JRC Information Day, BULGARIA
Sofia, 27 April 2004, Hotel Hilton, Moussala conf. room
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

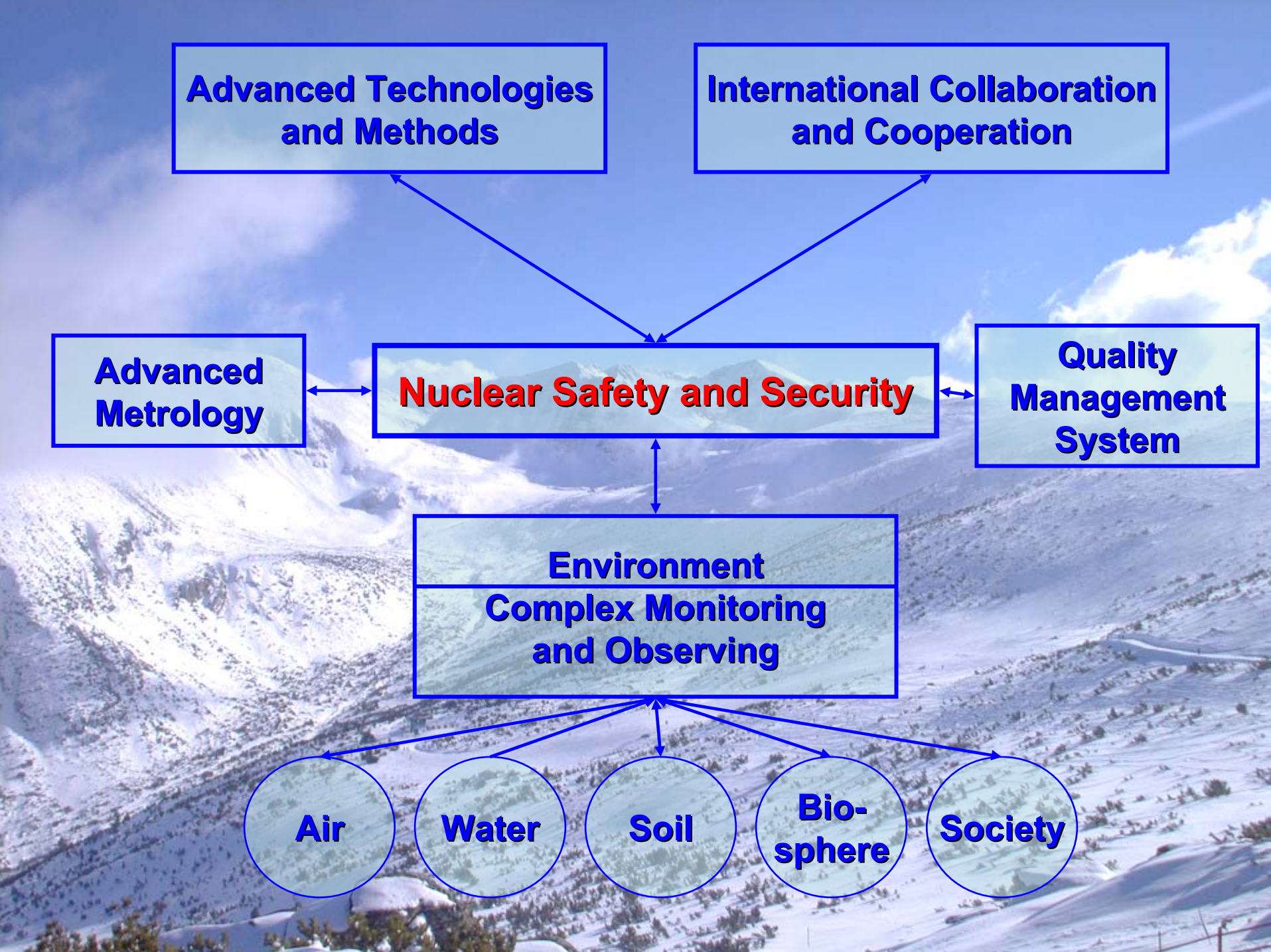
Past, Present and Next Future

Excellence,
Sustainability,
Integration

Jordan Stamenov, Boyko Vachev

EUROPEAN COMMISSION
DIRECTORATE-GENERAL
Joint Research Centre

NUSRS
FP5 Project


Advanced Technologies and Methods
International Collaboration and Cooperation
Advanced Metrology
Nuclear Safety and Security
Quality Management System
Environment
Complex Monitoring and Observing
Air
Water
Soil
Bio-sphere
Society

Mission

INRNE is nuclear research institution and the biggest leading complex centre in Bulgaria for scientific investigations and applications of the nuclear science

Vision

INRNE has to satisfy the needs of the society for support and development of the nuclear science and knowledge towards to perform investigations and applications on the field of nuclear technologies, medicine and industry

Quality management system since 2003/2004

ISO 9001:2000
ISO 14000:1996

JRC - INRNE prehistory of scientific collaboration

ITU, Karlsruhe

1993 - 98 FERONIA Project: European bilateral PHARE project to purchase and to implement the TRANSURANUS code, to train and educate INRNE specialists and to perform thermo-mechanical analysis of the nuclear fuel operated at the Kozloduy NPP

1998 - 2002 Different projects devoted to safety aspects of fuel rods and licensing

1998 - 2002 Different projects devoted to the problems connected with illicit traffic of nuclear materials and radioactive substances and upgrade of nondestructive capacities for fissile nuclear material analysis

IRMM, Geel

2000 - Neutron data measurements and evaluation

2001 - Neutron activation crossections for safety of nuclear reactors

2001 - Nuclear fission

IE, Petten

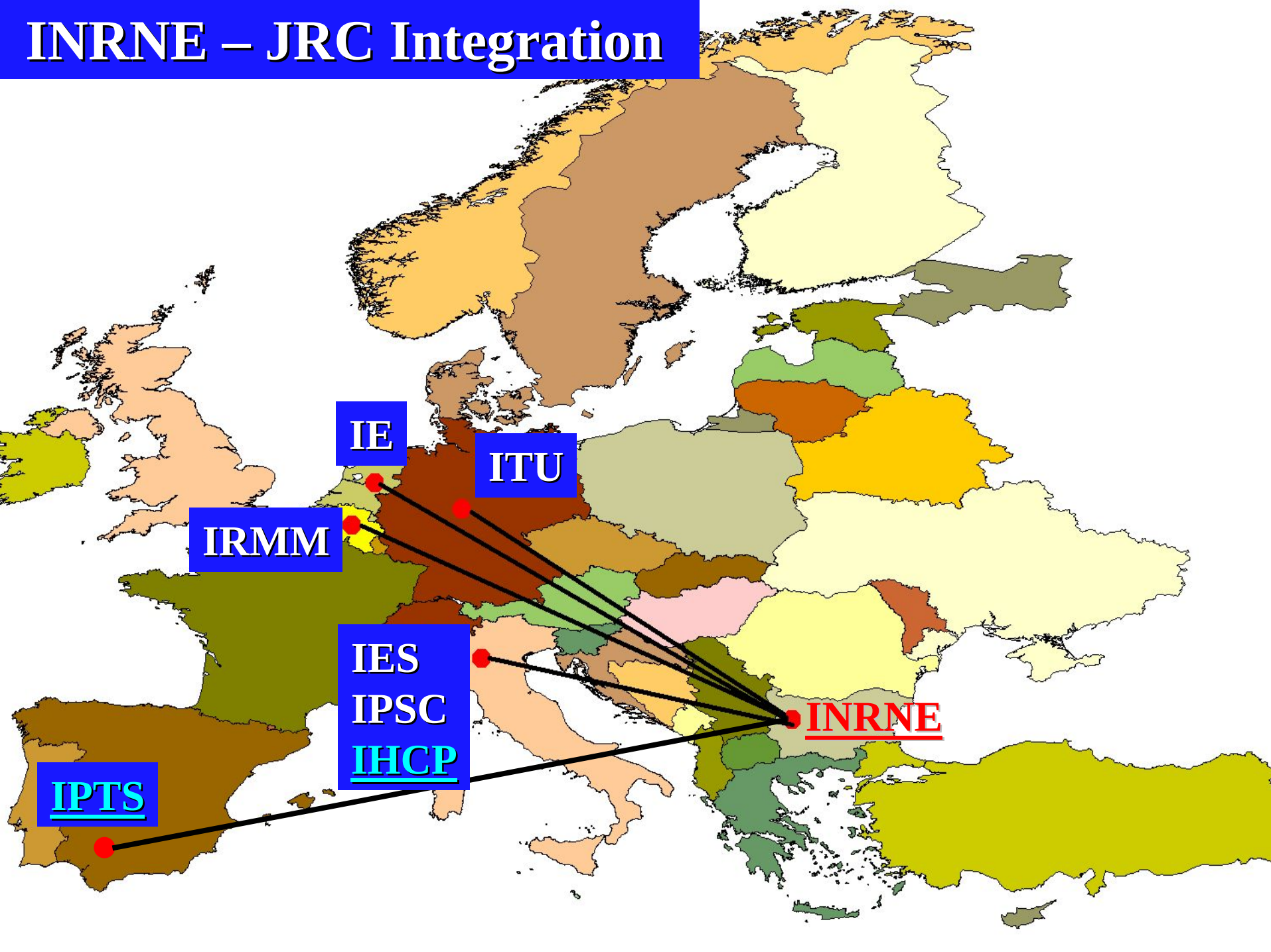
2001-2004 REDOS project (EUROATOM) Accurate determination and benchmarking of radiation field parameters, relevant for reactor pressure vessel monitoring

