# NRAO Users Committee Report 2011

## 1 Executive Summary

NRAO enables forefront science at radio frequencies by operating and building the world's largest and most productive radio telescopes. NRAO is now on the cusp of completion of two large, decade-long efforts: the Expanded Very Large Array (EVLA) and the Atacama Large Millimeter Array (ALMA). The EVLA is already producing exciting results in a wide range of areas, taking advantage of the increased continuum sensitivity and spectral line capabilities. The performance of the WIDAR correlator is excellent, and continuing efforts to improve wide-band imaging and to mitigate RFI are emerging as successes. ALMA is now entering the operational phase, even while construction is on-going, and the Cycle 0 Call for Proposals resulted in over 1000 proposals from the world-wide community, hinting at an exciting (and over-subscribed) future. At the same time, the GBT is the finest single dish radio/mm telescope in the world, taking advantage of innovative receivers and improvements in the antenna surface. Finally, the VLBA is continuing to achieve impressive improvements in sensitivity (now at 2 Gbps) leading to leaps in science achievement, particularly with parallax measurements establishing the astronomical distance scale within the Galaxy. The focus on large projects, and progress on securing funding support from USNO and international partners should keep the VLBA vital. NRAO's engineers, scientists, and managers are doing a remarkable job on all these projects, while maintaining internal scientific excellence.

The advent of EVLA and ALMA presents an opportunity for NRAO to expand its user base beyond the traditional users. However, this also presents an acute challenge as the data volumes and complexity increase relative to previous facilities. The Users Committee (UC) anticipates increased pressure on NRAO staff for user support in the coming years. The first real test will occur shortly with the availability of EVLA 2 GHz bandwidth data to the broad community; so far these data have only been available to NRAO commissioning staff and to expert users through the highly successful Resident Shared Risk Observing (RSRO) program. At the May meeting the UC recommended that NRAO hold a workshop on EVLA data reduction prior to this transition, and we were delighted to see that such a workshop has been organized before the UC report was even submitted. We anticipate that NRAO will need to hold additional workshops in the future for both EVLA and ALMA data.

The increased complexity of EVLA and ALMA data, and the associated computational needs, lead to an urgent need for user grant support. We continue to be disappointed with the lack of progress on this issue, and fear that in the absence of user funding the US radio astronomy community will lose its edge in the ALMA/EVLA era vis-a-vis the international community. While we were heartened that the ALMA operations budget does include a user grants section in the over-guide request, this only potentially affects one component of NRAO. We encourage NRAO, in concert with its Users Committees and the broad user community, to make a push for more action on this front. In the immediate term, we strongly recommend an increase in the student support budget, and a mechanism to support post-doctoral and faculty-level researchers. Specifically, we recommend an expansion of the Student Observing Support program, for example by allowing support for multiple students or for multiple years for Large and/or Key Projects, and by relaxing the funding limit per student and the prohibition on covering tuition costs. In the absence of such support even the mere reduction of EVLA and ALMA data (let alone analysis and publication) will become a severe bottleneck to the existing community, and will hamper efforts to attract new users.

A common theme that continues to be of concern is the large data volumes that are already being generated by EVLA and GBT, and which will produce even more pressure with ALMA. Even modest projects with EVLA/ALMA will require terabytes of disk space and fast desktop computers that are not generally available to the average user. At the same time, NRAO does not possess the computational resources to support the entire community, particularly if there is a real growth in the non-expert user base. The UC recommends that NRAO invest in computing resources that can support data analysis (both hardware and if possible, personnel). Equally important, NRAO should help users and institutions to set up off-site computing resources, by providing clear advice on specifications and assisting in the installation of CASA. This will reduce user support load on NRAO. The UC would not like to see data analysis as a bottleneck for publication of NRAO data.

Although the CASA software package is emerging as a functional package, the software is cumbersome

and slow, particularly to the non-expert user. CASA also requires large data analysis and storage volumes of many Tb. CASA is also currently missing effective tools for data flagging, and for post-processing data analysis and visualization (e.g., datacube viewers and analyzers). A parallelized version of CASA is also urgently needed for EVLA and ALMA data. The UC recommends open communication between the EVLA and ALMA efforts on CASA development, and a strong push from NRAO to simplify some basic operations of CASA. There is a concern that AIPS will continue to be the *de facto* analysis tool for EVLA users, preventing the broad adoption of CASA.

