



SKA Status Update

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SQUARE KILOMETRE ARRAY
Exploring the Universe with the worlds' largest radio telescope

 **ICALEPCS2017**
Barcelona • Spain, October 8-13 • Palau de Congressos de Catalunya

16th International Conference on
Accelerator and Large Experimental
Physics Control Systems

SKA Key Science Drivers: The history of the Universe



Testing General Relativity
(Strong Regime, Gravitational Waves)

Cosmic Dawn
(First Stars and Galaxies)

Galaxy Evolution
(Normal Galaxies $z \sim 2-3$)

Cradle of Life
(Planets, Molecules, SETI)

**Broadest range of
science of any facility,
worldwide**

Cosmology
(Dark Energy, Large Scale Structure)

Cosmic Magnetism
(Origin, Evolution)

Exploration of the Unknown

SKA Observatory Vision



3 sites
2 telescopes
1 observatory

Design Phase:

~ €200M; 600 scientists+engineers,
80% complete

SKA Phase 1 (SKA1)

Construction: 2019 – 2025

Construction cost cap: €674.1M
(2016 inflation-adjusted)

Operations cost: (estimate) €89M/yr

MeerKAT integrated

Observatory Development Programme
(€20M/year planned)

SKA Regional centres out of scope of
centrally-funded SKAO.

>50 years lifetime!

Drives need for reliability,
and adaptability

SKA Phase 2: start mid-2020s

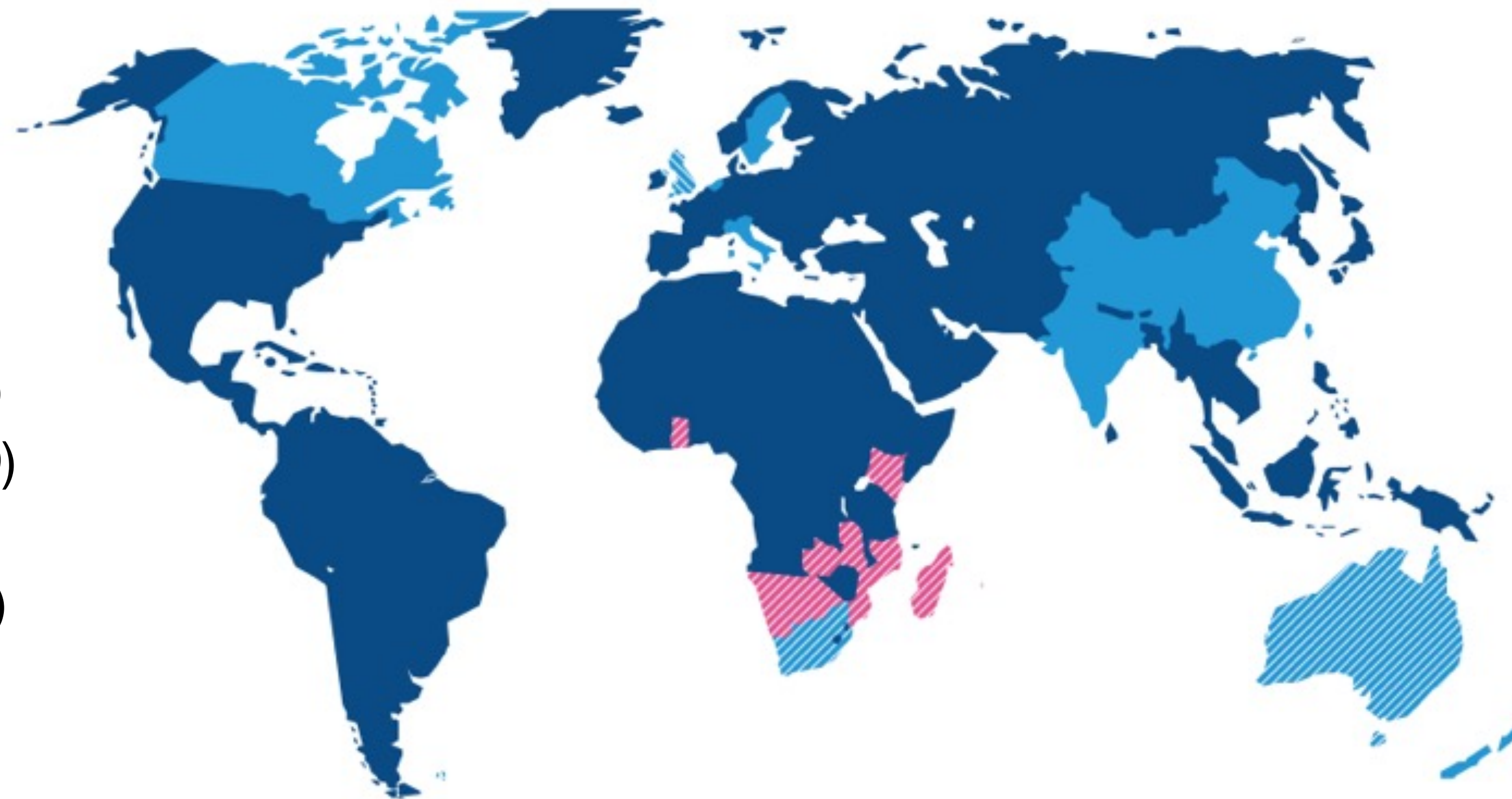
~2000 dishes across 3500km of
Southern Africa

Major expansion of SKA1-Low
across Western Australia

SKA Organisation



- Australia (DoI&S)
- Canada (NRC-HIA)
- China (MOST)
- India (DAE)
- Italy (INAF)
- Netherlands (NWO)
- New Zealand (MED)
- South Africa (DST)
- Sweden (Chalmers)
- UK (BEIS/STFC)



In discussion with:

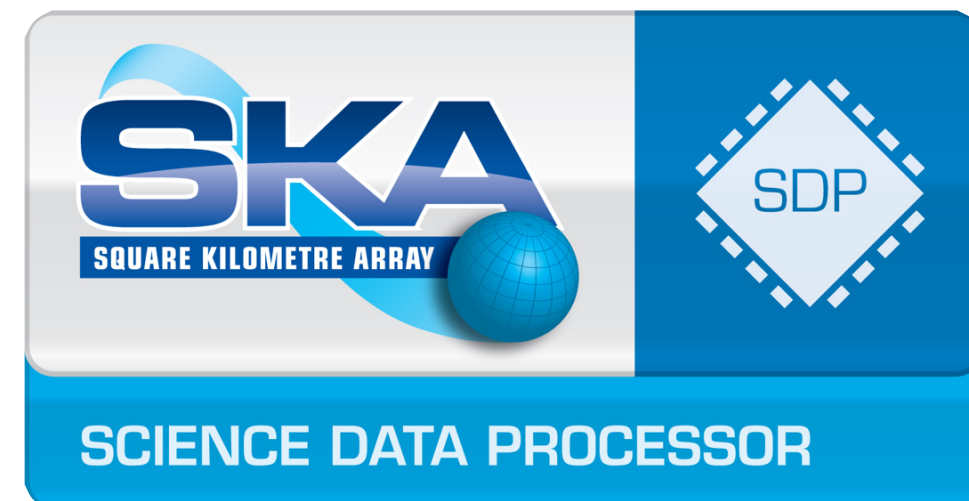
- Germany
- France
- Portugal
- Spain
- Switzerland
- Japan
- South Korea



This map is intended for reference only and is not meant to represent legal borders

