Section A: Overview of the Research Project Proposal

1. Masters
2. Engineering
3. Design and implementation of a dual-band planar integrated 22/31 GHz water vapour radiometer
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.

Section B: Supervisor(s) Details

1. Primary supervisor's details

a. Dr Tinus Stander
b. University of Pretoria
c. tinus.stander@up.ac.za
d. Supervision of postgraduate students
i. Doctoral Students:

Name of student	**Nationality**	**Date started Doctoral Degree (Month and Year)**	**Date completed / will complete Doctoral Degree (Month and Year)**	**Title of Research Project / Thesis**	**Co-Supervisor (if relevant)**
Piotr Osuch (Also supervised for M.Eng)	RSA	01/2016	07/2018	Synthesis and monolithic integration of in-system analogue data pre-processing networks	
Flavien Sagouo Minko	Cameroon	01/2014	12/2018 (part-time)	Broadband, radiation hardened mm-wave components for space-based Sun observation instruments	
Brilliant Habeenzu	Zambia	02/2015	12/2018 (part-time)	Radiation degradation characterization and modelling in mm-Wave microelectronics	
Titus Oyedokun	Nigeria	01/2014	08/2018	Planar Groove Gap Waveguide	Prof. RH Geschke (primary, UCT)
Hannes Venter (Also supervised for M.Eng)	RSA	06/2018	12/2020	Dispersive and multi-band phase shifters	

ii. Masters Students

Name of student	**Nationality**	**Date started Doctoral Degree (Month and Year)**	**Date completed / will complete Doctoral Degree (Month and Year)**	**Title of Research Project / Thesis**	**Co-Supervisor (if relevant)**

Nishant Singh	India	01/2015	05/2017	Active Q-Enhanced Tunable High-Q On-Chip E-band Resonators and Pseudo-Combline Coupled Resonator Filters in 130nm SiGe BiCMOS	
Vishal Bhana	RSA	01/2013	11/2017 (part-time)	A Slow-Wave CMOS Delay Line Filter for mm-Wave Applications	Prof. S. Sinha (UP)
Shaunel Walker	RSA	01/2016	12/2018	Low cost RF PCB integrated front-ends for mm-wave water vapour radiometry	Mr AC de Villiers (TUT)
Edward Hunter	RSA	01/2017	12/2018	Radially distributed mm-wave array antennas	Prof. DIL de Villers (SU)
Anthony Gaskell	RSA	01/2016	12/2018 (part-time)	Resonant tunnelling diode based analogue to digital converters	Prof. WE Meyer (UP)
James Smith	RSA	01/2014	12/2018 (part-time)	A substrate integrated waveguide amplifier matching scheme	

2. Co-supervisor / Research Supervisor's details (if relevant): N/A

Section C: Full Research Project Proposal

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 Areas 3 (Radio Astronomy antennas and receivers), 5 (Instrumentation and systems for Radio Frequency Interference (RFI) detection and data analysis/archival/interrogation/visualization), and 8 (Interferometric Data Processing and Analysis, including calibration and imaging). The receiver techniques developed in this study may be applied in future receiver (for radio astronomy, or for RFI detection) design, while the data generated from accurate WVR measurements could be used for correction in data processing in observations (potentially).

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.

Section D: Signatures

1. Signed: T. Stander  Date: 31 August 2018