Review of the PhD. Thesis of PhD. student Sviatoslav Shekhanov presented at the Faculty of Nuclear Sciences and Physical Engineering of Czech Technical University entitled: "Nonlinear laser absorption under high-energy-density conditions."

The thesis of Mr. Shekhanov is concerned with the interaction of focused high energy laser beam with the self-created plasma corona produced on a solid target. The aim is to describe the detailed kinetics of plasma particles and the consequences for the process of laser energy absorption and reflection using 1D and 2D plasma PIC codes. The analysis includes classical solid targets of a homogeneous plastic, as it is often the case in laser driven target compression experiments on large facilities, as well as organic foams, which are believed to increase the laser energy absorption and at the same time to improve the homogeneity of the ablation pressure imprint on the target surface. The temporal regime of the laser irradiation is supposed to correspond to the popular scheme of the shock wave ignition when the initial less intense pulse front is meant to compress the target adiabatically and only after that the intensity is raised to launch a shock wave inside the pre-compressed target for the purpose of heating the compressed fusion fuel to thermonuclear temperatures. The complex pulse shape led the author to the necessity to apply a 1D hydrodynamic code to pre-calculate the plasma density, temperature and velocity profiles on the moment of arrival of the final heating peak, which are subsequently fed into the PIC codes to examine the true particle behaviour under the high-energy-density conditions. The thesis is thus structured in such a way that first the relevant wave-wave interaction process of interest (such as Brillouin and Raman scattering of the impinging laser light as well as the two-plasmons-decay) are defined and described by means of coupled wave equations. These coupled mode equations give an overall idea of the behaviour of the heating laser wave, its transformations in the ion sound daughter wave or electron plasma wave, but they say nothing about the evolution of the plasma particle distribution across their phase space. To answer this crucial question the author is resorting to the PIC simulation in the next part of his thesis. Here, several results are achieved, some of them confirming those obtained previously, but mostly they are original, and really interesting. For me it was novel the simulation of the two-component plasmas with the resulting two kinds of ion sound wave, and an ensuing substantial increase in the energy absorption due to an enhanced Landau damping on lighter protons as against the heavier carbon nuclei. Similarly, the phenomenon of plasma cavitation accompanying the Raman scattering near the quarter critical density as well as the hot electron generation are of great interest not only of the view of pure theory. Important is also a comparison of 1D with a much more computationally exacting 2D PIC simulation. These are all interesting results, but I am finding as the most valuable contribution of the thesis the chapters 3 and 4 occupied with the foam targets. The detailed analysis of the scattering process on miniature foam elements supported in the chapter 4 by the corresponding PIC simulation and above all an implementation of the foam heating into a macroscopic hydrodynamic model based on the previous detailed microscopic analysis of the foam structure as presented near the end of the thesis I find very original and naturally also very useful for any further work with the targets of this kind.

When reading the text I missed an alphabetic list of used acronyms, which would simplify the reading especially in the introductory parts of the thesis.

I would also like to know the author's opinion on the following problem: among other factors influencing the PIC simulation results he also included the heating laser light spectral width, which, if I understand it rightly, is in his modelling included artificially. However, a naturally occurring spectral width is generated naturally by the interaction process itself, particularly by the trapped particle instability (see e.g. his citation [12]), which may lead to a formation of satellites to the main line etc. Is this, in fact, spectral widening process visible in his simulations?

I find the thesis presented by Mr. Shekhanov to be of a high quality and a very useful starting point for any further work in this direction. Therefore, I am pleased to recommend it to the commission to be accepted as a PhD. Thesis.

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RNDr. Karel Rohlena
FZÚ AV ČR