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ABSTRACTS BROCHURE

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Introduction

Welcome to the XXth Russian Conference on Charged Particle Accelerators (RuPAC 2006) in Novosibirsk, Akademgorodok!

Novosibirsk is called the capital of Siberia. It is the biggest city in the area between the Urals and the Pacific Ocean and is the third largest city in Russia after Moscow and St.Petersburg with a population of about 1,4 Million people. Novosibirsk was founded in 1893. It is located on both sides of the Siberian river Ob and its history is closely connected with the building of the Trans-Siberian railroad Moscow-Vladivostok. Today Novosibirsk is an important industrial, agricultural, transport, cultural and scientific center. The city has the biggest Siberian modern airport Tolmachevo, a river port and railway station.

Akademgorodok - a part of Novosibirsk is a world-known scientific center. Akademgorodok-the Siberian city of science - is 40 kilometers south of the center of Novosibirsk. It was founded in 1957 and was intended to be an interdisciplinary research center. Physicists, chemists, mathematicians, archaeologists, electronics specialists, philosophers, geologists and geneticists are its residents. Akademgorodok is an agglomeration of a large number of scientific and educational institutions: Novosibirsk State University, one of Russia's three leading universities, Physics-Mathematics School, Higher College of Informatics, fifty scientific research and design institutes of Siberian Branch of Russian Academy of Science are among them. Most of research Institutes are located along Lavrentiev Prospect - the street was listed in the Guinness Book of World Records as the most scientific street in the world.

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CONTENT

PLENARY SESSION

Plenary session: Modern trends of accelerator development, large accelerator design, colliding beams

D.Kraemer (GSI, Germany)

FAIR - An International Facility for Antiproton and Ion Research

An international facility for antiproton and ion research - FAIR - will be built on the GSI site during the years 2007 to 2014. The Baseline Technical Report has been worked-out. This unique accelerator complex will provide high intensity primary and rare ion beams, ranging from anti-protons up to uranium for nuclear- and astrophysics studies, plasma and atomic physics, applied physics and fundamental studies. The paper will give an overview on the present R&D activities and on the status of the project.

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I.Syratchev (CERN, Switzerland)

Status of a 3 TeV Compact Linear Collider (CLIC)

The current progress of the CLIC program will be reviewed. The resent experimental results of the CLIC Test Facility (CTF3) operation will be presented.

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A.Valishev (FNAL, USA)

Tevatron Collider Status and Plans

Tevatron is currently the world's highest energy collider operating at 980 GeV per beam. Peak luminosity attained during the collider Run II is 1.7×10^{32} cm^{-2} s^{-1}. In this report a summary of the collider performance is presented, accelerator physics issues and future plans are discussed.

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D.Prasuhn (IKP – FZ, Juelich, Germany)

From COSY to HESR

The High Energy Storage Ring proposed at the FAIR project will extend the hadron physics regime beyond the energy regime of COSY. Experiments for optimum cooling scenarios in the HESR and their modeling can be tested easily at COSY, where electron and stochastic cooling are in operation.

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Yu.Shatunov for VEPP-2000 Team (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Status of VEPP-2000 Project

The new electron-positron collider VEPP-2000 with beam energy E=1 GeV and luminosity $L=10^{32}$ $cm^{-2}s^{-1}$ is under construction at Budker Institute of Nuclear Physics. The report describes main features of machine optics and magnetic and RF elements design. First results of the machine commissioning are given.

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Ya.Derbenev (Jefferson Laboratory, USA)

The Concepts for ELIC- a High Luminosity CEBAF based Electron-Light Ion Collider

A CEBAF accelerator based electron-light ion collider of c.m. energy from 20 to 65 GeV and luminosity from 10^{33} to10^{35} cm^{-2} s^{-1} with both beams polarized is envisioned as a future upgrade to CEBAF. The concept of luminosity of ELIC has been established based on high energy electron cooling (HEEC), short ion bunches, very strong focus at interaction point, use of crab-crossing as a way to achieve very high bunch collision rate, and stacking an intense polarized ion beam while overcoming the space charge at injection to booster. Two steps upgrade scenario is under study: CEBAF accelerator-ring - ring scheme as the first step, and a multi-turn ERL - ring as the second step, to attain a better electron emittance and maximum luminosity. The spin polarization of both beams and HEEC schemes will be discussed and illustrated, and numerical examples will be presented.

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A.Aleksandrov (Oak Ridge National Laboratory, USA)

Spallation Neutron Source Project: Commissioning Results, First Operation Experience, and Upgrade Plans

The Spallation Neutron Source accelerator systems will deliver a 1.0 GeV, 1.4 MW proton beam to a liquid mercury target for neutron scattering research. The accelerator complex consists of an H- injector, capable of producing one-ms-long pulses at 60Hz repetition rate with 38 mA peak current, a 1 GeV linear accelerator, an accumulator ring and associated transport lines. The 2.5MeV beam from the Front End is accelerated to 86 MeV in the Drift Tube Linac, then to 185 MeV in a Coupled-Cavity Linac and finally to 1 GeV in the Superconducting Linac. With the completion of beam commissioning, the accelerator complex began operation in June 2006. Commissioning results and first operation experience will be presented. A plan is being developed to increase beam power up to 3MW. Parameters, design and status of the SNS Power Upgrade Project will be presented.
ORNL/SNS is managed by UT-Battelle, LLC, for the U.S. Department of Energy under contract DE-AC05-00OR22725

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Ya.Derbenev , R.P.Johnson (Muon Inc., USA)

Advances in Beam Cooling for Muon Colliders

A six-dimensional (6D) ionization cooling channel based on helical magnets surrounding RF cavities filled with dense hydrogen gas is the basis for the latest plans for muon colliders. The helical cooling channel (HCC) has solenoidal, helical dipole, helical quadrupole, and helical sextupole magnetic fields, where emittance exchange is achieved by using a continuous homogeneous absorber. Momentum-dependent path length differences in the dense hydrogen energy absorber provide the required correlation between momentum and ionization loss to accomplish longitudinal cooling. Recent studies of 800 MHz RF cavities pressurized with hydrogen, as would be used in this application, show that their maximum gradient is not limited by the required external magnetic field, unlike vacuum cavities. Two new cooling ideas, Parametric-resonance Ionization Cooling and Reverse Emittance Exchange, will be employed to further reduce transverse emittances to a few mm-mr, which allows high luminosity with fewer muons than previously imagined. We describe these new ideas as well as a new precooling idea based on a HCC with z dependent fields that is being developed for an exceptional 6D cooling demonstration experiment. The status of the designs, simulations, and tests of the cooling components for a high luminosity, low emittance muon collider will be reviewed.

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VEPP-4M Status Report

An electron-positron collider VEPP-4M is under operation now at BINP. The main goal of the present run is the precise measurement of mass of ψ-family resonances and τ-lepton with the help of resonant depolarization technique. The status and recent results of the experiment are reviewed.

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Status of VEPP-5 Injection Complex

The present status of VEPP-5 Injection Complex is presented. The results of VEPP-5 positron source operation are discussed.

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International Linear Collider: status of international mega-project and proposal of siting in Dubna region

Low Energy Particle Toroidal Accumulator LEPTA with focusing by longitudinal magnetic field was launched in September, 2004. That time first circulating electron beam was achieved in the installation. Results of testing the storage ring focusing system with electron beam are presented in the article. Effects which define beam lifetime in the accumulator are discussed. This work is supported by RFBR grant 05-02-16320.

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Plenary session: SRS and FEL

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Status of the Novosibirsk High Power Terahertz FEL

The first stage of Novosibirsk high power free electron laser (FEL) was commissioned in 2003. It is based on the normal conducting CW energy recovery linac (ERL). Now the FEL provides electromagnetic radiation in the wavelength range 120 - 230 micron. The maximum average power is 400 W. The minimum measured line width is 0.3%, which is close to the Fourier-transform limit. Four user stations are in operation now. Manufacturing of the second stage of the FEL (based on the four-turn ERL) is in progress.

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Status of the 1.5 GeV Synchrotron Light Source DELTA and Related Accelerator Physics Activities

The University of Dortmund, Germany is operating the 1.5 GeV storage ring based synchrotron light source DELTA. The machine is operated at 3000 h/year, 2/3 for dedicated synchrotron radiation research at 6 beamlines and 1/3 for machine dedicated accelerator physics research. Education and training of students of undergraduate and graduate level is a major task of the facility. Nominal beam parameters at 1.5 GeV are: beam current 120 mA, lifetime ~8 h, emittance 20 nm rad. Two undulators and a superconducting multipole wiggler serve as insertion devices. The paper will cover the present status of machine, beamlines and operation and will give an overview on accelerator related research activities. Presently the prototype of a 500 MHz higher order mode damped cavity, developed in the framework of an EU-collaboration under the leadership of BESSY, Berlin, is installed and tested. Other topics addressed will be the operation experience with the 5.5 Tesla superconducting wiggler, the implementation of turn by turn diagnostic tools for quick instability analysis and progress concerning orbit control and stabilization.

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The accelerator complex work in Kurchatov Center of Synchrotron Radiation

An electron-positron collider VEPP-4M is under operation now at BINP. The main goal of the present run is the precise measurement of mass of ψ-family resonances and τ-lepton with the help of resonant depolarization technique. The status and recent results of the experiment are reviewed.

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Numerical simulation of nonlinear effects in Volume Free Electron Lasers (VFEL)

First lasing of Volume Free Electron Lasers (VFEL) in mm wavelength range was obtained recently (NIM A483 (2002) 21). Theoretical investigations show that it is one of the effective schemes with volume distributed feedback (VDFB). In VFEL operation the linear stage quickly changes into the nonlinear one where most of the electron beam energy is transformed into electromagnetic radiation. A detailed numerical analysis of this stage is necessary for experiment design, optimal geometry determination and result processing. We proposed a mathematical model and numerical methods for VFEL modeling (Comp. Math. Math. Phys. 45(2005) 666). They are implemented in computer code VOLC (Math. Model. Anal. 11 (2006) 13). Different VFEL geometries are investigated in light of future experiments on VFEL device at INP. VFEL is analyzed as a dynamical system. Bifurcation points corresponding to transitions between different regimes of generation are considered. Dependence on position of bifurcation points on geometry of VDBF and other VFEL parameters are analyzed.

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V.Sajaev for the APS study team (ANL, USA)

X-ray slicing and compression using deflecting cavities in the Advanced Photon Source: a feasibility study

Conventional third-generation light sources can provide radiation pulses with duration of the order of 100 ps. However, there is growing interest within the synchrotron radiation user community in performing experiments with even shorter x-ray pulses. It was recently proposed by A. Zholents et al. to use rf orbit deflection to generate sub-ps x-ray pulses. In this scheme, two deflecting cavities are used to deliver a longitudinally dependent vertical kick to the beam, thus exciting longitudinally correlated vertical motion of the electrons. This makes it possible to spatially separate the radiation coming from different longitudinal parts of the beam. An optical slit can then be used to slice out a short part of the radiation pulse, or an asymmetrically cut crystal can be used to compress the radiation in time, or coordinate-time correlation in the x-ray pulse can possibly be used for time-dependent measurements. In this paper we present a feasibility study of this method applied to the Advanced Photon Source. We find that the pulse length can be decreased down to a 1 ps range using superconducting deflecting cavities.

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Status of Metrology Light Source in Berlin

For more than 25 years, the Physikalisch-Technische-Bundesanstalt (PTB) uses synchrotron radiation at the storage rings BESSY I and II for photon metrology in the spectral range of UV to x-rays. Since decommissioning of BESSY I (1999), there is a gap in the spectral range of UV and EUV wavelength due to the higher electron energy of BESSY II. Thus, in 2003, the Metrology Light Source (MLS), an electron storage ring of low energy, was approved as central instrument in the future Willy Wien Laboratory (WWL). Design, construction and operation of the MLS are realized by BESSY, based on the PTB requirements for a permanent accessible radiometry source, optimized for the spectral range between UV up to VUV. The MLS is tuneable in energy between 200 MeV and 600 MeV, designed for currents between 1pA up to 200mA. Civil construction of WWL in the close vicinity to BESSY is nearing completion. The assembly of the MLS is running, commissioning of the 100MeV Microtron is scheduled for summer 2006, while commissioning of the storage ring will start in spring 2007. Regular user operation will begin in January 2008. A status and an overview on the construction of the MLS are given.

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A.P.Potylitsyn, L.G.Sukhikh, A.V.Kostousov (Tomsk Polytechnic University, Tomsk, Russia); J.Urakawa, A.Aryshev (KEK, Tsukuba, Japan).

Generation of soft X-ray pulse using Thomson scattering of coherent diffraction radiation by a short electron bunch

The processes of generation of coherent diffraction radiation (CDR) by a short electron bunch of 45-MeV S-band electron accelerator and it's Thomson scattering on one of the subsequent bunches have been simulated. Backward CDR is emitted when electron bunch with population and length passes in a vicinity of a conducting target along the direction of specular reflection. In the wavelength region all electrons in a bunch emit coherently and CDR intensity becomes proportional to the square of a bunch population. For a target with inclined angle 45^o CDR beam may be extracted from the accelerator chamber at right angle to an electron beam. For this geometry we calculated CDR spectral-angular distributions from concave targets with different profiles which allow to focus radiation at different distances. If the direction of specular reflection coincides with electron path it is possible to use a concave target with a focal distance providing the maximal overlapping of CDR pulse and a subsequent electron bunch. In this case one may obtain hard radiation in forward direction for the photon energy range as a result of Thomson scattering. The yield of hard photons is proportional to [1]. For the following accelerator parameters [2]: Beam energy - 45 MeV; Charge/bunch - 500 pC; Beam emittance - 3 mm mrad; Bunch length - 0.3 mm. we estimated the efficiency of considered schemes for obtaining of radiation and soft X-ray radiation (eV) with duration ps.
REFERENCES [1] A.P. Potylitsyn, Physical Review E, vol. 60, 1999, p. 2272. [2] H. Koichiro et al., Nucl.Instrum. and Methods A, 2006 (to be published).

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Plenary session: Superconducting accelerators and cryogenic technology

N.A.Mezentsev (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Superconducting magnets for SR generation in Budker INP: the status of works

The synchrotron radiation (SR) user's community in their requirements moves ahead to more rigid SR spectrum and to higher photon flux density. Performance of these requirements on SR sources with electron energy of 1-3 GeV is carried out by simple and cheap enough way – installation of superconducting shifters and multipole wigglers with high magnetic field. Besides there is an opportunity of replacement of normal conducting bending magnets on superconducting ones with magnetic field up to 8.5 Tesla, that essentially expands spectral range of radiation. Parameters of the superconducting magnetic systems made in Budker INP for the SR centers in the world are resulted. Consumer SR properties from these devices are discussed.

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Investigations concerned with development of SC dipole for the SIS 300 accelerator

GSI, Darmstadt, is planning to build FAIR (Facility for Antiproton and Ion Research). This facility will include the SIS300 stage, a fast-ramping heavy ion synchrotron with a rigidity of 300 T-m, based on 6-T, 100-mm coil aperture superconducting dipoles, ramped at 1 T/s. This article presents investigations concerned with development of the SC dipole for the SIS 300 accelerator. Measured characteristics of the most suitable steels for the iron yoke as well as of superconducting cable are presented. The results of a study of experimental and calculated differences between straight and bent dipole coils are shown. Optimization of geometries from the viewpoint of magnetic and mechanical characteristics was carried out.

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D.Kayran, V.N.Litvinenko, I.Ben-Zvi (Brookhaven National Laboratory, USA)

Status of High Current R&D Energy Recovery Linac at Brookhaven National Laboratory

We present the design and the parameters of a small test Energy Recovery Linac (ERL) facility, which is under construction at Collider-Accelerator Department, BNL. This R&D facility has goals to demonstrate CW operation of ERL with average beam current in the range of 0.1 - 1 ampere, combined with very high efficiency of energy recovery. The heart of the facility is a 5-cell 703.75 MHz super-conducting RF linac with HOM damping. Flexible lattice of ERL provides a test-bed for testing issues of transverse and longitudinal instabilities and diagnostics of intense CW e-beam. ERL is also perfectly suited for a far-IR FEL. We present the status and our plans for construction and commissioning of this facility.

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Commissioning of superconducting radiofrequency separator cryogenic system

The cryogenic and vacuum system is built to cool by superfluid helium at 1.8 K two niobium cavities of the RF superconducting kaon separator being under construction at IHEP. First commissioning runs were carried out. During the last run both cavities were successfully cooled down to the operating temperature and cryostated for several days. System description, test results and planned improvements are presented.

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Compact Hard X-Ray Synchrotron Radiation Source with Superconducting Bending Magnets

Synchrotron radiation (SR) with relatively hard spectrum (up to 50 keV) is necessary for realization of number modern X-ray analytical methods. These methods can be effectively used in industrial and medical applications, in universities and scientific centers. So, the task of developing of compact source of hard synchrotron radiation is still actual. Budker INP has a big experience for developing and fabrication of high field superconducting insertion devices for different SR centers. In frame of this activity a superconducting bending magnet with field up to 9.6 T was fabricated for BESSY-II and commissioned in 2004. This magnet also became a prototype for compact hard SR source. A project of such storage ring is under developing in Budker INP now. This design fixed beam energy to 1.2 GeV, ring circumference about 52 m. Estimated horizontal equilibrium emittance will be near 20 nm. This report includes a detailed description of main parameters and magnetic structure of designed storage ring as well as preliminary design of injector system and beamline layout.

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Accelerating complex "SALO"

During last three years NSC KIPT and Technische Universiteit Eindhoven develop the recirculator project with superconducting accelerating structure TESLA on energy up to 730 MeV. The accelerator will be disposed in existing buildings on linac LU2000 exit. The source of polarized electrons will allow to receive quasicontinuous beams with energy from 250 up to 730 MeV and a current up to 100 microA. RF photogun will accelerate continuous and impulse electron beams with a charge up to 1 nC in one bunch and an average current up to 1 мA. Base tasks which to be solved with the help of new accelerator: 1. Problems of fundamental nuclear physics 2. Framing accelerator driven sub-critical assembly facility, neutron source and its applications in different fields of science 3. Free electron laser 4. Radiation physics, nuclear physics applications, isotope manufacturing

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Plenary session: High intensity cyclic and linear accelerators

G.L.Khorasanov, A.P.Ivanov, A.I.Blokhin (Institute for Physics and Power Engineering, Obninsk, Russia)

Neutronic and physical characteristics of an accelerator driven system with a target and core coolant from the lead-208 isotope

Presently, several research centers of the European Community are planning to construct in 2025-2030 an Accelerator Driven System (ADS), named as EFIT, with the aim to transmutate minor actinides (MA), wastes of nuclear power plants. It is supposed that thermal capacity of the EFIT subcritical core will be equal to several hundreds of MW and it will be driven by a proton beam of energy Ep=1000 MeV and current about Ip=20 mA. In supporting this project, in 2001-2004 in Europe the facilities PDS-XADS with 80 MW thermal capacity and XT-ADS (MYRRHA) with 50 MW thermal capacity were considered within a design phase. In these facilities a conventional eutectic of natural lead (Pb-nat) and bismuth, Pb-nat(45%)-Bi(55%), was proposed as a coolant material for the target and core. With the aim of hardening the ADS target neutron spectrum, earlier an opportunity of using the modified lead-bismuth eutectic consisted from (80-90)% of the slow neutron moderating lead isotope, Pb-208, and (20-10)% of Bi-209 has been proposed by authors, that was presented at the ICONE 13 and GLOBAL 2005 International conferences on nuclear science and engineering. In this paper a possibility of using molten pure Pb-208 as the coolant for the subcritical core of 80 MW thermal capacity of the PDS-XADS type facility is considered. Calculations of neutronic and physical characteristics of the ADS were performed using Monte Carlo code. The following initial data were chosen: the annular core with the target in its center; the core coolant Pb-208(100%); a fuel, a mix of mono nitrides of depleted uranium and power plutonium with a small share of neptunium and americium; the target coolant, the modified eutectic, Pb-208(80%)-Bi(20%); proton beam energy 600 MeV; effective multiplication factor of the core Keff = 0.97; thermal capacity of the core N = 80 MW. From calculations follows that in using Pb-208 as the core coolant the intensity of external source of neutrons to deliver 80 MW thermal capacity is equal to S = 2.29·1017 n/s, that corresponds to proton beam current Ip = 2.8 mA and beam capacity Pp = 1.68 MW. In using natural lead instead of Pb-208, effective multiplication factor of the core in normal operating regime falls down to the value equal to Keff =0.95. In these conditions multiplication of external neutrons in the core and thermal capacity of the core are below nominal by 1.55 times. For achievement the rated core power N=80 MW it is required on ~20-30 % to increase the fuel loading and volume of the core, or by 1.55 times to increase intensity of external source of neutrons. In the last case, the required parameters of proton beam and its target are following: intensity of external source neutrons S = 3.55·1017 n/s., beam current Ip = 4.32 mA, beam capacity Pp = 2.59 MW. Thus, replacement of the coolant from natural lead by the coolant from lead-208 results in economy of capacity of the proton beam on the value of Pp=0.91 MW, and using the uranium - plutonium nitride fuel allows to establish the worth of capacity of the proton beam on burning out the fuel in limits of less than 10 %, due to the core breeding ratio equal to ~1. It allows in the ADS core with thermal capacity equal to 80 MW to lower capacity of the required proton beam to the value about 2 MW instead of capacity of the proton beam equal to 3.6 MW considered the PDS-XADS project. Hence, the proposed variant of the ADS allows to save capacity of the proton beam about Pp=1.6 MW. To exploit the accelerator with this lower proton beam current it will be required about ~ 56 tons of Pb-208, as a minimum, for the core coolant. Charges for it obtaining can be recovered at the expense of the economy of the proton accelerator construction cost. In this case, the accepted price of the lead isotope Pb-208 must be less than $2,860/kg.