Beyond the positive developments in hardware and facilities, the UC also applauds NRAO's implementation of a new panel-based time allocation process. Feedback from NRAO, panel and TAC members, and the user community clearly indicate that this is a positive development that will lead to greater transparency. The switch to semester-based calls for proposals will also reduce the pressure on NRAO users and the panel/TAC members. While minor issues still need to be addressed, the UC believes that the process will be optimized within a few semesters. The UC was presented with some preliminary data on over-subscription rates, and statistics on resulting publications and citation rates. However, a more detailed breakdown by facility should be provided in the next meeting. The UC also recommends that NRAO make public the list of accepted proposals (titles, investigators, abstracts), and create a mechanism for tracking the progress of accepted programs that will be visible to the user community.

With these points in mind, the UC would like to hear about progress in the following areas at the next UC meeting:

- A plan for expanding user support (particularly for students) using existing budgetary resources, as well as a discussion of a coordinated plan with AUI and NSF for expanded user support.
- A report on how budget cuts and the re-tasking of personnel have affected NRAO's ability to meet the community's needs.
- A plan for EVLA and ALMA data analysis support within NRAO, as well as plans to assist with community-based computational resources that may alleviate the pressure on NRAO. A similar plan for VLBA data analysis support, potentially using national resources.
- A progress report on the parallelization of CASA in anticipation of full-blown EVLA and ALMA data sets. A report on the continued development of flagging and analysis algorithms in CASA.
- A report on publication statistics for NRAO programs, with a particular focus on programs with and without NRAO funding support.
- A plan for additional CASA analysis tutorials at the EVLA and Charlottesville, as well as for additional ALMA Science Days.
- A plan for expanding the flexibility of the NRAO archives to support a wider user base.
- A progress report on the delayed 3-bit samples for the EVLA.
- A defined process for user community input into the use of ALMA development funds.
- A report on the future of the Jansky Post-Doctoral Fellowship in the ALMA era.

## 2 User and Scientific Support

The Committee continues to be concerned about the lack of direct support for the analysis and publication of NRAO data, particularly with the advent of powerful new facilities (EVLA and ALMA), which will provide large and challenging data volumes. A substantial fraction of NSF's astronomy funds for facility construction have gone to NRAO over the past decade, including on-going construction of EVLA and ALMA. The new instruments are impressive: Early results from EVLA and ALMA verification show amazing promise for superb science, but also highlight the challenges of data analysis. The metric of NRAO-related papers shows a gradual 3% annual rise over the past decade. The UC would be interested in knowing how the

number of accepted proposals relates to to the number of publications to assess the impact of funding on the dissemination of NRAO science.

The UC is deeply worried that the paucity of funding for scientists to analyze and understand EVLA and ALMA findings will be a critical bottleneck to the scientific productivity of NRAO's telescopes. The current system relying on individual NSF grants to radio astronomers creates double jeopardy, and NRAO's partial funding (page charges, a few students, travel and visitors) is useful but inadequate. A new system of user funding that is tied to successful observing proposals, particularly for Key Science Projects of established scientific importance, is needed. This argument was made in detail in several previous UC reports, and appears as well in two NAS Decadal Reports. We applaud the inclusion of a user grants request in the ALMA operations budget over-guide request, but stress the need for extending such a program to all NRAO facilities. This is particularly important for facilities like the VLBA, where more than 50% of the time is now devoted to large projects; the double-jeopardy funding system for data analysis reduces the chances for completion and timely dissemination of research results. The broader topic of funding for ground-based observing at national facilities was also the subject of a white paper (Weinberger 2009) submitted to the most recent Decadal Survey. It is clearly a long-standing structural problem in the funding of radio astronomy in the US. We strongly encourage action on this issue by NRAO, AUI and NSF. At the same time, we ask NRAO to employ the UC and other relevant committees, as well as the broader user community, to create the right atmosphere for change in NSF funding support.

Specific action items:

- Compile and report publication statistics as they relate to the number of allocated programs, and as a function of program size.
- Compare and report publication statistics for programs with and without NRAO user support (travel, student support, etc.)

# 3 CASA

As with the 2010 report, the UC sees considerable progress with CASA and our recommendations here are primarily with regard to ensuring a smooth and rapid transition from AIPS to CASA and to extend the knowledge of radio/mm data reduction to the larger community.

The UC applauds the efforts made by the NRAO staff with regard to ALMA Community Days and hopes that these can be extended to "CASA Community Days" in the spirit of the "One Observatory" concept. Reassurances at the meeting to the contrary, a concern continues to be the possibility of a fragmentation in the radio community if EVLA users fail to adopt CASA. Indeed, anecdotal evidence (both directly from UC members and more indirectly by word of mouth) suggests that AIPS is still being used in places and situations where a transition to CASA should be made.

