SKAO Project Status update

Luca Stringhetti, Project Engineer

SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope

Luca Stringhetti, SKA Project Engineer

11/05/2020

What I do?

Luca Stringhetti

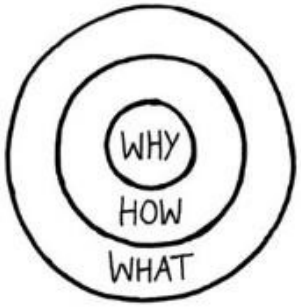
Physic degree in 1996
Antenna Engineer 1996-2004
LFI Planck Verification Eng. 2004 -2008
ACES System Engineer 2004 – 2010
SRT Verification manager 2010-2013
ASTRI/CTA system Engineer 2011-2016
SKAO Project Engineer 2016- now

Agenda

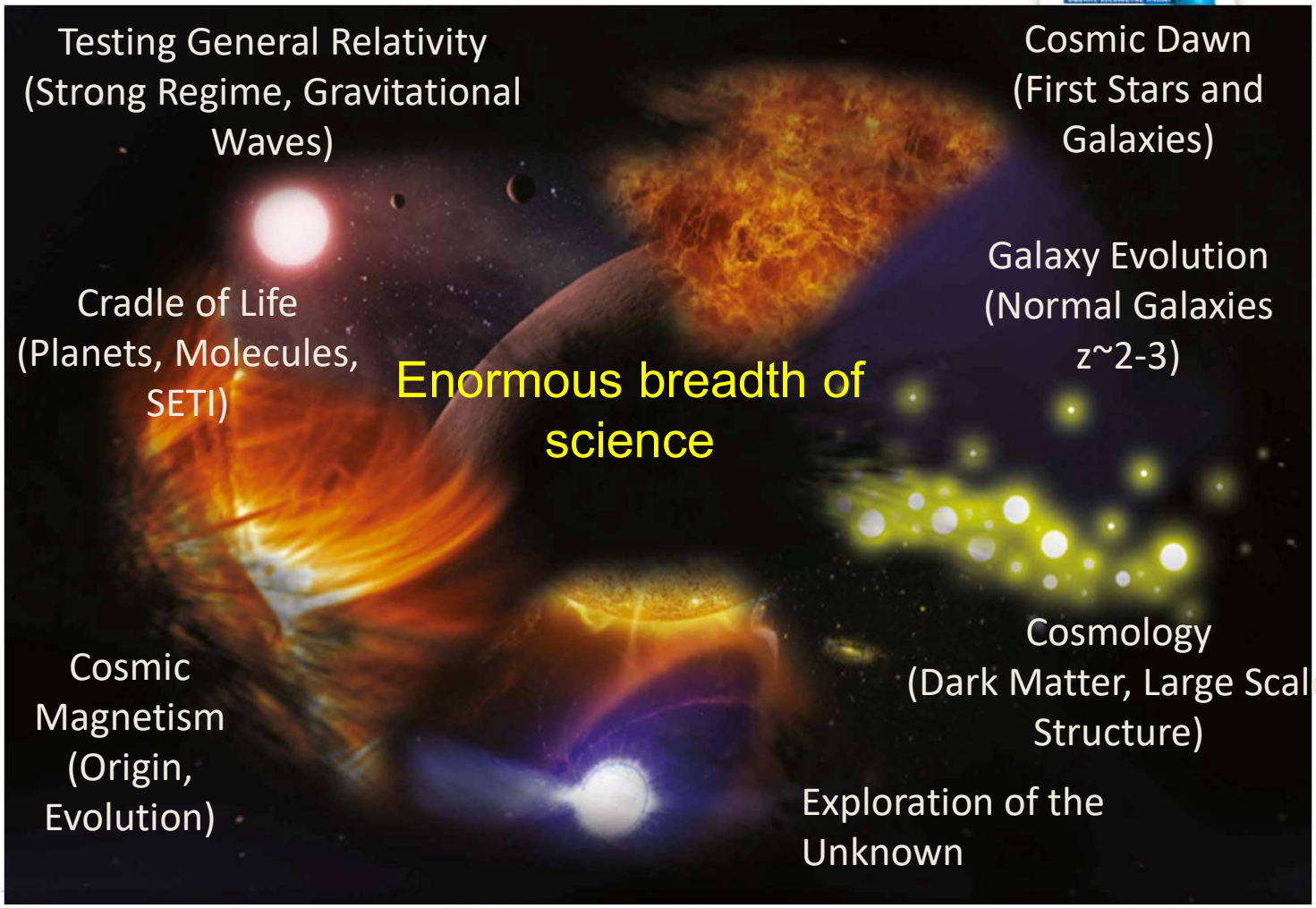
- Introduction
- WHY we do what we do?
- HOW we do what we do?
- WHAT are we going to do?
  - The Organisation
  - The project
  - The plan
  - The future
- A few not serious lessons learnt from my first 5 years in SKAO

WHY we do what we do?

SKA – Key Science Drivers



Simon Sinek
https://www.ted.com/talks/simon_sinek_how_great_leaders_inspire_action?language=en



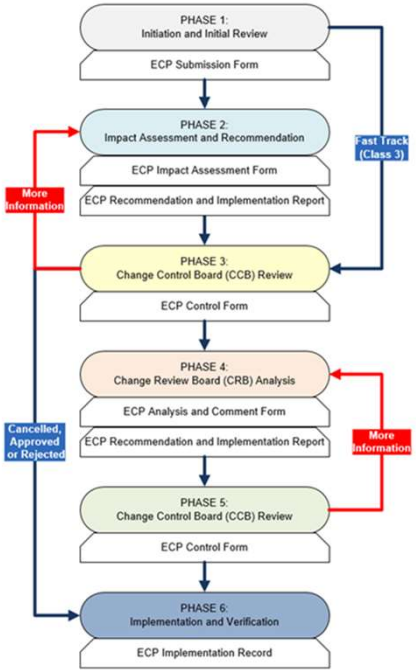
HOW we do what we do?

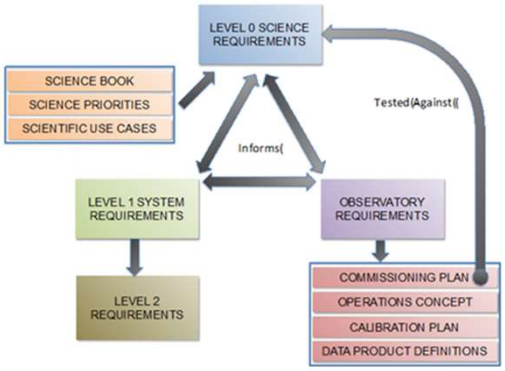
It's all about the people!

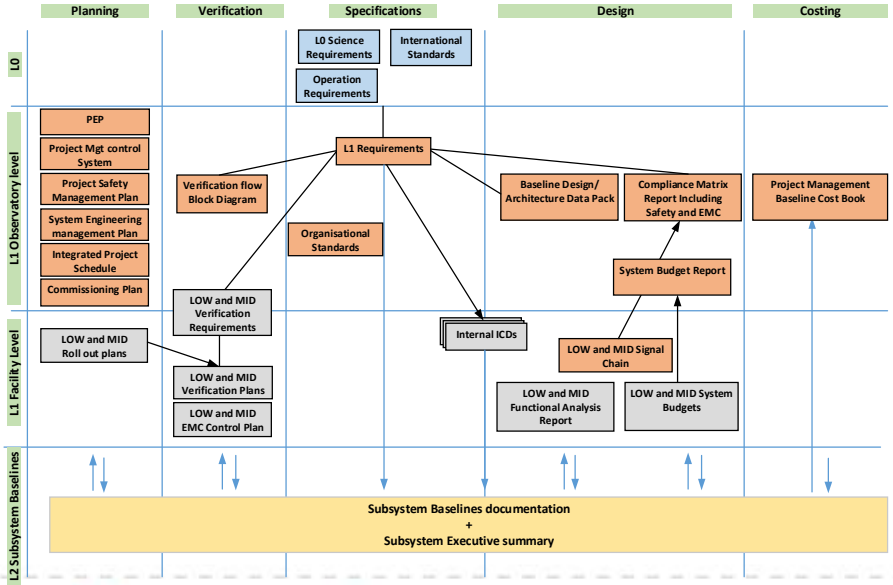
….and yes, a lot of good application of engineering!

HOW we do it?

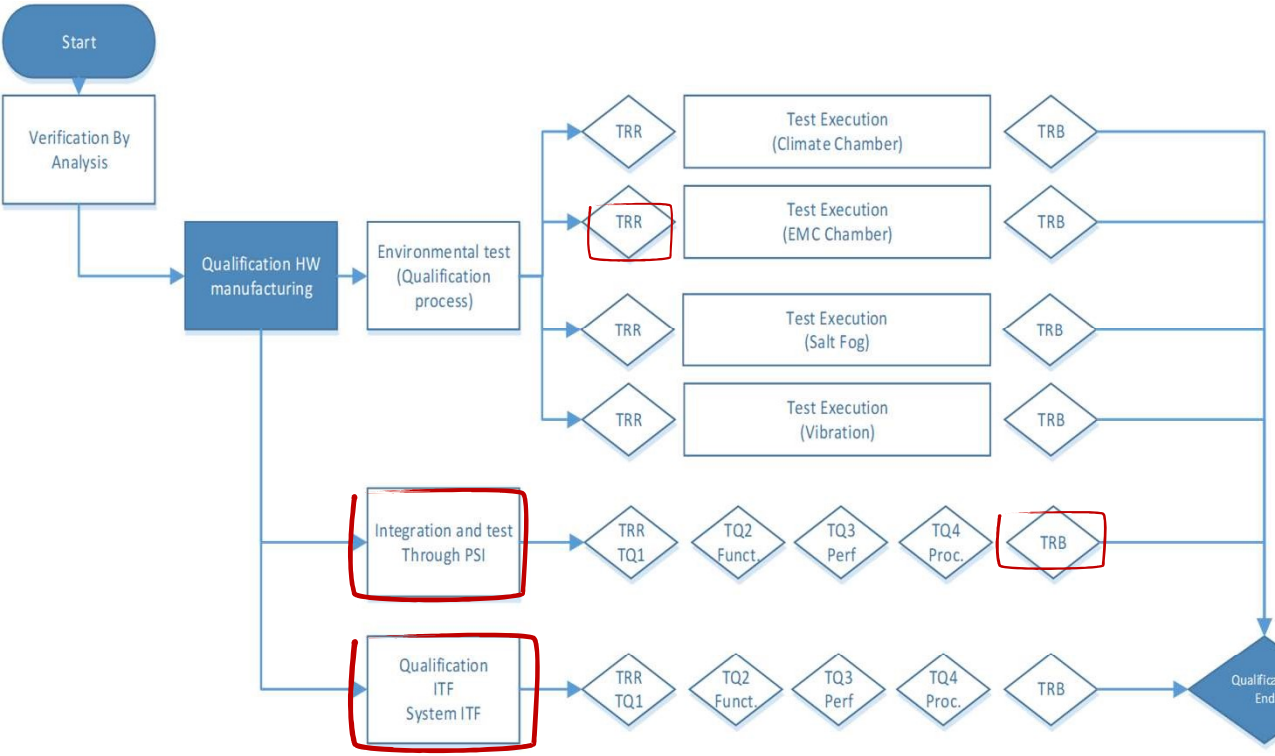
- **Systems Engineering**
  - Requirements management and flow-down.
  - Document tree, including ICDs.
  - Engineering Change Procedure.
  - Design definition
  - Design Justification
  - Modelling
  - Diagrams
  - Testing often and early

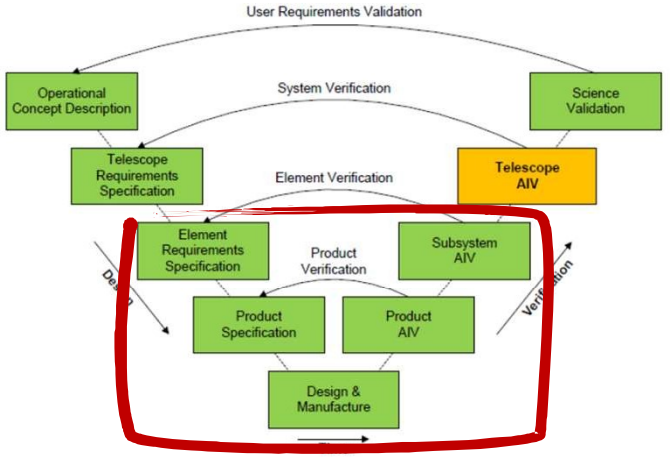




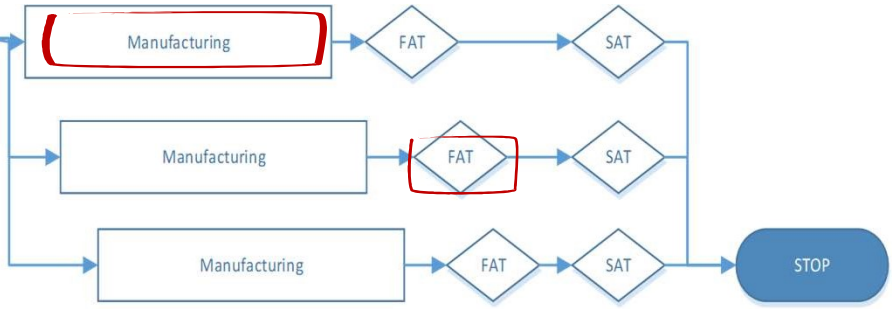


Verification at Product level (example)





Key points for SKA AIV/QA personnel



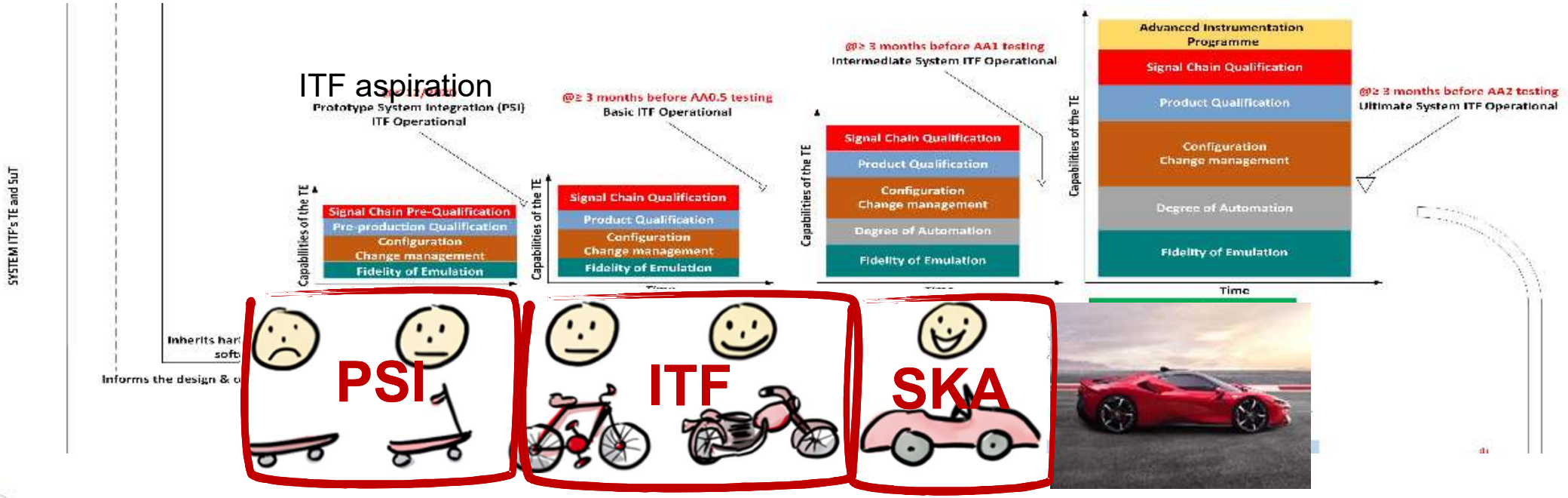
TRR : Test Readiness Review
acceptance Test
PSI: Prototype System Integration
SAT: Site Acceptance Test
Facility

