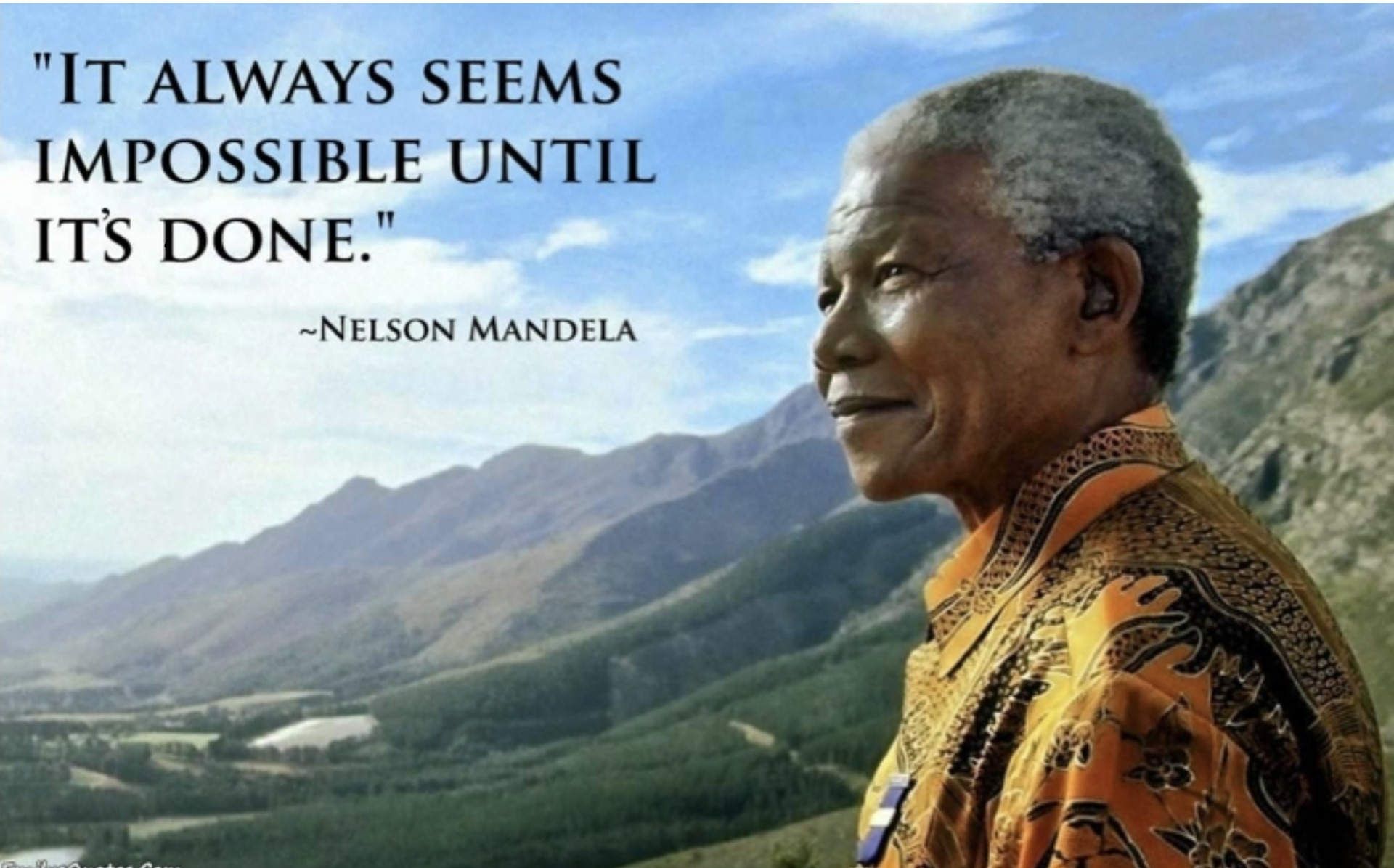
THE SKA SA

History of Astronomy
7 March 2018

THE MANDELA DICTUM



MY ADDITION

LOOK BEYOND THE HORIZON: WHAT SHOULD BE DONE BUT LOOKS IMPOSSIBLE?

- Ending apartheid?
- Building non-racial, democratic trade unions?
- Building the SKA in Africa?

- Have a vision.
- Build teams committed to the vision.
- Be prepared to work hard and long.
- Be (fairly) patient.
- Set an example.
- **Carpe diem and apologise later**

IT ALL STARTED IN SOUTHERN AFRICA ANYWAY: BLOMBOS CAVE - OLDEST EVIDENCE OF ABSTRACT THOUGHT

South African Astronomical Observatory

South African Council for Scientific and Industrial Research

in association with the Science Research Council of the United Kingdom

Telephone 551341
Telegrams: ASTRONOMER
P.O. Box 9
Observatory, C.P.

Prof Sir Martin Ryle FRS
University of Cambridge
Madingley Road
Cambridge
UK

Our Ref. Your Ref. Date

26th March 1973

Dear Ryle

I have no immediate vacancy for Fanaroff but something might be done. It would not be worth while, unless he were anxious to turn his attention to the optical astronomy which can now be done with our modest equipment, and spend a time learning optical techniques by studying stars down to the fifteenth magnitude. I hope, of course, that more powerful equipment will come here in time, but it is not here yet, and at the moment it seems wise to concentrate on doing as much as we can with what we have got. I am sure that there are many interesting problems on variable stars and on the distance to the centre of the Galaxy that we can study with our present equipment. In particular, however, Fanaroff may not be the man for SAAO at this time.

I had long and interesting conversations with Lynden Bell, on the proposed millimeter dish, amongst other things. It appears quite likely that it will come to Sutherland by the mere unwinding of the official process, whether anybody of enough capacity wants to direct its work or not. I am sure that if there is no such person, primarily interested in astronomy and not in engineering, and willing to devote five years of his life out here making the thing go, it had better not be sent here and perhaps not built at all. With the right man in charge I am perfectly willing to have it as part of SAAO.

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I hear that you haven't been too well but I hope this is largely untrue, and that you will soon see Cambridge a strong centre of all kinds of astronomy as well as your own.

Yours ever

Richard Woolley

SETTING THE SCENE

- Rein Arndt FRD 1983 – shake up research in SA universities
- CSIR hives off FRD including astronomy facilities in 1988
- Rein convenes astronomy meeting 1988 – 4m telescope – Bob Stobie project lead – R50m cost in rands
- Germans wanted it on Gamsberg, so project dormant
- By 1996, cost had escalated in rands because of exchange rate
- Khotso Mokhele – 1992 - VP of FRD to help lead it into a new era
- White Paper on Science and Technology 1996
- Buckley meets HET people: 10 metre telescope for cost of 4 metre
- Khotso revives telescope project: HET people invited to meet Roger Jardine and Rob Adama at the DST – Khotso to raise ½ of R100m, R50m from DST
- David Buckley and Bob Stobie found possible partners and Khotso was deeply involved in motivating, especially in the USA – world-competitive astronomy and also Mandela's new SA and science in the RDP
- Debate with Dennis Brutus at Carnegie Mellon – put SA's own money into astronomy so that we can lead the science agenda of the telescope

GOVERNMENT WHITE PAPER ON SCIENCE AND TECHNOLOGY 1996

- “Scientific endeavour is not purely utilitarian in its objectives and has important associated cultural and social values.

- **It is also important to maintain a basic competence in flagship sciences such as physics and astronomy for cultural reasons.**

- Not to offer them would be to take a negative view of our future - the view that we are a second class nation, chained forever to the treadmill of feeding and clothing ourselves”

MAKING THE WHITE PAPER REAL

- Khotso became convinced that astronomy is uniquely placed to excite people: “I was transformed by the transformative power of the astronomy discipline”.
- White Paper – mentions astronomy
  - SALT gave it substance
  - We believed in ourselves after SALT
  - So SALT set the scene for SKA
  - And laid the basis for the IAU OAD
- Khotso convened astronomy conference in 2000 with Patricia Whitelock – SALT took 12 years, what in the next 12 years?
- Invited Justin Jonas at suggestion of George Nicolson to talk about SKA.
- Unanimous support for SKA site proposal
- Justin pessimistic – Khotso said dream big.
- Khotso, George and Justin to Rob Adam – 20 minutes – “a no-brainer”

THE SQUARE KILOMETRE ARRAY (SKA) SITE BID

- Building largest science instrument in the world
- Project started early 1990s - South Africa joined 1 January 2003
- First week – Sheereen Rawat identified possible sites in Kalahari, Namaqualand and Karoo
- Expression of interest May 2003 with eight other African countries
- Bid 2005; shortlisted 2006
- Independent committee recommended African bid 2012

THE SITE BID

- Ten years from 2003 – 2012.
- Intense negotiation on criteria for the site selection.
- Intense negotiation on criteria for radio quietness.
- Selection based on scientific and technical criteria, including RFI, troposphere, ionosphere, climate, wind, moisture, industry, banking and financial stability, customs and taxes and waivers, immigration requirements and waivers, security, hydrology, geotech, mining potential, seismicity, cost, infrastructure, schools and health system, etc.
- All nine African countries had to be covered to some extent.
- 2006 - shortlisting committee chaired by Richard Hills (Cambridge)
- 2012 - site advisory committee chaired by Jim Moran (Harvard).

