

PRESENTER: Dr Braam Otto  
South African Radio Astronomy Observatory  
Senior Engineer - RFI

# Controls to Manage RFI in a Radio Astronomy Environment

*A. J. Otto, C. van der Merwe & A. Tiplady*

5<sup>th</sup> IUCAF Spectrum Management Summer School  
Stellenbosch, South Africa :: 2 to 6 March 2020



science  
& technology

Department:  
Science and Technology  
REPUBLIC OF SOUTH AFRICA



**SARAO**  
South African Radio  
Astronomy Observatory



# SARAO RFI Team

It really is a TEAM effort...



Adrian Tiplady – Head: Strategy & Business  
Justin Jonas – Chief Technologist

Aneshka Bothma – Young Professional  
Antheun Botha – RF Development Engineer  
Ashley Kotze – RFI Engineer  
Braam Otto – Senior Engineer  
Busisiwe Dube – Logistics Specialist  
Carel van der Merwe – Manager  
Gerhard Botha – RFI Site Quality Assurance  
Isaac Sihlangu – Science Data Processing  
Jason Fynn – Young Professional  
Johan Havenga – RFI Analyst  
Kabo Mabusha – Young Professional  
Siya Tshongweni – RFI Facilities Manager  
Thabo Nhlapo – RFI Systems Engineer



# Presentation Overview

## Controls to Manage Radio Frequency Interference in a Radio Astronomy Environment



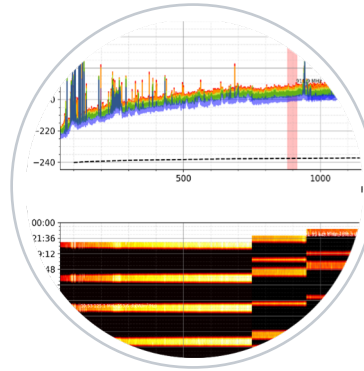
### Introduction

RFI & EMI  
Impact on SKA



### EMC Control Plans

RFI Impact Assessment  
& Risk Analysis



### RFI Controls

RFI Permits, CoCs & NCR



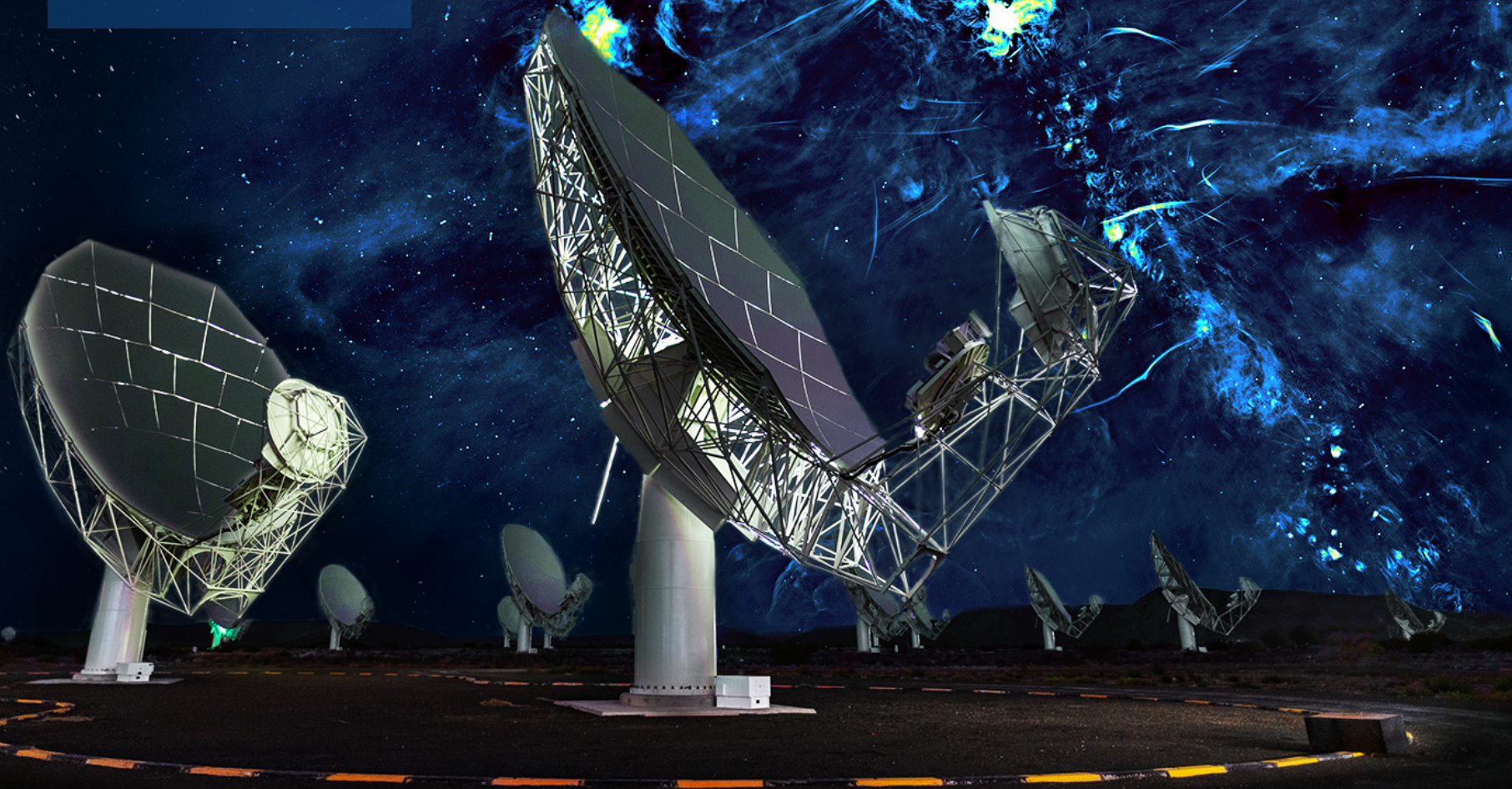
### RFI Management Tools

RFI Dashboards & Measurement  
Reports Database



# INTRODUCTION

RFI & EMI  
Impact on SKA





# Introduction

## MeerKAT, MK+ & Square Kilometre Array

### SKA

The SKA is set to be the world's largest and most sensitive radio telescope ever built [1]

### AGA Area

The SKA1-Mid located in Astronomy Geographic Advantage Area [3]



### SKA Phase 1

SKA Phase 1 Mid Frequency Array will consist of approximately 200 dishes deployed at various spiral arm location in the core, incorporating the 64-dish MeerKAT precursor [2]

### MK+

MeerKAT Extension (MPIfR) will consist of additional 20 telescopes based on SKA1 design



[1] Square Kilometre Array Organisation, [Online] [www.skatelescope.org](http://www.skatelescope.org). Last visited Nov. 2019.

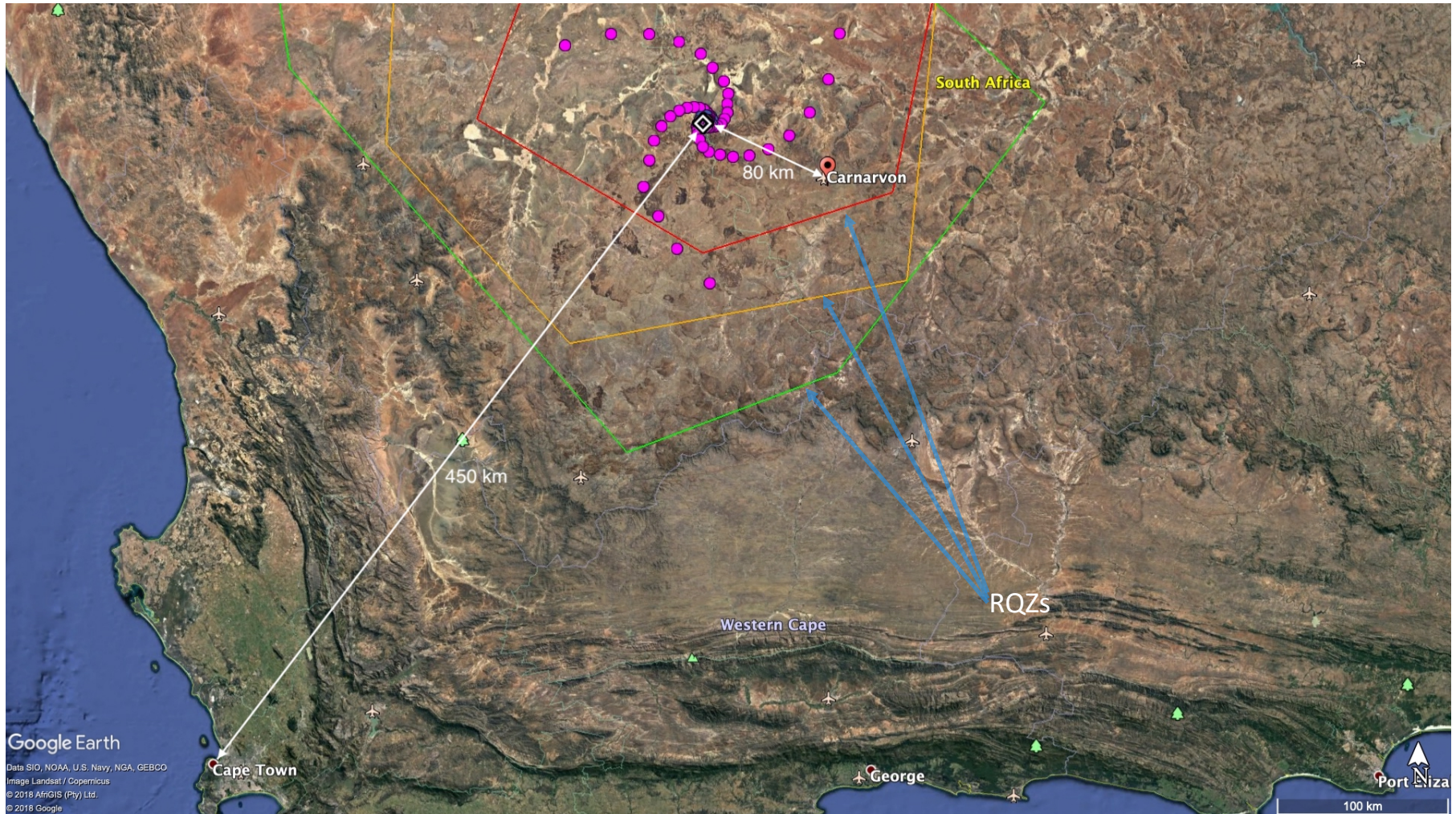
[2] South African Radio Astronomy Observatory, [Online], [www.ska.ac.za](http://www.ska.ac.za). Last visited Nov. 2019.

[3] Astronomy Geographic Advantage Act, 2007, No. 21 of 2007, Government Gazette, Vol. 516, No. 31157, Cape Town, Republic of South Africa, 17 June 2008.



# Introduction

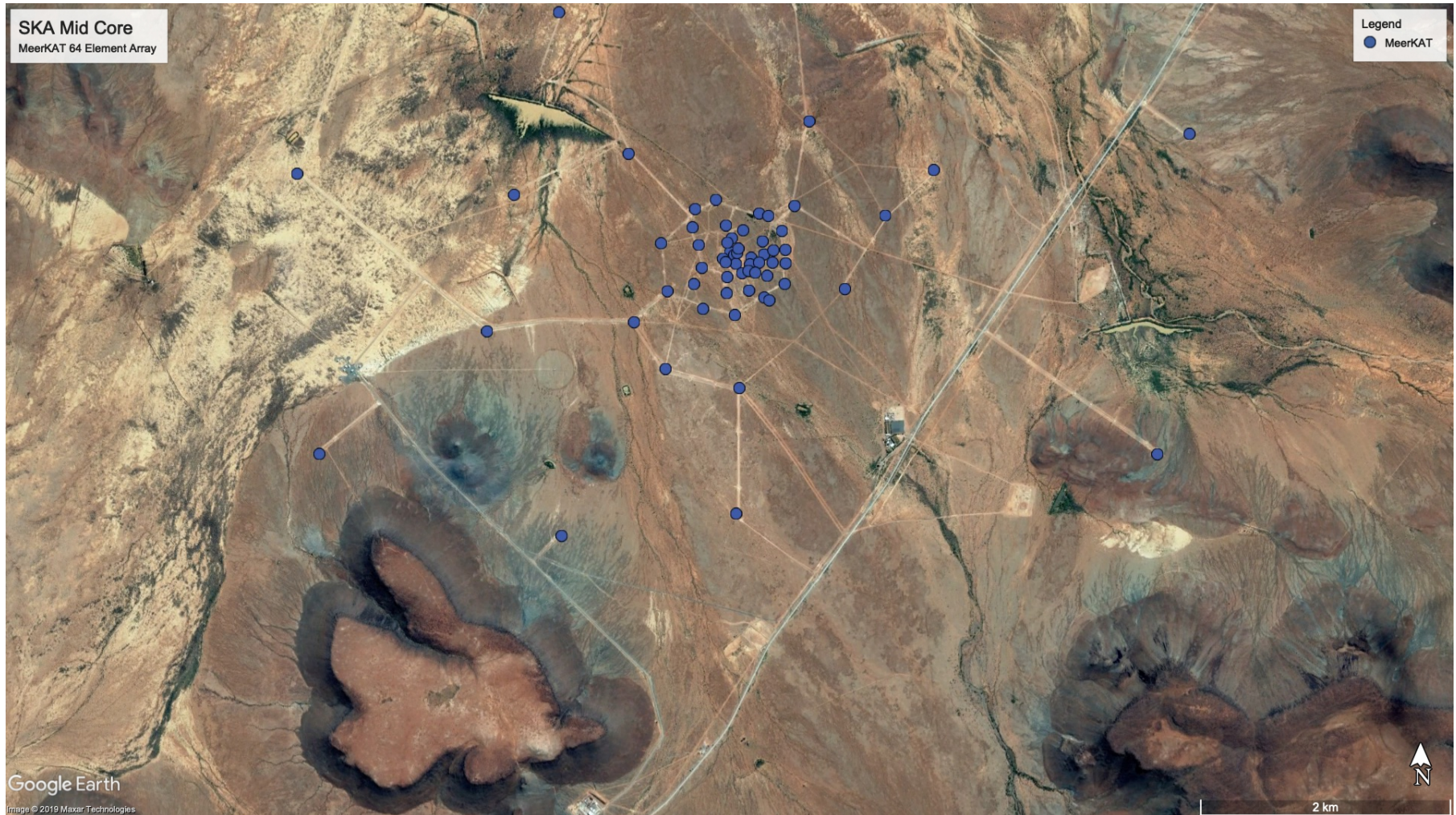
What is meant with “Core” and “Spiral Arms”?





