moehl D. (Co-Chairman)	CERN
Balakin V.	BINP
Baldin A.	JINR
Dikansky N.	BINP
Dmitrievsky V.	JINR
Dzhelepov V.	JINR
Grunder H.	TJNAF
Hirata K.	KEK
Kimura Y.	KEK
Kravchuk L.	INR
Kulipanov G.	BINP
Lebedev A.	LPI RAS
Llewellyn Smith C.	CERN
Meshkov I.	JINR
Oganessian Yu.	JINR
Peoples J.	FNAL
Richter B.	SLAC
Sessler A.	LBNL
Shukeilo I.	RIEPA
Wiik B.H.	DESY
Yano Y.	RIKEN

JINR Organizing Committee

Kadyshevsky V. (Chairman)
Meshkov I. (Co-Chairman)
Sissakian A. (Co-Chairman)
Shirkov G. (Sc.secretary)
Bogolubov P.
Ivanov I.
Ivanova S.
Katrasev V.
Kovalenko A.
Lebedev A.
Lukyanov S.
Melnichenko I.
Nazarenko A.
Russakovich N.
Zhabitsky V.

General questions, programme
Prof. Igor Meshkov, LNP JINR,
141980 Dubna, Moscow Region, Russia
Phone: (+7 09621) 65193, fax (+7 09621) 66883
e-mail: meshkov@nusun.jinr.ru

Reports, Proceedings
Dr. Grigori Shirkov, LPP JINR,
141980 Dubna, Moscow Region, Russ a
Phone: (+7 09621) 65136 fax (+7 09621) 65767
e-mail HEACC98@sunse.jinr.ru

Registration, accommodation, visas, etc.
Mrs. Natalia Dokalenko, Intern. Depart., JINR,
141980 Dubna, Moscow Region, Russ a
Phone: (+7 09621) 65011 fax (+7 09621) 65599; 65891
e-mail natasha@cv.jinr.ru

XVII International Conference on High Energy Accelerators

September 7-12, 1998, Dubna

Book of Abstracts

Dubna 1998

IDENTIFICATION OF CONTRIBUTIONS

Each contribution in the program can be easily identified from the program code, which is put together as follows:

the first (and sometimes second capital letters) pertain to the session: **A, S, C, D, E, F, H, T, BD, FB, PC;**
next comes a number indicating the place within the session;
and the last small letter indicates the report status: for invite sessions **i**, for oral sessions **o** and for poster sessions **p**.

TOPICS:

A Contemporary Problems of the Particle Physics
S Status Reports
C Linear Colliders and Related Problems
D Particle Beam Dynamics
E Extraction of Beam from High Energy Accelerators
F Future Accelerators and Frontier Research
H Hadron Colliders and Facilities, Related Problems
T Magnet Systems and Power Supplies
BD Beam Diagnostics
FB Feed Back and Control
PC Particle Beam Cooling

ISBN 5-85165-509-7
© Joint Institute for Nuclear Research. Dubna, 1998

A THE CONTEMPORARY PROBLEMS OF THE PARTICLE PHYSICS

A 1i The physics motivations for future particle accelerators

J.ELLIS
CERN, Switzerland

The physics motivations for future particle accelerators will be reviewed, with particular emphasis on the problems of mass, flavour and unification that have been left unanswered by the Standard Model. The capabilities of B factories and the LHC will be reviewed, and the physics case for a linear electron-positron collider will be underlined. Possible further accelerators such as neutrino factories, muon colliders and very large hadron colliders will also be discussed.

A2o THE ACCELERATOR PARAMETERS FOR THE INVESTIGATIONS IN THE DOMAIN OF ULTRARELATIVISTIC NUCLEAR PHYSICS

A.I.Malakhov

Joint Institute for Nuclear Research
Laboratory of High Energies
141980, Dubna, Moscow reg., Russia
e-mail: malakhov@lhe.jinr.ru

ABSTRACT

The principles of symmetry and self-similarity have been used to obtain an explicit analytical expression for inclusive cross sections of production of particles nuclear fragments and antinuclei in relativistic nuclear collisions in the central rapidity region. The result is in agreement with available experimental data. It is shown that the effective number of nucleons participating in nuclear collisions decreases with increasing energy and cross section tends to a constant value equal both for particles and antiparticles. The analysis of the obtained results makes it possible to recommend the accelerator parameters for the testing our predictions at ultrarelativistic energies.

The work is supported by the INTAS-RFBR 95-1345 and RFBR 96-02-18728 Grants.

S THE STATUS REPORTS

S 1i FNAL STATUS REPORT

G. Jackson,

FNAL, USA

S2i Operation of 70 GeV IHEP Proton Synchrotron and Status of UNK Project.

K.P.Myznikov, E.F.Troyanov.
IHEP, Protvino, RF

The IHEP 70 GeV proton synchrotron is still reliable machine after 30 years of operation providing experimental set ups with protons of wide range of intensity in parallel with secondary particle beams. Operational characteristics as well as some improvements already done and expected to be done are given in 1-st part of the report. The 2-nd part describes status of UNK project.

S3i DAΦNE e^+e^- COLLIDER COMMISSIONING RESULTS

M. Zobov and DAΦNE Project Team
INFN Laboratori Nazionali di Frascati, C. P. 13 - 00044, Frascati (Roma), Italy

The Φ-Factory DAΦNE, e+e- collider aimed to reach the ultimate luminosity of $5.2*10^{32}$ $cm^{-2}s^{-1}$ at the energy of Φ resonance (1020 MeV in the center of mass), is being commissioned at the INFN Frascati National Laboratory, Italy. Here we describe the performance of the accelerators of the DAΦNE complex: the electron-positron Linac, the intermediate accumulator ring and the two main rings. The principal subsystems, such as vacuum, RF, longitudinal feedbacks etc., are addressed in details. We also present our observations and experience gained during the machine commissioning in single and multibunch regimes and discuss measures undertaken to optimize the collider luminosity and lifetime.

S 4i THE RECENT ADVANCES IN HEP ACCELERATORS DEVELOPMENT AT THE JOINT INSTITUTE FOR NUCLEAR RECEARCH

A.N.Sissakian
Joint Institute for Nuclear Research, Dubna, Russia

JINR is one of the major users of the HEP beams and stable contributor to new accelerator design and construction.

The recent results achieved in this field at JINR are connected to the new, strongly developing branch of HEP – the relativistic nuclear physics.

The report describes the main features of the so called NUCLOTRON accelerator recently put in operation at JINR. The designed accelerator particle energy is 6 Gev/nucleon and the currently achieved figure is 3.2 Gev/n. With projected beam intensity of 1×10^{11} particles on orbit (for deuterons) the currently reached value is 1.2×10^{10}. The short review is also given concerning the Nuclotron physics research program, as well as on the development of accelerator itself (slow extraction etc).

JINR participates also in several accelerator projects in different laboratories over the world, like LHC at CERN, TESLA at DESY, Tevatron upgrade at Fermilab and others. The report includes the review of these activities as well.

S 5i

DESY LABORATORY REPORT

Dieter Trines

Deutsches Elektronen-Synchrotron DESY

Notkestr. 85, D-22607 Hamburg, Germany

The performance of the accelerators at DESY serving a large scientific community, the e-p collider HERA and the synchrotron radiation source DORIS, will be presented as well as the planning for the future of these machines. Latest results from the R&D work for the international TESLA project, a superconducting linear collider with an integrated x-ray FEL laboratory, will be given. The status of the TTF (Tesla Test Facility) at DESY and the plans to use the facility for an FEL laboratory will be described. Finally an outlook on the planning of the TESLA project will be given.

S 6i

Status Report on KEK Activities

Shin-ichi Kurokawa
Accelerator Laboratory
KEK, High Energy Accelerator Research Organization
1-1 Oho, Tsukuba-shi, Ibaraki-ken, 305-0801, Japan

KEK has two major high-energy accelerators, namely, KEKB and KEK 12-GeV PS.

KEKB is a two-ring, asymmetric-energy, electron-positron collider now under construction. 3.5-GeV positrons and 8-GeV electrons stored in separate rings circulate in opposite directions and collide at one interaction point (IP). BELLE detector surrounds the IP. KEKB is aimed at achieving a luminosity of $10^{34}cm^{-2}s^{-1}$, which is realized by squeezing the high current positron (2.6 A) and electron (1.1 A) beams to one σ width of 77 μm horizontally, and 1.9 μm vertically at the IP. One of the features of KEKB is an adoption of a finite-angle crossing of $\pm$ 11 mrad. Main physics goal of KEKB is to observe the CP-violation effect in B-meson decays. KEKB will be commissioned in the fall of 1998.

JLC, Japan Linear Collider, is the future project in the electron-positron sector at KEK. The project is to construct 500-GeV electron-positron linear collider in its first phase and extend the energy beyond 1 TeV by future upgrades. The major focus of the current R&D work for JLC is on ATF, Accelerator Test Facility, which consists of a 1.54-GeV injector linac and a 1.54-GeV damping ring, to study a feasibility of producing an unprecedently low emittance beam. The damping ring was commissioned in January 1997.

KEK PS has been in operation since 1975 and is still playing important roles in particle and nuclear physics. Currently, a large effort is invested to carry out a long-baseline, neutrino-oscillation experiment, known as K2K. Neutrions produced by 12-GeV protons shoot the Super Kamiokande detector, 250 km west of KEK. Upgrade of PS is uderway to enable it to provide K2K with 10^{20} protons in three years. K2K will start from 1999.

Future project in the proton sector is JHF, Japan Hadron Facility, which consists of a 200 MeV injector proton linac, a 3-GeV booster synchrotron of 200 μA, and a 50-GeV proton synchrotron of 10 μA. This facility will provide intense proton beams to broad fields, from particle and nuclear physics to material and life sciences. The project has been proposed to the ministry and KEK expects approval of the project within a few years.

S 7i **STATUS OF RHIC AND ACTIVITIES AT BNL**

S.Ozaki

BNL, USA

S 8i **HIGH ENERGY ACCELERATORS ACTIVITY AT BUDKER INP**

A.Skrinsky,

BINP, Russia

S 9i **CESR Satus and Plans (*)**

A. Temnykh (1), Cornell University, USA

CESR operates with nine equally spaced trains of bunches with three bunches per train. The bunches within each train are 2.8ns apart. A small horizontal crossing angle (q = +- 2.1 mrad) provides beam separation at the nearest parasitic crossing. The typical starting luminosity is around 5x10^33 cm-2 s-1 with 200 mA of current per beam (~400mA of total current). Beam-beam tune shift parameter is around 0.04.

The replacment of conventional copper with superconducting RF cavities, upgrades to the vacuum system and interaction region optics will allow us to operate with nine 5-bunch trains and 900mA of total current. It will result in luminosity above 1x10^33 cm-2 s-1.

(*) Work Supported by National Science Foundation.
(1) For the CESR Operations Group.

S10i **Status of the SLAC program**

Dorfan J.

Stanford Linear Accelerator Center, USA

The status of the SLAC program will be presented, including the SLC, the B Factory machine and accelerator, and the fixed target program.

S11i **BEPC STATUS AND FUTURE PLANS**

Zhao Zhentang Wang Shuhong of BEPC Group
Institute of High Energy Physics, Chinese Academy of Sciences
P.O.Box 918, Beijing 100039, China

Beijing Electron and Positron Collider (BEPC) and its current status are summarized, the recent progress and the achieved results of the BEPC upgrade project are presented, the proposed future plans. BEPC-II and BTCF, are briefly reported.

S12i

SPS AND LEP STATUS REPORT

K.H.Kissler, CERN, Geneva, Switzerland

Driven by the needs of the neutrino experiments, the intensity of the SPS proton beam has considerably increased during the past years, with a maximum of 4.8 x 10^{13} protons per pulse accelerated to 450 GeV/c. This progress was achieved by an improved quality of the injected beam as well as improved operational procedures.

The heavy ion programme of the SPS has been continued since 1994 with the acceleration of fully stripped lead ions Pb^{82+} to 158 GeV/c per nucleon. Fixed frequency acceleration at the beginning of the cycle is followed by acceleration using a normal synchronous frequency programme. This procedure results in a good spill quality of the extracted ion beam while coping efficiently with the relatively low β of the lead ions at injection.

A new extraction channel which will be installed in the SPS for the transfer of 450 GeV/c protons to the LHC, opens the option of a neutrino beam to the Gran Sasso laboratory in Italy, 732 km away from CERN. The conceptual design of this beam will be described.

The energy of CERN's flagship, the large electron-positron collider LEP has been raised in several steps since 1995, following the installation of an increasing number of superconducting RF cavities. At present, a total of 272 superconducting cavities are in operation with an average gradient of 6 MV/m. This allows relatively comfortable operation of LEP at an energy of 94.5 GeV per beam. After the installation of 16 additional cavities and an increase of the gradient to values close to 7 MV/m it is hoped to reach a beam energy of up to 100 GeV during the years 1999 and 2000, the last years of LEP operation. The performance of LEP and its limitations will be discussed.

S1pStatus of Yerevan Synchrotron and some Perspectives of its Upgrade

Mkrtchian R.L., Nikogosyan V.Ts., Amatuni A.Ts., Avakian R.H., Babayan A.Z., Badalian E.A., Baryshev A.I., Begloyan E.D., Gazazian A.D., Egiyan K.Sh., Karabekov I.P., Laziyev E.M., Martirosyan H.A., Melikyan R.A., Oxuzyan G.G., Petrosyan M.L., Sadoyan K.A., Simonyan Kh.A., Toumanyan A.R., Tsakanov V.M., Vardapetyan H.A., Zapolski N.A.

During the 30 years' functioning of Yerevan electron synchrotron (YES) there have been received a number of fundamental results on investigation of hadron and nuclear matter in the photo- and electroproduction on nucleons and nuclei. In the course of the development of the new physics program it has become very important to improve the Yerevan electron synchrotron. In the present report are given the main results of the YES modernization such as: the modernization of the new injection system, development of the magnetic field flat top for substantial increase of duty factor, of a new 460 MHz RF system, of a simultaneous and independent gamma-beams extraction by two channels, etc. The results of investigation (in collaboration with MRTI) of the opportunities of acceleration of protons up to 250-500 MeV required for the radiation therapy are also discussed.

C1o Recent Luminosity Increases at the SLC

M.G.Minty, SLAC

During the 1997-98 high energy physics run, the SLAC Linear Collider luminosity has been increased by more than a factor of three. This substantial increase is due primarily to the much anticipated disruption enhancement which results from smaller beam emittances and higher beam currents. Emittance preservation was achieved more effectively by improving the emittance measurement diagnostics near the final focus, by revising the strategy for high-current wakefield cancellation, by optimizing beam orbit and optics feedback algorithms, by lattice modifications which allowed for increased demagnifaction at the interaction point, and by upstream lattice changes to remove higher order chromatic aberrations. In addition, the beam currents were increased slightly by decreasing losses in upstream systems. With these improvements, the logged Z-production rates are consistent with theoretical estimates which include a disruption enhancement ranging from 50 to 90$\%$. In this report we review recent progress and possible plans for further luminosity increases at the SLC.
This work was supported by the U.S. Department of Energy under Contract Nos. DE-AC03-76SF00098 and DE-AC03-76SF00515.

C2i ACCELERATORS-RECUPERATORS AND THEIR APPLICATIONS

N. A. Vinokurov

Budker Institute of Nuclear Physics

11 Ac. Lavrentyev Prosp., 630090, Novosibirsk, Russia

For many applications the deceleration of the used electron beam is desirable. Such energy recuperation is useful for the reduction of both of the power, required for the beam acceleration, and the radiation hazard. The potential applicatoins of accelerator-recuperators are free electron lasers, very high brightness X-ray sources, nuclear physic facilities with thin (internal) target and high luminosity electron-positron colliders. The particular design problems and beam dynamics issues for such installations are discussed.

