Section A: Overview of the Research Project

1. Title of the research project:
Designing an Active Integrated Antenna for the Rhodes University Transient Array Radio Telescope

2. Broad area of research:
Science

3. Academic level of research project:
Masters

4. Abstract of research project:

The project involves designing and fabricating an active integrated antenna (AIA) for Transient Array Radio Telescope (TART). We need antennas that can be modified anytime to optimize the performance of TART. Computational softwares such as Altair FEKO will be used as well as testing and characterization of the fabricated AIA by actual measurement.

5. Primary supervisor's details: Dr Stanley Kuja, s.kuja@ru.ac.za, Rhodes University

Section B: Details of Research Project

1. Scientific merit:

The Rhodes University Transient Array Radio Telescope (RUTART) will need 24 antennas for the array. The front end of a receiver module for the RUTART will have an antenna and a low noise amplifier (LNA). In order to achieve optimum power transfer from the antenna to the LNA, a matching circuit is necessary between the two devices i.e. the output impedance of the antenna (50 Ω) should match the input impedance of the LNA. It should be noted that the quality of the received signal from the antennas through to the receiver system greatly influences the output of the entire radio telescope system. Usually, it is possible to optimize the matching circuit to obtain the best power transfer, at a particular operating temperature, however this may compromise the power transfer between the two elements at other operating temperatures. To avoid the operation requirements of the matching network, an Active Integrated Antenna (AIA) is preferred. The AIA is a circuit where the antenna of the receiver link is directly integrated with the LNA circuit without the use of impedance matching circuit.

The RUTART radio-hub modules do not have built-in LNAs. Therefore, this project will focus on the design and characterisation of a patch antenna and an active LNA circuit for the AIAs which will be used on the RUTART. We have already obtained four radio-hubs (each with six front end receivers), base-station and commercial off-the-shelf (COTS) GPS patch antennas. The disadvantage of the COTS GPS antenna is that it cannot be modified and is expensive in the long run. We need to manufacture low-cost AIAs that can be used as replacement or in RUTART2.

2. Feasibility:

The infrastructure that is available in our department and collaborator institution - Stellenbosch University, Department of Electrical and Electronic Engineering, can be used to design and characterise

the AIA system. Such facilities/ tools include a technical workshop, anechoic chamber, network analysers, simulation software (Altair FEKO), etc.

An estimate of the project timeline is as follows:

Months 1 – 6: *Preparation*: Complete a thorough literature study on patch antennas, LNAs, AIA designs, and measurement techniques in a controlled electromagnetic environment

Months 7 – 18: *Design and deployment*: Antenna and LNA design, testing, and optimisation

Months 19 – 24: *Thesis*: Write up and submission

Note: This is a pre-approved Rhodes University Group Grant project

3. SARAO research priority area:

This project relates to the first SARAO engineering priority area: Radio astronomy antennas and receiver systems (including digitisation) associated with supported and hosted instruments.

4. Specific qualifications/abilities/skills/experience required:

No specific requirements.

Interested students to email the supervisor well in advance of application deadlines. Interviews will be undertaken