J. Kay

PAUL SCHERRER INSTITUT

SWISS LIGHT SOURCE SLS

# MEDSI 2000

**July 13 - 14, 2000**

**1st International Workshop on Mechanical Engineering Design of Synchrotron Radiation Equipment and Instrumentation**

*Auditorium, PSI West*

## Preliminary Program

### Thursday, July 13, 2000

| | |
|---|---|
| 08.30 - 08.45 | Welcome<br>*A. Wrulich* |
| 08.45 – 09.00 | Opening remarks<br>*S. Zelenika* |
| 09.00 – 10.30 | Oral session 1<br>*J. Kay (Chairman)* |
| 10.30 – 11.00 | Coffee break |
| 11.00 – 12.30 | Poster session *(5 min. introduction / poster)*<br>*D. Lowe (Chairman)* |
| 12.45 – 13.45 | Lunch |
| 14.00 – 16.00 | Visit PSI / SLS |
| 16.00 – 16.30 | Coffee break |
| 16.30 – 17.30 | Poster exhibition |
| 19.00 | Social dinner<br>Landgasthof Schloss Böttstein |

### Friday, July 14, 2000

| | |
|---|---|
| 09.00 – 10.30 | Oral session 2<br>*M. Woodle (Chairman)* |
| 10.30 – 11.00 | Coffee break |
| 11.00 – 12.30 | General discussion |
| 12.45 – 13.45 | Lunch |
| 14.00 | Closing |

# Oral sessions

# Heat Load Problems on Storage Ring Vacuum Chambers at ELETTRA

A. Gambitta and A. Turchet

*ELETTRA, Sincrotrone Trieste, I-34012 Trieste, Italy*
*phone: +39 040 3758 676, fax: +39 040 3758 565*
*e-mail: gambitta@elettra.trieste.it*

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 (ID) which can work in circular and vertical polarized modes besides the usual linear one. These new ID working modes could have undesiderable heat load effects on the bending magnet vacuum chambers. For this reason new chambers have been developed in aluminium alloy, obviously for the higher value of thermal conductivity, 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 alluminium chamber projects, focusing our attention on the heat load problems.

# High Heat-Loads Absorbers for the APS Storage Ring

S. Sharma, E. Rotela and A. Barcikowski

*Argonne National Laboratory, Advanced Photon Source (APS), Argonne, IL 60439, USA*
*phone: +1 630 252 6820, fax: +1 630 252 5948*
*e-mail: sharma@aps.anl.gov*

The power density of the dipole x-rays in the 7 GeV APS Storage Ring is 261 watts/mrad at 300 mamps of beam current. An array of absorbers are used in the ring to shield its vacuum chambers and diagnostics components in the path of these intense x-rays. This paper describes some of the unique absorber designs that were developed to handle the requirements of high power density and UHV compatibility with no water-to-vacuum joints.

# In situ Measurement of Mirror Vibration in the Beam Line

D. J. Wang, T. C. Tseng and C. K. Kuan

*Synchrotron Radiation Research Center, Hsinchu 300, Taiwan*
*phone: +886 3 578 0281, fax: +886 3 578 3890*
*e-mail: djwang@srrc.gov.tw*

Vibration of mirror is essential for the performance of beam line. In some stringiest condition to attain high resolution with small entrance slit opening the first mirror require 0.1 μrad vibration to have light intensity deviation lessen than $10^{-4}$. It is about 0.05 μm vibration for one meter long mirror. For the usual sampling rate of the user the frequency range is studied below 50 Hz.

This paper presents a noncontact optical method to in-situ measure the vibration of mirror and grating. We use the laser vibrometer and autocollimator. For the study of low frequency, a piezoelectric shaker was adopted to calibrate the laser vibrometer down to 10 mHz. Different kinds of mirror mounting mechanism in the Taiwan Light Source was measured and compared. The factors influencing the vibration are discussed. Some experiences in the measurement and vibration suppression are also mentioned.

