L-17 Wednesday, 15.06., 15^{00} - 15^{40}

Status of the petawatt-class twin optical laser facility for the synergy experiments with XFEL (SACLA)

H. Tomizawa[1,2]*

[1] *Japan Synchrotron Radiation Research Institute, Kouto 1-1-1, Sayo, Hyogo 679 – 5198, Japan*
[2] *RIKEN, SPring-8 Center, Kouto 1-1-1, Sayo, Hyogo 679 – 5148, Japan*

Keywords: petawatt-class laser, synchrotron radiation, x-ray free-electron laser

*e-mail: hiro@spring8.or.jp

SACLA [1] X-ray Free Electron Laser (XFEL) has been constructed and operated next to the largest 3rd-generation synchrotron radiation source at SPring-8. Recently, the XFEL was upgraded to a seeded FEL scheme as one of the options to improve the longitudinal (temporal) coherency. There is the synergy experimental facility at the meeting point of both SACLA and SPring-8 (see Figure 1). The synergy experiment uses can utilize both x-ray sources at this facility.

We are preparing the third "extreme" light source in this facility: petawatt-class optical laser systems synchronized to the 3rd-generation synchrotron radiation source and full-coherent seeded XFEL. These light sources are a complementary trinity to discover the dynamical nature of a variety of materials under different conditions. Experimental research using high power optical lasers combined with XFELs open new frontiers in high energy density (HED) sciences. The capabilities of pump/probe methods are dramatically improved due to the brightness of the XFEL pulses with ultrafast duration.

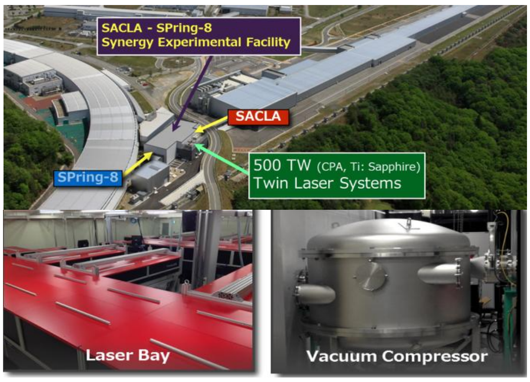

Figure 1. The synergy experimental facility with a pettawatt-class laser systems (500 TW x2.).

Currently, an experimental platform for HED sciences with a twin 500 TW Ti:Sapphire laser system is under beam commissioning for experiments combined with the XFEL for research objectives that require high peak power in the optical laser pulses. Thanks to alternative seeding from one of the common front ends, two optical laser pulses are delivered simultaneously with the maximum power of 500 TW in each into a target chamber located in an experimental hutch 6 (EH6) at BL 2, which was recently commissioned as a SACLA's 2nd hard x-ray beamline. A focusing capability using sets of compound refractive lenses will be applied to increase the x-ray fluences on the sample. One of the most key issues for the integrated experimental platform is the development of diagnostics that meet requirements both from the high power optical laser and XFEL.

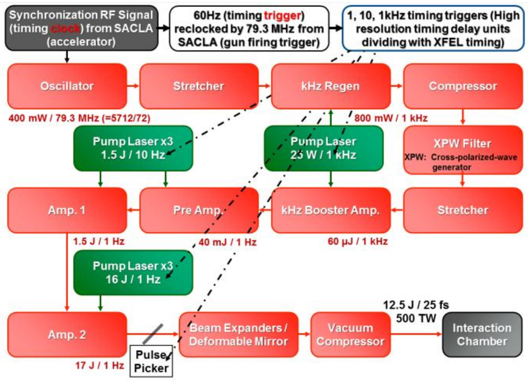

Figure 2. The petawatt-class twin optical laser system synchronized to XFEL (SACLA).

One of the most important key technologies for pump/probe methods is high-resolution timing delay units between the petawatt laser pulses and XFEL pulses (see Figure 2). The laser timing system consists of timing clock and re-clocked trigger delay systems. The laser oscillator is synchro-locked to RF clock of 79.3 MHz, which is a divided-by-72 frequency of the SACLA accelerator basic RF (C-band: 5712 MHz).

The optimizations of laser pulse characteristics are strongly required for user experiments. Hitherto, laboratory lasers have been tuned and aligned for each requirement manually by laser experts. Automatic laser tuning requires sophisticated algorithms, and the metaheuristic algorithm is one of the best solutions. The metaheuristic laser tuning system is expected to reduce the human resources and time required for laser preparations. I demonstrated some successful results on a metaheuristic algorithm based on a genetic algorithm to optimize spatial (transverse) laser profiles, and a hill-climbing method extended with a fuzzy set theory to align the laser path automatically [2]. I have developed an auto-aligner for a large laser system together with Photo-Physics Laboratory Inc. since 2007 [3]. It was named the Advanced Tactical Aligner (ATA). We are installing the ATA system based on a metaheuristic algorithm in the front ends of this petawatt laser system.

The status and future perspective of the developments of this facility will be reported in the presentation. The synergy user experiments utilizing extreme light sources will be openly discussed.

[1] T. Ishikawa, *et. al.*, *Nat. Photonics.* **6** (2012) 540.
[2] H. Tomizawa, *Rad. Phys. Chem.***80** (2011) 1145.
[3] H. Tomizawa and T. Kojima, Application Date: March 3 2010; Japanese Patent No.5545830.