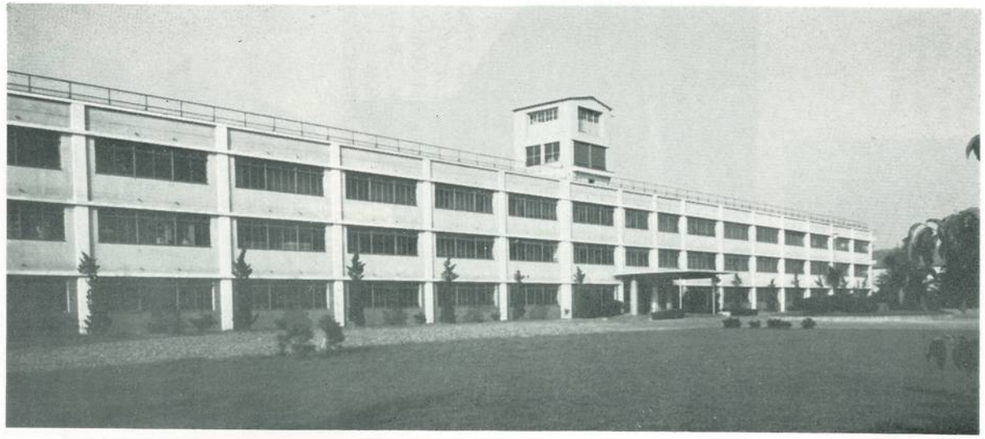
RADIO RESEARCH LABORATORIES

1968

CONTENTS

Layout and Illustration: Y. Hayakawa



HISTORY OF THE RADIO RESEARCH LABORATORIES

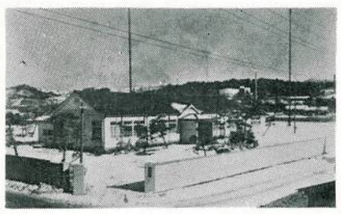
The Radio Research Laboratories came into existence on August 1, 1952, as an auxiliary organ attached to the Ministry of Posts and Telecommunications in integration of the Central Radio Wave Observatory engaged in researches on the ionosphere and radio propagation and the sections of the Radio Regulatory Bureau in charge of the broadcasting service of the standard frequencies, investigation and research in radio technics, and the governmental type approval of radio apparatus and devices. Several changes have been made ever since. Recently the Laboratories are making good progress in research work upon all the aspects of radio waves including space communications, information processing, and the research and development of artificial satellites. The Laboratories underwent a complete change by reorganization on June 1, 1967. The history of Sections in charge of respective responsibilities is as follows:

The Physical Institute for Radio Waves, Ministry of Education, the predecessor of the Central Radio Wave Observatory was established in 1942. This establishment was accelerated by the Radio Propagation Research Committee established in the National Research Council of Japan in 1922. In particular, the observation of the ionosphere that began in 1943 is now the work on a world-wide basis. The standard frequency and time signal service, through years of researches beginning in about 1925, officially began at Kemigawa transmitting station and Iwatsuki receiving station, Ministry of Communications, in January, 1940. The seat of this service moved to Koganei, Tokyo, in 1949, and up till now rapid improvement was made of accuracy.

The work of investigation and research of radio technics originated with research in radiotelegraphy at the Electro-Technical Laboratory, Ministry of Communications, back in 1896. With regard to the type approval of radio apparatus and devices, it first came into force as the result of enactment of the "Convention for the Safety of Life at Sea" and because in 1915 the Ministry of Communications made the Private Radiotelegraph Regulations in which the standards on radio equipment and apparatus were provided for. In addition, the type approval now in force has taken effect since November, 1950.

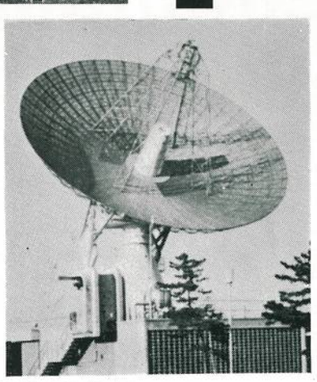
LOCATION OF THE RADIO RESEARCH LABORATORIES

WAKKANAI RADIO WAVE OBSERVATORY
45°23.6′N 141°41.1′E
3-37 MIDORI-CHO, WAKKANAI-SHI, HOKKAIDO.
TEL. 01622-3-3386



AKITA RADIO WAVE OBSERVATORY
39°43.5′N 140°08.2′E
5-1 TEGATA SUMIYOSHI-CHO, AKITA-SHI,
AKITA-KEN.
TEL. 01882-2-3767

HIRAISO BRANCH
36°22.0′N 140°37.5′E
3603 ISOZAKI-MACHI, NAKAMINATO-SHI,
IBARAKI-KEN.
TEL. 029262-2920, 2019



KASHIMA BRANCH
35°57.2′N 140°40.0′E
KASHIMA-MACHI,
IBARAKI-KEN.
TEL. 02998-2-1211

INUBO RADIO WAVE OBSERVATORY
35°42′N 140°51′E
9912 TAKAGAMI
TENNODAI, CHOSHI-SHI, CHIBA-KEN.
TEL. 04792-2-0871

OUTLINE OF THE RADIO RESEARCH LABORATORIES

BUDGET ...APPROXIMATELY 1,500 MILLION YEN (FISCAL YEAR 1968)

REGULAR PERSONNEL.....448 (AS OF APRIL 1, 1968)

CONSTITUENT MEMBERS

DIRECTOR	1
DEPUTY DIRECTOR	1
RESEARCH OFFICIALS	241
ADMINISTRATIVE OFFICIALS	199
OTHERS	46
TOTAL	488

FREQUENCY STANDARD DIVISION
35°42′N 139°31′E
4-1-3 MIDORI-CHO, KOGANEI-SHI, TOKYO.
TEL. 0423-81-1661

HEADQUARTERS
35°42.4′N 139°29.3′E
4-2-1 NUKUIKITA-MACHI,
KOGANEI-SHI, TOKYO.
TEL. 0423-21-1211

YAMAGAWA RADIO WAVE OBSERVATORY
31°12.1′N 130°37.1′E
2719 NARIKAWA, YAMAGAWA-MACHI, IBUSUKI-GUN,
KAGOSHIMA-KEN TEL. 09933-4-0077

ORGANIZATION OF THE RADIO RESEARCH LABORATORIES

(As of April 1, 1968)

- Director
- Deputy Director
- Planning and Support Division
  - Project Support Section
  - Technical Service Section
- Technical Consulting Division
  - International Radio Affairs Research Section
  - Frequency Utilization Research Section
  - Radio Application Research Section
  - Communication Systems Advisory Section
- Information Processing Division
  - Information Processing Research Section
  - Computer Applications Research Section
  - Computer System-Research and Service Section
- Radio Wave Division
  - Radio Propagation Research Section
  - Ionospheric Radio Prediction Section
  - Space Physics Section
  - Radio Meteorology Section
- Artificial Satellite Division
  - Communication Satellite Development Section
  - Ionospheric Satellite Development Section
  - Satellite Control Systems Section
  - Satellite Environment Study Section
- Communication System and Apparatus Division
  - Communication Systems Section
  - Speech Processing Research Section
  - System Performance Research Section
  - Standards and Measurements Research Section
  - Applied Radio Physics Section
  - Communication Apparatus Section
- Frequency Standard Division
  - Atomic Standards Section
  - Standard Frequency and Time Research Section
  - Standard Frequency and Time Dissemination Section
- Special Research Section for Space Physics
- Special Research Section for Ionosphere Experiments
- Special Research Section for Radio Physics
- Special Research Section for Precision Quartz Resonators
- Special Research Section for Satellite Communications
- Special Research Section for Satellite Tracking
- Administrative Division
  - General Affairs Section
  - Accounts Section
- Kashima Branch
  - Space Communication Section
  - Space Research Section
- Hiraiso Branch
  - Upper Atmospheric Research Section
  - Solar Radio Research Section
- Wakkanai Radio Wave Observatory
- Akita Radio Wave Observatory
- Inubo Radio Wave Observatory
- Yamagawa Radio Wave Observatory

GENERAL ACTIVITIES

PLANNING AND SUPPORT DIVISION

Planning and coordination of researches and investigations, publication, and public relations.

Collection of technical information, administration of books and publications, communications and Ursigram broadcasting, and engineering workshop for research requisites.

TECHNICAL CONSULTING DIVISION

Fundamental research and investigation in the radio science and technology called for by the international conferences or by consultation with foreign countries.

Fundamental research and investigation for the development and utilization of radio frequencies, elimination of interference, prevention of radio noise, and in technical matters of radiocommunication circuits.

INFORMATION PROCESSING DIVISION

Information processing and research for increase in efficiency of its conveyance.

Research in the application of an electronic computer.

RADIO WAVE DIVISION

Research in the characteristics of radio waves and related phenomena of the ionosphere and atmospherics.

Research on radio forecasts, radio warnings, aerospace, and ionospheric observations in Antarctica.

ARTIFICIAL SATELLITE DIVISION

Research on planning and designing satellites for communications and for the ionosphere.

Research on the composition and functions of satellites, their attitude control, telemetering, and environment tests.

COMMUNICATION SYSTEM AND APPARATUS DIVISION

Research on the radiocommunication system and routes.

Research on measurement of radio waves and on their standardization.

Research on analysis and disposition of the voice.

