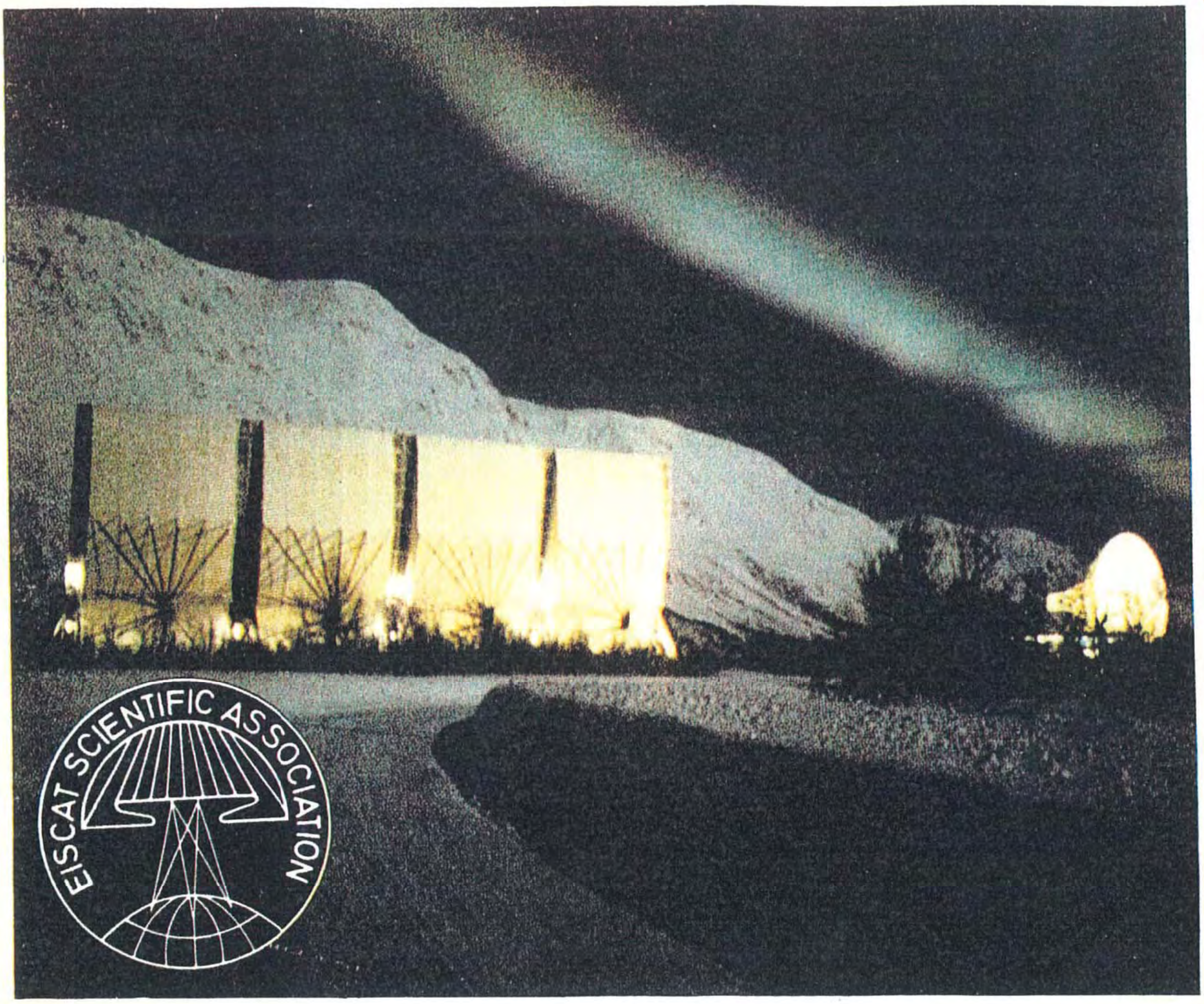

EISCAT

EUROPEAN INCOHERENT SCATTER SCIENTIFIC ASSOCIATION

ANNUAL REPORT 1979

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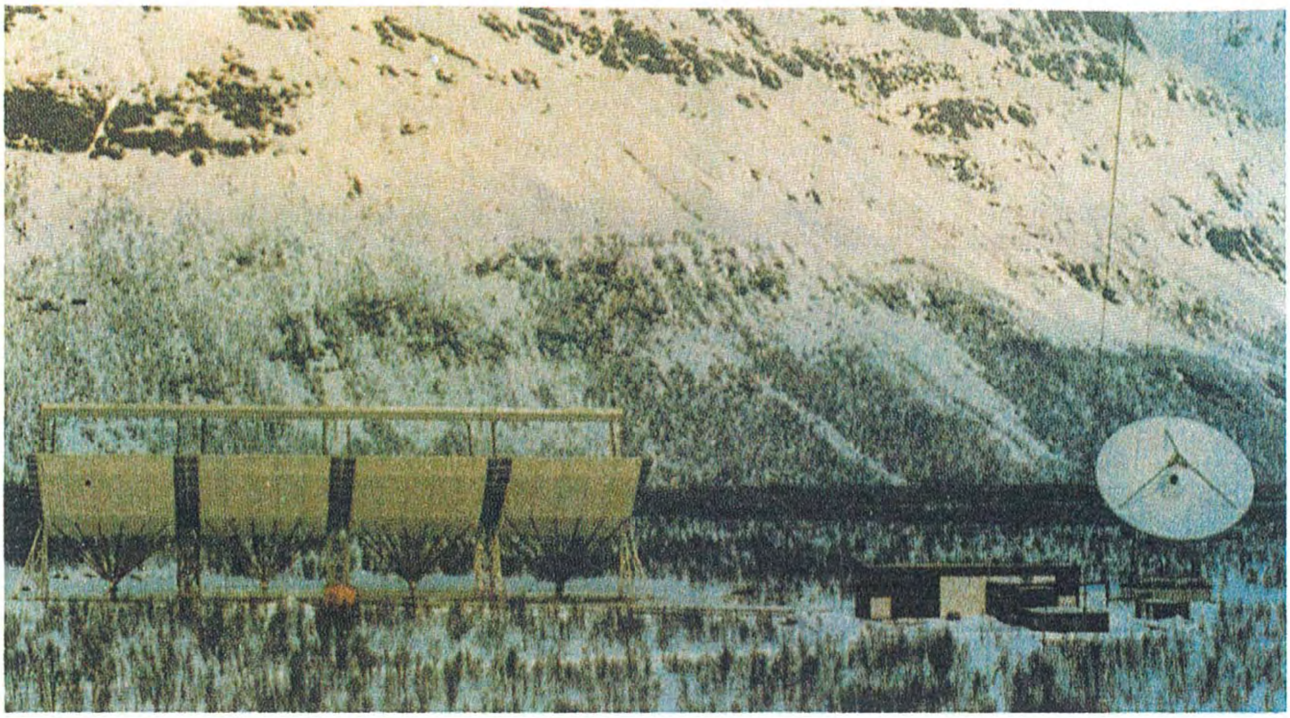


The VHF and UHF antennas at Tromsø

CONTENTS

INTRODUCTION

The physical principles of the observational method and the nature of the problems which can be solved by EISCAT formed the theme of the introduction to last year's annual report. This anticipated that the first observational results and their implication would be announced in the present report.

Unfortunately, our hopes of presenting data have been frustrated by the continuing failure of the manufacturers to deliver the transmitter despite continuing pressure by both the EISCAT Staff and the Council. Indeed, there has been virtually no progress with the transmitter so that during the year our estimate of the time when the system will be in full operation has slipped by a year. A detailed discussion of the problems delaying the transmitter will be found in the body of the report.

Fortunately there has been an encouraging development with the VHF antenna. This was sufficiently complete during November and December to allow us to test important features of the performance. These tests show that the antenna meets — or exceeds — the performance specifications.

The UHF antennas have been tested extensively and automatic programs have been developed to correct for pointing errors. Some faults have occurred in the control systems, but these have not proved to be major.

All sites are now connected by permanent data lines and data and control information can be passed from one station to another. Any one site computer can access any other and antennas can be steered from remote sites.

