

Results of competition: Developing the civil nuclear supply chain - feasibility study

Total available funding for this competition was £3m from the Technology Strategy Board.

Note: These proposals have succeeded in the assessment stage of this competition. All are subject to grant offer and conditions being met.

Participant organisation names	Project title	Proposed project costs	Proposed project grant
Create Technologies Limited (lead) OC Robotics	SeeSnake	£149,452	£112,089
Project description - provided by applicants			
<p>Decommissioning costs will be impacted by the quality of data that can be captured in the planning stages of a typical project. 'What are we dealing with?' is often the first question asked by the decommissioning team. The primary challenge is to identify the location of any radiation sources. An ideal solution would be to have a complete and accurate, high resolution, 3D map of radiation overlaid on the visible contents.</p> <p>SeeSnake will be a major advance in this area as it will combine and demonstrate the N-Visage radiation mapping capability with snake-arm manipulators. This addresses experienced weaknesses of N-Visage being delivered 'on a stick' and being unable to see behind obstructions. Combining the technologies of two successful innovative SMEs exemplifies the industry need for mature solutions. This project will de-risk purchasing decisions and demonstrate multi-functional capability of snake-arm systems. Support from Sellafield and Culham is indicative of end user need and pull.</p>			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Fiberstone Products Ltd (lead) Double Precision Consultancy Ltd University of Cambridge	Feasibility study to develop DEnsification processing of a Ceramic MAtrix composite material for nuclear waste containment (DECMAN)	£157,735	£129,900
Project description - provided by applicants			
<p>The aim of this collaborative feasibility study between two UK SMEs and the University of Cambridge is to investigate the potential of whether a metal matrix ceramic reinforced composite can be used to store low-level nuclear waste by developing consolidation and chemical process reactions to densify or consolidate the material. The composite already has high toughness, strength, relatively low density, is thermally stable and is economically attractive. These attributes are well suited to the intended nuclear waste storage application. However, in its standard form, its permeability to aqueous liquids is too high. The objective of this project is to study the potential for reducing the permeability, by low-cost modifications to the production procedures, using laboratory demonstrations to increase composite density, and to carry out fluid dynamics modelling of the long-term permeation behaviour of the consolidated material. The project is expected to last for 9 months and to result in the development of tough, lightweight, low-cost ceramic composite material for further prototype development of low-level nuclear waste containment vessels.</p>			

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Forth Engineering Limited (lead) University of Manchester	Development of a robotic spider for remote characterisation and retrievals	£212,437	£123,750
Project description - provided by applicants			
<p>This project aims to develop a remote mobile cutting and retrieval platform for the decommissioning of legacy storage facilities based around a robotic spider. Access to the storage facilities is often limited, so a robot which can move around and retrieve the waste would speed up the process. It is envisaged that such a vehicle could be used in both dry and wet storage facilities</p>			

