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## Development of array-type secondary electron emission monitor toward single-shot determination of extraction efficiency of oscillator FELs

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The extraction efficiency is one of the key parameters of an FEL oscillator. In the conventional way of extraction efficiency measurement in Kyoto University FEL (KU-FEL), temporal evolutions of the electron beam energy distribution in a macro-pulse with and without FEL lasing were measured by a Faraday cup placed after an energy analyzer[1]. Then the extraction efficiency is evaluated from the difference between the instantaneous average energy with and without the FEL lasing. Due to the scanning nature, the conventional way needs a long measurement time. To enable single-shot determination of the extraction efficiency, we developed a monitor that enables us to measure the temporal evolution of the electron beam energy in a macro-pulse by using an array-type secondary electron emission monitor[2]. The monitor consists of 24 ribbon-shaped electrodes and 2 shielding electrodes are placed after the energy analyzer magnet. The beam energy evolutions in a macro-pulse with and without FEL lasing were measured in a single-shot with <100-ns temporal resolution. This monitor will enable single-shot determination of the extraction efficiency of FEL oscillators.

### Footnotes

[1]H. Zen et al., Phys. Rev. Accel. Beams 23, 070701 (2020).

[2]A.R. Berdoz et al., Nucl. Instrum. Methods Phys. Res. A 307, Pages 26-34 (1991).

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