THE SITE IN 2003 - AVOIDING RADIO FREQUENCY INTERFERENCE

What it will look like by 2030: 2 500 dishes in 9 African countries (subject to final cost and design)

science & technology
Department: Science and Technology
REPUBLIC OF SOUTH AFRICA

NRF National Research Foundation

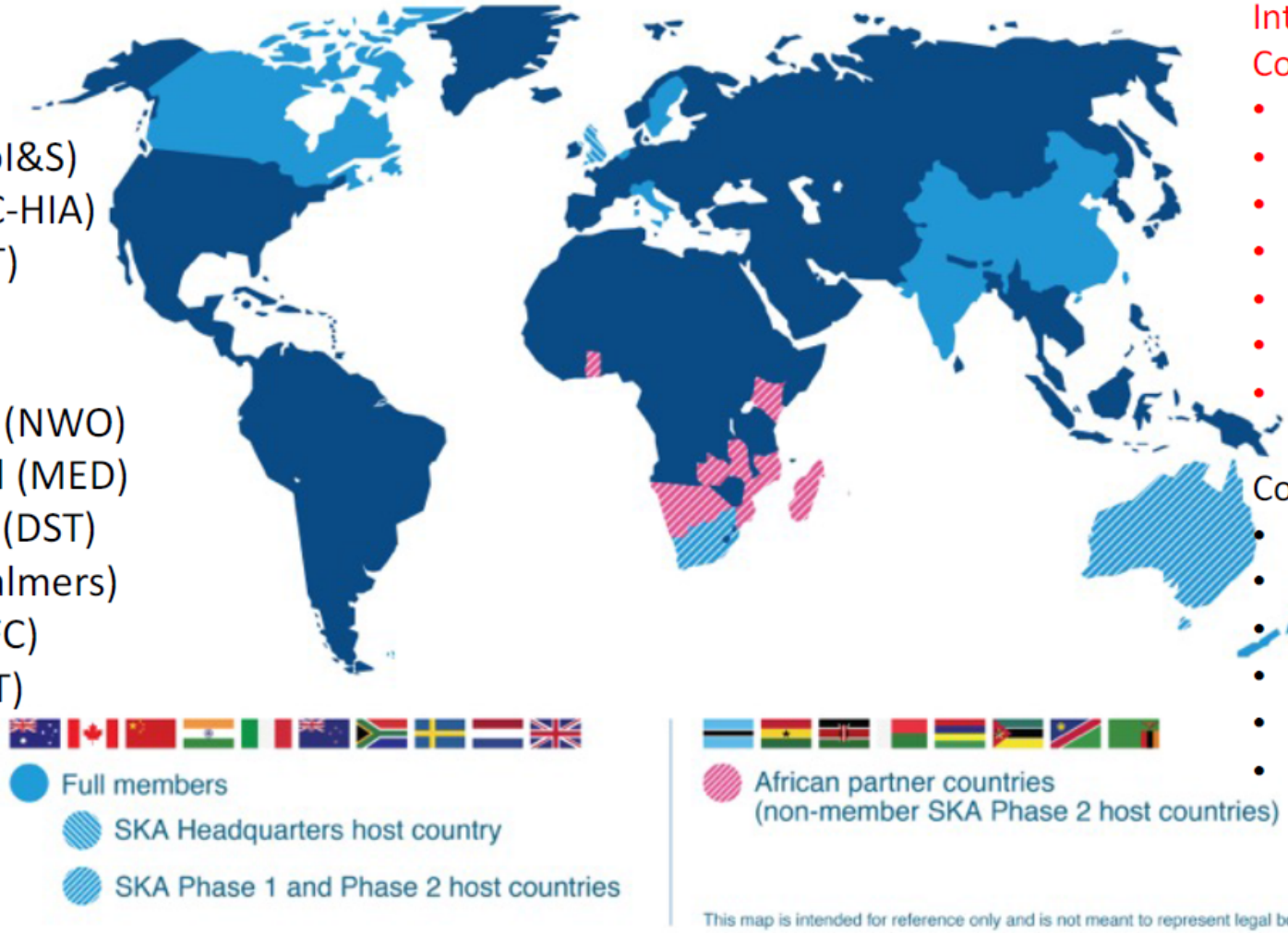
SKA AFRICA

SKA SQUARE KILOMETRE ARRAY Africa

WORKING ON THE 150 +25 000 PAGES OF OUR SITE SUBMISSION

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)
Portugal (FCT)



Interested Countries:

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

Contacts:

- USA
- Malta
- Mexico
- Brazil
- Ireland
- Russia

THE AUSTRALIAN BID IS CLEARLY SUPERIOR?

- THE Federal Government says it remains confident Australia's bid to host the world's largest radio telescope is “superior” to that of its main rival, South Africa.
- Federal Science and Research Minister Chris Evans says it has been a "tough contest" but is hopeful Australia can win the site selection.
- "Australia is very confident that we've got a very strong bid, we think we've got the best site and a very strong scientific case," Senator Evans said.
- "We recognise that South Africa's got a strong bid as well, but we think we've got a superior case and we're going to keep arguing and pushing it until a decision is made.“
- The SKA site advisory committee submitted its report in February and a decision was expected when all its members met on 3 April.
- But the Sydney Morning Herald released what it said were the findings of the report, which made it clear that the SA bid was the better of the two. Since then many people on both sides have rubbished the validity of this leak, but it has set the agenda.
- **The Australian then quoted Australia’s science minister, Chris Evans, as saying: “The thing that works against us the most is the sympathy for doing more in Africa — the European view that says we ought to be doing more development in Africa.” Other media have reflected the national sentiment in their headlines, such as The Australian‘s “Aussie SKA bid far ‘superior’ to cocky South Africa”.**

SPLIT THE SITE? YOU MUST BE MAD

- Australian Science Minister Chris Evans was reported in The Australian last month as saying there was no scope to split the SKA between SA and Australia.
- “While some people have suggested that’s a way of dealing with the very strong competitive bidding process, I’m told it doesn’t make good scientific or economic sense.
- “This idea that somehow, like Solomon, we’ll cut it in half and give half each to South Africa and Australia – I don’t think that makes sense,” Evans said.
- Naledi Pandor, the Minister of Science and Technology, recently said she agreed with Evans.
- “If the leaked reports on the recommendation of the SKA site advisory committee are indeed accurate and there is no ‘scientific or economic’ basis for a split decision, then it is logical to expect that the southern African site will be preferred.”
- SA, partnered with eight other African countries, is competing against Australia, paired with New Zealand, to host the SKA.
- Features of the SA site proposal include low construction costs, low population density, its suitable weather conditions and quiet radio frequency.
- Australia’s bid has highlighted the country’s security, good business environment and fast broadband network.

SPLIT THE SITE? MAKES PERFECT SENSE.

