

Towards the SKA: using
ASKAP, MeerKAT
and APERTIF



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Towards building the SKA: timeline

It all takes time, but its Precursors will be ready soon:



SKA Road map:

- 2013-2016 Pre-Construction Phase, detailed design
- 2018-2022 construction of SKA1 - 10% of the SKA
- 2020 early science starts
- 2022-2025 construction of SKA2 - "The" SKA

SKA Precursors:

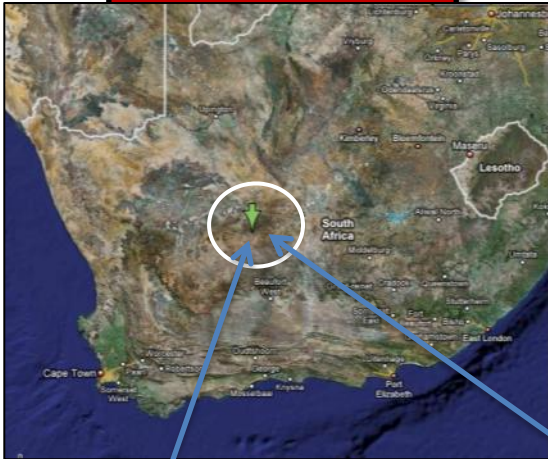
ASKAP (AUS) & MeerKAT (RSA) 2016

+ APERTIF (NL) 2015

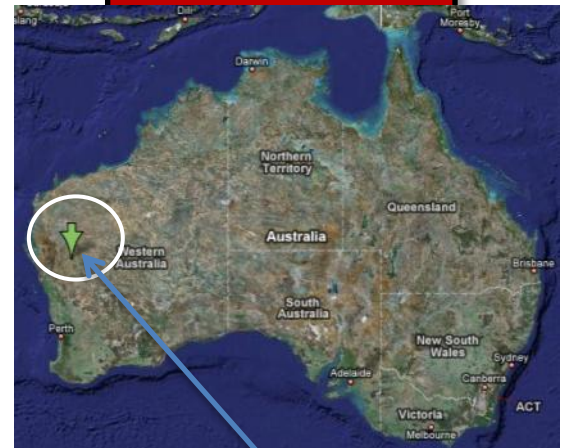
- **Interferometers: as they are being built out, their science cases evolve...**

SKA Phase 2 (SKA2) – ultimate goal

Southern Africa



Australia



SKA2_MID
2500 Dishes



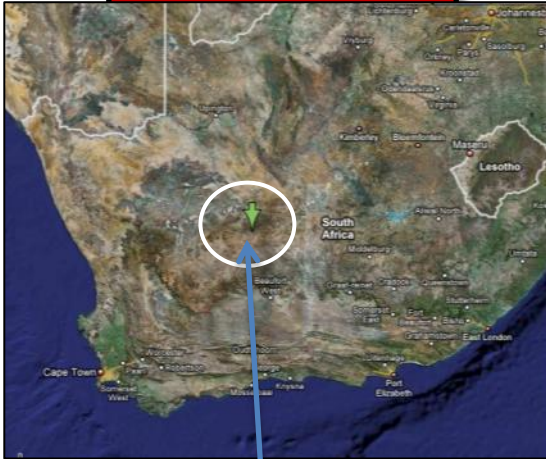
SKA2_AA
250 x Mid Frequency
Aperture Array Stations



SKA2_LOW
250 x Low Frequency
Aperture Array Stations

SKA Phase 1 (SKA1)

