

Abstract

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Laser induced proton – boron fusion using TW-class laser system – study of novel approach employing protons produced during thermonuclear $D(d,p)T$ reaction

Majority of current research related to proton-boron approach of laser fusion employ hundreds of TW and PW-class laser systems to increase yield of alpha particles produced during $p + {}^{11}\text{B}$ reaction. Recently, such laser systems became much more accessible, however the importance of enabling as many research groups as possible to contribute in the laser-fusion field requires seeking alternative approaches that could be implemented using moderate laser intensities. This dissertation is written in regard of generation of energetic ($E_{max} > 4 \text{ MeV}$), intense and directed proton beam during Cavity Pressure Acceleration (CPA) scenario of laser-matter interaction, where CD_2 powder was used inside the target cavity. The origin of these protons is one of deuterium-deuterium fusion reaction channels, in which ${}^3_1\text{H}$ and p^+ are produced. The applicability of this approach is discussed based on magnetohydrodynamic simulations by evaluation of thermodynamical parameters, such as density, electron temperature and pressure arising during laser-matter interaction, which are crucial for driving the thermonuclear reactions. The measurements of proton energy spectra carried out during experimental session served as an input for Monte Carlo simulations (FLUKA) of proton beam colliding with boron targets of different thickness, which suggest potential for few-TW laser systems to generate alpha particle flux comparable to these achieved using the most powerful laser beamlines.