High Value Manufacturing and Services Research Fund - 2015 Science Investment Round Successful Proposals

Short Title	Organisation	Term	Total funding (excl GST)	Summary
Bessel beam sensors - new generation agritech exports	Lincoln Agritech	3	$1,200,000	Bessel beams offer a new approach to sensing, based on highly novel research, with a wide range of potential applications. This programme will undertake the underpinning research and develop a prototype for the first application, the “on-the-hoof” body condition sensor. This will be a valuable stock management tool for production, livestock health and nutrition, which will be developed in collaboration with our industry partner. Bessel beams are narrow, non-divergent beams of light, radio waves or sound, and a relatively new discovery. In this programme we will work on microwave Bessel beams - they are well-suited to sensing because of the consistent narrow beam. Further, the signals scattered from objects or layers provide information about their size and the material from which they are made. The research will extend knowledge of how Bessel beams behave, as well as how they can be used to provide high resolution data. The estimated market for body condition sensors is $33m pa by 2025. More importantly, understanding Bessel beams will open up the wide range of potential future applications including measuring fruit and vegetable yield, the internal quality of trees and identifying buried objects, while placing New Zealand at the forefront of this emerging field of knowledge.
Quantitative Benchtop NMR using Bayesian Analysis	University of Canterbury	3	$863,149	Nuclear Magnetic Resonance (NMR) is an analytical chemistry technique used in academic laboratories and large industrial organisations around the world. Conventionally NMR instruments rely on superconducting magnets to produce a sufficiently strong signal. These magnets are expensive, typically costing $1 million each, and require the instruments to be placed in a dedicated building to ensure that the magnetic field is contained safely. Smaller, benchtop NMR instruments are becoming available that use much weaker magnets and are an order of magnitude cheaper. However, these have a correspondingly lower signal strength and so quantitative measurements are challenging. This project will develop a new mathematical approach to extract quantitative measurements from benchtop NMR instruments. Preliminary research indicates that our approach could yield an order of magnitude improvement in the accuracy of NMR measurements, enabling benchtop NMR to compete directly with traditional superconducting magnet systems. Furthermore, the portability and low cost of such benchtop NMR instruments enables entirely new applications of NMR, not possible with superconducting magnets. A New Zealand company has recently developed the most advanced benchtop NMR instrument available. Therefore, this research has the potential to establish New Zealand as a global leader in an emerging discipline in analytical chemistry.
Repurposed drugs for multiple sclerosis: confirming suitability, regulatory process and mode of action	Victoria University of Wellington	3	$1,200,000	We aim to develop a new treatment for a currently untreatable form of multiple sclerosis (MS). There are approximately 2.5 million MS sufferers worldwide with 400,000 in the US and over 3,000 in New Zealand of whom one third suffer from moderate to severe disability characterized by impaired vision, coordination, and paralysis. There is no cure, and while disease-modifying drugs are available, they are only effective in the relapsing-remitting form of MS. No drugs are available to treat progressive forms of MS, though patients with progressive MS suffer the greatest reduction in quality of life. The principal goal of our research is to address this urgent need for therapies to treat progressive MS. In recent experiments, we discovered that two commonly-used antipsychotic agents, clozapine and risperidone, significantly reduced MS disease. Clozapine and risperidone have been used for decades to treat patients with various mental health disorders, but to adapt them to treat MS, we must balance the possible side effects with the drugs’ potential therapeutic benefits. Our research will compare clozapine and risperidone and assess their clinical effects in treating secondary progressive MS. We will select the best therapeutic form of these drugs, identify the mode of action by which these agents reduce MS disease, and delineate the pathway that is required to obtain regulatory approval and progress our candidate drug to clinical use. Ultimately, this research will deliver a new (and first-ever) treatment for secondary progressive MS.