# Ultra-Precision Motion Control Technique for High-Resolution X-Ray Instrumentation

D. Shu, T. S. Toellner and E. E. Alp

*Argonne National Laboratory, Advanced Photon Source (APS), Argonne, IL 60439, USA*
*phone: +1 630 252 4684, fax: +1 630 252 9350*
*e-mail: shud@aps.anl.gov*

With the availability of third-generation hard x-ray synchrotron radiation sources, such as the Advanced Photon Source at Argonne National Laboratory, x-ray inelastic scattering and x-ray nuclear resonant scattering provide powerful means for investigating the vibrational dynamics of a variety of materials and condensed matter systems [1]. Novel high-resolution hard x-ray optics with meV energy resolution [2, 3] requires a compact positioning mechanism with 20-50 nrad angular resolution and stability. In this paper, our technical approach to this design challenge is presented. Sensitivity and stability test results are also discussed.

This work was supported by the U.S. Department of Energy, Office o Science, under Contract No. Worten-31-109-Eng.-38.

## References

[1] E. E. Alp, et al., Hyperfine Interactions 90 (1994) pp. 323
[2] T. S. Toellner, T. Mooney, S. Shastri, E. E. Alp, SPIE Proceedings, vol.1740 (1992) pp.218
[3] T. M. Mooney, T. Toellner, W. Sturhahn, E. E. Alp, S. D. Shastri, Nucl. Instrum. Methods A 347 (1994) pp.348

# Ultraprecise Translation and Rotation Devices for X-ray Tomographic Microscopy (XTM)

P. Wyss, M. Stampanoni, R. Abela, F. Beckmann, Th. Lüthi, U. Sennhauser, R. Brönnimann, E. Hack and P. Rüegsegger

*EMPA, Electronics / Metrology Section, CH-8600 Dübendorf*
*phone: +41 1 823 4319, fax: +41 1 823 4579*
*e-mail: peter.wyss@empa.ch*

X-ray tomographic microscopy (XTM) is a method to investigate three-dimensional structures non-destructively with equal resolution in all three dimensions. In order to resolve details of a few micrometers or smaller within a reasonable time synchrotron light has to be used as a source. X-ray tubes are not capable to provide the required intensity and a source small enough in size and divergence. The future XTM-system at the SLS is planned to trespass the limit of one micrometer spatial resolution. This target not only has a strong impact on the design of the source and the detector but it also makes a careful design of the sample handler necessary. The reason for this is that the stability of the sample handler rotation axis has to be one order of magnitude better than the required tomographic resolution. This paper is proposing ideas how to achieve the necessary performance of a sample handler consisting of a rotation stage and translation stages for precision positioning.

**Keywords:** X-ray tomographic microscopy (XTM), rotation stages, translators, runouts, wobble

# Mechanical Design of the SLS Storage Ring

S. Zelenika, R. Kramert, L. Rivkin, M. Rohrer, D. Rossetti, V. Schlott, A. Streun and P. Wiegand

*Paul Scherrer Institut, Swiss Light Source, CH-5232 Villigen PSI*
*phone: +41 56 310 4586, fax: +41 56 310 3151*
*e-mail: sasa.zelenika@psi.ch*

The SLS Storage Ring mechanical support and disturbance compensation systems will be described in this work. In particular will be addressed the design of the girder structure that is used as the basic support unit of all the storage ring elements. The upper part of the girders is designed so as to provide ground horizontal and vertical reference surfaces with a precision of $\pm$15 μm. The coupling of the girders in each of the 12 triple bend achromats is obtained by way of kinematically supported dipole magnets.

The micrometric range alignment and long-term thermal and geological disturbance compensation aims have been met by using eccentric cam shaft kinematic drives ('movers') based on a recent SLAC development [1]. This arrangement provides hysteresis-free and remotely controllable motion with a resolution of 2μm. The feedback signal is obtained via absolute rotary encoders.

The monitoring of the relative horizontal and vertical positions of the girders is performed by using the linear encoders-based Horizontal Positioning System (HPS), and the capacitive proximity gauge-based Hydrostatic Levelling System (HLS), both having micrometric range accuracies.

The conceived SLS storage ring support and displacement monitoring arrangement, when coupled with the in-house developed mover control algorithms, creates all the pre-conditions for on-line storage ring alignment.

## References

[1] G. Bowden, P. Holik, S. R. Wagner, G. Heimlinger, R. Settles, "Precision Magnet Movers for the Final Focus Test Beam", SLAC-PUB-95-61326132, June 1995.

