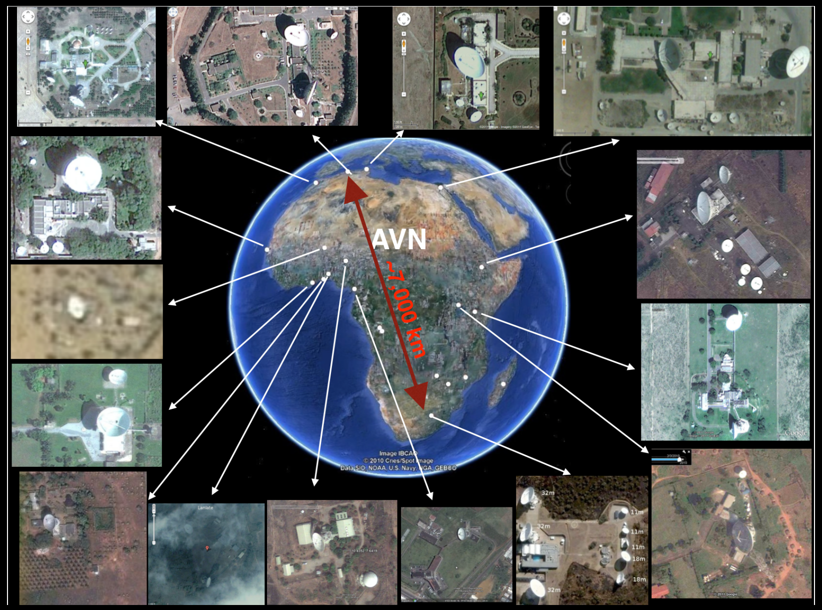
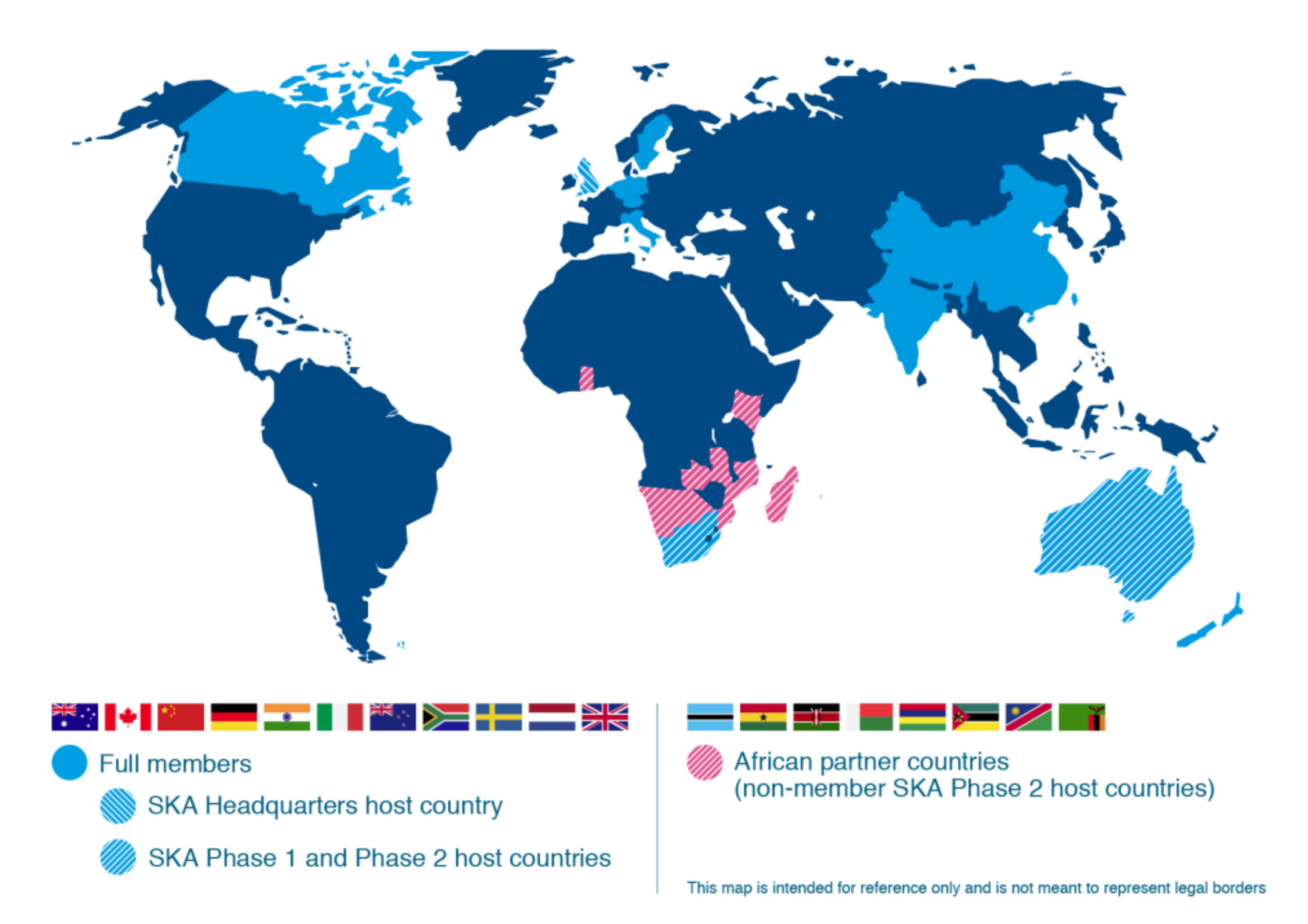
African VLBI Network (AVN) - Status and Initial Science Results



James O. Chibueze
(SKA/AVN, University of Nigeria)

SKA– Key Science Drivers: The history of the Universe

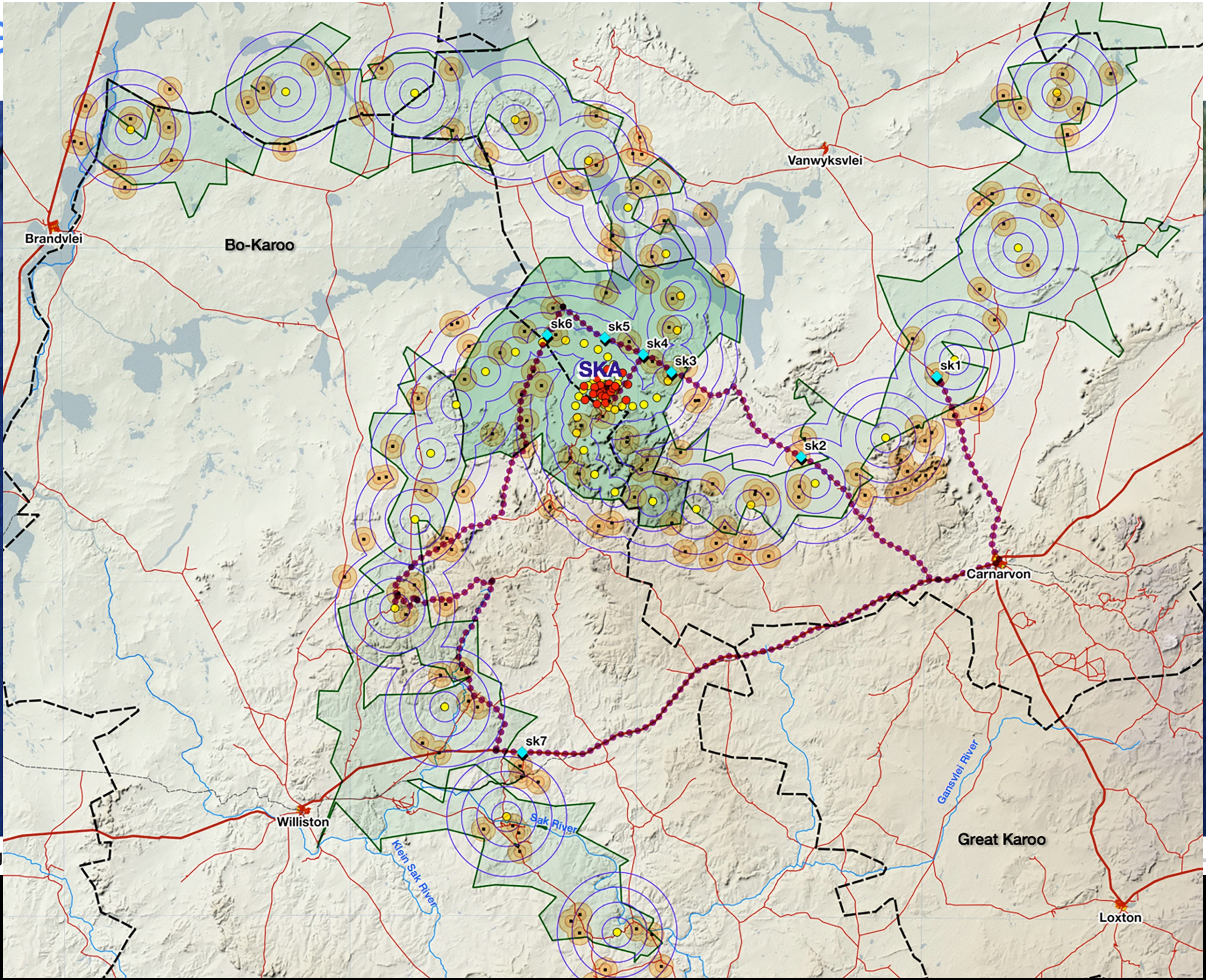
Broadest science range of any facility on or off the Earth.



