PARTITIONING AND TRANSMUTATION RESEARCH IN THE EURATOM FIFTH AND SIXTH FRAMEWORK PROGRAMMES

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Abstract

Partitioning and Transmutation (P&T) of long-lived radionuclides in nuclear waste is one of the most notable research areas of the EURATOM Fifth (1998-2002) as well as the sixth (2002-2006) framework programmes (FP). The objective of research work in this area is to provide a basis for evaluating the practicability, on an industrial scale, of P&T for reducing the amount of long lived radionuclides to be disposed of thus easing the waste management problem. In FP5, there are 13 projects in the area of P&T with a total budget of about € 69 M of which the EU contribution is about € 28 M. A network ADOPT co-ordinates the activities of the accelerator-driven system (ADS) design project with those of the four clusters, one on chemical separation (i) PARTITION and three on transmutation, (i) Basic studies (BASTRA), (ii) Technological studies (TESTRA) and (iii) Fuel studies (FEUTRA). Each of these clusters is formed by 3-4 projects, which are briefly described. A sketch of the proposed P&T research work programme of FP6 is also given where one of the spot-lights is on the nuclear waste management. International co-operation in the area of P&T with non-EU countries including the Commonwealth of Independent States (CIS) is also outlined.

Introduction

The priorities for the European Union's research and development activities for the period 1998-2002 are set out in the Fifth Framework Programme (FP5). [1] The FP5 priorities were identified on the basis of a set of common criteria reflecting the major concerns of increasing industrial competitiveness and the quality of life for European citizens. To maximise its impact, FP5 focuses on a limited number of research areas combining technological, industrial, economic, social and cultural aspects. FP5 and its predecessors have contributed effectively to the policy of supporting science and technology by encouraging co-operation between research players of the Member States. Despite this achievement, no specific European research policy has yet emerged. National research programmes are still undertaken to a large extent independently of one another.

The objective is to achieve greater co-operation between Member States' research strategies and a mutual opening up of programmes. With the challenges and prospects opened up by the technologies of the future, there is a need that European research efforts and capacities should be more thoroughly integrated. With this view in mind, the European Commission launched the so-called "European Research Area" (ERA) initiative in January 2000. [2] The Sixth Framework Programme (FP6) [3] encompassing the period 2002-2006 is geared to make ERA a reality. [4]

The overall organisation of FP6 reflects the broad avenues of approach that are implicit in the proposed implementation of ERA. FP6 has three main blocks of activities:

- Integrating research in the well focussed research priority areas principally by using new research implementation instruments such as Networks of Excellence (NoE) and Integrated Projects (IP).
- Structuring the ERA by research and innovation, human resources and researcher mobility, research infrastructure and science and society issues.
- Strengthening the foundations of ERA by networking of national research and opening up of national programmes, closer links between EU and other European organisations (such as CERN), benchmarking of research policies, mapping of excellence etc.

In this context, the scientific and technical goals of the EURATOM FP6 specific programme "Research and Training Programme on Nuclear Energy" is to help exploit the full potential of nuclear energy, both in the long and short term. Its development and exploitation is to be done in a sustainable manner while combating the climate change and reducing the energy dependency of the EU. Research and development activities in this programme have been subdivided into (a) Controlled thermonuclear fusion, (b) Management of radioactive waste, (c) Radiation protection and (d) Other activities in the field of nuclear technologies and safety.

Controlled thermonuclear fusion is perceived to be one of the long-term options for energy supply whereas nuclear fission presently provides about 35% of the EU's electrical power. Some of the fission power plants of the current generation will continue to operate for at least 20 years. In the short term, the priority is to find a more permanent and safe solution for the management of long-lived, high-level waste that is acceptable to society. A priority in this area is to establish a sound technical basis for demonstrating the safety of disposal of spent fuel and long-lived radioactive wastes in geological repositories. This is to be supported by evaluating the practicability, on an industrial scale, for reducing the amount and/or hazard of the waste to be disposed of by partitioning (chemical separation) and transmutation (nuclide conversion). This is further supplemented by exploring the potential of system concepts that would by themselves produce less waste in nuclear energy generation**.**

The paper briefly recalls the goals of P&T, its position in the framework of nuclear waste management and disposal and its renewed interest world-wide. The research projects on P&T that are being funded in FP5 are then briefly described. A brief sketch of the proposed P&T research work programme of FP6 is also given where once again the focus is on the nuclear waste management. Finally, co-operation in this field with some countries of the Commonwealth of Independent States (CIS) through the International Science and Technology Centre (ISTC) in Moscow is also outlined.

