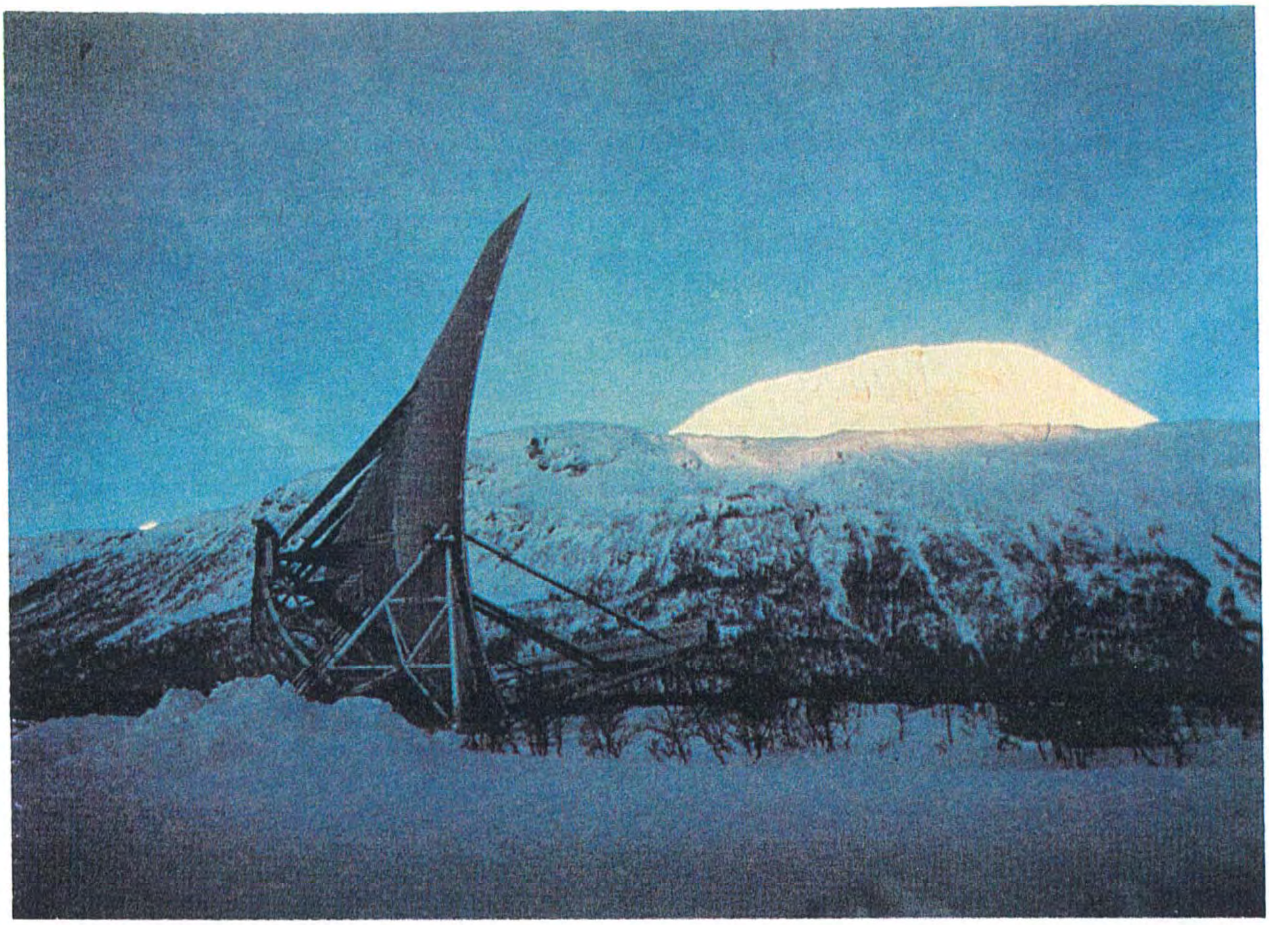

EISCAT

EUROPEAN INCOHERENT SCATTER SCIENTIFIC ASSOCIATION

ANNUAL REPORT 1982

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Tor Hagfors with John Evans, Gerhard Haerendel, and Herb Carlson at Prof. Hagfors' farewell colloquium.

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CHAIRMAN's PAGE

When looking at the draft of the 1982 Annual Report, I see with great satisfaction how many novel scientific results were obtained during the first year of operation of the UHF system. This in a year that, after a promising beginning, was characterized by an unexpected series of technical problems. Although we are, at the moment of writing, still under the impression of these problems and their consequences for the operation of EISCAT, we are also encouraged by the expectation of an exciting scientific future. I am confident that the origins of the various difficulties will soon be located and proper remedies will be found.

1982 was a year of substantial turnover of personnel. The most decisive one was the leave of EISCAT's first director, Tor Hagfors, and the arrival of his successor, Murray Baron. "Director" describes poorly what Tor Hagfors was for EISCAT. He was truly the scientific and technical father of the facility, whose detailed concept grew largely out of his mind. We feel sorry that he was not in the position of using EISCAT scientifically while being director, but expect that he will return many times as a user.

Murray Baron had to start just at the moment when the aforementioned problems appeared. Instead of beginning the era of intense data taking, he found himself immediately occupied with the search for failure modes and design flaws. On behalf of all members of EISCAT council, I want to express our thanks to the EISCAT staff and director for their deep engagement in carrying out the task.

Gerhard Haerendel
Chairman

Headquarters staff — December, 1982

DIRECTOR's PAGE

The year 1982 was one of both progress and setbacks for EISCAT. Many hundred hours of operations were achieved, and scientific results obtained from the EISCAT data were presented at several international scientific meetings. A number of journal articles have been written and will be published in 1983. The results obtained to date are indeed significant. New findings regarding the ionosphere's thermal structure, ionic composition, plasma and neutral motions, and morphology have emerged. Scientists from all the EISCAT associate countries have contributed to the scientific progress. Highlights are given in the next section of this report. There can be no doubt that the EISCAT facility will soon be at the forefront of high-latitude upper-atmospheric research.

But EISCAT is not yet realizing its potential primarily because of continuing unreliability in some critical parts of the system. Following the UHF transmitter modifications and acceptance tests in April, several months of relatively reliable transmitter operation were achieved. However a sequence of failures in the transmitter permitted only minimal operations throughout the last third of the year.

On the positive side, much progress was made in 1982. A second ND-10 computer system was installed at Tromsö and provides the additional computational power and disc storage needed at that site. The headquarters computer system was replaced by an ND-500, shared with KGI, that provides EISCAT with a very capable machine for data analysis. Processing of EISCAT data has been speeded up by an order of magnitude and now can be done in approximately 1/10th real time for typical integration times. Raw data tapes from almost all of the 1982 Common Program experiments have been copied and sent to CNES, EISCAT's contractor responsible for archiving, cataloguing, and distributing the data. A new on-line information system was installed on the HQ computer enabling associates quickly to obtain up-to-date information on experiment schedules, data availability, and system status.

Many improvements have been made to the EISCAT analysis software. Electron and ion temperatures deduced independently from the data at the three sites now agree to within acceptable limits. This provides convincing evidence that the EISCAT analysis program is working properly. Also, several improvements were made to the receiver system in 1982. These significantly improved the data quality and system reliability.

The visiting scientists quarters at Ramfjordmoen were completed and "inaugurated" by members of council during the May council meeting held in Tromsö. These quarters have already proven their value in relieving visitors from the tiring drive and high cost of staying in down-town Tromsö.

The completion of the VHF system remains a problem. By the end of 1982, the transmitter vendor had not been able to make the VHF klystrons perform properly in the system. One of the klystrons had been damaged and must be rebuilt, and another appears so far unable to meet specifications. Some circuit modifications and diagnostic measurements will be made in an attempt to identify and cure the difficulties. A third klystron, ordered as a spare, remains to be tested in the transmitter. Clearly, delivery of the VHF transmitter is again delayed and is not expected in 1983.

Finally, 1982 has been a year of many staff changes, particularly at Headquarters. Tor Hagfors, EISCAT's director since its establishment, has taken a new position as Director of the National Astronomy and Ionosphere Center in the USA. His vision and untiring efforts in bringing EISCAT into being are well recognized and appreciated by the EISCAT community as well as by scientists throughout the world.

As the most recent newcomer to Headquarters, I am grateful to have been provided with such an able and professional staff. The new assistant director-science, Dr. Jürgen Röttger, and the new head programmer, Dr. Walter Schmidt, have already made important contributions to the organisation. The assistant director-technical, Dr. Kristen Folkestad, has maintained his sense of humor and dedicated efforts in spite of the technical difficulties. All of us at EISCAT are dedicated to making the facility a fully operational one that completely fulfills the expectations of the associates.

