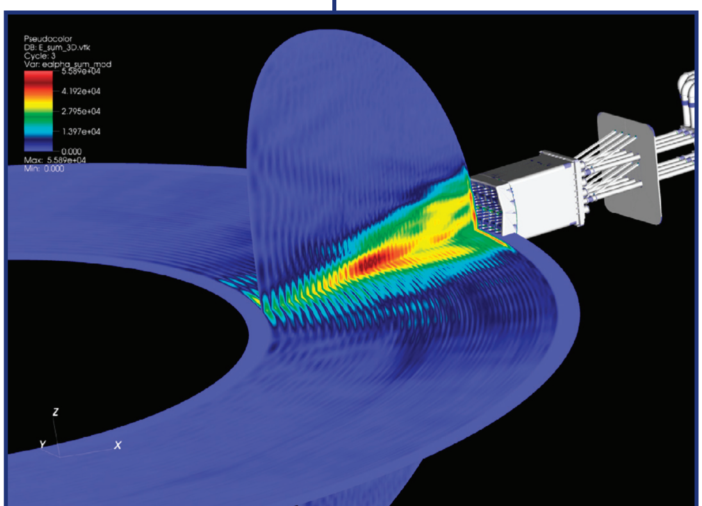
NATIONAL CENTER
FOR COMPUTATIONAL SCIENCES

Radio Waves Will Make Reactor Hotter Than the Sun

A fusion research team led by Fred Jaeger and Lee Berry of Oak Ridge National Laboratory (ORNL) has achieved a performance of more than 75 trillion calculations per second (75 teraflops) on the National Center for Computational Sciences (NCCS) Cray XT4 Jaguar supercomputer.

The team employed 22,500 processor cores for its AORSA code, which calculates the interaction between radio waves and particles in a fusion plasma as well as the current produced by the interaction.



AORSA ITER Simulation of RF Heating

The team's research is focused on simulations of the multinational ITER fusion reactor, an especially daunting challenge. According to Jaeger, the simulation of wave-particle interactions in ITER is difficult for two primary reasons: First, ITER will be much larger than existing fusion devices, and second, densities reached in the fusion plasma will cause the wavelength to be very small compared to the size of ITER. As a result, calculations performed in the simulation must be an order of magnitude higher in resolution than previous calculations.

Jaeger's team is now able to simulate a mesh of 500 by 500 cells, providing 250,000 individual cells. This is more than triple the resolution of earlier simulations, which provided meshes of about 256 by 256, or something over 65,000 cells.

The ITER reactor will use antennas to shoot radio waves carrying 20 megawatts of power into the plasma. These waves will both heat the plasma—which must reach a temperature about ten times hotter than the center of the sun—and create a current that controls the plasma. Jaeger's simulations will help the reactor's designers configure the antennas to make the most of that power in both heating the plasma and controlling it.

The AORSA team is part of a Scientific Discovery through Advanced Computing (SciDAC) project known as the SciDAC Center for Simulation of Wave-Plasma Interactions. The team includes plasma scientists, computer scientists, and applied mathematicians from the Massachusetts Institute of Technology; Princeton Plasma Physics Laboratory; General Atomics; CompX, Inc.; Tech-X Corporation.; and Lodestar Research Corporation.

AORSA solves Maxwell's equations—four equations that encompass electromagnetic theory—in very hot plasma, working out both the propagation of the waves and the absorption of energy by the plasma. According to Jaeger, it is the first code that solves the integral wave equation in more than one dimension without making any approximation about the size of the wavelength.

For more information, contact:
National Center for Computational Sciences • Oak Ridge National Laboratory
Phone: 865-241-7202 • Fax: 865-241-2850 • E-mail: help@nccs.gov • URL : www.nccs.gov

OAK RIDGE National Laboratory

ORNL 2007-G00906/jcn_June