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Associated Universities, Inc.
Action Plan for Broadening Participation

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Executive Summary

Associated Universities, Inc. (AUI) and the National Radio Observatory (NRAO) are firmly committed to the principles of diversity and broad participation within its workforces and within the broader science, engineering, and public communities that their missions touch. This is rooted in fundamental AUI corporate policies, and carried through in corporate practices. It is further realized by NRAO policies and procedures, and their vigorous enforcement. NRAO has an operational Diversity Plan. It has made significant progress, particularly in diversifying NRAO's senior leadership, and its efforts across the spectrum of staff positions are ongoing.

NRAO has many programs that reach out to its broader communities, professional, educational, and lay. Some programs provide research experiences for K-12 teachers and students, and training for K-12 and undergraduate science teachers. Other programs provide hands-on training for the next generation of scientists and engineers from the secondary to post-doctoral levels. These programs are delivered in communities in West Virginia, Virginia, and New Mexico that have substantial populations of underrepresented groups.

AUI and NRAO have developed a comprehensive action plan to leverage the investments in current programs by strengthening internal policies and management structures as they relate to diversity and broadening participation, and by adding new programs to reach even farther. These management-level activities include an internal review of all AUI policies (including participation and diversity), and appointing a senior AUI corporate officer as the AUI Diversity Officer, to oversee diversity matters across all AUI-managed programs. This is linked with NRAO recruiting a professional Broadening Participation Coordinator to team with the NRAO functional-unit heads responsible for educational, training, and science program delivery in order to find ways to (1) engage members of underrepresented groups in existing programs, (2) retain a professional diversity consultant to review its diversity program and develop training for the staff to engage them further in the processes, and (3) create grassroots employee diversity groups to provide channels for direct employee input to management's diversity process.

In addition to these structural and procedural innovations, the action plan includes a broad new program to reduce or remove the barriers that may stand between members of underrepresented groups and fuller participation in current programs. There are new programs targeting such areas as K-12 teacher training, with astronomy as a context for enhancing STEM education in schools with high underrepresented populations, and mentoring and job opportunities for post-secondary students in targeted schools, such as traditionally black and Hispanic U.S. institutions, and also Chilean universities. Finally, there is a novel initiative to reduce the obstacles for scientists from underrepresented groups gaining access to NRAO telescopes and data-reduction facilities. This program provides NRAO staff as mentors to assist in the preparation of observing-time proposals, and allows the award of Director's Discretionary Time to jump start minority scientists into the system.

Altogether there are eleven specific initiatives in the AUI/NRAO action plan. Five of these are targeted at strengthening the institutional diversity infrastructure, participation, and culture; the others target broadening participation in community educational programs in astronomy and STEM, address making existing NRAO training programs more accessible, and making NRAO research facilities more broadly available to underrepresented scientists.

Associated Universities, Inc.

Action Plan for Broadening Participation

1 Introduction

Associated Universities, Inc. (AUI) is an independent, non-profit corporation committed exclusively to serving the broad national interest by constructing and operating large scientific projects and facilities effectively and with the utmost integrity. Institutions managed by AUI must be centers of excellence in their own right, with staffs comparable in quality to the faculties and staffs of major research universities. Other projects in which AUI participates must also be aimed at facilitating the highest quality research with the best possible staff. Scientists, engineers, and supporting personnel at AUI facilities have two broad areas of responsibility:

- Development, maintenance, and support of forefront user facilities for the benefit of the research community;
- Pursuit of research programs of the highest quality relevant to the broad missions of AUI's Research Centers and funding agencies, where appropriate.

To meet these requirements, AUI is firmly committed to developing and maintaining the highest caliber workforce that, at the same time, is diverse and broadly inclusive of members from underrepresented groups. AUI's high-level goals in this area include maintaining competence in the science and technical skills necessary to carry out its missions, fostering diversity among its staff, and helping to train a diverse next generation of scientists and engineers.

By the nature of their purpose and function, AUI Centers must necessarily interact with the science communities that they serve, the educational establishment that drives the research and training of the next generation of science, technology, engineering, and mathematics (STEM) expertise, the local communities that host their various operational sites, and the general public whose taxes support the whole enterprise.

As consistent with its mission, AUI is firmly committed to broadening participation in its various programs and bringing the benefits of AUI programs to a broad cross-section of the public. It does so with the same strong commitment to diversity and the involvement of underrepresented groups that it brings to its workforce. There is a great synergy and overlap between developing an inclusive workforce, and developing inclusive programs with broader public impact. Steps to reach these collective goals include:

- Aggressively recruiting staff from a pool representing a diverse cross-section of society,
- Creating a work environment conducive to the employment and retention of women and minorities,
- Creating programs that help train, and help universities educate, the new generations of scientists and engineers, including institutions that serve underrepresented communities,
- Bringing the benefits of research conducted at AUI facilities to the general public, to help develop a scientifically and technologically literate society.

While in the past AUI has had multiple operating centers supported by different agencies, at the present time its only center is the National Radio Astronomy Observatory (NRAO), which it operates under a cooperative agreement with the National Science Foundation (NSF). Thus, in presenting this *Broadening Participation* plan, we recognize that the implementation of the plan will be overwhelmingly realized at NRAO. Notwithstanding, it includes steps taken at the corporate governance level, and is representative of the general nature of actions and programs that will be taken at additional centers in the future.

The various sections that follow summarize the considerable progress that has been made to date, the new programs and program enhancements that will be done during the next five-year period, and the approaches that will be used to achieve these goals.

2 Relevant Existing Policies and Processes

AUI and NRAO both have existing policies and processes that bear on broadening participation. In general, AUI's policies reflect the governance level, and specify general policies that its operating centers must follow; Center policies are appropriate to their specific missions, and must be consistent with overall AUI policy.

2.1 AUI Staff Policies

AUI is committed to fostering an appreciation and advancement of diversity and inclusiveness in its culture and environment. In its commitment to provide equal opportunity for its staff, AUI does not discriminate on the basis of gender, marital status, pregnancy, race, color, ethnicity, national origin, age, disability, religion, sexual orientation, gender identity or expression, veteran status or other legally protected characteristics.

AUI's current policies related to equal employment and diversity are included in the AUI Organization and Policy Manual (July 2006) in Section II, entitled Personnel Policies:

A. General Principles

The development and operation of world-class user facilities and the conduct of frontier research requires a staff of the highest caliber. AUI's personnel policies, which are designed to attract and retain such individuals, are guided by the following principles:

- *Maintaining employer/employee relationships based on mutual respect;*
- *Selecting and/or promoting the best qualified candidate(s) for open positions;*
- *Enabling employees to pursue their professional goals in the context of the goals of AUI and its Centers;*
- *Compensating employees fairly and consistently;*
- *Complying with all applicable laws and regulations; and*
- *Adhering to the terms of all contracts.*

Each AUI Research Center shall develop and disseminate to its staff detailed policies suited to its missions that are consistent with these principles and with the general policies outlined in the

AUI Organization and Policy Manual. Policy and procedure manuals/handbooks developed by Centers, shall be reviewed and approved by the President prior to distribution and prior to submission for any contractually required funding agency review and approval. The Corporate Office shall also establish policies, perhaps coincident with one or more Research Centers, consistent with the principles already set forth. General oversight of the personnel policies of the Corporate Office and of the Centers rests with the Board and its Committees to which the Corporate Office shall report significant personnel-related issues.

B. Standards of Conduct

All AUI employees are expected to comply with the following policies in performing their work:

1. Policy on Non-Discrimination and Harassment

Every individual has the right to work in an environment where everyone is treated with respect and dignity, where equal employment opportunities are promoted and where illegal discriminatory practices, including harassment, are prohibited. All relationships among AUI employees, employment candidates, subcontractors, vendors, customers, guests and members of the general public must be business-like and free of bias, prejudice and harassment. Employees are expected to report incidents that are inconsistent with this policy. Allegations of discrimination and harassment will be promptly investigated and, when substantiated by the facts, remedial action will be taken.

AUI will conduct a review of its corporate policies to ensure that they are up to date and otherwise complete. As part of that process, AUI will improve the coordination and integration of its existing policies that relate to the different aspects of broadening participation and diversity to ensure that any unintended gaps are properly closed.

2.2 NRAO HR Policies

NRAO recognizes the importance of its Human Resources Policies in supporting a diverse workforce. Its Human Resources Division maintains legal and regulatory compliance with all HR policies and procedures and has been working on an initiative launched in 2007 to improve the accessibility and comprehension of its policies. It has improved the organization of and employee access to HR policies on the NRAO intranet website. It also has moved the NRAO Employee Handbook to the NRAO intranet website. Both of these changes allowed NRAO to eliminate two manuals, thereby eliminating paper waste and ensuring that supervisors and employees do not rely on outdated policies. In 2009, Human Resources will consolidate the Employee Handbook with the HR policies manual document to further streamline the documents and eliminate the redundancy and confusion resulting from describing the same policies in two separate documents. The consolidation process will include a review of all HR policies that support the NRAO diversity program to ensure that diversity is included in the policy language where appropriate. The following are examples of HR Policy sections that relate to diversity:

- Employment
- Salaries and Wages
- Basic Compensation
- Holidays
- Employee Consultation with Supervisor

- Employee Education Assistance
- AUI Trustee Scholarship Program
- Non-discrimination and Sexual Harassment
- Grievance Procedure
- Fluctuating Workweek

HR will also develop new policies to support the new NRAO diversity initiatives in the areas of training and employee involvement. These policies will help institutionalize these initiatives by making them as much a part of NRAO operations as other HR policies.

3 Current Status of Broadening Participation

AUI has made significant strides at AUI and NRAO in a variety of areas involving the nature of the participation in its workforce and public programs.

3.1 Diversity

3.1.1 AUI Corporate

AUI is committed to increasing and promoting diversity on its Board of Trustees, in its Corporate Office staff, and at its operating centers. It is also committed to supporting diversity activities in the broader science community

3.1.1.1 AUI Board of Trustees

At the corporate level, AUI has expanded on the diversity of its governance structure. Whereas maintaining and or increasing the number of women on the Board of Trustees has been a priority for some time, AUI also now considers the presence of underrepresented minorities as a factor in recruiting new Trustees. The AUI Board's Nominating Committee explicitly considers this criterion, along with diversity of discipline, relevance to our current and anticipated missions, and overall excellence, as factors in recommending candidates for new Trustees when vacancies on the Board arise. The last two additions to our Board of Trustees include a woman astronomer, and a minority computational scientist. Of the 22 elected Trustees, three (15%) are women; one is a minority.

