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Gamma-ray radiation in beam-plasma interaction as a diagnostics for emittance growth in PWFA and for beam filamentation instabilities

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Low-emittance ultra-relativistic electron beams delivered for next gener- ation of plasma wakefield acceleration (PWFA) experiments are expected to produce very high wakefields over very large distances when going through a plasma. Assessing electron beam dynamics under such fields will be of key importance to achieve the next milestones of the PWFA concept. Here we report on the use of the betatron X-ray and gamma-ray radiation emitted by the electron bunches under these fields to assess the electron beam dynamics and emittance evolution. We will present simulation results showing how the betatron radiation emitted by a relativistic electron beam is correlated to its emittance growth when propagating through the plasma in the highly non-linear regime. Gamma-ray radiation can also be a powerful tool in a related context: the growth of electromagnetic filamentation instabilities during beam-plasma interaction, with plasma densities ranging from gas density to solid density. We will present simula- tion results showing how very large electromagnetic fields produced during the electron beam filamentation instability can cause the production of bright gamma rays, which in turn can be used to assess the onset and evolution of the instability.

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