

# 2021 NRAO/GBO Users Committee Report

June 1-3, 2021, Zoom online

## Executive Summary

The NRAO/GBO Users committee (UC) met online for two and half days and appreciated the opportunity to provide feedback on user-facing issues regarding NRAO/GBO operations.

The pandemic has brought numerous challenges. The UC was impressed that both the management and staff members of NRAO/GBO quickly adapted to the changing work and social environment, sent consistent messages to the user community, and have kept the research and educational missions running effectively and efficiently. On behalf of the entire user community, the UC wishes to thank every NRAO and GBO staff member for their effort and dedication and request that this message be passed on to the staff members.

The UC was enthusiastic about the incorporation of the Green Bank Observatory into the purview of the UC. We are hopeful that this re-established connection will increase opportunities for collaboration between the observatories, both scientifically and with regards to technology development. The UC was particularly impressed with initiatives to collaborate over radar development. The UC recognized that the protected environment for radio experiments is a precious resource for radio astronomy and that continuous instrument development at GBO is important for the future. The UC recommends having a formal GBO 2030 exercise to set priorities on the development, and to have a user-supported document for a justification of funding in the future.

Hiring has been an issue at NRAO Charlottesville and Socorro in past years. The UC was delighted that many new staff members joined the observatories and recognized that the CDL and software groups were particularly successful in the past year. The UC strongly encourages NRAO/GBO to continue monitoring the status of recruitment and retention, especially as hiring begins to pick up around ngVLA positions. The UC urges NRAO/GBO to continue supporting and developing new work models, such as long-term options for remote work. In the areas where knowledge transfer is crucial (such as in CDL), the UC recommends extending the overlap period of departing and new employees. There is growing competition with jobs in industry in the fields of software, engineering, and data science, and the post-pandemic normal may not always work to the observatories' benefit. NRAO/GBO should continue to explore ways to make positions more appealing, if not by higher wages, then through other perks.

An important area where NRAO/GBO is lagging other major facilities (now including ALMA) is in offering dual-anonymous peer reviews (DAPR) of VLA, VLBA, and GBT observing proposals. The UC feels *strongly* that this should be corrected as soon as possible.

The UC appreciates the new procedure to alert users on data and software issues that was developed as a response to the UC's request. The UC endorses the proposed procedure. The UC's position is that the observatories should always take the side of transparency when an ambiguous situation arises in the future. While its implementation starts from VLA/VLBA, the UC recommends that the policy be extended to all telescopes in the future, including ALMA.

Data management and software were a focus of our discussions. The UC was very pleased to see the significant progress in software development *on all fronts* and that the software group was particularly successful in recruitment in the past year. There were also some concerns raised regarding the obsolescence of the proposal submission tool (PST) and observation preparation tool (OPT) as discussed in the 2018 UC report. The UC strongly recommends immediate improvements in this area. The UC appreciated the planned suites of new software that would comprehensively cover the full proposal-to-data-reduction process. While we look forward to using them, one concern is that if they are released at once after years of development there is a risk that the end product could potentially deviate from the user's expectations. The UC strongly recommends to release the software piece by piece and to receive user feedback frequently and incrementally. For GBO, the UC recommends following modern trends and moving away from IDL as soon as practical, so that users can reduce the GBO data both from their observations and from the archive at their home institutions.

The UC commends NRAO for the great progress in ngVLA planning and preparation over the past 5-6 years. Depending on the outcome of the Decadal 2020 report, the transition from VLA/VLBA to ngVLA will be on the horizon. The UC does not endorse the option of immediate shutdown of VLA/VLBA at the start of ngVLA. It strongly encourages NRAO to work with the community, by forming a blue-ribbon panel or a community working group, to define options for continued US scientist access to cm-wavelength observing capabilities in the transition period. This process must be a transparent, community-wide process.

With the expansion of GBO-related discussion in the UC meeting, the UC feels that the current meeting length of 2.5-days is no longer sufficient. We would like to expand the presentations by one half-day, with the second half of the third day reserved for the closing executive session. In addition, the UC would like to receive the presentation materials at least two weeks in advance of the face-to-face meeting such that the UC can review them and hold an internal telecon one week prior to the meeting. This telecon will allow the UC to identify key focus areas for the meeting. During the UC meeting, we would like to condense some of the presentations' content and expand the time for Q&A, discussion, and executive sessions.