Testing of control and data-taking prototype equipment has progressed satisfactorily and delivery of such equipment will occur to all sites during the first half of next year.

The low noise parametric amplifiers, which in the past have been very capricious, have finally started to perform in a satisfactory manner. At UHF the EISCAT system noise is now down to 40 K which is lower than at other incoherent scatter facilities.

Proposals for special observing time have continued to be submitted at a high rate. As some of these programmes are of a co-operative nature we face a situation where some may have to proceed without EISCAT participation because of the delay in the transmitter. All in all 1979 was a frustrating year both for the staff and, even more, for that part of the European scientific community which counts on using EISCAT data to perform their research. We confidently expect 1980 to be better. As a result of the special measures taken by EISCAT to propose modifications to the klystrons we have good reason to believe that progress with the transmitter can now resume and that delivery may occur during the autumn.

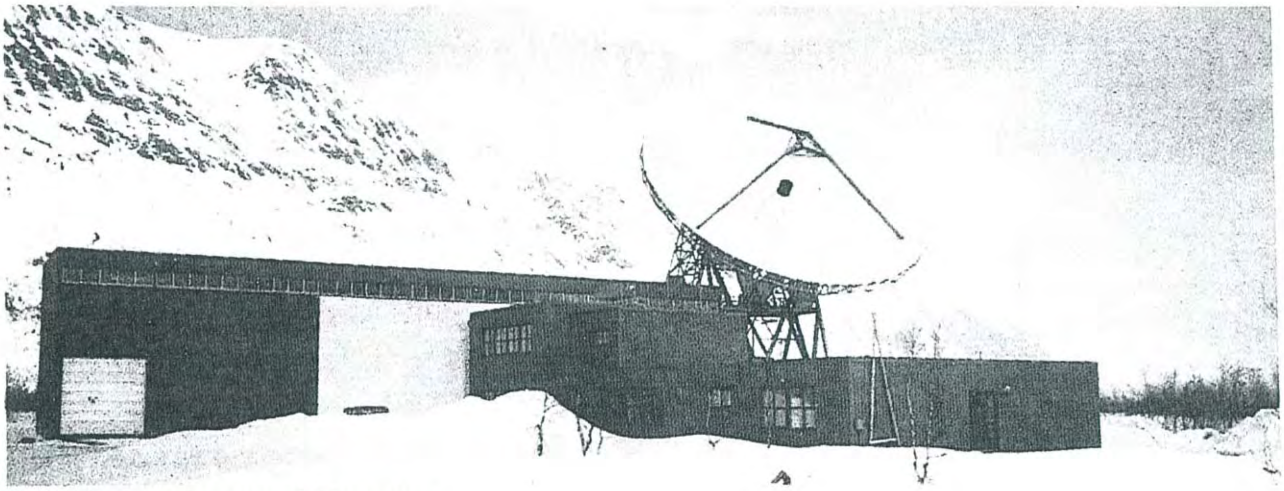
Tor Hagfors
Director

UHF ANTENNAS

The UHF antennas were accepted on 4 December 1978. During 1979 they were tested thoroughly in order to discover design faults and other weaknesses before the one year warranty expired. Among other tests was a ten-day continuous period in which the antennas were moved every minute. Some minor failures occurred but nothing took more than an hour to repair. The major faults covered by the warranty were a faulty azimuth brake in Tromsø, a section of the Sodankylä dish that was not heated, misalignment of the azimuth wheel assemblies in Sodankylä and a broken gearbox in the azimuth drive system in Kiruna. The azimuth wheels in Sodankylä will be realigned in spring 1980 by TIW but all the other faults have been corrected. A number of minor faults in the electronics, notably in the power supplies, have also been remedied.

A Fortran program package has been designed for the pointing calibration of the UHF antennas. The program selects known radio sources automatically according to a preset schedule and stores the results in a disk file. The direction of each source is then found by scanning across it in azimuth and elevation and cross-correlating the recorded signals with idealized scans. Information is then obtained giving the pointing errors in elevation and azimuth. A new corrected direction is computed and a new scan is made. The process is repeated until the correction is less than a preset value.

The second part of the program package takes the apparent and true positions stored in the disk file and fits a model to the data pairs



The UHF antenna at Tromsø

that can later be used to convert between indicated and actual pointing directions.

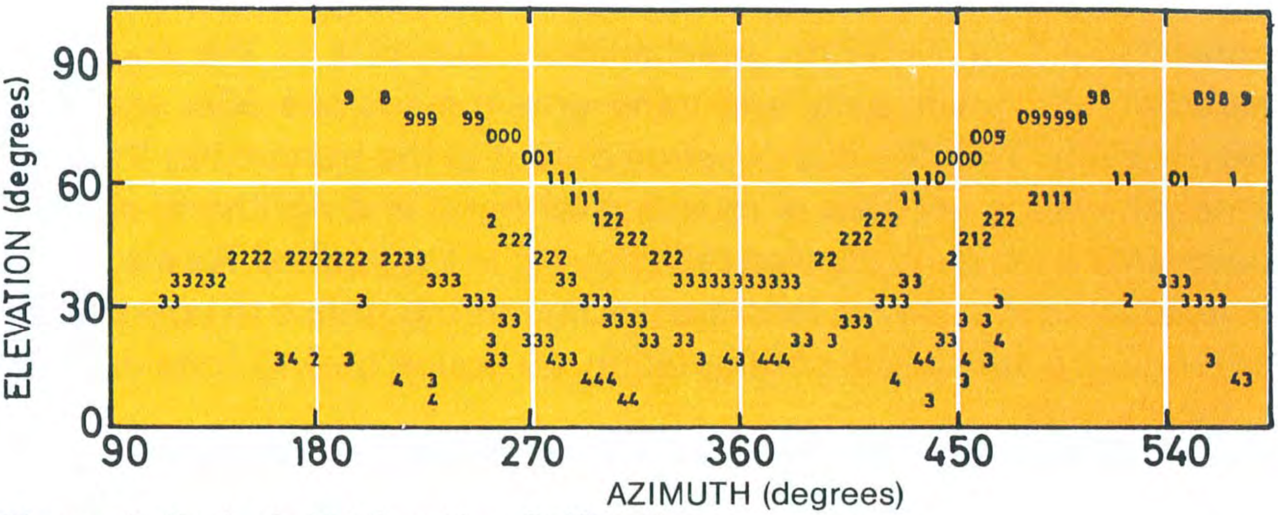


Figure 1: Sodankylä Elevation Calibration
Average elevation offsets between measured and indicated pointing directions. (1 to 5 means an offset of + 0.1° to + 0.5°; 6 to 9 means an offset of − 0.4° to − 0.1°).

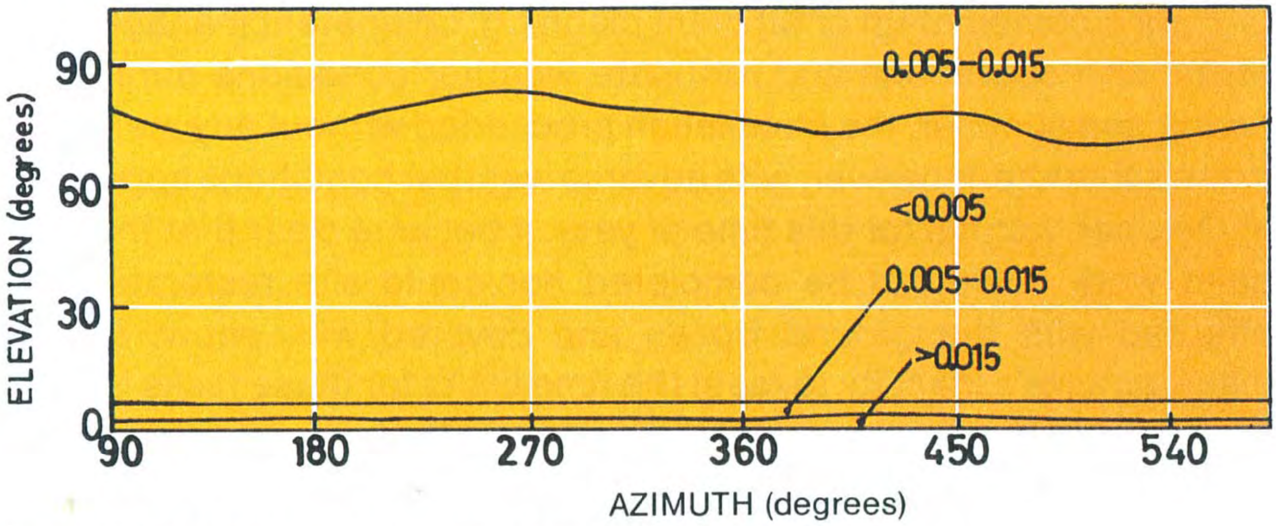


Figure 2: Sodankylä Elevation Calibration
Estimated remaining error in elevation in degrees after calibration. The error is largest at low elevations where refraction is important. At high elevation calibration points are sparse.

