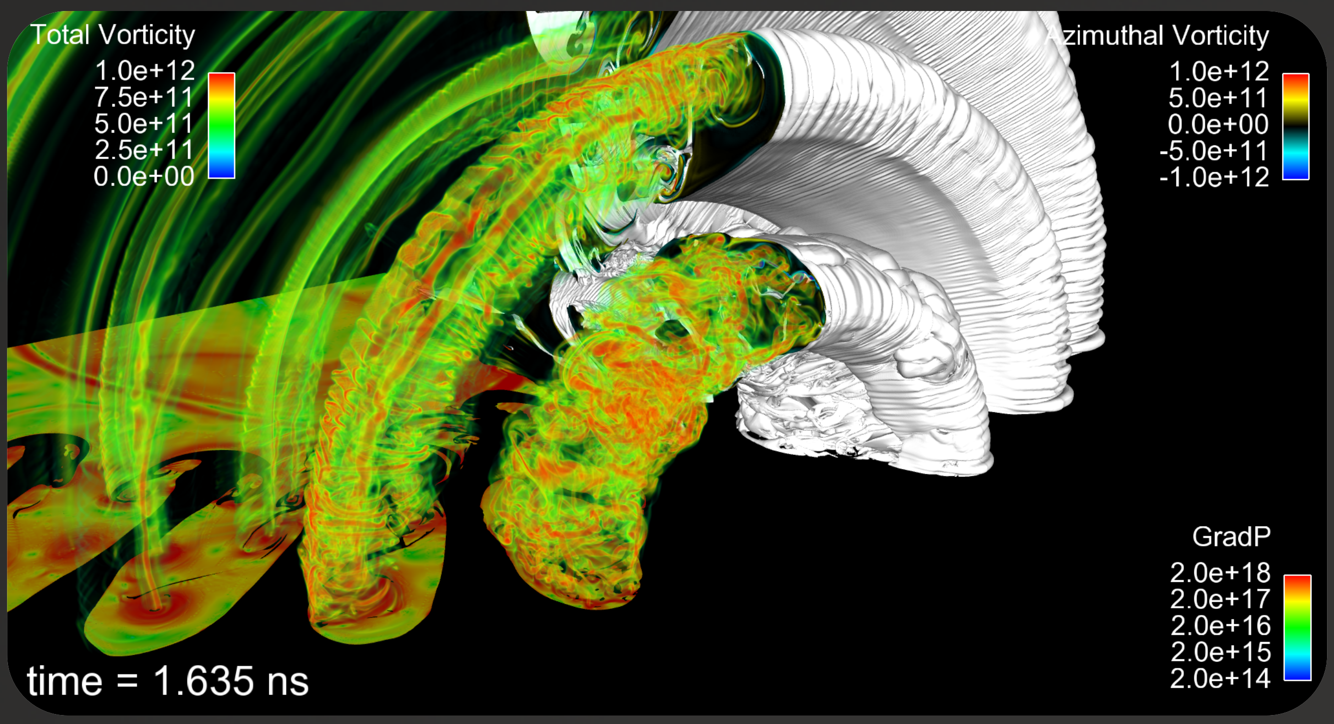
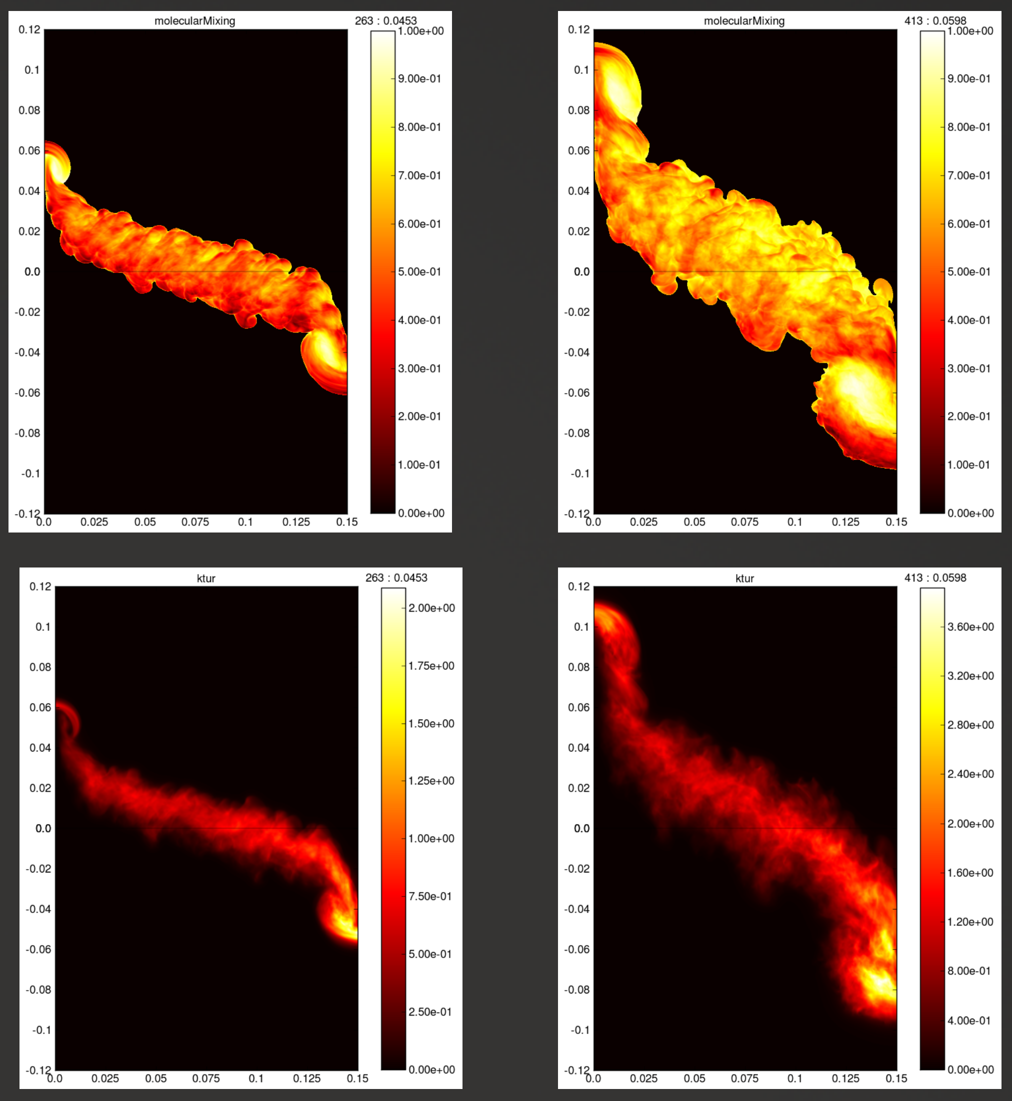
DOE/NNSA Laboratories Fulfill National Mission with Trinity and Cielo Petascale Computers

