Applications of ALE Method to Laser Plasma Studies

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Laser plasma, created by the interaction of laser radiation with matter, is modelled as compressible fluid by Euler equations with heat conductivity and laser absorption source term. Simulated problems typically involve large scale corona expansion or target compression with moving boundaries. Lagrangian coordinates moving with the fluid are much more convenient for such problems than Eulerian static coordinates which are not suited well for large scale changes of computational domain and for moving boundaries. For many problems, e.g. those with shear flow, however, the Lagrangian moving mesh can degenerate rather soon during the simulation. The mesh distortion problems can be avoided by using the Arbitrary Lagrangian Eulerian (ALE) method. The ALE method, either after several Lagrangian time steps or when the mesh becomes distorted, rezones the mesh and remaps conservative quantities from the original Lagrangian mesh to the new rezoned (smoothed) mesh. After rezone and remap stage the Lagrangian computation can continue. We have developed 2D ALE code for laser plasma simulations using logically rectangular quadrilateral mesh in Cartesian or cylindrical coordinates.

On three particular laser plasma modelling problems, which we were unable to treat by pure Lagrangian simulation, we demonstrate the usefulness of the ALE method for laser plasma simulations. The problems model particular physical experiments performed at the Prague Asterix Laser System (PALS) and include high velocity impact, double foil target and foam target.