Two diagrams are shown in Figures 1 and 2 as examples of the result of the calibration. In Figure 1 the measured difference between actual and indicated pointing direction is shown. In Figure 2 the error remaining after correction is indicated. During the calibration of the Sodankylä antenna it was found that the elevation showed a hysteresis of a few tenths of a degree. This was rectified by tightening the bolts in the dish framework.

VHF ANTENNA

As described in the annual report of 1978, the VHF antenna consists of four sections, mechanically movable in the magnetic meridian, each with axial and transverse dimensions 30m and 40m respectively. With the dual klystron output of the transmitter the VHF antenna will be capable of radiating lefthand and righthand circular polarization, and linear polarization at 45° to the vertical. A switchyard inserted into the coaxial feed system makes it possible to operate the antenna in a split beam configuration, an option having considerable scientific merit.

One year after the contract for the VHF antenna was signed with the KRUPP, MAN and MBB consortium the first parts of the steel assembly arrived in Tromsø by ship. Preparations for the erection started immediately.

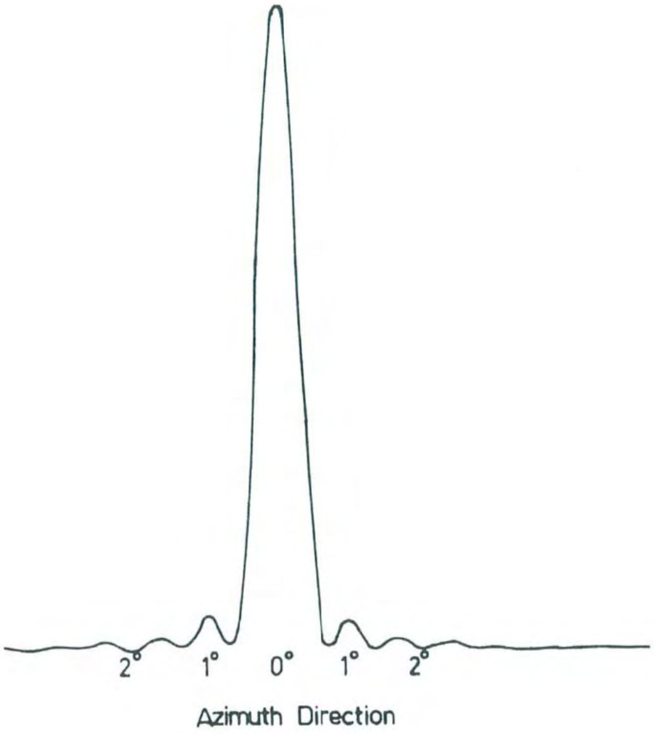
By a combination of efficient planning, competent management of the site operations and fortunate weather conditions during the spring and summer, the installation proceeded without any major slip in the schedule. However, with adverse weather conditions appearing in October, normal for this time of year, it became clear that the final paint work could not be completed nor could site restoration be effected with the ground frozen and covered with snow. As the manufacturer's inability to meet the time limits for these tasks is in no way detrimental to the project, with EISCAT's agreement the completion of these jobs has been postponed until the spring of 1980.

Procedures for the preliminary acceptance tests were approved by EISCAT at a meeting on 20 November 1979, and the tests were carried out during the subsequent weeks. The acceptance assessments fall into three categories:

- Mechanical structures
- Drive and servo systems
- RF parts.

Included in the first two categories were inspections of major parts of the steel structures, pointing accuracy of each antenna section, speed of antenna movement, interlock system, control

Figure 3: Azimuth Polar Diagram of VHF Antenna (as shown by transit of Cassiopeia A)

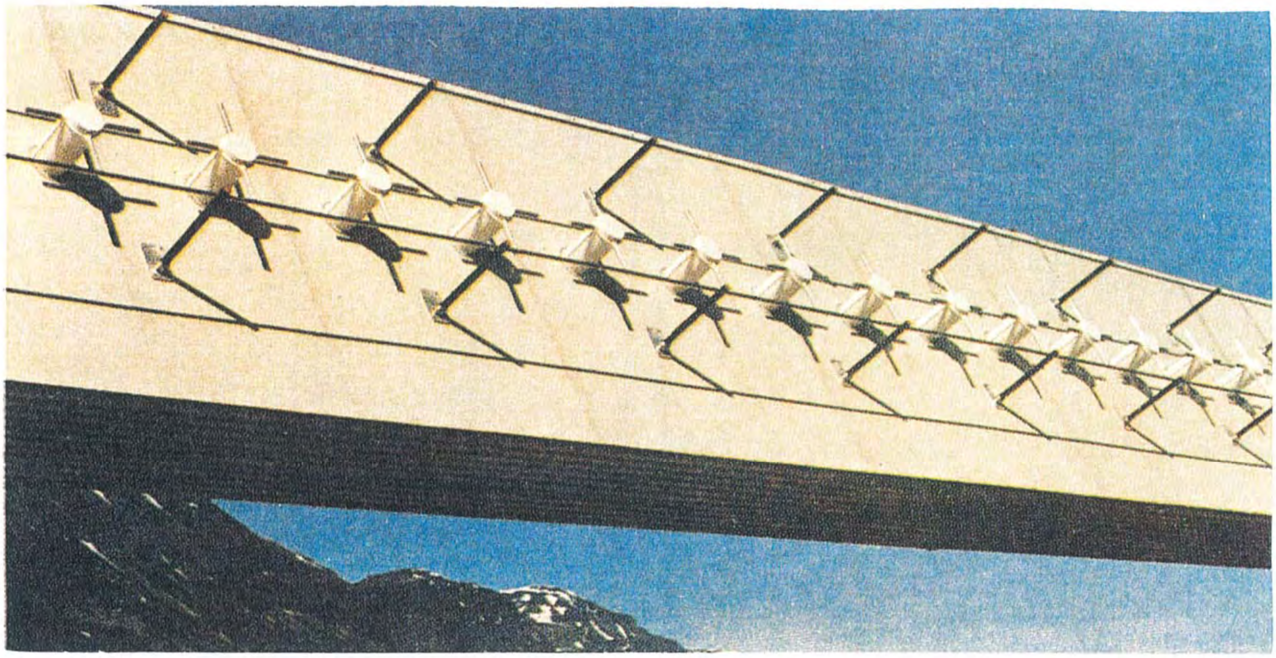


modes of antenna and stow pin activation. (For practical reasons approvals of the foundations and the surface alignment arrangements were performed during earlier stages of the installations).

As a whole the mechanical performance of the VHF antenna was found to be satisfactory with the exception of the three following items:

- The present mechanism for stow pin activation, intended to work for an arbitrary antenna position, needs to be modified to ensure operation during severe winds.
- The capacity for heating the oil for the holding brakes was inadequate. An arrangement for reinforcement, temporarily adopted, must later be replaced by a more permanent installation.
- The cover over the feeder bridges should be improved to give better protection against rain and snow.

The consortium recognizes responsibility for these deficiencies and will correct them during spring 1980.



Feeder Bridge of the VHF antenna

The RF acceptance tests included measurements of the amplitude and phase distributions along the dipole arrays, input impedances of RL 345 feed lines, line attenuations, phase conditions at the switchyard for the split beam option and decoupling between orthogonal polarizations. High power tests were also described in the test document, but these must necessarily be postponed until the transmitters have been delivered.

