JRC Information Day in Bulgaria
Sofia, 28 April 2006, Kempinski Hotel Zografski

INRNE – JRC Conference – Informational Days,
Sofia, 19-22 February 2003, Hotel Moscow, Kiev conf. room

Nuclear Science for Sustainable Environment and Security

JRC and INRNE Joint Activities

Recent Results

Excellence, Sustainability, Integration

INRNE

EUROPEAN COMMISSION
DIRECTORATE-GENERAL
Joint Research Centre

NUSES 3 Years later FP5 Project

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Hot projects, New ideas

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Editorial

The collaboration between INRNE and JRC institutes started in 1993 and was essentially developed and improved after the NUSES FP5 project (INRNE – JRC Conference – Informational Days “Nuclear Science for Sustainable Environment and Security”) event in 2003 in Sofia, aiming the further integration between JRC and INRNE.

The exchange and implementation of good practices, advanced technologies and reference science by joint projects and cooperative activities are necessary to reach synergetic, diversification and long-term effect.
Moreover after the NUSES event in Sofia the substantial deepening and diversification of the joint JRC – INRNE activities were reached covering regional and global aspects and obtaining the sustainable development.

During the last two years were started successfully: 7 new EURATOM projects,
1 ITU – INRNE project, GAMDETEC, 2 FP6 projects – 1 Centre of Excellence, BEOBAL and
1 Integrated Infrastructure Initiative, EUSAAR and several other activities between INRNE, ITU, IRMM, IE and IES.

In this connection we would like to thank one more time the JRC leadership personally the Director General, Dr. Roland Schenkel, Dr.h.c.; the Enlargement Officer Dr. Jiri Burianek; Dr. Giancarlo Caratti, Head of Unit, Enlargement and Associated Initiatives; Dr. Pierre Frigola, JRC, Directorate General and many colleagues from different JRC institutes as: Dr. Klaus Lützenkirchen, Dr. Peter Rullhuzen, Dr. Maria Betti, Dr. Marc de Cort, Dr. Philip Taylor, Dr. Uve Wätjen, Dr. Arwyng Jones, Dr. Andre von Zweidorf, Ms. Doris Florian, Mr. Victor Esteban Gran, etc.

Taking into account the obtained results, we strongly believe in the future development and success of the JRC – INRNE joint activities in the frame of the NUSES work programme.

Sofia, 28 April 2006

Prof. D.Sc. Jordan Stamenov

Director of INRNE
NUSES Co-coordinator
BEOBAL Coordinator

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Neutron Data for Science and Technology

^{232}Th resonance parameters evaluation

In the frame of the started in year 2002 fruitful partnership, Neutron Data Laboratory at INRNE-BAS together with the Neutron Data Unit at JRC-IRMM have finished the project on re-evaluation of the ^{232}Th resonance parameters for the Th-U Fuel Cycle. The project that has been started as a joint research activity between INRNE and IRMM has been extended in a Coordinated Research Project (CRP) “Evaluated Nuclear Data for the Th-U Fuel Cycle” supervised by the International Nuclear Data Committee (INDC) of the IAEA (Vienna) later in the year 2003.

The full set of ^{232}Th resonance parameters has been derived from the 3 transmission and 2 capture experimental data sets, obtained at the time-of-flight spectrometer GELINA in IRMM, Geel, Belgium. To optimize the derived resonance parameters data the transmission data from ORELA (ORNL, USA) and n-TOF (CERN, Switzerland) thorium capture data have been used and compared with (see **Figure1**). As the result in the new evaluation the overall numbers of resonances have increased significantly with the number of hundreds.

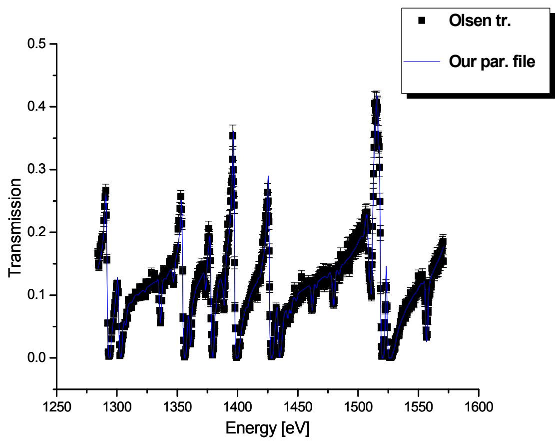

Figure 1. *Agreement between transmission data and evaluated resonance parameters.*

In the ^{232}Th unresolved resonance region (URR) the self-shielding factors have been calculated and compared with the experimental ones, both for total and radiation capture cross sections. The practical schemes for total cross section calculation with accounting the R^{∞} for each value of the orbital momentum ℓ, have been elaborated and these describe better the experimental data. A new methodology and a code have been created for calculation of resonance averaged total cross sections in the unresolved region (using Monte Carlo and cross sections periodicity), that include one-channel and multi-channel cases as well (see **Figure2**).

The results of the above investigations are presented in scientific journals and in proceedings of international conferences.

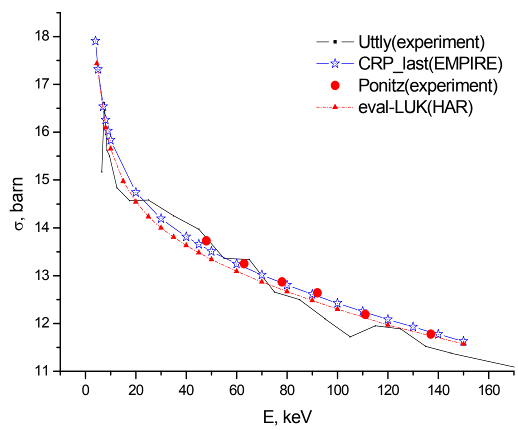

Figure 2. ^{232}*Th total cross section in the energy interval* [4-160] keV.

Refereces

N. Janeva, A. Lukyanov, N. Koyumdjieva, K. Volev, *“Neutron Cross Sections in the Unresolved Resonance Region”* ANS Topical meeting in Mathematics & Computation, Avignon, France, 2005.

INRNE Bulgarian scientists in IRMM-JRC, Neutron Physics Unit, 2005 – 2006

Valentina Semkova – national expert
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IRMM – JRC joint investigation
^{10}B(n,α) standard reaction cross-sections measurements
Multi-section ionization chamber for charged particle spectrometry

Neutron reaction (absorption, radiation capture, fission) cross-sections (the probability of a neutron to interact with a nucleus) are one of the most important reaction characteristics because they are the basis for all neutron applications (nuclear reactor safety, boron cancer therapy, neutron activation analysis, detecting of fissile materials, etc.).

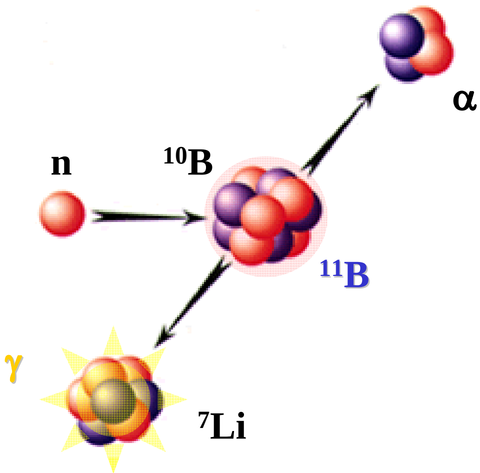

Fig. 1.The interaction of a neutron with ^{10}B forms a compound nucleus ^{11}B, which disintegration in ~ 6% of the cases leaves the ^{7}Li in an exited state, going to its ground state by emission of a γ-ray with energy ~ 478keV.

The neutron reactions with well known cross-section are used as a "standard" to determine the cross-sections of other reactions of interest.

This type of cross-measurement, when one standard reaction is used as a reference for determining the cross-section of another reaction, helps to avoid the influence of unexpected systematical effects on the experimental data.

The collaboration between EC-JRC-IRMM and BAS-INRNE in the field of neutron standard reaction studies is related with a new more detailed and precise measurement of the ^{10}B(n,α) and ^{10}B(n,$\alpha_1\gamma$) standard reaction cross-sections relative to that of ^{235}U neutron induced fission standard reaction ^{235}U(n,f). At the same time, it is intended to improve the accuracy of the already measured branching ratios ^{10}B(n,α_o)/^{10}B(n,$\alpha_1\gamma$) for incident neutron kinetic energies up to 2.5-3MeV [1].

In order to perform such measurements, a new charge particle spectrometer was constructed in 2005 and is now tested at the Neutron Physics Unit of IRMM.

Chamber construction

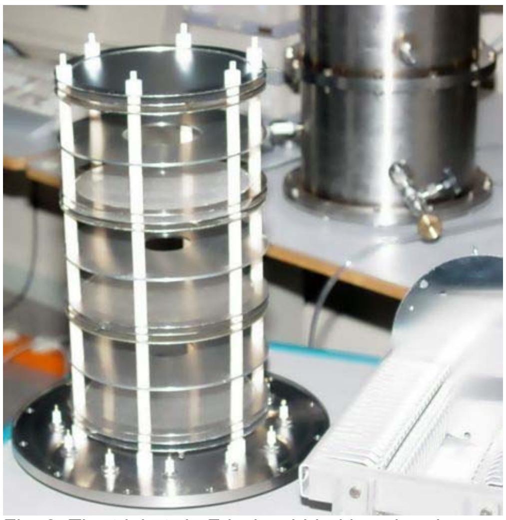

Fig. 2. The triple twin Frisch-gridded ion chamber electrodes configuration.

Actually, the new chamber is a modified triplet of standard twin Frisch-gridded ion chambers, copies of those used for studying the fission of Actinides [2] and disintegration of ^{10}B [3] by neutrons of different energies.

Two standard containers were joined together to form the container of the new triple-pack electrode construction (Fig. 2).

On two of the 3 common electrodes the 94% ^{10}B- enriched thin boron samples were mounted in a back-to-back geometry with the ^{235}U-samples. This way the perturbation and attenuation of the neutron flux are smaller. So are the corrections involved.

The third section of the chamber can be kept empty (dummy sample on the common electrode). This way the neutron induced reaction on the detecting gas media nuclei can be measured.

This information can be used to estimate the influence of this "background" on the data from the other two chamber sections. If needed, a thin sample of another isotope can be mounted on this common electrode for flux (^{237}Np, ^{238}U for example) measurements or some other fundamental studies.

To measure the charged reaction products from the ^{10}B(n,α) and ^{235}U(n,f) reactions, a mixture of 95%Ar and 5%CO_2 was used. To avoid gas quality degradation during the irradiation, the gas was flowing through the chamber with a constant flow of about 0.1l/min. To ensure stopping the α-particles with kinetic energies up to 5MeV before the grid, the gas pressure in the chamber was chosen to be about 950mbar. The amount of the ionization of the gas atoms caused by their interactions with α-particles and fission fragments (electron-ion production) is a measure for the kinetic energy losses of the stopped particles. These electrons and ions are collected applying high-voltage to the collecting electrodes. The values of the high voltages were adjusted to have electron drift velocities of about 4cm/μs. The average length of the tracks from fission fragments is about half of that of 5MeV α-particles.
Using grids (in this case, a 0.1mm thick wire net with a pitch of 1mm) in front of the anode permits the determination of the angular distributions of the α-particles and fission fragments.

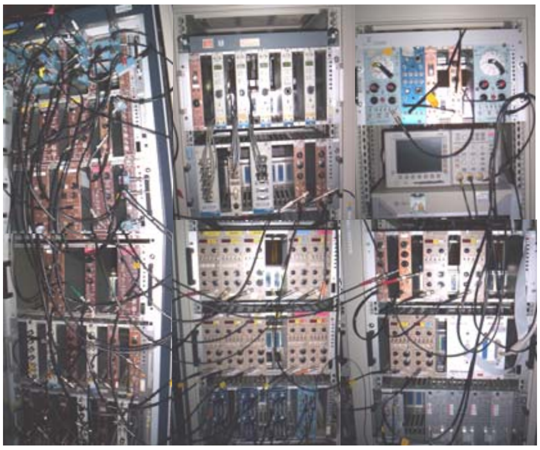
Fig.3 The main part of the collecting electronics

Collecting electronics

All the signals from the electrodes were fed, via standard electronic chains consisting of (charge sensitive + fast summing + main spectroscopic) amplifiers and fast analog-to-digital converters (ADC), to the input gates of 4 Modular Multi-Parameter Multiplexers (MMPM) working in coincidence mode [4]. The outputs of the MMPMs through a multi-parameter interface MPI-8000 enter a SUN UNIX computer (Fig. 3)
This way, every event can be sorted into 1d- or 2d- histograms for on-line displaying and is stored in a LIST mode data-file on the hard-disk for further off-line analysis by the LISA computer program [5].
Test measurements at a 60m station of the GELINA neutron time-of-flight spectrometer are presently undertaken.