C3i **LINEAR COLLIDER DEVELOPMENT AT BUDKER INP**

V.E.Balakin

Budker INP, 630090, Novosibirsk, Russia,

Branch of INP, 142284, Protvino, Russia

Activities on linear colliders (LC) at Budker INP started in early 70s. Our studies have shown that the main problems are solvable. In the given report, the most significant results are presented, namely, those of studying the high acceleration gradient (100 MV/m), developing the gridded klystron with a PPM focusing system and a high gain, also single bunch dynamics and methods to damp instabilities. Beam-beam effects at the interaction point, including standing and traveling foci regimes, are considered. Problems of alignment and development of high precision equipment are discussed. Briefly outlined is the current development of LC technologies at Budker INP carried out in the framework of the international collaboration.

C4i GAMMA-GAMMA, GAMMA-ELECTRON COLLIDERS

Valery Telnov

Budker Institute of Nuclear Physics, 630090, Novosibirsk, Russia

e-mail: telnov@inp.nsk.su

Using backscattering of a laser light on high energy electrons at linear colliders one can obtain $\gamma\gamma$ and γe colliding beams (photon collider) with the energy and luminosity comparable to that in e^+e^- collisions. Recently, three international collaborations NLC (USA) and TESLA/SBLC (Germany) and JLC (Japan) have published conceptual design projects of linear colliders envisaging special interaction regions for gamma-gamma and gamma-electron collisions. Photon colliders can considerably increase discovery potential of linear colliders at the relatively low additional cost (second IP with detector and laser). Some of physics arguments in favour photon colliders are the following: a) some phenomena can be studied here better than in other types of collisions (single Higgs production); b) cross sections of charged pair production in $\gamma\gamma$ collisions are higher than those in e^+e^- collisions by a factor 5-15 (for different types of particles); c) in $\gamma\gamma$ and γe collisions some particles can be produced with masses larger than those at e^+e^- colliders with the same energy; d) the luminosity in $\gamma\gamma$ collisions can be potentially much higher than that in e^+e^- collisions (due to the absence of some collision effects). This talk includes: status of photon colliders, physics goals and ways to high luminosity.

C5i Superconducting Cavities

S.Mitsunobu

KEK, Japan

C6i **Status of Cavity Development for TESLA**

D.Proch,

DESY, Germany

C7o HYDROFORMING OF SEAMLESS NIOBIUM CAVITY OF TESLA SHAPE

H.Kaiser, W.Singer, G.Weichert
Deutsches Elektronen-Synchrotron DESY, Germany

I. Gonin, I. Jelezov, T. Khabiboulline, W. Kuchtiev
Institute for Nuclear Research INR, Russia

H. -G. Brokmeier,
Technical University Clausthal, Germany

H. -G. Priesmeyer
GKSS Research Center, Germany

The fabrication by hydroforming of a seamless bulk niobium cavity of TESLA shape, with a ratio of equator diameter to iris diameter about three, is a challenging task and requires special development. This technology allows not only to reduce the production costs, but also to improve the cavity's accelerating performance.
A machine for hydroforming experiments was built at INR institute and installed at DESY. Fabrication of some one-cell and two-cell Cu cavities proved the functioning of the machine. Devices for investigations of mechanical properties and structure of Nb were also set up.
Development work includes three aspects:

- Studies of Nb properties and microstructure on different stages of the preparation, investigation of texture distribution by using of neutron scattering, analysis of experimental results in order to optimize the seamless tube production procedure.
- The numerical simulation of the hydraulic expansion of the tube using the finite element code ANSYS. The calculations were carried out on the basis of experimentally determined strain-stress characteristic of used tubes and resulted in the relation of applied internal pressure against axial displacement (path of the expansion) for the hydroforming process.
- The hydroforming process itself is an expansion of a seamless tube into a mold by the internal liquid pressure. It was found that maximum possible strain of niobium could be increased by using a particular strain rate, and by periodic stress fluctuation.

For the first time, a TESLA shape single-cell superconducting cavity has been fabricated at DESY without intermediate annealing. The cavity is rather rigid, because of the achieved wall thickness distribution, what makes the stiffening ring unnecessary.

C8i The CLIC Study of a 0.5 to 5 TeV e+/e- Linear Collider.

I. Wilson, for the CLIC team: R. Bossart, H.H. Braun, G. Carron, F. Chautard, W. Coosemans, R. Corsini, E.'d.Amico, J.P. Delahaye, M. Dehler, J.C. Godot, G. Guignard, J. Hagel. S. Hutchins, C.D. Johnson, E. Jensen, I. Kamber, A. Millich, P. Pearce, J.P. Potier, A.J. Riche, I. Rinolfi, D. Schulte, G. Suberlucq, L. Thorndahl, M. Valentini, D.J. Warner, W. Wuensch, CERN;

T. Raubenheimer, R. Ruth, SLAC

The CLIC study of a high energy (0.5 to 5 TeV) and high luminosity (10^34 to 10^35 cm^-2 sec^-1) e+/- linear collider is presented. Beam acceleration with high frequency (30 GHz) normal conducting structures operating with high accelerating fields (100 to 200 MeV/m) significantly reduces the length and, in consequence the cost of the linac. Based on new beam and linac parameters derived from a recently developed set of general scaling laws for linear colliders, the beam stability is shown to be similar to lower frequency designs in spite of the strong wake-field dependence on frequency. The generation of the drive beam for RF power production by the so-called "Two Beam Acceleration (TBA)" method, is based on a novel scheme that is potentially very efficient, cost effective and reliable. It relies on a conventional heavily loaded linac at low frequency (937.5 MHz) and RF multiplication by beam funneling in compressor rings. Recent 30 GHz hardware developments and results from the CLIC Test Facility assessing the feasibility of the scheme are described.

C 9i The Route to the Energy Frontier: A New Kind of Two Beam Accelerator

R.Ruth,

SLAC, USA

C10o Recent Results on KEK/ATF Damping Ring

J.Urakawa, M.Akemoto, S.Araki, Y.Funahashi, H.Hayano, T.Higo, E.Kim, S.Kamada, T.Korhonen, K.Kubo, Y.Kurihara, S.Kuroda, Shuji Matsumoto, T.Mimashi, Takashi Naito, K.Oide, T.Omori, S.Sakanaka, Toshikazu Suzuki, K.Takata, Seishi Takeda, T.Tauchi, N.Terunuma, N.Toge, High Energy Accelerator Research Organization (KEK), Tsukuba, Japan; K.Bane, A.Donaldson, P.Emma, J.Frisch, R.Iverson, K.Jobe, T.Kotseroglou, D.McCormick, M.Minty, N.Phinney, T.Raubenheimer, M.Ross, J.Turner, D.Williams, M.Woodley, F.Zimmermann, Stanford Linear Accelerator Center (SLAC), Stanford, USA; W.Bialowons, S.Choroba, E.Gianfelice, W.Kriens, C.Montag, Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany; J.Choi, T.Lee, K.Kim, M.Kim, Pohang Accelerator Laboratory, POSTECH (PAL), Pohang, Korea; L.H.Jin, X.Luo, Institute of High Energy Physics (IHEP), Beijing, P.R.China; J.Corlett, (LBLN), Berkeley, USA; J.P.Potier, European Organization for Nuclear Research (CERN), Geneva, Switzerland; K.Dobashi, T.Okugi, K.Sugiyama, Tokyo Metropolitan University, Japan; S.Kashiwagi, The Graduate University for Advanced Studies, KEK, Japan; H.Sakai, Kyoto University, Japan; T.Imai, Science University of Tokyo, Japan; D.Aizawa, M.Kagaya, T.Sakamoto, Tohoku-Gakuin University, Japan; F.Hinode, Tohoku University, Sendai, Japan; F.Tamura, University of Tokyo, Japan; and M.Takano; Toho University, Chiba, Japan

To achieve the desired luminosity, all linear collider schemes need very small transverse and longitudinal emittances. One of the more stringent requirements on a future linear collider is the generation and preservation of beams with very small emittances. The Accelerator Test Facility(ATF) has been designed to investigate the feasibility of the linear-collider operation scheme and to accumulate beam-control techniques for the linear collider. The purpose of the ATF is to develop accelerator technology that can stably supply to the main linear accelerator an extremely flat "multi-bunch beam" that can be squeezed down to a few nanometers at the collision point within the linear collider. Also, the construction is progressing to verify that this technology can supply a truly flat multi-bunch beam to the main accelerator. This technology development is not the only aim, but rather our belief is that it is essential to gather experience with the analysis and control of extremely small multi-bunch beams in order to most effectively design, construct, and operate linear colliders. This paper reports the results from commissioning and accelerator studies of the damping ring that has started in January, 1997.

C11i **Development Status of JLC/NLC**

N. Toge,

KEK, Japan

C 1p **THE MAXIMUM ENERGY ATTAINABLE IN RF LINACS**

A.N.Opanasenko, NSC, KIPT, Kharkov 310108, Ukraine

It has been shown that in high-energy electron linacs based on periodical structures off-axis electrons of a beam must radiate photons. The averaged radiation power of the electron is proportional to the square of its energy. This circumstance leads to the principal limitation of attainable energies of electrons in rf-linacs. The extreme attainable energy of electrons of a beam was estimated for rf-linacs with parameters that are typical for the future linear TeV colliders. The possibility of effective conversion of rf power into radiation in periodical accelerating structures for obtaining gamma-beams is discussed.

C 2p NEW SCHEME OF TWO BEAM ACCELERATOR DRIVER BASED ON LINEAR INDUCTION SECTIONS

A.V. Elzhov, A.A. Kaminsky, A.K. Kaminsky, V.I. Kazacha,
E.A. Perelstein, S.N. Sedykh, A.P. Sergeev.
Joint Institute for Nuclear Research, Dubna, Russia

In the previously proposed schemes of the two-beam accelerator (TBA) driver [1], [2] electron beam moves in alternating discrete row of microwave generators and reaccelerator sections. The microwave power is totally extracted from the driver after every generation section.

A new scheme of TBA driver [3] based on a linear induction accelerator (LIA) is suggested in this work. The driver consists of an injector, buncher, and long row of separate LIA sections producing the external accelerating electric field. The injector produces the initial electron beam with energy 1-2 MeV and current 0.5-1 kA. The beam is injected into a buncher. It may be a travelling wave tube (TWT) working in the amplification mode. Then the electron bunches move in accompaniment of the enhanced in the TWT microwave, which maintains the beam bunching, and simultaneously are accelerated in the LIA electric field. In such system the microwave radiation and the electron beam achieve the steady state mode of interaction at the distance of a few tens meters where the bunch energy increases up to 10 MeV. The total power, which is inserted into the beam by the accelerating field, transforms into the microwave power in the steady state.

The experimental setup based on the JINR LIA-3000 facility to test the new scheme is discussed. It consists of 800 keV, 200 A injector and two reaccelerating sections. The possibility of studying of the electron beam bunching, microwave generation, beam propagation and twofold microwave extraction is considered.

REFERENCES

[1] A.M. Sessler, Proc. Workshop on the Laser Acceleration of Particles, eds. C. Yoshi and T. Katsouleas, AIP Conf. Proc. 91 (1982), p.154.

[2] W. Schnell, CERN-LEP-RF/86-27 (1986); CERN-LEP-RF/88-59 (1988).

[3] A.V. Elzhov, V.I. Kazacha, E. A. Perelstein , Proceedings of XV International Seninar on Charged Particle Linear Accelerators. Kharkov (the Ukraine), v.II (1997), p.129.

C 3p "Project of a multipurpose accelerator complex for NSC KIPT "

E.Bulyak, P.Gladkikh, A.Dovbnya, A.Zelinsky, I Karnaukhov, V.Kozin, S.Kononenko, V.Lapshin, N.Mocheshnikov, A.Mytsykov, F.Peev, A.Tarasenko, Yu.Telegin, A.Shcherbakov
National Science Center " Kharkov Institute of Physics and Technology"
1, Academichna Str., Kharkov, 310108, Ukraine

In NSC KIPT on basis of the existing linear electron accelerator of LUE-2000 with maximum energy of 2 GeV the project of a multipurpose accelerator complex consisting of a source of a synchrotron radiation (SR) of high spectral brightness (energy of the circulating electron beam up to 2 ГэВ) and a pulse stretcher ring (energy of the extracted electron beam ranges from 300 up to 500 МэВ) is developed. The storage ring with a perimeter ~91 m is to be built in the existing hall of the magnetic spectrometer, that enables us to avoid any capital construction. The optimization of the focussing structure of the storage ring has enabled to achieve the spectral brightness at a level of the dedicated SR sources with longer circumference. For generation of a quasicontinuous electron beam it is supposed to use a slow extraction from the ring on the parametric resonance. The performances of a complex are presented in the report.

C 4p

VIT 040 - the high level code for controlling of RF process in linear accelerator.

V.V. Podlevskih

Budker INP, 630090 Novosibirsk, Russia

Abstract

This paper presents the analysis of algoritm and description of the special code for Monitoring, Diagnostic and Error Finding of the RF system in linear accelerator.

VIT 040 special code may be used for RF system considered of: source unit, SLED system, accelerating structures, grouper, RF load, waveguide , hybrids and other elements.

C 5p EMITTANCE REDUCTION VIA DYNAMIC RF FREQUENCY SHIFT AT THE SLC DAMPING RINGS

M.G. Minty, R. Akre, F.-J. Decker, J. Frisch, S. Kuroda, F. Zimmermann

The generation of small emittance beams is a key issue determining the luminosity at a future linear collider. Dedicated damping rings have been designed to produce such beams, but techniques to further reduce the design emittances would yield immediate improvements in terms of higher luminosity. At injection into damping rings, the transverse beam emittance is large and the beam fills a large fraction of the physical aperture. At later times during the store, after the beam has radiation damped, the horizontal damping time and equilibrium emittance may be reduced by shifting the rf frequency such that the particle orbit moves inwards. By passing off-center through the quadrupoles in regions of nonzero dispersion, the horizontal partition number is changed. This reduces both the horizontal damping time and equilibrium emittance. In addition, to the extent that the vertical emittance is determined by betatron coupling, the reduction in horizontal emittance may be accompanied by a corresponding reduction in vertical emittance. We report preliminary experience with such a scheme at the Stanford Linear Collider damping rings and compare the predicted emittance reduction and luminosity increase with experimental data.

C 6p REDESIGN OF A DAMPING RING FOR THE SBLC-PROJECT

D. Einfeld, A. Hagestedt, J. Schaper, Fachhochschule Ostfriesland,
D-26721 Emden, Germany

In most of the damping ring proposals for linear colliders the rings have the shape of a racetrack with damping wigglers in the long straight sections. The disadvantage of such a design is the small dynamic aperture of a few millimeters. In a previous design study for the damping ring of the SBLC-project at DESY we proposed a ring with a sixfold symmetry. The lattice design was similar to the lattice design of a third generation light source. In this paper a modified version has a 12-fold periodicity with more space for the wigglers in order to decrease the emittance (=3.1 mm mrad at 3 GeV and a circumference of 660 m) and the damping time (=3.1 msec). The RF system consists of 8 normal conducting ELETTRA cavities which allow to store a beam of 300 mA without any excitation of multibunch instabilities.

