# esa bulletin

european space agency
agence spatiale européenne

no. 13
may 1978

The European Space Agency was formed out of, and took over the rights and obligations of, the two earlier European Space Organisations: the European Space Research Organisation (ESRO) and the European Organisation for the Development and Construction of Space Vehicle Launchers (ELDO). The Member States are Belgium, Denmark, France, Germany, Italy, Netherlands, Spain, Sweden, Switzerland and the United Kingdom. Ireland has signed the ESA Convention and will become a Member State upon its ratification. Austria, Canada and Norway have been granted Observer status.

In the words of the Convention: The purpose of the Agency shall be to provide for and to promote, for exclusively peaceful purposes, co-operation among European States in space research and technology and their space applications, with a view to their being used for scientific purposes and for operational space applications systems,

(a) by elaborating and implementing a long-term European space policy, by recommending space objectives to the Member States, and by concerting the policies of the Member States with respect to other national and international organisations and institutions;
(b) by elaborating and implementing activities and programmes in the space field;
(c) by co-ordinating the European space programme and national programmes, and by integrating the latter progressively and as completely as possible into the European space programme, in particular as regards the development of applications satellites;
(d) by elaborating and implementing the industrial policy appropriate to its programme and by recommending a coherent industrial policy to the Member States.

The Agency is directed by a Council composed of representatives of Member States. The Director General is the chief executive of the Agency and its legal representative.

The Directorate of the Agency consists of the Director General; the Director of Planning and Future Programmes; the Director of Administration; the Director of Scientific and Meteorological Satellite Programmes; the Director of Communication Satellite Programmes; the Director of the Spacelab Programme; the Technical Inspector; the Director of ESTEC and the Director of ESOC.

The ESA HEADQUARTERS are in Paris.

The major establishments of ESA are:

THE EUROPEAN SPACE RESEARCH AND TECHNOLOGY CENTRE (ESTEC), Noordwijk, Netherlands.

THE EUROPEAN SPACE OPERATIONS CENTRE (ESOC), Darmstadt, Germany.

THE SPACE DOCUMENTATION SERVICE (ESRIN), Frascati, Italy.

Chairman of the Council: Dr. W. Finke (Germany).

Director General: Mr. R. Gibson.

*L'Agence Spatiale Européenne est issue des deux Organisations spatiales européennes qui l'ont précédée – l'Organisation européenne de recherches spatiales (CERS) et l'Organisation européenne pour la mise au point et la construction de lanceurs d'engins spatiaux (CECLES) – dont elle a repris les droits et obligations. Les Etats membres en sont: l'Allemagne, la Belgique, le Danemark, l'Espagne, la France, l'Italie, les Pays-Bas, le Royaume-Uni, la Suède et la Suisse. L'Irlande a signé la Convention de l'ESA et deviendra Etat membre de l'Agence lorsque la Convention aura été ratifiée. L'Autriche, le Canada et la Norvège bénéficient d'un statut d'observateur.*

*Selon les termes de la Convention: L'Agence a pour mission d'assurer et de développer, à des fins exclusivement pacifiques, la coopération entre Etats européens dans les domaines de la recherche et de la technologie spatiales et de leurs applications spatiales, en vue de leur utilisation à des fins scientifiques et pour des systèmes spatiaux opérationnels d'applications:*

*(a) en élaborant et en mettant en oeuvre une politique spatiale européenne à long terme, en recommandant aux Etats membres des objectifs en matière spatiale et en concertant les politiques des Etats membres à l'égard d'autres organisations et institutions nationales et internationales;*
*(b) en élaborant et en mettant en oeuvre des activités et des programmes dans le domaine spatial;*
*(c) en coordonnant le programme spatial européen et les programmes nationaux, et en intégrant ces derniers progressivement et aussi complètement que possible dans le programme spatial européen, notamment en ce qui concerne le développement de satellites d'applications;*
*(d) en élaborant et en mettant en oeuvre la politique industrielle appropriée à son programme et en recommandant aux Etats membres une politique industrielle cohérente.*

*L'Agence est dirigée par un Conseil, composé de représentants des Etats membres. Le Directeur général est le fonctionnaire exécutif supérieur de l'Agence et la représente dans tous ses actes.*

*Le Directoire de l'Agence est composé du Directeur général, du Directeur des Programmes futurs et des Plans, du Directeur de l'Administration, du Directeur des Programmes de satellites scientifiques et météorologique, du Directeur des Programmes de satellites de communications, du Directeur du Programme Spacelab, de l'Inspecteur technique, du Directeur de l'ESTEC et du Directeur de l'ESOC.*

*Le SIEGE de l'ESA est à Paris.*

*Les principaux Etablissements de l'ESA sont:*

*LE CENTRE EUROPEEN DE RECHERCHE ET DE TECHNOLOGIE SPATIALES (ESTEC), Noordwijk, Pays-Bas.*

*LE CENTRE EUROPEEN D'OPERATIONS SPATIALES (ESOC), Darmstadt, Allemagne.*

*LE SERVICE DE DOCUMENTATION SPATIALE (ESRIN), Frascati, Italie.*

*Président du Conseil: Dr. W. Finke (Allemagne).*

*Directeur général: M. R. Gibson.*

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c/o ESTEC, Noordwijk
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**Circulation Office**
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8-10 rue Mario Nikis
75738 Paris 15, France

**Publication Manager**
Bruce Battrick

**Editors**
Bruce Battrick
Duc Guyenne

**Assistant Editor & Layout**
Simon Vermeer

**Editorial Assistants**
Catherine Rowley
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8-10, rue Mario-Nikis
75738 PARIS 15, France

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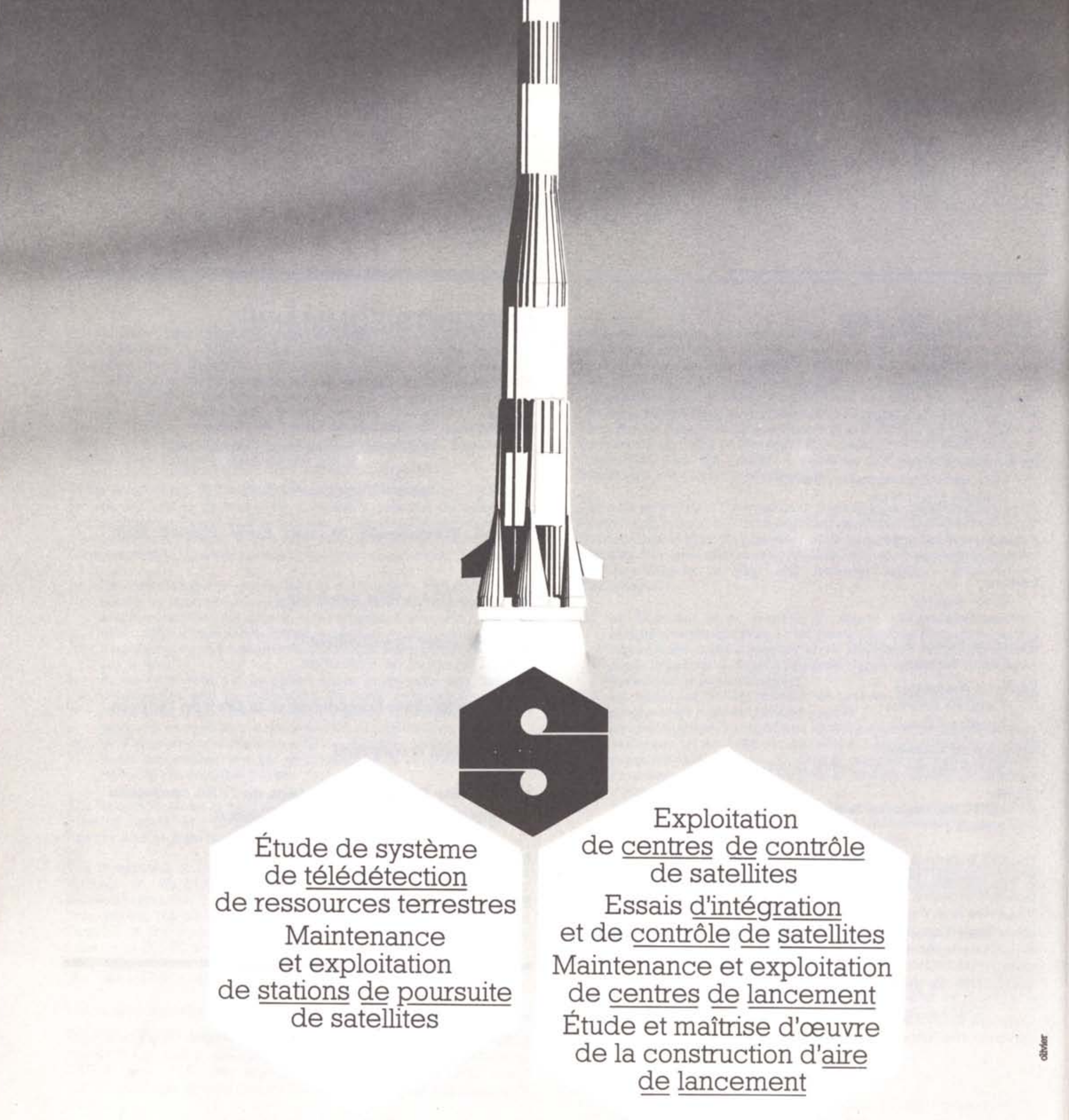
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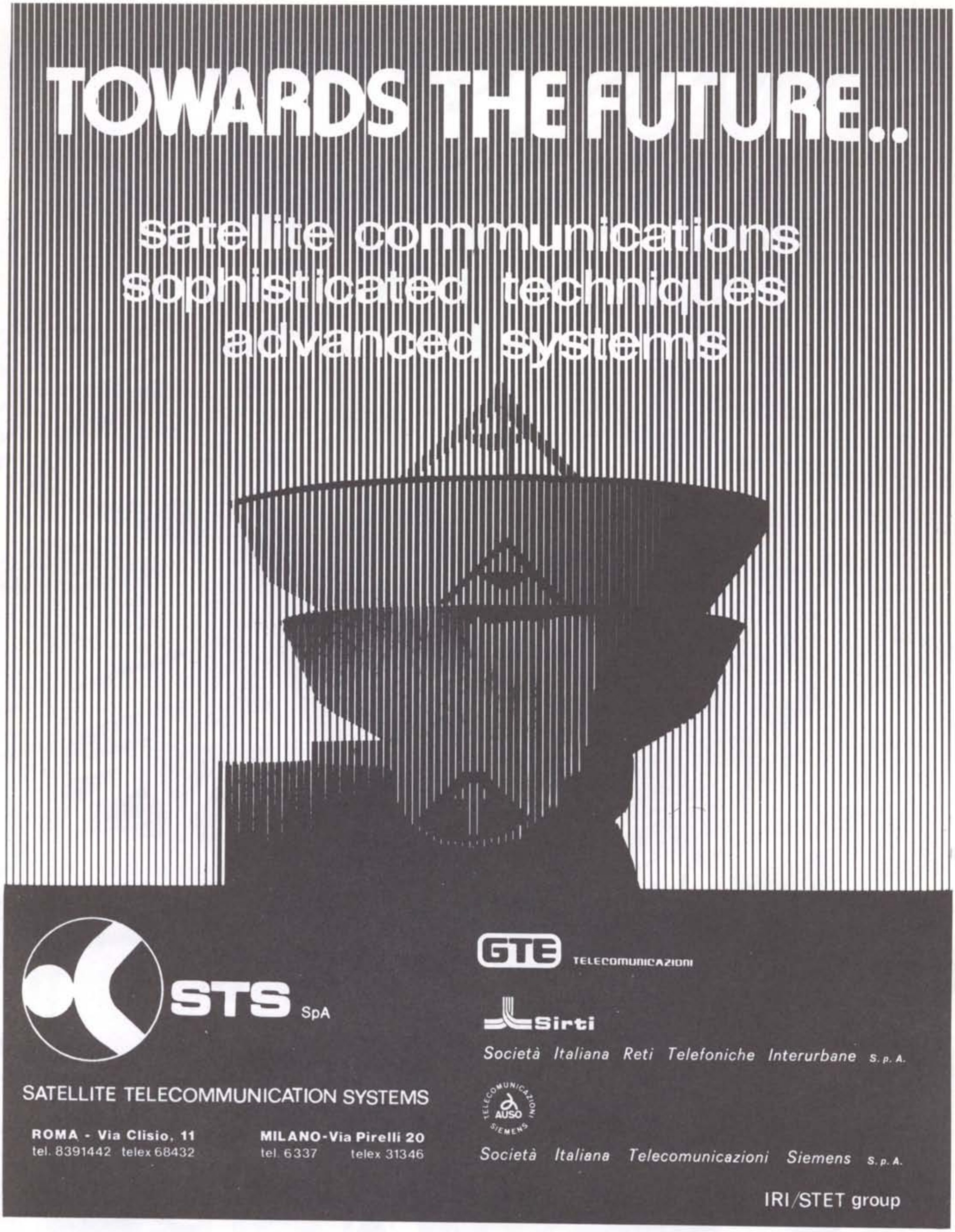
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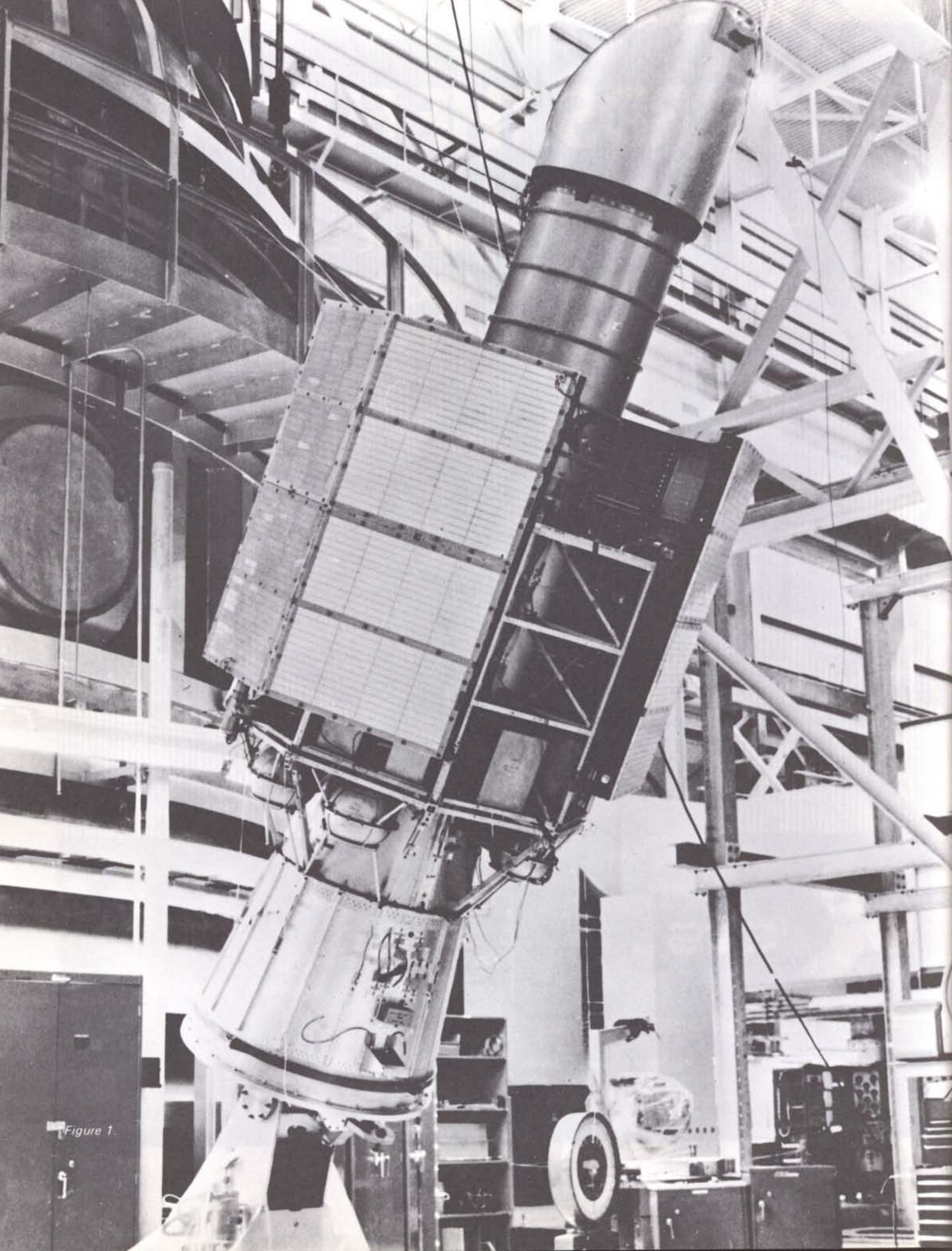


Figure 1.

# The International Ultraviolet Explorer

*F. Macchetto & M.V. Penston,*
*Space Science Department of ESA, ESTEC, Noordwijk, The Netherlands*

**With the launch of the International Ultraviolet Explorer (IUE) satellite on 26 January this year, an ambitious experiment in space astronomy has started which will bring access to a scientific space project within the reach of the general scientific community without obliging its members to have specialist knowledge of space techniques. Because IUE is in geosynchronous orbit, it is in continuous communication with ESA's ground station at Villafranca, near Madrid, and NASA's ground station at Goddard Space Flight Center during the observing shifts. The satellite can therefore be commanded and data received in real time, allowing the observer, present at the ground station, to make decisions about his observing programme as it develops in the same way as he would at a ground-based observatory. The first true space observatory, with an expected lifetime of three to five years, is therefore now in operation, and it has already begun taking data of unique scientific importance.**

The IUE satellite (Fig. 1) is a joint undertaking on the part of NASA, the United Kingdom Science Research Council (SRC) and ESA. ESA's role has been to contribute the deployable solar-cell array and to design and build, and now to operate, a ground station in Europe. In exchange for its contribution to the construction of the spacecraft and the ground exploitation facilities, Europe has been allotted eight hours of satellite observing time per day, shared equally between ESA and SRC. Until the end of March, IUE is reserved for carrying out a priority programme of scientific and technological observations. On completion of this first phase, the results will be exploited by astronomers throughout the world under scientific programmes conducted jointly by NASA, ESA and SRC.

By being in a synchronous orbit such that it can be in continuous contact with the two operations centres, at Goddard Space Flight Center and Villafranca, IUE differs conceptually from previous orbiting observatories, which communicated with ground stations only intermittently and so had to be self-contained, automated systems that acquired data while not under direct ground control. In the case of IUE, control and performance monitoring is exercised continually from the ground. The telescope field is displayed to the observer, who can identify his target star and direct the course of the observation essentially in real time. The 'observatory', therefore, consists of the ground control centre where the astronomer views the television monitors, and the optical and electronic instrumentation in orbit at synchronous altitude (Figs. 2 & 3).

Two significant scientific advantages of the synchronous orbit are that the astronomer has physical access to the observatory, whereby he can participate directly in the telescope control loop, and the observing circumstances develop at the diurnal rate so that plans and real-time decisions can be made in an effective and orderly manner. Also, the earth subtends an angle of 17° as seen by the telescope, and the area of sky available at any given time is much greater than from lower orbits or from the ground. Moreover, the region of the celestial sphere periodically occulted by the earth is also greatly reduced. As a result, in most parts of the sky, long exposures or the monitoring of variable phenomena need not be periodically interrupted because of earth occultations.

## THE SCIENTIFIC GOALS

The scientific aims of the project, unchanged since the earliest studies of its feasibility, are:
- to obtain high-resolution spectra of stars of all spectral types in order to determine their physical characteristics more precisely
- to study gas streams in and around some binary systems
- to observe faint stars, galaxies, and quasars at low resolution and to interpret these spectra by reference to high-resolution spectra
- to observe the spectra of planets and comets as these objects become accessible
- to make repeated observations of objects known or newly found to show variable spectra
- to define the modifications of starlight caused by interstellar dust and gas more precisely.

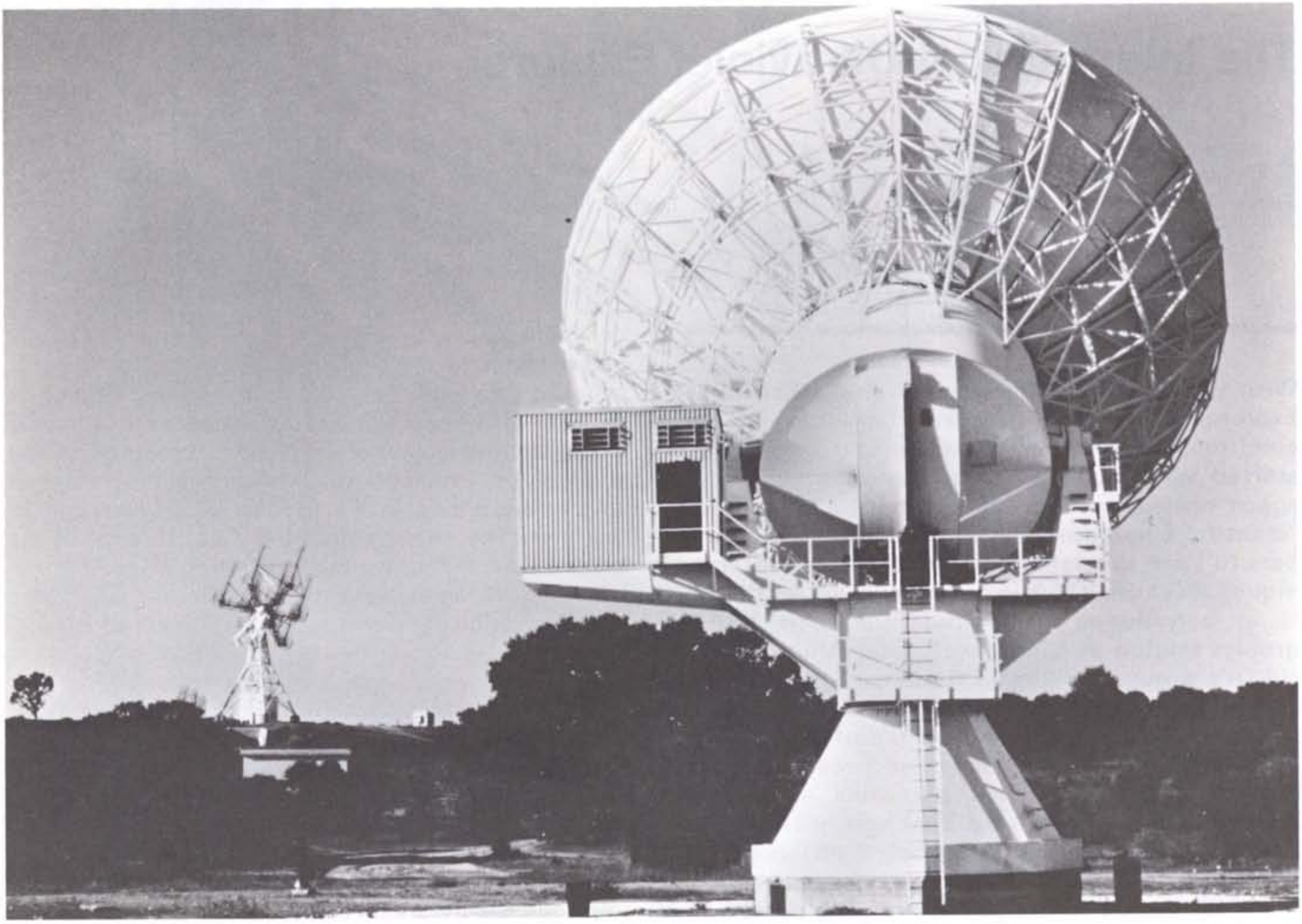


*Figure 2— Two of the antennas at ESA's IUE ground station at Villafranca, near Madrid.*

The scientific aims of IUE call for both high-resolution spectra (~0.1 Å) of bright objects and low-resolution spectra (~6 Å) of fainter objects. Determining the equivalent widths of faint lines used to measure chemical abundance, or the profiles of stronger lines used to study gas motions, requires a spectral resolution of at least 0.2 Å. Low-dispersion spectroscopy, on the other hand, serves primarily in the observation of faint sources. The observing programmes calling for this capability either do not require high resolution for analysis or they involve sources with intrinsically broad spectral features. The emphasis is placed on limiting magnitude rather than resolving power. The desire to record complete ultraviolet spectra rather than selected spectral regions dictates the use of spectrographs able to record a spectral image, rather than spectrum scanners.

## THE INSTRUMENTATION

IUE's main instrumentation comprises a 45 cm aperture telescope, and an echelle spectrograph. The latter has been selected to obtain the high-resolution spectra sought for brighter objects. With this type of instrument a high dispersion is easily achieved, and there is an additional advantage in that the format of the spectrum consists of a series of adjacent spectral orders displayed one above another in a raster-like pattern. This format makes efficient use of the sensitive area of the SEC Vidicon television tubes used to integrate and record the spectrum. Since the echelle spectrograph design contains a high-dispersion echelle grating in series with a low-dispersion grating, the instrument is easily converted into a low-resolution spectrograph by simply inserting a plane mirror in front of the echelle, leaving the low-dispersion grating to act alone.

To achieve the dispersion required in the high-resolution mode, it has been necessary to split the spectrum from 1150 to 3200 Å into two ranges, and two exposures are required to record the entire spectrum. Observing efficiency is not significantly affected, however, for the grating blaze angles and other design parameters can be optimised separately for the two spectral ranges, greatly

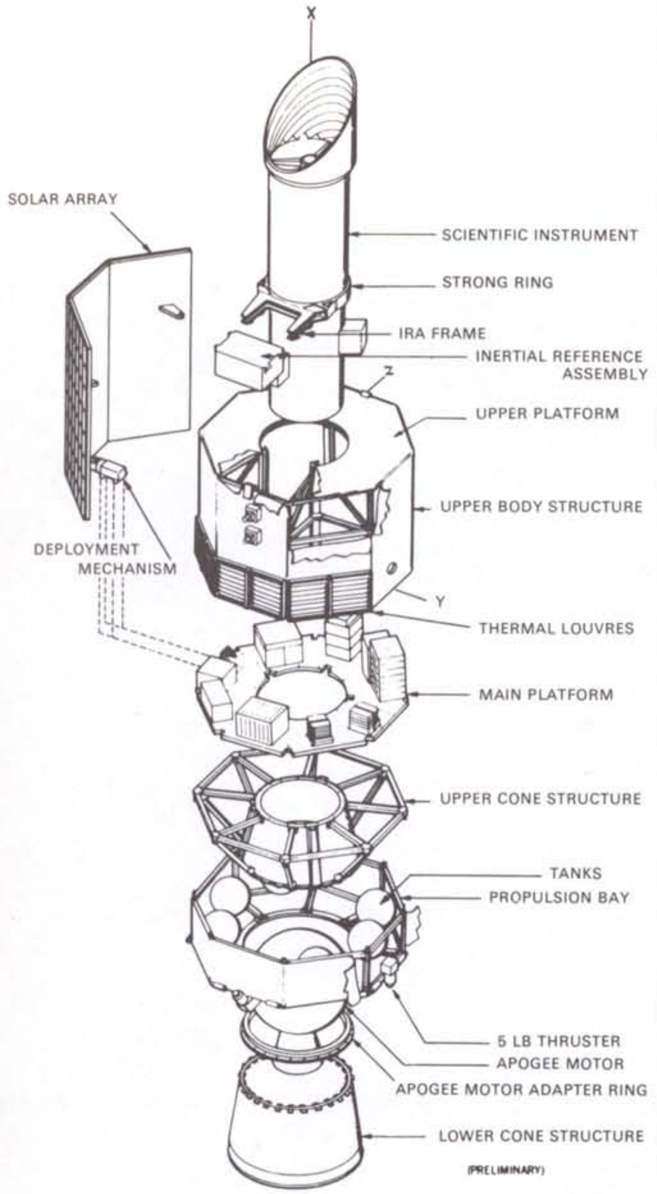



*Figure 3 — Exploded view of the IUE spacecraft.*

improving the optical efficiency. Two exposures will frequently be required in any case in order to expose both the short- and long- wavelength portions of the ultraviolet spectrum optimally. The two spectrographs are physically separate and one is selected by pointing the telescope so that the image of the target enters an aperture for that spectrograph.

