NATIONAL RADIO ASTRONOMY OBSERVATORY
GREEN BANK, WEST VIRGINIA

ELECTRONICS DIVISION TECHNICAL NOTE NO. 139

Title: **MORE ON DECLINATION POINTING OF THE 300-FOOT TELESCOPE**

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MEMORANDUM

From: H. Payne

Subj: More on declination pointing of the 300-foot telescope

In Electronics Division Technical Notes 137 and 138, Jim Condon and I proposed changes in the way pointing corrections for the 300-foot telescope are implemented. My suggestion was that the pointing correction be written as the sum of terms that are physically meaningful. Subsequently, Rick Fisher pointed out a physical effect that I had overlooked: if the lateral defocussing moves the focus more than a critical distance away from the feed location, then the beam deflection factor (BDF = ratio of the angular displacement of the beam to the angular displacement of the feed) changes. This critical distance seems to scale with wavelength, so it is not possible to derive a pointing correction simply from the positions of the feed and the focus; the observing frequency must also be considered.

This effect should not be seen if the lateral focus mechanism is being used to track the focus, but should be apparent in old pointing runs at 6cm and 9cm. I have modelled a pointing correction based on BDF behavior determined in the east-west direction, and applied it to some of these old pointing runs. After applying this correction, the pointing error is then well fit by the sum of constant, gravity, and refraction terms. Figure 1 shows the residuals from a 6cm pointing run omitting this new correction. The fit was restricted to declinations between the obvious breaks. Discrepant points outside these dec limits have not been filtered out. Figure 2 shows the residuals from the same run including this new correction, fitting to all declinations. The most discrepant points have been filtered out, and do not appear on the plot. My conclusion is that the behavior of the BDF is determined to sufficient accuracy from its behavior in the east-west direction.

Take as the nominal BDF as value of 0.854. Then every inch of feed motion in the focal plane corresponds to

BDF * 135.26"/inch or 115.51"/inch

of pointing correction. Taking the nominal change in BDF to be 0.1222 once the feed is more than the critical number of inches away from the focus, then every inch of feed motion in the focal plane corresponds to

(BDF * deltaBDF) * 135.26"/inch or 129.63"/inch

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or an additional correction of 14.12"/inch. The critical distance is about

6.8inches * (5000 MHz/ observing freq)

Following Rick's suggestion, suppose that we hardwire a simple equation for the motion of the north-south position of the focus into the H316. Let the computed feed position be x_0 and the actual position of the feed be x, both in inches. Increasing x moves the box south and the beam north. The first component of the pointing correction is

$$deccor_1 = -BDF * 135.26"/inch * x$$

This is a correction with respect to the way the pointing curves have always been measured, i.e. by keeping x = 0. Next compute the critical distance x_c from

$$x_c = 6.8 * (5000/ observ.freq.1) \text{ inches}$$

Then

```
if( ( x - x0 ) .gt. xc ) then
     deccor2 = -deltaBDF * 135.26"/inch * ( x-x0-xc )
else if( ( x - x0 ) .lt. -xc ) then
     deccor2 = -deltaBDF * 135.26"/inch * ( x-x0+xc )
else
     deccor2 =  0
endif
```

Then the total pointing correction is

$$deccor_1 + deccor_2 + \text{basic correction} + \text{level correction}$$

The basic correction is a pointing curve that depends only on declination, and the level correction is the difference between the level reading and a level curve which only depends on declination. New forms for the pointing curve and level curve were suggested in EDTN 138.

We know that the lateral focus mechanism is speedy enough to follow any changes in declination, so it seems safe to servo the lateral focus mechanism to the error between the commanded and actual lateral focus position and then to servo the declination drive with an error that depends on the actual lateral focus position. If the lateral focus mechanism stops, then the declination drive will always go to the declination of the source, even though the gain might not be optimized.

Rick and Jim suggest that we apply $deccor_1 + deccor_2$ to the apparent declination, and call that result the apparent declination. The lateral focus position must be recorded separately to know whether it was at the commanded position.

