Section A: Overview of the Research Project Proposal

1. Title of research project: High-Stability Band-Defining Filters for Wideband Radio Astronomy Receivers

2. Broad area of research: Engineering

3. Academic Level of research project: M.Eng

4. Primary supervisor's details:

a. Full name: Dr Leanne Bodenstein

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

c. University: Stellenbosch University

5. Co-supervisor's details: N/A

6. Research project abstract/summary:

Radio astronomy receivers operate in increasingly congested spectral environments, where strong out-of-band and in-band radio frequency interference (RFI) can degrade sensitivity, compress low-noise amplifiers (LNAs), and introduce intermodulation products that corrupt astronomical observations. Wideband receivers such as those used in MeerKAT and future SKA-Mid systems require band-defining filters that exhibit low insertion loss, high selectivity, excellent stability, and robustness to strong-signal conditions.

This Master's project will focus on the design, analysis, and validation of high-stability band-defining microwave filters for wideband radio astronomy receivers. The student will design a low-loss, wideband bandpass filter suitable for a selected radio astronomy band (e.g., L-band or UHF), with emphasis on minimizing insertion loss to preserve system noise temperature while maintaining sharp rejection of adjacent RFI-dense bands. The project will further investigate filter–LNA interaction, including stability analysis, impedance sensitivity, and the impact of strong interfering signals on receiver performance.

The project aims to design, implement, and comparatively evaluate high-stability, low-loss band-defining filters, investigating multiple filter topologies to determine the optimal architecture for robust, RFI-resilient radio astronomy receiver front-ends. Prototype filters will be fabricated and experimentally characterized to validate and compare the designs.

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. Link the proposed project to one or more of the SARAO research priority areas for 2027 (refer to section 4), and explain in some detail how the proposed research will contribute to the priority area(s).**

Radio astronomy receivers operate in increasingly congested spectral environments, where strong out-of-band transmissions can degrade sensitivity, compress low-noise amplifiers (LNAs), and generate intermodulation products that contaminate astronomical observations. A key engineering challenge is the development of band-defining filters that provide low insertion loss (to preserve system noise temperature), strong out-of-band rejection (to mitigate radio frequency interference), and stable impedance behaviour across wide operational bandwidths. While filter synthesis methods are well established, comparatively limited work has addressed receiver-level robustness — particularly the interaction between filter topology, stability margins, nonlinear strong-signal behaviour, and fabrication tolerances in radio astronomy front-ends.

This project will design and comparatively evaluate multiple high-stability band-defining filter topologies for a selected radio astronomy band (e.g., L-band or UHF). The student will perform full-wave electromagnetic design, circuit-level co-simulation with representative LNAs, stability analysis, nonlinear performance assessment under strong-signal conditions, and tolerance-aware robustness evaluation. By comparing planar, substrate-integrated waveguide (SIW), and cavity/waveguide-based implementations under identical specifications, the project will establish structured topology-dependent trade-offs in insertion loss, selectivity, impedance stability, power handling, and manufacturability.

The proposed research directly aligns with SARAO's 2027 priority area of antenna and receiver systems associated with radio telescopes supported and hosted by SARAO. Improved band-defining filters enhance receiver resilience, protect dynamic range, and reduce susceptibility to RFI, thereby supporting the integrity of downstream digital signal processing systems. The project also contributes to the engineering testing and qualification of radio telescope subsystems (Master's priority) by developing tolerance-aware design methodologies and comparative performance guidelines applicable to SARAO-supported instrumentation.

This research aligns directly with the following SARAO research priority areas for 2027:

- 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.

- Hardware and data analysis systems for detecting, monitoring and locating sources of Radio Frequency Interference (RFI).

2. Feasibility: outline the methods that will be used to achieve the objectives.

The proposed research project is technically feasible within the scope and time frame of a Master's degree and will be carried out using established RF and microwave engineering methodologies supported by existing facilities and expertise at Stellenbosch University.
The project will be executed through the following stages:

1. Literature Review and Problem Definition
    - Conduct a focused literature review on band-defining filters for radio astronomy receivers, including wideband filter topologies (planar, SIW, cavity/waveguide), low-loss design approaches, and reported strategies for stability and strong-signal resilience.
    - Review relevant RFI environments and receiver front-end constraints for radio astronomy bands (e.g., L-band or UHF).
    - Translate the findings into clear electrical specifications and receiver-level requirements (insertion loss, return loss, rejection, group delay variation, power handling), including acceptable noise temperature degradation and stability margins.

