8-11.1 Small Offset Reflectors (Minimum Reflector Size)

An offset reflector was analyzed using both PO/PTD and MoM to determine the size limit of a reflector. A Gaussian beam feed was used for all cases and placed so that it would not block the reflector aperture Figure 8-11.1.1. By changing the geometry of the horn and reflector in each case, we can eliminate the direct horn aperture blockage of the reflector. A circular disk placed at the aperture of the horn with currents excited by the radiation of the reflector currents simulated the horn blockage. The feed spillover produced a large lobe in the positive pattern region while the horn blocked radiation on the negative side of the patterns in the offset plane. Using a central feed horn with a symmetric reflector would cause significant blockage as diameter is decreased and produce a useless design. Of course, these antennas have significant cross polarization in the symmetric plane of the offset fed reflector, but we can still determine the limits of reflector size.

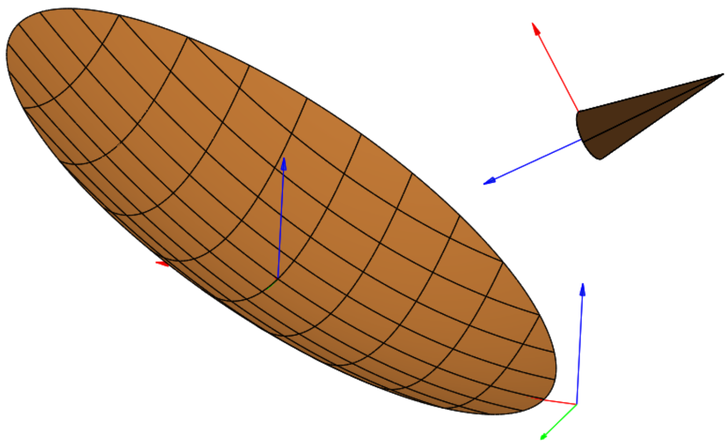

Figure 8-11.1.1 Offset Reflector Fed by Gaussian Beam Feed

Figure 8-11.1.2 shows the geometry of a 10λ diameter offset reflector. It has a focal length of 5λ and the feed has a beam taper of -12 dB at the rim of the reflector. The feed was located out of beam radiated from the reflector to reduce the coupling from the currents on the reflector radiating into the far-field by having the last ray pass λ/2 from the horn aperture.

A circular plate placed in the aperture accounted for the scattering of the field radiated from the reflector. Its diameter is 0.5λ larger than the minimum waist of the Gaussian beam. This circular plate scatterer reduces the pattern along the –*x* axis.

The Gaussian beam feed accounts for near-field radiation when the reflector surface is sufficiently close to merit the expansion. GRASP feeds can be forced to use the far-field approximation. Figure 8-11.1.3 illustrates the pattern differences when using the near-field approximation on a 10λ diameter offset reflector solved with both PO/PTD and MoM. The pattern cut through the symmetry plane PO/PTD (red) and MoM (blue) have small differences at the -40 dB level sidelobe near -90° and in the spillover lobe region near 75°. The spillover pattern region is a combination of the feed spillover and the radiation from feed blockage. The symmetric plane pattern of the offset reflector contains the typical high cross polarization lobes and shows little difference between the MoM (black) and PO/PTD (green) analyses. The green curve lies on top of the black curve over most of the pattern range. It also lies on top of the red (PO/PTD) and blue (MoM) curves of the asymmetric plane pattern in the main beam.