FAT: Factory

TRB: Test Review Board (or Meeting)
ITF: Integrated Test

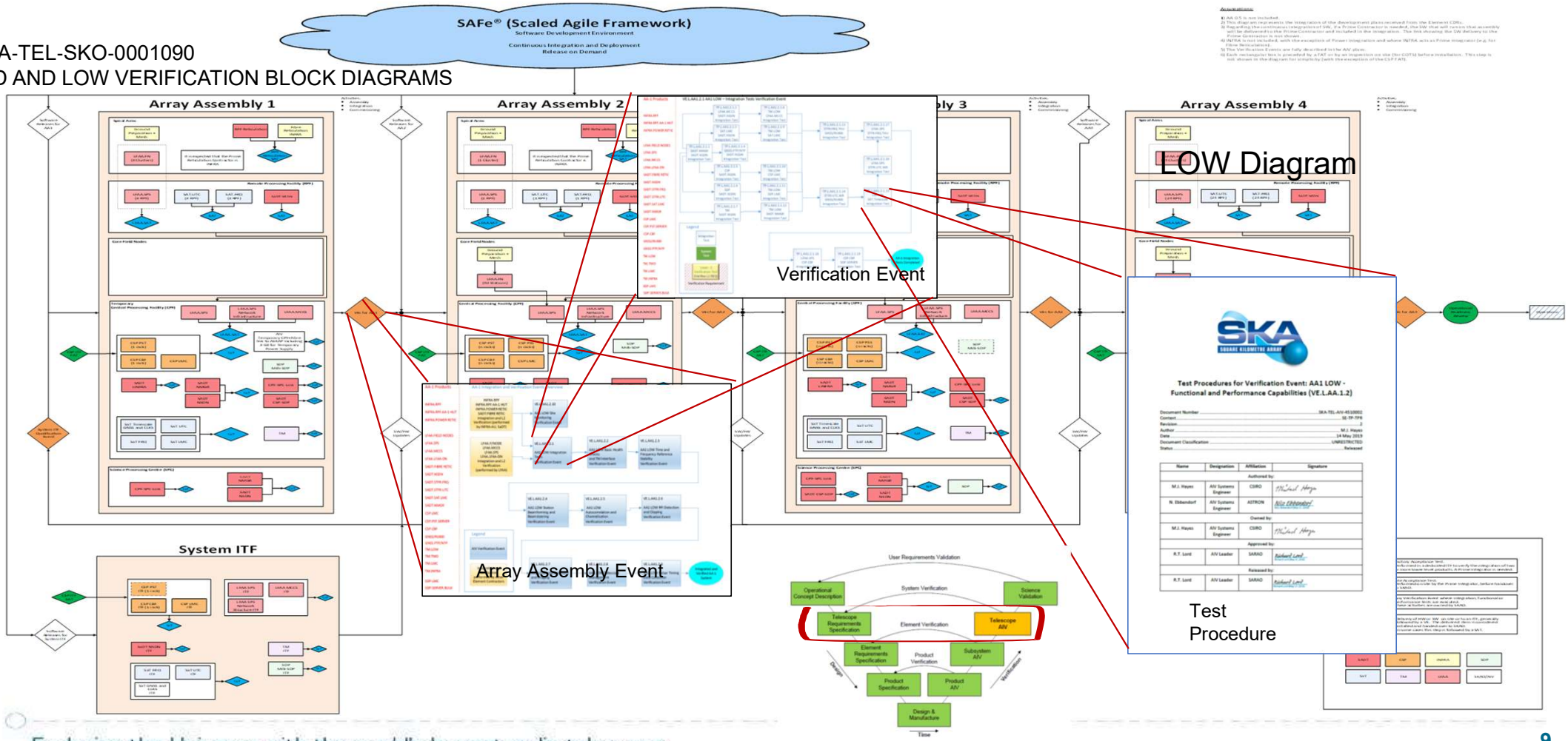
Verification before Site

- SKA has adopted two programs to minimise risks of the Site integration
  - PSI Verification program: can happen in any part of the world with pre-construction SW/HW
  - ITF Verification program: Will happen in Host countries facility with construction SW/HW.



System Level AIV

SKA-TEL-SKO-0001090
MID AND LOW VERIFICATION BLOCK DIAGRAMS



What is what we do? What is SKAO?

SKAO is an Organisation

- A global collaboration to design, build and operate the next-generation radio astronomy observatory
- A treaty has been signed to establish the SKA Observatory: a new Inter-Governmental Organisation for astronomy and fundamental science with a 50-year lifetime.
- On the 1st of May 2021 all the staff transitioned in the SKAO and in the IGO

SKAO is a Project

- It will consist of:
  - An array of 197 dishes in South Africa
  - An array of ~132,000 antennas in Australia
  - Global HQ in the UK
  - 2 Data processing centres (AU and ZA) and a global network of Regional Centres delivering science-ready data to end users
- Governments working to provide ~€1.9B for 2021-2030, will cover construction and first 10 years of operations.

SKAO is…people working together with passion

SKAO is a new organisation

What is our vision?

SKAO

Our values

Our values are at the heart of who we are and what we stand for. They define our standard of conduct. Every SKAO employee is expected to embody these values in their professional relationships. They were defined through extensive consultation with both internal and external stakeholders and are backed by high-level statements in the Preamble to the SKAO Convention, to which every Member State adheres.

Diversity & Inclusion

We aim to create a welcoming and inclusive environment where everyone feels they belong, there is fairness and respect for everyone as an individual, and diverse perspectives and ideas thrive.

In the SKAO Convention

COMMITTED to an organisation where diversity and equality are promoted and respected.

Creativity & Innovation

We will foster a culture of creativity and innovation where we take time to seek innovative, better solutions and problem-solving, focusing on delivering value to our user's community.

In the SKAO Convention

EMBRACING the potential for scientific discovery to contribute to advances in technology and innovation and to deliver a broader benefit for industry and society.

Excellence

We value professional excellence in the delivery of world class transformational science. This is founded on ways of working where leadership, integrity, personal responsibility and safety are at the heart of everything we do.

In the SKAO Convention

DESIRING to deliver one of the most visionary and ambitious science projects of the 21st century involving significant international cooperation.

COMMITTED to testing the limits of engineering and scientific endeavour and to exploring fundamental questions in astronomy and physics.

NOTING that the Square Kilometre Array will be a next generation radio telescope facility that has a discovery potential far greater than any previous instrument.

DEDICATED to realising the full ambition of the Square Kilometre Array Project.

Collaboration

We are aligned around common goals and actively create and promote collaborative working across cultural and geographical, functional and specialist boundaries.

In doing this we will communicate appropriately and in an open manner, delivering on commitments and building long term supportive, trusting and professional relationships.

In the SKAO Convention

RECOGNISING that the scale and ambition of the Square Kilometre Array demand a global effort with long-term investment.

Sustainability

We take a long-term view and ensure sustainability is integrated into everything we do, taking into account social, financial, ecological and environmental responsibilities, both globally and locally. In doing this we demonstrate care towards the people, places and resources on which we rely and seek to build long-term sustainable relationships.

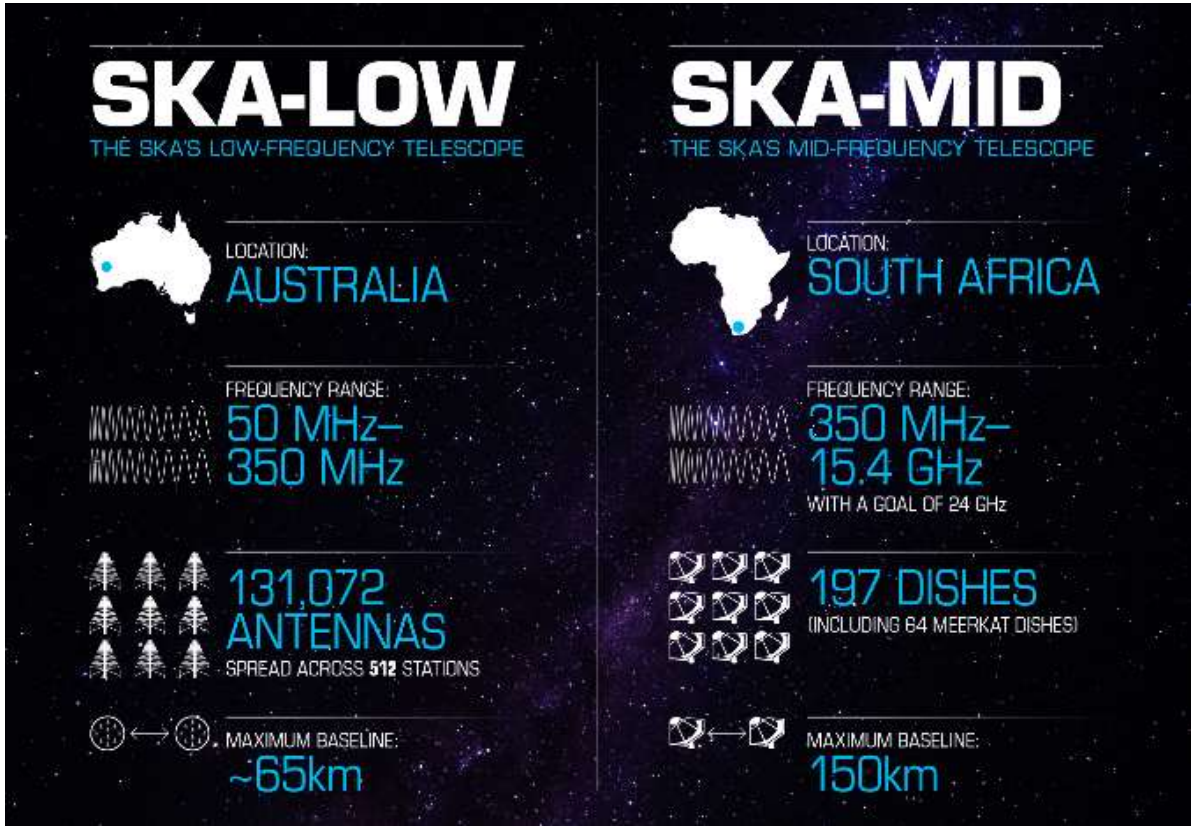
SKAO is a project

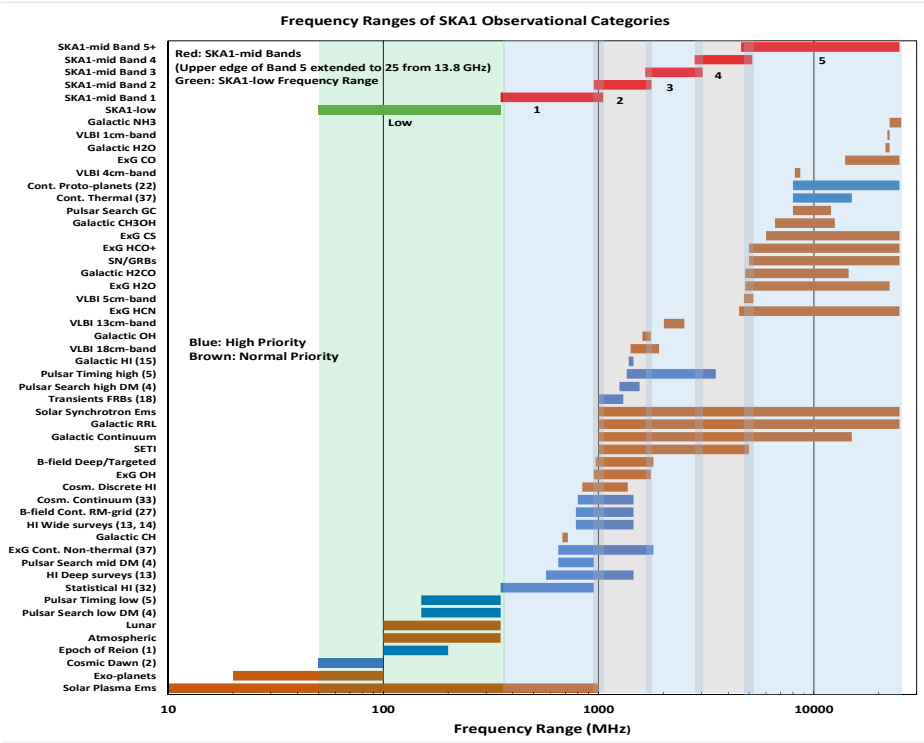
SKAO 1, 2, 3…

1 Observatory
2 Telescopes
3 Host countries

SKAO Head quarters in Jodrell Bank (UK)

