

PROSPECTUS FOR FOREIGN PARTICIPATION IN THE MILLIMETER ARRAY

BACKGROUND

The National Radio Astronomy Observatory (NRAO) is a facility of the U.S. National Science Foundation (NSF). Forbidden by its enabling legislation to operate its own facilities directly, NSF funds Associated Universities, Inc., (AUI) through a cooperative agreement to operate NRAO. AUI is an independent, not-for-profit, research management corporation. AUI has operated the NRAO since the Observatory's founding in 1957. The current cooperative agreement between the NSF and AUI for the operation of the NRAO (AST9223814) covers the period 1 January 1994 to 31 December 2001.

The telescopes of the NRAO include the 140 Foot Telescope in Green Bank, West Virginia, to be superseded by the Green Bank Telescope now under construction; the Very Large Array, and the Very Long Baseline Array, operated out of Socorro, New Mexico; and the 12 Meter Telescope on Kitt Peak in Arizona, to be superseded by the Millimeter Array.

This Prospectus is meant to serve as a "blueprint" for negotiations with interested parties. The actual terms of the agreement(s) will be decided by the actual partners.

MILLIMETER ARRAY

The Millimeter Array (MMA) is an array of thirty-six 10 meter antennas that operates at millimeter and sub-millimeter wavelengths to produce aperture synthesis images with high angular resolution, sensitivity, and spectral resolution. The MMA is uniquely equipped for answering questions about the formation of stars and protoplanetary systems, the formation and evolution of galaxies, the nucleosynthetic history of evolved stars, and astrochemistry. The MMA is capable of state-of-the-art observations in nearly every area of current astronomical research. Placed on a high quality site, the MMA will have an unprecedented sensitivity for millimeter and sub-millimeter observing.

The MMA is expected to cost on the order of \$200,000,000 and will be located on a high plateau, about 40 miles east of San Pedro de Atacama, in Chile's Second Region. The NSF expects the MMA to be an international project with foreign shares totaling no more than 50 percent of the project.

MMA ASSOCIATES

Partners who contribute to the capital costs will be designated as MMA Associates. The minimum share for an Associate is \$20,000,000. Associates' share of the available observing time will be pro rata, with the minimum corresponding to ten percent minimum share. (Available observing time is defined in this prospectus as the total observing time less any observing time owed by virtue of a site agreement and less any observing time necessary for engineering, maintenance, tests, and calibration.) Operating costs for the MMA are estimated to be \$10,000,000 per year, including \$1,000,000 for routine upgrades and improvements to instrumentation. For the minimum contribution to construction of \$20,000,000, the annual operating share for an Associate would then be \$1,000,000. NRAO will consider participation in the MMA by Associates who

contribute only to capital costs and not to operation costs. Such an agreement would reduce the Associate's access to observing time by 50 percent.

The terms of MMA Associate agreements are to extend for 20 years, the nominal lifetime of the MMA without significant upgrades.

BENEFITS TO MMA ASSOCIATES

The primary benefits to the Associates are a voice in the definition and development of the facility, in its construction, and in its operation and continued development; and assured access to observing time. It should be noted that Associate participation in the operation of the MMA greatly enhances the effectiveness of MMA use by their astronomical community. Presence at the facility of Associate personnel who understand its operation in depth is a major advantage. It is expected that all the available observing time would be divided among the U.S. and the Associates on a basis proportional to their investments. A pool of observing time could be made available by the U.S. and the Associates from their shares to be used in a general competition by the worldwide community. Aside from this pool, U.S. observing time will not be available to non-U.S. observers. MMA observations will be archived and made available to any qualified astronomer after a reasonable length of time from the date of observation.

Secondary benefits to the Associates include but are not necessarily limited to detailed design, construction, and development activities that can appropriately take place in the Associate countries, a voice in the site development, participation in a program that encourages exchanges and visits of personnel among the Associate countries, and access to the state-of-the-art technology that will accompany the MMA throughout its development, construction, and operation.

MANAGEMENT CONSIDERATIONS FOR ASSOCIATES

A description of how the MMA is to be managed is best begun with a description of how NRAO operates its present facilities. This makes it easier to describe the proposed changes required to recognize the rights of the Associates.

A simplified version of the present NRAO organizational chart is attached as Figure 1. The first level of user input to the operation of NRAO, beyond the direct day to day contacts with staff and site directors, is through the Users Committee. It is advisory to the Director and holds a two-day meeting once per year. The Committee is broadly based, with roughly 24 members from all areas of radio astronomy. It is self-organized and constructs its own agenda. A summary of its report appears in the NRAO Newsletter.

User input is also available at a higher level through the AUI Visiting Committee. This committee is appointed by AUI as part of its oversight of the Observatory. It reports to the AUI Board of Trustees. Its report is, in turn, forwarded to the NSF by the Trustees.

Local, day to day management is delegated to the assistant directors who are responsible for the various NRAO sites. A good deal of consultation occurs with the Director. There are monthly meetings of the entire Observatory directorate. The Director reports to the AUI Board of Trustees at roughly six meetings throughout the year.

