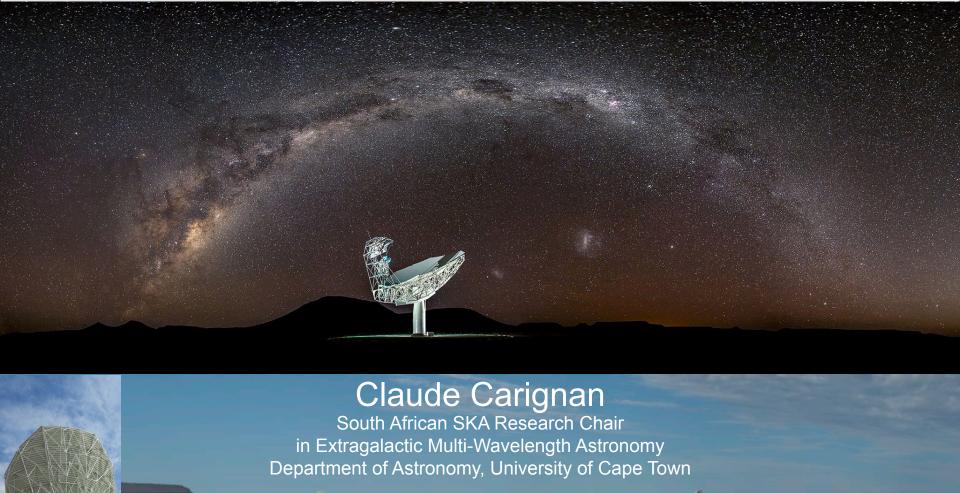
Status update on MeerKAT







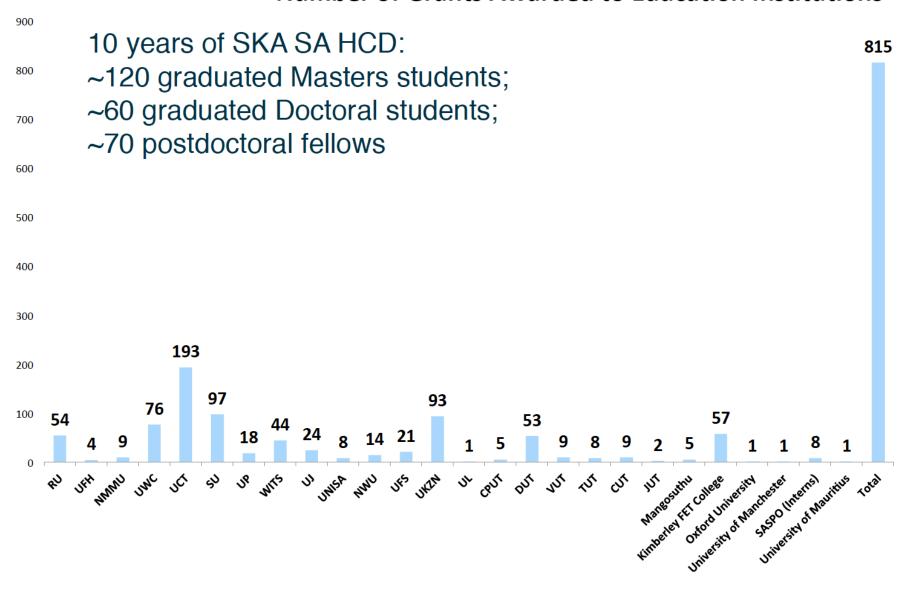
- Phase 1: construction of the pathfinder KAT-7 (7 x 12m antennae) completed in December 2010 & in full operation until end 2015 7 HI scientific publications (more to come: see p.e. Brenda Namumba's talk) + 1 technical paper + X in other fields
- Phase 2: construction of the SKA precursor MeerKAT (mb ~8 km) (64 x 13.5m antennae), fully funded (RSA), 64 antennas completed ~March 2018 & survey ready ~mid-2018
- Phase 3: merged with SKA₁-mid (64 + 136 = 200 antennae max baseline ~150 km ~1/2 FAST collecting area) **2018-23**
- Phase 4: SKA₂ (~2500 ?, SF or PAFs ? antennae) (phases 1 & 2)
 2023-2030

