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 of P&T, on an industrial scale, for reducing the amount of long lived radionuclides to be disposed of thus easing the waste management problem. In FP5, there are 15 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 (FUETRA). Each of these clusters is formed by 3-4 projects, which are briefly described.

Eleven projects have been completed and the remaining ones are due to be completed at the latest in about 2 years. The FP6 is geared towards creating "European Research Area" (ERA) by strongly increasing the collaborative research and innovation efforts across Europe. An element in achieving ERA is the organisation of sizeable European "Networks of Excellence" and "Integrated Projects". The EC budget of the P&T research in FP6 is only marginally higher but the emphasis is on organising fewer but fairly large coherent projects. There are two Integrated Projects, one on partitioning "EUROPART" (started in 2004) and the other on transmutation "EUROTRANS" (as yet under negotiations) and there is a Specific Targeted Research Project on the impact of P&T on waste management "Red-IMPACT" (started in 2004). The total funding of these three projects, of 3-4 year duration, is approximately 56 M€ whereas the EC contribution is about 31 M€. A brief outline of these projects is given. A further call for proposals is planned in Spring 2005. 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]. 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 was seen to emerge. National research programmes were still undertaken to a large extent independently of one another.

One of the objectives of EU 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 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 (JRC) 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 FP5 budget available for these indirect actions is 193 M€.

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.

P&T activities lie in the area of the safety of the fuel cycle which also encompasses waste and spent fuel management and disposal. The implementation of the key action on nuclear fission is made through targeted calls for proposals with fixed deadlines. Following the three calls for proposals made since the start of FP5, 15 projects were funded in the area of P&T, with a total budget of 69 M€ out of which EU contribution is 28 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 of partitioning and transmutation, on an industrial scale, 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 basic and technological data necessary for its development including the development of fuel and targets for an ADS [5].

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).**

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; and

(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 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 also addresses the critical points of the entire system, identifying the research and development (R&D) required in support, the definition of the safety and licensing issues, assessing the preliminary cost of the installation and consolidating 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) has allowed to identify the most promising solution(s) (Pb-Bi cooled system with a gas back-up) which would 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 are selected and tested. Electrochemical studies of Ln and An have provided basic data to assess electrochemical separation methods in molten chloride salts. New pyrometallurgic equipments have also been developed.

Table 2. **PARTITIONING 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 process), then separated from the lanthanides (by SANEX process). The DIAMEX process, based on the use of the malonamide DMDOHEMA is mature. The SANEX process based on BTP, while giving good An(III)/Ln(III) separation performances does not appear suitable for an industrial development owing to the insufficient stability of the BTP extractant.

The **CALIXPART** project deals with the synthesis of more innovative extractants. Functionalized organic compounds, such as calixarenes, are synthesised with the aim of achieving the direct extraction of minor actinides from HLLW. The extraction capabilities of the new compounds are studied together with their stability under irradiation. About 160 extractants for removal of minor actinides from high activity liquid wastes were synthesised. The most promising molecules able to separate minor actinides from lanthanides were tested on real wastes from the PUREX process.

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 has been done.

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 have been 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.

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 49m	2.0
HINDAS	High and intermediate energy nuclear data for ADS	UCL (B)	16	01-09-00 39m	2.1
n-TOF-ND-ADS	ADS nuclear data using time-of-flight facility	CERN(CH)	18	01-11-00 50m	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) have been 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 have been 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 has been carried out. Thermal-hydraulic experiments have been 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 39 m	2.5
MEGAPIE-TEST	A megawatt heavy liquid metal spallation target experiment with proton beam	FZK (D)	17	01-11-01 61 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 (see Table 5). 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 a material test reactor. Carbo-thermic process is also used for the production of (Am, Zr)N pellets at ITU, Karlsruhe. Successful high temperature (≈2500°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) have been 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).

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.

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 64 m	1.0
THORIUM CYCLE	Development of thorium cycle for PWR and ADS	NRG (NL)	7	01-10-00 66m	1.2
FUTURE	Development of transuranic oxide fuels for transmutation	CEA (F)	7	01-12-01 60 m	1.7

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.