# Introduction

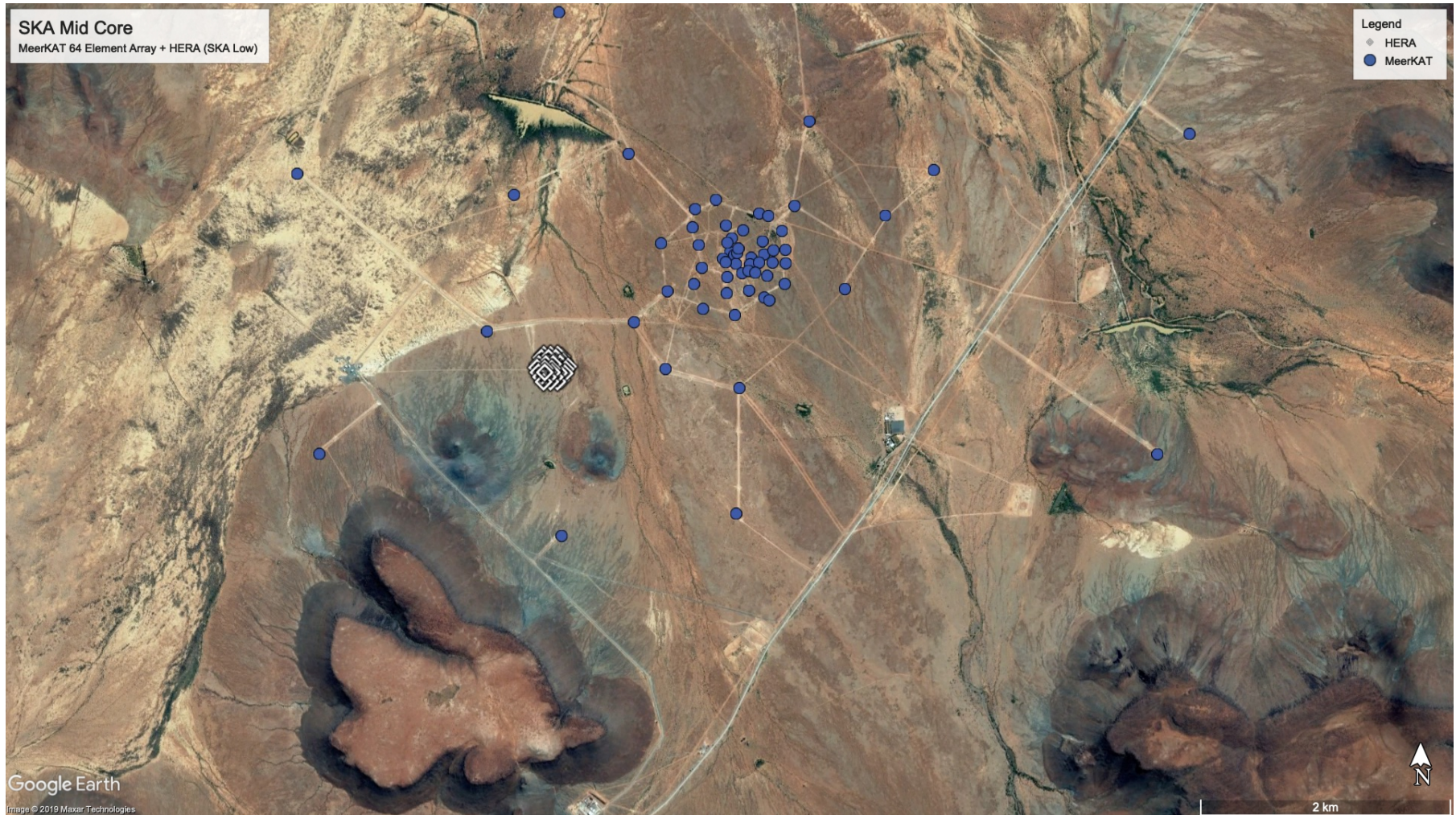
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# Introduction

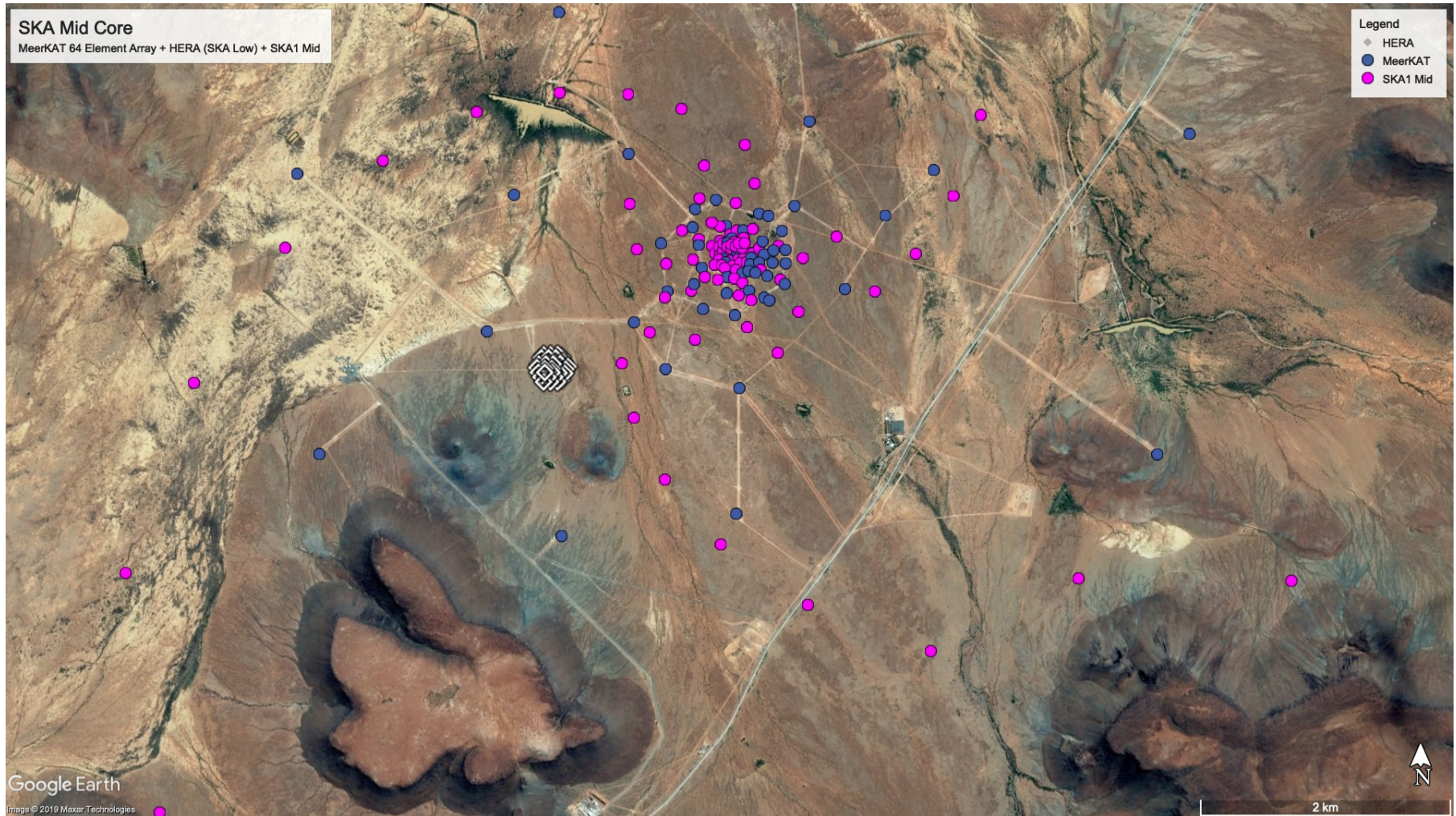
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# Introduction

What is meant with “Core” and “Spiral Arms”?

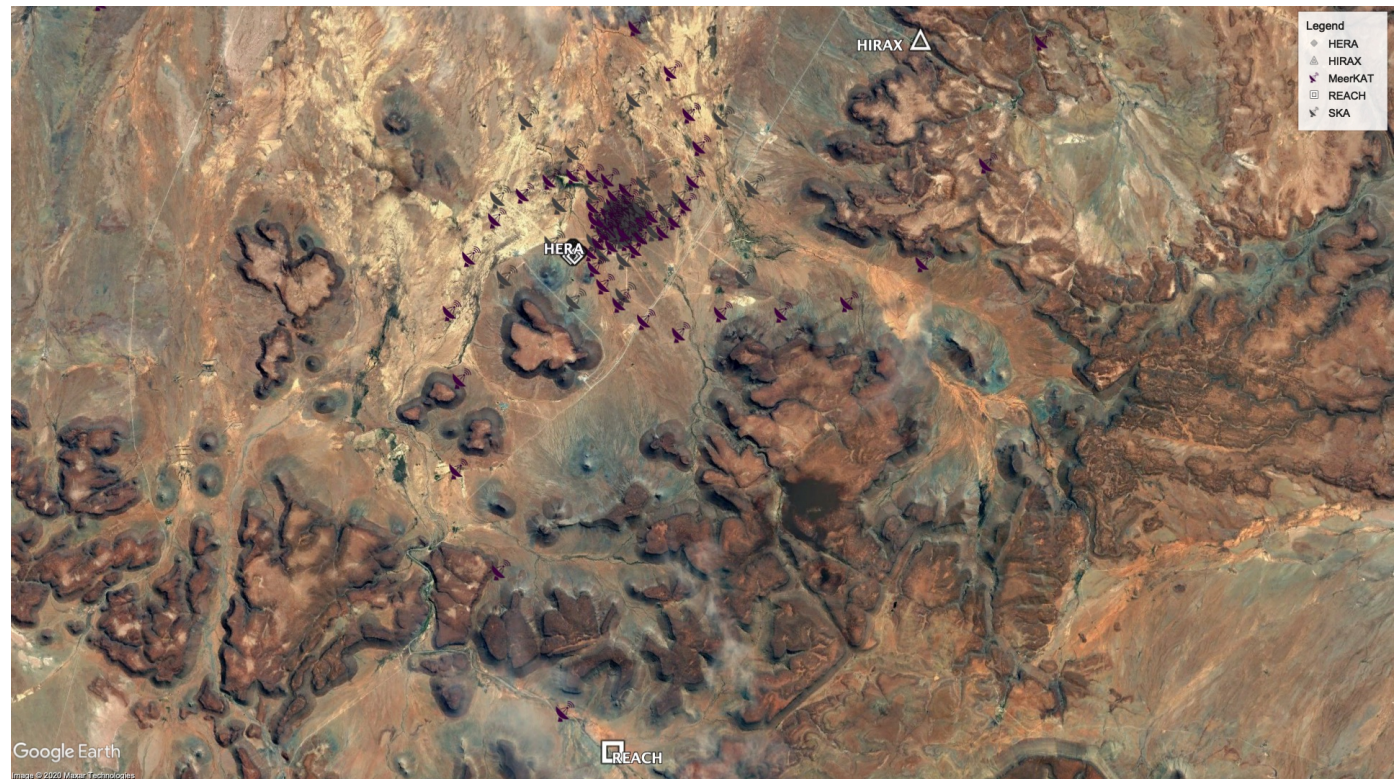




# Introduction

What is meant with “Core” and “Spiral Arms”?