3.1.1.2 AUI Corporate Office

Of the four Corporate Officers, one (the Controller) is a woman. She also serves on the NRAO Diversity Committee and oversees the recruitment of staff for the corporate office. In this capacity, she is in regular contact with the NRAO Human Resources Manager. Of the six staff members in the Corporate Office, three (50%) are women, one of whom is a minority. Two years ago, AUI sponsored a Workshop on Diversity Awareness for its Corporate Office staff and it will hold another workshop this year. AUI will name an AUI Diversity Officer at the corporate level, to formally oversee and coordinate all diversity plans and activities at AUI and all its operating centers. AUI will also add a broadening participation and diversity section to the public AUI website, which will highlight activities and initiatives to promote diversity in the workplace and broaden participation in AUI's programs.

3.1.1.3 AUI Support for NRAO Diversity Recruitment and Staff Development

The AUI Board of Trustees recognizes the importance of achieving a more diverse workforce at NRAO and strongly endorses and supports the diversity initiatives undertaken by NRAO. In June 2007, the Board of Trustees passed a resolution to support NRAO diversity recruitment and staff development initiatives with Corporate funds to share in the costs associated with new hires at NRAO who explicitly meet one or both of the following criteria:

- *Improve NRAO's staff diversity*
- *Maintain a staff with the technical skills necessary to retain NRAO's leadership position in radio astronomy science.*

For 2008 and 2009, the AUI Board of Trustees approved using Corporate funds to help recruit a senior African-American astronomer, who now holds a joint tenured faculty appointment at NRAO and the University of Virginia.

3.1.1.4 AUI Scholarship Program

Further affirming its commitment to education and diversity, and to providing a supportive environment for its workforce, the AUI Board of Trustees established a Scholarship Program for children of AUI and NRAO employees. Each year, three scholarships are awarded to children of regular employees of the National Radio Astronomy Observatory. The scholarships are awarded competitively and are renewable for up to four years of study toward an academic degree. In addition, up to two additional scholarships are awarded to NRAO employees' children who are underrepresented minorities.

3.1.1.5 Other AUI Support for Diversity Initiatives

AUI also contributes financial support to the broader community for workshops and meetings that endorse diversity and the promotion of minorities. Recent examples of sponsorship activities are:

- AUI provided a donation to the “Committee on the Status of Minorities in Astronomy (CSMA)” to assist in covering the costs for a luncheon held at the January 2009 AAS meeting in Long Beach. This meeting provided a forum where attendees could discuss the important role that mentoring could play in increasing the numbers of astronomers with minority backgrounds and to provide an opportunity for members and potential members of the CSMA to meet the broader community.
- AUI contributed funds for the “Third IUPAP International Conference on Women in Physics”, which took place in Seoul, Korea in October 2008. The funding was used to support publication of the conference proceedings and travel for representatives from developing countries, especially in Latin America and Africa. There were nearly 300 participants from 57 countries. The travel for one-quarter of the participants, and participation by more than one-third of the countries, was made possible by donations.
- AUI has committed to help support the upcoming meeting “Women in Astronomy and Space Science: Meeting the challenges of an increasingly diverse scientific work place”, to take place October 2009 in College Park, MD. The meeting will focus not only on gender, but also on challenges related to generations and minorities.

3.1.2 NRAO

The current NRAO Diversity Plan was implemented in July 2007. NRAO has made solid progress in increasing the diversity of its workforce and in broadening opportunities for its staff and for the general public. NRAO is building on these gains with new programs and concepts that draw from the successful experiences of a number of organizations, as well as our own.

3.1.2.1 Diversity Progress

The AUI Board recruited a male minority as NRAO Director in 2002, and he is dedicated to increasing the diversity throughout NRAO. Six Assistant/Associate-Director-level positions were filled during the past three years, three by females and one by a male minority. Moreover, international staff members hold four of the top 15 positions. A key executive position in Green Bank was recently filled by the promotion of a female astronomer. A senior female external candidate filled the opening at the North American ALMA Science Center. NRAO recently recruited one, of only three, senior U.S. African-American radio astronomers. Several Chilean astronomers have recently chosen to work on the ALMA project by joining the NRAO staff.

Perhaps the most significant positive diversity change at NRAO is the visibility of the diverse staff at the highest levels in the organization. Employees and managers can see that minorities, females, and internationals can and do rise to the highest levels in NRAO. During the same period, NRAO has actively promoted females and minorities to positions of greater responsibilities in areas below the executive level, including management.

3.1.2.2 Success Recognized

The success of NRAO's diversity program has already been recognized outside of NRAO by the leading diversity recruiting publication, *Diversity Careers in Engineering and Information Technology*, which noted NRAO's culture of diversity and career opportunities recently in no fewer than three different articles between June 2008 and January 2009, including one devoted to a special recognition of NRAO's minority Director (see Appendix A).

3.1.2.3 Workforce Investments and Future Opportunities

Developing and promoting NRAO's existing diverse staff is another measure that will retain these employees and open the door for other diverse candidates to be hired into the vacated positions. Whenever a search is conducted for a new employee, HR seeks sources that will reach minority and female candidates. For a key position, HR will engage the services of a recruiter who is tasked to deliver a diverse pool of qualified candidates for NRAO to interview. NRAO has also engaged a professional consultant to prepare its annual Affirmative Action Plan, to assess progress toward meeting goals, and to advise on any actions required.

NRAO has a number of other opportunities for broader social impact by virtue of the location of its facilities. The Green Bank telescope is located in the heart of Appalachia. The EVLA is headquartered in Socorro, New Mexico, with large Hispanic and Native American populations. ALMA's location in Chile presents opportunities for international cultural exchange. Some of these opportunities are discussed further below.

3.1.2.4 Summary of Accomplishments

Significant recent NRAO accomplishments related to advancing diversity include:

Employment:

- Hired prominent African-American astronomer.
- Hired female AD to head the North American ALMA Science Center
- Promoted two females to Associate AD level in Socorro.
- Promoted female to become AD for Green Bank.
- Promoted Hispanic male as Site HR Manager for Socorro.
- Hired female Senior Compensation Analyst (a new position) to improve NRAO's compensation process and oversee equal pay and promotion for females and minorities across the Observatory.

Human Resources Department:

- Reorganized to strengthen functional support for diversity in the areas of employment, compensation, benefits, training, and employee relations.
- Strengthened functional support of recruitment in the Human Resources Division by devoting 2.5 FTE of HR's 5.8 FTE in Charlottesville to support employment.
- Implementing an electronic resume management and applicant tracking system to identify, track and support all female and minority candidates who apply for NRAO jobs.

Diversity Recruitment:

- NRAO participates annually in the following diversity targeted conferences and job fairs:
 - Black Engineer of the Year Awards
 - National Society of Black Engineers
 - Society of Women Engineers

Diversity Related Training:

- Conduct annual management briefings of NRAO's Affirmative Action Plan
 - Led by Cornelia Gamlen of GEMS Group, a female-owned small business
- Performance Evaluation Training for all supervisors
 - Led by Joyce Oliner, a female-owned consulting service

Diversity Advertising and Recognition:

- Diversity Careers in Engineering & Information Technology, a female-owned publication
 - NRAO was voted by its readers as one of the best diversity employers in both 2007 and 2008
 - NRAO staff were featured in two articles:
 - Focus on Diversity – Gene Cole, Technical Specialist and Project Scheduler for the EVLA in Socorro, New Mexico appeared in the June/July 2008 edition.

- Feature Story – Dr. Fred Lo (NRAO Director) was interviewed for the feature story in the October/November 2008 Anniversary Issue.

Diversity Outreach – Howard University:

- Initiated contact with Dr. Marcus Alfred, Associate Professor of Physics at Howard University, to explore opportunities to work together in support of the sciences at Howard University

3.2 Educational Programs

AUI fully endorses a comprehensive Education and Public Outreach (EPO) effort as part of its mission to bring the benefits of the research facilities it operates to society as a whole. NRAO has, through the years, engaged in a variety of formal and informal education programs to help train the next generation of scientists and engineers, increase public awareness of science and its value to society, improve teacher practice in science and mathematics, and encourage students to consider careers in science, technology, engineering and mathematics (STEM). AUI encourages and supports the growth of these programs.

3.2.1 Research Experience for Teachers

As a national research center, NRAO conducts an education program that includes opportunities to engage teachers in real-world research experiences. The Research Experiences for Teachers (RET) program mentors about five teachers each year. During their appointment, teachers work with scientific staff advisers on a project in the adviser's area of expertise. Teachers also take part in a summer lecture series that introduces them to the fundamentals of astronomy and to current topics in astronomical research. Teachers also participate in workshops and educational sessions to develop classroom activities that make use of their NRAO experience. At the conclusion of their appointment, participants produce oral and written reports describing their work, and most present these results at a professional meeting during the fall/winter following their appointment. During the following school term, these teachers field-test their curricula and send revisions to EPO staff so that they can be disseminated to past and future RETs and teachers in other venues.

3.2.2 Chautauqua Short Courses

Three-day intensive residential Chautauqua programs are sponsored by the NRAO each year in Green Bank and Socorro, continuing a more than 20-year-long NRAO tradition of serving undergraduate science faculty.

3.2.3 West Virginia Governor's School for Math and Science

The NRAO has hosted the West Virginia Governor's School for Math and Science (GSMS) each summer since 2005, providing an in-depth research experience for sixty gifted, rising 8th graders, encouraging their interest in STEM careers. GSMS focuses on instilling a strong appreciation for mathematics and the sciences while students are in middle school, before they make the critical decisions that will guide their later academic and professional careers.

3.2.4 Pulsar Search Collaboratory

In 2008, NRAO proposed to NSF to establish a Pulsar Search Collaboratory (PSC), a three-year (2008-2010) NRAO – West Virginia University joint program in which teachers and students work with a worldwide team of astronomers in discovering new pulsars. The NSF Deputy Director publicly announced the success of this proposal. The project introduces students to computational mathematics and distributed computing applications, while engaging them in authentic scientific research. The program has already hosted workshops in Green Bank for 15 teachers and 35 students from West Virginia, Virginia, Pennsylvania, and Texas this past summer (2008). The workshop taught science teachers of all disciplines astronomy to use in their classrooms and engaged high school students in astronomy by teaching them to search for pulsars

3.2.5 Sister Cities: Educational/Cultural Exchange Across Hemispheres

The villages of Magdalena, New Mexico in the United States, and San Pedro de Atacama in Chile's Region II are culturally similar. They are both small, with dominantly indigenous/Hispanic populations and single high schools serving large areas; both their economies are based primarily on agriculture and tourism; and both are in high desert regions near world-leading radio observatories -- the Very Large Array is 25 km west of Magdalena; and the Atacama Large Millimeter/submillimeter Array (ALMA) is 40 km east of San Pedro de Atacama.

