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INSTITUTE FOR REFERENCE MATERIALS AND MEASUREMENTS

ACTIVITY REPORT 2001

EUROPEAN COMMISSION
JOINT RESEARCH CENTRE

Report EUR 20246 EN

Mission

The mission of the IRMM is to promote a common European measurement system in support to EU policies, especially internal market, environment, health and consumer protection standards.

European Commission
Directorate-General Joint Research Centre
Institute for Reference Materials and Measurements (IRMM)

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Institute for Reference Materials and Measurements

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irmm

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Foreword

The year 2001 marked another year of success from in-house scientific achievements to increased impact on the measurement infrastructure via global networking and measurement inter-comparison exercises. Particularly in the metrology areas linked to chemical, biological and radionuclide measurements, IRMM made very important contributions in close collaboration with its European partners, particularly the metrology institutes. In keeping abreast with the recent and dramatic evolution in biotechnology due to the elucidation of the human genome, IRMM has commenced several new initiatives in the area of *Biometrology,* i.e. applying the science of measurements (metrology) to biotechnology, especially genomics, proteomics and microbiology. A biometrology network was created and application areas for these recent initiatives will include forensic testing, genetics identification, biotechnology products analysis and clinical diagnostic markers.

Support to food quality and safety in 2001 was given, amongst others, through the evaluation of 5 newly developed post-mortem BSE tests, the production of 37,000 units of third generation GMO certified reference materials, the completion of both evaluation and feasibility studies for beef gender testing and the determination and production of 5 new genomic DNA reference materials for food borne pathogens. IRMM also rendered support to health through the creation of a global network for collaboration and cohesion between key-players in the in-vitro diagnostic sector. For nuclear safety and safeguards, groundbreaking measurements were carried out on an isotope of protactinium and a series of 10 uranium isotopic standards were certified at IRMM for use by the South American Safeguards Organisation. Enhanced training in Metrology in Chemistry for Candidate Countries resulted in awarding 316 certificates and 349 laboratories from Candidate Countries have participated in IRMM's International Measurement Evaluation Programmes. To conclude this snapshot summary, IRMM and Europe's leading low-level underground laboratories merged together to form a newly established low-level radioactivity measurement network within the ERA.

IRMM's contribution to EU standardisation and reference systems worldwide, as a vital part of its mandate, was benchmarked in 2001. We organised a total of 13 CCQM/EUROMET comparisons and participated in 9 additional comparisons that carried the EUROMET, BIPM or CCQM label. 70 reference measurement certificates and documents were issued and a sum total of 201 global reference points have, to date, originated from IRMM evaluations. 12,452 units of BCR® and IRMM CRMs were delivered to customers and over 700 participants were reached through IRMM's Measurement Evaluation Programmes.

The recent construction of new biotechnology laboratories and our careful selection of competent personnel coupled with our proactive approach to collaboration and networking allows us to now move towards the sixth Framework Programme with heightened enthusiasm and a true identity within the JRC and ERA.

I wish to express my appreciation and gratitude to our spectrum of research partners and customers from Commission Directorates General and National Measurement and Metrology institutes to industry and public and private research institutions in the Member States, the EFTA (European Free Trade Association) countries, Candidate Countries, Switzerland, Israel, USA, Canada, Japan, Australia, China, Chile and international organisations.

Special recognition is also warranted for our colleagues in DG JRC and last, but by no means least, my sincere thanks to all the staff of IRMM for their dedicated work throughout the year.

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Mission and Overview

"The mission of IRMM is to promote a common European measurement system in support of EU policies, especially internal market, environment, health and consumer protection standards."

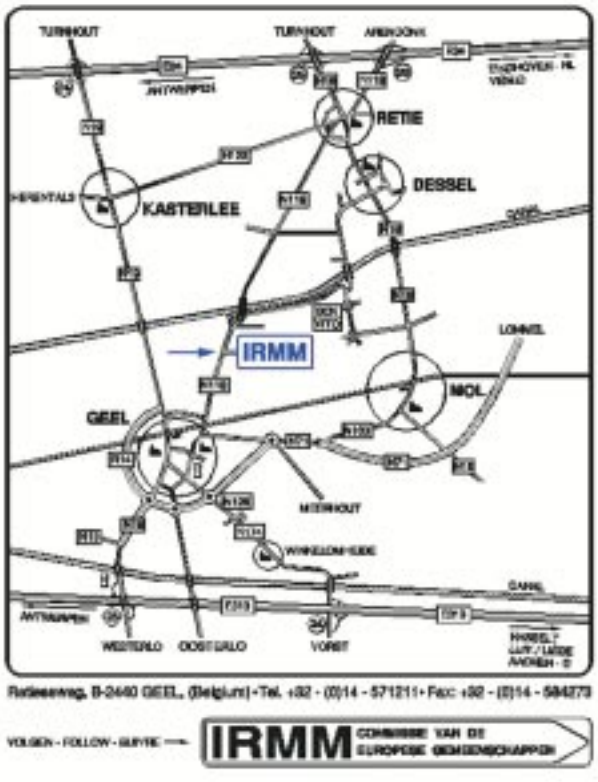
IRMM's main objectives are:

- to develop and perform specific reference measurements,
- to produce certified reference materials,
- to organise international measurement evaluation programmes,
- to establish transnational data bases,
- and to carry out pre-normative research.

The IRMM is one of the seven institutes of the Joint Research Centre and is situated in Belgium some 80 km north-east of Brussels. Founded in 1957 and located in the tranquil surroundings of the Flanders countryside, the IRMM consists of 10 buildings located within a 42 hectare site.
With it's mission and activity profile, the IRMM is a Metrology Institute of the EC and in this role is in many ways analogous to the National Metrology Institutes (NMIs) of the Member States, but with a position independent of national, private or specific political influences. In this function it represents the European Commission in international organisations like BIPM, EUROMET, EURACHEM, EA, CITAC, ISO-REMCO and executes a generic task therein on behalf of the whole Commission. Its customers are not only confined to the Directorates General of the EC but also include Member States and their institutions, international organisations (OECD, IAEA, ESARDA) as well as industry and SMEs.

The Joint Research Centre

The Joint Research Centre is one of the two Directorates General of the European Commission under the responsibility of Research Commissioner, Philippe Busquin. Its mission is to provide scientific and technical support to Community policy-making through its own research and through bringing together the research capabilities of its extensive scientific networks.
The period 2001-2002 is a time of change for the JRC. Within the last year the number of JRC institutes was reduced from 8 to 7. Most of the remaining institutes were restructured and three institutes were renamed; the Institute for Protection and Security of the Citizens, the Institute for Environment and Sustainability and the Institute for Energy. A consequent reduction in the overall number of units followed.
The JRC's main objective for the year 2002 will be the consolidation of these changes in order to render the JRC operation more efficient and to further focus on its customer-driven activities. In this context, a High-Level Users Group comprising the Directors-General of all Commission services supported by the JRC scientific work and chaired by the JRC Director General was set up in July 2001. The Group regularly reviews the work programme of the JRC in order to ensure that the latter focuses on the top priorities for scientific support to EU policy-making.
In addition to the High-Level Users Group, the JRC Board of Governors provides an increasingly effective link between the JRC research strategy and the priorities of EU Member States.



Select Objectives 2001

In the frame of Total Quality Management, IRMM set concrete managerial and scientific objectives for 2001. A select number of these objectives, including the percentage achievement for each, are quoted here and the remainder are injected throughout the relevant sections of this report.

Managerial

- Publish 70 articles in peer reviewed journals - 100%
- Publish 40 articles in conference proceedings - 100%
- Produce 70 reference certificates - 100%
- Organise 10 certification campaigns - 100%
- Provide access to 10 outside researchers to use institute facilities within ETTI - 100%
- Construct a new wall for the Van De Graaff (100%) and dismantle the 3.5 MV Van de Graaff (100%)
- No accidents or incidences requiring reporting to supervisory bodies - 100%
- Competitive income target of 3000kEUR - 79%

Scientific

Food, Chemical Products and Health

- Support the Community Reference Laboratories (CRLs) by organising 1 Proficiency Testing Programme on heavy metals in meat - 80%
- Evaluate 5 new post-mortem tests on BSE - 100%
- Develop 12 CRMs for the detection of GMOs - 100%
- Develop 2 CRMs for clinical laboratory medicine (in co-operation with IFCC) - 50%
- Organise 1 Key Comparison for BIPM/EUROMET focussing on the detection of food contaminants - 100%
- Organise 1 feasibility study for reference methods to identify beef gender for customs laboratories - 100%
- Inhouse validation of 1 reference method for hairdyes - 100%
- Execute a method comparison (using reference laboratories) for sugar in industrial syrup - 100%
- Develop procedures towards a method for the detection of antibiotics in meat - 100%

Environment

- Develop 3 CRMs for monitoring of water quality - 100%
- Organise 2 IMEP rounds for reference laboratories for environmental monitoring - 100%
- Develop procedures (depending on matrix) for the characterisation of radionuclides in environmental matrices - 75%
- Negotiate Quality Assurance activities for EU/REM (Radioactivity Environmental Monitoring) network - 75%

Nuclear Safety and Waste Transmutation

- Provide activation cross-sections reference data on vandadium, ^{99}Tc for OECD databank - 75%
- Investigate the potential of a network of EU Large Scale Facilities (LSFs) for neutron data - 25%
- Train 4 scientists from EU and 1 scientist from Candidate Countries - 100%
- Provide access to LINAC and Van de Graaff accelerators for outside users: 14 from EU and 8 from Candidate Countries - 100%

Nuclear Safeguards

- Organise 2 Proficiency Testing rounds (REIMEP / NUSIMEP) - 100%
- Provide 150 units of nuclear CRMs to customers - 100%
- Develop 2 new primary isotopic CRMs - 100%

Further develop Metrology in Chemistry (MiC) toghether with the National Metrology Institutes

- Train 5 scientists from Candidate Countries - 100%
- Organise 3 Proficiency Testing (PT) programmes together with the EA (European Co-operation for Accreditation) - 66%
- Organise 1 BIPM/EUROMET Key Comparison for Metrology in Chemistry - 100%

To develop IRMM to become the European Centre for Reference Materials (ECRMs)

- Deliver 12,000 BCR® and IRMM Certified Reference Materials (CRMs) to customers - 100%
- Enhance marketing of CRMs at Pittcon exhibition, USA, with LGC and BAM - performed
- Develop advanced methods for the characterisation of CRMs (proteins, DNA, heavy metals, organic residues) - performed

Harmonisation in Radionuclide Metrology

- Continue the production of the prototype of the World Primary Standard of Radioactivity (CCRI/BIPM) - 50%
- Establish a "Virtual European Institute" for Radionuclide Metrology - 75%
- Finalise 2 CIPM/CCRI Key comparisons - 100%
- Retrospective assessment of the neutron flux in the environment of the Tokai-Mura accident - 75%

Organisation and Competencies

Prioritisation of scientific activities has led to the creation of 4 pillars of strength, i.e. 4 unique reference laboratories with clearly defined tasks and objectives.

1. JRC Centre for Reference Materials and Chemical Reference Measurements

The Facility

- houses a unique multi-functional and flexible production laboratory with clean chambers, cryo grinding, freeze drying, high purity milling, ultrafine classification and levitation melting;
- can quickly adapt its production facilities to cater for urgent requests that stem from the policy makers;
- contains chemical, biochemical and radiochemical laboratories with high performance analytical instrumentation: XRF, ICP-MS, LC-ICP-MS, AAS, UV-Vis, LC-HG-AAS, LC-UV, LC-MS-MS, CE-UV, CE-MSn, ICP-OES, solid sampling methods, NAA, GC, HPLC, MS, LC-MS-MS, CE-MSn, CZE, SFE, PCR, GC-MS PCR-DNA analyser, immunochemical techniques, alpha and gamma spectrometry and mass metrology instrumentation.

Its Objective

- to provide support to standardisation and EU Directives, e.g. to secure the safety and quality of food, consumer and industrial products, to combat fraud and adulteration and to support the enforcement of environmental and health standards.

Its Tasks

- the production of highest quality chemical, biological, clinical, industrial, environmental and nuclear Certified Reference Materials and proficiency testing materials;
- the storage, stability control and distribution of BCR®- and IRMM-CRMs with 500 different CRMs and a storage of half a million samples;
- the development of analytical reference methods for measuring elements (and their chemical forms), radionuclides and organic constituents.

2. JRC Reference Laboratory for Isotopic Measurements

The Facility

- hosts the largest isotope mass spectrometry infrastructure in Europe with 19 high performance instruments (ThI/EI/ICP-MS);
- adjoining this infrastructure is a class 5-10 Ultra Clean Chemical Laboratory (UCCL) with 120 m^2 space, 16 work places and the complete laboratory is designed using corrosion resistant construction;
- combining these two facilities IRMM has an ideal environment for the certification of Isotopic Reference Materials (IRMs) and spikes.

Its Objective

- to provide support for the development of a coherent chemical measurement system in the European Union and to promote the harmonisation of border-crossing measurements to guarantee fair trade, nuclear safety and to combat fraud.

Its Tasks

- to perform primary isotopic measurements and certification of primary and isotopic CRMs;

- to produce nuclear CRMs (largest provider globally);
- to promote Metrology in Chemistry;
- to manage and carry out International Measurement Evaluation Programmes (IMEP, REIMEP and NUSIMEP).

3. JRC Reference Laboratory for Neutron Physics

The Facility

- houses a 150 MeV linear electron accelerator (GELINA) with neutron spectrometer used for the production of pulsed neutrons with a broad energy spectrum (1 ns - 2 μs, 1 meV - 20 MeV). This installation has the best energy resolution world-wide, is unique in Europe and one of the few available world-wide;
- also houses a 7 MV Van de Graaff accelerator used to produce monoenergetic neutrons (0,1 - 20 MeV) with specialised detector equipment. This accelerator complements the 150 MeV linear electron accelerator through extending the energy range for neutron data cross section measurements;
- has specialised equipment for neutron-induced total, capture, fission, charged-particle emission and activation cross section measurements and the study of related reaction parameters.

Its Objective

are to support the development of technology needed for:
- waste minimisation and transmutation;
- reactor and fuel cycle safety;
- European industrial competitiveness in energy production.

Its Tasks

to study neutron-material interactions:
- to perform very high resolution neutron cross-section measurements in the resonance energy domain;
- to perform reference measurements with monochromatic neutrons in the unresolved region;

4. JRC Reference Laboratory for Radionuclide Metrology

The Facility

- contains unique (mostly specifically developed) equipment for performing primary radioactivity measurements and certifying primary radioactivity standards;
- performs accurate measurements of decay data, such as half lives, γ-ray and α-particle emission probabilities and fluorescence yields. It also develops and improves radioactivity measurement methods and provides special, highly accurate X-ray emitting sources for the calibration of detector systems, especially in the energy range between 1 keV and 6 keV.
- uses an underground laboratory HADES located at the SCK•CEN site in Mol (223 m below ground level) with extremely low background radiation for ultra-sensitive measurements.

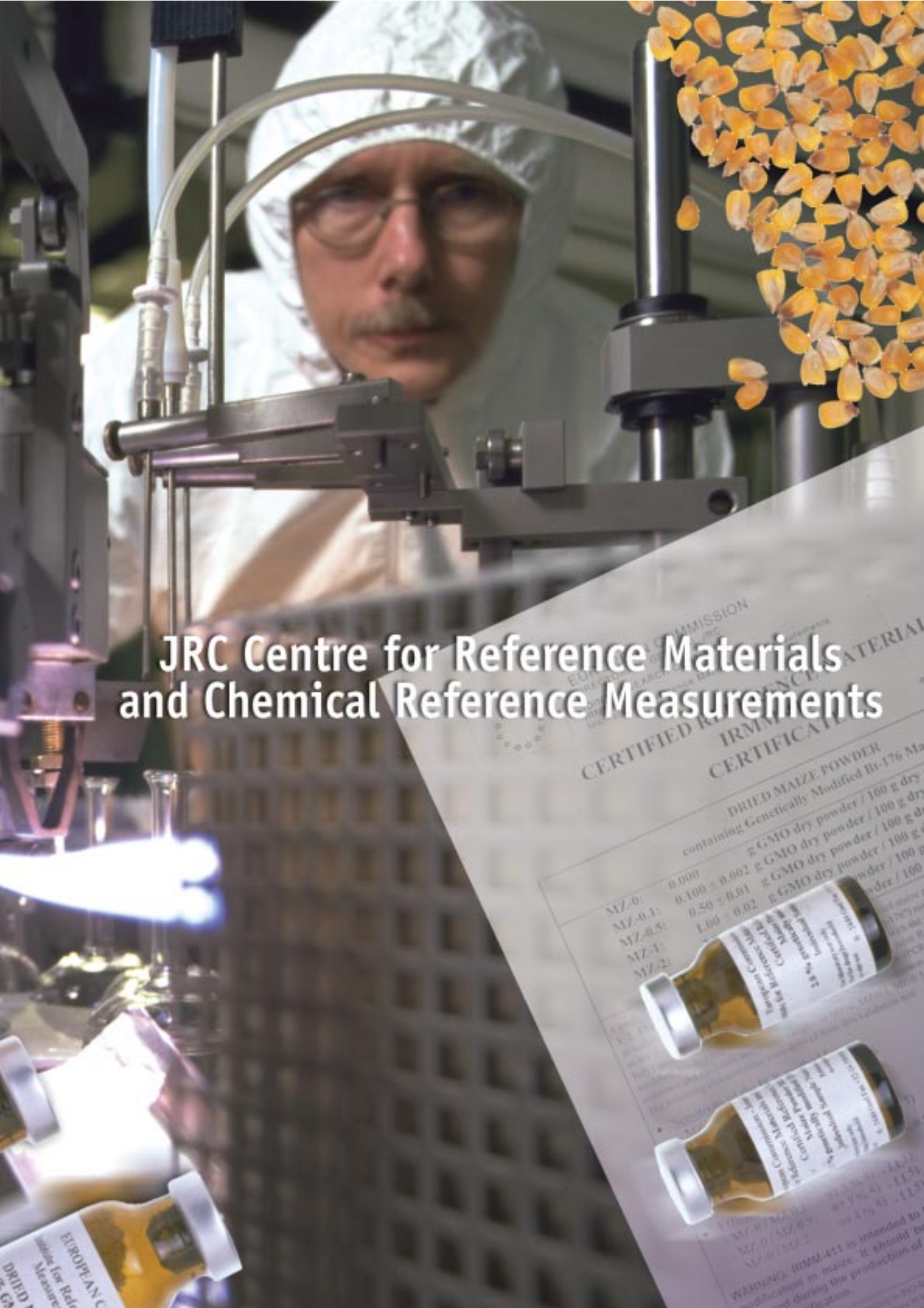
Its Objective

- to support standardisation and EU Directives with respect to radiation protection and radioactivity standards.