C 7p Resent Results on KEK/ATF Damping Ring

Takata Koji

KEK, Japan

C 8p SETUP FOR MEASURING RF CHARACTERISTICS OF ACCELERATING CAVITIES

E. Kenjebulatov, S. Krutikhin, I. Kuptsov, A. Tribendis, and V. Veshcherevich
Budker Institute of Nuclear Physics, 630090 Novosibirsk, Russia

The accelerating cavities built at BINP are incorporated with fundamental mode tuners and higher order modes (HOM) tuners. A special computerized setup is used for measuring RF characteristics of the fundamental mode and HOMs. Amplitude-frequency and phase-frequency characteristics of evacuated cavities are measured at 21 or more different positions in the tuning range of each tuner. The setup allows to take measurements at the fundamental mode frequency (180.4 MHz) and in the frequency range of 225–1800 MHz. The frequency range may be extended up to 3600 MHz, if necessary. The measurement circuit contains a sweep-generator and a superheterodyne receiver. The receiver is tuned simultaneously with the sweep-generator. The setup provides a dynamic range of 70 dB and a sensitivity of 3 μV. The range of the measured quality factor values extends from 800 to 100000. Also the characteristic impedances are measured using the bead pull technique. About 100 modes are considered for each cavity. Up to now over 15 cavities have been measured at this setup.

C 9p Non Quadratic Losses in Nb-coated Superconducting Cavities and Method of their Decrease

N.I. Balalykin, A.B. Kuznetsov
Joint Institute for Nuclear Research

S.Gazi, S.Benachka
Electrotechnical Institute Slovak Academy of Science, Bratislava

Non quadratic losses observed experimentally in Nb-coated superconducting cavities are explained as an essentially surface phenomenon. When magnetic RF-field amplitude exceeds the first critical field B_{c1} of the Nb film, fluxons generate into the surface part of the film. The length of fluxons which generate in the roughness of the film (reflecting the roughness of the copper surfaces of the cavity) is defined by the transverse sizes of the roughness. The initial length of fluxons which generate lower the base of the roughness is the order of the magnetic field depth λ. The fluxon motion under the influence of interaction forces with the surface and of Lorents force defined by the action of currents screening the magnetic RF field, leads to additional losses. From this explanation it follows, that the non quadratic losses can be reduced by increasing B_{c1} as well as by smoothing the roughness of the copper cavity surfaces.

The results of measuring B_{c1} of the two-layer NbN/Nb and three-layer NbN/Nb/NbN films, obtained by the planar magnetron, have shown, that B_{c1} is significantly higher for these films than for Nb films.

A possibility to use an improved axial magnetron, whose rate of sputtering process is close to the planar magnetron, is discussed

C10p Heating Of a Superconducting Cavity Due to High Frequency Wakefields

Hulsmann Peter

Inst. fur Angewandte Physics, Germany

C11p HIGH POWER RF GENERATOR FOR STORAGE RING VEPP-4

E. Gorniker, V. Arbuzov, A. Bushuev, A. Kondakov, and V. Petrov
Budker Institute of Nuclear Physics, 630090 Novosibirsk, Russia

Characteristics, features and design of the 500 kW generator for RF system of VEPP-4 at a frequency of 180 MHz are described. The modular principle of the output stage design permits to build different RF stages of generator with maximum output power from 150 to 600 kW using three standard units. The stage consists of one to four tetrode modules, a tuner and a coupler. These units can be easily connected to each other. As a result the output RF power is produced from one tube or combined from several tubes. High power water cooled GU-101A tetrodes produced by SVETLANA, St. Petersburg are used in the stage. The features of the stage provides stable operation of RF system using no ferrite circulators. A two-tube stage worked on 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. For this condition a power consumption from the d.c. anode power supply was as high as 1000 kW.

C12p NEW RESULTS OF THE 7 GHz PULSED MAGNICON AMPLIFIER INVESTIGATION*

E.V. Kozyrev, O.A. Nezhevenko, A.A. Nikiforov, G.N. Ostreiko, B.Z.Persov,
G.V. Serdobintsev, V.V. Tarnetsky, V.F. Yakovlev, .A. Zapryagaev
Budker Institute of Nuclear Physics, 630090 Novosibirsk, Russia

The report presents experimental results obtained on 7 GHz pusled magnicon amplifier and planes of next investigations. This magnicon was developed at INP as an prototype of a microwave power source for next generation of linear colliders. The tube operates in frequency-doubling mode of the drive signal. At present time the following parameters were achived : maxumum output power of 55 MW, efficiency of 56 %, gain of 63 dB.

* Work is supported by Russian Fund of Basic Research

C13p 150 MW Modulators for power supply of Pulse Klystrons 5045

V.E. Akimov, P.A. Bak, R.H. Galinov, K.V. Gubin, I.V. Kazarezov, N.H. Kot,
A.V. Novokhatsky, V.V. Rashenko, A.M. Rezakov, Yu.E. Tokarev, A.G. Chupyra,
B.S. Estrin
Budker INP, 630090 Novosibirsk, Russia

Abstract

Four modulators each for a pulse power of 150 MW are designed and manufactured to power the preinjector klystrons of the VEPP-5 complex. The modulators differ in types of charge devices, pulse forming network capacitors and the design of the pulse forming networks. There are described special features in the modulator design, the adjastment and operation of the modulators.

C14p QUASI-OPTICAL RF POWER DISTRIBUTION SYSTEMS OF FUTURE LINEAR ACCELERATORS

S.V.Kuzikov

Institute of Applied Physics, Russian Academy of Sciences

46, Ulyanov Str., 603600 Nizhny Novgorod, Russia

A problem of particle acceleration up to 1 TeV energies for linear colliders requires high-power microwave sources, to be placed consequently along ~20 km long accelerator and provided ~10^9 W of microwave power during 100-300 ns. In order to reach the mentioned power level, it is expedient to sum up few times lower powers produced by microwave amplifiers. To reduce a total number of the necessary sources, the amplifiers have to produce long ~1 μs pulses which are to be divided in few (3-4) parts. In such a case every part is delivered independently to different acceleration sections. A combination of the described ideas is realized at so-called Delay Line Distribution System (DLDS) [1]. This concept uses one-mode -3dB directional couplers which allow to sum up powers, switching on π mutual phases of the amplifiers.

Here a new quasi-optical concept of the DLDS is proposed. It provides DLDS's projects to be more electrically proof, that is actually the great problem at higher than 11.4 GHz frequencies. In particular, quasi-optical versions of a -3dB hybrid as well as a four-channel coupler are suggested. The main idea to sum up and to distribute RF power simultaneously is achieved by means of an operation by mutual phases of paraxial wavebeams led into oversized rectangular waveguide. The wavebeams are combined into a final wavebeam of the same shape at different places of the waveguide. These places depend on the mutual phases of the incident wavebeams. Therefore, changing the phases of the amplifiers, it is possible both to multiply RF power and to extract it at different acceleration sections. This allows to provide the total length of the used delay lines as short as possible.

References

1. JLC Design Study. April, 1997, High Energy Accelerator Research Organization Tsukuba, Ibaraki 305, Japan.
2. S.V.Kuzikov, Wavebeam Multiplication Phenomena to RF Power Distribution Systems of Future Linear Accelerators, Int. J. of Infr. and Mil. Waves, 1998. (in print)

C15p THE 8 kV POWER SUPPLY FOR RF-GENERATORS ANODE FEEDING.

B.A.Baklakov, A.I.Erokhin, Yu.A.Evtushenko, K.M.Gorchakov, V.V.Kolmogorov, D.A.Markov, L.E.Medvedev, A.S.Medvedko, S.P.Petrov, V.F.Veremeenko.
BINP, Novosibirsk, RUSSIA.

Abstract

In the report the 8 kV power supply with an output power 2,6 МВт for the tube RF-generators anode power feeding is described.

The base of power supply is the three-phase thyristor rectifier bridge with passive LC-filter reducing of output voltage ripples up to 1%.

The power supply is equipped with load fast protection in occasion of sparkovers in the tubes of generators. The 6-10 microsecond time of output voltage cutoff allows to avoid destruction in RF-generator tubes. The output voltage cutoff is realized by shorting of power supply output with the help of parallel thyristor switch. In the report the fast protection operation in detail is considered, the diagrams of transients and schematics of function modules are represented.

Used method of fast load protection determines overloading capability and high protect reliability of power supply. The big amount of thyristors of the rectifier bridge and fast protection switch forces to check their condition. The monitoring system is designed on basis of optron pairs with fiber optics cables. The information about condition of thyristors is checked by the computer.

C16p The high power test of RF load for VEPP-5 preinjector.

M.V. Korabelnikov, V.V. Podlevskih, V.M.Pavlov
Budker INP, 630090 Novosibirsk, Russia

Abstract

This paper presents the results of the high power tests of the RF load for VEPP-5 preinjector. The electrical engineering parameters and the load design are presented.

C17p RF High Current Electron Gridded Gun for FEL Injector.

V.M. BOROVIKOV, A.N. KERGINSKY, G.S. KRAINOV,
A.M. KRYUCHKOV, E.A. KUPER , A.V. MADORSKY,
E.G. MIGINSKAIA , A.M. MOLOKOEDOV, V.K. OVCHAR ,
I.N. SOROKIN , M.A. TIUNOV, G.I. YASNOV,
BINP NOVOSIBIRSK.

We present the design and experimental results of the electron gun for the injector of the free-electron lazer (FEL) [1]. The main features are: the wide repetition rate 0-22.5 MHz, the high peak current ~2A, the short pulse duration ~1.3 ns, and the low emittance of the 300 keV electron beam. The low emittance is provided by the tetrode type of the cathode unit. The average current ~30 mA has been reached.

[1] N.G.Gavrilov et al., "Status of the Novosibirsk high power free electron laser project." in Free-Electron Laser Challenges, Proceedings of SPIE , **2988** , 185 (1997)

C18p CALCULATION OF IMPEDANCE FOR MULTIPLE WAVEGUIDE JUNCTION USING SCATTERING MATRIX FORMULATION

V.A.Dolgashev
Budker Institute of Nuclear Physics
Novosibirsk, 630090, Russia

ABSTRACT

A method of computing the electromagnetic characteristics of a complex 3D cavity consisting of series of waveguides with arbitrary cross section is derived. The scattering matrix formulation is used for the simulation. For calculations of modes in waveguide with arbitrary cross sections a finite element code SLANS is applied. The computer code based on the method is used to calculate scattering parameters, dispersion characteristics of periodical structures, resonances, longitudinal and transverse impedances. The method was originally developed for simulations of long range wake fields in accelerator structures and for calculations of RF windows. Advantages of the technology make possible to simulate long open cavities like accelerating structures and complex vacuum chambers. The method and some results are presented.

D1o Beam Commissioning of the PEP-II *B*-Factory High Energy Ring.

U. Wienands, SLAC, for the High Energy Ring Team.

The 9-GeV, High Energy Ring of the LBNL-LLNL-SLAC *B* Factory was completed in the spring of 1997 and by January 1998 has seen three beam commissioning runs of about 3.5 month total time. A sector test with beam was performed in March 1997. At the end of May the vacuum system was closed and a one-month beam commissioning run started, verifying proper operation of the accelerator systems and achieving a maximum beam current of 60 mA. The ring systems diagnostics and controls performed remarkably well, allowing rapid progress. In September and October 1997 the maximum beam current was raised to 300 mA—about 1/3 of the nominal beam current— and commissioning of the bunch-to-bunch feedback systems and rf loops made good progress. First evidence of collective effects on the beam dynamics was recorded. During the third run in January 1998 the rf loops were further commissioned and optimized and the beam current record increased to 0.75A; this current would be sufficient to achieve design luminosity. Longitudinal beam parameters were measured and found to agree, within errors, with the design values. Backgrounds in the interaction region were measured and found to be rather higher than expected. A fourth commissioning run is planned for July 1998; commissioning the Low Energy Ring and the optics (which is common to both rings) of the interaction region, with the possibility of first collisions. The report will give an overview of the ring performance and beam parameters achieved so far and of the beam-dynamics measurements performed.

D2o "Density Effect on Quantum Fluctuations in Synchrotrons"

S.V. Koutin and A.N. Lebedev
P.N. Lebedev Physical Institute of RAS.
LEBEDEV@SCI.LPI.AC.RU

We discuss an influence of short-time electron correlations on quantum excitation of particle oscillations by synchrotron radiation. The effect should decrease the "natural" beam emittance and can be observable at reasonable intensities at 1-2 GeV energy.

D3o BUNCH MERGING AND SPLITTING TECHNIQUES IN THE INJECTORS FOR HIGH ENERGY HADRON COLLIDERS

R. Garoby, CERN

One problem in the design of TeV hadron colliders arises from the choice of the radio frequency. To produce the short bunches needed during collision economically, a high frequency (400 MHz or more) is essential. On the other hand, in the injector chain at lower energies, lower frequencies are generally preferred to alleviate space charge and instability problems and, partially also, for historical reasons. The classical solution is to transform the bunch structure by passing via a debunched beam state, during which the whole machine circumference becomes filled with particles and the beam is subjected to induced parasitic fields and is often prone to microwave instabilities. *Bunch merging* and *bunch splitting* have therefore been developed as alternative methods that allow the number of bunches to be changed without passing via that state. Bunch merging has been used in the CERN-PS since 1989 for the anti-proton production beam. The reverse process of bunch splitting was first proposed in the frame of the CERN injector complex for LHC, as a means of quasi-adiabatically changing the time structure of the beam, increasing the number of bunches from four at low energy in the PS Booster to 16 at high energy in the PS. When the CERN accelerator complex re-starts in March 1998, this technique will be in routine operation. New plans are now being considered to replace the debunching-rebunching process that is still needed at 26 GeV in the PS to generate the train of 84 bunches required by the SPS and LHC. The experience gained in the application of bunch merging and splitting techniques is reviewed in this paper together with the further extensions now envisaged and the analysis of the expected advantages with respect to the more classical process of debunching-rebunching.

D4o Nonlinear Single Particle Issues for the LHC at CERN

Schmidt Frank[1]

CERN, CH 1211 Geneva, Switzerland
[1] E-mail: Frank.Schmidt@cern.ch

One of the critical design issues of the LHC is the field quality of the super-conducting dipole and quadrupole magnets, in particular at injection energy. In close collaboration with the magnet designers this field quality is optimised with respect to required dynamic aperture and technological and financial limitations. The main tool is still brute force tracking simulations. The simulation codes are simple, easily adaptable to new requirements and highly optimised for the use on modern computer architectures. To allow very systematic studies a cluster of 20 DEC alpha workstations has therefore been purchased.

On the other hand one has to analyse these tracking results with tools that allow the evaluation of the highly nonlinear content of the accelerator structure. In the last decade the Normal Form Tool and more recently the Frequency Map Analysis have been introduced to our field which allow for such an analysis. A number of programs have been developed that are based on these method and their usefulness will be demonstrated for the special case of the LHC.

D5o PROVIDING THE LONGITUDINAL BEAM PARAMETERS OF THE LHC BEAM

T.Linnecar, CERN, Geneva, Switzerland

The luminosity foreseen for the Large Hadron Collider (LHC), at present being built at CERN, places stringent requirements on the longitudinal beam parameters of the high intensity proton beam. Critical points in the production of this beam occur both in the injector chain and at transfer and capture in the LHC itself. The consequent design of the superconducting RF system in the LHC as well as the proposed damping and higher harmonic RF systems is discussed. Emphasis is also placed on some areas in the SPS machine, injector for the LHC, where transient beam loading and both single and multi-bunch instabilities must be carefully controlled to attain the high beam quality required.

D6o Compensation of Beam-Beam Effects in Tevatron Using Electron Beam

Vladimir SHILTSEV, FNAL

Beam-beam interaction in the Tevatron collider sets limits on bunch intensities and luminosity. These limits are caused by a tune spread in each bunch which is mostly due to head-on collisions, but there is also a bunch-to bunch tune spread due to parasitic crossings in multibunch operation. It is suggested to use a counter traveling low-energy high-current electron beam to provide "electron compression" of the beam-beam footprint or/and to modulate the electron current in order to equalize betatron frequencies of all bunches. General consideration, physical limatations and technical requirements are presented for the electron beam set-up as well as status of the Fermilab test experiment.

