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Advances in X-ray Free-Electron Lasers Instrumentation IV

**Thomas Tschentscher
Luc Patthey**
Editors

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The CID Number appears on each page of the manuscript. The complete citation is used on the first page, and an abbreviated version on subsequent pages.

Contents

- v *Authors*
- vii *Conference Committee*
- ix *Introduction*

STATUS AND DEVELOPMENT PLANS OF PLANNED AND OPERATIONAL VUV, EUV, SOFT X-RAY AND X-RAY FEL FACILITIES

- 10237 06 **Overview of optics, photon diagnostics and experimental instruments at SACLA: development, operation and scientific applications (Invited Paper)** [10237-5]
- 10237 08 **Commissioning for the European XFEL facility (Invited Paper)** [10237-7]
- 10237 0C **Four-wave-mixing experiments and beyond: the TIMER/mini-TIMER setups at FERMI (Invited Paper)** [10237-11]

HIGH BRIGHTNESS AND ULTRASHORT X-RAY AND EUV SOURCES: JOINT SESSION WITH CONFERENCES 10237 AND 10243

- 10237 0F **High quality electron beams for high quality FEL (Invited Paper)** [10237-14]

FEL SCHEMES AND CHARACTERIZATION OF ELECTRON BEAM AND FEL RADIATION

- 10237 0G **Innovative FEL schemes using variable-gap undulators (Invited Paper)** [10237-15]
- 10237 0H **Statistical characterization of an x-ray FEL in the spectral domain** [10237-16]
- 10237 0I **Transverse coherence and pointing stability of the radiation from x-ray free electron lasers** [10237-17]
- 10237 0J **Radiation properties of the SASE3 afterburner for European XFEL** [10237-18]

CHARACTERIZATION OF FEL RADIATION

- 10237 0K **Development of a hard x-ray wavefront sensor for the EuXFEL (Invited Paper)** [10237-19]
- 10237 0M **Single-shot beam profile diagnostics for x-ray FEL's using gas fluorescence** [10237-21]
- 10237 0N **Characterization of the LCLS "nanosecond two-bunch" mode for x-ray speckle visibility spectroscopy experiments** [10237-22]

**X-RAY OPTICS AND BEAM TRANSPORT ISSUES INCLUDING PROPAGATION OF COHERENT
X-RAY FEL RADIATION AND SIMULATION OF X-RAY FEL I**

10237 0O **Ultrahigh performance mirrors for diffraction limited light sources (Invited Paper)** [10237-23]

**X-RAY OPTICS AND BEAM TRANSPORT ISSUES INCLUDING PROPAGATION OF COHERENT
X-RAY FEL RADIATION AND SIMULATION OF X-RAY FEL II**

10237 0R **Development of a hard x-ray split-delay system at the Linac Coherent Light Source**
[10237-26]

10237 0S **Simulations of ultrafast x-ray laser experiments (Invited Paper)** [10237-27]

10237 0T **Design of compressors for FEL pulses using deformable gratings** [10237-28]

**ADVANCED INSTRUMENTATION FOR FEL EXPERIMENTS IN THE AREAS OF SPECIAL X-RAY
TECHNIQUES, SAMPLE ENVIRONMENT, DETECTORS AND LASERS**

10237 0W **Detector sustainability improvements at LCLS** [10237-31]

POSTER SESSION

10237 0Z **Magnetic force study for the helical afterburner for the European XFEL** [10237-34]

10237 10 **Frequency doubler and two-color mode of operation at free electron laser FLASH2**
[10237-35]

10237 11 **Application of statistical techniques for characterization of SASE FEL radiation** [10237-36]

10237 12 **A soft x-ray split-and-delay unit for FLASH II** [10237-37]

10237 13 **A hard x-ray split-and-delay unit for the HED instrument at the European XFEL** [10237-38]

10237 14 **Duty-cycle dependence of the filamentation effect in gas devices for high repetition rate
pulsed x-ray FEL's** [10237-39]

10237 16 **Grating monochromator with ultrafast response for FLASH2 at DESY** [10237-41]

Authors

Numbers in the index correspond to the last two digits of the seven-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first five digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