In 2006, with the cooperation and encouragement of the NRAO and AUI, Mayor Jim Wolfe and the Village Council of Magdalena and Alcaldesa Sandra Berna of San Pedro de Atacama officially proclaimed Magdalena and San Pedro de Atacama as Sister Cities. This opened a close relationship between these two towns, including a mutually beneficial educational and cultural exchange, nourished and funded by AUI and NRAO.

In 2007, San Pedro high-school Principal Myriam Rivera, tourism teacher Gabriela Rodriguez, and Alcaldesa Sandra Berna visited Magdalena and participated in numerous school and community events. Magdalena Schools teachers Jim Sauer and Sandra Montoya traveled to San Pedro the following July and participated in numerous educational and community activities. In 2008, two Magdalena high-school seniors spent their northern hemisphere fall semester in Chile; and two San Pedro students attended the Magdalena High School during the same semester. Videoconferences between classrooms in San Pedro and Magdalena also enable and promote the ongoing educational and cultural exchange.

3.3 Training New Scientists and Engineers

NRAO is committed to training the next generation of astronomers and engineers as a core element of its mission. Several programs exist for this purpose. They include opportunities at the undergraduate (NSF REU program, internship program, NRAO summer student program, and the engineering co-operative program), graduate (summer student program, internship program and pre-doctoral fellows) and post-graduate levels (Jansky Fellows and NRAO postdoctoral Fellows, and Research Associates). In order to reach the largest audience possible, we communicate these opportunities via the NRAO web page, the NRAO Newsletter, the American Astronomical Society Newsletter, user email lists, and through brochures distributed from booths at scientific meetings. Below are short descriptions of each program.

3.3.1 Summer Student Research Assistantships

Since its inception in 1959, the NRAO Summer Student Research Assistantship program has engaged nearly 1,000 young people in scientific research, and many of our summer students have gone on to distinguished careers in astronomy, physics, and other sciences. The list of former NRAO summer students includes women and men who represent a wide range of careers, research interests, geographic locations, and ethnic backgrounds.

To celebrate the NRAO summer student program's 50th anniversary, we are featuring the stories of several former summer students on our web site. We will periodically add new people and their stories to this site throughout 2009. Our goal is to convey the diversity of careers and experiences that NRAO summer students have enjoyed, and to encourage prospective students to connect their ambitions to the achievements of our summer student alumni. We also seek to humanize radio astronomy and help the public better understand the many possible paths to a rewarding career in science.

3.3.2 Undergraduate Internship Program

NRAO has an Undergraduate Student Internship Program. This program is intended for students enrolled in an undergraduate program at a U.S. university and who are interested in pursuing research in radio astronomy, instrumentation development for radio astronomy, or areas of electrical engineering or computer science that are closely related to radio astronomy observing techniques or data analysis. Each NRAO undergraduate student intern will work part-time, usually during the academic year. The program has been especially popular with engineering and physics undergraduates at nearby universities in New Mexico.

3.3.3 Cooperative Education

This program provides opportunities for undergraduate students in engineering, applied physics, or computer science to enrich their classroom learning experience by working closely with NRAO technical staff on projects at the technological forefront in radio astronomy instrumentation. The program offers participants a way to help finance their college education, while accumulating career-related work experience and skills, and making valuable professional contacts. In this program, students work under the supervision of an NRAO staff advisor in one or more areas of instrumentation or scientific programming. There are cooperative education opportunities available at all three of the NRAO's main sites: Green Bank, Charlottesville, and Socorro.

3.3.4 Essential Radio Astronomy

NRAO research staff have created a one-semester course called "Essential Radio Astronomy" (ERA). It is intended for astronomy graduate students and advanced undergraduates with backgrounds in astronomy, physics, or engineering. The goal of ERA is fostering the community of researchers using radio astronomy by attracting and training the most talented university students. ERA is available via the World Wide Web at no cost.

3.3.5 Workshops and Schools

For 25 years the NRAO has held the Synthesis Imaging Workshop on a biannual basis. More recently, it has partnered to offer the Single Disk School. These popular summer schools are

designed to introduce graduate-level researchers to synthesis imaging techniques. The NRAO scientific staff runs the workshop and the majority of lectures are drawn from the staff. The synthesis workshop has educated 1,450 participants within the U.S. and the world since its inception. The style and format of the NRAO workshop has been widely emulated by other National centers.

3.3.6 Graduate Student Internships

The Graduate Student Internship Program is intended for graduate students who need to gain some experience in radio astronomy, instrumentation or algorithm development for their PhD research. The goal is to build research connections between NRAO and U.S. universities, allowing the latter to draw upon the unique research expertise of the NRAO staff.

3.3.7 Pre-Doctoral Research Program

The program is jointly sponsored by NRAO and universities that wish their Ph.D. thesis students to have a concentrated exposure to radio astronomy research, its instruments, or its computational techniques. With the consent of the student's academic department, the student comes to the NRAO to do thesis research under the supervision of an NRAO scientist or engineer. The duration of the appointments range from several months up to two years. The time spent at the NRAO need not be continuous. Opportunities for participating in the pre-doctoral program are available at all NRAO sites.

3.3.8 Student Observing Support

NRAO maintains a program to provide financial support of research by students, both graduate and undergraduate, at U.S. universities and colleges. This program is intended to strengthen the proactive role of the Observatory in training new generations of telescope users. Students who submit successful observing proposals for telescope time are eligible to apply for research funds.

3.3.9 Postgraduate Programs

The Jansky Postdoctoral Fellowship Program remains one of the top postdoctoral fellowship programs in the world. Jansky Fellows carry out investigations independently or in collaboration with others within the wide framework of interests of the Observatory. About half of the roughly 14 fellows are in residence at NRAO, while the others are located at U.S. universities or research institutes. Resident fellows are encouraged to spend time at universities working with collaborators during the course of their fellowship, while non-residents are encouraged to make frequent and/or long-term visits to the NRAO sites. An annual NRAO postdoctoral symposium is held (rotated between sites) to keep all postdocs connected to NRAO and each other, and to allow them to share their research results.

In addition to the Jansky Fellows, the Observatory funds the NRAO Postdoctoral Fellows and Research Associates. These appointments are similar to Jansky Fellowships, but the NRAO Fellows and Research Associates have responsibilities (up to half time) for the operation and support of the NRAO facilities.

3.4 Science Research Support

NRAO works to facilitate a vibrant U.S. radio astronomy community. This is accomplished in a variety of ways including staff community service, visitor programs, organizing science meetings, and funding university-led hardware and software projects. All of these interactions keep the NRAO engaged in the wider astronomical community, and more importantly, act as a conduit through which the community can maintain its connection to the NRAO. One of the more tangible benefits of these programs is that they allow for community-wide input into Observatory priorities for science, instrumentation, and algorithm development. We describe a few of these programs below.

3.4.1 Visitor Research Support

The NRAO encourages, and can provide financial support for, Ph.D. scientists and engineers in radio astronomy and related fields to visit any of its sites to interact with NRAO staff and to carry out research programs other than while observing. The length of a visit can range from weeks (e.g., summer research visits) to months (sabbatical visits). NRAO is particularly interested in supporting visits by young scientists who are junior faculty members at colleges and universities, and in encouraging collaborations that may lead to "first light" science with new instruments. NRAO has also initiated contacts with Chilean universities to establish exchange programs in astronomy and related technology.

3.4.2 Travel Support

To increase U.S. astronomers' access to radio telescopes, NRAO supports the cost of visitor travel with two different programs.

3.4.2.1 Observing, Data Reduction and Page-Charge Support

NRAO manages the peer review process for the allocation of telescope time for all of its telescopes. As part of that process NRAO supports the cost of travel to the NRAO to observe, and to reduce data. In addition, NRAO pays page charges to cover the cost of publishing in peer-review journals. These programs are especially useful in cases where traveling to observe at a distant radio telescope and the cost of publishing research results can be an economic hardship on the investigator's institution and therefore represent barriers to US astronomers' participation in radio astronomy research,

3.4.2.2 US Astronomers at Foreign Telescopes

On behalf of NSF, NRAO manages, a program that provides funding to support observing by U.S. astronomers at foreign-owned telescopes. The program operates on a first-come, first-served basis during each calendar year and there is no wait list. One person's travel is supported per observing run, although exceptions to this rule have been made in cases of exceptional urgency.

3.5 Broadening Participation via Chilean Outreach

AUI and NRAO are in a special position by way of their operations in Chile. Whereas astronomy has a long history in Chile, Chile's place in radio astronomy is taking a dramatic leap forward with the construction of ALMA as a world-leading radio astronomy observatory. This

provides us with a unique opportunity to broaden participation, both by reaching out to the Chilean public, and by engaging Chileans in radio astronomy and technology.

We have started informal exchange programs with universities; this will be expanded via initiative 4.10. NRAO also uses astronomy to help in the development of a more scientifically literate society in Chile. We have set up a sister cities program, mentioned above. In addition, NRAO's extensive public outreach program in the U.S. has been extended to Chile, through interviews and news translated and relayed to the Chilean media. AUI created a Chilean Advisory Committee in 2008, composed of known Chilean personalities from many walks of life, including business, media, science, telecommunications, and the mining industry, expanding the reach of our organization in Chile. This Committee is allowing us to reach a broader section of the Chilean community, understand their needs, and at the same time is providing us with a valuable political and social umbrella.

4 Broadening Participation Initiatives

AUI and NRAO are implementing a suite of *Broadening Participation* initiatives over the next five years. The initiatives constitute a structured *system* of interrelated steps that reinforce the AUI/NRAO participation and diversity infrastructure, and then connect it to important programs that broaden participation. Some of these initiatives are totally new programs, while others provide important new features to the platforms provided by existing programs, thereby providing significantly leveraged new access to these programs.

4.1 AUI Policy Review and Update

AUI operates under *Corporate Bylaws* and maintains an *Organization and Policy Manual* under which the Corporation and its operating centers must function. As time passes it is inevitable that circumstances will change and situations will arise that may not have been fully anticipated when such documents were last considered. Thus, from time-to-time such documents need to be reviewed in order to ensure that they are up to date.

