Summer Research Projects 2024/2025

How to apply

Applications for projects are submitted through the online form. Send copies of CV, transcript, and expression of interest letter with subject line "RE: Summer RA Programme 2024/2025" to rri-postgrad@vuw.ac.nz .

Projects

Other project opportunities may become available later. We will update this list if those opportunities arise. Keep an eye on the website.

Application deadline is Friday 19 July.

For more information about your project of interest, please email rri-postgrad@vuw.ac.nz

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Advanced materials for quantum technologies

Supervisor: Dr William Holmes-Hewitt

Project Description

Superconducting memory systems and other advanced components are required to facilitate the scale up of quantum computing. The designs for these systems exist, but the materials to realize these designs at scale do not. In this project we will investigate the insulating ferromagnetic materials required for this application.

We will form thin films (~100 nm) of the ferromagnetic semiconductor GdN and manipulate the electronic and magnetic properties by Lu substitution. We will undertake SQUID magnetometry and optical spectroscopy of the produced thin films to determine their electronic and magnetic properties and compare these to computational studies.

Project Outcomes

1. Grow five thin films of (Gd,Lu)N with Lu compositions of [0, 0.25, 0,5, 0.75, 1].
2. Complete magnetic measurements of these films to determine the saturation magnetization and coercive field.
3. Complete optical spectroscopy measurements of these films to determine the band gap.
4. Determine the composition most suited for application in a magnetic Josephson junction.

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Flux pump switching electronics and control

Supervisor: Dr Grant Lumsden

Project Description

Flux pumps are used to contactlessly supply current into a superconducting coil. Two fundamental components in many designs are:

1. A step-down transformer that must be driven to a specific and unusual waveform
2. Switching solenoids that are used to apply magnetic fields to the superconductor

These both represent challenging inductive loads, and this project involves the development of compact and efficient power supplies and power electronics that will drive them. Large laboratory power supplies have been used up until now, but practical flux pumps will need integrated driver electronics, possibly in a very space-limited package.

A number of options are available for the driver circuits, and some evaluation modules have been purchased. This project will entail:

1. Characterising the existing driver options over a range of operating conditions including different transformer and switching solenoid options
2. Identifying areas for hardware and software improvements in the drivers
3. Prototyping improved hardware and software
4. Characterising the performance of the new hardware

Project Outcomes

- Test plans
- Test reports
- Hardware designs
- Hardware prototypes
- Embedded software as required

Ideal Candidate

Candidates should ideally have an understanding of and experience with power electronics hardware for driving inductive loads, such as motor drivers, audio amplifiers and the like.

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High-temperature fibre sensing for plasma rockets

Supervisor: Dr Ben Mallett

Project Description

Electric propulsion systems for spacecraft, and many other plasma sources, use cathodes that emit electrons via thermionic emission. Measuring the temperature of the emitter is important, but difficult to achieve in practice, not least due electrical noise from the plasma itself. An optical fibre based temperature sensor has the potential to circumvent many of these difficulties. The aim of this project is a proof-of-concept temperature measurement of an operational hollow cathode via fibre optics.

Project Outcomes

- Design and implement fibre mounting to the cathode of a miniature plasma rocket.
- Sub 1000 degC measurement of the cathode using a fibre-Bragg-grating technique in silica fibres.
- Validate an optical fibre-based blackbody radiator measurement concept (and methods) with a known black-body source.
- Written report of project results and findings.

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Hybrid flux pumps

Supervisor: Dr Ben Mallett

Project Description

Flux pumps are superconducting devices that have demonstrated the potential to energize superconducting magnets much more efficiently than possible with conventional methods. Although flux pumps can delivering very high currents, most flux pumping methods struggle to generate more than 1 mV charging voltage. This project will design, build and test a 'hybrid flux pump', incorporating cryogenic semi-conductor components, that has the potential to generate higher charging voltages.

Project Outcomes

1. An electrical and mechanical design of a 'hybrid flux pump'.
2. Build of the flux pump, including incorporation of test superconducting magnet.
3. Experimental set up, including the control and acquisition software.
4. Performance tests
5. Project report.

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Real-time cryogenic measurements of x-ray radiation damage to superconductors

Supervisor: Dr Bart Ludbrook

Project Description

Superconductors are used to make the magnets for applications in fusion energy and aerospace applications. In both these applications large radiation doses can alter the materials' properties and affect the performance of the technology.

This project aims to study the impact of high dose rates and doses of x-rays on a superconductor commonly used for magnet manufacture. The key research question to be answered is does cryogenic X-ray irradiation affect the critical current in a superconductor sample?

The key steps to answer this question are:

1. Make superconductor samples, etching away metallic stabiliser and patterning bridges
2. Perform critical current measurements in liquid nitrogen
3. Set up samples in the Robinson X-ray irradiation facility and measure critical current with increasing dose of ionizing x-ray radiation

Project Outcomes

- Ability to etch and pattern HTS bridges.
- Measurements of HTS tapes under intense x-ray radiation.
- Delivers milestone for S&F catalyst project.

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