Imaging Capabilities of Outriggers in HERA-61

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Abstract

I present results from imaging simulations of two configurations of HERA-61: the HERA-61 hex and the inclusion of 3 inner ring outrigger (HERA-61+3).

1 Array Configuration

Using the HERA layouts as shown in Figure 1, I conduct simulations of HERA-61 (shown in red) with and without the three outriggers which have been circled. The configuration including the 3 outriggers will be referred to as HERA-61+3.

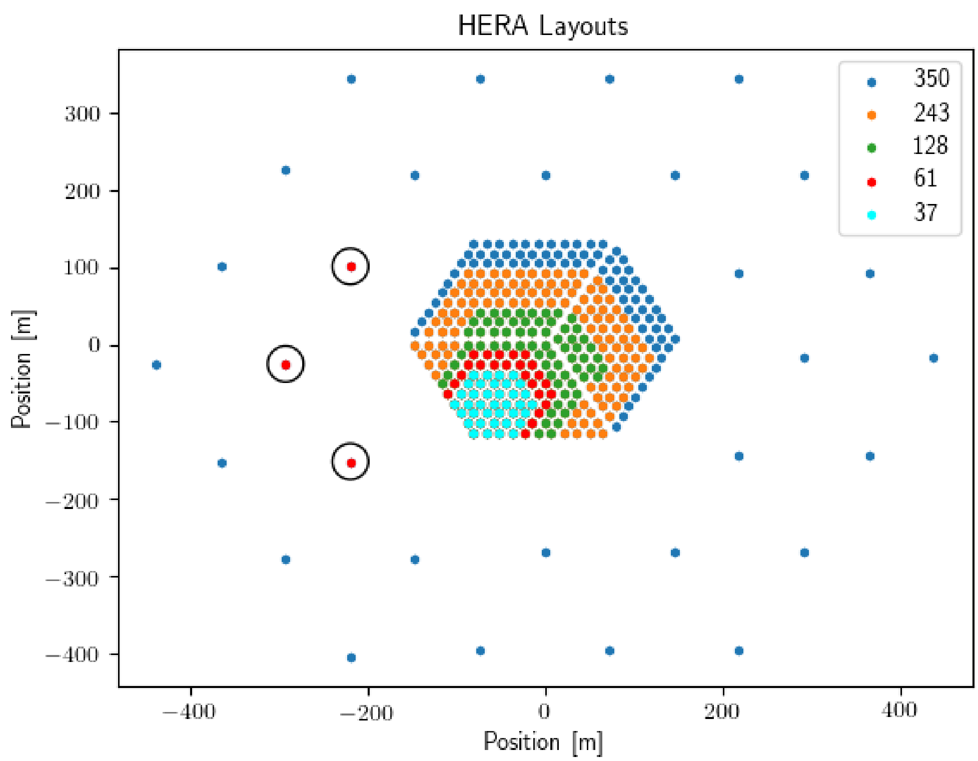

Figure 1: HERA staged antenna layouts.

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2 Simulation Parameters

The simulations used are performed with the PRISim[1] software and imaged using CASA[2]. I simulate an 11 minute integration at LST 4.85 hours with 100MHz of bandwidth divided into 1024 channels.

Using the GLEAM catalog, I simulate the E-polarized signal from sources whose flux is at least 5Jy at 150 MHz with no diffuse emission included.

The UV-coverage from both HERA configurations integrated over the 11 minute simulation are shown in Figure 2.

