Radio Interferometers Around the World

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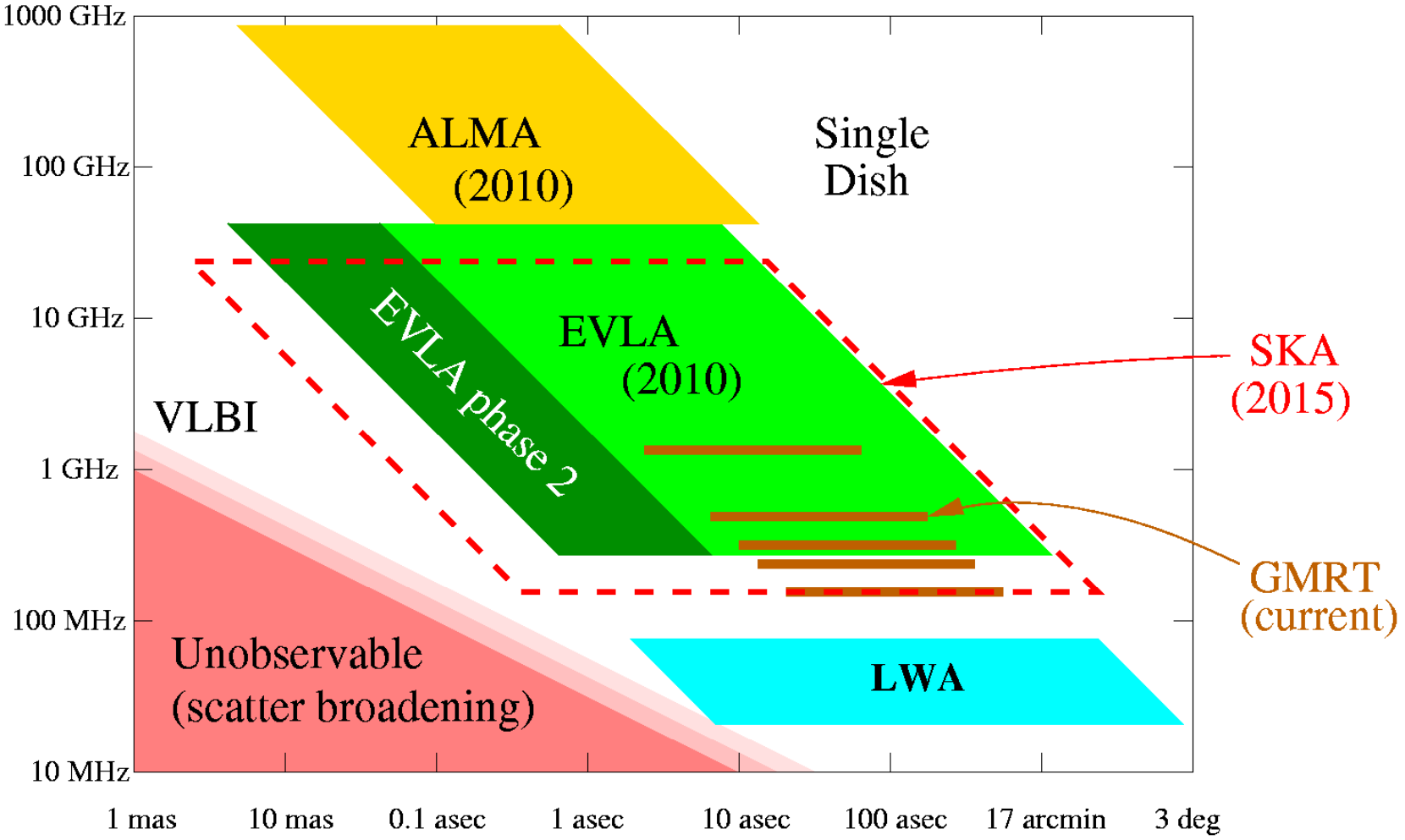
A somewhat biased view of current interferometers

- Limited to telescopes that exist or are in the process of being built (i.e., I am not going to talk about SKA).
- Will only talk about one millimeter telescope, ALMA
  - There are others the SMA, KARMA etc..
- Will have a slight emphasis on NRAO telescopes mostly because that is what I know the most about and I want to encourage you to apply for them.
- Only include ones I remember, so I could be missing a few.