The DOE National Nuclear Security Administration (NNSA) and its national security laboratories play a leading role in large-scale computing in the United States because they are responsible for assuring the safety, security, and reliability of the U.S. nuclear stockpile. The U.S. has not engaged in the actual testing of nuclear weapons for more than 20 years; therefore confidence in the aging stockpile relies upon expert scientific judgment based on historical nuclear test data, experimental data, and validated models and simulation. The complexity of this mission involves detailed 3D physics simulations with high physical and spatial resolution, which demand increasingly large-scale advanced computing platforms.



A snapshot of a 3D simulation of an implosion using the RAGE computer code.

> *HPC is the only place where we bring all of theory and science experiments that are being done at the labs and facilities across the country together in one spot in order to make a nuclear weapon assessment. In the absence of nuclear testing, the evaluation of the integrated response can only be done with high-performance computing.*
>
> —Bob Weaver, ASC Los Alamos



Tilted Rayleigh-Taylor instability represents a novel unit problem in which turbulence is produced by both buoyancy and shear and the mean flow is two-dimensional. The images show the mean molecular mixing and turbulent kinetic energy from the first Direct Numerical Simulations of this flow. The simulations, on $1536^2 \times 4800$ grid points, are also some of the largest to date.

Advanced Simulation and Computing (ASC)

Within DOE/NNSA, the ASC Program has fulfilled the responsibility for providing simulation tools to support the stockpile stewardship mission for nearly 20 years. Computation and research to support this effort is carried out at Los Alamos National Laboratory, Sandia National Laboratories, and Lawrence Livermore National Laboratory. Supercomputers such as Cielo and Trinity are used by researchers at all three laboratories.