References

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[4] J. González, C. Bastian, S. de Jonge, K. Hofmans, Modular Multi Parameter Multiplexer (MMPM), EC-JRC-IRMM GE/R/INF/06/97.
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NET – European Network on Neutron Techniques Standardization for Structural Integrity

The European Network NET was launched in May 2002 with 35 participating organizations from 11 European countries and South Korea. The network main objective is to work toward improvement of performance and safety of European energy production systems. It works towards standardisation of neutron methods for assessment of internal stresses, microstructure and defects in welded nuclear components, as well as their evolution due to operational loads and irradiation exposure. By the end of 2004 about 40 organisations are participating in the Network, including the Institute for Nuclear Research and Nuclear Energy of the Bulgarian Academy of Sciences.

The coordinator of the project is A. Youtsos and C.Ohms (starting from year 2006) on behalf of Institute for Energy (IE), JRC - Petten. The Neutron Techniques sector, playing the leading role in the network operates successfully 3 horizontal beams (HB) of High Flux Reactor (HFR) - Petten. It must be pointed out that three neutron instruments are already available at HFR. This year Small angle neutron scattering (SANS) instrumented installed at HB3 of the reactor is to be commissioned and brought back to operation with renewed electronics.

Many research tasks have been accomplished under the patronage of NET in France, Germany, Italy, Great Britain, Greece and new member states - Poland, Czech Republic, Hungary and associated member - Romania, also Russia. For standardisation purposes same samples have been measured during round robins across Europe, results compared and full 3D residual stress maps in various welded materials (single seam and multipass welds) have been elaborated. For this purpose 3 task groups have been organized. Their subjects are scaled down models of real critical power plant components like single bead on plate weld, assessment of post- weld stress relief heat treatments or effects of thermal ageing to cast duplex stainless steels. It is foreseen that SANS is to be employed by the last task group.

Extensive numerical calculations have been done by NET partners for modeling of welding including in-process temperature and stress distribution and post-weld state. The results have been compared with stress data from neutron diffraction. Many NET partners also took active participation in experimental work by applying numerous alternative methods for residual stress measurement- contour method, hole drilling, X-ray diffraction, ultrasonic and for investigation of mechanical properties of the alloys used in specimen procurement.

Other ongoing NET related activities, are ENPOWER - assessment of novel methods for weld repair and INTERWELD - investigation of irradiation induced material changes in the heat-affected zone of reactor pressure vessel welded internals as core shrouds. The NEU-DI-CIWI facility has been installed in place of the Large Component Neutron Diffraction Facility in front of beam tube HB4. This facility is dedicated to residual stress analysis in radioactive components relevant to nuclear power applications. The central element of this facility is a container, which is used both for transport of the specimens between the HFR and the Hot Cell Facilities and for holding the specimens during the experiments. Inside of the container there is a small positioning table providing 100 mm of linear movement in the x-, y- and z-directions and about 135° of specimen rotation about a vertical axis. The INRNE participation in NET is realized by research performed on NEU-DI-CIWI instrument at the HFR-Petten by Dr. D. Neov, postdoctoral fellow on leave from INRNE.

Other achievements for the last year is the building of a new diffractometer and new flooring on HB5 allowing besides free positioning of the sample along three cartesian axes and rotation around vertical axis also movement of the whole system on air-cushions (Fig.1).

Employing its modern and versatile equipment, the group of JRC scientist plan to continue using it in future for residual stresses (diffraction) and inhomogeneties in materials (SANS) for applications related to safety of nuclear energy production.

Fig.1. HFR/HB5: new diffractometer for residual stress analysis installed on "Tanzboden" floor

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WORKSHOP RADE 2006

Bansko, Bulgaria
1 - 8 April 2006

RADE EURATOM SSA project

Use of RPV Dosimetry Benchmark's Results for Determining Radiation Embrittlement Damage

Radiation embrittlement of the reactor pressure vessel (RPV), as well as of other reactor components, has become one of crucial consideration for the safe operation of ageing nuclear power plants. The plant life management needs reliable estimation of radiation field parameters including their uncertainty to minimize the conservatism of estimations. The main activities of VVER dosimetry refer to the following problems:

- Reliable assessment of reactor pressure vessel lifetime for VVER reactors,
- Prolongation of the RPV lifetime for VVER reactors beyond the design lifetime.

In this relation, the workshop RADE 2006 had the purpose to disseminate the new results of RPV dosimetry benchmarks and to demonstrate how to use these results for determining the radiation embrittlement damage. The reactor dosimetry results, which were presented and discussed at the workshop RADE 2006, were obtained within the REDOS, RETROSPEC, TACIS, and COBRA projects of 5FP of EC. These results are important for the justification of the safe operation and the prolongation of the lifetime of nuclear power plants with VVER type of reactors.

Conclusive summary on the state of the art and necessity of prospective studies in reactor dosimetry was elaborated.

The lecturers and their presentations

Luigi Debarberis
Institute for Energy, JRC of the EC
The Netherlands
"What is reactor dosimetry needed for?"

Sergey Zaritsky
RRC Kurchatov Institute, Russia
"VVER Surveillance Dosimetry"

Krassimira Ilieva
INRNE, Bulgaria
"Introduction to Reactor Dosimetry"
"Conformity Between LR0 Mock-Ups and VVERs NPP RPV Attenuation"

Tom Serén
VTT Processes
Finland
"Completion of the new surveillance programme for Loviisa 1"

Bohumil Ošmera
Nuclear Research Institute Řež plc,
Czech Republic
"Benchmarking of Radiation Field Parameters, Relevant for Pressure Vessel Monitoring. Review of Experimental Results in VVER-440 and VVER-1000 Benchmarks in LR-0 Experimental Reactor"

Josef Hogel
ŠKODA JS a.s.
Czech Republic
"Ex-vessel measurements and its legal aspects"

Sergey Belousov
INRNE, Bulgaria
"Calculations - methods, libraries, and comparative results"
"Adjustment approach for VVER RPVs"

Jan Wagemans
SCK/CEN
Belgium
"Experience of SCK•CE in RPV dosimetry measurements"

Bertram Böhmer
Forschungszentrum Rossendorf,
Germany
"Comparative Studies and Uncertainty Sources"

Mikhail Gurevich
RRC Kurchatov Institute
Russia
"Progressive trends in the calculational methods"

Antonio Ballesteros
Tecnatom S.A., Spain
"Contribution of gamma to the irradiation damage of RPV. Attenuation through the RPV Wall"

Willem Voorbraak
The Netherlands
"Niobium retrospective measurements"

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SARNET EURATOM NoE
Network of Excellence for a Sustainable Integration of European Research on Severe Accident Phenomenology

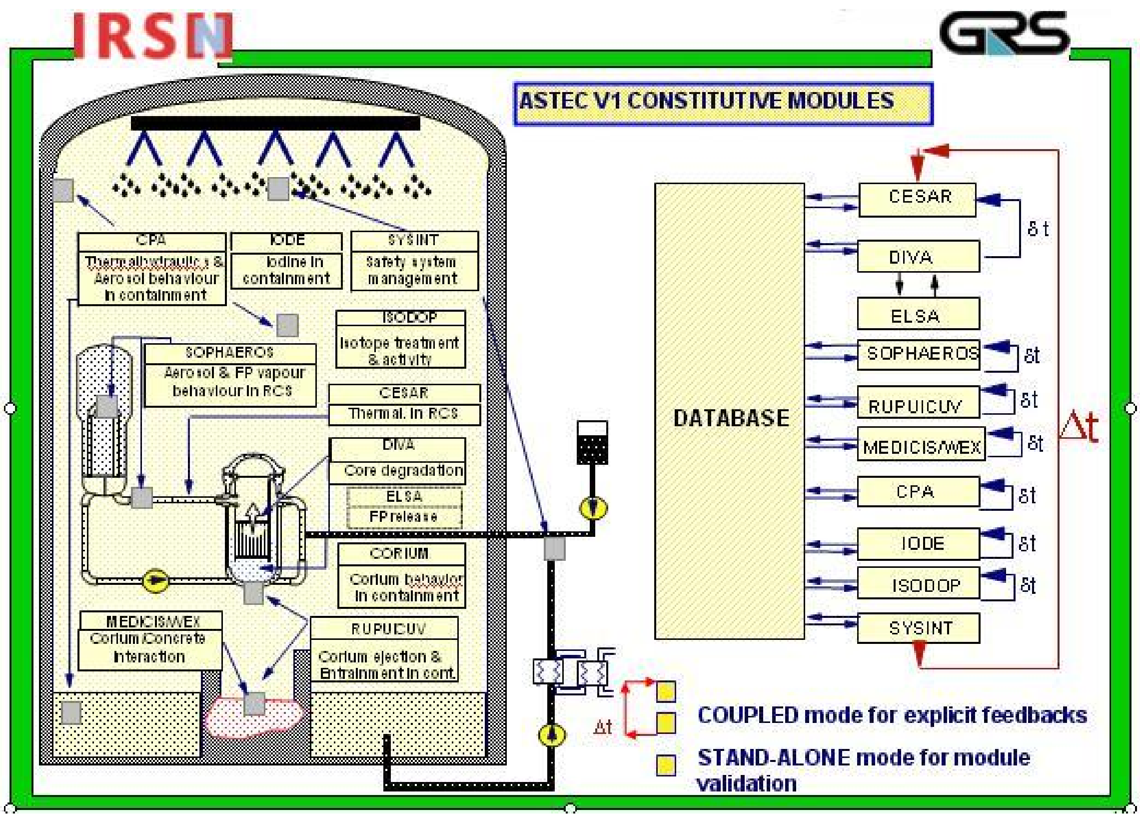
49 Organisations network in SARNET (Network of Excellence). their capacities of research in order to resolve the most important remaining uncertainties and safety issues for enhancing, in regard of Severe Accidents, the safety of existing and future Nuclear Power Plants (NPPs).

ASTEC: Accident Source Term Evaluation Code

ASTEC code was created by IRSN/GRS in cooperation since 1996 for development of an integral code for LWR (present/future PWR, BWR, VVER) as a source term severe accident calculations.

Main objectives:

1. Applications to PSA2, including uncertainty analysis,
2. Accident management studies,
3. Investigations of NPP behaviour in SA conditions, including source term evaluation,
4. Support and interpretation of experiments,
5. Basis for a better understanding of SA physical phenomena.



Progress during the second year of SARNET project

During the 2nd year, the analyses of SBLOCA and SBO sequence had been performed with the ASTEC and MELCOR codes. Several reports had been created with the aim to be assessing ASTEC code modelling of main in-vessel phenomena during hypothetical severe accidents and second to be made of proposals for improvement of ASTEC capability in the simulation of severe accident scenarios (with intervention of safety systems and/or operators intervention and SAM procedures. They are:

1. "**VVER 1000 SBLOCA Calculations with ASTEC v1.1 and Comparison with MELCOR 1.8.5 and RELAP-SCDAP5**", June 2005. The performed analyses covered several types of SB LOCA- 30mm, 40mm, 60mm and 70mm LOCA with total loss of emergency systems and with/without passive safety injection systems (hydro-accumulators).
2. "**VVER 1000 SBLOCA Calculations with ASTEC v1.2 and Comparison with ASTEC v1.1 and MELCOR 1.8.5**", November 2005 The performed analyses covered several types of SB LOCA- 30mm and 60mm LOCA with and without passive safety injection systems (hydro-accumulators). The main targets of this study were the understanding of discrepancy between ASTEC v1.2, ASTEC v1.1-p2 and MELCOR 1.8.5.
3. "**VVER 1000 SBO Calculations with ASTEC v1.2 and Comparison with MELCOR 1.8.5**", December 2005.

It was created "**ASTEC Engineering Handbook for Kozloduy NPP VVER1000/V320**". It had been accomplished a review of the input deck of the ASTECv1.1 version with the aim to focus on the input data for a VVER-1000 nuclear power plant.
All performed reports are uploaded to the SARNET web page.

The Forum of Bulgarian ASTEC Users, FoBAUs (i.e. INRNE, EI, TUS and the University of Pisa) visited IRSN/Cadarache, France during the period 12 - 16 September 2005. The aim was a verification of the reference input deck for VVER1000/V320 (as the Kozloduy NPP) with IRSN developers. The reference input deck, describing the VVER-1000, had been used for two sequences: SBLOCA & SBO sequences.

It was released three publications during the second year. They are:

1. "**ASTEC & MELCOR Comparison for a VVER-1000 / 60mm Small Break LOCA**" to the Energy Forum 2005, Varna-Bulgaria-June-8-11, 2005
2. "**VVER-1000 Small-Medium Break LOCAs Predictions by ASTEC**" to the International Conference "Nuclear Energy for New Europe 2005",Bled-Slovenia-September 5-8, 2005
3. "**Medium Break-LOCA (150mm) Calculations for a VVER-1000/V320 and Comparison of ICARE2 V3 Mod1.4 and MELCOR 1.8.5 Codes Results"** to the European Review Meeting on Severe Accident Research, Aix-en-Provence-France-November-14-16, 2005

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COVERS EURATOM CA
VVER Safety Research

The **COVERS EURATOM FP6 project** is based on the “State of the Art” in the relevant research areas: safety, component integrity and plant life management. Its overall goal it to intensify and improve utilization of accumulated experience and knowledge for safe operation of VVER reactors, even with extended service life and increased operational efficiency and/or power output.

