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Advances in X-ray Free-Electron Lasers Instrumentation IV

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Luc Patthey
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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 Corea; 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

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