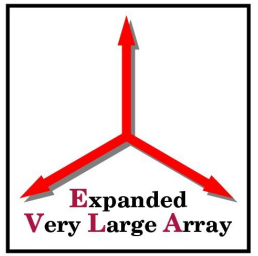


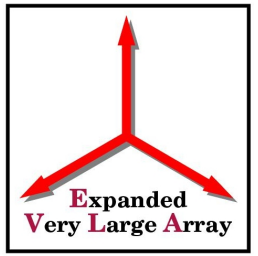
The ‘New Mexico Array’

Preliminary Configuration and Imaging Performance Studies

Rick Perley

EVLA Phase II Definition Meeting
Aug 23 – 25, 2001.

Goals for the 'N.M. Array'



- Increase VLA resolution by ~10.
- Provide image fidelity on a par with existing VLA.
- Have the new stations be useful for VLBA
- Keep it affordable
- Implement it quickly.

Basic Plan

- The ‘NMA’ will contain:
  - Two or more of the VLBA antennas (PT, LA)
  - A number of new antennas/stations located around the VLA.
- All of these will be connected by fiber to the ‘WIDAR’ correlator, for real-time operation.

Basic Plan

- This will provide us with a very flexible array:
  - VLA + NMA in one array. (normally in ‘A’ config.)
  - 1 – 4 VLA antennas + NMA in one subarray, remaining VLA antennas in another.
  - NMA as standalone array.
  - NMA + VLBA to enhance VLBA capabilities
  - Numerous combinations of the above.
- The WIDAR correlator will permit all of these.

NMA Performance

Full-Bandwidth Continuum Performance

(12 hours, 1-σ)

	Resolution (5 GHz)	Sensitivity (5 GHz)	Brightness Sensitivity
NMA + VLA	32 mas	0.75 μJy	25 K
NMA alone	20 mas	2.9 μJy	250 K
NMA + 2VLBA+4VLA	24 mas	1.65 μJy	100 K

NMA Performance

Spectral Line Performance

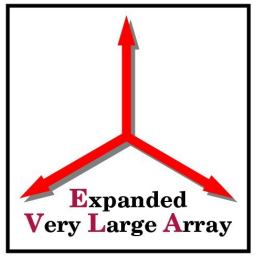
(12 hours, 1-σ, 1 km/sec)

	Resolution (5 GHz)	Sensitivity (5 GHz)	Brightness Sensitivity
NMA + VLA	32 mas	5.8 mJy	9600 K
NMA alone	20 mas	22 mJy	96000 K
NMA + 2VLBA+4VLA	24 mas	1.65 μJy	21100 K

A Critical Issue

- The most critical issue is: How many antennas/stations to add?
- Since antenna/stations are expensive, (~$6M each for 25-meter) the issue is one of incremental imaging performance.
- An ‘Imaging Performance/$’ quantifier is needed.