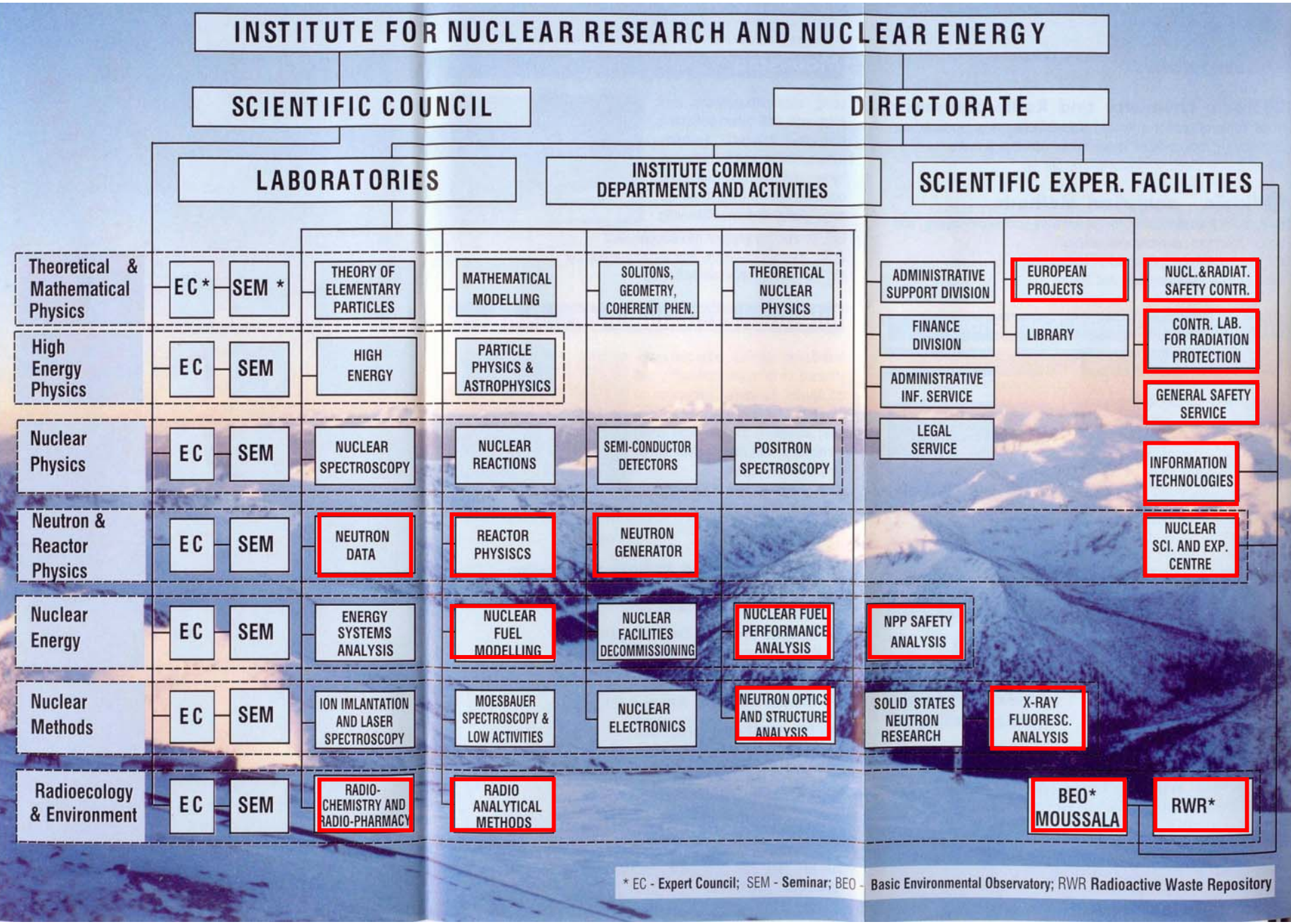
IES, Ispra

2003 – EURDEP: European Radioactivity Monitoring Data

2003 – Atmospheric Aerosol Monitoring

INRNE – JRC Integration



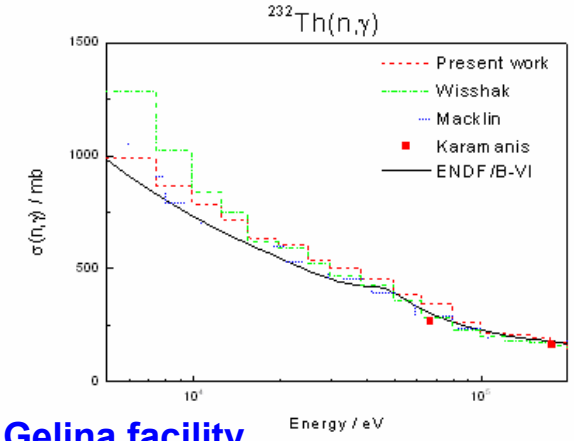

INSTITUTE FOR NUCLEAR RESEARCH AND NUCLEAR ENERGY
SCIENTIFIC COUNCIL
DIRECTORATE
LABORATORIES
INSTITUTE COMMON DEPARTMENTS AND ACTIVITIES
SCIENTIFIC EXPER. FACILITIES
Theoretical & Mathematical Physics
EC*
SEM *
THEORY OF ELEMENTARY PARTICLES
MATHEMATICAL MODELLING
SOLITONS, GEOMETRY, COHERENT PHEN.
THEORETICAL NUCLEAR PHYSICS
High Energy Physics
EC
SEM
HIGH ENERGY
PARTICLE PHYSICS & ASTROPHYSICS
Nuclear Physics
EC
SEM
NUCLEAR SPECTROSCOPY
NUCLEAR REACTIONS
SEMI-CONDUCTOR DETECTORS
POSITRON SPECTROSCOPY
Neutron & Reactor Physics
EC
SEM
NEUTRON DATA
REACTOR PHYSISCS
NEUTRON GENERATOR
Nuclear Energy
EC
SEM
ENERGY SYSTEMS ANALYSIS
NUCLEAR FUEL MODELLING
NUCLEAR FACILITIES DECOMMISSIONING
NUCLEAR FUEL PERFORMANCE ANALYSIS
Nuclear Methods
EC
SEM
ION IMLANTATION AND LASER SPECTROSCOPY
MOESBAUER SPECTROSCOPY & LOW ACTIVITIES
NUCLEAR ELECTRONICS
NEUTRON OPTICS AND STRUCTURE ANALYSIS
Radioecology & Environment
EC
SEM
RADIO-CHEMISTRY AND RADIO-PHARMACY
RADIO ANALYTICAL METHODS
ADMINISTRATIVE SUPPORT DIVISION
FINANCE DIVISION
ADMINISTRATIVE INF. SERVICE
LEGAL SERVICE
EUROPEAN PROJECTS
LIBRARY
NUCL.&RADIAT. SAFETY CONTR.
CONTR. LAB. FOR RADIATION PROTECTION
GENERAL SAFETY SERVICE
INFORMATION TECHNOLOGIES
NUCLEAR SCI. AND EXP. CENTRE
NPP SAFETY ANALYSIS
SOLID STATES NEUTRON RESEARCH
X-RAY FLUORESC. ANALYSIS
BEO* MOUSSALA
RWR*
* EC - Expert Council; SEM - Seminar; BEO - Basic Environmental Observatory; RWR Radioactive Waste Repository