Allaria, E., 0F
Alonso-Morí, Roberto, 0M
Andreev, A. A., 0S
Appel, Karen, 0S, 13
Barada, Andrew H., 0R
Bencivenga, Filippo, 0C
Berujon, Sebastien, 0K
Bonora, Stefano, 0T
Branco, J., 0S
Braun, Stefan, 13
Brenner, Günter, 16
Briggs, R., 0S
Browne, Michael C., 0W
Busmann, M., 0S
Buzmakov, A., 0S
Calvi, Andrea, 0C
Capotondi, Flavio, 0C
Carini, Gabriella, 0W
Chollet, Matthieu, 0M
Cojocar, Ruxandra, 0K
Cucini, Riccardo, 0C
Damiani, Daniel S., 0M
Decker, Franz-Josef, 0N
DePonte, Daniel P., 0W
Fabris, Nicola, 0T
Feng, Yiping, 0H, 0M, 14
Foglia, Laura, 0C
Fortmann-Grote, C., 0S
Frassetto, Fabio, 0T, 16
Freijo-Martin, I., 0O
Fuoss, Paul H., 0N
Galtier, Eric C., 0W
Garten, M., 0S
Gawlitza, Peter, 13
Giovine, Ennio, 0T
Glownia, James M., 0M
Grübel, Gerhard, 0N
Grund, A., 0S
Gumerlock, Karl L., 0R
Hart, Philip A., 0W
Hastings, Jerome B., 0M
Hruszkewycz, Stephan, 0N
Huang, Zhirong, 0H
Huebl, A., 0S
Inoue, Ichiro, 06
Inubushi, Yuichi, 06
James, Justin H., 0R
Jurek, Z., 0S
Kärcher, Victor, 13
Katayama, Tetsuo, 06
Kiskinova, Maya, 0C
Kon, Akira, 06
Koralek, J. D., 0W
Koyama, Takahisa, 06
Krzywinski, Jacek, 0H
Kuhlmann, Marion, 10, 12, 16
Li, Peng, 0J, 0Z
Li, Yuhui, 0J, 0Z
Loh, N. D., 0S
Ludwig, Karl, 0N
Lutman, Alberto, 0H
Mahne, Nicola, 0C
Mancuso, A. P., 0S
Manfreda, Michele, 0C
Martin, Thierry, 0K
Masciovecchio, Claudio, 0C
Mincigrucci, Riccardo, 0C
Miotto, Paolo, 0T
Mittra, Ankush, 0W
Nakahara, Kazutaka, 0W
Nakatsutsumi, M., 0S
Nelson, Silke, 0M
Nicolas, Josep, 0R
Nölle, D., 08
Ohashi, Haruhiko, 06
Osaka, Taito, 06
Osier, Ted O., 0R
Owada, Shigeki, 06
Pedersoli, Emanuele, 0C
Pflueger, Joachim, 0J, 0Z
Plönjes, Elke, 12, 16
Poletto, Luca, 0T, 16
Principi, Emiliano, 0C
Quintavalla, Martino, 0T
Raimondi, Lorenzo, 0C
Raubenheimer, Tor O., 14
Robert, Aymeric, 0M, 0N, 0R
Röling, Sebastian, 12, 13
Rollnik, Matthias, 12, 13
Roseker, Wojciech, 0N
Samoylova, Liubov, 0S, 13
Santra, R., 0S
Schafer, Donald W., 0R
Schneidmiller, E. A., 0G, 0I, 0S, 10, 11
Sharma, A., 0S
Shi, Hongliang, 0R
Siewert, Frank, 13
Simoncig, Alberto, 0C

Smith, Brian, OR
Song, Sanghoon, OM, ON
Steiniger, K., OS
Stephenson, G. Brian, ON
Sun, Yanwen, ON, OR
Sutton, Mark, ON
Togashi, Tadashi, O6
Tono, Kensuke, O6
Vannoni, M., OO
Wahlert, Frank, 12, 13
Wei, Tao, OJ, OZ
Weninger, Clemens, OM
Whitney, Randy, OR
Wu, Juhao, OH
Yabashi, Makina, O6
Yabuuchi, Toshinori, O6
Yakubov, S., OS
Yoon, C. H., OS
Yumoto, Hirokatsu, O6
Yurkov, M. V., OG, OI, OS, 10, 11
Zacharias, Helmut, 12, 13
Zangrando, Marco, OC
Zastrau, Ulf, OS, 13
Zhang, Lin, OR
Zhu, Diling, OH, OM, ON, OR
Ziaja-Motyka, B., OS
Ziegler, Eric, OK

