Radiometers for free-electron lasers

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In recent years, the development of free-electron laser (FEL) sources based the self-amplified spontaneous emission (SASE) has been rapidly in progress. FEL sources generate intense and short femtosecond laser pulses, and the wavelength reaches the hard x-ray range of shorter than 0.1 nm. In general, the statistical nature of SASE leads to strong pulse-to-pulse fluctuations; therefore, a reliable detector is required for measuring FEL power.

In Japan, a new x-ray FEL facility, SPring-8 Angstrom Compact free-electron LAser (SACLA), started operation in 2011. Our group has developed several radiometers to measure the laser power of FEL in absolute scale and to calibrate online FEL detectors. Firstly, we have developed a cryogenic radiometer for hard x-rays, and succeed in the absolute laser power measurements of FELs. However, the cryogenic radiometer cannot cover the whole range of laser power at SACLA. Though the typical laser power at SACLA is approximately 15 mW (0.5 mJ/pulse with a repetition rate of 30 Hz), the use of superconducting wires in the cryogenic radiometer limits the measurement range to less than 4 mW. Hence, a room-temperature calorimeter (radiometer) has been developed, and was demonstrated to accurately measure laser power of above 4 mW and to calibrate online FEL detectors of SACLA. Recently, we have succeeded in a development of a compact radiometer which also can operate at room temperature.

In this talk, an overview on the radiometers will be presented with our recent FEL measurements by using these radiometers.