Design Considerations for the ngVLA Antennas

David Woody
Owens Valley Radio Observatory, Caltech, Big Pine, CA USA

The next generation VLA (ngVLA) is planned to be a major new instrument that needs to meet stringent performance and cost requirements. This will require careful evaluation of the performance vs. cost tradeoff. It is unlikely that the cost of an instrument that does everything we would like it to do is affordable and we will need to make strategic choices.

The ngVLA will have baselines as long as 300 km and operate at wavelengths as short as 3 mm. The delay fluctuations caused by water vapor can be as large as several wavelengths at the highest observing frequencies and will need to be corrected in order to produce high fidelity images. One of the simplest methods for correcting the atmospheric delay fluctuations is to perform phase calibration on a nearby calibrator on a timescale short enough to "freeze" the atmospheric fluctuations. This fast switching requirement will impact the design and cost of the antenna. Larger and off-axis antennas will be less stiff and be slower to switch between sources. It is important to quantify the switching time required to correct the atmospheric delay fluctuations and include that in the antenna specifications. In addition smaller antennas will have larger beams and more likely to have a self-calibration source in the field.

Another area that impacts the antenna cost is the range of motion for pointing. Telescopes can be made lower to the ground and stiffer if the lower elevation limit is increased. This will decrease the cost and increase the servo bandwidth and switching speed.

The antenna size is the dominant parameter in the cost per unit collecting area and the fast switching capability. It is important to get this cost dependence correct in order optimize the scientific return on investment. A fixed budget for the antennas will produce the largest collecting area using smaller symmetric antennas. It is also important to understand the infrastructure, correlator and image processing costs, which scale as the number of antennas in the range from N to N^2, before arriving at an optimal design.