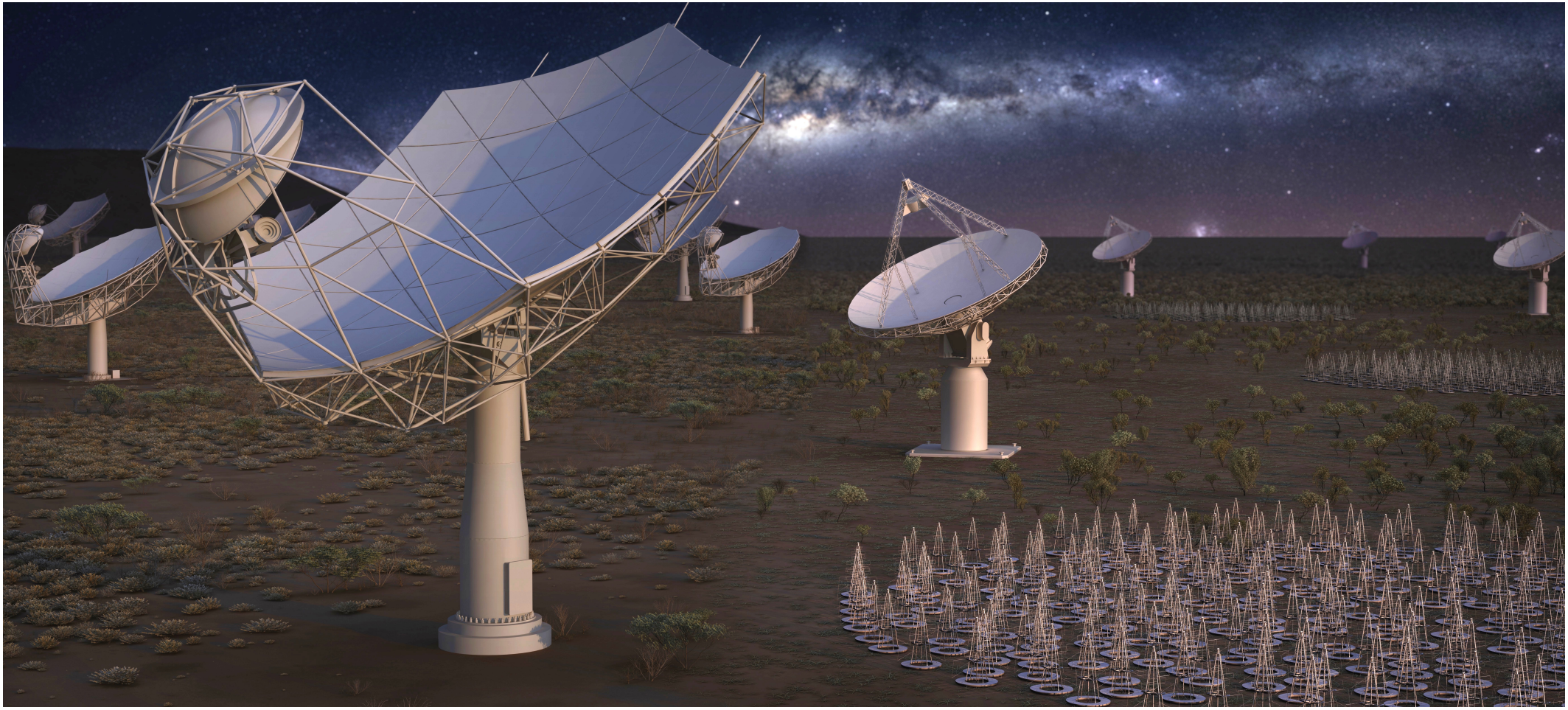
SKA Regional Centres

Background and Framework



SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope

Dr Antonio Chrysostomou

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Outline

Introduction to the Square Kilometre Array

The data flow that drives us to a model for SKA Regional Centres

Model for collaborative network of SRCs

The SKA Regional Centres Coordination Group

One Observatory
The Square Kilometre Array

Two Telescopes
SKA-LOW
SKA-MID

Three Sites
Australia (LOW)
South Africa (MID)
UK (GHQ)

One Observatory
The Square Kilometre Array

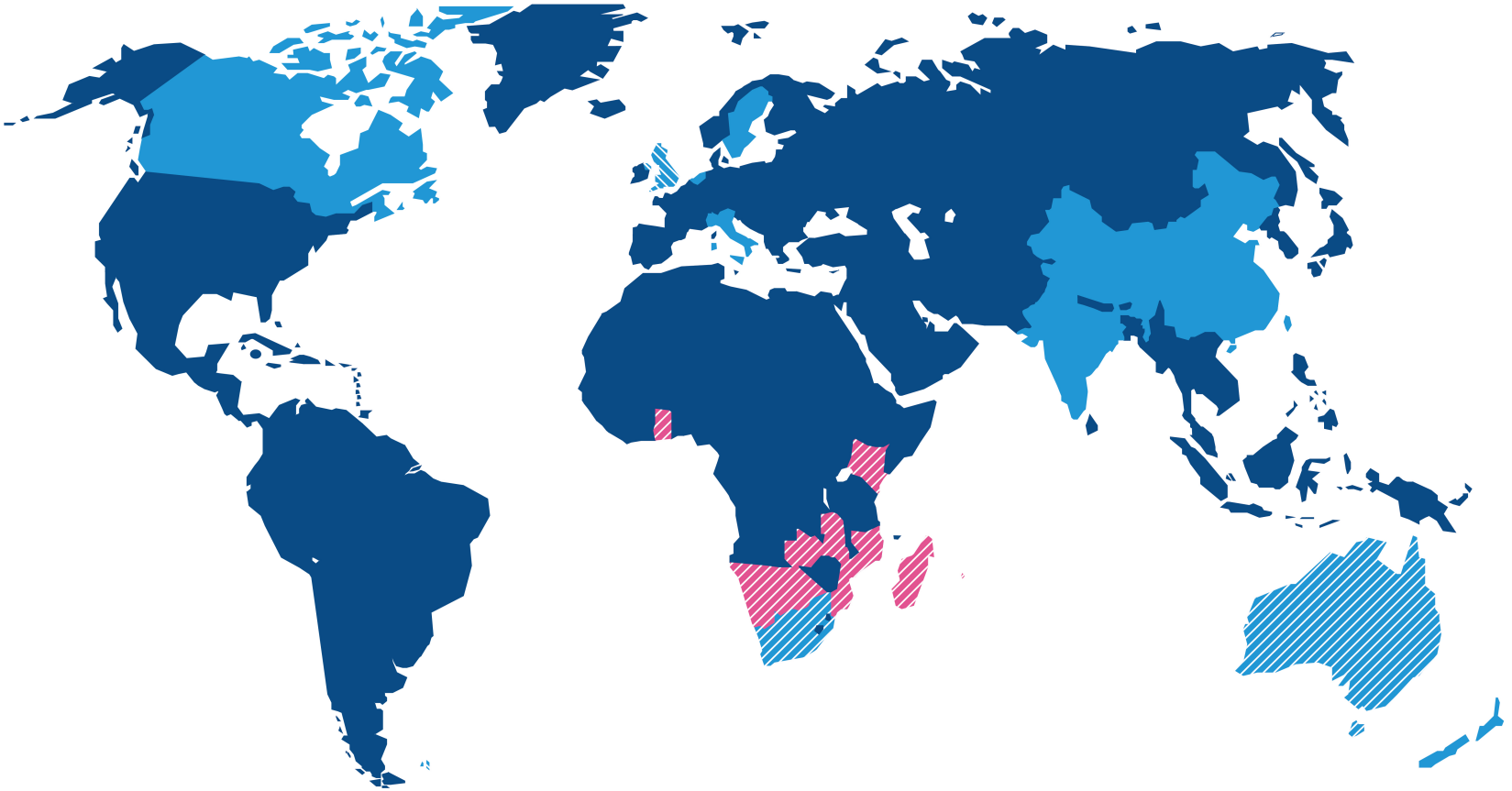
SKA1-LOW	GHQ	SKA1-MID
Australia	UK	South Africa

