Stockpile Stewardship

Nevada Test Site

Atlas

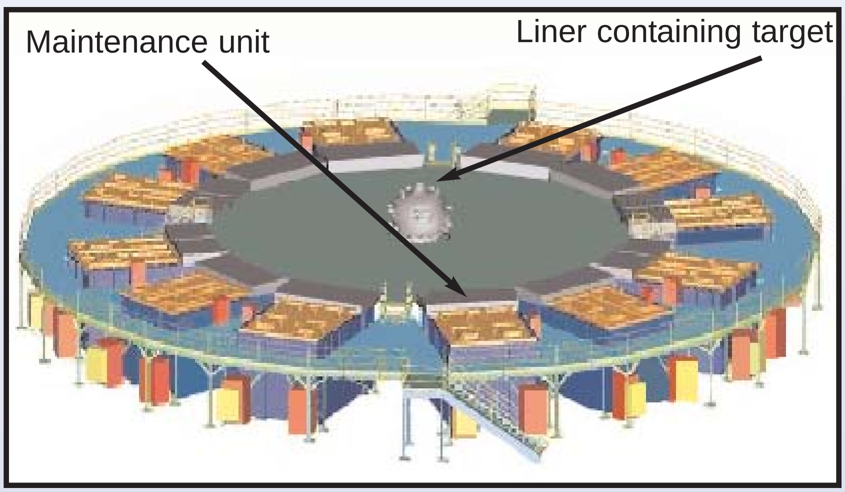
Introduction

Since the cessation of underground nuclear testing in 1992, above-ground laboratory and underground subcritical experiments have provided the principal source of new experimental data to benchmark and improve predictive models for nuclear weapons performance and reliability. Developing accurate, reliable models that provide the confidence needed to certify stockpile weapons without nuclear testing is the main goal of the National Nuclear Security Administration's Stockpile Stewardship Program. The Atlas pulsed power machine was conceived in 1993 as one of a family of aboveground capabilities that provide an alternative to underground nuclear testing.

The Atlas machine at the Nevada Test Site.

Background

The Atlas construction project began in 1995 at Los Alamos National Laboratory (LANL), with engineering design and component testing. Full-scale assembly began in November 1999 and construction was completed in August 2000. In 2001, LANL scientists performed the first pulsed powered driven implosion shot. This successful experiment demonstrated the facility's capability to provide materials data supporting the certification of the nuclear weapons stockpile. Atlas was relocated to the Nevada Test Site in 2004, where it provides data needed to increase the understanding of the performance and operation of nuclear weapons.

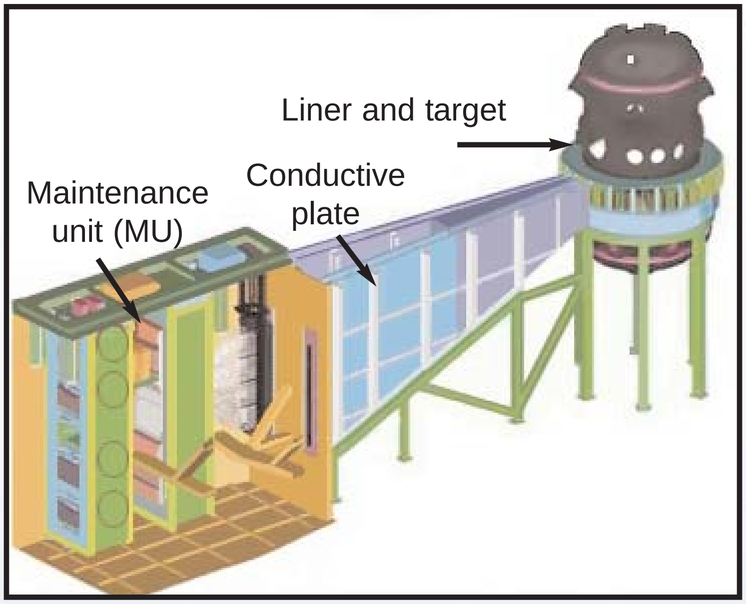


The Atlas machine is 80 feet in diameter. It is comprised of a pulse power system which includes 12 Maintenance Units (MU).

How It Works

Atlas consists of high voltage capacitor banks that discharge electrical energy into a system of parallel plate transmission lines. Large electrical currents flowing through the plates produce an intense magnetic field, applying a huge pressure pulse into a cylindrical liner and target containing materials of interest.

Atlas acts as a giant power amplifier, using energy that accumulates slowly at 480 volts and is stored in the machine's capacitor banks for sudden release into the liner and target. As the electrical current surges through Atlas, it accelerates materials to velocities well in excess of that required to escape Earth's gravity (as high as 22,000 miles per hour), and generates pressures equivalent to millions of times that of Earth's atmosphere. During the few millionths of a second that it is operating at full performance, the tremendous electrical output of Atlas is approximately three to four times that of the world's total electric power production (4 trillion watts)!



A cross-section of a maintenance unit.

The imploding cylindrical liners also can impinge on axial targets with tremendous force to study the shock and compression properties for materials of interest to weapons design, manufacturing, and performance. Highly advanced optical and x-ray diagnostic equipment measures the properties of the imploding materials.

The Atlas pulsed power system is made up of 24 maintenance units, each comprised of four Marx generators, a charging system for the capacitators in the Marx generators, a triggering system, and transmission lines that connect the Marx generators to the target chamber. Each maintenance unit and its gas-insulated triggered switches, are the primary active elements in the pulsed power system.

Why Pulsed Power?

Pulsed power can concentrate more total energy on larger (centimeter-scale) experimental targets for longer periods of time compared to other Stockpile Stewardship experiments. The data from pulsed power experiments allows the Stockpile Stewardship Program to develop better physics models of material properties and implosion hydrodynamics.

Atlas produces strain rates that are at five to ten times greater than other pulsed power machines. This increase will greatly enhance our ability to study important material failure in converging geometries, strength effects in implosion systems undergoing large distortion, and effects of imperfections and complex engineering features.

Conclusion

The physical environments produced by Atlas enables a wide range of safe, reproducible and controllable experiments in areas of basic science and civilian technologies that have no significant impacts on the environment in an era that precludes nuclear weapons testing. The extreme conditions of high energy density, strongly coupled plasmas, and high magnetic fields have potential applications for understanding planetary physics, condensed-mater physics, fusion-energy research, and astrophysics.

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