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GSE Systems Ltd (lead) EDF Energy PLC University of Sheffield	Enhanced learning through the use of virtual, augmented reality and simulation	£141,699	£111,751
Project description - provided by applicants			
<p>There is an industry need to train more engineers more quickly and to a higher level. Today's new learners learn in different ways to previous generations. These two aspects mean that new ways of training need to be embraced. Virtual reality is an obvious candidate. This feasibility study will assess the current relevant technologies and define the methodology by which existing and new scenarios will be translated into this new training environment. As an adjunct to the virtual reality training, there will be an additional assessment of the feasibility of transfer of the VR digital asset into an augmented environment so that mobile or portable training 'prompts' can be taken with the engineer and contextualised to the scenario for which he has been trained.</p>			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Hybrid Instruments Limited (lead) Lancaster University	TRIBECA (TRItium detection By ElectroChemically Assisted radiometrics)	£149,822	£123,313
Project description - provided by applicants			
<p>Tritium (T) is a radioactive isotope of hydrogen made during routine operation of nuclear reactors. This can give rise to waterborne tritium (as tritiated water HTO) in nuclear facilities process and waste streams and tanks – all potential sources of leakage to ground. HTO behaves identically to H₂O and so is highly mobile in both the environment and human tissue, with associated health risks on ingestion. There are therefore good safety, environmental & economic reasons for fast, accurate & precise measurement of tritium around nuclear sites.</p> <p>Tritium’s radiation is very weak, making its measurement by radiation detectors very difficult. We have devised a method by which tritium can be selectively absorbed by palladium metal from HTO, this pre-concentrated tritium then being easily detected by radiometric counting. Building on this innovation, we aim to explore the feasibility of building a palladium-based tritium sensor that offers cheaper, faster, more sensitive and more reliable tritium detection than current technology.</p>			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Ionix Advanced Technologies Ltd (lead) National Nuclear Laboratory Limited	Stability of piezoelectric materials for nuclear applications	£87,693	£60,563
Project description - provided by applicants			
<p>This project will test whether a new piezoelectric material, for use in structural health monitoring systems, is suitable for use in nuclear power generation plants. The material's resistance to radiation damage will be assessed by testing the functional properties of the material after exposure to various doses of radiation. If the radiation hardness is sufficient, the new material could then be successfully used as the basis of sensors that can be permanently installed in in nuclear power plants to continuously monitor the integrity of key components, such as vessels and pipes containing nuclear materials. The sensors would greatly enhance safety and reduce the operation and maintenance costs of the plant, leading ultimately to cheaper electricity.</p>			

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Metrosol Limited (lead) NPL Management Limited	Development of a driftless thermometer to improve safety and efficiency in the nuclear power industry	£148,694	£107,901
Project description - provided by applicants			
<p>Metrosol Limited, an established manufacturer of high precision temperature metrology products, will collaborate with NPL (the National Physical Laboratory) in the development of a novel type of thermometer based on Johnson Noise. This thermometer will be driftless and as such will improve the measurement of temperature in nuclear power plants. The measurement of temperature is crucial to the safe operation of these plants so this technology will assist in continuing to provide safe nuclear power in the future. It will also enable nuclear power plants to operate safely at higher temperatures, which will improve efficiency. An initial target is to improve efficiency by 3.3% , which would reduce the cost of electricity generated by nuclear by the corresponding amount and also displace higher carbon sources. With the current generating mix planned by the UK government, the efficiency improvement would reduce carbon emissions by 4,100t (metric tonnes) per day or 60 million tonnes over the life of the reactors.</p>			

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Microlab Devices Limited (lead) National Nuclear Laboratory Limited	Modular radiochem sample analysis for integrated fast/cost efficient workflow	£137,347	£98,016
Project description - provided by applicants			
<p>MicroLab Devices is a micro SME based in Leeds and is working with the UK's National Nuclear Laboratory to develop intelligent instrumentation and special plastic cartridges to help the analysis of nuclear materials in a more cost and time-efficient manner which represents an important function to enable the operation of nuclear facilities such as reactors as well as waste processing and storage sites through the UK, Europe and beyond. The system termed "RadSep" not only aids workers in the lab, but it is believed that it can be taken to the sample, to avoid highly active samples from being transported for analysis. This project looks to expand and develop further some of the technology to allow a greater impact to radiochemical sample analysis, helping to impact positively on the environment, reduce operator exposure in line with the ALARP principle, driving down the repeat rate for sample analysis therefore saving cost which public safety and future nuclear regulation.</p>			

