NRAO Users Committee Report 2009

1 Executive Summary

The 2009 NRAO Users Committee (UC) meeting was held May 4-5 in Socorro, NM. NRAO runs and is building several of the world's largest and most productive radio telescopes, and we are glad to have the opportunity to provide feedback on its successes and challenges. We are grateful for 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 is a time of some uncertainty, with potential "stimulus package" funding on the one hand and flat budgets on the other, and the ongoing efforts to implement the recommendations of the Senior Review. Meanwhile the National Academy of Sciences Decadal Survey offers the opportunity to argue for the next generation of radio projects in which NRAO could take the lead.

The UC feels that the NRAO is doing a great job of meeting its challenges but finds some areas where improvement is needed. Here we summarize the pressing user issues that we consider need to be addressed by NRAO and funding agencies.

- NRAO staff levels urgently need boosting, being critically low at some facilities (eg VLBA and Green Bank). Without remedy this could lead to a crucial loss of the best possible science being undertaken by these facilities.
- A mechanism needs to be put into place by some combination of NSF and NRAO to ensure better access to grant funds for data reduction for US observers with successful NRAO observing proposals. The ALMA-preparatory NSF grants are one step in the right direction, but we recommend that the entire funding model for US university radio observers be reconsidered.
- NRAO is undertaking two very well-thought out large-scale programs, on the one hand to consolidate user-support efforts across the Observatory (OSO) and on the other hand to leverage the expertise of university researchers in bring the EVLA online (RSRO). We are so impressed with the RSRO concept that we encourage NRAO to broaden the spirit of this program to include needs at other observatories – exposure-time calculators, quality-assurance automation, data reduction pipelines, algorithm development and other areas. While the specific issues of "residency" and "shared-risk" might apply best to the start-up phase of the EVLA, the Observatory should explore ways to reward (global) community members who contribute substantially to making NRAO more efficient and productive. Examples include extra observing time (if justified), support for conference travel, or free accommodation in the Quarters during observing.
- The CASA software package is developing well, but we encourage NRAO to look into potential hardware and software bottlenecks for observers looking to reduce their data. With EVLA and ALMA coming online, there is a critical need for algorithm development for data-cube analysis. Meetings to acquaint more users with the workings of CASA are also needed to transition the community from AIPS-based interfermetric data analysis to reduction and analysis with CASA.
- The data archive continues to have problems in supporting the desired range of user queries; this is another area that needs to be addressed in an urgent fashion.
- We endorse the plans for changing the time allocation system for all NRAO telescopes to a semester-based system with panels of referees.
- We endorse the financially necessary plan to limit full quality assurance checks for VLBA data to those projects with the highest scientific merit rankings. We applaud the progress on efforts to seek new partnerships for VLBA operations.

2 User and Scientific Support

The UC commends the NRAO for remaining proposal-driven at all the telescopes, because this ensures that the observatory is supporting the science that the community considers important and exciting. The Observatory Science Operations (OSO) consolidation of many of the commonalities of operations amongst the various telescopes is a good practical step forward toward greater efficiency in user support. Here we discuss some of the specific concerns that we think are most critical for ensuring continued excellent functioning of the NRAO science pipeline.

2.1 Staffing

Staffing shortages across the NRAO telescope sites is a concern, with the exception of staffing for the North American ALMA Science Center, which is growing. Even considering the excitement for and focus on ALMA and EVLA, it is critical that the observatory strive to maintain as much scientific productivity and innovative staffing for user support at existing facilities, particularly GBT and VLBA. We encourage NRAO to assess the tasks that are being done independently at each site, to eliminate redundant effort, and to pool talent, as is starting to happen through the OSO initiative. Where possible, efforts developed for ALMA should be made with cross-observatory usage in mind – issues such as the consistency of the websites, proposal preparation, observation preparation, and organization of peer review. In particular, the observatory should consider whether some of the burden on the inadequate VLBA data analyst staff could be eased by any overlap with ALMA objectives.

The UC is very enthusiastic about the Resident Shared Risk Observing (RSRO) plan being used for the EVLA and suggests that NRAO consider such a program in other areas such as the VLBA, software development and archiving. Exploring this and other ways that in-kind contributions (including both hardware and services) can lead to telescope access is encouraged as a way to alleviate the critical staffing shortages. The UC explicitly recommends that NRAO investigate innovative ways to tap the pool of user talent. For instance, a fraction of the available observing time could be set aside for a separate category of proposers who would provide open-source software that meets the format, capabilities, interface, and deadline requirements provided by NRAO as part of that category's call for proposals. Immediate examples include dynamic scheduling software, software for sensitivity/exposure time calculators, pipeline data quality checks, scripts for the reduction/analysis of their data, etc., if deemed possible by NRAO. A significantly enhanced suite of web proposal tools is needed to minimize mistakes and the need for extensive technical reviews, and proposers themselves (or their students) could be the group that builds those tools.

2.2 User Grants

The UC again discussed the need for substantially enhanced funding provided to US-based non-NRAO investigators with successful observing proposals for data reduction and science analysis. NRAO's funding program for users includes Student Observing Support, Jansky Fellowships, and page charge support and visitor support. The Jansky Fellowships remain an excellent way to build the future user base and to ensure interactions with the broader community, and the Student Observing Support is a focussed method of providing funding to train the next generation of radio astronomers. Other science programs, such as the Visitors Program, mainly enhance intra-NRAO science capabilities. Page charge support is well-received, but comes at the end of a research project. We believe that overall this level of community support is inadequate today, and will be seriously injurious to NRAO science as the EVLA and ALMA telescopes begin operations.

