GBT Memo No. 25

NATIONAL RADIO ASTRONOMY OBSERVATORY
Green Bank, WV

MEMORANDUM

November 28, 1989

To: GBT Optics Group

From: James R. Coe

Subj: **Receiver Selection using a Rotating Mirror**

To facilitate receiver selection without moving the receivers, a compact Gregorian system including a flat mirror is proposed. This system would be used with the smaller subreflector at 6 cm and shorter wavelengths.

The mirror size and subreflector are kept small and the feed diameter is not too large with the following Gregorian parameters:

Eccentricity = 0.650 Ellipsoid Focal Length = 5 meters.

The subreflector is 2.1 x 2.3 meters and the feed horn semiangle is 10.2°.

The flat mirror must be large enough to reflect 99.9% of the power into the feed. The mirror radius then is calculated from [1].

[1] Mirror Radius = LC * tan ($\Theta_{30\ dB}$) * sec (ψ)

where

LC is the feed phase center to mirror center distance; $\Theta_{30\ dB}$ is the feed pattern angle at -30 dB taper; ψ is the feed axis to mirror surface angle.

To provide clearance to rotate the mirror past the feed, the distance LC must be the feed phase center to feed aperture distance, L_p, plus 1/2 the mirror diameter. Equation [2] can be used to calculate the mirror radius with L_p is known.

[2] Mirror Radius = L_p * tan ($\Theta_{30\ dB}$) * sec(ψ)/(1-tan $\Theta_{30\ dB}$ * sec(ψ)).

The angle subtended by the mirror from the feed phase center must be large enough to intercept the feed pattern at the -30 dB level. For a feed with a taper of -12 dB at 10.2°, the -30 dB taper should be at an angle of 20° or less off axis.

The compact corrugated horn has a phase center to aperture distance of six wavelengths. With a wavelength of 6 cm and, assuming a maximum ψ of 60°, the mirror radius would be 0.96 meter. The mirror half-height through the rotation axis would only have to be (.96 + .36) * tan(20) or .48 meter. A flat mirror with dimensions of 1.92 meters by .96 meter could be used.

The **advantages** of this system are:

(1) Permits rapid frequency change by rotating a flat mirror.

(2) Provides a compact arrangement of feeds and sub-reflectors which can be readily enclosed.

(3) Avoids the cable and cryogenic line wrap problems encountered with rotating turret type receiver changers.

The **disadvantages** that are apparent are:

(1) Another mechanism must be developed to rotate the mirror.

(2) Not readily adaptable to multiple beam receivers.

(3) The short distance between foci (5 meters) reduces the field of view. The number of half power beamwidths for 0.5 dB scan loss may be as small as 8.

JRC/cjd