Its Tasks

- to conduct radionuclide metrology and perform ultra low-level radioactivity measurements;
- to develop new measurement methods and equipment (detectors) including the calibration of equipment;
- to prepare and certify primary radioactivity standards for research, medicine and industry.


EUROPEAN COMMISSION
CERTIFIED REFERENCE MATERIAL
IRMM 410
CERTIFICATE
EUROPEAN COMMISSION
The Certification of Reference Mat
Soya Powder with different Mass F
Roundup Ready™ Soy
Certified Reference Materials
(SB-0 / SB-0.1 / SB-0.5



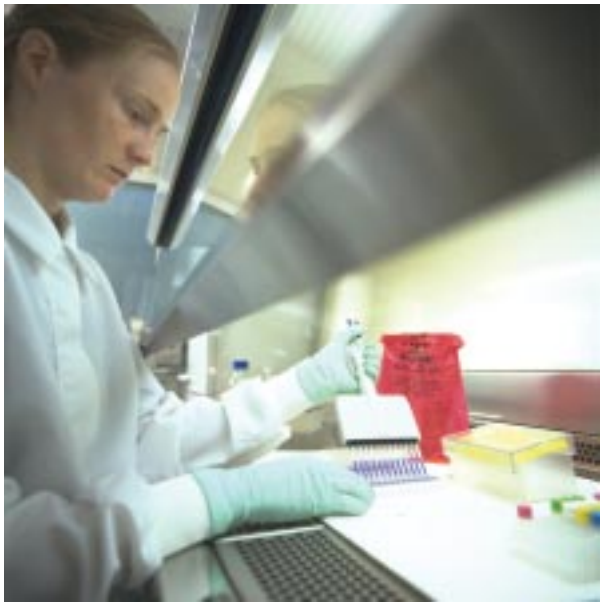
JRC Centre for Reference Materials and Chemical Reference Measurements

JRC Centre for Reference Materials

Certified Reference Materials (CRMs) constitute an essential tool in achieving comparability and traceability of measurements. CRMs enable the optimisation of industrial processes, the protection of public health and our environment, the promotion of international trade and the implementation and standardisation of European legislation.

Rationale

The IRMM, in collaboration with the EC's Directorate General Research (Programme Measurements and Testing, Infrastructure), is a world leader in production, certification and distribution of CRMs. Since 1995, the IRMM has shared the responsibility for the production and certification of BCR® (Bureau Communautaire de Référence - BCR® is a trademark of IRMM) CRMs with DG Research and since then has taken over full responsibility for the stock management (including storage, stability monitoring, distribution and replacement of exhausted BCR® CRMs). At present, IRMM offers over 500 different BCR® CRMs, with a total stock load of some 500,000 samples. The reference materials produced, certified and distributed by IRMM support measurements carried out in a wide range of sectors ranging from agriculture to industry, food to clinical chemistry and environmental protection.



These materials are produced and certified in accordance with internationally accepted guidelines, the International Standards Organisation (ISO) and the World Health Organisation (WHO). They are produced either on IRMM's own initiative (e.g. to replace exhausted stocks of BCR® reference materials) or on requests from research, public or industrial organisations and/or partners. Examples include the International Federation of Clinical Chemistry (IFCC), the European Working Group on Reactor Dosimetry (EWGRD), the Istituto Superiore di Sanità (IT) and Fluka Chemie AG (CH). One important criterion in selecting reference materials projects is consistency with and the requirements of European legislation and one essential part of the IRMM reference materials mission is support to other Directorate Generals of the EC.

Benefit to Customers

IRMM provides its customers with CRMs for the calibration and validation of analytical measurements and the means of establishing a vital link in the chain of traceability. IRMM supplies proficiency testing materials for assessing the performance of analytical laboratories, particularly the National and Community Reference Laboratories. It also advises DGs on metrological and analysis issues relevant to implementation and monitoring of Community legislation.

The neutral and international character of IRMM's activities help to overcome measurement problems and improve the mutual recognition of measurement results within the EU and elsewhere. This holds true especially in cases where national interests within the EU are involved or the position of the Member States is different (like BSE or dioxin related aspects) or where common European interests (like GMO) need to be defended but on the other side international trade to be enabled.
Reference material projects are funded by IRMM's spe-

cific programme, income from CRM sales, institutional support to the Commission, participation in shared cost actions of the Framework Programme and third party work. In 2001 some 10,850 units were sold either directly or through authorised distributors.

Future Prospects

The reference materials activity at IRMM is being expanded to include further facilities for handling of GMO and clinically infectious materials, for example samples for the further evaluation of BSE post-mortem tests and for the detection of food-borne pathogens (new types of DNA CRMs). These facilities include a clean-cell system to minimise cross-contamination risks, a sterilizable freeze-dryer, autoclave and processing equipment built to clinical specifications.
In the area of GMOs, work will focus on both (as yet) unapproved varieties and on replacing exhausted stocks of existing CRMs. Particular attention will be given to improving long-term stability of GMO CRMs. The necessary analytical services for production control (e.g. via PCR) are also being established. Generally the new facilities will be used to produce CRMs related to new technologies (biotechnology, molecular biology, genome projects).
The level of international co-operation in the field of GMOs has to be enhanced, working through existing networks, to facilitate the supply of raw materials for CRM production and to improve the availability of test methods and reference materials.
For BSE research, IRMM will further evaluate more sensitive methods for BSE detection at the pre-clinical stage. In a multiple step approach, novel detection methods promising to enable the distinction between scrapie and BSE in sheep (financed via a combination of institutional and competitive work - DG Health and Consumer Protection) will be investigated. For quantitative prion analysis, the establishment of quantitative test principles, e.g. in respect to the relation between the infectivity titre and the prion concentration will also be investigated. IRMM is aiming to produce a CRM for the calibration of BSE test kits which would ensure comparability of results between assays and production batches. It is also planned to assess the performance of BSE control laboratories in the EU Member States in an inter-comparison.

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Food Safety and Quality

Gender Testing of Beef

Commission Regulations 2457/97, 1964/82 and in collaboration with DG AGRI

EU export and import of beef carries a subsidy difference of some 130 EUROS per 100 kg of meat depending on whether the beef is declared as male (considered to be higher quality) or female. This subsidy difference requires strict legislation to ensure the correct gender declaration of beef at the EU level. On request of DG Agriculture (market division for livestock and beef), IRMM evaluated the available methods and proposed the most promising DNA technique. 430 "blind samples" were distributed to 8 customs laboratories and a feasibility study was carried out. The results showed that the selected method exhibits the required reliability for routine use and can now be taken up into regulations for anti-fraud control.

Latest on BSE Research

Upon request of DG SANCO

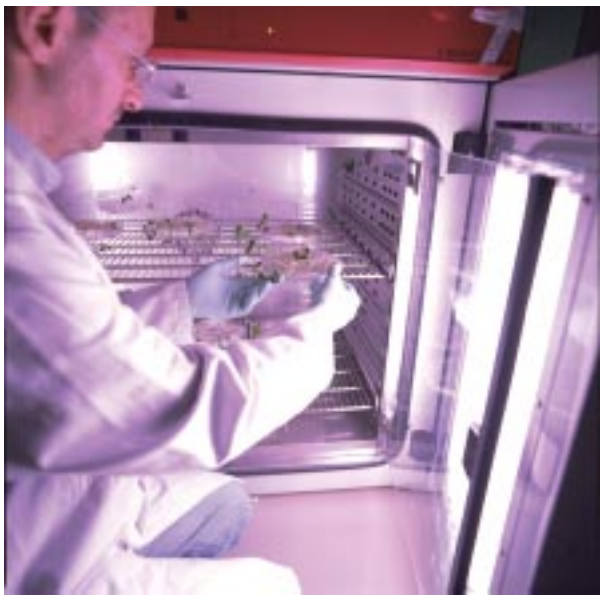
To enhance consumer protection, IRMM has continued evaluating tests to detect the infection of cattle with BSE. This work is performed on direct request from DG Health and Consumer Protection. The focus in 2001 was on the evaluation of 5 newly developed post-mortem BSE tests and the production of BSE positive and negative CRMs for BSE test calibration. The first ever proficiency testing exercise for NRLs active in post-mortem testing was carried out in collaboration with the Central Veterinary Agency, UK, which is the Community Reference Laboratory (CRL) for BSE. Non-infected and infected samples were acquired from both New Zealand and the UK, the samples were prepared and sets (each containing 80 blinded samples) were sent out to 14 of the

15 EU States. The results were discussed at a Workshop at IRMM in October and revealed a generally very high performance standard of the NRLs.

GMOs

EC Directive 258/97 and in collaboration with DG SANCO, DG ENV, DG TRADE and DG ENTR

GMO Certified Reference Materials (CRMs) are used throughout the EU and third countries like the USA and Japan, to both calibrate and validate analytical methods for the detection of genetically modified materials in food and feed. In support to the Novel Food Reg. EC 258/97 and in collaboration with DG Health and Consumer Protection and the JRC-Institute for Health and Consumer Protection, IRMM was the first and still is the main producer of GMO CRMs globally.
In 2001, the stock of CRMs for soybeans (Roundup Ready) approached exhaustion so a new batch of 17,984 units of RR soybeans was produced and bottled using newly developed IRMM technology to minimise DNA degradation of these delicate materials during production. This technology involved changing from wet to dry mixing and this also will improve the quality of follow-up analyses due to (1) increased amount of analyte and (2) less band broadening when applying samples for gel electrophoresis stability control. Furthermore 18,826 units of Maize (MON 810) were produced in 2001 and both batches of materials are now being distributed to customers worldwide via Fluka Chemie AG and IRMM's own sales network. Furthermore a new GMO CRM (T25 maize) was grown and is presently being certified. IRMM actively participated in the European Network of GMO Laboratories (ENGL) coordinated by the IHCP and chairs the working group on Reference Materials. It also collaborates with IPTS to keep abreast of quickly developing future scenarios as well as anticipating needs for measurements within the regulatory framework of the EU was carried out. In the long term, IRMM plans to house a repository for GM materials and become the CRL for producing GMO CRMs.



FOOD-PCR Project

Establishing PCR-based methods for food safety

PCR-based methods need to be established for food safety and this involves the extraction, stability control and amplification of DNA from various food borne pathogens (E Coli, Salmonella, Listeria, Yersinia and Campylobacter). A database (at JRC-IHCP) was set up and 200 units each of five stable and easily reconstitutable reference materials for genomic DNA of the aforementioned pathogenic bacteria were produced. These were actually the first pure DNA CRMs to be produced. Because the materials proved sufficiently stable (transport at ambient temperature possible) and the DNA quality remained intact after reconstitution, this technique can now be implemented for other types of DNA reference materials (clinical, GMO etc.).

Cocoa Butter CRM

Triglyceride analysis to check the addition of vegetable fat other than cocoa butter (5% limit) in adherence to Directive 2000/36/EC

In cocoa butter the addition of vegetable fat other than cocoa butter may not exceed 5%, so to monitor and prevent adulteration, the detection and quantification by triglyceride analysis is required. IRMM produced a batch of 1600 units of pure cocoa butter candidate reference and in collaboration with the JRC-IHCP, certification measurements of this cocoa butter CRM were completed and evaluated. The technical discussion took place at IRMM, and the material was approved for certification.

Certification of Aflatoxin M1 in Milk Powder

Commission Directive 98/53/EC,
Regulations EC 1566/1999 and EC 1525/98

Food safety and consumer protection requires the residue analysis of metabolised aflatoxins in whole milk powder. CRMs are required to enact this legislation and in 2001 the production and labelling of the required CRMs was completed and stability and homogeneity studies started with two laboratories. First in-house measurements of the three candidate materials indicate that the target values have been reached. This certification will be completed in 2002.

Clinical Diagnosis and Metrology

The present situation in clinical diagnostics is characterised by a lack of comparability of clinical data between different testing laboratories creating problems for the cost-effective maintenance of the health care system. For example, NIST commissioned a study on the economic impact of improving the quality of their cholesterol CRM which is used as a primary calibrant and they claimed an annual economic gain of 100 million $ through better diagnostics. The European policy makers have reacted to this situation by enacting the Directive for In-Vitro Diagnostics and Medical Devices (98/79/EC) which foresees traceability of diagnostic results to reference materials or reference methods of higher order (where available). IRMM has reacted at a very early stage by entering a collaboration with the International Federation of Clinical Chemistry (IFCC) and this has already led to the development of a series of important CRMs for tumour markers, infectious diseases, cardiac damages (in total ca 40 different protein markers), etc. IRMM is recertifying the catalytic activity of enzyme CRMs at 37°C (previously certified at 30°C) with the aim to improve the diagnosis of associated diseases.

Examples include creatine kinase (for heart infarct), alkaline phosphatase (for hepatobiliary and bone diseases associated with increased osteoblastic activity), aspartate aminotransferase (for viral hepatitis and other forms of liver disease associated with liver necrosis and liver cirrhosis) and alpha amylase (for pancreatic diseases). IRMM is now placing particular emphasis on the rapidly evolving field of genetic testing and participates in an extensive study on the critical issues thereof carried out by IHCP on behalf of DG Research. There, it will concentrate on the harmonisation of testing methods and production of CRMs. Steps were taken to produce the first DNA CRMs for the diagnosis of genetic disorders such as factor V Leiden. prothrombin, cystic

fibrosis and sickel cell anemia. This project involves a consortium of top genetic laboratories in Europe including partners from NAS states. To conclude, IRMM also provides a total of 30 different clinical BCR® CRMs to clinical laboratories.

New Joint Committee for Traceability in Laboratory Medicine (JCTLM)

Promoting a common measurement system for health

Founded in 2001, the JCTLM initiative aims at the creation of a global sustainable network to establish collaboration and cohesion between key-players in the in-vitro diagnostic (IVD) sector. Its main objectives are to establish specialised networks of reference laboratories, to develop reference methods and Certified Reference Materials of higher order as required by the IVD Directive 98/79/EC, to ensure the understanding of the traceability requirements of the Directive and to improve knowledge transfer about metrological issues such as traceability, comparability, measurement uncertainty and quality systems. The JCTLM Network will be based on already existing structures and more intensely involve the IFCC, the IVD industry, metrology organisations like the BIPM, Metrology Institutes of EU Member States, the main producers of CRMs like IRMM and NIST, accreditation bodies and the WHO.

Biometrology Initiative

Together with the National Institute for Standards and Technology (NIST), USA and LGC, UK, IRMM has taken the initiative to set up a Working Group on Biometrology within the BIPM (Bureau International des Poids et Mesures), the global organisation for Metrology. The tasks of this working group are to explore critical measurement issues in genomics and protenomics, to organise international studies and key comparisons for DNA and protein analysis and to establish traceability schemes in order to achieve a global equivalence of measurement results. This activity will be of great significance for GMOs and clinical CRMs.

Total Protein in Human Serum

Directive 98/79/EC (IVDMD) and in collaboration with DG RTD/IFCC

The total protein serum test indicates liver disease and many other disorders. A candidate reference material was acquired and 7,192 ampoules of human serum were produced by NIBSC. Tenders for Homogeneity and Stability studies of human serum were received and characterisation studies of the calibrator and human serum are now being planned. This certification will be completed in 2003.

New Enzyme Reference Material Certified

Together with the IFCC, IRMM has completed the certification of creatine kinase, alanine aminotransferase, gamma glutamyl transferase and lactate dehydrogenase (IRMM/IFCC-452 to 455) at 37°C. Presently the enzymes aspartate aminotransferase and alkaline phosphatase are also being re-certified at 37°C.
The catalytic activity of the enzyme reference material alpha amylase (IRMM/IFCC-456) has now been certified according to the new IFCC primary reference method. Uncertainty of the material is 3.8% of which only one tenth originates from the variation between laboratories, demonstrating the exceptionally high measurement standard of the participants. Uncertainty contributions from homogeneity and stability have been included, as required by the Guide to the Expression of Uncertainty in Measurement. This is part of an ongoing project for the re-certification of enzyme reference materials at 37°C (body temperature) and not at 30°C as was previously the case.

Environmental Protection

EUROSOIL CRMs

Directive 79/831/EEC
and in collaboration with OECD and DG ENV

The classification of dangerous substances and new chemical products and the assessment of their physico-chemical properties, toxicity, ecotoxicity and environmental hazards, includes the study of chemical adsorption in soils. The harmonisation of classification methods requires the provision of CRMs to standardise experimental soils in order to ensure comparability of results and proper risk assessment.
In collaboration with JRC-IES, the certification of the adsorption coefficients for atrazine, 2,4-D and lindane, the pH, as well as the total N, total C and total organic C were finalised for the different EUROSOILS. The certification report was completed and first sales have already been recorded.

