



Department of Neutron Activation Analysis & Applied Research

Division of Nuclear Physics

Frank Laboratory of Neutron Physics

Joint Institute for Nuclear Research



STATE OF THE ART IN NEUTRON ACTIVATION ANALYSIS AT THE REACTOR IBR-2 OF FLNP JINR

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ISINN-24, Dubna, Russia, May 23-27, 2016

Neutron activation analysis is an isotope specific analytical technique for the qualitative and quantitative determination of elemental content

P. Bode, J. J. M. de Goeij, *'Activation Analysis'*, Encyclopedia of Environmental Analysis and Remediation, J. Wiley & Sons, New York, **1998**, ISBN 0-471-11708-0, pp 68–84

The method is based upon the conversion of stable atomic nuclei into radioactive nuclei by irradiation with neutrons and the subsequent detection of the gamma radiation emitted during the decay of these radioactive nuclei. Activation by neutrons may result in radionuclides from all elements (that have radioactive daughter products) present in the sample, with sometimes strongly different production rates

Neutron Activation Analysis: A Primary (Ratio) Method to Determine SI-Traceable Values of Element Content in Complex Samples



Peter BODE
Delft University
of Technology
The Netherlands



Robert GREENBERG
National Institute of Standards
and Technology, NIST
USA



Elisabete FERNANDES
Univer. de Sao Paulo Centro de
Energia Nuclear na Agricultura
Brazil

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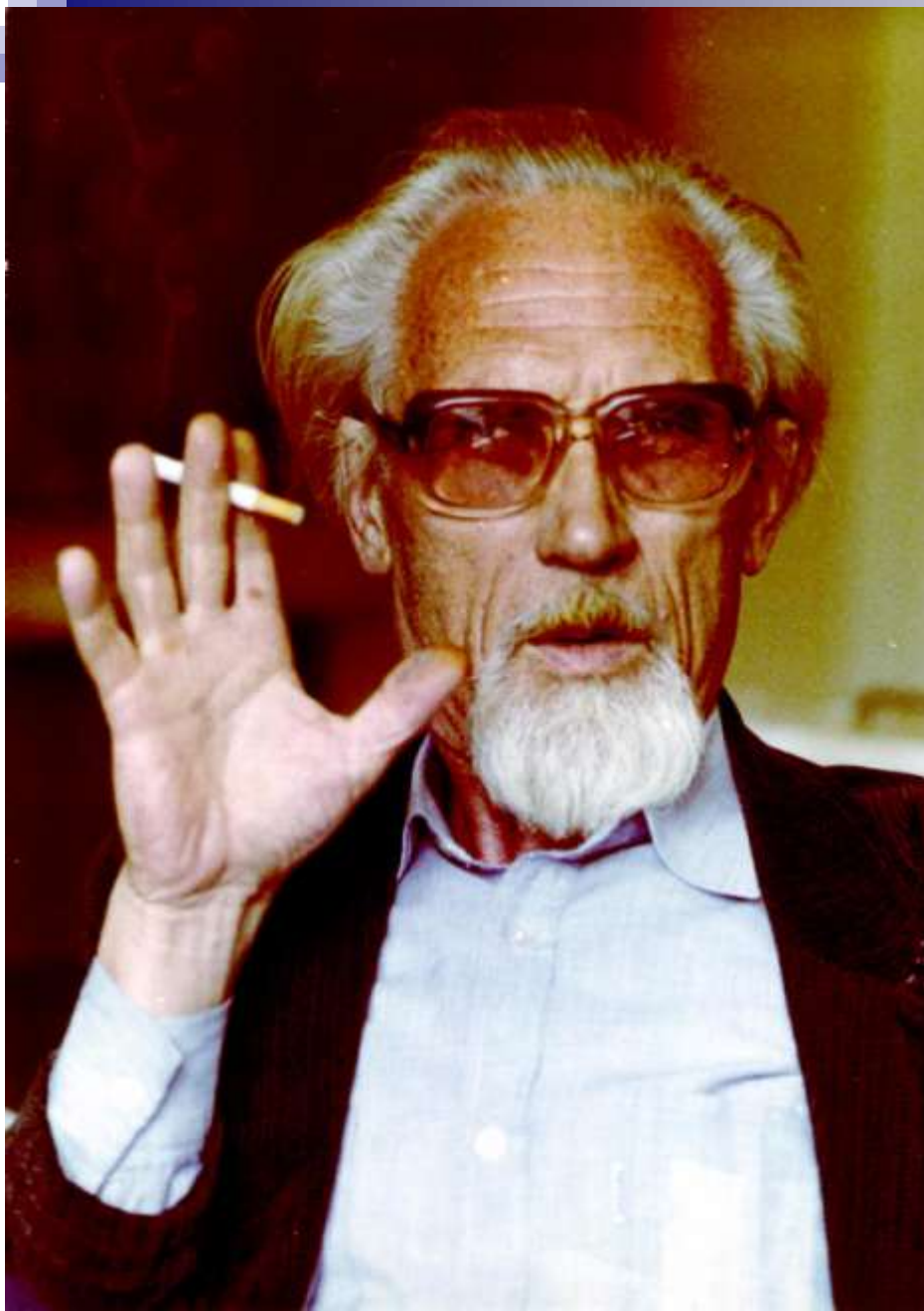
1. Introduction (**mile-stones**)
2. Radioanalytical complex REGATA and automation of NAA (IAEA CRP) (**Accreditation**)
3. Outline of scientific activity (**International projects**)
4. Educational programme (**Schools & Practicals**)
5. Perspectives (**Radioecology**)



...50 years of
Neutron Activation Analysis
at FLNP JINR...



**NAA was established in LNF in
1963-1965**



V.M. Nazarov

10.12.1931 - 30.12.1994



The first publications in medicine

- Late 60es-early 80es: **role of Zn in cancer tumors**
- Contact with Institute of Physics, Tbilisi, Georgia:
E. Andronikashvili and L. Mosulishvili (IRT-M research reactor)
- Phantom of Man and **tissue studies** at the reactor IBR-30
- Contact with the **N.N. Blokhin Cancer Research Center** of Russian Academy of Medical Sciences in Moscow

M.V. Golovanov, [N.A. Gundorin](#), S.F. Gundorina, B. Otgooloi, M.V. Frontasyeva, V.P. Chinaeva, [A.S. Shilovtseva](#). **Neutron activation analysis used to study of some indicators of water-salt metabolism.** *JINR Communication*, 18-12262, Dubna, 1979.

M.V. Golovanov, [N.A. Gundorin](#), S.F. Gundorina, B. Otgooloi, M.V. Frontasyeva, V.P. Chinaeva, [A.S. Shilovtseva](#). **Natural dispersion of elemental content in normal and tumor tissues.** *Medical Radiology*, No. 1, 1983, p. 51-55.

The first publications in the environmental studies

С.Ф. Гундорина, В.М. Назаров, В.Ф. Переседов, Л. Урле,
М.В. Фронтасьева, В.П. Чинаева. **Определение золота,
серебра и других элементов в природных водах методом НАА.**
*Труды IV Совещания по использованию ядерно-физических методов
для решения научно-технических и народнохозяйственных задач.*
Дубна, 20-23 октября, **1981**, с. 284

S.F. Gundorina, V.M. Nazarov, V.F. Peresedov, L. Urle,
M.V. Frontasyeva, V.P. Chinaeva. **Investigation of element
content of natural water by the neutron activation analysis
method using the adsorption complexes.**
II Workshop «*Radioisotopes and Radiation Processes in Industry*»,
Leipzig, GDR, **1982**

A.B. Bogatsky, N.G. Lukjanenko, E.I. Nazarov, I.P. Tsimbal, A.Ya. Oleshko, I.A. Iontov, A.N. Zakharia, V.M. Nazarov, M.V. Frontasyeva, V.F. Peresedov. **Biological activity of macroheterocycles: to the question of biological activity of criptand [2,2,2].** *Biological Membranes*, Vol. 1, No. 7, **1984**, p. 677-683.

The first publication in Material Science

V. Kliment, V.M. Nazarov, M.V. Frontasyeva. **Determination of impurities in SiO₂ by means of nondestructive activation analysis.** *7 Czechoslovak Spectroscopic Conference and VIII CANAS*, **1985**, p. 104-105.

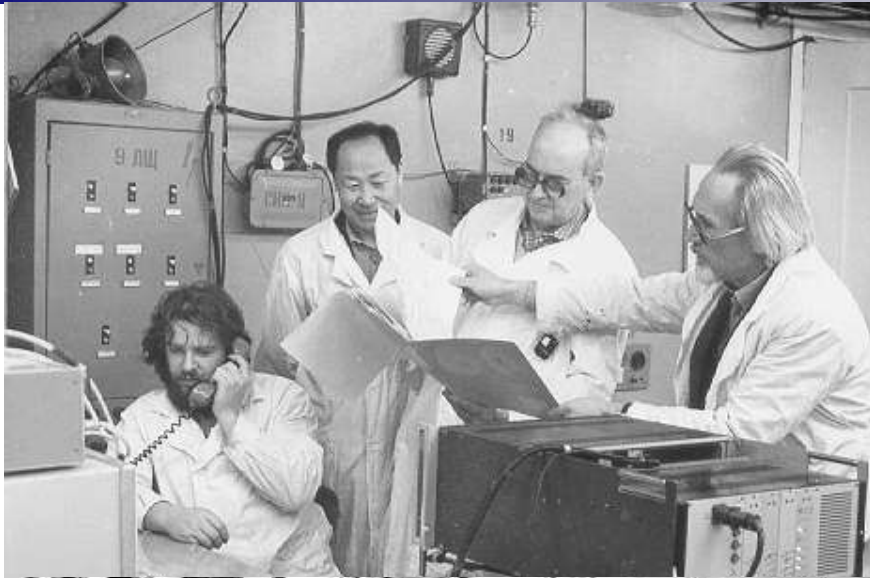


РЕГАТА – REGATA

V.M. Nazarov, S.S. Pavlov, V.F. Peresedov, M.V. Frontasyeva. **Channels for irradiation and pneumatic system at IBR-2 reactor.**

JINR Rapid Communications, No. 6-85, Dubna, 1985, p. 37-41.

JINR award: the First Prize for 1985

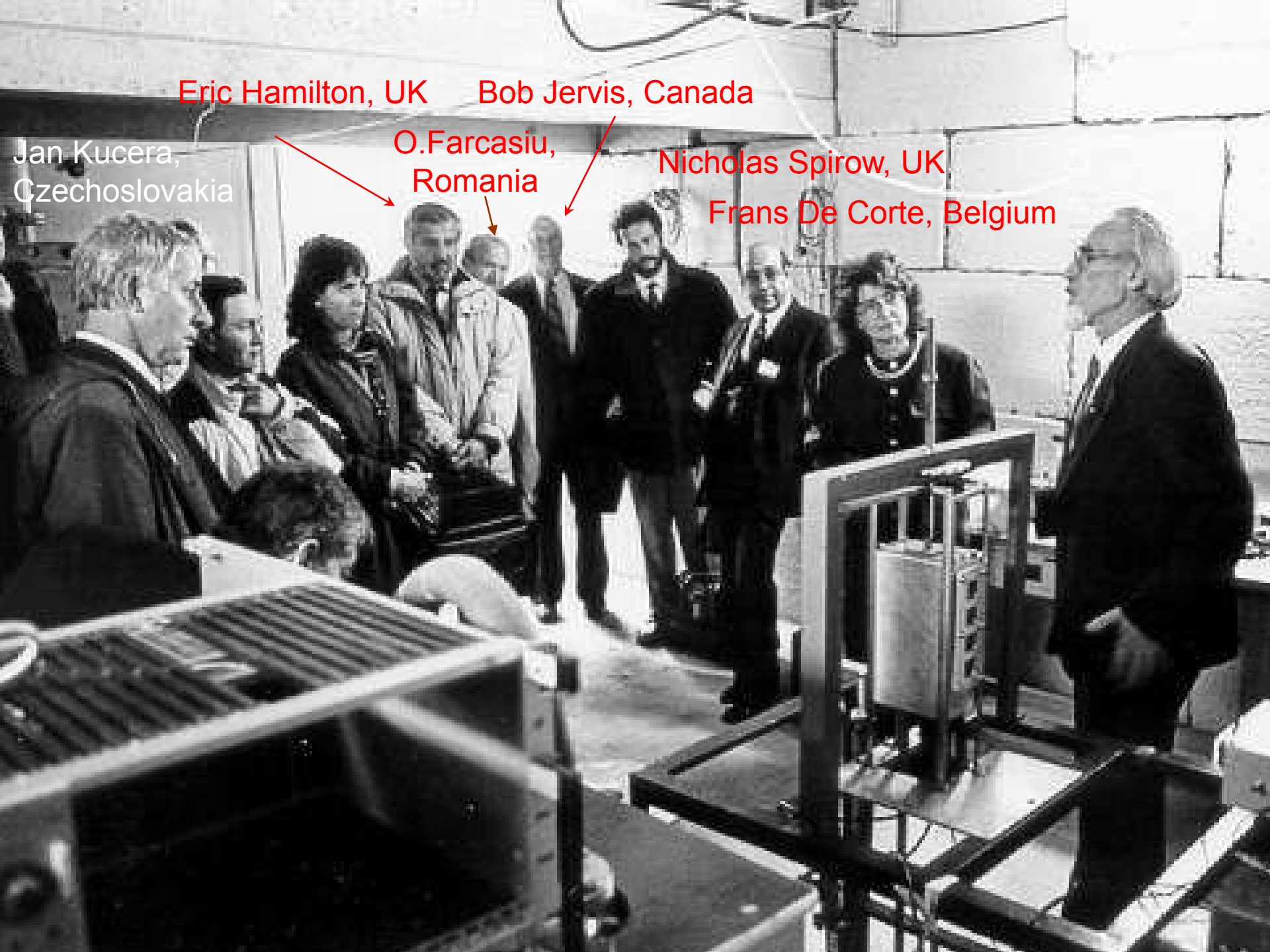


M.V. Frontasyeva, N.G. Baboshin, S.F. Gundorina, I.A. Engovatov, P.A. Lavdanskij, V.M. Nazarov, N.I. Stefanov. **Activation studies of concrete binding agent ingredients used for nuclear radiation shielding.** *Kernenergie*, Vol. 34, **1991**, p. 7-8.

T.E. Burkovskaya, V.M. Nazarov, M.V. Frontasyeva, S.F. Gundorina. **Elemental bone composition of the rats flown in «Cosmos-2044» biosatellite.** *The Physiologist*, Vol. 35, No. 1, **1992**, p. 235-236;

V.M. Nazarov, T.M. Ostrovnaya, S.S. Pavlov, V.P. Sysoev. **An analyzer for the determination of protein concentration in corn.** Conference on Industrial Radiation and Radioisotope Measurement Applications, *Transactions*, USA, Vol. 65, No. 1, **1992**, p. 68-69.

T.M. Ostrovnaya, L.S. Nefedyeva, V.M. Nazarov, S.V. Borzakov, L.P. Strelkova. **Software for INAA on the basis of relative and absolute methods using nuclear database.** In «Activation Analysis in Environment Protection», *JINR Preprint*, D14-93-325, Dubna, **1993**, p. 319-326.