1000 GHz
100 GHz
10 GHz
1 GHz
100 MHz
10 MHz
1 mas
10 mas
0.1 asec
1 asec
10 asec
100 asec
17 arcmin
3 deg
ALMA
(2010)
Single
Dish
EVLA phase 2
EVLA
(2010)
SKA
(2015)
VLBI
GMRT
(current)
Unobservable
(scatter broadening)
LWA

Telescopes that exist: General interest for the most part

- Westerbork Radio Synthesis Array (WRST)*
- Australia Telescope Compact Array (ATCA)
- Giant Metrewave Radio Telescope (GMRT)
- Expanded Very Large Array (EVLA)*
- eMerlin*
- Very Long Baseline Array (VLBA)*
- Other VLBI arrays*

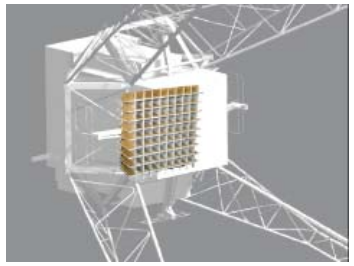
* Currently in the process of being upgraded

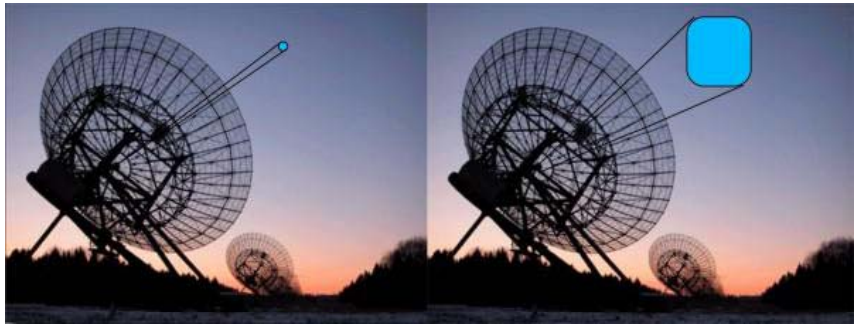
WRST

- Located in the Netherlands
- 14 x 25meter antennas arranged on a 2.7 km East-West line
  - 10 fixed 4 can be moved
- Observes between 3.5-92 cm
- Upgrade called Apertif
  - APERture Tile In Focus

(WRST) Apertif

- Aim is to replace single pixel detector with an array
  - Focal plane array
- This turns single disk into a camera
- Enlarges the field of view
  - Increasing survey speed by a factor of 20-40
- Prototyped and funding done
- Plan to have it on sky 2012-2013
- For surveys only, data will be public





ATCA

- 6 x 22 meter telescopes located in Australia
- 5 antennas are movable on an 3km track. 6th antenna is fixed.
- 3mm-20cm

GMRT

- 30 x 45meter antennas in India
  - 12 dishes in compact array
- Spread over 25 km in a Y-array.
- Operational since 2001 at 150, 235, 325, 610, 1000-1450 MHz.
- Largest radio telescopes at low frequencies

EVLA

- 27 x 25 meter telescopes in a Y shaped array in the USA
  - 4 configurations, $B_{max} \approx 1, 3, 11, 36$ km
- Upgrade started in 2001, completed in 2013
  - Full frequency coverage from 1 to 50 GHz.
  - Up to 8 GHz instantaneous bandwidth, per polarization
  - ~3 μJy (1-σ, 1-Hr) point-source continuum sensitivity at most bands.
  - ~1 mJy (1-σ, 1 km/sec, 1 Hr) line sensitivity at most bands.

EVLA (cont.)

