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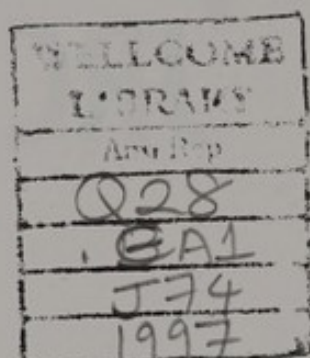
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1997 was, for the Joint Research Centre, both a year of continuity in terms of work initiated in earlier years and a year of gestation and reflection.

The year was marked, on a scientific level, by some outstanding success stories, in particular the use of radioisotopes and particles for medical applications, especially to treat cancer. Mention should also be made of the JRC's efforts to support the development of new, faster and safer anti-personnel mine detection systems. The European Integrated Pollution Prevention and Control Bureau was set up in Seville. It will enable experts to compare the environmental performance of various processes, sector by sector and activity by activity, and to identify the best available technologies in terms of environmental protection. Many other scientific and technical advances were made. You will find a description of them in this report.

1997 was also a year for taking stock of the 4th Framework Programme and making preparations for the future. A preliminary review was carried out and the new terms of reference for the JRC were established: to provide scientific and technical support for the preparation, implementation and monitoring of European Union policies.

The quality of this support is based on the JRC's ability to listen to the other players involved in the EU's decision-making process. It is also based on four other areas of activity (research, scientific cooperation, technology transfer and competitive activities) which will provide the JRC with access to new ideas and new skills. These activities will also enable it to face up to other laboratories and to economic realities and to assess the quality of its support.

The research conducted within the JRC needs the recognition of the scientific world and the level of its skills needs to be ensured. The European technology transfer initiative, which took shape in the course of 1997, will enable the JRC to transfer the results of its research and contribute towards the innovation process. The competitive activities will also make it possible to confront the JRC with the skills that other scientific laboratories can offer, and thus to assess its own value. The volume of these activities should be significant, but must not call into question the JRC's independence. The levels achieved this year would seem to represent a good compromise. Last but not least, the mobility of researchers and experts and the secondment programmes will make it possible to create the interfaces and networks that the JRC needs both to fulfil its mission and expand its range of skills.

There is therefore a great deal to show for a year of work and reflection! It augurs well for 1998, a year of transition in which the JRC will need to adapt itself to the requirements of its mission.



Edith Cresson

Member of the Commission
responsible for research, innovation,
education, training and youth



Foreword



1997 has been a successful year in the evolution of the JRC towards more user driven research and competitiveness within the framework of the technical objectives defined by the Council decisions for the period 1994-1998. While keeping its character of an organisation which is at the service of the Commission, and devoting a considerable part of its effort to research linked to the activities of European Institutions, the JRC is also sensitive to the needs of the market. Work performed on a contractual basis for outside third parties forms a growing part of its endeavors. The Centre has research installations which are too expensive or specialised to be multiplied in Europe, and which can thus only be set up at the European level. These installations are used in its own programmes and also made available for other public or private organisations through collaboration agreements or contractual arrangements.

JRC activities have the effect of creating links and networks between industrial and academic teams in Member States. These collaborations thus help to bring the Member States closer together and to work with JRC on important European topics. At the initiative of Commissioner Madame Edith Cresson, the JRC has initiated a new approach to the marketing, exploitation and commercialisation of results in conjunction to a better structured communications policy. Dissemination of information has thus been intensified in an effort to establish closer collaboration with industry, research centres and universities in the Member States. On technology transfer and networking, new mechanisms have been proposed to provide more flexibility in accessing JRC facilities, to bring forward its results and to target JRC intellectual property at companies, research consortia and individuals across Europe.

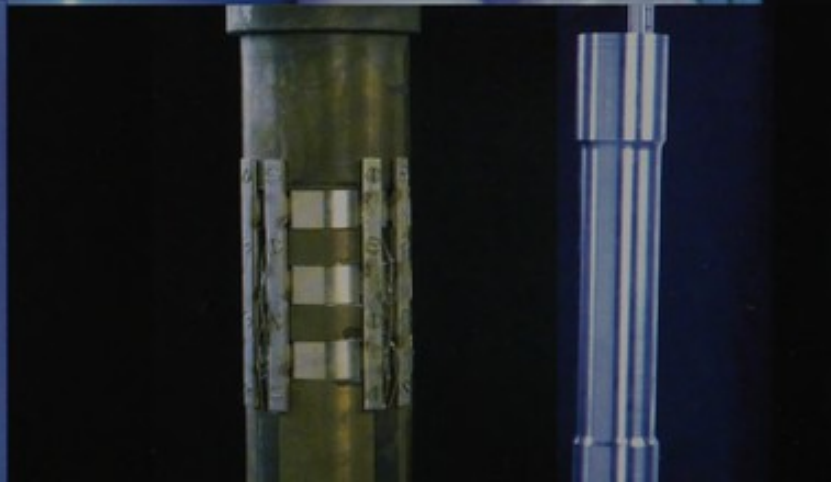
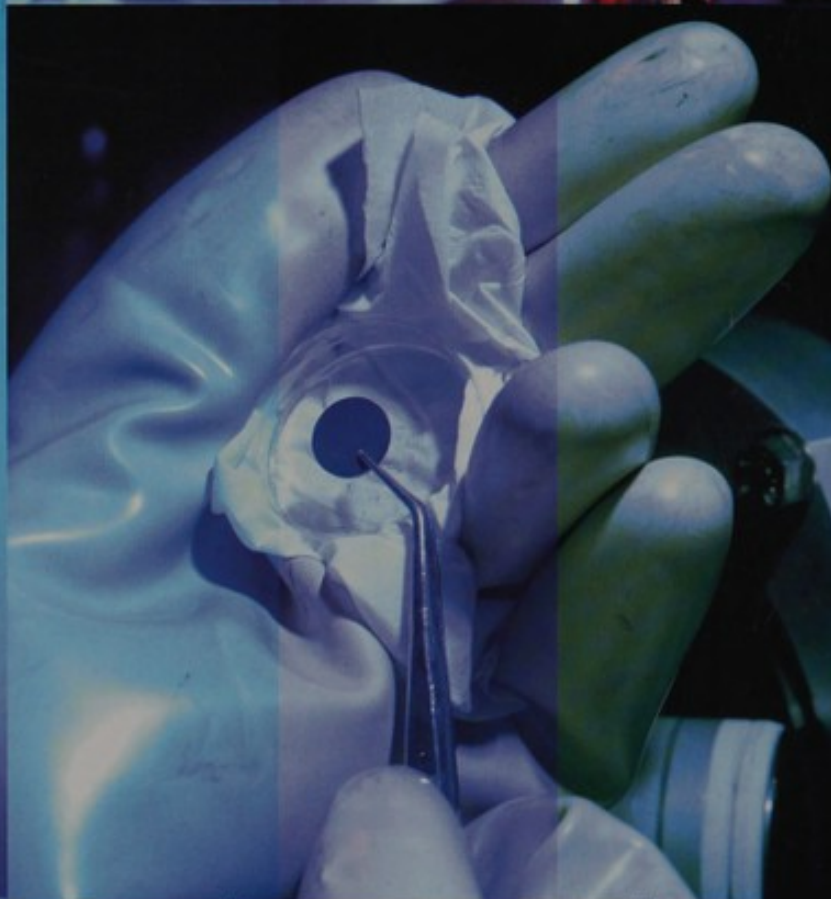
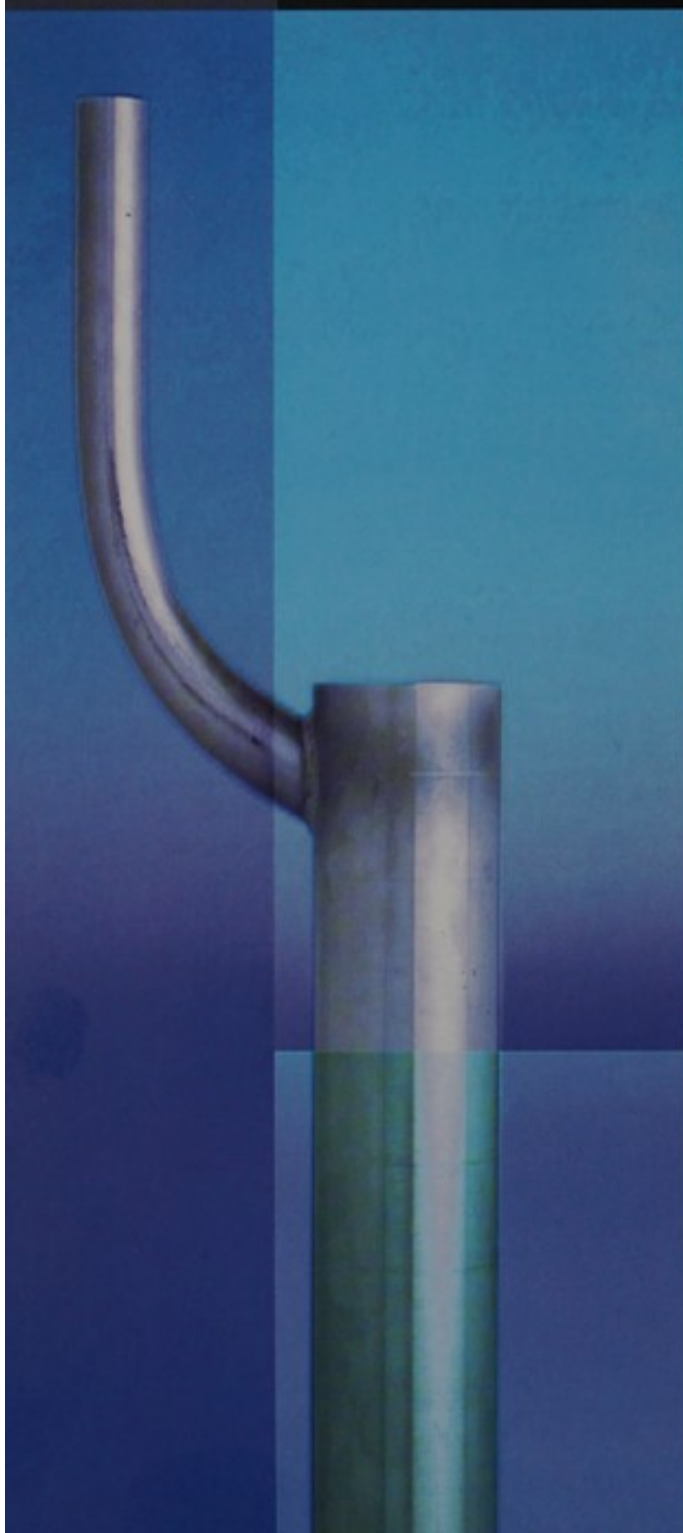
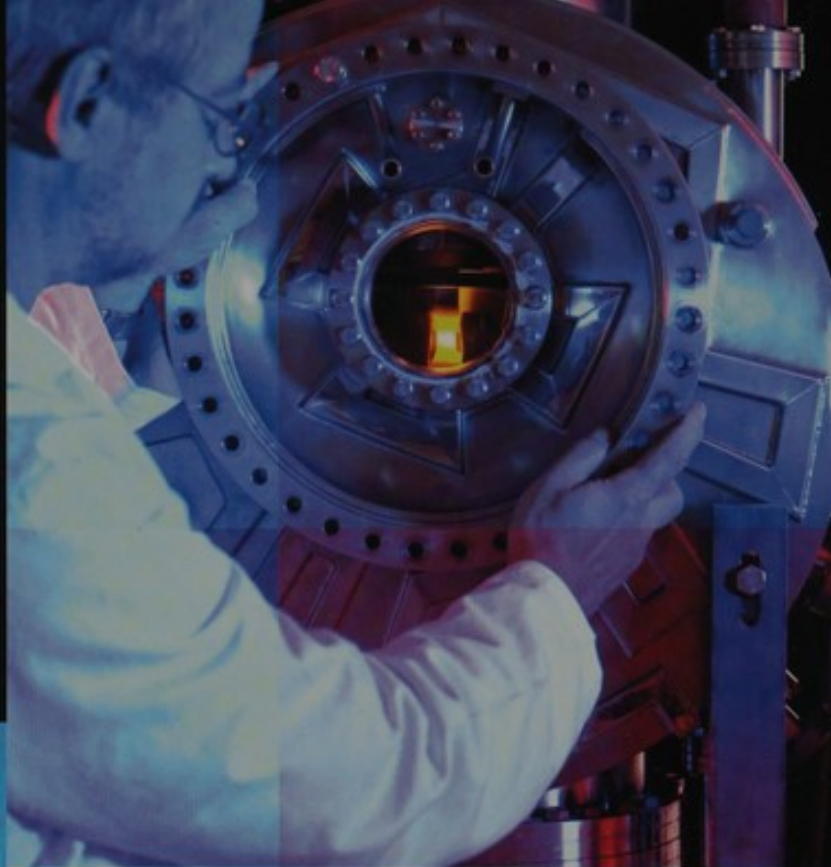
As regards the preparation of the Fifth Framework Programme, the JRC contributed with its specific programmes' proposals. The Centre will constitute one of the essential mechanisms for the Framework Programme implementation, with particular emphasis to areas such as serving the citizen, enhancing sustainability, underpinning European competitiveness, nuclear fusion, safety of nuclear fission and nuclear safeguards. Greater emphasis will be also given to socio-economic activities. The JRC plans to capitalise on its multidisciplinarity and on its role as an independent research organisation of the European Commission to establish many collaborations and networks with research organisations in the Member States.

To complement its institutional activities the JRC continued its participation in a large spectrum of competitive activities: shared cost actions with partners from Member States; Scientific and Technical support to the Commission services and third party work for external customers. Overall results during the year were more than promising.

The activities of the JRC will be user oriented; the user being represented by the Commission services and the European Parliament. Its objective is to support the conception, implementation and monitoring of EU policies. As a service of the European Commission the JRC will act as a centre of science and technology reference for the Union. It will remain close to the policy-making process, in order to serve the common interest of the Member States, while being independent of private or national interests.

H.J. Allgeier

Director General



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Introduction



1997 was a year of evolution towards a more customer-driven approach in JRC institutional activities and was characterized by several scientific achievements in various research fields. These achievements are highlighted in the report. In particular, it should be mentioned that, for the first time, an innovative form of radiotherapy was tested on patients suffering from a very aggressive type of brain cancer, and that preliminary clinical trials have shown promising results in treating leukemia with alpha-immunotherapy.

During the year, the JRC continued its successful performance as a neutral organisation at the service of the Commission within the frame of the objectives of the Council decisions on the JRC Specific Programmes for the period 1994-1998. In addition, JRC contributed to the preparation of the 5th Framework Programme with a proposal for the Centre's research in future years. In so doing, the Centre undertook an overall analysis of the demand for S&T assistance from the different customer Directorates General of the Commission. As a result of this analysis, a stronger emphasis is given to life sciences topics related to consumer protection, anti-fraud, prospective technological studies, sustainable growth and environment high on the Commission's agenda. The new orientation of the Centre is characterized by greater emphasis on socio-economic activities, reflecting the general orientation to "Research at the service of the individual and the citizen" given to future European Union's programmes.

A particular effort was also made to improve the image of the JRC through a more determined communications policy. The visit in September of the Members of the European Parliament from the Committee on Research, Technological Development and Energy,

allowed for the presentation of future strategy and projects and to highlight the relevance of the Institutes scientific work to the European citizen. Additional efforts were made to open the Centre, in a more user-friendly approach, to the scientific press in order to render the JRC better known by the general public.

A new technology transfer initiative was also approved by the Commission in early 1998, departing from earlier ideas for the creation of a technology park on the traditional model. Such a model was deemed not appropriate for the JRC in view of the need to preserve the independence and neutrality associated with its institutional role. Instead, an integrated set of flexible access mechanisms is foreseen through collaborative agreements with users for the sharing of large installations, as well as a technology transfer capital fund, a virtual technology park and training and education initiatives.

JRC developed diverse collaborations with other research organisations, both in Member States and in the rest of the world, by participating in various networks to undertake different research and development initiatives. Competitive activities, such as participation in shared cost actions and work for external clients, continued to be obtained by JRC at a very significant pace, making the achievement of the four year objectives to appear attainable by the end of the programme.

By capitalising on its multidisciplinary, the JRC has maintained a high level of quality in its activities together with a continuous thrust to achieve better overall performance; efforts continued to render the internal organisation more flexible; these will be pursued and extended in 1998.

The Joint Research Centre



The Joint Research Centre is the European Union's scientific and technical research laboratory, established by the European Commission, with headquarters in Brussels. Five separate sites, located in Belgium, Germa-

ny, Italy, the Netherlands and Spain, house seven different institutes, each with its own focus of expertise.

These institutes are:

IRMM	The Institute for Reference Materials and Measurements	Geel (B)
ITU	The Institute for Transuranium Elements	Karlsruhe (D)
IAM	The Institute for Advanced Materials	Petten (NL) and Ispra (I)
ISIS	The Institute for Systems, Informatics and Safety	Ispra (I)
EI	The Environment Institute	Ispra (I)
SAI	The Space Applications Institute	Ispra (I)
IPTS	The Institute for Prospective Technological Studies	Seville (E)

The Joint Research Centre is an integral part of the Community research and technological development system, and has developed over the years special skills and unique tools to provide neutral and Europe-wide expertise, in order to get a better understanding of the links between technology, economy and society. JRC aims to carry out the specific Community research programmes, decided upon by the Council and funded by the European Union budget; provide customer-driven research as scientific and technical support for other Community policies, such as those on the environment, agriculture or nuclear safety; and engage itself ever more successfully in competitive activities, i.e. participating on a par with industry, research organisations and universities of the Member States or associated countries in Community programmes, including shared-cost actions under the Framework Programmes, or providing paid services to private and public customers.

The statutory staff, comprising officials, temporary and auxiliary agents, was 2 092 at the end of 1997. To this number one must add 148 scientists who were active in the Centre and were paid by the JRC under various hosting schemes.

The global financial appropriations committed by the JRC in 1997 were around 291,316 Mioecu.

This Annual Report is intended to give a general overview of JRC activities in 1997.

The seven Institutes of the JRC produce their own Annual Reports. Readers may find more details in these Annual Reports. The JRC also publishes numerous scientific reports, presents papers to conferences and in scientific journals, and organizes workshops, seminars and conferences to disseminate its scientific output.

bservations *by the* Board of

The Board of Governors is pleased to note that the progress recorded in the 1996 Annual Report was sustained and consolidated during 1997. In particular the progress recorded in fulfilment of the mission of the JRC notably in support to EU Policies. The year saw a series of significant achievements which are highlighted in the present report. Competitive activities too are now an integral part of the JRCs working life—in particular together with its national partners the JRC has demonstrated success in obtaining contracts for participation in the shared-cost action programmes.

Exploitation of Knowledge

The Board of Governors is pleased that the JRC is moving positively to use and develop its knowledge and expertise for the benefit of the citizens of the European Union. The Board expects the JRC to continue to adapt its reservoir of knowledge as a resource for relevant and commercial exploitation.

As highlighted in the report, the JRC is collaborating in the development of an innovative form of radiotherapy which is now undergoing clinical trials, and which could hold out hope for thousands of brain tumour sufferers. The JRC has also been involved in the development of an alpha-emitting radioisotope adapted to a new kind of immunotherapy against cancer which is now undergoing various clinical trials at the Memorial Sloan-Kettering Cancer Centre in New York and in European hospitals.

Technology Transfer

On a broader front, the JRC is developing a coherent set of initiatives to stimulate technology transfer, collaborative research and networking across Europe. An integrated set of mechanisms is being explored which should allow flexible access to JRC facilities, results, intellectual property, expertise and know-how. This is targeted at companies, large and small, research centres and individuals across Europe. The JRC is also addressing how best to exploit the significant range of intellectual property ideas residing in its various institutes.