Eric Hamilton, UK

Bob Jervis, Canada

Jan Kucera,
Czechoslovakia

O. Farcasiu,
Romania

Nicholas Spirow, UK

Frans De Corte, Belgium

Imperial College Reactor Centre in Ascot, England (1989)

V.M. Nazarov, V.P. Chinaeva, M.V. Frontasyeva,
S.J. Parry, B.A. Bennet, Chen Sen Pal, Li Chel Zu

**Fine-powder AL_2O_3 and SiO_2 for preparation of
multi-element standards for rare-earth elements
analysis.**

*Journal of Radioanalytical and Nuclear Chemistry,
Articles, Vol. 168, No. 1, 1993, p. 163-168; Preprint
JINR, E14-91-398, 1991, Dubna; MTAA-8, Vienna,
Austria, 16–20 September, 1992.*



Director of ICRC, Desmond MacMahon, his team and two Russian guests

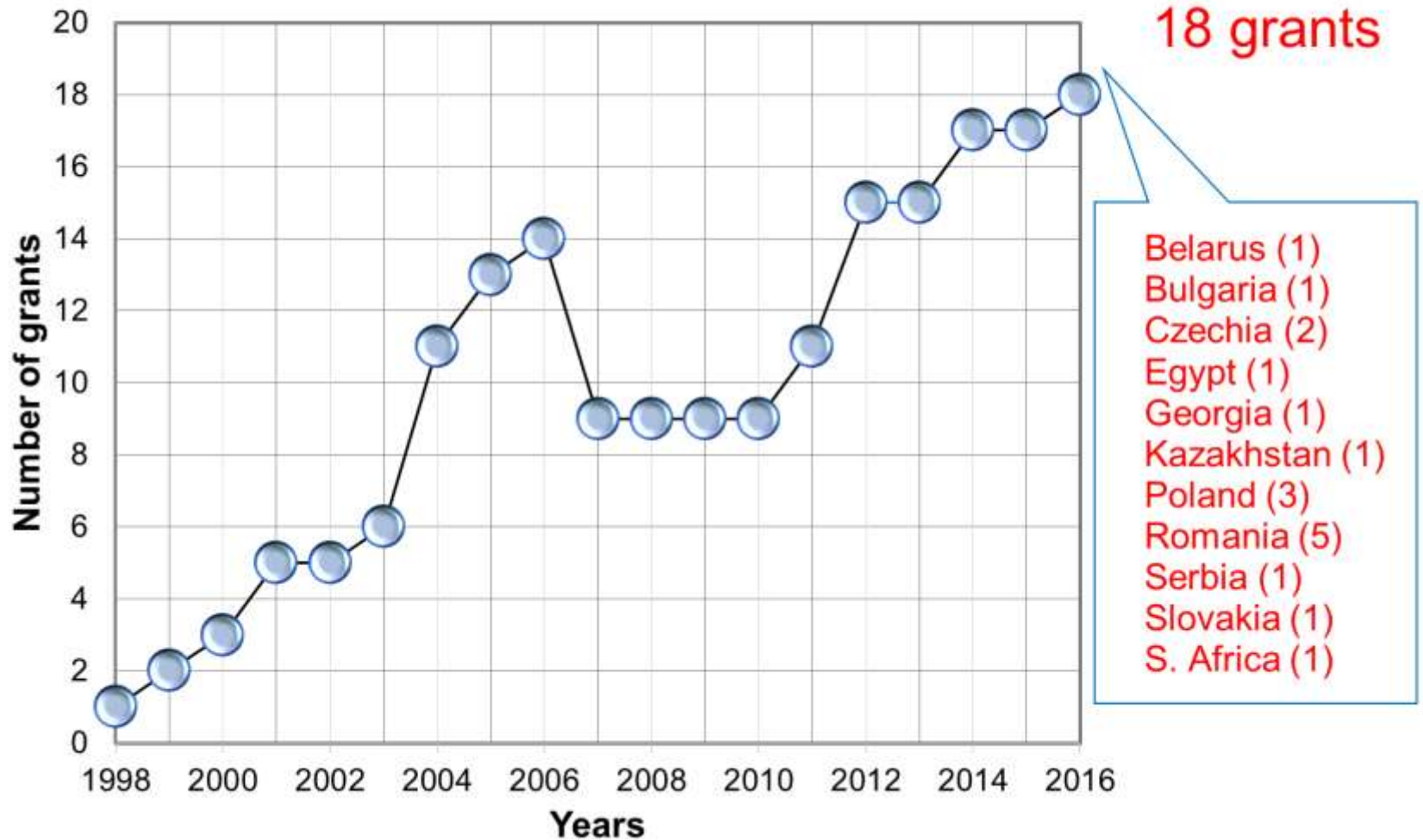
Last year...

V.M. Nazarov, S.S. Pavlov, E. Herrera, M.V. Frontasyeva. **Recent developments of radioanalytical methods at IBR-2 pulsed fast reactor.** *Journal of Radioanalytical and Nuclear Chemistry, Articles*, Vol. 167, No. 1, **1993**, p. 11-21.



International Conference Hall, Dubna, December, 1993

Grants of Plenipotentiaries of JINR member-states



IAEA Coordinated Research Projects

1994–1997 — **Workplace monitoring and occupational health studies...**
(Contract No. 9480/RBF)

1997–2002 — **Biomonitoring air pollution in Chelyabinsk Region**
(Ural Mountains, Russia) (Contract No: 9939/RBF)

2002–2005 — **Use of INAA, AAS and XRF in studying health impacts of toxic elements consumed through foodstuffs**
(Contract No. 11927/RBF)

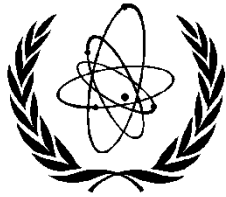
2002–2003 — **Selenium containing blue-green algae *Spirulina platensis* for preventive health care** (Contract No. 11528/RBF)

2005–2007 — **Assessment of exposure to toxic/potentially toxic elements (Hg, Pb, As, Mn, etc)** (Contract No. 13249/RBF)

IAEA Technical Cooperation Projects

2003–2005 — **Investigation of Health Effects on Children** from the Consumption of Foods Grown in Industrially Contaminated Areas

2007 –2008 — **Quality Assurance & Quality Control** (International harmonization of QA/QC systems according to ISO standards in nuclear analytical laboratories of the Russian Federation)



IAEA

International Atomic Energy Agency

TITLE OF RESEARCH CONTRACT:


Automation of Reactor Neutron Activation Analysis

Part of the IAEA's Coordinated Research Project (CRP):

Development of an Integrated Approach to Routine
Automation of Neutron Activation Analysis
(Ref. F1.20.25 / CRP1888)

Sergey Pavlov, Andrey Dmitriev are the key contributors

CRP Meetings: August 2012 – Delft; May 2013 - Vienna



Radioanalytical complex
REGATA
and automation of NAA

Chemical laboratory of Dept. NAA & Applied Research

and some equipment for
sample preparation

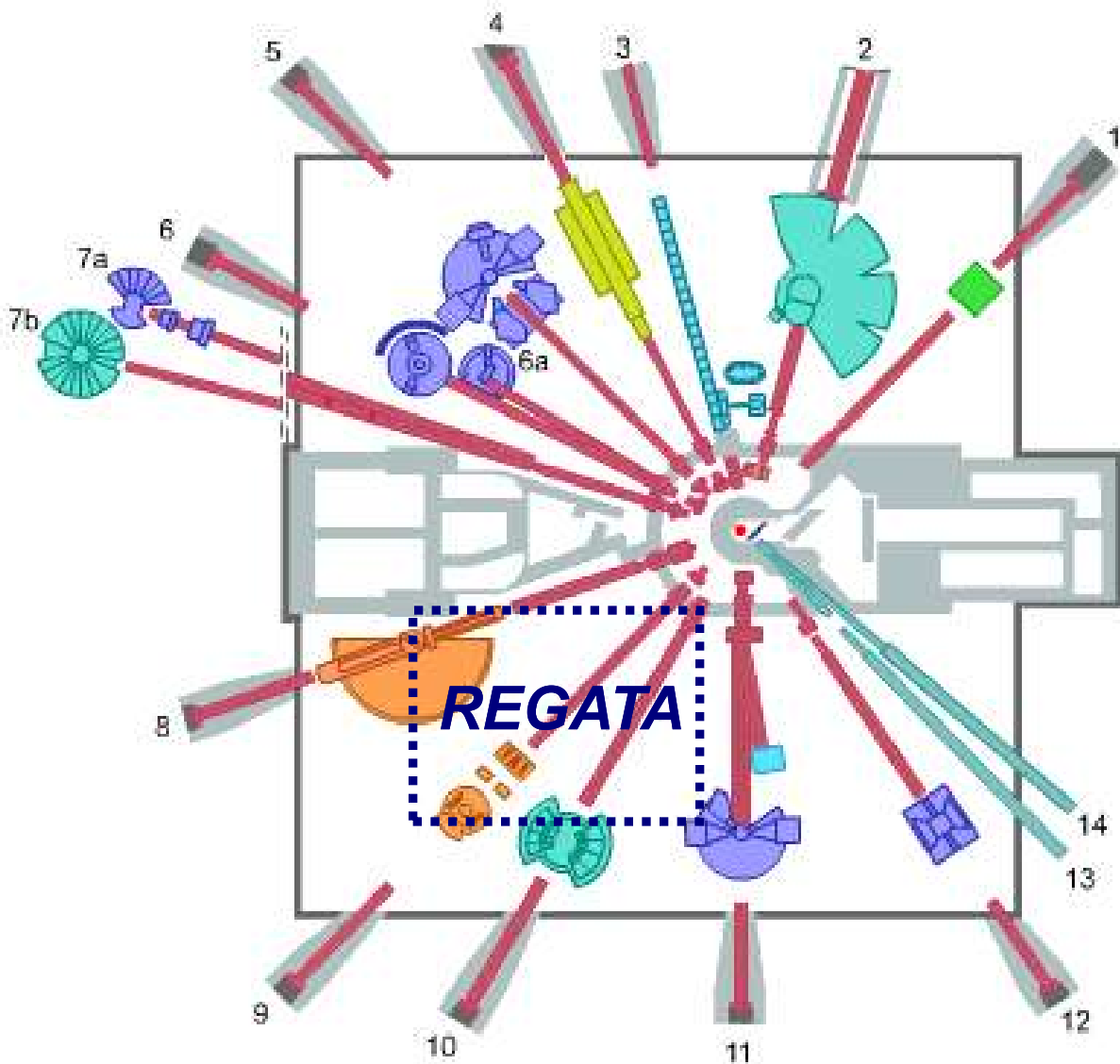




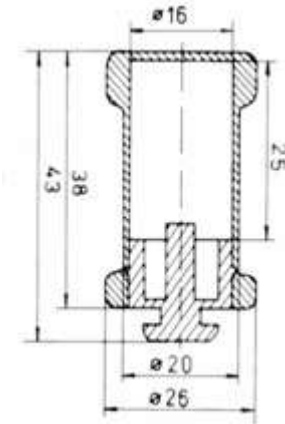
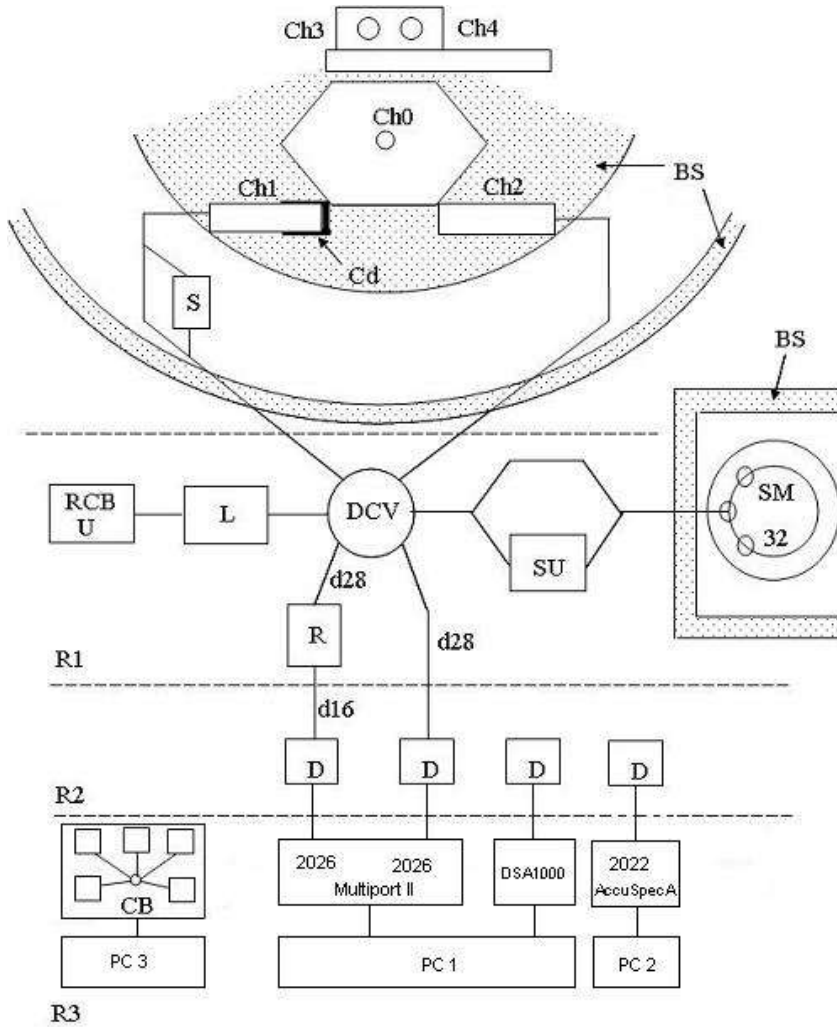
Sample preparation



IBR-2 Pulst Fast Reactor and Radioanalytical complex REGATA



Experimental facility REGATA at IBR-2 reactor

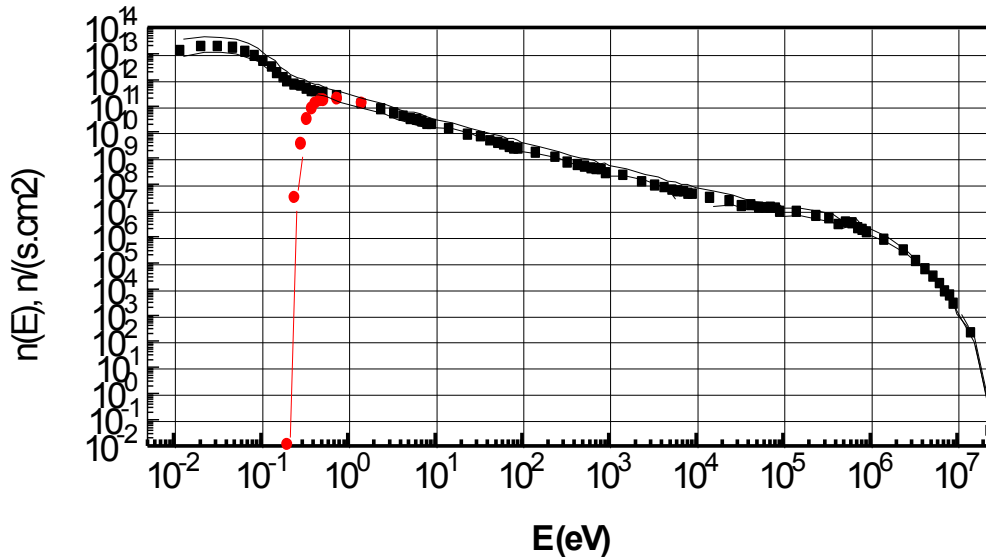


Transport capsules for irradiation



Ch1-Ch4 –irradiation channels, S- intermediate storage, DCV- directional control valves, L- loading unit, RCB- radiochemical glove-cell, U- unloading unit, SU- separate unit, SM- storage magazine, R- repacking unit, D- detector, CB- control board, R1-R3- the rooms where the system is located.

Neutron energy spectra and irradiation channels



Neutron energy spectra
in irradiation channels
CH1(■) and CH2 (curve)

The main characteristics of the irradiation channels at 1.5 MW

Irradiation site	Neutron flux density ($n/cm^2 s$) 10^{12}			$T^{\circ}C$	Channel diam., mm	Channel length, mm
	Thermal	Resonance	Fast			
Ch1	Cd-coated	3.31	4.32	70	28	260
Ch2	1.23	2.96	4.1	60	28	260
Ch3	Gd-coated	7.5	7.7	30-40	30	400
Ch4	4.2	7.6	7.7	30-40	30	400





Control board

Directional control valves

“Hot” cell





Automation of NAA



The main goals of automation of reactor Neutron Activation Analysis

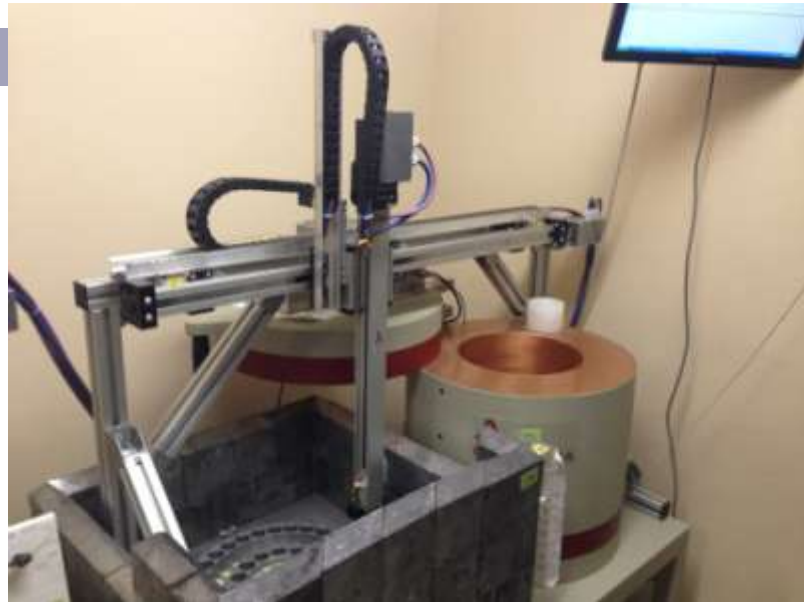
1. To improve the quality of NAA:

- automatic access to the data for analysis;
- programmed procedures of QC during analysis;
- fast and easy statistical analysis of results and procedures of QC/QA.