Early Science Programs

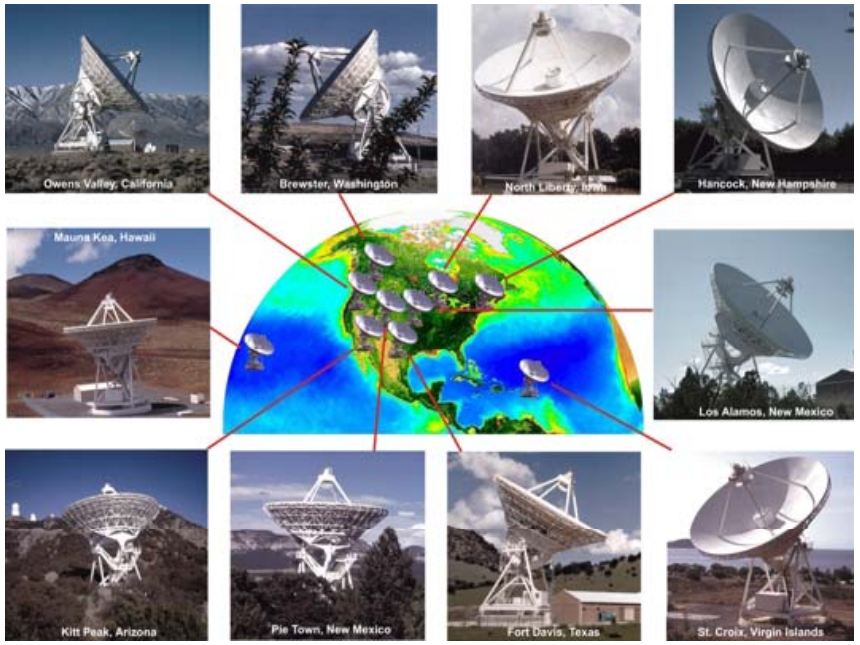
- Open Shared Risk Observing (OSRO)
  - 258 MHz maximum bandwidth
  - 512 channels
- Resident Shared Risk Observing (RSRO)
  - Allows access to more extensive observing capabilities.
  - Participants will assist NRAO staff in expanding capabilities
  - Observing time proportional to length of residency.
  - Current RSRO bandwidth 2GHz

e-MERLIN

- 7 telescopes spread across the UK
- B_{max}=220km
  - Only array with baselines of intermediate length (between EVLA-type arrays and VLBI).
- Currently being upgraded
  - New recievers
  - New correlator
  - New fiber optic links
  - 0.4 to 2 GHz bandwidths
- 1.4, 5 and 22 GHz recievers

VLBA

- 10 x 25 meter telescopes spread from Hawaii to the Virgin Islands
- Observing frequencies from 1.4-45 GHz (not continuous)
- Resolutions of 0.1-5mas
- World's only dedicated VLBI array
- Excellent for astrometry
  - 0.02 mas accuracy routine
- Undergoing upgrade to increase sensitivity by a factor of 4
  - Should be available early next year



