Footprint Sharing Sparse Arrays for 20 and 30 GHz

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I. INTRODUCTION

Communication via satellites primarily uses reflector antennas on the spacecraft. In future systems, direct radiating arrays can be an alternative, but in order to reduce the number of elements, sparse arrays are considered. Furthermore, it would be advantageous if the transmit (TX) and receive (RX) arrays could be colocated within the same footprint.

II. RESULTS

Two concepts were investigated for applications on the 30/20 (RX/TX) GHz communication frequency bands. The layouts were found using convex optimization [1].

In the first case, single frequency pipe horn elements are used for each frequency band. The element gain is 9 dBi. One common array layout was found and scaled to the two design frequencies. A constraint in the array optimization was that no central elements were allowed. The two arrays were then fitted into the same footprint with no element collisions. Figure 1 (left part) shows the resulting layout and Figure 2 shows the far field radiation pattern. Note that the same pattern is valid for both TX and RX.

Mutual coupling has not been included at this stage. This will certainly affect the final design, but we have found in previous studies that the layout change will be limited for this type of fairly directive elements. Also, it is important that the two interleave arrays have a common aperture plane. This minimizes the scattering.

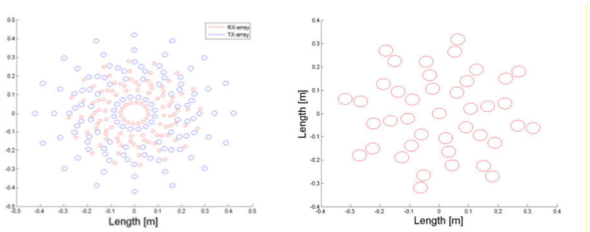

Figure 1. The interleaved (left) and combined (right) element layouts. The circle sizes match the element aperture sizes. In the interleaved array, RX elements are shown with blue circles and RX elements with red slightly smaller circles.

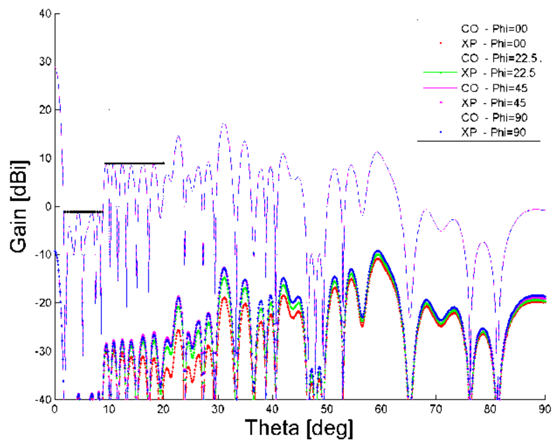

Figure 2. The far field pattern for the left array of Figure 1.

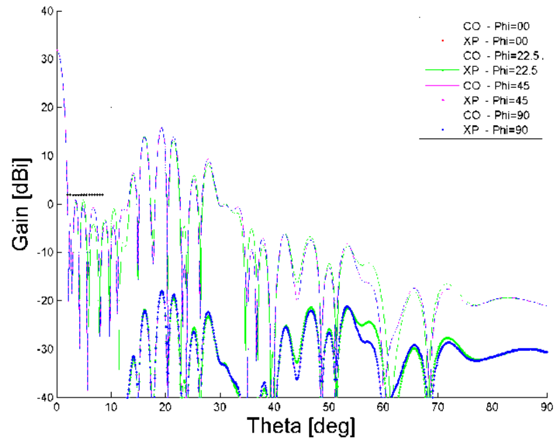

Figure 3. The far field pattern at 20 GHz for the right array of Figure 1.

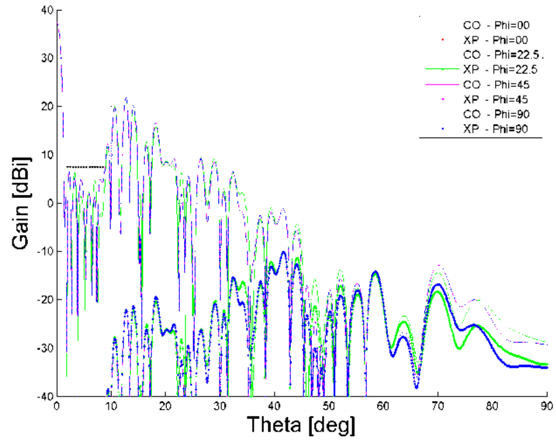

Figure 4. The far field pattern at 30 GHz for the right array of Figure 1.

In the second case, a dual frequency corrugated horn was used as array element. The element gain is 16 dBi for RX and 19 dBi for TX. A co-optimization was performed, where radiation pattern constraints for both frequency bands were used. The resulting array is shown in Figure 1 (right part), the RX radiation pattern in Figure 3 and the TX radiation pattern in Figure 4.

III. CONCLUSIONS

We show that interleaved or dual frequency combined sparse arrays with a limited number of elements, sharing footprints for TX and RX at 30/20 GHz are feasible candidates for future satellite communication antennas.

REFERENCES

[1] C Bencivenni, M V Ivashina, R Maaskant, J Wettergren, "Design of Maximally Sparse Antenna Arrays in the Presence of Mutual Coupling ", IEEE Antennas and Wireless Propagation Letters, September 2014.