

NRAO Users Committee Report 2010

1 Executive Summary

The 2010 meeting of the NRAO User Committee occurred on May 20 and 21 in Charlottesville, VA.

NRAO enables forefront science at radio wavelengths by operating and building the world's largest and most productive radio telescopes, and is poised to continue this trend well beyond the post-ALMA and -EVLA construction periods. We are grateful to have the opportunity to provide feedback on NRAO's successes and challenges so that further scientific insights can be made. We appreciate the consideration which NRAO has shown to our requests and suggestions in the past and would like to maintain the same level of communication, as it benefits both sides.

This year is marked by some uncertainty, as the results of the Decadal Survey of the National Academy of Sciences will not be released until later this summer. This report will have major implications for the future direction NRAO takes after the EVLA and ALMA construction periods. At the same time, lean federal budgets may temper or restrict the availability of funds for new initiatives. NRAO has been remarkably successful in maximizing the efficiency of its resources for the purpose of providing scientific facilities which can do ground-breaking research, and we expect this trend to continue. We would like to call out specific items for particular praise:

- We endorse the idea of soliciting input from the community to help guide decisions regarding directions for future instrumentation. NRAO's technical engineering expertise is world-class, and this effort will ensure that NRAO continues to play a major role in the international radio astronomical community, by maximizing the science that can be done with NRAO's facilities.
- We applaud NRAO on its restructuring activities. The Observatory Science Operations represents a tremendous effort on the part of the observatory, but will have a major impact on users, particularly encouraging new users. We encourage NRAO to look beyond its employees in this effort and seek participation by observers through an expanded RSRO-type program. Experienced users of NRAO's facilities are a fantastic resource which should be mined.
- The progress being made on projects at Green Bank was impressive, particularly the increase in aperture efficiency at 90 GHz, but also the new projects which will extend the scientific capability of the GBT while making technological contributions to the next generation of instruments and telescopes. The UC applauds the effort to obtain a broadband internet connection, noting that this is crucial in keeping up with the increasing data rates which pulsar and multi-pixel focal plane array instruments accrue. The success of the dynamic scheduling system is evident in the further reduction of observing backlogs, and seems to work well with both low- and high-frequency observers.
- In a similar vein, we are pleased with the progress on EVLA construction, commissioning and observing. There has been an astounding response to the RSRO concept, and we reiterate last year's recommendation to NRAO to implement this idea in other areas of the observatory where user contributions are appropriate. The UC also endorses the suggestion to rename the array once the construction and commissioning phases are over.
- The VLBA has experienced challenges and successes. While the UC was disappointed to learn of the fall-through of several funding efforts, the sensitivity upgrades being done are positive steps which will increase the capability of the array and widen the science and hopefully, user base. We support the key project policy to enable the best science return, as well as the joint observing partnerships like Fermi and VSOP-2. We wholeheartedly endorse the MOU with JAXA for commitments to the VSOP-2 mission. While recognizing that an increase of outside partners will necessitate a decrease in the amount of open time, we find this preferable to the closing of the telescope. We urge NRAO to continue its efforts in obtaining outside funding for operations of the VLBA.
- The UC was impressed with the progress being made on ALMA construction, and the state and functioning of the NAASC. The inclusion of a user grants request to the ALMA operations budget

deserves special commendation. With the build-up of community expectations about ALMA it is important to manage those expectations with the reality of early ALMA science so as not to dampen enthusiasm for the full-up ALMA. The UC would like to receive an update on the call for ALMA early science after the decision point in November.

- NRAO's outreach programs deserve commendation for the breadth and depth of those programs in reaching not just the scientific community, but the public at large. Splitting the EPO effort into a two-pronged approach enables high visibility within the astronomical community but also ensures that resources are available to develop outward-facing activities. The UC applauds the effort which resulted in the 20-m telescope at Green Bank becoming part of Radio Sky Net.

NRAO is continuing to provide users with world-class radio astronomical observational facilities. The UC feels that in general, NRAO does a great job of operating these facilities and responding to the increasing demands of users while at the same time operating under constrained resources. However, we identified some areas of concern which we see as potential roadblocks to fulfilling NRAO's mission of enabling transformative science in the present and future. Here we summarize the most pressing user issues.