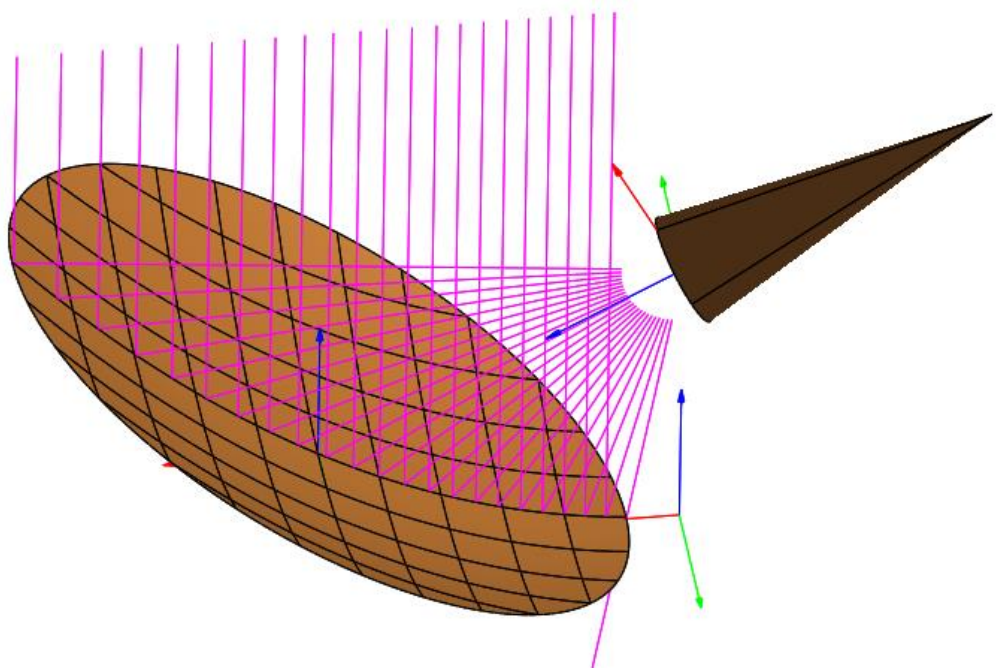

Figure 8-11.1.2 10λ Diameter Offset Reflector fed by Gaussian Beam Feed included as a Circular Disk Blockage, plane of rays in asymmetric plane

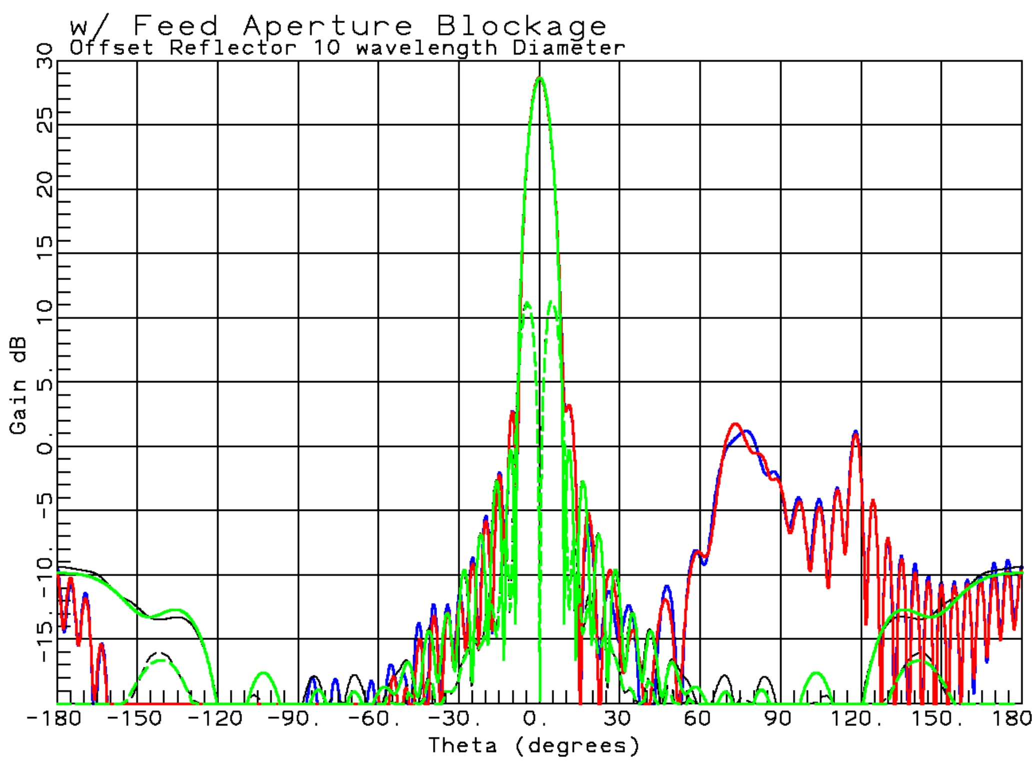

Figure 8-11.1.3 10λ Diameter Offset Reflector: Asymmetry Plane cut: Blue: MoM, Red: PO/PTD Symmetric Plane cut: Black: MoM, Green: PO/PTD

