Getting the Big Picture: Design Considerations for a ngVLA Short Spacing Array

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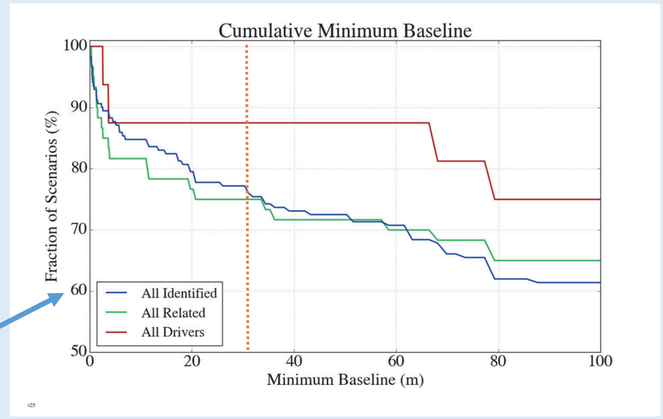
The Need for Short Spacings

- The ngVLA reference design – driven by the sensitivity requirements of Key Science use cases subject to cost constraints – calls for 214 antennas of 18m diameter.
- The largest spatial scales that can be imaged are limited by the shortest baselines, which are in turn set by the antenna diameter. ***Approximately 25% of identified science use cases require shorter spacings than the ngVLA main interferometric array will provide.***
- Larger scale spatial information can be provided by appropriate single-dish data; by data from a more compact interferometer; or by a suitable combination of both.
- ***Here we present a conceptual design for a compact "ngVLA Short Spacing Array" interferometer.***



ngVLA Small Antennas

NRC has created a prototype design for a small antenna for use in a ngVLA Short Spacing Array **(below right)**. The design, like the 18m antennas, calls for a composite structure & pedestal mount, with rim-supported, offset Gregorian optics.

Key antenna features:

- Dish diameters 1/3 those of the main array, providing good spatial frequency complementarity
- Clear aperture
- Electronics that are inter-changeable with those on 18-m antennas.

Array	Number	Antenna Diameter	Min. Baseline	Max. Baseline
Main array	214	18m	30m	1,000 km
Main array (core)	114	18m	30m	1.5km
Short Spacing Array	19	6m	11m	60m
Total Power Array	4	18m	-	-

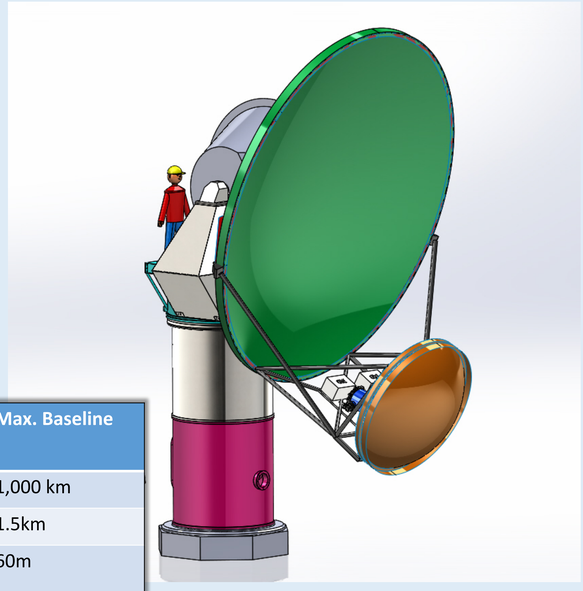


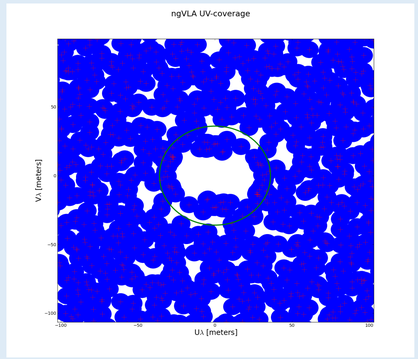
Image credit: NRC Canada

Short Spacing Array Configuration

Primary Conceptual Design Constraints:

- Baseline coverage out to the shortest, well-covered main-array baselines (31m), with some overlap.
- Enough antennas (19) to provide comparable surface brightness sensitivity to 18m Array, in equal observing time, when 18-m Array is *uv*-tapered to the natural resolution of the small Array.
  - Allows commensal main-array/small-array observing
  - Allows full cross-correlation & cross-calibration
- Semi-randomized antenna positions to improve PSF

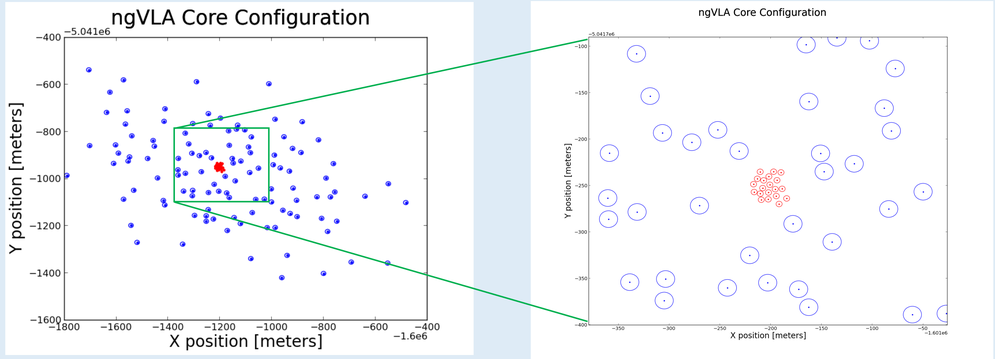
Key features are being verified by simulation in CASA.



Top Left: cumulative histogram of the minimum baseline needed to recover the largest angular scale of interest for the representative suite of science use cases that has been identified *(ngVLA Memo #18).* The vertical, red dashed line shows the approximate minimum ngVLA baseline of 1.75xD = 31.25m

Left: Aperture (UV) plane coverage for ngVLA (blue) and the ngVLA Short Spacing Array (red).

Below: Array configurations for the central 114 ngVLA antennas (blue) and the ngVLA Short Spacing Array (red).



Next Steps

We will conduct a trade study to assess options for providing short spacing information. Our study will include:

- Reviewing ngVLA Science Use Cases & systematically benchmarking different implementations: short spacing array, single dish(es), or both; as well as optimizing the number of elements in each.
- Detailed simulations of several key science use cases
- Collaboration with the broader science community through the ngVLA Community Studies Program (*Short Spacing Issues for the Mapping of Milky Way Extended Emission and Nearby Galaxies*; Teuben & Dale)

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