Murray Baron
Director

SCIENTIFIC RESULTS

A great deal of scientific progress has resulted from the early experiments performed in 1981 and from experiments performed with the improved system during 1982.

Many of the first results from EISCAT were presented at the International Scientific Radio Union Symposium "Radio Probing of the High Latitude Ionosphere and Atmosphere" in Fairbanks, Alaska (9—13 August, 1982), and at the Ninth Annual Meeting of the European Geophysical Society (EGS) in Leeds, UK (23—27 August, 1982). Several publications are in process.

It is clear that new and substantial findings have emerged which prove the usefulness of the EISCAT system for high latitude ionospheric and atmospheric research. Some of the significant results are summarized below.

Ion Composition

Large variations of the thermospheric ion composition are correlated with auroral Joule heating and particle precipitation. This was demonstrated by the French group using EISCAT common program measurements. They found that Joule heating resulted not only in electron density and ion temperature changes, but also in important variations of the ion composition. In Figure 1, the derived ion composition is shown as a function of time and altitude. The colour scale indicates the percentage of 0^+ ions: black indicates 100% molecular ions ($0_2{}^+$ and NO^+) and red 100% atomic ions (0^+). During the middle of the day, near 200 km altitude, about 70% of the ions were atomic oxygen. Around 20 UT a brief increase of 0^+ concentration occurred above 180 km resulting from a strong electron precipitation event. Later, around 22 UT, a sharp increase of molecular ions occurred in the 140—260 km altitude region at the time of a Joule heating event.

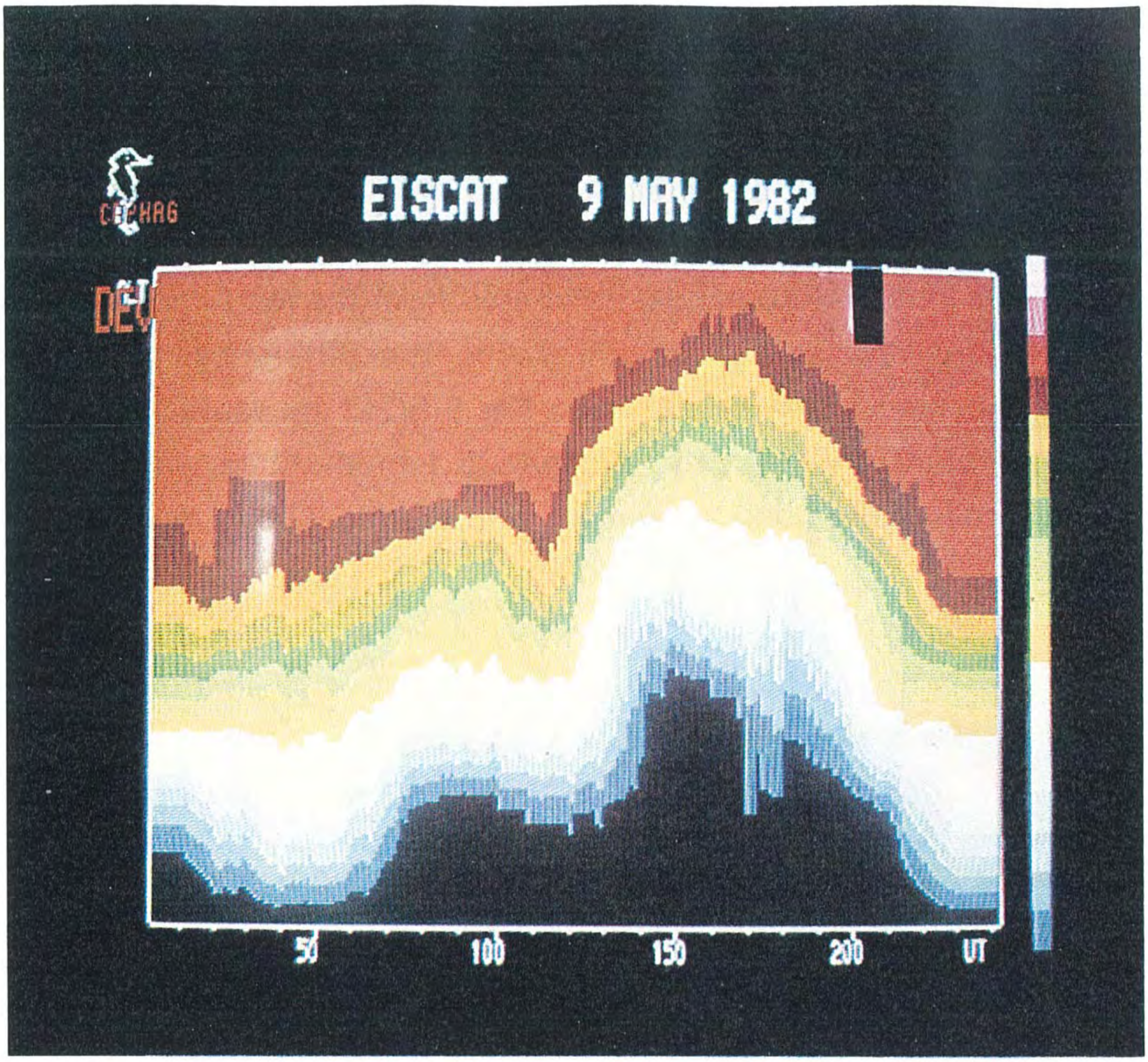


Figure 1: Ion composition as a function of altitude and time. Black indicates 100% molecular ions and red 100% atomic ions. Variations due to soft particle precipitation, at 20 UT, and Joule heating, at 22 UT, are evident.

The same group also analysed an early EISCAT experiment to derive the hydrogen ion concentration at altitudes between 300 and 600 km. Because of the low system sensitivity and marginal measurement conditions during the early months of operation, a long integration time of 30 minutes had to be used to obtain statistically significant results. Nonetheless, the derived atomic hydrogen concentration showed a clear and systematic altitude variation, from essentially 0% at 300 km to 2—3% at 600 km.

Exospheric Temperature

French scientists applied the ion energy balance equation to relate ionospheric to thermospheric parameters. In the absence of electron gas heating by photoelectrons or soft particle precipitation, the exospheric temperature can be estimated from the ion temperature and a frictional (Joule) heating term arising from differences between the ion and neutral velocities. From the EISCAT measurements of ion temperature and velocity, exospheric temperatures were deduced that are in quite good agreement with thermospheric models.

Plasma Velocities

Plasma motions at high latitudes are driven primarily by convection electric fields. A single station, exploring a range of latitudes cannot distinguish between temporal (universal time) and spatial (local time) effects. However, long period simultaneous observations by several stations can help resolve the spatial/temporal ambiguities. Such observations were performed by the EISCAT, Chatanika, and Millstone Hill incoherent scatter radars as part of the MITHRAS (Magnetosphere, Ionosphere, Thermosphere Radar Studies) program of coordinated operations. Cooperative work between EISCAT associates and the U.S. groups revealed that after the usual period of evening westward drift, both EISCAT and Chatanika abruptly entered a region of almost zero drift velocity at approximately the same magnetic local time, but well separated in universal time. These observations, made during a period of high magnetic activity, suggested that the auroral convection pattern had expanded southward and remained rather stable for at least ten hours.

Scientists from Norway and France observed a significant correlation between the eastward component of the plasma velocity, measured with the tristatic EISCAT system, and the horizontal component of the Earth's magnetic field monitored by the Tromsö magnetometer. This close correspondence is expected since the magnetic field perturbations are caused by the auroral electrojet currents which in turn are a consequence of the plasma motions. The good correlation between these two independently measured quantities confirms EISCAT's capabilities for determining the plasma flow patterns. East-west velocities as high as 1600 ms^{-1} were measured with EISCAT.

The German group compared EISCAT plasma drift velocities with STARE auroral backscatter radar measurements. The STARE measurements yield the drift velocity of irregularities in the 100 km altitude region, which is interpreted as an electric-field-driven drift of the electrons. Comparison of the STARE and EISCAT drift velocities showed good agreement of the velocity direction. For velocities below 800 ms^{-1}, the agreement was also good in magnitude; but for larger velocities, the STARE measurements consistently yielded lower values than EISCAT. An explanation for the discrepancy at high velocities was developed through theoretical work.

