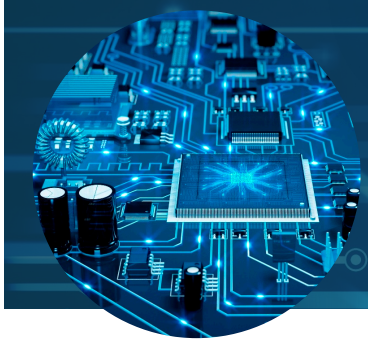
Sandia National Laboratories



Radiation Hardening Assurance & Assessments

Sandia National Laboratories provides expert Radiation Hardening and Radiation Hardness Assurance for National Security missions. Radiation Hardened microelectronic components are vital for systems that operate in space, high altitude, and defense systems with harsh radiation requirements. Due to the ionization effect that radiation produces, hardening provides an additional level of protection that is necessary in extreme environments.

Radiation Physics Total Ionizing Dose Testing

Gamma Ray Radiation Sources

The Advanced Microsystems Radiation Effects department maintains 4 gamma ray radiation sources, including two Cobalt-60 sources and two Cesium-137 sources. These sources are routinely used for radiation qualification of Sandia and commercially fabricated ICs, as well as basic studies of the physical mechanisms responsible for radiation effects in semiconductor devices. Radiation testing in these cells requires that the parts tested are packaged and mounted on circuit boards. For low-dose-rate irradiations, the department uses three J. L. Shepherd radiation sources shown in Figure 1. The large irradiator in the background is a Cobalt-60 radiation cell capable of dose rates ranging from < 0.1-30 rad(SiO_2)/s. This cell is primarily used for qualification testing and basic studies of radiation damage mechanisms in electronic components at low to intermediate dose rates. In the foreground in Figure 1 are two identical Cesium-137 radiation cells used for studies and qualification testing of electronic components at low dose rates (< 0.001-5 rad(SiO_2)/s).

Figure 1. Sandia Radiation Physics Department Shepherd 60Co and 137Cs gamma radiation sources.

Figure 2 shows a Nordion Gammacell 220 radiation cell used for qualification testing of electronic components per MIL-STD 883, TM 1019, which requires testing to be performed in the dose rate range of 50-300 rad(SiO_2)/s. The current maximum dose rate achievable in this radiation cell is ~60 rad(SiO_2)/s.

Figure 2. MDS Nordion Gammacell.

X-Ray Radiation Sources

The Advanced Microsystems Radiation Effects department at Sandia also maintains three Aracor 4100 X-ray irradiators. These irradiators use X-ray tubes to irradiate the device under test, and are especially well suited to wafer-level radiation studies.

MESA Research | Develop | Produce
U.S. DEPARTMENT OF ENERGY
NNSA National Nuclear Security Administration

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Figure 3 shows one of these irradiators, which consists of a cabinet in which the x-ray tube is located, as well as a probe station which is used for wafer-level irradiation. Although these irradiators are primarily used for wafer-level radiation testing of products and test structures for technology development and process monitoring of wafers fabricated in Sandia's own fabrication facility, they can also be used to irradiate parts that have already been packaged.

Figure 3. Aracor wafer-level x-ray irradiator.

Sandia Ion Beam Laboratory

Using this facility, the Advanced Microsystems Radiation Effects team has established a leadership role in characterizing and understanding the effects of neutrons on a wide variety of technologies. Researchers are able to assess the mechanisms and evaluate possible mitigation techniques to protect against neutrons. Our team is advising leaders in the DOD and the DOE on novel test methods and hardening approaches to enable many new microelectronics in national security applications.

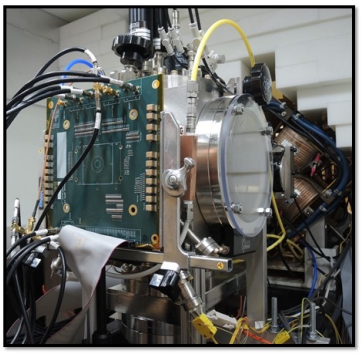

Figure 4. Sandia's Ion Beam Laboratory, Neutron End-Station

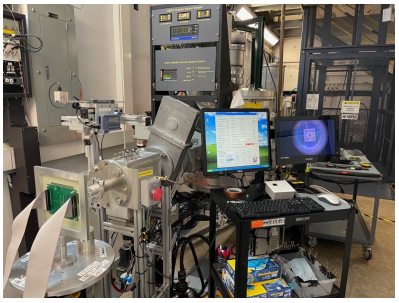

Figure 5. TAMU beam End-Station

Radiation Physics Single-Event Effects Testing

Broadbeam Heavy Ion and Proton Accelerators

Single-event effect testing is typically performed off-site at large heavy ion or proton accelerator facilities such as the Texas A&M University Cyclotron (Figure 5), and various proton cyclotrons, including some medical facilities.

These are all user facilities and are routinely available for parts characterization and evaluation. In such facilities the device under test is typically placed at the end of the beam line and is subjected to energetic particle irradiation while any anomalous behavior is recorded. The resulting measured single-event upset cross section curve is used in conjunction with the expected radiation environment to calculate the predicted upset rate for a given application. The Advanced Microsystems Radiation Effects department conducts several remote-site radiation tests per year and is intimately familiar with procedures for performing testing at all these radiation facilities.

Sandia's Advanced Microsystems Radiation Effects department researches, develops, integrates, characterizes, and assures the radiation hardness of advanced microsystems and their technologies for national security.

For additional information, visit our website at:
www.sandia.gov/mesa

MICROSYSTEMS ENGINEERING, SCIENCE & APPLICATIONS

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