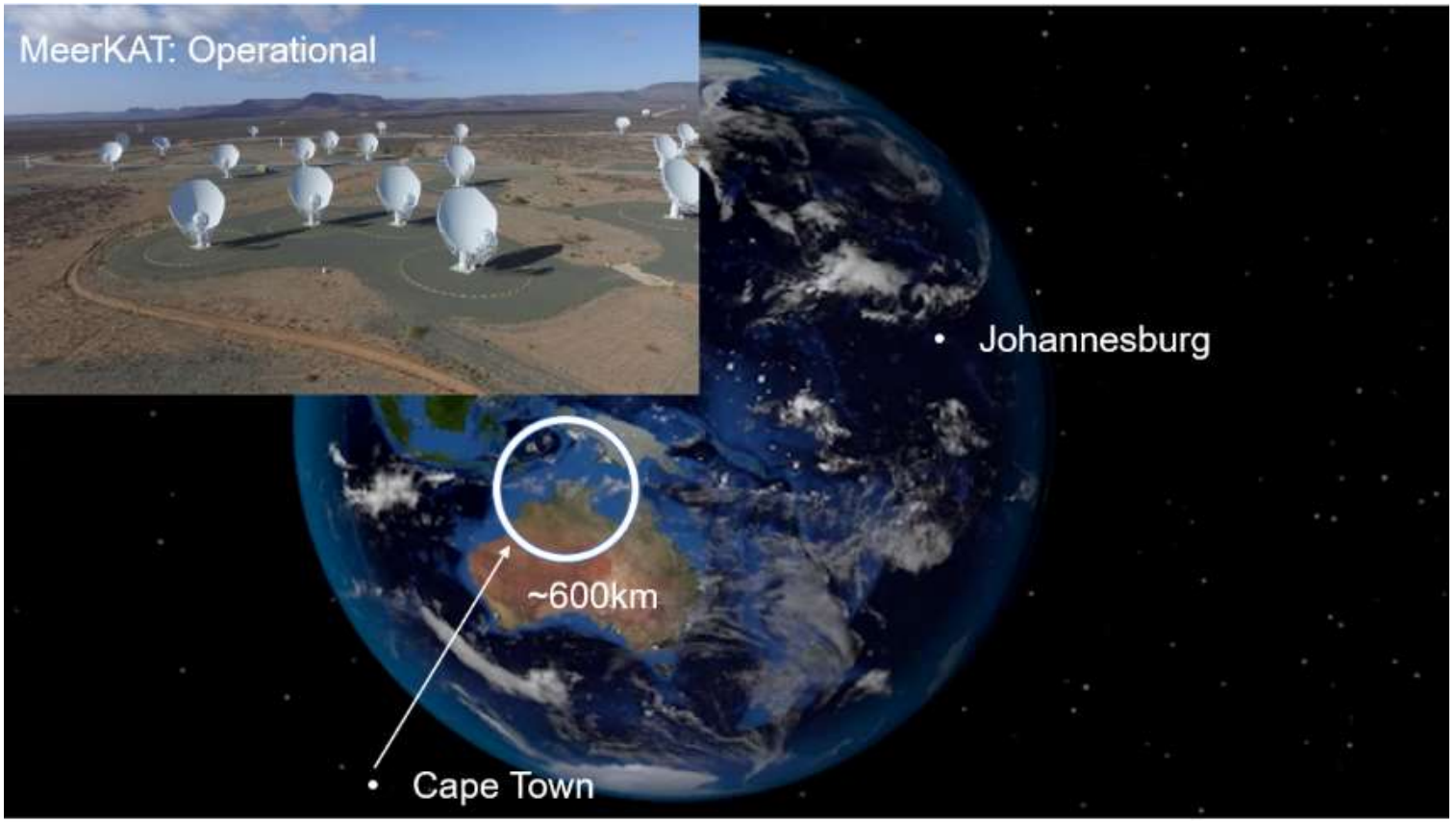
SKAO is two telescopes



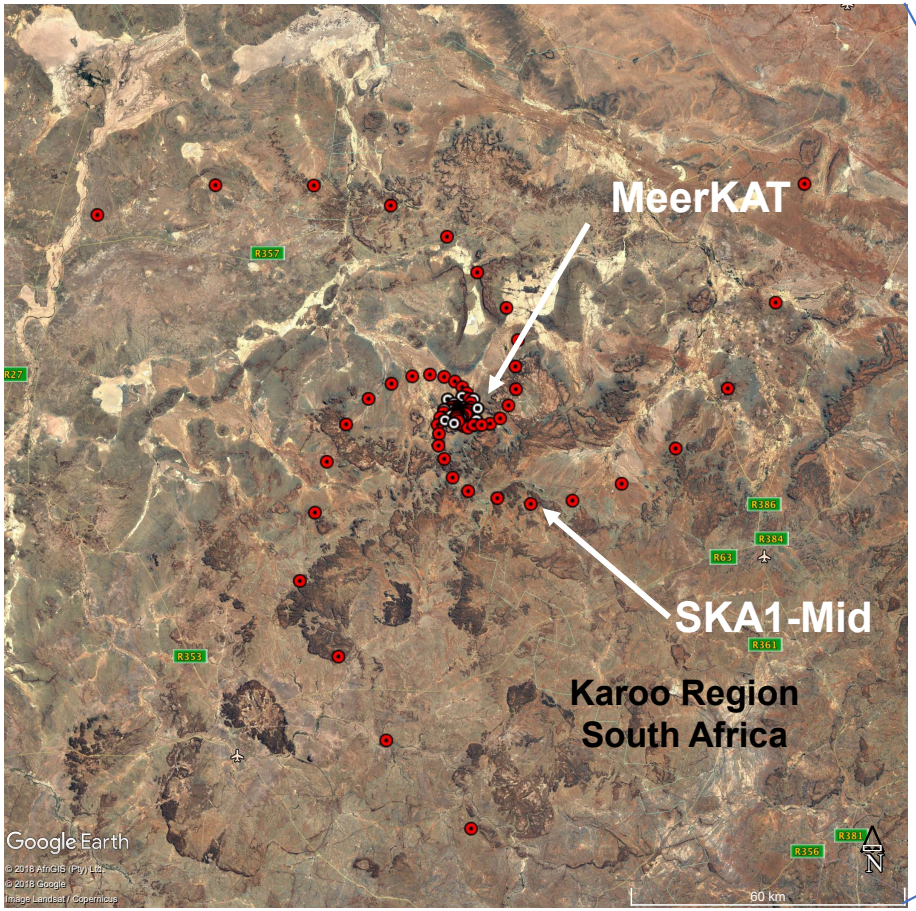


SKAO telescopes are an multi objective observatory so frequency coverage is a paramount

Karoo SKAO Site South Africa

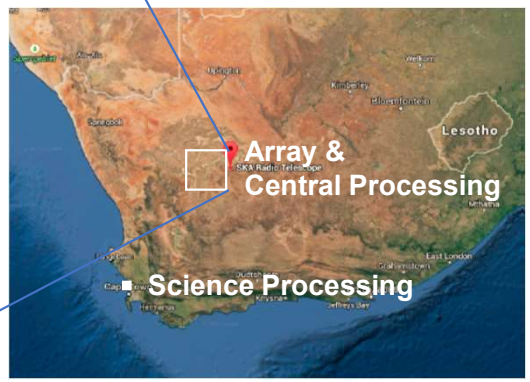


SKA1-MID Configuration

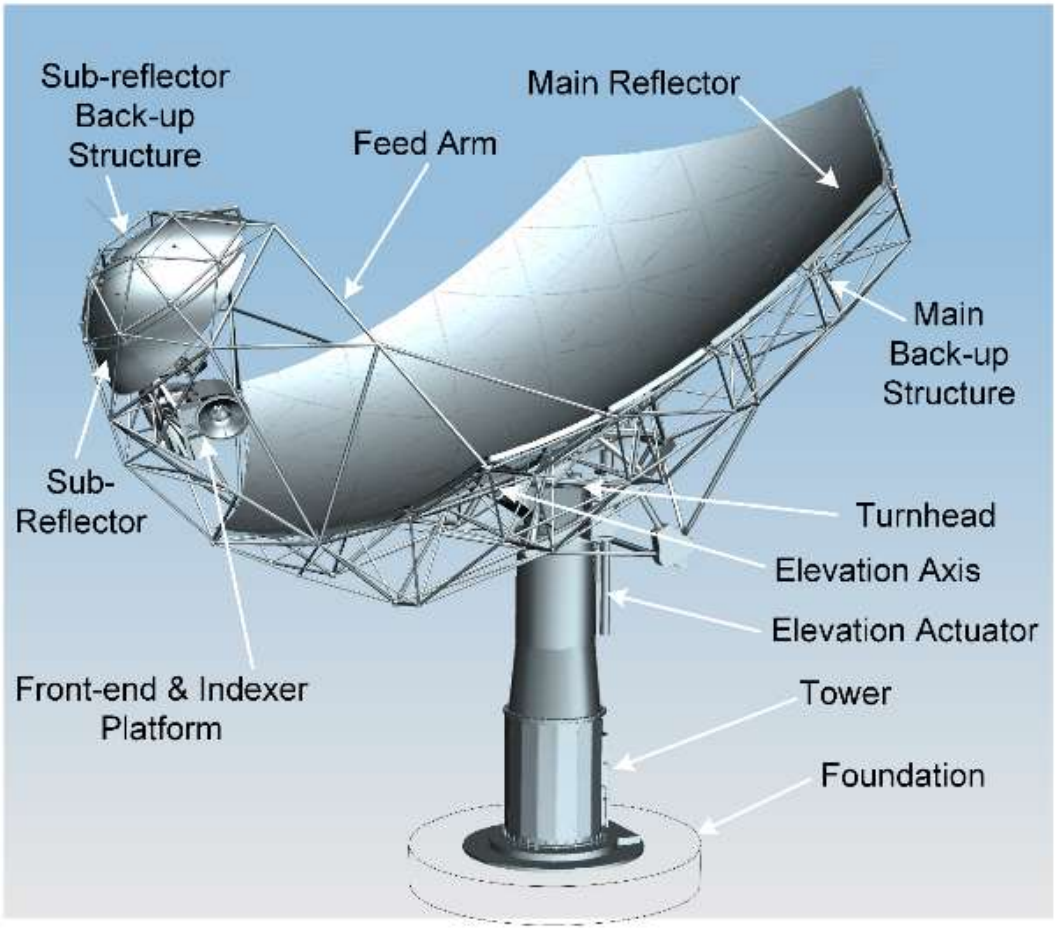


60km

- 133 SKA 15m dishes
- 64 MeerKAT 13.5m dishes
- Maximum baseline 150 km
- 3 logarithmic spiral arms
- Frequency range: 350 MHz to 15.4 GHz



SKA1 Mid Antenna



Antenna Features

- Frequency: 350MHz – 15.4GHz +
- 15 metre offset Gregorian optics
- Sub-reflector: 5 m, with skirt
- Tracking speed: 30 times sidereal rate @ 10arcsec accuracy
- Slewing Speed:
  - 1deg/sec elevation
  - 3deg/sec Azimuth
- Indexing speed: Less than 30 sec

Antenna Performance

Sensitivity per Band estimates

Band	Frequency (GHz)	BW (MHz)	Sensitivity Requirement (m^2/K)		Design (m^2/K)
			Array (L1)	*Dish (L2)*	*Dish (L2)*
1	0.35 – 0.650 0.65 – 1.050	700	272 – 545 545	2.1 – 4.2 4.2	2.5 – 5.0 5.4
2	0.95 – 1.760	808	916	7.1	10.9
3	1.65 – 3.050	1403	916	7.1	--
4	2.80 – 5.180	2380	833	6.6	--
5a	4.60 – 8.500	3900	1110	8.86	9.52
5b	8.30 – 15.40	7000	805	6.74	7.93

Pointing performance estimates

		RMS error (arcsec)	RMS error (arcsec)	RMS error (arcsec)
Blind Pointing Error	Requirement	9	18	36
	Design	5.5	11	21.7
Relative Pointing Error	Requirement	1.3	2..6	5.2
	Design	1.2	3.5	6.7
Tracking Stability	Requirement	2.3	4.6	9.2
	Design	1.5	4.4	8

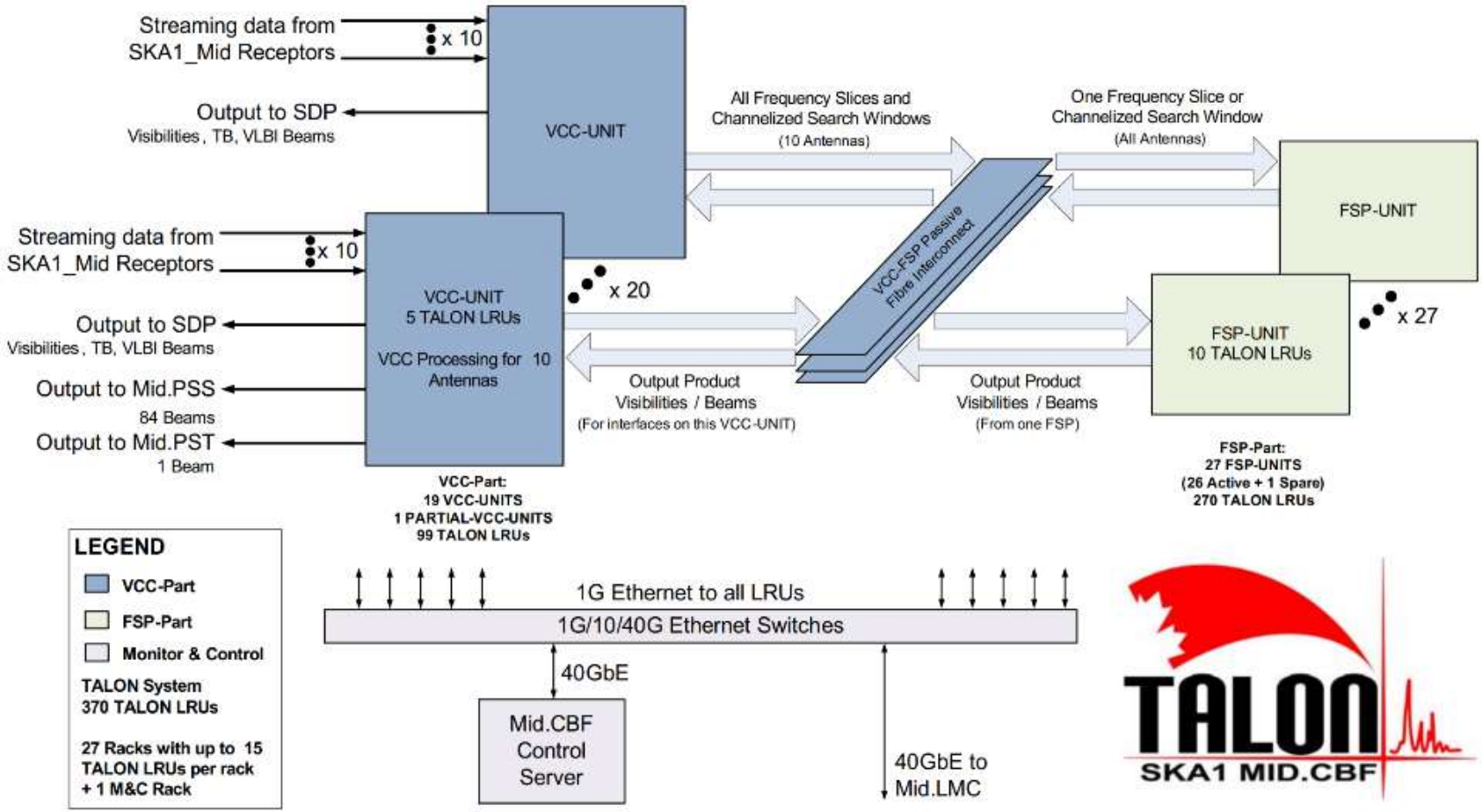
SKA1-MID SPF Receiver (Digitisation)

- RF samplers located on the Feed Indexer
- Packetiser, DSP and C & M located in RFI enclosure in the Dish Pedestal (TALON)
- Separate Band 123 and 345 Digitisers

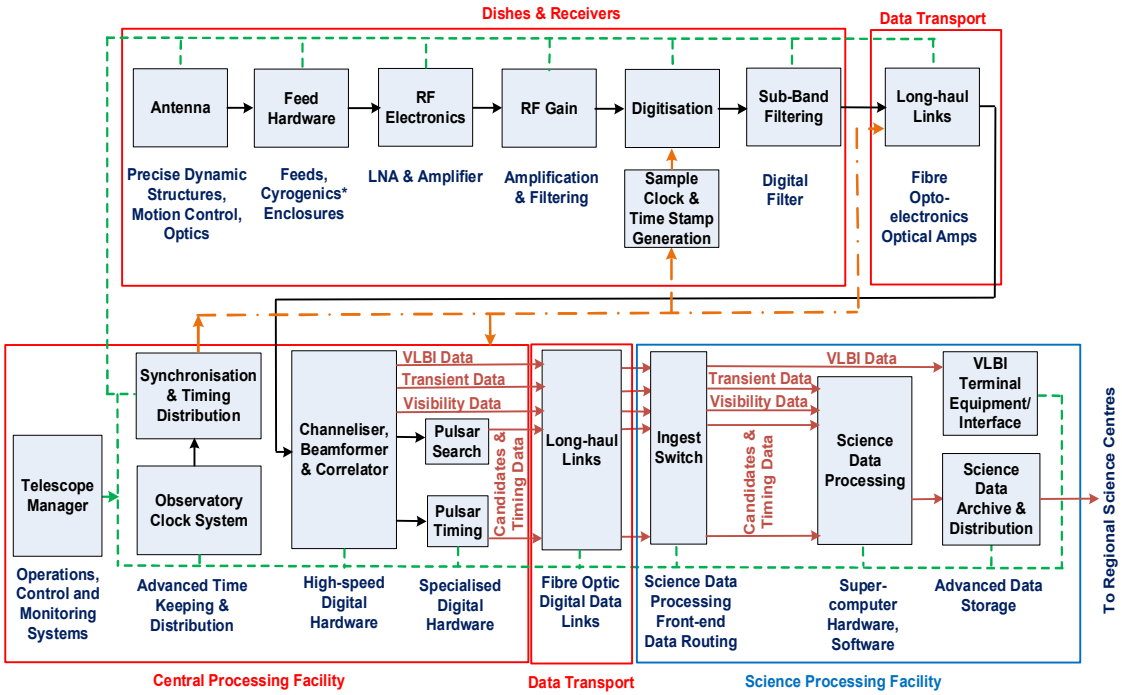
Band	Frequency (GHz)	RF BW (MHz)	Sampling Rate (GSps)	Nyquist Zone	ADC Sampling Bit Depth	Transport Sampling Rate (GSps)	Transport Bit Depth	Transport Data Rate (Gbps)
1	0.35 – 1.050	700	3.96	1	8	3.96*	12	95.04
2	0.95 – 1.760	808	3.96	1	8	3.96*	12	95.04
3	1.65 – 3.050	1403	3.168	2	6	3.168*	12	76.032
4	2.80 – 5.180	2380	15.84	1	4	5.94*	8	95.04
5a	4.60 – 8.500	3900	8.91	2	3	2 x 5.94*	4	95.04
5b	8.30 – 15.40	7000	15.84	2	3	2 x 5.94*	4	95.04

