Section A: Overview of the Research Project Proposal

1. Title of research project: Radio astronomy integrated filter and antenna for RFI mitigation

2. Broad area of research: Engineering

3. Academic Level of research project: MEng

4. Research project abstract/summary:

At the SKA Karoo site there exists challenges concerning interference from other radio signals resulting in reduced signal-to-interference ratio. One method of mitigating these interferences is by integrating a filtering stage into the antenna before the first amplification stage. This projects aims to develop an integrated filtering antenna.

5. Primary supervisor's details:

a. Full name: Dr Leanne Bodenstein

b. Email address: ljohnson@sun.ac.za

c. University: Stellenbosch University

6. Co-supervisor's details:

a. Full name: Dr Jacki Gilmore

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

c. University: Stellenbosch University

Section B: Details of Research Project

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.

An ongoing problem at the SKA Karoo site is interference resulting in reduced signal signal-to-interference ratio.

The main goal of this master's study is to design a system that is able to suppress various sources of RFI by incorporating integrating the antenna and band-pass filter in a single module. Another benefit to integrated filtering antennas is that saturation of active components are reduced due to the filtering stage before the amplification stage. This solution also offers a space-effective way to improve isolation by suppressing out-of-band emissions and simplify integration into a system.

Low loss variable filtering solutions will be investigated for the design of the filtering antenna to ensure a small system noise figure.

Envisioned minor contributions:

- A review of various integrated receiver topologies in view of figures-of-merit such as operational bandwidth, frequency range and system noise temperature.

Envisioned major contributions:

- Development of an integrated filtering antenna structure 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 integrated filtering antenna will be designed using commercial electromagnetic simulation software such as CST, FEKO and AWR. The prototype will be 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: System design and advanced simulation will take part in this semester.
Semester 3: Design refinement, prototype manufacturing and assembly.
Semester 4: Measurements, data analysis, and writing of dissertation.

3. Link the proposed project to one or more of the SARAO research priority areas for 2024 (refer to Section 5 of the Application Guide), and explain in some detail how the proposed research will contribute to the priority area(s).

The following research priority areas will be investigated during this project:

Research priority area: 5.2.1 Antenna, receiver, (analogue and digital) signal processing, data analysis and data recording systems associated with radio telescopes and geodesy instruments supported and hosted by SARAO.

Research priority area: 5.2.3 Hardware and data analysis systems for detecting, monitoring and locating sources of Radio Frequency Interference (RFI), including the use of telescope data (e.g., using MeerKAT or HERA visibilities to locate RFI sources).

The aim of the project is to design an integrated filtering antenna with adaptable RFI mitigation. The project will therefore contributes to radio astronomy antennas and receiver systems given the design, manufacturing and measurement of a novel integrated receiver solution. This research will also contribute to RFI source identification and the development of hardware for effective RFI mitigation strategies.

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.

Leanne Johnson

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(+33) 766 340 582

Career History

Lecturer
Permanently appointed from 01/01/2023 to present.
Research focus: Design and optimization of Microwave Filters and Antennas.

Postdoctoral research fellow at Stellenbosch University
Appointment from 01/02/2022 to 31/12/2022.
Research focus: Yield Optimisation of Millimetre-Wave Antennas using NLPLS based PCE. The position was part of a collaborative European Union EUREKA project with Chalmers University in Sweden, and Aalto and Tampere Universities in Finland.

Intern at Reutech Radar Systems
Temporary appointment from 01/09/2021 to 31/12/2021.

Tertiary education

Joint PhD. from Stellenbosch University and Universitié de Bretagne Occidentale in France, Electrical and Electronic Engineering, 2018 - 2022. PhD. topic: Advances in Pedestal Surface Integrated Waveguide Filters.

B.Ing., Electrical and Electronic Engineering (Cum Laude), 2013 – 2016.
Fields: Electromagnetics, Telecommunication, High Frequency Techniques, Microwave Filters.

