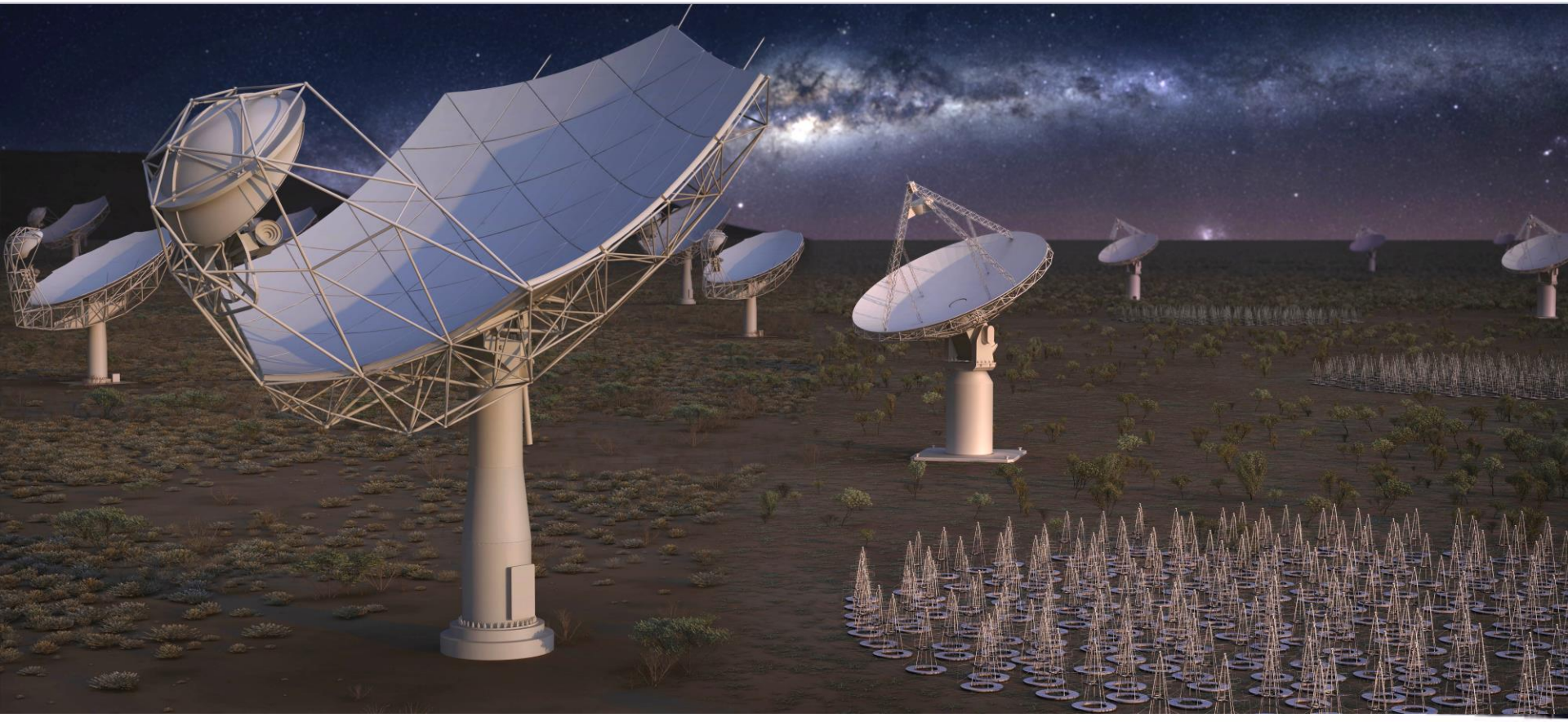
SKA era and the role of National Facilities



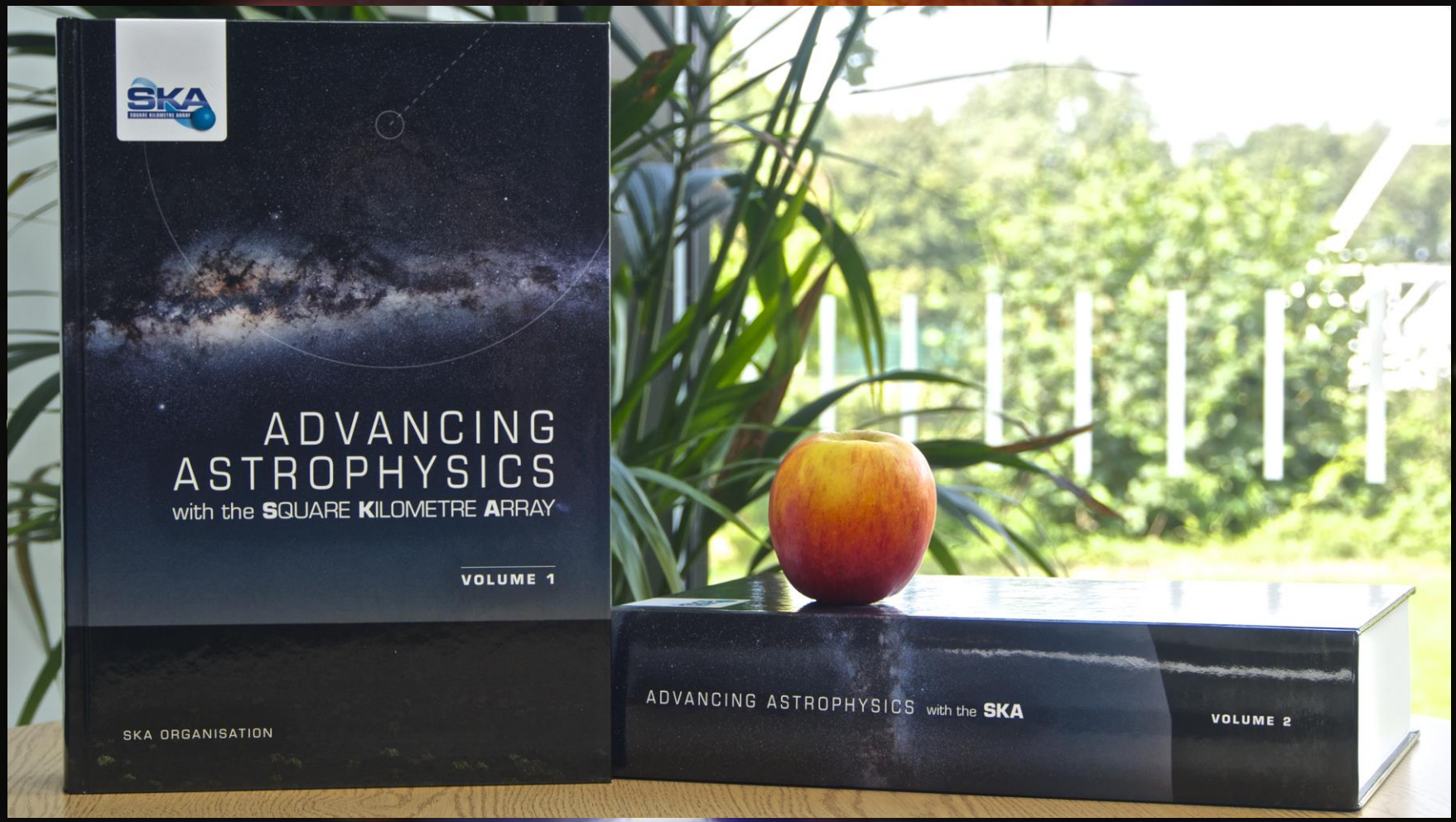
SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope

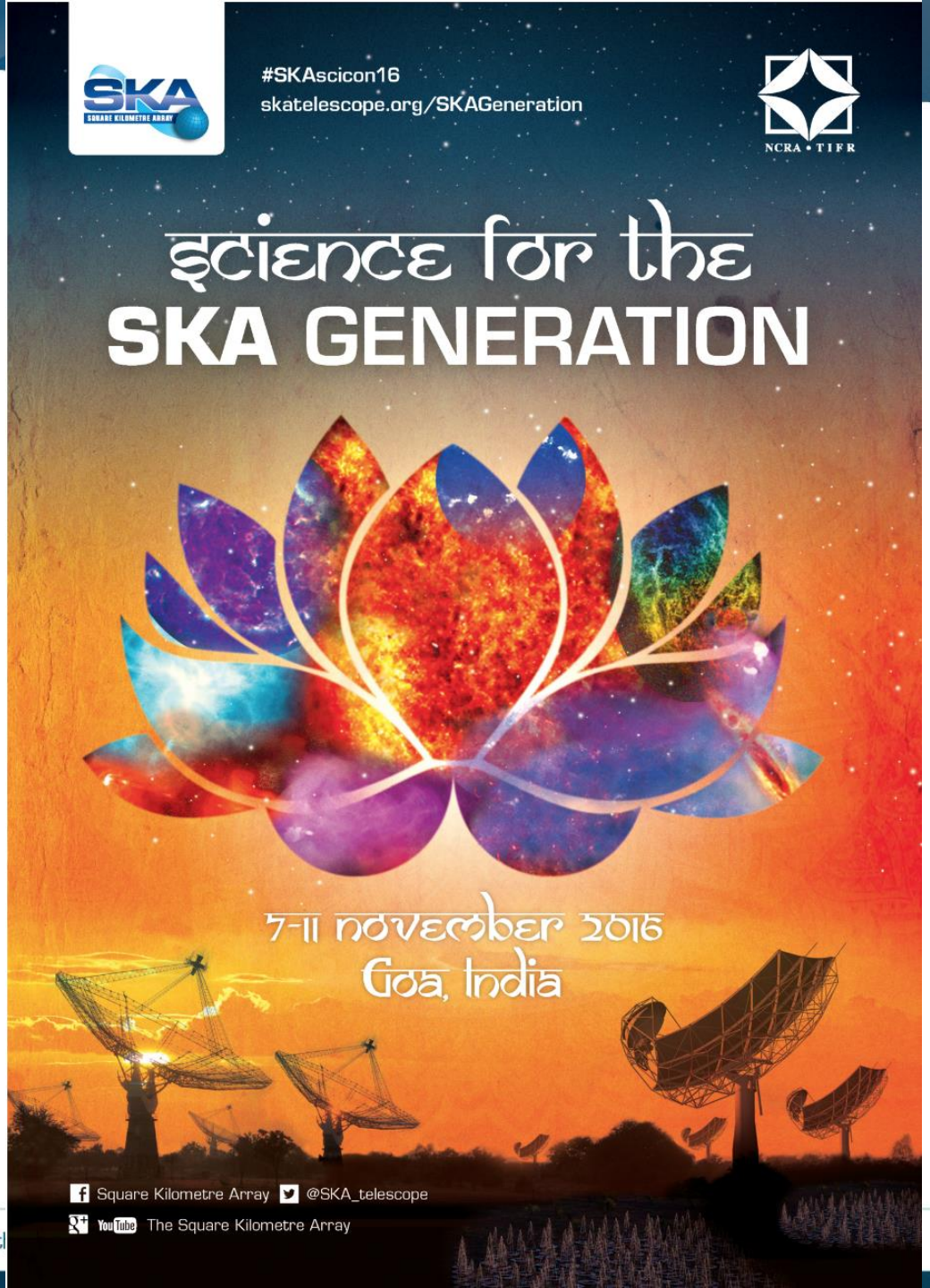
Philip Diamond, Director General

15th September2016

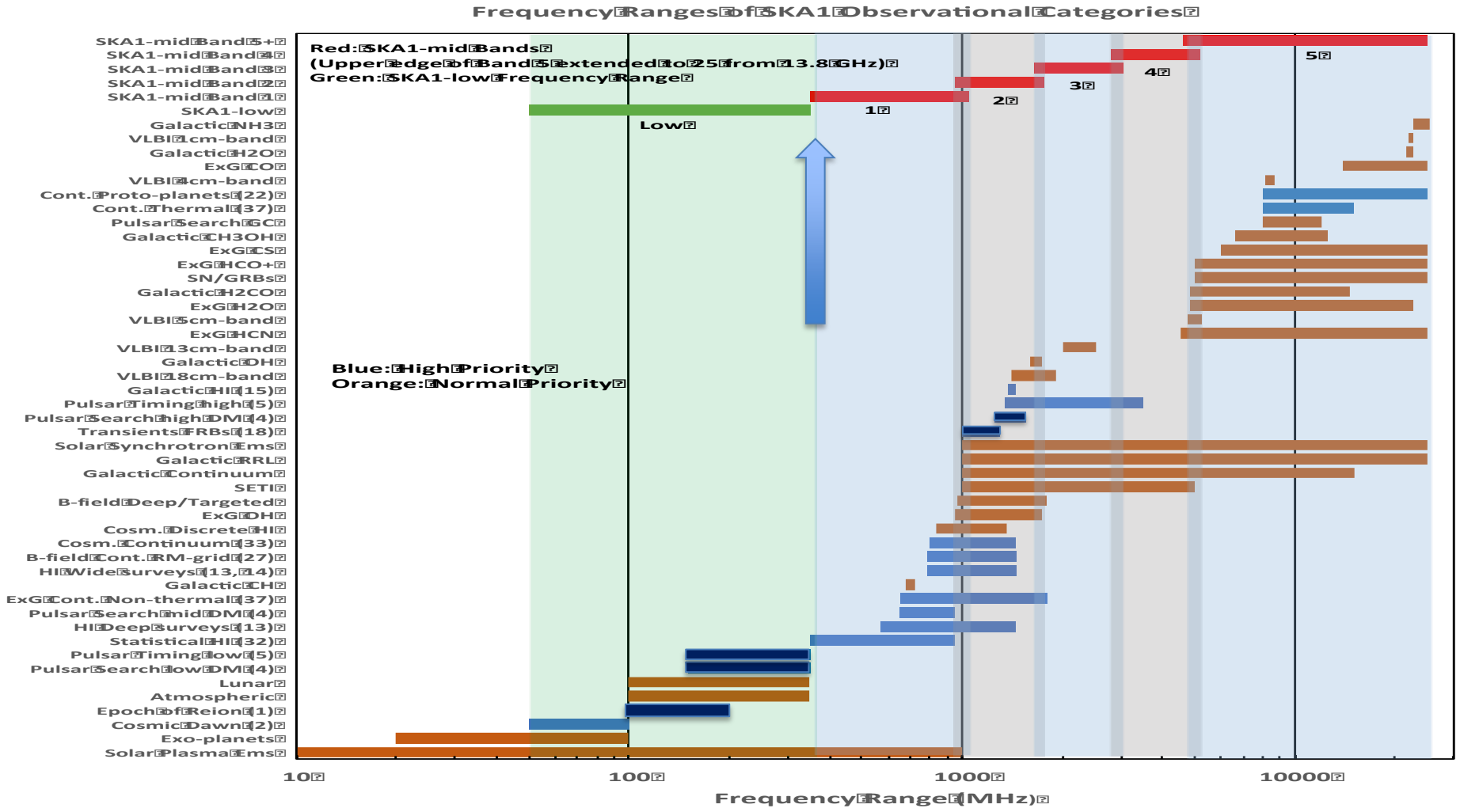
SKA– Key Science Drivers: The history of the Universe



Broadest science range of any facility on or off the Earth.