4.1.1 Action Item

AUI will conduct a comprehensive review of the AUI *Organization and Policy Manual* and update AUI policies to ensure that they are current and otherwise complete, including ensuring that any unintended gaps relating to broadening participation and diversity are properly closed. This will include a review of the AUI Strategic Plan, and suggestions for modifications as may be appropriate to broaden participation in AUI programs.

4.1.2 Approach

The AUI Corporate Office will initiate a review of the current Manual. It will identify any deficiencies, and make preliminary recommendations for modifying existing policies and/or creating new policies where appropriate. It will present the results of this review to the AUI Board at its June 2009 meeting. Following discussion by the Board, AUI will develop a final set of recommended Policies, present them to the Board's Operations and Administration Committee for discussion, and bring them to the full Board for approval at its annual meeting in October 2009.

Since the AUI Strategic Plan has not been reviewed for a number of years, an effort has already been initiated to review the plan in the light of changing research priorities in the country. In addition, AUI's Strategic Planning Committee will be asked to review the Strategic Plan in the light of the goal of broadening participation in AUI programs

4.1.3 Goals, Metrics, and Consequences

The goals and milestones for this program are to:

- Complete a comprehensive review of AUI policies regarding all matters, including broadening participation and diversity, by the June 2009 AUI Board meeting.
- Present the results of this review to the AUI Board in June 2009.
- Develop a final set of proposed policies, with new and amended policies as indicated, and present it to the AUI Board's Operations and Administration Committee before October 2009.
- Secure full Board approval at the annual meeting in October 2009.

AUI will report the outcome of the Board's final policy actions in the next Quarterly Report after October 2009. Any serious delay of the process could pose potentially serious issues on a number of fronts, not just broadening participation.

4.2 AUI Diversity Officer

While AUI has been increasingly proactive in monitoring and enhancing diversity, both at the corporate governance level and at NRAO, there should be a named individual, responsible to the President and the Board, who ensures that diversity considerations receive high visibility, and that diversity efforts are coordinated across the organization. This will be especially important as AUI explores new business opportunities, with the anticipation of multiple operating centers. The Diversity Officer will be responsible for coordinating and monitoring diversity initiatives, collecting metrics on diversity across the organization, generating summary reports as required, and making recommendations for policies and initiatives as appropriate. The AUI Diversity Officer will also serve as an ombudsman for diversity issues across the organization. A section of the AUI Website will be devoted to diversity issues, under control of the Diversity Officer.

4.2.1 Action Item

AUI will name an AUI Diversity Officer, reporting directly to the AUI President.

4.2.2 Approach

The Diversity Officer has already been named: Ms. Cynthia Allen, an existing Corporate Officer. A Charge for the Diversity Officer, and recommendations for a Diversity and Broadening Participation section of the AUI Website will be developed.

4.2.3 Goals, Metrics, and Consequences

The program goals and milestones are to:

- Name the AUI Diversity Officer – *Done*.

- Develop and authorize the AUI Diversity Officer's charge/job description by June 2009.
- Develop recommendations for the AUI Diversity web section by September 30, 2009.
- Implement the new web section by January 31, 2010.

AUI will provide a brief report on the status of these milestones semiannually beginning in July 2009, and ending when all the milestones have been accomplished. This report will be appended to the existing NRAO quarterly reports. If for any reason a milestone is not reached on time, AUI will include an explanation and a summary of the mitigating steps to be taken.

4.3 NRAO Broadening Participation Coordinator

NRAO is establishing several significant programs to achieve Broadening Participation goals. These cut across a number of different Observatory departments, including HR, EPO, and SAA, and also across NRAO's wide spread operations sites. Given this breadth, it will be essential to have a full-time professional with appropriate diversity expertise dedicated to ensuring the coordination, execution, and tracking of these programs.

4.3.1 Action Item

NRAO will develop a full-time Broadening Participation Coordinator position within NRAO and fill it in 2009.

4.3.2 Approach

NRAO will retain the services of a diversity consultant to assist NRAO in defining the role and objectives of the Broadening Participation Coordinator position, including the processes that need to be in place to support the position. NRAO believes this investment in expertise, money and time will help ensure that the Broadening Participation Coordinator is successful in the job. The Broadening Participation Coordinator will be involved in all diversity related activities throughout the Observatory, including HR, EPO, SAA, and site-based community support and outreach activities.

4.3.3 Goals, Metrics, and Consequences

The goal and milestone for this program are to:

- Identify a qualified professional as the NRAO Broadening Participation Coordinator and have this person in place by December 31, 2009.

NRAO will advise the NSF of the outcome of this effort in FY2010 quarterly reports spanning the period.

The Coordinator is seen as fundamental to carrying out the balance of the NRAO broadening participation initiatives described below. Failing to meet the time line above would threaten the timetables for virtually all of the remaining NRAO initiatives.

4.4 Diversity Training and Review

Broadening opportunities and enabling the participation of all citizens, women and men, underrepresented minorities, and persons with disabilities, are essential to the health and vitality of science and engineering. AUI/NRAO is committed to this principle of diversity and deems it central to its programs, projects, and activities. Training managers and staff to understand and support diversity is a critical program element. In addition, having an external professional review and provide feedback on the state and direction of the effort is seen as an important element in the overall ongoing diversity program effort.

4.4.1 Action Item

NRAO will train all staff on priorities and mechanisms for broadening participation and workforce development, including topics such as *EEO*, *Affirmative Action* and *Diversity in the Workplace*.

4.4.2 Approach

AUI/NRAO will engage a professional trainer, experienced in the areas of employment law compliance and diversity in the workplace. This trainer will develop a suitable training program and deliver the training to the staff during the fourth 2009 and first 2010 quarters. The consultant will also be charged with reviewing the current overall diversity program, and providing advice on proposed new efforts.

The training program will include units on:

- Gender awareness,
- Diversity,
- Disability, pregnancy, and religious accommodation,
- Harassment prevention, and
- Affirmative action.

There will be two training course levels: One for supervisors and another for employees. The courses and materials will be organized for live presentations and also provided as video recordings of the presentations, suitable for use, as needed, for both new employees and as make-up tools for staff members who are unable to attend scheduled live presentations.

The trainer will deliver the initial training in person at each of the principal NRAO sites in Charlottesville, Green Bank, and Socorro. Some training may be delivered by live video, and AUI Corporate staff will participate in one or more of the sessions.

4.4.3 Goals, Metrics, and Consequences

The initial program goals and milestones are to:

- Complete the training procurement contract by July 31, 2009.
- Complete the program development by October 31, 2009.

- Complete the initial face-to-face training sessions, with at least 90% staff participation, by December 31, 2009.
- Complete video training for all the staff that did not attend the initial face-to-face training by March 31, 2010.

The long-term goals are to ensure that:

- All new employees receive at least the video training appropriate for their level of responsibility within the first week of employment.
- All ongoing employees at the principal sites will receive refresher training annually.

NRAO will report its training-program progress against the above milestones to NSF in its quarterly reports. The report will include the percentage of completion for each milestone, and where appropriate, contain a description of the training delivered and the number and percentage of employees who completed or did not complete the diversity training. If there are serious discrepancies between the actual progress and the above schedule NRAO will determine suitable remedial steps and advise the NSF of the proposed mitigations.

Failure to meet these goals in a timely way will impede progress-enhancing inclusivity throughout the Observatory, thereby lessening the attractiveness of NRAO to diverse job candidates as an employer of choice.

4.5 Grassroots Employee Diversity Participation

In addition to the traditional top-down approach for initiating organizational change, AUI/NRAO will incorporate both bottom-up and top-down approaches, working in concert, to support and strengthen the diversity program throughout the organization. This initiative engages employees at the grassroots level to promote employee diversity commitment and acceptance, in a way that directly complements the “top-down” Diversity Committee.

4.5.1 Action Item

AUI/NRAO will formalize the bottom-up approach by encouraging and supporting the formation of Employee Diversity Groups (EDGs) along diversity lines (e.g., women, men, minorities, persons with disabilities, older persons, religious persons) to actively participate in the organization’s diversity efforts.

4.5.2 Approach

The Diversity Committee will oversee and support the development and formation of volunteer employee groups organized along diversity lines over the course of the next five years, with joint leadership support and commitment from the Director’s Office and NRAO’s site Assistant Directors, with AUI Corporate oversight.

On an ongoing basis, the Employee Diversity Groups will be free to initiate conversations with, and act as information channels to, the Diversity Committee for advice, feedback, and insight regarding staff diversity issues and concerns. The Diversity Committee will establish procedures by which the resulting ideas flow freely and are shared among the various geographic locations,

and ensure that these dialogs move forward to resolve issues and enhance the culture of diversity sensitivity within the organization.

This program is breaking new ground in several respects, and the details of its implementation are still being developed. While NRAO's *Diversity Plan* has been in place and operational for more than a year and a half, taking the effort to the next level is intimately tied to the creation of the AUI Diversity Officer (4.2) and NRAO Broadening Participation Coordinator (4.3) positions, and rather immediately to the *Diversity Training Program* (4.4), all as previously described here.

Broadly, the detailed formation and empowerment process of the EDGs will be linked to the Training program. As a component of that program, the diversity-training consultant will work with AUI and NRAO to flesh out the EDG formational and operational processes. Thus, the introduction of these concepts will be introduced to the NRAO staff as an important component of the initial (and subsequent) employee diversity training.

4.5.3 Goals, Metrics, and Consequences

The initial goals and milestones for the program are to:

- Complete the plan for EDG roles, formation, and startup processes by October 31, 2009.
- Begin active EDG formation with major training completion by January 1, 2010.
- Complete formation and begin operation of first-round EDGs by April 1, 2010.
- Begin an internal review the first six-month period of EDG/Diversity Committee interoperation by October 31, 2010.
- Complete the review with an assessment of performance, and recommendations for improvements by December 31, 2010.

The long-term goal is to:

- Establish the Diversity Committee/EDG function as a valuable and respected part of the AUI/NRAO diversity culture.

NRAO will report its training-program progress against the above milestones to NSF in its quarterly reports. The report will include percentage of completion of each milestone, and where appropriate, contain a summary of the resulting plans, findings, new directions, and actions to be taken. If there are serious discrepancies between the actual progress and the above schedule NRAO will determine suitable remedial steps and advise the NSF of the proposed mitigations.

Failure to complete this initiative would create an atmosphere of employee disillusionment with AUI/NRAO management over its commitment to diversity, thereby substantially impeding progress toward building a more diverse workforce. To avoid failure, this initiative will require active oversight, and prompt action by management, if necessary.