D7o NON LINEAR CUMULATIVE INTERACTION AND HALO HEATING IN MULTI CAVITY LINAC*, V.G.Kurakin, P.V.Kurakin, Lebedev Physical Institute, 117924 Moscow, Russia -- Multi mode approach in cumulative beam break up theory results in number of features of beam dynamics. Besides enhanced action of induced fields deflecting rf gradient manifests much more strong co-ordinates dependence than that in the case of single mode approximation for non resonance cavities excitation. Beam heating is a consequence of such non linear beam rf cavity interaction in transient particle dynamics. Transverse beam dynamics in induced electromagnetic fields in multi cavity linac is the subject of this paper. Multi mode approach is used for the processes modelling in multi cavity linac composed of single cell uncoupled cavities. Beam kernel coherent motion computer simulation is accompanied by trajectories calculation of halo particles. Plots presented serve to illustrate beam kernel envelope evolution along the accelerator length as well as halo emittance growth.

* The work is supported by Russian Foundation for Fundamental Research, project No 97-02-17082.

D1p Realistic Numerical Modeling of Synchrotron Motion.

J. A. MacLachlan,
Fermi National Accelerator Laboratory, Batavia IL, USA

Usually the easiest way to connect the observed phase-energy motion in a beam to the well-known single-particle equations of motion (EOM) is by a modeling program that iterates the EOM for a representative particle distribution. Typically the qualitative features can be reproduced without invoking nonlinear or collective motion, and a truly simple program suffices. However, even in this simplest situation, the desire to experiment with the parameters and features of the rf system can be discouraged because the modeling program fails to provide the flexibility to accommodate the new idea. When the effects of instability or the beam-generated potentia are central concerns, the program is perforce more elaborate and may need continual elaboration over time as new issues are raised. ESME is a program that has undergone eighteen years of development responding to a variety of interests. It has been elaborated as needed to deal with collective effects without greatly changing its suitability for simple applications. Although it has been necessary from time-to-time to clean up some code, generally the structure has sustained elaboration without ad hoc patches which interfere with further development or introduce subtle traps for the unwary. There are very few such programs generally available. This paper is intended to convey the general capabilities of ESME and, so far as possible, the ways in which the design has been informed by beam physics and accelerator experience.

D2pSTUDY OF THE NON-LINEAR BEHAVIOUR OF THE LHC USING NORMAL FORMS

Yannis Papaphilippou[1] and Frank Schmidt[2]
CERN, CH 1211 Geneva, Switzerland

Normal form tools are used in view of predicting the causes, which limit the dynamic aperture in the LHC versions 4 and 5. To this end, maps of up to 11^{th} order have been produced and analysed by means of Lie algebraic methods for all models and 60 different realisations of the accelerator at injection energy. Our approach is validated through the comparison of the detuning functions extracted by normal forms with the tunes given by frequency analysis. The resonances up to 12^{th} order and the detuning terms are systematically analysed and correlated with the dynamic aperture for a number of amplitude ratios. It has been of particular interest to establish the link between the individual multipole coefficients and the higher order contributions to a specific resonance.

[1] E-mail: Ioannis.Papaphilippou@cern.ch
[2] E-mail: Frank.Schmidt@cern.ch

D3p

Asymptotic description of betatron oscillations by the modified Hill equation

O.E.Shishanin

Moscow State Industrial University

Studying the features of synchrotron radiation we have found that its properties depend substantially on the vertical betatron oscillations. To explain this effect we have obtained the uninterrupted solutios describing motion of an electron on whole closed path for the concrete magnetic structures. Moreover it seems that these asymptotics and technique of their derivation are of some interest also for a theory of accelerators since they depict clearly the dynamics of particles in the ordinary three-dimensional space and give just one more approach for the calculation of frequencies.

In principle our method is appropriate for any compound structure including storage rings. Restricting ourselves to two examples only, we examine strongfocusing FODO and FOFDOD lattices. Developing the field gradient or transverse magnetic components into a Fourier series and using the Floquet theorem we seek solutions of the Hill equation in the form of the other series. Finally, the asymptotics of vertical and radial oscillations are superposition of sine and cosine with modulated amplitudes.

D4p

The effect of betatron oscillations on angular properties of synchrotron radiation

O.E.Shishanin

Moscow State Industrial University

At the beginning we have considered the influence of betatron oscillations on radiation problem for axisymmetric magnetic field. Then we have investigated the emission properties in strong- and weakfocusing accelerator systems.

Using beta function in the present report we wish to derive the formulas for complicated magnetic structures of the modern accelerators and storage rings. We show that vertical emittance and beta function, its derivation change essentially the spectral-angular distributions of radiation intensity.

In due to vertical vibrations one of radiation component is not equal to zero in the plane of equilibrium orbit. Therefore we have not hundred-per-cent polarization of synchrotron light.

D5p Beam losses simulation in accelerators with extended version of RTS&T code.

Institute for High Energy Physics
Protvino, Moscow region, 142284, Russia

I.I. DEGTYAREV, Yu.S.FEDOTOV, A.E.LOKHOVITSKII, I.A.YAZYNIN

A complex of codes for calculation of scraper, shield, extraction and beam dump systems is described. Modeling of beam motion in an accelerator electromagnetic fields and the distribution of losses is made by the code SCRAPER.

The movement of particles with allowance of a real interaction processes with substance of elements and shielding components of the accelerator is simulated by the code RTS&T. The image of irradiated objects in three-dimensional space and the calculation of thermal processes as well as durability of materials is made by codes ACAD and ANSYS.

The complex of the codes is incorporated in one integrated shell, available through Help and tree of processes.

D6p CALCULATION OF THE HIGH-ORDER BEAM OPTICS IN TOROIDAL MAGNETIC LENS

I.P. Yudin and V.V. Andreev

Joint Institute for Nuclear Research, Dubna 141980, Moscow region, Russia
E-mail: yudin@cv.jinr.ru

We describe the procedure within the transfer matrix formalism to obtain the solution of nonlinear equations of charge particle motion in toroidal magnetic lens (with an axis-symmetrical potential) for high-order aberrations.

D7p EFFECTS OF NONLINEAR SYNCHRO-BETATRON COUPLING IN LARGE ELECTRON STORAGE RINGS

Y. Alexahin

JINR, Dubna 141980 Russia

Modern high-energy electron storage rings - e^+e^- factories and synchrotron light sources - usually employ low emittance lattices. Strong nonlinearity in such lattices produces, in particular, strong chromatic aberrations: off-momentum beta-beating and higher order dispersion, which can drive nonlinear synchro-betatron resonances (SBRs).

Another feature of large storage rings is high value of the synchrotron tune (Q_s~0.05÷0.15) which makes classical mechanism of SBR excitation via betatron tune modulation less important, on the other hand, synchro-betatron resonances of relatively low order may occur in the neighborhood of the working point. It will be shown that under realistic conditions they can be strong enough to limit the dynamic aperture.

Even at a distance from a resonance, synchro-betatron coupling can strongly affect the distribution of radiating particles, the most harmful effect being increase in the vertical emittance. Analytical estimates for contribution of different SBRs to the vertical emittance are given, on the example of LEP 108/90 lattice this contribution is shown to be quite important.

D8p Luminosity Constraints due to Beam-Beam Effect in RIKEN RI Beam Factory Project

Yuri K. Batygin and Takeshi Katayama*)

RIKEN, Hirosawa, 2-1, Wako-shi, Saitama, 351-01, Japan
*) Center for Nuclear Study, School of Science, University of Tokyo, -2-1, Midoricho, Tanashi, Tokyo 188, Japan

Among variety of planning experiments at RIKEN RI beam factory the ion-ion merging collisions and interaction of electron beam with unstable ion beams are of the most importance. Merge beam technique is very useful method for the study of nuclear fusion processes. Merging two RI beams deliver low energy collisions just above the Coulomb barrier threshold that is difficult to be realised in other experimental methods. Another important experiment at the new RI beam factory is a collision of 2.5 GeV electron beam with unstable ion beams. Electron -ion collision experiment is intended to be used for determination of the charge and current distribution in the radio active nuclei.

Beam intensity in circular ion colliders is limited by effects of beam-beam interaction. Significance of the phenomena is characterised by the value of beam-beam tune shift, linear part of which does not exceed the magnitude of ξ=0.005. Taking this value for electron-ion collision, luminosity is limited by the value of $L < 2x10^{18} N_i^{total} sm^{-2} sec^{-1}$, where $N_i^{total} = 10^7 .. 10^{12}$ is a total number of stored ions in a ring. In the merging case beam-beam effect is less severe, because both beams have almost the same vector of velocity and merging angle is rather small (10°). Luminosity of merging collisions (10^{26} sm^{-2} sec^{-1} at maximum) is several order of magnitude less than that for head-on collisions at the same number of stored particles.

The physical reason for the beam-beam limitation is usually attributed to excitation of a set of nonlinear resonances due to periodic nonlinear kicks to the linear system. Overlapping of nonlinear resonances is a universal mechanism of stochastic particle instability in nonlinear systems. Another mechanism of unstable particle motion is diffusion created by random fluctuations in distribution of the opposite beam. Noise in the beam-beam collision always induces instability if beam-beam kick is a nonlinear function of the coordinate. Due to diffusion character, noise beam-beam instability does not have a threshold character and can exist at any value of beam-beam tune shift.

Electron and stochastic cooling are effective methods to decrease phase space volume of the beam. Combination on beam-beam interaction with cooling is expected to be a way to suppress beam-beam instability and to increase the maximum achieved value of beam-beam parameter up to ξ = 0.02. In this case luminosity of electron-ion collisions can be increased at least 4 times as compare with that without cooling.

D9p CONTINUOUS ANALOGUE OF NEWTON'S METHOD IN BEAM DYNAMICS PROBLEMS

E.P. Zhidkov, R.V. Polyakova, I.P. Yudin

Joint Institute for Nuclear Research, Dubna 141980, Moscow region, Russia
E-mail: Mag @ lcta50.jinr.dubna.su

An algorithm of the continuous analogue of Newton's method (CANM) is proposed for the solving of the boundary value problems of beam transport.

The efficiency of CANM has been practically shown on a number of the problems of beam dynamics leading to the solving of ordinary differential and integral equations.

The solving of the problem of determining the optimal (in sense of some criteria of quality) parameters P_i for charged particles transportation systems taking into account different nonlinear effects, is given. The results of the calculation of the consistent "invisible" straight section (insertion) of the accelerator obtained with the help of CANM are shown.

D10p POLARIZED ELECTRONS AT AmPS

I.Koop, P.Klimin, A.Lysenko, I.Nesterenko, B.Militsyn, E.Perevedentsev, V.Ptitsyn, E.Pozdeev, Yu.Shatunov
Budker Institute of Nuclear Physics, Novosibirsk, 630090, Russia

P.W. van Amersfoort, H. Boer Rookhuizen, G. Luijckx, R. Maas, I. Passchier
National Institute for Nuclear and High-Energy Physics (NIKHEF),
Amsterdam, the Netherlands

In 1995 Siberian Snake was installed on AmPS to maintain longitudinal beam polarization in the Internal Target area. Since that time several successful commissioning and experimental runs were made with high polarization level observed. Also self-polarization was detected caused by the spin-orbit coupling mechanism.

This report presents the snake optics design as well as polarization measurement results.

D11p Compensation of the insertion devices effect in electron storage rings

A Zelinsky, I. Karnaukhov

National Scientific Centre

" Kharkov Institute of Physics and Technology"

1, Academichna Str., Kharkov, 310108, Ukraine

The method of designing of the local compensation schemes for suppression of wigglers and undulators affects on lattice functions of low emittance storage rings is described. The method is based on the analysis and optimization of a transport matrix of the insertion device section. The features of magnetic lattices permitting to compensate effects of various wiggler and undulator types are discussed.

The effects of the insertion devices to lattice functions and parameters (emittance, energy spread etc.) of storage rings ISI-800 and UNK Kharkov is discussed. The schemes of compensation are presented.

D12p Transverse Acceptance Studies at the ATF Damping Ring

F. Zimmermann, J. Turner, Stanford Linear Accelerator Center(SLAC), Stanford, USA; J. Urakawa, H. Hayano, K. Kubo, N. Terunuma, N. Toge, High Energy Accelerator Research Organization(KEK), Tsukuba, Japan; T. Okugi, Tokyo Metropolitan University

The transverse acceptance of the ATF damping ring can be inferred from the vacuum pressure and the beam lifetime, since the lattice is limited by elastic scattering off the residual gas. The acceptance thus obtained is significantly smaller than the design value. We have measured its dependence on sextupole settings, linear coupling, global orbit distortions, local orbit bumps, rf frequency, rf voltage, and on the working point in tune diagram. In this report, we present the measurement results and compare them with simulations.

D13p Global correction of coupling of oscillations in storage ring ASC NSC KIPT.

A.Zelinsky, I. Karnaukhov

National Scientific Centre

" Kharkov Institute of Physics and Technology"

1, Academichna Str., Kharkov, 310108, Ukraine

The high quality of a photon beams can be provide only by small emittance of an electron beam in an storage ring. The electron beam is affected by perturbing electromagnetic fields caused by misalignment of electromagnetic elements and field errors. It results in coupling of vertical and horizontal oscillations, producing of a vertical dispertion.

Design horizontal emittance of an storage ring ASC NSC KIPT makes $2.5*10^{-8}$ m*rad. The purpose of the present work - to minimize a coupling ratio in a ring for producing of minimum value of vertical emitance. The scheme of compensation of oscillations coupling to optimize a coupling ratio in storage ring ASC NSC KIPT is present.

D14p SEARCHING FOR BIG LINEAR PERTURBATIONS IN SYNCHROTRONS

D. Dinev

Institute for Nuclear Research and Nuclear Energy

72 Tzarigradsko chaussee, 1784 Sofia, Bulgaria

E - mail : dinnet@inrne.acad.bg

A new algorithm of successive orbit approximation have been developed for searching for availability of large linear perturbations, i. e. field errors and element misalignments and tilts in synchrotrons. Such big perturbations often occur during the machine commissioning and may cause very large closed orbit distortions. The new algorithm has been applied to the superconducting heavy ion synchrotron Nuclotron in JINR-Dubna.

D15p The formation of electron beam with quasi gaussian radial density distribution for beam-beam compensation in colliders

I. Meshkov, E. Syresin, I. Titkova

The electron beam with quasi gaussian radial distribution can be used in the system for compensation of beam-beam effect in collider. So called electron lense, which is very similar to the electron cooling system, will be installed in TEVATRON for the beam-beam compensation. The electron beams with gaussian distributions are required for compensation of beam-beam effects at the collisions of proton and antiproton beams with gaussian radial distribution. The three-electrode gun used for generation of the electron beam with quasi gaussian radial distribution is discussed in this paper. The electron energy in the beam corresponds to 10 keV and beam current is about 1A. The gun simulations are performed by computer code SAM.

D16p Parasitic Collisions

Parkhomtchouk Dmitri, KEK, Japan

In multibunch colliders with small bunch separation, there are so-called parasitic collision points (PCP) near the interaction point (IP). The interaction in these PCPs can influence the orbit distortion, stability condition, and after all reduce the maximum reachable luminosity. PCPs can occur in the case of crossing angle design, or insufficient separation by deflector. In this article, based on nonlinear analysis, we evaluate some critical parameters that could limit the luminosity and discuss what happens in the unstable regime.