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Oliver Crispin Robotics Limited (lead) TWI Limited	LaserPipe – remote in-bore laser welding of nuclear pipelines	£149,967	£105,830
Project description - provided by applicants			
<p>Nuclear sites require regular maintenance to replace and/or repair corroded/deteriorated pipes. A result of the challenging environment, confined space and limited external access is that external orbital cutting and welding processes are not viable for many applications, and consequently, in-bore remote processing has generated significant interest in recent years.</p> <p>The LaserPipe project will develop a compact in-bore laser welding head and investigate the procedures for an all positional laser welding process. The resulting in-bore processing system will integrate the compact laser welding head to a snake-arm robot, to demonstrate remote locating of weld joint, aligning laser beam path and perform in-bore laser welding. The same tool can also be employed for in-bore laser cutting and pre/post-weld heat-treatment, thus reducing the capital investment necessary for in-bore pipe processing operations, and improving related productivity.</p>			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Arvia Technology Limited	An investigation into the use of the Arvia Technology in treating radioactive organically contaminated resins	£132,774	£99,580
Project description - provided by applicants			
<p>Arvia Technology Ltd develops highly innovative new solutions for the destruction of aqueous organics in water and waste water treatment that are cost and energy-efficient and chemical and waste-free. It is based on the multi-award winning, patented platform technology of adsorption and electrochemical regeneration.</p> <p>Whilst originally designed for water and wastewater treatment, Arvia were pulled into the nuclear industry to treat radioactive organic waste streams that were unable to be treated using conventional processes. One class of compounds that falls into this class are degrading active ion-exchange resins. These materials cannot go for long term storage as they are too unstable. Hence they are currently stored at nuclear sites. Arvia has not been able to treat these wastes as they are in solid form, but an American company, Kurion, has developed a liquifaction technique that produces an aqueous waste.</p> <p>This project involves developing the process stream to take these solid active wastes, liquify them and treat this liquified waste in the Arvia Process. The resulting active water from this process can then be treated by conventional techniques.</p>			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Arvia Technology Limited	Submersible treatment of pond waters	£141,117	£105,837
Project description - provided by applicants			
<p>Some of the most significant radioactive risks are present in the legacy fuel storage ponds at Sellafield. These are 50-60 years old and are in need of major attention. However, the presence of algal and bacterial blooms in these ponds is hindering in the retrieval process, slowing down the rate of reducing the hazard. This project will aim to provide a novel treatment approach by using a submersible system to treat the water.</p> <p>Based on the Arvia process of adsorption, coupled with electrochemical oxidation, this approach has the benefit that it requires no space around the tanks (which are heavily congested), does not require the removal of radioactive water from the tank (reducing risk), makes use of the existing tank and water (reducing shielding requirements) and will require minimal operator involvement (minimising operator dose). In addition, if this treatment process is proven for a site like Sellafield, it opens the market for this technology for other nuclear operators. A key possibility would be the treatment of water stored in the storage tanks at Fukushima, where a large number of units could be deployed to make the tank water suitable for further treatment.</p>			

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Barron Limited	Feasibility – pre-industrial research of horizontal sludge dredge	£182,400	£136,800
Project description - provided by applicants			
<p>Barron Ltd. are developing a novel new system to safely remove sludge from nuclear storage ponds and silos where nuclear waste is stored under water. The system will allow faster and more efficient collection of the sludge and will not unduly disperse it into the water. Ponds and silos of all sizes and depths will be catered for, and the system will be developed to collect a full range of sludge consistencies.</p> <p>UK nuclear decommissioning projects will be targeted first, but the system has potential to be used in similar projects worldwide.</p> <p>According to the World Nuclear Association there are currently 270,000 tonnes of used nuclear fuel in storage, and 90% of this is stored in ponds, mostly at the reactor sites. Each year a further 12,000 tonnes of used fuel arises, with 9,000 tonnes going into storage and 3,000 tonnes being reprocessed. See http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Nuclear-Wastes/Radioactive-Waste-Management/</p>			