For SKA-Phase1

Construction phase begins: 2018-19
Cost : €674M
Operational cost : ~€100M/yr + Dev
(still under development)

10 member countries

Expect membership to increase



Observers:
France
Germany
Japan
Malta
Portugal
Spain
Korea
USA

Full members

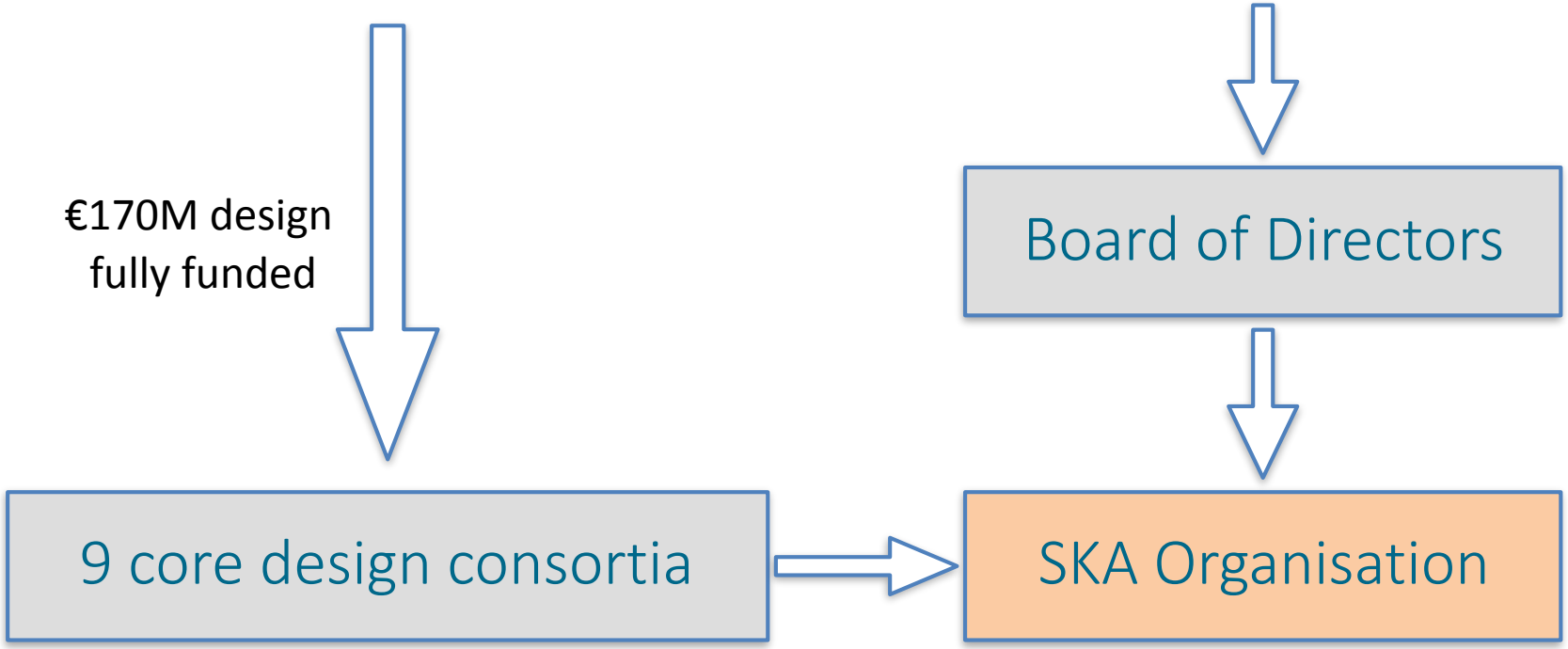
SKA Headquarters host country

SKA Phase 1 and Phase 2 host countries

African partner countries
(non-member SKA Phase 2 host countries)

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

Global collaborative effort to build the world's largest radio telescope



Future Governance

Member governments are negotiating to set up the SKAO as an Inter-Governmental Organisation (IGO)

Rationale:

- scale of project
- political and financial stability into the future
- independence and protection of investment
- privileges and immunities
- Freedom to Operate

Timeline:

- agree convention in 2017
- ratification by governments over ~12-months

SKA Science Case

The SKA Science Book

https://www.skatelescope.org/books/

- 135 chapters
- 2000 pages
- 1200+ authors, 31 countries
- 9kg

SKA Science Case

The Cradle of Life & Astrobiology

- How do planets form? Are we alone?

Strong-field Tests of Gravity with Pulsars and Black Holes

- Was Einstein right with General Relativity?

The Origin and Evolution of Cosmic Magnetism

- What is the role of magnetism in galaxy evolution and the structure of the cosmic web?

Galaxy Evolution probed by Neutral Hydrogen

- How do normal galaxies form and grow?

The Transient Radio Sky

- What are Fast Radio Bursts? What haven't we discovered?

Galaxy Evolution probed in the Radio Continuum

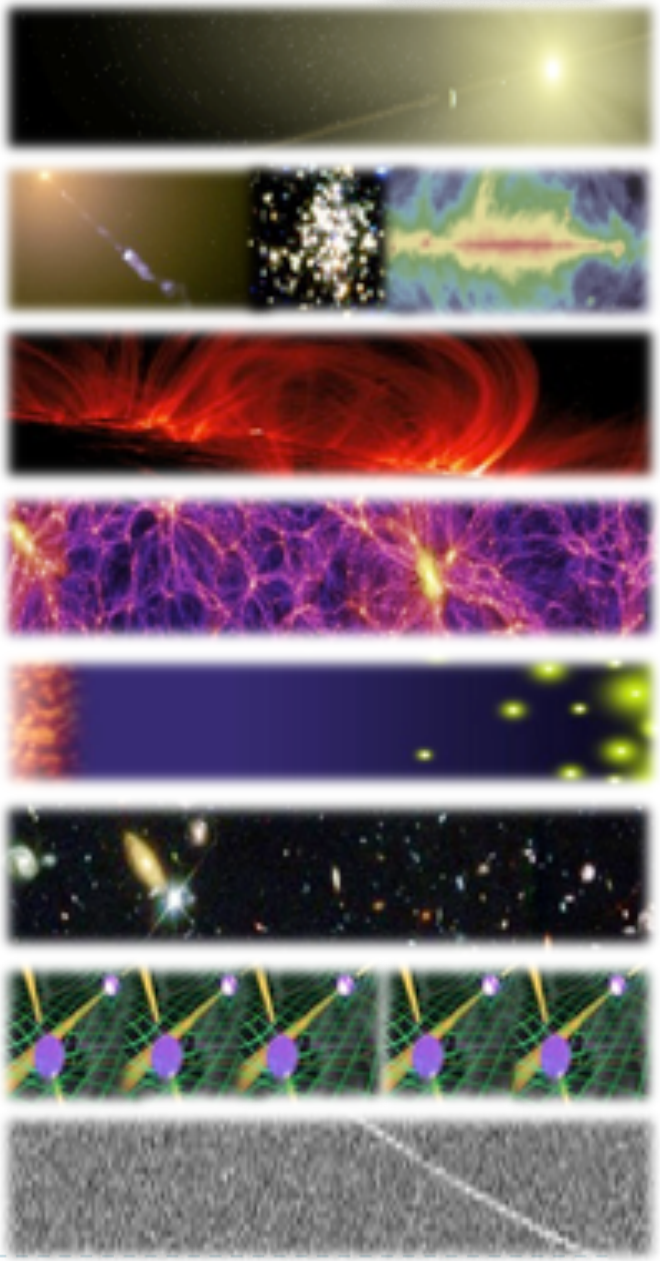
- What is the star-formation history of normal galaxies?

