ngVLA Technical Overview

Mark McKinnon

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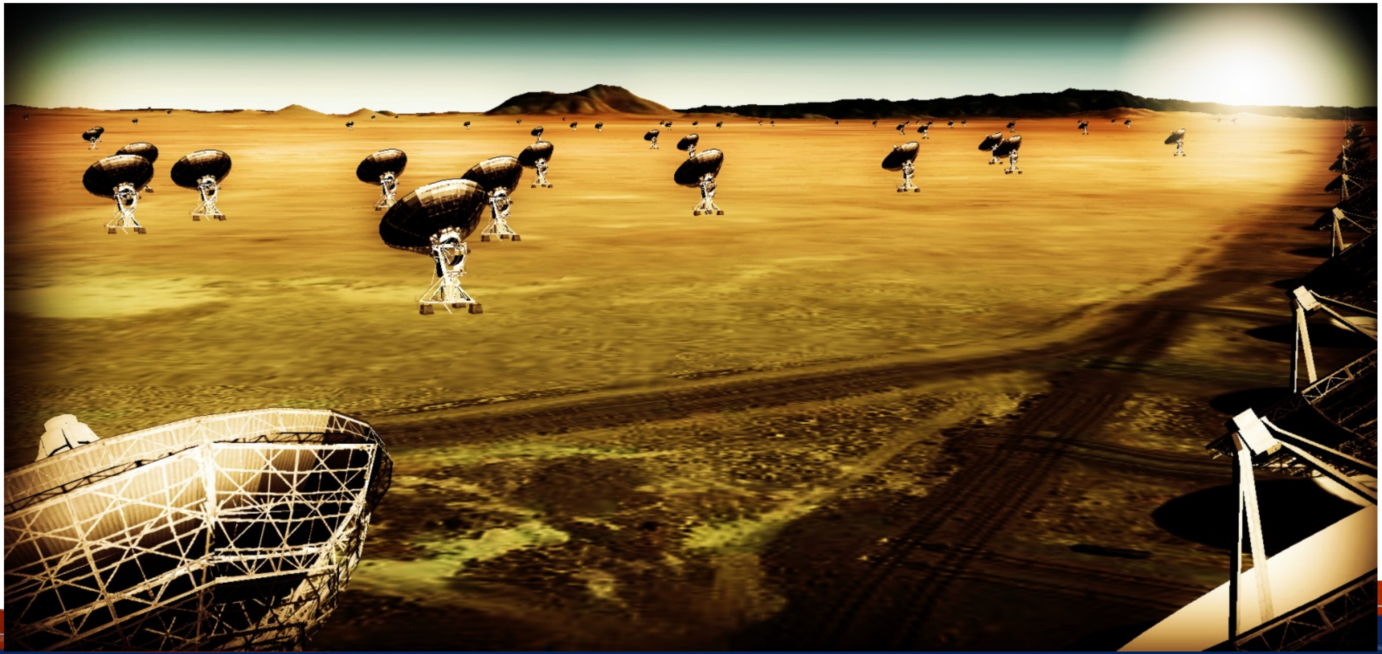
Outline

- ngVLA Concept
- Technical Issues to Consider in Science Use Cases
- Additional Information

ngVLA Concept

- Effective collecting area: 10x JVLA
- Frequency range: 1-115GHz
- About 300 antennas, ~18m diameter, fixed location
  - Distribution: about half on the Plains of San Augustin in New Mexico, with remaining half out to 300km



Nominal Technical Parameters

	2GHz	10GHz	30GHz	80GHz	100GHz
Field of View FWHM (18m[a]) arcmin	29	5.9	2	0.6	0.51
Aperture Efficiency (%)	65	80	75	40	30
A^b_{eff} x10^4 m^2	5.1	6.2	5.9	3.1	2.3
T^c_{sys} K	29	34	45	70	80
Bandwidth[d] GHz	2	8	20	30	30
Continuum rms[e] 1hour, μJy beam^{-1}	0.93	0.45	0.39	0.96	1.48
Line rms 1hour, 10 km s^{-1}, μJy beam^{-1}	221	70	57	100	130
Resolution[f] FWHM milliarcsec	140	28	9.2	3.5	2.8
T^g_B rms continuum 1hr K	14	7	6	15	23
Line[h] rms 1hour, 1" taper, 10 km s^{-1}, μJy beam^{-1}	340	140	240	860	–
T^i_B rms line, 1hour, 1" taper, 10 km s^{-1}, K	100	1.8	0.32	0.17	–

[a]Under investigation: antenna diameters from 12m to 25m are being considered.

