The Next-Generation Very Large Array Antenna Reference Design

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ngVLA Array Concept
The ngVLA will be a synthesis radio telescope constituted of approximately 244 reflector antennas each of 18 meters diameter, operating in a phased or interferometric mode. It will operate over a frequency range extending from 1.2 GHz to 116 GHz.

The signal processing center of the array will be located at the Very Large Array site, on the plains of San Agustin, New Mexico. The array will include stations in other locations throughout New Mexico, west Texas, eastern Arizona, and northern Mexico.

Operations will be conducted from both the VLA Control Building and the Array Operations Center in Socorro, NM.

Table 1: ngVLA Key System Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Antenna Diameter</td>
<td>18m Main Array, 6m Short Baseline Array, 18m Total Power</td>
</tr>
<tr>
<td>Number of Antennas</td>
<td>244 x 18m, 19 x 6m</td>
</tr>
<tr>
<td>Antenna Optics</td>
<td>Offset Gregorian, Feed Low, Shaped</td>
</tr>
<tr>
<td>Frequency Range</td>
<td>1.2 GHz – 50.5 GHz, 70 GHz – 116 GHz</td>
</tr>
<tr>
<td>Instantaneous Bandwidth</td>
<td>Up to 20 GHz / Pol.</td>
</tr>
</tbody>
</table>

General Dynamics Mission Systems Antenna Concept
The low-tech/low antenna design for the ngVLA antenna study was developed by General Dynamics Mission Systems. The design is to a specification developed by the ngVLA project team with an optical design advanced by the National Research Council of Canada.

The GDMS concept is scaled from the successful 13.5m MeerKAT antenna design. The offset Gregorian optics are provided by an aluminum segmented main reflector and a single piece subreflector. These are supported by a steel radial truss structure and feed arm. A central cavity in the Gregorian optics are provided by an aluminum segmented main reflector and a single piece with an optical design advanced by the National Research Council of Canada.

Two studies were pursued for the Reference Design: a single piece composite primary (developed by the National Research Council Canada, NRC) and a traditional multi-panel (General Dynamics Mission Systems). This presentation focuses on the GDMS study and highlights the antenna concept, initial surface analysis, and deflections of the back-up structure.

We will highlight further studies and design work as well as discuss areas of technical risk, and where technical advances may be required for successful antenna production and assembly.

Abstract
The next-generation Very Large Array (ngVLA) is an astronomical observatory planned to operate at centimeter wavelengths (25 to 0.26 centimeters, corresponding to a frequency range extending from 1.2 GHz to 116 GHz). The observatory will be a synthesis radio telescope constituted of approximately 244 reflector antennas each of 18 meters diameter, operating in a phased or interferometric mode.

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We will highlight further studies and design work as well as discuss areas of technical risk, and where technical advances may be required for successful antenna production and assembly.

Optical Design
The antennas will be constituted of a shaped paraboloidal reflector, with a subtended circular aperture of 18m diameter. The optical configuration is an offset Gregorian feed-low design supported by an Attitude-Azimuth mount. The benefits of this design include: subreflector and support do not block the primary, off-axis geometry minimizes scattering, spillover, and sidelobe pickup, and the wide subtended angle of the subreflector leads to very compact feed designs that can be combined into a limited number of cryogenic dewars, reducing operations costs.

The reference optical design was developed by Lynn Baker in collaboration with the National Research Council of Canada.

Analysis & Expected Performance
As stated, the proposed antenna study delivers a baseline cost and performance model to use as a benchmark for future trade studies. Given this approach, the baseline design does not meet all the design requirements, most notably the pointing and surface accuracy requirements. GDMS has provided incremental changes that, when adopted, should provide a suitable design that will meet the design requirements.

GDMS identified that thermal loading, based on the CFD and FEA analysis, is the largest contributor to the proposed antenna’s inability to meet the surface accuracy (rms) specification.

Further Information

http://ngvla.nrao.edu/