

Hesslein

RESEARCH PROPOSAL  
to the  
NATIONAL SCIENCE FOUNDATION

July 26, 1954

for a Grant in Support of a  
FEASIBILITY STUDY OF A NATIONAL RADIO ASTRONOMY FACILITY

by  
ASSOCIATED UNIVERSITIES, INC.  
350 Fifth Avenue  
New York 1, New York

1. Associated Universities, Inc., respectfully requests a grant in the sum of \$105,000 to carry out over a period of approximately twelve months a feasibility study of a national radio astronomy facility. Ultimate responsibility for the conduct of the study would reside in the President of Associated Universities, Inc., Mr. Lloyd V. Berkner. The principal member of the organization working full-time on the study would be Dr. Richard M. Emberson, Assistant to the President and Assistant Secretary of the corporation.
2. Radio astronomy evolved as a distinct branch of science in two decades, starting with the pioneering work of Jansky and Reber in the late twenties and early thirties. The interruption of World War II was followed by a great expansion, due largely to the tremendous technical advances from radar and allied fields. Radio astronomy had its birth in the United States and a major portion of the recent technical advances may be attributed to U.S. scientists. Despite these contributions, the United States has not assumed leadership in this new field. Radio astronomy is now further advanced in other countries, notably in England and Australia, than in the United States. Scientists in these countries are now better equipped than we to carry on studies in both the solar and cosmic phases of radio astronomy at practically all wave-lengths.

Two recent conferences, the first held in Washington on January 4-6, 1954, and the second held in New York on May 20, 1954, clearly indicate that a genuine need exists for large research equipment not now existing nor likely to be acquired by any of the universities or other institutions interested in radio astronomy. These conferences covered program objectives and requirements; the relationship of a national, joint facility to the smaller facilities of the universities and similar institutions; staffing a national facility and training students; supporting a national facility through staff, equipment, and direct participation in the research programs; and the basic goal of providing the highest single-beam resolution and gain now feasible, both economically and technically. No detailed description of the basic research needs underlying the proposed study is necessary. These were considered at the Washington Conference above referred to and were reviewed and confirmed at the meeting held May 20, 1954. The proceedings of the Washington Conference were published in the Journal of Geophysical Research, Volume 59, No. 1, March, 1954. An abridged version appeared also in "Science", Vol. 119, p. 588, April 30, 1954. They included a survey of world progress in radio astronomy and of some of the more pressing problems in the general field.

3. This proposal by Associated Universities, Inc., covers the first of two phases in the establishment of a national radio astronomy facility:

- I. Feasibility study
- II. Physical Plant and Organization
  - A. Planning and detailed design
  - B. Construction

Phase I is intended to provide the basis for a decision, but not to decide, whether or not to follow through on Phase II, and so must be conducted on the hypothesis that Phase II will follow. However, neither this request nor the actual initiation of Phase I is intended to make any commitment, expressed or implied, on the part of either the National Science Foundation or Associated Universities, Inc., with respect to Phase II. At the conclusion of Phase I, the questions of when and by whom Phase II should be conducted and the sources of required funds would still be open. The fact that Associated Universities, Inc., conducted Phase I would carry no implication that it should be requested to conduct Phase II. However, the selection of a contractor to conduct Phase II would carry with it a strong implication that the same contractor would become responsible for the operation of the completed facility. This implication would arise from the fact that a critically important part of this work of Phase II would be the creation of an operating organization and the selection of an operating staff.

4. Description of Proposed Study: The report that would be the end product of Phase I would consist of the following principal parts:

- A. A consensus of scientists now active or interested in the field of radio astronomy with respect to foreseeable research objectives;
- B. An examination of various suggestions made on the major equipment items for the purpose of providing some understanding of the technical problems that would have to be solved in design and construction, and to permit comparison of performances and costs;\*
- C. An examination of possible sites, with respect to program and staff requirements, housing and transportation, meteorological factors, radio interferences, accessibility to other centers of intellectual activity, and such other factors as Parts A and B indicate to be important;

\* One of the persons attending the May 20th conference suggested a figure of \$5,000,000 as the order of magnitude necessary to cover sites and site improvements, the detailed design and construction of major equipment items, laboratory or other buildings, and all other related facilities.

- D. An examination of any other essential expenditures to achieve a functional radio astronomy facility, e.g. access roads, power lines or power generating equipment, laboratory buildings, etc.;
- E. Preliminary estimates of the costs involved in Phase II and preliminary proposals with respect to methods of financing these costs, and appropriate consideration of the time scale to be adopted in carrying out this phase;
- F. Preliminary estimates and proposals with respect to the organization and staff necessary for operating the completed facility on a national basis, including budgets, personnel policies, and methods of promoting cooperation by interested institutions.