Other VLBI arrays: EVN, LBA

European VLBI Network

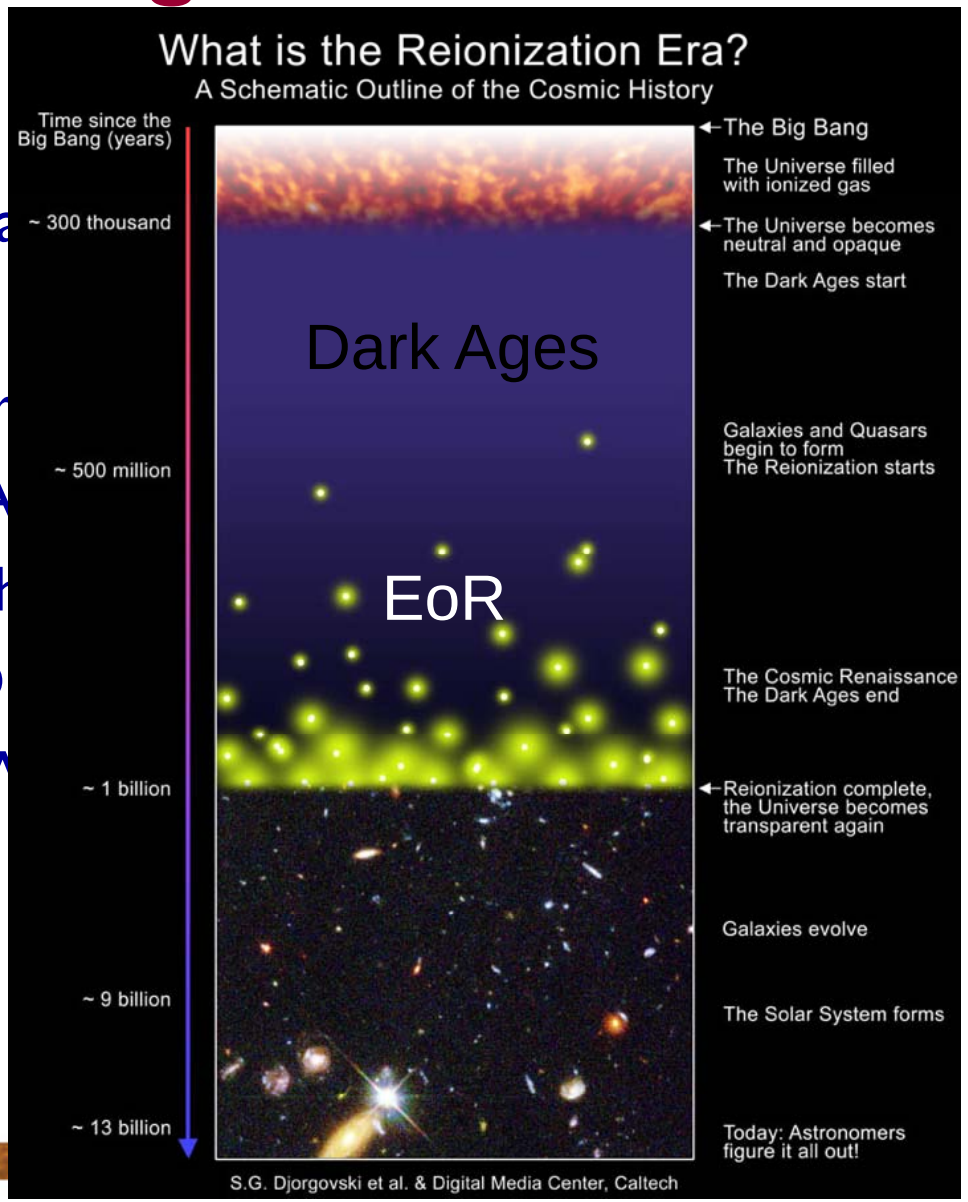
- Various telescopes in Europe
  - From 25-100 meter telescopes
- Get together a few times a year for a few weeks to do VLBI
- Leading the devolopment of e-VLBI

Long Baseline Array (LBA)

- In Australia
- Mix of telescopes, most baselines < 1000 km
- 1 week block schedules, several times per year
- Frequencies up to 22 GHz
- Only Southern Hemisphere array
- e-VLBI development

