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Observation of Burnham-Chiao Ringing with Pi-Phase Jumps in a High-Efficiency Superradiance FEL Oscillator

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At the mid-infrared free electron laser oscillator in Kyoto University (KU-FEL), high extraction efficiency (9.4%) operation has been achieved [1] by introducing the dynamic cavity desynchronization technique [2] and photocathode operation of a thermionic RF gun [1]. Because of the interaction between the electron beam and FEL electromagnetic field, a maximum electron energy decrease of 16% was observed. The measured energy decrease was consistent with the measured FEL spectrum. The FEL pulse structure under the high extraction efficiency operation was obtained by a phase retrieval based on the result of fringe resolved autocorrelation measurement [3]. As the result, it was confirmed that the FEL pulse has several sub-spikes after the main spike having a 4.2-cycle pulse length at the wavelength of 11 μm . Moreover, the neighboring spikes has 180-degree different optical phases, i.e. π -phase jumps. The appearance of the sub-spikes and the π -phase jumps are the specific feature of the Burnham-Chiao ringing (or Superradiance ringing) [4], which has been predicted by numerical simulations [5] but not yet fully characterized in experiments. The ringing and the π -phase jumps are clear evidence of the periodic acceleration and deceleration of the microbunched electrons. In this talk, we present an overview of few-cycle FEL lasing with the high extraction efficiency, >9%, and the details of FEL pulse measurements to reveal the Burnham-Chiao ringing. This work was supported by MEXT Q-LEAP (JPMXS0118070271).

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Yes

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