RESEARCH FACILITIES AND PROGRAMS

Haystack radio telescope

Lincoln Laboratory's new Haystack Microwave Research Facility, located on Haystack Hill in Tyngsboro, Mass., was formally dedicated on October 8. The installation will serve as a radio telescope, a ground terminal for space communications, and a tracking and measurements radar.

The telescope's design incorporates features analogous to the Cassegrainian systems used in optical telescopes and only very recently applied to the design of microwave systems. The primary reflector is a 120-ft paraboloid which reflects incoming signals onto a 9′4″ secondary mirror suspended along the axis of the primary. The secondary directs the radiation to a feed horn mounted in a hole in the center of the primary. The feed horn is connected to receiving or transmitting instruments as desired.

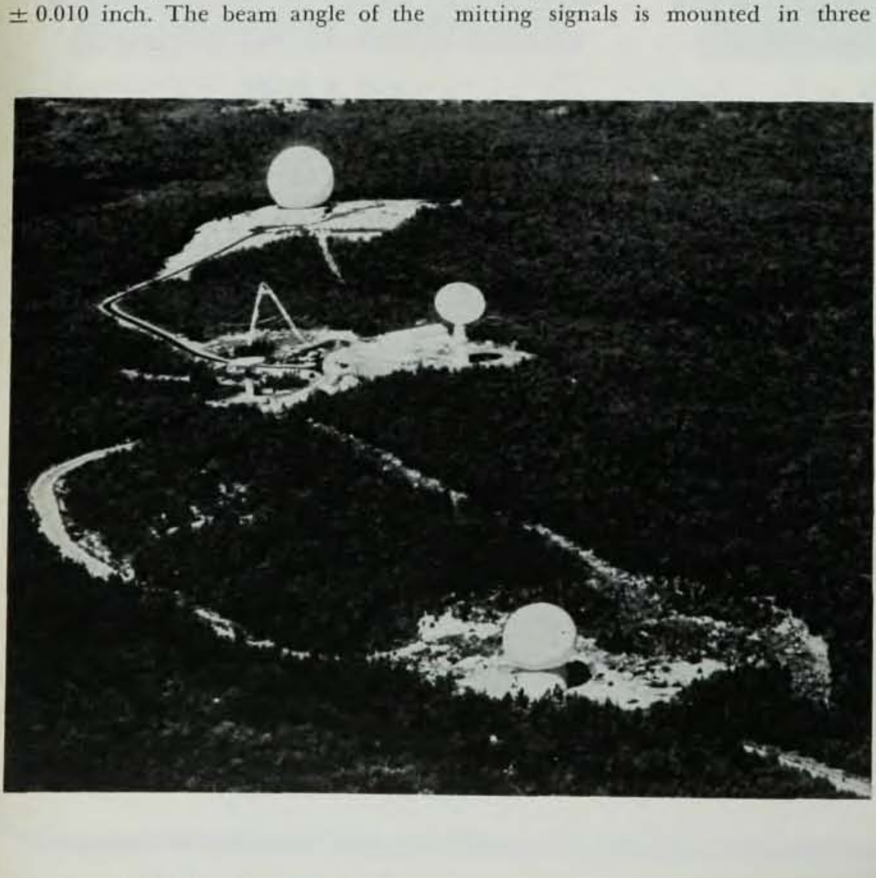
The surface of the primary mirror deviates from a true paraboloid by no more than 0.075 inch at any point; the secondary is accurate to within $\pm$ 0.010 inch. The beam angle of the system is about three minutes of arc at an operating frequency of 10 000 Mc, and preliminary measurements indicate that the antenna can be used at frequencies two or three times greater than 10 000 Mc, where the beam width will be two or three times sharper. Its designers claim that Haystack is the first radio system with an angular resolution comparable to that of the human eye.

The telescope can be pointed with an accuracy of 18 seconds of arc and is equipped with a special digital electromechanical system that senses angular changes of less than 2.5 seconds. It can slew from one position to another at a speed greater than three degrees per second, and can execute any change of position, including a 180-degree turn, in one minute or less. The telescope is pointed automatically by a digital computer whose operator gives it instructions by means of a typewriter keyboard.

Equipment for receiving or transmitting signals is mounted in three interchangeable "plug-in" boxes, which are hoisted to a position behind the center of the primary mirror. Each box is $8 \times 8 \times 12$ feet in size and capable of carrying two tons of equipment. The "optics box" contains an optical measuring system used to check and adjust the contour of the primary reflector. Sights are taken on more than 17 000 optical targets located in eight circular rows on the surface of the reflector. The system's measurement uncertainty is about one part in one hundred thousand.

For radio astronomy, a radiometer box is available which now contains radiometers at 5000, 8000, and 15 500 Mc (6.0, 3.7, and 1.9 cm wavelength). In the future, equipment will be installed for 35 000 Mc (8.5 mm wavelength), for 1420 Mc (hydrogen-line absorption), and 1670 Mc (hydroxyl-radical absorption). Data are processed, recorded, and plotted automatically by the computer that points the antenna.