Not included in MBB's test responsibility was an assessment of the antenna gain and effective area by means of radio star observations. Measurements of this kind were performed by Mr. Kildal prior to, and during, the execution of the test procedure accepted by MBB.

Table I has been derived on the basis of measurements of Cassiopeia A, applying updated values for the strength of this radio source.

The general conclusion is that in almost every respect the VHF antenna behaves better than specified.

Originally MBB did not regard it as their responsibility to prove experimentally the antenna performance with the beam steered in the east-west direction. MBB have now changed their attitude on this matter and tests will be conducted in February-March 1980.

Table I: Gain measurements, accuracy ± 0.5 dB

Mode	Efficiency	Aperture area
Vertical polarization	0.61	2950 m^2
Horizontal	0.68	3250 m^2
Circular	0.64	3090 m^2
Specified	0.60	2900 m^2
Expected	0.66	3200 m^2

Table II: Line feed measurements

Line feed measurements	Polarization	Measured	Specified
Amplitude distribution	HOR	0.11 dB	0.8 dB
Amplitude distribution	VER	0.16 dB	0.8 dB
Phase distribution	HOR	2.3°	5°
Phase distribution	VER	2.39°	5°
Insertion loss	HOR	0.39 ± 0.1 dB	< 0.6 dB
Insertion loss	VER	0.43 ± 0.1 dB	< 0.6 dB
VSWR, transm. band	HOR	1.03	1.4
VSWR, transm. band	VER	1.07	1.4
VSWR, receive band	HOR	< 1.12	
VSWR, receive band	VER	< 1.30	
Phase between HOR and VER pol.,	Sec. 1 and 2	92.0°	90° ± 5°
switch yard pos. II	Sec. 3 and 4	92.5°	90° ± 5°
Coupling to dummy gate in switch,	HOR	42.8 dB	
switch yard pos. II	VER	31.0 dB	

SWITCHYARD

The VHF antenna can operate in two ways, selected by using the switchyard.

With the switching elements in the position shown below the switchyard feeds the output from the first transmitter into antenna sections 1 and 2 and the output from the second transmitter into sections 3 and 4. In this case the two halves of the antenna radiate separate beams with fixed circular polarisation.

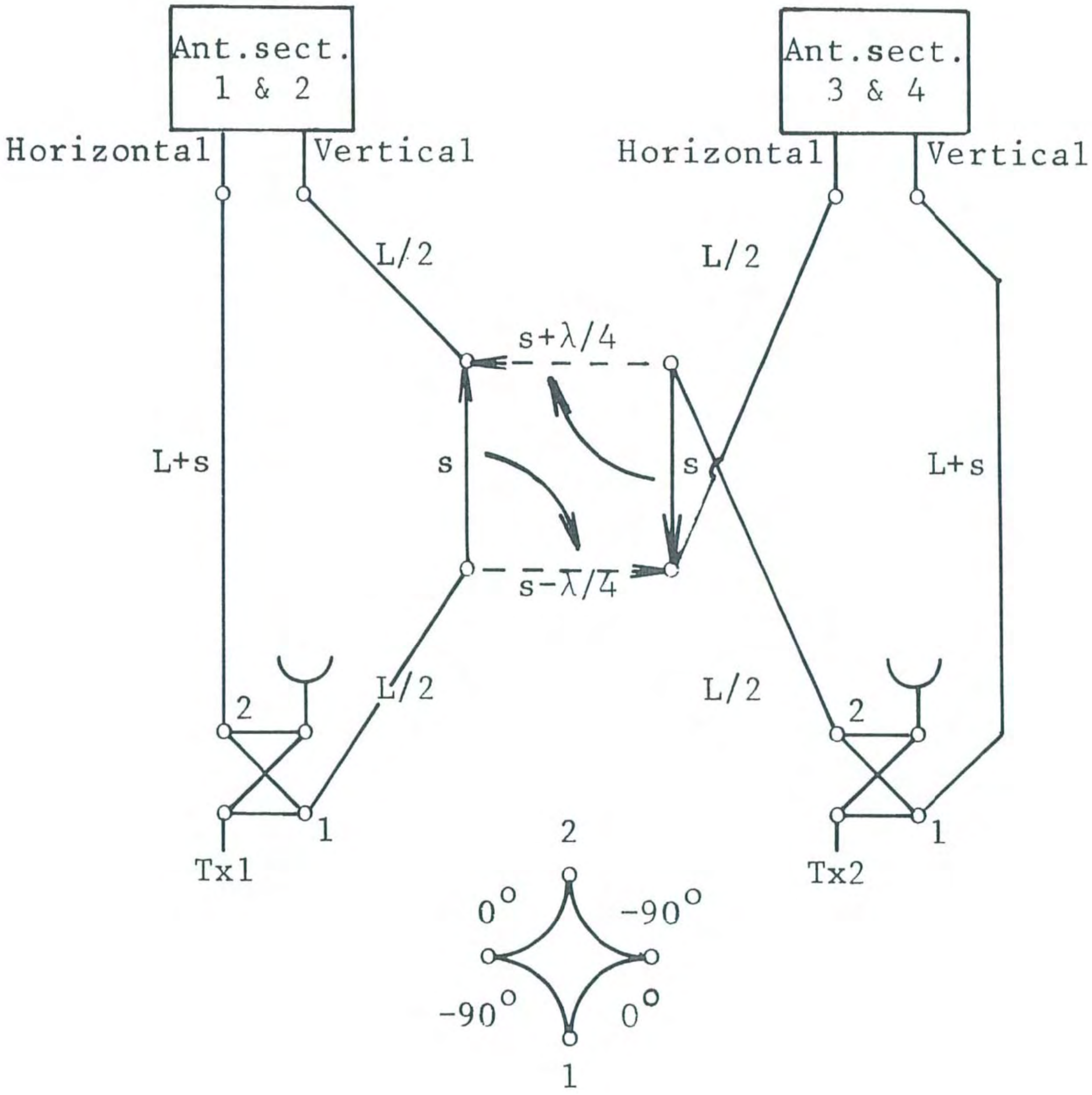


Figure 4: Pathlengths through Switchyard (Hybrid shown in inset)

With the switches in the alternative position (indicated by the broken line) the first and second transmitters feed the entire horizontal and vertical dipole arrays respectively. In this case all sections are combined to give a single beam with left-handed or right-handed circular polarisation or linear polarisation at ± 45° to the axis of the antenna. In this case the polarisation can be changed from pulse to pulse by altering the relative phase of the signals from the two transmitters.

As the switchyard has to carry the full power transmitted, it is a major piece of equipment and the switching elements are constructed of 280 mm coaxial rigid line. It is housed in a separate building at the centre of the VHF antenna.

TRANSMITTERS

Because of the serious delay in the delivery of the transmitters the full history of the developments leading to the present situation deserves to be reviewed.

The contract with Aydin Energy Systems for both the UHF and VHF transmitters was signed after competitive bidding on 2 March 1976. Installation and checkout of the UHF part was scheduled for completion on 2 July 1978 and of the VHF part on 2 November the same year.

The project encountered delays when the chief project engineer was involved in an accident and subsequently passed away. It also became apparent that Varian, the klystron manufacturer, had problems in completing the UHF tube. This tube was intended to be a slightly modified version of a tube which had operated extremely successfully in accelerators. The modifications required were a change in frequency from 805 to 933 MHz and an increase in power level from 1.25 MW peak, 150 kW average to 2 MW peak and 250 kW average. It was not anticipated that these modifications would cause any great difficulty, but it turned out that the tube went into oscillation due to oscillations in the electron gun region. Considerable time was required to identify the problem and correct it.

The VHF klystron with magnets removed

The two UHF tubes were finally delivered to Aydin during the fall of 1978 after undergoing acceptance tests in the Varian plant. Tube installation and initial transmitter checkout occurred during the first part of 1979. Both tubes failed in the checkout process.

