PhotonMEADOW23

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Report of Abstracts

Poster Session - Board: 1 / **5**

An efficient polycapillary beam collimator for soft X-rays

Authors: Christoph Braig[1]; Heike Löchel[2]; Jürgen Probst[2]; Semfira Bjeoumikhova[3]; Christian Seifert[1]

[1] *Institut für angewandte Photonik e.V.*

[2] *Nano Optics Berlin GmbH*

[3] *Helmut Fischer GmbH*

Corresponding Authors: heikeloechel@googlemail.com, seifert@iap-adlershof.de, probst@nanooptics-berlin.com, semfira.bjeoumikhova@helmut-fischer.com, braig@iap-adlershof.de

A halved polycapillary lens (PCL) may be used as an efficient collimator in the soft X-ray domain. We present recent results of laboratory-based experiments with a micron-sized fluorescence source (Carbon K_α line, 277 eV). Its emission is collected by the PCL and converted into an almost parallel beam, with a residual angular divergence less than 7 mrad. As evaluated by a CCD camera at six positions along the maximal propagation distance of 0.9 m, the beam diameter spreads to no more than (5.6 ± 0.2) mm (FWHM). The measured 3-D beam profile is reproduced by simulations approximately, applying a newly developed ray tracing code witten in the Mathematica^{TM} / Optica^{TM} language. It turns out that both the experimental and the theoretical intensity distribution can be well described by the same, universal fit model. We guess that our findings may open the door to compact and versatile, table-top metrology of optical components in the soft X-ray range — with high efficiency: to verify the gain provided by the PCL, the photon flux through a narrow slit ($\sim$ 1 mm) is recorded in a variable distance of several 10^{-1} m from the collimator's exit aperture. In comparison to unconfined radiation, the PCL yields an up to $90\times$ enhanced count rate on the detector. In this way, relatively weak laboratory X-ray sources, equipped with customized polycapillary lenses, might enable quick and flexible in-house testing of the reflectivity of mirrors, or the diffraction efficieny of transmission and reflection zone plates in the future, for instance.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 2 / **6**

Soft X-ray wavefront sensing at an ellipsoidal mirror in the lab

Author: Christoph Braig[1]

Co-authors: Jürgen Probst [2]; Christian Seifert [1]; Thomas Krist [2]; Heike Löchel [2]; Ladislav Pina [3]

[1] *Institut für angewandte Photonik e.V.*

[2] *Nano Optics Berlin GmbH*

[3] *Czech Technical University in Prague*

Corresponding Authors: heikeloechel@googlemail.com, seifert@iap-adlershof.de, probst@nanooptics-berlin.com, braig@iap-adlershof.de, ladislav.pina@fjfi.cvut.cz, info@nanooptics-berlin.com

We report on a fast and reliable method for wavefront sensing in the soft X-ray domain, developed for the characterization of rotationally symmetric optical elements, like an ellipsoidal mirror shell. In our laboratory setup, the mirror sample is irradiated by an electron-excited (4.4 keV), micron-sized ($\approx 2\,\mu$m) fluorescence source (Carbon K_α, 277 eV). The near-focal, 3-D intensity distribution $I(\vec{r})$ is recorded by a CCD camera (512×512 pixels à $13.5\,\mu$m) at multiple positions along the optical axis, displaced by $(20 - 25)\,\%$ from the focus. The transport-of-intensity equation is interpreted in a geometrical sense from plane to plane and implemented as a ray tracing code in Mathematica^{TM} / Optica^{TM}, to retrieve the phase $\phi(\vec{r})$ from the radial intensity gradient on a sub-pixel scale. 15

intra-focal CCD image pairs are evaluated in this way and averaged to an annular 2-D map of the wavefront error. In units of the test wavelength (C K_α), we find $\sigma = \pm 47\,\lambda$ (rms) and a P-V of $\pm 118\,\lambda$. The wavefront can be used in a threefold purpose: First, the focus is predicted with a result of $48.3\,\mu$m (rms), in reasonable agreement with the direct experimental observation of $55.3\,\mu$m (FWHM). Secondly, the combined figure and alignment error of the ellipsoid is reconstructed — and again, the statistical mean of ± 9.4 arcsec (rms) roughly coincides with independent estimations from the measured focal intensity distribution (± 11.8 arcsec). At last, a diffractive wavefront corrector may be computed and fabricated, for wavelength-dispersive spectroscopy with high efficiency and optimized resolution.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 3 / **11**

Micropore Optics for the SMILE SXI Instrument

Authors: Gillian Butcher[1]; Charly Feldman[1]; Graeme Hansford[1]; Jim Pearson[1]; Paul Houghton[1]; Tony Crawford[1]; Phil Peterson[1]; Adrian Martindale[1]; Steve Sembay[1]

[1] *University of Leicester*

Corresponding Author: gib2@le.ac.uk

Micropore optics (MPOs) have become the optic of choice in recent years for low mass and wide-angle field of view x-ray missions, such as SVOM and Einstein Probe. The Soft X-ray Imager (SXI) instrument for ESA's SMILE mission aims to spectrally map the location, shape and motion of the Earth's magnetosphere as it interacts with high energy particles excited by the Sun's solar wind. To meet this aim, an array of 8 by 4 Photonis MPOs will provide angular coverage of 15.5° x 26.5° over the energy range 0.2 to 2.5 keV. One of the key requirements of the mission is for low optical straylight to reach the detector, so the transmission of visible light through the optic is a key parameter. In this paper the x-ray performance of the individual MPOs, both qualification and flight MPOs, will be presented as well as investigation into their straylight performance and the quality of the optical blocking filter.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

no

Poster Session - Board: 4 / **14**

Development of Precision, Variable Slits for Dynamic X-Ray Scattering Instrument

Author: Jean-Pierre Torras[1]

[1] *SLAC National Accelerator Lab*

Corresponding Author: jtorras@slac.stanford.edu

The LCLS-II-HE beamline at SLAC (Menlo Park, USA) is planned to come online in 2027. With FEL photon energies ranging from 0.25 keV to more than 18 keV at up to 1 MHz repetition rate, the upgraded beam calls for new science endstations to be developed. The Dynamic X-ray Scattering (DXS) instrument will employ experimentation methods such as X-Ray Photon Correlation Spectroscopy

(XPCS) and High Resolution Inelastic X-Ray Scattering (IXS) to investigate quantum materials and condensed matter chemistry among other topics. To realize its science goals, DXS requires an energy resolution of less than 3 meV for energies ranging from 6-18 keV, with a tunable energy bandwidth. A key component of DXS is a 4f-High Resolution Monochromator (4f-HRM), featuring a Wavelength Defining Slit (WDS) mechanism. A novel slit blade design absorbs 10 W direct beam heat load, while preventing transmission of relevant photon energies. To achieve less than 3 meV energy resolution with tunable bandwidth, the WDS mechanism features an adjustable slit gap size down to 1.0 micron with 0.1 micron motion resolution and stability. This presentation discusses the goals, design challenges, and solutions for the WDS.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 5 / **16**

Fast shaping control of X-ray beams using a closed-loop adaptive bimorph deformable mirror

Author: SIMON ALCOCK[1]

Co-authors: IOANA-THEODORA NISTEA [1]; VIVEK G. BADAMI [2]; RICCARDO SIGNORATO [3]; MATTEO FUSCO [4]; LINGFEI HU [1]; HONGCHANG WANG [5]; KAWAL SAWHNEY [5]

[1] *Diamond Light Source*

[2] *Zygo Corporation*

[3] *S.RI. Tech*

[4] *CAEN*

[5] *Diamond Light Source Ltd*

Corresponding Authors: vivek.badami@ametek.com, riccardo.signorato@cinel.com, hongchang.wang@diamond.ac.uk, kawal.sawhney@diamond.ac.uk, m.fusco@caen.it, lingfei.hu@diamond.ac.uk, simon.alcock@diamond.ac.uk, ioana.nistea@diamond.ac.uk

