PhotonDiag2015 - Workshop on FEL Photon Diagnostics, Instrumentation, and Beamlines Design - ICTP, Leonardo Building, Budinich Lecture Hall - 8 - 10 June 2015

Abstracts book

POSTER CONTRIBUTIONS

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Abstract ID : 3

Report on THz streaking activities at the seeded FLASH experiment

Content :

Report on THz streaking activities at the seeded FLASH experiment

To characterize ultra-short pulses in the XUV regime one can use light-field assisted THz streaking. In order to measure the pulse duration as well as the temporal contrast ratio of the seeded free electron laser pulse at the sFLASH experiment, we have installed a THz streaking diagnostic setup at the end of its beam line. In this report we present the current status of the diagnostic and the optically pumped THz source.

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Track classification :

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Submitted by : Dr. AZIMA, Armin

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Abstract ID : 5

Gas-monitor detectors for x-ray FELs.

Content :

A.A. Sorokin (DESY), Y. Bican (DESY), S. Bonfigt (DESY), M. Brachmansk (DESY),M. Braune (DESY), F. Jastrow (DESY), S. Kreis (DESY), M . Richter (PTB), K.Tiedtke (DESY)

During the last years an impressive progress has been achieved in the development of powerful short wavelength coherent laser light sources like self-amplified spontaneous emission (SASE) free-electron lasers (FELs). The first source of this kind was Free-electron LASer in Hamburg (FLASH) which operates in the extreme ultra-violet (EUV) from 48 nm (25.8 eV) down to 4.3 nm (288 eV) [1]. In 2009, the X-ray FEL Linac Coherent Light Source (LCLS) in the United States has been put in exploitation, which provides radiation in the spectral range between 2.2 nm (564 eV) and 0.12 nm (10.3 keV) [2]. Recently, the new FEL for hard X-ray SACLA (SPring-8 Angstrom Compact free-electron Laser) in Japan has started operation at photon energies even beyond 10 keV [3]. Moreover, new hard x-ray FEL facilities in Germany and Switzerland (European XFEL and SwissFEL) are currently under construction which will deliver radiation with photon energies as high as 24 keV.
The absolute photon intensity of the FELs is a fundamental quantity, knowledge of which is mandatory for many user experiments. However, measurement of this quantity is a particularly challenging due to the laser's unique properties such as ultra-short femtosecond pulse length and extremely high peak power of up to few GW which can easily saturate or even destroy solid state detectors commonly used at synchrotron facilities. Moreover, due to the statistical nature of SASE, on-line pulse-resolved characterization of the photon intensity is essential. In order to monitor FEL radiation pulse intensity, sophisticated concepts have been developed at the different facilities [4-7]. At FLASH, the pulse resolved radiant power and beam position is measured on-line and non-destructively using calibrated gas-monitor detectors (GMDs) developed in close cooperation between DESY, PTB, and Ioffe Institute [4]. The GMDs are based on the atomic photoionization of rare gases at low pressures from 10-2 Pa to 10-4 Pa and the charge detection of photoions and photoelectrons by Faraday cups.
Here we present recently developed upgrade version of GMD (so-called XGM) including a huge area open electron multiplier which enable increase dynamic range of the detector by more than seven orders of magnitude. The new GMDs will be permanently installed at the European XFEL and SwissFEL as a part of photon diagnostics for intensity and photon beam position monitoring.
[1] W. Ackermann, et al., Nat. Photonics 1, 336 (2007).
[2] P. Emma et al., Nat. Photonics 4, 641 (2010).
[3] I. Ishikawa et al., Nat. Photonics 6, 540 (2012).
[4] K. Tiedtke et al., J. Apl. Phys. 103, 094511 (2008).
[5] S.P. Hau-Riege et al., J. Appl. Phys. 103, 053306 (2008).
[6] K. Tono et al., Rev. Sci. Instrum. 82, 023108 (2011).
[7] T. Tanaka et al., Nucl. Instrum. Methods Phys. Res. A 659, 528 (2011)

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Track judgments :

Abstract ID : 6

Quantitative studies of photoionization processes of rare gases.

Content :

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We studied the photoionization of rare gages in the linear and non-linear regime. Particularly, total and partial photoionization cross sections of Kr and Xe in the X-ray range have been determined with low uncertainty. In the non-linear regime, sequential, simultaneous and collective electron multiphoton processes have been investigated in the soft X-ray range. The data might be essential for the understanding of the dynamics of photon-matter interaction and for many applications including photon diagnostics of soft- and X-ray FELs.

