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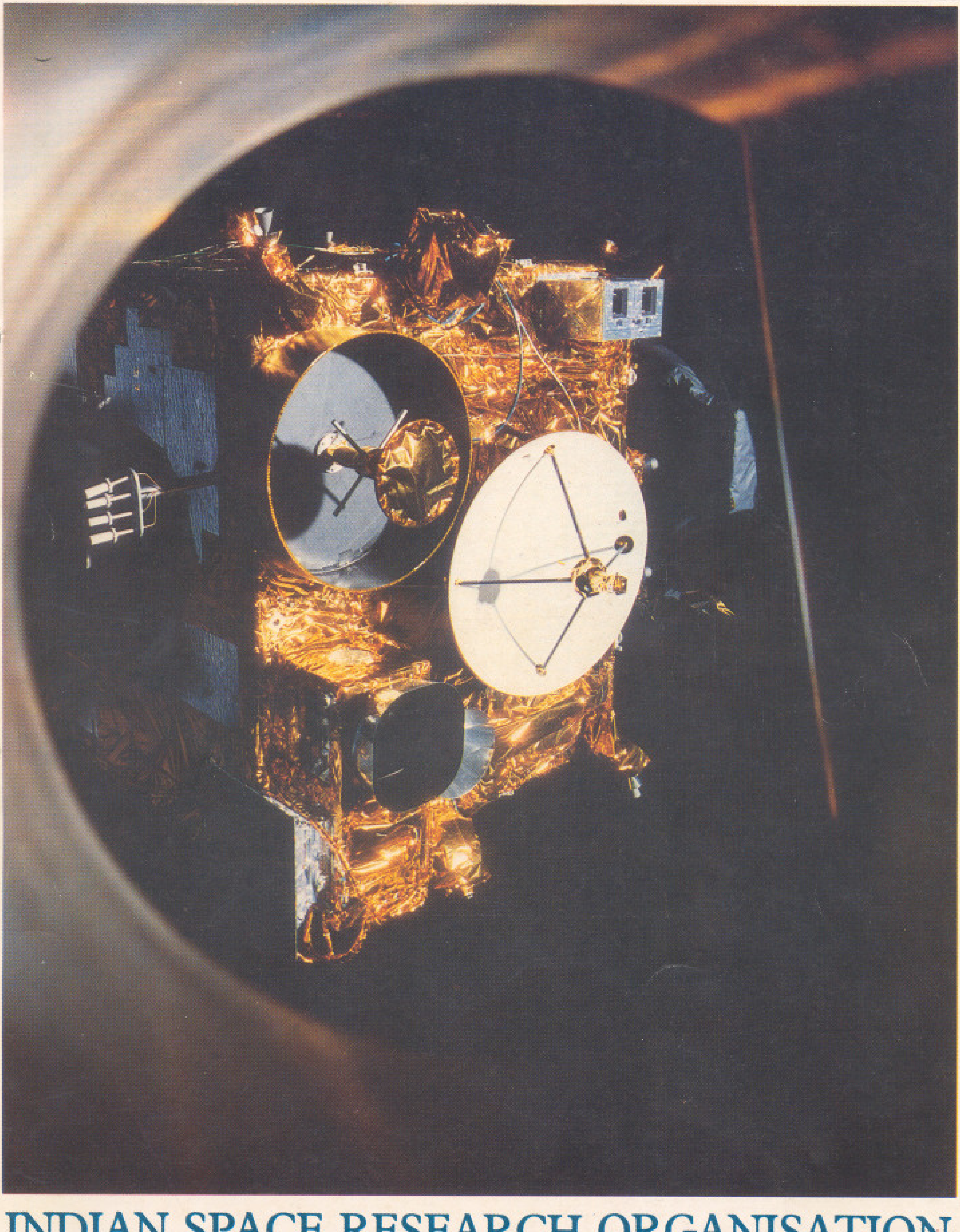
SPACE india



INDIAN SPACE RESEARCH ORGANISATION

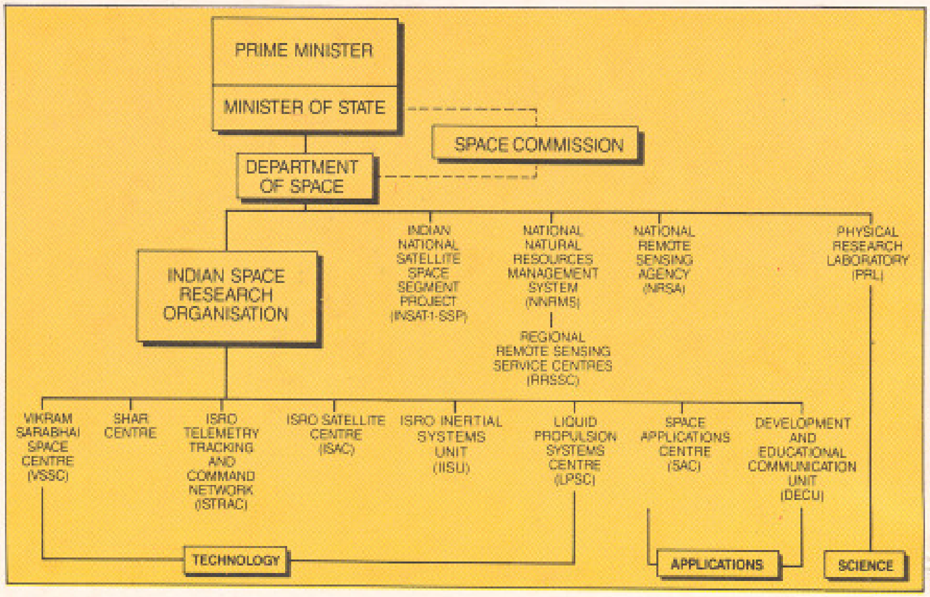
The Indian Space Programme

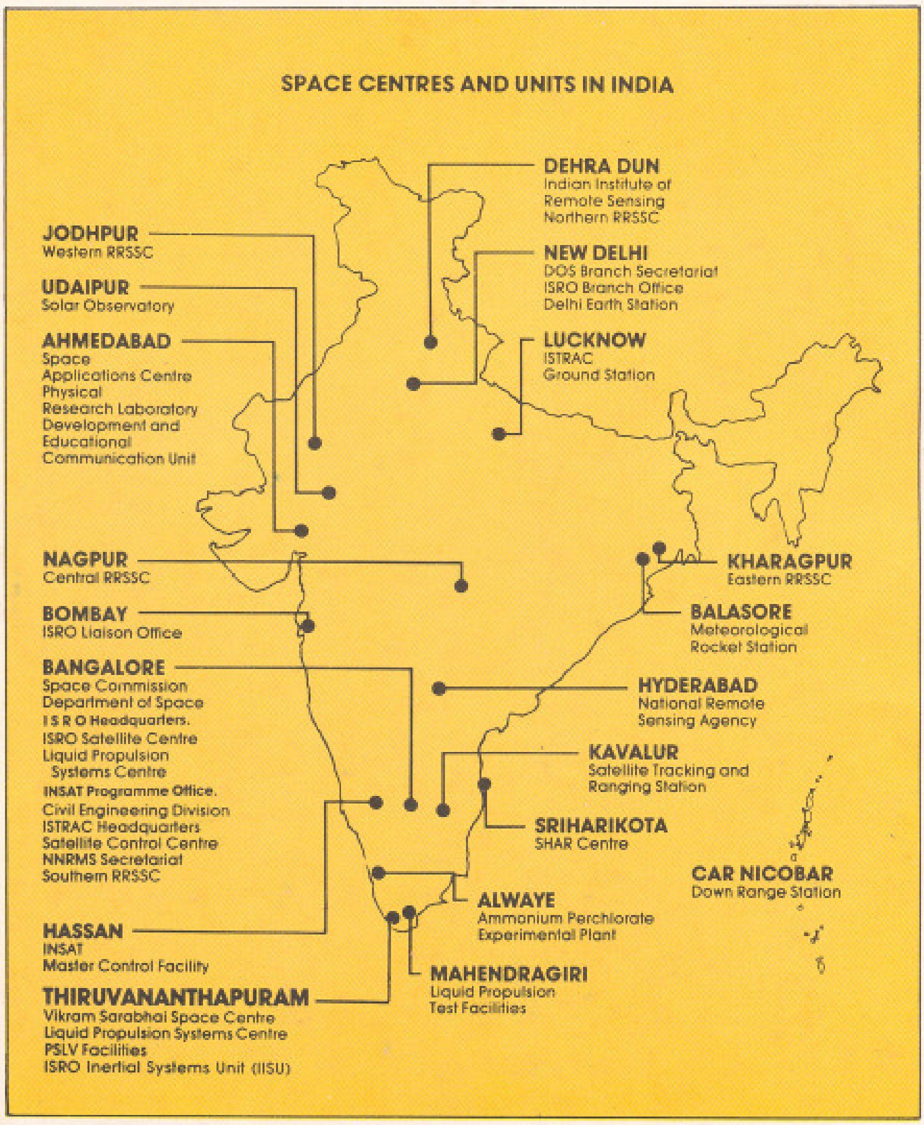
The setting up of the Thumba Equatorial Rocket Launching Station (TERLS) in 1963 marked the beginning of the Indian Space Programme. The Space Commission and the Department of Space (DOS) were established by the Government of India in 1972 to promote unified development and application of space science and technology for identified national objectives.