Prior Studies



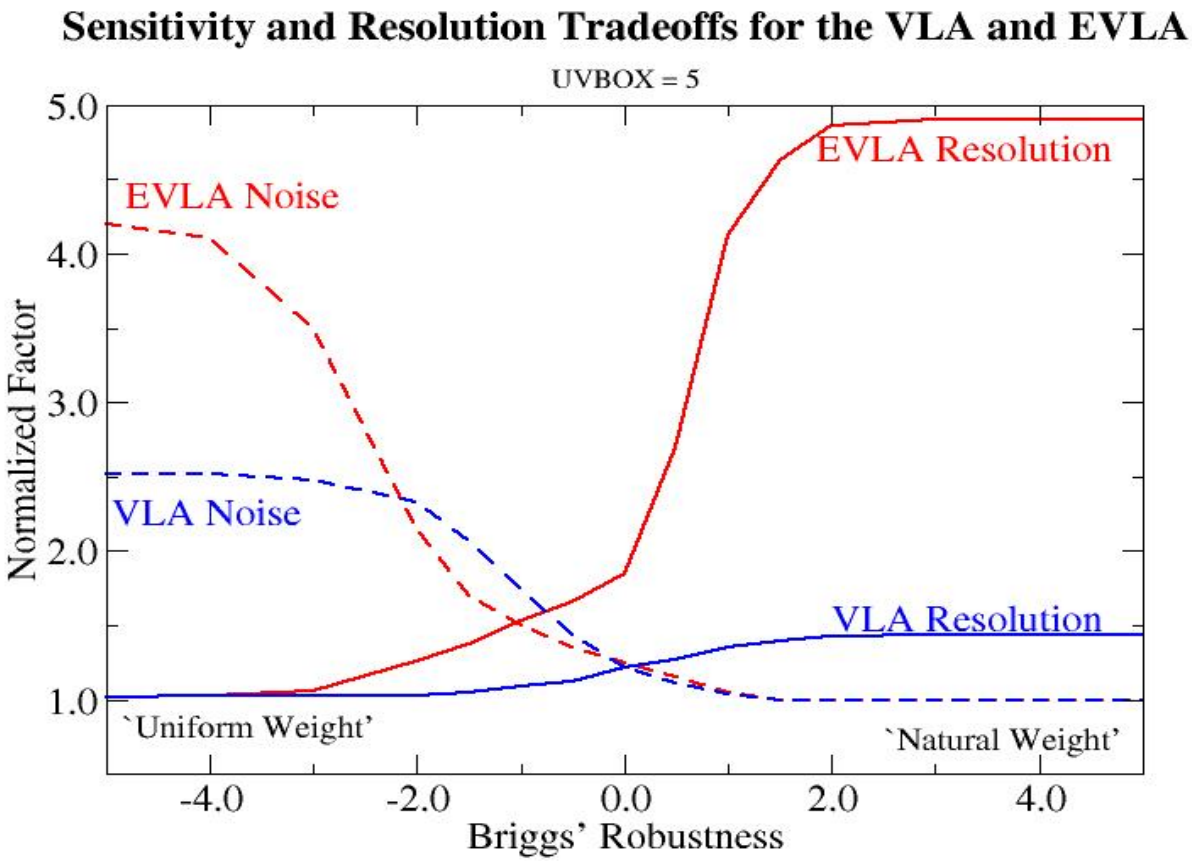
- There have been a number of early studies of 'NM Array' configurations.
  - Walker (VLBA Project Book)
  - Holdaway and Perley (EVLA Memo # 7)
  - Keto (EVLA Memo #9)
  - Cohen and Perley (EVLA Memo # 20)
- Difficult to compare these – differing goals and quantified measures.

A Fundamental Issue

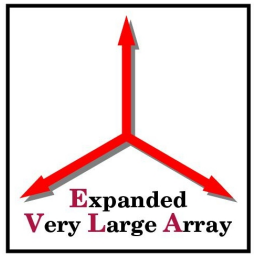
- All ‘NMArray’ designs will suffer the problem of a centrally-condensed array.
  - On 500-Km scales, the VLA (even in ‘A’ config) looks like a large single dish (27 antennas into 35 Km)
  - High SNR spacings are in the inner half, low SNR spacings are in the outer half.
  - ~60% of the visibility measures are in the inner 1% of the UV plane!
  - This causes <u>significant</u> tradeoffs between resolution and sensitivity.

Balancing Sensitivity and Resolution

A centrally condensed array like the EVLA can never give full resolution and sensitivity together.



