

South(ern) African Astronomy On its Way Toward the SKA



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KAT-7 Commissioning & Science Processing Teams @ SKA SA Project Office

SKA Italy 2012, Roma, 19 June 2012

DST's 2008-2018 10-year plan



- By 2018 South Africa anticipates that it will
- ... have become the preferred destination for **major astronomy projects** and associated international investment in construction and operations
- ... have constructed a **powerful radio-astronomy telescope** and used it for world-class projects

SAAO : South African Astronomical Observatory

Total staff: 120

Scientists:

Physics

Astronomy

Mathematics

Engineers/Technicians:

Electronics

Mechanical

Optical

Computing

Science Educators



History : dates from 1820 (as Royal Observatory at the Cape of Good Hope)

HQ : Cape Town, Western Cape

Observing Facilities : Sutherland, Northern Cape



SAAO Optical Facilities



Sutherland

Good dark
astronomical site:

~75% nights useable

Altitude: 1800 m

SAAO Optical Facilities

Carnarvon KAT-7/MeerKAT/SKA-SA Site

Sutherland

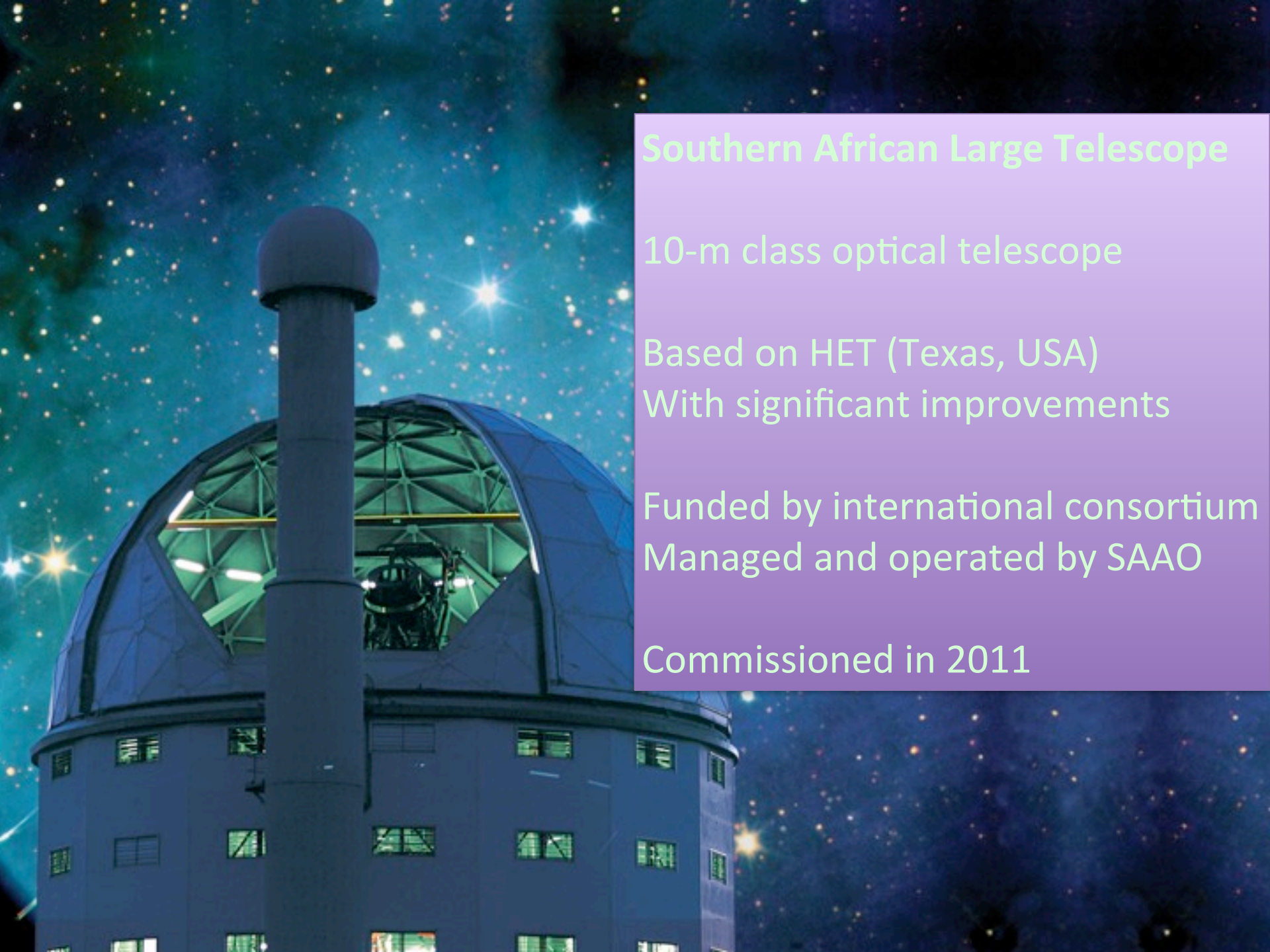
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Southern African Large Telescope

10-m class optical telescope

Based on HET (Texas, USA)