In accordance with this goal three working meetings have been planned and organized during the first period (01.04.2005-31.03.2006):

- Kick-off meeting on 22 June 2005, Rez, Czech Republic. 31 representatives of EU and Contractors have been participated in the meeting. COVERS Work Planning and Time Table baseline has been presented and discussed.The Final version of Consortium Agreement of COVERS project has been prepared;
- Kick-off-meetings of WP3 (Working Package 3 ”Operational safety”) and WP4 (Working Package 4 “Material and equipment ageing”) on 26-29 September 2005 in Trnava, Slovak Republic. The total number of participants was 41 and high share of institutions contributing to WP3 and WP4 were represented;
- Middle Term Meeting on 28-30 March, 2006 in Trnava, Slovak Republic, devoted on the knowledge and experience exchange according to the Working plan.

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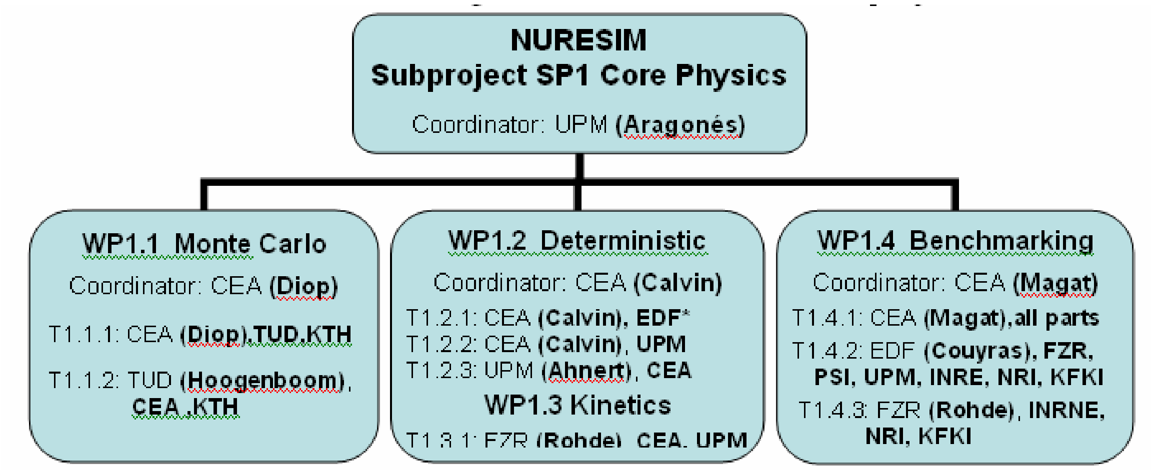
NUSIMS 3 Years later FP6 Project

NURESIM EURATOM IP
European Nuclear Reactor Simulation Platform

The European Nuclear Reactor Simulation Platform is an Integrated Project of FP6 aiming at the development of advanced and standardized software tools for the European nuclear industry. It includes Core physics, Thermal hydraulics, Multi-physics, Uncertainty analysis and Integration subprojects.

INRNE participates in the Core physics (SP1) sub-project which main objective is to integrate the most advanced software (physical modelling and numerical techniques) for reactor core physics in the common European software platform using the CEA codes DESCARTES, TRIPOLI-4 and GALILEE as a starting basis. Other advanced solvers, modules or codes and methods will be considered for integration within the SALOME interface, after their implementation, demonstration and evaluation. The organizational chart of subproject SP1, including the coordinators and partners per WP and Task, is:



The DESCARTES code system pertains to core physics codes, and is developed jointly by CEA and EDF. The specific objective of the DESCARTES project is to develop a general and comprehensive set of tools for computing criticality and shielding problems for RTD and industrial purposes. The general architecture underlying DESCARTES is depicted in Figure 1 below, and comprises 5 levels (shared between the NEPTUNE thermal-hydraulic code and DESCARTES).

The TRIPOLI4 code will become the starting point for a common European Monte Carlo code.

The CEA-based GALILEE nuclear data processing system (which includes the modules RECONR, BRAOADR, THERMR, ACER, GROUPR from the US-based code NJOY), together with the French module CALENDF, which accurately computes probability tables (PT) for the unsolved resonance energy range, will serve as the backbone for nuclear data processing within the NURESIM project. The GALILEE system provides multi-group and continuous-energy nuclear cross sections and other nuclear data for DESCARTES and TRIPOLI4. The GALILEE system allows precise comparisons between deterministic methods and Monte Carlo solutions, and is currently being used for R&D and industrial needs.

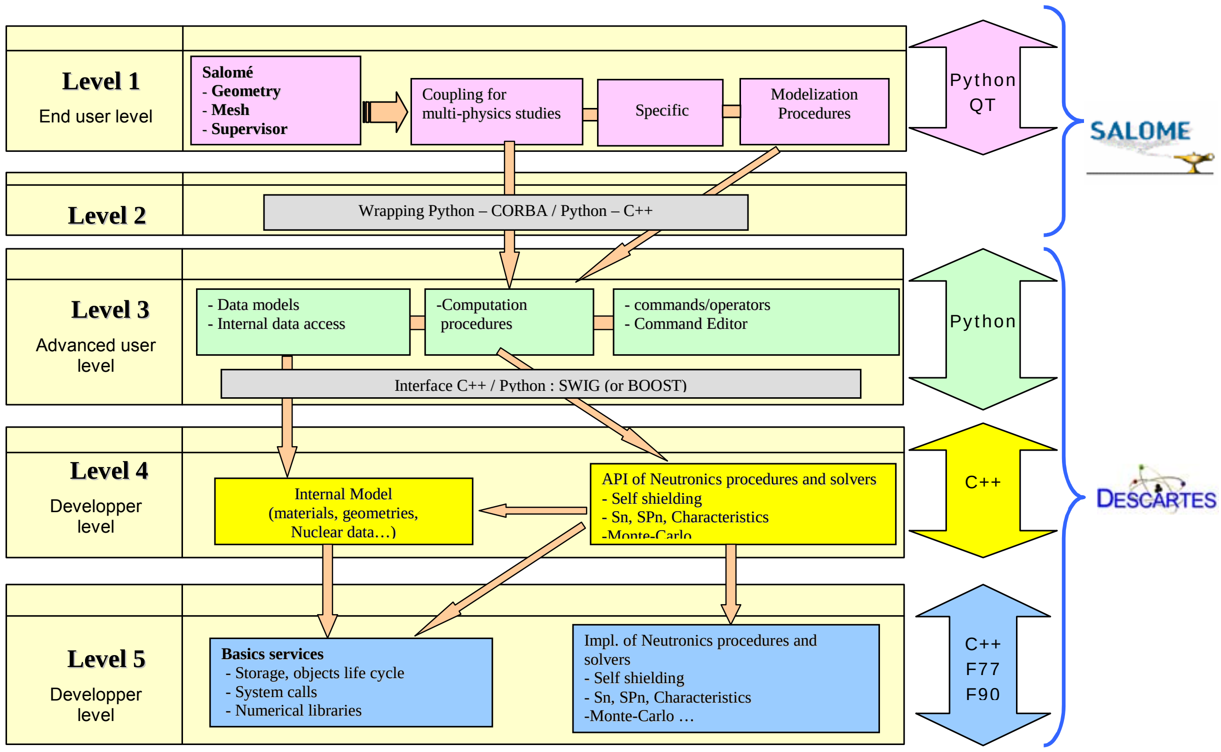


Figure 1: General architecture of DESCARTES

INRNE is involved in the Benchmarking of the NURESIM Core Physics Platform which includes 3 tasks:

- T1.4.1b: Physical cross-analysis of the NURESIM benchmarks results
- T1.4.2: Benchmarking for PWR
- T1.4.3: Specification of data and reference results for VVER Benchmarks

The Institute has prepared data and defined mathematical benchmark problems (V1000-3D-C1 [1], V1000CT-2 EXT1) as well as a multi-physics benchmark (V1000CT-2 EXT2) for VVER-1000. Fine-mesh reference solutions of the AER-DYN2 Rod-ejection Benchmark have been provided for testing the NURESIM solvers.The multi-physics benchmark is consistent with the OECD/NEA VVER-1000 MSLB benchmark [2].

The first phase of the sub-project will deliver the capability to perform lattice and core calculations within the common architecture. The respective solvers will allow initiation of tasks with coupled 3D neutronic-thermal hydraulic calculations.

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1. N. Kolev, R.Lenain and C.Magnaud, *V1000-3D-C1 Benchmark,* AER Benchmark Book, KFKI Publ., 1999, Budapest

2. N.Kolev et al., *OECD/NEA VVER-1000 MSLB Benchmark Specifications, Vol. II*, NEA/NSC DOC (2006)6

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Licensing Fuel in Bulgaria
Research and Development

Introduction

The contract, presented below and signed on 18 March 2004, is referred to as Project No. 370011–2004–02 F1FD KAR BG, between:

- the European Commission – Contracting Authority;
- the European Institute of Transuranium Elements – Karlsruhe, Germany – Contractor;
- the Institute of Nuclear Research and Nuclear Energy of the Bulgarian Academy of Sciences, – Sofia, Bulgaria, Nuclear Regulatory Agency, Physics Department of the Sofia University, Technical University in Sofia and the Nuclear Power Plant - Kozloduy.

The goal of this study, performed in Bulgaria, was to prove the applicability of the TRANSURANUS-WWER version code to the safety analyses, performed at the NPP-Kozloduy. This work is a continuation of an existing collaboration between ITU – Karlsruhe, Germany and, manifested, up to now, in two projects – FERONIA PHARE project (1996 – 1998) and a bilateral ITU – INRNE project, 1999.

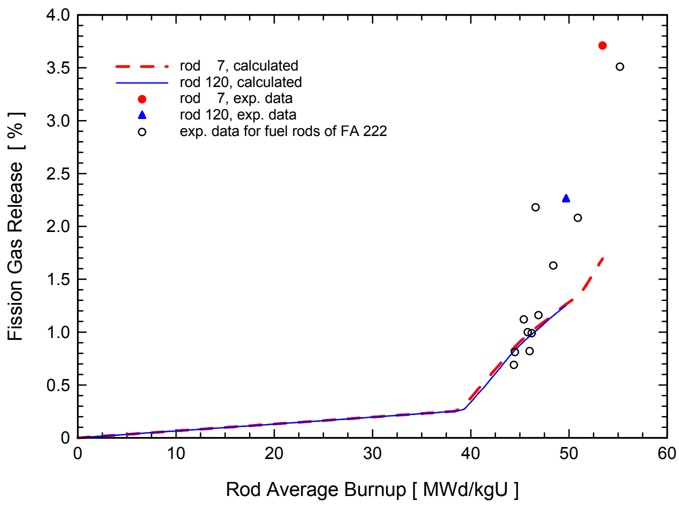
Summary of the Project

According to the working program of the project, INRNE – Sofia, Bulgaria, had to perform verification of the latest TRANSURANUS-WWER versions on the basis of the IFPE-OECD/NEA-IAEA database. The work was planned in a working program, consisting of 5 tasks.

The results, obtained from the analyses of some fuel experiments are presented. The most important of them follow below.

TRANSURANUS-WWER calculations

In the frames of the IFPE-OECD/NEA-IAEA data base, calculations have been performed on the burn-up, fuel central temperature (FCT), fission gas release (FGR) and geometrical change. Within the Kola-3 data base, calculations have been done of the burn-up, FCT, geometrical changes, inner gas pressure and FGR



Calculated FGR for Russian VVER–440 fuel - comparison with experimental data

Scientific results

The main results are:

- the TRANSURANUS-WWER latest versions were verified against the IFPE-OECD/NEA-IAEA Data base;
- the existing creep correlations were studied against experimental data;
- creation of TRANSURANUS Verification Data Base (TUVDB) for data storage of a given verification procedure
- a program facilitating a user in working by the TRANSURANUS post-processor URPLOT, was written;
- detailed analysis of the documentation of 6 IFPE-OECD/NEA-IAEA Data base was done, some errors and omissions in the data base were corrected;
- over 300 cases altogether were analysed within the contract.

Practical aspects

Besides the scientific achievements, the project is important from point of view of implementing sophisticated scientific tools into the practical nuclear industry. For commercial WWER's, operated in the East European countries, the TRANSURANUS-WWER code is a powerful tool for assessing fuel performance.

On this basis, projects like the reported here, are important for further development of the studies in this area, especially in the field of:

- Fuel behaviour modelling as a part of reactor material research;
- Fuel performance modelling as a component of fuel design;
- Fuel modelling as a component of commercial fuel licensing;
- Fuel modelling for NPP's operational needs and decision making;
- Training of research and operational NPP staff for fuel licensing by using TRANSURANUS code.