It would seem that there are a number of issues including speed and interactive data flagging that are driving continued use of AIPS (or a return to AIPS for those attempting to adopt CASA). While the reports regarding data flagging sound positive, the UC feels that it would be useful to have a bulleted list of issues that remain with CASA. If the UC were more cognizant of these issues, the members would be in a better position to help identify resources to speed the transition to CASA. As such, we would like a mid-term report on CASA as indicated by the first action item below.

Related to CASA development is the need for broader adoption of its use outside the realm of current radio experts, which leads us to the last two action items below. IRAF, despite some problems, provides excellent documentation, which serve as a guideline for what is needed to turn novices into NOAO facility users. For example, *The basics of IRAF*: http://iraf.noao.edu/iraf/ftp/pub/beguide.ps.Z.

Similar tutorials for: (i) interferometry in general; and (ii) data reduction for specific types of sources or situations would be extremely valuable. The CASA guides are a step in the right direction, but more is needed at a more basic level. This is extremely important as there is a need/desire for NRAO to significantly increase its user base. The semi-annual summer schools are a fantastic resource, but are insufficient given the recent and coming changes to NRAO facilities. We recommend that NRAO build on the experience of EVLA RSRO users who have developed expertise and pipelines to put together documentation for beginning and expert users.

It is worth noting that other major multi-wavelength observatories have very successfully made this transitions. Complete novices in X-ray and IR astronomy regularly are awarded time on Chandra and Spitzer and are able to become comfortable with reducing data from those facilities. CASA should similarly become a lingua franca.

Specific action items:

- Report back within six months of this report with a detailed CASA to do list.
- Actively work to prevent distinct ALMA/EVLA communities from forming due to continued use of AIPS for EVLA data reduction
- Increase the number of hands-on CASA tutorials (and do not wait for ALMA data to do so).
- Develop online tutorials for beginners that fill the gaps in time between summer schools in order to help attract students to radio astronomy; one particular possibility is the upcoming array transition since it represents the first open use of 2 GHz bandwidth data at the EVLA.

# 4 Archive, Computing, Algorithms

**Data archive.** Strategies appear to be inconsistent from one facility to the next within the observatory: web-based queries are not available for all NRAO facility data, and archives that are based in facility computers require an NRAO account to log in, which is an additional obstacle for archive users to overcome. The UC requests a report next year on the archive status, goals for archiving data from each telescope, and the practicalities/limitations of making archives available to future users. Emphasis should be placed on making archive queries more powerful (for example, batch searches) in order to increase the usefulness of archival NRAO data.

In addition, archive latency issues have been fully overcome at the EVLA, but the UC has voiced some concern about the expected long delay associated with archiving reduced ALMA products (several days). The UC recommends that NRAO establish a path for rapid access to the raw data for relevant projects.

The UC does not recommend the adoption of a distinct data release policy for time-domain projects. Although these projects are carried out on a rapid timescale, the resulting analysis and integration with data from other facilities share the same complexities as other projects.

**Computing and Analysis.** CASA is emerging as a functional package, with a major release expected this fall for ALMA early science reduction, with later releases to be made every 6 months. Necessary parallelization and I/O improvements are underway to improve throughput. In addition to coding, work is progressing on testing, CASA guides, community training, user forums, and help-desk support. We recommend that a documentation level be added for the beginner user without experience in interferometry. The UC applauds the clear improvement of CASA for EVLA and ALMA, but notes that the software can be cumbersome and slow, particularly to the non-expert user. The required large amount of data storage space ($\sim 0.2$ Tb for a single hour of EVLA data processed with CASA) may also hinder casual users.

The coordination of EVLA- and ALMA-oriented software development, and the prioritization of tasks that benefit the largest number of future users, are not clear. A schedule for the devolution of support for AIPS should be established, and NRAO staff scientists should be encouraged to test CASA in the situations where they are still using AIPS. The UC expressed its concern again about the scientific analysis of large data-cubes produced from EVLA and ALMA. This includes cube visualization, faint source (both continuum and line) detection, structure extraction and characterization. Some aspects of this were discussed at the recent "Innovations in Data Intensive Astronomy" workshop at Green Bank, and may again be raised at a planned ALMA science software workshop. At present, the schedule for algorithm development for datacube analysis is still years away, but users will be receiving large data-cubes starting this year. Fortunately, many methods are available from other fields such as medical imaging, computer vision, and video processing; the adoption of existing software systems may allow NRAO to quickly provide the user community with advanced capabilities. Following major observatories at other wavebands, a goal of producing automated source lists from datacube analysis should be a goal of the EVLA and ALMA pipelines. NRAO management should quickly decide where in the organization datacube software development should reside, and should report regularly to the UC on its status.