UltraD3: Ultrasonic Dental Diagnostic Device	University of Otago	3	$1,199,869	A combined team from University of Otago School of Dentistry and Callaghan Innovation aims to develop a device that will improve the early diagnosis of gum disease around teeth and around titanium dental implants. Earlier intervention for gum problems will reduce both the discomfort and the cost of late-stage surgical treatment for these conditions. The team has world-leading capabilities in dental research, ultrasonics, electronics and materials science. The UltraD3 employs miniaturised high frequency transducers and imaging systems and applies these to the clinical problem of diagnosing early inflammation around teeth and dental implants. Contacts: Professor Warwick Duncan, University of Otago, warwick.duncan@otago.ac.nz Mr Paul Harris, Callaghan Innovation, paul.harris@callaghaninnovation.govt.nz
Production of an improved anti-cancer antibody using NZ goats as an efficient, economical and safe production platform	AgResearch	3	$1,200,000	Monoclonal antibodies (mAbs) are the most important class of biopharmaceutical drugs, with seven products ranked within the ten top-selling biopharmaceuticals. The mAbs are used to treat serious conditions such as cancer. The first generation therapeutic mAbs are coming off patent, creating significant opportunities for the production of bioequivalent versions of innovator drugs, so called 'biosimilars' or, further improved 'biobetters'. The proposal is aimed at positioning NZ as a leader in producing high value biopharmaceuticals using animals as bioreactor by building a platform industry based on the dairy and medical sectors. Goats represent an attractive production platform due to the mammary gland's high protein production capacity, great scalability and cost effectiveness. Such a platform is especially well suited for NZ because it can leverage its competitive advantage in the primary sector, including disease-free status of livestock and world-leading research capabilities. Cetuximab is a mAb3 produced in mouse cells under the brand name Erbitux, for treating colorectal and head and neck cancers. In a collaborative proof of concept study, AgResearch and LFB USA, Inc. (LFB) have generated two transgenic goat founder lines that were engineered for the production of cetuximab as a biosimilar version of Erbitux. This study demonstrated the feasibility of producing high cetuximab levels in milk, with approximately 100 goats enough to satisfy market demands. Our preliminary data further suggested improved functionality compared to the innovator drug, due to the absence of a modification causing adverse effects in patients12. The use of goats to produce mAbs for the treatment of human conditions is still in its infancy with key questions still to be addressed to prove its value. The research project aims to validate the NZ goat production system's ability for safe and consistent delivery of efficacious drugs through the generation of the necessary new knowledge. The project will be carried out using complementary capabilities available at AgResearch and the University of Auckland. Specifically, our research aims to determine i) the stability of genotype, phenotype and health of the mAb-producing goats, ii) the bioequivalence and improved functionality of the goat-produced mAb in comparison to the approved drug and iii) investigate and develop an emerging strategy for arming mAbs with toxins as a new avenue to improve anti-cancer immunotherapies. The project has the continued support by LFB, a pioneer in goat-produced human drugs, with extensive experience in the relevant regulatory processes. The involvement of the NZ biotechnology company Transgenic Proteins NZ Ltd., engaged in the production of antibodies from livestock and contract manufacturing of human therapeutics, provides an ideal partner for the project in the future commercialisation of the goat produced biosimilar to secure economic benefits for NZ. Assuming successful development and adoption, model analysis predicts possible benefits to NZ comprise Net Present Value (NPV) of $116 million and an Internal Rate of Return of 43%. The main financial benefits will arise through annual royalties from biosimilar mAb sales, estimated to be $45.2 million, and treatment cost-saving to the NZ health sector of $11.6 million (both for NPV year 20).
Precision Acoustic Sensors for Pastoral and Arable Farming	University of Auckland	3	$1,200,000	Professor Stuart Bradley and his acoustics research team at the Phyiscs Department, University of Auckland, are teaming up with AgResearch scientists Dr Robyn Dynes and Dr Warren King, to develop a smart acoustic sensor for estimating pasture biomass, an important element in modern farm planning. Partner Gallagher Group Limited will produce a commercial version of the Precision Acoustic Pasture Meter for hand-held use, or mounting on a farm quad-bike, and also projected as being mounted on an unmanned aerial vehicle (UAV), for convenient and wide-spread use on farms in New Zealand and overseas.