Performance vs. # of Antennas Study

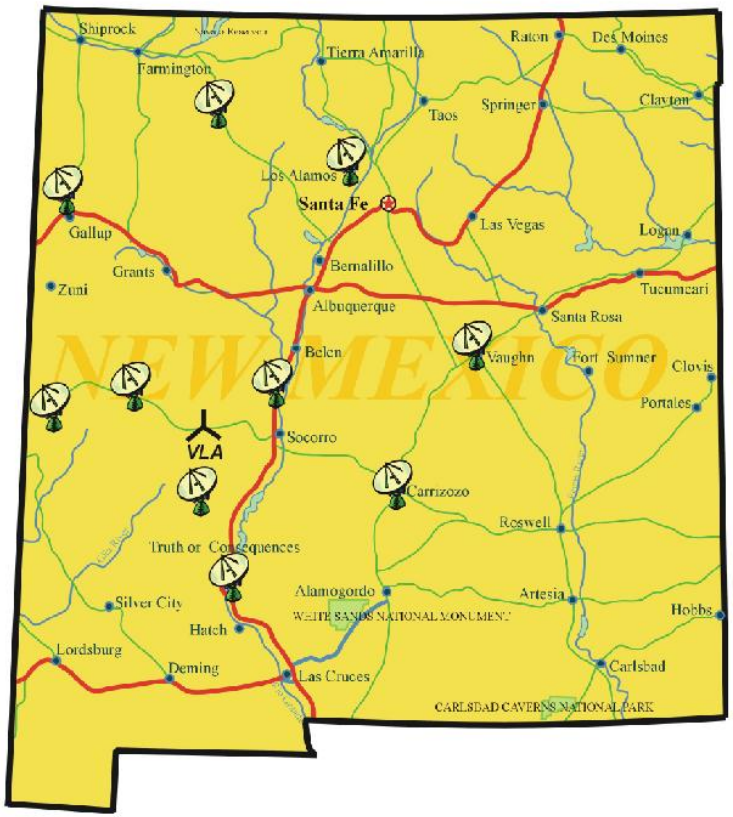


- The only study so far of the incremental performance gained by adding more antennas is EVLA Memo #20.
- To simplify the task, the authors assumed:
  - The 'Kogan Rings' design
  - No geographic or cultural barriers to siting
  - No wide-band synthesis capability.
- A complicated, well-known object was used as the trial image.

The Kogan Rings Design

The ‘Kogan Rings’ design comprises two rings around the VLA:

- An inner ring of 3 (incl. PT)
- An outer ring of 7 (incl LA)