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Race-track microtron on 50 MeV with a small number of orbits.

The description of mathematical model of a race-track microtron on 50 MeV is submitted. One of features of the accelerator consists in the fact, that the accelerator section of a microtron has the significant transverse sizes (e.g. a cryostat of superconducting section). For detour of such section by the beam on the first revolution, frequency rate of acceleration is increased up to four. Other feature is application of injection directly in accelerating section at rather low energy of a beam. A gain of energy of a beam per revolution - 10 MeV, number of revolutions - 5, energy of injection - (0,8 - 1) MeV. The done modeling has shown, that phase-energy area, from which particle are captured in the mode of acceleration, allows to receive on an output the intensive accelerated beam. Transverse focusing a beam is carried out by the poles, creating a field of an opposite direction along a gap of bending magnets. Also before an input in accelerator section and after section quadrupole singlets are put. Such system of focusing provides transverse stability of a beam for all orbits.

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8 MeV H- cyclotron to charge the electron cooling system for HESR

A compact cyclotron to accelerate negative Hydrogen ions up to 8 MeV is considered the optimal solution to the problem of charging the high voltage terminal of the Electron Cooling System for High Energy Storage Ring at GSI (HESR Project, Darmstadt). Physical as well as technical parameters of the accelerator are estimated. Different types of commercially available cyclotrons are compared as a possible source of a 1 mA H- beam for HESR. An original design based on the application of well-established technical solutions for commercial accelerators is proposed.

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New compact cyclotron CC-18/9 designed and manufactured in NIIEFA

In the paper is presented a brief description of a cyclotron providing the acceleration of negative hydrogen and deuterium ions to energies of 18 and 9 MeV respectively. The cyclotron is intended to produce short-lived and ultra short-lived radio isotopes. The beam is extracted by charge-exchange of ions by stripping foils. The specific feature of the machine is location of the resonance system inside the vacuum chamber of a shielding-type magnet as well as the vertical position of the median plate of the magnet. The cyclotron has a beamline to transport the beam to remote targets. Two such machines have been manufactured and put into operation: one cyclotron is operated in the PET center of Turku, Finland and the other is functioning in the medical center in Pesochnaya in St.Petersburg, Russia

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Plenary session: Magnetic and power supply systems for accelerators

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Design and manufacture of the superconducting bus-bars for the LHC main magnets

The main magnets of the LHC are series-connected electrically in different powering circuits by means of superconducting bus-bars carrying a maximum current of 14 kA. These superconducting bus-bars consist of a superconducting cable thermally and electrically coupled to a copper profile all along the length. The function of the copper profile is essentially to provide an alternative path for the current in case the superconducting cable loses its superconducting state and returns to normal state because of a transient disturbance or of a normal zone propagation coming from the neighboring magnets. When a superconducting bus-bar quenches to normal state its temperature must always stays below a safe value of about 100 degrees C while the copper is conducting. When a resistive transition is detected, the protection system triggers the ramping down of the current from 14000 kA to 0. The ramp rate must not exceed a maximum value to avoid the transition of magnets series-connected in the circuit. This paper concerns the design and the manufacture of high current superconducting bus-bars needed to interconnect the magnetic elements of the main dipoles, the main quadrupoles of the arcs and of the dispersion suppressors of the LHC.

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Bending magnets for the metrology light source (PTB, BERLIN)

Eight bending magnets for Metrology Light Source (PTB, Berlin) were manufactured by Budker INP, Novosibirsk, Russia. MLS operate within wide electron energy range (200 – 600 MeV), which corresponds to 0.43 T - 1.31 T for the bending magnets. The laminated C-shape dipoles have the bending radius of 1.528 m (bending angle of 45 deg.) and parallel edges. The bending magnets were magnetically measured by Hall probe system designed in Budker INP and the magnetic field homogeneity inside the working area was ± 2.5.10-4. The main features of magnetic modeling, manufacture and magnetic measurements are presented in the paper. The measured basic parameters of the manufactured bending magnets have good agreement with the model simulation.

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Control and power supply systems of electron accelerators with power up to 500 kW

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Tens kilowatt power supply based on half-bridge inverter with zero current commutation

The 40 kW power supply prototype based on half-bridge inverter with zero current commutation has been developed. The power supply is to be used for VEPP-5 modulators pulse forming networks charge up to 45 kV with repetition rate up to 50 Hz. The inverter operation algorithm provides IGBT switching with zero current condition. The power supply test results are presented. The design of the step-up power transformer operating at frequency up to 30 kHz is described.

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Power supply systems for the buster ring BEP and for the collider VEPP-2000

Two power supply systems for bending magnets of the buster ring BEP and for the collider VEPP-2000 are described. The power supply for bending magnets of buster ring BEP has reversible current polarity with maximal current up to 10kA and maximal voltage up to 340V. Current instability is better than 50ppm. System is designed like a combination of eight thyristor rectifier modules and their passive filters joined in parallel to organize twelve ; pulse rectifier. System is equipped with the 10kA thyristor bridge to reverse the current polarity. The power supply for the collider VEPP-2000 consists of two thyristor rectifier modules and their passive filters joined in parallel. This power supply has unidirectional output current of up to 10kA with maximal output voltage 120V. Current instability is better than 10ppm. Precise DAC and ADC modules for control and measurements are essential parts of the systems. Parameters, interesting schematics and tests results should be presented.

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Power supply system for corrector magnets of VEPP-2000 complex

A magnet system of Electron-positron collider VEPP-2000 include about 180 elements of field correction. It includes more that 80s correctors for the BEP-buster ring, about 70 for collider VEPP-2000 and about 30 for transportation channels. Powering of the correctors were realized by bipolar DC current sources PA-6 and PA-20, with output current 6A for PA-6 and 20A for PA-20. The current ripple do not exceed 0,1%. An output voltage 120V for PA-6 and 80V for PA-20. A structure of correction unit and amplifying module is described.

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High voltage power supplies for ion beams electron coolers

High voltage power supplies, developed for feeding the electron coolers EC-35 and EC-300, are described in this report. Stabilized voltage power supplies with output voltages 35 kV and 300 kV with the current up to 5mA and stability up to 10-5 are used for electron cooling of heavy ion beam. Under high potential of these power supplies there are many auxiliary power supplies, feeding the gun, control electrode, suppressor and control electronics. In this report the original decisions underlying in development of power supplies are considered. The electron coolers were developed under the contract between Budker Institute of Nuclear Physics (Novosibirsk, Russia) and Institute of Modern Physics (Lanzhou, China)

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Plenary session: Heavy-ion accelerators and electron cooling

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Comissioning of the LEIR electron cooler with Pb^{+54} ions

New LEIR cooler with variable profile of the electron beam and electrostatic bending was comissioning 2005-2006. In this paper we present our experience with the comissioning of the new device as well as the first results of ion beam Pb^{+54} cooling with a high- intensity variable-density electron beam.

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Status of High Energy Electron Cooling in FNAL Recycler Ring

Electron cooling of 8 GeV antiprotons at Fermilab's Recycler storage ring is now routinely used in the collider operation. It requires a 0.1-0.5 A, 4.3 MeV DC electron beam that increases the longitudinal phase-space density of the circulating antiproton beam. This paper discusses the current status of the electron cooler including the electron beam properties, its mode of operation within the context of Fermilab's accelerator complex and cooling force measurements for various conditions. Along with the data, theoretical models will be presented.

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ITEP-TWAC Facility Progress Report

The ITEP-TWAC facility is in three years of operation with proton and ion beams in several modes of acceleration and accumulation by using the multiple charge exchange injection technique. Some progress is achieved in laser ion source technology development, in output ion beam current of the linear injector I3, in intensity of the buster synchrotron UK, in efficiency of ion beam stacking and longitudinal compression in the storage ring U10. The machine status analysis and current results of activities aiming at both subsequent improvement of beam parameters and extending beam applications are presented

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Electron Cooling of Proton Beam at COSY and S-LSR

Results of experimental studies of the electron cooling of a proton beam at COSY (Juelich, Germany) are presented. Intensity of the proton beam is limited by two general effects: particle loss directly after the injection and development of instability in a deep cooled ion beam. Results of the instability investigations performed at COSY during last years are presented in this report in comparison with previous results from HIMAC (Chiba, Japan) CELSIUS (Uppsala, Sweden) and LEAR (CERN). An influence of secondary ions stored in cooling electron beam was studied, the results are presented. The methods of the instability suppression, which allow increasing the cooled beam intensity, are described. Electron cooling at COSY was also investigated at extremely low proton current. Experimental results for the attempt to achieve of ordered state of proton beam is presented. This work is supported by RFBR grant # 05-02-16320 and INTAS grant #03-54-5584.

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Cooling of Secondary Beams

The storage ring ESR at GSI is equipped with stochastic cooling and electron cooling. For experiments with rare isotope beams a combination of stochastic pre-cooling and final electron cooling provides shortest cooling time and highest beam quality. In the FAIR project cooling of rare isotope beams and antiprotons is required. An overview of the proposed cooling systems of the FAIR project will be given.

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Plenary session: Accelerators for medical applications

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REKORD - Regional System for the Radioactive Isotopes Diagnostics

The REKORD system is intended for the mass radioactive isotopes (MRI) diagnostics of the cardiological, oncological and neurological diseases, which determine the average value of inhabitants lifetime. The potentialities inherent in the MRI diagnostics enable a disease to be identified at the early stage, which is very important for the successful treatment and gives considerable social and economical effects. The system consists of a cyclotron with target systems to produce short-lived and ultra short-lived radionuclides, modules for radiopharmaceuticals synthesis systems built in protection boxes, tomographs for SPECT and PET, which are networked to the regional computer database. The system has no domestic analogues. The advantages over foreign analogues are the universality of the RECORD system and its autonomy, as the isotopes used for diagnostics are produced directly by this system. One sample of the equipment has been delivered to the Central Roentgen Radiological Institute in Pesochnaya and is under operation, excluding PET at the time being. The equipment has been designed and produced mainly in NIIEFA, which is granted the State License certifying the production of medical facilities and the International Quality Certificate. The delivery of the REKORD systems to the regions of the country will allow the problem of the clinical examination of the population of Russia on the modern level of medical diagnostic and information technologies to be successfully solved.

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Neutron therapy facility based on high current proton accelerator KG-2,5

In terms of activity directed to create therapeutic facility on high current cascade generator KG-2,5 three accelerator based intensive neutron sources was investigated for neutron capture, fast and boost therapy. To make possible neutron capture therapy beam shaping assembly (BSA) was designed and manufactured. BSA transform neutron spectra from 7Li(p,n)7Be reaction in to epithermal energy neutrons with energy 1-10E4 eV. Mostly appropriate BSA materials and optimal BSA configuration was found as a results of computer simulations. Calculation results were verified by direct neutrons spectra measurements by time-of-flight method. For fast neutron therapy proposed to use neutron source with energy 1-17 MeV. Special assembly for shielding and beam shaping was designed. It make possible to form neutron beams with various geometry, including narrow neutron beam which looks as analog of gamma-knife. Also possibility to perform combined neutron-electron therapy at one exposition was studied. Created facility is prototype of neutron therapeutic facility for maintaining at oncology clinic. Manufacturing series of such facility will significantly increase area of neutrons usage in radiation oncology techniques.

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Modernization of the NG-12I Neutron Generator

Neutron generator NG-12I apart from research into nuclear physics is used for nuclear therapy of cancer. Treatment of more than 300 patients was realized in the Nuclear Therapy Centre. Modernization of the neutron generator was began in 2002 to increase capacity of the Neutron Therapy Complex. The main purpose of the modernization was ion beam current and life-time of the tritium target increasing. In 2004-2005 designed and manufactured equipment was installed, a test of neutron generator was carried out and treatment of patient has began once again

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Commercial cyclotrons for medical applications

Compact isochronous cyclotrons to accelerate negative Hydrogen ions up to 30 MeV are widely used for the production of medical isotopes. Physical and technical parameters of accelerators are estimated. Different types of commercially available cyclotrons are being compared. Design of high current (3mA of H- beam) compact cyclotron could be based on well-established technical solutions and commercial subsystems.

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Specialized cyclotron for proton therapy application

Dubna scientific medicine center is under development since 1967 on the base of the proton beam of LNP JINR Phazotron. Proton beam with energy Ep~170 MeV and intensity I~0.1 mkA is used for patients irradiation. Proposal of creating of the cyclotron with the same beam characteristics was reported earlier at the conferences RUPAC04, ICAA05 and printed in different magazines. The development of this project was considered in this paper. Behavior of different types of magnet yoke was studied by computer modeling and optimal form of the yoke was chosen taking into account the cost of elements manufacturing and assembling of the electromagnet. The ability of optimal combination of the magnet yoke, HF and extraction systems of the cyclotron taking into account the dynamics of the proton beam in calculated magnetic and accelerating field is under discussion.

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Plenary session: Beam dynamics, cooling methods, new methods of acceleration

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Numerical optimization of a plasma wakefield acceleration experiment

The possibility of high acceleration rates has already been demonstrated by plasma wakefield accelerators driven by electron beams. The next necessary step is obviously the demonstration of high acceleration efficiency and good quality of the beam. One possible way to achieve both the efficiency and quality is to prepare matched drive and accelerated beams by removing a central slice from a single high-quality electron bunch (parent beam). For parameters of the parent beam given, the question arises how to maximize the number and energy of accelerated particles and minimize their energy spread and emittance. This question is addressed by LCODE numerical simulations. As a reference point, the design beam parameters of VEPP-5 injection complex are taken. Optimum shape of the beams, required plasma length, achievable energy gain and energy spread are found as functions of the plasma density and parent beam characteristics. The required control accuracy of adjustable beam and plasma parameters is determined.

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Optimal Beamlines for Beams with Space Charge Effect

Space charge effect is ever of fundamental importance for low-energy parts of accelerators. Criteria of the significance of space charge effect are derived in the presentation. Simple and robust estimations of the emittance degradation in various space charge affected beamlines were obtained analytically and numerically. Nonuniform longitudinal and transverse distribution of current, accelerating and bunching were taken into account. The parameters of optimal beamlines for space charge affected beams were estimated.

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Determination of precise model of a storage ring using response matrix fit: application to Advanced Photon Source and Tevatron

Response matrix fit has proved itself as a very powerful tool for storage ring model determination and optics measurements. First application of this technique was reported at NSLS and then it was further developed at ALS. For the past several years this method was extensively used at APS for optics correction and development. The software developed at APS was also successfully employed at Tevatron, where physicists were able to increase luminosity by about 15% based on the newly developed model. In this paper we will describe the technique and show its various applications to the APS storage ring and Tevatron including transverse impedance determination at APS.

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Beam-size effect and particle losses at colliders

In the modern colliders, the macroscopically large impact parameters give a substantial contribution to the standard cross section of the $e^+e^- \to e^+e^-\gamma$ process. These impact parameters may be much larger than the transverse sizes of the colliding bunches. It means that the standard cross section of this process has to be substantially modified. Such a beam-size effect has been discovered in BINP (Novosibirsk) twenty years ago. In this report we give simple qualitative description of this effect and present two novel topics. First, we present our calculations related to bremsstrahlung at B-factories KEKB and PEP-II. We find out that this effect reduces beam losses by about 20%. Second, we derive formulas which necessary to take into account quantitatively the effect of particle correlations in the beams on the spectrum of bremsstrahlung as well as in pair production. This report is based on the papers: G.L. Kotkin and V.G. Serbo, NIM B227 (2005) 137 and Phys. Rev. STAB 7 (2004) 101001.

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Development of LEPTA facility.

General goal of the LEPTA (Low Energy Particle Toroidal Accumulator) project, which is under development in JINR now, is to create small positron storage ring equipped with an electron cooling system. Storage ring of LEPTA facility was commissioned in September, 2004. Results of testing the storage ring with electron beam are presented. Positron injector for the ring is based on ^{22}Na radioactive source. Positrons from the source are moderated in the solid neon and stored in electromagnetic trap. First experiments with the solid moderator have been performed. The positron trap is under test now with electron beam. This work is supported by RFBR grant 05-02-16320.

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Beam Tests of a Stochastic Slow Extraction System Prototype in the U70

The paper reports on development of a stochastic slow extraction system prototype beam-tested during the 2004-6 MD runs of the 70 GeV proton synchrotron of IHEP-Protvino. Flat-topped 2-3 sec long and smooth (r.m.s. AC-to-DC ratio < 0.3) spills were obtained. The scheme implemented has a few inventive features. Protons are forced into the 3-rd order horizontal resonance with a supplementary 200 MHz RF system driven by sum of a non-random RF carrier and an additive base-band low-pass phase noise. Waiting beam stack is kept coasting in a close outer vicinity of 200 MHz buckets, in the longitudinal phase half-plane opposite to that housing momentum image of extraction resonance. RF buckets are kept repopulated by inward diffusion from the outer stack. Shape of noise power spectrum is invariable (no conventional frequency sweeping is applied), magnitude of noise being controlled via a proportional DC-coupled feedback loop acquiring data from a beam loss monitor. Terminal travel to resonance is carried out via a fast trapped cyclic motion inside buckets. It drastically improves immunity of extraction to ripples in power supplies of beam optics. No mains harmonics are observed in spills.

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Nonlinear Compton scattering and its application to polarized positron source for ILC

We propose a novel gamma-source suitable for generating a polarized positron beam for the next generation of electron-positron colliders, such as the International Linear Collider (ILC) and the Compact Linear Collider (CLIC). This 40-MeV polarized gamma-source is based on Compton scattering inside a picosecond CO2 laser cavity from electron bunches produced by a 4-GeV linac. We identified and experimentally verified the optimum conditions for generating at least one gamma photon per every electron. After multiplication at several consecutive interaction points, the gamma-rays so produced will be stopped on a target, thereby creating a copious numbers of circularly polarized positrons. We address the practical feasibility of having an intracavity Compton polarized positron source as the injector for these new colliders.

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Plenary session: Accelerators for industrial applications

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Status of ELV-type electron accelerators

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Application of High Power Electron Accelerator in Wastewater Treatment

Textile dyeing processes are characterized as high consumption of water, steam and electricity, and discharge of the filthy and colored wastewater. Increased use of assorted dyes and other chemicals hurries in re-equipment of purification facilities by application of efficient methods based on radiation technology. Based on the pilot plant operation since 1997 at Daegu Dyeing Industrial Complex (DDIC), a commercial plant has constructed in 2005. Electron accelerator of 1MeV, 400kW with three separate irradiators was used for the flow rate of 10,000m3 per day. Wastewaters are delivered through the injection nozzles under the electron beam. Continuous operation of this plant showed the preliminary electron beam treatment reduced bio-treatment time twice at the same degree of removal and resulted in more significant decreasing TOC, CODCr, and BOD5. This project is supported by the International Atomic Energy Agency (IAEA), Korean Government and the City of Daegu.

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Requirements on Electron Guns for Innovative Applications in Polymer Industry

Electron beam technology is well-established in many industrial branches and in manufacturing techniques. These applications use local and temporal precise input of energy into surfaces, random layers or volumes in order to exactly heat materials or to generate excited atoms or molecules and ions for subsequent molecule changes. The effect of molecule change is used for cross-linking and degradation of polymers. In comparison to alternative chemical processes the polymer structure can be change without any use of additional additives. Thus ecologically harmful agents are not required. It is well known that properties of plastics form parts can be modified by electron treatment of plastic pellets before the polymer forming process. Thus the latest electron beam technology in surface treatment of bulk goods has been tested for this application. The mobile “e-ventus” plant (Fig.1) enables a specific modification of processing qualities of plastic pellets and final properties of plastic products. The new plant generation REAMODE is designed for modification of polymers with electrons in reactive gas atmosphere. It has been tested for modification of recycled rubber meal and polypropylene. These modified raw materials were used for the production of thermoplastic elastomers. Finally, a 1.5 MeV electron accelerator was directly coupled with a typical single screw plastics processing extruder for a continuously modification of thermoplastic strands in molten/liquid state at high plastics temperatures (MOBRAD1/T, Fig.2). These tested applications of polymer modification with electrons as well as the requirements on electron beam technology will be presented in detail. Key words: electron beam technology, polymer modification, recycling Fig. 1: Mobile plant for modification of plastic pellets Fig. 2: Mobile Radiation Facility MOBRAD1/T

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Industrial electron accelerators type ILU

The report describes ILU type industrial electron accelerators. It describes their main parameters, design, principle of action, electron beam extraction devices, wide set of auxiliary equipment for various technological processes and ways of their usage.

