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To: Millimeter-wave VLBI Group

From: Alan E.E. Rogers AEER

Subject: 7mm Feed

After discussion with Bill Fitzgerald, Xiaolei Zhang, and Peter Napier, we have chosen a feed based on a design by Xiaolei Zhang with a flare semi-angle equal to the half-angle subtended by the subreflector and aperture size to match the Australian wide-band design of Thomas, et al. The advantage of the wideband corrugated horns are that they require no lenses for phase correction and hence eliminate the concern that dielectric and scattering losses in the lens will increase the system temperature.

Design:

1] Copy the throat design of Xiaolei by scaling the dimensions of Figure 7 by (100/43)=2.326

2] Copy the horn design by scaling dimensions of Figure 12 (except horn length) by 2.326

3] Change the flare-semi-angle from 12° to 6.7° (this will give a taper of 17 dB at the edge of the subreflector)

4] Choose an aperture size to meet the criteria then $\Delta > \lambda/2$ at the longest wavelength. Since Xiaolei's feed covers 70-115 GHz, our scaled version will cover 30-50 GHz. In order to make $\Delta = \lambda/2$ at 30 GHz, the aperture diameter should be 6.75".

Performance:

Depending on receiver temperature, a 17 dB taper will provide close to optimum SEFD for Haystack. In Figure 1, I show the expected spillover and aperture efficiency (neglecting surface roughness or Ruze loss) for a 1 dB space frame loss and 1 dB radome panel reflection loss.

Beam Switcher:

The feed will be about 30" long with phase center about 20" down into the feed. If we mount the feed so that the front is about 5" from the wheel the focal point, which is 16" from the wheel central ray reflection point, will be 9" further back into the box then it should be to minimize the spherical aberration. However, this 9" and even the 9+12=21" displacement for the offset beam focus will produce negligible loss provided the subreflector is refocused.