Gravity Waves

The auroral zone is an important source of atmospheric gravity waves that carry substantial amounts of energy and momentum to lower latitudes. These waves, propagating in the neutral atmosphere, can cause periodic variations in electron density, electron and ion temperatures, and plasma velocity, quantities observable with EISCAT. Several EISCAT experiments were performed to investigate these phenomena. Analyses by the United Kingdom group indicated that waves with periods of between 40 and 80 minutes and wavelengths of several thousand km were detected in the F-region. They also suggested that the periodic, almost monochromatic, electron density variations observed were a consequence of an oscillating magnetospheric electric field driving a sharp latitudinal boundary back and forth across the radar beam.

Morphology and structure

Many high latitude morphological features have been observed in the EISCAT data: the trough, effects of hard and soft precipitation, auroral arcs, and diurnal variations of many parameters. Comparisons have been made of ionospheric quantities measured on a quiet, a moderately disturbed, and a very disturbed day.

The value of coordinated radar and optical experiments was demonstrated by the United Kingdom group. Bright visual arcs, typically 200 meters in latitudinal width, monitored by Southampton University auroral TV cameras, were found to be situated near the edges of broad regions of enhanced E-region ionization. The arcs and associated ionization enhancements moved equatorward at speeds of several hundred meters per second (see Figure 2).

E-region electron density enhancements caused by precipitating particles were studied by the German group. With the meridionally scanning operation of Common Program Three, they found a correspondence between the electron counting rates measured by the GEOS satellite and the E-region electron density. The electron density enhancement observed by EISCAT was quite localized in latitude indicating that the precipitation was confined to a small region around the footprint of the GEOS magnetic field line.

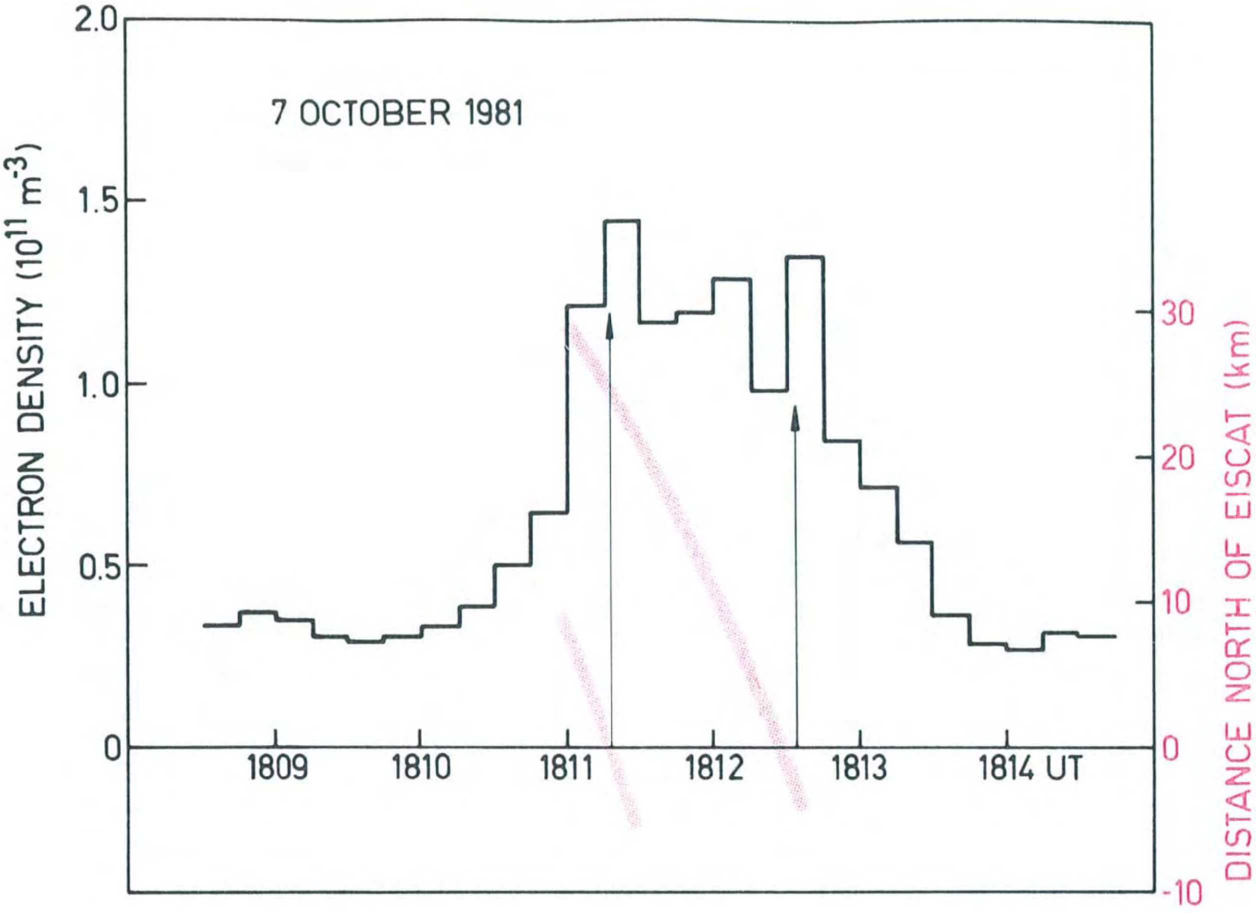


Figure 2: Auroral optical emmissions and ionization enhancements are co-located. The shaded lines show the motions of two distinct optical auroral arcs through the EISCAT beam. The solid curve shows the corresponding electron density variations at 120 km as measured by EISCAT.

Scientists from the United Kingdom investigated the structure of F-region irregularities of 5—50 km scale size. Using EISCAT measurements of electric fields and density gradients, they found that the observations are consistent with the formation of irregularities by the gradient drift instability.

Observations of sporadic-E events were performed by groups from Finland, Sweden and the UK. The EISCAT measurements were compared with, and related to, simultaneous ionosonde measurements leading to a better understanding of the ionogram signatures.

Plasma line

Plasma lines are signals displaced from the transmitted frequency by approximately the ionospheric plasma frequency. Natural plasma lines, excited by photoelectrons, are very weak and difficult to detect. To perform broad-band plasma line measurements, a special high-speed correlator was supplied by the French group, and experiments were carried out late in 1981.

The data analysis proved that photoelectron-excited plasma lines in the F-layer could be detected. The electron density at the peak of the F-layer was obtained from the highest frequency of the plasma line spectrum. The temporal behavior of peak electron density derived from the plasma line observation compared well with the simultaneous ion line measurements. The ability to detect the natural plasma line provides a means for absolute calibration of the ion line electron density measurements, independent of other instruments.

Stratosphere/Mesosphere

The first EISCAT detection of signals from the stratosphere and mesosphere was made in the summer of 1982 after a special correlator program for pulse-to-pulse correlation was prepared. Scientists from France, United Kingdom, Sweden and EISCAT participated in these experiments.

Stratosphere echoes are due to coherent scatter from clear air turbulence. The turbulence is carried by the neutral wind, resulting in a Doppler-shifted echo. By varying the antenna pointing direction in a monostatic experiment, wind velocities could be deduced for altitudes up to 20 km. The derived velocities were in very good agreement with radiosonde-derived winds. In the bistatic mode, echoes from stratospheric heights up to 30 km were received. Preliminary estimates of the turbulence refractive index constant showed an order of magnitude decrease from 20 to 30 km altitude.