The Indian Space Programme is directed towards the goal of self-reliant use of space technology for national development, its main thrusts being: (a) satellite communications for various applications, (b) satellite remote sensing for resources survey and management, environmental monitoring and meteorological services and (c) development and operationalisation of indigenous satellites and launch vehicles for providing these space services.

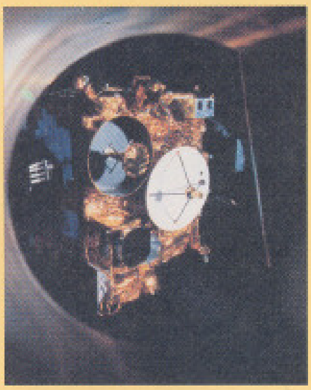
The Indian Space Research Organisation (ISRO) is the research and development wing of DOS and is responsible for the execution of the national space programme. ISRO also provides support to universities and other academic institutions in the country for research and development projects relevant to the country's space programme.

Both the DOS and ISRO Headquarters are located at Bangalore. The development activities are carried out at the Centres and Units spread over the country. □





SPACE CENTRES AND UNITS IN INDIA



FRONT COVER
INSAT-2 Electrical Thermal Model undergoing space simulation test in Large Space Simulation Chamber.

EDITORS
S Krishnamurthy
Manoranjan Rao

EDITORIAL ASSISTANCE
S.K. Dutta

PRODUCTION ASSISTANCE
B. Chandrasekhar

Contents

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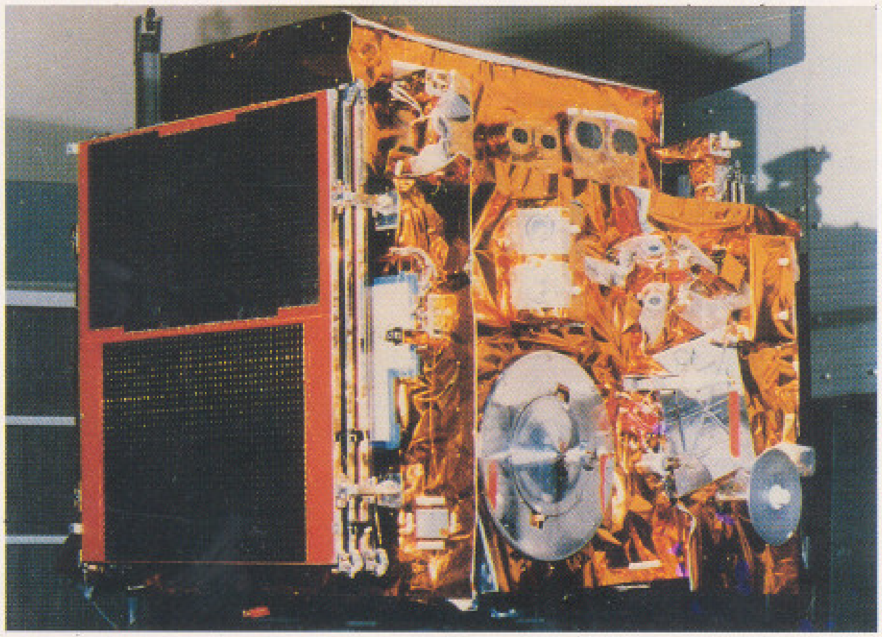
Indian Remote Sensing Satellite, IRS-1A, Completes Three Years



Indian Remote Sensing Satellite, IRS-1A

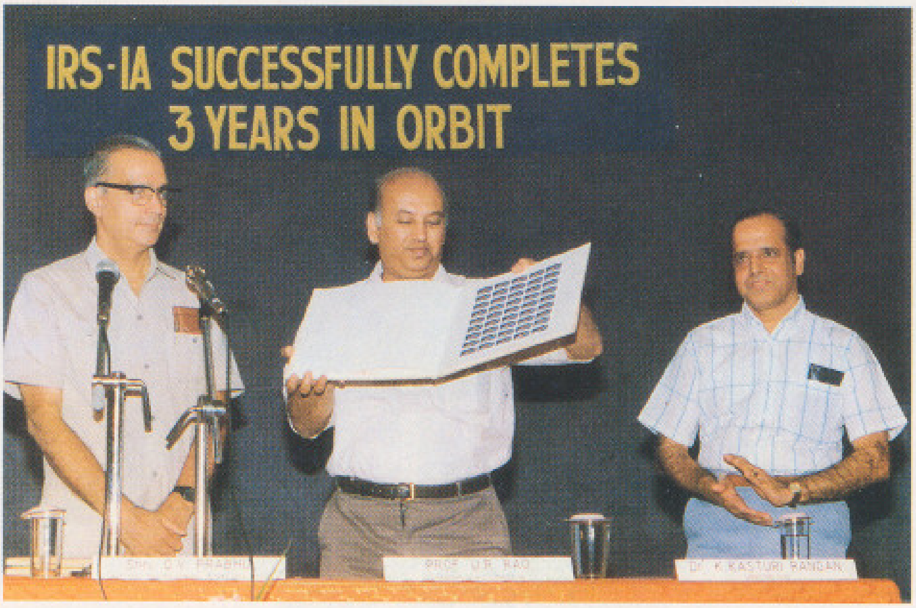
March 17, 1991 was an important day in the history of Indian space programme. For, on this day, the first operational Indian Remote Sensing Satellite, IRS-1A, successfully completed three years of its life and continue to provide valuable data for the management of natural resources in the country. For a developing country, striving to achieve self reliance in the use of advanced technology for its progress, the success of state-of-the-art satellite is an achievement to be proud of and an occasion to celebrate. It was only befitting then, that a commemorative postage stamp on IRS-1A was released by the Department of Posts, to mark the occasion. On March 18, 1991 Prof U.R.Rao, Chairman, Space Commission, released the postage stamp and addressing the ISRO community via the INSAT-1B satellite called upon them to rededicate themselves to furtherance of the progress of space programme and thus contribute to the alround development of the nation.

We reproduce here a talk by Prof U.R.Rao, which was broadcast by All India Radio on the national network on March 16, 1991.

