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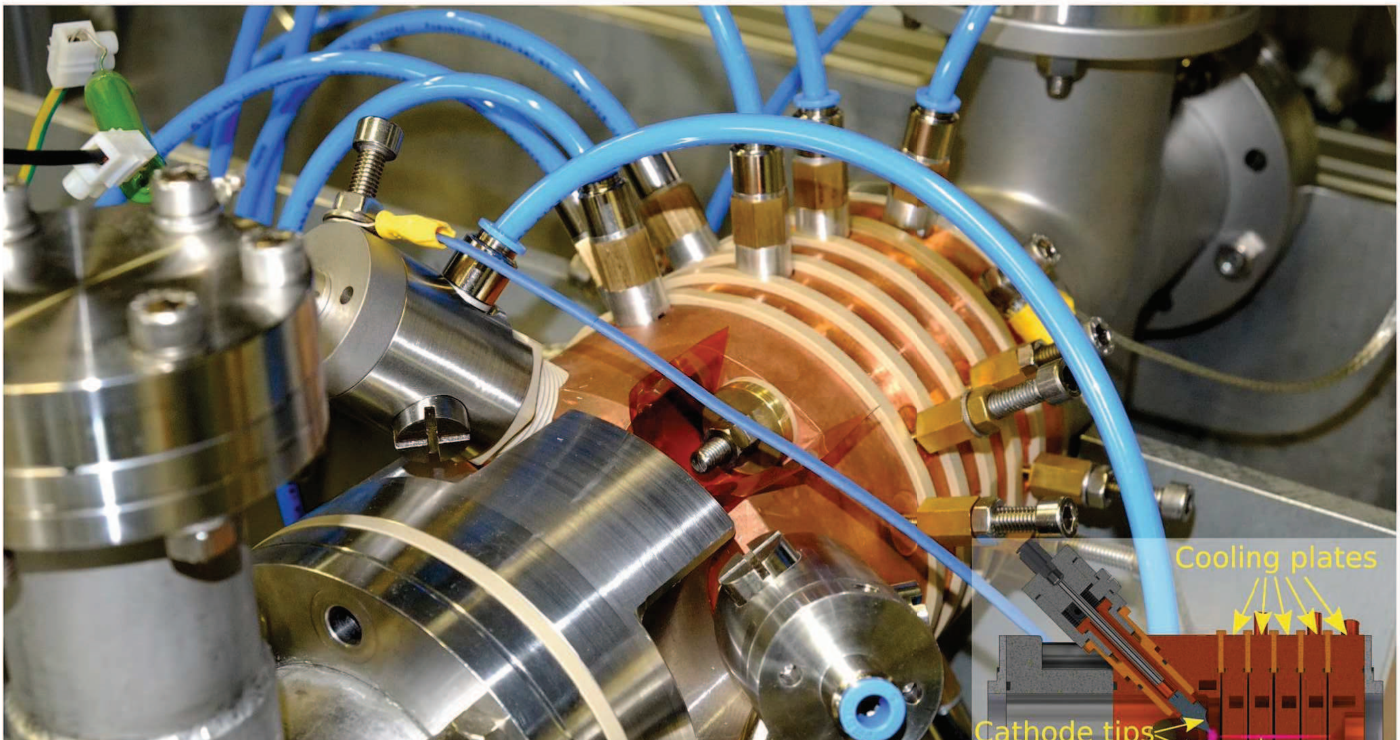
High Energy Density generated by Heavy IOn and Laser Beams



HEDgeHOB Collaboration at FAIR - Report 2015

Dynamical properties of dense plasma in inertial confinement fusion*

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Recently, considerable attention of researchers has been paid to the study of matter with high energy densities and, as a consequence, with high pressures and temperatures. The research in the field of inertial confinement fusion (ICF) on heavy ion beams takes a special place among the works on various aspects of this problem [1-3]. One of the most important parameters used to describe the interaction of ions with matter is the energy of projectiles. The stopping power is a parameter characterizing the rate of loss of the average energy of fast electrons or ions in plasma [4-5]. The Coulomb logarithm based on the effective interaction potential of the particles is determined by the scattering angle of the pair Coulomb collisions [6-8]. In this work the dense plasma is considered for which quantum effects must be taken into account at short distances. Further, the effective interaction potential including both charge screening at large distances and quantum effects at short distances will be used [9-10].

In the present work the stopping time, the mean deflection angle, the depth of penetration and the effective range of particles with different energies generated in the DT plasma have been studied.

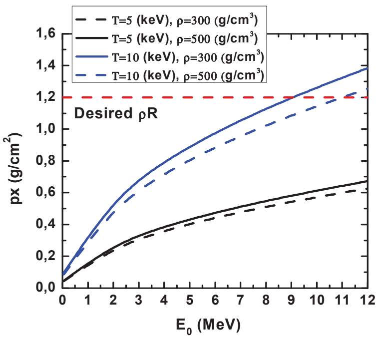

Figure 1: The penetration depth of the proton in DT plasma at different values of density and temperature.

Fig. 1 illustrates the dependence of the range and the penetration depth ρx [11] of protons with different energies on the density and temperature of the target. The results show that at a lower target temperature of $T = 5\ \kappa eV$, the target protons may conserve their energy inside the target if $\rho R < 1.2\,g/cm^2$. However, when the target is hotter $T = 10\ \kappa eV$, the required initial energy of the proton is reduced to $E \le 2\ MeV$, in order to meet the required optimal deposition depth.

The relaxation time of the temperature in the plasma were calculated for different density values on the basis of the Coulomb logarithm using the effective potential. Fig. 2 shows the comparison of the temperature relaxation time obtained on the basis of the effective potential with the results of MD at $r_S = 1,\ T_i = 10eV$. It is seen that the relaxation time increases with increasing temperature.

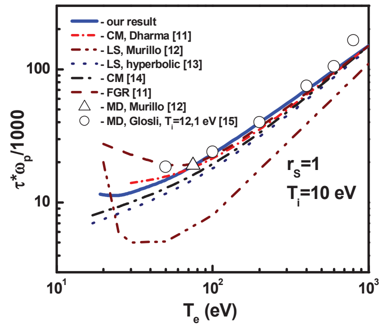

Figure 2:The relaxation time in units of plasma frequency.

The stopping time depends on the values of initial energy, density and temperature of the fuel. The results obtained for the Coulomb logarithm and temperature relaxation times for different plasma parameters are consistent with the results of other authors.

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