- We continue to be disappointed about the lack of progress on the issue of user grants. 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 the user community, to make a push for more action on this front.
- One concern about the EVLA project from the point of view of the UC is that CASA is not being used extensively for EVLA data analysis even within NRAO (with AIPS being used instead). The UC stresses that further development of tools such as CASA and the OPT are necessary to widen the user base.
- A common theme which emerged from presentations on NRAO's facilities is the large data volumes which are currently being generated by EVLA and GBT, and which will become a reality with ALMA as well. While we were encouraged that CASA seems capable of keeping up with the data rates and timescales, it is not clear to us that NRAO has considered the full import of these large data volumes from the perspective of users. In particular, what we found lacking was an observatory-wide plan for supporting multiple users of TB-level datasets, in terms of on-site storage and processing, and supporting off-site data distribution and processing. We would not like to see data analysis as a bottleneck.
- NRAO's archive is an important tool for astronomers, both to assess the feasibility of future observing proposals, as well as to conduct research projects on existing data. As such, it is critical that interactions with the archive be made as flexible and as user friendly as possible, particularly in light of the VAO. We heard about the archive in terms of its size, its strategy, and the new architecture, but any discussion of user interface and improvements was missing. This was and remains an item of great concern to the UC, particularly in light of the specific suggestions made in last year's report. In addition, the UC does not endorse a shorter (6 months) archive data release policy for time-domain projects, and instead recommends keeping a uniform release date of 1 year for all projects.
- The UC applauds the restructuring of the Time Allocation Committee deadlines and proposal review, but finds considerable problems with the proposed three-tiered structure of the refereeing and science review panel. In brief, we feel that this raises more issues than it potentially solves, by increasing the timescale involved in the entire cycle from proposal submission to notification, by potentially decreasing the level of feedback, and by removing an interactive discussion of a proposal's merits and deficiencies by the experts who are best situated to make that evaluation. We instead encourage NRAO to adopt a two-tiered system with panels composed of the proposal referees followed by a merging TAC composed of the panel chairs. This is identical to the time allocation process at other national and NASA facilities.

2 User and Scientific Support

2.1 User Grants

The Committee is disappointed that no progress, even a formal report of investigation, was made concerning the need to increase funding for extra-mural science analysis of data from NRAO telescopes. A large fraction of NSF's astronomy funds for facility construction have gone to NRAO over the past decade, and continues today. The new instruments are very impressive: GBT is emerging as a unique spectroscopic instrument, the early results reported here on the EVLA show amazing promise for superb science, and an enormous community is awaiting the early science of ALMA. The metric of NRAO-related papers shows a gradual 3% annual rise over the past decade, roughly half of which is attributable to the GBT. A much faster rise can be expected during the next decade as EVLA and ALMA emerge into science production.

The Committee 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 has completely failed, and NRAO's current 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 our 2009 Users Committee report, and appears in some form in most Committee reports of the past decade as well as two NAS Decadal Reports. We applaud the inclusion of a user grants request in the ALMA operations budget over-allocate 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, and it is possible that the forthcoming Decadal Report will provide some momentum to this issue. 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.

2.2 Observatory Structuring

We strongly commend the observatory's attempts at restructuring as implemented in the One Observatory framework. It makes sense to leverage as much knowledge and work effort as possible across telescopes where such commonalities exist. It serves the purpose of both being an efficient use of resources and ensuring that wheels are not reinvented. It is important that lessons learned in one area of the observatory are likewise not compartmentalized. It seems that this transition will likely be transparent for the users. We understand that the transition in October should be largely transparent to users; we would like to receive an update on this at next year's meeting.

We particularly commend the implementation of metrics to track progress in this initiative and to prioritize future efforts. It was instructive to see a comparison of NRAO with Spitzer, Chandra, and HST in terms of the number of papers being published. Another important metric is to track the number of users, both in terms of each telescope and also the total number using NRAO facilities. We encourage the NRAO to update the UC at next year's meeting with preliminary findings of the metrics being gathered.

A list of user-facing science operations which form part of the Observatory Science Operations' scope of work was presented, and updates on some aspects of these were given. We particularly encourage work on observation preparation support, data processing, pipelines, archives, and user training; these activities will make the most difference in terms of encouraging new users of NRAO's facilities, as well as in helping existing users to migrate to CASA, EVLA, and ALMA. We also applaud efforts to make it easier to submit joint proposals. The UC encourages NRAO to continue to leverage the RSRO concept in a wider framework than EVLA commissioning, particularly the data processing and pipelines work, where experienced users can provide critical contributions.

2.3 CASA

The UC is impressed with the amount of work that has been done on CASA. It clearly is in a position to succeed where AIPS++ fizzled. Most of our recommendations center on ensuring a smooth and rapid transition from AIPS to CASA and for widespread adoption of CASA by those currently unfamiliar with AIPS (and radio/mm data reduction in general).

