Title
Radial polarization

Author
Li, Jiajun

Publication Date
2022

Radial polarization

JIAJUN LI

1. INTRODUCTION

This paper serves to provide a explanation on the basic principles used in *Direct longitudinal laser acceleration of electrons in free space*[1]. The direct longitudinal laser acceleration demonstrated in this experiment is driven by radial electromagnetic pulse's electric field. This radial polarization of the laser pulse has high intensity and is focusable. The electron is accelerated along the optical axis by the longitudinal electric field component. The output of this set up has TM_{01}mode beams with high stability and nearly diffraction limited. The experiment conducted in the paper highlights many key principles of photonics.

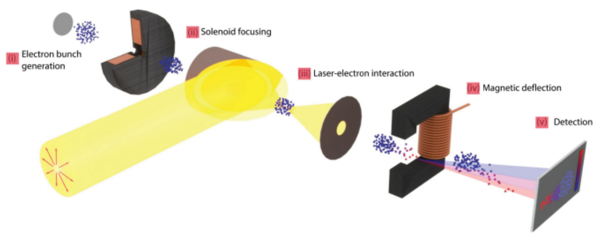

Fig. S1. Experiment setup[1]

2. EXPLANATION

The direct longitudinal laser acceleration demonstrated in this experiment is driven by radial electromagnetic pulse's electric field.The setup of the experiment can be seen in figure S1. This radial polarization, figure S3. of the laser pulse has high intensity and is focusable. The electron is accelerated along the optical axis by the longitudinal electric field component. The vectoral structure of an optical field determines the polarization state of the optical field. The initial polarization of the laser is linear that is produced from a source. This linearly polarized optical field can be expressed as a real constant vector. The electric field of the wave oscillates orthogonally and is restricted to a single plane in the direction of propagation.

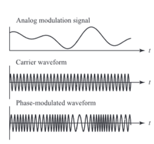

Fig. S2. Phase modulation[2]

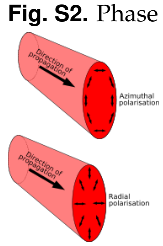

Fig. S3. Radial Polarization[3]

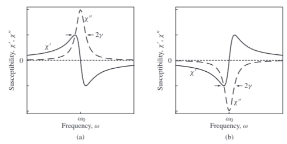

Fig. S4. Frequency chirping dude to varying refractive index[2]

The hollow-waveguide is coupled the pulse amplifier causing a broadening of the linewidth. Coupling of normal modes ignores the time dependency electric and magnetic fields caused by spatial dependent perturbations. When the laser of high optical intensity is traveling thorough the medium, a nonlinear phase delay is caused by the Kerr effect as refractive index of the medium is varying. The short and intense input pulses of the laser is a time-dependent pulse in which a time-dependent phase shift is caused the Kerr effect. This is a result of the time-varying refractive index. Since the propagation of the laser is spatial dependent and the phase-variation due to the Kerr effect, the laser is self-phase modulated and self-focusing, figure S3. The time-dependent phases shift causes a chirp in the laser resulting in a variation of the temporal instantaneous frequency. This temporal variation of frequency increases the optical bandwidth of the laser resulting in spectral broadening.

3. CONCLUSION

The successful results of the experiment in *Direct longitudinal laser acceleration of electrons in free space* provides as a proof of many principles of photonics. Principles such as polarization, coupling, Kerr effect, and many more demonstrated lay the foundation for this field of research and its advancement.

4. REFERENCES

[1]Carbajo, S., Nanni, E. A., Wong, L. J., Moriena, G., Keathley, P. D., Laurent, G., Miller, R. J. D., amp; Kärtner, F. X. (2016). Direct longitudinal laser acceleration of electrons in free space. Physical Review Accelerators and Beams, 19(2). https://doi.org/10.1103/physrevaccelbeams.19.021303
[2]Liu, J.-M. (2017). Principles of Photonics. Cambridge University Press.
[3]Wikimedia Foundation. (2021, October 31). Radial polarization. Wikipedia. Retrieved March 14, 2022, from https://en.wikipedia.org/wiki/Radial$_{polarization}$