



The Ghana 32m Radio Telescope (Nk)

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Acknowledgement:



Outline

- **Introduction of Nk; GRAO**
- **Current State of Nk and the way forward**
- **Impact of Nk, the Ghana Radio Telescope**
- **Capacity Building in Radio Astronomy**
- **Future of the GRAO: Nk**

Nk: Ghana 32m Radio Telescope (GRAO)

AVN Ghana Project

- Hosted at GRAO (Ghana Radio Astronomy Observatory)
- Located at Kuntunse, a suburb 25km west of Accra
- Converted and refurbished telescope from a disused Satellite Communication Earth Station Antenna
- First AVN operational radio telescope (AVN Ghana)



GRAO, Kuntunse, Accra - Ghana



White Dots: Redundant satellite communication earth station antennas across Africa

Official Launch: August 24, 2017



Daily Graphic
No. 20464 Friday, August 25, 2017 Visit www.graphic.com.gh PRICE GH¢2.50
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President Akufo-Addo attending a press conference at the launch of the Ghana Radio Astronomy Observatory

Ghana launches radio telescope

To harness potential of space science

Story on page 3

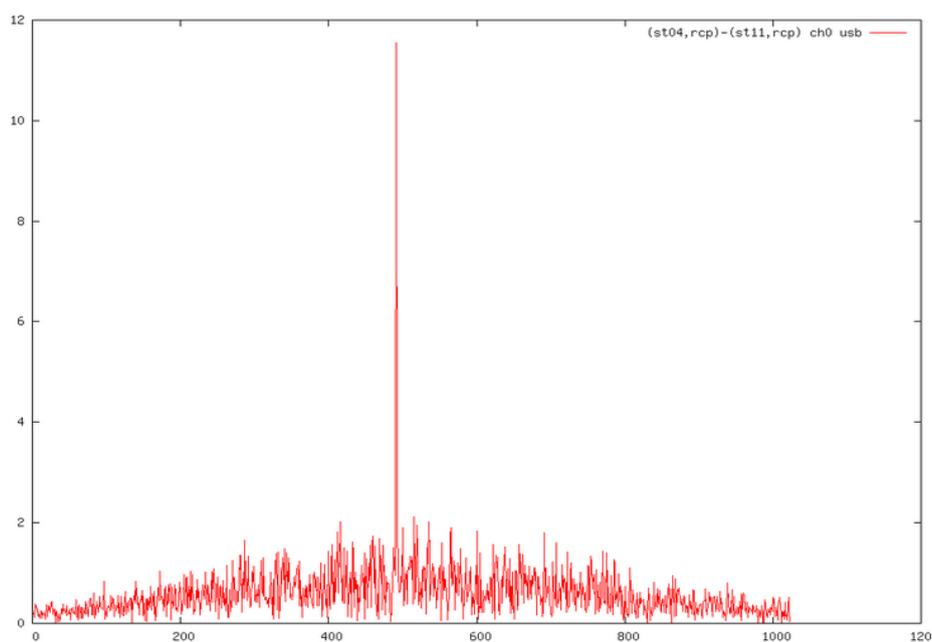
Appearance in EVN Observations: Nk

EVN Observations

- Still in early science mode or commissioning stage
- Joined a couple of times since last year (Feb. 2017) with **Dr. James Chibueze** as the lead VLBI astronomer
- Participated in latest observations (i.e., N18C1) on May 05, 2018
- And performed not badly at all in fringe testing/detections

