Potential and Expected Contribution of the Nuclear Physics Institute of the AS CR to the BEOBAL Project

BEOBAL Methodological and Coordination Meeting 2005

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NUCLEAR PHYSICS INSTITUTE
DEPARTMENT OF DOSIMETRY

Biophysical et microdosimetric aspects of the Ionizing energy transfer to the matter

- **Theoretical modelisation of the indirects effects of the energy transfer to biomolecules, particularly to DNA**

- **Experimental microdosimetry (including modelisation of the detector's fonctionning) and its use in the different radiation fields (hadron beams for radiotherapy, onboards aircraft and spacecraft, natural radiation envoronment**

NUCLEAR PHYSICS INSTITUTE
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Environmental radiation dosimetry

- **Radionuclides in the environment (T, ^{14}C, ^{85}Kr, I, α-emitters), radiocarbon dating – liquid scintillation and/or Ge(Li) spectrometry, etc.**

- **Rn and its descendents – track etch detectors in soil and/or dwellings**

- **External exposure to natural radiation – high-mountains stations measurements, dosimetry and radiation protection of aircraft crews, etc.**

International collaboration - EC

- **Dosimetry of Aircrew Exposure to Radiation during Solar Maximum, (5th FP) – FIGM–CT2000-00068, up 2004**
- **Euronetwork for Light Ion Hadrontherapy, (5th FP), up 2005**
- **Developing of Scientific Basis for Monitoring, Modeling and Predicting Space Weather“. COST 724, 2002/7**
- **Harmonisation of Techniques and Methodologies for Measuring Radioactivity in the Environment. JRC, ITE, Karlsruhe. since 2003**
- **Dosimetry for Space Biological Experiments, ESA, 2006/8**
- **CONRAD: „A Coordinated Network for Radiation Dosimetry“. – (6th FP), 2005-2008**
- **COST Action P9: „Radiation Damage in Biomolecular Systems“, since 2005**

Other international collaborations

- **BAS, Sofia: INRNE, STIL, Geol– environmental radiation dosimetry, dosimetry in complex radiation fields, including aircraft nad spacecraft boards**
- **Centre de Biophysique Moleculaire CNRS, Orléans, France - radiation damage to biomolecules**
- **Limoges University – environmental radiation dosimetry**
- **IRSN, Fontenay-aux-Roses, France: aircraft and spacecraft dosimetry, individual and accidental dosimetry**
- **JINR Dubna: environmental dosimetry, biophysics, radiotherapy, radiation protection (RP), ADTT**
- **IMBP, RAS, and RTCRS-CO, Moscow – environmental dosimetry, cosmic ray dosimetry and RP**
- **HAS, INR Debrecen – dosimetry applications of TED (Rn)**

Basic experimental facilities

- Liquid scintillation spectrometers (3);
- Gamma spectrometry measuring unit ORTEC;
- Apparatus for scintillation measuring of ^{85}Kr;
- Gas chromatograph Carlo Erba GC 8000;
- Appliances for aerosols and deposition sampling and for iodine filter sorbent tests;
- Set of dosimetry methods for the measurements on aircraft board and in the environment;
- Universal stand for multiple electrochemical etching.
- Facility LUCIA G for automatical evaluation and LET spectra calculation on the base of track etched detectors;
- Etalon radiation beams and fields (^{60}Co, ^{137}Cs, AmBe, ^{252}Cf, AmF, etc.); radiotherapy unit Chisostat, electrometers Keithley 617 and 35617;
- Bubble detectors neutron spectrometers;

S&T cooperation NPI related to BEOBAL - overview

- Results presented during INSINUME04, Albena, September 2004
- Recent activities, 2004-2005
- Proposed actions

ENVIRONMENTAL EXTERNAL RADIATION AT SOME BULGARIAN LOCALITIES

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Content

- Comparison of methods used to characterise the exposure due to the environmental radiation background

- Results of studies on the territory of the INRNE

- Results of studies on the high-mountain station at Moussala, comparison with Lomnický Štít (High Tatras)

Methods used

1. Active instruments:

- ***Environmental radiation dose rate meter NB 3201*** **with a plastic scintillator as sensitive element; able to measure the environmental radiation background with low linear energy transfer (LET) (10 nSv to few mSv/h)**
- *MDU-Liulin semiconductor spectrometer* **with Si-diode as the sensitive element; able to estimate both low LET and neutron component of the natural background (10 nSv to few mSv/h)**