A drawback of IUE's synchronous orbit is that observations must normally be made in full sunlight. Telescope baffle designs for the spacecraft were therefore carefully evaluated, both theoretically and by comparison with flight-tested designs, and it has been possible to reduce scattered sunlight to a negligible amount. Scattered earth light is more difficult to control, and the scattered light level may noticeably increase when the telescope is oriented so that earth light falls inside the telescope tube. Fortunately, the earth's spectrum contains very little energy below 3000 Å. Since the optics and detector system have been designed to be insensitive to visible wavelengths, the limiting magnitude of the spectrograph is not appreciably affected by earth light. The offset guiding system can be influenced by this light, however, and near-earth's-limb observations may be restricted to fields containing relatively bright guide stars.

The stars are identified and manoeuvred into the spectrograph slits with the aid of a fine-error sensor. This sensor can map a field of view of up to 16 arc min and transmit the information to the ground station. Once the target star has been identified on the ground and placed in the slit, the sensor is then commanded to lock on any star in the field of view brighter than about 14th magnitude. The fine error sensor, in combination with the gyro package, will maintain $\pm 1$ arc sec guidance for as long as required. It only provides guidance information about the pitch and yaw axes. Control of roll about the optical axis of the telescope is much less critical and can be maintained adequately by the roll gyro, with occasional updates from a sensor that monitors sun position to within about 1 arc min.

Since the SEC Vidicon equipment has a storage capability, it is used to integrate an extended exposure and retain the image until it is read out directly into the telemetry system and processed by the ground data computer. No intermediate buffering or storage on board the spacecraft is used. Prior to each exposure, the Vidicon target is 'cleaned' of all traces of prior exposures by exposing the tube to an incandescent floodlamp, which uniformly irradiates the face plate, and then calling for a readout, which removes nearly all charge from the target. Exposures are shuttered by turning the camera high voltage on and off.

Experience shows that it is possible to obtain high-dispersion spectra of hot stars as faint as magnitude 9 and low-dispersion spectra of the brightest quasars and active galaxies at least to the 13th magnitude.

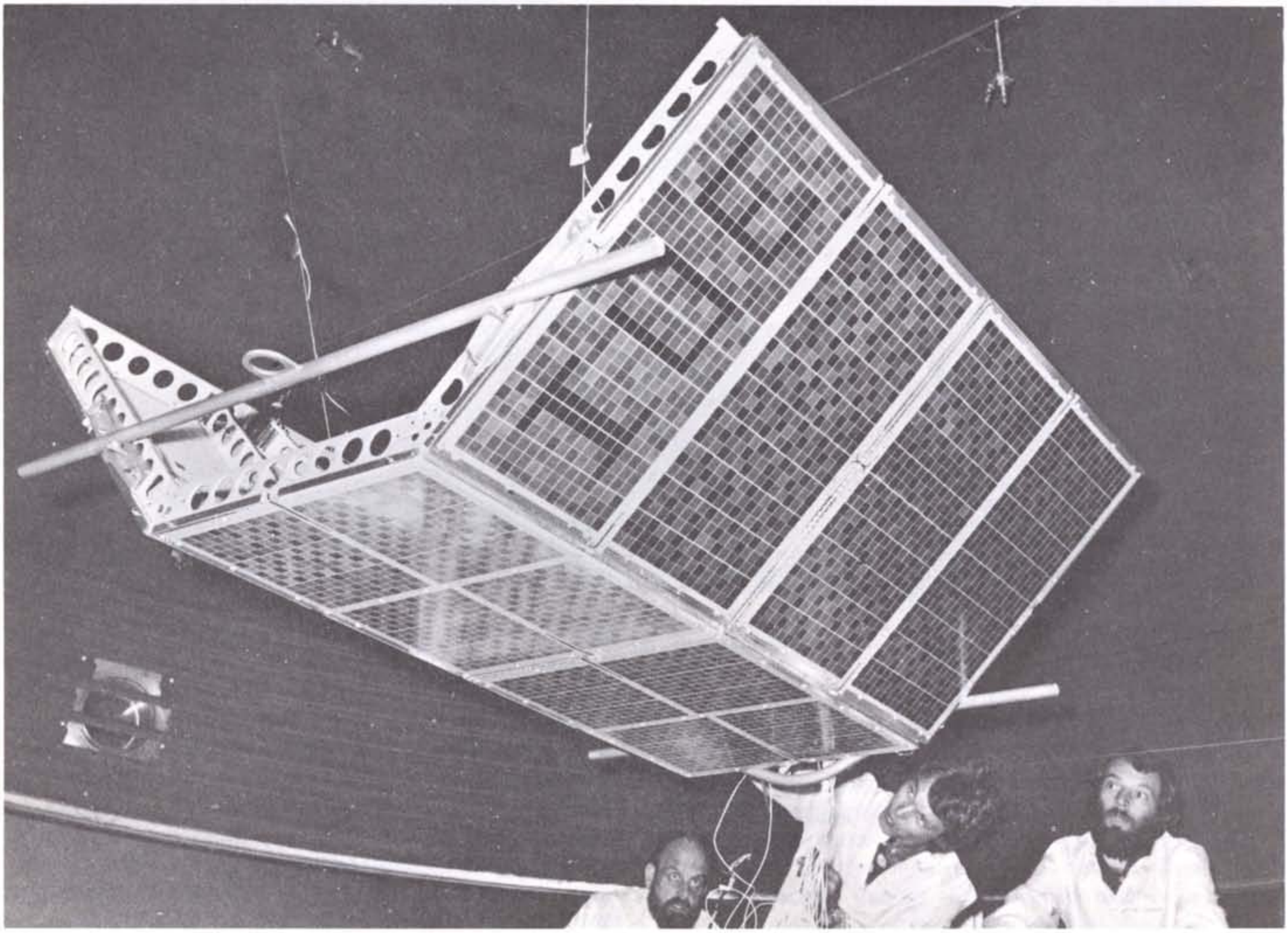


*Figure 4 — One of IUE's solar panels being prepared for a vacuum-chamber test at ESTEC.*

## THE SPACECRAFT

The IUE spacecraft's overall length, from the hood over the telescope, which serves to baffle sunlight, to the exhaust of the apogee boost motor, is 4.22 m. Its body diameter, excluding the solar paddles, is 1.42 m. The spacecraft's total weight, including the apogee motor, the scientific instrument and the spacecraft systems, is 668 kg (Fig. 3).

In addition to the telescope and its instrumentation, the spacecraft body houses three principal subsystems which provide power, stabilisation and control, and communications and data handling.

The power source, contributed by ESA, is the solar array which energises IUE directly when it is in sunlight and also charges the batteries that provide power whilst it is in shadow (Fig. 4). These daily eclipses, which last a maximum of 1 hour, occur at approximately six-monthly intervals. The solar paddles are fixed relative to the spacecraft's body, but the fact that their surface is convex towards the sun allows them to generate over 400 W of power for a wide range of spacecraft orientations.

IUE's stabilisation and control subsystem consists of a set of reaction wheels, which slew the spacecraft or stabilise it while pointing at a star, and a set of gyroscopes, which control the slews and pointing. Slews are executed sequentially about one axis at a time at a rate of 4-5°/min, and the positional error at the end of a slew sequence is less than 2 arc min. The momentum wheels slowly accumulate angular momentum due to external torques on the spacecraft and due to noise in the wheels themselves, and this excess energy must occasionally be dumped by firing small hydrazine jets. Angular momentum dumps are initiated manually when necessary. The amount of hydrazine on board ultimately limits the useful lifetime of the spacecraft, which had a five-year supply when launched. Fine guidance, to an accuracy of 1 arc sec, is achieved by use of the fine error sensor looking at an off-axis star in the telescope field. With guide stars brighter than magnitude 12, the star tracker controls the momentum wheels directly. When fainter stars must be used, direct control comes from the gyros, which are periodically updated with information from the star tracker. Guide stars as faint as magnitude 14 can be used with this mode of operation.

The communications and data-handling subsystem accepts commands from the ground and transmits scientific data, pointing information, and engineering status. This subsystem also contains the spacecraft computer, which is used for performing attitude-control calculations and some other functions whose timing is too critical to be subject to the reliability of the ground data link. The spacecraft can accept ground commands at 1200 bit/s through a VHF receiver. Data is sent to the ground via an S-band transmitter operating at 40 000 bit/s.

## THE OBSERVATIONAL ROUTINE

To ensure that the observers visiting the ground stations are able to make maximum use of the satellite observing time available to them, a small group of 'resident astronomers' will be available to provide assistance and to guide and train visiting scientists, many of whom are expected to be astronomers from universities, conventional observatories and other institutes.

During his shift, the observer will direct the activities of the spacecraft- and scientific-instrument operators and a data-reduction specialist. An observing sequence will start with the observer requesting that the telescope be slewed to the co-ordinates of his first target. After the slews have been accomplished, a fine-error-sensor image will be commanded, resulting in a display on the television monitor of the positions of all stars brighter than a predetermined magnitude. The observer can then compare this display with a finder chart, identify his target star, and designate a suitable guide star.

When the target image is in the correct aperture, the spectrograph camera high voltage will be commanded 'on' to start the exposure. During exposure, the guidance quality will be monitored on the ground by examining the signal from the fine-error sensor. At the end of the exposure, the tube high voltage will be turned off, and the camera commanded to read out the image. The telescope may be held on target until the observer has had an opportunity to examine the data. About three minutes after the end of the exposure, the raw spectrum from the television camera can be displayed on a television monitor to see if the observation should be repeated or if the subsequent observing schedule should be modified in some way. When the observer determines that useful data have been obtained, the spectral image will be stored for full processing and the observing session will continue.

Routine data processing, defined as those calculations that require special knowledge of IUE but that do not require astronomical interpretation of the data, will be done by the observatory staff. These tasks include noise and distortion removal, wavelength determination to an accuracy comparable with the spectral resolution, and photometric calibrations.

## PRELIMINARY RESULTS

At the time of writing (late February), a thorough scientific and engineering commissioning of the satellite is in progress and the first guest observers are expected in

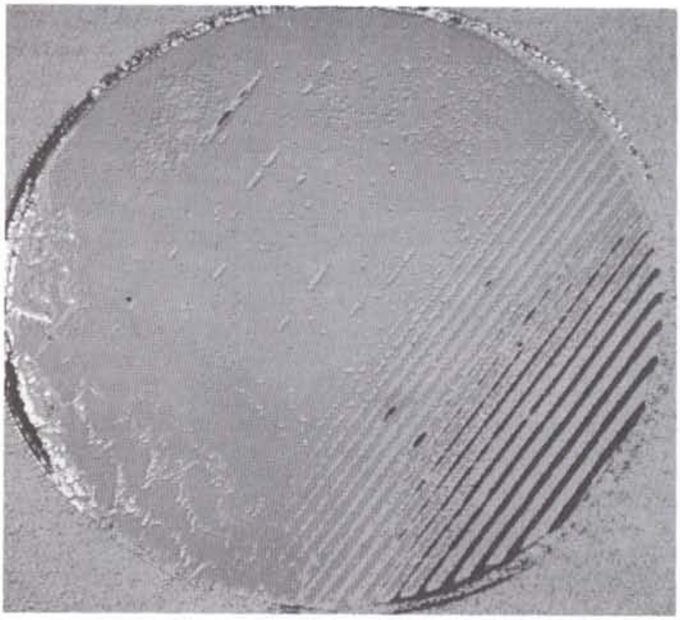


*Figure 5 — Short-wavelength echelle spectrum of the cool star Capella.*

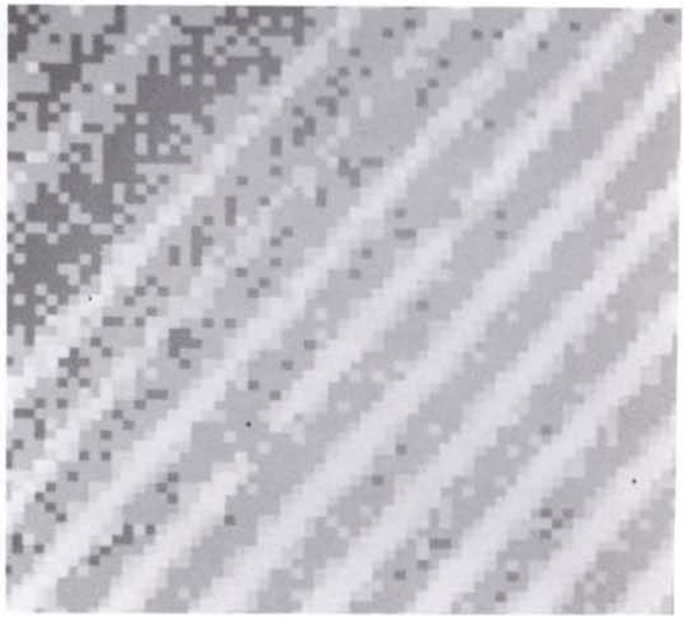


*Figure 6 — Part spectrum of the star Zeta Ophiuchi, showing the resolution of interstellar lines.*

early April. Already, however, an exciting body of new information about the ultraviolet spectra of astronomical objects has been obtained, following a preliminary sensitivity calibration using two standard stars.

A spectrum of the cool star Capella (Fig. 5) has been recorded at high dispersion showing many new emission lines from the outer, hotter parts of the star's atmosphere. The quality of the data is the best yet obtained for study of the outer regions of cool stars, with the exception of the sun.

Similarly new exciting data has been obtained on an unusual hot star, BD +75° 325, showing many new spectral features which will be used to estimate the carbon and nitrogen abundances in this star and to obtain a better understanding of its evolution to its present state.

In the field of extragalactic astronomy, an active galaxy NGC 4151 has been observed. In this object, which closely resembles the enigmatic quasars and for which no ultraviolet results were previously available, many new emission and absorption lines can be seen which will help us understand the behaviour of gas around the active nucleus.

Spectra of the x-ray emitting star HD 153919 have also been obtained which similarly show emission features which will be analysed to study the gas streams around the object under the heating effects of the x-ray flux.

Excellent data on the composition and velocity of the gas between the stars will be deduced from the spectrum obtained from the star Zeta Ophiuchi (Fig. 6). This star lies behind a cloud of interstellar gas and its spectrum shows numerous absorption lines caused by atoms in the cloud.

Finally, observations of the planet Mars show several absorption features in addition to those present in the light of the sun and IUE will therefore be useful for measuring atmospheric composition for this planet.

Clearly, with the results of these observations as a mere foretaste of what is to come from IUE, astronomers are on the verge of an exciting few years in ultraviolet astronomy. □

# Meteosat – An Historical Note from the World Meteorological Organisation

*Extract from a statement made by Mr. David Arthur Davies, Secretary-General of the World Meteorological Organisation (WMO) to the Commission for Science and Technology of the Council of Europe, in Geneva, on 11 September 1967.*

D.A. Davies, Secretary General, World Meteorological Organisation.

... In the domain of outer space, ... all the effort so far has been left to the United States and the Soviet Union, and these two countries have exploited meteorological satellite programmes very profitably. The whole world has benefited from the results obtained and the activity of these two countries in this field constitutes an essential contribution to the implementation of the World Weather Watch.

The WMO still hopes that other countries will play a part in this major undertaking. In fact, the approved plan expressly foresees that 'the WMO should contribute to the development of the co-ordination of the satellite programmes undertaken by different countries or groups of countries'.

It is clear that for several years to come very few countries or groups of countries will have the scientific competence and scientific and technical knowhow necessary to participate in a meteorological satellite programme. In this respect, a particular responsibility falls upon the European countries.

Permit me, at this stage, to make a personal remark: I have always been surprised that the joint efforts of European countries in space activities have not been oriented towards a meteorological programme. It seems to me that such a programme contains all the appropriate elements to make it both attractive and fruitful. It would bring immediate practical advantages and would provide interesting data of scientific interest. These advantages would accrue not only to the European countries, but also to many others. For example, if a geosynchronous meteorological satellite were to be placed in orbit above Africa, over the equator, it would provide highly significant information not only on Europe, but also on the whole African continent and would, in a certain sense, constitute a form of indirect technical assistance to the developing countries of this region.

The cost of a programme of this kind would, I believe, be comparatively modest, if one considers the scale of other space enterprises. Last – and this would by no means be the least of the merits – the European countries would also be making a meaningful contribution to the achievement of the World Meteorological Organisation's plan, with the design and setting up of which they have been fully associated prior to approving it unanimously. ... □

# Météosat – Rappel historique par l'Organisation météorologique mondiale

*Extrait de l'allocution prononcée par Monsieur David Arthur Davies, Secrétaire général de l'Organisation météorologique mondiale (OMM), à la Commission de la science et de la technologie de l'Assemblée du Conseil de l'Europe à Genève, le 11 septembre 1967.*

... Dans le domaine de l'espace extra-atmosphérique, ... tout l'effort a été laissé jusqu'ici à la charge des Etats-Unis et de l'Union soviétique, et ces deux pays ont mis en exploitation des programmes de satellites météorologiques très fructueux. Le monde entier tire bénéfice des résultats obtenus et l'activité de ces deux pays en la matière constitue une contribution essentielle à la mise en oeuvre de la Veille météorologique mondiale.

L'OMM espère toutefois que d'autres pays assumeront leur part de cette importante responsabilité. De fait, le plan approuvé prévoit expressément que 'l'OMM devrait contribuer à réaliser la coordination des programmes de satellites entrepris par différents pays ou par des groupes de pays'.

Il est clair que durant de nombreuses années encore très peu de pays ou groupes de pays auront la compétence scientifique et le savoir-faire scientifique et technique nécessaires pour participer à un programme de satellites météorologiques. A cet égard, une responsabilité particulière incombe donc aux pays européens.

Permettez-moi, à ce stade, de formuler une remarque personnelle: je me suis toujours étonné de ce que les efforts conjugués des pays européens dans le domaine de l'espace ne se soient pas orientés vers un programme météorologique. Il me semble qu'un tel programme comporte tous les éléments propres à le rendre attrayant et fructueux. Il apporterait des avantages pratiques immédiats et fournirait des données intéressantes aux fins de la recherche scientifique. Ces avantages seraient recueillis non seulement par les pays européens mais également par de nombreux autres. Par exemple, si un satellite météorologique synchrone de la terre était mis en orbite au-dessus

*D.A. Davies, Secrétaire général, l'Organisation météorologique mondiale.*

de l'Afrique, à hauteur de l'équateur, il fournirait des renseignements extrêmement importants non seulement sur l'Europe mais aussi sur l'ensemble du continent africain et constituerait, en un certain sens, une forme d'assistance technique indirecte aux pays en voie de développement dans cette région.

Le coût d'un programme de ce genre serait, je crois relativement modeste, si on le considère à l'échelle des entreprises spatiales. Enfin, et ce ne serait pas là leur moindre mérite, les pays européens contribueraient ainsi de façon importante à la réalisation du plan de la Veille météorologique mondiale à la conception et à l'établissement duquel ils ont été pleinement associés avant de l'approuver unanimement. ... □

# The In-Orbit Performance of, and Early Results from Meteosat

C. Honvault, Project Manager Meteosat Ground Segment, Meteorological Programmes Department, ESA, Toulouse

**Since its launch from Cape Canaveral in the early hours of 23 November and its subsequent injection into geostationary orbit over the Gulf of Guinea, Meteosat has more than lived up to expectations by providing excellent images in both the visible and infrared bands, and acceptable quality from its water-vapour channel. The first data, including photographs and images on computer tapes, have already been delivered to the meteorological services of ESA's Member States, and the spacecraft has begun fulfilling its role as an essential component of the World Weather Watch (WWW) programme of the World Meteorological Office, and the First GARP Global Experiment (FGGE).**

Meteosat-1 is in a geostationary orbit with an altitude of 35 790 km and an inclination of 0.23°, which maintains the spacecraft over the Gulf of Guinea. It makes a daily excursion to the north and south of the equator of about 0.23°, and has an east-west drift of less than 0.005° per day, which is corrected when necessary by firing the spacecraft's hydrazine thrusters to maintain station within ±1° of longitude.

It is this 'fixed' location with respect to the earth that allows Meteosat to fulfil its three main mission objectives, namely

1. to image the earth's surface and cloud cover simultaneously in three spectral bands at half-hourly intervals
2. to disseminate image and other data from the Ground Facility for Meteosat (GFM), via the satellite, to remote Primary and Secondary Data User Stations (PDUS and SDUS)
3. to collect environmental data measured locally by remote, automatic or semi-automatic Data-Collection Platforms (DCPs).

Although means and mechanisms for achieving these three prime objectives were described at some length in ESA Bulletin No. 11, devoted to Meteosat at the time of launch, it is perhaps worthwhile just recapitulating the salient features of the imaging process, data extraction and data dissemination and collection processes briefly here, for those readers not yet familiar with the system, before going on to report the early operational results.

*Imaging Mission*
The principle payload of the satellite is the telescope radiometer which scans the earth from east to west by virtue of Meteosat's spin and is stepped once in each spin period to move the line of scan from south to north across the earth's disc.

The radiometer contains:
- two visible channels (VIS) in the 0.4–1.1 μm spectral band
- one infrared (IR) channel in the 10.5–12.5 μm band (plus an additional, redundant, IR sensor)
- one infrared water-vapour (WV) channel, working in the range of the water-vapour absorption band (5.7–7.1 μm) and operating in a time-sharing mode with one of the two visible channels.

The image data are received initially at the Ground Facility (GFM) and pre-processed before utilisation, archiving or distribution to users. Examples of images taken in the three spectral channels are shown in Figures 1–3, produced by a laser-beam recorder at the GFM.

*Data Extraction*
The raw image data is used within the GFM for the extraction of meteorological parameters. The full system is not yet complete, but the intention is to extract such information as cloud-motion vectors (winds), sea-surface temperatures, cloud-top heights and radiation-balance data, as well as objective analyses of cloud and water-vapour distributions.

The temperatures needed at cloud height and at sea level are obtained by use of the IR 'window' channel radiance, with corrections for atmospheric attenuation obtained from the 'water-vapour' channel and from meteorological data obtained from conventional sources. The predicted accuracies are 1°C for sea temperatures and 3°C for cloud-top temperatures. The vertical resolution for cloud heights is 1500 m and is calculated with a horizontal resolution of 4 IR pixels (instantaneous fields of view) to give a ground resolution of about 20 km.


*Figure 1 – Image from Meteosat's visible channel at 11.55 GMT on 3 February.*


*Figure 2. – Image from Meteosat's infrared channel at 11.55 GMT on 3 February.*

The extraction of all other parameters forms part of a fully integrated scheme based on the processing of segments consisting of 32 × 32 IR pixels, leading to a ground resolution of about 150 km at the subsatellite point, increasing to about 250 km at a 50° (earth-centred) radius, the probable limit for objective use of the image data. Wind vectors are extracted by using small clouds as tracers, the displacements of which over three successive images are calculated by correlation methods based mainly on the IR data. The three images are known as a triplet, and calculations are repeated for both adjacent pairs. This yields two estimates for each wind tracer and this duplication is used as a fundamental quality control element before combining the two estimates to give the final product. The results of this processing have not yet been analysed, but the objective is an accuracy of 3 m/s for winds determined at up to three levels in each segment, and the Meteosat-1 orbital parameters are so good there is every reason to suppose that the results will prove to be entirely acceptable.

*Dissemination of Data*

The second mission objective is the dissemination of Meteosat images, and other meteorological data, to the meteorological community. For this purpose the satellite is being used to relay data from the GFM to data users operating either a Primary or Secondary Data User Station (PDUS or SDUS). The PDUS provides for reception of digital transmissions of the full earth disc as shown in Figures 1–3 and of the European sector as a separate and more frequent transmission. The SDUS is used to receive analogue transmissions in standard WEFAX form, in which the full image is sectorised into a variety of formats within the GFM before transmission, and grid data are added.

Also included in the dissemination mission is the relay of images produced by the American GOES satellite system. These are received by the Centre of Space Meteorology (CMS) in Lannion, France and sectorised before transmission to PDUS and SDUS users via Meteosat.

This space dissemination programme was tested within two weeks of Meteosat's launch and routine transmissions have been made daily since then, with the operational programme amounting to some 24 digital and over 180 WEFAX transmissions each day by the end of February. They are received regularly by a growing spectrum of users, there being at least 20 SDUSs in Europe alone, with 4 PDUSs either in operation or under final construction.

The transmission schedule is not yet fully implemented, but when complete it will include the relay of other meteorological data, including maps of cloud-top heights obtained from the image data, as well as meteorological charts obtained from Area Forecast Centres (AFC) via a landline link with Offenbach in Germany.

The dissemination mission will be completed by the introduction of meteorological products into the WMO Global Telecommunications System (GTS), again via


*Figure 3. – Image from Meteosat's water-vapour channel at 11.55 GMT on 3 February.*

Offenbach, for use in near real time by applied meteorologists.

*Data Collection*

The final mission objective is related to the acquisition of environmental data by remote Data-Collection Platforms (DCPs), either installed at fixed sites on land, or mounted on ships, buoys, balloons or aircraft. These data will be relayed via Meteosat to the GFM, where they will be pre-processed and distributed to the DCP operators and to other interested parties. The relevant spacecraft subsystem has been tested successfully and provides for 66 telecommunications channels, 33 of which will be for regional use, i.e. for DCPs operating exclusively within the Meteosat system. The other channels will be used for international DCPs, i.e. mainly for those platforms that move from the field of view of one geostationary satellite to that of another.

Four types of DCP are currently being tested or developed for regional use, and the 'international' class of platform is represented by the ASDAR prototype, with which trials are already in progress. The ASDAR system consists of a telecommunications package linked to the in-flight computers of wide-bodied commercial aircraft so that meteorological parameters available to these computers can be relayed via the satellite network of which Meteosat forms a part. Four ASDAR DCPs are expected to be in operation by mid-1978, and some 20 by mid-1979.

