Workshop on Accelerator R&D for Ultimate Storage Rings

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Book of Abstracts

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Pulsed Sextupole Injection for BAPS

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We will introduce the design of the pulsed sextupole injection for BAPS.

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SOLEIL orbit feedback systems and photon BPMs

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A global orbit correction system based on two feedback loops, slow and fast, stabilizes the photon beam to the submicron level at the SOLEIL light source. Having two systems, each one using a different set of correctors is advantageous for performance and cost. The recent addition of dipole frontend XBPMs into the fast loop improves the stability of the bending magnet beamlines. A similar approach is planned for improving the stability of the in-vacuum undulator beamlines. An X-BPM just in front of the first BL critical element seems the most promising if it is sufficiently insensitivity to the gap aperture. It is not the case of all our Blade X-BPMs. The issue of the X-BPM readings sensitivity to the gap size is even more critical for the Apple II undulators because the blade X-BPM cannot work for all gap and phase configurations. There is a strong need for XBPMs insensitive to undulator configuration changes.

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Anticipated limits on machine stability and consequences on machine and beamline designs

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With the small emittance the future USRs will provide, the beam stability is going to be more and more a critical issue. I will compare a ±sigma/10 position stability tolerance for a 30 keV diffraction limited photon beam to the actual beam stability of an existing light source. The future USRs might or not achieve a better stability. We will see that for acquisition times from 10 ms to about 10 s a ±100 nm stability requirement can be met. For shorter or longer acquisition times, photon beam position and angle feedback systems will likely be necessary. I briefly report on a state of the art BPM and orbit feedback system; on stable supports made of INVAR for BPM; and of a high performance hydrostatic leveling system (HLS).

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A 5BA low emittance lattice with superbends for Sirius

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We present the lattice design issues of the new Brazilian synchrotron light source (Sirius) currently under construction at the Brazilian Synchrotron Light Laboratory (LNLS) in Campinas. The Sirius lattice was recently revised to achieve a lower emittance. The new design is based on a 3 GeV, 5BA achromatic lattice with 0.28 nm.rad natural emittance without wigglers. The circumference is 518 m with 20 straight sections of alternating 6 and 7 meters in length. The dipoles will be based on the use of permanent magnet technology and will combine low field magnets (0.6 T) for the main beam deflection with a short 2 Tesla high field slice magnet (superbend) integrated in the center dipole. This will produce a longitudinal dipole gradient that is used to lower the emittance as well as to provide hard x-ray sources with a modest total energy loss.

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Some engineering considerations for USR light sources

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Various projects of storage ring based light source under construction, and upgrade program of existing 3rd generation light sources are pushing the emittance lower and lower. Diffraction limited emittance in vertical direction is achieving in a number of light sources. Diffraction limited emittance in horizontal direction is ultimate performance for storage ring based light source –USR. There are many challenges in lattice design and optimization, in magnet design and manufacturing. Diffraction limited emittance means very small beam size. What should be the beam stability requirement for the USR? Some engineering issues are addressed in this presentation:
• Vacuum chamber and thermal absorber
• Beam stability requirement
• How to reach beam stability
• Heat load issues for beamline optics

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Experience with Damping Wigglers at PETRA III

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PETRA III is a third generation light source which started operation
in 2009. Twenty damping wigglers are installed in dispersion free
straight sections in order to achieve a horizontal emittance of 1nmrad. We give a short overview of design considerations and beam

dynamics issues and report on experience from commissioning and user operation.

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Development and Commissioning of a Single Non-linear Kicker Magnet System for the BESSY II Storage Ring Injection

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Top-Up injections without noticeable motion of the stored beam is a challenge. The common method of beam accumulation with a local bump formed by four independent pulsed dipole kicker magnets usually causes beam oscillations. The matching of the four independent kicker systems regarding pulse jitters and shapes is technologically limited. Powering neighboring kicker magnets in pairs reduces the excitation of the beam. An even more promising approach is to deploy a single non-linear kicker magnet with zero Bx,y-field in the center and an off-axis maximum, By, which is horizontally displaced by 10-12 mm. There the injected beam gets kicked and looses half of its transverse momentum. Such a magnet was designed and built as a short in-vacuum magnet with a small vertical gap height. For first beam tests the kicker was placed in the second straight section after the injection point, and the 1.5 µs pulse was designed to deflect the 1.72 GeV beam by 1 mrad. In this talk, the calculation and measurement of the magnetic fields, the mechanical design as well as the electrical

pulser circuit are described. The experiences with the commissioning of this kicker magnet system are discussed.