With significant improvements

Funded by international consortium

Managed and operated by SAAO

Commissioned in 2011

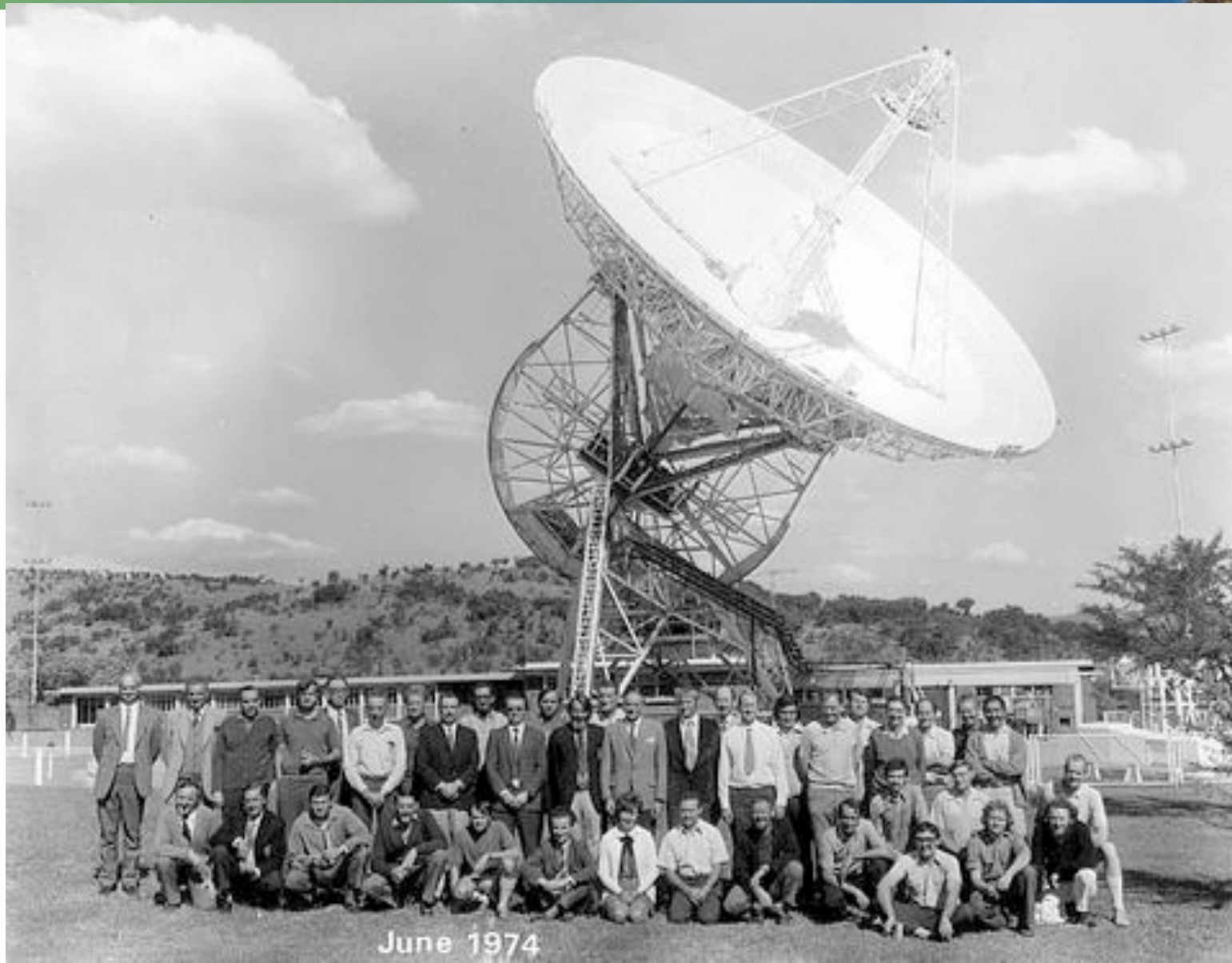
Radio Astronomy in Africa



Extract from the South African proposal to host the SKA:

- “Radio astronomy in South Africa originated at Rhodes University in the 1960’s, with the development of small instruments to study **Solar and Jovian radio emissions**,
- and in parallel at the (then) National Institute for Telecommunications Research, using the **26 m NASA Deep Space Station** antenna at Hartebeesthoek”

NASA/DSN => HartRAO (1974)