We are aware that successful US-based radio astronomers can seek funding from NSF Astronomy Directorate. However, only a handful of NSF grants are provided annually in radio astronomy, and some of these support research at NAIC or university-based radio telescopes. The vast majority of extramural US-based NRAO observers do not receive NSF, or other, funding for data and science analysis. Even if more NSF grants were awarded using NSF's centralized proposal mechanism, funding levels cannot be fairly matched to actual data analysis costs without detailed (and often, advance) knowledge of the telescope allocations.

We have heard that NSF does not traditionally delegate the decisions of research funding awards to an outside panel. The UC respectfully suggests that NRAO referees and telescope allocation committees are not outside panels. We, the research community, provide the referees for the observing time and funding allocation review committees for all Federally-supported telescopes. NASA has a long and successful track record of issuing research funding after observing programs are scientifically evaluated and accepted (normally after data has been succesfully obtained). NASA telescope administrators specify, either via formula or by specific approval of proposed amounts, the funding allocated to each observation. These NASA budgetary allocations are not subject to a second science review; this was done by the telescope allocation committees. Care is taken to avoid double-funding the same science through other science programs (such as NASA's Astrophysics Data Program) by examination of Current and Pending Funding documents.

The UC believes that the current level of US community funding is inadequate to support high-quality radio astronomical science. The deficit between true costs incurred by the successful NRAO observer and the available funds is a subtle inhibitor of high-quality research as talented scientists are drawn to other telescopes with immediate associated funding allocations. The problem is particularly acute for Large Projects which NRAO is now expanding to 25-50% of the observing time. Here, several person-years are typically needed to analyze the large datasets and write a series of papers. A U.S.-based astronomer suffers a serious penalty by successfully preparing a Large Project proposal without adequate external funds to carry out the science program. We fear that this damper on radio astronomical progress will seriously injure the scientific potential of the EVLA and ALMA. These are Great Observatory class facilities for which NRAO management justifiably seeks to broaden the Observatory's user community and deepen its scientific impact.

Finally, we note that this issue has been raised in various contexts in the 2001, 2002, 2003, 2004, 2006, 2007 and 2008 UC reports. For example, the 2002 report stated: "A long-standing complaint in the radio astronomy community is a lack of funding for research using national (specifically NRAO) instruments. Although NRAO has established a number of programs to aid the user committee, ... there is still a need for more significant support for research costs. ... We therefore encourage NRAO in its proposed efforts to explore alternative funding possibilities with the NSF." We note that there was some mention of the NSF/AST forming a working group to explore the possibility of user grants. We endorse this as a step in the right direction but again stress that we view user grants as crucial to the ultimate success of frontline facilities such as ALMA.

We therefore request that NRAO, in close consultation with AUI and NSF, report to the Users Committee by its 2010 meeting regarding new funding sources and mechanisms to aid the US community in achieving data and science analysis for NRAO observing programs. We understand that full support of all US-based observers is not feasible within budgetary constraints. Choices must be made, such as emphasis on Large Projects or top-rated proposals. We do not recommend exclusion of any NRAO telescope from the program, as science quality rather than technology should guide the funding decisions. Funding mechanisms might be based on NRAO's existing Student Observing Support program, NSF's FastLane-based programs, or other method.

2.3 OSO

The UC commends NRAO on the organization of a new Observatory Science Operations (OSO) division. OSO is designed to provide an integrated interface between NRAO and the user community with responsibility for proposal management, Web services, data pipelines, archives, algorithms, and community support programs. OSO should help to reduce historical barriers and achieve synergies between the different NRAO telescopes, and to broaden the Observatory's outreach to non-traditional astronomers in the EVLA and ALMA era. The UC had a concern that the job of leading OSO will be very complex, and perhaps should not be combined with the Head of the North American ALMA Science Center.

The OSO project should streamline operations and take advantage of reusable efforts at each of the observatories. As the OSO efforts proceed, the UC recommends that the NRAO set priorities for allocating staff efforts to centralize tasks, and not immediately try to do everything from the list shared with us at the May meeting. Furthermore, the UC endorses a staged approach, allowing the users to adapt to a few changes at a time (and with good publicity about coming changes) rather than a major overhaul administered at once. The Kayako helpdesk system seems to be an appropriate choice, but its implementation should be monitored to ensure that it is both serving the users and streamlining staff efforts.

The Users Committee would like to remain informed about the implementation of OSO plans, with the ability to respond to suggested changes before they "go live" for all users. Specifically, we hope that the "one observatory" initiatives presented by Carol Lonsdale will be implemented with due consideration for facility uniqueness where warranted.

Specifically, the UC came up with these items which can be centralized easily:

- "Science web"
- User Portals, if the efficiency increase is compelling
- Helpdesks, streamlined by telescope
- Proposal Preparation and Submission – as long as these continue to link to site-specific documentation
- Observing Summaries and Metrics
- Archives
- Algorithm R&D
- Pipelines for a few specific common modes of observing
- Science User Outreach
- Community Support Programs

The proposal review process is also on the list of items to be centralized; we comment on the plans for the new time allocation process in Section 2.8 below.

