NEW LASER ENERGY DEPOSITION ALGORITHM FOR THE RADIATION-HYDRODYNAMICS CODE RALEF-2D[1]

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Correct modeling of the laser beam evolution and power deposition on unstructured grids is a computationally and numerically challenging task. The first goal for a new algorithm for the radiation-hydrodynamics code RALEF-2D [1] is the calculation of the refracted laser light distribution with minimal numerical diffusion. Therefore a long characteristics approach is applied. The incoming laser beam intensity is spatially discretized into single rays being traced through the computational grid. In the undercritical regime the equation of motion of a ray [2] is derived from the eikonal equation in geometrical optics [3]. Continuous transitions of the ray trajectories up to the first spatial derivative between the numerical cells are guaranteed by the division of the original two-dimensional quadrilateral grid into triangles. Within each triangle the free electron density then is uniquely defined piecewise linear by the vertex-centered values. For each ray segment within a given triangle the optical depth and the deposited power are calculated by Kramers' inverse bremsstrahlung formula.

The second goal for the new algorithm is the calculation of the deposited and reflected powers and the angular distribution of the reflected laser light close to and above the critical free electron density, e.g. at the surface of a solid metal. Therefore the raytracing algorithm is augmented by an one-dimensional wave optics solver for the wave propagation and energy deposition in a stratified medium [3]. A geometrical optics ray can split up into an "overcritical" wave optics ray propagating perpendicular to the critical surface and a reflected geometrical optics ray.

First tests have been conducted and shown good agreement with the corresponding analytical solutions. The new algorithm will be applied in future radiation-hydrodynamics simulations, especially to support upcoming experiments at the ion beam and laser facilities at GSI [4] and FAIR [5] in Darmstadt, Germany.

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[4] GSI Helmholtzzentrum für Schwerionenforschung GmbH, http://www.gsi.de.
[5] Facility for Antiproton and Ion Research in Europe GmbH, http://www.fair-center.de.

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