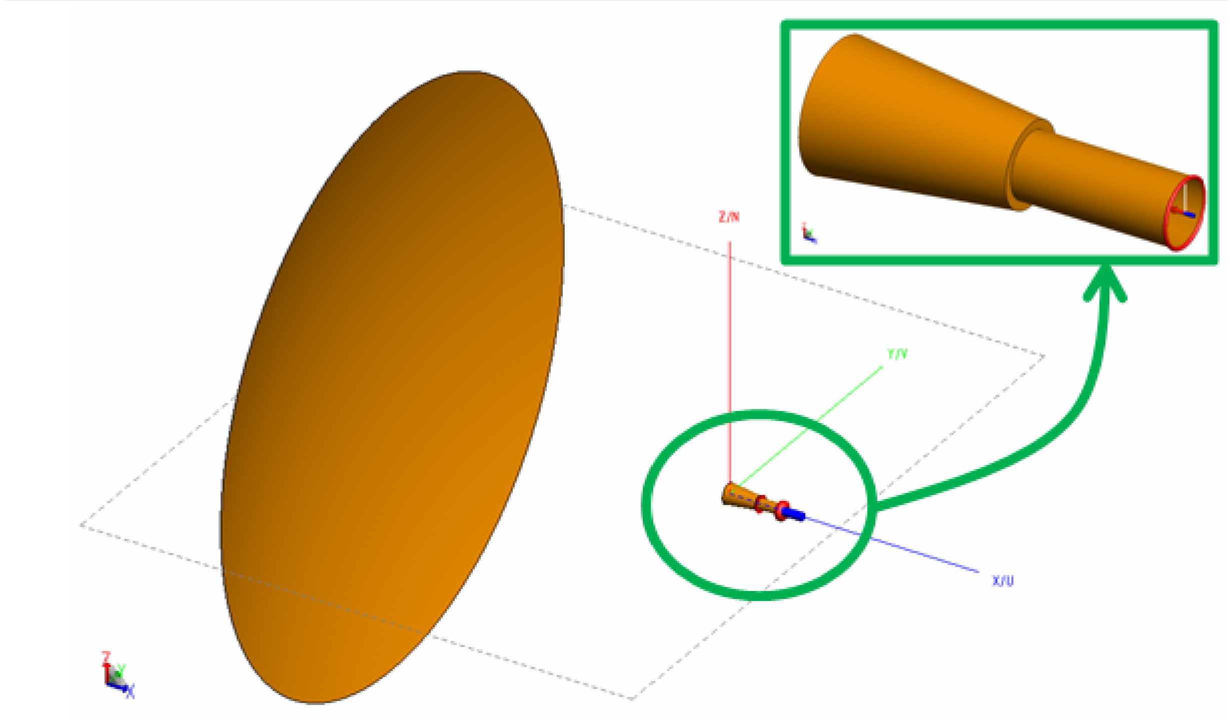
Reflector antenna with circular horn feed, analyzed with GO (ray launching)

Introduction

Consider a parabolic reflector with 36 wavelengths aperture at 8 GHz. The reflector is fed with a circular horn antenna at its focus. The geometry is shown below in Figure 1. This is a large problem to solve with standard full-wave methods such as the FEM or MoM.

Figure 1: Reflector antenna geometry.



Here, the MLFMM, GO and PO methods will be used to solve this problem and the results compared. Four approaches will be considered:

Method	Reflector	Horn
MLFMM (horn + reflector)	Included	Included
MLFMM (pointsource + reflector)	Included	Equivalent spherical mode source
PO (pointsource + reflector)	Included	Equivalent spherical mode source
GO (pointsource + reflector)	Included	Equivalent spherical mode source

In the last three cases, the horn feed is first characterized on its own. A spherical mode representation of the feed radiation pattern is then used as an impressed source to feed the reflector itself. This procedure avoids including the details of the feed in the analysis, which reduces the computational cost. This approach assumes that the presence of the feed does not influence the scattered field of the reflector.

Verification of equivalent source approach

To verify that the equivalent source approach is a reasonable approximation, an MLFMM analysis of the full structure is compared with an MLFMM analysis using the equivalent source. Figure 2 shows the radiation patterns of the horn, as analyzed in isolation. Figure 3 compares the reflector antenna directivity pattern, obtained with the two MLFMM approaches. As can be observed, the equivalent source has practically no effect on the result.

