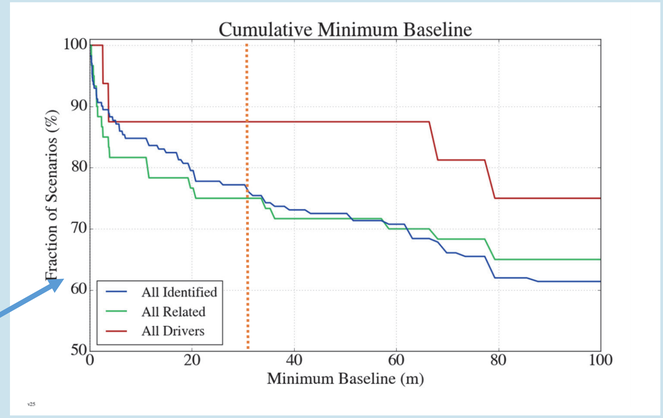
The ngVLA Short Baseline Array

Brian Mason[1], Ryan Parziale[2], Alan Erickson[3], Rob Selina[3], Dean Chalmers[4], Eric Murphy[1]

[1]National Radio Astronomy Observatory, Charlottesville VA ; [2]University of Wyoming, Laramie WY; [3]National Radio Astronomy Observatory, Socorro NM; [4]National Research Council, Penticton BC

The Need for Short Spacings

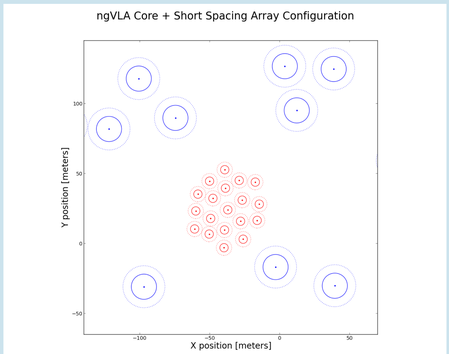
- The ngVLA reference design – driven by the sensitivity requirements of Key Science use cases subject to cost constraints – calls for 244 antennas of 18m diameter, including 30 antennas at very long (continent scale) baselines.
- The largest spatial scales that can be imaged are limited by the shortest 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 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.



Short Baseline Array Configuration

Primary SBA Reference Design Features:

- 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 SBA.
  - Allows commensal main-array/SBA observing
  - Allows full cross-correlation & cross-calibration
- Semi-randomized antenna positions to improve PSF



Above: cumulative histogram of the minimum baseline needed to recover the largest angular scales 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: 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.

ngVLA Small Antennas

NRC has created a concept design for a small antenna for use in a ngVLA Short Baseline Array **(below right)**. The design, like the 18m antennas, incorporates an offset Gregorian, Single-Piece, Rim-supported Composite (SRC) reflector & steel pedestal mount.

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).

Array	Number	Antenna Diameter	Min. Baseline	Max. Baseline
Main array	214	18m	30m	1,000 km
Main array (core)	94	18m	30m	1.5km
SBA	19	6m	11m	60m
Total Power Array	4	18m	-	-

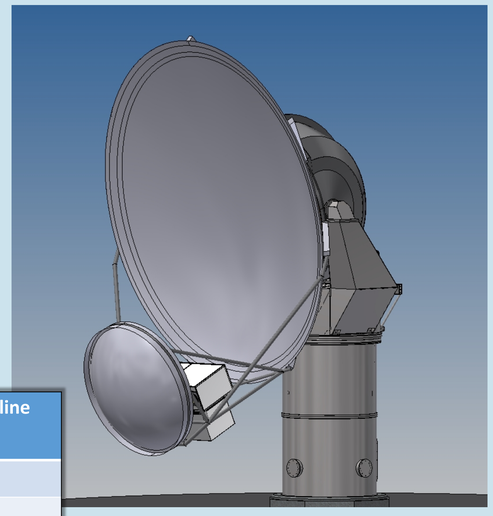
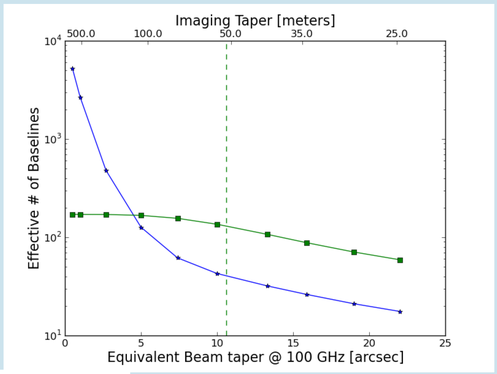


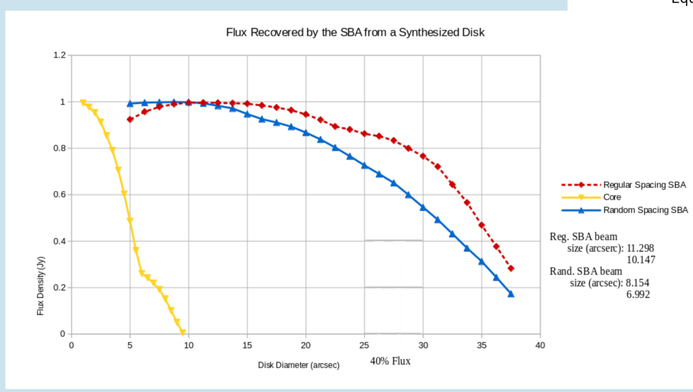
Image credit: NRC Canada

SBA Evaluation

The SBA has been evaluated analytically and using simulations in CASA to determine its efficacy at complementing the ngVLA 18m array.

Right: effective number of baselines for the ngVLA core (blue) and the SBA (green) as a function of applied *uv*-taper. The vertical dashed line is the SBA natural weighted beam size (*from ngVLA memo #43).*





Left: integrated flux density recovered by CLEANing a simulated observation of a 1 Jy disk as a function of disk diameter. The SBA reference configuration (red) is highly effective at extending the response of the ngVLA core. A somewhat more extended SBA configuration (blue), with less regular spacings hence lower sidelobes, is less effective.

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

The National Radio Astronomy Observatory is a facility of the National Science Foundation operated under cooperative agreement by Associated Universities, Inc.