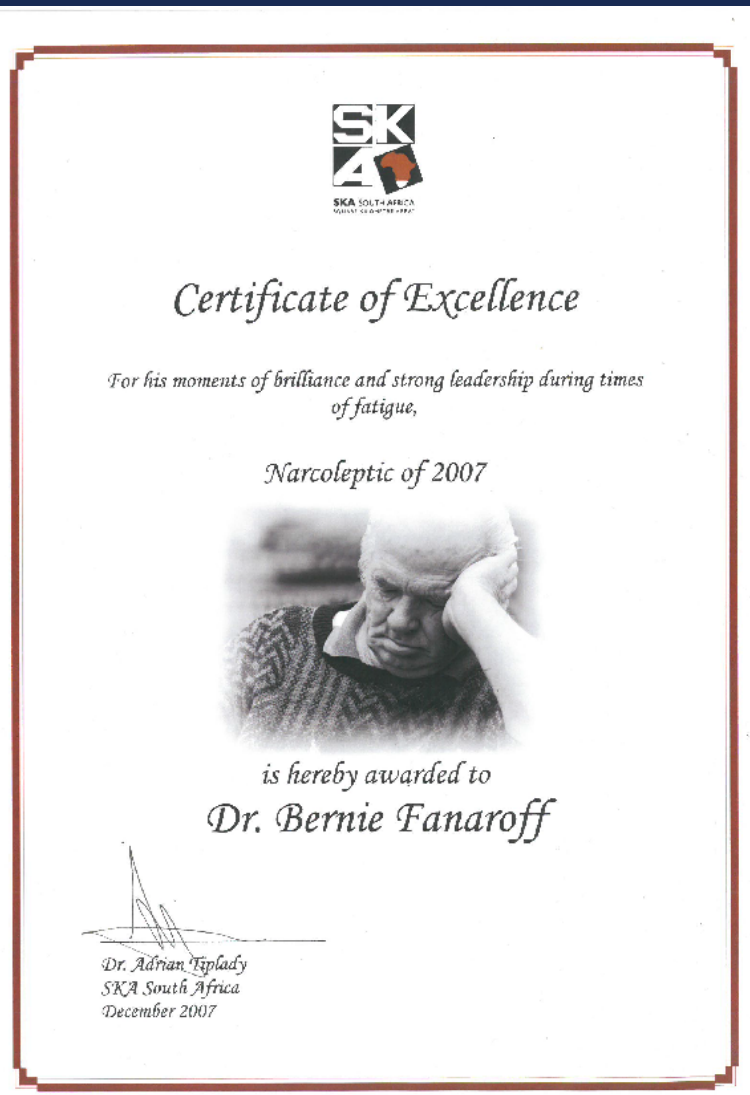
- Chris Evans, Australia's Science and Research Minister, told *The Australian* :"This is an outstanding result for the Australia-New Zealand bid after many years of preparation and an intensive international process.”
- South African newswire news24.com reports South African Science and Technology Minister Naledi Pandor as saying "We accept the compromise in the interest of science and as acknowledgement of the sterling work done by our scientists and the excellent SKA project team."

AND SOME SAID …..

- Anonymous Australian director of a big radio astronomy observatory in the USA
  - “I knew as soon as I heard the South African and Australian presentations at Banff”. (The SKA Forum was held in Banff in July 2011).

SUCCESS FACTORS

- Excellent site
- Project **of** government but not **in** government – agile, flexible
- Lean, committed team believed in the vision and sacrificed for years
- Weekly steering committee meeting included heads of Department of Science and Technology and of the National Research Foundation – very quick decision-making
- Delivered what we promised
- Made things which politicians could see and touch
- Good support by government and the public



SKA SOUTH AFRICA

Certificate of Excellence

For his moments of brilliance and strong leadership during times of fatigue,

Narcoleptic of 2007

is hereby awarded to

Dr. Bernie Fanaroff

Dr. Adrian Tiplady
SKA South Africa
December 2007

Union Buildings, Pretoria

Tuynhuys, Cape Town

PUBLIC SERVICE OF THE REPUBLIC OF SOUTH AFRICA

Admission to the

Managerial Echelon

Dr B L Fanaroff

GREETINGS

By reason of the exceptional trust placed in your
oyalty, proficiency and conduct you are, under the powers ve
in me by the Public Service Act, 1994 appointed to a
management post in the Public Service with effect from

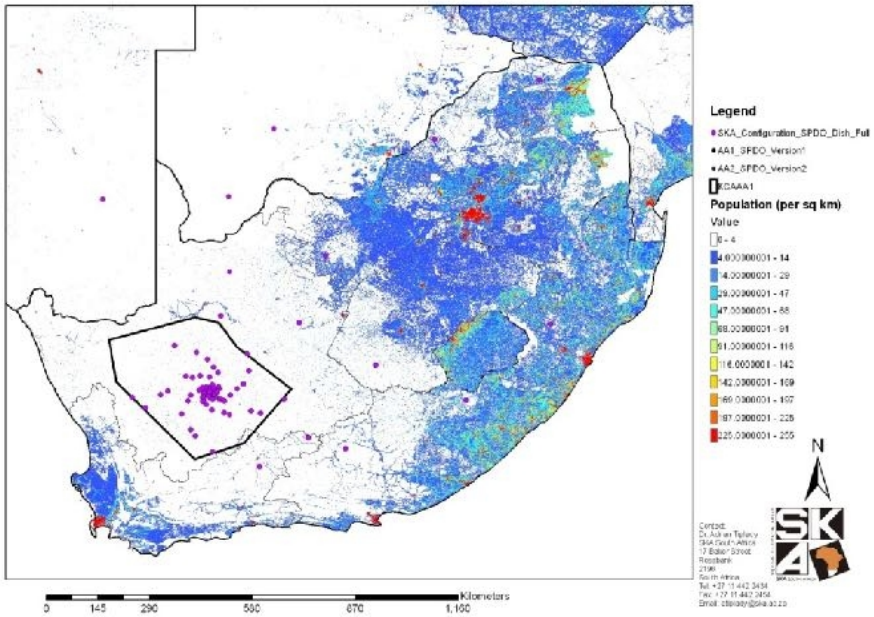
15 September 1994

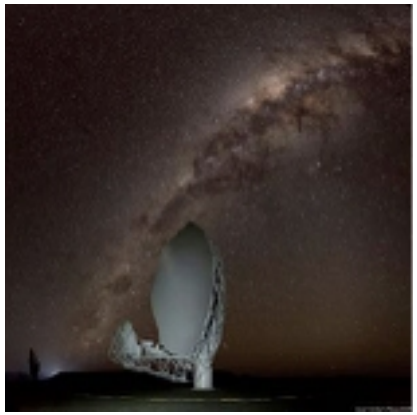
As the incumbent of such a post you are expected to
rve the Republic of South Africa with loyalty, dignity and ho
discharge your duties conscientiously and with diligence a
excellence; be reasonable, fair and mindful of
human dignity in your conduct and
set a good example to those over whom you are appointe

NMandela
President
1996.12.11.

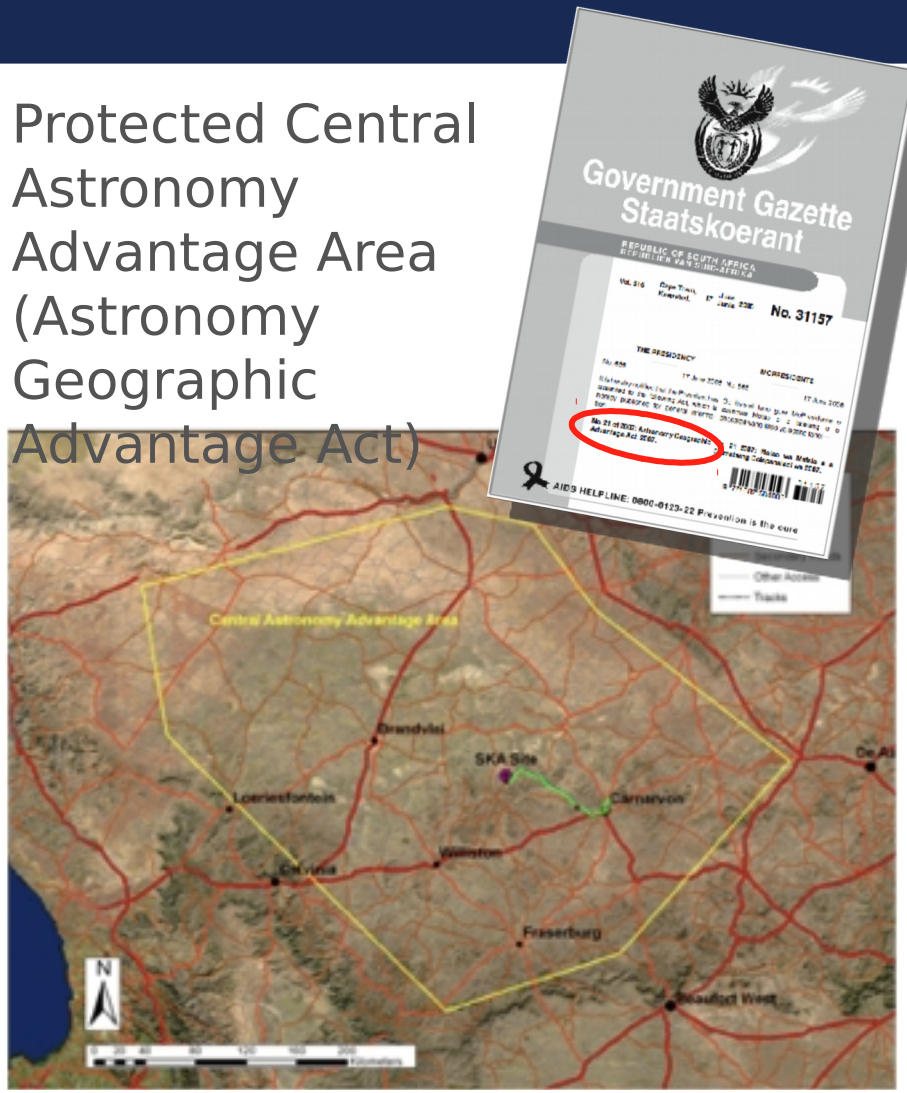
SKA SITE IN SOUTH AFRICA

POPULATION DENSITY





Protected Central Astronomy Advantage Area (Astronomy Geographic Advantage Act)



Alternative telecomms systems for farming communities

SKA IN AFRICA

Partner Countries:

- Botswana
- Ghana
- Kenya
- Madagascar
- Mauritius
- Mozambique
- Namibia
- Zambia

MoU now in place

NASA DSN ARRAY SITE BID 2005
$1BN PROJECT – DELAYED TO 2019?