In the process of becoming an Inter-Governmental Organisation

SKA1 Design Consortia



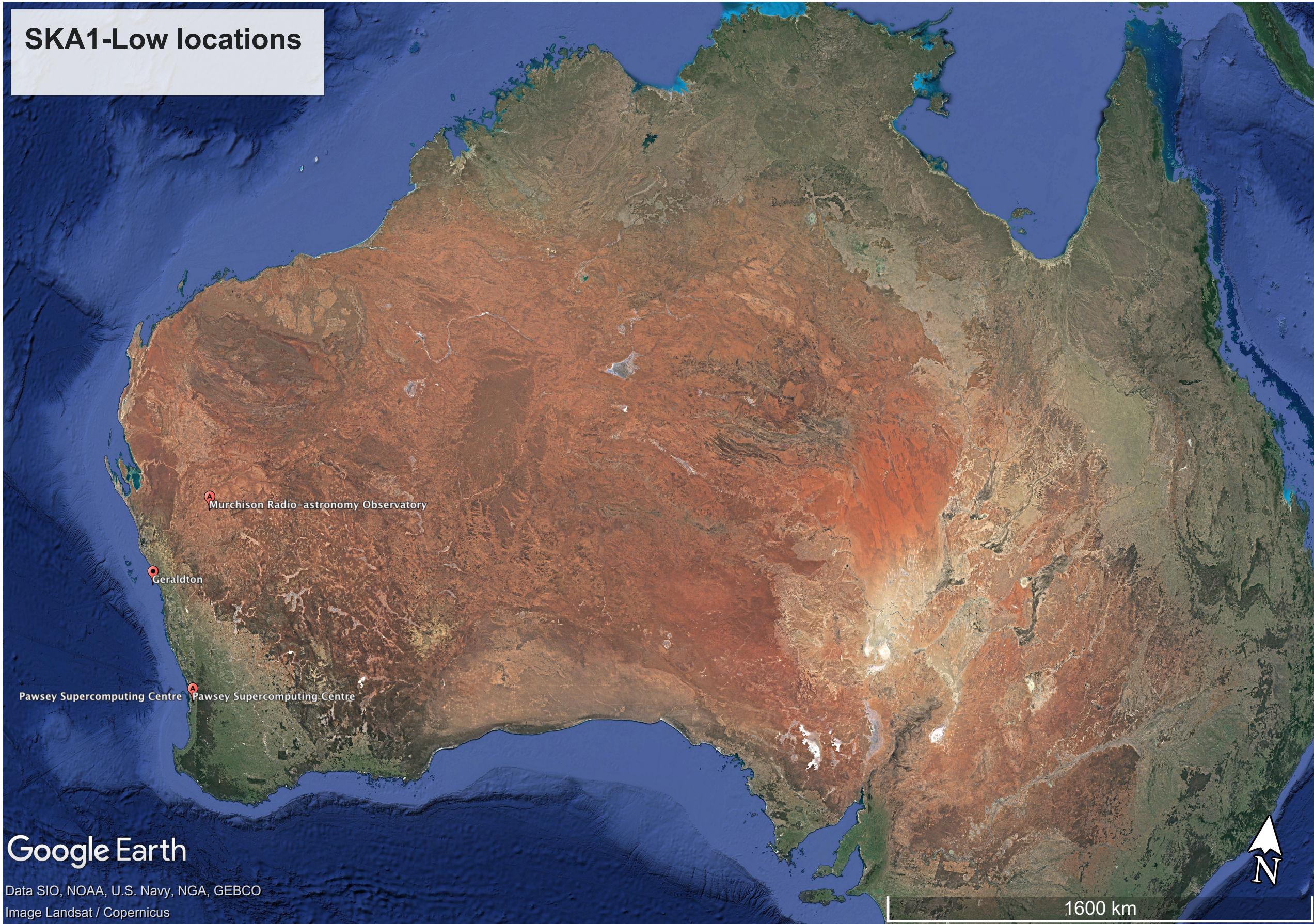
SKA1 Design Consortia



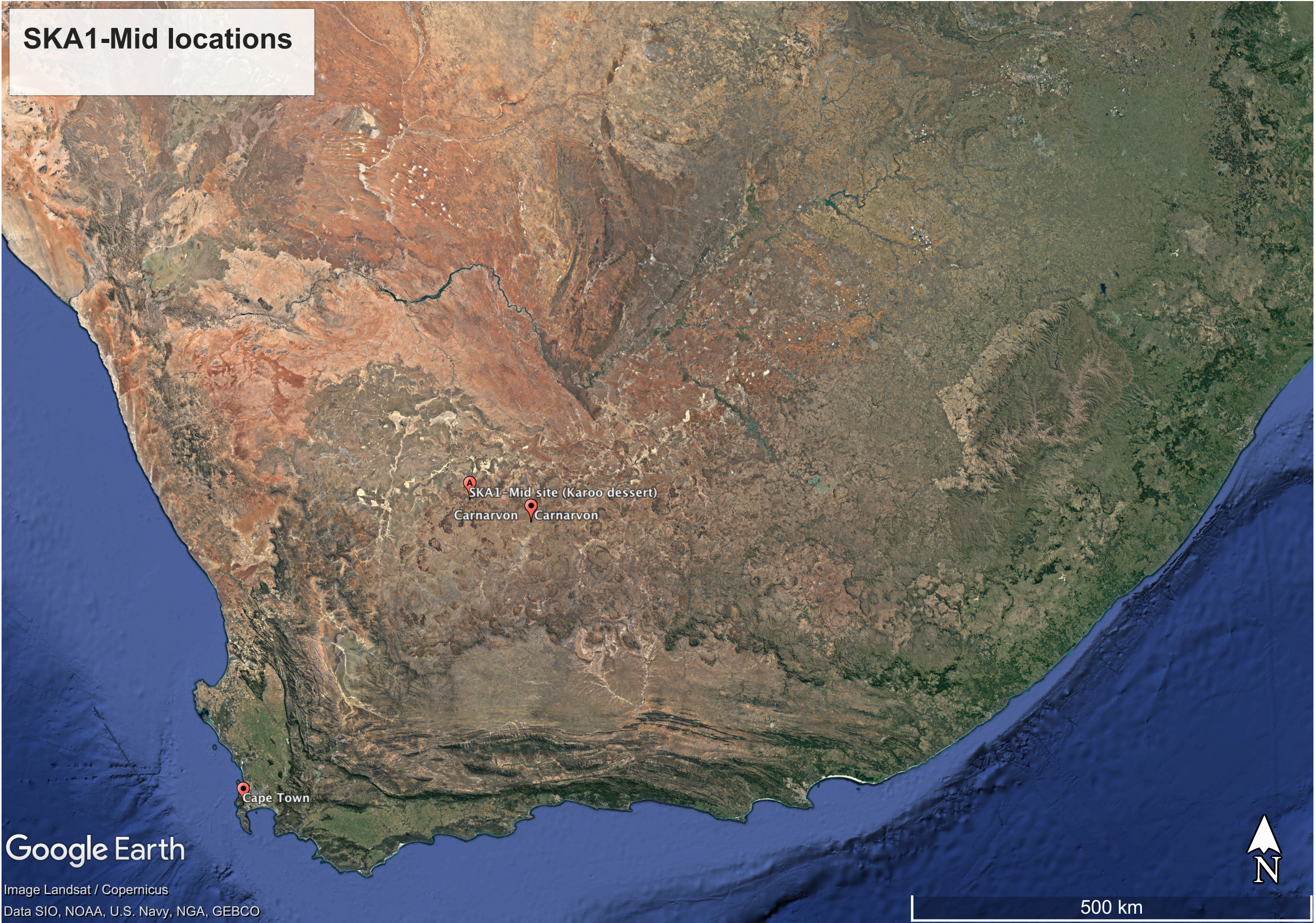
SKA1 Sites



SKA1-Low locations



SKA1-Mid locations



SKA1-Low Site



300 km

Murchison Radio Astronomy Observatory

Murchison Radio-astronomy Observatory

Geraldton

Geraldton

Perth

Pawsey Supercomputing Centre



SKA1-Mid Site



SKA1-Mid site (Karoo dessert)

SKA1-Mid site (Karoo dessert)
Carnarvon Carnarvon

Carnarvon

500 km

Cape Town

Cape Town

Google Earth

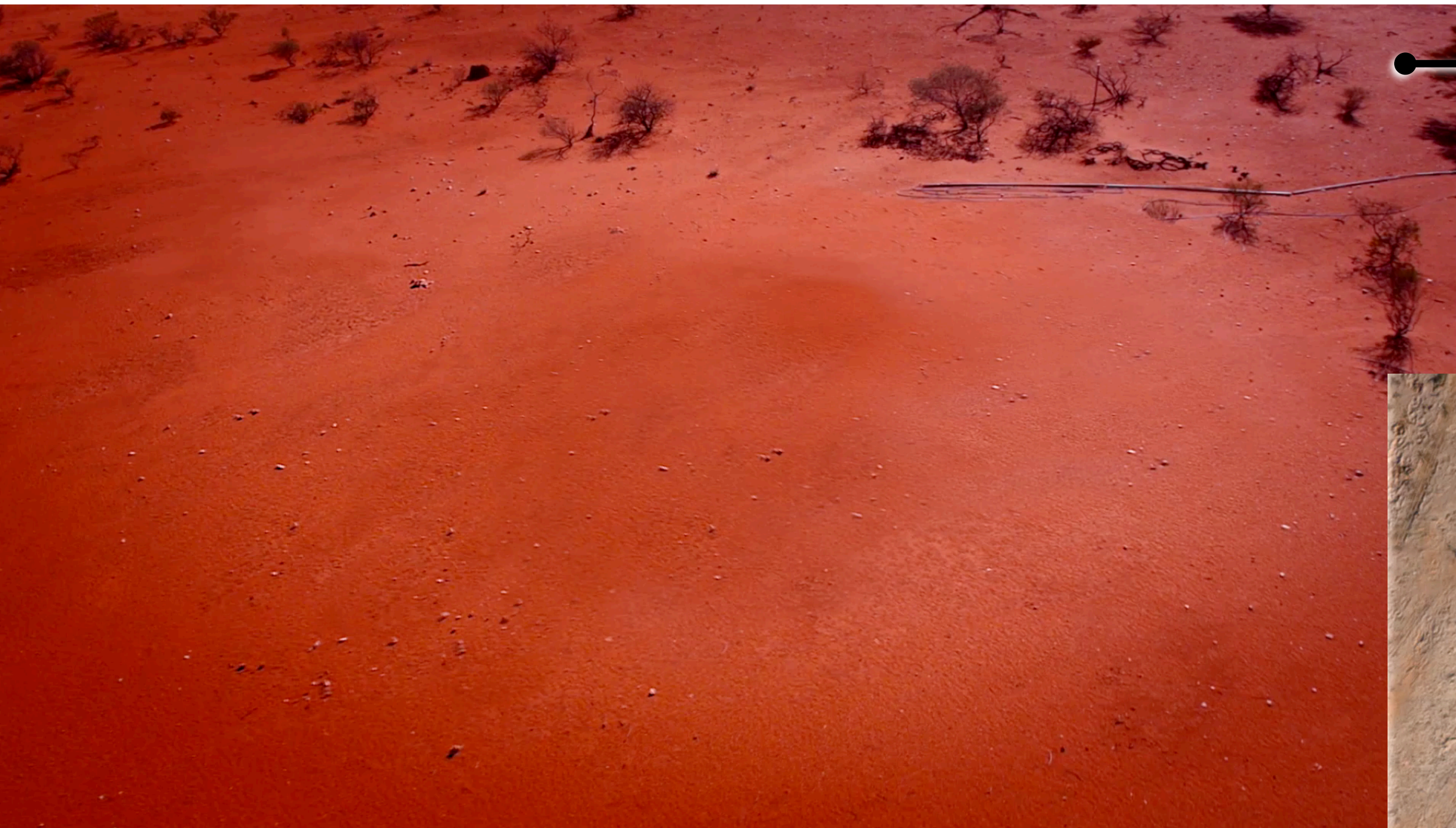
Exploring the Universe with the worlds' largest radio telescope



SKA1 Telescopes



SKA1-LOW: 50 – 350 MHz
Phase 1: ~130,000 antennas
across 65km



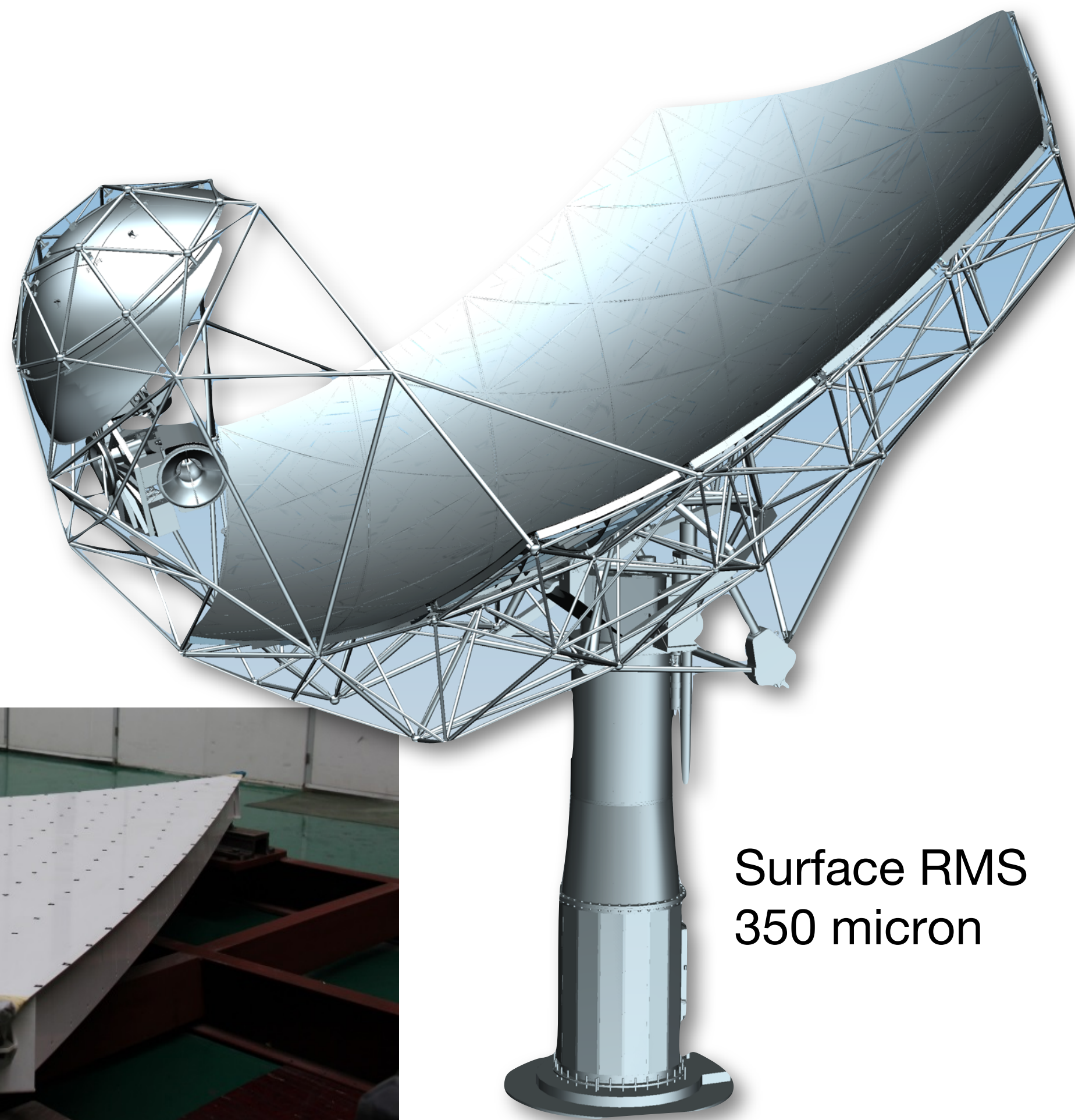
SKA1-Mid: 350 MHz – 24 GHz
Phase 1: 200 15-m dishes
across 150 km



