NLSRT Memo No. 19

UNIVERSITY OF CALIFORNIA, BERKELEY

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December 1, 1988

Dr. Paul Vanden Bout
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Dear Paul:

It turns out that I will not be able to attend your meeting in Greenbank after all. There have been too many things going on here of late, and I have just run out of time. On the other hand, I do have strong feelings about the situation at Greenbank, and I want to communicate those thoughts. Apparently, an emergency allocation from congress to replace the 300 foot in Greenbank is a real possibility, and we must certainly make the best of this.

The memo from Ken's committee discusses two options that were considered. Plan A, the preferred, is a 70m class dish good down to 7mm, or possibly 3mm. I find this option entirely uninteresting. Plan B, a 100-150m low frequency replacement for the 300 foot alone, is very attractive. All of the arguments on pages 11 and 12 of the memo are compelling and need not be repeated here. A true replacement of the 300 foot antenna with a surface useable to 20 cm wavelength, and no lower, and a diameter of possibly 150m would provide a truly unique instrument for low frequency research. This instrument must reach all declinations down to the galactic center, and, if possible, should be capable of about two hours of tracking. Really new capability will be provided by such an instrument. No such large antenna is available anywhere in the world, except for Arecibo, and it can reach only about 40 percent of the sky. This telescope could reach high redshift galaxies in H and OH and study the largest population of quasars, providing important information both about the quasars and the ionized component of the ISM.

The site is a key issue here. It is the National Radio Quiet Zone. An inspection of the Frequency Allocation Chart shows that ground based interference is mostly concentrated at frequencies below one GIIz. Here the NRQZ is a real asset. At frequencies above about one GHz, the allocations shift more to satellite and meterological transmissions. These signals from the sky go everywhere, and the quiet zone is less effective. Thus it is natural to exploit our quiet zone resource with a large low frequency antenna at Greenbank.

This unique low frequency telescope can probably be built for 5-10 million dollars. This represents a sensible high quality replacement for 300 foot telescope.

Plan A, the 70m telescope is a poor choice from every point of view.

1. It is not unique. The Russians are building one or more of these antennas. There is already a 100m in Germany.

2. It will be expensive, 50 million dollars. Perhaps that much money is available for this emergency. However, next year and in the future the congress and the scientific community will regard it as another 50m to the NRAO (and for radio astronomy) and will not welcome any further requests from that quarter.

3. The site is perhaps the strongest argument against this plan. Paragraph 5 of the memo notes that Greenbank has the poorest weather of any site in the U. S. for observations at short centimeter and (obviously) millimeter wavelengths. The Bell Labs 7m millimeter dish has done well for its very small group of users by being useable for a few months in the dead of winter. A national instrument must be more available. When the planned 70m telescope is put to work at low frequencies during all that bad weather at Greenbank, it will be a a small but expensive antenna. If we are serious about a facility for short wavelength work, we must put it in a good location.

4. The scientific program is not very appealing. (a) The best program is space VLBI. But here we are too little and too late. The space VLBI is apparently going to be done by the Europeans and/or the Japanese. They both have or are building 70m class antennas and don't need us. (b) Pulsars can better studied with the large low frequency telescope of Plan B. (c) The microwave background must be studied at short cm or millimeter wavelengths. Greenbank is a poor site for these wavelengths, particularly for low brightness continuum, as experience has shown. (d) Extragalactic III will be done better with the Plan B antenna. (e) Atomic and molecular spectroscopy. Most of the molecular work is at millimeter wavelengths, where Greenbank is a poor site. At centimeter wavelengths where interference is more of an issue, the VLA offers both a clearer sky and good RFI rejection. Of course, it has high sensitivity and resolution and modest extended brightness sensitivity in the D array. It is often argued that the VLA does not have good frequency agility. This is a very out of date argument. Centimeter wave receiver technology is very mature, and the cost of equipping the VLA with receivers for any wavelength is tiny compared with the cost of a large single dish. Note that the Australians have figured out how to use octave bandwidth feeds and one to 32 GHz is five octaves, the same as the number of bands now in use on the VLA. (f) Galactic HI and HII. The Plan B telescope will do a better job on III and the low frequency recombination lines. The higher frequency more compact HII regions are being done at the VLA, both in the continuum and the recombination line, at the needed high resolution. The single dish cannot compete here. There is an enormous amount of high resolution HI work to do at the VLA. It is hard work, but that is no excuse for not doing it. (g) SETI. SETI needs collecting area, more than that of a 70m telescope. The 150m telescope will be more valuable for this program.

At this point it may be worth considering the relationship of this proposed replacement antenna with the Arecibo telescope. For that 40 percent of the sky which it can see, the Arecibo telescope has no competition. With its upgraded feed, it will be our major cm wavelength telescope for deep studies. It's present surface is 2mm RMS, and because the individual panel RMS is 0.5mm, it can probably be further improved. That makes it a solid telescope down to 2cm wavelength with an effective diameter of about 250m. Where is it weak? It is clobbered by interference at low frequencies, and its sky coverage is limited. A low frequency 150m full sky coverage antenna at (radio quiet) Greenbank is a perfect complement.

There is one technical point that I would like to comment on. The 70m antenna is to be shaped for high gain and also be able to carry focal plane arrays. For all the shaped antennas that I am aware of, these two requirements are incompatible. The shaped systems have very small regions of good image quality in the focal plane. The VLA antennas are an example. I am not certain that this is fundamental, but someone had better demonstrate the feasibility before any proposal is written up.

Let me summarize. The fact that money for a replacement antenna at Greenbank is probably available is certainly an opportunity that must be taken. A large low frequency antenna will provide a unique instrument that will best exploit the best qualities of the site. It's cost will be modest, 5-10M. Let us not buy an expensive cm wave antenna that is not unique and is a mismatch to the site, just because the money might be there. Let us not mortgage our future plans.

Good luck with the meeting.

Best regards,

Jack

Wm. J. Welch