Novel Designs of Accelerator and Beamline Components

Design of a Monolithic Aspherical Mirror Bender for an Active Grating

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Abstract

A novel monolithic bender was designed for an active bendable polynomial grating as shown in Fig.1. The grating was proposed to increase the resolution of the CEM design used in the Dragon type beamlines of the SRRC. The grating can eliminate the defocus and coma aberrations to yield a theoretically ultrahigh resolution. The bender was designed with an almost fixed center point after bending and a low height to fit requirements of installation. Two PZT actuators are used to bend the bender to an adjustable third-order polynomial surface profile and meet the grating adjusting rage specification. After a series of FEM analyses to optimize the design, a prototype bender was fabricated and tested to achieve satisfactory results. This paper presents in detail the design and analysis processes.

Keywords: beamline, active grating, mirror bender, FEM

Presentation: Poster

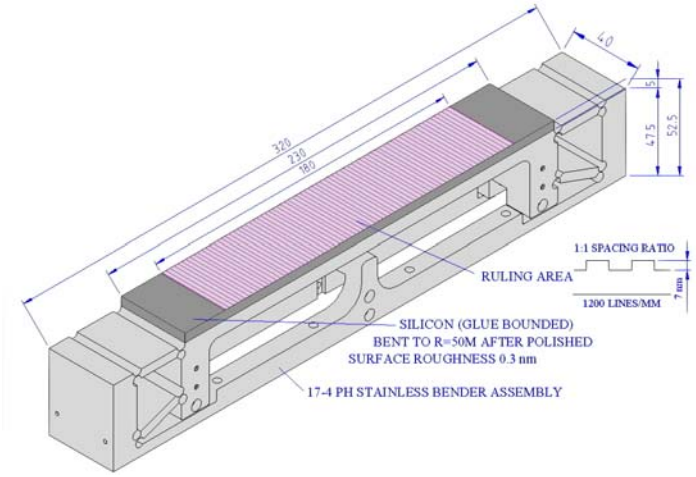

Fig. 1 A monolithic bender designed for an active bendable polynomial grating

Easy Access Shielding Structures for the DUVFEL Beamline at BNL's Source Development Laboratory

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Abstract

A novel method of beamline shielding has been implemented that maximizes radiation safety and allows easy access to beamline components while minimizing the stacking of lead bricks. This method can be applicable to other beamline shielding applications. A radiation analysis established minimum shielding requirements for the Near Infrared Scalable Undulator System (NISUS) and the Deep Ultraviolet Free Electron Laser (DUVFEL) beamline at BNL's Source Development Laboratory (SDL). In addition to the 1.2-meter-thick modular concrete walls that surround the beamline additional shielding above and on either side of the NISUS gap was required to prevent skyshine and secondary particles from becoming a radiological hazard to personnel in the SDL building. The challenge of the shielding design was to eliminate the radiation hazard while maintaining easy access to the many beam monitors and a various diagnostics on the NISUS table and beamline that require hands-on manipulation. A novel approach to shielding design has been implemented around the NISUS magnet: 2,000 pounds of lead and 18,000 pounds of boronated polyethelyne were incorporated. In addition, over 25,000 pounds of cast lead plates surround other areas of the beamline. Presented is the detailed design of the movable shielding. This novel approach allows a single user to gain full access to NISUS within a matter of seconds. Administrative and engineered safeguards are implemented prior to interlocking to prevent any noncompliant occurrence. This shielding system greatly simplifies the earlier method of lead-brick stacking and can be used in future beamlines to eliminate overhead skyshine problems. This method greatly simplifies and improves the immediate access to the beamline, shortening shut down periods and reducing operational costs.

Keywords: SDL, NISUS, radiological safety, shielding, easy access

Presentation: Poster

Fabrication Techniques for Septum Magnets at the APS*

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Abstract

The design, construction, and installation of pulsed septum magnets for particle accelerators presents many challenges for the magnet engineer. Issues associated with magnet core structure design, component alignment, weldment design, and electrical insulation choices are among those requiring careful attention. The designs of the six septum magnets required for the APS facility have evolved since operation began in 1996. Improvements in the designs have provided better injection/extraction performance parameters and extended the machine reliability to meet the requirements of a world-class, third-generation synchrotron radiation facility. Details of the techniques used to address issues involved in producing septum magnets at the APS are described here to aid magnet engineers in the fabrication of future septum magnets.

