NRAO/GBO Users Committee
2024 Report

June 12, 2024

EXECUTIVE SUMMARY

The committee convened in a hybrid meeting from 21–23 May at the Green Bank Observatory and conducted a thorough review of NRAO/GBO's various operational and developmental areas, commending the organization's progress while identifying key areas for improvement. Overall, NRAO/GBO continue to deliver high-quality services and science despite funding challenges. Significant progress has been made on key initiatives like the ngVLA Conceptual Design Review, ALMA WSU development, and the next-generation radio data processing system (RADPS). The committee appreciates advancements in science-ready data products (SRDP) and acknowledges the forward-thinking approaches to future data interactions, including providing remote access for data analysis.

Efforts in GBT's preventative maintenance and the development of projects such as ALPACA, UWBR, WIKID, and ngRADAR are particularly noteworthy. However, the committee raised concerns about financial limitations affecting ALPACA, the need for clear survey prioritization, and potential duplication of existing platforms in the RADPS development. The committee stresses the importance of monitoring participation, improving user feedback mechanisms, and ensuring that developments are driven by ground-level needs rather than top-down approaches.

The addition of joint proposals with ALMA, NICER, and JWST is a positive development, and improvements in gender metrics are acknowledged. However, the lack of anonymized proposals is a concern: dual-anonymous peer review is an expectation for major observatories and the most clear-cut way to minimize review bias (including and going beyond gender bias). The committee strongly recommends implementing dual-anonymous review to minimize potential biases in the proposal review process and emphasizes the need for NRAO to innovate beyond traditional newsletters, adopting new and effective means of user engagement. In terms of user-facing communications, the committee commends the effective strategies at AAS meetings and community webinars but notes the need for innovation in communication practices and clearer distinctions between educational public outreach (EPO) and communications.

The committee was impressed by the comprehensive efforts in spectrum management, including securing NSF-funded grants and developing RFI monitoring tools. Engaging in the regulatory process and public outreach to support radio astronomy, particularly regarding the NRQZ, is crucial. The committee urges continued support for spectrum management at the current level and recommends enhancing public understanding of the NRQZ through outreach efforts.

In summary, the committee highlights several critical recommendations: maintain high engagement with the user community, especially in planning and development initiatives for RADPS and WSU; prioritize the development of TTA tools with continuous improvements based on user feedback; enhance public outreach and education efforts to increase support for radio astronomy; and implement dual-anonymous review to reduce biases in proposal evaluations. NRAO is encouraged to continue its progress and collaboration with the scientific community to address these key areas and further advance its mission.

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1 NRAO Overview

Summary. The committee commends NRAO for its continued delivery of high-quality services and science in a challenging funding environment. User support is rightly prioritized, and significant progress has been made on key initiatives, particularly in promoting diversity and inclusion. Notable milestones include the ngVLA Conceptual Design Review and the prototype antenna at the VLA site. However, the committee remains concerned about the risks posed by potential delays to critical infrastructure maintenance due to constrained funding. The leveling off in ALMA proposals and publications is a natural trend for maturing observatories, and promoting the reuse of archival data is essential. The committee emphasizes the importance of seeking external contracts, preserving unique functions if cuts become necessary, leveraging AI capabilities, and recognizing staff excellence in community support.

1.1 Findings

- The committee commends NRAO for continuing to deliver high-quality services and science in an increasingly difficult funding environment.
- The committee appreciates that user support is considered a core activity that NRAO will strive to protect against possible budget cuts.
- The committee is encouraged by progress on key initiatives and the continued emphasis on activities that promote diversity and inclusion.
- The completion of the ngVLA Conceptual Design Review (September 2024) and the prototype antenna at the VLA site (early 2025) will represent important and tangible progress towards building the ngVLA.
- The leveling off in numbers of proposals and papers from ALMA is consistent with trends seen at other maturing observatories. Encouraging the re-use of archival data in publications should be a priority. The SOS archival opportunity is a good example of such efforts.

1.2 Response to Prior Recommendations

- The committee reiterates its concern about critical infrastructure maintenance.

1.3 Concerns

- With the constrained funding environment and rising costs, the committee remains concerned about the risks posed by potential delays to needed repairs and refurbishment, e.g., re-coating the GBT and shoring up the St Croix antenna track.

1.4 Recommendations

- NRAO should continue to seek external contracts that support and complement its core missions.
- Should cuts to user-facing programs become necessary, they should be implemented in a way that preserves unique functions and prioritizes support for early career scientists.
- NRAO should continue to partner with the community to leverage AI capabilities and seek related funding opportunities, exploiting rich and uniformly-handled data sets such as the Large Programs and VLASS.
- The UC encourages efforts to recognize staff who excel in community support and values the opportunity to express its gratitude in person during its annual meetings.