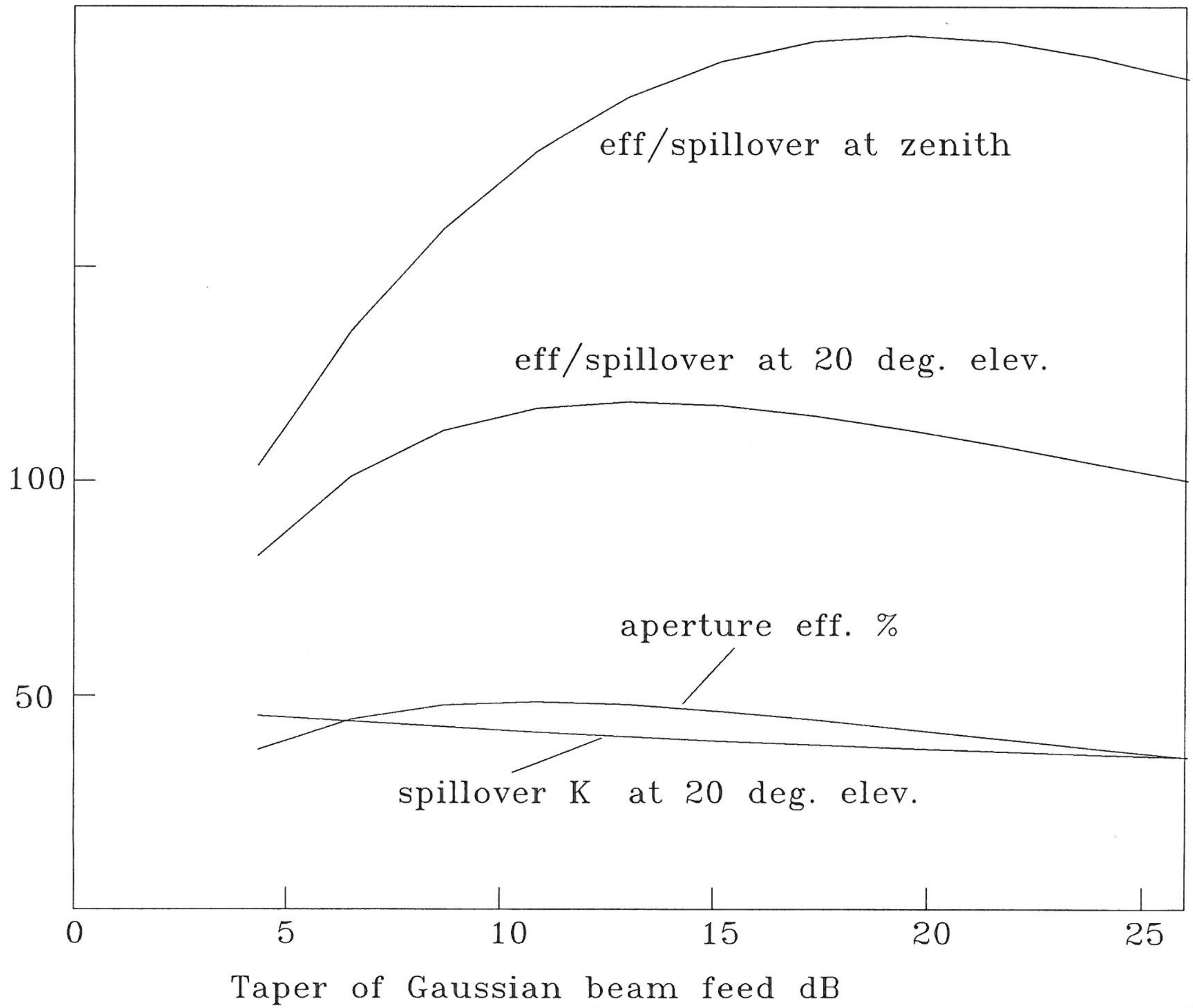
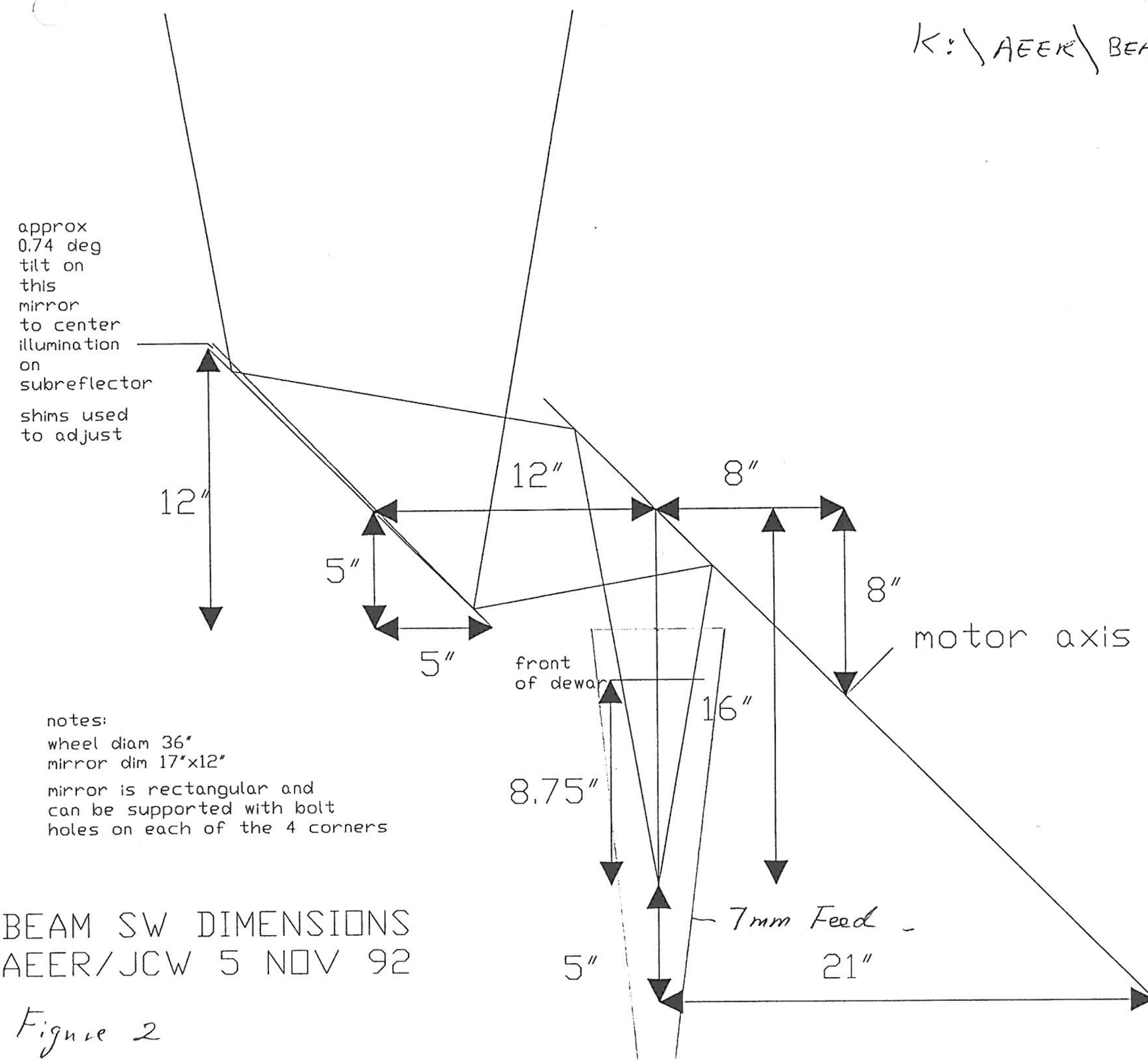

eff/spillover at zenith
eff/spillover at 20 deg. elev.
aperture eff. %
spillover K at 20 deg. elev.
100
50
0
5
10
15
20
25
Taper of Gaussian beam feed dB

Figure 1.

