Contribution ID: **25** Type: **talk**

Radiative losses in plasma-based electron accelerators in ultrahigh energy limit

Tuesday, 4 June 2013 18:00 (15 minutes)

The electrons accelerated in plasma-based accelerator undergo betatron
oscillations and emit synchrotron radiation. The energy loss to synchrotron radiation may seriously affect electron acceleration. The electron dynamics under combined influence of the constant accelerating force and the classical radiation reaction force is studied. It is shown that electron acceleration cannot be limited by radiation reaction. If initially the accelerating force was stronger than the radiation reaction force then the electron acceleration is unlimited. Otherwise the electron is decelerated by radiative damping up to a certain instant of time and then accelerated without limits. It is shown that regardless of the initial conditions the infinite-time asymptotic behaviour of an electron is governed by self-similar solution providing that the radiative damping becomes exactly equal to 2/3 of the accelerating force. The relative energy spread induced by the radiative damping decreases with time in the infinite-time limit. The multistage schemes operating in asymptotic acceleration regime when electron dynamics is determined by radiation reaction are discussed.

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Session Classification: WG1+4

Track Classification: WG1+4