The UC was chaired by Jin Koda, with Ilse Cleeves as the vice-chair. Ilse Cleeves will take over the chair in 2022, and Thomas Maccarone was elected as the new vice-chair in 2022. We discuss the various topics in more detail in the next pages. **We highlight, in boldface, those issued where we request NRAO/GBO action.**

## NRAO Overview

Despite a challenging year, the UC was very impressed with NRAO and GBO's scientific output and maintained access to observational facilities, the high level scientific support for the community, the expansion of Diversity, Equity, and Inclusion (DEI) efforts, and the overall response to the pandemic.

We commend NRAO for **its proactive role in spectrum management** and preserving dark skies, and we encourage NRAO to take an active role in educating the community both within and beyond radio astronomy. We encourage multiwavelength collaboration to develop better technical solutions to some of the issues surrounding spectrum management. We are enthusiastic about NRAO's establishment of the National Radio Dynamic Zone project.

Additionally, the UC was impressed by expanded efforts around adapting to the changing work and social environment the last year has presented. The pandemic has brought a lot of challenges; however, NRAO's/GBO's flexible working models and consistent messaging have kept the observatories running effectively and efficiently over the last year. In addition, the social climate continues to change and evolve in important and significant ways. We were impressed to see the expanded dialogue and activities surrounding DEI education among staff and scientists. We recommend **supporting these activities** going forward, along with encouraging broad participation across the observatories.

The UC strongly encourages NRAO/GBO to monitor the status of recruitment and retention, especially as hiring begins to pick up around ngVLA positions. The UC urges NRAO/GBO to continue supporting and developing new work models, such as long-term options for remote work, to bring top talent to the observatory. To ensure the success of recruitment for remote positions, support will be necessary for outfitting of remote offices and/or paying for office space offsite, travel for on-site days, and flexibility with hours/time-zones. While it is clear that funding is an important point of consideration, there is growing competition with jobs in industry in the fields of software, engineering, and data science. There is a widespread feeling that NRAO wages in these areas are not competitive with industry standards. NRAO should **explore ways to make positions more appealing**, if not by higher wages, through other benefits. For example, one could allow for some fractional time to be spent on personal education or side projects of personal interest related to the observatory. Such a model may also accelerate innovation and interdisciplinary collaboration.

## ALMA Operations & Development

The UC commends the ALMA operations in Chile and the North American ALMA Science Center (NAASC) for navigating through the pandemic and now on the way to return to regular operation. The UC recognizes that we are still in the midst of the pandemic world-wide, and it is remarkable that ALMA has successfully restarted the arrays from the total shutdown, and is almost back to normal science operations. The UC is also very impressed with the management's mindfulness of staff members who were working under the COVID stress.

The UC believes that **the continuous expansion of the user base is vital to maintain broad community support for future development of ALMA, ngVLA, and other radio astronomy facilities**. On this front, the UC is impressed by the high-level of activities in the ALMA ambassador program, the start of the archival SOS program, the success of the proposal webinars/workshops, regular SOS program, Reber fellows, summer student and NAC/graduate support. The UC encourages NRAO to continue these efforts. **The UC recommends monitoring the outcomes of these activities** by tracking the number of observational proposals (and their success) among the program participants, and the number of first-time PIs. Note that in the last couple of years, the UC had decided that it is not necessary to discuss the statistics of regional ALMA publications in the UC meeting every year, while it should be continuously monitored and be brought to the UC's attention when it is required. The UC maintains this position. Please include the statistics of the user base expansion in the list of parameters to monitor.