4.6 University Diversity Recruiting

AUI/NRAO offers unique employment opportunities in localities that generally fall outside the mainstream locales for most job seekers. As a result, those positions that AUI/NRAO must

recruit beyond just the local areas, in order to have adequate pool sizes, also offer great potential for expanding AUI/NRAO staff diversity, precisely because it reaches into markets where qualified diverse candidates reside. Experience has shown that the areas of science, engineering, information technology, administrative professionals and management offer the most opportunities. An important source of such potential candidates is the colleges and universities that have high student-population fractions from traditionally underrepresented groups.

4.6.1 Action Item

NRAO will establish internal support and external university outreach processes that increase NRAO's ability to attract and hire diverse candidates from local and, where applicable, remote labor markets.

4.6.2 Approach

NRAO will develop a program that establishes employment and mentoring relationships with universities that graduate diverse students in the fields of science and engineering. Building on the groundwork laid by AUI and NRAO (section 3.1), the unfolding relationship with Howard University will become a model for building similar relationships with other diversity-oriented universities. This model will be developed by:

- Partnering with Howard University – with Dr. Marcus Alfred as NRAO's prime contact.
- Actively recruiting Howard students for NRAO's Summer Student programs and co-op positions.
- Working to establish NRAO mentors for Howard students.
- Sending NRAO scientific staff members to Howard to conduct scientific lectures and discuss career opportunities in the field of astronomy.
- Annually placing one or two Howard undergraduates at NRAO in REU-type positions.
- Attracting scientists at Howard to conduct research with NRAO and other observatory facilities.
- Becoming a preferred employer for Howard science graduates.

The lessons learned for this effort will result in a fine-tuned approach that will be documented and established as NRAO's university outreach program, which will be reproduced in other suitable venues as resources permit.

4.6.3 Goals, Metrics, and Consequences

The initial goals and milestones for the program are to:

- Target the recruitment of one Howard University student for NRAO's Summer Student program or co-op program each year, beginning in 2009.
- Beginning with 2009-2010 academic year:
 - Establish at least one mentor relationship with Howard students each academic year.

- Send at least two NRAO scientific staff members to Howard each academic year to conduct scientific lectures and discuss career opportunities.
- Annually place one or two Howard undergraduates at NRAO in REU-type positions, beginning in the summer of 2010.

The long-term goals are to:

- Build a successful relationship with Howard University and use this model to develop new relationships with other diverse universities.
- Establish on-going, mutually supportive relationships with a multiple of universities that graduate diverse students in the fields of science and engineering.

NRAO will report these activities to NSF in its quarterly reports. The report will contain a summary of diversity recruiting activities including the number and diversity of Howard University students enrolled in NRAO's Summer Student program or co-op program, mentoring relationships established with Howard students, and Howard undergraduates working at NRAO in REU type positions. There will also be a summary report on NRAO scientific staff member visits to Howard University to conduct scientific lectures and discuss career opportunities, and the number of Howard University scientists doing research with NRAO and other observatory facilities.

Failure to meet these goals will limit NRAO's ability to increase staff diversity in the near and long term future. NRAO will strive to support Howard University students and faculty to mitigate problems that may adversely impact their ability to participate in NRAO programs.

4.7 K-12 Science Education for Disadvantaged Populations

The AUI/NRAO research facilities are located in relatively remote parts of North America, which are homes to ethnically diverse and economically and educationally disadvantaged populations. The Robert C. Byrd Green Bank Telescope lies in the heart of Appalachia. The Expanded Very Large Array (EVLA) operates in a part of the southwest U.S. that encompasses many disadvantaged Hispanic and Native American populations. Several of the Very Long Baseline Array (VLBA) antennas are in underserved regions. Educational opportunities and student performance in these regions frequently fall below national standards. AUI/NRAO can have a substantial positive broader impact by addressing science education for these underserved communities in a more targeted manner, in conjunction with the office of the Broadening Participation Coordinator and in partnership with SAA and EPO.

4.7.1 Action Item

NRAO will create and deliver K-12 education opportunities and content, using astronomy as subject motivation and context for STEM education, targeting underrepresented/disadvantaged populations in regions of North America that host AUI/NRAO research facilities. (An optional, currently unfunded, enhancement for this program is described in Appendix B.)

4.7.2 Approach

Using a phased approach, the NRAO EPO will create and distribute content about radio astronomy science and technology that are appropriate for K-12 science and mathematics curricula. The target audience will be science and mathematics teachers, in order to improve the quality and availability of science education in the school districts in the disadvantaged communities near NRAO research facilities. We will establish a partnership between the NRAO, the Astronomical Society of the Pacific (ASP), and the targeted schools and districts enabling direct access to STEM content available through educational networks, such as Project ASTRO and Astronomy from the Ground Up. We will mine, adapt, and blend content from these networks in innovative ways with science and technology content developed by the NRAO education team for other purposes.

EPO management will work closely and collaboratively with the Observatory's Broadening Participation Coordinator to ensure that our education staff can quickly and efficiently be connected with the target disadvantaged populations and gain an improved understanding of how the NRAO meet their particular needs.

The first phase of the program will begin in Pocahontas County, WV, in FY 2010. Pocahontas County is the site of the Robert C. Byrd Green Bank Telescope and the Green Bank Science Center, and NRAO has well-established ties to the local K-12 education community. The disadvantaged populations in this region are primarily lower-income families.

Working with the ASP and the school districts, the NRAO will identify the target audiences, and then create and test the program's content and methods in the classroom. We will proactively work to engage the local teachers and school boards in our program and will flexibly adapt to the particular interests and curricular requirements for our target K-12 audience.

In FY 2011, the second phase will expand the program to the disadvantaged populations in Socorro County, the home of the NRAO Pete V. Domenici Science Operations Center, the Expanded Very Large Array (VLA), the Very Long Baseline Array, and the VLA Visitor Center. As in West Virginia, the NRAO facilities there are already well connected to the local K-12 community, for example, through the Sister Cities program developed by AUI/NRAO with the Magdalena, NM school district near the VLA.

For this new education program, we will adapt the science content and methods developed in West Virginia the previous year to the needs and requirements of the New Mexico curriculum and the local school districts, specifically targeting the quality and availability of science education for the region's large disadvantaged Hispanic and Native American populations.

In FY 2012, the third phase will expand the program into the Charlottesville and Albemarle County, VA where the NRAO Headquarters and the North American ALMA Science Center reside. The Director's Office and the EPO Office have established connections to the local K-12 STEM education communities in FY 2008, and these will expand in the coming years via other EPO initiatives. The target audience for this program will be improving the quality and availability of science education for disadvantaged African-American students in Charlottesville

city public schools and students from the lower socio-economic tier who attend disadvantaged rural schools, many of which are close to Charlottesville and serve a good fraction of the county.

4.7.3 Goals, Metrics, and Consequences

The delivery of the programs must be coordinated with the underlying host-school calendar year. Thus, the following timetable is feasible, but preliminary, and subject to discussions and negotiations with the respective school systems, which have yet to be undertaken. Targeting teachers, the schedule below is based on the assumption of a summer delivery for the first program. However, there are other credible schedules that might be implemented at other times of the year and that could affect the timetable details.

The initial goals and milestones for the program Phase 1 are to:

- Begin conversations the Pocahontas County school officials by September 30, 2009.
- Complete agreement on needs and methods by December 31, 2009.
- Develop first-pass curriculum content by May 31, 2010.
- Finish initial program delivery by September 30, 2010.
- Do critical evaluation of outcomes and begin any program revisions by November 30, 2010.
- Create plan for next delivery by December 31, 2010.

The goals and milestones for the program Phase 2 are to:

- Begin conversations with Socorro County school officials by January 1, 2011.
- Complete agreement on needs and methods by March 31, 2011.
- Develop (now second-pass) curriculum content by May 31, 2011.
- Finish initial program delivery by September 30, 2011.
- Do critical evaluation of outcomes and begin any program revisions by November 30, 2011.
- Create plan for next delivery in Pocahontas County by December 31, 2011.

The goals and milestones for the program Phase 3 for Charlottesville and Albemarle Counties follows the same schedule as Socorro County, with all the dates, one year later (2011/2012).

The long-term goal is to:

- Sustain the program in each of the localities on an annual basis.
- Work toward ultimately training “master teachers” within the school systems who, in turn, will conduct similar trainings on a self-sustaining basis, reaching an even wider number of schools and students.

NRAO will report progress on a quarterly basis. This will initially be based on meeting the milestones in the proposed three-phase start-up schedule. NRAO will report any schedule changes that might result for host-school requirements and re-phase the program if required. When appropriate, NRAO will report such statistics as the number of K-12 teacher and student contacts achieved by the program at each location.

NRAO will create an assessment tool for use with local school boards, and the teachers whose classes employ the program's content and methods. We will include a summary of the program and its evolution via the annual Progress Report, including any programmatic changes motivated by the assessments.

Failure to achieve the goals would mean that the NRAO outreach program is not serving the most needy students and teachers in the communities that host NRAO research facilities.

4.8 Radio Astronomy for Teachers

The state of New Mexico is home to an especially large and often disadvantaged population of Hispanic American and Native Americans. The development and long-term support of K-12 STEM education programs that specifically target and serve these disadvantaged populations are vital to achieve the goal of effectively integrating Hispanic and Native Americans into the U.S. mainstream.

4.8.1 Action Item

NRAO will improve the quality of K-12 STEM teaching and increase the understanding and awareness of radio astronomy science, technology, and their value among K-12 educators.

4.8.2 Approach

NRAO will partner with the New Mexico Institute of Mining & Technology (NM Tech) in Socorro, New Mexico, and the NM Tech Department of Astronomy and Physics, to design and produce periodic summer workshops for graduate students enrolled in the Master of Science Teaching program. This program provides high quality, content-based, hands-on, experiential STEM learning for practicing K-12 educators.

To facilitate transfer of knowledge and skills to K-12 students, the program requires teacher participants to develop inquiry-based curriculum for their respective classrooms and laboratories from what they experience as they pursue a graduate degree in science teaching. A research internship component provides active involvement by teacher participants at research centers of excellence, including the NRAO. Curriculum development and implementation originating from these experiences allow teachers to open the world to their K-12 students, offering them a comprehensive understanding of complex diversity issues worldwide. Elevating K-12 teaching to this level is an increasingly important aspect of education as we move toward a more global society.

This collaboration between NRAO and the NM Tech Department of Astronomy and Physics will provide two-week residential programs in radio astronomy and optical astronomy in alternate

years. The first radio astronomy program conducted and led by the NRAO will be scheduled for summer 2010.