IRMM - INRNE

Neutron Investigation

towards to access
safe operation of nuclear reactors, model the ageing of operating NPP, development of new reactor concepts, various technological applications

Neutron cross sections investigations



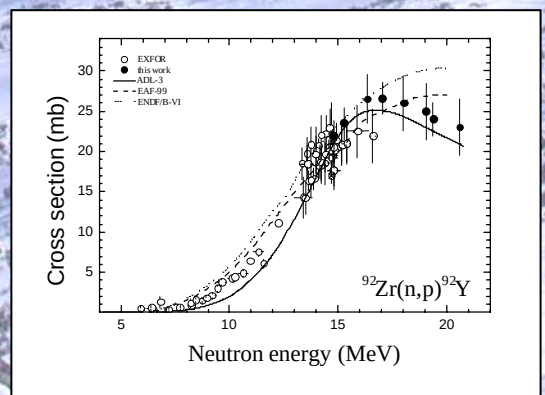
Gelina facility

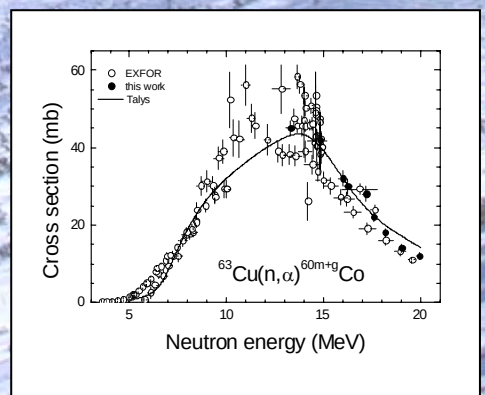
The thorium – uranium fuel cycle is very attractive because it limits the build up of highly radioactive trans uranium nuclides.

Accelerator Driven Systems based on Th– U – fuel cycle → to increate the waste of NPP

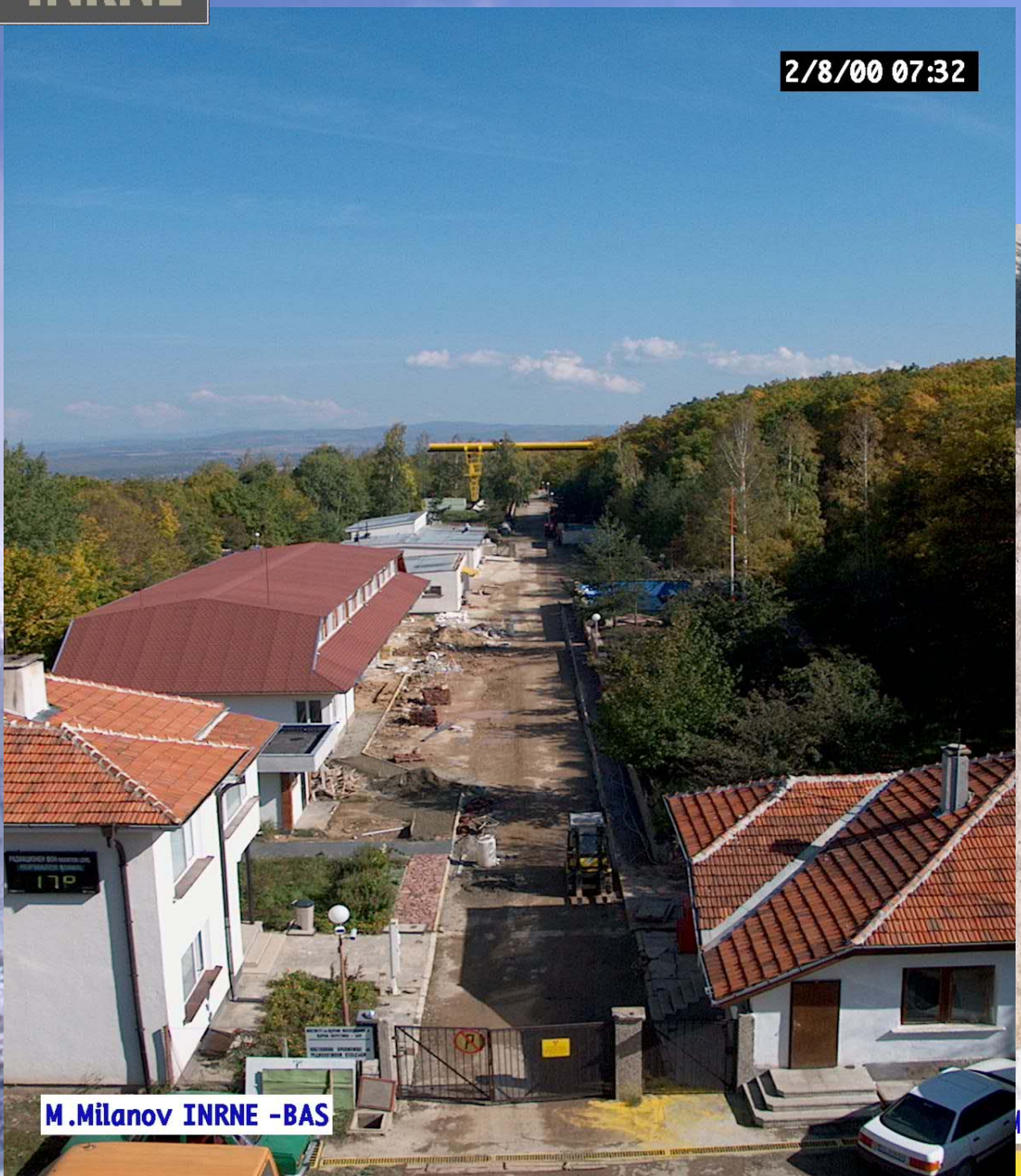
Activation neutron – induced reaction Cross section measurements

needed to determine activity levels induced during the reactors operation and for low activation material development





NOVI HAN Radioactive Waste Repository

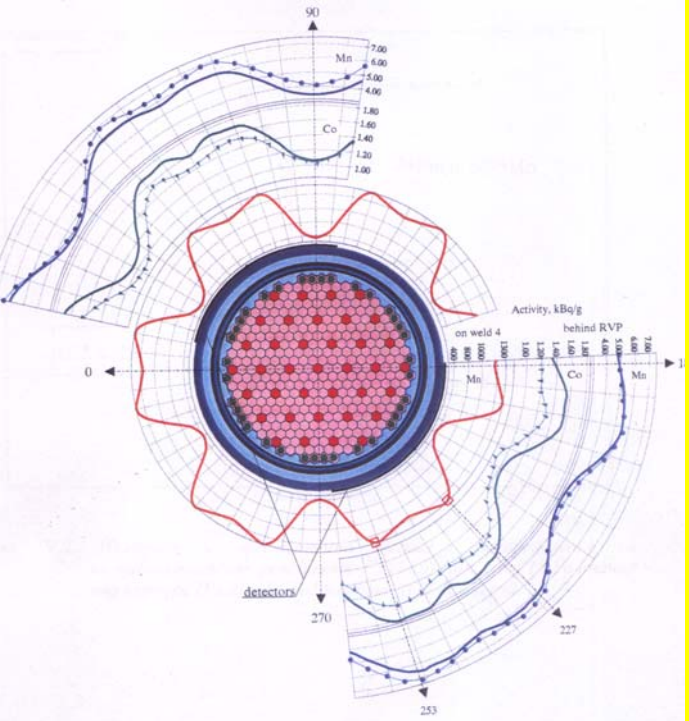


IE - INRNE

Neutron Fluence for Reactor Vessel Embrittlement

The assessment of the fast neutron fluence onto the RPV is therefore required for evaluation of vessel steel degradation .

PERFECT COVERS **Projects**



Calculated (curves) and measured (signs) induced activities of the scraps and ex-vessel detectors, Unit 1, Kozloduy NPP, 18th cycle.