Race to the Finish: Processing and Properties Optimization of self-cleaning, antimicrobial	University of Canterbury	3	$1,142,424	Hospital-acquired infections (HAI) are the third leading cause of death, afflicting people like Ian Thorpe, Australian swimming gold medalist, who went into the hospital for simple shoulder surgery, and ended up with a life-threatening infection. "High-touch" surfaces in hospitals,

ceramic coatings for buttons, knobs, handles and rails in hospitals.				such as door handles and elevator buttons are the source of more than 40% of pathogen transmissions. Aggressive chemical cleaning, hygiene practices, and copper and silver nanoparticle paints are being tried, but the microbes are rapidly becoming resistant to these poisons, and the finishes do not last very long. A game-changing product solution is photocatalytic destruction of microorganisms by a titanium dioxide (TiO2 or titania) ceramic finish on the metal fittings. TiO2 is a long-wearing, continuously working, self-cleaning and antimicrobial action (AM) coating posing no risk to human health and no chance of microbe resistance. The use of TiO2 is well known for self-cleaning glass and is approved by the US FDA for use in healthcare facilities. There are currently no TiO2 coated metal fittings available for a market in the USA estimated to be worth $3 billion. Today, New Zealand manufacturers of hospital fittings could charge up to five times as much if they could offer a TiO2 finish on their products. KOTI Technologies, Inc. has developed a unique process to apply AM finishes on stainless steel handles manufactured by Mercer Medical, NZ. The AM activity of the KOTI TiO2 finish has been shown to be faster than currently available commercial coatings on glass. Today, if KOTI could guarantee that the coating was also anti-fouling and scratch-resistant, the manufacturing line could be developed and Mercer could start filling orders. Our USA distribution partner, HAI Control Inc. has a boat load of elevator buttons, light switches and faucet handles ready to be on their way to NZ to be AM finished. This research project will support KOTI's race for an AM finish ahead of other international manufacturers. The research objective is to develop the range of material tests and models relating processing parameters to AM activity as well as wear resistance, anti-fouling and cleanability. Developing the processing-property-performance models through scientifically controlled experiments and material analysis will allow KOTI to bring its first product to the market in under a year, rather than the several years that would be needed for experimental development alone. Conservative export revenues are forecast to reach $33.7 million by 2023 and $45.6 million by 2028, from initial sales of AM coated products that will exhibit unprecedented levels of performance and affordability.
Enabling faster communication with 1 GHz quartz oscillators	Victoria University of Wellington	2	$800,000	We will create the methods required for manufacturing high fundamental frequency quartz oscillators to exploit market opportunities in communications infrastructure. We will develop micro electromechanical (MEMs) processes for the manufacture of quartz structures and develop new electrode materials. The goal is to produce quartz micro-machined inverted-mesa resonators with a fundamental frequency of 350 MHz, with a longer term goal of higher fundamental frequencies, for products operating at GHz frequencies. The technology developed in this programme will be applied in new high-value markets of data centres, coherent optical networking and 5G wireless. These markets will drive the growth in the telecoms industry for the next 5-10yrs. Quartz timing devices have steadily been miniaturized over recent years with continued improved performance. Further miniaturisation and step changes in performance can now only be achieved by applying techniques developed around MEMS. We will develop and modify known techniques for etching quartz at the microscale, in particular reactive ion etching and wet etch techniques, to achieve an oscillator with higher fundamental frequency and improved performance characteristics. What is novel in our research is to apply MEMs techniques in a manner which results in a high throughput, high yield manufacturing process. We will further develop novel electrodes for high fundamental frequency inverted mesa oscillators that have an improved coefficient of performance over standard Au electrodes and have reduced cost. A key goal of the research is to establish the structure-property relations between the realized device and the performance as a timing device. Further details can be obtained through emailing: nicholas.long@vuw.ac.nz
Total over 3 years			**$8,805,442**	