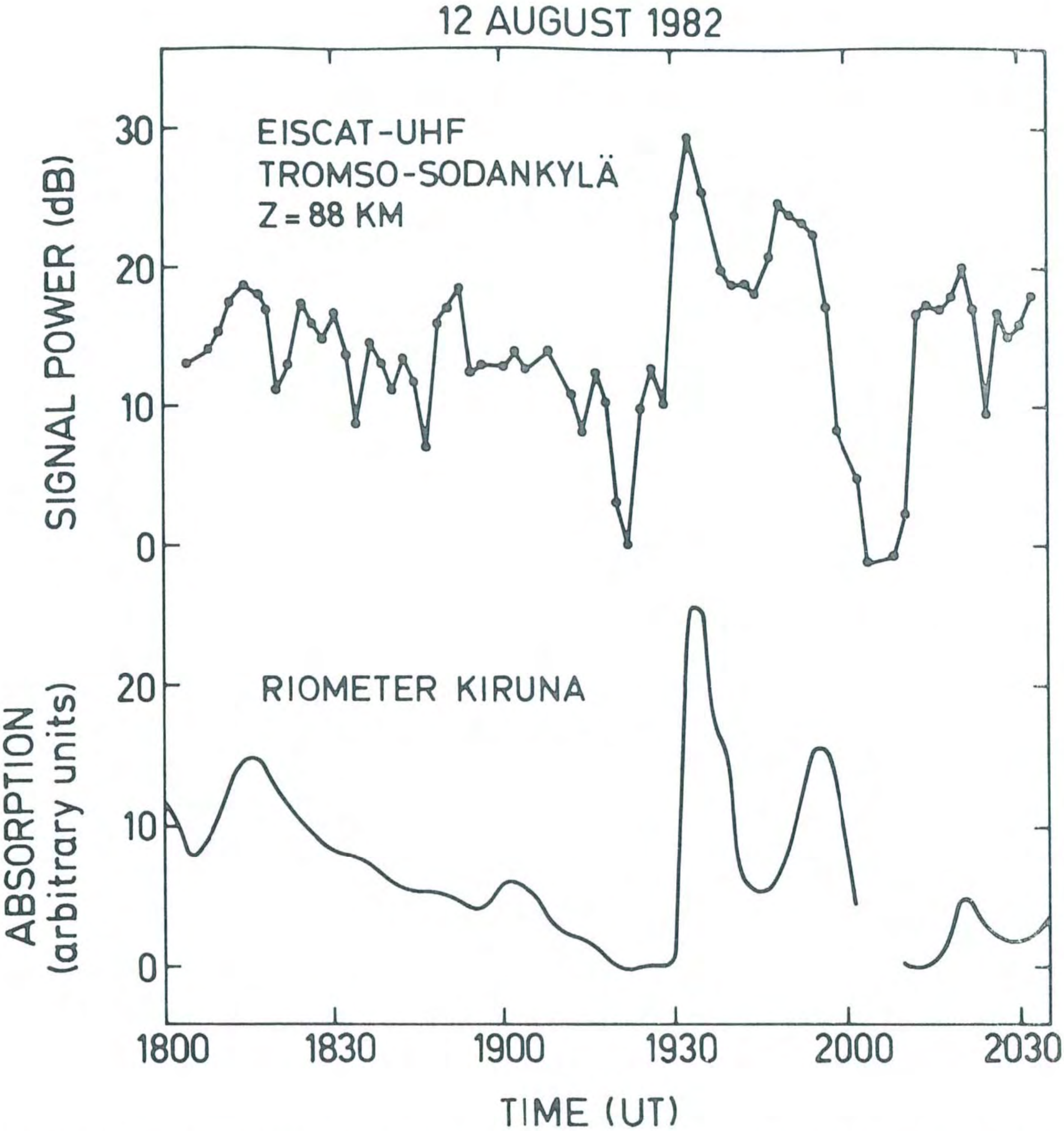


Figure 3: Comparison between EISCAT signal strength at 88 km and riometer absorption. The close correspondence demonstrates EISCAT's ability to make incoherent scatter measurements in the mesosphere.

Signals from mesospheric altitudes were observed in both monostatic and bistatic mode. In an extended series of operations to support the CAMP rocket campaign in July/August 1982, a fairly clear view of the occurrence frequency of these mesospheric echoes was obtained. Their appearance usually was limited to short durations up to ten minutes. Intense echoes often were connected with high absorption events recorded by nearby riometers. Figure 3 shows the good correlation between the riometer absorption and the average EISCAT signal power received from a scattering volume at 88 km altitude. An ionization increase of almost three orders of magnitude was found during the peak of the absorption event. It is fairly evident, therefore, that the mesospheric echoes are due to incoherent scatter from D-region ionization which was enhanced by high-energy particle precipitation.

The pulse-to-pulse correlation scheme allowed the first EISCAT measurements of D-region ion line spectra (Figure 4). The spectral width is dependent on the temperature, the collision frequency, and the ratio of negative ions to electrons. Using a model for two of these parameters, the remaining parameter can be deduced. By this means, indications of negative ions below the mesopause region were found. The spectra also exhibited a Doppler shift caused by a neutral wind. The wind profile deduced from the mesospheric data is consistent with mean circulation models. In continuing these analyses, a unique chance exists to compare the EISCAT measurements with simultaneous rocket-borne measurements made during the CAMP campaign.

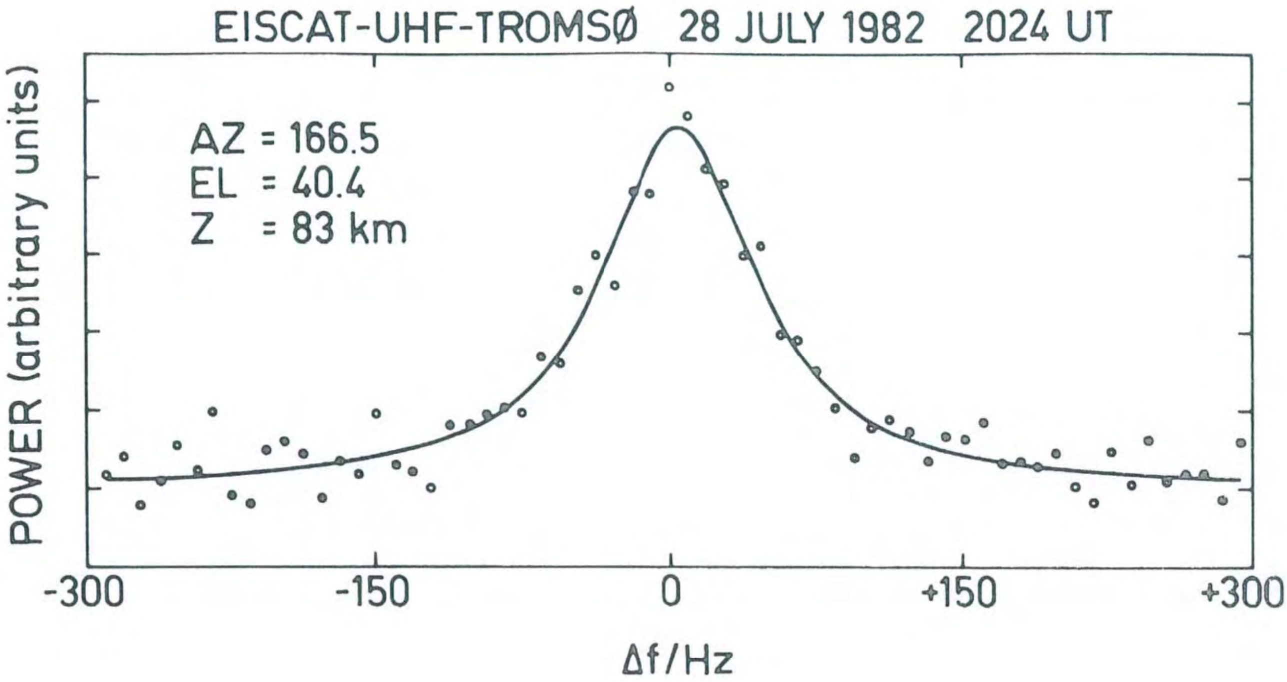
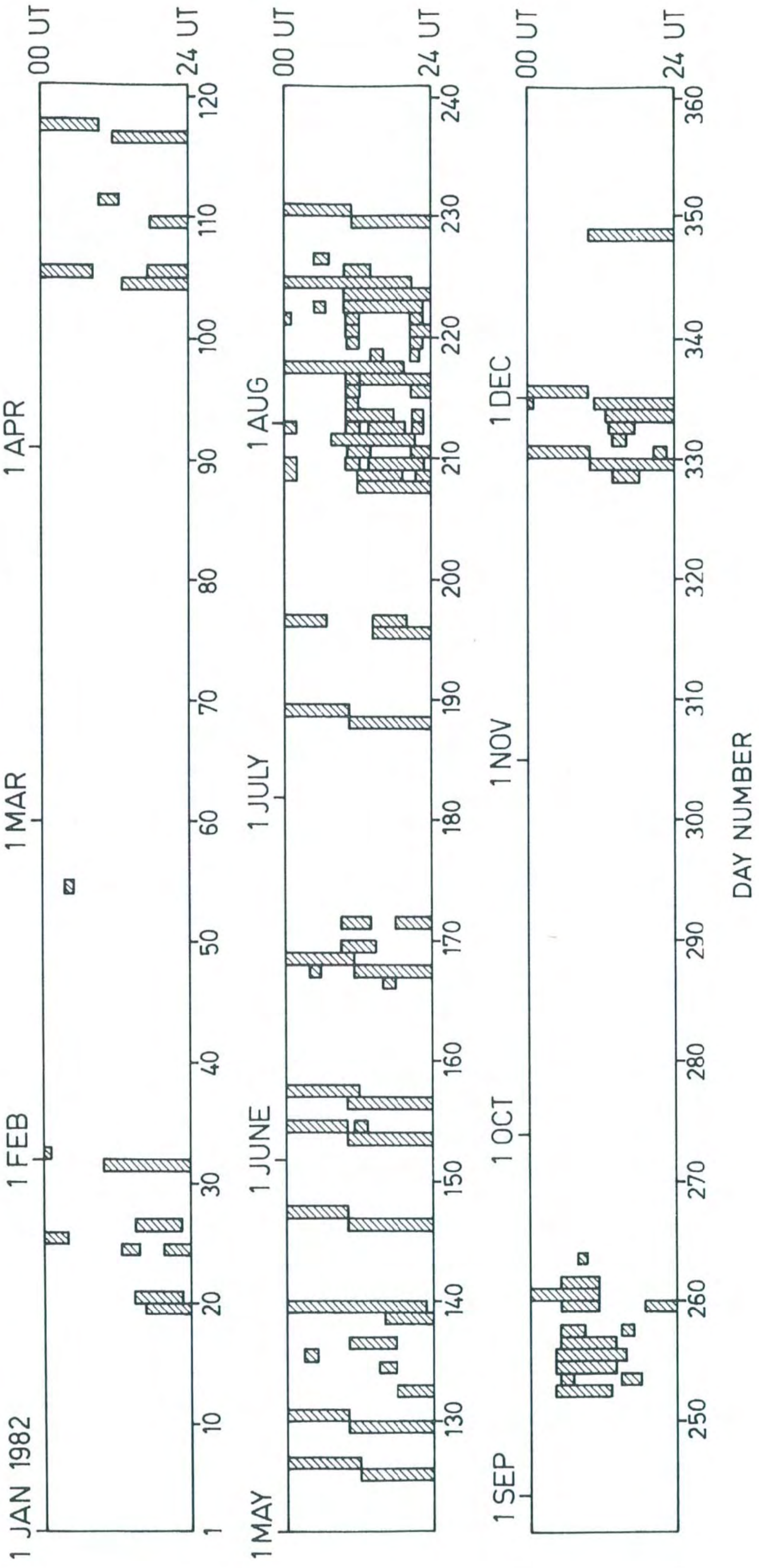


