SACLA Beam Performance

Recent update of accelerator

In the time-resolved beam injection from the SACLA linac (hereafter, referred to as “beam injection from SACLA”) to the storage ring, the most severe issue affecting the reliable and steady beam operations is the reduction of the downtime upon the failure of the electron gun system at SACLA. Installing a spare electron gun next to the existing gun is not feasible because passage of emission electron beams from the gun cathode through the non-straight line by kicking the beam results in the fatal deterioration of the beam quality. Thus, such a spare gun adjacent to the existing gun cannot provide experimental users with high-performance XFELs. To solve this problem, the gun system was heavily modified in the summer shutdown period of 2022. The entire gun system, including the high voltage tank and gun cathode was constructed as an exchangeable module to facilitate quick recovery from any fatal problem that may occur in the gun system. Figure 1 shows the two module-typed gun systems in the test stand. The spare gun is always ready in case of the requirement for replacement at the gun conditioning bench. This system has significantly reduced the downtime owing to the gun cathode exchange module and facilitated quick restart of user operations at both SACLA and SPring-8. Figure 2 shows the recovery example of the

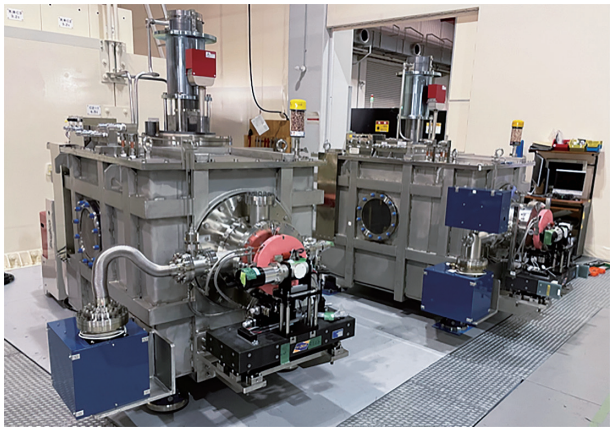

Fig. 1. Two developed module-typed gun systems in the test stand. One of the two is used for the beam operation in the tunnel and the other is on stand-by in the gun conditioning bench.

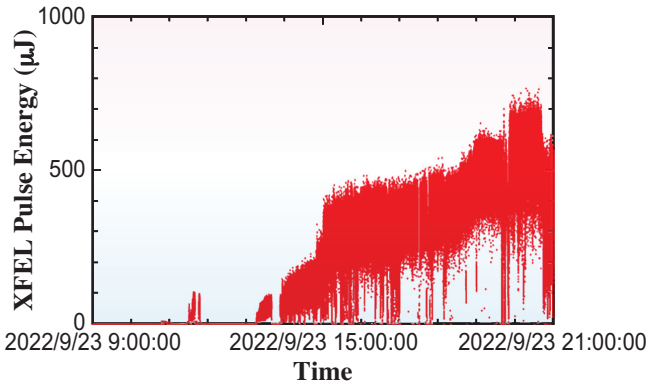

Fig. 2. Recovery example of pulse energy of XFEL after the gun exchange.

pulse energy of XFEL after the gun exchange. The XFEL pulse energy could be smoothly increased up to an intensity level of approximately 0.5 mJ in half a day.

Multi-beamline operations with pulse-by-pulse route switching have been routinely used for user experiments at SACLA. To maximize the XFEL performance and beam injection stability during this operation, a pulsed quadrupole focusing system has been developed to set pulse-by-pulse optimum focusing parameters according to the selected beam route. In the fiscal year of 2022, the new pulsed AC magnets replaced seven existing quadrupole DC magnets in the summer shutdown period. The necessary replacement work will be continued through the next year and the full pulsed quadrupole focusing system will be completed at the end of the fiscal year of 2023. Figure 3 shows the newly installed quadrupole laminated magnet.

A tube-type RF source referred to as inductive output tube (IOT) has been used as the RF source for the 476 MHz booster cavity in the buncher section of the SACLA linac. As the IOT tube used in SACLA was discontinued, we began to develop a new 476 MHz RF source by using the recent advancement of power semiconductor technology for reliable and steady operations. In 2022, newly developed RF source was installed near the old IOT coupled with a switcher to facilitate quick switching between the two sources. Figure 4 shows the newly installed 476 MHz RF source. The basic source performance was experimentally confirmed and now the 476 MHz new source is ready for routinary use. The switch from the old source to new one is scheduled for 2023.

Fig. 3. Quadrupole laminated magnet newly installed to realize pulse-by-pulse beam optimal focusing.

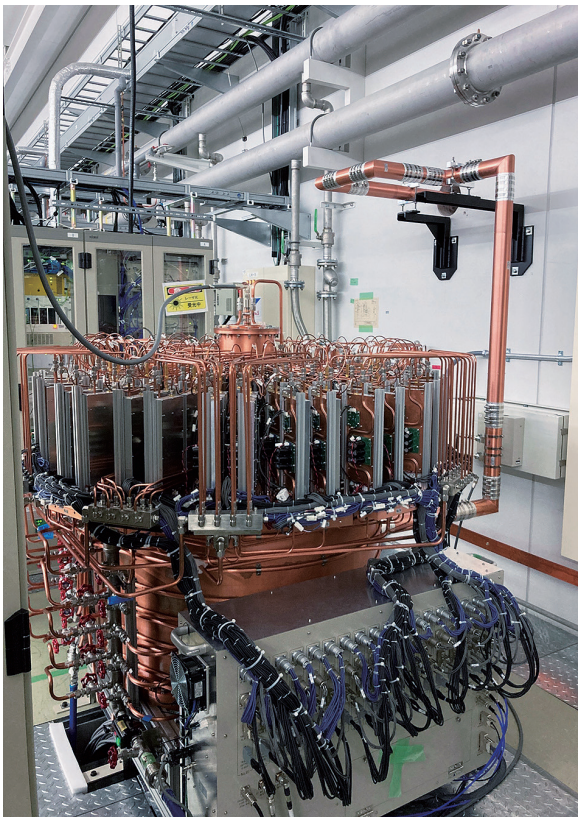

Fig. 4. New 476 MHz RF source installed at the klystron gallery of SACLA.

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