For the 6λ diameter reflector, Figure 8-11.1.4, the feed was moved relative to the feed of the 10λ diameter reflector to keep the coupling between the reflector currents and feed low. The MoM and PO/PTD analyses produce matching patterns (Figure 8-11.1.5) except for a few areas of difference at low pattern levels. The differences between the

MoM and PO/PTD analyses are small in limited regions. Similar to the 10λ diameter reflector the last curve (green) overlaps the black, red, and blue curves in the main beam. The green curve (PO/PTD) overlaps the black curve (MoM) in most areas of the symmetric plane pattern.

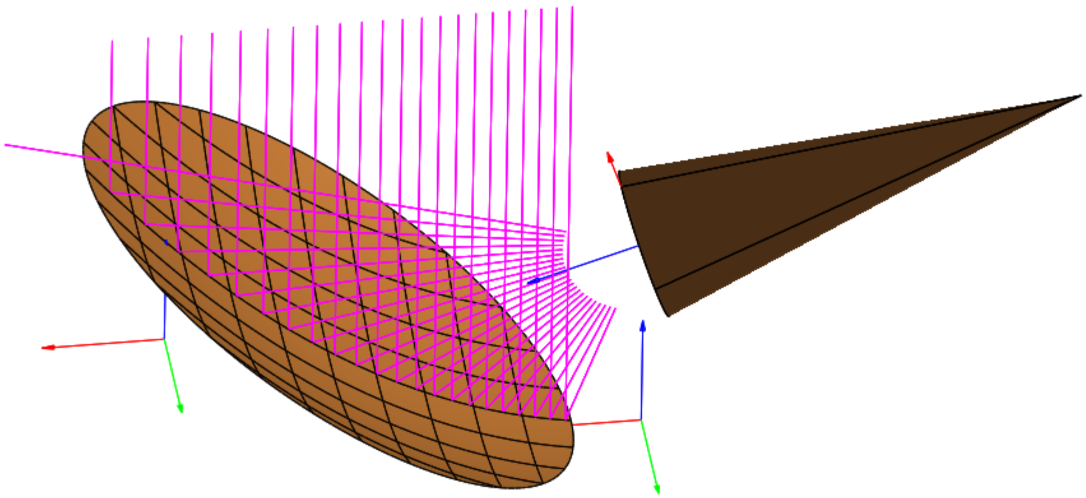

Figure 8-11.1.4 6λ Diameter Offset Reflector fed by Gaussian Beam Feed included as a Circular Disk Blockage, plane of rays in asymmetric plane