5. **Procedure:** The Phase I study proposed herein would be carried forward by a full-time director who would be guided on scientific and technical policy matters by a small steering group\*. Appropriate scientific, clerical, secretarial and fiscal assistance would also be provided. In view of the breadth of the undertaking, the director would rely heavily for the solution of specific problems on consultants engaged on a per diem or other short term basis. Both the wide range of competence required and the short duration of the study tend to make the recruitment of a full-time staff difficult and costly. By using carefully chosen consultants, the director can be sure of obtaining professional assistance of the highest calibre.

In conducting the equipment study (4B above), tentative conclusions would first be reached on what was desired and where and how it might be set up, and then very preliminary studies of technical feasibility and overall construction costs would be made. These studies generally might be conducted by individual consultants or by appropriately qualified university groups through a subcontracting arrangement, and would consist of the following elements:

\* An indication of willingness to serve on the Steering Committee has been obtained from the following:

- B. J. Bok - Harvard University
- A. J. Deutsch - California Institute of Technology
- Leo Goldberg - University of Michigan
- W. E. Gordon - Cornell University
- J. P. Hagen - Naval Research Laboratory
- J. D. Kraus - Ohio State University
- A. B. Meinel - University of Chicago
- M. A. Tuve - Carnegie Institution of Washington
- J. B. Wiesner - Massachusetts Institute of Technology

- (a) Comparison of various distinct designs or types of equipment to determine the relationship between the fundamental design parameters and the performance characteristics (gain, resolution, etc.), with an indication of construction tolerances that would be necessary;
- (b) For the most promising design, an estimate of the cost of construction to meet a stipulated standard of performance and, conversely, the optimum performance that might be obtained from a fixed expenditure.

The site study would be carried on in three distinct stages as follows:

- (a) The first stage would include a tabulation of all available data (average and maximum winds, snow, ice, dust; distance to source of construction materials and services; housing possibilities; etc.) to permit the selection of the most promising sites. This work would be carried forward by the director with the advice of the steering committee and with the help of specially selected consultants.
- (b) The next stage would be a review of possible sites largely based on proposals solicited from interested institutions and groups\*. These proposals would be expected to meet certain basic criteria (accessibility, latitude, freedom from obvious radio noise sources, etc.) defined with due regard to the research objectives and equipment requirements.
- (c) The final stage would be the making of noise measurements at the selected sites to determine those with the lowest levels. These measurements might be done through a subcontract or other suitable arrangement with a university or a government agency\*\* already equipped to make and engaged in making radio noise measurements.

\* Astronomers east of the Rockies have been hampered by the lack of a large facility, because of the relatively poor seeing conditions in the eastern half of the United States. Radio astronomy makes it possible to eliminate this serious deficiency. Furthermore, the present intention of California Institute of Technology is to construct a radio astronomy facility of some sort, apart from the possibilities inherent in this proposal. Both these factors would tend to throw less weight on sites in the far west.

\*\* For example, mobile noise-measurement equipment has been assembled by the National Bureau of Standards for the programs of the Central Radio Propagation Laboratory. A two-man crew working at each possible site for about a month should be able to provide adequate data at an estimated cost of about \$3,000 per month.

It is believed that the major portion of the work covered by this proposal could be completed with a period of twelve months.

6. **Facilities:** Associated Universities, Inc., is a non-profit corporation chartered by the Board of Regents of the State of New York to conduct research, educational, and related activities in all fields of science. The office of Associated Universities, Inc., is located in New York City, which makes it readily accessible, through modern communication and transportation, to scientists throughout the country. The organization and experience of Associated Universities, Inc., lends itself to the successful execution of a short-term study such as proposed herein. Although, as stated above, Associated Universities, Inc., is an independent corporation, nevertheless its greatest source of strength is its active sponsorship by nine great universities, namely, Columbia, Cornell, Harvard, Johns Hopkins, Massachusetts Institute of Technology, Pennsylvania, Princeton, Rochester, and Yale.

The sole official connection of these institutions is their nomination of ~~AI's~~ Board of Trustees. However, unofficially they provide a unique arsenal of technical and administrative ability and experience and general intellectual activity the value of which has been amply demonstrated in a long term operation such as the Brookhaven National Laboratory and a crash program such as PROJECT EAST RIVER. It should also be noted that three of the sponsoring institutions, namely, Cornell, Harvard and M.I.T., are among the most active in the country in research in the field under consideration.

7. The governing body of Associated Universities, Inc., as stated above, is its Board of Trustees. The present members, nominated by the nine sponsoring universities as indicated, are:

Associated Universities, Inc. - Lloyd V. Berkner,  
Trustee ex officio;  
Columbia - George B. Pegram, Vice President Emeritus and  
Special Adviser to the President;  
I. I. Rabi, University Professor;  
Cornell - Franklin A. Long - Chairman, Dept. of Chemistry;  
Theodore P. Wright - Vice President for Research;  
Harvard - Norman F. Ramsey, Professor of Physics;  
Edward Reynolds, Administrative Vice President;  
Johns Hopkins - P. Stewart Macaulay, Provost;  
William D. McElroy, Professor of Biology,  
Director McCollum-Pratt Institute;  
M. I. T. - Edward L. Cochrane, Dean of Engineering;  
Jerrold R. Zacharias, Director of Laboratory for  
Nuclear Science;  
Pennsylvania - William H. DuBarry, Executive Vice President;  
Francis C. Wood, Chairman, Dept. of Medicine;  
Princeton - George A. Brakeley, Vice President and  
Treasurer Emeritus;  
Joseph C. Elgin, Chairman, Dept. of Chemical  
Engineering, Associate Dean of Engineering;  
Rochester - William S. McCann, Head, Dept. of Medicine;  
LaRoy B. Thompson, Coordinator of Sponsored  
Research;

