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Holographers

To: Alan E.E. Rogers AEER

Subject: Subreflector tilts and lateral motion

1] Subreflector tilt for illumination

For symmetrical illumination of the dish the subreflector needs to be tilted when an offset feed is used by an amount equal to half the angle by which the feed is offset (as seen from the subreflector). For example, the holography feed is about 26" off axis or about 3.2°, which requires about 1.6° subreflector tilt for symmetric illumination - assuming feed is pointed at the center of the subreflector.

If the feed is high by b, the subreflector needs to be tilted up by

$$\theta=(\frac{1}{2})(\frac{b}{B})$$

where

B (≈38.4') is the distance from the secondary focus to the subreflector vertex.

2] Pointing offsets

A subreflector tilt (upwards by θ about vertex) produces a pointing shift of

$$2A\theta/F$$

where

F = Focal length = 48'

A = Distance of subreflector vertex to prime focus 3.6'

and a lateral motion (upwards) produces a pointing shift of

$$-a/F + a(A/B)/F$$

where

a = lateral - upwards motion

while a feed offset produces a shift of

$$-b\ (A/B)/F$$

3] Coupling of tilt and lateral motion in present subreflector

For our present subreflector

$$a = \theta(A - c)$$

where

c = distance from prime focus to tilt axis (≈24")

so that the pointing shift ϕ is

$$\phi = 2A\theta/F - \theta(A-c)/F + \theta(A-c)(A/B)/F$$

$$= (A+c)\theta/F + (A-c)(A/B)\theta/F = 0.12\theta$$

If the subreflector is tilted for best illumination the pointing offset is under-corrected by

$$-(A-c)(1-A/B)(b/B)/F$$

That is, the amount of tilt needed for symmetric illumination is less than that needed to correct the pointing offset.

4] Coma aberration

An offset feed produces coma which can be corrected by lateral motion a, of the subreflector. Equating coma terms in reference one, (AEER Memo, 31 December 1984).

$$a = b(A/B)^3$$

where

A = the distance from the subreflector vertex to the prime focus (≈3.6')

b = feed offset

Lateral motion of the subreflector produces a coma of

$$ay^3/(4F^3)$$

Tilts about the prime focus behind the subreflector vertex produces little coma as the lateral motion of the vertex and the tilt of the vertex compensate for each other. Steve Milner reports that the expected motions for the new subreflector about the subreflector vertex are:

Tilt ±2.85°
Translation ±1.5"

For a feed which is 26" off-axis 1.6° tilt is needed for symmetric illumination this allows only

+0.16" to -2.84"

translation about the prime focus. Thus it looks like only just enough subreflector translation is available for off-axis feeds. If additional translation is required for antenna rigging bias or compensation for deformation changes with elevation, the amount of available subreflector translation might be somewhat marginal.

xc: Steve Milner