CORIS360™

Advanced radiation imaging technology

Delivering world first radiation imaging inside a nuclear reactor vessel to support safe, cost effective reactor decommissioning

CASE STUDY

HIFAR reactor

HIFAR overview

The High Flux Australian Reactor (HIFAR) was a 10 MW DIDO class reactor used primarily for neutron scattering experiments and radioisotope production. HIFAR commenced operations in 1958 and after almost 50 years of safe and productive service, ceased operations in 2007 and is now being decommissioned by ANSTO.

Decommissioning challenge

The safe, efficient and cost effective dismantling of the HIFAR reactor requires an accurate characterisation of radionuclide activity, including the mapping of any radiation and its dose rate.

Comprehensive sampling is very expensive and time consuming, especially when performed in high radiation environments. Predicting dose levels using modelling, while beneficial, is based on decades of historical records that contain a considerable amount of uncertainty.

The ability to quickly and cost effectively locate, identify, and quantify gamma emitting radionuclides using gamma imaging in very high dose environments was a superior way to reduce uncertainty that is associated with the established sampling methods and dose modelling. It was the basis for a more efficient decommissioning plan to deliver safe and cost effective outcomes for the project.

HIFAR KEY FACTS

Class
10MW DIDO Materials Test Reactor

First critical
1958

Shut down
2007

Reactor vessel
Fuel no longer present, but residual dose in the reactor tank is ~10-100 Sv/h

"What would have taken about six months to accurately characterise and map the facility, instead was completed in six weeks. And it was done at a fifth of the cost of traditional surveying, saving us more than $430,000."

Alec Kimber
Project Lead
HIFAR Decommissioning

CORIS360™ Gamma imaging

CORIS360™ enables people working in radioactive environments to make better operational decisions by providing radiation identification and imaging quickly and accurately.

Because it can be deployed remotely, workers are kept safe from exposure to potentially harmful radiation in high dose environments.

CORIS360™ uses compressed sensing technology to accurately localise sources of radiation. This advanced technology allows spectroscopic images to be taken with far fewer samples than conventional imaging techniques. There is a significant reduction in the time to acquire images, while maintaining high image quality. The technology can be flexibly deployed in a range of dose rate environments.

Compressed sensing achieves this by exploiting sparsity within an image. When an image contains less information, relatively few samples are needed to reconstruct the image. The compressed sensing technology used in CORIS360™ imaging systems, uses only a single, non-position sensitive detector and enables images to be acquired in far fewer samples compared to conventional imaging techniques.

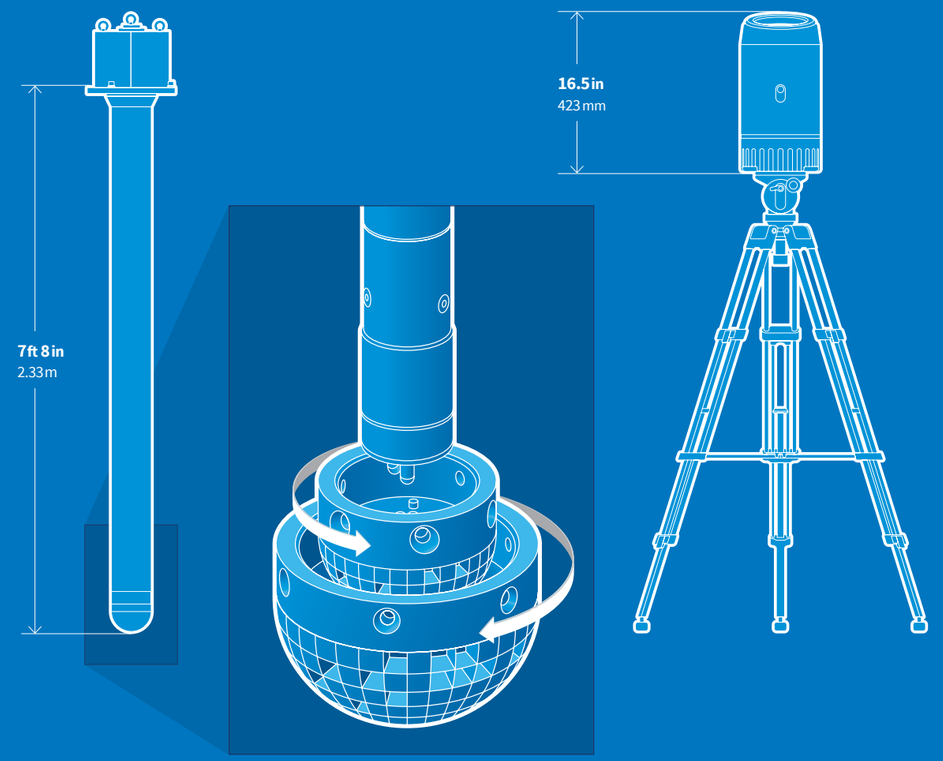
Two products were developed and deployed; one was designed for imaging inside the HIFAR reactor vessel and the other to image environments with low to medium dose rates in the facility.