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Energy Process Developments Ltd	Study of the feasibility of setting up and operating a pilot-scale nuclear molten salt reactor demonstration	£128,496	£75,477
Project description - provided by applicants			
<p>A micro-enterprise, Energy Process Developments Ltd is able with Technology Strategy Board funding to undertake a £100,000 study of the feasibility of a pilot-scale nuclear molten salt reactor programme. Molten salt reactor technology may have the potential to bring a step-change in the civil nuclear power industry. Nuclear is the only available technology with sufficient energy density to address the challenge of global energy poverty. Molten salt reactor technology claims a role in this, because inherent advantages make it possible to provide energy competitive with coal.</p> <p>This feasibility study will lead to a choice from the various options of a configuration that will demonstrate for the public, decision makers and all interested parties, a working pilot-scale reactor that opens a new pathway for the civil nuclear power industry. A pilot-scale reactor can subsequently be scaled up to an industrial prototype that will lead the way to a new industry-standard reactor for nuclear power.</p>			

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Ferroday Ltd	Interoperability for ultrasonic NDT data	£52,020	£39,015
Project description - provided by applicants			
<p>The investigation will study the feasibility of importing an ICT method from aerospace and automotive and applying it to the representation of data from phased array ultrasonic testing for defects in fabricated components in nuclear plant. This method uses standardised information models for the computer representation of engineering data that is independent from proprietary software in order to support interoperability between different engineering systems.</p> <p>The study will be the first time that this technology has been used anywhere for the representation of NDT data. The study will investigate whether the information model defined in ISO 10303-235 can represent the component data together with the instrumental conditions and the size and location of defects and whether new software developed by Ferroday Ltd to implement the standard can be used to support this new application of the technology. Success will also provide a specification to support procedures for engineering quality control and quality assurance for the reported results and enable data to be conserved to compare with future tests over the component's lifetime.</p>			

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GeoRoc Ltd	Large-scale hot-isostatic pressing of waste forms for the treatment of Magnox sludge and other wastes	£149,333	£112,000
Project description - provided by applicants			
<p>The thermal treatment of radioactive wastes offers the opportunity to significantly reduce the waste volume and realise life-cycle cost savings. In this project GeoRoc Limited aims to demonstrate the use of hot-isostatic pressing (HIPing) to treat Magnox fuel pond sludges. Hot-isostatic pressing involves the use of heat and pressure to make dense materials. HIPing is a mature advanced materials production method. However, design innovation is required to adapt it to routine use in the treatment of radioactive wastes.</p> <p>By selecting tailored additives, high waste loading ceramics and glass-ceramics that are geologically stable and lock-up the nuclear waste, can be produced via HIPing. The environmental benefits are not limited to transforming existing and future wastes into stable forms and because it is a sealed process it eliminates the potential for any release of radioactive or chemotoxic waste. Additionally, the reduced volume means less repository space is required and in the long term fewer repositories, so reducing CO2 emissions and yielding savings that could be used for other government initiatives.</p>			

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Heat Trace Limited	Feasibility study into novel materials for heat tracing applications inside nuclear containment	£146,924	£110,193
Project description - provided by applicants			
<p>This project will develop, for application in nuclear power and processing, an electrical heating cable which is capable of high temperatures withstand and resistance to irradiation. The cable will be a high-temperature type built around a novel self-regulating core material suitable for nuclear application. This self-regulating cable, built on new materials, offers significant cost reductions and reduced installation time while offering superior safety credentials; as the cable cannot burn out, hence making it safer than the current technology. This new material and technology could be utilised in other areas, requiring radiation such as long-term radiation storage and satellite technologies.</p>			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Kromek Group PLC	High dynamic range spectroscopic radiation detectors	£147,971	£110,978
Project description - provided by applicants			
<p>We will test the feasibility of novel radiation detectors having a larger dynamic range than currently available devices, achieved by an innovative electrode geometry on the radiation detector itself. The electrode will comprise pixels of differing sizes. These new instruments would allow high-resolution spectroscopy in environments where very high levels of radiation exist, in addition to measurements in low-dose environments; a range typically encountered in nuclear power generation scenarios. This removes the need for multiple detectors to be carried for different environments, speeds up making measurements and decisions, improves safety and reduces cost. Trial detectors with test electrode geometries will be made using our existing manufacturing capability and tested in high-dose environments to assess their performance and determine if they will be suitable for inclusion in a final manufacturable and saleable device. Final technology readiness level at the end of the project is expected to be level 4 or 5.</p>			

