Experimental Activities in Europe

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EU programmes supporting Nuclear Data Measurements

**EUROTRANS:** Integrated Project

  sub-domain **NUDATRA:**
  *Nuclear Data for Transmutation*

**EFNUDAT:** Integrated Infrastructures Initiative

  *European Facilities for Nuclear Data Measurements*

**CANDIDE:** Co-ordinated Action:

  *Coordination Action on Nuclear Data for Industrial Developments in Europe*

**NUDAME:** Transnational Access Programme:

  *Nuclear Data Measurements at IRMM*
In Framework Programme 6 (FP6) the EU finances three major programmes related to nuclear waste transmutation:

EUROPART: an Integrated Project on partitioning
EUROTRANS: an Integrated Project on Transmutation
RED-IMPACT: a specific targeted research project on the study of the impact of P&T

EUROTRANS: European Research Programme for the Transmutation of High Level Nuclear Waste in an Accelerator Driven System

Strategic objective: a European Transmutation Demonstration (ETD)
step-wise approach:
1. first advanced design of an experimental facility (XT-ADS)
2. generic conceptual design of a modular European Facility for Industrial Transmutation (EFIT)

consortium: 29 partners (ENEN: 17 universities, JRC: 3 labs.)
co-ordinator: Forschungszentrum Karlsruhe
Structure of EUROTRANS:

Institutes participating in NUDATRA:

CIEMAT: coordinator Spain
FZK Germany
CEA France
CNRS France
CSIC Spain
FZJ Germany
ENEN 9 Universities from Consortium

GSI Germany
INFN Italy
INRNE Bulgaria
JRC European Commission
NRG Netherlands
PSI Switzerland
SCK-CEN Belgium
WP5.1: Sensitivity analysis
Compilation of available uncertainties, identification of topics for sensitivity evaluation
Sensitivity methodologies for reactor design, operation and safety parameters
Sensitivity methodologies for the fuel cycle and the repository parameters
Evaluation of the sensitivities, priority list and table of required accuracies
Simulation programs for transmutation plants

WP5.2: Low and intermediate energy nuclear data measurements
Pb and Bi cross sections and branching ratios (Po production)
MA capture cross sections and branching ratios
MA fission cross sections

WP5.3: Nuclear data libraries evaluation and low-intermediate energy models
Improvement of low and intermediate energy reaction models
Evaluation of new MA data (results from nTOF)
Re-evaluation of data libraries for Pb and Bi

WP5.4: High energy experiments and modelling
High energy experiments for Radioactivity, chemical modification and damage assessment
High energy Nuclear model improvement
Quality assessment, validation and impact of the new models in ETD simulations

WP5.5: Integral experiments for validation of nuclear data and simulation tools
Nuclear data and models validation for the spallation target
Minor actinide and Pb nuclear data validation in integral experiments
CANDIDE

Coordination Action on Nuclear Data for Industrial Developments in Europe

13 partners:
University of Uppsala: coordinator
Commissariat à l’Energie Atomique (CEA)
Joint Research Centre – IRMM
Nuclear Research and Consultancy Group (NRG)
Budapest University of Technology and Economics
Teollisuuden Voima Oy (TVO)
Nuclear Research Institute Řež (NRI)
Slovenské Elektrárne (SE)
Center of Technology and Engineering for Nuclear Projects (CITON)
AREVA NP (Framatome ANP)
AREVA NC (COGEMA)
Nexia Solutions (BNFL)
Electricité de France (EDF)

Sweden
France
European Commission
Netherlands
Hungary
Finland
Czech Republic
Slovakia
Romania
France
France
United Kingdom
France
CANDIDE

Purpose: identify the needs for nuclear data
          assess the present status of knowledge
          estimate what accuracy can be reached

Encompasses transmutation in critical reactors (Gen-IV type concepts)
as well as sub-critical systems (ADS).

Structure:

Activity-1 Management of CANDIDE
          WP1 Project management

Activity-2 Networking and education
          WP2 Networking workshops: NEMEA
          WP3 Education: new Summer School EXTEND

Activity-3 Assessment of nuclear data needs:
          WP4 Nuclear data needs
          WP5 Performance of current nuclear data libraries
          WP6 Assessment of competences and practices
              in nuclear data production
          WP7 Conclusions and recommendations
EFNUDAT

European Facilities for Nuclear Data Measurements

11 partners:

- CENBG Bordeaux: coordinator, France
- IPNO Orsay, France
- JRC/IRMM Geel, European Commission
- IKI Budapest, Hungary
- FZK Karlsruhe, Germany
- FZR Rossendorf, Germany
- PTB Braunschweig, Germany
- UU-TSL Uppsala, Sweden
- CEA/DAM Bruyères-le-Châtel, France
- CERN/ n_TOF Geneva, Switzerland
- NPI Řež, Czech Republic