The EURATOM Fifth Framework Programme (FP5) (1998-2002)

The Fifth Framework Programme of the European Atomic Energy Community (EURATOM) has two specific programmes on nuclear energy, one for indirect research and training actions managed by the Research Directorate General (DG RTD) and the other for direct actions under the responsibility of the Joint Research Centre of the European Commission (EC). The strategic goal of the first one, "Research and training programme in the field of nuclear energy", is to help exploit the full potential of nuclear energy in a sustainable manner, by making current technologies even safer and more economical and by exploring promising new concepts. [1] This programme includes a key action on controlled thermonuclear fusion, a key action on nuclear fission, research and technological development (RTD) activities of a generic nature on radiological sciences, support for research infrastructure, training and accompanying measures. The key action on nuclear fission and the RTD activities of a generic nature are being implemented through indirect actions, i.e. research co-sponsored and co-ordinated by DG RTD, but carried out by external public and private organisations as multi-partner projects. The total budget available for these indirect actions during FP5 is € 193 M. [5]

The key action on nuclear fission comprises four areas: (i) operational safety of existing installations; (ii) safety of the fuel cycle; (iii) safety and efficiency of future systems and (iv) radiation protection. The operational safety of existing installations deals with plant life extension and management, severe accident management and evolutionary concepts. In the safety of the fuel cycle, waste and spent fuel management and disposal, and partitioning and transmutation are the two larger activities, as compared to the decommissioning of nuclear installations. The objective of safety and efficiency of future systems is to investigate and assess new or revisited concepts for nuclear energy, that would be more economical, safer and more sustainable in terms of waste management, utilisation of fissile material and safeguards. Radiation protection has four sub-areas: (i) risk assessment and management, (ii) monitoring and assessment of occupational exposure, (iii) off-site emergency management and (iv) restoration and long-term management of contaminated environments.

The implementation of the key action on nuclear fission is made through targeted calls for proposals with fixed deadlines. The generic research on radiological sciences is the subject of a continuously open call. Following the three calls for proposals made since the start of FP5, 278 projects were funded in the area of nuclear fission and radiation protection. In the area of P&T, 13 projects were funded with a total budget of € 69 M out of which EU contribution is € 28 M.

Partitioning and Transmutation (P&T)

Spent fuel and high level waste contain a large number of radionuclides from short-lived to long-lived ones. The time-scales involved are very long before the waste becomes harmless which raises concerns in guaranteeing the safety of waste disposal in geological repositories. Partitioning and Transmutation aims at reducing the inventories of long-lived radionuclides (actinides and some fission products) by transmuting them into radionuclides with a shorter lifetime. [6,7] Partitioning in itself can be of help in the disposal strategy by specific conditioning of the minor actinides and long lived fission products.

Partitioning is the set of chemical and/or metallurgical processes necessary to separate from the high-level waste the long-lived radionuclides to be transmuted. This separation must be very efficient to obtain a high decontamination of the remaining waste. It should also be very selective to achieve an efficient transmutation of the long-lived radiotoxic elements.

Long-lived radionuclides could be transmuted into stable or short-lived nuclides in dedicated burners. These burners could be critical nuclear reactors and/or sub-critical reactors coupled to accelerators, the so-called accelerator-driven systems (ADS). An ADS is a concept that would allow large quantities of minor actinide waste to be burned efficiently. In a *sub*-critical reactor, additional neutrons are supplied by an external source, from spallation reactions, for instance, in which an energetic proton beam from a particle accelerator impinges on a heavy metal such as lead. Subject to more detailed studies, for minor actinide-rich fuel, an ADS seems likely to be safer than critical reactors, as the neutron chain reaction can, in principle, be stopped when desired by switching off the additional supply of neutrons (the accelerator). This, however, still leaves the task of removing the decay heat.

If successfully achieved, P&T will produce waste with a shorter lifetime. However, as the efficiency of P&T is not 100%, some long-lived radionuclides will remain in the waste, which will have to be disposed of in a deep geological repository. P&T are still at the research and development (R&D) stage. Nevertheless, it is generally accepted that the techniques used to implement P&T could alleviate considerably the problems linked to waste disposal.

There has been a renewal of interest in P&T world-wide [5] including Japan, Korea, Europe, China and the USA. In Europe, the most notable is the idea of Energy Amplifier (EA) developed by CERN, Geneva. In addition, there are a number of research activities on ADS going on in several EU countries including Belgium, France, Germany, Italy, Spain, Sweden as well as in Switzerland. P&T activities are also pursued in Czech Republic and Russia.