Member countries:
Australia
Canada
China
India
Italy
South Africa
New Zealand
Sweden
The Netherlands
United Kingdom

Interested countries:
France, Japan, Malta, South Korea, Poland, Portugal, Switzerland, Spain

Contacts: Brazil, Ireland, Russia


Brandvlei
Bo-Karoo
Vanwyksvlei
SKA
sk6
sk5
sk4
sk3
sk2
sk1
sk7
Carnarvon
Williston
Sak River
Klein Sak River
Gansvlei River
Great Karoo
Loxton

KAT-7 (MeerKAT precursor - operational since 2009)

Image: Maik Wolleben

SKA
SKA AFRICA
SQUARE KILOMETRE ARRAY

MeerKAT (64-dish SKA precursor - under construction)

Image: SKA SA

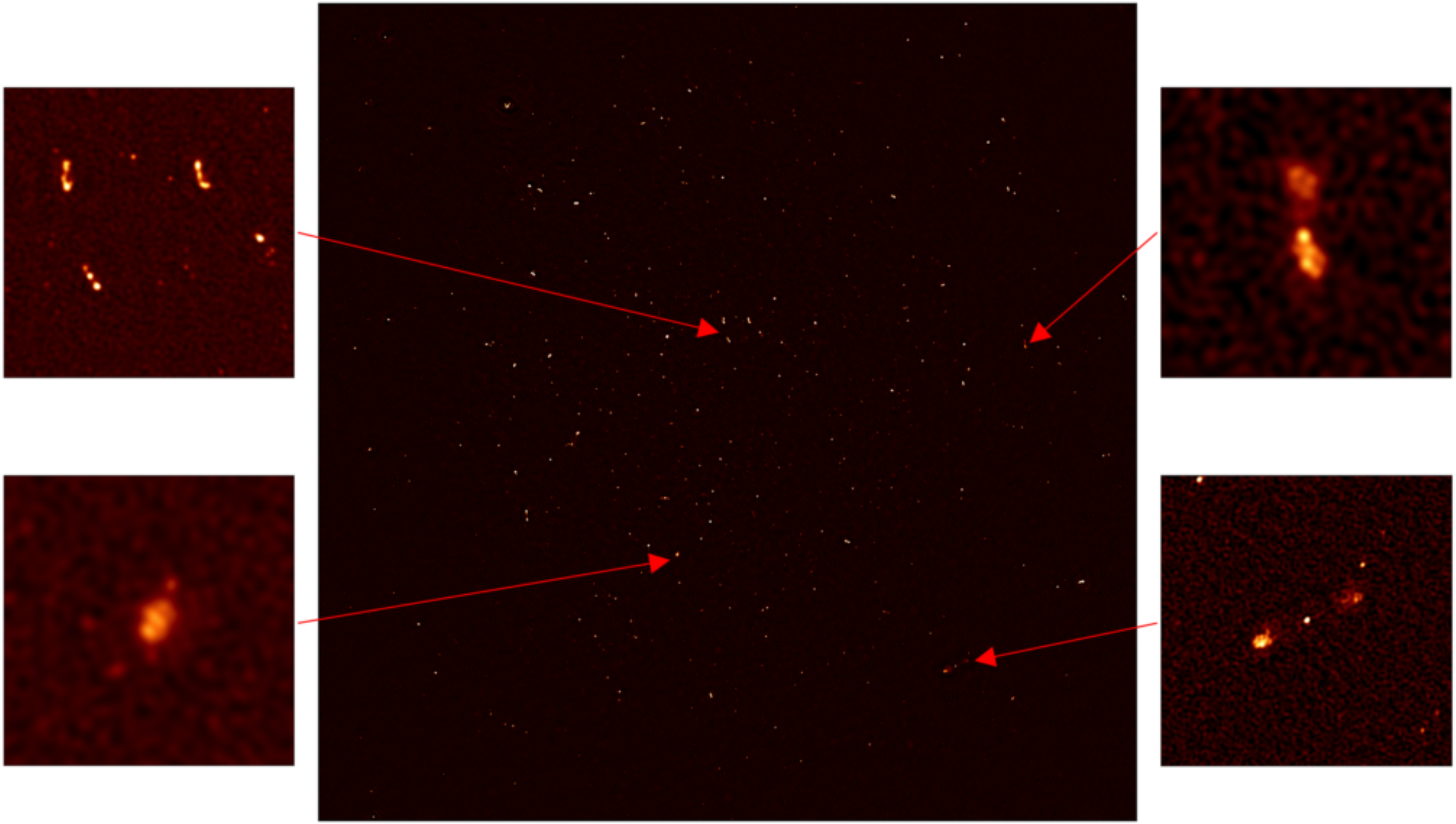
SKA
SKA AFRICA
SQUARE KILOMETRE ARRAY

MeerKAT (64-dish SKA precursor - under construction)

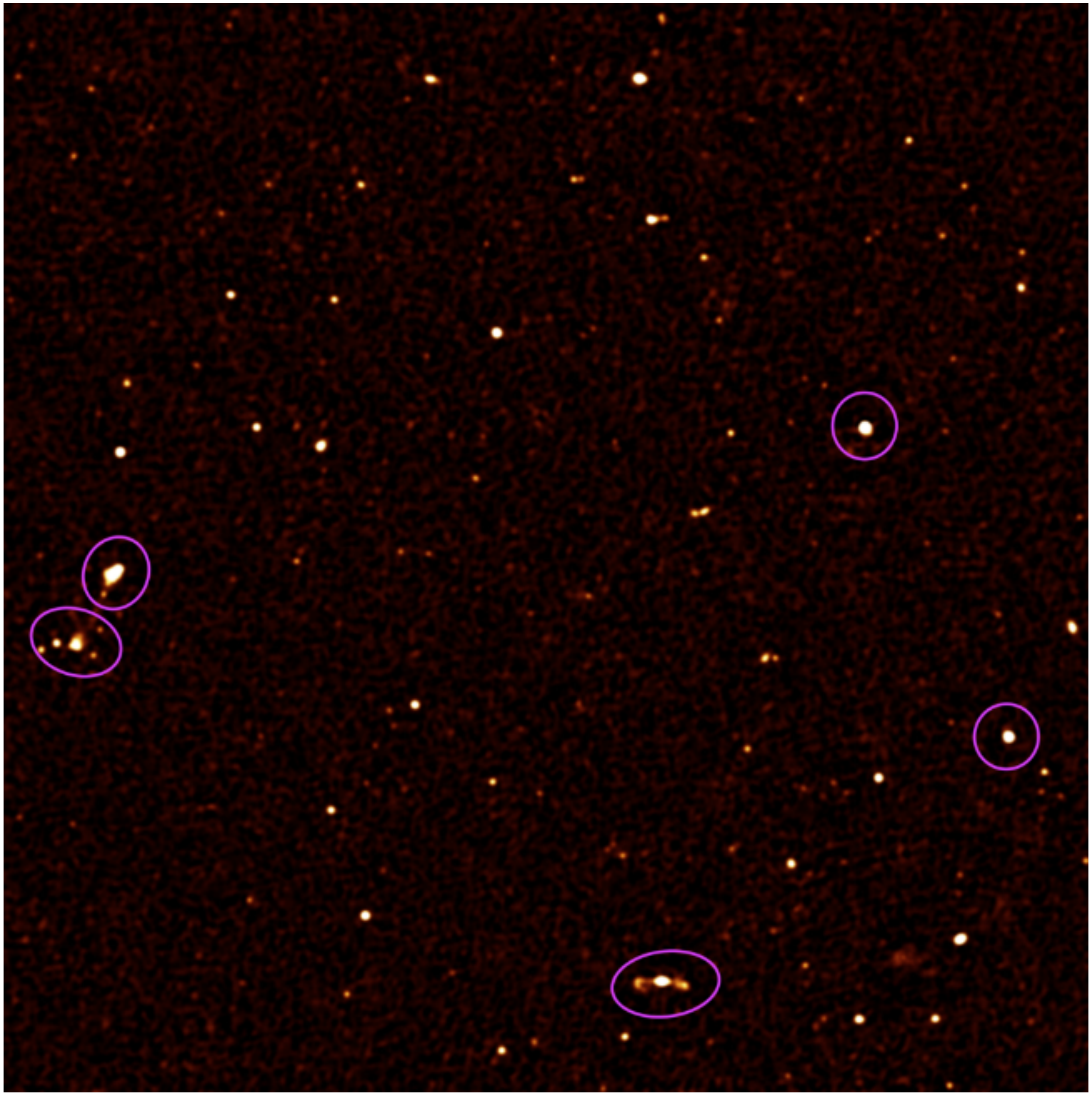
Image: SKA SA

64th (last MeerKAT) antenna lifted onto its pedestal (18 Oct, 2017)
56 antennas handed over for integration into the array.