Keywords: septum, magnet

Presentation: Poster

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The NISUS Magnet Diagnostic

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Abstract

This paper presents the detailed design of the diagnostic "pop-ins," a description of their use for FEL operation, examples of data obtained, results of reproducibility studies, and a description of associated external diagnostic components. The Near Infrared Scalable Undulator System (NISUS) is a 10-meter-long undulator magnet that serves as the radiator section of the Deep Ultraviolet Free Electron Laser (DUVFEL) currently in operation at BNL's, Source Development Laboratory (SDL) in the NSLS department. The NISUS undulator requires extensive diagnostic capability to assure generation of SASE light for nonseeded or seeded operation with the anticipated upgrade to high-gain harmonic generation (HGHG). The design of the e-beam and laser in-vacuum diagnostics was challenging due to the fact that all of the sensing components resided in the undulator's gap and had to be compatible with an existing vacuum chamber. Budget constraints and the required quantity (18) made a highly reliable, multifunctional, economic design paramount. The pop-in monitors are novel, low-cost, in-vacuum diagnostic devices that perform the following functions: laser alignment, e-beam trajectory, e-beam position, and e-beam profile monitoring using visible YAG and OTR emission, emittance measurement, and FEL light sampling. The reproducibility of ± 1 CCD pixel with a resolution of 9 microns has been achieved. Using these devices, operators were able to achieve SASE operation in record time.

Keywords: SDL, NISUS, SASE, diagnostic, pop-in monitors

Presentation: Poster

Characteristics of a Mechanically-Bent-Shaped Mirror

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Abstract

The experimental apparatus to test the characteristics of a mechanically-bent-shaped mirror for x-ray optics was prepared. The applied mirror bender is one developed by Toyama, and many similar types of mechanisms have been used at SPring-8 as well as at KEK/PF in Japan. We performed a series of actual measurements by using a LTP (Long Trace Profiler) at SPring-8. The items to be tested are: 1) difference from the ideal curvature, 2) reproducibility of bent radius in each trial, 3) time-dependent stability, 4) gravity effect, 5) temperature effect, 6) influence by the side cooling system and so on. These tests are still under way and their results will be discussed later. However, the conclusion so far is that the reproducibility and the stability seem to be good enough for normal use as x-ray reflecting mirrors, although the bent-shaped curvature is sensitive to the disturbance elements.

Keywords: mirror bender, x-ray optics, LTP

Presentation: Poster

The Mechanical and Shielding Design of a Portable Spectrometer and Beam Dump Assembly at BNL's Accelerator Test Facility

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Abstract

A portable assembly containing a vertical-bend dipole magnet has been designed and installed immediately downbeam of the Compton electron-laser interaction cell on beamline 1 of the Accelerator Test Facility (ATF) at Brookhaven National Laboratory (BNL). The water-cooled magnet designed with field strength of up to 0.75 Tesla will be used as a spectrometer in the Thompson scattering and vacuum acceleration experiments, where field-dependent electron scattering and beam focusing will be analyzed. This magnet will deflect the ATF's 70-MeV electron-beam 90° downward, as a vertical beam dump for the Compton scattering experiment. The dipole magnet assembly is portable and can be relocated to other beamlines at ATF or other accelerator facilities to be used as a spectrometer or a beam dump.

The mechanical and shielding calculations are presented in this paper. The structural rigidity and stability of the assembly were studied. A square lead shield surrounding the assembly's Faraday Cup was designed to attenuate the radiation emerging from the 1"-copper beam stop. All photons produced were assumed to be sufficiently energetic to generate photoneutrons. A safety evaluation of groundwater tritium contamination due to the thermal neutron capturing by the deuterium in water was performed, using the updated Monte Carlo neutron-photon coupled transport code (MCNP). High-energy neutron spallation, which is a potential source to directly generate radioactive tritium and sodium-22 in soil, was conservatively assessed in verifying personal and environmental safety.

