VLBA TEST MEMO NO. 26

SUMMARY OF RESULTS OF FOCUS-ROTATION RASTER TESTS AT 1 ~~3CM~~
Nov. 26, Dec 4 and 7, 1991

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Observations were made with the first 7 VBLA antennas to test the quality of the focus and rotation values in use and check the behaviour of the gain as a function of rotation. The nominal rotation values are those determined by optical surveying by the antenna division. The nominal focus values are those determined by either myself or the telescope operators. When the nominal focus values were determined, no special attention was paid to the elevation other than to be sure it was high enough to get good data.

The current observations were made at 1.3 cm using the water maser in W3OH and the quasar 3C273. For Nov 26 and Dec 4, a 9 point pattern with 3 values each of focus and rotation was observed. At each point, the expected pointing offset due to the rotation offset was removed apriori in the schedule and then a full pointing pattern was done. The pointing analysis programs were used to determine the best fit pointing position and the antenna temperature that would have been obtained had the pointing been optimal. The apriori pointing offsets proved to be reasonably good - good enough that in most cases the highest amplitude was found in the center position of the pointing pattern at all focus and rotation positions. On Dec 7, a 12 point pattern with 3 focus and 4 rotation values was observed and wider spacing between the rotation measurements was used than in the previous observations.

The results of the observations are:

Rotation	Nominal	Eyeball best fit.	Offset
PT	129.7	128.5	-1.2
KP	262.9	260	-2.9
LA	260.7	259	-1.7
FD	278.3	276	-2.3
NL	299.1	297	-2.1
OV	245.2	Data too poor - FRM trouble.	
BR	50.5	49	-1.5

Focus	Nominal	Value at ~35 deg el.	Offset	Measured range
PT	9.26	9.18	-0.08	8.85-9.60
KP	8.73	8.86	0.07	8.45-9.05
LA	8.87	8.85	-0.02	8.50-9.10
FD	9.26	9.13	-0.13	8.95-9.38
NL	7.68	7.32, 7.45 (2 days)	-0.34, -0.23	7.10-7.75
OV	7.95	7.85	-0.10	7.80-8.05
BR	9.93	10.02	0.05	9.80-10.32

Focus as function of rotation:

PT	Very small effect. Less than 0.05 cm over full 15 degrees.
KP	Maybe 0.1 cm for 10 deg rotation (eyeball estimate). Much larger than PT
LA	Very small effect.
FD	Very small effect.
NL	About 0.12 change of focus over 5 deg rotation day 330. 0.1 cm over 15 degrees on day 341.
OV	Probably small - hard to tell.
BR	Order 0.12 cm in 5 degrees on days 330 and 338.

Rotation as function of focus:

All	Small effect - order 2 degrees from peak focus to half power (eyeball).
OV	Cannot tell.

The "Focus Beam" FWHM is about 2.1 cm at all sites as derived by fitting a gaussian to the amplituded measured at the 3 focus values at each rotation. This is reasonably close the the expected value.

The FWHM of "Rotation Beam" is about 20 degrees as derived from eyeball

estimates. This is close to the theoretical value.

The system temperature varies by less than about 2 degrees over the full range of focus and rotation explored. Errors in setting focus and rotation will not account for the excess system temperature found in other tests.

Some antennas (those with old firmware?) had a lot of trouble making the small moves in rotation that were requested by this observing program. They often did not get to the requested position.

Other points:

PT	Focus at high elevation seems about 0.1 cm different on days 330 and 341. Rotation appears constant with elevation.
KP	Bad FRM problems on day 338. Ok on 341 - new proms.
LA	
FD	
NL	Over 1 mm change in focus between days 330 and 341. Focus is off by up to 0.5 cm at low el. This would cause amplitude loss of about 17% which could account for some of the non-flat gain curve.
OV	Non flat gain curve. Not clearly explained by focus effect. Very poor FRM performance - degraded data badly
BR	Some FRM trouble - not as bad as KP and OV.

All: There does not appear to be a significant rotation vs. elevation effect.