JRC Water Cluster

Water Policy Framework Directive 92000/60/EC

In collaboration with the JRC Institutes IES, IPTS and the IPSC, the JRC is supporting the new Water Policy Framework Directive. Activity areas include surface water management, the analysis and monitoring of priority pollutants and river basin management. In 2001, three CRM's for trace elements in wastewater were certified following a 16-laboratory certification campaign.
Complementary to this is the International Measurement Evaluation Programme (IMEP), which is the tool for result oriented evaluation of measurement capability and regularly addresses measurements of metals in water. A present IMEP round on metals in water involves 348 laboratories from 48 countries.

Sulfur in Diesel

Council Directives 93/12/EEC, 1999/32/EEC

The precise sulphur content of diesel is important for assessing the quality and environmental effects of this fuel and new legislation has further reduced the allowable sulphur levels, creating a need for new reference materials.
Homogeneity and stability tests of three candidate CRMs were completed and certification measurements were carried out by IRMM and NIST, USA using IDMS. The three CRMs will be submitted for certification early in 2002.

Preparation of three CRM's for Trace Elements in Wastewater

Directives 91/271/EEC and 2000/60/EC

To enact legislation on municipal wastewater treatment this project with DG Research also supports the new Water Policy Framework Directive. 3000 ampoules of wastewater samples were produced and a certification campaign was conducted with 16 laboratories. At the certification meeting very good results were presented for all elements to be certified with only Pb yielding a somewhat larger uncertainty. Stability measurements are presently being conducted.

CRM for Heavy Metals in Incineration Ash

Directives 89/369/EEC and 89/429/EEC

Emissions of a number of heavy metals from municipal and industrial waste incinerators are limited under EU regulations. Since a previous batch of incineration ash CRM was sold out, this material has to be remade.
This CRM is characterised for its mass fractions of As, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Sb, Se, Tl, V and Zn (partly as trace impurities). It is intended for use with all kinds of analytical techniques and is of high demand in the sectors of environmental monitoring and research. The candidate reference material proved to have an excellent homogeneity for all 15 elements listed above, and the available characterisation data from al-

together 12 different analytical techniques, discussed thoroughly in a technical meeting of all participating laboratories, allow to certify this material for all envisaged elements.

CCQM-P11: Arsenic in Oyster Tissue

In collaboration with the BIPM-CCQM

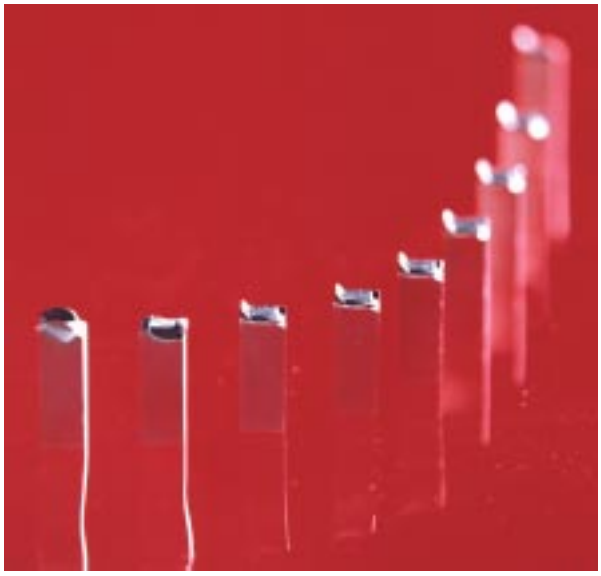
A CCQM pilot study on the determination of arsenic in oyster tissue was organised by NIST (Gaithersburg/USA) among National Metrology Institutes. IRMM was invited to participate by performing neutron activation analysis. The analyses were performed and the results of the arsenic determination with two methods (INAA and k0-NAA) deviated only by 1.6% from the mean value, and are as such among the six closest values for this high level metrological comparison.

BCR® Reference Materials

This project is directly connected with the EC Programme "Measurement and Testing" of DG Research which finances research for the development and production of BCR® CRMs. Once certified, these materials are transferred to the IRMM who has the responsibility for storage, stability control, distribution and renewal. Presently 500 different BCR® CRMs are available at IRMM with a storage load of over 500.000 units.

Mechanical Test CRMs

Extremely important CRMs from BCR® are those for the testing of impact toughness of steel (Charpy test) where the EN standard 10045-2 specifically requires their use for machine verification. In 2001, 8 batches of Charpy CRMs were certified and international intercomparison of Charpy systems (EN/ASTM/JIS) with NIST and NRLM (Japan) was continued.
Other new mechanical test CRMs were BCR-661 certified for tensile properties and BCR-692, a diamond-like carbon coating on steel, for verification of scratch test instruments used to test coating adhesion (pr EN 1071).



Stability Monitoring and Storage of BCR® CRMs

An ongoing action at IRMM is to monitor and ensure the stability of BCR® reference materials (as required by ISO guidelines for CRM producers) and assign shelf lives. This activity has become more important in recent years with the expansion of the BCR® programme in areas such as food, clinical and other biological RMs where the risk of instability is significant for improperly prepared and/or stored materials. Stability monitoring involves a substantial logistic exercise (storage and dispatch of bulk and reference samples, at particular dates and appropriate temperatures, to a network of 50 laboratories) as well as data evaluation. Stability monitoring campaigns are organised through calls for Expressions of Interest in the Official Journal with batches of contracts with external laboratories placed annually. In-house analytical services are employed as appropriate. In 2001, stability tests on 120 CRMs were performed.

A new CRM storage building, which will provide secure and appropriate temperature controlled storage for all CRMs, including clinically infectious materials, is planned for construction in 2002.

Reference Materials for Solid Fat Content

In response to a request by the American Oil Chemists Society for an official European CRM for NMR calibration of solid fat measurements (e.g. in margarine), a contract was signed for the supply of synthetic (plastic-in-oil) calibration samples to be certified by IRMM. Sealed NMR tubes with various mixtures of tristearin in triolein, to be used as "master samples", were prepared and characterised and a bench-top NMR instrument for calibration of the plastic-in-oil samples was installed.

Other Industrial CRMs

Four new CRMs for trace elements in unalloyed Zn as well as a thin film reference sample were certified and are now on sale. Four aluminium alloy CRMs for use as activation monitors (for reactor dosimetry) were certified in 2002. One of these (Al-0.1%Au) play an important role as a monitor material for k0-neutron activation analysis (NAA). IRMM has its own NAA facility and co-organised an international k_0-NAA workshop in Brugge, Belgium.

JRC Centre for Chemical Reference Measurements

With globalisation, EU expansion and an increased importance attached to world trade issues, more scientific reference methods are needed to enact EU policies and provide hands-on scientific support towards EU harmonisation and interaction with the EU's trading partners and in particular with the Candidate Countries.
Reference analytical measurements are developed to provide cornerstones for ensuring the quality and safety of food, agricultural and consumer products, since they allow the unambiguous characterisation of a product with respect to its chemical composition. The reference analytical methods developed at IRMM undergo a full in-house validation, meaning that the performance characteristics are extensively established. They thus fulfil the requirements for reliability and accuracy at the highest level. Reference analytical methods are developed at IRMM on behalf of various Directorate Generals (DGs) to support the implementation of Community legislation and increasingly for the IRMM production programme of Reference and Proficiency Testing Materials (CRMs, PTMs).

Rationale

An in-house potential for the certification of reference materials is indispensable and serves to provide credibility for the assignment of reference values for CRMs and Proficiency Testing Materials (PTMs) as required by internationally agreed concepts for CRM production. This is very strongly emphasised by the world's number 1 provider of CRMs (NIST in the USA). The mutual recognition of CRMs between the US and EU providers (IRMM being globally the second largest provider) is a goal foreseen in the EU-US Mutual Recognition Agreement developed under the Transatlantic Economic Partnership.
All reference material certifications involve the analytical laboratories in various steps of the procedure: homogeneity testing, stability testing, certification measurements and/or various support activities. Often the required methods are available in stand-by, but in many cases new ones or adaptations of known ones must be developed, validated and extensively tested.
For this purpose, dedicated teams of analysts and scientists in various fields of specialisation are constantly developing, adapting, improving, and of course applying their knowledge for the sake of improving the quality and number of Reference Materials. The continuous compilation of appropriate analytical methods and know-how will also be an important asset for increased engagement of IRMM in the production and certification of BCR-CRMs. Then a substantial amount of certification work will be performed in-house.

Benefit to Customers

IRMM provides support to international organisations like IAEA via DG External Relations by making available its special expertise on chemical enrichment of radionuclides and low-level measurements in the frame of joint projects supporting the implementation of EU policies. It further focuses on the important issue of radionuclides in environmental and food matrices, a matter of interest in the context of enlargement and foreign policy.
In general the beneficiaries of chemical reference measurements are analytical laboratories charged to perform analytical determinations in foodstuff, agricultural products and cosmetics in the frame of implementation and monitoring of Community legislation. These include the National Reference Laboratories for Veterinary Residues in the EU and Candidate Countries (for antibiotics in food) and customs laboratories of the Member States

(for sugars in industrial syrups). Such laboratories can also participate in international Proficiency Testing exercises and seek advice on aspects of reference measurements. The metrological service is the backbone to all IRMM activities. Precision mass determinations provide direct traceability to the SI unit of mass, and form the underlying traceability link in amount of substance metrology to the SI unit - the mole. Other measurement capabilities of the laboratory include density, length, thickness, surface area and the alignment of beam tubes and flight paths.

Future Prospects

For the characterisation of clinical diagnostic materials, the structure elucidation and quantitative determination of complex proteins like ferritin or myoglobin that are used as new diagnostic markers and produced as global CRMs (in support of the implementation of the IVD Directive) will be performed. The characterisation of bio-molecules (like proteins in support to the production of CRMs for clinical diagnosis) will figure strongly in the future.
The development of standardised control methods to be used in the fight against fraud by customs laboratories or national competent authorities (e.g. to determine proteins in milk with DG Agriculture) will be continued.
Proficiency Testing Programmes will be developed to provide support to the Community Reference Laboratories (CRLs) and National Reference Laboratories (NRLs) for the control of contaminants and residues in food stuffs (e.g. heavy metals and antibiotics in meat).
The development of chemical separations and determinations of (usually low-level) radionuclides in environmental and food matrices, for which substantial know-how has been accumulated, will be continued. Analytical support in the frame of certification, homogeneity and stability control of CRMs will be expanded. For reference measurements of radionuclides, the development of methods and distribution studies of radionuclides for protection of workers and the citizen (e.g. Ra in groundwater, Th in airborne dust at work places) will also be developed.

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Food Safety and Quality

Antibiotics in Food

Directive 70/524/CEE, Regulation 2821/98 and in collaboration with DGs ENTR and SANCO

Addressing food safety and consumer protection standards, one of the prime concerns is to detect and control the presence and concentration of antibiotics in foods of animal origin. This year a multiresidue procedure based on reversed-phase HPLC with electrochemical detection and using a C_{18} narrow bore column was fully optimised for the separation of a mixture of four commercial macrolides (josamycin, kitasamycin, rosamycin and roxithromycin). Preliminary detection limits between 12 and 24.8 ng and RSD below 15% were reached. For (fluoro) quinolones (FQ) a highly sensitive LC-ESI-MS/MS method has been fully developed for the simultaneous identification and quantification of eleven compounds in swine kidney. Limits of quantification around 35 $ng.g^{-1}$, much lower than the official MRLs were reached. The method was validated for each analyte in terms of selectivity, linearity, accuracy and precision. Furthermore, the development of a CE-MS procedure for FQ has well progressed after achieving the difficult task of coupling CE to MS.

Sugar in Industrial Syrups

EC 97/00/632, Directive 79/796/CEE, Regulation 394/70 and in collaboration with DG AGRI

On request of DG Agriculture a modern method for sugar in industrial syrups was needed to replace an outdated official method. Two HPLC methods were developed and tested using BCR® reference materials and the report was sent to DG Agriculture. The method selected for further validation has been submitted to an interlaboratory test with 8 participants and the evaluation of the results will take place in 2002.

Selenium in Food Stuff

Directives 70/524/CEE, 89/398/CEE and Share Cost Action project SEAS

This research contributes to the project "Feasibility study for Se speciation in yeast candidate reference

material". It is rather unique in that it concerns the development of Se fractionation by size-exclusion LC after a sequential extraction for separation and isolation of the water-soluble and non-soluble compounds. Anion-exchange LC with online ICP-MS detection has been optimised to monitor the speciation of Se in low-molecular weight compounds. A further separation and determination of Se-containing proteins in high-molecular weight species has been newly applied, which includes protein separation by gel electrophoresis and determination of Se in the proteins by electrothermal vaporisation-ICP-MS. For the MULtielemental SPeciation in Oyster Tissue project for the certification of Hg, As, Sn and Se in BCR® 710 candidate reference material, IRMM has contributed significantly to the Se part. Values were presented for inorganic selenium (Se^{IV} and Se^{V}), selenocystine and selenomethionine. An acknowledged improvement of sample preparation has been proposed by IRMM to preserve the integrity of Se species initially present in the material.

Oxidative Hair Dyes

EC Directive 76/768/EEC and in collaboration with DG ENTR

The implementation of the EC Cosmetic Directive (76/768/EEC) requires the harmonisation of analytical methods now more so than ever as the Scientific Committee on Cosmetic and Non-food products announced a significantly increased risk of bladder cancer among long term regular users of hair dyes. In support to DG Enterprise, the IRMM has developed and "in-house" validated method for commercial formulations which will be internationally validated in 2002 using the AOAC Peer Review procedure.

Proteins / metal-Binding Proteins (MBP) in Food and Clinical Matrices

Directives 83/417/CEE, 91/32/CEE and in collaboration with DGs AGRI and SANCO

In the frame of a collaboration between IRMM and IFCC (International Federation of Clinical Chemistry and Laboratory Medicine), a method has been developed, based on cation-exchange LC, for the determination of HbA_{1c}, a glycated isoform of human haemoglobin that can be used as a biomarker for diabetes. The method was applied to the determination of HbA_{1c} in blood from 60 volunteers; the method succeeded to detect the three samples from diabetic patients. The official method of IFCC for the determination of HbA_{1c}, based on HPLC-MS and/or HPLC-CE, is also currently being implemented.
Additionally, various CZE separation systems have been developed for several MBPs and fast separations (<5 min) were achieved. Besides bare silica capillaries, coated capillaries equipped with an extended light path were successfully applied for clinical samples. Commercial protein standards were tested for isoforms and contaminants by means of an electrospray ionization-quadrupole ion-trap mass spectrometer (ESI-QIT). Currently the suitability of a CZE-ESI-QIT coupling for MBP determination is under investigation and first results are extremely promising.
In the field of food analysis, preliminary studies have been carried out for the development of a method to detect fraudulent manipulation of meet. The method is based on the identification of the major isoforms of haemoglobin which are characteristic of the different species studied, namely cow, sheep and pork.
The development of a LC reference method for the separation and quantification of all major proteins in several types of powder and liquid bovine milk has continued, and a single-laboratory method validation was carried out. The reliability of the results was further enhanced by the establishment of a full uncertainty budget. The applicability of the proposed method is being successfully tested for the assessment of bovine raw milk adulteration by addition of different powdered milks.

Reference Measurements

The Thorium Network

EURATOM 96/29 and in collaboration with DG RTD

The European Directive laying down the basic safety standards for health protection of the general public and workers requires that environmental and workplace materials exceeding 100 Bq/g Thorium must be reportable. The Directive has been changed (EUROATOM 96/29) so that from May 2000 this value has decreased. However, it has been shown by the National Physical Laboratory (UK) that there is a real need for reference materials and validated methods for thorium analysis. For this reason, a network was set up by DG Research and IRMM is participating as an expert laboratory.
This year, the results of the 3rd intercomparison exercise were received and the final report was written. The organisation of a workshop in March 2001 took place in collaboration with the Belgian Nuclear Centre (SCK.CEN) with 72 participants from 17 countries.

IRMM Denuclearisation

The denuclearisation and refurbishment of the Chemistry building continued in 2001 with 2 laboratories denuclearised. Another 2 laboratories were renovated and a third laboratory was brought back into operation. This task will be completed as soon as the radioactive waste is removed from the bunker.

Analytical methods in support to Reference Materials certification

In view of increasing request for analytical support measurements for the certification of reference materials, and as a complementary activity to denuclearisation, within the "management-of-change policy" activities have been streamlined, new channels and procedures for enhanced communication with customers were implemented and the complete measurement infrastructure is being modernised. During this phase a variety of contributions to RM certification were given:

- Feasibility study for the measurement of iodine isotope ratios by ICP-MS;
- Stability testing for Ca, Mg and Li in a Human Serum RM;
- Homogeneity testing of rice flour (BCR-804) and GMO soy flour;
- Stability testing of Na, K, Mg, Ca and Mn were performed for 2 artificial groundwater reference materials (BCR-616 and -617);
- Feasibility measurements for the certification of future honey RMs;
- Stability testing of K, Ca, Mg and Zn in a Hay Powder RM;
- For tuna fish reference materials (BCR-463 and 464), measurements of total and methyl mercury were completed;
- Homogeneity measurements of future sediment reference materials (BCR-277R, -280R and-320R);
- XRF measurements of teaspoons from Tokai-mura, Japan were also completed.

