APPLICATION OF GTD/UTD TO THE ANALYSIS OF ANTENNAS ON-BOARD THE ISS

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INTRODUCTION

The objectives of the current work are a) to determine the effects of the structure of the International Space Station (ISS) over the radiation pattern of the SPORT antennas and b) to determine the coupling between pairs of antennas.

To do that, the FASANT code[1] has been used. This is an efficient software tool based on the Geometric Optics (GO) and in the Uniform Theory of the Diffraction (UTD)[2] that takes into account the following effects: direct field, reflected, diffracted in edges, diffracted in vertex, slope diffraction, double reflected, reflected-diffracted , diffracted-reflected, double diffraction and creeping waves.

2.- PROBLEM DEFINITION

The geometric model of the ISS structure has been described in DXF format, through which the program obtains the needful information. Another input data are the radiation patterns of the SPORT antennas in the free space (isotated from the structure) at their working frequencies. These are 85.5, 90.0 and 94.5 GHz. Figure 1 shows the geometric model of the structure and figure 2 shows the theta component of the electric field of the radiation pattern for the cut phi=0° at 90 GHz.

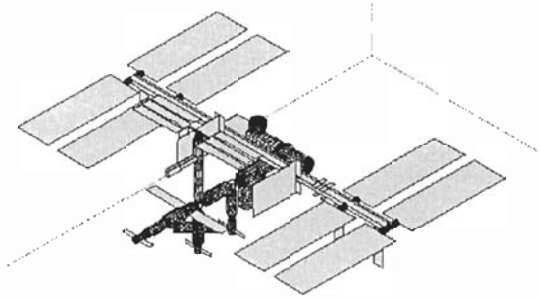

Figure 1. Geometric model of the ISS

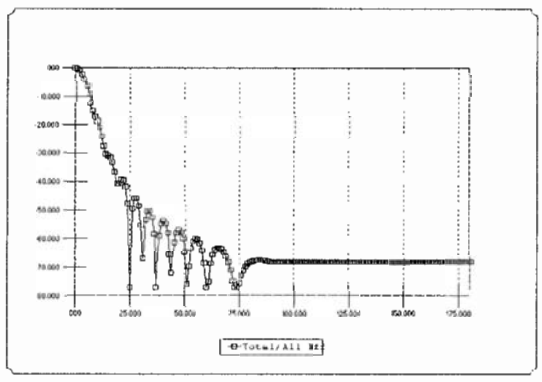

Figure 2. E-theta component of the SPORT antennas radiation pattern (in free space) at 90GHz for the cut phi=0.

3.- RESULTS.

In this section, two cases will be presented. In the first case, it is computed the radiation pattern of a SPORT antenna mounted on the ISS. The second case shows the coupling prediction between two SPORT antennas on-board the ISS

3.1.- Case 1: Radiation pattern computation.

Figure 3 shows the ISS structure and the antenna location. Notice that the solar pannels are located in a critical possition because the antenna radiation will be very influenced by them. Figure 4 shows a detailed view of the antenna location. It is orientated according to the z axis respect to the absolute coordinate system shown in figure 1. Figures 5 and 6 show results of the radiation pattern for the cuts phi=0° and phi=90° at 90 GHz.

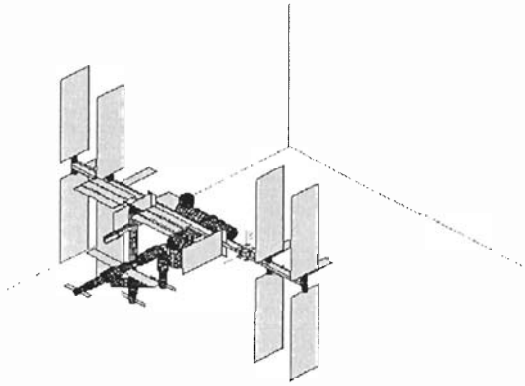

Figure 3. The ISS and a general view of the antenna location of the structure for the case 1