The Success Story of Indian Remote Sensing Satellite, IRS-1A

Exactly three years ago, on March 17, 1988, the Indian Space Research Organisation successfully launched and operationalised its first indigeneous, state-of-the-art, Indian Remote Sensing Satellite, IRS-1A, and thus achieved a major milestone in the management of natural resources of the country. In the last three years of its operation in space, IRS-1A has demonstrated its unquestionable importance, having become the mainstay of our National Natural Resource Management System.

Remote sensing from space has



Prof U.R. Rao, Chairman, Space Commission, releasing the IRS-1A Postage Stamp. Shri G.V. Prabhu, Chief Post Master General, Karnataka Circle (left) and Dr K. Kasturirangan, Director, ISRO Satellite Centre are also seen

become a vital component of the application of space technology for the development of land and water resources all over the world. For a large and developing country like India, with diverse geological features and limited per capita land resource, optimal management of its natural resources is of crucial importance for meeting the needs of its growing population. Space remote sensing with the advantage of providing synoptic and repetitive coverages of large areas is the only effective tool for providing rapid and cost effective information on various natural resources of the country.

IRS-1A is the result of the experience accrued through experiments conducted over the last two decades using aerial flights and experimental satellites like Bhaskara-1 and 2. Joint Experiment Projects involving various users amply demonstrated the potential of satellite based remote sensing for India thus paving the way for operationalising satellite remote sensing.

IRS-1A imaging cameras, which employ highly sophisticated Charge Coupled Devices in a push-broom scanning mode, have been taking high resolution imageries in four spectral bands in the visible and near infrared regions of the electromagnetic spectrum.

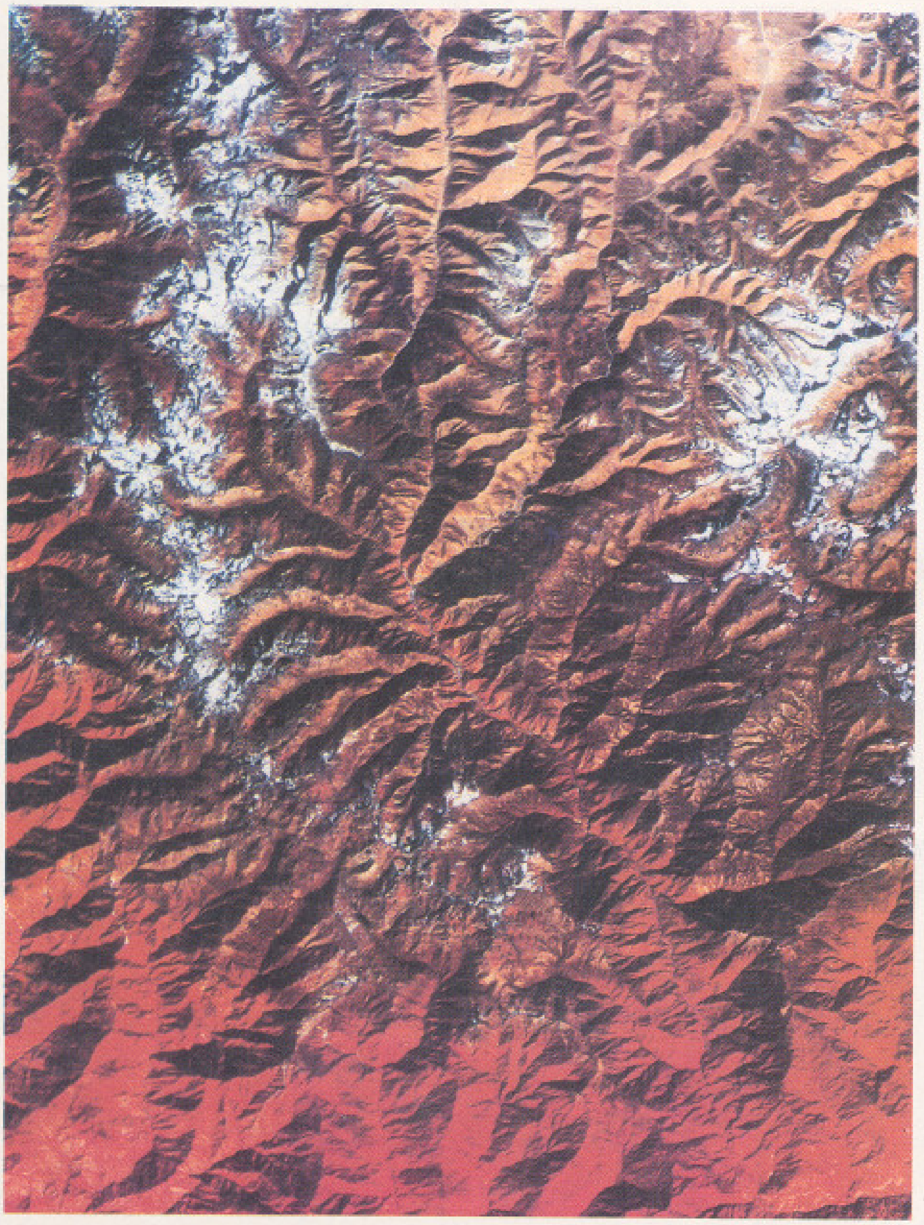
IRS-1A was launched on a VOSTOK rocket from Baikanur in USSR, into a polar sun-synchronous orbit at a height of 904 km. In the last three years, IRS-1A has covered India more than 50 times to

Prof U.R. Rao addressing the Press Conference

provide over three lakh high quality imageries, fulfilling all its mission objectives. The imageries are comparable in quality to those obtained from the French SPOT and the American LANDSAT satellites, demonstrating the Indian capability for building and operating state-of-the- art remote sensing system.

The Spacecraft Control Centre located at Bangalore, along with ground stations at Lucknow and Mauritius, is tracking and monitoring the satellite health continuously. The data reception station at Shadnagar near Hyderabad regularly receives satellite data and, after processing, the data is disseminated among the users. IRS data has been used for diverse applications in the fields of agriculture, drought warning, wasteland management, water resources, ocean resources, urban land use, mineral resources, marine and inland fisheries, etc.

IRS data is being regularly used for estimating acreage and production of large agricultural crops like rice, wheat, sorghum, mulberry and cotton.



North Sikkim as photographed by IRS-1A LISS-II Camera

Forecasting silk and cotton production to determine exportable surplus and inventorying commercial crops like tea and coffee in the hills of southern and north-eastern regions of the country have also been initiated using IRS data.

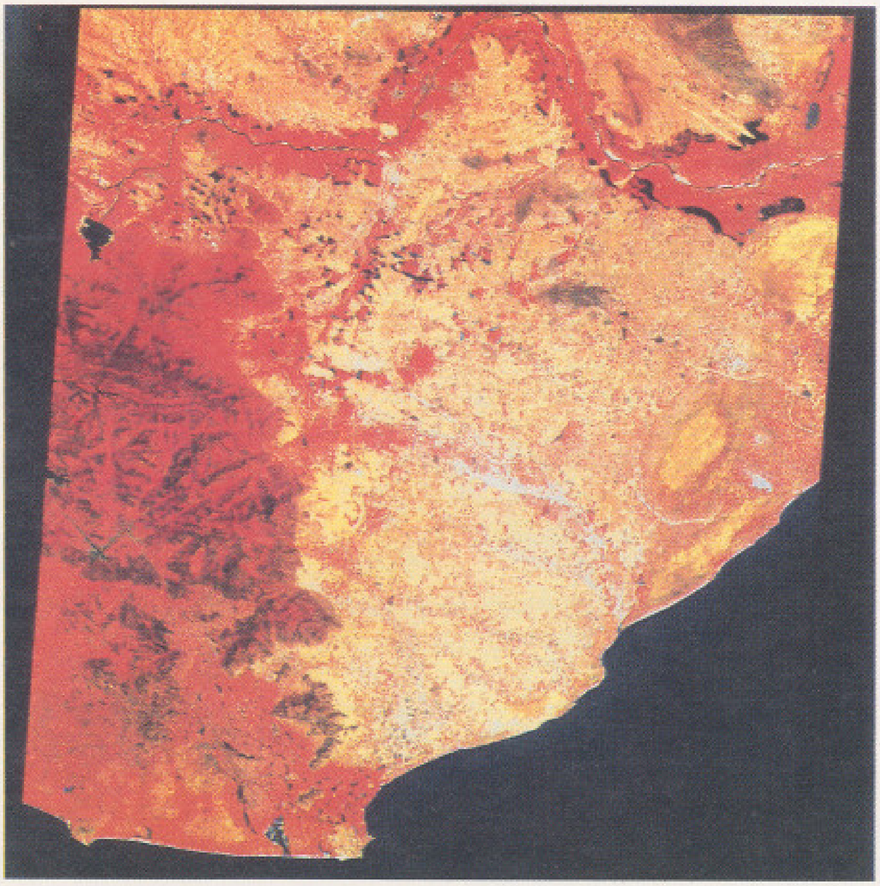
Continuous monitoring of our national forest wealth using satellite remote sensing dramatically showed the decrease in closed forest from 14 per cent to 11 per cent in the last ten years. IRS imageries have now become a powerful tool for monitoring forest cover at district and taluk levels to ensure that further deforestation does not take place resulting in devastation of our rich natural heritage and causing drastic soil erosion.