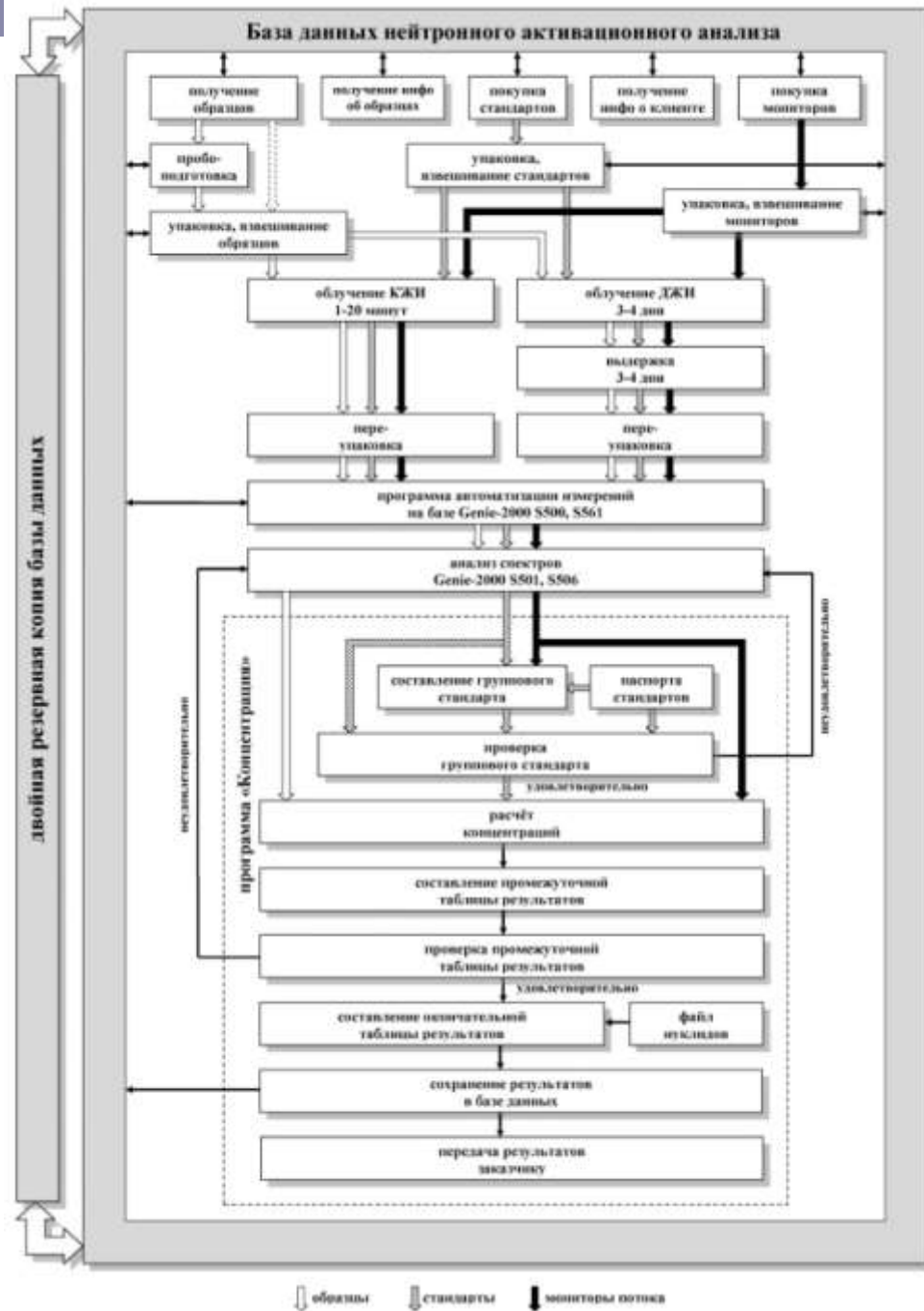
2. To make work of our staff easier and faster:

- automatic measurement in the evening and at night;
- automatic, fast and easy access from any PC of our Sector to all information on all steps of the analysis.

3. To increase the number of analyzed samples.



NAA DATABASE



Client and samples info programs

Информация о клиенте

Файл Язык Помощь

Страна
Kazakhstan

Индекс Республика Область Район
070010 Казахстан ВКО

Город Улица Дом Строение
Усть - Каменогорск Амурская 18/1 к. №8

Организация
ВКГУ им. С. Аманжолова, лаборатория УНИЦ Экологии

Обращение Пол Фамилия Имя Отчество
Dr. m Чурсин Анатолий Сергеевич

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+7 723 2222148

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+7 723 2222148 +7 777 8587214

Эл. почта 1 Эл. почта 2
eko.chursin@mail.ru

Примечания

Сохранить Закреть

Информация об образцах-1.2

Файл Помощь

Номер образца Тип образца Растительность
29р растительность другая растительность

Широта (дес. град.) Долгота (дес. град.) Место сбора
Кош-Агач

Определяемые элементы
все элементы
Select all

Группа элементов
 Галогены
 Тяжёлые металлы
 Короткоживущие
 Долгоживущие

<input checked="" type="checkbox"/> F	<input checked="" type="checkbox"/> Co	<input checked="" type="checkbox"/> Cd	<input checked="" type="checkbox"/> Er
<input checked="" type="checkbox"/> Na	<input checked="" type="checkbox"/> Cu	<input checked="" type="checkbox"/> In	<input checked="" type="checkbox"/> Tm
<input checked="" type="checkbox"/> Mg	<input checked="" type="checkbox"/> Zn	<input checked="" type="checkbox"/> Sn	<input checked="" type="checkbox"/> Yb
<input checked="" type="checkbox"/> Al	<input checked="" type="checkbox"/> Ga	<input checked="" type="checkbox"/> Sb	<input checked="" type="checkbox"/> Lu
<input checked="" type="checkbox"/> Si	<input checked="" type="checkbox"/> As	<input checked="" type="checkbox"/> I	<input checked="" type="checkbox"/> Hf
<input checked="" type="checkbox"/> S	<input checked="" type="checkbox"/> Se	<input checked="" type="checkbox"/> Cs	<input checked="" type="checkbox"/> Ta
<input checked="" type="checkbox"/> Cl	<input checked="" type="checkbox"/> Br	<input checked="" type="checkbox"/> Ba	<input checked="" type="checkbox"/> W
<input checked="" type="checkbox"/> K	<input checked="" type="checkbox"/> Rb	<input checked="" type="checkbox"/> La	<input checked="" type="checkbox"/> Re
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<input checked="" type="checkbox"/> V	<input checked="" type="checkbox"/> Nb	<input checked="" type="checkbox"/> Eu	<input checked="" type="checkbox"/> Hg
<input checked="" type="checkbox"/> Cr	<input checked="" type="checkbox"/> Mo	<input checked="" type="checkbox"/> Gd	<input checked="" type="checkbox"/> Th
<input checked="" type="checkbox"/> Mn	<input checked="" type="checkbox"/> Ru	<input checked="" type="checkbox"/> Tb	<input checked="" type="checkbox"/> U
<input checked="" type="checkbox"/> Fe	<input checked="" type="checkbox"/> Ag	<input checked="" type="checkbox"/> Dy	

Примечания (например, наиболее важные элементы)

№	Номер образца	Тип образца	Подтип образца	Широта	Долг
69	69	почвы			
70	70	почвы			
71	71	почвы			
72	72	почвы			
73	1р	растительность	другая растительность		
74	2р	растительность	другая растительность		
75	3р	растительность	другая растительность		
76	4р	растительность	другая растительность		

Заменить Добавить Удалить Закреть Сохранить

The customer fills in the forms with information about himself and the samples for analysis. The customer can take both programs from the website of our Sector. These data can be stored automatically in the database and edited in the future

Программа *Standard search*

Поиск стандартов - 1.4.

Список файлов-паспортов

- 085.REF
- 140.REF
- 1515.REF
- 1547.REF
- 1549.REF
- 155.ref
- 1566b.REF
- 1567a.REF
- 1568a.REF
- 1570a.REF
- 1571.REF
- 1572.REF
- 1573a.REF
- 1575.ref
- 1575a.REF
- 1577.REF

Группа элементов

- галогены
- КЖИ
- ДЖИ-1
- ДЖИ-2

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<input type="checkbox"/> Fe	<input type="checkbox"/> Ag	<input type="checkbox"/> Dy	

Ошибка меньше, %

10.00

	Имя файла	NA PPM	NA ERR. %	MG PPM	MG ERR. %
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	1547.REF	24	8.3	4320	1.9
	1549.REF	4970	2	1200	2.5
	155.ref	15800	1.9	3190	2
	1566b.REF	3297	1.6	1085	2.1

Удалить строку Поиск Сохранить в файл



Outline of scientific activity

ANALYTICAL INVESTIGATIONS AT IBR-2M REACTOR

*Instrumental
neutron activation analysis*
INAA

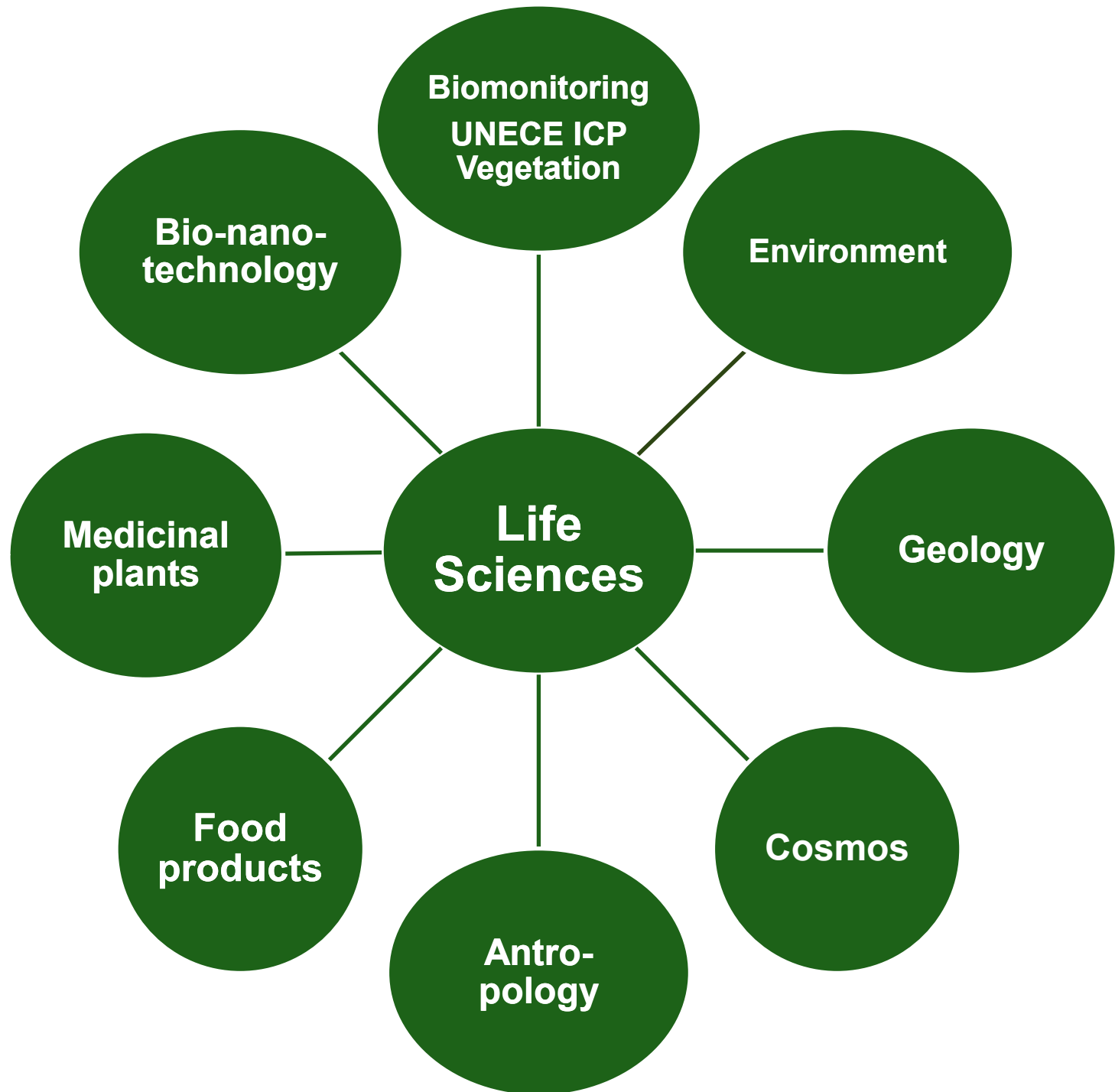
*Epithermal
neutron activation
analysis*
ENAA

*Cyclic
neutron activation
analysis*
CNAA

Life Sciences

Material Science

- **Biomonitoring** of atmospheric deposition of heavy metals and other elements (Project **REGATA**)
- Assessment of different ecosystems and their impact on **human health**
- **Analysis of extraterrestrial materials**
- **Bio-nano-technologies:** synthesis of nanoparticled (Ag, Au, Se, Ti., etc) wastewater treatment
- NAA for technological process of synthesis **of diamonds and NB**
- Analysis of **archaeological and museum objects** from Russia and other countries



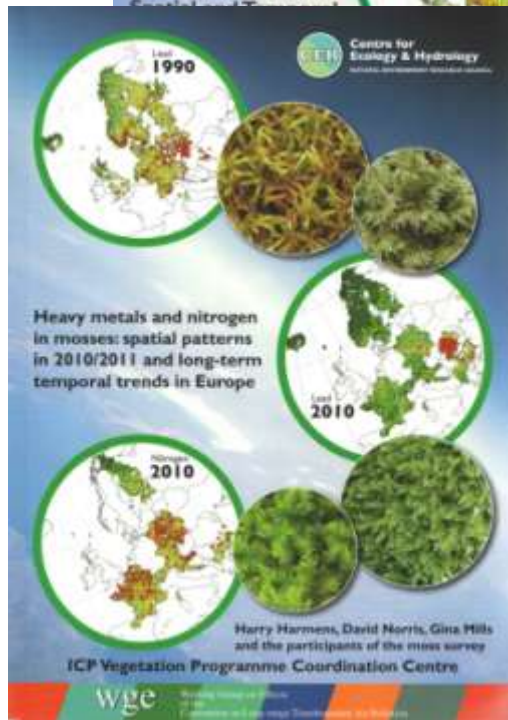
NAA + AAS

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac**											Rf	Db	Sg	Bh	Hs
	*	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		
	**	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lw		

NAA ~ 55 elements



Air pollution studies based on moss analysis



UNECE

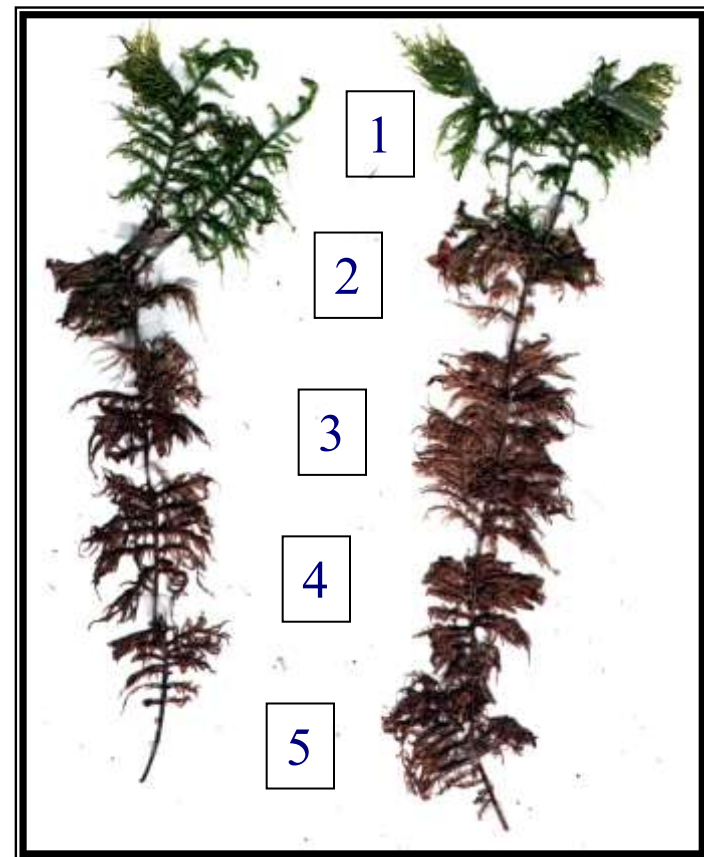
United Nations Economic Commission for Europe

International Cooperative Programme on Effects of Air Pollution on Natural Vegetation and Crops