Cosmology & Dark Energy

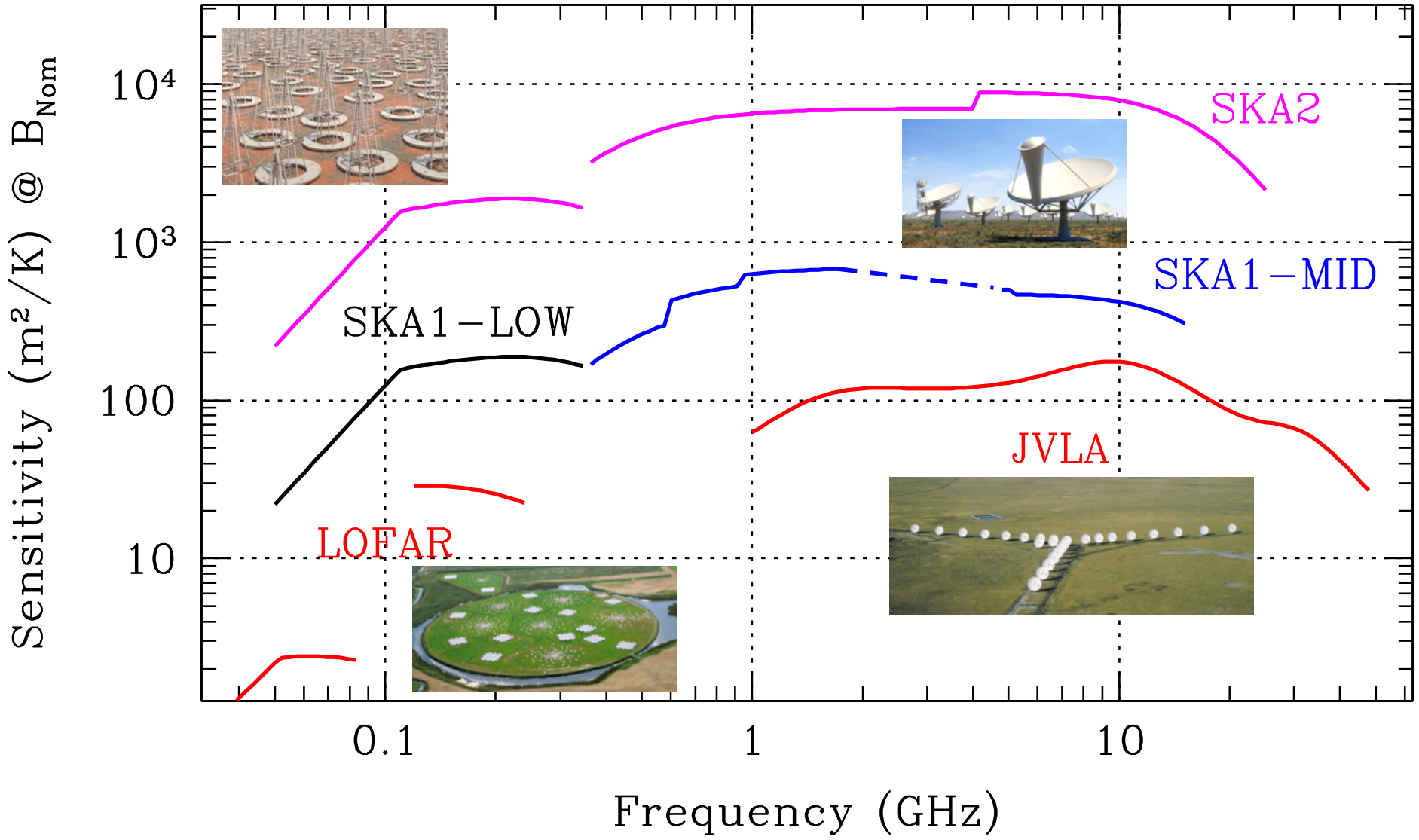
- What is dark matter? What is the large-scale structure of the Universe?

Cosmic Dawn and the Epoch of Reionization

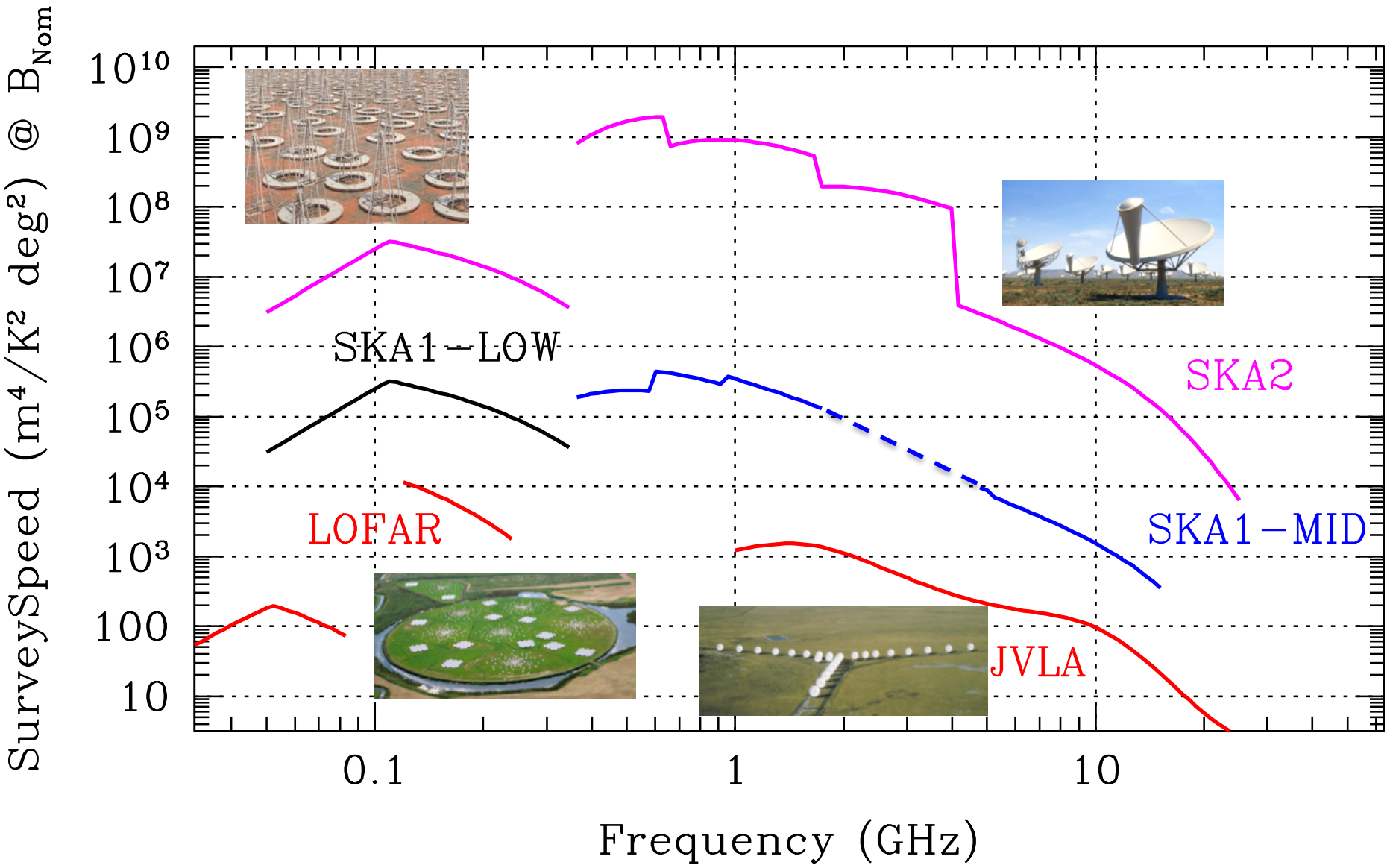
- How and when did the first stars and galaxies form?