**Computational hardware.** Efforts are simultaneously oriented towards developing powerful intra-NRAO computational capability and assisting the user community with distributed computing. High-throughput links are planned between NRAO facilities and with ESO. Within NRAO, the UC applauds the planned upgrades to network architecture, archive storage, rapid I/O capabilities, and scalable parallel clusters. However, the UC is concerned about scientific computing for EVLA and ALMA outside of NRAO. The dominant computing facility available to university scientists is a desktop workstation; this is inadequate for analyzing the new large datasets using CASA. Multi-node cluster computing is sometimes available to university researchers, and efforts to parallelize computing-intensive steps in CASA should be coordinated with users' computational resources. For example, parallelization of computationally intensive operations in CASA can be guided by beta-testing relationships with university-based observers with local computer clusters. NRAO might also consider purchasing and operating additional parallel clusters, exploring the potential use of national computing resources, or joining existing "cloud computing" environments, to support intensive computational needs of distant observers. An additional possibility is to help support intensive computing resources at NRAO that are purchased with PI funds.

**Algorithmic improvements on analysis of interferometric visibilities.** The analysis of high dynamic range imaging in wide-field, wide-band data from EVLA and ALMA is very valuable and is progressing well. This includes treatment of primary beam rotation, beam squint, and pixelization errors. The UC looks forward to implementation of these methods during the next two years. These advanced methods may need parallelized computation. The UC also recommends NRAO investigate the potential of "compressive sensing", a remarkable new advance in signal and image analysis, for future speedup of data analysis and compression. The UC requests semi-annual management reports on CASA developments and annual management reports on algorithmic research and development.

Specific recommendations:

- NRAO should quickly plan strategies to avoid a computational bottleneck in EVLA and ALMA data analysis in the distributed user community.
- Software analysis tools for datacube analysis, probably adopted or adapted from existing non-astronomical software systems, should be provided to the user community.
- Regarding management, the UC would like semi-annual progress reports on CASA developments, annual reports from the algorithm development group, and regular reports on datacube analysis development.
- The UC requests a report on practical archive status and strategies for making raw and reduced data from each telescope accessible.

# 5 Time Allocation

The UC congratulates the entire NRAO staff on making the transition to the new semester proposal submission and panel-based review process that was implemented in semester 2011B. This is a major milestone in the continuing unifying process for proposals across NRAO's facilities, and for improved transparency in the time allocation process. From the reports and input from reviewers we understand that the process went quite well and that NRAO is actively soliciting feedback from everyone involved in the process to work to fine tune it. We expect that within another year the new process will be mature and running smoothly. Regarding specific issues and questions raised at the UC meeting, we have the following comments and recommendations.

1. How should NRAO best handle proposals with largely EPO objectives?
These proposals should not be forwarded to the science review panels. We recognize that EPO proposals are important and they should be handled through the Director's Discretionary Time (DDT) process.

2. Should NRAO continue to send the proposal disposition email to all co-investigators?
Yes, most definitely. This allows for broad dissemination of the results and hopefully to long-term improvement in the quality of proposals.

3. Is the current panel make-up optimal?
Eight panels does appear to be about the right number but the UC strongly recommends that instead of having each panel review different science categories that the panels be divided into four broad science categories with two parallel panels covering each topic. The Space Telescope Science Institute looked at statistics for single topic panels versus parallel panels and there was clear bias in favor of reviewers on the panel who submitted proposals. Even though they left the room during discussion of their proposal it is just human nature to be a little more favorable to a proposal for someone serving on the panel with you. This effect disappeared when parallel panels were instituted. Therefore current proposers can still serve on the panels, which is good because they have the expertise, but their proposal goes to the parallel panel.

4. Should NRAO have a high-risk/high-return proposal category?
The UC recommends that NRAO explore adding language to the call for proposals that encourages high-risk/high-return science proposals. Proposal review committees periodically identify one or two proposals that would provide very high impact science but are either technically difficult to implement or just have a low or undefined probability of getting a positive result. These proposals will often be highly ranked but in the final ranking get moved off the selection list in favor of other science that is more likely to provide a guaranteed return. The Spitzer project implemented this type of program during the cryogenic mission. The language used in the Spitzer call for proposals is provided here as an example.

"The Director will make available up to 200 hours of Director's Discretionary Time that the Time Allocation Committee can allocate to high-risk/high-gain GO programs that have a very high science ranking. These 200 hours of DDT time may only be allocated for programs deemed high risk/high gain. The TAC may not allocate it as part of the general pool for Cycle-X. The TAC will identify these programs from the pool of submitted Cycle-X GO proposals."

5. Should technical reports be provided to the individual panels, or just the time allocation committee?
The UC recommends that technical reports, in particular technical problems, be made available to the individual panels. This will help to avoid situations of highly ranked, but unfeasible proposals making it to the time allocation stage.

