Contribution ID: **328** Type: **talk**

Numerical implementation of a hybrid PIC-fluid framework in laser-envelope approximation

Wednesday, 18 September 2019 18:40 (20 minutes)

In Laser WakeField Acceleration, when relevant scale lengths of the laser envelope and of the plasma waves are well separated from the wavelength of the laser fast oscillating component, the time-averaged particles trajectories can be computed by means of a set of more efficient, properly modified equations of motion [1,2]. Besides, in regimes well described by the Lorentz-Maxwell fluid system, solving Euler equations can be significantly more convenient than the Particle-in-Cell approach. We describe the new solvers for laser-plasma dynamics in envelope approximation and Euler equations that have been recently implemented in ALaDyn [3]. Both the explicit envelope solver and the one step upwind solver for Euler equations in non-conservative form are integrated with the standard PIC framework allowing hybrid PIC-fluid and envelope description and favouring ease of implementation for any PIC code relying on the FDTD Maxwell's equation solver. The speedup obtained with the hybrid scheme is consistent and allows for short time 3D simulations of the ongoing experiments with the 200-TW class laser at the ILIL group of INO-CNR.

[1] P. Mora et al., Phys. Plasmas 4, (1997)
[2] B. Cowan et al., J. Comput. Phys. 230 (2011)
[3] D. Terzani et al., Comp. Phys. Comm. 242 (2019)

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Session Classification: WG6 - Proposed solution(s) to physical problem, Envelope PGC model

Track Classification: WG6 - Theory and simulations