[b]300 x 18m antennas with given efficiency.

[c]Current performance of JVLA below 50GHz. Above 70GHz we assume the T_{sys} =60K value for ALMA at 86GHz, increased by 15% and 25%, respectively, due to increased sky contribution at 2200m.

[d]Under investigation. For much wider bandwidths, system temperatures are likely to be larger.

Carilli et al. 2015, ngVLA memo #5

Pointed or Survey Telescope?

- ngVLA is envisioned to be a general purpose, PI-driven, pointed telescope
  - Used much like current JVLA
  - Can be used for occasional, dedicated surveys (e.g. FIRST, NVSS)
- ngVLA is *not* a dedicated survey instrument that delivers generic data products (e.g. a radio-LSST)
  - Drives telescope design in a very different way (large N, small D)

Technical Issues for Consideration in Science Use Cases

Phase Calibration

- Options (Clark, ngVLA memo #2)
  - Self calibration
  - Fast switching (Carilli, ngVLA memo #1)
  - Dedicated reference array (Owen, ngVLA memo #4)
  - Paired antennas
  - Water vapor radiometers
- See D. Woody's presentation for assessment of options

Array Configuration

- Sensitivity to low surface brightness. Options:
  - Large array of smaller diameter (~12m) antennas
  - Compact array of smaller diameter antennas at the core of the overall array (similar to ALMA)
  - Large single dish (e.g. GBT)
  - (See B. Mason's presentation for assessment of options)
- VLBI implementation. Options:
  - Used in concert with other, existing telescopes
  - ~20% of collecting area, perhaps in groups of antennas, on long baselines
  - (See W. Brisken presentation for implementation possibilities)
- Fixed or moveable antennas?

Antenna Optical Configuration – I

- Offset Gregorian
- Likely optical configuration if science priority is high dynamic range imaging at low frequency
  - Excellent receiver performance (i.e. low Trx) at these frequencies
  - Tsys dominated by scattering, spillover, sidelobe pick up
    - Mitigate with unblocked aperture
  - Large number of background sources
- Standing waves reduced
- Easier access to receivers and cryogenics, particularly in a feed low design

Antenna Optical Configuration - II

- Symmetric Cassegrain
- Likely optical configuration if science priority is sensitivity at high frequency
  - Tsys dominated by atmosphere and receiver
  - Fewer background sources (dynamic range not a big science driver?)
- Design inherently more stiff (symmetric)
  - Can more easily accommodate fast switching requirement
- Lower cost

Receiver Band Definition

- High bandwidth ratio feed (BWR 3:1 - 7:1)
  - Excellent continuum sensitivity
  - Cover desired frequency range with fewest number of receivers
    - Minimizes operations costs
- But when compared to conventional corrugated horns (~2:1 BWR), high BWR quadridge flared horns (QRFH) tend to have:
  - Higher cross-polarization (by ~10 dB)
  - Freq-dependent beamwidths (lower aperture efficiency at high freq)
  - Higher sidelobes (higher Tsys and RFI susceptibility)
  - Asymmetric beam patterns (adversely impact dynamic range)
- Guidance needed on band definition to capture desired molecular lines in a single band

Additional Information

- ngVLA webpage
  - https://science.nrao.edu/futures/ngvla
- ngVLA memo series
  - http://library.nrao.edu/ngvla.shtml
- ngVLA science working groups
  - https://science.nrao.edu/futures/ngvla/science-working-groups

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