June 1974

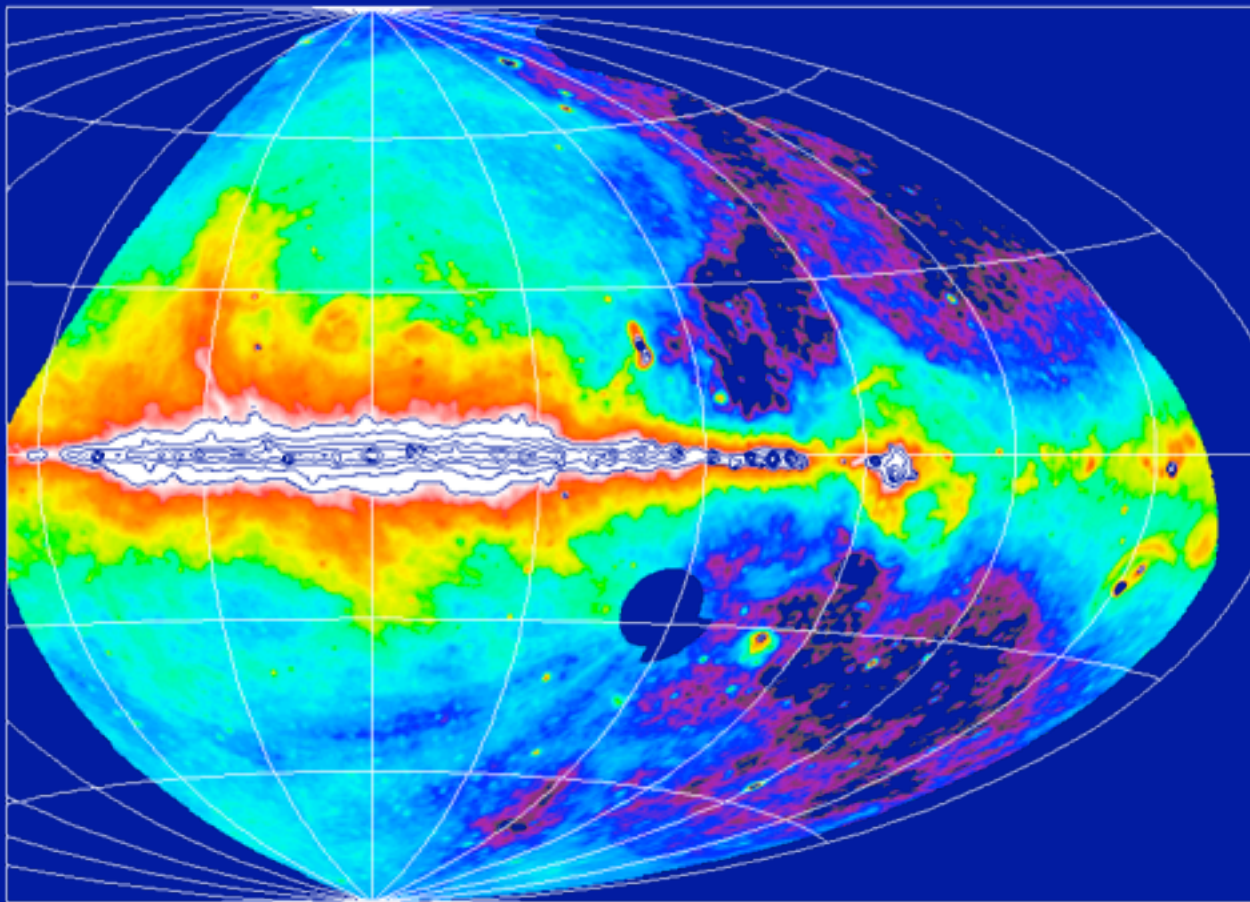
HartRAO Niche Science



HartRAO Niche Science



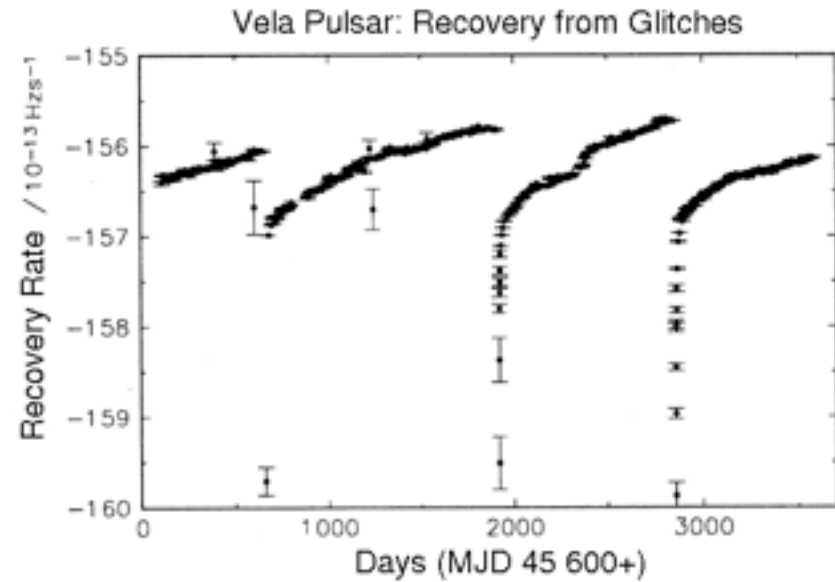
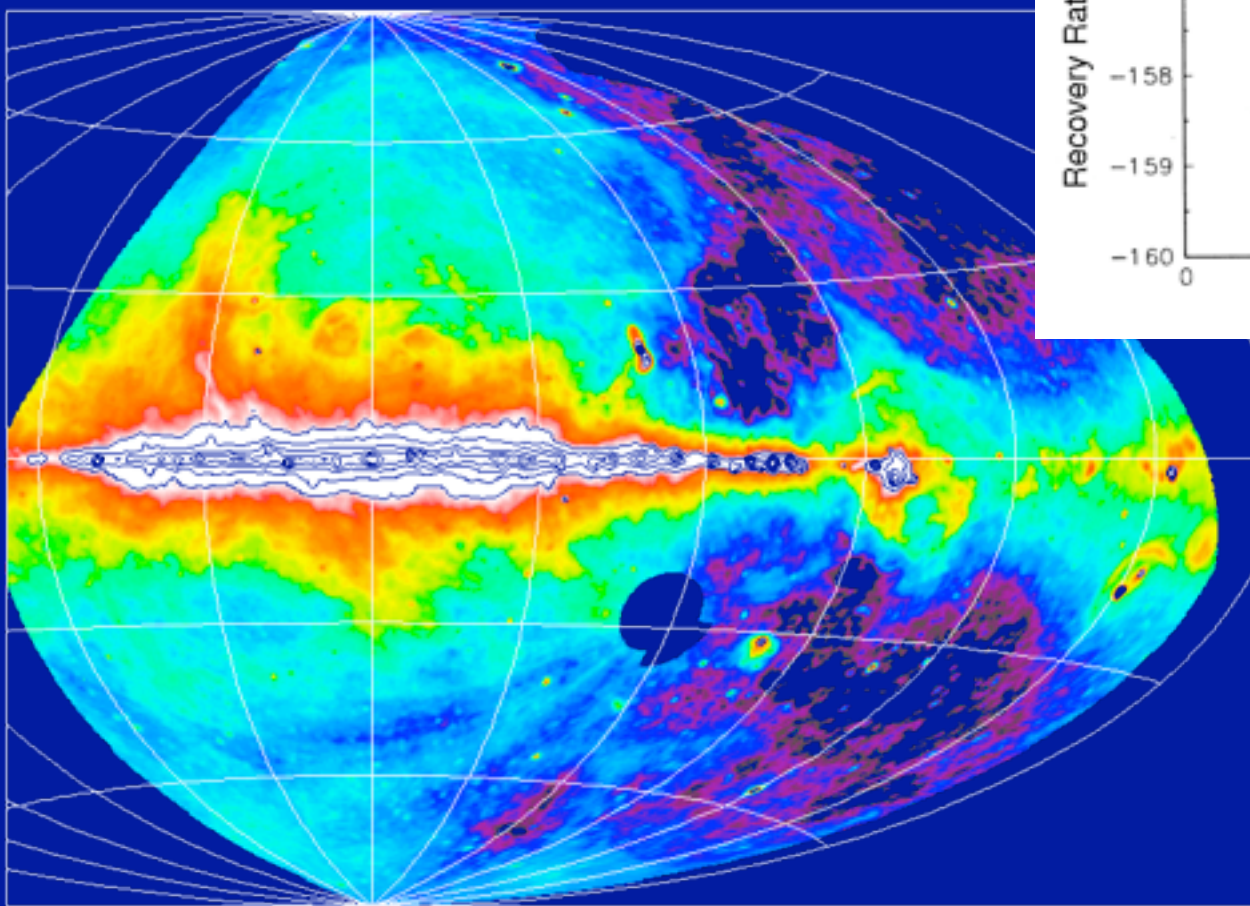
Rhodes/HartRAO 2326 MHz survey