Future of the collaboration

As a result of the first NUSES meeting – Sofia, February 2003, recently Bulgarian side declared, on behalf of the Nuclear Regulatory Agency, the Institute for Nuclear Research and Nuclear Energy of the Bulgarian Academy of Sciences, the Nuclear Power Plant "Kozloduy", Physics Department of the Sofia University and the Technical University in Sofia that the results, obtained in the frames of projects like the present one, serve the national needs in the field of the radiation safety, safe operation of the NPP and the reactor physics science.

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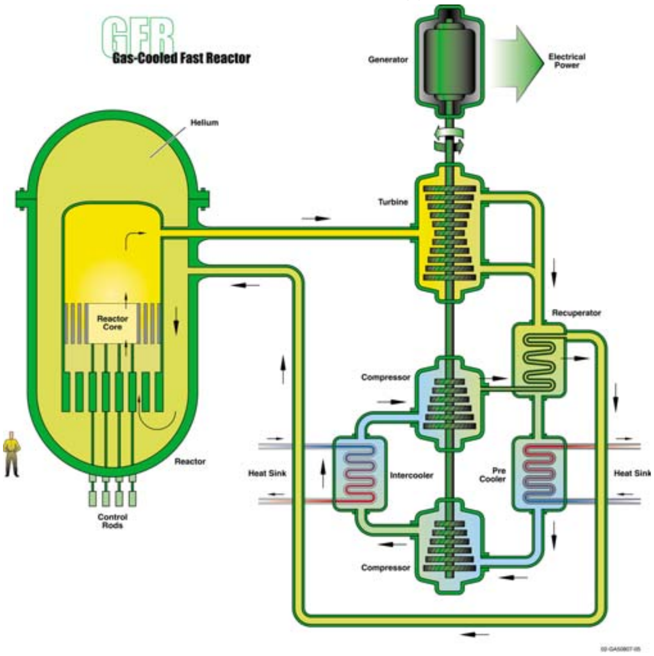
Generation IV
Future Nuclear Energy Systems

Generation IV is an international initiative aimed at developing nuclear energy systems that can supply future worldwide need for electricity, hydrogen, and other energy products. These systems are to be deployable no later than 2030, for providing competitively priced energy products while satisfactorily addressing nuclear safety, waste, proliferation, and physical protection concerns. To enable nuclear energy to fulfill an expanded worldwide role, many countries have been cooperating within the framework of the Generation IV International Forum to advance this new generation of nuclear energy systems.

The Reactor Physics Laboratory of INRNE has taken initial steps in seeking opportunities for joining the Generation IV international initiative. First contacts with the correspondent European experts in this field have been obtained by Prof. J. Stamenov. Following this idea representatives of the Reactor Physics Laboratory have gained relevant knowledge through participation in international meetings, including a Summer School on Generation IV Reactors, Fuels and Fuel Cycles, held in Cadarache, France, and an International Workshop on Nuclear Data Needs for Generation IV Nuclear Energy Systems, held in Antwerp, Belgium. The experience gained by the Reactor Physics Laboratory in the research of materials, processes, and parameters of currently operating nuclear systems, under international cooperation with the Atomic Energy Research as well as with institutes from Russia, France, etc., can be used in collaborative efforts on the viability and performance demonstration of the Generation IV systems.



Presentations on Generation IV Nuclear Energy Systems have been made at an INRNE seminar and at the “Nuclear Physics for the People” Conference held in Sofia.

The Reactor Physics Laboratory is mainly interested in collaborations aimed at advancing the Gas-Cooled Fast Reactor (GFR) system. This system employs helium gas as coolant and features a fast neutron spectrum core and closed fuel cycle. The GFR is primarily envisioned for missions in electricity production and actinide management, although it may be able to economically support hydrogen production. The Reactor Physics Laboratory recognizes the importance of establishing international collaborations with partner research centers in the European Union in order to effectively participate in the research and development of the Generation IV systems.

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EUROTRANS EURATOM IP

Neutron Data Libraries for Pb and Bi: status and perspective

To solve the problem of nuclear waste two major options exist. The first one is to dispose the spent nuclear fuel in repositories and to keep watching for minimal possible contact with the environment long enough to become as low as possible radiotoxic. The second one is to perform partitioning and transmutation (P&T) of nuclear waste in energy systems with additional option to produce energy during the process. The accelerator-driven system (ADS) has recently been receiving increased attention due to its potential to become safe and flexible transmutation systems. From the ADS target design point of view the precise knowledge of Pb and Bi neutron cross sections is of critical importance.

^{204}Pb	JEFF	Reich-Moore resolved resonance parameters covering the energy range 1.0e-5 eV to 50 keV were adopted from the JENDL3.3 evaluation.
	JENDL	Resolved resonance parameters for MLBW formula. Resonance ranges: 1.0e-5 eV to 50 keV. Parameters were evaluated from the data of Horen
^{206}Pb	ENDF	Resolved resonance parameters covering the energy range 16keV to 900keV
	JEFF	Reich-Moore resolved resonance parameters covering the energy range 1.0e-5 eV to 900 keV were adopted from the ENDF/B-VI.8 evaluation.
	JENDL	Resolved resonance parameters for reich-moore formula. Resonance range: 1.0e-5 eV to 500 keV
^{207}Pb	ENDF	Resolved resonance parameters covering the energy range 40keV to 500keV
	JEFF	Reich-Moore resolved resonance parameters covering the energy range 1.0e-5 eV to 450 keV were adopted from the ENDF/B-VI.8 evaluation.
	JENDL	Resolved resonance parameters for Reich-Moore formula Resonance ranges: 1.0e-5 eV to 475 keV Parameters were based on the data of Horen
^{208}Pb	ENDF	Reich-Moore resolved resonance parameters covering the energy range 1.0e-5 eV to 1 MeV
	JEFF	Reich-Moore resolved resonance parameters covering the energy range 1.0e-5 eV to 1 MeV were adopted from the ENDF/B-VI.8 evaluation.
	JENDL	Resolved resonance parameters for Reich-Moore formula Resonance ranges: 1.0e-5 eV to 1.0 MeV. Parameters were adopted from Horen

Table. Pb isotopes evaluation information.

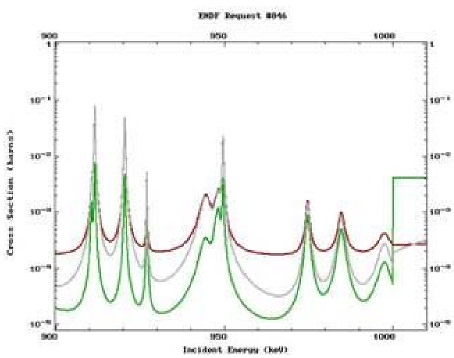

Figure. ^{208}Pb capture cross sections from ENDF/B-VI (violet), JEFF-3.1(grey) and JENDL 3.3 (green) library.

To satisfy the need of high quality neutron data the Neutron Data Group at INRNE-BAS has been involved in the FP6 EUROTRANS project. The main purpose of this project is to propose the advanced design and construction of an experimental facility demonstrating the technical feasibility of Transmutation in an Accelerator Driven System (XT-ADS), as well as to accomplish a generic conceptual design of a modular European Facility for Industrial Transmutation (EFIT).

A thorough examination of all existing data – both experimental (EXFOR library) and evaluated one (ENDF/B-VI, JEFF-3.1 and JENDL-3.3) have been performed in the case of Pb and Bi nucleus (see **Table**). The experimental neutron cross section data for ^{206}Pb and ^{209}Bi are rather scarce. In the resolved resonance region, the experiments were primarily performed in support to fundamental physics research but not for the projects related to the nuclear fuel cycle. Therefore, the measurements were never tailored to define in an unambiguous way the resonance parameters
It was found that Pb and Bi resonance parameters data in the major evaluated nuclear libraries suffer from severe differences between each other not only for the unresolved resonance region (URR) but for the resolved resonance region (RRR) too (see **Figure**). Therefore a new evaluation was proposed for all isotopes where experimental data allow. The input files for resonance analysis codes (SAMMY, REFIT) are in process of preparation.

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NUSIMS 3 Years later Project

ITER: the next step towards a fusion reactor

EFDA

MCPLD EURATOM SSA project
Model Calculations of Positron Lifetime in Be containing H and He

Main objective and Method of the investigation

At present beryllium is considered as one of candidate materials for first wall in ITER. The neutron irradiation of beryllium leads to elastic and inelastic interaction of neutrons with the matrix atoms. The production rates of hydrogen and helium atoms from fusion reactions are much higher than in the environment of fission reactor. In materials irradiated by high energy neutrons the production rates of H and He by (n, p) and (n,α) reactions are much higher than those by low energy neutrons. It was found that He-vacancy complex is more stable against thermal activation than the H-vacancy complex. One of the important tasks of the positron interaction in solids has been the prediction of the positron lifetimes for nano-voids as a function of the nano-void size and decoration of defects by impurities like hydrogen or helium. Positron spectroscopy is capable of monitoring the void formation process over the full range of vacancy-cluster sizes and it is also capable of monitoring of micro-voids even at the earliest stages, which has a strong impact on understanding the micro-void formation phenomena in advanced reactor materials. Electron-positron correlation in bulk solids can be approximated by local density approximation LDA. The model calculations of the positron lifetime of defects in pure non irradiated and 14 MeV neutron irradiated Be at various doses will be carry out by the Density Functional Theory [DFT] methods- the local density approximation [LDA] and weight density approximation [WDA]. By model calculations using Local Density Approximation (LDA) based on the homogeneous electron gas theory developed by Kohn and Sham, the behaviour of nano-voids containing hydrogen and helium are studied. The proposed project contributes to an improved understanding of the basic mechanisms of radiation damages. The basic theoretical tool in interpreting positron data from defects in beryllium containing hydrogen or helium is the positron trapping model. The annihilation rate λ or the lifetime τ of a positron in an inhomogeneous electron gas is:

$$\frac{1}{\tau} = \lambda = \int dr \left|\varphi_+(r)\right|^2 \Gamma[n(r)]\,, \qquad (1)$$

where $\Gamma[n(r)]$ is a function of the electron density.

Γ is composed of two electron densities (for valence electrons and for core electrons)

$$\Gamma[n(r)] = \Gamma_V[n_v(r)] + \Gamma_{in}[n_{in}(r)]\,, \qquad (2)$$

where $n_v(r)$ is the valence electron density and $n_{in}(r)$ is the core electron density. The relaxation of the complex is computed, while coordinates of the lattice "border" atoms are not fixed. The positron density profiles in a pure vacancy and vacancy-hydrogen or vacancy-helium complexes are very different. The preliminary results from model calculations of positron lifetime show a correlation between the vacancy-clusters size in Be and the values of positron lifetime.

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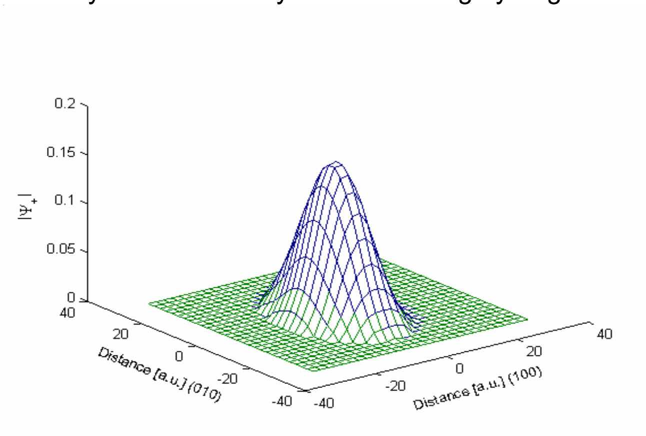
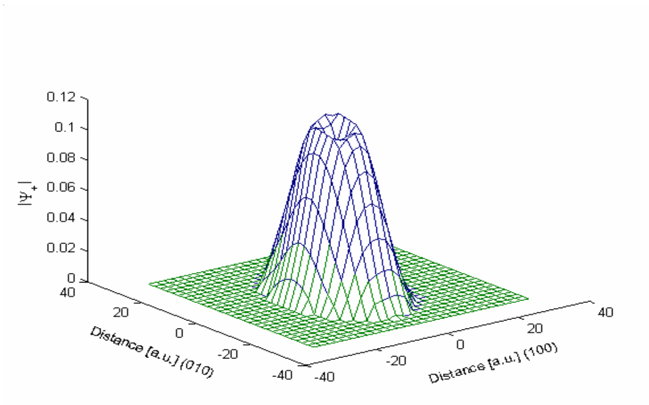
The positron trapping is reflected by a lowered annihilation rate, due to the lower electron density. According to DFT the correct ground-state energy of an interacting electron gas in an external potential can be determined by minimizing the functional of the electron density. That is why we do not need the full wave function but only the electron density. In order to understand the effect of hydrogen and helium decoration of vacancies on the positron lifetime, DFT calculations will be carried out as a function of the vacancy-cluster size in beryllium and vacancy-clusters in beryllium containing hydrogen.