Figure 4: Example of first EISCAT measurement of spectra from the D-region. From such spectra, the neutral wind velocity can be obtained and other parameters estimated.

Passive experiments

Two series of passive experiments were conducted by scientists from France, Finland and the United Kingdom in 1982 to measure interplanetary scintillations. In these experiments, radio stars were tracked simultaneously by the Kiruna and Sodankylä stations. As the signal from the radio source passes through the solar corona, it is modulated by inhomogeneities in the plasma. Analysis of the fluctuating signals received simultaneously at the two sites provides information about the plasma streaming from the sun (the solar wind). Initial data analysis indicates that the EISCAT results provide a very good estimate of the anisotropy of the solar wind plasma, the solar wind direction and the turbulence velocity.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OPERATIONS

The EISCAT UHF system was operated and 840 hrs of data were recorded in 1982. This total is quite remarkable considering that transmitter modifications and repairs restricted scientific operations to three periods encompassing less than 6 months of time. The distribution of operations throughout the year is shown graphically in Figure 5.

About half of the operations time was used for experiments in which the data is distributed to all associates, termed common program experiments. Within the common program the time was almost equally distributed to the three different experiments. Common Program Zero gives continuous measurements of electron density, electron and ion temperatures and velocities in the F-region. For this experiment the Tromsö antenna is directed parallel to the magnetic field and the remote antennas are pointed to a common volume at 300 km altitude. In Common Program Two, the Tromsö antenna sequentially points to the vertices of a triangle at 300 km height and the remote antennas follow accordingly. This allows observations of temporal and spatial variations. Common Program Three is used to make measurements over a wide range of latitudes; its 16-point trajectory extends from 64.25°N to 74.25°N. During the operational periods, extended duration common program experiments were performed once per week. Common Program Three was additionally operated nine times during passes of the Dynamic Explorer-2 satellite.

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Figure 5: EISCAT operating periods in 1982. For each day of the year (abscissa), the shaded bars indicate the times (ordinate) during which experiments were performed.

Almost 440 hours of operation were used for particular experiments of individual associates or groups of associates, termed special programs, and for test operations. Figure 6 shows how the operation time was shared between the common programs and special programs. Most of the special program operations were performed during campaigns in which visiting scientists worked cooperatively on a set of experiments. The most intensive period was between late July and early August, when more than 100 hours of sporadic-E and D-region experiments took place as a joint campaign of France, Sweden, United Kingdom and Germany. The D-region observations were carried out in connection with the CAMP (Cold Arctic Mesopause) rocket campaign at ESRANGE.

About 85 hours were devoted to passive observations of interplanetary scintillations (by France, United Kingdom and Finland) using the Kiruna and Sodankylä receiving sites. Examples of other extended special program operations were: diurnal variation of thermospheric composition and electric fields (Finland), observations of plasma convection at high latitudes (United Kingdom), measurements of traveling ionospheric disturbances, drifting F-region irregularities and electric field fluctuations (United Kingdom, France), detection of the heater-induced and natural plasma line (France, Germany, United Kingdom), and tests to develop new programs and improve the system capabilities. EISCAT staff members were involved in many of the special experiments. Unfortunately, planned special program operations by Norway, Germany and Sweden in support of the HERO and AURELD HIGH rocket campaigns were unsuccessful due to transmitter malfunctions.

