Looking into the future of the radio reference frame with SKA

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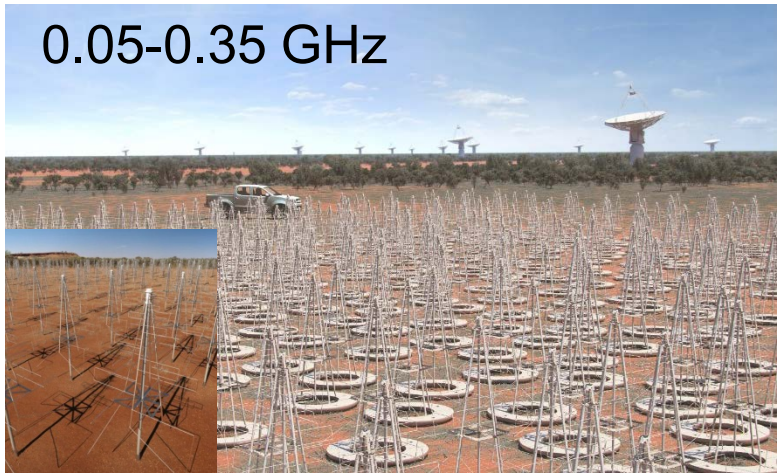
Outline

- What is SKA?
- Combining SKA with VLBI arrays
- SKA-VLBI astrometric survey

Square Kilometre Array (SKA)

Two telescopes

Australia



2 m dipoles

South Africa

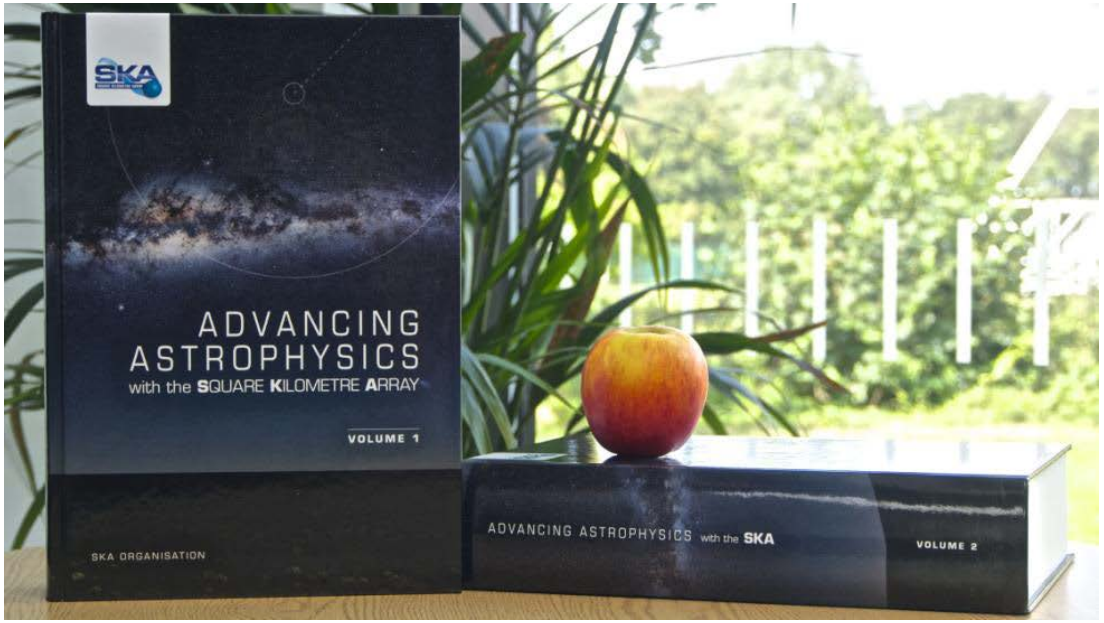
15 m dishes

(possibly reaching 24 GHz ?)

+ headquarters (UK)

SKA science

« Study the history of the Universe from its formation until now by using its main constituent, hydrogen »

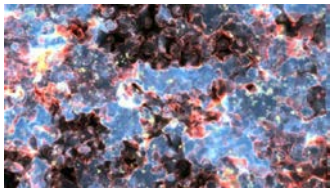


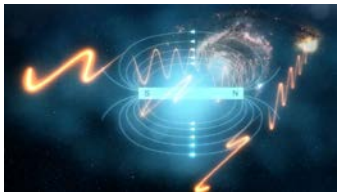
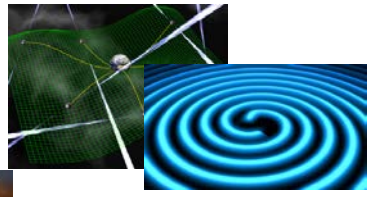
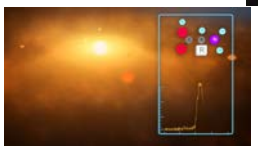
SKA science summarized in two big volumes of 1000 pages each, …for a total weight of 9 kg

Key science drivers

- How were the first black holes and stars formed?
- How were the first galaxies formed? How do they evolve?
- What is the origin of cosmic magnetism?
- Was Einstein right about gravity?
- Are we alone?

