1999 NRAO Users' Committee Report

Final Version ----- 19 July l999

The Users Committee met June 11-12 in Green Bank, West Virginia. The meeting was chaired by Jeffrey D. Kenney, Yale University.

EXECUTIVE SUMMARY

The Users Committee is impressed with the quality and range of projects currently being pursued by the NRAO. We are especially pleased with recent organizational developments regarding ALMA, the recent VLBA "revitalization" program, and with the advertised capabilities of the soon-to-be released AIPS++. Overall, the Committee feels that NRAO is making excellent use of its limited financial and human resources.

Some of our principal recommendations are listed below, not in order of priority.

- The radio interferometry summer school should be held every two years and should cover both VLA and VLBA issues. Also, the NRAO should provide support for short visits by students who wish to learn about VLA and VLBA techniques.

- Support of AIPS should continue at the present level for at least the next few years. However, the emphasis should be shifted to bug fixes and to implementation of new capabilities required by new observing hardware.

- AIPS++ should be released as soon as possible, but not before a relatively bug-free version is available. To facilitate use and acceptance of AIPS++, package developers should respond rapidly to bug reports, NRAO staff scientists should be strongly encouraged to use the package in their own research, and NRAO should organize outreach seminars at major institutions to demonstrate the use of the package.

- The Committee makes specific recommendations regarding receiver and imaging instrument priorities for the GBT. Highest priorities go to the prime focus receiver box, the 3-mm receiver module and the L-band phased array.

- The Committee supports the concept of dynamic scheduling on the GBT. However, fixed scheduling should be possible when warranted. Also, computer links for remote observers should include display options that do not require large internet bandwidth.

- To discourage boredom and increase telescope productivity, GBT operators should be encouraged to accept significant responsibilities beyond simple system monitoring. For example, operators may be able to perform significant services for remote observers.

- While the Committee understands the financial need to stop full support for the 140 Telescope, NRAO should consider a scaled-down observing mode for survey work or consider the use of the telescope and control room as a visitor museum.

- The VLBA should retain the flexibility necessary to cater to the special needs of observers who wish to pursue unusual or otherwise more challenging projects. Feedback should be provided to users of dynamic scheduling to allow them to assess the likelihood of observation at any particular time.

- The NRAO should provide leadership in the effort to protect radio astronomy frequency allocations. Low-cost steps include, the dissemination of information about opportunities for the community to participate in the international frequency allocation debate.

- The Committee applauds efforts at Green Bank and VLA sites at education and public outreach (EPO). Especially noteworthy, is the National Science Foundation (NSF)-supported Green Bank teacher professional development program that has operated since 1987. NRAO should increase efforts in EPO, coordinate efforts at the various sites, and seek outside assistance in the preparation of comprehensive EPO proposals seeking dedicated NSF funding.

- At future committee meetings, NRAO presenters, including the director, should include a response to recommendations from the previous year's report.

VLBA/VLBI

Recent efforts by NRAO to enlarge the user-base of the VLBA are well targeted, including attracting students and special assistance for novice users. Naturally, NRAO will have to reapportion manpower to make these initiatives workable. Delays in the development of some new capabilities, such as 512 Mbs mode, are reasonable though a questionnaire sent to past users may help in the setting of priorities.

Institution of a quality control team and automation of scrutinization are good ideas. Quality control tests should be engineered to tax a wide variety of the array and correlator operations. Scrutinization procedures should be capable of uncovering with certainty documented problems that have occurred in the past, such as errors in the number of spectral channels, and in source coordinates. Subtle correlator-related problems that have occurred as well should also be targeted. It is important that the system adopted be flexible to permit careful consideration by staff of special experiments. Examples include irreplaceable, time-critical observations, such as monitoring programs with specific time-spacing, and high-sensitivity observations combining the VLBA with the VLA, GBT, DSN, or MPI.

Dynamic scheduling of the VLBA is a welcome development. There is not currently adequate feedback to the user about the status of projects in the dynamic queue. Some VLBA observers need to know when observations will occur, for the scheduling of PhD research or student summer research projects. Users should be able to assess regularly the probability that any given project will be observed. If NRAO regards the chances of execution to be unusually small due to circumstances, then the investigators should be appraised. Overall, guidelines for the assignment of projects to dynamic scheduling should be published, though the system should be flexible to accommodate individual cases.

Scheduling of experiments is one of the first experiences a user has with the VLBA. While the SCHED program is well equipped, the user interface is clumsy and the program is difficult to use, especially for new users. A

program that is not oriented around manual construction of a text file would be helpful (e.g., the new JOBSERVE would be a reasonable model).