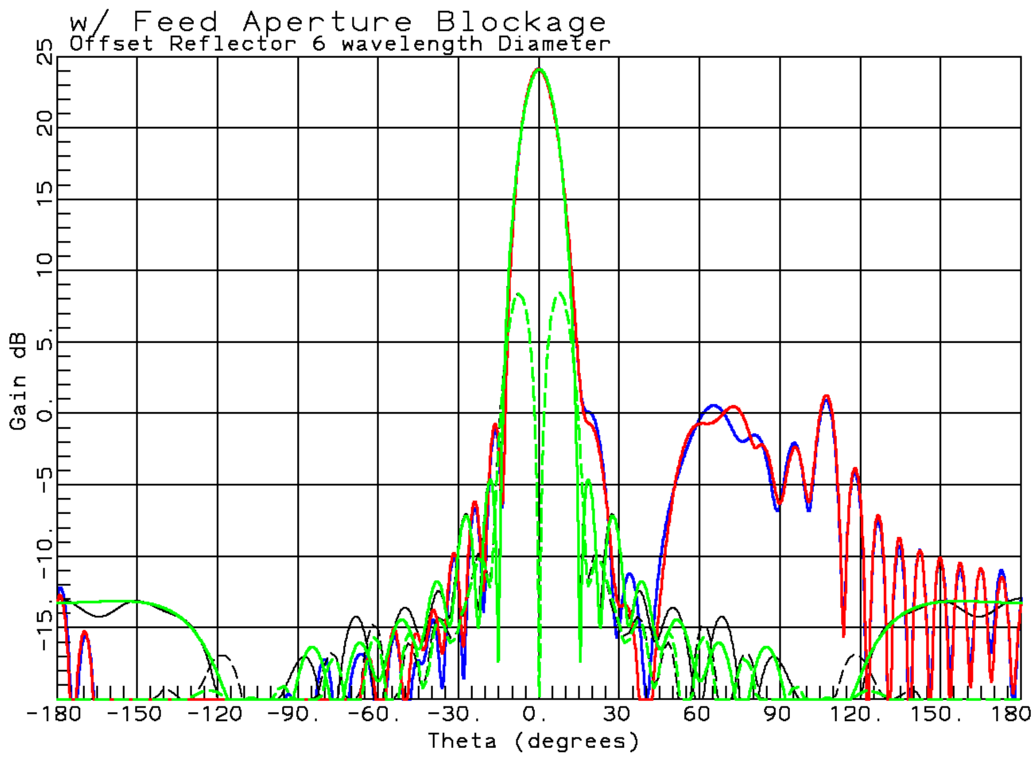

Figure 8-11.1.5 6λ Diameter Offset Reflector: Asymmetry Plane cut: Blue: MoM, Red: PO/PTD Symmetric Plane cut: Black: MoM, Green: PO/PTD

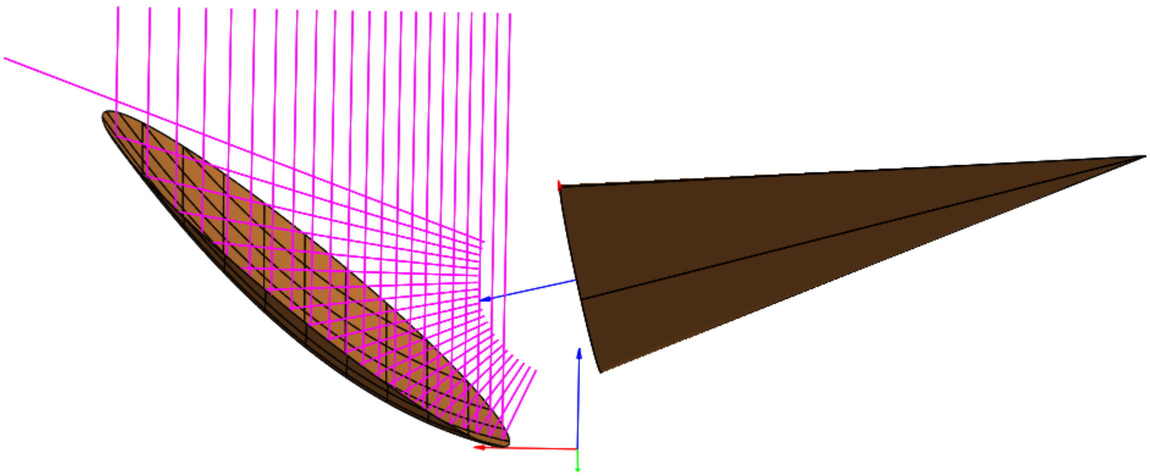

Figure 8-11.1.6 4λ Diameter Offset Reflector fed by Gaussian Beam Feed included as a Circular Disk Blockage, plane of rays in asymmetric plane

