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Subject: Diffraction Effects of Subreflector Deformation

It has been pointed out by our Visiting Committee that the "ring C" subreflector deformation will be smeared in the 12 GHz holography. In addition, the subreflector deformation will not perfectly compensate for surface deformations. I find, however, that at 120 GHz the compensation is near perfect for moderate deformations. Figure 1 shows the result of the diffraction from a circularly symmetric deformation of the subreflector. Peak deformations of 20,40,60,80 mils (40,80,120,160 mils path length) are considered with half amplitude full width of 6.5' on the surface or 6" on the subreflector. For deformations as small as 20 mils the compensation is perfect at 120 GHz while the deformation is smeared to a width of about 11' at 12 GHz. This is consistent with the diffraction scale size of approximately

$$(F(F-f)\lambda/f)^{1/2} \approx 7' \text{ at } 12 \text{ GHz}$$

where

$F = 48'$

$f = 3.6'$

λ = wavelength = 0.08'

As the subreflector deformation increases, the phase compensation is degraded and illumination is redistributed. In Figure 1 the deformation shown is negative (that is a depression the subreflector as needed for a bump in the main reflector). In this case, a large deformation tends to focus more energy (viewing the antenna as a transmitter) into the center of the region to be compensated. The opposite occurs when the subreflector is deformed outward.

Figure 2 gives the calculated efficiency loss as a result of the focus/defocussing of the subreflector for an otherwise perfect surface, and an 11 dB illumination taper. Also shown is the antenna efficiency loss which results from ring C without subreflector correction. At 43 GHz and 22 GHz subreflector deformation loss is only 7% and 2% respectively for 80 mils correction. These results using the GTD method, while they are somewhat tentative, they confirm the SGH comment (page 17 on the design report for the deformable subreflector), that the diffraction has only a "small" effect on the axial gain. While the deformation will be smeared in the 12 GHz holography, it should be possible to "deconvolve" the holographic maps well enough to provide a good check on the operation of the subreflector deformation.