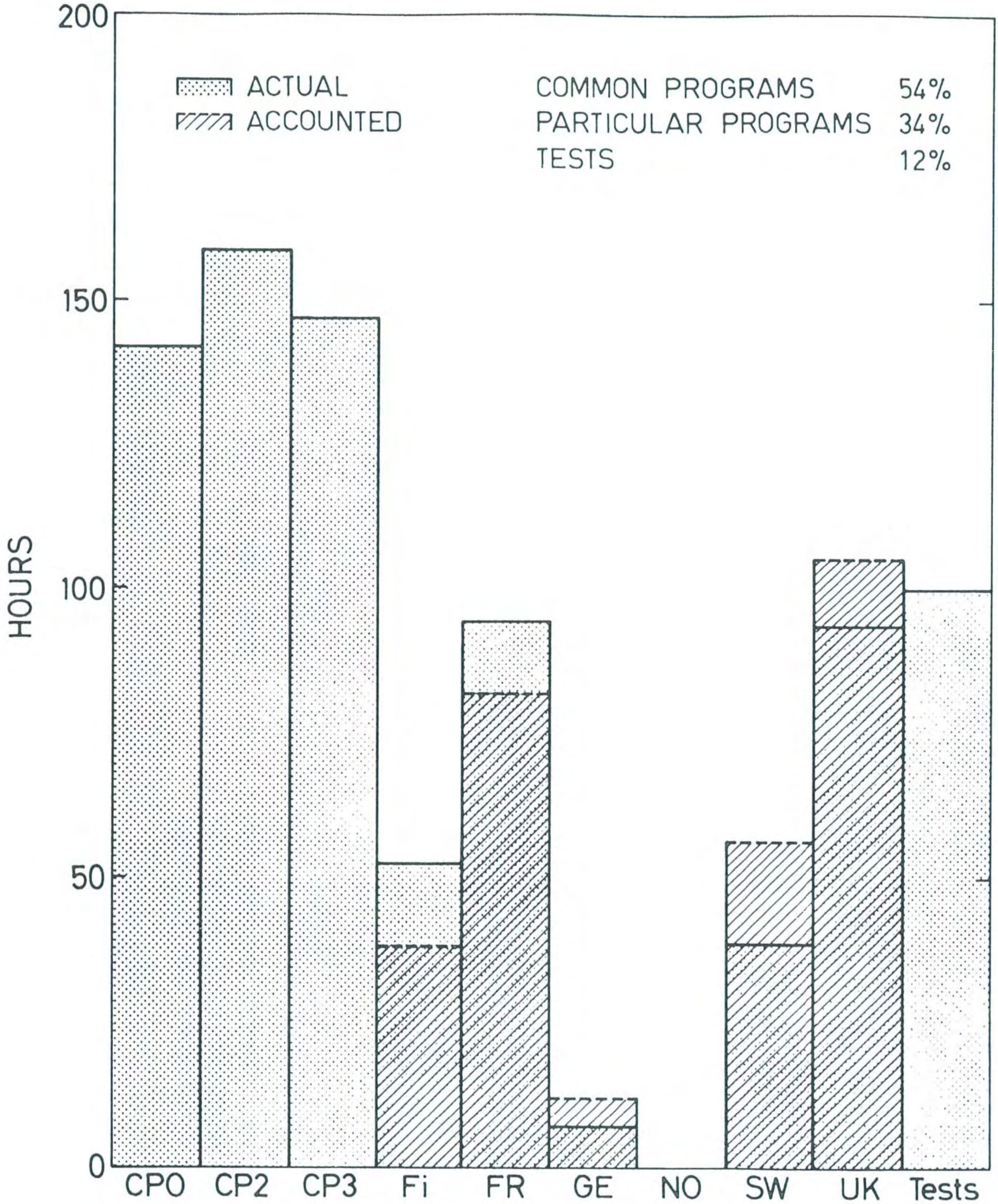
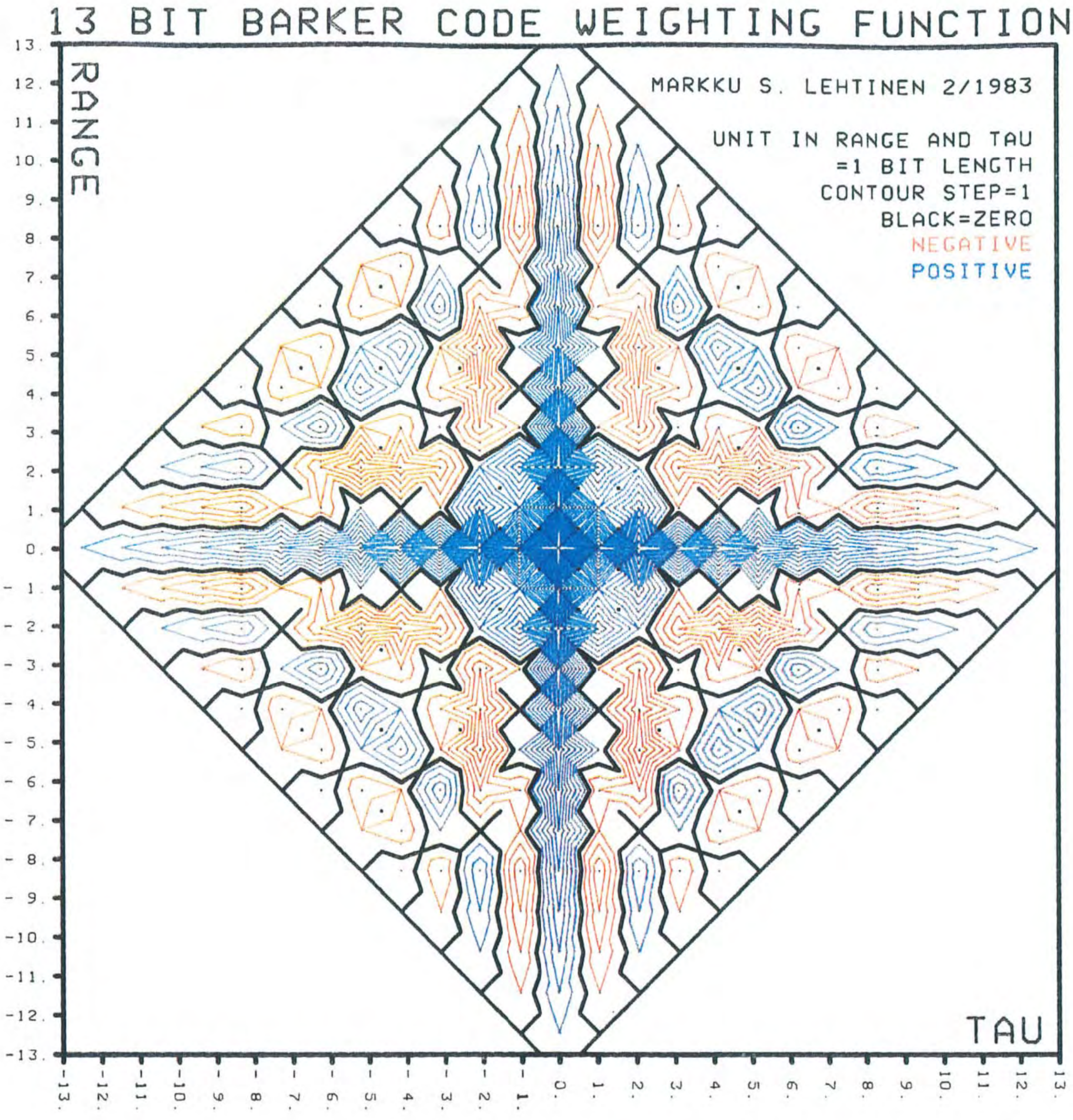


Figure 6: Distribution of operating time among the common programs and associate's particular programs. Accounted time includes adjustments: upward for unused minimum operating periods, downward for passive experiment periods.



TECHNICAL REVIEW

UHF Facility

For yet another year the UHF transmitter proved to be the most crucial part in the operation of the system. An Aydin team was at the Ramfjordmoen site from the middle of February to the beginning of April, preparing and carrying out the final acceptance tests.

Several modifications were implemented and helped to improve the behavior of the equipment. The transmitter was provisionally accepted by EISCAT with the understanding that leaks still present in the coolant water pump, the inadequacy of the dummy load in accommodating the rated power, and other minor deficiences would be corrected.

Although full peak power of 2 MW was achieved as part of the acceptance tests, a peak power of around 1 MW was used for most of the transmitter operations in 1982. This was done primarily to protect the preamplifier stage of the receivers against possible effects of harmonics in the transmitted signals. An attempt was made in 1981 to reduce the harmonic output by installing a high power filter in the waveguide near the transmitter. However, the filter was persistently found to arc at low powers. By filling it with SF6 gas, higher powers could be achieved; but the barriers installed to confine the SF6 gas had a tendency to burn out. The filter was thereafter removed and an alternative filter with a higher power rating was ordered.

In the middle of August, after several weeks of prolonged operations, the power output of the klystron suddenly dropped by more than a factor of two. Inspection revealed that two of the magnet coils surrounding the tube showed signs of overheating. The magnet assembly was replaced by the spare assembly, but this turned out to have several leaks in the cooling system and was therefore unusable. After further diagnostic measurements, both the klystron and the spare magnet assembly were returned to Varian for closer inspection and repair. Subsequent investigations showed that under operating conditions the two suspect coils intermittently acted as almost short circuits.

Transmitter operation was resumed in November after replacement of the two coils. In reinstalling the magnets, measures were taken to prevent similar misbehavior in the future. The spare klystron was installed and found to work, but the transmitter continued to be troublesome for the rest of the year. The nature of the problems was much the same as depicted earlier: disruption and damages done by "crowbars" to various parts of the system. Most annoying were repeated destructions of the preamplifier in the antenna instrument room.

At Sodankylä and Kiruna the parametric preamplifiers worked satisfactorily throughout the year, yielding effective system noise temperatures in the range 40—60 K. The transistor amplifier employed at Tromsö was replaced in the summer by a GaAs-FET amplifier built by Dr. Wannberg and the Kiruna staff. The GaAs-FET version lowered the system noise temperature from 350—400 K to 130—160 K. Its simple design, easy alignment and low cost were a major asset in the numerous replacements which took place in 1982.

The original version of the postdetection filters, reported earlier to be temperature sensitive, were replaced by much more stable Butterworth filters developed by Dr. Turunen and built at the Sodankylä site. Linear phase filters to accommodate coded and short pulse sequences have also been provided as well as a few narrow band filters for application in mesospheric experiments.

The remaining units of the ion-line (slow) A/D converters, constructed and built by the University of Oulu, were delivered in 1982. The development of the plasma-line (fast) A/D converters at Oulu was proceeding, but these had not been delivered by end of the year.

In general, the antennas, receivers, controllers, and data handling systems worked well. Minor improvements and modifications were made as dictated by operational experience. The graphical supervision arrangement was refined in various ways in 1982. A provision for post-integrating data dumps before displaying the results was implemented. An option for having one site supervise operations at all three stations was installed.

In summary, hundreds of hours of successful experiments in 1982 have demonstrated the UHF facility's superior capability and flexability as an incoherent scatter radar. On the other hand, the reliability of the system, primarily the transmitter, was far from being as good as it must be if the intended operational standard is to be achieved.

VHF Transmitter

The technical work continued on the VHF transmitter. Modifications made to the UHF system were incorporated into the VHF transmitter. Finally, late in the year, power was applied to the VHF klystrons. Soon significant new problems surfaced. One VHF klystron exhibited so-called "gun oscillations" and the second klystron lost vacuum as a result of an unfortunate accident. A third klystron, procured as a spare, is available and will be tested early in 1983. Two working klystrons are needed for the transmitter to meet its specifications.