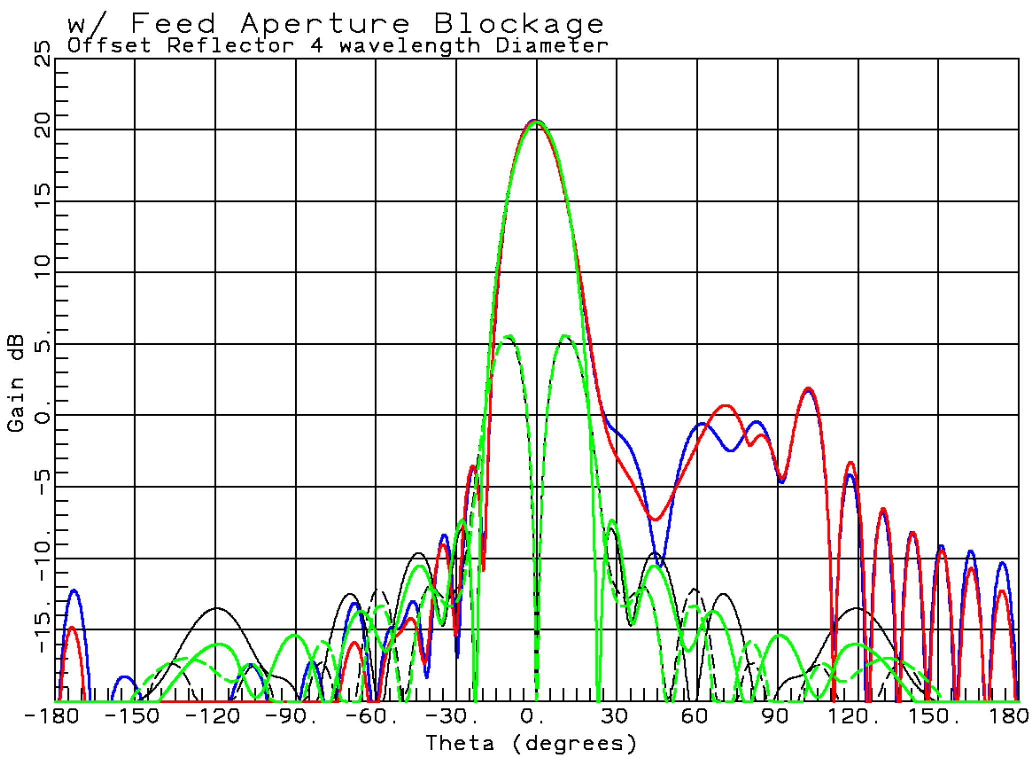

Figure 8-11.1.7 4λ Diameter Offset Reflector: Asymmetry Plane cut: Blue: MoM, Red: PO/PTD Symmetric Plane cut: Black: MoM, Green: PO/PTD

Figure 8-11.1.6 illustrates how the feed antenna is become larger and its blockage is more significant relative the main beam. The two analysis techniques only show small differences (Figure 8-11.1.7) at a 6λ diameter and the antenna works well.

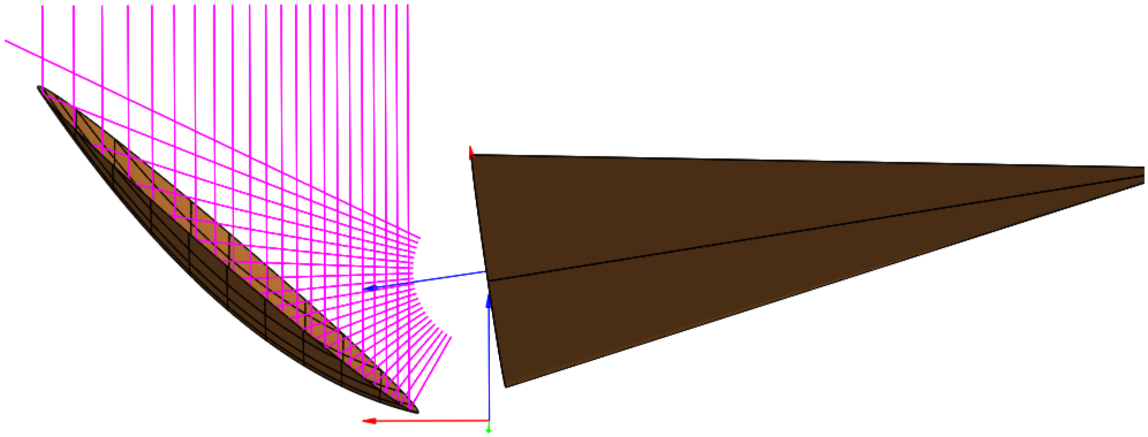

Figure 8-11.1.8 3λ Diameter Offset Reflector fed by Gaussian Beam Feed included as a Circular Disk Blockage, plane of rays in asymmetric plane