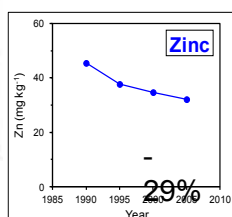
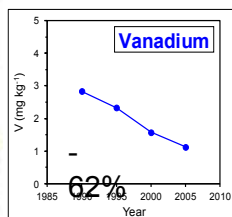
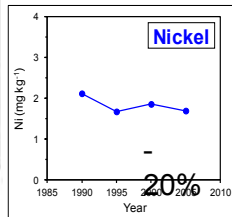
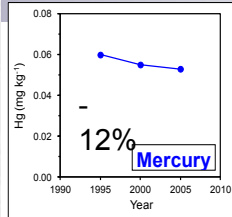
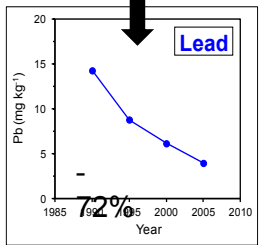
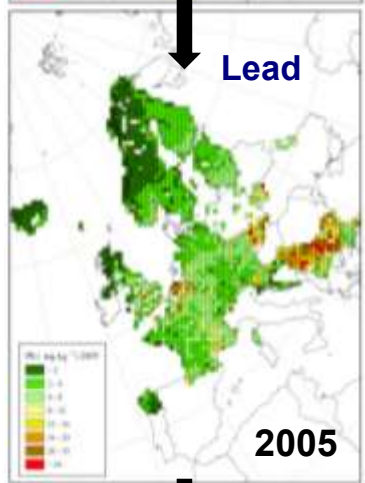
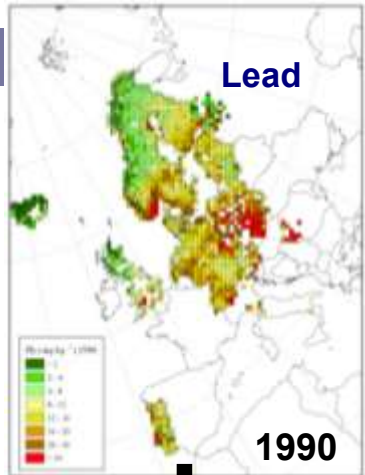
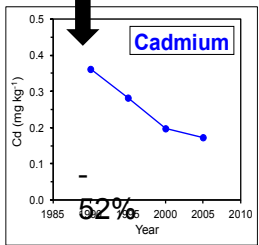
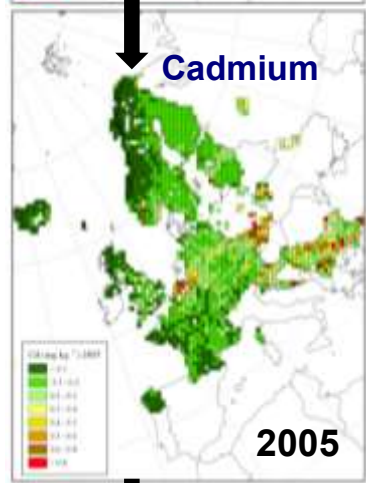
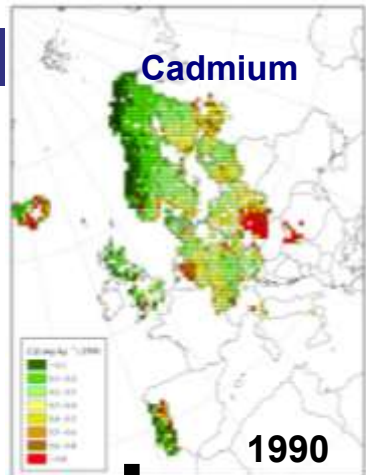
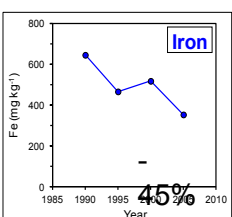
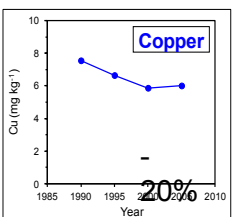
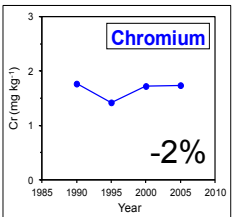
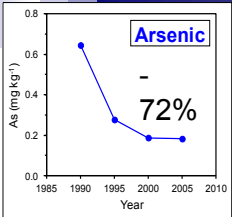
Working Group on Effects - 1981

1993: Biomonitoring...

M.V. Frontasyeva, V.M. Nazarov and E. Steinnes. **Mosses as monitors of heavy metal deposition: Comparison of different multi-element analytical techniques.** In R.J. Allan and J.O. Nriagu, eds., *Heavy Metals in the Environment*, Vol.2, pp. 17-20. CEP Consultants, Edinburgh **1993**.







Mosses provide a complementary method to assess **spatial patterns** and **temporal trends** of atmospheric heavy metal deposition:

- ❑ Carpet forming mosses receive trace elements and nutrients mainly from the atmosphere.
- ❑ In recent years, the lowest concentrations of heavy metals in mosses were found generally in northern Europe and the highest concentrations in Belgium and eastern Europe .
- ❑ Europe-wide the concentration in mosses of **arsenic, cadmium, lead and vanadium** has declined the most between 1990 and 2010, with hardly any reduction being observed for **chromium and mercury**.
- ❑ Temporal trends were country-specific.
- ❑ Spatial patterns and temporal trends

for cadmium and lead agree quite well with those modelled by the **European Monitoring and Evaluation Programme (EMEP)**.

ICP Vegetation Programme Coordination Centre



Project REGATA


(1995-2000-2005-2010-2015)

Title

Heavy metal atmospheric deposition study in selected European and Asian countries using nuclear and related analytical techniques

Participating countries:

Russia, Azerbaijan, Belarus, Bulgaria, Croatia, Georgia, Poland, Romania, Slovakia, Greece, Kazakhstan, Macedonia, Serbia, Croatia, Albania, Turkey, Mongolia, Vietnam, South Korea, Thailand



Transfer of the coordination of the European moss survey to the Joint Institute for Nuclear Research, Dubna, RF

- ▶ Secretariat of the UN LRTAP Convention in October 2013 –approval of Russia, JINR, Dubna
- ▶ The 27th Task Force Meeting, January 27-30, 2014, Paris, France – official procedure of transfer of coordination

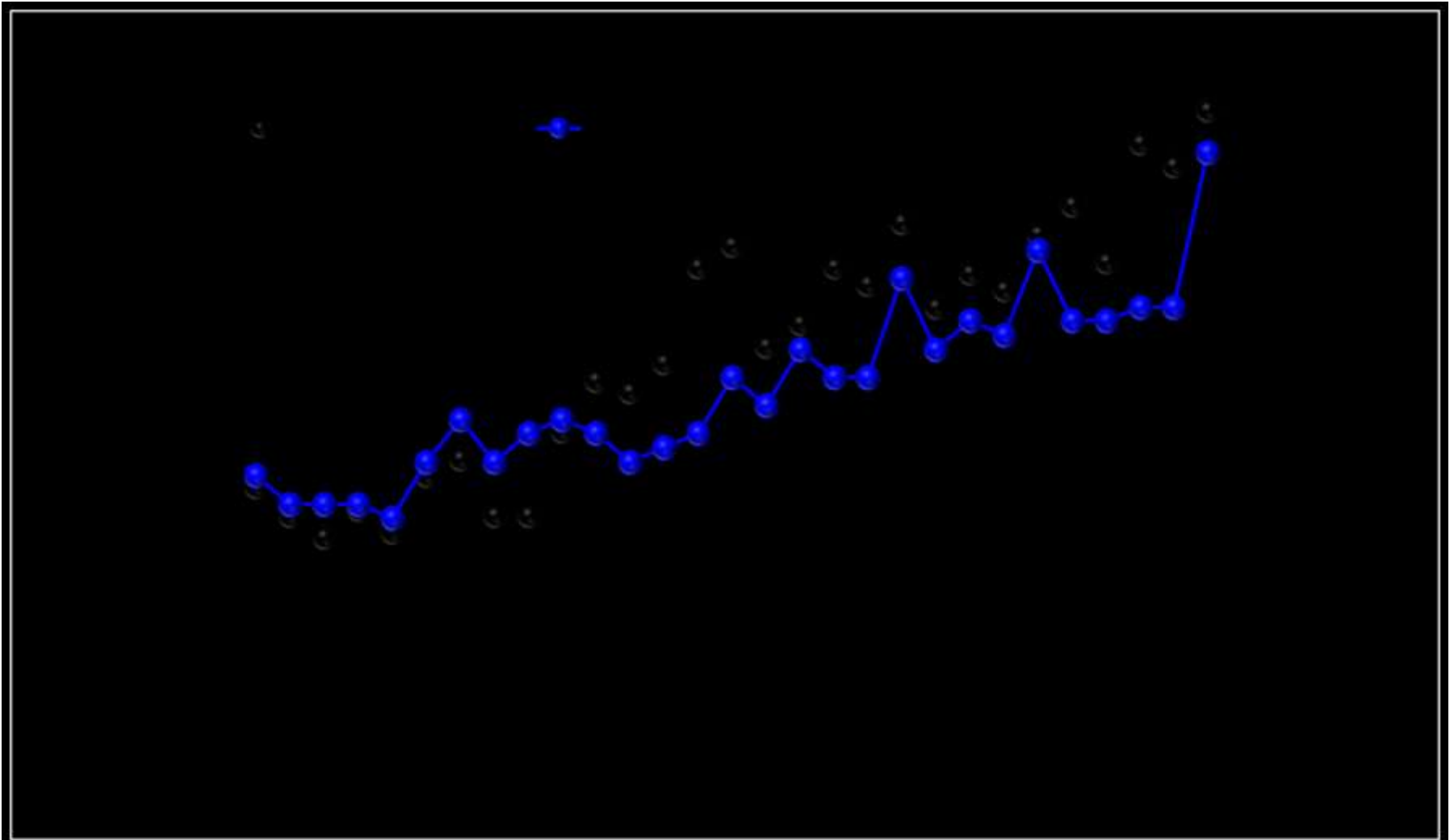
Priority LRTAP Convention

(see Decision 2010/18 and 2011/14)

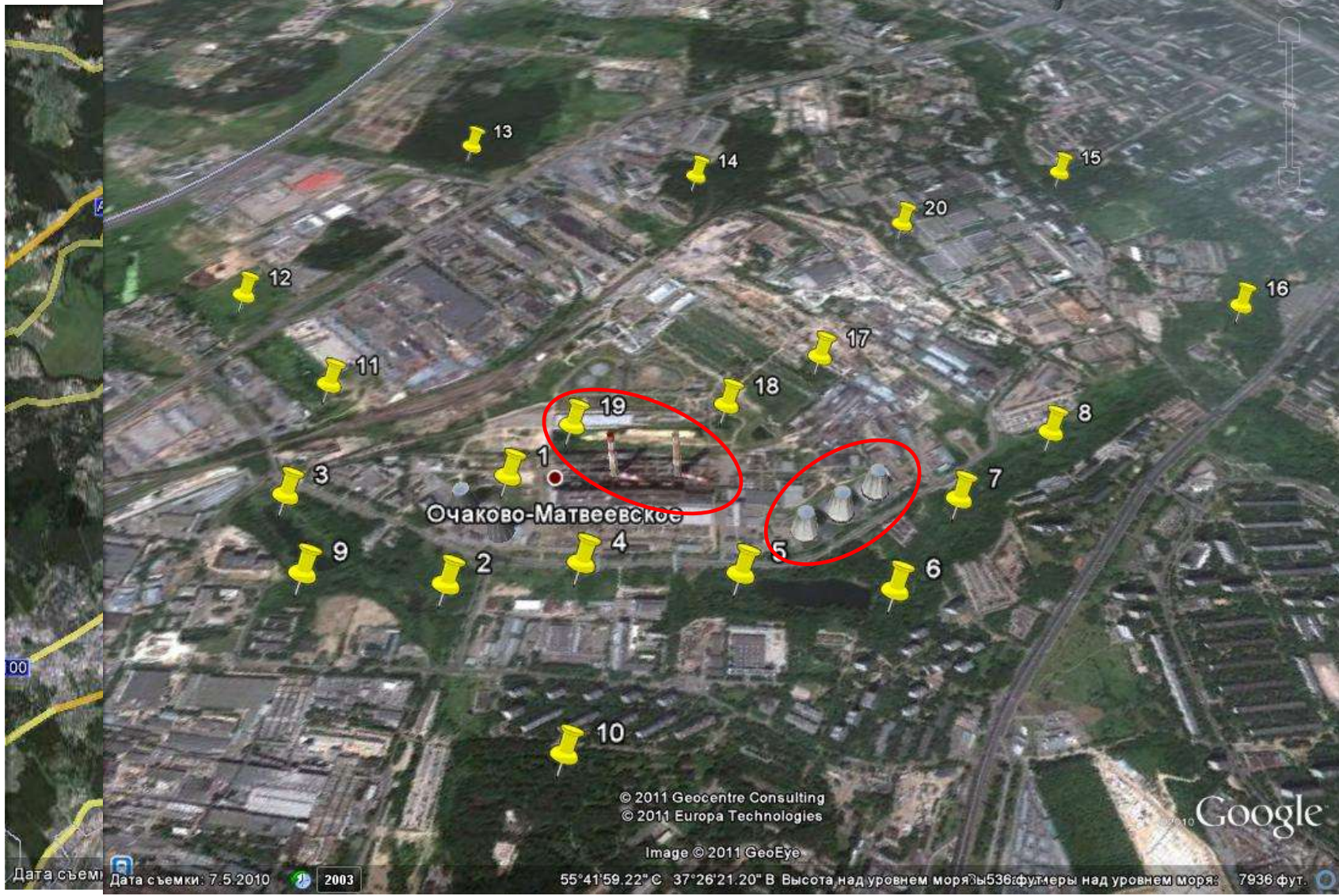
- ▶ Improve ratification and compliance of Protocols by countries in **Eastern Europe, the Caucasus and Central Asia and South-Eastern Europe** to improve air quality
- ▶ Increase participation and activities of all Convention Bodies (including ICP Vegetation) in those countries
- ▶ Hence, decision to transfer coordination European moss survey to the Russian Federation to enhance network activities as supported by JINR

The 29th Task Force Meeting of UNECE ICP

will be held in Dubna, Russia
February 29 – March 4, 2016



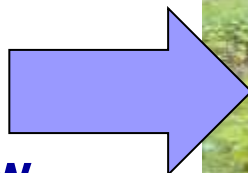
Thermal Power Plant in Moscow in Ochakovo-Matveevskoe

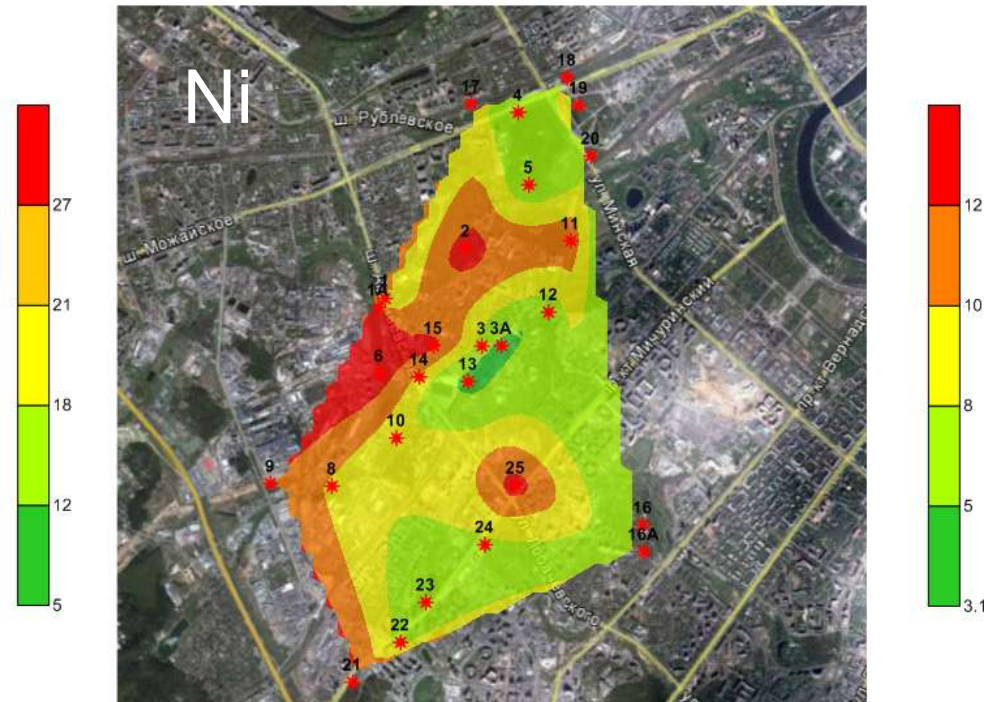
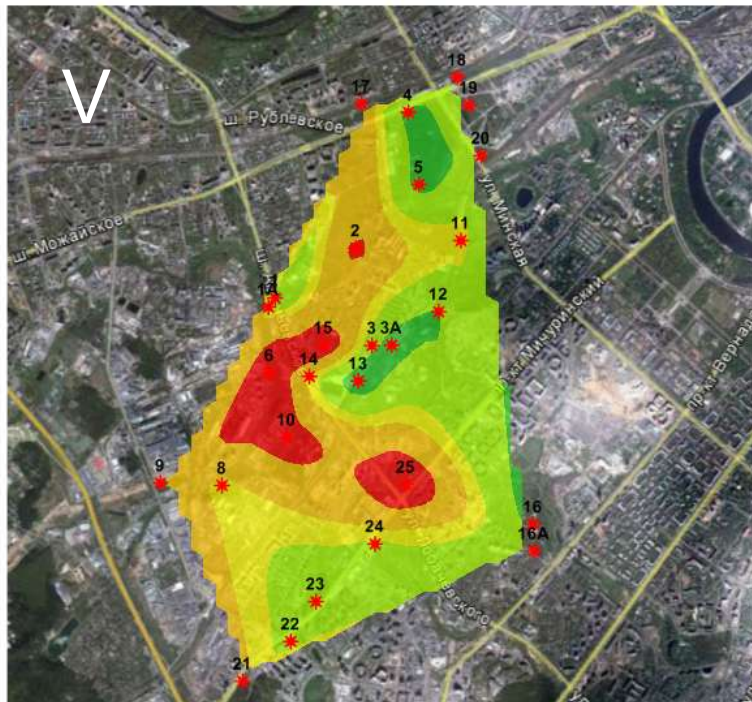