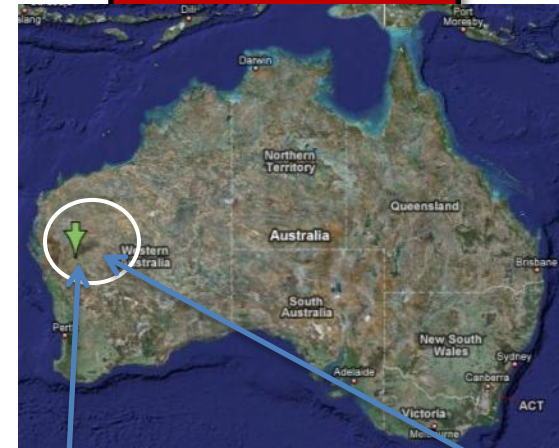
Southern Africa



SKA1_MID

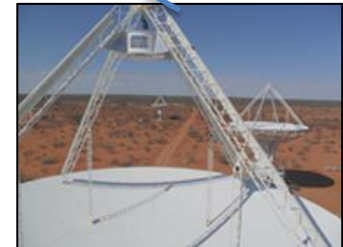
254 Dishes including:
64 x MeerKAT dishes - precursor
190 x SKA dishes

Australia



SKA1_LOW

50 x Low Frequency Aperture
Array Stations



SKA1_SURVEY

96 Dishes including:
36 x ASKAP - precursor
60 x SKA dishes
with large FoV

SKA mid-frequency Precursor instruments I.

SKA dual site decision: South Africa & Australia

on each site an SKA Precursor is being built:

ASKAP in Australia

MeerKAT in South Africa,

+ in the Netherlands; APERTIF upgrade of Westerbork

Will be operational in 2016/7 ; funding independent of SKA



SKA mid-frequency precursor instruments II.

The instruments will be complementary:

- ASKAP & MeerKAT: southern sky

 - APERTIF: northern sky

- ASKAP and APERTIF have phased arrays: FoV 8-30 deg²

 - all-sky surveys

- MeerKAT has a FoV of 1 deg², but larger bandwidth and surface

 - higher sensitivity over smaller areas

- Collecting areas: 4000-8000 m²

 - ASKAP: 36×12m, MeerKAT: 60×13m ; APERTIF: 12×25m dishes

 - not larger than present telescopes, but two have much larger FoV

SKA: a revolution in radio astronomy

The SKA is designed for gigantic surveys

Example: HI surveys of galaxies

2014: 30,000 detections, out to $z \sim 0.05$

2020: 1,000,000 detections, out to $z \sim 0.5$

2028: 1,000,000,000 detections, out to $z \sim 2$

SKA Precursors

SKA Phase 1 + 2

Wide-spread interest in these data,
also from non-radio astronomers,

who need to be made aware of the SKA potential,
and helped to prepare for using its data/results

France preparing for the SKA: what and when?

Technology:

- SKADS (FP6 2005-2009) and PrepSKA (FP7 2008-2011)
- SKA Pre-Construction Phase Consortia (2012-2016)
 - Nançay & Bordeaux: micro-electronics (13 FTE/yr)

Science:

- Simulations (science data; instruments)
- Observations, with

actual instruments, radio and others: till 2016

SKA Precursors : from 2017

SKA Phase 1: from 2020

SKA Phase 2: from 2024

France preparing for the SKA: who?

- France has a large astronomical community,
but relatively less radio astronomers than some other countries;

= no problem: SKA is not only for radio astronomers, *au contraire*

- Leading the French community towards the SKA

is a role of our radio astronomy community:

training students, supervising postdocs

leadership in surveys and projects

helping non-experts find their way in radioland

multi-wavelength projects, access to many other telescopes; modeling

Preparing for SKA science with radio telescopes

"Known" instruments:

dm: Nançay, interferometers (VLA, WSRT); mm: IRAM + ALMA
extragalactic surveys, pulsars

SKA Pathfinders (now):

LOFAR: station in Nançay, plans for LOFAR Super Station
surveys (planetary, pulsars, transients, galaxies, clusters)
EMBRACE: SKA phased-array demonstrator in Nançay

SKA Precursors (2016):

Expressed French interest in 10 MeerKAT Large Proposals (2010):
80% are not radio astronomers...