Recent technological advances at synchrotron and free electron laser facilities, including brighter X-ray sources, faster detectors, and automated sample handling, have led to an increasing demand to tailor the X-ray beam profile to the size and shape of the sample. For beamlines which routinely measure hundreds of samples per day, such changes need to be made rapidly and autonomously. Bimorph piezo-electric deformable mirrors are widely used to control the profile of the reflected X-ray beam. However, when operated in open-loop, such optics suffer from curvature drift when large and frequent changes are made. To resolve these issues, we have successfully demonstrated a high-resolution, real-time, closed-loop "adaptive"optical system capable of rapidly changing and stabilizing the shape of the X-ray beam. The bimorph's optical surface is continuously monitored by an array of Zygo ZPS absolute distance measuring sensors operating at 20 kHz. Surface corrections are autonomously applied to each piezo, with sub-500 picometre resolution, at a refresh rate of ~ 1 Hz, using a programable high-voltage power supply. After calibration of the X-ray wavefront at the B16 Test beamline using speckle scanning, the wavefront diagnostic was removed from the X-ray beam path. Non-invasive control of the reflected X-ray beam was then demonstrated, including variable beam size, or non-Gaussian profiles, such as flat-top intensity or multiple split-peaks with controllable separation and relative amplitude. Such changes can be applied in any order and in rapid succession without the need for invasive wavefront diagnostic sensors which block the X-ray beam for scientific usage.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 6 / **18**

MooNpics –European metrology round-robin collaboration observing different aspects on high-quality X-Ray mirrors

Author: Silja Schmidtchen[1]

Co-authors: Idoia Freijo Martin [1]; Maurizio Vannoni [1]; Elke Ploenjes [2]; Harald Sinn [1]

[1] *European XFEL*

[2] *Deutsches Elektronen-Synchrotron DESY*

Corresponding Authors: harald.sinn@xfel.eu, silja.schmidtchen@xfel.eu, maurizio.vannoni@xfel.eu, idoia.freijo.martin@xfel.eu, elke.ploenjes@desy.de

We present here a summary of the European metrology round-robin project MooNpics - Metrology On One-Nanometre-Precise Optics. Established in 2017, this collaboration between ten European light sources and two X-ray optic manufacturers aimed to improve the quality and availability of high-precision X-ray mirrors. Several work packages were created to focus on the metrology and analysis methods used in the European light sources'metrology labs as well as on software and methods for focal spot reconstruction and fast mirror alignment. Different aspects of X-ray mirror production and metrology were observed. For this purpose, three high-quality X-Ray mirrors with different shapes and surface structures were investigated in a European-wide round-robin experiment over four years. Mirrors with very different parameters were chosen to meet the large variety of metrology instruments used in the facilities and to explore different aspects of height and slope error measurements. One of the round-robin mirrors, a 950 mm long plane mirror could be used to calibrate instruments and to identify errors due to its very high flatness and extremely good surface quality. One strongly curved spherical and one elliptical mirror served these purposes with their strong shapes and imprinted structures. Results of the plane mirror will be presented here.
With the large amount of metrology data collected, a cross-calibration of instruments and methods used in the facilities was made possible. In addition, it enabled the metrology labs to develop new methods, to create standards and to improve deterministic polishing methods in close collaboration with our industrial partners.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 7 / **19**

Wavefront analysis by Shadow raytracing program

Authors: Hossein Khosroabadi[1]; David Laundy[1]; Vishal Dhamgaye[1]; Kawal Sawhney[1]

[1] *Diamond Light Source*

Corresponding Authors: kawal.sawhney@diamond.ac.uk, hossein.khosroabadi@diamond.ac.uk, david.laundy@diamond.ac.uk, vishal.dhamgaye@diamond.ac.uk

X-ray wavefront provides precise information about optics misalignments, optics figure errors, and beam caustics. The knife edge wavefront sensing method is developed recently at Diamond Light Source and used in the wavefront profile reconstruction of focusing elements such as X-ray mirrors and lenses [1]. The wavefront profile is reconstructed from the intensity drop in each pixel of an area detector as the knife edge obscures the rays. We have developed a modelling tool for the knife-edge wavefront sensing method in Shadow [2] under the OASYS interface to simulate and analyse the X-ray wavefront and determine its polynomial compositions. The simulation tool was employed in understanding and interpreting the wavefront data obtained from combined optics consisting of the Alvarez X-ray lens [3] and an elliptical mirror. Unique coordination between the adaptive radius of the Alvarez lens and the incident angle of the elliptical mirror was proposed for reducing the

defocus and the lowest-order coma aberrations of combined optics and simulated data were verified with measured data. This paper presents the performance of the wavefront analysis tool in Shadow and its further use in designing the wavefront compensation optics and overcoming the optics misalignments.
References:
[1] Adaptable refractive correctors for x-ray optics; D.Laundy, V.Dhamgaye, T.Moxham, & K.Sawhney, Optica 6, 1484 (2019)
[2] OASYS: A software for beamline simulations and synchrotron virtual experiments; M.Sanchez-del Rio, L.Rebuffi, AIP Conf. Proc. 2054, 060081 (2019).
[3] An Alvarez varifocal X-ray lens; V.Dhamgaye, D.Laundy, H.Khosroabadi, T.Moxham, S.Baldock, O.Fox, & K.Sawhney (Submitted for publication).

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 8 / **26**

On the design of monochromators for high-resolution inelestic x-ray scattering

Author: Hengzi Wang[1]

[1] *SLAC*

Corresponding Author: hengzi@slac.stanford.edu

Traditional back-scattering high resolution monochromators for synchrotron light sources can't inadequately address the unique thermal problems of XFEL beam, especially seeded X-rays. Alternatively, LCLS-II-HE will support a novel in-line instrumentation design for ultra-high-resolution inelastic x-ray scattering based on perfect silicon crystals. The initial design of the monochromators applies zig-zag 4-bounce optical traces, before evolving into double-crystal monochromators (DCM). However, even DCMs can't meet the stability requirement of the system. In order to meet the stability and minimize thermal induced distortions, the final design has been settled to double channel-cut crystal monochromators (DCCM). Asymmetrically cut crystals are intentional designed to reduce the thermal intensity by spreading the beam over a larger surface areas. In this article, the reasoning processes of the design evolution and the final implementation of the monochromator designs will also be presented.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

no

Poster Session - Board: 9 / **30**

At-Wavelength Metrology facility for EUV, XUV and tender X-ray energy range optics

Authors: Andrey Sokolov[1]; Frank Eggenstein[2]; Peter Bischoff[2]; Peter Baumgärtel[3]; Matthias Mast[2]; Marcel Mertin[2]; Ingo Packe[2]; Franz Schäfers[2]; Frank Siewert[3]; Jens Viefhaus[3]

[1] *Helmholtz-Zentrum Berlin fur Materialien und Energie, BESSY II*

[2] *Helmholtz-Zentrum Berlin für Materialien und Energie, BESSY-II*

[3] *Helmholtz-Zentrum Berlin*

Corresponding Authors: frank.eggenstein@helmholtz-berlin.de, marcel.mertin@helmholtz-berlin.de, peter.bischoff@helmholtz-berlin.de, ingo.packe@helmholtz-berlin.de, franz.schaefers@helmholtz-berlin.de, andrey.sokolov@helmholtz-berlin.de, frank.siewert@helmholtz-berlin.de, matthias.mast@helmholtz-berlin.de, jens.viefhaus@helmholtz-berlin.de, peter.baumgaertel@helmholtz-berlin.de

An accurate characterization of the real performance sophisticated reflective or diffractive optics including such cases as XUV reflective zone plates (RZP) or multilayer coated gratings is extremely demanding task to experimental conditions. An At-Wavelength Metrology facility for EUV and XUV optics is under operation since many years at the BESSY-II storage ring. As the main instrument a versatile 11-axis UHV-reflectometer is permanently connected to a dedicated Optics beamline. The setup is suitable for measurements on both small test samples and real size optics up to 360 x 60 x 60 mm3. 6-degrees of freedom in alignment and surface mapping of tested optical elements are possible due to flexible sample stage support system based on an UHV-tripod. It is possible to care out measurements with beam incident angle from 0 to 88.9 degrees and scan outgoing radiation in almost complete in-plane circle as well to continuously rotate whole system from s- to p- polarization geometry. High spectral purity beam in energy range from 13.5 eV ato 1800 eV is provided by 4-mirorrs High-Order Suppressor System. In additional to that a small Reflectometer as a portable end-station is used to get access to UV-EUV or X-ray energy ranges by setting it up at U125-2_NIM (4eV –30eV) and KMC-1 (2keV –10keV) beamlines at BESSY-II. The present status of the metrology facility, their latest upgrade projects and most challenging results will be presented in our contribution.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

no

Poster Session - Board: 10 / **31**

TRIXS end-station at FLASH for ultrafast high-resolution soft X-ray spectroscopy

Author: Siarhei Dziarzhytski[1]

Co-authors: Mangalika Sinha [2]; Holger Weigelt [2]; Federico Pressacco [2]; Elke Plönjes [3]; Martin Beye [2]; Günter Brenner [2]