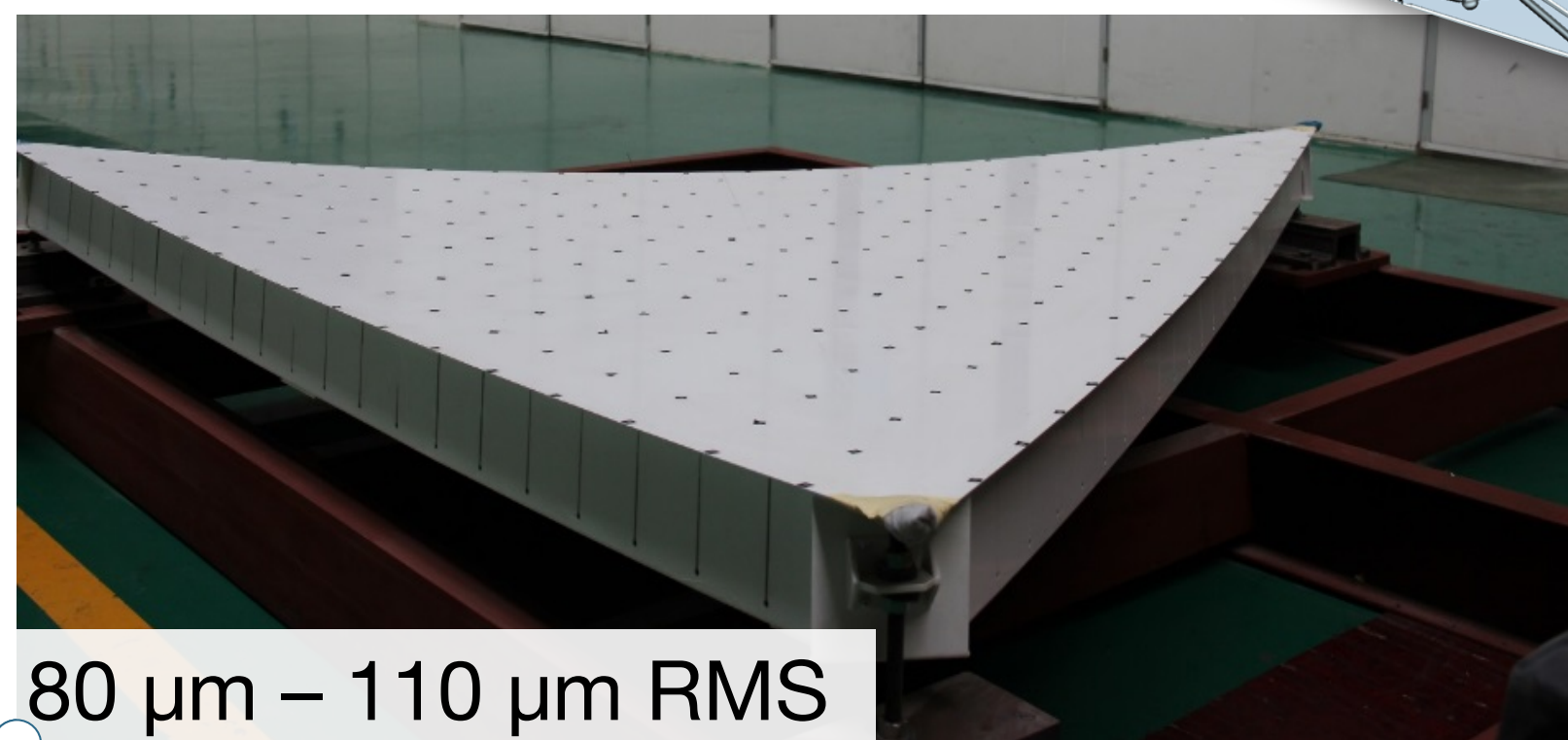
SKA1-Mid Report



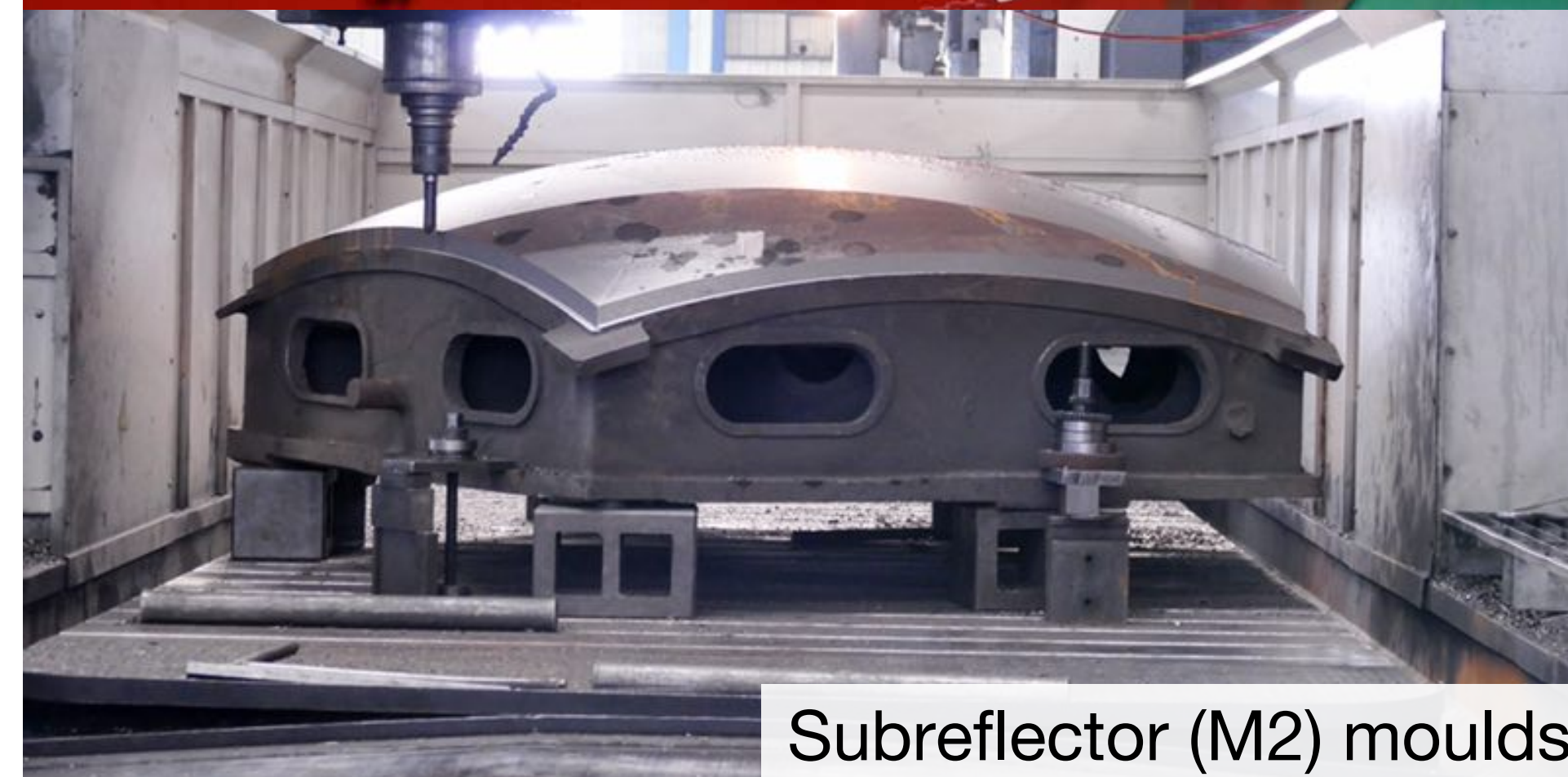
66 x M1 moulds, each 12 tonnes, with average surface accuracy of $\sim 50\mu\text{m}$ RMS.



