

*Ultrafast Time-resolved X-ray Spectroscopies at SACLA*

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Time-resolved X-ray spectroscopy is one of the most promising applications of XFEL: X-ray absorption and/or emission measurements that combines XFELs with ultrafast optical lasers enable to probe ultrafast change of electronic states and geometric structures during real reactions at an angstrom and a femtosecond spatio-temporal resolution.

We present recent developments, applications, and future perspectives for ultrafast X-ray experiments at SACLA. For X-ray absorption spectroscopy, signal normalization scheme [1] has been developed and applied for dilute system to detect a small absorbance change. For X-ray emission spectroscopy, we are developing a dispersive scheme in a von Hamos geometry with high energy resolution and efficiency.

To improve a temporal resolution with suppressing influences of a timing jitter in pump-probe experiments, we developed a scheme for measuring an arrival timing with a high efficiency by using 1-D X-ray focusing system [2]. We further constructed a beam-splitting scheme to perform simultaneous measurement of the timing tool with user experiments [3]. This timing tool is now applied for most of pump-probe user experiments. We show several user experiments that demonstrate how the temporal resolution is improved by this tool.

In future, we will develop a platform for X-ray spectroscopy and X-ray scattering. With this platform, we can perform two measurements simultaneously and use XFEL beamtime effectively.

[1] T. Katayama et al., *Appl. Phys. Lett.* 103, 131105 (2013)

[2] T. Sato et al., *Appl. Phys. Express* 8, 012702 (2015)

[3] T. Katayama et al., *Struct. Dyn.* 3, 034301 (2016)

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