As we enter 1983, the completion schedule for the VHF transmitter cannot be predicted with any certainty. First, the spare tube must be evaluated. Second, further tests are needed to determine whether the gun oscillations are intrinsic to the tube(s) or a consequence of the transmitter configuration. Third, negotiations must be held regarding the rebuilding of the defective tube(s). Clearly, delivery of the VHF transmitter has slipped yet another year into 1984.

PUBLICATIONS

A good indicator of the productivity of any facility is the resulting scientific publications and presentations. Following are lists for 1982 of the publications and presentations of scientists from associate countries and EISCAT staff based wholly or in-part on EISCAT results.

Papers presented at meetings

Hapgood, M.A., "A comparison between television and EISCAT observations of auroral arcs", Royal Astronomical Society Meeting, Lancaster, England (March 1982).

McCormac, G.M., R.W. Smith, K. Winser, "Combined observations of ion drift in the F region using the EISCAT radar and a Fabry Perot interferometer", Royal Astronomical Society Meeting, Lancaster, England (March 1982).

Alcaydé, D., "Contribution of high latitude incoherent scatter observatories to the knowledge of the auroral thermosphere", COSPAR-CIRA WORKSHOP, Invited review, Ottawa, Canada (May 1982).

Nielsen, E., J.D. Whitehead, "Radar auroral observations and ionospheric electric fields", COSPAR, Ottawa, Canada (May 1982).

Schlegel, K., E. Nielsen, "STARE-EISCAT electric field comparison", American Geophysical Union, Philadelphia, Pennsylvania (May/June 1982).

St-Maurice, J.P., K. Schlegel, E. Nielsen, "Plasma waves in the auroral E-region and implications for the interpretation of auroral radar experiments", European Geophysical Society General Assembly, Leeds, England (Aug. 1982).

Folkestad, K., T. Hagfors, P.J.S. Williams, "EISCAT: The first results", European Geophysical Society General Assembly, Leeds, England (Aug. 1982).

Caudal, G., D. Alcaydé, O. de la Beaujardière, G. Lejeune, "Simultaneous measurements of the electro-dynamic parameters of the auroral ionosphere by the EISCAT and Chatanika radars", European Geophysical Society General Assembly, Leeds, England (Aug. 1982).

Hapgood, M.A., P. Rothwell, M.J. Taylor, "A comparison between television and EISCAT observations of auroral arcs", European Geophysical Society General Assembly, Leeds, England (Aug. 1982).

Williams, P.J.S., A.P. van Eyken, "A periodic variation in nighttime electron density in the auroral zone", European Geophysical Society General Assembly, Leeds, England (Aug. 1982).

Bourgois, G., G. Daigne, J. Silén, T. Turunen, P.J.S. Williams, "Measurements of the solar wind velocity using the EISCAT facility", European Geophysical Society General Assembly, Leeds, England (Aug. 1982).

Bertin, F., W. Kofman, G. Lejeune, "Observations of the gravity waves in the auroral zone", URSI Symposium on Radio Probing of the High-latitude Ionosphere and Atmosphere, Fairbanks, Alaska (Aug. 1982).

Lejeune, G., C. Lathuillere, W. Kofman, "First EISCAT results: determination of ion composition in the F-region (light and heavy ions)", URSI Symposium on Radio Probing of the High-latitude Ionosphere and Atmosphere, Fairbanks, Alaska (Aug. 1982).

Kofman, W., and G. Lejeune, "Plasma line measurements with the EISCAT facility", URSI Symposium on Radio Probing of the High-latitude Ionosphere and Atmosphere, Fairbanks, Alaska (Aug. 1982).

Hagfors, T., T. Äijänen, H. Kopka, P. Stubbe, W. Kofman, "Observations of heater-induced plasma lines with EISCAT", URSI Symposium on Radio Probing of the High-latitude Ionosphere and Atmosphere, Fairbanks, Alaska (Aug. 1982).

Folkestad, F., T. Hagfors, S. Westerlund, "EISCAT — an updated description of technical characteristics and operational capabilities", URSI Symposium on Radio Probing of the High-latitude Ionosphere and Atmosphere, Fairbanks, Alaska (Aug. 1982).

Schlegel, K., E. Nielsen, "Electric fields from EISCAT and STARE — A first comparison", URSI Symposium on Radio Probing of the High-latitude Ionosphere and Atmosphere, Fairbanks, Alaska (Aug. 1982).

Nielsen, E., K. Schlegel, "Elektrische Felder in der polaren Ionosphäre mit STARE und EISCAT — Ein erster Vergleich", Annual German URSI Meeting, Kleinheubach, West Germany (Oct. 1982).

Schlegel, K., E. Nielsen, "Erste Vergleichsmessungen zwischen EISCAT und STARE", Meeting of the Arbeitsgemeinschaft Extraterr. Physik, Köln, West Germany (Oct. 1982).

Schlegel, K., "Erste Ergebnisse mit EISCAT", Annual German URSI Meeting, Kleinheubach, West Germany (Oct. 1982).

Schlegel, K., "Laufende und zukünftige Projekte des MPAe in der polaren Ionosphäre", Colloquium in honor of the 75th birthday of Prof. Dr. W. Dieminger, Katlenburg-Lindau, West Germany (Oct. 1982).

Williams, P.J.S., "Measurement of the solar wind using EISCAT", Royal Astronomical Society Meeting, London, England (Nov. 1982).

Hapgood, M.A., A.P. van Eyken, K.S.C. Freeman, R.B. Horne, "EISCAT and TV observations of an auroral arc on 1981 September 30", Royal Astronomical Society Meeting, London, England (Nov. 1982).

Journal publications

EISCAT Scientific Association, "EISCAT — the European incoherent scatter facility at auroral latitudes", EOS, Transactions, American Geophysical Union, Vol. 64, No. 1, (1982).

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Hagfors, T., "Incoherent Scatter Radar Observations of the Plasma line with a Chirped Pulse System", Radio Science, Vol. 17, No. 3, (1982).

Rishbeth, H., "Europe probes the auroral ionosphere", Nature, Vol. 295, No. 5845, (1982).

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Lathuillere, C., G. Lejeune, W. Kofman, "Direct measurements of ion composition with EISCAT in the high latitude F1 region", Submitted to Radio Science.

Bertin, F., W. Kofman, G. Lejeune, "Observations of the gravity waves in the auroral zone", Submitted to Radio Science.

Alcaydé, D., J. Fontanari and P. Bauer, "High latitude neutral atmosphere temperature and concentration measurements from the first EISCAT incoherent scatter observations", Annales de Geophysique, Vol. 38, No. 4, (1982).

Folkestad, K., T. Hagfors and S. Westerlund, "EISCAT — an updated Description of Technical Characteristics and Operational Capabilities", Submitted to Radio Science.

Hagfors, T., T. Äijänen, H. Kopka, P. Stubbe, W. Kofman, "Observations of heater-induced plasma lines with EISCAT", Submitted to Radio Science.

Reports — 1982

R. Gras: EISCAT Technical Note 82/23:
The EISCAT Correlator.

W. Kofman: EISCAT Technical Note 82/35:
A Mesospheric Experiment: Measurement Scheme and Program Implementation.

B.W. Törustad: EISCAT Technical Note 82/36:
CORLAN (CORrelator LANguage).

K. Folkestad (Editor):
EISCAT Meetings 82/7 Vol. I—II.
Proceedings EISCAT Annual Review Meeting, Riksgränsen, Sweden, 8—12 March 1982.


Staff at Riksgränsen Meeting

EISCAT MEETINGS

COUNCIL
19th meeting, Tromsö, 22—23 April 1982
20th meeting, Hamburg, 4—5 November 1982

SCIENTIFIC ADVISORY COMMITTEE (SAC)
22nd meeting, Kiruna, 22 and 26 March 1982
23rd meeting, Copenhagen, 8—9 September 1982

ADMINISTRATIVE AND FINANCE COMMITTEE (AFC)
18th meeting, Hamburg, 4 March 1982
19th meeting, Hamburg, 21 September 1982

EISCAT Annual Review Meeting
7th meeting, Riksgränsen, 8—12 March 1982

EISCAT Programmers Meeting
Kiruna, 11—14 October 1982

BALANCE SHEET

Assets

	At Dec. 31, 1981	Additions: Pool Cap.Op	Additions: In Kind[2]	Depre-ciation[3]	At Dec. 31, 1982
FIXED ASSETS					
Buildings	1.4	0.3	7.5	0.7	8.5
Transmitters[1]	24.4	0.8			25.2
UHF-antenna	22.6			1.3	21.3
VHF-antenna	27.6	(0.2)		1.5	25.9
Receivers	0.4		7.2	3.0	4.6
Computers etc.	3.5	1.2	5.4	4.7	5.4
Other	1.1	0.7		0.3	1.5
Total	81.1	2.8	20.1	11.5	92.4
CONTRIBUTIONS					
Pool uncalled	1.5				—
CURRENT ASSETS					
Debtors	0.4				0.4
Prepayments and accrued income	0.1				0.3
Cash and Ordinary Bank Accounts	7.2				9.6
Special Accounts	2.3				—
Total Current Assets	10.1				10.3
GRAND TOTAL	92.7				102.7

NOTES ON THE BALANCE SHEET:

1) Remaining commitments: MSEK 4.0.
2) Accumulated In Kind contributions by Nordic Associates have been entered in 1982.
3) Includes accumulated depreciations of In Kind investments for previous years: MSEK 6.1.