The ALMA proposal system has significant changes from Cycle 8 (i.e., new small/medium/large proposal categories, Dual Anonymous Peer Review - DAPR, and Distributed Proposal Review - DPR). The UC is delighted that the change to the proposal categories boosted the number of medium and large proposal submissions. The UC welcomes the use of DAPR which is becoming standard for modern reviews. The UC notes that the outcomes of DPR have not been fully evaluated. **The UC recommends that NAASC work with the Joint ALMA Observatory (JAO) to analyze users' response to all of the changes**. This

analysis should include a user survey and a statistical analysis of the proposal selection results. The analysis should be performed in both the short- and long-term and **should include possible downsides** (e.g., DPR misses the expertise of those who do not submit ALMA proposals such as pure theorists or observers outside of sub-mm wavelengths). The UC learned that about 1500 proposals went into the DPR and about 15% of their PIs were non-PhDs (i.e., those declaring mentors to help their review). In the user survey, the UC recommends **including questions on how the mentoring process worked from both reviewer and mentor perspectives**, so that the observatory can learn whether the non-PhD reviewers are receiving proper guidance from their mentors. In order to facilitate the participation of the non-PhD or first-time reviewers, the UC recommends the NAASC develop a webinar (or video tutorials) for them and their mentors about reviewing proposals (e.g., writing constructive criticism, ethical issues, mentoring). The UC also recommends assessing the efficiency of communications on technical issues between reviewers and the observatory, as to whether one-on-one communications are sufficient and whether more broader communications to all reviewers at once during the review process is necessary.

Given the expanded nature of the UC with a number of new members, the UC appreciated the clear description of the ALMA development funding process and the relationships between the different regions in the way the funding is handled. The presentation also described the approach, coordinated across the executive regions, being taken to implement the ALMA 2030 roadmap, and the extensive community consultation involved in making technical recommendations. The UC commends ALMA for this approach, as we believe coordination between the regions to be the only path forward for achieving the goals of ALMA 2030.

The UC notes that the North American (NA) development program can be very proud of the important capabilities that it has produced for ALMA, including the phased-array implementation that was crucial for the success of the Event Horizon Telescope (EHT). The UC is impressed and pleased that project proposals are being considered now that meet the requirements for the ALMA 2030 correlator and a Band 6 upgrade: this is a sign that the NA community is playing an important role in achieving the ALMA 2030 goals. The requirements for the new correlator, and in particular the fact that the full spectral resolution can be employed across the entire IF bandwidth of a receiver, will have an enormous impact on all spectral line work. Having a suitable correlator ready before 2030 would help with commissioning of new receiver systems as they arrive and speed up their availability to ALMA users.

The project is aware that the entire ALMA digital system needs upgrades in order to meet the 2030 goals, and the UC trusts that the project will continue to work towards these goals in a timely fashion. The UC applauds the efforts demonstrated in the presentation to ensure that the disruption to science operations during the implementation of the new hardware is minimized: placing the new correlator at the Operation Support Facility (OSF), as anticipated, will be important to this end.

## GBO Operations & Development

The UC commends GBO for successful operations through the pandemic, efficient communications with users (virtual town hall, bi-weekly science talks, twitter, etc), and multiple educational programs to engage students *at all levels*. The UC is very impressed by GBO's presentation summarizing their development activities over the previous years. The UC commends GBO for their resourcefulness and hard work across the board, and for supporting users.

While the UC recognizes the limited budget and personnel available to GBO, it is very clear that the protected environment for radio observations at and around GBO is already a precious resource that the

radio astronomy community cannot lose. **GBO must continue in the future.** The strength of this area is its ability to enable the current and future use and development of instrumentation in the national radio quiet zone (NRQZ) which has been cultivated and established by the GBO's continuous research and educational activities. The UC recognizes that **instrument development is important for the future.** GBO has been excellent in receiving user feedback through workshops and user surveys and implementing them in the operations and planning. The UC recommends extending this effort and **having a more formal GBO 2030 exercise under various budgetary scenarios** to have a presentable user-supported document and to justify funding for additional instrument development.

The recent completion of the Phase I GBT radar system is an exciting and encouraging development. Arecibo has played a significant role as a radar transmission station for NASA, and its recent collapse has directed focus to the GBT as an important facility for planetary science. **The UC encourages GBO to actively find a role in this development** and continue correspondence with the planetary and astrophysics radar communities.