[1] *Deutsches Elektronen Synchrotron (DESY)*

[2] *DESY*

[3] *Deutsches Elektronen-Synchrotron DESY*

Corresponding Authors: martin.beye@desy.de, federico.pressacco@desy.de, holger.weigelt@desy.de, mangalika.sinha@desy.de, guenter.brenner@desy.de, siarhei.dziarzhytski@desy.de, elke.ploenjes@desy.de

We present the upgraded TRIXS (Time-Resolved Inelastic soft X-ray Scattering Spectrometer) end station at the PG1 monochromator beamline at the soft X-ray free-electron laser FLASH [1]. TRIXS was developed for studies of ultrafast processes in condensed matter, e. g. various types of interactions in strongly correlated electronic systems, by means of femtosecond pump-probe IXS technique with the energy resolution of about 50 - 100 meV. The spectral range of TRIXS spans from 40 eV to 250 eV and covers M-edges of the 3d transition metals and N-edges of rare earth elements. High brilliance and high repetion rate photon source as FLASH and high spectrometer collecting efficiency are mandatory for such type of experiments. A recent upgrade of the sample allows now to explore dynamics also in XAS in transmission as well as in reflectivity regimes with 0.01-degree angular resolution. FLASH synchronized femtosecond facility laser PIGLET provides 80 fs fwhm long pulses to pump samples with 1030 nm photons as well as with higher harmonics down to 257 nm. The overall time-resolution is in the range between 180 and 250 fs fwhm. First time-resolved RIXS measurements were already carried out with the new TRIXS chamber and further experiments are envisioned. New control system and machine-learning-based alignment and stabilization algorithms will provide a better user interface and even more stable operation, and cover new FLASH features that will become available after the FLASH2020+ upgrade.
[1] S. Dziarzhytski et al. Structural Dynamics 7, 054301 (2020), https://doi.org/10.1063/4.0000029

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

no

Poster Session - Board: 11 / **33**

Development of Ion beam figuring (IBF) system at Diamond Light Source

Author: ARINDAM MAJHI[1]

Co-authors: Matthew Hand [1]; Weichen Gu [1]; Simone Moriconi [1]; Murilo Bazan Da Silva [1]; Riley Shurvinton [1]; Simon G. Alcock [1]; Hongchang Wang [1]; Kawal Sawhney [1]

[1] *Diamond Light Source*

Corresponding Authors: weichen.gu@diamond.ac.uk, matt.j.hand@gmail.com, riley.shurvinton@diamond.ac.uk, hongchang.wang@diamond.ac.uk, murilo.bazan-da-silva@diamond.ac.uk, kawal.sawhney@diamond.ac.uk, simone.moriconi@diamond.ac. arindam.majhi@diamond.ac.uk, simon.alcock@diamond.ac.uk

Modern synchrotron and free-electron laser sources demand ultra-high-quality x-ray mirrors for many challenging x-ray applications, including nano focusing, preserving coherence, and extreme energy resolution. As a deterministic polishing technique, Ion Beam Figuring (IBF) is often used to produce these mirrors with the required precision. Recently, an in-house IBF system has been developed and commissioned at Diamond Light Source [1]. It has a large diameter DC gridded ion source, 4-axis motion stages, and an imaging system for alignment. In addition, a laser Speckle Angular Metrology (SAM) instrument [2] has been incorporated to monitor progress during each IBF iteration, thereby reducing the overall time required. We describe developmental details of our position–velocity–time (PVT) algorithm, including the fiducialization procedure for precise alignment with ex-situ metrology data [3]. Preliminary figuring results will be presented for 1D and 2D corrections, with accuracy on the sub-nanometres level.

Reference:
1. M. Hand, S. G. Alcock, M. Hillman, R. Littlewood, S. Moriconi, H. Wang, K. Sawhney, Advances in Metrology for X-Ray and EUV Optics VIII. Vol. 11109. SPIE, 2019.
2. H. Wang, S. Moriconi, and K. Sawhney, Light: Science & Applications, 10, 195 (2021).
3. M. B. Da Silva, S. G. Alcock, I. T. Nistea, and K. Sawhney, Optics and Lasers in Engineering 161, 107192 (2023).

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 12 / **34**

Recent developments in Speckle Angular Metrology (SAM) for X-ray mirrors at Diamond Light Source

Author: SIMONE MORICONI[None]

Co-authors: IOANA-THEODORA NISTEA [1]; MURILO BAZAN DA SILVA [1]; SIMON G. ALCOCK [1]; ALEXANDER M. KORSUNSKY [2]; HONGCHANG WANG [3]; KAWAL SAWHNEY [3]

[1] *Diamond Light Source*

[2] *University of Oxford*

[3] *Diamond Light Source Ltd*

Corresponding Authors: alexander.korsunsky@eng.ox.ac.uk, hongchang.wang@diamond.ac.uk, murilo.bazanda-silva@diamond.ac.uk, kawal.sawhney@diamond.ac.uk, simone.moriconi@diamond.ac.uk, simon.alcock@diamond.ac.uk, ioana.nistea@diamond.ac.uk

High precision and accurate metrology plays a pivotal role in the characterization and improvement of X-ray mirrors for synchrotron and X-ray Free Electron Laser (FEL) sources. To meet the stringent requirements of nano-precision metrology for demanding X-ray mirrors, a novel metrology instrument called Speckle Angular Metrology (SAM) has been recently developed at Diamond Light Source [1]. We present the latest experimental results in the form of comparison between measurements performed using SAM, the Diamond- Nanometre Optical Metrology instrument (NOM) [2], and a Fizeau Interferometer [3]. The results are given for three challenging X-ray Mirrors: a 9.3m spherical mirror (also measured by various facilities around Europe as part of the MOONPICS collaboration); a flat grating blank with a radius of curvature > 16 km, and a super-polished JTEC cylindrical, low-reflectivity glass substrate mirror with a radius of ~ 116 m. The study considers systematic errors and assesses the advantages and limitations of SAM. The SAM will extend the capability of the existing metrology instruments and provide an alternative and complementary metrology means for future X-ray mirrors.

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2. Alcock,S.G.et al. The Diamond-NOM: A non-contact profiler capable of characterizing optical figure error with sub-nanometre repeatability. Nucl. Instruments Methods Phys. Res. Sect. A Accel. Spectrometers, Detect. Assoc. Equip. 616, 224–228 (2010).
3. da Silva,M.B.,Alcock,S.G.,Nistea,I.T.& Sawhney,K. A Fizeau interferometry stitching system to characterize X-ray mirrors with sub-nanometre errors. Opt. Lasers Eng. 161, 107192 (2023).

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 13 / **35**

New wavefront sensor for renewed differential pumping unit at FLASH2 beamlines

Author: Barbara Keitel[1]

Co-authors: Maciej Brachmanski [1]; Günter Brenner [1]; Pragya Chopra [1]; Siarhei Dziarzhytski [2]; Svea Kreis [1]; Marion Kuhlmann [1]; Mabel Ruiz Lopez [1]; Sven Toleikis [1]; Holger Weigelt [1]; Klaus Mann [3]; Maik Lübbecke [3]; Bernd Schäfer [3]; Elke Plönjes [4]

[1] *DESY*

[2] *Deutsches Elektronen Synchrotron (DESY)*

[3] *IFNANO*

[4] *Deutsches Elektronen-Synchrotron DESY*

Corresponding Authors: pragya.chopra@desy.de, maciej.brachmanski@desy.de, mabel.ruiz-lopez@desy.de, holger.weigelt@desy.de, sven.toleikis@desy.de, svea.kreis@desy.de, maik.luebbecke@ifnano.de, klaus.mann@ifnano.de, marion.kuhlmann@desy.de, bernd.schaefer@ifnano.de, barbara.keitel@desy.de, guenter.brenner@desy.de, siarhei.dziarzhytski@desy.de, elke.ploenjes@desy.de

In the past years, DESY developed in collaboration with the Institut für Nanophotonik Göttingen e.V. several Hartmann wavefront sensors (WFS) for FEL focus characterization and optics alignment in the soft x-ray spectral range, approx. 5 - 40 nm. In principle, a WFS is used in the direct beam

at an appropriate position behind the focusing system which is to be characterized. Practically, at FLASH this straight direction is often blocked by an experimental setup, thus prohibiting fast focal spot characterization and in-situ adjustment during the experiments. For this reason and as a first improvement, the FEL beam at beamline FL24 can be deflected at 90° just before the experiment and guided to a WFS located in a distance of about 3 m behind the focus position.
As this concept is very space consuming, a new differential pumping unit with a permanently integrated WFS located directly after the K-B focusing optics system, was developed. This newly designed WFS is located in front of the nominal beamline focus position under an angle of 45° to the beam. The beam is directed to the WFS by means of a Ni mirror, which is adjustable in 6 degrees of freedom. This deflecting mirror can be moved in very fast for optics alignment and focus optimization. Although not in-situ this allows one to efficiently prepare the beamline focus for user experiments.