HI science with KAT-7 Baselines from 26 to 185 m

KAT-7 HI Science Verification Projects Completed

- NGC 3109 (C. Carignan, B. Frank, K. Hess, D. Lucero, T. Randriamampandry, S. Goedhart, S. Passmoor 2013, AJ, 146, 48)
- NGC 253 (D. Lucero, C. Carignan, E. C. Elson, T. Randriamampandry, T. H. Jarrett, T. A. Oosterloo, G. H. Heald 2015, MNRAS, 450, 3935)
- Antlia Cluster (K. M. Hess, T. H. Jarrett, C. Carignan, S. Passmoor, S. Goedhart 2015, MNRAS, 452, 1617)
- Pisces A & B (C. Carignan, Y. Libert, D. Lucero, T. Randriamampandry, T. H. Jarrett, T. A. Oosterloo, Tollerud, E. J. 2016, A&A, 587, L3)
- ➤ M 83 (G. Heald, E. de Blok, D. Lucero, N., C. Carignan, T. Jarrett, E. Elson, N. Oozeer, T. Randriamampandry, L. van Zee 2016, MNRAS, 462, 1238)
- Virgo Cluster HI (A. Sorgho, K. Hess, C. Carignan, T. A. Oosterloo 2017, MNRAS, 464, 530)
- ➤ **HCG44** (K. Hess, M.E. Cluver, S. Yahya, L. Leisman, P. Serra, D. Lucero, S. Passmoor, C. Carignan 2017, MNRAS, 464, 957)
- ➤ Engineering and Science Highlights of the KAT-7 Radio Telescope (Foley, A. R. et al 2016, MNRAS, 460, 1664)

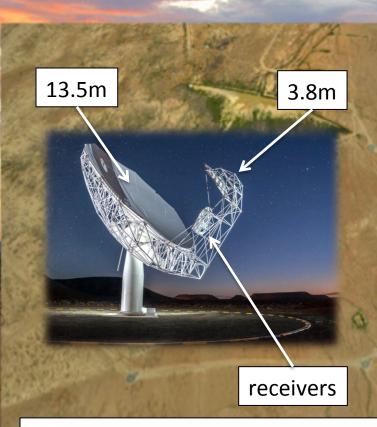
Number of Grants Awarded to Education Institutions



- Phase 1: construction of the pathfinder KAT-7 (7 x 12m antennae) completed in December 2010 & in operation until end 2015
 7 HI scientific publications + 1 technical paper
- Phase 2: construction of the SKA precursor MeerKAT (mb ~8 km) (64 x 13.5m antennae), fully funded (RSA), 64 antennas completed ~March 2018 & survey ready ~mid-2018
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 2023-2030

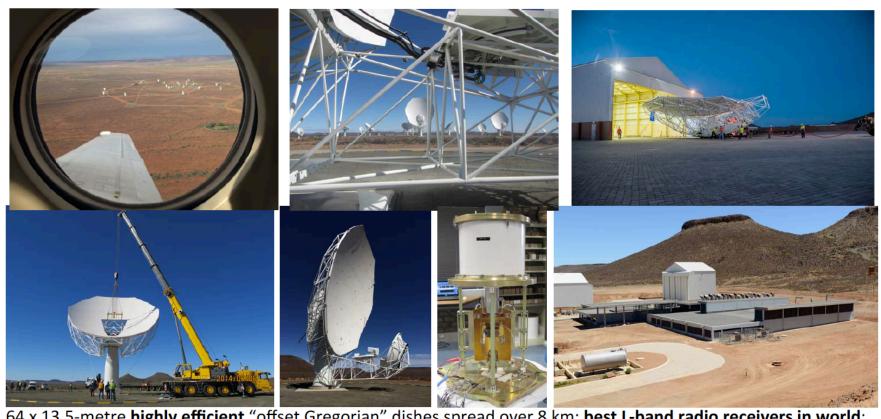
The SKA precursor MeerKAT



- 64 antennae
- 48 antennae in the core (< 1 km)
- Maximum baseline 8 km



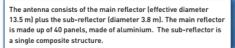
MeerKAT in the Karoo: SKA precursor under construction



64 x 13.5-metre **highly efficient** "offset Gregorian" dishes spread over 8 km; **best L-band radio receivers in world**; unique digital processing, and radio frequency interference mitigation features

MeerKAT ANTENNA

TOTAL HEIGHT: 19.5 m; TOTAL STRUCTURE WEIGHT: 42 TONS



Lightning conductors around the reflectors protect the structure during lightning strikes.

