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Introduction

The Soft X-ray Laser and Applications VIII conference, held in San Diego, California, 4–6 August 2009, continues the series of meetings on plasma-based x-ray lasers and related research areas. Since the last meeting in 2007, new progress was presented in the 10 oral and one poster session in source development and new applications of extreme ultraviolet (EUV) and soft x-ray lasers. This volume reviews the state-of-the art in the field, presents topical areas, and indicates new directions for the future as detailed and discussed at the conference. Other related topics are included on recent free electron lasers (FELs) with applications, hard x-ray synchrotron sources as well as high intensity laser generated higher order harmonic generation (HOH).

Presentations on HOH sources gave a review of improving the harmonic conversion efficiency at wavelengths in the water window as well as using two-color irradiation to improve the phase, increase the harmonic flux, and achieve attosecond pulse trains. HOH sources were also used to generate an oscillator pulse to wavelength-match and seed amplifier stages of laser-driven solid targets, and optical field ionization-driven (OFI) gas targets operating at various wavelengths. The seeded or hybrid lasers with better wavefront, coherence, diffraction-limited output, and peak brightness characteristics were being used for nanoscale imaging experiments by coherent diffraction. Activities in modeling and conducting seeded laser experiments were discussed in several sessions. Further insight was reported on the resultant seeded pulse characteristics. The intention to install secondary laser systems for HOH sources for seeding plasma x-ray lasers by additional groups at existing laser facilities underlines that this is a growing and topical area.

Laser driver technology continues to be important for x-ray laser research advances, and reports by several groups on improvements in x-ray laser performance were shown for saturated output at progressively shorter wavelengths 10–11 nm pumped by small laser systems. Many groups were active in developing high repetition rate sources operating at 10 Hz and achieving stable output conditions for tens of thousands of shots. The higher repetition rate allows for detailed tuning of the x-ray laser characteristics. High average power approaching 20 μW was now available on several soft x-ray lasers. The potential for new laser architectures including high efficiency diode pumped solid state lasers (DPSSL) to extend this to the 100 Hz regime was also discussed. The larger single shot laser systems operating at 0.1 Hz or longer durations between shots are available to drive shorter wavelength lasers. With proposed new Petawatt facilities on the horizon in the next few years, the large facilities had great potential for x-ray laser research on different schemes.

The recent commissioning of the Linac Coherent Light Source (LCLS) in April delivering full energy of 1 mJ at 1.5Å was a notable milestone for hard x-ray FEL sources. An overview of the source was presented and several talks discussed the use of FELs to pump x-ray laser inversions to give better understanding of the atomic kinetics as well as develop new lasing schemes. The first experiments are proposed for the coming months with many new applications available to study x-ray heated materials, atomic physics, molecular imaging, high energy density science, and other areas.

That four sessions were devoted to applications using x-ray lasers reflects how this research continues to expand. Many presentations demonstrated the short wavelength advantage of soft x-ray lasers for nanoscale probing, material studies, interferometry, imaging, metrology, lithography, machining, and ablation studies. Full-field microscopy of nanostructures with resolution approaching 50 nm was shown. Time-of-flight mass spectroscopy used a soft x-ray laser probe to study the heterogeneous catalysis of clusters for hydrogen storage. High repetition x-ray lasers were used for irradiating DNA samples to further understand the double-strand breaks. X-ray laser interferometry probing of plasma jets, and studies of plasma opacity were presented.

We would like to thank SPIE for the continuation of this series of conferences on plasma based x-ray lasers. We would like to express our gratitude for the superb organization of the conference by SPIE before during and after this three-day meeting. Also the rapid publication of the proceedings volume would not be possible without the considerable effort and support of the SPIE staff. We would like to thank the advisory board for advice and suggesting invited papers and to the session chairs for help in the running of the conference. The success and continuation of the conference is dependent on the research community and we give our thanks to the many speakers for their participation and contributions to the high quality of the 2009 meeting.

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