Figure 2: Radiation pattern of the feed horn in isolation.

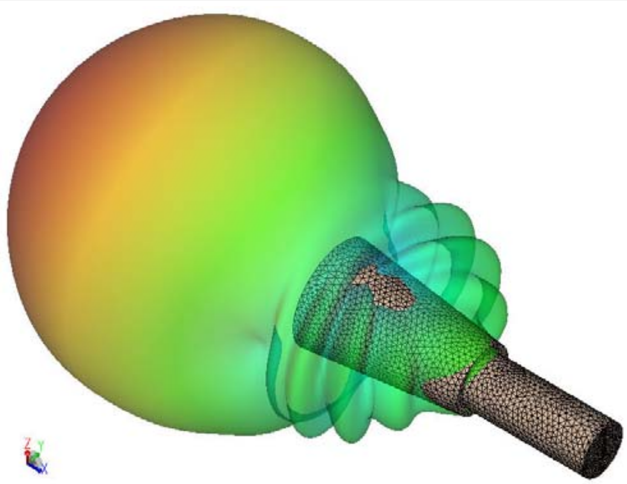
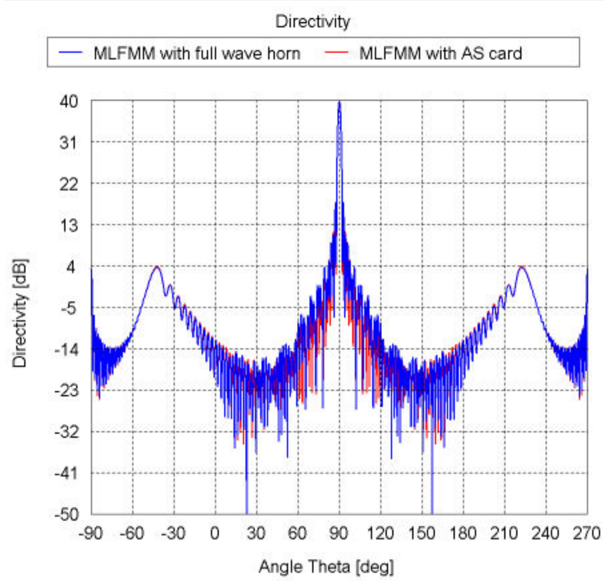


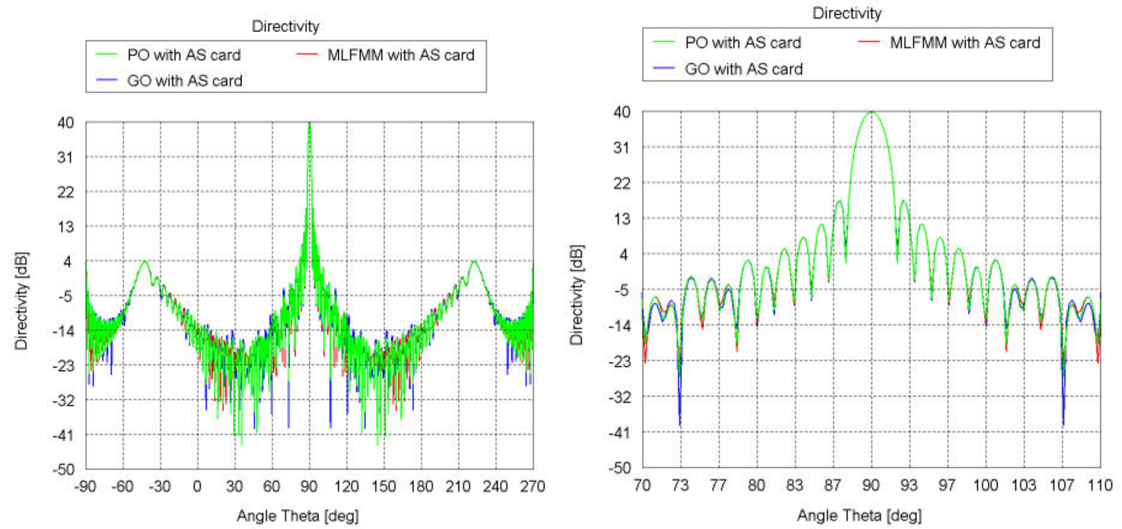
Figure 3: Verification of equivalent source model to represent the feed.