Basic studies in the relation between radio waves and the property of matter and in radio apparatus with the property of matter applied to.

Governmental type approval, performance test, and calibration of radio apparatus and devices.

FREQUENCY STANDARD DIVISION

Research for the atomic frequency standards.

Determination of the standard frequency value and maintenance of the atomic time on its basis.

Transmission on the standard frequencies of time signals and bulletins for radio warning.

For the above purposes, research on precision metrology, the development of utilization, the international comparison, and so on.

SPECIAL RESEARCH SECTION FOR SPACE PHYSICS

Synthetic studies in space physics.

SPECIAL RESEARCH SECTION FOR IONOSPHERE EXPERIMENTS

Experimental research in the ionosphere by the use of satellite frequencies.

SPECIAL RESEARCH SECTION FOR RADIO PHYSICS

Theoretical research in the characteristics of radio waves and the ionosphere.

SPECIAL RESEARCH SECTION FOR PRECISION QUARTZ RESONATORS

Research in highly stable quartz.

SPECIAL RESEARCH SECTION FOR SATELLITE COMMUNICATIONS

Synthetic studies in space communications.

SPECIAL RESEARCH SECTION FOR SATELLITE TRACKING

Studies in satellite tracking technique.

ADMINISTRATIVE DIVISION

Taking charge of the general affairs, documents, personnel affairs, salaries and wages, and the welfare of the personnel.

Budget planning, acts of obligation for various supplies, and taking charge of the gevernment property and of articles and commodities for maintenance purposes.

KASHIMA BRANCH

Research and development of space communications.

Experimental research on cosmical space with radio waves.

HIRAISO BRANCH

Researches in radio propagation and the ionosphere.

Observations and studies necessary for radio warning, measurement of HF field intensity on the international standard, and observations and studies of solar and cosmical radio waves.

WAKKANAI RADIO WAVE OBSERVATORY

Observations of the ionosphere and geomagnetism, and studies of radio propagation.

AKITA RADIO WAVE OBSERVATORY

Observations of the ionosphere and studies of radio propagation.

INUBO RADIO WAVE OBSERVATORY

Observations and studies of radio propagation.

YAMAGAWA RADIO WAVE OBSERVATORY

Observations of the ionosphere and studies of radio propagation.

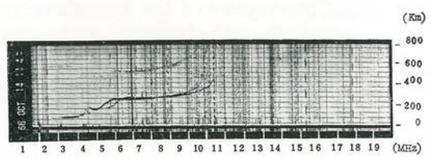
BASIC RESEARCHES ON CHARACTERISTICS OF RADIO WAVES

OBSERVATION OF THE IONOSPHER AT VERTICAL INCIDENCE

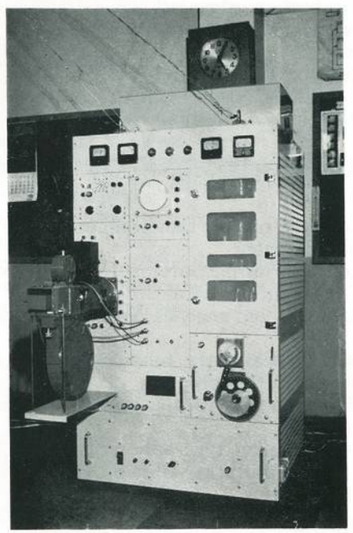
The observational result of the ionosphere gives the most important information on the conditions of radio propagation of LF to VHF bands, and the data most contributory to the investigation of physical characteristics of the ionosphere itself. Therefore, among various countries in the world are exchanged the observational data obtained by regular ionospheric sounding on a world-wide basis. The ionospheric observatories at present number about 170 all over the world, and the ionosphere is being clarified with the exception of some parts of the ocean and polar regions.

This records the observed electron densities and height of the reflection layer of the ionosphere measured by radiating vertical impulse waves up from the ground. This observational recording is dealt with daily by the method adopted internationally and is published monthly in the "Ionospheric Data in Japan" for distribution among the Agencies concerned at home and abroad.

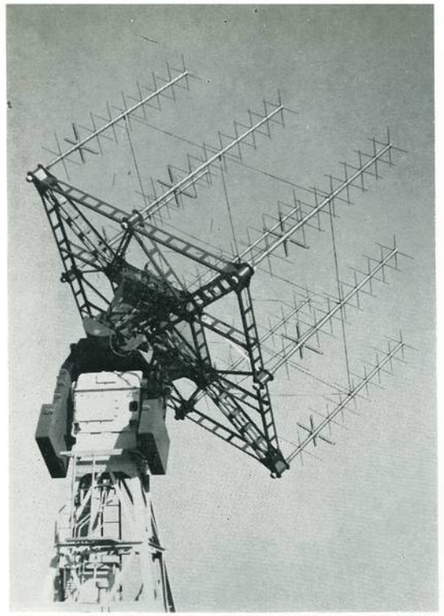
Ionogram Printer by Optical Fiber Tube



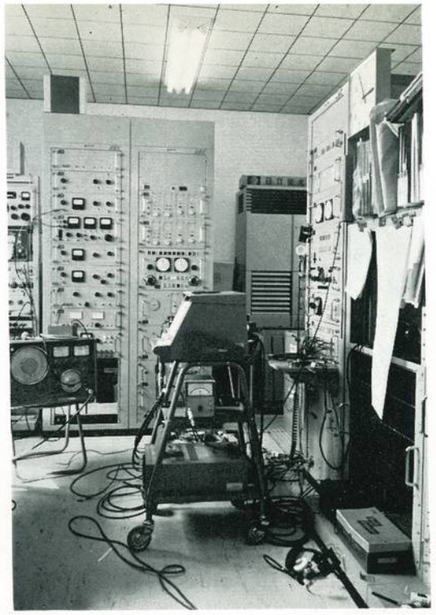
h'-f Ionogram



Ionosonde (Type 8)

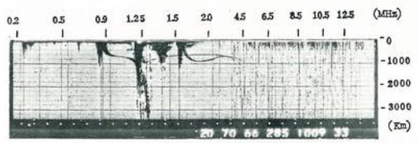


Telemeter Receiving Antenna for Artificial Satellites (Kashima Branch)



Telemeter Receiving Equipment for Artificial Satellites (Kashima Branch)

OBSERVATIONS OF THE IONOSPHERE BY ARTIFICIAL SATELLITE



Ionogram of Topside Sounding

Observation of Radio Waves from Artificial Satellites

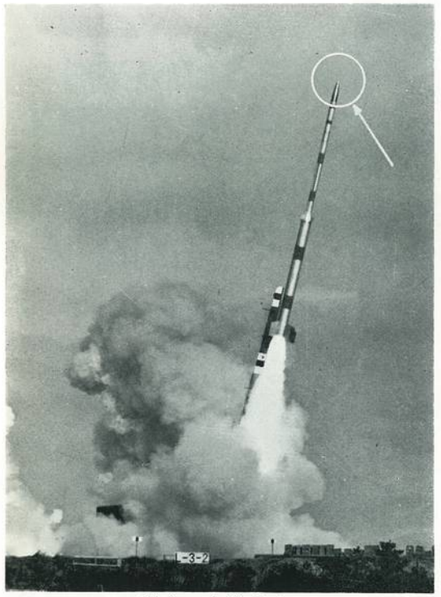
Analogue Faraday Equipment

The observation of the ionosphere by means of impulse waves radiated from the ground does not clarify the ionospheric conditions above the maximum electron density of the ionosphere. Therefore, the ionospheric observation is carried out by artificial satellite carrying the ionosonde on board and flying in the upper region of the ionosphere. This system of observation is called "topside-sounding". Now the observation is made by the ionospheric satellite called "Alouette" (developed in Canada and launched in and by U. S. A.).

The Radio Research Laboratories took part in this plan of sounding in August, 1966, and are carrying on observations far up in the sky of and around Japan.

The photograph is the ionogram of topside sounding; the observational recording on the ionospheric satellite was received by telemetering signals at the ground station. Such recording gives the entire picture of distribution of electron densities in the ionosphere interdependent on h'-f ionogram obtained on the ground.

In addition, the study of the ionospheric conditions is in progress from phase variations of radio waves due to Faraday or Doppler effect.

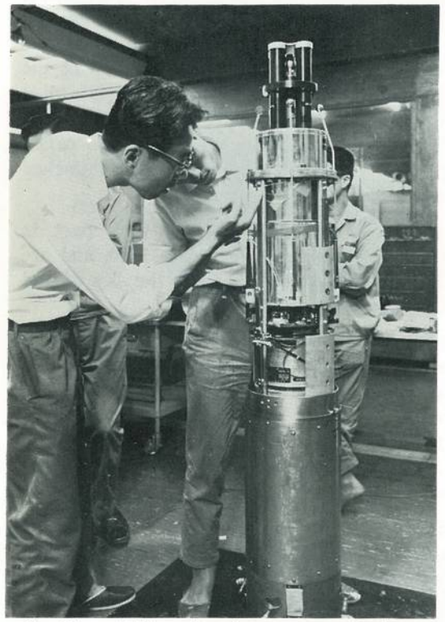


Firing of Rocket

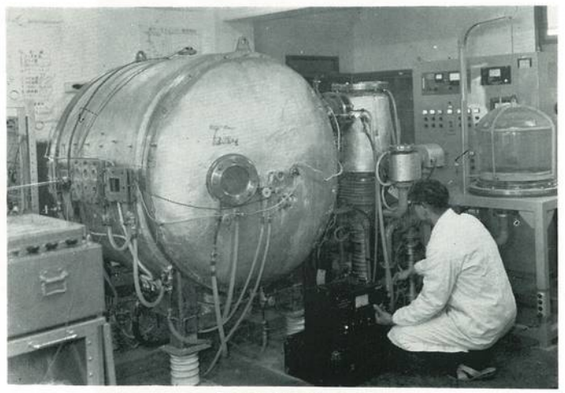
DIRECT SOUNDING FOR AERONOMY BY ROCKET

Rocket launching is carried on for direct sounding for the electronic density of aeronomy and cation density, distribution of electronic energy, space electric potential, formation of ions, and others. The Radio Research Laboratories have developed ionospheric direct-sounding instruments airborne called "resonance probe" and very convenient for measurement. Down to October, 1966, thirty-six times, the instruments were flown on rocket Kappa or Lambda with great success in cooperation with the Kagoshima Space Center, Tokyo University. Further, these instruments were used experimentally at NASA, U. S. A., and were acknowledged to be excellent. Researches in the ionospheric direct-sounding instruments on board rocket or ionospheric satellite are still in progress.