We have deeper concerns about Observation Preparation Support, Data Processing (except for certain "pipeline" modes and the overall functionality of CASA) and User Training as regards the technical details of the particular instruments. Each of these items is far along the continuum toward "telescope-specific elements" and will have to be treated as such.

2.4 CASA

It was encouraging to hear that advances in CASA have been made to the point where it can reduce VLA and OSRO data, and that the range of algorithms being developed include those needed for EVLA/ALMA. The state of CASA was a large improvement over what the committee saw last year. The committee was also encouraged by the training activities that are going on to ensure that people at NRAO are developing familiarity with CASA, and the inclusion of CASA tutorials

at the synthesis imaging workshop last year. However, there were aspects of CASA which were troubling to members of the committee. The data sizes which CASA can handle currently are only a small portion (1-10 GB) of the sizes expected from the full EVLA and ALMA. We understand that effort is being made towards the terabyte levels which will be typical of peak data usage, and we would like to hear more about the status of this at next year's meeting. The committee was concerned about the impact of CASA on early science with the EVLA and whether users would need to travel to the AOC to reduce their EVLA data and/or whether computer clusters would be necessary. This would dovetail into visitor support issues, and it was not clear that the Observatory had considered this ramification of CASA. We encourage NRAO to continue to publicize CASA as the de-facto replacement for AIPS, and to increase the number of CASA workshops in the next 1-2 years. We would also like to hear about NRAO's long-term plans for the maintenance and support of AIPS.

We were additionally concerned that CASA still lacks a head, and whether the staffing levels for CASA are adequate to complete the necessary elements in a timeframe consistent with availability of new data capabilities with EVLA once the new correlator starts rolling out new modes. It was also not clear how the role of international programmers fit in with activities at NRAO. We encourage NRAO to continue to leverage ALMA money for CASA development as much as possible, recognizing that many similar issues affect the processing of both ALMA and EVLA data. We point out that CASA is one of many areas where more direct community involvement (i.e. in-kind software contributions via the RSRO program) should be sought.

2.5 Computing and Algorithms

NRAO recently reorganized the informal NRAO Algorithms Working Group into a formal Algorithm Research and Development Group (ARDG) with clear goals and staff. Most of the algorithms under study are intended to help the EVLA achieve its scientific potential. The planned algorithmic developments for the 2009–12 period include improvements in wide-band imaging, wide-field imaging, high-dynamic range imaging, beam corrections, ionospheric corrections, deconvolution, and mosaicking.

The UC warmly commends NRAO for a renewed emphasis on algorithms. While we understand the need to meet urgent data analysis needs of the EVLA and ALMA, we emphasize the need to meet challenges the user community will face in extracting scientific insights from the flood of the resulting datasets. Without improvements and automation in data visualization, statistical modeling, and source characterization, we fear that a bottleneck in scientific productivity will be encountered when the user community is confronted with huge collections of reduced data. Facilitation of science analysis (in contrast to earlier stages of data analysis) will also smooth the passage of non-experts into use of NRAO data products, facilitating the "One Observatory" theme. We encourage the ARDG to integrate itself into the nascent but growing enterprises of astroinformatics and astrostatistics throughout astronomy, as discussed in cross-disciplinary Working Papers recently submitted to the NAS Decadal Survey.

We are particularly concerned with the analysis of three-dimensional datacubes. In the past, only a limited number of VLA users performed spectroscopic mapping (e.g. HI in galaxies, maser groups, molecular cloud cores). In the near future, common datasets emerging from EVLA and ALMA, and many from FPA surveys with GBT, will be in the form of datacubes. NRAO's current software for visualizing and analyzing datacubes is quite primitive and requires considerable human intervention to obtain scientifically valuable results. Some more capable tools, such as ClumpFind, have been developed by other groups. But a more comprehensive integrated and (semi)automated suite of analysis tools is needed. Tasks include automated identification and re-

moval of RFI-contaminated channels, identification and characterization of continuum sources in 2-dimensions, and identification and characterization of line sources in 3-dimensions. Many methods can be adopted from developments in computer vision, remote sensing, medical imaging, and applied statistics in addition to the wider radio/mm community. An important science outcome of a software pipeline for datacube analysis would be the standard production of radio source catalogs. These could quickly be incorporated into the NRAO archive and be made available to the multiwavelength community through the Virtual Observatory.

We strongly encourage the ARDG not to delay facing the challenges of datacube analysis. To accomplish this in addition to its other algorithmic tasks, additional staff and expertise may be needed. NSF has a number of new funding programs to promote cross-disciplinary research efforts, particularly the Cyber-enabled Discovery and Innovation program that is growing to \$0.25B/yr. The UC encourages NRAO to energize CASA, e2e, and OSO effort in this direction, and to collaborate with extramural groups with expertise that is lacking within the Observatory, for example through an Observatory-wide expansion of the RSRO program that will be in place for the early observations with the EVLA. In the long term, improved automation in science software should save substantial labor costs, achieving the desired science with fewer employees in science staff both at NRAO and at the observers institutions.

2.6 Data Archive

The UC reiterates from previous reports that the size and quality of the data archive, its accessibility to the users (experts and otherwise), and the flexibility and power of its user interface are all key to maintaining and expanding both NRAO's scientific community and its scientific productivity, all at a relatively low cost.