| Nk | -- | - + | + - | ++ | invalid | avg sign bit | avg mag bit |
|----------------------|--------|--------|--------|--------|---------|--------------|-------------|
| 4966.49MHz, LSB, Rcp | 1.531% | 2.543% | 2.533% | 1.518% | 91.87% | 0.4986 | 0.4998 |
| 4966.49MHz, LSB, Lcp | 1.525% | 2.547% | 2.537% | 1.516% | 91.87% | 0.4989 | 0.5001 |
| 4966.49MHz, USB, Rcp | 1.494% | 2.513% | 2.544% | 1.574% | 91.87% | 0.5069 | 0.503 |
| 4966.49MHz, USB, Lcp | 1.481% | 2.524% | 2.563% | 1.557% | 91.87% | 0.507 | 0.5022 |
| 4982.49MHz, LSB, Rcp | 1.528% | 2.549% | 2.538% | 1.509% | 91.87% | 0.4981 | 0.4995 |
| 4982.49MHz, LSB, Lcp | 1.524% | 2.547% | 2.535% | 1.52% | 91.87% | 0.499 | 0.5004 |
| 4982.49MHz, USB, Rcp | 1.48% | 2.519% | 2.56% | 1.565% | 91.87% | 0.5078 | 0.5027 |
| 4982.49MHz, USB, Lcp | 1.482% | 2.526% | 2.561% | 1.556% | 91.87% | 0.5067 | 0.5024 |
| 4998.49MHz, LSB, Rcp | 1.528% | 2.548% | 2.54% | 1.51% | 91.87% | 0.4984 | 0.4994 |
| 4998.49MHz, LSB, Lcp | 1.525% | 2.549% | 2.539% | 1.511% | 91.87% | 0.4986 | 0.4997 |
| 4998.49MHz, USB, Rcp | 1.489% | 2.511% | 2.553% | 1.573% | 91.87% | 0.5078 | 0.5026 |
| 4998.49MHz, USB, Lcp | 1.49% | 2.516% | 2.55% | 1.568% | 91.87% | 0.5069 | 0.5027 |
| 5014.49MHz, LSB, Rcp | 1.534% | 2.545% | 2.532% | 1.514% | 91.87% | 0.498 | 0.4996 |
| 5014.49MHz, LSB, Lcp | 1.532% | 2.539% | 2.536% | 1.518% | 91.87% | 0.4989 | 0.4993 |
| 5014.49MHz, USB, Rcp | 1.506% | 2.489% | 2.541% | 1.589% | 91.87% | 0.5083 | 0.5019 |
| 5014.49MHz, USB, Lcp | 1.481% | 2.521% | 2.562% | 1.561% | 91.87% | 0.5075 | 0.5024 |

Performance in N18C1 Observations



Fringe testing/detection in N18C1 scan 01

| | Jb | Wb | Ef | Mc | Nt | O8 | T6 | Ur | Tr | Ys | Sv | Bd | Zc | Hh | Ib | Km | Nk | Cm | Da | Kn | Ta | De | |
|-------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|---|
| Observed | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Frng. (ftp) | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | N | N | N | N | N |
| Record. OK | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Crs.pols OK | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | - | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Check VCs | | | | | | | | | | | | | | | | | | | | | | | |
| See notes | | b | | | | c | | | | | a | | | | | | d | e | e | e | e | e | e |

Participation in N18C1 Observations on May 05, 2018

Still in Early Science Operations Mode

Testing system in both:

- * Single Dish Mode
- * Network (VLBI) Mode

A probable publication from the test observations (verification and validation events)

Pulsar Astrophysics - The Next Fifty Years

Proceedings IAU Symposium No. 337, 2017

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P. Weltevrede, B.B.P. Perera, L. Levin Preston & S. Sanidas, eds. DOI: 00.0000/X0000000000000000X

Pulsar Observations at the Ghana Radio Astronomy Observatory

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Current State of Nk

- **Uncooled dual pol. receiver system: (using Rb GPS clock)**
- Operational frequencies
 - * **5 GHz (124 MHz)**
 - * **6.7 GHz (370 MHz)**
- Azimuth range:
 - 8 - 327 deg
 - (Az challenge: 327 – 352 deg)
- Elevation range:
 - 5 - 90 deg
 - (science purpose: > 10 deg)
- **Slew rate (max. speed):**
0.27 – 0.29 deg/sec
- **Angular Resolution at 6.7GHz:**
6 arcmin (0.1 deg).



Steerable in both automatic and manual modes

Key Components of Nk System



★ The Rack with Science Equipment:

- ROACH-1
- DBBC / MarkV
- Pulsar Timing System (PTS) *
- Rubidium GPS Clock



★ Antenna Steering Controller System (ASCS)