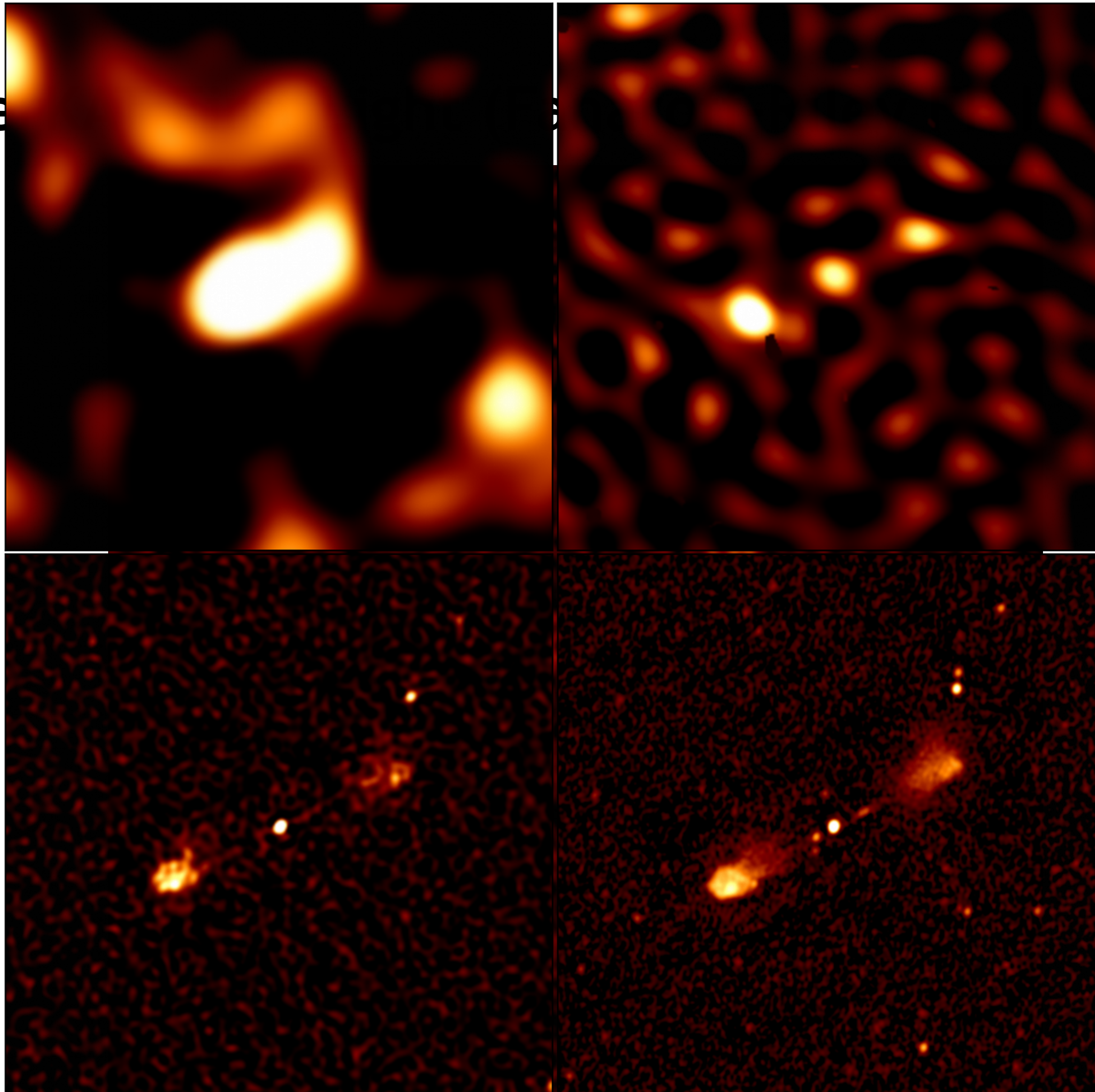
MeerKAT First Light Image



MeerKAT First Light 10% (purple=known)



Mee e alaxy)




+00.6°
+00.4°
+00.2°
+00.0°
-00.2°
-00.4°
-00.6°
-00.8°
Galactic Latitude
+00.6°
+00.4°
+00.2°
+00.0°
-00.2°
-00.4°
-00.6°
-00.8°
Galactic Latitude
332.5°

African VLBI Network (AVN)

SKA-South Africa partner countries

Little or no radio astronomy in partner countries.

Key question: How will they handle such a big project?

Options???? Build mini-SKA for training the partner countries.

Cost?

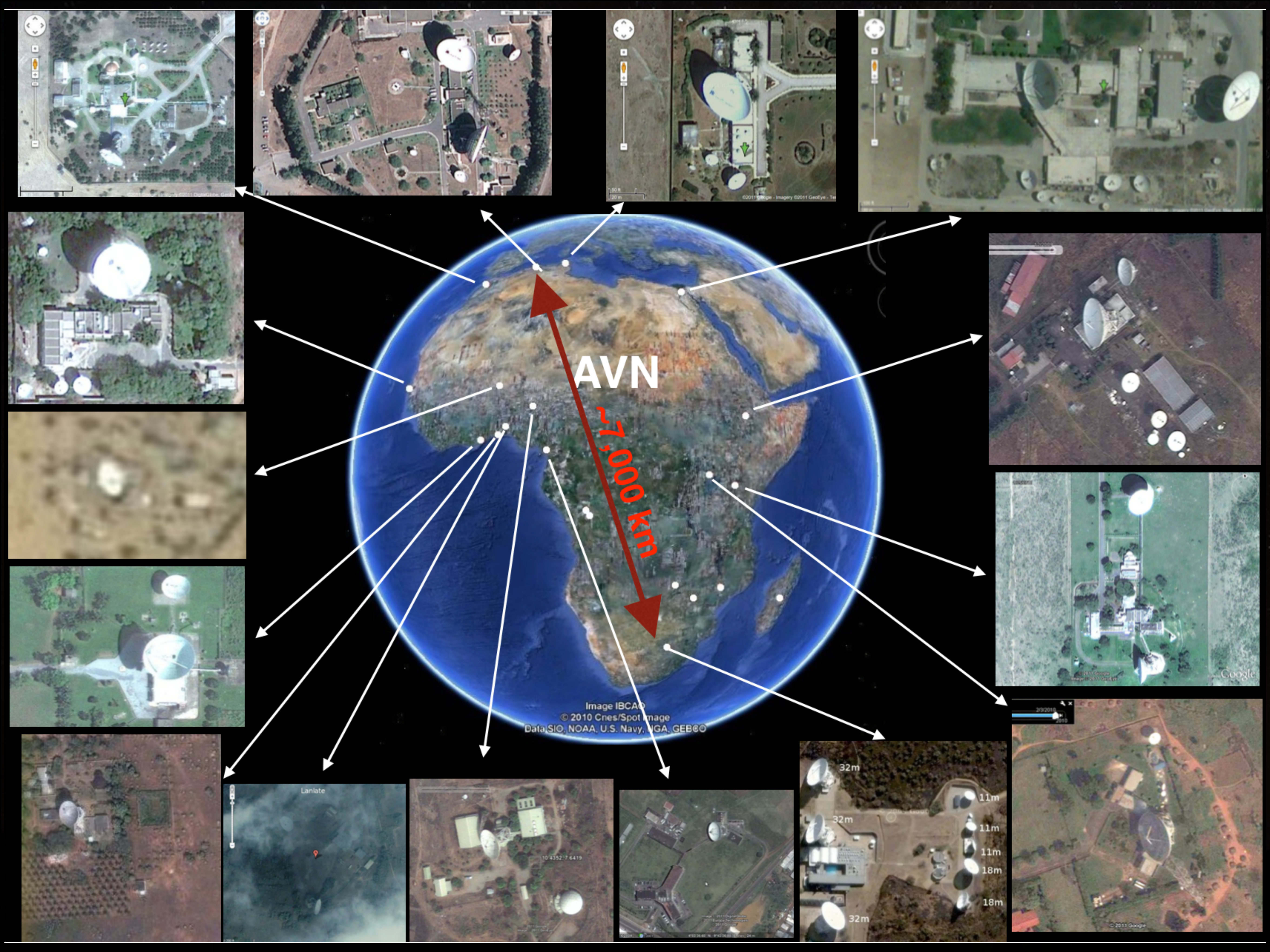
Objectives

- Develop a network of VLBI-capable radio telescopes on the African continent
- Africa (led by South Africa) to co-host the Square Kilometre Array telescope with Australia, 9 African countries to host stations in SKA2 (including SA):

– Develop the skills, regulations and institutional capacity needed in SKA partner countries to optimise African participation in SKA2 and enable participation in SKA pathfinder technology development and science

– Skills and knowledge transfer in African partner countries to build, maintain and operate radio telescopes independently

– Bring new science opportunities to Africa on a relatively short time scale and develop strong RA science communities.


AVN
~7,000 km
Image IBCAO
© 2010 Cnes/Spot Image
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Lanlate
32m
32m
32m
11m
11m
11m
18m
18m
Google
© 2011 Google

Starting point — GHANA

"VLBI = Science + Politics"

Ghana core essential observatory team trained in SA

One per discipline: Structural & Mechanical Engineering, Control and Monitoring Engineering, Analog & Digital Electronics (Signal Chain / RF Engineering, Software (data processing, control software, user interfaces etc.), project management.

Conversion process

Structural and mechanical

Conversion process

Quadrupod

Original quadrupod structure. The quadrupod legs have to be rigid enough to ensure that the 300kg subreflector is held in the correct position, at the correct angle, in order to focus signals along the right path down the beam waveguide.

From left: Alex and Sampson in undergoing welding training according to AWS D1.1 techniques. Test plate produced by Sampson. Inspecting the test welds using radiography. Radiography inspection plate.

Alex Nahr | Award of training certification | Sampson Saah

The path to a new quadrupod...

Clearing the factory | Tube mounts installed | Cutting the plate for the tube sections | Rolling and welding tube sections | Visual inspection of longitudinal welds | Joining two tubes together | Quarter-lengths done!

A tight spot! Visual inspection of root welds.

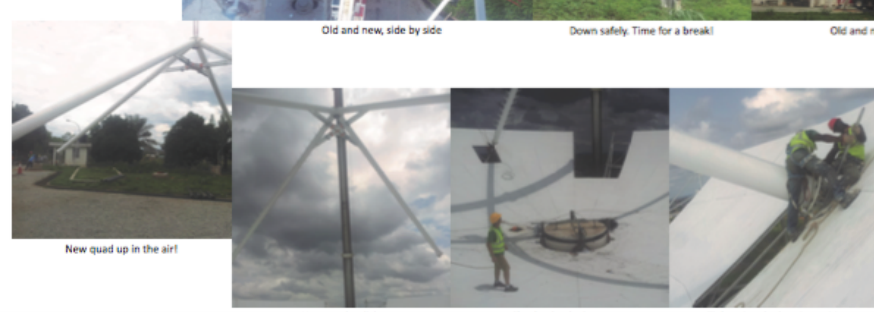
Done! | Rungs, cross-brace attachments, and primer | Visual inspection of flange welds | Attaching end flanges | Full lengths appearing!

Loading onto the truck that will take them to Kuntunse

Slow and steady from GAEC to Kuntunse | Temporary support to enable assembly | One leg up | Two legs up | New quadrupod, ready for installation!

Lots of risk needs lots of planning

Old and new, side by side | Down safely. Time for a break! | Old and new | Up and away! | Getting ready to lift | Bracing the old structure at its weakest points



New quad up in the air!

