The ngVLA Short Baseline Array: Design and Quantitative Evaluation

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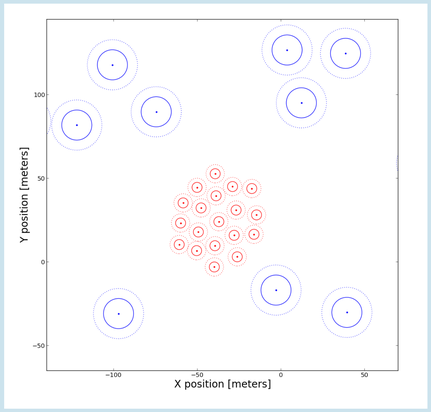
The Need for Short Spacings

- The ngVLA antennas, due to cost constraints, will not be reconfigurable. 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 (< 30m) 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 conceptual design for a compact "ngVLA Short Baseline Array" interferometer, or SBA.*** The SBA is included as a component of the overall ngVLA reference design, which also includes four 18m total power antennas.

The Short Baseline Array

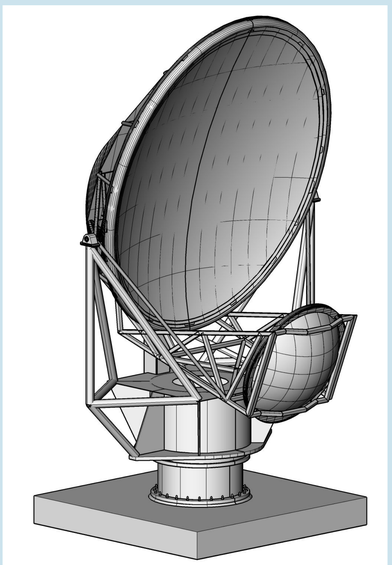
- **Antennas:** 6m diameter, clear aperture; the conceptual design by NRC is shown to the right.
- ***Inter-changeable electronics*** with those on 18-m antennas.
- The **number of antennas** (19) was chosen to provide ***comparable surface brightness sensitivity to 18m Array in equal observing time*** when 18-m Array is *uv*-tapered to the natural resolution of the SBA; while also providing ***good baseline coverage from 11m (set by mechanical clearance) to 55m, overlapping with the ngVLA main arra***y.
- The ngVLA reference design also includes a ***"Total Power Array" (TPA) of four 18m antennas*** outfitted to operate as single dishes which provide larger spatial scale information.

Array	Number	Antenna Diameter	Min. Baseline	Max. Baseline
Main array	214	18m	30m	1,000 km
Main array (core)	94	18m	30m	1.3km
SBA	19	6m	11m	55m
Total Power Array	4	18m	-	-



Above: SBA configuration (red) with a notional placement near the center of the ngVLA core antennas (blue). The mechanical exclusion zones– 11m and 30m for 6m and 18m antennas respectively– are shown as dashed lines.

Below: NRC Conceptual design for the SBA 6m antenna.

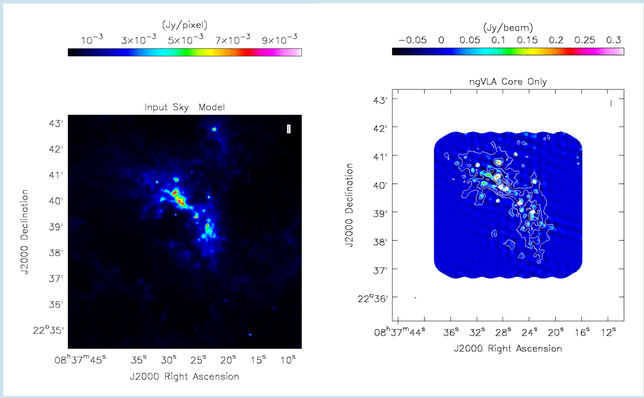


Simulations of SBA and ngVLA Core Performance

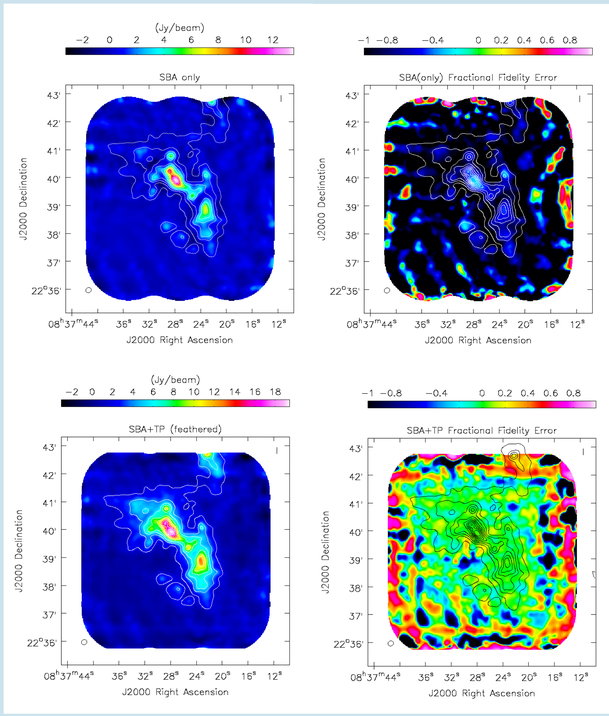
Simulated observations of a spatially extended (~5') object were carried out to quantify the imaging fidelity and integrated flux recovery performance of the ngVLA core, the SBA, and the SBA with single dish data from the TPA. For this use case***, total power information is essential: SBA+TP accurately recovers the true total flux, and delivers 95% imaging fidelity.***

Quantitative results are in the table **below**. Further details of the simulations and analysis are in ngVLA memo 67.

Image	Total Flux	Fidelity
Truth	**1225 Jy**	---
ngVLA Core	71 Jy	14%
SBA	238 Jy	32%
SBA+TP	**1232 Jy**	**95%**



Above (left): Input "truth" image. **Above (right):** simulated ngVLA core (only) observation. **Below:** simulated SBA only observation (**first row**) and SBA+Total Power (**bottom row**) . The right-hand columns of the images below show the fractional error in the reconstructed image. Contours show the truth image at 10%, 20%, … 90% peak intensity.



The Short Baseline Array is a component of the ngVLA Reference Design. More information about it can be found in ngVLA memos 43 & 67.

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