6. Tracking Proposal Progress.
There appears to be no system for tracking proposal progress and completion that is visible to the community. The UC strongly encourages NRAO to provide such a system, both for active users and for potential proposers of Director's Discretionary / Exploratory time.

7. Large/Legacy programs
The UC continues to support NRAO's desire to combine a diverse set of small projects with a several large/legacy projects. The current minimum time request is 200 hours, and the UC sees no clear reason to modify this cut-off. The UC feels that ideas for large/legacy programs should come from within the community, rather than top-level implementation by NRAO.

# 6 Community Support Programs

NRAO has an active program supporting summer students, graduate students, science visitors and the Jansky post-doctoral fellows.

With respect to the program providing observing support for students the UC feels that the exclusion of proposals led by NRAO scientists from this pool is too extreme. The travel funding goes to the university where the graduate student works, not to NRAO, and therefore NRAO should be able to come up with a process that supports this and does not give the appearance of providing more funding to NRAO scientists. We suggest decoupling the science proposal and the student support process.

The UC applauds the graduate student fellowship support but suggests that NRAO provide support for one-year (with some cap), instead of just a fixed amount, since graduate students cost different amounts at different institutions. The UC also recommends that NRAO push for removal of the prohibition on graduate student tuition support. Finally, the UC strongly recommends that the Student Observing Support program be expanded, for example by allowing support for multiple students or for multiple years for Large and/or Key Projects.

The UC was not provided with any information about the Jansky Fellowship program nor is there anything on the NRAO website about the latest class of fellows that have been selected. We recommend that this be prominently displayed as the Jansky Fellowship program is excellent. We also suggest that NRAO webcast the Jansky Fellowship symposium talks to increase the visibility of the program and of NRAO. The Jansky Fellowship program should continue to be strongly supported by NRAO.

# 7 NRAO Visibility/EPO

Education and Public Outreach (EPO) activities at the NRAO continue to reach a broad audience. Particularly noteworthy items reported this year include some aerial photography at the ALMA site, attention to diversity and accessibility, both in the presentation of NRAO to the public as well as to populations served, and the judicious use of the existing artistic and visualization skills of any NRAO staff in ongoing EPO efforts. The UC were very impressed with the self-concept improvements of the under-represented students participating in the pulsar collaboratory, and encourages any expansion of this result possible, such as the inclusion of urban/minority schools elsewhere in the region. The UC applauds the observatory EPO office in its efforts to reach out within the scientific communities, and encourages seeking even more publicity for the astronomy-loving public through magazines such as Sky & Telescope or National Geographic. It would be terrific to see an NRAO-related cover story on such a magazine, either on a scientific discovery or on a new facility such as ALMA or EVLA.

The UC suggests that NRAO consider the mission model used by NASA and others in presenting scientific work to the public: feature several willing people, both internal staff and external users, with action photos if possible, and a short plain-language description of what they do at the observatory. This is particularly helpful if it spans disciplines outside astronomy, such as engineering, computer sciences, and other technical roles. Staff volunteers who like to take pictures could take some of the pictures over the course of each year. An additional effective tool for outreach is short videos using science images with a voice-over describing the science.

In a limited budgetary environment, it is laudable that the observatory provides as much as possible to the visiting public for free. The need to institute a fee for the Green Bank bus tours is understandable for the general public, and we recommend that the use of this service be monitored to see if the fees present any hardships for public school groups or others with limited resources.

The UC was compelled by the notion of getting users to contribute summaries for "what is the telescope observing now?" The user community should certainly be called upon to contribute to public outreach efforts in this way. We recommend that users who are granted time be asked to supply a brief public summary of who they are (including students involved), what they are observing, and why. If possible, NRAO should offer staff support for editing these short statements for public consumption. Statements could be submitted as the observe files are prepared, via the web, and/or within the observation preparation tools within my.nrao.edu.

# 8 Facilities

## 8.1 ALMA and NAASC

Progress on ALMA construction and commissioning over the past year continues to be impressive, from the deployment of a growing number of antennas at the high site to the production of spectacular test images that demonstrate end-to-end performance. We congratulate everyone involved for these achievements.

A major milestone for the user community has been the release of the Cycle 0 Call for Proposals, designed to take advantage of the early but powerful capabilities of the partly complete ALMA. The UC is tremendously excited about the potential of early observations with ALMA, as evidenced by the response to the solicitation for science verification targets and the submission of notices of intent to propose. At the same time, we note that the very limited public release of science verification data to date is a reminder of the difficulty of realizing reliable and efficient operations during ongoing construction, with attendant hardware and software problems. As much as we are looking forward to Cycle 0 science, this activity should not interfere with the completion of the full ALMA.

