# Deep saturation of a Cerenkov wakefield amplified by an active medium

Z. Toroker and L. Schächter

*Department of Electrical Engineering, Technion Israel Institute of Technology, Haifa 32000, Israel*

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A trigger bunch of electrons traveling inside or in the vicinity of a dielectric medium generates a Cerenkov wake. If the dielectric medium is active, a small fraction of the spectrum of the wake is amplified and far behind the trigger bunch where the active medium is fully depleted, the amplitude and the phase of the wake are virtually constant. In this range, a second bunch of electrons trailing behind the trigger bunch can be accelerated. For optimal operation, the trigger bunch should be density modulated at the resonant frequency of the medium. However, we demonstrate that even if the bunch is uniform along many wavelengths we may still take advantage of the saturation characteristics to obtain conditions adequate for acceleration. Further we demonstrate that for large enough number of electrons it is possible to have a coherent amplified wake after a saturation length which is determined analytically and tested numerically. In addition, we show that almost 100% of the stored energy in the active medium can be transferred to the acceleration of the trailing bunch electrons. The relatively large energy spread due to the beam loading is well suited to a medical accelerator. When the beam loading is weak, the gradient is virtually constant but the acceleration efficiency drops to about 2% for typical parameters.

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