The AOC is well equipped to assist VLBA users in their data reduction, which is important. However, the AOC does not have a proper complement of tape devices with which one can conveniently archive large VLBA datasets. DLT drives (35 GB), DDS3 DAT drives (12 GB), Type 8505 or Mammoth Exabyte drives (> 7 GB) are examples of what should be available to users of both SUN and SGI machines. The limit of 2 GB in file size for AIPS running on SUNs is a problem. Even though other architectures do not share this limitation, a compressed UV dataset that is 2 GB on disk expands to 6 GB on tape, and older DAT and Exabyte tapes are inadequate.

VLA/USA

The Committee finds that NRAO provides a reasonable balance between service and new capabilities given current budget constraints. Progress on the VLA upgrade and plans for the Ultra Sensitive Array show that the VLA/USA will remain at the forefront of radio astronomy. Specific recommendations to improve services to the user community are, in order of priority:

- The radio interferometry summer school should be held every two years, covering both VLA and VLBA issues. This more frequent scheduling would make it easier to attract novice users, particularly students who could be introduced to VLA/VLBA techniques during the early stages of their graduate studies making it more feasible to incorporate radio observations into thesis projects.

- Short visits to NRAO for students to learn VLA and VLBA techniques should be available to increase the number of future users and funnel radio interferometry expertise back to their home institutions. NRAO funding to support travel or housing costs for students will increase the availability of this service to a larger community base.

- The VLA Cs configuration is acceptable. NRAO's effort to insure that SED measurements are not adversely affected by the Cs configuration is appreciated. The policy of calling out maintenance staff on weekends to repair antennas near the "Cs gap" should continue.

- VLA-Pie Town observations should be scheduled with OBSERVE or the new JOBSERVE program.

GREEN BANK

SECTION 1: NRAO'S QUESTIONS FOR THE COMMITTEE.

QUESTION 1, RECEIVER DEVELOPMENT PRIORITIES:

We rank the four receivers in the following priority order (although our discussion on this was rushed).

1. *Prime Focus Box 2:* This box is necessary for pulsar observers, and the GBT can make significant contributions to this area from day one. Also, this box is inexpensive; lots of scientific value for the

money.

2. *W-band Module 1:* We encourage the NRAO to move to Phase III as quickly as possible. The GBT will be a spectacular 3-mm wavelength telescope and the sooner the better! However, if there is no 3-mm receiver, there will be a tendency for the laser metrology group, and also the observatory as a whole, to relax on this development. This must not happen.

3. *Ka-band system:* Spectral lines in this band have not been explored very well, partly because this band was a stretch for the 140 Foot Telescope. This is also a prime band for highly redshifted CO, which is very high-profile science.

4. *4-feed Q-band system:* (a distant fourth).

QUESTION 2, IMAGING INSTRUMENT PRIORITIES:

We considered only three items to be important enough to mention at this time (although our discussion on this was rushed).

- *L-band phased array:* This is new technology in imaging devices, offering well-sampled mapping with high efficiency. The approach needs to be tried first at L-band, where the technological problems are easier; we hope that the lessons learned will be transferable to higher-frequency systems. WE ENDORSE THIS PROJECT VERY STRONGLY.

- *20-26 GHz:* The NH3 molecule is perhaps the GBT's most valuable tracer of physical conditions in molecular clouds and the ability to map is very important.

- *85-115 GHz:* This band covers many important molecular lines and the GBT has exquisitely high angular resolution at these frequencies. Moreover, continuum observations are important, too--there has never been anything approaching a sensitive blind survey at 3-mm wavelength. The continuum sensitivity of this array will be quite good--not quite as good as with a bolometer array, but plenty good enough to make a big scientific impact. This array will be very important when the GBT is in full phase III. However, we are somewhat reluctant to strongly endorse this imaging array without knowing the time scale and success of the Phase III development. (We also advocate investigating the possibility of a 3-mm bolometer camera, since a bolometric receiver would have ~50 times the bandwidth of a heterodyne receiver.)

QUESTION 3, DYNAMIC SCHEDULING:

We are pleased to see the emphasis on remote observing and dynamic scheduling. It is important to include these important aspects in the planning from the very start so that they will be an integral component of observing and scheduling processes instead of a less satisfactorily implemented add-on. We have these words of caution.

- First, single-dish observing is often characterized by a high degree of inter-activeness between observer and data/equipment. In many cases observations are straightforward and inter-activeness could be maintained in remote observing. In other cases involving novel observing modes or which challenge the limits of the system the presence of the observer is important. Dynamic scheduling must not eliminate the possibility of this OBSERVER-IN-RESIDENCE observing mode. Moreover, when observers need THIS mode, EVEN WHEN THEY ARE OBSERVING REMOTELY, they should get it without much interference from dynamic scheduling.