# Parastic Motion of Cross-Spring Pivots: Theoretical Analysis and Experimental Assessment

S. Zelenika and F. De Bona

*Paul Scherrer Institut, Swiss Light Source, CH-5232 Villigen PSI*
*phone: +41 56 310 4586, fax: +41 56 310 3151*
*e-mail: sasa.zelenika@psi.ch*

The work will address the parastic motion of a high-precision rotation mechanism based on flexural pivots made by two equal-dimension leaf springs crossing at their midpoints. From the theoretical point of view the problem will be approached by studying the large deflections of an elastic frame. The equilibrium equations will be considered and a solution based on the Newton-Raphson method will be proposed. The developed solution will be evaluated by comparison with the analytical methods proposed in literature that are characterised by different degrees of approximations. In fact, in [1] the exact expression of the leaf spring curvature involving the calculation of elliptic integrals is used. Other authors have obtained approximate solutions based on geometrical or kinematic considerations. However, these approaches result in widely scattered data and none of them permits to take into consideration externally applied horizontal and vertical loads.

Experimental results reported in literature [2, 3] do not allow to asses the limits of applicability of the various theoretical approaches, as the used measurement techniques were characterised by a high degree of uncertainity. Thus, in this work an experimental assessment performed by using an interferometric technique of laser triangulation will be presented.

It will thus be shown that the proposed analytical solution permits to establish clearly the influence of lateral loads and provides an adequate approach when the most common cases of limited lateral loads and angular rotations are considered.

## References

[1] Haringx, J.A.: "The Cross-Spring Pivot as a Constructional Element", App. Sci. Res. A, vol. 1, no. 4, 1949, pp.313-332.

[2] Nickols, L.W. and Wunsch H.L.: "Design Characteristics of Cross-Spring Pivots", Engineering, no. 10, 1951, pp. 473-476.

[3] Young, W.E.: "An Investigation of the Cross-Spring Pivot", J. Appl. Mech., Trans. ASME, vol. 11, 1944, pp. A-113-A-120.

# Poster session

# Comparison of some Commercial Viscoelastic Material in Vibration Damping

D. J. Wang, S. Y. Perng, S.-J. Chen and C. J. Lin

*Synchrotron Radiation Research Center, Hsinchu 300, Taiwan*
*phone: +886 3 578 0281, fax: +886 3 578 3890*
*e-mail: djwang@srrc.gov.tw*

It was known that passive damping by the viscoelastic material is effective to reduce the vibration of machine components in the big ring like APS, ESRF. In the Taiwan Light Source, the girder and magnet were with different weight and stiffness. Some commercial viscoelastic damping material was chosen to study the effectiveness of vibration suppression. In the preliminary study, a massive granite was used as a structure to study the damping behavior by different viscoelastic material. The damping performance of the structure was measured by the hammer test. The loss factor and storage modulus dynamic of viscoelastic material was measured by dynamic mechanical analysis at different temperature and frequency. The creep phenomena were also monitored. We had installed one damping pad in the girder of the storage ring. The performance of damping in the different structures were compared and discussed.

# Performance of the Vibration Pads in the APS Storage Ring

D. Mangra, S. Sharma and C. Doose

*Oak Ridge National Laboratory, SNS, Oak Ridge, TN 37831, USA*
*phone: +1 865 241 3348, fax: +1 865 241 6739*
*e-mail: mangrad.ornl.gov*

Beam stability goals for the APS Storage Ring require that its quadrupoles' vibrations be limited to 110 nm (rms, 4-50 Hz). Viscoelastic damping pads were installed between the pedestals and magnet girders in order to bring down the magnet vibration levels to within the specified range. This paper presents the design of the damping pads and the results of recent vibration tests to evaluate their performance.

