Section A: Overview of the Research Project

1. Design and implementation of a dual-band planar integrated 22/31 GHz water vapour radiometer
2. Engineering
3. Masters
4. Accurate estimation of tropospheric water vapour is imperative to site surveys, observation management, and path length correction in mm-wave radio astronomy. Water vapour radiometer systems are commercially available, but are large and expensive, and require several moving parts. A new project, called PILCHARD (Planar Integrated Low-Cost H_2O Atmospheric Radiometric Detection) aims to develop an RF PCB integrated dual-band water vapour radiometer in the 22/31 GHz at low cost, suitable to site surveys in remote areas. This project will build on a previous M.Eng project (where different radiometer architectures were evaluated and a system simulation approach was established) with detail design, implementation, and validation of a working prototype.
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Section B: Details of Research Project

1. Scientific merit:

Accurate estimation of tropospheric water vapour is imperative to site surveys, observation management, and path length correction in mm-wave radio astronomy. This may be estimated at 183 or 225 GHz, or with dual-band methods at 22 and 31 GHz.

Water vapour radiometer systems are commercially available, but are large and expensive (due in large to the extensive reliance on connectorised or waveguide components). A new project, called PILCHARD (Planar Integrated Low-Cost H_2O Atmospheric Radiometric Detection) aims to develop an RF PCB integrated dual-band water vapour radiometer in the 22/31 GHz at low cost, suitable to site surveys in remote areas. This will build on the success of compact, low-cost planar integrated transceivers in similar frequency bands for satellite communications.

2. Feasibility:

This project will build on a previous M.Eng project, where different radiometer architectures were evaluated and a system simulation approach was established. It will generate a detail design of the PILCHARD prototype, implement it, and validate its performance both in lab and on site (where a suitable site has already been identified in Gamsberg, Namibia).

The M4 lab at the University of Pretoria has experience in radiometer design, mm-wave design, hybrid integration, and testing of mixed signal and RF circuits. The lab is further equipped with all the necessary laboratory facilities for measurement (including anechoic measurements), as well as software for circuit and system modelling.

Potential objectives for this project would be:

Y1: Coursework. Literature review. Architecture design. Detail component design.

Y2: Implementation of detailed design, including a basic digital and control interface. Lab characterization. Site survey deployment.

3. This proposal relates to Research Priority Area 4. The prototype developed in this study may be deployed both for surveying potential new mm-wave radio astronomy sites in Africa, and to provide monitoring data at existing centimetric observation sites.

4. A firm undergraduate background in high frequency electronics and / or electromagnetics is advisable for this project. This would include knowledge of basic RF components (transmission lines, filters, couplers, mixers, amplifiers) as well as RF simulation software.