SKA
SQUARE KILOMETRE ARRAY
#SKAscicon16
skatelescope.org/SKAGeneration
NCRA • TIFR
science for the
SKA GENERATION
7-11 november 2016
Goa, India
Square Kilometre Array
@SKA_telescope
YouTube
The Square Kilometre Array

A Package of Notional SKA1 Key Science Projects



- HPSOs distilled from much broader package of survey ideas and goals

Square Kilometre Array

3 sites; 2 telescopes + HQ
1 Observatory

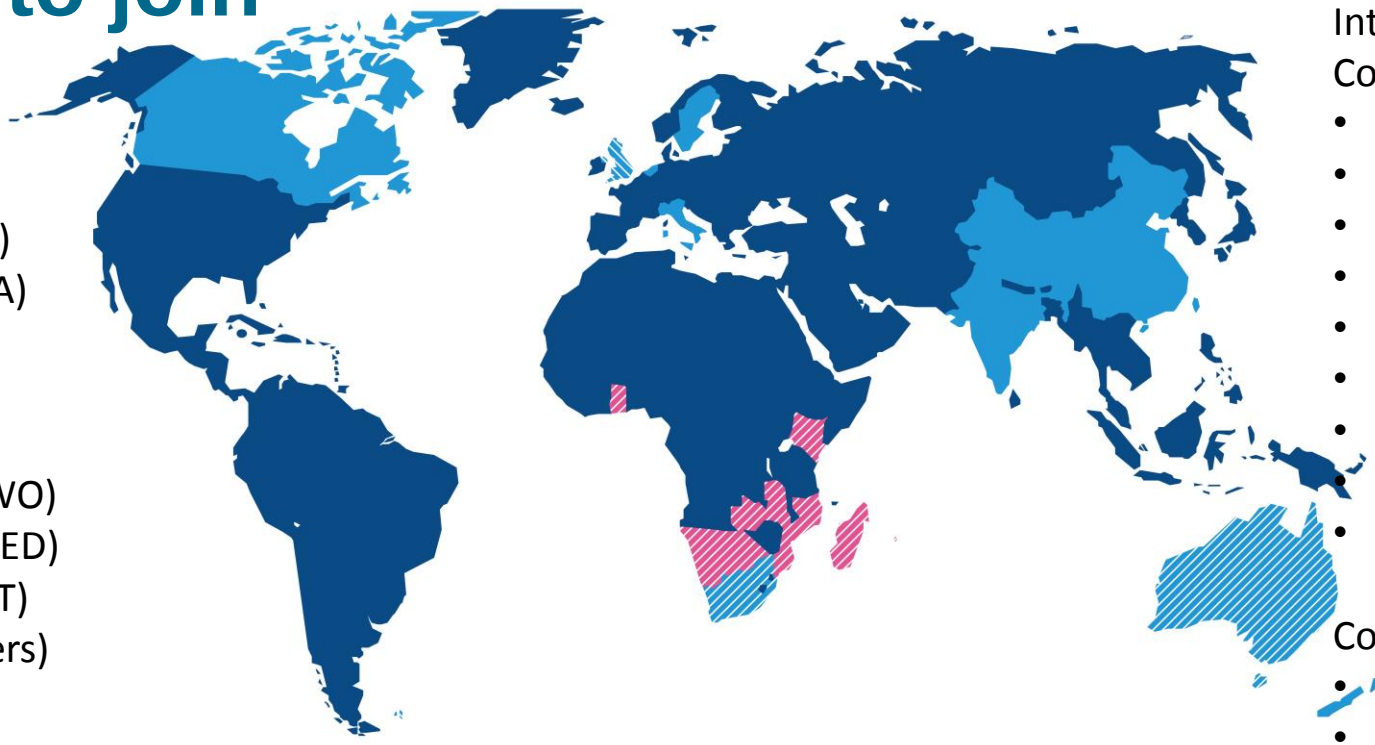
Design Phase: ~€170M; 600 scientists+engineers

Phase 1
Construction: 2018 – 2024
Construction cost: €674M (inflation-adjusted cost cap)
Operations cost: ~€130M/yr

Phase 2
2024 - 2033
Multi-billion Euro project

SKA Organisation: 10 countries, more to join

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)



Interested Countries:

- France
- Germany
- Japan
- Korea
- Malta
- Portugal
- Spain
- Switzerland
- USA

Contacts:

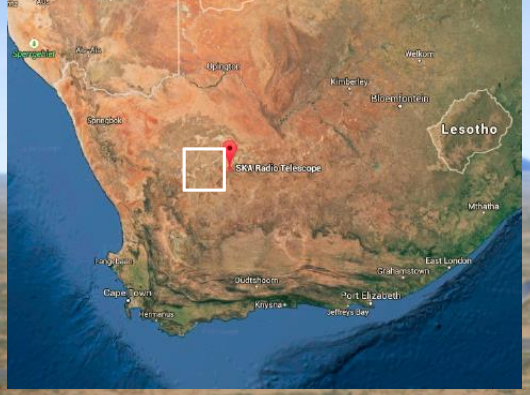
- Brazil
- Ireland
- Russia

SKA1-LOW: Australia

50 – 350 MHz

Phase 1: ~130,000 antennas across 65km

Phase 2: ~ 500,000



Phase 1: 200 15-m dishes across 150 km

Phase 2: ~2,000 dishes across southern Africa

SKA1-MID: Africa

350 MHz – 20 GH

Phase 2:
Mid-frequency
aperture array

Phase 1: 200 15-m dishes across 150 km
Phase 2: ~2,000 dishes across southern Africa

MRO Power – now operational

High-level SKA1 specifications

Parameter	Unit	SKA1-Low	SKA1-Mid
Initial Frequency range	GHz	0.05 – 0.35	0.35-1.8, 4.8-13.8
Fiducial frequency	GHz	0.11	1.67
A_{eff}/T_{sys} (at Fiducial freq.)	m^2/K	550	1500
Field of View (at Fiducial freq.)	deg^2	14	0.33
Best Resolution (at Fiducial freq.)	arcsec	7	0.25

65,536 channels maximum across band
Pulsar processor on each telescope
Dish design capable of observing up to 24 GHz

Relative to state-of-the-art:

