GBT Memo No. 59

The GBT's Adjustable Optics

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One important feature of the GBT's design is its active primary surface, which will be reviewed in this memo. GBT Memo No. 12 addressed the question of implementing the active surface at the secondary reflector rather than at the primary. The conclusion was that correction at the primary was preferable, but no argument presented was overriding and many of the advantages and disadvantages have been nullified as other aspects of the antenna design have evolved. For instance, at the time Memo No. 12 was written, the number of actuators in the primary reflector was much smaller than the 2,000+ now planned because the use of panel rafts was envisioned. Therefore, we feel that the use of active subreflector surface, rather than the active primary surface, should be considered seriously again. The following points are presented for consideration.

Advantages of Actuators on Main Surface:

1. Initial adjustment of the primary surface could be accomplished with the actuators.

2. Because each 2-meter surface panel is actuated, approximately 2,000 "patches" can be used to remove small scale errors in the surface. It is unlikely that it will be practical to provide that many "patches" with an active subreflector surface.

3. Shaping of the main reflector using the actuators is feasible, but only if the actuator throw is at least 7 cm.

Advantages of Actuators on Subreflector Surface:

1. The cost would be much less because fewer and lighter actuators would be required. The direct cost for the active primary (excluding labor) is estimated to be 4,000 k$. The incremental cost for an active subreflector is estimated to be $300 k$.

2. Weight above the elevation bearings would be much less. The large actuator room behind the reflector would no longer be required, and weight of the actuators and cabling would be greatly reduced. (The primary actuators alone are estimated to weigh more than 40,000 pounds.)

3. The possibility of bending the primary surface panels due to actuator failure is eliminated. Long-term panel fatigue is reduced.

4. The need to walk on the primary surface would be greatly reduced and risks due to removal of primary surface panels to service actuators would be eliminated.

5. An active subreflector system could be assembled and completely tested under laboratory conditions and could be removed from the antenna for major repairs or improvements if necessary. Interface with the antenna contractor is much cleaner; no installation of actuators and cabling would be required by him.

The second advantage of the active primary listed above is thought to be the most important because that could ultimately limit the high frequency performance of the antenna. More information is needed from the structural analysis, detailing small scale deformations of the main reflector in order to judge the ability to compensate these types of deformations at the secondary. There is no doubt, though, that correction of large scale deformations due to gravity could be done just as well, at much less cost and complexity, at the subreflector surface.

Retroreflectors and a laser ranging system measuring the primary surface should still be implemented, possibly with fewer range points, if an active subreflector surface is selected. This is the only way to measure and correct for deformations and pointing errors due to thermals and wind. It should be emphasized that the concept of active surface compensation is just as valid with subreflector surface adjustments as it is with primary surface adjustments.

Note that the original idea of doing prime-focus work at high frequencies is no longer applicable because of the low accuracy positioning specifications on the prime-focus arm.