SKA1 sensitivity



SKA1 survey speed



SKA1 resolution - complementarity

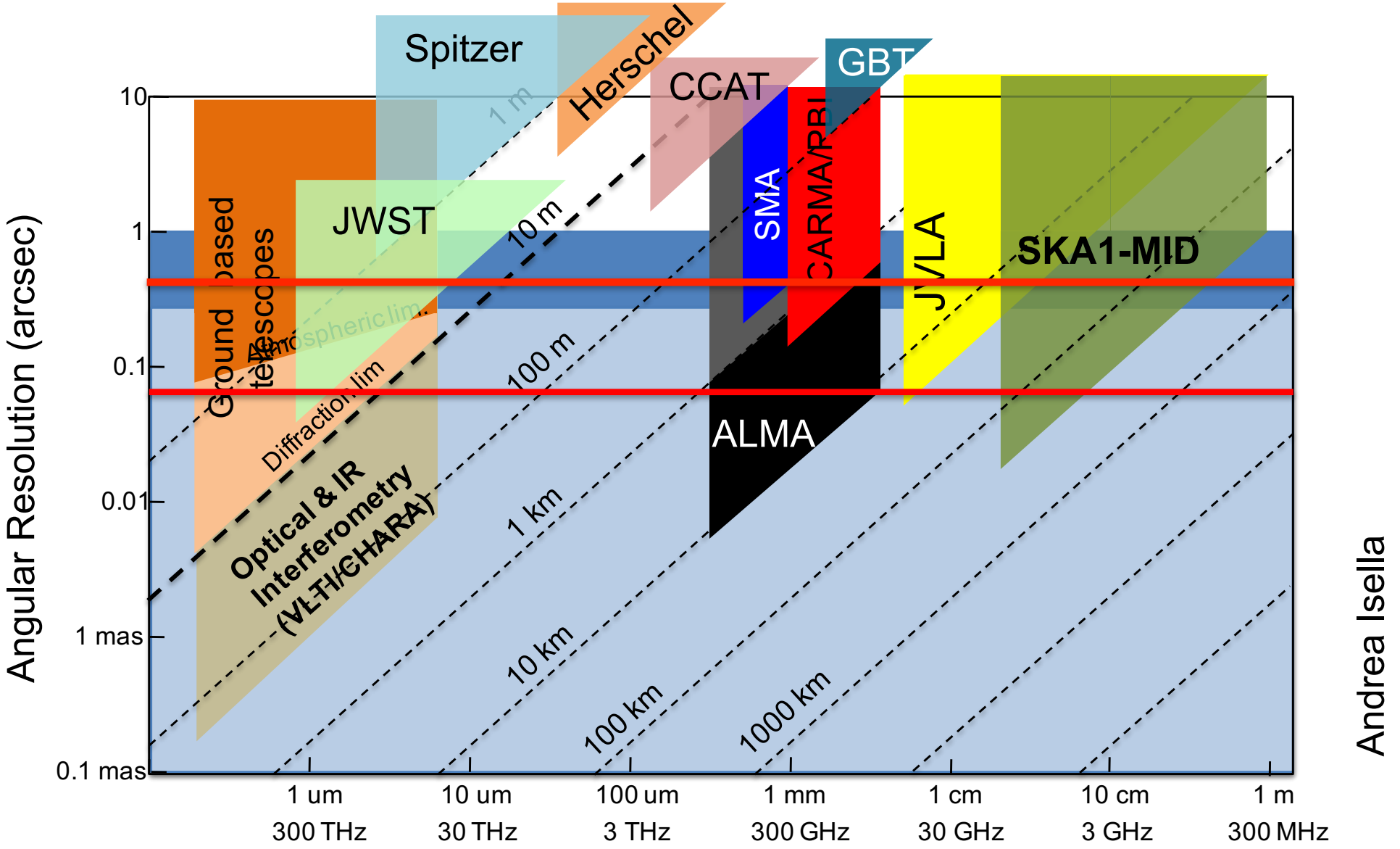
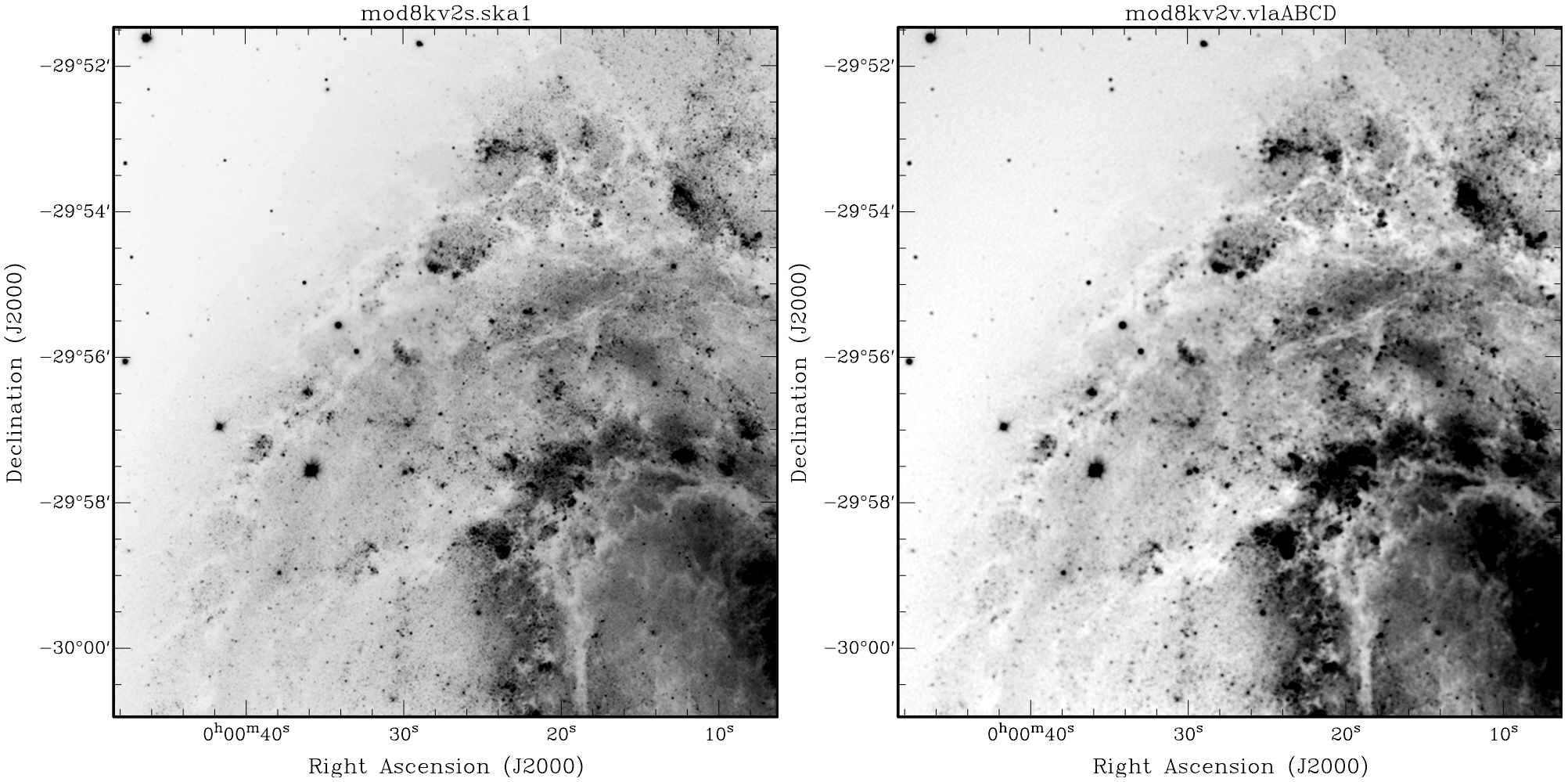