*Offsets are added to these frequencies to reduce correlated noise

CBF Hardware concept

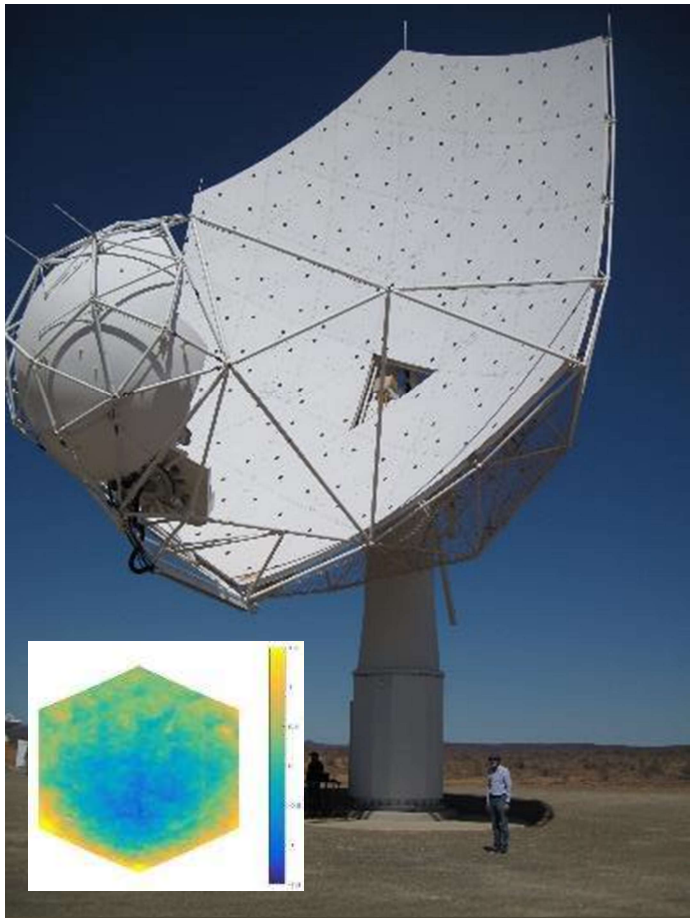


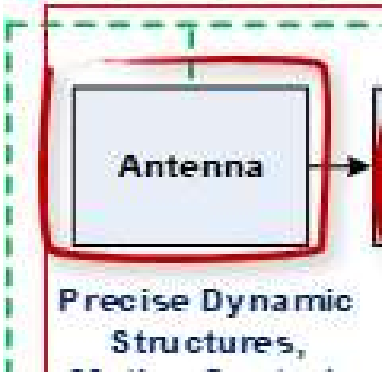
SKA MID in a nutshell



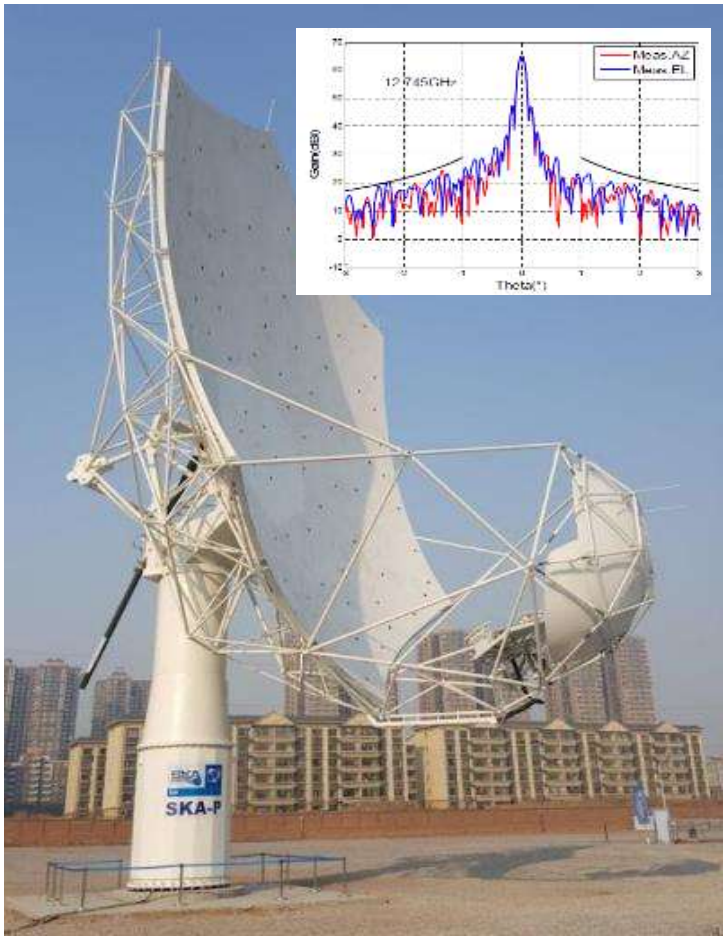
Aperture	m^2	133 x 15-m (equiv. dia.) offset Gregorian reflectors Plus 64 x 13.5-m (equiv. dia.) offset Gregorian reflectors
Total physical aperture	33306	
Total Available aperture	31641	Availability 95%
Minimum Elevation Angle	15 deg	All Azimuths – 270° wrap
Array Configuration	Antenna	Filling factor %
radius <~400 m	80 (41%)	2.67
~400 m < radius < ~1000 m	35 (18%)	0.22
~1000 m < radius < 2500 m	23 (12%)	0.023
~2500 m < radius < 4000 m	13 (6.6%)	7.04E-03
~4000 m < radius < 10000 m	13(6.6%)	8.53E-04
10000 m < radius < 30000 m	15 (7.6%)	1.05E-04
~30000 m < radius < 100000 m	18 (9.1%)	1.11E-05
Antenna RF System		
Frequency Range	GHz	
Band 1 (high) + UHF Band	0.58 – 1.015	Dual pol'n. Shared Frequency Range
Band 2 + L-band	0.95 – 1.67	"
Band 3 [3]	1.65 – 3.05	Dual pol'n. SKA antennas only
Band 4 [3]	2.80 – 5.18	"
Band 5a	4.60 – 8.50	"
Band 5b	8.30 – 15.4	"
Band 5c [3]	15.0 – 26	"
Continuum Sensitivity		
SEFD (available antennas, Stokes I)	Jy	Equivalent A_e/T_{sys} (m^2/K)
Band 1 (high) + UHF Band	2.85	967
Band 2 + L-band	1.55	1784
Band 3	2.50	1102
Band 4	3.49	792
Band 5a	2.38	1161 (Max. Sampled Bandwidth 2 x 2.5 GHz)
Band 5b	2.77	998 (Max. Sampled Bandwidth 2 x 2.5 GHz)
Min. detectable flux (rms) (ΔS_{rms})	$\mu Jy\ s^{1/2}$	
Band 1 (high) + UHF Band	99.8	Average over RF bands
Band 2 + L-band	42.1	"
Band 3	48.9	"
Band 4	53.1	"
Band 5a	25.3	"
Band 5b	29.4	"
Signal Processing System		
Correlator		
Freq. chans (widest sampled BW)	65536	
Full Bandwidth Velocity Resolution	$km\text{-}s^{-1}$	
Band 1 (high) + UHF Band	~5	Non-Zoom, all available frequency channels
Band 2 + L-band	~5	"
Max. Frequency Resolution	0.21 kHz	$13.440 \cdot 2^{-n}$ kHz $n \in (0, \ldots, 6)$ kHz in Zoom mode
Standard Frequency Resolution	13.44 kHz	220.200960 / 16384
Complex Correlations	5.1×10^9	(197²/2) baselines x 4 pol'n prod's x 65536 chans

MID Prototype

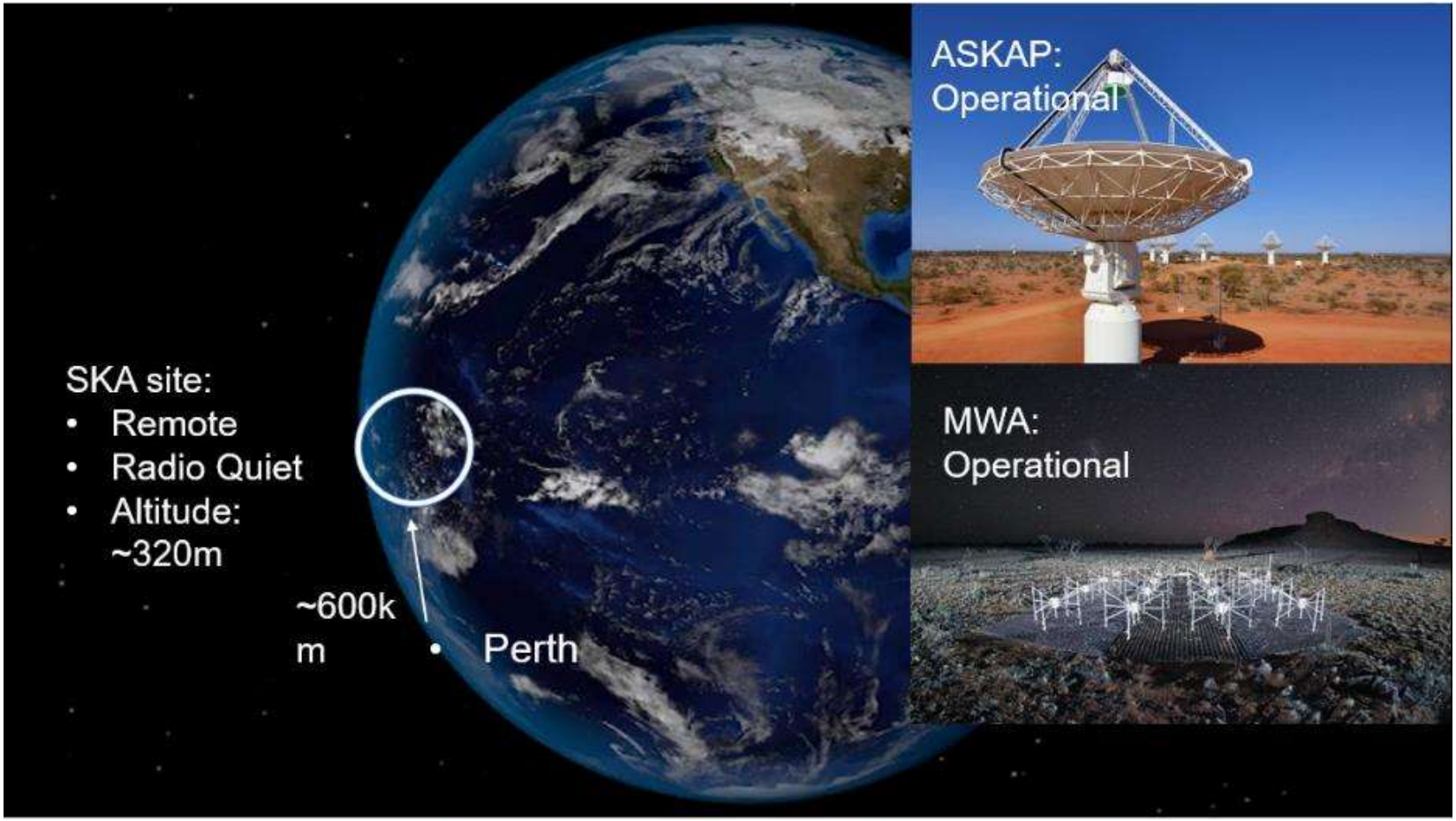




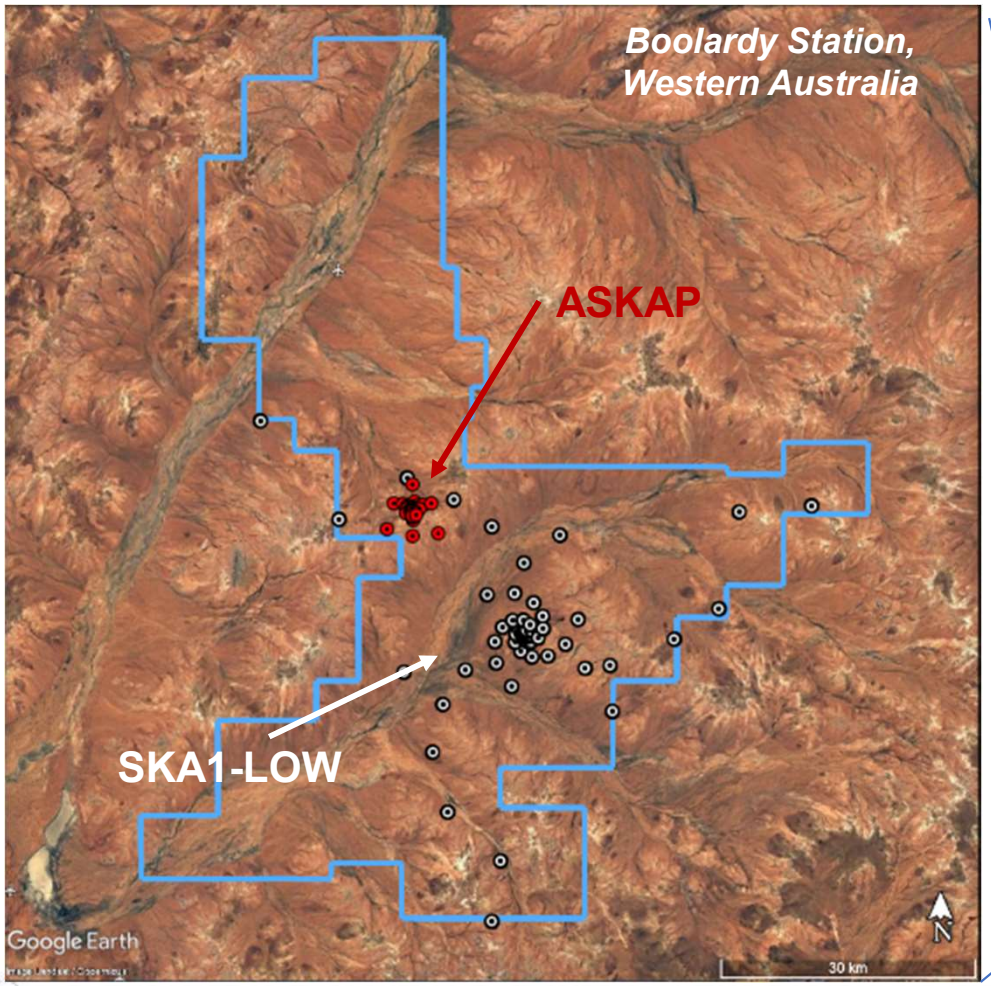
Two structure prototype available to test manufacturing, and basic mechatronic performance. Used to test surface accuracy (photogrammetry) and pointing performance. Test still happening.