Positron Density Distribution in Be vacancy



Positron Density Distribution in vacancy bound with H in Be

Contact

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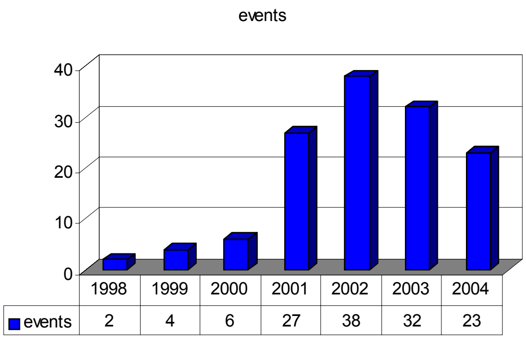
GAMDETEC project
Combating Illicit Traffic
of Nuclear and Radioactive Materials

for mobile equipment for nuclide identification using high resolution gamma spectroscopy delivered by ITU to INRNE, under the contract No. 203042-2005-09 F1SC KAR BG

A contract between the JRC Institute for Transuranium Elements (ITU), Karlsruhe, Germany and the Institute for Nuclear Research and Nuclear Energy (INRNE) of the Bulgarian Academy of Sciences, Sofia, Bulgaria has resulted in assisting INRNE in combating illicit trafficking and criminal use of nuclear and radioactive material (NRM). The main purpose of the project is to upgrade the analytical capabilities and to strengthen co-operation between national experts and international organizations in this field.



The first objective was the supply and implementation of dedicated equipment for mobile nuclide identification with the additional opportunity to operate for a more detailed analytical examination of samples. The equipment consists of a hand-held Mobile Stirling-cooled HPGe gamma spectrometer ORTEC DETECTIVE including docking station with calibration source, adapter cables for car based operation, proper hard- and software to perform mobile low energy gamma spectrometry analysis and detailed analytical visualization and evaluation of the spectral data. This will enable the identification of nuclear material even in the presence of a radioactive source (e.g. illicit trafficking of plutonium can even be detected in the presence of medically or industrial used radioactive isotopes).

The equipment will be used to assist law-enforcement services to counteract criminal use of radioactive and nuclear material and will underline the expertise of national experts in INRNE and facilitate more bilateral and regional cooperation in the combating illicit trafficking and criminal use of NRM.

Mobile nuclide identification on the spot using gamma spectroscopy is usually done with scintillation devices. The major disadvantage of these devices is their low energy resolution, which results in broad signals in the gamma spectra. As a consequence, it is not possible to detect illicit nuclear material in the presence of legal radioactive sources in case of similar signals in the gamma spectra, e.g. the presence of illegal plutonium can be disguised by legit medical isotopes. High purity germanium (HPGe) detectors operating at the temperature of liquid nitrogen have a far superior resolution and provide the possibility for a detailed analysis even in the presence of interfering isotopes. Recently, Stirling-cooled devices have been developed which allow the operation without the presence of liquid nitrogen. These devices can operate using electricity only and since their energy consumption is moderate, a battery based operation mode allows the end-user to perform mobile analytical investigations for approximately 8 hours. With this, mobile HPGe detection systems are suitable for analytical investigations on the spot, but can also be used for a detailed analysis in the laboratory. It is noteworthy, that Stirling-cooled detection systems provide an economic approach, since the maintenance costs are lower compared to detections systems which require the recurring purchase of liquid nitrogen.

The illicit traffic of nuclear and radioactive materials is a new threat, which requires rapid implementation of comprehensive, mutually measures and efforts, new approaches, co-ordination of services and institutions and even new legislation.

The co-operation of all national competent authorities, as well as with the Ministry of Internal affairs in the field of nuclear security aims at improving the physical protection and fire safety of nuclear facilities, strengthening the control at the national borders and inside the country regarding the illicit traffic, illegal moving and storage of nuclear material and radioactive substances.

Combating illicit traffic of nuclear (or radioactive) materials will be much more effective if regional approach is adopted through regional cooperation and regional interrelations between Customs, Border police, Antiterrorist or similar Services of neighboring countries are involved. In this way it will be much easier to bring together people from the law enforcement institutions and to facilitate the communications and collaboration between them.

The Institute for Nuclear Research and Nuclear Energy is a partner in the European International Technical Working Group (ITWG) for Combating illicit trafficking of Nuclear and Radioactive Materials. The main objective of the ITWG is to coordinate the efforts of European states to combat nuclear terrorism.

BEOBAL FP6 project Small Portable Devices Seminar

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Monitoring of the Radioactivity in the Aerosols at BEO "Moussala"

Introduction

In the laboratories of BEO "Moussala" are conducting a broad spectrum of scientific investigations, including ecological one. In the frame of the project BEOBAL was realized a system for detail analyzing of radioactivity of aerosols, the natural and human produced. The disposition of the BEO Moussala is very convenient for such monitoring, because of high altitude and very intensive exchange of the air from different directions. The results for some isotopes, like Be^7 are important for the physics of atmosphere, others are interesting for ecological description of the situation in Bulgaria.
In the emergency case, connected with the trans border diffusion of the radioactivity, this system could be very important, to and can give independent information.

Present status

With supporting of the project BEOBAL was mounted a new air sampling device, consisting of filter house and separate turbine house, with capacity about 1200m3/h. (see pictures)

Mounting works of the turbine and filter houses of the aerosols sampling

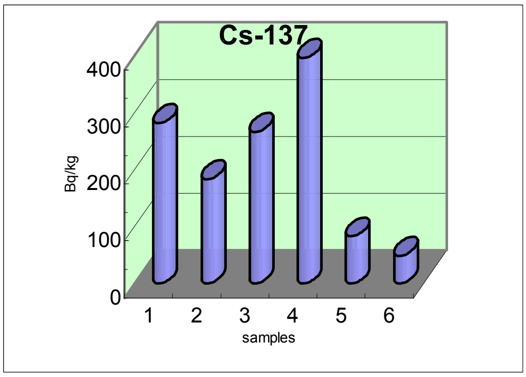
A new low-background gamma-spectrometer was putting in action, for measurements of the spectra of filters with aerosols. A open view of the spectrometer and filters after pressing on convenient shape are shown on the pictures below.

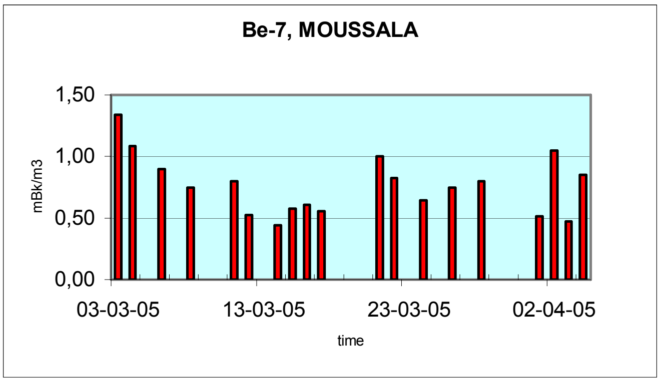
Gamma-spectrometer and filter after pressing to the shape for measurements

Gamma-spectrometer was calibrated with absolute standards, in two different geometries, for $50cm^3$ and for $150cm^3$, with density $1gr/cm^3$ and $1.2gr/cm^3$.

Possibilities of the new system

We have opportunity to measures the spectrum of gamma-rays of the radioactivity of the aerosols from pick Moussala in the energy interval 50 - 2500KeV, with resolution (WFHM) 1.5 - 3.0KeV. It is possible to give a contents of the radioactivity in m3, or in kg, in the case for other samples, for example dry plants, water from rivers and sources. (see pictures). All kind of natural and human done radioactivity could be detected with very high sensibility, in some cases less then mBq.





Cs-137 in some dry plants, Dr.A.Damianova results from Moussala

Be^7 in samples with filter material

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EUSAAR

BEO Centre of Excellence

EUSAAR I^3 project
European Super - sites for Atmospheric Aerosol Research

The **EUSAAR FP6 project** is devoted to the integration of measurements of atmospheric aerosol properties performed in a distributed network of **20 high quality European groundbased stations (Supersites).** This integration will contribute to a sustainable and reliable operational service in support of policy issues on air quality, long-range transport of pollutants and climate change. A major concern of EUSAAR is that networking and joint research activities consolidate current observation efforts across Europe to ensure their continuation beyond the frame of the project.

Tropospheric aerosols are of great importance because of their impact on human health, visibility, continental and maritime ecosystems, or the Earth's climate, requiring dedicated monitoring of their concentrations and properties at the European scale. Aerosol impact on climate is repeatedly mentioned as one of the most uncertain aspects of climate change, and their impact on human health is a growing matter of concern in Europe. There is a need to understand regional to intercontinental transport of aerosols in order to design efficient policies for monitoring of aerosols and their precursors and emission abatement strategies. Aerosol observational data are currently available from European monitoring (e.g., EMEP / GAW) networks and within regional, national and international projects.
However, **the vast majority of information arises from stations located in urban centers** and this information is often limited to regulated parameters as PM10 (mass of particles under 10µm in size), depending on the present Air Quality Limits following European directives. Although particulate matter has become a priority under the Convention in relation to the envisaged review and possible revision of the Gothenburg Protocol, it is only measured at comparably few regional background stations. It is also one of the major issues to be dealt with under the CAFÉ (Clean Air for Europe) programme. The present situation is, therefore, clearly not sufficient in the context of an integrated atmospheric observing system for air quality and climate studies. This has been clearly expressed by the EMEP Task Force of Measurements and Modeling. The non-regulated aerosol properties of interest to air quality and global climate modelling are the following:

Aerosol parameters of interest to Air Quality and climate Studies

	Parameter	Air Quality	Climate	Status
Chemical Properties	Aerosol inorganic composition	yes	yes	Implemented within EMEP (level 1)
	Aerosol organic composition (OC/EC)	yes	yes	Suggested as EMEP level 2
Physical Properties	Aerosol size distribution (dN/dlogD)	yes	yes	Suggested as EMEP level 3
	Aerosol Mass	yes		Implemented within EMEP (level 1)
Optical Properties	Light scattering Coefficient		yes	
	Light absorption coefficient		yes	
	Aerosol Optical depth		yes	Implemented inhomogeneously within AERONET / PHOTON / GAW
3D - distribution	Aerosol Vertical profile	yes	yes	Implemented within Earlinet (currently not continued)

*Grey area: parameters proposed to be integrated within EUSAAR. Dashed area: these parameters will be integrated only if performed outside of existing networks.

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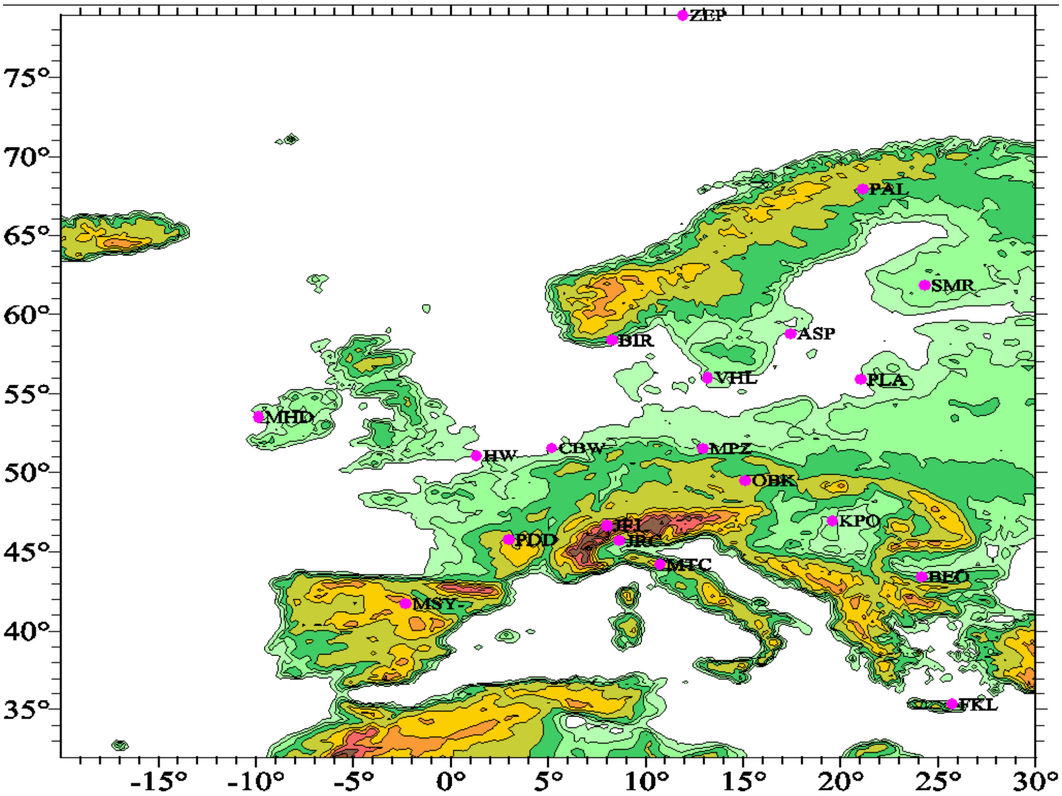
NUSES 3 Years later Project

The **major goal** of EUSAAR, through its **6 networking activities**, is to provide easy access to high quality data bases and promote standardised measurement protocols, intercomparability of observations and quality assurance common to all research sites. This will contribute to:

- Documenting trends in atmospheric composition
- Validation of remote sensing results
- Providing climate relevant data
- Validating transport models
- Improving air quality forecast
- Improving climate modelling

The networking activities will be complemented by **three joint research activities** aimed at developing future tools for aerosol monitoring and dissemination of information and **13 transnational access activities**. These developments can only be achieved through transnational coordinated research projects sharing experience, know-how and human capital, as offered by the proposed infrastructure.