Keywords: dipole magnet, spectrometer, beam dump, portable magnet, accelerator device

Presentation: Poster

The Design and Performance of the New Toroidal Mirror for ID09 (ESRF)

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Abstract

ID09 is a dual-purpose beamline dedicated to time-resolved and high-pressure experiments. The time-resolved experiments use a high-speed chopper to isolate single pulses of x-rays. The chopper is installed near the sample (focal spot) and the shortest usable opening time depends on the sharpness of the vertical focusing. In the 16-bunch mode, for example, the height of the chopper tunnel has to be as small as 0.145 mm to produce a 0.3 μs opening window (900 Hz rotation). To enhance the pulsed flux on the sample, we have therefore built a high precision mirror that focuses the beam 22.4 m downstream in M= 0.67 geometry. The 1.0-m long silicon mirror is bend by gravity into a toroid with a meridional radius of 9.9 km. The curvature is fine-tuned by a push & pull stepper motor that works from below the mirror. The figure error from the sag and the correcting force is less than ±0.3 μrad and the polishing error is as small than 0.7 μrad (rms) over the central 450-mm of the mirror. The observed focal spot in the polychromatic focus is 0.100 x 0.070 mmh x mmv. This performance is the result of high quality polishing, a strain-free holder and a low-vibration cooling system.

Keywords: toroidal mirror, gravity, slope error and bender

Presentation: Poster

Beam Stability: Vibration and Thermal Effects

Identification of X-ray Beam Instability Sources for a MX Beamline at the ESRF

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Abstract

The stability of the support of optical components, in particular monochromators and mirrors, is of crucial importance for most beamlines. A number of vibration analysis techniques, including modal testing, can be used to identify structural resonances. Due to the specific beamline configuration, only some of these vibrations affect the X-ray beam stability. A study of the correlation of the X-ray intensity with vibration measurements is necessary in order to highlight the most disturbing movements of the mechanical components of the beamline.

Here, vibration and X-ray intensity measurements performed on a Macromolecular Crystallography (MX) beamline at the European Synchrotron Radiation Facility (ESRF) are presented. The effect of pumps, monochromator crystal cooling, and structural dynamic responses of relevant structures are reported. Significant improvements for the stability of this beamline were implemented as a result.

Keywords: vibration, mechanical stability, beamline, X-ray intensity

Presentation: Poster

Effect of Environmental Factors on Electron Orbit Stability at PLS Storage Ring

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Abstract

The investigation on the stabilization of the electron beam orbit at PLS storage ring has been conducted to enhance ID beamline performance. The measurements such as the micro-scale displacements, the cooling air, and water temperatures were in particular focused on local sector #4 in the storage ring due to the experimental set-up scale limit at the beginning stage. Data collection was performed as real-time during normal user service beam operation to evaluate the environmental influences. As a result, it was found that there might be a strong correlation between the beam orbit stability and the mechanical behaviors of the magnets. Furthermore, during the beam injection period, it was analyzed that the ramping process caused the deformation of bending magnets with an order of tens of microns, in which the beam orbit drift occurred in the storage ring about one order higher in magnitude as compared with that of normal beam operation.

Keywords: deformation, orbit stability, storage ring

Presentation: Poster

Instrumentation for Low-Frequency Vibration in a Synchrotron Facility

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Abstract

Many commercial accelerometers and tilting sensors for monitoring the vibration at low amplitude (submicron order) and low frequency (below 1 Hz) were compared. A piezoelectric-driven shaker in the submicron to micron range was used to calibrate the instruments. A new design of a low-frequency accelerometer is presented. The accelerometer includes a constant force device, a high-sensitivity displacement sensor, and an appropriate mechanism. Some applications in the beamline and storage ring are also presented.

