Centre Lasers Intenses et Applications
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Post-doctoral contract – Physics/Artificial Intelligence

Minimizing the laser imprint through machine learning within the frameword of inertial confinement fusion

The CELIA laboratory carries out studies on various schemes for inertial confinement fusion by high energy lasers in order to find a solution to the production of large scale energy. The experimental and theoretical works at CELIA are supported by experiments carried out on various large laser facilities in France (as Laser MégaJoule at CEA) or abroad (Omega laser at Laboratory for Laser Energetics (LLE) in Rochester, USA). In order to optimize the target implosion which eventually gives rise to thermonuclear reactions, the laser pulse is shaped in space and time, notably with a prepulse which full width at half maximum is 100 ps and maximum intensity is hundreds of TW/CM2. However, this prepulse induces spatial inhomogeneities on the surface of the target due to the initial solid state of the matter. These laser imprint damages the initial spherical symmetry of the target in the course of implosion, and ultimately decrease the efficiency of the inertial confinement design. Up to now, numerical hydrodynamic codes dedicated to model the inertial fusion assume a plasma as the initial state of matter (the initial solid state is not included), and are not able to account for experimental observations. The mitigation of the laser imprint can be done by using foams (non homogenous material) which smooth the laser absorption. However the expected influence of the solid to plasma transition of foams has never been studied.

To reduce the influence of the laser imprint, the hydrodynamic code of CELIA will be coupled to a microscopic model describing the transient optical response of a foam during the laser induced solid to plasma transition. The first step will be to build this microscopic modeling based on a previous work devoted to the resolution of the Helmholtz equation. The computing time being too long in this perspective of coupling with the large scale hydrocode, the microscopic model will be substituted by a neural network. The second stage of the postdoc will be the training of the neural network so that it reproduces as well as possible the predictions of the microscopic modeling. The relevant parameters will be determined in particular. The last stage will consist of large scale simulations with the developed numerical tool, and compare results obtained with homogeneous and non homogeneous materials. The reliability of obtained results will be analyzed which will allow us to finely understand the influence of the solid to plasma transition of foams on the hydrodynamics. Experiments will be proposed in order to validate these developments.

The candidate should have followed a formation in physics or applied mathematics, including programmation and numerical simulations. 2-year post-doctoral contract, expected starting date : 12/01/2021.

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