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CONCEPT OF A QUASI-OPTICAL BEAM-SWITCHING SCHEME ON THE GBT

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The subreflector of the GBT does not nutate, unlike that of the 140-foot or the 12-meter telescopes. Nutation is provided for the purpose of canceling fluctuations due to atmospheric emission by switching the telescope beam in the sky. Maddalena and Salter have presented the advantages and disadvantages of different methods of beam-switching in GBT Memo No. 58. The subreflector of the GBT is too large for nutation. As an alternate, a concept for beam-switching via a quasi-optical means is suggested here. The optics used could correct for wind-induced pointing errors.

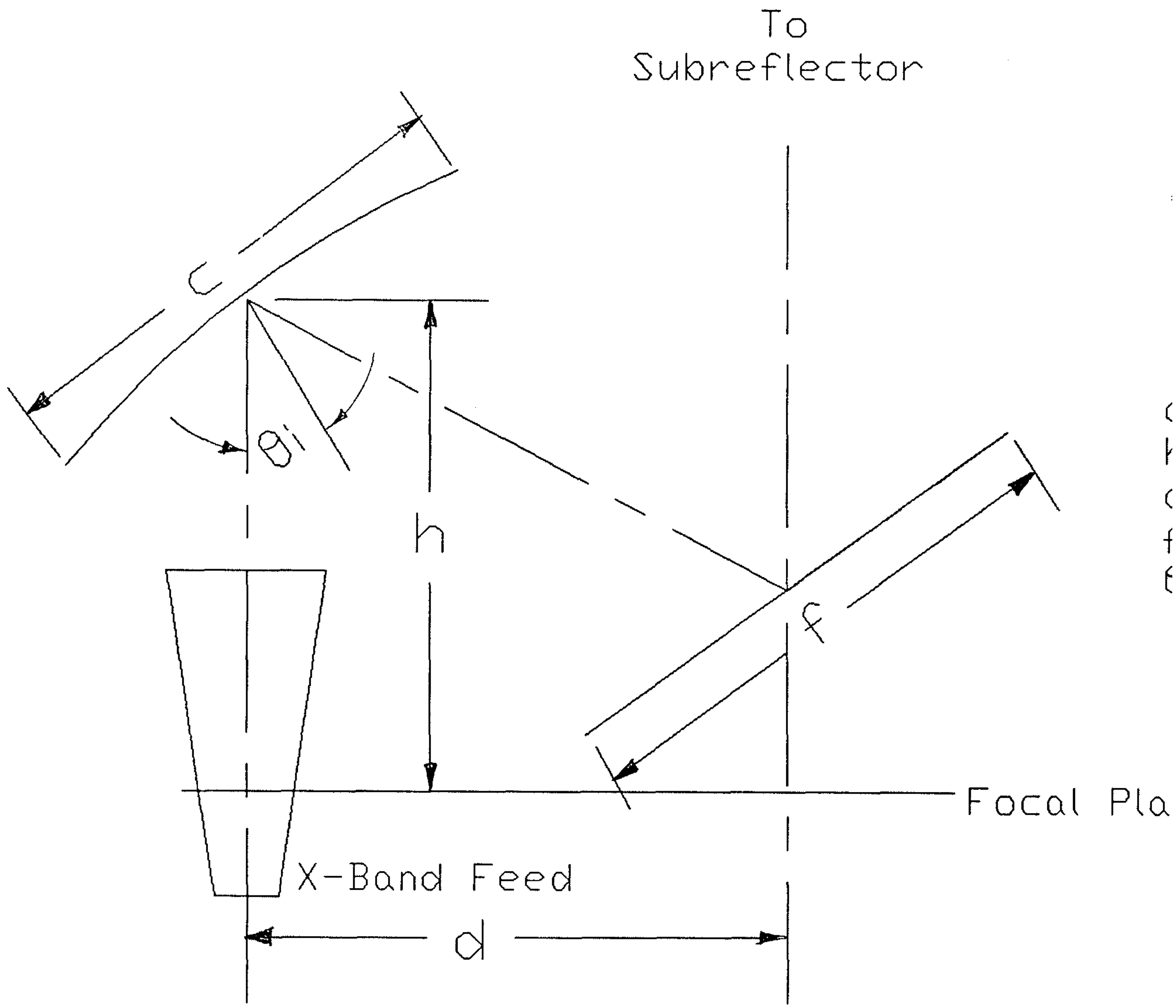
The optics consists of a pair of reflectors, one curved and the other plane. These are mounted above the feed turret independent of the turret itself. The flat reflector is directly below the subreflector (where the feed would normally be), while the curved reflector is above a selected feed for a particular frequency of operation. The curved reflector is an ellipsoid in this scheme. The beam from the feed in transmission, after reflection from the pair of reflectors, illuminates the subreflector. By translating/tilting one of the reflectors, the telescope beam can be moved in the sky. Figure 1 shows a view in a plane containing the feed axis, and an axis passing through the secondary focus and center of the subreflector. In the absence of the beam-switching scheme, these two axes will be the same. In Figure 1, θ_i is the angle of incidence on either of the two reflectors.