In the area (b), the priority is to find a 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. Combating the decline in both student numbers and teaching establishments by a better integration of European education and training in nuclear safety and radiation protection is another important aim.

The detailed work programme of EURATOM FP6 has been adopted by the EC [6]. 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 [7].

Two Calls for proposals have been made in December 2002 and November 2003 respectively, and a third call is expected to be made in Spring of 2005. In the first two calls, the so-called new instruments (such as Integrated Projects) are used as a priority. 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 is given to the consortia in the management (both scientific and financial) of projects that will be judged on the global end-results. Specific Targeted Research Projects (STREPS) are sharply focused on research and technological development designed to gain new knowledge either to improve or develop new products, processes or services or to meet other needs of society and Community policies.

The research activities on P&T in the EURATOM Sixth Framework Programme

The following projects in the area of P&T have been selected for funding until now:

(i) RED-IMPACT project [8]

Partitioning, transmutation and conditioning (P&T/C) and waste reduction technologies are expected to reduce the burden associated with radioactive waste management and disposal. P&T is likely to ease the final repository requirements and it will also contribute to the sustainability of nuclear energy in those countries that pursue this source of energy.

The objectives of this 3-year RED-IMPACT project (Total budget 3.5 M€ including EC contribution of 2 M€) are: (i) Assess the impact of P&T on geological disposal and waste management, (ii) Assess economic, environmental and societal costs/benefits of P&T (iii) Disseminate results of the study to stakeholders (scientific, general public and decision makers) and get feedback during the course of the study and (iv) Iterate and refine the work based on stake-holders' feedback to achieve full impact of this study on the implementation of the waste management policy of the European Community.

(ii) EUROPART project [9]

The main objectives of research work in this 3-year project (total budget: 10.3 M€ and EC contribution: 6 M€) are (i) the development of methods for the separation of individual minor actinides that are contained in aqueous nuclear wastes issuing from the reprocessing of uranium oxide (UOX) or mixed oxide (MOX) nuclear spent fuel and (ii) partitioning of all actinides (An) together for recycling e.g. in an Accelerator Driven System following double-strata advanced fuel cycle concept.

Partitioning techniques used are: (i) hydrometallurgy and (ii) pyrometallurgy. In hydro-metallurgy, the partitioning methods are mainly based on the use of solvent extraction methods or extraction by chromatographic methods which will be applied for (a) individual separation of the trivalent Am/Cm/Bk/Cf ions (b) joint partitioning of An and (c) reprocessing of innovative nuclear spent fuels. In pyrometallurgy, the nuclear wastes issuing from the reprocessing of present or future nuclear spent fuels can be dissolved into molten halide salts at temperatures of several hundreds of degrees followed by the separation of individual MAs (from U to Cf) or all actinides. This will be considered by several methods, such as (a) electro-deposition as metals, (b) liquid extraction using a molten metallic solvent and (c) selective precipitation as oxides. The basic properties of An in molten halides and the partitioning processes of An from spent fuel and advanced dedicated fuel cycles will be investigated. The flow-sheet of various processes including the conditioning methods for the wastes to be generated by the partitioning processes will also be established.

Processes for possible industrialisation of partitioning strategies will also be defined. Training and education of the young researchers also constitutes an important part of the work in the project.

(iii) EUROTRANS project [10]

The objective of this 4-year IP EUROTRANS (total budget of 42.3 M€ including 23 M€ of EC contribution) is to carry out a preliminary detailed design of a ≈100 MW experimental facility (realisation in a short-term, say about 10 years) demonstrating the technical feasibility of transmutation in an accelerator driven System (XT-ADS) as well as to accomplish a reference conceptual design (several 100 MW) of a modular generic European Transmutation Demonstrator (ETD) in the long-term.