The UC notes that while some progress on the archive and its user interface have been made in the last year, we feel that such progress is either insufficient, or poorly documented. For instance, the UC had asked in 2008 for the fraction of images available, but this information was not given to us. The UC would like to know what the bottlenecks are in pipeline processing — parameter setup, data I/O, CPU time, visual inspection?

Of critical importance is the fact that web paths to genuinely useful archive queries are obscure. The main NRAO websites for astronomers (`http://www.nrao.edu` and `http://science.nrao.edu`) only provide a link to the "Data Vault", which does not provide a useful search engine – the various query-resolution problems that we complained about last year are still in place – and seems to be more geared toward Google Sky and the NVO than toward providing astronomers with access to usable data.

The archive query tool which allows the most options and is best for raw data inquiries (at `https://archive.nrao.edu/archive/advquery.jsp`) is not easily located – it is in fact under a button that reads, "Use the old archive search." The UC strongly recommends that this "Advanced Search Tool" be used as the model from which to develop the full archive query, and that it be linked directly from the NRAO website in an intuitive fashion. This can replace the current site `http://www.nrao.edu/archives`, which is an intuitive link for the data archive, but which instead provides a historical collection of records and papers.

In regards to the "Advanced Search Tool", the UC feels that this is an excellent first step in implementing a full-scale archive. It provides some basic functions of data retrieval and search based on a wide range of parameters (e.g. program ID, dates, positions, telescope). However, in its current incarnation, this search tool lacks several primary functions which are of the utmost importance for the long-term use of NRAO archival data:

- The search tool must allow for batch searches using a list a flexible list of parameters (using

for example an uploaded table of coordinates). Currently, only one object, program, etc. can be searched at a time. This precludes archival work on large samples of objects, or an efficient search of archival data prior to submission of a new proposal. Moreover, object names that can be resolved successfully via Simbad in ADS return parsing errors in the archive interface.

- There are large gaps in the availability of meta-data, leading to inefficient searches based on program ID and observer name. Currently, this information is available from the relevant observe file entries for VLA/VLBA data, and should be available from GBT proposal files and astrid records. However, if an individual observer fails to provide this information, it is no longer available as a search criterion. NRAO should strive to populate the archive with these meta-data (preferably in real time), in order to ensure the long-term use of the archive.
- 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 on which the astronomer is only a co-Investigator. This access needs to be broadened.
- The archive output for each observation should include the release date, which is currently not available.
- The archive should include an easily-accessible project list (including program title, ID, PI name, and abstract). Currently, there is no simple way to find out what program IDs can be searched on. There is also no way for proposers to know whether a similar proposal has already been approved. This is of particular importance for Director's Discretionary Time requests, which may cover already-approved programs. The UC strongly feels that this aspect of the archive should be separate from the Search Tool, and should be designed to include completion fraction for each program. This will provide increased transparency.
- The current archive system uploads new data only once per day. This limits the usability of the archive for rapid data access in the case of time-sensitive observations (for example, observations of transient sources, or the design of follow-up observations). Our discussion with NRAO personnel leads us to believe that there is no technical barrier to a more rapid transfer of data into the archive, even at the level of real-time transfer. We strongly encourage NRAO to pursue this issue.
- The Image Retrieval Tool should be updated along the same lines (allowing for batch submissions, etc.) It is unclear to the UC what fraction of all data are currently available in the image archive, and what is the rate of progress on new observations.
- The Advanced Search Tool claims to be able to access GBT data, but in practice appears not to recognize GBT project code names nor to have access to information about what the GBT has actually observed. This needs to be changed. The Data Vault does provide access to some GBT data (apparently only through the end of the GO era and not since astrid came online in 2005) but even that is incomplete (pulsar data taken by proprietary backends are not available, though the related cleo fits files are) and subject to metadata errors due to GO state memory problems (eg previous-observer names associated with some observations).

In addition to these specific recommendations, the UC would like to stress that with the beginning of EVLA operations, the pressure on the archive is likely to increase significantly. We therefore encourage NRAO to make progress on these items as soon as possible to avoid a bottleneck in access to EVLA data. As a specific recommendation, the UC encourages NRAO to call on members of the user community for volunteer testing of the archive, and for assistance in query tools. In terms of making progress on these issues, NRAO could consider a major update to the archive as an NRAO/REU student project.

2.7 Science and Academic Affairs and Budget Impact on User Programs

The postdoctoral Jansky Fellowships are well-established in the community as prestigious positions, and are arguably the greatest "user program" NRAO currently has. Their value is greatly enhanced by the recipient's ability to choose a host institution. Due to recent budgetary difficulties, it was suggested during the meeting that NRAO could use ALMA funding to keep the same number of Jansky Fellows. The UC felt that adding ALMA funding as well as ALMA-focused positions is an excellent opportunity for increasing the number of Jansky fellows, not just maintaining the current level. With ALMA and EVLA starting soon, a larger group of Jansky Fellows is necessary to ensure early scientific returns.

We are also impressed with NRAO's student support programs, and their organization of various scientific and educational meetings, workshops and summer schools. These are very important ways to engage the scientific community at large, and broaden the NRAO user base. The UC would like to stress that the page charge support program is critically important for the user community and should continue to feature prominently in the future.

