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Production of The Charged Particles: Laser Based Techniques

Hamdi Şükür KILIÇ[1,2,✉], Kenneth W.D. LEDINGHAM[1,3]

[1]*Selcuk University, Faculty of Science, Deoartment of Physics, Campus, Selcuklu, KONYA/TURKEY*
[2]*Selcuk University, Advanced Technology Research and Applications Center (İLTEK), KONYA/TURKEY*
3 University of Strathclyde, SUPA Department of Physics, Glasgow G4 0NG, SCOTLAND.

Abstract

All naturally occurring elements contain charged particles (positively charged protons and negatively charged electrons). Electrons, protons and ions are the best known charged particles and can be produced using several techniques such as nuclear decays, electrical discharges, photoelectrical effects and even laser based techniques. Electrons are used in several industrial applications such as welding, lithography, sterilization, material heating/melting, particle accelerators, x-ray tubes, oscilloscopes, diffraction imaging, electron microscopy (SEM, TEM, STM, *etc.*), medical therapy e.g. very high energy electron (VHEE) therapy, photomultipliers, vacuum tubes, lasers and all semiconductor components while protons are widely used in cancer therapy and hadron experiments such as LHC (Large Hadron Collider) to understand fundamental physics of nature.

High Intensity laser based particle production and acceleration have produced MeV energetic protons using Target Normal Sheath Acceleration (TNSA). Radiation Pressure Acceleration (RPA) with non-linear polarized laser beams generates ~100MeV protons and C^{6+} ions up to 164MeV using ultrathin (~10nm) film targets. Particle-in-cell (PIC) simulations have shown recently that proton beams having energies higher than 200 MeV can be produced by using the TNSA procedure and higher utilising the RPA method. Other simulation studies (using 2D VPIC code) have shown that protons with energies higher than 450MeV can be produced in the so-called Break-Out Afterburner (BOA) regime.

In this presentation, the production techniques and properties of all charged particles mentioned above will be presented and discussed in details.

Keywords: *proton, laser, therapy, acceleration*

✉ ***Corresponding Author Email*** *:* hamdisukurkilic@selcuk.edu.tr