The Board of Governors sees all of this as a continuous process of trying to create better linkages between the JRC and its clientele in the Member States, and of creating networks and synergies of relevant groupings for the benefit of European industry and its citizens. The Board intends to follow these developments closely.

Evolution of the JRC Status

In 1996 the Commission took a significant step when it decided to give the JRC the status of an autonomous Directorate General, a step which was welcomed by the Board of Governors.

The Board has always strongly advocated giving the JRC the necessary freedom to play a fuller role and realise its full potential. In 1997 the Board issued a favourable opinion on a draft proposal to endow the JRC with legal personality. This move, properly executed, could help to enable the JRC to respond more fully to the competitive environment in which it is increasingly expected to operate.

Evaluations

During 1997 the Board continued to assess and supervise the implementation of the recommendations from the detailed and horizontal evaluations of the JRC activities carried out in late 1996 by Professor J.M. Rojo and the visiting groups. During 1997, the institutes systematically implemented detailed plans designed to give effect to these recommendations; for example addressing the spread of activities and how better to focus and concentrate resources. This is to be welcomed.

5th Framework Programme

The Board of Governors noted with keen interest the Commission's proposal for the 5th Framework Programme. The Board has followed and has participated in the ensuing discussions at various levels—addressing the CERT (Committee on Research, Technological Development and Energy) of the European Parliament, preparing a submission to and addressing members of

Governors on the JRC Annual Report 1997

CREST (Scientific and Technical Research Committee), and in developing its own thinking concerning *inter alia* the compatibility of the programme and the capacity of the Centre. It adopted an Opinion in October 1997 emphasising the JRC mission on the basis of its neutrality, impartiality and competencies necessary to underpin European policies. The opinion further stated that the institutional budget in the 5th Framework Programme should be similar in real terms to that of the 4th Framework Programme and that a target for the competitive activities should be in addition 15% of the institutional budget.

The Board believes that, as a result of solid progress made by the institutes over the past 5 years, the JRC is in a much stronger position to contribute to achieving the aims of the 5th Framework Programme.

Staff

The Board of Governors learned with regret that Director General Jean-Pierre Contzen would leave his position from July 1997. The Board would like to place on record its debt to him for the excellent contribution he

made to building up the JRC and taking it into its new competitive role. The responsibilities of Director General during the second half of 1997 fell on the Deputy Director General, Mr. Hugh Richardson.

After the period covered by the present Annual Report, the Commission in January 1998 selected and appointed Mr. Herbert Allgeier as Director General of the JRC. Mr. Allgeier is well familiar with the JRC which he, in a previous period, served as the first Director of the Institute for Prospective Technological Studies in Seville.

Acknowledgements

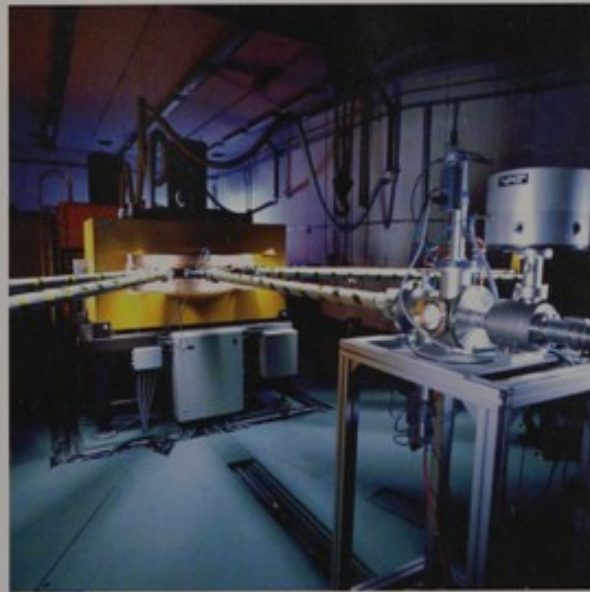
The Board was pleased to have the opportunity in December 1997 of a detailed exchange of views with Commissioner Cresson on a range of pertinent issues, including the future orientation of the JRC. The Board looks forward to continuing a constructive dialogue with her in the future.

The Board would also like to thank all of the staff of the JRC for their services and for the way they are responding to the new directions being charted out for the JRC.

FAT (Faro Advanced Tank) vessel for molten fuel/coolant interaction



Bending magnet and beamlines of the Mc-ya cyclotron in the cyclotron hall



H Highlights of 1997



The JRC's scientific and technical work is mostly interdisciplinary and covers a large number of projects.

The following few selected examples of work from the JRC Institutes illustrate various areas of activity and varied funding arrangements elaborated for JRC work in 1997.

The Boron Neutron Capture Therapy (BNCT): Exploration of an Innovative Treatment for Malignant Brain Tumours

Approximately 15000 Europeans are affected each year by glioblastoma, an extremely malignant type of brain tumour. Little progress has been made during the last 40 years in this field, and the average survival time of patients has not changed considerably, due to the low effectiveness of conventional treatments. An innovative form of radiotherapy is for the first time being tested in Europe at the HFR reactor in the JRC (Petten, The Netherlands). Five patients have already been treated in the framework of clinical tests that began in October 1997. The boron neutron capture therapy (BNCT) is carried out shortly after the patient's surgical operation in his/her own country; it replaces conventional radiotherapy. The principle of this new treatment is to destroy only the cancerous cells, leaving healthy cells unharmed.

It should be noted that the development of this therapy is only at the stage of clinical trials. The tests should make it possible to determine the optimal level of irradiation for the brain—varying the time, the dose, and the number of exposures to the new neutron beam. It is the first multi-national clinical application in Europe, where patients from one European country are treated in another country by physicians from a third country. This opens the way to organize clinical schemes that would use sophisticated and unique facilities to treat patients suffering from this aggressive type of brain cancer.



Head phantom placed on the BNCT therapy table in the neutron beam at the HFR BNCT facility. Boron therapy inauguration, 1998.

Anti-Personnel Mine Detection Systems and Strategies

The Space Applications Institute (SAI) is gaining recognition as a focal centre for mine detection and identification. Its work is continuing in close collaboration with national groups from EU Member States as well as with NGOs, representatives from mine-infected countries, and mine clearance teams.



Detection and identification of anti-personnel mines at the EMSL (European Microwave Signature Laboratory).

[Page 13] Detection of U_{-234} and U_{-235} in particles. Comparison of results obtained by ITU using SIMS and those obtained by other laboratories using other techniques. a) Low enriched particles; b) High enriched particles.

SAI set up an outdoor test range for establishing standards to validate the performance of mine detection sensors (e.g. metal detectors, ground penetrating radars and thermal infra-red sensors). This "bench-marking" action began in October 1997 with a workshop attended by the United Nations Department for Peace Keeping Operations (UNDPKO), non-governmental organisations, mine clearance organisations, mine detector producers (SMEs), national research organisations, universities, and other Commission services concerned with mine clearance. The facility has been used by various mine-detection sensor producers, and in feasibility studies of a multi-sensor system for anti-personnel mine detection and identification. The standards obtained will be applied to subsequent SAI tests, as well as to mine clearance projects supported by the European Commission in mine-infected countries.

Network Laboratory for Environmental Sampling

The discovery of the secret Iraqi nuclear weapons programme has led to a substantial strengthening of the safeguards system of the International Atomic Energy Agency (IAEA) in Vienna. It became evident, that it is necessary to provide assurance that no undeclared nuclear activities are taking place in States having signed the Non-Proliferation Treaty.

Ultra-sensitive environmental sampling techniques are one of the key new developments to help to detect the presence of clandestine activities.

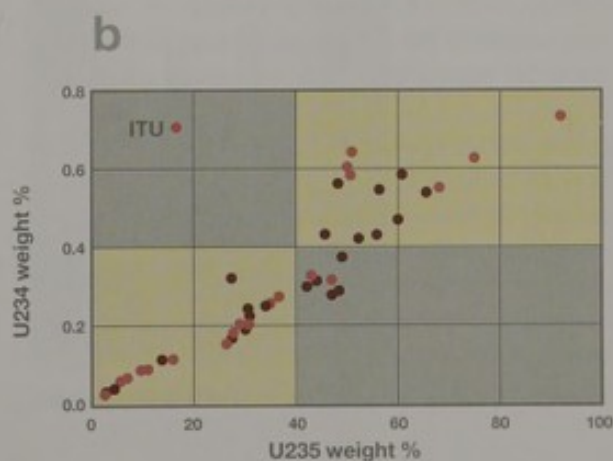
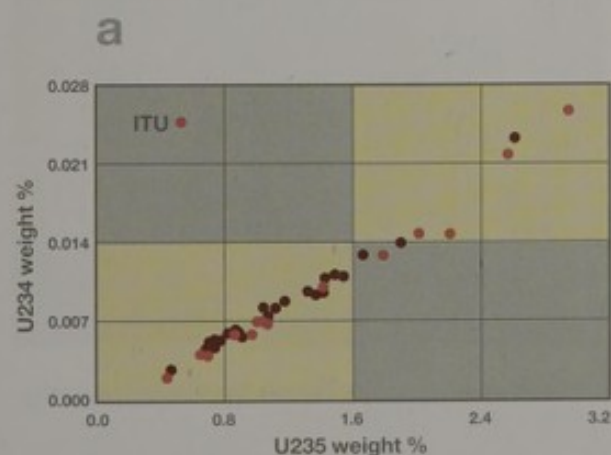
Following the agreement signed in July 1997 between the International Atomic Energy Agency (IAEA) and the

JRC, the **Institute for Transuranium Elements (ITU)** has become one of the network laboratories for the analysis of environmental samples. In this way the Institute is actively contributing to the policy of the European Union to support and strengthen the International Atomic Energy Agency's activities in nuclear safeguards.

The Institute is also closely collaborating with and providing similar support to the Commission's Euratom Safeguards Directorate (ESD) in the area of High Performance Trace Analysis (HPTA). ESD is providing financial support for increased automation of measurement technology.

Technology Transfer, Intellectual Property and Networking at the JRC

Developing at the JRC a coherent set of activities to stimulate technology transfer, collaborative research and networking across Europe should be an indispensable and desirable complement to institutional activities. A feasibility study was thus carried out to define how this potential can best be exploited, taking into account, however, the need to preserve the institutional role of the JRC with its inherent neutrality and subsidiarity. As a result, an integrated set of mechanisms has been proposed for flexible access to JRC facilities, results, intellectual property, expertise and know-how, targeted at companies big and small, research centres and individuals across Europe. The objective is to achieve results across Europe and, therefore, to offer flexible options such as collaboration agreements and innovation-oriented actions. All components aim at facilitating access from geographically distant locations



without having to invest in premises on the JRC sites. The proposed concept is thus a radical departure from traditional "technology parks", which aim at attracting investment and include a high proportion of property development.

A particular effort was made in 1997 to increase the awareness of the JRC staff on intellectual property issues. A special leaflet explaining the need to protect inventions and the means to do so has been distributed to all staff. This message was amplified by a poster "Patent FIRST, then Publish". Patent coordinators have followed special training courses and have received access to specialised patent databases.

Alpha-Immunotherapy

Alpha-immunotherapy is a spin-off activity of the Basic actinide research work carried out at the Institute for Transuranium Elements (ITU). It has gained increasing interest and attention as a therapy for cancer treatment.

The unique expertise of the **Institute for Transuranium Elements (ITU)** in the nuclear field allowed it to prepare an alpha-emitting radio-isotope, Bismuth-213, adapted to a new kind of immunotherapy against cancer. A by-product of nuclear energy and derived from nuclear waste, Bismuth-213 is easier to handle than other alpha-emitters and decays rapidly into a non-radioactive substance.

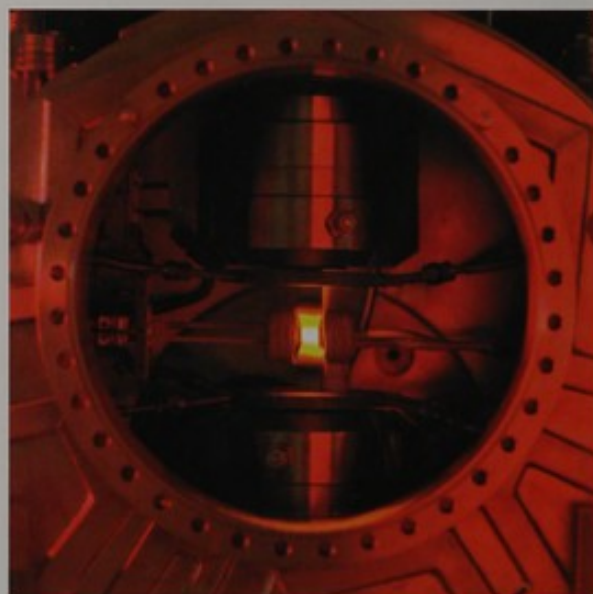
Early clinical trials carried out at the Memorial Sloan-Kettering Cancer Center in New York, USA, on leukemia patients showed for the first time that alpha-particle therapy could be feasible and appears safe: no significant uptake of the isotope was registered outside of the target areas of bone marrow, liver and spleen.

Similar studies sponsored by the European Commission are being carried out at Nantes, France, and Heidelberg, Germany. The French research focuses on an *ex vivo* bone-marrow purging feasibility study; the German one, on the other hand, is looking into the treatment of non-Hodgkin's lymphomas (NHL) with *in vitro* tests. Bismuth-213 is being studied for cancers such as leukemias and lymphomas as well as for micrometa-

static carcinomas. Alpha-particle therapy is also being investigated with the first *in vitro* tests for prostate cancer. ITU is already developing an additional production of Bismuth-213 in collaboration with the cyclotron department of the Forschungszentrum für Technik und Umwelt in Karlsruhe.

Standards and Norms in the Materials Field

Standards and norms are of vital importance for industry, in particular when reliability and quality are at stake. Pre-normative work, i.e. all activities helping in the preparation of norms and standards, receives special attention at the **Institute for Advanced Materials (IAM)** where such activities have been undertaken for several years in the materials field. To date, the results obtained at IAM have strongly contributed to the development of standard test methods for mechanical performance assessment, for new classes of materials (technical ceramics, composites), for new test methods (thermo-mechanical fatigue, damage tolerance of ceramic composites, residual stress), as well as for the improvement of existing standards. IAM collaborates closely with CEN (Comité Européen de Normalisation), VAMAS (Versailles project on Advanced Materials and Standards) and ESIS (European Structural Integrity Society).



Detail of specimen mounted in vacuum chamber for thermomechanical fatigue testing.

Collaboration on Improving Safety and Waste Treatment

To support the safe economic production of energy, extensive studies on the interaction of neutrons with matter and experiments were performed using the unique accelerators of the JRC at IRMM.

The collaboration with CEA (Commissariat à l'Energie Atomique), on data needed for waste transmutation studies, was continued with the analysis of the measured cross sections of ^{99}Tc . Measurements of ^{237}Np in the resonance region have also been started. Similarly, in the context of a concerted action for the same goal, resolution measurements of the inelastic scattering cross sections on ^{208}Pb have been initiated. The international collaboration on the Doppler broadening of neutron resonances, also with CEA, was continued with measurements on UO_3 , NpO_2 and Hg_2Cl_2 . Measured data for metallic U and UO_2 were successfully analysed with a simple solid state model; these data are important for the calculation of the temperature coefficient of reactivity, especially for high fuel burn-up.

Transport Safety

Industry worked closely with ISIS using the Large Dynamic Test Facility (LDTF), firstly to understand better the behaviour of material at high strain rates (in order to calibrate computer codes that simulate crashes) and secondly to test the crash resistance of new lightweight materials. This will help the industry meet European crash-test standards with vehicles that weigh less

and consume less. During 1997 new understanding was reached on the behaviour of commonly used automotive steel. LDTF can now be used also for crash energy absorption studies of train and helicopter components.

The European Integrated Pollution Prevention and Control Bureau (EIPPC)

The European Integrated Pollution Prevention and Control (EIPPC) Bureau, was born out of the directive of the same name, adopted by the Environment Council in September 1996. The directive aims at a high level of overall environmental protection for which the objective is to set out high standards of practice, based on "Best Available Techniques" (BAT), and to reduce emissions and the impact of such emissions on the environment as a whole.

The Institute for Prospective Technological Studies (IPTS) operates the EIPPC bureau and is responsible for formulating and distributing the BAT Reference Documents, organizing the exchange of information on the achievement of these standards, and informing authorities of Member States of any developments and changes in policy implementation. The Bureau is also establishing a dedicated electronic information management system to facilitate immediate broadcasts.

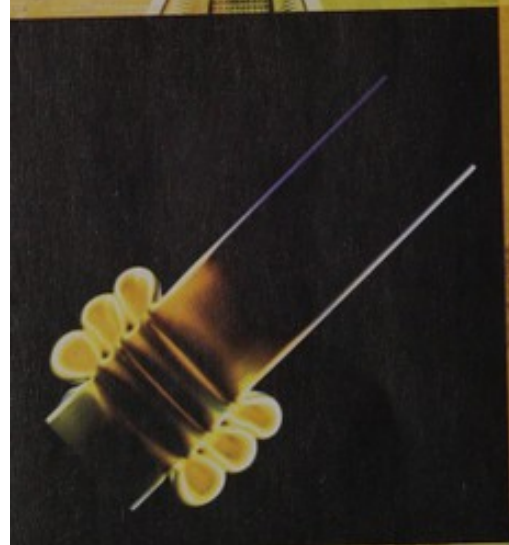
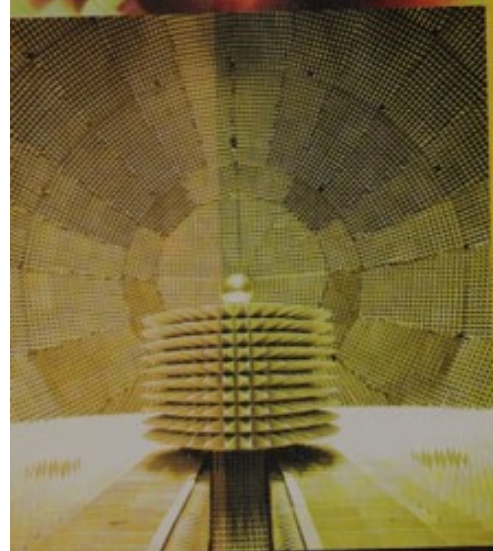
During 1997 the EIPPC's work programme has concentrated on the following four sectors: paper and pulp; cement and lime; iron and steel; and cooling and vacuum systems.



Dynamic testing on a reinforced concrete beam in the Large Dynamic Test Facility (LDTF).



Food packaging material.



The Joint Research Centre in 1997



Geel



Karlsruhe



Petten



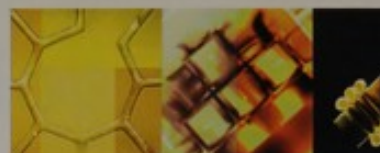
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Seville

PART

Institutional Activities



Institutional Research Activities

The JRC research activities contribute to several lines of the Community Framework Programmes through the JRC specific programmes 1995-1998:

- ▶ The **Industrial Technologies and Materials Technologies** programme was carried out by the Institute for Advanced Materials (IAM), and encompasses research projects on advanced materials, on surface engineering, and on non-destructive evaluation techniques for the inspection of industrial structural components.
- ▶ The **Measurements and Testing** programme encompassed research projects on reference measurements and materials – carried out by the Institute for Reference Materials and Measurements (IRMM) – and on the assessment of the reliability of buildings and civil engineering structures – carried out by the Institute for Systems, Informatics and Safety (ISIS).
- ▶ The **Environment and Climate** programme included: research projects on the atmosphere, soil, water, and waste pollution, executed by the Environment Institute (EI); the setting up of the Centre for Earth Observation (CEO), a decentralized European data management and information system; applications of remote sensing techniques, carried out by the Space Applications Institute (SAI); and industrial hazards studies carried out by the Institute for Systems, Informatics and Safety (ISIS).
- ▶ The **Non-Nuclear Energy** programme consisted of research projects related to materials for clean technologies and to the standardization of photovoltaic devices – carried out by the Institute for Advanced Materials (IAM).
- ▶ The **Targeted Socio-Economic Research** programme included the Science and Technology Observatory function and prospective work carried out by the Institute for Prospective Technological Studies (IPTS). The essential role of the Institute is to harvest the available contributions from experts, consultants, research organisations and institutes in Member States, and when possible in third countries, in order to analyse, process and integrate them

impartially and in depth and, more importantly, to distil clear trends or needs for action in a usable form for decision makers.