The UC applauds the efforts to secure and build a GBO archive system. The UC encourages GBO to continue to build and grow this system and to host calibrated data sets starting from legacy programs and observer reduced data. **It is also important to improve data reduction software so that outside users can easily reduce the archival data with their home computers.** Making GBO data more accessible to the community would help to grow the user base and produce archival publications. As it now stands, only experts can use the archived data. Accessibility of archived data is especially important for undergraduate and graduate students, and allows students to start working right away.

The UC commends efforts to enable operator-driven observations at GBO, and encourages this to continue. This work can be done in parallel with the development of standardized observing modes, as well as standardization of operator-driven observations incorporated as data products into the new archive.

The UC **encourages GBO and NRAO to seek more synergy** by sharing resources and knowledge in management, science and engineering, as well as education and outreach. Note that there are additional recommendations in other sections of this report, e.g., "Data Management", "Education and Public Outreach/Science Comms", and "Proposals & User communications".

## VLA/VLBA Operations & Development

The UC applauds the VLA/VLBA teams for continuing to operate and support cutting edge science during a very difficult time. Major new initiatives of the NRAO, such as the VLA Sky Survey (VLASS) and the ngVLA, have grown out of interest and support by VLA and VLBA users. It is clear that continued excellence at these facilities will be critical to the future success of the NRAO. The UC sees that the NRAO does not simply maintain the VLA and VLBA, but that they invest in innovations that improve prospects for future science. VLBA real-time correlation, the VLBA New Digital Architecture (VNDA) project, and VLA commensal instruments are all very welcome developments. They demonstrate that the NRAO has a healthy appetite for risk and an interest in supporting new users.

The UC was impressed by the retirement of risk related to aging infrastructure at the VLA and VLBA. The process of building up spare parts, power system upgrades, and focus rotation mount replacement are not highly visible, but are critical to continuous operation. Continuous operation is important for early

career and user community development. Recommendations for VLA/VLBA operations during the transition to ngVLA are included in the ngVLA section below.

The GBT/VLBA radar experiment is an impressive example of a development that opens new funding opportunities, pushes inter-observatory planning, and opens novel science capabilities. The NRAO has responded well to the failure of Arecibo by considering radar at the GBT. However, coordination of observations between NRAO and GBO facilities will remain a niche application without improvements to scheduling and planning of time-constrained observations.

The UC is happy to see that the first VLA X-proposal program is starting this year. Considering the long time spent to make this program ready, the UC recommends that NRAO **should start preparing now for the next X-proposal cycle.**

Optical astrometry satellite missions (e.g., Gaia) and the EHT are major successes that demonstrate the existence of a large community of potential VLBA users. Strong support for VLBA observers (e.g., through the Helpdesk) is a good investment in growing the VLBA user base and should continue, even if current use is limited. We feel that **CASA support for VLBA is critical** to persuading members of these other communities that the VLBA is user-friendly.

The UC appreciates the new procedure for *quickly* disseminating data and software issues to the user community. This point, as well as operations during a transition to ngVLA, are discussed in separate sections below.

## ngVLA

The UC commends NRAO on the great progress in ngVLA planning over the past 5-6 years. The current plans are impressive, and ongoing or planned studies to further refine the design are well thought-out. The project appears well-prepared to move out if / when recommended by Decadal 2020.

The UC is impressed by the momentum of product teams, as well as by the very active community science involvement, and the community-based science and technical advisory groups. These have all helped to build and maintain community support for the project. We are also pleased at the high participation in workshops / short talks / mini conferences etc. by early-career scientists. We suggest that **it might be helpful in “selling” the ngVLA to make the point that ngVLA will replace both VLA and VLBA**; this could be a selling point, or at least a mollification point, to persuade other ground-based astronomers that radio astronomy is willing to close facilities when appropriate.

The UC is pleased to hear that the prototype antenna contract has been awarded, and that other design work is proceeding. The plan to advance further as an NSF Major Research Equipment and Facilities Construction (MREFC) candidate is well thought-out, and we agree that the appropriate time to do so would be after the Decadal 2020 report is released. We suggest that the ngVLA protoproject could investigate possible partnerships with industry to address, e.g., computing issues for the array. The UC encourages the ngVLA team to **consult with people who were involved with this development stage of ALMA, or even those involved with the VLA and VLBA** - they can offer insight / advice based on hard-learned lessons from the corresponding development phases.

