

Section A: Overview of the Research Project Proposal

1. Academic level of research project

Doctoral

2. Broad field of research

Engineering

3. Title of the research project

C-BASS South Development and Commissioning

4. Full Names of Supervisor and Co-Supervisor

Dirk Izak Leon de Villiers

5. University where postgraduate student would be registered

Stellenbosch University

Section B: Research Project Proposal

1. Scientific merit:

C-BASS (C-band All Sky Survey), is a single dish experiment to map the Stokes parameters of the Galactic radio emission in the 4.5-5.5 GHz band, mostly to determine a foreground model to be used by cosmic microwave background experiments. Partners in the project are Oxford, Manchester, Caltech and South Africa as a collective (SARAO/UKZN/Rhodes). The northern hemisphere part of the experiment was conducted at Ovens Valley, CA USA, and is complete. The southern hemisphere experiment uses a 7.6m dish at Klerefontein, and has been under development and commissioning for some time. The optics are Cassegrain, with the sub-reflector supported by a transparent foam cone, so the aperture plane is quite clean (low sidelobes are very important for single-dish work). The receiver is cryogenic, and the He compressor has just been replaced with a prototype for the SKA. The receiver is purpose-built for high precision polarimetric measurements, and includes a cold load reference and noise diodes. A heterodyne system produces a baseband signal for a ROACH digital backend that is configured as a 64 channel, dual polarization spectrometer and polarimeter. Various RF hybrids and switches are used in the polarimeter to calibrate out instrumental effects. Currently the designers of the system are no longer involved in the project, and final implementation and commissioning of the telescope is still far from complete.

This project will require the candidate to complete the full design, implementation, and commissioning of the system – from the reflector and feed through the digital back-end software. Once complete, the system will be used to map the southern sky as a complement to the completed northern survey. The candidate will also be involved in the initial part of the astronomical survey.

2. Feasibility:

The timeline of the project will require the candidate to get to know the current system and status of all the sub-systems as soon as possible – preferably within the first semester of the project. Thereafter, for the rest of the first year, all identified issues must be listed and solutions suggested. During this time a research proposal must also be prepared. The second year will be spent mostly on continuing implementing fixes to identified problems, and finalising commissioning of the telescope. The final year will see the start of observations and the writing of the dissertation.

Intermediate results will be presented at international IEEE and URSI conferences, while major results will be reported in international peer-reviewed journal papers.

Given the collaborative nature of the C-BASS project, the entire PhD project will be done in very close collaboration with the other groups involved in the project. It will also require some time spent on site in Klerefontein for physical commissioning work on the telescope, and the infrastructure in place on site (mechanical workshop) can be used. Additional instrumentation (spectrum analysers etc) can be brought from Stellenbosch University (after RFI certification) to site to perform field measurements. The rest of the required measurement, simulation, and prototyping equipment and infrastructure is available within the hosting department (including anechoic antenna chamber, network and spectrum analysers, oscilloscopes, CEM simulation software, etc.).

3. SARAO research priority area:

- Radio astronomy antennas and receiver systems (including digitisation) associated with supported and hosted instruments.

This project works directly towards the completion of a SARAO hosted instrument at the Klerefontein site.

4. Qualifications, academic abilities, skills and/or experience required:

The successful candidate for this project needs a Masters (or equivalent) degree in electronic engineering, with experience in designing radio astronomy receiver systems. This project covers a very broad base of microwave engineering skills, as well as digital signal processing and instrument control. As such, a versatile candidate is sought, confident in a range of electronic engineering disciplines.