- ▶ The **Nuclear Fission Safety** programme encompassed a number of research activities ranging from studies on reactor safety – carried out by the Institute for Systems, Informatics and Safety (ISIS) and the Institute for Advanced Materials (IAM) – to research activities on nuclear safeguards and fissile materials management, executed by the Institute for Systems, Informatics and Safety (ISIS) and the Institute for Transuranium Elements (ITU). ITU carried out research on the safety of nuclear fuels and actinides.
- ▶ The **Controlled Thermonuclear Fusion** programme (Technology and Safety) was carried out by the Institute for Systems, Informatics and Safety (ISIS) and the Institute for Advanced Materials (IAM).

This research is executed in the seven JRC Institutes as shown in *Table 1* and it accounted for 65 % of the JRC programme activities in 1997.

A more detailed description of these research activities in 1997, per institute, will be provided in *Part Two* of this document. However, some significant results have been highlighted in this first chapter: they illustrate how research has enabled the JRC to contribute to the advancement of science and technology for the benefit of European industry and the well-being of the European population.

The agreement concluded in 1996 between the **Institute for Reference Materials and Measurements (IRMM)** and the International Federation of Clinical Chemistry (IFCC) for the preparation of Certified Reference Materials (CRMs) has led to projects aimed at preparing bio-medical, environmental and public health protection materials. Such CRMs are needed to achieve accuracy and world wide comparability in clinical diagnostics of human diseases. The activity thus supports the improvement of health standards.

Certified reference materials of foodstuffs were prepared, to assist in the enforcement of European legislation on quality control. The analysis of cosmetics and a

Table 1 – JRC Research Activities

FRAMEWORK PROGRAMME LINES	IRMM	ITU	IAM	ISIS	EI	SAI	IPTS
Industrial Technologies and Materials Technologies							
Advanced Materials and Standards for Industrial Innovation			•				
Surface Engineering for Improved Properties and for New Industrial Applications			•				
Non-Destructive Evaluation, Testing and Inspection of Industrial Structural Components			•				
Measurements and Testing							
Prenormative Research in Support of Construction Norms and Standards, including Seismic Design Codes (Eurocodes)				•			
Measurement and Testing for Car Safety				•			
Reference Materials	•						
Reference Measurements	•						
Environment and Climate							
• <i>Global Change</i>							
Centre for Earth Observation (CEO)				•		•	
Atmospheric Processes over European Regions					•		
Remote Sensing for Terrestrial Biosphere (Land Degradation in the Mediterranean Region, Forest Monitoring)						•	
Remote Sensing for Marine Biosphere (North Atlantic Ocean, Mediterranean Sea)						•	
Advanced Earth Observation Techniques (Environment and Road Conditions Monitoring and Land Mine Detection)						•	
• <i>Environmental Quality</i>					•		
Techniques & Equipment for Environmental Quality Monitoring					•		
• <i>Innovative Environmental Technologies</i>							
High Performance Information Technologies for Environmental Protection				•			
Natural Hazards / Seismic Research				•			
Integrated Environmental Assessment				•			
Natural Hazards / Flooding, Droughts						•	
Non-Nuclear Energy							
Photovoltaic Energy and Electricity Storage			•				
Materials for Clean Combustion Engines			•				
Targeted Socio-Economic Research							
Technology Watch / Technology-Employment-Competitiveness							•
Nuclear Safety and Safeguards							
• <i>Reactor Safety</i>							
European Networks on Component Ageing, Inspection Techniques & Structural Integrity			•				
Severe Accidents including Probabilistic Studies				•			
• <i>Fuel Cycle Safety</i>							
Basic Actinide Research		•					
Safety of Nuclear Fuels		•					
Mitigation of Long-lived Actinides and Fission Products		•					
Spent Fuel Characterisation in view of Long-Term Storage		•					
• <i>Safeguards and Fissile Materials Management</i>							
Safeguards R&D		•		•			
Controlled Thermonuclear Fusion							
Fluid Separation and Analysis			•				
Fusion Materials			•				
Remote Handling				•			
Hydrogen Materials Interaction			•				

data bank on product safety were further developed. The production of CRMs of genetically modified organisms was a topic of particular interest. Negotiations with industry have been concluded and the work has started. These CRMs will enable the validation of analytical methods to be applied in the enforcement of the Directive on Novel Food (EC 258/97).

IRMM focused also on quality health care with, as a new project, the validation of a ^{13}C isotopic measurement method applicable to the diagnosis of stomach disease by a non-invasive and inexpensive technique. This technique will allow a substantially more cost-effective and less intrusive diagnosis of internal diseases, avoiding the risk of *Helicobacter Pylori* infection, a major cause for ulcers and stomach cancer.

Following the agreement signed in July 1997 between the International Atomic Energy Agency (IAEA) and the **Institute for Transuranium Elements (ITU)**, the Institute is now part of the network of laboratories dealing with the analysis of environmental samples. In this way the Institute is actively contributing to the European Union's policy to support and strengthen the International Atomic Energy Agency's activities in nuclear safeguards. The Institute is also closely collaborating with, and providing similar support to, the Commission's Euratom Safeguards Directorate (ESD) in the area of high performance trace analysis (HPTA). Ultra-sensitive environmental sampling techniques are part of the key new developments to help to detect the presence of clandestine activities.

In the field of basic actinide research, the work focused particularly on elucidating the electronic structure of those actinide elements and compounds which attract increasing interest, due to their peculiar chemical and solid-state properties. Actinide research as a whole is important in the framework of applications on fuel cycle, waste management and nuclear medicine.

The Institute is also actively working on further reducing radiotoxicity in highly active wastes. For the first time, a closed partitioning and transmutation cycle was experimentally demonstrated, and shows that it is technically feasible to reduce the radiotoxicity of minor actinides by a factor of 100.

The Institute was also involved in the development and application of the alpha nuclide Bi-213, used in a promising alpha-immunotherapy against cancer.

The **Institute for Advanced Materials (IAM)** directed its research towards the development of innovative processing and testing methods for advanced materials. The emphasis was put on cost efficiency, performance improvement and the potential for standardization, for the benefit of industry competitiveness.

In the context of achievement of the European Single Market, IAM also developed the preparation of industrially important norms and standards, in close collaboration with responsible international bodies such as CEN, VAMAS and ESIS. Standard test methods were developed for the assessment of mechanical performance, either for new classes of materials (technical ceramics, composites), for new test methods (thermo-mechanical fatigue, damage tolerance of ceramic composites, residual stress), or for the improvement of existing standards. This work helps to develop the European Standards System.

To the benefit of the environment and human health, IAM continued to develop multiphase Ti-B-MoS₂ permanent coatings for cutting tools; this could lead to phasing out in most machining processes the synthetic, lubricating cutting fluids which are non biodegradable and can produce allergies.

The Institute runs the European Network for Inspection Qualification (ENIQ), the Network for Evaluation of Steel Components (NESC) and the Network on Ageing Materials Evaluation and Studies (AMES), in which participate industries, service vendors, licensing bodies and R&D institutions. These networks aim at the safety and integrity of nuclear fission reactors for the benefit of the citizen and the environment.

The **Institute for Systems, Informatics and Safety (ISIS)** contributes to improving safety in industry and to the well-being of the European population. The Institute develops and applies its expertise in many fields, including: nuclear safety and safeguarding of nuclear materials; industrial and transport safety; seismic protection of buildings and civil engineering works;

natural resource and environment management; support to antifraud measures, consumer protection, and the preservation of cultural heritage. In 1997, the Institute increased its efforts in the regulation of biotechnology in industry and on the evaluation of the potential risks of transgenic manipulations.

As part of the Centre for Earth Observation (CEO) project, and complementary to the activities of the Space Applications Institute, ISIS continued to operate and update information systems to promote the use of satellite-based Earth observation data. The work included: updating the European Wide Service Exchange (EWSE), now recognized as the leading source of information regarding Earth observation in Europe; enhancing the G7 Environment and Natural Resource Monitoring (ENRM) server by integrating it with 20 environmental databases across the world; developing the CEO's Information Locator System (CILS) on behalf of Third World countries; and developing a new Internet protocol for remote searching of geospatial databases.

The major part of the **Environment Institute (EI)** activities provides scientific and technical support to other Commission Services in designing and implementing European Union policies, in the fields of environment protection, and food and drug consumer protection.

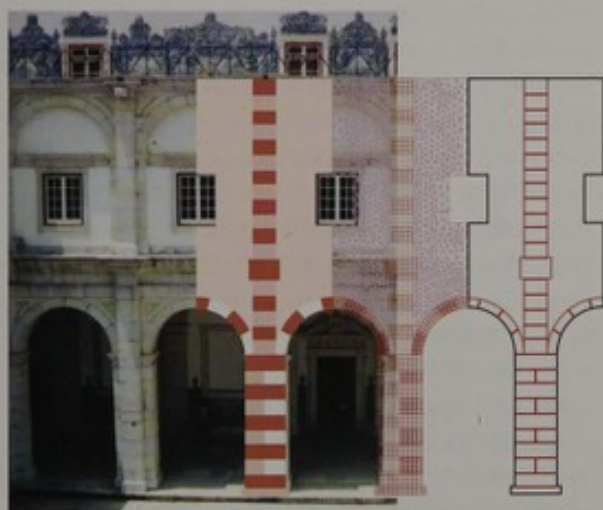
However, institutional research activities continued in the areas of water and soil, including the use of AMAL (Advanced Mobile Laboratory) to assess industrial sites

and landfill contamination. Four *in situ* campaigns were performed in the subalpine ecoregion to contribute to setting up algorithms describing lake water quality and to compare different methods for the determination of phytoplankton pigments.

Research activities have continued with the objectives of developing cost-effective tools for monitoring the state of European lakes and for the optimization of water-resource planning and management. The harmonization and development of analytical methods, which is a basic requirement for the implementation of EC directives on water quality, has continued with AQUACON (Analytical Quality Control) project.

In the field of atmospheric processes, research activities were mainly focused on tropospheric ozone, which affects human health, crops and vegetation, and on atmospheric aerosols, which are of major importance in evaluating and predicting climate trends. An understanding of this is a key element in the design and implementation of EU environmental policy.

The **Space Applications Institute (SAI)** concentrated on possible applications of remote earth observation, sensing and detection. The Institute's mission is to maximise the use of space systems for the benefit of Europe's policy makers, industry, scientists and citizens. SAI's institutional research on environment and climate covers the terrestrial and marine biospheres, the lithosphere and the atmosphere, resulting in a comprehensive approach to uses of earth observation.



S. Vicente Cloisters view with numerical modelling (mesh).



S. Vicente test model at ELSA. Servo-actuator for vertical loading.

Significant progress was made towards establishing standards for mine detector performance and sensor validation: these standards will be applied to mine clearance projects supported by the European Commission in mine infected countries. The feasibility of a multi-sensor system for anti-personnel mine detection and identification was also studied.

SAI's work on the improved management of natural hazards focused on developing the Space Techniques for Risk Management (STRIM), a joint venture with ESA and the Council for Europe, and on liaison with the DGXII task force on Natural Hazards. Work on forest fires saw links to the European Community Humanitarian Office (ECHO) and DG VI (Standing Forest Committee on Forest Fires). An inventory of existing techniques and models to assess flood risk and flood damage was completed, and work on drought indicators was developed in co-ordination with the Mediterranean Observatory.

The **Institute for Prospective Technological Studies (IPTS)** addressed priority subjects in various technological fields, ensuring a neutral, Europe-wide assessment of scientific and technological change. It attempts to gain a better understanding of the impact of technology on the socio-economic environment, in particular on employment and competitiveness. The fields covered were Mobility and Transport Research, Environment, and Energy.

Through the ESTO (European Science and Technology Observatory) network, made up of 14 European national S&T organisations which share the responsibility of providing timely access to information on scientific and technological change of socio-economic relevance, IPTS has direct access to a very large number of specialists. Information obtained through the Observatory contributed to studies and, the "IPTS Report", which is the main "broadcasting" journal of the Institute, directed towards European decision makers.

The European Integrated Pollution Prevention Control Bureau (EIPPC) was created to support the European Union policy for a high level of overall environmental protection. Its objective is to set high standards of practice, and to reduce emissions and their impact on the

environment as a whole. It is responsible for the formulation and the distribution of the Best Available Techniques (BAT) Reference Documents.

Institutional Scientific and Technical Support for Community Policies

The JRC scientific and technical (S&T) expertise was directly available to the various Directorates General of the Commission in order to support the formulation and implementation of Community policies. The Institutional support activities fall under the Community Framework Programmes and accounted for 35% of the JRC's programme activities in 1997. They were related to the following Framework Programme lines: **Information Technologies, Environment and Climate, Agriculture and Fisheries, Targeted Socio-Economic Research and Nuclear Safety and Safeguards** through the JRC specific programmes 1995-1998.

The support activities are customer driven, in fulfillment of impartial and neutral scientific and technical requirements arising from EU directives, decisions of the Commission and the Council, or obligations stemming from the Euratom Treaty. The work carried out in the JRC Institutes is illustrated in *Table 2*.

In 1997, the three main lines of JRC support activities were:

1. JRC Support for the Environmental Policy, which accounted for 43% of the scientific and technical support budget. It provided DG XI (Environment, Nuclear Safety and Civil Protection) with scientific and technical assistance for the implementation of the legislation on chemical pollutants, atmospheric pollution, water quality, chemical waste, industrial risks, and nuclear safety. This work is part of the 5th EC Action Programme in the field of the environment, and includes:

- ▶ The European Chemicals Bureau (ECB), which is now handling all the technical and scientific tasks required for the classification and labelling of dangerous substances, the implementation of the notification scheme for new substances, testing methods for chemicals, export/import control of dangerous substances and preparatory work on the Biocides Directive.

Table 2 – JRC Support Activities

FRAMEWORK PROGRAMME LINES	IRMM	ITU	IAM	ISIS	EI	SAI	IPTS
Information Technologies							
Safety and Reliability of Systems				•			
Geographic Information Systems				•			
High Performance Computing and Networks				•			
Environment and Climate							
• Environmental Quality							
European Reference Laboratory for Air Pollution (ERLAP)					•		
European Chemicals Bureau (ECB)					•		
European Centre for the Validation of Alternative Methods (ECVAM)					•		
Support to the European Environment Agency (EEA)					•	•	
Analysis of Foodstuffs and Chemicals in Support of Industrial Policy					•		
European Technical Office for Medicinal Products (ETOMEP)					•		
Quality Control of Consumer Products (Consumer Protection)	•				•		
S&T Support to the Commission Antifraud Services				•			
Coordination Unit of the Alpine Observatory					•		
• Innovative Environmental Technologies							
Industrial Reliability-Biotechnology and Environment				•			
Major Accident Hazards Bureau				•			
Agriculture and Fisheries							
Remote Sensing for Agriculture						•	
Electronic Identification of Animals and Volume Measurements				•			
European Office for Wine, Alcohol and Spirit Drinks (BEVABS)					•		
Reference Measurements and Materials for Quality Control of Foodstuffs and Microbiology of Foodstuffs	•				•		
Targeted Socio-Economic Research							
Prospective Technological Studies							•
Nuclear Fission Safety							
• Reactor Safety							
European Networks on Component Ageing and Inspection Techniques and Structural Integrity			•				
Harmonisation of Safety Criteria				•			
• Safeguards and Fissile Materials Management							
Euratom Safeguards Support: General	•	•		•			
Euratom Safeguards Support: On-site Laboratories and ECSAM	•	•		•			
IAEA Safeguards Support	•	•		•			

► The European Technical Office for Medicinal Products (ETOMEP). This office, which forms part of a unit at ISIS, is established both in London, at the European Medicine Evaluation Agency, and in Ispra, at the Institute for Systems, Informatics and Safety. It is dedicated to the development of technical systems necessary for the implementation of European Union legislation on medicinal products. It contributes to the study, design and implementation of the telematics applications required by the European

Union pharmaceutical regulatory sector. Its work is of direct and vital use to the European Medicine Evaluation Agency and the Member States.

► The European Reference Laboratory for Air Pollution (ERLAP), which was particularly active in the preparation and implementation of EC Directives on ambient air quality, with emphasis on the urban environment and industrial emissions and the harmonisation of measurements in the EU air quality

monitoring networks. The laboratory contributed also to the implementation of EC Directives on environmental radioactivity, particularly those related to information exchange with Member States, both under normal conditions and following an accident.

- ▶ The European Centre for the Validation of Alternative Methods (ECVAM), which continues to coordinate efforts to promote orderly scientific and regulatory acceptance of alternative methods which are of importance to the biosciences and which can reduce, refine, or replace the use of laboratory animal procedures. Its activities included pre-validation on photoirritancy, skin corrosivity, embryotoxicity, haematotoxicity, nephrotoxicity and epithelial barriers. Various international studies on *in vitro* methods for vaccine potency and safety testing were also started.
- ▶ The Major Accident Hazards Bureau, which supports the "Seveso" Directive on industrial hazards by operating the Major Accidents Reporting System (MARS) and the Community Documentation Centre on Industrial Risk. End users include all the actors in the legislative and regulatory process concerned with plant safety, such as national and local authorities, industry and safety practitioners.
- ▶ Support services related to the Alpine Observatory (Alpine Convention), with the aim of producing and/or collecting data, indicators and information characterizing the environmental and socio-economic status of the Alpine region. These data will be useful to the National Communication Centres, for distribution at national level.
- ▶ Institutional support to the European Environment Agency (Council Regulation 1 210/90) whose role is to establish and coordinate, in cooperation with the Member States, a European Environment Information and Observation Network. The JRC contributed mainly in the areas of harmonisation of environmental measurements methods, the intercalibration of instruments, and the development of new measurement methods and instruments.
- ▶ Support for the elaboration of methodologies for the EU antifraud policy (UCLAF), via the effective devel-

opment, introduction and use of new information technologies and data and risk analysis methods.

2. JRC Support for the Common Agricultural Policy (DG VI), which accounted for 17% of the Scientific and Technical Support budget. Work is mainly carried out in the following research areas:

- ▶ Application of remote sensing to agricultural statistics, with the aim of developing and demonstrating methodologies which can integrate remote sensing data into the collection of statistics for the monitoring of crop acreage and agricultural production in the EC, the main objective being improvement of accuracy, objectivity, homogeneity and time delivery of statistics and forecast on the main crops produced in the European Union.
- ▶ Monitoring and control of the Common Agricultural Policy: research and development of new remote sensing techniques allowing improved monitoring and control of the Common Agricultural Policy through accurate measurements of areas and identification of specific land uses and comparison of results with declarations of Member States.
- ▶ Implementation of Community wine sector legislation through the operation of the European Office for Wine, Alcohol and Spirit Drinks (BEVABS). The work focuses on the control of adulteration and of the origins of wine, using nuclear magnetic resonance (NMR) and mass spectrometry (MS) techniques, with the aim of setting up a European Union Wine Data Bank. Every year some 1400 wines are investigated, thus updating the wine data bank.
- ▶ Research and development of new verification methods and instruments for verification of electronic animal identification, in order to make it possible to take appropriate sanitary measures when needed and to control the market and prevent fraud within the Union. An identification system was under preparation, including electronic identifiers, readers, data acquisition systems, control strategy, data base and data transmission techniques with headquarters evaluation.

The technical specifications of a large scale demonstration project, IDEA, for electronic animal tagging with passive transponders, were prepared. The tagging of one million animals in various countries of the EU is contemplated. The general database structure for the follow-up of the IDEA project was defined. The testing of animal identification devices for the development of standardized test procedures between IDEA and the International Committee for Animal Registration (ICAR) has also started.