- Second, we anticipate that GBT dynamic scheduling will evolve fairly rapidly to the state in which most observers do not, in fact, travel to the site for their observations, just like the VLA. This generates a problem for the site: without a flow of external observers, GB staff might suffer problems of stagnation and isolation. This problem needs to be addressed by GB management, but the solution should not involve the GBT. Possibilities might include broadening the Charlottesville colloquium series to include Green Bank, so that the normal mode becomes that a speaker gives the talk at both places; increased travel budgets for Green Bank scientific staff to attend meetings and observe at other telescopes; expansion of GB's current program of having scientific symposia and workshops. We recommend that GB management query the GB scientific staff for their input on these matters.

- Third, there was heavy emphasis on the necessity for a wide-bandwidth link to a remote observer, together with a very capable computer and displays at the remote site. This is, of course, desirable. However, not all remote observers will have such hardware, and also some observers will want to keep up with things while they are at home where they probably won't have much bandwidth. We strongly feel it is important for NRAO to provide, in addition, a remote observing capability that does not require high bandwidth. As a minimalist example, a remote observer could effectively monitor progress of an observing program from home using an ASCII terminal by listing well-selected quantities such as system temperature, position, peak line brightness; or, with somewhat more capability, one could add graphical displays such as a digital chart recorder and an occasional spectrum.

QUESTION 4, NETWORK UPGRADE AND COMPUTING RESOURCES:

Here the Committee's initial response was 'more is better', but in the light of limited resources we prioritize as follows:

- Green Bank's computing support for visiting observers is quite weak. There are a number of Sun Ultra's around the site and these are fast enough for most purposes. However, they all have limited memory--the most is 60 MB. This is barely sufficient for a modest program using the Spectral Processor and will be totally inadequate for the GBT Correlator, for which each spectrum will require about 1 MB.

One can solve these problems either with a large central machine or by distributed computing. We much prefer the latter for reasons too numerous to mention here. This could be achieved economically by increasing the memory, the local disk capacity, and perhaps the channel speed on the existing Sun Ultra's. NRAO might assign each observer a specific workstation on which the attached disk holds all the relevant data to eliminate transfer of large files across the ethernet during processing.

- The current link to GB is sufficiently fast for current purposes, and computing resources are better directed toward distributed computing. As remote observing with the GBT increases increasing the network speed may become higher priority.

SECTION 2: THE COMMITTEE'S UNSOLICITED COMMENTS TO NRAO.

We were very pleased to hear that it may be possible to rotate the receiver turret without stowing the telescope. This is crucial for many observations that require switching between different receivers. We underscore the importance of making this happen from day one.

We reiterate the importance of supplying a suite of data reduction packages as requested by the users. IDL and CLASS are two of particular importance because they are very popular in the community. It is unreasonable to expect all users to use any one particular package, such as AIPS++, because when forced to use an unfamiliar package one's productivity is greatly reduced. The GBT's scientific productivity will be directly related to the ability of users to exploit its potential without worrying about software issues.

We have not been presented with a plan for using telescope operators effectively. We are concerned about operators being given inadequate responsibilities and activities, with the result that their shifts become repetitive exercises in netsurfing and inventing whatever activities can help them stay awake and combat boredom. Telescope operators are critical for maximizing the scientific productivity of the telescope, and can serve as the main institutional memory for system operations and problems. This can happen only by keeping them trained, and by involving them meaningfully in the telescope operations at a higher level than previous generations of operators. As a specific example, the planning document for remote observing mentioned a number of duties to be performed for remote observers by NRAO astronomers; perhaps some of these could be performed by operators. The GBT operators should be having an important role in remote and/or dynamically scheduled observations. Generally speaking, people rise to the level expected of them. If too little is expected of the operators, then their level of involvement will be commensurate.

Finally--while the Committee recognizes the financial need to stop full support of the 140 Foot Telescope, it would be a shame to turn the telescope into scrap metal. We encourage NRAO to continue pursuing other potential users, including university partners. Have scaled down modes of operation been considered? How about a full sky survey at 22 GHz? Or a fully-sampled 21-cm line sky survey (the current standard, the Leiden/Dwingeloo survey, is far from fully sampled). Such surveys could be done by turning off the power, letting it sit at one declination and then moving a little day by day, gradually covering the sky. Have one single NRAO operator have the 140 Foot as his part-time responsibility; let the telescope run unattended most of the time (after all, all pumps are off); do maintenance on electronics and drives once per month.