This fast and space-saving method will be presented and first results will be shown. A new and compact WFS under development will be presented.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

no

Poster Session - Board: 14 / **37**

Ultrafast Pump-probed Resonant Elastic X-ray Scattering Station Based on Soft X-ray Free Electron Laser in Shanghai

Authors: Qi Jiang[1]; Mao Ye[2]

[1] *Shanghaitech University*

[2] *Shanghai Advanced Research Institute*

Corresponding Authors: jiangqi1@shanghaitech.edu.cn, yemao@mail.sim.ac.cn

X-ray Free Electron Laser (XFEL) represents the cutting-edge advancements in light sources, characterized by their exceptional features of ultra-short pulse durations, extraordinarily high pulse peak brightness, and remarkable coherence. These intrinsic properties establish a development for practical implementations in ultrafast X-ray diffraction and scattering techniques. With the successful construction of the Soft X-ray Free Electron Laser facility in Shanghai, we have enabled the establishment of the XFEL-based Resonant Elastic X-ray Scattering (REXS) experimental station, which offers a remarkable platform for investigating and exploring long-range states, such as charge, orbital, and spin states, in strongly correlated systems. Notable examples of such states encompass superconducting phases, microscopic magnetic structures, and charge density waves, among others. Moreover, The REXS station facilitates selective excitation of electronic states within correlated systems by employing infrared pump lasers. Subsequently, the ultra-short pulse duration of the XFEL, reaching the remarkable timescale of 100 femtoseconds, enables precise detection and comprehensive exploration of the ultrafast dynamic processes associated with these states. Thus, this platform provides an ideal opportunity to investigate transient superconductivity, magnetization dynamics, and various other phenomena of scientific interest.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 15 / **38**

Linear Error Elimination Procedure for 2D stitching metrology

Author: Albert Van Eeckhout Alsinet[1]

Co-authors: Igors Sics [1]; Josep Nicolàs Roman [1]

[1] *ALBA Synchrotron*

Corresponding Authors: isics@cells.es, aveeckhout@cells.es, jnicolas@cells.es

We present a new 2D stitching method that effectively removes the systematic errors introduced by the reference flat, as well as any other additive measurement error constant across the sub-aperture measurements. This method, referred to as Linear Error Elimination Procedure (LEEP), can provide the two-dimensional error map for a wide range of X-Ray mirror lengths and figures, with sub-nanometer accuracy and lateral resolution well below the millimeter. We discuss the main features of LEEP, including the conditions required for the measurement routine. A main condition is that the scan trajectory along the surface under test must be two-dimensional, i.e. not a straight line, in order to allow for 2D reconstruction. In addition, it must have a non-constant stitching step, to avoid periodic errors in the reconstructed surface. We will prove that, in order to determine the curvature and twist of the surface under test, one can track the orientation of the interferometer at every step. We provide experimental results that show the effective error suppression by means of the proposed method, applied to several mirrors, and that allow estimating the systematic errors with a repeatability of 40 picometers.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

no

Poster Session - Board: 16 / **42**

MINERVA, a new X-ray facility in operation for the characterization of the NewATHENA Mirror Modules at the ALBA Synchrotron

Authors: Dominique Heinis[1]; Antonio Carballedo[1]; Carles Colldelram[1]; Guifré Cuní[1]; Núria Valls Vidal[1]; Alejandro Sánchez[1]; Joan Casas[1]; Josep Nicolàs Roman[1]; Nicolas Barriere[2]; Max Collon[2]; Giuseppe Vacanti[2]; Dieter Skroblin[3]; Levent Cibik[3]; Michael Krumrey[3]; Ivo Ferreira[4]; Marcos Bavdaz[4]

[1] *ALBA Synchrotron*

[2] *cosine*

[3] *Physikalisch-Technische Bundesanstalt*

[4] *ESA*

Corresponding Authors: acarballedo@cells.es, dheinis@cells.es, jnicolas@cells.es, ivo.ferreira@esa.int, m.collon@cosine.nl, marcos.bavdaz@esa.int, nbarriere@cosine.nl, g.vacanti@cosine.nl, michael.krumrey@ptb.de

The ALBA Synchrotron (Barcelona, Spain) is commissioning MINERVA a new X-ray beamline designed to support the development of the NewATHENA mission (Advanced Telescope for High Energy Astrophysics), which mission is to observe and study energetic objects in space (accretion disk around black holes, large-scale structure, etc...). MINERVA is dedicated to assemble stacks manufactured by cosine into mirror modules (MM), building blocks of the NewATHENA optics. The new beamline is originally based on the monochromatic pencil beam XPBF 2.0 at the Physikalisch-Technische Bundesanstalt (PTB at BESSY II) but also includes additional features on the scanning scheme to improve the characterization time of each MM produced. Interoperability between MINERVA and XPBF 2.0 is nonetheless preserved to strengthen the mass production of the MMs and characterize their performance. MINERVA is funded by the European Space Agency (ESA) and the Spanish Ministry of Science and Innovation and will enter in operation by autumn 2023.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

no

Poster Session - Board: 17 / **47**

X-ray Optical Delay Line at European XFEL

Author: Marziyeh Tavakkoly[1]

Co-authors: Maurizio Vannoni ; Jan Gruenert ; Andreas Koch ; Daniele La Civita ; Mikako Makita ; Michael Meyer ; Marc Planas ; Svitozar Serkez ; Harald Sinn ; Torsten Wohlenberg

[1] *European XFEL*

Corresponding Author: marziyeh.tavakkoly@xfel.eu

Free-electron lasers (FELs) are the most advanced class of light sources, enabling a wide range of innovative experiments such as two-color pump-probe spectroscopy. For this experiment, it is required to control the temporal delay between two X-ray pulses. For this purpose, the soft X-ray Self-Amplified Spontaneous Emission (SASE3) beamline at the European XFEL was equipped with a magnetic chicane (MC) that delays the electron beam and therefore the corresponding photon sources. Using an optical delay line (ODL) would allow the implementation of two pulses crossed with zero-time as well as negative delay. The ODL consists of a double optics chicane using 4 flat silicon mirrors coated with 50 nm B4C that delays the x-ray beam.
We present a brief description of ODL and review its specification. The mirror surface was measured and wavefront propagation software was used to examine the effects of the mirror surface on the beam spot. The study of the damage threshold was also an important challenge that we examined.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 18 / **51**

Single-shot spectrometer usage for I-zero normalization for Bragg-diffraction investigations with pink beam

Authors: Jakub Vonka[1]; Alexander Steppke[1]; Simon Gerber[1]; Christoph Arrell[2]; Bill Pedrini[1]

[1] *Paul Scherrer Institute*

[2] *PSI*

Corresponding Authors: bill.pedrini@psi.ch, alexander.steppke@psi.ch, simon.gerber@psi.ch, jakub.vonka@psi.ch

At FELs, Bragg diffraction experiments are usually performed with monochromatic beam, whose bandwidth is smaller than the acceptance of the Bragg peak under investigation. This enables straightforward normalization of the measured Bragg peak intensity by detecting the FEL pulse intensity with a “scalar”detector (e.g. a diode measuring the scattering from a thin foil). In certain FEL applications, however, the bandwidth markedly exceeds the acceptance of the Bragg peak under investigation. In this case, the normalization can be achieved by integrating the spectrum measured by a “vector detector”, typically named single-shot spectrometer, after multiplication with a suitable windowing function.