Reactor
Imaging system

A customised product was designed to enter the reactor vessel through shafts located above it. The device collected images inside the harsh environment at the top of the reactor vessel, where the dose rate reached 10 Sv/h. The deployed system could remotely image the entire vessel with a hemispherical field of view.

CORIS360™
Imaging system

The portable imaging system, which weighs approximately 21 kilograms, was designed to operate in environments where the dose rate is 0.5 - 2000 µS/h. This system produces 360° × 90° gamma images, which are overlaid onto a corresponding optical panorama image — making it easy to visualise and identity sources of gamma radiation that are present.



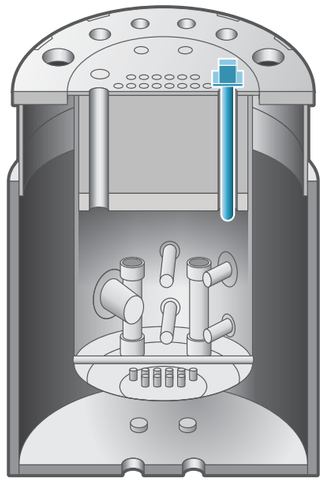
Outcomes

Reactor imaging system

This customised device successfully identified and located ^{60}Co as the dominant radionuclide present inside the HIFAR reactor vessel. A series of quantitative images, capturing the dose rates, were collected from four different locations where the technology was deployed.

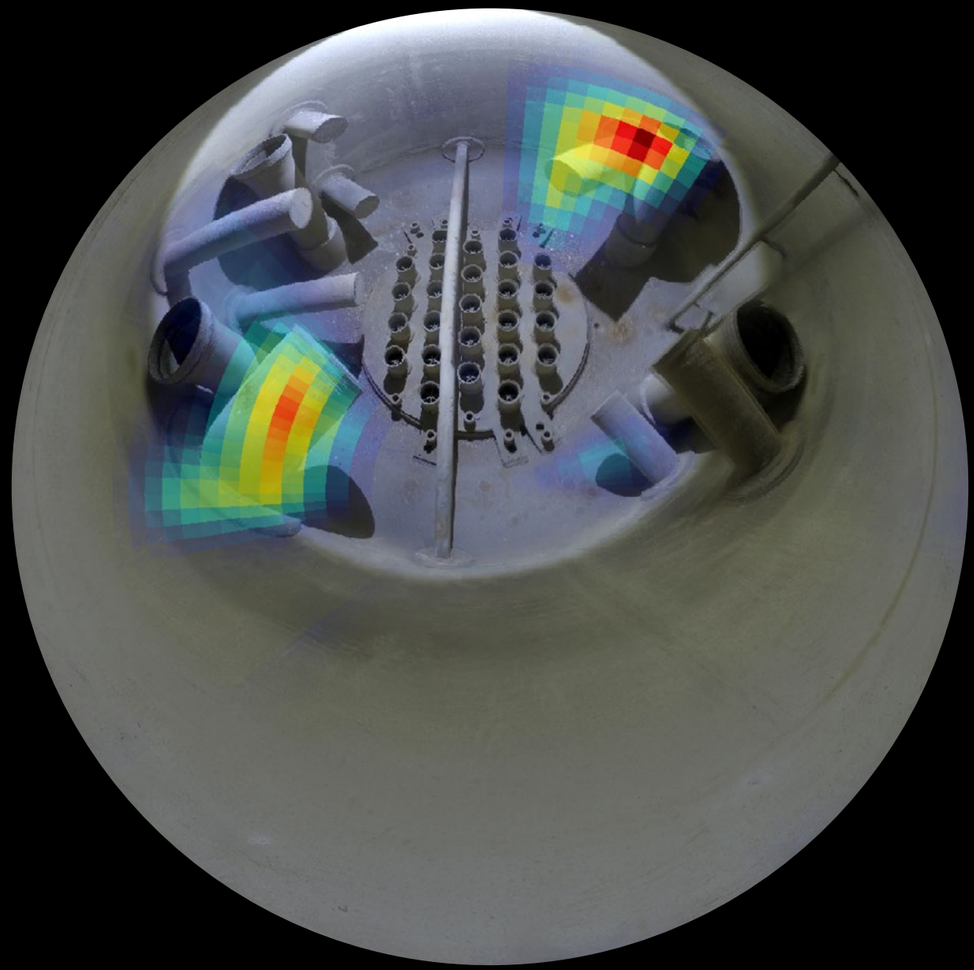
At the first location, the technology determined that two primary hot spots had dose levels of 1.8 Sv/h and 2.5 Sv/h. Three additional hot spots with lower dose rates were found, giving a total ^{60}Co dose rate of 6 Sv/h. The source of the hot spots matched stainless steel components that were identified in the HIFAR historical records.