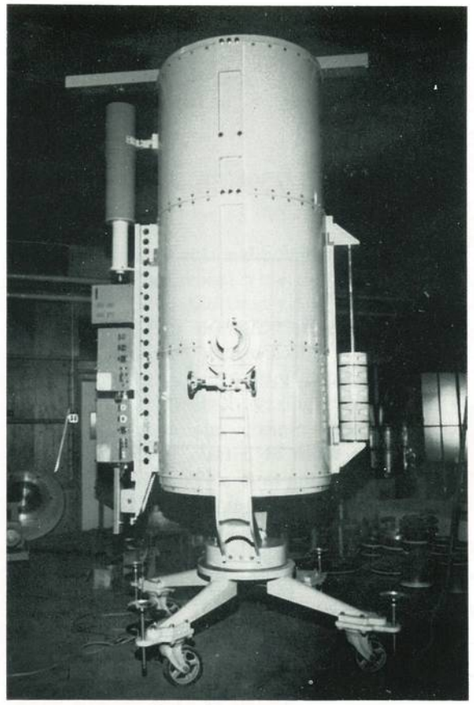
As seen by photograph, the same environment as the ionosphere is created in the space chamber for basic researches into the aeronomy.



Checking of Measuring Apparatus on Rocket



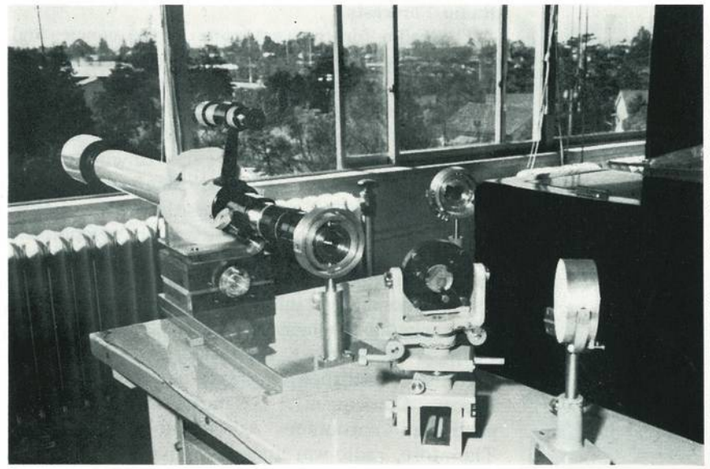
Space Chamber



Laser Transceiver

UPPER ATMOSPHERIC OBSERVATION BY LASER BEAM

Observation of the upper atmosphere is now in progress by the use of a laser beam. In this research a high-powered giant pulse beam by ruby laser is shot up into the sky, the scattering lights from the sky are received, and the height distribution of the dust is observed. The laser beam is capable of detecting the aerosol layer, meteoric dust, and the temperature distribution of the atmosphere which can not be detected by radio waves. As the result, for research in relation to night air glow and meteorology, development is in progress in such a new field as observation of neutral drift in the lower ionospheric region by tracking the movement of neutral corpuscles around this region.



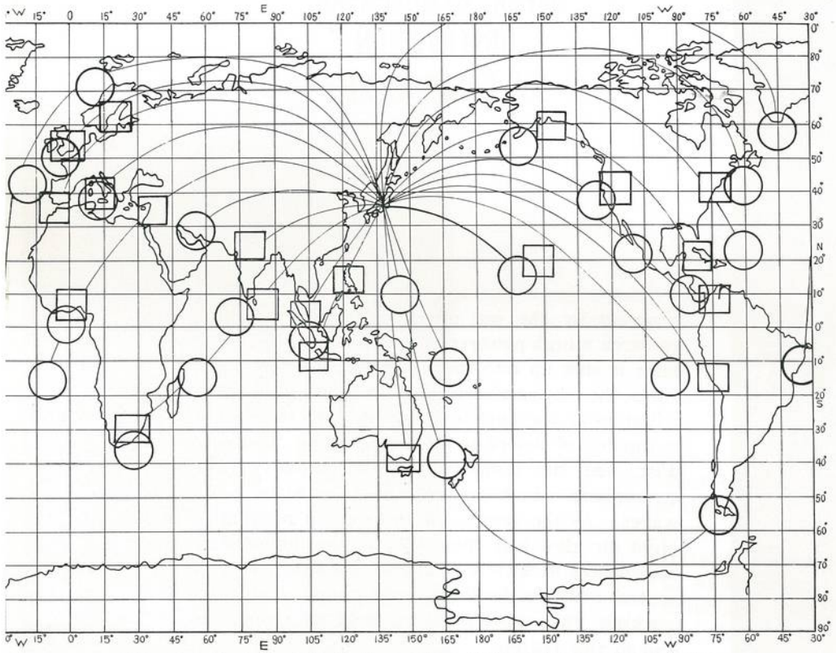
Gas Laser Transmitter

BASIC RESEARCHES ON LASER COMMUNICATIONS

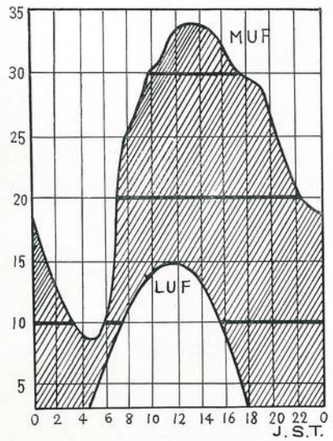
Since the advent of gas laser in 1961, the application to communications of visible laser or infrared laser having the same nature of interference as radio waves has come to attract much attention.

Various points at issue of radio propagation in the atmosphere are now under research, e. g., the relation between absorbability in the atmosphere and meteorological conditions (rain, fog, etc.), various radio propagational characteristics, high frequency modulation making use of diffraction of ultrasonic waves, usable frequency bands in heterodyne reception, various optical systems, and so on.

Laser Receiver



Objective Regions of Radio Forecasts and Radio Propagational Paths



Sample of Radio Forecast Curves

RADIO FORECASTS AND WARNINGS

Radio Warning Room (Hiraiso Branch)

Radio Forecasts

The radio forecasts estimate the frequencies and power for efficient use in stable communications between two places at a certain time, and are very important for designing and operating HF-band radio circuits. The Radio Research Laboratories are carrying on the service of radio forecasting of three months ahead for leading cities at home and abroad and for the waters where merchantmen or fishing fleets are on voyage.

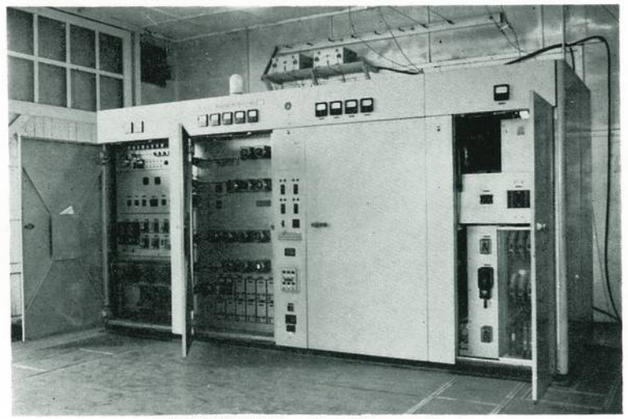
Radio Warnings

The ionosphere is influenced by the sun's activity and various phenomena of the earth not only to increase or decrease ionization density always, but also sometimes to create ionospheric disturbances. Consequently, HF radiocommunication in particular encounters considerable difficulties. Therefore, radio warnings are requested to the time and degree of occurrence. At the Radio Research Laboratories, for warning against radiocommunication hindrance, the Hiraiso Branch is collecting, through the Regional World Center for Ursigram and World-Days Service, varied information on variations in the field intensity of long-distance propagation, spatial radio waves, geomagnetics, earth current, etc., and daily observational data on the sun and various geophysical phenomena at many observatories at home and abroad. The radio warnings are broadcast on the standard frequencies (JJY) by the Radio Research Laboratories. Some are sent to the specified Agencies by telephone, telegram, or post.

URSIGRAM BROADCASTING

There is the International Scientific Radio Union (U. R. S. I.) for the world-wide cooperation in researches concerning the theory and observation of radio waves. This organization carries on the service of Ursigram broadcasting. It aims at reception by the observatories concerned in the world of information on various phenomena of the sun, geomagnetism, cosmic rays, the ionosphere, etc., closely related to radio propagation.