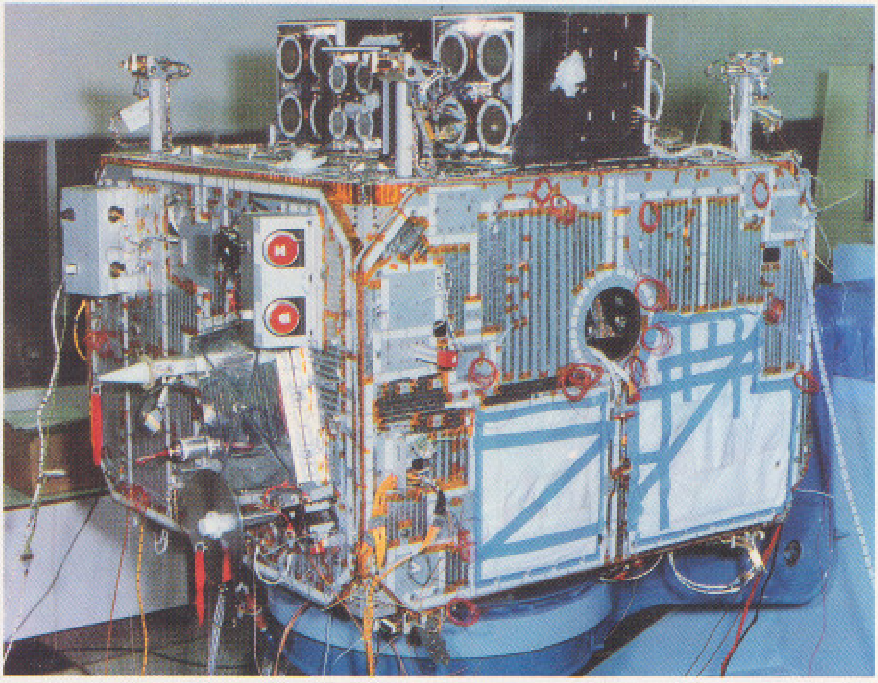
A number of land use and land cover projects have been carried out for classification of land use into irrigated and non-irrigated lands, open and closed forests, open scrub, wasteland, water bodies, orchards, plantations, vacant land, grasslands, industrial areas, urban settlement, etc. A national project on land use and land cover mapping at district level is being carried out to plan strategies for an agro-climatic region based planning.

The entire country has been mapped for ground water potential under the national drinking water mission using IRS data. These maps have helped to vastly improve success rate for drilling bore-wells from the earlier 45 per cent to 90 per cent, thus not only saving the overall cost but also providing the most vital drinking water to the rural areas.

Extensive monitoring of the extent of sedimentation and water spread in reservoirs to

LISS-I imagery of Chandigarh and Ludhiana area


Part of Tamil Nadu, LISS-II imagery



IRS-1B under final stages of integration

plan irrigation scheduling and command area development has now become possible because of the satellite imageries. For the first time, we are now able to provide accurate estimates of the snow melt run-off into the rivers and lakes in north India using these imageries.

Under the project Vasundhara, prospecting base metal mineral zones had been carried out earlier in southern India. Two similar projects, Bhu Sampada and Singh Bhumi, have now been initiated by Geological Survey of India for prospecting minerals in northern and eastern regions using IRS data.

IRS-1A imageries have also found their application in ocean and coastal studies including mapping of wetland and mangroves, off-shore sediment dispersion, etc. Identification of brackish water and water bodies suitable for inland fisheries have also been made.

All major cities have been covered under a detailed study on urban sprawl using IRS data. Recently, a survey was conducted to align the ring road for Bangalore Development Authority using satellite and ground based data at less than a twentieth of the cost and time.

Real time monitoring of flood affected areas and estimate of amount of flood damages using satellite data has become an extremely important use of IRS, particularly to enable timely implementation of disaster mitigation strategies.

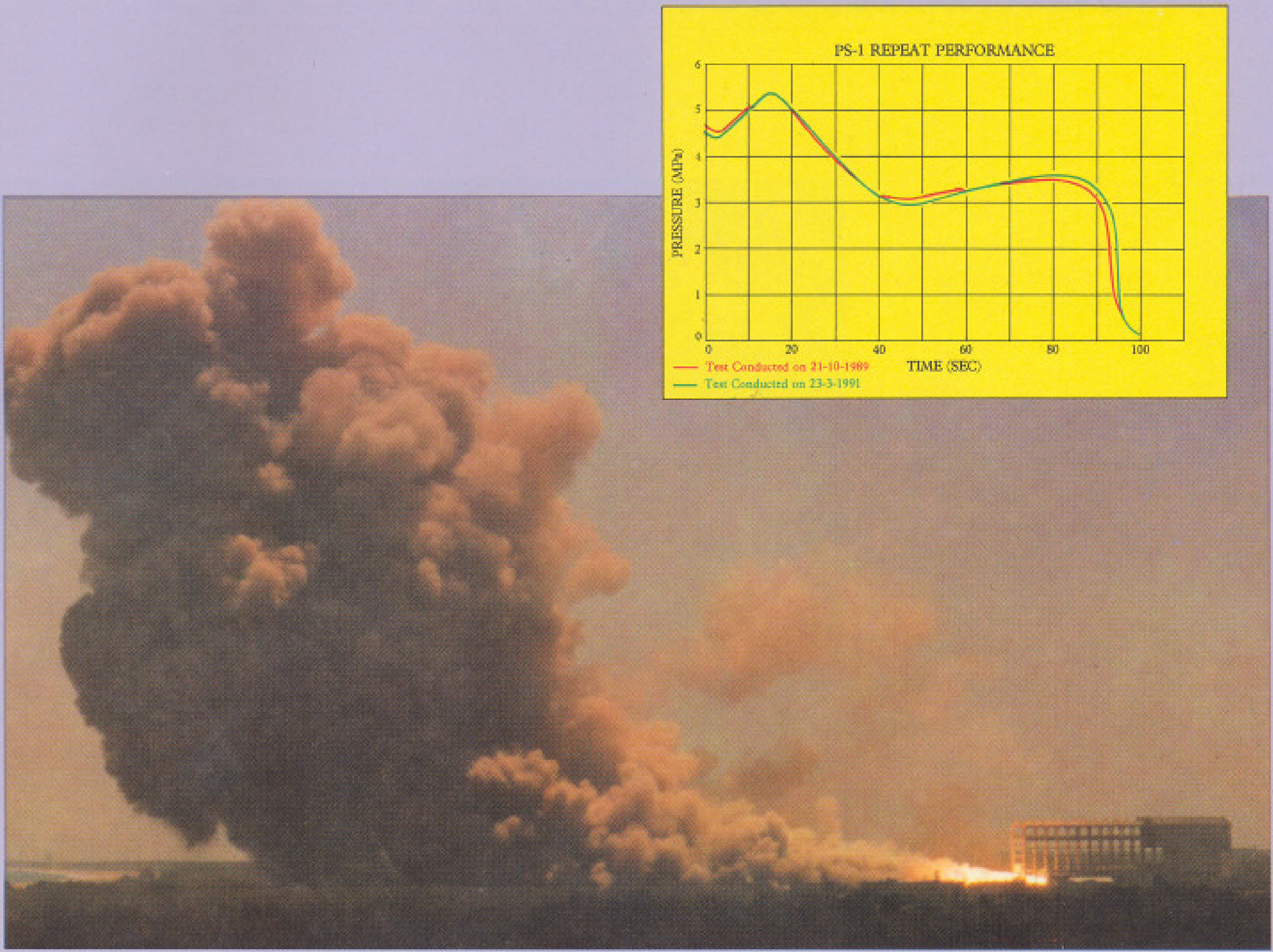
Monitoring of soil characteristics on a nationwide basis has clearly shown the areas requiring soil conservation and appropriate soil management. For the first time, a detailed inventory of the wastelands at village level has been made which indicate that nearly half of the wasteland – almost 25 million hectares – can be reclaimed with appropriate agricultural practices. For a country with a target of producing 230 million tonnes of foodgrains by 2000, wasteland reclamation offers an unique solution.