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Scientific Applications of Laser- and Accelerator-based X-ray Sources: Joint Session with Conferences 10237 and 10243
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Temporal, Spatial and Coherence Diagnostics of Ultrashort X-ray Pulses: Joint Session with Conferences 10237 and 10243
Carmen S. Menoni, Colorado State University (United States)

Status and Development Plans of Planned and Operational VUV, EUV, Soft X-ray and X-ray FEL Facilities
Rolf Treusch, Deutsches Elektronen-Synchrotron (Germany)

High Brightness and Ultrashort X-ray and EUV Sources: Joint Session
with Conferences 10237 and 10243

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FEL Schemes and Characterization of Electron Beam and FEL
Radiation

Luc Patthey, Paul Scherrer Institut (Switzerland)

Characterization of FEL Radiation

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X-ray Optics and Beam Transport Issues Including Propagation of
Coherent X-ray FEL Radiation and Simulation of X-ray FEL I

Luc Patthey, Paul Scherrer Institut (Switzerland)

X-ray Optics and Beam Transport Issues Including Propagation of
Coherent X-ray FEL Radiation and Simulation of X-ray FEL II

Luc Patthey, Paul Scherrer Institut (Switzerland)

Advanced Instrumentation for FEL Experiments in the Areas of Special
X-ray Techniques, Sample Environment, Detectors and Lasers

Thomas Tschentscher, European XFEL GmbH (Germany)

Introduction

Free-electron laser (FEL) user facilities for the short-wavelength regime from vacuum-ultraviolet to hard x-rays are operational for more than a decade now. In Europe FLASH (Hamburg) and FERMI (Trieste), world-wide LCLS (Menlo Park, U.S.A.), SACLA (Harima, Japan) and PAL-XFEL (Pohang, South Korea; from 2017) are the facilities to be listed here. In Europe, two new facilities with presently nine end-stations for experiments turn on in the current year: SwissFEL (Villigen) and European XFEL (Hamburg). X-ray FEL radiation provides exquisite beam properties in terms of pulse duration, coherence, and pulse energy. High repetition rate facilities like FLASH and European XFEL also provide high average flux. Short-wavelength FELs combine features of conventional x-ray sources and of ultrashort and highly intense optical laser sources. At the same time the FEL sources are highly complementary to these x-ray sources, like e.g. provided by synchrotron radiation from storage rings, and optical laser sources.

In the past decade x-ray FEL radiation has already been applied to a large number of high profile scientific applications reaching from physics, over chemistry, material and earth sciences to biology. Many of these applications were enabled by employing state-of-the-art developments of the FEL sources and their properties, of new x-ray and optical laser techniques, and of new instrumentation developed for and at the FEL facilities. Vice-versa, science applications generated additional and new requirements for the further development of the FEL sources, x-ray techniques and their instrumentation. This very dynamic field of development of FEL sources and instrumentation for x-ray FEL experiments has led to a large number of new results in many different areas since this conference was held last, two years ago.

The conference therefore has a specific focus on these new developments and on scientific applications requiring these developments. The conference itself and the papers in this proceeding volume address new and outstanding scientific applications of x-ray FELs, the start of new FEL facilities and the further development of existing ones, the development of new FEL and similar radiation schemes, the progress with high quality x-ray optics designed for general and specific applications, the development and implementation of x-ray diagnostics methods, and the further development and the implementation of ancillary instrumentation like detectors and laser systems, which are so important for the success of experiments using these large scale user facilities. Specific topics are the current developments in the areas of special FEL schemes and the major development activities with respect to providing high average brightness and ultrahigh peak brightness.

In 2017 part of this conference was organized jointly with the conference on "X-Ray Lasers and Coherent X-Ray Sources: Development and Applications" [1]. Joint sessions were held on the topics "high brightness and ultrashort x-ray and

EUV sources”, “scientific applications of laser- and accelerator-based x-ray sources” and “temporal, spatial and coherence diagnostics of ultrashort x-ray pulses”. These areas represent a highly common interest, both in terms of method developments and scientific application.

Thomas Tschentscher
Luc Patthey

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- [1] A. Klisnick, C. Menoni (eds.), *X-Ray Lasers and Coherent X-Ray Sources: Development and Applications*, Proceedings of SPIE 10243, Prague, 24. - 27. April 2017