COUNCIL MEMO #4

October 25, 1984

VLB ARRAY MEMO No. 437

To: NRAO Council

From: George Seielstad

Subject: VLBA Antenna in Green Bank

I. Proposal

I propose that one of the ten VLBA antennas be located in Green Bank. I intend to show that such a move both enhances the Array and strengthens NRAO.

II. Background

Having been involved in the first successful VLBI experiment and nearly every one since, NRAO-GB has the most experience of any site in the world with the technique. The experience has been overwhelmingly favorable; had it been otherwise, the VLBA proposal would have struck a deadend long ago.

A similar statement can be made about NRAO. The success of its initial site was the foundation upon which its succeeding developments built. A spirit was forged here that still persists: of all the NRAO sites, Green Bank employees have the most pride in the national observatory, as contrasted with an "its-just-a-job" attitude. This spirit translates into a tangible benefit in terms of immediate response to problems occurring outside the normal 40-hour week.

The VLBA will be the biggest (perhaps the only) new astronomical instrument of the 1980s (now slipping into the 1990s). Personnel at Green Bank would like to contribute to this venture. They have much to offer.

Given the above general comments, it is a perverse quirk of history that a memo of this type is necessary. The burden should properly lie with those who do not feel an antenna should be located in Green Bank, and their burden should be onerous.

III. UV Coverage

I have compared the UV coverage of the proposed configuration with one in which a single antenna from that configuration is moved to Green Bank. My personal conclusion was that the two arrays provided coverage so close to

equal that choosing between them, on this basis alone, was impossible. That is not to say that no differences exist. One array might have been slightly poorer at a particular declination and a particular range of resolution, but the other array compensated by being superior elsewhere.

To confirm my reaction, I created a blind test sent to various NRAO people. (You should all have received a copy by the time of the meeting.) The responses divide into two categories. On the one hand, people who were not involved in the original configuration study unanimously conclude that the UV coverages of the two arrays are equivalent. This sample includes scientists familiar with interferometry and even practitioners of VLB interferometry. On the other hand, those who did participate in the configuration study conclude that Array Gamma, which is the presently proposed array, provides better UV coverage.

The crucial question becomes, how much better? Proponents of Array Gamma can make their own case. I will point out only that: (1) superiority is claimed only in certain ranges of resolution ($\approx 10^3$ km) and declinations (near the equator); (2) Array Delta, the one including Green Bank, involved relocating a single antenna. I am convinced that that change alone achieved equivalence, but stand on the conservative statement that UV coverage at least as good as is provided by Array Delta can be achieved. The crucial point is, a perfectly satisfactory array which includes an antenna at Green Bank can be designed.

IV. Additional Factors

The question of which array is superior is clearly much broader and more comprehensive than UV coverage alone can answer. Quoting Alan Bridle, "I do not think the differences are so huge that I would recommend one array over the other entirely on the grounds of UV coverage."

When these other factors are considered, the case tips overwhelmingly in favor of locating an antenna in Green Bank. A partial listing of advantages follows:

A. Economic

NRAO-GB already possesses a maser oscillator (savings ≈$250k = cost of outfitting all antennas at one frequency). No new building would have to be constructed (savings ≈$100k?). Site acquisition, either purchase or lease, would be unnecessary (savings ≈$100k?). Roads, power, sewer and water are

already available, at least very nearby (savings ?). Vehicles are already owned (savings ≈$30k). The new antenna could be serviced with approximately the same total number of employees, but perhaps a slightly different mix, at Green Bank (savings ≈$50-100k per year).

B. Personnel

People with the skills necessary to operate a telescope are already employed by NRAO. Many of the Green Bank electronics staff are scheduled to construct several of the receivers used on the VLBA antennas. An engineer who has a personal and permanent involvement with a receiver will produce a better product than one who merely delivers a "finished product" to someone else.

Skills other than electronics engineering are also available: programming, digital engineering, welding, carpentry, truck driving (for delivery of tapes or repair components), machine shop skills, rigging, *etc.* None of these will have to be contracted for.

C. National Radio Quiet Zone

Green Bank sits in the only site in the U. S. where some protection against manmade interference is guaranteed. The significance of this fact increases now that the VLBA is moving from paper to reality: some sites have already been found wanting. Green Bank's advantage is particularly striking for the 327 and 600-MHz frequencies.

When evaluating Green Bank for high-frequency studies (>20 GHz), the fact that more and better K-band research has been accomplished here than anywhere else deserves note.

D. Operational Reliability

The response time should any problem arise will be shorter at Green Bank than at any of the proposed VLBA sites. It shrinks effectively to zero.

The communications grid linking NRAO sites is in place at Green Bank. Daily shuttle service is already provided.

E. Management

All the employees are NRAO's. Their duties can be assigned, rather than negotiated for (and then paid for).

In addition, NRAO avoids opening another site. The history of the organization demonstrates that management of distributed sites adds complexity and expense.

F. Politics

The configuration of the Array should be decided primarily on the basis of scientific criteria. It is a fact, however, that politics has become intertwined with this project, and in such a way that the Minority Leader of the U. S. Senate is dissatisfied. We can either assume that the VLBA has surmounted all political hurdles and is on its way to completion, or we can gain a strong and influential supporter for it.

G. Morale

It is bad enough that dedicated employees of NRAO are left out of the most exciting project their employer is undertaking. But injury turns to insult when several of the antennas end up at existing sites (OVRO, Kitt Peak, Fort Davis, U. of Iowa, Haystack). Either extraordinary luck prevailed when institutions founded those sites in proper locations at a time when VLBI did not exist, or perfection of UV coverage was sacrificed to include them.

A more positive statement of the effect of site selection is that NRAO has an opportunity to reward dedication and commitment by involving all its branches. To do so will tie together the organization. That this can be accomplished while at the same time improving the VLB Array changes the decision from desirable to imperative.

V. Summary

Optimizing an array involves finding the maximum of a multidimensional surface. Difficulties arise because more than one extremum may exist, the maximum along a single one-dimensional cross-section may not coincide with that along orthogonal cross-sections, and the maximum may be so broad that its precise summit is undetectable.

I have considered above as many of the dimensions of the surface as occur to me. The result is that the summit defining the best VLB Array occurs when one of the ten antennas is located at Green Bank.