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On the design of the 18 m offset Gregorian dual reflector antenna for the ngVLA

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The Next Generation Very Large Array (ngVLA), a project of the National Radio Astronomy Observatory (NRAO), is a new radio astronomical instrument with its core envisaged to be built on the Plains of San Agustin in New Mexico, USA. This instrument's reference design specifies offset Gregorian dual reflector antennas, and the array will consist of approximately 244 antennas with an 18 meter aperture diameter and 19 antennas with 6 meter aperture diameter [1]. A suite of cryogenic feeds mounted on an indexer mechanism at the reflector system's focus will have a frequency range extending from 1.2 GHz to 116 GHz. The work presented here will focus on the 18 meter reflector antenna which has a sub-reflector with maximum cord length of 3.5 meter.

Various antenna parameters, within the constraints set out in the reference design, need to be chosen in order to ultimately achieve maximum receiving sensitivity, the main performance metric of the system, with practically realizable feeds.

This paper investigates the performance limits of both the classic conic section (unshaped) reflector system – as a reference – and a shaped reflector system when illuminated with ideal feeds. The ideal feeds are axially symmetric flat-topped Gaussian, but have been spatially filtered so that their physical size corresponds to the spatial limits allowed on the indexer. The ideal feed is determined by means of full parametric searches. Parameters such as the sub-reflector opening angle and the size of a sub-reflector extension, for reduced spillover (pickup of radiation from hot ground), are investigated for both the feed-down, meaning scanning to the horizon lowers the sub-reflector towards the ground, and feed-up tipping scenarios.

Once the performance limits are established for a variety of optical configurations, most importantly the sub-reflector subtended angle, which drives the feed horn technology and size, the result will be used to aid the down selection of final optics and feed antenna technologies.

References

[1] R. Selina and E. Murphy, "ngVLA Reference Design Development & Performance Estimates", *ngVLA Memo # 17*.