2 ALMA Operations

Summary. The committee commends ALMA Operations for its continued productivity and efforts to achieve the goal of 4300 hours of observations. The transition of ACA to the baseline correlator for Cycle 11 and the increase in joint proposals are positive developments. Progress on WSU is promising, although there are concerns about its impact on operations. The committee appreciates the detailed updates on the Ambassador and student programs and encourages ongoing efforts to expand and diversify the user community. However, the committee is concerned about the lack of support for the time domain science community and urges ALMA to seek community input for improvements. Efforts to initiate conversations and science drivers for ALMA x10 are crucial and should involve engaging the science community for feedback.

2.1 Findings

- The committee commends ALMA Operations for continued productivity and efforts to achieve the goal of 4300 hours of observations.
- The committee appreciates the update and commends ALMA on the transition of ACA to the baseline correlator for Cycle 11.
- The increase in joint proposals is encouraging and demonstrates the community is considering ways to combine efforts across multiple platforms.
- The committee appreciates details on the Ambassador and student programs and encourages continued tracking of metrics and efforts to expand and diversify the user community, including more virtual options in these events.
- The committee agrees that efforts to initiate conversations and science drivers for ALMA x10 should be started and efforts to engage the science community through solicitation of white papers, workshops, and other mechanisms are needed for proper feedback.

2.2 Concerns

- While progress on the WSU is good, the committee is concerned about the impact on operations during the implementation and commissioning of the WSU.
- The committee is concerned that there have not been any new efforts to further improve ALMA's capabilities for time domain science, but understands the restrictions due to WSU. Community input on requirements for implementation to support time domain science in the era of Rubin and Roman is needed.

2.3 Recommendations

- The committee understands there are working groups investigating the impact of WSU commissioning, but encourages ALMA to engage the science community for input on strategies to most efficiently use the observatory during reduced observation time.
- The committee encourages the solicitation of white papers with specific program requirements needed to support time domain science observations be made in a timely manner. We would appreciate an update from the NRAO working group on this topic as well.
- The committee encourages efforts to track metrics on new users and consider ways to expand the user community and engage early career scientists. An exit survey from the Ambassador program participants can provide useful information on the success of the program and is encouraged.

3 GBO Operations and Development

Summary. The committee was impressed by the level of forward planning in preventative maintenance on the GBT, including significant efforts on recoating, foundation repair, azimuth wheels, track, and active surface actuators. Progress on time purchase policy and external sponsorships to offset the loss from NANOGrav is commendable. The committee appreciates the development of Dysh in collaboration with UMD and looks forward to its roll-out. The completion and utilization of the data center facility are encouraging, although clarity on survey prioritization is needed. Concerns were raised about the financial limitations affecting ALPACA's full development. Progress on WIKID, UWBR, and ngRADAR is notable, with UWBR poised to enhance NANOGrav timing precision. Addressing the competition for high-frequency time through complementary use of CHIME is recommended. Efforts to improve pointing models are acknowledged as critical for future high-sensitivity observations.

3.1 Findings

- Significant efforts by GBO staff and UMD in developing Dysh and the upcoming roll-out are appreciated.
- The completion and utilization of the data center facility are encouraging, with sufficient space for up to an exabyte (1000 PB) of data.
- The RAMPS survey data products have been archived, an excellent step in archiving and serving data from Large Programs.
- Significant contributions to future archived data will come from the cyclic spectroscopy backend, which is close to full integration.
- Progress on ALPACA, UWBR, WIKID, and ngRADAR development is noted. UWBR will enhance NANOGrav timing precision and has potential for breakthrough observations of repeating FRBs.
- Discussions on low- versus high-frequency time on the GBT highlighted the need to alleviate competition for high-frequency time through efforts like using CHIME for pulsar timing.
- Significant effort to improve pointing models, crucial for future high-sensitivity observations at higher frequencies, is acknowledged.

3.2 Concerns

- The committee is concerned about financial limitations affecting the full development of ALPACA, which may jeopardize the excellent work done so far.
- Uncertainty remains about which Large Projects will be prioritized for archiving and when this will occur.
- The competition for high-frequency time on the GBT is a concern.