Two schemes are proposed for two different angles of incidence. The asymmetry of the system introduces cross-polarized fields, which are a function of θ_i. The lowest frequency of operation of these schemes is assumed to be 8.2 GHz. In both schemes the ellipsoidal reflector is located at a convenient distance above the X-band feed (the largest) while the flat reflector clears the top of the K_u-band feed (the second largest). The size of the flat reflector in both schemes is large enough for a beam throw of ± 4.5 arc-minutes maximum, which is three beamwidths at 8.2 GHz. In the first scheme, the two reflectors are located diametrically opposite on the feed circle. In the second scheme, the reflectors are closer together but with no interference between them.

Figure 2 shows Scheme A, a view looking down on the feed turret. The ellipsoid is 39.4" above the focal plane and θ_i is 39°. In the incident plane the ellipsoid is 38.00" across, 36.7" in the orthogonal plane, and has a focal length of 43.7". The flat reflector is 102.4" x 99.7". By tilting the ellipsoidal reflector about an axis, along AA′ (Figure 2) and perpendicular to the normal at the center of the ellipsoid (Figure 1), the beam center from this reflector traces a line perpendicular to AA′ on the flat reflector. The telescope beam would move in the azimuth plane as a result of this. The spillover losses of both reflectors is 0.35%. The ratio of the beam rotation in the sky (ω) to the ellipsoid rotation (α) is 0.0149. By translating the flat reflector along AA′, the beam can be moved in elevation. The coefficient for translation is 26.72 arcsec/inch.

In Scheme B, as shown in Figure 3, the distance between the two reflectors is 42.1" in the focal plane. A half angle of 25° around the beam axes is clear of any blockage for this separation. The ellipsoidal reflector is 38.0" above the focal plane, and the angle of incidence is 31°. The ellipsoidal reflector is 38" x 35.4", and the flat reflector is 48.0" x 35.0". If the ellipsoidal reflector is nutated about an axis, through BB′ and perpendicular to the normal at the center of the ellipsoid, the telescope beam would move in the sky, having components of movement both in elevation and azimuth. The elevation movement is undesirable. In order to move the telescope beam only in azimuth, the beam from the ellipsoidal reflector should trace a line on the flat reflector which is a projection of line CC′. The axis about which the ellipsoidal reflector is nutated in order to achieve the above is unknown at this time. For the ellipsoid, ω/α is 0.0071. For translation of the flat reflector along AA′, which results in elevation throw of the beam, the coefficient is 26.72 arcsec/inch.