The UC is extremely concerned about the possibility of closing down the VLA and/or the VLBA before the ngVLA is science-usable, likely resulting in a multi-year gap for radio astronomy students and postdocs.

We do **not** endorse the option of shutting down the VLA at the beginning of ngVLA construction. **We strongly recommend that NRAO work with the community, by forming a blue-ribbon panel or a community working group, to define options for continued US scientist access to cm-wavelength observing capabilities.** This process must be transparent. A community working group to explore the transition should be identified immediately upon Decadal recommendation, and the decision process should involve the community through workshops, listening sessions, and user surveys, as well as the community-led panel and/or community working group.

## The VLA Sky Survey (VLASS)

Overall the UC is impressed with the progress of VLASS during the past year. Regarding the quick look images, the UC is happy to see the use of these images in scientific publications by the community, and the implementation of routine quality assurance steps for the quick look images themselves. Regarding the single epoch (SE) images, the UC commends the efforts put forward to satisfy the UC's previous year request for releasing 100 deg<sup>2</sup> SE images early. The UC is impressed with the solution that has been found for the critical computational challenge posed by VLASS SEs, and compliments the team for developing a faster algorithm that works over most of the sky and only fails to meet requirements in a limited range of elevations.

Going forward, the UC strongly recommends the incremental release of SE images with significant sky coverage. The UC requests that a clear, updated plan be put forward to inform the community on upcoming data releases including the SE images. **The UC strongly encourages publication of this plan within the next 3 months. The UC recommends a plan to include frequent, incremental releases of the SE images for at least 30-50% of the surveyed sky, rather than waiting for all data to be collected before a single final release.**

The UC is impressed with the software/pipeline development work undertaken during the last year. In order to distribute expertise in general new survey capabilities and related data analysis techniques, **we strongly encourage the development of a CASA tutorial (or similar) to cover the on-the-fly analysis recipe** that goes into generating the SE images for VLASS.

## Data Management and Software

The UC commends the Data Management and Software Division (DMSD) and the Science Ready Data Product (SRDP) initiative for their continued excellent progress. The UC was particularly pleased to see the continued enhancements to the NRAO archive, the broad success of the ALMA pipeline reliably producing calibrated data for the most recent observing cycles, the integration of CARTA for ALMA and NRAO archives (VLASS), and the successful recruitment for developers into software positions.

The UC thanks the DMSD and SRDP teams for accommodating the UC's request for in-depth discussions on software this year. Because of the extended discussions, this section of the UC report is relatively long. The UC made the request because some of the current proposal/observing/data reduction tools have been an obstacle for users. The issues of the current software have been discussed piece by piece in past UC meetings, and the UC felt that a discussion in the broad context of software development and management is valuable at this point. **Overall, the UC recommends receiving user feedback more frequently and incrementally throughout the design, development, release, and maintenance phases of software.** In what follows, we discuss each component of the software.

Data Archive and Data Reduction Pipelines: The UC supports continued efforts to make the NRAO archive more accessible. In particular the UC recommends that the new archive interface **enable queries across more of the metadata** associated with an observation. As one example, the UC noted that it would be useful if users were able to query based on time on individual sources within an observing block for both VLA and VLBA observations. The UC also encourages continued progress in several ongoing initiatives. Successful development of the ALMA pipelines and software support for the next generation ALMA correlator are both essential contributions to the observatory. The UC looks forward to continued development of the VLA calibration pipeline with expansion toward S and ultimately L bands. The UC recognizes that RFI and gain compression are major issues in these bands and hopes that **lessons learned from VLASS can be incorporated in the general calibration pipeline**. The UC encourages **continued development of the VLA imaging pipeline** with a goal of calibrating and imaging as much archival data as possible.