- Increase Guest Instrument Activity that should also be protected receiver bands in the greater SKA core:





# Introduction

## MeerKAT & HERA Receivers

- MeerKAT Telescope is a precursor for the SKA Mid Telescope
- Integrated into the mid frequency component of SKA Phase 1



### MeerKAT Receivers:

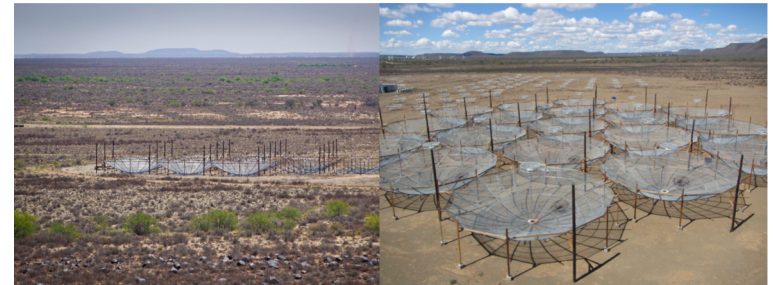
- UHF Band :: 580 to 1015 MHz
- L-Band :: 900 to 1670 MHz
- S-Band :: 1750 to 3500 MHz
- X-Band :: ~~8 to 14.5 GHz~~



### Guest Instruments:

#### Hydrogen Epoch of Reionization Array (HERA)

- VHF-Band :: 50 to 250 MHz








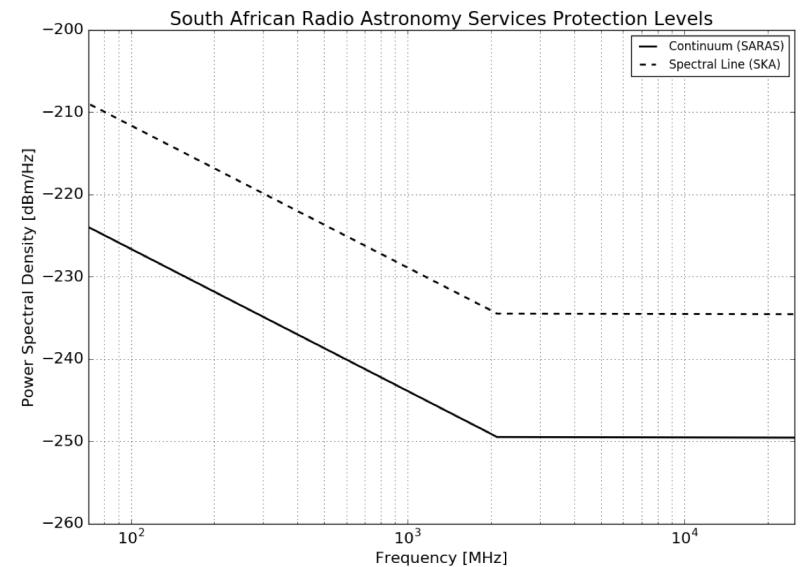
# Introduction

## RFI & EMI (Astronomy Geographic Advantage Act – Radio Astronomy Protection Levels)

- AGA Regulations define **Radio Astronomy Protection Thresholds**
  - Physical Damage Levels (+10 dBm)
  - Saturation Levels (-100 dBm)
  - Continuum (ITU-R RA.769) & Spectral Line Protection Levels
  - $RBW_{\text{Cont}} = 1\% \cdot f_c$  and  $RBW_{\text{Spect}} = 0.001\% \cdot f_c$

- Intentional transmitters (**RFI**)
  - Carrier Frequency
    -  Protection Levels (Core)
    -  Saturation (Spiral Arms)

- Unintentional Transmitters (**EMI**)
  - Harmonics
  - General Electromagnetic Emissions
    -  Protection Levels (Core + Spiral Arms)



$$\text{SARAS [dBm/Hz]} = -17.2708 \log_{10}(f) - 192.0714 \quad f < 2 \text{ GHz}$$

$$\text{SARAS [dBm/Hz]} = -0.065676 \log_{10}(f) - 248.8661 \quad f \geq 2 \text{ GHz}$$



# RISK MANAGEMENT

EMC Control Plans

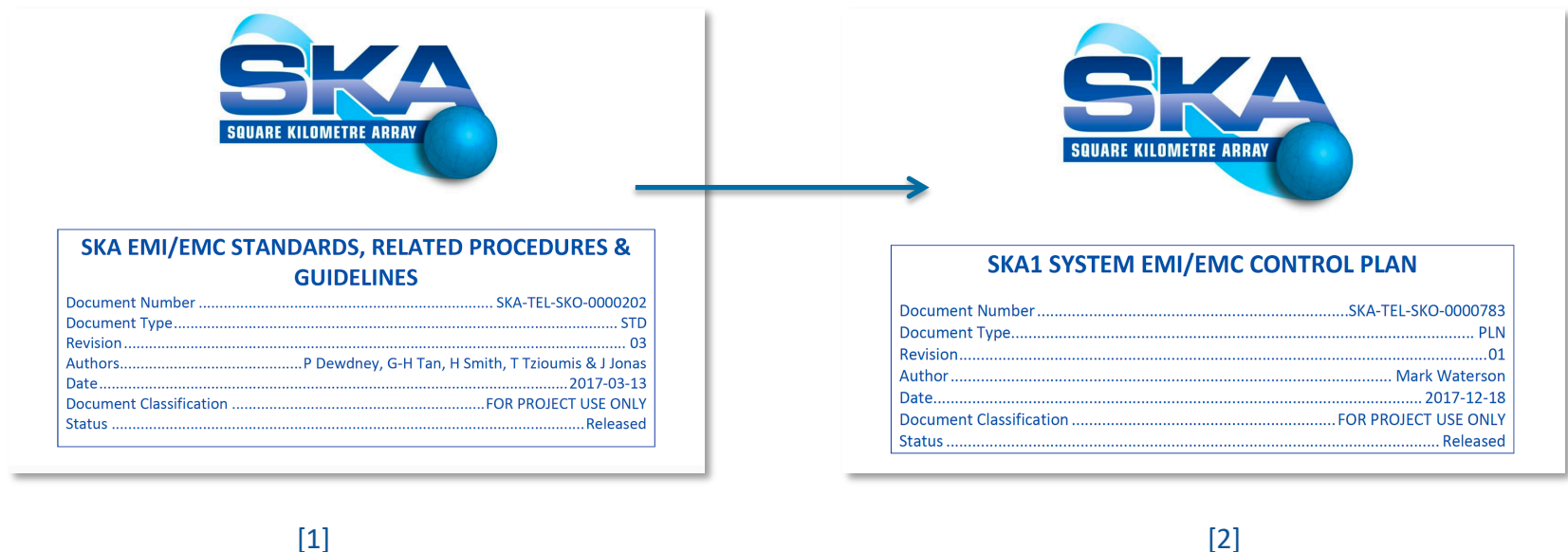




# RFI Risk Management

## EMI/EMC Control Plan

EMI/EMC Control Plan [2] documents the **process** to **ensure system design compliance** to with *SKA EMI/EMC Standards, Related Procedures and Guidelines* [1]





# RFI Risk Management

## EMI/EMC Control Plan

## SKA EMI/EMC Standards, Related Procedures and Guidelines

*“Set **thresholds of allowable emission levels** for **equipment** located on SKA sites referred to the guided wave input of the telescope antennas.” [1]*

## EMC Control Plan

*“Initial documentation in the form of an EMC Control Plan (EMCCP) shall be submitted by the **entity responsible for the product design or manufacture** to SKAO for initial approval.” [1, 2]*

Similar to SKAO, this is required by SARAO RFI Team.

<b>Organisation</b>	: NRF (National Research Foundation)
<b>Facility</b>	: SARAO (South African Radio Astronomy Observatory)
<b>Project</b>	: N/A
<b>Document Type</b>	: EMC Control Plan (EMCCP)
<b>Function/Discipline</b>	: Safety, Health, Environment, RFI & Risk Management 0008)



**Electromagnetic Compatibility (EMC)  
Control Plan for ...**



# EMC Control Plan

## EMI/EMC Control Plan

1. General Definitions (RFI Culprits, Protection Levels, Thresholds)
2. Description of System / Equipment to be Deployed
  - a. Characteristic emissions from EUT\*\*
  - b. Where EUT will be located (RFI Zones)
  - c. When and how often EUT will be used (Time Occupancy)
3. RFI Risk Identification and Qualification
  - a. RFI Risk Analysis
4. RFI Mitigation Measures
5. RFI Controls Required (Permit, CoC's)
6. Definition of Roles and Responsibilities

\*\*If not known (and not previously measured in RFI Database), EUT will have to be characterised in the SARAO Reverberation Chamber

<b>Organisation</b>	: NRF (National Research Foundation)
<b>Facility</b>	: SARAO (South African Radio Astronomy Observatory)
<b>Project</b>	: N/A
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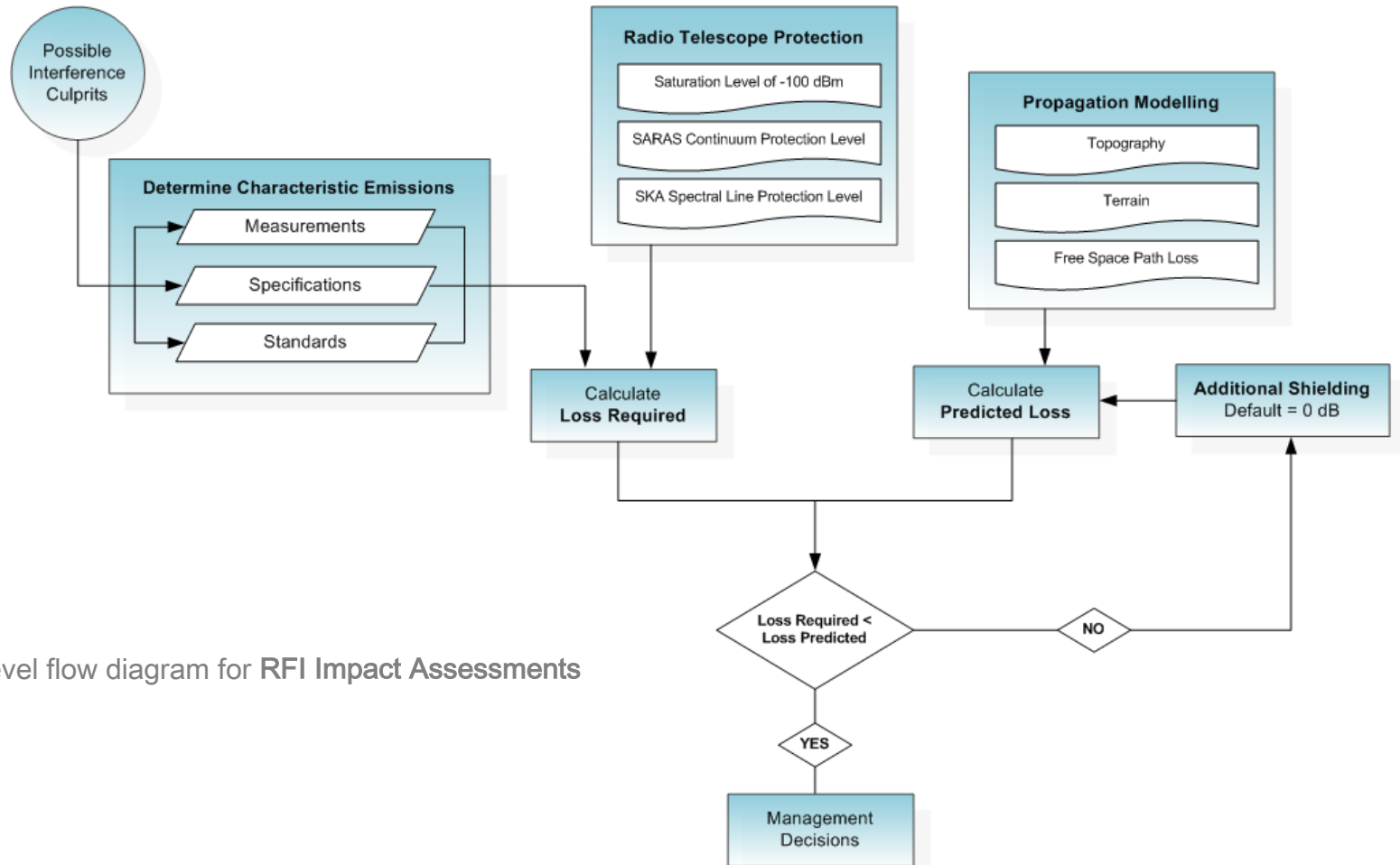


**Electromagnetic Compatibility (EMC)  
Control Plan for ...**



# RFI Impact Assessment & Risk Analysis

## Automated Risk Analysis Software :: Case Study



High-level flow diagram for RFI Impact Assessments



# RFI Impact Assessment & Risk Analysis

## Automated Risk Analysis Software :: Case Study

Investigate possible impact of construction camps at the following locations relative to the MeerKAT core:





# RFI Impact Assessment & Risk Analysis

Automated Risk Analysis Software :: Case Study

## Risk Analysis based on:

Level of interference

Damage, Saturation, Spectral Line and Continuum Thresholds

Time Occupancy (Based on ITU-R P.769-2)

Class A ::  $TO < 2\%$

Class B ::  $2\% < TO < 5\%$

Class C ::  $TO > 5\%$

Frequency Channel Occupancy  
(Telescope Receiver Bands Affected)

Rec. ITU-R RA.769-2

RECOMMENDATION ITU-R RA.769-2

Protection criteria used for radio astronomical measurements

# RFI Impact Assessment & Risk Analysis

## Automated Risk Analysis Software :: Case Study

	<b>FARM RFI CHARACTERISATION REPORT</b>	RFI Report No	RFI2020-001
		Farm Name	Swartfontein
		Date Audited	2020-01-01
		Date Issued	2020-01-01
<b>Part 1: Farm Information</b>			
Farm Name	Swartfontein		
Farm Location	-30.97677° S 21.558602° E		
Distance to SKA Virtual Core	11.5 km		
Distance to Closest Telescope	SKA027, 1.39 km		
Farm Owner	SARAO		
Residency	Permanent		
Power	Eskom		
<b>Part 2: Audit/ Measurements Responsible Person</b>			
(Title) Name & Surname	Kabo O. Mabusha		
Company	SARAO		
Designation	RFI Department Young Professional		
<b>Part 3: Measurement Equipment</b>			
RF Receiver	Rohde & Schwarz FSH-8 (SN: 123-456-7890)		
Antenna / Current Probe	Log Periodic Dipole Array (LPDA) Antenna		
Other	1.5 m Sucoflex Coaxial RF Cable		
<b>Part 4: Measurement Locations</b>			
Measurement Location 1	Living / Office Area		
Measurement Location 2	Workshop Area		
Measurement Location 3	Power Generation Area		