REDOS (Reactor Dosimetry: Accurate determination and benchmarking of radiation field parameters, relevant for reactor pressure vessel monitoring) is being carried out during 2001-2004 in joint works of Tecnatom (Madrid), JRC-IE (Petten), INR (Prague), INRNE (Sofia), Skoda (Plzen), KFKI (Budapest), INR (Rossendorf), Framatome (Erlangen).

INRNE responcibilities are:

- Neutron and gamma transport calculations of VVER440 and VVER1000 RPV benchmarks.
- Data and analyses of ex-vessel detectors measurements in Kozloduy NPP.
- Calculations of neutron and gamma fluxes and radiation damages on VVER1000 and VVER440 RPVs.

IE - INRNE NPP Safety Analysis

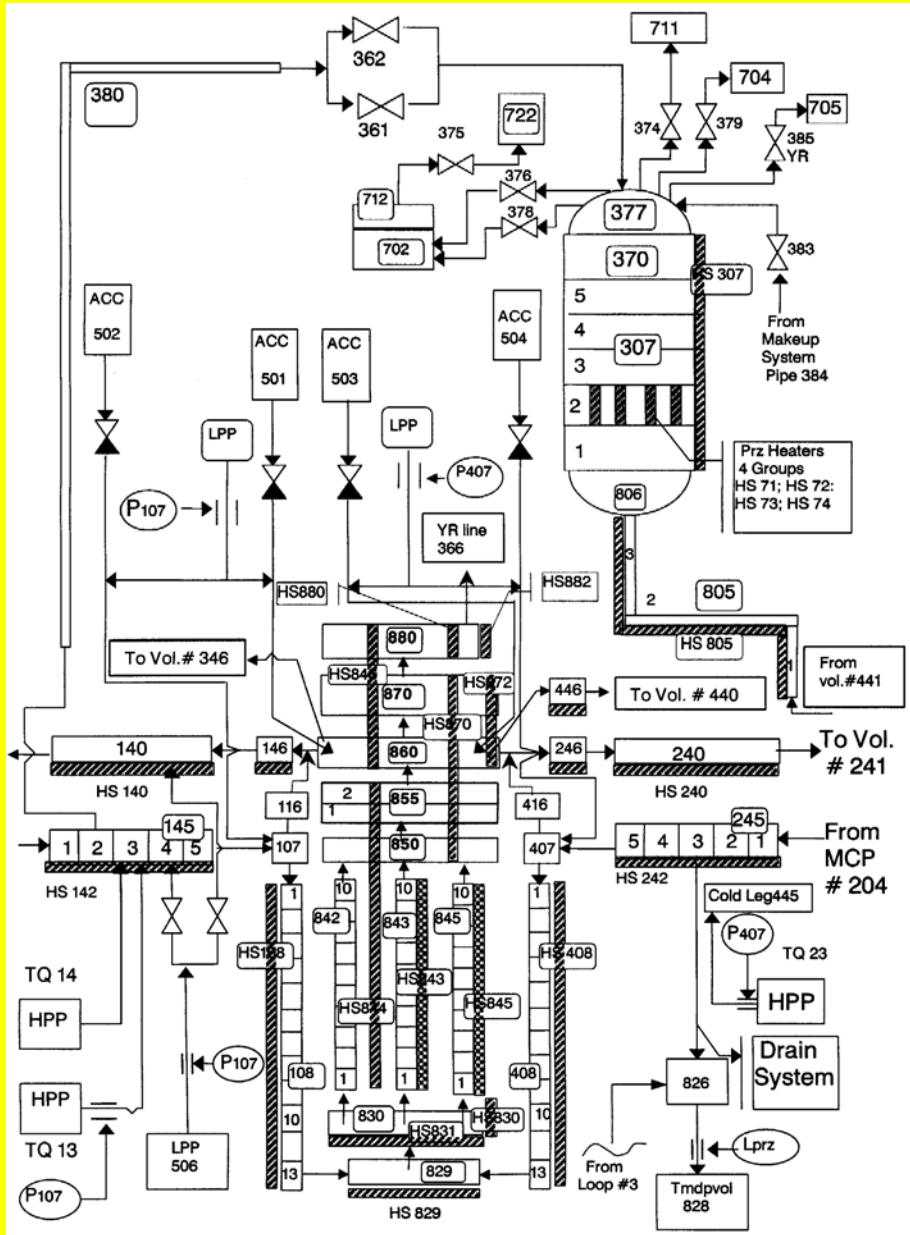
- Analytical Code Validation
- Analytical validation of Emergency Operating Procedures
- Severe Accident Analysis

FR5 and FR6 Projects:

SARNET

IMPAM

LACOMERA



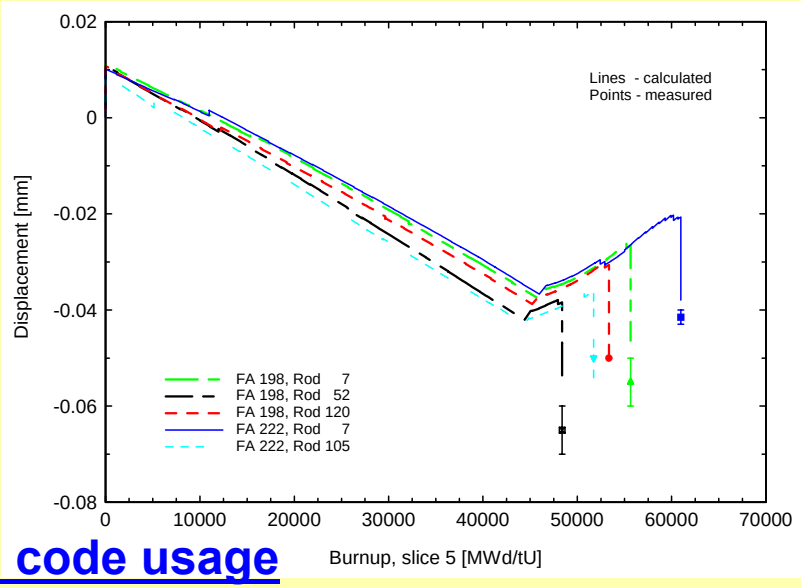
Kozloduy VVER-1000 Reactor and Pressurizer RELAP5 Model

ITU - INRNE Nuclear Fuel Modelling

PECO Project, INRNE – Sofia, Bulgaria, had to perform verification of the latest TRANSURANUS-WWER versions on the basis of the IFPE-OECD/NEA-IAEA database.

Conclusions to TRANSURANUS-WWER calculations

- the burn up calculations are in excellent agreement;
- the fission gas release calculations are in very good agreement;
- the size changes of the cladding are reproduced satisfactorily;
- the gas pressure is reproduced very well.



Development of tools serving TRANSURANUS code usage

Collaboration activities after NUSES:

contract 370011–2004–02 F1FD KAR BG

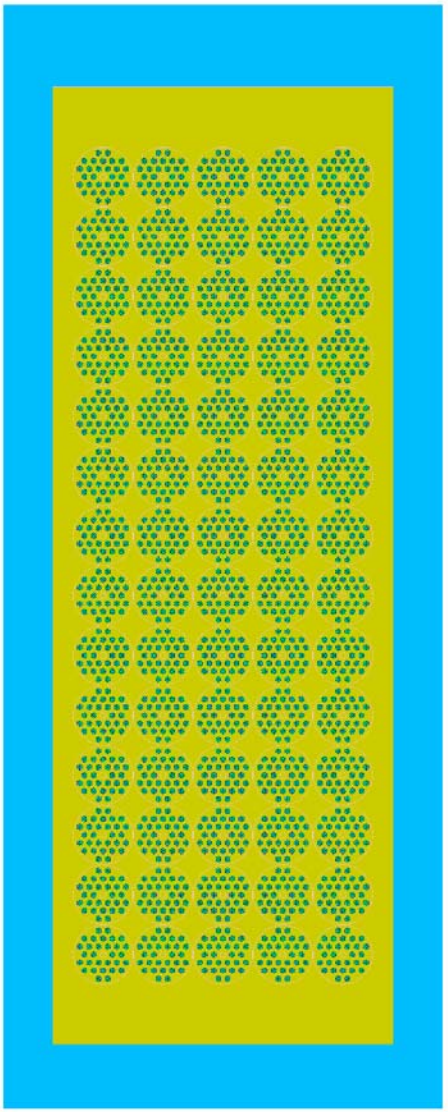
Towards to serve the national needs in the field of the radiation safety and reactor safe operation

Development of further studies

- Fuel behavior 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.