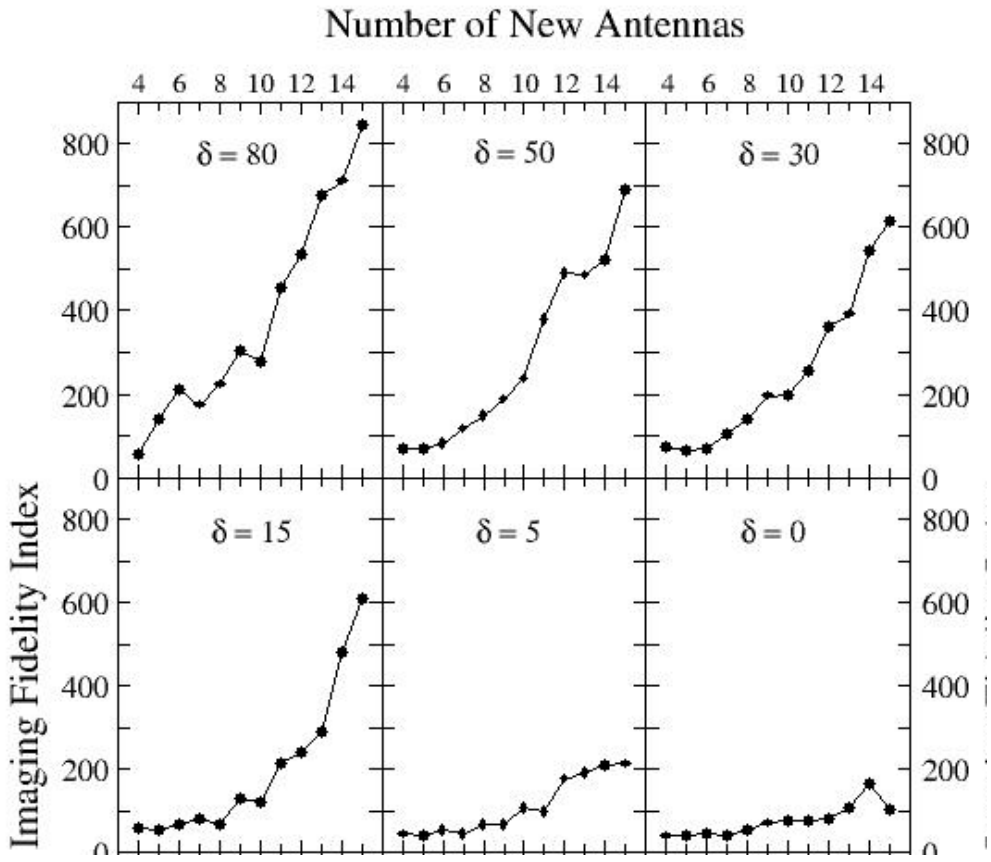


Performance vs. # of Antennas

- Basic performance characteristics were computed for differing numbers of antennas in the outer ring:
  - Sensitivity
  - RMS of (model – image)
  - 'Fidelity' (Peak/RMS)
- An elementary calculation of the benefits of bandwidth synthesis was also made.

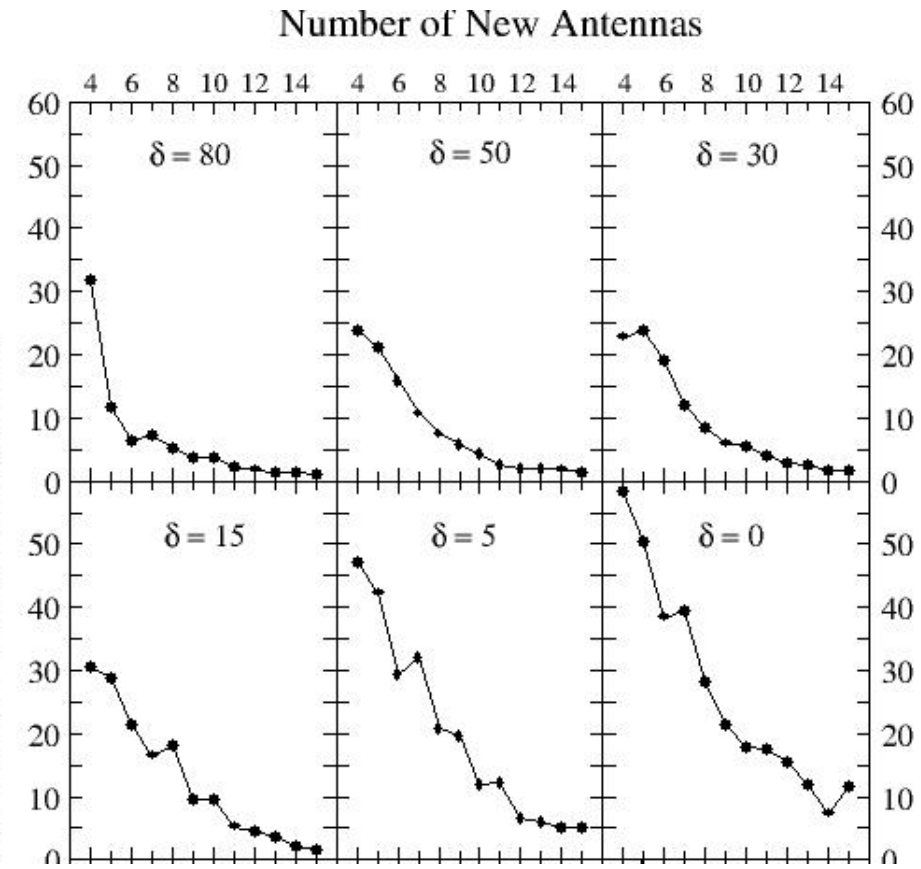
Performance vs. # of Antennas

- This shows the ‘fidelity’ as a function of # of new antennas, and declination.