We commend the NAASC for their extensive and proactive efforts to inform and prepare prospective users, in particular through presentations and tutorials at AAS meetings and at ALMA Community Day events organized with institutions across North America. These local and regional events have done well to balance the ALMA hype with the realities of Cycle 0, and especially to reach beyond traditional users of millimeter-wave facilities. We are pleased to see the help-desk in place and the increasing amount of information available to prospective users on the web portals. There is a general impression that software like the CASA simdata task and the Observing Tool are capable but not complete, perhaps to be expected at this early and rapidly evolving stage. We would like to stress the importance of continued development of basic functionality in simdata, such as the incorporation of calibration sequences and the development of recommended continuum frequencies and noise parameters, which will lead to proposals with realistic and homogeneous assumptions. Given the success and popularity of the ALMA Community Day events, we recommend that the NAASC continue to offer such events as the instrumental capabilities continue to change over the next few years.

The processing of ALMA data is expected to be challenging, especially as the data volume grows larger and local desktop computers become inadequate. The resulting paradigm shift for many users should not be underestimated. It is reassuring that plans are in place for sufficient high performance computing capacity at the NAASC for processing and eventual pipeline "reprocessing" of ALMA data. However, the path through the quality assurance process has yet to be made clear, including the insertion of break points to assess data sets within projects as they are obtained. The data processing situation must be monitored closely and must not become a bottleneck to producing the best science from ALMA. We also urge the NAASC to provide support to astronomers who aim to establish high performance processing capabilities at their home institutions. We are very interested in the long term plan for building up expertise in ALMA data analysis and reduction in the wider community, and we would welcome an update on this topic at the next meeting.

We are encouraged that ALMA has an ongoing plan for significant development funds that will enable hardware and software upgrades and prevent stagnation. It is imperative that these funds are not raided for operations support. We would like to see a transparent process in North America for the selection of specific development programs. A first workshop held in Charlottesville was attended by representatives from many of the relevant groups. We recommend that NRAO work to facilitate cooperation and coordination toward ALMA developments, in particular among the millimeter-wave community, such as CARMA and SMA, which offer both expertise and potential testbeds.

Finally, we remain very enthusiastic about the exciting series of NAASC topical science workshops. The latest, on astronomical spectroscopy, held in Victoria, Canada, was again filled to capacity and highly successful in raising awareness of the potential of ALMA. The next ones will provide terrific venues to present some of the first new science from ALMA.

## 8.2 EVLA

Our report on the EVLA largely parallels last year's report as the UC continues to be impressed with the progress on EVLA construction and commissioning. We look forward to the official WIDAR acceptance, the installation of the last receivers next year, the upcoming special issue of ApJL and are encouraged that there appears to be sufficient contingency funds. As discussed at the meeting, we encourage NRAO to hold a workshop during the array re-configuration this Fall in anticipation of 2 GHz OSRO as a way to push CASA and make users more aware of the extent of changes that the EVLA has undergone. We believe that such a concerted effort will reduce the load on NRAO staff for community assistance in the long term

As positive as things are, the UC has a number of concerns. Obviously the first is the delay in 8 GHz bandwidth capability; we look forward to hearing about the installation of the redesigned 3-bit samplers later this Fall. Another area of concern is that of data transfer for large EVLA data sets. It is possible that disk shipment may be the best option in many cases. If so, it would be wise to bulk-order disks to keep user's costs down, but please consult with the user community first. The community will similarly be interested in knowing what capabilities will exist for remote processing. Whatever the solutions, the user community should be informed and consulted.

We reiterate our recommendation for closer interaction between the UC and the PASEO committee to provide wider feedback and avoid conflicting advice. Ideally the chair of the UC should attend the PASEO committee meetings as an observer. This is less of an issue since Ue-Li Pen is currently on both committees,

but the UC chairs should be made aware of the meeting details.

Finally, the UC was asked to comment on a number of items. Our thoughts on those questions are itemized below.

- We encourage keeping the RSRO going past 2012 into the operations phase and expanding it to include new observing modes. We further reiterate last year's recommendation to NRAO to implement the RSRO concept in other areas of the observatory where user contributions are appropriate.
- We also endorse the availability of RSRO capabilities to non-RSRO projects in unique situations that can highlight the capabilities of the EVLA. These specific cases should be evaluated through the Director's Discretionary time process.
- We reiterate our endorsement of renaming the array once construction and commissioning are finished.
- The UC was also asked to comment on the notion of an E configuration. Obviously that should be driven by science and it is not clear that we have sufficient information to weigh in on this decision. However, we understand the desire to increase low surface brightness sensitivity by taking advantage of the new ELVA capabilities and that the E array would bridge the factor of 10 gap between the resolution of the GBT and the EVLA D-array. However, the added length of time between D and A configurations and/or the reduced time in other configurations is a source of concern. Another question is how the amount of time for such a reconfiguration compares to the amount of time that other moves take (as going into/out of E involves some complicated gymnastics). In short, our main recommendation is that, if these plans go forward, the UC should be made aware of the trade-offs.
- Finally, if specific UC commentary on the PST and OST are required before the next meeting, we will solicit feedback from the community.