- Quality control of foodstuffs, by supplying certified reference materials, providing suitable analytical procedures, and supplying and/or coordinating laboratory intercomparisons for evaluation and improvement of existing methods and development of new methods of analysis.

3. JRC Support for Nuclear Safeguards (Euratom Safeguards DG XVII, IAEA Safeguards support programme DG I) accounted for 28% of the scientific and technical support budget.

Most of the work undertaken dealt with the following tasks:

- Completion of the design phase of the on-site laboratory for safeguards analysis at the reprocessing plant at La Hague; routine analysis of nuclear materials samples; examination of the purchase and testing of major equipment, including the development of analytical techniques and their implementation in these on-site laboratories and the training of inspectors in the application of safeguards techniques.
- Training of inspectors, harmonisation of in-service nuclear safeguards inspection practices, providing state of the art equipment and reference analyses of nuclear materials samples.
- Work on non-destructive assay, sealing and identification techniques, surveillance techniques, testing of safeguards equipment, data information treatment, health physics and training.



Enzymatic activity measurement on cultured cells

Other Institutional Scientific and Technical Support Activities

In addition to supporting the three major sectors listed above, the JRC has also drawn on its capacities and on the presence in its institutes of appropriate teams and tools to provide the EU with support activities in other institutional scientific and technical fields:

For instance, it has helped DG III (Industry) by working on the safety and reliability of informatics systems needed for other activities. Another area in which assistance was provided to DG III is foodstuff analysis, with particular emphasis on toxic materials in contact with food, irradiated food, and the development of analytical methods related to fertilisers. This work is in support of the industrial policy.

For DG XXIV (Consumer Policy and Consumer Health Protection), the quality control of consumer products was further focused on, with particular attention to trace contaminations in industrial products such as cosmetics.

Finally, in support of DG XI (Environment, Nuclear Safety and Civil Protection) and DG XVII (Energy), techniques for inspecting ageing nuclear components, in order to prevent any danger to the environment, were further developed.

Competitive Activities



Competitive activities are in the process of becoming an integral part of the JRC corporate culture. This change is taking place at a rate compatible with the overall evolution of the JRC's mission.

The introduction of Third Party Work, towards the end of the eighties, was the first step in opening the JRC up to competition. This process reached a new stage with the Fourth Framework Programme (1994-1998), which aims to gradually introduce a market-oriented, customer-contractor relationship into most JRC activities. The year under review (the third since this new competitive mandate was instituted) has been for the JRC a period of further adjustment to the competitive challenge, but has also represented an opportunity for consolidating the achievements of the first two years.

The market in which the JRC operates since the 1st of January 1995 can be described as falling under two main categories: the traditional external market, where the JRC conducts research and supplies services under Third Party contracts, and an enlarged competitive market, where the JRC:

- ▶ competes for, and participates in Shared-Cost Actions under the 4th Framework Programme, in association with partners from Member States;
- ▶ competes for scientific and technical support work for other services of the Commission, in response to invitations to tender (also under the 4th Framework Programme);
- ▶ participates, in the context of a competitive approach, in various other Community activities that are put out to tender.

The JRC portfolio of Shared-Cost Actions had reached over 95 contracts in number by the end of December 1997, for a total net earned value of 15.5 Mioecu for the year 1997. These results show that the JRC has something to offer to research consortia as a source of high-quality research, generally in the form of expertise and facilities that closely match the requirements of many

companies and research institutes involved in the Specific Programmes.

Competitive scientific and technical activities in support of the Commission have continued at a sustained rate in 1997. The total of new contracts won in 1997 is well over 55 with a total contract value of 18.5 Mioecu.

Examples of S/T support activities where the JRC successfully bid in response to Commission services calls for tender can be found in the following projects:

- ▶ in support of the Environment Policy: monitoring of tropical forest ecosystems via remote sensing applications;
- ▶ advanced comparative food analyses for industrial and Consumer Protection Policies;
- ▶ the study and implementation of ways and means for transferring selected technologies belonging to the Community to targeted industries.

Outside the Framework Programmes, the JRC has gained competitive contracts with a total value of 6.1 Mioecu in 1997. New activities cover, amongst others, studies for the definition of a decision support system for coastal area management.

In addition to these activities, the JRC continued to perform and obtain new work under contract from Third Parties. New contracts in 1997 totalled 11.1 Mioecu (cumulative actual 43.2 Mioecu over 3 years). Recent significant contracts being carried out include:

- ▶ the design, procurement and operation of an integrated information system delivering network services to a large group of cooperative banks in one Member State;
- ▶ the study of the optimisation processes for planning, managing and protecting the water resources of a large European region.

HFR Supplementary Programme

As reported earlier, the High Flux Reactor (HFR) at Petten is operated by the Commission in accordance with the Euratom/Netherlands agreement of 25 July 1961. On 27 June 1996, the Council adopted a four-year (1996-1999) supplementary research programme to be implemented by the Joint Research Centre for the European Atomic Energy Community, concerning the operation of the High Flux Reactor (HFR) at Petten. Under previous supplementary programmes, the activities of the HFR were essentially the outcome of a co-operation between two partners, Germany and the Netherlands. The new supplementary programme introduced two major changes. On the one hand, the co-operation was enlarged to include France, which decided to support the HFR. On the other hand, besides traditional work for the nuclear R&D and industry, it was decided to dedicate a large part of HFR activities to medical applications. On the basis of contractual relationships, the reactor is now a major contributor to the production of medical radioisotopes for the European radio-pharmaceutical industry. Taking advantage of

the unique possibilities offered by the HFR for the treatment of glioma, a highly malignant cancer of the brain, a pilot clinical testing of Boron Neutron Capture Therapy (BNCT) was continued within a demonstration project funded by DG XII. After 10 years of efforts by all the partners working with the JRC in this field, this is the decisive step which will make this promising new therapy available for human treatment.

In 1997, the HFR went successfully through the in-service inspection of the reactor vessel, an operation which has to take place every 3 years. The number of operational days in 1997 was 280 days, slightly above the planned 273 days, and the occupation level for experiments was on average around 80%.

Another significant achievement is the upgrading of one of the beam tubes, used for the measurement of residual stress in materials by neutron diffraction. This technique is applicable to a wide range of components used in industrial plants, aeronautics, or the car industry.

Table 3 – Competitive Activities (Mioecu)

	Inscribed in 1995 accounts	Inscribed in 1996 accounts	Inscribed in 1997 accounts	TOTALS
Third Party Work	18,5	13,6	11,1**	43,2
Shared-Cost Actions	3,9*	9,8*	15,5*	29,2*
Competitive Support	4,8	10,6	18,5	33,9
Competitive Activities outside the FWP	1,3	4,2	6,1	11,6
TOTALS	28,5	38,2	51,2	117,9

* "Matching funds" (i.e. for participation by JRC in specific programmes of indirect action) not included.

** These figures do not include the activities performed under external contract and related to the HFR reactor at Petten (NL), carried out by the Institute for Advanced Materials, which amount to around 5,5 Mioecu for 1997.

JRC Information Days, Publications, and Conferences



As one of the measures to increase the visibility of the JRC and stimulate collaboration with industry and the national research and academic world, members of the JRC Board of Governors have taken the initiative in recent years in organizing JRC Information Days in Member States. Following successful events in Ireland and Finland last year, the Swedish Member of the Board of Governors, Professor Janne Carlsson, President of the Royal Institute for Technology, Stockholm, took the initiative and a similar event was held on 25-26 September 1997.

The event, organized by the Swedish R&D Council with the JRC, drew some 140 participants representing industry notably SMEs, research institutes and universities. The programme of the first day in Stockholm was devoted to a presentation of the JRC by the JRC delegation led by Mr. H. Richardson, the Acting Director General, and directors and representatives of all JRC institutes. This was followed by discussion sessions on the individual institutes and their projects of interest to the Swedish participants. During the second day the JRC participants visited Swedish industry, research institutes, and authorities in the Stockholm and Gothenburg areas. The JRC unit for Public Relations and Publications took care of the dissemination of information material to the participants, who also followed JRC presentations on Internet.

The Information days in Sweden gave rise to further collaboration by Swedish partners in JRC activities. To consolidate this, a Swedish delegation recently paid a

visit to the JRC Ispra Site. This will be followed up by other schemes for extending JRC collaboration with this Member State, for instance in multi-lateral networks through which the JRC conducts much of its work.

The JRC offers a vast array of publications on scientific matters, ranging from papers and articles published in scientific magazines, to conference papers, EUR reports, reviews, and information about the JRC posted on INTERNET.

In 1997 the JRC published in total around 1333 papers, and their distribution by Institute is shown in Table 4.

The detailed list of JRC publications is published each year in the "Publications Bulletin". The last issue, No. 17, published in March 1997, lists all publications issued in 1996.

Most of these publications are available upon request from the Public Relations and Publications Unit, Ispra.

In addition to publications, the above mentioned Bulletin lists all patents obtained by the JRC. There were 23 patents granted in 1997. A considerable increase in comparison with previous years.

Each year, the JRC organizes a number of conferences, workshops and seminars at its five sites in Europe. The numerous visitors show the constant interest of the scientific community in the contributions to research and development made by the JRC.

Table 4 – JRC Publications in 1997

Institute	Articles in Journals	Articles in Proceedings	Conference Papers	EUR Reports	Special Publications	TOTAL
General Management	1	3	–	3	9	16
Institute for Reference Materials and Measurements	30	57	49	4	1	141
Institute for Transuranium Elements	46	20	48	2	–	116
Institute for Advanced Materials	42	106	56	15	13	232
Institute for Systems, Informatics and Safety	49	150	35	26	21	281
Environment Institute	63	67	87	34	10	261
Space Applications Institute	30	78	42	21	45	216
Institute for Prospective Technological Studies	2	15	12	28	13	70
TOTAL	263	496	329	133	112	1333



Human Resources

The JRC's statutory staff is made up of officials and temporary agents, including both scientific-technical and administrative staff. Although at a pace limited by the actual recruitment possibilities, the JRC has started implementing the new research staff policy, which establishes targets (40% for permanent staff, 35% for temporary agents with a 5 year contract and 25% for temporary agents with a 3 year contract) to be achieved within a 5 year period.

By the end of December 1997, the statutory staff numbered 1871 + 221 auxiliary agents, as compared with 1746 + 190 auxiliary in December 1996. *Table 5*

gives the distribution of statutory staff in 1997. Besides normal mobility, a number of staff members retired in 1997, having reached the statutory age limit. Recruitment for replacements was in progress at the end of the year.

In addition to statutory staff, 148 scientists were also active in the JRC under various hosting schemes:

- senior scientists hosted as visiting scientists;
- national experts seconded to the JRC by Member States, to participate in selected scientific work;

Table 5 – Distribution of statutory staff (including auxiliary agents)

Institute	1995	1996	1997
Directorate General	25	34	41
Programmes Directorate	13	8	10
Resources Coordination—Scientific & Technical Support Ispra	347	428	426
Institute for Reference Materials and Measurements	169	181	186
Institute for Transuranium Elements	194	186	190
Institute for Advanced Materials	250	267	291
Institute for Systems, Informatics and Safety	433*	276	287
Environment Institute	219	222	240
Space Applications Institute	101	100	147
Institute for Prospective Technological Studies	26	35	43
JRC staff seconded to national bodies	9	9	10
Auxiliaries	143	190	221
TOTAL	1929	1936	2092

* Total staff of the Institute for Systems Engineering and Informatics and Institute for Safety Technology.

- post-doctoral scientists and post-graduate students trained through a programme of fellowships.

Table 6 gives the distribution, by Institute, of these scientists working at the JRC at the end of December 1997.

In addition, about 10 scientists each year come from a third country, assisted by a grant within the framework of a Commission agreement with their countries or with the International Atomic Energy Agency (IAEA).

Besides the above mentioned scientists, several senior scientists and about 142 trainees work at the JRC Institutes at no cost to the EU budget, in general for short periods of time.



Doppler broadening project flight station at 10m.

Table 6 – Visiting scientists, seconded experts, grantholders (as of December 1997)

Institute	Visiting Scientists	Seconded Experts	Post-Doctoral Scientists	Post-Graduate Students	TOTAL
Resources Coordination	—	—	—	1	1
Institute for Reference Materials and Measurements	2	—	8	13	23
Institute for Transuranium Elements	—	—	7	10	17
Institute for Advanced Materials	1	—	3	11	15
Institute for Systems, Informatics and Safety	7	1	9	12	29
Environment Institute	2	3	4	14	23
Space Applications Institute	9	3	4	9	25
Institute for Prospective Technological Studies	4	3	2	6	15
TOTAL	25	10	37	76	148

Finances



The budget (commitments credits), as implemented by the JRC in 1997, is given in Table 7.

Total JRC committed financial resources amounted to 291,316 Mioecu:

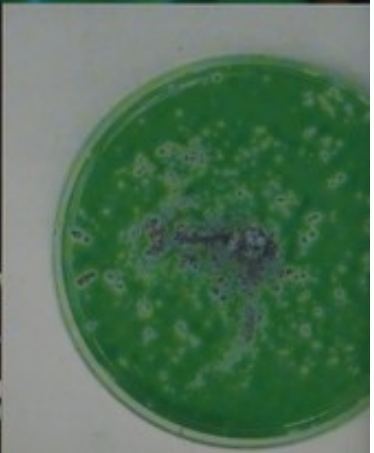
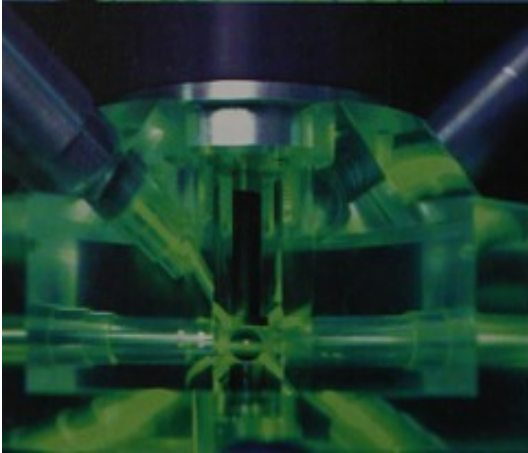
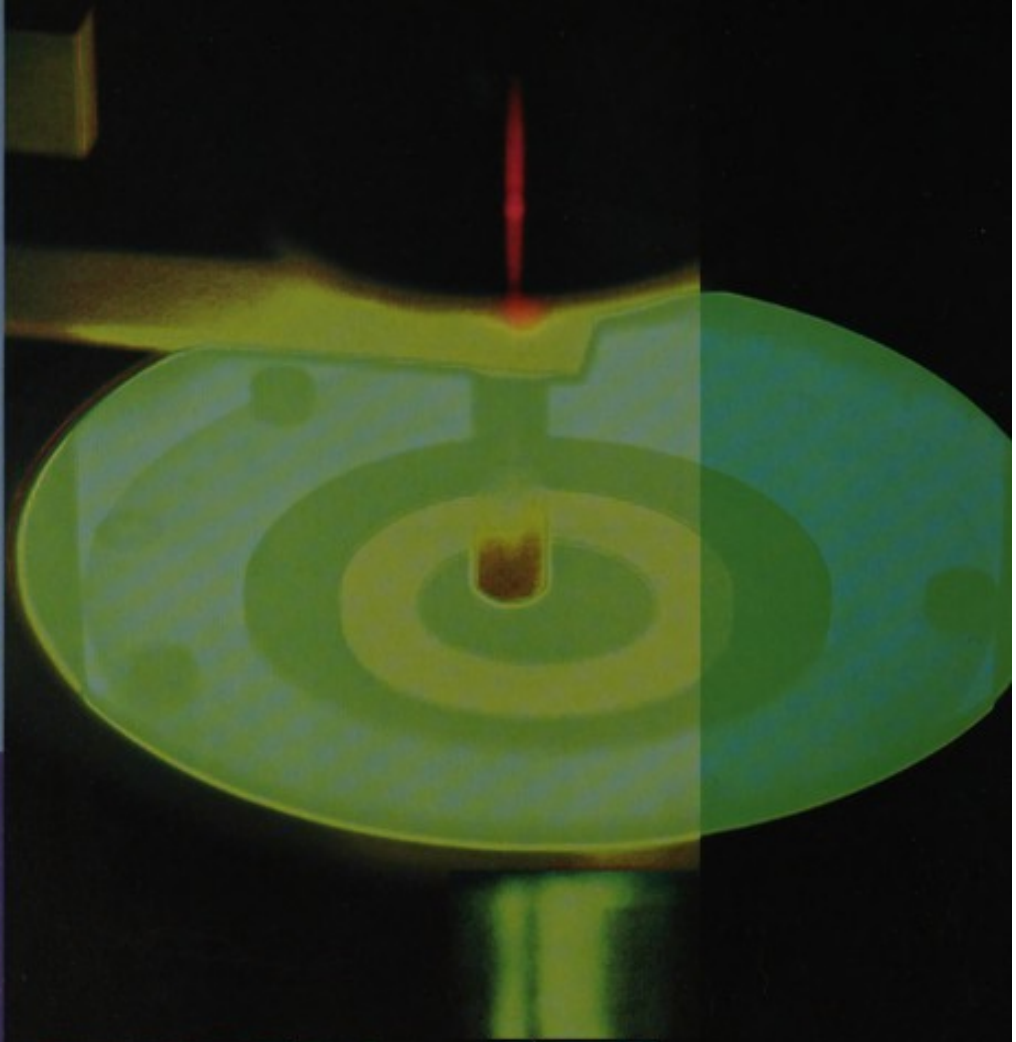
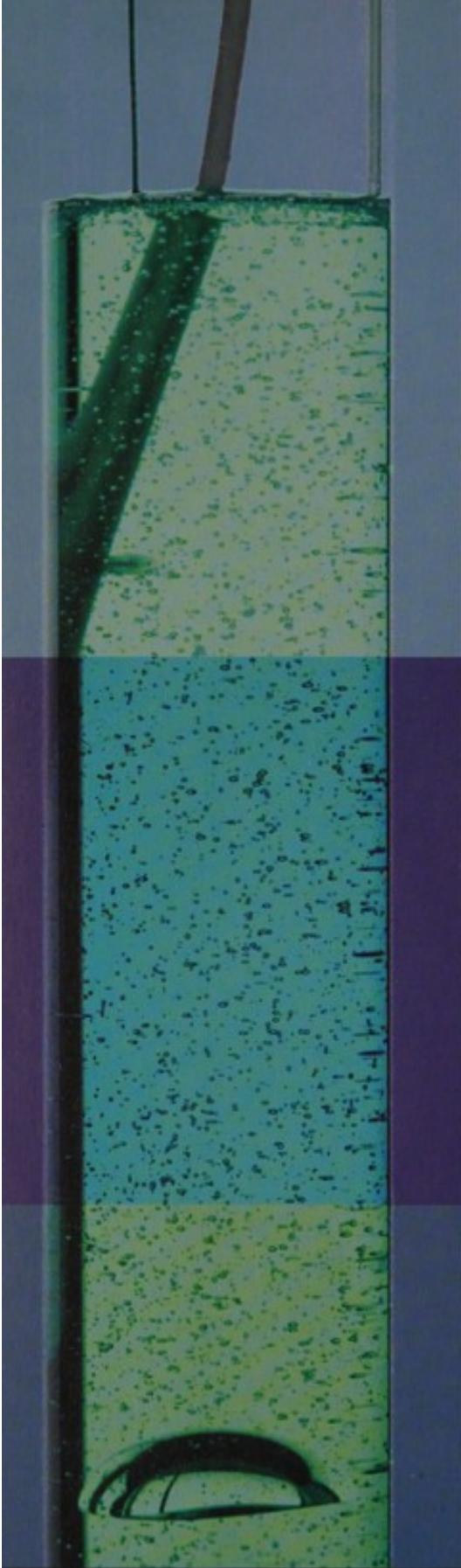
- ▶ for the execution of the JRC specific programmes (Research and Institutional support activities for the services of the Commission)
- ▶ for the execution of JRC competitive activities within the framework of the EU budget (participation in shared-cost actions, competitive support activities

for the services of the Commission, JRC participation in other Community activities, contributions from the Dutch, German and French governments for the operation of the HFR and from JRC customers for the execution of work at their request).