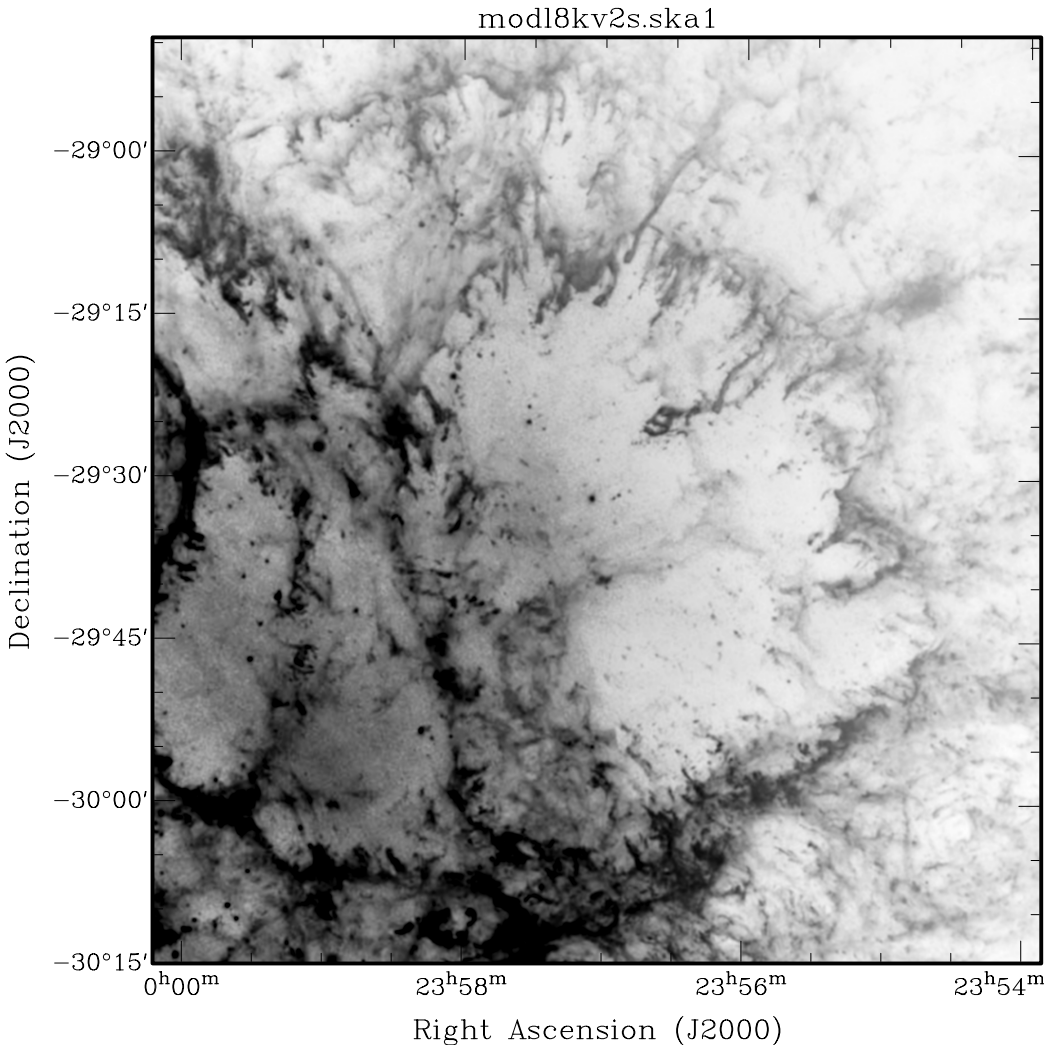
Image quality comparisons

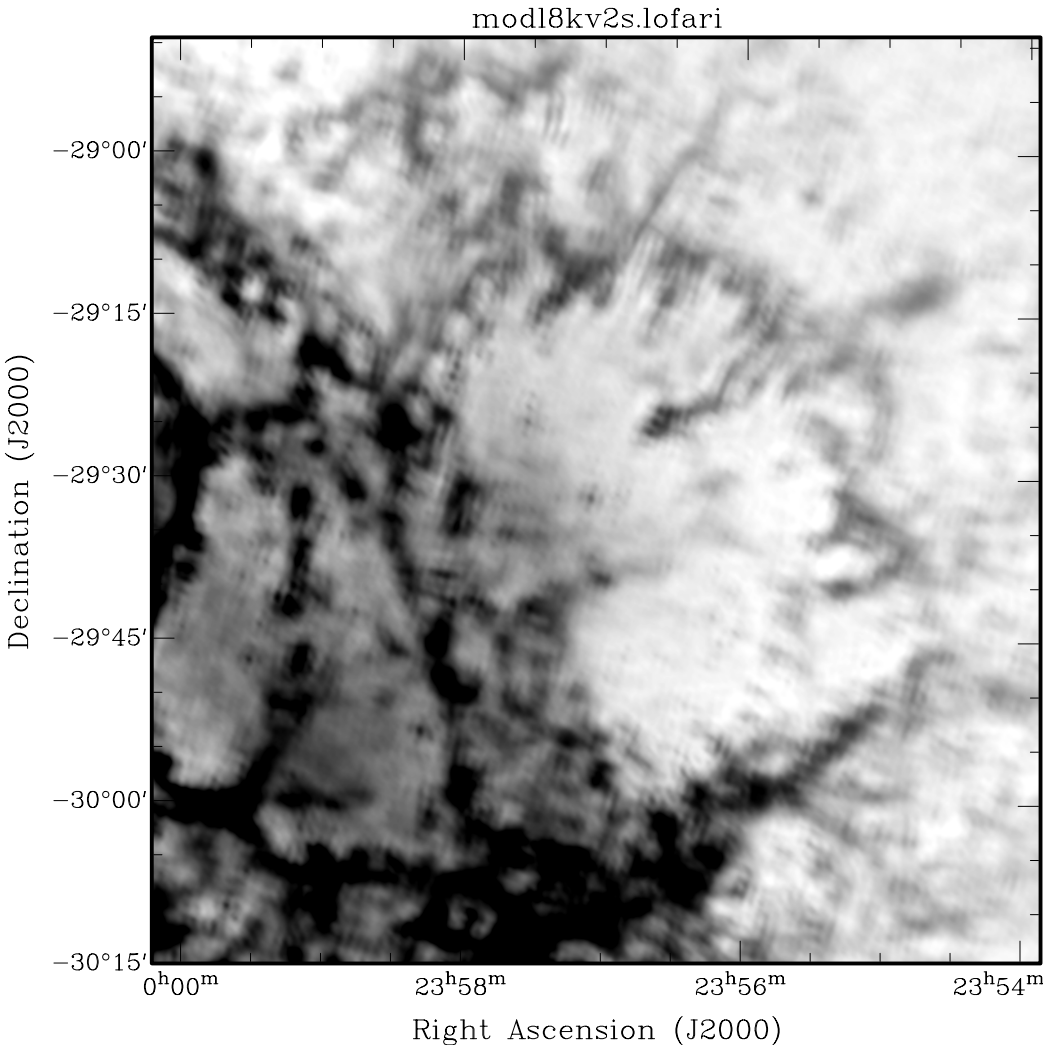


M83: Single SKA1-MID track compared with JVLA A+B+C+D

Simulations courtesy R. Braun

Image quality comparisons

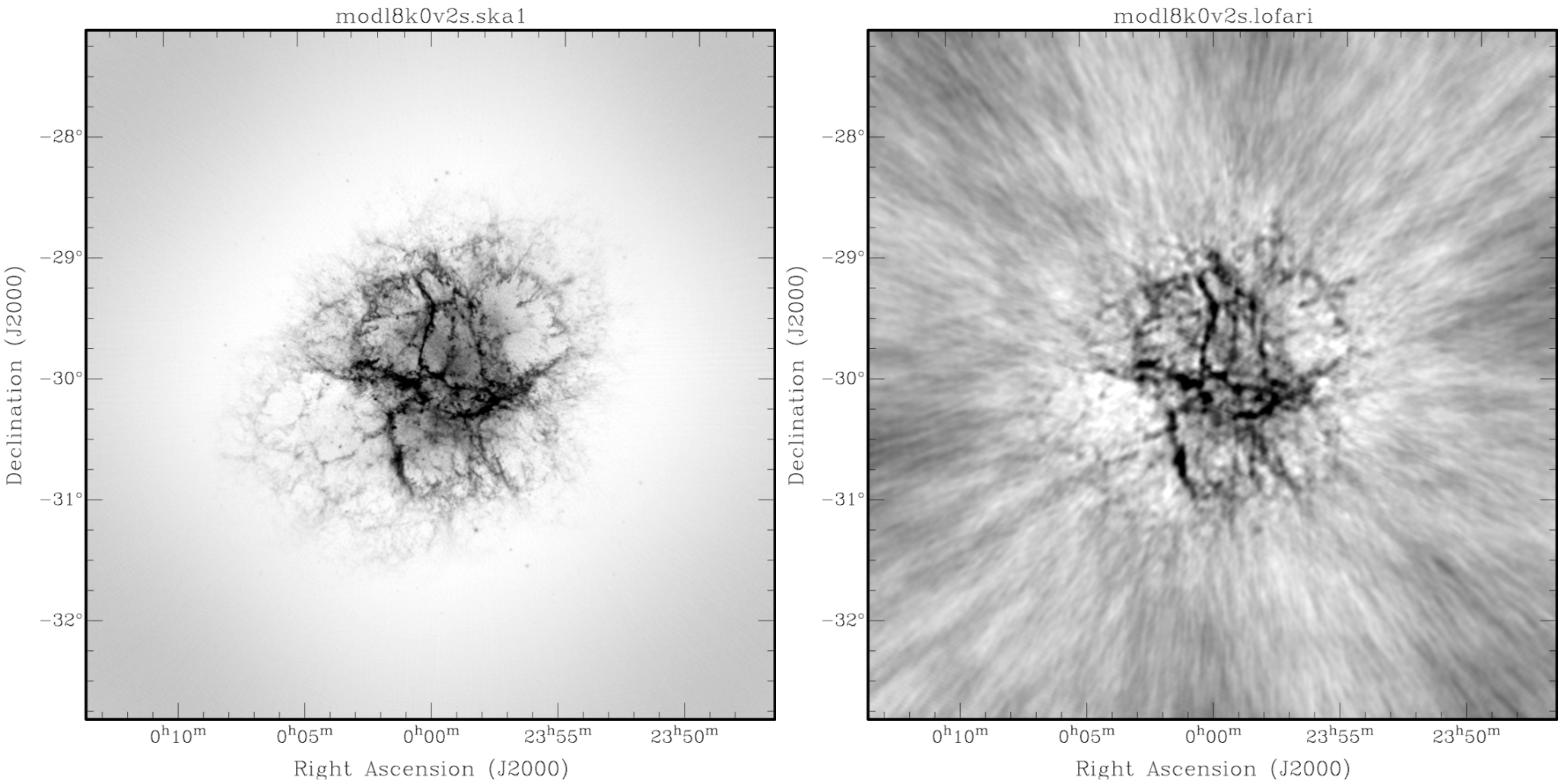




Crab Nebula: Single SKA1-Low track compared with LOFAR-INTL