## OPERATIONS

The three missions described – data extraction from imagery, dissemination, and data collection – are implemented by the operators in the Meteosat Control Centre (Darmstadt). Day and night, some six operators perform meteorological credibility analyses, detect image deformations, follow up the dissemination and the data collection, pilot the satellite, and monitor the remotely controlled telemetry receiving station. These six operators are helped in their task by interactive keyboards and displays driven by the large Meteosat ground computer system, thus combining the flexibility and speed of a large computing capability with the indispensable ingredient of human judgment.

## EARLY RESULTS

Because the spacecraft has been placed into an orbit well within the specified parameters, it provides a stable platform for the primary task of imaging, with consequent beneficial results on the entire system. The radiometer has lived up to its promise and is providing excellent pictures in both the visible and infrared channels. The water-vapour pictures are affected to a certain degree by interference of some kind, but they are still of usable quality, as witnessed by Figure 3. Considerable progress has been made in reducing the worst effects and it seems likely that the residual noise can be filtered out during the ground pre-processing. Apart from this, image quality is good and it is being monitored and analysed in depth to confirm the performance specifications.

Initial data, including image photographs and images on computer tapes, have been delivered to users for a more detailed scientific appraisal. There is no doubt that the images will constitute a welcome tool for a great variety of research tasks and operational applications within the meteorological community. The Meteosat data have already been greeted with enthusiasm by research worker and applied meteorologist alike, particular interest being shown in the water-vapour channel.

The early pictures make it clear that this channel, unique to Meteosat in the geostationary satellite network, will provide new information for all scales of meteorological

TABLE 1

*Scheduled Disseminations of High-Resolution and WEFAX Images in 1978*

| DATE | CMS LANNION CH1 | | CH2 | MGCS DARMSTADT CH1 | | CH2 | TOTAL | |
|---|---|---|---|---|---|---|---|---|
| | HR | WF | WF | HR | WF | WF | HR | WF |
| 1/1-9/1 | 8 | 48 | 15 | – | 6 | 63 | 8 | 132 |
| 10/1-19/1 | 8 | 48 | 15 | 3 | 6 | 43 | 11 | 112 |
| 20/1-22/1 | 8 | 48 | 15 | 17 | 5 | 73 | 25 | 141 |
| 23/1 | 8 | 48 | 15 | 13 | 5 | 42 | 21 | 110 |
| 24/1-29/1 | 8 | 48 | 15 | 31 | 7 | 97 | 39 | 167 |
| 30/1-31/1 | 8 | 48 | 15 | 29 | 7 | 92 | 37 | 162 |
| 1/2-2/2 | 8 | 48 | 15 | 12 | 63 | 78 | 20 | 204 |
| 9/2-26/2 | 8 | 48 | 15 | 19 | 63 | 78 | 27 | 204 |
| 27/2-F.O. | 7 | 48 | 13 | 10 | 56 | 81 | 17 | 200 |

*Meteosat Dissemination from MGCS (Darmstadt)*

| DATE | SCHEDULED DISSEMINATION | FAILED DISSEMINATION | SUCCESSFUL DISSEMINATION | SUCCESS IN PERCENT |
|---|---|---|---|---|
| 1/2 | 152 | 101 | 51 | 33.5 |
| 2/2 | 173 | 54 | 119 | 68.7 |
| 3/2 | 152 | 30 | 122 | 80.2 |
| 4/2 | 152 | 35 | 117 | 76.9 |
| 5/2 | 152 | 50 | 102 | 67.1 |
| 6/2 | 152 | 43 | 109 | 71.7 |
| 7/2 | 152 | 65 | 87 | 57.2 |
| 8/2 | 152 | 46 | 106 | 69.7 |
| 9/2 | 171 | 47 | 124 | 72.5 |
| 10/2 | 159 | 44 | 115 | 72.3 |
| 11/2 | 159 | 51 | 108 | 67.9 |
| 12/2 | 159 | 45 | 114 | 71.6 |
| 13/2 | 159 | 69 | 90 | 56.6 |
| 14/2 | 159 | 37 | 122 | 76.7 |
| 15/2 | 159 | 19 | 140 | 88 |
| 16/2 | 159 | 100 | 59 | 37.1 |
| 17/2 | 159 | 19 | 140 | 88 |
| 18/2 | 159 | 17 | 142 | 89.3 |
| 19/2 | 159 | 29 | 132 | 81.7 |
| 20/2 | 159 | 13 | 146 | 91.8 |

phenomena, ranging from global events down to the presence of water-vapour 'clouds' which have already been identified. It should also provide meteorologists with the opportunity to use water vapour as a wind tracer. Frontal structures and jet streams are readily identifiable on the water-vapour images, and the distribution of water vapour seen in this way must give meteorologists fresh insight into the behaviour of the atmosphere as a whole.

Meteorologists are already familiar with the type of image data produced by the visible and infrared 'window' channels, and these data are now in daily use as an additional working tool for the applied meteorologist.

All subsystems, including radiometer power supplies, propulsion jets and the dissemination and DCP transponders have been tested and shown to work. The dissemination of Meteosat and GOES images is well under way (see Table 1) and it appears that Meteosat-1 is in very good shape and heading for a long and successful mission. □

# Choosing ESA's First Astronaut

*D.J. Shapland, Spacelab Directorate, ESA, Paris*
*J. de Waard, SPICE, Porz-Wahn, Germany*
*G. Nichols, Personnel Department, ESA, Paris*

**The development of Spacelab, with European funds, for NASA's advanced Space Transportation System (STS) provides ESA's Member States with their first opportunity to participate in a manned space venture. The European member of the first Shuttle-Spacelab crew will be a payload specialist. He, together with an American colleague, will be responsible for the on-board operation of some 70 experiments to be flown on the first Spacelab mission. The seven-day flight will take place at the end of 1980, but the selection and training process has already begun and four persons have been chosen as potential European payload specialists. In mid-1978 this number will be reduced to three, who will be suitably trained in the operation of the experiments. Some months before the flight, the payload specialist to fly will be designated, the other two acting as back-ups and, if not required for the flight, participating in the mission from the payload operations centre on the ground.**

The first flight of Spacelab will take place in December 1980, when it will be taken into a 250 km, 57° orbit by the Space Shuttle's Orbiter vehicle. The Spacelab payload for this flight consists of the Verification Flight Instrumentation (VFI) and an experiment payload generally referred to as the First Spacelab Payload, or FSLP. The former has been developed to verify Spacelab's performance, whereas the latter represents a group of experiments selected to satisfy mission objectives jointly agreed by ESA and NASA, and to demonstrate that valuable data may be obtained in a number of diverse scientific and applications fields. The Spacelab and Orbiter resources will be shared equally between the separate ESA and NASA complements of FSLP.

The Spacelab configuration for its first flight will consist of a long module plus one pallet segment. The module will provide a working laboratory for the two payload specialists (one European and one American) who will operate the FSLP experiments – within the module itself and (remotely) those on the pallet. They will work on a shift basis, spending about 10 hours of each day in the laboratory and their off-duty hours in the Orbiter cabin. The experiments on-board the Spacelab for its first flight will provide data in the fields of Atmospheric Physics, Solar Physics, Plasma Physics, Astronomy, Earth Observations, Material Science and Life Sciences. The last of these includes measurements to be made with an ESA-developed facility – the Space Sled – which exerts low acceleration forces on the human body in a gravity-free field in order to study vestibular reactions. The total FSLP payload will weigh about 2800 kg, consume some 120 kilowatt hours of electrical energy, and will have approximately 100 man-hours of payload specialist time devoted to it. The experiments originate from ESA Member States, the USA, Japan and India.

## SELECTION CRITERIA

In September 1977, 53 candidates for the ESA payload specialist on FSLP were nominated by ESA Member States and ESA itself (Table 1). These residual candidates

TABLE 1

*Spacelab Payload Specialist Candidates Proposed to ESA – Geographical Distribution*

| Origin | Number Proposed |
|---|---|
| Austria | 5 |
| Belgium | 5 |
| Denmark | 1 |
| France | 5 |
| Germany | 5 |
| Ireland | 2 |
| Italy | 5 |
| Netherlands | 5 |
| Spain | 4 |
| Sweden | 2 |
| Switzerland | 5 |
| United Kingdom | 5 |
| ESA | 4 |
| TOTAL | 53 |

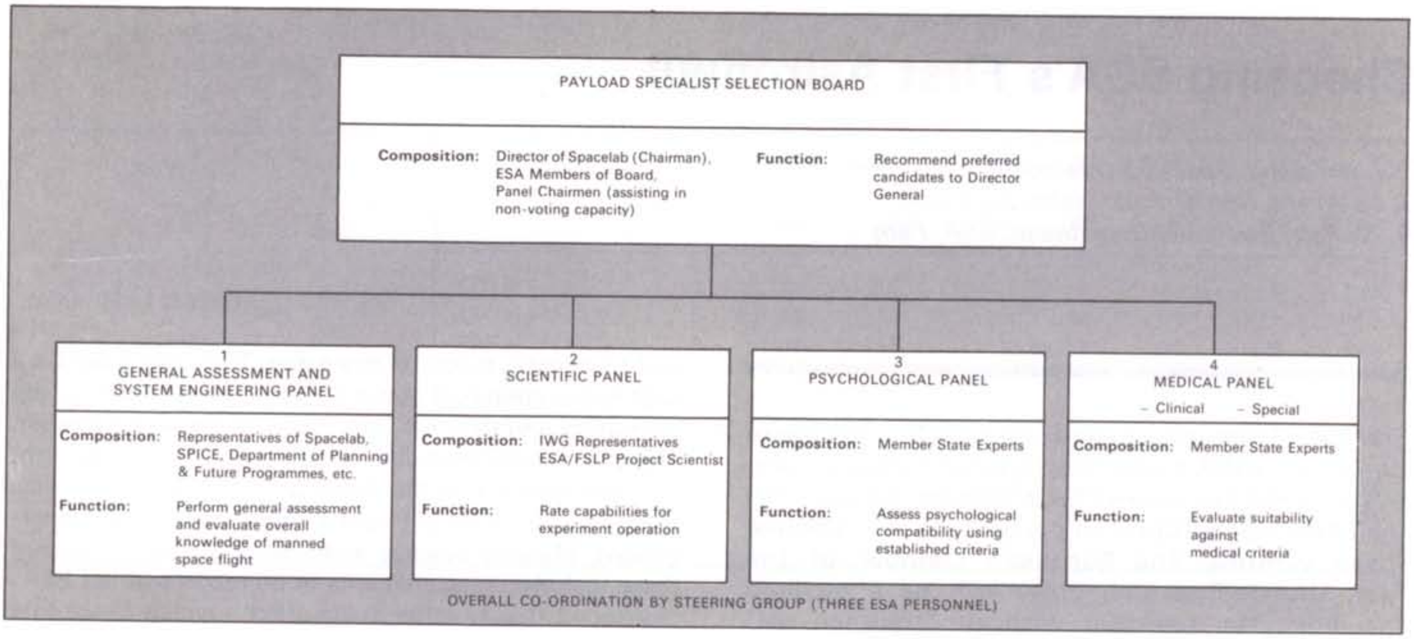



*Figure 1 – ESA organisation for Spacelab payload-specialist selection.*

resulted from over 2000 original applications, in response to an 'Announcement of Opportunity' (AO) issued by ESA in March 1977. The AO provided a description of the roles foreseen for the payload specialists, the planned ESA selection scheme, and the professional, psychological and medical criteria to be used. The method of arriving at a response to the AO was left entirely to the Member State, which was then fully aware of the techniques to be adopted later by ESA. A limit of five candidates per Member State was suggested.

The psychological and medical criteria were established by experts from ESA Member States. These were of a somewhat higher standard than will be applied for later missions – to ensure that the crew for the first Spacelab flight were comfortably within the limits of acceptability – and were fully consistent with the NASA requirements. The professional criteria were set up by ESA in co-operation with the scientists who have experiments in the first Spacelab payload. In summary, these criteria reflect the need for a payload specialist to be not older than 47 years, between 150 and 190 cm in height, in good health, emotionally stable and of high scientific/engineering ability. It should be stressed, however, that Spacelab is being developed for normally-fit scientists rather than super-fit astronauts.

*Figure 2 — Science Panel interviewing a payload-specialist candidate (left).*

## SELECTION PROCEDURE

The selection procedure followed, as closely as practicable, the normal ESA routine for the selection of personnel. The various activities were carried out under the auspices of a Selection Board which was supported by four specialist Panels. The composition and functions of the Panels and Board are summarised in Figure 1. The Chairmen of the Panels were:

*Figure 3 – A memory test being performed at DFVLR, Hamburg, under the wary eye of Dr. Goeters.*

*Panel 1: Prof. Trella (ESA)*
*Panel 2: Dr. Von Baumgarten (Germany)*
*Panel 3: Dr. Goeters (Germany)*
*Panel 4: Colonel Bande (Belgium)*

The work of the Panels was sequenced (1 through 4) so that the higher cost activities were performed with smaller numbers of candidates. Panel 1 was composed of senior ESA personnel experienced in many fields of technology. After interviewing all 53 candidates, this Panel recommended that 26 of them be retained. Panel 2 consisted of representatives of the Investigators Working Group (IWG), which is composed of all the experimenters associated with the European and American portions of FSLP. This Panel interviewed the 26 candidates from Panel 1 and recommended that 12 should proceed to the psychological and medical tests. An analysis of the clinical test results indicated that 11 should continue with the special medical tests. Finally the Board, under the chairmanship of the Director of Spacelab (M. Bignier), recommended four preferred candidates to the Director General for approval. These four persons were presented to the news media at a press conference in Paris on 22 December 1977. A final choice of the three men to undergo a joint ESA/NASA training plan will be made in May 1980, after further evaluation and interviews.

## CANDIDATE EVALUATION ACTIVITIES

Although the work performed by Panels 1 and 2 represented extremely important aspects of the assessment and furnished essential inputs to the Board, the psychological and medical tests provided the more newsworthy activities.

The psychological tests were performed at DFVLR's Department of Psychology in Hamburg during the period 5-15 October 1977. These tests evaluated the performance, personality and behaviour attributes of the candidates and involved established methods for the assessment of such aspects as attention and memory spans, reasoning, spatial orientation, motivation, emotional stability and manual dexterity. The tests were supplemented by personal interviews, structured to verify and further assess the candidate's results.

The medical tests, which were performed during the period November/December 1977, can be divided into two main categories – clinical and special. Clinical testing involved medical examination and laboratory evaluation

*Figure 4 – Electroencephalogram (EEG) tests at Soesterberg.*

*Figure 5 – Candidate undergoing cardiopulmonary tests at Soesterberg.*

of basic physical conditions, including blood, eyesight, heart, lungs and brain functioning. In addition to the exhaustive but more conventional clinical evaluation, a series of special tests were performed with each candidate. These included the assessment of the effects of physical stress, acceleration tolerance and vestibular functioning. For both sets of tests, existing facilities in Member States were used. Thus, the clinical testing was carried out equally by the National Aerospace Medical Centre at Soesterberg (Netherlands) and Ecole d'Application du Service de Santé pour l'Armée de l'Air et Centre de Recherches de Médecine Aéronautique in Paris (France). The special testing was similarly divided between the DFVLR Institute for Aviation Medicine at Bonn-Bad Godesberg (Germany) and the Institute of Aviation Medicine at Farnborough (United Kingdom).

The four recommended ESA payload-specialist candidates have now been accepted by NASA as suitable for flight in the Space Shuttle (after further tests at the Johnson Space Center) and have started their orientation training on the STS, Spacelab and FSLP. These activities have been performed at SPICE*/Porz-Wahn, ESTEC/

* SPICE stands for Spacelab Payload Integration and Co-ordination in Europe.

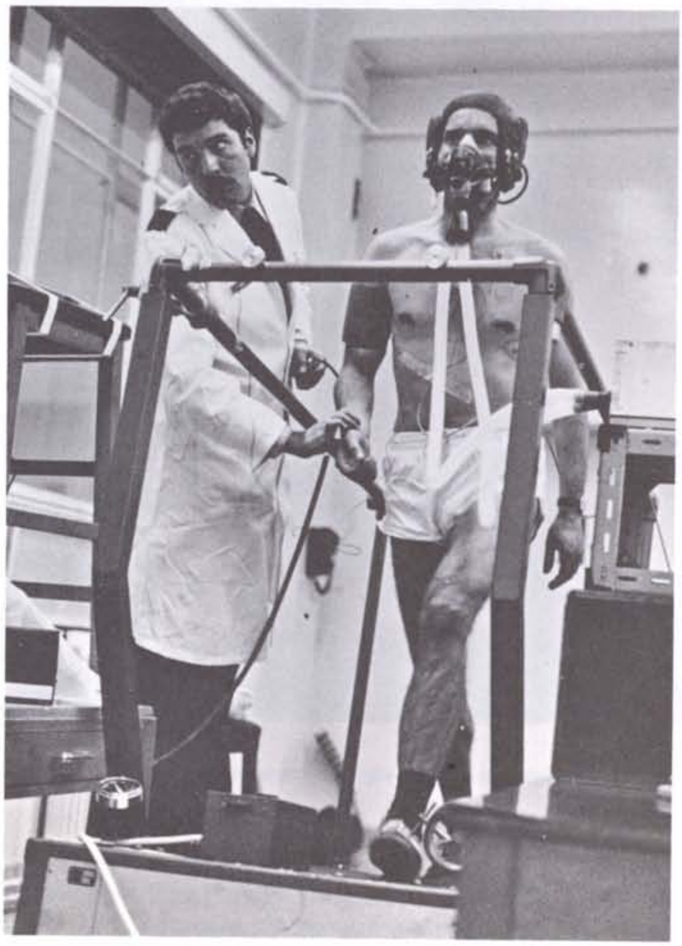


*Figure 6 — Exercise stress test on the treadmill at IAM, Farnborough.*

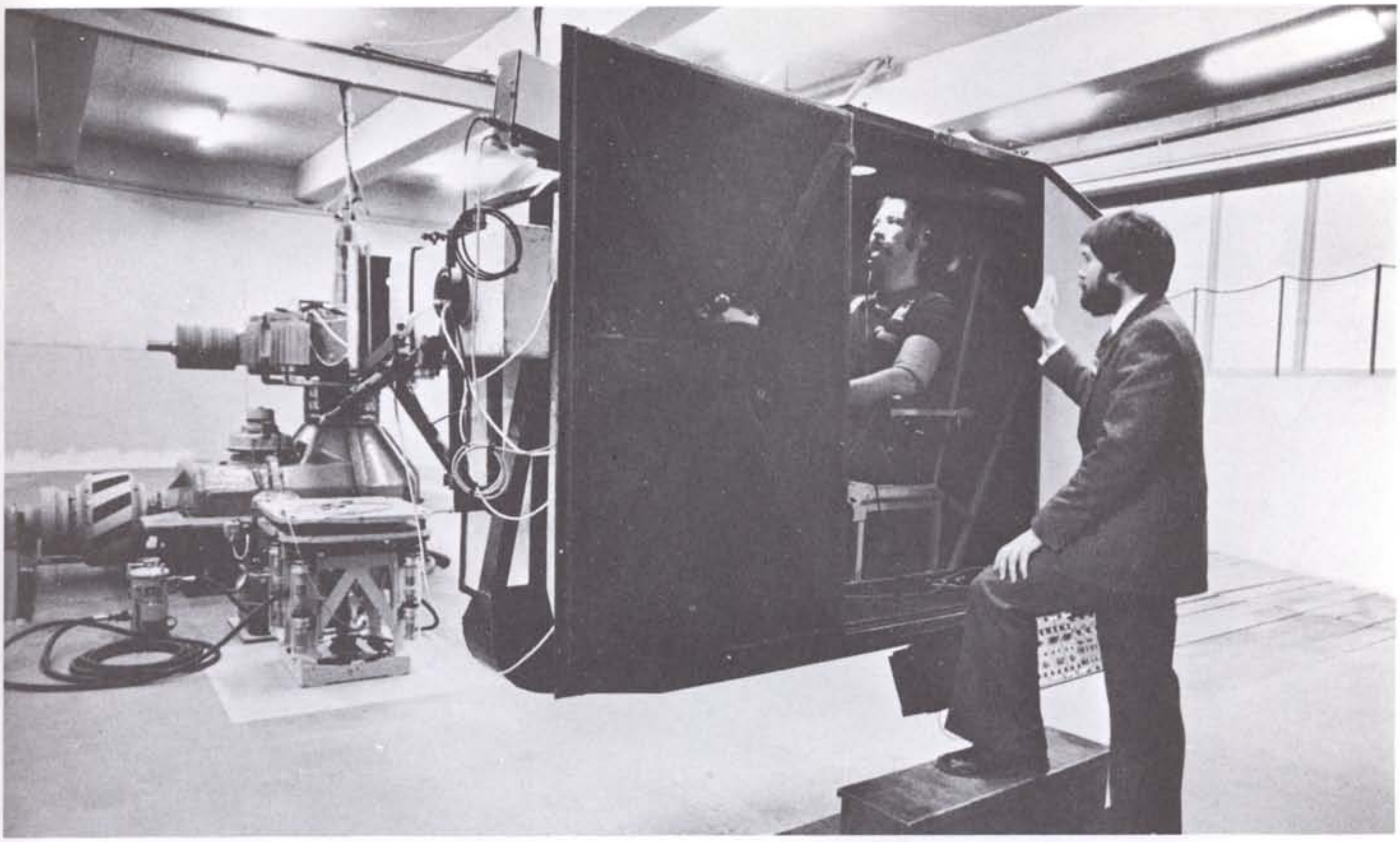


*Figure 7 — Centrifuge tests at DFVLR, Bonn-Bad Godesberg.*

Noordwijk and ERNO/Bremen. Also, visits have been made to research centres in the United Kingdom, Germany, The Netherlands and France to assess the current status in the fields of Atmospheric Physics, Life and Material Sciences, Astronomy and Earth Resources.

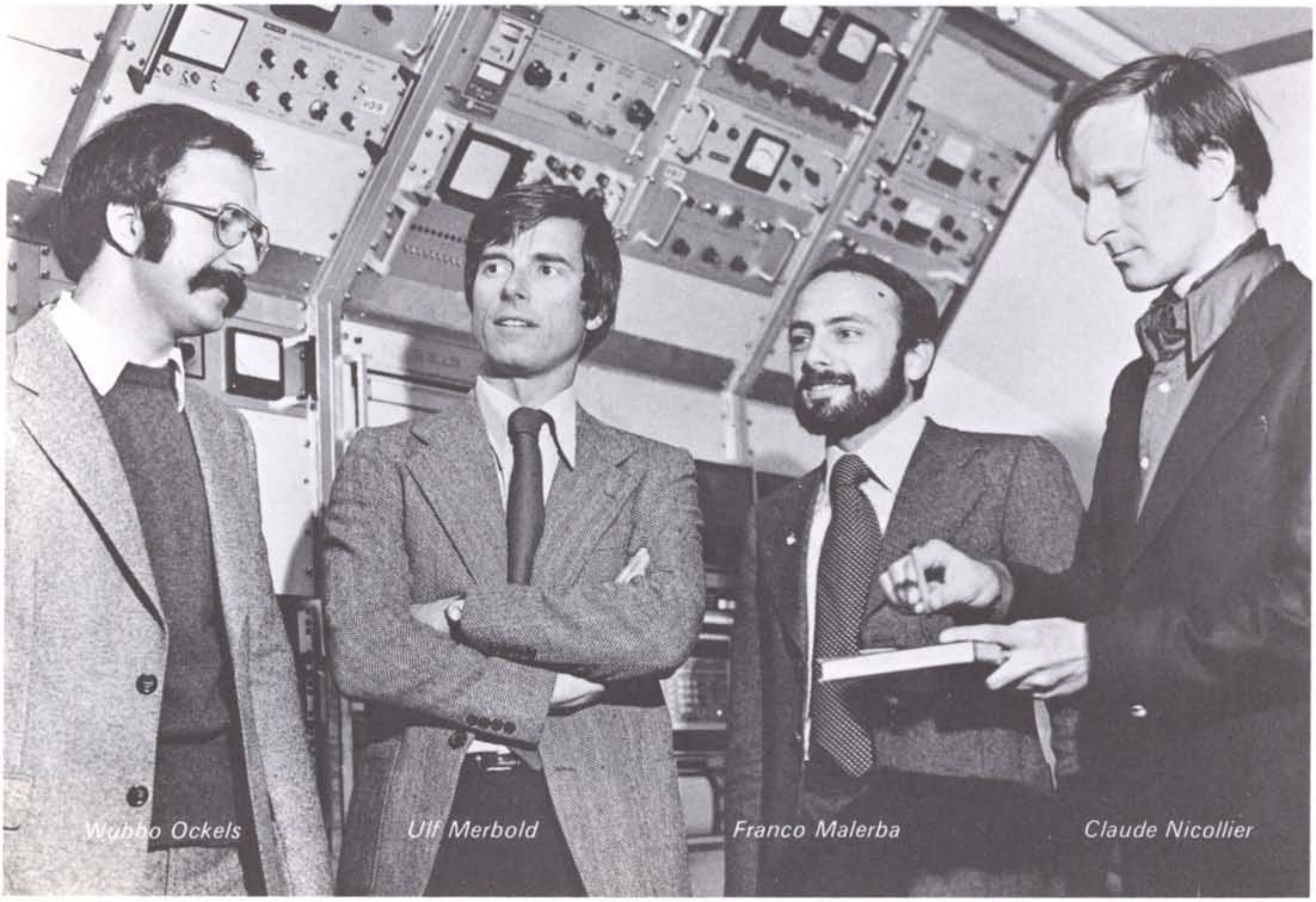
## FUTURE ACTIVITIES

After the selection of the three preferred candidates in mid-1978, they will become staff members of ESA and will be integrated into ESA's SPICE team at Porz-Wahn. A full training programme, which will include visits to laboratories and research institutes in Europe and the United States, will be followed to ensure complete familiarity with the FSLP experiments, their interfaces with Spacelab, and their operation. As the payload evolves and during the period up to 12 months prior to the flight, the three payload specialists will be taking part in the European ground activities associated with the integration of the various experiment elements into a payload. After shipment of the European payload complement to the USA, they will participate in the integration of the NASA and ESA components into a total payload. The actual flight period will of course, be hectic for all concerned, whether on-board Spacelab or in the Payload Operation Control Center in Houston.

The Selection Board and Panels have been unanimous in their high regard for the standards exhibited by all 53 of the payload-specialist candidates. Because of the rather severe criteria (particularly the medical ones) which ESA chose to impose, only four have been chosen as candidates for Western Europe's first astronaut. For subsequent flights of Spacelab, ESA will re-examine these selection criteria with NASA so that less severe ones can be formulated.