Yale - C. Hamilton Sanford, Jr., Business Manager;  
William W. Watson, Chairman, Dept. of Physics;

It is expected that in accordance with prior practice, a special committee of the Board will be established to follow in detail the progress of the work contemplated by this proposal. Like the Board itself, this committee presumably would be balanced between high scientific ability and business and administrative experience.

The conduct of the study would be the ultimate responsibility of Lloyd V. Berkner, President of Associated Universities, Inc. Mr. Berkner: B.S. Minnesota 1927; Elec. Engineer U.S. Bureau Lighthouses 1927-28; Bureau of Standards 1928-33; Dept. of Terrestrial Magnetism, Carnegie Institution 1933-41; Director, Electronics Material Branch, U.S. Navy 1941-46; Exec. Sec'y. Joint Research & Development Board 1946-47; Chairman, Sect. of Exploratory Geophysics of the Atmosphere, Dept. Terrestrial Magnetism, Carnegie Inst. 1947-49. Member of Byrd Antarctic Expedition 1928-30. Chairman, Sect. on Geophysics, National Academy of Sciences; Chairman, Administrative Committee of the Professional Group on Nuclear Science, Institute of Radio Engineers, 1953-54; Chairman, Joint Technical Advisory Committee, Inst. of Radio Engrs.; Chairman, U.S. Commission III, "Ionospheric Radio Propagation", International Scientific Radio Union; Vice President, Special Committee (International) on the International Geophysical Year; Member, U.S. Committee on the International Geophysical Year. Specializes in radio wave propagation; structure of the high upper atmosphere; ionization measurements of the ionosphere; relation of upper atmospheric ionization to terrestrial magnetism; aviation radio development; solar phenomena; solar and terrestrial relationships.

The principal full-time member of the staff, and thus the principal investigator for the proposed study, would be Richard M. Emberson. Dr. Emberson: A.B., A.M., Ph. D., University of Missouri 1936; Fellow, Harvard College Observatory 1936-39; Instructor, Medical School, University of Pittsburgh, 1939-40; Staff member, Radiation Laboratory, M.I.T., 1941-46; Elec. Engineer, Naval Research Laboratory, 1946; Secretariat, Research and Development Board, Dept. of Defense, 1946-51; Assistant to President, Associated Universities, Inc., 1951, Assistant Secretary, 1952-.

The names listed in the footnote to Section 5 are illustrative of the calibre of the scientists and engineers who would be sought to assist with the study. Associated Universities, Inc., has not deemed it prudent to make any commitments for consultants or others at this stage of the proposal but past experience indicates that we can engage people of the requisite calibre when needed.

8. Budget: A budget for the project has been prepared, and a copy is attached hereto. It is based, in part, on AUI experience with similar short-term studies and, in part, on necessarily crude estimates of costs. Although the overall estimate is considered to

be reasonably sound, adjustments within the total amount undoubtedly will be needed. It should be noted that in view of the nature of the study, little or no equipment or hardware will be required. The existing AUI office in New York City appears to be adequate as a headquarters for the work.

9. This proposal is submitted on behalf of Associated Universities, Inc., by virtue of authority of the Board of Trustees.

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Richard M. Emberson  
Principal Investigator

Lloyd V. Berkner  
President

**FEASIBILITY STUDY OF A NATIONAL  
RADIO ASTRONOMY FACILITY**

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<b>Personal Services</b>		
Salaries & Wages (1 year)		
Richard M. Emberson, Director	\$15,000	
Secretary	<u>5,000</u>	
		\$20,000
Consultants and part-time employees		<u>19,000</u>
		\$39,000
<b>Subcontracts</b>		
Equipment Study*	15,000	
Site Study*	<u>25,000</u>	
		40,000
<b>Equipment and Supplies</b>		2,000
<b>Travel</b>		10,000
<b>Insurance (Workmen's Compensation,     Group Life, etc.)</b>		1,000
<b>Publication Expenses</b>		<u>2,000</u>
<b>TOTAL DIRECT COSTS</b>		\$ 94,000
<b>Indirect Costs (12 + % of Direct)</b>		<u>11,000</u>
<b>TOTAL BUDGET</b>		\$105,000

\* These amounts are intended to include the entire cost of this aspect of the work, whether incurred by subcontract, employment of consultants, or provision of services by a government agency or agencies. In the last case, the total amount of the cash grant presumably would be reduced by the cost of the services.