Conclusions:

1. The optimum focus changes with elevation (cos(ZA)?). The full range is about 0.7 cm.
2. Some current focus values are for high elevation and can cause significant gain loss at low elevation.
3. Nominal focus values should be set for about 35 deg el.
4. Focus change with elevation will cause losses of up to about 8% at extreme elevations with above setting and no compensation at 1.3 cm.
5. Over the very short period of these observations, focus changes of up to 1 mm were seen on different days. What is the full annual effect?
6. Any pointing offset as a function of focus is small. However, it would be wise to redetermine the pointing equations if a focus offset with elevation is implemented.
7. Optimum focus and rotation are sufficiently independent that they can be investigated separately, if careful. Optimum focus vs. elevation should be determined first, and then the optimum rotation can be found without further peaking in focus.
8. The nominal rotation values seem to be off by about 1 to 3 degrees in the same direction at all sites. The resulting amplitude loss is 1 to 6 % at 1cm.
9. The apparent low efficiency at Fort Davis at 1.3 cm (about 35%) is not the result of a poor FRM position in focus or rotation. Of course, I have no way of checking the subreflector position in the direction orthogonal to the feed circle.

Figures:

1. Pie Town, Dec 7. Pointing offsets vs. focus and rotation and focus offsets vs. rotation and elevation. Some other sites show more indication of a cos(ZA) focus vs. elevation than this one.

2. Pie Town, Dec 7. Sample data. Each pair of plots is for one focus/rotation raster. The antenna temperature is plotted. In the plot vs. rotation, the points are plotted at rotation values that are slightly offset as a function of offset from the nominal focus to make the focus pattern apparent. The central point is at the correct rotation value. For the plots vs. focus, the same trick is used to separate the values for different rotations. Note that the nominal focus/rotation value is on the middle focus point of the third rotation set.