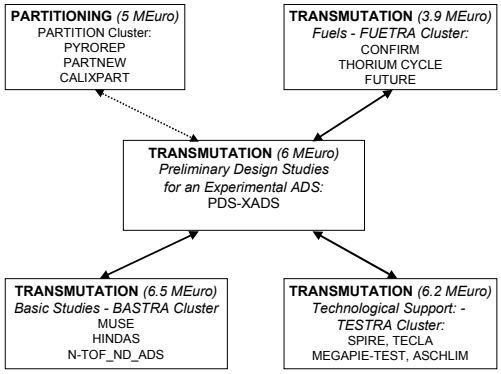
The interest for P&T in the EU is reflected in the increase of funding in this area over the successive EURATOM Framework Programmes, 4.8, 5.8 and about € 28 M for the Third, Fourth and Fifth Framework Programmes respectively. In the Sixth Framework Programme (2002-2006), the indicative budget for P&T of € 25-35 M.

The Research Activities on P&T in the EURATOM Fifth Framework Programme

The objective of the research work carried out under FP5 is to provide a basis for evaluating the practicability, on an industrial scale, of partitioning and transmutation for reducing the amount of long lived radionuclides to be disposed of. The work on partitioning concerns the experimental investigation of efficient hydro-metallurgical and pyrochemical processes for the chemical separation of long-lived radionuclides from high-level liquid waste. The work on transmutation is related to the preliminary design studies of an accelerator-driven sub-critical system (ADS) and acquisition of data, both technological and basic, necessary for its development including the development of fuel and targets for an ADS.

The selected projects in this area address various scientific and technical aspects of P&T and have therefore been regrouped. A network ADOPT co-ordinates the activities of the accelerator-driven system (ADS) design project with those of the four clusters of FP5 projects in the area of P&T (see Figure 1). One cluster is on chemical separation of radionuclides **(PARTITION)** and there are three on transmutation: (i) Basic studies **(BASTRA),** (ii) Technological studies **(TESTRA)** and (iii) Fuel studies **(FUETRA).**

Figure 1. **FP5 funded projects in the area of P&T under the umbrella of ADOPT network**



ADOPT network

The objectives of ADOPT network (see Table 1) are: (i) to formulate actions with a view to promote consistency between FP5 funded projects and national programmes, (ii) to review overall results of the FP5 projects, (iii) to identify gaps in the overall programme of P&T research in Europe, (iv) to provide input to future research proposals and guidelines for R&D orientation, (v) to maintain relations with international organisations and countries outside the EU involved in P&T and ADS development.

Table 1. **Advanced options for P&T (ADOPT) network and preliminary design studies for an experimental ADS (PDS-XADS)**

Acronym	**Subject of research**	**Co-ordinator** (country)	**No. of partners**	**Start date & duration**	**EC funding** (M€)
ADOPT Network	Thematic network on advanced options for P&T	SCK/CEN (B)	16	01-11-01 36 m	0.4
PDS-XADS	Preliminary design studies of an experimental accelerator-driven system	Framatome-ANP (F)	25	01-11-01 36 m	6.0

Design Studies of an experimental ADS

Successful operation of an ADS together with the coupling of an accelerator to the neutron spallation target and the sub-critical core is a first step for demonstrating the practicability of a transmuter of this type of transmuter on an industrial scale. Aim of the PDS-XADS project (see Table 1) is to make well documented study with supporting evidence to choose and adopt the most promising technical concepts for ADS. It will also address the critical points of the entire system, identify the research and development (R&D) required in support, define the safety and licensing issues, assess the preliminary cost of the installation and consolidate the road mapping of the XADS development. The assessment and comparison studies of the different conceptual designs of the main systems (accelerator, spallation target unit, sub-critical core, primary system) will allow to identify the most promising solution which could be studied in detail during the next phase of the design activities.

Partitioning projects

The PARTITION cluster includes three projects, the main characteristics of which are given in Table 2. The first one, **PYROREP**, aims at assessing flow sheets for pyrometallurgical processing of spent fuels and targets. Two methods, salt/metal extraction and electrorefining, investigate the possibility of separating actinides from lanthanides. Materials compatible with corrosive media at high temperature will be selected and tested.