This general scheme will be maintained for the MMA with the following changes:

- 1) There would be a separate MMA Users Committee that would include representation from the Associate countries, appointed to the Committee by the responsible institutions in the Associate countries.
- 2) There would be a separate MMA Visiting Committee that would include representation from the Associate countries, appointed to the Committee by AUI from nominations made by the responsible institutions in the Associate countries, reporting to the AUI Board of Trustees.
- 3) There would be a MMA Steering Committee with representation designated from each of the Associate countries that would meet regularly with the Assistant Director for MMA Operations and the NRAO Director to review operational issues.
- 4) The NRAO Assistant Director for the MMA would be appointed in consultation with the responsible partner institutions in the Associate countries.
- 5) All proposals would be reviewed and rated by a common set of referees in a common pool. Referees would be appointed by the NRAO Director in consultation with the responsible institutions of the Associate countries, with referees from all Associate countries being included.
- 6) Observing time allocations would be made by a Time Allocation Committee containing representation designated from each Associate country. Time allocations would be made in individual Associate pools, starting with the most highly rated proposals and proceeding until, on average, the Associate's time share was filled.
- 7) The priorities for new instrumentation for the MMA will be formulated by the Steering Committee with formal input from the MMA Users Committee.
- 8) The terms of the agreement between the U.S. and the Associate countries are to be contained in a memorandum of understanding between the NSF and the funding agency of the Associate country. Funding contributions would flow from the Associate funding agency to the NSF, to AUI through the cooperative agreement between the NSF and AUI. The fiscal reporting would be AUI to NSF to the Associate funding agencies. Reports internal to NRAO that are generated for purposes of managing MMA operations would be shared with the responsible institutions of the Associate countries through the Steering Committee.

An organization chart showing these modifications for the MMA is shown as Figure 2 and attached.

MMA AFFILIATES

NRAO may consider reducing its operating expense obligation through foreign participation in the MMA by so-called MMA Affiliates. Affiliates do not contribute to the capital expense, but rather, they exchange operating expense contributions for portions of the U.S. time-share. Affiliates agree to pledge annual operating contributions for a ten-year period at a rate of \$1,500,000 for each five percent share of the available observing time. No more than three such five percent shares are anticipated. On the fifth year the agreement is either extended to a new ten-year period or notice is given that the agreement will be allowed to expire at the end of

the current ten-year period. During any ten-year period the annual contribution remains fixed; adjustments for inflation are negotiated when the agreement is extended to each new ten-year period.

The MMA Affiliates do not participate in MMA governance as outlined above for the MMA Associates. However, MMA Affiliates do receive the same support for utilization of observing time, including, for example, data reduction software.

STATUS OF THE MMA AND PROPOSED SCHEDULE

A proposal to build the MMA was submitted by AUI to the NSF in 1990. The proposal was reviewed and has received the endorsement of every major advisory body including the U.S. National Academy of Sciences Decade Review (Bahcall) Committee. It was presented to the National Science Board (NSB), the governing body of the NSF, and was approved for further planning and, subsequently, it has been approved for a three-year phase of "detailed design and development of prototypes," which was begun on June 1, 1998. It is expected that the MMA will be approved by the NSB for construction starting in 2001. Construction would be completed on this schedule in 2006.

The NRAO has formed the MMA Development Consortium with the Owens Valley Radio Observatory (OVRO) of Caltech and the Berkeley-Illinois-Maryland Association (BIMA) which operates the Hat Creek millimeter array. A steering committee composed of two NRAO members and one member each from the two university groups directs the development phase of the MMA. Development tasks will be done at the university facilities as well as at the NRAO. Associates who become part of the MMA project during 1998, or before, will be incorporated into the planning and development process. During the operational phase of the MMA it is expected that the two university arrays in the U.S. might be merged into a common development facility for the U.S. MMA program. It could also serve usefully for certain observing programs. There are possibilities for participation by Associates in this merged array for student training.

The NRAO has formed the MMA Advisory Committee (MAC) to provide regular scientific and technical review of the Project during its development and construction phases. MMA Associates will have representation on the MAC.

SITE CONSIDERATIONS

The MMA Project has studied two sites in the continental U.S., one on Mauna Kea in Hawaii, and one in Chile. It has become clear that the Chile site is superior to the other three sites for atmospheric transparency. Therefore, this site has been selected as the location of the MMA. It is a high plateau with an elevation of 16,000 feet above sea-level, located about 40 miles east of San Pedro de Atacama, in Chile's Second Region.

DISCLAIMER

This prospectus is intended to present a framework for negotiation between NRAO and potential MMA Associates/Affiliates. It is not a legally binding offer on the part of the NRAO, AUI, or the NSF.