We have performed experiments at the SwissFEL ARAMIS hard x-ray beamline exploiting the “broadband mode”(bandwidth > 0.005), characterized by a substantial temporal/photon energy chirp, and the “sub-fs mode”(bw ~ 0.002), characterized by one to few FEL temporal spikes. In both cases, the bandwidth markedly exceeded the acceptance of the Bragg peak under investigation. Here, we report on our work assessing the windowing function from the measured per-pulse spectra and Bragg peak intensities, focusing on the emerged problems and discussing possible improvements on the spectrometer.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

no

Poster Session - Board: 19 / **52**

A wavefront propagation study of the effect of apertures in laser transports on the beam profile achieved with relay imaging illuminated circular masks

Authors: Mark Roper[1]; Katie Morrow[1]

[1] *STFC Daresbury Laboratory*

Corresponding Authors: katherine.morrow@stfc.ac.uk, mark.roper@stfc.ac.uk

Relay imaging an illuminated circular mask is a common way of projecting a laser beam onto the photocathode in an RF photo-injector whilst generating a round laser beam spot with a sharp-edged profile. The mask is illuminated with the laser beam and an optical system images the mask onto the cathode. Geometrical optics predicts the beam on the cathode will be an exact replica of the intensity profile at the aperture. However, in physical optics, generating a sharp-edged profile requires an infinite Fourier series of spatial harmonics. The Gibb’s phenomenon shows that truncating the Fourier series at any point, for example with the finite aperture of the transport system, results in a peak at the edge and ripples over the beam profile.

This work explores this effect using a wavefront propagation code. We show that the finite aperture of the transport can have a marked effect on the final image even when an aperture truncates the beam at very low intensity. Small beams at the cathode require correspondingly larger apertures in the transport. This has significant implications when a small beam size is required at the cathode because the apertures in RF photo-injector guns can be very restrictive and asymmetric with respect to the laser beam centre. Furthermore, when a ‘virtual cathode’ is used to monitor the laser beam profile, the beam profile at the actual cathode may be significantly different to that at the virtual cathode unless the path to the virtual cathode has identical apertures.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 20 / **53**

Addressing slow drift effects in the SASE3 Soft X-ray Beamline at the European XFEL: performance of an autocollimator-based correction method

Author: Maurizio Vannoni[1]

Co-authors: Tommaso Mazza [1]; Alberto De Fanis [1]

[1] *European XFEL GmbH*

Corresponding Authors: tommaso.mazza@xfel.eu, alberto.de.fanis@xfel.eu, maurizio.vannoni@xfel.eu

The SASE3 soft X-ray beamline at the European XFEL is equipped with a 100-meter-long-arm monochromator, which delivers to the experiments (SQS, SCS, SXP) pink or monochromatic beam in the photon energy range of 250 eV - 3000 eV. Due to the considerable length of the arm, ensuring stability becomes crucial in the short and long timescale. Currently, the system does not have cooling installed, primarily due to the complexity of that installation and the challenges associated with fabricating the long grating.
The absence of cooling is triggering a slow drift of the system, which is not entirely captured by the encoders and therefore cannot be corrected. Consequently, this drift results in an undesired drift of the photon energy of the delivered monochromatic beam, causing challenges for high-precision experiments. The effect becomes more pronounced when using multiple pulses and high pulse energies, due to the higher heat load.
To address this issue, we have installed an autocollimator that directly observes the grating position from outside the chamber, providing an independent measurement of the drift. In this presentation, we will discuss the performance of this system, present the results obtained from experiments, and outline potential future improvements. While the proposed method offers a straightforward solution for on-site correction of these drifts, it is important to acknowledge certain limitations that need to be taken into account.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 21 / **55**

Optical metrology for bender and adaptive optics optimization and characterization

Authors: Josep Nicolas[1]; Igors Sics[1]; Albert Van Eeckhout[1]; Dominique Heinis[1]

[1] *ALBA Synchrotron Light Source*

Corresponding Authors: isics@cells.es, aveeckhout@cells.es, dheinis@cells.es, jnicolas@cells.es

We present some of the methods, procedures and analysis tools used at ALBA to characterize mirror benders, and other adaptive optics mirror systems. The tests we describe combine measurements of different instruments, including our NOM and our stitching interferometry platform, with a number of optimization routines based on the deformation model of the mirror within the bender.
The characterization of an adaptive optics system has three distinct purposes: Checking that the system meets the optical requirements, Optimizing some mechanical adjustments, and providing information for the operation of the bender at the beamline. Besides this, metrology often reveal features of the opto-mechanical system which are useful information for continuous improvements.
The characterization of an adaptive optics system is very time consuming, since one must explore the configuration space of the system under test with sufficient surface measurements. At the same time, the continuously-improving quality of optical surfaces requires that the measurements are taken with sufficient averaging, redundancy and stabilization. To be effective in this aspect, we have optimized our metrology instruments to be fast and still accurate.
A feature of the presented procedures is the analysis of the obtained surface measurements using the deformation model of the system. This analysis allows minimizing the number of required measurements for a complete characterization, and allow identifying the nature of some of the observed deviations.
We describe the procedures and provide results based on measurements on more than 50 systems, with a wide range of optical lengths, figures and surface qualities.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 22 / **56**

Updates on the optical design and initial characterization activity of the MOST beamline in view of Elettra 2.0

Authors: Fabio Frassetto[1]; Gabriele Bonano[2]; Luca Poletto[1]; Marcello Coreno[3]; Monica De Simone[4]; Roberta Totani[5]; Sergio D'Addato[2]

[1] *CNR-Istituto di Fotonica e Nanotecnologie (Italy)*

[2] *Università di Modena e Reggio Emilia*

[3] *CNR-ISM*

[4] *CNR - IOM*

[5] *ELETTRA SINCROTRONE TRIESTE*

Corresponding Authors: fabio.frassetto@pd.ifn.cnr.it, gabriele.bonano@unimore.it, desimone@iom.cnr.it, daddato@unimore.it, marcello.coreno@mlib.ism.cnr.it, poletto@dei.unipd.it, roberta.totani@elettra.eu

We report on the latest developments regarding the design and initial operations of the Molecular and Optical Science Technology beamline (MOST), the new beamline specifically devoted to serve the atomic and molecular physics community at Elettra 2.0.
Two new insertion devices (IDs) have recently been installed, adopting an in-line configuration; one covers the low-to-intermediate photon energy range (8-300 eV), a second one the intermediate-to-high photon energy range (80-3000 eV). Both undulators provide full polarization control of the emitted radiation.
The optical layout will be presented, as well as future prospects for the beamline. A central main line will allow for the intermediate-to-high energy range, and it will be complemented by two branches, one for low-energy equipped with a normal incidence monochromator (NIM, currently at the Circular Polarization beamline of Elettra) and a second for the intermediate XUV range equipped with the spherical grating monochromator (SGM, currently at the GasPhase beamline at Elettra). The main line will use five optical elements implementing a spherical mirror and a novel variable line spacing grating monochromator, to deliver a beam parallel to the orbital plane.
We are currently carrying out preliminary measurement of the performances of the two new undulators exploiting the old CiPo beamline layout. Later this year we plan to undertake polarimetric characterisation of the radiation, too.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 23 / **58**

Determination of astigmatism in XFEL sub-10 nm focusing system using speckle patterns from random nanoparticles

Author: Atsuki Ito[1]

Co-authors: Jumpei Yamada [2]; Yuto Tanaka [1]; Kota Shioi [1]; Ichiro Inoue [3]; Taito Osaka [3]; Gota Yamaguchi [3]; Yuichi Inubushi [4]; Makina Yabashi [3]; Kazuto Yamauchi [1]

[1] *Osaka university*

[2] *Osaka university & RIKEN SPring-8 Center*

[3] *RIKEN SPring-8 Center*

[4] *Japan Synchrotron Radiation Research Institute*

Corresponding Authors: shioi@up.prec.eng.osaka-u.ac.jp, yamauchi@prec.eng.osaka-u.ac.jp, ito@up.prec.eng.osaka-u.ac.jp, yamada@prec.eng.osaka-u.ac.jp

The intense X-ray free-electron laser (XFEL) focused on a single-nanometer scale has facilitated the exploration of new frontiers in X-ray nonlinear physics. We have developed an XFEL sub-10 nm focusing mirror system, based on Wolter III-advanced KB mirror optics, for achieving 10^22 W/cm^2 intensity at SACLA. The focus size has been characterized by ptychography and reached 6.8 × 6.9 nm. However, in the ptychography, the sample has required to be placed at defocus position to avoid radiation damage, making a determination of the low-order wavefront errors difficult. This lead to subtle remaining astigmatism that significantly affects the intensity reduction of the focus.
In this study, we applied speckle interferometry to determine the low-order wavefront errors. When sufficiently small nanoparticles are illuminated by coherent X-ray, distinctive scattering patterns are observed, referred to as the speckle. The randomly distributed nanoparticles provide an inversely proportional relationship between the sizes of the speckle and the focused beam. The experiment was performed at SACLA BL3 with a photon energy of 9.124 keV. As a scattering media, 2-5 nm diameter Pt particles were randomly spread on a 50-μm-thick polyimide film. The nanoparticles were placed near the focus of the sub-10 nm XFEL and speckle patterns were acquired by MPCCD placed 0.7 m downstream from the focus. As a result, we identified remained astigmatism from the difference of the center of speckle size envelopes. By correcting the 3 μm astigmatism, a finely focused sub-10 nm spot corresponding to the intensity of 1.45×10^22 W/cm^2 was achieved.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

no

Poster Session - Board: 24 / **61**

Testing some limits of long trace profilers using Zemax simulations.