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Lablogic Systems Limited	Novel system for localised, real-time radiometric measurements of ground water at civil nuclear sites	£98,331	£73,748
Project description - provided by applicants			
<p>Monitoring of groundwater in and around nuclear sites and facilities is of key importance, both in terms of ensuring that any possible contamination resulting from unlikely fluctuations in detected levels is established in a timely fashion and to satisfy the regulatory demands of the Office for Nuclear Regulation and the Environment Agency. Regular ground water data is used to protect workers, the public and the environment. Currently, the periodic monitoring process is resource heavy in terms of both the cost and time required to obtain, analyse and collate the data from groundwater samples. In this project, we propose to develop a novel, automated water sampling and analysis system. The resulting system will encompass a number of features to satisfy the demands for groundwater monitoring, including direct sample acquisition from boreholes, sample pre-treatment, improvements to the lower limit of detection to enable more accurate quantification of key environmental radionuclides and a specific software package to automate the data acquisition and analysis processes.</p>			

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Metamet Consultants Ltd	A condition-based structural integrity and remaining life model for austenitic stainless steels	£143,382	£107,537
Project description - provided by applicants			
<p>This feasibility study focuses on structural integrity issues arising from the continued life extension of the AGR fleet, in particular with the austenitic steels used in heat exchangers for tubing and supports. Operating in the creep regime, these materials show considerable microstructural development in service, with consequent changes in mechanical properties.</p> <p>It includes an experimental programme comprising creep, tensile, and impact testing of pre-aged Type 316 steel, with associated metallographic studies.</p> <p>The aims are to assess the potential for a formal method of classifying microstructural development, a model of this development, and a preliminary model of the resultant mechanical behaviour.</p> <p>The deliverables will include demonstration software that estimates remaining creep life on the basis of observed microstructural state, using the preliminary model.</p>			

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Metrix NDT Limited	Metrology using optical and X-ray inspection – MOXI	£147,262	£110,447
Project description - provided by applicants			
<p>This project will evaluate the feasibility to use both optical and x-ray 3D imaging techniques to provide a novel metrology inspection instrument that is capable of providing both high-resolution external and internal measurements for cast, moulded, forged or sintered components manufactured from a wide variety of materials including metals, ceramics, composites and even plastics. This new instrument (MOXI -- metrology using optical and X-ray inspection) will also provide suitable data to enable the end-user to readily identify concealed latent faults such as porosity, cracks, delaminations, that may lead to premature in-service failure.</p> <p>A key feature of this project is to also substantially reduce the cost of current NDT/NDE equipment, opening up opportunities for new entrants in the supply chain.</p>			

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Somers Forge Limited (lead) TWI Limited	TransForge – production of forged dissimilar metal transitions for improved reliability in new nuclear power plant	£146,243	£101,855
Project description - provided by applicants			
<p>Transforge aims to show that the fabrication of forged transitions from dissimilar materials can be achieved by using single-pass electron beam welding followed by re-forging and appropriate heat treatment to develop the required integrity and properties. This will allow the fabrication of higher quality and higher performance components for the construction of new nuclear power plant, including newly developing Small Modular Reactors (SMRs). The spin-off benefit will be in a possible production route for other dissimilar metal joints for use in marine environments and oil and gas applications as well as for producing forge tools.</p> <p>Transforge will enable us to offer a significant differentiator which will allow us to enter the nuclear supply-chain. Within the feasibility study we will examine the properties of a number of dissimilar material joints produced with an advanced welding technique, including post process heat treatment of the welds and re-forging.</p>			