Integrated development at village level is the only answer for environmentally sustainable development of the nation to meet the minimal requirements of our growing population. Combining the remote sensing information on soil, water, forest, agriculture, wasteland with demographic, culture specific information and meteorological status, it is possible to plan the appropriate strategies for integrated development at microlevel. Such a strategy which identifies areas requiring soil conservation, afforestation, rotation of agricultural crops and recharging of water to ensure adequate supply of ground water has already been successfully demonstrated in a number of drought prone districts.

Thus IRS-1A, over the last three years of its operation, has opened up a number of vital areas of national economy requiring use of satellite remote sensing. Launch of IRS-1B, identical to IRS-1A, in the next three months will ensure the continued availability of space imageries. The second generation satellites, IRS-1C and IRS-1D, to be launched in 1993-94 and 1996-97 respectively, will have better spatial and spectral resolutions, more frequent revisits, stereo viewing and on-board data recording facilities which will open up newer areas of space application for the management of our natural resources.

The successful operation of IRS-1A and the series of remote sensing satellites that are planned affirms the commitment of the Indian space programme to harness the unlimited potential of space technology for national development. □

PSLV First Stage Motor -Another Successful Test



The second ground test on the PSLV first stage motor was successfully conducted at SHAR Centre on March 23, 1991. Prof U.R.Rao, Chairman, ISRO witnessed the test. The quick look data show that the motor and control system performed satisfactorily.

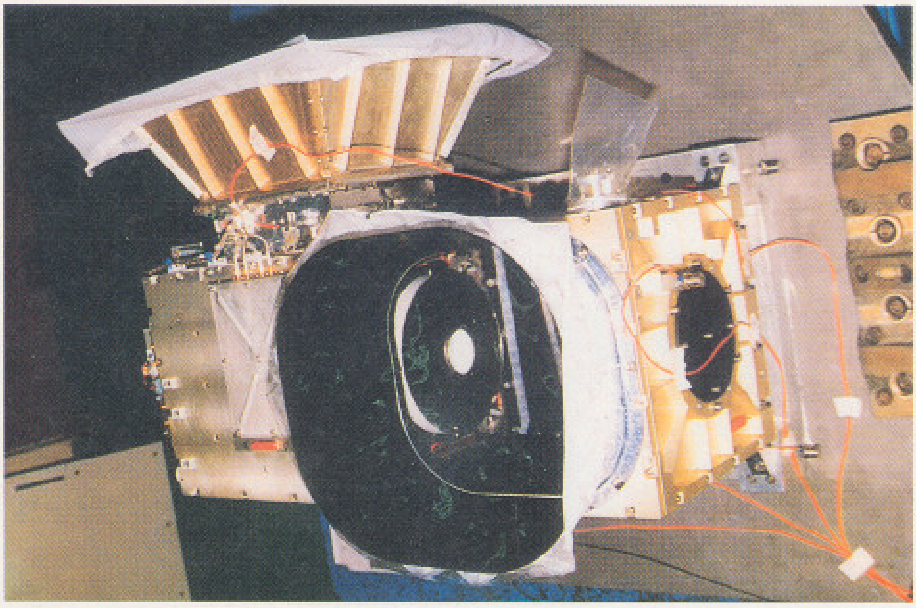
The 2.8 m diameter, 128 t motor which is the third largest booster in the world is designed by Vikram Sarabhai Space Centre, Thiruvananthapuram. The propellant consists of the hydroxyl terminated polybutadine fuel with ammonium perchlorate as oxidiser. The entire propellant is expended in about 96 seconds producing a peak thrust of 450 t. (See Space India 2,3 & 4/1989 for details of the motor).

The five segment motor was processed at SHAR Centre, Sriharikota, and the Secondary Injection Thrust Vector Control system was developed by Liquid Propulsion Systems Centre, Thiruvananthapuram. The motor and its control system were tested on a specially designed six component test stand to measure forces and moments in all the three principal directions. About 300 parameters were monitored during the test to assess the rocket motor and control system performance.

The repeatability of the performance of the motor, as demonstrated in this test, has paved the way for the preparation of the motor for the first development flight of PSLV. ☐

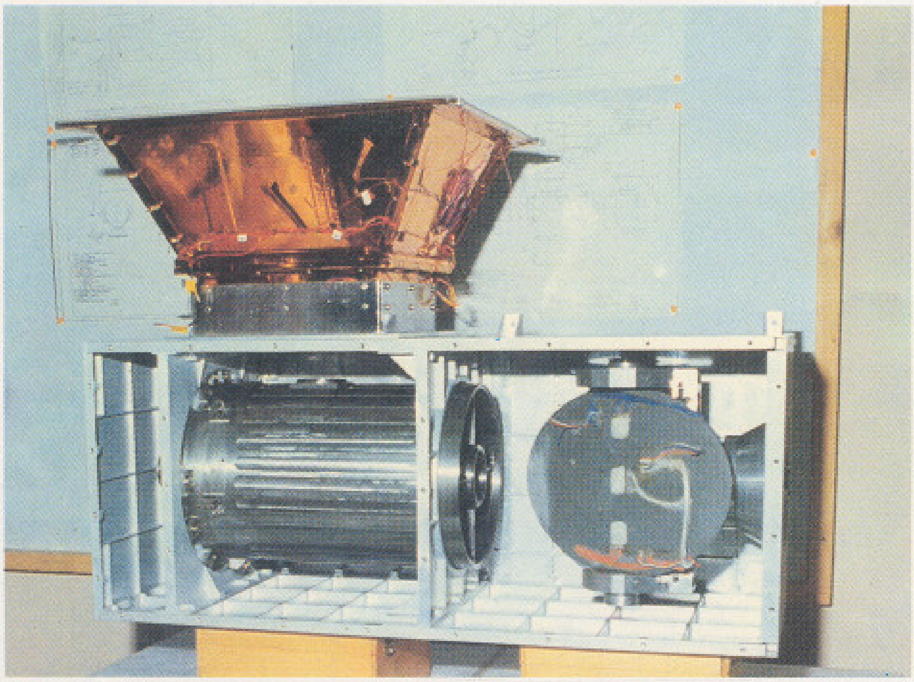
Very High Resolution Radiometer for INSAT-2

Communications and meteorological observation from geostationary satellites are two important applications of space technology today. India is perhaps the first country to effectively combine these two services on a single operational geostationary satellite, INSAT. INSAT-1 has been continuously providing these services since 1983. The development of indigenous INSAT-2 series of satellites to replace the foreign procured INSAT-1 satellites is in an advanced stage. The Engineering Thermal Model of INSAT-2 is now undergoing space simulation test in the newly commissioned Large Space Simulation Chamber at ISRO Satellite Centre, Bangalore.