MEERKAT

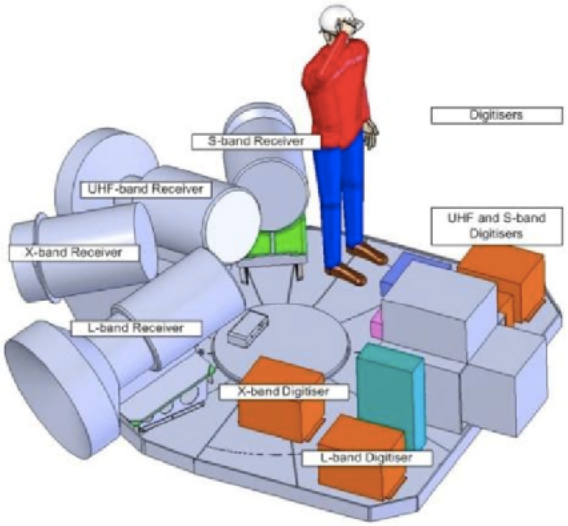
- 2004 – Steering Committee decided to build a South African precursor
  - Technology development
  - Focus for developing a scientific and instrumentation community
  - Show we can do it
  - Have something to show even if the bid fails

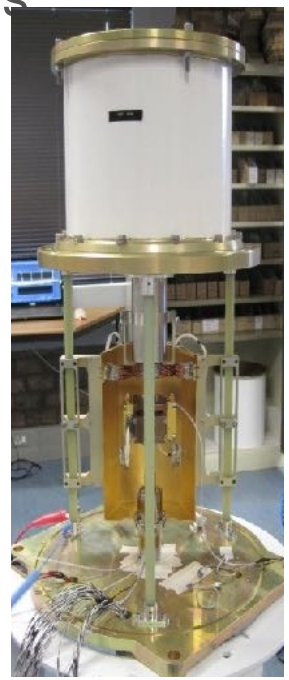
MEERKAT DESIGN AND DECISION-MAKING

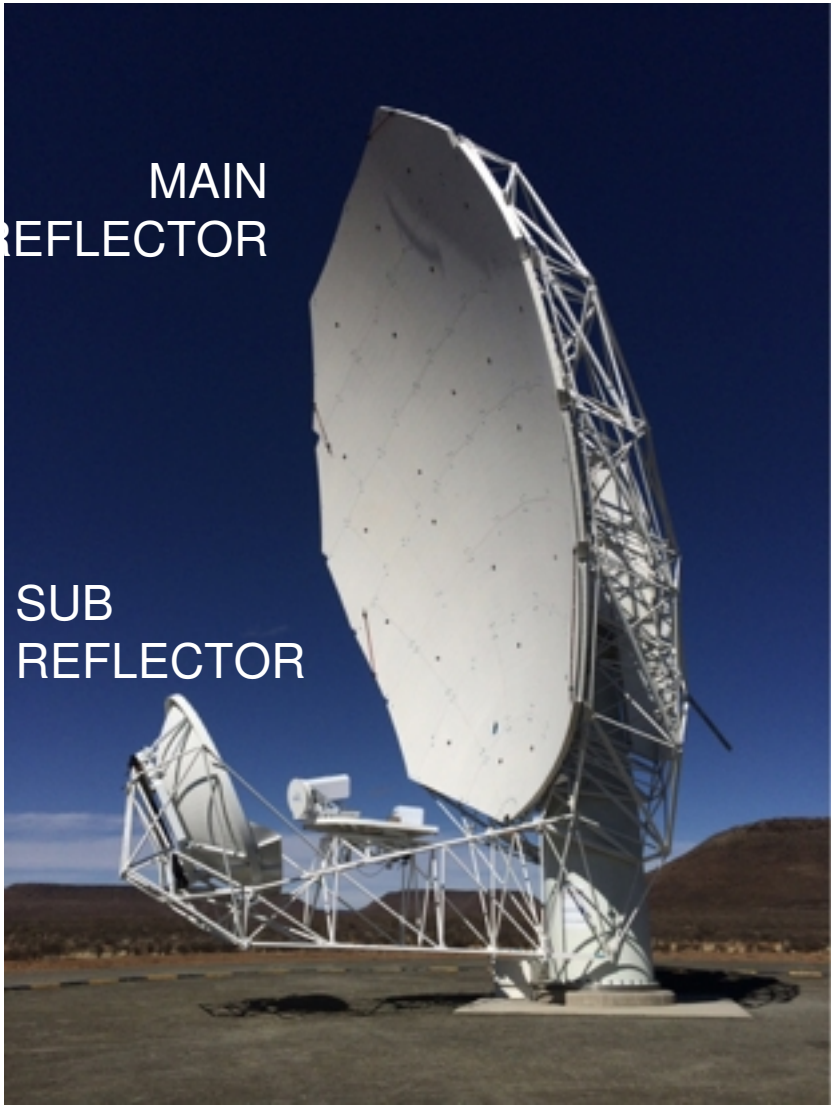
- Driven as an engineering project from the start - South African design
  - system engineering and logistics engineering – availability and cost
  - rapid prototyping
  - significant technology innovation
- **Streamlined decision-making – no elaborate science case.**
- Scientific criteria
  - Sensitivity and resolution are good
  - Highest possible dynamic range (clean beam is good – offset dish)
  - FPA or multi-pixel or single pixel? Sensitivity and dynamic range are best.
- Low cost (including first glass fibre 15m dish ever)

MeerKAT DISH – Good to 25GHz Offset Gregorian for a Very Clean Beam

South African design and development
75% by value sourced in SA – new skills, new factories
Combined RMS surface error < 0.25mm
Pointing error 5 arcsec
Cryogenic radio receivers







PERFORMANCE @ 1420 MHZ

	JVLA	MeerKAT RfP	MeerKAT 2013	MeerKAT 2014
N_{dish}	27	64	64	64
D_{dish}	25 m	13.5 m	13.5 m	13.5 m
T_{sys}/ε_a	47.3 K	44.1K	29.4 K	22.5 K
N_{beam}	1	1	1	1
BW	1 GHz	750 MHz	750 MHz	750 MHz
A_e/T_{sys}	1	0.74 (×1)	1.11 (×1.5)	1.45 (×1.96)
SS	1	1.88 (×1)	4.24 (×2.25)	7.24 (×3.84)

Confirmed by subsequent measurements.
T_{sys} measured at <18K.

