Australian Government

ANSTO
Science. Ingenuity. Sustainability.

Electronic irradiation facilities

The National Space Qualification Network (NSQN) has access to comprehensive irradiation facilities at ANSTO to irradiate electronic chips for the space applications. The combinations of ion beam, gamma-ray, and x-ray sources can simulate a broad range of space radiation environments. Instruments scientists have considerable expertise in select irradiations.

LOCATION
ANSTO Lucas Heights Campus (NSW)

Centre for Accelerator Science

Four high voltage (1MV to 10MV) accelerator systems are available for heavy ion irradiations, for ions from protons to uranium. These accelerators can produce particle rates from single ions/sec to currents of several microamps. The **10MV ANTARES external beamline irradiation facility** (EBIF) allows for the scanning of these ion beams with micron-sized spots across several millimetres of an electronic chip in ambient air.

ANTARES

The external in-air beamline facility and its corresponding chamber on the 10 MV ANTARES accelerator have been designed to irradiate single, decapped electronic chips and smaller circuit boards (up to 10cm by 10cm) with high energy protons, light ions, and heavy metallic ions.

The Centre for Accelerator Science acquired an acid jet decapsulation system to improve its irradiation of **commercial off-the-shelf** (COTS) chips. The system can expose the die and bond wires of most **plastic integrated circuit** (IC) packages, while leaving the chip and its die in a fully functional state.

ANSTO's 10MV ANTARES accelerator.

ANTARES external in air beam.

Gamma Irradiation
GATRI

The **Gamma Technology Research Irradiator** (GATRI) is an accredited cobalt-60 gamma-ray facility, that can provide MeV energy photons for the irradiations of electronic circuits.

Two internal facility options are available, depending on size of the device under test and the desired dose rate required. The GATRI pool, suitable for larger electronic systems with a 1m by 1m ^{60}Co source, and the Gammacell tank, for smaller circuit boards and individual chips less than 15cm by 20cm. ^{60}Co emits two gamma rays of 1.1732 MeV and 1.3325 MeV with an average energy of around 1.253 MeV.

Dose rate data is calculated for chips which have not been decapped. The irradiated area is 25mm^2 at 680mm from the source. Irradiations will meet:

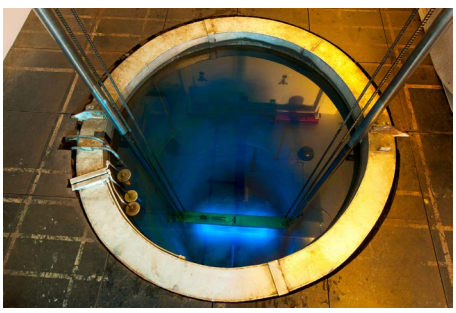
- most basic standard radiation test (level 2)
- well-established international standards (eg. ASTM-F1892, MIL-STD-883F)

GATRI can irradiate space payload circuits for (level 2) total ionizing dose (TID), in both offline and online testing. An absorbing material is used on thin materials, such as circuit boards, to surround the to provide approximate electronic equilibrium.

Gammacell

The fully self-contained 24 linear Cobalt-60 research irradiator provides a field of high-intensity gamma irradiation without additional shielding requirements for safe operation.

The nominal dose rate is around 550Gy/hour but decreases over time. The dose rate in the Gammacell cannot be varied and maximum sample dimensions are much smaller. Online testing is easy to perform.



ANSTO's Gamma Technology Research Irradiator (GATRI).

NSQN

National Space Qualification Network

ANSTO is proud to be a foundation partner of the National Space Qualification Network.

LOCATION
ANSTO Australian Synchrotron (VIC)

Synchrotron X-ray irradiation

The Imaging and Medical beamline

The Imaging and Medical Beamline (IMBL) at the Australian Synchrotron in Clayton, Melbourne is available for X-ray irradiation of COTS chips. The method has been tested using a standard electronics system. The beamline has a custom irradiation board and laser positioning system.

The IMBL, which has a monochromatic beam, houses in-air ionisation chambers to monitor the beam intensity during irradiation. The calculation of dose deposition within a chip or circuit structure is simple to calculate.

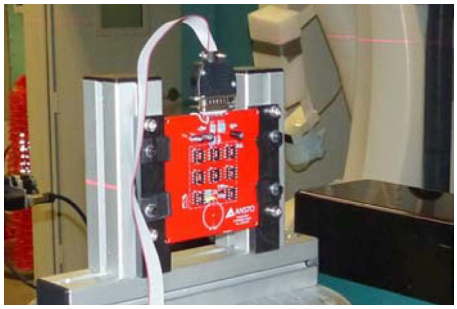
The chambers can also be used as approximate dosimeters. The in-line ionisation chambers can remain in the beam during testing to monitor the dose rate over time. A commercial x-ray dosimeter system is available for more accurate dosimetry.

ANSTO can facilitate a direct comparison of results from its different facilities.

Imaging and laminography techniques are also techniques available on the IMBL. 3D computed tomography can be generated for more detailed depth/dose determination and to provide good geometric information about the internal structure (with some limitations).

Tomosynthesis delivers a series of images with a limited range of angles of the chip or circuit. This technique provides better than 1% accuracy on the depth of easily visible features in the integrated circuit.

ANSTO's Australian Synchrotron in Clayton, Vic.



Custom irradiation board on IMBL.

Decapsulation System

ANSTO uses Nisene JetEtch Pro CuProtect system for the decapsulation of plastic-encapsulated semiconductor devices. Decapsulation can be carried out within a fume cupboard in an ANSTO chemistry lab. Guidelines are provided to determine runtime parameters and other factors.

Dose Modelling and Calibration

CERN's GEANT4 modelling suite is available for the modelling and calibration of LET and dose rate for each facility at ANSTO. GEANT4 is a Monte Carlo simulation package provides the expected outcomes based on stochastic radiation-particle interactions. Basic in-house FORTRAN codes provide reasonably accurate dose rate results in a couple of seconds, compared to full GEANT4 Monte Carlo simulations.

Decapsulation system.

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Further information

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ANTARES Accelerator

GATRI
Gamma Irradiation

Australian Synchrotron
Imaging and Medical beamline

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