Part 5: Visual Inspection - List of EUT				
Type	Equipment Description	Usage	Model Number	Other Information
EMI	Microwave Oven	5min daily	Generic	
RFI / EMI	WiFi Router	24/7	Generic	
RFI / EMI	VOX Telecoms Router	24/7	Generic	
RFI / EMI	VHF-Mid Radio	1 hour/day	Generic	
EMI	Air Conditioner	8 hours/day	Generic	
EMI	Network Switches	24/7	Generic	
EMI	Digital Cameras	1 hour/day	Generic	
EMI	Petrol Weld	1 hour/day	Generic	
RFI / EMI	GSM	24/7	Generic	
EMI	Printers	24/7	Generic	
EMI	UPS	24/7	Generic	
EMI	Screens	8 hours/day	Generic	
EMI	Alarm System	24/7	Generic	
RFI / EMI	DECT	24/7	Generic	
RFI / EMI	Laptop	8 hours/day	Generic	
RFI / EMI	Bluetooth (Vehicles)	8 hours/day	Generic	

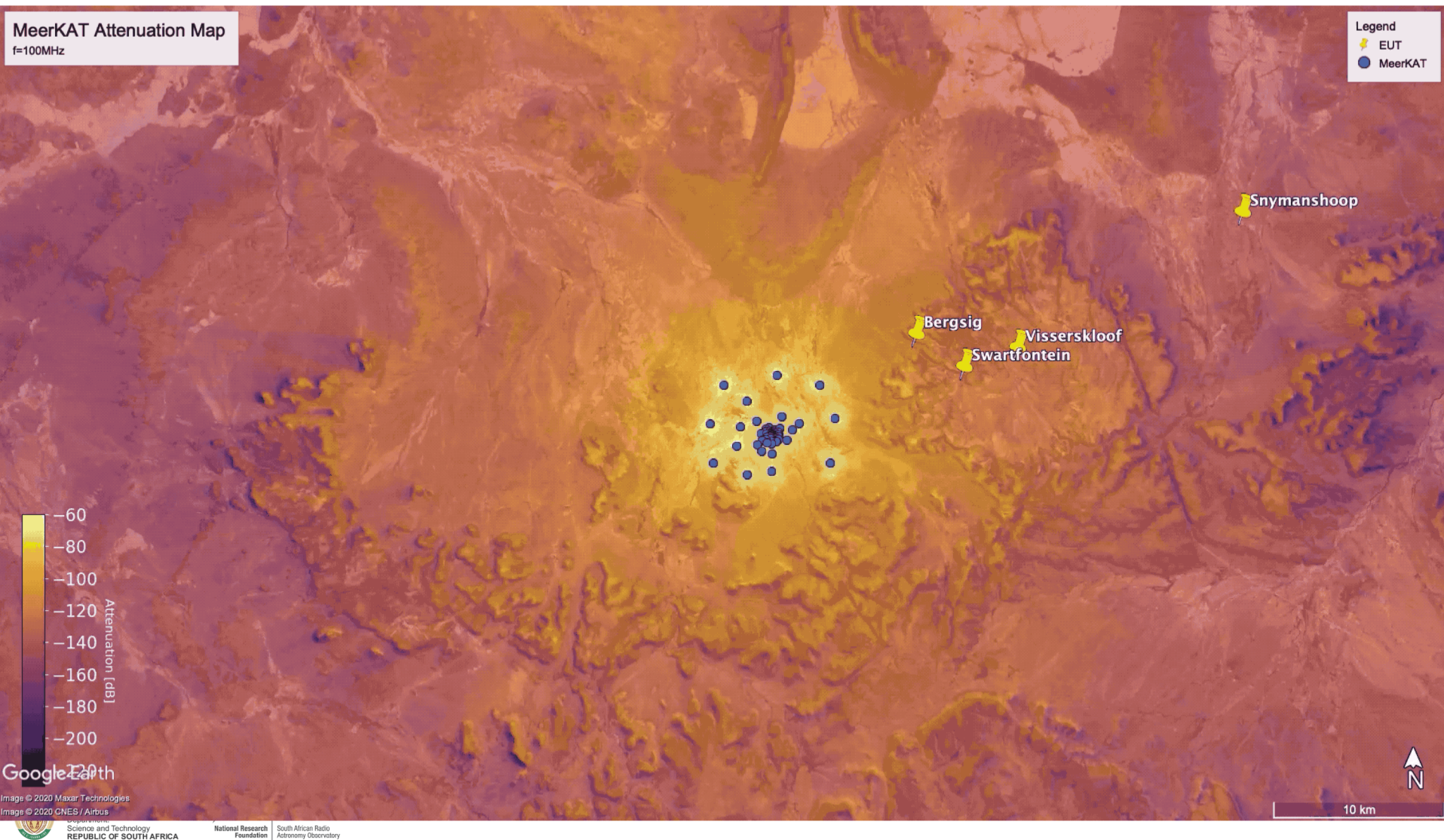


## Automated Risk Analysis Software :: Case Study



# RFI Impact Assessment & Risk Analysis

Automated Risk Analysis Software :: Case Study



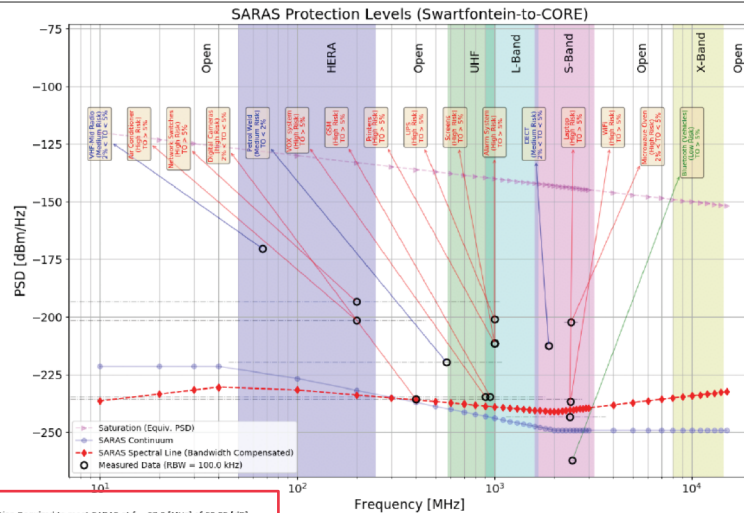


# RFI Impact Assessment & Risk Analysis

## Automated Risk Analysis Software :: Case Study

### Part 6: Risk Analysis

#### EUT toward the SKA Virtual Core



ion Required to meet SARAS at f = 67.0 [MHz] of 60.05 [dB]  
ion Required to meet SARAS at f = 200.0 [MHz] of 40.41 [dB]  
ion Required to meet SARAS at f = 2447.0 [MHz] of 37.9 [dB]

Culprit / EUT	Type	Affected Telescope Receiver Bands	Risk Level
VHF-Mid Radio	RFI	[PAPER / HERA (VHF)]	Medium
Air Conditioner	EMI	[PAPER / HERA (VHF)], 'SKA1-MID (UHF)'	High
Network Switches	EMI	[PAPER / HERA (VHF)], 'SKA1-MID (UHF)', 'SKA1-MID / MeerKAT / KAT-7 (L-Band)', 'SKA1-MID / MeerKAT (S-Band)'	High
Digital Cameras	EMI	[PAPER / HERA (VHF)], 'SKA1-MID (UHF)', 'SKA1-MID / MeerKAT / KAT-7 (L-Band)', 'SKA1-MID / MeerKAT (S-Band)', 'C-BASS (C-Band)'	High
Petrol Welder	EMI	[PAPER / HERA (VHF)], 'SKA1-MID (UHF)', 'SKA1-MID / MeerKAT / KAT-7 (L-Band)'	Medium
Vox Telecom	RFI/EMI	[SKA1-MID (UHF)], 'SKA1-MID / MeerKAT / KAT-7 (L-Band)', 'SKA1-MID / MeerKAT (S-Band)'	High

### RFI Culprit Identification

Freq [MHz]	Power [dBm]	Distance [m]	Description	WB Start	WB Stop	TO	RBW[kHz]
67	-25	3	VHF-Mid Radio			B	100
570	-67	10	Petrol Weld	100	1150	A	30
950	-70	3	GSM	945	955	C	10
1880	-40	3	DECT			B	10
2430	-52	3	WiFi	2390	2450	C	100
2447	-23	3	Microwave Oven	2200	2600	B	30
900	-60	3	VOX system	300	2100	C	120
200	-68	10	Air Conditioner	10	500	C	100
2400	-69	10	Laptop	80	2600	C	100
1000	-36	3	Printers			C	120
200	-60	10	Network Switches	80	1800	C	100
1000	-36	10	UPS			C	120
400	-94	10	Digital Cameras	80	4800	B	10
1000	-36	3	Screens			C	120
1000	-36	3	Alarm System			C	120
2480	-68	1	Bluetooth (Vehicles)	2400	2480	C	100

Level of interference

Time Occupancy

Frequency Occupancy  
(Affected Rx Bands)

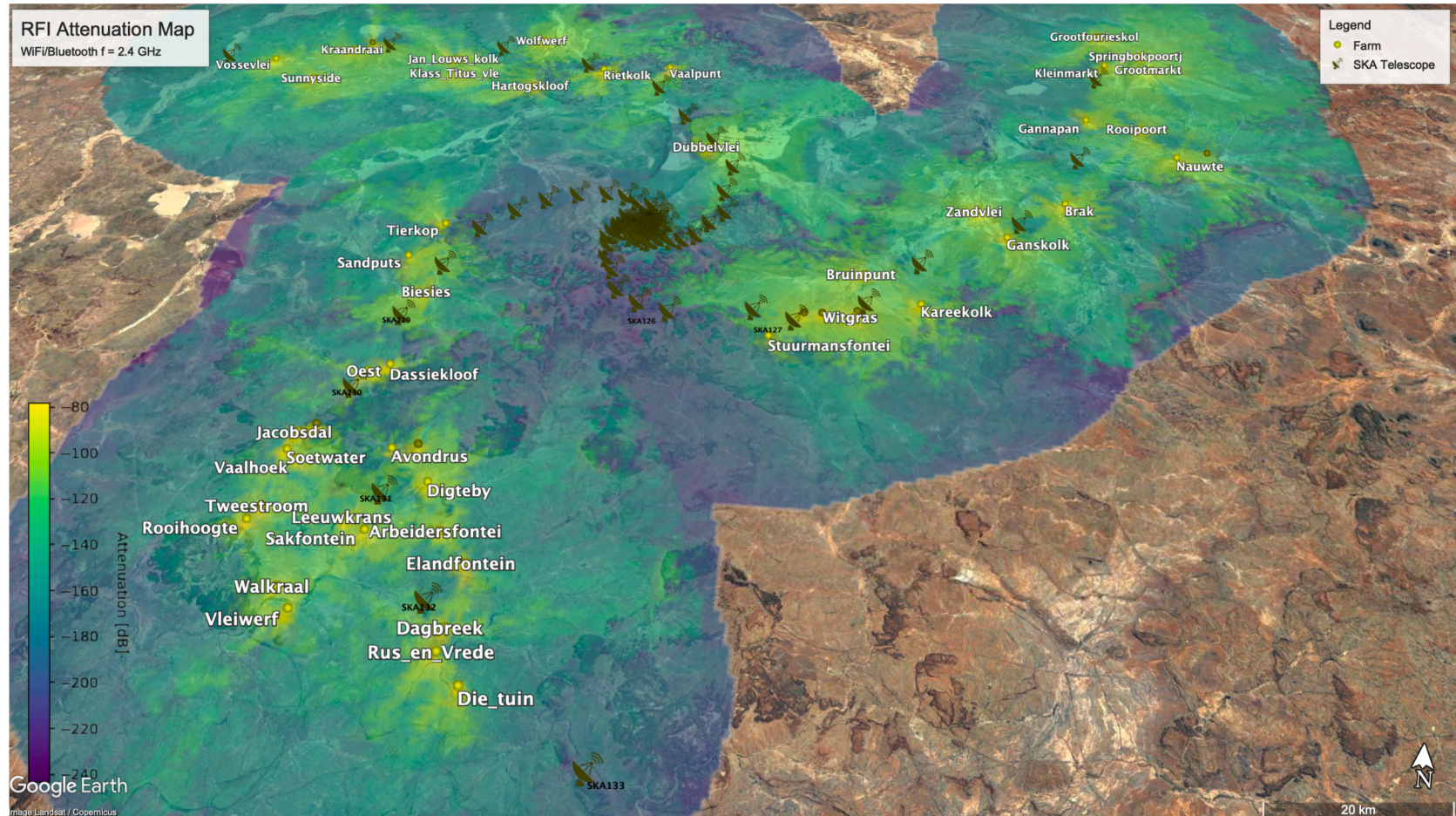
Attenuation Required to meet SARAS at f = 67.0 [MHz] of 60.05 [dB]  
Attenuation Required to meet SARAS at f = 200.0 [MHz] of 40.41 [dB]  
Attenuation Required to meet SARAS at f = 2447.0 [MHz] of 37.9 [dB]

# RFI Impact Assessment & Risk Analysis

## Automated Risk Analysis Software :: Case Study

Impact from Technology Specific Devices

[2.4 GHz WiFi Routers or 1.8 GHz DECT]