Postgraduate subjects

Electromagnetics 813
Antennas 813
Microwave Networks 813
Microwave Electronics813
Method of moments 813
Microwave Filters

Presented conferences

2023, presenting at CIRP CMS conference in October.

Attended conferences

2023, 17th European Conference on Antennas and Propagation.
2018, South African IEEE Joint AP/MTT/EMC Chapter Conference.
2016, South African IEEE Joint AP/MTT/EMC Chapter Conference.

Journal Papers

Pedestal Substrate Integrated Waveguide filter with both electric and magnetic cross-couplings (SAIEEE 2020)
Authors: Leanne Johnson; Petrie Meyer; Elmine Meyer

Novel High-Q Partially Air-filled Pedestal Resonator and Filter Integrated in a Printed Circuit Board (PCB) (IEEE 2022)
Authors: Leanne Johnson; Hassan Bouazzaoui; Elmine Meyer; Petrie Meyer; Benjamin Potelon; Cédric Quendo; Rozenn Allanic

Substrate integrated waveguide pedestal filtering-antenna and -arrays for 5G radio frequency front-ends (International Journal of Microwave and Wireless Technologies)
Authors: Elmine Meyer; Cornelis Vertegaal; Leanne Johnson; Petrie Meyer; Ulf Johannsen

Conference Papers (Peer reviewed)

Non-Linear Partial-Least- Squares-based Polynomial Chaos Expansion (NLPLS-based PCE) approach for global sensitivity analysis of a High-Q Partially Air-Filled Pedestal Resonator Integrated in a Printed Circuit Board (PCB) (Presenting at CIRP CMS Oct. 2023)
Authors: Leanne Johnson; Dieter Klink; Hassan Bouazzaoui; Elmine Meyer; Benjamin Potelon; Cédric Quendo; Rozenn Allanic; Petrie Meyer

Yield and sensitivity analysis of multi-element antenna arrays using the non-linear partial least squares polynomial chaos expansion technique (UNCECOMP 2023)
Authors: Ketshabile Nfanyana; Leanne Johnson; Petrie Meyer

Optimization-Based Multimodal Characterisation of Waveguide Transitions (ICEAA 2022)
Authors: Bea Wessels; Kobus Kotze; Leanne Johnson; Werner Steyn; Petrie Meyer

Substrate Integrated Waveguide Pedestal Filtenna for Sub-6 GHz 5G Radio Frequency Front-Ends (EuCAP 2022)
Authors: Elmine Meyer; Cornelis Vertegaal; Leanne Johnson; Petrie Meyer; Ulf Johannsen

R´esonateur SIW partiellement vide en technologie PCB multicouche innovante (INM 2022)
Authors: L. Johnson; H. Bouazzaoui; E. Meyer; P. Meyer; B. Potelon; C. Quendo; R. Allanic; A. Manchec

Grants obtained

2023 ECAD Mentorship.
2023, nGap grant.
2013, Subcomm B.

Teaching and assisting

2017, Tutor Systems and Signals 315.
2017, Tutor: Electromagnetics 344.
2017, Tutor: 10th Grade Mathematics.
2018, Tutor: Electromagnetics 344.
2019, Tutor: Systems and Signals 214.
2020, Teaching assistant: Systems and Signals 244.
2022, Teaching assistant to Prof. Meyer for High-frequency technique - 814
2023, Lecturer for Systems and Signals 214
2023, Lecturer for Computer Programming 143

Student Supervision

Student name	Start date	End date	Project title	Position
Doctoral Students				
Ketshabile Nfanyana	01/01/2023	Present	Statistically Optimized Antenna Arrays for the SKA Mid-Frequency Aperture Array (MFAA)	Primary supervisor
Masters Students				
Franco Hill	01/01/2024	Present	Design and optimization of novel filtering antenna	Primary-supervisor
Thom van Zeijl	01/01/2023	Present	Inverse Design of microwave components Based on Generative Adversarial Network	Primary-supervisor
Final year project students				
Thom van Zeijl	01/01/2023	09/06/2023	Vertically-Stacked Substrate Integrated Waveguide Pedestal Filtennas	External-supervisor
Victor Ndhabambi	01/07/2023	05/12/2023	Design, Simulation, and Optimization of Ka-Band Double Ridged Rectangular Waveguide Filter	Primary-supervisor