Simulations courtesy R. Braun

Image quality comparisons



Crab Nebula: SKA1-Low snapshot compared with LOFAR-INTL

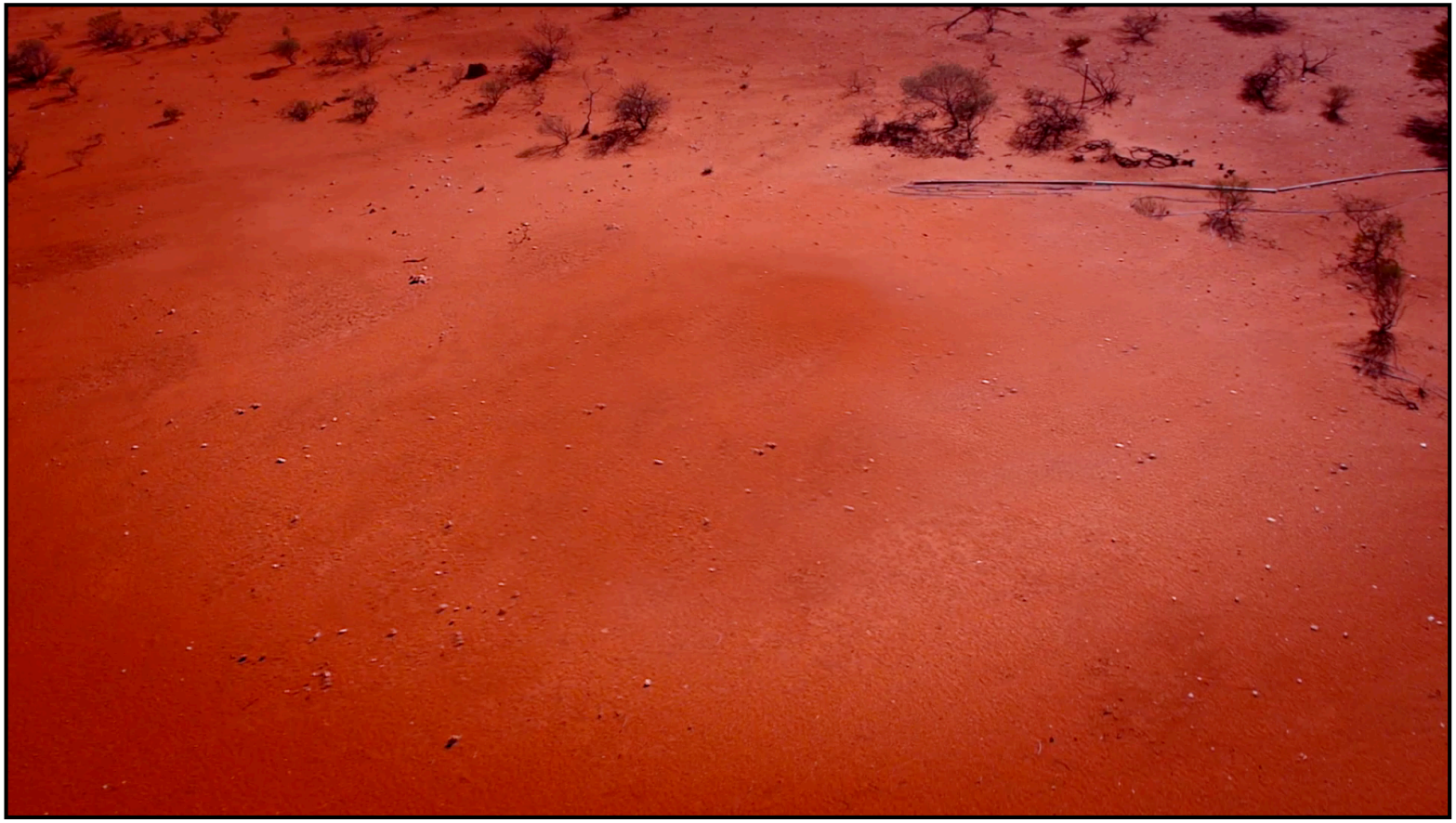
Simulations courtesy R. Braun

SKA1 LOW - Western Australia

131,072 antennas : 512 stations of 256 antennas, core + 3 spiral arms, 65km baselines