2. Topology Selection and Initial Synthesis
    - Select multiple candidate filter topologies (e.g., planar microstrip/stripline, substrate-integrated waveguide (SIW), and cavity or waveguide-based implementations).
    - Use established microwave filter synthesis techniques to generate initial designs for each topology.
    - Develop equivalent circuit models and baseline layouts for simulation.

3. Electromagnetic Simulation and Design Optimisation
    - Perform full-wave electromagnetic (EM) simulations using established tools (e.g., CST or HFSS).
    - Optimize each topology to achieve low insertion loss, high selectivity, and stable impedance behaviour across the operating band.
    - Extract S-parameters and field distributions to support receiver-level evaluation.

4. Receiver-Level Co-Simulation and Stability Analysis
    - Integrate EM-derived models into circuit simulation environments (e.g., ADS).
    - Evaluate filter–LNA interaction through stability analysis (K-factor, μ-factor), impedance sensitivity studies, and reflection coefficient assessment.
    - Investigate nonlinear and strong-signal behaviour, including potential compression and intermodulation performance under representative interference conditions.
5. Prototype Fabrication
    - Select at least two optimized topology for implementation.
    - Fabricate the prototypes using available PCB manufacturing or precision machining facilities.

- Ensure practical considerations such as connector transitions, housing, and assembly tolerances are incorporated.

6. Experimental Measurement and Validation
    - Perform experimental characterization using vector network analysis to measure S-parameters and group delay.
    - Compare measured results with simulated predictions.
    - Assess compliance with defined electrical and stability requirements.
    - Conduct a structured comparative evaluation of all investigated topologies.

7. Analysis and Documentation
    - Document findings in the form of a Master's thesis and prepare at least one conference or journal publication.

3. Skills development: Describe the skills the student will develop from the research project.

Through the completion of this research project, the student will develop a range of advanced technical and research skills that are directly applicable to radio astronomy receiver instrumentation and align with SARAO's engineering priorities.

Technical and Engineering Skills:

- RF and microwave band-pass filter design, including wideband synthesis and topology comparison (planar, SIW, cavity/waveguide).
- Full-wave electromagnetic simulation using commercial tools such as CST Microwave Studio, Altair FEKO, or Ansys HFSS.
- Circuit-level co-simulation and filter–LNA interaction analysis using RF design software (e.g., ADS).
- RF front-end stability analysis (K-factor, μ-factor) and impedance sensitivity assessment.
- Nonlinear performance evaluation, including strong-signal behaviour and intermodulation considerations.
- Practical RF measurement techniques using vector network analysers for S-parameter and group delay characterization.
- Interpretation and correlation of simulated and measured RF performance data.

Research and Analytical Skills:

- Critical review and synthesis of technical literature relevant to radio astronomy receiver systems and RFI resilience.
- Translation of system-level radio astronomy requirements into quantitative engineering design constraints.
- Comparative engineering trade-off analysis between electrical performance, stability margins, robustness, and manufacturability.

- Sensitivity analysis and structured performance evaluation across multiple design implementations.
- Quantitative data analysis and technical reporting of simulation and experimental results.

Professional and Transferable Skills:

- Independent engineering design and analysis within a structured research framework.
- Technical writing and preparation of a Master's dissertation.
- Oral presentation of technical work to academic and engineering audiences.
- Project planning and time management within a defined research timeline.

The skills developed through this project are directly applicable to the design, testing, qualification, and optimization of radio telescope receiver front-ends. The student will gain expertise in RF subsystem engineering that supports SARAO's objectives of strengthening national capacity in radio astronomy instrumentation development and RFI-resilient receiver design.

4. Provide details (and confirmation) on the availability of required data / access to required equipment / availability of research facilities and other resources required.

The proposed research project is technically feasible within the scope and time frame of a Master's degree and will be undertaken using established RF and microwave engineering methodologies supported by existing infrastructure at Stellenbosch University.

The integrated filtering antenna will be designed using commercial electromagnetic simulation software, including CST Microwave Studio, Altair FEKO, and AWR Microwave Office. These tools will be used for full-wave electromagnetic analysis, circuit-level co-simulation, and performance optimisation of the proposed filter–antenna structure. Design targets will be defined based on radio astronomy receiver requirements, with particular emphasis on insertion loss, selectivity, bandwidth, and impact on system noise performance.