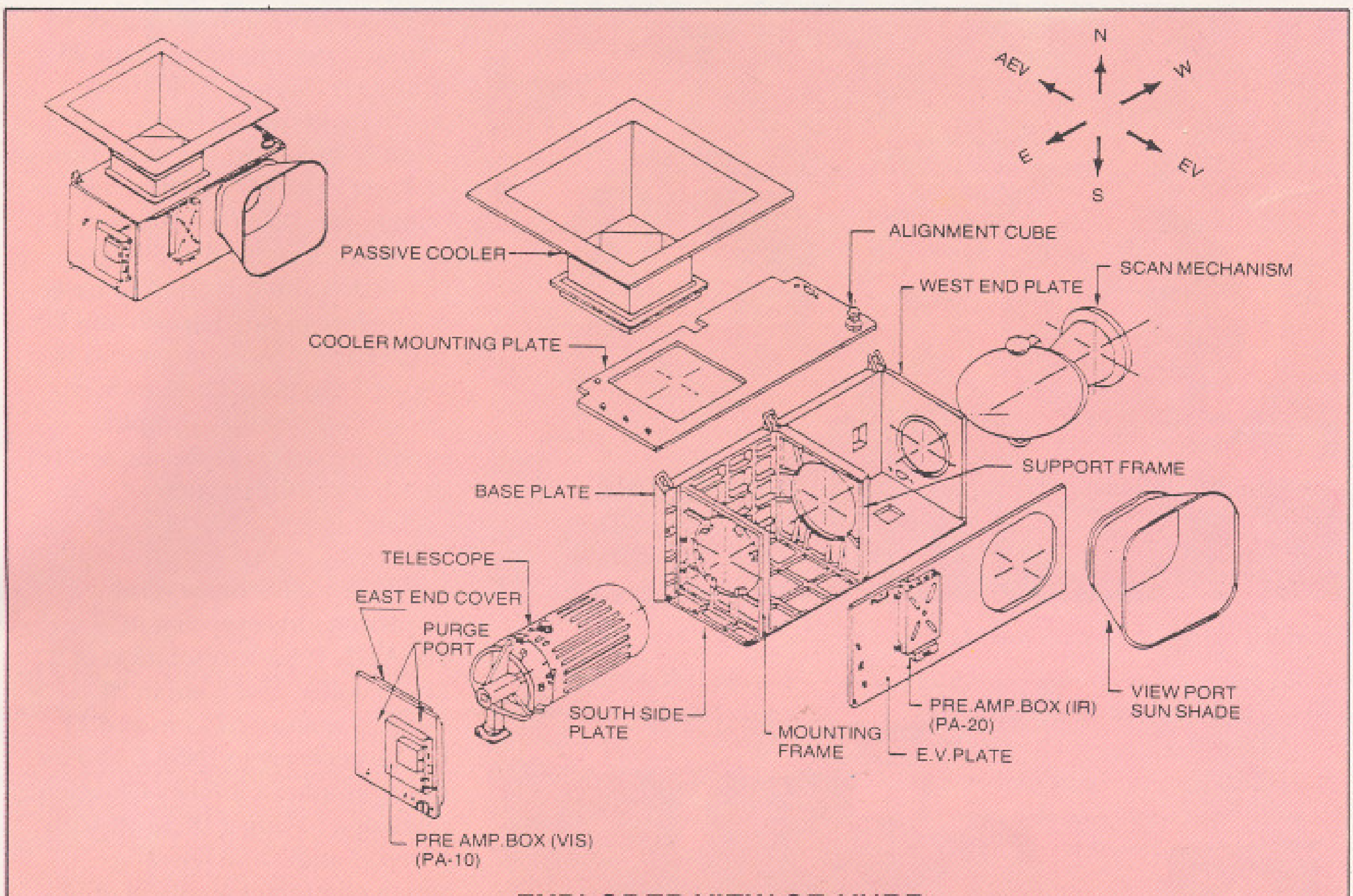
VHRR Electrical Thermal Model

The Very High Resolution Radiometer (VHRR) and Data Relay Transponder (DRT) constitute the meteorological segment of INSAT-2. The DRT relays data from unattended ground based data collection platforms which acquire in-situ meteorological data. The VHRR acquires visible and infrared images of the earth.



Structural Model

The structural model of VHRR, to validate the structural and mechanical aspects, has successfully undergone spacecraft level vibration and acoustic tests. The electrical thermal model has been



EXPLODED VIEW OF VHRR

completely qualified at payload level and integrated with the spacecraft. The flight system fabrication has also begun.

The VHRR provides meteorological earth imageries in the visible (0.55-0.75 micron) and thermal infrared (10.5-12.5 micron) bands. The ground resolution at the subsatellite point is 2 km x 2 km in the visible and 8 km x 8 km in the IR band.

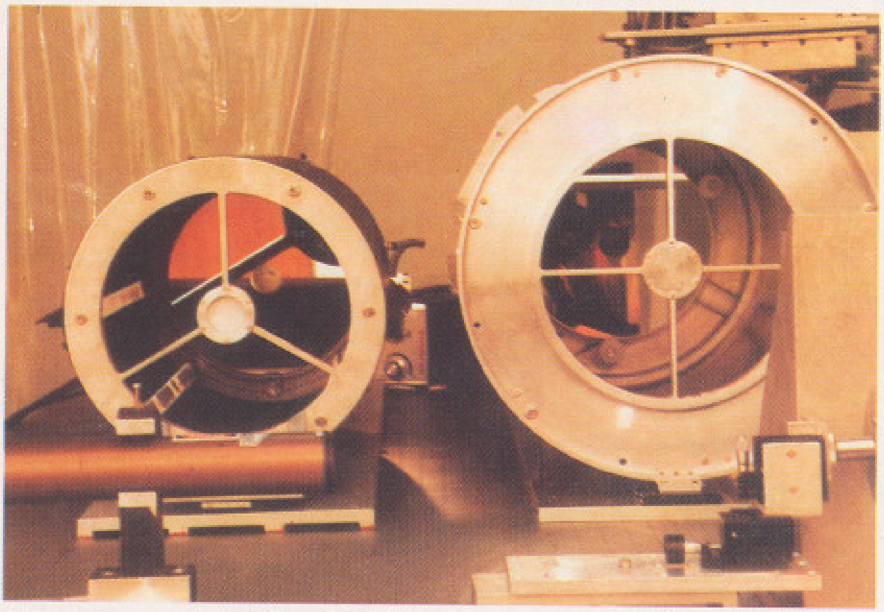
The VHRR receives the radiation from the ground which is reflected on to a 200 mm aperture of its telescope by a beryllium scan mirror which is mounted at 45 degree to the optical axis. The optical system includes a gold film dichroic beam-splitter which transmits visible light but reflects IR energy thus enabling channelling of earth radiation on to the visible and IR channel focal planes simultaneously. The detector configuration consists of redundant linear arrays of four silicon photodiodes for visible band and redundant mercury-cadmium-telluride detectors operating at 105 degree K for Thermal IR (TIR) band. The TIR detector is cooled by a passive radiative cooler.

The scan mirror is mounted on a two-axis gimballed mechanism to generate a two dimensional image by sweeping the detector instantaneous field of view (IFOV) across the earth's surface in the east to west (fast scan) and north to south (slow scan) directions.