Facilities offering beam time through transnational access scheme:
Van de Graaff accelerators, cyclotrons,
neutron time-of-flight facilities, research reactor
1. Network Activities:
NA1  Consortium Management
NA2  Experimental activities
       inventory of experimental equipment, data processing and analysis codes, workshops
NA3  Facility competence management
       inventory of machine characteristics, exchange of technical know-how, intercomparisons
       harmonise user access organisation
NA4  Training
       organisation of summer schools
       coordination of calls for proposals for fellows and short-term visits
NA5  Dissemination
       rapid dissemination of results through partners and beyond
       liaison with other FP6 projects, e.g. EUROTRANS, CANDIDE

2. Transnational Access
   Central Programme Advisory Committee

3. Joint Research Activities
JRA1  Development of novel acquisition and analysis methods for nuclear data
       Fast Digitizer Data Acquisition System and Analysis Software
JRA2  Quality assurance for nuclear data measurements
       Inter-comparison of spectral fluence measurements, absolute neutron fluence standards
       Novel time-of-flight detectors, simulation of detectors and facilities
JRA3  Nuclear target upgrade for improved nuclear data measurements
       Neutron converters
       Reaction targets
NUDAME

Nuclear Data Measurements at IRMM
Transnational Access project

http://www.irmm.jrc.be/
NUDAME - neutron data measurements at IRMM

IRMM is equipped with a unique scientific infrastructure for accurate neutron data measurements:

- **SELINA** is a 150 MeV electron accelerator serving as strong white neutron source for high resolution neutron time-of-flight measurements. The facility covers the energy range from thermal to 15 MeV, has unsurpassed time resolution of less than 1 ns (FWHM) and serves an array of flight paths up to 400 m long on which as many as 12 experiments can be carried out simultaneously.

- The 7 MV **Van de Graaff facility** is an electrostatic accelerator for the production of continuous and pulsed proton, deuterium- and helium ion beams. Six beam lines and experimental set-ups are attached to the accelerator. Quasi mono-energetic neutrons in the energy region 0 - 24 MeV are produced by using lithium, deuterium or tritium targets.

New opportunities for access to this infrastructure have been created within the framework of the *Euratom Transnational Access programme*. Any type of experiment in the areas of radioactive waste management, radiation protection and other activities in the field of nuclear technologies and safety can be proposed provided the IRMM experimental infrastructure can offer a significant added value to the project. Selection will be based on peer review by a programme advisory committee (PAC).
## NUDAME – funded projects

| PAC 1-1 | CEA Cadarache | High-resolution capture and transmission measurements of $^{\text{nat}}$Hf
| PAC 1-2 | CENBG Bordeaux | $^{243}$Am(n,f) in the 0.7 – 10 MeV energy range
| PAC 1-3 | INFN Frascati | Validation of a multi-sphere spectrometer
| PAC 1-4 | IAEA - Vienna | Capture and Transmission on $^{\text{nat}}$Cad

| PAC 2-1 | CENBG Bordeaux | $^{233}$U capture-to-fission ratio
| PAC 2-2 | INFN Bari | Test of data acquisition with C$_6$D$_6$ detectors using fast signal digitisers
| PAC 2-3 | IReS Strasbourg | $^{235}$U(n,2n)
| PAC 2-4 | University of Barcelona | Validation of $^3$He counter and Bonner spheres
| PAC 2-5 | CEA Cadarache | $^{241}$Am(n,2n) measurements
| PAC 2-6 | University of Debrecen | Leakage spectrum measurements on Pb and Bi
| PAC 2-7 | University of Örebro | Fission decay of shape isomer in $^{235}$U
| PAC 2-8 | University of Vienna | Short-lived activation cross-sections on $^{206,207}$Pb
ongoing experiments at IRMM

GELINA:

\[(n,\gamma), \sigma_{\text{tot}}:\]

- FP (\(^{55}\text{Mn},^{103}\text{Rh},^{133}\text{Cs},^{155}\text{Gd},^{\text{nat}}\text{Sm})\): DOE collab.
- \(^{209}\text{Bi}\) (br.r.): NUDATRA
- \(^{241}\text{Am}\): new project (with CEA, ITU, FZK, CRC)

\[(n,n'\gamma), (n,xn\gamma):\]

\(^{10}\text{B}(n,\alpha)\):

- x-sects. up to 2 MeV

Van de Graaff:

\(^{131}\text{Pa}(n,f)\) (recently finished)
\(^{16}\text{O}(n,\alpha)\)
\(^{235}\text{U}(n,f)\) fission neutron spectrum
\(^{238}\text{U}(n,f)\) fission-fragment distributions
\(^{239}\text{Pu}(n,f)\) \(n\) multiplicities (+ spectra?)

activation: Ta, W

Verdi detector for fission fragment measurements

(TOF; long-term objective: precursors for delayed \(n\))
$^{231}\text{Pa}$ fission cross section

comparison with previous measurements and evaluated data files

Data are being included in latest evaluation (black curve) and IAEA-CRP F4.10.20 "Evaluated Nuclear Data for Thorium-Uranium Fuel Cycle"
VERDI

VElocity foR Direct particle Identification

fission fragment properties: $Z$, $A$, $E_{\text{kin}}$

⇒ identification of pre-cursors for delayed neutron emission

two-arm spectrometer

16 fission fragment detectors