SRDP: The UC has been impressed by the quick and significant progress made by the SRDP team in the past 3-4 years. For further improvement, **the UC recommends reviewing SRDP tools frequently with a broad section of the community**. In particular, the UC recommends using an investigation of the lower-than-expected uptake for the ALMA User Driven Imaging (AUDI) as a focal point for an external user review. By engaging with external users, the SRDP project should determine how to encourage AUDI use and implement broadly-requested features from external users. For example, several UC members noted additional features they think would be helpful: it would be useful to enhance query capabilities in the new archive (e.g., search for all data sets that contain a specific spectral line and to trigger re-imaging based on those spectral lines). The ability to reimage the ALMA 7m and 12m data together from a single project would be useful as would the ability to trigger calibration and reimaging of multiple different measurement sets following a “shopping cart” style query. The 10-measurement-set limit for recalibration had previously impeded their use of the archive. The UC also suggested including an explicit identification of the recommended CASA version for recalibration in the archive interface, citing the version-dependent nature of the pipeline as an impediment. This list of suggestions is not meant to be exhaustive but are examples of features that enthusiastic community members can suggest under a user-engagement exercise.

Current and Next Generation PST/OPT: The PST/OPT have been obsolete for some time and are a barrier for potential new users and even at times for experienced users. While it may be desirable to develop the new software whose components seamlessly communicate between each other and with the database, users would likely be satisfied with only small shortcuts on the surface of the current PST/OPT (i.e., web/GUI interfaces). Such shortcuts include a wrapper to fill the boxes in PST/OPT from the user's ascii table or a table format converter between PST to OPT. The UC encourages NRAO to **consider such shortcuts to improve user experience quickly**. Additionally, the UC **strongly recommends tools to be developed to allow double-anonymous peer review soon**. The UC recognizes that ultimately a full replacement of the current tools is necessary. The UC was encouraged to see that the full suite of software from proposal to data reduction is in the scope of the next generation of development. For this, **the UC recommends an approach encouraging incremental and frequent user feedback throughout all phases of the development**. Without such feedback, the UC sees a danger that the final product may not improve user experience or may become too inflexible to accommodate ever-changing needs in the future. The UC notes that even the current standard (e.g., ALMA OT) can become obsolete in a few years.

CASA and next generation CASA (ngCASA): New and upcoming CASA improvements are all exciting. However, the UC notes the following more urgent needs of the user community:



- **Supporting Mac users is vital**, as a large fraction of astronomers use Macs. Some institutions require/mandate OS updates (for security reasons), which can render CASA inaccessible to users at those institutions. CASA support for new Mac OS releases is essential.
- The UC reiterates that **CASA needs to support VLBI use**. The requirement to use AIPS is a barrier that keeps the VLBA from being as high impact as it might otherwise be. AIPS has been stable and reliable, but is largely maintained by a single staff member, making it a potential failure point.

The ngCASA project and the high-throughput computing initiatives for CASA will enable a wider variety of user interfaces to allow work to be done on centralized computing resources. VLASS-driven development also brings useful byproducts (e.g., GPU-based gridding methods). These are welcome developments, however, **the UC again sees benefits of continuous and frequent communications with users throughout the CASA and ngCASA development**. For example, the UC does not feel the ngCASA development as urgent as the two topics above. The UC also requests that reports from the CASA users committee be routinely made available to the UC when they are issued, so that the two UCs can be on the same page.

GBO Data Reduction Software: The UC recognizes that the IDL-based software has been working reliably at GBO. However, the UC notes that it has come of age and **encourages GBT to move away from IDL in the future**, so the tools can be used by people without IDL licenses at their home institutions. IDL is largely obsolete among most professional astronomers with PhDs earned in the last 15 years. This shift is important for archival users as well as observers. Until this change can be accomplished, please highlight the fact that users, including archival users, who do not have an IDL license of their own can run the software on the GBO computers using the GBO licenses.

VO Support: The team asked what level of virtual observatory (VO) support is needed. Full compliance with all VO protocols is not necessary, but the UC would like to see data releases done in a way that can interface in a straightforward manner with common tools like astropy, astroquery and Topcat.