# Thermal Contact Resistance Measurement and Results for Indirectly Cooled SR Optics

B. Fell and K. Fayz

*Daresbury Laboratory, CLRC, , Cheshire WA4 4AD, UK*
*phone: +44 1925 603 443, fax: +44 1925 603 416*
*e-mail: b.d.fell@dl.ac.uk*

Indirectly cooling components by using an intermediate thermal transfer material is desirable in ultra high vacuum (UHV) systems for synchrotron (SR) optics applications, as it largely eliminates the need for expensive integrally cooled optic systems and in-vacuo seals. Such intermediate materials act to fill in the small voids between the actively cooled plate and the optic that arise from microroughness, asperities and other machining/finishing imperfections, and so aid heat transfer by conduction. These materials must be UHV compatible and offer effective heat transfer, which greatly limits the range of materials for selection. Liquid metals such as gallium have been used successfully but have their own particular problems. Solid interfaces such as indium and gold foils are also employed but the efficiency of the thermal heat transfer, directly related to the so called thermal contact resistance, has not been measured in use against the different material interfaces typically found in SR instrumentation. It also cannot be estimated theoretically or empirically with any reasonable accuracy.

We report on a method for measuring the thermal contact resistance in vacuum and also present the results for measured thermal contact resistance values for likely combinations of optic and cool heat-sink surfaces (such as copper, silicon, stainless steel etc.) and thermal interfaces (indium foil, gold foil, bare contact and gallium wetting etc.). This design data can be used, along with FEA, to more accurately predict the behavior of optics at the design stage.

# Glidcop Brazing

Q. Chen, M. Baumgartner, R. Bruetsch, M. Kleeb and W. Hiltpold

*Paul Scherrer Institut, AMI, CH - 5232 Villigen PSI*
*phone: +41 56 310 2579, fax: +41 56 310 2549*
*e-mail: michael.baumgartner@psi.ch*

Brazing Glidcop to copper has been successfully performed at the mechanical workshop (AMI) of the Paul Scherrer Institute (PSI). The Swiss Light Source (SLS), a dedicated high brightness synchrotron radiation source presently under construction at PSI, will include insertion device beamlines producing photon beams with high power. The high heat flux and heat flux cycling will cause thermal schock and fatigue problems in beamline components such as shutters, diaphragms, etc. Glidcop, a dispersion-strengthened OFHC copper made by a powder metallurgy technique, is an interesting design material, due to its high thermal conductivity and superior mechanical properties as compared to copper and its alloys. Because Glidcop is very difficult to fusion weld, vacuum brazing techniques are very important. In this contribution the mechanical and physical properties of Glidcop will be given, and the detailed brazing procedure and study results will be presented.

# Utility and Mechanical Component Stability at SRRC

J. R. Chen*, Z. D. Tsai, C. K. Kuan, S. H. Chang, D. Lee, F. Y. Lin and D. J. Wang

*Synchrotron Radiation Research Center, Hsinchu 300, Taiwan*
*Phone: +886 3 578 0281, fax: +886 3 578 3890*
** Department of Nuclear Science, National Tsing-Hua University, Hsinchu, Taiwan*
*e-mail: jrchen@srrc.gov.tw*

The utility and mechanical component stability at SRRC were studied. It was observed that two major heat sources, from the heating of magnet coil and from the synchrotron radiation power loss on vacuum chamber, affected the mechanical stability and the electron beam orbit as well. The cooling water temperature and the air temperature fluctuations in the storage ring tunnel were improved from about 1°C to ± 0.1°C. The injector energy was also upgraded from 1.3 GeV to 1.5 GeV to increase the temperature and the mechanical stability. Experimental results on the correlation among temperature, mechanical, and orbit stability of the SRRC synchrotron light source is described and discussed in this paper.

# The Switching Mirror Unit

T. Noll, Th. Zeschke, F. Senf, H. Lammert, G. Reichhardt and W. Gudat

*BESSY, Albert Einstein Str. 15, D-12489 Berlin-Adlershof*
*phone: +49 30 6392 4655, fax: +49 30 6392 2990*
*e-mail: noll@bessy.de*

BESSY has developed, verified and implemented a new mirror moving mechanics for the first mirror of undulator/wiggler beamlines. This chambers has two mirrors which moves alternative in the beam. They reflects the beam either to the left, or to the right, or let them unreflected.

The intend was to use the undulator light in two or three experimental user groups alternatively. During the time of preparing an experiment of one team the light is used by the other team.

The poster presents the function and testing results of this Switching Mirror Unit.