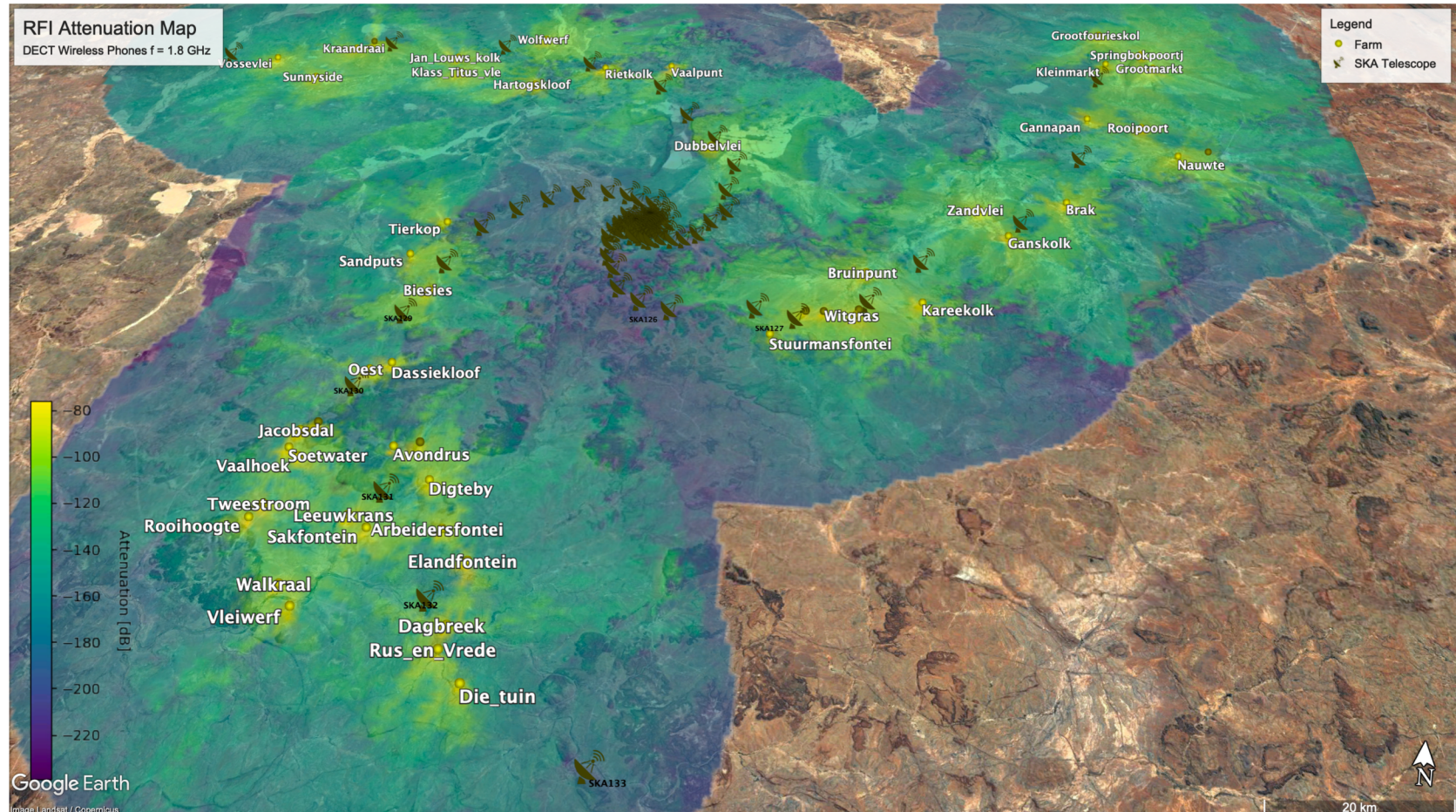


# RFI Impact Assessment & Risk Analysis

## Automated Risk Analysis Software :: Case Study

Impact from Technology Specific Devices

[2.4 GHz WiFi Routers or 1.8 GHz DECT]





# RISK MANAGEMENT

RFI Controls





# RFI Controls: Permits & CoCs

## Process to take equipment to site: RFI Permits and Certificate of Compliance

Requirements for SARAO employees or contractors to bring equipment onto site:

- Be in possession of an **RFI Permit** or **Certificate of Compliance (CoC)**

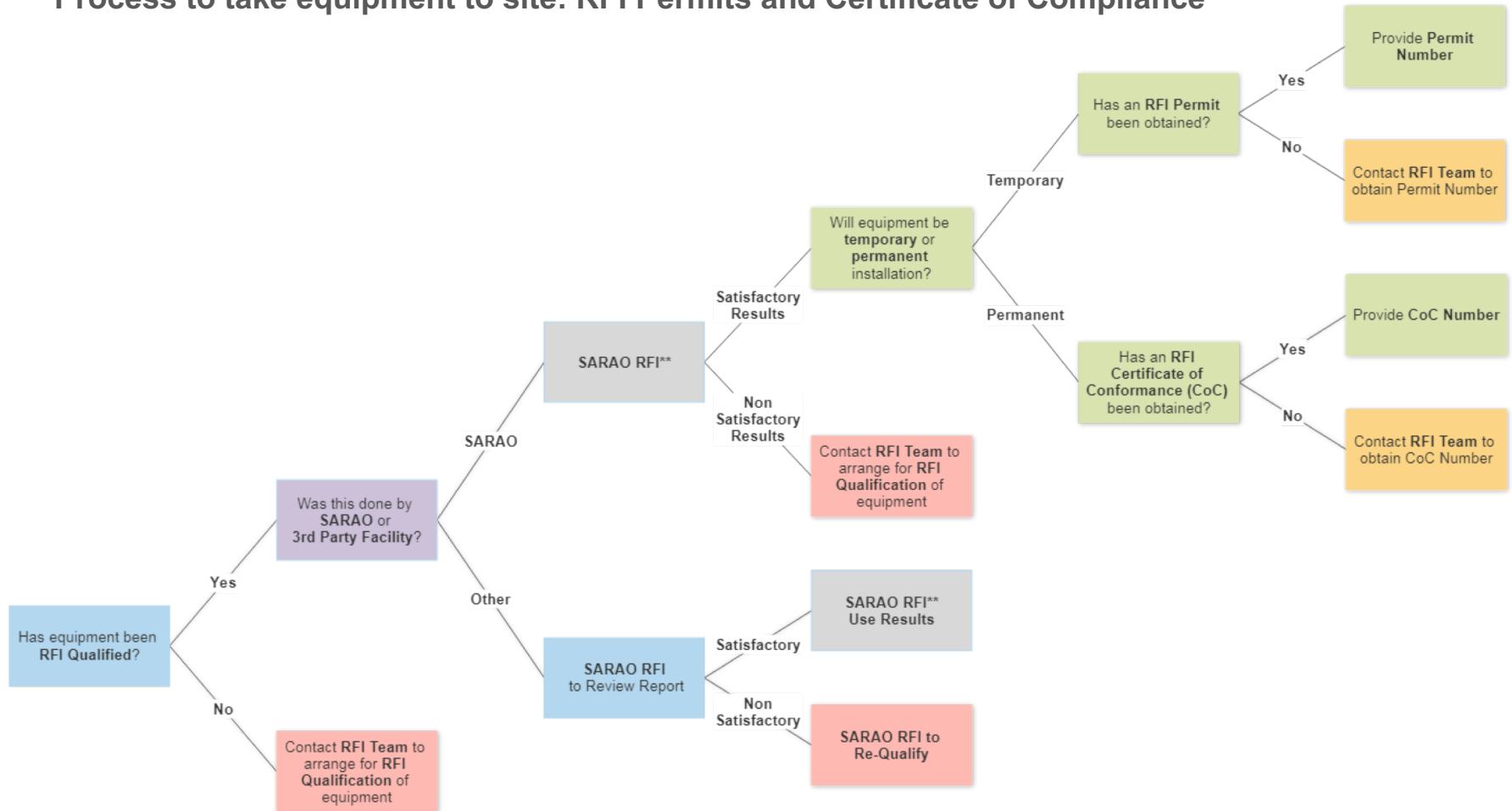
Any person not in possession is required to obtain from SARAO RFI Team.

Obtaining is done by the following:

1. Undertaking **measurements by SARAO RFI**, through appropriate agreement, in calibrated and controlled RFI facility, who will issue the permit; **OR**
2. Undertaking **measurements by a third party** in a qualified measurement facility, using calibrated measurement equipment *in accordance with SARAO RFI Measurement Requirements, Procedures and Methodologies*. (Such measurement reports shall be submitted to SARAO for consideration and issuing of relevant Permit or Certificate of Compliance. If not satisfactory (1) would be required to obtain Permit or CoC)

# RFI Controls: Permits & CoCs

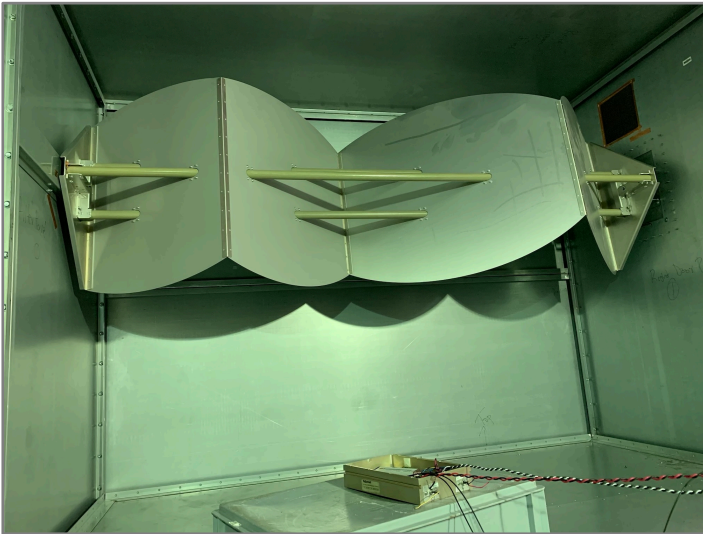
Process to take equipment to site: RFI Permits and Certificate of Compliance





# RFI Controls: Permits & CoCs

EMI Characterisation :: Risk Analysis :: Permit / CoC Issue with Restrictions of Use



Measurements in the SARAO  
Reverberation Chamber in Cape  
Town, South Africa

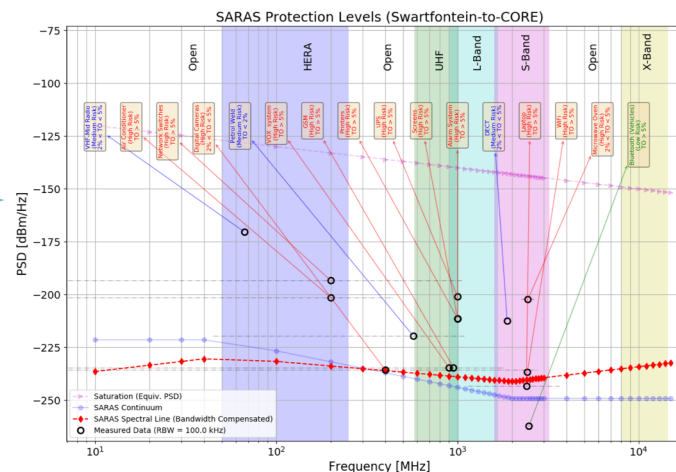


Tektronix RSA5115B  
Real Time Spectrum Analyser  
15 GHz; 160 MHz Acq. BW



RTA-3.6  
Real Time Transient Analyser  
20 MHz to 3 GHz, 800 MHz Inst. BW

Total Emitted Power for DUT  
(EIRP)




Ion Required to meet SARAS at f = 67.0 [MHz] of 60.05 [dB]  
Ion Required to meet SARAS at f = 200.0 [MHz] of 40.41 [dB]  
Ion Required to meet SARAS at f = 2447.0 [MHz] of 37.9 [dB]

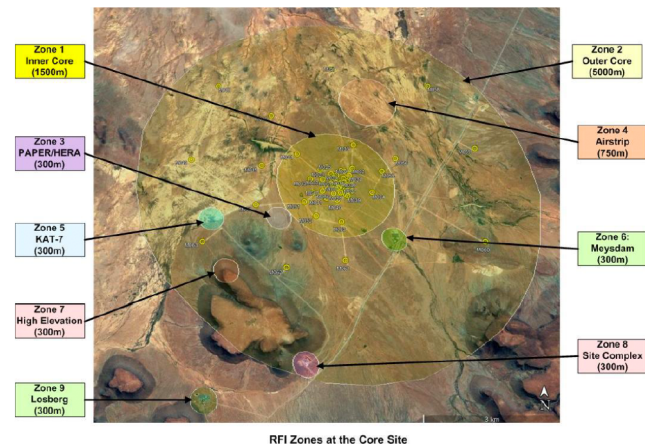
Searchable Databases:  
1. Measurements Reports  
2. Permits / CoCs

# RFI Controls: Permits & CoCs

## EMI Characterisation :: Risk Analysis :: Permit / CoC Issue with Restrictions of Use

	<b>SARAO</b> <b>RFI Notice Type A</b> <b>RFI Permit</b>	RFI Permit No	RFI1807-0030-001
		Date Issued	2019/03/26
		Valid Until	2019/09/30
<b>Part 1: Description of RFI Source / Culprit</b>			
1.1. Short description of equipment		Ancillary equipment used during construction.	
1.2. Equipment make / brand name and Model		See Table 1 in Report M2901-0000-167	
1.3. What will the equipment be used for?		Construction of SKA1 DISH Prototype	
1.4. Will the equipment be Permanent or Temporary?		Temporary	
1.5. Date deployed to site		2019/03/01	
1.6. Date to be removed from site (if applicable)		2019/09/30	
1.7. Contact1 Name and Organisation		Henk Niehaus	SKAO
1.8. Contact1 email		henk@ska.ac.za	
1.9. Contact2 Name and Organisation		Thomas Kusel	SARAO
1.10. Contact2 email		tkusel@ska.ac.za	
<b>Part 2: RFI Test</b>			
2.1 RFI Test - Test Facility		On Site Measurement ( Losberg)	
2.2 RFI Test date		2018/07/01	
2.3 RFI Test report reference		M2901-0000-167	
<b>Part 3: Restrictions on Location and Use</b>			
3.1 This equipment may be used within the following zones, subject to other restrictions listed below			
No	<b>Zone 0:</b> Within 20m from Antenna	No	<b>Zone 1:</b> Inner Core (1500m)
Yes	<b>Zone 2:</b> Outer Core (5000m)	No	<b>Zone 3:</b> PAPER/HERA (300m)
N/A	<b>Zone 4:</b> Airstrip (750m)	No	<b>Zone 5:</b> KAT-7 (300m)
N/A	<b>Zone 6:</b> Meysdam (300m)	N/A	<b>Zone 7:</b> High Elevation Site (300m)
N/A	<b>Zone 8:</b> Site Complex (300m)	N/A	<b>Zone 9:</b> Losberg (300m)
N/A	<b>Zone 14:</b> Surrounding Farms	N/A	<b>Zone 15:</b> Klerefontein
3.2. Restrictions on Day / Night use		As set out in Section 3.5 of this permit	
3.3 Do Not use after (time)	Sec. 3.5	3.4 Do Not use before (time)	Sec. 3.5

