Interoffice

National Radio Astronomy Observatory

Green Bank, West Virginia

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12 METER MILLIMETER WAVE TELESCOPE
MEMO No. 105

To: 12-M File

From: R. Fisher and J. Payne

Subject: Tolerances for subreflector positioning on the 12-m telescope

The conversion from lateral subreflector displacement, ΔX, to angular displacement of the beam on the sky, $\Delta\theta$ is given by

$$\Delta\theta(\text{arcsec}) = 2.05 \times 10^5 \, \Delta X \left(\frac{BDf}{f} - \frac{BDF}{F}\right)$$

where f and F are the focal length of the main reflector and the effective focal length of the cassegrain system, in the same units as ΔX. The corresponding beam deviation factors are BDf and BDF.

The conversion from angular tilt of the subreflector, $\Delta\beta$, to angular beam displacement is given by

$$\Delta\theta = -\frac{\Delta\beta \ell}{f} (BDf + BDF)$$

where $\Delta\beta$ and $\Delta\theta$ are in the same units, and ℓ is the distance from the vertex of the subreflector to the focal point of the main reflector.

The parameters for the 12-m are

$$f = 5.08 \text{ m} \qquad BDf \simeq 0.85$$
$$F = 151.0 \text{ m} \qquad BDF \simeq 1.0$$
$$\ell = 0.364 \text{ m}$$

so

$$\Delta\theta('') = 32.99 \, \Delta X \text{ (mm)}$$

and

$$\Delta\theta('') = -0.133 \, \Delta\beta('')$$

The beamwidth of the 12-m at λ1 mm will be about 20" so the peak error on the beam shift due to subreflector movement should definitely be smaller than $\pm$ 1\".0. Translated into subreflector motion this would be

$$\Delta X = \pm\ 0.030\ \text{mm}\ (0.0012\ \text{in})$$

$$\Delta\beta = \pm\ 7\overset{''}{.}5$$

assuming that one or the other motion contains all of the error. If the error were distributed equally and quadratically between the two

$$\Delta X = \pm\ 0.021\ \text{mm}\ (0.0008)$$

$$\Delta\beta = \pm\ 5\overset{''}{.}3.$$