We re-emphasize the need for a significant number of CASA workshops in the coming year. The number of tutorials outside the US in the past year has been exemplary. However, there is a clear need for some geographically targeted tutorial sessions (~ 1 day) to be held in the US (e.g., Boston, Tucson, Pasadena, Baltimore/Philadelphia, and Chicago). Such sessions are crucial to the adoption of CASA by the community. NRAO should actively seek to arrange these directly and/or seek help from UC members in those regions to do so.

It is particularly important that early adopters have a conduit to the code developers — it is only through the reduction of real data that many bugs will be found. Thus strong feedback mechanisms between users and developers are needed during the transition period. RSRO contributions are clearly important and necessary, but insufficient.

NRAO must also actively advertise CASA and push it on the community. While the on-line documentation is impressive (e.g. CASAguides), it is too well hidden. CASA needs a more obvious link from the main pages (big red flashing signs even) that emphasize that *now* is the time for users to adopt CASA. (“If you build it, they will come” only works in the movies). In this vein, the UC is concerned that both EVLA/RSRO participants and NRAO staff are still using and developing AIPS procedures for EVLA data reduction. A common complaint appears to be that CASA does not allow interactive data flagging.

At the meeting it was asked if the online documentation would allow self-learning by new users (particularly those who have never used AIPS). One member and his student put this to the test. While there are indeed good tutorials online, they fall short of meeting this criterion. Much more hands-on information is needed. One suggestion is for more video tutorials like the one available for the CASA Viewer. Another is to add some video content to the tutorials that explain what is happening at each step (possibly taken from actual in-person tutorial sessions). The tutorials should also have the user type the commands instead of simply hitting enter. Obviously, new users will be unable to learn the intricacies simply by following these tutorials, but they must be detailed enough to avoid turning off potential new members of the NRAO community.

We were encouraged to hear that the pipeline clusters should be able to support data processing on timescales less than the observation duration, but the size and management of CASA-based datasets remains a concern. Clear data distribution and/or on-site processing plans are needed. Here, broader user feedback is also important. We encourage NRAO to consider creating a user forum where CASA users can share expertise and experience, and share user-contributed software. The UC would like an update on the status of tutorials and efforts to increase the number of CASA users at next year’s meeting.

The previous year’s UC report stressed the importance of continuing algorithm development within CASA as a means to facilitate not only data reduction, but scientific analysis of the datasets. The advent of routine collection of three-dimensional data “cubes” with EVLA and ALMA means that a far larger number of NRAO users than at present will have concerns with data analysis and visualization. This is one area where NRAO’s efforts on developing capable tools will have large payoffs. We would like to hear about NRAO’s progress in this direction at next year’s meeting.

2.4 Computing and Data Distribution

More than once during the meeting the committee heard of the voluminous datasets being generated or soon to be generated by EVLA, GBT, and ALMA. Data volume could be as large as a terabyte in a few hour observation, giving new meaning and import to the term “data reduction”. It is clear that the on-site data acquisition and storage systems are being designed to handle this load, but with no margin for error. Similarly, examples of CASA data processing presented to the committee suggest that a high-end modern desktop can process a terabyte raw data-set in of order a day. That being said, what is not so clear to the committee is the NRAO observatory-wide plan for supporting dozens of users generating terabyte-class datasets on a few-per-day basis addressing on-site storage, on-site processing, distribution to users outside the observatory and off-site processing. The last item, off-site processing, naturally takes

advantage of the distributed nature of user's computers, but is only effective if datasets can be transmitted efficiently to remote sites. Current users complain about the impracticality of collecting datasets of tens of gigabytes in size. Network transport of terabyte datasets seems daunting, even with improvements in current network infrastructure, particularly when dozens of users attempt to transfer data simultaneously (and internationally). The UC can speculate that a strategy in which the vast volume of data never leaves the site and users conduct most of their analysis remotely with access to on-site super/parallel-computing provides a workable solution. However, the important issue is that NRAO make clear both to the committee and the user community how they plan to manage the coming deluge of data volume so that users have timely and ready access to immense datasets or to the on-site processing necessary to reduce these datasets to manageable size.

We strongly encourage NRAO staff involved with the development of in-house computing to provide a list of specifications for external institutions which are interested in implementing their own cluster-scale data analysis centers. This may help to relieve some of the pressure on the internal computing resources.