2. Passive detectors:

- ***Thermoluminescent detectors (TLD) $CaSO_4$:Dy***
- ***Moderator sphere (12 inches)with TED in contact with B-radiators***

Measuring localities

1. *Territory of the INRNE BAS at Sofia:*

- Outside of the building of the Division of Cosmic Ray Physics (DCRP) and on its terrace on which a radiation monitor is permanently measuring;
- Around the reactor IRT 2000 building

2. *Basic Ecological Observatory (BEO) Moussala;* altitude 2925 m, geographic coordinates 25°35’ E and 42°11’ N
3. *Lomnický Štít Observatory of the Institute of Experimental Physics SAV, High Tatras;* altitude 2634 m, geographic coordinates 20°22’ E and 49°20’ N

Results - INRNE

Measuring point	H*(10), nSv/h, as measured by		
	NB 3201	MDU-Liulin*	TLD
DCRP – in front of	106	-	-
DCRP – terrace	102	103	78-141
Reactor – 1	110	134	130-154
Reactor - 2	100	104	124

* Mean value for two MDU units

Results – BEO Moussala

Measuring point	H*(10), nSv/h, as measured by		
	NB 3201	MDU	TLD
Ground level of building	240	-	-
First floor of building	138	130*)	-
Outside of building	176	-	165-183
Terrace of building	138	140*)	-

***) Corresponding only to low LET radiation**

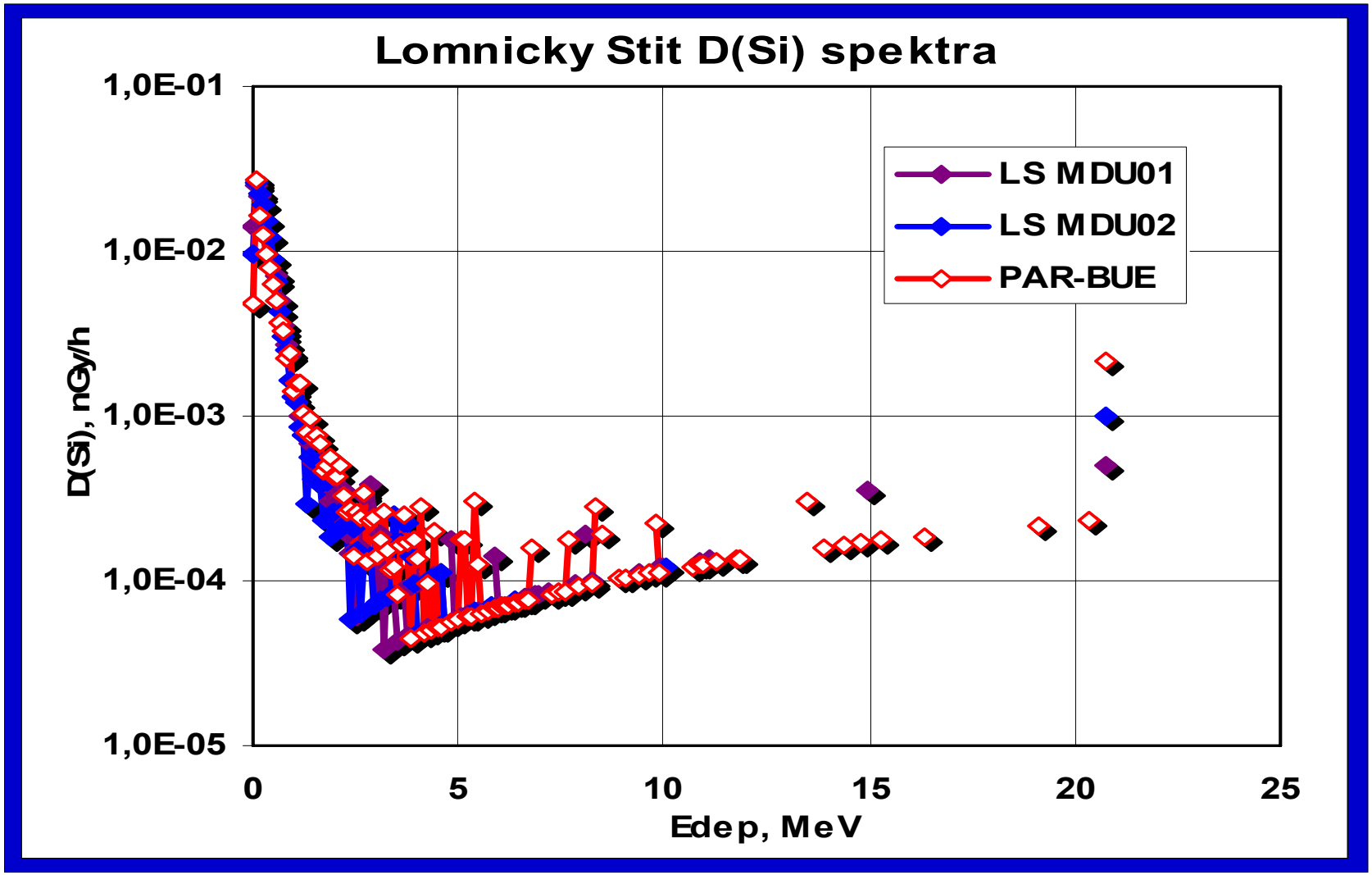
The average value of monitors of INRNE BAS110 nSv/h; minimum and maximum values 87.5 and 128.1 mSv/h