At this stage EISCAT decided to set up a fact-finding committee of klystron and transmitter experts to assess the situation. The report of this committee became available during December 1979 and it suggested certain modifications in the klystron design. Most of these modifications were accepted by Varian and a modified tube will be delivered before the end of February 1980.

The VHF klystrons have been accepted by Aydin and delivered, but they have not been installed in the transmitter, since the limited capacity of the factory requires the UHF transmitter to be completed and shipped before the final assembly of the VHF transmitter can take place. The illustration gives an idea of the size of the VHF klystron.

If everything goes well from now on the first operation of the system can begin in August 1980.

RECEIVERS

The cooled parametric preamplifiers that were already in use in the UHF acceptance tests at the end of 1978 did not perform well throughout 1979 and it was not until the end of the year that satisfactory performance was achieved. However, the situation is now brighter than anticipated when discussing this same matter in last year's annual report. We are now able to operate the paramps continuously for several months and repairs usually take only one to three days.

There are several reasons for the improved performance. Firstly, the manufacturer has made some improvements to the electronic circuitry, primarily replacing the power supplies. Secondly, we have learned the art of successfully running a cryogenic system. It is difficult to point to any special lessons that have been more important than others, but to generalise we would say that the paramps work well if they are kept absolutely clean and are not disturbed once they are operating.

The final feed system in the UHF antennas has been installed in Kiruna and Sodankylä. This drastically improved the system noise from 60 - 70 K to the present measured level of 38 - 45 K. In Tromsø we must await the installation of the transmitter parts before measurements can be made but the system noise temperature expected in Tromsø is 90 - 100 K, the worse performance being due to the additional noise from the polarizer, the duplexer and the PIN diode switches between the horn and the paramp.

As a back-up for the paramps, adequate in many applications, transistor amplifiers have been bought. Their noise temperature is 140 K, which will give an overall system noise temperature of about 190K. Better transistor amplifiers are available at a higher price but it is expected that in the near future prices will drop and noise performance improve even further.

The rest of the receiver, between the paramp and the AD (Analogue to Digital) converter, was delivered but not accepted during 1979. Some components are still needed for satisfactory performance.

Some of the AD converters and matched filters have been accepted by EISCAT. AD converters for two slow channels per receiver have been delivered. In the final configuration each receiver will be fitted with eight AD converters, six of which are slow with a maximum sampling rate of 500 kHz, and two are fast with maximum sampling rate of 10 MHz. The six remaining channels for each receiver will be delivered in 1981.

CORRELATOR

The EISCAT radars will be used to determine several ionospheric parameters at many different heights with high time resolution. To do this, the signal from one height, represented as a complex function of time, must be converted into an autocorrelation function with a sufficient number of lags in both the real and imaginary domain to allow the parameters to be determined by comparison with theoretical models. In order to do this with adequate height resolution it may be necessary to transmit concurrently a number of different pulse schemes, including multipulse groups where variable interpulse spacings are used.

The correlator performs the key role of accepting the data from several different channels, dividing it into range gates, computing the autocorrelation function for each range at a suitable number of time lags, accumulating the results for a suitable integration period and delivering the output. To achieve this an extremely sophisticated programmable correlator was developed by Hans-Jørgen Alker.

The prototype correlator is now operating successfully. It will accept data from up to 8 receiver channels, for any of the pulse schemes used by EISCAT and will compute the autocorrelation function at a number of heights. The experimenter will be free to choose the best combination of the number of heights and the number of lags determined: a typical experiment may require 100 different heights with the autocorrelation function determined to 25 different lags every 10 seconds. The ability to do this depends on the advanced design of the correlator.

COMPUTERS AND CONTROL

During 1979 progress was made in establishing computer control of the major components of the EISCAT System. By the end of the year communication between the following devices had been achieved.

UHF Antenna steering control unit
VHF Antenna steering control unit
Receiver control unit
Radar controller
Correlator
Correlator Buffer Memory
Polarisers
Analogue to digital converters
Matched filters

Moreover a range of equipment of lesser importance could be easily controlled through standard CAMAC interfaces; included in this category are such devices as general purpose CAMAC analogue to digital converters, input/output registers etc.

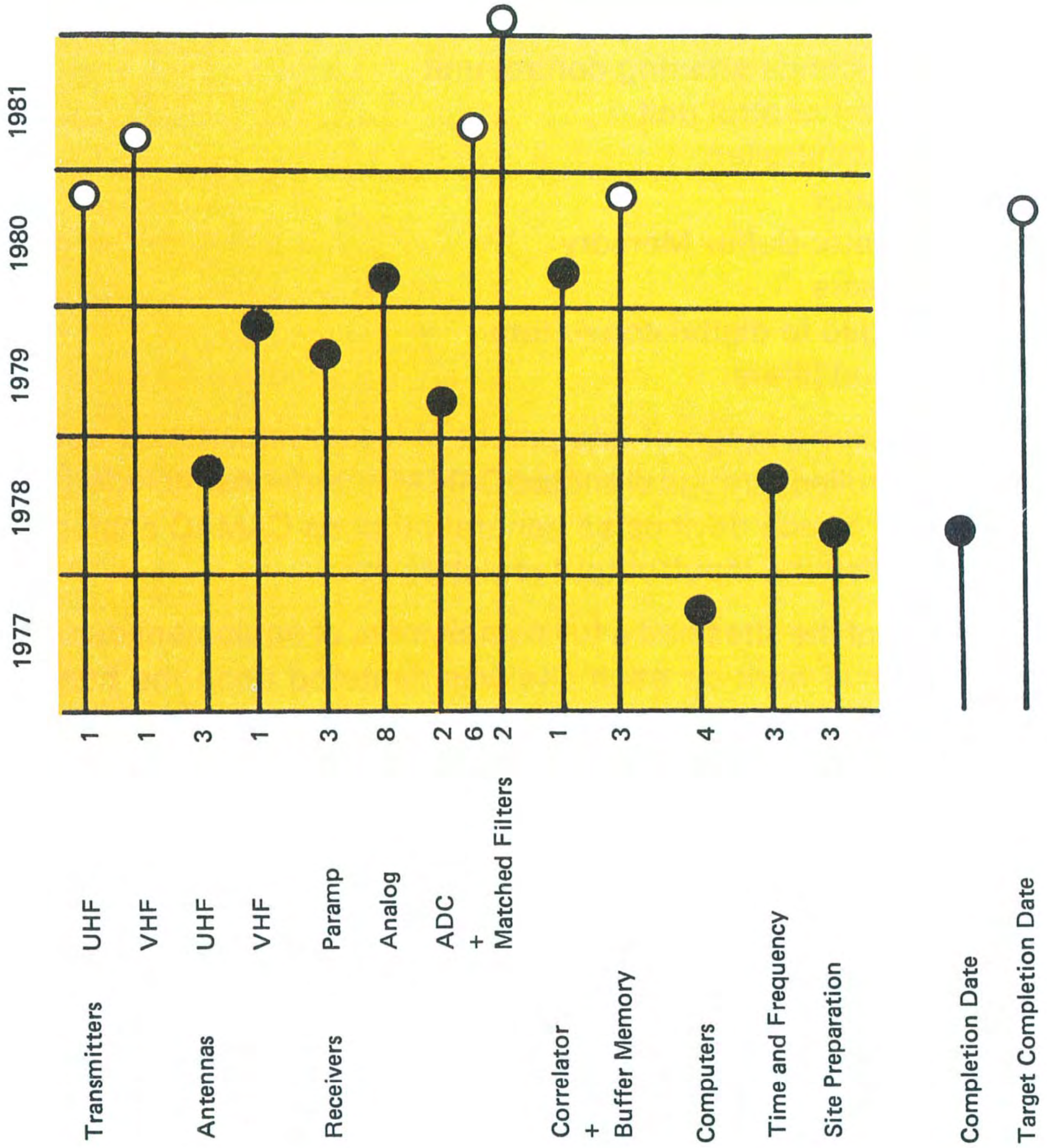
None of the sites had a full complement of equipment during the year and thus work on each site was centered upon the hardware developments pioneered at those sites.