> Steel support framework

connecting

back-up

structure.

The L-Band receiver and the UHF-Band receiver are mounted on the receiver indexer. The indexer can accommodate up to four receivers.

> The yoke, elevation bearing and drive motors allow the reflectors to tilt up and down.

The receiver indexer can rotate each receiver to the desired focal position.

The L-Band digitiser and the UHF-Band digitiser are mounted on the indexer.

An underground network of fibre optic cables links each receptor to the Karoo Array Processor Building (KAPB) on site. The azimuth bearing and azimuth drive motors allow the structure to rotate in a horizontal plane.

Wind stow (gust)

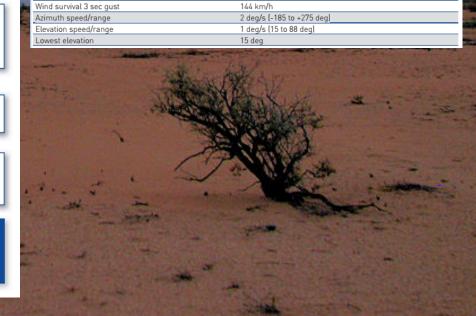
The pedestal contains the drive control system.

The pedestal is anchored and bolted to a concrete foundation.

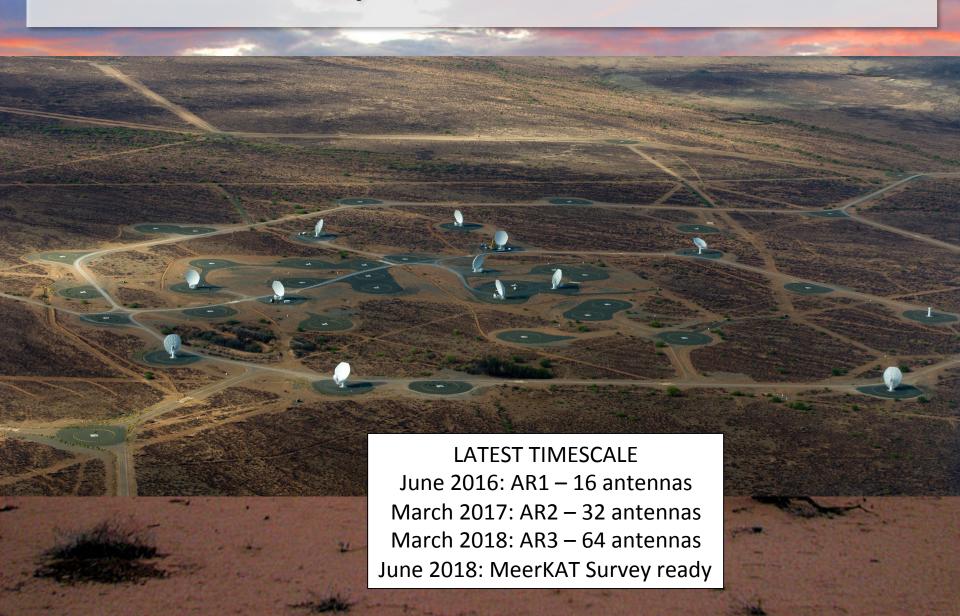
SKA South African Project Office 17 Baker Street, Rosebank, Johannesburg, South Africa Tel: +27 [0] 11 442 2434 Meerkat Engineering Office 3rd Floor, the Park, Park Road, Pinelands, South Africa Tel: +27 (0) 21 506 7300 SKA Organisation: www.skatelescope.org
More information, visuals and media releases at www.ska.ac.za
Project updates at www.facebook.com/skasouthafrica