Results - neutron component of cosmic radiation at BEO Moussala – Comparison of different instruments and methods

Method (Quantity measured)	Annual value measured	Annual value corrected
Harwell 3208-1	(190 - 390) μSv[1)]	(380 – 780) μSv
Sphere with ^{10}B	(254 ± 26) μSv[2)]	(508 ± 52) μSv
MDU-Liulin	(180 ± 72) nGy[3)]	(1080 ± 380) μSv
UNSCEAR 2000	-	~ 680 μSv

[1)] Period 09/02 ÷ 05/03; [2)] Period 11/00 ÷ 02/04; [3)] November 2000

Results - neutron component of cosmic radiation at Lomnický Štít - Event spectra in MDU Si-diode instrument



Results - neutron component of cosmic radiation– Comparison of BEO Moussala and Lomnický Štít high mountain stations

Estimated from	Annual values measured at			
	Moussala[1)]		Lom. Štít[1)]	
	D(Si), μGy	H*(10), μSv	D(Si), μGy	H*(10), μSv
MDU-Fr	180 ± 72	1080 ± 380	-	-
MDU-CZ01	-	-	135±6	820±36
MDU-CZ02	-	-	113±7	757±45
UNSCEAR 2000	-	~680	-	~670

[1)] Measuring times 14 hours at Moussala, 95 hours at Lomnický Štít

S&T cooperation NPI related to BEOBAL – activities 2004-2005

- **Rn detection and dosimetry:**
  - In soil – comparison of TLD and track etch detectors
  - Automation of track counting by means of a scanner
- **External exposure to natural radiation:**
  - Cosmic neutrons at BEO Moussala – continue
  - TLD (INRNE) exposure onboard a Czech Airlines aircraft,
- **Radioactivity in the environment**
  - Consulting concerning ^{14}C monitoring at NPS
  - Measuring and evaluation methods for LSC
  - Equipment and evaluation for ^{14}C monitoring in air

S&T equipment – renewal, upgrading

- **Lent from NPI for long-term**

➢ Universal stand for multiple electrochemical etching;

➢ LSC Tricarb 1050 - in preparation

- **Detector's calibration**

➢ TLD – NPI calibration facilities; high energy heavy charged particles (HIMAC, Chiba, Japan);

➢ Comparison of TED evaluation procedures;

Improvement of Human Resources

- Stays for PhD students in NPI:

➢ **30 + 14 days – advances in TED method, particularly for Rn detection and dosimetry – just started**

➢ **30 + 14 days – advances in radioactivity measurements, particularly for ^{14}C and T measurements by LSC - planned 2006/2007**

- Seminars to advanced topics:

➢ **Track etch detectors and their use for environmental dosimetry and other studies - done**

➢ **Methods and equipment for external exposure in the environment; their metrology – planned early 2006**