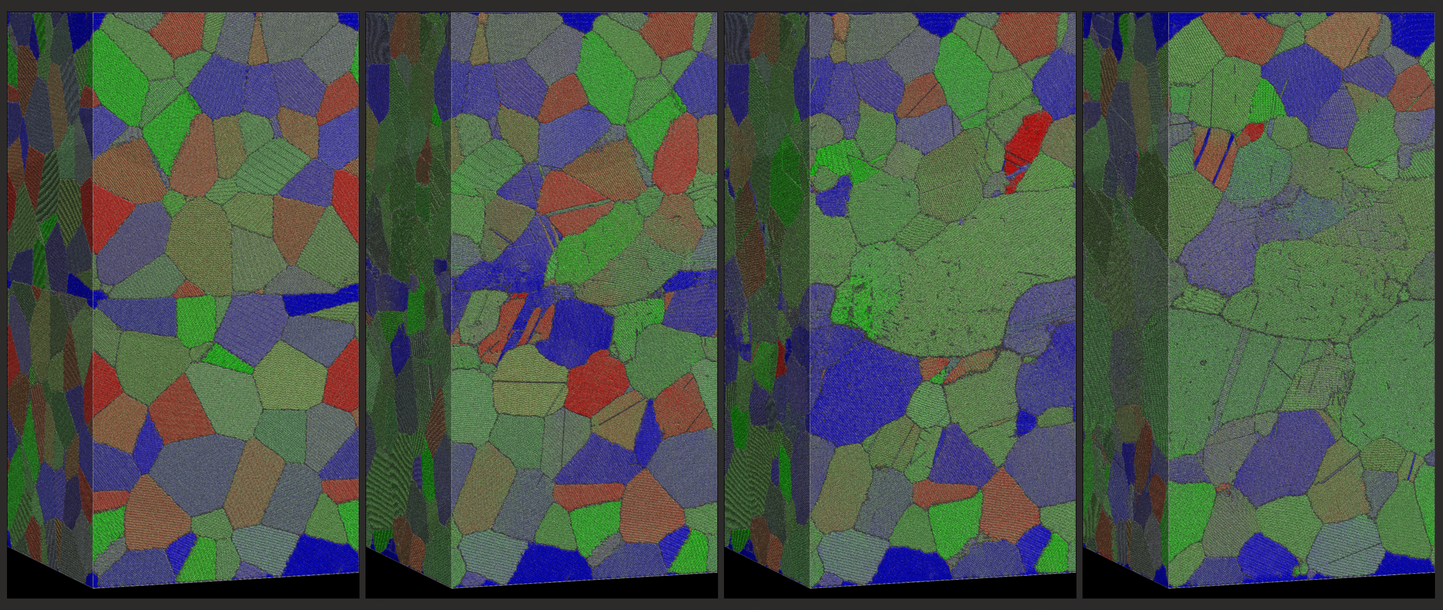
Cielo: Current Mission Workhorse

The Cielo large-scale computer, installed in 2010 at Los Alamos, was the first ACES platform and computes at a peak 1.37 Petaflop/second. Cielo is the current large-scale workhorse computer for the National Security Laboratories in carrying out the stockpile stewardship mission. The 3D theater in this booth provides visitors an opportunity to see some of this work.

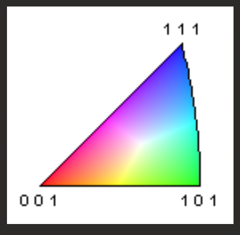
Trinity: Advanced Technology System

TRINITY
NNSA
New Mexico Alliance for Computing at Extreme Scale

The next large-scale DOE/NNSA computing system is Trinity, now being developed. Trinity will be an Advanced Technology System (ATS) managed by the NNSA Los Alamos and Sandia national laboratories as the New Mexico Alliance for Computing at Extremes Scale (ACES). ATS systems are platforms designed to meet unique mission needs and help prepare the ASC program for future system designs. Trinity will be used to begin transitioning the ASC application code base to next-generation technologies and programming models. The Trinity platform will be installed in 2015.



0 ns 1 ns 5 ns 10 ns



Molecular dynamics simulation of high-speed sliding friction (relative velocity 50 m/s) between two nanocrystalline aluminum workpieces (grain size 20 nm) performed on Cielo. Grains coarsen and become elongated near the sliding interface. Arrows indicate the relative direction of the upper and lower workpieces; the sliding interface is just below the center. Atoms are colored by their local fcc crystallographic orientation (key at right). Dimensions are 100 nm x 200 nm x 100 nm, and involve 138 million atoms.

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Los Alamos NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY