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Feedback control of the spatio-temporal properties of high-intensity laser pulses to optimize x-ray and 100 MeV electron generation

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We describe how active feedback routines can be applied at limited repetition rate (5 Hz) to optimise high power laser interactions with clustered gases. X-ray generation and 100 MeV electron beams were produced and optimized using genetic algorithms approximately doubling the x-ray flux and increasing electron beam charge by a factor of 3. The complicated interaction dynamics of the cluster ionization and absorption processes and laser dispersion in plasma, all controlled through the feedback loop, lead to the evolution of the laser pulse into a slowly rising intensity profile or multiple pulses, which we believe optimises the few-picosecond expansion and subsequent laser energy coupling into the cluster medium and tailors the plasma wake acceleration process. Our work suggests that this technique can be more widely utilised for control of intense pulsed secondary radiation from petawatt-class laser systems. This demonstration represents an important step towards the improvement of these sources for their use in scientific and societal applications

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