The financial resources for the specific programmes were provided by the JRC part of the General Budget for the European Union 1997 and the contributions from the EEA (European Economic Area) countries: Iceland, Liechtenstein and Norway for the EC programmes. In addition, there is a contribution from 1996 onwards to the EC programmes from Israel.

Table 7 – 1997 Budget implementation in Mioecu (Commitment Credits)

Institutional activities	1996	1997
Information and Communications Technologies	2,946	3,516
Industrial Technologies and Materials Technologies	21,534	21,190
Measurements and Testing	26,722	28,312
Environment and Climate	74,451	80,800
Agriculture and Fisheries	10,849	13,548
Non-Nuclear Energy	3,838	4,691
Targeted Socio-Economic Research	7,728	9,406
<i>Subtotal EC Specific Programmes</i>	148,068	161,463
Nuclear Safety and Safeguards	63,229	64,365
Controlled Thermonuclear Fusion	10,310	12,483
<i>Subtotal EAEC Specific Programmes</i>	73,539	76,848
SCA EC Programmes	3,013	6,029
SCA EAEC Programmes	0,411	2,012
<i>Subtotal SCA</i>	3,424	8,041
Total Specific Programmes	225,031	246,352
Competitive Activities		
Participation to Shared-Cost Actions (SCA)	4,011	5,074
Competitive Scientific and Technical Support Activities	10,191	8,908
Participation to Community Activities outside the FWP	1,879	2,754
Work for Third Parties	16,561	20,051
<i>Subtotal</i>	32,642	36,787
HFR Reactor	8,088	8,110
HFR Completion of Previous Programmes	6,262	0,067
<i>Subtotal</i>	14,350	8,177
TOTAL	272,023	291,316



Activities of the JRC Institutes

in 1997



irm

Institute for Reference Materials and Measurements

itu

Institute for Transuranium Elements

iam

Institute for Advanced Materials

isis

Institute for Systems, Informatics and Safety

ei

Environment Institute

Sai

Space Applications Institute

ipts

Institute for Prospective Technological Studies

P
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The Institute for Reference Materials and Measurements (IRMM)

The IRMM promotes and harmonizes the use of European standards, reference materials and methodologies at the European level. In 1997, the Institute pursued its specific programme under the heading Measurements and Testing and contributed to the Framework Programme line "Industrial Technologies and Materials Technologies". IRMM consolidated its responsibility for managing the BCR's (Bureau Communautaire de Référence) reference materials.

IRMM also provided support activities for Community policies in the area of environment and nuclear safeguards, the safety and quality control of consumer products, and reference measurements and materials for quality control of foodstuffs. It provides services and reference materials to various customers from the European Member States and around the world.

A. Institutional Activities

Institutional Research Activities

The measurement expertise and refined analytical techniques of the Institute have made it possible to establish a coordinated analytical measurement system at the European level, for the characterisation and certification of high quality reference materials, applicable in both the nuclear and non-nuclear fields. Within this framework, IRMM has further extended its tasks and responsibility for storage, stability control, distribution, sales administration and recertification for BCR certified reference materials.

Special Certified Reference Materials (CRMs)

The agreement signed in 1996 with the International Federation of Clinical Chemistry (IFCC) led IRMM to focus on the preparation of materials for bio-medical, environmental and public health protection. The first stages of a project on urinary proteins are under way. Planning is in progress for other projects, on glycated haemoglobin (for monitoring glycaemia in diabetes patients), multi-enzyme calibrants and a serum panel for hCG (human chorionic gonadotrophin hormone) isoforms, used to detect early pregnancy, certain types of cancer and em-

bryonic disorders. In addition, preliminary discussions on projects for osteoporosis and markers for cardiac damage are being conducted. In another agreement with the Swedish and Swiss National Measurement Institutes, the determination of trace elements in serum is being assessed. Negotiations have been concluded with industry for the production of CRMs of genetically modified organisms. A contract has been signed to make possible the validation of measurement equipment for reading isotopic signatures in breath gases, used for the early detection of stomach ulcers and cancer.

In order to provide a reliable basis for the determination of a possible radioactive contamination of deceased persons having been in contact with nuclear materials in the past the US National Institute of Technology is preparing a reference material for which IRMM has been invited to provide specific certification data.

Intentional and accidental releases of radionuclides have been continuing for almost 40 years. To enable correct assessment of related potential health hazards to the European population, reliable, precise and rapid analytical methods are necessary, both for monitoring purposes and in the case of incidents. This requirement resulted in the ongoing development with respect to low level radioactivity determination in various matrices relevant to the dose burden of the European citizen. The year 1997 saw the finalisation of procedures for water and sediment and the start of a procedure for shellfish samples, all applying highly selective chromatographic techniques in combination with extremely sensitive spectrometric detection. Advantages of the new methods are accuracy, speed and the strong reduction of hazardous wastes. This instrumentation is used to provide primary isotopic gas standards for the international measurement community, e.g. in the area of atmospheric chemistry.

The expansion of the International Measurement Evaluation Programme (IMEP) which enables field laboratories world-wide to compare their results to SI-traceable values, has continued. The International Measurement Evaluation Programme on trace elements in water has been completed, with about 200 participants from 26 countries, an exercise for trace ele-

ments in serum has started in cooperation with a Scandinavian External Quality Assessment Scheme (EQAS) and the programme was extended to the industrial sector with a proficiency testing exercise for trace elements in polyethylene attacking an important problem for car manufacturers. This 10th IMEP round is also important because of the EC Directive 94/62/EG (metals in packaging waste). Samples have been sent to participants for analysis.

Materials for neutron dosimetry were produced in support of the nuclear energy producing industry and research institutions operating test reactors. These dosimeters are used for neutron fluence rate measurements in the reactor, for safety surveillance purposes and for optimising reactor performance.

Quick Response to Consumers Concerns: Safety of Euro Coins

In the field of heavy metal traces of environmental or biomedical relevance, analytical research was carried out on the release of nickel from Euro coins, in order to evaluate their allergenic potential. Concern had been raised by the European Bureau of Consumers' Unions about the potential of nickel released from such coins to provoke allergies while being handled by consumers, banks, shops, etc. The JRC carried out the necessary chemical reference measurements and found that the nickel content release from the new Euro coins was similar to that of many coins currently in circulation, and substantially lower than some of them.

Current developments in the nuclear energy sector (increased fuel burnup, Pu recycling, plans for waste transmutation), require improved knowledge of basic nuclear data. This is clearly spelled out in the "Michelangelo Initiative" which was formulated by the European nuclear industry under the aegis of the European Commission. IRMM is the only European laboratory which is capable of producing these data over a wide energy range from a few meV to about 20 MeV. Especially the GELINA facility is the only facility worldwide to provide the high resolution neutron cross-section data required for many of the above mentioned applications.



Automated filling and sealing of ampoules.

With the two versatile neutron sources of the Institute (LINAC and 7 MV Van de Graaff), neutron interaction data measurements were performed for applied purposes, following the recommendations of the OECD NEA Nuclear Science Committee, in particular its Working Party on International Evaluation Cooperation. IRMM coordinated the worldwide experimental activity to solve the remaining High Priority Requests in the frame of the NEA Working Party on Measurements Activities.

Neutron Reference Measurements for safe energy production, for waste transmutation and for shielding applications were performed.

In particular, measurements of the fission fragment mass distributions of neutron induced fission of ^{238}U were continued and the analysis of the data has started. In a collaboration with the University of Gent, light particle accompanied fission has been measured for neutron induced fission of ^{239}Pu in the resonance energy region and for spontaneous fission of the even Pu isotopes. Activation data for about 30 short-lived activation products, measured in collaboration with the "Forschungszentrum", Jülich, and Argonne National Laboratory, are being analysed.

IRMM has a Treaty obligation (1) to improve the data for the set of neutron reactions which are used as reference standards for all neutron data measurements, and (2) to act as a standards laboratory for radionuclide metrology. In 1997, work concentrated on three important standard cross-sections: $^{10}\text{B}(n,\alpha)$, $^{235}\text{U}(n,f)$ and $\text{H}(n,n)$.

The total cross section data of ^{10}B , measured within the framework of an international collaboration on the ^{10}B neutron cross section standard, have been analysed. The construction of an improved ionisation chamber for the determination of the ratio of the reference cross sections $^{235}\text{U}(n,f)$ and $\text{H}(n,n)$ is making good progress.

In radionuclide metrology, two ^{204}Tl solutions are being standardized within the framework of the "Bureau International des Poids et Mesures" (BIPM) comparisons. A solution of ^{169}Yb , which is a candidate nuclide in cancer therapy was standardised and decay data were measured in the frame of an EUROMET project. At the "Linear Accelerator" (LINAC) for neutron data, equipment and shielding in the new experimental hall for radiation physics have been constructed for the production of X-ray sources.

International Collaboration: Measurements for Improving Safety and Waste Treatment

Collaboration with the Commissariat à l'Energie Atomique (CEA), Saclay, on data needed for waste transmutation studies, was continued with the analysis of the measured cross sections of ^{99}Tc . Measurements of ^{237}Np in the resonance region have been started. Similarly, in the context of a concerted action to the same end, high resolution measurements of the inelastic scattering cross sections on ^{208}Pb have been initiated. These measurements are important for applications in the development of nuclear fuels and the management of nuclear waste materials. International collaboration on the Doppler broadening of neutron resonances, also with CEA, was continued with measurements on UO_3 , NpO_2 and Hg_2Cl_2 . Measured data for metallic U and UO_2 were successfully analysed with a simple solid state model; these measurements are important for the calculation of the temperature coefficient of reactivity, especially for high fuel burn-up.

Institutional Support Activities

IRMM's support activities were, among others, related to Nuclear Safeguards at the request of DG I (External Relations), for the International Atomic Energy Agency (IAEA), and of DG XVII (Energy, Euratom Safeguards

Directorate). Numerous non-nuclear certified reference materials were also prepared for other DGs (III, VI). The following activities highlight work carried out as institutional support to other Directorates General:

- Work on dried nitrate or metallic spike materials was continued, to improve safety at large processing plants, and uranium and plutonium isotopic reference materials were prepared on behalf of DG I for IAEA. Low concentrations implied meticulous chemical work in IRMM's ultraclean chemical laboratory.
- IRMM provided solutions for detector calibration needed in non-destructive assays of uranium and plutonium at the request of DG XVII (Energy).
- Certified reference materials of foodstuffs were prepared for DG III (Industry) and DG VI (Agriculture), in order to fulfil quality control requirements for the enforcement of European legislation. For DG VI, the new activities on selenium speciation in animal foodstuffs made significant progress and further research is in progress. Cosmetics analysis and a product safety data bank were being further performed and developed for DG XXIV (Consumer Policy).



Boron-10 evaporation system.

B. Competitive Activities

Shared-Cost Actions

deal mainly with the following topics:

Preparation of a set of environmental reference materials for the measurement of rare earth elements in tuna muscle, mussel tissue and sediment for the monitoring of environmental pollution by these increasingly used elements.

Preparation of a sludge and a fly ash reference material for the measurement of contamination by polychlorodibenzo-dioxins (PCDD) and polychloro-dibenzofurans (PCDF) for use in environmental monitoring, as e.g. required by EC Directives 94/67 CE on the maximum emission of PCDD/DF during waste incineration.

Preparation of bronze reference materials for corrosion studies on bronze antiquities to support the development of restoration and conservation techniques for the protection of the cultural heritage and for calibration of analytical methods for examination of bronze antiquities.

Competitive Support for Community Policies

Via support to DG XIII (Telecommunications, Information Market and Exploitation of Research) a contract was concluded with industry, aiming at the validation of a ^{13}C isotopic measurement method which can be applied to the diagnosis of stomach diseases by a non-invasive and inexpensive technique based on the isotopic measurement of exhaled breath. Both safeguarding nuclear material and proper nuclear material management are strictly intended to increase the safety and/or ensure public health of the European citizen.

A set of standard waste barrels presently being produced via support to DG XIII will be used to develop calibration standards for waste characterisation measurements, and therefore will lead to an increase of measurement consistency between different waste handling installations and hence, to a general harmonisation of radwaste measurements in Europe. This will contribute to both above aspects by enabling high

performance calibration of waste measurement systems, thereby greatly enhancing measurement quality and hence population safety.

Activities under Contract

IRMM also provides services on a commercial basis, and the BCR's reference materials have been made commercially available for non-nuclear applications.

Three low-energy detector calibration multi-X-ray reference sources were produced, certified for their X-ray emission rates and sold to CIEMAT, Madrid, the Danish Space Research Institute, Copenhagen, and the LPRI/CEA, Saclay. The activity of ^{37}Ar implanted in Al layers was determined for the University of Gent. At the Van de Graaff accelerator, hydrogen profiling studies have been performed on industrial semiconductors at the request of the Royal Institute of Technology, Stockholm.

The supply of nuclear samples to external customers, in particular for reactor neutron dosimetry, was continued. Uranium-doped glass reference materials for uranium contaminated soil samples were prepared.



The Institute for Transuranium Elements (ITU)

The Institute for Transuranium Elements contributed to the Framework Programme line Nuclear Fission Safety with specific research areas such as basic actinide research, safety of nuclear fuels, mitigation of long-lived actinides, and spent fuel characterisation.

Work on the safety of actinides in the nuclear fuel cycle continued to be the major contribution of the Institute.

ITU also provided scientific and technical support for Community policies in the area of nuclear safety and safeguards, predominantly related to the implementation of on-site laboratories at Sellafield and Cap la Hague, but also related to nuclear safety in Eastern countries and the Russian Federation. In addition, ITU continued to carry out contractual work at the request of various customers.

A. Institutional Activities

Institutional Research Activities

Work in Basic Actinide Research continued as one of the major activities of the Institute in 1997. The continuing and rapidly growing interest in the actinides results from four major reasons:

- ▶ The application of two "major" actinides (uranium and plutonium) in the fuel cycle;
- ▶ The growing interest in some "minor" actinides (neptunium, americium and curium) in the framework of waste management (partitioning and transmutation programmes);
- ▶ The growing interest of the scientific community in the multiplicity of very unusual and highly interesting chemical and physical phenomena of actinide compounds and
- ▶ The potential applications of actinides in nuclear medicine, for example alpha-immunotherapy.

Synchrotrons Shine New Light on Basic Actinide Research

The use of X-ray synchrotron sources has already made a substantial impact on studies of magnetic phenomena. Because of the presence of absorption effects associated with each element, the X-ray beams can be made "element specific" by tuning to these absorption edges. An elegant demonstration of this is the study of solid solutions between two compounds, where the important question is the magnetic configuration of each species. Using very small crystals (less than 1 mg in mass, and dimensions of about $1 \times 1 \times 0.1 \text{ mm}^3$) of Np substituted into a uranium compound, researchers at ITU, Karlsruhe, using the world's most powerful synchrotron in Grenoble, France (the European Synchrotron Radiation Facility), have shown that the technique can see individually the magnetic signal associated with both U and Np atoms. These experiments, using new techniques involving resonance scattering, open up the possibility of determining the electronic structure and hence the speciation of transplutonium ions in the solid state.

In vitro studies on alpha-immunotherapy continued in collaboration with partners from Nantes (France). At the Memorial Sloan Kettering Cancer Center in New York, 9 patients were subjected to phase 1 clinical tests. The production of actinium-225 by cyclotron irradiation of radium-226 was demonstrated.

New Production Method for Nuclide Used in Alpha-Immunotherapy

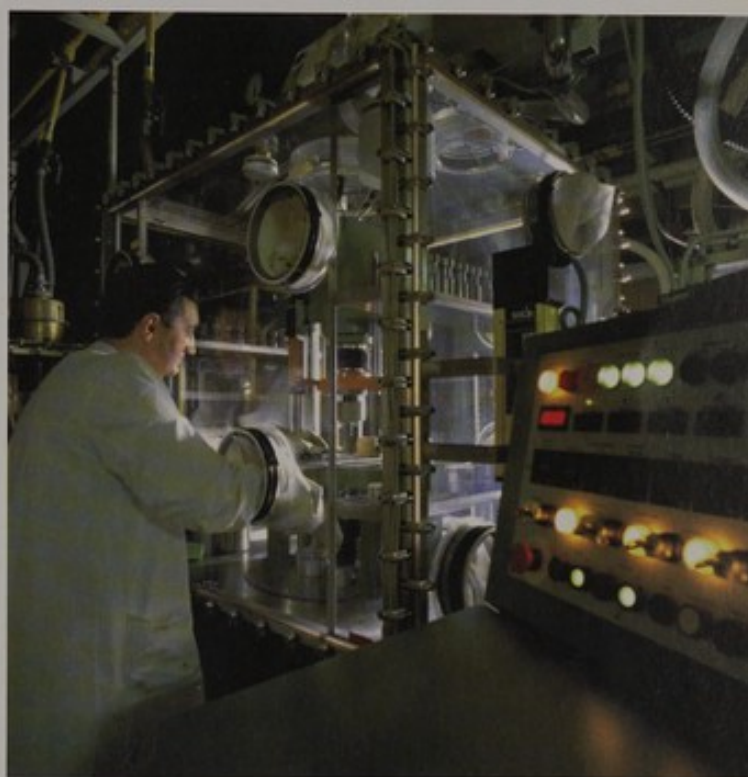
The Institute is involved since a few years back in the development and application of the alpha nuclide Bi-213 for a new alpha-immunotherapy treatment against cancer. One of the problems was the lack of sufficient amounts of this nuclide for current and future medical applications. Bi-213 used in alpha-immunotherapy was successfully generated by irradiating Ra-226 with protons. Together with the Cyclotron group of the Forschungszentrum Karlsruhe, it has been demonstrated that Ac-225, which is the precursor for a Bi-213 generator, can be obtained by this new method in shorter time periods and with less effort than by processing aged U-233 the previous source material.

In order to increase cost-effectiveness of nuclear power production, research and development is underway to increase the fuel residence time in the reactor, i.e. the burn-up of the fuel, without putting safety at stake. The Institute is establishing those basic parameters and characteristics, which are relevant to the safety of the fuel and which are incorporated in a code (TRANSURANUS) developed at the Institute and used *inter alia* by many licensing authorities.

In the area of safety of nuclear fuel, porosity distribution and micromechanical property measurements continued with fuel of 80 GWd/t average burn-up. Simulated high burn-up UO_2 fuel up to 200 GWd/t has been fabricated and characterised in order to perform micro-structural examinations. Fission gas release from power reactor fuel of a burn-up of 90 GWd/t was analysed and evaluated. Source term measurements on samples from safety experiments were performed and equipment was up-graded for fast fission product release measurements.

In the field of fuel fabrication technologies, new technologies (sol-gel and infiltration) were tested for various applications in transmutation programmes. The fuel performance code TRANSURANUS was further improved and consequences of high burn-up were modelled. These activities, of particular interest to operators of nuclear reactors and fuel fabrication plants, and to national and international authorities in charge of licensing and regulation, contribute to improved nuclear safety, particularly in phenomena which occur in light water reactor fuel rods at extended times of operation.

In the area of spent fuel characterisation, leaching, oxidation and corrosion experiments continued on SIMFUEL, irradiated UO_2 as well as irradiated PuO_2 and irradiated MOX fuels. The leaching and corrosion experiments were performed in granite environments and simulated groundwater. The oxidation experiments were performed at temperatures of up to 1000°C. This work is directed towards the characterisation of unprocessed spent fuel and its behaviour under long term storage conditions, determination of its radiotoxic potential, and investigation of leaching of this waste form under various realistic conditions.



Fabrication of inert matrices (spinel $MgAl_2O_4$, zircon $ZrSiO_4$, etc.) to replace U-238 in nuclear fuels for transmutation of the minor actinides Am and Np.