2.8 Time Allocation Committee

NRAO proposed a reorganization and rationalization of the time allocation process across the observatory. The fundamentals of the NRAO peer review process are sound but as the base of NRAO observers broadens, the community has different expectations than a smaller community comprised of instrument experts. NRAO put together a draft plan that was discussed and iterated with a subcommittee of the Users Committee prior to the full UC meeting.

We all want a fair, transparent and familiar process that optimizes the science done with the observatory.

The highlights of the recommended reorganization are:

1. Semi-annual proposal calls.
2. Single web portal for users to access all information about applying for time.
3. Panel-based referee system. Panel will rank order the list of proposals and the chair will attend the TAC meeting.
4. One TAC for all the telescopes together
5. TAC interacts with telescope scheduling
6. Final recommendations are made to the Director's office.
7. Full reporting of proposal metrics is provided to the community. Some of the metrics the UC would like to see reported are a breakdown of telescope, frequency, configuration and seasonal impacts on telescope subscription rates.
8. Continuation of TOO/rapid response or exploratory projects.

The UC recommends a transition from the current individual referee reports to panel reviews by telecon, with the final TAC being a smaller face-to-face meeting. This process has been recently adopted by the Spitzer Space Telescope, and is already in existence at several ground-based facilities (e.g. Gemini). The telecons make the entire process much less expensive to implement and the details of how this worked have been provided to NRAO to help in their planning.

The OSO is currently reviewing the proposed reorganization plan. It will be important to notify the community well in advance (at least 6 months) of the change in proposal due dates, cadence and selection process. It will be best if TAC results can be available before NSF research proposal deadlines. NRAO proposes making the changes incrementally. Providing a single portal website for proposal information can be done sooner than changing the review process. The UC noted the importance of keeping corporate memory on the review panels, i.e. making sure people serve for more

than just one review, but not requiring such a long time commitment that it discourages reviewers from participating. Rotating members every 2-4 years also ensures that the fresh viewpoints are introduced on a regular basis.

We also encourage the observatory to solicit and facilitate important efforts as science "legacy projects" that might run on each telescope, or even observatory-wide using several telescopes.

2.9 NRAO Visibility/Communication/EPO

The UC commends NRAO for supporting an enthusiastic and successful outreach group, both to the user community, astronomers and scientists in general and the interested public. In addition, we uniformly feel that the effort Mark Adams has placed on community outreach is outstanding and deserves special note.

We feel that the eNews is an effective and useful way for the NRAO to communicate information to the extended user community (encompassing all telescopes), although we suggest that the latest science press releases should also be linked in. The UC also recommends that each separate facility still announce key changes in emails specifically to its users as opposed to folding this information into eNews. However, it is important to reiterate important telescope specific news within eNews in order increase visibility. There were some issues raised with facility-specific news not being widely known in the relevant sub-community (for example the GB Code Repository, etc.), which we feel can be addressed both with these separate emails and with important issues being highlighted in e-News.

The UC is very supportive of the goal of making the websites consistent and more intuitively navigable across the whole observatory. With regard to efforts to develop a consistent website approach, the UC suggests that the Green Bank website (example: `http://www.gb.nrao.edu/php/shp/index.php`) be used as a model for easy-to-read and searchable telescope schedules and historical schedules.

The UC commends the NRAO for convening several workshops with a science focus towards EVLA and ALMA. These conferences allow the community to focus more directly on the science possible with these new facilities. These meetings are a good way at reaching the community that is already aware and thinking of science with EVLA and ALMA. These have led to important user development and discussion. The UC supports this approach as more productive than wavelength or single instrument-focused workshop strategies. However, the UC is concerned that the radio astronomy user base still needs to expand. In particular in light of the increase in sensitivity and expanded capabilities of both ALMA and EVLA it is important for NRAO to reach a broader community. One possible approach is that adopted by Spitzer (then SIRTF) and by SOFIA. The teams associated with these observatories created a speakers bureau (see `http://www.sofia.usra.edu/Science/speakers/archive.html`). In this area talks specifically aimed at broad audiences are stored offering a place for either in-house or outside individuals to gather slides and create presentations. In the case of SOFIA the team contacted major universities and paid for someone to give a colloquium. As EVLA and ALMA near completion it might be useful to NRAO to adopt similar measures in addition to the informational talks being given by staff such as Rick Perley. This could involve asking outside NRAO experts to give talks along with NRAO staff members. The idea of roving Jansky lectures was also put forward, although it is understood that in the current funding climate this may not be feasible.

Similar to NRAO helping astronomers do outreach (especially on ALMA and EVLA capabilities) to their fellow astronomers/scientists, the UC suggests that NRAO consider more effort to help astronomers do general outreach in radio astronomy. The Essential Radio Astronomy Course is a fantastic example of good practice, used by many teaching staff in universities as a basis for a course on radio astronomy. Material similar to this at different levels could be produced (or advertised if

it currently exists) to help astronomers more effectively communicate the science capabilities and successes of NRAO to a wider audience.

