

BR-184 (VII)
August 2002

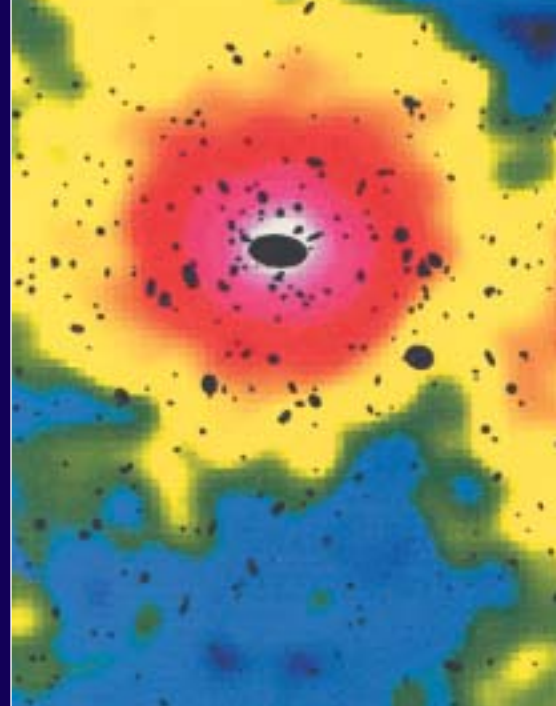


MEDICINE I

Technology Transfer Programme



Technology Transfer Programme



What do medical examinations and satellites have in common? This brochure will help you find out, and tell you just how the European space industry is having an increasing impact on medicine in general.

Several of the technologies used in the medical field come from systems that were developed for applications in space. I hope this brochure will give you an insight into how advanced European space technologies are being applied to our precious life, not only to protect it but also to prevent it, as much as possible, from the scourge of illness.

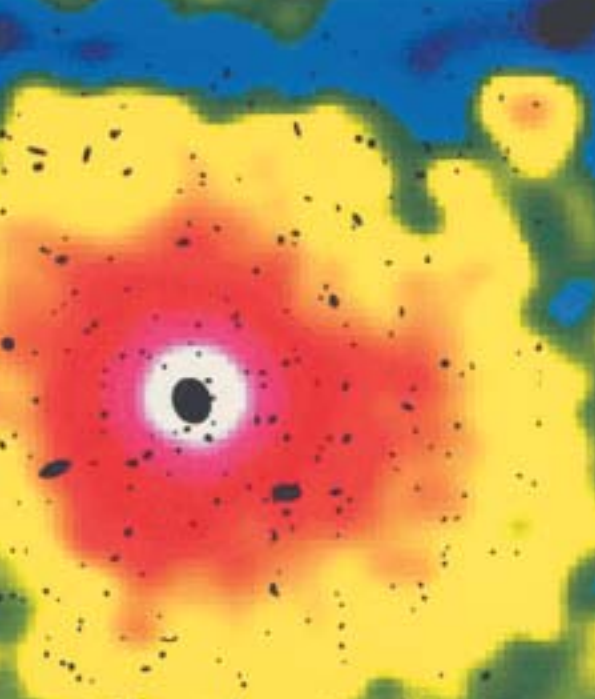
Many innovative non-space products and services that will benefit society are now being introduced as a result of technological spin-offs from the space industry, and it is worth remembering that medicine is not the only sector to take advantage of the new technologies developed by European space companies.

I hope this brochure will enable you to discover the new and unexpected ways in which space activities improve our daily lives.

It is no coincidence that the complex sensors and instrumentation developed to probe the distant reaches of the Universe can be adapted to assist doctors and biomedical researchers in analysing the human body. Both fields of research place great demands on the development of advanced detection, imaging and data processing techniques.

Pierre Brisson
Head of the Technology Transfer and Promotion Office





An endoscope from the company Richard Wolf GmbH, with a close-up of the optical system



FROM SUPERNOVAS TO MELANOMAS

One of the challenges facing astronomers studying stars and galaxies is to extract meaningful information from the jumble of signals that reach us from the far reaches of the Universe. This was a particular problem for scientists at the Max Planck Institute for Extraterrestrial Physics in Germany who were using the ROSAT satellite to observe distant X-ray signals from exotic objects like

FROM OUTER SPACE TO INNER SPACE

Everyone is fascinated by those images made by a tiny camera sitting on the end of a fibre-optic tube moving down the inside of the digestive tract. The device - an endoscope - is, of course, a vital tool to help doctors see internal organs and detect and diagnose diseases such as tumours and ulcers without actually having to cut a patient open.