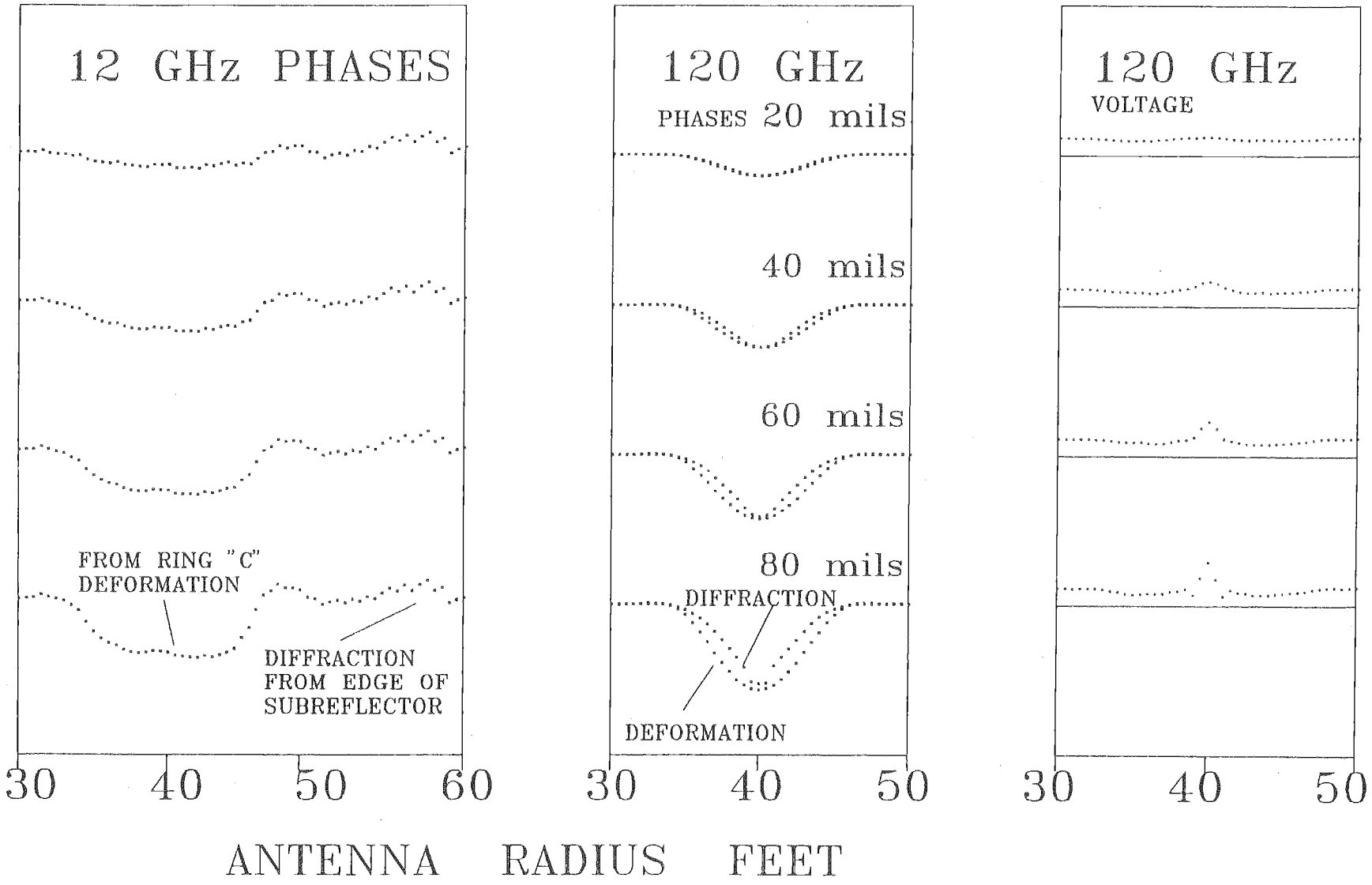

Figure 1 DIFFRACTION OF SUBREFLECTOR DEFORMATION ONTO MAIN SURFACE

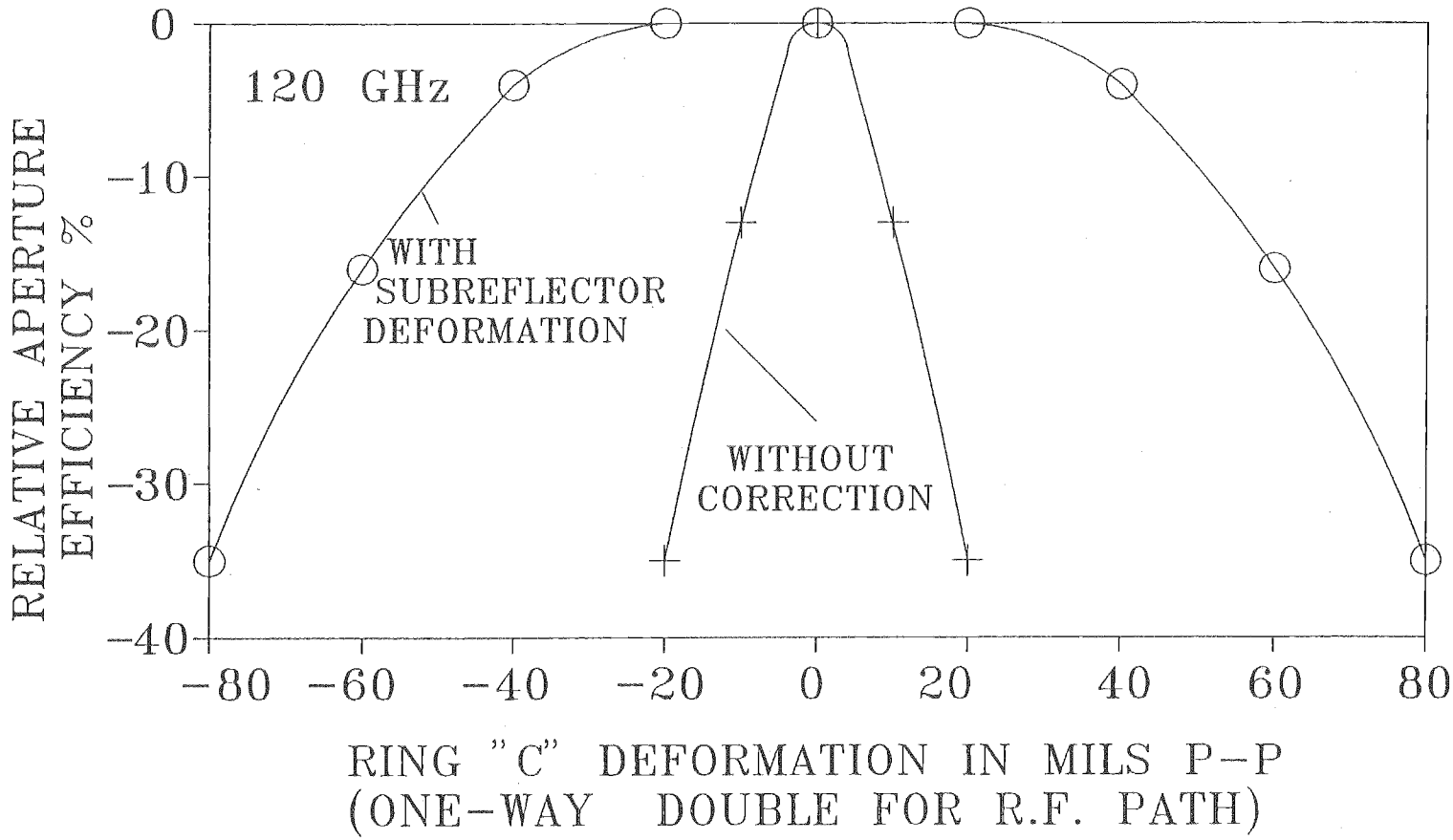

Figure 2 Efficiency loss of subreflector deformation