Surface RMS
350 micron



80 μm – 110 μm RMS

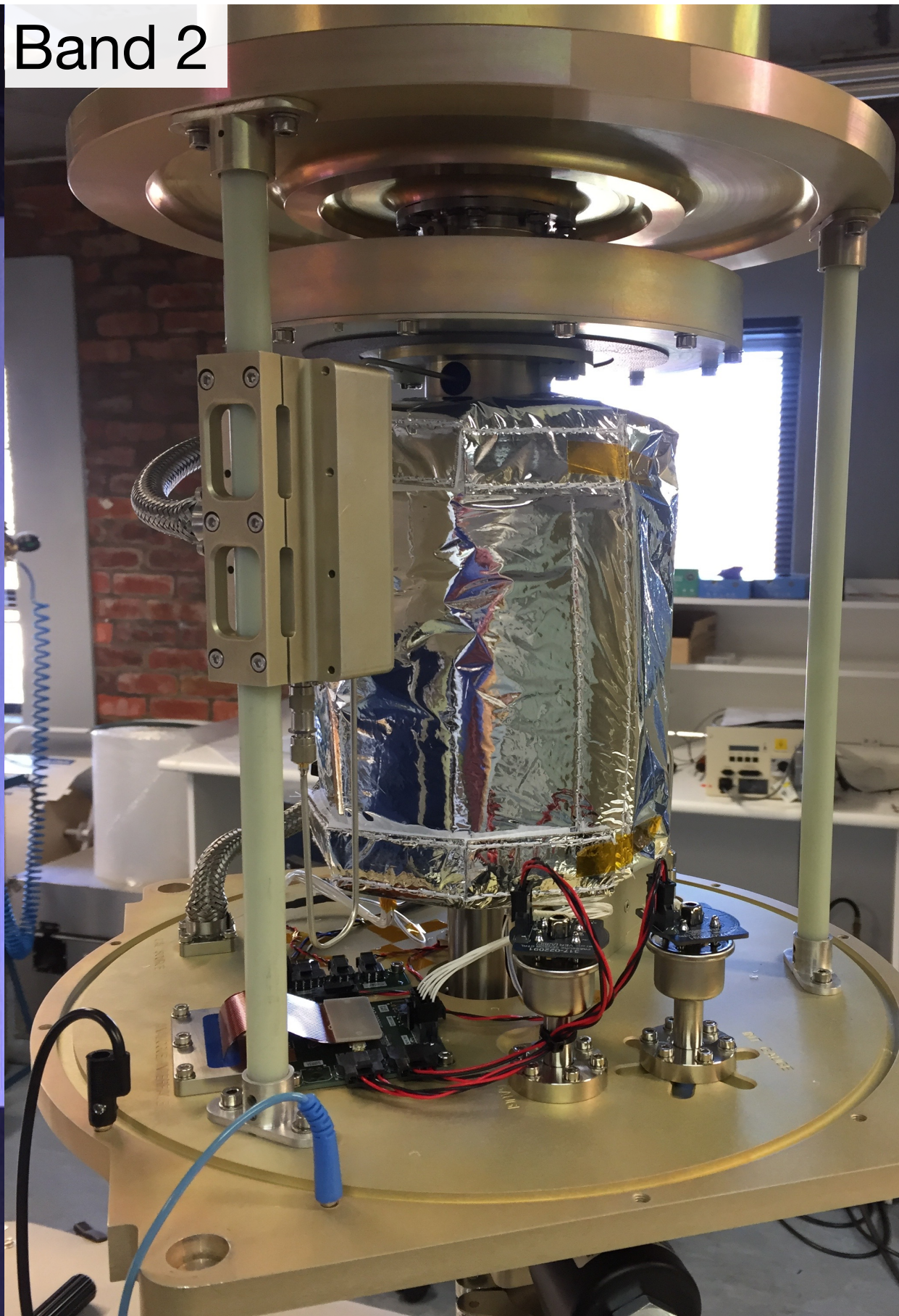


Subreflector (M2) moulds

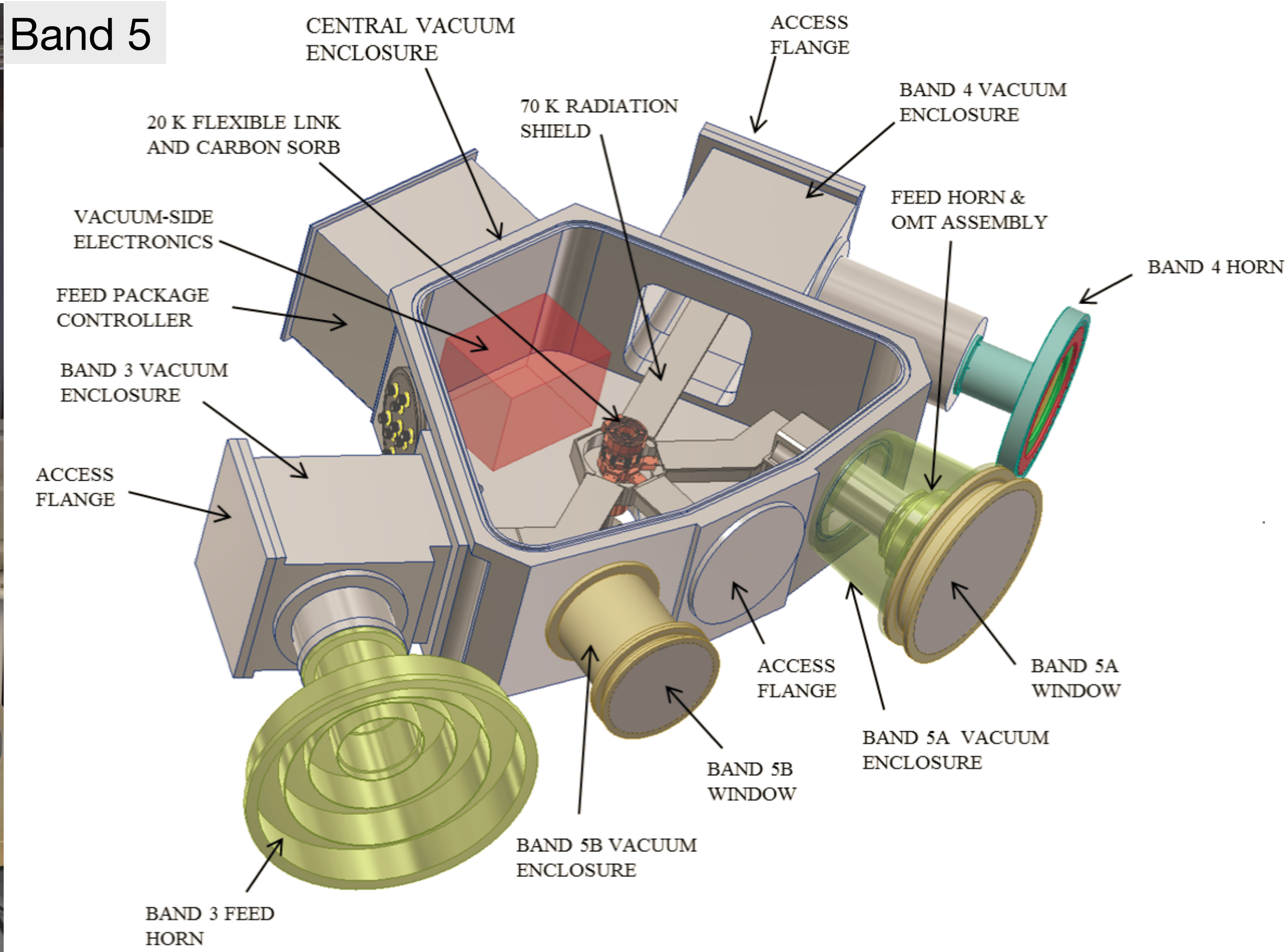
SKA1-Mid Report



PSS Prototype



Band 2

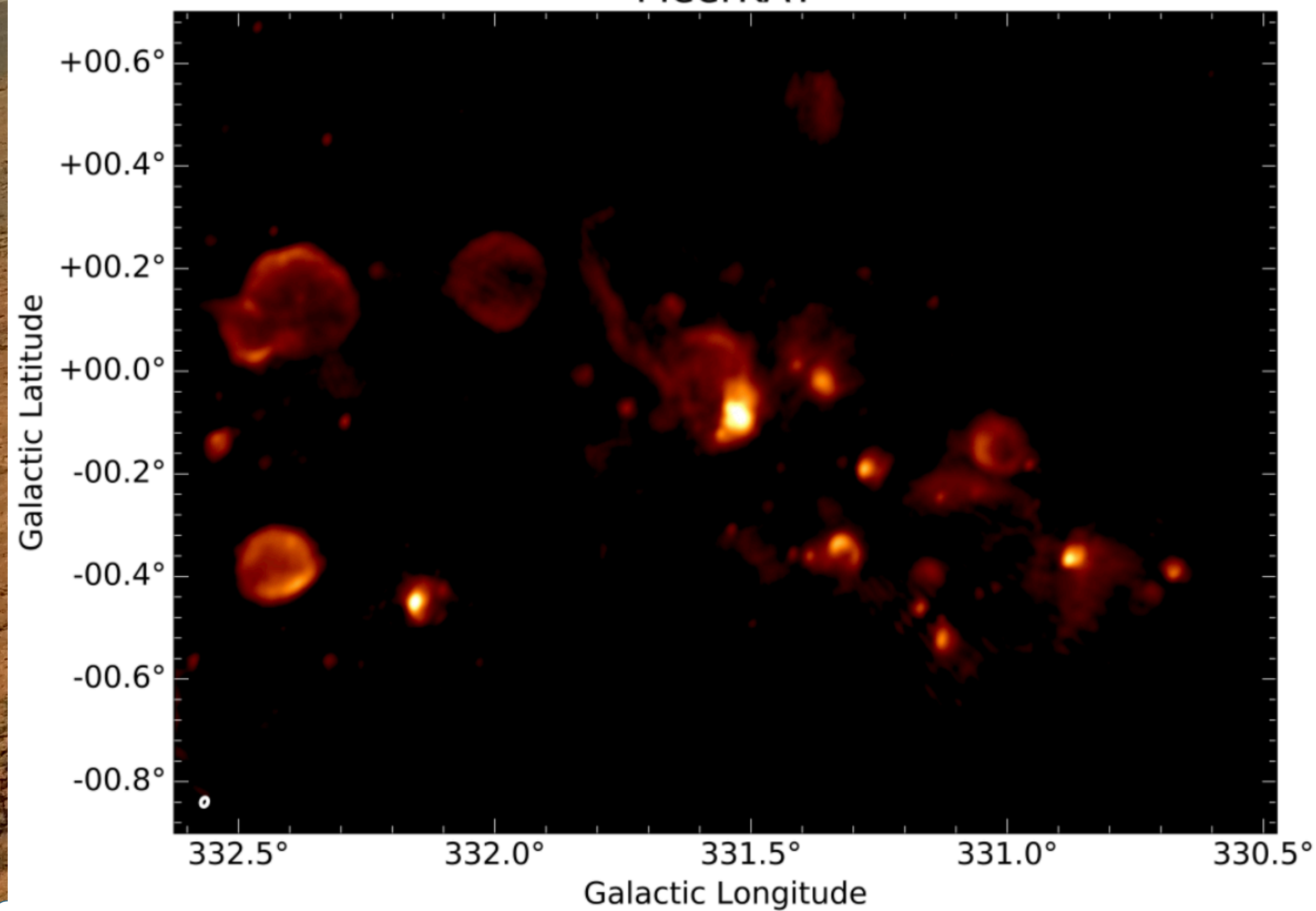