Electrical power is 1370 MWt



**Olga Kapturova and
Alexandra Volokhova
School No. 814, Moscow**





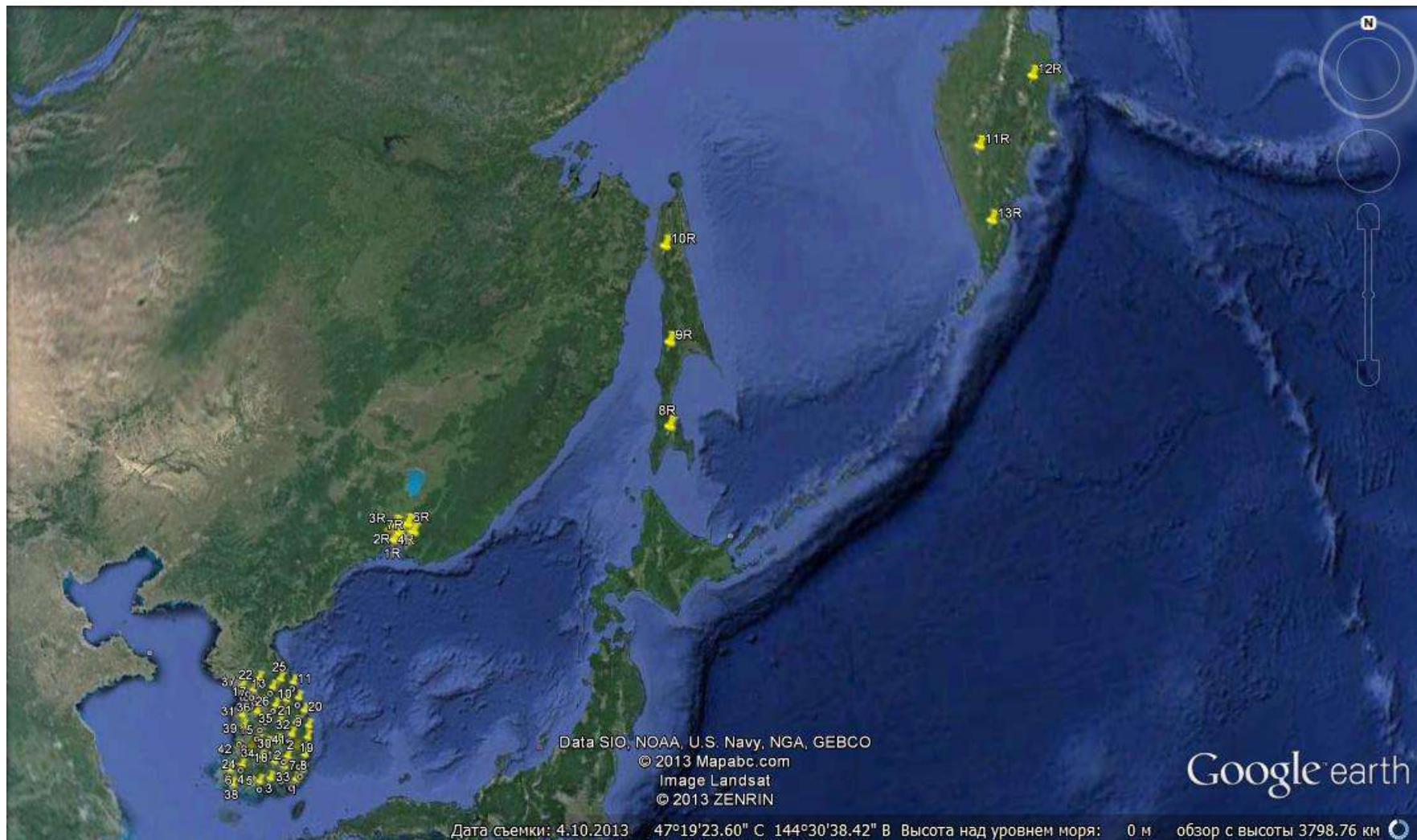
Magister Thesis by Nikita YUSHIN, Dubna University of Nature, Society and Man



Long-lived radionuclides in the Far East of RF and South Korea

The moss technique is supposed to be used for assessing sequences of the Fukushima disaster in the Far East of the Russian Federation and entire territory of South Korea

Long-lived radionuclides in the Far East of RF and South Korea



Дата съемки: 4.10.2013 47°19'23.60" С 144°30'38.42" В Высота над уровнем моря: 0 м обзор с высоты 3798.76 км

октября 2013 года



Other environmental projects

(Rep. of South Africa, Egypt, Serbia,)



necsa
We're in your world



Atmospheric Deposition of Trace Elements in the Western Cape, South Africa, Studied with the Biomonitoring Technique, NAA, ICP-MS and GIS Technology (PhD student study)

Study on Levels of Priority Aquatic Pollutants in South African Cultivated Bivalve Mollusks ("The South African Mussel Watch")

Use of INAA to determine rare earth element contents in different fresh and weathered South African fly ash (PhD student study)

"The South African Mussel Watch"



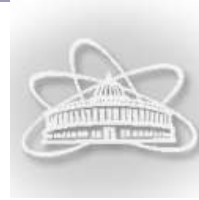
CHAASector of NAA FLNP JINR –
Stellenbosch University



November 28, 2012- Atlantic Ocean

**Study of priority aquatic
pollutants in the South
African cultivated bivalve
mollusks (oysters)**





Assessment of the environmental situation in the the **River Nile basin** using nuclear and related analytical techniques (2011-2015)

*Sector of Neutron Activation Analysis and Applied Research
Division of Nuclear Physics, Frank Laboratory of Neutron Physics
Joint Institute for Nuclear Research*

**Assessment of the environmental situation in
the **River Nile basin** using nuclear and
related analytical techniques (2011-2015)**



Spokesman from JINR: Assoc. Prof., Dr. **Marina Frontasyeva**,
Department of Neutron Activation Analysis and Applied Research
(NAA & AR), Division of Nuclear Physics,
Frank Laboratory of Neutron Physics

Co-spokesman from Egypt: Prof., Dr. **Hussein El Samman**,
Faculty of Science, Menoufia University Shibin El-koom, Egypt

Institutes of Egypt:



Menoufia University, Shibin El-koom

South Valley University, Aswan

Tanta University, Tanta

Alexandria University



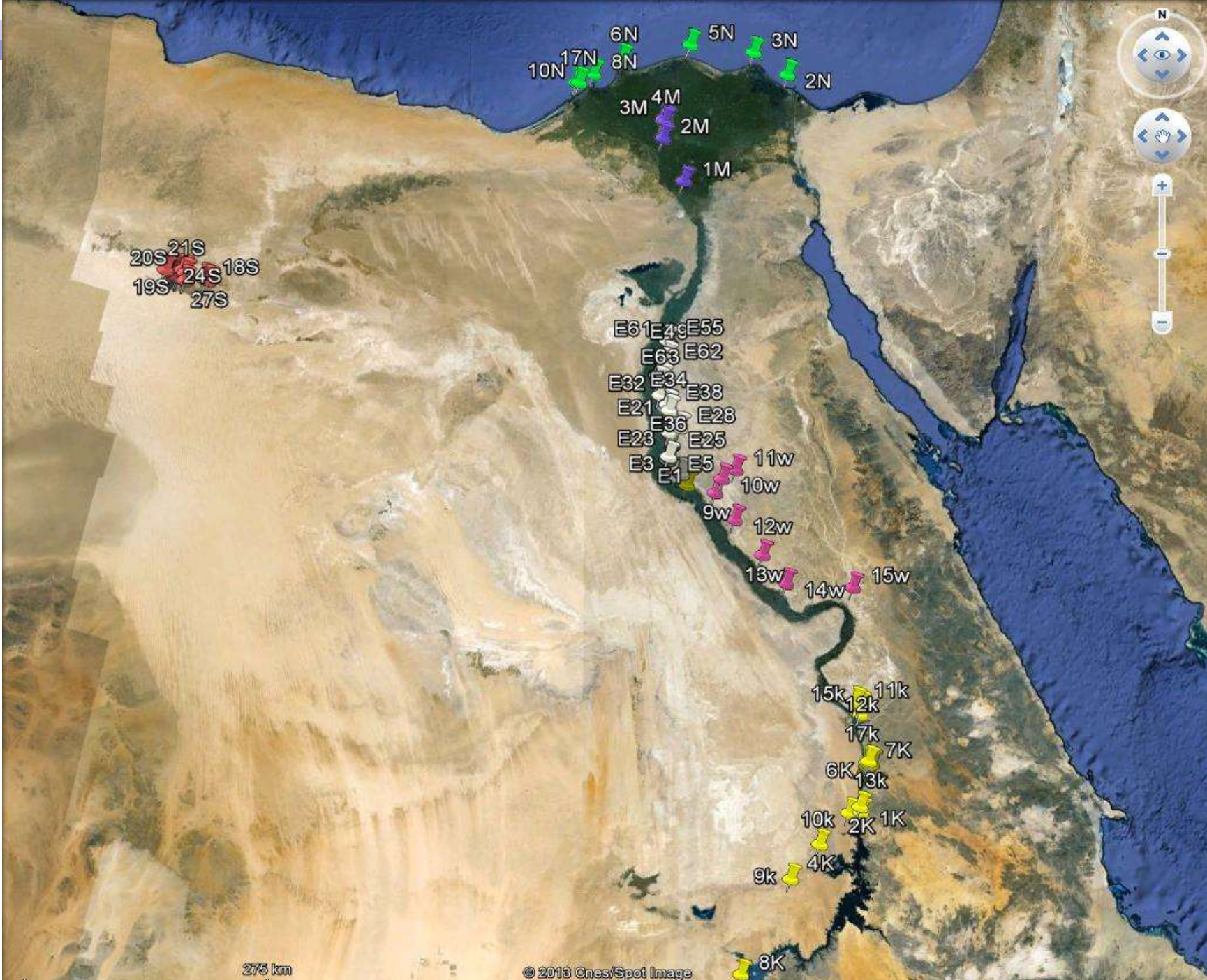
Egyptian Atomic Energy Authority

*Academy of Sciences of Egypt
(Prof. **Tarek Hussein**)*

May 16, 2011



Leaders of the project, Prof. **Hussein El Samman** (Egypt), Dr. **Marina Frontasyeva** (JINR, RF) and associates discussing the project (first on the right is **Khaled Ali Mohammed** who will come to Dubna in December 2011 to participate in NAA of the Egyptian samples



© 2013 Cnes/Spot Image

Image U.S. Geological Survey

Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Google earth



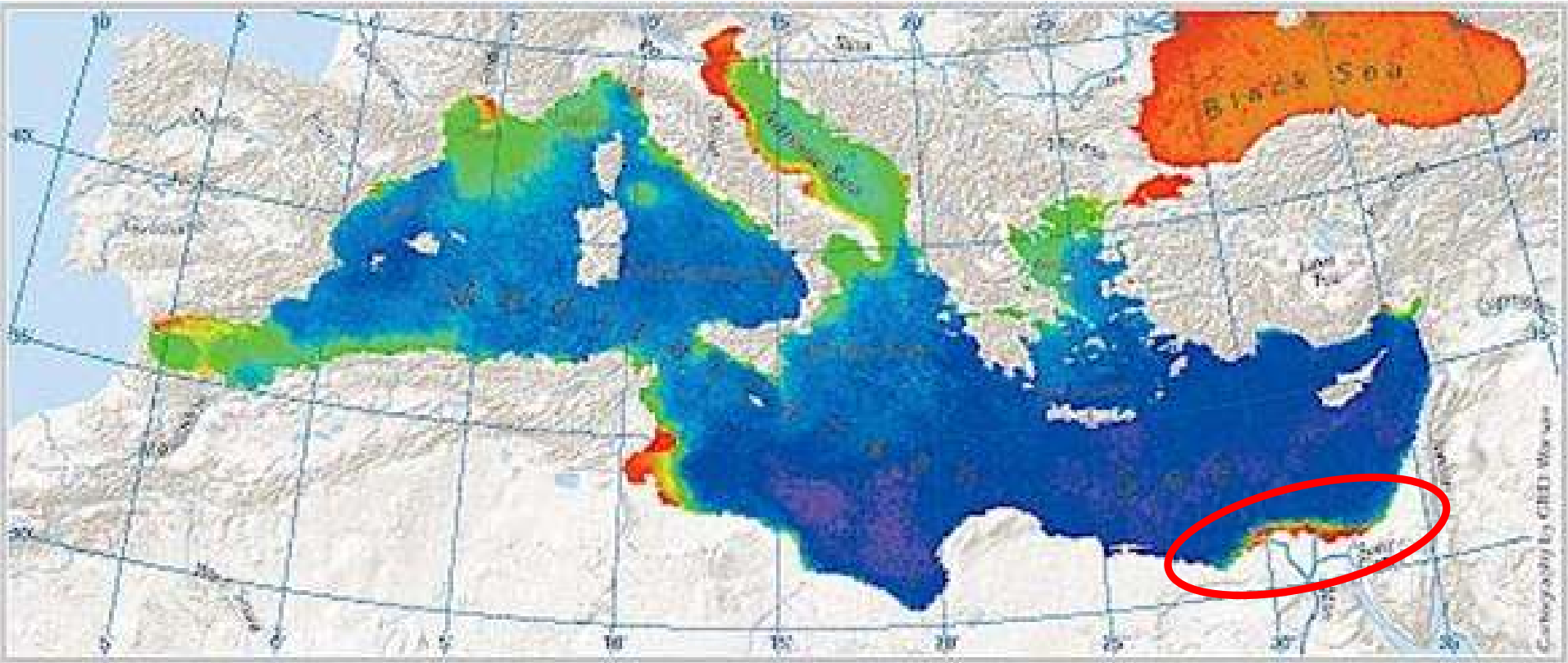
Wafaa M. Arafa, Wael M. Badawy, Naglaa M. Fahmi, Khaled Ali, Mohamed S. Gad, Octavian G. Dului, Marina V. Frontasyeva, Eiliv Steinnes

Geochemistry of sediments and surface soils from the Nile delta and lower Nile valley studied by epithermal neutron activation analysis

African Earth Sciences. No. 107, 2015, p. 57-64. Elsevier (**Impact Factor 2.2**)



Assessment of Mediterranean coastal waters affected by eutrophication, anthropogenic contamination of the Suez and Ismailia Canals and the Red Sea



ELEMENTAL CONTENT OF MARINE MACROPHYTES (THE MEDITERRANEAN SEA, EGYPT) STUDIED BY NEUTRON ACTIVATION ANALYSIS

Kravtsova A. ^{1,2}, Nassar N. ³, Frontasyeva M. ¹, Sherif M. ³

¹ FLNP JINR, 6, Joliot-Curie str., 141980, Dubna, Russia

² The A.O. Kovalevsky Institute of Marine Biological Research of RAS, 299011, Sevastopol, Russia

³ Department of Physics, Faculty of Science, Cairo University, 12613, Giza, Egypt

The work presents the preliminary results of studying the peculiarities of accumulation of wide range of elements in marine macrophytes (algae and seagrass) collected along the Mediterranean Sea coast of Egypt. The concentrations of 40 elements (Na, Mg, Al, S, Cl, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Zn, As, Se, Br, Rb, Sr, Zr, Mo, Ag, Sb, I, Cs, Ba, La, Ce, Sm, Eu, Tb, Yb, Hf, Ta, W, Au, Th, and U) in samples were determined by means of INAA at the pulsed fast reactor IBR-2, FLNP.