HartRAO Niche Science



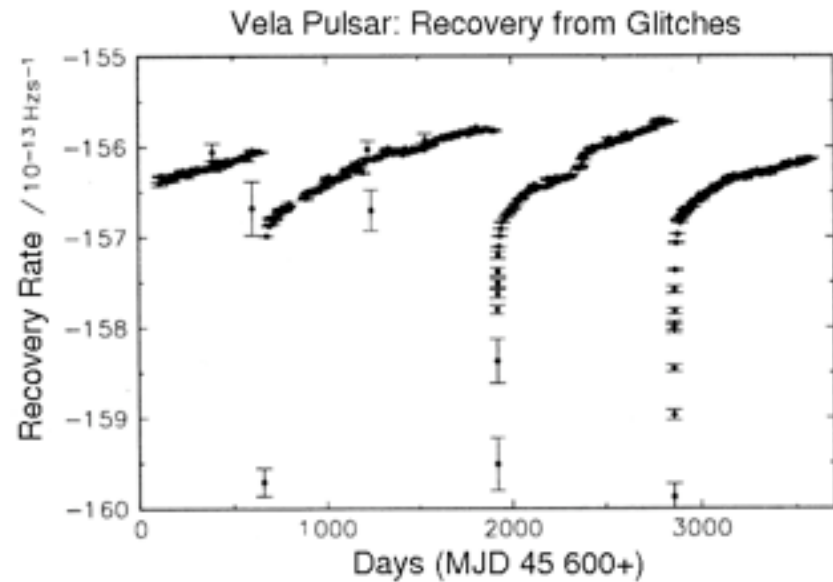
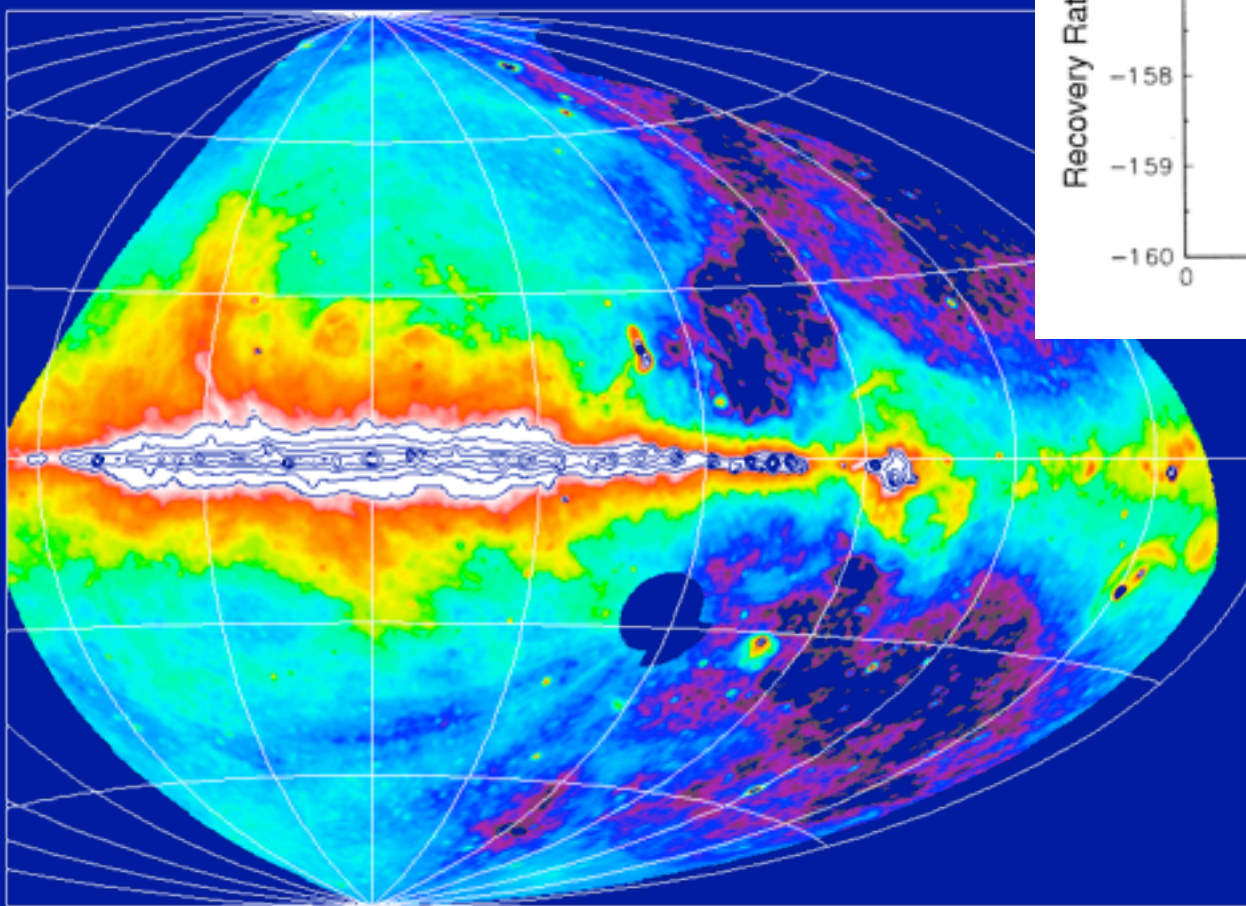
Rhodes/HartRAO 2326 MHz sur