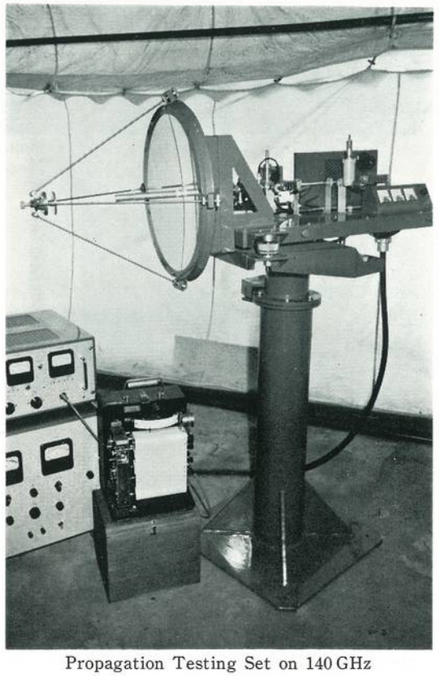
In Japan, this service was interrupted during World War II, but it was resumed at the Radio Research Laboratories on December 25, 1951, at the request of the 9th U. R. S. I. Plenary Assembly. The Radio Research Laboratories have taken the role of the Western Pacific Regional Center since 1957, and the information concerned is exchanged with three other Regional Centers (Nederhorst den Berg, the Netherlands, Ft. Belvoir, U. S. A., and Moscow, U. S. S. R.).



URSIGRAM Broadcast Transmitter

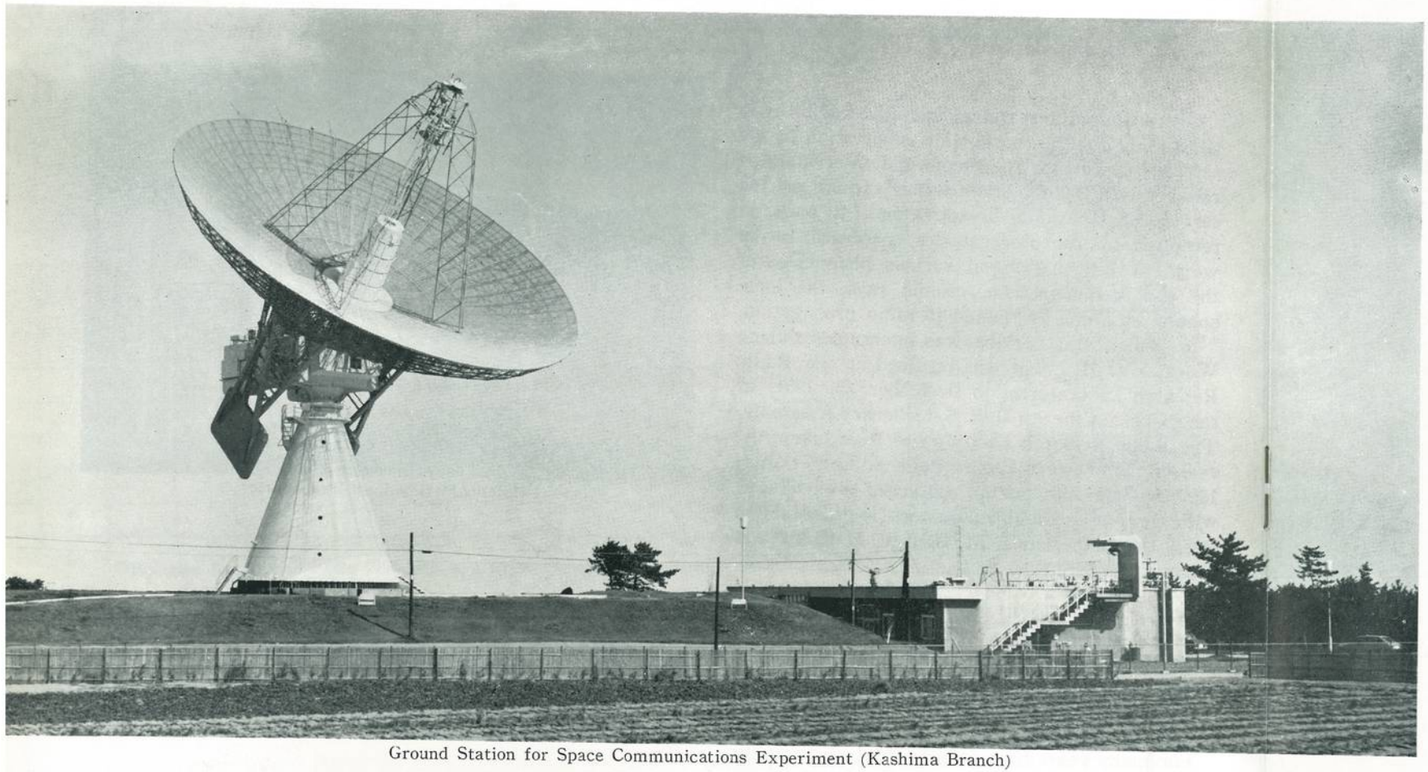
TROPOSPHERIC PROPAGATION OF MILLIMETRIC WAVES

For many years have lasted experiments on the scattering propagation over long distances between Tokyo and Sendai, or between Tokyo and Moji, measurement by aircraft of atmospheric refractive indices relative to propagation, tropospheric propagational characteristics of VHF and UHF waves, and research in radio meteorology. Further studies are in progress in the propagation on much higher frequencies such as EHF (millimetric) waves on 35 GHz or 140 GHz.



Propagation Testing Set on 140 GHz

SPACE COMMUNICATIONS



Ground Station for Space Communications Experiment (Kashima Branch)

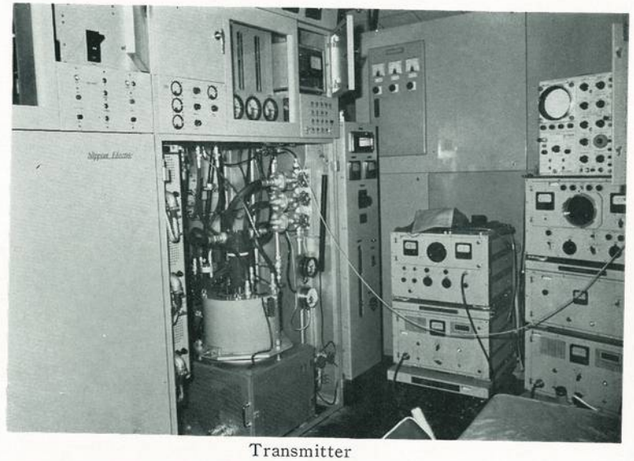
Control Room

In October, 1957, the U. S. S. R. first successfully launched an artificial satellite, and many of them have since secured excellent results in practical use for observations into space, communications, meteorological, navigation, surveying, and so on. Above all, practical use for space communications uniting all the world into one deserves special mention.

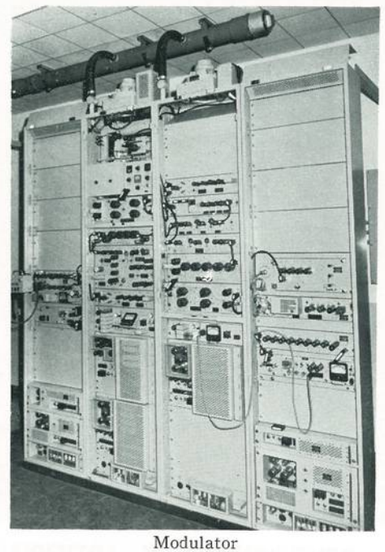
The Radio Research Laboratories, in preparation for the days of space communications, established a ground station for space communication experiments at Hirai, Kashimamachi, Ibaraki Prefecture, in 1960. In 1964, this station succeeded in international TV relaying of the Tokyo Olympic Games by satellite Syncom III, and showed clearly at home and abroad the might of satellite communications and the height level of science and technology in Japan. Subsequently, repeated experiments were carried on in cooperation with the U. S. A. by means of relay satellite (mobile) or satellite Syncom (stationary). In addition, various communication experiments were made with Nothern Europe and West Germany. Further, in connection with launching of Applications Technology Satellite (ATS), the facilities necessary for testing have been improved, and various experiments are being made of the precise measurement of satellite orbits, observation of the satellite attitude, TV relaying (U. S. A., Australia, etc.), PCM communication strong against noises and interference, and so on. Besides, the satellites are used for receiving weather charts and for the world-wide synchronization of the standard frequencies and time signals. This large parabolic antenna is used for radio observation of the nebulosity useful for radio astronomy.

