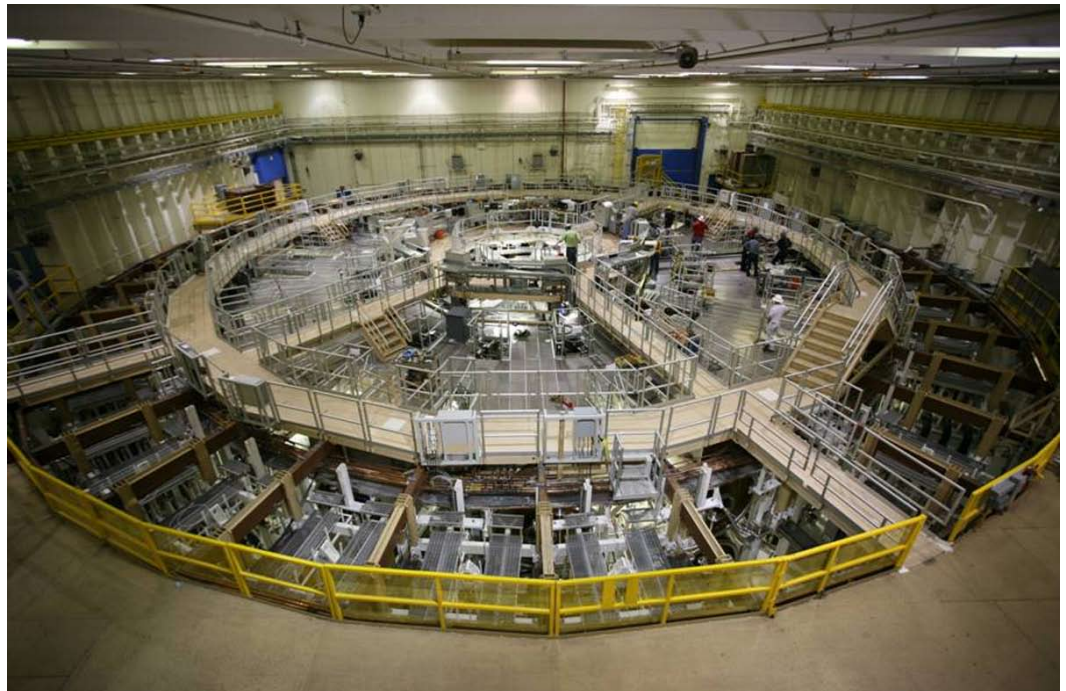




SANDIA NATIONAL LABORATORIES Pulsed Power and Z Facility

The long-range goal of Sandia's pulsed power program is to provide a high-yield fusion capability for stockpile stewardship and energy applications.



Overhead view of the gymnasium-sized refurbished Z facility.



A technician builds an array of tungsten wires for a Z experiment that produces x-rays from a z-pinch implosion. Each wire is 1/10 the thickness of a human hair.

Z: The World's Largest Pulsed Power Driver

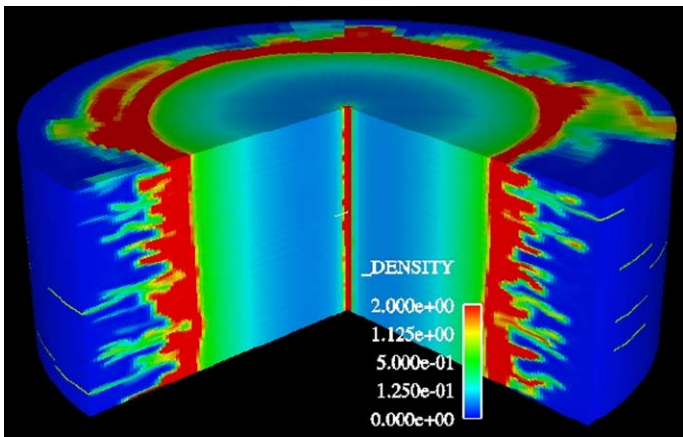
Sandia National Laboratories is the world leader in using pulsed power drivers for achieving high energy density plasmas in the laboratory. Pulsed power offers an efficient, inexpensive, and unique approach to achieving high-energy-density conditions. As the world's largest pulsed power driver, **Z** enables scientists to routinely perform and diagnose experiments designed to address nuclear weapon issues in the areas of dynamic material properties, secondary assessment, and nuclear survivability. The **Z** facility also enables scientists to access experimental conditions of interest for fundamental science in areas such as planetary physics, material properties, and laboratory astrophysics. Notably, pulsed power drivers also offer promise for achieving thermonuclear fusion ignition and high yield, which could provide a clean and abundant long-term energy source for the nation and the world.