3.3 Recommendations

- Provide a clear schedule for archiving further surveys into the data center.
- Continue to investigate complementary use of CHIME.
- Seek community involvement in ALPACA to identify funding, WIKID, UWBR to raise awareness for non-NANOGrav observations, cyclic spectroscopy for scintillometry, and ngRADAR.
- Continue to seek external support for GBT operations (e.g., DSN).

- Improve proposer guidance on available time vs. observing frequency and LST, similar to ALMA.
- Consider steps to enable real-time processing of scintillometry data once the current version of the cyclic spectrum backend is implemented.

4 VLA/VLBA Operations

Summary. The committee commends VLA and VLBA for their continued production of high-impact science and stable proposal pressure over the past decade. Both facilities remain at the forefront of scientific research and are expected to be critical for the next decade. Efforts to maintain aging infrastructure under budgetary constraints, including preventative maintenance, are particularly noteworthy. Progress on the VLBA backend upgrade and other technical advancements is encouraging. Public and community engagement efforts, such as the successful open house and Synthesis Imaging School, are highly valued. However, concerns remain about the long-term maintenance costs, RFI mitigation, and the complexity of the data reduction path for VLBA/VLBI through CASA. The committee emphasizes the importance of continuing these efforts and suggests exploring AI technologies for RFI mitigation.

4.1 Findings

- Both telescopes continue to produce excellent science, with high impact results and significant time on-sky dedicated to science. Both facilities have stable proposal pressure and paper production over the last decade and will remain critical for the next 10+ years.
- The committee commends the efforts at the VLA and VLBA to maintain aging infrastructure under budgetary and personnel pressure, including extensive preventative maintenance.
- Progress on the VLBA backend upgrade (VNDA) and prospects for other upgrades, including real-time processing and potential future wide band receivers, is encouraging.
- Public and community engagement efforts in New Mexico, including the highly successful open house, AAS engagement, support for 50 scientific visitors, and the continued offering of the Synthesis Imaging School, are appreciated.
- The deployment of solar panels to power the Array Operations Center is great progress.
- Deployment of user-defined VLA continuum imaging and later spectral line imaging, along with the availability of SRDP including selfcal, represents significant progress.

4.2 Response to Prior Recommendations

- The 2023 report's recommendation to emphasize long-term maintenance was reflected well in the presentations.
- It was commendable to hear that $\sim$50 science visitors were supported at Socorro last year, alongside the Synthesis Imaging School.
- The committee acknowledges that the VLBA antennas are not necessarily useful for single dish work without considerable investment.

4.3 Concerns

- Aging infrastructure and costly maintenance for both telescopes are concerns, especially since these facilities need to operate for 10+ years.
- RFI mitigation remains a major concern for both telescopes and affects their scientific utility. The potential loss of S-band for the VLBA is particularly alarming. Making RFI mitigation easy and automated is crucial for enabling science.
- Although significant progress has been made, the data reduction path for VLBA/VLBI through CASA is still not straightforward, despite being the long-term direction. The need for TEC corrections and concerns about FRINGEFIT are main issues. Keeping the VLBA CASA Guide up to date and expanding it to reflect improving capabilities is important.

4.4 Recommendations

- The committee reiterates that maintaining the availability of both facilities close to their current level of performance for over 10 years is a high priority for the US radio community.
- Continued work to enable full CASA support for the VLBA is recommended, noting the need for TEC corrections and addressing user concerns about FRINGEFIT.
- The committee commends the deployment of real-time online RFI flagging at the VLA and encourages both facilities to work on further mitigation strategies. Developing and testing software, coordination, and hardware strategies for ngVLA, including the potential use of AI technologies, is suggested.
- As on-demand user-defined imaging capabilities are deployed for the VLA, the committee recommends continued efforts to advertise these capabilities and solicit user feedback to improve them and the pipeline.

5 Data Management

Summary. The committee commends the significant advancements in science-ready data products (SRDP), including calibrated measurement sets and user-defined imaging, which are major assets for the community. Moving archives towards best practices and developing a next-generation radio data processing system (RADPS) are endorsed, acknowledging funding constraints. The success of CARTA as a collaborative international project is noted. However, the scope and impact of the RADPS project require careful stakeholder review and community consultation. The committee emphasizes the importance of detailed discussions on the ALMA Wideband Sensitivity Upgrade (WSU) impact and continued improvement of SRDP based on user feedback.