The ground station (Kashima Branch) for space communications experiment is outlined as follows:

Latitude 35°57′10.0″N
Longitude 140°39′57.8″E
Height 42.2 m (24.7 m above sea level plus 17.5 m to the center of the elevation axis)
Transmitting frequency: 6,301.050 MHz (Signal)
Receiving frequencies:
4,178.591 MHz (Signal and precision tracking)
4,195.172 MHz (Precision tracking)
136 MHz (Roughness tracking)



Transmitter

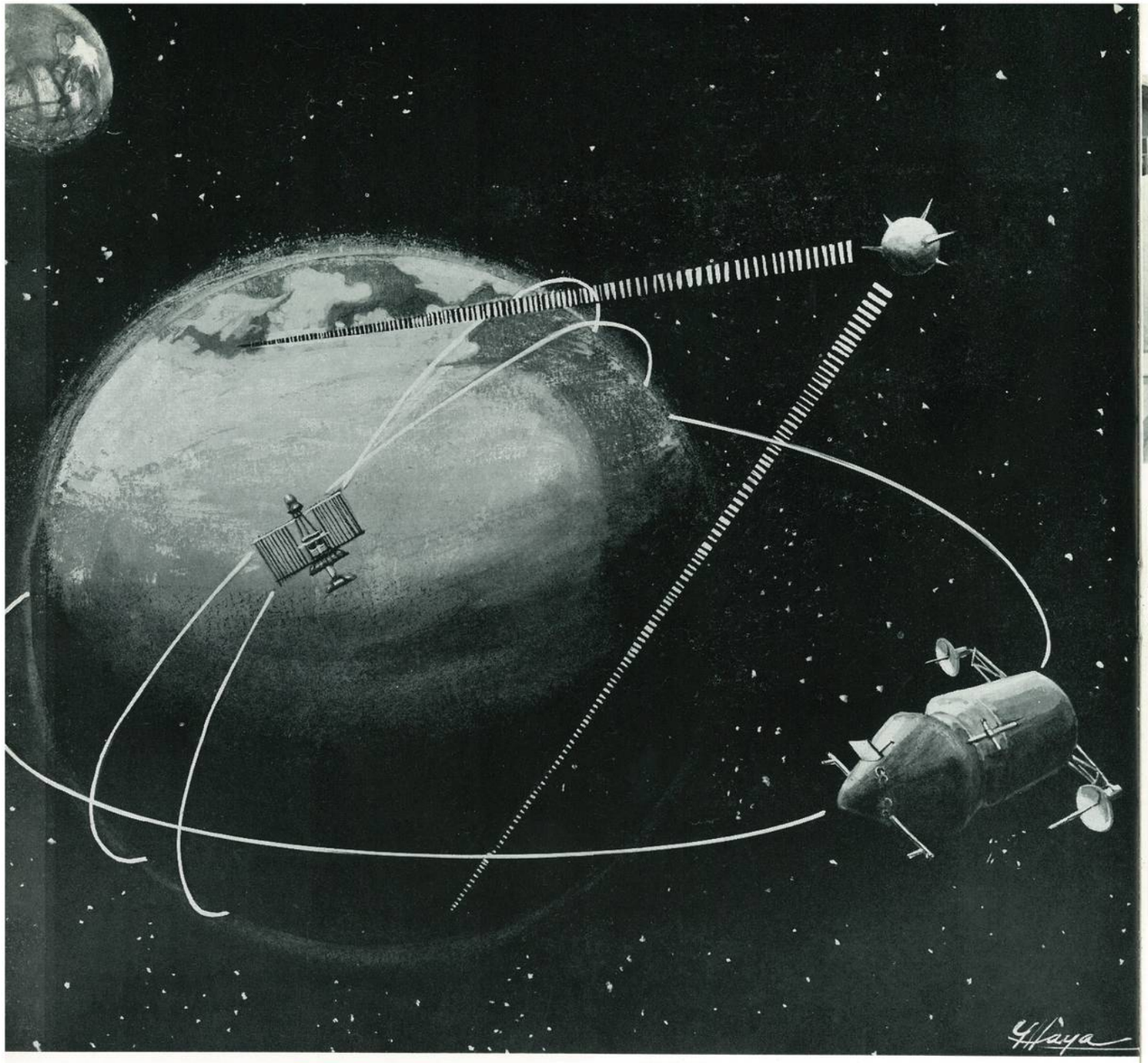


Modulator

ANTENNA AND FEEDING SYSTEM

The paraboloidal Cassegrain antenna is 30 m in diameter of azimuth-elevation movable type as seen in the photograph. The transmitting waves on 6301 MHz are reflected by the dish reflector from the main horn on the center of this paraboloid and are radiated by way of the paraboloid. On the other hand, the receiving signals enter the receiver on the reverse course through the main horn in common use for transmission. Four orthogonal Yagi antennas around the dish reflector are receiving ones for roughness tracking on 136 MHz. Around the main horn are fixed sixteen subhorns, with which the precise tracking in the direction and polarization is made.

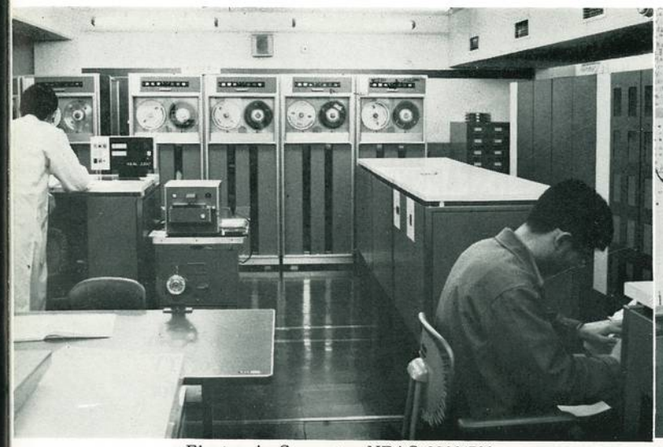
The parabolic antenna is driven by oil pressure. Search and tracking are made correctly by manual or automatic control or an electronic computer. The accuracy is ±0.5° and ±0.02° in rough and precise tracking respectively.



DEVELOPMENT OF ARTIFICIAL SATELLITES

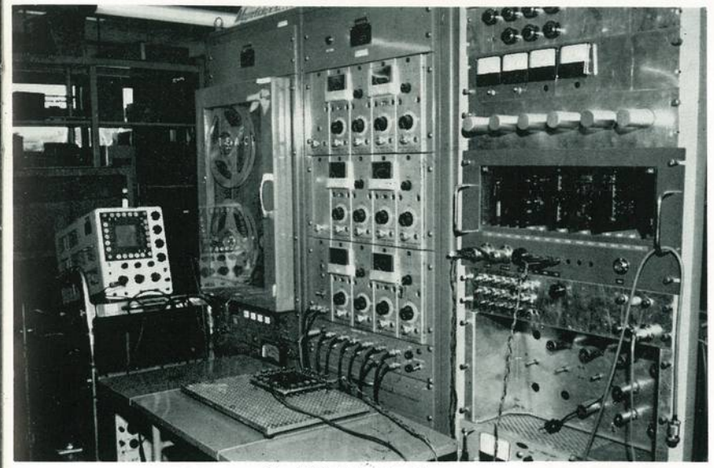
Space communications and the observation of aerospace by means of artificial satellites succeeded in the United States of America, the U. S. S. R., France, Canada, Britain, and other countries. These satellites, however, were sent up for their respective purposes, so the communications or observations making use of the said satellites are not necessarily satisfactory to Japan. For the utilization of further developing space communications, the exploitation of the unknown, or for the acquisition in future of the privilege of the country on the international stage in this field, it is necessary to launch homemade satellites, to develop our own communication system, and to proceed on the new course of observation and research.

For the above purposes, the Radio Research Laboratories set to work on the development of artificial satellites in 1967 and on the occasion of reorganization in June the same year inaugurated the Artificial Satellite Division. At present entire staff in charge is carrying out investigations and researches into the planning of the satellite, the control system, and the environment test (man-made-room the same as the spatial condition). Within 1968, new equipment for the environment test and its building will be completed for experimental researches on the actual satellites.



Electronic Computer NEAC 2200/500

Analog Input-output Processing Equipment



Hand-Writing Analyzer

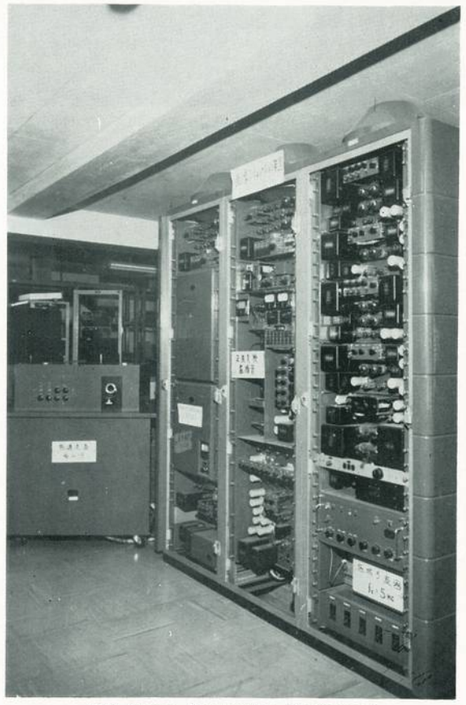
INFORMATION PROCESSING

It is considered that speech and characters contain much redundance from the viewpoint of information. If this redundant part can be eliminated, the level of transmission efficiency will be raised. Therfore, studies are in progress on the sampling of characters, speech, figures, etc. as patterns and on the method of coding and automatic recognition of them.

APPLICATION OF COMPUTERS

The application of an electronic computer widens day after day to information processing, simulation of research on the communication system, orbital computation for satellite communications, data processing on radio observations, calculation of numerical values in various researches, and so on. For these reasons, the efficient use of computers, the study of soft wares, and research in new radio technique making use of electronic computers are now in progress.