Murchison SKA Site Australia

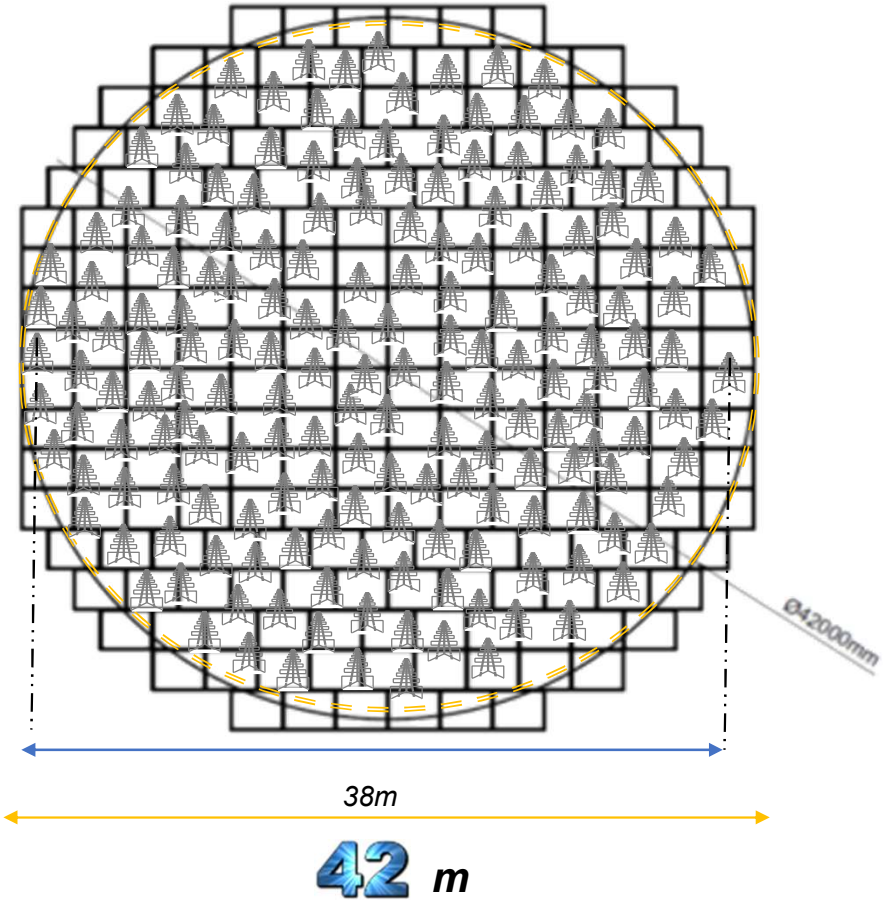


SKA1-LOW: Configuration



- 512 aperture array stations
- Maximum baseline 65 km

SKA1-LOW: Field Station



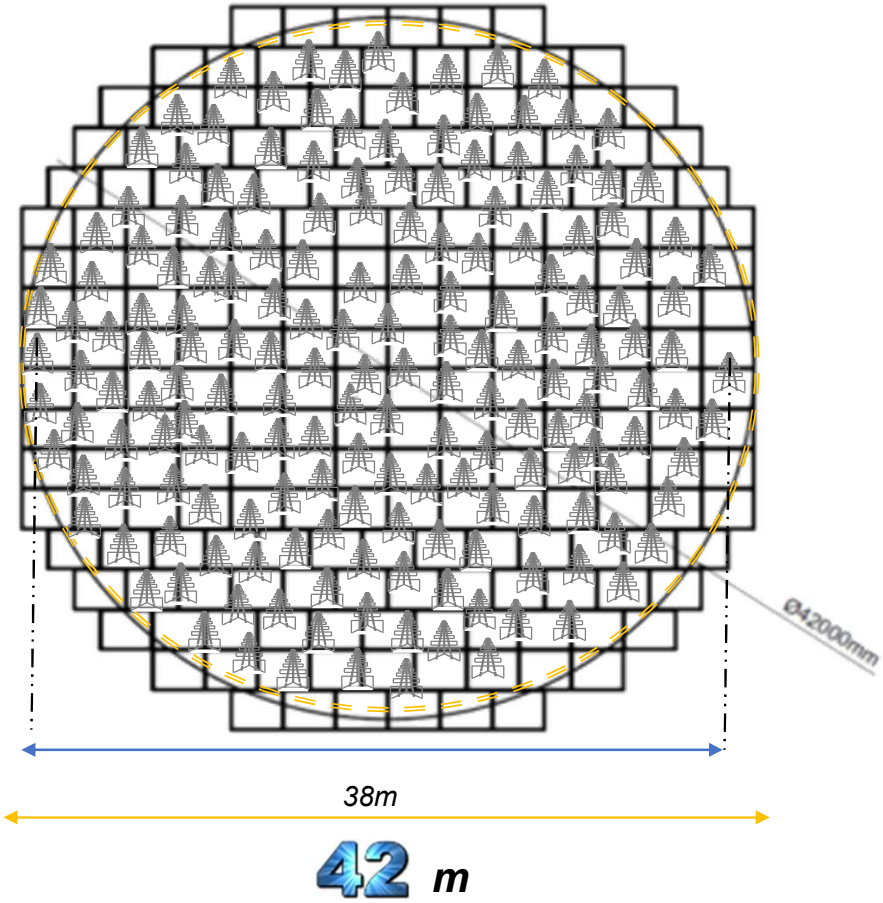
- 256 antennas
- Circular area
- 38 m (*effective station diameter*)
- Ground plane

Mesh	50mm x 50mm
Wire gauge	4mm
Sheet size	2400mm x 3000mm

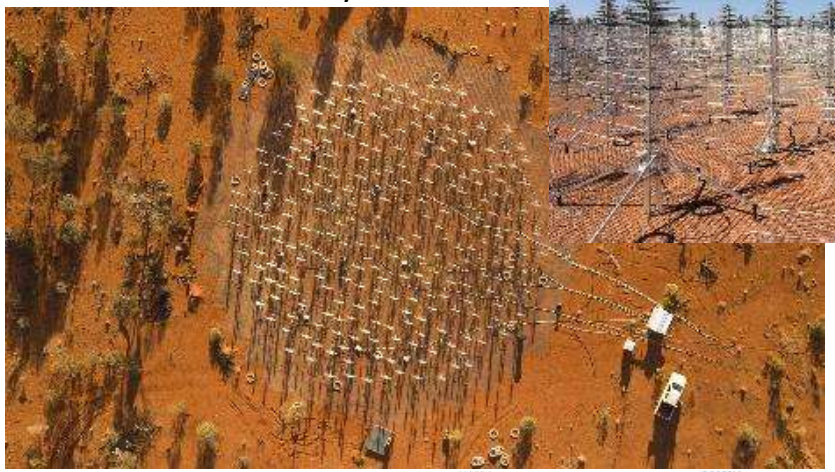
The Hitchhiker's Guide to the Galaxy

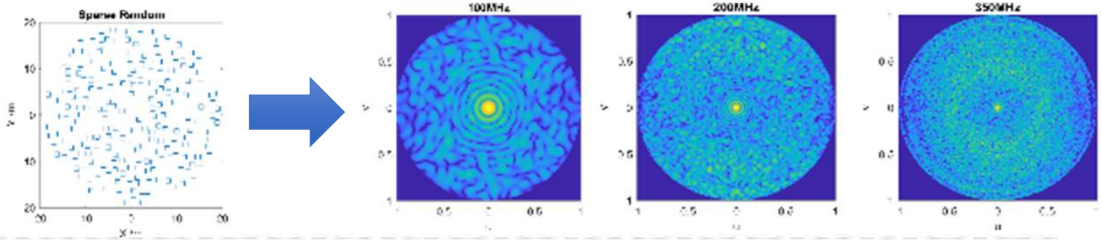
The "Answer to the Ultimate Question of Life, the Universe, and Everything"
calculated by an enormous supercomputer named Deep Thought over a period of 7.5 million years

SKA1-LOW: Field Station

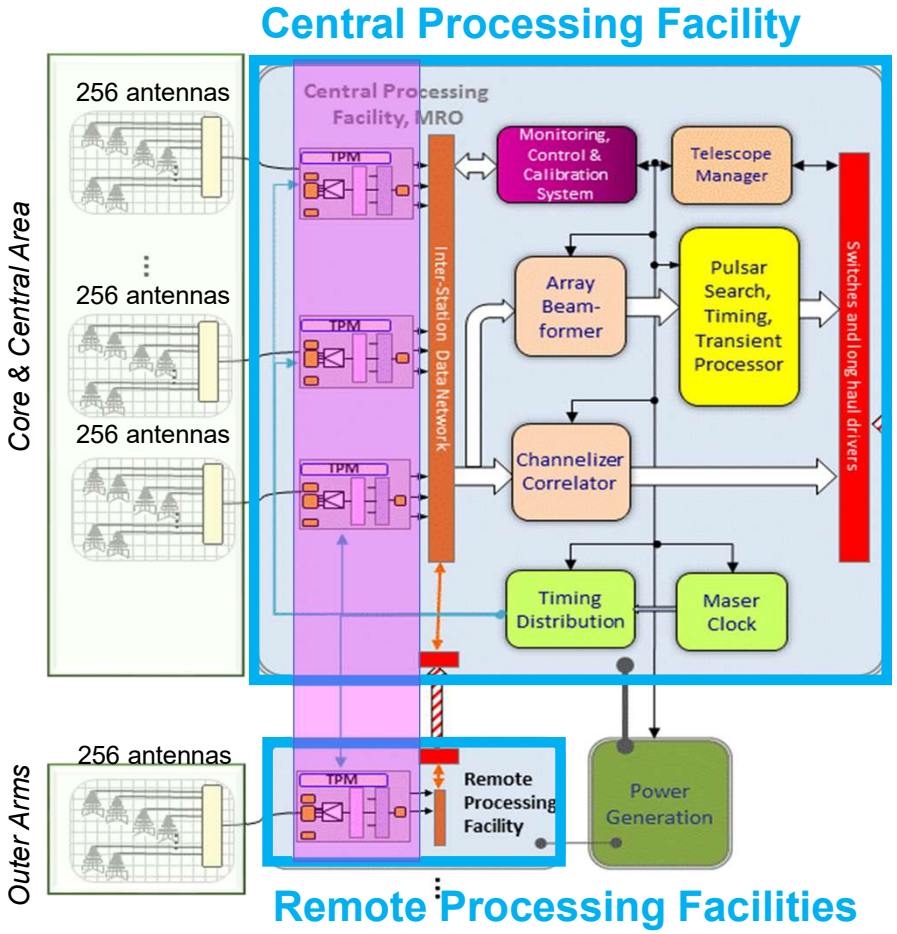


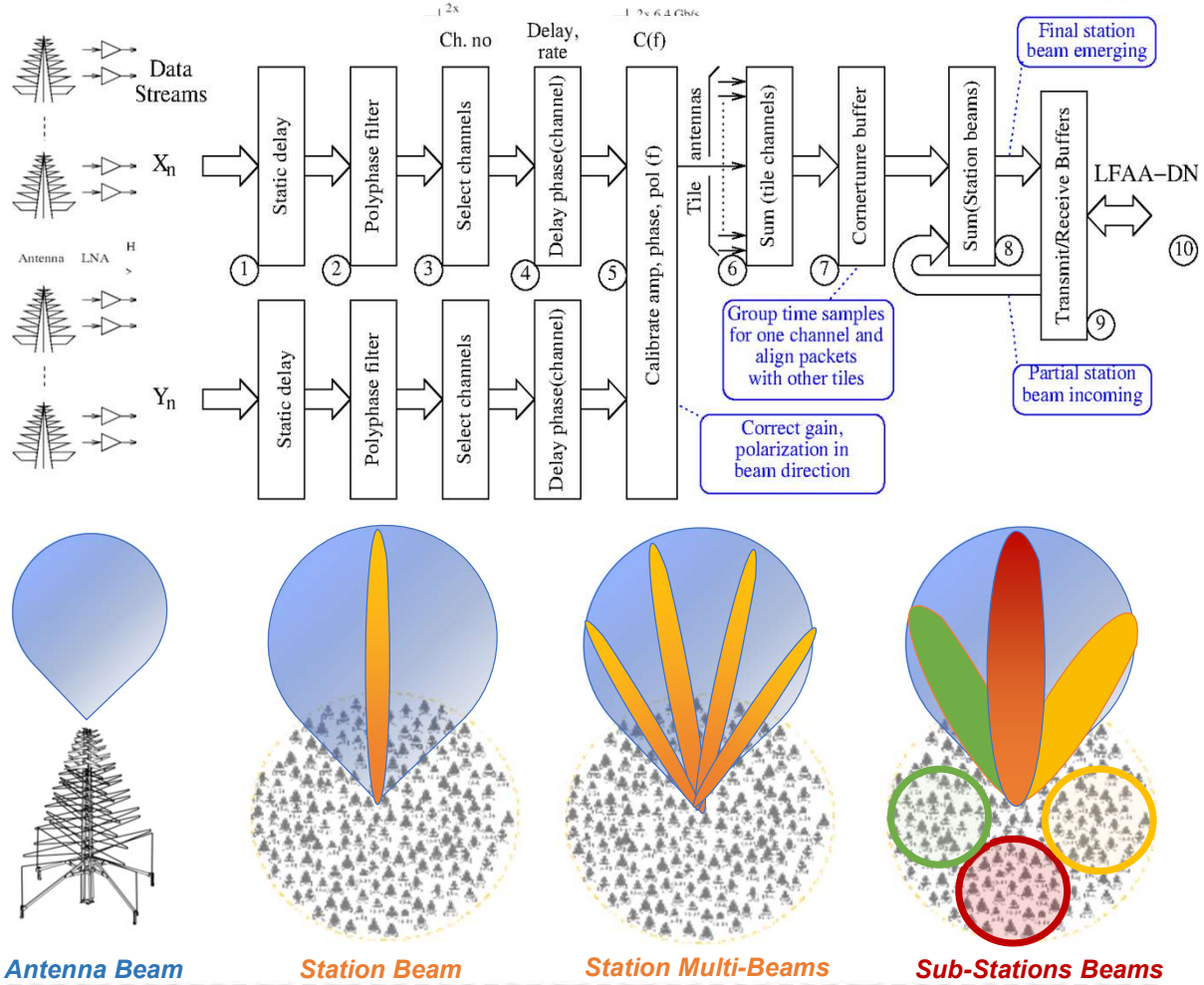
- 256 antennas
- Circular area
- 38 m (*effective station diameter*)
- Ground plane
- 256 antennas randomly distributed