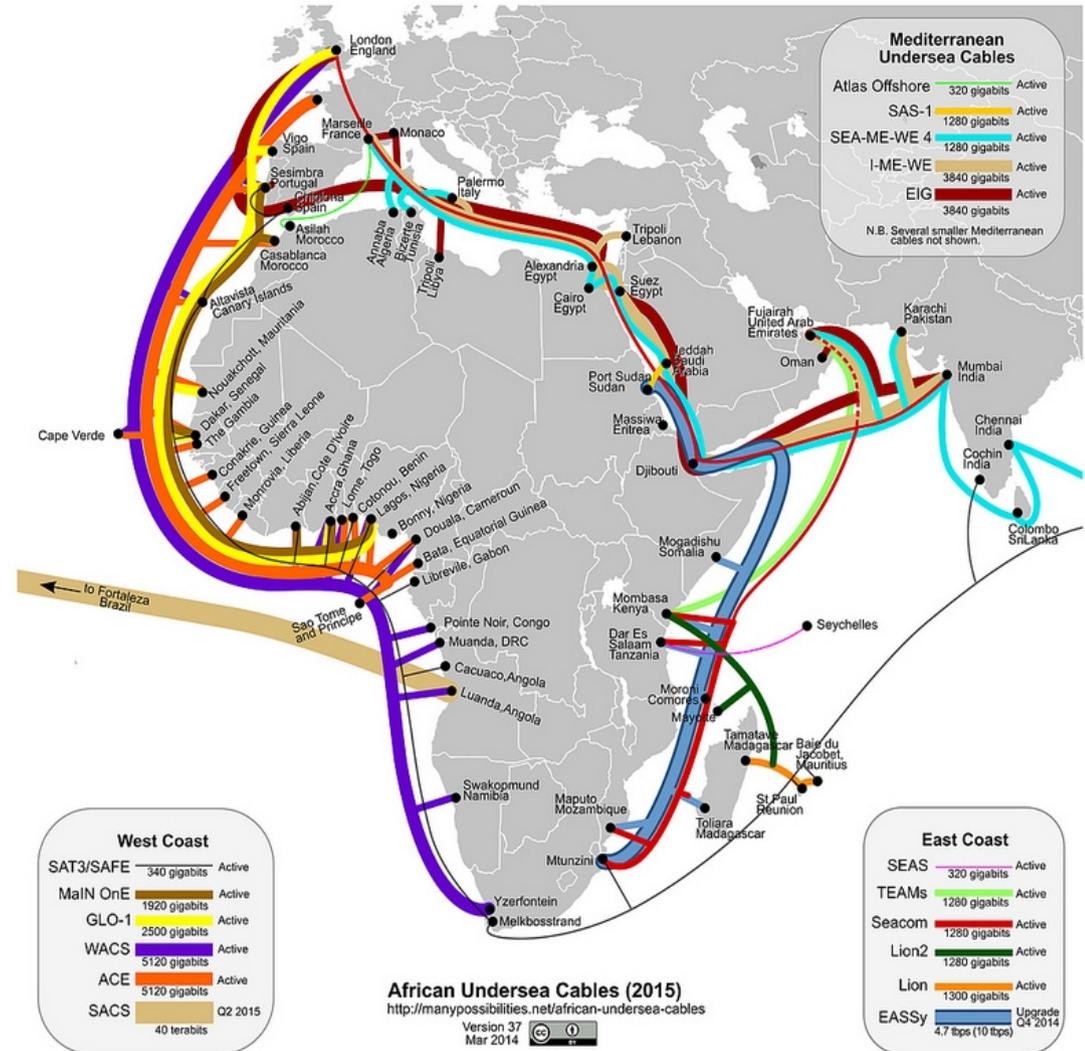


★ Dual Uncooled receiver (C-band) system at central frequencies of 5 GHz and 6.7 GHz

