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PREDICTIONS OF THE IMPLOSION DYNAMICS FOR THE DOUBLE-CONE EXPERIMENTS VIA MACHINE LEARNING ENHANCED SIMULATIONS

F.Y. WU, Y.H. WANG, J.F. MA, Y.Y. LEI, X.H. YUAN, J. ZHANG
[1]School of Physics and Astronomy, Shanghai Jiao Tong University, Shanghai, China

R. RAMIS
E.T.S.I. Aeronáuticos, Universidad Politécnica de Madrid, Madrid, Spain

Email: jzhang1@sjtu.edu.cn

ABSTRACT

Laser fusion has a potential to provide an ultimate energy with low-carbon release. In 2022, NIF achieved the fusion ignition target with a fusion energy gain greater than unit for the first time by using a 2.05 MJ laser energy with the help of machine learning [1]. Double-cone ignition (DCI) scheme is one of the promising fast-ignition schemes for high-gain laser driven fusion energy [2-4]. DCI scheme employs two head-on gold cones to guide the nanosecond laser driven implosion to obtain high-density colliding plasmas with sharp edges, for the injection of relativistic electrons generated by PW picosecond ignition laser pulses. In this work, we propose to employ a machine learning enhanced simulations to predict the implosion dynamics of the DCI experiments conducted on the SG-II upgrade facility as shown in Fig. 1. The laser pulse shape is optimized with the MULTI-2D simulations [5,6] guided by genetic algorithm. The laser beams are modulated by special CPPs (Continuous Phase Plates) to achieve quasi-uniform irradiation. Both the gold cones and laser screens are included in the simulations. It is found that compressed colliding plasmas with densities higher than 100 g/cc can be achieved on the SG-II upgrade laser facility.

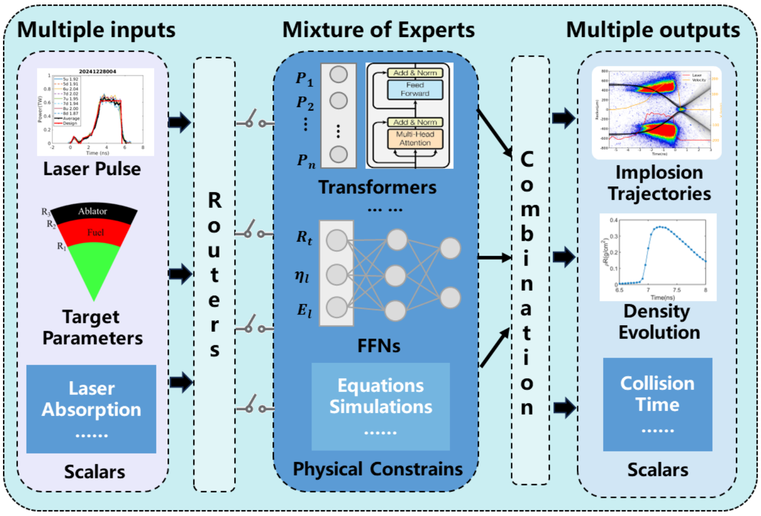

Fig. 1 sketch of the machine learning model for the predictions of the DCI implosion dynamics.

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