IE - INRNE

Safety Analysis for Spent Fuel Facilities



Radial Model of a Storage Pool Containing 70 Baskets T12 with WWER-440 Spent Fuel Assemblies

INRNE – continuous improvement of models and calculation methods

The scale system for WWER application is currently in progress

Problems:
Field content
Spent field casks
Storage facility design

FP6 project COVERS

IE - INRNE

BNCT Application of IRT-200 Research Reactor

Boron Neutron Capture Therapy (BNCT) is a form of radiotherapy that has the potential to selectively kill the cancer cells embedded within normal tissue. It uses boron-10 isotope, which emits two short-lived high-energy alpha particles when irradiated a beam of thermal energy neutrons. The tumour treatment goes through two stages:

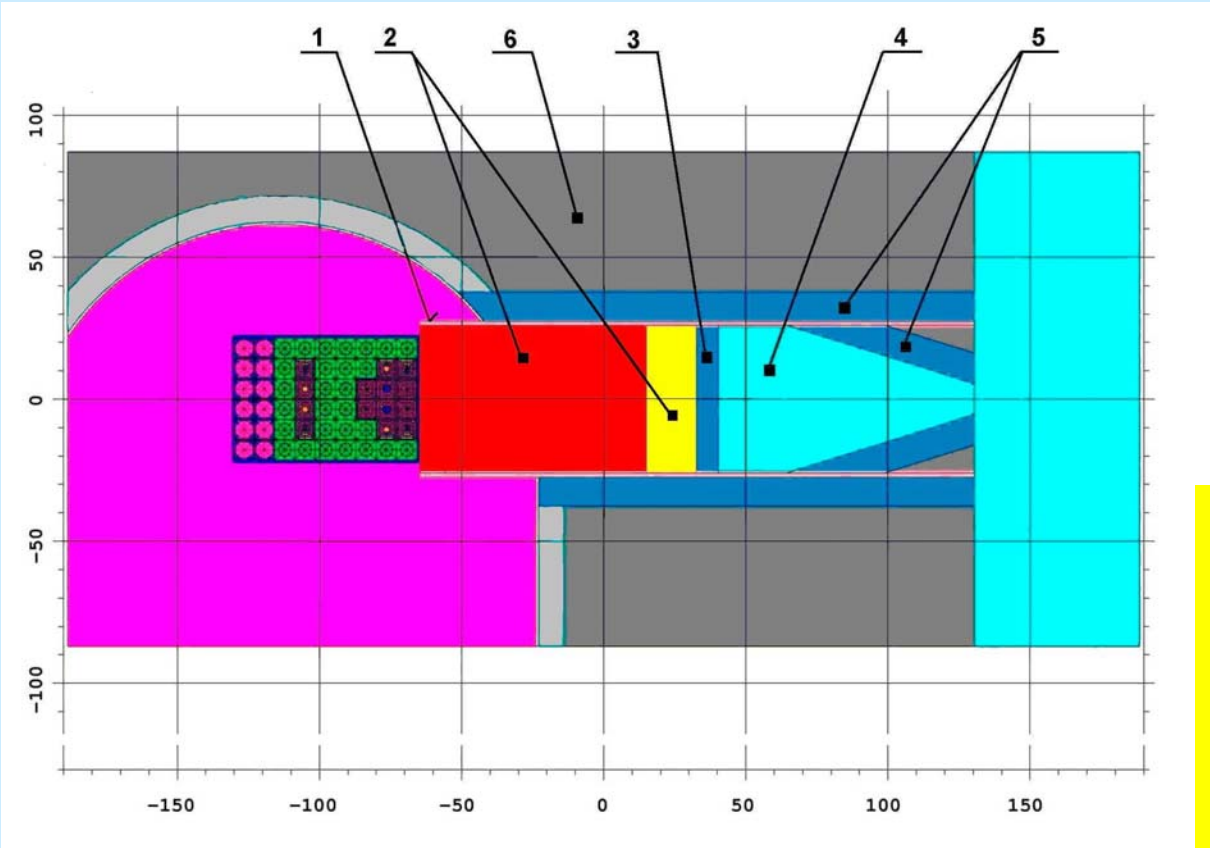
- **A tumour-seeking chemical compound, which contains a predefined concentration of boron atoms, is loaded intravenously in the patient**
- **The tumour area is then irradiated with thermal neutrons from nuclear reactor**

According the governmental decision from 2001 the research reactor IRT–2000 will be reconstructed into reactor with low power 200kW - IRT-200

BNCT Channel

15 mm stainless steel plate with rectangular profile 700mm X 550mm. For selected filter and collimator the epithermal flux is estimated as 0.9×10^9 neutron/cm^2 x s.

The fast neutron dose is in tissue per one epithermal neutron is: $1.95.10^{-11}$cGy.cm^2n^{-1} and for gamma – $1.98.10^{-11}$cGy.$cm^{-2}n^{-1}$



1. Vessel of Channel;
2. Filter (80cm Al+ 17cm CF2 + 0.04cm Cd);
3. Lead Shielding;
4. Collimator;
5. Lead Shielding of Channel;
6. Concrete.

Open problems:

- The assessment of the irradiation conditions
- Modelling of the neutron reaction distribution in the living tissue
- Dosimetry technique skills

ITU - INRNE

Combating Illicit Trafficking of Nuclear Materials

The illicit traffic of nuclear and radioactive materials is a serious violation nonproliferation laws as well as a risk for the health of the population. Criminal diversion of fissile materials could lead to the potential construction of nuclear weapon or applied with conventional explosives the radioactive material could pose a threat to dwelling places, water supplies etc.

I. Internal traffic

These devices consisted of level and dense meters, irradiation devices, removing static electricity, smoke detectors etc. mainly containing the isotopes Cs-137, Co-60, Ir-192, Ra-226, Am-241 etc.

II. External traffic

This traffic included Al, Os, Cs, Sc, Rare earth elements, Red Mercury, Pu, Enriched U.

Creation of specialized Laboratory for Non-destructive Analysis of Illicit Nuclear and Radioactive Materials

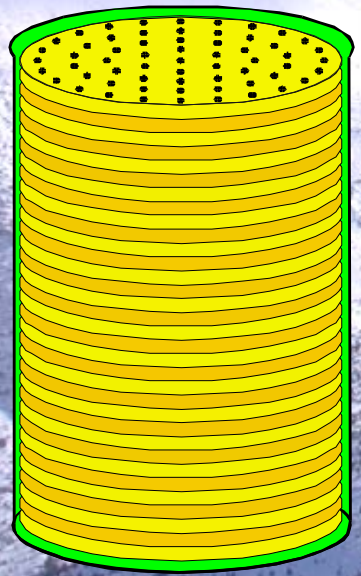
ITU - INRNE

Environmental and manmade radioactivity

Checking of sampling procedures and analytical methods towards to reach the EU-wide harmonisation of analytical procedures and the development of a common quality assurance/quality control programme.

INRNE **Laboratory of radioanalytical methods** develops methodology for preparation of secondary efficiency calibration standards with different geometries and densities.

An **unique product of our Lab is a 200 l barrel – efficiency calibration standard** for Waste Department of NPP "Kozloduy".