Scheme A is straightforward except that the flat reflector is large, about half the size of the subreflector. Scheme B has manageable sizes for the two reflectors, but the nutation axis of the ellipsoidal reflector has to be determined. Also, Scheme B has 4 dB lower cross-polarization than Scheme A. The size of the flat reflectors in both schemes is large enough so that the spillover losses do not exceed 0.35% even when the beam is thrown off axis. The two reflectors are in space and a mechanical scheme has to be worked out. Possibly, the two reflectors can be translated into position for use and retracted when not required. For frequencies above, say 22 GHz, another pair of smaller reflectors could be used. This is only a preliminary scheme, and more detailed design would involve a couple months work.



	h. A	Sch. B
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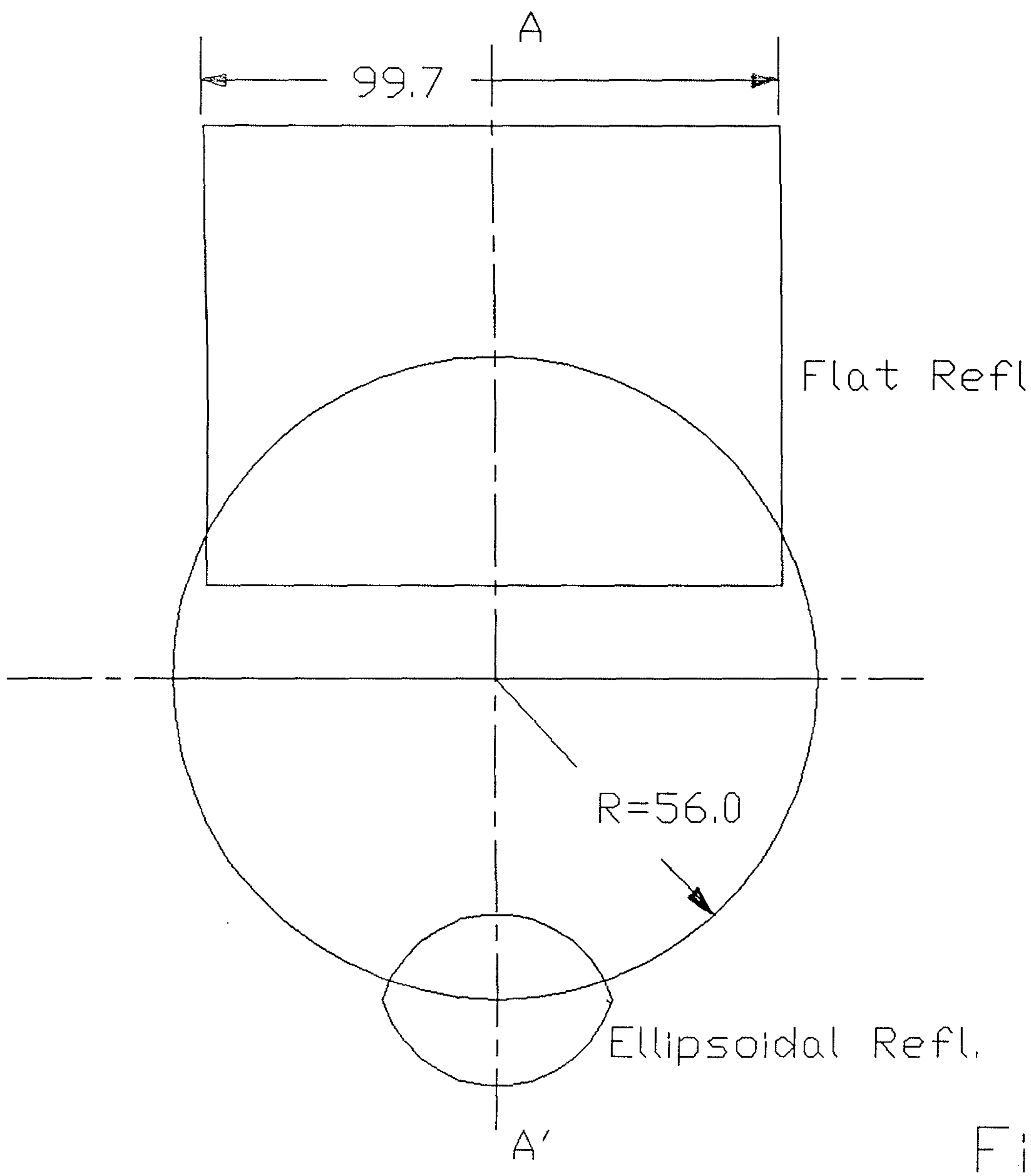