MEDICINE

exploding stars (supernovas) and black holes. They, therefore, developed an algorithm for picking out the weak signals from the background of random 'noise'. The algorithm, known as the Scaling Index Method (SIM) helped the astronomers pinpoint thousands of faint X-ray sources and analyse their structures more accurately.

Researchers realised that the technique would have applications in other situations where vital data might be buried in the background noise. Working with scientists and doctors from Munich, and with the support of the German Space Agency, they developed a system for the early recognition of skin cancer. Skin cancer is a growing problem as more of us take holidays in the sun. But now, doctors can spot the early signs thanks to a computer method used to analyse X-rays from space.

The system, known as MELDOQ (Melanoma Recognition, Documentation and Quality Assurance System) and which incorporates the SIM package, uses a computer to analyse images of a highly magnified section of the skin surface very precisely. It can spot fine differences in colour, which can then lead to the detection and measurement of the irregular cell growth associated with malignant melanoma - a particularly virulent form of skin cancer. Now the MELDOQ system has been built into a range of hand-held tools under the DermoGenius trade mark. Use of the tools is so straightforward that even those doctors who are not experts in dermatology can diagnose skin cancer much earlier and more accurately. The system can also be used to train medical students in diagnosis.

Through the development of miniaturised instruments, endoscopy is also used to carry out minor procedures such as removing small pieces of tissue for tests, and increasingly 'keyhole' surgery. This requires much more accurate imaging, so endoscope manufacturers have been looking for ways to improve their instruments.

Fortunately, in the early 1990s European space scientists were developing techniques to address similar deficiencies in equipment deployed in laser communications. An efficient way of transmitting data between spacecraft is to send it as a stream of laser pulses, which is then detected by a camera. One problem, however, is that of light scattering in the detection system. In 1993 a German company, PTS, developed a coating process that produces layered, optically perfect black surfaces without the use of varnish (which increases light-scattering effects). The coating, called Plasmocer, has been used in cameras in European and Russian satellites and is planned for use in the STEXTILEX mission, which will test the transmission of data by laser between satellites in geostationary and low-Earth orbits.

STEXTILEX will employ these Plasmocer-coated cameras and by overcoming the effects of light-scattering, satellite controllers will be able to steer the beam of light more precisely, allowing higher rates of data transmission with low power consumption.

However, through the ESA Technology Transfer Programme, Richard Wolf, a German company manufacturing medical and industrial endoscopes, learnt about the new coating and decided to try it out. Tests showed that it enhanced the optical quality of his company's product by reducing light scattering by about 20%! The coating is now included in the production process for endoscopes to the benefit of doctors and patients alike.



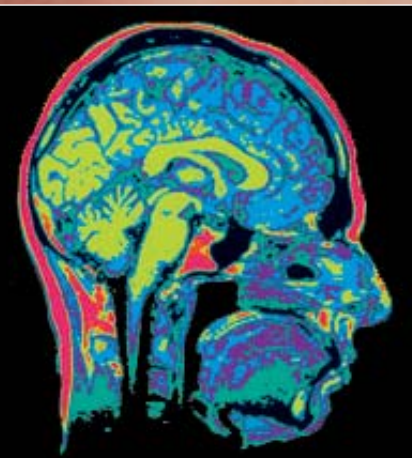


NEW CHIP BRINGS BETTER BABY PICTURES

When you go to the hospital for an ultrasound or some other scan, you probably don't realise just how much computer processing goes into creating the image of the expected baby or internal organ seen on the computer screen. Medical imaging requires a huge amount of digital information to be analysed quickly, accurately and cheaply. A chip for mathematical processing designed for satellites will now be able to help doctors check your health faster and more accurately

The kind of complex data generated during the scan can be broken down into its component parts using a mathematical method called 'Fourier transformation' (invented by the 18th-century French mathematician Jean-Baptiste Fourier) and then quickly processed. As well as being a standard tool for physicists, the method is exploited in many kinds of chemical and biological analysis through a computer algorithm known as the Fast Fourier Transform (FFT). The technique is also used in electronic engineering to process data, for example, in telephone networks and radio communications.