Band 5

SKA1-Mid Report: MeerKAT

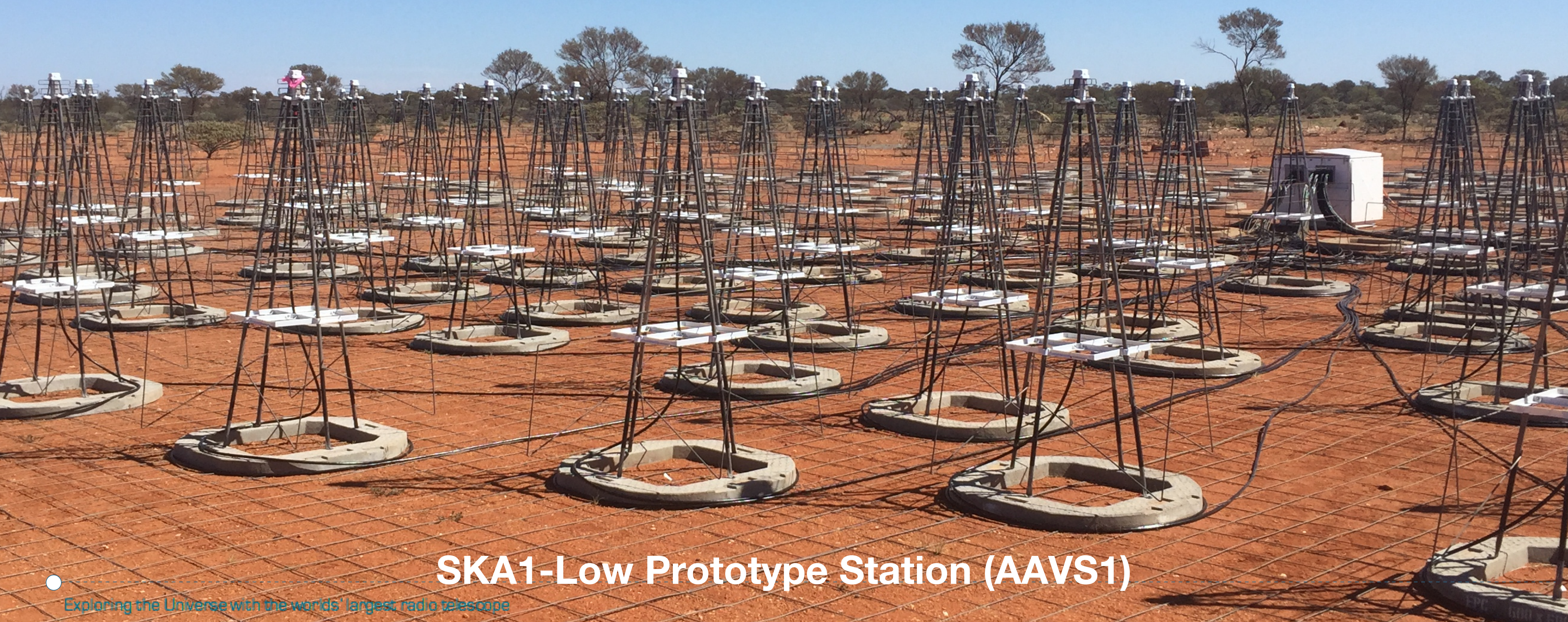


MeerKAT



49/64 antennas built

SKA1-Low Report



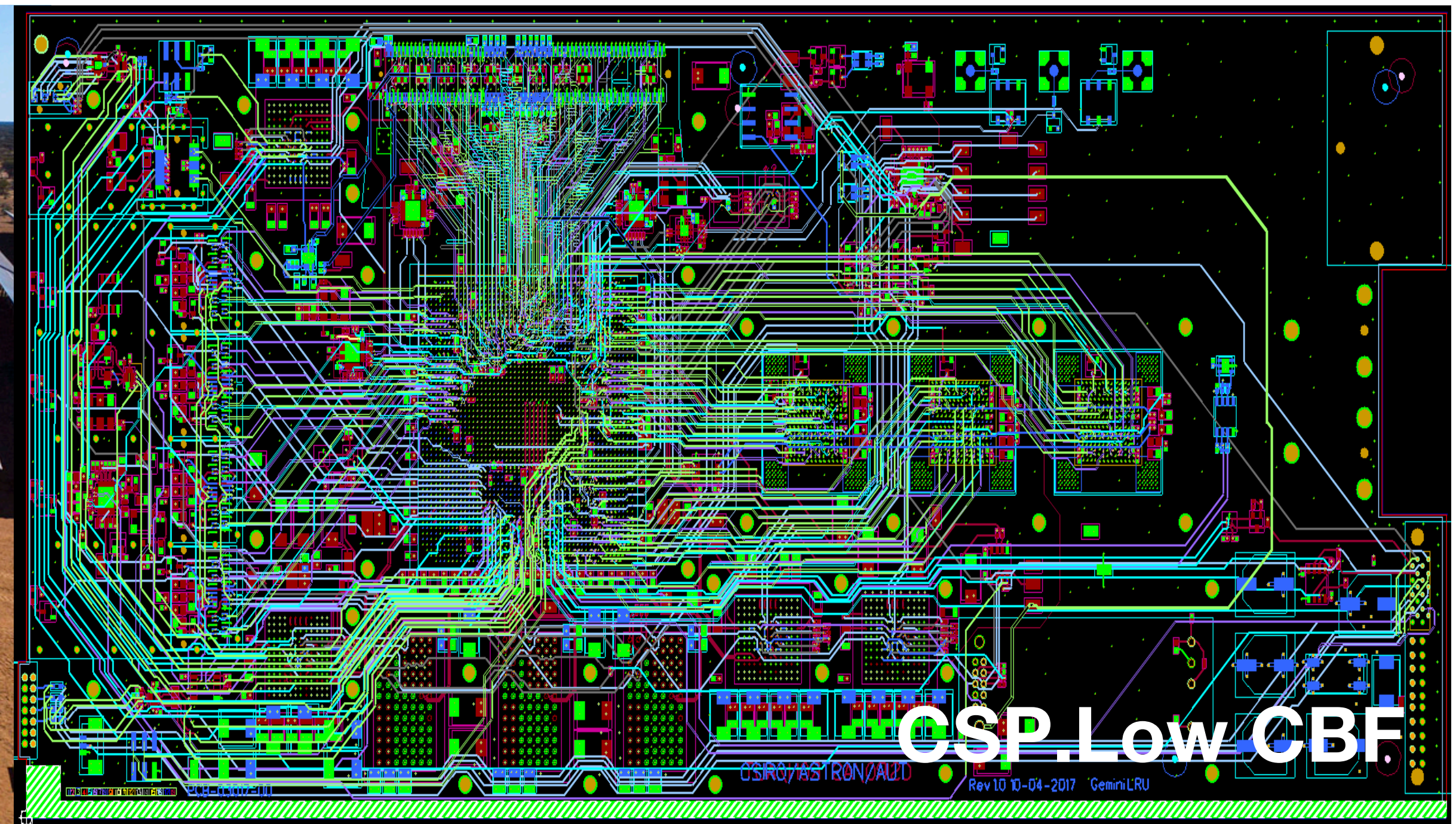
SKA1-Low Prototype Station (AAVS1)

