Summary of breakout sessions A2: High-power optical lasers

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Future improvements and upgrades to the experimental platforms with high-power optical lasers (nanosecond/femtosecond lasers) at SACLA were discussed in this breakout session.

The current status and capabilities of the platforms were introduced by K. Miyanishi (SACLA) as an introduction from the facility.

The typical experimental methods and recent results were reported from users as follows.

<X-ray diffraction measurements>
Kinetics of phase transformation in SiO2 — **G. Morard (Univ. Grenoble Alpes)**

<High-resolution X-ray imaging>
Triggering Star formation: from the cosmos to the laboratory — **B. Albertazzi (Ecole Polytechnique)**

<Small-angle X-ray scattering>
Expansion measurement of sub-micron rod targets — **Y. Sakawa (Osaka Univ.)**

The following slides summarize topics raised in the roundtable discussion with responses from the facility.

Round table discussion
- Feedback and requests for experimental platforms (long pulse) 1/2 -

Requests for nanosecond laser system

- **Higher power with a shorter pulse duration (e.g., 1.5 ns) is desirable for some applications.**
- **Ramp and step shaped pulses would be beneficial. Ramp pulse could have a higher priority.**
- **To discuss the laser parameters, users need information on the acceptable peak power of the laser system.**
  - **Currently, the pulse duration is fixed to be 5 ns with quasi-square pulse shape in most experiments due to some technical difficulties of the laser system. Osaka University, which has developed the laser system, will work to increase the options of laser parameters in collaboration with the SACLA facility. Close communication is important between the user community and Osaka University/SACLA. Comments on prioritization of the parameters are very welcomed.**

Round table discussion
- Feedback and requests for experimental platforms (long pulse) 2/2 -

Diagnostics for X rays (XFELs) and laser-matter interactions

- **Improvement of the XRD capabilities: transmission or other geometry, the energy-scan capability of x-ray photons**
  - Expanding the availability of the geometries for XRD is under consideration by the facility. X-ray photon energies can be varied by changing the K-values of the undulators. Contact facility staff to get details.
- **Improvement of XFEL beam pattern on the sample (unfocused beam)**
  - The facility plans to investigate the source disturbing the beam pattern. If it comes from Be windows, they will be replaced.
- **Absolute calibration of SOP to obtain the temperature of the laser-shocked sample**
  - It is planned to perform absolute calibration of SOP in 2021.

Other requests

- **Gas-filled environment in the sample chamber**
  - The preliminary test has been performed. So far, the facility does not recognize any issue with filling the chamber with gas.
- **Development of new options for more extreme environments: external magnetic field generation, starting temperature control (heating up to 1000 K), cryogenic/RT liquid sample delivery**
  - Since those requests contain many development components, the facility encourages users to propose the item for SACLA Basic Development Program.

Round table discussion
- Feedback and requests for experimental platforms (short pulse) 1/2 -

Requests for femtosecond laser system

- **Higher intensity is necessary for some applications, achieved either 1) by increasing the laser energy to ~10 J or more (at the best performance of the laser system), or 2) by reducing the focal spot with smaller pointing fluctuations.**
  - The energy is currently limited to ~8 J in typical experiments for stable operation. Increase the energy keeping operation stability will influence the operation cost and the tuning time. The facility will keep working to improve the focused intensity by several approaches.

- **A parabolic mirror with a shorter focal length (F/3) for particle acceleration experiments. In most experiments, a single beam of the high-power laser is good enough.**
  - The facility is still working to improve the stability of the 1st beam (mainly in terms of the synchronization to the XFEL in time and space). The 2nd beam with an F/3 parabola will be commissioned once the available issues for the 1st beam are cleared.

- **Timing monitor to know the arrival timing with an accuracy better than 100 fs or desirably less than the jitter (~30 fs)**
  - The facility is working to develop a feedback system to compensate for the long-term (i.e. slow) drift. This system may be enough for 100-fs accuracy but won't be enough to ensure the timing with a few 10's fs resolution. The facility will keep updating the development status.

Round table discussion
- Feedback and requests for experimental platforms (short pulse) 2/2 -

Diagnostics for X rays (XFELs) and laser-matter interactions

- **Diagnostics, such as Thomson parabola, for energetic ions accelerated by laser-matter interactions**
  - The facility has just started a preliminary attempt to measure ions using multi-layered films as reported in the facility poster on the meeting website. Continuous discussion is welcome with the user community on the development of the diagnostics to measure ions.

Other requests

- **Better optical imaging system for sample alignment with a spatial resolution of 2-5 μm**
  - There are some challenges to make such a high-resolution camera for common use on the platform because the desired specifications, such as viewing direction or field of view, should depend on the experiments. Detailed input from the user community is important to start the designing work.

- **Gas jet system**
  - Since the facility does not have enough resources and experience to develop such a system, a collaboration between the facility and the users (for example, through SACLA Basic Development Program) is necessary to implement.