Comparison of results

Now compare the MLFMM (as reference) with PO and GO, using the equivalent source excitation in all cases. Figure 4 compares the radiation patterns (the full range of -90 to 270 degrees is shown as well as the restricted range of 70 to 110 degrees, to resolve the detail behaviour in the vicinity of the main lobe).

Figure 4: Comparison of radiation patterns obtained with MLFMM, PO and GO.

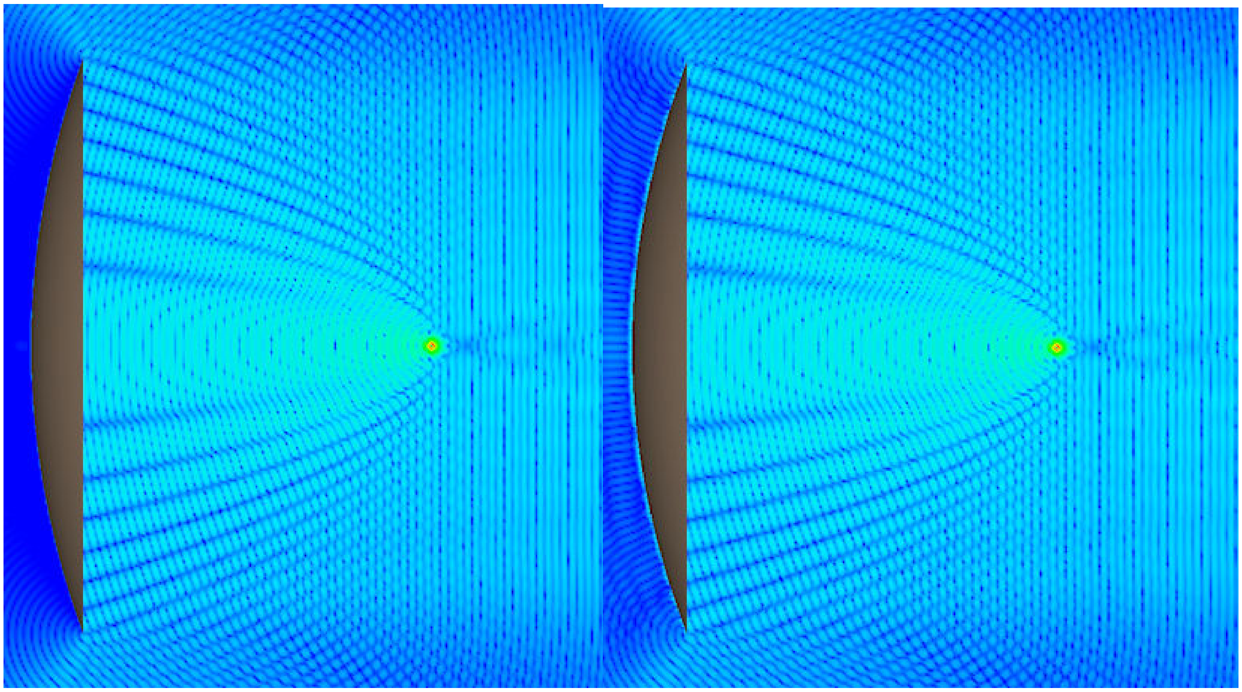


Now compare the computational resource requirements of all the solutions:

Method	Memory (MBytes)	Runtime (hours)
MLFMM (horn + reflector)	5286	2.199
MLFMM (pointsource + reflector)	5098	1.996
PO (pointsource + reflector)	97.4	0.421
GO (pointsource + reflector)	2.74	0.011

As a final comparison, the near field around the antenna, as calculated with the MLFMM and GO, is compared in Figure 5.

Figure 5: Comparison of antenna near fields, as calculated with the MLFMM (left) and GO (right).



Conclusion

Clearly, the asymptotic methods (PO and GO) maintain excellent accuracy in this case and reduce the resource requirements dramatically. The GO is especially efficient. Even in the case of near fields, it can be seen that there is only a small difference in the deep shadow region behind the reflector.