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Abstract ID : 7

Alignment Concepts of the VUV Raman Spectrometer at FLASH

Content :
The permanently installed high-resolution double stage VUV-Raman Spectrometer at the PG1 branch of
the FLASH monochromator beamline allows to study various samples with different techniques, e.g. using
resonant inelastic X-ray scattering (RIXS) to probe low-energy elementary (charge, spin, orbital and
lattice) excitations in strongly correlated materials. The spectrometer employs an entrance slitless double
monochromator setup which – along with enhanced stray light rejection – allows high energy resolution
measurements close to the Rayleigh line. Each monochromator is equipped with two parabolic mirrors
and four interchangeable gratings. In order to reach the ultimate resolution of below 10 meV the precise
alignment of all monochromator optics of the VUV Raman Spectrometer is absolutely crucial. Here, the
overall alignment concept is presented, focusing on the elaborate diagnostics scheme which includes interferometers,
optical lasers and detection of scattered VUV radiation from FLASH. Furthermore, first
results on the imaging properties of the instrument will be shown.

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Track classification :

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Abstract ID : 8

Hartmann wave front measurements at FLASH

Content :
In the past years, DESY's new wave front sensor for the soft x-ray spectral range, approx. 6-40nm, has been extensively used both at FLASH and at FERMI. This wave front sensor could be demonstrated to be a very valuable tool for characterizing and aligning different FLASH beamlines, the K-B optic systems at FERMI as well as the reflectometry beamline at the Metrology Light Source at PTB.

The Hartmann plate divides the incoming FEL into sub rays and illuminates a phosphor coated CCD chip. From lateral deviations in the beam spot pattern, the wave front for single pulses is reconstructed using a modal approach. Second moment beam parameters such as beam width, divergence, Rayleigh length, waist position, waist size and M^2 are calculated, as well as aberrations of the optical system. Here, we will present different results from our measurements.

Next, the influence of high order harmonic generation (HHG) parameters on the wavefront quality of the generated soft x-rays will be investigated at an attosecond table-top water window (WW) radiation source at ICFO. Wave front measurements to optimize the alignment of a grazing incidence soft x-ray ellipsoid for the attosecond beamline for the user facility at ICFO are also planned.

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Abstract ID : 14

A modular and portable spectrometer for photon in-out experiments at FEL sources

Content :

A very compact grazing incidence photon spectrometer realized for photon in/photon out experiments is presented. The main instrumental parameters have been adapted for the use at the FERMI@ELETTRA Free Electron Laser, but the working principle can be adapted to a generic FEL source. The working region spans the entire 25–800 eV energy range, covering the full emissions of the FEL1 and FEL2 stages of FERMI. Such a large spectral range is analyzed using two interchangeable spherical varied-lined-spaced gratings and a movable detector (CCD). The flexibility in the use is assured employing a changeable input section that can accommodate or not an entrance slit and, if necessary, an additional relay mirror. This solution permits to adapt the instrument to different experimental chambers and to different experimental conditions.

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Abstract ID : 15

Microfocusing beamline exploiting only toroidal mirrors for pump/probe attosecond experiments

Content :
We report the design and characterization of an attosecondbeamline developed for attosecond-pump/attosecondprobe experiments. The main driving parameters are: i) XUV source demagnification higher than ten; ii) exit arm long enoughto installdifferent experimental setups at the target region for pump-probe measurements, this maintaining a compact envelope; iii) production of two variable delayed XUV pulses replica in an intermediate region (where the XUV beam is collimated). All these features are obtained using only toroidal mirrors. The coma aberration, typical of such a type of optical configurations, is reduced ideally to zero using a compensated optical design. The layout is composed of three toroidal mirrors and two flat mirrors used as beam splitters. The toroidal mirrors are controlled via a genetic algorithm to optimize the focal spot. Using a HHG source realized with6 fs - 2 mJ IR pulses, we measured at the target area apeak intensityof about 3 × 1011 W/cm2.

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Abstract ID : 18

The At-Wavelength Metrology facility for UV- and XUV reflection and diffraction optics at BESSY-II

Content :

We have established a technology center for the production of high precision reflection gratings. Within this project a new optics beamline and a versatile reflectometer for at-wavelength characterization of UV- and XUV reflection gratings and (nano-) optical elements has been set up at a BESSY-II bending magnet.
The Plane Grating Monochromator beamline operated in collimated light (c-PGM) is equipped with an old SX700 monochromator, of which the blazed gratings (600 and 1200 l/mm) have been exchanged by new ones of improved performance produced in-house recently. Over the operating range from 10 to 2000 eV this beamline has very high spectral purity achieved by (1) a four-mirror arrangement of different coatings which can be inserted into the beam at different angles and (2) by absorber filters for high order suppression. Stray light and scattered radiation is removed efficiently by in-situ exchangeable apertures and slits. By use of off-plane synchrotron radiation the beamline can be adjusted to either linear or elliptical polarization.
The main feature of the novel 4-circle and 6-axes reflectometer is the possibility to incorporate real lived-sized gratings. The samples are adjustable within six degrees of freedom by a newly developed UHV-tripod system carrying a load up to 4 kg, and the reflectivity can be measured between 0 and 90 degrees incidence angle for both s- and p-polarization geometry. A variety of detectors will be accessible with a high dynamic range of at least 10 orders of magnitude.
This novel powerful metrology facility has gone into operation recently and is now open for users. First results on optical performance and measurements on multilayer gratings and will be presented at the workshop.