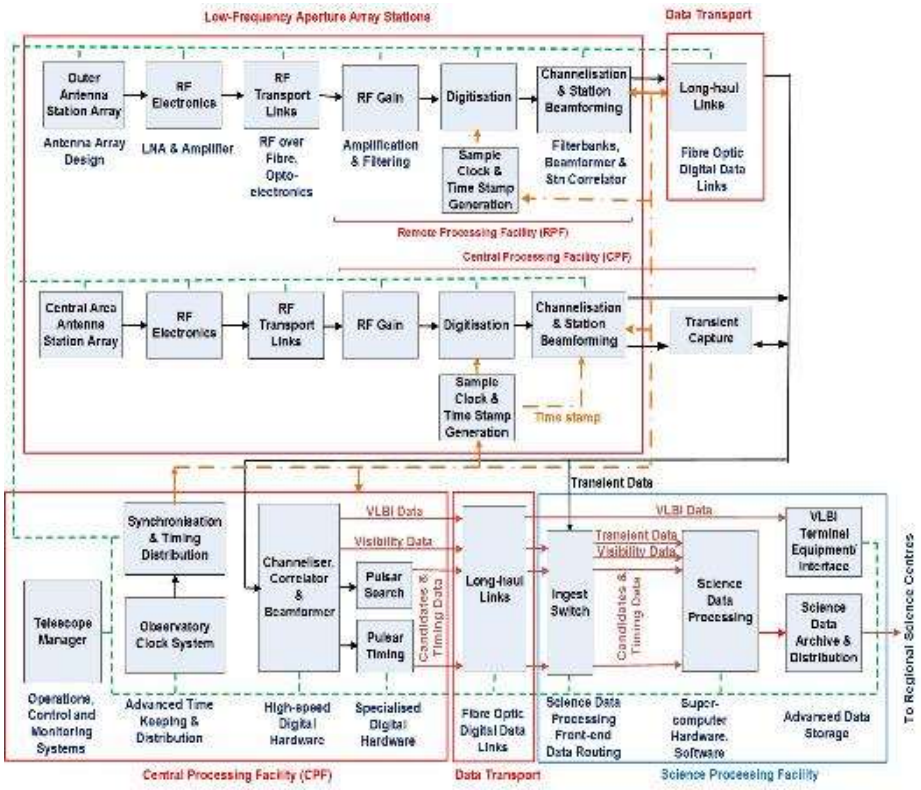
SKA1-Low Architecture: Station Beamforming





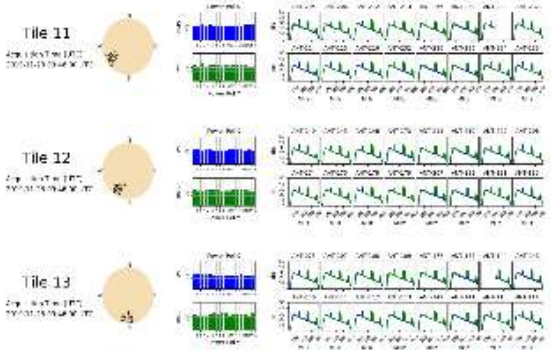
SKA1-Low in a nutshell

Aperture Arrays		
Lower Frequency	50 MHz	Each antenna element covering full range
Upper Frequency	350 MHz	Dual pol'n
Number of antennas per station	256	Log-Periodic-Dipole antennas
Station Effective Diameter[1]	38 m	
Number of stations	512	
Total physical aperture	5.8 x 10^5 m^2	
Dense/Sparse Transition[2]	~94 MHz	
Array Configuration		
Core (radius <500 m)	224 stations	See Figure C-1
Inner (radius <1700 m)	278 stations	"
Spiral Arms	234 stations	"
Station Beam Forming		
Number of beams[3]	1-384	Each with dual polarisation.
Max. bandwidth per beam	300 MHz	Each polarisation.
Max. no. of antennas per beam	256	
Signal Processing System		
Max. no. frequency channels	55296	
Standard Frequency Resolution	5.4 kHz	300 MHz/55296 = 5.4 kHz
Max. Frequency Resolution	226 Hz	Zoom mode
Complex Correlations[4]	2.9 x 10^{10}	(512·513/2) baselines x (1) beams x 4 pol'n prod's x 55296 chans
Integration Time	0.9 s	Reduceable to 0.3 s for a limited number of sub-stations
Array Beam Former		
Full beamformer	512 stations	
Within 20-km Array Diameter	404 stations	
Pulsar Search	500	Independently steerable; 2 pol'n
Pulsar Timing	16	"
VLBI	4	"
Max. bandwidth per beam	300 MHz	300 MHz; 2 pol'n
Pulsar Search	118 MHz	Per beam; 2 pol'n
Pulsar Timing	300	"
VLBI	300	"

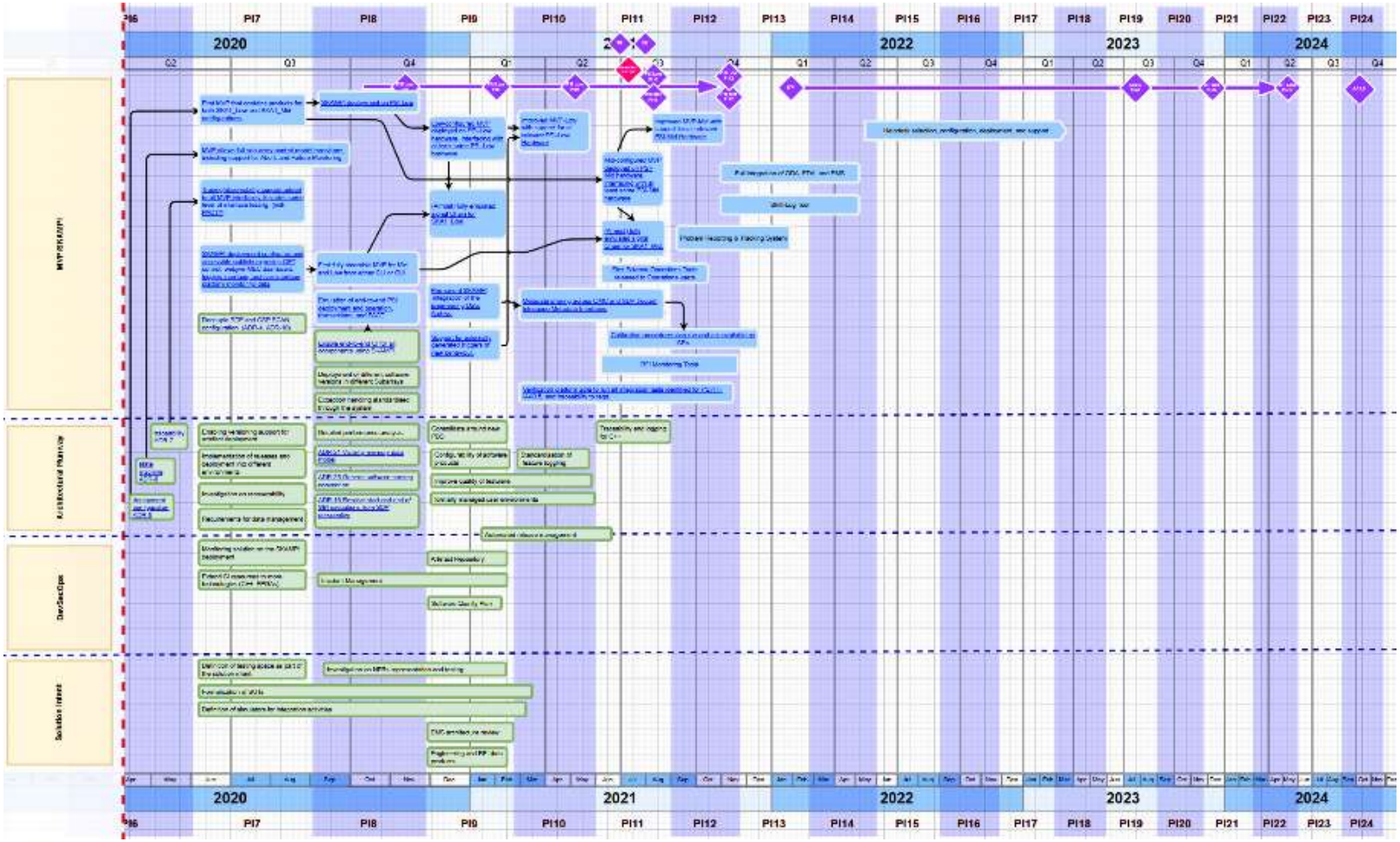


LOW prototype

Commissioning of a prototype station is still on going. We plan to install a second one and do interferometry



….and the SW?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PI8
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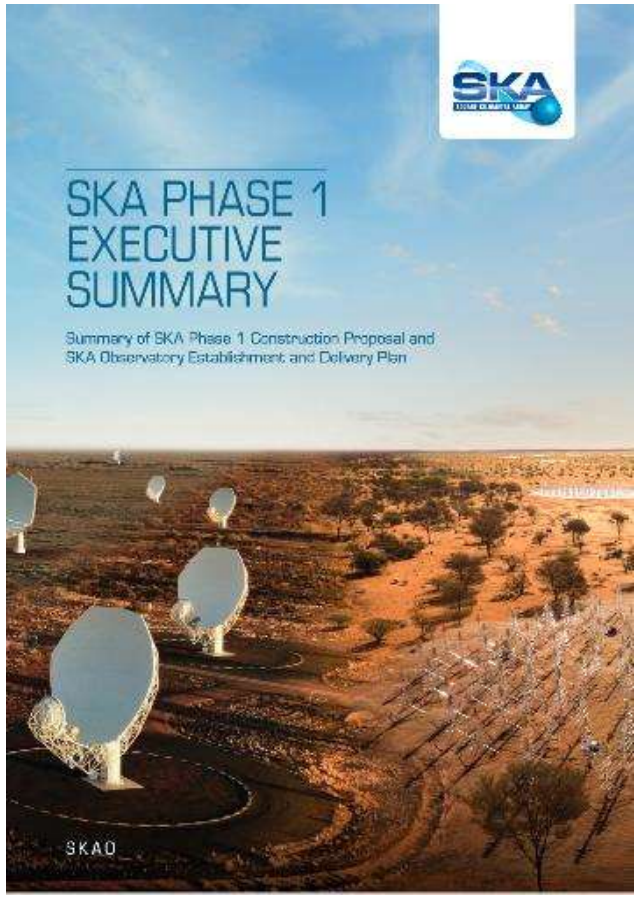
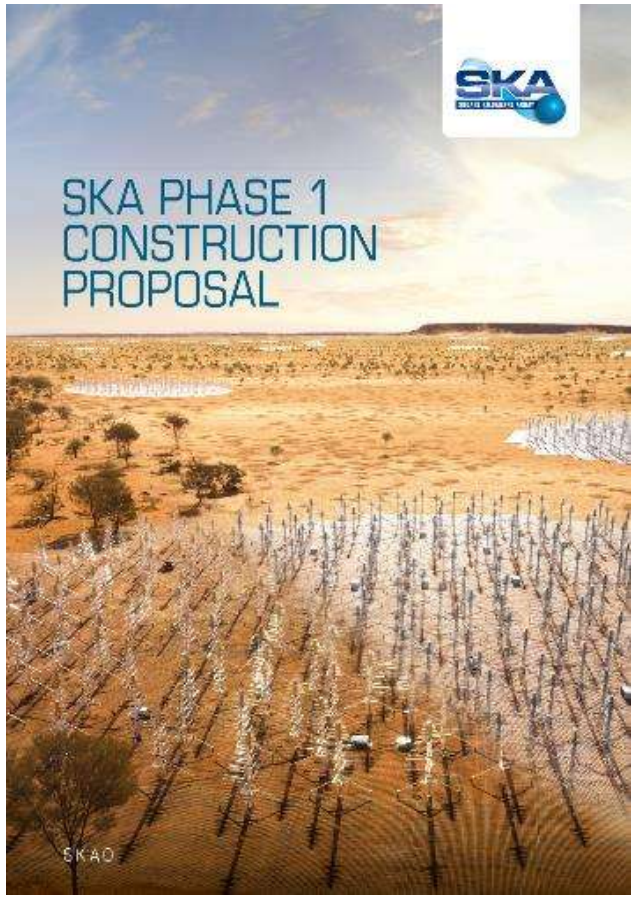
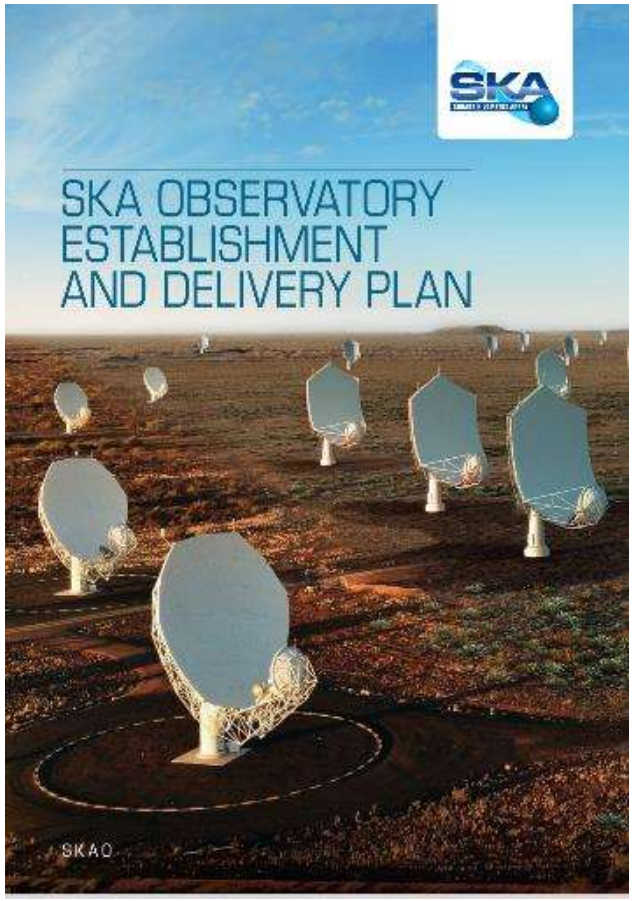
2024
Q2
Q3
Q4
Q1