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SKA1-Low Report



2.6 MWhr lithium ion battery

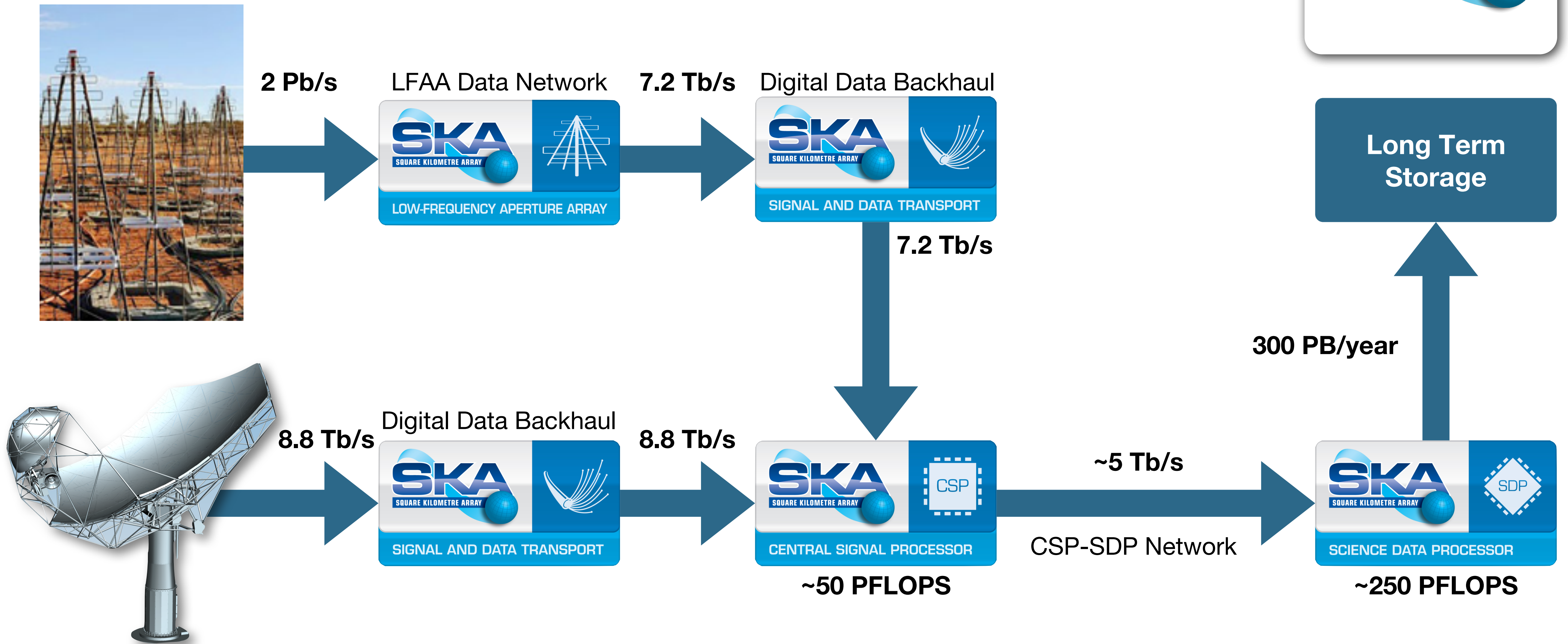


SKA HQ2 Aerial View



Building a Nexus for
Radio Astronomy

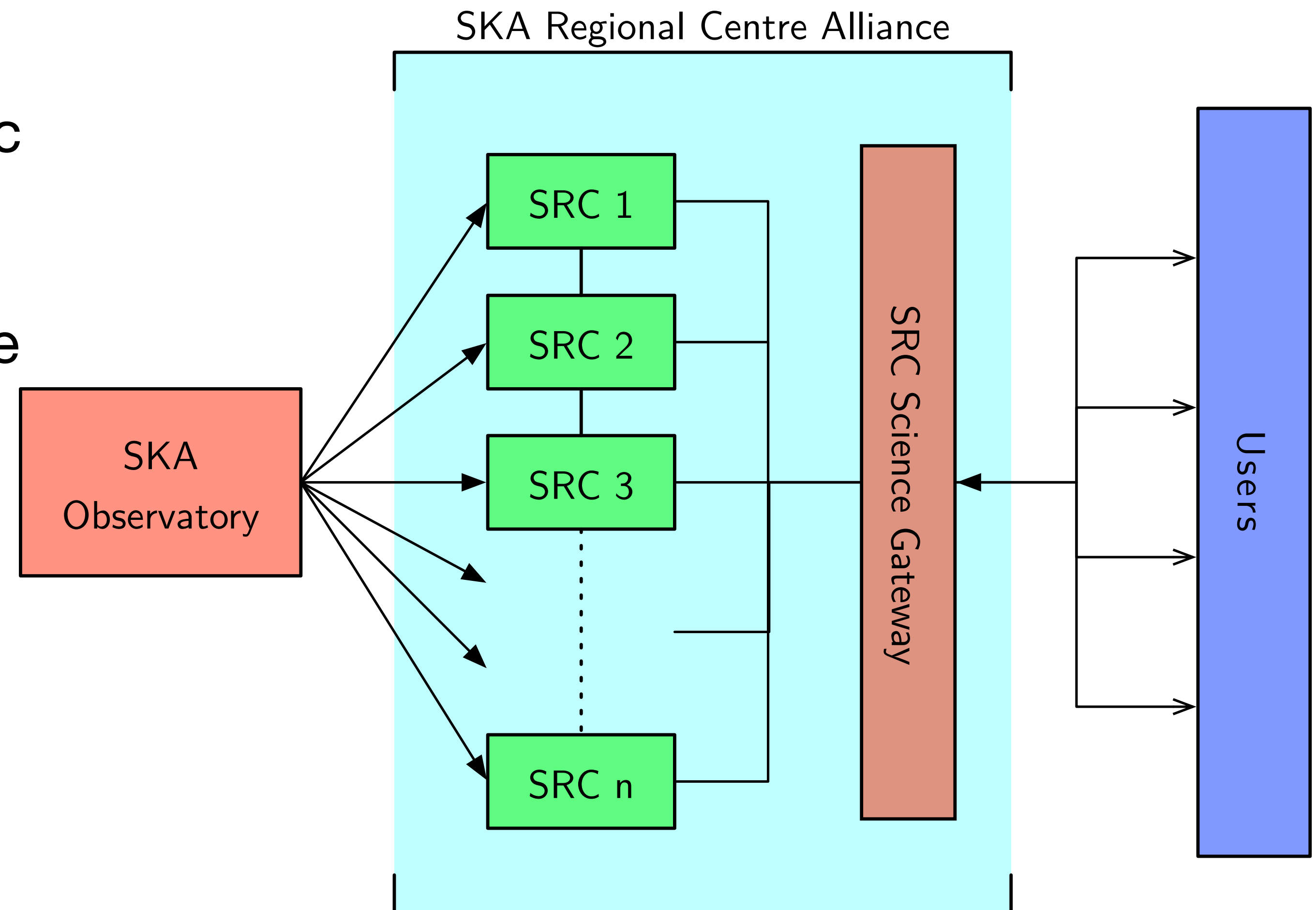
SKA1 Notional Data Flow



SKA Regional Centres



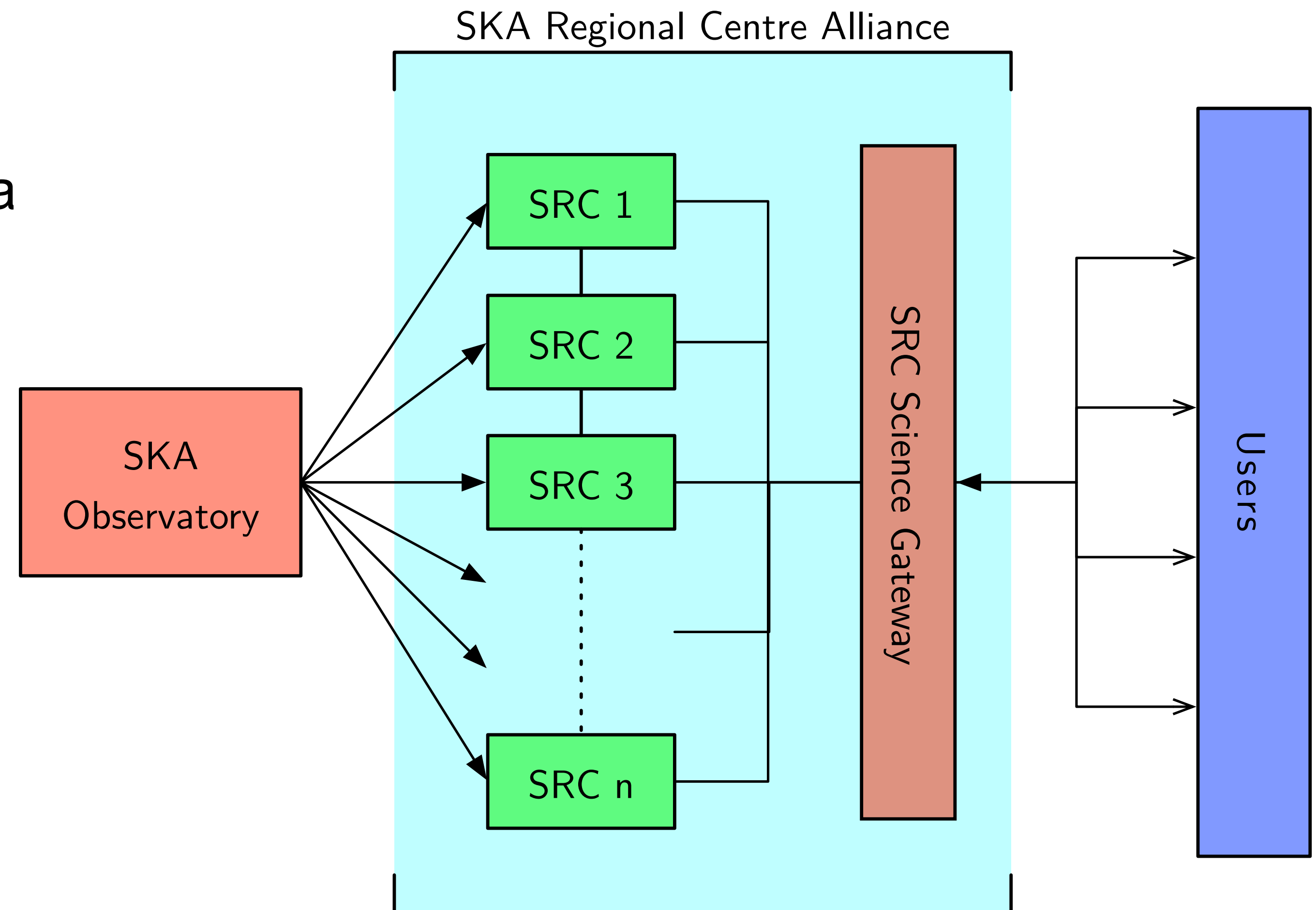
- Collaborative alliance
- Transparent and location agnostic interface to SRCs for users
- SKA users should not care where their data products are
- All SKA users should be able to access their data products, irrespective of whether their country or region hosts a regional centre



SKA Regional Centres



- SKA Regional Centres (SRCs) will host the SKA science archive
- Provide access and distribute data products to users
- Provide access to compute and storage resources
- Provide analysis capabilities & user support
- Multiple regional SRCs, locally resourced and staffed



SKA Control: TANGO



Talk by
Lorenzo Pivetta
MOBPL03

- Decided in March 2015
- Control Harmonisation Project started March 2016 → **CS_Guidelines**
- Good uptake from the community
- INAF, SKA SA, and SKAO are now members of the TANGO Controls Organisation

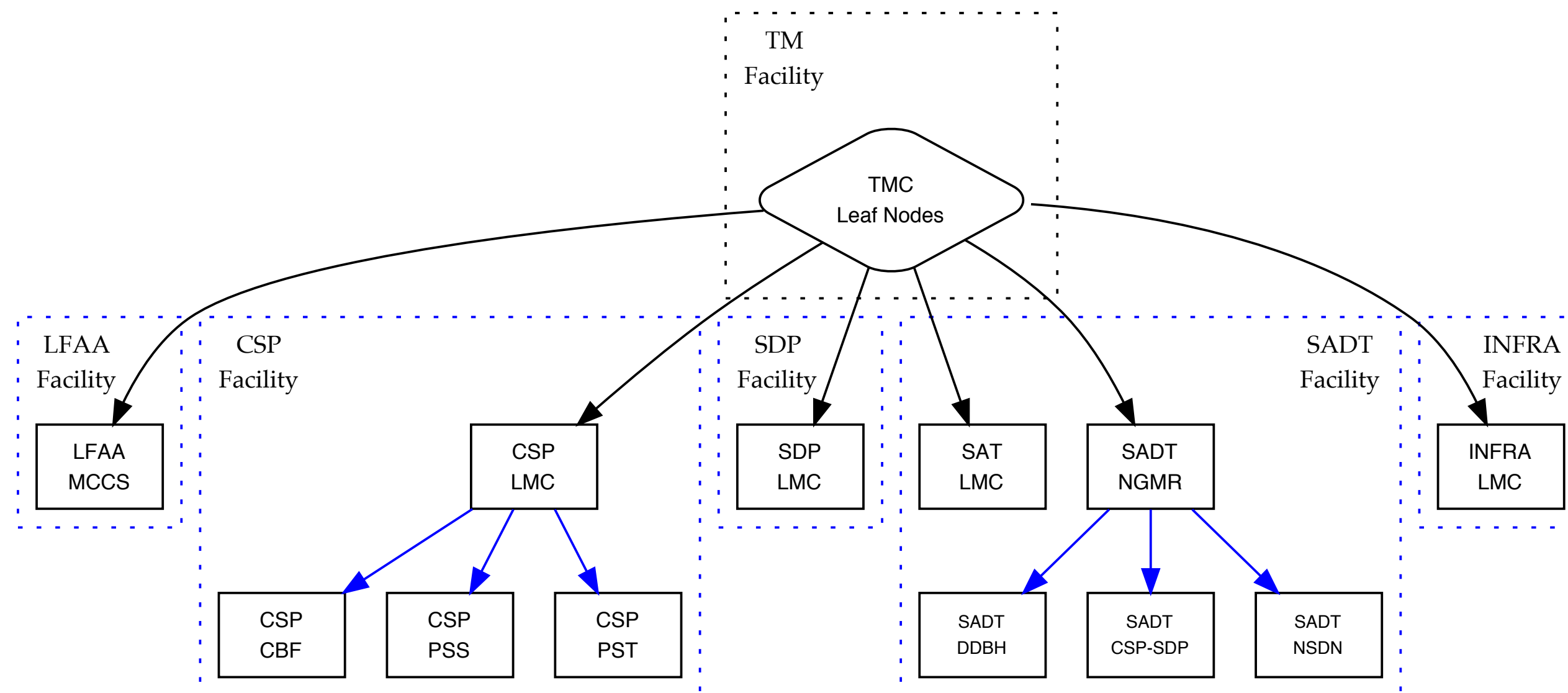
TANGO is the collaborative effort of many people. It is a free open source project i.e. the source code is available under GPL and LGPL open source licences (on [tango-cs](#) and [tango-ds](#) on [SourceForge](#)) and it can be downloaded and modified by anybody. Anyone can send a patch with their changes but changes to the official source code are done by authorised developers. If you want your modifications to be included then send them to the TANGO Controls mailing list. TANGO Controls started at the [ESRF](#) but has since then been adopted by a number of sites. The following sites have committed to the sustainable development of TANGO Controls by signing a Collaboration Contract and committing to financing the development of TANGO:

- [ALBA](#)
- [DESY](#)
- [ELETTRA](#)
- [ESRF](#)
- [INAF](#)
- [MAX-IV](#)
- [SKAO](#)
- [SKA-ZA](#)
- [SOLARIS](#)
- [SOLEIL](#)