Spacecraft also have large data processing requirements, and recently a Dutch-based company DoubleBW Systems BV - a spin-off of TNO Physics & Electronics Laboratory which works closely



MEDICINE

with ESA - developed a computer chip using FFT for satellite operations. The chip is one of the fastest known and manages to combine exceptional performance with flexibility. It turns out that the chip can be employed in many non-space applications, including seismic data processing, pattern recognition, communications and spectrum analysis. One of the most exciting applications is for the medical world and the company is now modifying the chip so it can be incorporated in 2D and 3D medical imaging instruments to provide clearer and sharper pictures.

Images like this one can be produced more efficiently using the new processing chips

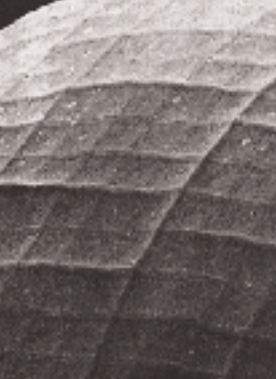
A LOBSTER'S X-RAY EYE VIEW

Astronomers are not content with looking at the night sky in just visible light. They also detect and study X-rays from space. This high-energy radiation is associated with violent phenomena in the Universe such as black holes and supernova explosions. X-ray telescopes are rather different from ordinary telescopes, however, because X-rays tend to pass through objects so they can't be focused in the same way as visible light. They have to be steered by bouncing them off metal-coated surfaces at very shallow angles.

This has created a problem in the past in that X-ray telescopes could only look at small areas of the sky at a time. Now, however, it seems that the lobster has the answer. Unlike the human eye, which relies on refractive lenses, lobster eyes have thousands of square tubes bound together, arrayed spherically end-on, which reflect light down the inner walls of each tube to focus it on the retina.

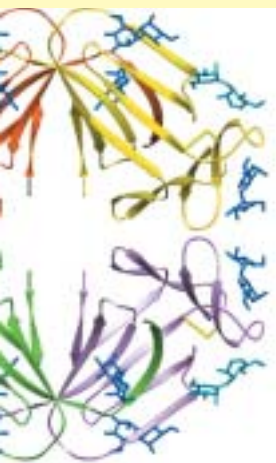
Scientists at the Space Research Centre at Leicester University (UK) have replicated the lobster's eye lenses using thousands of microscopic, hollow glass tubes bundled together around the surface of a sphere to focus X-rays from much larger portions of the sky. The lobster-eye X-ray lens is actually based on microchannel plate technology. A microchannel plate is an array of tiny parallel channels, which focus the X-rays, point by point, onto a detector.





Surface of a lobster's eye in close-up

X-ray imaging is used to determine protein structures



IMAGING BETTER PARTICLES

Lobster-eye telescopes have already flown on US space missions and the Leicester telescope will now be mounted aboard the International Space Station. The Leicester team have recently been investigating how to exploit this type of innovative X-ray optics in areas other than astronomy.

What they have been looking at is a different form of microchannel plate technology to detect and image another kind of energetic radiation - beta particles - which are emitted by certain radioactive elements such as the hydrogen isotope tritium. In medicine, such beta emitters are used to 'label' biological materials so they can be analysed by monitoring the radiation given off.

One exciting use is in the new field of proteomics. Now that the human genome - our genetic code - has been analysed, the next stage is to identify and study all the proteins that the genes code for. Proteins are the workhorses of living cells, and understanding how they control the body's biochemical processes is vital in the fight against disease and in the search for new drugs. Labelling a protein thought to be associated with a disease with a beta-emitting isotope is one way of probing interactions with potential drug molecules.