V = 207 dm 3
P = 0,449 kg/dm3
A = 29488 kBq

ITU Project " Harmonization of techniques and methodologies for sampling and measuring radioactivity in the environment"

IES - INRNE

EURDEP Network

HIMONTONET
FP5 project

Director

Scientific council

Head

Expert Councils

- Basic Environmental Observatory Moussala
- Radio Analytical Methods
- Radio Chemistry & Pharmacy
- Radioactive Waste Repository Low Activities
- X-ray - Fluorescent Analysis
- Neutron Generator
- Neutron Data
- Control Laboratory of Radiation Protection
- Information Technologies
- Department of European Projects

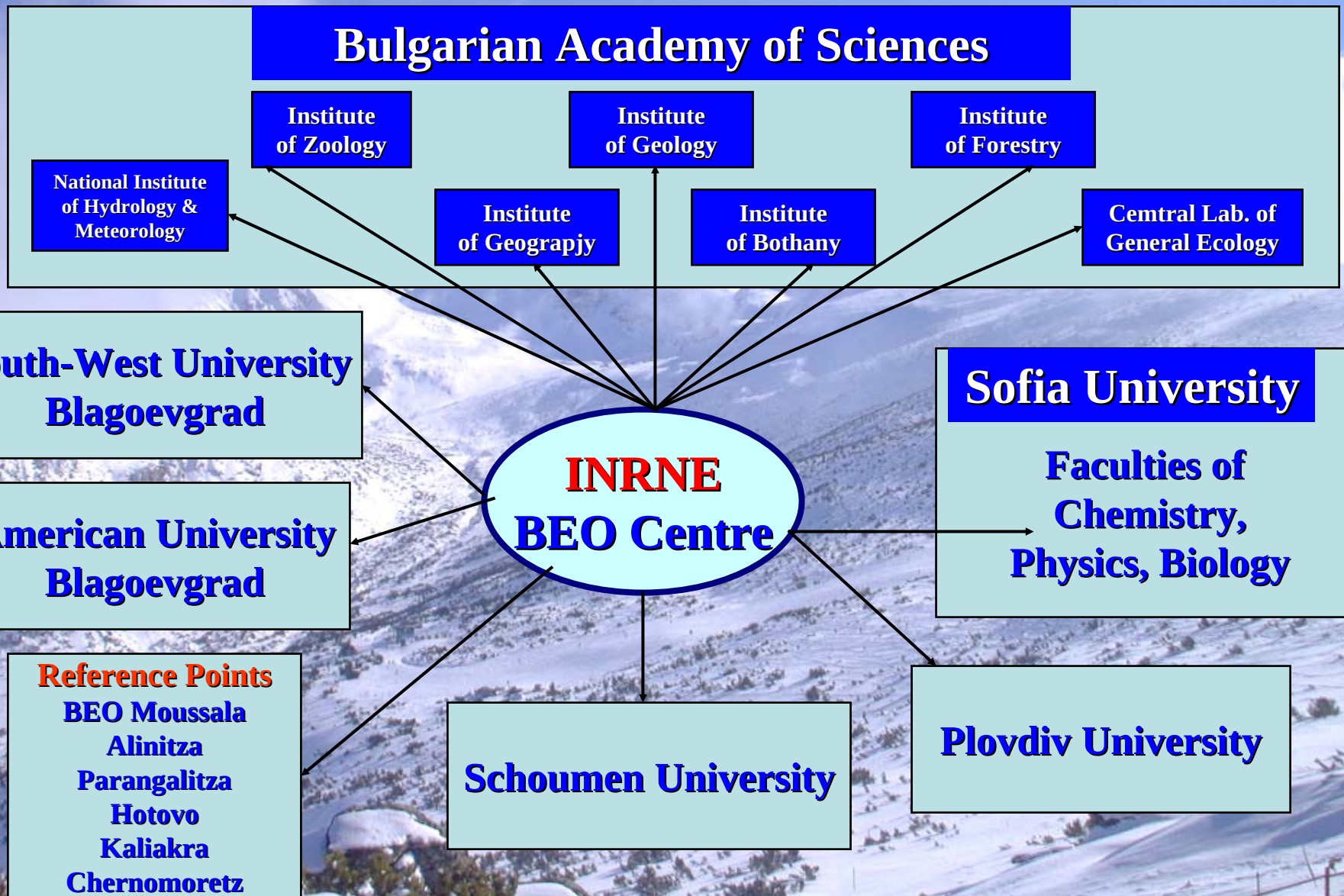
BEO Centre of Excellence

Laboratories and Scientific Experimental Facilities

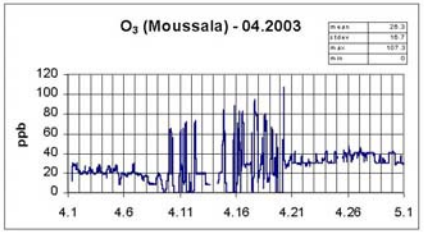
- Radioecology &Environment
- Nuclear Methods
- Neutron & Reactor Physics