- Raw Sensitivity > 5,
- Survey Speed > 10 to 100

Data flow through SKA

SKA-LOW

7.2 Tb/s

~50 PFlops

5 Tb/s

SKA SDP SCIENCE DATA PROCESSOR

~100 PFlops

8.8 Tb/s

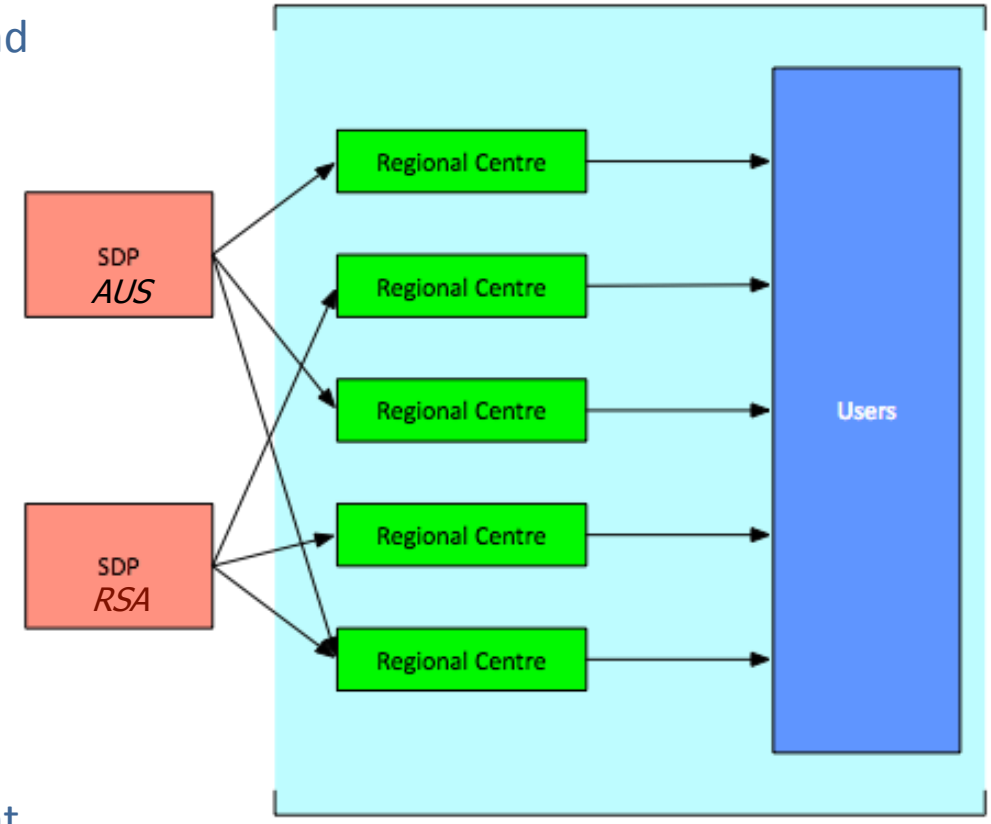
SKA-MID

~130 PB/yr

34 Gb/s

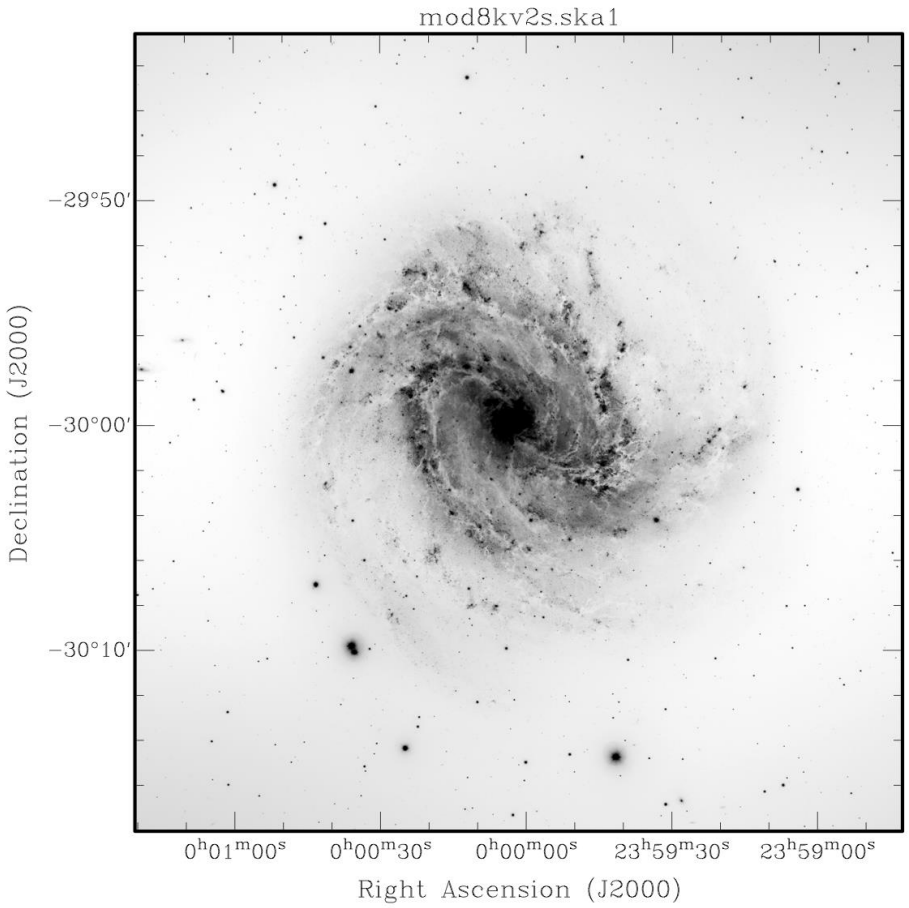
High-level SKA ICT architecture:

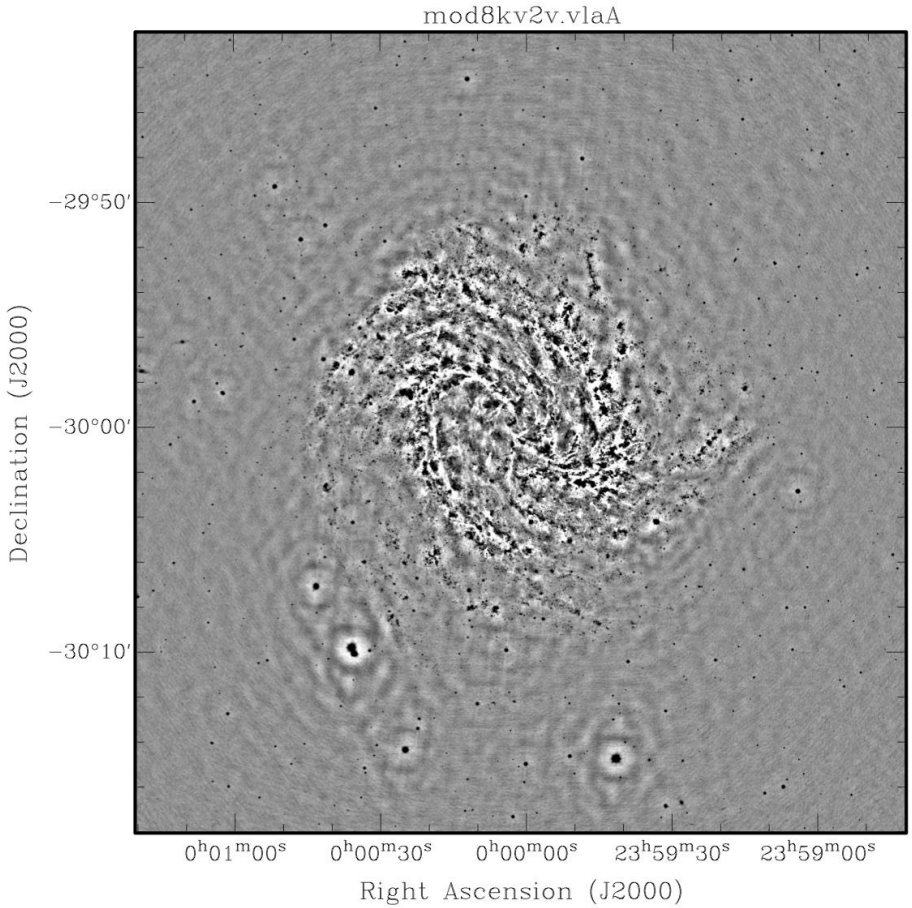
- What is missing from data management plan?
  - capacity for reprocessing data and their analysis
  - storage for a long-term archive
  - local user support
- Board endorsed the concept of SKA Regional Centres (SRCs)
- SKAO has set up SRC Coordination Group to develop
  - requirements
  - guiding principles
  - environment to allow transparent data access & support to users