Older members of the UC recall the 1980s when Charlottesville and the Maddelena site were the only places where large VLA projects could be reduced. Even these in-house resources were barely adequate with long processing times.

The UC finally notes that the ability to obtain and reduce EVLA data in real-time is of the utmost importance for time-domain projects which currently account for about 12% of all EVLA time (and which may be expected to increase with time). These projects require access and analysis generally within a day and the UC is worried that the current system will not be able to accommodate such constant pressure. Open discussion with the time-domain community are encouraged to determine what capabilities are required.

2.5 Archive

NRAO's archive is a key component of maintaining and expanding its scientific community and scientific productivity. A potentially new user of NRAO's facilities may well have her first interaction with NRAO at the archive. Thus, the UC was particularly discouraged that there was no apparent progress on any of the numerous specific issues highlighted in the 2009 report with regard to functionality of the NRAO archive. While we were encouraged to hear about the growth of the size of NRAO's archive, this underscores the urgency of developing user interfaces which allow for scientifically productive interrogation of the archives. A better effort should be made to connect the archive with the Proposal Submission Tool (what were the objectives of the proposal which obtained the data-set?), the Observation Preparation Tool (how was the observation set up?) and other metrics being collected (were the data published in a journal?). Purchasing disk space is an important component of growing the archive, but the user interface is just as critical. We did appreciate hearing that data quality issues have been improved and pipeline imaging of continuum VLA observations in the archive is also finished. We again encourage NRAO to make significant progress on updating the archive's capabilities.

An additional concern was that Access to proprietary data requires a project access key or the use of the "my NRAO" login. This last consolidation feature is terrific, but in practice does not currently provide access to data for projects which are proposed outside the PST (e.g., joint proposals with NASA satellites) and on which the astronomer is only a co-Investigator. This access needs to be broadened.

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.

2.6 Suggestions from Community

The technical infrastructure and engineering personnel of NRAO are valuable resources that can be used to expand the capabilities of its telescope systems. These are guided, in part, by the scientific needs of the NRAO user community. Yet, to date, there is no formal mechanism to convey the community's technical "wish list" to NRAO nor a procedure that would ultimately select a program for development and implementation.

The UC recommends that NRAO solicit input from the community to guide future instrument developments for the NRAO telescopes. There should be an announcement published in the NRAO and AAS

newsletters requesting white papers that would describe the science enabled by a new instrument or a sub-system enhancement. The cadence of such a solicitation should be set according to the ability of NRAO to realize one or more of these technical programs. An advisory panel comprised of NRAO technical and scientific staff members and scientists from the user community should review the white papers and make a recommendation to the NRAO Director for consideration as a future technical program. Following this recommendation and the NRAO Director’s decision, NRAO would need to carry out a more detailed study and budget analysis to gauge the feasibility of the selected program(s). This ensures that NRAO facilities retain their capabilities to do cutting edge science.

2.7 Time Allocation Committee

The UC encourages NRAO to finalize its re-ordering of the proposal submission time-lines and to decouple the proposal cycle from operational considerations such as configuration cycles. We recognize that this is an evolving process and we welcome the opportunity to provide our input on the matter.

The Users Committee unanimously felt that the structure of the new time allocation process proposed by NRAO (with three tiers: referees, panels, and TAC) was unnecessarily cumbersome. Such an approach would increase the timescale from proposal submission to learning the outcome, and would be difficult to implement — it will be impossible to stop reviewers from doing their own refereeing. We welcome the idea of specialized panels plus a TAC formed by the chair of each panel. However, we feel that the panels should be composed by the referees in each sub-discipline (with the number of panels based on the proposal pressure). This system will eliminate the problem of the panelists trying to divine the intent of the referees when evaluating their reports. The referees would cease to be anonymous, but we do not think that this will be particularly harmful. Indeed, this is in essence the scheme that we had proposed in the 2009 UC report (Section 2.8, particularly point 3) and is a similar system to that used by several observatories (e.g. HST, Chandra, Spitzer, Gemini). Within this new time allocation framework, the referee independence can be preserved with the following scheme. The referees/panelists will be requested to send in an initial report and a grade on each proposal before the panel meeting, and these reports/grades will be distributed to the rest of the panelists. Following a discussion at the panel meeting (in person or by telecon) a final grade and joint report will be issued by the panel. These will be reviewed by the TAC, which will merge the results of the various panels. There was some additional concern that the information sent back to the proposer would be decreased in such a three-tiered system: several UC members commented that they appreciated getting the different opinions of referees, even if contradictory. NRAO may choose to distribute the individual reports in addition to the final panel consensus report.