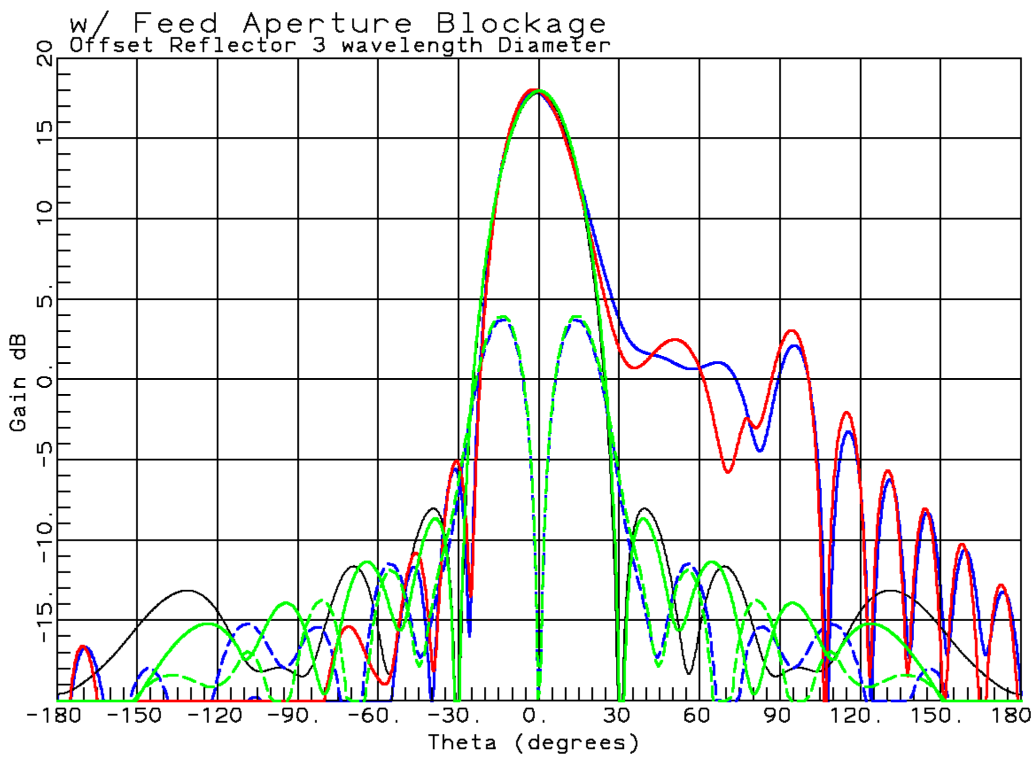

Figure 8-11.1.9 3λ Diameter Offset Reflector: Asymmetry Plane cut: Blue: MoM, Red: PO/PTD Symmetric Plane cut: Black: MoM, Green: PO/PTD

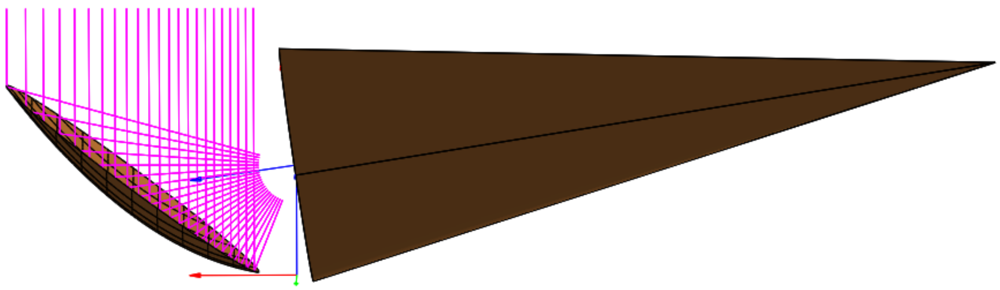

Figure 8-11.1.10 2λ Diameter Offset Reflector fed by Gaussian Beam Feed included as a Circular Disk Blockage, plane of rays in asymmetric plane