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Electrophysical complexes on basis of the electrostatic accelerator ESA-2 for fundamental and applied investigations

Electrostatic accelerator ESA-2 is a multi-purpose tool for fundamental and applied research in nuclear and particle physics. Usage of ESA-2 in quality an implanter, and as a source of ions for conducting of investigations of solid-state materials by non-destructive control methods, such as, for example, the Rutherford backscattering (RBS) is discussed. Ion implantation usage for electrical isolation of microelectronic devices based on IV group (Si) and III-V (GaAs) semiconductors is described. In case of Si, substoichiometric nitrogen implantation is proposed as method for the creation of buried dielectric layers for device/substrate isolation. For III-V semiconductors, device/device isolation can be achieved by the formation of ion beam induced defect regions where radiation defects produce deep-level traps for carriers. Polyenergetic and high energy ion implantation is studied as the method for the formation of uniform defect distributions. The Rutherford backscattering spectrometer has been designed and assembled. It has a high resolution provided for usage an electrostatic energy analyzer. The energy range of detected ions is 40 to 300 keV. The energy resolution is better than 1.2 percent. Basing on experimental results it is shown that RBS spectrometer with electrostatic analyzer as a sensor can be successfully applied both for shallow depth impurities profiling and also for measurements such ion beam parameters, as energy and energy width. The present paper deals with the interaction of 380 keV H+ ions with Si surface at glancing angles corresponding to the quasi-channeling regime.

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Accelerators for Non-destructive Inspection of the Nuclear Reactor Equipment

In compliance with requirements of IAEA, thorough inspection of the weld seams of the 1st category should be provided when manufacturing the equipment of nuclear reactors. The potentialities of the accelerators for defectoscopy designed and manufactured in NIIEFA are described in the paper. The accelerators allow the radiographic and radioscopic inspection to be performed in compliance with the ASTM-1-1T standard in the range 20-600 mm for steel.

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Radiation technology facilities based on electron beam accelerators at the branch of the Federal State Unitary Enterprise (FSUE) "Karpov Institute of Physical Chemistry": manufactured products and promising developments.

At present five EB accelerator-based technological facilities are operated at the Karpov Institute to solve the following tasks: manufacture of various commercial products (foamed polyethylene, pipeline insulation, pipe products for electrical engineering, composite materials), scientific research and development of promising radiation-chemical technologies.

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Status of BINP proton tandem-accelerator for explosive detection by NRA method and for boron neutron-capture therapy.

Status of original 2.0 MeV, 10 mA proton tandem-accelerator with vacuum insulation is presented. The accelerator is intended to be used in facilities generating resonance gamma rays for explosives detection and epithermal neutrons for boron neutron-capture therapy of brain tumors. Steady-state sectioned rectifier from industrial ELV-type electron accelerator is used as a high voltage source for the accelerator. A dc high-current negative ion source has been developed for injection into the tandem. In the tandem accelerator there is set of nested potential electrodes with openings which form a channel for accelerated negative ion beam and subsequently for proton beam after stripping gas target. The electrodes are fixed on a high voltage feedthrough insulator though which required potentials are applied to them from the rectifier by means of resistor voltage divider. In the paper the first experimental results obtained with vacuum insulated tandem accelerator are also given. Keywords: vacuum insulation tandem accelerator, gamma resonance absorption, boron neutron capture therapy.

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Plenary session: Control and diagnostic systems

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Innovative Beam Diagnostics for the challenging FAIR Project

The planned FAIR facility consists of two heavy ion synchrotrons and four large storage rings. The super-conducting synchrotrons are build for high current operation and secondary ion production. A large variety of low current secondary beams is stored and cooled in the four storage rings. A complex operation scheme with multiple use of transport lines is foreseen. This demands an exceptional high dynamic range for the beam instrumentation. Due to the enormous beam power, non-destructive methods are mandatory for high currents. For the low current secondary beams, non-destructive diagnostics are preferred due to the low repetition rate. Precise measurements of all beam parameters and automatic steering or feedback capabilities are required due to the necessary exploitation of the full ring acceptances. Moreover, online beam-corrections with short response times are mandatory for the fast ramping super-conducting magnets. Due to the ultra-high vacuum condition and the demanding measurement accuracy, novel technical solution are foreseen. An overview of the challenges and projected innovative solutions for various diagnostic installations will be given

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Low energy electron beam as a nondestructive diagnostic tool for high power beams.

The report is devoted to possible applications of low energy electron beam in diagnostics of intense beams. Experimental results of electron beam probe application in BINP are presented.

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Method of Monitoring Crystal Deflectors

The accelerated beams extraction is one of the important problems of modern facilities, such as J-PARC or Tevatron. One of an efficient approach is the beam extraction with using bent crystal deflectors. The on-line control of the quality of crystal structure of deflector becomes necessary, when crystal deflector is used to extraction of intense proton or ion beams. For example, intensity of proton beam at accelerator J-PARC is ~ $3*10^{14}$ per spill. Investigation the possible radiation damage of usually used silicon deflectors is the open question for such beams. In this work, the monitoring of crystal deflectors quality based on registration of parametric x-ray radiation (PXR) is proposed. Proposed method gives a possibility to control a uniformity of deflector bending by measuring a PRX line width and allows to estimate a damage of deflector crystal structure under intense beam.

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High energy micron electron beam non-invasive diagnostics based on diffraction radiation

The requirement for the accelerator installations of the next generations such as linear collider, where a small beam size at the interaction point is required to achieve a reasonable luminosity, stimulated new techniques development for a non-invasive measuring an electron beam size as small as 10 mm. The development of the non-invasive bunch size diagnostics based on the optical diffraction radiation (ODR) is now in progress in frame of TPU-KEK-SLAC collaboration. The experimental test of a transverse beam size measurement was performed successful on the KEK-ATF extracted electron beam using the optical diffraction radiation from a flat conductive target with a slit. However many difficulties emerge if we going from the one GeV electron energy to the several tenth GeV electron beams. The extremely high Lorenz-factor value gives rise to the some problems, such as a catastrophic decreasing of the method sensitivity to the beam size, extremely pre-wave zone effect even in the optical range and so on. We discuss here the origins of these difficulties and suggest the ways of these problem solutions. To provide the necessary method sensitivity to the ~5mm beam size we suggested to use the ODR from a target, consisting on two crossed conductive semi-planes. In this geometry ODR splits into two beams with phase difference depending on an electron position. If we bring together these beams, the interference picture became depending on the transverse beam size. However in contrast to the flat slit target technique this method sensitivity does not depend on a Lorenz-factor and may be used for high-energy electrons. Also the same technique may be used as a non-invasive beam size monitor by choosing of target parameters. This method was developed and successful tested on the extracted KEK-ATF electron beam. This test showed the possibility of a single bunch micron beam size measurement. All of the preceding allows us to hope to create a tools for the non-invasive beam diagnostics of electron beam with Lorenz-factor higher than 60000.

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Embedded device set for control systems. Implementation and applications.

Creating new installation and upgrading existing facilities require a great amount of control devices. There was designed a unified device set for new control systems. All devices implemented as embedded controllers for incorporating into controlled equipment like power supplies, RF-station and so on. First applications show a lot of advantages embedded controllers over classical modular devices. Now these devices are widely used in control systems both in BINP and in other scientific institutions. Here are presented the developed device set, described implementation and discussed typical applications.

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Control System of VEPP-2000 Collider (software, hardware)

Electron-positron collider VEPP-2000 is under commissioning at Budker Institute of Nuclear Physics. The paper presents architecture, implementation and functionality of the software of the collider control system. The software according to hardware system consists of interacting subsystems responding on different acceleration facility parts. Control system software is based on several TCP/IP connected PC platforms working under operating system Linux and uses client-server techniques. The paper describes implementation, operating possibilities and perspectives of VEPP-2000 software.

The paper also presents structure, architecture and implementation of the hardware of the collider control system. The system consists of pulse-elements, steering coils power supplies, high-current main field power supply, RF subsystems and some other special subsystems (such as vacuum, temperature, etc. control subsystems). The system is based on modern industrial protocol CAN-bus and specialized electronic BINP manufactured blocks according the standard. The paper describes implementation of different subsystems based on CANbus devices, and operating characteristics and possibilities.

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The new VME-based system for magnetic measurements with Hall sensors

In BINP for creation of measuring systems with Hall sensors CAMAC - electronics were used many years. This system had good parameters and successfully used for measurements of magnets produced in BINP as for installations of VEPP-family as for foreign facilities: LHC (CERN), SLS (Switzerland), BESSY (Germany), SAGA (Japan). Hardware deterioration and MS DOS application of previous system demanded to design a new electronics and modern software. The paper describes the new VME-based system and MS Windows application developed for replacement of old system. The system hardware consists of VME crate controller, VME - RS-232 interface, VME - CAN interface and three specialized units: Hall-Sensor analogue Interface (VMEHSI), precision ADC (VMEADC16) and Hall carriage Thermo Stabilizer (HTS), fabricated in Budker INP. Resolution of measuring devices is less than 1uV and stability is better than 10^{-5}. Software of the Hall-sensor measuring system consists of embedded part, which operates on VME-controller under the mcLinux operational system, and user's high-level software "WinHall", which is a MS Windows application with user-friendly graphical interface. The features of new system and practice results are reported.

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Precise magnetometers on base of pulsed NMR technologies

A series of precise magnetometers on base of pulsed Nuclear Magnetic Resonance (NMR) techniques has been developed in BINP. In the range of 0.025÷13 T error of homogeneous magnetic fields measurements not exceeds (1÷2) ppm, resolution is better than 0.1 ppm. The magnetometers provide automatic search of NMR signal and tracking of the magnetic field. One type of the magnetometers is able to work with aluminum or copper powder as working substances of NMR probes. These probes can be used for measurements of magnetic fields at liquid helium temperature. A special NMR probe with very small sensitive volume (about 1 mm3) has been designed to measure of fields with the gradient up to 150 G/cm. At present NMR magnetometers developed and fabricated in BINP work successfully in some scientific centers in Russia and abroad. The features of the magnetometer's electronics design and more interesting examples of magnetometer's application in charged particle storage rings are presented.

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Beam Energy Spread Measurement at the VEPP-4M Electron-positron Collider

The article presents rated data for analysis of efficiency of concrete shielding against slant penetration of bremsstrahlung of 5.0 MeV electrons with due account of the angle-energy distributions of radiation from targets. Initial angle-energy distributions for aluminum, iron and tungsten targets have been obtained by direct Monte-Carlo simulation of interactions with the help of the program SCIN_PC. Then the value of air kerma was computed analytically and kerma attenuation by concrete shielding was estimated with application of available reference information. Kerma values at checkpoints behind the concrete shielding of the existing bench, which is intended mainly for electron accelerators of smaller energy, have been estimated. Bench operating restrictions for adjustment works with the ILU-10 accelerator have been formulated

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POSTER SESSION

Poster session: Modern trends of accelerator development, large accelerator design, colliding beams

P.1. S.A.Nikitin (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Influence of Errors in KEDR Detector Field Compensation on the Spin Tune Shift and the Beam Polarization Lifetime in VEPP-4M Collider at Energy of Tau Lepton Production Threshold

At present the experiment on precision measurement of tau lepton mass at VEPP-4M storage ring-collider with KEDR detector using the resonant depolarization technique is in process. Polarized beams needed in this technique are injected from VEPP-3 booster storage ring. The beam energy in experiment is near tau production threshold (1777 MeV) where a vicinity of the spin integer resonance (1763 MeV) strongly amplifies an influence of various field imperfections on spin motion. In particular, a spin tune shift, related to the energy quantity not through a simple proportional law, appears. Beside, a depolarization processes become significant. A few percent difference from zero of the longitudinal magnetic field integral in KEDR is worth to be considered in this viewpoint. We have studied the effects of KEDR field compensation errors on an accuracy of beam energy calibration by spin precession frequency as well as on a "lifetime" of beam polarization in VEPP-4M. Results of special experiments are presented and discussed in comparison with the calculation.

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P.2. A.V.Bogomyagkov, S.A.Nikitin, A.G.Shamov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Influence of the vertical closed orbit distortions on accuracy of the energy calibration done by resonant depolarization technique

The series of the experiments on precise mass measurement of $J/\Psi,\Psi'$ mesons have been performed in 2002-2004. Energy calibration has been done with the help of the resonant depolarization technique. The present report discusses the influence of the vertical orbit distortions on the accuracy of the energy calibration. The sources of the orbit distortions are misalignment of the quadrupoles and sextupoles in vertical plane and kicks of the vertical correctors.

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P.3. D.E.Berkaev, Yu.M.Shatunov, I.A.Koop, F.V.Podgorny, A.P.Lysenko, P.Yu. Shatunov, V.V.Druzhinin, D.B.Shwartz, V.P.Prosvetov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Beams injection system for e+e- collider VEPP-2000

Electron-positron collider VEPP-2000 is under commissioning at Budker Institute of Nuclear Physics. The paper presents the injection system of the collider delivering the beam from the booster storage ring BEP with maximum energy 900 MeV. A matching of the beam injection with the storage ring optics is done with a respect to nonlinear kicker field. Features of beam diagnostic and transfer line magnets including pulse septums (100 mksec; 30 kGs) and fast kickers (20 nsec; 70 kV) are described. Results of magnetic measurements and their comparison to calculated data are given.

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P.4. N.I.Balalikin, V.V.Kobets, I.N.Mechkov, V.F.Minachkin, V.G.Chabratov, G.D.Chirkov (Joint Institute for Nuclear Research, Dubna, Russia)

Physical starting of the first section of accelerator LINAC-800

In work results of a construction and physical starting of the first section of a linac of electrons LINAC-800 are given. The program of works on this accelerator is discussed.

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P.5. P.Shatunov, D.E.Berkaev, A.Borisov, I.Koop, N.A.Mezentsev, E.Perevedentsev, Y.Shatunov, D.Shwartz (Budker Institute of Nuclear Physics, Novosibirsk, Russia); A.Valishev (Fermilab, Batavia, Illinois)

Magnet Structure of the VEPP-2000 Electron-positron Collider

Electron-positron collider VEPP-2000 with beam energy up to 1 GeV is under commissioning at Budker Institute. This paper presents magnetic elements of the storage ring including 13T focusing superconducting solenoids in interaction regions. Features of magnet elements design and magnetic measurements results are given together with comparison to previously calculated data.

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Poster session: Heavy-ion accelerators and electron cooling

P.6. M.I.Brizgunov, A.V.Bubley, V.M.Panasiuk, V.V.Parkhomchuk, V.B.Reva (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Particle motion features in the storage ring with the longitudinal magnetic field.

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P.7. E.S.Masunov, S.A.Kostin, A.V.Samoshin (Moscow Engineering Physics Institute (State University), Moscow, Russia)

Ion Beam Focusing Methods in Superconducting Low Energy Linac

Ion superconducting linac is based on independently phased cavities. The low charge state beams require stronger transverse focusing. This focusing can be reached with the help of electric or magnetic quadruples, SC solenoid lenses and RF fields. In this paper the various focusing methods are compared for low ion velocities.

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P.8. A.V.Bubley, M.I.Brizgunov, V.M.Panasiuk, V.V.Parkhomchuk, V.B.Reva, M.A.Vedenev, V.A.Vostrikov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Ion storage ring at low energy with high intensity and electron cooling

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P.9. D.V. Pestrikov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Space charge limit on the intensity of an ion coasting beam during its electron cooling

The cooling of an ion beam increases strengths if its space charge forces and the nonlinearities of such forces. These variations change the stability conditions for transverse coherent oscillations of the ion beam and the shape of the stability diagram of these oscillations. The beam cooling holds until the coherent frequency shift of the beam approach the border of its stability diagram. Without special efforts this phenomenon defines a nonresonant limit on the attainable value of the Laslett tune shift of the ion beam during its electron cooling.

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P.10. Y.V.Korotaev, I.N.Meshkov, V.N.Pavlov, A.U.Rudakov, A.O.Sidorin, P.I. Shmidkov, S.L.Yakovenko (Joint Institute for Nuclear Research, Dubna, Russia)

Generation and accumulation of low energy positrons

The cryogenic source of low energy positrons based on the 22Na isotope had been designed at JINR. A Solid neon as moderator has allowed to form slow positron beam at energy 1,2 eV and width of the spectrum 1 eV. Such positrons are accumulated after in the Penning-Malmberg trap. Description of the installation and experimental results are presented in this paper. This work is supported by RFBR grant # 05-02-16320

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P.11. I.Meshkov, R.Pivin, A.Sidorin, A.Smirnov, G.Trubnikov (Joint Institute Nuclear Research, Dubna, Russia)

Beam dynamics in storage rings simulation. BETACOOL code.

BETACOOL program developed by JINR electron cooling group is a kit of algorithms based on common format of input and output files. The program is oriented to simulation of the ion beam dynamics in a storage ring in presence of cooling and heating effects. The version presented in this report includes three basic algorithms: simulation of r.m.s. parameters of the ion distribution function evolution in time, simulation of the distribution function evolution using Monte-Carlo method and tracking algorithm based on molecular dynamics technique. General processes to be investigated with the program are intrabeam scattering in the ion beam, electron cooling, interaction with residual gas and internal target.

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Poster session: Accelerating structures and high-power electronics

P.12. V.Vogel, Yo.Ho Chin, Sh.Matsumoto, Sh.Takomoto, M.Akemoto (High Energy Accelerator Researcher Organization (KEK), Tsukuba, Ibaraki (V. Vogel since August 2005 at DESY, Germany)); V.Revkov, D.Valyaev, U.Valyaev, A.Fogel (Branch of Institute of Nuclear Physics (BINP), Protvino, Russia); E.Kokin, A.Volkov, A.Cherepenko (Budker Institute of Nuclear Physics, Novosibirsk, Russia); A.Malenkov (Institute of High Energy Physics (IHEP), Protvino, Russia)

IGBT MODOLATOR FOR X-BAND KLYSTRONS

The Solid State Induction type modulator was developed at KEK for the JLC project. This modulator was design for tunnel installation. The modulator consist from two oil-filled tanks, the first is for two klystrons and the second for pulse transformer. The pulse transformer consist from 42 core made from Finmet3 material, each core is drive by voltage 3.2 kV by two IGBT plates in parallel, one of them has core reset circuits. The total number of IGBT plates is 84. Each core has one turn at primary and transformer has four turns for secondary. This modulator can drive: short up to 1.6 microsecond, high voltage up to 500 kV pulse with current up to 540 A for two X-band 75 MW klystrons. The pulse top flatness is 2%. The expected modulator efficiency is about 75%. The step one of the modulator test was done in the summer of 2005, 300 kV of output voltage and full current at 1 pps was achieved.

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P.13. V.V.Repkov, S.S.Vasichev, V.F.Veremeenko (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Bidirectional Precision Current Source for Superconducting Solenoids.

This paper describes a precision bidirectional current source VCH-300-10 designed for supplying superconducting solenoids. This device has the following parameters: - output current -300 0 +300A, - output voltage -10 0 +10V, - current long-term stability 0,005%, - power grid harmonics ripple level no more than 10mV. This device has both manual and PS control. PS control uses RS-232 and USB interfaces.

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P.14. Sadovoi G. S. (Novosibirsk State Technical University, Novosibirsk, Russia)

FEATURES OF THE PHYSICAL PHENOMENA IN THE HIGH-POWER UHF ELECTRONICS

The status of the ultrahigh frequency (UHF) powerful generators for accelerators is discussed. Characteristics and limiting parameters of accelerators of the charged particles always were defined by opportunities of radio engineering systems. High-frequency systems contain generators which output cascades are executed on powerful grid-controlled tubes. In the project of the powerful UHF generator intended for use in accelerators of the charged particles, ways of the decision of two tasks are offered: increase of efficiency of the generator; increase of factor of amplification with the purpose of reduction of number of cascades. Typical parameters of power electronics are huge: power up to 1014 W, voltage U up to 107 V, current up to 106 A, current density J up to 109 A/cm2. It is obvious, that in such high current beams it is necessary to take into account the phenomena dependent on space-time ratios. For research of these phenomena for a basis the concept of the author about general applicability of a principle of variability is accepted. We receive equality criterion of length of a particle wave and electron distances in a beam. A trajectory of electron at presence of a magnetic field is bent under action of Lorentz force. Due to this the density of a current grows, and the distance between electrons decreases and with other things being equal becomes big, than in case of absence of a magnetic field. At the same time there is an opportunity of that the De Broglie wavelength appears comparable with electron trajectory length. The appropriate ratios for this case are examined. Calculations of electric modes of the powerful triode or tetrode are carried out with use of computer modeling. The theory of the nonlinear physical phenomena in powerful tubes is developed. Problems of mathematical modeling arising at it are solved with use of object-oriented

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P.15. I.A.Frejdovich, P.V.Nevsky, V.P.Sakharov, M.Yu.Vorob'ev, Yu.N.Gavrish, V.M.Nikolaev, A.S.Alimov, V.I.Shvedunov, Yu.D.Chernousov, V.I.Ivannikov, I.V.Shebolaev, H.Yamada, A.Kleyev, E.A.Knapp, W.P.Trower (Toriy, Russia)

Multi-beam klystrons with reverse permanent magnet focusing system as the universal RF power sources for the compact electron accelerators.

High power multi-beam klystrons with reverse permanent magnet focusing system destined for electron accelerators are produced by SRPA "Toriy" since 80-th. In this report we describe six types of pulsed and continuous wave S-band klystrons and present some details of electron accelerators which are fed by these klystrons. We also describe parameters of the perspective C- and X- band klystrons for miniature electron accelerators and L-band klystron for superconducting accelerator, which can be built following the same technology.

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P.16. P.Avrakhov (Physical Technical Central of Lebedev Physical Institute, Protvino, Russia)

Traveling Wave Accelerating Structure for a Superconducting Accelerator.

