High current colliding beams as a potential source of energetic radiation and relativistic pairs

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At the interaction point of TeV particle colliders, three detrimental beam driven effects are important: disruption [1], beamstrahlung radiation [2], and pair production [2]. Disruption is due to the transverse motion of the beam particles which can focus (e^-e^+) or defocus (e^-e^-) on the self-fields of the counter-propagating beam. In this process, photons are emitted and can decay into new pairs by interacting with the collective field of the beams. These two effects are more pronounced in the quantum regime which is usually avoided by using flat and long shaped beams. Conversely, the upgrade of the linear collider at SLAC (FACET II) [3] and the next generation of laser wakefield accelerators (LWFA) will deliver high current ultrashort round bunches capable of reaching the quantum regime at 10s of GeV. We investigate the collision of these beams envisaging a secondary source of collimated γ ray photons and ultrarelativistic pairs [4]. We estimate the photon spectrum and the secondary pairs yield both analytically and with PIC simulations, performed with QED-OSIRIS [5]. Our analytical model and the simulations show good agreement. The collective fields topology favors the quantum effects to take place in a distinguishing region of each beam resulting in a yield of secondary pairs considerably higher than what previously predicted [2]. Our results encourage the exploitation of this setup as a secondary source of radiation and of relativistic pairs. This secondary source of photons, electron, and positrons may be of interest in reproducing astrophysical lepton jets in the laboratory, or in delivering positron beams already at ultrarelativistic energies.

References

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