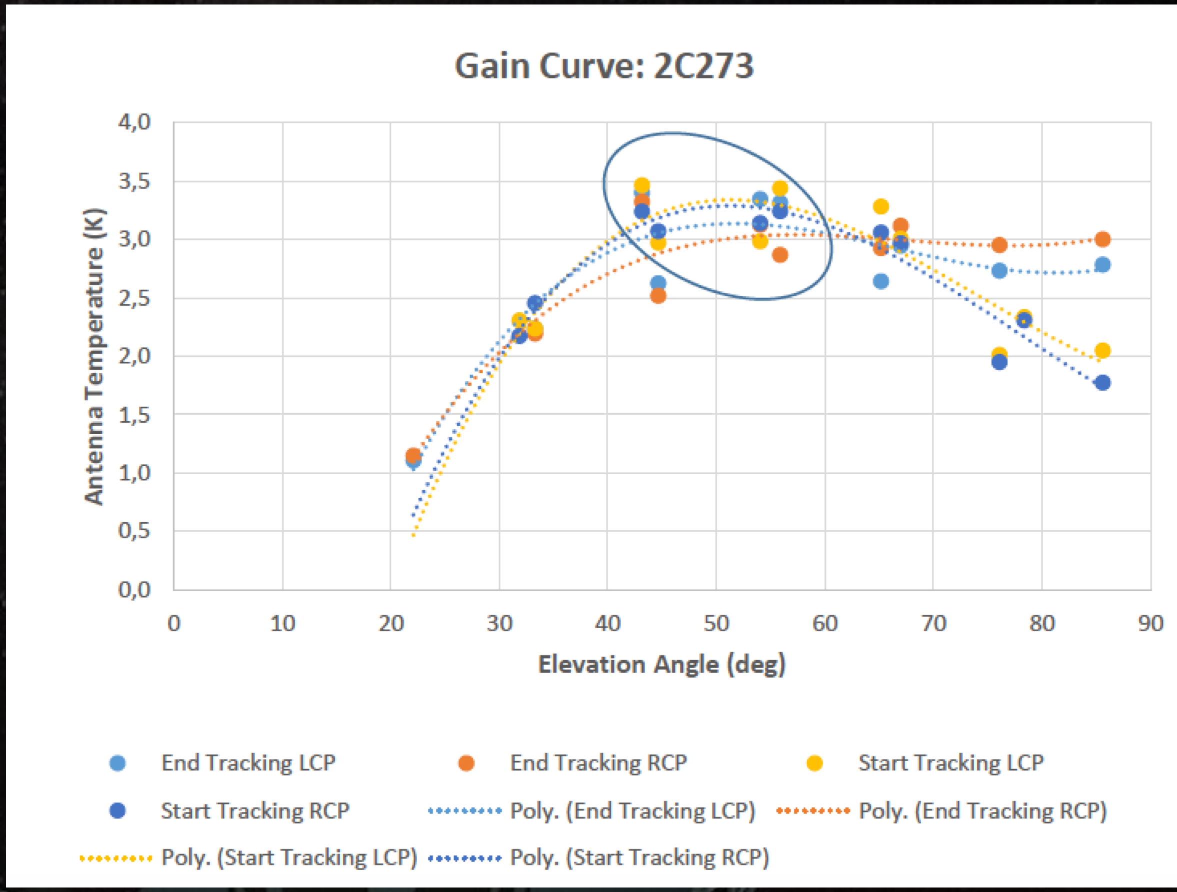
Up over the dish | Slowly, slowly down | Tightening the legs in position

The Installation Team

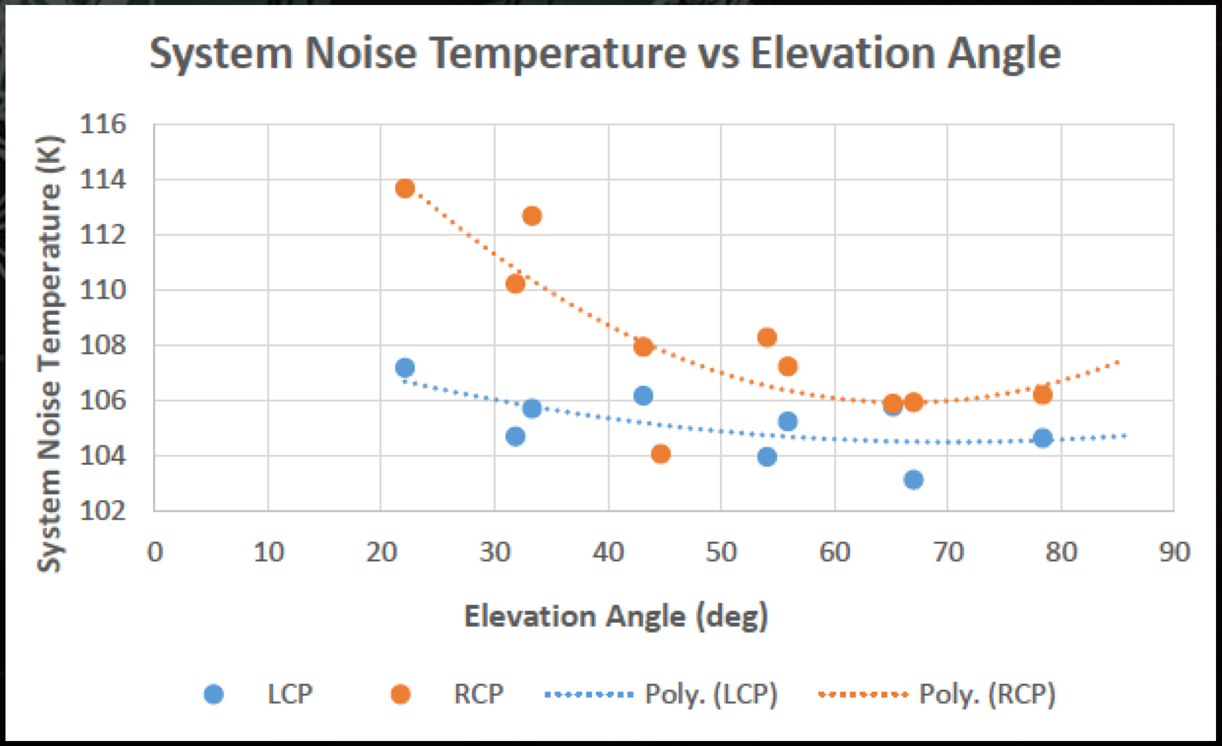

GHANA RADIO ASTRONOMY OBSERVATORY
TLC200 PRO 2016/09/22 16:36:41

Spec

- ★ 32-m, beam wave-guide
- ★ C-band (4 — 8 GHz, ambient receiver)
- ★ HPBW 6’
- ★ 400 MHz wideband, 1.56 MHz narrowband
- ★ System Equivalent Flux Density (SEFD) 975 Jy.
- ★ Continuum and spectral line observations
- ★ Very Long Baseline Interferometry (VLBI) capabilities

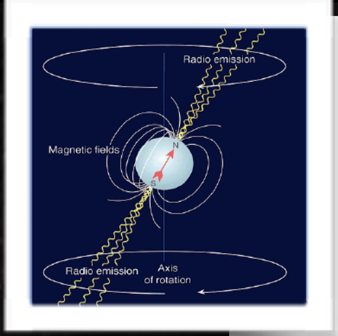


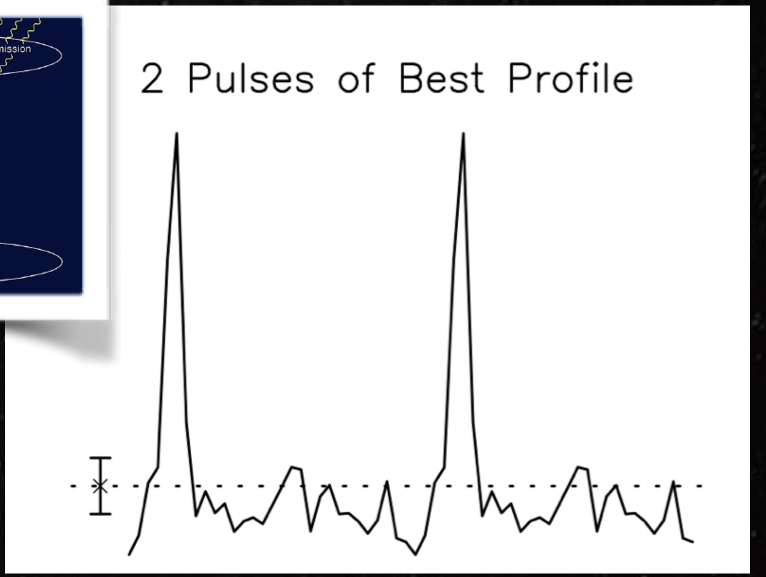
- ★ GPS/Rb clock (H-maser?)
- ★ ROACH
- ★ DDBC & Mark5B (64 TB)
- ★ Hebe - Pulsar timing (JBCA)