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P.17. I.I.Averbukh (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Accelerating cavities with amorphous iron

Some questions of the application of amorphous iron in accelerating cavities for proton and ion synchrotrons are considered. The comparison with devices based on ferrites is given and some description of existing working devices are given also.

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P.18. G.N.Ostreiko, K.N.Chernov, V.N.Korchuganov, G.V.Kuznetsov, I.G.Makarov, S.I.Ruvinsky, G.V.Serdobintsev, V.V.Tarnetsky, M.A.Tiunov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Electron Injector for Linear Accelerator of TNK Facility

The paper presents the electron injector for the linear accelerator of TNK facility (Zelenograd). The injector has rather simple design because of realized injection scheme with no prebunching. The beam is divided into bunches directly by the accelerating RF field of the linear accelerator. The injector block diagram is presented, the process of electron beam bunching and acceleration is described.

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P.19. K.Chernov, A.Frolov, Ye.Gusev, N.Kot, S.Krutikhin, I.Kuptsov, G.Kurkin, I.Makarov, N.Matyash, L.Mironenko, S.Motygin, V.Osipov, G.Ostreiko, V.Petrov, A.Popov, E.Rotov, I.Sedlyarov, G.Serdobintsev, A.Shteinke, V.Tarnetsky, V.Volkov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Startup of RF System for VEPP-5 Booster Ring

RF system for VEPP-5 booster ring has been created at Budker INP. It operates at 700 MHz and consists of the RF power source based on KU-393 klystron, waveguide section with wave-to-coax transitions, accelerating cavity, and control system. The cavity higher order modes are damped by resistive loads to eliminate the beam instability. Results of the cavity cold tests and RF system high power level tests are presented.

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P.20. V.S.Arbuzov, Yu.A.Biryuchevsky, A.A.Bushuev, E.I.Gorniker, E.K.Kendjebulatov, A.A.Kondakov, I.A.Koop, S.A.Krutikhin, Ya.G.Kruchkov, I.V.Kuptsov, G.Ya.Kurkin, N.V.Mityanina, S.V.Motygin, V.N.Osipov, V.M.Petrov, A.M.Pilan, A.M.Popov, V.P.Prosvetov, E.A.Rotov, I.K.Sedlyarov, Yu.M.Shatunov, A.G.Tribendis, V.N.Volkov, S.V.Volobuev (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

STATUS OF 172 MHZ RF SYSTEM FOR VEPP-2000 COLLIDER.

The description of storage ring VEPP-2000 RF system is given. The RF system consists of an RF generator with a tetrode GU-101A in the generator output stage and with output power of 60 kw in CW mode, an accelerating cavity with damping of the high orders modes (HOM) and accelerating voltage of 120 kV and a control system providing tuning of RF cavity and control of accelerating voltage phase and amplitude. Detailed description of operation of automatic frequency tuning system of choke-filter, which prevents a leakage of RF power of the accelerating mode to one (of two) HOM dumper, and a system of automatic frequency tuning of cavity operating mode is given. The results of RF system commissioning are given. Now the RF system is made, assembled and installed to the storage ring.

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P.21. G.V.Serdobintsev, O.V.Anchugov, K.N.Chernov, I.N.Churkin, A.V.Filiptchenko, A.S.Medvedko, G.N.Ostreiko, S.I.Ruvinsky, S.V.Sinjatkin, A.G.Steshov, S.V.Tararyshkin, V.A.Ushakov, V.D.Yudin (Budker Institute of Nuclear Physics, Novosibirsk, Russia); I.Yu.Boiko, N.N.Grachev, V.P.Khramtsov, N.V.Spinko (Lukin State Research Institute for Problems in Physics, Zelenograd, Russia); A.M.Dolgov, O.E.Kildisheva, RIPR, St. Peterburg. V.N.Korchuganov, Yu.V.Krylov, D.G.Odintsov, A.G.Valentinov, Yu.L.Yupinov (Kurchatov Institute, Moscow, Russia)

Status of the Linear Accelerator of TNK Facility

TNK facility (F.V. Lukin Institute, Zelenograd) was designed and manufactured at Budker INP. It includes 80 MeV electron linear accelerator-injector and two electron storage rings: the main ring for energy of 2.5 GeV and booster ring for energy of 450 MeV. The paper presents the functional layout of the linear accelerator. The disk-and-washer 2.8 GHz accelerating structure is described. Results of the accelerator startup is presented. In December 2005, accelerated electron current of ~50 mA with energy of ~50-60 MeV was obtained; the beam was captured into the booster ring.

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P.22. A.E.Levichev, Yu.D.Chernousov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

The prototype's characteristics of the cavity for excitation of parallel coupled RF accelerating structure.

The prototype of the cavity for excitation of the parallel coupled RF structure is performed as a segment of conventional rectangular waveguide with short circuit on one side and coupling aperture on the other side. It is loaded by reactive rods to decrease the wave length from Lg to L0. The oscillation type is TE105. The operating frequency is 2450 MHz. The report presents dependence of the resonance frequency on the reactive rods height; measured quality factor for the TE105 oscillation type; measured field amplitudes inside the cavity. The aspects of connection of the exciting cavity with accelerating cavities and waveguide tract are considered. The working cavity for excitation of the parallel coupled accelerating structure for electron energy 5 MeV and frequency 2450 MHz will be developed on the basis of this prototype.

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P.23. V.S.Arbusov, E.I.Gorniker, S.A.Krutikhin, I.V.Kuptsov, G.Ya.Kurkin, , V.N.Osipov, V.M.Petrov, A.M.Pilan, I.K.Sedlyarov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

RF system of Minor Storage ring of Technological Storage ring Complex

The status of the commissioning of the RF system of the minor storage ring for Technological SR source is discussed. This minor storage ring is designed as independent SR source and as injector for major storage ring of the Technological SR source complex. The component parts of RF control system, RF power amplifier 34.52 MHz 5kW and RF cavity are described. Initial results of measurements and tests are presented.

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P.24. A.D.Chernyakin, V.R.Kozak, S.P.Petrov, S.S.Vasichev, V.F.Veremeenko, Yu.M.Velikanov, V.G.Volohov (Budker Institute of Nuclear Physics, Novosibirsk, Russia).

Powerful Precision Current Source IST-1000-100 for Magnetic Systems of accelerators magnetic systems.

This paper describes a precision current source 1000A 100V designed for supplying storage ring magnetic systems. This device has the following parameters: - current long-term stability: 0,005%. - output current ripple level no more than 0,01%. The device is controlled by PC using CAN interface.

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P.25. V.S.Arbuzov, E.I.Gorniker, E.K.Kenjebulatov, A.A.Kondakov, S.A.Krutikhin, Ya.G.Kruchkov, I.V.Kuptsov, G.Ya.Kurkin, S.V.Motygin, V.N.Osipov, V.M.Petrov, A.M.Pilan, A.M.Popov, E.A.Rotov, I.K.Sedlyarov, A.G.Tribendis, V.N.Volkov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Feedback system for damping of longitudinal bunch oscillations in VEPP-4 collider.

In order to luminosity increase in VEPP-4 collider at BINP, it was acceded to increase the current in four-bunch mode (2e-2e+) from 5мA up to 30мA in each bunch. One of the problems on the way to current increase is instability associated with longitudinal bunch oscillations. A feedback system is being developed for bunch oscillations control. The feedback system consists of two identical parts, each works with separate amplifier of 100 W and deals with only one type of particles. Each part contains two channels: one for damping of inphase oscillations, another for damping of antiphase oscillations. Decrement due to the feedback system is about 3000 1/s, that exceeds the decrement due to radiating losses approximately by 180 times.

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P.26. V.G.Kurakin (Lebedev Physical Institute, Moscow, Russia)

Coupling Strength and Cavity Detuning Calculations for the rf Resonator Excited Over an Aperture

Bubnov-Galerkin method is used to calculate the coupling strength and cavity detuning for an rf cavity that is connected to a rf waveguide over a rectangular aperture in cavity surface. Both these so call external parameters are of a value in order to develop properly accelerating system of an accelerator, microton for example. In this method, electrical fields on coupling aperture surfaces are approximated by finite sums coordinate functions and expansion coefficients are founded out by appropriate procedure of join of solution of neighboring regions. In Bubnov-Galerkin method, this procedure provides energy flow continuity while crossing coupling surfaces, and this provides fast convergence of appropriate infinite sums. Appropriate expressions for aperture conductances are derived, followed by numeric calculations.
Waveguide standing wave ratios as well as cavity detuning are represented as functions of conductances mentioned.

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P.27. E.I.Zhmurikov, P.V.Logachev (Budker Institute of Nuclear physics SB RAS, Novosibirsk, Russia); A.I.Romanenko, O.B.Anikeeva, Yu.V.Lavskaya, L.G.Bulusheva, A.B.Okotrub (Nikolaev Institute of Inorganic chemistry SB RAS, Novosibirsk, Russia); S.V.Tsybulya, O.G.Abrosimov (Boreskov Institute of Catalysis SB RAS, Novosibirsk, Russia)

THE INVESTIGATION OF ELECTRONIC STRUCTURE OF PRISTINE CARBON COMPOUNDS FOR PRODUCTION OF NEW MATERIALS BASED ON ^{13}C ISOTOPE FOR NEUTRON CONVERTER

The creation of intensive source of high-energy neutrons based on proton accelerator is the important task of high-energy physics. The neutron producting target is a principal part of the neutron source. Materials for making the neutron target must be with high strength to high temperature. While working neutron target has took from a beam and has remove 150-200 kW at a spot 1 sm^2 size during continuous process. The carbon nanomaterial containing large quantity of ^{13}C isotope are the most perspective material for strict conditions. The aim of this work is to investigate the electronic properties of starting substance composed of ^{13}C isotope, using the X-ray fluorescence spectroscopy, quantum chemistry calculation and conductivity measurements. From analysis of X-ray fluorescence spectra we can attain the information about material valence band structure and about electronic interaction between carbon atoms during a formation of chemical binding. The density of C2π-state for the spectrum of substance composed of ^{13}C is increased in comparison with the spectrum of graphite. The analysis of the X-ray diffraction of the starting substance composed of ^{13}C shows to the presence of graphite particles with 20A and 40A thickness in equal parts. Temperature dependence of a relative conductivity $\sigma(T)/\sigma(300K)$ for ^{13}C samples with higher density was measured. This dependence can be submitted as power one, where the power is close to 1. Such character of temperature dependence for conductivity in principal can be connected with the unelastic resonance tunneling mechanism in intercrystalline phase, or three-dimensional quantum correction to the conductivity of carbon-carbonic composite. So C_{150} graphen structure was modeled, and it has a size about 20A. For the proposed structure of the C_{150} structure quantum-chemical calculations (B3LYP method, 6-31G** basis set) were made. On the base of the result of this calculation the theoretical CKα - spectrum of the graphen was obtained. Also the theoretical CKα-spectra of the graphite was obtained taking into account carbon atoms of central hexagon of the C_{150} graphen. The theoretical spectrum of graphite agrees closely with the experimental one.

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Poster session: Control and diagnostic systems

P.28. V.R.Mamkin, P.A.Selivanov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Can bus gateway for data acquisition and control

The new controller, used for CAN bus based automation, is described. Controller (CANGW) is developed in the BINP and wide used for data acquisition and power sources control. The main features of CANGW are: Linux 2.4 kernel, available SDK, Ethernet and CAN interfaces.

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P.29. E.N.Dementyev, V.R.Kozak, E.A.Kuper, A.S.Medvedko, A.D.Oreshkov, A.V.Ovchar, T.V.Salikova, P.A.Selivanov, S.S.Serednyakov, E.N.Shubin, S.V.Tararyshkin, N.A.Vinokurov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

The architecture and basic hardware components of FEL control system

In this article the architecture of control system of Free Electron Laser for the Siberian Center for photochemical research is presented. The basic structure of whole control system and the basic hardware components of individual subsystems are described. Also the hardware interfaces and main types of control devises, used for connection and control are shortly described. The main features of each subsystem and of whole control system are enumerated. Also the main features of control software are described.

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P.30. M.G.Fedotov, A.N.Selivanov, S.M.Pischenuk (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Progressive-scan digital television camera for the particle beam monitoring.

New version of progressive-scan digital television camera on the basis of Fast Ethernet interface was developed. Camera is intended for the measurement of position and parameters of particle beams in the VEPP-4 and VEPP-2000 storage rings by the using of synchrotron radiation. In the report the structure, key parameters and some features of the new camera are described. The assumed directions of further camera modification and the corresponding schemes of its application in the physical experiment are discussed too.

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P.31. E.Miginsky, V.Repkov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Control systems of superconducting magnets fabricated in Budker INP

General principles of automation of superconducting multipole magnets (wigglers) delivered to centers of synchrotron radiation in Germany, Canada, Italy and other countries are described. The following items are considered in the presentation: - monitoring of the basic parameters of a wiggler (temperature distribution, helium consumption, pressure in a cryostat, etc.); - setting and maintaining of the main field (currents); - developing of users interactive codes; - modification of the software according to requests of customers. Main results of works are presented.

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P.32. A. Barladyan, D.Dorohov, S. Tararyshkin (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Controller of the piston-type expander machine for cryogenic system of the KEDR detector

Due to a piston-type expander machine of the helium refrigerator with cooling power of 600 W the total consumption of liquid helium by the superconducting magnet system of the KEDR universal electromagnetic detector for general purpose created for experiments with e+e- collider VEPP-4M (BINP, Novosibirsk, Russia) could be decreased by factor of two. For exploiting the expander machine, an electronics controlling its valves and allowing adjust a mode of its work is necessary. Developed system consists of the controller and program for PC interacting with it.

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P.33. A.Batrakov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

The usage of signal shape digitizer in the daily operation at BINP accelerator facilities

At present, many parameters at BINP accelerator facilities are continuously measured, using signal shape digitizers. These devices are the part of beam diagnostic systems, magnet power supply "watch" systems, local experimental setups, control room information systems and so on. Signal shape digitizers have been developed at BINP and directed to physical applications. Physics-friendly features of these devices are discussed. The most popular usages are reported also.

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P.34. Cherepanov V.P. (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Video Pulse Power Amplifier for Accelerator Technology Applications.

Video pulse power amplifier for VEPP-4M storage ring vertical betatron oscillations damping system is designed. Low level signal band of the amplifier is 0.5-50MHz, impulse power is 400W. The amplifier is fulfilled in standard "Cherry", width of module is 80mm. In sight the amplifier will find application in betatron frequencies measurement systems of accelerators and storage rings and as preamplifier in RF systems of heavy particles beams accelerators. In the report the amplifier parameters and base elements are described. At present time one of the amplifier prototype is used in beam spin resonant depolarization system on storage ring VEPP-4M. Design documentation for production of small set of the amplifiers is prepared.

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P.35. A.Batrakov, P.Vagin, D.Shichkov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Hardware and software for precise magnetic measurements with moving coils

The method of magnetic measurement with the help of moving coils is the most important measurement method for particle accelerator magnets. Although this oldest of the currently used method have remained unchanged for a very long time, the electronic equipment and software have been subjects to continual development and improvement. Report describes a new set of specialized electronic modules intended for measurement with moving coil. This set includes Integrator with Digital Output (Digital Flux meter) and Low Noise Zero Drift preamplifier. The principles of operation and main characteristics of these devices are discussed. A few systems, based on described equipment, are built up during last two years. These systems used different coil configuration: rotating coils, flip-flop coils, stretched wire. Parameters of systems are reported. Finally, the description of software, developed for moving coil measuring systems is presented.

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P.36. Yuelin Li (Argonne Naitonal Laboratory, USA)

Application of laser techniques for accelerator-based radiation sources

The marriage of laser and accelerator technology is promising in broadening the scope in scientific research and technology development. In this paper, we discuss applications of laser techniques in accelerators. The topics include: 1) signal distortion of single shot electro-optical sampling technique for particle beam profile measurement; 2) the techniques for 3-D laser pulse shaping to generate the much desired ellipsoidal beam in photoinjector; and 3) a Thomson-scattering scheme for generating short-pulse, high-flux Gamma ray radiation and its potential for generating ultrashort position beams. * Work supported by U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences under Contract No. W-31-109-ENG-38.

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P.37. V. N. Zamriy (Joint Institute for Nuclear Research, Dubna, Russia)

Diagnostic Front-End Assemblies for IREN Facility Linac Control

The approaches to modular instrumentation systems under discussion, provide various allocation levels of signal processing, as well as the supervisory levels included into the control structure for the designed facility. The system nodes, which provide handling of signal groups, as well as desirable on-line data processing, have been offered to equip the pulsed facility. This work considers some features of the distributed assemblies intended for the timed data taking and control of the electron linear accelerator. The front-end assemblies for diagnostics of duty cycles and state transitions for protection control of IREN facility linac, are developed. Besides, the realized front-end signal-processing units are presented.

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P.38. Boriskin V.N., Mitrochenko V.V., Perezhogin S.A., Popenko V.A., Savchenko A.N., Shevchenko V.A.,Tatanov V.I. (NSC KIPT, Kharkov, Ukraine)

MONITORING POSITION OF THE ELECTRON BEAM IN THE AIR.

A possibility of the operative control position of the electron beam with energy from 20 to 90 MeV, pulse currents up to 1A and operate frequency 50 - 300 Hz at the exit of two-structure electron linac has been investigated. The irradiated samples are situated in ambient air of the linac bunker. Special secondary emission monitors are developed for the operative control of the beam position on the target. The monitor signals are used by linac control system.

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P.39. B.Gudkov, A.Filipchenko, V.Kozak, E.Kuper, G.Kurkin, A.Medvedko, G.Serdobintsev, S.Tararyshkin, V.Ushakov, (Budker Institute of Nuclear Physics, Novosibirsk, Russia); V.Korchuganov, Yu.Krylov, A.Valentinov, Yu.Yupinov, KCSR RSC Kurchatov Institute, N.Spinko, (LSRIPP, Zelenograd, Russia).

REVISION OF ZELENOGRAD SYNCHROTRON RADIATION FACILITY CONTROL SYSTEM

Control system of Zelenograd Synchrotron Radiation facility, designed at the end 80-th last century, is in commission now. Old system was CAMAC based mainly. More advanced variant will consist in replacement of CAMAC modules with the embedded controllers. The report describes new hardware and software solutions.

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P.40. E.A.Kuper, A.D.Oreshkov, A.V.Repkov, T.V.Salikova, D.A.Sklokin, S.V.Tararyshkin, N.A.Vinokurov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Radiation Dosimetry Diagnostic System of FEL

In this article is described the radiation dosimetry diagnostic system of the powerful terahertz Free Electron Laser constructed in the Siberian Center for Photochemical Research. Radiation dosimetry system contains the new technological decisions: hardware and software intended for the radiation's monitoring and tracing of losses of a beam in the vacuum chamber.

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P.41. E.V.Bykov, S.V.Tararyshkin (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Measuring system with fiber-optical interface.

The system represents as eight ADCs. Each ADC module has 2 independent channels with range of measurement 3V. The modules connected with computer through optical fiber which take possibility to use the system for measuring parameters under high voltage. A realization of the system and its basic parameters introduced in the report.

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P.42. V.Kaplin, S.Karnaev, I.Morozov, O.Plotnikova (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

The precision measuring temperature system of the electron-positron collider VEPP-4M

The temperature of the magnets is an important factor of the average energy stability of the circulating bunches. The work describes the VEPP-4M temperature measurement system based on 32 channel temperature controllers using High-Precision Digital Thermometers DS1621 and DS1631 with the resolution 0.02 and 0.06 degrees centigrade respectively. Temperature values are renewed for the all of 32 channels of each controller every second automatically. The controllers are connected to PC via serial interface RS232/RS485. The program running in PC inquires all controllers and writes data to database in terms of PostgreSQL at every minute. The graphic interface provides browsing of the temperature diagrams of the selected sensors over any period of time. The programs run under Linux and use Motif library.

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P.43. V.P.Cherepanov, E.N.Dementev, A.S.Medvedko, V.V.Smaluk, D.P.Sukhanov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

The VEPP4-M transverse bunch-by-bunch feedback system

The fast head-tail and coupled-bunch instabilities are the reasons of the increased beam emittance, energy spread and of the operating current limitations and beam loss. For suppression of any excited transverse mode of the beam oscillation the wide-band bunch-by-bunch digital feedback system have been developed and installed on the VEPP-4M storage ring. A description of the system parameters and architectures, of the available diagnostic tools and of the experimental results is given.

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P.44. D.Liakin, O.Sergeeva, Vl.Skachkov (SSC of Russian Federation Institute for Theoretical and Experimental Physics, Moscow, Russia); P.Forck, T.Giacomini (GSI, Darmstadt, Germany); Vic.Skachkov, A.Vetrov (NPI at MSU, Moscow, Russia)

Magnetic system for residual gas monitor

The advanced residual gas monitor requires very careful design of each structural component and special attention to match the properties of different subsystems. An important point is a proper magnetic guiding system design. As it is shown, high field uniformity, which is required for sub-mm spatial resolution, can be achieved despite the presence of the field-distorting hole for the light signal transmitting. The low energy (down to 10 MeV/u) beam disturbance compensation methods are also discussed. The ionization process and electron dynamics simulations are used for proving this system design.