EUSAAR super - sites and their location in Europe

CNRS, Centre National de la Recherche Scientifique; **PSI**, Paul Scherrer Institut; SU, Stockholms Universitet; **JRC**, EC – GD JRC, IES; **TNO**, Netherlands Organisation for Applied Scientific Research ; **IFT**, Leibniz Institut für Troposphärenforschung e. V.; **NILU**, Norsk Institutt for Luftforskning; **ISAC-CNR**, Consiglio Nazionale delle Ricerche; **UHEL**, University of Helsinki; **NUIG**, National University of Ireland Galway; **UoC**, University of Crete; **FMI**, Finnish Meteorological Institute; **ACUV**, University of Veszprém; **ICPF**, Institute of Chemical Process Fundamentals AS CR; **UHEI**, Ruprecht-Karls-Universität Heidelberg; **INRNE**, Institute for Nuclear Research and Nuclear Energy, BAS; **UNI BHAM**, University of Birmingham; **IPL**, Institute of Physics; **ULUND**, Lunds Universitet; **CSIC-IES**, Consejo Superior de Investigaciones Cientificas; **HMT**, Hoffmann Messtechnik GmbH.

Contact

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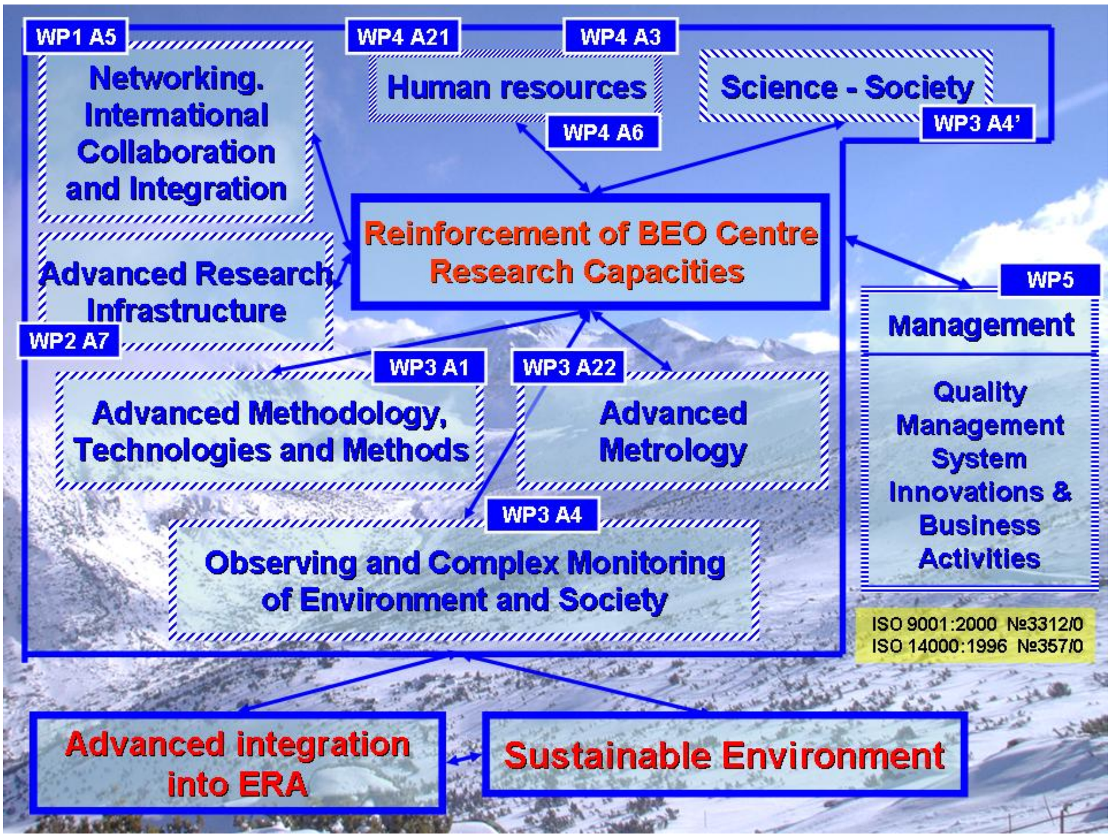
BEOBAL SSA project

BEO Centre of Excellence
Research Capacity Improvement
for Sustainable Environment
and Advanced Integration into ERA

The **BEOBAL FP6 project** is devoted to **Reinforcement of the BEO Centre of Excellence Research Capacities,** and by this way the respective S&T potential of INRNE and Bulgaria for advanced **Sustainable Environment** studies, devoted to the main Global change and ecosystems observing problems, using sophisticated information technologies and advanced **Integration in ERA**, in their institutional, national, regional and European aspects

BEOBAL Executive summary



<u>The main purpose of these projects is BEO Moussala in next years to be developed as (implemented):</u>

- an observatory attracting the scientists from abroad and to be included as “research infrastructure for transnational access”
- the regional station of GAW (Global Atmosphere Watch) programme of Wold Meteorological Organisation

EUROPEAN COMMISSION
DIRECTORATE-GENERAL
Joint Research Centre

• implementation and development of advanced methodology, technology, methods and advanced metrology
• enhancement of observing and complex monitoring of global change and ecosystems
• diversification, broadening and enhancement of international collaboration and cooperation
• advanced Human Resources long-term management and stimulate of youth in science
• active science communication by advanced Science – Society interaction policy
• application and development of advanced management system
• reinforcement of S&T equipment and systems of BEO CoE directed to enhancement of the research infrastructure of European importance

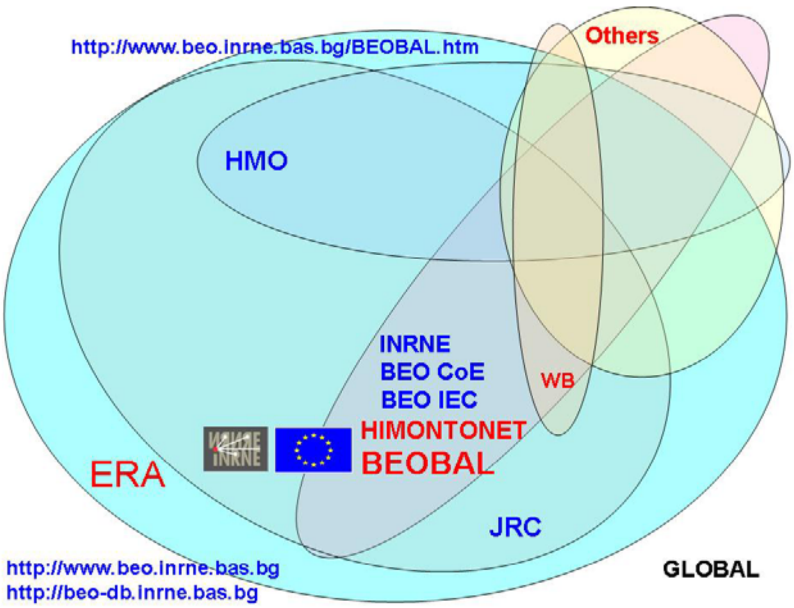
The basic fields of current and future work and studies at BEO Moussala and in BEO Centre of Excellence are:

- **Global change**
- **Space weather**
- **Sustainable development**
- **Measurement devises and systems development and enhancement.**

WP1: ***Networking****. Diversification, broadening and* ***enhancement of international collaboration*** *and cooperation.* **Operational goal A1** (Networking, International Collaboration & Integration and Reinforced Research Infrastructure)

Objectives ***Networking. Diversification, broadening and enhancement of international collaboration and cooperation*** towards to reach real European integration.

The special attention is paid and a substantial part of work is directed to the joint activities with Balkan institutions, deepening of international collaboration, networking and integration in the space of ERA with European centers of excellence - JRC institutes (**ITU**, Karlsruhe, Germany, **IES**, Ispra, Italy, **IRMM**, Geel, Belgium), European High Mountain observatories (**HMO**), large international institutions of European and global importance like **CERN** and other leading European institutes, traditional and new INRNE partners (**INP**, Prague, Czech Republic, **INFN**, Torino, Italy, **INS**, Izmir, Turkey).



Study visits: 7
2 in Western Balkan counties institutes - INP, Tirana, Albania; VINS, Vinca, Serbia; CETR, Podgirica, Montenegro; IF, Skopje, FYRO Macedonia; **1** in INP, Prague, Czech Republic; **1** in INS, Izmir, Turkey and **3** in Bern university, PSI and HAFS Jungfraujoch &Gornegrad, Switzerland; UFS Schneefernerhause, Zugspitze and Hochenpeissenberg Observatory, Germany.

BEOBAL project has been presented, protocols, memorandums, agreements have been signed and agreements for collaboration, joint research and exchange of information have been reached.

Special regional task was directed to the activities with **Balkan countries.**

Joint work programme with JRC institutes (in the framework of NUSES initiative and BEOBAL project)

Bilateral cooperation and joint cooperative agreements with European HMO (in the framework of HIMONTONET, BEOBAL, ACCENT, EUSAAR and other EU projects and initiatives).

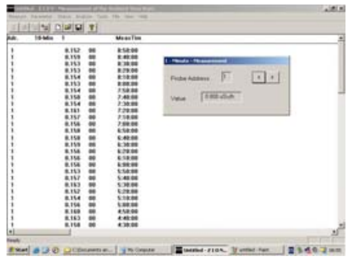
Deepening of international collaboration, networking and integration in the space of ERA with **large international institutions of European and global importance and INRNE traditional and other new partners**

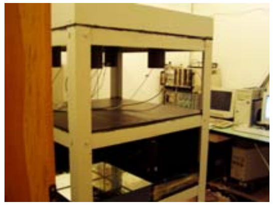
WP2: Reinforcement of S&T equipment and systems of BEO CoE
Operational goal A2 (Networking, International Collaboration & Integration and Reinforced Research Infrastructure)
Objectives Reinforcement of S&T equipment and systems of BEO CoE directed to enhancement of the research infrastructure of European importance, connected with: global change observing, ecosystems monitoring, technological and natural risks (study, early detection and control) widely using new information technologies and platforms. The improving of systems for observing and complex monitoring in attempt to realize adequate management towards to reach sustainable environment. Improving BEO Moussala to a regional GAW station, creating and improving by this way South - East European part of this network, joining ERA.

Upgrading and renewal of S&T equipment: 18

The following equipment is delivered and is at stage of test operation and measurements (see table for details):

- Air quality monitoring system (NOx, CO, SO2, O3 analysers, portable calibrator and data acquisition system);
- Aerosol instruments (according GAW requirements)
- PM10 and PM2,5 device for aerosol measurements;
- Cascade impactor for particle size distribution;
- Integrated nephelometer for determination of integral light-scattering coefficient of aerosol
- Systems for cosmic particles, radioactivity detection and complex environment monitoring
    a. Gamma background probe;
    b. Neutron detector;
    c. Moun telescope;
    d. Rn low level analyzer;
    e. Alpha - spectrometer;
- Modernization of set of portable small devices for complex environmental monitoring (new gamma spectrometer)
- Modernisation of computer network;
- Improvement of automatic weather station (new wind sensor);
- Upgrading of the system for uninterruptible emergency power supply;
- Improvement of equipment for radioaerosols research
- Improvemet and modernisation of video control and observing system
- Modernisation of electricity supply, thunder protection, transport and other technical infrastructure systems, ect.