Metrological Support

Precision mass determinations provide direct traceability to the SI unit of mass, and form the underlying traceability link in amount of substance metrology to the SI unit, the mole. In 2001, the regular calibration of weight sets and the checking, maintenance and calibration of balances was continued at the highest level. Metrological measurements were carried out in direct support to numerous ongoing project tasks. Examples of executed tasks include:

- IRMM-1027f (dried spikes), IRMM-058 (^{233}U), MP2-solution (^{239}Pu) and BCO1758 (Pu metal spike);
- IMEP-17, IMEP-12 (serum), density on serum samples;
- alignments of the Linear accelerator;
- ^{10}B on Inox backings;
- IDMS weighings for Cl, Fe and Ca as well as for Ca, Li and Mg standards;
- length measurements on 5 micro reference materials;
- 15 moisture measurements for IMEP-19 (rice powder) and 18 measurements on sulphur mixtures;
- mass determination of Nb on 42 strips;
- Repairing and calibration of 2 balances in a glove box.


Measurement Evaluation Program
IMEP-16
Pb in wine
European Commission – JRC – IRMM
Retieseweg B-2440 Geel, Belgium
IMEP


JRC Reference Laboratory for
Isotopic Measurements
CERTIFICATE

JRC Reference Laboratory for Isotopic Measurements

Rationale

In the EU alone, 5-10 billion analytical data are being generated annually and the annual costs of chemical measurements approach some tens of billions of Euros. There is an underlying need to improve the quality of chemical measurements and for the European Commission to provide leadership and co-ordination in this task (see 'Metrology in Chemistry', B. King, 1998, EUR 19074 EN, p.7).

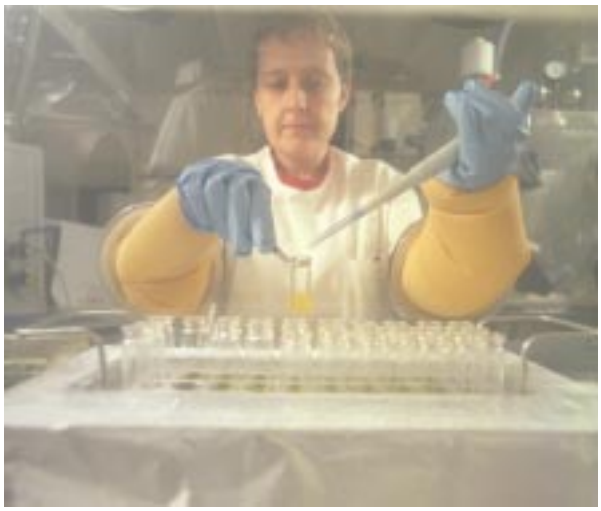
IRMM is a leading institution in the development of a metrological measurement system in chemistry through:

- conceptual input to international fora such as BIPM (Bureau International des Poids et Mesures), EUROMET (European Organisation of Metrology), EURACHEM (Analytical Chemistry in Europe), CITAC (Co-Operation on International Traceability in Analytical Chemistry) and EA (European Co-operation for Accreditation),
- its reference materials,
- the targeted development of chemical reference methods,
- its International Measurement Evaluation Programmes (IMEP) and
- its role as signatory of the Mutual Recognition Arrangement between 39 Metrology Institutes including JRC-IRMM under the auspices of BIPM and on behalf of the European Commission and as partner of the EUROMET regional metrology organisation.

In the metrology research area, IRMM specialises in Primary Methods of Measurement and Primary Reference Materials (elemental and isotopic) —an approach that originated in the nuclear safeguards programme. These provide the basis for traceability —hence comparability— of nuclear and non-nuclear measurements. Both nuclear measurements (e.g. carried out by Nuclear Plant Operators and Safeguard Authorities such as IAEA or EURATOM) as well as measurements on materials exported from or imported into the European Union, require comparability via traceability.

Benefit to Customers

IRMM provides its customers with solid 'anchor values' for both chemical and nuclear safeguards measurements. In this collaboration, these organisations can have access to highly reliable and specific reference chemical measurements of undisputed metrological quality. These laboratories may be provided with reference materials and participate in international measurement evaluation rounds (IMEP, REIMEP and NUSIMEP) and in that way test their own measurement capabilty or that of other laboratories. They also can obtain advice on aspects of isotopic measurements and/or isotopic reference materials, exchange information and help contribute to the development of a structured measurement system in chemistry. On regular occasions, scientists from these organisations come to work at IRMM, receive training and use the unique facilities. A special training programme for scientists from NMIs of the Candidate Countries has been set up to introduce the principles of Metrology in Chemistry there and to support these States in the integration to the EU measurement system.
Due to its demonstrated measurement capability, IRMM was invited by the US Department of Energy to jointly develop with New Brunswick Laboratory, (the official US Safeguards Laboratory) THE global isotopic reference material for the accountancy of uranium.



Future Prospects

For IRMM's Primary Isotopic Gas Standards (PIGS), the production and certification of the isotopic ratios of pure gases will be expanded (e.g. CO_2 for accurate monitoring of the carbon fluxes in the atmosphere within the JRC Global Climate Change Cluster). IRMM is calibrating the international carbon and oxygen isotopic measurement scales in close co-operation with the IAEA.
In collaboration with NMIs, a production and distribution system for Primary Reference Materials is being established to realise the endpoint of the SI traceability chain. This laboratory will consolidate and expand its leading position as one of the largest world suppliers of nuclear Isotopic Reference Materials (IRMs) and spikes. New IRMs and spikes of U and Pu will be produced for use in reprocessing plants (on-site Laboratories Sellafield and La Hague and Japan) and a set of global IRMs of uranium (collaboration with NBL, USA) will be prepared. Furthermore, new plutonium IRMs and spikes using the enriched Pu-244 material from Arzamas, Russia (in collaboration with the Department Of Energy (DOE) and the IAEA) will also be prepared.
Identified focal areas for the future include:

- Candidate and Mediterranean States for the implementation and monitoring of Community legislation in the food and environmental sector by establishing the degree of international measurement equivalence achieved by reference and field laboratories (e.g. for important compounds in clinical materials, PCBs in fat, radionuclides in water and sediments).
- European Accreditation has the ultimate "responsibility" for achieving proper quality of chemical measurements so a strategic collaboration has been formed here, with an official letter of intent of collaboration signed in 2001.
- Metrology in Chemistry (MiC). IRMM will advise and support the Candidate Countries (MiC network) and the Mediterranean Member States (MetMED network) towards building up a structured measurement system in chemistry (also a free trade zone will exist with North Africa in 7 years time).

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Metrology in Chemistry and International Comparisons

Contribution to the Consultative Committee on Amount of Substance (CCQM) Programme

In collaboration with the BIPM-CCQM, EUROMET, EA and DG TRADE

IRMM is signatory of the CIPM-Mutual Recognition Arrangement and offers EU support in setting up appropriate internationally structured measurement systems.
The draft reports of CCQM-K13 (Cd in sediment) key comparison and the CCQM-P12 study (Pb in wine) were prepared and samples for CCQM-P26 (S in Fuel) and CCQM-P14 (Ca in serum) studies were distributed.
IRMM participated in CCQM Working Group meetings and the CCQM plenary meeting (Sèvres, France) as well as the CCQM president meeting (Gaithersburg, USA) on behalf of the Inorganic Analysis WG. Other meetings included the "inter-regional meeting" concerning chemistry CMCs (BIPM, Paris) and the Working Group meeting (Geel). Progress in the different key comparisons was presented with agreement achieved on the KCRV and equivalence statements for the CCQM-K13. Finally results were collected from participants in CCQM-K24 (Cd in rice) and CCQM-P29 (Zn in rice).
Eleven IRMM claims for measurement capability were submitted via EUROMET for the BIPM Appendix C database and were accepted.

Contribution to CITAC Programme

In collaboration with the CCQM, EURACHEM, EA and EUROMET

IRMM, as Secretariat of CITAC, compiled, printed and distributed 4000 copies of the CITAC annual newsletter. CITAC meetings were organised and co-ordinated in Gaithersburg, USA, Athens, Greece and a CITAC session was held at the IMA 2001 conference in Ioannina, Greece.

Primary Isotopic Gas Standards (PIGS)

In collaboration with the IAEA and Member State laboratories involved in isotopic measurements

PIGS enable SI traceable isotope ratios to be obtained in areas of food, clinical, atmospheric and environmental isotopic measurements.
In 2001, the SF_6 certificate concerning absolute sulphur ratios of the international sulphur standards (IAEA S1, S2 and S3 and V-CDT) was finalised.
The Kr-PIGS certificate was also finalised, progress was made for the conversion of SO_2 in SF_6 and measurements were performed on five CO_2 standards.

Avogadro Project

In collaboration with PTB, IMGC, NRLM, CSIRO

For this international collaboration aiming at redefining the kilogram, new Si synthetic isotope mixtures were prepared by mixing enriched SiF_4 in gaseous form. Molar mass measurements on 40 silicon single crystal samples were performed, which enabled IMGC/PTB to understand the link between crystal growth conditions and the degree of perfectness of the crystals grown. A road map for improvements to the silicon molar mass was set up and IRMM was invited as an external consultant to contribute in an external review of the PTB Avogadro project.

^{41}Ca Isotopic Calibrants for OSTEODIET Project

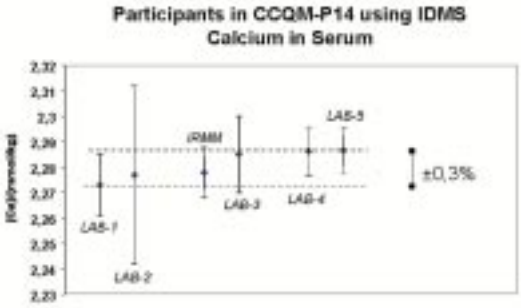
A shared cost action with Univ. Cork and ETH Zürich

The impact of diet and gene-nutrient interactions on calcium and bone metabolism (1999/C 64/14) is important for the prevention of osteoporosis. To enact this, calcium spike materials are needed. In 2001, ^{41}Ca was received from USA and the check on gamma ray emitting impurities was performed (contained small amounts of ^{60}Co, ^{40}K, ^{133}Ba, ^{137}Cs and ^{138}La). A check on Ca - Ni separation was performed (NiS precipitation, CaC_2O_4 precipitation or Ni-Dimethylglyoxim precipitation) and the separation was performed.

Blends of the ^{41}Ca solution were prepared by mixing with a ^{44}Ca enriched material and these will be used for the production of the reference materials. 88g of solution was sent to ETH in Zürich, and the remaining 3g will be used to prepare reference materials for the osteoporosis project. Measurements of the isotopic composition and amount content are presently ongoing.

Formalising the Collaboration with EA

Interactions between IRMM and the European co-operation for Accreditation (EA) which have been taking place for a number of years, have now led to a formal collaboration agreement EA-IRMM. EA associates National Accreditation Bodies in 26 European countries. The intention is that EA will use IMEP as a tool for result oriented evaluation of the measurement capabilities of laboratories. The first annual meeting was held at IRMM in December 2001.
IRMM provides participants of the International Measurement Evaluation Programme (IMEP) with highly reliable and specific reference chemical measurements of undisputed metrological quality. It also enables the end-users of chemical measurement results (e.g. the customers, government bodies, regulatory bodies, etc.) the capability to assess the measurement capability of the measurement laboratory.



IMEP-12 (Metals in Water)

Directive 98/83/EC
and in collaboration with MS water laboratories and EA

Water quality is a key issue in all Member States and IRMM offers laboratories the only metrological evaluation programme, where the reference values are not obtained by consensus.
340 registered participants received IMEP-12 samples and documents. The participants' results were inserted into the IMEP-12 database, confirmed by the participants and the certification report was finalised and the certificate was distributed to the participants.

IMEP-15 (WMO Metals in Water)

World Meteorological Organisation, Member State labs in water and geochemical analysis

In 2001 this round (using IMEP-12 samples) was carried out in collaboration with the World Meteorology Organisation (WMO) and approximately 35 calibration labora-

tories of WMO participated. These WMO calibration laboratories are part of the WMO network to monitor global precipitation and via IMEP-15 their measurement capability will be benchmarked.

Online reporting was used for the first time where data were imported to the IMEP-15 WMO database and later confirmed by the participants. IMEP-15 certificates were sent to the participants.

IMEP-16 (Lead in Wine)

Regulation 390-2676 and in collaboration with BIPM-CCQM, EA, EUROMET, DG AGRI, OIV and MS food laboratories

This round was accepted as an EA comparison as well as being used for the EUROMET project 568 and the CCQM-P12 study. Results received from 129 laboratories were entered into the database and results were presented at the International Wine Federation (OIV) meeting in Paris (March 2001). The final report is available at http://www.irmm.jrc.be/imep. The results of 24 EA nominated laboratories were presented at the annual IRMM-EA meeting in Geel (December 2001) and also reported to the EA co-ordinator and the National Accreditation Bodies concerned.

IMEP-19 (Cadmium in Rice)

In support to DG TRADE, DG SANCO, BIPM-CCQM, EA, EUROMET and MS laboratories in Food Safety

In collaboration with NIMC, Tsukuba, Japan (rice provider) these samples will also be used for the CCQM-P29 study, which has been co-piloted by IRMM and NIMC and for the EUROMET project 565. Additionally it was registered with the EA.
The rice samples, which will be used for the preparation of a rice IRMM-CRM, were rebottled, labelled and stored in 15g units. Water content and water activity were measured. Micro-homogeneity measurements were performed and tests on multiple spiking for ICP-MS certification conducted. Water content and hygroscopicity (moisture pickup) of the rice were thoroughly investigated and k0-NAA measurements performed and the certification of the rice material was completed. The IMEP round will be launched in 2002.

Nuclear Safeguards

With a special focus on metrology and quality assurance for nuclear safeguards and in close collaboration with the EURATOM Safeguards Directorate and DG External Relations (IAEA), IRMM has the capacity and established impartiality to perform 'referee' measurements needed for Nuclear Safeguards and to maintain and expand an independent European metrological capability in the area of nuclear analysis. For the same token, IRMM is one of the world's largest suppliers of isotopic reference materials (IRMs).

Certification of Isotopic Reference Materials (IRMs)

In collaboration with Safeguards authorities and analytical NMC laboratories

A series of 10 uranium isotopic standards were certified at IRMM for use by the South American Safeguards Organisation (ABACC). The materials were prepared at IPPN, São Paulo and certified at IRMM. These materials will now act as the traceability basis for all uranium enrichment measurements carried out in Brazil and eventually later throughout the ABACC countries.
A series of uranium isotopic standards were also prepared for JNFL, Japan. These materials are needed for the calibration of instruments used in the large nuclear fuel cycle programme in Japan.

Reference Materials for High Performance Environmental Sampling

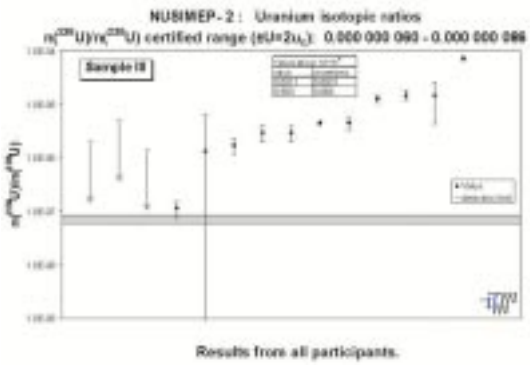
In collaboration with Safeguards authorities, especially DG TREN and analytical NMC laboratories

The improvement in sensitivity in measurement devices (e.g. ICP-MS) has led to a demand for dilute IRMs. The preparation of IRMM-073 (dilution of IRMM-072) was performed for the 15 mixtures making up the set. This series was then ampouled and labelled and the certification procedure will be completed in early 2002. This IRM is unique in the world, in that it carries ratios that are linear to within 0.03% over 6 orders of magnitude. This material will enable laboratories involved in environmental nuclear safeguards measurements to validate and calibrate their measurement procedures.
IRMM-058, a highly enriched ^{233}U spike for the measurement of U in environmental samples was also prepared, ampouled, labelled and packed. Certification is presently ongoing.

External Safeguards Quality Control

In collaboration with Safeguards authorities and analytical NMC laboratories

IRMM provides an objective external quality control (QC) programme (REIMEP) for nuclear Safeguards measurements and offers specific external QC materials suitable for Safeguards laboratories. The latest evaluation round (REIMEP-15: Uranium isotopic ratios in UF_6) was completed with 9 participant Safeguards laboratories.
IRMM's evaluation round for nuclear signatures in the environment (NUSIMEP-2) was also completed in 2001. Thirty participants from 12 countries measured the isotope ratios (233/238, 234/238, 235/238, and 236/238) of 100ng uranium. The results shown below clearly reveal that there are still huge discrepancies between claimed and demonstrated measurement capability in this area.



Results from all participants.