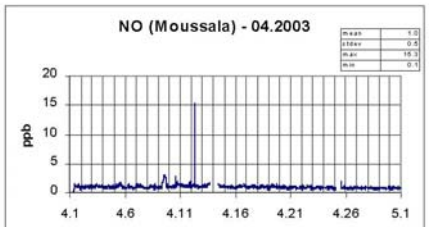
BEO IEC

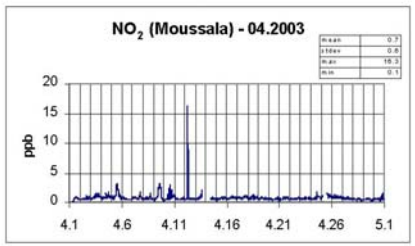
BEO Integrated Environmental Centre

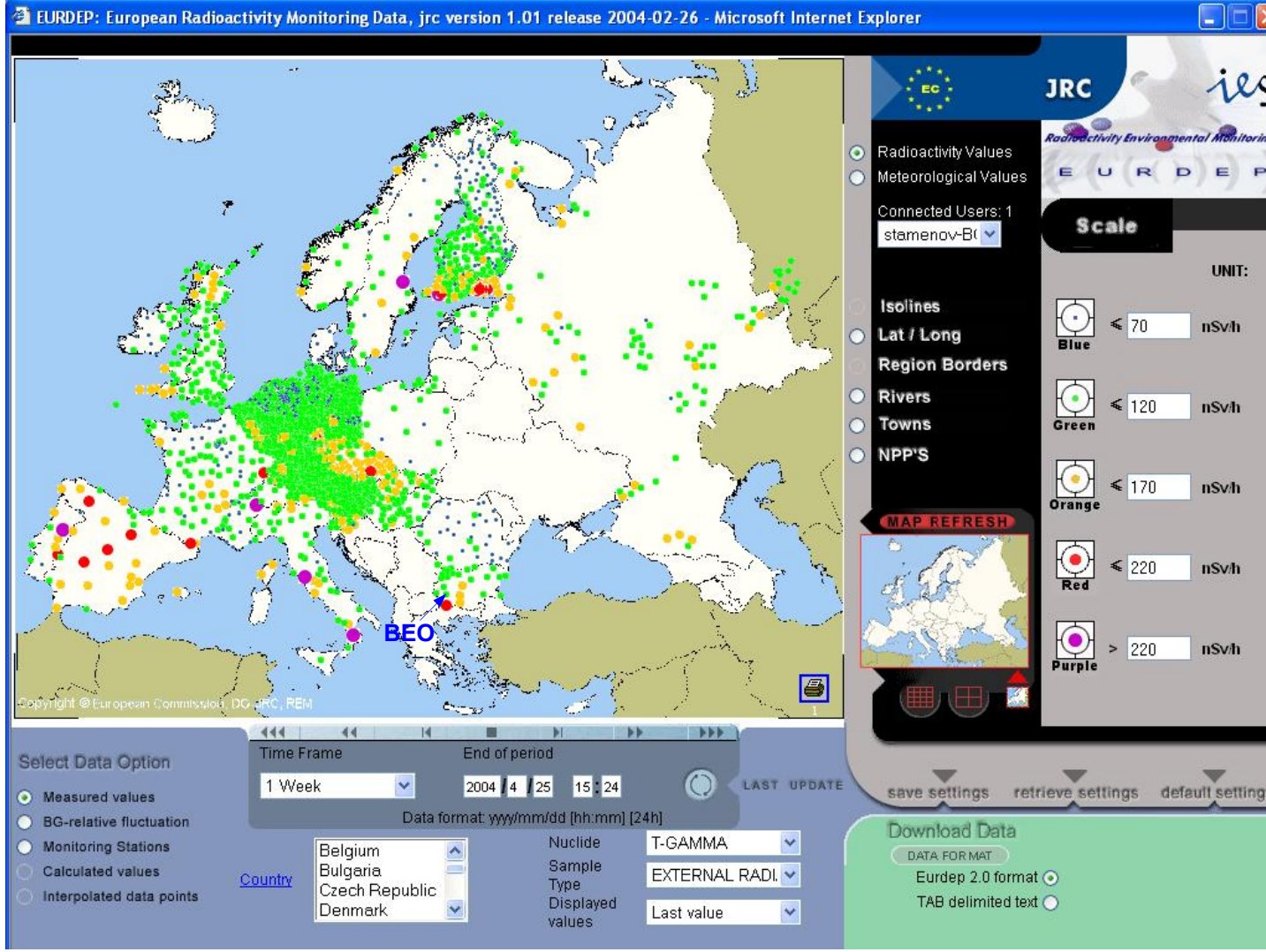


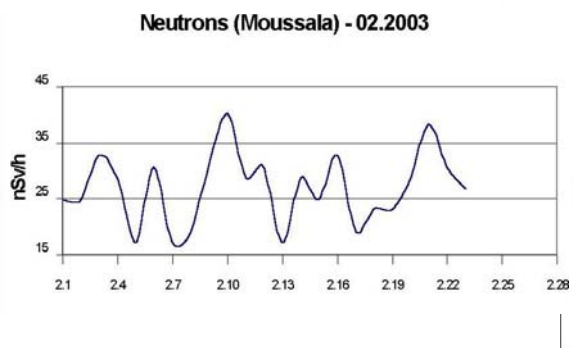
EURDEP

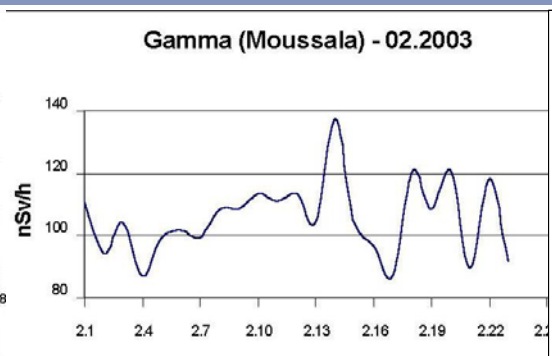

O3 (Moussala) - 04.2003
ppb
120
100
80
60
40
20
0
4.1
4.6
4.11
4.16
4.21
4.26
5.1

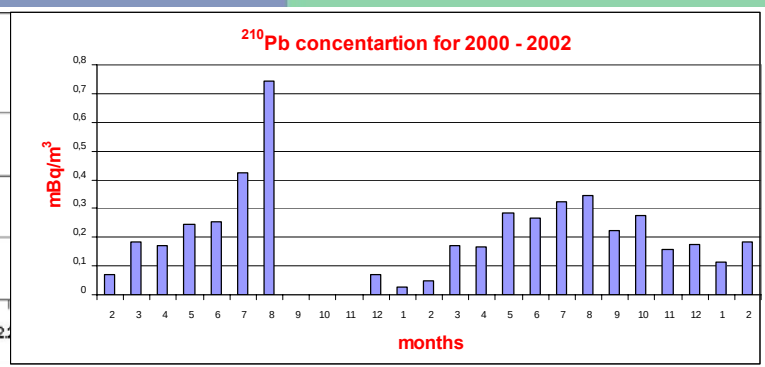

NO (Moussala) - 04.2003
ppb
20
15
10
5
0
4.1
4.6
4.11
4.16
4.21
4.26
5.1


NO2 (Moussala) - 04.2003
ppb
20
15
10
5
0
4.1
4.6
4.11
4.16
4.21
4.26
5.1

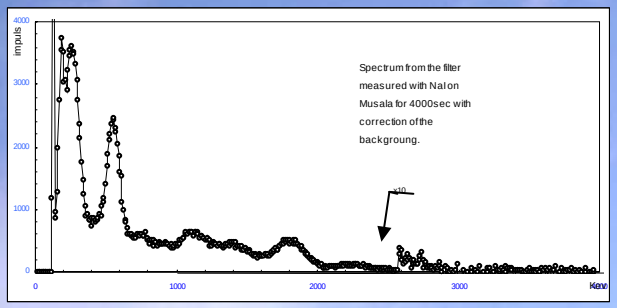

EURDEP: European Radioactivity Monitoring Data, jrc version 1.01 release 2004-02-26 - Microsoft Internet Explorer
JRC
Radioactivity Values
Meteorological Values
Connected Users: 1
Isolines
Lat / Long
Region Borders
Rivers
Towns
NPP'S
Scale
UNIT:
Blue
≤ 70 nSv/h
Green
≤ 120 nSv/h
Orange
≤ 170 nSv/h
Red
≤ 220 nSv/h
Purple
> 220 nSv/h
MAP REFRESH
BEO
Copyright © European Commission, DG JRC, REM
Select Data Option
Measured values
BG-relative fluctuation
Monitoring Stations
Calculated values
Interpolated data points
Time Frame
1 Week
End of period
2004 / 4 / 25 15 : 24
LAST UPDATE
Data format: yyyy/mm/dd [hh:mm] [24h]
Country
Belgium
Bulgaria
Czech Republic
Denmark
Nuclide
T-GAMMA
Sample Type
EXTERNAL RADI.
Displayed values
Last value
save settings
retrieve settings
default setting
Download Data
DATA FORMAT
Eurdep 2.0 format
TAB delimited text


Neutrons (Moussala) - 02.2003
nSv/h
45
35
25
15
2.1
2.4
2.7
2.10
2.13
2.16
2.19
2.22
2.25
2.28

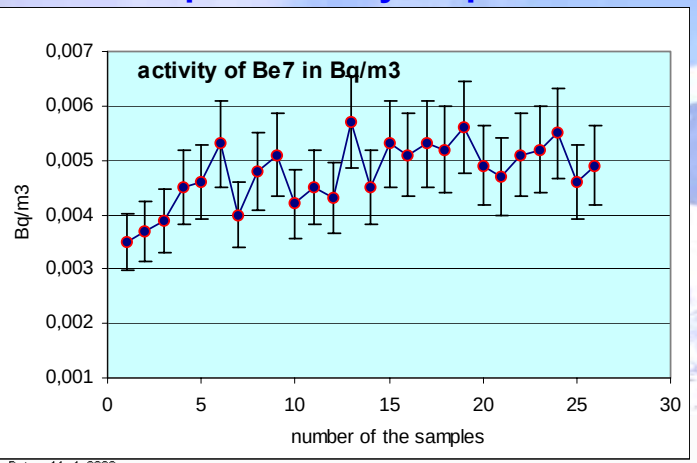

Gamma (Moussala) - 02.2003
nSv/h
140
120
100
80
2.1
2.4
2.7
2.10
2.13
2.16
2.19
2.22


210Pb concentartion for 2000 - 2002
mBq/m3
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2
months

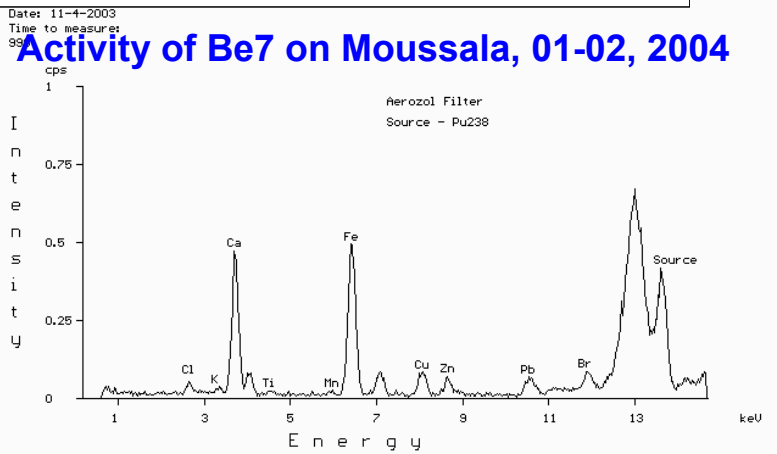
Monitoring of the Radioactivity and Heavy Metals in Aerosols



Gamma spectrometry on peak Moussala



Activity of Be7 on Moussala, 01-02, 2004



PIXE analysis of heavy metals

For collecting of aerosols are used three different devices: two with air capacity 80 and 800m3/h on BEO Moussala and a portable with 1500m3/h.

