

South African Square Kilometre Array Project Postgraduate Bursary Programme

M Eng Research Project Proposal to be considered for Bursary Funding to Commence in 2019

1. Title of Research Project: EM Material Development and Characterisation

2. Academic Level: M Eng

3. Supervisor's Title and Full Name: Dr Pieter Gideon Wiid

4. Co-supervisor's title and full name: Dr Scott A Kuehl

5. Supervisor's University: Stellenbosch University

6. Overview and Aims of the Research Project:

To evaluate the electromagnetic properties of materials across a wide band is not trivial. Different techniques apply to different frequency ranges. The available methods covering all the frequency ranges for SKA would need to be investigated, evaluated and tested. Methods include (in increasing frequency), Coaxial test methods, Coaxial single probe methods, Free Space Setups, Waveguide Setups and Radar Cross Section Methods. The design and calibration of setups for these measurements would be required, as well as the development/adaptation and implementation of the relevant equations to extract the electromagnetic properties. As example, soil properties have been notoriously difficult to measure. The measurement techniques used here will be relevant for the evaluation of different shielding materials, where the concomitant part of the project will include the development of alternative materials for shielding and EM miniaturization purposes.

7. Relevance of the research proposed to the priority areas of MeerKAT / SKA:

Shielding of equipment to levels complying with the SARAS and SKA Threshold levels are imperative to the SKA project. This project will involve the development and characterisation of alternative EM and shielding materials for this purpose. This falls in priority area 5 - Instrumentation and data analysis for Radio Frequency Interference (RFI) detection, analysis and archival.

8. Research work breakdown:

a. Year 1

The student will conduct an in-depth literature study in the first semester of all the EM material property measurement techniques available across the SKA frequency band. In this time, additional postgraduate course material will be covered to aid in the literature study. The second semester will include evaluation of EM shielding materials in the literature as well as how their chemical composition determines their EM properties. Additionally, proposals for improved high-loss EM shielding material compositions, as well as combined high-permittivity high-permeability low-loss materials for antenna-miniaturization applications, will be done.

b. Year 2

During the 1st semester, the EM material property measurement techniques will be tested and optimised to suit measurements of the proposed composition materials.

The material development will run in conjunction, with iterative testing and design stages to improve the materials and testing techniques. During the 2nd semester, critical analysis of the material designs and measurement techniques will aid in the selection of new shielding and EM miniaturization materials which can be used for SKA applications. The dissertation writing will be done during this time as well.

9. Availability of required data / access to required equipment /availability of research facilities and other resources required:

The Stellenbosch University anechoic chamber, reverberation chamber, R&S 8 GHz VNA and PNAX 26 GHz network analyser are all available for testing. There are coaxial setups, single-probe setups, a free-space horn antenna setup, as well as different waveguide setups for material measurements. A 3D-printer is available at the E&E Department, if any mounting prototype parts are required. A radar cross section technique can also be implemented in the anechoic chamber.

The polymer Science department has the ability to mix and sinter different materials, also available for this project through Dr Scott Kuehl.

10. Signature and Date



Dr Pieter Gideon Wiid

2018/10/30

Date