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P.45. D. Korotkov, A. Feschenko (Institute for Nuclear Research, Moscow, Russia)

Development of negative hydrogen ion beam diagnostics for INR Linac using laser photo detachment

The H-minus injector construction along with the injection line for the INR Linac is under completion now and the first acceleration of negative ion beam is scheduled for 2007. The noneperturbing beam diagnostics using the laser induced photo detachment effect is being developed. The emittance measurements in the injection line at 400 keV with detection of neutrals downstream of the bending magnet as well as several other detectors for higher energies with detection of the detached electrons are considered. The configuration of the detectors and their parameters are described.

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P.46. E.A.Gusev, V.V.Oreshonok, O.V.Pirogov, D.P.Sukhanov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

The RF phase and amplitude monitoring system of the VEPP-5 preinjector

The VEPP-5 500 Mev preinjector has some 2856 MHz power klystrons and others RF devices to drive the accelerating modules. The amplitude and phase control of RF power for the energy doubler device (SLED) and for the preinjector accelerating section is necessary. The system of the RF parameters manipulation and of the precision monitoring is created. A description of this system parameters and architectures, of the available diagnostic tools and of the experimental results is given.

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P.47. S.Korepanov, S.Khodyachykh, M.Krasilnikov, A.Oppelt, V.Paramonov, F.Stephan (DESY, Germany)

Comparison of RF deflecting structures for future beam phase space studies at PITZ

A detailed characterization of the longitudinal and transverse phase space of the electron beam provided by the Photo Injector Test Facility at DESY in Zeuthen (PITZ) is required to optimize the photo injectors for Free-Electron Laser (FEL) applications. By means of the RF deflector the transverse slice emittance and the longitudinal phase space can be analyzed. In this paper we compare two standing wave and one traveling wave deflecting cavities. We present comparisons of beam dynamic simulations of the measurements with these cavities. This work has partly been supported by the European Community, contracts RII3-CT-2004-506008 and 011935, and by the 'Impuls- und Vernetzungsfonds' of the Helmholtz Assciation, contract VH-FZ-005.

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P.48. E.A.Bekhtenev, E.N.Dementev, S.M.Gurov, G.V.Karpov, P.V.Logatchev,A.S.Medvedko (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

BEAM POSITION MEASUREMENT SYSTEM IN VEPP-5 PREINJECTOR

A new beam position measurement (BPM) system has been designed, manufactured and tested in VEPP-5 preinjector. This system measures position of single electron and positron bunches for each injection cycle with help of stripline pickups. New BPM electronics provides more high sensitivity with respect to existing one developed in 1998. The system can measure the position of bunches with 10^8 particles per bunch. The whole dynamic range is from 10^8 to $5*10^{10}$ particles per bunch. The resolution of measurements of single bunch is better than 20 microns for 10^{10} particles per bunch. The features of system design, the main parameters and results obtained in VEPP-5 preinjector are presented.

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P.49. S.E.Karnaev, M.Khelik, M.V.Kollegov, V.R.Kozak, E.A.Kuper, A.N.Selivanov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Intelligent digital to analog converters for VEPP-4M magnetic system.

VEPP-4M collider has been worked since 80th. Growing expenses for maintenance of obsolete electronics make us to conduct a number of modernization programs. The problem is in keeping of facility in operating state during modernization process. To achieve it we have decided to implement new electronics on modern components but pin-to-pin and bit-to-bit compatible with obsolete prototypes. It allows keeping intact software and replacing old equipment by hidden way. There were described two of these new devices. They are intelligent multichannel DACs for controlled power supplies. VEPP-4M includes approximately 300 power supplies for bending magnets and steering coils controlled by these devices. One device provides 16 channel of DAC with resolution 16 bit and accuracy better than 0,01%. The second device is intended for precise power supplies for bending magnets and provides resolution 20 bits and accuracy up to 0,001%. The paper covers different aspects of design and resolved problems and shows achieved results.

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P.50. E.G.Miginskaya, I.I.Morozov, V.M.Tsukanov, A.A.Volkov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Temperature stabilization of RF- cavities of VEPP-4M Electron-Positron Facility

Temperature variation of RF-cavities leads to a change of their geometrical sizes that provides undesirable cavity modes and to excitation of phase oscillations. It leads to decrease in luminosity and a beam life time. Flowing water heaters with stabilization of temperature have been established for elimination of this disadvantage. Temperature probes LM335 were used with a sensitivity of 10 мВ per degree. The power part is made on the controllable switches CPV240. The analysis of temperature of input and output temperatures of water is carried out by microcontroller ADAM connected to a computer by means of interface RS-485. The temperature variation have been reduced from 5 to 0.2 degrees centigrade. That has led to decrease in probability of occurrence of parasitical phase oscillations more than in 100 times.

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P.51. Vladimir Ovchar, Eduard Kuper (Budker Institute of Nuclear Physics, Novosibirsk, Russia); Knud Dahlerup, Petersen Gert-Jan Coelingh.

ARC DETECTOR SYSTEM FOR EXTRACTION SWITCHES IN LHC CERN.

Cluster of 8 electro-mechanical D.C. breakers will be used for current interruption and fast extraction of magnetic field energy to dump resistors in the superconducting chains of main dipoles and quadrupoles in LHC (Large Hadron Collider), CERN, Switzerland. Parallel connection (four brunches) and series connection (two in series) will be used in cluster for current and voltage matching. Contact erosion as usual occurs in the slowest branch, in two breakers from eight in cluster. The number of interruption is limited by contact erosion and some parts need replacement after some interruptions with arcs. The total number of breakers in the system is 256. For breakers resources registration and for prophylaxis works facilitation the 8 channels Arc Detector was designed. Each channel consists of light signal integrator, comparator and counter of events. Spark Detector for registration of discharges in power RF generators and feeders was designed on the base of Arc Detector

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P.52. A.N.Kyrpotin (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Measurement of beam oscillations spectrum in BEP.

The system for measurement beam betatron oscillations in BEP booster (VEPP-2000 collider complex) is described. At the time of injection when beam oscillations are excited, the system collects array of amplitudes of the impulses induced by flying bunch on each turn. These amplitudes depend on position of the beam and are modulated by betatron oscillations which spectrum is accessible after corresponding processing. The system works with frequency of injection cycle, about once a second, and allows to measure betatron tunes "in fly" during magnetic structure reconfiguration.

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P.53. E.Bekhtenev, E.Dementev, A.Frolov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Beam Position system for collider VEPP-2000 and VEPP-5 dumping ring

A beam position measurement (BPM) system for VEPP-5 dumping ring and VEPP-2000 has been developed in BINP. The electrostatic pickup is used for beam position measuring, 4 in VEPP-2000 and 16 in VEPP-5 dumping ring, and electronics is same. BPM system is able to measure the position of each of 1-4 bunches at every turn for beam current range 1-100mA. Diameter vacuum chamber is 40mm. The resolution of measurement of the single bunch is about 100 microns for beam current of 10mA. It is possible the average up to 32000 revolution. The features of system design, the main parameters and results obtained in VEPP-5 dumping ring are presented.

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Simulation of INR RAS DTL frequency stabilization system

Theoretical modeling by means of Matlab Simulink program and experimental investigation of heat processes in the INR Linac drift tube tanks allow studying influence of these processes at the tank resonance frequency and creating of the frequency control system model. At that, the main attention is paid to accordance of modeling results and processes in the real systems. In turn, creation of control frequency system model gives a possibility to optimize the structure and parameters of the control system, stabilizing tank resonance frequency, and increase the accelerator operation efficiency.

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INTELLECTUAL CRATE-CONTROLLER K167

This paper describes hardware and software of ICC-controller K167, developed for modernization of Kurchatov synchrotron radiation source (KSRS) automated control system (ACS). K167 is based on SBC-computer of miniMODUL167 type, programmable logical integrated circuit CPLD XC95288XL and being controlled by RTX-166Full V4.0 RTOS. Controllers K167 are installed into 18 crates and connected to the LAN server of ACS (automated control system) through CAN-bus. They will control CAMAC devices developed in Budker Institute of Nuclear Physics SB RAS.

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IST DISTRIBUTED DAQ SYSTEM FOR INR LINAC

The INR Linac is intended for acceleration of H+ and H- ions. DC power supply of quadrupole doublets of the INR Linac is realized by means of stabilized current sources (SCS) IST type. The Distributed Data Acquisition (DAQ) System, based on ADAM blocks (5000/485), was designed and put into operation for the SCS distance control. In this paper the structure, right choice of communication protocol and hardware are specified. In process of DAQ system designing some peculiarities of SCS operation was taken into account: placement of SCS at a long distance (more then 300 m) and work in conditions of high electromagnetic disturbances.

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P.57. Y.Krylov, K.Kouznetsov, L.Moseiko, N.Moseiko, Y.Yupinov (RRC Kurchatov Institute, Moscow, Russia)

ENHANCEMENT OF VACUUM MONITORING SYSTEM OF KCSR ACCELERATOR FACILITY

The vacuum monitoring system of Kurchatov Center of Synchrotron Radiation is built on current measuring of sputter ion pumps mounted over vacuum chambers of accelerating units. Measuring hardware designed in INP SB RAS is using CAMAC standard and has been operating for a decade now. Hardware upgrade is accomplished by installing a PC workstation, connected through CAN bus to an in-house crate controller. Developed software comprises three levels. Firstly, there is a low-level program running inside the crate controller under RTX-166 operational system. Secondly, we have SQL Server database with client program, whose function is to create the queries at workstation side. And finally there are high-level applications running over network needed to display a current facility status and a data processing.

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P.58. V.G.Kurakin, V.P.Busygin, V.M.Alekseev, A.V.Koltsov, P.V.Kurakin (Lebedev Physical Institute, Moscow, Russia)

Instrumentation for Computer Based Monitoring and Control System Deployment

We have developed the kernel basis of hard and software tools to deploy computer based monitoring and control system for experimental and industrial complexes. Hardware part consists of interface devices that provide external data acquisition as well as steering signals production to control physical equipment. Software is FlexUsI – program tool that provides several functions. First, it allows building up user interface of any desired configuration for measurements and control. This procedure is the filling in appropriate forms (future measurement console) with appropriate virtual devices that are program components corresponding to real hardware interface devices mentioned above and their configuration by filling in necessary information in special tables. Second, it provides real time measurement and control immediately after interface construction. At last, it provides hardware interface control as well as hardware auto configuration in a manner similar to plug and play in modern computers. The key feature of visual programming system described is that it works at program run time. The instrumentation developed was used to deploy computer based monitoring and control system for Lebedev Physical institute accelerator complex.

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P.59. O.V.Chutko, A.V.Spiridonov (National Instruments, Moscow, Russia)

PXI data acquisition systems for beam diagnostics, RF cavity tuning and magnetic system diagnostics.

The world wide usage of National Instruments PXI modular instruments and multichannel data acquisition systems in development of accelerator control and diagnostics systems will be presented. The single platform could be used in many kinds of applications such as beam diagnostics, RF cavity tuning and magnetic system diagnostics. The fast adoption of LabVIEW software and PXI hardware to new tasks allows to rapidly create distributed multichannel DAQ systems for accelerators.

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P.60. Markus Stockner, Bernd Dehning, Ewald Effinger, Jonathan Emery, Gianfranco Ferioli, Gianluca Guaglio, Eva Barbara Holzer, Daniel Kramer (CERN, Switzerland)

MEASUREMENTS AND SIMULATIONS OF IONIZATION CHAMBER SIGNALS IN MIXED RADIATION FIELDS

The LHC beam loss monitoring (BLM) system must prevent the super conducting magnets from quenching and protect the machine components from damages. The main monitor type is an ionization chamber. About 3500 of them will be installed around the ring. The lost beam particles initiate hadronic showers through the magnets, which are measured by the monitors installed outside of the cryostat around each quadrupole magnet. They probe the far transverse tail of the hadronic shower. The specification for the BLM system includes a factor of 2 absolute precisions on the prediction of the quench levels. To reach this unprecedented accuracy a number of simulations are being combined to calibrate the monitor signals. To validate the monitor calibration the simulations are compared with test measurements. This paper will focus on the development of the hadronic shower tail and the signal response of the ionization chamber to the various particle types and energies. Test measurements have been performed at CERN and DESY and compared to GEANT4 simulations.

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P.61. A.Artemiev, V.Korchuganov, V.Rezvov, V.Moiceev, V.Novikov, A.Valentinov, Yu.Yupinov, A. Zabelin (RRC Kurchatov Institute, Moscow)

Betatron motion coupling control in the electron storage ring Siberia-2 in Kurchatov Center of Synchrotron Radiation

For synchrotron radiation (SR) sources - the dedicated electron (positron) storage rings - a high brightness of a photon beam represents the most interest. In turn the brightness of SR depends oppositely on the transverse phase volumes (emittances) of an electron beam as radiation source. For the given optical structure a horizontal emittance of electron beam is determined, mainly, by quantum fluctuations of SR, whilst vertical emittance is defined, basically, by a level of a coupling (width of a resonance) between vertical and horizontal betatron oscillation of particles. It is reported in the work that the control of the betatron coupling factor in SIBERIA - 2 storage ring in Kurchatov institute reaches a level of 0.001 with the use of skew-quadrupoles. Closed orbit distortions control at a micron level, an arrangement and the forces of skew - quadrupoles also are the objects of research. Experimental dependence of the electron bunch transverse sizes on the coupling factor is presented.

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Poster session: High intensity cyclic and linear accelerators

P.62. T.A.Yaskina, S.M.Gurov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Positron beams in VEPP-5 injection complex linear accelerator

Injection complex VEPP-5 which is currently under construction at BINP is designed to provide BINP VEPP-4 and VEPP-2000 colliders with intense electron and positron beams. Positrons are generated by 300 MeV electron beam incident on Ta target. In order to optimize the beam transport through the downstream linac the code that simulates dynamics of positrons in real linac fields was developed. Recent experimental and computer simulation results are presented. Positrons number of $6*10^8$ in a single bunch is achieved that corresponds to positron yield of 0.1 1/GeV.

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P.63. O.Belyaev, Yu.Budanov, I.Zvonarev, A.Maltsev, E.Mazurov, V.Stepanov, S.Strekalovskyh, V.Teplyakov, N.Turin (State Research Centre of Russia Institute for High Energy Physics, Protvino, Russia)

Status of Linac URAL-30M - Novel Injector to Accelerator Complex of IHEP

The URAL-30 proton linac was commissioned in 1977. It applies a through front-to-end RFQ-focusing up to the top energy of 30 MeV. Since 1985 till now, this facility operates as an injector to IHEP booster. A-few-year-long scientific research efforts and computer simulations allowed to launch design of a novel, upgraded machine. This accelerator, URAL-30M is currently being manufactured in IHEP. Accelerating rate in URAL-30M is greater then in old injector, in RFQ by means of electrode's shape and in RFQ-DTL (RFQ Drift Tube Linac) by means of increasing voltage in accelerating gaps. For the time being, a conventional RFQ and three of four RFQ-DTL sections (up to 22 MeV) are assembled and subjected to pre-commissioning tests. Fourth is being tuned. In this machine, measures are foreseen to facilitate a better section-to-section matching of beam. New injector exhibits a higher shunt impedance and enable much an easier assembly of the electrodes. Preliminary testing of the first two RFQ-DTL sections of URAL-30M indicates that emittance growth is now significantly lower, as compared to its predecessor. All the more, URAL-30M has a shorter length of 23.4 m.

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P.64. F.A.Emanov, S.M.Gurov, P.V. Logachev, T.V.Rybitskaya (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Electron linear accelerator of VEPP-5 preinjector

The main purpose of VEPP-5 complex is to produce intense electron and positron bunches for e+e- colliders (VEPP-4, VEPP-2000). Complex consists of a preinjector for the production of e+e- bunches and their acceleration up to an energy of 510 MeV, and a damping ring. The paper presents 300 MeV electron linac of VEPP-5 preinjector which gives birth to high quality electron bunches.

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P.65. M.F.Blinov, R.M.Lapik (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Positron system of VEPP-5 Injection Complex

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P.66. I.Meshkov, V.Shvets, V.Piataev, A.Sumbaev, V.Kobets (Joint Institute for Nuclear Research (JINR), Dubna, Russia)

Linac LUE-200. Status Of The Project

In the report the status of the project of the S-band electron linear accelerator LUE200 - the driver of a resonant neutron source IREN in the Joint Institute for Nuclear Research is presented.

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Poster session: Superconducting accelerators and cryogenic technology

P.67. V.N.Volkov, Ya.G.Kruichkov, V.M.Petrov, A.G.Tribendis(Budker Institute of Nuclear Physics, Novosibirsk, Russia), D.Janssen (FZ Rossendorf, Germany)

Stop-filter of superconducting RF gun cathode assembly

Photocathode radio-frequency (RF) guns of electron beams on the basis of superconducting cavities call major interest in the world. In many laboratories the drafts of making of such RF guns are considered. In BINP in cooperation with FZ Rossendorf (Germany) the prototype of such RF gun was developed, made and successfully tested. On the basis of these engineerings in FZ Rossendorf (for the accelerator ELBE) the creating of full scale RF gun with 3.5 cell superconducting cavity is in progress now. The stop filter allows to prevent a leakage of RF power from the cavity along the cathode assembly. The stop filter is integrated with the cathode assembly [1]. In the paper the perfected construction of the stop filter tested in the prototype of a superconducting RF gun is considered. [1] V.N. Volkov et al. Cathode assembly of photocathode superconducting RF gun. // this conference.

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P.68. V.N.Volkov, V.M.Petrov (Budker Institute of Nuclear Physics, Novosibirsk, Russia), D.Janssen (FZ Rossendorf, Germany)

Overview of advantages and new possibilities of superconducting RF guns

Photocathode radio-frequency (RF) guns of electron beams on the basis of superconducting cavities call major interest in the world. In many laboratories the drafts of making of such RF guns are considered. In BINP in cooperation with FZ Rossendorf (Germany) the prototype of such RF gun was developed, made and successfully tested. On the basis of these engineerings in FZ Rossendorf (for the accelerator ELBE) the creating of full scale RF gun with 3.5 cell superconducting cavity is in progress now. In the paper the advantages and new possibilities of a superconducting RF guns developed under the work at the prototype are considered.

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P.69. V.N.Volkov, Ya.G.Kruichkov, V.M.Petrov, A.G.Tribendis (Budker Institute of Nuclear Physics, Novosibirsk, Russia), D.Janssen (FZ Rossendorf, Dresden, Germany)

Cathode assembly of superconducting photocathode RF gun

Photocathode radio-frequency (RF) guns of electron beams on the basis of superconducting cavities call major interest in the world. In many laboratories the drafts of making of such RF guns are considered. In BINP in cooperation with FZ Rossendorf (Germany) the prototype of such RF gun was developed, made and successfully tested. On the basis of these engineerings in FZ Rossendorf (for the accelerator ELBE) the creating of full scale RF gun with 3.5 cell superconducting cavity is in progress now. The cathode assembly allows to integrate normal conducting cathode into the superconducting cavity. In the paper the perfected construction of a cathode assembly tested in the prototype of a superconducting RF gun is considered.

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Poster session: Magnetic systems, power supply and vacuum systems for accelerators

P.70. D.Gurov, O.Kiselev, I.Morozov, A.Ogurtsov, V.Petrov, E.Ruvinsky, A.Sukhanov K.Zhilayev (Budker Institute of Nuclear Physics, Novosibirsk, Russia); D.Cornuet, D.Gérard, W.Kalbreier, S.Ramberger, G. de Rijk (CERN, Switzerland)

Normal-Conducting Separation and Compensation Dipoles for the LHC Experimental Insertions

The experimental insertions of the LHC employ normal-conducting magnets to provide for part of the beam separation and to compensate the effect of two large spectrometer dipoles. In the interaction regions IR1 for the ATLAS experiment and IR5 for the CMS experiment, each of the optical elements D1 for beam separation on either side of the experiment consist of 6 MBXW dipoles. Each magnet has a core length of 3.4 m, a large single aperture with a gap height of 63 mm and will operate in the field range up to 1.5 T. The MBXWT and MBXWS magnets are shorter versions of the MBXW magnet and will be used as vertical and horizontal compensation dipoles for the spectrometer dipoles in IR2 for the ALICE and in IR8 for the LHCb experiments respectively. The MBXWT and MBXWS have a core length of 1.5m and 0.75m respectively. Additionally on MBXW magnet serves as a main compensator for the LHCb experiment. The magnet design was done in collaboration between CERN and BINP and the dipole magnets are produced by BINP. So far all three MBXWS, all three MBXWT and thirteen of twenty-nine MBXW magnets including spares have been manufactured and delivered to CERN. The report presents the main design issues and results of the acceptance tests including mechanical, electrical and magnetic field measurements

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P.71. V.V.Anashin, A.N.Dranichnikov, R.V.Dostovalov, A.V.Evstigneev, L.G.Isaeva, A.A.Krasnov, V.S.Kuzminykh, L.M.Schegolev, Yu.M.Shatunov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

The vacuum system of the VEPP-2000 storage ring

Perimeter of VEPP-2000 is 24.4m only and the average density of SR flux is 1.2*10E19 photon/s per meter and SR power is 1000W per meter at maximum design currents Ie-=Ie+=200mA. Special SR receivers are used along the total length of the ring except interaction regions and RF cavity. An intense gas load due to photon stimulated desorption should be compensated by high enough molecular pumping speed. VEPP-2000 high vacuum system consists from different parts: 8 vacuum chambers inside the dipole magnets, vacuum chambers of the solenoids, experimental and technical straight sections and vacuum chamber of the RF cavity. VEPP-2000 high vacuum pump system consists from 16 ports with ion-getter pumps PVIG-100 situated on the bending magnets vacuum chambers edges; ion- getter pump PVIG-250 connected with resonator area; 4 cryopumps presented by solenoid cold surface. To prevent SR heating of cryosurface at T=4.2 K a perforated cooper liner have been made that is cooled by liquid nitrogen. Slits in the liner should provide linear pump speed at rate of 5 l/sec/cm for nitrogen. Cold surface at 4.2 K is the ideal pump for all residual gases except hydrogen, since after adsorption more than one monolayer of hydrogen at T=4.2 K saturated vapor pressure the one reaches 5*10E-7 Torr. In spite of such circumstances calculations showed the beam lifetime will be determined of CO residual pressure. By now the vacuum system has been made, assembled, pumped and baked in-situ at 200C. The obtained average pressure in vacuum chamber of storage ring is better than 10E-9 Torr. But pressure is about 10E-9 Torr inside resonator vacuum chamber baked in-situ at 120C.