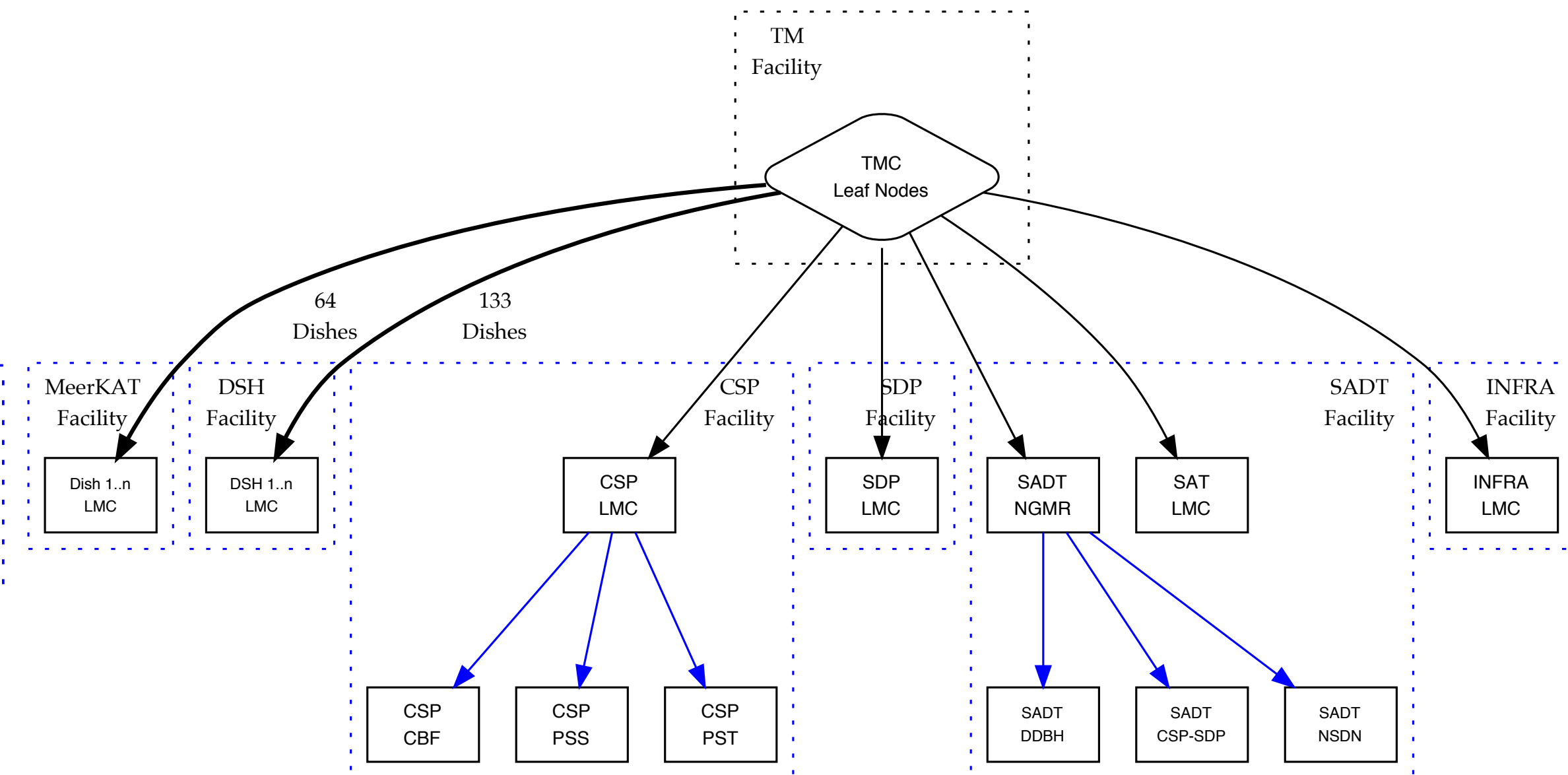
SKA1 Control Hierarchies



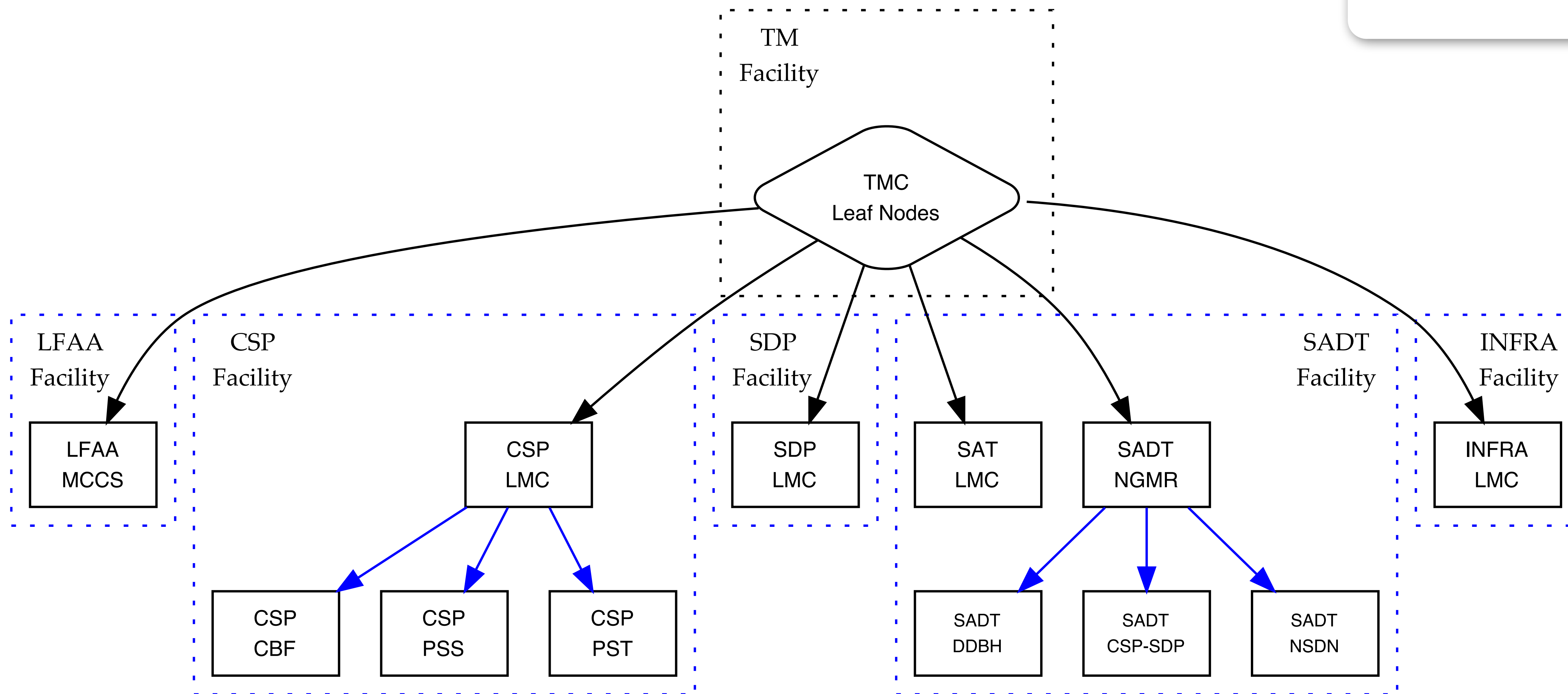
SKA1-Low



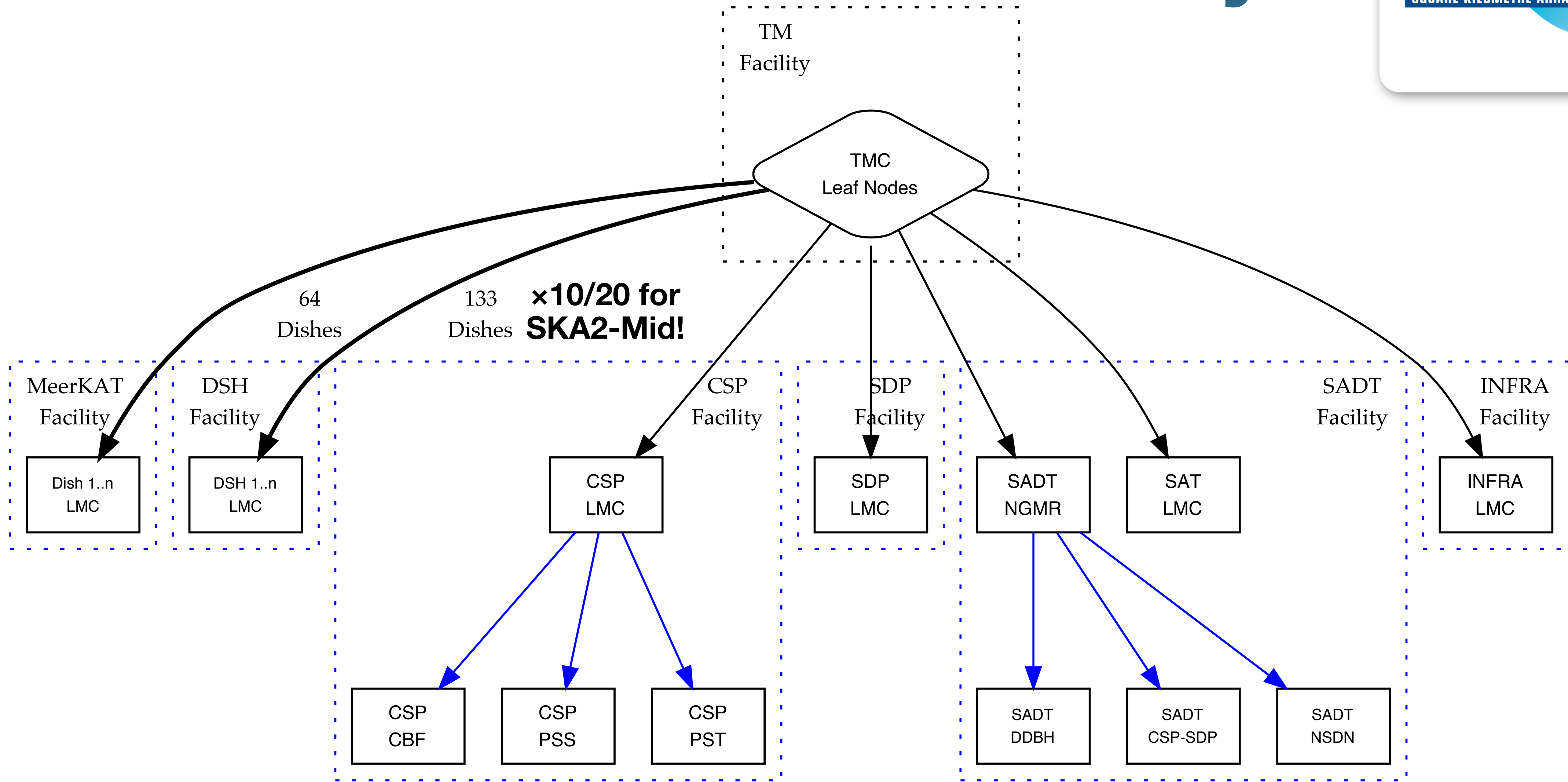
SKA1-Mid



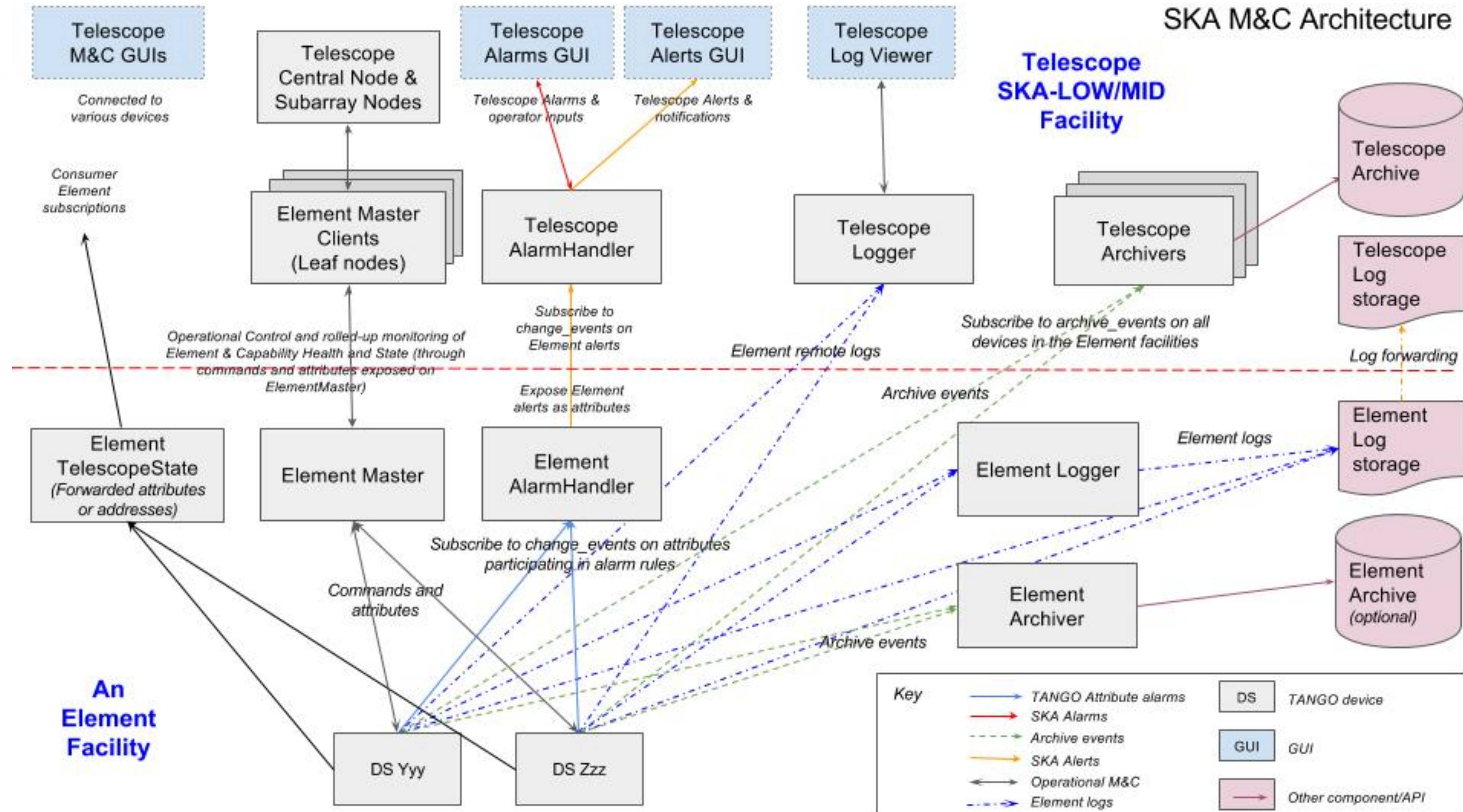
SKA1-Low Control Hierarchy



SKA1-Mid Control Hierarchy



Integrating TANGO Facilities



Focus on diminishing global, cross-facility traffic

Use of logviewer tools, and potential for viewers direct to the devices, but most monitoring in remote