Author: Théo Sieg-Letessier[1]

Co-authors: Amparo Vivo [2]; François Perrin [2]; Julien Marque [3]; Ray Barrett [2]; Marc Ferrari [4]

[1] *Laboratoire d'Astrophysique de Marseille (LAM), ESRF*

[2] *European Synchrotron Radiation Facility : ESRF*

[3] *Bertin Technologies*

[4] *Laboratoire d'Astrophysique de marseille : LAM*

Corresponding Author: theo.sieg-letessier@lam.fr

Acquiring direct images of distant exoplanets or focusing X-rays requires high performance optics. Laboratories and optics suppliers are therefore actively seeking to improve polishing methods and metrology. For slope-error evaluation, many accelerator-based light sources use Long Trace Profilers (LTP) whose measurement accuracy can reach 80 nrad in a relatively short period of 6 hours, and which typically have a better reproducibility in radius determination for highly curved mirrors than interferometers with stitching. The ESRF implementation of this measuring device, the result of over 35 years of development, has been modelled using Zemax from Optic Studio. This ray-tracing code offers the possibility to configure the simulations using Python code. This provides a convenient means to explore the potential influence of multiple parameters of the LTP (e.g. alignment, optical aberrations) upon the measurement accuracy. This can guide and complement experiments with the instrument itself. This study is the beginning of a theoretical approach, which aims to improve LTPs, and identify the key parameters in slope profiler accuracy and repeatability. For example, in the ESRF LTP design, errors in positioning the sensor from the Fourier Transform (FT) lens focal plane have been predicted to induce repeatable errors. However, slight misorientation of this sensor, or the (FT) lens, has no impact compared with the lowest measurement noise. Field curvature can

also be neglected, but pixel size can have an importance depending on interpolation algorithms. The impact of calibration in different configurations is also discussed.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

no

Poster Session - Board: 25 / **62**

How not to become a ghost writer

Authors: Analía Fernández Herrero[1]; Nazanin Samadi[2]; Andrey Sokolov[3]; Grzegorz Gwalt[4]; Jana Buchheim[5]; Stefan Rehbein[1]; Anke Teichert[6]; Thomas Krist[6]; Christian David[2]; Frank Siewert[1]

[1] *Helmholtz-Zentrum Berlin*

[2] *Paul Scherrer Institute*

[3] *Helmholtz-Zentrum Berlin für Materialien und Energie, BESSY II*

[4] *Helmholtz-Zentrum Berlin für Materialien und Energie, BESSY-II,*

[5] *Helmholtz Zentrum Berlin*

[6] *Nano Optics Berlin GmbH*

Corresponding Authors: analia.fernandez_herrero@helmholtz-berlin.de, grzegorz.gwalt@helmholtz-berlin.de, nazanin.samadi@psi.ch, andrey.sokolov@helmholtz-berlin.de, frank.siewert@helmholtz-berlin.de, jana.buchheim@helmholtz-berlin.de, info@nanooptics-berlin.com

Accelerator-based photon sources have improved in brilliance, stability, and coherence over the last decades. To transfer those properties to photon-hungry and high-resolution-demanding users and experiments in the VUV-, soft- and tender X-ray photon energy range, high-quality blazed profile gratings are mandatory. In addition, such gratings are of interest e.g. for spectroscopic applications at laboratory sources or as master gratings for the production of replica gratings. Currently, their availability is critical due to technological challenges and limited manufacturing resources. To counterbalance this bottleneck, grey-tone e-beam lithography is been investigated for the production of blazed profile gratings. E-beam lithography (EBL) allows patterning of arbitrary shapes over relatively large areas in a short time. However, in order to achieve a high-quality grating and a stable manufacturing process and precise metrology is essential. We report on the ongoing investigation of blazed profile gratings to track the lithography process and on challenges that EBL poses to structure characterization. Measurements performed by atomic force microscopy as well as at-wavelengths at the Optics Beamline at BESY II will be presented. We focus on the investigation of the imperfections and their causes. Ghosts are additional peaks that appear on the dispersion plane, which ultimately reduce the resolution and performance of the grating. At EBL they are caused by stitching of the fields while writing and reducing its impact on the scattering plane is sought.

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Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 26 / **66**

PyLOSt –a software package for sub-aperture stitching and data analysis of surface metrology data of reflective X-ray optics

Authors: Amparo Vivo[1]; Bharath Reddy Adapa[2]; Francois Perrin[2]; Ray Barrett[2]

[1] *European Synchrotron Radiation Facility : ESRF*

[2] *ESRF*

Corresponding Authors: bharatreddy199@gmail.com, barrett@esrf.fr, francois.perrin@esrf.fr

The apertures of X-ray mirrors are often larger than the measurement apertures of common optical metrology instruments. To overcome this limitation, sub-aperture stitching is an increasingly used technique for X-ray mirror surface metrology. In this approach, the full surface is measured in a series of highly overlapped sub-apertures which are subsequently recombined numerically to recover the overall surface topography. The fidelity of the stitched data to the measured surface can be strongly influenced by the stitching algorithms which are employed. Although some commercial software is available to perform the numerical reconstruction of such surfaces, the algorithms employed are rarely documented and are inflexible for the implementation of new calculation strategies. PyLOSt (Python Large-Optic Stitching) is an open-source software tool designed to perform stitching and data analysis of surface metrology data. The standard software release includes several algorithms for stitching and performing routine operations such as surface fitting and extraction of statistical parameters. The code framework is also designed to allow the straightforward integration of new calculation tools for surface reconstruction and analysis. PyLOSt has been extended to run in the Orange data analysis suite which provides an intuitive interface to the data pre-processing, stitching and analysis tools. In this presentation we will showcase the current code features including global optimisation algorithms permitting the reduction of stitching errors.
This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreements Nos.730872 and 101004728.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 27 / **67**

Characterizing SASE X-ray Pulses Using Machine Learning

Author: Gesa Goetzke[1]

Co-authors: Felix Möller [2]; Thorsten Otto [1]; Christopher Gerth [1]; Evgeny Schneidmiller [1]; Juliane Roensch-Schulenburg [1]; Matthias Vogt [1]; Christopher Behrens [1]; Stefan Düsterer [1]; Gregor Hartmann [2]

[1] *Deutsches Elektronen-Synchrotron (DESY)*

[2] *Helmholtz-Zentrum Berlin für Materialien und Energie GmbH*

Corresponding Authors: gesa.goetzke@desy.de, gregor.hartmann@helmholtz-berlin.de, stefan.duesterer@desy.de

Accurate online characterization of the intensity, spectral distribution, and temporal structure of X-ray pulses is crucial for free-electron lasers. We propose a novel approach for characterizing temporal profiles of X-ray pulses at the free-electron laser FLASH in Hamburg, using β-Variational Autoencoder (β-VAE) [1] networks in conjunction with a Transverse Deflecting Structure (TDS).

The TDS in combination with a dipole spectrometer allows the measurement of time and energy variations of electrons with femtosecond resolution after they pass through the undulator, providing valuable insights into the temporal structure of the electron bunches influenced by the lasing process. [2]. To obtain a XUV power profile, a lasing off reference is required. However finding a suitable lasing off reference may prove challenging due to stability issues and drifts. For highly fluctuating electron beam properties, this matching may not be possible at all.

To address this challenge, we demonstrate the effectiveness of β-VAE networks in identifying key principles within the dataset. By training artificial neural networks on datasets comprising both lasing on and lasing off shots, we can artificially create matching lasing off images for each shot. The β-VAE networks exhibit noise reduction capabilities, uncovering hidden data artifacts and enabling enhanced analysis of the temporal structure of the electron bunches, thereby helping to obtain temporal characteristics of SASE X-ray pulses in a non-invasive manner.

