Break-out session
Synchronized laser system

SACLA Users' meeting 2021
March 10, 2021

Pump and probe capabilities at SACLA

- Stability of the SACLA optical laser:
  Improved spatially and temporally
  => see Togashi-san's talk
- Time resolution

XFEL + Pump laser + Instrument function

-~30 fs pulse duration with the 800 nm fundamental

- ~10 fs with arrival timing monitor, ~50 fs without timing monitor

- ~10f fs XFEL pulse

- Wavelength

- 200 nm ~ Mid-IR, (THz)

- Synchronization + timing monitor

- BOM-PD + Grating & GaAs

- Laser parameter report after beamtime

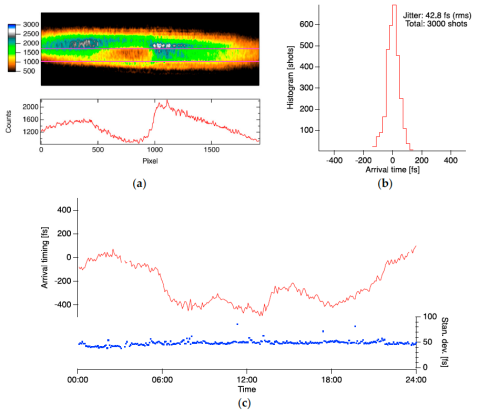

Figure 15. (a) Camera image of the timing monitor and vertical projection trace in the irradiated area by the XFEL (indicated by pink lines); (b,c) statistical data of the relative arrival timing between the XFEL and the optical laser pulses; (b) histogram of 300 shots; (c) trends of averages (red) and standard deviations (blue) in 24 h.

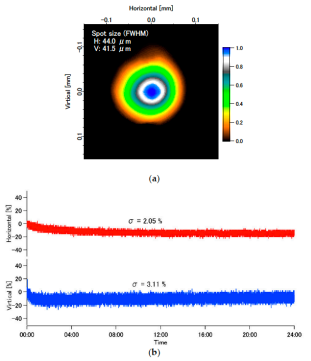

Figure 11. (a) Focusing spot profile; (b) variety of centroid positions normalized by the beam size (FWHM) in 24 h at EH2.

Applied Sciences. 10, 7934 (2020).

What is next (potential requests from user community)?

- Stability of the SACLA optical laser (Facility report)

  From SACLA (Dr. Togashi)
- Time resolution => sub 10 fs laser pulse and timing diagnostic

  Prof. Fushitani from AMO

  (AMO is one of the scientific field requiring "ultimate time resolution".)
- Wavelength => "Intense" THz(Organic crystal or $LiNbO_3$), Phase stabilized Mid-IR, DUV,

  Dr. Prasankumar, Dr. Suzuki (Intense THz activities)
- Application for liquid phase experiment (Chemistry needs wavelength tunability and stability)

  Dr. Ki
- Synchronization => synchronization + timing monitor(with higher sensitivity),

  From facilities (Dr. Togashi(SACLA), Dr. To. Sato(EU-XFEL), Ta. Sato(LCLS)

Topics to be discussed in this session

Laser capabilities

- Wavelength, shorter pulse duration, stability, etc.

Diagnostic

- Temporal, spatial, drift between the timing monitor path and pump laser line

User supports

- Parameter change capability (for example OPA), etc.

System integration

- Installation and matching
- Scan, DAQ for pump & probe

Summery (1/2)

Laser capabilities

(Wavelength, Shorter pulse duration, Stability)

- AMO science (e.g. Auger process) needs precise time resolution in the total system. The BOMPD locking system is required in BL1 for coincidence measurement in AMO.
- Short pulses in THz and Mid-IR regions are quite important for materials science. In SACLA, Mid-IR pulses are available with DFG units of OPA. THz pulses are generated by LN, and the air plasma scheme and organic crystal will be tested.
- There were not any specific proposals using shorter pulses of < 10 fs in the session.

Diagnostic

(Temporal and spatial overlap, Timing monitor)

- Spatial & Temporal overlap:

  Precise overlap in temporal depends on sample holding. Almost all users define t0 with their samples in SACLA. Transient transmittance change of YAG and XRD of Bi are available for temporal overlap.
- Timing monitor & synchronization:

  Considering the plan of attosecond pulse generation, synchronization of the optical laser is hard to control in the attosecond region. The time resolution of the timing monitor needs to improve.

Summery (2/2)

User supports (Parameter change capability)

- User support of the optical lasers are very flexible and helpful in SACLA.
- In LCLS, because of 12h shift operation, quick setting parameter change is realized.
- The trial of remote experiments was succeeded thanks to BL scientists and engineers in SACLA.
- The laser parameter report is very helpful.

System integration

(Installation and matching, Scan DAQ)

- THz shining with low-temperature cooling (< 10 K) are useful for researches of quantum materials. More discussions on how to integrate the setup with the chamber are needed. The input from the user community is welcome (from SACLA)
- A diffractometer with the Huber kappa (in Osaka-san's poster) is suitable for pump-probe experiments since its compact design, especially THz excitation with high NA focusing.
- Regarding the request for a quick delay change of CANDOX TDU in a nanosecond to microsecond region, the counting delay with 12-ns steps is available. However slow-scan within 12 ns is needed because of the synchronization of the mode-locked oscillator. Users can automatically control the delay with the specified software.
- The DAQ and experimental control systems are very stable in SACLA.
- Incident angle of liquid jet setup or thin jet to minimize the velocity mismatch.