Following simulation and optimisation, a prototype of the integrated filtering antenna will be manufactured using available in-house fabrication facilities. Experimental validation will be conducted using the Department of Electrical and Electronic Engineering's RF and antenna measurement infrastructure, including vector network analysers and a well-equipped antenna test range. An established workshop with qualified technical staff is available to support fabrication and assembly, ensuring that prototype development and testing can be completed within the project timeline.

To support computationally intensive full-wave simulations and parametric optimisation studies, the project will have access to a dedicated high-performance workstation. The proposed computing platform consists of a modern multi-core CPU and GPU-accelerated architecture suitable for large-scale electromagnetic simulations, enabling efficient handling of high-resolution models and iterative design processes. This computational capability significantly reduces simulation turnaround time and mitigates risks associated with limited computing resources.

The combination of commercial simulation tools, in-house fabrication and measurement facilities, experienced technical support, and adequate computational resources ensures that the project objectives can be realistically achieved. The proposed methodology relies on proven engineering practices and does not require access to external or experimental infrastructure, making the project well suited to completion within a Master's research framework.

5. Include expected milestones and associated time-frames towards attaining the overall objectives of the project.

The proposed research project will be conducted over the standard duration of a Master's degree.

<u>2027 - Semester 1:</u>

During the first phase of the project, a comprehensive literature review will be conducted on band-defining filters for radio astronomy receivers, with particular emphasis on wideband planar, substrate-integrated waveguide (SIW), and cavity or waveguide-based implementations. Based on this review, electrical specifications will be defined for a selected radio astronomy band (e.g., L-band or UHF), including insertion loss, bandwidth, rejection, and group delay requirements. Receiver-level performance criteria will also be established, such as stability margins and allowable noise temperature degradation when cascaded with a representative low-noise amplifier. Guided by these requirements, suitable candidate filter topologies will be selected, and initial filter synthesis will be performed to develop preliminary circuit models for subsequent electromagnetic simulation and optimization.

Milestone: Written literature review and clearly defined design specifications.

<u>2027 - Semester 2:</u>

In the second phase of the project, detailed geometries will be developed for each selected filter topology, followed by full-wave electromagnetic simulations to accurately model their performance. Iterative optimization will be performed to achieve the required insertion loss, bandwidth, and out-of-band rejection levels in accordance with the defined specifications. From the optimized models, S-parameters will be extracted and analysed to evaluate impedance behaviour across the operating band. Preliminary stability assessments and filter–LNA interaction analyses will then be conducted to ensure that each topology meets receiver-level performance and robustness requirements.

Milestone: At least two validated simulated design meeting initial performance targets and documented comparative performance data.

<u>2028 - Semester 3:</u>

In the third phase of the project, receiver-level co-simulation will be conducted by integrating the optimized filter models with a representative low-noise amplifier to evaluate stability margins and nonlinear performance under realistic operating conditions. This will include assessment of potential compression effects and overall robustness in the presence of strong signals. Based on a structured comparison of electrical performance, stability behaviour, tolerance sensitivity, and manufacturability considerations, the most suitable topology will be identified. At least one selected filter design will then be fabricated as a prototype for experimental validation.

Milestone: At least two fabricated prototypes and structured comparative evaluation report.

2028 – Semester 4:

In the final phase of the project, the fabricated prototype will undergo experimental characterization using vector network analysis to measure key performance parameters such as insertion loss, return loss, and bandwidth. The measured results will be compared with simulated predictions to validate the modelling and optimization approach. A comprehensive comparative trade-off analysis across all investigated topologies will then be completed, leading to the development of practical design guidelines for band-defining filters in radio astronomy receiver front-ends. The outcomes of the research will be documented in a Master's dissertation, and, where feasible, prepared for submission to a peer-reviewed conference or journal.

Milestone: Validated experimental results, completed Master's dissertation, and publication-ready manuscript.

6. If relevant, describe any qualifications, academic abilities, skills and/or experience that a student should have to successfully deliver on the objectives of the research proposed.