SKA1 imaging capability

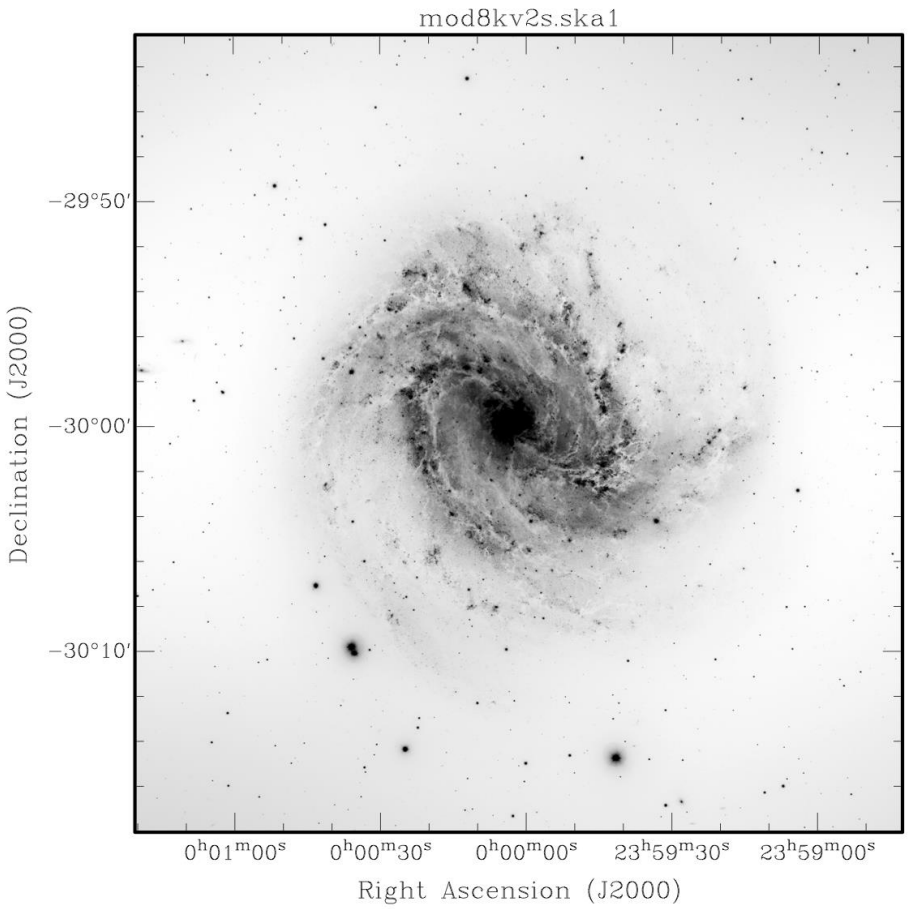
Image Quality Comparison

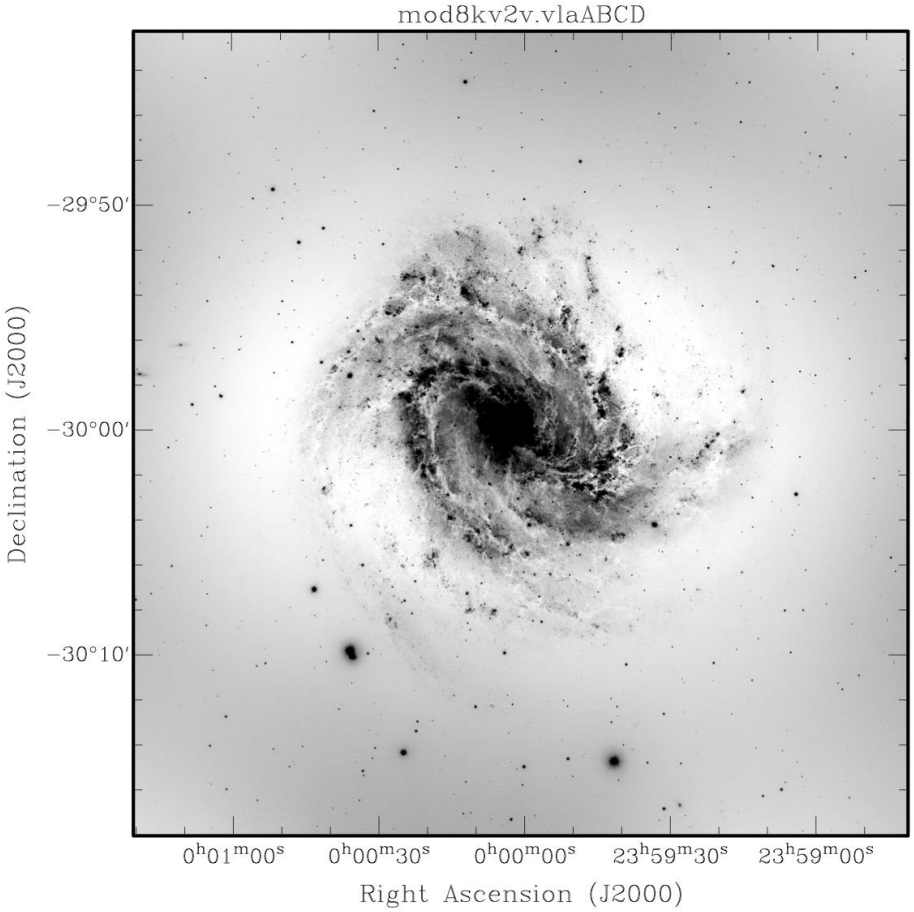




- “Structural” dynamic range of ~1000:1 rather than ~3:1 per VLA track (eg. SKA1-Mid vs. VLA A-config.)