At Sodankylä work concentrated on the development of antenna steering and calibration programs. Packages of programs were developed for antenna pointing calibrations (see page 4) and for the pointing of the antennas during experiments. Software is now available for the EISCAT user to define a tri-static intersection volume in the following coordinate systems:

—latitude, longitude, height
—azimuth, elevation, range

In the first system the user specifies the latitude, longitude and height of the required tri-static intersection region. In the second the region is defined by the azimuth and elevation of the intersection region as seen from some reference point on the earth together with the distance between the reference point and the required inter-

TIMETABLE


1977
1978
1979
1980
1981
Transmitters
UHF 1
VHF 1
Antennas
UHF 3
VHF 1
Receivers
Paramp 3
Analog 8
ADC
+
Matched Filters
2
6
2
Correlator
+
Buffer Memory
1
3
Computers 4
Time and Frequency 3
Site Preparation 3
Completion Date
Target Completion Date

section region. This reference point can be arbitrary, though usually it would be fixed at Tromsø.

For astronomical work, provision is made to track stars (coordinates given in 1950 R.A. and declination) and to point at the sun, moon and planets of the solar system.

Next year it is hoped to include magnetic frames of reference into the antenna pointing system.

At Kiruna work proceeded with the computer control of the receiver and polariser control systems. Under computer control the following receiver functions can be selected

- Signal Path
- Frequency
- Attenuators
- Filters
- Noise injection level

Moreover, the polarisers were successfully placed under computer control.

At Tromsø tests continued with the prototype radar controller and correlator. The newly developed correlator buffer memory was tested under computer control as were the analogue to digital converters and the matched filters. The correlator buffer memory and radar controller were used in the acceptance tests of the AD converters and the matched filters. Work towards the establishment of an integrated data acquisition system comprising the AD converters, matched filters, radar controller, correlator buffer memory, correlator, correlator result memory and finally correlator DMA to the NORD 10 memory was started. While parts of this system work it is not expected that the complete system will work before 1980.

1979 saw the late delivery of the HDLC (High speed Data Link Communication) hardware. Unfortunately neither HDLC software nor hardware functioned when it was installed and even at the end of the year all software for effective use of the system had not been provided.

EISCAT Headquarters concentrated on the development of EROS, EISCAT Real-time Operating System, the system to be used to control experiments. Individual tasks were clarified and the major control programs developed. Interfaces between the high level of experiment description and the low level of the actual hardware instructions necessary to perform an experiment were clarified, i.e. the physicist can specify some action in broad terms (e.g. initiate an antenna scan) without having to know anything about the internal details of how this is performed. In addition several experiment proposals together with the experiments of the EISCAT Common Programme were examined in detail to understand exactly how they could be implemented and what consequences they had for overall system performance. Work continued at the headquarters in the examination of the data reduction problems involved in dealing with EISCAT data once it has been recorded. Plans were drawn up concerning the analysis and distribution of EISCAT data, it was realised that such plans are difficult to make in advance of receipt of real data, but certain calculations can be made in advance that at least indicated what the general line of attack should be. Attention was also given to the problems of analysing incoherent scatter data, and of providing "quick-looks" at the data being collected.

Towards the end of the year an attempt was made to perform a rehearsal of a full experiment using the equipment delivered to the different sites. The exercise proved useful in highlighting the operational difficulties likely to occur in real experiments. Inadequate communications between sites resulted in the first "dry-run" of an experiment being unsuccessful. In future we are planning several repeats of such rehearsals culminating in the performance of a real experiment.

DATA HANDLING

The large amounts of data produced during measurements consist mainly of correlation functions related to many heights. The basic time resolution will be of the order seconds to minutes depending on experimenters requirements. If the capacity of the telephone communication lines permits, the data will be merged onto a single magnetic tape, usually in Tromsø. Otherwise data will have to be collected separately at each site.

In any case, the raw data will have to go through a tidying and sorting process and possibly also a merging procedure.

The next step is to analyse the data to produce the physical parameters that characterize the ionosphere. Here an abbreviated line-printer summary or a plot will be generated that can be used as an index to the reduced data. These data will be stored on tape and sent to the experimenter. In case of common program data, tapes with reduced data will be supplied to all the EISCAT associates.

Some experimenters will need a more refined analysis. They could for instance require an extremely good time resolution or accurate determination of the composition parameters. Such requirements could be met to a limited extent only and would involve experimenting with different analysis schemes until a satisfactory one is found. This would have to be done by the experimenter himself, generally at his home institution. EISCAT would in such a case rather supply the sorted raw data tapes and the standard analysis programs. For that purpose the analysis programs are written in standard ANSI FORTRAN 77 with a minimum of statements being unique to our computer.

SCIENTIFIC PROGRAMME

Over fifty experimental proposals for using EISCAT have already been received on behalf of 89 scientists in 30 different research groups. These proposals fall into three categories:

i) passive experiments;
ii) active experiments using EISCAT in a mode similar to one of the Common Programme modes; and
iii) active experiments using EISCAT in an advanced and original way.

Passive Experiments

With the delay in delivery of the transmitter several proposals have been received to use EISCAT in a passive mode. The four radio telescopes have unique features to offer. The three UHF telescopes have a very low noise figure while the VHF telescope has a very large collecting area. All four are unique by being located in the auroral zone farther north than any comparable radio telescope.

One proposal is to use the UHF antennas to detect and interpret the radio emission from aurorae. This proposal was the first to be executed by EISCAT and observations began in September 1979. Possible 'spikes' of auroral emission were detected but a further experiment is now planned to observe the same volume simultaneously with two or three telescopes so that any 'spikes' of local origin can be eliminated.

Another proposal plans to use the UHF antennae as part of the VLBI (Very Long Baseline Interferometer) network of radio telescopes. Here the EISCAT antennas will provide valuable north-south baselines, while at the same time providing observations from stations on the Fennoscandia shield. Such observations will be used to determine the fine structure of quasi-stellar radio sources, the spectral lines within astronomical radio emission and the movement of the earth's crust in Scandinavia.

They will require an extra horn and receiver to operate at the much higher frequencies used for VLBI but fortunately the surfaces of the antennas are already designed to operate at these frequencies.

A third proposal plans to use the VHF antenna to calibrate the flux density scale of radio sources at metre wavelengths.

Active Experiments in a Mode similar to the Common Programmes

The three modes of the Common Programme were described in the 1978 Annual Report. Great care was taken by the SAC in defining the three modes, and it is not surprising that many of the experimental proposals will either use Common Programme data or will use EISCAT in a similar way for a Special Programme. As the staff of EISCAT will give highest priority to implementing the Common Programme it follows that these proposals will have the best chance of early implementation.

When EISCAT comes into full operation there are several important scientific problems that will be studied immediately and these have each attracted several experimental proposals. However, it is recognised that many of these were anticipated in the original proposal for EISCAT so it would be unfair if priority were given to any one experimental group. It has therefore been agreed that there should be an initial observing programme that includes these proposals and that the following observations should be reported jointly:

- Clear detection of the polar wind outflow;
- a map of currents, electric fields and temperatures through an auroral arc;
- a high time resolution density profile through the E and D regions associated with rapid variations in particle flux;
- clear detection of the association of electrojet currents with the generation of atmospheric gravity waves;
- clear identification of the 'image' of the polar cleft, the plasmasheet and the plasmapause in the ionosphere;
- measurements of convection patterns within the polar cap; and
- the first demonstration that EISCAT can make meaningful mesospheric observations.

In many other cases, EISCAT will be used in a Common Programme mode as a reference instrument to provide a comprehensive and continuous background of ionospheric data which will allow the specific observations made by other equipment to be correctly interpreted.

An example of such a co-operative experiment will be the Energy Budget Campaign due to take place in November-December 1980 with the launch of over fifty rockets in a joint experiment designed to measure the different sources of energy in the auroral zone. It will be a serious loss to science if the transmitters are not available for EISCAT to participate in this campaign.

A continuing programme of co-operative measurements will occur between EISCAT and the STARE/SABRE/SAFARI network of auroral radar systems, providing information on the relationship between magnetic pulsations and particle precipitation, allowing a study of the instabilities that lead to auroral electron density irregularities, and monitoring the variations of electric fields with time and latitude. Measurements of electric field may also be combined with whistler direction finding to compare the plasma drift velocity with the horizontal movements of the exit points of ELF/VLF whistlers.

