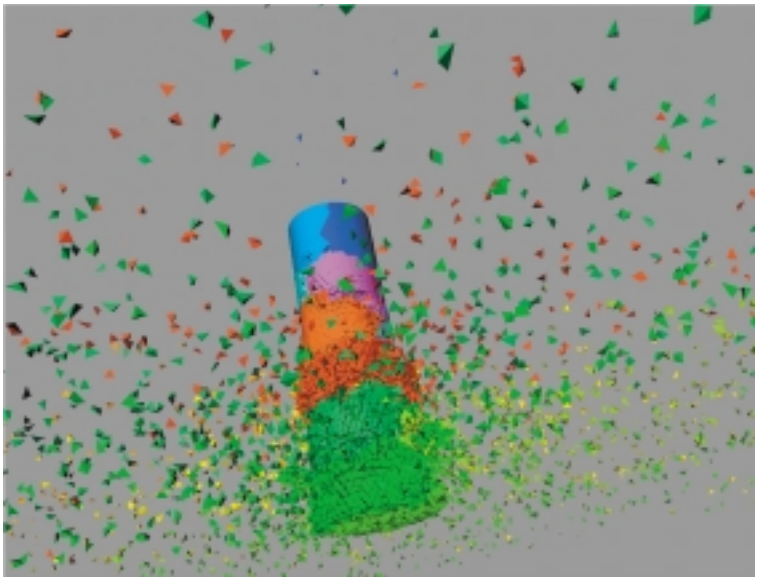
ASCI Integration Program

History and Background for 'One Program—Three Laboratories'

The United States nuclear deterrent historically has been a product of weapons physics, experimental science, and computation. During the years of regular nuclear test experiments, we did not rely on a thorough understanding of the wide variety of physical processes involved, because test results answered many of the questions posed.

Consequently, relatively less complex computer models were used on the best supercomputers available at the time to help design, modernize, and maintain the weapons stockpile. Now that nuclear testing is no longer the final arbiter of our scientific judgment, weapons scientists and engineers rely on computers to simulate the aging process and its impact on our weapon systems, as well as the effects of any required modifications.

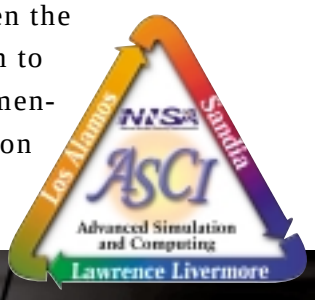
The Advanced Simulation and Computing program (which continues to retain its historical name ASCI) creates simulation capabilities through the development of advanced weapons codes and high-performance computing that incorporate high-fidelity scientific models validated against experimental results, past tests, and theory. The goal is to meet the science-based simulation requirements of the Stockpile Stewardship Program (SSP) so that the National Nuclear Security Administration (NNSA) can complete its nuclear weapons responsibilities. This includes the means to assess and certify the safety, performance, and reliability of nuclear weapons.



Raul Radovitzky of the California Institute of Technology presented this virtual image of shock propagation in polycrystalline Tantalum during a 2001 ASCI Site Review. Tantalum is a silvery-white, ductile, very heavy metal used to form alloys with other, typically lighter, metals. The goal of this research is to quantitatively assess the microstructural effects in macroscopic material response through the computation of full-field solutions of polycrystals. Grain-boundary constraint effects and Inhomogeneous plastic deformation fields are both considered.

The ASCI program actively addresses stockpile issues by developing and using simulations to study problems ranging from advanced design and manufacturing processes, to understanding accident scenarios, to weapons aging and to the resolution of Significant Finding Investigations (SFI). This spectrum of scientific inquiry demands a balanced system of hardware, software, and computer science solutions.

The 100-teraflop supercomputer platform, which historically has been the desired entry-level system to support realistic three-dimensional, high-fidelity weapon simulation and visualiza-



tion, is now close at hand. Future platforms beyond 100 terascale {100 teraflops/second) are essential to support continuing SSP activities, and these are now being planned.

Investigating SSP Questions

The questions that ASCI investigates on behalf of the SSP span the activities and responsibilities of the three NNSA national laboratories. Cooperation among these labs is essential to solving SSP problems in an efficient and effective manner. In accordance with this collaborative philosophy, representatives of all three laboratories participated in the development of the *Advanced Simulation and Computing (ASCI) Program Plan 2002–2003*.

Additionally, the three laboratories now cooperate in unprecedented ways. ASCI investigations are being implemented by project leaders at each of the laboratories guided by the NNSA Office of Research, Development, and Simulation through its Office of Advanced Simulation and Computing, under the Deputy Administrator for Defense Programs. The laboratories share ASCI code development, computing, storage, visualization, and communication resources across laboratory boundaries in joint development efforts.

The ASCI programmatic approach integrates multiple management structures—the staff at ASCI Headquarters, the Tri-Lab Executive Committee, and subject-area teams staffed by specialists at the three NNSA national laboratories.

During the past year, ASCI program leaders significantly reassessed and redefined the major milestones, in collaboration with weapons designers, the Directed Stockpile Work community, and with the Science Campaigns. Major accomplishments ranged from the installation of new platforms and their subsequent use for the first prototype three-dimensional full-system weapons simulations, to the resolution of SFIs and the redesign of weapons components due to changes in mission requirements.

Integration Strategies

The following four key strategies guide the ASCI integration effort.

- Operate ASCI as a single, three-laboratory program activity with seamless management and execution across the facilities.
- Sponsor annual principal investigator meetings.
- Encourage collaboration on development and share hardware and software resources.
- Hold external workshops and meetings.

Information compiled from the *Advanced Simulation and Computing (ASCI) Program Plan 2002–2003* (SAND–2002-2940P), issued by Sandia National Laboratories, a Department of Energy Laboratory operated by Sandia Corporation, a Lockheed Martin Company, under contract DE-AC04-94AL85000. The Program Plan was issued under the joint auspices of Sandia National Laboratories, Los Alamos National Laboratory, and Lawrence Livermore National Laboratory.