GBT Memo No. 62

**GAPS OR SEAMS IN THE SUBREFLECTOR SURFACE**

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G. Morris has provided an estimate of 65 meters for the seam or gap length, for a conceptual M1 surface made of 28 panels. In this memorandum an attempt will be made to estimate the effect of these seams and set limits on their width and thickness if filled from the back.

The important parameter here is the ratio of the gap area to the total sub-reflector surface area (which is about 50 $m^2$). Following the notation in Fisher's 12/29/90 memo:

$$\Delta P = \frac{65W}{50} = 1.3W$$

where W is gap width in meters. Our goal throughout this project has been to keep the total scattered fractional power below -30 dB, requiring each contribution to be less than that. If we require $\Delta P < -33$ dB $= 5 \times 10^{-4}$, then for this layout and open gaps:

$$\Delta P = 1.3W < 5 \times 10^{-4}$$

or

$$W < 4 \times 10^{-4} \mathrm{m} = 0.4 \mathrm{mm} = 15 \mathrm{mils}.$$

If we try to use 2 mm wide gaps and seal them from the back or fill with some conductive material, by Fisher's equation (9), the depth of the resulting groove, t, must be:

$$t < \frac{\lambda}{4\pi}\sqrt{\frac{260 \cdot 5 \times 10^{-4}}{0.2}} = 0.064\lambda$$

Therefore, to reach our scattering goal at $\lambda$ = 30 mm (10 GHz):

$$t < 1.9 \mathrm{mm} = 75 \mathrm{mils}$$

At $\lambda$ = 3 mm (100 GHz):

$$t < 0.19 \mathrm{mm} = 8 \mathrm{mils}.$$

It is interesting to note that these results are quite close to those Fisher obtained for the main reflector gaps. This is because the ratio of total gap length to surface area is about the same for the subreflector panel layout as for the main reflector layout, resulting in about the same requirements for the gap widths.

A second requirement is that we avoid subreflector panel layouts that have gaps lying on constant path length curves from the feed position. This should be checked for any potential layout. The most troublesome area is likely to be the area of the subreflector nearest the paraboloid axis because that area lies nearly perpendicular to the feed axis. Gaps in this area should be avoided or carefully filled.

To summarize, any panel layout considered for the subreflector should meet the following criterion:

$$L\cdot\frac{W}{A} \leq 5\times10^{-4}\,(\text{open gaps})$$

where L is total gap length,
W is width of gaps, and
A is subreflector surface area (50 $m^2$).

If we attempt to seal the gaps, the depth, t, and width, w, of the resulting grooves should satisfy the following relationship:

$$t < \frac{\lambda}{4\pi}\sqrt{\frac{260\cdot5\times10^{-4}}{W(\text{cm})}}$$

where perhaps a wavelength of 7 mm would be a good compromise. Finally, the layout should be checked for equal phase gaps. Final check of this last effect may require numerical integration along potentially offending seams.

As a final note, I again urge that we seriously investigate fabrication techniques that would have a continuous surface or a small number of sections, and that the thermal characteristics of the design be thoroughly studied. Thermal deformations in the subreflector may set the high frequency limit of the GBT once the main reflector laser ranging system is working.

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