The imaging results were able to quantitatively determine the level of radioactivity of the identified components, with measured ^{60}Co activities ranging between 2.0 TBq and 17.2 TBq. The new characterisation data provided invaluable insights to construct a broader reactor dose model. It will be used to inform decommissioning planning and be integral to the future safe and cost effective decommissioning of the HIFAR reactor.



Schematic of the imaging system developed for HIFAR.

HIFAR
Cobalt-60 Gamma image

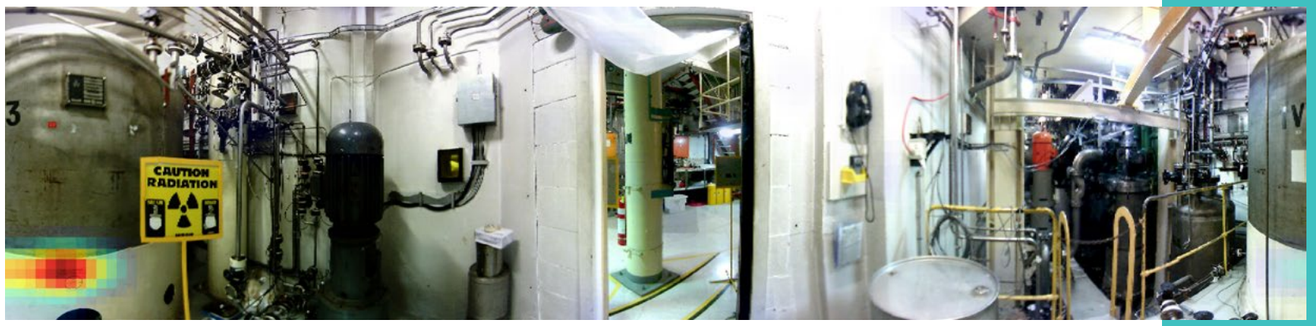


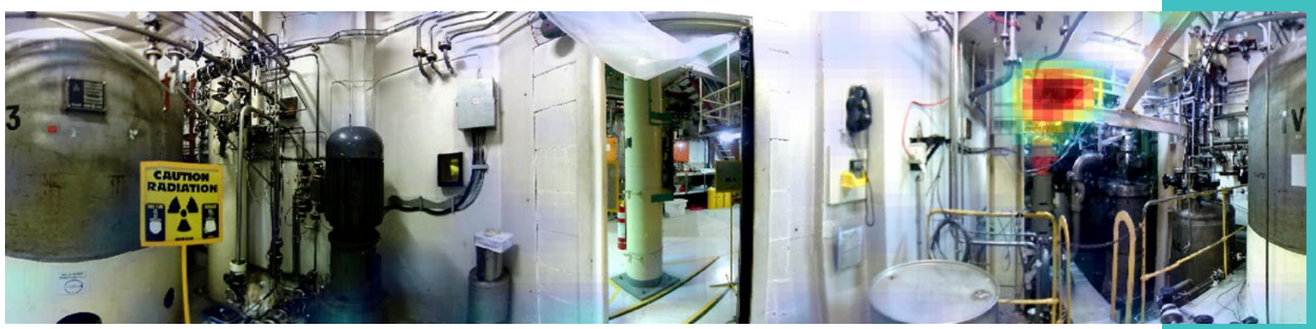
Outcomes

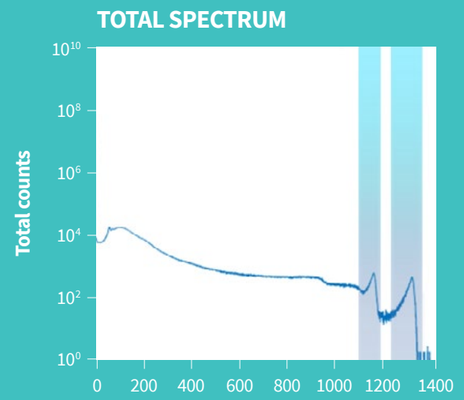
CORIS360™ Imaging system

This portable system was deployed in various locations around the HIFAR facility, including the D_2O plant room where the dose rate at the detector was measured to be 7.5 µSv/h. Gamma images from different energy regions of the gamma spectrum were generated from a single acquisition.

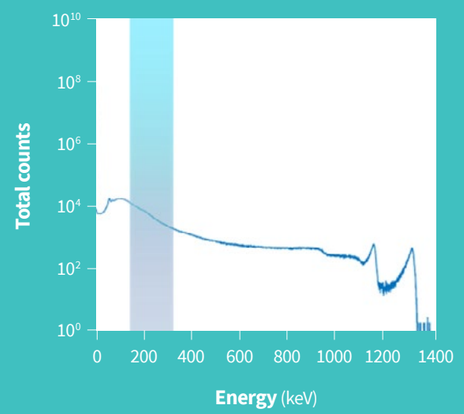
This allowed both ^{60}Co and low energy scatter hot spots to be localised. Whilst the location of the ^{60}Co was known (and is marked in the image below) the presence and dose contribution from the scattered radiation in an overhead pipe provided new and valuable information which increased the operational understanding of the radiation environment.







Cobalt-60
Radiation



Low energy scattered
Radiation

Customer feedback

Alec Kimber, Project Lead, HIFAR Decommissioning, said that the CORIS360™ platform imaging technology proved to be highly effective and accurate in imaging radiation at the reactor to ensure a safer work environment.

“We were particularly impressed with the speed of the acquisitions and imaging throughout the facility; it confirmed initial assessments, and in some instances, detected radiation sources we had not anticipated. In the case of the reactor chamber, this unique technology provided us with a solution that would not have been possible using conventional techniques.”