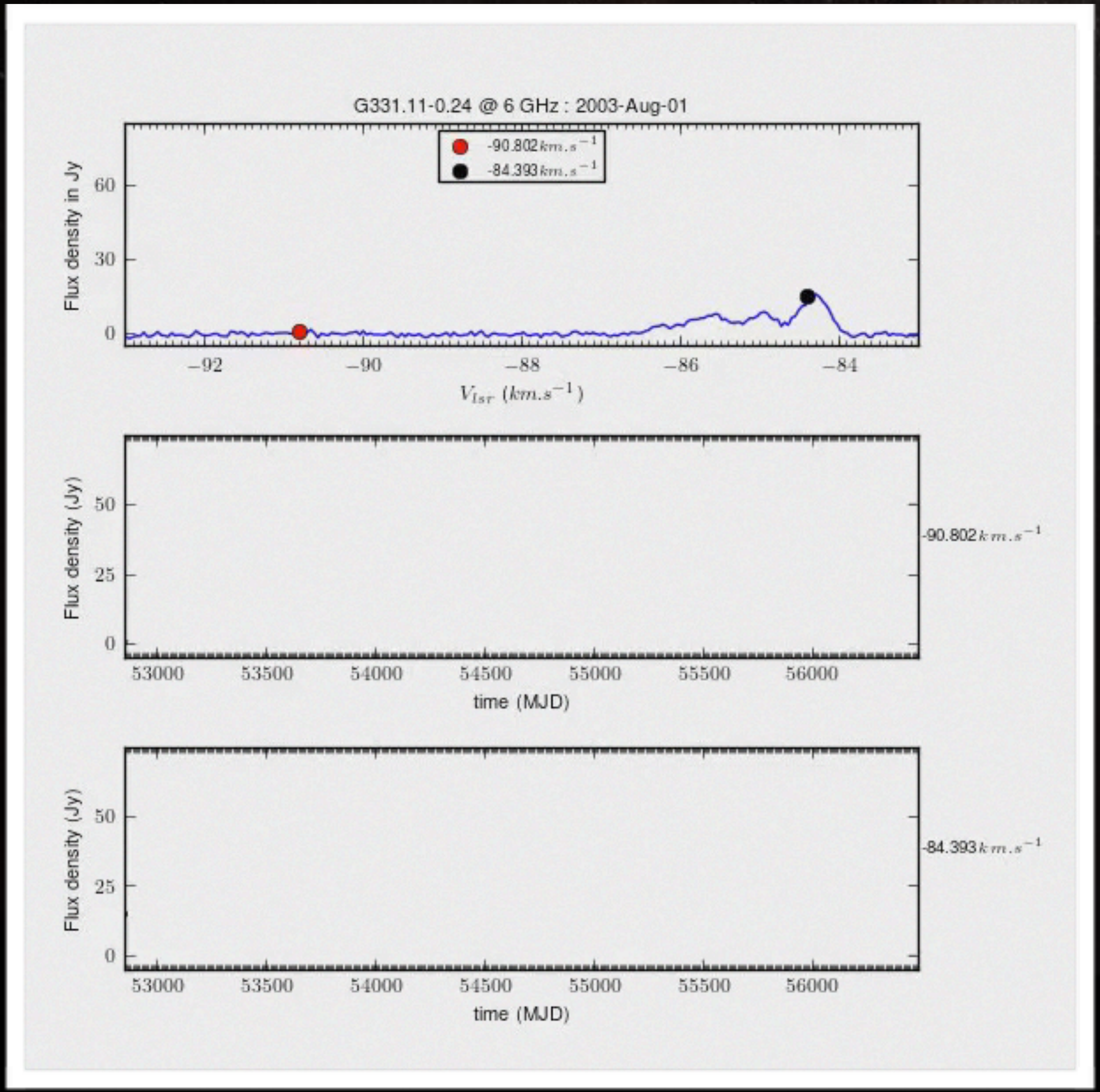


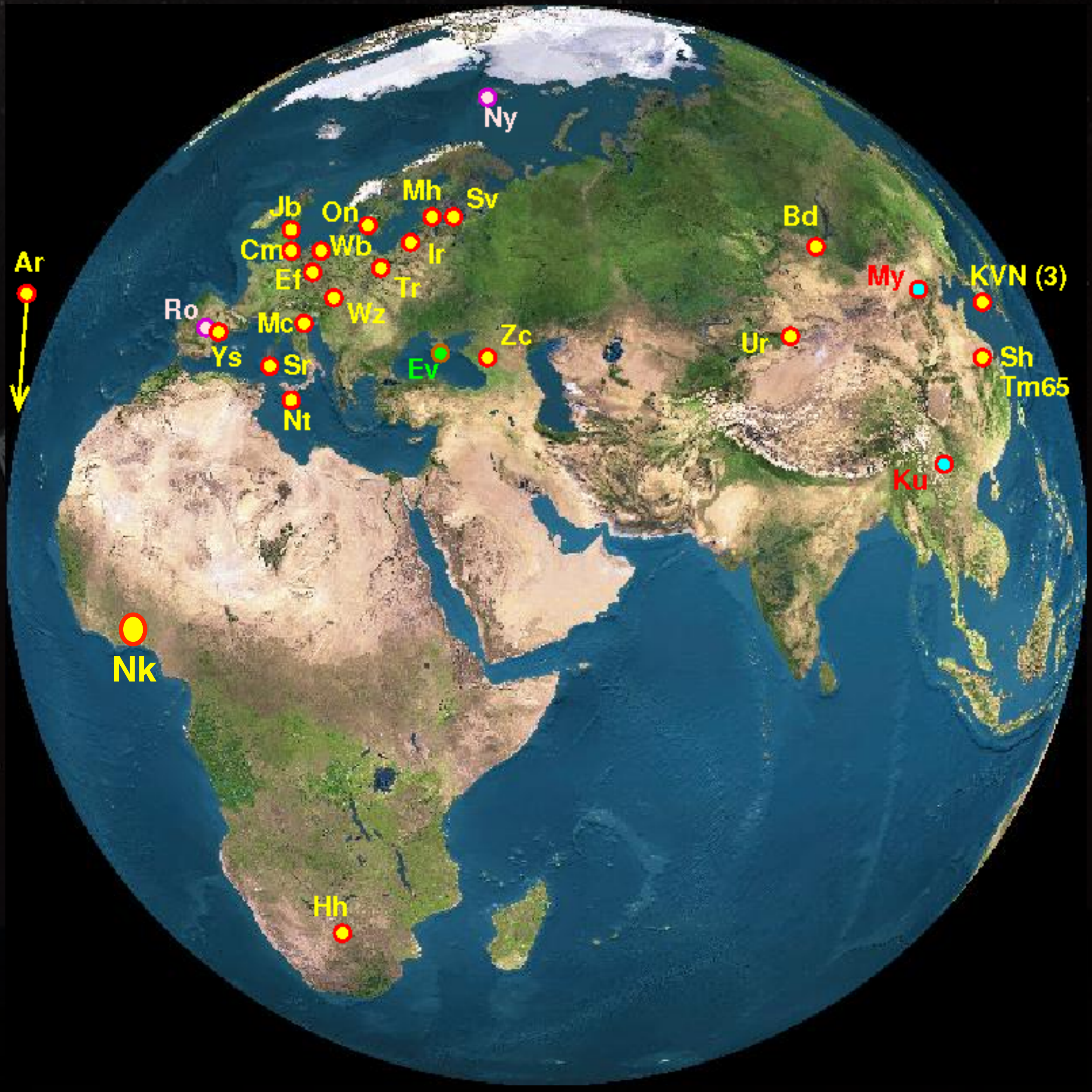
Science cases

- 6.7 GHz methanol (CH_3OH) maser study (massive stars)
- Pulsar observations, and FRB search
- VLBI