There will certainly be European Spacelab missions beyond FSLP. This will open up the possibility of reconsidering the excellent candidates who were proposed to ESA for FSLP, but who did not fully satisfy the stringent requirements established for that particular mission.

(Astronaut biographies overleaf)



Wubbo Ockels — Ulf Merbold — Franco Malerba — Claude Nicollier

## *The chosen few: The first of many?*

ULF MERBOLD

Ulf Merbold (36) was born at Greiz, Germany, and is married with one child. After obtaining a diploma in physics at Stuttgart University in 1968, he joined Max Planck-Institut für Metallforschung, first on a scholarship and, in 1973, as a staff member. He obtained a doctorate in Science (Dr. Rer. Nat.) from Stuttgart University in 1976. Dr. Merbold is a member of a research team working in the field of crystal-lattice defects and has been involved with fast-neutron irradiation experiments on iron and vanadium.

FRANCO MALERBA

Franco Malerba (31) was born at Busalla, Italy. He qualified as an electronics engineer in 1970 (Genoa University) and obtained a doctorate in Physics in 1974 (Genoa). He has held research fellowships at the Italian National Research Council, where he began to specialise in biophysics, and at NATO's Saclant Research Centre at La Spezia, Italy. He then spent approximately two years as Visiting Scientist at The National Institute of Health, Bethesda, USA, where he carried out a research programme in neurophysiology. In 1975, he joined the Computer Special Systems Department of Digital Equipment (France), and in 1976 was transferred to Digital Equipment (Italy) where he was appointed Head of the Computer Special Systems Group.

WUBBO OCKELS

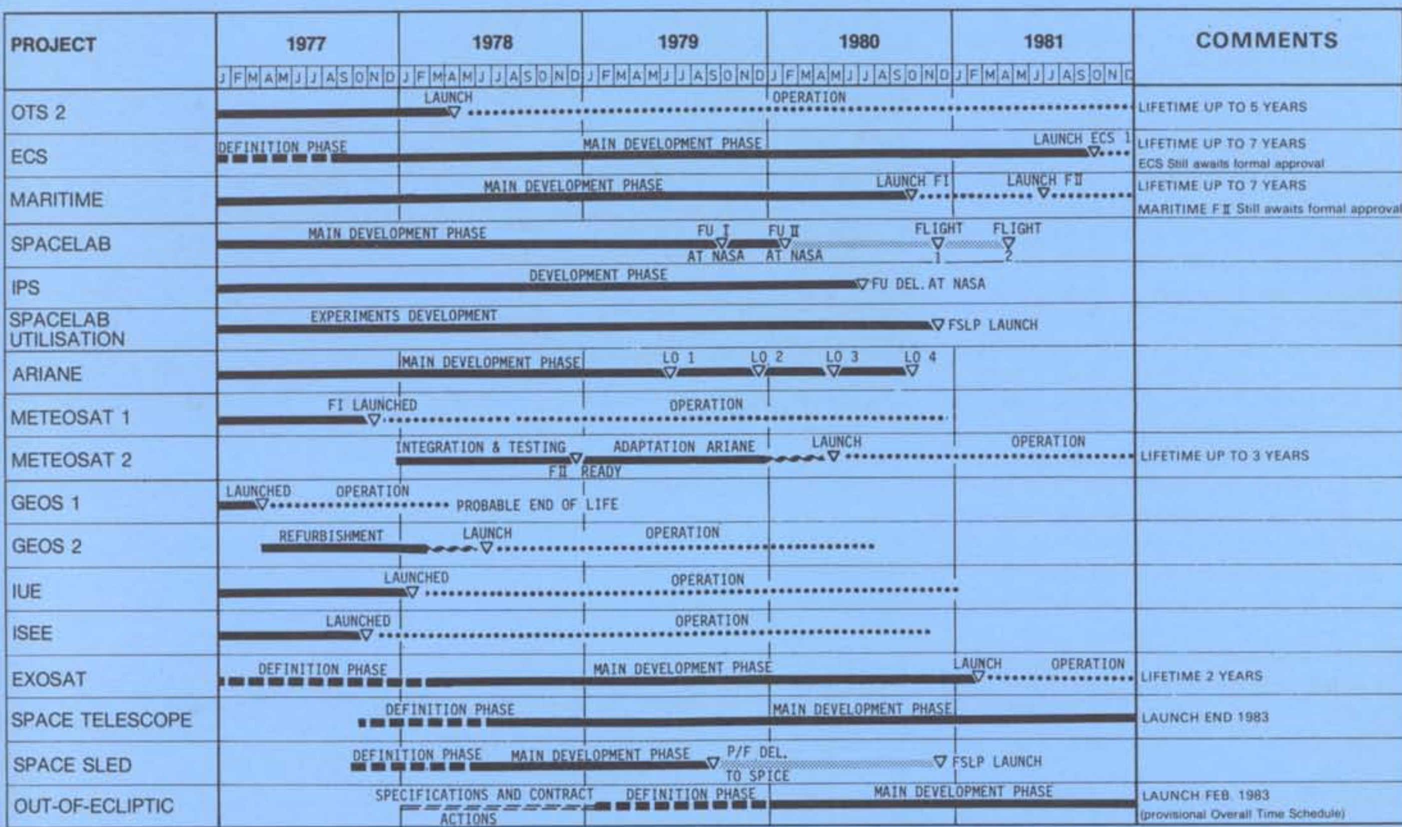
Wubbo Ockels (31) was born at Almelo, Netherlands, and is married with one child. After obtaining a doctorate from the University of Groningen in 1973, he joined the Nuclear Physics Accelerator Institute at Groningen, where he has been carrying out research on nuclear physics, primarily on the decay of nuclear systems directly after formation. He is currently writing a thesis on the basis of this experimental work.

CLAUDE NICOLLIER

Claude Nicollier (33) was born at Vevey, Switzerland, and is married with one child. After graduating in Physics at Lausanne University, he did research at the Astronomical Institute of Lausanne and Geneva Observatory, on the photometric classification of super-giant stars. Having qualified as a professional pilot, he interrupted his research (1973-1976) to work as an airline pilot for Swissair. He was awarded a degree in astronomy and astrophysics by Geneva University. He resumed his research activities in 1976 and is presently a Visiting Scientist at ESTEC. In this capacity, he participated in the ASSESS-II Spacelab airborne simulation mission in May 1977 as an experiment operator.

# Projects under Development
# Projets en cours de réalisation

**THE ESA DEVELOPMENT AND OPERATION PROGRAMME (END FEBRUARY 1978)**




## OTS-2

*Space segment*
During January and February, system-level testing was successfully completed and the pre-ship review took place at ESTEC on 1 and 2 March. Permission was given to ship the satellite to Eastern Test Range (ETR). A number of corrective actions which were shown to be necessary by anomalous test results will be made at ETR before launch. The satellite arrived at ETR on 13 March.

Preparations at ETR are in progress, but because of the need to investigate certain launcher anomalies during a recent Delta-2914 launch (which did not, however, affect the successful placing of the satellite in orbit), NASA has rescheduled launch of OTS-2 for 27 April.

The OTS launch vehicle preparation was reviewed with NASA and its contractors in January, and again at pre-ship review. The production of the new solid strap-on motors is proceeding satisfactorily.

*Ground segment*
The preparations for the Orbital Test Programme are well advanced. Experiments have been carried out at the Satellite Control and Test Station (SCTS) at Fucino to maximise station performance. The Villafranca terminal is also operational and has been receiving signals from the Italian Sirio satellite. The other ESA fluxmeters in Sweden, Ireland and Sicily are also ready.

## ECS

The current authorisation to industry to proceed with Phase C/D activities extends until 28 February 1978. However, at the ESA Council

## OTS-2

Secteur spatial

*Les essais au niveau système se sont achevés avec succès dans le courant de janvier et février et l'examen avant expédition s'est tenu à l'ESTEC les 1er et 2 mars. L'autorisation a été donnée d'envoyer le satellite à l'Eastern Test Range (ETR). Des mesures correctives, dont la nécessité a été démontrée par certaines anomalies dans les résultats d'essais, seront prises, avant le lancement, à l'ETR, où le satellite est arrivé le 13 mars.*

*Les préparatifs à l'ETR progressent mais, une enquête étant nécessaire à cause de certaines anomalies du lanceur enregistrées au cours d'un récent tir Delta 2914 (anomalies qui n'ont toutefois pas affecté la bonne mise en orbite du satellite), la NASA a repoussé le lancement d'OTS du 2 au 27 avril.*

*La préparation du lanceur d'OTS a été examinée avec la NASA et ses contractants en janvier puis une nouvelle fois lors de l'examen d'avant-expédition. La production de nouveaux propulseurs accolés à ergols solides progresse de façon satisfaisante.*

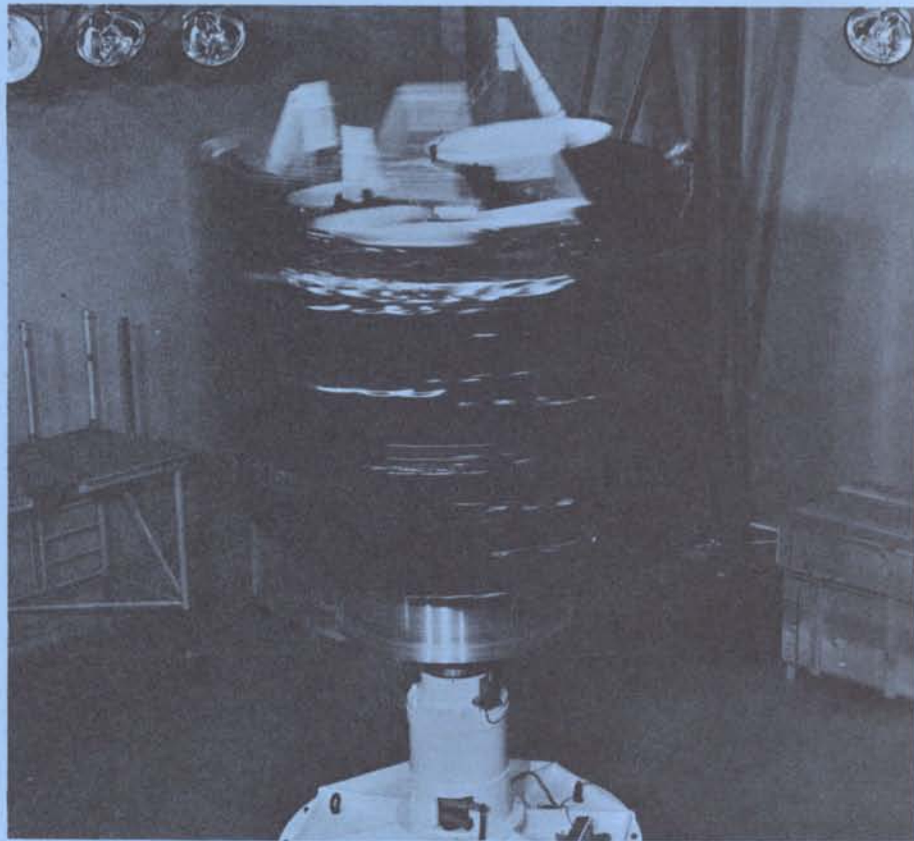
Secteur terrien

*Les préparatifs en vue du Programme d'essais orbitaux sont bien avancés. Des expériences ont été menées à la station de contrôle et d'essai du satellite (SCTS) à Fucino pour en améliorer au maximum la performance. Le terminal de Villafranca est, lui aussi, opérationnel et a déjà reçu des signaux du satellite italien Sirio. Les autres stations de mesure de flux de l'ESA, en Suède, Irlande et Sicile, sont également prêtes.*

## ECS

*Actuellement, l'autorisation donnée à l'industrie de poursuivre les activités de phase C/D vaut jusqu'au 28 février 1978. Toutefois, lors de la réunion que le Conseil de l'Agence a tenue le 1er mars 1978, la décision a été prise d'entreprendre la phase 3 du programme de satellites de télécommunications avec effet au 21 mars. A cette date, le Conseil directeur commun du programme de satellites de communications se réunira pour régler définitivement la question des contributions encore en suspens. Le but de cette phase du programme est de mettre à la disposition d'EUTELSAT intérimaire deux satellites opérationnels (un en orbite, un en réserve au sol) pour un système européen régional de satellites de télécommunications.*

*Sur le plan technique, l'analyse de couplage avec le lanceur Ariane a commencé. Lorsque ces travaux essentiels seront terminés, on pourra 'geler' définitivement, fin mai, la conception de la structure, ce qui représente une étape primordiale dans l'avancement du programme. Le développement des autres sous-systèmes avance également, bien que les travaux relatifs à la charge utile de télécommunications aient été retardés sous l'effet conjugué de l'insuffisance du financement et du report de la date de lancement de février 1981.*



*Spin-testing of the OTS-2 spacecraft, prior to its shipment to ETR.*

*Essai de rotation d'OTS-2 avant son transport à l'ETR.*

## SATELLITE MARITIME

Satellites maritimes A et B

*A sa réunion de février, le Comité de Politique industrielle (IPC) a autorisé le démarrage dans l'industrie, sous la maîtrise d'oeuvre de British Aerospace (Dynamics Group), d'activités portant sur la nouvelle configuration à 4/6 GHz du satellite maritime A basé sur une plate-forme de type ECS. Les préparatifs nécessaires sont faits entre-temps en vue de la fourniture de deux satellites maritimes (A et B) conformes à la nouvelle configuration et compatibles avec le lanceur Ariane.*

'Association d'intérêts' pour un système maritime mondial

*L'idée de la constitution d'une 'Association d'intérêts' regroupant les*

Meeting on 1 March, it was decided to undertake Phase-3 of the Communication Satellites Programme with effect from 21 March 1978. On this date the Joint Communications Programme Board will meet to finalise the outstanding question of contributions. The aim of this phase of the programme is to make available to Interim EUTELSAT two operational satellites (one in orbit, one spare on the ground) for a European regional communication satellites system.

In technical terms, the coupled analysis with the Ariane launcher has started. Completion of this essential activity will allow final freezing in late May of the structural design, a major milestone in the development of the programme. Development of the other subsystems is also progressing, although the communications payload work has been delayed due to the combined effect of insufficient funding and the change in launch date from February 1981.

## MARITIME SATELLITE

*Maritime-A and B*

At the February meeting of the Industrial Policy Committee (IPC), authorisation was given for the start of industrial activities on the new 4/6 GHz-configuration Maritime-A satellite based on an ECS-type platform, with British Aerospace (Dynamics Group) as Prime Contractor. In the meantime, preparations are being made for the procurement of two Maritime Satellites (A and B) in the new configuration and compatible with the Ariane launcher.

*Joint Venture for a global maritime system*

The idea of forming a 'Joint Venture' of nations interested in participating in a global maritime satellite system evolved during 1977. The initiative was taken by COMSAT General on behalf of the MARISAT Consortium for the purpose of ensuring continuity of availability of a maritime space segment after the nominal lifetime of their existing Marisat satellites. As presently envisaged, the system would consist of Maritime-A and B, supplied by ESA via Interim EUTELSAT, plus a further procurement of a third and fourth spacecraft (C and D) to be supplied to the Joint Venture. At present, the Agency is evaluating the industrial offers for C and D prior to their incorporation in a firm fixed-price offer (including ESA costs) for submission to the Joint Venture at the end of March 1978.

## SPACELAB

*Critical Design Review*

The Spacelab project has passed a very important milestone in its development; the Critical Design Review (CDR). The main purposes of this review, the last before the Flight Acceptance Review linked with the delivery of Spacelab, were firstly to verify the results obtained in the design phase and the manufacturing master drawings for the flight unit, and compare both with the requirements defined in the agreements between ESA, NASA and European industry; secondly to correct any discrepancies; and thirdly to give formal approval to the manufacturing of the flight unit.

The CDR lasted two months, starting with the delivery in January of the drawings and detailed documentation and ending with a meeting of the ESA/ERNO Review Board at the Prime Contractor's premises in Bremen, with NASA participation. Specialists in mechanics and structures, thermal control, electrics and electronics, management and operations contributed to this examination.

NASA congratulated ESA and European industry on the very positive result of the CDR. The review enabled the Agency to authorise the manufacture of the Spacelab flight unit by European industry.

*Top-level Spacelab documents signed*

The ESA and NASA Spacelab Programme Directors have signed revised versions of two important Spacelab documents. The Spacelab Joint Programme Plan amplifies in greater detail the gross descriptions of the Spacelab Programme and of the phasing and scheduling mentioned in the Spacelab Memorandum of Understanding and describes the working arrangements between the two Agencies. The Programme Requirements Document establishes the Level-I programme requirements, which are jointly controlled by the ESA/NASA Spacelab Programme Directors. It consists of two parts; the first relating to overall system requirements, subsystem characteristics, operational constraints and interface requirements, and the second to programme implementation requirements.

*Software industrial reorganisation*

Owing to the complexity of the Spacelab software, and in order to incorporate new NASA operational software requirements, ESA, together with the Prime Contractor ERNO, has decided to reorganise the industrial team responsible for software development. The new team comprises four European companies (Kampsax, BTM, MATRA and Rovsing) assisted by an experienced US company (TRW). A software systems requirements review is taking place in March.

*Instrument Pointing System (IPS)*

The IPS Preliminary Design Review was successfully completed in January. The only significant new problem highlighted by the Review is the susceptibility of some mechanical items to stress corrosion cracking, and this is currently under review by a special working group.

## ARIANE

All three stages of the launcher have now reached the phase of complete-stage testing.

*First stage*

The success of a series of propulsion-bay tests totalling 404.5s of operation made it possible to introduce flight-configuration tanks and to begin the series of development tests on the stage. The first test, carried out at the Vernon test centre on 13 December, was satisfactory, in spite of premature cut-off. The test was stopped after 111s, instead of the planned 150s, following erosion of the graphite throat of one of the four Viking engines. The functioning of the hot-

*nations intéressées par une participation à un système mondial de satellites maritimes a pris corps en 1977. L'initiative en revient à COMSAT General agissant pour le compte du Consortium MARISAT soucieux d'assurer la disponibilité continue d'un secteur spatial maritime lorsque la génération actuelle de satellites Marisat atteindra le terme de sa durée de vie nominale. Le système, tel qu'on l'envisage actuellement, se composerait des satellites maritimes A et B, fournis par l'ESA par l'intermédiaire d'EUTELSAT intérimaire, auxquels s'ajouterait la fourniture ultérieure à l''Association d'intérêts' d'un troisième et d'un quatrième véhicules spatiaux (C et D). A l'heure actuelle, l'Agence évalue les offres de l'industrie concernant les satellites C et D avant de les incorporer dans une offre à prix forfaitaire définitif (y compris les frais de l'ESA) qui doit être soumise à l''Association d'intérêts' fin mars 1978.*

## SPACELAB

Examen critique de la conception

*Le projet Spacelab a franchi avec succès une étape très importante de sa phase de développement, l'examen critique de la conception (CDR). Cet examen, le dernier avant celui de la recette définitive qui aura lieu lors de la livraison du Spacelab, avait trois objectifs principaux. Le premier était de vérifier les résultats obtenus au cours de la phase de conception et les dessins de fabrication du modèle de vol et de les confronter avec les impératifs définis dans les accords conclus entre l'ESA, la NASA et l'industrie européenne; le second objectif était d'éliminer les divergences éventuelles; le troisième d'approuver officiellement la mise en fabrication du modèle de vol.*

*Le CDR a duré deux mois, commençant en janvier avec la livraison des liasses de dessins et des descriptions détaillées de fabrication pour se terminer par une réunion du Comité d'évaluation ESA/ERNO qui s'est tenue dans les locaux du maître d'oeuvre à Brême, réunion à laquelle participaient les représentants de la NASA ainsi que des spécialistes en mécanique et structures, régulation thermique, électricité et électronique, gestion et opérations.*

*La NASA a félicité l'ESA et l'industrie européenne du résultat très positif de cet examen qui a permis à l'Agence de donner à l'industrie européenne le feu vert pour la fabrication de l'unité de vol du laboratoire spatial.*

Signature de documents fondamentaux par les responsables du Programme

*Les Directeurs du Programme Spacelab de l'ESA et de la NASA ont signé les versions révisées de deux documents importants relatifs à ce Programme. Le premier, le Plan commun d'exécution du Programme, développe en les précisant les descriptions sommaires, l'échelonnement et le calendrier du programme mentionnés dans le Mémorandum d'Accord Spacelab et définit les arrangements de travail entre les deux Agences. Le document sur les impératifs du programme définit les impératifs au niveau I dont les Directeurs du Programme assurent conjointement le contrôle. Ce dernier document comporte deux parties: la première a trait aux impératifs généraux du système, aux caractéristiques des sous-systèmes, aux contraintes opérationnelles et aux impératifs d'interfaces. La seconde concerne les impératifs relatifs à la mise en oeuvre du programme.*

Remaniement de l'équipe industrielle chargée du logiciel

*En raison de la complexité du logiciel du Spacelab et afin de prendre en compte les nouveaux impératifs de la NASA relatifs aux logiciels opérationnels, l'ESA a décidé, de concert avec le maître d'oeuvre ERNO, de réorganiser l'équipe industrielle chargée du développement du logiciel. La nouvelle équipe est constituée de quatre firmes européennes (Kampsax, BTM, MATRA et Rovsing) assistées par une firme américaine expérimentée (TRW). Un examen des impératifs au niveau des systèmes de logiciel est prévu en mars.*

Sous-système de pointage des instruments (IPS)

*L'examen préliminaire de conception de l'IPS s'est terminé avec succès en janvier. Le seul problème nouveau important qu'il ait fait apparaître est celui de la vulnérabilité de certaines pièces mécaniques à une fissuration par corrosion sous tension. Un groupe de travail spécial suit actuellement ce problème.*

## ARIANE

*Tous les trois étages du lanceur sont maintenant entrés dans la phase d'essais de mise au point d'étages complets.*

1er étage

*Le résultat positif d'une série d'essais de la baie de propulsion totalisant 404,5 s de fonctionnement a permis d'introduire les réservoirs en configuration de vol et de commencer la série d'essais de mise au point de l'étage. Le premier essai qui a été effectué le 13 décembre au Centre d'essais de Vernon a donné satisfaction malgré l'arrêt prématuré du tir. L'essai fut arrêté après 111 s au lieu des 150 s prévues, par suite de l'érosion du col en graphite d'un des quatre moteurs Viking. Il a été démontré que le fonctionnement du système de pressurisation à gaz chaud en relation avec les réservoirs de vol et le comportement dynamique de l'étage étaient nominaux.*

2ème étage

*Le premier essai du deuxième étage en configuration de vol a eu lieu avec succès au Centre d'essais de la DFVLR à Hardthausen en Allemagne le 31 janvier. L'étage équipé de son dispositif correcteur Pogo, a fonctionné selon l'objectif de l'essai pendant 138 s avec agitation du moteur.*

*L'arrêt du tir s'est effectué sur épuisement UDMH. Tous les paramètres étaient nominaux. L'essai a permis de vérifier la compatibilité entre l'ensemble propulsif et les réservoirs de vol, et la performance du système de pressurisation.*

3ème étage

*Suite au tir de longe durée (470 s) de l'ensemble propulsif en version banc, le premier essai du 3ème étage en configuration de vol a été effectué avec succès le 10 janvier au Centre d'essais à Vernon. L'étage a fonctionné d'une façon nominale* gas pressurisation system in relation to the flight tanks was shown to be nominal, as was the stage's dynamic behaviour.

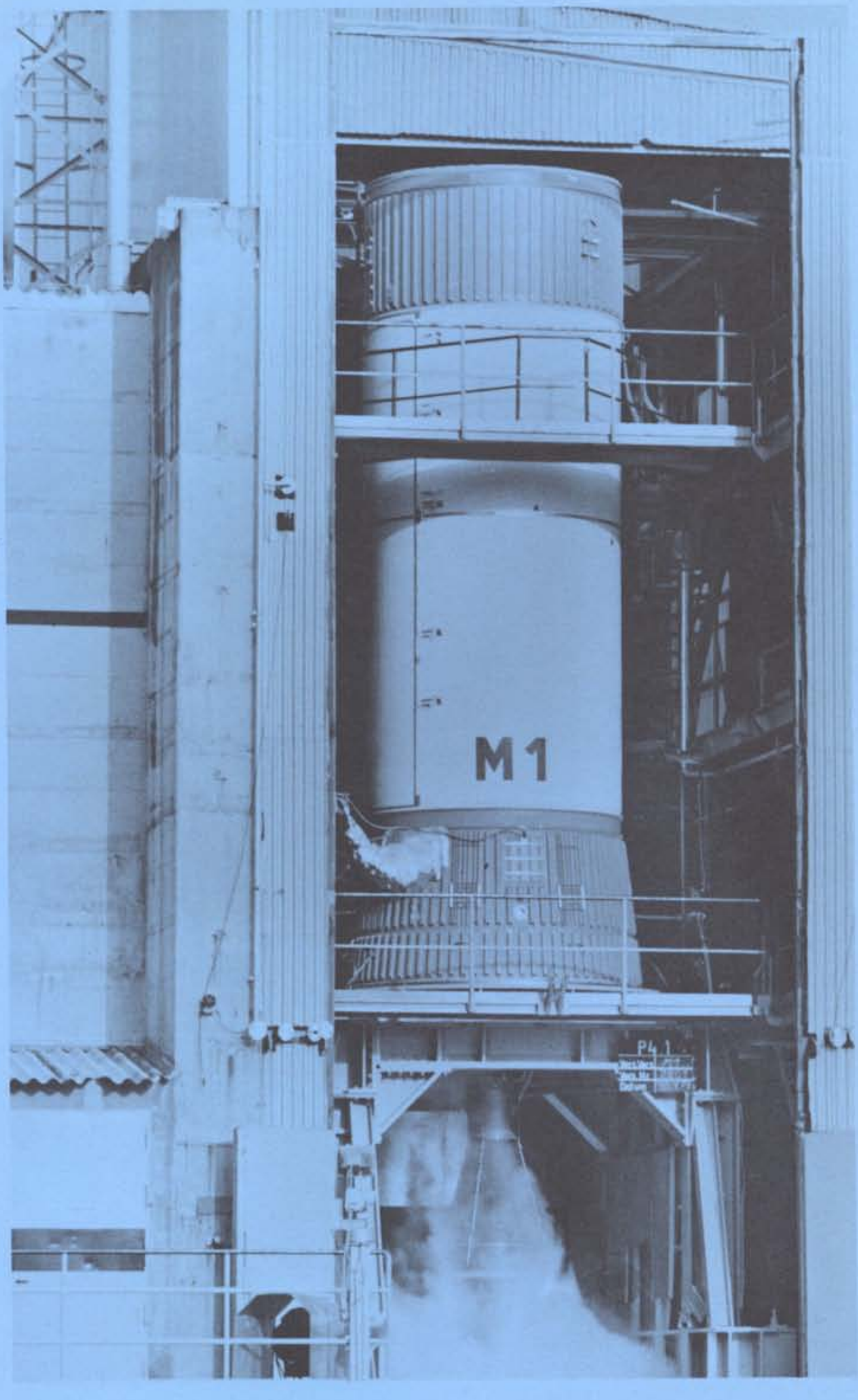
*Second stage*
The first test of the second-stage in flight configuration took place successfully at the DFVLR test centre at Hardthausen on 31 January. The stage, equipped with its pogo-correction system, functioned as planned for 138s, with swivelling of the engine.