In the true spirit of spin-off, the Leicester Space Centre has established a Bio-Imaging Unit and produced prototype beta-radiological equipment. Some recent research exploiting the technique includes measuring the effects of organophosphates - such as fly killer and sheep dip - on brain proteins. The pharmaceutical company Bayer, working with the UK Medical Research Council, is funding further research in this area. Other uses for the equipment include evaluating the use of therapeutic radioisotopes to treat bladder cancer. So a variation of the same eye of the lobster technology is helping medical researchers to fight disease.

MEDICINE



A BLOOD TEST ON A CHIP

Many of us will have had a blood test at one time or another, but we probably don't think about the complex analysis that goes on in the hospital lab to give us our results. One powerful analytical method used is high performance capillary electrophoresis (HPCE), which can separate out complex chemicals like proteins from a biological sample so that they can be identified. The separation is based on the simple physical principle that different substances move at different rates under the influence of an electric field. HPCE has the advantage of requiring only small samples and, with minimum preparation, being able to detect a wide range of complex substances. As well as being used in the clinic, for example to analyse blood samples for metabolic disorders and monitor concentrations of anticancer drugs and anaesthetics in the body, it is also employed extensively by drug companies and the chemical industry.

In the Netherlands, research on capillary electrophoresis had been centred at Eindhoven University, which several years ago started to investigate the possible applications of HPCE in space. One important use of Shuttle and Space-Station missions is to exploit microgravity conditions to prepare and analyse materials of biological significance. It is, for instance, extremely difficult to grow protein crystals on Earth that are large enough and perfect enough to analyse, partly because of the effects of gravity. Such materials are often limited in stability so it is necessary to analyse the structure quickly - and space provides the ideal environment.



It was with this aim that Eindhoven University, and an industrial consortium including the companies Comprimo BV and Lauerlabs BV, began to develop a range of small, modular, fully-automatic HPCE systems, some adapted for manual operation, to monitor physiological changes in the body fluids of astronauts. These would initially be used on Spacelab missions and possibly in future on the Columbus module of the International Space Station.

PORTABLE SYSTEMS FOR THE HEALTH INDUSTRY

As a result of promoting the non-space use of these modular systems, Helena BioSciences, a UK company making analytical instruments for the health and pharmaceutical industries, spotted the synergy with its own range of products. The company also saw the possibility of improving its analytical support to clients by introducing portable automated machines.

Helena determined that the most effective way of achieving the necessary technology transfer would be to acquire Lauerlabs BV (who were producing the modular systems), in order to bring the benefits of a valuable programme of space-focused research to the wider European pharmaceutical and clinical community. At the conclusion of the acquisition, Lauerlabs changed its name to Prince Technologies.

In recent years the technology has been further developed to become even more flexible. It has been extended so that it can be used with a wider range of chemicals, and even more excitingly it is now being miniaturised so that the separation can be carried out on a chip - which promises even smaller sample sizes and faster separation times.



Modular HPCE units like this one are planned for use on the International Space Station

MEDICINE

THE SWEET SMELL OF SUCCESS

The human nose is extremely sophisticated. It can detect and distinguish a huge range of odours. As well as enhancing the experience of eating, our noses also act as early-warning devices by helping to sense danger or decay. If you smell gas at home, it is usually easy enough to locate the source. This is not quite so easy to do in space, however, and this is why ESA supported the development of sensors to act as gas detectors on space stations such as the Russian MIR.

Scientists studying how smell works in humans have employed electronics to mimic the processes involved. Arrays of sensors can emulate the different types of olfactory receptors found in our noses. Processing electronics then convert the signals from the sensors into patterns and store them for future recognition. These 'electronic noses' employ many different types of sensors, electronics and sampling devices

The Department of Instrumentation and Analytical Science at the University of Manchester Institute of Science and Technology (UMIST) in the UK was under contract to ESA to produce a gas-sensing device for monitoring vital safety functions on the Russian Space Station MIR - such as the air quality, in particular any contamination resulting from leaks, and also signs of any fire break-outs.

In 1994 the technology was transferred from UMIST to a company called Aromascan (now called Osmetech plc). Osmetech employs sensors made of conducting polymers arranged in arrays of up to 48 individual detectors. The way the polymers are arranged is unique to Osmetech and enables each element on the array to have a different conductive property. The multiple sensors can detect a range of distinctive smells and odours.