Fig.1. Marine macrophytes used at the study.



Fig. 2. Samples were collected at 3 sites (Citadel beaches and Abo-Quir bay, Alexandria; Kleaopatra beach, Marsa Matrouh city) along the Mediterranean Sea coast of Egypt during the summer of 2015

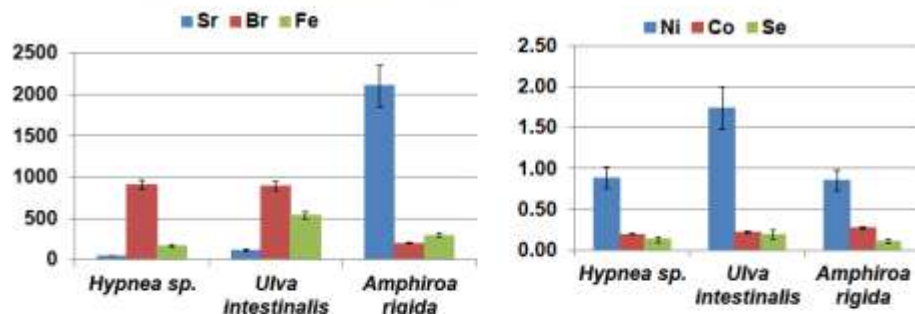
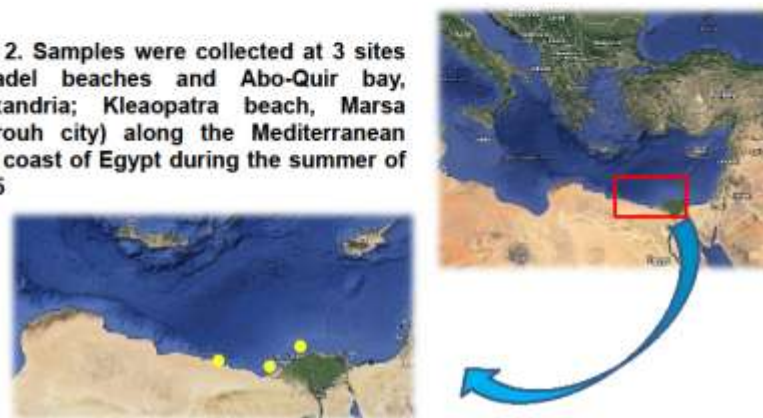


Fig. 3. The concentration of some elements (mg/kg) in *Hypnea sp.* (red algae), *Ulva intestinalis* (green algae) and *Amphiroa rigida* (red algae) collected at one sampling site (Abo-Quir bay, Alexandria). The content of Sr, Br, and Fe varies greatly, while the level of Ni is very similar for red algae, and the concentration of Co and Se is similar for all three species

It is shown that the level of accumulation of the elements in marine macrophytes varies depending on their type (brown, green, red algae or seagrass), species and the ambient water conditions. Thus, the

◆ Black Sea coast of Crimea ■ Mediterranean Sea coast of Egypt



Project JINR-Serbia, **2011-2015**

Atmospheric deposition study in street canyons of Belgrade and Moscow

Method of moss-transplants

In Moscow: Leninsky Prospect in the area of the Gagarin Square - 1 – 5 – 9 floors

Belgrade, Serbia



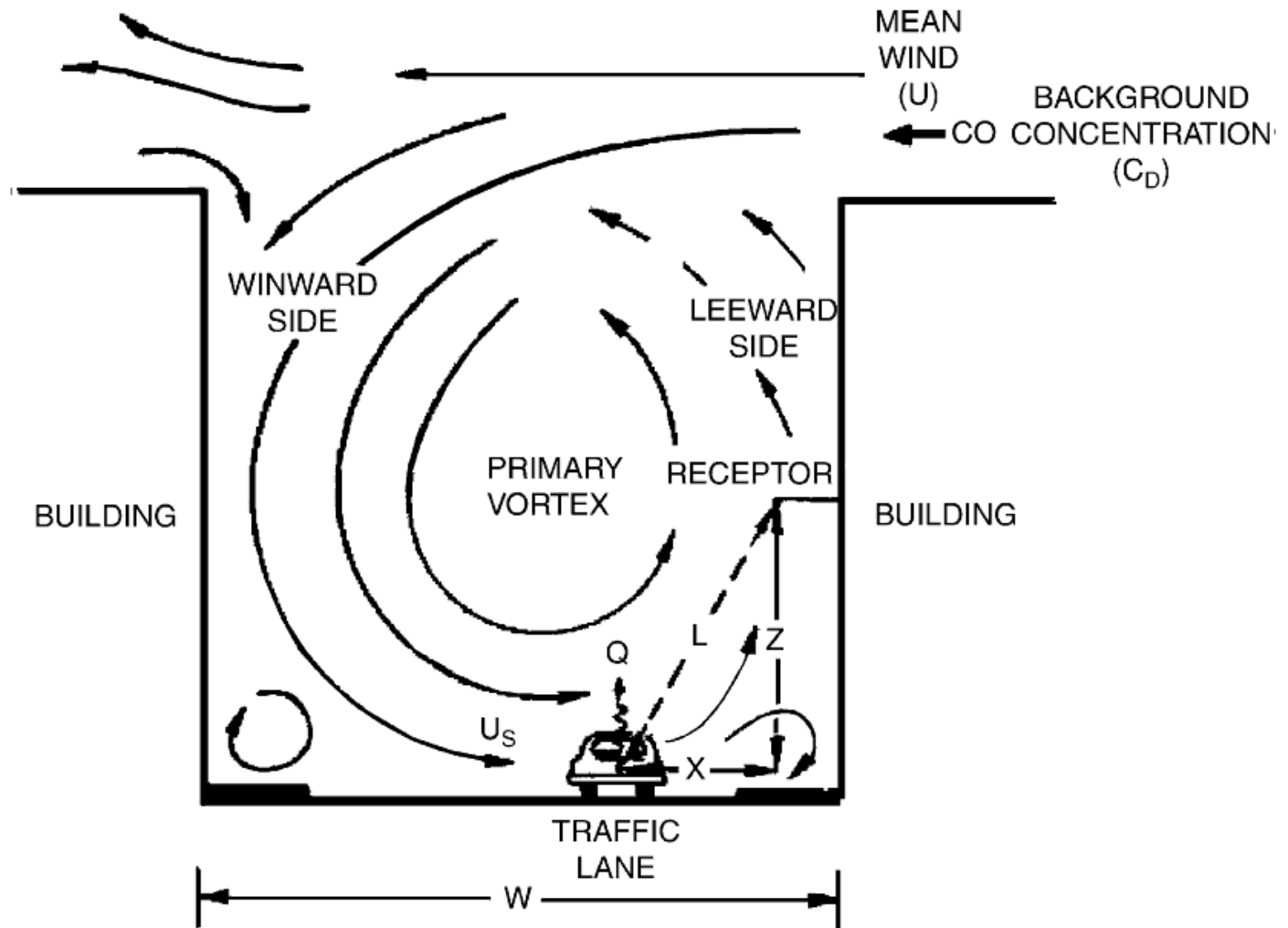


Fig. 1. Pollutant dispersion in a regular street canyon (Dabberdt et al., 1973).

Collection of moss ...

Sphagnum girgensohnii Russow

The background territory – Domkini Bay of Ivan'kovo Reservoir - 140 km North of Moscow





Preparation of moss bags (10×10 cm) for exposure, nylon net is if with 1mm mesh





Bio-nano-technology:

**synthesis of Ag, Au, Se, Ti nanoparticles
by blue-green alga *Spirulina platensis* and
some microbial strains**



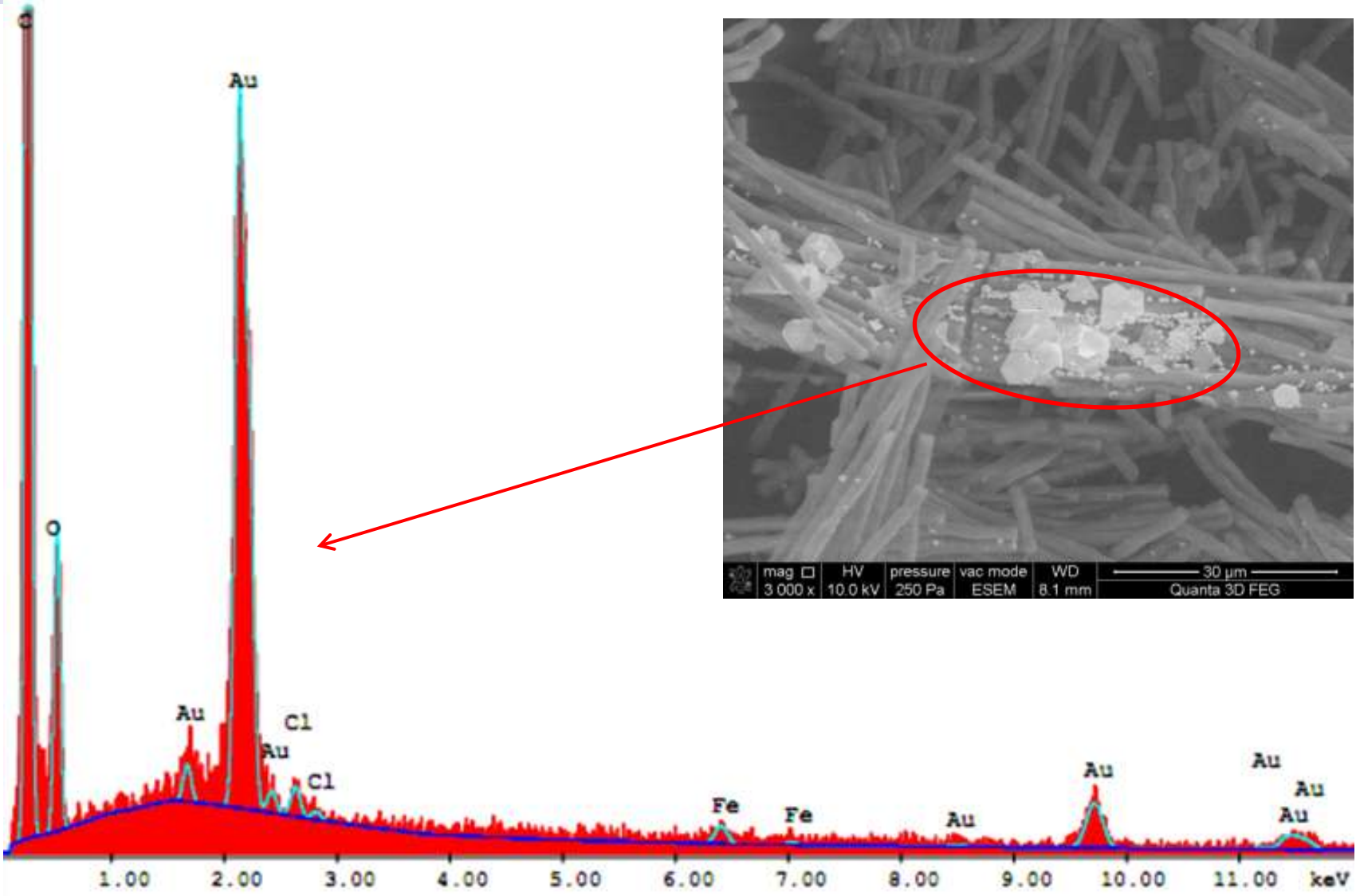
M.V. Frontasyeva, S.S. Pavlov
*Frank Laboratory of Neutron Physics ,
JINR, Russian Federation*



**T. Kalabegishvili, E. Kirkesali, I. Murusidze,
D. Pataraya, E.N. Ginturi**
Andronikashvili Institute of Physics, Tbilisi , Georgia



I. Zinicovscaia
*Institute of Chemistry of the Academy of Science of Moldova,
Chisinau, Moldova*



EDAX spectrum of *Sp. platensis* cells after exposure to hydrated gold chloride solution



DIPLOMA

SAȘI - ROMÂNIA



BIOLOGICAL TREATMENT OF INDUSTRIAL WASTEWATER
CONTAINING ZINC BY SPIRULINA PLATENSIS
I. ZINICOVSICAIA, L. CEPOI, T. CHIRIAC, GH. DUCA, T. MITINA,
M.V. FRONTASYEVA, S.S. PAVLOV, S.F.GUNDORINA

GOLD MEDAL



President of International Jury
Prof. Adrian GRAUR

President of Exhibition
Prof. Ion SANDU



EUROINVENT
2013



11 May 2013



DIPLOMA

SAȘI - ROMÂNIA



Cyanobacteria - new materials for wastewater treatment

I. Zinicovscaia, L. Cepoi, T. Chiriac, A. Valuta, T. Mitina,
M.V. Frontasyeva, S.S. Pavlov, S.F.Gundorina

GOLD MEDAL

President of International Jury
Dr Eng. Mohd Mustafizul Baki ABDULLAH

President of Exhibition
Prof. Ion SANDU



EUROINVENT
2015



May 16, 2015



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*Advanced Science,
Engineering and Medicine*
Vol. 4, pp. 1–7, 2012
(www.aspbs.com/asem)

Synthesis of Gold Nanoparticles by Blue-Green Algae *Spirulina Platensis*

T. Kalabegishvili^{1,2}, E. Kirkesali¹, A. Rcheulishvili¹, E. Ginturi¹, I. Murusidze², N. Kuchava¹, N. Bagdavadze¹, G. Tsertsvadze³, V. Gabunia⁴, M. V. Frontasyeva^{5,*}, S. S. Pavlov⁵, I. Zinicovscaia⁵, M. J. Raven⁶, N. M. F. Seaga⁶, and A. Faanhof⁷

¹*I. Javakhishvili State University, E. Andronikashvili Institute of Physics,
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²*Ilia State University, 3/5 K. Cholokashvili Ave., Tbilisi 0162, Georgia*

³*Georgian Technical University, 77, Kostava Str., Tbilisi 0175, Georgia*

⁴*I. Javakhishvili State University, P. Melikishvili Institute of Physical and Organic Chemistry,
5 Politkovskaya str., Tbilisi, 0186, Georgia*

⁵*Joint Institute for Nuclear Research, 6 Joliot-Curie Str., 1419890, Dubna, Russia*

⁶*Nuclear Energy Corporation of South Africa (NECSA), Pelindaba, Pretoria, South Africa*

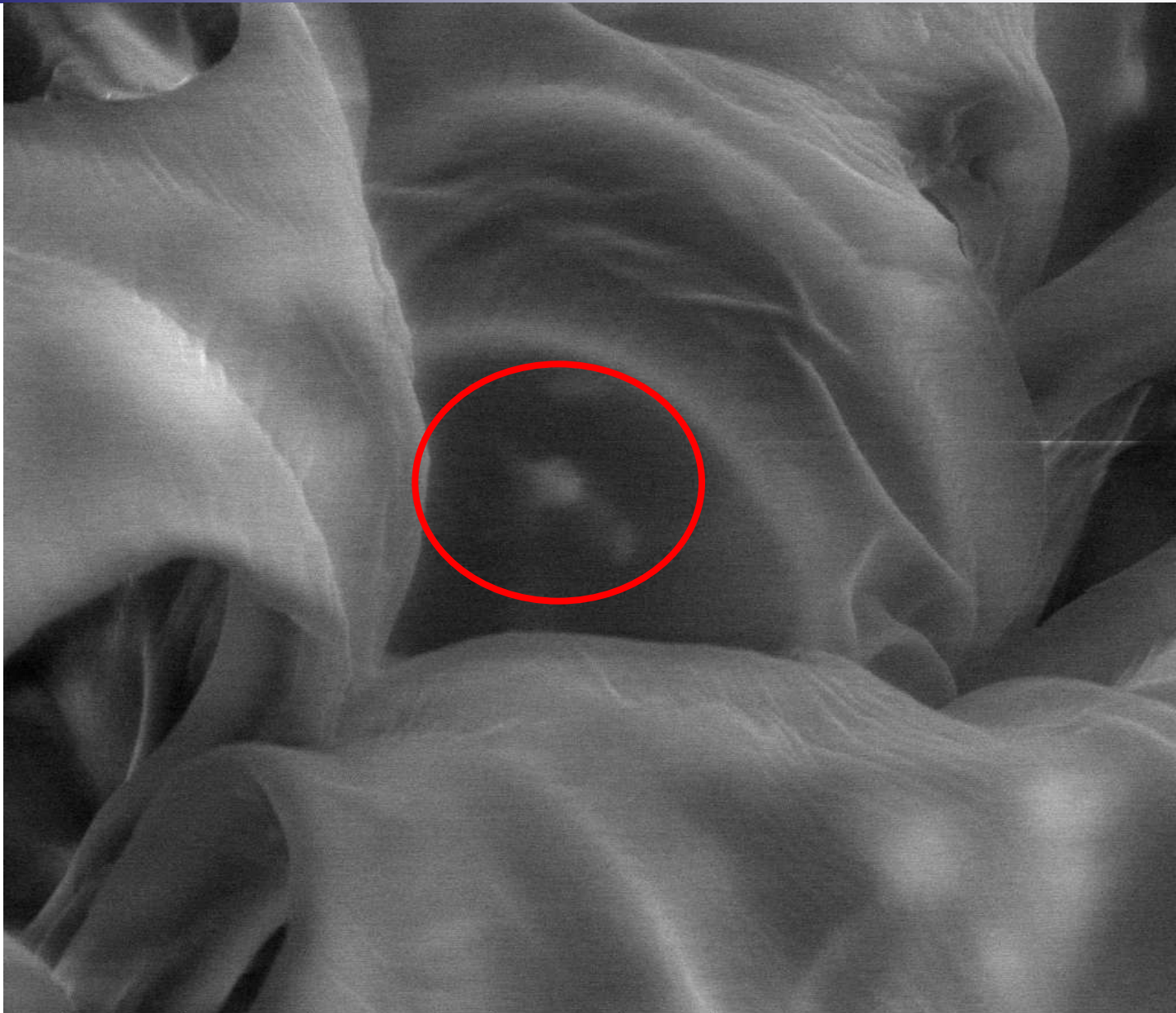
⁷*Centre of Applied Radiation Science and Technology, North-West University (Mafikeng Campus),
Mafikeng, South Africa*