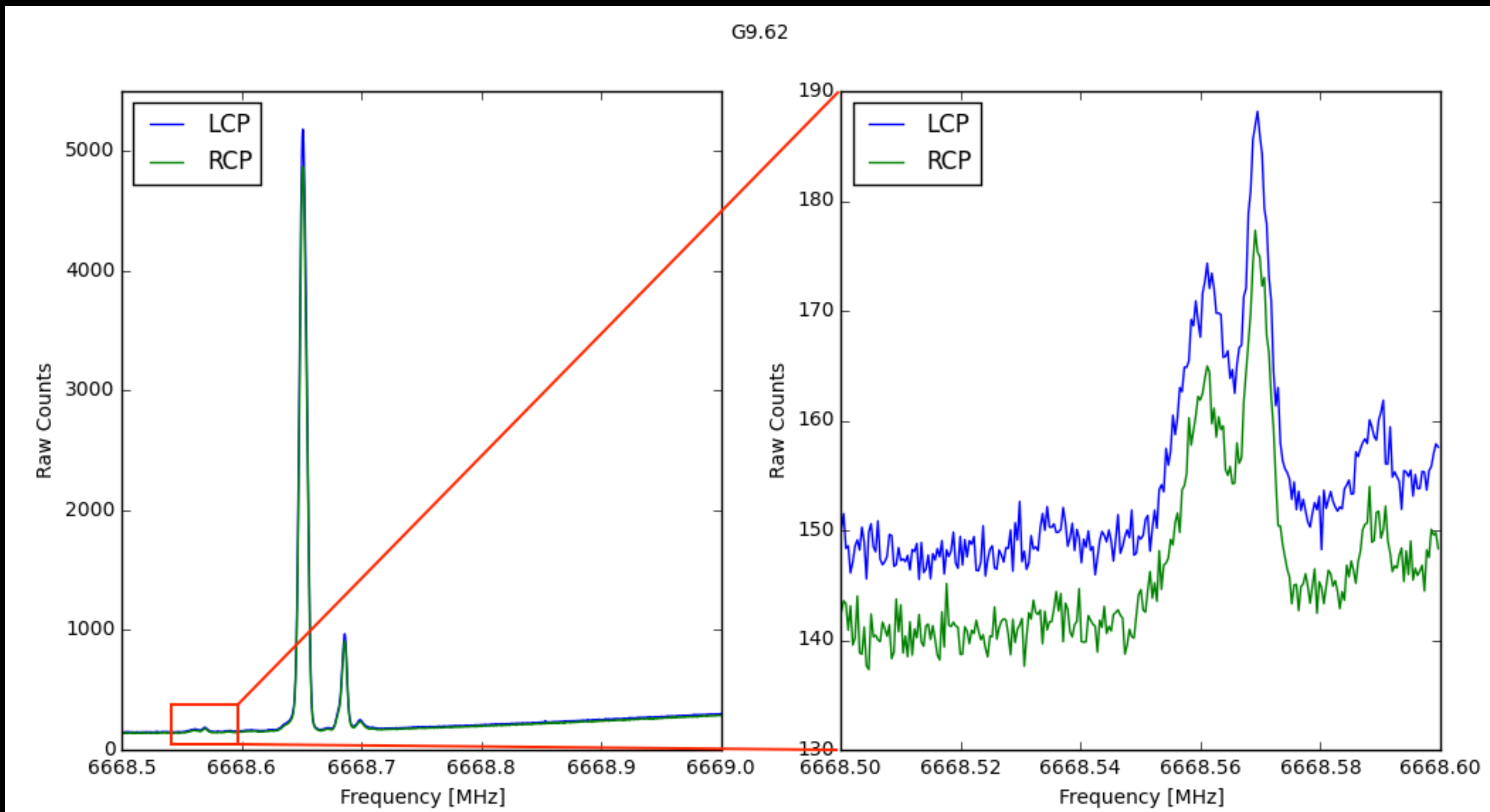








6.7 GHz methanol maser detection



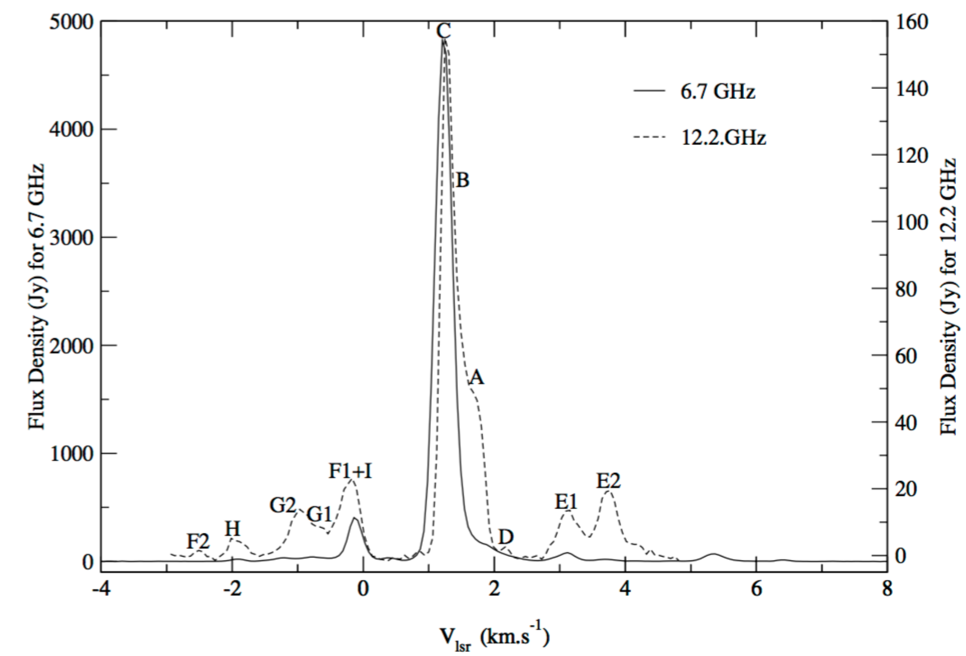
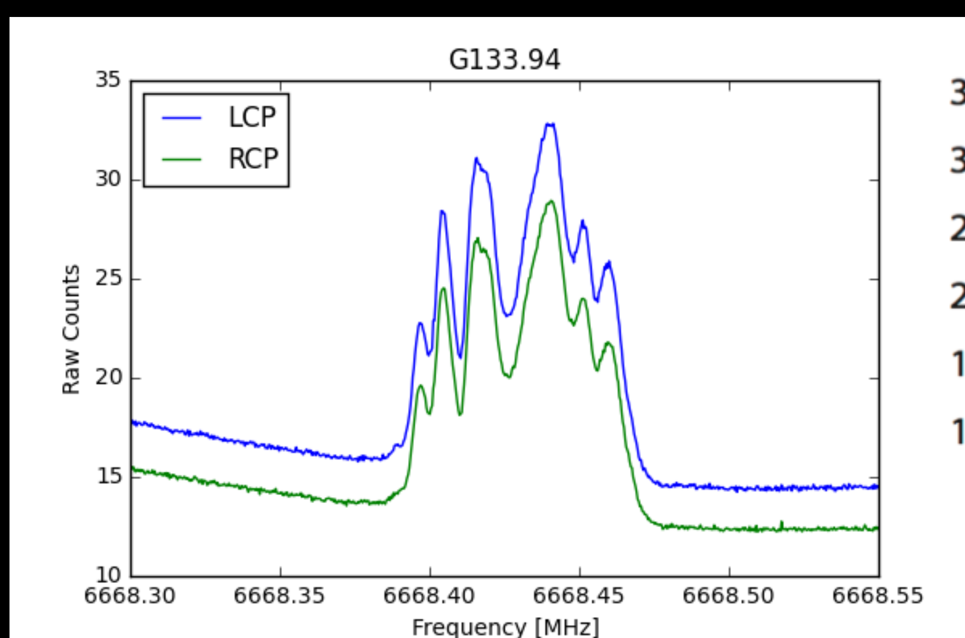
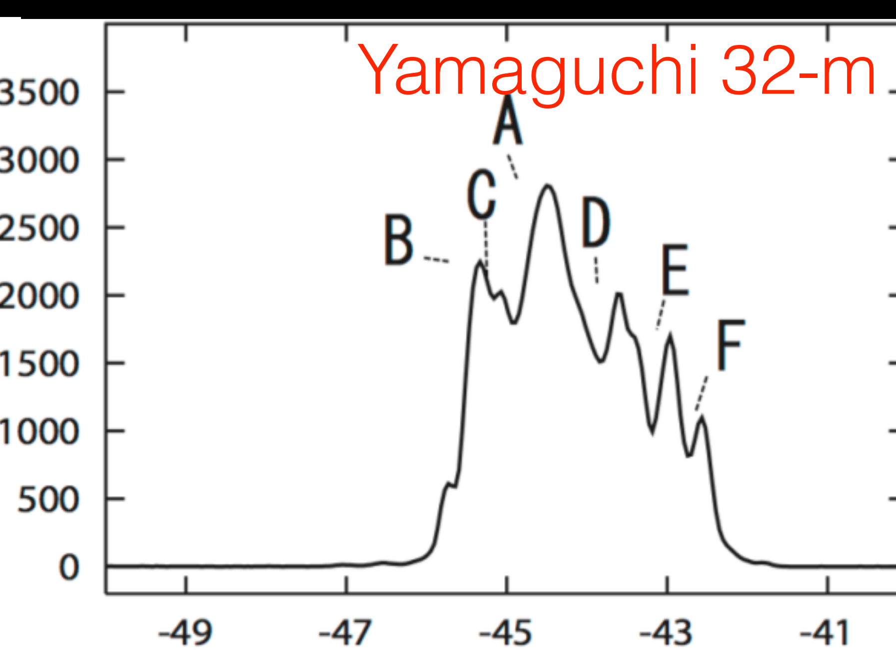


Figure 1. Time-averaged spectra of G9.62+0.20E. The solid line is the 6.7-GHz spectrum and the dashed line is the 12.2-GHz spectrum.

6.7 GHz methanol masers of G9.62 massive star forming region.





6.7 GHz methanol masers of G133.94 massive star forming region.

Pulsar detection

Pulsar Astrophysics - The Next Fifty Years
Proceedings IAU Symposium No. 337, 2017
P. Weltevrede, B.B.P. Perera, L. Levin Preston & S. Sanidas, eds. DOI: 00.0000/X000000000000000X
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Pulsar Observations at the Ghana Radio Astronomy Observatory

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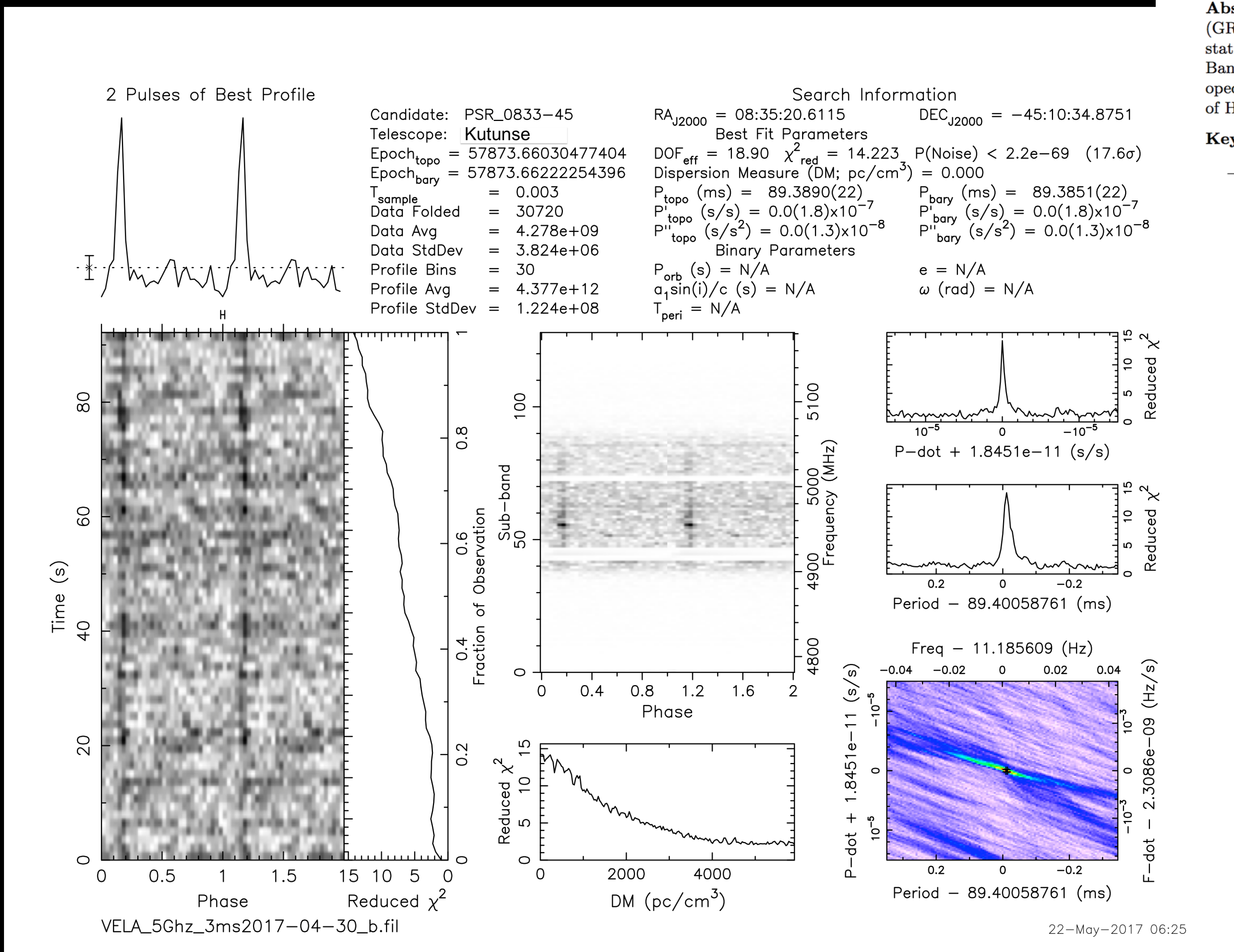
email: `thomas.scragg@postgrad.manchester.ac.uk`