Keywords: low frequency vibration

Presentation: Poster

High Precision Positioning Mechanisms

A Precision Io Monitor System at the SRRC

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Abstract

The intensity monitor (Io) system is used to monitor the beam stability at the SRRC. It includes a reflection mirror, a pinhole, a photon detector, and a precision water-cooling system. The beam stability will be increased to $\Delta I/I=0.1\%$. The mechanical stability of the system should be on the order of 0.1 μm. This study considers the vibration and thermal deformation problems of the entire system. The vibration and deformation of the mirror chamber were isolated using an independent manipulator [1]. The thermal effect of the beam was reduced by the Invar material and precision water-cooling system. The beam was scanned using a 0.1-μm resolution micro-stepping motor system.

Keywords: Io monitor, mechanical stability

Presentation: Poster

[1] D.J. Wang, T.C. Tseng, S.Y. Perng, C. K. Kuan, J.R. Chen, C.T. Chen, "A compact mirror manipulator in the SRRC beamline," J. Synch. Rad. 5 (1998) 801-803.

Design and Characterization of a Light Frame KB Table, and Comparison with a Concrete Block Support

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Abstract

The high-resolution diffraction beamline at the European Synchrotron Radiation Facility (ESRF) is characterized by a small angular size of the X-ray source leading to a very high geometrical resolution. New experiments using a Kirkpatrick-Baez (KB) mirror setup [1] in order to demagnify the photon beam to reach the smallest possible spot size require very high dynamic stability of the supporting mechanical assemblies.

A new KB table designed with this need in mind has recently been built at the ESRF. In order to fulfil these mechanical stability requirements, low mass and high rigidity were primary targets. Particular attention was also paid to the stiffness of the "floor/table" interface. Stability was assessed using vibration as well as static measurements. A direct comparison with a heavy concrete block KB support was performed. Both of them can be moved on a marble floor, with pneumatics air pads.

The results show that the lighter KB table, mounted on more rigid feet, provides a more stable solution than the massive assembly. Indeed, the overall larger stiffness-to-mass ratio leads to higher frequency rigid body vibration modes. The first natural frequency mode occurs at 85 Hz for the lighter structure, compared to 16.5 Hz for the concrete support. This effect, combined to the spectral amplitude of the floor excitation decreasing with the square of the frequency, explains the better performances of the light frame table. This table allowed, in particular, to decrease the spot size obtained with a 20-keV X-ray beam to less than $0.2 \times 0.2\ \mu m^2$ [2].

[1] P. Kirkpatrick and A.V. Baez, J. Opt. Soc. Am. **38** (1948) 766-774.
[2] O. Hignette and P. Cloetens, private communication.

Keywords: vibration, mechanical stability, stiffness, natural frequency, KB

Presentation: Poster

Kinematic Couplings for Synchrotron Radiation Instrumentation

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Abstract

Kinematic couplings are often used in synchrotron radiation facilities to achieve high-precision positioning and relocation of opto-mechanical components. These devices are self-locating and free from backlash, allowing re-positioning repeatabilities in the sub-micrometric range to be attained. Moreover, since they are not overconstrained, kinematic couplings are deterministic and therefore their behavior can be represented in a closed form solution. The biggest shortcoming of kinematic couplings is that, with only six contact points generally accompanied by the absence of a lubrication layer, they present high contact stresses, which are difficult to calculate both analytically and numerically. In fact, the analysis of such devices implies the necessity to consider the mathematical theory of mechanical contacts between elastically deforming solids, known as the Hertz theory.

In literature various approaches can be traced to deal with such an analytical problem. The exact model based on the principles of mechanical elasticity is complex since it involves an iterative evaluation of elliptic integrals. Most of the other approaches are based on approximated methods that make use of diagrams or tabulated values for the calculation of the stress-strain behavior as a function of the mechanical characteristics of the couplings.

The aim of this work is to establish the limits of applicability of the various analytical approaches available in literature depending on the required degrees of accuracy. The validity of the theoretical models will be assessed experimentally via high-precision experimental measurements; these will allow the influence of the various mechanical parameters on the behavior of kinematic couplings to be established.