… and the exploration of the unknown




SKA construction

- Design phase is ending (critical design reviews)

- Phase 1: 2021-2025+
  - 130 000 dipoles
  - 200 dishes
  - Construction cost cap: 674 M€

- Phase 2: 2025+
  - 1 million dipoles across Western Australia
  - 2000 dishes across 3500 km in Southern Africa

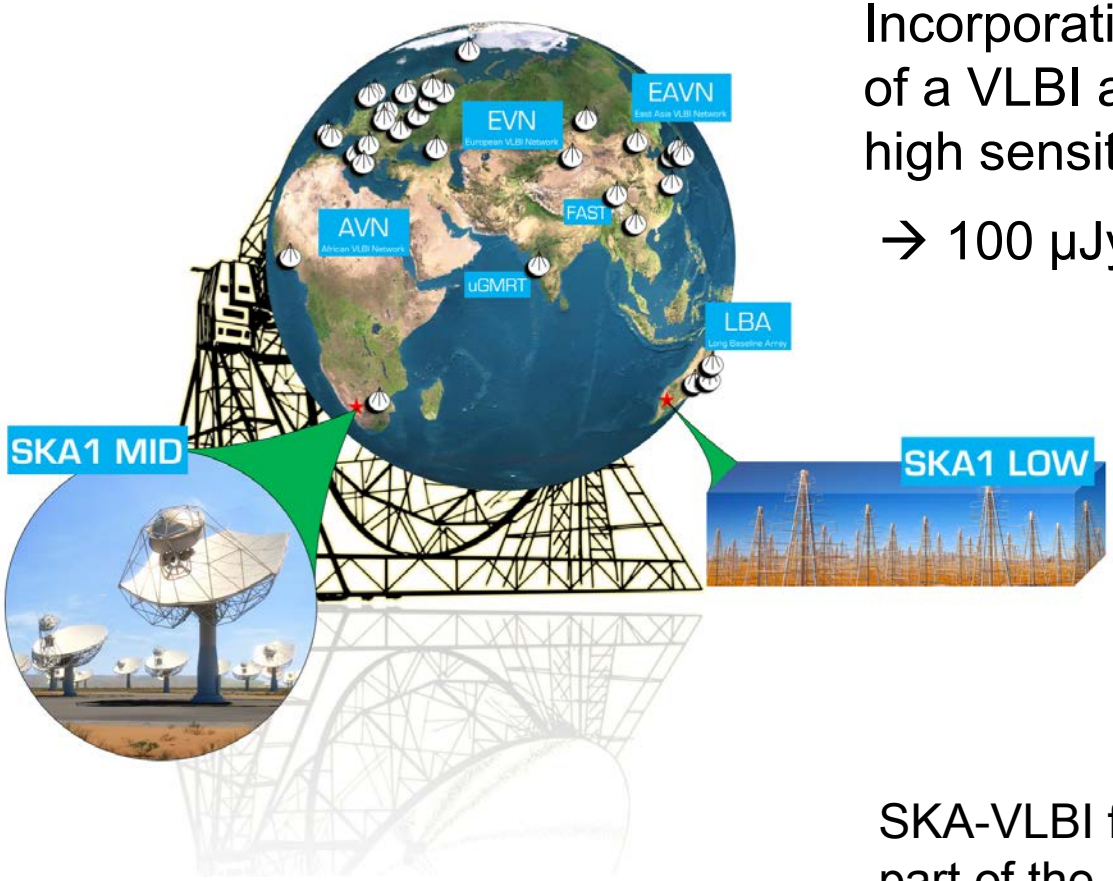
SKA Organisation

Members
Australia
Canada
China
France
Germany
India
Italy
New Zealand
South Africa
Spain
Sweden
The Netherlands
United Kingdom

Treaty for setting up SKA Observatory signed on 12 March 2019 (inter-governmental organisation)

Signatories of Treaty
Australia
China
Italy
Portugal
South Africa
The Netherlands
United Kingdom

SKA-VLBI



Incorporating SKA as an element of a VLBI array will provide ultra-high sensitivity:

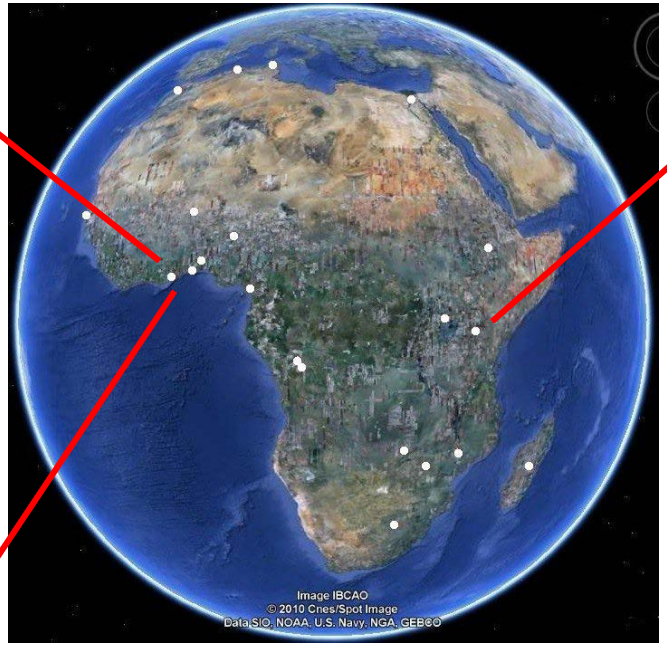
→ 100 μJy in 1 min to a 30 m dish.

