A GPU based 3D raytracing algorithm for DUED code

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An Inertial Confinement Fusion (IFE) experiment involves many physical phenomena [1] that need an accurate description. Among those, laser power coupling to the plasma is one of the most crucial for designing IFE targets and assessing their robustness in terms of stability of implosion and fusion yield. Power imbalance between different rays or mis-pointing of the beams could lead to hydrodynamic instabilities which ultimately degrade the plasma ignition. To this purpose the 2D DUED Lagrangian radiation-hydro-nuclear code ([2], [3]) has been improved with a new 3D laser ray-tracing scheme, which allows to study realistic multi-beam irradiation geometries. To keep the numerical noise at low level, a large number of rays (living in 3D), tipically 100k-1M, are traced at each step producing a 3D power absorption distribution which is then mapped onto the DUED 2-D axially symmetric mesh. This raytracing scheme is based on the concepts of [4], from which an old MPI version was derived [5]. Resort to massive parallelism turned out necessary to make simulation times acceptable. In order to have comparable times for both the raytracing step and the hydrodynamic step, more than 1000 CPU cores are needed. To no longer depend on the use of external computational clusters, the original code is ported and upgraded to GPU through the use of the OpenCl™ framework ([6],[7]). On a conventional workstation with an high-end GPU, a complete simulation can be obtained in a few hours, as for the case of simplified 2D raytracing.

References

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