The first invitation for participation for NUSIMEP-3: 'uranium isotopic abundances in saline media' were sent out to potential participants and investigations on sample preparation were performed. NUSIMEP-2 and NUSIMEP-3 can and have been used to scrutinise measurement capability for uranium in urine, which has for

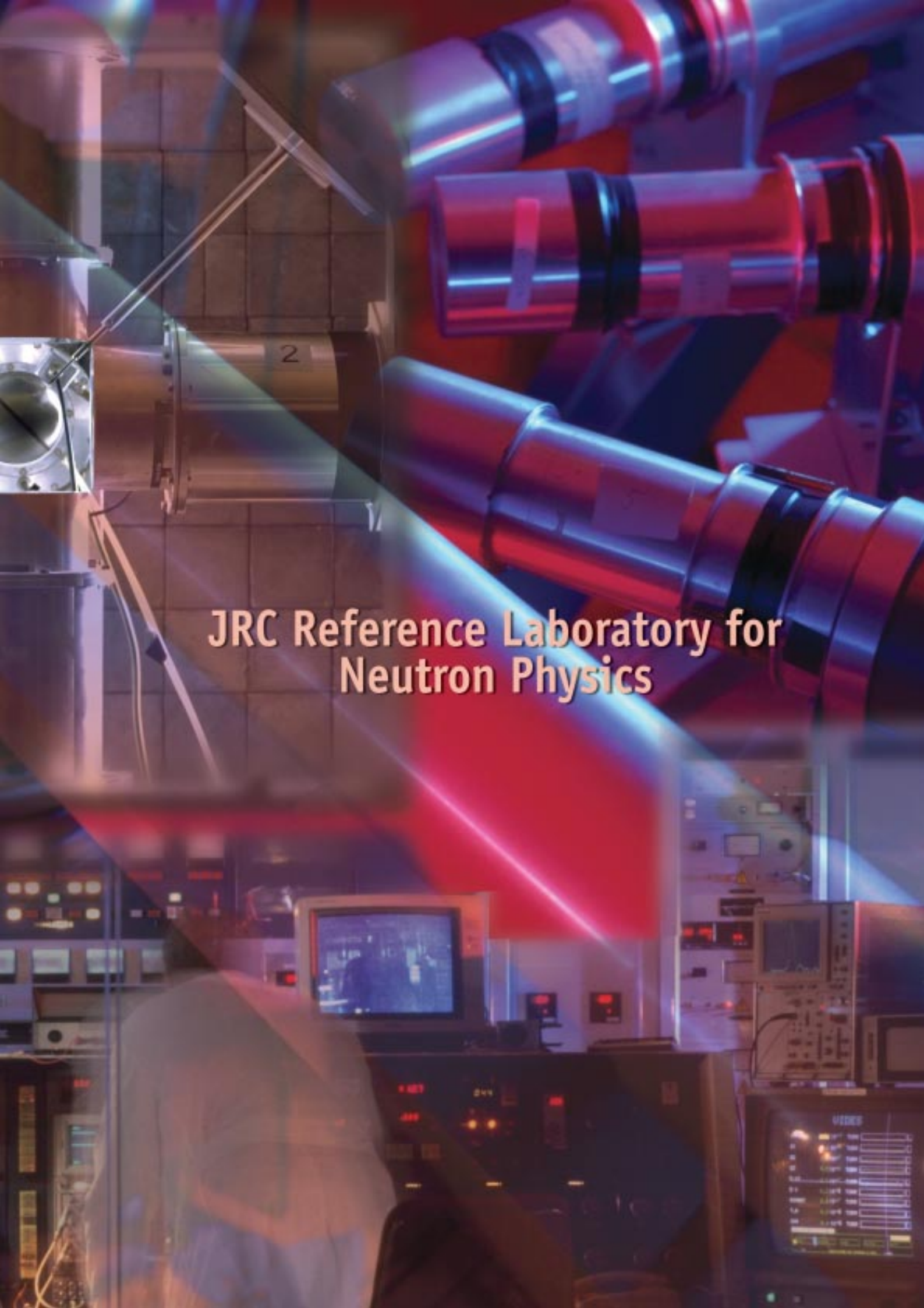
instance come up in the context of the use of depleted uranium in tank ammunition. The NUSIMEP-3 samples were selected, blank measurements were finished and the letters with application forms were sent out to the participants.

Environmental Quality Control Samples

Safeguards authorities, especially DG TREN and analytical NMC laboratories

There is a growing demand for low-level RMs which IRMM can produce using the ultra-clean laboratory facilities in particular for QC applications where laboratories are asked to analyse 'blind' samples previously certified at, for instance, IRMM. Swipe samples taken by the Luxembourg Safeguards Inspectors are delivered to IRMM, where they are routinely stored, archived and redistributed.

A series of measurements for background levels of U have been made using a quadrupole ICP-MS and very low amounts of uranium were successfully measured. Resulting values of ca. 12 ng/g were judged too high for these swipes to be used as the basis of isotopic reference QC swipes as requested by the European Safeguards Office. UO_2 particle materials were delivered from Harwell, UK, for ESO with the request to measure isotopic abundances. The first 'bulk' certified external QC samples were made for uranium on paper filters ('CENTS': Certified Environmental Nuclear Test Samples) and have been sent to ESO, Luxembourg. Blank measurements were also performed on the paper blanks and the first QC swipes were delivered to JRC-ITU.



JRC Reference Laboratory for Neutron Physics

JRC Reference Laboratory for Neutron Physics

Rationale

A sustainable energy supply for the near- and mid-term future in Europe faces the obligatory reduction of the greenhouse effect and the foreseeable and inevitable limits of fossil fuels. Electricity from nuclear energy may be the answer to those questions if safety and environmental issues can be controlled. At present already one third of the electricity produced in Western Europe comes from nuclear reactors. So nuclear reactor safety and waste minimisation is of paramount importance to us all. Irrespective of current views on the future of nuclear power programmes, society is concerned about:

- the safe operation of currently operating power plants, especially of ageing reactors —not only in the EU but also in the Candidate Countries and Russia,
- the environmentally acceptable and economic management of the nuclear waste already generated.

A thorough knowledge of the interaction of neutrons with matter is of fundamental importance to assess the safe operation of nuclear reactors, to model ageing of presently operating power plants, to develop advanced reactor concepts (e.g. the high-temperature reactor (HTR), the Thorium fuel cycle, etc.), and to advance various technological applications in energy production, mining, non-destructive testing, etc. A satisfactory solution to the problem of nuclear waste disposal is a necessary pre-condition for the public acceptance of nuclear energy in the European Union. In the event of a decline or even cease of electricity production via nuclear energy, the need still exists for safely disposing of, or destroying, the nuclear waste accumulated so far. Such transmutation applications require the knowledge of capture and fission cross sections of the concerned isotopes as a function of the neutron energy. The majority of basic and applied measurements in neutron physics are relative to reference standards. It is therefore essential that these standards are continuously improved and the underlying basic physics is understood. To this end, IRMM provides invaluable data for the improvement of the OECD standards data file to be used for environmental protection and for the safety of energy production.

For all the above applications, complete and accurate databases, that are freely accessible to scientists and engineers working in various disciplines, are required. Databases of experimental as well as evaluated neutron data are maintained by the OECD-NEA (Nuclear Energy Agency), in particular the JEFF (Joint European Fusion and Fission File) library of evaluated neutron data. For many isotopes' neutron energy regions experimental data are lacking or are inconsistent, and then evaluations rely on model codes. Especially in these cases there is the necessity to improve the database by performing new and accurate measurements. The detailed requirements for neutron data measurements are collected in a high priority request list that is edited by the Working Party on International Evaluation Co-operation (WPEC) of the OECD-NEA.

Benefit to Customers

IRMM has the unique facilities and the neutral status to perform nuclear measurements and therewith provide independent measurement support to fission technology for reactor and fuel cycle safety (benefiting the OECD-NEA, the JEFF project and nuclear industry). It provides invaluable data for waste minimisation important for environmental protection and safety in energy production. The European citizen benefits indirectly through the fact that Europe has its own politically independent measurement capability to tackle the scientific challenges of the nuclear energy cycle.

Future Prospects

The future programme of the Neutron Physics Unit will evolve according to application requirements in reactor and fuel cycle physics, especially with respect to safety aspects. The main emphasis will be on the measurement of data needed for safety issues related to increased fuel burn-up and plutonium recycling, and for feasibility studies of waste transmutation strategies, accelerator driven systems, and the Th fuel cycle. The neutron data standards cross-sections will be extended towards higher neutron energies.
IRMM participates in the Michelangelo Initiative Network (MICANET), which aims at a co-ordination of nuclear research in Europe and will cover not only reactors in operation, but also their evolution and more particularly, next-generation concepts. In the frame of MICANET, a high-priority request list tailored to the needs of European industry and research institutions will be established.
IRMM will also contribute to the recently created High-Temperature Reactor Technical Network (HTR-TN) providing neutron data for the development and safety assessment of HTRs.

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Neutron Data Measurements

Doppler Broadening

In collaboration with Institut Laue-Langevin (ILL), Grenoble

This project provides important reactor data for the temperature dependence of reactivity in nuclear reactors.

For the Doppler work at low temperatures on $^{240}PuO_2$ and $^{242}PuO_2$, test experiments with Au samples were carried out for calibration purposes. The $^{240}PuO_2$ sample was prepared for Doppler measurements and the test experiments were completed. Low temperature work on Hf led to measurements performed with samples of 0.25 and 10 mm thickness, at temperatures between 15K and 300K. The measurements were completed and the data analysed. Comparison of IRMM experimental results with three data libraries reveals the deficiencies in all present libraries.
For high temperature work on UO_2, the modified furnace was transferred to IRMM and installed in flight path 9. The water and electrical supplies were also installed and the preparation of new graphite electrodes started.

Cross Section Measurements with the Activation Technique: short half lives

In collaboration with Argonne National Laboratory, FZ Jülich, INRNE Sofia, NIPNE Bucharest, University of Debrecen, HU

Reaction cross sections are studied primarily in the range between 14 and 20 MeV due to the apparent lack of data and the contemporary interest in devices with a very hard neutron spectrum (ADS). Cross-sections studied contribute to the understanding of H and He production in structural materials, the (n,xn) and (n,n') processes, and the production of short-lived products (hazard, heat).
A considerable number of cross-section measurements leading to short-lived activities on isotopes of Mo and

Pb were completed. New measurements on a large number of reaction channels on all isotopes of Ni were started in collaboration with INRNE and to a large extent completed. Further studies are being carried out for Co, Cu, Ag and Au. An important effort involved the understanding and experimental determination of large summing corrections (>25%). Finally, model calculations were performed for all reactions on Mo (INRNE), Pb (Debrecen) and Tc (Debrecen, Brookhaven, Petten).

Charged Particle Emission Cross Sections

In collaboration with ILL, Grenoble and the University of Gent

The (n,α), (n,p) measurements carried out at the Van de Graaff accelerator with monoenergetic neutrons are needed for radiation damage calculations, to remove discrepancies at 14 MeV and to fill the energy gap at 5-20 MeV.
Data on the light charged particle emission for ^{251}Cf(n,f), the heaviest nuclide experimentally accessible, have been measured at ILL and analysis is in progress.

In 2001, measurements were performed with a polished Ta blank substrate in order to uniquely identify signatures of background events from the detector gas and the structural materials, which interfere with the signal events produced by the ^{10}B(n,α)^{7}Li reaction. The data acquisition system based on the 12 bit PCI wave-form digitizer, which has been used for data taking in (n,α) reactions at the Van de Graaff laboratory, was successfully used for the measurement of (n,γ) reactions at GELINA. High quality data have been measured for the ^{10}B(n,α)^{7}Li and ^{58}Ni(n,α)^{55}Fe reactions at the Van de Graaff accelerator. The cross section data show good agreement to the JENDL 3.2 data base for a neutron energy larger than 2 MeV and strong discrepancies to the ENDF/B-VI. For the ^{58}Ni(n,α)^{55}Fe reaction, the particle groups α_0, α_1, α_2, and α_3-α_4 have been clearly resolved and identified. The ^{10}B data complement the 10 keV - 1MeV measurements at GELINA using a classical GIC (Gridded Ionisation Chamber). A feasibility study was performed on the use of the TPC at GELINA.

Reference Measurements on Actinides

In collaboration with FZ, Jülich; FZ, Karlsruhe; the Studsvik Laboratory of the University of Uppsala and the Universities of Örebro and Gent

In 2001, the first ever direct measurements were performed on an important element for the Thorium fuel cycle. In the Thorium (Th) fuel cycle, an isotope of Protactinium, ^{233}Pa, with a half-life of only 27 days, is the important transition nucleus to produce the Uranium (^{233}U) fuel. Measurements of the fission cross section of ^{233}Pa are important because during operation of an advanced system based on the Th fuel cycle, ^{233}Pa is formed by neutron capture and after shut down of the system continues to decay into ^{233}U and hence influences the reactivity of the system. Up to now such measurements were not performed due to the very difficult handling of the highly active Protactinium, the short half-life and the in-growth of ^{233}U by the ^{233}Pa decay with it's large fission cross section. For the first time ever, direct monoenergetic neutron fission cross section measurements have been performed at the Van de Graaf accelerator on ^{233}Pa. Future work may well pave the way towards an improvement in the neutron data files and elucidating the obstacles that stand in the way of safely utilising the Thorium fuel cycle for innovative reactor concepts.
For ^{232}Th(n,γ), the experimental setup for the transmission experiment on ^{232}Th on GELINA flight path 5/14 m has been tested. Two runs have been successfully carried out with a 0.5 mm thick sample using different sets of "black" filters. A 0.5 mm thick ^{208}Pb sample was also used for background determination. The data were analysed and within a systematic uncertainty of about 7% our data agree with the data of Macklin et al. ^{232}Th neutron capture measurements in the resonance region have also been started.

Feasibility Studies of Waste Transmutation

In collaboration with CEA, Saclay and CERN, Geneva

Improved neutron data for long-lived fission products and minor actinides are needed to tackle the problem of nuclear waste transmutation.
^{99}Tc(n,T), (n,γ) cross sections progressed with simultaneous R-Matrix analysis of the capture and total cross-section measurements completed up to 100 keV for 600 resonances. Analysis of the cross sections in terms of average parameters was also performed up to 100 keV.
Work on ^{129}I(n,T), (n,γ) cross sections continued with low-energy measurements completed. The resonance analysis of 5 samples of ^{127}I and ^{129}I was completed up to 1 keV. The transmission measurement of the 5g/cm^2 ^{127}I sample was set up and completed at the end of the 2001 measurement campaign.

For the ^{237}Np(n,T), (n,γ) cross sections, a re-analysis of transmission data with improved resolution function started and the feasibility study of a capture measurement on a purified ^{237}Np sample was carried out. Methods to purify ^{237}Np were investigated and analysis for the three runs of transmission at GELINA flightpath 4/50 m were completed for up to 100 eV.
IRMM continues to be involved with the nTOF collaboration at the 24 GeV proton spallation source of CERN, dedicated to the determination of cross-sections for waste transmutation using accelerator-driven systems. In addition to total cross-section measurements complementing capture cross-section measurements at nTOF, IRMM offers its facilities for the testing and calibration of detectors and for feasibility studies on new detector systems. In 2001 several experiments were performed by groups from CERN and Saclay (detector calibration) and IReS Strasbourg, University and Technical University of Vienna (feasibility studies).

Data for shielding and structural materials

These measurements are needed for both reactor criticality safety considerations and radiation shielding calculations.

Cross sections of ^{52}Cr(n,n') and ^{58}Ni(n,n') progressed with the mechanical setup for mounting detectors at the 200 m station being finalised and installed at the flight path. The flux distribution was measured at the 100m station with 2 available fission chambers for comparison. Two $^{52}CrO_2$ samples as well as ^{58}Ni and ^{52}Cr samples were prepared in-house and delivered for use. The characterisation of the data acquisition system and detectors to maximize the range of applicability of the setup in terms of incident neutron energy range was performed.
First test runs were made with the ^{58}Ni sample and steps are presently being taken to improve the shielding against background.
A second well-calibrated fission chamber (^{238}U) installed at 200 m for absolute normalisation of the flux proved to be inadequate and will soon be replaced by a newly designed ^{235}U fission chamber of increased sensitivity.

Cross Section Measurements with the Activation Technique: long half lives, radioactive targets

In collaboration with FZ Jülich, Argonne National Laboratory, INRNE Sofia, NIPNE Bucharest, University of Debrecen HU, University of Vienna, Brookhaven National Laboratory, NRG Petten

Reactions leading to products with half lives in excess of 1 year concern waste disposal, emission, occupational hazard and decay heat.

In 2001 the measurements of the cross-sections for the ^{94}Mo(n,p)^{94}Nb and ^{204}Pb(n,p)^{204}Tl reactions were completed. These reactions on important materials for reactors were on the high priority request list of the OECD-NEA. Measurement results were reported in the thesis of P. Reimer (Köln University) together with new model calculations performed in Bucharest and Debrecen. New measurements were started to study the production of ^{60}Co from (n,p) reactions on Ni and the (n,α) reaction on ^{63}Cu (with INRNE). A feasibility study was started for

the determination of the $^{14}N(n,p)^{14}C$ cross section at energies above 14 MeV where no data exist. Use will be made of the AMS facility of the University of Vienna.
The data for the $^{99}Tc(n,p)^{99}Mo$, $^{99}Tc(n,a)^{96}Nb$ and $^{99}Tc(n,n'\gamma)^{99m}Tc$ reactions were completed, compiled in EXFOR format, and submitted to NEA. A large effort involved the low-energy neutron corrections at the highest energies for the latter reaction (in collaboration with ANL). Model calculations with three different approaches have been performed (Debrecen, Brookhaven, NRG Petten).

$^{10}B(n,\alpha)$ Branching Ratio

Collaboration with NIST, IPPE and Tohoku University

The $^{10}B(n,\alpha)$ reaction is considered as a standard for neutron flux measurements due to the very large cross section at thermal energies and the smooth energy dependence up to about 100 keV. Above this energy, however, this reaction is no longer used as standard due to its structure and larger uncertainties. The intention to solve discrepancies in recent experimental investigations and the extension of the standard to higher energies has triggered an international collaboration (NIST (USA), IPPE (Russia), Tohoku University (Japan) and IRMM) to measure the $^{10}B(n,\alpha)$ branching ratio.
In 2001, the experimental set-up was moved to the 60m flight path station, boron shielding was added and analyses were performed. Van de Graaff measurements at higher n-energies were also performed and the new "Time Projection Chamber" spectrometer was tested. The data showed significant disagreement with the ENDF/B-VI database above 1MeV neutron energy, but showed agreement below that energy.