68.4 km/h

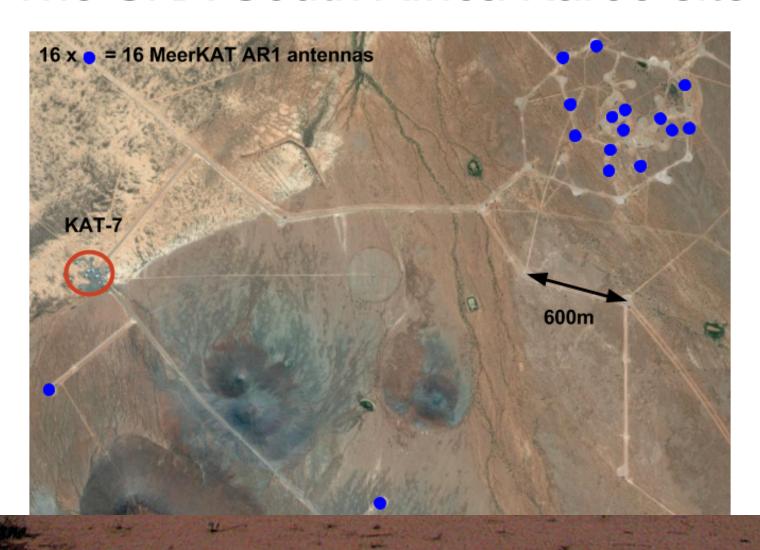


The SKA precursor MeerKAT





The SKA South Africa Karoo site



MeerKAT AR1 First Light Image

Observational Setup:

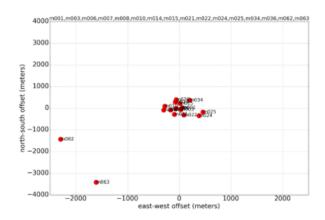
- Pointing is a commissioning field 10 degrees from the South Celestial Pole
- 16 antennas, 4096 channel correlator mode.
- Observation on 2016-06-19 from 04:00 to 16:00 UTC
- 7.5 hours on source after calibration overheads

Calibration:

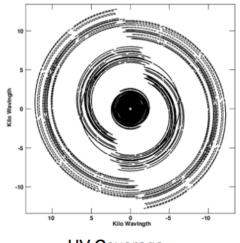
- Data were flagged over full frequency range (900-1670 MHz) after masking known satellite bands.
- Gain variation per antenna is less than 10% in amplitude and 10 deg in phase over the course of the observation

Imaging:

- Image made using Multi-Frequency Synthesis with entire available band, centre frequency is 1284 MHz
- Image made with uniform weighting has resolution of ~7 arcseconds
- Image rms noise level ~12 uJy
- Image contains >1300 sources to 5 sigma limit.