Reduction of Minor Actinide Radiotoxicity by a Factor of 100

The safe disposal of highly active wastes dominates the nuclear debate in several countries. The major issue is the potential risk due to the long-term radiotoxicity of transuranium elements and some long-lived fission products, such as for example technetium and iodine.

To further reduce the potential long-term hazard of such wastes, partitioning and transmutation research is being performed in several countries. The objective is to separate the long-lived nuclides from the waste to recycle them in reactors and to "transmute" or "burn" them by neutron capture or fission into nuclides with much shorter half-lives.

For the first time a closed partitioning and transmutation cycle was demonstrated. The remaining minor actinides of a previous transmutation in the PHENIX reactor (SUPERFACT experiment) were partitioned from fission

products with an overall partitioning yield of 99.9%. From this and the observed transmutation half-life of 2 years it can be concluded that it is technically feasible to reduce the radiotoxicity of minor actinides by a factor of 100 with a half-life of about 3 years including the out-of-pile time.

Collaborative work with leading national laboratories takes place mainly in the area of mitigation of long-lived actinides and fission products, with particular emphasis on further reduction of the radiotoxicity of highly active wastes.

In the framework of cooperation with various European partners, fuels have been fabricated, characterised and welded into pins for different irradiation experiments, including the irradiation of americium in the thermal reactor Osiris (Actineau) and the homogeneous incineration of fuel with high plutonium contents in the High Flux Reactor at Petten (TRABANT).

The extension of the minor actinide laboratory made substantial progress in line with the schedule. The separation of actinides from the SUPERFACT fuel was demonstrated with advanced reprocessing techniques, and material science and fission damage investigations of inert matrices continued.

In the area of safeguards R & D a new chemical separation method for preparation of mass spectrometer filaments was developed, validated and implemented. A highly sensitive thermal ionisation mass spectrometer, capable of measuring up to four masses simultaneously, is under evaluation for safeguards applications.

Institutional Support Activities

Non-proliferation of nuclear weapons is an important policy objective of the European Union. In addition, the European Commission has itself executive powers under chapter 7 of the Euratom Treaty to control nuclear materials in the Union. The Euratom Safeguards Directorate of DG XVII is carrying out inspections in acceptance with Treaty requirements and international obligations of the Community.

In support of Community Policies in the area of nuclear safeguards and fissile material management for

DG XVII, major progress was made towards the implementation of the on-site laboratory at Sellafield. The design phase for the on-site laboratory at Cap la Hague was completed, and tender procedures for equipment purchases were launched. ITU analysts continued to perform on-site and in-field support at the request of DG XVII (about 1700 measurements). In-house analytical services continued (about 500 samples p.a.), and work on quality assurance procedures and the nuclear material data bank progressed significantly.

In support of IAEA safeguards, analytical services were provided in relation to waste and swipe samples. Consultancy and training was provided in clean laboratory techniques, robotised analyses of nuclear materials, and on-site laboratories.

B. Competitive Activities

Shared-Cost Actions

The Commission supports the further safe development of nuclear energy in the European Union. For this purpose, funds have been made available under the 4th Framework Programme by DG XII on a Shared-Cost basis. The work on ongoing projects in the framework of the Nuclear Fission Programme continued in close cooperation with partners. Some examples are: new partitioning techniques for the recovery of minor actinides from high level liquid waste; Joint Experimental Feasibility for Targets and Transmutation (EFTTRA) Experiment on Transmutation of Americium; Source Term for Performance Assessment of Spent Fuel.

Activities under Contract

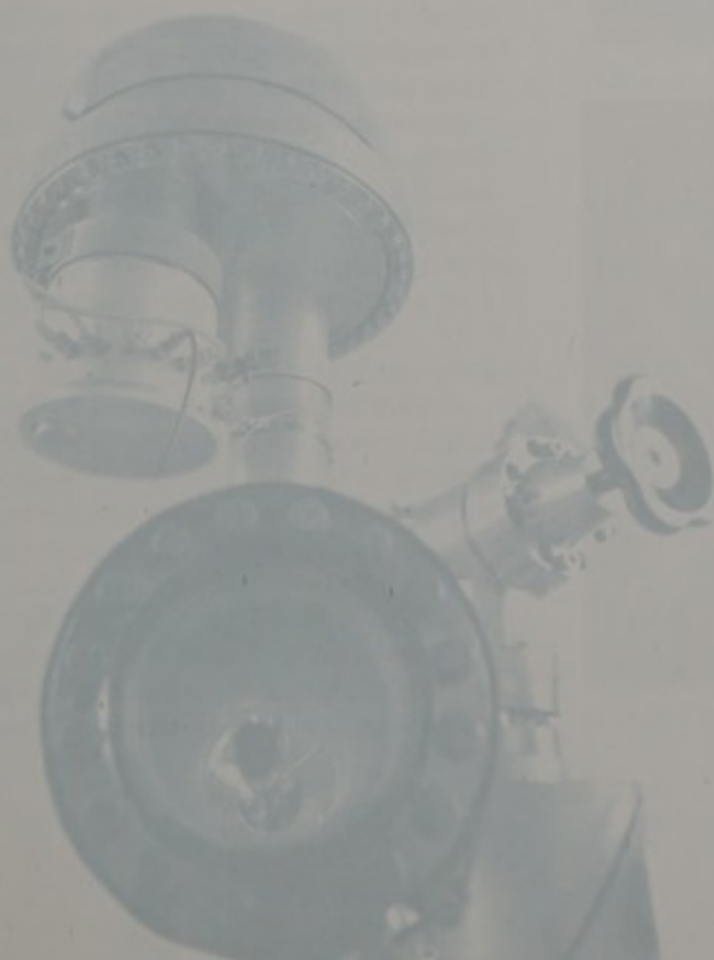
As in previous years, the work carried out for various customers concerned post-irradiation examination of irradiated fuel, fabrication and characterisation of fuels for transmutation, and examination of high burn-up oxide and mixed oxide fuels. A significant number of new contracts was signed during 1997 with Siemens, AG-Bereich Energieerzeugung (KWU), CEA Cadarache, COGEMA (Compagnie Générale des Matières Nucléaires, Vélizy, France), The British Nuclear Fuels plc, and

the Central Research Institute of the Electric Power Industry, Tokyo, Japan.

Other Competitive Activities

- Cooperation with Bulgaria and the Czech Republic in the area of fuel modelling to improve reactor safety continued, a PHARE project.

- Cooperation with MINATOM and GOSATOMNADZOV in setting up analytical facilities in the Russian Federation for nuclear material accountancy and control, is ready to start, within the framework of the Commission's TACIS programme (Technical Assistance to the Commonwealth of Independent States).



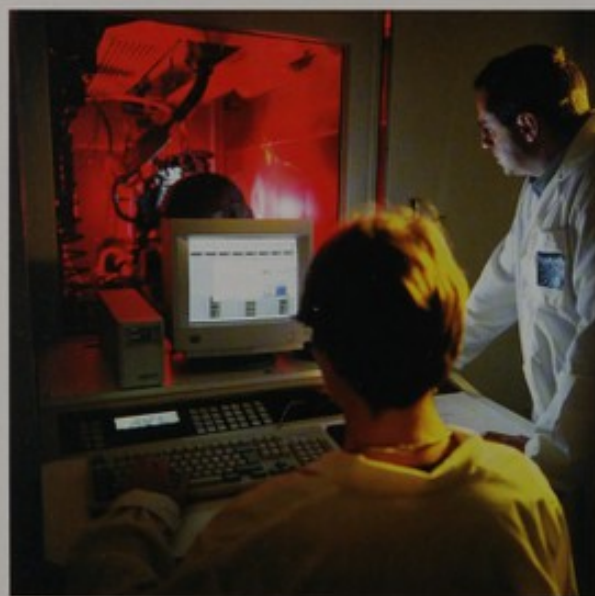
itu

The Institute for Advanced Materials (IAM)

IAM contributed with its Research and Technological Development activities in 1997 to the following Framework Programme lines: Industrial Technologies and Materials Technologies, Non-Nuclear Energy, Nuclear Fission Safety, and Controlled Thermonuclear Fusion.

IAM developed research activities on advanced materials, contributing to science and technology for the benefit of European industry as well as European consumers; some examples are the development of radio tracer methods for the determination of heavy metal release from gas catalysts and during food processing, the investigation of the safety aspects of future fusion machines, and the reassessment of industrial needs on novel catalytic washcoats to be used in car gas exhaust systems.

IAM showed a special interest in pre-normative work of vital importance for industry. In 1997, the results obtained at IAM have strongly contributed to the development and improvement of standard test methods for mechanical performance assessment and for new classes of materials, such as technical ceramics and composites.



View from the control room on the engine test facility (IAMSET project).

A . Institutional Activities

Institutional Research Activities

The main goals of the **Industrial Technologies and Materials Technologies** programme address the pre-normative needs of industry in Europe, including:

- ▶ development of innovative processing and testing methods for advanced materials, focusing on cost efficiency, performance improvement and standardisation potential;
- ▶ alignment of the broad scope of testing, processing and analytical research on advanced materials, including composites and interfaces, with the information and data requirements of industry and standards development by CEN (Comité Européen de Normalisation) and ISO (International Organisation for Standardisation);
- ▶ establishment of a European methodology for inspection qualification associated with the validation of advanced NDE (Non Destructive Evaluation) techniques for pressure vessels, piping and power generation components;
- ▶ networking of users in power industries, collaborating on the Institute's data facilities for mechanical properties and corrosion;
- ▶ enhancement of the potential of surface engineering methods, for the improvement of fatigue, wear and corrosion behaviour, thermal barrier performance, and in biomedical and sensor applications;
- ▶ development of radio tracer (thin layer activation) methods for the determination of heavy metal release from gas catalysts and during food processing;
- ▶ development of radio tracer methods for advanced applications in technical components and consumer goods.

For the **Non-nuclear Energy** programme, the work was divided into two lines: Photovoltaic Energy and Electricity Storage, carrying out research and support activ-

ities relevant to the White Paper "Energy for the future: Renewable sources of energy", and Materials for Clean Combustion Engines, under directives for reduction of emissions and gaseous pollutants.

The goals of the Photovoltaic Energy and Electricity Storage line were, on the one hand, to develop and operate diagnostic testing and monitoring techniques for photovoltaic components and installations as well as electricity storage, and, on the other hand, research on methodologies and procedures for photovoltaic devices to be standardised at a European or international level. In the Materials for Clean Combustion Engines line, emphasis was put on reassessing industrial needs for novel catalytic washcoats to be used in car gas exhaust systems, and on characterisation of previous results in near-to-engine operation conditions.

The **Nuclear Fission Safety** activities were focused on a better understanding of ageing mechanisms of components materials in nuclear power plants. In particular, a new test facility was installed at IAM for irradiation of vessel material (the LYRA facility). Design rules for pressure vessels and stress corrosion damage were also investigated.

IAM was involved in long term activities within the **Controlled Thermonuclear Fusion** programme, and carried out specific tasks at the request of the Next European Torus (NET) and the International Thermonuclear Experimental Reactor (ITER) projects. Activities covered three main lines: fluid separation and structural analysis, fusion materials, and tritium materials interaction. The safety related aspects of future fusion machines were also investigated.

Standards and Norms in the Materials Field

Standards and norms are of vital importance for industry, and the safety of users, in particular when reliability and quality are at stake. Pre-normative work, i.e. all activities helping in the preparation of norms and standards, receives special attention at the Institute for Advanced Materials, where such activities have been undertaken for several years in the materials field. Today, the results obtained at IAM have strongly contributed to the develop-

ment of standard test methods for mechanical performance assessment, for new classes of materials (technical ceramics, composites), to new test methods (thermo-mechanical fatigue, damage tolerance of ceramic composites, residual stress) as well as to the improvement of existing standards. IAM collaborates closely with international organisations such as CEN (Comité Européen de Normalisation), VAMAS (Versailles project on Advanced Materials and Standards), and ESIS (European Structural Integrity Society).



Mock-up Ds/Cn-I. Bottom-view with cooling tubes.

Institutional Support Activities

IAM provided support to DG XI (Environment, Nuclear Safety and Civil Protection) and to DG XVII (Energy) in topics related to nuclear fission safety, in particular by running the European Network for Inspection Qualification (ENIQ), the Network for Evaluation of Steel Components (NESC) and the network on Ageing Materials Evaluation and Studies (AMES). For DG XI, considerable assistance was provided to the Codes and Standards Working Group and to its action on Inspection and Manufacturing, on Fracture Mechanics, and on Materials. For DG XVII, participation and support were provided to the European Non Destructive Evaluation Forum (ENDEF).

B. Competitive Activities

Shared-Cost Actions

The financial volume of contracts signed in Shared-Cost Actions at the end of September 1997 was 45% higher than in 1996.

New Coatings for Dry Machining

Presently almost all machining processes are based on the use of synthetic cutting fluids with the threefold task of reduction friction, cooling pieces, and removing metal chips from the machining area. They also have significant drawbacks from an environmental point of view: they are non bio-degradable and can produce allergies. In Germany alone, 100 000 tons of oil-based lubricants are now used each year. Lubricant-free machining would be preferable in many ways, but is difficult to achieve.

Lubricant-free machining would thus be preferable to enhance safety at work as well as decrease environmental impact of industrial processes.

The JRC approach is to develop multiphase hard coatings for cutting tools, able to sustain the severe wear they are exposed to, and which have low friction coefficients in

order to reduce contact temperature. So far, promising results have been obtained at IAM on the basis of Ti-B-MoS₂ coatings which were synthesised by a special innovative technique.

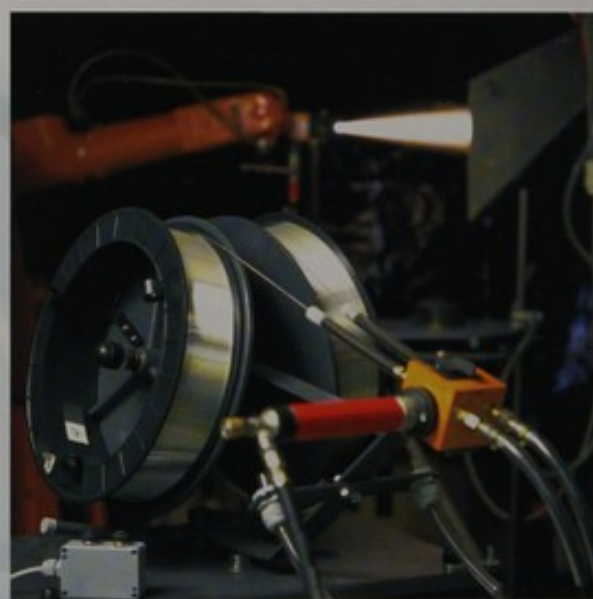
Competitive Support for Community Policies

Four IAM proposals were retained for funding in 1997 by DG XIII (Telecommunications, Information Market and Exploitation of Research) within the framework of the Innovation programme. They are in the areas of nano-technology, surface engineering, and materials testing and characterisation.

DG III (Industry) financed an IAM proposal for the setting-up and coordination of activities within the framework of the European Pressure Equipment Research Council.

Activities under Contract

Contracts signed in 1997 were at the same financial level as those signed in 1996, and served the same portfolio of industrial needs, including non-destructive evaluation techniques, coating technologies, and corrosion studies on materials for power generation.



Robotized wire spraying unit, used for the deposition of thick metal coatings.

The Institute for Systems, Informatics and Safety (ISIS)

The Institute for Systems, Informatics and Safety (ISIS) is the JRC's centre of expertise in the science and technology of safety management, the multi-disciplinary analysis of industrial, socio-technical and environmental systems, and the application of information technology.

Work at ISIS focused on those well identified tasks under the Fourth Framework Programme where it uses its skills and unique facilities to advance European research for the benefit of European industry and the well-being of the European population. ISIS was particularly active in supporting efforts towards the regulation of biotechnology in industry and the evaluation of its potential risks.

ISIS continued to provide scientific and technical support for Community policies. Customers included DG I (External Relations) and DG XVII (Energy), DG XI (Environment, Nuclear Safety and Civil Protection) for work related to safety and licensing issues in the nuclear, chemical and biotechnology industries, DG III (Industry) for Information Technology, DG VII (Transport) for Aircraft Safety, the European Environment Agency, the Forward Studies Unit, and DG VI (Agriculture) and the Commission antifraud service (UCLAF) for fraud control.

A. Institutional Activities

Institutional Research Activities

As part of the long term research that will help the safeguards inspectorate harness new technology to improve efficiency and prepare for the inevitable new challenges that will be raised by disarmament and the enlargement process, significant progress has been made in neutron measurement techniques for Non Destructive Assay. A high efficiency counter for passive neutron interrogation was constructed; sealing-bolt production was improved by implementing quality control techniques, and seal-reading instruments were improved by the adoption of a new compact board; a prototype of a high resolution acquisition system based on a new laser type was developed for the 3D reconstruction of plants and structures; a laboratory

prototype of a distributed surveillance system based on digital cameras, compact industrial PCs and Ethernet network was developed.

Reactor safety research concentrated on severe accidents in light water reactors and covered the following activities: tests at moderate pressures (< 5 bar) were performed in both FARO and KROTOS facilities at Ispra on the test sections to allow better observation of the mixing, jet break-up and quenching processes; the development of the REACFLOW code for the numerical simulation of deflagration and detonation processes in arbitrary gas mixtures continued. A two-dimensional axisymmetric code version has been completed which is now ready for industrial application. A fully three-dimensional pilot code version is in the testing phase.

Seismic Resistance of Structures

The facilities of the European Laboratory for Structural Assessment (ELSA), continued to provide a unique testbed for the application of the pseudodynamic test method for checking the seismic resistance of structures. The data from these tests provide a scientific basis for the building standard—Eurocode 8—that constitutes Europe's main protection against damage to life and property from



Palazzo Geraci facade model post-test identification of the damage zones (cracks).



earthquakes. The advantages of using base isolation techniques for the seismic protection of monument buildings have been explored. Tests were conducted at ELSA on the Palazzo Geraci model by using a special steel base isolation device. A series of tests were performed to assess the adequacy of the pseudodynamic test method for structures equipped with high-damping rubber bearings. A reduced-scale structure, already tested on a shaking table, was tested pseudodynamically at ELSA, and the results were compared.

As part of the Centre for Earth Observation (CEO) project, and complementary to the activities of the Space Applications Institute, ISIS continued to operate and update information systems to promote the use of satellite-based earth observation data. The work included updating the European Wide Service Exchange (EWSE), now recognised as the leading source of information regarding Earth Observation in Europe, enhancing the G7 Environment and Natural Resource Monitoring (ENRM) server by integrating it with 20 environmental databases across the world, developing the CEOS Information Locator System (CILS) on behalf of Third World countries, and developing a new Internet protocol for remote searching of geospatial databases.

ISIS contributed to the Fusion Programme with its heavy robotics facility ROBERTINO. The control and data acquisition systems of a blanket test facility for ITER have been developed, as part of an international effort to develop assembly procedures for blanket modules inside the vacuum vessel.

Institutional Support Activities

The Institute acted as the main scientific adviser to the Euratom Safeguards Directorate (ESD) (DG XVII) for the following topics:

- ▶ development of two passive neutron counters for measurements of Mixed Oxide (MOX) fuel pins and of a passive neutron counter for the assay of Pu scraps;
- ▶ development of a multimedia safeguards training package including a multilingual keyword search

engine and the quantification of measurement uncertainty in neutron assay methods;

- ▶ supply of a complete site station for ultrasonic sealing/identification of spent fuel elements stored in ponds, including a powerful seal-management database, to be used by Euratom inspectors at THORP Sellafield (UK);
- ▶ training courses for EURATOM inspectors in Non Destructive Assay (NDA) and mass and volume measurement techniques in large tanks.