3 Future of NRAO

3.1 Decadal Survey

NRAO has provided sensible input into the Decadal Survey process with the strategic submission of a series of white papers describing moderate, cost effective, science-driven upgrades to each of its four major telescopes (EVLA, ALMA, GBT, VLBA), as well as an increased role in the international SKA program and technology development toward the future realization of a high-frequency (5–45 GHz) SKA evolving from a North America Array. The UC endorses this portfolio of planned enhancements, which range from "shovel-ready" projects, such as E-array stations for the EVLA, to longer term initiatives with substantial community involvement, such as focal plane array development for the GBT. The prioritization of these many upgrades will not be easy, and NRAO will need to pay close attention to the recommendations of the Decadal Survey. Specific feedback from the UC on the relative merits of these projects is not likely to be constructive until after the decadal survey reports in mid-2010. Ideally, appropriate funding streams for ongoing development as currently envisioned within the international ALMA project can be obtained for all of the NRAO telescopes, thereby leveraging these major capital investments with state-of-the art technologies to continue to produce forefront science into the foreseeable future.

For US users of NRAO telescopes, one of the most important recommendations of the previous decadal survey was specific grant funding for data analysis from new facilities at the level of a small percentage of capital costs. The UC reiterates that such support is essential to achieve the full scientific potential of the exciting new capabilities of all NRAO telescopes. Such support will also be needed for any significant expansion of the US user base beyond the traditional, limited, radio astronomy community.

3.2 SKA

NRAO has been a major player in North American radio astronomy efforts for the past several decades. Its strong role has been an important factor in allowing access to facilities to individuals at all institutions, from Tier 1 research universities to smaller teaching institutions. This stands in direct contrast to other wavelength ranges (e.g. optical) where access to some of largest telescopes is not community based. As such the UC strongly feels that NRAO should play a major role in the SKA. It is important to maintain this high level of access to the entire community. ALMA stands out as an excellent example of a new transformative instrument that will have wide-based access. We therefore support the goal of including an SKA program office within NRAO to focus R&D. We also agree in principle with the concept of technological development with a goal to potentially build SKA-high out from the EVLA site. In this regard we support the current graded approach of involvement (i.e. no major role while building both ALMA and EVLA). However, this should not preclude NRAO involvement in other aspects of SKA, in particular the current international focus on lower frequencies. The UC encourages NRAO involvement in these efforts in order to help ensure access to these potential new facilities for the US community.

4 Facilities

4.1 ALMA and NAASC

The UC applauds the current pace of ALMA construction. Given the size of the project, the fact that ALMA remains on schedule for operation with 50 antennas in late 2012 is impressive. We also encourage the desire to start early science in the second half of 2011, as long as the capabilities at that time far exceed those of existing millimeter facilities and will therefore highlight the transformational nature of ALMA. Given that proposals for early science are anticipated to be due in December 2010, just a year and half away, we would like to understand how these proposals will be managed by NRAO in light of the complexity of the ALMA international collaboration.

We also recognize the important strides the NAASC has made in terms of staffing and software development. We reiterate the statement from the previous year's report that ALMA must be attractive to users from a broad range of wavelengths, including those with little or no interferometry expertise, and CASA must be designed with this in mind. It might be useful in the next meeting to have a brief tutorial on CASA functionality. The UC also recognizes the important efforts of the NAASC and NRAO in community outreach for ALMA through several successful topical science meetings. These efforts are important. The recent workshop on observing with ALMA at McMaster University is also a good step, and the UC recommends that NRAO/NAASC begin the organizational steps for additional observing workshops for broader participation from astronomers in the US community. We agree that a Helpdesk for ALMA is a necessary part of the NAASC linkage to North American astronomers. The current plans to use Kayako (similar to NASA Herschel Science Center) seems like a good path to follow. We note, however, that a key to the success of the helpdesk effort will be the ability of the staff to respond in real time.

The UC encourages NRAO to make additional efforts to promote pre-ALMA preparation proposals to the NSF, and to publicise their availability. A series of guidelines on how to highlight the ALMA relationship in a proposal would be an effective approach (with the proper caveats that following such guidelines does not guarantee success). One area that has particular import is the assignment of molecular lines at high frequencies. This will be a major problem for ALMA (and also for Herschel). While some efforts are underway to mitigate this problem, NRAO could act as a conduit to bring interested individuals together to organize a larger community effort.

4.2 Green Bank

The UC commends Green Bank on its excellent observing record of 82% of the time available scheduled. This is a significant achievement. The over-subscription rates for GBT and the impressive array and variety of science results highlighted clearly indicate how important this observatory is to the astronomical community in general. The UC understands that there are some proposal backlogs at GBT in Ka band from an instrument problem. In future meetings, we would appreciate a short summary of the amount of time proposed and awarded at each frequency (and instrument if possible), so that the UC can keep an eye on both the proposal pressure and the user community. We also recommend encouraging creativity and project development targeted at the less-oversubscribed LST ranges.

The UC believes that the DSS project is an important part of efficient observing and the best way to span a large range of observing frequencies. However we are concerned that low staffing levels are delaying its implementation and hurting users, and the loss of a key staff member is making scheduling more difficult in the lead-up to DSS. Since dynamic scheduling will be important for ALMA and other NRAO facilities, perhaps some of the growing ALMA staff could be assigned to help with things relevant to this task to move things along. The UC is glad to see that user feedback

is being considered, and encourages NRAO to make every effort to maximize the scientific output of the telescope at high AND low frequencies. Clearly high frequency observers are very happy that DSS is happening, but GB needs to be careful not to disenfranchise low frequency observers (in particular pulsar timing observers who are uniquely affected by DSS) who also produce valuable science output from GB.