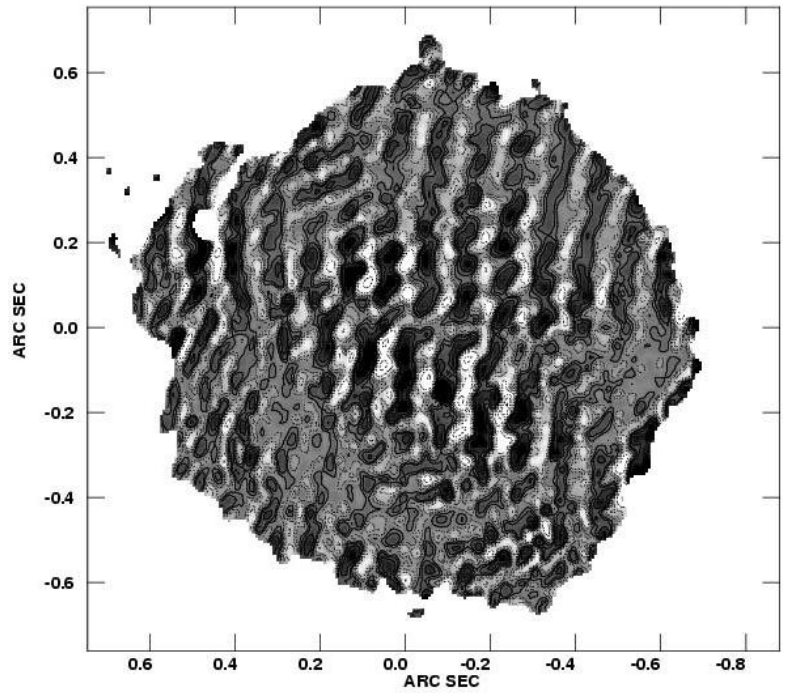


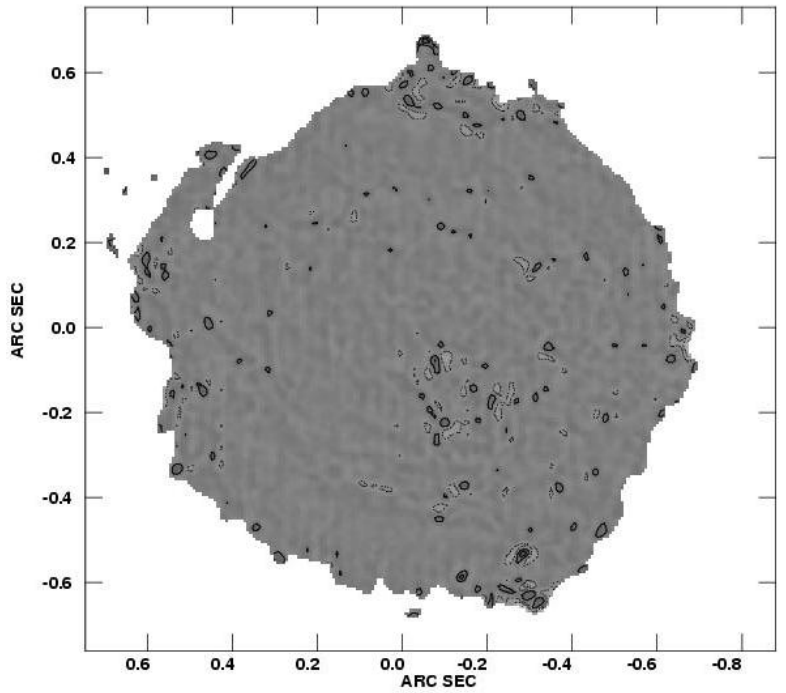
Error vs. # of Antennas

- This shows the RMS error between the ‘truth’ image and the reconstruction as a function of # of antennas and declination.



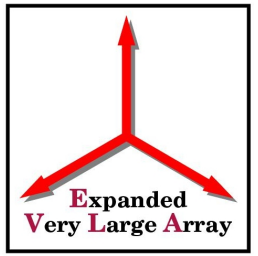
Effect of Bandwidth Synthesis





- Spreading four frequencies over 2:1 BWR is good.

Study Conclusions



- Imaging quality in general was very good.
- No magic break numbers were found.
- More antennas are good.
- Bandwidth Synthesis is very good.
- More studies, and more sophisticated studies are needed.