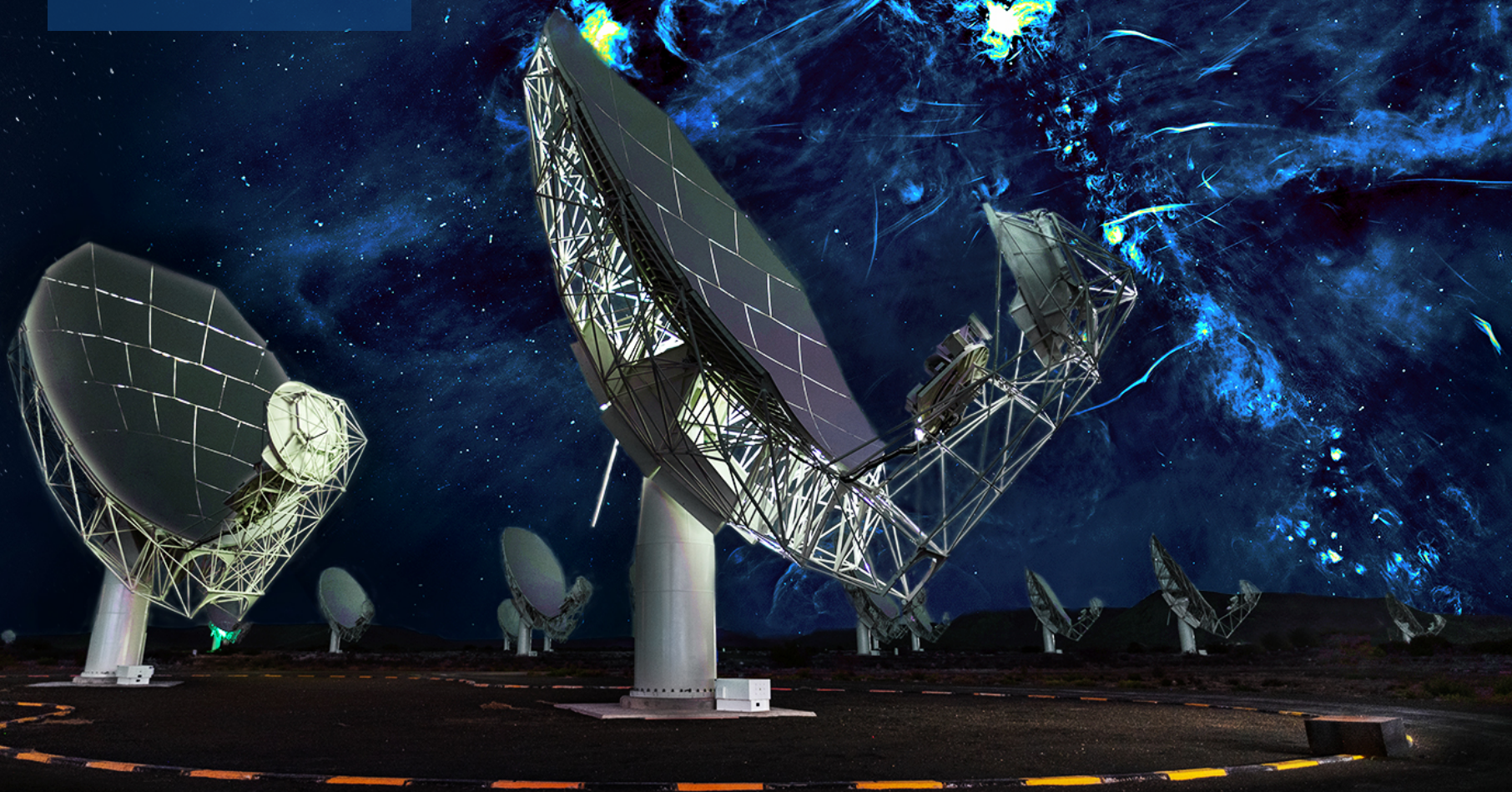
3.5 Other Restrictions	<p>From the results presented in M2901-0000-167, some of the equipment like the drill (#3) and heater (#4) due to their wideband interference levels can only be used at minimum distances of 4.7 km and 5.8 km from the core respectively. Other drills (#15, #21), grinders (#18) and cameras (#17) can be used approximately 2.5 km from the core. The Bluetooth in the vehicles will cause interference closer than 3.3 km from the core.</p> <p>It is recommended that these highlighted pieces of equipment, similar to the SKA1 Dish Structure Control System RFI Permit in RFI1807-0026-001, only be used at the SKA1 Prototype location during Engineering Hours (not while MeerKAT is doing science observations). The use of this equipment should furthermore always be communicated at the SARAO Science Planning Meetings. If the equipment can be used at Losberg rather than the Prototype pedestal location in the core, this should be done at all time.</p> <p>The rest of the equipment can be used between 8am and 5pm during weekdays.</p>
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Part 4 Signatures			
	Name and Organisation	Signature	Date
Requested by	Henk Niehaus SARAO	<i>Henk Niehaus</i> Henk Niehaus (Mar 26, 2019)	Mar 26, 2019
Approved by (RFI Manager)	Dr. Braam Otto SARAO	<i>Braam Otto</i> Braam Otto (Mar 26, 2019)	Mar 26, 2019
Accepted by (Site Manager)	Dawie Fourie SARAO	<i>Dawie Fourie</i>	Mar 26, 2019



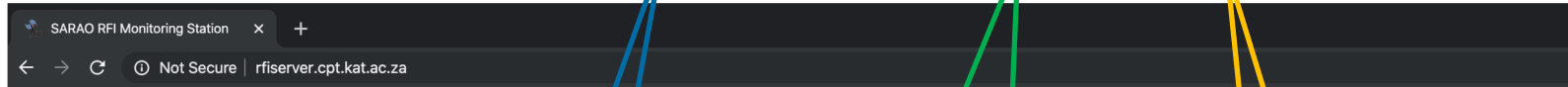
# RFI MANAGEMENT TOOLS



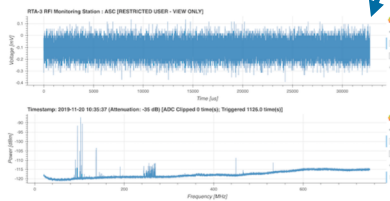


# RFI Management Tools

RFI Dashboard – RFI Monitoring Stations [Live View, Statistical Data Playback, RFI FoM]

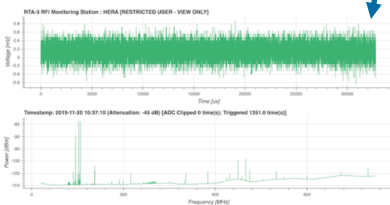


## Radio Frequency Interference Monitoring - ASC

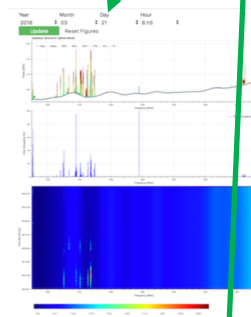


[Live View \[Restricted User\]](#)

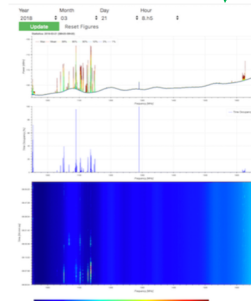
## Radio Frequency Interference Monitoring - HERA



[Live View \[Restricted User\]](#)



[Statistical Data Playback](#)



[Statistical Data Playback](#)



[RFI Figure of Merit \(FoM\)](#)



[RFI Figure of Merit \(FoM\)](#)



# RFI Management Tools

RFI Dashboard – Permits, CoC & NCR Dashboard; RFI Reports Database; Detections Dashboards

## Radio Frequency Interference Management Tools



[SARAO RFI Controls Dashboard \[Restricted User\]](#)

**SARAO RFI reports**

Category	Report Name	Report Date	Report Status
Permits	Report on Permits	2019-05-19	Completed
CoCs	Report on CoCs	2019-05-19	Completed
NCRs	Report on NCRs	2019-05-19	Completed

[SARAO RFI Report Database \[Restricted User\]](#)

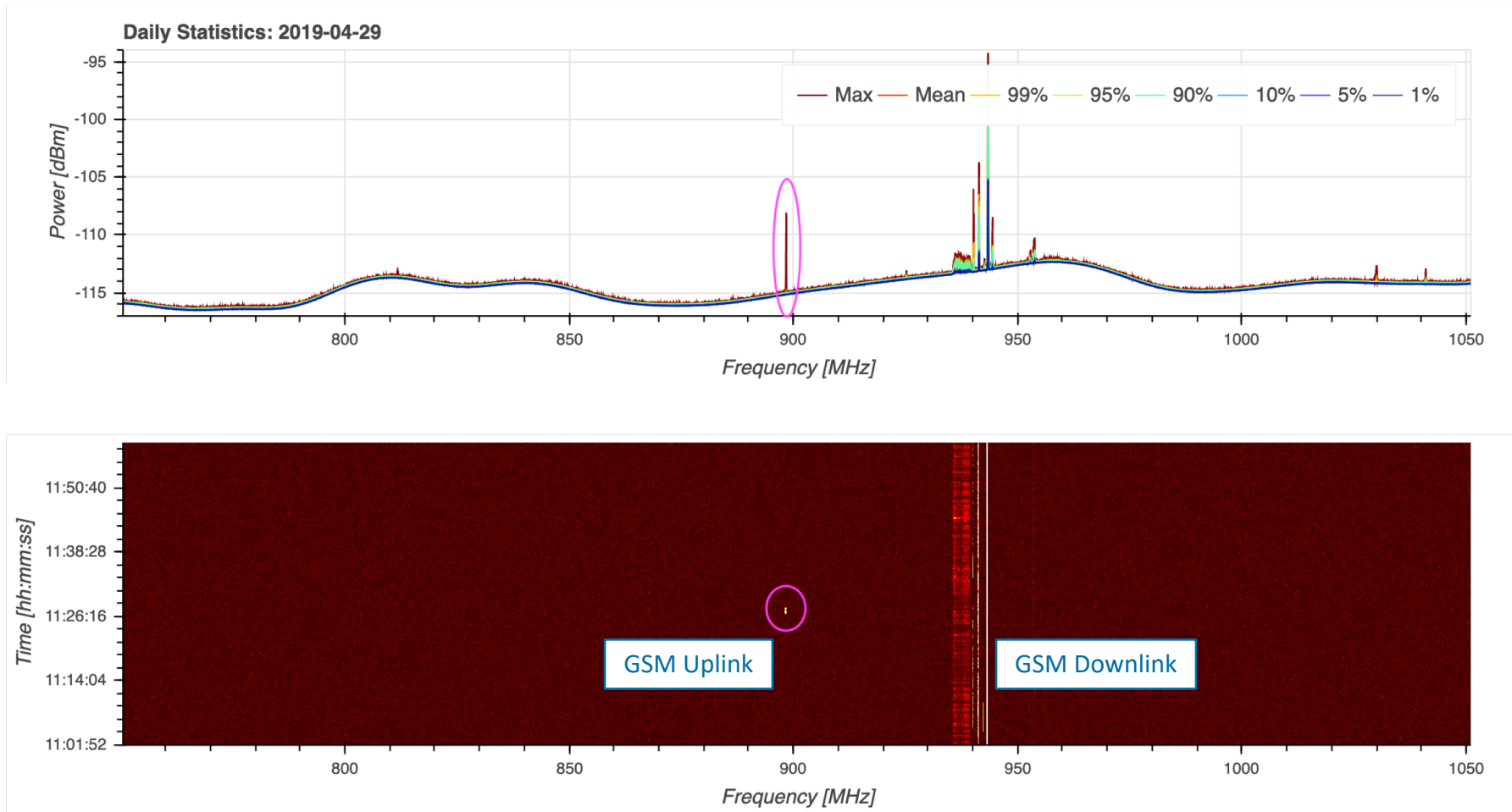


[SARAO RFI Detections Dashboard](#)