5.1 Findings

- The SRDP, including calibrated measurement sets, user-defined imaging, and target self-calibration in the pipelines, are significant assets for the community and major steps forward for the field. The availability of calibrated measurement sets is a major science-enabling factor for many users.
- The committee endorses continued support and advertising for SRDP as it enters operations mode, and looks forward to user-defined VLA imaging.
- Moving archives towards best practices (three copies, modern architecture, serving GBO large program projects) and plans to save the visibility data in a future ngVLA archive are endorsed, despite funding constraints. An astroquery hook-up for the new archive interface is an important near-term step.
- Plans for a next-generation radio data processing system (RADPS) are headed in the right direction, though they remain in early stages. The committee endorses plans to move CASA capabilities towards a library with a modern, robust architecture able to handle large data sets and interface with multiple scales of computing environments. The effort is potentially very large, and plans for multiple stages of expert external review are important.
- CARTA has been a big success as both a software product and a collaborative international project, continuing to gain traction.

5.2 Response to Prior Recommendations

- The 2023 committee recommended further automation of QA, and major strides have been made in ALMA QA.
- The overhaul of the archive interface now underway addresses last year's recommendation.
- Advertising the availability of SRDP and AUDI remains an important goal. Monitoring use of these capabilities, advertising them, and improving them in response to feedback should remain a priority, even with SRDP formally in operations.

5.3 Concerns

- The large scope of the next-generation data processing system project and its major impact on users requires careful review by all major stakeholders and technical experts. Broad consultation with users, including power users who write pipelines, is crucial. Prioritizing core capabilities, attention to the user interface, and clear communication will be important for community buy-in. A white paper describing the plan and open for community comment might be an appropriate step after the preliminary design review.
- The ALMA Wideband Sensitivity Upgrade (WSU) is frequently invoked as a driver for next DMS steps, but the exact impact of the WSU was unclear to the committee. The committee

would like to understand better the concrete, practical impacts of larger data volumes as well as plans for handling them effectively.

- With SRDP entering operations mode, it is important to continue improving this initiative. Combining multi-configuration or multi-array data sets in user-defined imaging could enhance scientific utility. Feedback driven by user use of SRDP would be ideal.

5.4 Recommendations

- The committee endorses continued progress towards a next-generation data processing system and looks forward to the results of the preliminary design review. Next year, it would be good to hear about stakeholder buy-in (NAASC, VLA, pipeline developers, general users) and partnerships. The committee also recommends sharing a white paper level description of the plans in a public way open for comment once these are available.
- The committee recommends that next year's meeting discuss the realistic impact of the WSU on users in detail. Specific topics to address include the likely impact on data volume and ability to process or analyze a median data set, as well as the most extreme cases. Guidance should be provided on the availability of compute and ability to process the median and most ambitious data upon completion of WSU.
- While maintaining SRDP in operations mode, the committee recommends continuing to solicit user feedback regarding key improvements and next steps and to remain open to improvements and future development. For maximum scientific utility for the VLA, multi-configuration imaging may be an important next step.

6 VLASS Status

Summary. The committee acknowledges the steady progress of the VLA Sky Survey (VLASS) towards completing its three-epoch survey, with significant use of current data products by the scientific community. A proposal for a fourth epoch is endorsed due to its broad scientific utility, potential to rectify data issues, and importance in bridging gaps with other major surveys. Computational and practical challenges, such as sub-optimal mosaic gridder results and pointing problems, are noted. Concerns about the long timeline for final data products are significant, with a risk of obsolescence if not available until the mid-2030s. Recommendations include timely availability of key science products, improvements to data serving interfaces, broader community consultation for future extensions, and prioritization of later epochs over the first if necessary.

6.1 Findings

- The VLA Sky Survey is progressing steadily and is nearing the completion of the originally conceived three-epoch survey. Current data products are seeing significant use by the scientific community, and the publication trajectory is encouraging.
- The time between observations and quicklook delivery has modestly decreased, which is a positive development.
- A proposal has been submitted to continue VLASS into a fourth epoch using a similar strategy as the previous three epochs, and this proposal is now under review by NRAO.
- The committee endorses the fourth-epoch proposal due to the broad scientific use of the survey, additional information from extending the survey baseline, potential rectification of SE data product issues from epoch 1, and avoidance of gaps between VLASS and other surveys such as Rubin, DSA-2000, and ngVLA.
- Current proposal pressure on the VLA suggests that the impact on general users of the additional time allocated to a continued survey is manageable.
- The committee commends NRAO for consulting their data analyst staff in advance of the proposed extension, as their support will be critical to the survey's success.

6.2 Concerns

- The computational and practical challenges of processing this large data set are substantial, requiring some tradeoffs. The mosaic gridder produces sub-optimal results for southern fields, and a pointing problem with the array at the start of the survey has complicated processing of epoch 1 data.
- Concerns remain about the overall timeline of data processing, with final data products projected to be approximately 10 years away. There is a significant risk that many of these products will be effectively obsolete if not available until the mid-2030s.