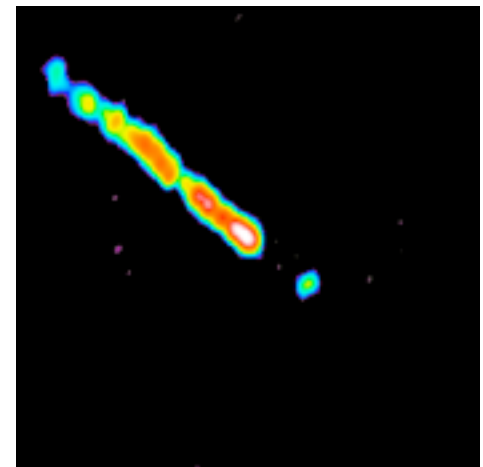
HartRAO Niche Science



Rhodes/HartRAO 2326 MHz sur



VLBI



The SKA in Africa



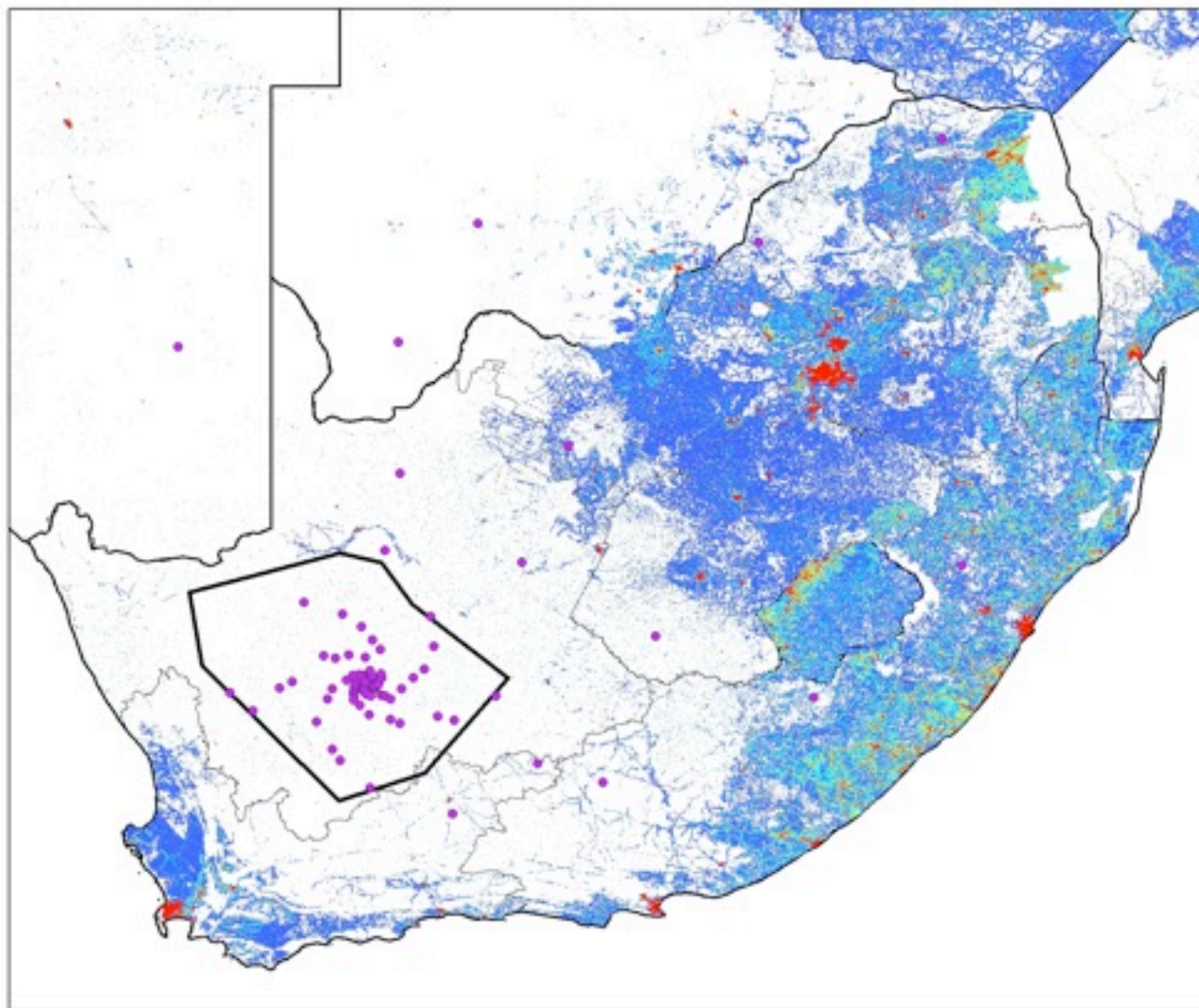
African Partner Working Group



SKA Sci. & Eng. Committee



Radio Frequency Interference



Legend

- SKA_Configuration_SPDO_Dish_Full
- AA1_SPDO_Version1
- AA2_SPDO_Version2
- KCAA1

Population (per sq km)

Value

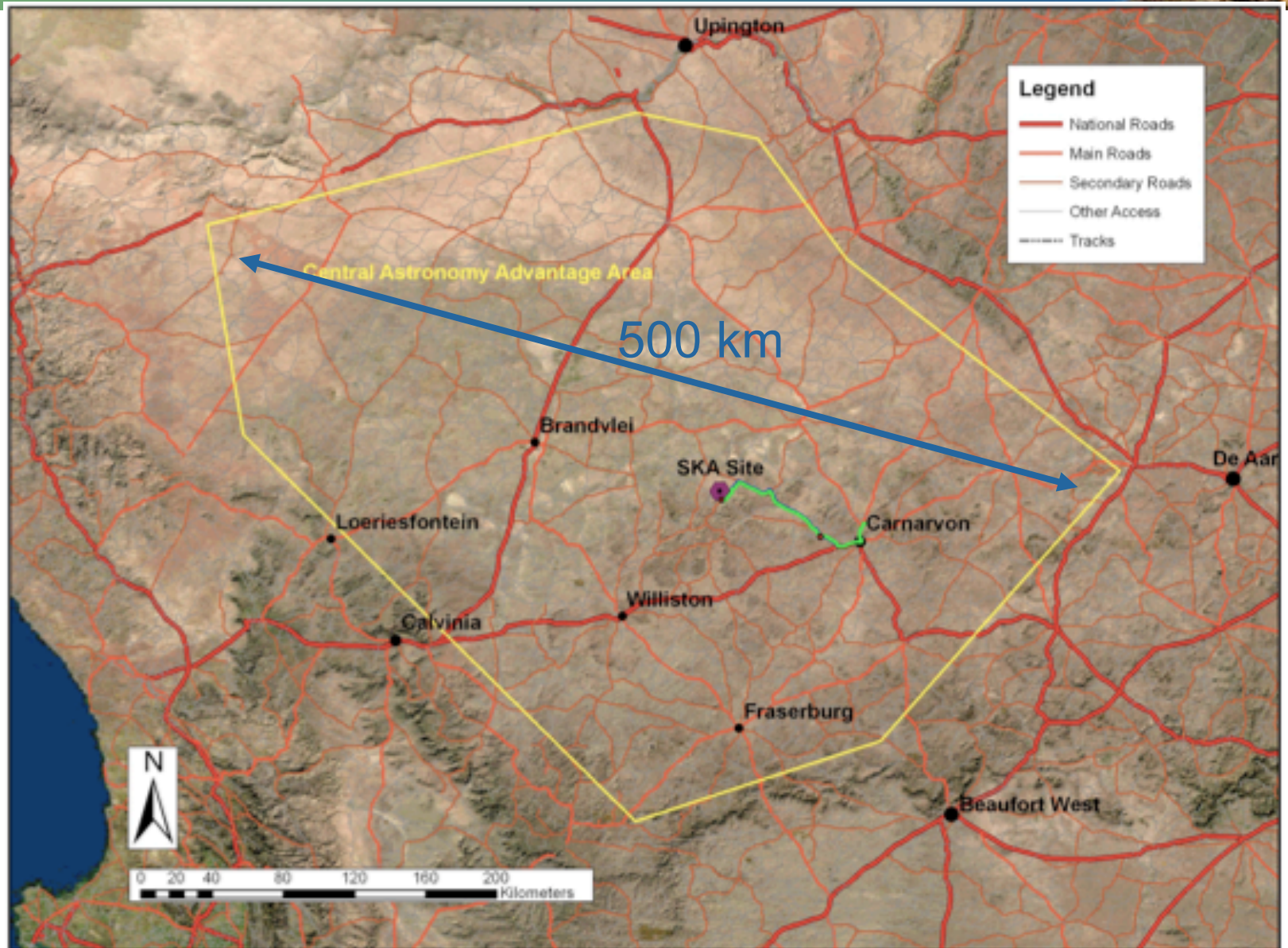
- 0 - 4
- 4.00000001 - 14
- 14.00000001 - 29
- 29.00000001 - 47
- 47.00000001 - 68
- 68.00000001 - 91
- 91.00000001 - 116
- 116.00000001 - 142
- 142.00000001 - 169
- 169.00000001 - 197
- 197.00000001 - 225
- 225.00000001 - 255



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0 145 290 580 870 1,160 Kilometers

Karoo Radio Astronomy Reserve



Astronomy Geographic Advantage Act



- <http://www.polity.org.za>
- Close cooperation with communities, ICASA, and broadcast and telco operators during drafting of the Act and formulation of the regulations.