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P.72. S.Krutikhin, V.Arbuzov, D.Starostenko (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Preliminary power amplifier for HF generator of small ring Siberia-1

Semiconductor preliminary power amplifier used for Siberia-1 booster HF power generator excitation. Maximum output power at operating frequency is 500W. A distinctive feature of this amplifier is an ability to operate at frequencies from 1MHz to 40MHz at maximum output power of 400W.

P.73. A.V.Akimov, P.A.Bak, I.V.Kazarezov, A.A.Korepanov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

The modulator for the 10 MeV 2 kA inductive accelerator pulse power supply

For the 10 MeV 2 kA electron inductive accelerator pulse power supply the modulator prototype operating in two-pulse regime has been developed. The modulator is used for the resistively-inductive load supplying with the pulse voltage 20 kV, current up to 10 kA, 300 ns pulse duration. The data obtained at the nominal modulator operation regime are presented. The basic technical developments of the modulator parts and the modulator design are described.

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P.74. N.A.Vinokurov, G.Ya.Kurkin, L.E.Medvedev, L.A.Mironenko., A.D.Oreshkov, T.V.Salikova, M.A.Scheglov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Vacuum system of FEL

In this article is described the vacuum system of the powerful terahertz free electron laser constructed in the Siberian Center for Photochemical Research. Vacuum system of FEL contains the new technological decisions: standby blocks - power supply of pumps; hardware and software intended for the vacuum's monitoring and ensuring the protection of some technological units of FEL in case of vacuum's downturn

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P.75. H.Leibrock, G.Moritz (GSI, Darmstadt Germany); Q.Wang (IEE, Beijing, China); P.Yuan, Ma Lizhen (IMP, Lanzhou, China); S.T.Wu (ASIPP, Hefei, China); J.Lucas (ELYTT Energy, Spain)

Superferric Magnets for Super-FRS and Storage Rings of FAIR

The Super Fragment Separator (Super-FRS) is conceived as a large acceptance fragment separator, with three branches serving different experimental areas, including a new storage ring complex. Rare isotopes of all elements up to uranium can be spatially separated by the Super-FRS. Unique studies with these isotopes and antiprotons will be performed in the Ring Branch, consisting mainly of a Collector Ring (CR), the New Experimental Storage Ring (NESR), and the Recycled Experimental Storage Ring (RESR). A common requirement for the magnets of these systems is a large acceptance at moderate fields, which can be fulfilled by superferric magnets with wide apertures. Similar requirements for the Super-FRS and CR magnets allow using the same magnet designs for both systems, yielding a reduction of costs and development time. Rare ions and anti-protons will be decelerated in the NESR and RESR, thus requiring pulsed magnets. This requires a coil design different from CR and Super-FRS. The cryostat design has to prevent large eddy current losses. This paper describes the status and development of the aforementioned superferric magnets. Differences and common features will be clarified.

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P.76. Dmitry Shvedov, Oleg Anchugov, Yury Matveev (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

High-voltage nanosecond generators system for injections - extraction kickers of FEL complex DUKE University

Booster-synchrotron of the maximum energy of 1.2 GeV has been created to increase the current in the Storage Ring electron bunches. The Storage Ring is expected the operating modes of 2, 4 and 8 bunches. The booster will be used to accelerate 19 electron bunches with the possibility of their extraction in SR FEL at the frequency of 25 Hz. This system allows to inject the bunch from linear accelerator into the booster with the minimal loss of particles and then to realize bunch-by-bunch extraction into the main ring in the energy range of 250 MeV-1.2 GeV.

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P.77. V.I.Davydenko, A.S.Krivenko, N.E.Popova (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Experimental study of the stripping target with differential pumping for 10 mA, 1.25 MeV ion beam.

An electrostatic tandem-accelerator with 2.5 MeV 10 mA proton beam is under development at BINP. One of the accelerator important parts is a target that converts the half energy accelerated negative hydrogen ions into the proton beam. To reduce argon flux from the target to accelerator gaps a gas recirculation by turbomolecular pump installed in high voltage electrode is provided. To study the argon recirculation and the plasma production in the stripping cell an experimental test stand is prepared. Results of experimental modeling of differential pumping with different length of tubes for ion beam pass are presented. Ionization of the target by 500 eV electrons is studied by injecting a corresponding electron beam.

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P.78. A.M.Bertyaev, N.N.Alexeev,V.I.Nikolaev, V.A.Schegolev (ITEP, Moscow, Russia)

Lambertson septum magnet for the U-10 ring slow extraction system

The ITEP 10 GeV proton synchrotron U-10 is upgraded for acceleration of ions to be utilized in experiments using fast extraction and internal target technique that in operation now. The slow extraction system based on the sextupole resonance in vertical plane with ejection trajectory deflection in horizontal direction using Lambertson type septum magnet is under construction. Optimization of the magnet construction has been performed to make a septum as thin as possible with maximum magnetic field in deflection gap and minimum fringe field in the orbit vicinity solving also the problems of high vacuum environment and moving off dissipated power. Results of the magnet construction optimization are presented.

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P.79. P.A.Bak (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

SOLID-STATE SUBMICROSECOND GENERATORS FOR NON-DESTRUCTIVE SINGLEPASS MONITOR

Method of generating high power pulses with nanosecond rise and fall times is described. This method is based on the use of series operation of power IGBT and MOSFET devices. Experimental results show that pulses can be generated with amplitudes of more then 3 kV, rise times in the range 2-4 nanoseconds and repetition rates of tens thousand Hertz.

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P.80. A.Batrakov, S.Belokrinitskiy, P.Budz, I.Churkin, N.Nefedov, A.Philipchenko, E.Rouvinski, E.Semenov, D.Shichkov, S.Sinyatkin, A.Steshov, P.Vagin (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

MULTIPOLE MAGNETS FOR THE METROLOGY LIGHT SOURCE (PTB, BERLIN)

The Metrology Light Source (MLS), a specialized synchrotron radiation source (electron energy up to 600 MeV) being built at the PTB in Germany. The multipole magnets of the Storage Ring consist of 24 quadrupoles, 24 sextupoles and 4 octupoles manufactured by Budker INP. The quadrupole magnets of 165 mm length have gradient of 13 T/m and aperture of 70 mm. The sextupole magnets of 80 mm length have strength of 280 T/m2 and aperture of 76 mm. The octupole magnets of 80 mm length have strength of 2400 T/m3 and aperture of 86 mm. The main features of magnetic modeling and manufacture are described in the paper. The multipoles were magnetically measured by Rotating Coil System and main results of the magnetic measurements are also presented.

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P.81. S.Minaev, O.Sergeeva, Vl.Skachkov (SSC of Russian Federation Institute for Theoretical and Experimental Physics, Moscow), A.Lombardi, E.Sargsyan, D.Cornuet, W.Venturini (CERN, Geneva), Vic.Skachkov (NPI at MSU, Moscow).

Permanent magnet quadrupole for the 1-st tank of LINAC-4

Rare-earth 60 mm diameter, 45 mm long quadrupole for the LINAC-4 focusing channel on the integrated gradient of 2.3 T is described. The thin side washers are used for tuning the quad into specified gradient integral with 0.5 % accuracy. The single washer contribution calculations are discussed. A method of the magnetic axis offset in the REPM quad decreasing down to 30 mm is discussed to exclude its compensation by the outer diameter machining before inserting into the drift tube. Nonlinearity of the field is less than 1 % in the reference range of 75% of beam aperture at the central cross-section near the quad axis. The angular quadrupole arrangement in the drift tube will be provided by machining the main groove on the quad surface in the median plane with 1 mrad accuracy. Calculations of the longitudinal gradient distribution between two closer quadrupoles showed that some percents should be added to the nominal gradient in the beginning of the LINAC-4 focusing channel because of partial field compensation.

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P.82. I.A.Gusev, A.S.Medvedko, A.Yu.Protopopov, D.N.Pureskin, D.V.Senkov, Yu.F.Tokarev, V.D.Yudin (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

High-voltage source with output voltage up to 60 kV with power up to 15 kW

The presented report contains the description of a high-voltage source with output voltage up to 60 kV with power up to 15 kW. The source consist of the converter whit IGBT switches, working with a principle of pulse-width modulation on 20 kHz frequency, and high voltage sectioned transformer with the rectifier. The schematic configuration and the optimal matching of the rectifier to the load has allowed minimizing the energy stored at the reactive components of the high-voltage stage at the level less than 15 J for 60 kV operation. The design of the high-voltage transformer provides preservation of working capacity at voltage up to 100 kV. A nominal output voltage of the source is 60 kV. The efficiency of system is more than 80% at the nominally output power. The controller of the source is developed with DSP and PLM, which allows optimizing operations of the source. For control of the source serial CAN-interface is used. The description of the source and the test results are presented.

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P.83. A.N.Dovbnya, V.V.Zakutin, N.G.Reshetnyak, V.P.Romasko, I.A.Chertishchev (Kharkov Institute of Physics and Technology, Kharkov, Ukraine)

A PULSED MODULATOR TO ENERGIZE THE SECONDARY-EMISSION ELECTRON SOURCE OF THE TECHNOLOGICAL ACCELERATOR

Experiments were made to investigate a pulsed modulator intended to energize the electron accelerator based on the secondary-emission electron source. The accelerator with a great pulse length (8 - 40 mks) and a pulse repetition rate up to 10 Hz is designed for material-surface treatment. To form long pulses in the modulator (with reservoir capacitor discharge through a step-up transformer), the nonlinear properties of the pulse-transformer core material are used, while the top of the pulse is formed through summation of a short spike and a flat-topped long-duration pulse. At a load resistance of 4300 Ohm; a voltage pulse with a spike amplitude of ~ 150 kV and a flat-topped pulse with an amplitude of ~ 130 kV of ~ 16 mks duration and a repetition frequency of 3 Hz were obtained. During formation of the beam with a current of ~ 100A the amplitude of the flat part of cathode voltage made ~ 100 kV.

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P.84. A.A.Pachkov, P.A.Bak (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

HIGH VOLTAGE DECOUPLED HIGH-CURRENT POWER SUPPLY

10 kW power supply (PS) with smooth adjustment of a load current from zero up to 2 кА is described. Depending on the load requirements operating modes with stability of a load current from 5% to 0.1% and long-term instability of 0.01% are possible. Power mains isolation is up to 35 kV. PS includes the high-frequency inverter, transformer-rectifier module and the control block. The high-frequency inverter is performed on progressive ZCZVS-PS-FB (Zero Cur-rent Zero Voltage Switching - Phase Shifted - Full Bridge) topology. It provides a full range load regulation with the minimal power losses. Dynamic losses of the inverter switching do not exceed 6%. The step-down transformer secondary winding has the form of a solid turn that allows to receive low leakage inductance and high working frequency. Rectifier block is based on the current symmetric doubler circuit. Total power losses of the transformer-rectifier module is about 15%. Thus, the high-frequency conversion and doubling of a load current allow to reach high power and low weight parameters of the device. The power supply control circuit is realized on an CPLD base by "ALTERA" firm. The intellectual algorithm of inverter management provides soft switching in a full range of load variations and precision stabilization of a load current. The remote control is carried out through the CAN-interface. Oscillograms of a power supply operating modes are presented, the received results are discussed.

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P.85. M.M.Basko, A.A.Drozdovsky, A.A.Golubev, A.Kancerev, A.E.Kochyaryan, Yu.B.Novojilov, B.Yu.Sharkov, V.B.Shvachkin (Moscow institute of physics and technology, Moscow, Russia), A.P.Kuznethcov, V.V.Yanenko (Institute for theoretical and experimental physics, Moscow,Russia), D.A.Sobur (Moscow engineering and physics institute, Moscow, Russia)

Investigation of the plasma lens for heavy ion accelerator ITEP –TWAC

The problem of transportation and focusing of an intense heavy-ions beam is an important issue for heavy ion beam-driven inertial confinement fusion and for investigation of high energy densities (HED) in matter produced by heavy ion beam. A plasma lens application has a number of essential advantages in comparison with traditional focusing system on a quadruple lenses basic [1]. Description of the plasma lens with the maximum of the current discharge in 250 kA for HED research on the heavy ion accelerator-accumulated facility TWAC-ITEP is presented [2]. The minimum beam spot size on a target which will get by using this plasma lens is 300 mm for 300MeV/u ion energy and the beam emittance 40 mm·mrad. The investigation of plasma discharge dynamic and a plasma parameters diagnostic in temporal and spatial resolution are reported. References [1] E. Boggasch, B. Heimrich, D.H.H. Hoffmann, Nucl. Instr.Meth.336 (1993), p.438-41. [2] B.Yu. Sharkov et al., Nucl. Instr.Meth. A464 (2001), p.1-5.

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P.86. V.V.Anashin, A.A.Krasnov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Experiments with TiZrV non-evaporated getter at BINP.

The aim of the presentation is a summary of Synchrotron Radiation experiments made at BINP (Novosibirsk, Russia) in 90K - 300K temperature range with TiZrV coated vacuum chambers. The sensitivity of applied method, the problem with scattered photons and photoelectrons, photon stimulated desorption, cleaning and pumping is under detailed discussion. The presentation includes the first results of XRF, XRD, EXAFS, SEY experiments and future proposed investigations.

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Poster session: Beam dynamics in accelerators and storage rings, cooling methods, new methods of acceleration

P.87. D.Kayran, V.N.Litvinenko (Brookhaven National Laboratory, USA)

Result of a merger system optimization in present of strong space charge force for high current BNL's R&D ERL

The R&D Energy recovery linac (ERL) is under construction in Brookhaven National Laboratory. This ERL will be used as a test-facility for many R&D projects relative with high current high brightness ERL's issues. One of the goals of this ERL is demonstrate electron beam with high charge (5 nC) per bunch and extremely low normalized emittance at maximum energy 20 MeV. In contrast with operational high brightness electron accelerators, axisymmetric systems operating normalized beam emittances at one mm-mrad level, all presently operating Energy Recovery Linacs (ERLs) produce in order of magnitude larger emittances in 10-to-20 mm mrad range. One of the reasons of emittance growth in merger system is the use of dipole magnets, which mix transverse and longitudinal degrees of freedom, and, consequently, can provide for conditions violating emittance compensation conditions. In this paper we discuss the reasons of emittance growth in merger system of the operational ERLs. We compare performances of the BNL's ERL system with the most popular ERL merger system designs.

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P.88. A.A.Asseev, P.T.Pashkov, S.V.Sokolov (Institute for High Energy Physics, Protvino, Russia)

New State of the Accelerated Beam at its Interaction With a Thin Internal Target During Extraction of Particles From the Accelerator.

In the process of investigations at the IHEP proton synchrotron (Protvino, Russia) of the new thin targets which cardinally improved the time structure of the beams extracted simultaneously for 5-6 experiments a new state of the circulating beam was discovered: the bunched beam of protons having the clear expressed single-turn structure after the fast ejection of 25 bunches changes its state due to interaction with the thin target and turned out in two phases - the bunched and debunched one simultaneously. The second phase of the circulating beam provides an improvement of the time structure of the extracted beams of the secondary particles and primary protons by about an order of magnitude. Influence of the thin target is universal: an appearance of the second phase of the accelerated beam on the flat top of the magnetic cycle does not depend on intensity (number of the accelerated bunches). It takes place even at injection from the booster and acceleration only a few (3-5 instead of 30) bunches.

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P.89. S.V.Miginsky, A.V.Bondarenko(Budker Institute of Nuclear Physics, Novosibirsk, Russia); B.C.Lee, S.H.Park, Y.U.Jeong, Y.H.Han

1.8 keV Compton X-ray source driven by SC linac at KAERI

A quasi-monochromatic X-rays source based on the KAERI SC linac system has been designed and is being manufactured now. 10 MeV 10 mA electron beam together with 20 W 1.06 um laser beam will be used for 1.8 keV Compton X-ray generation with a few percentage of energy spread and 10^7 photons per second. A simple straight beamline was designed to deliver the electron beam with no degradation of its emittance and energy spread and to focus it to a proper size to produce the desired X-rays. We expect the first demonstration of 1.8 keV Compton X-ray generation in autumn, 2006.

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P.90. S.V.Miginsky, A.V.Bondarenko (Budker Institute of Nuclear Physics, Novosibirsk, Russia); B.C.Lee, S.H.Park, Y.U.Jeong, Y.H.Han

An upgrade of SC linac at KAERI to ERL

A project of an ERL at Korea Atomic Energy Research Institute is described. The future ERL will be connected to the existing machine without any modification. It consists of two 180 deg. bents and two straight sections: one for an FEL, another for a Compton X-ray source. One can choose the source controlling the magnets. The total ERL is isochronous to avoid any problems with longitudinal beam instability. The total relative emittance degradation through the whole machine is 1.5. The FEL will be based on a 2 m helical in-vacuum undulator made of permanent magnets. One mirror of the optical cavity is blind and made of copper, the other one, the outcoupler, is semi-transparent and made of CVD diamond. The expected average FEL power is a few kW, the tuning range 35, ,70 um.

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P.91. A.V.Petrenko, A.V.Burdakov, A.M.Kudryavtsev, P.V.Logatchov, K.V.Lotov, and A.N.Skrinsky (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Design of an Experiment on Plasma Wakefield Acceleration at Budker INP

The project of an experimental facility based upon the VEPP-5 injection complex at Budker INP is described. Due to a good quality of electron beam and special beam preparation system based on arc bunch compressor the facility opens several possibilities for studies of the plasma wakefield acceleration: high peak beam currents, arbitrary beam profiles, and long term beam-plasma interaction (up to the full driver depletion). End-to-end simulations of the beam dynamics are presented. Due to nonlinear effects in the bunch compressor the peak beam current is limited to 3 кА. Coherent synchrotron radiation in magnets appears to be an important issue for maximum compression ratios resulting in manyfold increase of the initial beam emittance

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P.92. Petar Belicev, Nebojsa Neskovic, Milan Rajcevic (Vinca Institute of Nuclear Sciences, Belgrade), Evgeny Perepelkin, Alexey Vorozhtsov, Sergey Vorozhtsov (Joint Institute Nuclear Research /DLNP, Dubna, Moscow Region)

ION BEAM DYNAMICS SIMULATIONS FOR THE VINCY CYCLOTRON

The VINCY Cyclotron has to accelerate ions operating with the harmonic number of the RF voltage equal to 1, 2, 3 and 4. Two different central region configurations have been designed in order to satisfy the need for the broad ranges of ion species and energies that are expected to be obtained from the machine. The latest design of the spiral inflector, in the axial injection line, was used in the simulations. We present here only the results of the H–ion beam dynamics simulations. The ion tracking calculations were performed using the CBDA code. The electric and magnetic field maps were obtained using the TOSCA/OPERA3D and MERMAID codes. The measured magnetic field maps were also used. The main criteria used in the simulations were the good centering, the highest possible energy gain in the accelerating gaps, the maximal transmission through the central and acceleration regions, and the best possible quality of the ion beam at the extraction radius. The overall performance of the machine was optimized by adjusting the corresponding operational parameters.

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P.93. N.I.Ayzatskiy, A.N.Dovbnya, V.V.Zakutin, V.N.Boriskin, V.V.Mitrochenko, N.G.Reshetnyak, V.P.Romasko, N.A.Dovbnya (Kharkov Institute of Physics and Technology, Kharkov, Ukraine)

ELECTRON BEAM FORMATION IN THE SECONDARY-EMISSION SOURCES WITH A UNIFORM AND NONUNIFORM ELECTRIC AZIMUTHAL ELECTRIC FIELD

The paper reports the results of experimental studies on formation of electron beams in three types of secondary-emission sources. Experiments were carried out with a magnetron gun having a cylindrical anode (70 mm in diameter): 1) with a smooth cathode (40 mm in diameter) and a modified cathode: 2) with 4 longitudinal seams and 3) composed of 8 copper rods (5 mm in diameter). Parameters of beams were studied and beam indentations were obtained. In the first case the beam formation occurs with a current of ~40 A (at a cathode voltage of 40 kV) and an azimuthal uniformity of ±5 %. In the second case, at a field nonuniformity of ~30%, the azimuthal nonuniformity is ~15 A. In the third case, at a field nonuniformity of ~60% there occurs formation of 8 separate beams having the form close to the half-ring and with a total current of ~10A (at a cathode voltage of 30 kV). The beam current amplitude stability in all the cases was 2 ... 5 %.