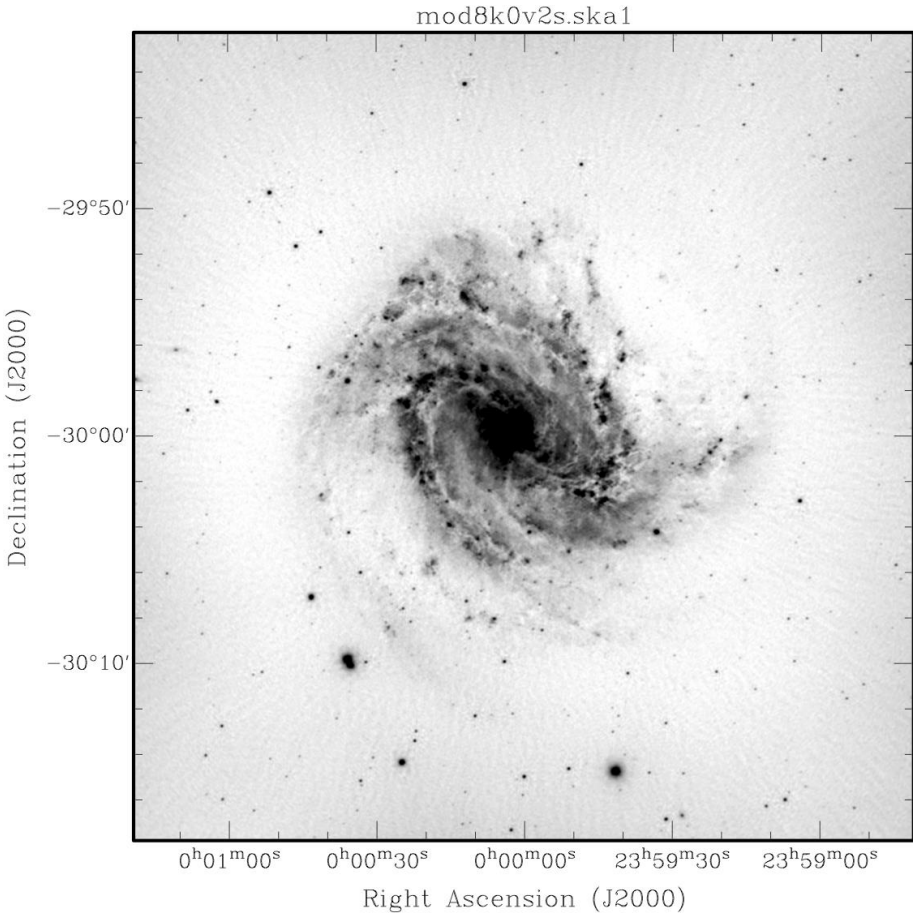
Image Quality Comparison

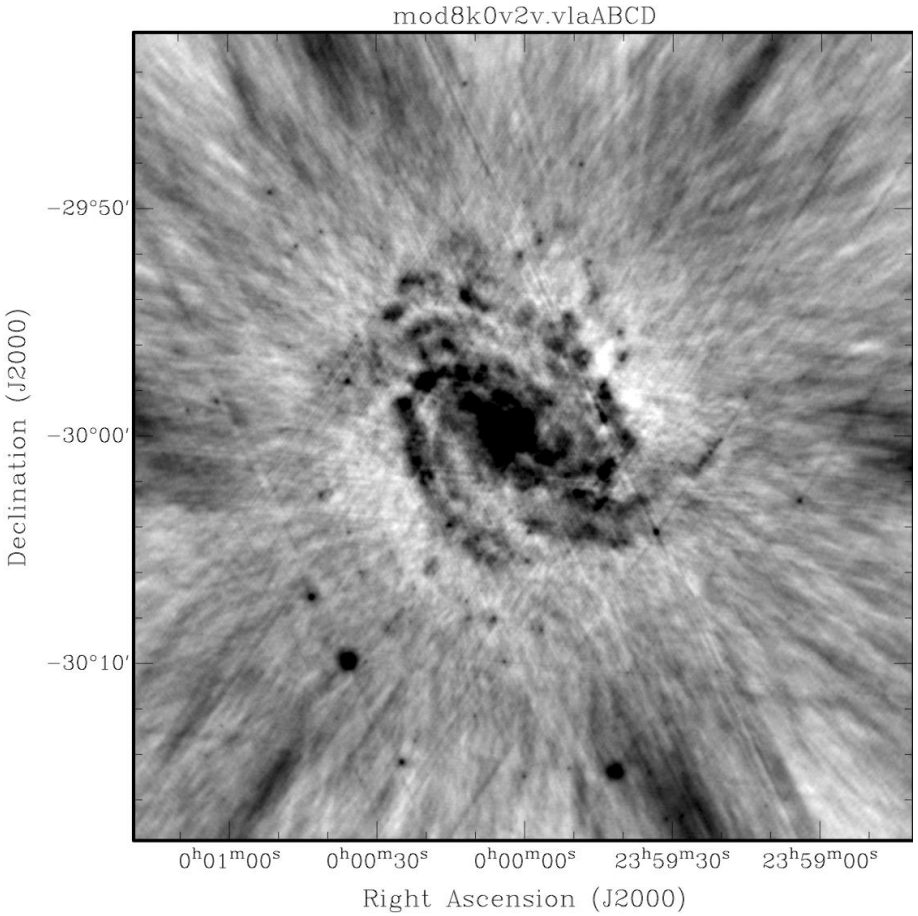




- Single SKA1-Mid track compared to combination of tracks in each of VLA A+B+C+D

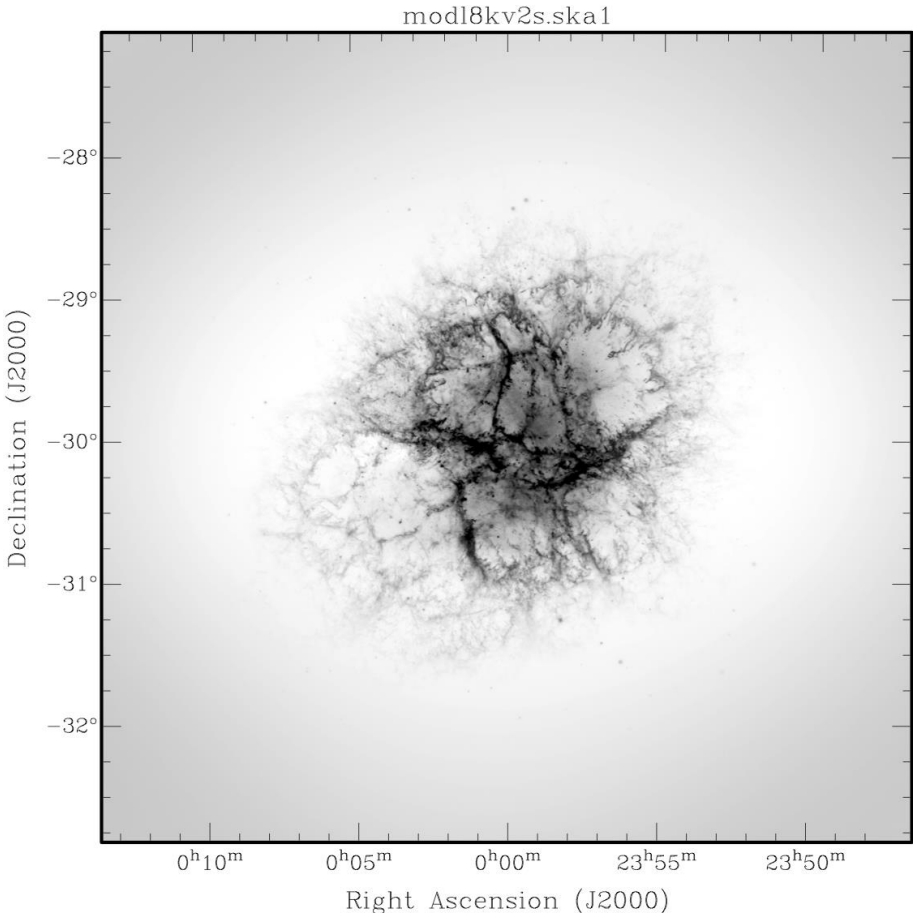
Image Quality Comparison

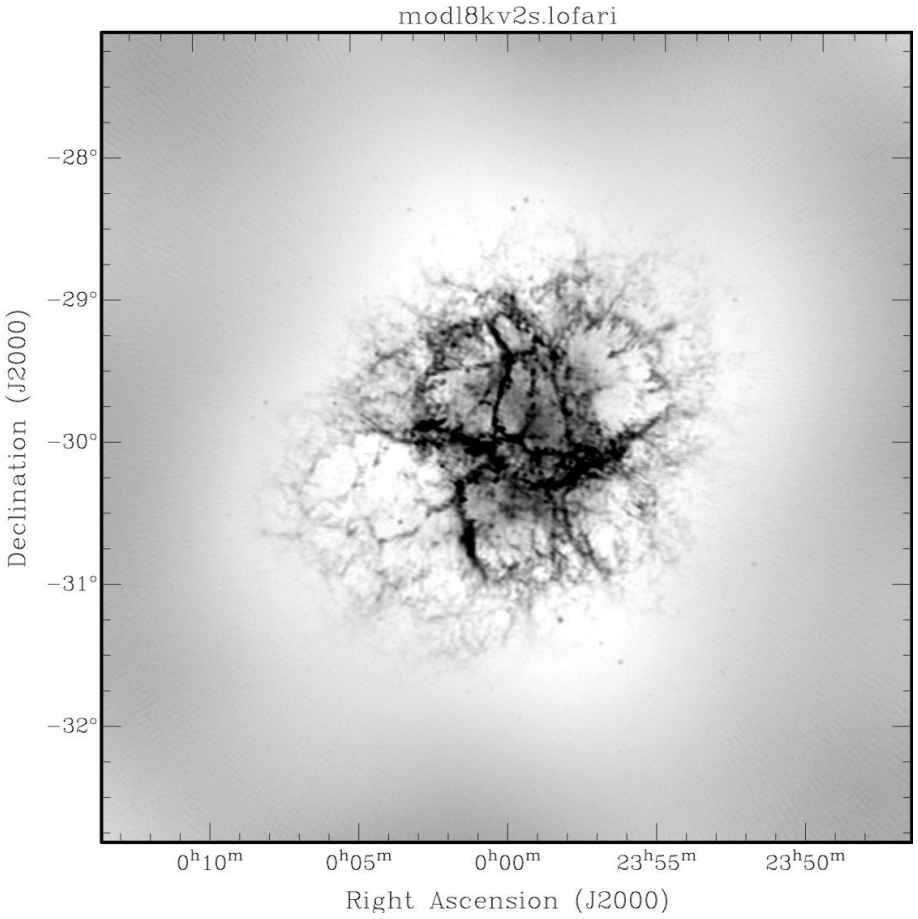




- Single SKA1-Mid snap-shot compared to combination of snap-shots in each of VLA A+B+C+D