The UC had discussion on the demarcation between regular and large proposals. We recognize that for ALMA, the line is drawn at 100 hours, compared to 200 for the other NRAO facilities. At the moment the use of 200 hours as a dividing line seems as reasonable as any other number, especially given the bias of the approved large projects to be in excess of several hundred hours. We encourage NRAO to consider adding a third, “middle” category, if necessary, but stress that NRAO must clarify to the community what proposal categories other than regular mean.

The UC also had several discussions on the issue of key science projects. We understand that key science projects are identified and selected post-proposal submission, but further clarification of this process is needed. What are the practical implications of being selected as a key science project? If the intent is to provide an additional level of support to ensure that the science goals are met, then it seems like this would be a good avenue to pursue if NSF funding for data analysis could be attached. We were not clear on how the concept of legacy proposals would be implemented at NRAO, and we would appreciate the opportunity for more discussion of this concept at next year’s meeting, along with a more concrete development if that is NRAO’s goal.

Finally, we recommend that NRAO adopt a uniform policy and structure for “Director’s Discretionary Time”. The UC suggests that such requests will be evaluated by the NRAO Director in consultation with the chair of the TAC and the panel chair(s) of the appropriate science program. This will prevent conflicts with existing TAC-approved programs.

2.8 NRAO Visibility/Communication

The committee was pleased to see that NRAO places outreach in high regard, particularly in the new approach which separates visibility and communication within the astronomical community from education and public outreach. We feel that this separation allows for a better focus on the different demands which these two areas require.

NRAO's outreach to journalists and scientific specialists has been thorough; the UC was impressed with Mark Adams' energy in organizing NRAO's presence at multiple large conferences. The push to increase NRAO's presence at major science community meetings (not just astronomy-centered AAS and IAU meetings) can only benefit the radio astronomical community, as a wider audience (importantly, with a large composition of science journalists) learns of the exciting results coming out of NRAO's facilities. The redevelopment of NRAO's web pages should enable a wider audience, from the casual public to expert radio astronomers, to gain the information they seek. We applaud NRAO's e-communication, whose newsletter has an impressive number of subscribers, particularly given the limited manpower available. We encourage NRAO to tap the User Committee for short articles (or referrals) about recent research results for the newsletter.

2.9 NRAO Visibility/EPO

The UC congratulates NRAO for its efforts in Education and Public Outreach (EPO). John Stokes' enthusiasm for his work is contagious. This group is clearly learning from successful programs at other facilities. The UC was particularly impressed by three key developments: combining ALMA and non-ALMA efforts for better use of resources; reorganizing outreach efforts by audience, so that the public and the scientific community can be addressed appropriately; and increased emphasis on multimedia outreach.

The UC appreciates the consolidation efforts, but we will be interested to hear next year about the local efforts at all sites, since local buy-in is particularly important in radio-quiet areas. Renovating the 20-m telescope at Green Bank to operate remotely (expanding UNC SkyNet) is potentially useful at all sites.

STEM Education programs are a clear focus of interest. NRAO seems to be putting the right sort of education emphasis on these. The pulsar discovery by a student is certainly grounds for celebration. The UC would like to hear about the results of NRAO's efforts to target under-served populations at the next meeting.

The approach of working to partner with institution/university/AAS press offices for press releases seems attractive, as well as the idea of regular contact to users to inquire about press-worthy topics. The need to emphasize imagery was clear. The Hubble Heritage model for making gorgeous imaging suggests that an effort be made to comb the archives. One possibility is to start with an enticing image and then provide additional detailed information. The UC encourages NRAO to revive the image contest which was discontinued in 2009 as one way to encourage more creative use of radio images.

If they have not already done so, the EPO group might also want to talk to the EPO/Public Affairs groups at Chandra and Spitzer. John Stokes mentioned that NRAO cannot afford NASA-sized programs, but we assume this refers to the outreach efforts at STScI. Other NASA missions have outreach programs that are an order of magnitude smaller, i.e. more similar to the scale of the effort at NRAO. Comparing notes with those groups might be useful.