SKA Site Proposal



- 150 page main document with 10 sections:
 - Basic Infrastructure
 - Electric Power
 - Data Transport
 - Physical Characteristics
 - Radio Frequency Interference
 - Political, Socio-economic & Financial
 - Customs & Excise
 - Legal
 - Security
 - Working & Support Environment
- Plus over 500 annexures totaling 2 GB

The MeerKAT Programme



- Africa must have a legacy of a large radio telescope
 - Irrespective of the outcome of the SKA site competition
 - But not independent of the SKA
 - Must have international buy-in (e.g into LOFAR & ASKAP)
- MeerKAT is an SKA “precursor”
 - Engineering prototype
 - Early science (SKA “Phase 0”)
 - Largest radio telescope in southern hemisphere, one of largest in the world
 - Phased development: XDM, KAT-7, MeerKAT
- Engage local academia and industry
- Liaise with Key International Science & Engineering Partners

XDM 15-m

- First MeerKAT prototype antenna (@HartRAO)
- Composite structure
- Being fitted with S/X-band receiver for geodetic VLBI



KAT-7



- Array of 7 antennas in the MeerKAT/SKA-SA Karoo Site
- Component and system level prototyping
- Build experience in science and engineering teams
- Establish infrastructure in the Karoo
- Engage with local industry
- Produce publishable science
- “Build it and they will come”
 - Steve Rawlings, quote from *Field of Dreams*



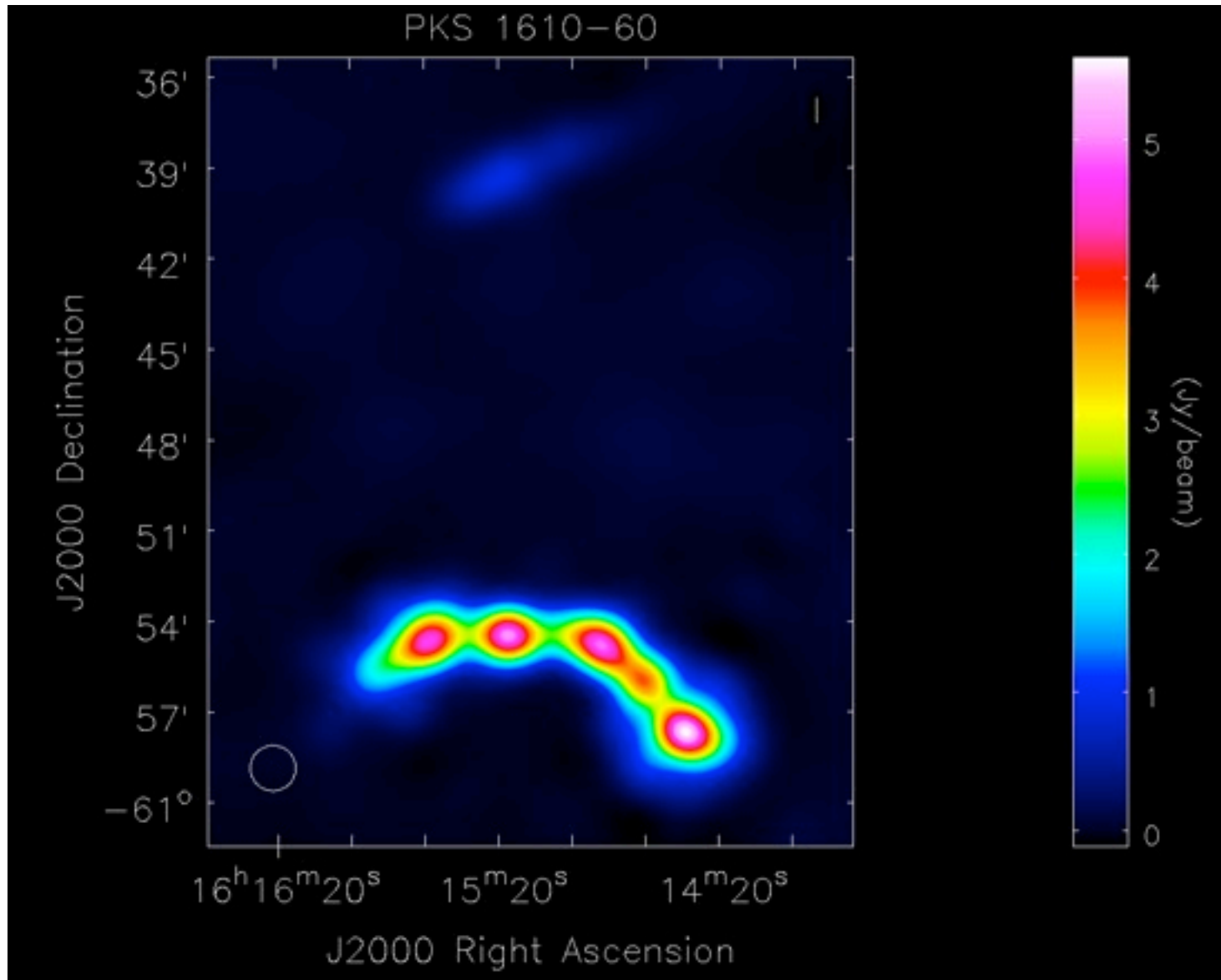
KAT-7 deployment



KAT-7



Radio galaxy observed with KAT-7



Cape Town KAT-7 Control Room



MeerKAT Specification



- The most sensitive cm telescope in the southern hemisphere (world)
- 64 x 13.5-m gregorian offset antennas
- 580 MHz – 15 GHz
- Imaging and non-imaging modes
- High filling factor < 1 km
- Baselines out to 20 km (plus VLBI)
- Status: Upgrading Karoo Site Infrastructure
- To be revised in the light of SKA split site?