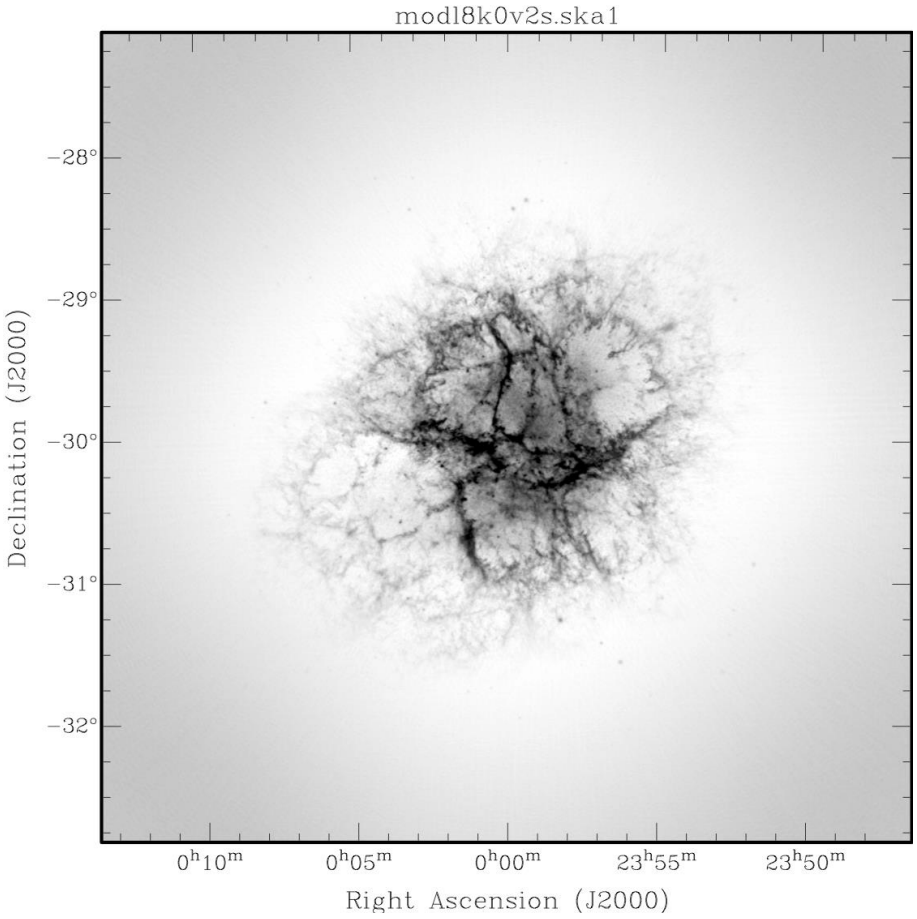
Image Quality Comparison

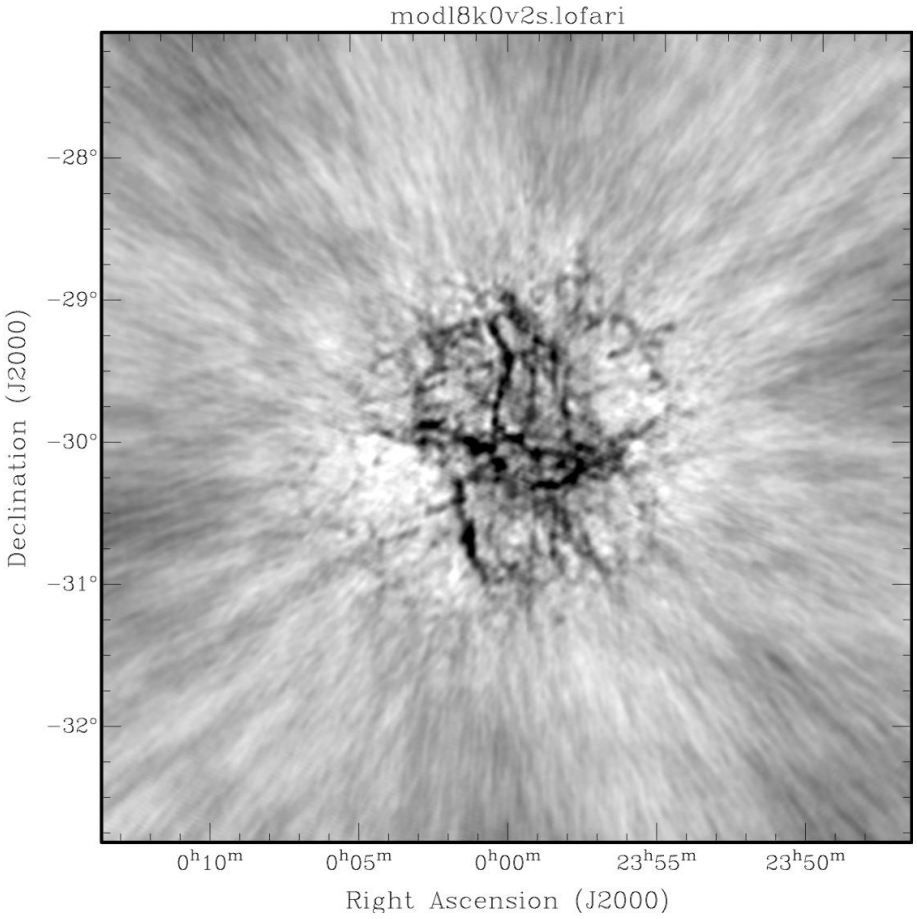




- Single SKA1-Low track compared to LOFAR-INTL

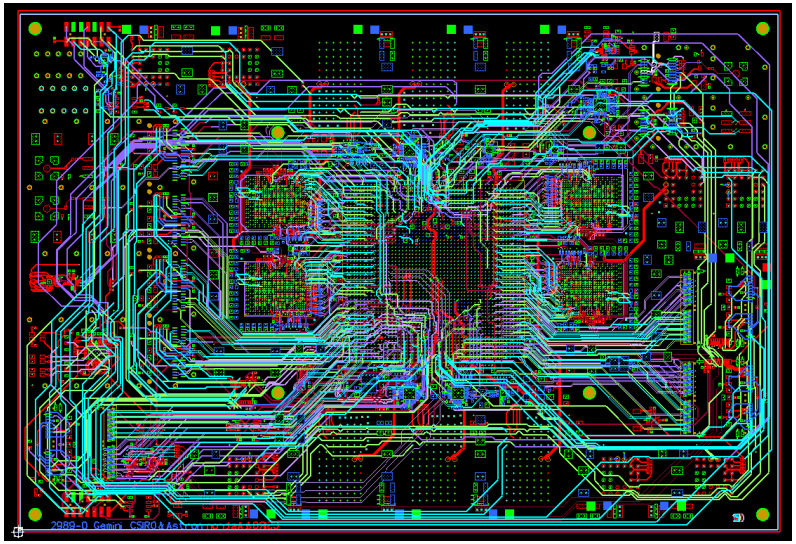
Image Quality Comparison





- Single SKA1-Low snap-shot compared to LOFAR-INTL snap-shot

Prototypes

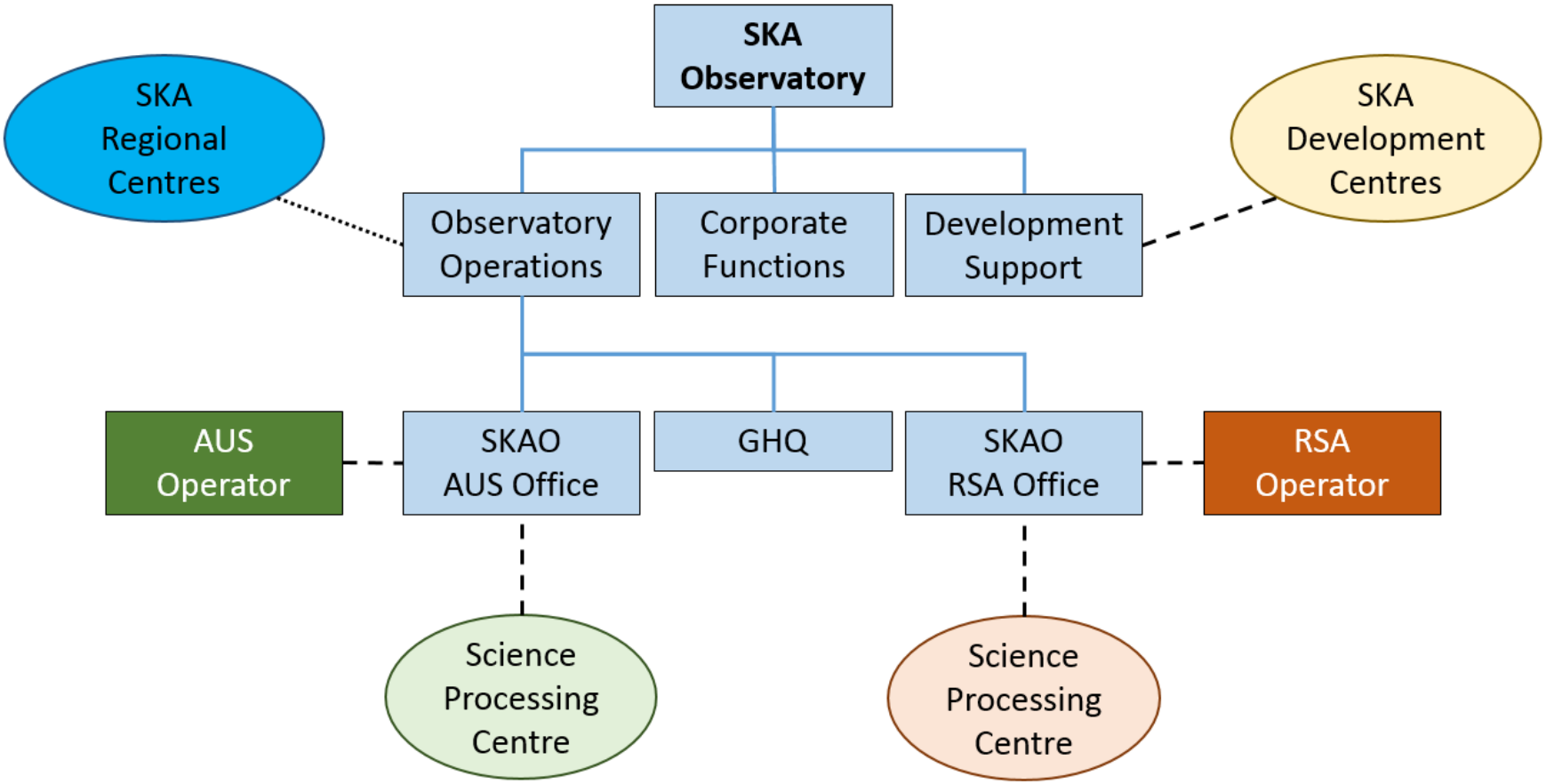


SKA1-Low

Current areas of focus

- Engineering/Operations:
  - Working towards CDRs
  - System-level work
  - Schedule
  - Costs: capex & opex
  - Development of operations model
  - Planning for construction
- Policy:
  - Finalising Convention and protocols text
  - Funding commitments
  - Finalising procurement and IPR policy
  - HQ & Hosting Agreements
  - New members
- Science:
  - Planning of science capability rollout
  - Planning for KSPs
  - Assisting with planning for commissioning and operations.
- Programmatic:
  - Transition planning
  - Resourcing
  - SKAO/consortia budgets for 2017 and beyond
  - SKA Regional Centre planning

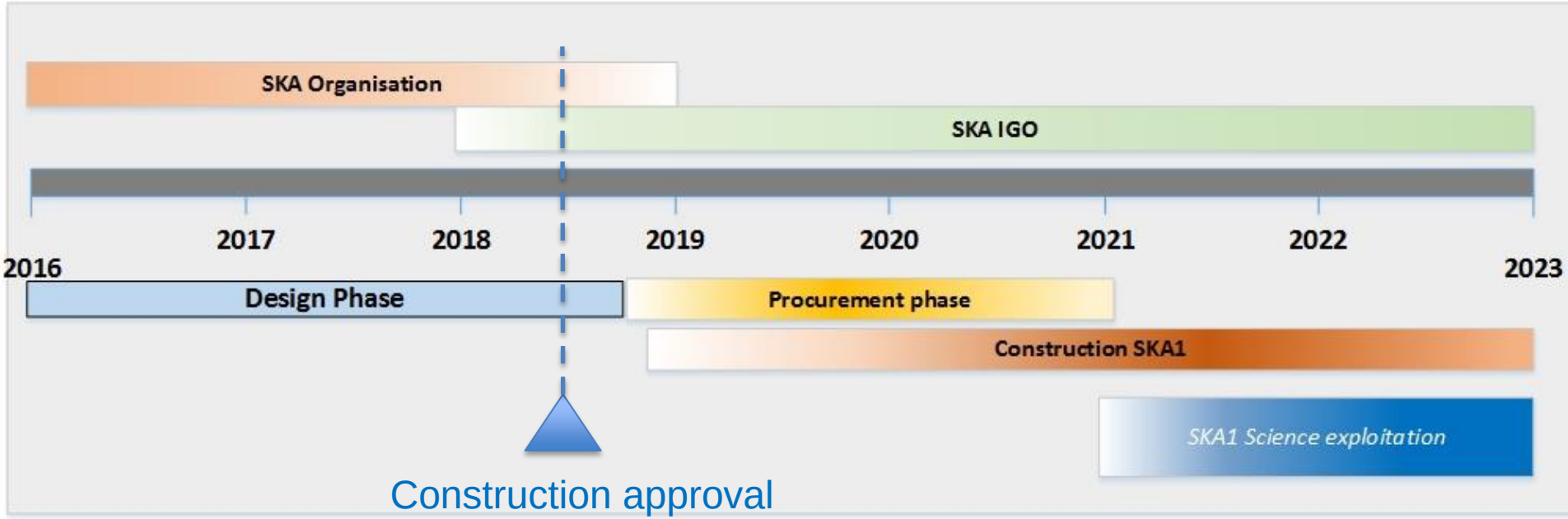
Structure of SKA Observatory



Negotiations underway to establish an Inter-Governmental Organisation.

4th meeting in Rome, Sept 27-29. Intent is to agree convention and protocols, with Ministerial signing event early 2017. Transition planning in progress.

Overall project timeline



Key dates:

- Convention agreed Q4 2016
- CDRs Q4 2017
- IGO in force Q1 2018
- SKA1 Construction approval Q3 2018

National Facilities essential

- SKA can't see the whole sky