3. The same data as figure 2 except that it is for Kitt Peak. Notice the clear change of focus value with rotation.

PT 1cm 91 Day 341

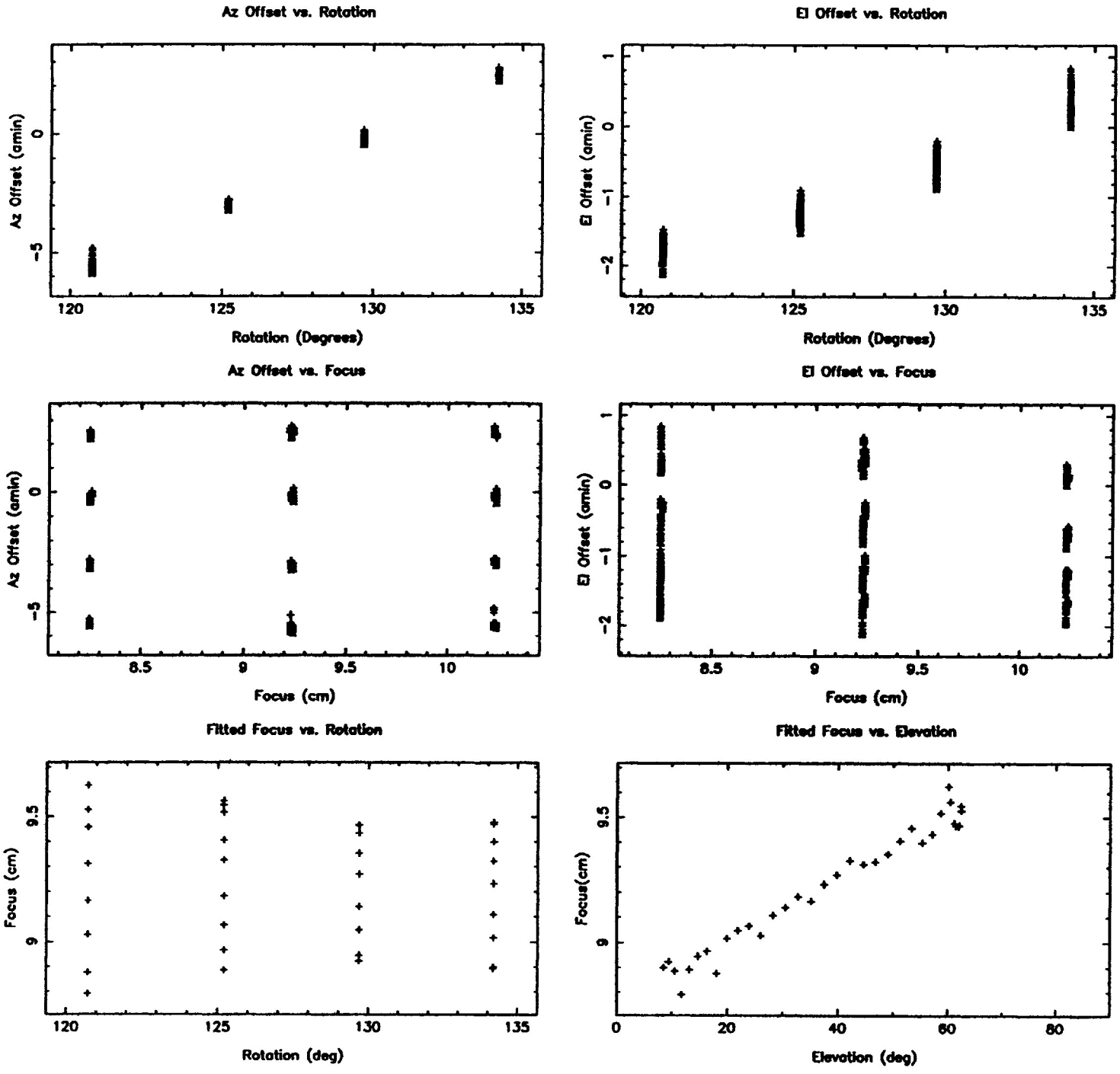


Figure 1