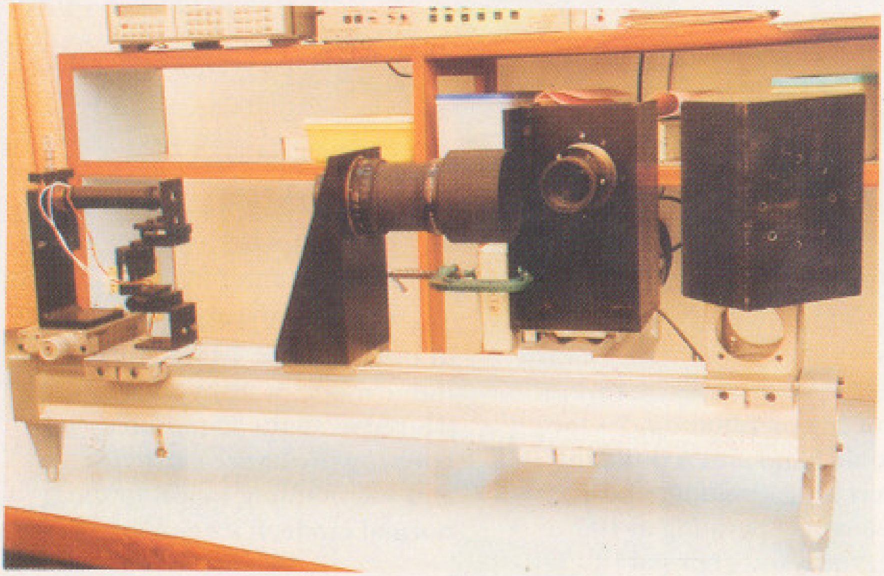
The digitised VHRR data from all the channels, housekeeping information and calibration data are transmitted to the ground station on one of the extended C-band channel.

The INSAT-2 VHRR can operate in three modes. In the full frame mode, it scans 20 X 20 degree in about 33 minutes covering the entire earth disc and surrounding space. In the the normal mode, it scans 14 degree

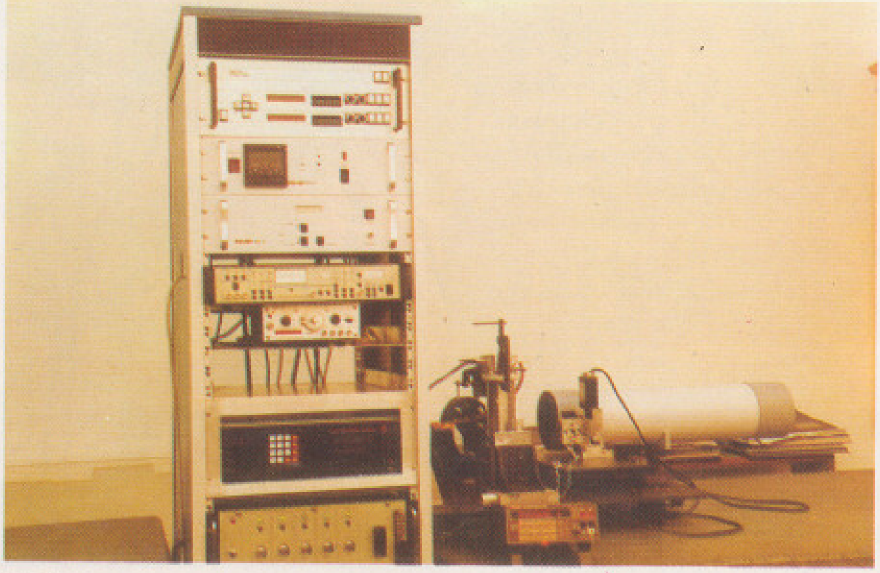
Bench cooler cryo surface



VHRR Telescope and scene simulator



Scan mechanism test setup



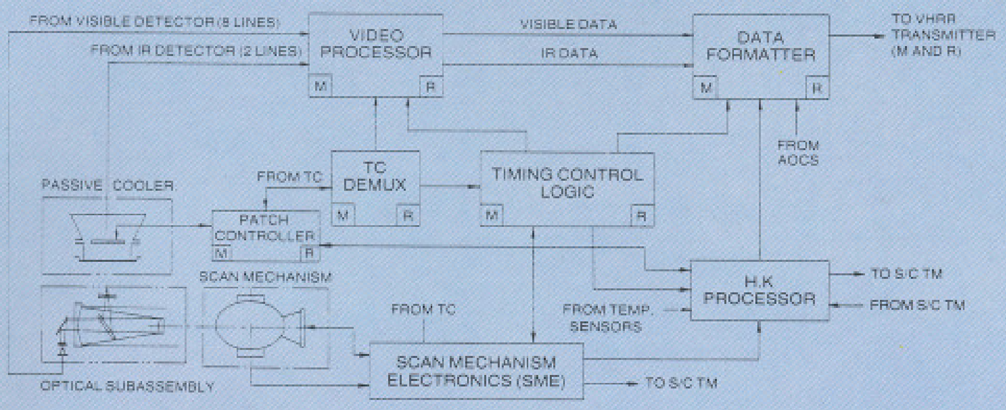
IR detector test setup

in north-south and 20 degree in east-west directions in about 23 minutes covering 50 degree north to 40 degree south latitude region which is of prime interest to India. In the sector scan mode, it can be positioned anywhere in steps of 0.5 degree in north-south direction to cover 4.5 degree in north-south and 20 degree in east-west directions in about 7 minutes. This mode is particularly useful for rapid, repetitive coverage during severe weather condition such as cyclone.

INSAT-2 VHRR has several improvements over that of INSAT-1. It has a resolution of 2 km in visible and 8 km in IR band as against 2.75 km and 11 km respectively in INSAT-1. The optics employ a Ritchey-Chretien telescope having a Dichroic with a wedge angle and curvature which eliminates auxiliary optics for visible channel and provide greater tolerance to mechanical misalignments. The IR detector can be controlled at 8 different points in the range 105 to 115 degree K, allowing optimal signal to noise ratio in the IR channel. Black body calibration can be carried out even when scanning is in progress.

Space Application Centre (SAC) of ISRO led the development of VHRR including overall system design, payload integration and qualification. The mirror scan mechanism was designed and developed by the ISRO Inertial Systems Unit. The telescope mirror fabrication and coating, and design and development of the passive radiant cooler were carried out at ISRO Satellite Centre. The CFRP optical port sunshade was fabricated by Vikram Sarabhai Space Centre.

A number of Indian industries and laboratories actively participated in the development



INSAT - 2 VHRR - SIMPLIFIED BLOCK SCHEMATIC.

of VHRR. Notable among them include:

-Government Toolroom and Training Centre, Bangalore, for mechanical fabrication of the passive radiant cooler components.

- National Aeronautical Laboratory, Bangalore, for electroplating of nickel on the cooler sunshield panels.

- Indian Institute of Astrophysics, Bangalore, for polishing of cooler sunshade panels.

Besides, a number of private industries helped in mechanical fabrication, electro-optics structure fabrication, scan mechanism parts fabrication, etc.

Several facilities were specially designed and built for the development of VHRR including those for visible detector and TIR detector evaluation, scan mechanism characterisation and test, near real time CCD based linearity and repeatability test, clean vacuum bench cooler for the operation of TIR channel during the payload integration and testing, calibration of 300 mm aperture for the VHRR visible channel and passive radiative cooler evaluation at component and integrated level.

The complete ground checkout system was designed and built inhouse for the autonomous testing of the VHRR payload. The detailed performance evaluation is carried out on a Microvax computer using an indigenously developed interface unit. The Computer Aided VHRR Evaluation System developed inhouse enables rapid but detailed performance evaluation of the payload.