The third box is for communications and radar. It contains a transmitter with 100 000 watts continuous power output at 7750 Mc, associated microwave circuits, cryogenic low-noise receivers and refrigeration equipment, and circuits for frequency control and manipulation. Combined with Haystack's narrow beam, this box could produce a radio signal strength on the moon comparable to that of a local broadcasting station. It produces a radar signal strong enough to track Venus and other planets at great distances.



Haystack microwave research facility (radome at top of picture) is one of several adjacent research installations in Massachusetts designed and operated by MIT Lincoln Laboratory for the Air Force. V-shaped tripod in middle distance, part of the Millstone Hill radar facility, is mounted over a fixed antenna used for ionospheric measurements. Radome in foreground covers an antenna used in the Project West Ford communications experiment. (Illustrations, including cover photo, courtesy MIT Lincoln Laboratory.)

Cut-away drawing shows Haystack antenna in its protective radome. One of three "plug-in" boxes carrying experimental gear is being hoisted up behind antenna.

The entire structure is housed in a radome. This protection from weather allowed the use of lighter materials in construction and thereby a substantial saving in cost. The telescope's moving part weighs 188 tons. It is estimated that an unprotected instrument with the same capabilities would have been ten times as heavy.

Among Haystack's possible uses in radio astronomy is the mapping of celestial radio sources with high precision. For example, the source Cassiopeia A is known to be about 0.05° wide, but its exact shape is unknown. The new telescope's narrow beam width (0.05° or less) will provide better definition than has been possible up to now. Similarly, interstellar clouds of hydrogen, and OH can be mapped, and other materials, not previously detected, may be located and identified. Planetological studies are expected to include the measurement of the dielectric constant and roughness of the surface layer of the moon and the study of the atmospheres and surface properties of Venus, Jupiter, Mars, and Mercury.

The installation's radar is capable of tracking small targets at great distances (a .22 caliber bullet at 1000 miles or a medium-sized satellite at 20 000 or more). It will be able to make detailed radar measurements of the moon and of Venus and other planets to study orbit perturbations and surface features.

The communications system will send signals to small (possibly mobile) remote terminals via the moon or active or passive satellites. It will study the effects of atmosphere and weather at higher frequencies than are now employed for satellite communications, and it will transmit to and receive from space probes at large distances (e.g., 100 million miles).

The new facility is a joint project of the Air Force Electronic Systems Division and the MIT Lincoln Laboratory. Its construction was first proposed in 1958, and procurement began in 1960. Herbert G. Weiss of Lincoln Laboratory served as project engineer.

150-inch reflector

Canadian Prime Minister Lester B. Pearson has announced that a site has been chosen for the new Queen Elizabeth II Observatory. When completed, the observatory will have as its main research instrument a 150-inch reflecting telescope, which is expected to cost nearly $10 million.

The site, chosen after a two-year search by astronomers from the Observatories Branch of the Canadian Department of Mines and Technical Surveys, is Mount Kobau, a 6200-foot mountain in Southwest British Columbia, about seven miles from the US-Canadian border. The advantages of the selected location are dry, stable weather, low auroral activity, and the absence of large industrial complexes and population centers.

In his announcement, Mr. Pearson said that the new telescope would enable " . . . Canada to carry out an aggressive program in the space sciences". It is planned to make the facilities of the observatory available to Canadian universities and other institutions doing research in astronomy and related sciences.

Megagauss by implosion

The Magnet Laboratory of the Department of Physics of Illinois Institute of Technology, in conjunction with the Explosives Research Laboratory of the Illinois Institute of Technology Research Institute, is constructing a pulse-implosion facility for the production of multimegagauss magnetic fields. The principle used increases field strength by holding magnetic flux constant while the area available to the field is decreased. The procedure is to set up an initial transitory magnetic field, typically about 100 kG maintained over a few microseconds, in a solenoid which is contained in a cylindrical jacket having explosives in its walls. When the field is present, the explosives are triggered to compress the jacket and provide the necessary space contraction.

The initial research effort at the Illinois facility will concentrate on the development of accurate magnetic probes suitable for calibrating fields in the two-to-ten megagauss range. Work on the physical mechanisms involved in the pulse-implosion process is planned, and it is hoped that several high-field shots will be achieved by the end of the next two years. One of the ultimate aims of the program is the development of such fields as targets for beams of high-energy particles.

Hydromechanical research

Hydromechanics research projects considered of importance to the Navy are conducted annually by nongovernment laboratories under a financial support program maintained by the Bureau of Ships. The middle of March is the next deadline for submitting proposals for the program, which is technically administered by the David Taylor Model Basin. Areas of interest are resistance, propulsion, stability, control, seakeeping characteristics, radiation of underwater sound, and other hydromechanics problems which may be applicable to surface and subsurface Navy craft.

Proposals for contract research under the program should be submitted to the Commanding Officer and Director, David Taylor Model Basin, attention Code 513, Washington, D. C. 20007. Inquiries concerning the program and the format for proposals should be addressed to Stuart F. Crump, Contract Research Administrator, Code 513.

ANL superconducting magnets

A large-bore superconducting magnet system developed at Argonne National Laboratory has sustained a field of 67 000 gauss at the center of its innermost coil. An outcome of a two-