

Section A: Overview of the Research Project Proposal

- 1) **Academic level of research project:** Masters
- 2) **Broad field of research:** Engineering
- 3) **Title of the research project:** Construction of an Active Dense Dipole Array prototype for the Mid-Frequency Aperture Array
- 4) **Research project abstract/summary (max 250 words):**

For Phase 2 of the SKA, large, electronically steerable phased arrays called “aperture arrays” are being developed for the mid-frequency band (450 - 1450 MHz). Stellenbosch University is a member of the Mid-Frequency Aperture Array (MFAA) Consortium which is tasked with developing the necessary technology to realise these large systems. This project aims to integrate various existing subsystems and work done previously to build an optimised active DDA front-end that is thermally stabilised and is capable of analogue beamforming.

Section B: Overview of the Research Project Proposal

- 1) **Primary supervisor’s details:**
 - a. **Title and full name:** Dr Jacki Gilmore
 - b. **Supervisor’s University:** Stellenbosch University
 - c. **Email address and/or contact telephone number:** jackivdm@sun.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)
Nelis Wilke	South African	January 2018	December 2020	Efficient Multi-Beam Calibration of Antenna Arrays	Prof. Stefan Wijnholds (ASTRON)

ii. Masters Students:

Name of student	Nationality	Date started Masters Degree (Month and Year)	Date completed / will complete Masters Degree (Month and Year)	Title of Research Project / Thesis	Co-Supervisor (if relevant)
Nelis Wilke	South African	January 2016	December 2017	Quantization Effects on Beamforming in Dense Phased Arrays	Prof. David Davidson
Corey Smale	South African	January 2017	December 2018	Thermal Analysis of a Dense Dipole Array for the SKA Mid-Frequency Aperture Array	
Helgard Oosthuizen	South African	January 2018	December 2019	Active Antenna Array Design using Additive Manufacturing Techniques	

Section C: Full Project Proposal

Scientific Merit:

Traditionally, reflector-based antennas have been the instrument of choice for radio-astronomy, however recent advancements in low power electronics and computing have made the use of large phased arrays (aperture arrays) a viable option for certain frequency bands. For phase 2 of the SKA, the mid-frequency aperture array (MFAA) consortium is currently evaluating several aperture array topologies of which the Dense Dipole Array (DDA), developed at Stellenbosch University, is one.

The aims of this project are two-fold:

- 1) To use existing optimisation tools to optimise the impedance matching between the DDA and an existing low noise amplifier (LNA). This step has the potential of significantly improving the overall system noise temperature and therefore the sensitivity of the system.
- 2) To integrate the front-end (antenna array and LNA) to an existing temperature-stabilising mechanical support structure, and to further integrate the system to an existing analogue beamformer board (developed by ASTRON).

Research Breakdown Structure

Semester 1: The first semester of the project will be dedicated to some advanced course work on fundamental antenna theory, electromagnetics and microwave systems.

Semester 2: The student will complete a thorough literature study on aperture array systems for radio astronomy and get acquainted with the different subsystems. The optimisation of the antenna for optimal noise performance will also be done.

Semester 3: The main part of the system integration and testing will take place in the third semester.

Semester 4: System testing will be wrapped up in the fourth semester, but the largest proportion of time will be spent writing up the thesis.

Access to resources/equipment:

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

SARAO research priority areas:

Since this project involves system-level design and integration of an antenna receiver system, it falls well within one of the priority research areas identified by SARAO. It also forms part of ongoing MFAA research and will involve regular contact with other member institutions of the MFAA consortium with whom we have well-established relationships.

Section D: Signatures



Dr. Jacki Gilmore, 2018/08/21