References:

[1] Higgins, I. et al. B-VAE, conference paper at ICLR 2017
[2] Behrens, C. et al. Nat Commun 5, 3762 (2014)

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

no

Poster Session - Board: 28 / **68**

Single shot tender X-ray spectral measurements via the 3rd harmonic using bent crystals

Author: Christopher Arrell[1]

[1] *SwissFEL, Paul Scherrer Institut*

Corresponding Author: christopher.arrell@psi.ch

The tender X-ray region provides access to various absorption edges, such as sulfur, chlorine, and silicon, which are of particular interest for developing organic semiconductors. Direct measurement of the X-ray spectrum in the energy region between 2.5 –4.0 keV is challenging and typically suffers from poorer energy resolution from ruled gratings or lower efficiency from scattering-based approaches. Presented here is the modification of a beamline spectrometer at SwissFEL[1], using bent silicon crystals, to measure the single shot spectrum of the 3rd harmonic FEL emission produced in operation at 2.5 keV.
Using a 2D CMOS detector, the transverse mode structure of the 3rd harmonic emission is discussed. The measured spectral bandwidth with the 3rd harmonic is compared to the bandwidth of the fundamental of 2.5 keV when measured via monochromator scanning.

[1] J. Rehanek et al 2017 JINST 12 P05024

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 29 / **71**

X-Ray mirror carbon contamination removal test at ESRF

Author: Amparo VIVO[1]

Co-authors: François PERRIN [1]; Christian Morawe [1]; Raymond BARRETT [1]

[1] *ESRF*

Corresponding Authors: morawe@esrf.fr, vivo@esrf.fr, barrett@esrf.fr, francois.perrin@esrf.fr

The performance of reflective optics such as X-ray mirrors or diffraction gratings generally degrades following exposure to high intensity X-ray or EUV beams. The most common degradation phenomenon is beam-induced contamination with the formation of inhomogeneous carbonaceous films on the optical surface.
Most X-ray light sources suffer from these effects which progressively reduce the optical reflectivity of the optic but can also introduce spurious signals into spectroscopic data. For tender and hard X-ray energies, phase-shifts of the X-rays after transmission though in the irregular thickness contamination film create perturbations in the reflected wavefront which can degrade focus quality. For diffractive crystal optics, contamination can cause strains in the crystal lattice which may give rise to spurious structure in the intensity profile of the diffracted beam. In time, performance degradation can become so severe that the optic becomes unusable with obvious impact to the performance of the analytical instrument.
Various light sources have investigated strategies to mitigate or remediate such contamination using in- or ex- situ techniques but, given the diversity of optical devices, either the methods are not generally applicable or the potential deleterious impact on the performance of the highest performance optics may not be well studied.
In order to build in-house expertise for the refurbishment of contaminated mirrors we have performed tests on several cleaning and remediation methods: UV-Ozone exposure, oxygen plasma treatment and stripping of various different coating materials. The impact of such treatments on micro-roughness and X-ray reflectivity measurements is presented.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 30 / **72**

LEAPS and LEAPS-INNOV - a status report

Author: Elke Plönjes[1]

[1] *Deutsches Elektronen-Synchrotron DESY*

Corresponding Author: elke.ploenjes@desy.de

Established in 2017, LEAPS is the League of European Accelerator-based Photon Sources, a strategic consortium initiated by the Directors of the Synchrotron Radiation and Free Electron Laser (FEL) user facilities in Europe. Its primary goal is to actively and constructively ensure and promote the quality and impact of the fundamental, applied and industrial research carried out at their respective facility to the greater benefit of European science and society.
The LEAPS-INNOV pilot project contributes to solving key technological challenges for the light sources, over 50 facilities in Europe and worldwide. It is kick-starting the implementation of the LEAPS Technology Roadmap and, at the same time, enhances partnership with industry through open innovation by offering joint technological developments and advanced research capabilities for industry as collaborators, suppliers and users.
Six technology work packages (WP) form the heart of LEAPS-INNOV, based on their potential for co-innovation and their ability to enhance European leadership. They integrate 50-some companies, are supported by an industry networking WP and complemented by pilot activities towards co-creation with the Horizon Europe clusters. In the context of open innovation, LEAPS-INNOV focusses on new approaches for partnership between industry and the photon science community, with the goal of accumulating a strategy for long-term industry engagement for LEAPS in Europe.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

no

Poster Session - Board: 31 / **74**

Power management, coherence and photon propagation for ESRF-EBS beamlines

Authors: Juan Reyes-Herrera[1]; Manuel Sanchez del Rio[1]; Philipp Brumund[1]; Francois Villar[1]

[1] *ESRF*

Corresponding Authors: juan.reyes-herrera@esrf.fr, francois.villar@esrf.fr, philipp.brumund@esrf.fr, srio@esrf.fr

Synchrotron facilities worldwide, including the ESRF, are adopting the fourth-generation storage ring, Extremely Brilliant Source (EBS). The EBS utilizes long undulators (~2 m) with short magnetic periods (< 20 mm) of in-vacuum cryogenic permanent magnets (CPUM) to enhance brilliance and coherence. However, this leads to high power deposition on beamline components, necessitating an evaluation of heat-induced deformations' impact on photon beam properties. This study introduces simulations and tools developed by the ESRF Mechanical Engineering Group to tackle EBS beamline challenges.

OASYS (Orange Synchrotron Suite), an open-source and user-friendly platform introduced in 2013, facilitates x-ray optics modeling [1]. Power transport calculations in OASYS combine XOPPY and ray-tracing algorithms for various optical components. Finite element simulations in ANSYS model heat-load-induced deformations, which are then integrated into OASYS using a dedicated widget. Photon transport simulations employing SHADOWOUI or WOFRY analyze the effects on beam properties. For example to investigate heat-load effects on crystal and multilayer monochromators.

ESRF has developed customized, open-source OASYS widgets (some are included in the official release). These widgets cater to EBS beamlines, allowing fast power transport calculations for tasks such as obtaining power density peaks based on undulator gaps and modeling beamline attenuators.

[1] https://oasys-kit.github.io/

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

no

Poster Session - Board: 32 / **75**

X-ray lens aberrations retrieved by deep learning from several beam intensity images

Authors: Juan Reyes-Herrera[1]; Rafael Celestre[1]; Manuel Sanchez del Rio[1]

[1] *ESRF*

Corresponding Authors: juan.reyes-herrera@esrf.fr, rafael.celestre@esrf.fr, srio@esrf.fr

In this study, we explore the capability of a Convolutional Neural Network (CNN) trained on synthetic data to accurately estimate the profile error in an x-ray lens. The CNN is able to retrieve the profile expresses as a list of Zernike coefficients from a series of intensity distributions simulated (or measured) at several positions. This approach offers a promising method for profile error assessment in x-ray lenses without wave-front sensor measurements, potentially reducing the need for time-consuming and costly characterization techniques. The results highlight the potential of using machine learning algorithms trained on synthetic data as a valuable tool in the field of x-ray optics for efficient and accurate error analysis.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

no

Poster Session - Board: 33 / **76**

An X-ray beam property analyzer based on dispersive crystal diffraction for next-generation light sources

Author: Nazanin Samadi[1]

Co-authors: Xianbo Shi [2]; Cigdem Ozkan Loch [1]; Dean Chapman

[1] *Paul Scherrer Institute*

[2] *Argonne National Laboratory*

Corresponding Authors: nazanin.samadi@psi.ch, xshi@anl.gov

The advent of low-emittance X-ray sources necessitates the development of new beam diagnostic methods. Existing systems tend to provide limited information or inadequate spatial resolution. A newly-developed spatial beam property analyzer has been introduced, which comprises a double-crystal monochromator followed by a Laue crystal arranged in a dispersive diffraction configuration. Through the analysis of the beam pattern transmitted via this multi-crystal arrangement, the device is capable of concurrently measuring various spatial source attributes - including size, divergence, position, and angle - with high sensitivity. This presentation details the experimental validation performed at two bending magnet beamlines at the Swiss Light Source. Additionally, simulations are conducted to explore the feasibility of employing this analyzer for characterizing source properties of synchrotron undulator beamlines and X-ray free electron lasers.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 34 / **77**

Stitching Interferometer at PAPS

Authors: 冬霓张[1]; 明李[1]

