GBT Memo No. 53

NATIONAL RADIO ASTRONOMY OBSERVATORY
Charlottesville, Virginia

GBT POINTING COEFFICIENTS

S. Srikanth
May 24, 1990

GBT Memorandum No. 34 presents the pointing coefficients for the Green Bank Telescope calculated from equations given by J. Ruze. Also given in the memo are the feed and subreflector positioning specifications. This memo presents the pointing coefficients as calculated using some analysis programs that are available at NRAO.

Ruze's equations are basically derived for symmetrical antennas and, hence, their applicability to the GBT had to be checked. Further, the pointing coefficients are likely to be different in the symmetric and the asymmetric planes of the clear aperture antenna. The pointing coefficients are shown in the next page. The positioning requirements for the feed and subreflector for the purposes of tracking stability and registration are calculated and attached herewith. Tracking stability is how accurately the feed or subreflector must be held (known) in position while tracking a source, while registration is the accuracy with which the feed or subreflector should be positioned when taken off and then put back in position.

POINTING COEFFICIENTS

	Symmetric Plane			Asymmetric Plane		
	arcmin/cm	BW/λ	arcmin/arcmin	arcmin/cm	BW/λ	arcmin/arcmin
Subreflector M1:						
Feed Translation $(\frac{\Delta\theta_{FT}}{\Delta d_F})$	0.177	0.433		0.179	0.435	
Subreflector Rotation $(\frac{\Delta\theta_{SR}}{\Delta\beta})$			0.150			0.134
Subreflector Translation $(\frac{\Delta\theta_{ST}}{\Delta d_S})$	0.600	1.464		0.624	1.523	
Subreflector M2:						
Feed Translation $(\frac{\Delta\theta_{FT}}{\Delta d_F})$	0.102	0.250		0.109	0.267	
Subreflector Rotation $(\frac{\Delta\theta_{SR}}{\Delta\beta})$			0.081			0.068
Subreflector Translation $(\frac{\Delta\theta_{ST}}{\Delta d_S})$	0.540	1.327		0.540	1.327	
Prime Focus:						
Feed Translation $(\frac{\Delta\theta_{FT}}{\Delta D_F})$	0.442	1.025		0.447	1.036	
Parabolic Rotation $(\frac{\Delta\theta_{PR}}{\Delta\alpha})$						1.937

NOTE: where $\Delta\theta$ is antenna beam pointing error

Δd_F is secondary focus feed translation

$\Delta\beta$ is subreflector rotation about its vertex

Δd_S is subreflector translation

ΔD_F is prime focus feed translation

$\Delta\alpha$ is parabola rotation

TRACKING STABILITY

Prime Focus Feed:

At 5 GHz, pointing error < ± HPBW/20 (HPBW = 2.5 arcmin)

$\Delta\theta_{FT} < \pm 0.125$ arcmin

$\Delta D_F < \pm 0.110"$

At 1.42 GHz, pointing error < ± HPBW/20 (HPBW = 9.2 arcmin)

$\Delta\theta_{FT} < \pm 0.46$ arcmin

$\Delta D_F < \pm 0.405"$

Subreflector M1:

At 9 GHz, pointing error < ± HPBW/20 (HPBW = 1.36 arcmin)

Allow 1/3 of 1.36/20 arcmin to each

$\Delta\theta_{FT} = \Delta\theta_{SR} = \Delta\theta_{ST} < \pm 0.023$ arcmin

$\Delta d_F < \pm 0.051"$

$\Delta\beta < \pm 9.2$ arcsec

$\Delta d_S < \pm 0.015"$

Subreflector M2:

At 100 GHz, pointing error < ± HPBW/10 (HPBW = 7.3 arcsec)

Allow 1/3 of 7.3/10 arcsec to each

$\Delta\theta_{FT} = \Delta\theta_{SR} = \Delta\theta_{ST} < \pm 0.24$ arcsec

$\Delta d_F < \pm 0.014"$

$\Delta\beta < \pm 3.0$ arcsec

$\Delta d_S < \pm 0.003"$

At 43 GHz, pointing error < ± HPBW/10 (HPBW = 17 arcsec)

$\Delta\theta_{FT} = \Delta\theta_{SR} = \Delta\theta_{ST} < \pm 0.57$ arcsec

$\Delta d_F < \pm 0.034"$

$\Delta\beta < \pm 7.0$ arcsec

$\Delta d_S < \pm 0.007"$

REGISTRATION

Pointing error $< \pm 0.5$ HPBW.

Prime Focus Feed:

Allow 1/2 of ± 0.5 HPBW to feed translation and feed rotation

$$\Delta\theta_{FT} = \Delta\theta_{PR} < \pm 0.25 \text{ HPBW}$$

$$\rightarrow \Delta D_F < \pm 0.24\lambda$$

$$\Delta\alpha < \pm 0.13 \text{ HPBW}$$

At 5 GHz, $\Delta D_F < \pm 0.567"$

$$\Delta\alpha < \pm 19.4 \text{ arcsec}$$

At 1.42 GHz, $\Delta D_F < \pm 1.996"$

$$\Delta\alpha < \pm 1.2 \text{ arcmin}$$

Subreflector M1:

Allow 1/3 of ± 0.5 HPBW to each

$$\Delta\theta_{FT} = \Delta\theta_{SR} = \Delta\theta_{ST} < \pm 0.17 \text{ HPBW}$$

$$\rightarrow \Delta d_F < \pm 0.39\lambda$$

$$\Delta\beta < \pm 1.13 \text{ HPBW}$$

$$\Delta d_S < \pm 0.11\lambda$$

At 9 GHz, $\Delta d_F < \pm 0.512"$

$$\Delta\beta < \pm 1.5 \text{ arcmin}$$

$$\Delta d_S < \pm 0.144"$$

Subreflector M2:

Allow 1/3 of ± 0.5 HPBW to each

$$\Delta\theta_{FT} = \Delta\theta_{SR} = \Delta\theta_{ST} < \pm 0.17 \text{ HPBW}$$

$$\rightarrow \Delta d_F < \pm 0.64\lambda$$

$$\Delta\beta < \pm 2.09 \text{ HPBW}$$

$$\Delta d_S < \pm 0.13\lambda$$

Subreflector M2: (continued)

At 100 GHz, $\Delta d_F < \pm 0.075"$

$\Delta\beta < \pm 15.3$ arcsec

$\Delta d_S < \pm 0.015"$

At 43 GHz, $\Delta d_F < \pm 0.176"$

$\Delta\beta < \pm 35.5$ arcsec

$\Delta d_S < \pm 0.036"$