3 Future of NRAO

The UC supports the establishment of the NRAO SKA Program office to interface with the national and international communities working to develop next generation large radio facilities. This office sensibly serves to organize the ongoing NRAO contributions to a variety of SKA activities, including preparatory science, technology R&D, and management. Several SKA precursor instruments aimed at the lower radio frequency ranges are under construction around the world, for example the South African MeerKAT effort where NRAO has established a formal collaboration. We would like to encourage NRAO to explore similar collaborative initiatives with other precursor instruments, especially as the SKA project enters a more focused phase (e.g. SKA Phase I). NRAO is well positioned to facilitate the development of a US-led concept for the more challenging high frequency component of the SKA Program. A key element is the "North America Array"

initiative, to develop enabling technologies and test them with existing infrastructure. The imminent reports from the Astro2010 process will be critical to guide the resources that can be devoted to realizing this goal. The UC strongly endorses the idea of a community workshop hosted by NRAO in spring of 2011, after the release of the Astro2010 reports, to discuss the way forward on the SKA Program for US astronomers.

4 Facilities

4.1 ALMA and NAASC

The UC is pleased to hear that ALMA construction continues on schedule. The main pacing items appear to be identified, understood, and mitigated, and it is notable that major milestone dates have changed little over the past few years, despite the overall complexity of the project, turnover in management, and even the disruption caused by an enormous earthquake in Chile. The individual components show impressive performance, including antennas with fantastic surfaces and sub-arcsecond pointing. We congratulate the ALMA team on achieving first fringes and phase closure at the high site. The official start of the commissioning and science verification phase brings the challenge of integrating the hardware and software into a reliable system that can efficiently produce science quality data. The short term goal is on the delivery of 8 antennas to the high site by August, in time for a readiness review in October where successful progress will trigger a call for proposals for early science in 2011, using 16 antennas on baselines up to 250 meters. The prospects for early science observations are very exciting. Nonetheless, community expectations for this early science phase must be carefully managed. Observing time for early science will be limited, robust pipelines are not likely to be complete, and capabilities will be fantastic but not yet orders of magnitude better than existing millimeter and sub-millimeter arrays. We caution that early science is a bonus activity that must not significantly interfere with, or slow down, ALMA construction and commissioning.

The NAASC appears to be making good progress recruiting staff and putting into place the procedures and software needed for proposal preparation and project tracking. The community preparatory activities by the NAASC, including special sessions and tutorials at AAS meetings and the Synthesis Imaging School have been effective. More of these preparatory activities at appropriate venues will be important during the build up to early science. For example, there will not be much time for prospective early science proposers to become familiar with the Observing Tool, which has yet to be released. We applaud the continued success of the annual NAASC science workshops. Attendance at these topical workshops has been at capacity, and they are working well to generate enthusiasm for science with ALMA.

We praise the efforts by the NAASC to prepare and submit the NSF proposal for ALMA operations for FY2012-2015. We are especially pleased that the proposal includes a user grants-with-time program (albeit as an over guideline request). The UC strongly endorses such grants that couple highly competitive observing time with the funding needed to deliver science, following the recommendation of the last Decadal Survey for newly constructed facilities. This support will be essential for US users to exploit the transformational capabilities of ALMA.

The previous year's UC report had urged NRAO to make additional efforts to promote pre-ALMA preparation proposals to the NSF. This was a topic on which we did not receive an update this year, and it is apparent that such work did not materialize. Given the complexity of interpreting ALMA data, there are several avenues of data analysis (e.g. spectral line identification, visualization and analysis of spectral data cubes) which could benefit from targeted support. We encourage NRAO to work with the NSF program officer to realize this, particularly with an imminent call for early science.

4.2 Green Bank

The Green Bank facility continues to see great improvements on several technical fronts that offer users more capabilities. The realization of a 250 μm surface accuracy and 2 arcsec tracking accuracy for the GBT are remarkable achievements that enable the telescope to be used in the 3mm band. We particularly applaud the timely completion of the project one year ahead of schedule. The technical, scientific, and management staffs are strongly applauded for their successful efforts in the surface and pointing improvements. The K-band focal plane array is steadily progressing towards deployment on the telescope and will soon become available to the user community. This will greatly help the high over-subscription rates at K band. The UC

supports making one more effort to fix the baseline ripples in the Ka-band receiver, and is looking forward to the increased time-savings in receiver changes once the new turret motors are installed.

The UC firmly supports efforts to bring broadband Internet to GB, as data volumes are becoming such that even moving the files from a pulsar timing observation (greatly reduced in volume from a survey observation) can take many hours and result in conflicts with other observing programs. Data archives and analysis pipelines must also remain high priorities.

The Dynamic Scheduling System (DSS) is proving to be a very valuable system, having greatly increased the efficiency of high-frequency observing while not imposing short-notice demands on low-frequency observers. The DSS has also been instrumental in helping to clear the backlog of A-rated projects, allowing more new projects to be scheduled.