NATIONAL RADIO ASTRONOMY OBSERVATORY ORGANIZATION CHART

1 AUGUST 1998

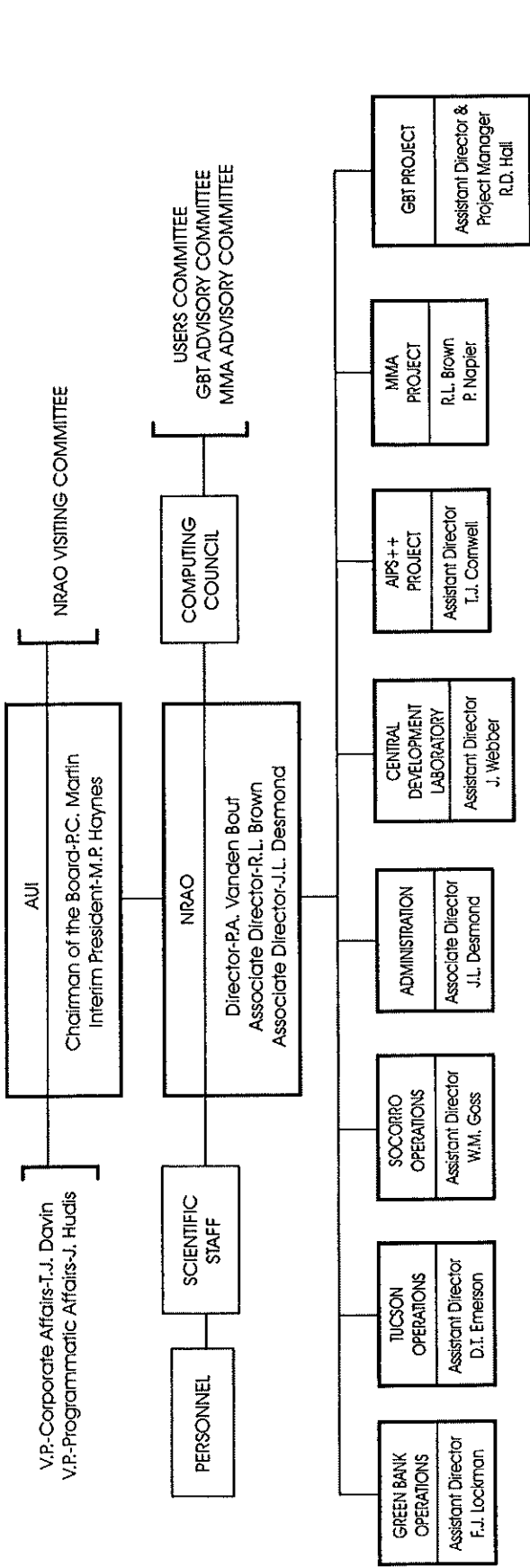


Figure 1. Present NRAO Organization Chart

NATIONAL RADIO ASTRONOMY OBSERVATORY ORGANIZATION CHART

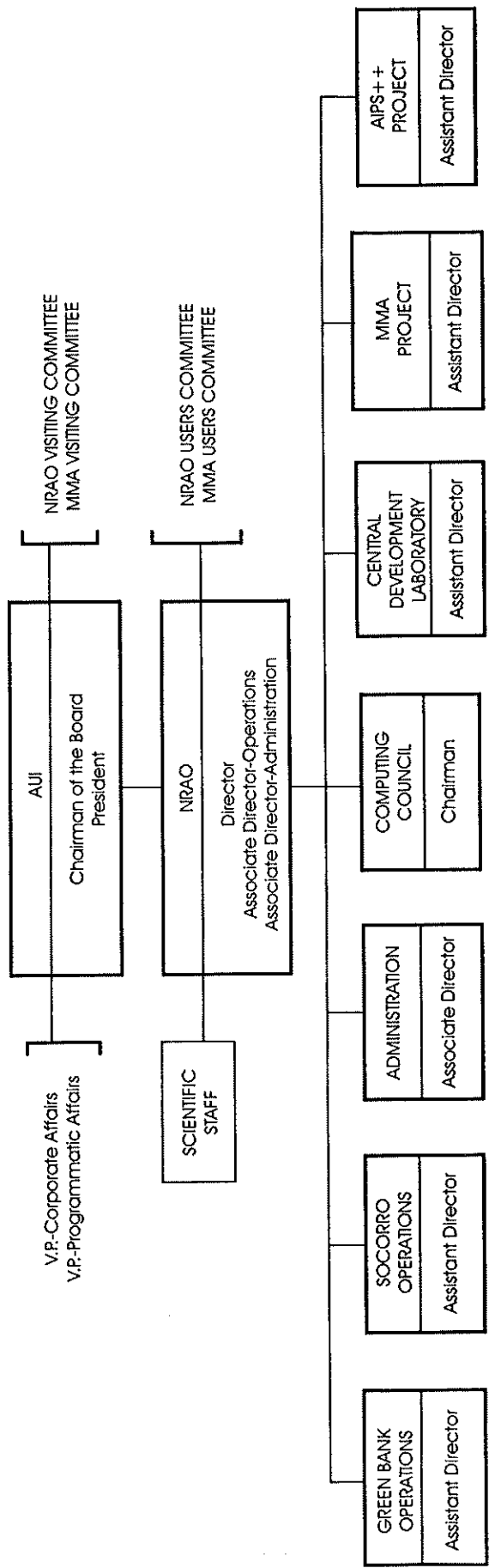


Figure 2. Outline Organization Chart for NRAO Including MMA