EISCAT measurements of the electron density, collision frequencies and electric field at different heights will be used to determine electric currents in the ionosphere and these can be compared with measurements of the fluctuations in the magnetic field. Similar measurements taken with the highest possible time resolution can be combined with measurements from a chain of magnetometers at different latitudes to indicate the propagation of magnetic pulsations through the ionosphere.

In monitoring the propagation of atmospheric gravity waves, EISCAT will be supplemented by ionograms from different stations, measurements of total electron content based on satellite signals, HF Doppler records and meteor radar. Similar measurements can also be used to determine the dominant tidal modes in the neutral atmosphere, and proposals have been submitted to investigate the role of gravity waves and tidal modes in the formation and modulation of sporadic E layers.

Finally, the coupling of the ionised and neutral atmosphere through ion-neutral collisions can be studied by comparing the observed behaviour of the ionosphere with suitable models. A direct study of the coupling has also been proposed where the plasma velocity measured by EISCAT is compared with the neutral velocity at the same height measured from airglow using optical interferometers.

These and similar proposals are an indication of the way in which EISCAT will provide the keystone in a wide range of auroral experiments during the 1980's.

Active Experiments in an Advanced Mode

Several proposals have already been made that seek to extend the range of measurements made by EISCAT.

Some will interpret the observations under conditions where the scattered spectrum of the ion lines is more complex than the standard forms used in the routine program — for example, when two or more ion species are present with different temperatures, and different velocities. In cases like this it is intended that EISCAT will make the observations and the analysis of the spectra will be completed by the experimenters, who will then provide EISCAT with the analysis program for general use in the future. A similar problem may occur in the D-region where the spectra are strongly affected by ion-neutral collisions and by the presence of negative ions. At even lower heights in the mesosphere the spectra become extremely narrow and it may be necessary to devise new modes of operation to obtain adequate spectral resolution.

Many other proposals seek to extend the analysis beyond the ion lines. A high priority must be the observation of the plasma lines and it is hoped that in the short term this will be possible using a correlator provided by France. Eventually it is planned to provide suitable correlators at all three sites and then it will be possible to implement proposals to measure electron densities, temperatures and currents directly from the plasma lines, while at the same time giving a useful indication of the spectrum of soft precipitated particles. It will also be possible to look for other resonance lines in the spectrum.

Other proposals will use EISCAT to observe modifications in the ionosphere. An important role will be played by the heating experiment of the MPG, located at Tromsø. Another proposal will use EISCAT itself, transmitting at two frequencies, to create a growing mode through non-linear interaction; this mode can then be observed at a third frequency.

It is clear that EISCAT, when fully operational, will provide the material for exciting science for many years to come.

MEMBERSHIP OF COUNCIL AND COMMITTEES

AT 31st DECEMBER 1979

	FRANCE	FINLAND	FEDERAL REPUBLIC OF GERMANY	NORWAY	SWEDEN	UNITED KINGDOM
COUNCIL	M. Blanc P. Creyssel M.Petit	O. Ranta A. Siivola	W.I. Axford G. Haerendel G. Preiss	O. Holt A. Sandbo	B. Hultqvist M. O. Ottosson	H.H. Atkinson W.J.G. Beynon H.Rishbeth
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AFC	J. Mirabel A. Schwerer	O. Ranta	G. Preiss M. Meinecke	A. Sandbo	M.O. Ottosson	G. Rowe J.D. Willcock

HEADQUARTERS SENIOR STAFF AT 31 DECEMBER 1979

T. Hagfors – Director
K. Folkestad – Associate Director
S. Westerlund – Associate Director
L. Topo – Business Manager

EISCAT STAFF

Headquarters	Director	Tor Hagfors
	Associate Director	Kristen Folkestad
	Associate Director	Svante Westerlund
	Business Manager	Lasse Topo
	Secretary	Gurli Hultqvist
	Senior Programmer	Joe Armstrong
	Programmer	Alan Farmer
	Administrative Assistant	Gunnar Isberg
Tromsø Site	Scientist	Truls Hansen
	Engineer	—
	Technicians	Halvard Boholm
		Jan Børre Henriksen
		Odd Jacobsen
		Svein Kvalvik
		Svein-Olaf Simonsen
	Programmer	Bård Tørustad
	Secretary	Leo Hedegaard
	Caretaker	John Hauan
Kiruna Site	Engineer	Sixten Olsson
	Technicians	Knut Koskenniemi
		Lars-Göran Vanhainen
		Ingemar Wolf
	Programmer	Kent-Ove Johansson
Sodankylä Site	Scientists	Markku Lehtinen
		Johan Silén
	Engineer	Tapani Äijänen
	Technicians	Tarmo Laakso
		Tarmo Mustonen
	Programmer	Anna-Liisa Turunen

EISCAT REPORTS PUBLISHED IN 1979

H-J. Alker:

Program CORRSIM: System for program development and software simulation of EISCAT digital correlator, User's Manual.

EISCAT Technical Notes No. 79/9, 1979.

H-J. Alker:

Instruction manual for EISCAT digital correlator.

EISCAT Technical Notes No. 79/10, 1979.

H-J. Alker:

A programmable correlator module for the EISCAT radar system.

EISCAT Technical Notes No. 79/11, 1979.

T. Ho and H-J. Alker:

Scientific programming of the EISCAT digital correlator.

EISCAT Technical Notes No. 79/12, 1979.

S. Westerlund (Editor):

Proceedings EISCAT Annual Review Meeting 1979. Part I and II, Abisko, Sweden, 12-16 March 1979.

EISCAT Meetings No. 79/3, 1979.

J. Murdin:

EISCAT UHF Geometry.

EISCAT Technical Notes No. 79/13, 1979.

T. Hagfors:

Transmitter Polarization Control in the EISCAT UHF System.

EISCAT Technical Notes No. 79/14, 1979.

B. Tørustad:

A description of the assembly language for the EISCAT digital correlator.

EISCAT Technical Notes No. 79/15, 1979.

J. Murdin:

Errors in incoherent scatter radar measurements.

EISCAT Technical Notes No. 79/16, 1979.

EISCAT Digital Correlator. TEST MANUAL.

EISCAT Technical Notes No. 79/17, 1979.

G. Lejeune:

A program library for incoherent scatter calculation.

EISCAT Technical Notes No. 79/18, 1979.

K. Folkestad:

Lectures for EISCAT Personnel, Volume I

EISCAT Technical Notes No. 79/19, 1979.

J. Armstrong (Editor):

Proceedings EISCAT Programmers Meeting 1979.

