An African VLBI network of radio telescopes

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Current VLBI-capable Radio Telescopes in Africa

26m Radio Telescope, HartRAO, South Africa
UV Coverage for Africa

HART
EB_VLBA
NOTO
TORUN
YEBES40M
MEDICINA
WSTRBORK
JODRELL1
GOONHILL
SHANGHAI
BADARY
ZELENCHK
SVETLOE
URUMQI
DECL=+20
African Countries with Large Satellite Earth Station Antennas

- SA SKA partners with large antennas:
  - South Africa, Ghana, Kenya, Madagascar, Zambia
- SA SKA partners without large antennas:
  - Botswana, Mauritius, Mozambique, Namibia
- Other African countries with large antennas:
  - Algeria, Benin, Cameroon, Congo Democratic Republic, Congo Democratic Republic, Congo People's Republic, Egypt, Ethiopia, Gabon, Malawi, Morocco, Niger, Nigeria, Senegal, Tunisia, Uganda, Zimbabwe
Africa VLBI Network - Potential

Large satellite antenna locations
North African Satellite Stations

Morocco
Souk el Arba
2011

Algeria
Lakhdaria
2011

Tunisia
Dikhla
2011

Egypt
Mahdi
2011
West African Satellite Stations

- Senegal
  - Gandoul
  - 2011
- Niger
  - Karma
  - 2009
- Nigeria
  - Kujama
  - 2009
- Nigeria
  - Lanlate
  - 2003
- Ghana
  - Kuntunse
  - 2011
East African Satellite Stations

Ethiopia
Sululta
2009

Uganda
Mpoma
2010

Kenya
Longonot
2010
West Central African Satellite Stations

Congo
Kinshasa
Nsele
2005

Congo PR
Moungouni
2009

Benin
Abomey
Calavi
2002

Cameroon
Bepande
2009
Southern African Satellite Stations

- Malawi
  - Kanjedza
  - 2010

- Zambia
  - Mwembeshi
  - 2001
  - 30m not in use 2009
  - Rehab quote 2011

- Zimbabwe
  - Mazowe
  - 2010

- Madagascar
  - Tsirinana
  - 2009

- South Africa
  - Hartebeesthoek
  - 2010

- South Africa
  - Hartebeesthoek
  - 2010
VLBI networks benefiting

European VLBI Network
Australia Telescope Long Baseline Array
MeerKAT
SKA?
Astrometry (IVS)?
EVN + HartRAO + Ghana

Michael Bietenholz
Benefits of antenna conversion for the country

- Continued use of very expensive installation that is now or is becoming redundant, at relatively low cost
- In country training in practical radio astronomy:
  - Single-dish research
  - Very Long Baseline Interferometry (VLBI) for high angular resolution imaging
- Create a pool of astronomers able to use current and future radio telescope arrays
- Stimulate fibre optic network development with spinoff for country
  - Links to global radio astronomy networks through VLBI
- Opportunities for training, research and development in engineering and technology:
  - low-noise microwave feeds and receivers
  - analogue and digital electronics
  - digital signal processing
  - control and monitoring systems
  - software engineering
  - wide bandwidth networks
- Stimulate interest in science, engineering and technology through outreach programme
- Promote the establishment / development of a national Space Agency
Science Objectives - VLBI

Imaging with high angular resolution of compact, bright radio sources:

- Quasars – changes in jet structure, calibrators, astrometry
- Microquasars – behaviour and parallaxes - distances
- Masers – star-forming (e.g. methanol) – understand variability and measure the distances to star-forming regions in the Milky by parallax, to map spiral arms
- Pulsars – proper motions and parallax, interstellar scattering, emission region size
- Transient sources
- Supernovae – behaviour of exploding star remnants
- Interacting binary star behaviour
- E-VLBI and TOO VLBI through internet – rapid response to new events
Science Objectives – single dish

- West African and Central African stations:
  - Near equator so see more of the sky than any other radio telescope
  - Can see the entire Milky Way

- Single dish opportunities:
  - Spectroscopy with narrowband multi-channel receiver
    - Monitor masers in star-forming regions eg for periodic variations (methanol at 6668MHz, 12178MHz)
    - Survey formaldehyde absorption in Milky Way dark clouds (4829 MHz, 14488MHz)
  - Pulsar observing with wideband multi-channel receiver
    - Monitor pulsars for glitches, long term behaviour, proper motion
    - Search / monitor for intermittent pulsars and transients (RRATs)
  - Radio continuum flux measurement with wideband multi-channel receiver
    - Monitoring of Gamma-ray flare sources
Antenna conversion examples

Australia Ceduna - operating
Japan Yamaguchi - operating
Peru Sicaya – First light 2011/03

New Zealand Warkworth - handed over 2010/11
Ireland Elfordstown – handed over 2011 May
England Goonhilly – shut down 2008, seeking funding
A Recipe for the Conversions?

Imbriale, Weinreb, Jones, Mani