MeerKAT Large Proposals call (2010):

- Expressed French interest in 10 Large Proposals (1000-8000 hours each)
- 27 astronomers, from 11 institutes

Bordeaux, Lyon, Marseille, Nice OCA, Orleans LPC2E, Paris Obs., Paris IAP, Saclay CEA, Strasbourg, Toulouse; IRAM

- 80% are not radio astronomers...
- Proposals (44,000 hours requested in total)

Virgo cluster HI (PI)
Slow transients
HI ultra-deep field
Radio continuum

Nearby Galaxies HI
Stellar envelopes
Galaxy clusters
Pulsars and fast transients

ASKAP Survey Science Proposals

Large Programmes, for first 5 years of operations

FoV: 30 square degrees; nominal resolution 30", but down to 6" is possible.

EMU: deep continuum survey of 75% of entire sky

10 μ Jy rms, 10 million sources – typical SF galaxy to $z\sim 1$

WALLABY: 21cm HI line survey of 75% of entire sky

mJy rms, 500,000 galaxies, mean $z\sim 0.05$

CRAFT commensal fast transients (<5 sec)

DINGO deep HI field

FLASH HI absorption lines

GASKAP galactic spectral lines

POSSUM polarization and magnetism

VAST variables and slow transients

COAST pulsar survey and timing

High Resolutions Components + VLBI

MeerKAT Large Programmes

Large Programmes, for first 5 years of operations

FoV 1 square deg., wide-band receivers, nominal resolution 8"

Pulsar timing

LADUMA

ultra-deep HI field

Fornax cl. HI

deep HI in nearby cluster – cosmic web

MESMER

molecules in EoR

MALS

absorption lines

MeerGAL

galactic plane, high frequencies

MHONGOOSE

deep HI, nearby galaxies

MIGHTEE

deep extragalactic, continuum

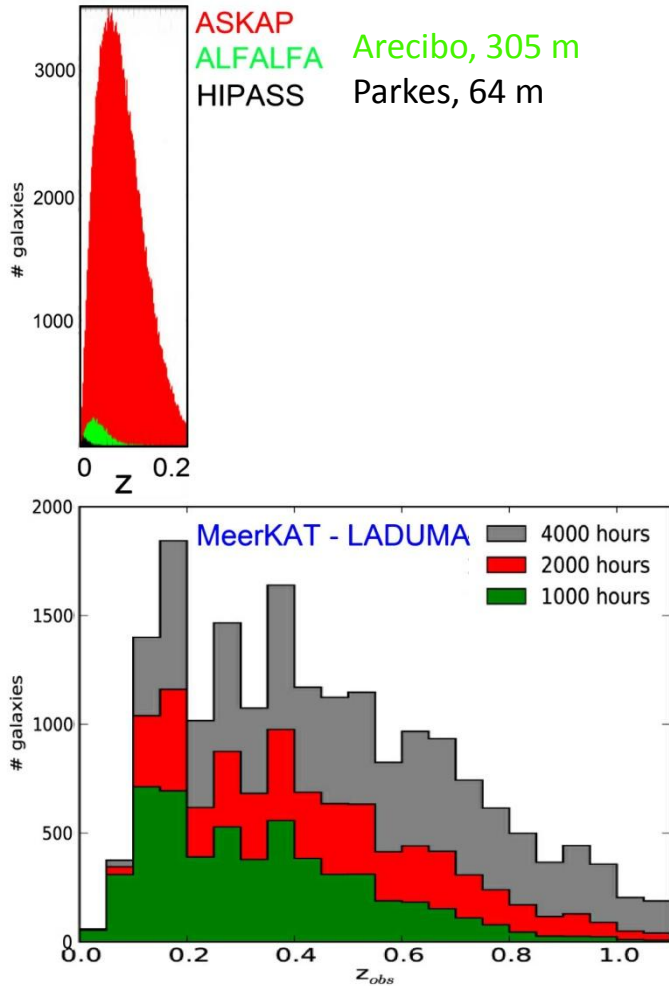
TRAPUM

transients and pulsars

ThunderKAT

transients

SKA Precursors: 21cm HI line surveys



ASKAP + APERTIF: all-sky, shallow

detection of a million galaxies
imaging of thousands of galaxies:
HI distributions and velocity fields