$^{252}Cf(SF)$

The spontaneous fission of ^{252}Cf is an important reference standard. Test measurements in connection with a new digitizer and to investigate the properties of different counting gas mixtures (Ar+10%CH_4, pure CH_4 and CF_4) were completed and the data analysis was performed.

Cm(n,f) for Waste Transmutation

Collaboration with RUG, ILL and in support to Industry and the OECD Data-bank

This is an important minor actinide for waste transmutation studies and in 2001 the data analysis of $^{245}Cm(n,f)$ was performed and compared to $^{246}Cm(SF)$. New measurements on $^{247}Cm(n,f)$ were performed at ILL, the thermal $^{247}Cm(n,f)$-data have been analysed and the ternary α-yield was determined. New measurements are planned at ILL to determine the tritium yield in the thermal neutron induced fission of ^{247}Cm.

Intercomparison of Neutron Fluence Measurements

In collaboration with BIPM/CCRI and PTB, Braunschweig

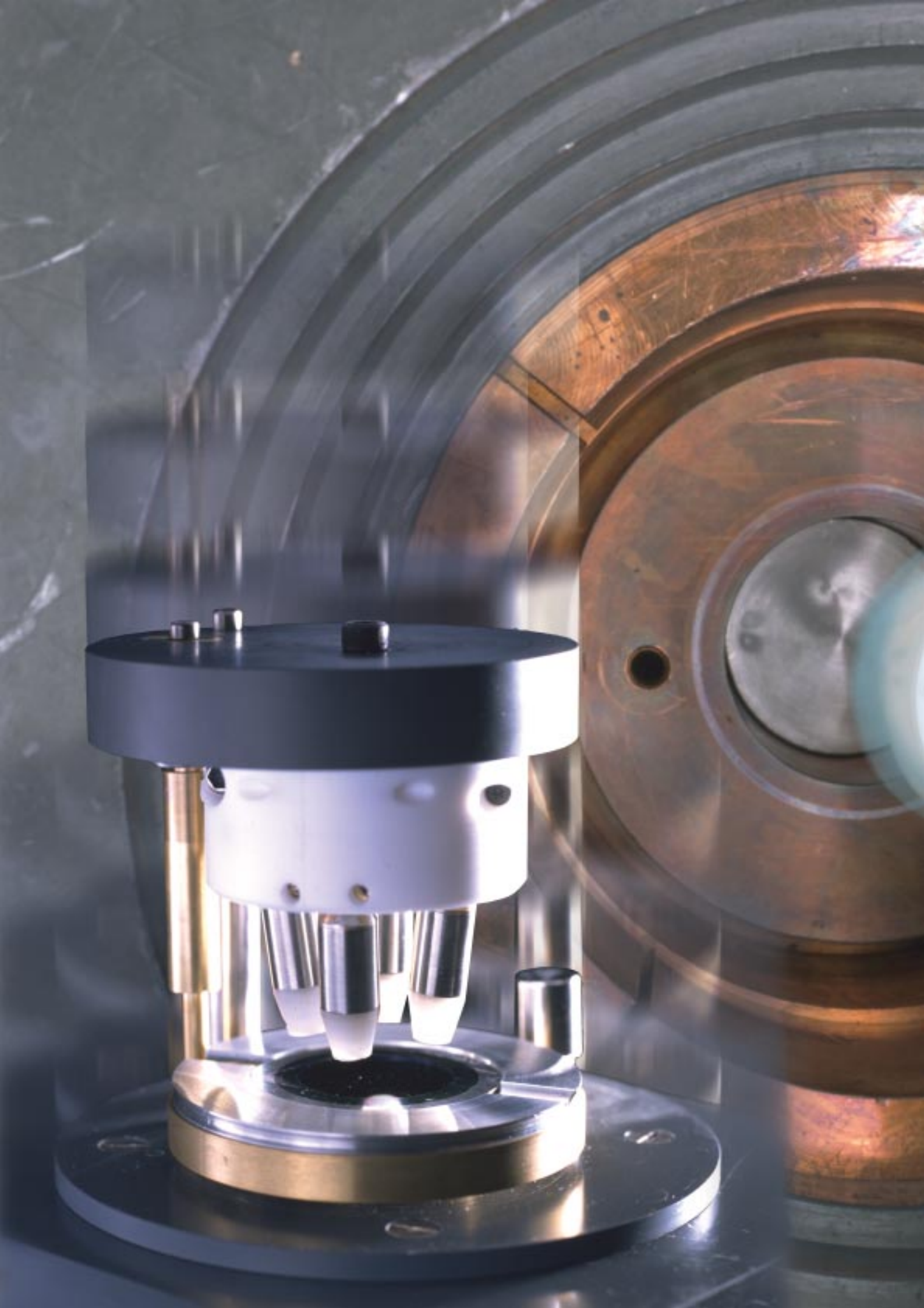
This BIPM key comparison of neutron fluence measurements at 1.2, 5.0 and 14.8 MeV with the IRMM proton recoil telescope was organised by the PTB (Physikalisch-Technische Bundesanstalt, Germany) within the frame of BIPM/CCRI key comparison exercises.

All measurements were successful and the data acquired were evaluated. A new Windows based programme ("Telescope") for fluence calculations was developed and the data analysis was finalized for final submission to the BIPM. Two new tasks commenced on fluence measurements and spectrum characterisation: the determination of the background neutron spectrum of Titanium-Tritide targets at the Van de Graaff of the University of Ohio, and the development of a new Bonner Sphere system at IRMM —important for the characterisation of the neutron source spectrum.

Collaboration with the Candidate Countries

The purpose of this task is to preserve and develop the knowledge of neutron data measurements and neutron data evaluation in the Candidate Countries and to integrate this knowledge into the programme at IRMM.
A study contract with S. Sudar (University of Debrecen, HU) concerning the evaluation of Tc and Pb cross sections measured at IRMM and FZ Jülich was completed. Contracts were awarded to Ferenc Cserpak and Laszlo Olah (15 months, University of Debrecen, HU), Ivan Ruskov (15 months, INRNE, Sofia, BG) Natalia Janeva (3 months, INRNE, Sofia, BG), and Sandor Sudar (3 months, University of Debrecen, HU).
A publication together with V. Avrigeanou on modelling of V cross-sections measured at IRMM was submitted to Physical Review C. V. Semkova started her postdoc work and completed a considerable number of cross-section measurements with reactions on Ni and Pb. The work was reported to the JEFF project. The measurement of the average capture cross-section of ^{232}Th was analysed in the 5 keV–200 keV energy range in collaboration with N. Ianeva (INRNE, Sofia, BG), during her stay at IRMM. Ivan Ruskov finalised the analysis on the ^{239}Pu(n,f) fission yield in resonances.

Prof. Vladuca and A. Tudora worked on the evaluation of fission cross sections and prompt neutron multiplicities and spectra for ^{239}U and ^{238}Np. M. Avrigeanu worked for 3 months at IRMM as scientific visitor on the alpha-particle optical-model potential and the pre-equilibrium contribution up to 150 MeV for ^{100}Mo and ^{90}Zr.



JCR Reference Laboratory for Radionuclide Metrology

JRC Reference Laboratory for Radionuclide Metrology

Rationale

Metrological measurements of radioactivity and the characterisation of the corresponding radionuclides are indispensable for a reliable assessment of α-, β- and γ-radiation emitted from environmental matrices, contaminated food/drink and for proper medical diagnosis and treatment. The importance of Radionuclide Metrology is even more exemplified since the signing of the Mutual Recognition Arrangement between National Metrology Institutes (NMIs) (including IRMM representing the European Commission) under the auspices of the BIPM, the Guardian of the Metre Convention. This arrangement spells out the need for so called "key comparisons" for the establishment of "International Equivalence" of radioactivity measurements. To achieve this, participation in and organisation of international primary radioactivity comparisons at the highest level of accuracy and providing direct traceability to the SI are indispensable. Furthermore, reference materials need to be characterised and certified for their radioactive components and accurate radioactivity measurements need to be performed for nuclear medicine and radiotherapy applications. The ability to perform ultra low-level radioactivity measurements is also becoming increasingly important especially in the fields of environmental safeguards, medicine and for the semiconductor industry.

Benefit to Customers

IRMM provides its customers with a vital link in the chain of metrology and traceability for radioactivity measurements. Through collaboration networks, these organisations can benchmark themselves for specific measurements of radionuclides. They may provide candidate reference materials (e.g. NIST ocean shellfish), participate in international evaluation rounds, proficiency testing exercises, seek advice on aspects of radionuclide measurements and/or reference materials certified for radioactivity, exchange information and help contribute to the development of a structured measurement system in radionuclide metrology. On regular occasions, scientists from these organisations come to work at IRMM and vice-versa. In international organisations (EUROMET, ICRM, CIPM/CCRI) IRMM takes office in various functions.

IRMM has the neutral status to evaluate measurements on politically sensitive issues (e.g. radionuclides in food) and has a long standing expertise in ultra low-level radioactivity measurements in various complex matrices (e.g. food and environmental matrices). An important role (on behalf of the European Commission) is to help build and maintain a structured measurement system in radionuclide metrology. IRMM's contribution to European Radionuclide Metrology is complementary, as there are only few top laboratories in this field.

Future Prospects

One principal aim is to build up a European network (CELLAR Network) of underground laboratories for the determination of low levels of radioactivity in environmental and food samples, which could provide quality assurance for radiation monitoring in the EU and the Candidate Countries as well as rapid support in crisis situations The partners are MPI für Kernphysik Heidelberg, Germany, LNGS, Italy, LSCE, France, PTB, Germany, University of Iceland and VKTA, Germany).

First negotiations for the creation of a "Virtual European Radionuclide Metrology Institute" (VERMI), were al-

ready undertaken. VERMI aims at becoming the Reference Point for radionuclide metrology laboratories in the European Research Area.
In collaboration with the JRC's Environment Institute and with direct support of DG Environment, a service of reference measurements and organisation of intercomparisons for REM (Radiation Environmental Monitoring) system will also be developed.
IRMM's work in Radionuclide Metrology is carried out in close co-operation with other European primary standards laboratories under the auspices of EUROMET, the International Bureau of Weights and Measures (BIPM), the Consultative Ionising Radiation Committee (CCRI) of the Metre Convention, the International Committee for Radionuclide Metrology (ICRM) and the International Atomic Energy Agency (IAEA).

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Radionuclide Metrology

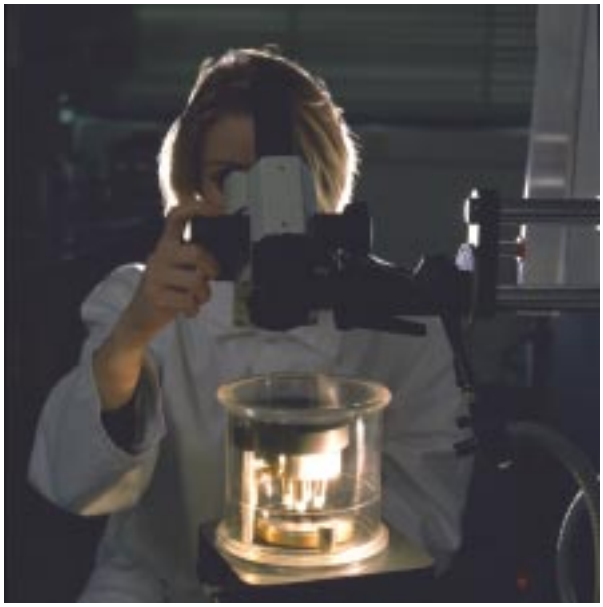
^{237}Np Measurements

EUROMET project

The radionuclide ^{237}Np is an important component in nuclear waste which will be stored in final waste repositories. It is of paramount importance to accurately know its decay scheme and to provide primary standards for the simulation of its behaviour in final repositories, e.g. heat dissipation.
In the laboratory, data acquisition software and hardware were tested for α–γ coincidence measurements and the mechanical set up of the equipment for the α–γ coincidence measurements was prepared. A previously measured alpha particle spectrum was analysed in CIEMAT and they confirmed at least one of the five new peaks detected at IRMM.

IRMM Source Drier

Improving the preparation of solid deposits on various substrates by accelerated drying of liquid deposits to yield homogeneous distribution and minimised crystal sizes is vital for good radioactivity measurements. IRMM developed a new technology for this application and it is presently being patented. The patent application was submitted to the US-Patent and Trademark Office, final design work commenced and the prototype was opened for inspection. Brass parts were affected by acid fumes from evaporating sources so reconstruction is presently ongoing to replace those parts. Already requests have been received from NPL, UK and BNM – LNHB, France for purchasing an instrument each.



Ultra low-level radioactivity measurements

IRMM was requested by the Japanese government to assist in retrospectively determining the radiation dose to which the general public living in the village of Tokai-

mura were exposed to during the nuclear accident in 1999. Using the underground laboratory HADES at SCK·CEN (Belgium), IRMM had already completed the first measurements of ultra-low activities (mBq) of Cr-51 (half-life = 28 days) in stainless steel samples and afterwards received 9 additional samples with the request to measure ultra-low activities of Co-60 (half-life = 5 years). Screening measurements for all samples were performed and final measurements of one sample were completed. Two partners in the CELLAR network (PTB and LNGS) will also perform measurements in their underground laboratories.
Because of IRMM's ultra low-level gamma-ray spectrometry (ULGS) measurement capacity in the underground laboratory HADES, IRMM is a partner in the BOREXINO collaboration. BOREXINO is a huge (18 m diameter) liquid scintillator detector for measurement of solar neutrinos and is located 1400m underground in the Gran Sasso laboratory in Italy. The role of IRMM is to measure materials that are to go into the BOREXINO detector and since there are extreme demands on the radiopurity on all construction details, only a few laboratories can provide the measurement capacity needed. This year IRMM has successfully measured nylon and stainless steel samples.

^{238}Pu CIPM/CCRI(II) Key Comparison

IRMM has standardised the radioactivity concentration of a ^{238}Pu solution in the frame of a CIPM/CCRI(II) key-comparison. Two dilutions of the ^{238}Pu mother solution were made and thin, open sources were prepared for the three different activity levels. Measurements by 4π liquid scintillation spectrometry and alpha particle spectrometry including (Large Pressurised Proportional Chamber (LPPC) measurements and alpha low geometry counting) were conducted, completed and the results were reported to the BIPM well before the deadline.

^{89}Sr CIPM/CCRI(II) Key Comparison

An International comparison of the radioactivity concentration of a ^{89}Sr solution was organised by BIPM/CCRI(II) because ^{89}Sr is a candidate for the establishment of international equivalence (extended SIR).
IRMM checked the solution for γ-impurities (^{85}Sr was found) and prepared 28 solid sources and 25 LS vials quantitatively and performed measurements using 3 different and independent methods; (1) 4π liquid scintillation spectrometry (2) 4π CsI sandwich spectrometer and (3) large pressurised 4π proportional counter. The results were submitted to the BIPM and published.

NIST Shellfish RM

Reference marine biological samples are necessary to test the performance of the analytical methods employed in surveying and monitoring radioactive materials in the sea and to assure comparability and reliability of data obtained from different laboratories. In this project IRMM collaborated with NIST in the certification of a Shellfish RM.
The gamma-ray spectrometry was completed, the data analysed and the final report was written and sent to NIST. The alpha spectrometry measurements were completed and are presently being analysed.

Milk Powder and Soil Reference Materials

Projects for the certification of 2 RMs commenced in collaboration with the IAEA. An initial study on the dissolution of soil and sediment samples by fusion was carried out and the report was made available. The contract with IAEA was signed and a time schedule and task distribution list was sent to the IAEA co-ordinator. Chemical separation procedures were tested and the samples were delivered (15 bottles of 250g each). Details on the tracers, sample size, etc. were agreed and preliminary gamma-ray spectrometry measurements were performed. This project is now set to run in 2002.

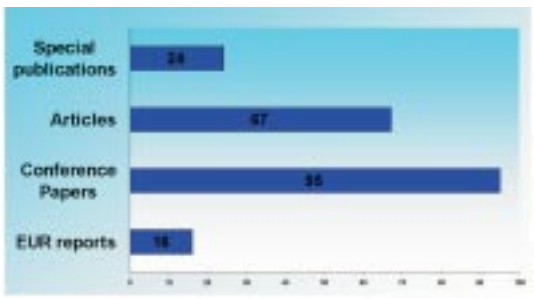
External Recognition

In 2001, IRMM organised and handled no less than 287 institute visitors. Invited lectures totalled 20 including a distinguished lecture from Wolfgang Schwitz (METAS) entitled *"From one global measurement system to the global mutual recognition of measurements"*.
IRMM made a concerted effort to enhance its strategic media coverage whereby a total of 20 articles were published in various journals/tabloids ranging from Nature and Cordis RTD News to "Nachrichten in der Chemie" and "Die Zeit" to local tabloids like "Tijd", "Het Belang Van Limburg" and "STOLA Dessel".

Visitors to IRMM

Scientific Recognition

In 2001 there were 33 invited presentations to international conferences and workshops, 3 international conferences were organised and a further 19 were sponsored. IRMM held 84 positions on scientific committees and bodies of international organisations and staff members were requested to review 68 papers during the year. A total of 24 accolades and letters of appraisal were filed and 6 professorships were held during the year. In terms of publications there were 67 articles in refereed journals, 95 conference papers, 16 EUR reports and 24 special publications making a total of 202 publications. Also in promotion of EU standardisation it is interesting to note that since 1998, 22 staff members have been employed by reference organisations in the Member States and IRMM is happy to report continued collaboration with those organisations.