Specific action items:

- Hold a workshop on CASA usage for 2 GHz bandwidth data analysis this fall during array reconfiguration (this item is in progress).
- Keep users informed with regard to data transfer/processing plans.

## 8.3 GBT

This year's UC meeting was held at the Green Bank facility, so the committee members were able to see first-hand all of the progress that has been made.

Several advances have been made that will increase the utility of the GBT.

- The turret rotation system was fixed and upgraded. The new system allows for instrument changes at any elevation which will significantly decrease the time between observations and therefore increase telescope efficiency.
- The dynamic scheduling has been fully implemented to make the best use of optimal weather conditions. This is especially important for the high frequency instruments.
- The PTCS team has made fantastic progress on tuning the surface and have achieved 250 micron RMS surface (35% efficiency even at 90 GHz) under optimal conditions. The GBT now exceeds the design specification in this area. This single effort has essentially enabled high frequency operations and opened up a new area for users. The UC applauds their efforts.
- Despite the obvious budget pressures, there has been significant headway to produce new capabilities for the GBT. The new FPGA-based spectrometer is a very good example of how NRAO can work with university teams to develop state of the art systems.

Members of the UC were concerned about the exact implementation of dynamic scheduling, as well as the ability to run the telescope in queue mode. While there is no desire to return to the "bad old days" of scheduling almost a week in advance, many users, especially at the lower frequencies, find that 24 hours of notice for observing can become a big burden. It becomes even more so with larger projects. It was suggested that part of this problem could be alleviated if the telescope could run in queue mode. In particular, if longer advance times are not practically possible due to intrinsic limitations of weather prediction, a queue like in use at the EVLA would alleviate the problem. The EVLA example suggests that this might be possible without increasing the burden to the observatory staff.

Specifically, the UC recommends that NRAO explore a hybrid Dynamic Schedule where low frequency projects are provided with a larger advance window and allow them to submit queues for all of the possible times. This will obviously take some experimentation. The UC recognizes that this process should be designed such that the burden on the observatory staff does not increase substantially.

From the outside, the Green Bank staffing seems to have taken a disproportionate hit during recent staff reductions and projected into this year. While the presentation from site director Karen O'Neil indicated that the reductions would not adversely affect operations, the UC remains concerned that there will be future problems. The UC would like to retain the "history" of the reductions and how the Green Bank staff has been re-tasked to compensate or what operations have changed or been eliminated.

## 8.4 VLBA

The UC applauds the efforts by NRAO management to secure continued funding for the VLBA. The MOA with USNO and the verbal commitments by several international partners for up to an additional $1M per year appear sufficient to maintain full VLBA operation at least for the coming 5 years, albeit with a lower level of user support. We strongly support the effort led by the NIO to renew discussions with NASA and explore the possibility of additional external funds. We particularly encourage NRAO to seek further partnerships with other VLBI facilities worldwide, with which synergistic projects might be identified.

The UC strongly supports the policy of joint Fermi/VLBA proposals, for which 10% of the VLBA observational time is reserved through the Fermi AO cycles. The successful coordination between the VLBA and Fermi facilitates VLBA visibility in the astronomical community. The UC encourages NRAO to continue joint observations between radio and current and planned space missions (at high-energy or other frequencies). This would increase the interest of space agencies such as NASA, ESA, and JAXA in sharing financial cost of the VLBA improvement and operation.

The UC also congratulates the NRAO staff on its progress toward operating the VLBA and the HSA at 2 Gbps by the end of 2011, and expanding the C-band receivers frequency coverage to enable observations of the methanol maser line at 6.7 GHz. We note the synergy between the VLBA and EVLA receiver developments whereby improved performance of the VLBA C-band receivers will positively impact the future performance of the EVLA receivers in the same frequency range. The expanded capabilities of the DiFX correlator, particularly for spectroscopy and wide-field imaging will also help stir interests for the VLBA in the astronomical community at large by enabling new applications. We are also impressed by the progress made in the phase-up mode of the EVLA, which will soon strongly contribute to increasing the sensitivity of the HSA.

