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Flying focus beams as a tool to investigate strong-field physics

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In a flying focus beam (FFB) the velocity of the focus can be "programmed" and it is independent of the group and the phase velocity of the beam itself. Recent experiments have demonstrated a moving focus over centimeter lengths, i.e., much longer than the Rayleigh length [1]. Scaling this technology to higher power laser pulses would allow one to employ FFBs as a tool for fundamental high-field physics, especially to investigate effects that accumulate with the interaction length. Specifically, by considering an ultrarelativistic electron beam counterpropagating with respect to a FFB, whose focus copropagates with the electrons at the speed of light, we show that the effects of the so-called transverse formation length of radiation on the radiation itself can be enhanced as compared to the case of a conventional Gaussian beam [2]. Analogously, radiation-reaction effects can be rendered measurable at much lower intensities than conventionally required in a similar setup [3]. Finally, we show how FF beams with angular momentum can be an efficient tool to transport ultrarelativistic electron beams over macroscopic distances without significantly spreading on the transverse plane [4].

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