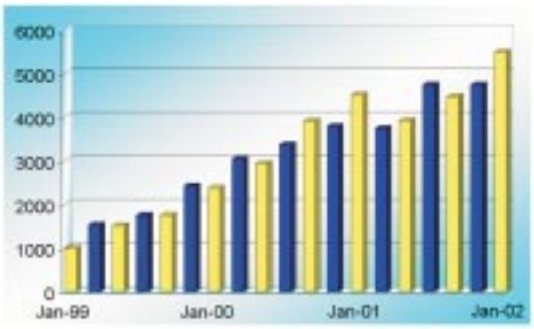


IRMM Publications

In terms of staff awards, Prof. Manfred Grasserbauer received the Austrian "Ehrenkreuz für Wissenschaft und Kunst 1. Klasse" for his engagement in international science.
Dr. Philip Taylor was elected chairman of the Commission on Atomic Weights and Isotope Abundances of IUPAC. IUPAC serves to advance the worldwide aspects of chemical sciences and contribute to the application of chemistry in the service of mankind.
Dr. Stefanie Trapmann won the JRC Young Scientist Prize in recognition of her contribution to the development and improvement of GMO reference materials.
A poster by Thomas Prohaska, et al on ICP-ID-MS measurements of Pb, Cu, Cd and Cr in Sediment and Fly-ash won the LNE award at the *"Environment, Health and Safety: A Challenge to Measurements"* conference organised by INERIS and supported by the European Commission.
The publication *"Evaluation of Detector Dead Time Calculation Models for ICPMS"* by Dr. Christophe Quètel, was among the 10 most accessed papers in the online version of the Journal for Analytical Atomic Spectroscopy —a leading journal in Analytical Chemistry.
Prof. Manfred Grasserbauer was invited to join both the Editorial Advisory Board of *"Analytical Chemistry"* which is globally the most important journal in the field and the International Advisory Board of "Analytical and Bioanalytical Chemistry" —the major European journal for these disciplines.
Dr. Piotr Robouch, was invited to become member of the Editorial Advisory Board for the *"Journal of Radioanalytical and Nuclear Chemistry"*.

The IRMM Website www.irmm.jrc.be

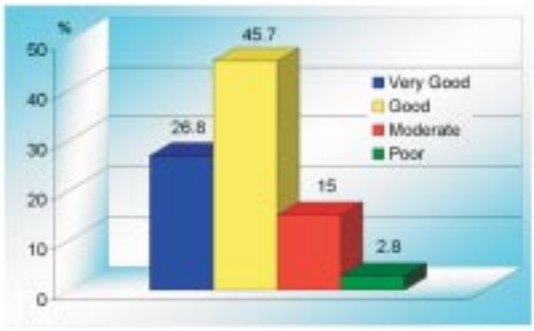
The IRMM homepage is updated once per week and customer feedback is closely monitored.
External visits to the IRMM's homepage have increased 5 fold since January 1999 (i.e. in 3 years). For example in January 2002 IRMM received 5115 visits originating from over 74 different countries whilst in January 1999, the figure stood at a mere 990 visits.



Visits to IRMM Homepage

Customer Survey 2001

A survey was conducted to assess customer satisfaction and identify areas for providing an improved service to our customers. The results are as follows:



Results of Customer Satisfaction Survey 2001

IRMM's participation in Networks

Food Safety and Quality Networks

European Network of GMO Laboratories (ENGL)

The activities herein support Directive 90/220/EEC on GMO release into the environment, Regulation 258/97 on Novel foods, and Regulation 1139/98 on the labeling requirements for two GMO products placed on the market (soybean and corn) and new legislation proposed by the Commission.
This network is co-ordinated by the JRC-IHCP and aims for an intensive collaboration between the European competent authorities as well as reference and research laboratories from the public and private sectors. It aims to establish databanks, harmonised protocols for compliance, validated detection methods and Certified Reference Materials. IRMM is heading the working group on reference materials.
The network also acts as a link with the Third countries like USA, Japan, pursuing a global harmonisation of sampling and detection techniques as well as a mutual acceptance of CRMs. It will be strongly involved in the operation of the Community Reference Laboratory for GMOs which to be established in the JRC.

European Network on TRANSgenic FOOD crops (ENTRANSFOOD)

This thematic network focuses on food safety and consumer protection within the scope of genetically modified food. IRMM's mandate is to contribute to an inventory of GMO CRMs, reference methods, validation and standardisation. Extra curricular work concerns safety assessment, horizontal gene transfer and the examination of unintended effects.

Bioexpress Network

This network has two main objectives, (1) the identification of scientific and technical requirements for the exploitation of biotechnology (e.g. new measurement techniques, reference materials and standards) and (2) the identification of the pre-normative research needed to ensure that society can have confidence in the products of the biotechnology sector (e.g. product conformity assessment, regulatory and trade compliance, etc.).

BSE Reference Laboratory Network

IRMM has an active mandate in this newly formed network co-ordinated by the Community Reference Laboratory for TSE (the UK Central Veterinary Laboratory Agency) to produce and provide control materials for future BSE proficiency testing schemes.
In this way the JRC will continue to reinforce its capacity to integrate its know-how into this key area of Community interest and assist the EU in re-establishing the confidence of public and consumers in the way that food is produced, regulated and controlled.

Validation and Standardisation of Diagnostic Polymerase Chain Reaction (PCR) for the Detection of Food Borne Pathogens

The main objective of this network is to facilitate the implementation of diagnostic PCR for both verification and detection of food borne pathogens (e.g salmonella, escherichia coli, etc) through the harmonisation and standardisation of methods in Europe.

Network for Water Determination in Food

IRMM's role in this network to develop and validate new methods for water determination in food.

Health

Network for the Development of Clinical Reference Materials in co-operation with the International Federation for Clinical Chemistry

Since 1996, IRMM and the IFCC have been producing Certified Reference Materials. This network will also provide the basis for introducing the principles of chemical metrology to the clinical chemistry sector especially now with the advent of the European "Directive for In Vitro Diagnostic and Medical Devices" (IVD-Directive 98/79/EC).

Joint Committee for Traceability in Laboratory Medicine (JCTLM)

The ultimate goal of this network is to develop a global reference system for clinical diagnosis encompassing the establishment of topical networks of Reference Laboratories, development of Reference Methods and the production of Certified Reference Materials.

Metalloenzymes and Chemical Biometrics

This involves the characterisation of metalloproteins which are key molecules for disease biological processes.

EMIR – European network for Medical radio-Isotope and beam Research

EMIR's mandate is to develop bio-medical applications of nuclear technologies and methodologies, in view of applications concerning the prevention, diagnosis and treatment of diseases.

Reference Materials and Measurements Networks

Networks for the Production of Certified Reference Materials (co-operation with DG Research)

IRMM collaborates closely with Europe's Major National Research Institutions for both Chemical and Physical Measurements in the certification of Certified Reference Materials. As second largest supplier in the world, IRMM offers over 500 different BCR® and IRMM CRMs, with a total stock load of some 500,000 samples.

CIPM/CCRI-BIPM Network for Primary Radioactivity Measurements

Here primary radioactivity measurements at the highest level of accuracy are carried out in support of National Metrology Institutes. IRMM participates in and/or organises international Key-Comparisons and is developing the future World Primary Standard of radioactivity for the BIPM.

EUROMET-IONRAD Network for Radioactivity Measurements

With a mandate to promote the co-ordination of metrological activities and services with the purpose of achieving higher efficiency, IRMM organises and participates in EUROMET projects concerning research in radioactivity measurements and also works for the establishment of the Appendix C database of the Mutual Recognition Arrangement.

Virtual European Radionuclide Metrology Institute (VERMI)

With the four leading Radionuclide Metrology laboratories in Europe, the VERMI aims to become the focal point in Radionuclide Metrology in the ERA. Its main objectives are to solve basic problems in primary radioactivity standardisation, develop and improve methods and train young researchers.

CELLAR (Collaboration of European Low-level underground LaboRatories)

CELLAR is a network involving Europe's leading underground laboratories performing gamma-ray radioactivity measurements. Its mission is to promote higher quality and sensitivity in ultra low-level gamma-ray radioactivity measurements for the improvement of crisis management, environment, health and consumer protection standards in Europe.

Metrology in Chemistry Networks

EUROMET-BIPM Network for Metrology in Chemistry

IRMM, as the Metrology Institute of the Commission, is a full and active partner of this European metrology network, which has been pioneering in research integration since more than a decade. IRMM collaborates in an integrated way with its national partners, and contributes significantly to the programmes of BIPM-CCQM and EUROMET by organising studies on analytical performance, degree of measurement equivalence and BIPM, EUROMET key comparisons.

Joint European Programme for Primary Isotopic Measurements (JEPPIM)

The JEPPIM Network has merged all the major European players involved in Primary Isotopic Measurements.

International Measurement Evaluation Programme (IMEP)

Established in 1989, and having carried out over 15 IMEP rounds (involving over 1000 laboratories), the IMEP network is growing from strength to strength. It's mandate is to promote an awareness in chemical measurements via analysis and evaluation particularly for reference laboratories in important chemical measurement sectors.

Biometrology Network (BIPM-CCQM Working Group)

This main task of this network is to develop metrological based concepts for biometrology and produce reference materials required for quality assurance in biochemical analysis. The network will develop concepts for Quality Assurance of biochemical measurements with the focus on genomics (DNA analysis) and proteomics (protein analysis). The result should be a measurement system that will provide reliable and internationally equivalent results in forensic testing, genetics identification, and analysis of biotechnology products and clinical diagnostic markers.

EU-CC-MiC Network

This is a network of NMIs (National Metrology Institutes) in the Candidate Countries linked with IRMM and the purpose is for the NMIs to demonstrate the degree of equivalence of their measurement capability, and to compare that to the present "acquis" of the EU. This is achieved by giving them advice, extensive training at IRMM and in their home countries (via the TrainMiC activity), as well as providing participation to the existing programmes (e.g. free participation in the International Measurement Evaluation Programme (IMEP)), donating CRMs, etc.

MedMet Network

In view of the future free trade zone in the Mediterranean area, the goal is to set-up an operational network of NMIs (National Metrology Institutes) in these States and for the NMIs to demonstrate the degree of equivalence of their measurement capability.
Again, this is achieved by giving them advice, extensive training at IRMM, as well as providing participation to the existing programmes (e.g. IMEP).

Nuclear Safety / Safeguards and Nuclear Waste Networks

Networks for Neutron Data Generation

The purpose of MICANET (Michelangelo Network for Competitiveness and Sustainability of Nuclear Energy in the European Union) is to propose a strategy for European R&D aimed at keeping the industrial nuclear option open in the 21st century. The approach will be global including all aspects from the fuel cycle front to final disposal, from technique-economic issues to political, social and psychological dimensions of acceptance.
The n-TOF-ND-ADS activities at the new time-of-flight facility at CERN aim at producing, evaluating and disseminating neutron cross sections of a precision of a few % for the majority of the isotopes relevant to the waste incineration and ADS design.
The High-Temperature Reactor Technical Network (HTR-TN) is a European Network for the co-ordination and management of expertise and resources in developing advanced HTR technologies.

Network of Metrology and Quality Assurance for Nuclear Safeguards

Here IRMM performs 'referee' measurements needed for Nuclear Safeguards and to support the expansion of an independent European metrological capability in the area of nuclear analysis.

Nuclear Proficiency Testing (PT) Network

IRMM's contribution is more than significant through its NUSIMEP (Nuclear Signatures International Measurement Evaluation Programme) and REIMEP (Regular European Interlaboratory Measurement Evaluation Programme) activities that have spun off from IRMM's long standing expertise in nuclear analysis.

Radioactivity Environmental Monitoring Network (REM)

The REM is a network operated by the JRC-IES to collect real-time data of radioactive fall-out in the EU for DG Environment. IRMM's role is mainly to check the measurement capabilities of the local field laboratories by providing reference samples and measurements.

IRMM Co-operations inside the EU

- Bundesanstalt für Materialforschung und-prüfung (BAM), Berlin, Germany
- Bureau International des Poids et Mesures (BIPM), Paris, France
- Bonn University, Germany
- Campagnie Générale des Matiéres Nucléaires (COGEMA), France
- Carso, Lyon, France
- CEA, Cadarache and Saclay, France
- Central Science Laboratory (CSL), United Kingdom
- Centre National de la Recherche Scientifique (CNRS), Villeurbanne, France
- Centro de Investigaciones Energétices Medioambientales y Tecnológicas (CIEMAT), Madrid, Spain
- Centro Nazionale per i Materiali di Riferimento (CNMR), Rome, Italy
- CNRS-IReS, Strasbourg, France
- Comité Européen de Normalisation (CEN), France
- Consorzio Italiano per la Ricerca Medica (CIRM), Italy
- Commissariat à l'Energie Atomique (CEA), France
- Comité de Liaison Européen de l'Industrie de la Parfumerie, des Produits Cosmétiques et de Toilette (COLIPA), Brussels, Belgium
- Consejo Superior de Investigaciones Cientificas (CSIC), Spain
- EQALM København, Denmark
- EURACHEM, Moving Chair
- EUROMET, Moving Chair
- European Collaboration on Accreditation (EA), Moving Chair
- European Synchrotron Radiation Facility (ESRF), Grenoble, France
- Finnigan MAT, Bremen, Germany
- Forschungszentrum (FZJ), Jülich, Germany
- Forschungszentrum (FZK), Karlsruhe, Germany
- Fraunhofer-Gesellschaft (FhG), München, Germany
- Hamburger Synchrotronstrahlungslabor, Hamburg, Germany
- Hellenic Institute for Metrology (HIM), Thessaloniki, Greece
- Institute for Agrobiotechnology (IFA), Tulln, Austria
- Institut Laue-Langevin (ILL), Grenoble, France
- Institute for Inorganic Chemistry of the University of Köln, Germany
- International Atomic Energy Agency (IAEA), Vienna, Austria
- Istituto di Metrologia Gustavo Colonnetti (IMGC), Torino, Italy
- Istituto Superiore di Sanità (ISS), Rome, Italy
- Laboratoire des Sciences du Climat et de l'Environment (LSCE-vallée), Gif-sur-Yvette, France
- Laboratoire National d'Essais (LNE), Paris, France
- Laboratori Nazionali del Gran Sasso (LNGS), Assergi, Italy
- Laboratoire Primaire des Rayonnements Ionisants (LPRI), Saclay, France
- Laboratory of the Government Chemist (LGC), Teddington, United Kingdom
- Max-Planck-Institut für Kernphysik Heidelberg (MPI), Germany
- Merck Gmbh, Darmstadt, Germany
- Messer Griesheim, Duisburg, Germany
- Montanuniversität Leoben, Austria
- National Physical Laboratory, London, United Kingdom
- Nederlands Meetinstituut (NMi), Delft, The Netherlands
- NRG Petten, The Netherlands
- Organisation for Economic Cooperation and Development (OECD), France
- Physikalisch Technische Bundesanstalt, Braunschweig, Germany
- Promochem, Wesel, Germany
- Risø National Laboratory, Roskilde, Denmark
- Roche-Böhringer, Mannheim, Germany
- Sheffield Hallam University, United Kingdom
- Studiecentrum voor Kernenergie, Mol, Belgium
- Swedish National Testing and Research Institute (SP) Borås, Gothenburg, Sweden
- Technical Research Centre of Finland (VTT), Finland
- Technische Universität München, Germany
- Technische Universität Wien, Austria
- TNO, Zeist, The Netherlands
- TU Delft IRI, The Netherlands
- Umweltbundesamt, Wien, Austria
- Universitaire Instelling Antwerpen (UIA), Belgium
- Universiteit Barcelona, Spain
- University of Athens, Greece
- University of Bonn, Germany
- University of Cork, Ireland
- University of Gent, Belgium
- University of Jyväskylä, Finland
- University of Köln, Germany
- University of Leuven, Belgium
- University of Mining and Metallurgy, Leoben, Austria
- University of Örebro, Örebro, Sweden
- University of Oxford, United Kingdom
- University of Pavia, Italy
- University of Surrey, Guildford, United Kingdom
- University of Uppsala, Dept. of Radiation Sciences, Studsvik, Sweden
- Verein für Kernverfahrenstechnik und Analytik Rossendorf e.V. (VKTA), Dresden, Germany
- VDA, Frankfurt, Germany
- Vrije Universiteit Amsterdam, The Netherlands
- Vlaamse Instelling voor Technologisch Onderzoek (VITO), Mol, Belgium
- Wagner Analysen Technik und Vertrieb, Bremen, Germany