4.8.3 Goals, Metrics, and Consequences

The initial goals and milestones for this program are to:

- Formalize partnership with NM Tech and the Master of Science Teaching program by October 1, 2009.
- Develop a plan to recruit graduate students from disadvantaged populations by December 1, 2009.
- Develop a course syllabus and support materials by February 1, 2010.
- Conduct the first Radio Astronomy for Teachers course by September 1, 2010.
- Review course evaluations and modify the curriculum by December 1, 2010.

The long-term goal for this program is to:

- Create an effective partnership with NM Tech and its Master of Science Teaching program so that the AUI/NRAO K-12 STEM education initiatives have the broadest possible impact, especially for Hispanic and Native American populations.

We will track and report the number of Masters of Science Teaching program graduate students enrolled in the Radio Astronomy for Teachers programs. We will also request that the students volunteer to periodically contact the NRAO regarding the value and impact that the Radio Astronomy for Teachers program has for their K-12 STEM teaching. We will also create an appropriate assessment tool for the graduate students to evaluate the summer workshops, and provide reporting via the NRAO Progress Report and Program Plan.

Failure to achieve our goal would mean the loss of a significant opportunity to work directly with a cohort of K-12 STEM educators who are likely to spend a significant fraction of their teaching careers in states, such as New Mexico, with significant disadvantaged populations.

4.9 Scientist and Engineer Training Access

The education of the general public about radio astronomy and the education, training, and career development of the future generations of scientists and engineers is vital to sustaining a vigorous and productive radio astronomy community and strongly supports the national interest. NRAO has made a strong commitment to this philosophy for decades. The challenge at hand is to make these opportunities more accessible to underrepresented communities who may not be aware of them or, for whatever reason, may not appreciate their value.

4.9.1 Action Item

NRAO will take positive steps to make underrepresented groups aware of what is available to them, and to lower the barriers to gaining access to them.

4.9.2 Approach

The core of NRAO training programs and opportunities is already in place. NRAO has a broad range of programs to educate and train next-generation students, scientists, and engineers, as outlined above in sections 3.2 and 3.3. NRAO will establish an overarching program designed to facilitate ready access to seats in these programs for members of underrepresented groups.

In cooperation with the office of the Broadening Participation Coordinator, SAA, EPO, and EPO will collaborate to get a better understanding of the barriers to making education and training opportunities known among the underrepresented communities and develop strategies to address them. As a part of this effort, SAA and EPO will establish a program to provide fast-tracking potential candidates across the whole spectrum of the NRAO programs.

4.9.3 Goals, Metrics, and Consequences

The first step of the process is to do a study to more clearly identify the obstacles to participation in the available training programs encountered by members of underrepresented groups. The second step of the process will be to use the information from the study to develop a practical attack on the problem, and finally to implement it. Therefore, the initial goals are wrapped around understanding the problem and finding a solution. Only then will NRAO be in a position to develop the final outcome expectations and devise numerical outcome measures. Notwithstanding, there are definable milestones for the process of characterizing the roots of the problem and producing a plan for the solution.

It should also be noted that this study will vitally depend on the participation of the new NRAO Broadening Participation Coordinator. Thus, like other initiatives in this suite of programs, the start-up timetable depends importantly on the hiring of the Broadening Participation Coordinator, a person who will have a very full plate from the outset.

The initial goals for the program are to:

- Complete the recruiting of the Broadening Participation Coordinator during 2009.
- Begin the study on obstacles to participation by December 2009.
- Complete the obstacles study by March 31, 2010.
- Complete the mitigation plan, including the implementation timetable by June 30, 2010.
- Begin implementation by August 31, 2010.

The long-term goal is to:

- Fully implement the fast-track plan,
- Engage participation in the training programs by a larger fraction of members of underrepresented groups.

NRAO will report progress on a quarterly basis. This will initially be based on meeting the milestones in the proposed initial start-up schedule. NRAO will also provide summary reports on the findings of the obstacles study, and on the implementation.

Failure to achieve these goals in a reasonably timely way would mean that the NRAO training program would be delayed in realizing, or missing altogether, an important opportunity to leverage the investments in its existing programs into broader participation by underrepresented groups.

4.10 US-Chile Science and Technology Exchange

NRAO is home to some of the world's finest and most advanced radio astronomy research facilities and also to world-class scientists and engineers who make them productive. NRAO has very successful pre- and post-graduate programs that enable students and early-career science and engineering professionals to work at NRAO facilities. NRAO also has a U.S.-Chile Sister Cities program that is a very successful international student and teacher exchange program at the high school level. Taken together, they suggest an opportunity to take the NRAO U.S.-Chile exchange program to a higher level, and to help further the U.S.-Chile relationship in cultural, educational, scientific and technical exchange in general.

4.10.1 Action Item

NRAO will establish an exchange program that will enable Chilean university-level students and early-career science and engineering professionals to participate in NRAO programs in the U.S. and Chile, and for their U.S. counterparts to participate in similar programs in Chile.

4.10.2 Approach

NRAO will begin by developing partnerships with Chilean entities engaged in, or supporting, astronomy science and engineering activities, such as CONICYT and the Chilean universities. The intent is to set up programs that permit Chilean participants to work with NRAO staff at NRAO sites in the U.S. and/or Chile, and for U.S. participants to work at Chilean institutions. NRAO will leverage its experience with cooperative education, internships, and pre- and post-doctoral fellowships to extend its current U.S.-centric programs to Chile. This will foster a spirit of openness and international cooperation, with real-world experiences that better prepare upcoming scientists and engineers for futures in the international mode for astronomy that will only become more pervasive in the coming years.

Some contacts with Chilean universities have already been made. In addition, AUI and NRAO have obtained concurrence from NSF to allow young Chilean astronomers to work as international staff on ALMA, as NRAO employees. This provides for a healthy and fruitful increase in the interchange of ideas and cultures between the growing Chilean astronomy community and the mature U.S. radio astronomy community.

A final component of this program will involve encouraging NRAO astronomers to take leaves or sabbaticals at Chilean institutions, possibly in conjunction with ALMA-related research, thereby enabling mentoring of Chilean students.

4.10.3 Goals, Metrics, and Consequences

The goals and milestones for this program are to:

- Engage in dialogs about collaborations and exchanges with Chilean universities. This has already started, and will continue through 2009.
- Begin a prototype exchange for one to three people in mid 2010.
- Assess the prototype program's effectiveness after the first exchange ends, but no later than December 31, 2010.
- Fold in lessons learned and carry out additional exchanges thereafter.

The long-term goal for this program is to improve relationships between NRAO and its partners and counterparts in Chile, and between Chilean and US universities, thus finding effective ways to prepare future scientists and engineers for the international future of astronomy.

NRAO will report the program's progress to NSF in its quarterly reports. Initially, the reports will summarize the conversations with prospective partners and their outcomes. Once exchanges begin, the awardees will fill out a program evaluation form at its conclusion, and reports will include descriptions of the awardees and the projects they are working on. Once experience is gained by doing these exchanges on regular basis, NRAO will summarize lessons learned, so that those lessons may be shared with others.

Failure to meet these goals would mean that NRAO will have missed an important opportunity to broaden participation in its programs on an international scale, and better support the training for future and new scientists and engineers.

We are mindful that the U.S. and Chile have opposite school seasons, and further vagueness in the starting date for the first (prototype) exchange is driven by the uncertainty about whether the exchange involves a pre- or post-graduate awardee, and which hemisphere the person is coming from and going to. Thus, the starting (and ending) dates will be adjusted to the awardee's circumstances.

4.11 Telescope and Data Reduction Access

NRAO's world-class radio astronomy research facilities are national facilities intended to be available to the entire U.S. community. It is important that the researchers and researchers-in-training be encouraged to make use of these facilities. While this is a multi-faceted problem, one aspect is providing enhanced opportunities for researchers from underrepresented groups to gain access for worthwhile research.

4.11.1 Action Item

NRAO will take a series of steps designed to increase the number of scientists from underrepresented groups who are using its telescope facilities by making sure they know what opportunities are available to them, and by lowering the barriers to gain access to them.

4.11.2 Approach

Open calls for proposals for all of NRAO's telescopes are currently made three times per year. To increase participation from underrepresented groups NRAO will advertise more widely, targeting Historically Black Colleges and Universities and Hispanic Colleges and Universities.

The oversubscription rate of telescope time can be very high, presenting a barrier to new teams who may lack experience in writing such proposals. NRAO will offer a staff collaborator to these groups so that they can draw on their experience and expertise to write more competitive proposals for the peer-review process, so that they can more effectively compete in the future.

It is a common practice among observatories to allow the Director the discretion to grant time in special circumstances, without interrupting the flow of programs formally awarded time by the normal peer review process. The existing NRAO observing-time policy allows a fraction of the total time budget as Director's Discretionary time (DDT). The NRAO Director has DDT on all of the NRAO telescopes. The NRAO Director will allocate a block of discretionary telescope time for worthwhile observing programs from underrepresented groups that were proposed and reviewed through the normal process, but did not make the time allocation cutoff.

4.11.3 Goals, Metrics, and Consequences

The initial program goals and milestones are to:

- Advertise calls for NRAO telescope proposals more widely, particularly in venues where underrepresented groups will more easily see them. As part of this program, staff collaborators will be available on request. This will begin in June 2009.
- As part of the ongoing re-organization of the observing-time proposal process, build tools to help identify proposals that have been submitted from colleges and universities with underrepresented groups. This will be completed by February 2010.
- Beginning in 2010, DDT can be used to allocate time for enhanced access.

The long-term goal is to:

- Create an environment in which researchers from traditionally underrepresented groups are well represented in the ranks of NRAO research users.

NRAO will report progress on a quarterly basis and annually through its "Telescope Observing Statistics" publication. The measurable goals are to see an increase in the fraction of both proposals and telescope users from underrepresented groups. The baseline from which to measure progress is not well established, since we currently do not specifically track telescope usage from underrepresented groups. As noted, this will be addressed.

This is a new effort, and there are aspects of the program that have yet to be worked out. We intend to make good use of experience and lessons learned as we move forward to fill in the blanks and fine-tune the program for best success. Failing to make a measurable positive impact would indicate that we would need to be even more creative in our efforts to meet this important long-term goal.

5 Summary

AUI and NRAO have used the platform of their existing corporate and observatory policies coupled with HR, EPO, and SAA programs to fashion a forward-looking plan of action to

address broadening participation in a very wide range of their respective activities. Altogether there are eleven new programs or program enhancements in this portfolio.