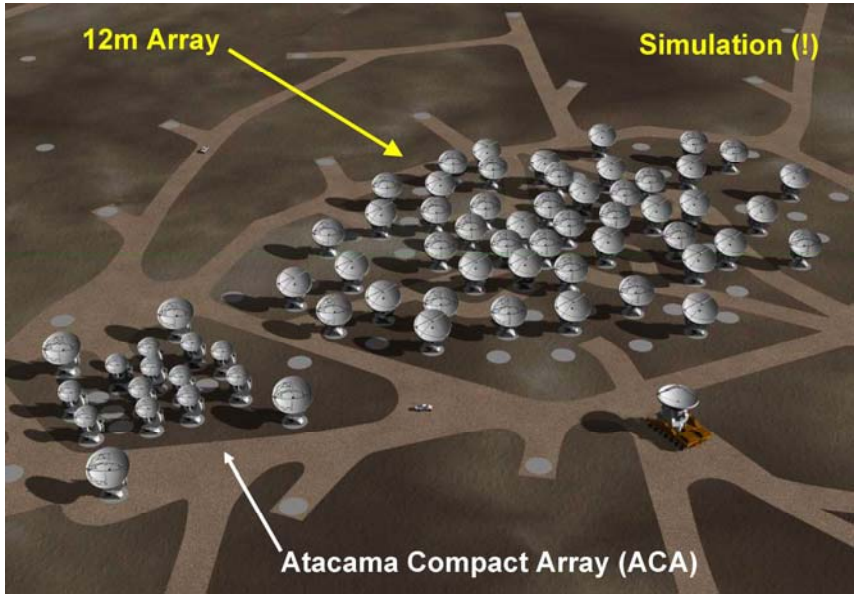
Telescopes that are being built

- Atacama Large Millimeter Arra
- Survey intruments:
  - Australian Square Kilometr
  - Allen Telescope Array (ATA
- Epoch of Reionization, iononsh
  - LOw Frequency Array (LO
  - Long Wavelength Array (LW



ALMA

- 50 x 12m antennas (up to 64)
  - plus 4 x 12m (total power)
  - plus ACA: compact array of 12 x 7m antennas
- 5000m site in Chilean Atacama desert
- A global partnership
  - North America (US, Canada)
  - Europe (ESO)
  - East Asia (Japan, Taiwan)



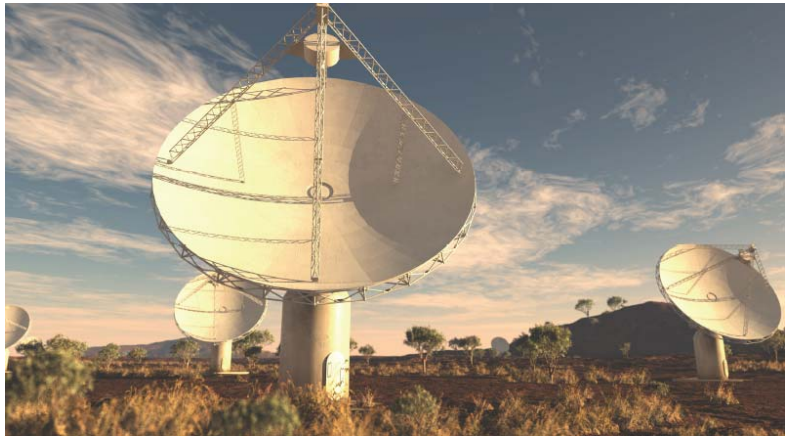
ALMA (cont.)

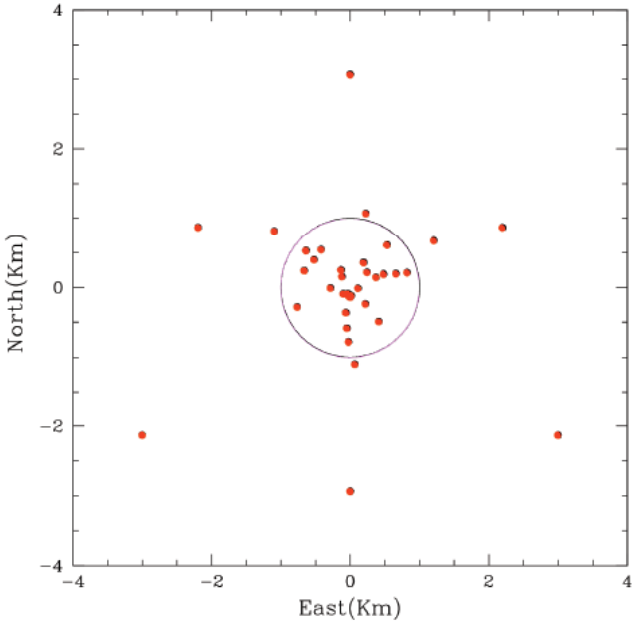
- Up to 15 km baselines
- Sensitive, precision imaging between 84 to 950 GHz (3 mm to 350 μm)
- Receivers: low-noise, wide-band (8 GHz)