Table 2. **PARTITION cluster projects**

Acronym	**Subject of research**	**Co-ordinator** (country)	**No. of partners**	**Start date & duration**	**EC funding** (M€)
PYROREP	Pyrometallurgical processing research	CEA (F)	7	01-09-00 36 m	1.5
PARTNEW	Solvent extraction processes for minor actinides (ma)	CEA (F)	10	01-09-00 36 m	2.2
CALIXPART	Selective extraction of ma by organised matrices	CEA (F)	9	01-10-00 40 m	1.4

The two other projects deal with the development of solvent extraction processes to separate minor actinides (americium and curium) from high-level liquid waste (HLLW). In the project **PARTNEW**, the minor actinides are extracted in two steps. They are first co-extracted with the lanthanides from HLLW (by DIAMEX processes), then separated from the lanthanides (by SANEX processes). Basic studies are being performed for both steps, in particular synthesis of new ligands and experimental investigation and modelling of their extraction properties. The radiolytic and hydrolytic degradation of the solvents are also studied and the processes are tested with genuine HLLW.

The **CALIXPART** project deals with the synthesis of more innovative extractants. Functionalised organic compounds, such as calixarenes, will be synthesised with the aim of achieving the direct extraction of minor actinides from HLLW. The extraction capabilities of the new compounds will be studied together with their stability under irradiation. The structures of the extracted species will be investigated by nuclear magnetic resonance (NMR) spectroscopy and X-ray diffraction to provide an input to the molecular modelling studies carried out to explain the complexation data.

Transmutation projects

(i) BASTRA cluster:

Three projects are grouped in the cluster of Basic Studies on Transmutation (BASTRA) (see Table 3). The **MUSE** project aims to provide validated analytical tools for sub-critical neutronics, data and a reference calculation tool for ADS study. The experiments are carried out by coupling a pulsed D-T/D-D neutron generator source (GENEPI) to the MASURCA facility loaded with MOX fuel operated as a sub-critical system with different coolants (such as sodium and lead). Cross-comparison of codes and data is foreseen. Experimental reactivity control techniques, related to sub-critical operation are being developed.

The other two projects deal with nuclear data. The objective of the **HINDAS** project is to collect most of the nuclear data necessary for ADS applications. This is achieved by basic cross-section measurements at different European accelerator facilities, nuclear model simulations and data evaluations in the 20-200 MeV energy region and beyond. Iron and lead (materials used for ADS) and uranium have been chosen to have a representative coverage of the periodic table.

The **n-TOF-ND-ADS** project aims at the production, evaluation and dissemination of neutron cross sections for most of the radioisotopes (actinides and long-lived fission products) considered for transmutation in the energy range from 1 eV up to 250 MeV. Measurements are being carried out at the n-TOF facility at CERN, at the GELINA facility in Geel and using other neutron sources located at different EU laboratories. An integrated software environment is being developed at CERN for the storage, retrieval and processing of nuclear data in various formats.

Table 3. **Basic studies for transmutation (BASTRA) cluster projects**

Acronym	**Subject of research**	**Co-ordinator** (country)	**No. of partners**	**Start date & duration**	**EC funding** (M€)
MUSE	Experiments for sub-critical neutronics validation	CEA (F)	13	01-10-00 36m	2.0
HINDAS	High and intermediate energy nuclear data for ADS	UCL (B)	16	01-09-00 36m	2.1
n-TOF-ND-ADS	ADS nuclear data using time-of-flight facility	CERN(CH)	18	01-11-00 36m	2.4

(ii) TESTRA cluster:

Four projects are grouped in the cluster of Technological Studies on Transmutation (TESTRA) (see Table 4). This cluster deals with the investigation of radiation damage induced by products of spallation reactions in materials, of the corrosion of structural materials by lead alloys and of fuels and targets for actinide incineration.

The **SPIRE** project addresses the irradiation effects on an ADS spallation target. The effects of spallation products on the mechanical properties and microstructure of selected structural steels (e.g. martensitic steels) are being investigated by ion beam irradiation and neutron irradiation in reactors (HFR in Petten, BR2 in Mol and BOR60 in Dimitrovgrad). Data representative of mixed proton/neutron irradiation are being obtained from the analysis of the SINQ spallation target at the Paul Scherrer Institute in Villigen (CH).

The objective of **TECLA** project is to assess the use of lead alloys both as a spallation target and as a coolant for an ADS. Three main topics are addressed: corrosion of structural materials by lead alloys, protection of structural materials and physico-chemistry and technology of liquid lead alloys. A preliminary assessment of the combined effects of proton/neutron irradiation and liquid metal corrosion is being carried out. Thermal-hydraulic experiments are being performed together with numerical computational tool development.