PT 91 Day 341

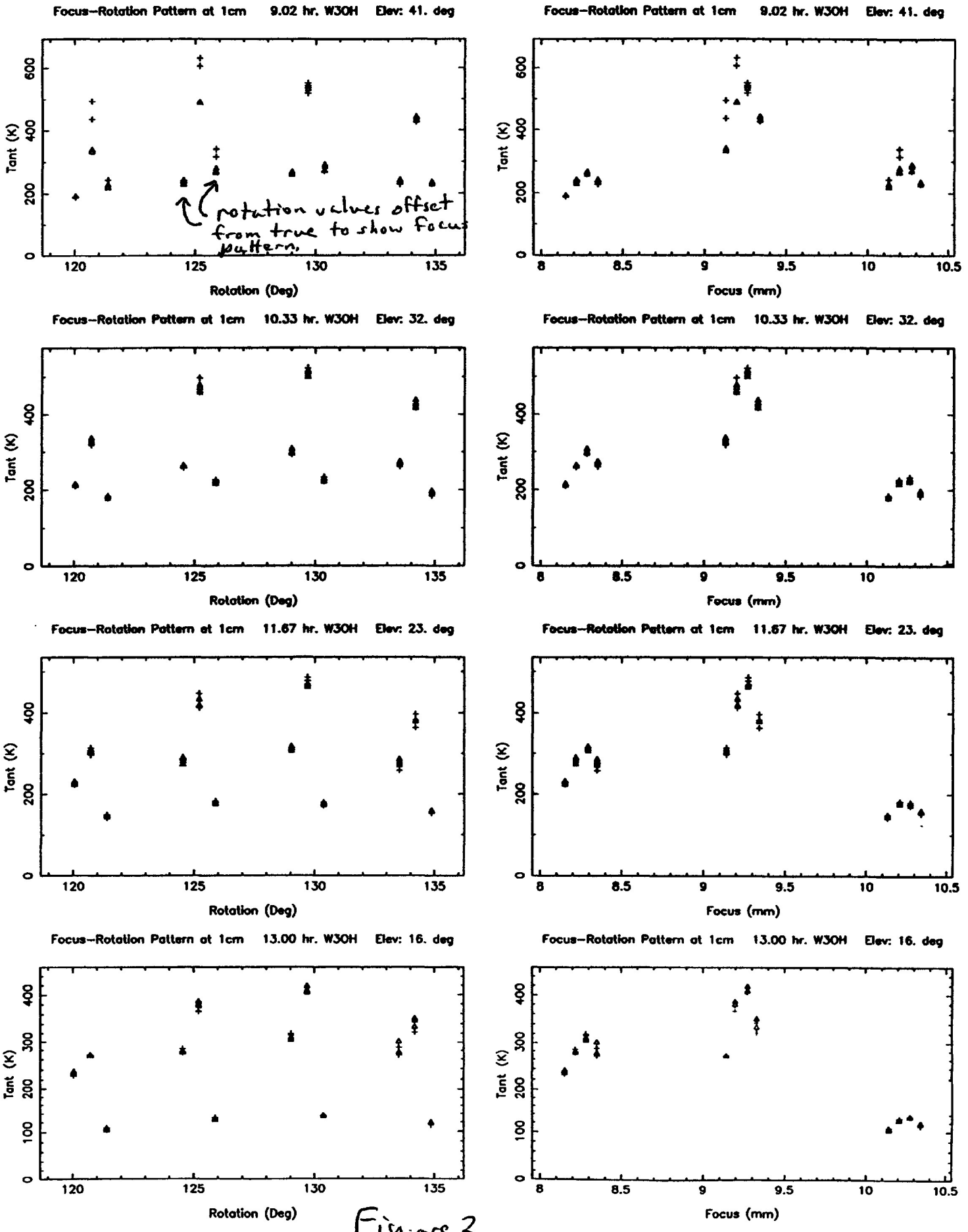
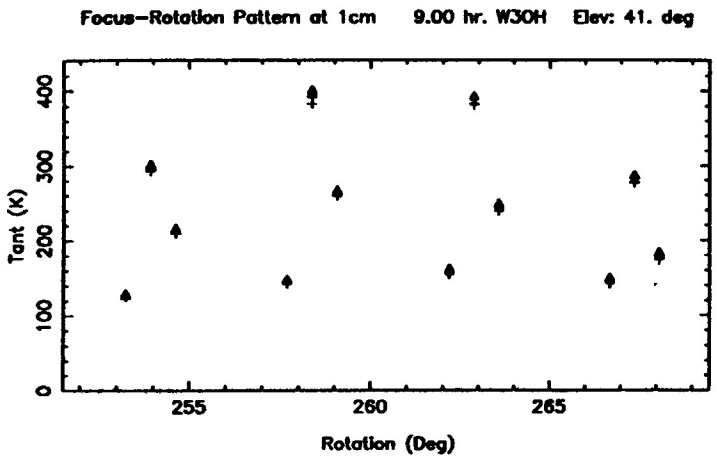
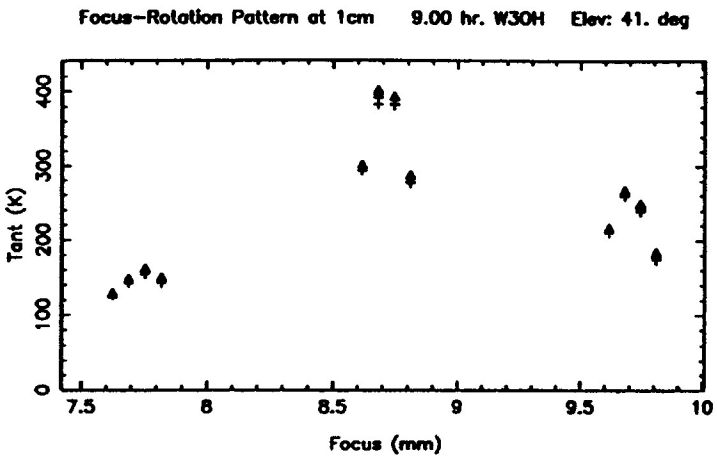
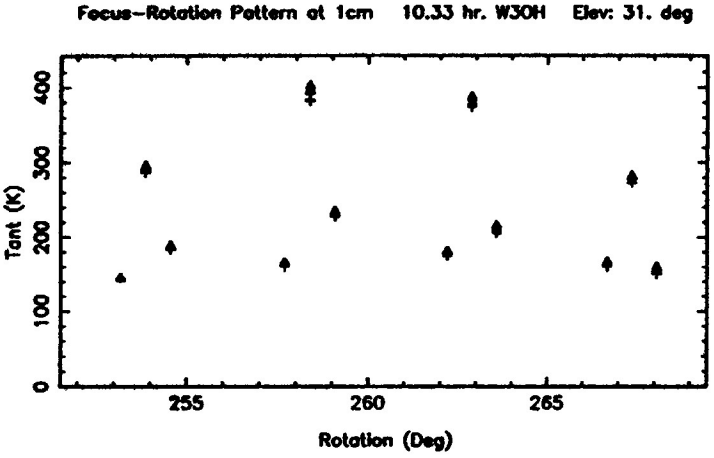