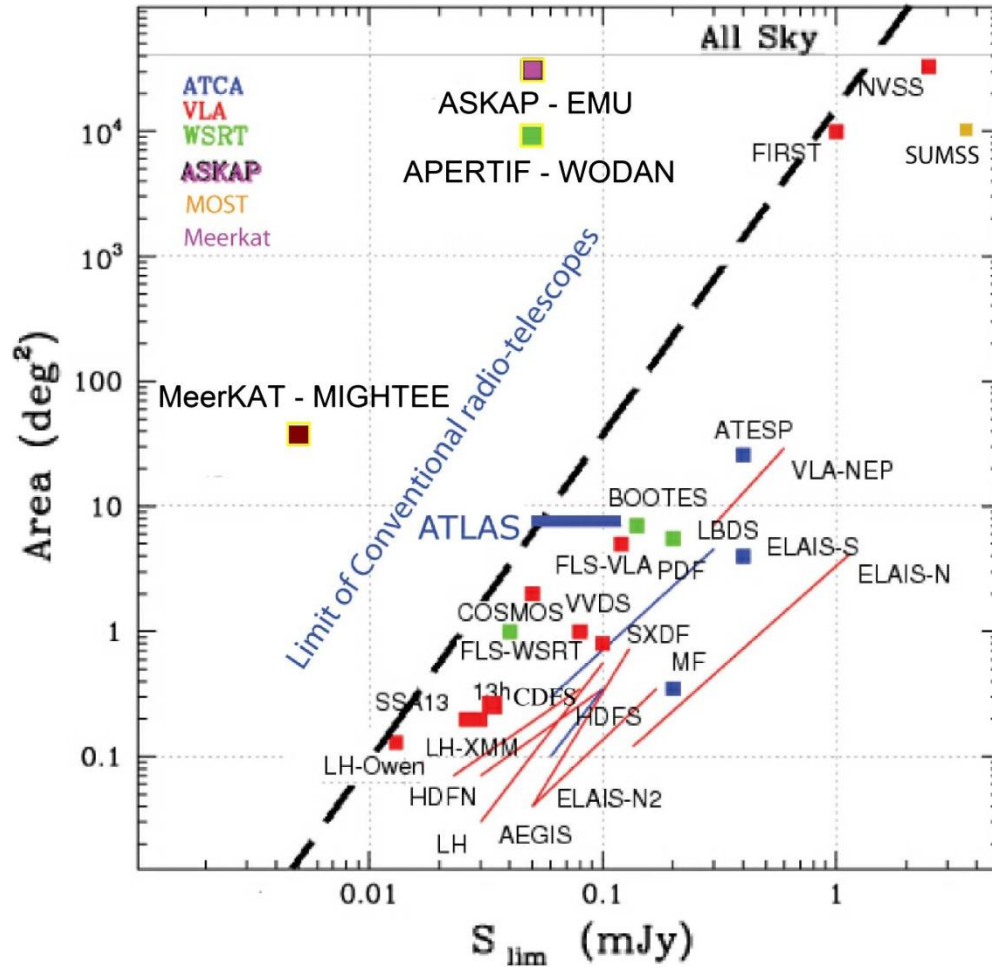
mean redshift ~ 0.05

MeerKAT: small field, ultra-deep

detection of 20,000 galaxies, in 1 sq.deg

mean redshift ~ 0.3

SKA Precursors: radio continuum surveys



← sensitivity

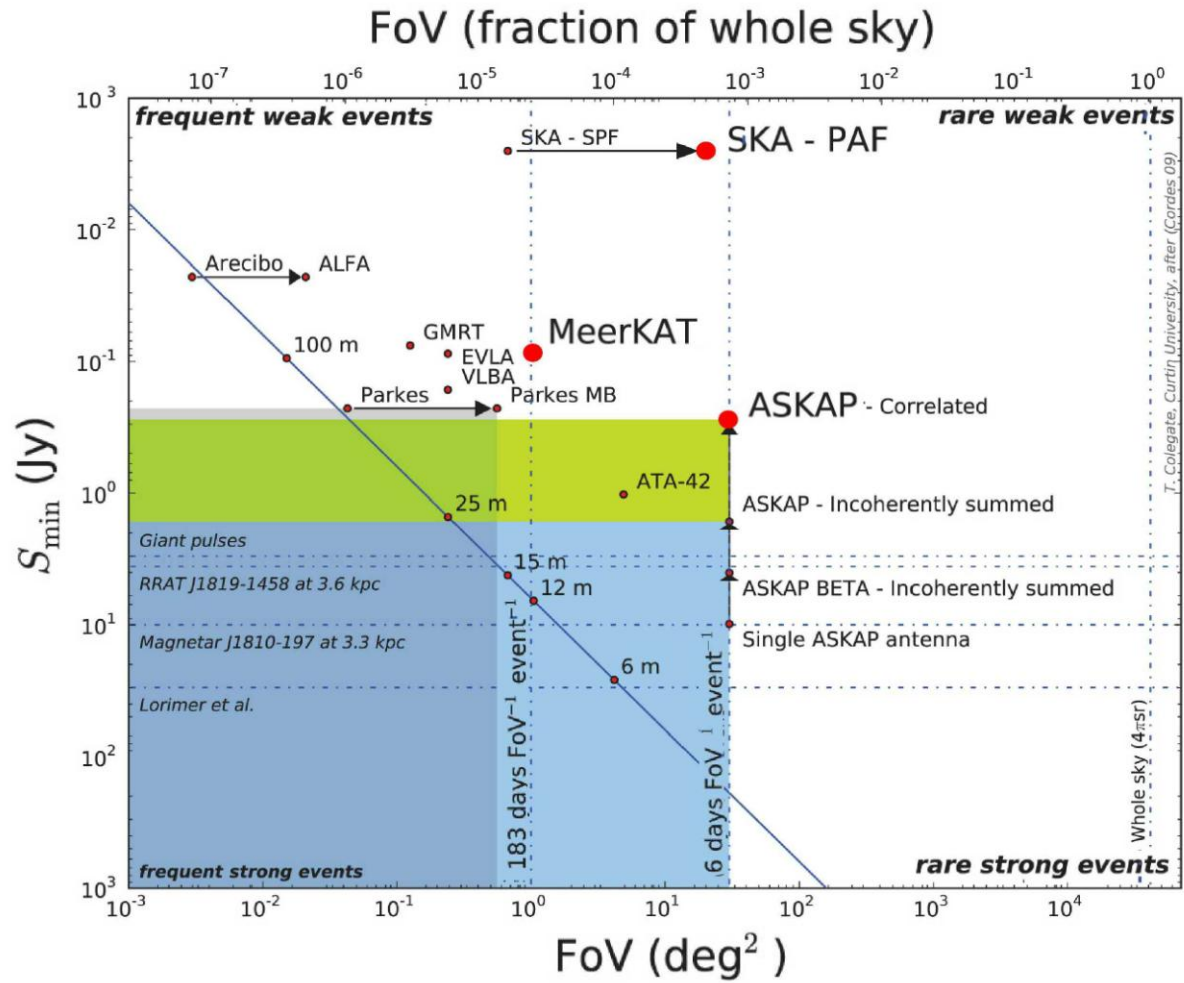
ASKAP + APERTIF:

all-sky, 50 μ Jy

MeerKAT:

40 sq.deg, 5 μ Jy

SKA Precursors: transient detection



Strong/weak
Rare/frequent

Using the SKA Precursors

Large Programmes for their first 5 years of operations were defined a few years ago

- Consortia are still open to new members
- Not all telescope time is for these Large Programmes,
there will be time (10% for ASKAP, 30% for MeerKAT?)
for smaller (<1000 hours each?)
PI-led programmes



SKA
SQUARE KILOMETER
KAY

Aux antennes, citoyens!