Potentials and Relevance of Nk

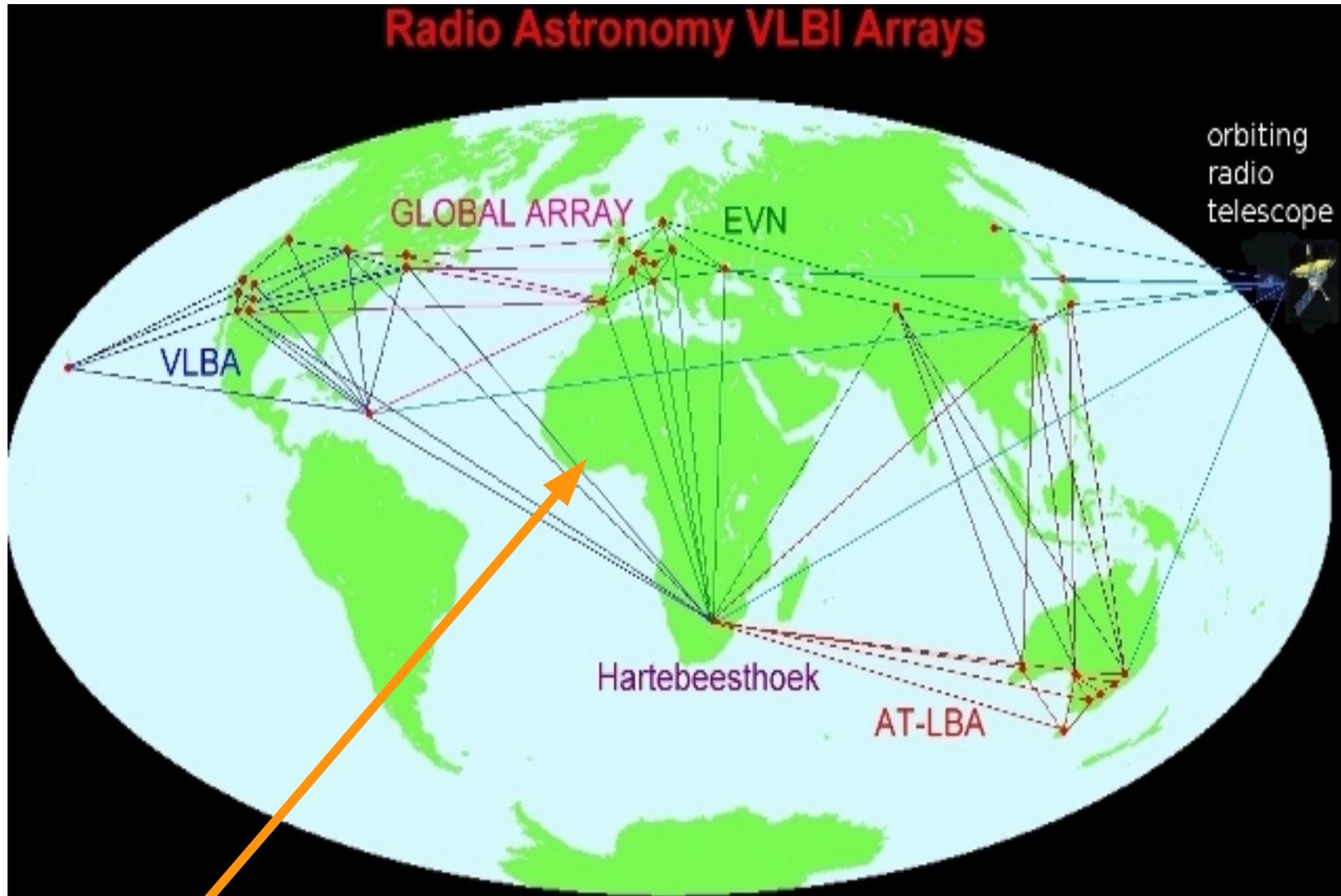
Both Science Cases:

- single dish observations
- VLBI Networks
- Ghana's **location** of 5° North of the Equator gives it a distinct advantage of viewing the entire plane of the Milky Way and nearly the whole sky better than any existing telescope.
- It's **proximity** to the African Undersea Optic Fiber Cables promises greater bandwidth and faster internet connectivity for data transport, an added advantage



African Undersea fiber Optic Cables

The Big Hole in Existing VLBI Networks: Nk ?



Existing VLBI Networks

Will full Nk help in any little way ?

To Do and Ongoing Tasks



- Hydrogen maser
- Pulsar Timing System
- Fix Az limitation
- Install Weather station (embedded with seismic activities warning system)
- Working to improve the pointing accuracy



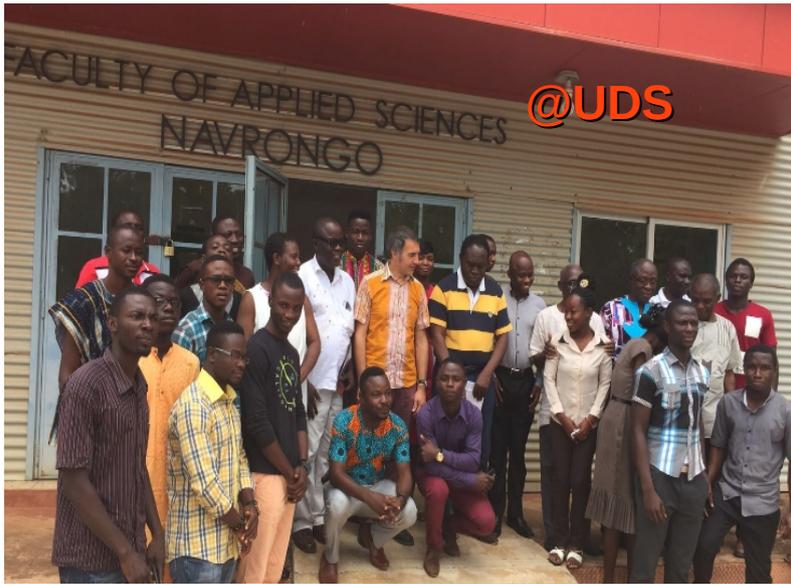
Capacity Building in Radio Astronomy & Technology