The firing was terminated on UDMH depletion. All parameters were nominal. The test allowed the compatibility of the propulsion system with the flight tanks to be checked, as well as the performance of the pressurisation system.

*Third stage*
Following the long-duration firing (lasting 470s) of the propulsion system in its 'battleship version', the first test of the third stage in flight configuration was carried out successfully at the Vernon test centre on 10 January. The stage functioned nominally for the exact planned duration of 250s. A second test took place on 2 February; it lasted 550s as planned, which corresponds pratically to the duration of third-stage powered flight (570s). The purpose of the tests was to check compatibility of the propulsion bay with the tanks in flight configuration, with particular reference to the pressurisation systems. The successful completion of these events shows that the technology has now been mastered.

*Qualification of the stage-separation system*
The fourth test, which took place on 15 December, completed the qualification phase for the pyrotechnic separation systems. For both stage separations (1/2 and 2/3), the results have allowed the pyrotechnic design to be validated and correct behaviour of the equipment to be verified.

*Delivery of the checkout system to the Ariane launch site*
The launch-vehicle checkout system intended for the Ariane launch site at Kourou (French Guiana) was delivered in December, and installation began immediately. In the meantime, validation operations using static simulators are in progress. An identical checkout system has been installed since last November at the Launcher Integration Site at Les Mureaux, France, where the electrical mockup tests are currently under way.




*First test of the Ariane second stage on the PF41 test stand at DFVLR, Hardthausen.*

*Premier essai du deuxième étage d'Ariane sur le banc PF41 de la DFVLR à Hardthausen.*

*pendant 250 s correspondant exactement à la durée programmée. Un deuxième essai de l'étage a eu lieu le 2 février, la durée était de 550 s comme prévu, ce qui correspond pratiquement à la durée de la phase propulsée du 3ème étage (570 s). L'objectif de ces essais était la vérification de la compatibilité de la baie de propulsion avec les réservoirs en configuration de vol, notamment en ce qui concerne les systèmes de pressurisation. L'achèvement de ces étapes démontre que la technologie est désormais maîtrisée.*

Qualification du système de séparation d'étages

*Avec le quatrième essai qui a eu lieu le 15 décembre se termine la phase de qualification des systèmes pyrotechniques de séparation. Pour chaque séparation d'étages (1/2 et 2/3), les résultats ont permis de valider la définition pyrotechnique et de s'assurer du bon comportement des équipements.*

Livraison du banc de contrôle de l'Ensemble de Lancement Ariane

*Après livraison, en décembre, du banc de contrôle du lanceur destiné à l'Ensemble de Lancement Ariane à Kourou (Guyane française), les travaux d'installation ont immédiatement commencé. Entre-temps les opérations de validation sur simulateurs statiques sont en cours. Un banc de contrôle identique est installé, depuis novembre, au Site d'Intégration du Lanceur (situé aux Mureaux, France) où se déroulent actuellement les essais de maquettes électriques.*

## METEOSAT

Secteur spatial

*Depuis son lancement le 23 novembre, Météosat-1 fonctionne parfaitement. En janvier, une certaine inquiétude s'est manifestée lorsque l'on a constaté que le radiomètre perdait de sa sensibilité dans le canal infrarouge. Ce phénomène était dû à la condensation de produits de dégazage de l'isolation thermique multicouches. Ces produits contaminants se sont évaporés grâce à la mise en route de radiateurs spécialement embarqués à cet effet. Des modifications occasionnelles non télécommandées ont été observées et l'on pense qu'elles sont dues à des phénomènes de décharge à la surface du véhicule spatial. Ceci mis à part, Météosat fonctionne à la perfection.*

*L'intégration de Météosat-2 dans la configuration Thor-Delta est achevée et les essais de performance des sous-systèmes sont en cours. L'adaptateur conique Météosat/APPLE est en cours de fabrication et l'on procède actuellement à une analyse structurelle de Météosat, pour déterminer quels sont les renforcements qu'il convient d'apporter au satellite pour pouvoir le lancer par Ariane.*

Secteur terrien

*Depuis la réception de la première image, le 9 décembre 1977, les installations terriennes augmentent progressivement la capacité du système. Comme par le passé, et en dépit de certains progrès réalisés au cours des dernières semaines, le point crucial reste le système de traitement des données.*

Opérations

*Les images et les bandes calculs ont été livrées aux utilisateurs pour une analyse scientifique détaillée. Ces données ont été accueillies avec le même enthousiasme par les chercheurs et par les météorologistes; les images du canal vapeur d'eau ont suscité un intérêt tout particulier.*

*La diffusion des images de Météosat et de Geos est en cours, mais en mode réduit.*

Démonstration/activités expérimentales

*La performance des équipements de la Station Secondaire d'Utilisateurs de Données (SDUS) et la mission de diffusion ont fait l'objet d'une démonstration, du 9 au 14 février, à Nairobi, à l'occasion de la 7ème session de l'Association Régionale No. 1 de l'Organisation Météorologique Mondiale (Pays africains).*

*Une plate-forme de collecte de données (DCP) opérationnelle a été installée à bord d'un navire français pour une campagne expérimentale qui doit se dérouler jusqu'à fin mai. Des messages seront reçus et analysés à Darmstadt ce qui permettra une évaluation préliminaire de la mission de collecte de données.*

Projet GOES

*Le satellite météorologique géostationnaire russe ne sera pas disponible pour la Première Expérience Mondiale du GARP (PEMG) l'an prochain; aussi la NOAA/NESS et l'ESA se sont-elles mises d'accord pour combler le hiatus: d'une part, la NOAA décalera un de ses satellites à 60° est; d'autre part, le satellite sera suivi et contrôlé depuis l'Europe, sous la responsabilité de l'ESA, en utilisant certains équipements américains.*

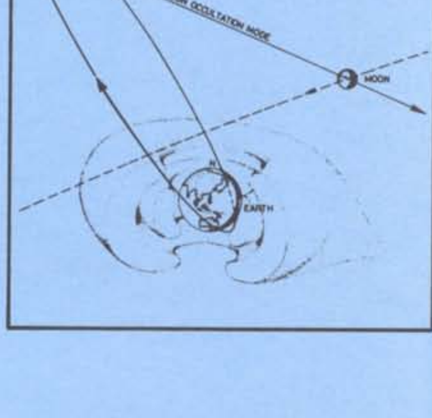
## EXOSAT

Satellite

*L'examen critique de la conception, dernier grand examen de la phase B, a dû être divisé en deux parties, la première en décembre de l'an dernier et la deuxième à la fin de février de cette année, pour tenir compte de la lenteur avec laquelle les travaux ont progressé dans certains secteurs clés: l'AOCS – système de commande d'attitude et de contrôle d'orbite –, les*

*Orbite prévue pour Exosat. Les rayons partant du véhicule spatial indiquent les modes de pointage arbitraire et d'occultation lunaire.*

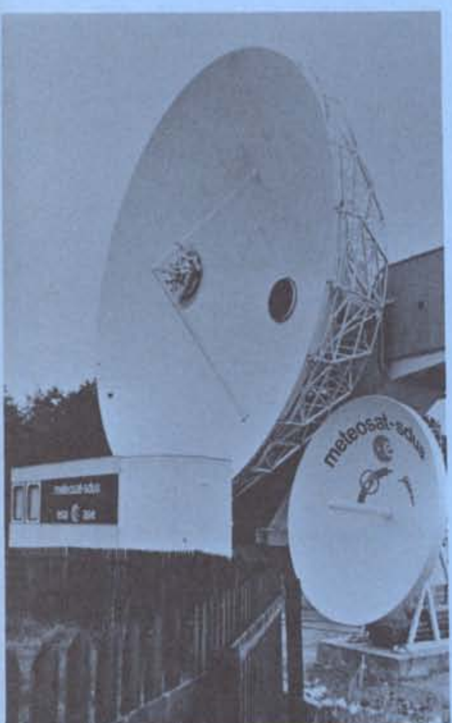
*The planned orbit for Exosat. The radii from the spacecraft distinguish the arbitrary-pointing and moon-occultation modes.*



# METEOSAT

*Space segment*
Meteosat-1 has been performing very well since its launch on 23 November. Some concern was felt in January when it was observed that the radiometer was losing sensitivity in the infrared channel. This was due to condensation of outgassing products from the multilayer thermal insulation. Use of the heaters, installed specifically for this purpose, evaporated these contaminants. Occasional uncommanded status changes have also been observed, and it is thought that these are caused by spacecraft surface discharging. Apart from these effects, Meteosat is working perfectly.

Integration of Meteosat-2 in Thor-Delta configuration has been completed and subsystem performance tests are under way. The Meteosat/APPLE conical adapter is being manufactured and structural analysis of Meteosat is in progress to determine what strengthening it will need for an Ariane launch.




*Ground segment*
Since the first image was received on 9 December, the ground facilities have steadily increased the capabilities of the system. As always, the crucial point remains the data-processing system, despite some progress during the last weeks.

*Operations*
Image photographs and computer tapes have been delivered to users for a detailed scientific appraisal. The data have been greeted with enthusiasm by research worker and applied meteorologist alike, and particular interest has been shown in the water-vapour channel pictures.

Dissemination of Meteosat and Goes images is in operation, albeit in a reduced mode.

*Demonstration/experimental activities*
A demonstration of Secondary Data User Station (SDUS) equipment performance and dissemination was held in Nairobi from 9 to 14 February on the occasion of the 7th Session of the Regional Association No. 1 of the World Meteorological Organisation (African countries). An operational stabilised Data Collection Platform (DCP) has been installed on a French ship for an experimental campaign until the end of May. Messages will be received in Darmstadt (ESOC) and analysed in order to make a preliminary assessment of the data-collection mission.

*GOES project*
Due to the unavailability of the Russian geostationary meteorological satellite for the First GARP Global Experiment (FGGE) next year, an agreément has been reached between NOAA/NESS and ESA to bridge the gap: NOAA will shift one of their satellites to 60° E, and it will be monitored and controlled from Europe by ESA, using some US equipment.

*A Secondary Data User Station (SDUS) in use at Michelstadt, Odenwald (Germany).*

*Une Station Secondaire d'Utilisateurs de Données en opération à Michelstadt, Odenwald (Allemagne).*

# EXOSAT

*Satellite*
The Critical Design Review, the last major review in the Definition Phase (Phase B), has had to be held in two parts, the first in December last year, and the second at the end of February, to allow for slow progress in certain key areas, e.g. attitude and orbit control (AOCS), structure and thermal subsystems and clean bench for experiment imaging telescopes. The reviews identified existing and potential system-schedule and weight-budget problems, and some at subsystem level concerning the AOCS in particular. Consequently, the Review Board made 21 recommendations for study and implementation.

Since the introduction of the Variant satellite concept in July 1977, a steady growth in satellite mass has taken place, resulting in a need to update the maximum figure to 480 kg for the complete satellite, of which 120 kg is allocated to the scientific payload. This new maximum is just compatible with the capabilities of the spacecraft structure and the performance of the back-up launcher. It therefore is of no significance that the primary launcher, Ariane, could place a heavier satellite into the desired orbit.

As a result of trade-off studies of the attitude reaction-control system, it was decided to change the propane-tank configuration. Instead of a single toroidal tank, two spherical tanks of the type used for Meteosat are now foreseen, which will alleviate fuel-sloshing problems and significantly improve performance.

Some main problem areas still requiring attention are qualification of the star-tracker image dissector tube, and of the microprocessor circuits for the attitude control electronics, on-board measurement of propane-tank content, and scheduling.

The contractor has submitted a proposal for the Main Development Phase (C/D) of the project which has been evaluated by the Agency. A number of problems need to be *sous-systèmes structure et thermique et le banc propre pour l'expérience de télescope de prise d'images. Ces examens ont mis en lumière des problèmes, existants et potentiels, concernant, au niveau système, le calendrier et le bilan de masse et, au niveau sous-système, l'AOCS, ce qui a amené la Commission chargée de l'examen critique à formuler 21 recommandations pour étude et mise en oeuvre.*

*Depuis l'adoption en juillet 1977 du concept de satellite Variant, la masse du satellite n'a cessé d'augmenter, ce qui a obligé à réviser en hausse le poids maximal qui atteint maintenant 480 kg pour l'ensemble du satellite, dont 120 kg alloués à la charge utile scientifique. En fait, la nouvelle masse maximale est tout juste compatible avec la capacité de la structure et avec la performance du lanceur de réserve, ce qui retire tout intérêt au fait que le lanceur Ariane puisse placer sur l'orbite souhaitée un satellite plus lourd.*

*A la suite des études d'arbitrage sur le système de contrôle par réaction de la commande d'attitude, il a été décidé de modifier la configuration du réservoir à propane. Au lieu d'un réservoir toroïdal, on prévoit maintenant deux réservoirs sphériques du type utilisé pour Météosat, ce qui atténuera le problème de ballottement des ergols et augmentera sensiblement les performances.*

*Les principaux secteurs dans lesquels des problèmes se posent encore sont: la qualification du tube dissecteur d'images du suiveur stellaire, les circuits du microprocesseur pour l'électronique de commande d'attitude, la mesure à bord du contenu des réservoirs de propane, et le calendrier.*

*Le contractant a fait, pour la phase principale de réalisation du projet (phase C/D), une proposition qui a été évaluée par l'Agence. Un certain nombre de problèmes doivent être résolus avant que l'on puisse passer un contrat à prix forfaitaire. Ces problèmes, ainsi que les activités de phase B qui ne sont pas encore terminées, sont actuellement suivis de très près, tant par les Contractants que par l'Agence.*

Charge utile

*Les contrats pour les quatre éléments principaux de la charge utile: les détecteurs moyenne énergie, les miroirs des réflecteurs rayons X, les ensembles d'instruments situés au plan focal et l'électronique, sont entrés dans la phase II – phase du modèle d'identification et de la qualification. Un contrat a été passé avec Montedel Laben pour le compteur proportionnel à scintillation à gaz, adjonction récente à la charge utile approuvée par le Comité du Programme Scientifique (SPC) en septembre dernier. Les progrès dans tous les secteurs sont assez satisfaisants et les travaux se déroulent conformément aux plans mais on craint un peu que le colimateur à fenêtre en verre au plomb de l'expérience moyenne énergie ne réussisse pas à supporter toutes les contraintes rigoureuses qui lui sont imposées.*

*Les modifications à tous les éléments, sauf les miroirs, ont été négociées avec le contractant et l'on attend sous peu la ratification des avenants à cet effet par l'IPC.*

*Le programme du modèle scientifique est maintenant considéré comme achevé, l'évaluation des essais sous faisceaux longs des miroirs à rayons X approchant de sa fin. Les résultats du programme sont considérés comme satisfaisants dans la mesure où, soit la preuve est faite que les objectifs de conception et de performance des unités ont été atteints, soit l'on a pu identifier des solutions permettant des améliorations nécessaires.*

*Des préparatifs sont actuellement en cours pour la phase opérationnelle, y compris le programme d'observation, la gestion et la réduction des données.*

ESOC

*Sur la base d'études internes exécutées au cours des derniers mois, la décision a été prise de conserver la solution de référence (Villafranca, Madrid) comme station terrienne pour le soutien de la mission Exosat. Un exercice de planning détaillé a commencé à l'ESOC concernant la mise en oeuvre des modifications nécessaires aux stations. Ces plans seront établis de façon à réduire autant que possible les incompatibilités potentielles avec les opérations IUE au cours des dernières années.*

## TELESCOPE SPATIAL

Réseau solaire

*Chez British Aerospace (BAe), les activités de phase B se poursuivent de façon satisfaisante. Elles sont centrées sur les études d'arbitrage relatives à la conception de référence et sur la préparation de la documentation à fournir à la NASA en soutien de l'examen des impératifs du Programme (PRR) pour le module du système de soutien (SSM). Cette documentation a été communiquée à la NASA à la mi-janvier.*

*Un Groupe de travail spécial sur les interfaces, composé de représentants de la NASA, de l'ESA, de BAe et de LMSC – contractant principal de la NASA pour le SSM – s'est réuni à Sunnyvale en Californie. Au cours de cette réunion, les participants ont étudié certains problèmes d'interface spécifiques et détaillés ainsi que les interfaces structurelles, mécaniques et électriques.*

*A l'ESTEC se sont déroulés avec succès des essais de cyclage thermique, effectués sur des échantillons de nappes de photopiles fournis par AEG-Telefunken et comportant au total 28 000 cycles (ce qui correspond à cinq années en orbite).*

*Les travaux approchent maintenant du stade de l'examen du concept de référence du réseau solaire, prévu pour la mi-avril.*

Module de la chambre

*Après réception des propositions de l'industrie, il a été recommandé à l'IPC de passer le contrat pour le module de la chambre avec Dornier, recommandation que ce Comité a approuvée à sa réunion de décembre. Un certain nombre de négociations se poursuivent au niveau du détail avec les sous-traitants portant notamment sur une meilleure définition des interfaces entre le module de la chambre et le PDA et sur une actualisation des diverses spécifications.*

resolved before a fixed-price contract can be concluded. These uncertainties and incomplete Phase-B activities are currently receiving maximum attention from both Contractor and Agency.

*Payload*
The contracts for the four major payload elements, namely Medium-Energy Detectors, X-Ray Mirrors, Focal Plane Assemblies and Electronics, have entered Phase II – the Engineering Model and Qualification Phase. A contract for the Gas-Scintillation Proportional Counter, a recent addition to the payload approved by the Science Programme Committee (SPC) last September, has been placed with Montedel Laben. Progress in all areas is largely satisfactory and according to plan, but there is some concern that the lead-glass collimator of the Medium-Energy Experiment may not fulfil all the stringent requirements placed on it.

Changes to all elements except the mirrors have been negotiated with the contractors and ratification by the Agency's Industrial Policy Committee (IPC) of contract riders is expected shortly.

The scientific-model programme is now regarded as complete, with evaluation of the long-beam testing of the x-ray mirrors nearing completion. The outcome of the programme is regarded as satisfactory in that unit design and performance goals have either been shown to be met or solutions for improvement have already been identified.

Preparations for the operational phase, including the observation programme, data handling and data reduction, are now under way.

*ESOC*
On the basis of internal studies carried out over the past months, a decision to maintain Villafranca (Madrid) as the ground station to support Exosat was taken. A detailed planning exercise has been initiated in ESOC for implementation of the modifications required at the station. These plans will be drawn up so as to minimise the potential conflict with IUE operations in later years.

## SPACE TELESCOPE

*Solar array*
Work by British Aerospace (BAe) on the Phase-B (Definition Phase) activities is continuing satisfactorily, concentrating on trade-off studies for the baseline design and the preparation of documentation to be supplied to NASA in order to support the Programme Requirements Review (PRR) of the Support System Module (SSM). This documentation was delivered to NASA in mid-January.

A special Interface Working Group meeting between NASA, ESA, BAe and LMSC, the NASA prime contractor for the SSM, was held in Sunnyvale, California. During this meeting specific and detailed interface areas, and structural, mechanical and electrical interfaces, were discussed.

At ESTEC, the thermal-cycling test with solar blanket samples from AEG-Telefunken (total of 28000 cycles, representing 5 years in orbit) was completed successfully.

Work is now progressing towards the Baseline Concept Review of the solar array, scheduled to be held in mid-April.

*Camera module*
Following the receipt of proposals from industry, a recommendation was made to the Industrial Policy Committee (IPC) for contract award to Dornier, which was approved by the IPC at its December meeting. A number of detailed negotiations with subcontractors are continuing. Special attention is being paid to a better definition of interfaces between the Camera Module and the Photon-Detector Assembly, and to an updating of the various requirement specifications.

*Photon-detector assembly*
Progress by BAe, the Prime Contractor, since the start of the Phase I (equivalent of Phase-B) activities has been satisfactory. Hardware manufacture of critical items in the detector-head unit has started, with encouraging results. A detailed system analysis of detector performance is being made.

*NASA activities*
Main emphasis has been related to the Space Telescope Project Requirements Review held in February, which was supported by ESA. At this review the Interface Requirements documents between the ESA elements and the Space Telescope have been reviewed.

Negotiations have been held with NASA (GSFC) to improve definition of the testing and integration philosophy for the Faint-Object Camera after delivery to NASA.

## SPACE SLED

The Preliminary System Design Review denoting the end of the first phase of the Sled Facility development programme, the Design Evaluation Phase, was held at ESTEC on 18/19 January. Contractor performance in achieving an overall system design concept was considered good, though the predicted total mass exceeds specification. A possible problem developing in the power-supply area could be avoided by a redefinition of a particularly stringent acceleration profile to one which, fortunately, is also more attractive to the scientific user community.

The preliminary design concept of the European Sled Experiment Package was reviewed at Mainz on 25 January. No major problems of incompatibility with the Sled Facility were identified, other than that of a significant increase in the predicted total mass above the previously agreed value.

## OUT-OF-ECLIPTIC

*Early history*
The latest of the ESA scientific projects officially started its active life in November 1977, when the Science Programme Committee formally authorised it. However, feasibility studies had been under way for a considerable time prior to this, and in April 1977 an invitation was made to

Détecteur de photons (PDA)
*Depuis la mise en route des activités de Phase I, les progrès réalisés par BAe, contractant principal chargé de la réalisation du PDA, ont été satisfaisants. Sur le plan des matériels, la fabrication des pièces critiques du détecteur proprement dit a commencé, avec des résultats encourageants. Une analyse détaillée des performances du détecteur au niveau système est en cours.*

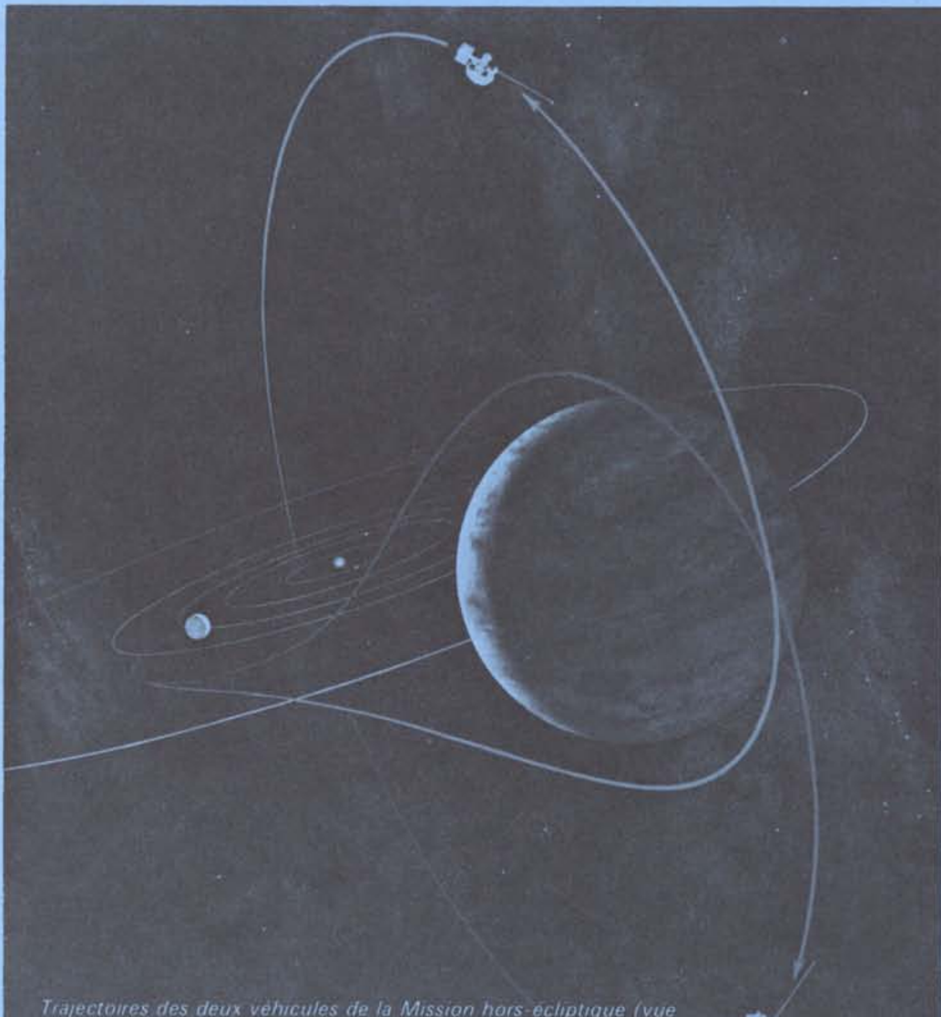
Activités de la NASA
*Les activités de la NASA ont porté principalement sur l'examen des impératifs du Projet qui s'est tenu en février et auquel l'ESA a participé. Les documents relatifs aux impératifs d'interface entre les éléments ESA et le Télescope spatial y ont été examinés.*

*Des négociations ont eu lieu avec le Goddard Space Flight Center de la NASA afin de définir de façon plus précise la ligne de conduite à adopter pour les essais et l'intégration de la chambre pour objets de faible luminosité après sa livraison à la NASA.*

# TRAINEAU SPATIAL

*L'examen préliminaire de la conception du système, qui marque la fin de la première phase du programme de développement du traîneau, c'est-à-dire de la phase d'évaluation de la conception, s'est déroulé à l'ESTEC les 18 et 19 janvier. La façon dont le contractant a conçu l'ensemble du système a été jugée bonne encore que la masse totale prévue dépasse la limite spécifiée. Il est apparu qu'un problème est susceptible de se poser dans le domaine de l'alimentation en énergie mais qu'on pourrait l'éviter en redéfinissant un profil d'accélération particulièrement rigoureux pour en retenir un autre qui, par chance, est également plus séduisant du point de vue de la communauté des utilisateurs scientifiques.*

*La conception préliminaire de l'ensemble européen d'expériences avec le traîneau a été passée en revue à Mayence le 25 janvier. Aucun problème important d'incompatibilité avec le traîneau n'a été relevé si ce n'est une augmentation notable de la masse totale prévue par rapport à la valeur précédemment convenue.*



*Trajectoires des deux véhicules de la Mission hors-écliptique (vue conceptuelle).*

*The trajectories of the two OOE spacecraft (artist's impression).*

# MISSION HORS-ECLIPTIQUE

Historique
*Le dernier en date des projets scientifiques de l'ESA a officiellement vu le jour en novembre 1977 lorsqu'il a été formellement approuvé par le Comité du Programme scientifique. Toutefois des études de faisabilité avaient été engagées fort longtemps avant cette date et dès avril 1977 la Communauté scientifique aux Etats-Unis et en Europe avait été invitée à proposer des expériences à embarquer sur les deux satellites que prévoit cette mission.*

La mission scientifique
*La Mission hors-écliptique (OOE) marque une nouvelle étape dans les activités de l'ESA puisqu'avec ce projet l'Agence s'attaque, pour la première fois, à la réalisation non d'un satellite destiné à graviter autour de la Terre mais d'une sonde pour l'espace lointain. Il s'agit également d'un fait sans précédent pour la recherche spatiale en général car aucune mission à ce jour n'a été conçue pour se dérouler hors du plan de l'écliptique (plan dans lequel se situent le Soleil et le système planétaire) afin d'explorer cette région et d'avoir une vue plongeante sur les régions polaires du Soleil.*

the scientific communities of USA and Europe to propose experiments to be flown on the spacecraft.