Type of equipment	Status, Date	Functional characteristics (specification)	Tender procedure	Data transfer	Illustrations
Environnement CE Mark Automatic System for Gas Concentration Measurements; ISO 9001:2000 & ISO14001	Test operation Start 09.12.2005	**NOx analyser:** Chemilumiscence technique ISO 7996/1985 & EN 14211; 0-0.05/0.1/0.2/0.5/1/2/5/10 ppm or auto ; Lower detectable limit (LDL) : 0.4 ppb; Response time (RT) (T90s) : 40 s min; NOx converter efficiency : 98.5% **SO2 analyser:** UV-fluorescence technique ISO 10498 & EN 14212; 0-0.05/0.1/0.2/0.5/1/2/5/10 ppm or auto; LDL: < 1 ppb; RT (T90) : 10 s min **CO analyser:** NDIR FC technique in accordance with ISO 4224 & EN 14626; 0-10/25/50/100/200 ppm or auto; LDL: < 0.05 ppm; RT (T90s) : 30 s min; **O3 analyser:** UV photometry technique in accordance with ISO 13964 & EN 14625; 0-0.05/0.1/0.2/0.5/1/2/5/10 ppm or auto; LDL: 0.4 ppb: RT (T90s) : 30 s min; **Portable calibration device**: fast and multipoint calibration of gas monitors by dynamic generation of standard gas at known volume content (method referenced by ISO standard n° 6349	Open tender 3 candidates	On screen and database output, Web integration is force coming	  
TSI 3563 Integrated nephelometer for mesuring of integral light-scattering coefficient of aerosol			Tender procedure with direct negotiation; GAW requirements and standards and 3 recommendations of leading experts		
Pixe Cascade impactor for particle size distribution for range 16 µm – 0.06µm;			Direct negotiation is force coming		
PM10 and PM2,5 device for aerosol measurements;			marketing survey stage		
Intelligent Gamma probe IGS421	Test operation started 09.12.2005	**Detector 2x GM tubes 20031E** Range: 10nGy/h … 2mGy/h Sensitivity: 1976 counts/min ~ mGy/h Detector background: 38 counts/min ~ 38nGy/h Energy range: 40 keV …1.25 MeV **Detector GM tube 20018E** Range: 0.1mGy/h … 10 Gy/h Sensitivity: 1.24 counts/min ~ µGy/h Energy range: 50 keV …1.25 MeV Sensitivity range: 10 nGy/h …10 Gy/h Accuracy: ~ 15% resp. to Cs-137 Operating temperature: -40 deg. C …+ 60 deg. C Dimensions, wight: 80/115mm x 635 mm; ~ 2300 g	No tender, 3 offers	On screen and file output, software and database integration is force coming	 
SNM15 **Neutron neutron detector**	Detectors in test operation	2 modules of 3 SNM-15 detectors SNM -15 detector: Dimensions 2mx15 cm diameter Filled with BF_3 enriched to 90% with B^{10} (pressure 1.2 atm); High voltage regime 2000-2200 V Moderator tube – 240x40 cm cylinder, approximativly 200 litters of glycerin; Data acquisition system - 6 channels of individual counters; 1 channel integrated sum.; Maximal counting rate 30 000 counts/s for each channel	No tender, direct negotiation		 

Type of equipment	Status, Date	Functional characteristics (specification)	Tender procedure	Data transfer	Illustrations
Moun telescope;	Test operation Start 28.04.2006	Threshold of energy 1 GeV Zenith angular interval ± 25° All others angular Intervals 0 … 45 ° Standard error/hour 0.5% Total effective detect area 1m2	No tender, direct negotiation	On screen and database output, Web integration is force coming	 
Rn low level analyzer;	Technical specification is evaluated	The device is based on the method of rotating filter. The instrument contains two measuring module, one with passive detectors (TLDs or track detectors) and another one with active (alpha spectrometric) detectors, which allows performing of discrete and continuous measurements.	No tender, Direct negotiation		
α-spectrometer;	Force coming evaluation of 3 offers	The upgrading consists of changing the electronic modules with more performing ones which will provide better resolution and will double the number of the simultaneously analyzed samples.	No tender, 3 offers		
Liulin - 6MB Modernization of set of portable small devices for complex environmental monitoring	Test operation 28.02.2006	**Hi - Tech Gamma spectrometer with wide range, incl. space application** - Dose range: 0.093 nGy – 1.56 mGy; - Flux range: - 0.01 – 1250 part/cm2s; - Energy loss range: - 0.0407 – 20.83 MeV; - Pulse height analysis range: - 9.25 mV – 5.0 V; - LET range: 0.135 - 69.4 keV/µ; - Temperature range: -20oC - +40oC; - Power consumption at normal operation: not more than 150 mA from 12 V - Spectrometer dimensions: 84x40x40 mm; weight 0.12 kg;	No tender, direct negotiation; recommen-dations of leading experts; wide international cooperation	Web based interface	 
2 PC NEC Power Mate ML7 2 Laptops NEC Versa M350 Modernisation of computer network;	Operation	MB-uATX/LAN10,100,1000 & Video 128MB Shared &Audio Integrated on MB, Processor Bus 533/800 MHz, 4 DIMM DDR Slots Dual Channel up to 2GB at 400 MHz, 1 PCI Express 16X, 1PCI Express IX, 2 PCI, 6 USB, 1 Serial, 1 LPT, 1PS2, LAN PJ-45, CPU 2.93 GHz Celeron D335 LGA775, RAM 1 GB, HDD 160 GB SATA, DVD RW Dual Lair, Optical Mouse 3 But. USB, Keyboard PS2, FDD 3,5", 1.44MB, Cas Tower Case 315 W Power Supply ATX NEC Versa M350, CPU 1.73GHz/2MB/533Mhz/Pentium M730, RAM DDR2x512MB, HDD 40 GB ATA 100, DVD RW Dual Layer, LAN 10/100/1000, Wireless LAN Mini PCI, Modem 56 K, 4 USB, IEEE1394 port, Audio out/Mic In, Modem RJ-11 port, LAN RJ-45 port, VGA Port, Infra red port, TV-Out, Connector for Duplicate port, 15" TFT XGA Screen 1024x768, Batt 4400 mAh	open tender INRNE; # candidates		  
Vaisala WINDCAP® Ultrasonic Wind Sensor WS425 Improvement of automatic weather station	Software adjustment and integration	**Wind speed** Measurement range serial output: 0...65 m/s (0...144 mph, 0...125 knots) analog output: 0...56 m/s (0...124 mph, 0...107 knots) Starting threshold virtually zero Delay distance virtually zero Resolution 0.1 m/s (0.1 mph, 0.1 knots, 0.1 km/h) Accuracy (range 0...65 m/s) ± 0.135 m/s (±0.3 mph, ±0.26 knots) or 3% of the reading, whichever is greater **Wind direction** Measurement range 0...360° Starting threshold virtually zero Delay distance virtually zero Resolution 1° Accuracy (wind speed over 1 m/s) ±2°	No tender, direct negotiation (improving of existing Vaisala automatic weather station)	Software adjustment; software integration is force coming	

Type of equipment	Status, Date	Functional characteristics (specification)	Tender procedure	Data transfer	Illustrations
Upgrading of the UPS system for emergency power supply;	Operation; 10.12.2005	**Input** Nominal Input Voltage 230V; Input Frequency 50/60 Hz +/- 3 Hz (auto sensing) ; Input Connections Bulgarian BDS Schuko type; Input voltage range for main operations 160 - 285V ; Input voltage adjustable range for mains operation 151 - 302V **Output** Output Power Capacity 1980 Watts / 2200 VA; Max Configurable Power 1980 Watts / 2200 VA; Nominal Output Voltage 230V; Efficiency at Full Load 95% ; Output Voltage Distortion Less than 5% at full load ; Output Frequency (sync to mains) 47 - 53 Hz for 50 Hz nominal,57 - 63 Hz for 60 Hz nominal Crest Factor up to 5 : 1; Waveform Type Sine wave Output Connections	Open tender, INRNE	Log files	  
Improvement of equipment for radioaerosols measurements	Test operation	El. motor - 3kw, 3 phases House for el. motor, 140x80x90cm, material - special isolation against noise and vibrations Air turbine - 3000t/minp capacity - 1200m^3/h, possibility for reduction till 300-400m^3/h Filter device, 50x50cm, filter material ФПП-15 Effectiveness for aerosols in the frame 0.2 - 5mkm more then 95% House for filter device, steel 80x80x80cm	No tender		  
Improvemet and modernisation of video control and observing system	Operation 15.03.06		No tender, direct negotiation	BEO-db web	http://beo-db.inrne.bas.bg/moussala/images/index.html?asddd 
Electro generator Modernisation of emergency electricity supply	Test operation	Electro generator based on YAZ – 204 engine, 30 kW, 400V	No tender, direct negotiation		
Improving of thunder protection system of BEO	Operation 10.10.05 Real tests are expected in late spring 2006		No tender, Direct negotiation	N/A	
Modernisation of transport and other technical infrastructure systems, ect. **UAZ 39094**	Operation 15.11.05 1.07.05	Reconstruction of storage building at cargo lift station 4x4 combined truck auto;			 

WP3 *Advanced methodology, technology, methods, metrology, observing and complex monitoring.*
***Science – society interactions.* Operational goal A3, (Networking, International Collaboration & Integration and Reinforced Research Infrastructure), Operational goal C (Advanced Science – Society Interaction policy)**

Objectives: *Implementation and development of advanced methodology, technology, methods and advanced metrology, observing and complex monitoring* in the field of Global change and ecosystems and their regional and European projections and components including: impact and mechanisms of greenhouse gas emissions and atmospheric pollutants from all sources on climate, ozone depletion and carbon skins, towards to improve predictions and forecasts; operational forecasting and modeling, global change observing systems; especially environmental radioactivity, monitoring and assessment of technological and natural hazard and risks.
Advanced metrology development and implementation in the field of global change observing, environmental radioactivity and radioecology, radiochemistry and radionuclide analysis, based on the close collaboration with JRC institutes. ***Observing and complex monitoring*** of Global change processes and ecosystems in attempt to realize adequate management towards to reach sustainable environment. ***Advanced Science – Society Interaction policy*** towards to reach not only dissemination of the obtained research results but to succeed in the active communication and dialogue with the public organizations, government and NGOs. ***Improving responses to socio-economic needs of the country.***

Exchange of personnel and of results and joint experiments: **5**
2 visits in INP, Prague, Czech Republic; **1** visit to UFS Schneefernerhause, Zugspitze and Hochenpeissenberg Observatory; **1** visit to CERN, Geneva, Switzerland and **1** visit to Monte Cimone research station.

Visits for research activities: 9
(visits for joint research activities to BEO Centre of Excellence of scientists from leading European institutions, BEOBAL partners, EU and Balkan countries)
1 from INP, Prague, Czech Republic; **1** from ITF, Leipzig, Germany; **3** from INFN, Torino and Torino University, Italy; **1** from INS, Izmir, Turkey; **1** from INP, Tirana, Albania (seminar connected with “Small portable devices…” seminar – X-ray measurement device) and 2 from CERN, Geneva, Switzerland.

Conference activities 2
Methodological and Coordination Workshop, Bachinovo, 22-26 Oct. 2005, Bulgaria
More **60** participants, from **11** countries, **16** HMO, universities, institutes and representative of the Delegation of European Commission in Bulgaria. See details at:

http://www.beo.inrne.bas.bg/BEOBAL/BEOBAL_Methodological%20Workshop.htm

The BEOBAL team participates active in the organization of INSINUME 3 symposium in Turkey (www.insinume2006.ege.edu.tr)

Science communication:
- Improvement of BEO web sites and development of BEOBAL web page

http://www.beo.inrne.bas.bg/BEOBAL.htm
http://www.beo.inrne.bas.bg
http://beo-db.inrne.bas.bg

- **3** CDs, electronic, **2** web sites and **1** web page and other publications
- **2** Public lectures
- **5** Posters
- **5** Exhibitions, including participation in the world exhibition during the XX Olympic Games in Torino, Italy “High Mountain Research Stations – a Window to the Universe”
- Media activities (TV interviews, news, ect., journal papers, ect.)
- BEOBAL brochure, ect.

BEOBAL FP6 Project

Methodological and Coordination Workshop

22 – 26 October 2005, Bachinovo, SWU campus, Blagoevgrad, BULGARIA

BEO Centre of Excellence Research Capacity Improvement for Sustainable Environment and Advanced Integration into ERA

Main topics

- The main methodological challenges of BEO Centre of Excellence Research Capacity Improvement
- BEOBAL first results and developments
- What have to be strengthened in the context of upcoming 7th Framework programme?
- What is the agenda of BEO Centre of Excellence and BEO Moussala development for the next 10 years?