ALMA will be 10-100 times more sensitive and have 10-100 times better angular resolution compared to current millimeter interferometers

ASKAP

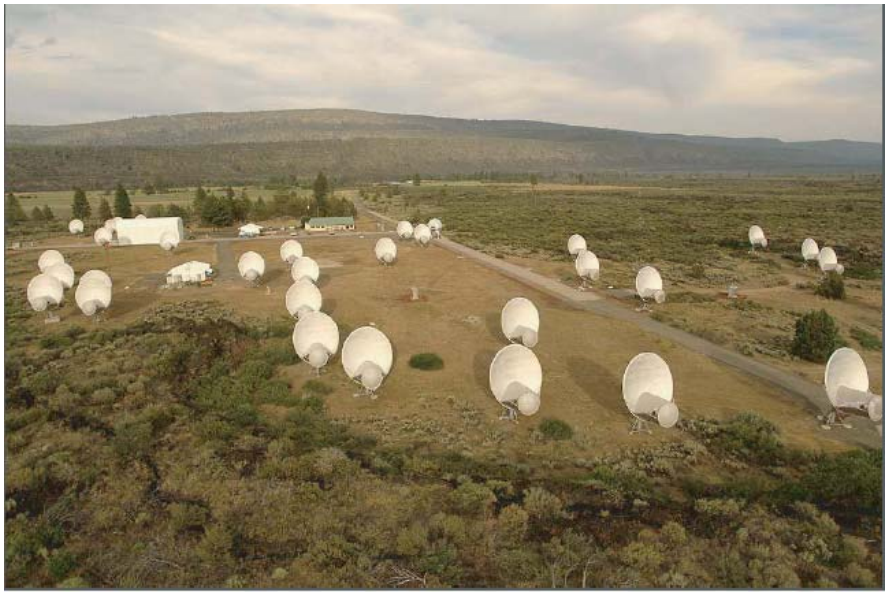
- 36 x 12 meter telescopes in Australia
- B_{max}=6 km
- Observing frequency 700-1800 MHz
- Large field of view
  - Focal plane array
  - Allow fast surveys
- Similar survey speed to Apertif (in the North)
- Sensitivity ~0.05 mJy/beam in one hour
- Operations start in 2014





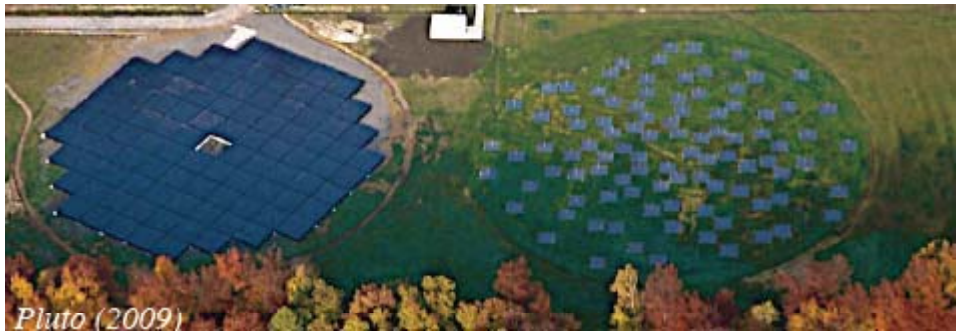
ATA

- Currently 42 x 6.1 meter telescopes in US
  - Goal 350 telescopes
- Collaboration between UC Berkley and the SETI Institute
- Log-Periodic Feed, which receives from 0.4-10GHz
- Beam forming
  - 16 pencil beams anywhere on sky
  - Can use active nulling
- Surveys and transient searches



LOFAR

- Combination of:
  - Low band dipoles, 30-80 MHz
    - 48-96 antennas/station
  - High band tiles, 120-240 MHz
    - 96 antennas/station
- 40 Netherlands and 8 EU stations
- Digital beam forming



LWA

- 52 stations of 256 phased dipoles serve as 'antennas'
- Intermediate array will have core plus 10 outlier sites
- Multi-beam, multi-frequency electronic array