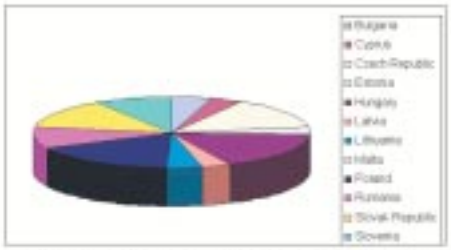
IRMM Co-operations outside the EU

- A.A. Bochvar All Russia Research Institutes of Inorganic Materials (VNIINM), Obninsk, Russia
- Asahi, Tokyo, Japan
- Agency of Industrial Science and Technology of Japan (AIST), Tokyo, Japan
- ATOMKI, Institute for Nuclear Research, Hungarian Academy of Sciences, Debrecen, Hungary
- Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials (ABACC), San Paulo, Brazil
- Bulgarian Academy of Sciences (BAS), Institute for Electronics, Sofia, Bulgaria
- CITAC (Co-operation on International Traceability in Analytical Chemistry), Moving Chair
- CONICYT (Chilean Commission for Science and Technology), Chile
- Curtin University of Technology, Australia
- Cyprus Central Laboratory, Nicosia, Cyprus
- EMPA, St. Gallen, Switzerland
- Fluka Chemie AG, Switzerland
- INRNE, Sofia, Bulgaria
- Institute Jozef Stefan (IJS), Ljubljana, Slovenia
- International Nuclear Target Development Society, Deer Harbour, USA
- International Committee for Radionuclide Metrology, Washington, USA
- International Federation of Clinical Chemistry (IFCC), Ontario, Canada
- International Standards Organisation (ISO), Geneva, Switzerland
- IPPE, Obninsk, Russia
- Japan Atomic Energy Research Institute (JAERI), Tokai, Japan
- Japan Nuclear Corporation, Tokai-mura, Japan
- Japanese Committee for Clinical Laboratory Standards, Tokyo, Japan
- Japanese Nuclear Cycle Institute, Tokai, Japan
- Khlopin Research Institute (KRI), Leningrad, Russia
- Korean Atomic Energy Research Institute (KAERI), Korea
- Korean Institute for Standards and Science (KRISS), Toejon, Korea
- Los Alamos National Laboratory, USA
- Metrology and Accreditation (METAS), Switzerland
- MFA Research Institute for Technical Physics and Materials Science, Budapest, Hungary
- Monsanto, USA
- National Institute for Standards (NIS), Giza, Egypt
- National Institute for Standards and Technology (NIST), Washington, USA
- National Measurement Laboratory, Sydney, Australia
- National Metrology Institute of Japan (NMIJ), Tsukuba, Japan
- New Brunswick Laboratory, Chicago, USA
- NIAST, Seoul, Korea
- NIPNE, Bucharest, Romania
- Novartis Seeds, Basel, Switzerland
- Nuclear Metrology Laboratory (VNIIEF), Moscow, Russia
- Nuclear Physics Institute, Rez near Prague, Czech Republic
- Oak Ridge National Laboratory, Tennessee, USA
- Pancyprian Union of Chemists, Nicosia, Cyprus
- Power Reactor and Nuclear Fuel Development Co-operation, Japan
- Research Centre for Certified Reference Materials, Beijing, China
- Russian Academy of Sciences, Institute of Microelectronics Technology, Chernogolovka, Russia
- Qinghai Institute of Salt Lakes, China
- Slovak Institute of Metrology, Slovakia
- Standards & Metrology Institute, Ljubljana, Slovenia
- Swiss Federal Office of Metrology and Accreditation (METAS), Wabern, Switzerland
- University of Bucharest, Romania
- University of Debrecen, Hungary
- University of Iceland, Reykjavik, Iceland
- Western Australia Institute of Technology, Perth, Australia

Successes under the Enlargement Programme

Metrology in Chemistry Workshop for Candidate Countries (Candidate Countries)

On 12th-13th February 2001, IRMM hosted a workshop entitled *"Improving the Scientific Base for Metrology in Chemistry (MiC) in Accession Countries"*. This workshop was attended by 52 participants from all 12 Candidate Countries plus invited speakers, external observers, DGs and IRMM staff. The participants were selected from mainly National Metrology Institutes, national accreditation bodies and universities. Presentations, bi-lateral discussions and training of regional co-ordinators for IRMM's International Measurement Evaluation Programme (IMEP) took place. IMEP is the only tool of it's kind to ascertain the true status of chemical measurements and it is gaining increased popularity in the Candidate Countries. Up to now a total of 340 laboratories from Candidate Countries participated (free of charge) in various IMEP rounds. Following short sabbaticals at IRMM, Prof. Ewa Bulska (Poland), Prof. I. Leito (Estonia), Dr. E. Vasilleva (Bulgaria) and Dr. B. Csefalvayova (Slovak Republic) created the first drafts of the *"Status Report Metrology in Chemistry"* for their home countries. Co-ordinated by IRMM, such reports are the end product of interactive collaboration involving major stakeholders in chemical measurements from each of the Candidate Countries. The report for Slovenia was completed following the termship of Dr. Nineta Majcen and reports for both Lithuania and Cyprus are presently in progress. Through these and other proactive initiatives, IRMM is sowing the seeds to promote a common European measurement system in the Candidate Countries.



349 labs in EU-CC's used IRMM's cost free opportunity to bench mark their measurement capability via IMEP

Training

IRMM organised and financed a 3-day training seminar in Romania on *'Improving the Quality of Chemical Measurements'*. 25 persons responsible for chemical laboratories (environmental, food and clinical sectors) throughout Romania attended. The scientific programme was established by IRMM, using input from the Romania Accreditation Body (RENAR) and the Romania National Metrology Institute (INM). RENAR highly appreciated this technical support project which will both strengthen the Romanian measurement infrastructure and boost their current negotiations for integration.

A first training course for Metrology in Chemistry was held at Maribor, Slovenia from 11th-13th October 2001. In total 25 people from 11 Candidate Countries participated in this high level training which was held under the scientific auspices of IRMM (3 IRMM lecturers), and intended for laboratory managers as well as staff from accreditation bodies, government agencies and ministries. Lectures given were followed by practical courses, including case studies on uncertainty estimation as well as case studies on measurement problems related to EU directives. IRMM also provided support to conferences through giving seminars on Traceability in Chemical Measurement in Cyprus, co-organizing and sponsoring Food Conferences in Warsaw and in Bled and the Isotope Conference in Zakopane.
Another successful initiative in 2001 was the participation in JRC information days held in Bratislava (April 2001), Riga (June 2001), Prague (September 2001) and Lublijana (December 2001).

Enlargement Web-site

(http://www.irmm.jrc.be/imep): IRMM established an enlargement web-site and linked it to the JRC enlargement website **(http://www.jrc.cec.eu.int/enlargement)**. This website is providing for effective communication with Candidate Countries especially the National Metrology Institutes (e.g. with regional co-ordinators for the IMEP programme: www.imep.ws). In this way, people in this network can access up-to-date information (planning of IMEP rounds, contribution to certification etc) and use this information when communicating to field laboratories in their countries.

JRC Neutron Data Measurement and Evaluation Activities

As most Candidate Countries, like in the EU, generate a substantial amount of their electricity using nuclear means it is therefore important to harmonise the policies and standards of safety and environmental protection and integrate all activities within the nuclear energy domain. A total of 10 scientists from these countries were engaged at IRMM in 2001 performing research ranging from Th and Np capture experiments and Ni and Co activation measurements, to cross-section calculations for the neutron induced fission of ^{235}U, ^{239}Pu and spontaneous fission of ^{252}Cf, and model calculations in support of evaluations of measured activation cross sections on V, Tc, Pb and Mo.

Mediterranean States

The Mediterranean States (MED-Met network) have the mandate to establish the Free Trade Zone in 7 years time. To promote this initiative, IRMM established first contacts with the National Institute for Standards in El Giza, Egypt, and foundation discussions were held for the construction of a structured measurement system in chemistry.

Benchmarking Indicators for 2001

As part of Total Quality Management, the Institute again collected Key Performance Indicators in order to benchmark itself, identify areas for improvement and increase it's transparency as stipulated in the European Commission Reform programme.

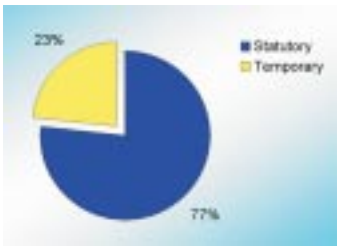
		66 IRMM Key Performance Indicators - 2001	
		Description of Indicators	2001 Results
		"Support EU policy makers and improve every-day life of the European citizen"	
1	Impact on the EU policy process		
	1.1	New EU legislation upon which JRC research had/has a decisive impact or where the JRC is mentioned in the legal	0
	1.2	No.of interservice consultations in which the IRMM has made a relevant contribution	1
	1.3	Percentage of budget linked to Commission strategic priorities 2000-2005	100%
	1.4	Percentage of project tasks relevant to DGs with a direct link to EU-legislation	92%
2	Deliverables to Member States' institutes (and international organisations) on EU issues		26
3	Contributions to EU Standardisation and Reference Systems worldwide		
	3.1	No. of Key comparisons (incl. BIPM) organised	14
	3.2	No. of Key comparisons (incl. BIPM) in which IRMM has participated (submitted reference values)	31
	3.3	No. of Intercomparisons organised	17
	3.4	No. of Intercomparisons in which IRMM has participated (submitted reference values)	27
	3.5	No of Reference Measurement Certificates and Documents issued (including certificates for RMs)	70
	3.6	No of data transfers to international data banks	5
	3.7	No of types of RMs available in IRMM catalogues (incl. nuclear, non-nuclear and radioactivity)	557
	3.8	No. researchers trained (% from Candidate Countries)	362
	3.9	No of former institute's researchers employed by Reference organisations (cummulative from 1998)	23
	3.10	No of presently valid Global reference points originating from IRMM evaluation (cummulative)	201
	3.11	No units of all BCR and IRMM CRMs delivered to customers (including IRMs, nuclear RMs, etc)	12452
	3.12	Number of participants reached through MEPs (Measurement Evaluation Programmes)	703
4	Results of the customer survey		27% V.Good, 46% Good, 15% Moderate, 3% Poor
5	Marketing and PR		
	5.1	Strategic Media coverage (no of positive articles in media/press)	20
	5.2	No of Visitors	287
	5.3	No of Seminar Lectures at IRMM	20
	5.4	Institute exhibitions (incl. CRMs at Pittcon exhibition, USA, with LGC and BAM)	3
		"Demonstrate scientific competence in mission-related areas"	
6	Networks and Collaborations		
	6.1	No. of bi-lateral collaborations (breakdown EU, CCs and other)	88
	6.2	No of institutional networks (breakdown in EU, CCs and other)	26
	6.3	Success rate in Shared Cost Actions selections	61%
	6.4	Number of partnerships (researchers) to share JRC's research infrastructure (facilities)	11
	6.5	Participation of Candidate Countries in projects	250
7	No of high-quality peer reviewed publications		
	7.1	Books of scientific reference including refereed scientific monographs	1
	7.2	Publications in peer reviewed scientific journals	60
	7.3	Publications in conference proceedings	55
	7.4	Patents	0
8	External recognition		
	8.1	Invited presentations to international conferences/workshops	33
	8.2	No of international conferences organized	3
	8.3	No of international conferences sponsored	19
	8.4	No of positions held by staff on editorial boards of international scientific journals	10
	8.5	No of positions held by staff in scientific committees/bodies of international organisations	84
	8.6	No of papers peer reviewed by IRMM staff on request of Editors of scientific journals.	68
	8.7	Awards received (incl. accolades and letters of appraisal)	25
	8.8	Number of professorships	6
	8.9	No of visit to institute homepage (per year)	51151
	8.10	No of countries from which internet visits originate	74
9	Number of spin off companies and license agreements		0
		"Be a good place to invest in research"	
10	Financials		
	10.1	Total budget (incl. external resources) in MEUR	34.288
	10.2	Revenue generated from external sources	2.361
	10.3	Budget utilisation	99%
	10.4+C30	Percentage of payments within the limit of 60 days	96%
11	Human Resources		
	11.1	No staff days spent on training	1099
	11.2	Training budget per staff member	439
	11.3	Overall gender balance	25% F-75% M
	11.4	No. of permanent staff	165
	11.5	No. of temporary staff	50
	11.6	No. of visiting scientists (gender balance)	1
	11.7	No. of grantholders (gender balance)	25

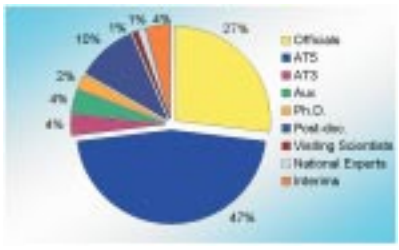
The Institute in figures

Human Resources

As in 2000, this year also saw a huge turnover of staff due to retirements/departures and this had obvious consequences for the recruitment effort and for the assimilation of new staff into the institute's work programme. On 31.12.2001 the total staff number at IRMM stood at 215 persons and a breakdown into statutory and permanent staff as well as category analysis is shown below.

Statutory-Temporary Staff Breakdown

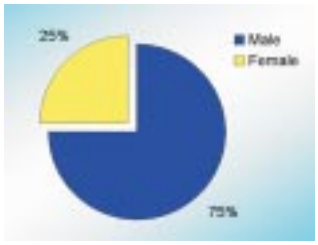


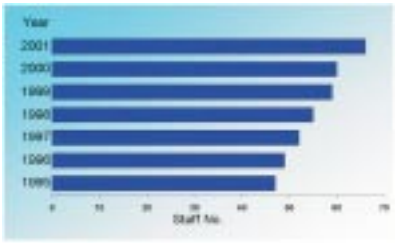


Staff Category Analysis

A conscious effort was made to improve the gender balance situation at the institute and the figures below show the gender breakdown as on the 31st December 2001 and the second figure shows the gradual increase in the number of females working at IRMM from 1995 till now. The number of staff has remained more or less constant over those years.

Gender Breakdown





No. Females at IRMM (1995-2001)

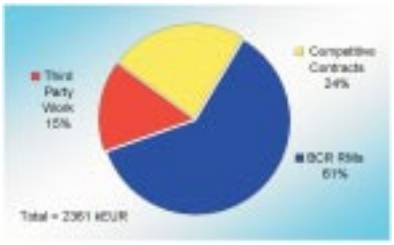
A vital component in human resources management is of course staff training and at IRMM we are delighted to report a significant increase in training actions at the institute for 2001.

Training Statistics (1998-2001)

Budget

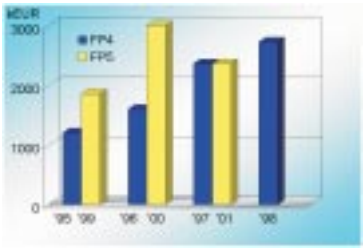
Total institutional budget without the allocation of overheads but including 2600 kEUR for decommissioning and including PECO credits came to a sum total of 34,288 k€ of which specific credits summed up to 4,992 K€.

Institutional Budget Breakdown



Competitive Budget Breakdown

IRMM raised approximately 2,361 k€ of competitive income in 2001, corresponding to about 7% of the total budget.



Competitive Income (1995-2001)

Acronyms

AAS: Atomic Absorption Spectrometry
ANL: Argonne National Laboratory, (USA)
BAM: Bundesanstalt für Materialprüfung (DE)
BCR: Bureau Communautaire de Référence
BIPM: Bureau International des Poids et Mesures
BSE: Bovine Spongiform Encephalopathy
Bt: Bacillus thuringensis
CEA: Commissariat à l'Energie Atomique (FR)
CCQM: Consultative Committee for Amount of Substance
CCRI: Consultative Committee for Ionizing Radiation/ Comité Consultatif des Rayonnements Ionisants
CITAC: Co-Operation on International Traceability in Analytical Chemistry
CRM: Certified Reference Material
CRL: Community Reference Laboratory
DAMRI: Département des Applications et de la Métrologie des Rayonnements Ionisants
EA: European Co-operation for Accreditation
EFTA: European Free Trade Association
ESARDA: European Safeguards Research and Development Association
EURACHEM: Analytical Chemistry in Europe
EUROLAB: European Federation of National Associations of Measurement Testing and Analytical Laboratories
EUROMET: European Organisation of Metrology
EWGRD: European Working Group on Reactor Dosimetry
FZJ: Forschungszentrum Jülich (DE)
FZK: Forschungszentrum Karlsruhe (DE)
HADES: High Activity Disposal Experimental Site (BE)
IAEA: International Atomic Energy Agency, Vienna (AT)
ICP: Inductively Coupled Plasma
ICRM: International Committee for Radionuclide Metrology
IDMS: Isotope Dilution Mass Spectrometry
IFCC: International Federation of Clinical Chemistry
IMEP: International Measurement Evaluation Programme
INRNE: Institute for Nuclear Research and Nuclear Energy (BG)
INTDS: International Nuclear Target Development Society
ISO: International Standards Organisation
IUPAC: International Union of Pure and Applied Chemistry
JAERI: Japan Atomic Energy Research Institute (JP)
JCO: Japan Nuclear Fuel Concersion Company (JP)
JNC: Japanese Nuclear Cycle Development Institute (JP)
JRC-IES: Institute for Environment and Sustainability (IT)
JRC-IHCP: Institute for Health and Consumer Protection (IT)
JRC-IPTS: Institute for Prospective Technological Studies (ES)
JRC-ITU: Institute for Transuranium Elements (DE)
JEPPIM: Joint European Programme for Primary Isotopic Measurements
LANL: Los Alamos National Laboratory (USA)
LEU: Low Enriched Uranium
LINAC: Linear Accelerator
LGC: Laboratory of the Government Chemist (UK)
LNE: Laboratoire National d'Essais (FR)
LNGS: Laboratori Nazionali del Gran Sasso
LNHB: Laboratoire National Henri Becquerel (FR)
MS: Member State
NAA: Neutron Activation Analysis
NEA: Nuclear Energy Agency
NBL: New Brunswick Laboratory (USA)
NIST: National Institute of Standards and Technology (USA)
NMI: National Measurement Institute
NPL: National Physical Laboratory (UK)
NRL: National Reference Laboratory
NUSIMEP: The Nuclear Signatures on International Measurement Evaluation Programme
OECD: Organisation for Economic Co-operation and Development
ORNL: Oak Ridge National Laboratory (USA)
PCR: Polymerase Chain Reaction
PIGS: Primary Isotopic Gas Standards
PTB: Physikalisch-Technische Bundesanstalt (DE)
REIMEP: Regular European Interlaboratory Measurement Evaluation Programme
RM: Reference Material
SCA: Shared Cost Action
SCK.CEN: Studiecentrum voor Kernenergie / Centre d'Etudes Nucléaires (BE)
SIR: Système International d'unité de Référence
TIMS: Thermal Ionisation Mass Spectrometry
UCCL: Ultra Clean Chemical Laboratory
XRF: X-ray Fluorescence

European Commission

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