Mechanical Stability of the AT Subreflectors

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This note describes some recent investigations into the mechanical stability of the subreflectors on the AT antennas. These experiments followed the movement of the subreflector as the antenna tipped from the zenith to the horizon. We find, relative to a coordinate frame attached to the receiver platform :

- The axial movement (axial defocussing) is 0.7mm
- The lateral movement, (in the focal plane, normal to the elevation axis) is 2mm, and no movement parallel to the elevation axis.
- A rotation of 3 arcminutes about the elevation axis.

These results are based on five experiments. The coordinate frame is attached to the feed rotator; the z-axis is normal to the vertex room floor (positive is up), the x-axis is parallel to the elevation axis. "North" is at positive y, "East" is positive x. The experimental setups are sketched in figure 1.

1. A telescope attached to the feed rotator tracked a target at the subreflector vertex. This gave the movement in the focal plane; the results are shown in figure 2.
2. A laser was attached to the feed rotator; its beam was reflected off a mirror attached to the subreflector vertex back to the vertex. The movement of the laser spot was tracked. This gave the rotation of the subreflector, shown in figure 3.
3. A laser was installed at the subreflector vertex, directed to the feed rotator. The laser spot was tracked. This experiment was a control on the previous two, as the movement is the sum of the reflector translation and the rotation. The closure is well within the measurement errors of $\sim$ 0.2mm.
4. Two thin wires were attached to the subreflector rim at the highest and lowest points; the wires were kept at constant tension. The movement of markers fixed to the wires relative to a scale on the vertex room roof was tracked. This allowed us to determine the axial movement (figure 4) and the subreflector rotation This is shown in figure 3, as the trace labelled "CA03".
5. A thin wire at constant tension was attached to the subreflector rim at the East point. This measured the axial movement.

The first three experiments form a consistent set (within the measurement errors of 0.2mm). The last two experiments are consistent within their measurement errors of 0.1mm. The rotation results are

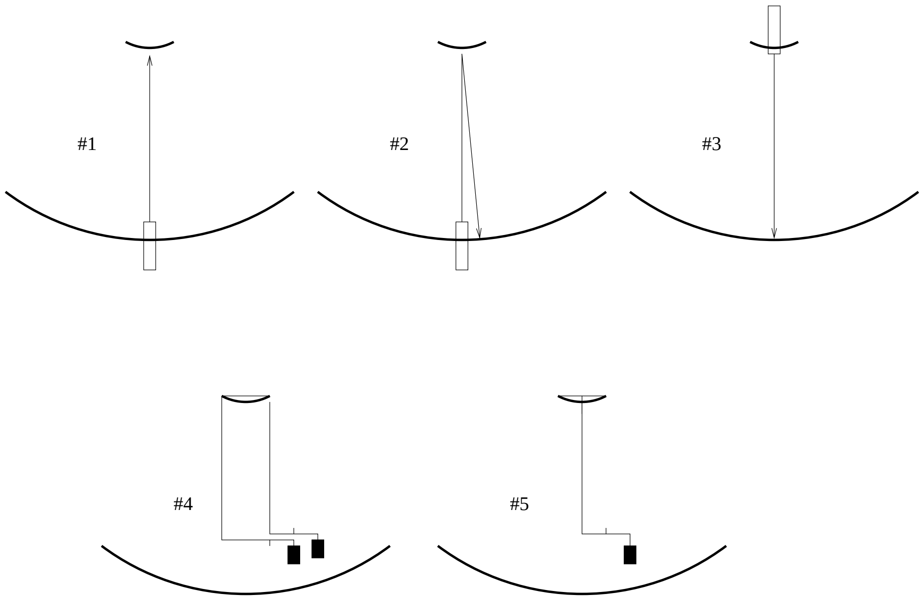

Figure 1: Organization of the five experiments

not as well defined over the entire set, with the optically determined values about 30 % higher than the mechanical values. Since the optical and mechanical observations were made on different antennas (Narrabri antennas CA01 for the optical, CA03 for the mechanical) one possibility is that there are antenna-to-antenna variations. We note that the stretched cables supporting the subreflectors were not adjusted to any rigorous standard, so that it is likely that the tensions vary vary from antenna to antenna. It might be prudent to develop a scheme to ensure that the tension in the cables is consistent over all the antennas.

Discussion

The optical measurements were made on a Narrabri antenna (CA01) and the antenna at Mopra. The stretched wire experiment was done on antenna CA03, Narrabri.

These results are encouraging as they suggest that the mm operations may not require active subreflector control. It must be recognised, however, that the deformation of the structure has yet to be factored into the debate - we don't know whether the reflector's focus shifts as the antenna tips. Preliminary 22 GHz observations (R. Gough) show that the axial focus shift is less than 1mm, which indicates that the structure's contribution is small. Detailed experiments to measure the structural deformation are planned.