Table 4. **Technological studies for transmutation (TESTRA) cluster**

Acronym	Subject of research	Co-ordinator (country)	No. of partners	Start date & duration	EC funding (M€)
SPIRE	Effects of neutron and proton irradiation in steels	CEA (F)	10	01-08-00 48 m	2.3
TECLA	Materials and thermal-hydraulics for lead alloys	ENEA (I)	16	01-09-00 36 m	2.5
MEGAPIE-TEST	A megawatt heavy **liquid** metal spallation target experiment with proton beam	FZK (D)	17	01-11-01 36 m	2.4
ASCHLIM	Computational fluid dynamics codes for heavy liquid metals	SCK/CEN (B)	14	01-01-02 12 m	0.12

The major objective of the **MEGAPIE-TEST** Project is to develop and validate the design and operation of a heavy liquid metal (Pb-Bi) spallation target at a level of a megawatt. The project aims to provide a comprehensive database from single-effect experiments, a full-scale thermal-hydraulic simulation experiment, and the first beam-on experiments. In parallel, numerical computational tools will be validated for Pb-Bi target design. The studies include neutronic calculations, materials, corrosion, thermal-hydraulics, structure mechanics, liquid metal technology, safety and licensing issues. Prospects on the extrapolation and applicability of the obtained results to an ADS spallation target will also be given.

The ASsessment of Computational fluid dynamics codes for Heavy LIquid Metals (ASCHLIM) project aims at bringing together various actors (industry, research institutions and university) in the field of heavy liquid metals both in the experimental and numerical fields and creating an international collaboration to (i) make an assessment of the main technological problems in the fields of turbulence, free surface and bubbly flow and (ii) co-ordinate future research activities in this area. The assessment is being made on the basis of existing experiments whose basic physical phenomena are analysed through the execution of calculational benchmarks using commercial and research codes.

(iii) FUETRA cluster

There are three projects in this cluster. The objectives of the **CONFIRM** project are to develop methods for fabrication (such as carbo-thermic reduction process) of uranium-free nitride fuels (Pu,Zr)N and to model and test their performance under irradiation up to 20% burn-up in Studsvik (Sweden) R2 reactor. Carbo-thermic process will also be used for the production of (Am, Zr)N pellets at ITU, Karlsruhe. Successful high temperature (≈2 500°C) stability tests of (U,Zr)N have been made and a study of C-14 production has been completed.

The objective of the project **THORIUM CYCLE** is to investigate the irradiation behaviour of thorium/plutonium (Th/Pu) fuel at high burn-up and to perform full core calculations for thorium-based fuel with a view to supplying key data related to plutonium and minor actinide burning. Two irradiation experiments are being carried out: (i) four targets of oxide fuel (Th/Pu, uranium/plutonium, uranium and thorium) will be fabricated, irradiated in HFR in Petten and characterised after irradiation, (ii) one Th/Pu oxide target is also irradiated in KWO reactor at Obregheim (D). Though this project was accepted for funding in the area of "safety and efficiency of future systems", it has been grouped with the FUETRA cluster.

Table 5. **Fuel studies for transmutation (FUETRA) cluster**

Acronym	Subject of research	Co-ordinator (country)	No. of partners	Start date & duration	EC funding (M€)
CONFIRM	Uranium-free nitride fuel irradiation and modelling	KTH (S)	7	01-09-00 48 m	1.0
THORIUM CYCLE	Development of thorium cycle for PWR and ADS	NRG (NL)	7	01-10-00 48 m	1.2
FUTURE	Development of transuranic oxide fuels for transmutation	CEA (F)	7	01-12-01 36 m	1.7

The main objective of the FUTURE project is to study the feasibility of oxide compounds (Pu, Am)O_2, (Th, Pu, Am)O_2 and (Pu, Am, Zr)O_2 to be irradiated as homogeneous fuel for an ADS. The R&D programme is largely devoted to the synthesis of the compounds, their characterisation (thermal and chemical properties at relevant temperatures) and the development of fabrication processes. Modelling codes will be developed to calculate the fuel performance. The input data for the codes will be based on experimental results. Assessment of the fuel behaviour under accident conditions will be analysed using the experimental data obtained at high temperatures.