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REFERENCES

[1] F. Eggenstein et al., A reflectometer for at-wavelength characterization of XUV-reflection gratings, Proc. of SPIE 9206, Advances in Metrology for X-Ray and EUV Optics V, 920607-1-12 (2014)
[2] A. A. Sokolov et al., An XUV Optics Beamline at BESSY II, Proc. of SPIE 9206, Advances in Metrology for X-Ray and EUV Optics V, 92060J-1-13 (2014)

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Abstract ID : 21

Seeding experiment at FLASH

Content :
The temporal and spectral radiation properties of a free-electron laser can be improved by seeding the amplification process with an external laser-field. In this contribution, the current status of the high-gain harmonic generation seeding experiment at the free-electron laser facility FLASH will be presented. The laser induced energy modulation of the electron bunch at 266 nm has been measured with a transverse deflecting structure and bunching has been demonstrated. We will present our photon diagnostics and show seeded spectra and energy contrast between seeded and unseeded pulses.

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Abstract ID : 23

Characterization of PG1 beamline focusing properties by photo ablation imprints & wave front measurements at FLASH

Content :

The PG1 branch of the plane grating (PG) monochromator beamline at FLASH is equipped with a re-focusing optics in Kirkpatrick-Baez (KB) configuration which focuses the FEL beam into the sample chamber of the double stage VUV-Raman spectrometer. In order to reach ultimate resolution of the Raman spectrometer a vertical focal spot size of below 10 μm is required. The focus optimization and characterization was done in on-line mode by employing a specially developed portable UHV compatible diagnostics chamber [1]. By combining three measurement techniques – namely focus imaging by luminescence crystal, in-situ analysis of photo ablation imprints on PMMA surfaces, and wave front measurements – a focal spot size close to the design value has been achieved. Here the focus properties characterization by the analysis of wave front measurement and ablation data is shown.

[1] In situ focus characterization by ablation technique to enable optics alignment at an XUV FEL source; N. Gerasimova, S. Dziarzhytski, H. Weigelt, J. Chalupský, V. Hájková, L. Vyšín, and L. Juha, Rev. Sci. Instrum. 84, 065104 (2013)

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Track judgments :

Abstract ID : 24

FLASH2 Photondiagnostics and Beamline Concepts

Content :

FLASH2 is the extension to the soft X-ray free-electron laser FLASH at DESY. An additional variable-gap undulator line in a new separate tunnel and a new experimental hall turn FLASH into a multi-beamline FEL user facility. The standard photon diagnostical measurements of intensity, position, wavelength, wavefront, and pulse length are optimized as well as photon beam manipulation tools such as a gas absorber and filters. FLASH2 aims for a large wavelength range with fundamental wavelengths from 40 nm and longer down in the water window (4.36 – 2.38 nm). The short wavelengths, while of high interest to the users, are challenging from the instrumentation point of view, while the long wavelength photon beams suffer from higher divergence and pulse length. Distinctive beamlines are discussed to support the broad scientific applications addressed at FLASH.
Presented is the the overall concept of the photondiagnostics, the desired developments and their implementation.

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Track classification :

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Track judgments :

Abstract ID : 27

The K-Monochromator system for the European XFEL

Content :
For undulator commissioning and beam diagnostics of spontaneous radiation a K-Monochromator system will be installed after each undulator of the European XFEL. One system consists of a filter chamber for calibration, a monochromator chamber with a 4-bounce Si crystal monochromator, and a detector chamber with a highly sensitive camera system.

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Submitted by : FREUND, Wolfgang

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Track judgments :

Abstract ID : 30

The Auto Correlator and Delay Creator (ACDC) at FERMI@Elettra

Content :
The new Auto Correlator and Delay Creator (ACDC) at FERMI@Elettra is described. The system is located in the experimental hall of the FERMI free electron laser and belongs to the PADReS photon transport system. Its operating principle is based on the splitting of the incoming FEL pulse into two half-pulses and their subsequent recombination. The splitting, recombination, and transport of the beam are made by means of eight plane, Au coating mirrors.
The path length of one of the branches can be changed moving two mirrors along two linear guides, with the consequence of putting a time delay Δt between the two half-beams. The time delay can be changed between -1.5ps and +30ps, with a time resolution of 0.3fs. The calibration of the delay has been recently done performing pump and probe reflectivity measurements on the DiProi beamline.
A further section, added before the recombination mirror, can host different solid state filters which can act independently on the two half beams, giving the possibility to have two pulses, separated in time and at different wavelengths.
In this work the mechanical layout is described, together with the calibration process and some preliminary results obtained using the splitting and delay line.

