Attachment 1: Research Project Proposal

Section A: Overview of the Research Project Proposal

1. Academic level (Masters or PhD): Masters

2. Broad field of research: Engineering

3. Title of the research project: Designing a reduction pipeline for TART that can be used as an educational tool in South Africa.

4. Research project abstract:

The goal of the project is to design a reduction pipeline for TART (Transient Array Radio Telescope) which can be used as an educational tool in South Africa. TART is a 24-element open-source telescope developed at the University of Otago. The aim of the project would be to re-create the reduction steps of this instrument, i.e. imaging and calibration, in such a way that the created pipeline can be useful for teaching interferometry at the postgraduate level. Creating a measurement set converter for TART data will also be developed, so that students can also be trained in using CASA (Common Astronomy Software Applications) via TART data. Porting the proposed pipeline to an FPGA (Field Programmable Gate Arrays) will also be explored.

Section C: Full Research Project Proposal

1. Scientific merit:

The need to develop educational tools which can be used to better train students in the field of interferometry is of critical importance within the South African context. This is evident from existing projects that have been undertaken. As an example, the RATT (Rhodes Centre for Radio Astronomy Techniques & Technologies) recently developed an interferometry ipython based textbook (https://github.com/ratt-ru/fundamentals_of_interferometry). TART is a low-cost open-source 24-element aperture synthesis array radio telescope which was developed as a test-bench for imaging algorithm development, and transient event detection at the University of Otago. As this is an open source project it can be utilized as an educational tool as the data it records would be free and easily obtainable. The aim of the project would be for a student to develop a reduction pipeline for TART. This pipeline will then be used in the future to teach interferometry to postgraduate students and as such its design will be influenced by this objective (it should be step-by-step, transparent, simplistic, graphical and understandable). A measurement set conversion tool for TART will also be developed so that TART data can be reduced using CASA as well. This will allow instructors to also use TART data to teach students to process data using more conventional tools. Porting this pipeline to an FPGA will also be investigated.

2. Feasibility:

Stellenbosch University has:

- A strong collaboration in place with the research group at Otago who developed TART.
- Its own TART currently located on the roof of its Engineering building (see figure below). Dr. D. J. Ludick, who is at Stellenbosch, is also familiar with its design.
- Access to a state of the art High Performance Computing (HPC) facility and other in-house resources (including digital storage).
- Offers a course in interferometry which the student would be able to take to familiarize themselves with the field.

In the first year, a detailed literature study and revision of interferometry is expected. The student will also familiarize themselves with the TART architecture. The student will also be expected to

create a simplistic initial end-to-end TART reduction pipeline which can then be refined in the second year.

The goal of the 2nd year is to focus on refining the developed pipeline, make it interactive and transform it into a useful teaching tool. The devolpment of a conversion tool and the porting of it to an FPGA will also be done in the second year.

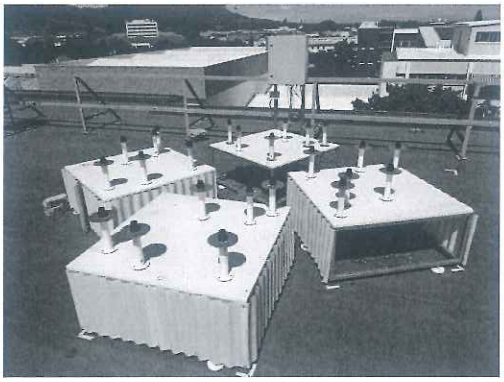

Figure: TART located on top of the Engineering building of Stellenbosch University

3. Relevance of the research proposed to the SARAO priority areas:

The skills that are acquired by the candidate will allow the student to become acquainted with interferometry. The student will be employable by the SARAO once they finish their degree. The student will also gain crucial software development skills and practices. As the developed pipeline will also be ported to an FPGA, the project falls under the following SARAO priority area: "Real-time digital signal processing instrumentation for radio astronomy". The project will also help to develop capacity within this priority area.

4. Ability or skills:

Students with an interest in programming, mathematics as well as software design will be ideal for this project.

Section D: Signatures

1. Signature of primary supervisor and date of proposal submission:

Dr. Trienko L. Grobler - 2019-09-23