Subject to negotiations, the experimental facility TRADE-PLUS will be operated, at a level of 100 kW, as a sub-critical device driven by an accelerator (a 40 kW, 140MeV proton cyclotron with a proposed solid tantalum spallation target. U-free oxide fuels such as (Pu, MA, Zr)O2 or CERCER (Pu, MA)O2+MgO or CERMET (Pu, MA)O2 + Mo will be developed with a view to their use both in XT-ADS and ETD and will be qualified in HFR and Phénix reactors. A further assessment of structural materials and heavy-liquid metal (HLM) (Pb-Bi) technologies for transmutation systems both as a spallation target material and coolant will be made. Further development of nuclear data evaluated files and models involving sensitivity analysis and validation of simulation tools will be made.

The EUROTRANS project has assembled a consortium of partners incorporating the most relevant actors in this field and it has a very broad multi-disciplinary scientific, educational and industrial background of partners from countries across Europe as well as three institutes of JRC. The universities across Europe are well represented. To provide education and training (E&T) in the nuclear field to young researchers is an important goal of this project. About 5% of the budget in each domain is assigned to PhD students whereas an additional sum is reserved exclusively for E&T courses.

The outcome of this project is expected to provide a fairly reliable basis for an assessment of the technical feasibility of transmutation by ADS and a first estimate of the cost of an ADS based transmutation system. It is also expected to provide certain important input elements to authorities to decide whether to embark on the detailed engineering design of an ADS for transmutation and its eventual construction.

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, Canada, 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. 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.

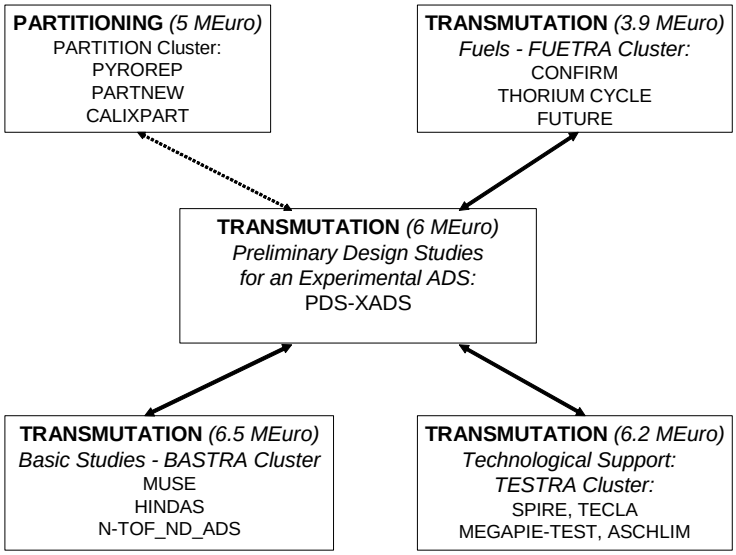
Five topics have been identified by the ISTC Contact Expert Group (CEG) for the ADS related projects: (i) accelerator technology, (ii) basic nuclear and material data and neutronics of ADS, (iii) targets and materials, (iv) fuels related to ADS and (v) aqueous separation chemistry. The EU CEG has developed co-operation between ISTC and FP5 and FP6 EU funded projects especially in the above area (ii), (iii) and (v) by organising joint meetings of BASTRA cluster with related ISTC projects and PARTITION cluster with related ISTC/STCU projects. In FP6, similar cooperation with EUROPART and EUROTRANS is being developed.

Cooperation between Euratom FP6 projects and US-DOE AFCI programme is also being fostered.

Conclusions

The research activities in the field of partitioning and transmutation under the EURATOM Fifth Framework Programme are nearly complete and have produced encouraging results. The research projects were regrouped into four clusters one on partitioning, and three on transmutation: basic studies, technological studies and fuel studies. These clusters and the design project formed a balanced programme on P&T that were 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. The three projects selected (RED-IMPACT, EUROPART and EUROTRANS) in the area of P&T under FP6 are expected to contribute to making the ERA in P&T a reality. The collaboration between EU funded FP5 and FP6 projects and the ISTC/STCU projects on P&T is progressing satisfactorily.

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



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