The EURATOM Sixth Framework Programme (FP6) (2002-2006)

Research and development activities of the EURATOM FP6 specific programme "Research and Training Programme on Nuclear Energy" have been subdivided into four areas (a) Controlled thermonuclear fusion, (b) Management of radioactive waste, (c) Radiation protection and (d) Other activities in the field of nuclear technologies and safety.

The priority in nuclear fusion area is to make progress towards demonstrating the scientific and technological feasibility of fusion energy by contributing to international activities for the successful realisation of the Next Step/ITER device which will be supported by Associations' programme in fusion physics and technology.

In nuclear fission, the priority is to find a more permanent and safe solution for the management of long-lived, high-level waste that is acceptable to society. This includes establishing a sound technical basis for the demonstration of long lived high level waste disposal in geological formations. This is to be supported by studies on P&T and further supplemented by exploring the potential of system concepts that would by themselves produce less waste in nuclear energy generation.

The priority of the research in the field of radiation protection is to consolidate and further advance European knowledge and competence in radiological sciences. This is essential for the safe and competitive use of nuclear energy and other industrial and medical uses of ionising radiation, including the management of natural sources of radiation and the effects of low levels of exposure**.**

In other activities in the field of nuclear technologies and safety, the thrust of research is (i) to evaluate the potential of innovative concepts and develop improved and safer processes for the medium-term exploitation of nuclear fission, (ii) to improve the safety of the operation of existing nuclear installations and (iii) to combat the decline in both student numbers and teaching establishments by a better integration of European education and training in nuclear safety and radiation protection.

The detailed work programme of EURATOM FP6 is currently under preparation. In P&T, the research areas include a fundamental assessment of the system and safety aspects of the overall concept of P&T and, in particular, of its impact on waste management and geological disposal. In the area of partitioning, continued R&D of hydrometallurgical and pyrochemical processes is envisaged with a view to the demonstration of the most promising techniques. In the area of transmutation, the development of basic knowledge and technologies for transmutation and evaluation of their industrial practicability, in particular, of transmutation devices such as accelerator-driven sub-critical systems (ADS) is proposed.

The first Calls for proposals will be made at the end of November 2002 where the so-called new instruments will be used as a priority. The Networks of Excellence (NoE) are aimed at strengthening and developing Community scientific and technological excellence by means of the integration, at European level, of research capacities currently existing or emerging, that are somewhat scattered, at both national and regional levels. The Integrated Projects (IP) are designed to give increased impetus to the Community's competitiveness or to address major societal needs by mobilising a critical mass of research and technological development resources and competencies. Avoiding the micro management, increased autonomy will be given to the consortiums in the management (both scientific and financial) of the projects that will be judged on the global end-results.

ADS related Research Activities in the Framework of the International Science and Technology Centre (ISTC)

The International Science and Technology Centre (ISTC) was established by an international agreement in November 1992 as a non-proliferation programme through science co-operation. It is an intergovernmental organisation grouping the European Union, Japan, the USA, Norway, the Republic of Korea, which are the funding parties, and some countries of the Commonwealth of Independent States (CIS): the Russian Federation, Armenia, Belarus, Georgia, Kazakhstan and Kyrgyzstan. The ISTC finances and monitors science and technology projects to ensure that the CIS scientists are offered the opportunity to use their skills in the civilian fields. A similar organisation, the Science and Technology Centre in Ukraine (STCU) has been established in 1995, in which the EU, Canada, the USA, Georgia and Uzbekistan are involved.

Five topics have been identified by the ISTC Contact Expert Group (CEG) for the ADS related projects: (i) accelerator technology, (ii) basic nuclear and material data and neutronics of ADS, (iii) targets and materials, (iv) fuels related to ADS and (v) aqueous separation chemistry. The EU CEG has started to develop co-operation between ISTC and FP5 EU funded projects especially in the above area (ii) by organising joint meetings of BASTRA cluster with related ISTC projects and PARTITION cluster with related ISTC/STCU projects.

Conclusions

The research activities in the field of partitioning and transmutation under the EURATOM Fifth Framework Programme are well underway. The research projects have been regrouped into four clusters one on partitioning, and three on transmutation: basic studies, technological studies and fuel studies. These clusters and the design project form a balanced programme on P&T that are co-ordinated by the ADOPT network. With a view to thoroughly integrate the EU research efforts, a European Research Area (ERA) initiative has been launched. Preparations are well underway for the launch of FP6 making the ERA a reality and the first calls for proposals are expected at the end of November 2002. The collaboration of EU funded FP5 projects and the ISTC/STCU projects on partitioning and basic studies of transmutation is progressing satisfactorily.

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