D17p BEAM-BEAM SIMULATION ON PARALLEL COMPUTERS

A. Jejcic, J. Maillard, J. Silva.
College de France, Laboratoire de Physique Corpusculaire
75794 Paris Cedex16, France

and

N. Dikansky, D. Pestrikov, D. Shatilov, E. Simonov

Budker Institute of Nuclear Physics
630090 Novosibirsk, Russian Federation

We report initial experience of the employment of the parallel computing for the beam-beam simulations. Although stronger advantages are expected when the number of processors is high, in this report we describe examples which were realized on the AlphaServer 4100 with 4 processors and on parallel computing set up from College de France with 32 of T9000 processors. An array of pentium stations operated with PVM is also worked out, the code portability is tested.

At the moment, the developed package consists of several independent codes enabling computer simulation for both weak-strong and strong-strong models. Here we discuss the new approaches and features implemented in the package.

D18p STATUS OF THE 2.5 GEV LIGHT SOURCE ANKA

D. Einfeld

ANKA is a 2.5 GeV synchrotron light source under construction at the Forschungszentrum Karlsruhe, Germany (circumference 110 m, variable emittance with minimum value of 40 nm, 8 DBA structures). Central part of its mission is to provide industry with services including micro-fabrication, analytical applications and non-destructive testing (3 beamlines for LIGA, 6 for X-ray analytical methods, one for XUV spectromicroscopy and one for infrared spectroscopy and microscopy). Four 6 m long and one out of four 2.2 m long straight sections can be equipped later with insertion devices. Prototypes of the magnets and the vacuum chambers will be delivered spring 1998. 4 ELETTRA cavities have been ordered and will be driven by two 250 kW klystrons for obtaining a current of 400 mA. The injector consisting of a 50 MeV microtron and a 500 MeV synchrotron is under construction. The novel control system of the accelerator will be based on LONWORKS (fieldbus), TACO under WindowsNT and JAVA. Bids for 11 complete beamlines are due at end of January 1998 and the contract will be awarded spring 1998. Construction of the building began January 1998 and will be finished October 1998. Commissioning of ANKA will start in fall 1999.

D19p **Project of a Multipurpose Accelerator Complex for NSC KIPT**

Gladkikh Peter (Co-authors)

KhPTI, Ukraine

D20p **Beam Dynamics in ITEP Heavy Ion Storage Ring**

Mustafin Edil, Zenkevich Pavel,

ITEP, Moscow, Russia

E EXTRACTION OF BEAM FROM HIGH ENERGY ACCELERATORS

E1i Crystal Extraction of Beam from High Energy Hadron Accelerators

C. Thornton Murphy

Final results from the Fermilab experiment which extracted beam from the halo of the Tevatron with a bent crystal will be presented. Data was taken in both proton-only stores and in stores with collisions of protons and antiproton beams, during which the protons incident on the crystal came from elastic scatters at the collision points. An extraction rate of 150 kHz was achieved without intollerable increases in the background rate at the two collider experiments. An extraction efficiency of about 25% was achieved. Results from the similar experiment at the CERN SPS will also be summarized, with special emphasis on their recent results with a germanium crystal and in the extraction of lead ions.

E2o NEW RESULTS ON STUDY OF EFFICIENT CRYSTAL EXTRACTION AT 70 GeV IHEP ACCELERATOR

V.I.KOTOV, A.G.AFONIN, V.M.BIRYUKOV, Yu.A.CHESNOKOV,
V.A.GAVRILUSHKIN, V.N.GRETH, V.A.MAISHEEV, A.V.MINCHENKO,
V.I.TERECHOV, E.F.TROYANOV, V.A.ZELENOV, IHEP Protvino (Russia),
B.A.CHUNIN, M.G.GORDEEVA, A.S.DENISOV, Yu.M.IVANOV,
A.A.PETRUNIN, V.V.SKOROBOGATOV, PNPI St.-Peterburg (Russia) -

A radical increase of extraction efficiency is reached by use of a short crystal of 5 mm length, bent by a small angle of 1.5 mrad, due to an increase in the average number of particle encounters with crystal. The record extraction efficiency of over 40% is experimentally achieved, in agreement with the theory predictions. An intensity of extracted beam about 6*10^11 ppp is obtained, which is 5 orders higher then previous results.

E3o NEW TRENDS IN ACCELERATOR BEAM EXTRACTION

A.M. Taratin

LHE JINR, 141980 Dubna, Russia

Experimental investigations of high energy charged particle deflection and accelerator beam extraction by a bent crystal are reviewed. The maximum efficiency observed in the experiments is higher than 50 % for the beam deflection and about 30 % for the beam extraction. The beam extraction efficiency increases due to multiple passages of circulating particles through the crystal – "multi-pass extraction". The different schemes of the beam extraction and the conditions to increase the efficiency in the single-pass and multi-pass extraction modes are analyzed.

F THE FUTURE ACCELERATORS AND FRONTIER RESEARCH

F1i The Role of Lasers and Plasmas in Future Accelerators

J. Wurtelle,

LBNL, USA

F2i FRONTIERS OF HIGH-GRADIENT ACCELERATOR RESEARCH

David H. Whittum, SLAC, Stanford University

The role of high-gradient accelerator research is to lead us beyond what can be engineered this year or next, to a future for physics beyond the 5 TeV energy scale. With this in mind we consider the limitations of acceleration mechanisms in solid-state and plasma, with attention to structure fabrication, wakefields and damage mechanisms, and accelerators based on fundamental-mode circuits, as well as overmoded and quasi-optical geometries, conducting and composite structures, active and passive circuits. Progress toward a 1 GeV, 1 meter linac is discussed.

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

F 3o DEVELOPMENT OF A LINEAR ION ACCELERATOR WITH RF FIELD EXCITATION BY AN ELECTRON BEAM IN CASE OF DOPPLER SHIFTED ELECTRON CYCLOTRON RESONANCE*

V.I.Butenko, B.I.Ivanov, I.N.Onishchenko, V.P.Prishchepov, A.M.Yegorov
NSC KIPT, Kharkov, Ukraine

A linear ion accelerator has been proposed and now is being developed in which accelerating and focusing electric fields are excited by an intense electron beam due to cyclotron instability at anomalous or normal Doppler effect. The results of theoretical studies and computer simulations show the advantage of this acceleration method that will allow to obtain acceleration rate 10–100 MeV/m, ion beam energy and current 10–1000 MeV, 1–10 A. The design and technical documentation of an Experimental (test) Accelerating Stand (EAS) are worked out. The installation will have following parameters: the electron beam energy 350 keV, the current 150 A, the pulse duration 2.5 mcsec, the wave frequency 148.5 MHz, the wave amplitude 56 kV/cm; the proton beam is assumed to be accelerated from 5 to 8 MeV.

Computer simulations of ion dynamics in a two-beam electron-ion accelerator have been accomplished for wide set of parameters including ones of the EAS. Motion equations take into account all electric fields in the accelerator: electromagnetic wave fields, RF and DC space-charge fields of the driving electron beam, and fields of accelerating ions (using the large particle method). The motion of the ions near the synchronous phase is as follows: the bunch collapses both in radial and phase directions (corresponding to simultaneous radial and phase focusing), and as a result a part of the ions leave in radial direction to the drift tubes because the ion concentration increases so much that the radial focusing fields can not compensate the Coulomb fields. This instability can be called as the collective transversal one. With its account, the ion current of 3–4 A have been determined for the EAS parameters.

At present, the accelerator-injector "URAL-5" of energy 5 MeV is in operation, preliminary experiments on RF-fields excitation have been carried out, experimental investigations of an accelerating RF-resonator model (in 1:1 scaling) are performed, and the EAS is under construction.

*It is a pleasure for authors to thank A.M. Sessler (LBL) for attention, valuable comments and support.

F 4i MUON COLLIDER RESEARCH AND DEVELOPMENT[1]

ROBERT PALMER,

Brookhaven National Laboratory, 901A, Upton, NY 11973-5000, U.S.A.

The status of the research on muon colliders is discussed and plans are outlined for future theoretical and experimental studies. Besides continued work on the parameters of a 3-4 and .5 TeV center of mass (CoM) collider, many studies are now concentrating on a machine near 100 GeV (CoM) that could be a factory for the s-channel production of Higgs particles. We discuss the research on the various components in such muon colliders, and also present theoretical and experimental R&D plans for the next 5-6 years that should lead to a better understanding of the design and feasibility issues for all the components.

[1]Work performed under Contract No. DE-AC02-98CH10886 with the United States Department of Energy

F5i VERY LARGE HADRON COLLIDERS

G. Dugan

Laboratory of Nuclear Studies*

Cornell University

Ithaca, NY 14853

Several possible realizations for future hadron colliders after the LHC will be discussed. The general characteristics and requirements of such machines will be outlined. A parametric description of possible design options will be presented. Component and system cost reduction is crucial for the feasibility of such large machines. The principal accelerator physics issues will be reviewed, highlighting the most significant challenges, and presenting design strategies which could lead to cost reductions. The major technical systems will be discussed, emphasizing areas with the potential for significant cost saving. Current R&D activities focusing on these systems will be described, and the prospects for future work will be outlined.

* Supported by the National Science Foundation

Flp 2.5-DIMENSIONAL NUMERICAL SIMULATION OF RELATIVISTIC ELECTRON BUNCH SELF-MODULATION IN A PLASMA

V.I.Karas', V.A.Balakirev, Ya.B.Fainberg G.V.Sotnikov, I.V.Karas',
V.D.Levchenko*, Yu.S.Sigov*

National Science Center "Kharkov Institute of Physics and Technology",
Akademichna St. 1, Kharkov. 310108, Ukraine
*) Keldysh Institute of Applied Mathematics, RAS, Miusskaya Sq. 4, Moscow, 125047, Russia

High-amplitude plasma wake waves are excited by high-density relativistic electron bunches (REB) moving in a plasma. The wake fields can be used to accelerate charged particles, to serve as electrostatic wigglers in free-electron plasma lasers (FEL), and also can find many other applications.

The electromagnetic fields in the region occupied by the bunch control the dynamics of the bunch itself. In particular, the transverse forces cause a strong compression (pinching) of bunches having small transverse dimensions ($k_p r_b << 1$, where $k_p = \omega_p / c$, ω_p is the plasma frequency, c is the light velocity, and r_b is the radius of the bunch). This phenomenon is at the basis of operation of plasma lenses that can be used to focus ultra-high energy particles. The longitudinal fields give rise to longitudinal modulation of an electron bunch. Specifically, an originally uniform bunch evolves into individual microbunches.

This paper presents the results of 2.5-dimensional numerical simulation of both the modulation of long REB in a plasma and the excitation of wake fields by these bunches. The previous one-dimensional study has shown that the density profile modulation of a long bunch moving in plasma results in the growth of the wake wave amplitude. This is explained by the fact that the wake fields generated by microbunches being due to the evolution of the initially uniform bunch during the modulation, are coherent. The bunch modulation occurs at the plasma frequency. The present study is concerned with the REB motion, taking into account the plasma and REB nonlinearities. It is demonstrated that the radial REB dynamics exerts primary effect on both the REB self-modulation and the wake field excitation by the bunches formed.

F2p PARTICLE ACCELERATION WITH A «WIGGLING» FIELD

A.V. Smirnov

Russian Research Center «Kurchatov Institute», 123182 Moscow, Russian Federation

A new method for acceleration of ultrarelativistic particles is considered. It is based on a resonance interaction of a straightforward charged particle beam interacting with electromagnetic beam having periodical perturbation of a wavefront vector. Electromagnetic beam guiding can be provided both in a vacuum waveguide and in overdense plasma channels under stimulated hose instability.

Main parameters of acceleration process in a periodically curved rectangular waveguide feeded by laser are analysed. The method proposed does nor require conventional undulator and has acceleration rate exceeding Inverse Free Electron Laser (IFEL) at low synchrotron radiation losses. It can be used in high energy accelerations of the next generation that contain special buncher based on OK or IFEL section.

F3p Two-dimensional Stationary Wake Fields in Vortexfree Cold Plasma

Arutunian Suren,

Yerevan Physics Institute,Armenia

F4p Linac Ring Colliders. Neutralisation in Muon Colliders.

Rossmanith Robert

Karlsruhe, Project ANKA, Germany

H1i PROGRESS IN CONSTRUCTION OF THE LHC

Philippe Lebrun
LHC Division, CERN, Geneva (Switzerland)

The Large Hadron Collider (LHC) project, approved by the CERN Council in December 1994, has now fully entered its construction phase. The optics and layout have been refined towards more robustness and flexibility, leading to an optimised design of the insertions. The injector chain has been upgraded to produce the beams with 25 ns bunch spacing and high phase-space density required for the collider performance. Following an intense industrial R&D program based on short and long model magnets, the design of the main dipoles has evolved towards its final configuration, before production of pre-series and series is engaged in mid-1999. The first full-length prototype, built in collaboration with INFN (Italy), has been successfully tested. The quadrupoles and short straight sections which enclose them have been the object of detailed design work and prototype construction, in collaboration with CEA and CNRS (France). In view of its position on the critical path of the project planning, the procurement of the superconducting cable has been engaged from specialised industry in Europe, Japan and the USA. Design and prototype work for the many types of insertion magnets has also started, in collaboration with Canadian, Japanese and US laboratories. The first prototypes of conventional magnets for the LHC injection lines have been designed and built by BIPN (Russia). The main components of the cryogenic system are also being procured. Four new helium refrigerators have been ordered from industry, together with the upgrade of the existing LEP refrigerators. Offers have been obtained for the 25-km cryogenic distribution line around the tunnel. Following successful model work on cold sub-atmospheric hydrodynamic compressors, the 1.8 K refrigeration units which constitute the lower stage of the LHC cryogenic refrigeration system, have been specified for procurement to industry. The design of the beam vacuum system, with its 1.9 K cold bore shielded from beam-induced effects by a 5-to-20 K liner ("beam screen"), is now firmly established, and technical solutions investigated for its construction. All critical accelerator systems, and their mutual interactions, have been tested at large in the String Test facility, a working model of a half-cell of the collider. Following adjudication of the major civil engineering contracts, and formal acceptance of the civil works by authorities in the Host States, ground breaking has started for the construction of underground tunnels and large experimental caverns, as well as new surface buildings, at several locations around the circumference of the LHC.

H2i AN ELECTRON-NUCLEUS COLLIDER DESIGN STUDY (ENC)

K.Blasche, J.Struckmeier
Gesellschaft fuer Schwerionenforschung (GSI), Planckstrasse 1, 64291 Darmstadt, Germany

and

N.S.Dikansky, Yu.I.Eidelman, V.V.Parkhomchuk, D.V.Pestrikov, R.A.Salimov, A.N.Skrinsky

Budker Institute of Nuclear Physics, 630090 Novosibirsk, Russian Federation

GSI has considered deep-inelastic electron-nucleon and electron-nucleus scattering at $\sqrt{s} = 10 \div 30$ GeV/u as one of the options for the future development of the laboratory. Therefore a feasibility study was started for an electron-nucleus collider (ENC) designed for high luminosity operation at $L = 1 \times 10^{33}$ 1/[cm^2 s] (electron-proton) and at $L = 4 \times 10^{30}$ 1/[cm^2 s] (electron-uranium). In addition, longitudinal polarization of the colliding bunches was included. High luminosity operation in this intermediate energy range makes application of strong cooling for both the electron and the ion bunches absolutely necessary. In this report some results of the feasibility study performed at the BINP are discussed, e.g. luminosity optimization, general layout including injection schemes, beam cooling, beam instabilities, beam-bean effects. As a consequence of the feasibility study DESY, GSI, and the BINP have started further research in high energy electron cooling.

