Optical Planar Bragg Accelerator

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Abstract

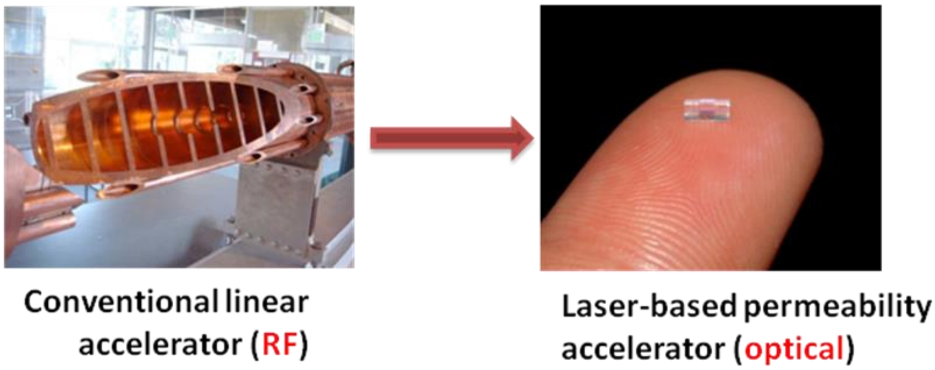
Electrons acceleration plays a vital role in many applications like T.V and computer monitors and even in many medical instruments that require the use of particle accelerators in order to generate radiation. Thus, this topic has always been interesting. Most of the accelerators today are made of metals and based on radio frequency (RF) technology, making them large and expensive, due to the need for durable structure that would overcome the electrical breakdown of metals in the presence of high electric fields.
Over the years, efforts have been made to improve the existing bulky acceleration devices. One method is based on laser acceleration in dielectric planar Bragg accelerator. This structure consists of dielectric layers, which can sustain higher fields than metals, and operates at optical frequencies, thus it can achieve higher accelerating gradient and in the same time be more compact.

Optical planar Bragg accelerator is a structure which consists of a Bragg waveguide operating at optical wavelengths that is made of a series of periodic layers. This structure is designed to guide light in a low reflective index region (such as vacuum) surrounded by high reflective index alternating layers. Confinement of the accelerating fields is achieved by adjusting the first layer width, which matches between the electromagnetic field in the vacuum core, and the Bragg mirror structure.

Our goal in this project is to design a planar Bragg accelerator which consists of permeability layers and supports propagation with phase velocity c by using the mode TM01 in the vacuum core. During the design, we will focus on a number of parameters that characterize the device, such as interaction impedance, which is a measure of the accelerating gradient experienced by the electrons for a given amount of power injected into the system, energy velocity and the weight of the first mode, which is a measure of the maximum acceleration efficiency.

Finally, comparison of the findings were made to those obtained in the dielectric layers structure.

The following figure shows the possible significant reduction in the accelerator's size by using a Laser-based accelerator



A conventional linear accelerator compared to a laser based accelerator