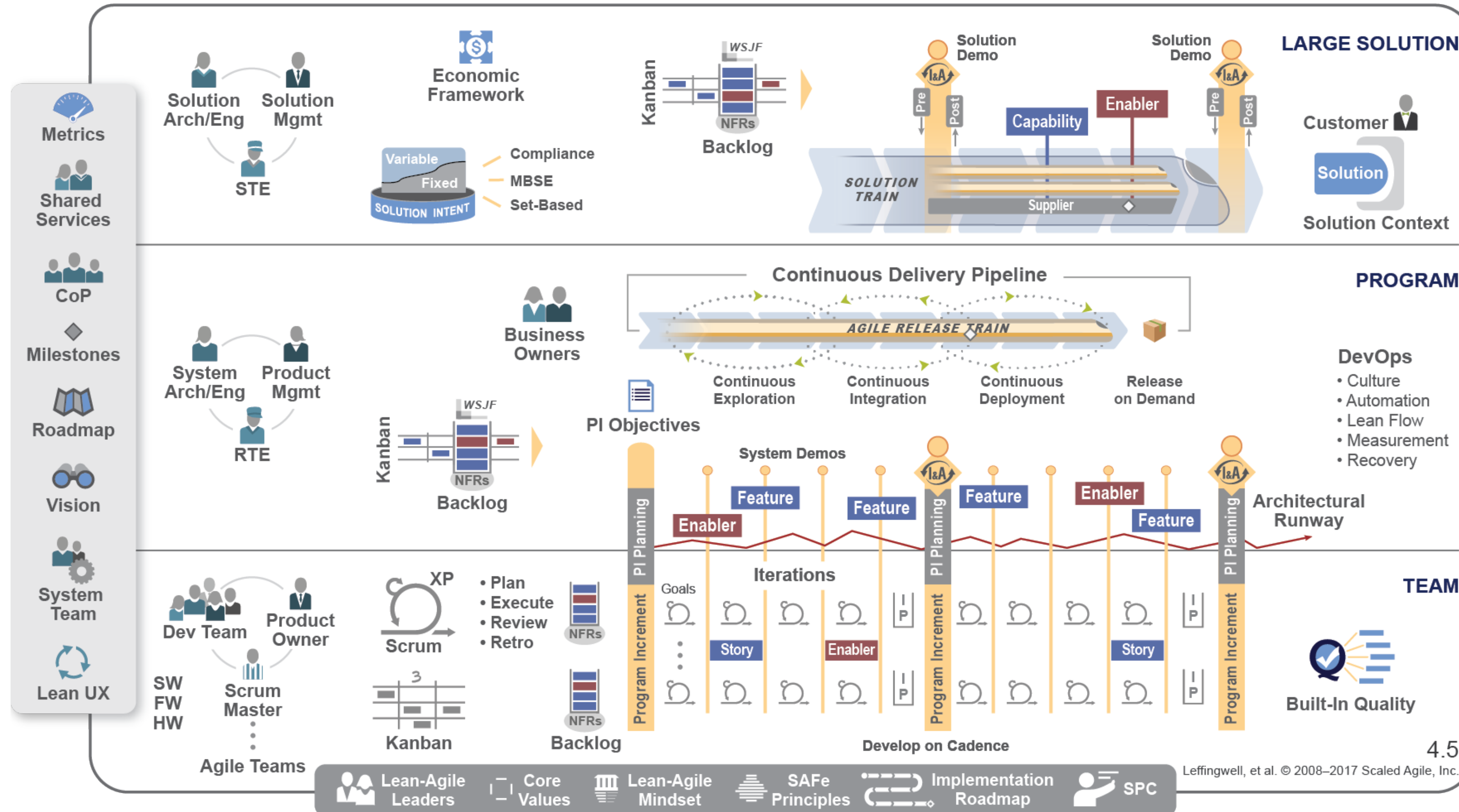
Slide courtesy Lorenzo Pivetta

How to develop all this software?

Agile, Scaled Agile (Framework)

SAFe® for Lean Enterprises

Large Solution SAFe



Agile Teams, 5-7 people (including Scrum Master), ±2 people

Agile Release Trains (ARTs) in Definition

Architectural Runway → Emulation & Simulation



CERN-SKA Agreement



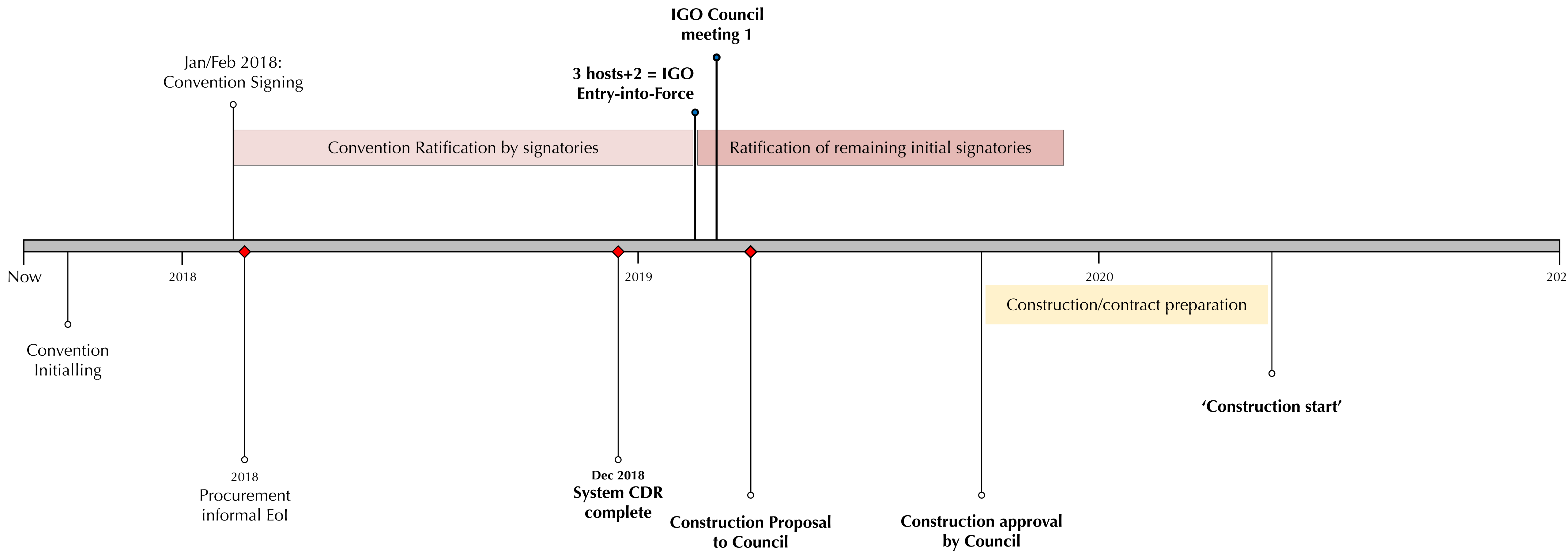
SKA Treaty Organisation



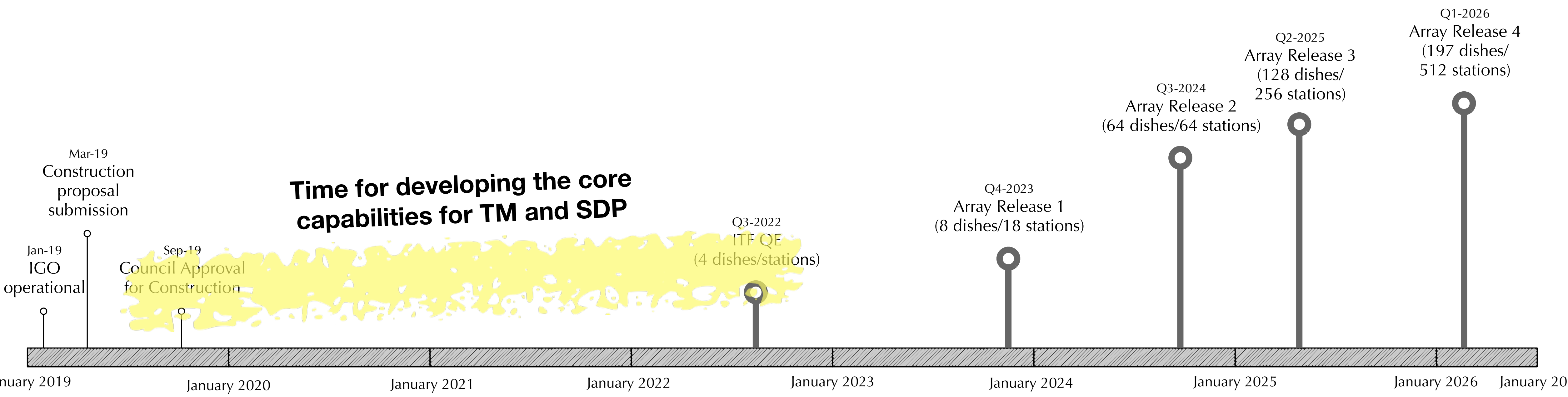
SKA Organisation member governments agreed in 2015 to develop an Intergovernmental Organisation (IGO)

- Rationale:
 - Appropriate for a genuinely global research infrastructure of SKA's scale
 - Government commitment: political stability, funding stability
 - A level of independence in structure
 - Availability of 'supporting processes' through Privileges and Immunities from members: functional support for project
 - 'Freedom to operate', specifically through procurement process, employment rules etc
- We are building an organisation analogous to successful IGOs such as ESO, EMBL, **CERN**
- Negotiations started October 2015 – four Plenary meetings led by Italian government;
- Expect Convention to be signed December 2017, ratified 12 months later

SKA Timeline



SKA Timeline



Conclusion



SKA is happening

- Excellent technical progress
- Prototypes being constructed and deployed
- Cost control effective
- Inter-Governmental Organisation proceeding
- Construction will begin in 2019; operations in mid-2020s

The future?

- SKA time will be allocated to those who contribute to both construction and operations
- Young, vibrant community across the world
- Using industry-standard safe approaches, like SAFe and TANGO in constructoin

SKA at



ICALEPCS2017

Barcelona · Spain, October 8-13 · Palau de Congressos de Catalunya

And SKA
precursors &
pathfinders!



Code	Author	Organisation	Title
MOAPL3	Lorenzo Pivetta	SKAO	SKA Control System Guidelines
TUBPA06	Francois Joubert	SKA SA	Scalable Time Series Documents Store
TUCPL01	Paul Boven	JIVE	White-Rabbit for Radio Astronomy
TUDPL03	Athanaseus Ramaila	SKA SA	Control System Simulation Using DSEE High Level Instrument Interface and Behavioural Description
THAPL03	Valentina Alberti	INAF-OAT	Usability Recommendations for the SKA Control Room Obtained by a User-Centred Design Approach
THBPA04	Anton Joubert	SKA SA	Orchestrating MeerKAT's Distributed Science Data Processing Pipelines
THCPL04	Ralph Braddock	UMAN	SKA Synchronization and Timing Local Monitor and Control - Software Design Approach
THSH201	Athanaseus Ramaila	SKA SA	Integration of MeerKAT and SKA telescopes using KATCP <-> Tango Translators
FRAPL01	Juande Santander-Vela	SKAO	Status of the Square Kilometre Array



Code	Author	Organisation	Title
TUPHA030	Matteo Canzari	INAF-Teramo	Using of Artificial Intelligence in the Predictive Model of the Fault Management of SKA Telescope Manager
TUPHA050	Simone Riggi	INAF-OACT	The SKA Dish Local Monitoring and Control System
TUPHA063	M. Marquarding	CSIRO-CASS	ASKAP: From Construction to Operation
TUPHA207	Matteo DiCarlo	INAF-Teramo	TM Service: An Architecture for Monitoring and Controlling the SKA Telescope Manager
THPHA004	Matteo DiCarlo	INAF-Teramo	Challenges and Solutions for the SKA TM Architectural Team
THPHA032	C. R. Haskins	CSIRO-ATNF	DiamoniCA: EPICS and Open-Source Data Analytics Platforms
THPHA066	L.R. Brederode	SKA SA	MeerKAT Project Status Report
THPHA085	Rajesh Warange	NCRA/TIFR	SKA Synchronization and Timing - Local Monitor and Control Project Status
THPHA137	Francois Joubert	SKA SA	Distributing Near Real-Time Monitoring and Scheduling Data for Integration With Other Systems at Scale

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Code	Author	Organisation	Title
THPHA142	Alessio Marassi	INAF-Trieste	The SKA Dish SPF and LMC Interaction Design: Interfaces, Simulation, Testing and Integration
THPHA164	B. Xaia	SKA SA	Automated Software Testing for Controlling And Monitoring the MeerKAT Telescope
THPHA168	Rajesh Warange	NCRA/TIFR	Dockers With TANGO – Control System Approach for SKA

SQUARE KILOMETRE ARRAY

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Thanks!

Subarray State Machine