# A High-Precision Cryogenically-Cooled Crystal Monochromator for the APS Diagnostics Beamline

E. Rotela, B. Yang, S. Sharma and A. Barcikowski

*Argonne National Laboratory, Advanced Photon Source (APS), Argonne, IL 60439, USA*
*phone: +1630 252 9687, fax: +1 630 252 5948*
*e-mail: rotela@aps.anl.gov*

A high-precision cryogenically-cooled crystal monochromator has been developed for the APS diagnostics beamline. The design provides for a large rotation angle, -5 to 180 degrees with a resolution of 0.001 degrees, to allow for both the Laue and Bragg reflections. The roll angle of the crystal can be adjusted by up to 3 degrees with a resolution of 0.0025 degrees to compensate for small errors in the angle of crystal cut. A vertical translational stage, with a stroke of 49 mm and resolution of 2 microns, is used to withdraw the crystal out of the beam, or to use different parts of the same crystal for reflecting x-rays. A unique feature of the monochromator is that it allows for the use of crystal holders of different designs through a 4 inch diameter vacuum feedthrough. This design feature will permit optimization of crystal holders and cooling schemes in order to minimize thermal distortions of the crystal under high heat loads.

# Design of Standard Refocussing Mirror Chambers for BESSY II Undulator Beamlines

J. Schmidt

*BESSY, Albert Einstein Str. 15, D-12489 Berlin-Adlershof*
*phone: +49 30 6392 4659, fax: +49 30 6392 4850*
*e-mail: schmidtj@bessy.de*

To meet the requirements of third generation synchrotron sources on precision and refinement of in vacuum manipulations new mechanical designs has to be developed. Refocussing mirror chambers are frequently used to define the horizontal and vertical focus geometry on the sample position. We present the design and setup process of the standard BESSY II refocussing chamber starting from the optical specification leading to the final alignment. This involves:

- specification of the setability and reproduceability of the refocussing mirror as a result of raytrace simulations;
- description of the final chambers and presentation of the assemblies;
- FEM stress calculations of the used joints and hinges;
- improvements of the measured focus size and shape under vacuum manipulations based on focus scans.

# Improved Piezo-QEXAFS methods for the millisecond time range

M. Richwin, R. Zaeper, D. Luetzenkirchen-Hecht and R. Frahm

*Institut für Materialwissenschaften und Fachbereich 8 – Physik, Bergische Universität - Gesamthochschule Wuppertal, Gaußstraße 20, D – 42097 Wuppertal, Germany,*
*phone: + 49 - 202 – 439-3102, fax: + 49 - 202 – 439-3101*
*e-mail: richwin@uni-wuppertal.de*

The Piezo-QEXAFS method has been developed and used for scientific investigations of fast time dependent processes using a standard double crystal monochromator at the beamline BW1, HASYLAB. We make use of piezo tilt tables mounted below the crystals in the monochromator which are usually used to align or detune the two crystals with respect to each other. The tilt tables reside on separate monochromator goniometers. A sinusoidal high voltage is applied to change the Bragg angle of both crystals in a synchronous, oscillatory manner. Currently this allows to perform fast energy scans over a range of about 0.13° in Bragg angle, corresponding to about 90 eV at the Cu K-edge using Silicon (111) crystals. Several experiments have been performed using this set-up showing the possibility of time resolved XANES spectroscopy.

To extend the energy range to the full EXAFS range and to increase time resolution, optimized components for the BW1 monochromator are currently under development. The new components are based on novel piezo driven tilt tables. The piezo tilt tables have been specially designed to allow for a complete EXAFS scan over about 1.5° in Bragg angel with a maximum frequency of about 30 Hz, yielding 60 spectra per second. Fast data acquisition equipment and software have already been designed and successfully tested.. The new components will be commissioned and tested at HASYLAB in May this year.

The Piezo-QEXAFS method is suitable for highly diluted samples as it allows for fluorescence mode detection. The experiment has the geometry of standard absorption spectroscopy experiments. Focusing optics may be inserted as needed, and surface sensitive measurements in reflection mode are possible.

Experiments that use this monochromator concept can make best use of third generation synchrotron sources as the attainable time resolution depends on the available photon flux.

# SLS Design Highlights

J. Kohout

*Paul Scherrer Institut, AMI, CH-5232 Villigen PSI*
*phone: +41 56 310 2887, fax: +41 56 310 2549*
*e-mail: jaroslav.kohout@psi.ch*