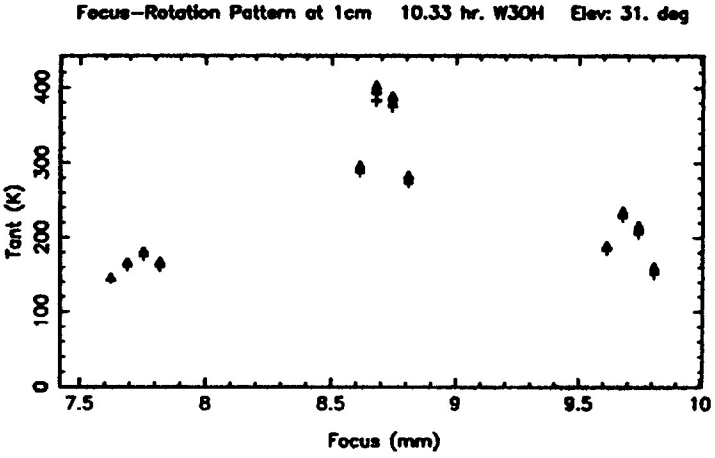
Figure 2

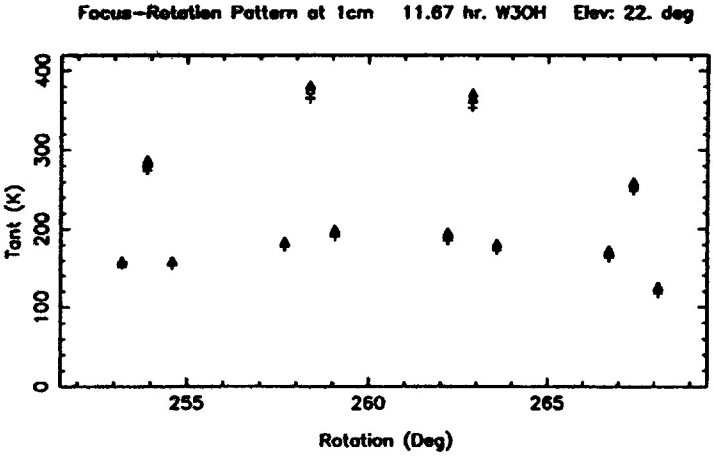
KP 91 Day 341

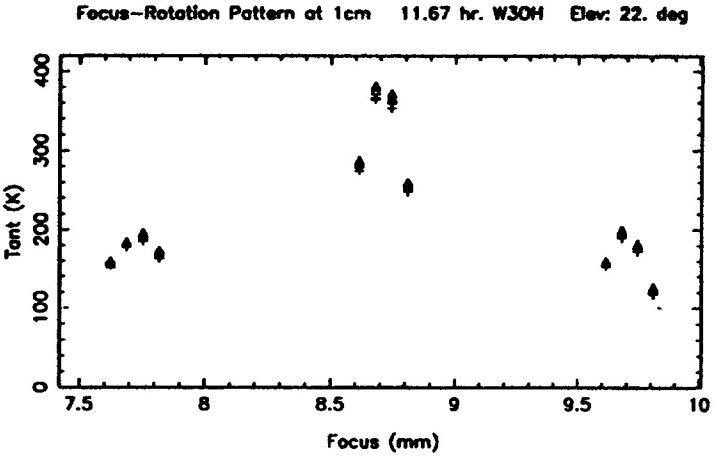


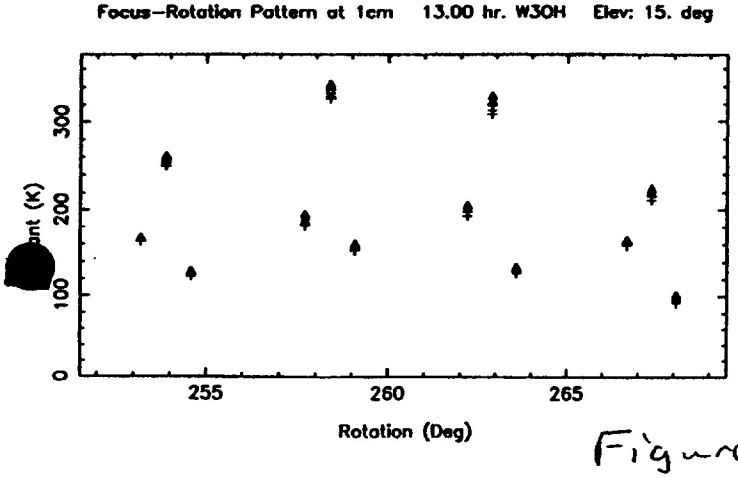












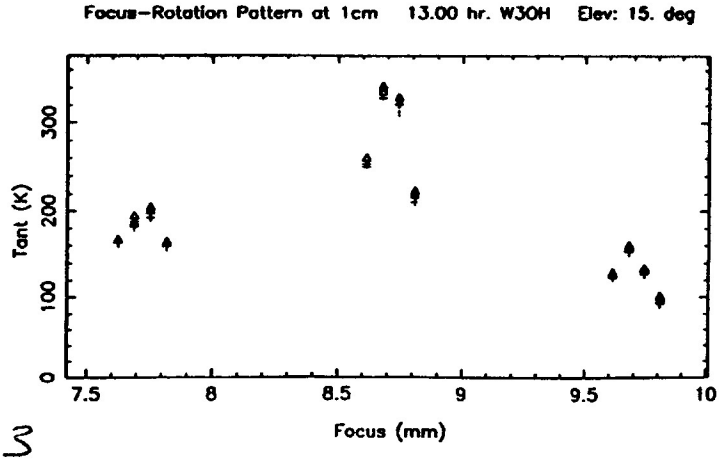


Figure 3