50 → 350 MHz full instantaneous bandwidth

Raw Data output approx. 2 Pbit/s → 7 Tbit/s into the correlator



SKA1 MID - Karoo, South Africa

133 SKA1 dishes (15m), 64 MeerKAT (13.5m), core + 3 spiral arms, 150km baseline

0.35 → 15GHz covered in 5 bands

Raw Data output approx. 9 Tbit/s into the correlator

Data flow

SKA1-LOW

SKA1-MID

~2 Pb/s

SKA SQUARE KILOMETRE ARRAY
LOW-FREQUENCY APERTURE ARRAY

7.2 Tb/s

8.8 Tb/s

SKA SQUARE KILOMETRE ARRAY
SIGNAL AND DATA TRANSPORT

SKA SQUARE KILOMETRE ARRAY CSP
CENTRAL SIGNAL PROCESSOR

~50 PFlops

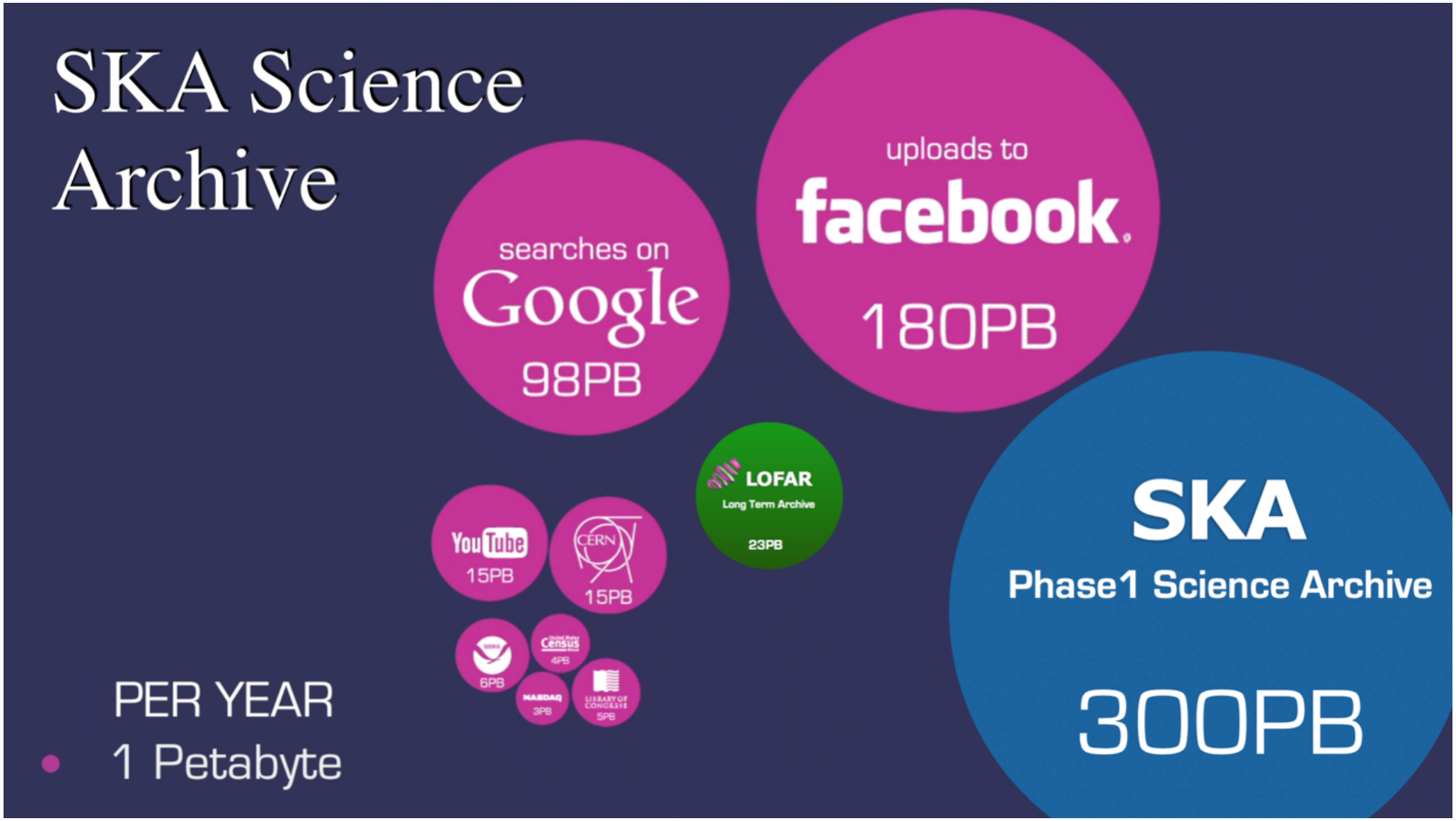
~5 Tb/s

SKA SQUARE KILOMETRE ARRAY SDP
SCIENCE DATA PROCESSOR

~250 PFlops

~300 PB/yr

Some perspective



A collaborative model of SRCs

Three main factors that lead to a model of a collaborative network of SRCs

(1) The science data products that emerge from the SKA observatory are not in the final state required for science analysis

(2) The data volumes are so large that direct delivery to end users is unfeasible

(3) The community of scientists working on SKA science data products will be geographically distributed

A collaborative model of SRCs

Three main factors that lead to a model of a collaborative network of SRCs

(1) The science data products that emerge from the SKA observatory are not in the final state required for science analysis

generation of advanced data products not in scope of project

SDP must maintain throughput matched to input data rate

combination & further analysis of data products outside of observatory boundaries

(2) The data volumes are so large that direct delivery to end users is unfeasible

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A collaborative model of SRCs

Three main factors that lead to a model of a collaborative network of SRCs

(1) The science data products that emerge from the SKA observatory are not in the final state required for science analysis

(2) The data volumes are so large that direct delivery to end users is unfeasible

does not account for possible future "discovery" archive

final data volume for each project will exceed that delivered by the observatory

downloading data to local machines/cluster expensive and unfeasible in long term

"take processing to the data"

(3) The community of scientists working on SKA science data products will be geographically distributed

A collaborative model of SRCs

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(3) The community of scientists working on SKA science data products will be geographically distributed