The UC is pleased to see the ongoing development work in GB, aimed at both increasing the scientific output of the GBT and planning for the SKA. In particular, the plan to develop a W-band feed array is the obvious next step for the GBT at high frequencies but backend and I.F. costs and requirements must necessarily be considered prior to proceeding with this effort. The L-band phased-array feed project deserves support as this concept provides the basis for the next generations of focal plane arrays. It is imperative that NRAO demonstrate technical leadership in this exciting development.

We are also pleased to hear of the new hires in GB, and to learn that, while the overall staffing levels have not changed since last year, the process of working with staff at other sites, particularly Charlottesville, has been made more efficient, so that GB staff are better able to manage their workloads. The formation of the Observatory Science Operations group will greatly supplement the GBT staff.

4.3 EVLA

The Users Committee congratulates the NRAO staff and their Canadian partners for the progress made on the construction and early commissioning of the EVLA, and particularly of the new WIDAR correlator. It appears that the instrument will be completed on time and on budget — a rare achievement. We fully support the continuing effort devoted to commissioning, and were particularly pleased to learn of the success of the RSRO program. We endorse the extension of the RSRO program if needed.

The early science that NRAO is quickly publicizing on the Web is truly exciting, and demonstrates without doubt that great scientific advances can be achieved right away with the new instrumentation. The UC endorses the renaming of the array once the construction phase is over, to demarcate the vast difference in capabilities compared to the VLA. The UC also encourages NRAO to consider taking “early release observations” akin to Hubble’s ERO program, to make stunning images for the purpose of releasing to the public, which will highlight the EVLA’s performance.

We encourage NRAO to further facilitate the access of the EVLA by the community. This would be most easily achieved through the archive and OPT, which could be improved in several ways:

1. The OPT should provide recipes and examples for the most common EVLA observing modes that could be downloaded to a user’s project.
2. The OPT should provide the current status of a project when its observational plan is submitted.
3. The user should get information through the OPT or via e-mail when an observation has been performed.
4. Taking into account a large size of current EVLA data files, a 2-day period for downloading the data from the archive is not sufficient.
5. We encourage NRAO to make available pipeline-processed images through the archive for quick-look evaluation of the data.

The UC was pleased to hear that although there is no current observing capability below 1 GHz, there is effort to test the 74 MHz system this fall as well as development by NRL of new low-frequency receiver designs.

Finally, we recommend closer interaction between the UC and the PASEO committee to provide wider feedback and avoid conflicting advice. We suggest that the chair of the UC attend the PASEO committee meetings as an observer.

4.4 VLBA and Partnerships

The VLBA is continuing to produce exciting and important scientific results and the UC is very pleased with the scientific performance of the instrument and the large acceptance in the community, demonstrated for example in the high over-subscription rate of the VLBA. The VLBA covers an impressively wide range of research fields like cosmology, formation and evolution of stars, Galactic dynamics, and active galactic nuclei.

The VLBA Sensitivity Upgrade is a very impressive program and the UC congratulates NRAO in having the upgrade largely completed. The UC strongly supports the involvement of outside partners in the program as well as the high level of activity of NRAO in raising money for continued development and maintenance of the VLBA.

The UC strongly supports the significant efforts which the NRAO is undertaking to find outside financial support for the annual operating cost of the VLBA by 2011 FY. The UC encourages NRAO to continue negotiations with NASA to persuade the agency that the unique capability of the VLBA to provide spacecraft tracking warrants its financial support. The UC hopes that the NRAO will make all possible efforts to cause the separate agreement with USNO to take place.

It is understood that any agreement with outside partners like the ones with NASA and USNO discussed above might result in the loss of substantial amount of open time for the VLBA users community. We consider this to be greatly preferred over complete loss of the instrument. In this context, the UC approves the key-project policy that NRAO has implemented in order to yield the best science return of the instrument during its mission lifetime.

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 UC notices that the multi-wavelength community is making ample use of this opportunity. The UC considers the first two rounds of the *Fermi*/VLBA MOU a great success so far and we strongly encourage NRAO to honor and continue this MOU as long as possible and independent of the unresolved status of the MOU with NASA for VLBA operations and funding.