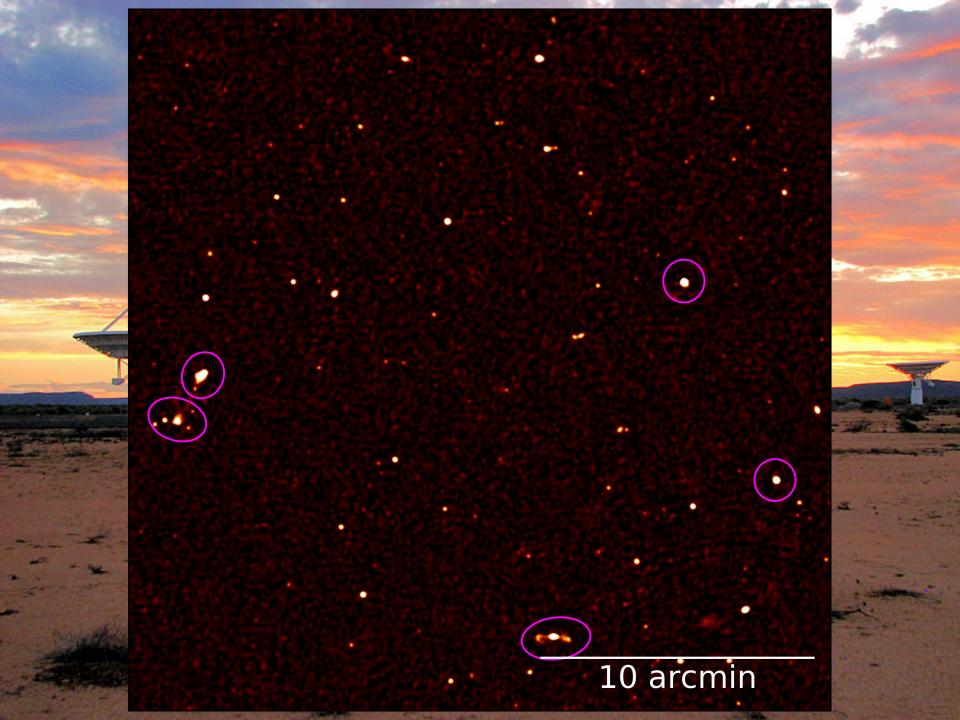


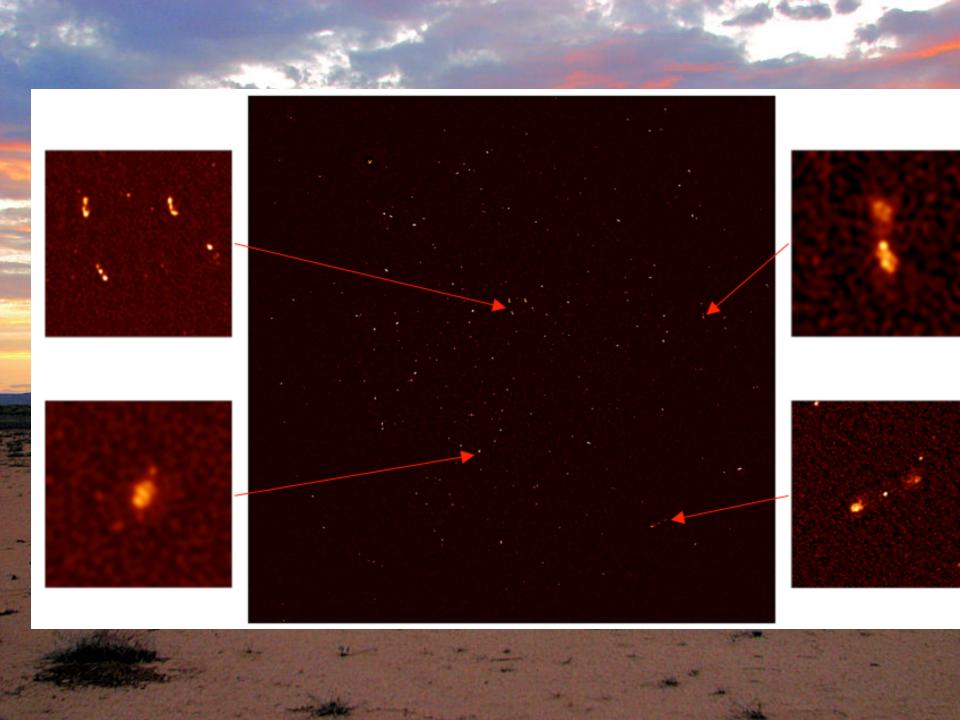
AR1 Antenna Layout



UV Coverage

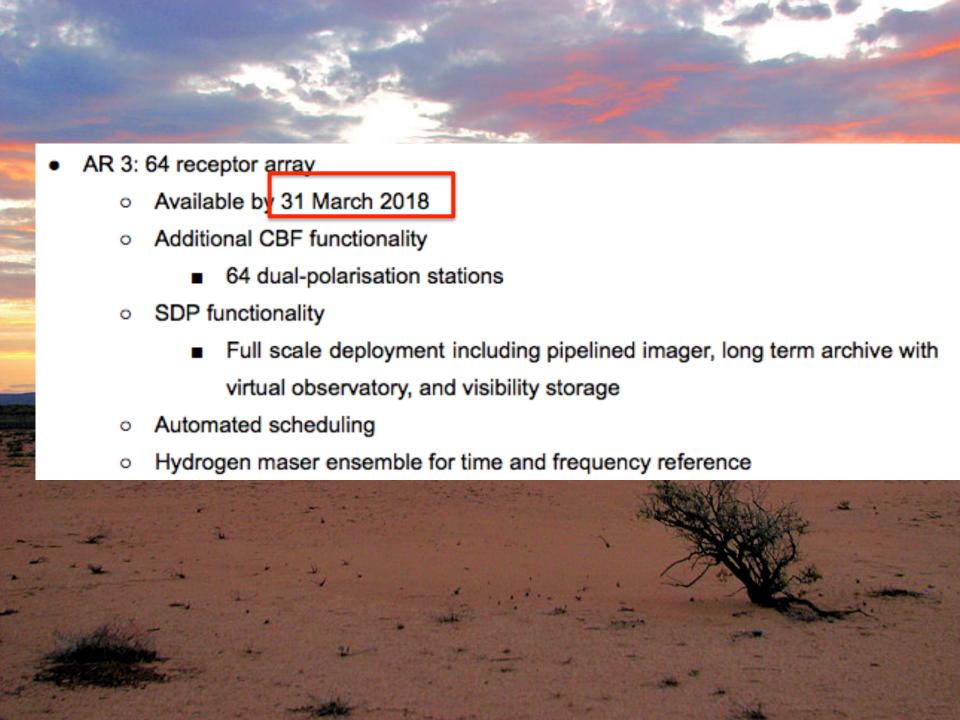






- AR-1: 16 receptor array
 - First light: 30 June 2016
 - L-band receivers only
 - ROACH-2 correlator/beamformer (CBF)
 - CBF functionality:
 - 16 dual-polarisation stations
 - 4k channel wideband imaging
 - entire digitized bandwidth
 - 32k channel wideband imaging
 - entire digitized bandwidth
 - Nominal 0.5 s integration time
 - Shorter periods down to 10 ms are technically feasible, but there are limitations of visibility storage
 - Longer integration periods would be accommodated by the Science Data Processor (SDP) ingress machine
 - Single, bore-sight tied array beam
 - 4k channel frequency domain beamformer
 - SDP functionality
 - Data ingest and real-time flagging
 - flux calibrated visibilities
 - manual imaging tools

- AR 2: 32 receptor array
 - 32 single-polarisation inputs (ROACH-2 CBF): 31 March 2017
 - 32 dual-polarisation inputs (SKARAB CBF): late 2017
 - Additional CBF functionality
 - SKARAB CBF
 - 32 dual-polarisation stations
 - Pulsar Monitoring mode
 - SDP functionality
 - Pipelined production of calibrated visibility product
 - First pass imaging pipeline
 - Initial archive deployment



RFI Bands

See Anja's talk on tuesday)

These frequency bands should be considered when planning and scheduling both line and continuum observations.

F _{low} [MHz]	F _{high} [MHz]	Source	Description
925	960	Terrestrial GSM towers	Sporadic in both time and frequency occupancy. Will be reduced over time as alternative communications system is deployed. Currently 925-935 MHz is unoccupied.
1085	1095	Airborne SSR radar	Persistent, but variable, during hours of air traffic (~06h00-23h00).
1082	1150	Airborne DME interrogators	Sparse frequency occupancy (~5 visible at any one time), narrow band (<1 MHz) signals, variable time occupancy during hours of air traffic.