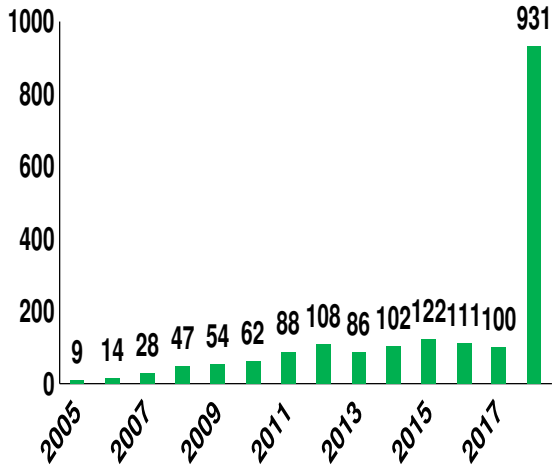
MEERKAT ON A VERY REMOTE SITE

CAPE TOWN CONTROL ROOM

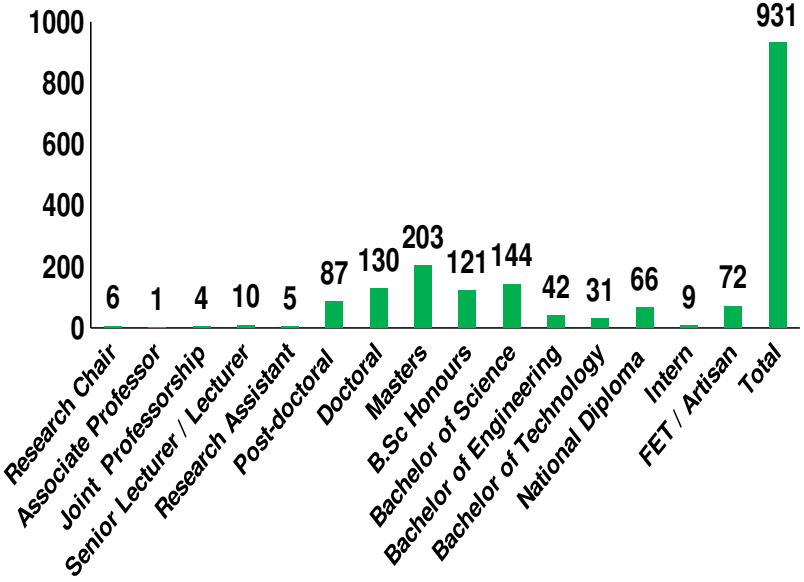
BUILDING A PIPELINE OF PEOPLE

- Human Capital Development Programme started 2005
- Pipeline approach essential for diversity
- Build skills and capacity for SKA and the economy
- Astronomy, engineering, technology, data science
- Human Capital Development Programme
  - Six research chairs
  - Grants programme for Post docs, PhD, MSc, BSc, BTech, National Certificates, artisan training
  - Artisan training centre in the Karoo
  - Schools development programme in the Karoo
- Outreach to schools, science fairs etc.

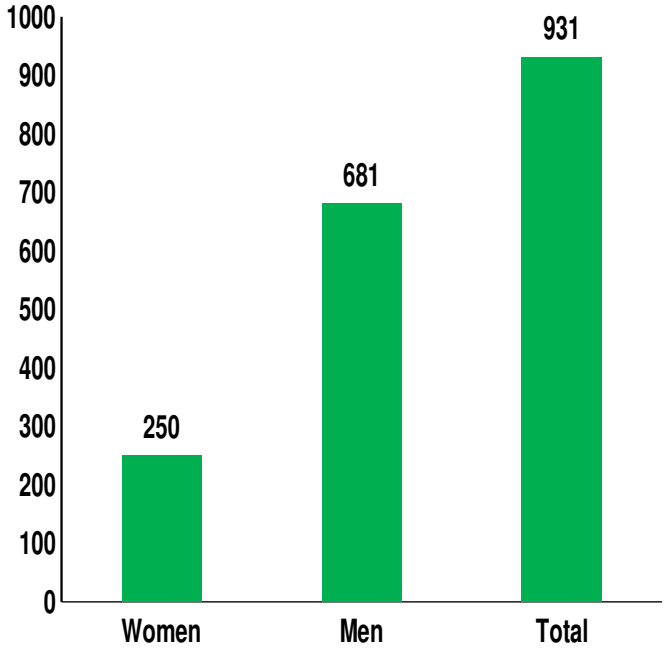
Number of Bursaries, Fellowships and Grants by Year



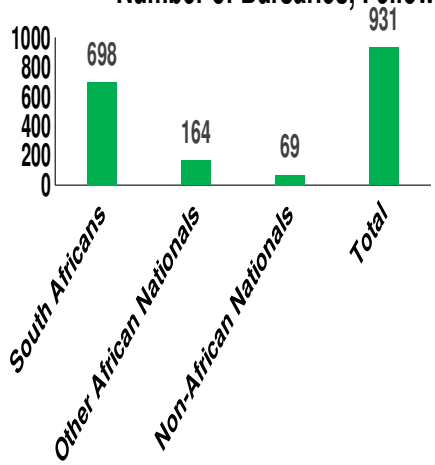
Number of Bursaries, Fellowships and Grants by Academic Level



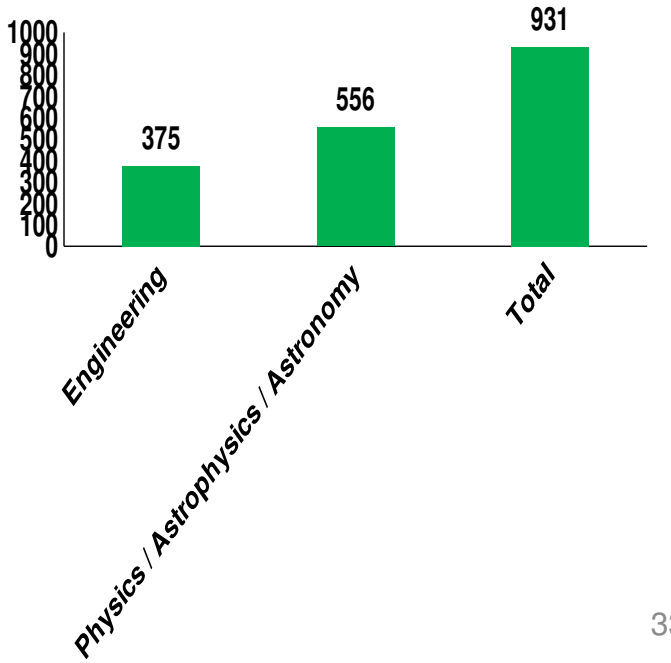
Number of Bursaries, Fellowships and Grants by Gender



Number of Bursaries, Fellowships and Grants by Nationality



Number of Bursaries, Fellowships and Grants by Field of Study



ANNUAL SKA SA GRADUATE BURSARY CONFERENCE
YOUNG PROFESSIONALS PROGRAMME

To make them feel part of a team.
To get them used to presenting their work to peers and senior researchers.

Outstanding graduates hired through competitive process into SKA SA project office in the Young Professionals Development Programme (now 37 in all).
They work and study further.

KAROO TRAINING

Community knowledge centre

4 of the first 5 school students from the area to pass maths and science with university exemption - supported by SKA SA school bursaries programme and now SKA SA university bursaries

Training and bank financing for local contractors

School teachers

Artisan training centre

ROBOTICS AND CODING AT CARNARVON PRIMARY SCHOOL

Teen Titans – 3rd place in the world robotics competition at Texas Tech

AFRICAN VLBI NETWORK (AVN) : GHANA

Ghanaian Essential Observatory Staff In Cape Town Training

Ghanain trainees at Kutunse

EXCELLENCE IN SCIENCE THE ROYAL SOCIETY

international relations & cooperation
Department:
International Relations and Cooperation
REPUBLIC OF SOUTH AFRICA

African Renaissance Fund

Newton Fund

AVN: REBUILDING THE KUTUNSE DISH

AVN team members in Cape Town

The Kutunse (Ghana) dish has had to be almost completely rebuilt – structure, drives, gears, bearings, receivers, repainting etc. “Unprecedented level of training: engineers, scientists, welders, painters, …. In Ghana”

DARA PROJECT STRUCTURE

- Joint UK – South Africa programme
- Basic Training Programme
    - An introduction to radio astronomy for graduates
    - Theory and practical training; Ghana and South Africa
- Advanced Training
    - MSc and PhD places in the UK and South Africa
- DARA Big Data has been funded alongside DARA2
    - Researching synergies in big data techniques with other areas such as climate change, sustainable agriculture, disaster management, smart cities, etc.
- DARA goes global

THE JOCELYN BELL PROBLEM

- Machine learning essential now for big science
- Detecting the unknown unknowns: objects and processes
- Building the Serendipity Machine – others also trying
- How to optimize human insight and knowledge in the search for outliers, patterns etc.? Not our current priority, but important for the future
- ***The black box problem - reproducibility – pipelines, machine learning etc.***
- ***Pipelines need a very serious system engineering process***

Ginny Rometty and Solomon Assefa (IBM) signing a memorandum of understanding with Rob Adam (SKA South Africa)

THE BARRY CLARK / RICK PERLEY (ET AL.) PROBLEM

- Huge scale and complexity of SKA (and even MeerKAT) challenges old models for commissioning, ops and maintenance – and getting the best out of the telescope – and getting reproducible results

- Even Barry Clark, Rick Perley, Justin Jonas, Darragh O'Donoghue and their clones may not know and understand every emergent problem (especially as software becomes more prevalent)

THE MARTIN REES PROBLEM

- Dependence on soft money means young and old researchers spend lots of time writing grant and time proposals

- Lots of time spent processing data
  - Post-docs are now usually earmarked for specific projects
  - No time to dream?