Keywords: kinematic couplings, Hertzian contact, high-precision, X-ray instrumentation

Presentation: Poster

Development of an Aspherical Bimorph PZT Mirror Bender with Thin Film Resistor Electrode

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Abstract

A bimorph PZT mirror bender was designed for active optics. The bender was constructed with two pairs of Si and PZT plates, and was glue bonded in a Si-PZT-PZT-Si structure. Each PZT was coated with one layer of Ag thin film as the ground electrode and one layer of TiN thin film as the control electrode. The TiN film performs as a resistor layer and different voltages can be applied on both sides to distribute linearly the voltage difference. When interacting with the ground electrode, an adjustable third-order polynomial surface profile can be achieved. A rigid holder was also constructed to provide firm support and constrain the deflection of the center part of the bender to within 5 μm. This article presents the fabrication processes and the testing results.

Keywords: bimorph PZT, mirror bender, thin film, TiN, electrode

Presentation: Poster

Approaches for Minimizing Tracking and Vibratory Errors in High-Bandwidth Beam Steering

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Abstract

Parallel advancements in the field of controls engineering have been commercialized that have application to the fields of active optics and high-bandwidth beam steering:

- Cost effective, industrial-class implementations of momentum compensation (also known as Frahm damping) provide low-order cancellation of inertial inputs to supporting structures and is of particular applicability to structures with low natural resonance frequencies;
- Input Shaping®, a patented controls technique developed at the Massachusetts Institute of Technology, provides effective cancellation of structural resonances in arbitrary actuation;
- Input Preshaping™, a technique realized in both *a priori* and self-learning implementations, substantially eliminates following errors in repetitive actuation.

The author reviews applications of each of these, alone and together, in a comprehensive overview of the state of the art of high-bandwidth active optic positioning techniques.

Keywords: active optics, positioning techniques, beam steering, Frahm damping

Presentation: Poster

Development of a Goniometer with Nanoradian Accuracy

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Abstract

Advanced Design Consulting, Inc. (ADC) designed a super accurate goniometer for applications where nanometer accuracy is required. The system is capable of achieving super accurate resolution, repeatability, orthogonality of motion, and stability at a wide range of load capacities.

This paper summarizes measurement data obtained from Brookhaven National Laboratory describing the precision, angular accuracy, and stability.

Keywords: goniometer, nanoprecision, stability

Presentation: Poster

Development of a Spectrometer for Inelastic X-ray Measurements

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Abstract

Advanced Design Consulting, Inc. (ADC) designed, fabricated and installed a spectrometer that is operating at the Spring-8 synchrotron in Japan as part of a dedicated inelastic beamline (BL12XU). The system is used for investigating electronic excitations with MeV volt resolution; therefore many of the specifications required high precision and accuracy on the micron level. The 3-meter analyzer arm on the spectrometer needed to have an angular stability measured in arc seconds over a long range of travel under vacuum conditions.

This paper summarizes the measurement data from different parts of the spectrometer describing the precision, angular accuracy, and stability.

Keywords: spectrometer, high precision, stability

Presentation: Poster

Insertion Devices and Vacuum Chambers

A Novel Undulator Magnet Gap-Separation Mechanism

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Abstract

A novel gap-separation mechanism has been designed for a permanent magnet undulator that is applicable for both FEL and synchrotron radiation sources. An upgrade to the SASE FEL currently in operation at BNL's Source Development Laboratory (SDL) is anticipated. Seeding with a 266-nm Ti Sapphire laser to produce 1 μJ of deep ultraviolet coherent radiation at 88 nm is being incorporated. A further improvement will be to incorporate high-gain harmonic generation (HGHG) to produce 200 μJ at 200 nm and a third harmonic of 1 μJ at 66 nm. This will require introduction of a modulating prebunch undulator magnet. Presented is a novel, relatively low-cost method to control the gap of the modulator magnet. A gap separation mechanism and corresponding magnet support structure have been designed. The rail-mountable undulator magnet support structure is to be incorporated with a precision rail and motorized strut-driven beam-based alignment system that is already in place on the beamline. A single motor is used to drive the separation mechanism. This novel approach can provide gap control and parallelism to within 20 microns, while allowing easy access to the gap for magnetic measurements, vacuum chamber installation, and beam diagnostics. The paper presents the detailed design of the system and describes assembly, testing, and installation procedures.