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P.94. A.N.Dovbnya, V.V.Zakutin, N.G.Reshetnyak, V.P.Romasko (Kharkov Institute of Physics and Technology, Kharkov, Ukraine)

ELECTRON BEAM FORMING IN THE MAGNETRON GUN WITH SECONDARY-EMISSION CATHODES OF DIFFERENT MATERIALS

A magnetron gun with a cold secondary-emission cathode in crossed fields is used as an electron source in the high-energy RF-devices. Experiments were carried out using the secondary-emission cathodes made of different metals: copper, aluminum, titanium, stainless-steel (cathode diameter of 40 mm, gun length of 140 mm). In experiments the electron beam production was observed. It has been established that the beam current dependence on the voltage obeys to the 3/2 law. Experiments demonstrated that despite the fact that the coefficient of secondary emission in the case of aluminum and titanium is less than unity, the processes of secondary-emission multiplication take place, apparently, on the cathode surface oxide layers formed in technical vacuum below 10^{-5} - 10^{-6} Torr and with the presence of organic materials inside the chamber.

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P.95. E.I.Kolobanov, A.N.Matveenko, T.V.Salikova, S.S.Serednyakov, O.A.Shevchenko, N.A.Vinokurov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

The study of the energy recovery efficiency at Novosibirsk FEL ERL.

12 MeV energy recovery non-superconducting linac of the Novosibirsk terahertz FEL is put into operation in 2003. The efficiency of energy recovery was studied. The transversal and longitudinal beam halo was investigated by studying the dependence of the beam dump current on steering corrector strength and RF system parameters. Ways to increase energy recovery efficiency are discussed.

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P.96. Yu.D.Chernousov, V.I.Ivannikov, I.V.Shebolaev (ICKC, Novosibirsk, Russia)

Possibility of stabilizing the beam energy in resonant accelerator on the leading edge of the microwave pulse

The effect of transients in the accelerating cavity by successive switching of generator and beam is discussed. The possibility of stabilizing energy increase in the process of transition oscillations in the cavity is demonstrated. With allowance made for the beam current the delay of injection can be chosen in such a way that the amplitude and phase of oscillations in the cavity change so that the two factors compensate for each other. It allows to eliminate the energy spread caused by the transients.

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P.97. Vasily Kvardakov, Evgeny Levichev (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Nonlinear Characteristics of the TME Cell

The TME (Theoretical Minimum Emittance) cell is being used now for designing the lattice of different storage rings (SR sources, damping rings, FFAG accelerators, etc.). Strong sextupoles required to correct the natural chromaticity of the lattice reduce the dynamic aperture. In the paper we consider the main features of the nonlinear perturbation strength and its connection with the essential lattice parameters: horizontal emittance, betatron tunes, and natural chromaticity. The analytical results are compared with the computer simulation.

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P.98. M.I.Ayzatskiy, A.N.Dovbnya, V.A.Kushnir, V.V.Mytrochenko, A.N.Opanasenko, S.A.Perezhogin, V.F.Zhiglo (National Science Center "Kharkov Institute of Physic and Technology", Kharkov, Ukraine)

Injector of electron linac for NESTOR storage ring

Design of the compact S-band injector and results of simulation of particle dynamics are presented in the report. The injector consists of the low-voltage diode electron gun and a bunching system based on the resonant system with the evanescent oscillations. RF field increases in amplitude along the axis in such bunching system. RF power is supplied to the injector through a coaxial coupler. The injector can be supplied with two types of the guns: 25 kV, 250 mA and 25 kV, 1.5 A. The first gun will provide the linac with the electron beam in a long pulse regime (1500 ns) while the second one will be used in a short pulse regime (40 ns). The resonance system of the injector has been optimized to obtain the electron bunches with energy about 1 MeV, phase length less than 20° and energy spread less than 5% (for 70 % particles) at the linac entrance. The coaxial coupler allows applying the solenoid magnetic field along the bunching system. Influence of magnetic field configuration on beam parameters is described.

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P.99. Victor Smaluk (BINP SB RAS, Novosibirsk), Dieter Einfeld (ALBA, Bellaterra, Spain)

Impedance Estimation for the ALBA Storage Ring

In the framework of the Spanish Light Source CELLS project, an analysis of coupling impedance of the ALBA storage ring has been carried out. Broad-band impedance has been evaluated using the MAFIA code and analytical formulae, for various components of the ALBA vacuum chamber, such as cross section transitions, bellows, button-electrodes, strip-lines, high-order modes of RF cavities, etc.

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P.100. V.G.Kurakin (Lebedev Physical Institute, Moscow, Russia)

Self Consistent High Current Beam Dynamics in Racetrack Microtron

So far, pulsed racetrack microtron was evolved as an alternative to a classical microtron in order to increase an electron beam energy as well as to improve the beam quality. Lebedev Physical institute racetrack microtron seems to be the only one that does not fit the logic mentioned and demonstrates the efficiency of the parallel acceleration in a single rf structure compared to multi section rf linac for high intensity beams. The intensity auto modulation that had been observed for this machine does not results in absolute current limitation because could be overcome by better injection. To find out other limitations as well non traditional racetrack applications, the computer simulation of self consistent beam dynamics has been undertaken in this paper. Formulas for a acceleration cavity excitation by the electron beam and an external rf generator are derived, followed by numerical computer calculations of bunch train longitudinal dynamics. In this simulation, higher order symmetrical TM modes are taken into account. The results are presented in the form of the plots and histograms, the possible short beam pulse racetrack applications are discussed as well.

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P.101. A.N.Dovbnya, V.V.Zakutin, N.G.Reshetnyak (Kharkov Institute of Physics and Technology, Kharkov, Ukraine)

INVESTIGATION OF ELECTRON BEAM PARAMETERS IN MAGNETRON GUNS AT REDUCED VOLTAGES

The paper presents the results from investigations into the generation of electron beams and their parameters in magnetron guns with secondary-emission cathodes. The beam parameters were investigated for two cases. In the first case the magnetron gun cathode diameter was 40 mm, and the anode diameter was 70 mm. In the second case the magnetron gun cathode diameter was 2 mm, and the anode diameter was 7 mm. The experiments have shown that in the first case, with the anode diameter of 70 mm and the cathode voltage of 10 kV, the beam current was 7.5 A. The magnetic field value was 600 Oe. At a cathode voltage of 6 kV the beam current was 3A, however, then the amplitude and the triggering pulse decay rate should be increased to 100 kV/mks. In the second case at a pulse decay of ~1200 kV/mks and a cathode voltage of 7 kV the beam current was 2 A at a magnetic field value of ~3000 Oe. The beam current as a function of the amplitude and the magnetic field distribution was studied.

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P.102. K.V.Lotov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Acceleration of positrons by electron beam-driven wakefield in a plasma

Wakefield acceleration of positron beams in electron beam-driven nonlinear plasma wave is analyzed. Three effects are analyzed which complicate positron acceleration as compared to electron acceleration: trapping of plasma electrons by the plasma wave, narrow interval of the focusing phase of the wave, and wave distortion due to beam loading.

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Poster session: Radiation problem in accelerators

P.103. V.G.Barkova, A.V.Kiselev, V.J.Chudaev (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Evaluation of efficiency of concrete shielding against bremsstrahlung of 5.0 MeV electrons for adjustment works with the ILU-10 accelerator.

The article presents rated data for analysis of efficiency of concrete shielding against slant penetration of bremsstrahlung of 5.0 MeV electrons with due account of the angle-energy distributions of radiation from targets. Initial angle-energy distributions for aluminum, iron and tungsten targets have been obtained by direct Monte-Carlo simulation of interactions with the help of the program SCIN_PC. Then the value of air kerma was computed analytically and kerma attenuation by concrete shielding was estimated with application of available reference information. Kerma values at checkpoints behind the concrete shielding of the existing bench, which is intended mainly for electron accelerators of smaller energy, have been estimated. Bench operating restrictions for adjustment works with the ILU-10 accelerator have been formulated.

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P.104. Y.N.Adischev, V.I.Bespalov, A.V.Vukolov, A.P.Potylitsyn, K.P.Artemov (Tomsk Polytechnik University, Tomsk, Russia), K.V.Afanasiev (High-current electronics institute SB RAS, Tomsk, Russia)

The Dose Field of Nanosecond Pulse Source of Bremsstrahlung X-Ray Radiation.

The dose field map of the nanosecond accelerator on the basis of the vacuum diode supplied by the high-voltage nanosecond generator with the coaxial forming line combined with the transformer has been measured. The high-current electric beam created by the "blade" metallodielectric cathode has been measured too. The accelerated electrons at the collector from the stainless steel 1mm in thickness have generated the bremsstrahlung radiation. The dose field map has been taken by the dosimeter ДКД - 01 on the basis of the diamond detector in the median acceleration plane. The bremsstrahlung radiation beam divergence has left 62°. It has been shown that the maximum dose is 16 cGrey/s at the distance of 10 cm from the collector, then it falls down proportionally to the square of distance to the level less than 0.1 cGrey/s at the distance of 1 m. Literature

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Poster session: Accelerators for medical and industrial purposes

P.105. V.G. Abdul'manov, V.L. Auslender, F.A. Emanov, A.D. Panfilov, V.S. Podobaev, B.L. Faktorovich (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Linear ion accelerator ILU-9

The pulse RF ion linear accelerator of ILU-9-type is described. The accelerator is intended to use for various radiation-technological processes and investigations. The parameters of the accelerator and the ion beam measured during the tuning are given. The main parameters of the accelerator are: energy of accelerated protons 2.9 or 5 (with additional accelerating section) MeV, energy of accelerated deutons 5.8 or 10 MeV with energy 5 MeV per nucleon, average current of accelerated ions up to 100 μA. Pulse operating mode as following: pulse duration-500 s, maximum pulse repetition- 50 Hz. The frequency of accelerator resonator is 43 MHz. Also data of carbon ions C12+4 acceleration probability are given.

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P.106. A.A.Bondus, V.P.Gorbachev, R.V.Maksimov, V.P.Stepanchuk (Saratov State University, Saratov, Russia)

X-band Microtron in Saratov State University

The problems of mastering of X-band microtrons, achievements in creating of small-size transportable microtrons, are considered. The project of microtron with permanent magnet with compatible microwave and vacuum system is described. Perspectives of decrease of mass and size of X-band microtrons are discussed.

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P.107. A.A.Bryazgin, B.L.Factorovich, E.A.Kuper, V.V.Repkov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Modulator of electron injector of industrial accelerator ILU-10.

Presented work describes the modulator of electron current of the industrial accelerator ILU-10. The main target of building of the unit is decreasing of energy spectrum and stabilization amplitude of the accelerated current. The base of unit is HV linear DC amplifier (up to 5000V) with power (up to 5 A) MOS-FET output stage. It allows to create feedback and stabilize either current or energy of the beam. Also this unit has mode for tuning any shape of beam current and energy. Unit has microprocessor control circuit which provides useful link with computer control system of accelerator and if needed provides the handle operation and indicates main parameters of electron beam.

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P.108. Evgeny Perepelkin, Alexey Vorozhtsov, Sergey Vorozhtsov and Leonid Onischenko (Joint Institute Nuclear Research /DLNP, LPP Dubna, Moscow Region)

BEAM DYNAMICS SIMULATIONS FOR THE CUSTOMS CYCLOTRON

The compact isochronous cyclotron is considered as a source of 1.75 MeV protons for the detection of explosives using gamma ray resonant absorption technique. Given the marginal request for the beam intensity and quality H^- ions were selected for acceleration in the cyclotron aiming at the high efficiency extraction by electrostatic deflector. The tracking calculations were performed by the CBDA code. The electric and magnetic field maps were obtained by the TOSCA/OPERA3D and MERMAID codes. Internal and external injection regimes were tried to select from. The space charge effects of the ions were taken into account in the calculations. The main criteria, imposed in selecting of the operational parameters, were good centering, as high as possible energy gain of the ions in the accelerating gaps, the maximal particles transmission through the machine and the best possible beam quality at the final energy. The overall performance of the facility was optimized by adjusting the corresponding parameters of the cyclotron. Simulation of the interface between the cyclotron and the storage ring was performed in order to provide the required intensity and beam quality for injection to the storage ring.

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P.109. H.Dorschner, M.Stephan, U.Wagenknecht, G.Heinrich (Leibniz- Institute of Polymer Research Dresden, Dresden, Germany)

ELECTRON ACCELERATOR ELV-2 IN POLYMER RESARCH-DIRECT COUPLING OF POLYMER EXTRUSION FOR MODIFICATION IN MOLTEN STATE

In 1972, an universal irradiation plant was built for research and service at the Leibnitz-Institute of Polymer Research Dresden. The accelerator - an industrial machine of the series ELV - of Budker Institute of Nuclear Physics, Novosibirsk, Russia (BINP), operates in the energy range from 0.6 MeV to 1.5 MeV, the beam power maximum is 20 kW, and the beam current maximum is 25 mA. The treatment by electron irradiation is a special possibility to modify polymers. Several applications in plastics industry are well known, such as radiation induced degradation, crosslinking, grafting, curing, and polymerization. Very interesting chemical reactions are to be accepted by irradiation in molten state. High temperature, intensive macromolecular mobility and the absence of any crystallinity are some reasons for achieving unexpected structures, processing behaviour and property changes in treated thermoplastics and rubbers. For examples crosslinking of polyethylene is much more effective, and long chain branching of polypropylene can be generated. These modification effects are also achievable by a direct coupling of electron beam irradiation and conventional polymer extrusion processing. For this unique processing technique a special MOBILE RADIATION FACILITY (MOBRAD1/T) was designed, constructed and manufactured in the IPF Dresden at which a lab-scale single screw extruder was adapted directly to the accelerator to realize a prompt irradiation of extruded polymer melt profiles before their solidification.

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P.110. V.V.Tarnetsky, V.L.Auslender, K.N.Chernov, V.G.Cheskidov, B.L.Factorovich, V.A.Gorbunov, I.V.Gornakov, M.V.Korobejnikov, G.I.Kuznetsov, A.N.Lukin, I.G.Makarov, S.A.Maksimov, N.V.Matyash, G.N.Ostreiko, A.D.Panfilov, G.V.Serdobintsev, A.V.Sidorov, M.A.Tiunov, V.O.Tkachenko, A.A.Tuvik (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Status of Work on 5 MeV 300 kW Industrial Electron Accelerator Prototype

New industrial accelerator prototype with electron energy up to 5 MeV, average beam power of 300 kW, and duty factor of 14% is under construction at Budker INP. The work is supported by ISTC (Project #2550). At present, the design work is completed, the accelerating structure is under production at INP workshop. The paper presents a general description of the accelerator, its block diagram, and experimental results obtained at recent tests of the accelerating structure and injection unit.

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P.111. N.I.Alinovsky, A.D.Goncharov, V.F.Klyuev, A.V.Kozhemyakin, A.M.Kryuchkov, V. V.Parkhomchuk, M.V.Petrichenkov, S.A.Rastigeev, V.B.Reva (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Status of Accelerator Mass Spectrometer at BINP

Present status of the accelerator mass spectrometry (AMS) facility at BINP is described. The AMS facility with additional electric and magnetic analyzers into the terminal of tandem accelerator is dedicated for precise analysis of carbon isotopes. The results of experiments on ion beams acceleration and stripping are given.

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P.112. V.P.Laricheva, A.F.Korotkiy, V.V.Krayushkin, L.A.Smirnova, B.A.Kovalev, N.P.Chelnakov (Branch of FSUE "Karpov Institute of Physical Chemistry", Obninsk, Russia); Vymorkov N.V., Nikulina I.P. (FSUE ONTPP "TECHNOLOGIYA", Obninsk, Russia)

ELECTRON BEAM TECHNOLOGY FOR MANUFACTURE OF COMPOSITIONS WITH UNIQUE CHARACTERISTICS

Two types of complex solvent-free binders were developed in the course of scientific research for radiation-induced technologies used in the manufacture of large-size items. A manufacturing process could be accomplished through a single stage of radiation curing or through a two-stage procedure, which implies radiation manufacture of the long-lived prepregs and subsequent thermo-chemical hardening. The developed binders make it possible to obtain composition materials with high heat stability (glass transition temperature ~260°C) and radiation resistance (>10 MGy).

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P.113. E.Antokhin (Budker Institute of Nuclear Physics, Novosibirsk, Russia); T.Fujisawa, M.Kumada, T.Matsumoto and S.Wakasa.

Magnet system for PET cyclotron based on permanent magnets.

The number of positron emission tomography (PET) centers based on proton cyclotron is rapidly growing nowadays worldwide. It actually requests for simple, reliable and cheap proton cyclotron of energy 10-20 MeV to be designed for mass installations. Normally the magnet system for PET cyclotron is made with iron and copper coils. Although the some optimization of conventional "warm" magnet is possible, the another approach could be the magnet system based on permanent magnet, aiming the cost saving due to no needs of electric power during cyclotron life time. The permanent magnet system for 10 MeV PET cyclotron was designed, manufactured and measured. The present paper describes the cyclotron permanent magnet system as well as beam trajectory analysis in measured magnetic fields and RF system design.

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P.114. V.Aleksandrov, Y.Jongen, N.Kazarinov, V.Shevtsov, G.Shirkov, A.Tuzikov (Joint Institute for Nuclear Research, Dubna, Russia)

Screening of injection channels for superconducting cyclotron C400

Possibility to use 2D model for preliminary choice of shielding is discussed. The comparison with real 3D geometry is done. Results of simulations of the 12C6+, 2H+ and 4He2+ ion beam injection are presented.

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Neutron producing target for accelerator based neutron capture therapy

Pilot innovative accelerator based neutron source for neutron capture therapy of cancer is now on the threshold of its operation at the BINP. One of the main elements of the facility is lithium target producing neutrons via threshold 7Li(p,n)7Be reaction at 25 kW proton beam with energies 1.915 MeV or 2.5 MeV. In the present report, choice of target was substantiated. The main problems of lithium target were determined to be: 7Be radioactive isotope activation, keeping lithium layer solid, presence of photons resulted from proton inelastic scattering on lithium nuclei, and radiation blistering. The results of thermal testing of target prototype, investigations of radiation blistering, lithium evaporation and results of simulations are presented. It becomes clear that water is preferable for cooling this target, and that the lithium target 10 cm in diameter is able to run up to 25 kW proton beam before melting. In the report, the conception of optimal target is proposed: thin metal disk 10 cm in diameter easy for detaching, with evaporated thin layer of pure lithium from the side of proton beam exposure, its back being intensively cooled with turbulent water flow to maintain lithium layer solid. Design of target for the neutron source constructed at BINP is shown. Conceptions of moderator for epithermal neutron beam obtaining, radiation protection and diagnostics of neutrons, gamma-rays and alfa-particles are presented also.

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USE OF 2-8 MeV ELECTRON BEAM ACCELERATORS TO CONTROL ELECTROPHYSICAL PARAMETERS OF THE MULTILAYER SILICON STRUCTURES

For the last two decades electron and proton irradiation of the rectifying components (diodes, thyristors, etc.) has become an integral part of the controlled technology used in manufacture of the fast-acting power semiconductor instruments. The attempts have already been made to use the technology in fabricating low-frequency high-voltage power semiconductor instruments for decreasing deviation of the minority charge carrier lifetime over large space silicon multilayer structures. Accordingly, the requirements to reproducibility and homogeneous irradiation over the silicon structure become more rigid in order to decrease a contribution of the technology into the net cost of the products. Several ways are proposed in the paper to increase the efficiency of radiation technologies used in fabrication of the power semiconductor instruments. The results are presented for the leading decrease of the minority charge carrier lifetime in the bulky regions of the silicon structures irradiated with electrons of Ee $\geq$ 2MeV.

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Carbon Ion Accelerator Facility for Cancer Therapy

A carbon ion or proton beams are a superior tool to x-rays in both physical and biological doses in treating a cancer. A carbon beam has an advantage in treating radiation resistant and deep-seated tumors. The main limitation of wide application is a high cost of facility. This problem can be solved by our proton and carbon ion accelerator facility proposal on the base of Cold Beam Synchrotron. The main feature of the facility is an application of electron cooling device. The ion beam is cooled down and the beam emittance and an energy spread are decreased. The final high quality cold ion beam with small transverse emittance and momentum spread allows to decrease significantly the aperture of the synchrotron and components of high energy beam transfer lines.

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P.118. V.Kiselev, E.Levichev, V.Parkhomchuk, Yu.Pupkov, V.Vostrikov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Conceptual Design of Rapid Cycling Booster for Accelerator Facility for Cancer Therapy

The rapid cycling booster synchrotron is used as pre-accelerator for carbon ion facility for cancer therapy. Booster provides about 10^{10} carbon ions per second at extraction energy 30 MeV/unit, at a repetition rate of 10 Hz. At the same time the booster can be used for acceleration of protons and delivers about 10^{12} protons per minute at a maximum extraction energy of 250 MeV in separate irradiation port.