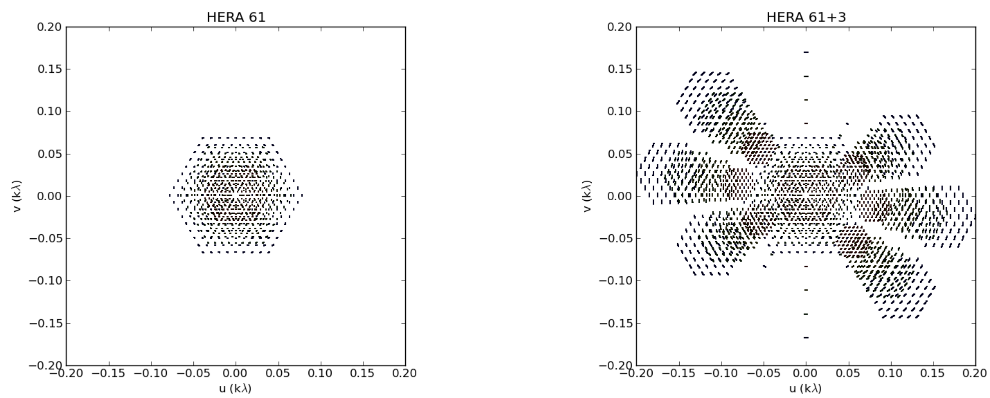

Figure 2: Resulting UV coverage from 11 min integration of HERA-61 (Left) and HERA-61+3 (Right).

The corresponding Point Spread Functions (PSF) from each configuration are shown in Figure 3. The inclusion of the three outriggers provides an increase in spacial resolution show in increased UV coverage and the narrower PSF.

3 Results and Discussion

Figure 4 displays the central field in the simulation, with a zoomed in region around NVSS J045405-304506 in Figure 5. The upper row corresponds to HERA-61 and the lower to HERA-61+3. The left column is the dirty image produced by each array and the right is the CLEAN and deconvolved image. CLEANing produces small improvements to the base HERA-61 image but noticeable improvements to the HERA-61+3 image.

Simulated sources with flux greater than .6 Jy at 150Mhz are highlighted in Figure 6.

The addition of outriggers to the HERA-61 will provide increases in UV-coverage, angular resolution and imaging sensitivity. The three additional dishes also reduce sidelobe power as shown in Figure 3. dynamic range of each image is quantified in Table 1. The addition of the outriggers reduces the rms of the image by 62.5% and increase the peak flux by 3%.

While these outriggers and their associated visibilities would require traditional calibration methods, the images made with these baselines are pretty good, especially compared to the HERA-61 images shown in Figure 4 and Figure 5. Imaging science with HERA would have a good head-start.

[1]https://github.com/nithyanandan/PRISim
[2]https://casa.nrao.edu/

	Max [Jy/beam]	RMS [Jy/beam]
HERA-61	16.84	3.23×10^{-1}
HERA-61+3	17.32	1.31×10^{-1}

Table 1: Maximum flux and RMS of the dirty images of HERA-61 and HERA-61+3.