Workshops and Developmental courses attended	2014, CHPC winter school. 2015, CHPC winter school. 2018, Creating a Thesis. 2018, Article Writing Workshop. 2018, CST workshop. 2023, Postgraduate Supervisor Training Course -PGSkillsDev. 2023, Workshop on communication by Elsibe Daneel. 2023, Professional Educational Development of Academics (PREDAC). 2023, Grant proposal writing workshop.
Achievements	2013, Received Full-time Bursary from the Department of Education of the Free State. 2014, Received second place in the National CHPC Student cluster competition. 2014, Member of the Golden Key International Honour Society. 2015, Received second place in the National CHPC Student cluster competition. 2016, First prize winners of the international ISC Student Cluster Competition. 2016, Received Cum Laude for B.Ing degree.
Leadership	Leader of a group of students competing in a computer cluster competition (2014 and 2015). Member of the House Committee of Nemesia Ladies Residence (2014/2015).
Technical Skills	CST Microwave Studio, Microwave Office, Matlab, Python, Linux, Bash OPENMPI, Programming (C/C++/Java), GIT, Circuit designing, Electrical measurements, RF measurements, Spice, LATEX.
Soft Skills	Problem solving, teamwork, verbal and literate communication, time management, project management.
Languages	English , Afrikaans (native), French (beginner).

References

Prof. P Meyer
Electrical and Electronic Engineering
Stellenbosch University
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+27 (021) 808 4322

Prof. Benjamin Potelon
IMT- Atlantique
benjamin.potelon@imt-atlantique.fr

Dr. E Meyer
Assistant Professor
Department of Electrical Engineering,
Electromagnetics Group
Eindhoven University of Technology
e.meyer@tue.nl,
+31 (0) 40 247 8890

Jacki Gilmore

Curriculum Vitae

32 Shelley Road
Kelderhof Country Village
Somerset West 7130
South Africa
+2782 232 4016
jackivdm@sun.ac.za

Personal Information

Surname	Gilmore
First Names	Jacki
Maiden Name	Van der Merwe
SA ID Number	8508290011083
Date of Birth	29/08/1985
Nationality	South African
Gender	Female

Education

2013 – 2015 **PhD (Electronic Engineering)**, *Stellenbosch University*.
Graduated March 2016

2008 – 2009 **MScEng (Electronic) *Cum Laude***, *Stellenbosch University*.
Graduated March 2010

2004 – 2007 **BEng (Electrical & Electronic)**, *Stellenbosch University*.

PhD Dissertation

title *Design of a Dual-Polarized Dense Dipole Array for the SKA Mid-Frequency Aperture Array*

supervisor Prof DB Davidson

Master's Thesis

title *The Effect of Mutual Coupling on the Noise Performance of Large Antenna Arrays*

supervisor Prof KD Palmer

Additional Postgraduate Courses and Short-courses attended

2016 **Antennas for Radio Telescopes**, *Stellenbosch University*.
European School of Antennas

2013 **Radio Astronomy for Engineers**, *Stellenbosch University*.
By Prof DB Davidson

2009 **Multi-field and Multi-beam science with the SKA**, *University of Oxford*.
MCCT-SKADS Workshop

2008 **Antennas**, *Stellenbosch University*.
By Prof KD Palmer

2008 **Radio-Astronomy: Fundamentals and New Instruments**, *University of Alcala*.
MCCT-SKADS Workshop

Languages

Afrikaans **Native/Bilingual Ability**

English **Native/Bilingual Ability**

German **Conversational** *Goethe-Zertifikat Level B2 Passed in 2009*

Experience

Lecturing Experience

2021 – 2023 **Senior Lecturer**, *Stellenbosch University*.

2016 – 2021 **Lecturer**, *Stellenbosch University*.

2015 – 2016 **Junior Lecturer**, *Stellenbosch University*.