K:\AEER\BEAM-SW1.DWG



notes:
wheel diam 36"
mirror dim 17"x12"
mirror is rectangular and
can be supported with bolt
holes on each of the 4 corners

BEAM SW DIMENSIONS
AEER/JCW 5 NOV 92

Figure 2

Centor 43 33 --> 55 GHz

Design of Conical Corrugated Feed Horns for Wide-Band High-Frequency Applications

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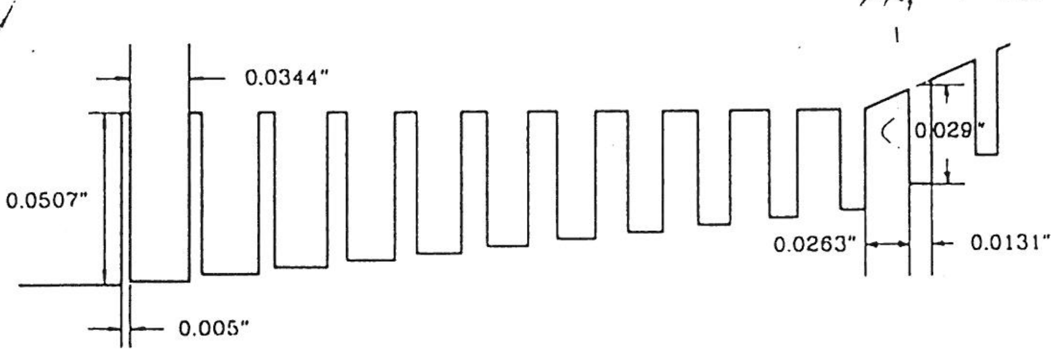

Fig. 7. Throat design for wide-band single-mode and wide-band impedance matching.

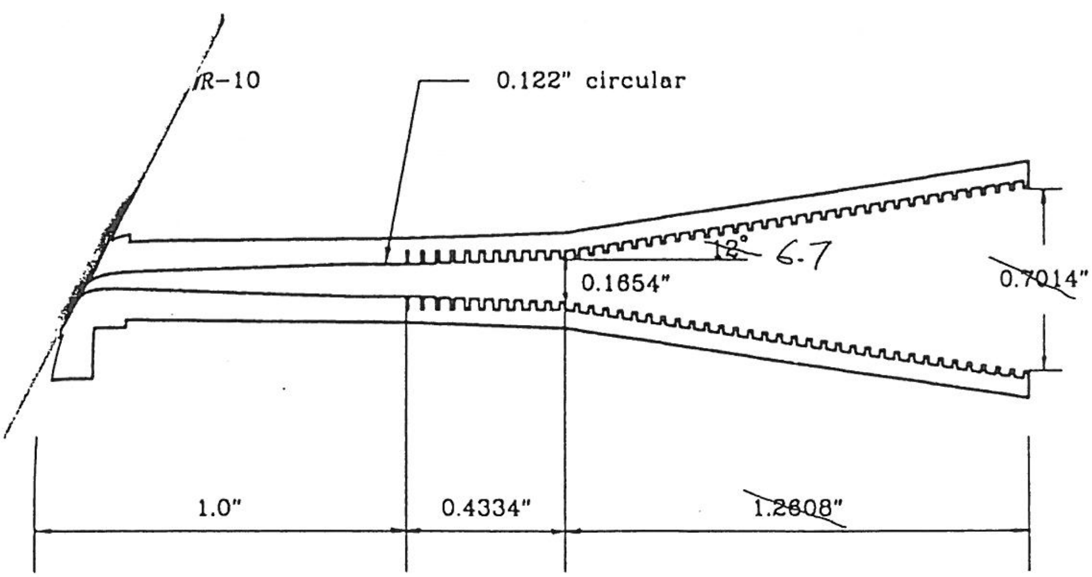

Fig. 12. Design layout for the new conical horn.

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Design of Wide-Band Corrugated Conical Horns for Cassegrain Antennas

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II. Design Principles

The basic corrugated conical horn supporting the HE_{11} hybrid mode is illustrated in Fig. 1(a). For wide bandwidth performance this horn must radiate a near frequency-independent pattern. This is achieved by ensuring that the aperture radius a_0 is sufficiently large that the aperture phase-error factor Δ is greater than one-half wavelength at the lowest operating frequency [1]. When this criterion is met the intensity of the main beam at an angle corresponding to the flare angle θ_0 is approximately 17 dB below the on-axis value and the phase center is located near the horn apex (point O in Fig. 1(a)). The radiation pattern is circularly symmetric and is