6.3 Recommendations

- The committee strongly recommends that the key science products from at least three survey epochs are available no later than 2030, to ensure the timely scientific use of the survey.
- The user community would benefit from further improvements to the serving of VLASS data products. User-friendly web interfaces and stable APIs, similar to those available for optical surveys, would increase usability and accessibility. Time-domain data products, such as queries for variable/transient sources and downloading of light curves, would be particularly valuable if the survey continues to a fourth epoch.

- While the epoch 4 proposal was community-led and included outreach at the summer AAS meeting, broader input from the user community on the merits or strategy for the extension was limited. If future delays to the ngVLA transition lead to consideration of a fifth epoch or similar extension, the full NRAO user community should be consulted prior to formulating the strategy.
- The committee endorses prioritizing epochs 3 and 4 over epoch 1 if necessary. Full processing of the epoch 1 data is desirable but not critical if pointing problems are not practically surmountable given available resources.

7 NRAO/GBO Software

Summary. The committee acknowledges the ambitious goals of RADPS and its potential to revolutionize data reduction for NRAO users through modern computing methods. The engagement with other observatories is commendable. However, concerns remain about whether RADPS development is sufficiently informed by user habits and needs. Progress on TTA tools and the continued development of Dysh are positive steps forward. Despite these advancements, the committee stresses the importance of surveying users and conducting regular reviews to ensure software developments align with user needs. Recommendations include prioritizing TTA tool development, enhancing user feedback mechanisms, and integrating "undo" functionality in all tools.

7.1 Findings

- The introduction of RADPS will represent a major paradigm shift in how NRAO users reduce data. RADPS is ambitious, and the use of modern computing methods will be key for tackling the large anticipated data volumes of ALMA WSU and ngVLA.
- The committee commends DMS for engaging with other observatories such as EHT, LOFAR, MEERKAT, and JIVE to share ideas for the design of msv4.
- The committee commends the DMS team for progress on the development of TTA tools after significant delays. Internal and external reviews have been largely positive, and the new interface appears to be well-designed.
- The continued work on Dysh is appreciated. A Python-based tool for GBT data display and reduction is essential for increasing accessibility to new users, given the widespread use of Python in astronomy.

7.2 Response to Prior Recommendations

- The UC previously recommended automated calibrator recommendation tools for the GBT. The committee is looking forward to the automated procedure set to be released in September 2024.

7.3 Concerns

- While the replacement of CASA with RADPS is critical for modernizing NRAO's data reduction approach, the committee is concerned that DMS has not yet engaged sufficiently with the current CASA user community during RADPS development. Surveying users and conducting detailed, regular external reviews will be important for ensuring that RADPS is well-matched to user needs and that resources are being appropriately deployed.

7.4 Recommendations

- The committee recommends that DMS survey users about how they engage with NRAO-related systems and software from proposal to publication to ensure that software development meets user needs. Users should be queried on usage of operating systems, NRAO data products, CASA features, and non-NRAO software used to reduce, analyze, or model data from NRAO, as well as to prepare proposals and publications. Specific recommended survey structure below. Methods for soliciting feedback beyond the NRAO newsletter should be devised to ensure a large number of responses. Aggregating information about software listed in publications using NRAO data could also provide insights into usage patterns.
- The committee continues to recommend that TTA tool development be prioritized and that DMS maintain a high level of community engagement.

- The committee continues to recommend "undo" functionality be developed as a core component and capability of all current and future tools developed by NRAO.

7.5 Survey Questions

For each of the following, users should be queried about which system(s) they are using to perform the tasks (Mac, Linux, PC), including the operating system version (Windows 10/11, MacOS X.X, RedHat X, Ubuntu LTS, etc.). They should be queried in each case about why they use those systems for that particular task.

- Which system(s) do you use for writing and submitting proposals?
- Which system(s) do you use for accessing the ALMA Archive?
- Which system(s) do you use for data reduction (e.g. calibration/self-calibration, imaging)?
- If you are choosing to re-process data provided by NRAO, why are you doing so?
  - Which products do you re-process?
  - Do you not trust the products delivered by NRAO?
  - Do the products delivered by NRAO not match your requirements?
  - Did NRAO not deliver the products you needed?
  - Something else?
- Which system(s) do you use for data analysis (e.g. viewing images, calculating values, making figures)?
- Which system(s) do you use for writing publications?