*The scientific mission*
The OOE mission represents a new development in ESA activities, since it is the first time that we have embarked on what is effectively a deep-space probe rather than an earth-orbiting satellite. It is also a novel activity for space research in general, since never before has a mission been designed to go out of the ecliptic plane (the plane containing the sun and the planetary system) to explore the out-of-ecliptic region and to look down upon the polar regions of the sun.

Because of the energy required, it is not possible to launch a spacecraft directly out of the ecliptic plane, and so OOE's initial trajectory will be directly away from the sun to pass by the giant planet Jupiter. The immense gravitational field of this planet gives a 'sling-shot' effect which will be used to put the spacecraft into orbit round the sun at right angles to the ecliptic plane. In this orbit the spacecraft will pass through a previously unexplored region of space and will also survey the sun from high latitudes, permitting hitherto impossible observations.

*Project organisation*
The Out-of-Ecliptic mission is a joint project with NASA in the same way that ISEE, launched in October 1977, was a joint project. Each Agency will provide one spacecraft and they will be launched in tandem, utilising the Shuttle and Integral Upper Stage (IUS). Part way towards Jupiter the two spacecraft are to be placed on slightly diverging trajectories so that one passes slightly north and the other slightly south of the Jovian equator. The 'sling-shot' effect referred to earlier will then force them out of the ecliptic plane. After passing over the polar regions of the sun, each spacecraft will recross the ecliptic plane and survey the other polar region. The accompanying figure (facing page) is an artist's impression of the trajectories.

Launch of the two spacecraft is foreseen for February 1983, the interplanetary passage to Jupiter will lasts approximately 18 months, and the complete mission to the second polar transit will take almost five years. This duration, and the harsh Jovian radiation environment, imposes severe conditions upon the design of subsystems and experiments and also upon the selection of components.

The present plan is to go to tender for the ESA spacecraft during the course of 1978, to conduct the Phase-B system development study during 1979 and to commence hardware during 1980. Jet Propulsion Laboratory (JPL), which is responsible within the USA for the NASA spacecraft, has a roughly comparable time scale.

*Scientific payload*
As with ISEE, the ESA and NASA spacecraft each have a complement of experiments provided by universities and research centres in the USA and Europe. The accompanying table shows the principal investigators for each of these. A total of more than 200 scientists in 65 centres are participating in the project. The stage is therefore set for the start of a new, and very exciting, scientific project which will, in the most literal sense, explore new frontiers of space.

**OUT OF ECLIPTIC – SCIENTIFIC PAYLOAD**

| *Principal Investigator* | *Institution* | *Experiment Title* |
|---|---|---|
| **ESA SPACECRAFT** | | |
| S.J. Bame | Los Alamos Scientific Lab. | Plasma spectrometer |
| G. Gloeckler/J. Geiss | Univ. Maryland/Univ. Bern | Solar-wind ion composition spectrometer |
| E. Gruen | Max-Planck Institute, Heidelberg | Cosmic dust |
| P. Hedgecock | Imperial College London | Magnetic field measurements |
| K.C. Hurley/ M. Sommer | CESR Toulouse/MPI Garching | Solar x-ray, cosmic gamma ray and Jovian x-ray |
| L.J. Lanzerotti | Bell Laboratories | Low-energy heliospheric spectrum, composition and anisotropy |
| J.A. Simpson | Univ. Chicago | Cosmic ray and solar particle |
| R.G. Stone | Goddard Space Flight Center | Plasma waves |
| **NASA SPACECRAFT** | | |
| M.H. Acuna | Goddard Space Flight Center | Magnetic fields |
| T.L. Cline | Goddard Space Flight Center | Solar x-ray and cosmic gamma-ray |
| R.H. Giese | Rühr-University, Bochum | Zodiacal light |
| R.M. MacQueen | High Altitude Laboratory | White light coronagraph and x-ray XUV telescope |
| H. Rosenbauer | Max-Planck Institute, Lindau | Fluid parameters of interstellar gas |
| H. Rosenbauer | Max-Planck Institute, Lindau | Solar wind |
| E.C. Stone | California Institute of Technology | Comprehensive particle analysis |
| R.G. Stone | Goddard Space Flight Center | Plasma waves |

*Un satellite ne pouvant être lancé directement hors du plan de l'écliptique en raison de l'énergie qu'exigerait l'opération, la trajectoire initiale suit une direction opposée à celle du Soleil de façon à passer à proximité de la planète géante Jupiter. L'enorme champ gravitationnel de cette planète produit un effet de 'catapulte' qui est mis à profit pour placer le satellite sur une orbite circumsolaire perpendiculaire au plan de l'écliptique. Cette orbite amène le satellite à traverser une région de l'espace qui n'avait pas encore été explorée, en même temps qu'elle permet d'observer le Soleil à partir de latitudes élevées ce qui était impossible jusqu'ici.*

Organisation du projet

*La Mission hors-écliptique est un projet conjoint ESA/NASA comme ce fut déjà le cas pour ISEE, lancé en octobre 1977. Les deux Agences fournissent chacune un satellite, à lancer en tandem au moyen de la Navette relayée par l'IUS Integral Upper Stage). Au cours de leur trajet vers Jupiter, les deux satellites sont placés sur des trajectoires légèrement divergentes ce qui les conduit à passer l'un, légèrement au nord, l'autre, légèrement au sud de l'équateur jovien. Sous l'effet de 'catapulte', déjà mentionné, ils sont alors rejetés hors du plan de l'écliptique. Après avoir survolé les régions polaires du Soleil, chacun des satellites traverse à nouveau le plan de l'écliptique et observe l'autre région polaire. Sur la figure ci-jointe sont représentées les trajectoires de chaque satellite.*

*Le lancement des deux satellites est prévu pour février 1983, le voyage interplanétaire vers Jupiter durant approximativement dix-huit mois et l'ensemble de la mission jusqu'au second passage au-dessus des pôles devant couvrir près de cinq années. La longue durée de la mission s'ajoutant à l'environnement très rigoureux constitué par les rayonnements joviens impose de sévères conditions tant en ce qui concerne la conception des sous-systèmes et des expériences que la sélection des composants.*

*On prévoit actuellement de lancer un appel d'offres pour le satellite de l'ESA dans le courant de l'année 1978, de procéder à l'étude de développement du système de phase B en 1979 et d'entamer la réalisation des matériels en 1980. Le Jet Propulsion Laboratory (JPL) qui est le responsable aux Etats-Unis du satellite de la NASA, a un calendrier sensiblement comparable.*

La charge utile scientifique

*Comme pour ISEE, les satellites de l'ESA et de la NASA emportent chacun des expériences fournies par des universités et centres de recherche américains et européens. Le tableau ci-dessons donne la liste des Chercheurs principaux. Au total cependant ce sont plus de 200 scientifiques, appartenant à 65 centres, qui participent au projet. Les éléments sont donc en place pour le démarrage d'un projet scientifique nouveau et particulièrement passionnant qui, au sens le plus littéral du terme, permettra de repousser les frontières de l'espace exploré.*

**MISSION HORS-ECLIPTIQUE – CHARGE UTILE SCIENTIFIQUE**

| *Chercheurs principaux* | *Organisme* | *Expérience* |
|---|---|---|
| VEHICULE SPATIAL ESA | | |
| S.J. Bame | Los Alamos Scientific Lab. | Spectromètre (étude du plasma) |
| G. Gloeckler/J. Geiss | Univ. Maryland/Univ. Bern | Spectromètre (composition ionique du vent solaire) |
| E. Gruen | Max-Planck Institute, Heidelberg | Poussière cosmique |
| P. Hedgecock | Imperial College London | Mesures du champ magnétique |
| K.C. Hurley/ M. Sommer | CESR Toulouse/MPI Garching | Rayonnements X solaire, $\gamma$cosmique et X jovien |
| L.J. Lanzerotti | Bell Laboratories | Composition et anisotropie du spectre héliosphérique faible énergie |
| J.A. Simpson | Univ. Chicago | Rayonnement cosmique et particules solaires |
| R.G. Stone | Goddard Space Flight Center | Ondes plasmiques |
| VEHICULE SPATIAL NASA | | |
| M.H. Acuna | Goddard Space Flight Center | Champs magnétiques |
| T.L. Cline | Goddard Space Flight Center | Rayonnements X solaire et $\gamma$ cosmique |
| R.H. Giese | Rühr-University, Bochum | Lumière zodiacale |
| R.M. MacQueen | High Altitude Laboratory | Coronographe en lumière blanche et télescope UV lointain en rayont. X |
| H. Rosenbauer | Max-Planck Institute, Lindau | Paramètres de fluide du gaz interstellaire |
| H. Rosenbauer | Max-Planck Institute, Lindau | Vent solaire |
| E.C. Stone | California Institute of Technology | Etude globale des particules |
| R.G. Stone | Goddard Space Flight Center | Ondes plasmiques |

# L'Agence Spatiale Européenne et le Droit de l'Espace

*M. Bourély, Conseiller Juridique, ESA, Paris*

**L'ensemble des textes qui constituent le 'droit de l'espace' est élaboré depuis 1957 par l'Organisation des Nations-Unies*. Organisation internationale intergouvernementale, dotée de la personnalité juridique, l'Agence Spatiale Européenne est intéressée au premier chef à la formation et au développement de ces règles, dont certaines s'imposent plus spécialement aux activités et programmes qu'elle exécute dans l'espace.**

## LES ACCORDS SPATIAUX SONT APPLICABLES A L'ESA

Pour l'instant, le 'droit de l'espace' est seulement constitué par les divers accords internationaux, conclus sous les auspices des Nations-Unies. Il ne semble pas que des textes législatifs purement nationaux soient venus – du moins en Europe – les compléter. Il existe actuellement quatre accords spatiaux:

- le Traité sur les principes devant régir l'activité des Etats dans le domaine de l'espace extra-atmosphérique, ouvert à la signature le 27 janvier 1967 et entré en vigueur le 10 octobre 1967
- l'Accord sur le sauvetage des astronautes, le retour des astronautes et la restitution des objets lancés dans l'espace, ouvert à la signature le 22 avril 1968 et entré en vigueur le 3 décembre 1968.
- la Convention sur la responsabilité internationale pour les dommages causés par des objets spatiaux, ouverte à la signature le 22 mai 1972 et entrée en vigueur le 1er septembre 1972
- la Convention sur l'immatriculation des objets lancés dans l'espace, ouverte à la signature le 14 janvier 1975, entrée en vigueur le 15 septembre 1976.

Comme l'indique expressément l'article XIII du Traité de l'Espace de 1967, les droits et obligations résultant de ces accords spatiaux appartiennent ou incombent au premier chef aux Etats souverains qui les ont signés. Sur l'insistance, en particulier, des Etats membres des organisations spatiales européennes, les accords internationaux ultérieurs sont allés un peu plus loin que ce que prévoyait le Traité, sans pour autant laisser les organisations internationales devenir des 'parties'. Chacun des trois accords actuellement signés contient, en effet, une clause** ouvrant la possibilité d'étendre ces dispositions à toute organisation internationale intergouvernementale qui se livre à des activités spatiales et qui se trouve, dès lors, liée en tant que telle. Cette clause fait même une obligation aux Etats qui sont à la fois partie à l'un des accords et membres d'une organisation 'spatiale' de prendre des mesures à cet effet.

Cette extension est soumise, dans chaque cas, à la double condition que la majorité des Etats membres de l'Organisation en question ait signé et ratifié tant le Traité que l'Accord particulier en cause et que l'Organisation fasse, de son côté, une déclaration formelle d'acceptation des droits et obligations résultant de cet accord.

A l'heure actuelle, le Conseil de l'ESA a déjà approuvé le texte de deux Déclarations d'acceptation[†], l'une de l'Accord sur le sauvetage des astronautes, l'autre de la Convention sur la responsabilité, qui ont été transmises par le Directeur général aux Gouvernements dépositaires et au Secrétaire général des Nations-Unies. La même procédure sera suivie lorsque les conditions requises seront remplies à l'égard de la Convention sur l'immatriculation.[††]

## LES ACCORDS SPATIAUX REGISSENT LES ACTIVITES DE L'ESA

Alors que le Traité de l'Espace ne peut influencer les activités de l'ESA que par l'intermédiaire de ses Etats membres qui assument eux-mêmes la responsabilité de son application, les autres accords spatiaux sont – ou seront – directement applicables à l'ESA. Ils auront donc des répercussions sur le fonctionnement de l'Agence tant vis-à-vis de l'extérieur que dans les relations internes entre ses Etats membres.

Trois questions, qui font l'objet des accords déjà signés, sont d'une particulière importance pour les activités actuelles de l'ESA:

### 1. LA RESPONSABILITE INTERNATIONALE

Pour l'exécution de ses programmes, l'Agence a fait et fera lancer ses satellites par la NASA et effectuera elle-même des lancements avec le lanceur européen Ariane.

* *Cette élaboration s'effectue dans le cadre du Comité sur l'utilisation pacifique de l'espace extra-atmosphérique dit 'Comité de l'Espace' qui compte actuellement 37 membres, chiffre qui doit être porté à 47 en 1978. Le Comité a créé deux sous-Comités, l'un scientifique et technique, l'autre juridique. Les projets de Traités ou d'Accords qui résultent des travaux du Comité de l'Espace sont ensuite transmis pour adoption à l'Assemblée générale. L'ESA a le statut d'observateur auprès du Comité de l'Espace depuis 1968.*

** *Article 6 de l'Accord sur le sauvetage, article XXII de la Convention sur la responsabilité, article VII de la Convention sur l'immatriculation des objets spatiaux.*

† *Ces déclarations sont établies au nom de l'Organisation Européenne de Recherches Spatiales conduisant ses activités sous le nom d'Agence Spatiale Européenne. En vertu de l'article XIX de la Convention portant création de l'ESA, elles resteront en vigueur après l'entrée en vigueur de ladite Convention.*

†† *En ce qui concerne les Etats membres de l'Agence,:*
- *l'Accord sur le sauvetage des astronautes a été ratifié par l'Allemagne, la Belgique, le Danemark, la France, l'Italie, la Suède, la Suisse et le Royaume Uni;*
- *La Convention sur la responsabilité a été ratifiée par l'Allemagne, la Belgique, le Danemark, la France, l'Italie, la Suède, la Suisse, et le Royaume-Uni;*
- *la Convention sur l'immatriculation a été ratifiée par la France, la Belgique, le Danemark, la Suède et la Suisse (signée en outre par l'Allemagne et le Royaume-Uni).*

††† *Résolution ESA/C/XXII/Rés. 3 du 13 décembre 1977. Elle a pour objet essentiel de poser des principes pour la conduite d'un différend (rôle de l'Agence) et pour la répartition de la charge financière entre Etats participants.*

Elle construit le Spacelab qui volera comme partie intégrante de la Navette spatiale développée par les Etats-Unis. Plus tard, elle se livrera à des activités opérationnelles pour le compte d'utilisateurs.

Dans tous les cas, la responsabilité internationale de l'Agence peut être mise en cause. Pour résoudre les divers aspects de cette question, qui est fort complexe, le Conseil a adopté, lors de sa 22ème session, une Résolution relative à la responsabilité juridique de l'Agence.[†††]

2. LE STATUT DE L'OBJET SPATIAL

Au titre des divers Arrangements conclus avec ses Etats membres, l'Agence est propriétaire, en leur nom, des objets spatiaux au financement desquels lesdits Etats membres ont contribué. L'acceptation par l'Agence de la Convention sur l'immatriculation – lorsque celle-ci sera entrée en vigueur – amènera à définir les mesures pratiques d'application de ce principe.
Il est d'ores et déjà acquis qu'une organisation internationale peut tenir le registre sur lequel seront portés les satellites dont elle a la propriété et en informer le Secrétaire général des Nations- Unies. Il restera à déterminer quel sera celui des Etats membres qui exercera, au nom de la collectivité, la juridiction et le contrôle sur l'objet spatial, qui restent de compétence étatique, en vertu de l'article VIII du Traité de l'Espace.

3. L'ASSISTANCE DANS L'ESPACE

Dans sa Déclaration d'acceptation de l'Accord sur le sauvetage, qui a maintenant force opérative, l'Agence a stipulé, de façon explicite, qu'elle se considérait comme 'autorité de lancement' au sens de l'article 6 de la Convention sur le sauvetage. Elle est donc tenue à tous les devoirs d'assistance dans l'Espace qui découlent de cet Accord.

## QUEL PEUT ETRE LE ROLE DE L'ESA DANS L'ELABORATION DES REGLES NOUVELLES?

Etant donné que l'élaboration des règles nouvelles du droit de l'espace est d'un intérêt direct et primordial pour les activités présentes et futures de l'ESA, il est essentiel que celle-ci soit associée aux travaux qui conduiront à la conclusion de nouveaux accords spatiaux. On peut ainsi mentionner parmi les questions qui sont encore à l'étude aux Nations-Unies la radiodiffusion directe par satellites, l'observation des ressources terrestres, la délimitation de l'espace extra-atmosphérique et le statut de l'orbite géostationnaire, dont les incidences sur les activités de l'Agence sont des plus importantes.

D'autre part, l'ESA peut apporter le concours de son expérience antérieure et de sa connaissance des problèmes actuels à tous ceux qui, dans ses Etats membres et au sein des Nations-Unies, travaillent à l'élaboration des règles du futur droit de l'Espace.

Concrètement, cette participation de l'ESA à l'élaboration des nouveaux accords spatiaux se manifeste sur deux plans:
- à l'intérieur de l'Agence, le Conseil a créé un Groupe Consultatif des Relations Internationales (IRAC) chargé particulièrement d'assurer la concertation – qui entre dans la mission de l'ESA – entre les Etats membres, en ce qui concerne les travaux des Nations-Unies et plus particulièrement ceux du Comité sur l'utilisation pacifique de l'espace extra-atmosphérique (COPUOS) et les sous-comités qui en dépendent;
- aux Nations-Unies où l'Agence est représentée aux réunions du COPUOS et entretient des relations de travail excellentes et constructives avec le Secrétariat général.

Ainsi, l'Agence Spatiale Européenne est impliquée au premier chef dans l'élaboration et l'application du droit de l'Espace. De par la nature de ses activités, qui s'exercent à l'échelle mondiale, elle est directement soumise aux règles déjà adoptées et elle a un intérêt tout particulier à être associée étroitement à l'élaboration des règles nouvelles du droit de l'espace qu'elle devra plus tard respecter. Il est donc justifié qu'elle puisse faire connaître ses besoins propres et mette son expérience au service de tous les Etats qui, au sein des Nations-Unies, définissent le droit de l'Espace. □

# The Earthnet Programme

*L. Marelli, Earthnet Manager, Directorate of Planning and Future Programmes, ESA, Paris*

**As a first step towards the establishing of a European Remote-Sensing Space Programme, the Council meeting at Ministerial level approved the Earthnet Programme in February 1977. This article attempts to outline the objectives, structure, interfaces, planning and prospects of this European network for the acquisition, preprocessing, archiving and distribution of remote-sensing satellite data, roughly one year after its birth.**

The importance of monitoring the earth and its environment continuously from space for the control of environmental parameters and conservation of resources is now widely recognised. Applications of such monitoring using space remote-sensing techniques include:
- agriculture (crop inventory and forecasting, forestry, etc.)
- geology (assessment of mineral resources)
- hydrology (water resources evaluation, etc.)
- ocean monitoring and surveillance
- snow and ice mapping and surveillance
- environmental control and pollution monitoring, and
- cartography.

ESA is actively engaged in the elaboration of a European Remote-Sensing Satellite Programme to be proposed to its delegate bodies in the near future. As a first step towards the setting up of such a programme, Earthnet was approved as an Optional Programme in February 1977. For the time being, the programme is financed by eight of the Agency's Member States (Belgium, France, Germany, Ireland, Italy, Spain, Sweden and the United Kingdom). It is hoped, however, that the remaining Member States (Denmark, The Netherlands and Switzerland) will also participate in Earthnet in the near future, allowing the Programme to become a part of the basic activities of the Agency.

## EARTHNET'S ACTIVITIES

The *prime objective* of Earthnet in the short term is to promote and increase European expertise in the use of space-derived remote-sensing imagery. This is considered a fundamental prerequisite for the success of a European remote-sensing programme, for which Earthnet would constitute the basis of the ground segment.

The tasks of Earthnet comprise:
- *acquisition* of remote-sensing data in a systematic fashion
- *data preprocessing*, i.e. calibration and correction of data both geometrically and radiometrically
- *distribution* of imagery with acceptable delays to users
- *archiving* of all imagery acquired to allow historical and/or multi-temporal studies.

Table 1 lists the salient characteristics of the remote-sensing missions that are or will be handled by Earthnet within its present terms of reference.

The key issues that underlie the tasks mentioned above are:
- Continuity: only if a long-term commitment to the provision of remote-sensing data exists, will the user community be in a position to make the necessary investments in data interpretation facilities and personnel.
- Promotion: prices of products need to be subsidised because the remote-sensing market is not yet commercially selfsupporting.
- Delivery time: rapid availability of data is a fundamental prerequisite for any application aimed at becoming operational.
- Multiplicity of mission: none of the existing remote-sensing missions alone can solve all the problems connected with the potential applications of this technology.

The *second objective* of Earthnet is to make use of all the expertise available in Europe at a national level in the fields of acquisition and preprocessing of remote-sensing data. This is why the facilities upon which Earthnet relies, with the single exception of the distribution centre housed at ESRIN (Frascati), are national ones offered by Member States for integration into the network. This approach has the advantage of reducing the Agency's direct investment in the programme, giving it much

TABLE 1

*Summary characteristics of NASA remote-sensing satellites for earth survey, marine and environmental monitoring applications (approved programmes only)*

| SATELLITE | ORBIT ALTITUDE (km) | ORBIT INCLI-NATION | ORBIT REPETITION RATE | LAUNCH DATE | MAIN IMAGING SENSORS | GROUND RESOLUTION (m) | NO. OF SPECTRAL BANDS | SWATH FIELD OF VIEW (km) |
|---|---|---|---|---|---|---|---|---|
| LANDSATS 1 and 2 | 920 | 99 | 18 d | 7/72 and 1/75 | MSS<br>RBV | 80<br>80 | 4<br>3 | 105<br>185 × 185 |
| LANDSAT-C | 920 | 99 | 18 d | 1978 | MSS<br>RBV | 80<br>40 | 5<br>1 (stereo) | 185<br>130 × 130 |
| HCMM (Heat Capacity Mapping Mission) | 600 | 98 | 12 h | 1977 | Heat Capacity Mapping Radiometer | 500 | 2 | 700 |
| SEASAT-A | 800 | 108° | N/A<br>36 h | 1978 | SAR<br>SMMR<br><br><br>V/IR Scanner | 25<br>16-144 km (function frequency)<br>3 km (vis)<br>5 km (IR) | <br>5 | 100<br>(250-350 off nadir)<br>900<br>1800 |
| NIMBUS-G | 925 | 99 | 2-3 days | 1978 | CZCS<br>SMMR | 800<br>Similar to SEASAT | 6<br>4<br>(+ 2 pols) | <br>600 |

Key to abbreviations:

| | | | |
|---|---|---|---|
| MSS | Multi-Spectral Scanner | CZCS | Coastal Zone Colour Scanner |
| RBV | Return-Beam Vidicon | SMMR | Scanning Multichannel Microwave Radiometer |
| SAR | Synthetic-Aperture Radar | | |

greater flexibility and decentralisation. The Agency's role is intended to remain, to the maximum extent possible, one of co-ordination, supervision and promotion.

The *third objective* is to tune the quantitative and qualitative level of the services offered to users to their actual requirements, still bearing in mind that Earthnet responsibility ends at data preprocessing and that the task of data interpretation and feature extraction remains the responsibility of the users. In other words, Earthnet is expected to increase the number of remote-sensing missions to be handled and to bring the standards of its products in line with the users' demands for improved service.

Finally, Earthnet aims to become a forum for all European remote-sensing data users, a medium through which they can exchange information, experiences and results, and an opportunity for them to elaborate new proposals for improving the effectiveness of remote-sensing missions, in terms of either space or ground segment.

## EARTHNET'S STRUCTURE

Figure 1 identifies the various elements of the network and shows their functional relationship, while Figure 2 shows the approximate coverage zones of the different Earthnet stations for the various missions they are intended to handle.

Figure 3 is a preliminary implementation chart for the various facilities and missions, including a few planned missions that would represent a logical extension of Earthnet's present terms of reference.

The structure of the basic network of acquisition stations has largely been dictated by the characteristics of the missions handled by or planned for by Earthnet, namely

(a) Satellites focussing primarily on land applications and working, at least until the mid-1980s, in the visible and infrared parts of the spectrum (Landsats 1, 2, C, D, D', etc.)