- Flood of data from new observatories combined with these trends ….
  When do we think about systematics, patterns and solutions?

BRICS HIGH-PERFORMANCE COMPUTING COMMITTEE GUANGZHOU APRIL 2017

TOP 10 Sites for November 2017

For more information about the sites and systems in the list, click on the links or view the complete list.

1-100 | 101-200 | 201-300 | 301-400 | 401-500

Rank	System	Cores	Rmax (TFlop/s)	Rpeak (TFlop/s)	Powe (kW)
1	**Sunway TaihuLight** - Sunway MPP, Sunway SW26010 260C 1.45GHz, Sunway , NRCPC National Supercomputing Center in Wuxi China	10,649,600	93,014.6	125,435.9	15,37
2	**Tianhe-2 (MilkyWay-2)** - TH-IVB-FEP Cluster, Intel Xeon E5-2692 12C 2.200GHz, TH Express-2, Intel Xeon Phi 31S1P , NUDT National Super Computer Center in Guangzhou China	3,120,000	33,862.7	54,902.4	17,80

SKA SA HISTORY

- Bernie Fanaroff and Graeme Addison writing it
- Telling the story through experiences of many individuals
- Tell us what you would like to know
- Give us anecdotes
- Send pictures
- bfanaroff@ska.ac.za

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History of Astronomy
7 March 2018

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- “Scientific endeavour is not purely utilitarian in its objectives and has important associated cultural and social values.
- **It is also important to maintain a basic competence in flagship sciences such as physics and astronomy for cultural reasons.**
- Not to offer them would be to take a negative view of our future - the view that we are a second class nation, chained forever to the treadmill of feeding and clothing ourselves”

MAKING THE WHITE PAPER REAL

- Khotso became convinced that astronomy is uniquely placed to excite people: “I was transformed by the transformative power of the astronomy discipline”.
- White Paper – mentions astronomy
  - SALT gave it substance
  - We believed in ourselves after SALT
  - So SALT set the scene for SKA
  - And laid the basis for the IAU OAD
- Khotso convened astronomy conference in 2000 with Patricia Whitelock – SALT took 12 years, what in the next 12 years?
- Invited Justin Jonas at suggestion of George Nicolson to talk about SKA.
- Unanimous support for SKA site proposal
- Justin pessimistic – Khotso said dream big.
- Khotso, George and Justin to Rob Adam – 20 minutes – “a no-brainer”

THE SQUARE KILOMETRE ARRAY (SKA) SITE BID

- Building largest science instrument in the world
- Project started early 1990s - South Africa joined 1 January 2003
- First week – Sheereen Rawat identified possible sites in Kalahari, Namaqualand and Karoo
- Expression of interest May 2003 with eight other African countries
- Bid 2005; shortlisted 2006
- Independent committee recommended African bid 2012

THE SITE BID

- Ten years from 2003 – 2012.
- Intense negotiation on criteria for the site selection.
- Intense negotiation on criteria for radio quietness.
- Selection based on scientific and technical criteria, including RFI, troposphere, ionosphere, climate, wind, moisture, industry, banking and financial stability, customs and taxes and waivers, immigration requirements and waivers, security, hydrology, geotech, mining potential, seismicity, cost, infrastructure, schools and health system, etc.
- All nine African countries had to be covered to some extent.
- 2006 - shortlisting committee chaired by Richard Hills (Cambridge)
- 2012 - site advisory committee chaired by Jim Moran (Harvard).

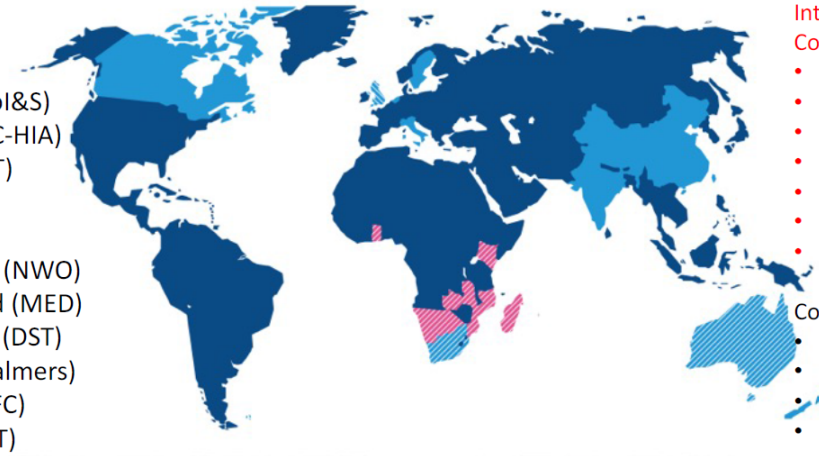
THE SITE IN 2003 - AVOIDING RADIO FREQUENCY INTERFERENCE

What it will look like by 2030: 2 500 dishes in 9 African countries (subject to final cost and design)

WORKING ON THE 150 +25 000 PAGES OF OUR SITE SUBMISSION

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)
Portugal (FCT)



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

Interested Countries:
- Germany
- France
- Portugal
- Spain
- Switzerland
- Japan
- Korea

Contacts:
- USA
- Malta
- Mexico
- Brazil
- Ireland
- Russia

THE AUSTRALIAN BID IS CLEARLY SUPERIOR?

- THE Federal Government says it remains confident Australia's bid to host the world's largest radio telescope is “superior” to that of its main rival, South Africa.
- Federal Science and Research Minister Chris Evans says it has been a "tough contest" but is hopeful Australia can win the site selection.
- "Australia is very confident that we've got a very strong bid, we think we've got the best site and a very strong scientific case," Senator Evans said.
- "We recognise that South Africa's got a strong bid as well, but we think we've got a superior case and we're going to keep arguing and pushing it until a decision is made.“
- The SKA site advisory committee submitted its report in February and a decision was expected when all its members met on 3 April.
- But the Sydney Morning Herald released what it said were the findings of the report, which made it clear that the SA bid was the better of the two. Since then many people on both sides have rubbished the validity of this leak, but it has set the agenda.
- **The Australian then quoted Australia’s science minister, Chris Evans, as saying: “The thing that works against us the most is the sympathy for doing more in Africa — the European view that says we ought to be doing more development in Africa.” Other media have reflected the national sentiment in their headlines, such as The Australian‘s “Aussie SKA bid far ‘superior’ to cocky South Africa”.**

SPLIT THE SITE? YOU MUST BE MAD

- Australian Science Minister Chris Evans was reported in The Australian last month as saying there was no scope to split the SKA between SA and Australia.
- “While some people have suggested that’s a way of dealing with the very strong competitive bidding process, I’m told it doesn’t make good scientific or economic sense.
- “This idea that somehow, like Solomon, we’ll cut it in half and give half each to South Africa and Australia – I don’t think that makes sense,” Evans said.
- Naledi Pandor, the Minister of Science and Technology, recently said she agreed with Evans.
- “If the leaked reports on the recommendation of the SKA site advisory committee are indeed accurate and there is no ‘scientific or economic’ basis for a split decision, then it is logical to expect that the southern African site will be preferred.”
- SA, partnered with eight other African countries, is competing against Australia, paired with New Zealand, to host the SKA.
- Features of the SA site proposal include low construction costs, low population density, its suitable weather conditions and quiet radio frequency.
- Australia’s bid has highlighted the country’s security, good business environment and fast broadband network.

SPLIT THE SITE? MAKES PERFECT SENSE.

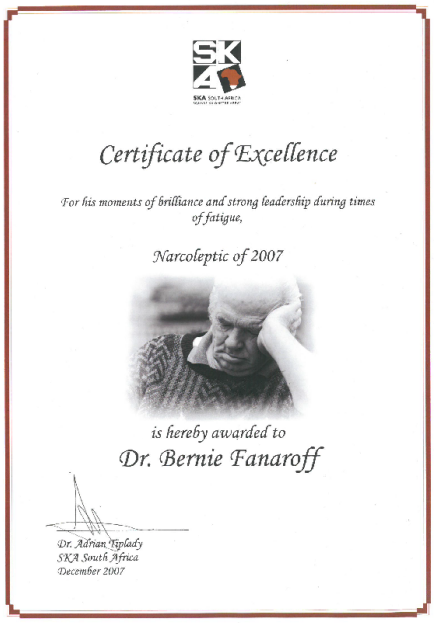
- Chris Evans, Australia's Science and Research Minister, told *The Australian* :"This is an outstanding result for the Australia-New Zealand bid after many years of preparation and an intensive international process.”
- South African newswire news24.com reports South African Science and Technology Minister Naledi Pandor as saying "We accept the compromise in the interest of science and as acknowledgement of the sterling work done by our scientists and the excellent SKA project team."