- Training programmes for graduate students (Royal Society - DARA)
- Summer schools for young astronomers/graduate (eg. WAISSYA-2017):
more local ones in future
- Study opportunities for our participating students...
- Schools and Group visits at Kuntunse (GRAO)
- Invitational talks at schools/colleges/universities
- Facilitators/Teachers Workshops *
- Astronomy clubs in the secondary schools and higher educational institutions
- **Introduction of Astronomy in school curriculum - pushing**
- **Media (FM, TV, print..) interactions and engagements:**

Astronomy Development: Outreach & Training



Outreach – University Tour



August 25 – September 03, 2017

Royal Society/ Newton Fund: Training Programme



Participants

- Cohort 1 - 12
- Cohort 2 – 13
- Cohort 3 - 11

During 2014 - 2017



Royal Society/Newton Fund Training Outline

Course Units for the Cohorts:

1. Astrophysics, Radio Astronomy Theory and multi-wavelength Astronomy
2. Radio Astronomy Observation, Survey Astronomy and Communication Skills
3. Radio Astronomy Data Reduction and Analysis, Telescope Time and PhD Applications
4. Satellite communication and Commercial Awareness (Entrepreneurship)
5. Observational and Technical training
6. Overseas Experience

Instructors for the Cohorts

1. *Prof. Melvin Hoare (UK)*
2. *Dr. Sharmila Goedhart (SA)*
3. *Dr. Charles Copley (SA)*
4. *Mr. Ian Jones (UK)*
5. *Dr. Katerine Johnson (UK)*
6. *Dr. Jay Blanchard (JIVE)*
7. *Dr. Alastair Gunn*
8. *Prof. Benjamin Strapper & PhD std Thomas*
9. *Dr. James Chibueze*
10. *South Africa AVN and Ghana Team, etc..*



Prof. Melvin G Hoare

Royal Society/DARA Training: PhD & MSc Studentship



Cohorts 1 & 2 Products

Alexander – PhD in SA (Rhodes)

Proven - PhD in Ghana (UG)

Benedicta- PhD in Ghana (UG)

Diana- MSc in SA (Rhodes)

• Emmanuel – Msc in UK (HU)

• Michael – Msc in Russia

• Benjamin – Msc in Finland

Mavis – MSc in SA (NWU)

Prosper - MSc in Brazil

• Kingsley – PhD (DARA), UK

Emmanuel – Msc/PhD (DARA), UK

Joseph- Msc (DARA) in UK

Naomi – PhD (DARA) in UK (MU)

Kuntunse Telescope Trainee Operators

- **Andrews**
- **Kingsley**
- **Benedicta**



DARA – Development of Africa with Radio Astronomy, a Newton Fund Project

The Mega Summer School – WAISSYA-2017

- 17 Instructors from Canada, Germany, South Africa, Nigeria, Gabon and Ghana
- About 80 students from Ghana and other West Africa countries
- Outreach to 3 schools
- Observational training with the Ghana 32m radio astronomy telescope (Nk)



Upcoming Programmes (2018)

- + HPC System administrators training
- + DARA (Ghana-Kenya) Technical and Observational training
- + HPC Applications in Astronomy and Meteorology Training
- + DARA/CHPC LINUX / Python training
- + ESO ART Outreach to Cape Coast University
- + **Teachers/Facilitators Workshop (Jumping Jive ?)**
- + Dish Conversion Workshop (STFC-UK)

Take Home Messages

- **Ghana has launched a 32m radio telescope (GRAO) in collaboration with South Africa at Kuntunse near Accra (known as the AVN Ghana, and as Nk to the EVN community)**
- **Astronomy has come to stay in Ghana with With Nk as pacesetter: a field the country has warmly embraced.**
- **Many enthusiastic students and young persons are seeking for opportunities to build carriers in astronomy and related fields to fully realize the potentials in the fields for socio-economic gains**
- **Ghana (Nk) is calling on all interested parties and institutions for partnerships, supports, collaborations and assistances in all areas of interests.**