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

<table>
<thead>
<tr>
<th>Subreflector M1:</th>
<th>Symmetric Plane</th>
<th>Asymmetric Plane</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>arcmin/cm</td>
<td>BW/λ</td>
</tr>
<tr>
<td>Feed Translation (\frac{\Delta \theta_{FT}}{\Delta d_{F}})</td>
<td>0.177</td>
<td>0.433</td>
</tr>
<tr>
<td>Subreflector Rotation (\frac{\Delta \theta_{SR}}{\Delta \beta})</td>
<td></td>
<td>0.150</td>
</tr>
<tr>
<td>Subreflector Translation (\frac{\Delta \theta_{ST}}{\Delta d_{S}})</td>
<td>0.600</td>
<td>1.464</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subreflector M2:</th>
<th>Symmetric Plane</th>
<th>Asymmetric Plane</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>arcmin/cm</td>
<td>BW/λ</td>
</tr>
<tr>
<td>Feed Translation (\frac{\Delta \theta_{FT}}{\Delta d_{F}})</td>
<td>0.102</td>
<td>0.250</td>
</tr>
<tr>
<td>Subreflector Rotation (\frac{\Delta \theta_{SR}}{\Delta \beta})</td>
<td></td>
<td>0.081</td>
</tr>
<tr>
<td>Subreflector Translation (\frac{\Delta \theta_{ST}}{\Delta d_{S}})</td>
<td>0.540</td>
<td>1.327</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prime Focus:</th>
<th>Symmetric Plane</th>
<th>Asymmetric Plane</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>arcmin/cm</td>
<td>BW/λ</td>
</tr>
<tr>
<td>Feed Translation (\frac{\Delta \theta_{FT}}{\Delta d_{F}})</td>
<td>0.442</td>
<td>1.025</td>
</tr>
<tr>
<td>Parabolic Rotation (\frac{\Delta \theta_{PR}}{\Delta \alpha})</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Where \(\Delta \theta\) is antenna beam pointing error
\(\Delta d_{F}\) is secondary focus feed translation
\(\Delta \beta\) is subreflector rotation about its vertex
\(\Delta d_{S}\) is subreflector translation
\(\Delta D_{F}\) 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)

\[ \Delta \theta_{FT} < \pm 0.125 \text{ arcmin} \]

\[ \Delta D_f < \pm 0.110" \]

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

\[ \Delta \theta_{FT} < \pm 0.46 \text{ arcmin} \]

\[ \Delta D_f < \pm 0.405" \]

Subreflector M1:

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

Allow 1/3 of 1.36/20 arcmin to each

\[ \Delta \theta_{FT} = \Delta \theta_{SR} = \Delta \theta_{ST} < \pm 0.023 \text{ arcmin} \]

\[ \Delta D_f < \pm 0.051" \]

\[ \Delta \beta < \pm 9.2 \text{ arcsec} \]

\[ \Delta d_s < \pm 0.015" \]

Subreflector M2:

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

Allow 1/3 of 7.3/10 arcsec to each

\[ \Delta \theta_{FT} = \Delta \theta_{SR} = \Delta \theta_{ST} < \pm 0.24 \text{ arcsec} \]

\[ \Delta D_f < \pm 0.014" \]

\[ \Delta \beta < \pm 3.0 \text{ arcsec} \]

\[ \Delta d_s < \pm 0.003" \]

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

\[ \Delta \theta_{FT} = \Delta \theta_{SR} = \Delta \theta_{ST} < \pm 0.57 \text{ arcsec} \]

\[ \Delta D_f < \pm 0.034" \]

\[ \Delta \beta < \pm 7.0 \text{ arcsec} \]

\[ \Delta d_s < \pm 0.007" \]
Pointing error < ± 0.5 HPBW.

Prime Focus Feed:

Allow 1/2 of ± 0.5 HPBW to feed translation and feed rotation
\[ \Delta \theta_{FT} = \Delta \theta_{FR} < ± 0.25 \text{ HPBW} \]
\[ \rightarrow \Delta D_F < ± 0.24\lambda \]
\[ \Delta \alpha < ± 0.13 \text{ HPBW} \]
At 5 GHz, \( \Delta D_F < ± 0.567" \)
\[ \Delta \alpha < ± 19.4 \text{ arcsec} \]
At 1.42 GHz, \( \Delta D_F < ± 1.996" \)
\[ \Delta \alpha < ± 1.2 \text{ arcmin} \]

Subreflector M1:

Allow 1/3 of ± 0.5 HPBW to each
\[ \Delta \theta_{FT} = \Delta \theta_{SR} = \Delta \theta_{ST} < ± 0.17 \text{ HPBW} \]
\[ \rightarrow \Delta d_F < ± 0.39\lambda \]
\[ \Delta \beta < ± 1.13 \text{ HPBW} \]
\[ \Delta d_S < ± 0.11\lambda \]
At 9 GHz, \( \Delta d_F < ± 0.512" \)
\[ \Delta \beta < ± 1.5 \text{ arcmin} \]
\[ \Delta d_S < ± 0.144" \]

Subreflector M2:

Allow 1/3 of ± 0.5 HPBW to each
\[ \Delta \theta_{FT} = \Delta \theta_{SR} = \Delta \theta_{ST} < ± 0.17 \text{ HPBW} \]
\[ \rightarrow \Delta d_F < ± 0.64\lambda \]
\[ \Delta \beta < ± 2.09 \text{ HPBW} \]
\[ \Delta d_S < ± 0.13\lambda \]
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

$\Delta d_s < \pm 0.036''$