RESEARCHES ON COMMUNICATION SYSTEM



TV Image Simulation Equipment

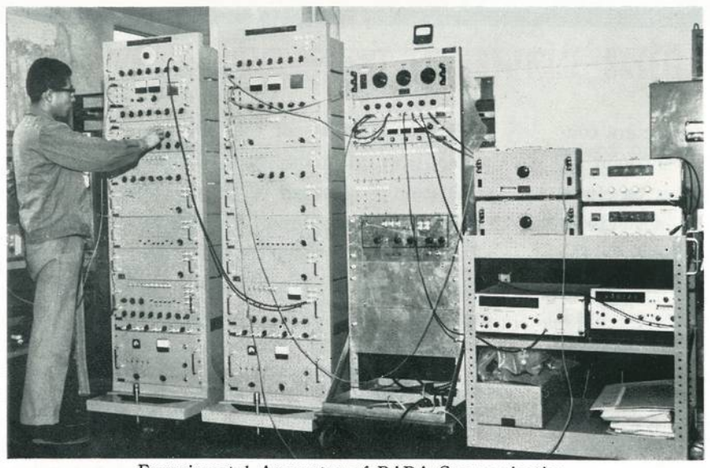
Researches on communication system now in progress are the bandwidth compression of TV signals and RADA communication system for effective use of frequencies.

EXPERIMENTS ON SIMULATION OF TV IMAGES

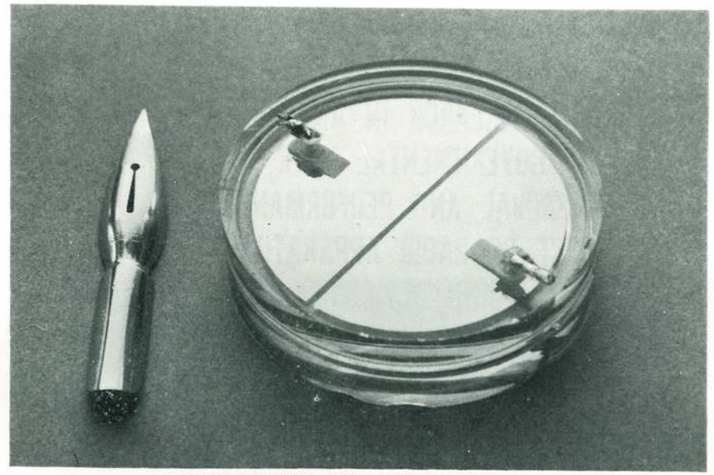
This shows the input and output equipment for simulation of TV signal processing by electronic computer. The output signals of this equipment are converted into the original picture on the standard TV set by the use of a storage cathode-ray tube. This equipment and the electronic computer installed in the computing center are connected directly by cable.

RADA COMMUNICATION SYSTEM

On account of limited radio bandwindths available, it is necessary to make the most of bandwidths in order to meet the increasing demand for radio waves. For this reason, in communications that do not necessarily require continuous working, many stations can make common use of wide frequency bands for working as occasion calls. This system is called "RADA" (Random Access Discrete Address) communication system. For studies in its modulation system and the field of its application, experimental simulation by computer and experiments by trial appliances are in progress.



Experimental Apparatus of RADA Communication



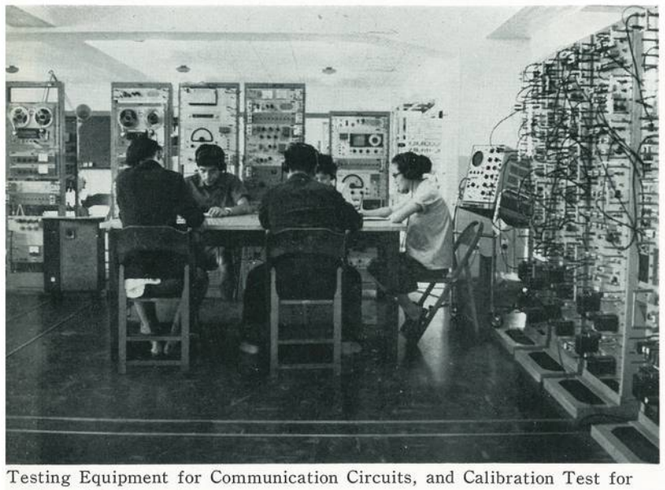
Superhigh-Q 1MHz AT-cut Crystal Resonator

Polisher for Crystal Resonator

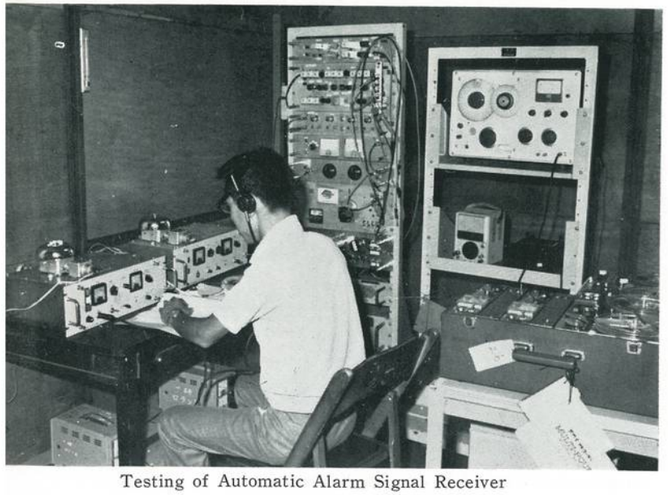
RESEARCHES ON HIGH-STABILITY CRYSTAL RESONATOR

In recent years many high-stability quartz oscillators very easy of handling have been produced, but in order to bring them into full play, the continuous operation for several weeks or months is required. In order that such defect may be overcome and a quartz oscillator may have much less dirrerence of frequency variation between long and short periods of time, the Radio Research Laboratories have entered into studies for development of superhigh Q and high-stability crystal resonators. The photograph shows a 1 MHz AT-cut crystal resonator manufactured on trial at the Laboratories lately. It is small-sized and designed to be strong against mechanical or thermal shock. The Q $(=\omega L/R)$ is approximately 2.2×10^7.

RESEARCH IN AND GOVERNMENTAL TYPE APPROVAL AND PERFORMANCE TEST OF RADIO APPARATUS AND DEVICES



Testing Equipment for Communication Circuits, and Calibration Test for Measuring Apparatus



Testing of Automatic Alarm Signal Receiver

RESEARCH IN RADIO APPARATUS AND DEVICES

For the effectual utilization of radio waves, there are in progress studies in the testing equipment necessary for the determination of the plan for establishment of radio stations, of frequency assignment, and of the technical standard of radio equipment, and in the apparatus necessary for calibration.

Principal items of researches are as follows:

(1) Development of the synthetic testing equipment for obtaining quantitatively the relation of the traffic quality of radiocommunication circuits to the performance required of the equipment used in the circuits;
(2) Development of the automatic recording equipment of spurious emissions;
(3) Establishment and improvement of various high-frequency working standards;
(4) Relation of interference in adjacent circuits to the modulation characteristics of transmitters;
(5) The minimum field intensity required by types of modulation;
(6) Method of testing for the evaluation of reliability of communication equipment under various environmental conditions;
(7) Method of calibration of the measuring equipment in use for Radio Regulatory purposes;
(8) Development and improvement of various testing instruments in use for type approval and calibration purposes.

TYPE APPROVAL OF RADIO APPARATUS AND DEVICES

In accordance with the Radio Apparatus Type Test Regulations, the type approval is given on application for testing from radio apparatus manufactures. In this case, if the apparatus or devices tested conform to the said Regulations, the Minister of Posts and Telecommunications will issue to the applicant a certificate of success in test and will announce the matter in the Official Gazette and the Official Report of the Ministry.

Principal kinds apparatus subject to type approval are as follows:

(1) Those making sure of safety of navigation (automatic alarm signal receivers, radio direction-finders, radio apparatus for survival craft, aircraft transmitters and receivers);
(2) Those to be compulsorily equipped with at radio stations for the sake of Radio-Administration (frequency meters);
(3) Those necessary for maintenance of the technical standard of radio equipment provided for by law (FM and SSB transmitters and receivers, radio equipment in the simple radio service, automatic distress informing transmitters, radio buoys, radio transmitters in the meteorological aids service, and equipment utilizing high frequencies).

CALIBRATION OF RADIO REGULATORY MEASURING EQUIPMENT

The working standards of various radio frequencies are under development, and with the equipment for calibration on this basis, the service of calibration is being carried on.

The working standards of frequencies established so far are as follows:

(1) Power,
(2) Field intensity,
(3) Voltage and current on high frequencies,
(4) High frequencies,
(5) Occupied frequency bandwidth.