8 ngVLA

Summary. The committee commends the progress on the ngVLA antenna prototype and system design, highlighting the successful meeting of key requirements such as surface accuracy. Community engagement efforts, including international workshops and science meetings, are praised. The project's entry into the MREFC process at the Conceptual Design Phase is a significant milestone. The committee supports the plan to store raw visibilities and looks forward to the results of the second prototype study for low elevations. Recommendations emphasize the importance of remaining open to new science cases, engaging the radio community, and building and formalizing international partnerships.

8.1 Findings

- The committee commends the progress made on the ngVLA antenna prototype and on system design work. The prototype antenna is meeting key requirements such as surface accuracy.
- The committee looks forward to the delivery, installation, and testing of the antenna in Socorro, including interferometric testing with the VLA.
- Continued efforts at community engagement, including international and interagency engagement through workshops and science meetings, are appreciated.
- The committee congratulates the ngVLA project for entering the MREFC process at the Conceptual Design Phase.
- The plan to store raw visibilities, as recommended by the science community, is supported.
- The committee is interested in the results of the second prototype study to support low elevations and looks forward to the findings.

8.2 Recommendations

- The committee recommends that the ngVLA remain open to new science cases and continue to engage the radio community, as new and unexpected science cases are likely to emerge in the next few years as other facilities become operational.
- The committee recommends that the ngVLA project continue to work on building international partnerships and formalize these relationships if possible.

9 ALMA Development

Summary. The committee is impressed with the progress in ALMA development plans, particularly the Wideband Sensitivity Upgrade (WSU). Significant advancements in hardware prototyping and design reviews for North American deliverables are commendable. NRAO's efforts in promoting the WSU to the broader user community are appreciated. The committee also notes increasing traction for the ALMA x10 concept and looks forward to future updates. Recommendations emphasize the importance of engaging the user community in WSU scheduling, providing visualization tools for planning, optimizing archive functionality during the WSU era, and convening workshops to brainstorm science drivers for ALMA x10.

9.1 Findings

- The committee continues to be impressed and enthusiastic about the progress in various ALMA development plans, particularly the Wideband Sensitivity Upgrade (WSU).
- Considerable progress has been made toward prototyping hardware and completing design reviews for the North American deliverables.
- NRAO's role in promoting the promise of the WSU to the broader user community is commendable, with specific examples provided in the presentation being especially illuminating.
- There seems to be more traction for the ALMA x10 concept in the user community, and the committee looks forward to hearing more about these plans in the future.

9.2 Recommendations

- As ALMA solidifies their expected needs related to scheduling of WSU commissioning, it is imperative that NRAO and all ALMA regional entities engage directly with the user community to mitigate the effects of increased oversubscription rates. Soliciting community opinions on antenna configurations or other observing limitations during WSU commissioning cycles is recommended. At the very least, the community should be informed of decisions as soon as they are made.
- The community would appreciate simple visualization tools to plan the use of WSU modes and better communicate the science they intend to pursue. Tools for exploring spectral setups and sensitivity calculations would be valuable for forecasting research plans to align with the WSU.
- The committee is interested in learning more about plans to optimize the functionality of the archive during the WSU era, potentially by creating a set of 'template' modes appealing to broad contingents in the community.
- The committee suggests that NRAO considers convening a workshop to brainstorm science drivers for the ALMA x10 concept from the user community.

10 Proposal Outcomes and Statistics

Summary. The committee acknowledges the comprehensive summary of proposal metrics and statistics through Semester 24B for VLA, VLBA, GBT, and GMVA, noting the addition of joint proposals with ALMA, NICER, and JWST. Gender metrics indicate improvement in correcting imbalances. The proposal statistics provide valuable information for strengthening the Observatory. However, concerns remain about the lack of anonymized proposals and potential biases in the review process. Recommendations focus on monitoring participation, reviewing user profile data, and working towards the implementation of dual-anonymous review.

10.1 Findings

- The committee was presented with a summary of the proposal metrics and statistics up through Semester 24B for VLA, VLBA, GBT, and GMVA. There were a total of 694 proposals in the semesters 24A and 24B, including Large proposals ($\sim$3%), triggered proposals ($\sim$11%), and joint proposals ($\sim$9%, with ALMA, HST, Swift, Chandra, NICER, JWST, and XMM-Newton).
- The committee commends the addition of ALMA (23B), NICER (24A), and JWST (24B) to the joint proposals.
- The committee recognized that proposal statistics and associated proposer profiles contain valuable information for strengthening the Observatory. While only a fraction of this information was presented to the committee, there is much to extract, such as the inflow rate of new users to each facility.