H3i Radioisotope Beam Factory Project at RIKEN

T. Katayama,

INS Univ. of Tokyo

H4i HIGH BRIGHTNESS HADRON INJECTORS FOR TEV COLLIDERS

K. Schindl, CERN

The ambitious performance goals of present and future hadron colliders call for a chain of injectors that are specially designed to provide high quality beams. However, for many reasons, not the least of which is cost, all these colliders make use of existing accelerator complexes that were not built for this new task and have therefore to be upgraded. The most important issue such hadron injectors have to deal with is the preservation of transverse normalised emittance: in the absence of cooling and synchrotron radiation, the emittance is bound to grow along the accelerator chain. Small transverse emittances are important because (i) the collider luminosity is proportional to N_b (N_b/ε) and becomes larger for smaller emittance; (ii) particle losses along the injector chain and, particularly, at injection into the collider are reduced so largely avoiding the risk of quenching a magnet. Sources of emittance blow-up, such as mis-steering and mismatch between machines, space charge, instabilities and intra-beam scattering, will be covered along with corrective measures such as automated beam steering, a thorough analysis of the optics by means of improved beam profile measurements and injection oscillation dampers. Problems common to the Tevatron, HERA-p, RHIC, LHC injector chains (the latter two including heavy ion production) will be discussed and the quite different requirements of hadron factories (e.g. JHF) will be touched upon. Comments on how to tailor the longitudinal emittance for the conflicting requirements of beam stability during acceleration and short bunches at collision will also be given. The lessons that the LHC injectors can learn from existing hadron colliders will be highlighted.

H5o Mechanical and Thermodynamical approach to Halo creation problem in High intense beams.

Yu.Senichev , ISA, Aarhus University*

During last decade the halo creation problem became one of the most popular problem, what can be explained by highest interest to the intense proton machines for Kaon and Neutron Factories and the linac for the transmutation technology. At present three accelerators of such class, JHF in KEK, ESS in Europe and NSNS in Oak Ridge are under design and construction. The halo creation is most serious problem in a such machines, since it restricts the intensity of the beam and the life time of the facility. In this work the halo creation problem is investigated using the nonlinear mechanics apparatus and the numerical modelling. The author consider two conceptions, the mechanical and thermodynamical ones and gives estimation of their applicability frame. on leave from Institute for Nuclear Research, Moscow

H 6o VLHC Based on the Nuclotron-type Cryomagnetic System

A.D.Kovalenko

JINR, Russia

The estimated parameters of a 2 x100 TeV proton (nuclei) synchrotron/collider based on the Nuclotron-type cryomagnetic system are presented. The esperimental data obtained during 5-year operation of the Nuclotron as well as the R & D works on the miniature low-cost iron dominated SC-magnets at the Laboratory of High Energies of JINR are discussed. Different options of VLHC are compared.

H1p

PHOTODESORPTION PROCESSES IN VACUUM CHAMBER WITH CRYOSORBING WALLS

V.V. Anashin and O.B Malyshev

Budker Institute of Nuclear Physics, Novosibirsk, Russia

In the beginning of 90th three project of next generation supercollider were started. One of the important problem was to predict the residual gas density inside vacuum chamber inside cold bore of superconducting magnets at liquid helium temperatures. There were the very few data and the real necessity for detail experimental study. In 1993 the studies of photon stimulated desorption in vacuum chamber with cryosorbed wall had been started. Initially the main interest was to hydrogen. It was shown what hydrogen gas density consist of three parts: (1) primary desorption of gas, (2) desorption of molecules cryosorbed on vacuum chamber walls and (3) thermal desorption (equilibrium pressure). The model describing that process was presented, all unknowns were experimentally defined. Following measurements of synchrotron radiation induced desorption from layers of H_2, CH_4, CO and CO_2 condensed at either liquid nitrogen and/or liquid helium temperatures are presented. The photodesorption yields of all cryosorbed gases are found to increase with increasing surface coverage and reach a saturation value. This value is about 0.55 molecules/photon for H_2 at $\sim 3 \cdot 10^{15}$ molecules/cm^2. For CH_4, CO and CO_2 saturation values reached at surface coverage of tree order high magnitude: at $\sim 10^{19}$ molecules/cm^2. The saturating values are about 0.45 molecules/photon for CO_2 and 0.4 molecules/photon for CH_4 while the corresponding final value for CO is about 0.04 molecules/photon. For three last gases the yield shows the very similar behaviour: increasing with surface coverage in beginning and reaching a constant at some high surface coverage, maximum value for large surface coverage above about 10^{19} molecules/cm^2. For surface coverage below 10^{16} molecules/cm^2 the removal coefficients are so small that they could not be distinguished from the desorption of the bare substrate without pre-condensed gas. Strong evidence was found for cracking of CO_2 and CH_4 molecules by the photons. There was found no dependency of studied desorption process on temperatures 5.5 K to 20 K for CH_4, 5.5 K to 15 K for CO and 5.5 K to 68 K for CO_2.

H2p Study of the Hot-Electron Acceleration and Warm-Electron Heating Mechanisms in an ECR Ion Source for High-Brightness Hadron Colliders

M. G. Niimura, A. Goto, and Y. Yano
Cyclotron Laboratory, The Institute of Physical and Chemical Research (RIKEN)
Wako City, Saitama 351-01, Japan

For the future hadron colliders the formation of high-brightness beams is of great importance. The key point of the problem solution is always an ion source with specific requirements to its parameters. For optimization of the total current and normalized emittance achievable by an ECR ion source (ECRIS) injector, a clear-cut information on the distributions and temperatures of the hot and warm electrons inside the ECRIS-nucleus is essential. We have previously reported an internal structure of ECRIS-nucleus which revealed by an analysis of experimental data. The deduced potential profiles were in good agreement with measured one. A shell-like hot-electron layer on the ECR surface was found to be a self-formed ion channel. Present paper discusses on the formation process, characteristic parameters, and role of the shell. We stress that the conventional stochastic model has deficiencies in explaining such as: shell thickness on the order of Larmor radius, shell locations at the harmonics and sub-harmonics of the ECR frequency, rapid formation time of shell, beam-like current-carrying shell, and directions of the rotation of particles in shell. We present numerical results demonstrating the processes of: radial acceleration of electrons by an electrostatic electron (Bernstein) wave propagating at the phase velocity vph, interaction of the trapped particles with the axial mirror magnetic field Bz, and their relativistic energy achievable in a time scale much shorter than the heating time of warm electrons. This collective (field) model can predict the direction of acceleration of the charged particles by vphxBz, and is free from the deficiencies of stochastic theories. The latter-half of this paper will discuss the warm electron heating mechanism where a beam-like rotation of electrons in shell plays an important role. Since the direction of shell current is same to the diamagnetic current in the minimum-B configuration ECRIS, the Bz field is forced to be annihilated inside the shell, thereby heating the core electrons in a time scale equal to the radial diffusion of Bz field. Our numerical results give realistic temperatures of warm electrons to be heated in the time scale of ~10 ms. These knowledges enable one to maximize the extractable heavy ion beam current while minimizing its normalized emittance for a given ECRIS injector, thus upgrading the brightness of hadron collider most effectively and inexpensively.

H3p **Cryogenic Source of Polarized Deutrons POLARIS**

Ershov V.,Fimushkin V.

JINR, Russia

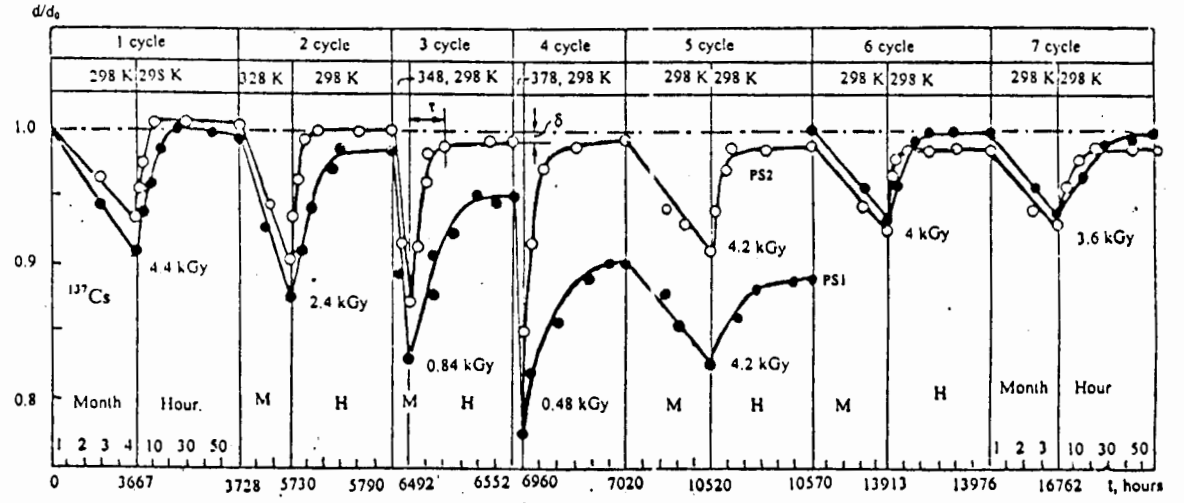
H4p DEPENDENCE OF RADIATION RESOURCE OF DETECTORS ON OPERATING CONDITIONS OF COLLIDER

Zaitsev L.N.

Laboratory of High Energies, Joint Institute for Nuclear Research

Joliot Curie street 6, Dubna 141980, Moscow region, Russia

In this study, the long-term (t = 2 years) cycling irradiation is performed for the first time of solid scintillators with the γ-source ^{137}Cs at $D^{\bullet}$=1.2±0.14 Gy/hr load over the temperature range from 298 to 378 K (see Figure). With the superposition method, the dependence is obtained of the limiting dose $D_{lim} = f(D^{\bullet}, \xi)$, where $\xi \sim 10\%$ - the light loss after irradiation. Coefficients k_3 are calculated for the resource formula: $t_r = k_3 (D_{lim} / D^{\bullet})$, if the D_{lim} is determined from the faster tests at $D^{\bullet} \geq 10^2$ Gy/hr. In the case of LHC radiation loads to the detectors, $10^{-1}...10^{-4}$, the values of k_3 are in the range $2 \cdot 10^{-2}...7 \cdot 10^{-4}$ what is explained by the photoradiation oxidizing. Under irradiation with the breaks, the resource $t_R >> t_r$, but it requires to correlate the sessions and the breaks with the account of collider operation regime and scintillator recovery time. In the frameworks of the present work, at $D_{lim} \leq 4$ kGy the record time of recovery is obtained: the PS2 sample recovers for 104% in 6 hours. This sample is made from PSM-115 by casting under pressure and, for the first time, it contains the anti-oxidants and photo-stabilizers added instead of the anti-rads. Therefore the new two approaches of alternative characters are under development recently: a) radiation exploration of liquid scintillators in a quartz capillary with the periodical refreshment of liquid scintillator; b) investigation of spontaneous recovery after irradiation of solid scintillators with the new adds.



T1i Superconducting Accelerator Magnet R&D in the United States

Peter J. Limon
Fermilab

Increased interest in the United States in a very large hadron collider (vlhc) of 100 TeV center-of-mass energy, and in a muon collider has inspired new work in superconducting accelerator magnets of many types. Development plans and results will be presented for on-going and new work on high-field vlhc magnets at 11 T and 15 T , and on a novel superferric design at 2 T. Some ideas for magnets appropriate for a muon collider will be discussed.

T 2i Permanent Magnets for Beamlines and the Recycler Ring at Fermilab

H.D. Glass,
FNAL, Batavia, IL, USA

Fermilab has nearly completed an upgrade to its accelerator complex which is called the Fermilab Main Injector (FMI). In addition to the FMI ring itself, which is built of standard electromagnets, there are additional components. Two of these components, a beamline used for transporting 8 GeV protons from the existing Booster to the new FMI ring, and a new storage ring for antiprotons, are made using permanent magnets. The storage ring has been named the Recycler because its function is to store leftover p-bars from the previous Tevatron Collider cycle after they have been decelerated to 8 GeV. Both the Recycler and the 8 GeV transfer line use magnets of similar technology. The magnetic material is strontium ferrite, chosen for reasons of economy and high Hc. The temperature dependence of the ferrite is compensated by a Ni(30%)Fe(70%) alloy operating near its Curie temperature. Field quality is provided by steel pole pieces and custom shims. The Recycler Ring requires about 350 gradient magnets, 100 quadrupole magnets, and small numbers of Lambertson and special magnets. Nearly all of the magnets have been built. We present details of magnet design, manufacturing, and testing.

T3i Magnetic Field Measurements in Beam Guiding Magnets

K.N.Henrichsen, CERN

Electromagnets used as beam guiding elements in particle accelerators and storage rings require very tight tolerances on their magnetic fields and on their location along the particle path. This article describes the methods and equipment used for magnetic measurements in beam transport magnets. Short descriptions are given of magnetic resonance techniques, the induction coil methods, the Hall generator and the fluxgate magnetometer. A few of the more exotic methods are briefly mentioned. References of historical nature as well as citations of recent work are given. The present=20 commercial availability of the different sensors and associated equipment is indicated. Finally we shall try to analyze possible future improvements and developments in those fields.

T4i Review of the Power Supplies for electromagnetic systems of the storage rings and accelerators.

A.S. Medvedko
Nuclear Physics Institute, SB RAS, Novosibirsk, Russia.

The Power Supplies (PS) for the systems with warm magnets of the electron -positron storage rings and accelerators are observed. The review presents an experience of INP as in the field of unipolar PS for bending and quadrupole magnets, as for four quadrant operating correcting magnets. The Thyristor and IGBT based PS for the current range of some Amps to some kiloAmps are described and compared. Comparison of the resonant PS systems and their components for electron Synchrotron are discussed. The examples of a special type of the PS - for the Insertion devices - wigglers with elliptically polarized synchrotron radiation light are presented. The PS of this type produce current of the trapezoidal shape with variable frequency of polarity switching.

T 1p THE MAGNETS FOR THE LHC INJECTION TRANSFER LINES

B. Sukhina, V. Mejidzade,
S. Labutsky, A. Sukhanov, I.Chertok, Yu.Pupkov, S.Mikhailov
V. Anashin, A. Bulygin
Budker Institute of Nuclear Physics, 630090, Novosibirsk, Russia

Kouba G., Weisse E., Giesh M.
CERN, CH-1211, Genrva 23 (Switzerland)

Institute of Nuclear Physics during two years take active part in designing of the magnets for the LHC Injection Transfer Lines. Present the main parameters of magnets, plans of work till 2000 and status of business.

T 2p EXPERIENCE OF MASS SCALE PRODUCTION OF KEKB B-FACTORY CORRECTION MAGNETS

P.Durnov, S.Mikhailov, V.Petrov
Budker Institute of Nuclear Physics, Novosibirsk, Russia

M.Masuzawa
KEK High Energy Accelerator Research Organization, Tsukuba, Japan

Correction magnets of four different types for 3.5 and 8 GeV storage rings of KEK B-factory, Tsukuba, Japan, have been designed, manufactured and measured by Budker Institute of Nuclear Physics, Novosibirsk, Russia. The total number of the magnets is 831. The length of the magnets is comparable with the pole-to-pole gap so that the fringe fields contribute a great deal into the field integral. Because of this reason, 3D calculations of the magnets has been performed with the use of MERMAID 3D code taking into account their laminated structure, and the pole shimmes have been designed so as to obtain a homogeneous integral in the aperture. The magnetic measurements performed for all the magnets showed a very good agreement with the calculations. Statistic analysis for the measured parameters of the magnets is also presented in the paper. The reasons of the dispersion are analyzed.