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RADIATION MODIFICATION OF POLYETHYLENE: INDUSTRIAL TECHNOLOGIES BASED ON EB ACCELERATORS

Radiation-chemical modification of polyethylene with accelerated electrons makes a basis of high-profitable industrial technologies, including: - manufacture of radiation-crosslinked polyethylene material and products, - manufacture of heat-shrinkable pipeline insulation material, - manufacture of heat-shrinkable polyethylene pipes for electrical engineering, - manufacture of heat-shrinkable polyethylene film. The paper gives a description of the commercial technologies and used equipment

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P.120. V.V.Krayushkin, B.I.Rubin (Branch of FSUE "Karpov Institute of Physical Chemistry", Obninsk, Russia)

METHOD FOR CALCULATION OF THE MAIN PARAMETERS OF ELECTRON BEAM ACCELERATORS USED IN INDUSTRIAL TECHNOLOGIES

A universal method was developed to calculate distribution of absorbed doze of the accelerated electrons in the energy range from 0.2 to 10 MeV. The method is used to make a final choice of the main parameters and electron beam configuration for industrial technologies.

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The use of betatron gamma-beam for digital radiographic technique

The problem of creation of the most effective high intensity x-ray radiation sources for a digital diagnostics in medicine and other fields remains actual till now. In the work, experimental results on design of digital radiographic set-up based on the bremsstrahlung source of betatron MB-6 are presented. Betatron has following parameters: electron energy is 6 MeV, beam current is 100 nA, frequency is 50 Hz, dose rate on bunch axis is 35mG/minute at distance 1m, thickness of tantalum target is 0.6 mm. The set of 640 gallium arsenide detectors with size 0.2x0.2x2 mm^3 with sensitivity in photon energy range up to 200 keV was used. The digital images of investigated object have been received by scanning technique. The use of thin betatron target allows avoiding self-absorption of bremsstrahlung photons in target. It will lead to increase in intensity of registered radiation by the detector and reduce an exposition time to achieve high level image quality and pattern contrast.

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P.122. V.G.Cherepkov, Yu.I.Golubenko, P.I.Kachalov, P.I.Nemytov, R.A.Salimov (Budker Institute of Nuclear Physics, Novosibirsk, Russia); Yang Jingtian

Based on two electron accelerators ELV disinsector of a grain in China (capacity up to 1000 t/h).

Budker Institute of Nuclear Physics (Novosibirsk, Russia) in cooperation with Tsinghua University and other institutions of China created a grain disinfector in Guangzhou district. When the disinfector was designed an experience gained during operation of Odessa Port elevator disinfector was being used. Two production lines for grain treatment are located in the detached building. Each line capacity is 500 tone/hour. In spring 2006 two ELV-8 accelerators have been put into operation at the grain disinfector plant.

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The facility for irradiation of shrinkable goods on the basis of the UELR-10-10T linac

A new facility for irradiation of shrinkable pipes has been put into operation in Obninsk branch of Physical and Chemical Karpov Institute in the end of 2005. The facility is made on the basis 10 MeV, 10 kW linear electron accelerator UELR-10-10T. This accelerator has high efficiency ~16% due to use solid-state modulator with energy recuperation to supply a klystron. The scanning system allows changing length of the vertical scanning field in the range of 90-170 cm with doses uniformity of +-5%. The pipes with length up to 170 cm and wall thickness of 6 mm are installing in three rows on the perimeter of a drum 3.7 m of diameter. The pipes are rotating around its axis during the irradiation process in order to ensure high uniformity of the doses and hereby good quality of shrinkable goods.

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P.124. B.A.Kovalev, V.V.Krayushkin (Branch of FSUE "Karpov Institute of Physical Chemistry", Obninsk, Russia)

RADIATION-CHEMICAL MODIFICATION OF SURFACE PROPERTIES OF POLYOLEFIN FILMS

A radiation-chemical technology has been developed at the FSUE "Karpov Institute of Physical Chemistry" for EB modification of the surface properties of polymeric films. The process makes it possible to manufacture continuously one- and two-side treated adhesive films of different polymers.

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P.125. N.G.Reshetnyak, A.N.Dovbnya, M.I.Ayzatskiy, V.N.Boriskin, V.V.Zakutin, V.P.Romasko, I.A.Chertishchev, N.A.Dovbnya (Kharkov Institute of Physics and Technology, Kharkov, Ukraine)

THE ELECTRON ACCELERATOR BASED ON THE SECONDARY-EMISSION SOURCE FOR MATERIAL-SURFACE TREATMENT

The electron accelerator for radiation technology purposes is being created at the NSC KIPT. The accelerator is designed to have a particle energy up to 200 keV and a beam power up to 5 MWt/cm2 at a voltage pulse duration between 8 and 40 mks and a pulse repetition rate up to 10 Hz. A magnetron gun with a cold secondary-emission cathode in cross fields is used as an electron source. Results are reported from the experiments on electron beam production in the magnetron gun (the diameters of the cathode and anode being 40 mm and 78 mm, respectively). The longitudinal magnetic field was measured to range from 1500 to 2300 Oe. In one of the modes of operation, an accelerated electron energy of ~ 100 keV was obtained (beam current 110 A, duration ~ 16 mks), the power density on the target was ~ 4 MW/cm2. Targets made from different materials (stainless steel, aluminum, etc.) were exposed to radiation.

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P.126. Zbigniew ZIMEK, Zygmunt DZWIGALSKI, Stanislaw WARCHOL; Sylwester BULKA, Karol ROMAN (Institute of Nuclear Chemistry and Technology, Poland)

UPGRADING OF ACCELERATOR FACILITY FOR RADIATION STERILIZATION

Upgrading of radiation facility located at Institute of Nuclear Chemistry and Technology in Warsaw equipped with linear electron accelerator towards higher technical and economical effectiveness is being performed to obtain better operational characteristics suitable for radiation processing and research programs in the field of radiation technology development. The objective of the project initiated in 2004 is related to construction of 10 MeV, 15 kW linear electron accelerator equipped with microwave source based on modern klystron device operated at frequency according to European standards and standing wave accelerating section. The project is indispensable in order to promote effectively in Poland the radiation technologies for sterilzation medical devices and tissue grafts as well as food product hygenization and other radiation processes where high energy electrons are required. The following stages of the project have been described: design of microwave system of accelerator including pulse power supply, completion and installation of necessary systems including klystron stand, pulse power supply stand, driving generator stand and waveguide system. The semiconductor HV transistor switch was applied in klystron modulator. The standing wave accelerating section has been implemented. Electron beam alignment, beam parameters evaluation and accelerator commissioning will be the final stage of the project. The better accelerator availability, more stable beam parameters, better spare parts availability, reduced exploitation costs and higher beam power are expected after successful project implementation foreseen in 2007.

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P.127. Zbigniew ZIMEK, Andrzej G. CHMIELEWSKI (Institute of Nuclear Chemistry and Technology, Poland)

IMPLEMENTATION OF HIGH POWER ELECTRON ACCELERATORS FOR ENVIRONMENTAL PROTECTION

High power accelerators have been recently developed to meet demands of flue gas treatment and other high throughput processes. Such accelerators can substantially increase the capacity of the process and reduced unit cost of operation. Automatic control, reliability and reduced maintenance, adequate adoption to process conditions, suitable electron energy and beam power are the basic features of modern accelerator construction. Accelerators have the potential to serve as big radiation sources which can transfer much higher amounts of energy into the irradiated objects than other types of facilities. That provide opportunity to construct technological lines with high capacity and they are more technically and economically suitable with high throughputs and low cost what is necessary in environmental protection technologies. Some special efforts should be done to optimize electrical energy consumption for accelerator, electron beam handling system and other auxiliary equipment related to radiation facility to achieve the highest electrical efficiency. Electron beam technology is already being utilized in many pilot plants and demonstration facilities for environmental application. Several full size facilities were constructed and implemented in different countries. Among them flue gas treatment unit equipped with four electron accelerators with total beam power over 1 MW installed in Poland. Accelerators may play a major role in new big market related to environment application of radiation processing if except high power, high efficiency, low cost they will be characterized by high reliability suitable for industrial standards. High power accelerator technology may need governmental support in design, construction and testing such equipment because environmental applications of EB technology are examples of high risk and not very high payoff but on the other hand radiation technology transfer to environmental application could be in result a substantial improvement in public health.

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Accelerator for Producing the Ion Beams in the Continuous and Pulse Modes

The device is based on a high-voltage hydrogen ion accelerator with switching magnet (effective beam rotation angle 0±450), which works with two beam lines. Fist beam line is designed for transporting the accelerated up to 300 keV atomic hydrogen ions beam with current up to 15 mA. Second beam line designed to obtain beam pulses of nanosecond length.

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P.129. A.Bakalyarov, M.Karetnikov, V.Lebedev, E.Meleshko, B.Obinyakov, N.Tupikin, Y G.akovlev, V.Lubkov, A.Makarov, A.Sukharev (Russion research Center "Kurchatov Institute", Moscow, Russia)

Experimental model of the device for detection of nuclear cycle materials by photoneutron technology

The inherent complexity of sea container control makes them potentially dangerous for smuggling nuclear materials. The experts believe that only active technologies founded on recording the products of induced fission of nuclear materials might solve the problem. The paper reports on the experimental model of the device on the basis of linear electron accelerator U-28 for detection of nuclear materials by photoneutron technology. The extensive numerical optimization of the output units (converter, filter, collimator) of the device was carried out. The efficiency of detection of various types of sensitive material by recording prompt photoneutrons, delayed neutrons and gamma-rays was simulated. The various types of container load (empty, fully loaded with material with low, medium, or large atomic number) and various positions of the sensitive materials in the container are considered. The problems of radiation damage and activation of the objects are analyzed. The U-28 accelerator was upgraded for the experiments. Two options (magnetic deflector and beam filter) for utilization of the electron beam after converter has been considered. The setup of experimental device and the results of recording the prompt and delayed fission products are discussed.

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Poster session: Ion sources, electron guns

P.130. A.S.Belov, V.I.Derbilov, S.K.Esin, A.V.Feschenko, O.T.Frolov, V.S.Klenov, E.S.Nikulin, V.L.Serov (Institute for Nuclear Research, Moscow, Russia)

H- Injector for the INR Linac

The H- injector has to provide a beam with the following parameters: mean current; up to 400uA; pulse duration; up to 200us; pulse repetition rate; 50Hz; energy of ions; 400keV. The surface-plasma H- ion source developed in BINP, Novosibirsk is used. Pulsed accelerating voltage source of 400kV and pulsed high-voltage modulators for H- ion source power supply with a discharge current up to 120A and extracting voltage up to 20kV have been fabricated and tested. Commissioning of the H- injector is scheduled by the end of 2006.

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P.131. V.E.Akimov, A.V.Bulatov, I.V.Kazarezov, A.A.Korepanov, D.A.Maliutin, A.A.Starostenko, A.A.Pachkov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

ELECTRON MINIACCELERATOR FOR THE CHARGED PARTICLES BEAM NUNDESTRUCTIVE DIAGNOSTICS

The electron miniaccelerator for the charged particles beam nondestructive diagnostics with operating voltage 200 kV, half-wave duration 4 mks and beam current within few mA is described. The primary circuit is switched by IGBT. The gun control and filament circuit power supply are performed through high frequency isolated transformer. The accelerating tube is performed from sectional welded metal ceramics insulator (ceramics 22 XC with diameter 95/85 mm). The accelerator test results are presented.

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P.132. P.A.Golubev, V.E.Karlin, E.I.Kolobanov, S.A.Krutihin, G.Ya.Kurkin, V.K.Ovchar, S.S.Serednyakov, S.V.Tararyshkin, N.A.Vinokurov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

High intensity generator of electron current for the accelerators injector

The device for forming pulsed electron current for injection into accelerators was designed and realized. The pulse current duration is 0.5 ns and average electron current is from zero up to 110 mA. The charge of electron pulse is variable from zero up to 1.5 nC.

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200 KEV PULSED ELECTRON BEAM SOURCE FOR THE VEPP-5 INJECTION COMPLEX

The pulsed electron beam source on voltage 200 kV and current 10 A with half-height pulse duration 3 ns is described. The gun is based on the dispenser cathode with 20 mm diameter. The current control is performed by means of molybdenum grid with the cell size 0.4x0.4 mm and optical transparency of about 0.7. The numerical optimization of cathode-grid unit is carried out. The experimental results obtained are in good agreement with project parameters.

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P.134. S.Mordyk, V.Miroshnichenko, D.Nahornyy, D.Shulha, V.Storizhko, and V.Voznyy (Institute of Applied Physics Nat. Acad. Sci., Ukraine)

DEVELOPMENT OF THE RF ION SOURCE FOR USE IN ACCELERATOR-BASED APPLICATIONS

A helicon and a multicusp version of a radio-frequency ion sources with compact permanent magnet systems have developed and tested to show the following performance data: plasma density of 10^{11} - $9*10^{12}$ cm-3, pressure of 2-10 mTorr, beam current densities of 10 - 130 mA/cm^2 , brightness ~100 A/(m2rad2eV), energy spread 8-30 eV, and an rf power input into the plasma of 40 - 300 W. Possibilities for a further increase in the brightness of the rf ion sources are discussed.

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P.135. M.I.Ayzatskiy, A.N.Dovbnya, I.V.Khodak, V.A.Kushnir, V.V.Mytrochenko (The National Science Center "Kharkov Institute of Physic and Technology" (KIPT), Kharkov, Ukraine)

RF ELECTRON GUNS WITH PLASMA-ASSISTED EMISSION CATHODES

Electron beams with charge up to 100 nC in a nanosecond current pulse can be generated by photoemission RF guns. Thermal heating of a cathode caused by high power flow density of laser pulse limits the increasing of the pulse charge. The alternative way the high charge can be achieved in RF guns is the application of cathodes with plasma-assisted electron emission. The feature of the cathodes is high emission current density (>10^2 A/cm^2). It was proposed earlier to apply in RF guns plasma cathodes based on ferroelectrics*. Results of beam dynamics simulation and results of the experimental research of one-cell S-band RF gun operation with driven plasma cathode are considered in the paper. Results of operation of experimental samples of the cathode are provided and analysed.

* I.V. Khodak, V.A. Kushnir. Performances of the beam generated by metal-dielectric cathodes in RF electron guns. Proc. EPAC04, Lucerne, Switzerland, p.767-768.

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P.136. I.Agapov, G.Blair (Royal Holloway University, London, UK), N.Mokhov, S.Striganov (FNAL), T.Sanami (KEK)

Geant4 and MARS15 Benchmarking and Modeling of The ILC Radiation Environment

The International Linear Collider (ILC), currently under study, will run with high-intensity 250-500 GeV e- and e+ beams. Detector backgrounds, radiation loads and shielding are among the key issues in the design of the beam delivery system, machine-detector interface and extraction beam lines. The study of radiation resulting from the interaction of the beam halo with machine and detector components are based on simulations with the Geant4 and MARS15 Monte-Carlo codes. Results of the code benchmarking are presented for photo-induced neutron and muon yields from thick targets and shielding. Preliminary results of radiation studies for the ILC simulated with both codes are presented and discussed.

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P.137. B.A.Frolov, V.V.Nizhegorodtsev (State Research Centre of Russia Institute for High Energy Physics, Protvino, Russia)

Simulation of negative ion extraction from a source with plasma emitter.

The two-dimensional simulation is carried out to develop a design for optics of the extraction of negative ion beam from a duaplazmatron with cold hollow cathode The simulation model is axially-simmetrical system, the self-consistent code is based on the methods of boundary integrated equations and macro particles to simulate the ion extraction from plasma. The stripping of negative ions during the ray-tracing is taken into account. The optics of the extraction and formation of H ion beam with energy of 100 keV and current up to 30 mA is calculated. Two possible ion optics systems consisting of three and four electrodes are investigated. The experimentally observed beam extraction characteristics are in reasonable agreement with the code results.

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Poster session: Synchrotron radiation sources and free-electron lasers

P.138. P.Budz, K.Buerkamnn, M.Abo-Bakr, W.Anders, O.Dressler, V.Duerr, J.Feikes, H.G.Hoberg, P.Kuske, R.Lange, J.Rahn, T.Schneegans, E.Weihreter, G.Wuestefeld (BESSY mbH, Berlin, Germany), D.Kraemer (GSI, Darmstadt, Germany), I.Churkin (Budker Institute of Nuclear Physics, Novosibirsk, Russia), R.Klein, G.Ulm (PTB, Berlin, Germany)

Status of Metrology Light Source in Berlin

For more than 25 years, the Physikalisch-Technische-Bundesanstalt (PTB) uses synchrotron radiation at the storage rings BESSY I and II for photon metrology in the spectral range of UV to x-rays. Since decommissioning of BESSY I (1999), there is a gap in the spectral range of UV and EUV wavelength due to the higher electron energy of BESSY II. Thus, in 2003, the Metrology Light Source (MLS), a electron storage ring of low energy, was approved as central instrument in the future Willy Wien Laboratory (WWL). Design, construction and operation of the MLS are realized by BESSY, based on the PTB requirements for a permanent accessible radiometry source, optimized for the spectral range between UV up to VUV. The MLS is tuneable in energy between 200 MeV and 600 MeV, designed for currents between 1pA up to 200mA. Civil construction of WWL in the close vicinity to BESSY is nearing completion. The assembly of the MLS is running, commissioning of the 100MeV Microtron is scheduled for summer 2006, while commissioning of the storage ring will start in spring 2007. Regular user operation will begin in January 2008. A status and an overview on the construction of the MLS are given.

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P.139. V.Korchuganov, A.Valentinov (RRC Kurchatov Institute, Moscow), N.Mezentsev (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

An Influence of 7.5 T superconducting wiggler on beam parameters of Siberia-2 storage ring

At present the dedicated synchrotron radiation source Siberia-2 in Kurchatov Institute operates with electron energy 2.5 GeV and current up to 200 mA. In order to expand spectral range of SR and to increase brightness an installation of 7.5 T 19-pole superconducting wiggler is planned at the end of 2006. Now the wiggler is under fabrication in BINP, Novosibirsk. Such high level of a magnetic field in the wiggler will have a great influence on electron beam parameters of Siberia-2. Changes of these parameters (betatron tunes, horizontal emittance of the electron beam, momentum compaction, energy spread etc.) are discussed in the report. Different methods of compensation (global and local) of betatron functions distortion are presented. Much attention is paid to dynamic aperture calculations using analytical approximation of magnetic field behavior in transverse horizontal direction.

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P.140. E.Bekhtenev, S.Khrushchev, N.Mezentsev, E.Miginsky, V.Shkaruba, V.Tsukanov (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

The main test results of the 3.5 Tesla 49-pole superconducting wiggler for DLS.

3.5 Tesla 49-pole superconducting wiggler with 16 mm magnetic gap and 60 mm period for Diamond Light Source (England) has been fabricated in Budker INP. A first wiggler test was carried out in bath cryostat in BINP on July 2005. The first wiggler test in own cryostat was performed in BINP on January 2006. This test includes field integrals measurements with stretched wire method and field measurements with hall probe. All this measurements was repeated on April 2006 in DLS. Design of special magnetic measurement system with anti-chamber and main wiggler tests results are presented in this paper.

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P.141. A.N.Dovbnya, V.A.Kushnir, V.V.Mytrochenko, A.Opanasenko, S.A.Perezhogin, V.F.Zhiglo (Kharkov Institute Physics and Technology, Kharkov, Ukraine)

ON POSSIBILITIES OF EXPERIMENTAL STUDY OF WAKEFIELD UNDULATOR RADIATION EMITTED BY 100 MeV ELECTRON BEAM

The wake-field undulator (WFU) radiation mechanism (first described in Ref.*) open up new opportunities for generating high brightness ultra-short wavelength light. The core of WFU radiation mechanism consists in photon emission by a short bunch of relativistic charged particles undulating in the nonsynchronous harmonics of wakefields, which are induced as the bunch moves through a periodic corrugated waveguide. There is interest in carrying out experiments on detecting the WFU radiation. This work is devoted development of experimental methods on viewing WFU radiation in visual range. We consider possibilities of applying short-pulsed ampere range electron beams with energy 100 MeV accelerated in a rf linac operating in energy stored mode. The WF undulator characteristics is presented. We analyze possible sources of background radiation such as: thermal radiation of a hot cathode; inelastic scattering of beam electrons on a residual gas; bremsstrahlung radiation of beam electrons on nucleus of a residual gas; synchrotron and diffraction radiation. The ways of decreasing influence of the background radiation on a valid signal are considered.

[*] A. Opanasenko, Proc. of MMET'02, Kiev, Ukraine, p.642; http://arxiv.org/abs/physics/0209100.

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Insertion Device Commissioning at the Canadian Light Source.

The Canadian Light Source (CLS) storage ring was commissioned in early 2004 and has been supplying light to a growing number of beamlines over the last two years. Insertion devices (IDs) for the beamlines include three planar undulators, an elliptically polarizing undulator (EPU) and a superconducting (SC) wiggler. Two of the planar undulators occupy the same straight in the CLS lattice where a small magnet chicane is used to separate the two beams by an angle of 1.8 mrad. Such a small chicane allows both beams to pass through the same beamline front end after which there is adequate separation to direct the beams to separate beamlines. The third planar undulator is an in-vacuum device that can operate at a gap as low as 5.5 mm. This device is also in a chicaned straight where there is room to install another device in the future. The EPU has a chicaning arrangement that allows several options for delivering the beam. In the near future a second EPU will be placed in the same straight. A system of five chicane magnets will allow the two EPU beams to be delivered to simultaneously to both beamlines or to either one of the lines. The second option will be used for rapid polarization switching. The SC wiggler occupies a single straight where there is no chicane. The storage ring commissioning of the various IDs will be discussed

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