Grating Lobe Suppression for the Next Generation Arecibo Telescope Concept

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Abstract: A recently proposed concept for the Next Generation Arecibo Telescope involves an array of tightly packed small dishes [1]. In support, we present mitigation methods for grating lobe effects inherent in regularly spaced aperture synthesis.

1. Introduction

After supporting valuable science discoveries for 57 years, the Arecibo Telescope collapsed at the end of 2020. Immediately thereafter, the science community began plans for a Next Generation Arecibo Telescope (NGAT) to expand on the impressive legacy of the former instrument. An international interdisciplinary team developed a concept for a telescope that would have 500 times the field of view and 1.8 - 3.6 times more sensitivity of the previous telescope. The concept involves co-mounting many smaller dish reflectors on a larger steerable platform. This approach minimizes shadowing and gaps for maximum effective aperture area. See Figure 1 below.

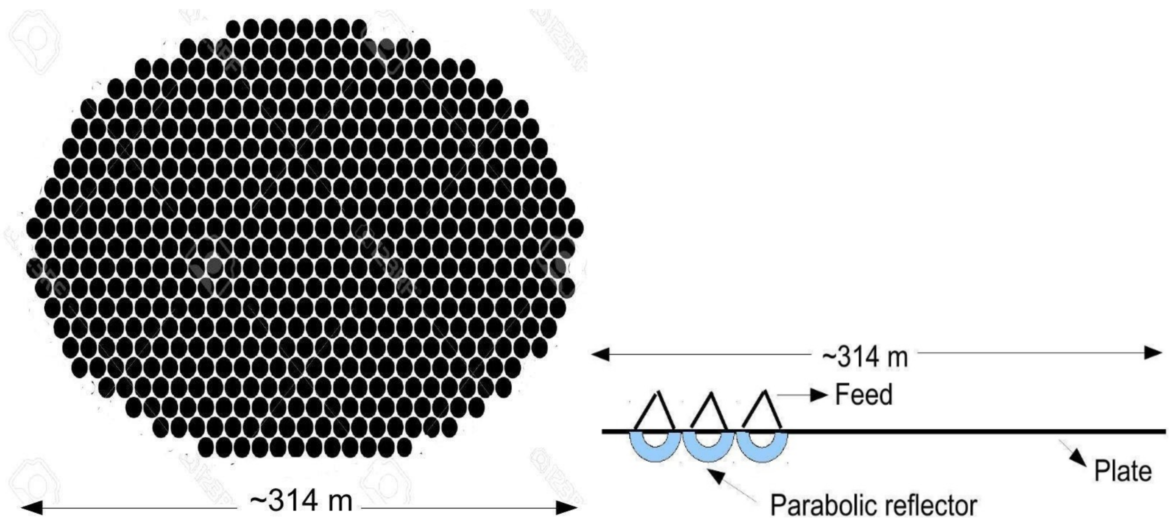

Fig. 1. A schematic of the NGAT concept showing an array of smaller dishes (left) and a cross section showing dishes co-mounted on a steerable platform (right). Image credit Arecibo Observatory.

2. Grating Lobes

For this aperture synthesis design concept, it is important to consider grating lobes. If dishes are packed in a regular array, the periodic gaps between dishes act as a diffraction grating that bring signal in from outside the central lobe. Similar effects have been observed due to gaps between panels in a single reflector [2] and phased array feed applications.

3. Potential Solutions

In array processing, grating lobes are typically mitigated by the directionality of the individual array elements, and/or by using an irregular or randomized placement pattern for the elements [3]. For optical telescopes, it has been shown that using spiral panel configurations greatly reduces bright artifacts in the telescope point spread function [4]. We examine these and similar approaches for the NGAT array elements. We use computer models to compare mitigation strategies such as:

- Hexagonal dishes that completely fill the aperture leaving negligible gaps between sub-apertures.
- Spiraled dish locations.
- Random dish diameters randomly close packed (see Figure 2).
- Multiple dish diameters close packed.
- Shaped dishes with flattened beam profiles.
- Off-Axis dishes.
- Reducing edge taper (monitoring the effects of spillover to adjacent dishes).

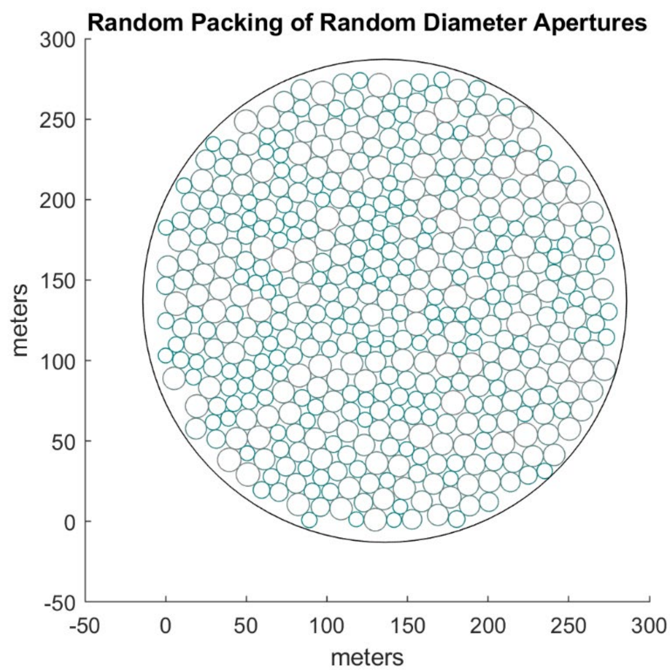

Fig. 2. A schematic of an array configuration that uses dishes with random diameters (flat distribution) ranging from 9 to 15 m in diameter that are close packed within a 300 m diameter circle.

3. References

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