# RFI Management Tools

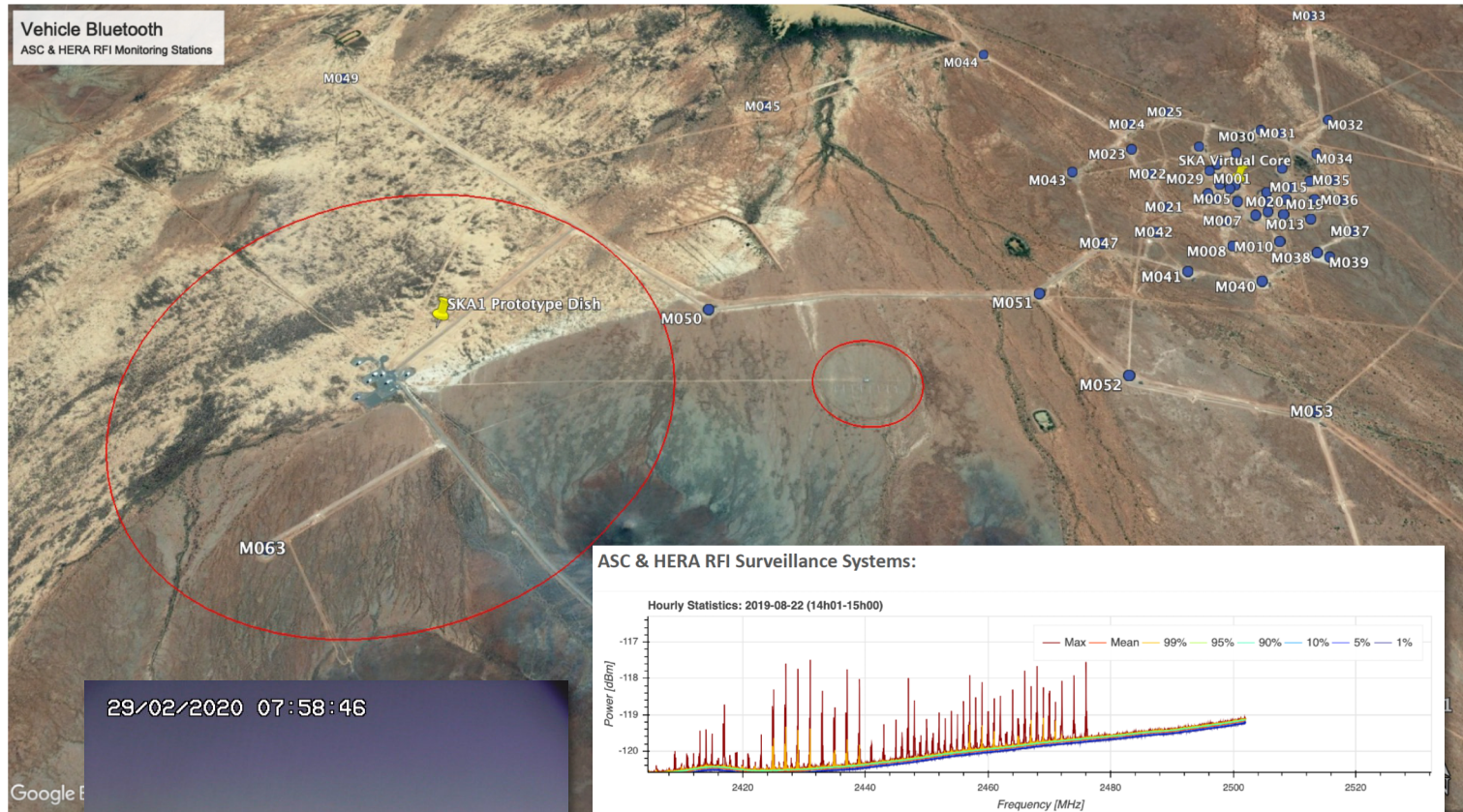
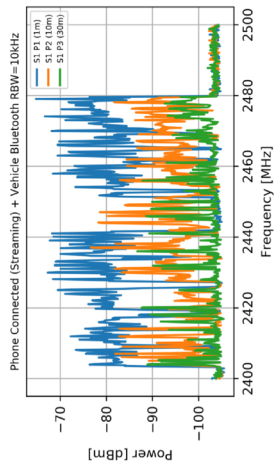
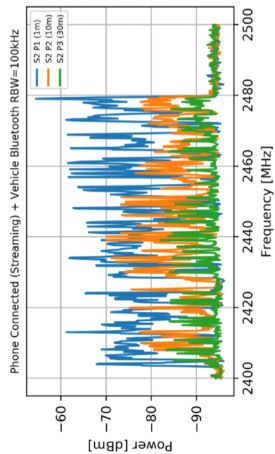
## Statistical Data Playback – Cellphone Uplink Detection



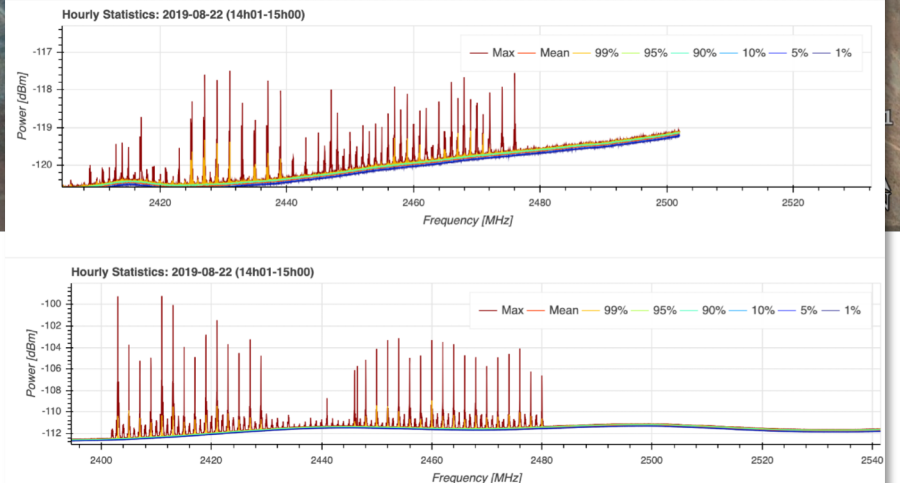


# RFI Management Tools

## Bluetooth Detection :: Crude Direction Finding & Video Grab

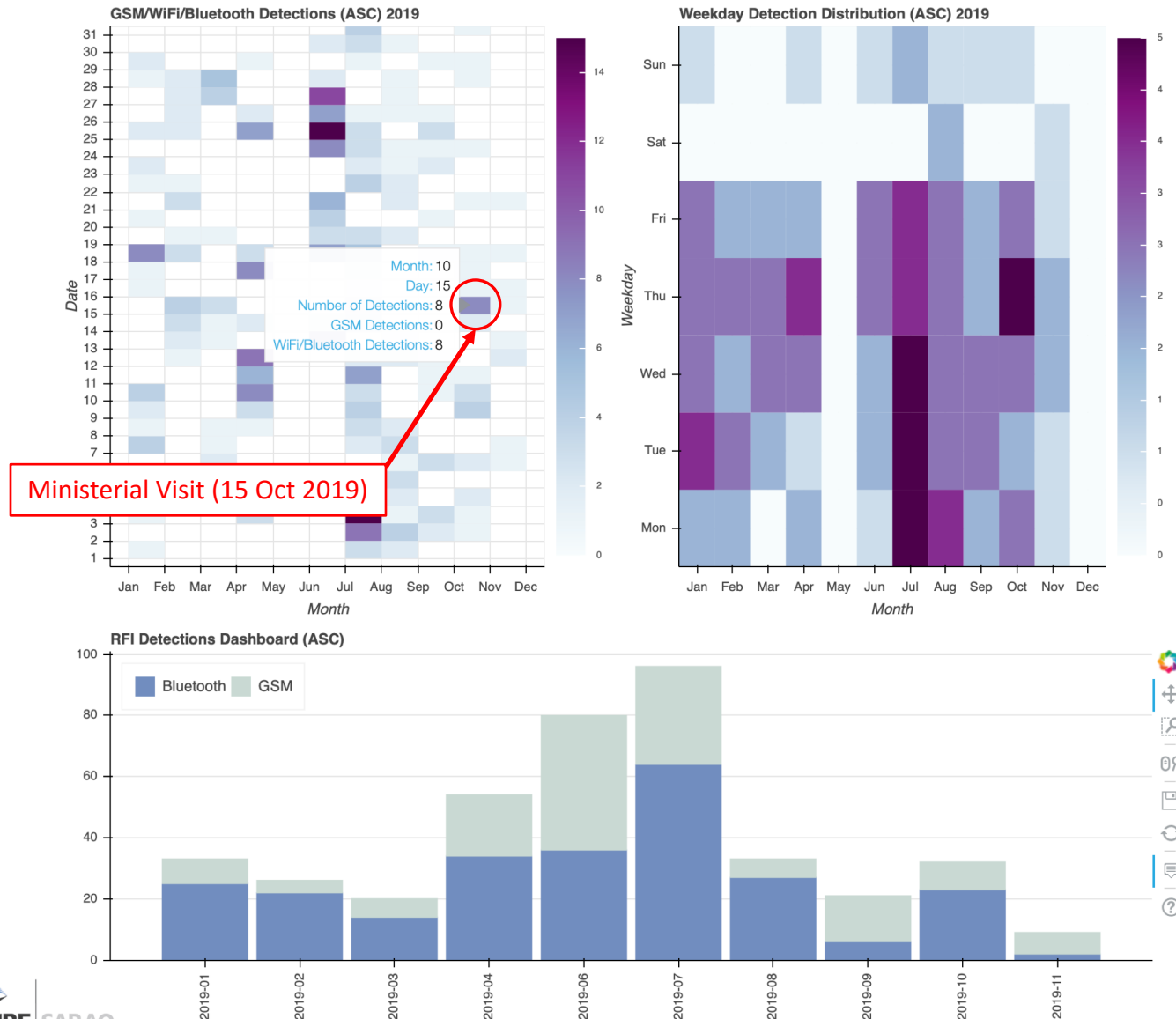


### ASC & HERA RFI Surveillance Systems:



# RFI Management Tools

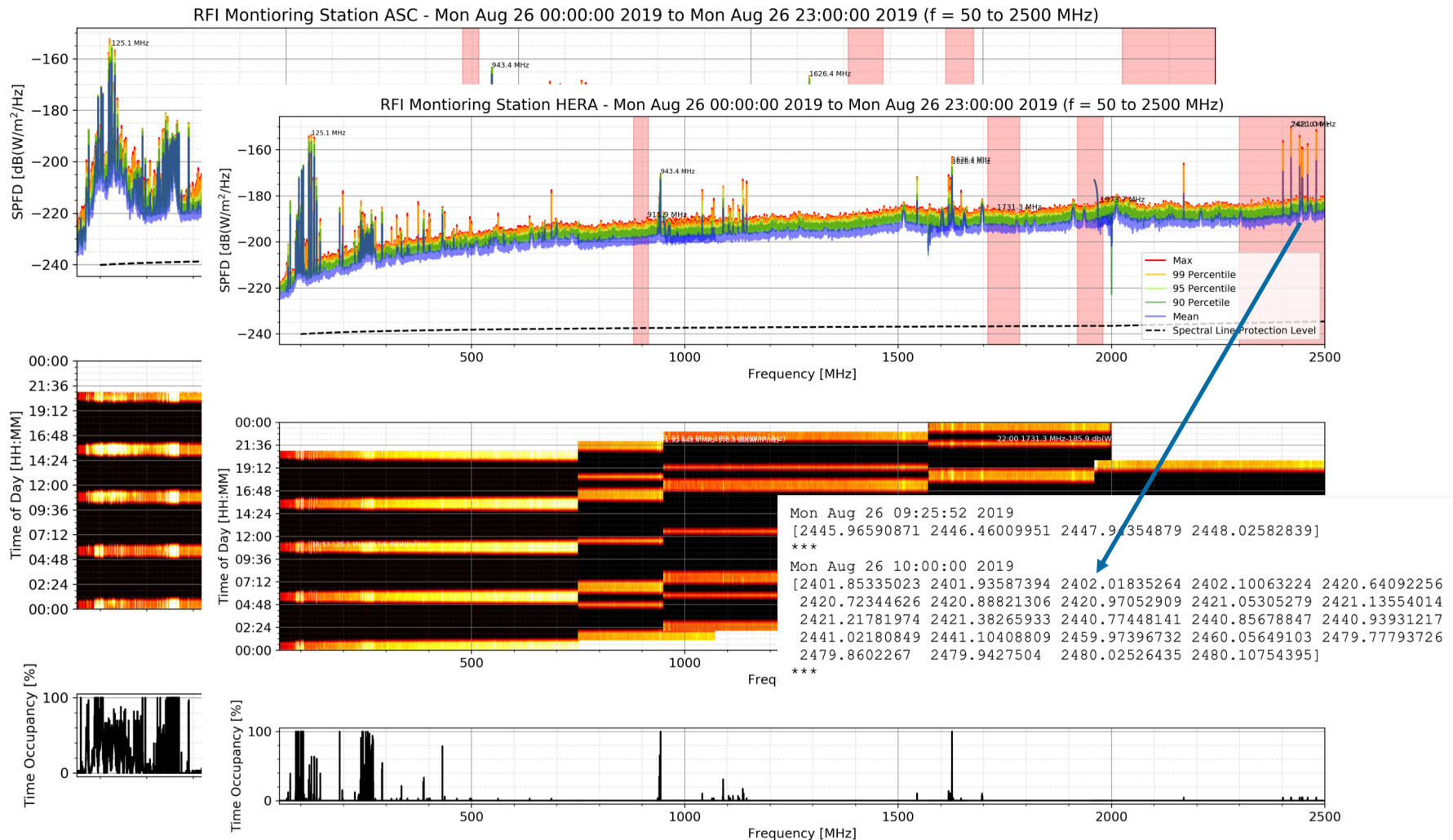
## "Controllable" Signal Detection (GSM Uplink/WiFi/Bluetooth)





# RFI Management Tools

## Daily Automated RFI Reports



# RFI Management Tools

## Daily Automated RFI Permits / CoC Validity Check & Email Notifications

RFI RFI1807-0059-001 RFI1807-0059-001 Expiration ➤



rfiserver@gmail.com

to bcc: jfynn

Wed, Feb 5, 8:31 AM



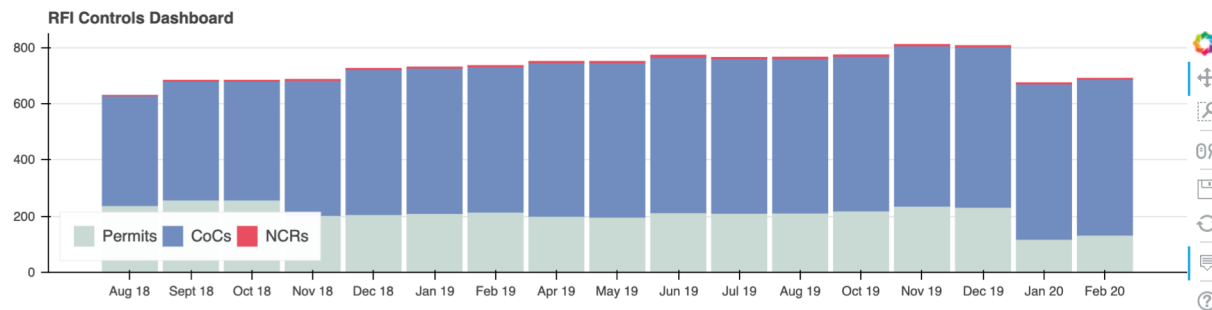
Good Day

Our database indicates that the RFI Permit RFI1807-0059-001 with description: "Hioki 3197 Power Quality Analyser", has expired on 31/01/2020. Going forward if you would, or would not like to renew your Permit please notify Busisiwe Dube, [bdube@ska.ac.za](mailto:bdube@ska.ac.za) within 5 working days of this email. If not the Permit will be marked as expired and will therefore no longer be valid.

