Getting the Big Picture: the ngVLA Short Baseline Array

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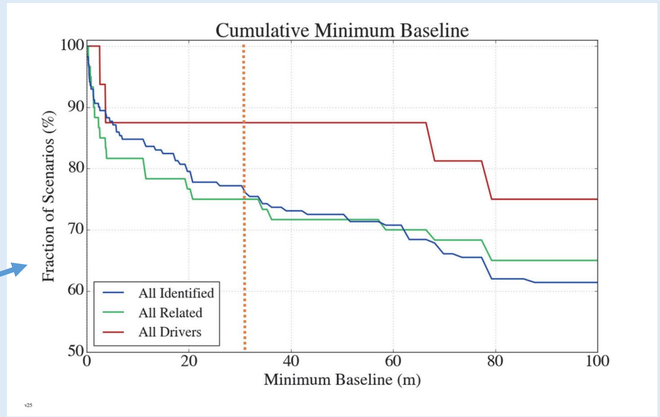
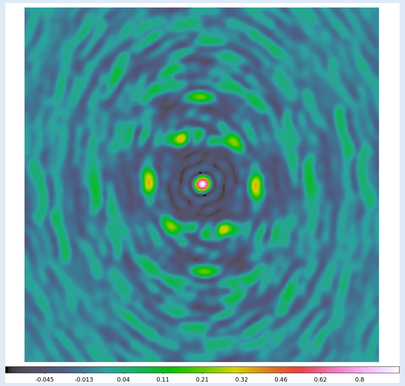
The Need for Short Spacings

- 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 antenna mechanical clearance requirements. ***At least 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 the ngVLA "Short Baseline Array" (SBA), which is the component of the ngVLA reference design which provides this information.*** Further information about the SBA design concept can be found in *ngVLA Memo #43*.





ngVLA Small Antennas

NRC has created a prototype design for a small antenna for use in a ngVLA Short Baseline 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.

Similar to the 18m antennas, which have a minimum spacing (30m) ~1.75x the dish diameter, the 6m antennas have a mechanically determined minimum spacing (11m).

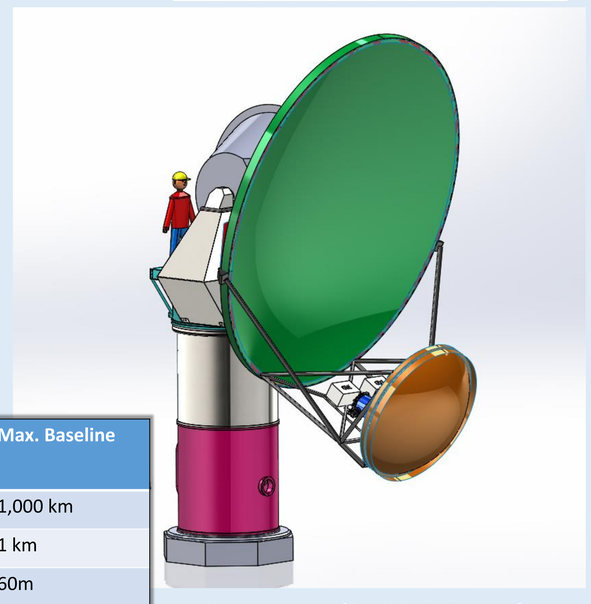


Image credit: NRC Canada

Array	Number	Antenna Diameter	Min. Baseline	Max. Baseline
Main array	214	18m	30m	1,000 km
Main array (core)	94	18m	31m	1 km
SBA (interferometer)	19	6m	11m	60m
SBA (total power)	4	18m	-	-

Short Baseline Array Configuration

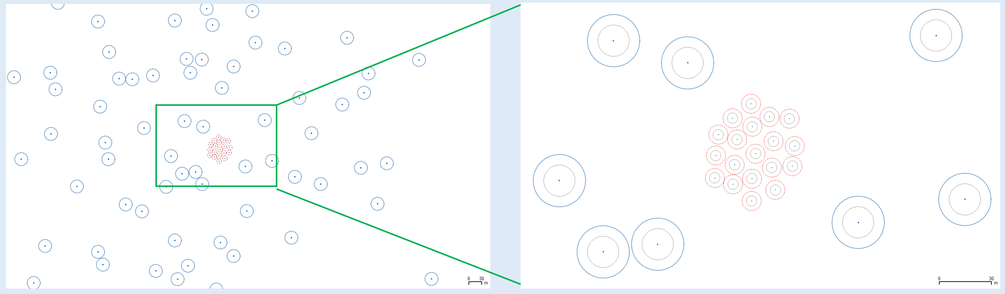
Primary Conceptual Design Constraints:

- Baseline coverage out to the shortest, well-covered main-array baselines (31m), with some overlap.
- Semi-randomized antenna positions to improve PSF
- 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.
  - Enables execution of the overall ngVLA science program in equal or less time as the main array component.
  - Supports commensal main-array/small-array observing and full cross-correlation & cross-calibration, if desired.

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: Simulated PSF for a short (17m) track at 100 Gz with the SBA. The natural-weight synthesized beam is 11" x 10". A future study will evaluate the imaging performance of this array against a sparser array with more randomly distributed antennas.

Below: Array configurations for the central 94 ngVLA antennas (blue) and the ngVLA Short Baseline Array (red). Solid lines show the 31m and 11m mechanical exclusion zones; actual antenna diameters are shown as solid grey lines in the right panel.



The SBA Reference Design

The ngVLA SBA design concept, documented in ngVLA Memo #43, comprises 19 6m antennas operated as a synthesis array plus 4 18m antennas operated as single dishes. Future work evaluating this concept will include:

- Detailed simulations of several key science use cases
- Assessment of the effect of changing the number of elements and their configuration (e.g., to a sparser but more random configuration).
- Collaboration with the 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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