Numerical investigations on fusion ignition process in plasma formed by the interaction of energetic and high current ion beams

Stavros D. Moustaizis[1], P. Lalousis[2], I. Pologiorgi[1] and S. Vlastos[1]

[1] *Technical University of Crete, Lab of Matter Structure and Laser Physics, Chania, Crete, Greece*
[2] *Institute of Electronic Structure and Laser FORTH, Heraklion, Greece*

Abstract

Numerical investigations on the interaction of two energetic and high current density ion beams trapped in a volume with external applied magnetic field enable to study nuclear fusion process for different ion species. The final plasma is formed by the interaction of the two beams and is composed by the two different ion species of the beams and by low density electrons. The configuration of the beams could be constituted in a first case by one proton beam and one ^{11}B beam and in a second case by two deuterium beams. The proposed scheme for the high power ion beams production is based on both the Magnetically Insulated Diode (MID) and Pulsed Power (PP) techniques. These techniques allow generating high energy ion beams up to hundreds of keV with current density up to few tens of A/cm^2, with relatively low electron density. The application of this scheme for fusion overcomes the difficulty concerning the Hydrogen - ^{11}B fuel for which the cross section for reactions is efficient for energies higher than 250 keV. The low electron density in the formed plasma minimizes the bremsstrahlung radiation losses, especially for the case of the Hydrogen-^{11}B fusion plasma. The temporal evolution of the plasma parameters and especially the reaction rate was investigated using a multi-fluid, zero dimension, and global energy code. The code allow to estimate the alpha heating effect on the temporal evolution of the formed plasma temperature and the maximum value of the reaction rate, especially for the Hydrogen-^{11}B fusion case, where each reaction produce three alphas with total energy of 8.7 MeV. The numerical study allows estimating the time interval to obtain the maximum of the reaction rate as a function of the initial conditions concerning the energy and the current density of the ion beams. The present work based on existing technologies (MID and PP) and will contribute on the design and potential development of Compact Magnetic Fusion Devices (CMFD) with output energy of the order of 100 MW.