AGILE
1
Requirements
2
Design
3
Development
4
Testing
5
Deployment
6
Review

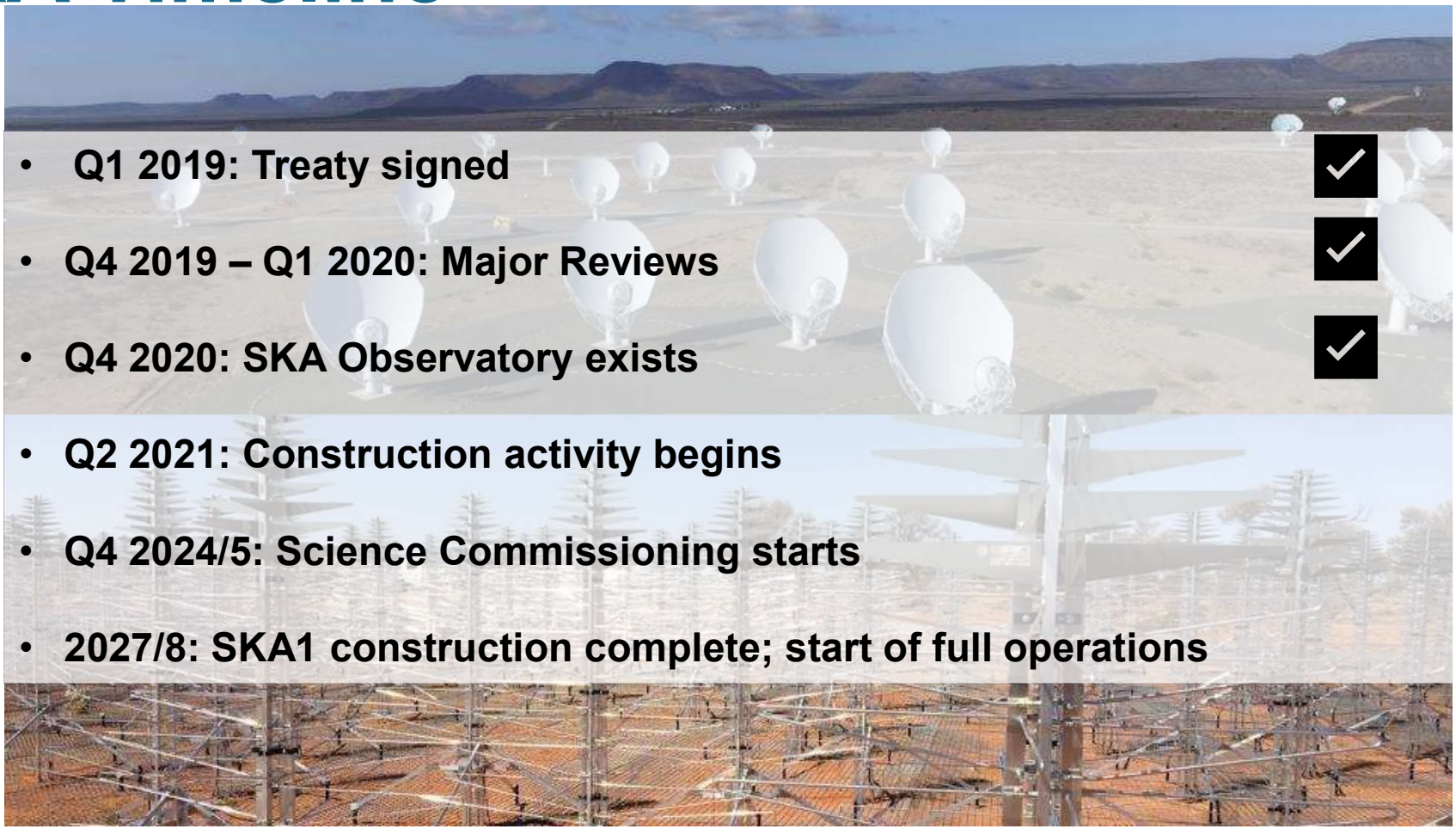
Where are we with the construction preparation?







SKA Timeline



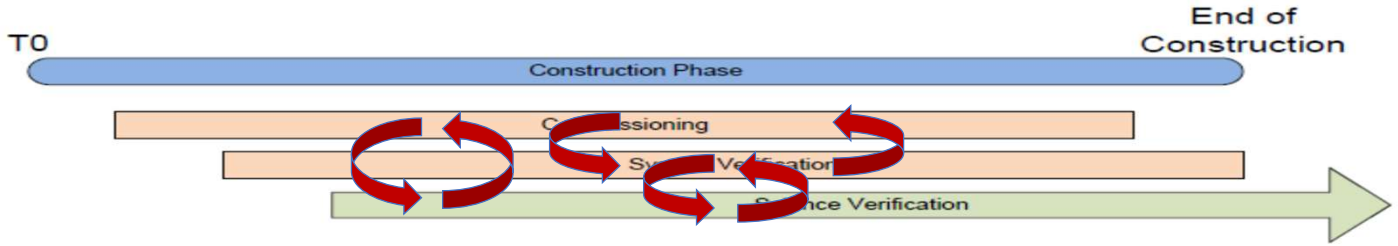
- Q1 2019: Treaty signed ✓
- Q4 2019 – Q1 2020: Major Reviews ✓
- Q4 2020: SKA Observatory exists ✓
- Q2 2021: Construction activity begins
- Q4 2024/5: Science Commissioning starts
- 2027/8: SKA1 construction complete; start of full operations

Key project milestones

	SKA-Low	SKA-Mid
Start of construction (T0)	1ST JULY **2021**	1ST JULY **2021**
Earliest start of major contracts (C0)	AUGUST **2021**	AUGUST **2021**
Array Assembly 0.5 finish (AA0.5) SKA-Low = 6-station array SKA-Mid = 4-dish array	FEBRUARY **2024**	MARCH **2024**
Array Assembly 1 finish (AA1) SKA-Low = 18-station array SKA-Mid = 8-dish array	FEBRUARY **2025**	FEBRUARY **2025**
Array Assembly 2 finish (AA2) SKA-Low = 64-station array SKA-Mid = 64-dish array, baselines mostly <20km	FEBRUARY **2026**	DECEMBER **2025**
Array Assembly 3 finish (AA3) SKA-Low = 256-station array, including long baselines SKA-Mid = 133-dish array, including long baselines	JANUARY **2027**	SEPTEMBER **2026**
Array Assembly 4 finish (AA4) SKA-Low = full Low array SKA-Mid = full Mid array, including MeerKAT dishes	NOVEMBER **2027**	JUNE **2027**
Operations Readiness Review (ORR)	JANUARY **2028**	DECEMBER **2027**
End of construction	JULY **2029**	JULY **2029**

The plan is staged in this way in order to have the possibility to test the array in different configuration.
AA0.5 is the time where also the industrial process is tested and qualified.

Is that all?



Commissioning

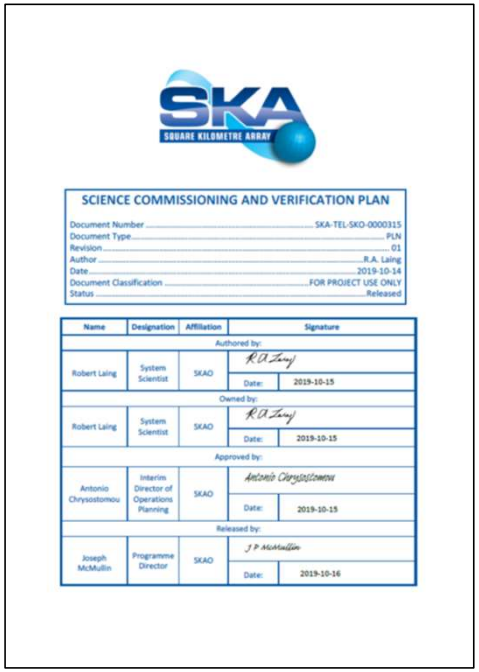
- All activities necessary to arrive at a working end-to-end system that can be used to perform system verification. These include:
  - setting-to-work
  - integration testing
  - system testing
  - execution and analysis of test science observations, with the aim of debugging the system.

Science Commissioning

The subset of commissioning which requires specification, execution and analysis of astronomical observations. This is separated out, since it will be primarily performed by a different group from that responsible for engineering commissioning and is a principal concern of this document.

Science **V**erification

All activities that are executed to verify the Telescope system against its Level-0 Requirements, i.e. to ensure that the Telescope system meets the needs of the science and operational users.


SCIENCE COMMISSIONING AND VERIFICATION PLAN

Document Number SKA-TEL-SKO-0000315
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Author ..... R.A. Laing
Date 2019-10-14
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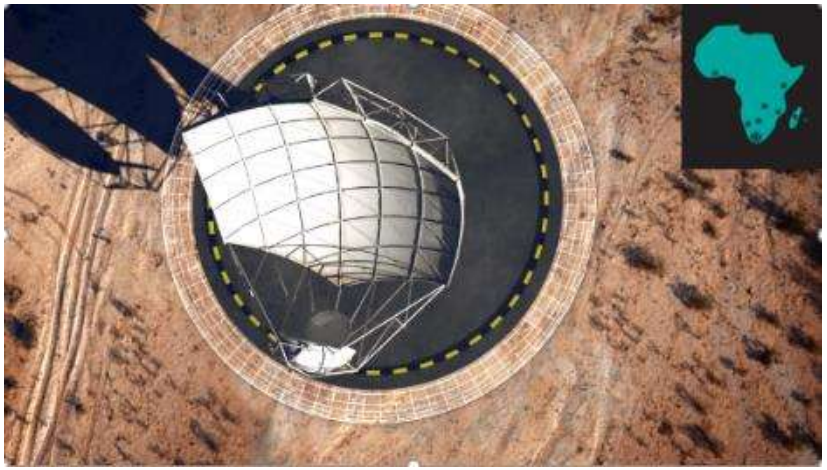
Approved by:			
Antonio Chrysostomou	Interim Director of Operations Planning	SKAO	Date: 2019-10-15
Released by:			
Joseph McMullin	Programme Director	SKAO	Date: 2019-10-16

SKA Construction

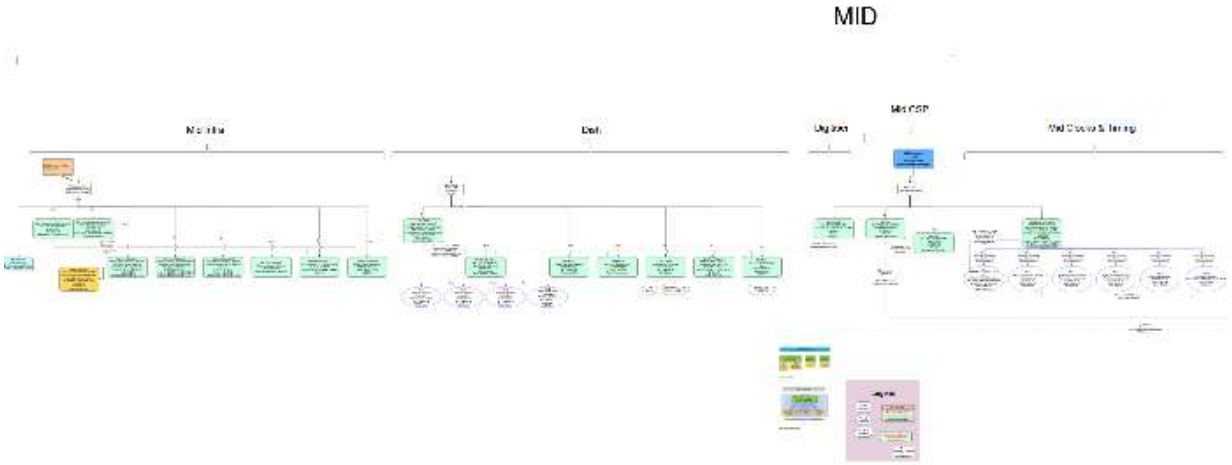
3 sites (AUS, RSA, UK-HQ): **2 telescopes (LOW, MID), one Observatory (SKAO)**
Construction: 2021-2028

SKA1-Low:
512 x 256 low-freq dipoles
50 – 350 MHz
65 km total extent
Murchison, Western Australia

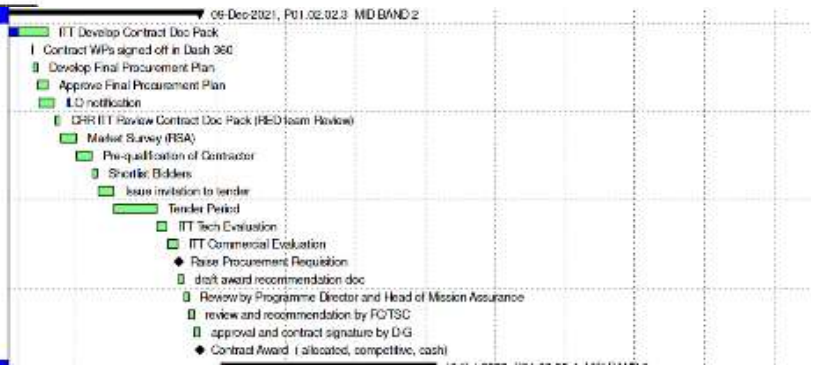
SKA1-Mid:
197 15m dishes
350 MHz – 15.3+ GHz
150 km total extent
Karoo, South Africa

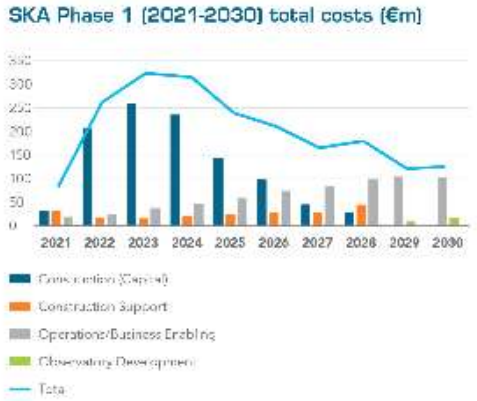


The contracting work



P01.02.02.3	MID BAND 2	212d	17-Feb-2021	09-Dec-2021
PP3100	ITT Develop Contract Doc Pack	70d	17-Feb-2021	25-May-2021
PP10030	Contract WPs signed off in Dash 360	0d	05-May-2021	05-May-2021
PP2830	Develop Final Procurement Plan	4d	06-May-2021	11-May-2021
PP2950	Approve Final Procurement Plan	10d	12-May-2021	25-May-2021
PP11510	ILO notification	15d	14-May-2021	03-Jun-2021
PP4820	CHR ITT Review Contract Doc Pack (HoD team Review)	5d	04-Jun-2021	10-Jun-2021
PP4840	Market Survey (RSA)	15d	11-Jun-2021	01-Jul-2021
PP5540	Pre-qualification of Contractor	15d	02-Jul-2021	22-Jul-2021
PP6030	Shortlist Bidders	5d	23-Jul-2021	29-Jul-2021
PP6190	Issue invitation to tender	15d	30-Jul-2021	19-Aug-2021
PP6790	Tender Period	40d	20-Aug-2021	14-Oct-2021
PP7390	ITT Tech Evaluation	10d	15-Oct-2021	28-Oct-2021
PP7530	ITT Commercial Evaluation	10d	29-Oct-2021	11-Nov-2021
PP2800	Raise Procurement Requisition	0d	12-Nov-2021	
PP7750	draft award recommendation doc	5d	12-Nov-2021	18-Nov-2021
PP2750	Review by Programme Director and Head of Mission Assurance	5d	19-Nov-2021	25-Nov-2021
PP7870	review and recommendation by FC/TSC	5d	26-Nov-2021	02-Dec-2021
PP2820	approval and contract signature by D-G	5d	03-Dec-2021	09-Dec-2021
PP8330	Contract Award (allocated, competitive, cash)	0d		09-Dec-2021



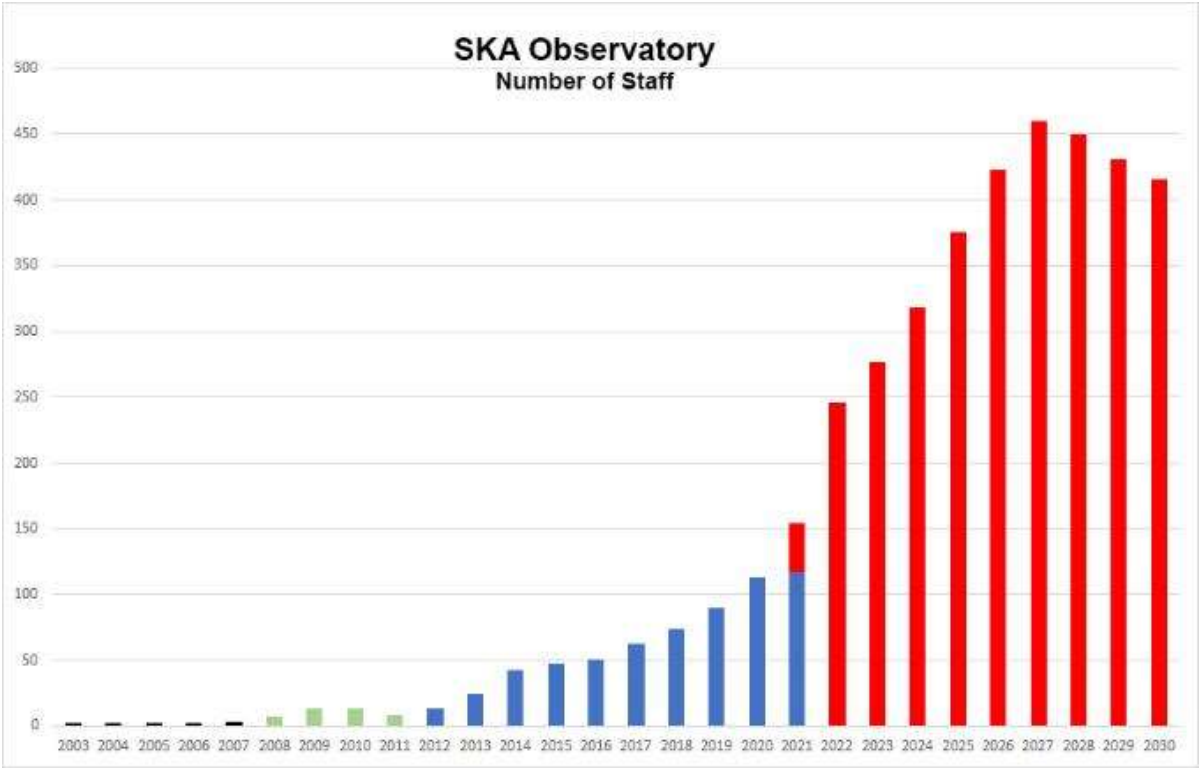


Where are we now and what are we doing?