Keywords: SDL, HGHG, SASE FEL, undulator, gap separation

Presentation: Poster

New Bending Magnet Vacuum Chambers at Elettra

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Abstract

The Elettra storage ring, in operation since October 1993, was originally designed with all its vacuum chambers in AISI 316 LN stainless steel. New beamline projects have required the development of new kinds of insertion devices (IDs) that can work in circular and vertical polarized modes besides the usual linear one. These new ID working modes however have undesirable heat load effects on the bending magnet vacuum chambers. For this reason new chambers have been developed in aluminium alloy with internal water cooling channels close to the critical points of interaction with the photon beam. In this contribution we describe some aspects of the aluminum chambers, focusing our attention on the heat load problems.

Keywords: aluminum chambers, heat load, undulators

Presentation: Poster

Deformation Under Bake of Extruded Aluminum Narrow-Gap Vacuum Chambers at the ESRF

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Abstract

The ESRF uses NEG-coated vacuum chambers made of extruded aluminum in six of its 32 straight sections. These chambers are internally coated with a so-called NEG (Non-Evaporable Getter) film to support the pumping of the chamber and reduce photon-stimulated desorption. The chambers have an inner elliptical cross-section, 74 mm wide, with a vertical aperture of 11 mm, and 2-mm minimum wall thickness. In order to activate the coating, a bakeout of the chamber up to at least 180 degrees Celsius is required. Recently a new 5-m-long aluminum vacuum chamber has been produced with elliptical cross-section, 57-mm horizontal aperture, only 8-mm internal vertical opening, and 1-mm minimum wall thickness. Finite-element simulations show that during the activation bake the elastic limit of the chamber under vacuum is approached. This report describes deformation measurements on baking and venting cycles performed in our laboratory prior to installation in the ring. A contactless setup of laser distance sensors based on the triangulation principle has been used to compare the real deflection of the chamber to the prediction of the finite element analysis.

Keywords: insertion device, vacuum chamber, aluminum, deformation, NEG coating

Presentation: Poster

High Heat Load Analysis and Design

New High-Heat-Load Beamline Components for the ESRF

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Abstract

Third-generation synchrotron light sources generate small and intense photon beams, of typically a few mm cross section and several 100 W/mm^2. This induces severe thermal constraints on the beamline components defining the beam size (slits) and filtering the beam (attenuators), and on beryllium windows. At the ESRF, the installation of small-gap undulators (in vacuum undulators, 11-mm gap in air undulators) has drastically increased the beam power density. The maximum power density at 27 m from the source has increased from 230 W/mm^2 to 400 W/mm^2 and could reach 720 W/mm^2 in the future. It was therefore decided to develop new primary slits and new attenuators, and to check the heat load acceptable by beryllium windows.

High power (HP) primary slits have been designed. The principle is based on the idea of the L5-92 slits designed by D. Shu at APS: Two water-cooled blocks with square apertures are moved in Y and Z by external translation stages. The main characteristics of the HP slits are: Beam size: 0 to 4 mm; Accuracy: 20 microns; Power density: 400 W/mm^2 (design value); Total length: 740 mm. Three of these slits are in operation and another five are being manufactured.

New attenuators are being developed. The purpose of the attenuators is to absorb the low-energy rays of the beam in order to reduce the heat load on the optical components. The HP attenuators use CVD diamond (thickness 400 to 1200 microns) as a filtering element. CVD diamonds offer extremely high thermal conductivity and relatively low volume X-ray absorption, which should enable it to absorb 50 W/mm^2 without thermal problems. The behavior of the water-cooled beryllium windows has also been studied.

Keywords: high heat load, primary slits, attenuators, beryllium windows

Presentation: Poster

Thermal Stress Analysis of the High-Heat-Load Crotch Absorber at the APS*

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Abstract

The Advanced Photon Source (APS) storage ring operation at higher beam current is one of the potential enhancements to increase beam brilliance. However, this would impact the beamline components and high-heat-load crotch absorbers. Thus, this analysis is conducted to better understand the impact of higher beam current on a water-cooled crotch absorber, made out of Glidcop, without introducing any heat-related problems.