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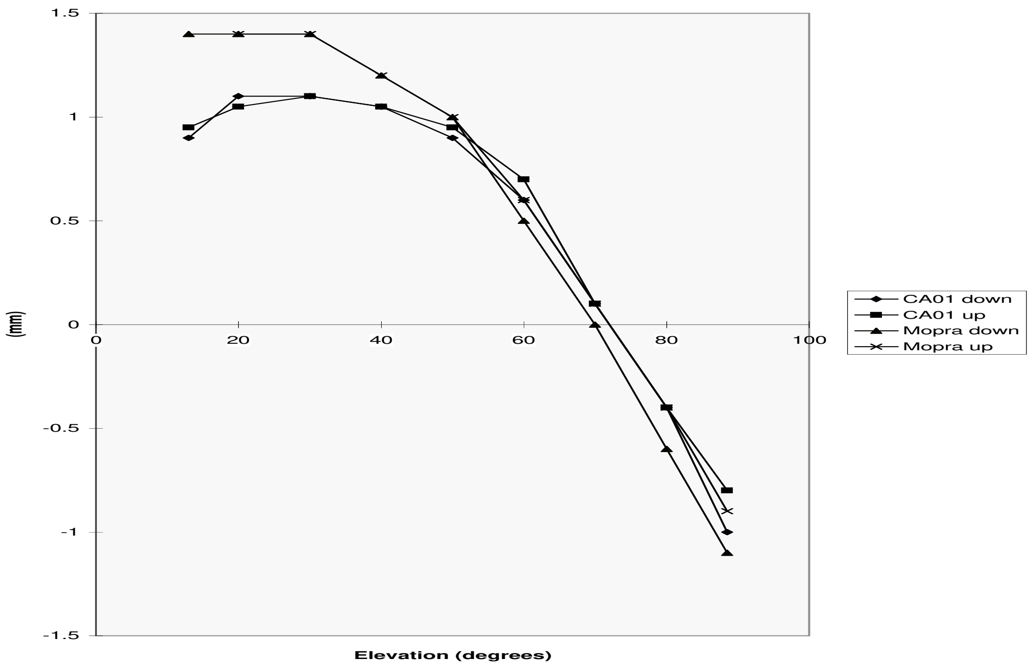

Figure 2: The lateral subreflector shift in the y-axis direction. Postive is "North" (ie. uphill)

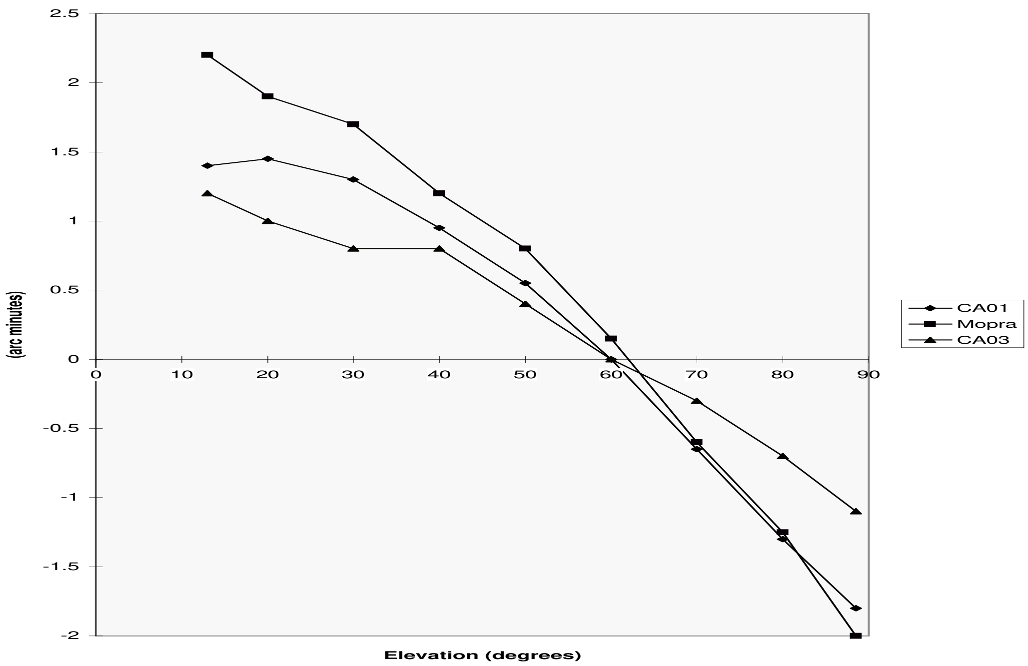

Figure 3: The rotation of the subreflector about the x-axis. Positive is counter-clockwise when viewed looking "East".

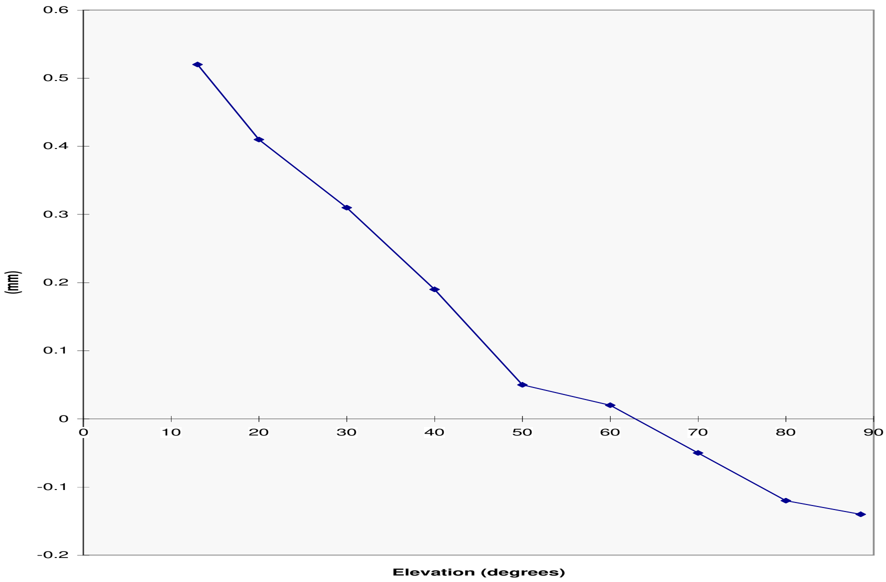

Figure 4: The axial subreflector shift. Postive is away from the vertex