## Central Development Laboratory

The UC commends CDL and CDL management for an extremely effective adaptation to work-from-home during COVID-19, as well as the successful implementation of safe work procedures in the laboratory when in-person work was necessary. The UC also commends CDL for the successful recruitment in the past year. It is clear that CDL takes the lessons learned from the work-at-home transition seriously, and is acting to implement the best aspects of these policies going forward even as the workforce returns to normal. This was particularly evident in efforts to explore remote work and telework as essential tools in new recruitment efforts. Expanded use of contractors and consultants during COVID seems to have been a successful endeavor, and the UC is pleased that CDL is using these options where appropriate. The UC recommends that **care be taken to ensure that too frequent use of these resources is not depriving CDL of long-term institutional knowledge**.

The UC is pleased to see that CDL recognizes the wealth of institutional knowledge among its staff and that many individuals are the sole repository of specific expertise. Combined with a late-career workforce, CDL recognizes that there is a challenge in ensuring that new staff are hired in time to ensure as complete a knowledge transfer as possible. The UC recommends that **CDL management make**

**extending this overlap period a priority**, with attempts to plan even further ahead for replacements, ideally on the 3-5 year time horizon.

The UC believes that incorporation of students and early-career staff into CDL is vital both for developing 'home-grown' talent, but also for increasing the reach of CDL into the broader community as these individuals take positions elsewhere. In that vein, the UC wants to highlight the recent successes of incorporating CDL into the Jansky Program. **NRAO is strongly encouraged to make it a priority to ensure CDL is always represented in the Jansky Program.** Contingent on funding, the UC also recommends that CDL and NRAO examine whether CDL might be a natural fit for a restoration of the NRAO Postdoc Program, where a CDL Postdoc's service duties can *directly align* with their own independent interests and career development desires. Finally, the UC recommends that **CDL and NRAO make intentional efforts to strengthen interactions with students at the bachelors, masters, and doctoral levels** through furthering opportunities such as co-ops, internships, and on-site course work with other institutions (e.g., UVa).

In terms of recent major projects, the UC commends CDL on substantial progress on the upgraded Band 6 receiver project. The successful partnership with industry to develop patentable technology in the form of reflection filters is another highlight. The UC is pleased that CDL has incorporated encouraging staff to actively seek out patentable projects as part of its 5-year plan, but is concerned at the low overall success rate in this area thus far. The UC recommends **CDL undertake some internal self-reflection to try to determine what has and has not worked in this arena.**

## Education and Public Outreach/Science Comms

The UC commends the EPO and Science Communications teams for their excellent year-over-year progress especially in light of Covid-19 limiting in-person events. The pivot to virtual tours and planning for private fundraising are novel and the UC recommends building on that excellent groundwork. The development of virtual tours has expanded the NRAO's ability to reach groups outside of its immediate geographic regions. While both live and recorded tours have value, the UC concurs with NRAO staff comments about the strong impact of live tours. We encourage the EPO team to **pursue more partnerships with museums and planetaria** to evolve existing VR tour material into media appropriate for large-dome viewing; outside partners may also have ideas for incorporating live tours with projection onto large domes.

Education of scientists is also important. The UC recommends that the NRAO and GBO **educate external scientists on how to evaluate their work for press-release "worthiness"** as well as track whose science is promoted by the Science Communications office by geography, institution type, career level, gender identity, etc. The UC noted that the NRAO sponsors Canadian community meetings but did not comment on Mexican community meetings. We recommend that **NRAO be open to attending and sponsoring the latter if it does not already do so.**

A new VLA visitor center will require a major effort and the UC commends the NRAO for hiring staff dedicated to develop private funding. This approach is novel in the observatory community but is a useful practice at universities. **The NRAO should consider increasing donor development** to serve as a long-term supplement (but not replacement) to existing funding for the EPO and Science Communications budgets.

Finally, the UC recommends that **the NRAO and GBO partner more closely to identify possibilities for joint NRAO/GBO EPO and science communications activities**. The development of a VLA visitor center may benefit from GBO experience with its excellent visitor center. The UC recommends NRAO and GBO to help each other in science communications as well. We request that future reports to UC include more information about GBO activities and NRAO/GBO EPO synergies.