In the same philosophy, the UC strongly supports NRAO's MOU with the National Astronomical Observatory of Japan (NRAO) for commitments of NRAO's telescopes to the VSOP-2 mission. This mission is realized by combination of the ASTRO-G spacecraft and ground-based radio telescopes including the VLBA, GBT, and EVLA. This MOU provides the unique opportunity for enabling major quests in the high energy physics found in AGNs in the ultimate angular resolution to the wide astronomical community. The UC expects that this MOU should be positively evaluated by the Scientific Steering Committee in the Japan Aerospace Exploration Agency (JAXA) held in 2010 July and September. The committed NRAO telescope time (currently 200 hours per year and instrument) should be reevaluated before the beginning of the VSOP-2 mission. Based on the MOU, any feedback to financial support for VLBA operation is encouraged by research facilities and the community.

The UC expresses its concern about the discontinuity of the VLBA/VLA polarization calibration database, although the UC understands the reason for this due to the VLA/EVLA transition phase. The UC encourages NRAO to restore these observations as soon as possible, since a significant number of VLBA users rely on this database for polarization calibration. In any case, we request that NRAO keep the user community informed about the status and planned time line.

Millimeter-VLBI still provides the highest resolution imaging possible in all of astronomy and the VLBA is a key instrument for this. The UC praises the usage of the VLBA at 86 GHz both in stand-alone mode and in Global Millimeter-VLBI Array observations. During blocks of VLBI observations at this frequency, the large monitoring programs with dynamical scheduling have significant gaps in monitoring. The UC suggests that dynamic scheduling officers discuss (by e-mail) with PIs of such programs possible epochs for dynamical schedule during these times to minimize the negative impact on their science.

The VLBA is the crucial key component of the High-Sensitivity Array (HSA), which also includes the Effelsberg, GBT, and Arecibo antennas, and used to include the VLA for strongly enhanced VLBI image sensitivity. After the upgrade to the EVLA, this instrument should be restored as soon as possible in the

HSA to keep the greatest sensitivity in its ultimate angular resolution. The HSA has extended the frontier of high angular resolution astronomy, including planet search and other achievements of particular appeal to the wider community of astronomy.

5 Central Development Laboratory

The Central Development Laboratory (CDL) continues to play a critical and innovative role in the current functions of NRAO and more importantly, in future telescope and instrument systems for radio astronomy. The CDL efforts in amplifier development and contributions to the K band focal plane array will provide the users with significantly expanded capabilities of the EVLA and GBT in the coming year. The work on the high frequency SIS systems and 3mm MMIC amplifiers appears promising. The UC looks forward to hearing of more progress on these devices in the coming year. The Users' Committee applauds the CDL work in the early digitization of the R.F. or I.F. signal and the ability to achieve side band rejection, polarization separation, and beam forming arrays. In particular, beam forming arrays offer the only realistic path to large format and densely packed focal plane arrays. The future of radio astronomy clearly lies in such early digitization methods so it is imperative that NRAO plays a leading role in the research and application of such techniques.

6 Miscellaneous Users Committee Issues

The Charlottesville meeting was a success, and the composition of the UC represents the diverse nature and concerns of users of NRAO's facilities. We appreciate the effort in scheduling the meeting for a full two days; as usual there was ample discussion which tended to scramble the schedule. The meeting is a full one, and we appreciate the opportunity to hear in lunch talks about the exciting science being done by NRAO staff. In general, the UC felt that the quality of the presentations was good. In the future, having the material available to UC members in advance of the meeting by two weeks or so would enable members to read through the material in depth before the face to face meeting. This would benefit everyone by reducing the time needed by presenters to present their material, and increase time for discussion on matters of relevance to the UC.

This is the second year that NRAO has been a member of the National User Facility Organization. The chair of the UC is a member of the NUFO and has been invited to participate in their annual meetings, but the timescale is often short and to date there has been no NRAO user presence at the NUFO meetings. The one-year tenure of the chair makes it difficult to use this resource effectively. The chair suggests that the UC and NRAO consider appointing someone to be the representative to the NUFO who will be available in this capacity more than one year, so that NRAO can get the most out of this organization.

The UC selected Edo Berger as the chair for 2011.

7 2010 Charlottesville Meeting Participants

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

Edo Berger
Eric Feigelson (telecon)
Mark Heyer
Hiroshi Imai
Svetlana Jorstad
Matthias Kadler (telecon)
Laurent Loinard
Amy Lovell
Rachel Osten (Chair)
Gordon Richards
Aneta Siemiginowska
Michael Skrutskie

Ingrid Stairs
Snezana Stanimirovic
Lisa Storrie-Lombardi
David Thompson
David Wilner