“What would have taken about six months to accurately characterise and map the facility, instead was completed in six weeks. And it was done at a fifth of the cost of traditional surveying, saving us more than $430,000.”

“Importantly this technology is deployed remotely, which reduced the dose to personnel to almost zero”, explained Mr Kimber.

“This is the first time, to the best of our knowledge, that spectroscopic gamma imaging has been used within a nuclear reactor chamber,” he added.

The compressed sensing technology used in the bespoke device, is now at the heart of the novel CORIS360™ radiation detection system. CORIS360™ is an innovative technology that can quickly image the full energy range (40 keV – 3 MeV) over a large 360° × 90° field of view, making CORIS360™ the comprehensive solution for the identification and localisation of sources of gamma radiation.

For people working in any radioactive environments CORIS360™ delivers the quick and accurate identification and imaging of radiation. If deployed in an environment where there is a high dose, workers can be kept safe from potentially harmful exposure the radiation.

“We were particularly impressed with the speed of the acquisitions and imaging throughout the facility.”

Alec Kimber
Project Lead,
HIFAR Decommissioning

Learn more

For further information on CORIS360™ including case studies and technical reports, please visit our website or contact us.

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CORIS360™ is a product of ANSTO, the Australian Nuclear Science and Technology Organisation, with over 60 years of experience in meeting the nuclear needs of industry.

Cover photo
HIFAR reactor, Lucas Heights Australia.
By Max Dupain. Circa 1950.

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