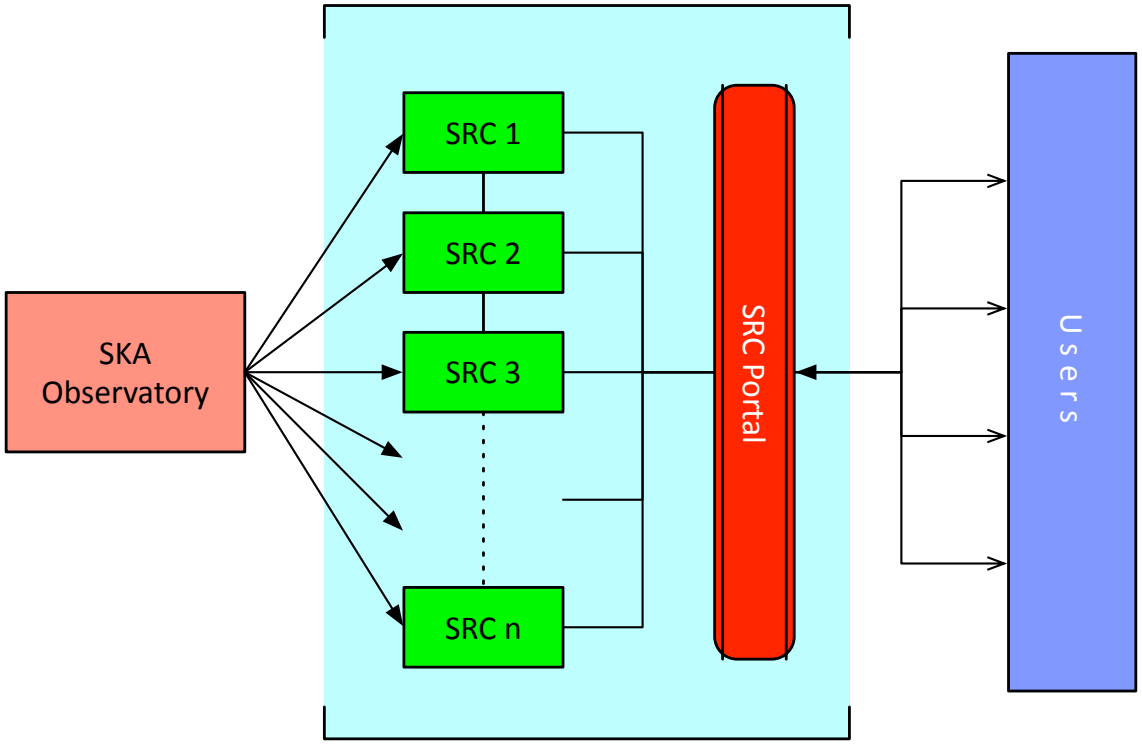
KSPs with 1000s of hrs of observing time will dominate the science programme

large international teams drawn from across the membership

need new methods, algorithms and techniques

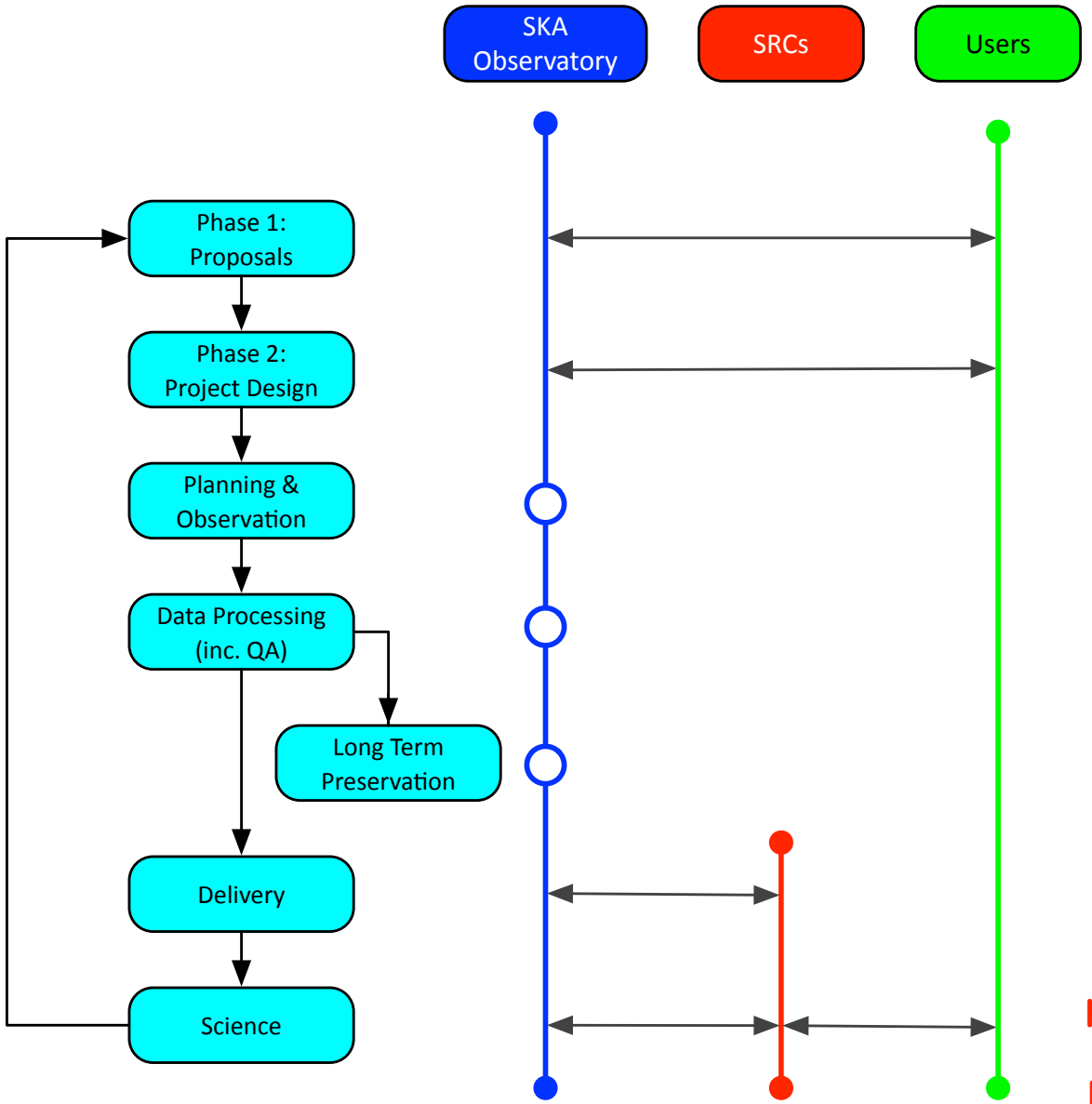
driven by the community so they need a platform on which to do this

Model for collaborative network of SRCs



Simplified description but highlights important factors

- a collaborative network
- transparent and location agnostic interface to SRCs for users
  - no SKA user should 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



The observatory executes the observing projects, the calibration, QA and generates the data products

Users interact with the observatory to write proposals and prepare projects for observing

SRCs receive data products from the observatory and provide resources to users to carry out higher level analysis

SKA Regional Centres Coordination Group

Essential Functions of SRCs:

- provide transparent access to SKA science data products & user support
- provide computational resources for post processing (analysis & visualisation)
- provide platform for development of software tools
- provide long-term science archive

SRCCG (abridged) instructions:

- define minimum set of requirements for SRCs
  - individual and whole network, including links with SKA telescopes
- draft MoUs between SKAO and the SRCs, and an accreditation process
- ingestion and curation of science archive for user-generated data products
- data challenges

Also need to recognise that requirements of KSP and PI projects will differ

SKA Regional Centres Coordination Group

SKAO:

- Antonio Chrysostomou - Chair
- Rosie Bolton (SRC Project Scientist)
- Miles Deegan
- Nick Rees

Members:

- Séverin Gaudet (NRC, Canada)
- Jasper Horrell (SKA-SA)
- Peter Quinn (ICRAR, AUS)
- Yogesh Wadadekar (NCRA, India)
- Michael Wise (ASTRON, NL)
- Shenghua Yu (BAO, China)

Externals:

- Ian Bird (CERN)
- Andy Connolly (LSST, UWash)
- Lourdes Verdes-Montenegro (IAA, Spain)

SRC Background and Framework document is now available (please email for a copy)

Note that this is a Coordination Group and not a Working Group

subgroups will be formed to study and report on specific issues

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