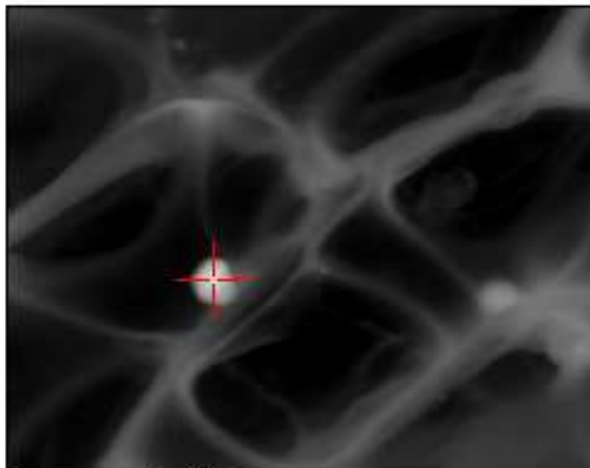


**Study of Cosmic Dust using natural
planchettes: peat-bog cores from Siberia**

**JINR, Tomsk University, MSU (Institute of Astronomy)
and Adam Mickiewicz University in Poland**

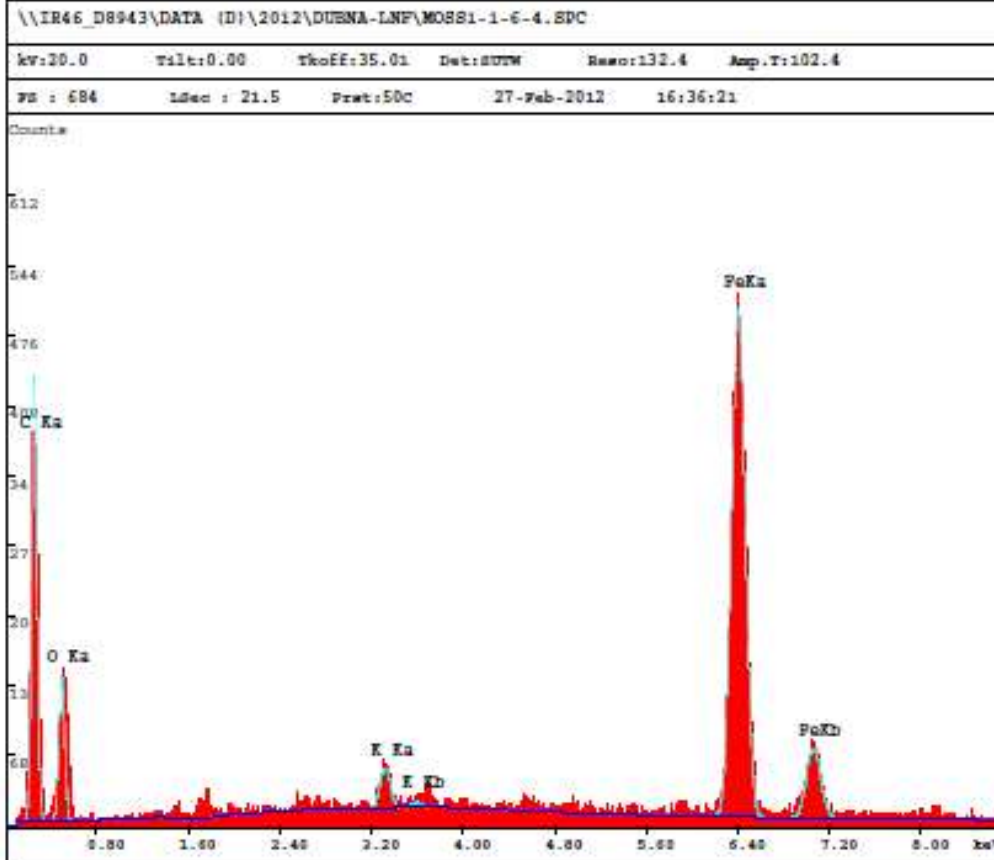


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							SMA QUANTA 3D FEG

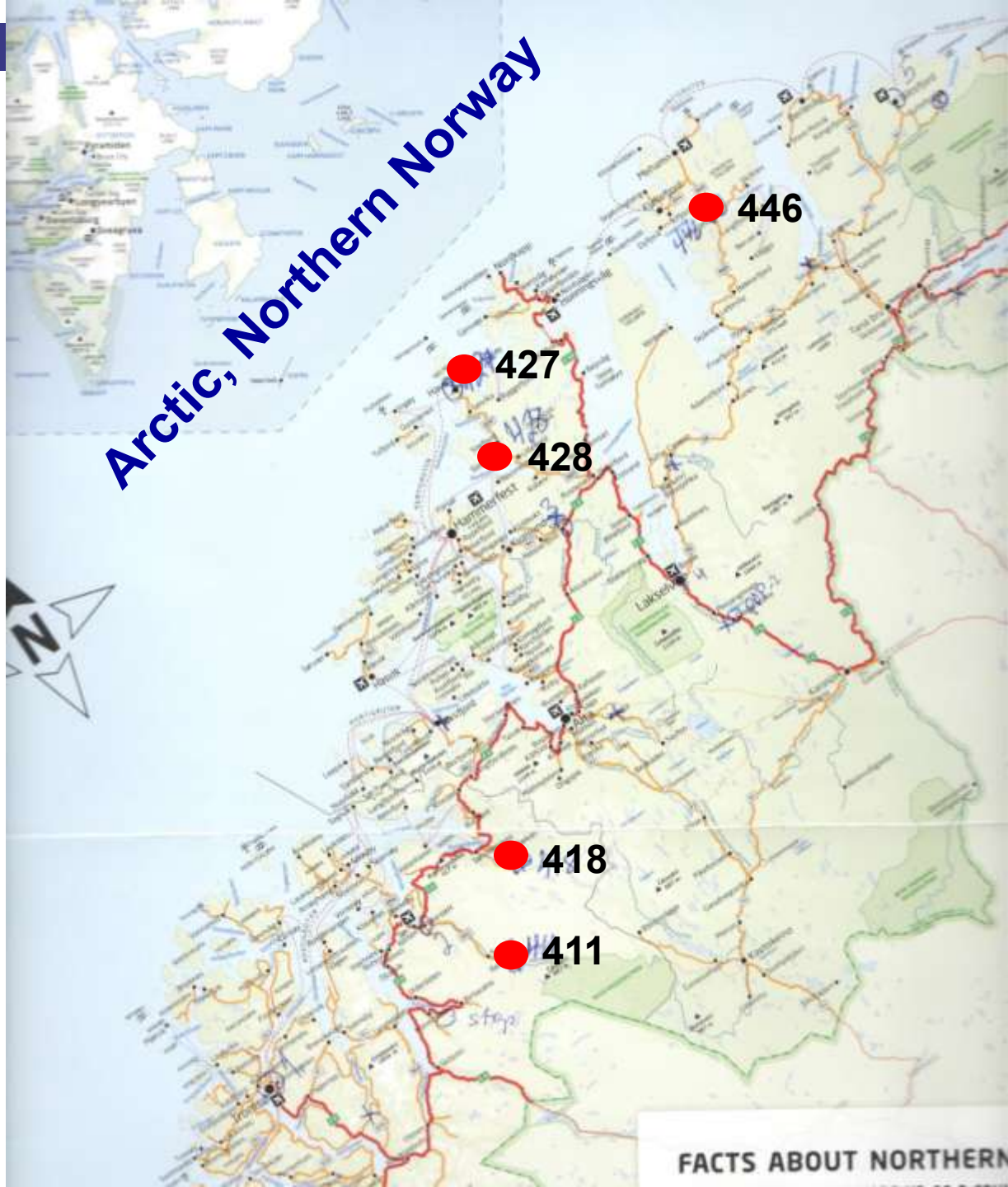


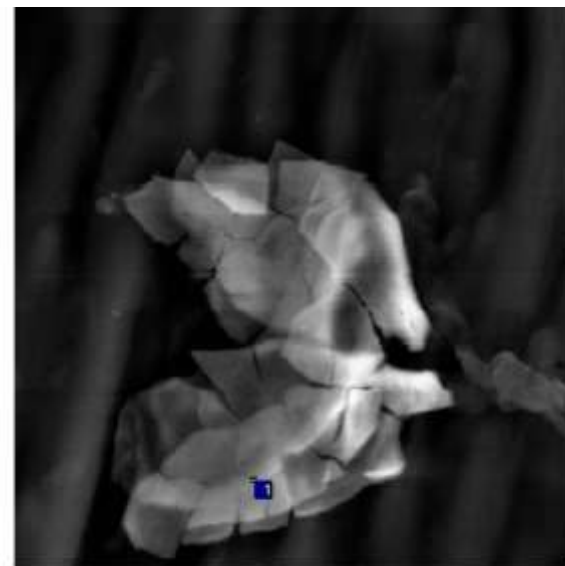
Matrix: 1024x800
 Data Type: SE1(ADC)
 Magnification: 8569x
 Image Size: 0.0319x0.0257mm
 kV: 20.0
 Tilt: 0

SE1 12µm



Arctic, Northern Norway





10µm

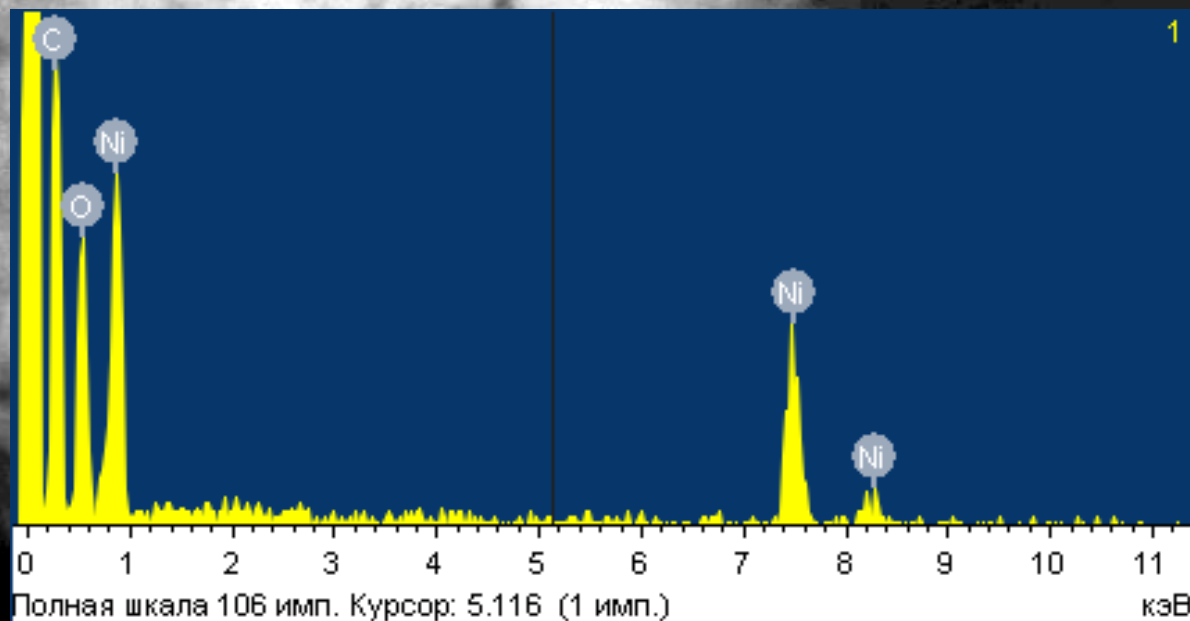
Electron Image 1

SEM HV: 20.00 kV SEM MAG: 9.56 kx
 View field: 34.60 µm Tselmovich V.A.
 Date(m/d/y): 10/06/15 Det: BSE Detector

10 µm

Элемент	Весовой %	Атомный%	
О K	43.33	71.62	
Al K	0.93	0.91	
Si K	0.99	0.93	
K K	1.00	0.67	
Mn K	53.76	25.88	
Итоги	100.00		

Элемент	Весовой %	Атомный%	
О К	38.15	69.36	
Ni К	61.85	30.64	
Итого	100.00		



SEM HV: 20.00 kV
View field: 3.937 μm
Date(m/d/y): 09/28/15

SEM MAG: 84.00 kx
Tselmovich V.A.
Det: BSE Detector

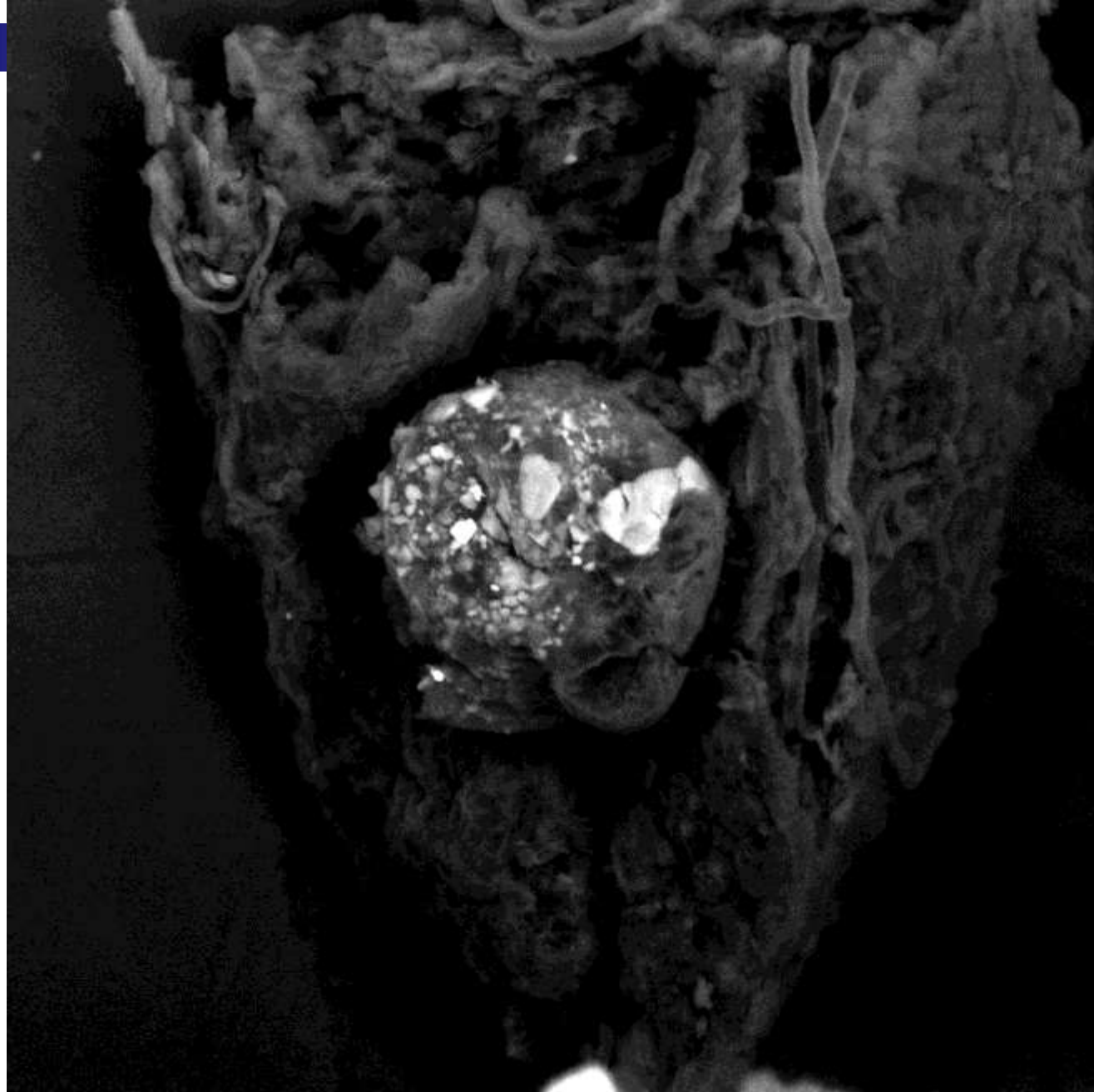
1 μm

VEGA\\ TESCAN

GO "Borok" IPE RAS



No. 418



SEM HV: 20.00 kV

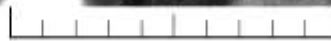
SEM MAG: 1.65 kx

View field: 200.3 μ m

Tselmovich V.A.