The underlying strategy has been to use an integrated approach, on the one hand, to leverage the NSF's investment in NRAO's excellent existing programs by lowering perceived barriers to participation, especially for members of underrepresented groups, and on the other hand, to add additional programs to the portfolio. Thus, the elements of the AUI/NRAO plan should not be viewed as a shopping list of disjoint programs, but rather a broad and coordinated effort to enhance participation across the range of NRAO's activities in both the science and public communities.

The program begins with a top-down internal review of all AUI policies, with careful attention paid to broadening participation and diversity issues. The AUI implementation, coordination and diversity infrastructure is then enhanced by naming an AUI corporate Diversity Officer, who is closely tied to the NRAO center processes, to provide oversight of the NRAO program and those of any future AUI operating centers. In addition, a professional NRAO Broadening Participation Coordinator is recruited to facilitate the interface between "diversity technology" and the programmatic efforts of other participating units such as EPO and SAA, and even HR. Overall, this integrates the leadership of the corporate and NRAO units charged with delivering essentially all aspects of the participation and diversity efforts.

Translating this solidarity to the NRAO staff then flows from engaging an external professional diversity consultant to place an independent eye on the now-evolving overall program and also by producing a high-quality employee diversity and participation training program. In this training, the AUI and NRAO staffs will not only be introduced to the legal and social aspects of broadening participation and workplace diversity, but they will also be indoctrinated in the vision of an enhanced and vigorous AUI/NRAO diversity culture.

This employee connection is then further amplified by creating an institutionally sanctioned and encouraged mechanism for grassroots employee participation in the diversity process, through Employee Diversity Groups. While the NRAO Diversity Plan's existing Diversity Committee represents a management-side tool for promoting diversity, the EDGs are formally linked upward to the Diversity Committee to ensure ready access to the participation and diversity dialog from all levels.

Resting within this now powerfully-enhanced and coordinated infrastructure, the AUI/NRAO program moves on to provide programs to further diversify the workforce, provide broader access to K-12 STEM teacher and student training, broader access to training opportunities for the next generation of scientists and engineers, and finally, enhanced and broadened access to NRAO's research telescopes and related facilities.

The ethnically, socially, and economically diverse populations of the communities that host NRAO's principal facilities in the environs of Socorro, Green Bank, and even Charlottesville, provide unique opportunities to broaden participation by members of underrepresented groups. Our operations in Chile provide another unique opportunity to broaden participation on an international level. One of the new programs will establish a partnership with historically black

Howard University in Washington, to have NRAO staff deliver lectures at Howard and establish mentoring relationships with students, and to guide Howard students into NRAO undergraduate internship programs, and encourage scientists on the faculty at Howard to use NRAO research facilities. Another will encourage training of Chilean engineers and scientists, with mentoring and job possibilities at NRAO.

Another program will systematically, over a three-year period, develop partnerships with the school systems in Green Bank, Socorro, and the Charlottesville areas and other entities, such as the Astronomical Society of the Pacific, to develop astronomy-based science and mathematics curricula matched to K-12 classroom STEM standards. NRAO will then facilitate NRAO staff and volunteers to work with the teachers in these school systems to prepare them to deliver these modules to their students, including working with the teachers in their classrooms. By targeting schools with large underrepresented populations, these highly leveraged efforts to “teach the teachers” will eventually result in a self-sustaining improvement of the quality and quantity of K-12 STEM education among these groups.

A similar program will partner with the New Mexico Institute of Mining & Technology in Socorro to deliver a biennial intensive summer program, but in the Master of Science in teaching program. This program is expected to achieve similar leveraged results as these teachers move into the areas schools. This may well serve as a prototype for introducing this sort of astronomy teacher training at the MS level.

AUI and NRAO have also supported outreach steps in Chile, ALMA’s host country. NRAO is working with the other ALMA partners in planning future Chilean programs.

NRAO offers many coop, internship, and fellowship programs for students in science and engineering at all levels from secondary school to the post-doctoral level. It is perceived that the traditionally underrepresented groups underutilize these programs. In conjunction with the office of the NRAO Broadening Participation Coordinator, a program will be developed to target these groups in order to make them aware of the opportunities, and provide fast-track encouragement to such students to get them into seats in these programs.

On the research side, it appears that members of traditionally underrepresented groups underutilize the core NRAO research facilities – the telescopes and data-reduction facilities. A program is being started to address this by encouraging researchers in these groups to use the facilities and providing experienced mentors to assist in preparing observing-time proposals, and finally providing access to Directors Discretionary Time on the telescopes. This provides experience with the proposal process, the technical systems, and the conduct of the desired research project, thereby enabling self-sustained successful research in the long term. As mentioned above, NRAO is also working with Chilean universities to improve the opportunities for astronomy and technology training there.

In almost every case, starting up a program is a project in itself. AUI and NRAO have identified milestones and timetables for each of the eleven programs, with performance metrics tuned to the start-up phase(s), such as the timely meeting of milestones. In many cases, there are additional metrics, like numbers of candidates or students served per unit time, and these will be

reported as well. However, being new programs, in many cases there are no clear baseline data for comparison. AUI and NRAO propose to gather these data in a bootstrap way and, with experience, learn how to guide meaningful conclusions about *relative* performance.

APPENDICES

6 APPENDIX A: Diversity Publication Honors NRAO

The following three articles appeared in *Diversity Careers in Engineering and Information Technology*, from June 2008 to January 2009, calling attention to the success of NRAO's aggressive and professional workforce diversity program.

6.1 October/November 2008 Issue

Diversity goes astronomical

It's not happening at the speed of light, but inclusion is gradually permeating the world of radio astronomy.

D/C editor in chief Kate Colborn talks with Dr Fred K. Y. Lo, who directs NRAO (Charlottesville, VA), the largest and most powerful radio astronomy observatory in the world.

NRAO is the world's largest

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Dr Fred K. Y. Lo, who now heads up the National Radio Astronomy Observatory (NRAO, Charlottesville, VA), came to the U.S. in 1965 to attend MIT because there weren't many universities offering science degrees in Hong Kong at that time. MIT, he says, was a wonderful experience.

□ "When I graduated from MIT in 1969 with a BS in physics, I was offered a graduate assistantship by my undergraduate advisor," says Lo. "He essentially paid me to go to school to become an astronomer." □

□ Here's how it worked: young Lo thought he would like to stay on at MIT for grad school, and his advisor said, "Well, in that case, why don't you work for me?" □ □

There was one problem: his advisor was in radio astronomy, not pure physics. "But I said, 'Why not? Sure, I can do that. I'll go to school, and if I don't like it I can always change.'" □ But I never did." □ □

At that point, says Lo, "I really had very little knowledge of astronomy at all, let alone radio astronomy. I was thinking of doing something practical, like solid-state physics," he says with □ a smile.

Lo did, in fact, get to do solid-state physics. "What we do in radio astronomy involves a lot of solid-state physics," he notes with a laugh. "We work with solid-state detectors and other □solid-state electronics. Besides, radio astronomy is actually astrophysics: the universe, and that's what I've always been interested in."□□

When Lo started his grad work the pulsar, the quasar and black holes were new. Interstellar masers were new. "It was a really exciting time and a burgeoning field," he says.

Moving along □

Lo made that field his own. When he completed his PhD in 1974 he spent ten years at Cal Tech and the University of California at Berkeley, researching and teaching. He moved to the University of Illinois-Urbana Champaign as professor of astronomy and later chair of the astronomy department. In 1997 he joined the Academia Sinica in Taipei as distinguished research fellow and director of its newly formed Institute of Astronomy and Astrophysics.□

What research was he doing? Among many other projects, Lo has worked on star formation in dwarf galaxies, starbursts, and the structure of the compact radio source in Sagittarius A. He's been intimately involved in construction and use of all the millimeter-wave interferometer arrays in the U.S., and he made the first millimeter-wave interferometric map of CO emission from an external galaxy.

In 2002 he came to NRAO as its director.

Still academic □

He feels that, in a way, what he's doing □is still academic. His job as director is to make the way smooth for staffers and visiting scientists in the astronomy community to do their research. "NRAO's Charlottesville HQ is on the grounds of the University of Virginia, with another branch at New Mexico Tech. So we're all somewhat involved in teaching, and we pride ourselves on having a largely academic attitude and tradition."□□

Helping NASA □

The NRAO is funded by the National Science Foundation. There's no formal connection with NASA, but "Over the years we have always collaborated with NASA."□□NRAO partnered with NASA for the Voyager mission almost twenty years ago, and recently helped with the Phoenix Mars Lander. The big Green Bank telescope was used to directly track the signal from the Lander, and the VLBA, which has very high positional accuracy, tracks

QuickTime™ and a decompressor are needed to see this picture.

the course of the orbiter. "We tracked the spacecraft approaching Mars and orbiting Mars. It's all pretty exciting," Lo says.□

U.S. and beyond □

Almost half the users of the NRAO telescopes come from outside the U.S. The observatory has about 500 staffers in North America, and hosts several thousand users per year at its various facilities, working on the four major instruments and others, Lo says. In addition, about half the support staff is technical. "That's quite a sizable group," Lo notes with pride.

NRAO scientific staffers are expected to do their own research as well as helping visitors, because "Only if you are an active researcher can you be sure that the scientific instruments are at the forefront. The active staffer/researcher will know if we need more sensitivity or more bandwidth, so we can improve the facility over time. The whole scientific community benefits," Lo explains.

A range of projects □

There are, of course, a multitude of projects going on at once, using NRAO's many telescopes. Researchers are studying quasars and black holes in the galaxies. "We are studying how stars form, how planets form, how galaxies were formed and have evolved. A number of people are working on cosmic microwave background radiation, the remnant heat left over from the Big Bang," Lo says, "All our staffers are involved in research of some sort, which is supported by the observatory budget. They may work alone or in collaboration with others, including professors at our host universities."□□

Moving toward inclusion



There aren't as many people of color in astrophysics as one could wish, Dr Lo comments, but nevertheless NRAO is pursuing diversity. It's doing quite well with women staffers, some tenured or on the tenure track. "We have one new woman assistant director and will have another one soon. She is on the short list for the position," Lo discloses.

In fact, at NRAO-associated universities "Half the graduate students in the astronomy departments are women," Lo notes. "That is a huge change. When I was going to MIT we would have twenty women out of 1,000 per class!