1164	1300	GNSS Satellites	Entire band occupied all of the time.
1467	1492	WorldSpace Satellite	Strong and persistent. Does not occupy entire band. May be decommissioned in the future.
1525	1610	GNSS and Inmarsat Satellites	Strong and persistent.
1616	1626.5	Iridium Satellite	Persistent.



MeerKAT and the Large Survey Projects

MEERKAT LARGE SURVEY PROJECTS (70% of all available time in the first 5 years)					
Radio Pulsar Timing	Bailes (AU)	7860 h			
Testing Einstein's theory of gravity and gravitational radiation - Investigating the physics of enigmatic neutron stars through observations of pulsars					
LADUMA	Blyth, Holwerda, Baker (UCT ,NL,US)	5000 h			
An ultra-deep survey of neutral hydrogen gas in the early universe					
MESMER	Heywood (UK)	6500 h			
Searching for CO at high red-shift (z>7) to investigate the role of molecular hydrogen in the early universe					
MeerKAT Absorption Line Survey	Gupta, Srianand (NL, IN)	4000 h			
Survey for H and OH lines in absorption against distant continuum sources; OH line ratios may give clues about changes in the fundamental constants in the early universe).					
MHONGOOSE	de Blok (NL, UCT)	6000 h			
Investigations of different types of galaxies; dark matter and the cosmic web					
MeerKAT HI Survey of Fornax	Serra (NL)	2450 h			
Galaxy formation and evolution in the cluster environment					
MeerGAL	Thompson, Goedhart (UK,SA)	3300 h			
Galactic structure and dynamics, distribution of ionised gas, recombination lines, interstellar molecular gas and masers					
MIGHTEE	Jarvis, van der Heyden (UK, <mark>UCT</mark>)	1950 h			
Deep continuum observations of the earliest radio galaxies					
TRAPUM	Stappers, Kramer (UK, DE)	3080 h			
Searching for, and investigating new and exoti	c pulsars				
ThunderKAT	Woudt, Fender (UCT,UK)	3000 h			
Study of explosive radio transients with Meer	KAT; accretion-induced outflow from compact stellar	r remnants, e.g. relativistic jets and (super)novae			