- For first *n* years, SKA will run a programme of Key Science Projects (KSPs)
  - Big teams
  - Large allocations of time, possibly 70%
  - Only 30% for PI-driven; highly competetive, c.f. ALMA
  - Serving a worldwide community.

National Facilities essential

- Must avoid the “VLBA problem”
- NFs essential for
  - Maintaining healthy core user community; domain knowledge in early years of SKA
  - Complementary science programmes
    - VLBI
    - Triggered ToO
    - Joint programmes with major satellite programmes, eg Athena, Eulid
  - Develop and test new technologies, techniques → SKA Observatory Development Programme
  - Act as core members of SKA Regional Centres
  - Train next generation students and engineers

Summary I

- Next steps:
  - Serious planning for construction, including staged construction planning.
  - Shift focus to telescopes and system rather than elements
- Project momentum excellent:
  - Preliminary Design Reviews completed
  - Design complete in Q4 2017
  - IGO formal negotiations in progress
- SKA construction is on the horizon.

Summary II

- SKA is next-generation instrument, but can only exist and thrive with strong, vibrant national facilities across the world.
- There may be funding challenges as governments refocus their funding priorities on SKA, but the case must be made to deliver the science and technologies and to ensure the continued existence of a growing base user community.

SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope

www.skatelescope.org