International Journal of Modern Physics A
Vol. 22, No. 22 (2007) 3898–3911

World Scientific
www.worldscientific.com

SCALING LAWS OF STRUCTURE-BASED OPTICAL ACCELERATORS

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A structure-based laser accelerator harnesses technological progress developed by the laser and optical fiber industries, potentially facilitating a compact and efficient system. In the optical regime, dielectrics sustain higher electric fields and gradients of the order of a few GV/m may become available, but the acceleration structures are different than those used in the microwave regime. Various dielectric structures have been analyzed, and from the pure accelerator parameters perspective (gradient, interaction impedance, group velocity, wake-fields), their performance is of great promise. Operation similar to current linear accelerators may lead to a prohibitively low efficiency. Therefore, including a feedback attached to each module may improve the efficiency from a few percents to higher than 90% – in fact, the efficiency is limited only by the constraints on the stability of the optical system. Single mode operation in the optical regime imposes that at least one of the dimensions of each micro-bunch ought to be sub-micronic leading to a stringent constraint on the emittance and thus on the luminosity. Attempting to increase the latter, imposes high energy density in the vacuum tunnel as well as in its adjacent dielectric layer(s). This, in turn, is bounded by the maximum stress, temperature increase and heat dissipation, dielectrics can sustain at these scales.