Date(m/d/y): 09/28/15

Det: BSE Detector

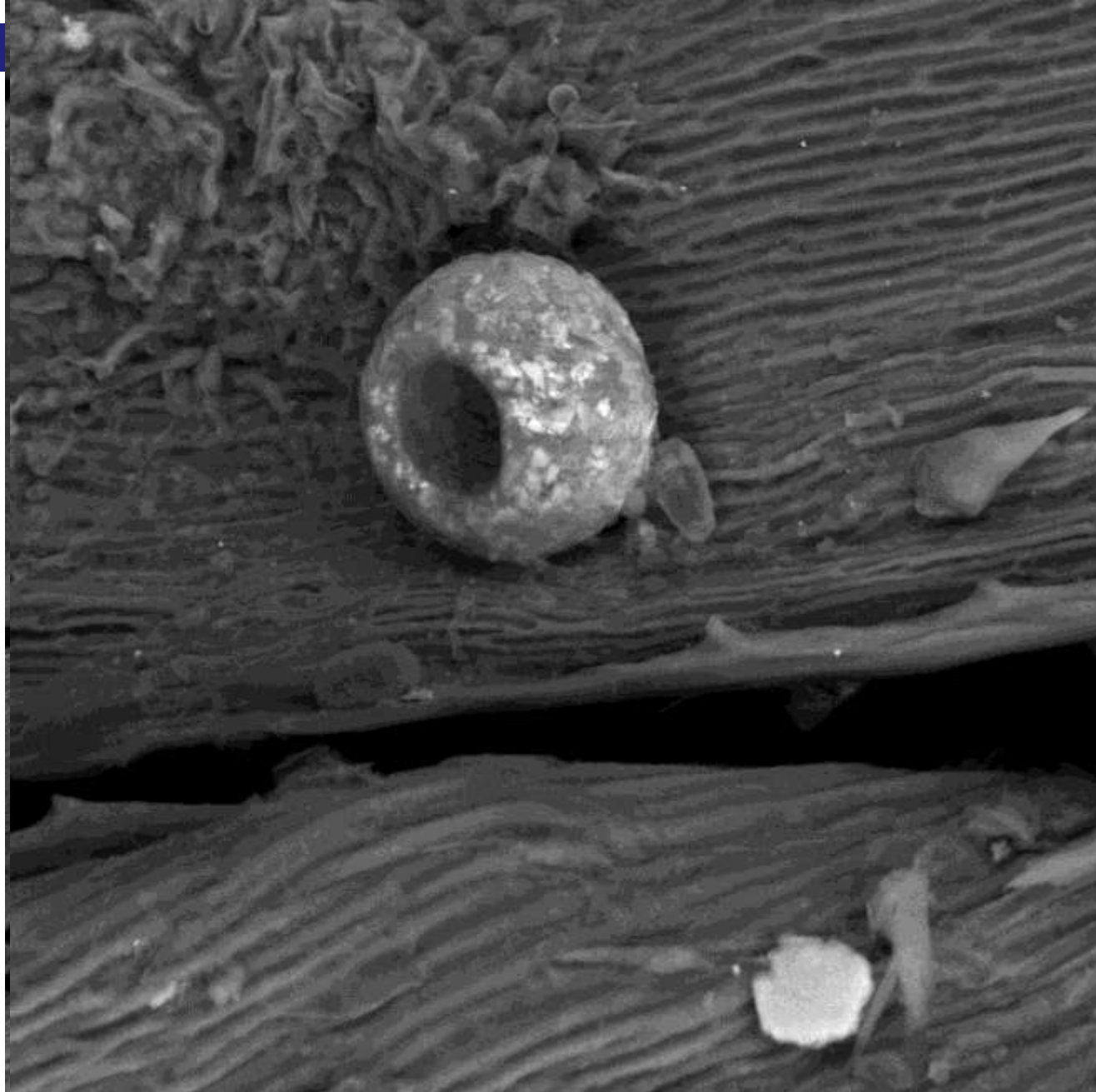


50 μ m

VEGA\\ TESCAN

GO "Borok" IPE RAS





SEM HV: 20.00 kV
View field: 194.6 μm
Date(m/d/y): 10/06/15

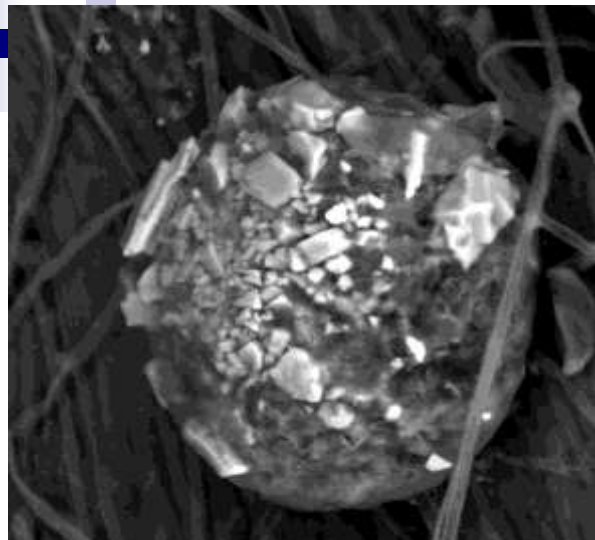
SEM MAG: 1.70 kx
Tselmovich V.A.
Det: BSE Detector



VEGA\\ TESCAN

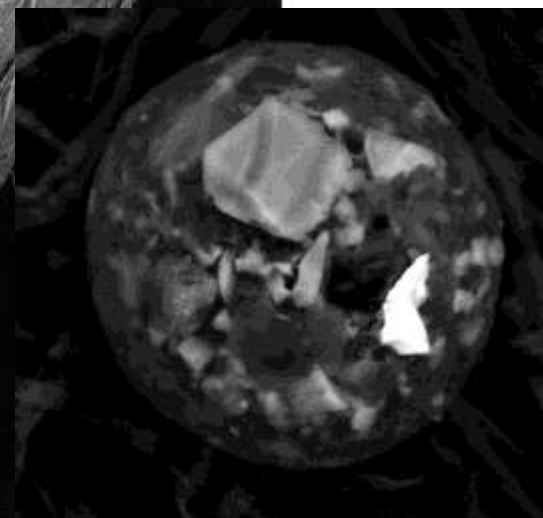
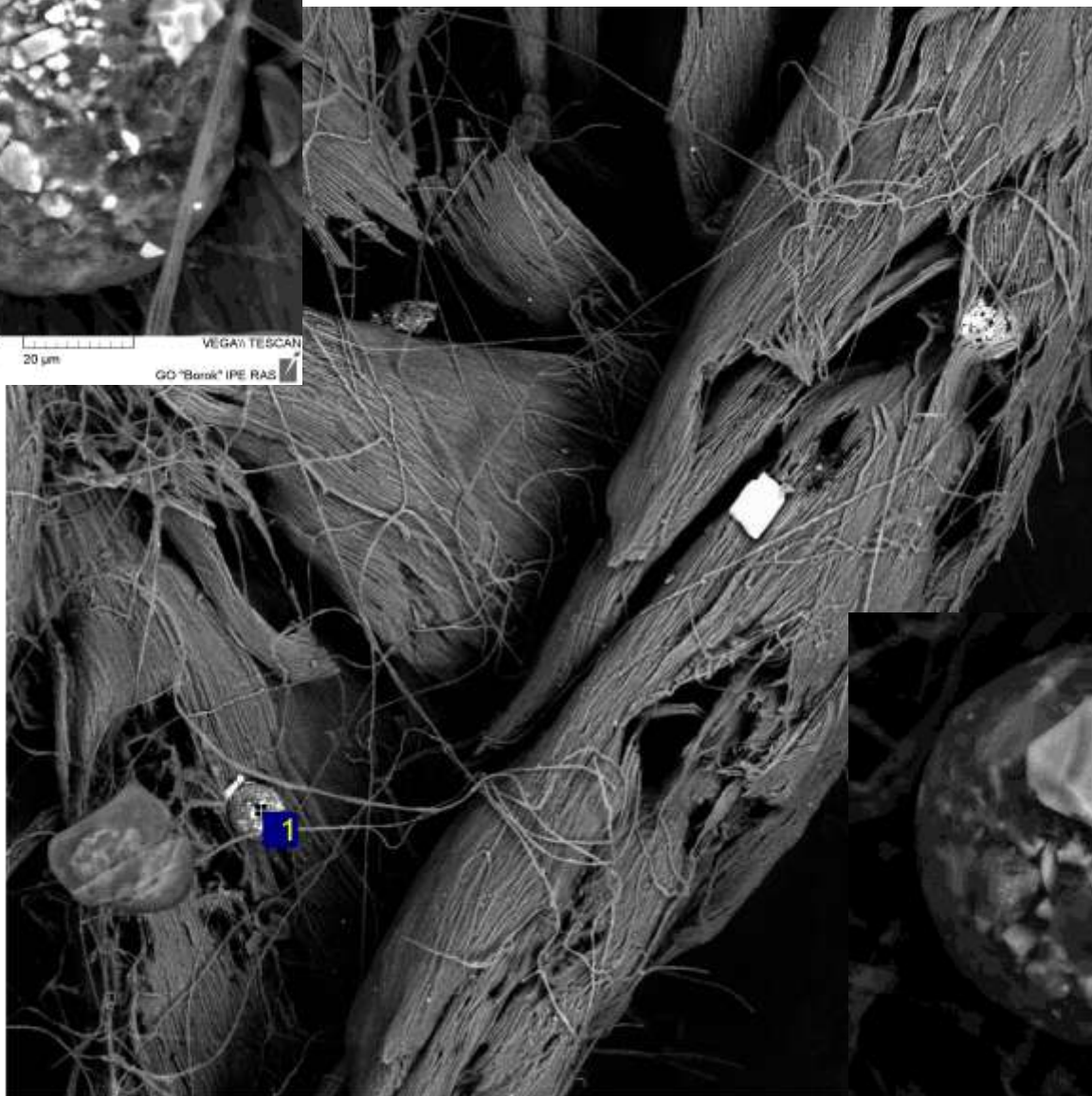
GO "Borok" IPE RAS





SEM HV: 20.00 kV SEM MAG: 3.26 kx
View field: 101.5 µm Tselmovich V.A.
Date(m/d/y): 09/28/15 Det: BSE Detector

VEGA1 TESCAN
20 µm
GO "Barok" IPE RAS



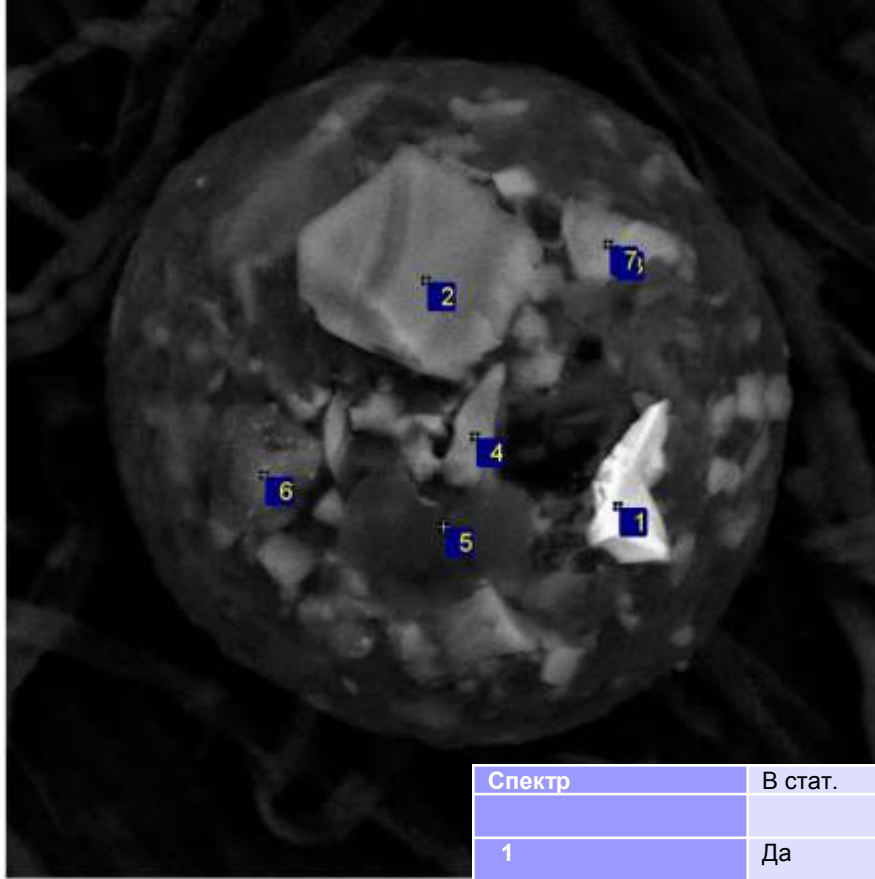
SEM HV: 20.00 kV SEM MAG: 5.04 kx
View field: 65.57 µm Tselmovich V.A.
Date(m/d/y): 09/28/15 Det: BSE Detector

VEGA1 TESCAN
20 µm
GO "Barok" IPE RAS

No. 411

**Testate amoebae (TA),
Centropyxis aerophila and
*Phryganella acropodial***

Раковинные амебы



Спектр	В стат.	O	Al	Si	K	Fe	Итог	
1	Да	15.72	0.00	0.00	0.00	84.28	100.00	
2	Да	56.28	0.00	43.72	0.00	0.00	100.00	
3	Да	54.78	10.01	24.32	10.90	0.00	100.00	
4	Да	53.88	0.00	46.12	0.00	0.00	100.00	
5	Да	79.29	0.00	20.71	0.00	0.00	100.00	
6	Да	65.93	10.96	23.11	0.00	0.00	100.00	
7	Да	55.55	9.80	26.95	7.71	0.00	100.00	
Среднее		54.49	4.40	26.42	2.66	12.04	100.00	
Станд. отклонение		19.38	5.49	15.46	4.63	31.85		
Макс.		79.29	10.96	46.12	10.90	84.28		
Мин.		15.72	0.00	0.00	0.00	0.00		



Training of young specialists and students

JINR-SA School (September 22–October 12, 2008)



Two young specialists (**Ntsoaki Seaga** (NECSA) and **Itumeleng Ramatlhape** (NWU, Mafikeng)) and **Marja Raven** (NECSA) were trained in the Sector of NAA during the School 2008

JINR-SA School (September 22–October 12, 2011)



January 12-14 , 2015

**Zlatko Pancevski and
Lamber Barandovski:**
PhD defenses

**Skopje University,
Macedonia**





Perspectives



**To extend the field of NAA application
in bilateral and international projects**

**To implement gamma spectrometry in
radioecology (natural and man-made
radioactivity)**

Dream Team



CONTACT DETAIL

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Division of Nuclear Physics
Frank Laboratory of Neutron Physics
Joint Institute for Nuclear Research
141980 Dubna, Moscow Region
Russian Federation

Tel: +7 (49621) 65609

E-mail: mfrontasyeva@jinr.ru

(<http://flnp.jinr/naa/>)



International Cooperative Programme on Effects of Air Pollution on Natural Vegetation and Crops

<http://icpvegetation.ceh.ac.uk/>

http://icpvegetation.ceh.ac.uk/publications/documents/Finalmossreportwithmaps_110708_proofedits_180708_highquality.pdf

http://icpvegetation.ceh.ac.uk/research/heavy_metals.html

Moss survey protocol

http://icpvegetation.ceh.ac.uk/manuals/moss_survey.html

Presentations by Marina V. Frontasyeva:

<http://icpvegetation.ceh.ac.uk/events/documents/Frontasyeva.pdf>

http://icpvegetation.ceh.ac.uk/events/documents/Frontasyeva_000.pdf