## Science Support & Research

The UC **strongly recommends implementing the Dual Anonymous Peer Review (DAPR) for all NRAO/GBO facilities** as soon as possible. The experimental phase of DAPR is over, and the outcomes are mostly positive at multiple observatories. It is becoming the standard among major observatories. The UC does not think that any managerial / technical issue can be an excuse to postpone its implementation. If there is any issue, it should be resolved immediately.

The UC commends NRAO/GBO for successfully enabling new scientific capabilities from all fronts. This includes breaking managerial barriers. The UC recommends NRAO to **continuously push for implementing ALMA joint-proposals with NRAO/GBO facilities as well as external facilities such as JWST**. The UC notes that it has been done with ALMA for EHT and GMVA and should be possible for other combinations.

The UC also suggests considering **multi-cycle small proposals** by accepting them at once or implementing a mechanism to smooth out TAC-to-TAC fluctuations. Such proposals can attract not only the astronomy transient community, but also the planetary science community, e.g., for mission support proposals (examples being the Juno and New Horizon missions) and for long-term monitoring programs (e.g., cometary apparitions through perihelion).

The UC thanks NRAO for proposing a standard procedure for communication with users about data and software issues. The UC thinks that **it is ready for implementation**, and recommends to see how it works in practice for improvement in the future. The proposed procedure leaves room for judgement (i.e. in the problem verification step), which can potentially result in ambiguity and user dissatisfaction. The UC requests that **when an ambiguous situation arises please always take the side of transparency**. The procedure may be implemented to VLA/VLBA operations first, but the UC hopes it to be extended to all NRAO/GBO telescopes including ALMA in the future.

## Fellowship, Students, and Mentorship

The UC was happy to see 5 Jansky fellowships awarded in 2020, but is disappointed that only one new Jansky appointment was made in 2021. **The UC recommends always awarding at least 2 Jansky fellowships each year and setting this as an observatory priority**. This is for the health and reputation of the fellowship: we feel that wildly fluctuating offerings from year to year harm the Jansky because potential good applicants don't know if it is worth the effort to apply in any given year. The community cannot rely on it unless it is awarded stably. In addition, NRAO is strongly encouraged to make it a priority to ensure CDL is always represented in the Jansky Program.

The UC welcomes the archival student observing support (SOS) program. The user response to this call is encouraging. The UC sees that this program is a support *not only for strong science cases, but also for a diverse range of students*, e.g., in large and small institutions. In order to find a good balance between regular and archival SOS allocations and success metrics, **the UC would like to see analyses** of the

demographics of applicants and recipients, and degree completion rates as well as publications resulting from SOS research over the long term.

## NRAO/GBO Users UC Membership

Edo Berger, *Harvard University* (2021)  
Ilse Cleeves (Vice-Chair), *University of Virginia* (2021)  
Alessandra Corsi, *Texas Tech University* (2024)  
Meredith Hughes, *Wesleyan University* (2023), ANASAC/ASAC  
James Jackson, *USRA/SOFIA Science Center* (2025)  
Melodie Kao, *ASU* (2025)  
Jin Koda (Chair), *Stony Brook University* (2021), ANASAC  
Casey Law, *California Institute of Technology* (2022)  
Laurent Loinard, *UNAM* (2021)  
Duncan Lorimer, *West Virginia University* (2025)  
Thomas MacCarone, *Texas Tech University* (2023)  
Karen Masters, *Haverford College* (2025)  
Brett McGuire, *Massachusetts Institute of Technology* (2025)  
Stefanie Milam, *NASA/GSFC* (2024)  
Susan Neff, *NASA/GSFC* (2022)  
Alexandra Pope, *University of Massachusetts Amherst* (2023), ANASAC/ASAC  
Erik Rosolowsky, *University of Alberta* (2023), ANASAC/ASAC  
Kazushi Sakamoto, *Academia Sinica Institute of Astronomy & Astrophysics* (2024), ANASAC  
Melissa Soriano, *NASA Jet Propulsion Laboratory* (2025)  
Kate Su, *University of Arizona* (2021), ANASAC  
Stephen White, *AFRL* (2021), ANASAC/ASAC