Clearly a lot of work in the past year has gone into improving the efficiency at high frequencies, and this is paying off in new scientific results. We were interested to see the reports on what is being done to increase the GBT efficiency, and would like to stay informed on the progress. We encourage all efforts to continue real time weather monitoring - for example of wind effects and cloud cover, both as part of the PTCS project to understand the impact on GBT efficiency and to help with DSS.

The UC urges that GB do more to advertise its script repository among users. It seems clear that users do have valuable scripts but are either not aware of or unwilling to use the script repository. To remove a possible barrier to repository contributions, in addition to advertising, users could be encouraged to submit scripts with a short (two-three sentence) description of what it does and what arguments are needed, because some users may be hesitant to submit scripts that are not fully commented.

The UC commends the Green Bank staff on very productive use of university partnerships for instrument development and in engineering, and is very pleased with such results as the Zpectrometer and the MUSTANG array, which has resulted in a wide variety of excellent science during its shared-risk period this year. The UC looks forward to the implementation of the coherent dedispersion mode on GUPPI and its integration into astrid.

The work on focal plane arrays is an important part of the future usefulness of the GBT for users, and the UC would like to see more staff allocated to the KFPA data pipeline development. Here again, since pipelining is becoming standard in many NRAO facilities, and will be important for ALMA, perhaps some ALMA staff could be tapped to move this project along and alleviate some of the burden for GB staff alone.

While the timing of the replacement of the GBT turret gearbox may be less than perfect, this is a critical maintenance need, and the UC endorses giving this replacement priority, even if it interrupts observations. We are pleased to hear that the replacement will enable more efficient instrument switching without tipping the telescope.

The UC is very concerned over staffing issues at Green Bank. Users are already affected by the low staff levels at GB. User support has been cut further, and we expect that this will only get worse if no action is taken. The UC is also concerned at the lack of young scientists at GB with only 1 postdoc and 1 predoc on site at present. With the recent dramatic decreases in the number of visiting observers (because of remote observing), which may be expected to increase further with the implementation of DSS, it seems that the scientific community at GB may be at serious risk.

Despite all this the UC is impressed that the feeling at GB remains so positive, and commends the GB staff for continuing to be so forward-looking in an environment when just running the telescope seems to be a burden on the number of staff available.

4.3 EVLA

The EVLA represents one of the primary efforts of NRAO, and is a major undertaking in every respect, from hardware to software development. Since the EVLA represents an order of magnitude or more increase in capabilities (in continuum sensitivity, spectral coverage, survey efficiency, etc.) the UC anticipates a very strong demand once the basic functions of EVLA are demonstrated. Here, as in many other areas, the UC notes that NRAO is achieving major milestones with minimal

staffing – we would like to praise and congratulate NRAO for nearing the end of the EVLA upgrade process.

The transition from VLA to EVLA operations is expected to place a heavy burden on the observatory staff. At the very minimum, NRAO will be dealing with a new facility, a new data reduction package (CASA) and a new observation preparation tool (OPT). The UC anticipates a flood of inquiries and requests for help as soon as EVLA and the associated software reach full operations. We therefore strongly encourage NRAO to stagger the release of these components, in order to avoid an overload on NRAO staff. In particular, the UC feels that the OPT can be released in its current state, and that NRAO should encourage (and perhaps require) its use in the final VLA configuration instead of the current JObserve software. This will allow VLA/EVLA users to familiarize themselves with one aspect of the new software, and will also allow NRAO to fix final bugs before OPT becomes the de-facto observation preparation program. At least one of us (Edo Berger) tested the software and found that it requires about 1-2 days of practice to produce the desired results. Similarly, NRAO should encourage users to download, install, and test CASA.

In terms of the hardware and data, we note that while the EVLA correlator provides a high level of versatility in observational setups, NRAO should encourage users whenever possible to choose from a basic group of setups. The UC anticipates that most users will not require the most technically challenging aspects of the EVLA as soon as it is turned on, and most likely in the long term. By providing basic correlator settings, NRAO will ease the use of the OPT, allow users to more readily analyze their data, and will aid in subsequent use of the data through the archive. This last issue is of particular importance since many basic observations aimed at continuum studies may automatically support ancillary spectral line studies (e.g. neutral hydrogen searches).

Finally, the UC encourages NRAO to continue to leverage the idea of Resident Shared Risk Observations (RSRO) as a way to gain access to new EVLA capabilities and to accomplish key outstanding tasks. However, we stress that more information on what specific tasks are needed will aid the community greatly in their response to this call. It will also focus NRAO on the best way to leverage the existing interest, and to match key personnel with key goals. We were very heartened to hear of the initial enthusiastic response to the RSRO call, and hope to hear about the contributions of RSRO scientists at next year's meeting. In a related note, we would like NRAO to clarify the role of graduate students in RSRO, as this seemed to be a gray area, and one where NRAO may lose important support if qualified graduate students are prohibited from participating in the program. In a similar manner, NRAO should clarify the statement that RSRO participants need to be present for their EVLA observations. This may not be feasible for extended projects, or ones that rely on target-of-opportunity observations.

On a final note, the committee was concerned about the removal of the P-band receivers and current lack of capability below 1 GHz, but we understand that this was needed in order to complete the EVLA roll-out.

