Introduction

The U1a Complex is an underground laboratory for subcritical and physics experiments that are used to obtain technical information about the U.S. nuclear weapons stockpile. These experiments support the U.S. Department of Energy, National Nuclear Security Administration’s (NNSA) Stockpile Stewardship Program, created to maintain the safety and reliability of the U.S. nuclear weapons stockpile. It is the only place in the nation where subcritical experiments can be executed.

Subcritical Experiments

In order to assure the safety, security and reliability of our nation’s nuclear weapons in the absence of underground nuclear testing, the U.S. Department of Energy collects data from actinide or special nuclear material experiments that inform highly accurate physics modeling using high performance computing. Among these experimental methods are subcritical experiments (SCEs), which are Stockpile Stewardship experiments. SCEs use chemical high explosives to generate high pressures that are applied to special nuclear materials located at the U1a Complex. The configuration and quantities of explosives and special nuclear materials are such that a self-sustaining nuclear chain reaction, or criticality, cannot occur. Because there is no criticality, SCEs are consistent with the U.S. nuclear testing moratorium.

Originally, SCEs were conducted in single use alcoves mined into the sidewalls of the tunnels or in vertical boreholes in the floor of the underground facility. Today, the experiments are conducted in a mined space known as a “zero room.” The experiments are contained within a robust confinement vessel allowing the reuse of the room for future experiments. During these experiments, state of the art diagnostics collect data from special nuclear material it is subjected to high pressures and temperatures. The Nuclear Weapons Laboratory assesses this data to assure the continued safety, security and reliability of the nation’s nuclear weapons stockpile.
Cygnus Machine

A pulsed X-ray radiography system named Cygnus is located at U1a and is a principal diagnostic source machine used for subcritical experiments. The Cygnus pulsed X-ray system is a medium-energy (endpoint energy of 2.25 mega-electron volts) radiography system. It is designed to take at least two equivalent, time-separated radiographs of an explosively driven experiment. The geometry is such that each of the two radiographs show the experimental package under dynamic shock. Cygnus has been used for multiple SCEs executed at U1a.

Notable Measurement Capabilities Include:

- Multiplexed photonic Doppler velocimeter
- Broadband laser ranging
- Two Cygnus pulsed x-radiographic sources
- Additional advanced implosion diagnostics under development

Future U1a Enhancements

The Complex continues to strengthen its existing rigor in conduct of operations and integrated scheduling to support future subcritical experiments and other nuclear projects and missions. Going forward, investments in U1a will support, expand and optimize this unique, flexible experimental test facility to support increased mission activities. The future vision is to offer users three parallel operational testbeds to enable new enhanced capabilities for subcritical experiments.

Construction of the testbed that will host the Advanced Sources and Detectors (ASD) Scorpius machine is underway. Scorpius will enable experiments that image special nuclear material during multiple stages of detonation in order to provide essential data that provides information about stockpile safety and certification, while still being subcritical and designed to never reach criticality. Upon completion in 2025, Scorpius will be the most capable weapons radiographic system in the world.

These proposed improvements maintain and expand U1a Complex’s ability to support specialized missions and projects in a secure, protected, environmentally controlled and well-managed facility.