Still we recognize that finding a user may be impossible and that mothballing the 140 Foot so that it can be used again is likely to be too expensive. If that turns out to be the case, we urge that the 140 Foot be stowed permanently and entered in its rightful place among the historic instruments at GB. As part of the visitor/education center perhaps state or other sources of funding could be pursued for renovation and painting. We encourage NRAO to communicate with people at Haystack Observatory on educational initiatives with older radio telescopes, since they are in a similar situation with their 26-m telescope.

TUCSON-ALMA

The Committee welcomed the signing of the Memorandum of Understanding with the various European groups and shared the enthusiasm for the progress made in the past year. We encourage continuing discussions with the Japanese on their possible involvement in ALMA, which would make for an even larger and more powerful telescope.

On the question of a time allocation strategy for ALMA, at this stage the Committee favored "open skies," as opposed to multiple TACs.

We encourage NRAO to pursue a streamlined management structure for ALMA, to the extent possible, in order to minimize additional costs and time delays associated with excessive bureaucracy. There seems to already be a large number of committees, and the natural tendency will be for the number of committees to increase over

time. While it is important to give reasonable representation to interested parties, there need to be enough individuals and leaders with decision-making power for the project to be completed in a timely manner.

TUCSON-12 Meter

The Committee expressed concern over the projected demise of Unipops support in Tucson within the next three to four years, by which time Linux ports are envisaged to be in widespread use. The Committee recommends that NRAO Tucson maintain Unipops on a limited number of Solaris machines until AIPS++ has been demonstrated to work and has been accepted by the community.

The Committee sympathized with the problems encountered with remote OTF observing due to the limited data volume and rate capability at the 12 Meter. It was widely felt that the guidelines already put in place by the 12 Meter staff are reasonable and acceptable. The proposed fiberoptic connection and higher bandwidth from the mountain is strongly encouraged.

AIPS

The Committee notes that the community is very strongly dependent on AIPS at present, and that this is unlikely to change quickly even after AIPS++ is generally available. Therefore, support of AIPS will need to continue at the present level for some years yet. In particular, AIPS will be needed for the VLBA and for mm-VLBI for some time. However, the Committee agrees that a "final" 31DEC99 version of AIPS -- after which the emphasis shifts to bug fixes and to implementing capabilities needed because of new observing hardware developments -- is a worthwhile goal. (We do not exclude improvements of existing tasks as long as backward incompatibilities are avoided.) With this release, AIPS could shift from the current system of periodic freezes and releases to one in which one version is kept current and available via internet.

AIPS++

The Committee is disappointed that the release of AIPS++ called for in last year's report has not yet been possible. However, we feel that it is critical for public perception of AIPS++ that this release be as error-free as possible, and believe that premature release could only do harm to the project. The Committee was impressed by the APPARENT power and functionality of AIPS++ in the areas where development has concentrated, and we look forward to the pending release. Clearly the long term success of AIPS++ will depend on providing the capability to import raw data from all major radio telescopes into AIPS++ and carry out the complete data processing stream from calibration to analysis. While this is not yet feasible, with the functionality demonstrated it should be possible to incorporate interferometer images made within AIPS++ in a refereed paper, and this would be a symbolic achievement important for demonstrating progress. To this end, we recommend that NRAO make more effort to persuade NRAO employees to use AIPS++ capabilities in their own research where possible. This development would also require that the AIPS++ project respond rapidly to any problems found by the testers, lest the delays deter their usage of AIPS++.

The Committee was asked to comment specifically on three areas. Given the preponderance of Solaris and Linux as the operating systems for AIPS and the limited resources of AIPS++, it seems logical to concentrate on these platforms for the initial release of AIPS++. Secondly, most "programming" by outsiders is likely to be done in the Glish environment rather than as C++ code, and we recommend that resources be devoted to exploiting programmability in Glish. Finally, with regard to the best forms of outreach for AIPS++ at present, the Committee felt strongly that visits to large institutions to demonstrate the capability of AIPS++, perhaps by helping users to analyze their own data, would be a valuable way of acquainting the community with AIPS++.

SPECTRUM MANAGEMENT AND RFI

Spectrum management

The Committee feels that NRAO should be leading the effort to protect radio astronomy's interests in the U.S. and internationally. Toward this end, NRAO should encourage grass-roots advocacy by informing the user community of existing opportunities for participation in the international frequency allocation debate. Wide dissemination of vital information not readily available to interested individuals (e.g., the dates, times, and locations of "working group" meetings and public hearings, the names and contact information for group/panel members) can be accomplished at little or no cost.