Figure 2. (Scheme A)

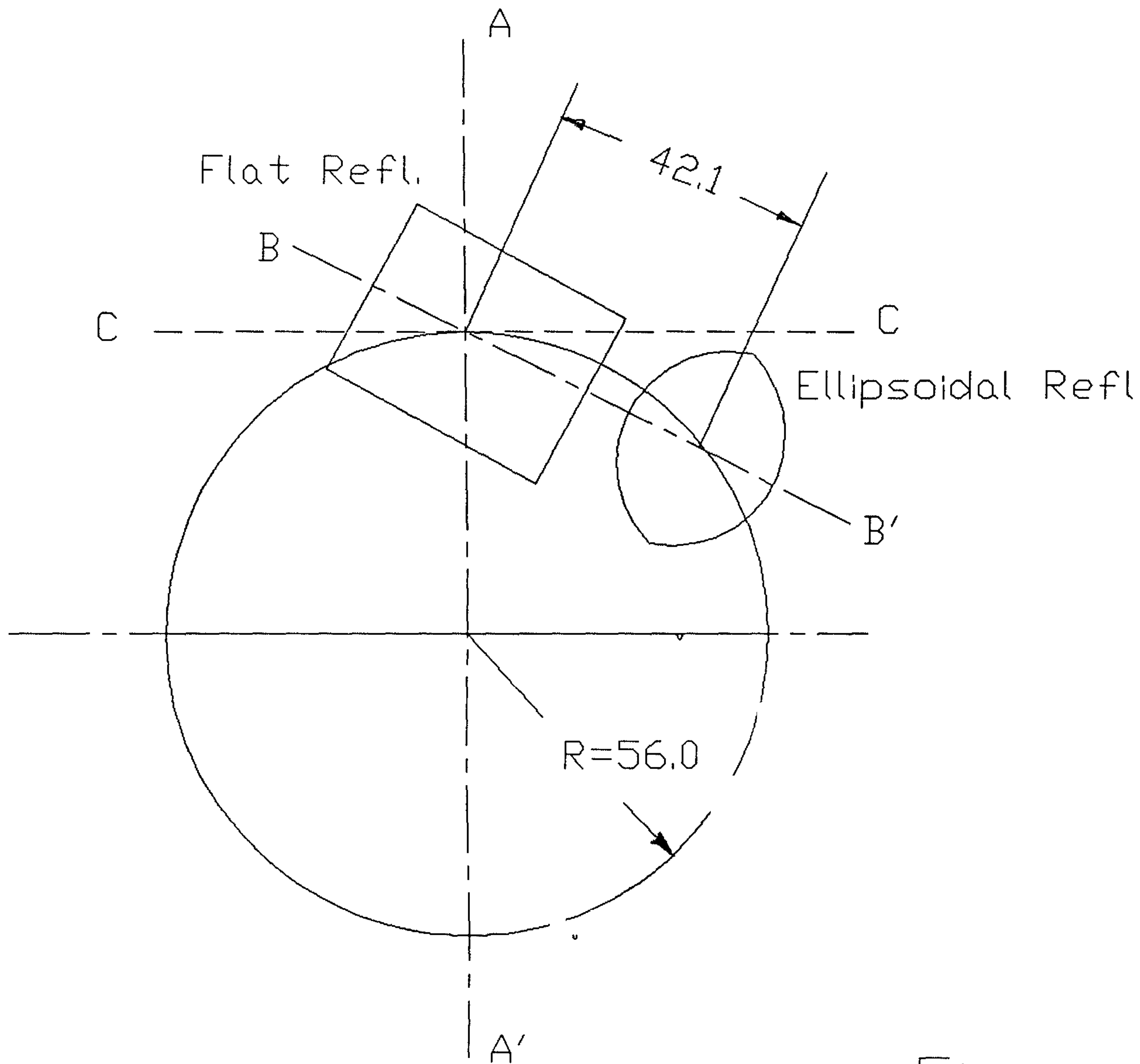

Figure 3. (Scheme B)