The successful development of VHRR payload for INSAT-2 reiterates the commitment of the Indian space programme to provide operational space services in a self reliant manner with maximum utilisation of infrastructure within the country. □

VHRR Specifications

Scanned Field	
- Normal Mode	20 Deg E-W & 14 Deg N-S
- Full Frame Mode	20 Deg E-W & 20 Deg N-S
- Sector Scan Mode	20 Deg E-W & 4.5 Deg N-S
Resolution (at subsatellite point)	
- Visible	2 km
- IR	8 km
Spectral Bands	
- Visible	0.55 to 0.75 micron
- IR	10.5 to 12.5 micron
Dynamic Range	
- Visible	0 to 100 % Albedo
- IR	4 K to 320 K
Scan Linearity	150 micro-rad (RMS)

Satellite Based Training Network Demonstrated

Lessons through satellite – the teaching end at Ahmedabad Earth Station ...... and the class room at Rupal village

A satellite based one-way video and two-way teleconferencing system was demonstrated by ISRO, involving Gujarat Vidyapeeth, Ahmedabad, during February 26-27, 1991 to train adult education teachers. The objective of the demonstration was to familiarise potential users with the system that can receive TV programmes and transmit a return audio to enable the viewers to enter into a discussion with the faculty at the transmitting end. The one-way video was transmitted from Ahmedabad Earth Station of ISRO which was used as the teaching end and received at Rupal village near Gandhinagar and Gujarat Vidyapeeth, Ahmedabad. Prof.U.R.Rao, Chairman, ISRO was present at Rupal village during the demonstration.

Satellite based television forms an integral part of our national broadcasting system. New configurations of the system are constantly being tried out for specialised needs. One of the configurations being explored for wide application is 'one-way video and two-way audio' teleconferencing network. Such a network can be used for training of extension/field staff and for educational purposes.

During the demonstration, the picture of the teacher addressing the participants - the Master Trainers of the "Saksharata Abhiyana" - was received via satellite at Rupal village and Gujarat Vidyapeeth, where classes were held simultaneously. The demonstration included lectures and video programmes produced earlier by Development and Educational Communication Unit (DECU) of ISRO for the Adult Education Department. At the end of each session, participants were able to put questions to the teachers through talk-back terminals via satellite. Social researchers of DECU interviewed the faculty and participants at the end of the demonstration to evaluate the effectiveness of this satellite based training.

The potential of such a system for training and education could be enormous, especially for field extension workers like para-medical and other health staff and school teachers. The system could also be employed by 'Open Universities' for interactive distance learning and by industry for training and updating the knowledge/skills of technicians and engineers.

A Satellite News Gathering (SNG) terminal was deployed during the demonstration to transmit a video picture of the Rupal class room to Ahmedabad via satellite which was also used for a video teleconference during the closing ceremony of the demonstration on February 27. This was an add-on demonstration of the use of SNG to feed video signals from a remote location. The demonstration was carried out using INSAT-1B. □

ASTRONAUTICAL SOCIETY OF INDIA
—Annual General Body Meeting

The Annual General Body meeting of the Astronautical Society of India (ASI) was held at ISRO Satellite Centre, Bangalore on January 30, 1991. The President of ASI, Prof U.R.Rao, in his address during the meeting, recalled the contribution of several institutions and industries in the country for the cause of astronautics. He called upon the members of the Society for their full dedication to the programmes such as the IRS and INSAT series of satellites and PSLV and GSLV launch vehicles, the operationalisation of which are critical for the country to attain self reliance in this area.

The ASI felicitated its members and others in the field, who were conferred with various honours and awards during the year.

The Executive Council of ASI is as follows:

Prof U.R.Rao
President

Dr. A.P.J.A. Kalam
Vice President

Shri P.S. Goel
Executive Secretary

Shri M.G. Chandrasekhar
Treasurer

Shri R.M. Vasagam
Member

Shri E.V.S. Namboodiry
Member

Shri V.A. Thomas
Member

Shri M. Annamalai
Member

Shri R.K. Rajangam
Member

The ASI which has its registered office at ISRO Satellite Centre, Airport Road, Bangalore 560 017 (Telephone - 0812 566251) has formulated a number of schemes for implementation during the next few years for furtherance of astronautics in the country. □

ISRO Develops Composite Material for Dentures

The Vikram Sarabhai Space Centre, Thiruvananthapuram, of ISRO has successfully developed a new composite material - Kevlar reinforced Poly Methyl Methacrylate (PMMA) - for fixed restoration of dentures. This material can replace the expensive materials normally used for fixed restoration such as gold, cobalt, chromium, etc.

Restoration and replacement of missing teeth by artificial ones (Prosthodontics) can be carried out in the form of fixed or removable dentures. Restoration by fixed dentures avoids periodic removal and gives a near-natural feeling.

Restoration of teeth – before

However, conventional fixed restoration involves expensive alloys containing gold, cobalt, chromium, etc, which make the treatment beyond the reach of common man. The Dental College, Thiruvananthapuram, was looking for an inexpensive material to substitute the costly materials and approached the scientists at VSSC who have expertise in the composite materials. The actual work on the development of the new composite material started after an indepth discussion between the dentists and the VSSC scientists.

Poly Methyl Methacrylate (PMMA) is bio-compatible, non-toxic and relatively inexpensive. The raw materials are easily available and processing is simple. Further, the dentures will have near natural colour. Kevlar fibres for reinforcement was selected after elaborate trials with other materials like carbon and glass. Kevlar reinforced PMMA has remarkable properties for use in prosthodontics. The composite product containing heat-curing type of PMMA mixed with 5 per cent short fibres and further reinforced with long fibres in desired direction, can withstand loads upto 90 kg against the normal requirement of 50 kg.

Intra-oral, intra-peritonial, intra-dermal and intra-venous administration of the extracts of the new material, prepared in cotton-seed oil and saline, on mice and rabbits has showed no toxic effects. Clinical trials conducted by the Dental College on 30 patients, who were provided with fixed dentures fabricated using this material, showed no ill effects (even after a period of 3 years) and there was no perceptible degradation of the material.

Besides being bio-compatible and non-toxic, the new material is relatively economical. Fixed dentures made of this material cost only about 5 per cent of those made with metallic alloys.

The successful development of the new Kevlar reinforced PMMA composite for use in Prosthodontics, is just another example of how spin-offs from space technology can find applications in diverse fields. □

...... and after

Awards and Honours

Prof U.R.Rao, Chairman, Space Commission has been awarded the Yuri Gagarin medal by the Cosmonautics Federation of the USSR for his outstanding contributions to space technology. The medal was presented by Academician Barmin, on behalf of the Presidium of the Bureau of Federation of Cosmonautics, USSR on January 14, 1991.

Dr.S.C.Gupta, Director, Vikram Sarabhai Space Centre, has been given the SICo-NAScI award of the National Academy of Sciences, India, for 1989 for his contribution in the area of Instrumentation.

Prof B.L.Deekshatulu, Director, National Remote Sensing Agency, has been conferred 'Padmashree' by the Government of India. The announcement was made on the eve of Republic day, January 26, 1991.

Shri N.Vedachalam, Director, ISRO Inertial Systems Unit, has been awarded the Biren Roy Trust award of the Aeronautical Society of India.

Dr G.V.Rao of Vikram Sarabhai Space Centre and Dr P.C. Pandey of Space Applications Centre have been awarded the Shanti Swarup Bhatnagar Awards for their contributions to Aerospace Structures and Satellite meteorology respectively.

Shri H.Narayana Murthy and his team including H.Bhojaraj, Shri Palaniswamy, Dr T.G.K.Murthy, Dr. C.L.Nagendra and Shri Unni Krishnan of ISRO Satellite Centre have been given National Research Development Council award for successfully developing optical solar reflectors for thermal control of satellite. □

Stop - press

Prof U.R. Rao explaining details of IRS to Prime Minister Chandra Shekhar during his visit to ISAC on April 19, 1991. The Prime Minister also addressed the ISRO scientists (below) during the visit

IRS-1C in orbit – an artist's concept