Touch-point	Jan '21	Feb '21	Mar '21	Apr '21	May '21	Jun '21	Jul '21	Aug '21	Sep '21	Oct '21	Nov '21	Dec '21	Full year 2022	Full year 2023
PR	All													
CRRs (43)		Mid CBF; Software Sole Source	Mid Infra PSC; Mid Infra 1; Mid Infra 2; Mid Infra 3; Mid Infra 4; Low Infra PSC; Low Infra 1; Low Infra 3; Low Infra 6;		Low CSP; Software Comp.;	Mid Dish Element ; Mid B2; Low & MID Timing Mid S-AIV; Low Infra 2; Mid CSP; Mid & Low Clocks;	Mid B1; Low Station Mgt & Int.;	Mid Dish Structure Low Antenna Ass.; Low PaSD; Mid Infra 6	Mid SPF Services; Low Infra 5; Low Station Dep.; Low S-AIV;	Low SPS; Mid Cryo	Mid SPFRx123 & PU		Mid Infra 5; Mid Networks; MeerKAT Integration; Mid CPF; Low Networks; Low CPF; Low PPA; Mid SPFRx45 Mid B5	Mid SPC; Low SPC
TEPs <u>start</u> reviewing tenders (71)					Mid Infra PSC; Low Infra PSC; Software Sole Source (17)		Mid CSP; Mid CBF Mid Dish Element	Low Station Mgt & Int.; Mid S-AIV; Low Infra 2; Software Comp. (10)	Mid Infra 4; Mid Infra 6; Low Infra 6; Mid B2;	Mid Infra 1; Mid Infra 2; Mid Infra 3; Mid B1; Low Infra 5 Low Infra 1;	Mid Timing; Mid & Low Clocks; Low CSP; Low & MID Timing Low Infra 3; Mid Dish Structure	Low S-AIV;	Mid Infra 5; Mid Infra 6; Mid B5; Mid Cryo; Mid SPF Services; MeerKAT Integration; Low Station Dep.; Low Antenna Ass.; Low PaSD; Low SPS; Low PPA; Mid SPFRx123; Mid SPFRxPU	Mid Networks; Mid SPC; Low SPC (2024); Mid CPF; Low Networks; Low CPF; Mid SPFRx45
C0s (71)							Mid Infra PSC; Low Infra PSC; Software Sole Source (17)		Software Comp. (10) Low Infra 2; Mid Dish Element	Mid Infra 6;	Mid Infra 4; Mid S-AIV; Low Infra 6 Low Station Mgt & Int.; Mid CBF; Mid CSP;	Mid B2; Mid Dish Structure; Low Infra 1;	Mid Infra 1; Mid Infra 2; Mid Infra 3; Mid Infra 5; Mid Infra 6; Mid B1; Mid B5; Mid Cryo; Mid SPF Services; Mid SPFRx123; Mid SPFRxPU; MeerKAT Integration; Mid & Low Clocks;; Low Infra 3; Low Infra 5; Low Station Dep.; Low Antenna Ass.; Low PaSD; Low SPS; Low & MID Timing Low CSP; Low S-AIV; Low PPA	Low CPF; Mid Networks; Mid CPF; Low Networks; Mid SPFRx45; Mid SPC (2024); Low SPC (2024)

KEY:
Ben = red
André = gold
Maurizio = brown
Du Bruyn = black
Mark = blue
David = green
Peter = orange
Jacque = pink
Jill = purple
Adriaan = yellow
Unassigned = grey

Staffing of the Observatory?

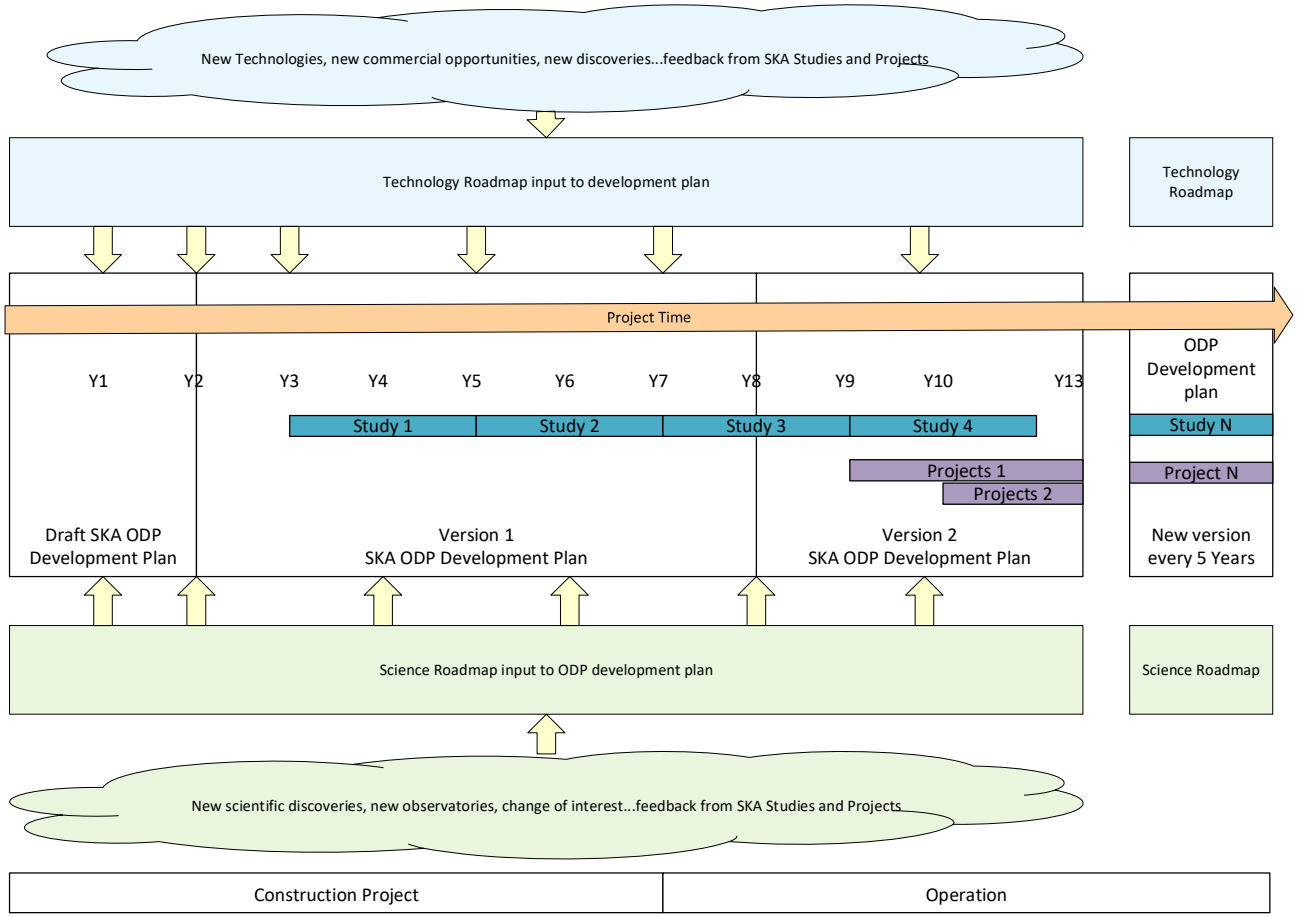


The SKA Observatory Development Plan

- Enhance SKA Science Output
  - Adapt to changes in scientific landscape and priorities
  - Enable new science (e.g. a new receiver band)
  - Improve science output (e.g. more reliable power system; increased RF bandwidth)
  - Reduce operations costs
  - Restore lost capability

A Development Programme is essential to the health of any Observatory

SKAO Observatory Development Program

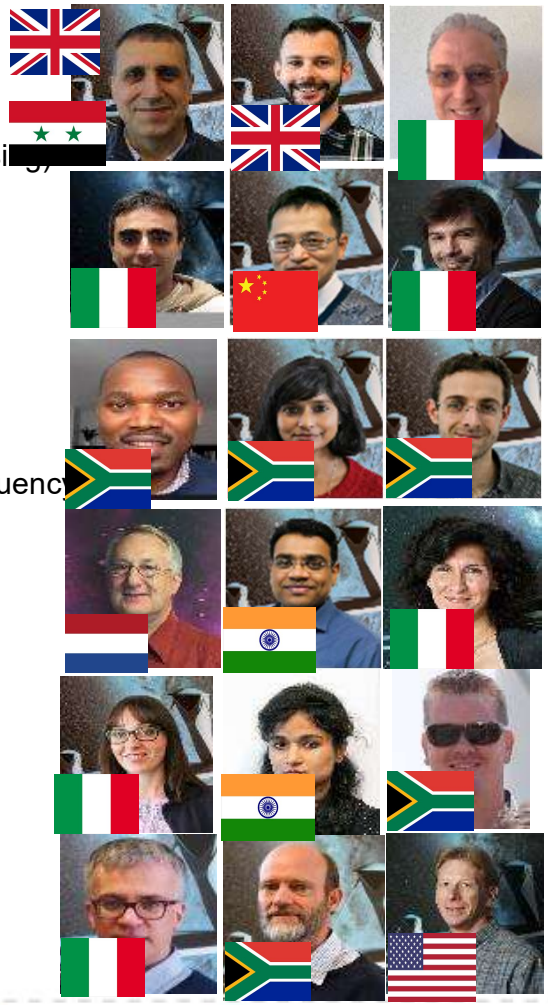


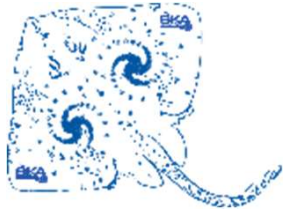
SKA is people

It’s all about people

The SKAO Telescope Engineering Team in SKA

•Alachkar, Bassem	•SKAO Domain Specialist (Signal Processi
•Anthony, Rob	•SKAO Junior System Engineer
•Barriere, Kevin	•SKAO Power Engineer Junior
•Caiazzo, Marco	•SKAO Senior System Engineer
•Chen, Songlin	•SKAO MID Domain Specialist
•Cremonini, Andrea	•SKAO MID System Engineer
•Gounden, Shagita	•SKAO Junior System Engineer
•Hayden, Daniel	•SKAO LOW System Engineer
•Hekman, Peter	•SKAO MID AIV Lead Engineer
•Hendre, Aniket	•SKAO Domain Specialist (Time and Frequenc
•Labate, Maria Grazia	•SKAO LOW Telescope Engineer
•Pellegrini, Alice	•SKAO Domain Specialist (RF/Antenna)
•Roy,Jayashree	•SKAO DSP Engineer
•Smith, Craig	•SKAO Electrical engineer
•Stringhetti, Luca	•SKAO Project Engineer
•Tirone, Lucio	•SKAO LOW AIV Engineer
•Swart, Gerhard	•SKAO MID Telescope Engineer
•Nkawu, Treasure	•SKAO Domain Specialist (EMC)
•Waterson, Mark	•SKAO LOW Domain Specialist





8 nationalities (Bassem counts for two!)

11 Languages (including American and English)

……better than an Emirates Airlines flying crew!

Conclusion

SKAO is now an International Organisation with the objective to lead the radioastronomy in the next decades.

Again SKAO is on a brink of a pivotal moment. In one months we will get the green light for the construction to start and first contracts will be placed.

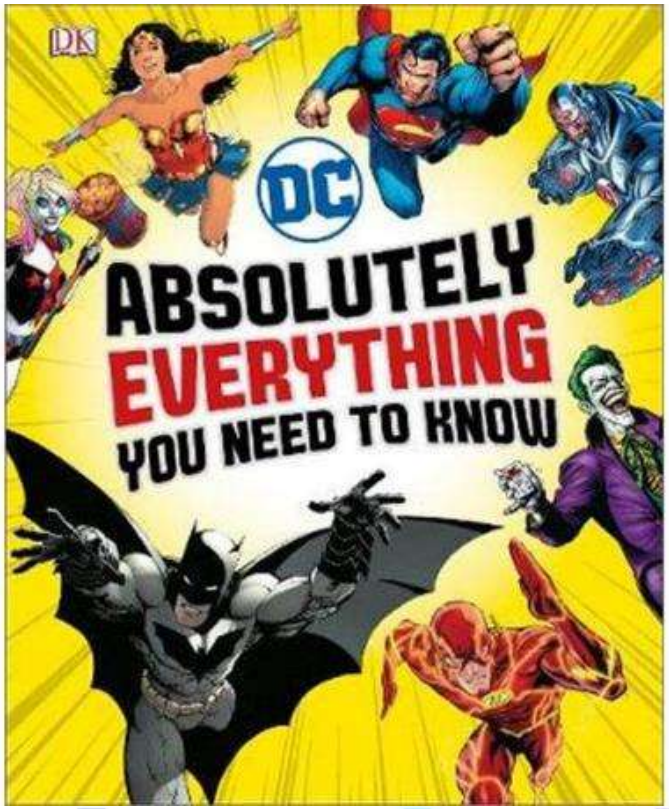
The engineering work is still on going and based on the systems engineering our next challenge will be secure and keep high quality in the delivery

Verification is getting more and more momentum now (more job adverts are out) and preparation is very active.

Thank you very much for you attention…

Questions?

You do not need to know everything…..it is ok (not super…just ok…but it works anyway). People first.



Culture is much more different than expected. People first.

Biases exist! Cultural, confirmation, and geographical….

People first

Alistair was wrong. Sometimes you need to repeat the same message more than seven times…People first.

Remote working is not my thing.... People first.