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Author(s):	Lunn, Maureen Elizabeth Fredenburg, David A.
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Lab's Z-machine efforts advance stockpile stewardship in multi-org collaboration

Sandia-based device advances Pu science, national security research

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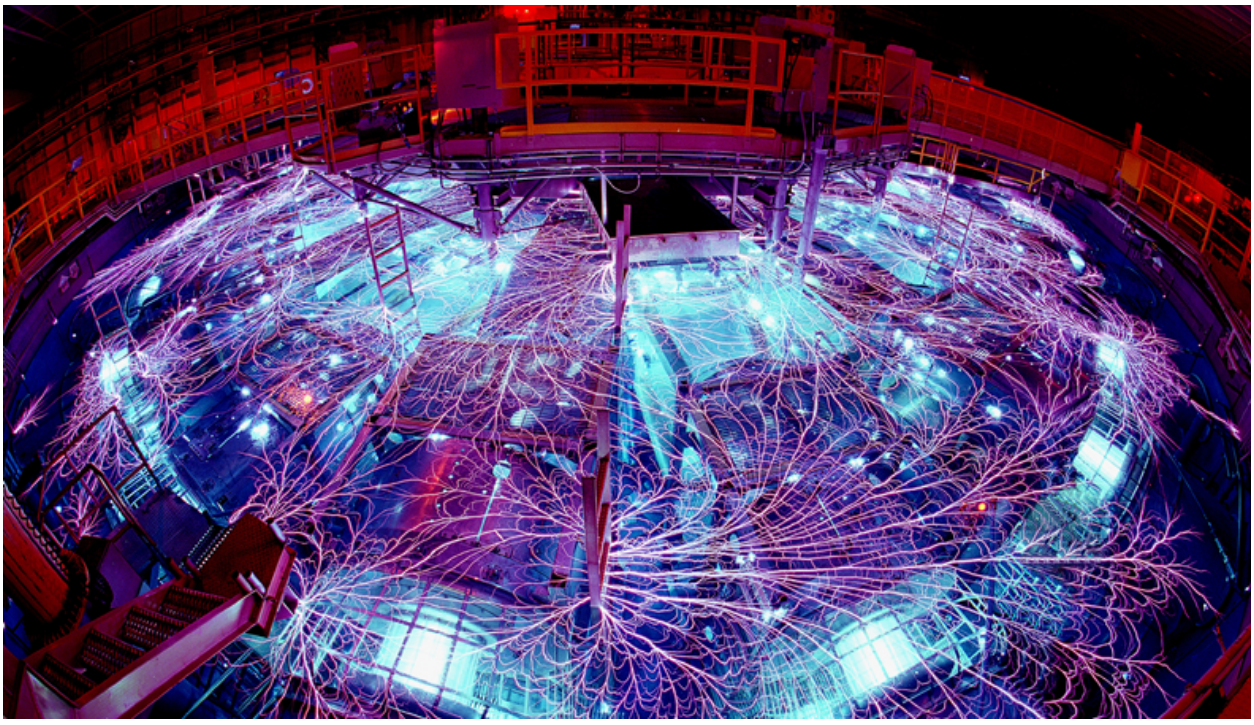

An open-shutter photo showing electrical energy coursing through the transmission line sections of Sandia National Laboratories' Z machine. (Photo by Randy Montoya)

For the past 15 years, Los Alamos (LANL) employees have played a major role in plutonium experiments using the Z-machine — a device at Sandia National Laboratories (SNL) that uses high magnetic fields, electrical currents, and X-rays to help scientists understand how materials behave under extreme temperatures and pressures.

High-energy density physics, or the study of matter under extreme conditions, is a key component of certifying the nation's nuclear weapons stockpile.

A long list of capabilities

Plutonium experiments are just a fraction of the work done on the Z-machine. LANL has been increasing its utilization of the Z-machine to address weapons physics questions, to enable manufacturing advances, and to inform decision making regarding the U.S. nuclear deterrent. LANL's partnership with SNL on Z experimental platforms is spurring advances in Advanced Simulation and Computing (ASC) codes and is supported by state-of-the art target fabrication in MST-7 and MST-16.

One of the most unique aspects of this platform, which makes it ideally suited to support national security science, is its pulse-shaping capability.

“On the Z-machine, it’s possible to mimic actual weapons trajectories while simultaneously measuring the response of plutonium along these trajectories with high fidelity,” said **Anthony Fredenburg** of the LANL Office of Experimental Science (OES).

The machine supports a broad array of academic studies and other scientific programs, including energy and fusion research. With access to Z-machine for plutonium experiments currently limited to four weeks per calendar year (one experiment takes an entire week to execute), and with the demand for this capability steadily increasing, it is more important than ever to design, build, and execute high quality experiments.

Learn more about the history of plutonium, weapons surveillance, and high-energy density physics in the latest issue of National Security Science magazine >

Cross-complex collaboration

“The Z-machine is the world’s largest pulsed-power machine and provides a truly unique capability to dynamically load macroscopic samples of plutonium to weapon-relevant conditions,” said **Chris Seagle**, the Dynamic Material Properties manager at SNL. “Sandia is proud to partner with LANL; this collaboration has pushed our capabilities in a positive direction and increased the impact of Z-machine experiments on national security and stockpile stewardship.”

Providing this world-class capability is no small feat and requires strong coordination across the national security enterprise. In addition to the highly collaborative lab-to-lab partnership between LANL and SNL, successful execution of these experiments requires engagement across all LANL associate Laboratory directorates, including Weapons (DDW), Science, Technology and Engineering (DDSTE), and Operations (DDOPS), as well as multiple external stakeholders including the Waste Isolation Pilot Plant (WIPP), Weston Solutions Inc., N3B, and the National Nuclear Security Administration (NNSA).

“The plutonium measurements on Z provided through this SNL-LANL collaboration are unique and tremendously valuable,” said **Mark Chadwick**, COO of Weapons Physics (ALDX). “They complement other plutonium data measured by LANL in Nevada subcritical experiments and supporting experiments on-site at Los Alamos that use gas guns, and other complex apparatus.”

A boon to national security

With typical plutonium sample sizes along the order of one square centimeter, recent work on the Z-machine is proof that small-scale plutonium science can have a big impact on national security.

This collaboration, and the combination of experiments provides the nuclear weapon design laboratories with confidence in their assessments of weapons materials, helping ensure the safety, reliability, and performance of the nation’s stockpile — without testing an actual weapon.

Learn more

To find out more about LANL’s role in pit production and plutonium science, check out the Plutonium Issue of National Security Science magazine >