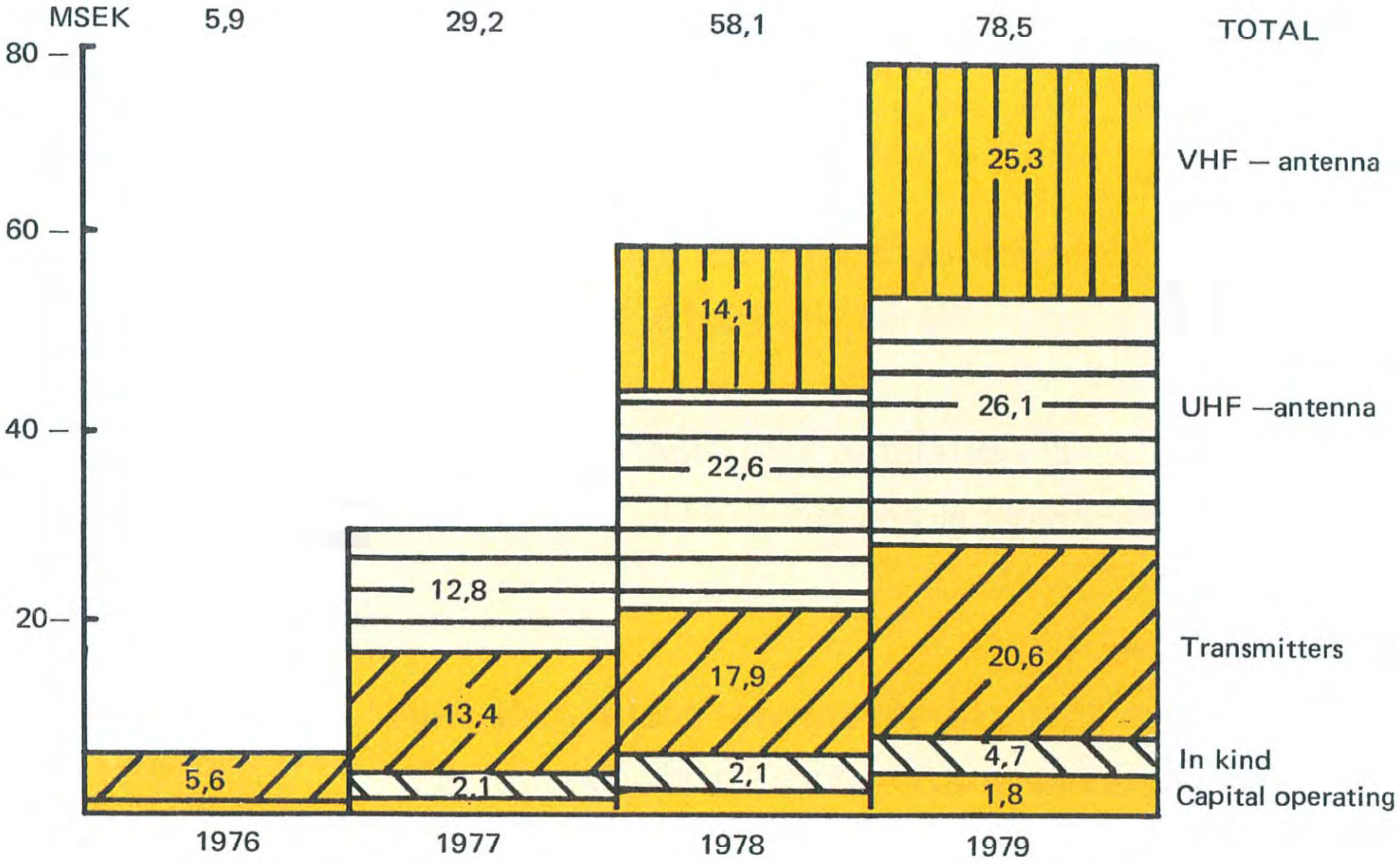
Sodankylä, Finland, 22-25 October 1979.

EISCAT Meetings No. 79/4, 1979.

FINANCE AND ACCOUNTS

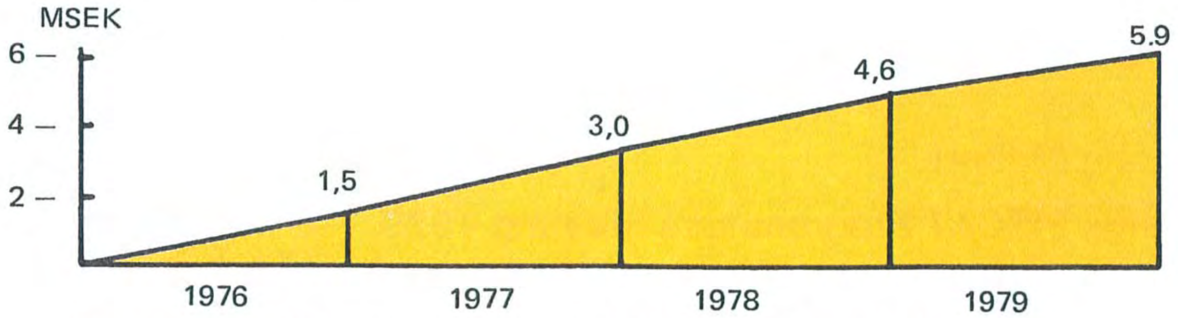
Capital investments

The capital investments amounted to 78 MSEK at the end of 1979. The cumulative cash flow of the capital investments has been as follows:



Operating costs

The operating costs increased by 1,3 MSEK to 5,9 MSEK in 1979, but are not yet up to the level for full operations. The annual costs have had the following annual progress.



Figures quoted are current values at the time of expenditure

Operating account
For the year ended
31 December 1979

SEK/000

	1979	1978
INCOME		
Contributions from Associates	5,900	4,200
Other income: Operating	54	215
Investment Pool	701	939
	6,655	5,354
EXPENDITURE		
Personnel	2,827	2,246
Travel	764	721
Administration and finance	1,157	942
Operation	730	362
Consultant's fee	402	295
	5,880	4,566
Surplus to Balance Sheet: Recurrent	74	(151)
Pool	701	939
	6,655	5,354

Balance sheet at 31 December 1979

Assets

	At Jan 1, 1979	Additions	Depreciation	At Dec. 31, 1979	At Dec. 31, 1978
FIXED ASSETS					
Pool:					
Transmitters	17,868	2,738		20,606	17,868
UHF-antennas	22,566	3,501	1,128	24,939	22,566
VHF-antenna	14,063	11,197		25,260	14,063
In Kind:					
Premises	1,475		30	1,445	1,475
Receivers	423			423	423
Time/frequency system	194			194	194
On-line computers	—	2,618		2,618	—
Total Pool/In Kind	56,589	20,054	1,158	75,485	56,589
Capital Operating					
Housing	18			18	18
Data processing system	666	164	95	735	666
Ancillary equipment and furniture	607	92	126	573	607
Motor vehicles	120	55	31	144	120
Total Capital Operating	1,411	311	252	1,470	1,411
Total Fixed Assets	58,000	20,365	1,410	76,955	58,000
CONTRIBUTIONS					
Pool — uncalled				3,000	5,200
CURRENT ASSETS					
Debtors				338	1,098
Prepayments and accrued income				70	—
Cash				8,005	10,430
Special account				2,955	2,151
Total Current Assets				11,368	13,679
				91,323	76,879

Notes on the Balance Sheet:

1. Remaining commitments due to main
   contracts: Transmitters, USD 1,147,000
   VHF-antenna, DEM 1,931,412
2. In Kind expenditure by Nordic Associates is only included to the extent that fixed assets have been formally handed over as contributions to EISCAT.

Liabilities

SEK/000

	At Dec. 31, 1979	At Dec. 31, 1978
CAPITAL		
Contributions		
Pool	76,630	63,100
Capital Operating	1,877	1,548
In Kind	4,739	2,122
	83,246	66,770
Un-called contributions	3,000	5,200
Depreciations	(1,500)	(90)
Total Capital	84,746	71,880
RESERVES		
General reserve	1,786	905
Special reserve	2,955	2,151
Total Reserves	4,741	3,056
LIABILITIES		
Provisions	485	429
Other liabilities	1,351	1,514
Total Liabilities	1,836	1,943
	91,323	76,879

EISCAT MEETINGS

COUNCIL
12th meeting, Slough, 24-25 April 1979
13th meeting, Lindau, 6-7 November 1979

SCIENTIFIC ADVISORY COMMITTEE
13th meeting, Geilo, 12-13 February 1979
14th meeting, Slough, 14-15 June 1979
15th meeting, Vienna, 10 September 1979

ADMINISTRATIVE AND FINANCE COMMITTEE
12th meeting, Hamburg, 1-2 March 1979
13th meeting, München, 20-21 September 1979

EISCAT ANNUAL REVIEW MEETING
The 3rd meeting, Abisko, 12-16 March 1979

EISCAT PROGRAMMERS MEETING
Sodankylä, Finland 22-25 October 1979

THE EISCAT ASSOCIATES

CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE,
FRANCE
(CNRS)

SUOMEN AKATEMIA,.
FINLAND
(SA)

MAX-PLANCK GESELLSCHAFT,
WEST GERMANY
(MPG)

NORGES ALMENVITENSKAPELIGE FORSKNINGSRÅD,
NORWAY
(NAVF)

NATURVETENSKAPLIGA FORSKNINGSRÅDET,
SWEDEN
(NFR)

SCIENCE RESEARCH COUNCIL,
THE UNITED KINGDOM
(SRC)