GBT Memo No. 6

Operation of the GBT at 3 mm Wavelength.

At the presentation at NSF on July 31 there was a lot of interest expressed in the possibility of operation at 3 mm. This short note will summarize the situation as I presently understand it.

The principal uncertainty in the high frequency performance of the telescope is related to thermal effects in the structure. If we find that it is possible to use a real-time position measurement system for the panels it should be possible to correct for such thermal deformations. The panel accuracy given in the proposal (0.07 mm) would then allow operation to 3 mm, even with as much as 0.1 mm additional error allowed for measurement and positioning. At this time we do not know whether it will be possible to incorporate real-time measurement in the design. It seems certain, of course, that it will be possible to add it at some point within the lifetime of the telescope.

Since we do not know that we can make a real-time measurement system at this time, we must assume that the high frequency performance is likely to be limited by thermal effects. Von Heorner's graph for the thermal limit is shown in Fig. 1 of NLSRT No.2. The only large antenna that surpasses the thermal limit is the one at Pico Veleta, for which Von Hoerner's curve predicts 1.5 mm and the actual limit (lambda/16) is 1.3 mm. It seems that it is very difficult to surpass the thermal limit to any significant extent, even with temperature regulation included in the structure. (Since it is not known to what extent gravitational deflections also contribute to the limit of the Pico Veleta antenna, some caution should be used in drawing conclusions). Thus for a very large antenna with no temperature regulation it must be assumed that, at best, the thermal limit for 1 deg C will apply. For a diameter of 100 m the limit is 5 mm (60 GHz). Thus an overall surface accuracy corresponding to lambda/16 at 5 mm is the best that we can promise at this time.

Since the thermal limit is proportional to diameter, it is possible that a central part of the GBT will work satisfactorily at 3 mm, even if the panel adjustment compensates only for gravitational effects. However, we cannot be sure about this. A good indication can be obtained when we have a detailed structural design. It should then be possible to compute the effect of temperature variations within the structure upon the surface accuracy. For example, one could examine the effects of random variations within a range of 1 deg. C. This procedure should give some indication of how much better theinner part of the surface will be than the whole aperture.

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