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Track judgments :

Abstract ID : 35

Growth of nano-dots on the grazing incidence mirror surface under FEL irradiation

Content :

A new physical phenomenon is experimentally detected: growth of nano-dots (40–55 nm diameter, 8–13 nm height, 9.4 dots/μm2 surface density) on the grazing incidence mirror surface under the irradiation by the free electron laser (FEL) FLASH (5–45 nm wavelength, 3 degrees grazing incidence angle). It is theoretically demonstrated that the growth of a contamination layer due to polymerization of incoming hydrocarbon molecules may explain an occurrence of nano-dots. The crucial factor responsible for the growth of nano-dots is the incident radiation intensity: its decrease by several times only (e.g., replacement of FEL beam by synchrotron radiation) may result in the total disappearance of the effect.

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Track judgments :

Abstract ID : 37

Diffraction effects caused by grazing incidence FEL optics

Content :

At the FLASH beamlines BL2 and BL3, the FEL beam is focused using ellipsoidal mirrors with a focal length of 2 m. The mirrors are made of Zerodur and the optical surface is coated by a 45 nm thick carbon layer. According to measurements at the HZB metrology laboratory, they exhibit a surface roughness < 0.5nm (rms), tangential slope error < 0.3 arcsec (rms) and sagittal slope error < 1.0 arcsec (rms). During measurement campaigns to characterize the coherence properties of FLASH and the focal spot quality of the beamlines, a peculiar effect was noticeable using different imaging techniques such as phosphor screens or PMMA imprints: While at the focal position the intensity appears uniformly distributed, a horizontal modulation visible as “stripes” develops for increasing distances within the Gaussian intensity profile. A similar effect has also been seen for the toroidal mirror previously installed at FLASH beamline BL1. These interference patterns can be reproduced using the beam transport codes developed at European XFEL, based on PHASE and PHASE4IDL (J.Bahrdt, Phys.Rev.Special Topics (2007)) and SRW – Fourier optics (O.Chubar, P. Elleaume (1998)), when the surface residual errors measured for the ellipsoid mirrors are included in the modeling. Consistent results could also be shown using the WISE code developed at Fermi@Elettra.

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Abstract ID : 48

Transmissive Spectrometer for Soft X-ray FEL’s

Content :
X-ray free-electron lasers operating in the SASE mode exhibits shot-to-shot fluctuations in all beam properties including the energy spectrum. The capability of spectral diagnostic is highly important for it enables users to perform quantitative data analysis for spectrum-sensitive experiments, as well as FEL operators to characterize, tune, and deliver prescribed spectral properties. A soft X-ray transmissive and single-shot capable spectrometer has been in development at LCLS, which is based on analyzing the kinetic energy distribution of the primary photoelectrons from a gas target excited by the LCLS FEL beam. In this talk, the preliminary results from recent experimental measurements will be presented.

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Status of mechanical design for diagnostics devices

Content :
The European XFEL facility equips several diagnostic devices [1]. The assembly of the first photoelectron spectrometer (PES) [2] was done in the last quarter of 2014. That device needs a remote control of all the degrees of freedom in order to be aligned online. The PES has been commissioned with beam at the AMO station of LCLS. The assembly of the 2D FEL imager [3] has been done in the first quarter of 2015, vacuum and final test will be done during April and May and all vacuum components have to accomplish the UHV specifications of XFEL [4]. That device can be aligned manually once on the beam and doesn't need to be remotely align after. During second quarter of 2015 the 2D FEL imager is going to be installed on the tunnel.

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PRESTO, the Pulse Resolved Energy Spectrometer, Transparent and On-line, at FERMI

Content :
FERMI@Elettra is the operative Italian Free Electron Laser (FEL) now open to users. It provides a fully coherent and transform limited radiation with a very high brilliance covering the VUV/Soft X-ray range from 100 nm to 4 nm. The aim of PADReS (Photon Analysis, Delivery and Reduction System) is to measure the FEL radiation properties, mostly on-line and shot-to-shot, as well as transport and focus the photon beam into the experimental chambers. Among all the instruments present along PADReS, PRESTO (Pulse Resolved Energy Spectrometer: Transparent and On-line) is the most valuable, and it is routinely used both by the machine physicist and the experimentalists. The working principles of the Variable Line Spacing (VLS) diffraction gratings used by the spectrometer, as well as the design concept, the ray tracing, and the efficiency simulations will be described and discussed. The metrological results of the optics involved will be shown together with the results using the FEL radiation. Some peculiar applications, like the spectral characterization of the two-colour double-pulse scheme, will be shown as well.

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