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MODELLING OF THE NANOSECOND LASER ABLATION WITH THE USE OF ANSYS FLUENT

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The model describing both the target heating, and plasma formation and expansion, consists of conservation equations of mass, momentum and energy. Set of equations is solved in axial symmetry with the use of the Ansys - Fluent software package [1]. The model was proven to give results in agreement with experimental ones [2]. The calculations were made only in the early phase of expansion because Fluent is a one temperature model. After the cessation of the laser pulse, the energy equilibration time between electrons and heavy particles is a few nanoseconds and due to high electron density it can be assumed that $T_e \approx T_h$ during first 50-100 ns of the plume expansion. Figure 1 shows the evolution of axial values of the plasma temperature, pressure and velocity during the carbon ablation into vacuum. Calculations were made for two wavelengths of an Nd:YAG laser– 355 nm and 1064 nm. The development of the plasma results in the growth of temperature and consequently the increase in pressure which in turn accelerates the plume. The greater ablation rate in the case of 355 nm results in higher pressure (and density) while a higher plasma temperature and velocity in the case of 1064 nm is the result of stronger plasma absorption.

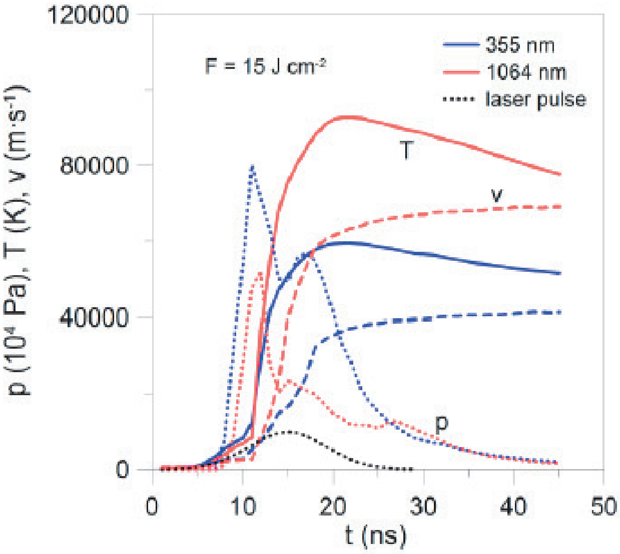

Fig.1. Axial distributions of plasma parameters during the ignition. Solid line — temperature, broken line — velocity, dotted line— pressure.

Corresponding calculations have been made in cases of the ablation into an ambient gas and in water and will be presented.

References

1. ANSYS® Academic Research, Release 14.0, Ansys Fluent User's Guide, ANSYS, Inc.
2. J. Hoffman, T. Moscicki, and Z. Szymanski, "Acceleration and distribution of laser-ablated carbon ions near the target surface" J. Phys. D: Appl. Phys. 45, 025201 (2012)