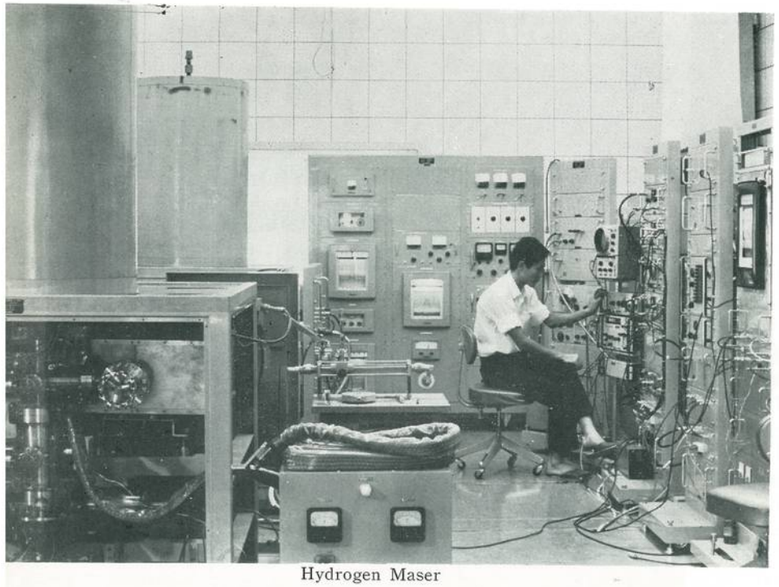
The service of calibration chiefly deals with measuring equipment for use in Radio Administration, but manufacturers, users, etc. in general may make use of this service.

PERFORMANCE TEST

The radio apparatus and devices which are the objects of governmental type approval, high frequency measurement, and the radio apparatus and devices with which radio stations requiring no licence are to be equipped, are tested and, upon the request of manufacturers, users, etc., the performance records are issued.

Testing of Field Strength Meter

Official Testing Equipment



Hydrogen Maser

STANDARD FREQUENCY AND TIME QUANTITY

As the standard for determination
the frequency and time interval,
e rotation of the earth has been
lopted for many years, but the
curacy has never been less than 1
rt in 10^8. In 1956 a second of
hemeris time came to be adopted
the basis of the revolution of the
rth, for the reason that this is the
rfect time expressive of universal
avitation lows, but even this ac-
racy remains within about 1 part
10^9.
However, modern physics have
ade clear that atomic and molecular
culiar vibrations are invariable, and
e development of electronics has
tended the practicable range of
e atomic frequency standard.
The atomic frequency standard of
drogen maser type developed at
e Radio Research Laboratories
akes use of the invariability of
drogen atomic spectrum, and this
the primary standard determining
e value of frequency standard and
ne quantity in Japan at present.
ne accuracy of frequencies deter-
ned thereby is now of the order
10^{-12}.

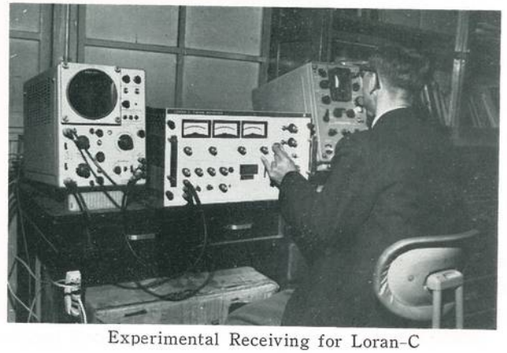
STANDARD

DEVELOPMENT OF THE FREQUENCY STANDARD AND PRECISION MEASUREMENT OF FREQUENCIES

In Addition to improvement in the primary standard hydrogen maser, the development and research of the atomic frequency standard by other atoms or systems are in progress, but on the basis of pure frequency spectrum of atomic hydrogen, detailed studies in the frequency spectra for and the stability of various other oscillators are carried on.

The frequency standard makes the source of oscillation for the precise standard frequencies and of modulated time signals on them. The standard frequencies and time signals are desired to be unified for world-wide use in common. Therefore, it is necessary to compare internationally the frequency standards in various countries with perfect precision. For this reason, considerable concern has arisen as to the use of the standard VLF or Loran-C signals, and international precise frequency comparison and time synchronization by means of a flying clock (carried by aeroplane), artificial satellites, or the like.

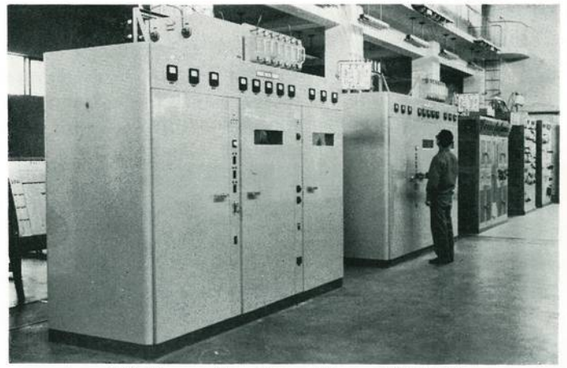
Standard Measuring Room



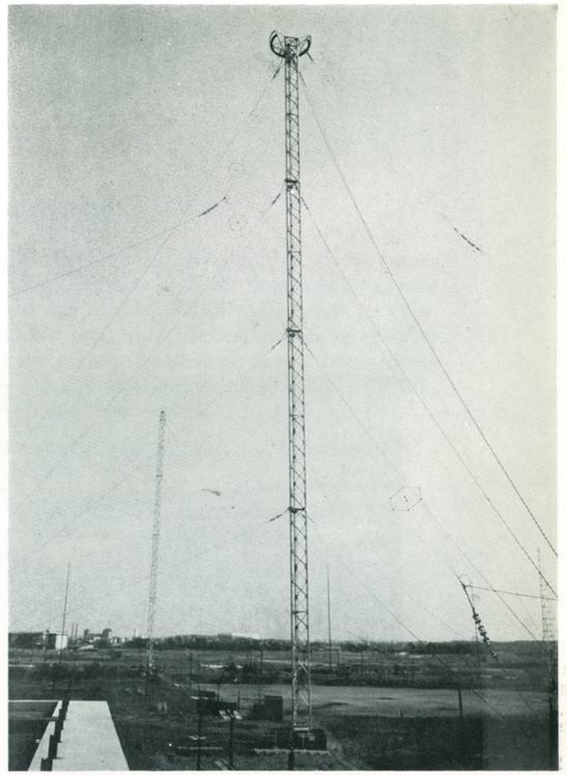
Experimental Receiving for Loran-C

VLF Receiving Equipment

FREQUENCIES



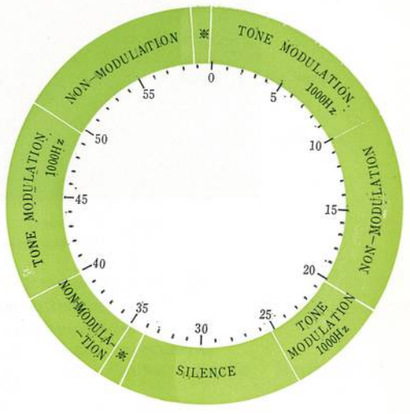
JJY Transmitter Room (Koganei Station)



LF 40 kHz Transmitting Antenna (Kemigawa Station)

Service station and experimental stations for standard frequencies

	SERVICE STATION	EXPERIMENTAL STATIONS			
CALL SIGN	JJY	JG2AE	JG2AQ	JG2AR	JG2AS
FREQUENCIES	2.5 MHz, 5 MHz 10 MHz, 15 MHz	8 MHz	16.2 kHz	20.0 kHz	40.0 kHz
OUTPUT POWER	2 kW	0.5 kW	3 kW	3 kW	10 kW
OPERATION HOURS	24	05 : 59～19 : 59	OCCASIONALLY	14 : 30～16 : 30 EXCEPT ON EVERY SATURDAY AND SUNDAY	04 : 00～15 : 00 EXCEPT ON EVERY SATURDAY AND SUNDAY
SECONDS PULSES	USUALLY	USUALLY	USUALLY	USUALLY	NONE
ACCURACY	$\pm 3\times10^{-10}$	$\pm 3\times10^{-10}$	$\pm 3\times10^{-10}$	$\pm 3\times10^{-10}$	$\pm 0.5\times10^{-10}$
LOCATION	KOGANEI, TOKYO	KOGANEI, TOKYO	KOGANEI, TOKYO	KOGANEI, TOKYO	KEMIGAWA, CHIBA PREFECTURE



The Hourly Broadcasting Schedule of JJY
*Station Announcement

STANDARD FREQUENCY AND TIME SIGNAL SERVICE

The standard frequencies are emitted on exact and stable frequencies as the basis of time and the standard time signals for users in general. The frequencies are at all times adjusted by the atomic frequency standard of hydrogen maser type of the primary standard to be maintained within $\pm 1\times10^{-10}$ against the value arranged internationally.

The time signals are synchronized within ± 1 ms internationally. If it makes a difference of more than 100 ms from UT2 (Universal time: In daily life, it may be deemed the mean tropical time as in the past), the time signals are adjusted by consultation among various countries concerned.