(b) Satellites designed mainly for sea and coastal-zone applications and using active and passive micro-wave type sensors (Seasat A, B, C, etc.), although Synthetic-Aperture-Radar (SAR) type data are also

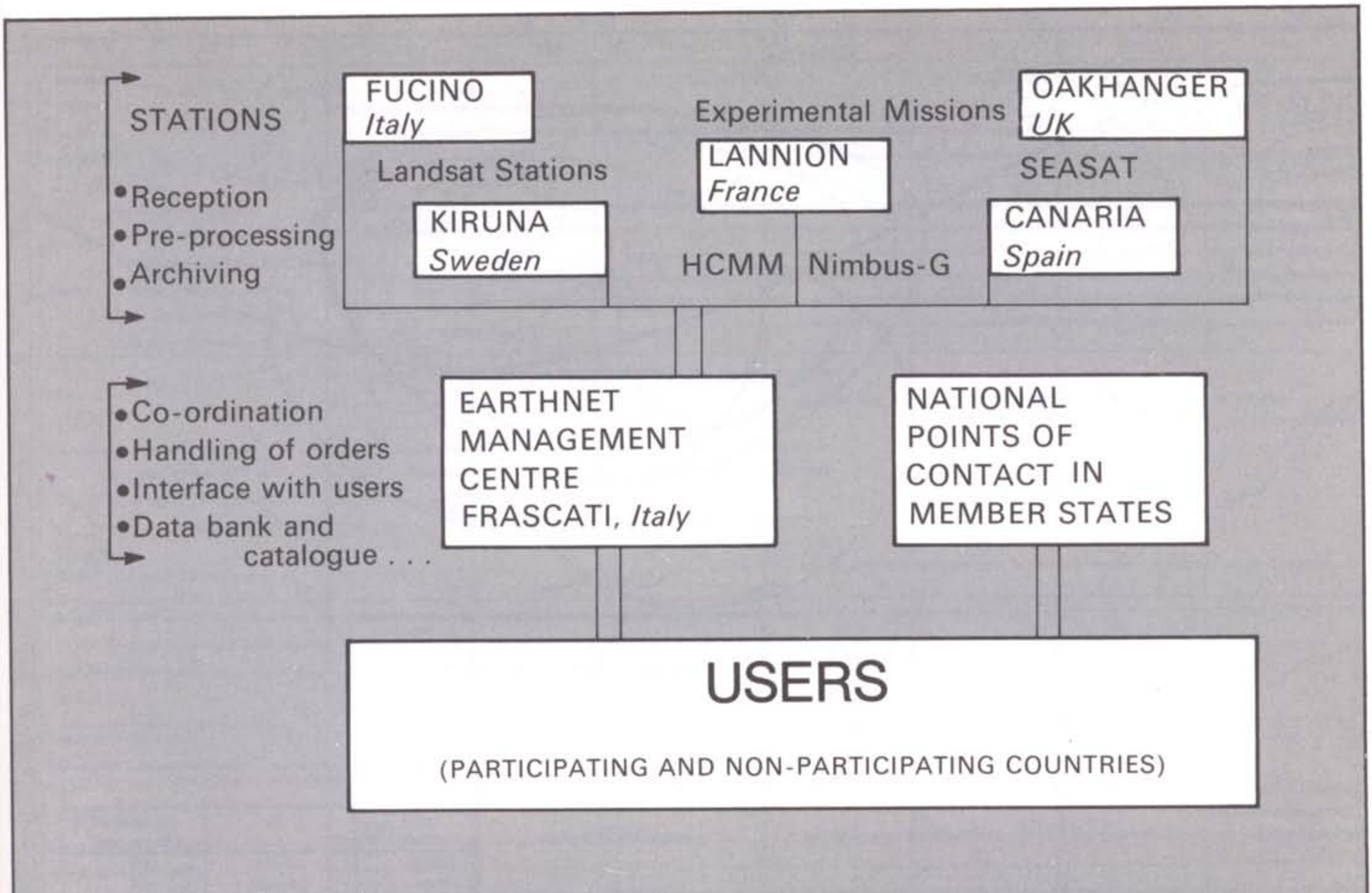



*Figure 1 — Organisation of Earthnet.*

expected to be useful for land applications

(c) Experimental satellites without any assured follow-on (e.g. HCMM, Nimbus-G).

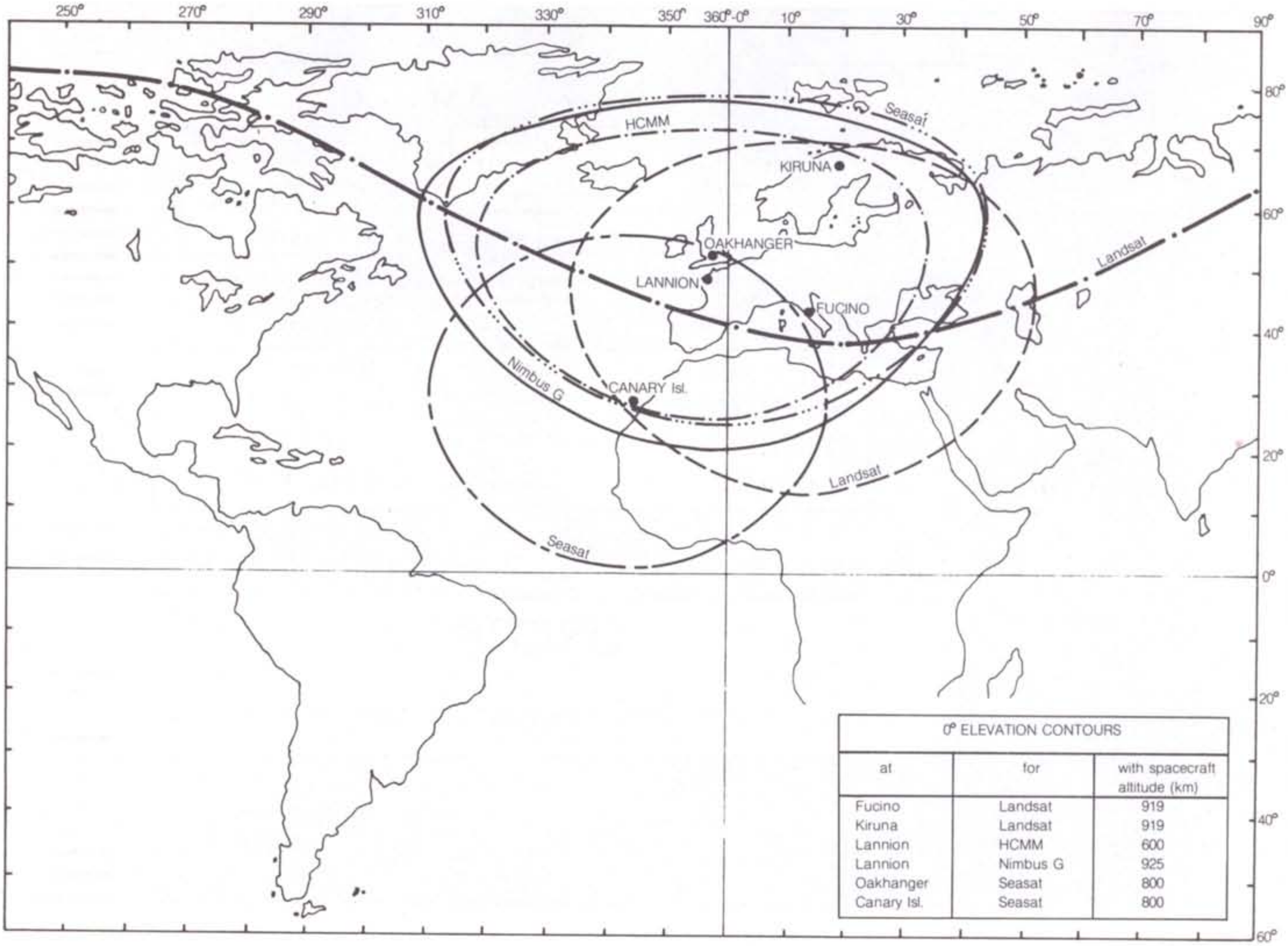
The Fucino (Italy) and Kiruna (Sweden) stations will handle type (a) missions and, in view of their long-term interest, the Agency plans to become partial or sole owner of these facilities. The Oakhanger (UK) and Maspalomas (Canary Islands) stations will operate with type (b) missions; the Agency will contribute financially to the procurement of part of the equipment and of an SAR processor in these cases. It is envisaged that the French station at Lannion and part of the Maspalomas station will be used for type (c) missions. The Agency plans to limit its own financial involvement in stations of this last type.

## INTERFACES WITH THE OUTSIDE WORLD

As already mentioned, all the ground stations used by Earthnet are national facilities that have been offered for integration into the network and have been adapted as necessary to meet European needs. The Agency has, or will draw up, a Memorandum of Understanding and a yearly renewable contract with each of the national authorities responsible for these facilities, setting out the legal, technical and financial framework for integration of the facility into Earthnet.

As regards interfaces with the user community, Member States have been invited to appoint, if they so desire, a 'National Point of Contact (NPOC)' to Earthnet, to be responsible for the distribution of remote-sensing data to the national user community, to promote its utilisation, and to arrange for an exchange of information between users on methods employed and results obtained. Most Member States have in fact already nominated an NPOC.

For the time being, the Earthnet/NPOC relationship is focussed on the distribution of Landsat imagery, but it may in future be extended to include data from experimental missions, which are handled slightly differently. The central distribution facility in Frascati is charged with the distribution of Landsat imagery to users not served by NPOCs and international organisations, plus experimental data. The pricing policy adopted implies the subsidising of the prices charged for Landsat imagery to bring them into line with those charged in the USA. Data from




| 0° ELEVATION CONTOURS | | |
|---|---|---|
| at | for | with spacecraft altitude (km) |
| Fucino | Landsat | 919 |
| Kiruna | Landsat | 919 |
| Lannion | HCMM | 600 |
| Lannion | Nimbus G | 925 |
| Oakhanger | Seasat | 800 |
| Canary Isl. | Seasat | 800 |

*Figure 2 —Approximate coverage zones of the Earthnet stations for the various observational satellites.*

the purely experimental remote-sensing missions such as Seasat will be distributed at no cost to Principal Investigators or their equivalent, and at cost of reproduction to others.

With reference to Earthnet interfaces with NASA, a Memorandum of Understanding for access to data from the Landsat series of satellites is being negotiated and will be signed shortly. Similar negotiations have taken place for the other missions handled by Earthnet and it is anticipated that formal agreements will soon be reached in these cases also.

The main principles agreed upon by ESA and NASA for inclusion in the Memoranda are:

- Open and nondiscriminatory distribution of data at fair and reasonable prices to all interested Landsat data users.
- Distribution of data to Principal Investigators whose test sites are within the coverage areas of an Earthnet station on the same conditions agreed upon by NASA and in a format of equivalent standard to that of NASA.
- Distribution of data at cost of reproduction to other users whose investigations are considered meritorious by the two Agencies, for the purpose of allowing them to carry out their proposed investigation.

It is worth noting that agreement on missions such as Seasat-A will involve the participation of European scientists in the management of the missions themselves, including their operations. In effect, European representatives will be members of the Seasat experiment teams and probably of the Steering Committee also.

## PROGRAMME PLANS AND PERSPECTIVES

Figure 3 gives an outline of Earthnet activities for the

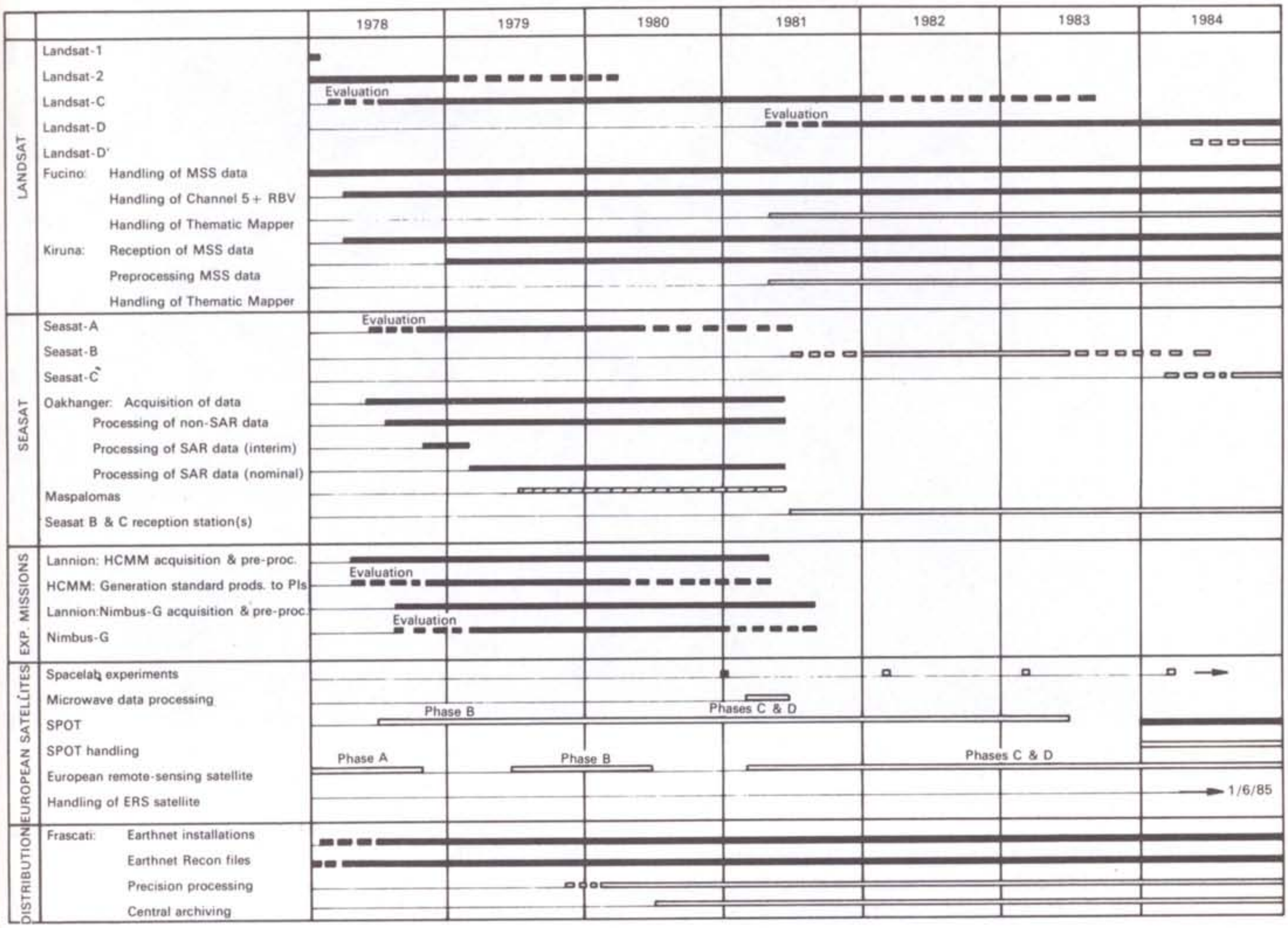



*Figure 3 — Preliminary implementation chart for Earthnet facilities and missions, including some activities still in the planning stage.*

foreseeable future, including those both approved and planned. The main effort for the first few years will be devoted to the establishment of a basic network of acquisition stations and to the provision of a limited set of standard products to users. The result of this initial effort should be the establishment of a basic European capacity to handle data from both American and European remote-sensing satellites. Thereafter effort will have to be switched to the provision of higher standard products tailored to the needs of users, as well as to the widening of the scope of the programme to include second-generation remote-sensing missions such as Landsat-D and D', Seasat-B and C, the Shuttle remote-sensing experiments, and of course the planned European remote-sensing missions, including the microwave experiment and metric camera to be carried on the first Spacelab flight.

## COMPLEXITY OF THE TASK

One of the characteristics of the Earthnet Programme is that it involves the implementation of an operational acquisition and distribution service aimed at a wide and inhomogeneous user community. Beyond the quality-control aspects, it involves marketing, promotion and training. Furthermore, the technical problems to be solved in setting up a network such as Earthnet are numerous, and in some cases involve technology in the front line of today's developments. By way of example,

- The very high bit rates generated by remote-sensing satellites impose severe performance constraints on the entire receiving chain, including antenna, amplifiers, down-converters, receivers, bit conditioners, recorders, etc. Furthermore, the tracking speed called for by the low-orbit missions handled tends to limit the size of the antenna dish that can be used.
- The large data volume, together with some near-real-time requirements on availability of data, imposes

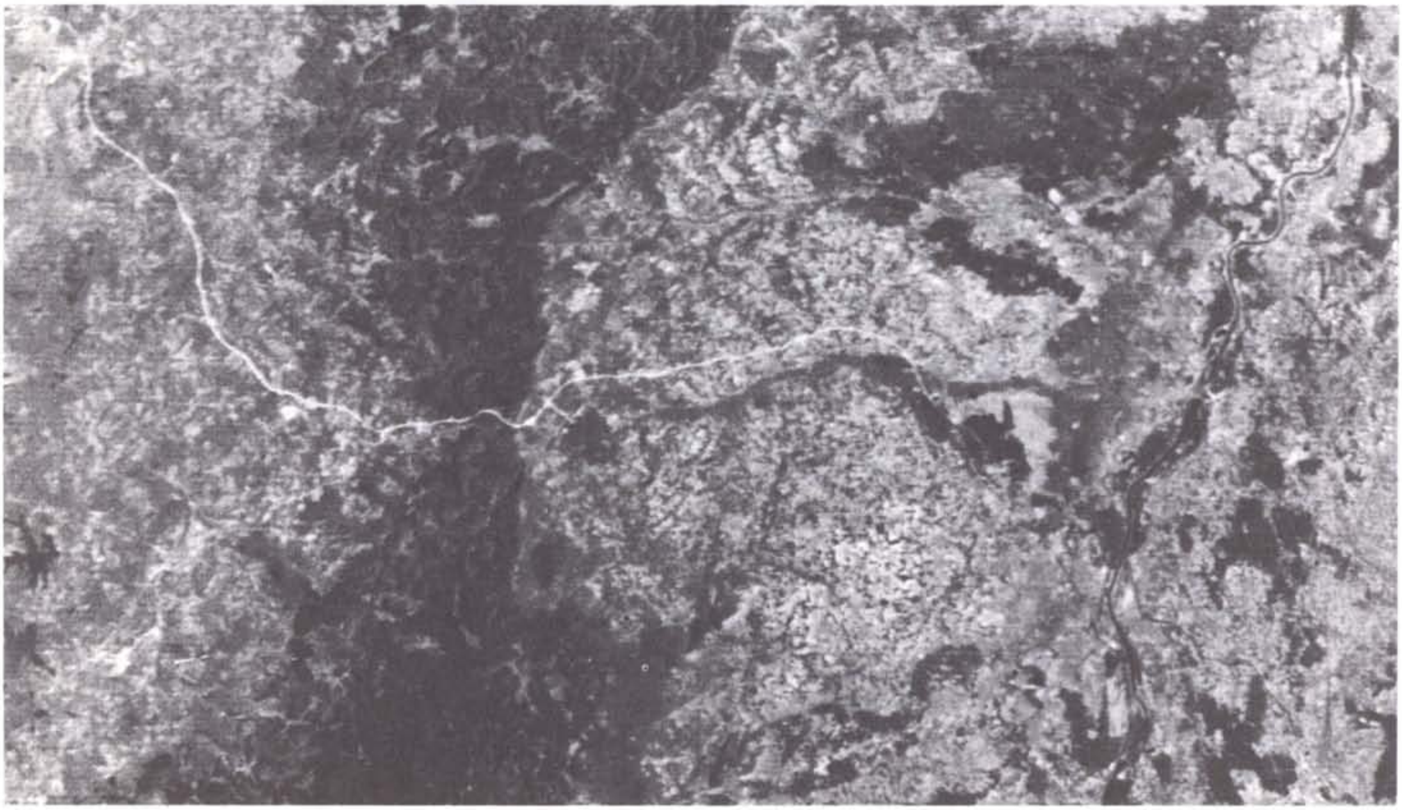


*Figure 4 — Landsat false-colour composite received and processed by Telespazio.*

important constraints on computing power and on the throughput capability of the processing facilities. For example, SAR data (after digitisation) requires a recorder capable of operating at up to 120 Mbit/s, which is very close to the limit of what the commercial market can presently supply.

- The preprocessing step is one of the most demanding, in terms of both volume and strictness of geometric- and radiometric-correction requirements. As an example, Landsat preprocessing involves a radiometric correction implying either statistical analysis of incoming imagery, or evaluation of the calibration wedges transmitted with data in order to obtain gain and offset for each sensor, as well as a geometric correction which will compensate for earth rotation, mirror scan nonlinearity, attitude, altitude, spectral-band offset, line equalisation, etc.

One of the most challenging tasks for Earthnet will be the preprocessing of Seasat synthetic-aperture-radar data, which will constitute the first example of spaceborne SAR sensor generated imagery. The SAR processor being developed has to cope with the extreme bit rate and reconstruct the image from the radar returns, taking into account classical SAR processing elements as well as those specific to the space application, such as range-walk problems originating from wave-front curvature and earth rotation.

## CONCLUSION

Although only a year has elapsed since the creation of Earthnet, several positive achievements can already be recounted:

- The Landsat station at Fucino has operated within Earthnet since 1 April 1977.
- The second Landsat station at Kiruna will start data acquisition on 1 March 1978.
- The Lannion and Oakhanger stations will start operations in April 1978.
- The Landsat Memorandum of Understanding with NASA has been approved and the others will be finalised shortly.
- Five agreements with NPOCs have been signed and the rest will follow in the near future.
- In the first six months of the programme, 533 Landsat orbits were acquired, corresponding to more than 14 000 scenes; more than 50 000 'quick-looks' at archived imagery were generated; some 300 Computer Compatible Tapes (CCTs) and over 850 photographic images were generated and distributed to users.

Much still remains to be done, but we are confident that given the full support of our Earthnet partners we will be more than able to achieve the aims and aspirations for the programme that have been outlined in this brief review. □

# LEDA: Une Banque de Données de l'ESA consacrée aux images de la Terre vue de l'Espace

*G.A. Proca, Service de Documentation Spatiale, ESA, Frascati, Italie*

**L'exploitation efficace des images de télédétection spatiale suppose que l'utilisateur soit informé en temps utile de leur existence même et connaisse leurs caractéristiques principales. Cela pose un problème de nature documentaire qui a été résolu par la création d'une Banque de Données spécialisée. La mise en oeûvre de cette dernière auprès du Service de Documentation Spatiale (SDS) de l'ESA rend possible son interrogation en temps réel et mode conversationnel par le moyen de terminaux d'emploi facile reliés à l'ordinateur du SDS sur le réseau commuté. De plus, l'utilisateur peut se servir du terminal pour passer commande de l'imagerie dont il a besoin au cours même d'une recherche effectuée sur la Banque de Données.**

## NECESSITE D'UNE BANQUE DE DONNEES

L'avènement des satellites consacrés à l'observation de la terre, et plus spécialement de ceux qui sont voués à l'étude des ressources terrestres ou aux phénomènes écologiques, a été marqué, entre autres, par une augmentation impressionnante de l'information transmise au sol. En effet, des quelques kilobits nécessaires aux premiers satellites scientifiques, on est passé à 15 Mbit/s pour les satellites Landsat puis à 180 Mbit/s pour Seasat-A.

Cette masse d'informations ne peut représenter fidèlement la réalité au sol qu'après divers traitements effectués sur des ordinateurs puissants: il s'agit d'éliminer les distorsions introduites lors de la prise de vues par des effets instrumentaux dus aux senseurs. Il faut aussi tenir compte des inévitables variations d'orbite, de l'attitude du satellite sur son orbite et des effets liés à la rotation de la Terre. Mais, même après toutes ces opérations, l'information contenue dans les innombrables images de la Terre ainsi obtenues, demeure pratiquement inutilisable tant qu'elle n'est pas *décrite* en un langage simple et que son *existence* même n'est pas largement connue et diffusée.

Il faut donc créer une *documentation* identifiant les caractéristiques principales de chaque scène enregistrée et il est nécessaire de rendre cette documentation accessible aux utilisateurs potentiels – à la limite, à tous les habitants de la planète.

C'est cette documentation qui est contenue dans la Banque de Données LEDA. Cet acronyme, qui signifie 'on *L*ine *E*arthnet *D*ata *A*vailability', résume

- le but de la Banque de Données: faire connaître l'existence et la disponibilité de scènes télédétectées,
- son origine: le programme Earthnet,
- la manière dont les données sont rendues accessibles: par dialogue en temps réel et mode conversationnel avec un ordinateur central auquel sont reliés des terminaux par l'intermédiaire de lignes téléphoniques.

## CONTENU DE LA BANQUE DE DONNEES

A l'heure actuelle la source principale de scènes télédétectées est constituée par les satellites Landsat. Ceux-ci ont des orbites telles que chaque point de la Terre est vu par un même satellite une fois tous les 18 jours. Cette durée constitue un cycle. A l'intérieur d'un cycle chaque orbite est numérotée et appelée 'track'. Le long d'une orbite, le centre de chaque scène est prédéterminé ('frame'). Ainsi il suffit en principe de connaître ces trois éléments (cycle, track, frame) pour définir une scène sans ambiguïté (Fig. 1).

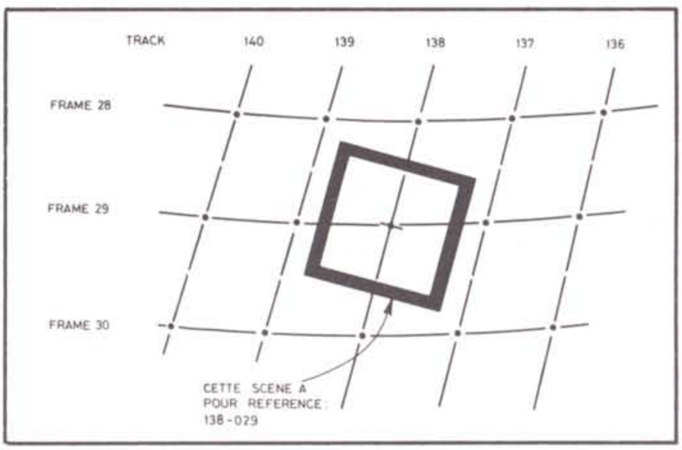



*Figure 1 – Système de référence géographique Landsat.*

Puisque les orbites sont répétitives, il est possible de définir (en grades) les longitudes et latitudes des centres de scènes. Ces valeurs, jointes à la date où la scène est acquise, constituent un second système de repérage redondant par rapport au premier.

Deux informations essentielles doivent être ajoutées pour définir complètement la scène: la couverture nuageuse et la qualité de l'imagerie. Un algorithme suivi d'une vérification humaine permet de définir le degré de couverture nuageuse sur une échelle en pourcentages pour chaque quadrant de la scène. La qualité de l'imagerie donne une indication sur le pourcentage d'information éventuellement perdue au moment de l'acquisition de la télémétrie ou due à d'autres causes ainsi que – subjectivement – la qualité des produits photographiques obtenus.

Si l'on ajoute le nom de la mission (Landsat 1, 2 et 3) et l'heure où une scène est acquise à la station de réception (Kiruna en Suède ou Fucino en Italie), on obtient les dix informations fondamentales qui doivent figurer sur chaque 'citation' de la Banque de Données représentant une scène donnée.

Un exemple de citation est présenté à la Figure 2. On constate l'existence d'informations supplémentaires telles que le numéro d'ordre dans la Banque (en haut à gauche), le nom de la station d'acquisition, le lieu d'archivage, le numéro de la bande magnétique où se trouve la scène sur le lieu d'archivage (HDDT) etc. Ces informations supplémentaires sont insérées dans la citation à l'intention des opérateurs Earthnet.

## MISE EN OEUVRE

Lors du passage d'un satellite en visibilité d'une station, les informations sont recueillies en temps réel et enregistrées sur bande magnétique à haute densité (HDDT = high-density digital tapes).

