National Radio Astronomy Observatory

Socorro, New Mexico

VLB ARRAY MEMO No. 285

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To: Ken Kellermann, H. Hvatum

VLBA CC Memo No. 7

From: B. Horne

VLBA Antenna Memo No. 1

Subject: VLBA Antenna Choice

Chapter III - The Antenna Elements of the VLBA report recommends a wheel and track antenna concept be used and points out the 2 wheel and track concepts considered. The first concept used a slightly improved VLA reflector, improved accuracy panels 200μm (0.008 inches RMS) and a fairly stiff tower and base structure to achieve quite comfortably the required error budget for both surface distortion and pointing error for operation at 43 GHz frequency. The second concept uses the same tower and base structure as the first but uses an advanced reflector design to get better performance of the reflector with respect to gravity and thermal exposure to make possible a later conversion to operation at 86 GHz. As pointed out in Chapter III the second concept is estimated to cost some $1.7M more than the first but to actually convert to a good 86 GHz design antenna additional expenditure of some $8M is required for primarily more accurate panels but also including better position indicating systems and more accurate track. It should be pointed out that the structural pointing performance of the two antenna concepts will be almost the same with the reflector of the advanced concept pointing slightly better. My initial inclination had been to prefer the 1st concept (the standard reflector design) on the basis that the additional $1.7M for the advanced design antenna was not money judiciously spent unless it was firmly intended to install an 86 GHz system and a fairly strong probability of securing the additional funding for higher precision panels existed. If a good 43 GHz antenna is the objective of the program then the concept I wheel and track antenna is all that is needed or justified.

As design has progressed and further study results have become available I now find that I would recommend the Concept II (advanced design reflector) since it now appears to be possible to obtain some useful 86 GHz performance from the Concept II antenna without the installation of the very expensive, accurate panels one would provide for a properly distributed error budget for the antenna. It must be understood that this higher frequency would only be possible under ideal conditions that is night-time with very minimal thermal differentials, no wind distortions etc.

Using the standard λ/16 requirement for surface accuracy the RMS error for 43 GHz would be 220μm (0.017 inches) and for 86 GHz would 435μm (0.0085 inches). A properly proportioned error budget for

these 2 frequencies would be as follows;

	43 GHz μm RMS	86 GHz μm RMS
Gravity Refl. Distortion 90°/50°	250	125
Panel Mfg. Accuracy	200	75
Panel Setting Accuracy	200	125
Wind Distortion (15.6 MPH)	150	100
Thermal (Refl.)	100	50
RSS	420	222

The gravity performance of the Concept II reflector as shown on page 25 of Chapter III VLBA report does meet the above budget requirement and we have recently been informed by T. Legg that TIW is involved in a program with JPL in which they anticipate manufacturing panels to an RMS of 125μm (0.005 inches) by semi-conventional methods (they had earlier confirmed to me manufacturing to an RMS of 175μm (0.007 inches) at a cost within our budget estimate). Using these factors we could prepare an error budget as follows:

	μm RMS
Refl. Gravity Distortion (90°/50°)	125
Panel Mfg. Accuracy	125
Panel Setting Accuracy	125
Wind Distortion (0.0 mph)	0
Thermal Refl.	25
RSS	220

This would indicate that even though the panels are not manufactured to the desirable accuracy, when conditions are very favorable some useful observations at 86 GHz could be made.