AND SOME SAID .....

- Anonymous Australian director of a big radio astronomy observatory in the USA
  - “I knew as soon as I heard the South African and Australian presentations at Banff”. (The SKA Forum was held in Banff in July 2011).

SUCCESS FACTORS

- Excellent site
- Project **of** government but not **in** government – agile, flexible
- Lean, committed team believed in the vision and sacrificed for years
- Weekly steering committee meeting included heads of Department of Science and Technology and of the National Research Foundation – very quick decision-making
- Delivered what we promised
- Made things which politicians could see and touch
- Good support by government and the public



Certificate of Excellence

For his moments of brilliance and strong leadership during times of fatigue,

Narcoleptic of 2007

is hereby awarded to

Dr. Bernie Fanaroff

Dr. Adrian Tiplady
SKA South Africa
December 2007

PUBLIC SERVICE OF THE REPUBLIC OF SOUTH AFRICA

Admission to the

Managerial Echelon

Dr B L Fanaroff

GREETINGS

By reason of the exceptional trust placed in your
oyalty, proficiency and conduct you are, under the powers ve
in me by the Public Service Act, 1994 appointed to a
management post in the Public Service with effect from

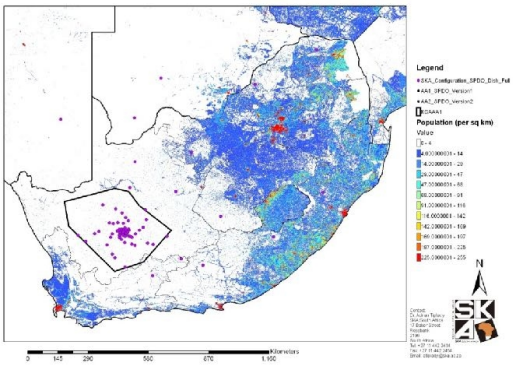
15 September 1994

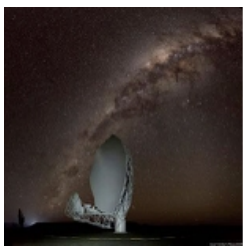
As the incumbent of such a post you are expected to
rve the Republic of South Africa with loyalty, dignity and ho
discharge your duties conscientiously and with diligence a
excellence; be reasonable, fair and mindful of
human dignity in your conduct and
set a good example to those over whom you are appointe

Mandela
President
1996.12.11.

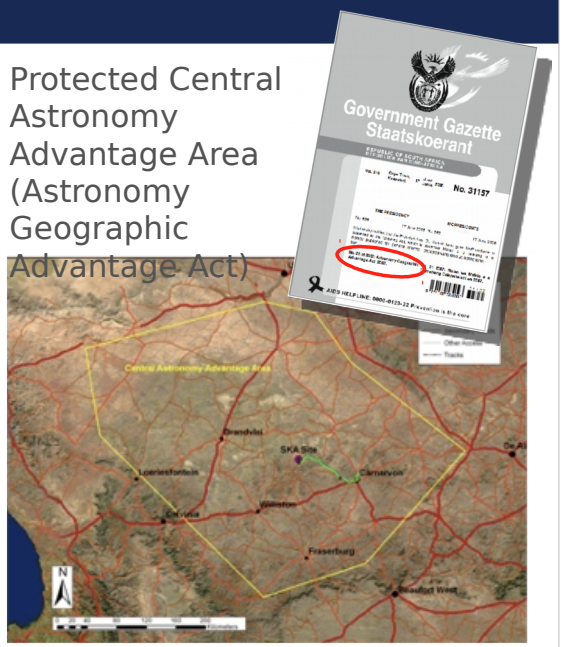
SKA SITE IN SOUTH AFRICA

POPULATION DENSITY





Protected Central Astronomy Advantage Area (Astronomy Geographic Advantage Act)



Alternative telecomms systems for farming communities

SKA IN AFRICA

Partner Countries:

- Botswana
- Ghana
- Kenya
- Madagascar
- Mauritius
- Mozambique
- Namibia
- Zambia

MoU now in place

NASA DSN ARRAY SITE BID 2005
$1BN PROJECT – DELAYED TO 2019?

MEERKAT

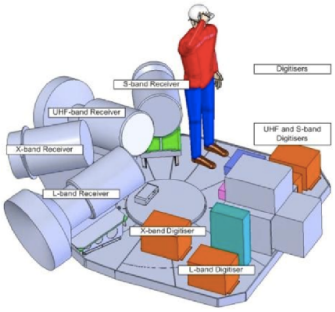
- 2004 – Steering Committee decided to build a South African precursor
  - Technology development
  - Focus for developing a scientific and instrumentation community
  - Show we can do it
  - Have something to show even if the bid fails

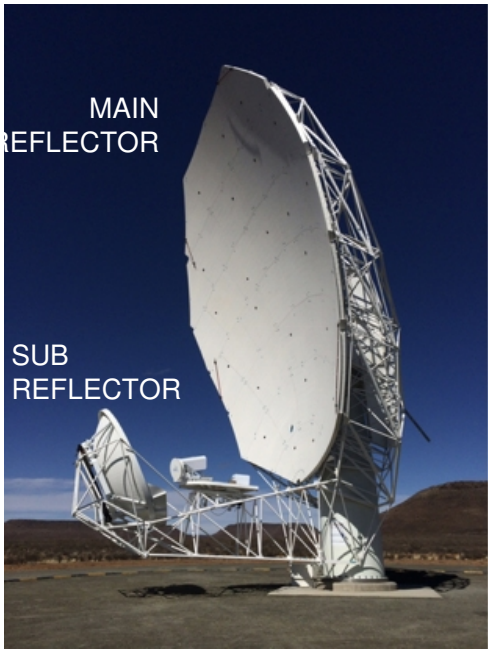
MEERKAT DESIGN AND DECISION-MAKING

- Driven as an engineering project from the start - South African design
  - system engineering and logistics engineering – availability and cost
  - rapid prototyping
  - significant technology innovation
- **Streamlined decision-making – no elaborate science case.**
- Scientific criteria
  - Sensitivity and resolution are good
  - Highest possible dynamic range (clean beam is good – offset dish)
  - FPA or multi-pixel or single pixel? Sensitivity and dynamic range are best.
- Low cost (including first glass fibre 15m dish ever)

MeerKAT DISH – Good to 25GHz Offset Gregorian for a Very Clean Beam

South African design and development
75% by value sourced in SA – new skills, new factories
Combined RMS surface error < 0.25mm
Pointing error 5 arcsec
Cryogenic radio receivers





PERFORMANCE @ 1420 MHZ

	JVLA	MeerKAT RfP	MeerKAT 2013	MeerKAT 2014
N_{dish}	27	64	64	64
D_{dish}	25 m	13.5 m	13.5 m	13.5 m
T_{sys}/ε_a	47.3 K	44.1K	29.4 K	22.5 K
N_{beam}	1	1	1	1
BW	1 GHz	750 MHz	750 MHz	750 MHz
A_e/T_{sys}	1	0.74 (×1)	1.11 (×1.5)	1.45 (×1.96)
SS	1	1.88 (×1)	4.24 (×2.25)	7.24 (×3.84)

Confirmed by subsequent measurements.
T_{sys} measured at <18K.

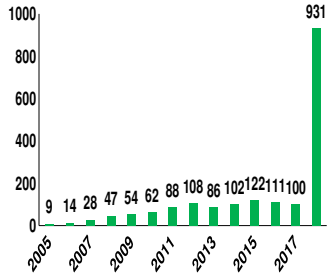
MEERKAT ON A VERY REMOTE SITE

CAPE TOWN CONTROL ROOM

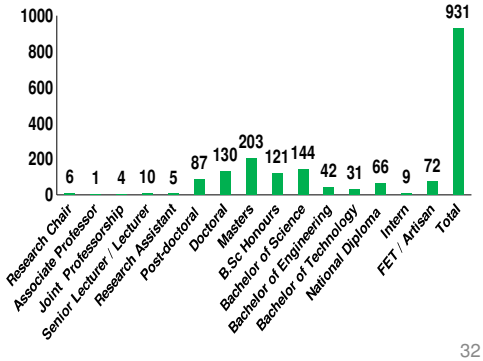
BUILDING A PIPELINE OF PEOPLE

- Human Capital Development Programme started 2005
- Pipeline approach essential for diversity
- Build skills and capacity for SKA and the economy
- Astronomy, engineering, technology, data science
- Human Capital Development Programme
  - Six research chairs
  - Grants programme for Post docs, PhD, MSc, BSc, BTech, National Certificates, artisan training
  - Artisan training centre in the Karoo
  - Schools development programme in the Karoo
- Outreach to schools, science fairs etc.