Virtual MeerKAT



MeerKAT Large Survey Proposals



- ~70% of observing time
- Highest priority:
 - Deep HI field (LADUMA)
 - Radio Pulsar Timing
- Compelling:
 - HI and continuum mapping of 30 nearby galaxies
 - Absorption line survey
 - Molecules in the EoR
- LOFAR/ASKAP Synergy
- ~30% left for GO & ToO
 - Fast Transients & Pulsars
 - HI survey of Fornax
 - X-band Galactic plane survey
 - Tiered Continuum Survey (MIGHTEE)
 - Slow transients
- Also:
 - VLBI
- Building a SA Community

HCD Programme Components



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- Research Chairs



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- Visiting / Joint Professorships



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A focused and structured programme with a 'pipeline' strategy

Institutional Links

ASTRON

Φxford
Physics

Max-Planck-Institut
für Radioastronomie



UNIVERSITY OF
Southampton



JPL
Jet Propulsion Laboratory
California Institute of Technology



National Radio Astronomy Observatory
A facility of the National Science Foundation



NCRA • TIFR

PAPER (Precision Array to Probe Epoch of Reionization)



Galford Meadow
NRAO:Greenbank



National Radio Astronomy Observatory
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PAPER (Precision Array to Probe Epoch of Reionization)



Karoo



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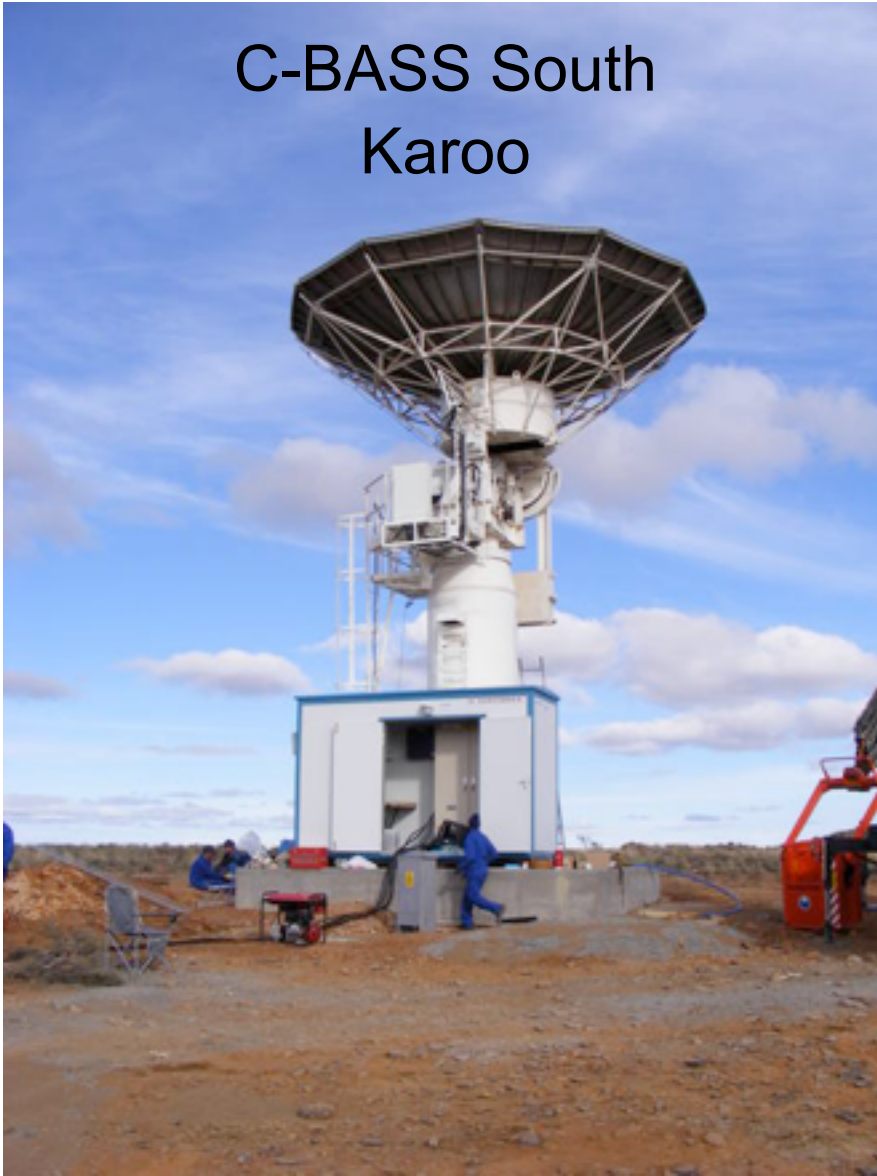
National Radio Astronomy Observatory
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C-BASS



