Roadrunner supercomputer models nonlinear physics of high-power lasers

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For years scientists have struggled with the difficult physics of inertial confinement fusion. This is the attempt to compress a target capsule containing isotopes of hydrogen with high-powered lasers to high enough pressure and temperature to initiate fusion burn.

To achieve fusion scientists must put as much laser energy on target as possible, a task complicated by energy loss due to laser backscatter, or reflection. Fusion is the basic energy-producing process of the sun, and is a source of energy released by nuclear weapons.

Los Alamos scientists Lin Yin and Brian Albright of Applied Science and Method Development, along with Los Alamos guest scientist Kevin Bowers, are using an adapted version of VPIC, a particle-in-cell plasma physics code, on Roadrunner to model the nonlinear physics of laser backscatter energy transfer and plasma instabilities to assist colleagues at Lawrence Livermore National Laboratory as they attempt to reach fusion ignition at the National Ignition Facility (NIF) next year.

"These are the largest plasma simulations ever done, looking at 0.4 trillion particles on the whole system," said Lin. "It would not be possible to do this without a petascale computer like Roadrunner, but even so, we are still only looking at a tiny segment of a laser beam."

VPIC is a computer code that models plasma at very high resolution, so even with Roadrunner it cannot simulate nonlinear backscatter in a full laser beam. "And so we focus on a single 'hot spot' in the laser beam to see if we can determine how the energy loss happens and what the nonlinear process is," said Lin.

Energy loss from laser reflectivity depends on laser intensity. This behavior has been observed in Roadrunner simulations and experiments using the Trident Laser at Los Alamos.

"We can use this physics understanding to infer energy loss from the whole beam and aid the experimental design," said Lin. "Using Roadrunner, we now understand why it's happening in the first place, how laser energy couples to this instability, and what limits the backscatter. We believe that this work will help ensure the success of NIF."

Source: Los Alamos National Laboratory (news : web)

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