ISIS also provided the technical means whereby DG I supported the International Atomic Energy Agency (IAEA) through: experimental investigation in TAME (Tank MEasurement) of error components in mass/volume measurements of liquids in large tanks; testing of portable pressure measurement equipment, and demonstration in particular of their unattended mode of operation through long term in-field trials in the USA; environmental testing of various safeguards devices in the TEMPEST laboratory on the basis of an IAEA test procedure, developed in 1996 with the support of JRC Ispra; training courses for IAEA inspectors in non-destructive assay, mass/volume determination and sealing/identification techniques.

ISIS supported DG XI through the running of the Major Accidents Hazards Bureau (MAHB), for the implementation of the new "Seveso II" Directive (96/82/EC).

ISIS continued to support the service performance of the Commission's antifraud service (SG/UCLAF) through the introduction of new information technology, data analysis and risk analysis methods into anti-fraud work.

The Institute's expertise in information technology was used to support the Information Technologies programme of DG III. Specific areas of work were: workshops on survivability and dependability of software; support to European pharmaceutical regulatory policy through the European Medicine Evaluation Agency (EMEA); European high performance computing and image processing and synthesis (pre-industrial software).

Biotechnology Regulation and Risk Evaluation

In 1997, ISIS has been particularly active in the field of biotechnology regulation in industry and the understanding of the potential risks.

On behalf of the Forward Studies Unit, which is directly associated with the President of the Commission, ISIS analysed the current procedures in biotechnological risk assessment for transgenic plants: the aim was to determine whether current scientific knowledge allows comparative environmental risks to be calculated and risk assessment procedures to be harmonised. The conclusions and recommendations of the study dealt with the limitations of quantitative risk assessment for genetically modified organisms and with problems in identifying hazards.

ISIS provided scientific support to DG XI on the implementation of the Biotechnology Directives (90/219/EEC on the contained use of genetically modified microorganisms and 90/220/EEC on the deliberate release and the placing on the market of genetically modified organisms). Priority was given to projects dealing with implementation in the EU Member States (plus Norway and Iceland) of an electronic system enabling the exchange of information among Member States and the Commission on deliberate field trials.

B. Competitive Activities

Shared-Cost Actions

During 1997, ISIS was involved in 3 Training and Mobility for Researchers (TMR) networks, 5 concerted actions and 36 shared-cost action projects.

- ▶ In the RESOLV project, a prototype of an Autonomous mobile platform with an Environment Sensor for Telepresence (AEST) was built to reconstruct real environments using images from a JRC-developed fast high resolution three-dimensional scanner. Further research on reconstruction of a three-dimensional environment is being undertaken in the framework of a Training and Mobility for Researchers (TMR) network linking seven of the most active European laboratories in the field.
- ▶ In the field of nuclear safety, ISIS coordinated two projects, aimed at improving the performance of computer codes used in analysing the safety of nuclear power plants.
- ▶ ISIS expertise in combustion modelling is being used in the nuclear reactor safety project, Combustion in Severe Accidents and in the Explosion Models Evaluation project which aims to assess vapour cloud explosions.
- ▶ The ROBERTINO heavy robotics facility, coupled with the TELEMAT CAD/CAE laboratory, is being applied for the automation and control of laser welding technology applied to heavy section components in the LASEROBOT project.
- ▶ In the ADAMS project, ISIS has analysed different methodologies for aircraft dispatch and maintenance, with a view to reducing human-factor related accidents.

Competitive Support for Community Policies

Complementary to its institutional work, ISIS was successful in a number of calls for tender issued by Commission services in areas related to its main competences. A selection of these projects, classified per customer DG, is mentioned below.

For DG III (Industry): Two full-size three-storey buildings were tested pseudodynamically at ELSA. A joint project with the Space Applications Institute on benchmarking of European neural network systems on remote sensing applications was completed; in the field of pharmaceutical regulation, the testing phase of the EudraTrack project for the procedure of Mutual Recognition between Member State health authorities was completed. The Eudramat database of pharmaceutical products marketed in the European Union was distributed on CD-ROM to health authorities.

For DG VII (Transport): As part of the ongoing effort to prepare the ground for a harmonization of the regulatory framework governing Europe's aviation the European Coordination Centre for Aircraft Incident



Reporting Systems (ECCAIRS) is being prepared for production. The software has been industrialised, the central office has been setup, and data exchange procedures, with the six EU aviation authorities initially involved, have been put in place.

For DG XI (Environment, Nuclear Safety and Civil Protection): The JRC has produced a synthesis report of an international benchmark aimed at harmonising the different methodologies used in calculating the radioactive release to the atmosphere in the case of an accident in the auxiliary building of a nuclear power plant. The report highlighted areas of agreement, and identified areas where further research is needed. Commissioning work has started, with preliminary work on a small incineration oven for the investigation of advanced waste treatment processes. A study on an overall strategy for Environmental Impact Assessment (EIA) and Strategic Environmental Impact Assessment (SEIA) research in the European Union, taking into account the views of acknowledged experts from the Member States, has been completed. A Community Information System on Natural Disasters is being established. Priority in the pilot phase has been given to a limited number of types of disasters: floods, earthquakes, and accidents of any kind causing significant environmental consequences. Eight Member States, as well as Iceland and Norway, are contributing to the project. The design of the prototype information system is now completed.

For Eurostat (Statistical Office): A study on environmental pressure indicator modelling has been completed. The study defined a generalised layout to summarise pressure indicator models, identified modelling activities in the Member States, and produced a model sheet for each of the twenty-five models identified.

As part of its mission, ISIS has transferred to industry some technologies it has developed. In 1997, 10 projects funded by DG XIII were completed and another 12 have started.

12 New Projects for Technology Transfer to Industry

- ▶ *Testing and demonstration of an automotive crash energy absorber based on high speed liquid jet formation.*
- ▶ *Fibre optic based acoustic emission sensor system.*
- ▶ *Industrialisation of a holographic flat display.*
- ▶ *Industrialisation of an ESPI based device for deformation measurements and mechanical characterisation of building materials.*
- ▶ *Integrated fixture for punch and bulge testing of small specimens.*
- ▶ *AWARE (Advanced Warning Against Runaway Events).*
- ▶ *Exploitation of STARS industrial reliability software.*
- ▶ *VASAT-3D: extension of JRC finite element simulators to model three dimensional water flow and contaminant transport in variably saturated soils.*
- ▶ *Implementation of W-SDI: a Windows tool for safety design improvement.*
- ▶ *Large scale testing of vibration sensor and micro-seismic monitoring.*
- ▶ *Integrated system for shape and condition monitoring of composite elements used in civil and aeronautical engineering.*
- ▶ *Validation of uncertainty and sensitivity analysis software.*

Activities under Contract

Third Party Work at the JRC is offered to clients who take advantage of products and techniques developed through research in ISIS and pay for these products to be customised to operational requirements. During 1997 more than 30 contracts were signed. Examples of some of the larger contracts: a full-size replica of a portion of the São Vicente de Fora Monastery

in Lisbon has been constructed by reproducing the original materials and workmanship, and is being tested at ELSA under a contract with the Portuguese Government; an integrated system for monitoring and preventing pollution and risks associated with industrial areas and movements of dangerous substances in Sicily, as well as for the on-line management of related emergencies, was installed on behalf of the Italian Ministry of Environment. Another contract was signed allowing the United States Nuclear Regulatory Commission access to results from FARO quenching tests.

Exploratory Research

ISIS made a special internal effort to explore some complementary research areas which might turn out to be important for its future institutional contributions; a total of 65 proposals were presented within the Institute and 12 of them were funded. At the end of 1997, 10 of these were allowed to continue for a second year, and a further 5 projects were added. The projects covered a wide range of subjects, including non-linear time series analysis, brain-actuated control systems for the disabled, voice to text conversion, regional flood vulnerability, remote measurement of water levels in environmentally sensitive areas, innova-

tive accelerator driven nuclear reactors, simulating energy-environment interactions in cities, determining how citizens can participate in environmental decisions, modelling particle gas flows, smart materials, protein folding, measuring the performance of artificial joint implants, seismic monitoring, earthquake prediction, and stress-wave release from fracturing rocks.

Safeguards Plant at Obninsk

The European Commission, through the TACIS Programme, is supporting efforts in the Russian Federation to improve nuclear material accountancy and control. As part of this work, a Safeguards Methodological and Training Centre (RMTC) is being set up at the Institute of Physics and Power Engineering (IPPE) at Obninsk, in the Kaluga region of Russia. ISIS, together with IPPE, has been given the task of designing and implementing the Centre. The principal tasks of the RMTC are the training of the Ministry of Atomic Energy (MINATOM) plant operators as well as of the domestic inspectors at the Russian Authority for Nuclear Security (GOSATOMNADZOR) in fields such as development and implementation of upgraded approaches for accounting and safeguarding fissile materials. It uses existing premises, already licensed for the use of bulk quantities of nuclear materials. So far:

- ▶ 15 Russian instructors and 70 Russian inspectors and operators have been trained;
- ▶ 8 specialist courses have been held in Ispra and 5 in Obninsk;
- ▶ seminars on fuel fabrication safeguards and reprocessing plant safeguards have been held in Obninsk.



Small incineration plant for the investigation of advanced waste treatment processes.

The Environment Institute (EI)

The Environment Institute (EI) contributed to the Fourth Framework Programme, mainly in the lines Environment and Climate and Life Sciences and Technologies. Through various competitive actions, the Institute also addressed Programme lines such as Measurements and Testing and Nuclear Fission Safety.

In 1997 the EI dedicated 70% of its institutional activities to providing scientific and technical support to other Directorates General of the Commission in the preparation and implementation of EC sectoral policies in the fields of the Environment and Consumer Protection.

The Environment-Water Task Force, headed by the Institute director, has concluded its final report, based on more than 450 "ideas-proposals" and on the position papers prepared by the national contact points and professional task forces. The proposed action plan will be used in defining the specific programmes of the Fifth Framework Programme on water-related activities.

A. Institutional Activities

An adequate balance between research and direct support activities has allowed the Institute to provide effective support while maintaining its scientific and technical competence.

Institutional Research Activities

In accordance with the European Union's research objectives laid out in the Fourth Framework Programme, the Institute set up and coordinated European research projects which contributed to major international environmental programmes such as IGBP (International Geosphere Biosphere Programme), IGAC (International Global Atmospheric Chemistry), and EUREKA.

In the field of atmospheric processes, activities have mainly been focused on tropospheric ozone, a harmful, globally increasing greenhouse gas, which affects human health, crops and vegetation, and on atmospheric aerosols which are of paramount importance in evaluating and predicting climate trends.

Biogenic Emissions from Vegetation and Ozone Formation in the Mediterranean Area

The aim of the Biogenic Emissions in the Mediterranean Area (BEMA) project developed by the Institute is to assess the contribution of biogenic emissions from vegetation to tropospheric ozone formation in the Mediterranean area, in relation to the contribution from anthropogenic sources. The last year of BEMA phase II was focused on modelling/up-scaling activities. A large mesoscale experiment, involving 17 European laboratories, was jointly organised by EI and Centro de Estudios Medioambientales del Mediterráneo (CEAM) in May/June 1997 in the Castellón area near Valencia in Spain, to test the multidimensional meteorological/chemical model developed already. The experiment included ground measurements (emission rates, canopy fluxes, concentrations), as well as measurements from aircraft and tethered balloons, to characterise transport and chemistry in the boundary layer of an 80 km corridor in the land-seabreeze direction.

The Aerosol and Climate project contributed to assessing the impact of the aerosol burden on Earth radiation. The Aerosols Characterisation Experiment (ACE-2) was during 1997 the main focus of the activity. The project was carried out in collaboration with 25 European laboratories and included preparation of logistics together with coordination of 250 scientists, 6 aircraft, 1 ship and 6 ground based stations. The JRC also participated successfully in the ACE-2 project by performing a series of gas measurements and aerosol physical and chemical characterisations in Tenerife, Madeira, the Azores and Portugal. The modelling activity thus provides a more realistic description of aerosols in global models, and should improve the estimates of radiative forcing by those aerosols. The results of this project are relevant to assess the impact of atmospheric aerosols on the global change and the extent to which this impact varies as a result of human activities and natural phenomena.

Institutional research activities in the water and soil areas included the use of AMAL (Advanced Mobile Laboratory) to assess industrial sites and landfill contamination. Samples from different estuaries have been analysed to establish the relationships between toxic element concentrations and flow variations, as well as

identification of sources. Four *in situ* campaigns were performed in the subalpine ecoregion, to contribute to the setting up of algorithms describing lake water quality, and for comparison of different methods for the determination of phytoplankton pigments.

Several reports were published on lake restoration/safeguarding projects and on drinking water quality. Collaborative data and uncertainty assessment studies continued within the AQUACON (Analytical Quality Control) project.

A new Unit, Environmental Toxicology and Human Health, which included the former Indoor Air and Life Science units was set up with the aim of reorienting activities in view of the 5th Framework Programme. The Institute's work in this area is being intensified and will be focused on: the impact of microbial and chemical pollution of water on aquatic life, and the consequent relevance to human health; the health risks of indoor air pollution, especially those related to volatile organic compounds; health effects resulting from food contamination; and age-related neurodegenerative disorders.



Test-methods: integration of comments to create the final test protocol (ECB).

Within the European Collaborative Action, Indoor Air Quality & Its Impact on Man (ECA-IAQ), an essential part of the institutional indoor pollution activity, two new reports have been published: *Evaluation of VOC Emissions from building products-solid flooring materials*, offering a labelling procedure for flooring materials awaited by industry, and *Total Volatile Organic Compounds (TVOC) in indoor air quality investigations*. An automatic air pollution analyser developed at EI for indoor and workplace applications has been extended to diisocyanates. Within the scope of competitive support activities, a contract has been granted from DG XIII for the construction of a commercial version of the analyser. Research was continued within the EURO-TERVITH (Trace-Element Reference Values in Human Tissues) project on basic levels of trace metals in the European population.

Institutional Support Activities

The Environment Institute's activities have been mainly devoted to providing scientific and technical support to the Commission Services in the design and implementation of European Union policies in the fields of environment and consumer protection.

The European Chemicals Bureau (ECB) acted as a focal point for the implementation of the EC directives in the field of chemicals control (DG XI Environment, Nuclear Safety and Civil Protection). The work of the ECB included risk assessment in relation to existing or new chemicals in close cooperation with competent national authorities and other international bodies, such as the Organisation for Economic Cooperation and Development (OECD), the United Nations Environment Programme (UNEP) and the Food and Agricultural Organisation of the United Nations (FAO).

The European Centre for the Validation of Alternative Methods (ECVAM), in support of DG III, DG XI and DG XXIV, worked on the validation of alternative, non-animal, toxicity testing procedures, in support of Commission regulatory actions on industrial chemicals, pesticides, cosmetics, and other products, for the protection of consumers, of the environment, and for the benefit of European industries.



The well established work of ERLAP (European Reference Laboratory for Air Pollution) and REM (Radioactive Environment Monitoring) provided DG XI with scientific and technical support for the EC legislation on air quality. The work will be extended to take account of growing concern about the causes and health effects of urban air pollution in relation to small aerosol particles and the use of alternative fuels.

The activities in support of the Alpine Convention for the sustainable development of the Alps have been maintained by coordinating the Alpine Observation and Information System (Alpine Observatory).

The Institute has managed the Technical Support Group for Urban and Regional Modelling in the project Auto-Oil 2. This support group provided expert advice and assistance for the impact assessment on the 10 cities selected. The methodology has been reviewed and the key parameters of reference have been analysed for assessing the current levels of air quality. The criteria for identifying the main stationary (industrial) and traffic sources of pollution have been also established.

Support was also offered to the European Environment Agency in the fields of measuring methods, intercalibration instruments, and the development of new methods and new environmental measuring devices.

Consumer Protection and Food Safety

Consumer protection has been one of the priorities of the EI, with activities on food safety, origin and quality, including the well established European Office for Wine, Alcohol and Spirit Drinks (BEVABS), which was created at the Environment Institute of the JRC in Ispra in 1993, as a community body with a high level of scientific expertise and specialised high-performance equipment, to provide Member States with the assurance that scientific cooperation between official laboratories is organised efficiently and that disputes between Member States over the interpretation of analytical results are handled objectively in true community spirit.

The main objectives of this office can be briefly summarised as follows: establishment of an analytical database for wine sector products, for the coordinated and uniform application of analysis methods, in particular those based on nuclear magnetic resonance; analysis of wine or alcohol samples taken by commission control agents; preparation for the acceptance of new isotopic methods based on mass spectrometry as future official methods of improving the fight against fraud; performance of measurements for Member States not yet equipped with isotopic techniques; the handling of possible disputes concerning Member States' interpretation of analyses of the same product.

The European Office for Wine, Alcohol and Spirit Drinks works in close collaboration with the specialised departments responsible for the wine sector within DG VI (Agriculture). The scientific and technical work carried out by this office complements the activities of the Commission's agents, who are responsible for cooperating with the fraud prevention and control authorities in the Member States. The European Office for Wine, Alcohol and Spirits collaborates with the official bodies and 15 official laboratories of the wine producing Member States for the collection and the validation of the data to be used for the establishment of the database and a multilingual software has been developed for this aim. So far the databank contains the deuterium isotope ratios of ethanol from more than 10 000 authentic wines taken from the wine producing countries in the European Union and covers the six vintages from 1991 until 1996.

B. Competitive Activities

Shared-Cost Actions

The EI has won 25 new shared-cost action projects within the programmes Environment and Climate, Standards, Measurements and Testing, and Nuclear Fission Safety and within the scope of Joule (Joint Opportunities for Unconventional or Long-term Energy supply) and INCO (International Cooperation).

The main topics addressed in these projects were: particles and photo-oxidants in chemistry; formation processes and role; climate change effects on freshwater

resources in Europe; air quality and effects of pollutants on the European population; development of analytical methods for food control; environmental risk assessment; endocrine disrupting chemicals.

Competitive Support for Community Policies

The EI has signed new contracts to provide support to other community services on a competitive basis, mainly in the fields of food and consumer protection.

Research has been carried out in support of DG III (Industry) and DG XXI (Customs and Indirect Taxation) on the development and validation of methods of assessing compliance with food legislation on chocolate, honey and olive oil.

DG XIII (Telecommunications, Information Market and Exploitation of Research) funded the development of a compact, portable and economic prototype version of an automatic laboratory analyser of indoor air pollutants. A patent has been obtained in 1997 from the European Patent Office.

Activities under Contract

The institute has also carried out research under contract to characterise industrial contaminated sites and has performed environmental impact assessment for regional authorities. In the Lombardia region in Italy, work has been carried out on soil pollution, on water resources management, and on air quality control.



Chemical ionisation mass spectrometer (CIMS) with flow tube reactor for studies of atmospheric chemistry.

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The Space Applications Institute (SAI)

The Space Applications Institute (SAI) carries out research leading to provision of up-to-date information on events and trends affecting the Earth's resources and environment. SAI plays an important role in the development of European Earth observation, and its activities are crucial to the exploitation of the investments made by Member States, particularly in the European Space Agency.

Its work within the Environment and Climate research programme addressed issues related to quality of human life, to sustainable resource management, and to promotion of a sustainable Earth observation industry in Europe.

A. Institutional Activities

Institutional Research Activities

In 1997, the Space Applications Institute used a full range of Earth observation space techniques for the study of our environment and climate, and began new work integrating these with space-based telecommunications and navigation systems.

The work of the Centre for Earth Observation (CEO) at SAI continued to encourage and strengthen the European Earth observation industry. European companies, with CEO guidance, carried out studies particularly focused on the customer requirements for five new earth observation markets: travel/tourism, environmental organisations, town/city authorities, insurance companies, and civil engineering organisations. Each study produced an information brochure to which all new markets reacted positively. The Enabling Services prototype, consisting of an INTERNET site and the European Wide Service Exchange (EWSE), saw a dramatic increase in use with up to 2000 registered users. CEO pilot projects demonstrating the potential operational use of information derived from Earth observation data for the services of the Commission, concentrated on coastal zones, European forestry, agricultural production in South East Asia, and an atlas of major European urban areas.

