# Protactinium-231: A new isotope for the Heavy Ion Accelerator Facility

P. Medley[1,2,3], S.G. Tims[2], M.B. Froehlich[2] and A. Bollhöfer[4]
[1] *Environmental Research Institute of the Supervising Scientist, NT 0820, Australia*
[2] *Department of Nuclear Physics, The Australian National University, ACT 2601, Australia*
[3] *Queensland Health, QLD 4107, Australia*
[4] *Bundesamt für Strahlenschutz, Baden-Württemberg 79098, Germany*

Protactinium-231 ($^{231}$Pa), as a naturally occurring isotope that is also linked to the nuclear fuel cycle, has applications of broad significance. First introduced as a new isotope for Accelerator Mass Spectrometry (AMS) in 2007 at the TANDY system in Zurich, $^{231}$Pa has recently been added to the capability of the 14UD tandem accelerator at the HIAF including development and application of novel nuclear chemistry techniques. Although there are several techniques capable of $^{231}$Pa measurement, only AMS can measure it at the environmental concentrations needed for many studies (potentially in the range of $10^{-15}$ g of $^{231}$Pa per g of sample).

Measurement of $^{231}$Pa at the HIAF was first applied to environmental monitoring and research for rehabilitation of the Ranger Uranium Mine (RUM). Surrounded by Kakadu National Park, RUM is in a region of cultural and natural significance. Measurements investigated environmental transport, and accumulation of $^{231}$Pa in native plants and animals, and bush foods consumed by the indigenous traditional owners contributing to world's best practice in understanding and assessing the potential impacts of uranium mining.

In nuclear forensics, $^{231}$Pa measurement can assist in determining the production date or age of a nuclear material as a forensic signature. Such information can allow identification of the source of nuclear materials for non-proliferation safeguards, and law enforcement and security investigations. Although $^{231}$Pa is a minor component of waste from the uranium fuel cycle, it is one of the most significant in the thorium fuel cycle. This is becoming increasingly relevant as countries seek to expand nuclear technologies, for example operation of the world's first molten salt thorium reactor is scheduled to begin in 2025.

Measurements of $^{231}$Pa also have applications in oceanography, including as an indicator of recent environmental changes, in developing ocean circulation models and understanding particle fluxes in marine environments. This makes $^{231}$Pa an important tool in understanding and monitoring changes in the environment associated with a changing climate.