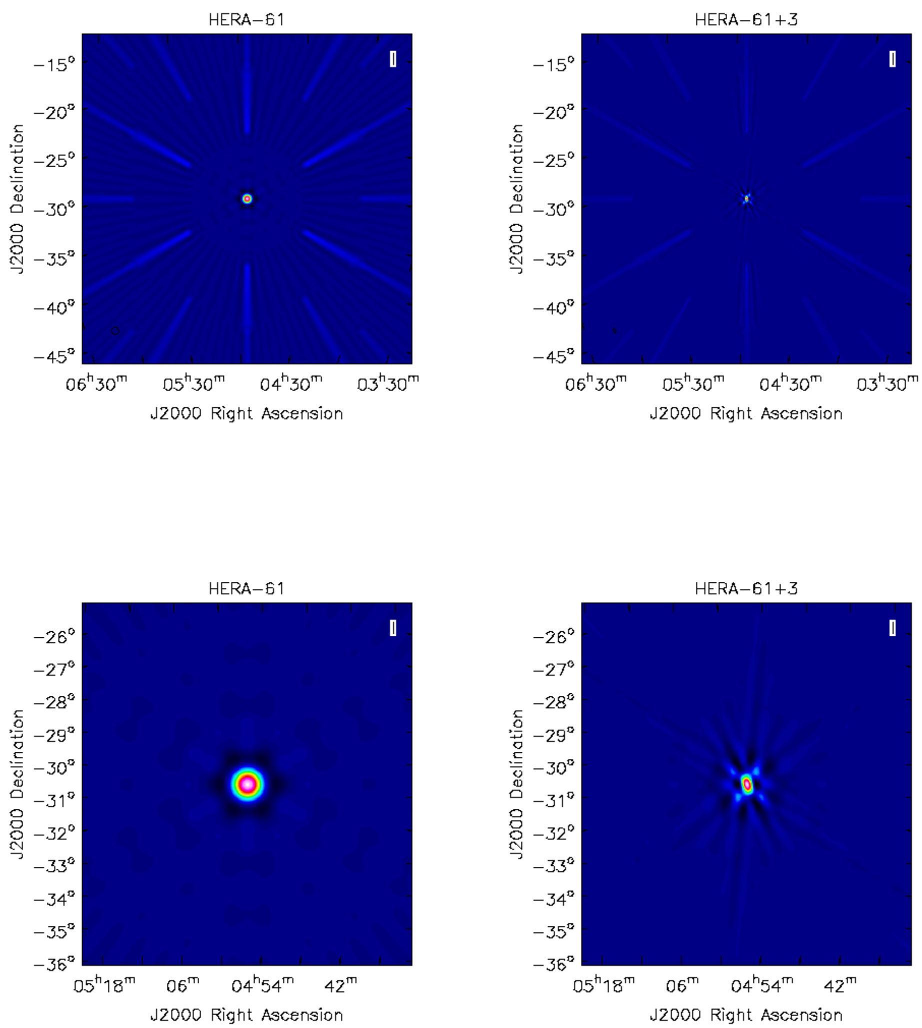

Figure 3: Point Spread Functions (PSF) of HERA-61 (left) and HERA-61+3 (Right). Lower row zooms in on the central lobe.

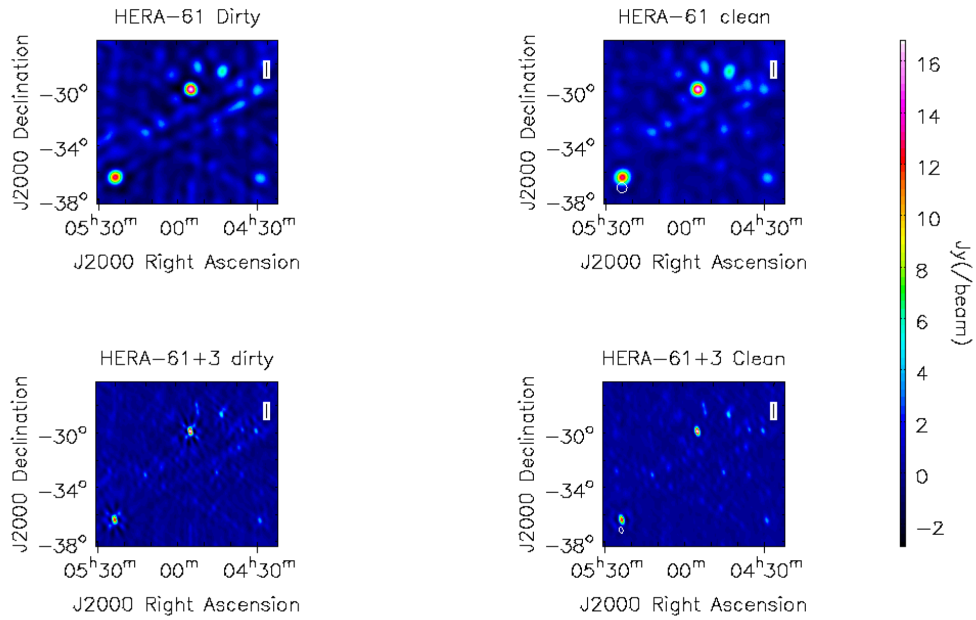

Figure 4: Central region of the field viewed at LST 4.85. Upper row: HERA-61, Lower: HERA-61+3. Left column: Dirty image, right: CLEAN + deconvolved image