Impressive Contributions to Stockpile Stewardship

Sandia's flagship pulsed power accelerator, **Z**, creates extreme states of matter at pressures equivalent to that at the center of planets and at temperatures hotter than the center of the sun to evaluate weapon science phenomena. **Z**'s unique strength is its ability to produce numerous x-rays, large plasma environments, and controlled high pressures. The **Z** Facility supports the National Nuclear Security Administration's (NNSA's) Stockpile Stewardship Program (SSP) by providing data to

- validate simulation codes and models for material properties, radiation transport, and complex hydrodynamics
- assess target design for high-yield advanced concepts with pulsed power and fusion ignition on the National Ignition Facility
- evaluate the performance of weapon components subjected to intense x-ray environments.





An example simulation of a Z-pinch implosion using the mass inflow model, illustrating the highly 3D nature of the pinch. (Sandia National Laboratories)

Z's Versatile Research Capabilities

Z data on the effect of electromagnetic pulse signals on test objects for Sandia's radiation effects mission have provided new insight for code models. A record neutron yield was obtained in an ignition-scale capsule with a beryllium shell. Z's unique material property capability, developed in 1998, routinely achieves accuracies of a few percent and has been used to obtain data for deuterium, for plutonium to address pit aging, and for beryllium and high-density carbon to constrain the acceptable target design space for ignition. Exceptionally high-quality radiographic images of a wire array implosion, the imploded core of a fusion capsule, and features in a weapon secondary have been obtained.

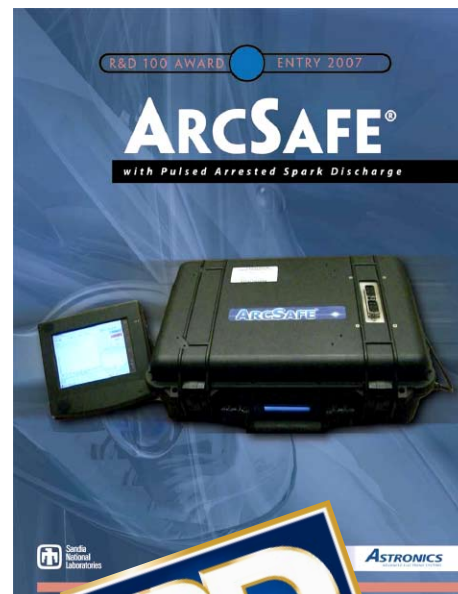
Enhancing Public Safety

Sandia's long-term expertise in pulsed power has been applied to public safety concerns. Pulsed Arrested Spark Discharge (PASD), a patented electrical wiring diagnostic developed for the Federal Aviation Administration, locates wiring insulation defects in commercial aircraft. Sandia's research in lightning and electrostatic discharge safety for stockpile facilities led to the assessment that indirect lightning was the probable cause of the Sago mine explosion near Buchannon, W. VA. Pulsed power has provided for irradiation of the U.S. mail in response to bio-terrorism attacks.

Recognition for Innovative Work

Sandia's efforts in pulsed power technology and the Z Facility have earned numerous honors.

- Pulsed power technology received R&D100 awards for PBFA II (Z's predecessor), a photonic high-speed data recorder, and an aircraft wiring diagnostic.
- ARCSAFE® with PASD received a 2007 R&D 100 award and the 2007 Federal Laboratory Consortium Interagency Partnership Award for Excellence.



- *Industry Week* declared Z one of the top 25 technologies of 1997.
- *Discovery* magazine listed neutrons on Z as one of the top 100 Science Stories of 2003.
- NNSA Weapons Program Awards of Excellence have been received for Z refurbishment project management, implementation methods to measure material properties accurately, advanced downhole radiography, z-pinch physics x-ray sources, and the plutonium experiments.

Sandia researchers, several who are professional society fellows, have also earned many honors such as IEEE Erwin Marx and Peter Haas Awards, the E.O. Lawrence Award from DOE, the Hannes Alfvén Award from the European Physical Society, the American Physical Society Shock Compression Award, and fellowship in the National Academy of Engineering.

A Promising Future

In September 2007, Z shook the ground for the first time since 2006 when the facility was taken off line for a complete upgrade. The year-long Z Refurbishment (ZR) was completed in 2007 to extend its life by replacing outdated components to enhance reliability and precision, allow pulse-shape flexibility, increase diagnostic access, and improve high-energy performance.

Now capable of storing twice the energy as the previous architecture, the ZR project goals were to increase facility utilization via the capacity to perform more shots, improve overall precision and pulse shape variability for better reproducibility and data quality, and increase delivered current allowing for additional performance. The improvements will enhance Sandia's pulsed power capabilities well into the next decade.