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Upgrade of IR-FEL low-level RF control system based on beam load feedforward

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Hefei Infrared Free-Electron Laser device (IR-FEL) is a user experimental device dedicated to energy chemistry research that can generate high brightness mid/far infrared lasers. It is driven by an S-band linear accelerator with a maximum electron energy of 60 MeV. The stability of the final laser output is determined by the quality of the electron beam, and optimizing the Low-Level RF (LLRF) Controlsystem can elevate the beam's ultimate quality. The IR-FEL linear accelerator boasts a beam length of 13 μ s, exhibiting a pronounced beam loading effect. The leading edge of the beam interacts with the RF field, absorbing energy, thereby influencing the acceleration process at the beam's tail. This interaction leads to an increase in beam emittance, impacting the final laser quality. However, by incorporating a feedforward algorithm to modulate the microwave field amplitude upon the beam's arrival, we can mitigate the beam loading effect and improve beam quality. Details regarding this upgrade, along with the experimental outcomes, will be elaborated upon in the main text.

Footnotes

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