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# ***X-Ray Free-Electron Lasers: Beam Diagnostics, Beamline Instrumentation, and Applications***

**Stefan P. Moeller  
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*Editors*

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## Introduction

The conference *X-Ray Free-Electron Lasers: Beam Diagnostics, Beamline Instrumentation, and Applications* was held for the first time in San Diego, California from August 13–16, 2012.

With the successful start-up and operation of the first hard X-ray free-electron laser (FEL), the Linac Coherent Light Source (LCLS) at Stanford in April of 2009, and, more recently, Japan's SPring-8 Angstrom Compact FEL, SACLA, in June of 2011, novel x-ray sources with unprecedented beam properties have become operational, offering great promise for exploring new scientific possibilities in ultrafast science with hard X-rays. These 4<sup>th</sup> generation light sources operate in the Self Amplified Stimulated Emission (SASE) mode and provide radiation with wavelengths typically as short as about 1Å and pulses of unrivaled brightness, brevity, peak power density, and transverse coherence, exceeding the values of the same parameters as 3<sup>rd</sup> Generation synchrotron radiation sources by up to ten orders of magnitude. The implementation of this class of sources using superconducting linac technology, for example in the European XFEL in Germany (planned operation in ca. 2015) and the FLASH VUV FEL, successfully operating since 2005, is also expected to match or exceed the time-averaged power density generated by most present day sources by several orders of magnitude. Besides the aforementioned facilities, there are nearly a dozen other FELs currently being proposed or under construction. All are scheduled to become operational before 2020.

The rapidly growing user community utilizes these sources for experiments in areas ranging from atomic physics, material science, x-ray diffraction, and x-ray coherent imaging to high-energy-density physics. The experimental techniques are becoming increasingly complex posing great challenges for beam transport and beam shaping optics, diagnostics, and detectors as well as synchronization techniques with optical lasers for pump probe experiments. Interpretation of scientific results necessitates the development and refinement of beam pulse diagnostic techniques. New developments are already underway to advance specialized schemes to generate ultra-short pulses of a few femtoseconds, and various seeding techniques promising improved bandwidth and coherence properties that will involve novel directions in scientific applications.

This conference captured recent developments in this exciting field, spanning topics from new facilities, optical components, instrumentation, beam diagnostics to optical lasers, novel detectors, applications, and simulations.

We gratefully acknowledge the support of SPIE in adding this conference to their program, and thank them for their outstanding organization of the conference as well as to the editorial staff for their efforts in publishing the proceedings' volume.

We would also like to thank the Program Committee for their support in many aspects of the program's organization, and the session chairs for their help in running the conference. Without the participants and their high-quality, scientific, and meaningful contributions, the success of 2012 meeting would not have been possible. Thank you.

**Stefan Moeller**  
**Makina Yabashi**  
**Stefan Hau-Riege**