4.4 VLBA and Partnerships

This is an extremely difficult time for the VLBA that will determine the future of the instrument. The deadline of 2009 September, by which financial support for the operation outside the NSF should be found, increases the pressure on the NRAO and users. The UC stresses that loss of the instrument would devastate high precision astrometry, studies of the structure of our Galaxy and its neighborhood, and the astrophysics of compact sources in the Universe. In particular, it would represent a major setback for multiwavelength astronomy.

The UC was impressed by the talk presented by Amy Mioduszewski showing absolutely unmatched accuracy for measuring the trigonometric parallax of T Tauri stars that demonstrate the

potential to determine the three-dimensional structure and kinematics of nearby star-forming complexes of interstellar gas. The UC is delighted that the VLBA continues to produce frontier science based on its unique coverage of a large region of parameter space in both angular resolution and the time domain. The UC applauds the strong support that the NRAO provides to the users despite a budget freeze and the loss of 2 data analysts and a dynamic scheduler.

The UC is pleased to see an increase in the number of proposals submitted the last year, a higher oversubscription rate, and larger number of active proposals during 2008. This reflects the important role that the VLBA is playing in multi-wavelength studies of blazars – among the most prominent sources of persistent gamma-ray emission in the sky – since the launch of the Fermi Gamma-ray Space Telescope on 2008 June 11. 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 multiwavelength community is making ample use of this opportunity.

The UC praises the thorough work performed by the NRAO in trying to identify potential partners that can contribute to the annual budget of the VLBA. The UC agrees that NASA is the most likely prospective partner and supports the NRAO's attempts to find funding for new receivers at 33 GHz to satisfy a NASA need. The UC encourages the NRAO and especially the Office of New Initiatives to continue to work with existing potential partners (NASA, Japan, the general European VLBI community, MPIfR, USNO, and UNAM) and to search for possible new sources of funds. Although partnerships can result in loss of observational time for the general VLBA users, the UC considers this to be greatly preferred over complete loss of the instrument. If increased observing bandwidths are possible through the use of new recorders, the reduced observing time may not even have a sizeable impact on the general-science productivity.

The UC understands that, under the conditions of possibly fewer hours available for general astronomy and reduced overall hours that the data analysis staff can devote to VLBA data, prioritizing the data quality assurance for projects with the highest peer-reviewed ranking is a wise way to optimize VLBA science. We therefore support the identification of "priority" high-ranked projects that will receive a higher level of quality assurance. We suggest also that NRAO ask for volunteers among investigators with the highest ranked proposals who feel qualified to perform the quality assurance themselves and who could perhaps provide futher QA tools through an expansion of the RSRO program.

Separately from the "priority" QA question, the UC endorses NRAO's idea to call specifically for "Large" or "Legacy" programs on the VLBA. It is likely that successful Legacy projects will fall into the "priority" category based on merit; however we want to ensure that smaller, highly rated projects still get the QA that they deserve.

The UC applauds the efforts that the NRAO expends to improve sensitivity and efficiency of the VLBA: 1) antenna repairs, 2) continuing bandwidth enhancement by implementing the Mark 5C recorder, 3) implementing the new VLBA-DiFX correlator with an international standard experiment description format, 4) simplifying scheduling of the correlator, and 4) developing a new "sniffer" program for automating some duties of the analysts. The UC agrees that maser issue can wait until the VLBA's financial problems have been solved.

5 Central Development Laboratory

The Central Development Laboratory (CDL) is critical to ongoing projects and to the future of NRAO. Although we do not have the technical expertise to comment on the direction of CDL efforts we can reiterate that we applaud the existing efforts which span a wide range of frequencies

and technologies. The 2009 presentation was excellent and we are intrigued by the potential for patented designs coming from NRAO and pushing the sensitivity barriers at 86 GHz. One area where concerns do exist is the level of staffing as the ALMA construction phase ends. Since this area is critical to the future of NRAO the UC encourages that all avenues be explored to keep key personnel. In particular in years of declining revenues it is important that any potential cuts not impact too strongly on this key area.

6 Miscellaneous Issues

The Socorro meeting was largely a success, and the composition of the UC has a good diversity of backgrounds and expertise. We would however like to request a few logistical changes for the next meeting.

We request that NRAO work harder to ease access for members of the UC to attend the meeting by telecon. Meetings involving discussion in a large room are difficult and frustrating to attend by telecon. The MyMeeting software works well for sharing slides, as an example. Simple ideas are the addition of extra microphones (eg. a dedicated mic for the presenter, and more mics among the UC members, and NRAO staff attending). We also recommend NRAO consider a private webcast of the room, perhaps from several angles.

We appreciated the extension of the meeting to two full days and felt that the extra time was necessary to cover all the topics. However, the days were very busy, with activities scheduled straight through both lunch breaks. While the science talk was extremely interesting and the Decadal Survey discussion useful, many of us could really have made good use of a "free" lunch break to catch up on home-institution administrative tasks or simply to recharge. We think that a little down time at lunch in future meetings will help us better provide NRAO with useful advice.

7 2009 Socorro Meeting Participants

The following members of the committee were in attendance for the meeting:
Edo Berger
Edwin Bergin
Eric Feigelson
Paul Green
Svetlana Jorstad
Hiroshi Imai
Matthias Kadler (telecon)
Amy Lovell
Karen Masters
Rachel Osten
Ingrid Stairs (Chair)
Snezana Stanimirovic
Lisa Storrie-Lombardi (telecon)
David Wilner
Lisa Young