N/A

Leanne Bodenstein

LECTURER

Stellenbosch University
Department of Electrical and Electronic Engineering
Bosman St, Stellenbosch Central Stellenbosch,
Western Cape, 7600

ljohnson@sun.ac.za
Leannej.1409@gmail.com

+277 949 55244

Summary

Dr. Leanne Bodenstein is a microwave engineer and lecturer at Stellenbosch University, specializing in the design, optimization, and statistical modelling of advanced RF and microwave components. Her work focuses on high-performance filters, antennas, and emerging microwave sensing technologies, with particular expertise in stochastic modelling, optimization methods, and machine-learning-assisted design workflows. She completed a joint PhD on substrate integrated waveguide (SIW) waveguide filters and went on to a Postdoctoral Research Fellowship at Stellenbosch University, contributing to a European EUREKA consortium with Chalmers University, Aalto University, and Tampere University. Her postdoctoral work centered on yield optimization of millimeter-wave antennas using NLPLS-based polynomial chaos expansion. She is currently involved in research on new manufacturing techniques for microwave devices, and is expanding into microwave sensors for biomedical applications.

Career History

01/01/2024 - present

Lecturer
Electrical and Electronic Engineering
Stellenbosch University

01/01/2023 - 31/12/2023

Junior Lecturer
Electrical and Electronic Engineering
Stellenbosch University

01/03/2022 - 31/12/2022

Postdoctoral research fellow
Electrical and Electronic Engineering
Stellenbosch University

01/09/2021 - 31/12/2021

Internship
Reutech Radar Systems, Stellenbosch, South Africa

Education

2017 - 2022

Joint PhD. in Electrical and Electronic Engineering from Stellenbosch University and Universitie de Bretagne Occidentale
Dissertation: "Advances in Pedestal Surface Integrated Waveguide Filters"

2013 - 2016

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

Grants

2023 - 2025

Early Career Academic Development program
ZAR 15 000 p.a.

2023 - 2028

nGap pragram
(NEW GENERATION OF ACADEMICS PROGRAMME)
ZAR 932 799,60

2025 - 2027

NRF Thuthuka grant
ZAR 230 000 p.a.

2023 - 2025

Subcommittee B project funding
Institutional funds
ZAR 65 000 p.a.

Teaching experience

Teaching experience includes lecturing second-year Systems and Signals, coordinating postgraduate training in stochastic modelling and optimization, and delivering specialized content in RF and microwave engineering. Responsibilities cover course design, assessment development, and academic administration, as well as supervising PhD, master's, and undergraduate final-year research projects. Additional teaching activities involve mentoring students, guiding independent research, and contributing to curriculum development within the department.

Systems and Signals 244	2024 – 2025	Coordinator
Systems and Signals 214	2024 – 2025 2023	Coordinator Lecturer
Computer Programming 143	2023	Lecturer
Microwave Networks 814	2024 – 2025	Lecturer

Research experience

Research focuses on the design, modelling, and optimization of advanced RF and microwave components, including high-Q resonators, SIW filters, waveguide transitions, and integrated filtering-antenna structures. Expertise includes stochastic modelling, yield optimization, and machine-learning-assisted design methods, supported by experience in both academic research and international industry-aligned collaborations. Current work explores new manufacturing techniques for millimeter-wave structures and the development of microwave sensors for biomedical applications, alongside the supervision of PhD, master's, and undergraduate final-year research students.

01/01/2023 - 31/12/2025

Doctoral Student: Ketshabile Nfanyana
Primary supervisor
Project: "Statistically Optimized Antenna Arrays for the SKA Mid-Frequency Aperture Array (MFAA)"

2024 - present

Doctoral Student: Steven Watts
Primary supervisor
Project: "Machine Learning- Enabled Design of Microwave Components for astronomy applications"

2023 - present

Doctoral Student: Thom van Zeijl - Eindhoven University of Technology
External collaborator
Project: "Miniaturized antenna with configurable radiation pattern based on pedestal loaded cavity resonator"

2023 - present

Masters Student: Franco Hill
Primary supervisor
Project: "Design and optimization of novel filtering antenna"

2024 - present

Masters Student: Roche Faure
Primary supervisor
Project: "Design and optimization of electromagnetic sensors"

2025

Final year student: Viva Rattue
Primary supervisor
Project: "A Wearable Flexible Energy-Autonomous Filtenna for Ethanol Detection at 2.45 GHz"

2025

Final year student: Pierre Louis Dupr´e Fourie
Primary supervisor
Project: "A Two-port Microwave Sensor for Liquid Fertilizer Concentration Measurement"

2025

Final year student: Ayrton Pask
Primary supervisor
Project: "Sensitivity and Yield Analysis of an Electromagnetic Sensor Using PCE"