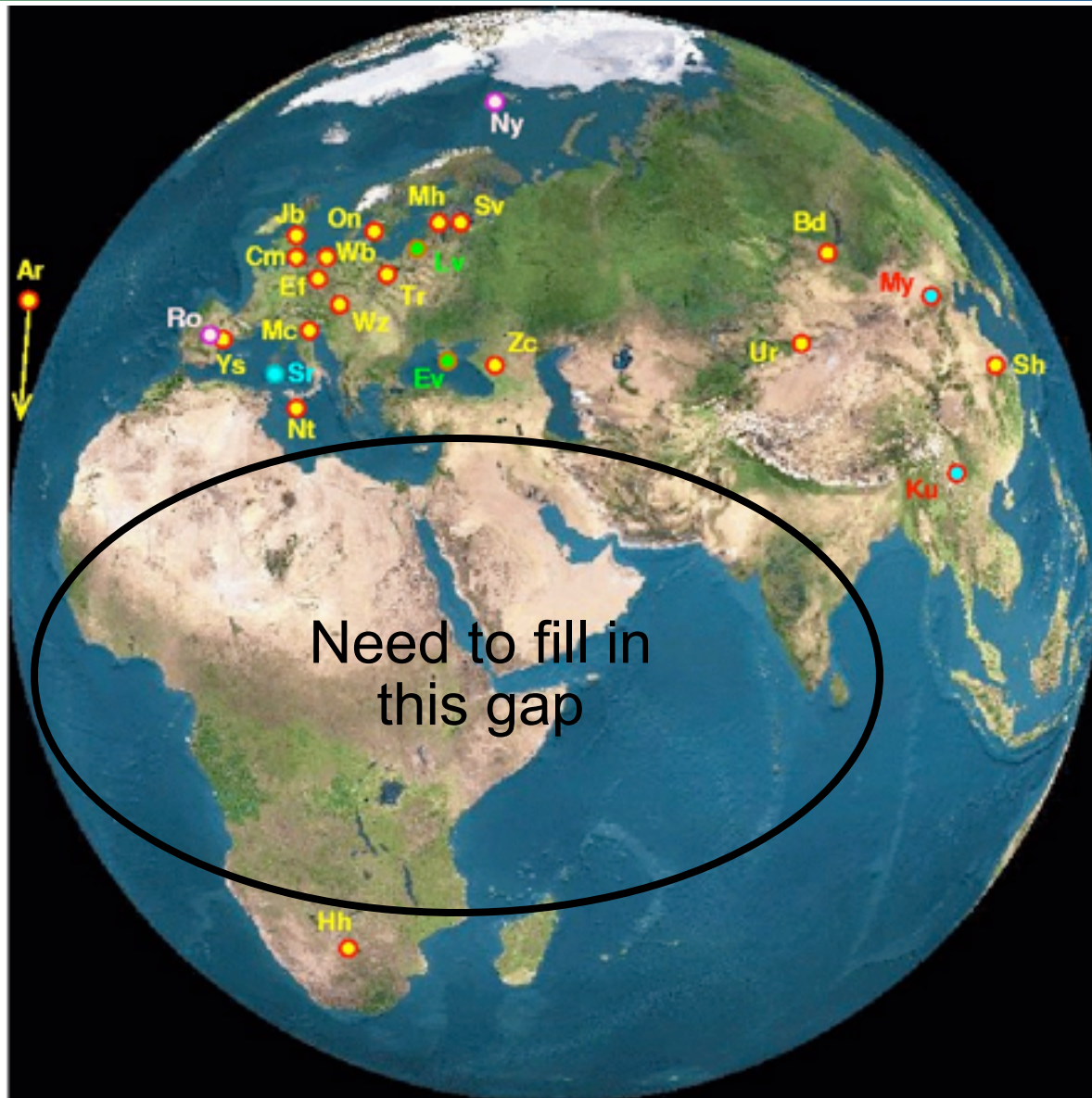
C-BASS South
Karoo



C-BASS North
OVRO



Mind the Gap : African VLBI Network



30-m class antennas in Africa

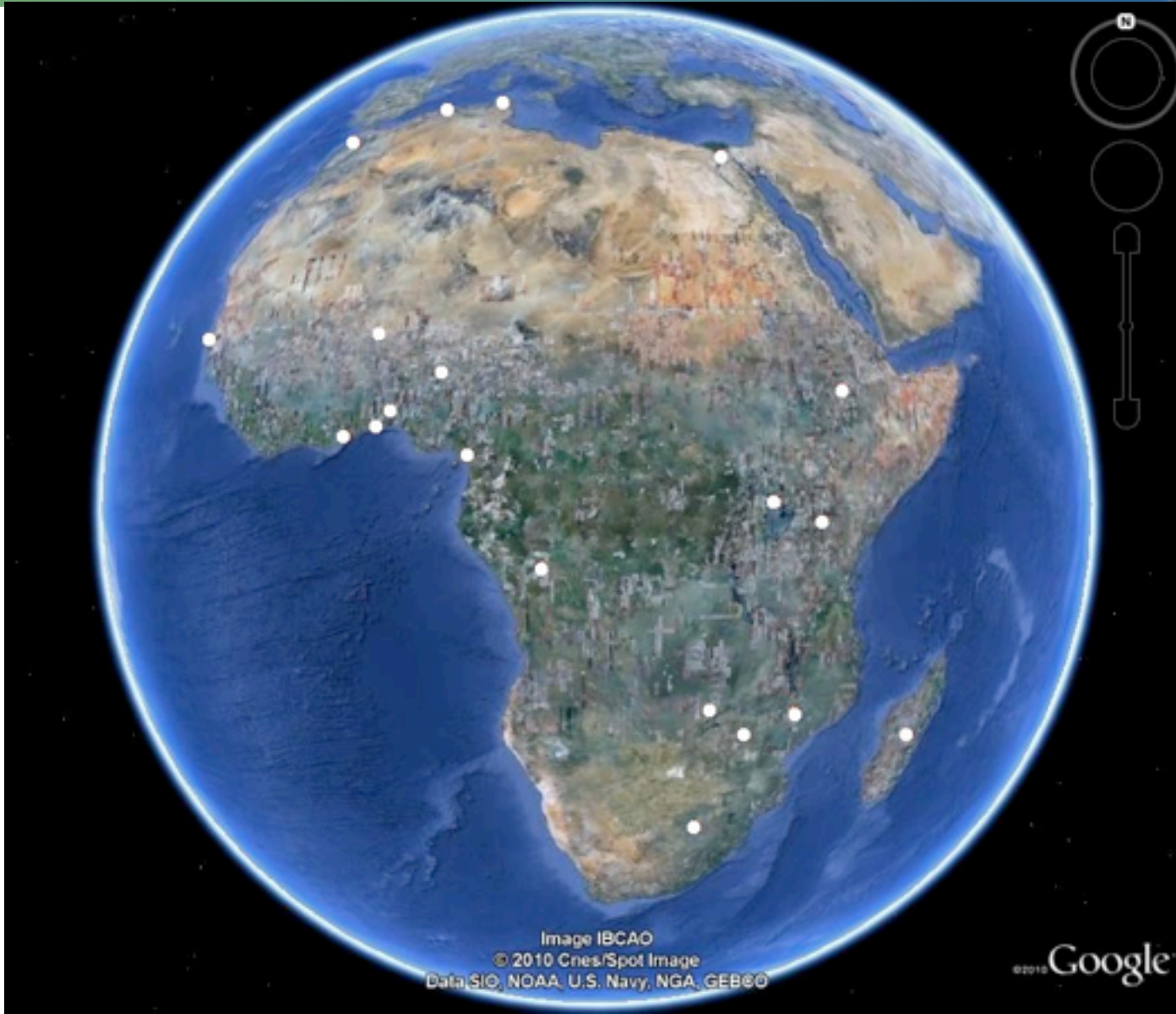


Image IBCAO
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Data SIO, NOAA, U.S. Navy, NGA, GEB©

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Summary



- In ~10 years South Africa and its partner countries have:
 - developed a viable **long-term strategy** to maximize the return-on-investment for **(radio) astronomy R&D**
 - built and now operate **big-science astronomical facilities**
 - created an environment to **attract & develop talent**
 - forged strong links with **international partners**
 - produced a ~~competitive~~ **successful bid to host the SKA**

Here's to the long road ahead...



“We have always said we are ready to host the SKA and the world has listened to us”, 25 May 2012

Ms Naledi Pandor, SA Minister for Science & Technology, SKA Site Decision Press Conference