“As we move into the future there is no question but that the demographics will continue to change. I think we are definitely moving in the right direction across the board.”□□

Dr Lo recently hired an African American astronomer, “one of only a handful. He is a very good astronomer, and the more I see him in action the more excited I am that he is here. He is very interactive and has many ideas, and I’m expecting him to stir things up a bit and be very stimulating.”□□

REU: bringing in the kids □

Lots of undergrads and even occasionally a keen high-schooler or two spend time at NRAO. In the Research Experiences for Undergraduates (REU) program, undergrads come in for a □ten-week stint working with the staff. Sometimes they’re analyzing data, sometimes working □on a specific problem. REU is a longstanding program. To his delight, Dr Lo often discovers that a distinguished astronomer or astrophysicist he’s just met is an NRAO REU alumnus.

“Come on down”□

Dr Lo himself is strongly international. He has taught and lived in several different countries. “I certainly feel my background and experience help me tremendously in doing my job,” he says. “I get to know everybody in the world of radio astronomy, in Hong Kong, Taiwan, Japan and mainland China as well as Europe and the Americas. I travel a great deal.”□□

As to the NRAO he loves so well, “We’re a very special organization. We attract and keep a lot of really good people from all over the world.

“If anyone is interested in NRAO they should come to see us,” says Dr Lo.

D/C

6.2 June/July 2008 Issue

Government jobs offer solid careers for African American techies

Some are senior-level, some in the middle ranks, but all these professionals have put their skills to work in years of top-notch service

“Our hiring programs have begun to attract a superb cadre of professionals with no letup in sight.” – Rick Stradford, Department of State

Angela M. Hutchinson
Contributing Editor

Corporate jobs in technology can pay very handsomely, but many companies are downsizing these days. While a government post may not offer the same salary as private industry, it usually offers much better job security. Many folks consider this the really big benefit of working in government, especially the Federal government.

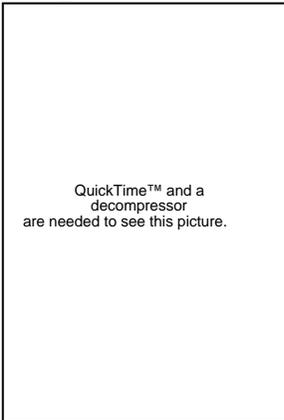
“I believe that one of the main reasons why technology professionals choose to work for the Federal government is the stability it offers, says Noemi Pizarro-Hyman, senior diversity recruitment advisor for the Defense Intelligence Agency (DIA). “In an unstable and uncertain job market, job security offers the peace of mind most people seek.”

In addition, government agencies welcome diversity. The DIA, says Pizarro-Hyman, “recognizes that valuing diversity raises employees’ level of comfort and enhances personal and working relations.” Differences among people, she says, “can be an asset to the agency.”

WorkforAmerica.com, a federal government jobsite, reports that in 2004 about 17.6 percent of federal government employees in all categories were African American, 7.6 percent Hispanic, 5.2 percent Asian/Pacific Islander and 1.9 percent Native American. The site also notes that minority employment with the feds has increased by better than 3 percent in the past decade.

The African American techies featured in this article are long-term professionals. They opted for work with the government, and have excelled at their jobs for many years.

Eugene Cole is a project controller at NRAO



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Eugene Cole has more than thirty-four years of experience in R&D, engineering and construction. He’s worked in areas from maintenance to electronics, and has managed both heavy processing plant and civil construction.

He’s been with the National Radio Astronomy Observatory (NRAO, Charlottesville, VA) for more than twenty years. He’s currently working at the observatory’s Expanded Very Large Array (EVLA) radio telescope near Socorro, NM.

“The purpose of the project is to create an astronomical research instrument of unprecedented power and flexibility in the meter-to-millimeter wavelength bands,” Cole explains. The EVLA instrument will

be used by scientists from around the world for cutting-edge research. It's expected to provide new information about magnetic fields, cosmic sources in dusty regions, transient phenomena, even the formation of stars and galaxies.

EVLA is being built on the site of the mature Very Large Array (VLA) instrument, familiar to movie buffs as the radio telescopes in the film *Contact*. The current project will retain the antennas, array design and infrastructure of the VLA, but replace older systems with state-of-the-art electronics and software. This, says Cole, will increase its technical capacities by "at least an order of magnitude in every key observational area."

Cole oversees the EVLA budget and schedule, and helps the project manager determine performance indices. He provides estimate support data, makes cost studies and monitors project activities. He also evaluates potential delays and looks for mitigation strategies.

The EVLA refurbishment is a long-term project. It began in 2001 and won't be done for another few years. "In my mind that's a long time on any project," says Cole; "yet there is a wide palette of activity."

His daily face-to-face involvement with senior management, engineers, scientists and technicians "helps make my job easier," he says. "It's rewarding to know that I am a part of the team."

Cole's mother was a nurse and his father served in the U.S. Air Force. After high school Cole worked for a building contractor, then as an engineering clerk for a construction company. While working, he earned his AA in business admin at the College of San Mateo (San Mateo, CA).

He went on to a thirteen-year career in design and build, working for Sverdrup Corp on a design management project for the Arizona DOT, for Pacific Gas & Electric Co as a maintenance scheduler, for Kaiser Engineers as a cost/scheduling engineer and for Fluor Engineers and Constructors as a scheduler and cost estimator.

Then he joined NRAO. "I was hooked on what was being done at the observatory and haven't looked back," he says. "I like the New Mexico culture and its vast history. Just as the travel ads say, living here is somewhat enchanting."

NRAO is a small organization with about 600 employees spread over several facilities in Virginia, New Mexico and West Virginia in the U.S., plus one in Chile. "Gene was one of the first full-time African American professionals at the observatory. But in the last two years the contingent has seen a good increase," says Roy Norville, NRAO employment manager.

Cole believes it's very important for minorities "to enrich our understanding of the mechanisms of being technical professionals." To that end, he volunteers his time to attend conferences of groups like NSBE, spreading the word about the technical opportunities in the field of radio astronomy.

In his off time, Cole sings, plays the bass guitar, goes skiing, hiking and bicycling, and works as a licensed emergency medical technician. In his remaining spare time he's building a new home near Socorro, NM.

6.3 December 2008/January 2009 Issue

NRAO was honored as one of the 100 Best Diversity Companies out of a field of 600. This is page one of the two in the article. The emphasis is added here to aid the eye.

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AEROSPACE & DEFENSE

Aerjet
BAE Systems
Bell Helicopter
Textron
Boeing Company
DRS Technologies
GE Aviation
General Atomics
Aeronautical Systems
General Dynamics
Gulfstream
ITT
Lockheed Martin
Parker Aerospace
Pratt & Whitney
Raytheon
Rockwell Collins

AUTOMOTIVE

Ford Motor Company
Honda
Johnson Controls
Navistar
Toyota

FOOD PRODUCTION

Archer
Daniels
Midland
Coca-Cola

FOREST PRODUCTS

Weyerhaeuser

GOVERNMENT

Defense Intelligence Agency
National Geospatial-Intelligence Agency
**National Radio Astronomy
Observatory**
National Security Agency
Naval Research Laboratory
Office of Naval Research
Sandia National Laboratories
U.S. Coast Guard Civilian Careers
U.S. Navy
U.S. Nuclear Regulatory Commission

HEALTHCARE & MEDICAL EQUIPMENT

GE
Healthcare
Mayo Clinic
Medtronic

7 Appendix B: NRAO Navigators, a National Initiative

This program has not been included in the formal list of initiatives because it cannot succeed without external funding. This additional funding has not been clearly identified, either as to the amount or the sources. As a result, neither the timeline, nor the actuality of the effort can be promised at this time. Nevertheless, it does point to what may be possible in the future.

7.1 NRAO Navigators

NRAO wishes to extend the reach of the K-12 STEM education content and methods developed by the EPO team for disadvantaged populations (section 4.7) beyond the communities that host NRAO research facilities.

7.1.1 Action Item

NRAO will deliver targeted K-12 STEM education content about radio astronomy science and technology to disadvantaged populations in regions of North America *beyond* those that host AUI/NRAO research facilities.

7.1.2 Approach

NRAO EPO will create and train a volunteer network of motivated and knowledgeable volunteers to deliver K-12 science content to disadvantaged populations in regions of North America outside to the NRAO host communities by establishing a partnership with Society of Amateur Radio Astronomers (SARA), a group of about 200 amateur radio astronomers with whom the NRAO already has a long history of mutually beneficial cooperation.

In addition to the STEM education content developed by the program described in section 4.7, the NRAO and SARA will collaborate to build, improve, and distribute copies of a small radio telescope system that has a DIRECTV satellite dish as its principal component. To accomplish this goal, we will solicit the financial participation of DIRECTV. The DIRECTV Corporate Citizenship program is interested in developing partnerships with non-profit organizations with a nationwide focus on fostering K-12 learning, a natural match for AUI/NRAO and our EPO program.

We will develop an on-line training program so that our volunteers can learn how to effectively present the science content we develop for the K-12 schools of our target disadvantaged communities. Each volunteer will be equipped with and trained in the use of an extensive educational package about radio astronomy science and technology, including a functional radio telescope. These will be suitable for use with students in formal settings or with youth groups and families in informal venues.

Assuming the availability of funding, we propose to develop the program content with a demo radio telescope in FY 2011, prototype the program with about five SARA volunteers in FY 2012, and expand to about 100 volunteers and telescopes by FY 2015.

7.1.3 Goals, Metrics, and Consequences

The goals and milestones for this program are to:

- Create initial program content with demo radio telescope by October 1, 2010.
- Conduct prototype program with about five SARA volunteers by June 1, 2011.
- Assess prototype program effectiveness by October 1, 2011.
- Establish one or more external funding sources for the additional radio telescopes required for the large-scale program by January 1, 2012.
- Complete construction of operational demo radio telescopes for full-scale program by January 1, 2013.
- Solicit and train SARA volunteers for full-scale program by June 1, 2013.
- Conduct full-scale program with about 50 SARA volunteers by June 1, 2014.

The long-term goal for this program is to:

- Extend our partnership with SARA so that the AUI/NRAO K-12 STEM education initiatives have the broadest possible national impact for disadvantaged populations.

We will track and provide quarterly reporting for the number of K-12 teacher and student contacts achieved by each SARA volunteer in the program. We will create an appropriate assessment tool for use with the K-12 classes visited by the SARA volunteers and another for informal education venues. We will include a summary of the program and its evolution via the annual Progress Report, including any programmatic changes motivated by the assessments and volunteer feedback.

Failure to achieve the program goals would mean that the disadvantaged populations outreach program described in section 4.7 would not extend beyond the communities that host NRAO research facilities and thus the NRAO would not be achieving its strategic goal to have national impact.