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Sound Mathematics Limited	Composite model-based signal and image processing algorithms for semi-automated crack characterisation	£135,536	£101,652
Project description - provided by applicants			
<p>Ultrasonic NDE (non-destructive evaluation) of industrial materials is an important and cost-effective way of monitoring plant integrity. The NDE requirements are particularly stringent in the heavily legislated nuclear industry. With a large ageing fleet and new build on the way it is becoming harder and harder to train a required number of suitably qualified personnel to conduct ultrasonic inspections. Also, the process often calls for performance of repetitive and therefore boring tasks, increasing chance of human error. A lot of data collection is now automated but not data interpretation.</p> <p>Funded by the Technology Strategy Board and Sound Mathematics Ltd., with 20 years of experience behind them in mathematical modelling of ultrasonic inspections, has recently developed a code which is capable of generating automatically and in real time several possible versions of inspection reports, and thus addresses this issue. The code could be used for detecting, locating, sizing and identifying orientation of a large planar crack. We now wish to investigate whether similar codes can be created for characterising other major types of cracks described in the British Standards: Ultrasonic Examination.</p>			

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STS Defence Limited	Project CLAIMS (Coolant Leak Artificially Intelligent Monitoring System)	£148,679	£111,509
Project description - provided by applicants			
<p>Project CLAIMS (Coolant Leak Artificially Intelligent Monitoring System) will provide a technology demonstrator of an advanced automated condition monitoring system for detection and classification of leaks from the primary circuits of designs of light water reactors. Nuclear plants are valuable, high capital cost assets with long operating lifetimes delivering reliable base electricity load to the grid. It is recognised that in order to maintain optimal safety and economic viability, application of advanced surveillance, diagnostic and prognostic technologies will be required, particularly as plant lifetimes extend to 80 years and beyond.</p>			

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Symetrica Security Limited	New techniques for the rapid characterisation of low-level waste and surface contamination	£125,990	£92,966
Project description - provided by applicants			
<p>This study will explore the feasibility of adapting Symetrica's spectral-processing techniques for use in the nuclear power industry. If this is successful, we expect that the process of decommissioning old plant will proceed more rapidly and in a more cost-effective way. We also believe that it will also provide an improved level of security in newly built plant. This technology is currently playing a very important and growing role in protecting ports and border crossings in several different countries around the world.</p>			

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Tacit Connexions Limited	Improving the decommissioning process with intelligent semantic building histories	£140,164	£105,123
Project description - provided by applicants			
<p>In response to a use case prepared by Sellafield Limited, Tacit Connexions Limited proposes to investigate the feasibility of developing a pilot knowledge technology (KT) solution that would speed the production of more accurate, complete and useable building histories for use by characterisation teams and others involved in post-operation clean-out and decommissioning activities. This would have application nationally, within the European Economic Area and globally, and would lead to safer, lower-cost disposal of wastes that required less human intervention.</p> <p>The proposed approach involves the development of intelligent, semantic 'wiki-like' publication formats for the experience, understanding and insight (the deeper tacit knowledge) of Sellafield's decommissioning experts. This would be compiled using a range of novel knowledge elicitation techniques and specialist software tools, transferred from another market sector, configured and incrementally developed to meet Sellafield's needs.</p>			

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XCAM Limited	In-situ monitoring of tritium and carbon 14 in groundwater	139384	104538
Project description - provided by applicants			
<p>Monitoring tritium in contaminated groundwater at nuclear sites using conventional techniques is slow, costly and has associated health and safety issues. In this project we plan to develop a novel tritium detection technique which will provide fast sampling, at lower costs and using methods which reduce worker exposure to contaminated groundwater samples. Our technique hopes to provide test results in 1 day, compared to the current 2- 4 weeks by the conventional method, and may ultimately permit high-frequency, long-duration remote sampling of tritium down bore-holes. If the technique is successful then it could be extended to provide a carbon 14 detector for use at problem sites and at geological disposal facilities.</p>			