JUMPING JIVE
Joint Institute for VLBI ERIC

SKA-VLBI feasibility is assessed as part of the JUMPING JIVE project.

African VLBI Network (AVN)

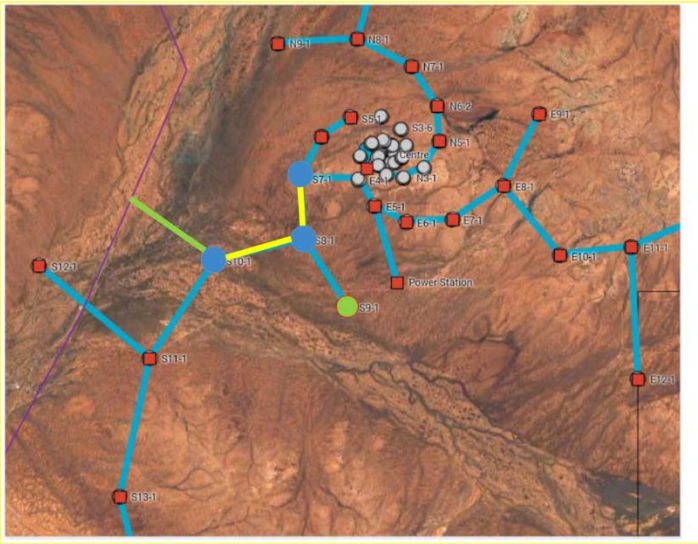
About 20 “retired” telecommunication antennas with large diameter (~ 30 m) identified over the African continent



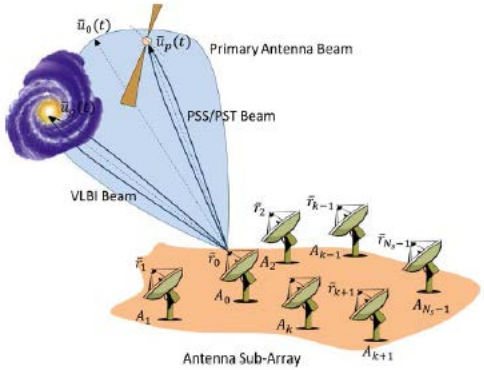
→ Large potential to create an African VLBI network (AVN)

VLBI with the SKA: key concepts

Independent sub-arrays:
different purposes, up to 16



Simultaneous/commensal observing modes:
Imaging/Non-Imaging



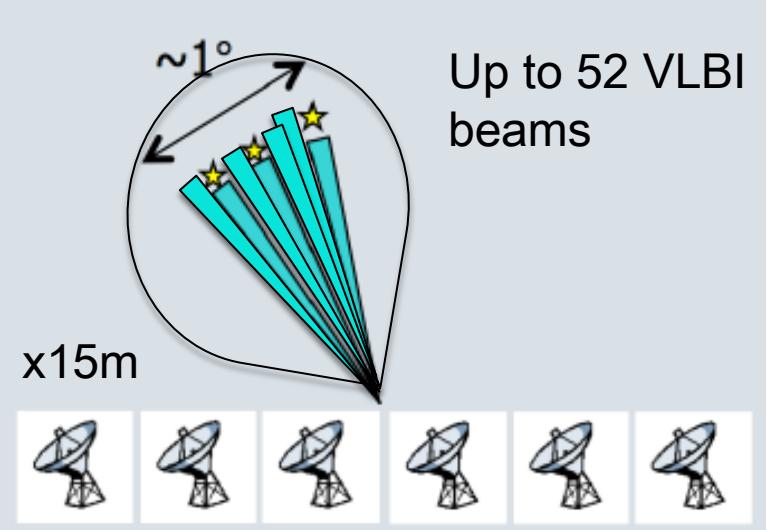
Independent multi-beam capability
within each sub-array

Global astrometry science case

- Goal: observe 50 000 extragalactic sources selected from the Gaia celestial reference frame
- Should the sources be selected randomly or based on detection in deep radio surveys (e.g. ~10% of the 1.8 million NVSS sources seen in Gaia CRF2) ?
- 250 targets measured per day, with 3 to 5 1-min long scans on every target → 200 days of observation
- Is this realistic ?

Commensal observing?

- Gaia has one source per square degree
- Up to 52 beams over about 1° can be formed for any SKA sub-array



- The idea would be to observe any Gaia CRF source that falls within the field of other SKA programs

Thank you for your attention