Undergraduate teaching responsibilities and approximate class sizes:
Systems and Signals 214 (Lectures, Practicals and Tutorials for 160 students)
Design E314 (Practicals for 220 students)
Electro-Techniques 143 (Module Convenor for 1000 students)
Electronics 365 (Lectures, Practicals and Tutorials for 100 students)
Electromagnetics 344 (Lectures, Practicals and Tutorials for 130 students)
Supervision of final-year projects.
Other undergraduate teaching-related experience and projects:
Took part in the restructuring of the module chain for Electronics. Was responsible for defining the module content for Systems and Signals 214
Ran various "Blended-Learning" projects.
Postgraduate Teaching:
Postgraduate Antenna Course
Postgraduate HF Simulation and Measurements Course
Research supervision of masters and doctoral students

Research

2019 – 2023 **Associate Editor**, *URSI Radio Science Letters*.

2017 – 2023 **Early Career Representative**, *International Union of Radio Science (URSI)*.
Commission J - Radio Astronomy

2015 – present **Reviewer for International Journals**.
IEEE Transactions on Antennas and Propagation
URSI Radio Science
URSI Radio Science Letters

2015 – present **Reviewer for International Conferences**.
European Conference on Antennas and Propagation (EuCAP)
URSI General Assembly (GASS)
URSI Atlantic Radio Science Meeting (AT-RASC)
URSI Pacific Radio Science Meeting (AP-RASC)

Industry Experience

January 2013 – March 2013 **Consultant (Part Time)**, *Shrike Marine*, Cape Town.
Oversee environmental qualification tests and compile configuration documentation for a military project.

October 2011 – December 2012 **Development Engineer**, *Shrike Marine*, Cape Town.
Design and build electronic equipment for military applications. Write development specifications and compile and maintain other relevant configuration documentation.

June 2011 – October 2011 **Technical Support Engineer**, *Kathrein South Africa*, Stellenbosch.
Provide technical support to sales personnel and clients on Kathrein products. Source products and suppliers for products outside the standard Kathrein portfolio. Provide technical insight into competitor products for comparison.

November 2009 – May 2011 **Researcher/Engineer**, *Stellenbosch University*, Stellenbosch.
Design and build electronic equipment for medical applications.

Journal Publications

2023 A Faustmann, L Schwardt, V van Tonder, J Gilmore, S Buchner, "Investigating the high time-resolution statistics of pulsar radio signals using spectral self-noise", Monthly Notices of the Royal Astronomical Society

2021 C. R. Wilke, S. J. Wijnholds and J. Gilmore, "Calibratability of Mid-Frequency Aperture Arrays with Self-Holography," in Journal of Astronomical Telescopes, Instruments, and Systems

2021 C. R. Wilke, S. J. Wijnholds and J. Gilmore, "Calibratability of Aperture Arrays Using Self-Holography," in IEEE Transactions on Antennas and Propagation

2020 A. Faustmann, J. Gilmore, V. van Tonder, M. Serylak, "A Bispectral Analysis of the Radio Emissions of Pulsar J0437-4715", Journal of Astronomical Instrumentation

2015 J. Gilmore and D.B. Davidson, "Suppressing Undesired Common-mode Resonances in Connected Antenna Arrays", IEEE Transactions on Antennas and Propagation

Conference Publications

October 2023 S. Snyman and J. Gilmore, "Wideband Antenna Design for Time Domain RFI Measurements," 2023 International Conference on Electromagnetics in Advanced Applications (ICEAA), Venice, Italy, 2023, pp. 399-402

August 2023 V. van Tonder, L. Schwardt, A. Faustmann, J. Gilmore and S Büchner, "Spectral Kurtosis applied to tied-array beamformer for pulsar observations," URSI GASS 2023 XXXVth General Assembly and Scientific Symposium, 2023, pp. 1-4

March 2023 S. Manas and J. Gilmore, "Using a Reverberation Chamber to Estimate the Noise Figure of Integrated Low Noise Amplifiers," 2023 17th European Conference on Antennas and Propagation (EuCAP), Florence, Italy, 2023, pp. 1-4