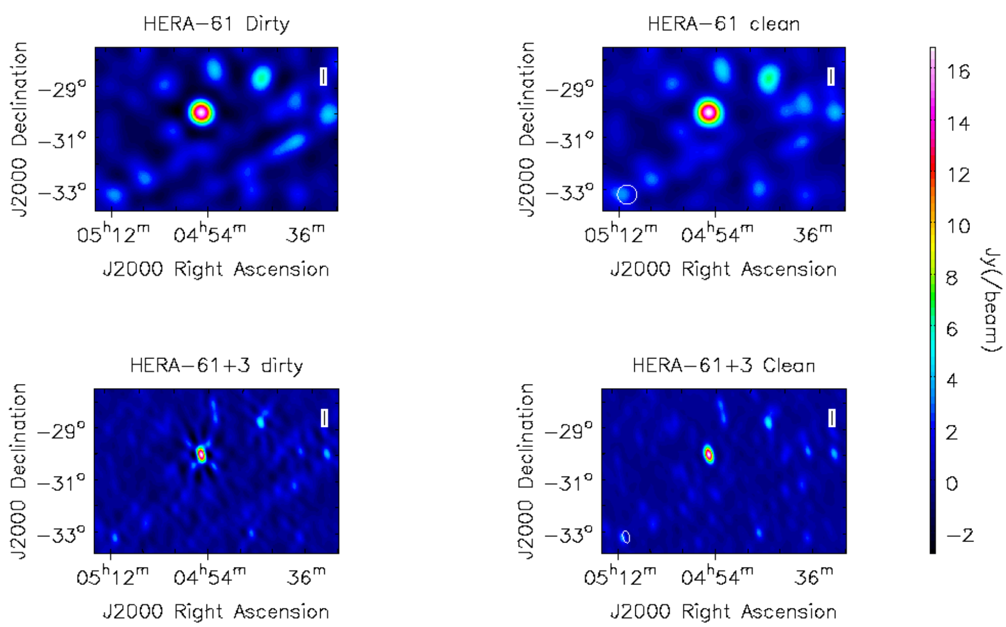

Figure 5: Zoomed image of NVSS J045405-304506 . Upper row: HERA-61, Lower: HERA-61+3. Left column: Dirty image, right: CLEAN + deconvolved image

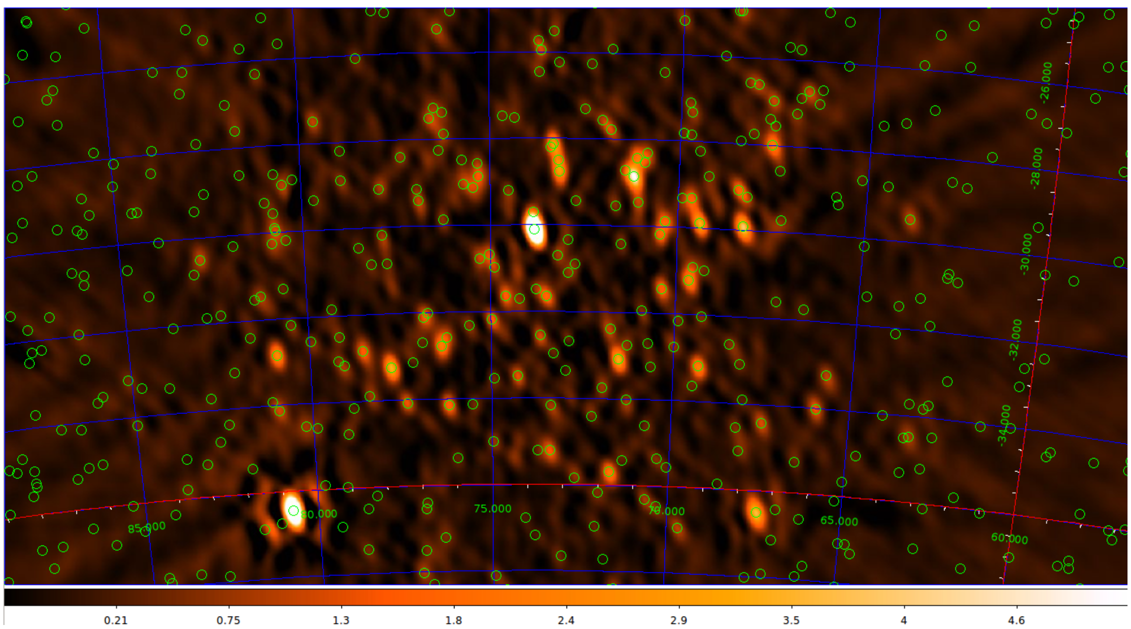

Figure 6: The HERA-61+3 CLEANed imaged field with sources highlighted which appear brigher than .6 Jy at 150Mhz.