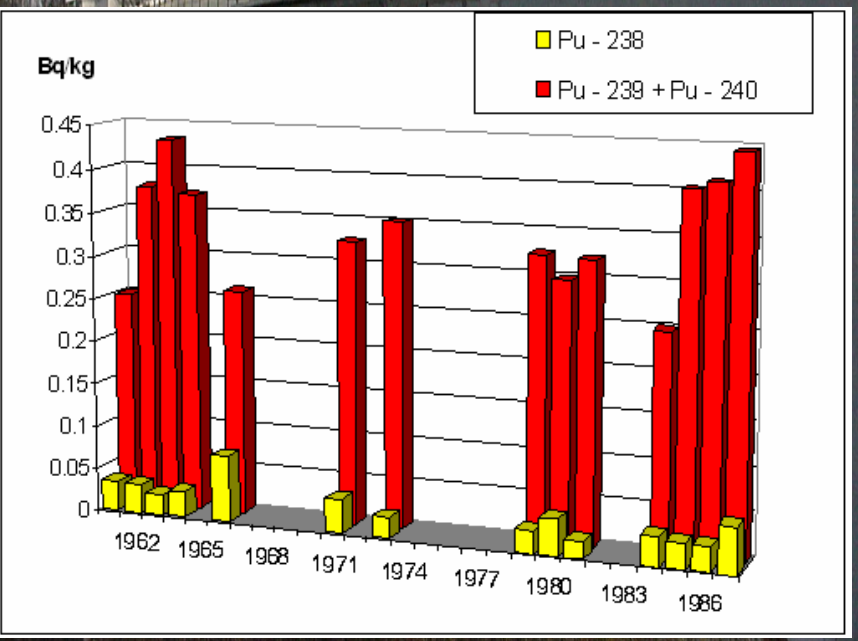
The filter used it is organic, ФПП-15 with high coefficient, more then 95%, of seizing for aerosols bigger then 0.1-02μkm . After sampling the filter is pressed to the size convenient for gamma-rays measurements.
In the laboratory of BEO-Moussala there is a scintillation gamma-spectrometer for fast analysis of the radioactivity of the air aerosols.

The detector is NaI with volume ~2l (ϕ150 x 110mm). Absolute efficiency of the detector was determined like 27 ± 4% from 4π in the geometry on the center of the flat side of the detector. It is almost constant in energy interval 200-2000keV. The spectra are measured on PC with ADC and suitable software.

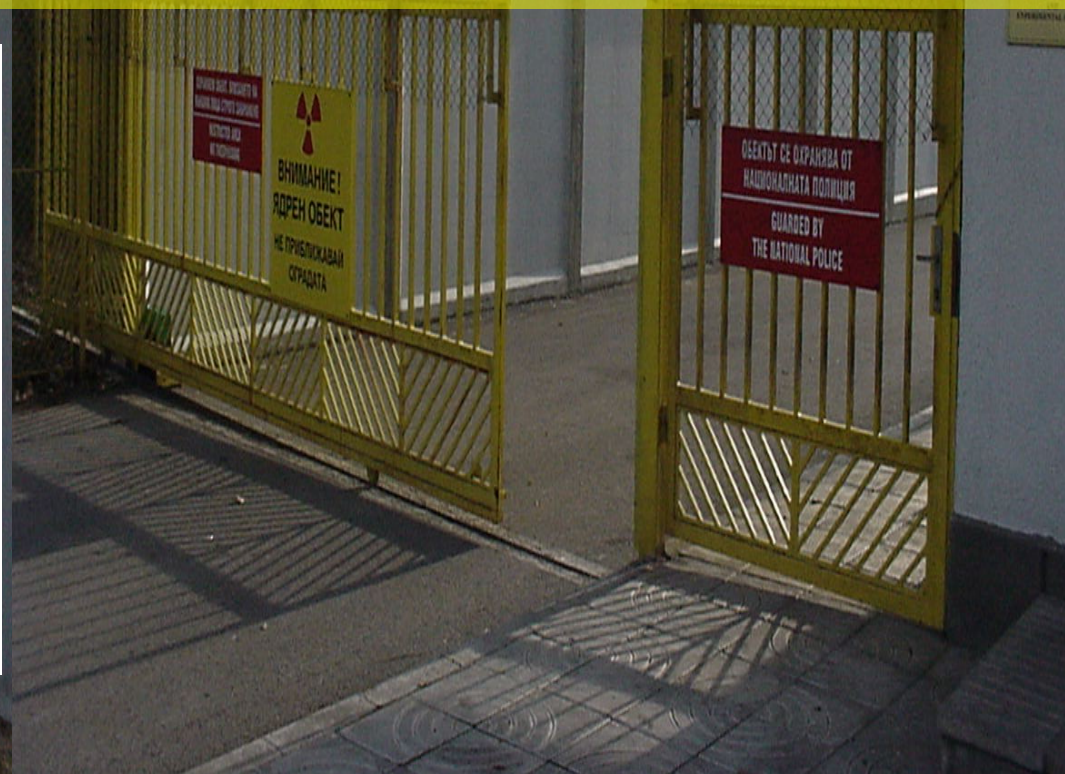
ITU - INRNE Environmental Radiation Monitoring

The environmental monitoring covers the areas of INRNE (including the area of IT-2000), the area of the National Radioactive Waste Final Repository Site in Novi Khan and 2 referent sites (mountain Vitosha and BEO Moussala).

More than 40 years this monitoring is carried out at the same sites with the use of same or compatible techniques, leading to the accumulation of a significant data base, including the period of atmospheric nuclear tests and the Chernobyl accident.



Plutonium concentration in soil samples from the INRNE area



ITU Project “ Harmonization of techniques and methodologies for sampling and measuring radioactivity in the environment”

Sampling of sediments from the bottom of the “Beli Iskar” dam lake

NUSES – 1 Year later
Short survey analysis

Inst Topics	Responses	Numb Quest.	Results	Progress	Problems	Recommendations	Future integration	Remarks
IE	2	2	2	2	3	2	1	based on E-mail
IES	3	1	4	2	1	1	2	2 generalised
IPSC	0	0						
IRMM	4	1	5	7			3	
ITU	4	2	6	5	1		2	
JRC, DG	0	0						
DG R, DJ	1	1			2	2	1	based on E-mail
EC Del	1	1	1	1	1	1		
ICIM, RO	0	0						
CITON, RO	0	0						
INS,Ege Univ, TR	1	1	1					based on E-mail
INRNE	12	9	8	6	6	4	9	
Total	28	18	27	23	14	10	18	

Hot Projects, New Ideas

JRC – INRNE Joint Scientific Programme

In the frame of NUSES at the middle of 2003 was established an INRNE NUSES Programme.

The main reasons of this are:

- **The good estimation of INRNE – JRC Conference – Informational Days and NUSES project** from JRC and **proposal of Dr. Roland Schenkel for monitoring of project progress after 12 month**
- **Wide response and good exception of NUSES project events and activities** from scientific community and grand public
- Inclusion in the INRNE Programme for management and development for 2003-2007 years **the enhancement of the integration with European research centres, especially with JRC** as a basic task.

Now we propose the formation of the JRC – INRNE NUSES Joint Scientific Programme.

The main goal of the NUSES Programme is the integration between INRNE and JRC and with other leading European and international research centres and institutions and has the following basic objectives:

- To develop and enhance results, **to implement and exchange the good practice of NUSES INRNE – JRC joint project** and other joint projects and activities, toward the reaching of **synergetic, multiplication and long – term effect**;
- **Regional and Global aspects,** diversification and deepening the joint activity of JRC and INRNE with neighbouring countries.
- **Sustainability and Durability of the programme**

The management and organizational structure of NUSES Programme **has to be discussed.** It is proposed to create **Joint Scientific Council,** with members - heads of all JRC and INRNE collaborating laboratories, co- headed by the directors of JRC and INRNE.

It will be an e-Programme, where discussion, statements and opinions exchange will be realized in a sophisticated informational and Internet environment, towards to reach better direct information and coordination.

For contacts

Prof. DSc. Jordan Stamenov
jstamen@inrne.bas.bg
tel: (359 2) 9743 761

Dr. Boyko Vachev
vachev@inrne.bas.bg
tel: (359 2) 974 63 10

fax: (359 2) 975 36 19

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