2025

Final year student: KK Poonasamy
Primary supervisor
Project: " Microwave Sensor Loaded with Complementary Curved Ring Resonator for Material Permittivity Detection "

2024

Final year student: GE Mudau
Primary supervisor
Project: "Innovative Material Characterization: Statistical modelling of electromagnetic sensors"

2024	**Final year student:** Hamida Mustapha Primary supervisor Project: “Design and Optimization of a Microstrip Image Rejection Filter Centered at 11.85 GHz”
2024	**Final year student:** Astha Sirothia Primary supervisor Project: “Microstrip Phased Array Antenna Design and Performance Analysis for Non-Invasive Biomedical Applications”
2024	**Final year student:** Reece Van Woerkom Primary supervisor Project: “Design and Implementation of a Filtenna for Sub-6 GHz 5G Radio Frequency Front-Ends”
2024	**Final year student:** M Engelbrecht Primary supervisor Project: “Anti-Aliasing Band-Pass Filter”
2023	**Final year student:** Victor Ndhabambi Primary supervisor Project: “Design, Simulation, and Optimization of Ka-Band Double Ridged Rectangular Waveguide Filter”

Publications

Journal publications

Meyer E, Vertegaal C, Johnson L, Meyer P, Johannsen U. Substrate integrated waveguide pedestal filtering-antenna and -arrays for 5G radio frequency front-ends. International Journal of Microwave and Wireless Technologies. 2023;15(8):1283-1290. doi:10.1017/S175907872300034X

L. Johnson et al., "Novel High-Q Partially Air-Filled Pedestal Resonator and Filter Integrated in a Printed Circuit Board (PCB)," in IEEE Access, vol. 10, pp. 101160-101167, 2022, doi: 10.1109/ACCESS.2022.3208351.

L. Johnson, P. Meyer and E. Meyer, "Pedestal substrate integrated waveguide filter with both electric and magnetic cross-couplings," in SAIEE Africa Research Journal, vol. 111, no. 1, pp. 36-43, March 2020, doi: 10.23919/SAIEE.2020.9007883.

Journal papers in review

K. Nfanyana, L. Bodenstein, and P. Meyer, “Yield Optimization of a KA Band Ridge Waveguide Filter by Feature-Based Non-Linear Partial Least-Squares Polynomial Chaos Expansion Surrogates and Particle Swarm”, Submitted to: IEEE Access

K. Nfanyana, L. Bodenstein, and P. Meyer, “Parametric Tolerance Optimization of a Ka Band Ridge Waveguide Filter Using Feature-based Non-Linear Partial Least-Squares Polynomial Chaos Expansion Surrogates and Particle Swarm”, Submitted to: IEEE Access

S.Watts, RP. Theart, and L Bodenstein, “Simulated Scattering Parameter Dataset for a Randomly Generated Non-Parameterized Microstrip Bandpass Filter between 1 and 10 GHz”. Submitted to: Data in Brief

Conference papers (Peer - reviewed)

L. Bodenstein, P. Meyer, “Filtenna Based on a Ridged Waveguide Filter Integrated with a Vivaldi Antenna for 5G Applications”, IEEE APWC IEEE-APS ,Italy, Palermo, 2025.

K. Nfanyana, L. Bodenstein, P. Meyer, V. Viikari, J. Bergman and J. A. Laurinaho, "Swarm Intelligence Parametric Yield Optimization of Microwave Devices Using the Non-Linear Partial Least-Squares Polynomial Chaos Expansion Technique," 2025 19th European Conference on Antennas and Propagation (EuCAP), Stockholm, Sweden, 2025, pp. 1-5, doi: 10.23919/EuCAP63536.2025.10999511.

L. Johnson, D. Klink, W. Steyn and P. Meyer, "Efficient yield optimization of a 100 GHz filter using the novel combination of a performance guided random walk and NLPLS-based PCE," 2024 54th European Microwave Conference (EuMC), Paris, France, 2024, pp. 1008-1011, doi: 10.23919/EuMC61614.2024.10732390.

L. Johnson et al.," 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)", CIRP CMS 2023.

E. Meyer, C. Vertegaal, L. Johnson, P. Meyer and U. Johannsen, "Substrate Integrated Waveguide Pedestal Filtenna for Sub-6 GHz 5G Radio Frequency Front-Ends," 2022 16th European Conference on Antennas and Propagation (EuCAP), Madrid, Spain, 2022, pp. 1-5, doi:10.23919/EuCAP53622.2022.9769565.