Ultérieurement, l'ordinateur de la station crée une bande magnétique normale sur laquelle se trouvent reportées les dix données fondamentales à la base de chaque citation. Les citations sont accumulées pendant un mois après quoi la bande est expédiée au Service de Documentation Spatiale de l'ESA, situé à Frascati (Italie). C'est là que

```
                DISPLAY 5/2/1
77B18264   LEDA  CURRENT   PERIOD:  1977

MISSION   LANDSAT 2   STATION      FUCINO

TRACK  FRAME  CYCLE   213  034  054

DATE ACQ    77/10/12   TIME ACQ  09:31:30

LATITUDE     +037.40   LONGITUDE  -000.03
SUN ELEV      033.12   SUN AZIM    135.65

CLOUD COVER 0,0,0,0    QUALITY          0

ARCHIVE LOC  FUCINO    HDDT No     016204
PHOTO AVAIL      NO
```

*Figure 2 – Citation LEDA complète.*

sont ajoutées diverses informations supplémentaires utiles aux opérateurs Earthnet et que le contenu de la bande est repris par une série de programmes logiciels destinés à mettre en forme les données de manière à ce que l'interrogation devienne possible en mode conversationnel.

Un exemple permet de saisir le principe sur lequel se fonde l'interrogation en mode conversationnel: supposons que l'on ait besoin de savoir quelles sont les scènes qui ont été enregistrées le long de l'orbite 127. Pour ce faire il faudrait en principe faire défiler les bandes existantes et isoler, lorsqu'elles se présentent, les scènes qui portent le numéro d'orbite choisi. On conçoit que ce mode de recherche (appelé recherche linéaire ou série) soit long et inadapté. Il est bien préférable de transférer le contenu des bandes sur disque magnétique en affectant une adresse à chaque citation et de créer un 'fichier inversé' où, à chaque valeur de paramètre (ici l'orbite 127) on associe l'ensemble des adresses des citations correspondantes.

Il suffit donc à l'utilisateur de donner l'instruction à l'ordinateur de rechercher, dans le fichier inversé, la ligne correspondant à l'orbite 127. La réponse lui parvient en quelques secondes: il y a tant de citations correspondant à cette valeur du paramètre choisi.

Il est évidemment possible de faire subir ce même traitement à chacune des dix quantités fondamentales présentes dans chaque citation. Dès lors chacun de ces dix paramètres est interrogeable et la Banque de Données est prête à l'emploi.

## INTERROGATION DE LEDA

Le système de ressaisie de l'information en temps réel et mode conversationnel mis en oeuvre par le SDS sous le nom de ESA-Recon utilise un langage simple aussi proche que possible du langage naturel. Ses différents 'mots' représentent autant d'instructions spécifiques à l'ordinateur. Il suffit de 13 instructions pour interroger LEDA. Cinq d'entre elles constituent l'essentiel et pourraient à la limite suffire. Elles ont pour nom EXPAND, SELECT, COMBINE, TYPE, PRINT.

- *EXPAND* fait apparaître sur un terminal relié à l'ordinateur le dictionnaire de LEDA, c'est-à-dire les paramètres interrogeables.
- *SELECT* permet de choisir l'un d'entre eux et de définir la gamme de valeurs numériques retenue pour ce paramètre; par exemple orbites 127 à 134, centres de scènes 25 à 42, couverture nuageuse inférieure ou égale à 30%. Chaque sélection donne lieu à la création d'un ensemble numéroté séquentiellement et contenant les (adresses des) citations répondant au critère choisi.
- *COMBINE* permet d'effectuer des combinaisons logiques, utilisant les opérateurs booléens ET, OU, SAUF, opérant sur les numéros d'ensembles créés lors des sélections précédentes. Le résultat est un nouvel ensemble où l'on trouve les citations – si elles existent – répondant aux divers critères imposés.
- *TYPE* permet de visualiser les citations elles-mêmes appartenant à un ensemble donné afin d'en vérifier la pertinence.
- Enfin *PRINT* permet l'impression en différé des citations sur imprimante rapide afin de réaliser des économies sur les coûts impliqués par les communications téléphoniques et ceux liés à l'utilisation de LEDA.

Une recherche simple est présentée à la Figure 3 où les instructions émises par l'utilisateur sont inscrites avec indentation ce qui les différencie des réponses de l'ordinateur.

## DIFFUSION DE LEDA

Tout utilisateur muni d'un terminal de transmission de données et d'un téléphone peut avoir accès à LEDA. En effet, le SDS maintient un réseau européen de lignes téléphoniques s'étendant sur plus de 12 000 km dans les Etats membres de l'Agence. Aux divers points terminaux de ces lignes de trouvent des concentrateurs. Il suffit à l'utilisateur de former le numéro de téléphone du concentrateur le plus proche pour entrer en communication directe avec l'ordinateur de Frascati.

De plus, dans certains pays, le réseau Esanet qui vient d'être mentionné est interconnecté à des réseaux nationaux. C'est le cas en particulier de la France où Esanet est relié au réseau national français Cyclades. Les points d'accès au réseau Cyclades sont à présent situés à Paris, Rennes, Lyon, Grenoble, Toulouse et, au cours de l'année 1978, Nice et Nancy.

Ainsi, pour une dépense modique en coûts de télécommunications, l'utilisateur peut avoir accès immédiat à LEDA et interroger cette Banque de Données comme s'il en était l'utilisateur unique: les temps de réponse sont extrêmement brefs et une recherche complète peut être effectuée en une dizaine de minutes sinon moins.

## ON PEUT AUSSI PASSER DES COMMANDES AU TERMINAL

La Banque de Données LEDA n'est pas une fin en soi. Elle n'existe que pour permettre l'accès aux documents primaires, c'est-à-dire les scènes télédétectées elles-mêmes. Ainsi, le chercheur qui a identifié une ou des scènes l'intéressant doit-il demander aux responsables du programme Earthnet de lui faire parvenir les produits photographiques ou les bandes magnétiques équivalentes. En général ces commandes sont passées par le demandeur aux 'Points de Contact Nationaux' dans chaque Etat membre de l'Agence.

Pour faciliter ces requêtes, le SDS a introduit une instruction supplémentaire dans son langage de ressaisie, c'est l'instruction 'ORDER'. Un dialogue spécial s'établit entre l'utilisateur et l'ordinateur qui pose une série de questions. Il suffit d'y répondre en indiquant le numéro

```
                    BEGIN13

----------13FEB78  14:05:52  USER0195---
------------  0.36 MINUTES IN FILE32----
           SET ITEMS DESCRIPTION
           --- ----- -----------
```

Début de recherche dans le fichier LEDA

```
                    EXPAND

       EXPAND
REF   INDEX-TERM             TYPE ITEMS RT
E1   - ----------------------
E2    CLOUD COVERAGE----------X 18965
E3    CYCLE-------------------X 18965
E4    DATE--------------------X 18965
E5    FRAME-------------------X 18965
E6    LANDSAT1----------------
E7    LANDSAT2----------------  18965
E8    LATITUDE----------------X 18965
E9    LONGITUDE---------------X 18965
E10   QUALITY-----------------X 18965
E11   TIME--------------------X 18965
E12   TRACK-------------------X 18965
```

Visualisation du dictionnaire

```
                    SELECT E12#210/213
           1   1992
              #210/213
```

Sélection des orbites 210 à 213

```
                    SELECT E5#25/34
           2   6290
              #25/34
```

Sélection des scènes 25 à 34

```
                    SELECT E2#0/2
           3   7697
              #0/2
```

Couverture nuageuse meilleure que 30%

```
                    COMBINE 1 AND 2 AND 3
           4     182
```

Combinaison de critères
182 citations obtenues

```
                    TYPE 4

77B18264    LEDA   CURRENT    PERIOD:   1977

MISSION    LANDSAT 2    STATION      FUCINO

TRACK   FRAME   CYCLE    213   034   054

DATE ACQ    77/10/12    TIME ACQ   09:31:30

LATITUDE     +037.40    LONGITUDE   -000.03
SUN ELEV      033.12    SUN AZIM     135.65

CLOUD COVER 0,0,0,0     QUALITY           0

ARCHIVE LOC  FUCINO     HDDT NO      016204
PHOTO AVAIL       NO

                    END
```

Visualisation de la citation la plus récente

Fin de recherche: durée 3 minutes

*Figure 3 – Recherche simple en mode conversationnel sur le fichier LEDA avec commentaires explicatifs.*

d'identification de l'utilisateur (délivré par les responsables Earthnet à Frascati), la ou les scènes qui sont demandées (définies par leur numéro d'ordre Recon ou le numéro de l'ensemble où elles se trouvent), les types de produits demandés pour chaque scène pris dans une liste de produits standard (bande magnétique, positif papier, positif transparent, en différents formats) et les quantités demandées par produit. Ce dialogue peut avoir lieu à tout moment au cours d'une interrogation.

Il est évident que les Points de Contact Nationaux seront probablement les utilisateurs principaux. Cette nouvelle instruction est néanmoins disponible pour tous. Un chercheur isolé peut passer commande par le terminal. Dans la plupart des cas, les produits commandés de la sorte lui parviendront par l'intermédiaire du Point de Contact National auquel il est géographiquement rattaché.

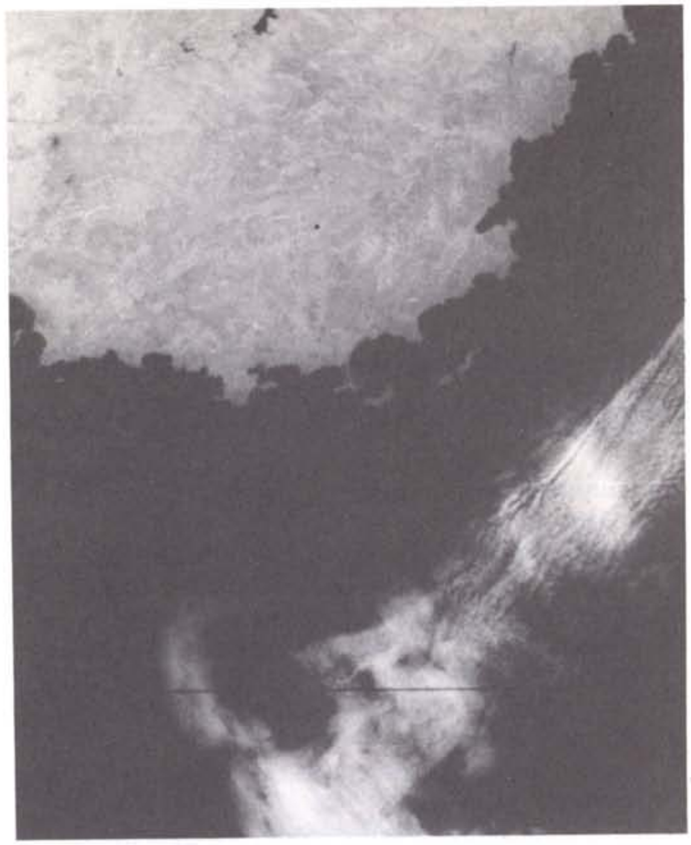


*Figure 4 – Exemple d'image 'quick look' (France méridionale).*

## PERSPECTIVES D'AVENIR

A ce jour la Banque de Données LEDA ne contient que des citations relatives à des images télédétectées par les satellites Landsat (environ 60 000 citations) et acquises par les stations du réseau Earthnet proprement dit (Kiruna, Fucino). Toutefois des discussions sont en cours avec la NASA afin de porter la couverture à l'échelle mondiale. Les références à la totalité des images Landsat acquises depuis le lancement de Landsat 1 seraient alors insérées dans LEDA avec indication du lieu d'archivage. La fonction ORDER pourrait encore être utilisée pour passer commande directement auprès des détenteurs des scènes, le Service de Documentation Spatiale jouant alors simplement le rôle de relais.

Bien entendu, les scènes acquises par les autres satellites intéressant le programme Earthnet seront introduites dans LEDA de même que les missions Spacelab. D'autres possibilités de développement sont également à l'étude. Par exemple, divers sous-produits de LEDA pourraient être distribués aux utilisateurs.

Il est possible de générer un profil de recherche tel que chaque mois, l'utilisateur reçoive automatiquement une liste l'informant des scènes acquises relatives à son domaine d'intérêt. Cette faculté existe dès à présent mais l'utilisateur doit, chaque mois, rappeler le profil de recherche emmagasiné dans la mémoire de l'ordinateur pour le faire réexécuter. L'étape successive serait entièrement automatisée.

Enfin, il est concevable que dans un proche avenir, la distribution de produits Earthnet soit accélérée par la mise à contribution de satellites de télécommunications. Il serait possible alors, en utilisant une option 'RUSH' de l'instruction ORDER, de faire parvenir, en moins de 24 heures à l'utilisateur, tel produit Earthnet nécessaire pour des raisons opérationnelles. Par exemple un image '*quick look*' comme celle représentée à la Figure 4 pourrait être transmise presque instantanément à l'aide de machines fac-similé opérant à une vitesse de transmission de 2 Mbit/s et reliées à des réseaux de communications intégrées satellite-lignes terrestres à hautes performances. □

# In Brief

## First Automatic Communications between a Ship and Meteosat-1

The European Space Agency's Meteosat-1 satellite has been transmitting daily since the end of March to the European Space Operations Centre (ESOC) in Darmstadt, Germany meteorological data collected in the North Atlantic by special equipment on board the French naval vessel 'Henri Poincaré'. This equipment comprises:

— a meteorological station, supplied by the French Directorate of Meteorology, and manufactured by Aerozur-CE;

— a radio transmitter (supplied by ESA) to which the station is connected.

Together it constitutes the first model of a Data Collection Platform (DCP) of the type intended for use within the framework of the Meteosat mission and developed for the Agency by Dornier System.

The purpose of the experiment, which is being carried out jointly by the French Meteorological Service and ESA, is to demonstrate the reliability of automatic communications between ships and the Meteosat satellite for the regular preparation of meteorological reports. The messages are transmitted every three hours and report such meteorological parameters as wind characteristics, sea condition and air and sea temperatures, as well as the ship's position. This particular experiment will last until July, but similar tests will be conducted thereafter with other European meteorological services. □

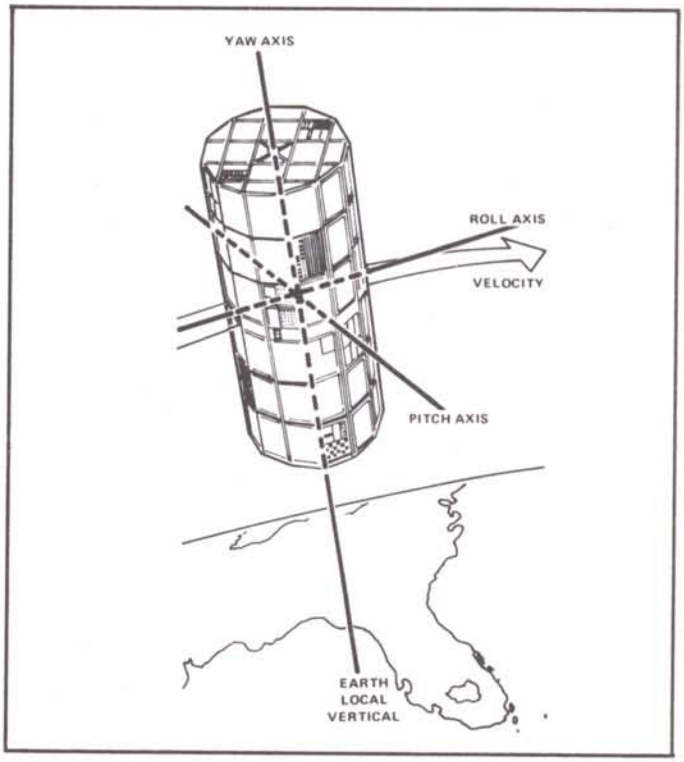
## European Cosmic-Ray Experiment Chosen for Shuttle Facility

An experiment proposed jointly by the Dublin Institute for Advanced Studies, Ireland and the Space Science Department of ESA has been selected by NASA for flight on the Long Duration Exposure Facility (LDEF) scheduled as a major Space Shuttle payload in 1980.

This experiment will study the charge and energy spectra of ultra-heavy cosmic-ray nuclei. The information obtained will contribute to the understanding of the physical processes of cosmic-ray production and acceleration at the source, and their propagation through interstellar space.

It is one of four scientific experiments chosen from 55 proposed from various scientific disciplines. Two of the other experiments selected are provided by scientists from Germany and Switzerland.

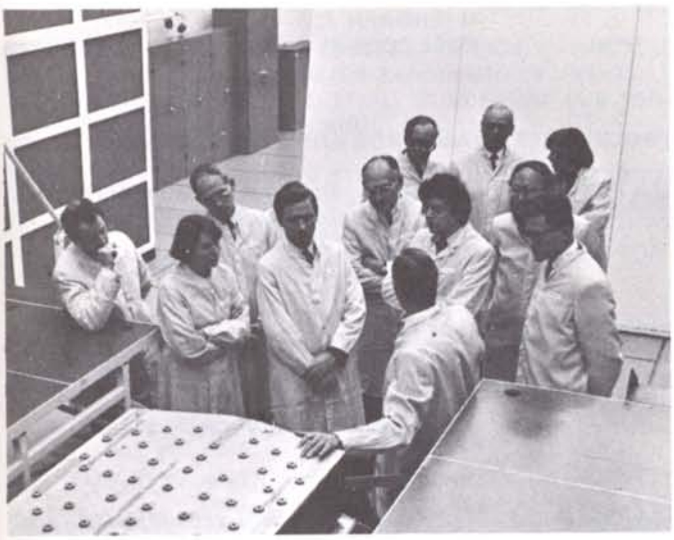
LDEF is an unmanned, free-flying facility on which different scientific and technical experiments can be mounted in special trays. Launched by the Shuttle Orbiter, LDEF will be placed in a circular earth orbit of 435 km altitude and remain there for six to nine months, whilst its experiments are exposed to the space environment, before being retrieved by the Orbiter and returned to earth. □




*Orientation of NASA's Long Duration Exposure Facility (LDEF) in free flight. It is a re-usable, unmanned, gravity-gradient-stabilised, free-flying structure.*

## Visitors to ESTEC

*NASA astronauts Bob Parker (lower left) and Joe Kerwin (second from right) at ESTEC in March for the Spacelab Crew Station Review.*



*Members of the Dutch Parliamentary Science Commission on the test floor at ESTEC, in February.*

## Experiments invited for Four European-Sponsored Spacelab Missions

The European Space Agency, in agreement with the German authorities, has made a call for experiments for four European-sponsored Spacelab missions currently envisaged to take place in 1982 and 1983. Two will be ESA missions (micro-gravity and earth-oriented), and two (micro-gravity and deep-space-oriented) will be German-sponsored with other European participation.

The first Spacelab flight, scheduled for the end of 1980 (one purpose of which is to verify the Spacelab/Shuttle system), will carry a multi-discipline, joint ESA/NASA mission. The four European-sponsored missions now announced mark the start of a permanent Spacelab Utilisation Programme in Europe.

The new call for experiments, sent to more than 2000 scientists, institutes and industrial companies, will enable a very wide European participation in Spacelab utilisation. The call is open to experimenters in the 12 countries participating in ESA's Spacelab Utilisation Programme (Austria, Belgium, Denmark, France, Germany, Ireland, Italy, The Netherlands, Spain, Sweden, Switzerland, and the United Kingdom) and in Canada and Norway which, like Austria, have observer status in ESA.

The closing date for the submission of preliminary experiment proposals is 16 May, and the sequence, dates and compositions of the first four European missions are to be finalised by mid-October.

ESA is reserving space free-of-charge on its first two Spacelab missions for experiments proposed and provided by young Europeans, for which a call will be made in 1979/80. Also, the Agency will soon make a specific call for experiments in the field of educational physics, also to be carried free of charge on both these ESA missions. The latter experiments will be designed to film, for educational purposes, experiments illustrating fundamental laws of physics such as the conservation of momentum, and heat transmission without convection. □

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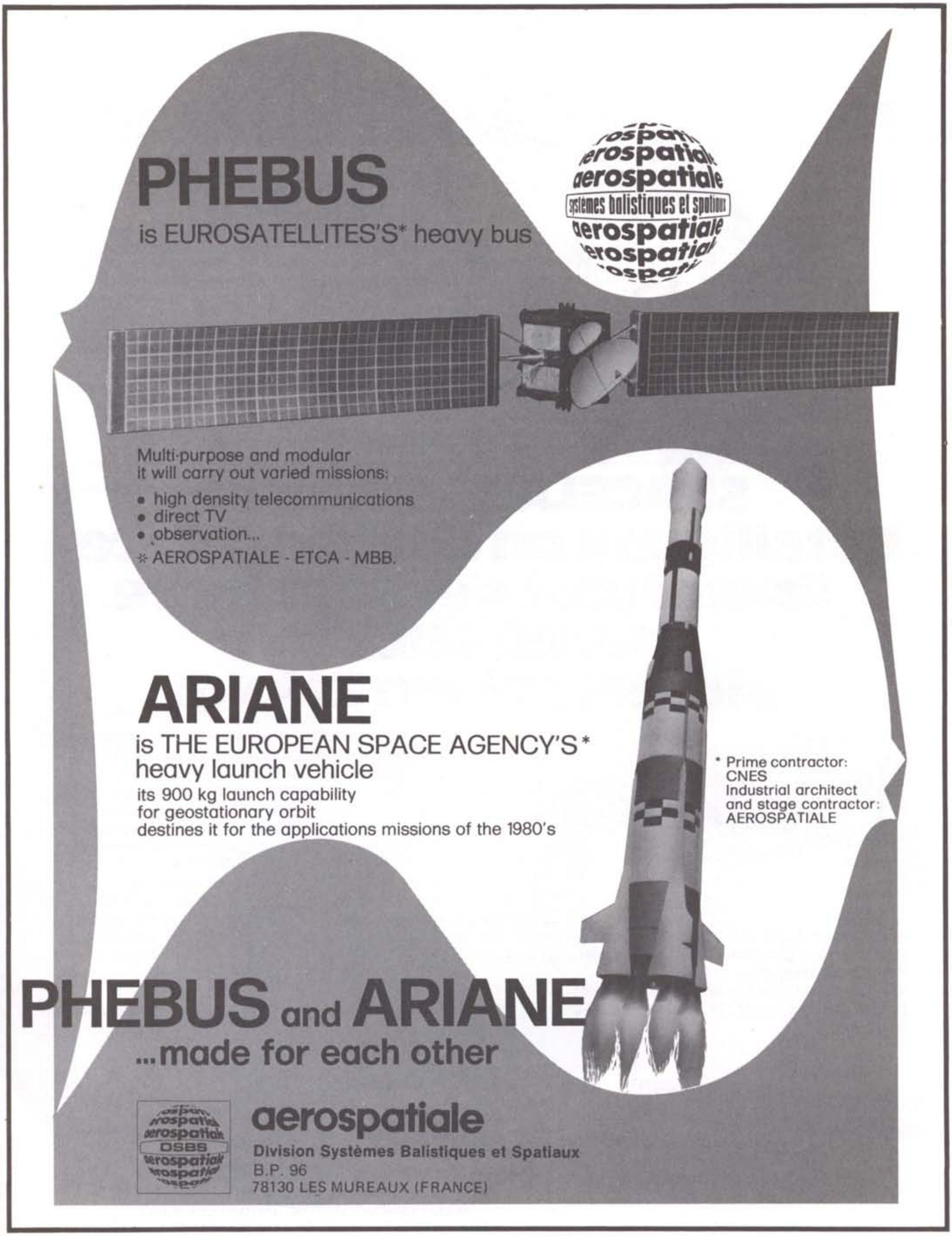
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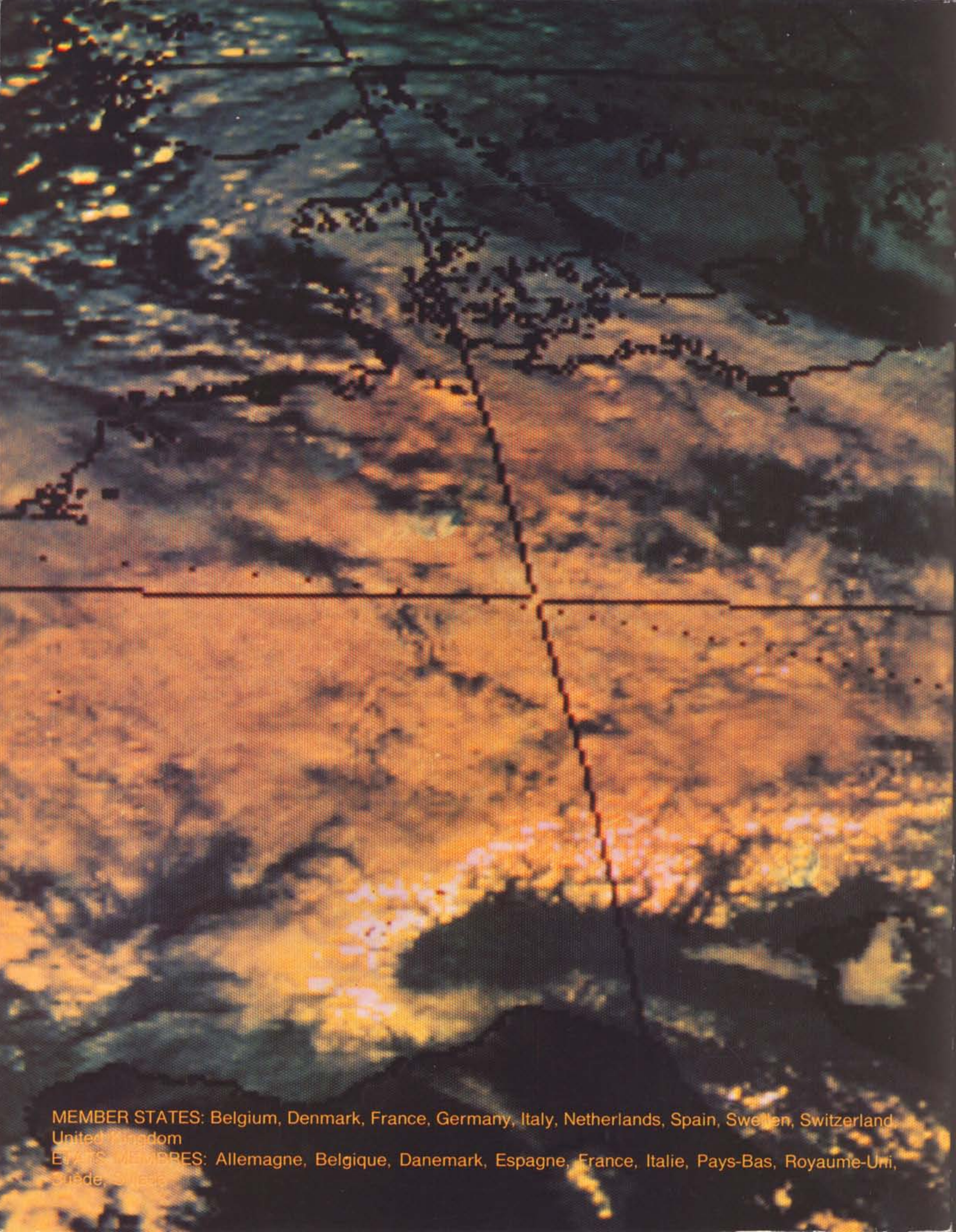

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