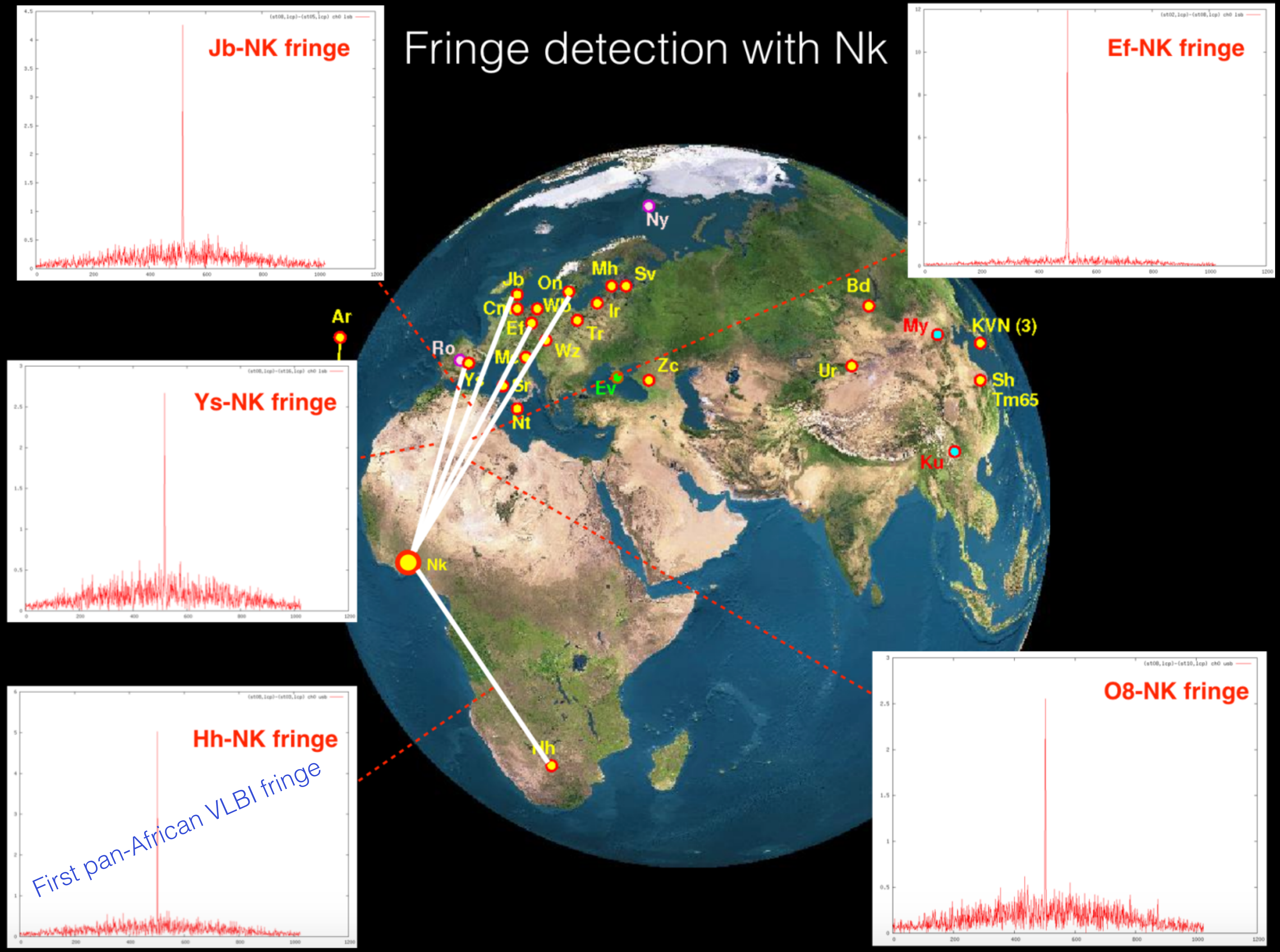
Abstract. In August 2017 a new radio telescope, the Ghana Radio Astronomy Observatory (GRAO), was officially inaugurated at Kuntunse, Ghana. The GRAO is a former satellite Earth station and now the first operational station in the African VLBI Network (AVN). The Jodrell Bank Centre for Astrophysics (JBCA), supported by the UK's STFC/Newton Fund, has developed a new pulsar timing system (Hebe) for the GRAO. We present some aspects of the design of Hebe and an outline of the first pulsar detection at GRAO.

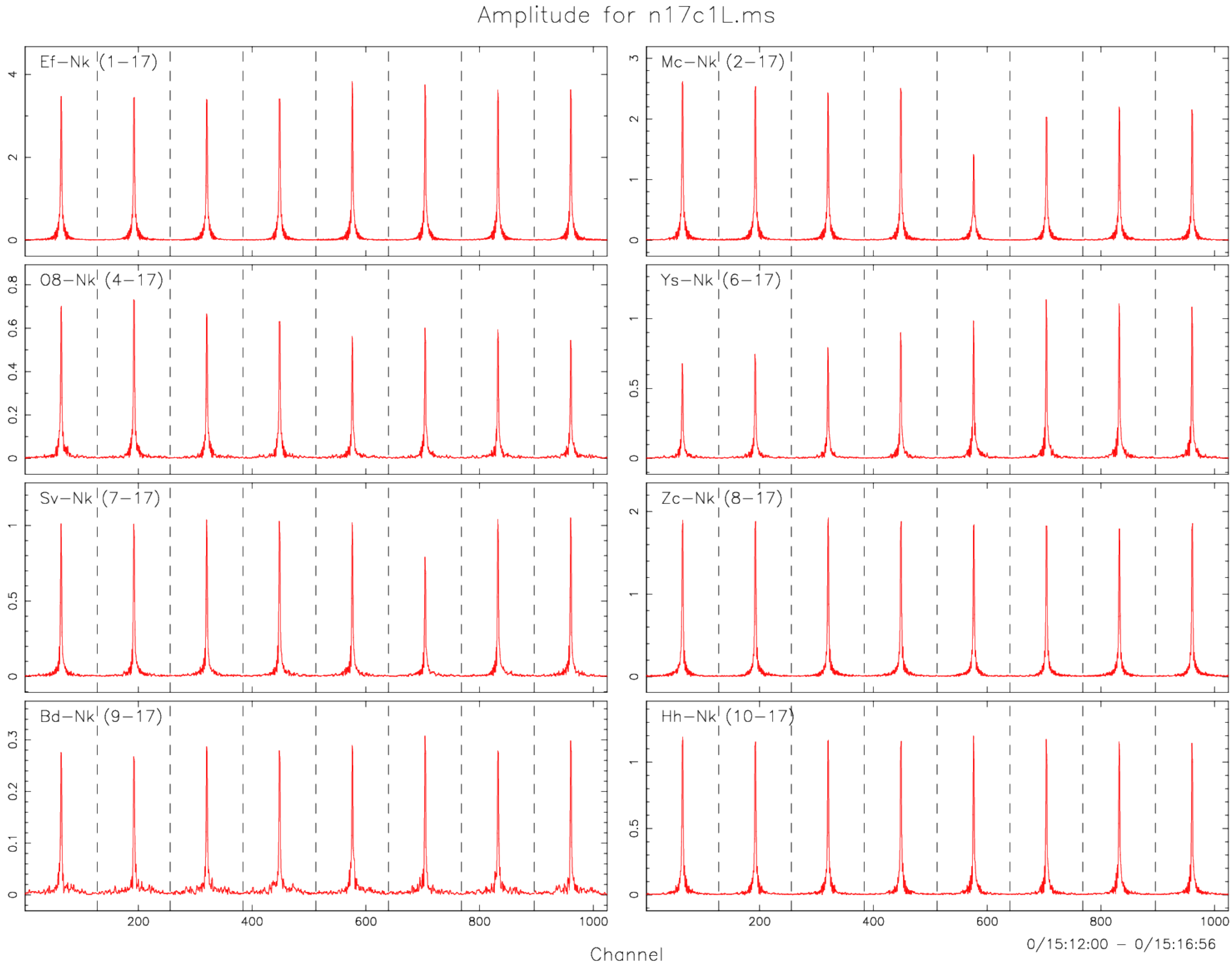
Keywords. Pulsars, instrumentation: miscellaneous, telescopes (GRAO).



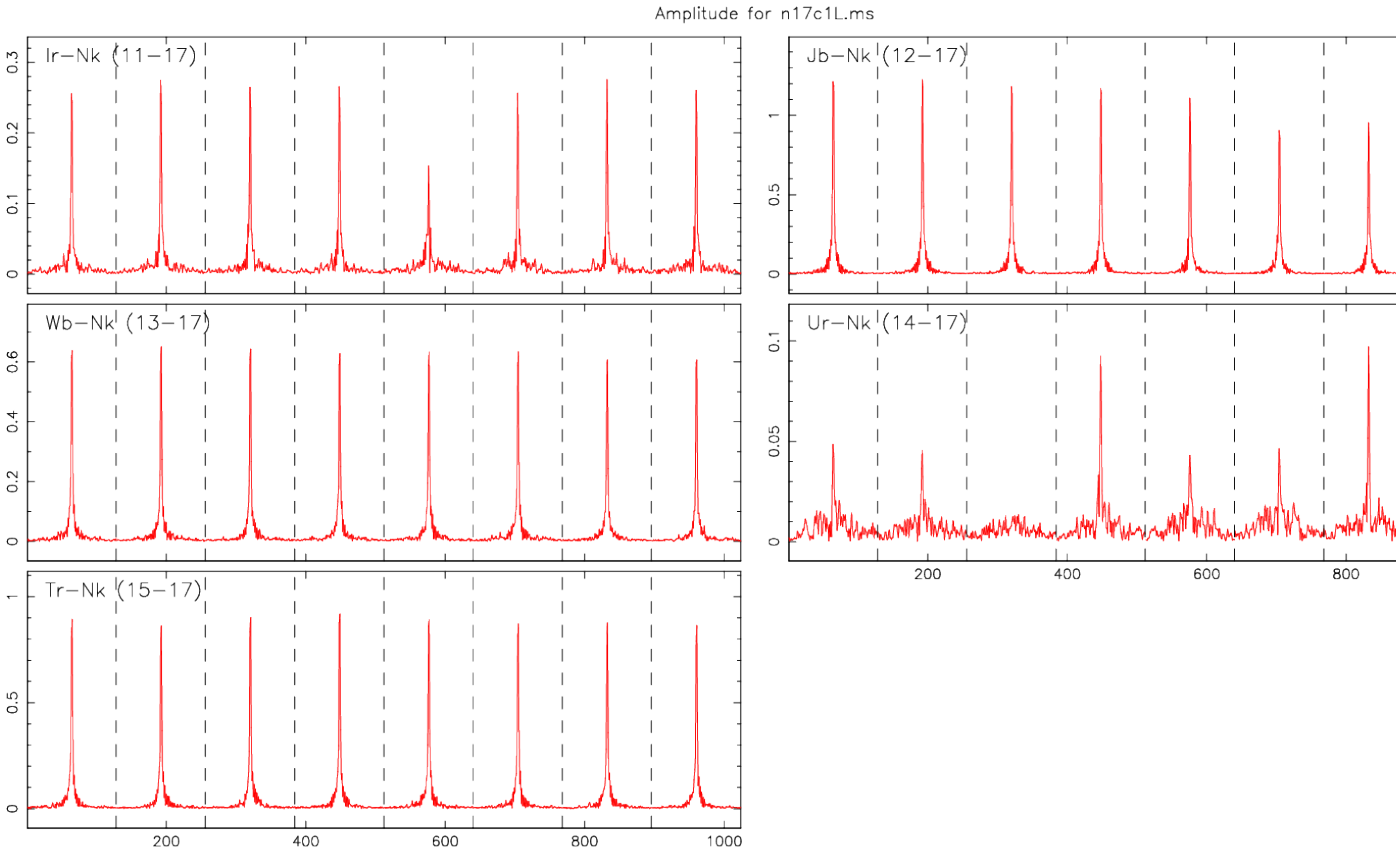
PSR 0833-45 pulses detected with the Kuntunse 32-m radio telescope, pulse period of 89.4 milliseconds (0.0894 second).