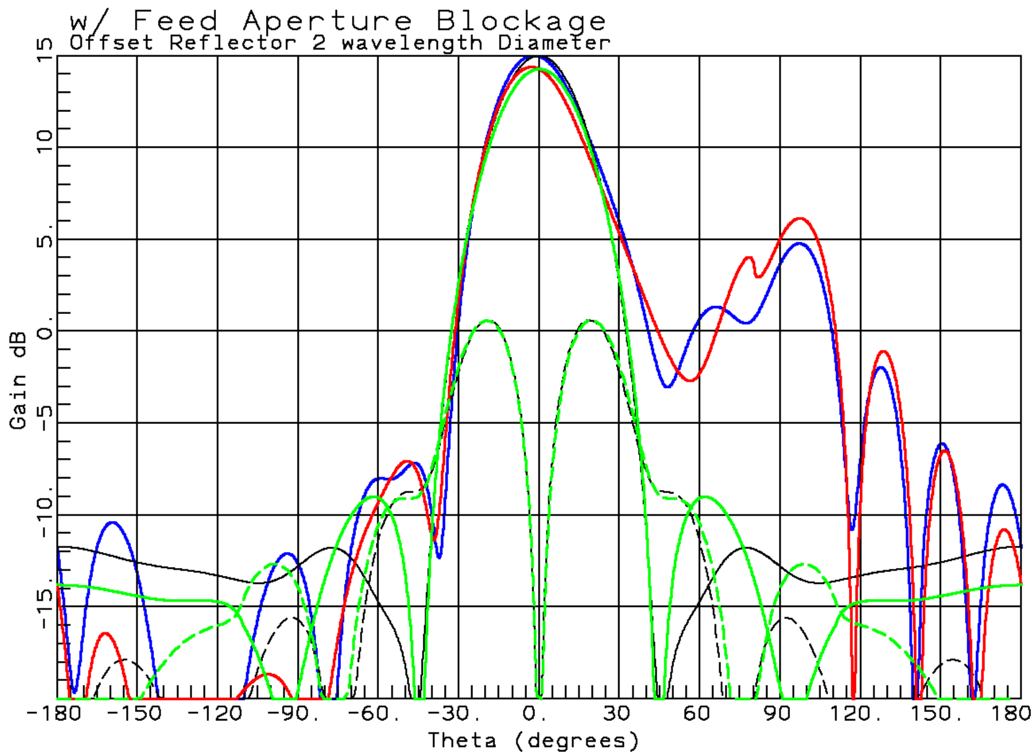

Figure 8-11.1.11 2λ Diameter Offset Reflector: ASymmetry Plane cut: Blue: MoM, Red: PO/PTD Symmetric Plane cut: Black: MoM, Green: PO/PTD

Diameter, λ	Focal Length, λ	Offset Center, λ	Gain MoM	Gain PO/PTD	Illumin. Loss dB	Feed Coupling
2	0.875	1.3	14.97	14.28	0.99	-34
3	1.189	2.06	17.82	17.97	1.57	-49
4	1.689	2.66	20.65	20.56	1.34	-64
6	2.663	3.86	24.13	24.12	1.38	-49
10	4.884	5.86	28.69	28.69	1.26	-52

Table 8-11.1.1 Small Offset Reflector Predictions including Feed Blockage. Feed 86° -12 dB beamwidth; Gain: 13.12 dB

Figure 8-11.1.11 finally shows a small difference in the main beam gain using the two analysis methods (MoM and PO/PTD) while at larger sizes the differences are small (Table 8-11.1.1). Table 8-11.1.1 lists the coupling between the currents induced on the reflector and the feed antenna. The low coupling means that the presence of reflector has little effect on the feed VSWR. The gain of the 2λ diameter reflector is not significantly higher than the feed horn and a practical solution is to just use a horn instead of the reflector. The wide pattern of the horn adds to the reflector pattern for the 2λ diameter case and decreases the effective illumination loss based on the reflector projected area. Similarly, the feed horn pattern for 3λ diameter case subtracts from the reflector pattern and increases illumination loss.