10.2 Response to Prior Recommendations

- In its last five reports since 2019, the committee recommended anonymizing proposals to avoid bias. The Observatory concluded that it is practically impossible to modify the current system for Dual Anonymous Peer Review (DAPR) and that DAPR will have to wait for the new Telescope Time Allocation Tool (TTAT), expected "not before 2026." The Observatory currently relies on educating reviewers to avoid potential bias due to visible names on proposals.

10.3 Concerns

- Many users may not perceive the current non-DAPR + reviewer-education system as free from potential bias. For example, ALMA's non-anonymous review results had prestige bias before anonymization, leading users to be wary of non-DAPR (Carpenter et al. 2022, PASP, 134, 045001).
- Reviewer demographics appear to be controlled only for gender and scientific expertise. ALMA users tend to expect a good demographic matching, which is achieved via distributed peer review at ALMA.
- The analysis of bias in proposal review outcomes seems to be limited to gender. Given the lessons from pre-17B gender bias, it is prudent to monitor multiple factors for bias in review outcomes.
- A ratio of M/F$\sim$1 on panels represents female members of the user community being overburdened by reviewing.

10.4 Recommendations

- The committee recommends actively using proposal data to monitor the Broadening of Participation initiative and bias in the proposal review system for multiple factors, such as the PI's career stage and the type and size of the working institute. Combining the statistical analysis of ALMA-NA and other NRAO/GBO telescopes is encouraged for better synergy and mutual learning. The committee looks forward to annual reports on the statistics and analysis of proposals, the review process, and user demography.
- The committee recommends regularly reviewing the information collected in the user profile database to conduct the above monitoring. Consulting DEI experts may be helpful. Establishing a mechanism that periodically reminds users to review and update their profiles is also recommended.
- The committee recommends being mindful of the strong community desire for dual-anonymous review and working towards its earliest possible implementation. Reviewer training should continue to avoid all potential biases, including gender and prestige bias.
- The committee suggests that NRAO move swiftly to DAPR to alleviate the overburdening of female radio astronomers with reviewing tasks while while continuing to close the gap in outcomes. The committee reminds NRAO that DAPR also helps control for other factors such as prestige bias which NRAO is not currently tracking and which an emphasis on a gender-balanced panel may not directly address.

11 Spectrum Management

Summary. The committee is impressed by the comprehensive efforts of Spectrum Management at NRAO, highlighting hardware, software, educational, and visibility initiatives. The engagement from telescope users and the broader community, including RFI monitoring tools and curriculum development, is commendable. Securing NSF-funded grants for this work is a significant achievement. The establishment of an RFI working group and increased visibility of spectrum management efforts are positive developments. However, concerns remain about the regulatory process and public perception of the radio quiet zone (NRQZ). Recommendations focus on continued support, public outreach, and active participation in the regulatory process.

11.1 Findings

- The committee was impressed by the comprehensive efforts of Spectrum Management and other staff at NRAO toward spectrum work.
- Highlights and successes include hardware, software, educational, and visibility initiatives.
- Efforts that promote engagement from telescope users and the broader telescope community, including RFI monitoring tools, increased data availability, and curriculum development aimed at scientists, are heartily endorsed.
- Spectrum Management secured several NSF-funded grants related to this work.
- The establishment of an RFI working group coming out of the upcoming workshop at GBO is endorsed.

11.2 Response to Prior Recommendations

- The committee was very pleased with the developments made in response to last year's recommendations.
- Efforts to increase visibility and recognition of spectrum management work by NRAO are appreciated.

11.3 Concerns

- While the success of ongoing work with Space-X is highly promising and cooperation with the private sector is important, engagement in the regulatory process is considered equally essential.
- Concerns about the public perception of the radio quiet zone and the perception, often misinformed, of the impact of the zone on communities surrounding it may impede public support for radio astronomy.

11.4 Recommendations

- The committee endorses continued activity and support for spectrum management at the level seen in the last year.
- Continued development of tools that help the scientific community engage in spectrum management efforts is encouraged.
- The committee encourages Spectrum Management to engage in public outreach efforts to educate surrounding communities about the NRQZ, helping them understand the importance and true impacts of the quiet zone.
- The committee reiterates the recommendation to emphasize support for NRAO staff to participate in the regulatory process to protect radio astronomy.