[1] 中国科学院高能物理研究所

Corresponding Authors: lim@ihep.ac.cn, zhangdn@ihep.ac.cn

We have established a new optical metrology laboratory belonging to the Platform of Advanced Photon Source (PAPS) technology R&D project located in Beijing. PAPS provides strong support for construction, testing and technology R&D for the High Energy Photon Source (HEPS). The optical metrology laboratory has proposed and developed a variety of optical metrology technologies with high accuracy to support the construction of beamlines in HEPS. In this optical metrology laboratory, we have independently developed the scanning and stitching interferometer platform system with high stability and high-accuracy metrology performance. We proposed and verified two methods based on angular measurement 7 years ago. Recently, based on this new stitching system at PAPS, another novel stitching method has been proposed and verified. The accuracy of two-dimensional surface profile measurement is as high as 0.1~0.3nm RMS.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

no

Poster Session - Board: 35 / **78**

Zooming optics in HEPS beamline design

Authors: Ming Li[1]; Xiaowei Zhang[1]; Dongni Zhang[1]; Fugui Yang[1]; Fang Liu[1]

[1] *Institute of High Energy Physics*

Corresponding Authors: fliu@ihep.ac.cn, yangfg@ihep.ac.cn, zhangxw@ihep.ac.cn, lim@ihep.ac.cn, zhangdn@ihep.ac.cn

With the reduction of the emittance of electron bunches in new generation synchrotron radiation sources, the generated X-ray beam is beneficial for applications with high spatial resolution, coherence, and flux, bringing opportunities for the design of multifunctional beamlines. Considering the partial coherent characteristics of the light field, the achievement of experiments requiring flux and coherence on the same beamline is important research. This paper studies the ZOOMing, or two-stage focusing configuration, aiming to control the coherence and the spatial resolution. The high-coherent field is obtained by limiting the field through a slit, The relationship between the coherence or flux and the range of the field is investigated to meet experimental requirements. We also present the zoom beamline design method based on geometric optics, including cascade focusing and secondary focusing. Taking into account the change in coherence, cases of both diffraction-limited and system-limited focusing are considered separately. Finally, the numerical experiments by wave propagation are also carried out to verify the design.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 36 / **79**

The Development of Wavefront Metrology Technique at Beijing Synchrotron Radiation Facility (BSRF)

Authors: Fang Liu[1]; Ming Li[1]; Junliang Yang[1]

[1] *Institute of High Energy Physics*

Corresponding Authors: yangjl@ihep.ac.cn, fliu@ihep.ac.cn, lim@ihep.ac.cn

In this work, we describe an innovative wavefront metrology technique at the first-generation synchrotron radiation source BSRF named Double Edges Scan (DES) wavefront metrology technique. It can achieve high precision measurement of the optical elements used in the fourth-generation synchrotron radiation source. The approach we proposed can resolve several vital problems of the first-generation synchrotron radiation source, including inferior lateral coherence, poor stability, and distortion of incident wavefront. As the lateral coherence has been improved by an order of magnitude, the monochromator crystals used in the fourth-generation synchrotron radiation source need to maintain the wavefront over a large range. By means of the DES wavefront metrology technique, we successfully measured diffraction surface slop error with a precision better than 22.5 nrad (rms). The lateral resolution was 50 microns on the crystal surface. The result proved that we have already realized diffraction limit level wavefront metrology. Currently, the DES measurement has been regarded as an important feedback in the next generation crystal fabrication process.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

no

Poster Session - Board: 37 / **80**

Study on UV FEL single shot damage threshold of an Au thin film

Authors: Meiyi Wu[1]; Qinming Li[1]; Mingchang Wang[1]; Qinghao Zhu[1]; Zhongmin Xu[1]; Jiandong Cai[1]; Long Huang[1]; Bingbing Zhang[1]; Runze Qi[2]; Zhe Zhang[2]; Wenbin Li[2]; Yinpeng Zhong[1]; Weiqing Zhang[1]

[1] *Institute of Advanced Science Facilities*

[2] *Tongji University*

Corresponding Author: wumy@mail.iasf.ac.cn

We evaluate the damage threshold of an Au coated flat mirror, which is one of the reflective optics installed on FEL-1 beamline of Dalian Coherent Light Source (DCLS), upon far UV free electron laser (FEL) irradiation. The surface of the coating is characterized by profilometer and optical microscope. We present also theoretical approach of the phenomenon by applying conventional single-pulse damage threshold calculation as well as one-dimensional thermal diffusion model to the case.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 38 / **81**

New Achievements in OAM beam characterization using Hartmann wavefront sensor and KAOS

Author: Luka Novinec[None]

Co-authors: Alberto Simoncig [1]; Matteo Pancaldi [1]; Flavio Capotondi [1]; Dario De Angelis [1]; Giovanni De Ninno [1]; Barbara Ressel [2]; Emanuele Pedersoli [1]; Marco Zangrando [3]; Michele Manfredda [1]

[1] *ELETTRA*

[2] *University of Nova Gorica*

[3] *Elettra Sincrotrone Trieste and CNR-IOM*

Corresponding Authors: barbara.ressel@ung.si, emanuele.pedersoli@elettra.eu, luka.novinec@elettra.eu, matteo.pancaldi@elettra.eu, alberto.simoncig@elettra.eu, dario.deangelis@elettra.eu, giovanni.deninno@elettra.eu, marco.zangrando@elettra.e michele.manfredda@elettra.eu

Light beams carrying Orbital Angular Momentum (OAM) are sparking new developments in several fields like the excitation of chiral magnetic phenomena, both in the static and dynamic regime, enhanced imaging and novel light-matter interaction. The creation and characterization of OAM beams is by itself a challenging task and thus a separate field of study.

At FERMI we can create an OAM beam either by tailoring the emission process on the undulator side, or, in most cases, by coupling a spiral zone plate in tandem with the KAOS active optic system. To provide a robust and reproducible workflow to our users we leverage on the use of a Hartmann wfs both for optics tuning and beam characterization. In particular, to operate KAOS in the so-called near-collimation mode and to provide an independent characterization of beam helicity and topological charge characterization after the creation of a structured beam. In this poster, we will

present our latest achievements in operating the KAOS system out of nominal configuration and in the beam characterization workflow while powering up the OAM research community.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 39 / **94**

Photon diagnosis for Shanghai high repetition rate XFEL and extreme light facility (SHINE)

Author: Zhi Guo[1]

Co-author: Haigang Liu [1]

[1] *Shanghai Synchrotron Radiation Facility, Shanghai, China*

Corresponding Authors: guoz@sari.ac.cn, liuhg@sari.ac.cn

SHINE is China's first Hard X-ray FEL and now is under construction. This facility has an 8-GeV CW superconducting linac accelerator. Using 3 phase-I undulator lines, the SHINE aims at generating X-rays between 0.4 and 25 keV at rates up to 1MHz for 10 experimental stations. We have finished the design concepts of photon diagnosis for different diagnosis purposes, including Photon Arrival Time Monitor (PAM), THz Streaking Pulse Length Monitor (PLM), X-ray pulse Energy and Position Monitor (EPM), Beam Position and Intensity Monitor (BPIM), Beam Loss Monitor (BLM), Soft X-ray Energy Resolution Measurement (SERM), Photoelectron Spectrometer (PES), Single Pulse Spectrometer (SPS), Hard X-ray Energy Resolution Measurement (HERM), Wavefront Sensor (WFS) and X-ray Imager (IMAGER). The major parameters as follows: the PAM sensitivity is better than 15 fs (rms), the PLM sensitivity is better than 20 fs (rms) when the pulse jitter is less than 40 fs (rms), the pulse energy and position measurement precisions for the EPM both approaches are better than 10%, the BPIM sensitivity is better than the 10% of beam size. The BLM response time is better than 10 us. The energy resolving power of SERM is better than 10-4, the SPS is 0.1 eV and the HERM is 1e-4 (⊠E/E), respectively. The wavefront accuracy sensitivity for WFS is better than λ/50 at the wavelength of 0.177nm, and the sensitivity is better than λ/50 at the wavelengths of 0.6nm and 3nm.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes

Poster Session - Board: 40 / **95**

Wavefront sensing using Talbot effect for Shanghai HIgh repetition rate XFEL aNd Extreme light facility (SHINE)

Author: Xiangyu Meng[None]

Corresponding Author: mengxy@sari.ac.cn

The SHINE aims at generating X-rays between 0.4 and 25 keV at rates up to 1MHz for 10 experimental stations. Wavefront sensing is important for aligning X-ray instruments, reconstructing the field at the plane of interest and conducting scientific experimental analysis. Based on the a Talbot interferometer at hard x-rays using a π-phase shift checkerboard grating, the wavefront accuracy sensitivity for WFS is better than λ/50 at the wavelength of 0.177nm. The soft X-ray WFS covers energy from 200 eV to 2500 eV by changing the grating plane position with different grating periods.

The grating plane motion region is approximately 0.5 m. The accuracy sensitivity in the soft X-rays region using a dot array grating is better than λ/50.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?:

yes