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Supporting information for article:

Application of mid-infrared free-electron laser for structural analysis of biological materials

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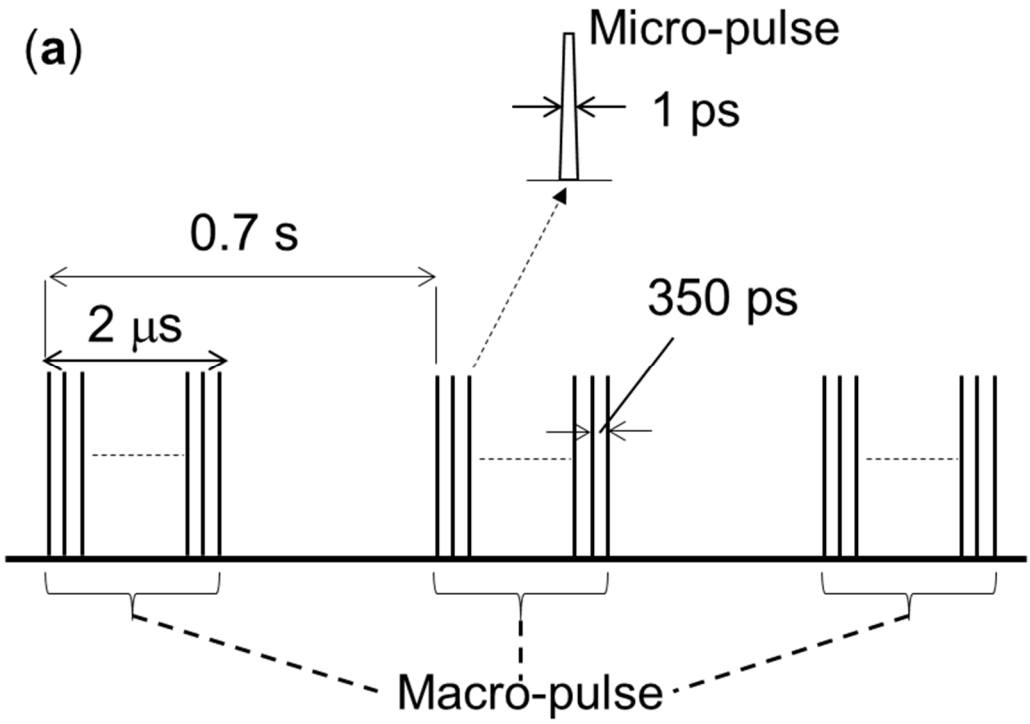
S1. Pulse structure and spectra of MIR-FEL

The pulse structure of MIR-FEL was shown in Fig. S1 (a). The macro-pulse contains about 6000 micro-pulses and has the repetition rate of 1.4 Hz. The typical duration time is 2 μs. The micro-pulse has the repetition rate of 2,856 MHz and the typical duration of 1 ps or shorter. FEL spectrum tuned to 9.6 μm was shown in Fig. S1 (b) and that tuned to 5.8 μm was shown in Fig. S1 (c). In both cases, the full width at half maximum was measured to be approximately 100-200 nm.



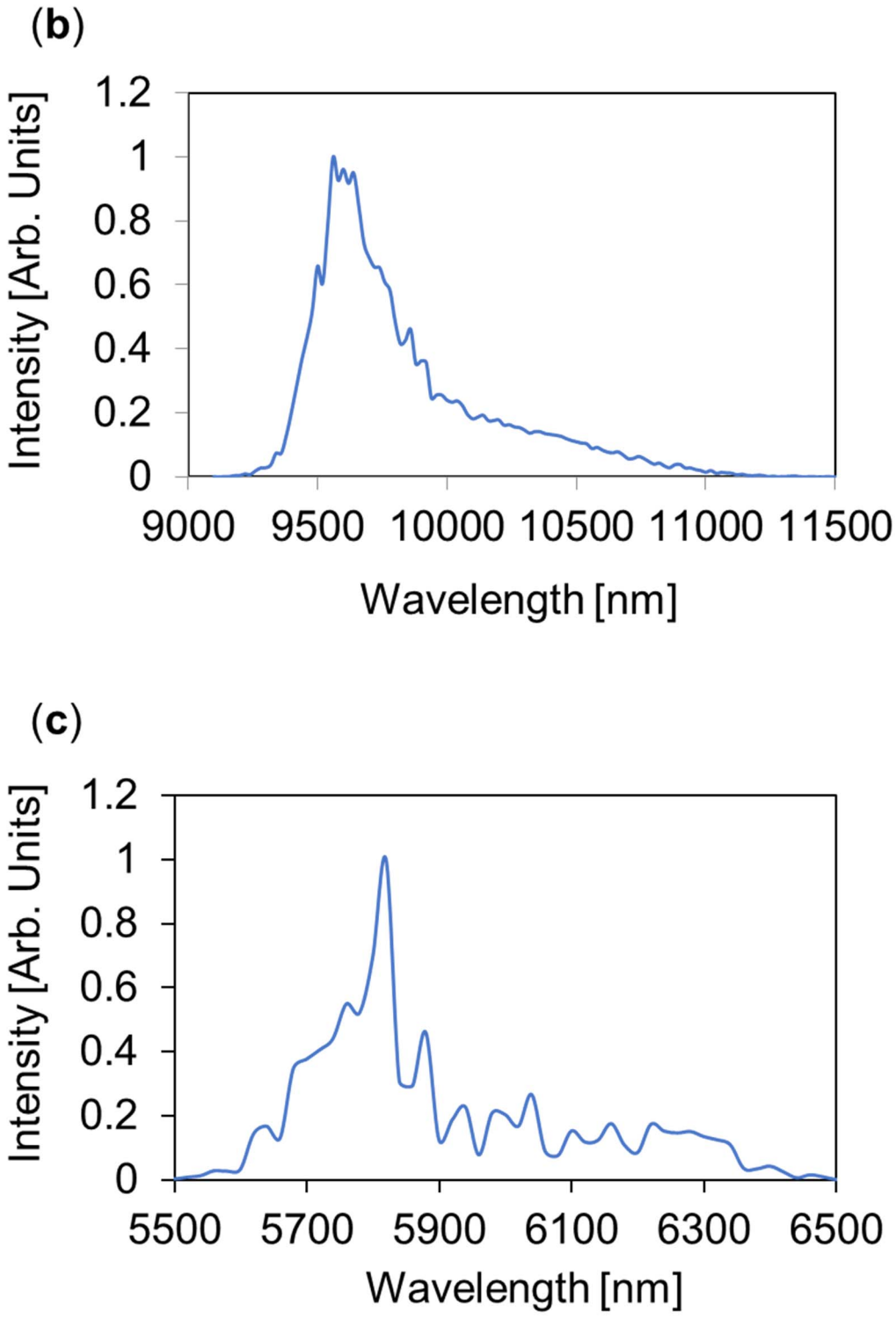


Figure S1 (a) Pulse structure of MIR-FEL. (b) FEL spectrum at 9.0-11.5 μm. (c) FEL spectrum at 5.5-6.5 μm.