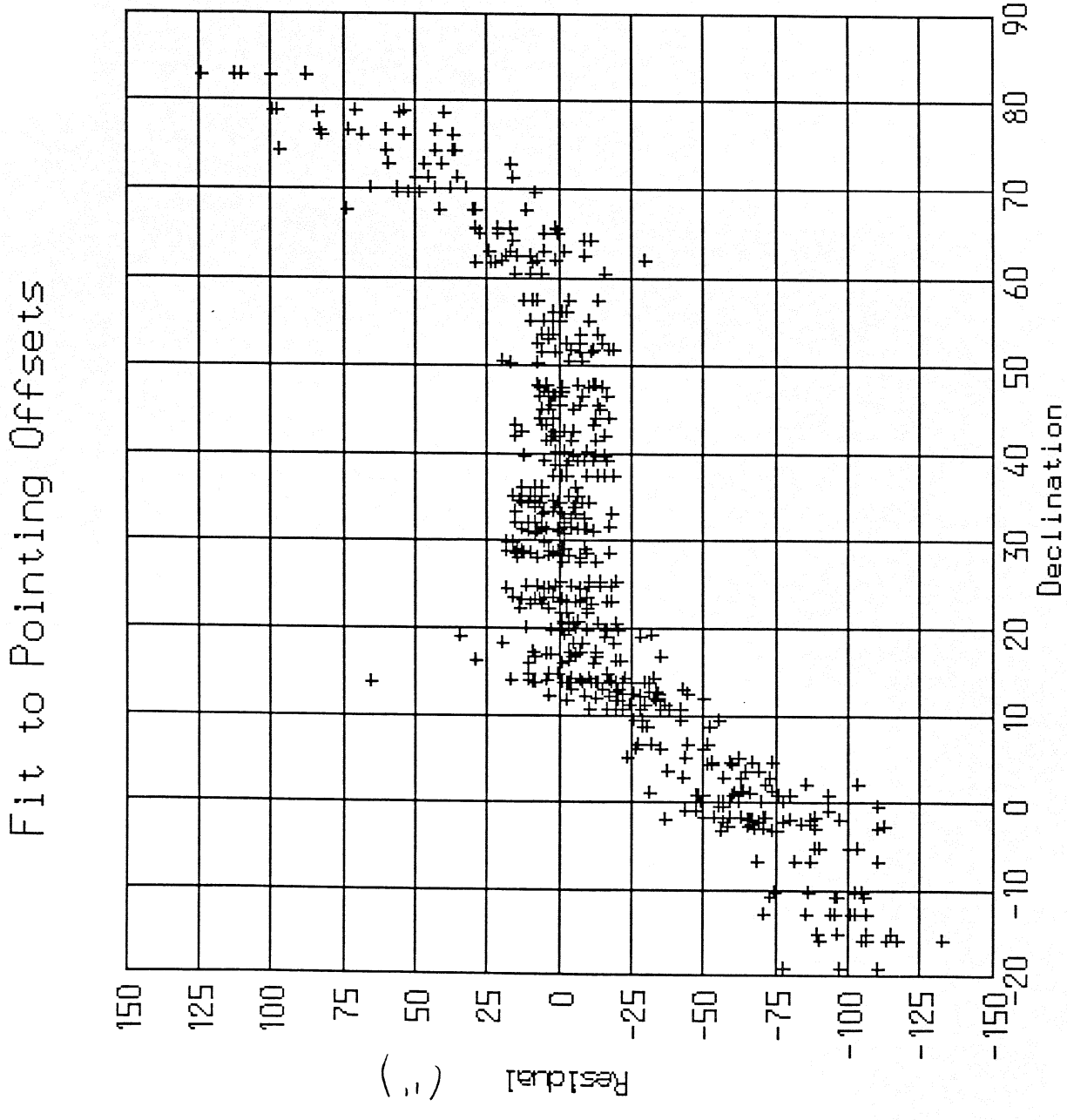
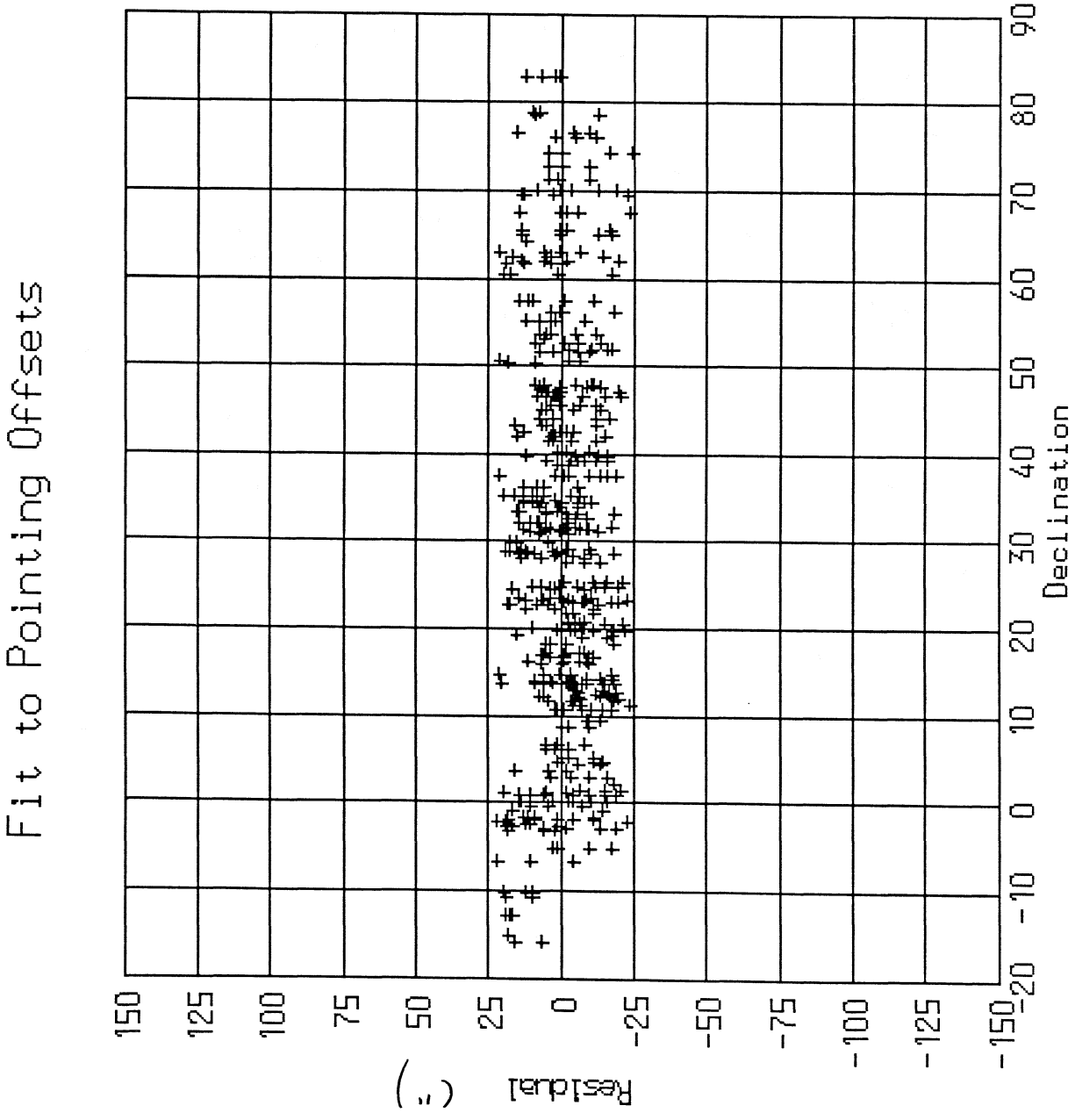

Fit to Pointing Offsets
Residual (")
150
125
100
75
50
25
0
-25
-50
-75
-100
-125
-150
-20
-10
0
10
20
30
40
50
60
70
80
90
Declination

FIGURE 1


Fit to Pointing Offsets
Residual (")
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-150
-20
-10
0
10
20
30
40
50
60
70
80
90
Declination

FIGURE 2.