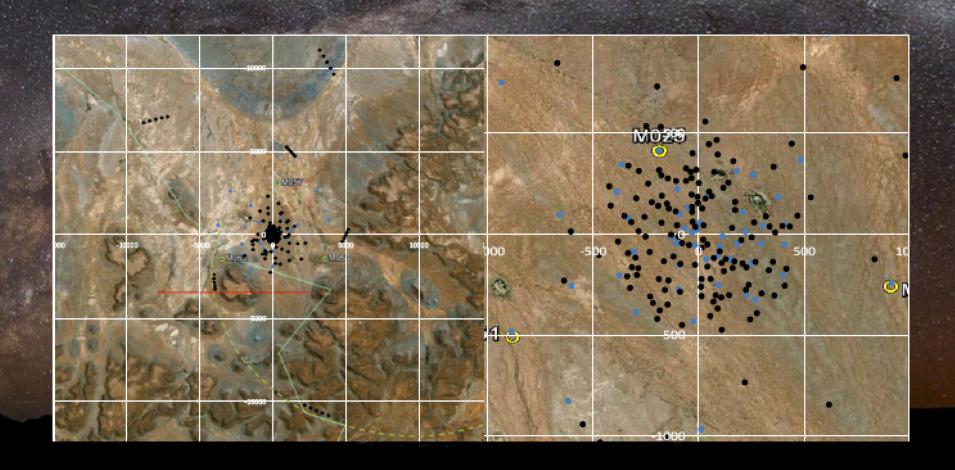
MeerKAT Science Programme

- 2010: Open invitation by SKA SA to propose MeerKAT "Key Science Projects" resulted in 10 approved "Large Survey Projects" (LSPs; each > 1000 hours of telescope time over 5 years)
- 2016: Relevant scientific context has evolved; also, particularly at L-band (~1.4 GHz), MeerKAT will be far more sensitive than planned
- Makes sense to revisit LSPs: eight revised LSPs submitted in mid 2016, and presented in May at MeerKAT Science Workshop (MSW)
- SKA SA aim to schedule ~70% of telescope time for LSPs, ~30% for "Open Time" projects
- Some ideas for Open Time and "Early/Shared-risk Science" were also presented at MSW

See my next talk on wednesday

- Phase 1: construction of the pathfinder KAT-7 (7 x 12m antennae) completed in December 2010 & in operation until end 2015 7 HI scientific publications (description of the results)
- Phase 2: construction of the SKA precursor MeerKAT (mb ~8 km) (64 x 13.5m antennae), fully funded (RSA), completed (survey ready) mid-2018
- Phase 3: merged with SKA₁-mid (64 + 136 = 200 antennae max baseline ~150 km ~1/2 FAST collecting area) 2018-23
- Phase 4: SKA₂ (~2500 ?, SF or PAFs ? antennae) (phases 1 & 2)
 2023-2030

MeerKAT (64) & SKA₁ (+136)



- Phase 1: construction of the pathfinder KAT-7 (7 x 12m antennae) completed in December 2010 & in operation since then
 4 HI scientific publications (description of the results) +3 submitted
- Phase 2: construction of the SKA precursor MeerKAT (mb ~8 km) (64 x 13.5m antennae), fully funded (RSA), completed end-2017
- Phase 3: merged with SKA₁-mid: 64 + 136 (15m) = 200 antennae
 max baseline ~150 km ~1/2 FAST collecting area) 2018-23

Phase 4: SKA₂ (~2500 ?, SF or PAFs ? antennae) (phases 1 & 2)
 2023-2030

MeerKAT & SKA₂