T 3p Double aperture Panofsky lens

I.Meshkov, I.Titkova
JINR, Dubna

The report presents a new focusing element – double aperture lens intended to be used in circular colliders.
The problem of high luminosity achievement in modern circular colliders requires usually separation of the orbits of the colliding beams. It leads to construction of the two independent focusing systems, separated either combined ones. In the last case double aperture lens can resolve the problems of focusing system design and decrease significantly the lens size and power consumption.
Computer simulation of the lens magnetic field distribution performed by POISCR code are presented. Different kinds of magnetic yoke form correction are described.

T 4p THE PECULARITIES OF THE CONCEPTUAL DESIGN OF THE ALICE MUON SPECTROMETER MAGNET INSERTED INTO THE LHC FOCUSING STRUCTURE

A.S.Vodopianov
for the ALICE Collaboration

The conceptual design of the large conventional dipole magnet which will be used as a spectrometer magnet in the ALICE forward muon arm is presented. The magnet consists of the iron yoke and saddle shaped conical coil. The ramping of the dipole will take place during LHC beam acceleration or the superconducting magnetic screen will be introduced into the magnetic field.

T 5p Superconducting Large Aperture Dipoles

Klimenko Evgueny

Kurchatov Institute, Russia

T 6p R&D Activity of IHEP on SC Magnets for Accelerators

Vassiliev L.

IHEP, Protvino, Russia

T 7p RUSSIAN TEMPERATURE SENSORS FOR SUPERCONDUCTING ACCELERATORS

Dedikov Yu.A.[†] and Filippov Yu.P.[‡]

[†]National Scientific and Research Institute for Physical Technical and Radiotechnical Measurements - VNIIFTRI, Cryometrology Department, Mendeleyevo 141570, Moscow Region, Russia

[‡]Joint Institute for Nuclear Research, Laboratory of Particle Physics, Dubna 141980, Moscow Region, Russia

Modern superconducting accelerators require the efficient systems to control the operation characteristics of the cooled devices - magnets, cavities, detectors, etc. - and monitor the thermodynamic state of cryogens with a sufficiently high accuracy. The value of temperature is one of the main parameters to determine the state of cryogen. High energy physics installations usually operate in environments of high radiation fluences and/or magnetic fields at wide temperature ranges.

This report presents the information about four types of Russian commercially available cryogenic temperature sensors for the range of 0.3 to 373 K. They are platinum and rhodium-iron resistance thermometers with the positive temperature coefficient, α, and two types of carbon sensors with the negative α-values: carbon-glass thermometers and TVO-resistors. Metrological installation to calibrate the sensors with the accuracy of about ± 10 mK and better is described: its characteristics corresponds to the International Temperature Scale of 1990. The effects of high intensity cryogenic irradiation and magnetic field on these sensors are presented. The total doses at 77.3 K were more than 10^{16} n/cm^2 and 10^5 Gy at average energy of the fast neutrons of 1 MeV, and maximum magnetic field was about 12 T at 1.5 K. The information concerning multichannel (up to 256 channels and more) measuring system based on ISA-bus and industrial PC, is presented as well. Two variants of multiplexers are considered: cold and warm ones.

T 8p **Nuclotron Cryogenic Thermometry**

Datskov Vladimir

JINR, Russia

T 9p **The stretched-wire measurement system of the magnetic field integrals of a 5-pole wiggler.**

E.A Bekhtenev, E.N. Dementev, M.G. Fedurin,

Budker Institute of Nuclear Physics, Novosibirsk, Russia.

There are presented the results of testing of the system for measurement of the first and second integrals of wiggler magnetic field by the stretched wire with DC current method. The system were used for measurement of characteristics and tuning of a five-pole superconducting wiggler with a 7 T maximum field in its center. Wiggler is on 1.5m long, the chamber aperture is 30x100 mm*mm. One of the main conditions of a correct tuning of a wiggler is that the position of the beam, located at the wiggler center, should not deviate in the entire range of the magnetic field intensity. To provide such measurements three wire position monitors are used. Two of them are placed outside of the wiggler at a distance of about 25 cm from the edges of the magnet poles and at a distance of 1.5 m from the point where the wire is fastened. The third monitor is placed at the wiggler center, where maximun the magnetic field are. The wire-tension force is close to 10N, DC current is equal 2A. For measurement of the wire displacement the inductive monitors are developed. To provide the measurements the wire was excited with an AC current of a 1.2 MHz frequency. The monitors produce a differencal signal, proportional to the wire position in the monitor. The electrical signal from the monitors goes to the synchronous detector and, through an ADC, to the computer. The system makes it possible to measure of the wire displacement in the range of 10 mm with sensitivity not worse than 5 microns.

T10p THE WIRE-OPTICAL METHOD FOR THE HIGH PRECISION ACCELERATOR ALIGNMENT

Ju.Kirochkin

Institute of the High Energy Physics, Protvino, Russia

The wire-optical method for the alignment of the accelerator equipment in plan is described. The method was specially designed for the radial position alignment of the UNK-600 quadrupole lenses. Distance between lenses are 45,9 - 47,5 м, the lenses are placed on the height 2,7 м from the floor. Method ensures a determination of position of magnetic lens centre relative to neighbouring lenses centres with accuracy not more as ±50 μkm r.m.s. Measurements are based on the using of the wire-optical system, including:

- strained wire, as referenc-line,
- special mechanical adjustments for fastening the wire,
- optical instrument on base of level H05,
- the invar bar with scale,
- precise mechanism for fastening the bar to magnetic lenses.

Method was tested on the experimental geodetic line. The order of processing measured data and results of experimental measurements with the evaluation of reaching accuracy are presented.

T11p A SMOOTHNESS CRITERIA FOR TREND CURVES USED IN ACCELERATOR ALIGNMENT.

Yu.A.Pupkov, Yu.I.Levashov

Budker Institute of Nuclear Physics, Novosibirsk, Russia

Abstract

This paper discusses physical aspects of the smooth trend curve application in accelerator alignment and how it will affect the orbit distortion. Emphasis is given to two major questions which concern the relative alignment; "How is relative defined?" and "What is smooth?" An analogy between the orbit distortion, caused by the positioning of accelerator components not on the ideal closed orbit but on the chosen smooth curve, and forced oscillations of a mathematical pendulum, which has a movable point of suspension is drawn. A new term of spectral sensitivity of magnetic structure is introduced. Samples of spectral sensitivity calculations for a few accelerator facilities are presented. Criteria for estimation of the smooth trend curve which would minimize the orbit distortion is suggested.

T12p Synthesis of the pole shape of multipoles by a method of conformal mapping

A.Mytsykov and I.Karnaukhov
National Scientific Centre, "Kharkov Institute of Physics and Technology"
1, Academichna Str., Kharkov, 310108, Ukraine

Considered is a method of designing the pole shapes formed with smooth curves which produces the flat field of required properties. The conformal mapping of area $0 < \mathrm{Im}\,(z) < H$ on a band with any boundaries without intermediate mapping to a half-plane is obtained. The relation of the field Taylor series to the parameters of conformal mapping is derived. Effects of different areas of a pole on the magnetic field distribution is analyzed. The dipole shape providing required field distribution is designed using the conformal mapping.

T13p MAGNETIC FIELD CALCULATIONS AND MEASUREMENTS OF THE FINAL FOCUS ELEMENTS AND BABAR DETECTOR OF THE SLAC B-FACTORY

E.Antokhin, A.Buzykaev, A.Chupyra, D.Fedorov, S.Ganzhur, A.Dubrovin, G.Kolachev, A.Litvinov, A.Medvedko, V.Mikerov, S.Mikhailov, Sh.Singatulin, A.Onuchin, P.Vobly
Budker Institute of Nuclear Physics, Novosibirsk, Russia

L.Keller, J.Krebs, H.Lynch, N.Yu
Stanford Linear Accelerator Center, Stanford, USA

R.Alexan, G.London, Ph.Bourgeois
Saclay laboratory, France

A series of 2D and 3D calculations of magnetic field in the region of final focus quads, in the tracking region, in the DIRC shield, and calculations of the force on the SC coil were performed with the use of MERMAID computer code. The comparison of the magnetic measurement results and those of the calculations is presented.

T14p A 20 kA Test Bench for High-Precision Current Measurements.

K. Dahlerup-Petersen, B. Halvarsson and R. Valbuena
CERN, Geneva - Switzerland.

Abstract:
In order to control and adjust the proton beams in the Large Hadron Collider (LHC), now under construction at CERN, its superconducting dipoles and quadrupoles will require current settings and -adjustments of an unprecedented accuracy. D.C. currents up to 13 kA for the machine and 20 kA for certain experimental magnets will need to be measured and set to an accuracy of a few p.p.m. Compared to the requirements of previous accelerators at CERN, such as the LEP, this is a factor of ten better in accuracy at more than twice the current. State-of-the-art, zero-flux current transducers (DCCT's) from Industry will be used for the precision measurements. However, a thorough evaluation and calibration of transducers from various manufacturers is needed in order to compare, select and optimize the products. It was, therefore, necessary to upgrade the current calibration facility of the existing Standards Laboratory at CERN in order to meet this new metrological challenge.
An important part of the upgrade consisted in the construction of a 20 kA test bed, for which the design criteria were:

-reduction of the stray electromagnetic fields from the busbars carrying the 20 kA in order to obtain field gradients across the transducer coils of only a few Gauss.
-automation of the loading and unloading procedures for the heavy transducer coils into the 20 kA test cell. This point is of major importance, as several hundred transducers will need regular calibration
-provide the possibility to study the influence of the fields from the return bars on the transducer performance, this being important information for the design of busbar arrangements around the DCCT coils of the machine

The test bed consists of a 20 kA, switch-mode power converter, a cell containing the regulation DCCT's of the converter, a 20 kA current inverting switch, a range extender, a cell containing the reference DCCT's, the measuring cell housing the transducers to be tested and a busway for the transport of the 20 kA between the various elements of the installation.
The facility contains different busbar topologies, air- and water-cooled systems, to be studied as possible candidates for the transport of high currents in the LHC collider.
The paper descibes the various phases of the project, from field calculations and design to the final commissioning. Special emphasis is given to the development of the pneumatically operated, automatic, high-current clamps, based on the use of louver-type of contact elements, which transfer the 20 kA between the various busbar systems and the measuring cell. The results of a thermal mapping of the complete installation at operating temperature is given. Finally, operational aspects of the calibration procedure, related to the use of the test bench, is reported.

T15p THE POWER SUPPLY SYSTEM FOR MAGNETIC STRUCTURE OF VEPP-4M STORAGE RING.

V.V.Antonov, A.I.Jmaka, V.V.Kolmogorov, A.S.Medvedko, S.I.Neskredov, S.P.Petrov, V.G.Popov, V.V.Svishov, V.F.Veremeenko, E.I.Zagorodnikov, Yu.V.Zarudnev.
BINP, Novosibirsk, RUSSIA.

Abstract

The magnetic system structure of VEPP-4M storage ring includes a lot of different types electromagnetic elements. Here we have bending magnets, quadrupol, sextupol and octupol lenses, correcting windings and so on. Currents needed for this elements are in range from 1 A to 6 kA, powers - from 10 W to 400 kW.

In this report several types of designed in BINP precision power supplies are described.

DC motor-generator is used for supplying of bending magnets. Thyristor power supplies named as IST supply electromagnetic elements with current up to 2.5 kA and with power up to 100 kW. Thyristor power supplies V-1000 are used for supplying of elements with current up to 1000 A with power up to 15 kW. Thyristor bipolar four quadrant supply TIR-25 is designed for supplying of sextupoles, octupoles and correcting windings with current up to 25 A and voltage up to 200 V. Several quadrupol lenses in two families wich are supplied by two ISTs are separately adjusted in diapason up to 100 A by special transistor controlled shunt system. Transistor bipolar power supplies with pulse-width modulation UM-4 provide output current up to 10 A with output voltage up to 20 V and are uzed for feeding of big amount of orbit correctors. Power supplies provide stabillity of output current in range from 0.1% to 0.001%. Total number of power supplies is up to 250. All of them are controlled and checked by VEPP-4M computer system. Number of control channels is 250, number of measurement channels is about 600.

T16p THE POWER SUPPLY SYSTEM FOR THE LIQUID LITHIUM LENS FOR THE FNAL ANTIPROTON SOURCE.

B.F.Bayanov, A.D.Chernyakin, V N.Eschenko, G.I.Silvestrov.
BINP, Novosibirsk, RUSSIA.

Abstract.

For collection of antiprotons the cylindrical liquid lithium lens is designed having 2 cm diameter and 13 T magnetic field on the surface. In this report the pulsed generator for the lens supply is described. Generator has the folowing parameters: output current up to 1 MA, pulse duration 300 microseconds, energy per pulse up to 50 kJ, repetition frequency up to 2 Hz. Generator consists of a capacitor battery for 50 kJ energy store, a thyristor switch for current up to 100 kA, a matching toroidal cable-type transformer and a system for the capacitor battery charging by the constant power.

BD BEAM DIAGNOSTCS

BD1i Development of Nanometer Resolution RF-BPMs and Accelerator BPMs

T. Shintake,

KEK, Japan

BD2o A new wide band time normaliser circuit for bunch position measurements with high bandwidth and wide dynamic range

C.Bovet, D.Cocq, H.Schmickler, G.Vismara

Trajectory and closed orbit measurements are vital for commissioning and operation of accelerators. With the push for high luminosities at modern colliders, the azimuthal bunch distribution becomes very complex, so that various phenomena (beam-beam forces, wakefields) strongly affect the orbits of individual bunches. Hence a system with high bandwidth capable of measuring the transverse position of any bunch is desirable. With the current techniques a bandwidth above 100 MHz can only be achieved by individual integration and digitisation of the pick-up signals. The drawback of such an approach is the limited dynamic range of typically 30 dB.

In the context of the development of an orbit system for LHC at CERN a high bandwidth could be achieved by extending the principle of phase normalisation to a wide band time normalisation of the position monitor signals. The circuit described in this paper combines the signals of two pick-up electrodes with different delays and converts the beam position information into a pulse width modulation of the digital output signal. This way a bandwidth of 40 MHz and a dynamic range of about 50dB could be achieved.

The paper describes the working principle of the wide band time normaliser including test measurements obtained at LEP and its application to the LHC and other future high energy accelerators.

BD3o SOFTWARE FOR CONTROL THE BETATRON PARAMETERS OF THE DESY HEPA PROTON RING.

S.Herb, C.Luttge (DESY, Germany)

L.Kopylov, M.Mikheev, S.Merker (IHEP, Russia)

Betatron parameters are critical for superconducting ring operation due to strong eddy current effects at the injection level. A set of applications has been developed to measure and control betatron tune, chromaticity and coupling. A DSP card is used for signal processing allows up to 8Hz tune refresh period. For realistic estimation of eddy current effects the data from on-line magnet measurements is used in chromaticity calculation. The physical model and implementation aspects are described.