May 2022 V. van Tonder, L. Schwardt, A. Faustmann and J. Gilmore, "Bispectra of simulated GPS data for potential RFI mitigation," 2022 3rd URSI Atlantic and Asia Pacific Radio Science Meeting (AT-AP-RASC), 2022, pp. 1-4

May 2022 A. Faustmann, L. Schwardt, V. van Tonder, J. Gilmore and S. Buchner, "A Short-Time Stationarity Test of Radio Signals From the Vela Pulsar Using Polyspectra," 2022 3rd URSI Atlantic and Asia Pacific Radio Science Meeting (AT-AP-RASC), 2022, pp. 1-4

March 2022 S. Manas, J. Gilmore and E. Meyer, "A Local Hot-Cold Antenna Measurement System," 2021 51st European Microwave Conference (EuMC), 2022, pp. 510-513

March 2021 Alexander Faustmann, Jacki Gilmore, Vereesè van Tonder, Maciej Serylak, "Higher-Order Spectral Analysis of Radio Pulsar Bursts Using MeerKAT", 2021 15th European Conference on Antennas and Propagation (EuCAP), Online

August 2020 C. R. Wilke, S. J. Wijnholds and J. Gilmore, "Self-Holography- Slimming Down Calibration of Large Aperture Arrays," 2020 XXXIIIrd General Assembly and Scientific Symposium of the International Union of Radio Science, Rome, Italy

August 2020 A. Faustmann, J. Gilmore "An Investigation of Nonlinear Adaptive Space-Time Processing for the Real-Time Detection of Extraterrestrial Transients",2020 XXXIIIrd General Assembly and Scientific Symposium of the International Union of Radio Science, Rome, Italy

September 2019 Helgard Oosthuizen, Jacki Gilmore "SLM 3D-Printed Active Phased Array for X-Band Satellite Communications",2019 IEEE-APS Topical Conference on Antennas and Propagation in Wireless Communications (APWC), Granada, Spain

September 2019 Kobus Kotzé, Jacki Gilmore "SLM 3D-Printed Horn Antenna for Satellite Communications at X-band",2019 IEEE-APS Topical Conference on Antennas and Propagation in Wireless Communications (APWC), Granada, Spain

September 2019	Kristian Zarb Adami, Andrew Faulkner, Eloy de Lera Acedo, Nima Razavi-Ghods, Hardie Pienaar, Jens Abraham, Edgar Colin-Beltran, Keith Grainge, Anthony K Brown, David Zhang, Laith Rashid Danoon, David Prinsloo, Rui Cao, Dirk de Villers, Jacki Gilmore "The Mid-Frequency Aperture Array", 2019 International Conference on Electromagnetics in Advanced Applications (ICEAA), Granada, Spain
March 2019	C.R. Wilke, S.J. Wijnholds, J. Gilmore "Performance Improvement of Self-Holography Based Aperture Array Station Calibration", 2019 13th European Conference on Antennas and Propagation (EuCAP), Krakow, Poland
October 2018	D.B. Davidson, A. Sutinjo, R. Wayth, D. Ung, D.I.L. de Villiers, J.G. bij de Vaate, R. Baelemans, A.B. Smolders "Recent Progress on the Design of Aperture Arrays for Radio Astronomy", 2018 IEEE Radio and Antenna Days of the Indian Ocean (RADIO), Grand Port, Mauritius
May 2018	C. R. Wilke, J. Gilmore "Quantization and Mutual Coupling Effects on Beamforming in Dense Phased Arrays", 2nd URSI Atlantic Radio Science Meeting (URSI AT-RASC), Gran Canaria, Spain
May 2018	C.J Smale, J. Gilmore "Thermal Analysis of a Dense Dipole Array for the SKA Mid-Frequency Aperture Array", 2nd URSI Atlantic Radio Science Meeting (URSI AT-RASC), Gran Canaria, Spain
September 2017	C. R. Wilke, J. Gilmore and D. B. Davidson "Reducing the maximum quantization scan error in dense phased arrays", 2017 International Conference on Electromagnetics in Advanced Applications (ICEAA), Verona, Italy
June 2017	J. Gilmore, K.E. Wolff and M. Bladergroen "The night before the test: Electrical engineering students' use of online resources to prepare for assessment", 4th Biennial Conference of the South African Society for Engineering Education (SASEE), Cape Town, South Africa
April 2017	J. Gilmore, C.R. Wilke and D.B. Davidson "Calculating the maximum quantization scan error in dense phased arrays", European Conference on Antennas and Propagation (EuCAP), Paris, France
April 2016	J. Gilmore and D.B. Davidson, J.G. Bij de Vaate "Progress on the Development of a Dual-Polarized Dense Dipole Array", Accepted to the European Conference on Antennas and Propagation (EuCAP), Davos, Switzerland
July 2015	J. Gilmore and D.B. Davidson, J.E. Noordam "A Dense Dipole Array for Mid-Frequency Aperture Arrays", 2015 IEEE International Symposium on Antennas and Propagation & USNC/URSI National Radio Science Meeting, Vancouver, Canada
April 2014	J. Gilmore and D.B. Davidson, "A Review of Full-Wave and Reduced-Order Modelling Methodologies for Dense Aperture Arrays", European Conference on Antennas and Propagation (EuCAP), The Hague, Netherlands