Progress towards Standards for Anti-Personnel Mine Detection Systems and Strategies

The SAI gained recognition as a focal point for mine detection and identification and is working in close collaboration with national groups from Member States as well as with Non-Governmental Organisations (NGOs), representatives from mine infected countries, and mine clearance teams.

The Institute established an outdoor test range for validating the performance of mine detection sensors (metal detectors, ground penetrating radars and thermal infrared sensors). This facility has been used by different producers of mine detection sensors as well as for testing the feasibility of a multi-sensor system for anti-personnel mine detection and identification.

This "benchmarking" action began in October 1997 with a workshop, attended by the United Nations Department of Peace Keeping Operations (UNDPKO), NGOs, mine clearance organisations, mine detector producers, national research organisations and Universities, as well as from other Commission services charged with mine clearance actions. The standards will be applied to subsequent SAI tests, as well as to mine clearance projects in mine infected countries supported by the European Commission.

Research activities at the European Microwave Signature Laboratory included the development of sequential radar imaging techniques for the monitoring of mechanical stress and deformation in structural elements, such as beams and girders. Such methods will be a major new tool for monitoring the safety of key civil engineering structures such as deformation of water reservoir dams.

Coastal Zone management systems, using data from new ocean colour sensors, are now being developed, to be used in areas such as aquaculture and coastal erosion defences. Work of this nature calls for well calibrated data and validated products. Work on sensor calibration and validation, in full collaboration with the international and national space agencies, development of bespoke geographical information systems, and modelling underpin this. Ocean colour and sea surface temperature data sets are also used for global change research.

Techniques developed with data from low-resolution sensors were then used to map soil and vegetation changes throughout the year, first for the Iberian peninsula and then extended to the entire Mediterranean Basin: this work will be the basis for a land degradation monitoring system as part of an emerging Mediterranean Observatory.

As input to the International Geosphere Biosphere Programme of climate change research, the SAI completed a data set showing the occurrence of wild-fires throughout the globe. Such monitoring responds to concerns expressed in Agenda 21 and the 5th Environmental Action Plan. These data are important to research and environmental management alike, as evidenced by the huge impact of the 1997 fires in Indonesia. Environmental studies concerning fire scars and forest resources in the tropics continued to benefit from the development of radar based mapping, in collaboration with North American (NASA) and Japanese (NASDA) partners.

The analysis of data from new sensors benefited from studies of the bidirectional reflectance properties of the Earth's surface, made by using advanced models of surface radiation interactions.

Institutional Support Activities

The Monitoring of Agriculture with Remote Sensing (MARS) project provided support to DG VI (Agriculture), EUROSTAT (Statistical Office) and the Member States through the Institute's advanced Agricultural Information System (AIS). The AIS provided production forecasts and identified regional anomalies for 14 major EU crops. In 1997, new crop types (olive trees and wine-grapes) were studied: qualitative information and estimation of their potential yield will be further improved. Information on the EU's neighbours in Central Europe, the Baltic states, CIS, the Maghreb countries and Turkey was also provided.

As in previous years, control by remote sensing of farmers' area aid declarations continued. The quality control of the work, done by private companies under contract from national administrations, was carried out, and

technical support and advice was provided in direct interaction with the Member States' administrations.

The Soil Geographical Database of Europe at scale 1:1 000 000, supporting the Agricultural Information System, has been extended to Norway, Finland, former Yugoslavia, Poland, Hungary, Czech Republic, Slovakia, Bulgaria, Switzerland, Austria, Romania and the Baltic states. This data supports the agrometeorological modelling of crop field.

B. Competitive Activities

Shared-Cost Actions

The Space Applications Institute submitted 18 proposals in a range of thematic areas including Agriculture, Telematics, and Environment and Climate. 13 of those projects, ranging from the marine environment to desertification and landslide monitoring, are being funded.

Competitive Support for Community Policies

DG XI (Environment, Nuclear Safety and Civil Protection) awarded a contract for the third phase of the operational tropical forest monitoring project started in 1995. This work will, on completion, provide an Earth Observation based system for tropical forest mapping, for management of diverse tropical forest data sets and for provision of an "alarm" system, highlighting areas of extreme deforestation. A portable satellite receiving station for fire detection was tested in Vietnam in this context. The overall objective is to provide a forest information system tuned to the needs of the Directorate General for Environment, Nuclear Safety and Civil Protection, notably to determine the effectiveness of EC funded projects in these regions.

Activities under Contract

Contract research, linked to the Institute's research programme, was performed for external clients, notably European and Japanese Space Agencies. SAI was a sub-contractor in a consortium testing a rain simulator

to support development of a rainfall-mapping mission, and staff were also involved in the development of new algorithms to handle information from Japan's planned Global Imager (GLI) instrument, and Europe's MERIS and VEGETATION instruments. The first instrument will be used to measure a range of atmospheric, terrestrial and marine parameters. The medium Resolution Imaging Spectrometer is a primary instrument in Europe's next major satellite ENV Sat 1 (Environment Satellite). Through these contracts the JRC recognised expertise, helps to maximise the returns on the investments made in Europe on these new sensors.

Other Competitive Activities

The MERA project (MARS and Environmental Related Applications) covering the 12 PHARE countries, entirely funded by DG I A (External Affairs), continued and concentrated mainly on forest issues such as mapping and monitoring. The techniques developed for remote sensing monitoring of agriculture projects in the Union will be transferred to neighbouring Eastern European countries where there is a strong emphasis on forest resource management and on environmental impact assessment. The SAI's role as provider of technical support management to the DGs also saw the continuation of a coastal zone management programme in Thailand for DG I B.



Fire is an established land use management tool throughout the tropics, but increasingly the negative impact of these fires is being felt. SAI's local satellite based fire detection systems provide local authorities with real time information on the location and spread of these fires.

The Institute for Prospective Technological Studies (IPTS)

The Institute for Prospective Technological Studies supported the European Union (EU) policy making processes by collecting, interpreting and communicating Science & Technology (S&T) developments (events, trends and impacts). Therefore, most of IPTS' work is undertaken in reply to specific requests of assistance to the European Union institutions, mainly the European Commission and the European Parliament services, as well as to third party organisations, in the framework of the competitive mandate given to the Joint Research Centre.

IPTS addressed various technological matters, where it is important to ensure a neutral and Europe-wide assessment of scientific and technological change, and to gain a better understanding of technology in the socio-economic environment. For this purpose, the Institute combines two perspectives in its work: a focus on emerging technologies, and a focus on socio-economic, policy relevant, options which involve technology. This unique combination of approach provides added insight, not only through empirical analysis of available data, but prospective exploration of the future. This characterises the specificity of the Institute's mission with respect to other research institutions.

Prospective studies are carried out by IPTS in major research areas of relevance, exploiting synergies and crossbreeding between those areas. IPTS' work has been developed in the following fields during 1997: Energy; Environment; Mobility and Transport; Information and Communication Technologies; Life Sciences and Bio-technology; Regulatory Frameworks for Emerging Technologies; Technology, Knowledge and Organisational Change; Innovation, Diffusion and Growth; Regional Development; Resource Management (both mainly focused on the Mediterranean region); and Perspectives for Europe.

In order to secure a direct access on a large network of specialists, IPTS has set up the European Science and Technology Observatory (ESTO). ESTO is a network of 14 European national S&T organisations which share the responsibility of providing timely access to information on scientific and technological change of socio-economic relevance. It contributes to IPTS studies and the "IPTS Report", which is the

Technology Watch bulletin of IPTS, directed towards European decision makers.

A. Institutional Activities

Institutional Research Activities

Institutional research activities focused in 1997 on areas highly relevant for EU policies such as Energy; Environment; Mobility and Transport Research; Technology Employment and Competitiveness. The most important projects per scientific area are mentioned here below:

Projects on **Energy** ranged from technology assessment to the understanding of the complex system of energy, natural resources and economy. Particular attention was paid to the interactions between the energy system and the environment on a global scale, as well as to regional energy markets.

Two examples of specific projects are the Climate Change Research and Policy, and the Socio-economic Impact of Renewable Energy Projects in Southern Mediterranean Countries: Definitions and Methodologies.

The **Environment** projects focused on the following three lines of action: consequences of the gradual introduction of clean technologies in the areas of innovation, competitiveness and employment; technology responses to environmental problems; new frameworks for environmental policy making.

Some examples of specific projects in this field are: The Dynamics of Innovation in Bio-Engineering Catalysis: Cases and Analysis; Biotechnology as a Cleaner Production Technology in Pulp and Paper; Waste Definitions and Impact on Waste Handling.

Research into **Mobility and Transport** aimed at supporting policy development concerning future trends in urban mobility, including social and economic factors. A special IPTS Report on "Urban Mobility" highlighted the importance of this evolving issue.



Projects referred to the Future of Individual Transport: Towards the Integration of Social, Technological, Economic and Political Driving Forces of Change; Future Analysis of Vehicle Technologies in Urban Environments.

On the basis of specific studies and technology watch, IPTS explored implications for the interface between **Technology, Employment and Competitiveness**, in order to improve the understanding of this trilateral relationship. Some examples of projects in this field are: "The role of networks or economic webs in the creation of employment"; "Evaluation of present water resources policy in the Mediterranean"; "The potential of S&T and Innovation for Regional development" and "Made in Europe".

Institutional Support Activities

Most of IPTS' work responds to direct requests from its main customers, the European Commission (EC) and the European Parliament (EP). During 1997 a new agreement has been signed between JRC-IPTS and DG III of the European Commission, which comes to enlarge the list of agreements IPTS has with the following specific EC services: Forward Studies Unit, DG XI and DG XVI. Further support activities have been carried out, outside of any bilateral institutional agreements. With regard to EP, the IPTS has supported

the work of the Committee on the Environment, Public Health and Consumer Protection, Committee on Economic and Monetary Affairs and Industrial Policy, and STOA (Scientific and Technological Option Assessments).

IPTS supported the European Industrial Policy under **DG III (Industry)** with projects on industrial innovation systems and technology foresight such as: trends in academia-industry technology transfer; benchmarking, diffusion of Information and Communication Technologies (ICT) and organisation practices; impact of regulation on innovation; profile of water industry in southern EU countries; and biotechnology and the greening of industry.

Major support to **DG XI (Environment, Nuclear Safety and Civil Protection)** was provided for setting new frameworks for environmental policy making.

Support to **DG XVI (Regional Policies and Cohesion)** was offered through the project "Towards sustainable management of water resources in the Mediterranean countries".

In support of the **Forward Studies Unit (FSU)** of the Commission, the Institute offered work in the following areas: micro-economic case studies, green accounting, climate change, risk assessment and regulations, risk assessment and governance, information society and governance.

Common support to various EC services: In addition to the above mentioned activities, support which encompassed several customer DGs was offered with the following projects: supervision of a feasibility study for a solar thermal power plant in Morocco (together with the World Bank) (DG I B, DG XII, DG XVII); biomass energy strategy (DG XII, DG XVII, DG VI); solar-thermal energy strategy (DG XII, DG XVII, DG I B); S&T support to the Euro-Mediterranean Monitoring Committee (DG I B, DG XII); environmental futures (DG XI, FSU); new initiatives in ETAN-support to ageing technologies and global climate change (DG XII, DG V, DG XI); Technology foresight-watch and socio-economic studies for industrial materials and technologies (DG XII, DG III, DG XIII, JRC); discussion paper on "Competitive and

Sustainable Growth: Products, Processes and Organisation anticipating FPV" (DG XII C); input to the Green Paper on Innovation (DG XIII); the Management of Intellectual Property Rights in the Public-Funded Research Organisation: 6 case studies of self-management.

Work for the **European Parliament**, and particularly its **Committee on the Environment, Public Health and Consumer Protection**, focused on: climate change: causes, impacts and options; recycling industries: impediments and prospects; green accounting; environment and employment; legal definitions of waste; prospective analysis of the pharmaceutical industry.

- For the **Committee on Research, Technological Development and Energy (CERT)**, projects referred to the following subjects: research and sustainability; research in the XXI century; state of the art in gerontotechnology.
- For the **Scientific and Technological Options Assessment (STOA)**, two projects were carried out: the future of the car, the car of the future; Prospective analysis of the pharmaceutical industry.
- For the **Committee on Economic and Monetary Affairs and Industrial Policy**, support was offered on a "Public Hearing at the European Parliament, on the *status quo* and the perspectives of four mature industries in Europe, textile, steel, automotive and aeronautics".

B. Competitive Activities

IPTS' two integrated research approaches, focused on emerging technologies, and on socio-economic, policy relevant, options which involve technology, provide an added value and hence a competitive advantage to the Institute.

The Institute has submitted 41 competitive activities proposals during 1997. By the end of that year, the success rate of approved proposals had reached a level of approximately 60%.

The setting up of the European Integrated Pollution Prevention and Control Bureau, within the IPTS, on behalf of DG XI is an example of a mixed project, sharing its financial resources between Competitive Activities 60% and Institutional Support Activities 40% (see also highlight on page 15).

Shared-Cost Actions

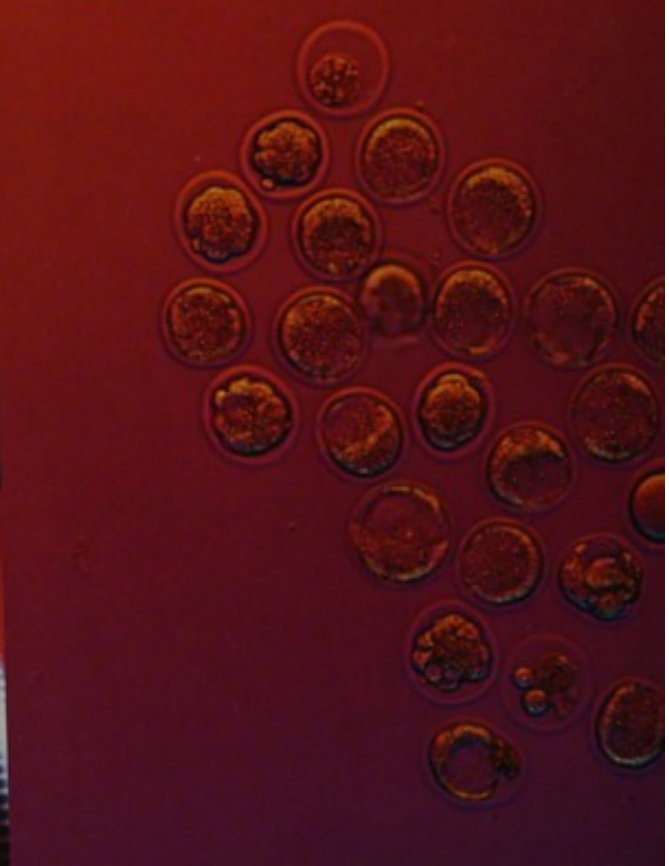
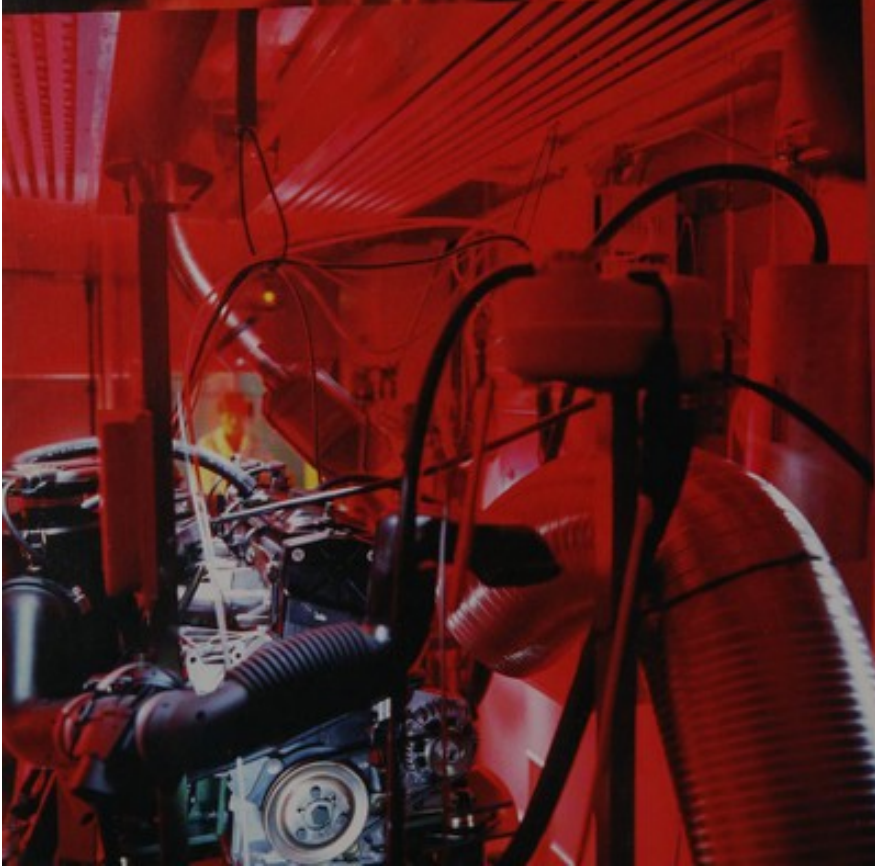
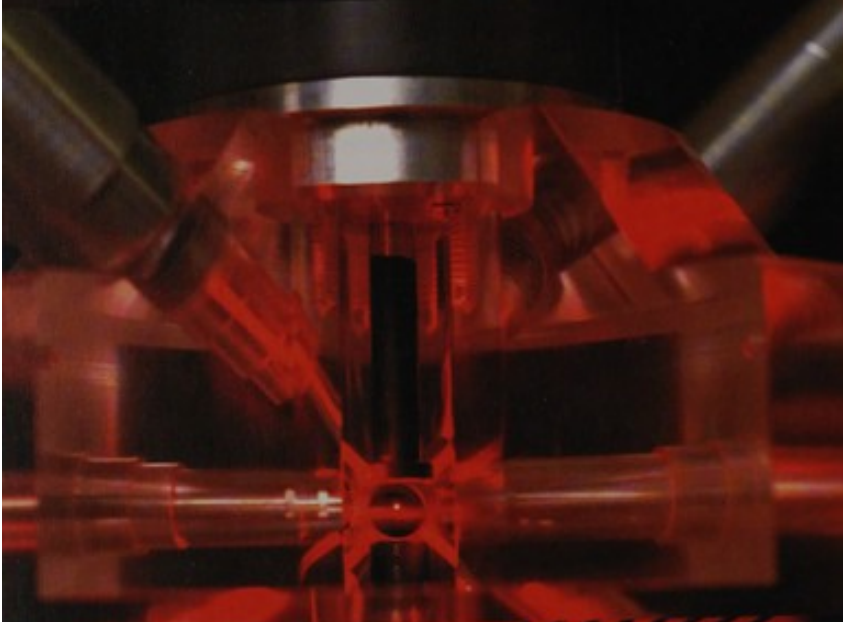
The IPTS has under way in 1997 thirteen shared-cost actions among which the following projects: Relationship between demand for freight transport and industrial effects, and Forecasting and Assessment of New Technological and Transport Systems and their Impacts on the Environment; Mediterranean Energy Markets Appraisal: trends and prospects for new technologies, Prefeasibility study for the introduction of renewable energies in the South Mediterranean area.

Competitive Support for Community Policies

Competitive activities in support of Commission policies dealt with the identification of a cluster of technologies, owned by the Community, which may have a major innovative impact on European enterprises. Moreover, a feasibility study was undertaken aimed at the mobilisation of resources for the utilisation of RTD results for the use of biomass as an energy source in Soria (Spain).

Work under Contract

In this context, the following studies were carried out: the peer review of the German Life Cycle Assessment (LCA) study; the assessment of the external costs of energy, and their taking into account at the national level; the assessment of the effects of the reform of the Common Agriculture Policy on the environmental pollution level in southern countries of the European Union; stock-taking and analysis of the present technical and legal situation of renewable energy sources in Europe - phase I of the integral renewable energy research and promotion programme; technic-juridical European forum on renewable energies I.



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(15 April 1998)

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