BD4oMATCHING AND USE OF DIPOLE WIGGLERS IN VEPP-4M TO CONTROL BEAM PROPERTIES AT LOW ENERGY RANGE OF OPERATION

V.A. Kiselev, S.A. Nikitin, I.Ya. Protopopov

Budker Institute of Nuclear Physics SB Russian Academy of Sciences,
Novosibirsk, 630090, Russia

A start has been made on the performance of physical experiments with the new detector KEDR at the modified storage ring VEPP-4M. Now we are looking for possibilities to measure the full section of annihilation e^+e^- into hadrons in the energy range from 0.7 GeV to 1.8 GeV which is of interest for our physicists. This energy range is not typical of the VEPP-4M, so here additional investigations are conducting in order to achieve an reasonable luminosity. In this connection, some experimental and calculation data on using the wigglers with the field up to 2 Tesla at the low energy range of the VEPP-4M operation are discussed. Two "warm" wigglers, each involving three magnets with the total length about of 1 m, are located on the opposite sides of the experimental section at the no zero-dispersion straights. They unacceptably disturb focusing peculiarities and the closed orbit in the whole ring with lowering the energy so the special procedure has been developed for matching the magnetic structure. According to calculations based on consideration of radiation effects, the wigglers, in particular, with the maximal field at E=1 GeV, increase the radiation decrements in 5 times, the radial emittance in more than 20 times and the energy spread in some 3 times. In practice, our wigglers allows to enhance in several times the threshold current determined by the TMC instability of a beam being injected from the booster VEPP-3. As follows from the calculations and experiments performed, the dipole wigglers in full measure ensure the damping of radial betatron oscillaltions at energies about of 1 GeV per se (usually, in VEPP-4M two dipole-gradient damping wigglers serve for this goal). The results of theoretical and experimental studies of the dependence of longitudinal and transverse beam sizes on wigglers' strength and energy of particles are presented. Here the intrinsic scattering (Touschek) effect has been taken into account in calculations since it sufficiently affects the beam properties in the energy range mentioned.

BD 1p BEAM POSITION MEASURING SYSTEM OF THE MICROTRON INJECTOR

Batrakov A.M., Shilo V.V., Shubin E.I., Zinevich N.I.

Budker Institute of Nuclear Physics (BINP), Russia

The described system is intended for the injector of the microtron-recuperator for Free Electron Laser . The injector can operate with repetition frequencies up to 22.5 MHz. The system measures beam position in four points of the vacuum tube. The method used is based on simultaneous measurement of pulse signal amplitudes from four electrodes of the selected pickup with following digital processing to obtain the beam position. The beam position can be measured with resolution of ~0.1 % of the injector vacuum chamber half aperture.

BD 2p MAGNESIUM JET PROFILE MONITOR

V.V. Parkhomchuk, B.M. Smirnov, V.I. Kudelainen, V.S. Tupikov, A.V. Bubley

Budker INP 630090, Novosibirsk ,Russian Federation

The Mg-jet profile monitors are designed and manufactured in BINP.

Measurement of a particles beam density cross structure in accelerators allows to make set-up of optimum mode operations for accelerator systems and internal target. The basic advantage of a described magnesium jet profiler is a combination of high sensitivity and weak influence of a spatial beam charge on the coordinate resolution. It is reached by that a thin jet of magnesium atoms is used, and density of a flow can be adjusted in large limits by rather small temperature change of the evaporator from 400^{O} up to 450^{O} centigrade degrees (it is possible also to increase temperature up to 520^{O}, that is determined by a level of vacuum and quantity of residual gas). The neutral atoms are not sensitive to electrical fields and by that there is no need in electron-optical image during collection and measurement of electrons created by ionization. The election-optical system should just direct electrons onto luminophor and measure it's light emission. Such system allows to measure small currents down to several electrons per second, that allows to measure a structure of a beam with currents about 0.1 μA.

BD 3p STREAK CAMERA FOR MEASUREMENTS OF PARTICLE BEAM DYNAMICS

V. K. Chevokin, V.A. Podviaznikov

Institute of General Physics, Russian Academy of Sciences

38, Vavilov Str., Moscow B-333, Russia

V. N. Shaliapin, S. I. Tiutiunnikov

Joint Institute for Nuclear Research

141980 Dubna, Moscow region, Russia

The streak camera for investigations on the synchrotron radiation of the electron bunch and on the radiation connected with electron bunch in FEL structure was developed. This device has time resolution of 5 psec and spatial resolution of 20 lines per mm. The low noise videocamera is used for reading optical picture from brightness amplifier.

BD 4p WIDE-RANGE BEAM CHARGE AND CURRENT MEASURING SYSTEM FOR BEAM LINE OF EXPERIMENTAL COMPLEX OF MMF

P.I.Reinhardt-Nickoulin, S.E.Bragin,
V.K.Gorbunov, M.I.Grachev

Institute for Nuclear Research of the RAS, 117312, Moscow, Russia

Low-noise measuring system for beam charge and current monitoring based on current transformer with ferrite core is developed. It is used for proton beam control in beam line of Experimental Complex of Moscow Meson Factory. The system can operate in wide range of beam pulse amplitude and duration. Special method of signal filtering and data processing resulted in low-frequency noise immunity and high accuracy of measurements. Accuracy of charge measurements equals 0.15 pC at pulse duration 1 micro-second, accuracy of pulse current measurements equals 50 nA at pulse duration 50 microseconds. Essential features of hardware, software, data acquisition and beam results are presented.

BD 5p Precise Emmittance and Measurements in the HERA Transport Lines

Wittenburg Kay,

DESY, Germany

3D 6p DATA PROCESSING FOR TURN-BY-TURN BEAM POSITION MONITOR

V.V.Smaluk
Budker Institute of Nuclear Physics
Novosibirsk, 630090, Russia

ABSTRACT

A computer program to analyze the data, obtained by turn-by-turn beam position monitor (BPM), has been developed. For the program, the input data are four arrays of the BPM signals. The program described is a set of data processing algorithms developed for various beam diagnostic problems of storage ring. They are: plotting of beam current and coordinates; fine spectral analysis of betatron and synchrotron oscillations; phase space diagram of non-linear betatron motion; statistical and spectral analysis of slow beam vibrations; integral and spectral resolutions of the BPM itself; etc. The program can be used also for processing beam motion simulation data to compare the diagnostic results of a real motion and its models. Such data are used for testing the algorithms too. The program operates in Microsoft Windows environment. Ample scope for beam diagnostics, offered by the program with its numerous service options is illustrated by examples of the program application at the VEPP-4M storage ring.

FB1i FEED - BACK AND EMMITANCE CONTROL

I.N. IVANOV

Joint Institute for Nuclear Research, Dubna

The feed-back system are needed at all modern accelerators and colliders for high energy due to strong requirements on emmitance grown. The review such systems are presented. Possible ways of development feed-back system discussed. Particular attention will devote to a more ambition recent project - LHC and RHIC.

FB2o DECOHERENCE FROM SPACE CHARGE

L. Vos, CERN, Geneva, Switzerland

Abstract

The theory of the Laslett direct space charge effect is well established since many years. Nevertheless, the fact that transverse coherent tune shifts and decoherence of transverse oscillations have been attributed to direct space charge, by lack of other explanations, is the origin of a lasting controversy. The observed decoherence in the CERN SPS and the expected decoherence in the CERN LHC has such profound consequences for the construction of transverse feedback systems that lifting the controversy has an interest that is more than purely academic. A collection of beam observations is presented concerning tune shifts and decoherence where the space charge effect is eminent. A physical model is proposed from which tune shifts and decoherence can easily be derived. The computation can not only be applied to machines where the effect is modest but not negligible, as the SPS and the LHC, but also to the CERN PS Booster where the effect is massive.

FB3i PHASE-FREQUENCY BEAM FEEDBACK SYSTEM IN THE UNK

S. Ivanov
Institute for High Energy Physics, Protvino, Moscow Region, 142284, Russia

The paper presents a design proposal of phase-frequency beam feedback at RF 200 MHz for the IHEP's 600 GeV UNK PS project. A cascade connection of a length-4 periodic notch filter followed by an ideal integrator (VCO) makes the core of the system. Overall path response is tailored to acquire first- order zero at fundamental RF (an AC-coupled feedback), and second-order zeros at other integer harmonics of rotation frequency. The latter is of utmost importance to ensure non- saturation of electronics since the UNK PS is to operate at a very small revolution frequency (around 14 kHz), being overloaded by heavy 'unequal-bunch' frequency lines due to partial orbit filling by bunch trains. The paper also addresses to other topics crucial to design of the feedback: (1) feasible damping rates of the beam barycentric mode, (2) non-excitation of parasitic modes due to inherent delays in finite-length impulse response (FIR) filter itself, and (3) safety margins against self-excitation of beam higher within- bunch multipole and coupled-bunch azimuthal modes.

FB4o THE BUNCH-BY-BUNCH TRANSVERS FEEDBACK SYSTEM AT VEPP-4M

G.V.Karpov, V.A.Kiselev. N.I.Zinevich

Budker Institute of Nuclear Physics, Novosibirsk, Russia

In this paper the bunch-by-bunch transvers feedback system for suppression fast head-tail and coupled bunch instabilities is described. The experimental results of the feedback affecting the current threshold are presented. The effects of the reactive and resistive feedbacks on the current threshold are discussed.

FB1p TRANSVERSE FEEDBACK WITH A DELAY-LINE NOTCH FILTER

S.Ivanov
Institute for High Energy Physics, Protvino, Moscow Region, 142284, Russia

Within frames of digital signal processing, a finite-length impulse response (FIR) filter based on digital delay lines (registers) serves as a basic tool to shape out overall response of a feedback circuit. Proceeding from impedance approach to a transverse beam feedback in a synchrotron, the paper exposes a way to set parameters of low-level signal processing for a system with one pickup and one kicker per direction. Formulae are given for FIR filter summation weights which ensure its compliance with the three practically important requirements: (1) to allow for an arbitrary pickup- to-kicker betatron phase advance, (2) to introduce a pure quadrature phase shift at betatron side-bands (i.e., no real coherent tune shift via feedback), and (3) to reject a common- mode signal due to closed-orbit distortions (first-order zero in response at rotation frequency harmonics for a length-3 filter or, alternatively, second-order zero for a length-4 filter). The approach is illustrated by technical details of a proposal to upgrade transverse feedback in IHEP's 70 GeV PS.

FB2p **THE STANDING WAVE TYPE KICKER FOR A LONGITUDINAL FEEDBACK SYSTEM.**

D.P. Sukhanov, N.I. Zinevich
Budker Institute of Nuclear Physics (BINP), Russia

In this paper the kicker for longitudinal bunch by bunch feedback system for KEKB is described. The kicker is of a coaxial transmission line design employing standing wave type regime. The description of the kicker construction, the calculation and measurement results of the shunt impedance and operating frequency bandwidth are presented. The shunt impedance of ~1000 Ohm for the bandwidth of 250 MHz at the operating central frequency 1 GHz is obtained.

FB3p **Damping Parameters of a Transverse Feedback System with a "Bang-Bang" Transfer Function**

V.M.Zhabitsky
Joint Institute for Nuclear Research, Dubna, Russia

A theory for obtaining damping parameters of a transverse feedback system with a "bang-bang" transfer function is described. For this system the dependence between the kick and the beam deviation at the pick-up location is a nonlinear function. This transfer function consists of a linear part for small amplitude oscillations and a high fixed level gain for large oscillations. The "bang-bang" regime was realised at the SPS (CERN) to increase the efficiency of its transverse feedback system. The beam dynamic equation of the transverse coherent motion for deviation from the closed orbit has been obtained. This nonlinear equation has been solved using Krylov-Bogoliubov method. The damping time and asymptotic behaviour of the beam oscillation amplitude are analysed for different parameters of the "bang-bang" transfer function.

PC PARTICLE BEAM COOLING

PC1i Stochastic Cooling in Hadron Colliders

D. McGinnis,

FNAL, USA

PC2i ELECTRON COOLING OF HADRONS IN GEV ENERGY RANGE

V. Parkhomchuk

Budker Institute of Nuclear Physics, Novosibirsk, 630090, Russia

The electron cooling used for accumulation beams and shrinking emittance of ions: from p up to uranium ions. Today using limited relativly small ions beam energy 1-200 MeV/n. At this report are discussed the different variant the system of electron cooling for high energy beams. The results of study using of electron cooling for project Electron Ion Collider are present. The limitations of beam parameters and possible problem discussed.

PC3o ELECTRON COOLING FOR THE FERMILAB RECYCLER

Sergei Nagaitsev
Fermi National Accelerator Laboratory
Batavia, IL 60510 USA

Although electron cooling has become a routine tool in many laboratories, its use has been restricted to lower energy accelerators (< 500 MeV/nucleon). Fermilab has undertaken a development program in high energy electron cooling focused on accumulating 8 GeV antiprotons in a new storage ring following the present Accumulator. The ultimate goal is to realize a luminosity of 10^33 cm^-2 s^-1 in the Tevatron collider. This new ring called the Recycler will be mounted in the tunnel of the Main Injector, which is now under construction.

Electron cooling of 8 GeV antiprotons requires high-quality dc electron beam of 4.5 MeV energy and current as high as one ampere. It will also require non-traditional approaches to the electron beam transport and confinement. This paper describes the electron cooling system design as well as the status of the Fermilab electron cooling R&D program.

PC4o Electron Cooling with Circulating Electron Beam in GeV Energy Range

I.Meshkov
Joint Institute for Nuclear Research
141980, Dubna, Russia

An application of traditional scheme of electron cooler to cooling of heavy particles of a few GeV energy meets, obvious problems of generation of high intense electron beams at energy of several MeV. One can avoid these problems using an electron beam circulating in a storage ring. This method of cooling technique has own limitations considered in the presented report, particularly - the "thermocapacity" of cooling electron beam.
So called "modified betatron" is one of possible schemes of the storage ring with cooling electron beam. Its application to the electron cooling is considered here. Combination of the ring with an injector provides an added bonus.

PC1p Modified Betatron Prototype Dedicated to Electron Cooling with Circulating Electron Beam.

M.Chelnokov, V.Kalinichenko, Yu.Korotaev, I.Meshkov, S.Mironov, A.Petrov, I.Sedykh, A.Sidorin, A.Smirnov, E.Syresin, I.Titkova, G.Trubnikov

A possibility of the application of the electron cooling system with circulating electron beam to cool down antiprotons in Fermilab Recycler is considered. In this system the Recycler ring is equipped with an additional electron one, which is periodically filled up with new portion of cold electrons. The electron beam circulates in longitudinal (quasitoroidal) magnetic field, and the long term stability of the beam is provided with additional spiral coils, which forms a quadrupole electric field. The acceleration of the electron beam without the distortions caused by RF system of linear accelerators is achieved by using of induction acceleration. Prototype of this system, called «modified betatron», is under construction in JINR now. General parameters of the prototype are presented. Ring circumference is 18 m, longitudinal magnetic field value is 1 kG, maximum electron current value is 0.5 A.

PC2p The stability of the circulating electron beam in the electron cooling system based on the modified betatron.

I.Meshkov, A. Smirnov, A. Sidorin, E. Syresin, JINR, Dubna
E. Mustafin, P. Zenkevich, ITEPh, Moscow

The electron cooling system with an circulating beam is considered for the cooling of ions with energy of few GeV [1]. The prototype of the electron cooling system on the base of modified betatron is developing in JINR for the cooling of antiprotons in Recycler ring (Fermilab). The peculiarities of the modified betatron are its section structure, the longitudinal guiding magnetic field and the quadrupole spiral coils. The longitudinal magnetic field leads as to the electron magnetization and long life time of the circulating electrons in the modified betatron as to the strong relation between horizontal and vertical degrees of freedom and to additional resonances.

The stability of the circulating beam with the low temperature is investigated in this paper. The different lattices of the modified betatron are considered. The dynamics of particles is analyzed and the angular characteristics of the electron beam are calculated here.

XVII International Conference on High Energy Accelerators

HEACC'98

XVII Международная конференция по ускорителям высоких энергий

E9-98-230

Ответственная за подготовку сборника к печати Е.Э. Ширкова

Макет Н.А.Киселевой

Рукопись сборника поступила 04.08.98. Подписано в печать 11.08.98
Формат 60 × 84/8. Офсетная печать. Уч.-изд. листов 10,59
Тираж 300. Заказ 50845. Цена 12 р. 75 к.

Издательский отдел Объединенного института ядерных исследований
Дубна Московской области