Keywords: storage ring, high heat load, absorber

Presentation: Poster

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The Design of a High Heat Load Shutter for a Superconducting Wiggler Front-End

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Abstract

A new superconducting wiggler will be installed in the Elettra storage ring; the maximum total power and power density of this new insertion device are 18.34 kW and 5.88 kW/mrad^2, respectively, with a 2-GeV beam energy and eventual 400 mA of beam current. This intense X-ray synchrotron radiation requires the installation of a new shutter in the beamline front-end. The high load absorber must be fitted in a preexisting vacuum chamber and moving frame. In this paper the design of the absorber is described and in particular the cooling system optimization used to minimize temperatures on the front face and the cooling channel surface of the shutter. A definition of the absorber design parameters and the choice of material are presented along with several designs that were evaluated using finite-element thermal analysis. Some improvements in the piping layout are also discussed in order to reduce the pressure losses.

Keywords: heat load, finite element analysis, wiggler

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Utility Systems and Temperature Control

Cooling Water Systems for Accelerator Components at the Advanced Photon Source*

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Abstract

As in most accelerators at the Advanced Photon Source, water is the media of choice for absorbing heat generated by a multitude of accelerator components. APS has a large cooling water distribution system with flow rate of nearly 10,000 gpm in the primary circuit and small closed-loop water systems with flow rates of less than 100 gpm installed. The central plant houses primary water distribution pumps, heat rejection equipment, and polishing and make-up systems. All water used for heat rejection by accelerator equipment is deionized and filtered to provide a minimum resistivity of 3 mega ohm-cm and a maximum particle size of 0.5 microns. Water temperature and pressure are controlled at 35 secondary systems before the water is delivered to the accelerator components. The temperature of various water systems is controlled to as tight as ∀ 0.1 deg F. With most accelerator components interlocked on water flow and temperature, it is imperative that both are maintained with a high degree of reliability. It is also necessary for water systems to be designed with sufficient flexibility to allow for easy modifications, additions, and expansions. Since the original water systems were installed, a number of system upgrades have been completed to improve reliability and to integrate new operating parameters. Additional improvements are being planned. Lessons learned will be discussed.

Keywords: deionized, cooling, process water

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Improved Temperature Regulation of Process Water Systems for the APS Storage Ring*

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Abstract

Beam stability and operational reliability of critical mechanical systems are key performance issues for synchrotron accelerators. Stability is influenced by temperature fluctuations of the process water used for cooling and/or temperature conditioning storage ring components such as vacuum chambers, magnets, absorbers, masks, etc. Water systems for the APS storage ring were originally provided with a distributive control system capable of regulation to ± 1.0°F, as specified by facility design requirements. After several years of operation, a particular mode of component mortality indicated a need for upgrade of the temperature control system. The upgrade that was implemented was chosen for both improved component reliability and temperature stability (now on the order of ± 0.2 °F). The design employs a programmable logic controller (PLC) for temperature control that functions under supervision of the existing distributive control system. The human-machine interface (HMI) of the PLC system employs RSView32 software. The PLC system also interfaces with the EPICS accelerator control system to provide monitoring of temperature control parameters. Eventual supervision of the PLC system by EPICS is possible with this design. Important design features of this improved system are presented as well as the implementation plan to incorporate the upgrade such that accelerator operations would not be compromised.

Keywords: water, temperature, control, stability, reliability

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Mitigation of Copper Corrosion and Agglomeration in APS Process Water Systems*

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Abstract

Copper corrosion has been observed in the APS process water systems dating to the early post-commissioning phase of the project. In time, copper corrosion products agglomerated significantly in certain preferred locations. Significant agglomerations can occur in copper cooling passages such as magnet conductors and x-ray absorbers having relatively large length-to-diameter ratios and where heat is removed by water cooling. Such agglomerations also occur at restrictions found in noncopper flow control components such as valve seats and fixed orifices. Modifications to the APS process water system that significantly reduce the rate of copper corrosion are discussed. These modifications have not prevented corrosion altogether, however. Other means used to prevent component clogging and malfunction as a result of current copper corrosion rates are listed.

Keywords: copper, corrosion, water, cooling

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