Site RFI

The Committee commends the Green Bank staff on its excellent work maintaining and protecting the National Radio Quiet Zone; these efforts are much appreciated by users of the site's telescopes. The Committee is also aware of the Soccoro Interference Protection Group's efforts in the past year to make site RFI information available online in the form of bulletins and spectral plots, though none of this information was provided to the Committee in reports or oral presentations. We reiterate our request, made last year, that all NRAO telescope sites report on their RFI mitigation efforts to the Committee.

Internally generated RFI at the VLA presents difficulties for all types of observations at P-band and 74 MHz, and is particularly detrimental to pulsar work at all frequencies. Potential scientific returns of the planned increase in continuum bandwidth will also be at the mercy of the RFI environment. We urge the Socorro IPG to act on the results of its testing so as to eliminate internally generated spurious emissions.

Contamination of the 1612 MHz OH maser line by IRIDIUM transmissions is a notable loss of VLA science. The Committee was asked to comment on the priority of filtering the IRIDIUM emissions at the telescope front ends, but because none of the current Committee members have been directly affected by this loss of capability, we are not able to provide well-founded advice. We suggest that NRAO poll the general user community (through an e-mail exploder, for example) about the filtering option--corruption of 1612 MHz data was described most recently in the October 1998 newsletter, but no mention was made of a front-end filter. Available on-line information is nearly one year old (August 1998).

We propose that NRAO do some sort of a press release about the impact of IRIDIUM on observing. Most people in the public are totally unaware.

The Committee endorses NRAO's MRI proposal to study active RFI excision techniques, and encourages further research in this important area.

CENTRAL DEVELOPMENT LABORATORY

The Committee was impressed with the many ongoing developments. In particular it felt that multi-beam array receivers should be a very high priority, especially given the GBT's small beam.

EDUCATION & PUBLIC OUTREACH AND PUBLIC RELATIONS

Relative to optical astronomy, radio astronomy has been traditionally under-represented in the areas of education, public outreach and public relations. The discrepancy has become more pronounced in recent years with the money that NASA has spent in support of recent missions.

NRAO, specifically the Green Bank and VLA sites, have developed significant education and public outreach (EPO) programs in the past few years. The breadth and content of these activities are impressive, and would seem to merit dedicated EPO grant support from NSF. Dedicated funds would help to alleviate the chronic budgetary pressures of NRAO operations. More importantly, specific grant support would help to integrate the individual site efforts into an NRAO-wide program, and enable programmatic access to new means and methods in the rapidly developing field of EPO.

Although individual NRAO sites have pursued such outside EPO support with great success (such as the new Green Bank visitor's center), we suggest that NRAO pursue such grants with a more unified approach, stressing the common radio astronomy pursued at each of the sites. Furthermore, there are professional consultants who may best guide the construction of a large NRAO EPO proposal to NSF. Many of the current NRAO efforts are clearly appropriate to NSF EPO grant support. But public relation activities (such as NRAO posters and brochures) are considered a separate function, not supported under EPO funding. The grant-supported EPO communities are fluent in understanding the nuances and growing diversity of which activities may be well regarded by the granting agencies. NASA has created EPO brokers in 5-6 sites across the country, whose role is to advise (without obligation of collaboration) scientists on the construction and implementation of proposed EPO efforts. NRAO should consult with such EPO advisory groups to construct a convincing and innovative proposal of site-wide NRAO EPO to win dedicated NSF funding.

In terms of NRAO public relations, we recommend three areas of increased activity. These include (1) a substantial rewrite of the NRAO web page that would be easier for non-astronomers to navigate with a more unified look between sites, (2) the construction of a library of NRAO image products, or perhaps even a library of radio images--a Radio Astronomy Image Archive--that would make available readable versions (i.e. jpeg format for most web surfers) of the greatest radio frequency images in a manner that emphasizes artistry as well as science, and (3) the implementation of a larger number of press releases (a staple of STScI).

USERS COMMITTEE MEETING FORMAT

Most Committee members felt that the NRAO presenters had not read or were not sufficiently aware of the suggestions made in the previous year's report. We request that all presenters, including the director, include in their presentations a response to the relevant items from the previous year's report.

The Users Committee needs to have at least three hours of time scheduled for discussion. The two hours scheduled this year was not enough. Perhaps one hour on first day, and two hours the second day is appropriate. It is better to have a full two-day meeting than to have insufficient time for discussions.

We advocate that ten minutes per presentation be specifically written into the schedule for questions and discussion by the Users Committee. There was not enough time in this year's meeting for questions by the Users.

We suggest that NRAO circulate the draft of each year's agenda to the Chair of the previous year's meeting (in addition to the new Chair). The previous Chair is the person who is most likely to know what had worked and what hadn't in the previous meeting.

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