Osmetech knew that there were many potential applications for the electronic nose technology. For example, when micro-organisms metabolise, they emit volatile components often possessing a characteristic smell, which the Osmetech sensor array technology can detect. The company realised that the sensor arrays



Benefits for our daily lives: The ESA Technology Transfer Programme

Over the past 35 years, the European space industry has gained considerable expertise in building, launching, controlling and communicating with satellites. From this long experience of how to overcome the hazards and problems created by such a hostile environment, many valuable new technologies, products and procedures have been developed. Today, this expertise is improving our daily lives by providing many innovative solutions for products and services on Earth.

Groundbreaking European space technologies are becoming increasingly more available for development and licensing to the

MEDICINE

could therefore detect the presence of pathogenic bacteria, fungi and moulds such as those causing urinary tract infection (UTI), infections that result in women going into early labour, bacterial throat infections and pneumonia. These sensors can be incorporated into automated multi-sample instruments for use in a hospital lab or at the doctor's surgery.

Osmetech has gone from strength to strength. In November 2001 it became the first electronic-nose company to receive the approval of the American Food and Drug Administration for the use of its UTI detection device. This will enable the technology to be commercialised within the US and subsequently throughout the rest of the world.

non-space industry through the process of technology transfer. The ESA Technology Transfer Programme has already achieved over 120 successful transfers or spin-offs from space to non-space sectors.

This success is reflected by the fact that since 1991 technology transfer has generated more than 20 million euros in turnover for European space companies and 120 million euros for the non-space industries involved. Already 2,500 jobs and 25 new companies have been created.

The ESA Technology Transfer Programme is carried out by a network of technology brokers across Europe and Canada. Their job is to identify technologies with potential for non-space applications on one side, and on the other side to detect the non-space technology needs. Subsequently, they market the technology and provide assistance in the transfer process.



To learn more about ESA's Technology Transfer Programme please contact:

Dr. P. Brisson

Head of the Technology Transfer and Promotion Office
European Space Agency-ESTEC
P.O. Box 299
2200 AG Noordwijk
The Netherlands

Tel.: + 31 (0)71 565 4929
Fax: + 31 (0)71 565 3854
E-mail: pierre.brisson@esa.int

Dr. D. Raitt

Technology Transfer and Promotion Office
European Space Agency-ESTEC
P.O. Box 299
2200 AG Noordwijk
The Netherlands

Tel.: + 31 (0)71 565 3017
Fax: + 31 (0)71 565 3854
E-mail: david.raitt@esa.int

or contact one of the Technology Transfer Network brokers:

MST Aerospace GmbH

Eupener Str. 150
D-50933 Cologne, Germany
URL: <http://www.mst-aerospace.de>

Tel.: + 49 (0)221 949 89 20
Fax: + 49 (0)221 491 24 43
E-mail: office@mst-aerospace.de

JRA Aerospace & Technology Ltd.

JRA House, Taylors Close
Marlow, Buckinghamshire
SL7 1PR, UK
URL: <http://www.jratech.com>

Tel.: + 44 (0)1 628 89 11 05
Fax: + 44 (0)1 628 89 05 19
E-mail: mail@jratech.com

D'Appolonia SpA

Via San Nazaro, 19
I-16145 Genoa, Italy
URL: <http://www.dappolonia.it>

Tel.: + 39 (0)10 362 81 48
Fax: + 39 (0)10 362 10 78
E-mail: info@dappolonia.it

Nodal Consultants

209-211, rue de Bercy
F-75585 Paris Cedex 12, France
URL: <http://www.nodal.fr>

Tel.: + 33 (0)14 002 7557
Fax: + 33 (0)14 002 7544
E-mail: info@nodal.fr

or visit the ESA Technology Transfer Website:

<http://www.esa.int/ttp>

or the ESA-supported technology market places:

<http://www.technology-forum.com>

and

<http://www.t4techonline.com>

Published by

ESA Publications Division
ESTEC, PO Box 299
2200 AG Noordwijk
The Netherlands

Editor

Bruce Batrick

Design & Layout

Leigh Edwards

Copyright

© ESA, 2002

ISSN No. : 0250-1589

ISBN No. : 92-9092-722-4