The UC appreciates that as a consequence of the reduced operations cost required to cope with its limited overall budget, the VLBA will remain an expert facility. We also understand that as a result of the new funding model, the VLBA may transition away from the open skies policy, and toward a large/key science projects model. We feel strongly, however, that it is important to maintain as broad a user base as possible for the VLBA, and encourage NRAO to undertake actions (like student training) geared toward that goal. We also encourage NRAO to promote novel uses of the VLBA through RSRO-type calls for proposals and modifications to the PST to accommodate non-standard observing modes.

## 8.5 CDL

The committee was briefed about the reorganization of CDL, which is now the *Coordinated* Development Laboratory. The reorganization merges the activities of the former CDL with with those of the research

engineering staff in Green Bank and Socorro and the committee recognized that this will improve communication between different sites and efforts. It was clear from the presentations that cutting-edge technology developments at CDL, NTC and NIO are continuing. These efforts will benefit not only NRAO facilities but also external projects in which NRAO will play a role, e.g. SOFIA instrumentation, PAPER and DARE. The committee urges NRAO to play close attention to the evolution of the Astro2010 priorities in order to maximize the effectiveness of these efforts.

The committee applauded the ODP Development Proposal Program, which resulted in a large and diverse set of proposals. It is recognized that this important mechanism that will seed the new ideas that can lead to new programs and external funding. The committee was concerned, however, about the lack of user community involvement in the proposal process and *de facto* in the priority setting for new CDL efforts. The following recommendations were made:

- It is recommended that some external reviewers be added as part of the proposal selection process.
- NRAO should consider how this program could be used to increase the involvement of the community, for example through external collaborations and coordination with user-generated proposals to NSF and other agencies. Ideally the inclusion of external proposals to the program could be considered as a means of strengthening NRAO-community partnerships but the committee recognized that this would be hard without the availability of extra funding.

This led to a broader discussion of the role of NRAO-university partnerships in the development of new instrumentation. There have been a number of successful examples such as MUSTANG, and partnerships with universities should be encouraged in order to take advantage of externally available resources and expertise. A more streamlined process to generate new partnerships is likely to generate increased proposal pressure from the radio astronomy community on agencies such as the NSF, highlighting the importance of the field in the next decade. The committee had the following recommendations:

- NRAO should develop a process that encourages university-proposed instruments that fulfill key needs for the user community, without creating barriers that would discourage new ideas. Through programs such as the ODP Development Program, NRAO can approach university partners, while universities can solicit NRAO partnership on NSF-funded efforts.
- There should be a well-identified process that allows the PI to benefit from their instrument-development efforts. At present a PI builds the instrument, integrates it on an NRAO telescope, and then applies for time on his/her own instrument. It may be appropriate to consider a guaranteed time program for externally-led instruments.

# 9 Future of NRAO

The UC continues to support the policy of joint NRAO proposals with Fermi/Chandra.

The UC supports NRAO's continued involvement and sharing of expertise with a wide range of on-going and future development projects. NRAO is currently involved with FASR, NANOGrav, and PAPER as mid-scale on-going projects. Additional projects that draw on NRAO's facilities, technical and scientific skills, and management structure include DVA-I )prototype SKA antenna), LWA, and MeerKAT expansion. The UC stresses that such activities should not hinder user support for existing NRAO facilities.

The UC was concerned about the reasoning behind NRAO's desire for involvement with the LSST project. NRAO should sign up as a partner institution only if the research activities of NRAO personnel will benefit from this added expense. NRAO's involvement as a partner institution will not open the door to NRAO user involvement in LSST since the partnership is institutional. NRAO should also continue to adhere to the notion of competitive community-based proposals, and should ensure that if it joins the LSST project it does not sign away observing time to the "project" in a non-competitive fashion. The UC appreciates that LSST will be a key project later in this decade, and that NRAO facilities can be used effectively for follow-up work, but would like NRAO to maintain its independent allocation of follow-up observing time. Overall, the UC strongly discourages expending vital resources in this direction.

# 10 2011 Green Bank Meeting Participants

The 2011 meeting of the NRAO User Committee was held at the Green Bank Observatory on May 11–12.

The UC selected Gordon Richards and David Wilner as co-chairs for 2012.

The following members of the committee were in attendance for the meeting:

Edo Berger (Chair)
Sarah Church
Helene Courtois
Mark Devlin
Eric Feigelson
Hiroshi Imai
Svetlana Jorstad (telecon)
Matthias Kadler (telecon)
Laurent Loinard
Amy Lovell
Ue-Li Pen
Gordon Richards
Eva Schinnerer
Aneta Siemiginowksa (telecon)
Michael Skrutskie
Lisa Storrie-Lombardi
David Wilner