12 User-Facing Communications

Summary. The committee commends many of NRAO's user communication strategies, particularly their strong presence at AAS meetings and dedication to community outreach through webinars and other events. However, there are concerns about the lack of innovation in communication practices and the indistinguishability between EPO, the press office, and science communications. Recommendations include adopting a version of the GBO Science Webinars, expanding user interactions at AAS, replicating the AAS experience at other venues, and ensuring a dedicated EPO/User-Communication session in future years to assess communication impact and innovations.

12.1 Findings

- AAS Meetings appear to be the single most effective mode of direct communication to users, and the committee commends NRAO for their dedication to making these exceptional events for interactions.
- The committee expresses strong appreciation for the GBO Community Webinars, which are excellent outreach to the community for both science and GBO updates.
- The committee commends NRAO for its consistent presence at meetings with large user bases besides AAS (ISMS, IMS, IAU, etc.).
- The committee found that the bulk of user feedback to the committee came from representatives listening to users at the NRAO booth at AAS.
- The strengthening of connections between user-facing communications and the public outreach/press office is positive.

12.2 Response to Prior Recommendations

- A recurring theme has been that the Newsletter is not an effective means of communicating information to users that NRAO feels is "critical." The committee has consistently recommended NRAO try new avenues and modes of communication other than the newsletter (e.g., dedicated, single-topic emails which are not walls of text). There was not much evidence of this other than updates to the format of the Newsletter.

12.3 Concerns

- The committee remains concerned that NRAO is not innovating in its communications practices.
- The distinctions between EPO, the press office, and science communications are not always clear to users.
- EPO has often given updates to the committee in prior years, and the committee was disappointed to not see at least some representation from EPO during this session.

12.4 Recommendations

- The committee strongly recommends NRAO adopt a version of the GBO Science Webinars. These should serve as both a forum for NRAO Management to update the community on topical news and to highlight excellent science being done with NRAO facilities (including ALMA). A cadence of approximately once a month is recommended, emphasizing getting early-career scientists to give the science talks.

- The committee strongly encourages NRAO to not only continue its engagement at AAS but to creatively expand interactions with users in this venue. At the very least, NRAO should have dedicated personnel from CDL to discuss opportunities for engagement beginning at the bachelor's level. Additionally, having staff on-hand to answer questions from post-bacc positions to proposal requirements and advice, to telescope capabilities, to computing resource access, and data reduction problems are all opportunities to directly engage users who are actively seeking engagement rather than passively receiving newsletters.
- NRAO should replicate the AAS experience at other communities they want to engage with, such as the Radar communities.
- NRAO should engage representatives of the Users Committee to maintain a frequent presence at the NRAO booth at AAS to solicit feedback from the community.
- The committee recommends GBO adopt a two-camera setup in the Auditorium (one rear-facing, one front-facing) to enable better engagement between the in-person participants and those attending remotely.
- The committee would like to see a dedicated EPO/Press/Science-Communication session in future years with more detailed interaction statistics. For example, assessing the effectiveness of SOS in reaching users, engagement numbers, new communication innovations tried, and their impact.
- The committee recommends implementing a "single-stream" contact method for users to reach the appropriate NRAO teams. Users should not have to know whether their communications inquiry should go to press, science communications, or EPO. A single contact form or email should be available for users, with the sorting of the correct person within NRAO to handle that interaction taken care of behind the scenes based on the users' expressed needs.

13 Next-Generation Science Platforms

Summary. The committee commends NRAO for its forward-thinking approach to how users will interact with data in the future. Providing remote access for data analysis aligns with future needs for interacting with large datasets. However, concerns include the potential for duplicating existing platforms and user hesitation about AI-supported helpdesks. Recommendations emphasize frequent communication with users, development driven by ground-level needs, leveraging existing user platforms, and exploring NSF funding opportunities for AI-related work.

13.1 Findings

- The committee commends NRAO for being forward-thinking and actively considering how users will interact with data in the future.
- It is clear that users will need to interact with future large datasets where they are stored.
- NRAO has been supporting this kind of working for decades by granting users remote access to observatory computers for data analysis.

13.2 Concerns

- The committee is concerned that NRAO may expend considerable effort re-inventing existing platforms.
- Several users expressed hesitation about "AI" supported helpdesks.

13.3 Recommendations

- The committee recommends that NRAO communicate frequently with users and the Users Committee on forward planning in this area for regular input.
- Development in this area needs to be driven by ground-level needs. The committee is more concerned about the availability of computing resources than the lack of collaborative platforms or single login.
- Working with users in the platforms they already use may be the most productive way to move forward. The committee recommends NRAO work to discover what platforms their users are currently using and what collaborative methods teams working with data make use of.
- Leveraging NSF funding calls for AI-related work may be lucrative for NRAO.