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Thesis Topic Proposal

Institute of Physics, Czech Academy of Sciences
ELI Beamlines laser centre

Degree Level: MSc
Starting date: October 1st 2022

Laser-plasma interaction in the context of inertial confinement fusion

Topic Characteristics/Abstract:

Laser plasma interaction is one of cornerstones of the inertial confinement fusion. The main objective of the target design is efficient delivery laser energy to the fusion target providing conditions favorable for symmetric implosion of the shell and ignition of fusion reactions at the moment of stagnation. Several processes are identified in the laser-plasma interaction (LPI) context.

These are: stimulated Brillouin scattering of laser beams in the target preventing the laser energy delivery to the absorption zone, laser beam filamentation and cross beam energy transfer spoiling homogeneity of laser energy deposition and consequently the shell implosion symmetry, stimulated Raman scattering and two plasmon decay producing energetic electrons preheating the fuel before stagnation, reducing the target compressibility and inhibiting ignition of fusion reactions.

Although these processes have been studied for many years, their performance under the ICF conditions is not known and requires experiments at high energy laser facilities with multiple laser beams and plasmas having appropriate temperatures, densities and scale lengths

The goal of this PhD project is to provide some responses to these high level questions by analyzing data obtained on the laser facilities available, performing dedicated simulations and developing models.

In particular the student will work on improving our understanding of specific foam targets which are used to generate low-density coronal plasmas in experiment to simulate certain aspects of ICF. The simulation and physics understanding of foam targets is at present a major challenge.

Scope:

The intended research work will be carried out in strong collaboration with theoretical and experimental team in the department as well as in Europe and worldwide. The department is operating a unique laser beamline which will allow to perform LPI-related experiments at a high repetition rate. Existing collaborations with other major laser

facilities will allow to obtain important experimental data which will serve the research project as well.

Methodology/Approach:

The student is expected to familiarize him/herself with the topic by reading the standard literature of the field and engage in regular discussions with his supervisors. In parallel he/she must master the use of numerical simulation tools on the macroscopic (hydrodynamic code FLASH) as well as microscopic level (particle-in-cell code SMILEI).

He/she will use the codes to perform predictive simulations of planned experiment and perform interpretation of diagnostic data. In due course analytical models will also be developed.

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