SOUTH-WEST UNIVERSITY "NEOFIT RILSKY"

Local organising committee

Jordan Stamenov, INRNE
Boyko Vachev, INRNE
Anna Damianova, INRNE
Ivan Sivriev, INRNE
Boyko Kolev, SWU
Vasil Kovachev, SWU
Nina Nikolova, INRNE
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Design and photo: Boyko Vachev

WP4: ***Improvement of Human Resources.*** **Operational goal B (Advanced Human Resources long-term Management)**

Objectives: ***Advanced Human Resources long-term management*** reaching and preserving European qualification level and creating the best home for young scientist, additionally attracting young scientist from other countries

Hosting scientist from aboard for teaching and training activities: 6

In the framework 6 training seminars have been organized:

- Environmental data quality management (1 lecturer, UFS Schneefernerhause, Zugspitze, Germany)
- Track detectors (1 lecturer, INP, Prague, Czech Republic)
- External exposure to natural radiation (1 lecturer, INP, Prague, Czech Republic)
- GRID technologies application in environmental and global change studies (2 lecturers, CERN, Geneva, Switzerland; INRNE, Sofia, Bulgaria)
- In situ measurements for complex environmental monitoring using portable equipment (4 lecturers, ITU, Karlsruhe, Germany, CLSTI and INRNE, Sofia, Bulgaria)
- Environmental monitoring and complex safety (4 lecturers, CERN, Geneva, Switzerland, INFN, Torino, Italy, NCRRO and NINH, Sofia, Bulgaria)

For details about BEOBAL training seminars see:

http://www.beo.inrne.bas.bg/BEOBAL/BEOBAL_events.htm

and BEOBAL web page

http://www.beo.inrne.bas.bg/BEOBAL.htm

Short stays for specialization: 4
2 visits in Lomnicky Stit observatory; **1** visit to INP, Prague, Czech Republic and **1** visit to Monte Cimone research station.

Young researcher's specialization: 2
2 specialisations are planned, agreed and will started in April, 2006 in the institutes of Joint Research Centre of European Commmission – **1** in IRMM, Geel, Belgium and **1** in IES, Ispra, Italy.

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http://beo-db.inrne.bas.bg


Institute for Nuclear Research and Nuclear Energy
INRNE
BEO Centre of Excellence
BEOBAL FP6 project
training seminars
30 – 31 Mar 2006
"Environmental monitoring and complex safety"
27 – 28 Feb 2006
"In situ measurements for complex environmental monitoring using portable equipment"
19 Dec 2005
"Portable X-ray spectroscopy equipment"
16 – 17 Feb 2006
"GRID technologies application in environmental and global change studies"
14 – 15 Feb 2006
"External Exposure to Natural Radiation"
27 Jun 2005
"Data quality at GAW stations"
15 - 16 Jun 2005
"Track detectors"
Seminars are organised in the framework of
INRNE BEOBAL FP6
EC project INCO-CT-2005-016663
For information:
Boyko Vachev, tel.: +(359) 2 9746310,
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http://www.beo.inrne.bas.bg

Track detectors

Dr. Karel Turek, NPI AS CR, Prague, Czech Republic

- Track-etch detectors – principles, processing, applications;
- Part B - Previous and recent studies. Colaboration NPI/INRNE

Dr. D. Pressyanov, SU St. Kl. Ohridski, Sofia, Bulgaria

- Traditions in the use of track methods at Physics Department at Sofia University

Assist. Prof. Metodi Gelev, INRNE, BAS, Sofia, Bulgaria

- Recent results from the processing of TEDs at LRPC

Data quality training seminar

Dr. Ludwig Ries, Federal Environmental Agency, Germany

- Data quality at GAW stations

Dr. Alexander Mishev, INRNE, BAS, Sofia, Bulgaria

- Data quality working programme

External Exposure to Natural Radiation

Prof. D.Sc. František Spurný, NPI AS CR, Prague, Czech Republic

- Source of the external exposure to natural radiation
- Dosimeter methods. Calibration
- External to natural sources – some examples

GRID technologies application in environmental and global change studies

Dr. Chris Jones, CERN, Geneve, Switzerland

- Basic GRID ideas and principles. GRID in particle physiscs and life scieneces
- Other GRIDs

Mr. Preslav Konstantinov, Miss Elena Puncheva, INRNE, BAS, Sofia, Bulgaria

- INRNE GRID activities
- INRNE GRID computer cluster demonstration

Portable X-ray spectroscopy equipment
Dr. Nicolla Civici, INP AAS, Tirana, Albania
Characteristics and applications of FPXRF system

In situ measurements for complex environmental monitoring using portable equipment
Dr. Andre von Zweidorf, ITU (DG JRC), Karlsruhe, Germany

- Combating Illicit Trafficking and Criminal Use of Radioactive and Nuclear Material. Activities of the Institute for Transuranium Elements
- Consequences of an Radiological Dispersal Event (RDE)

Dr. Boyko Vachev, Assist. Prof. Metody Gelev, INRNE, Sofia, Bulgaria

- Some INRNE activities in the field of Radiological Dispersal Device ("Dirty Bomb")

Dr. Alexander Strezov, INRNE, Sofia, Bulgaria

- Mobile nuclide identification techniques application for gamma-spectroscopic analysis of seized nuclear and radioactive materials. Gamma Detective (portable high purity Germanium detector) demonstration in seminar room

Dr. Tsvetan Dachev, CLSTR, Sofia, Bulgaria

- "Liulin" portable spectrometer

Environmental monitoring and complex safety
Pavol Vojtyla, CERN, Geneva, Switzerland

- Radiological environmental protection at CERN

Sevdalina Topalova, NCRRP, Sofia, Bulgaria

- National action plan "Environment – Health"

Kiril Slavov, NIMH, Sofia, Bulgaria

- Meteorological Aspects of Nuclear Accident and Bulgarian Emergency Warning System

Alba Zanini, INFN, Torino, Italy

- Neutron dosimetry by passive detectors: Environment and Medical Applications.
- Response of Photosyntetic organisms to radiation for space application

NUSES Work Programme

Main goal: **Integration between JRC and INRNE**

Other aims:

1) to exchange and implement good practices, advanced technologies and reference science by joint projects and other activities towards reaching synergetic multiplication and long-term effects;
2) diversification and deepening the joint JRC – INRNE activities covering regional and global aspects work programme
3) to reach sustainability

The programme results after 3 years:

- **7 new EURATOM projects**
- **2 FP6 project – BEOBAL, CoE and EUSAAR, I^3**
- **1 INRNE – ITU project – GAMDETEC**
- **joining to Generation IV initiative**
- **extremely active personal exchanging and training in JRC institutes ITU, IRMM and IE**
- **fulfillment of measures and activities as a result of Brussels meeting with JRC leadership in Summer 2004**

Good joint practices:

1) leadership coordination meetings
2) development of joint project proposals
3) regular estimation of the work programme progress

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Hot Projects, New Ideas

Complex effect of environmental global changes on the biota

The Biosphere is exposed on the influences of different impacts. In a study of global atmospheric changes one of the main tasks is the evaluation of their complex effect on the biota. The prolonged influence of one or several harmful factors (even with low intensity) on the organisms reduce their compensatory adaptive possibility. Among the main environmental factors are the radiation and chemical influences – both can cause genetic damages.

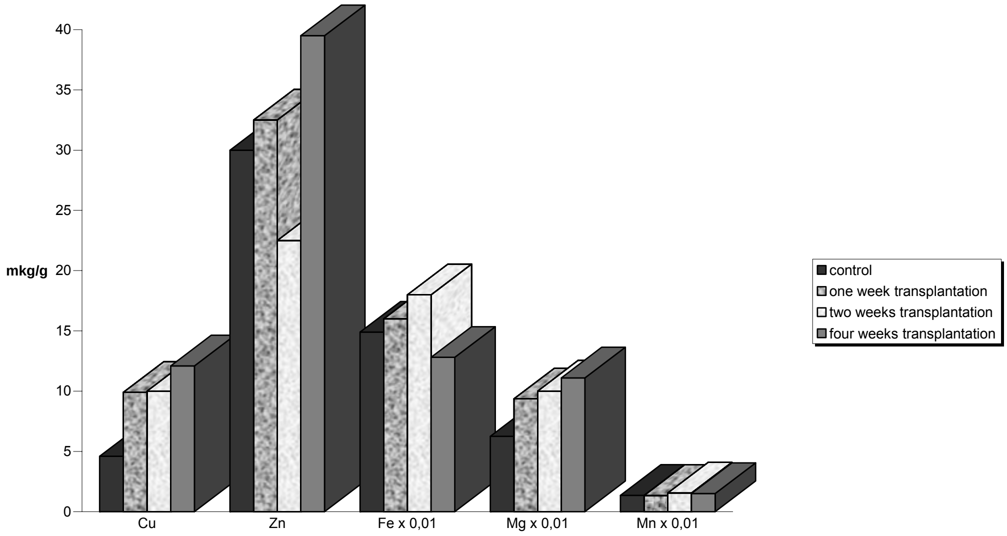
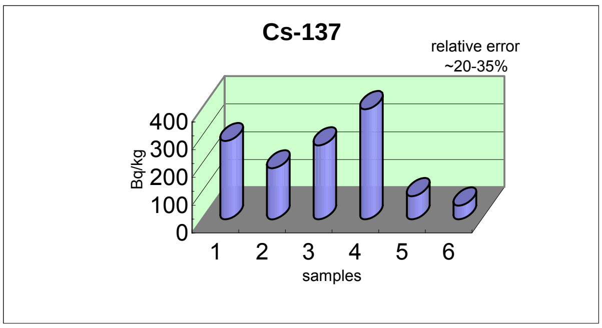


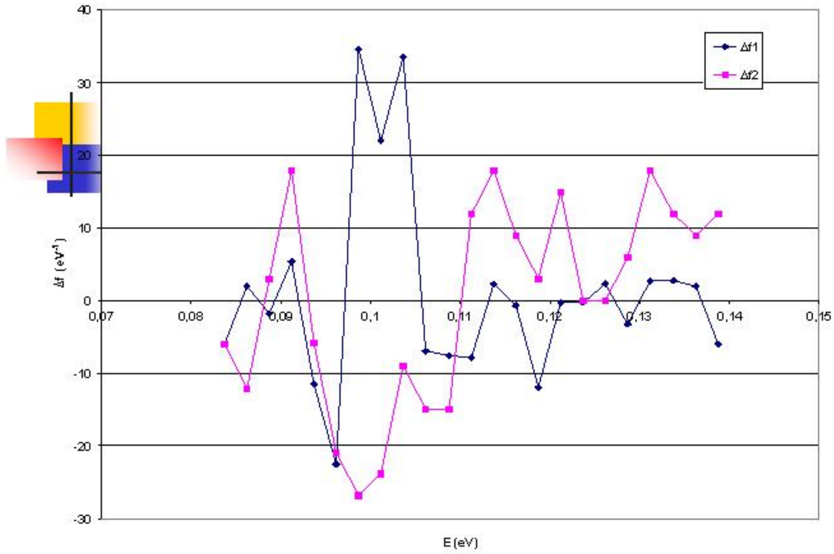
Fig. 8
Changes in the chemical content of F. antipyretica from river Musalenska Bistriza after transplantation in the river Iskar

In order to evaluate the complex environmental impact on the organisms the investigation of some harmful factors as chemical elements and radioactivity are carrying out. At the same time the accumulation capacity of biomonitors –bryophites Fontinalis antipyretica is used for improving the quality of river waters.



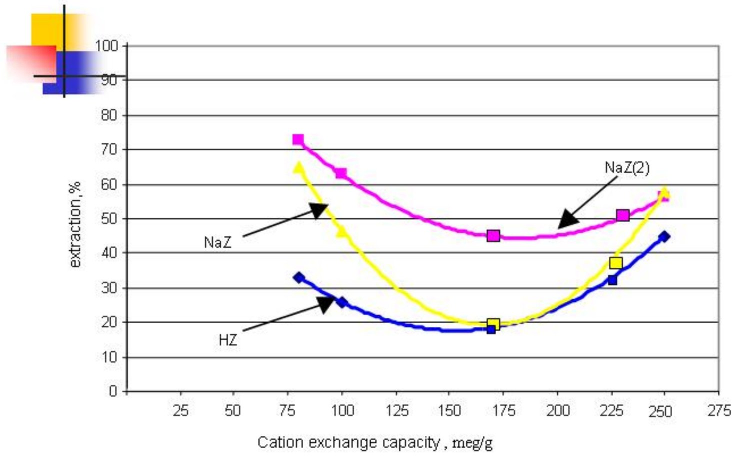
Radioactivity of water plants (Fontinalis antipyretica) from Rila rivers

A special attention is given to the pollution influence on the energy spectra and the structure of water as the most wide spread part and center of the biological systems.The variations of the environmental parameters influence on the living organisms also via the changes in the water intramolecular energy spectrum.The presence of the plants (bryophytes) in the water stabilizes the energy of its H-bounds and increases the water activity.



Influence of Cu $^{2+}$ (curve 1) and bryophytes F.antipyretica (curve 2) on the energy spectrum of water

For purification of polluted river waters the capacity of modified zeolites for absorption for low concentration of chemical elements (Cu) in the water is used in order to increase their quality and ensure their use for agricultural applications.



The capacity of modified zeolite and the adsorption of low concentration of Cu $(NO_3)_2$ in water solution

The complex approach enables the more accurate evaluation of the influence of global changes on the biota in order to protect it.

Contact

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