B. Wessels, K. Kotze, L. Johnson, W. Steyn and P. Meyer, "Optimization-Based Multimodal Characterization of Waveguide Transitions," 2022 International Conference on Electromagnetics in Advanced Applications (ICEAA), Cape Town, South Africa, 2022, pp. 343-348, doi: 10.1109/ICEAA49419.2022.9899884.

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

Conference papers in review

T.P. van Zeijl, P. Meyer, L. Bodenstein, U. Johannsen, and E. Meyer, "Miniaturized Antenna with Configurable Radiation Pattern Based on SIW Pedestal Loaded Cavity Resonator", submitted to: EuCAP 2026

Presentations and invited lectures

2024

Paper Presentation
"Swarm Intelligence Parametric Optimization of Microwave Devices using the Non-Linear Partial-Least Squares Polynomial Chaos Expansion Technique", The 9th European Congress on Computational Methods in Applied Sciences and Engineering ECCOMAS Congress 2024, 3 – 7 June 2024, Lisboa, Portugal

2024 - 2025

Workshop
Microwave Networks – Stellenbosch University

Professional training

2024

Grant proposal writing workshop
Stellenbosch University, Stellenbosch

Research Development of Engineering Academics in Higher Education (REACH)
Stellenbosch University, Stellenbosch

2023

Professional Educational Development of Academics (PREDAC)
Stellenbosch University, Stellenbosch

Workshop on communication by Elsibe Daneel (DRD)
Stellenbosch University, Stellenbosch

Postgraduate Supervisor Training Course (PGSkillsDev)
Stellenbosch University, Stellenbosch

		Workshop on Recent Advances in Topologies, Technologies and Practical Realizations of Microwave Sensors European Microwave Week, France, Paris, 2024
	2018	**CST workshop** Stellenbosch University, Stellenbosch
		Article Writing Workshop (DRD) Stellenbosch University, Stellenbosch
		Workshop on Creating a Thesis (DRD) Stellenbosch University, Stellenbosch
	2014 - 2015	**CHPC winter school** Cape Town and Nelspruit, South Africa

Professional Organizations

2025 - present	**Professional Engineer** ECSA - Engineering Council of South Africa 202503915
2017 - present	**IEEE member** 96276303

Languages

Afrikaans	Native language
English	Advances speaking, reading and writing
French	Beginner

Skills

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.

References

Prof. P Meyer	Electrical and Electronic Engineering Stellenbosch University, pmeyer@sun.ac.za, +27 (021) 808 4322
Prof. JAA Engelbreght	Electrical and Electronic Engineering Stellenbosch University, jengelbr@sun.ac.za, +27 21 808 4334
Dr. E Meyer	Assistant Professor Department of Electrical Engineering, Electromagnetics Group Eindhoven University of Technology, e.meyer@tue.nl, +31 (0) 40 247 8890

Electrical & Electronic Engineering
Elektriese & Elektroniese Ingenieurswese

Stellenbosch
UNIVERSITY
IYUNIVESITHI
UNIVERSITEIT

ENGINEERING
EYOBUNJINELI
INGENIEURSWESE

26 February 2026

To whom it may concern

<u>Confirmation of Data Collection Facilities for Postgraduate Research</u>

This letter is to confirm that the Department of Electrical and Electronic Engineering at Stellenbosch University has the following software licences and data collection facilities available for postgraduate research.

<u>Software Licences for Full-Wave Electromagnetic Simulations:</u>
- Altair Feko
- CST Microwave Studio
- Ansys HFSS

<u>Software Licenses for RF system design:</u>
- AWR Microwave Office
- Keysight ADS

<u>Software License for Asymptotic Electromagnetic Analysis:</u>
- GRASP by TICRA

<u>Software License for Data Analysis and Mathematical Modelling:</u>
- MATLAB

<u>RF Measurement Equipment and Facilities</u>
- Vector Network Analysers
- Spectrum Analysers
- RF Signal Generators
- Oscilloscopes
- Anechoic Antenna Measurement Range
- Reverberation Chamber

Kind regards,

Dirk de Villiers

forward together
sonke siya phambili
saam vorentoe

Electrical & Electronic Engineering
Elektriese & Elektroniese Ingenieurswese
+27 21 808 4011 | ddv@sun.ac.za | www.sun.ac.za
Private Bag X1 | Privaat Sak X1 | Matieland 7602 | South Africa | eMzantsi Afrika | Suid-Afrika