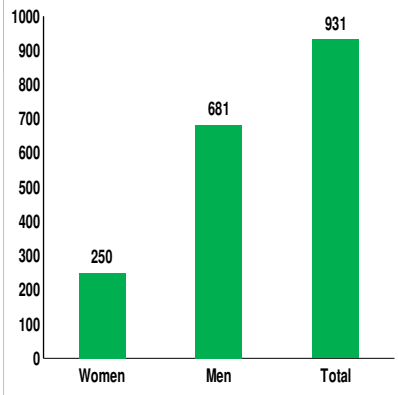
Number of Bursaries, Fellowships and Grants by Year



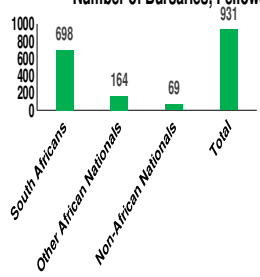
Number of Bursaries, Fellowships and Grants by Academic Level



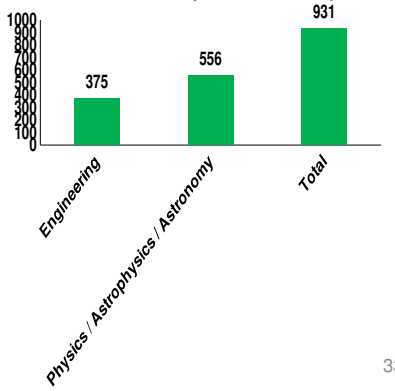
Number of Bursaries, Fellowships and Grants by Gender



Number of Bursaries, Fellowships and Grants by Nationality

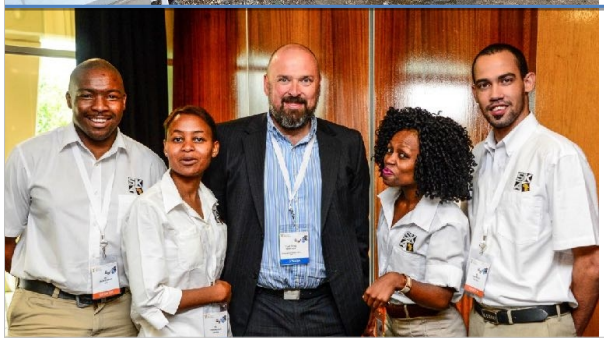


Number of Bursaries, Fellowships and Grants by Field of Study



ANNUAL SKA SA GRADUATE BURSARY CONFERENCE
YOUNG PROFESSIONALS PROGRAMME

To make them feel part of a team.
To get them used to presenting their work to peers and senior researchers.



Outstanding graduates hired through competitive process into SKA SA project office in the Young Professionals Development Programme (now 37 in all).
They work and study further.

KAROO TRAINING

Community knowledge centre

4 of the first 5 school students from the area to pass maths and science with university exemption - supported by SKA SA school bursaries programme and now SKA SA university bursaries

Training and bank financing for local contractors

School teachers

Artisan training centre

ROBOTICS AND CODING AT CARNARVON PRIMARY SCHOOL

Teen Titans – 3rd place in the world robotics competition at Texas Tech

AFRICAN VLBI NETWORK (AVN) : GHANA

Ghanaian Essential Observatory Staff In Cape Town Training

Ghanain trainees at Kutunse

EXCELLENCE IN SCIENCE THE ROYAL SOCIETY

international relations & cooperation
Department:
International Relations and Cooperation
REPUBLIC OF SOUTH AFRICA

African Renaissance Fund

Newton Fund

AVN: REBUILDING THE KUTUNSE DISH

AVN team members in Cape Town

The Kutunse (Ghana) dish has had to be almost completely rebuilt – structure, drives, gears, bearings, receivers, repainting etc. “Unprecedented level of training: engineers, scientists, welders, painters, …. In Ghana”

DARA PROJECT STRUCTURE

- Joint UK – South Africa programme
- Basic Training Programme
    - An introduction to radio astronomy for graduates
    - Theory and practical training; Ghana and South Africa
- Advanced Training
    - MSc and PhD places in the UK and South Africa

•DARA Big Data has been funded alongside DARA2

- Researching synergies in big data techniques with other areas such as climate change, sustainable agriculture, disaster management, smart cities, etc.

•DARA goes global

THE JOCELYN BELL PROBLEM

- Machine learning essential now for big science
- Detecting the unknown unknowns: objects and processes
- Building the Serendipity Machine – others also trying
- How to optimize human insight and knowledge in the search for outliers, patterns etc.? Not our current priority, but important for the future
- ***The black box problem - reproducibility – pipelines, machine learning etc.***
- ***Pipelines need a very serious system engineering process***

Ginny Rometty and Solomon Assefa (IBM) signing a memorandum of understanding with Rob Adam (SKA South Africa)

THE BARRY CLARK / RICK PERLEY (ET AL.) PROBLEM

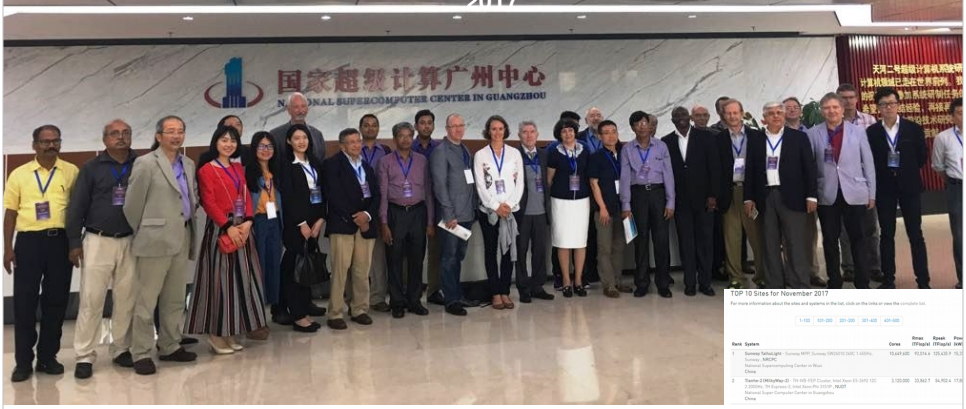
- Huge scale and complexity of SKA (and even MeerKAT) challenges old models for commissioning, ops and maintenance – and getting the best out of the telescope – and getting reproducible results

- Even Barry Clark, Rick Perley, Justin Jonas, Darragh O'Donoghue and their clones may not know and understand every emergent problem (especially as software becomes more prevalent)

THE MARTIN REES PROBLEM

- Dependence on soft money means young and old researchers spend lots of time writing grant and time proposals
- Lots of time spent processing data
  - Post-docs are now usually earmarked for specific projects
  - No time to dream?
- Flood of data from new observatories combined with these trends ….
  When do we think about systematics, patterns and solutions?

BRICS HIGH-PERFORMANCE COMPUTING COMMITTEE GUANGZHOU APRIL 2017



TOP 10 Sites for November 2017

For more information about the sites and systems in the list, click on the links or view the complete list.

1-100 | 101-200 | 201-300 | 301-400 | 401-500

Rank	System	Cores	Rmax (TFlop/s)	Rpeak (TFlop/s)	Power (kW)
1	Sunway TaihuLight - Sunway MPP, Sunway SW26010 260C 1.45GHz, Sunway , NRCPC National Supercomputing Center in Wuxi China	10,649,600	93,014.6	125,435.9	15,3
2	Tianhe-2 (MilkyWay-2) - TH-IVB-FEP Cluster, Intel Xeon E5-2692 12C 2.200GHz, TH Express-2, Intel Xeon Phi 31S1P , NUDT National Super Computer Center in Guangzhou China	3,120,000	33,862.7	54,902.4	17,8

SKA SA HISTORY

- Bernie Fanaroff and Graeme Addison writing it
- Telling the story through experiences of many individuals
- Tell us what you would like to know
- Give us anecdotes
- Send pictures
- bfanaroff@ska.ac.za