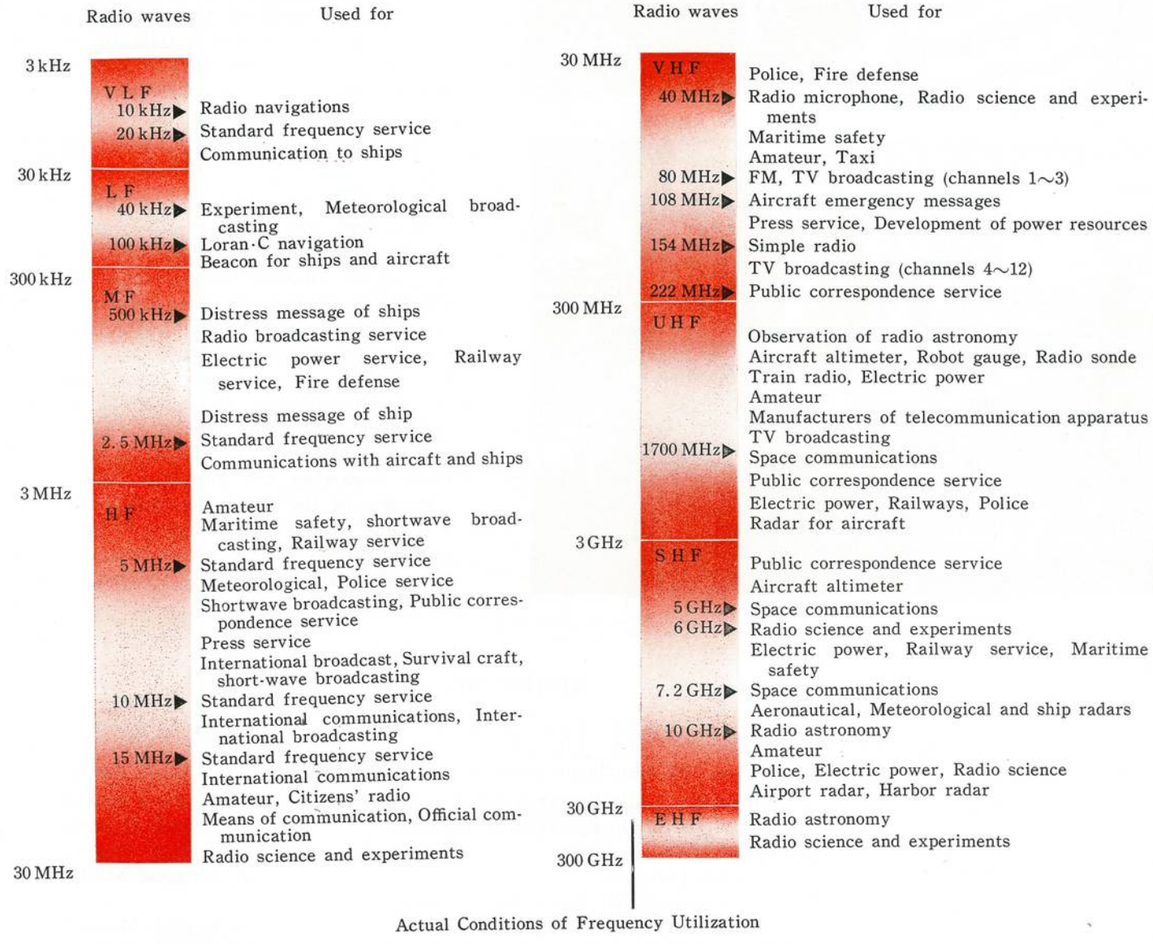
WORLD DATA CENTER C2 FOR THE IONOSPHERE

World Data Center C2 for the Ionosphere

In order that the ionospheric observational data collected in various countries in the world may be interchanged internationally for contribution to the geophysics, and when the World Data Centers were organized in the IGY (International Geophysical Year) in 1957 to 1958, Japan was elected one of the World Data Centers in the fields of geomagnetism, ionosphere, cosmic rays, and air glow. The Radio Research Laboratories were designated as the World Data Center C2 for the Ionosphere, and at present the data in as many as fifty countries are compiled in cooperation with the three other Centers "A" (Institute for Telecommunication Sciences and Aeronomy, U. S. A.), "B" (Izmiran, U. S. S. R.), and "C1" (Radio and Space Research Station, U. K.).

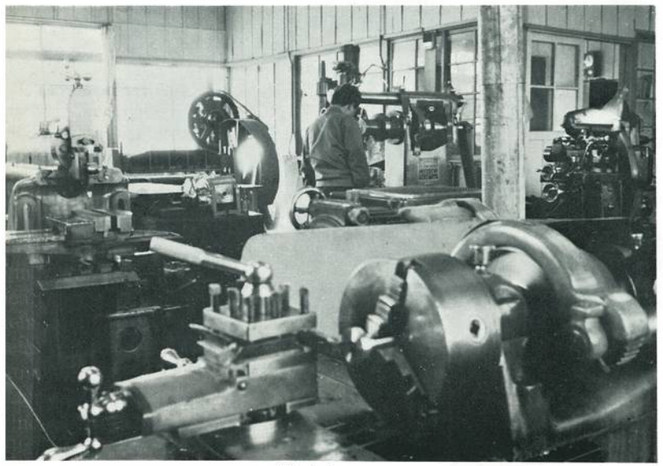
RESEARCH ON FREQUENCY UTILIZATION

The Radio Research Laboratories, as an auxiliary organ of the Ministry of Posts and Telecommunications, are engaged in the practical research directly useful for the radio administration under the jurisdiction of the Ministry. Therefore, it is necessary to rationalize and increase efficiency in the assignment and use of limited frequencies, to make synthetic observation of traffic in general, and to enter into close investigation of the future plan in cooperation with the Agencies concerned at home and abroad. With these points in view, the fundamental and practical studies in effective use of the present frequency spectra, contributory to the international conferences (C.C.I.R., U.R.S.I., etc), are now in progress.



Actual Conditions of Frequency Utilization

Library



Workshop

PERSONNEL IN SUPPORT OF RESEARCH WORK

The technical information activities and trial manufacture of requisites for use in researches at the Radio Research Laboratories belong to the service department highly important for acceleration of the research work. The collection and charge of technical information on radio science and technology at home and abroad and of research papers and literature, complete dealing with application for patents, and thorough work on publications confer propulsive force upon researches. Moreover, though the work on manufacture and repair of apparatus and accessories for purposes of research is plain and quiet, it is very conductive to cooperation with researchers and increase in research efficiency.

PUBLICATION OF RESULTS OF RESEARCHES

The results of researches at the Radio Research Laboratories are made public twice a year (in spring and autumn) for use by not only the members of the Ministry but also the general public. The first meeting for reading research papers was held in July, 1950. Subsequently, one after another the meetings took place and amounted to the 34th in April, 1968. In addition, at the monthly consultatory meeting of the personnel of the Laboratories, the results of researches concluded are reported one by one. The contents of these researches are published in the seasonal "Review of the Radio Research Laboratories" and the "Journal of the Radio Research Laboratories" for world-wide introduction. The monthly consultatory meetings amounted to 100 times as of March, 1968.

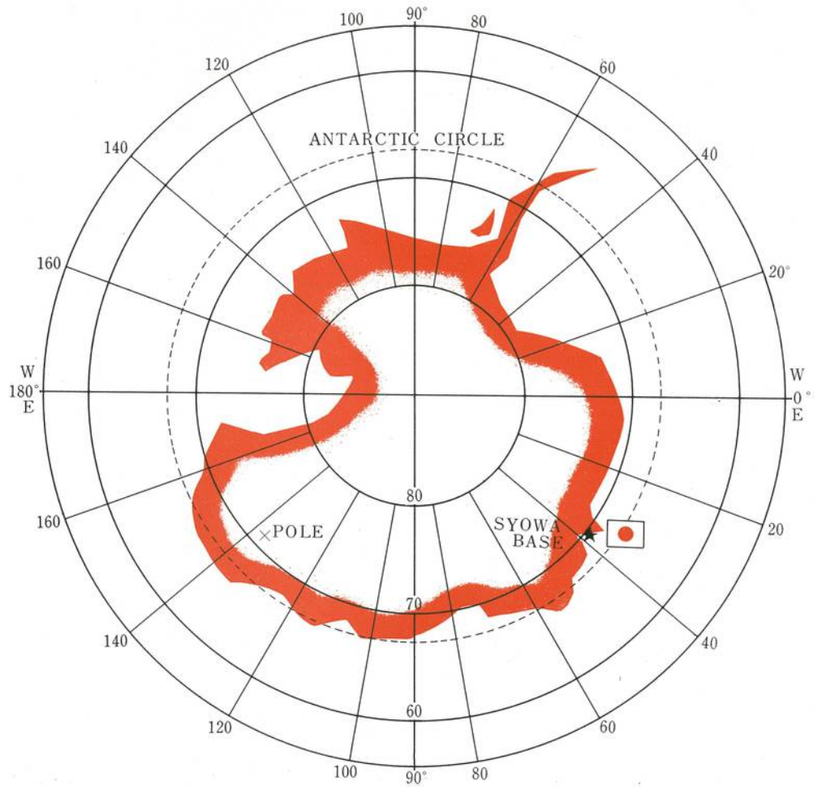
PUBLICATIONS AND PERIODICALS

The publications and periodicals issued by the Radio Research Laboratories are as follows:

Review of the Radio Research Laboratories	In Japanese Bimonthly
Journal of the Radio Research Laboratories	In English Bimonthly
Ionospheric Data in Japan	In English Monthly
Propagation Forecasts	In Japanese Monthly
Monthly Forecast and Actual Disturbance in Radiocommunication	In English Monthly
Catalogue of Data in WDC C2 Center for Ionosphere	In English Annually

Air View of the Syowa Base

Apparatus for Sounding the Ionosphere



IONOSPHERIC OBSERVATIONS AT SYOWA BASE ANTARCTICA

Since 1965, Syowa Base, Antarctica, has been resumed as a permanent base. This program is supported by the Special Committee for Antarctic Expeditions and the Promoting Headquarters, Japanese Antarctic Research Expedition, Ministry of Education.

The ionosonde recording equipment designed and constructed by the personnel of the Radio Research Laboratories had been installed by the Antarctic explorers at the base.

It will not be long before the observational data clarify various phenomena of the ionosphere over the Antarctic circle.