Fringe detection with Nk

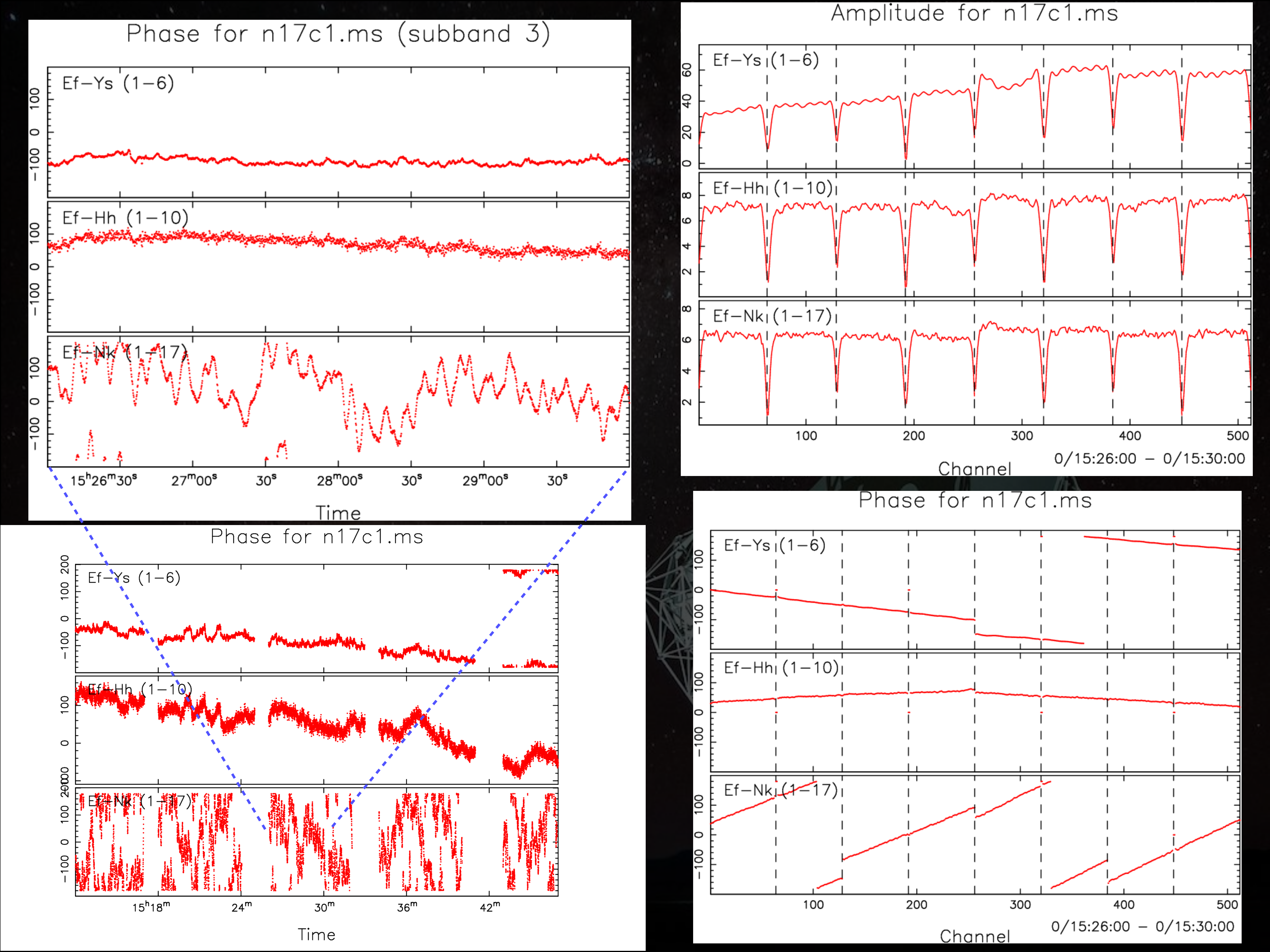




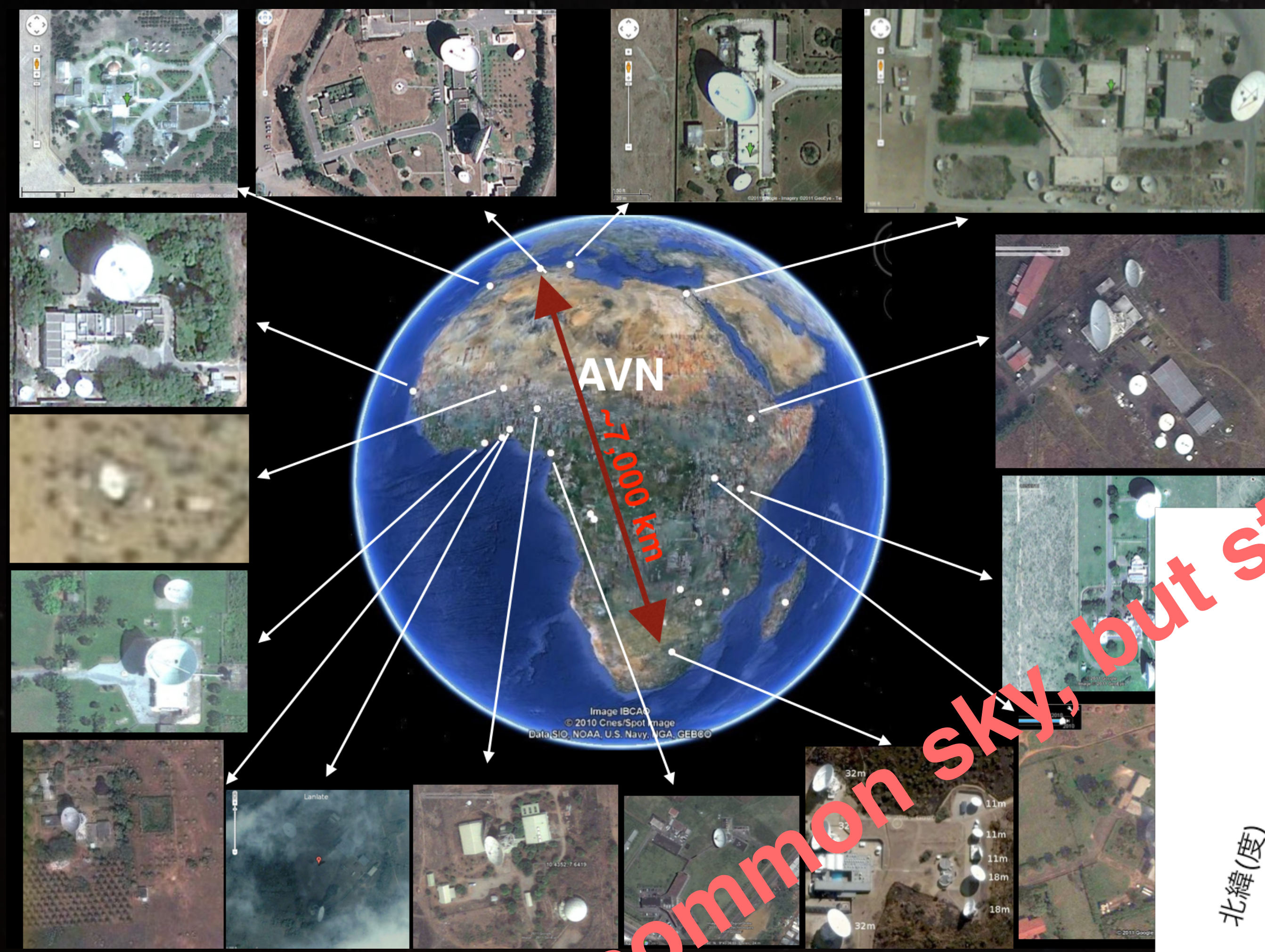
Ef = Effelsberg, O8 = Onsala85, Mc=Medicina, Ys=Yebes, Sv=Svetloe, Zc=Zelenchk, Bd=Badary, HH=HartRAO26,



Ir=Irbene, Jb=Jodrell1, Wb=Westerbork, Ur=Urumuqi, Tr=Torun


Phase for n17c1.ms (subband 3)
Ef−Ys (1−6)
Ef−Hh (1−10)
Ef−Nk (1−17)
15h26m30s
27m00s
30s
28m00s
30s
29m00s
30s
Time
Amplitude for n17c1.ms
Ef−Ys (1−6)
Ef−Hh (1−10)
Ef−Nk (1−17)
Channel
0/15:26:00 − 0/15:30:00
Phase for n17c1.ms
Ef−Ys (1−6)
Ef−Hh (1−10)
Ef−Nk (1−17)
15h18m
24m
30m
36m
42m
Time
Phase for n17c1.ms
Ef−Ys (1−6)
Ef−Hh (1−10)
Ef−Nk (1−17)
Channel
0/15:26:00 − 0/15:30:00

Fringe test observation AVN - VERA/KVN



Small common sky, but still possible