Towards the optimisation of high power laser-plasma accelerator experiments

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Numerical simulations play an important role in the success of high-power laser experiments. The optimisation of the experimental configurations and the physical models can be achieved by numerical simulations. The exploration of new experimental setups is also the subject of the ongoing research that significantly improve the operation efficiency of the facilities involved in terms of time and cost. Particle-in-cell – PIC method is an essential tool for the simulations of laser-plasma interactions. The Institute of Plasma Physics and Lasers – IPPL and the Extreme Light Infrastructure, Nuclear Physics – ELI-NP are in close collaboration aiming to perform Target Normal Sheath Acceleration - TNSA and Laser Wakefield Acceleration - LWFA experiments with the ‘Zeus’ 45TW laser system in Hellas, as well as the 100TW and 10PW laser systems of ELI-NP. These laser-plasma accelerators are capable for Inertial Confinement Fusion, X-ray production by betatron radiation and hadron therapy, studies and applications. A series of PIC simulations of extreme parallelization are performed using on Greek National HPC facility – ARIS under the project: Laser Matter Interactions and Plasma Simulations II - 'LaMIPlaS-II' of the ‘7th Call for Production Projects Accessing ARIS' and the HPC-Europa3 Transnational Access. The simulation of TNSA and LWFA under real experimental condition are performed on the ARIS HPC system by taking the advantage of parallelization to CPU and GPU architectures. The performance of the adopted PIC codes is evaluated, and the simulation results provide valuable data for the parametrisation and optimisation of the high power laser TNSA and LWFA experiments, with Al thin foil targets and He gas targets respectively and the laser intensities provided from both systems. This collaboration is supported by Short Term Scientific Missions – STSMs provided by the COST CA17126 – TUMIEE and HPC-EUROPA3.