Document Link:

Kind Regards

Your Friendly RFI-bot :-)



**Cumulative Controls Issued**

#	Date	Permits	CoC's	NCR's
0	Feb 20	134	553	3
1	Jan 20	119	552	3
2	Dec 19	233	569	4
3	Nov 19	237	569	4
4	Oct 19	220	549	4
5	Aug 19	213	548	4
6	Jul 19	212	548	4
7	Jun 19	214	551	7
8	May 19	198	548	4

**Permits Expiring Soon**

#	Status	RFI ID	Document Type	Document Link
3	expired	RFI1807-0015-001	Permit	<a href="https://drive.google.co...">https://drive.google.co...</a>
4	expired	RFI1807-0018-001	Permit	<a href="https://drive.google.co...">https://drive.google.co...</a>
5	expired	RFI1807-0039-001	Permit	<a href="https://drive.google.co...">https://drive.google.co...</a>
6	expired	RFI1807-0040-001	Permit	<a href="https://drive.google.co...">https://drive.google.co...</a>
7	expired	RFI1807-0050-001	Permit	<a href="https://drive.google.co...">https://drive.google.co...</a>
8	expired	RFI1807-0051-001	Permit	<a href="https://drive.google.co...">https://drive.google.co...</a>
9	expired	RFI1807-0052-001	Permit	<a href="https://drive.google.co...">https://drive.google.co...</a>
10	expired	RFI1807-0057-001	Permit	<a href="https://drive.google.co...">https://drive.google.co...</a>



# RFI Management Tools

## RFI Database

SARAO RFI reports

camera

01/01/2008 to 02/03/2020

**FILTERS**

219 results for **camera**

**CATEGORIES**

- Camera (202)
- Optical Pointing Camera System (7)
- Video Camera (3)
- Camera Flash (2)
- Camera Remote Control (2)
- Camera (1)
- Camera Display Monitor (1)
- Microphone (1)

**MANUFACTURER**

- Canon (81)
- Nikon (44)
- Sony (27)
- GoPro (11)
- Pentax (10)
- Panasonic (8)
- DJI (5)
- Olympus (5)
- EO (4)
- Samsung (3)
- SARAO (2)
- 360fly (1)
- Arri (1)
- Atomos (1)
- BFR Digital (1)
- Brinno (1)
- EasyCAP (1)
- FujiFilm (1)
- Go Pro (1)
- Hahnel (1)

**AUTHOR**

**Digital Camera**  
Report Generation Date: 2019-04-18T00:00:00Z  
report id: M2901-0000-176

**Digital Camera**  
Report Generation Date: 2019-03-20T00:00:00Z  
report id: M2901-0000-168

**EO Optical Pointing Camera**  
Report Generation Date: 2019-09-18T00:00:00Z  
report id: SSA-0008J-027

**Canon D50 Camera**  
Report Generation Date: 2018-05-02T00:00:00Z  
report id: M2901-0000-121

**Nikon D750 Camera**  
Report Generation Date: 2018-05-09T00:00:00Z  
report id: M2901-0000-123

**Nikon Camera**  
Report Generation Date: 2019-04-23T00:00:00Z  
report id: M2901-0000-177

**Nikon Digital Camera**  
Report Generation Date: 2019-02-18T00:00:00Z  
report id: M2901-0000-163

**Digital Camera**  
Report Generation Date: 2020-01-06T00:00:00Z  
report id: SSA-0008J-052

**MeerKAT 62 Optical Camera**  
Report Generation Date: 2015-06-25T00:00:00Z

**Nikon D7000 Camera Video**  
Report Generation Date: 2018-02-05T00:00:00Z

Radio Frequency Interference Report

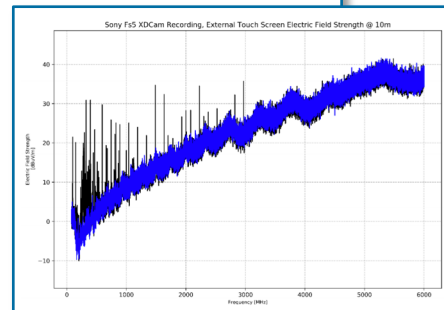
**NRF** National Research Foundation

**SARAO** South African Radio Astronomy Observatory

Client : Eaton De Jongh  
Email : eaton.dejongh@gmail.com  
Project : SKA  
Type : RFI PERMIT

RFI MEASUREMENTS: Sony a6500, Sony a7S Mark II, Sony FS5 XDCam 4K

Document Number: M2901-0000-176  
Revision: .01  
Classification: Commercial in Confidence  
Author: Jason Fynn  
Date: 26/04/2019



**SKA** South African Radio Astronomy Observatory

**SARAO** RFI Notice Type A

RFI Permit No: RFI1807-0030-001

Date Issued: 2019/03/26

Valid Until: 2019/09/30

**Part 1: Description of RFI Source / Culprit**

1.1. Short description of equipment	Auxiliary equipment used during construction.
1.2. Equipment make / brand name and Model	See Table 1 in Report M2901-0000-167
1.3. What will the equipment be used for?	Construction of SKA1 DISH Prototype
1.4. Will the equipment be Permanent or Temporary?	Temporary
1.5. Date deployed to site	2019/03/01
1.6. Date to be removed from site (if applicable)	2019/09/30
1.7. Contact1 Name and Organisation	Henk Niehaus SKAO
1.8. Contact1 email	henk@ska.ac.za
1.9. Contact2 Name and Organisation	Thomas Kusel SARAO
1.10. Contact2 email	tkusel@ska.ac.za

**Part 2: RFI Test**

2.1 RFI Test - Test Facility	On Site Measurement ( Losberg )
2.2 RFI Test date	2018/07/01
2.3 RFI Test report reference	M2901-0000-167

**Part 3: Restrictions on Location and Use**

3.1 This equipment may be used within the following zones, subject to other restrictions listed below

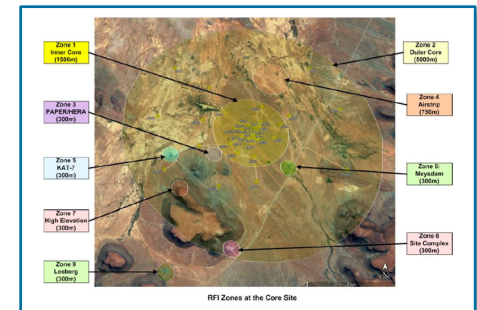
No	Zone 0: Within 20m from Antenna	No	Zone 1: Inner Core (1500m)
Yes	Zone 2: Outer Core (5000m)	No	Zone 3: PAPER/HERA (300m)
N/A	Zone 4: Airstrip (750m)	No	Zone 5: KAT-7 (300m)
N/A	Zone 6: Meydum (300m)	N/A	Zone 7: High Elevation Site (300m)
N/A	Zone 8: Site Complex (300m)	N/A	Zone 9: Losberg (300m)
N/A	Zone 14: Surrounding Farms	N/A	Zone 15: Klerfontein

3.2. Restrictions on Day / Night use

As set out in Section 3.5 of this permit
------------------------------------------

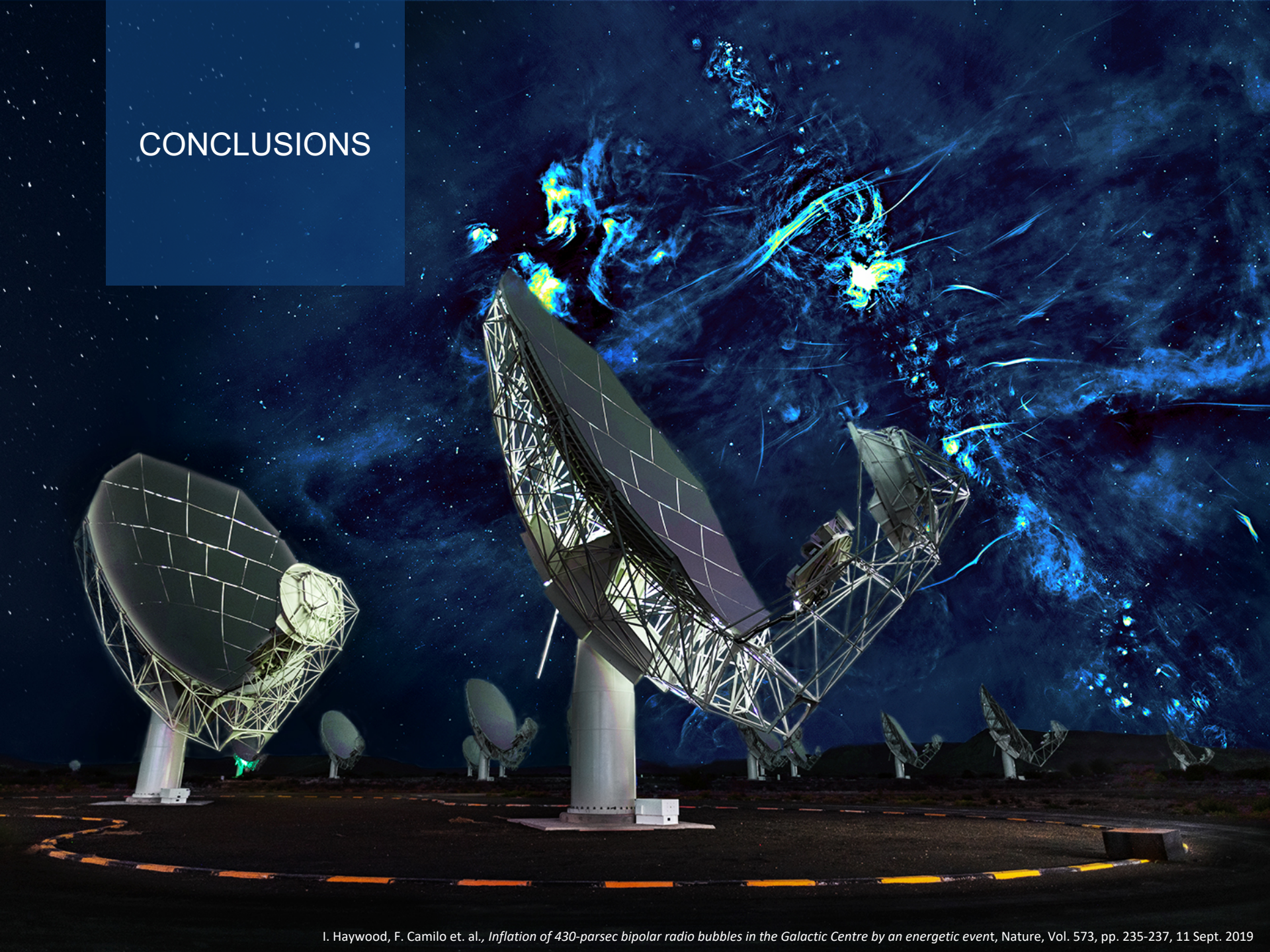
3.3 Do Not use after (time)

Sec. 3.5	3.4 Do Not use before (time)	Sec. 3.5
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# CONCLUSIONS





# Conclusions

- The successful management of protected radio quiet zone will be crucial to the success of the SKA project
- To take equipment to site: RFI Permit or CoC is required from SRAO RFI
- RFI Impact Assessment:
  - Measurements (reverberation chamber)
  - Calculate loss **required** to adhere to Telescope Protection Levels
  - Calculate path loss **available** (ITU-R P.1546-4)
  - Consider additional shielding (if required)
- RFI Controls & Management Tools to manage RFI culprits:
  - RFI Monitoring Stations
    - Live Views
    - Statistical Data Playback
    - Figure of Merit
  - RFI Permits, CoCs and NCRs (Automated notifications)
  - Detections Dashboards
  - Automated Daily RFI Reporting



science  
& technology

Department:  
Science and Technology  
REPUBLIC OF SOUTH AFRICA



National  
Research  
Foundation



[www.ska.ac.za](http://www.ska.ac.za)

The South African Radio Astronomy Observatory (SARAO) is a National Facility managed by the National Research Foundation and incorporates all national radio astronomy telescopes and programmes. SARAO is responsible for implementing the Square Kilometre Array (SKA) in South Africa.

## Contact information

**Dr Braam Otto**

Senior Engineer - RFI

South African Radio Astronomy Observatory

Email: [botto@ska.ac.za](mailto:botto@ska.ac.za)