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Single and Multiple Touschek scattering in low emittance rings

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A quick overview on the intra-beam scattering theory and conventional computations will be presented, as well as for the Touschek effect. A parallelized tracking code for the IBS has been recently developed in view of the SuperB project; benchmarking with measurements (at SLS), with theory and with other codes (SIRE-CLIC-DR) have been done. Touschek lifetime is evaluated in most 3rd generation light sources, high intensity machines and damping wigglers for linear colliders, being one of the major limits of the beam lifetime. The STAR code developed to study their effect in DAFNE and SuperB will be described. To conclude, some remarks on the IBS and Touschek effect for the USRs.

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Superconducting IDs at BINP

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Superconducting wigglers are very popular devices for generation of synchrotron radiation (SR) in the hard X-ray spectral range. Moreover, recently superconductive wigglers have also been used for emittance reduction in a few projects of light sources and damping rings of linear colliders.
Budker Institute of Nuclear Physics (BINP) has great experience in the design and fabrication of superconducting wigglers. In the past thirty years, the Institute developed and fabricated more than twenty devices, which are now used at many SR centers over the world. A detailed analysis of this activity shows many interesting trends in the demand for superconductive IDs and their development in the past and at present and can be helpful in predicting the future tendency in this field.
This report reviews the BINP activity for developing and fabrication of superconductive IDs, tries to reveal the main trends, and presents some new ideas for future improvement of their design.

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MAX IV vacuum System design

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The fact that the 3 GeV storage ring of MAX IV has a compact lattice and small aperture for the magnets makes the vacuum system a challenge in all stages, from design to installation and commissioning. The talk will cover the considerations for the vacuum system together with the layout. The design of the copper vacuum chambers, NEG coating and production issues are presented.

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Undulator Technology for Ultimate Storage Rings (USRs)*

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Abstract
One of the limitations on tuning range, brightness, and flux from undulators in storage rings is the extreme x-ray power and power density. It is difficult to engineer photon shutters and other components that can withstand these high heat loads. An alternative is to turn off the heat load when the photon shutter is closed by, for example, turning off the current in an electromagnetic undulator. To remove the heat load produced by a hybrid permanent magnet (HPM) undulator, the gap must be opened mechanically.

Electromagnetic undulator technology has progressed at the APS with the recent development of three new devices: a normal-conducting electromagnetic variably polarizing undulator with quasi-periodic capabilities has been installed at the APS, a superconducting undulator is scheduled to be installed at the APS, and a test model of a normal-conducting variably polarizing undulator with the added capability of rapid switching (10 Hz) between left- and right-circular polarizations is being built. A review of these devices along with the application of electromagnetic devices used with USRs will be discussed. The application of helical superconducting undulators to take advantage of the narrower horizontal emittance of the beam in a USR is also discussed.

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Lattice design for Spring-8 II

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A feasibility of a very low-emittance storage ring has been studied for an upgrade project of the SPring-8, SPring-8 II. Its ultimate goal is to provide a superior brilliance for 0.5 ˜ 100 keV photons. A sextuple bend achromat lattice with the natural emittance of 70 pmrad at 6 GeV has been examined as the first candidate. In order to increase the brilliance and to enlarge the dynamic aperture until the required values, the step-by-step optimization has been performed in designing linear optics, in selecting the betatron tune, and in designing nonlinear optics. The latest design for the coming upgrade of SPring-8 will be presented.

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Two-frequency RF system for short bunches for SPring-8 II

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Harmonic RF system for SPring-8 II will be presented. The frequency of the harmonic would be half-integer multiple of fundamental RF. This RF system lengthen most of bunches in order to suppress emittance growth and lifetime decrease due to Intra-beam scattering. With this harmonic RF system, short-bunch is also available.

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Multi-bunch feedback system in USR

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In ultra-low emittance ring for light source, hybrid filling of bunches and narrow gap undulators would contribute transverse instability. Under the hybrid filling, isolated bunch with high current and bunch train with high average current would be stored simultaneously. Mode coupling single bunch instability and multi-bunch instability due to resistive wall impedance must be suppressed by bunch-by-bunch feedback system in transverse plane. Since bunch current ratio in the hybrid filling would reach 2 orders of magnitude, an automatic attenuator which is sensitive to bunch current is developed at SPring-8 in order to avoid saturation in feedback processor. We will discuss effect of noise at BPM signal and signal processor of feedback system on effective beam size.

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BAPS Lattice Design

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The USR is one of the choices for Beijing Advanced Photonic Source(BAPS). The goal of the lattice design is approaching diffraction limit for 10keV X-ray. In the talk we will show several resluts of lattice design, parameters of damping wiggler, method of making round beam, process of chromaticity correction and tracking results of dynamic aperture.