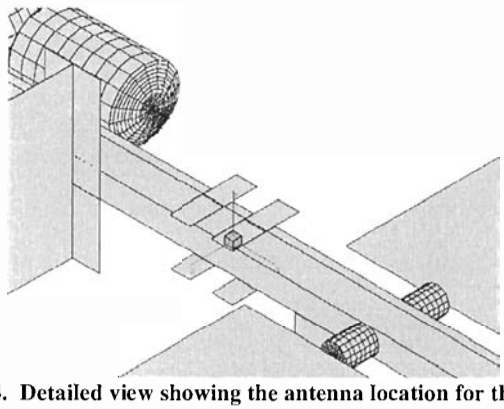

Figure 4. Detailed view showing the antenna location for the case 1

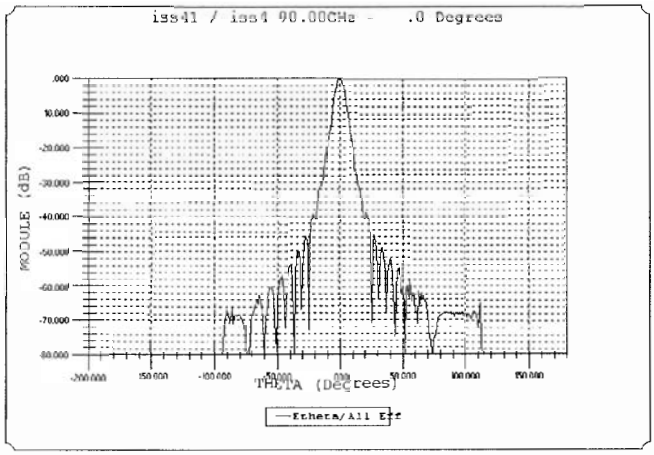

Figure 5. Etheta component for the cut phi = 0° of the radiation pattern of the on-board antenna for the case 1

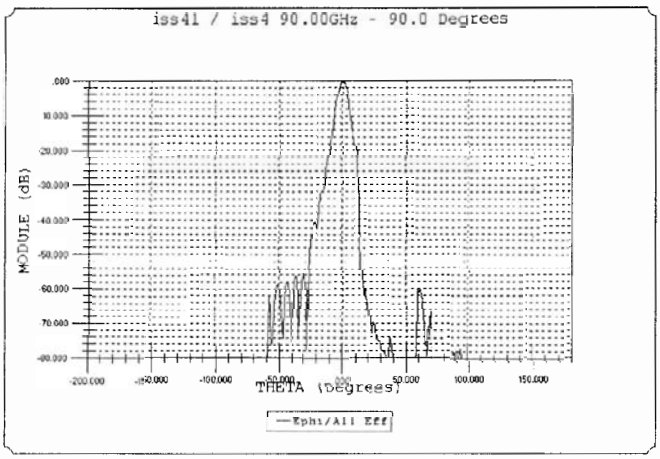

Figure 6. Ephi component for the cut phi = 90° of the radiation pattern of the on-board antenna for the case 1

It can be observed that for the cut phi=0°, the radiation pattern is not so far than the radiation pattern of the antenna in free space. In the other hand, for the cut phi=180°, the secondary lobes appearence changes so much with respect the free space situation. This is because the influence of the solar panels

3.2.- Case 2: Coupling computation

In this case, it is computed the coupling between the antennas show in figure 7. The active antenna is in black art the passive antenna is in grey. The solar pannels are as in case 3.1. The radiation pattern of both antennas, in the free space, is the same. Figure 2 shows the E-theta component for the cut phi=0 at 90 GHz.

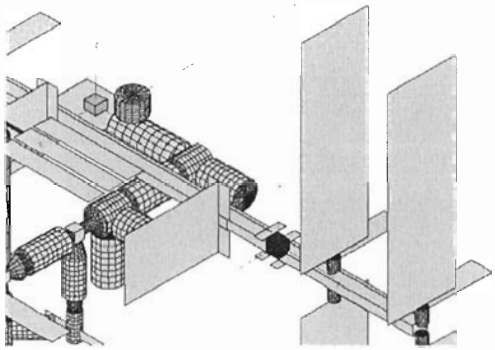

Figure 7. Antennas location for the case 2

The coupling value obtained was: -180 dB. This level is very low, practically null, because there is not direct sight between the antennas. The mains coupling mechanisms are edge-diffractions and double effects, as reflection-diffraction, etc. (there is not reflected rays). Figure 8 shows the ray tracing illustrating the coupling contributions

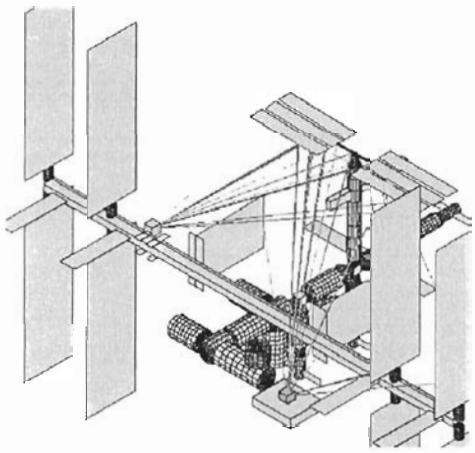

Figure 8. Ray tracing for the case 2

4.- ACKNOWLEDGEMENTS

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5.- REFERENCES

[1] J. Pérez, F.Saez de Adana, O.Gutierrez, I. González, M.F.Cátedra, I.Montiel, J.Guzmán. "FASANT: Fast Computer Tool for the Analysis of On-Board Antennas". IEEE Antennas and Propagation Magazine, Vol. 41, No. 2, pp. 94-98, Abril 1999

[2] D.A. MacNamara, C.W.I. Pistorius, J.A.G. Malherbe. "Introduction to the Uniform Theory of Diffraction". The Artech House Microwave, 1989.