Postgraduate Supervision

Doctoral Students

Name of student	Nationality	Starting Date	Graduation Date (Projected if unfinished)	Project Title	Co-Supervisor
Cornelis Wilke	South African	January 2018	December 2021	Efficient Multi-Beam Calibration of Antenna Arrays	Prof. Stefan Wijnholds (ASTRON)
Lanche Grootboom	South African	February 2020	December 2023	Active Array Measurements	Prof. Petrie Meyer
Alexander Faustmann	South African	January 2021	March 2023	Detection of Weak Radio Pulsars Using Non-Gaussian Statistics	Dr. Ludwig Schwardt (SARAO)
Vereese van Tonder	South African	January 2021	March 2024	GPU Acceleration of Pulsar Detection using Higher-Order Signal Statistics	Dr. Ludwig Schwardt (SARAO)
Sean Manas	South African	March 2021	December 2024	Using a Reverberation Chamber as an Evaluation Tool for Integrated Receiver Systems	

Masters Students

Name of student	Nationality	Starting Date	Graduation Date (Projected if unfinished)	Project Title	Co-Supervisor
Cornelis Wilke	South African	January 2016	March 2018	Quantization Effects on Beamforming in Dense Phased Arrays	Prof. David Davidson
Corey Smale	South African	January 2017	March 2019	Thermal Analysis of a Dense Dipole Array for the SKA Mid-Frequency Aperture Array	
Helgard Oosthuizen	South African	January 2018	March 2020	Active Antenna Array Design using Additive Manufacturing Techniques	
Sean Manas	South African	January 2019	March 2021	Design of a Hot/Cold Antenna measurement facility	Dr Elmine Meyer (TU/e)
Dylan Fry	South African	January 2019	December 2021	Differential LNA Design for the SKA Mid-Frequency Aperture Array	Dr Elmine Meyer (TU/e)
Alexander Faustmann	South African	January 2019	PhD Upgrade: November 2020	Higher-Order Spectral Analysis of Radio Pulsar Bursts	
Millicent Mguni	South African	January 2019	March 2022	Portable RFI Detection System	Dr Gideon Wiid (CPUT) Dr Arno Barnard
Aneshka Bothma	South African	January 2020	December 2024	Reverberation chamber stirrer design	Dr Gideon Wiid (UCT)
Shane Hattingh	South African	January 2020	March 2023	Design of an Active Dense Dipole Array for the SKA Mid-Frequency Aperture Array	
Sandra Snyman	South African	January 2022	December 2023	Wide-Band Antenna Design for Time-Domain Measurements in a Reverberation Chamber	