Section A: Overview of the Research Project Proposal

1) **Title of research project:** Radio astronomy receiver system with integrated, adaptable RFI mitigation

2) **Broad area of research:** Engineering

3) **Academic Level of research project:** PhD

4) **Research project abstract/summary (max 250 words):**

A well-known problem at the SKA Karoo site is the interference from other radio signals, such as air traffic communication, that results in a reduced signal-to-interference ratio and problems with amplifier linearity for specific frequencies. Therefore, this doctoral project aims to yield a system design that can suppress various sources of RFI by integrating an adaptable notch filtering stage into the antenna before the first amplification stage.

5) **Primary supervisor's details:**

a. **Full name:** Dr Jacki Gilmore

b. **Email address:** jackivdm@sun.ac.za

c. **University:** Stellenbosch University

5) **Co-supervisor's details:**

a. **Full name:** Dr Elmine Meyer

b. **Email address:** e.meyer@tue.nl

c. **University:** Eindhoven University of Technology

Section B: Details of the Research Project Proposal

1) **Scientific/Engineering merit: describe the objectives of the research project, placing them in the context of the current key questions and understanding of the field.**

A well-known problem at the SKA Karoo site is the interference from other radio signals, such as air traffic communication, that results in a reduced signal-to-interference ratio for specific frequencies. The main goal of this doctoral study is to design a system that is able to suppress

various sources of RFI by incorporating adaptable notch filters into the antenna. A notable advantage of a filtering stage before amplification is that the saturation of active components by strong interferers can be avoided. However, care should be taken to minimise the system noise figure. Therefore, low loss variable filtering solutions will be investigated.

Envisioned minor contributions:

- A review of variable integrated receiver topologies in view of figures-of-merit such as operational bandwidth, frequency range and system noise temperature.
- Development of measurement techniques for highly integrated receiver systems.

Envisioned major contributions:

- Development of a tunable integrated filtering antenna structure with amplification for radio astronomy receivers.
- Novel manufacturing techniques for highly integrated receiver systems, possibly using additive manufacturing.

2) **Feasibility: outline the methods that will be used to achieve the objectives. Provide details on the availability of required data / access to required equipment / availability of research facilities and other resources required. Include any relevant expected intermediate milestones and associated timeframes towards attaining the overall objectives of the project.**

The antenna will be designed with the aid of commercial electromagnetic simulation software, and manufactured and measured at in-house facilities.

A well-equipped antenna test range and all the required software tools, and an established workshop with qualified technical staff are available in-house at Stellenbosch University.

Timeframe and intermediate milestones:

Semester 1: The student will complete a thorough literature study on integrated antenna systems and filter theory and complete a research proposal for approval by an examination panel.

Semester 2-3: Preliminary RFI measurements and theoretical system design and advanced simulation will take part in this semester.

Semester 4: Design refinement, prototype manufacturing and assembly.

Semester 5: Final system construction and preliminary measurements.

Semester 6: Final measurements, data analysis, and writing of dissertation.

3) **Link the proposed project to one or more of the SARAO research priority areas for 2021 (refer to Section 5 of the Application Guide), and explain in some detail how the proposed research will contribute to the priority area(s).**

Research priority area: 5.2.1 Radio astronomy antennas and receiver systems (including digitisation) associated with supported and hosted instruments and 5.2.3 Hardware and data analysis systems for detecting, monitoring and identifying Radio Frequency Interference (RFI), including the use of telescope data (e.g. using MeerKAT visibilities to locate RFI sources).

The aim of the project is to design an integrated receiver system with adaptable RFI mitigation by means of a variable stopband notch. The research therefore contributes to radio astronomy antennas and receiver systems given the design, manufacturing and measurement of a novel integrated receiver solution. It is necessary to do preliminary RFI measurements and identify RFI sources in order to create initial design specifications.Therefore, the research also contributes to RFI identification and hardware for RFI mitigation.

4) **If relevant, describe any particular qualifications, academic abilities, skills and/or experience that a student should have in order to successfully deliver on the objectives of the research proposed.**

Not relevant