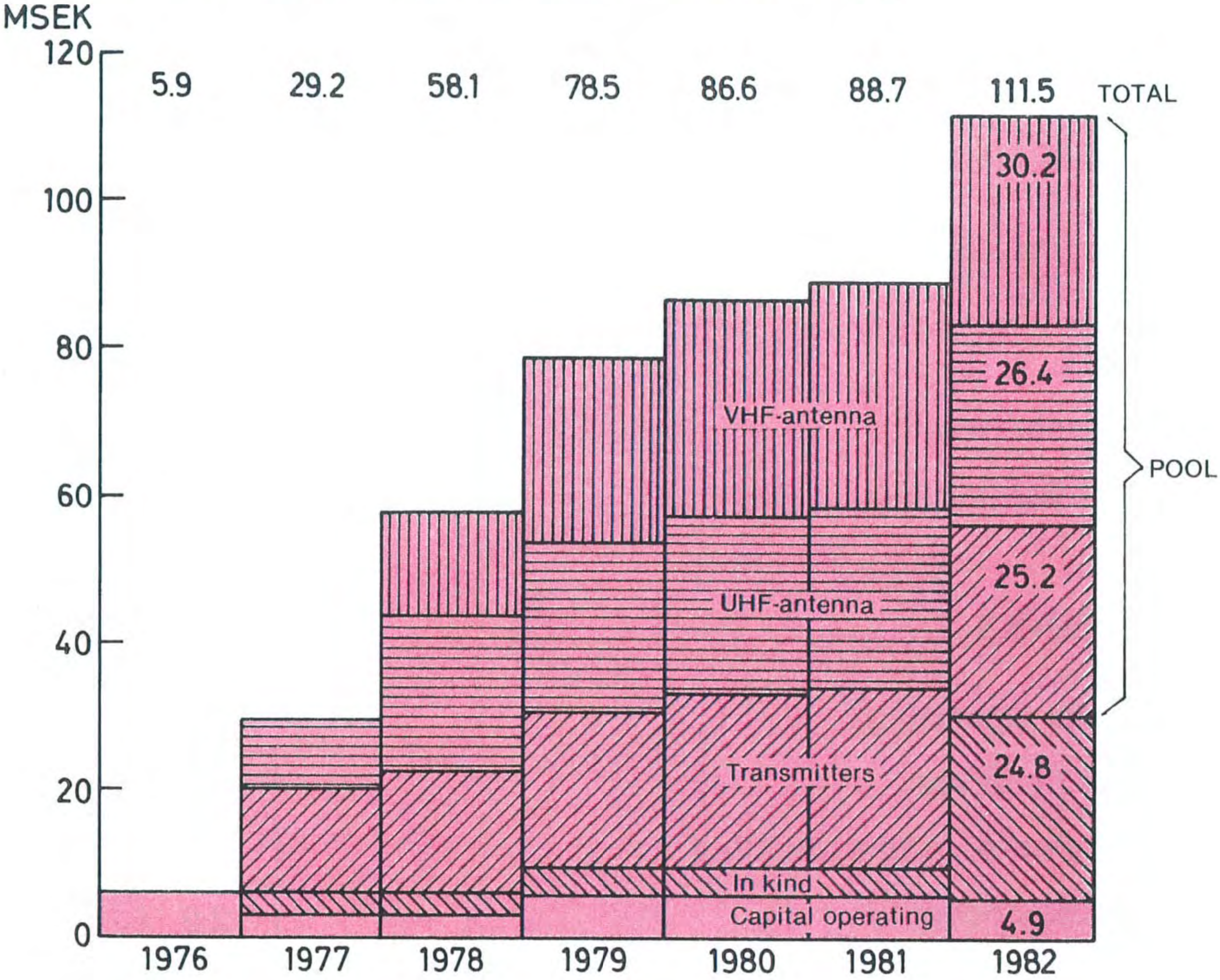
AT 31 DECEMBER 1982

Liabilities

	At Dec. 31, 1981	At Dec. 31, 1982
		MSEK
CAPITAL		
Contributions		
Pool	81.1	81.8
Capital Operating	2.8	4.9
In Kind	4.7	24.8
	88.7	111.5
Depreciations	7.6	19.1
Total Capital	81.1	92.4
RESERVES		
Pool	5.5	7.1
Capital Operating	1.2	0.9
Total Reserves	6.7	8.0
Pool Contributions uncalled	1.5	—
Special Accounts	2.3	—
LIABILITIES		
Provisions	0.7	1.6
Other Liabilities	0.4	0.7
Total Liabilities	1.1	2.3
GRAND TOTAL	92.7	102.7

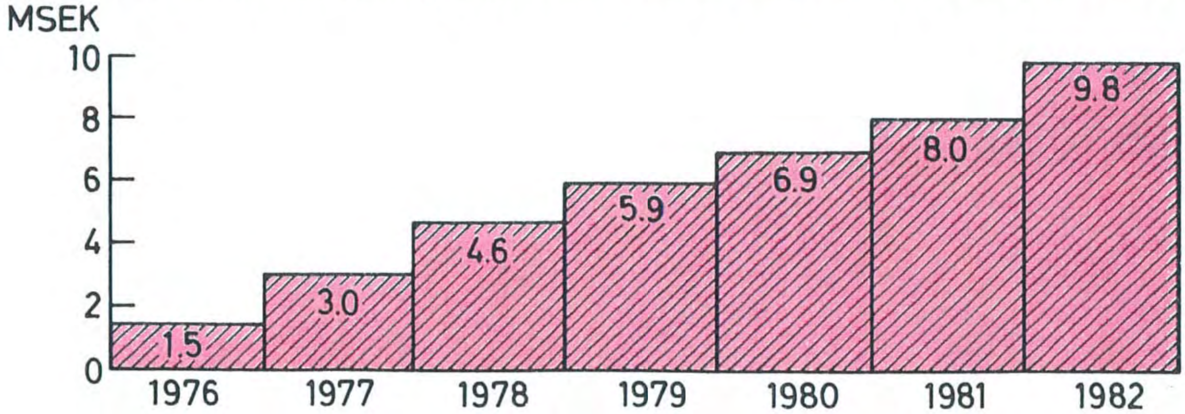
CAPITAL INVESTMENTS

The capital investment amounted to 111.5 MSEK at the end of 1982. The cumulative investments have been as follows:



OPERATING COSTS

The operating costs increased to 9.8 MSEK in 1982 but are not yet up to the level for full operations. The annual costs history follows:



Figures quoted are current values at the time of expenditure.

MEMBERSHIP OF COUNCIL AND COMMITTEES

	FRANCE	FINLAND	FEDERAL REPUBLIC OF GERMANY	NORWAY	SWEDEN	UNITED KINGDOM
COUNCIL	M. Blanc M. Petit J-C. Ribes	O. Ranta A. Silvola	G. Haerendel H. Kohl G. Preiss	O. Holt A. Omholt	B. Hultqvist M.O. Ottosson	H.H. Atkinson W.J.G. Beynon H. Rishbeth
SAC	D. Alcayde P. Bauer	J. Oksman	P. Christiansen K. Schlegel	A. Brekke	R. Boström	T.B. Jones H. Rishbeth
AFC	J. Mirabel A. Schwerer	O. Ranta	M. Meinecke	L. Westgaard	M.O. Ottosson	G. Rowe

HEADQUARTERS SENIOR STAFF AT 31 DECEMBER 1982

Director — M. Baron
Associate Director — K. Folkestad
Associate Director — J. Röttger*
Business Manager — B. Thorwid

*on secondment from MPG

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 AND ENGINEERING RESEARCH COUNCIL,
THE UNITED KINGDOM
(SERC)